वार्षिक प्रतिवेदन

ANNUAL REPORT

2016-2017

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सीएसआईआर-केन्द्रीय भवन अनुसंधान संस्थान, रूड़की
CSIR-Central Building Research Institute, Roorkee

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सीएसआईआर-केन्द्रीय भवन अनुसंधान संस्थान, रुड़की - 247 667 (भारत)

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निदेशक की कलम से

सीएसआईआर–केंद्रीय भवन अनुसंधान संस्थान, रूड़की का वर्ष 2016–2017 का वार्षिक प्रतिवेदन प्रस्तुत करना मेरे लिए अत्यन्त हर्ष की बात है। रिपोर्ट में वर्ष के दौरान संस्थान द्वारा की गई प्रगति के मुख्य बिंदुओं को दर्शाया गया है। संस्थान को देश सेवा में निर्माण विज्ञान एवं प्रौद्योगिकी के विकास, उत्पादन एवं संचार का महत्वपूर्ण उत्तरदायित्व सौंपा गया है। इस दिशा में पूर्ण निष्ठा से कार्यरत हो, संस्थान भवन एवं निर्माण उद्योगों के हित में वैज्ञानिक अनुसंधान और विकास, प्रौद्योगिकी विकास एवं प्रसार, सामाजिक गतिविधियों, मानव संसाधन विकास और भवन अनुसंधान के क्षेत्र में राष्ट्र निर्माण योजनाओं का विकास कर राष्ट्र की सेवा में अपना बहुमूल्य योगदान प्रदान कर रहा है।

आरम्भ से ही सीएसआईआर–सीबीआरआई ने भवन एवं आवास के सभी पहलुओं पर अनुसंधान एवं विकास करने तथा मितव्ययिता, सुखदता, कार्यात्मक दक्षता, गति, निर्माण में उत्पादकता, पर्यावरण परिरक्षण एवं ऊर्जा संरक्षण को ध्यान में रखते हुए भवन नियोजन, अभिकल्पन, नींव, सामग्रियॉं एवं सभी प्रकार के भवनों में आपदा न्यूनीकरण सहित निर्माण संबंधी समस्याओं का समाधान खोजने में भवन उद्योग की सहायता करने पर बल दिया है। संस्थान ने अपने एकल लक्ष्य ''भवन सामग्रियों, निर्माण प्रौद्योगिकी, स्वास्थ्य प्रबोधन, अग्नि इंजीनियरी एवं आपदा न्यूनीकरण सहित भवन/आवास नियोजन एवं निर्माण के लगभग सभी क्षेत्रों में समाधान उपलब्ध कराने हेतु विश्वस्तरीय ज्ञान आधार के रूप में कार्य करना'' को प्राप्त करने की दिशा में कार्य किया है।

इस अवधि में संस्थान ने दो महत्वपूर्ण परियोजनाओं पर कार्य किया है – एक सुप्रा संस्थागत नेटवर्क परियोजना (SINP) जो संस्थान की प्रमुख समर्थता के क्षेत्र से संबंधित है तथा दूसरी नेटवर्क परियोजना के समन्वय से संबधित है, जिसमें बहुत सी सहयोगी प्रयोगशालाओं ने प्रतिभागिता की है।

lçk lLFkkxr uVodl ifj;kstuk ¼SINP½ के अंतर्गत विभिन्न वर्क पैकेजों के माध्यम से **^uDLV tuj'ku xhu fcfYMx l gr uohu lkexh ,o çk|kfxfd;k** ¼INMATE½* पर कार्य प्रगति पर है। **^uuk çk|kfxdh d ek/;e l lkexh d fu"iknu e of)*** वर्क पैकेज के अंतर्गत नैनो–इंजीनिर्यड कंक्रीट में C-S-H मात्राकरण एवं विश्लेषण पर अध्ययन, नैनो प्रौद्योगिकी के उपयोग से बहु–कार्यात्मक लेपों का विकास तथा गारे में फेज चेंज सामग्री के समाविष्ट माइक्रोएन्काप्सुलेशन के तापीय चालकता की जांच पर अध्ययन किए गए। **^l?kkj.kh; fuek.k d fy, uDLV tuj'ku dØhV***, के वर्क पैकेज में, प्लास्टिक ऑप्टिकल फाइबर प्रबलित पारभासी कंक्रीट तथा सेल्फ हीलिंग सामग्री के रूप में जैव कंक्रीट के व्यवहार पर अध्ययन का कार्य किया गया। **^xhu fcfYMx l çk|kfxdh*** के वर्क पैकेज के अंतर्गत, कार्यालयों के भवनों के लिए ग्रीन रेट्रोफिट नीतियों पर अध्ययन, शीत जलवायु क्षेत्र के लिए सोलर विंडो सिस्टम का विकास, सतत निर्माण उत्पादों के लिए कच्चे माल के रूप में विध्वंस अपशिष्टों का उपयोग, सोलर थर्मल एयर कंडीशनर, विभिन्न भू–जलवायु क्षेत्रों हेतु शहरी क्षेत्रों में जन आवासों के लिए प्रौद्योगिकी पैकेज, स्वचालित खोखले जिप्सम पैनल बनाने की मशीन तथा नयी संरचनाओं के लिए दीमक रोधी प्रतिबंध का निर्माण से संबंधित कार्य किए गए। **^tkf[ke U;uhdj.k gr lkefx;k ,o çk|kfxfd;k***, वर्क पैकेज में, प्रबलित कंक्रीट संरचनाओं के लिए स्वदेशी कैथेडिक संरक्षण प्रणाली पर अध्ययन, अग्नि सुरक्षित पॉलिमेरिक कम्पोजिट पैनल का विकास, संघात प्रतिरोधी आरसी बीम हेतु एक प्रदर्शन आधारित डिज़ाइन विधि तथा निर्मित पर्यावरण हेतु उन्नत संवातन प्रणाली पर कार्य किए गए।

विभिन्न वर्क पैकेजों के माध्यम से **^ljf{kr ,o LekV fufer i;koj.k d fy, vkink U;uhdj.k ,o LokLF; fuxjkuh vfHk;kf=dh** ¼EDMISSIBLE½*, पर नेटवर्क परियोजना पर कार्य जारी रहा। **^HkkL[kyu vkink U;uhdj.k vfHk;kf=dh*** के अंतर्गत कई सहयोगी प्रयोगशालाओं ने प्रतिभागिता की। विभिन्न प्रतिभागी प्रयोगशालाओं द्वारा की गई गतिविधियों में चमोली–जोशीमठ

क्षेत्र गढ़वाल हिमालय का भूस्खलन जोखिम मूल्यांकन पैकेज (सीएसआईआर–सीबीआरआई), चमोली–जोशीमठ क्षेत्र गढ़वाल हिमालय में जोखिम निर्धारण हेतु पूर्व चेतावनी उपकरण एवं निर्णय पैकेज (सीएसआईआर–सीबीआरआई), चमोली–जोशीमठ क्षेत्र, गढ़वाल हिमालय में जोखिम निर्धारण हेतु जीपीएस आधारित समन्वित भूकम्प प्रतिरूपण (सीएसआईआर–4 पीआई), एस ए आर इंटरफेरोमीटरी के उपयोग से भूस्खलन निगरानी (सीएसआईआर–सीएसआईओ), भूस्खलन निगरानी के लिए आप्टिकल फाइबर आधारित मल्टीप्लेक्स सेंसर नेटवर्क सिस्टम का विकास (सीएसआईआर–एनईआईएसटी), चमोली–जोशीमठ क्षेत्र गढ़वाल हिमालय में वृहत भू–अन्वेषण तथा भूस्खलन के नियंत्रण उपाय (सीएसआइआर–सीबीआरआई), भूस्खलन आपदा सूचना प्रणाली तथा भूस्खलन नियंत्रण अभिकल्प के अभिनव उपाय (सीएसआईआर–सीआरआरआई) एवं पहाड़ी क्षेत्रों में भूस्खलन न्यूनीकरण तथा ढलान स्थिरता समस्याओं के लिए फायटोरेमीडिएश्न ऑप्शन (सीएसआइआर–नीरी) द्वारा प्रतिभागिता की गई।

^HkkdEi vkink U;wuhdj.k vfHk;kf=dh* के वर्क पैकेज में श्रीनगर, उत्तराखण्ड के भूकंपीय सूक्ष्म अनुक्षेत्र पर अध्ययन, गतिक पार्श्वभारण के अंतर्गत पाइलों का भूकंपीय व्यवहार तथा अर्थ–स्थैतिक अवस्था में परिरूद्ध चिनाई भवनों का प्रदर्शन पर कार्य किया गया। इस वर्क पैकेज में, **^bathfu;fjax v,Q Qk;j fMtkLVj fefVx'ku***, डवलपमेंट ऑफ लो ओजोन डिप्लेशन पोटेंशियल (0.01 – 0.5) इन्नोवेटिव फायर सप्रेसन सिस्टम का कार्य चल रहा है। **^vkink i'pkr vkJ; ifj;kstuk*** के वर्क पैकेज के अंतर्गत पश्चिमी हिमालय क्षेत्र के ग्रामीण क्षेत्रों में आपदा पश्चात आश्रय परियोजना हेतु कार्य प्रगति पर है। **^Hkouka dk LokLF; fuxjkuh gsrq ok;jysl lsalj uVodZ***, वर्क पैकेज में, इस्पात और प्रबलित कंक्रीट भवनों के लिए वायरलेस सेंसर नेटवर्क का उपयोग करते हुए स्वास्थ्य निगरानी के दृष्टिकोण का विकास और मान्यकरण तथा **^baVsyhtsaV fcfYMax Q,jh e,My jftMsfl;y ;fuV***, के वर्क पैकेज में इंटेलीजेंट बिल्डिंग फीचर्स को एकीकृत करती आवासीय इकाई के वास्तुशिल्प नियोजन और डिजाइन पर अध्ययन, आस–पास के पर्यावरण की अनुक्रिया में इन्टेलिजेंट HVAC एंड लाइटिंग कंट्रोल एवं ग्लास फेकेड क्लीनिंग रोबोट सिस्टम पर अध्ययन का कार्य किया।

^uVodZ ifj;kstuk^ जिसमें, सीएसआईआर–सीबीआरआई एक सहभागी प्रयोगशाला है, उड़न राख का उपयोग करके पानी से भारी धातुओं को हटाना तथा इसे उपयोगी भवन घटकों के निर्माण में उपयोग करना (नोडल प्रयोगशाला सीएसआईआर–नीरी), गढ़वाल हिमालय की भूपृष्ठीय विकृति का अध्ययन गढ़वाल के पहाड़ी क्षेत्रों के लिए किया जा रहा है (नोडल प्रयोगशाला सीएसआईआर–4पीआई), भूमिगत कोयला खानों का विश्लेषण तथा कोयले के खम्बों को सुदृढ़ करने के लिए नीतियों पर कार्य किया जा रहा है (नोडल प्रयोगशाला सीएसआईआर–सिंफर), अच्छी गुणवत्ता वाले बीजों की बरबादी व खराब होने से बचाने के लिए नियंत्रित पर्यावरण के साथ ऊर्जा दक्ष बीज भंडारण भवन को विकसित करने का कार्य भी किया जा रहा है (नोडल प्रयोगशाला सीएसआईआर–सीएसआईओ), सिविल संरचनाओं के अनुरक्षण एवं सूक्ष्म निरीक्षण की दृष्टि से भवनों एवं अन्य संरचनाओं हेतु सर्विस रोबोट परियोजना एक बहुत ही उपयोगी परियोजना है (नोडल प्रयोगशाला सीएसआईआर–सीएमईआरआई) पर भी कार्य किया जा रहा है।

वर्ष के दौरान संस्थान ने **^lh,lvkbZvkj&QkLV&VSd Vkalys'ku ¼FTT½^** परियोजना के कार्य को आरम्भ किया जिसमें कोटा स्टोन कटिंग तथा सलरी वेस्ट के उपयोग से निर्माण उत्पादों का विकास, हल्की संरचनाओं के लिए नींव प्रणाली तथा ट्रेंचलेस प्रौद्योगिकी पर आधारित बोरिंग मशीन का विकास किया गया। सीएसआईआर के फास्ट ट्रैक ट्रांसलेशन परियोजना का उद्देश्य बहुत ही लघु अवधि मे समाज को उत्पाद प्रदान करके तत्काल लाभ प्रदान करना है।

सीएसआईआर–सीबीआरआई को **^,u baVhxzsfVM ,.M dksykcksjsfVo bafM;k&;w,l fjlpZ çksxzke ½ bEçqfoax fcfYMax ,uthZ ,fQfl,alh Ý,e bafMk&;w,l ,l ,.M Vh Qksje ¼IUSSTF½^** शीर्षक पर ज्वाइंट क्लीन एनर्जी आर एंड डी सेंटर ग्रांट–इन–एड परियोजना पर **^juj&vi*** पुरस्कार प्राप्त हुआ। सीएसआईआर–सीबीआरआई ने पिछले वर्षों में इन हाऊस अनुसंधान एवं विकास कार्यक्रमों तथा बहुत से अन्य संविदा अनुसंधान परियोजनाओं को संधारणीयता के सभी पहलुओं पर अपेक्षित विचार करते हुए पूरा किया है। प्रबलित संरचनाओं के कार्बोनेशन, स्थैतिक तथा भूकंपीय स्थिति में शैलो स्ट्रिप एंकरों की क्षमता को बढ़ाना, भवनों में उष्मा हस्तांतरण के क्षेत्र में हस्त पुस्तिका तैयार करना, औद्योगिक एवं कृषि अपशिष्टों के उपयोग से इंजीनियरीकृत हल्के गारे–फूस सम्मिश्र का विकास तथा सामान्य तथा जियोसिंथेटिक युक्त पत्थर कॉलम उन्नत नरम मृदा के कठोरीकरण तथा विरूपण विशेषताओं पर अध्ययन किए गए। संस्थान ने इस अवधि में 7 इन–हाऊस अनुसंधान एवं विकास परियोजनाएं, 25 परामर्शी परियोजनाएं, 9 ग्रांट इन एड, 35 प्रायोजित तथा 76 परीक्षण परियोजनाओं पर कार्य किया।

संस्थान ^**Hkou vfHk;kf=dh ,o vkink U;wuhdj.k** ¼BEDM½^ के क्षेत्र में समन्वित स्नातकोत्तर–पीएचडी कार्यक्रम चला रहा है। कार्यक्रम के छठे बैच के विद्यार्थी शोध प्रबंध तैयार कर रहे हैं। अगस्त 2016 में पीएचडी के लिए अभियांत्रिकी विज्ञान में 04 तथा भौतिक विज्ञान में दो छात्रों को सम्मिलित किया गया। वर्तमान में कुल 17 पीएचडी विद्यार्थी एसीएसआईआर, सीएसआईआर–सीबीआरआई में नामांकित हैं। सीएसआईआर–सीबीआरआई के दो वैज्ञानिकों ने आईआईटी, रूड़की तथा एसीएसआईआर में वास्तुकला और नियोजन तथा भू–तकनीकी इंजीनियरी पर अपने शोध प्रबंधों के लिए पीएचडी उपाधि प्राप्त की ।

संस्थान में वर्ष 2016–17 के दौरान करार अनुसंधान एवं विकास, अनुदान सहायता, परामर्शी परियोजनाओं तथा तकनीकी सेवाओं के लिए सरकारी, सार्वजनिक तथा निजी क्षेत्र की एजेंसियों/संगठनों से लगभग 11.28 करोड़ रूपए बाह्य नकदी प्रवाह प्राप्त किया गया। यह धनराशि सीएसआईआर–सीबीआरआई के कुल बजट का 21.125 प्रतिशत है। इस अवधि के दौरान विभिन्न जर्नलों के साथ–साथ सम्मेलनों की कार्यवाहियों में कुल 97 शोध लेख प्रकाशित किए गए।

संस्थान में राष्ट्रीय प्रौद्योगिकी दिवस, विश्व पर्यावरण दिवस तथा सीएसआईआर–सीबीआरआई स्थापना दिवस के दौरान छात्रों तथा आम जनता को संस्थान के अनुसंधान एवं विकास गतिविधियों के बारे में जानकारी देने के लिए ओपन डे के रूप में मनाया गया। सीएसआईआर–केन्द्रीय भवन अनुसंधान संस्थान, रूड़की ने 29 सितंबर, 2016 को सीएसआईआर का प्लैटिनम जुबली स्थापना दिवस बड़े ही उत्साह एवं घूमधाम से मनाया। संस्थान को आम जनता के लिए खुला रखने के अलावा इन अवसरों पर विभिन्न कार्यक्रमों, स्थापना दिवस व्याख्यानों, विभिन्न राष्ट्रीय दिवसों पर इन राष्ट्रीय दिवसों के महत्व की जन सामान्य को जानकारी देने के उद्देश्य से प्रतिष्ठित एवं गणमान्य व्यक्तियों के व्याख्यान कराए गए।

संस्थान ने ‘**QdYVh Vfux] e,fVo’ku ,M ,MkI’ku v,Q LdYl ,M d,fyft t ck; lh,lvkbvkj yCl*** की सीएसआईआर योजना के अंतर्गत अध्यापकों तथा छात्रों के लिए विज्ञान शिक्षा को रोजगारपरक, स्कूलों तथा अंडर ग्रेज्युएट कॉलेजों में वैज्ञानिक शिक्षा का स्तर ऊपर उठाने तथा युवाओं में विज्ञान को लोकप्रिय बनाने के उद्देश्य से विभिन्न प्रेरणापरक, जागरूकता तथा शैक्षणिक कार्यक्रम आयोजित किए।

संस्थान में 21 जून, 2016 को अंतरराष्ट्रीय योग दिवस मनाया गया जिसमें सतत विकास लक्ष्यों को प्राप्त करने में स्वस्थ जीवन शैली के महत्वपूर्ण योगदान के बारे में जानकारी दी गई। संस्थान में सभी धर्मों, भाषाओं, राज्यों तथा प्रत्येक नागरिक के बीच सदभाव तथा सौहार्द को बढ़ावा देने के लिए सदभावना दिवस मनाया गया। संस्थान में बड़े उत्साह और जोश के साथ हिन्दी सप्ताह का आयोजन भी किया गया। सतर्कता जागरूकता सप्ताह के दौरान विभिन्न कार्यक्रमों का आयोजन किया गया जिसमें कर्मचारियों, छात्रों तथा जनमानस में एकता एवं अखंडता को बढ़ावा देने तथा भ्रष्टाचार उन्मूलन में आम जनता की भागेदारी की आवश्यकताओं के बारे में बताया गया।

सीएसआईआर–केन्द्रीय भवन अनुसंधान संस्थान रूड़की को 14–27 नवंबर, 2016 के दौरान प्रगति मैदान, नई दिल्ली में आयोजित इंडिया इंटरनेशनल ट्रेड फेयर 2016 में इंजीनियरी तथा आधारिक संरचना पवेलियन का समन्वयक बनने का अवसर प्राप्त हुआ तथा संस्थान ने इसमें सक्रियता से प्रतिभागिता एवं प्रदर्शन किया। ‘**bt hfu;jh rFkk bUÝkLVDpj**’ थीम, जिसमें सीएसआईआर–सीबीआरआई ने थीम कोर्डिनेटर के रूप में भाग लिया तथा सीएसआईआर–पवेलियन में ‘**xkYM**’ मैडल प्राप्त हुआ। IITF में समग्र रूप से ‘**lyfVue eMy**’ अपने आप में सीएसआईआर की एक उपलब्धि है। संस्थान ने 7 से 11 दिसम्बर, 2016 के दौरान राष्ट्रीय भौतिकी प्रयोगशाला, नई दिल्ली में आयोजित द्वितीय भारतीय अंतर्राष्ट्रीय विज्ञान मेले में भी प्रतिभागिता की तथा इस मेले में अपनी चार प्रौद्योगिकियों : सी–ब्रिक मशीन, लिक्विड फायर एक्सटिंगुशर, स्ट्रक्चरल हैल्थ मॉनीटरिंग सिस्टम तथा फ्लोर क्लीनिंग रोबोट का प्रदर्शन किया। इस मेले के विषय में आम जनता को जानकारी देने के लिए सरस्थान में 2 नवंबर, 2016 को प्रेस मीट का आयोजन किया गया। IISF कार्यक्रम की प्रस्तावना के रूप में संस्थान में 3 नवंबर, 2016 को विज्ञान मेला, ओपन डे, तथा तकनीकी प्रदर्शनी का आयोजन किया गया, जिसमें छात्र, अध्यापकगण, आम जनता तथा उपयोग कर्ता एजेंसिया सम्मिलित हुई। IISF में सस्थान के दो वैज्ञानिकों ने सर्वश्रेष्ठ प्रस्तुतिकरण तथा सर्वश्रेष्ठ पोस्टर प्रतियोगिता का पुरस्कार प्राप्त किया तथा माननीय मंत्री, विज्ञान तथा प्रौद्योगिकी से पुरस्कार प्राप्त किए। संस्थान ने 6–8 मार्च, 2017 के दौरान चंडीगढ़ में आयोजित डेस्टीनेशन नॉर्थ–ईस्ट में भी प्रतिभागिता की तथा सीएसआईआर–800 कार्यक्रम के अंतर्गत अनुसंधान एवं विकास गतिविधियों पर आधारित विकसित उत्पादों का प्रदर्शन किया।

डॉ. गिरीश साहनी, महानिदेशक, वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद तथा सचिव, विज्ञान एवं प्रौद्योगिकी अनुसंधान विभाग ने 10 जनवरी, 2017 को सीएसआईआर–केन्द्रीय भवन अनुसंधान संस्थान, रूड़की की अनुसंधान एवं विकास गतिविधियों की समीक्षा की तथा माननीय प्रधानमंत्री के आह्वान पर चलाए गए 'मेक इन इंडिया' अभियान में अपने ज्ञान आधार के माध्यम से सहयोग प्रदान करने का आह्वान किया और वैज्ञानिक, सहकर्मियो तथा छात्रों का उत्साहवर्धन किया।

देश–विदेश के लोगों के साथ निरंतर संवाद एवं संचार बनाए रखने के क्रम में संस्थान ने बड़ी संख्या में भवन एवं निर्माण क्षेत्र की विभिन्न समस्याओं संबंधी पूछताछ के उत्तर दिए। कर्मचारियों, विद्यार्थियों, आम जनता तथा समाज को बड़ी मात्रा में उत्साहित करने के लिए विभिन्न कार्यक्रम आयोजित किए गए और भ्रष्टाचार से लड़ने में प्रौद्योगिकी का उपयोग किस प्रकार किया जा सकता है, पर मंथन, भवन निर्माण के क्षेत्र में, नए अनुसंधान एवं प्रौद्योगिकियों के विषय में आम जनता के बीच जागरूकता पैदा करने के उद्देश्य से प्रदर्शन एवं प्रशिक्षण कार्यक्रमों, तकनीकी प्रदर्शनियों आदि का आयोजन किया।

इस वर्ष त्रैमासिक द्विभाषी **‘lhchvkjvkbl U;tyVj&Hkofudk’** सहित सरलता से कार्यान्वित करने हेतु चित्रित और डिजाइन उदाहरणों पर एक पुस्तक, **‘dQkf;M eluj’** सीएसआईआर–सीबीआरआई के **‘iVV’** और **‘fjlp ,M fctul çkQkby’** पर दो सारांश, ‘**fyfDoM ,DlVhUxb’kV Qk;j ,DlVhUxb’kj Q,j d,eu eul Qk;j l¶Vh**’, ‘**uuk&bthfu;M dØhV**’ और ‘**fcfYMx dLVD’ku e’khuj**’ पर तकनीकी ब्रोशर्स तथा ‘**lhchvkjvkbl&,d >yd**’ और ‘**lhchvkjvkbl&,V , Xykl**’ दो द्विभाषी संस्थान ब्रोशर का प्रकाशन एवं विमोचन भी किया गया।

संस्थान ने दिल्ली स्थित अपने प्रसार केन्द्र के साथ मिलकर केंद्रीय, राज्य, सार्वजनिक/निजी क्षेत्रों के संगठनों के साथ सम्पर्क बनाए रखा। यद्यपि यह वर्ष हमारे लिए चुनौतियों तथा उपलब्धियों से भरा रहा, हम अपनी उपलब्धियों से आत्मसंतुष्ट नहीं हैं तथा हम भविष्य में आने वाली चुनौतियों एवं जिम्मेदारियों का सामना करने के लिए तत्पर हैं।

सीएसआईआर–सीबीआरआई की वार्षिक रिपोर्ट हमारे वैज्ञानिक अनुसंधानों तथा संबंधित उपलब्धियों को दर्शाती है। इस रिपोर्ट में दर्शाया गया उच्च गुणवत्ता वाले कार्य का श्रेय, साथी वैज्ञानिकों, तकनीकी अधिकारियों तथा प्रशासनिक कार्मिकों के कर्तव्यनिष्ठा एवं लग्नशील प्रयासों को जाता है, जिन्होंने अपने कार्य को सफलतापूर्वक करने के लिए कठिन परिश्रम किया है। मैं उन सभी की हार्दिक प्रशंसा करते हुए उन्हें शुभकामनाएं देता हूँ। हमारी अनुसंधान परिषद के अध्यक्ष और सदस्यगण अपने अमूल्य परामर्श, मार्गदर्शन एवं सहायता के लिए विशेष धन्यवाद के पात्र हैं। मैं सीएसआईआर के महानिदेशक तथा सीएसआईआर मुख्यालय के अपने साथियों को, उनके निरंतर सहयोग एवं मार्गदर्शन के लिए सदभावपूर्वक धन्यवाद देता हूँ। मैं अपने सभी साथियों का उनके सहयोग के लिए आभार व्यक्त करता हूँ, जिन्होंने मुझे मेरे दायित्वों को निभाने में मेरी मदद की है। मैं संस्थान के पूर्व निदेशकों प्रो. एस के भट्टाचार्य, डॉ. गिरीश साहनी, श्री यादवेन्द्र पांडेय एवं प्रो. सतीश चन्द्रा का संस्थान को दिए गए बहुमूल्य योगदान का हृदय से आभार व्यक्त करता हूँ।

संस्थान में इस वर्ष नियुक्त हुए नवागन्तुक युवा वैज्ञानिकों का स्वागत करते हुए मुझे अत्यन्त हर्ष हो रहा है। इस नए परिवार को साथ लेकर हम राष्ट्र एवं मानव सेवा में नए उत्साह के साथ सदैव कार्य करते रहेंगे। इस वार्षिक प्रतिवेदन के लिए आवश्यक सूचना उपलब्ध कराने वाले सहकर्मियों को मैं धन्यवाद देता हूँ। साथ ही, इस वार्षिक प्रतिवेदन की उत्तम एवं रिकार्ड समय में प्रस्तुति के लिए, मैं सम्पादक को हार्दिक धन्यवाद देता हूँ। अंत में, अपने मूल्यवान ग्राहकों, प्रायोजकों, शुभ चिंतको तथा सीएसआईआर–सीबीआरआई के सेवानिवृत्त कार्मिकों के सहयोग तथा सहायता का स्मरण करना मेरे लिए प्रसन्नतादायक पल है।

भवन निर्माण एवं अवसरंचनात्मक उद्योग में वृद्धि के साथ हम उज्ज्वल भविष्य की ओर अग्रसर हैं।

दिनांक: जून 9, 2017

ना. गोपालकृष्णन्

(डॉ. एन गोपालकृष्णन)

From the Director's Desk

It gives me immense pleasure to present the Annual Report of CSIR-Central Building Research Institute, Roorkee for the year 2016-2017. The report highlights the progress made by the Institute during the year. The Institute has been vested with the responsibility of generating, cultivating and promoting building science and technology in the services of the country and has contributed immensely in scientific research and development, technology development, technology dissemination, social activities, human resource development and national planning for building research in order to sustain the building and construction industries.

Since its inception, CSIR-CBRI has laid emphasis on carrying out R&D on all aspects of building and housing and assist the building industry in solving problems of planning, designing, foundations, materials and construction including disaster mitigation in all kinds of buildings with a view to achieve economy, comfort, functional efficiency, speed, productivity in construction, environment preservation and energy conservation. The Institute has worked to attain a single objective, "To work as world class knowledge base for providing solutions to almost all area of Building / Habitat planning and construction including building materials, construction technology, health monitoring, fire engineering and disaster mitigation."

During this period, the Institute pursued two important projects- One Supra Institutional Network Project (SINP) in core competency area of the institute and the other as Network project being coordinated by the Institute and being participated by number of other sister laboratories.

A **Supra Institutional Network Project (SINP)** on **'Innovative Materials and Technologies for Next Generation Green Buildings (INMATE)**' was continued through different work packages. In work package, '**Performance Enhancement of Materials through Nanotechnology**', studies on quantification and characterization of C-S-H in nano-engineered concrete, development of multifunctional coatings using nanotechnology, and investigation of thermal conductivity of incorporated microencapsulation of phase change materials into mortar were carried out. In work package, '**Next Generation Concrete for Sustainable Construction'**, studies on plastic optical fiber reinforced translucent concrete and bio concrete as self-healing material were carried out. Under the work package, '**Green Building Technologies'**, studies on green retrofit strategies for office buildings, development of solar window system for cold climatic region, demolition wastes as raw materials for sustainable construction products, solar thermal air conditioner, technology packages for mass housing in urban areas, development of an automatic hollow gypsum panel making machine, and development of anti-termite barrier for new buildings were carried out. In work package, '**Materials and Technologies for Hazard Reduction',** studies on development of indigenous cathodic protection system for RC structures, development of fire safe polymeric composite panels, a performance based design method for impact resistant RC beams and improved ventilation system for cleaner built environment have been carried out.

Network Project on **'Engineering of Disaster Mitigation and Health Monitoring for Safe and Smart Built Environment (EDMISSIBLE)'** was continued through different work packages. Under **'Engineering of Landslide Disaster Mitigation'**, different sister laboratories are participating. The activities taken up by different participating laboratories include landslide hazard and risk assessment of Chamoli-Joshimath region of Garhwal Himalayas (CSIR-CBRI), early warning instrumentation and decision package for a landslide in Chamoli-Joshimath region of Garhwal Himalayas (CSIR-CBRI), GPS based integrated landslide modelling for hazard assessment in Chamoli-Joshimath region of Garhwal Himalaya (CSIR-4PI), landslide monitoring using SAR interferometry (CSIR-CSIO), development of optical fibre based multiplex sensor network system for landslide monitoring (CSIR-NEIST), comprehensive geo-investigation and control measures of landslide in Chamoli-Joshimath region of Garhwal Himalaya (CSIR-CBRI), landslide hazard information system and design of innovative measures for landslide control (CSIR-CRRI), and bio-engineering – a phytoremediation option for the mitigation of landslide and slope stability problems in the hilly regions (CSIR-NEERI).

In work package, **'Engineering of Earthquake Disaster Mitigation'**, studies on seismic microzonation of Srinagar, Uttarakhand, seismic behaviour of piles under dynamic lateral loading and performance of confined masonry buildings under quasi-static conditions were continued. In work package, '**Engineering of Fire Disaster Mitigation**', development of low ozone depletion potential (0.01-0.5) innovative fire suppression system is progressing. In work package, '**Post Disaster Shelter Planning',** post disaster shelter planning for rural areas in the Western Himalayan region was continued. In work package, '**Health Monitoring of Buildings using Wireless Sensor Network',** development and validation of heath monitoring approach using wireless sensor network for steel and reinforced concrete buildings is progressing and under work package, '**Intelligent Building System for Model Residential Unit',** studies on architectural planning and design of a residential unit integrating intelligent building features, intelligent HVAC and lighting controls in response to ambient environment, and glass facade cleaning robot were carried out.

In **'Network Projects'** where CSIR-CBRI is a participating laboratory, studies on removal of heavy metals from water using fly ash and its subsequent use in the production of value added building components (Nodal lab CSIR-NEERI), estimation of crustal deformation of Garhwal Himalaya (Nodal lab CSIR-4PI), analysis of underground coal mines and strengthening strategies for coal pillars (Nodal lab CSIR-CIMFR), energy efficient seed storage structures (Nodal lab CSIR-CSIO) and robotic technology for periodic inspections of civil infrastructures (Nodal lab CSIR-CMERI) are also being carried out.

During the year, the Institute has initiated **'CSIR Fast-Track Translation (FTT) Project'** in which development of building products using Kota stone cutting and slurry wastes, foundation system for light structures, and development of a boring machine based on trenchless technology are being carried out. The CSIR's Fast Track Translation Project aims to provide immediate benefit to the society by delivering products in short period by completing the last mile from lab to market.

CSIR-CBRI bagged **'Runners-Up'** award on joint clean energy R&D centre grant-in-aid project entitled **'An Integrated and Collaborative India US Research Programme: Improving Building Energy Efficiency from INDO-US S&T Forum' (IUSSTF).** CSIR-CBRI as in the previous years has handled a number of its own in house R&D programmes and many other contract research projects giving due consideration to all aspects of sustainability. Study of carbonation of reinforced structures, uplift capacity of shallow strip anchors under static and seismic conditions, preparation of hand book in the area of heat transfer in building, development of engineered lightweight mud-phuska composite using industrial-cum-agricultural wastes and studies on consolidation and deformation characteristics of ordinary and geosynthetic encased stone column improved soft soil have been carried out. The Institute has handled 7 in-house R&D projects, 25 consultancy projects, 9 grants-in-aid, 35 sponsored and 76 testing projects.

The Institute is offering Integrated M.Tech.-Ph.D. (IMP) programme in the area of **'Building Engineering and Disaster Mitigation (BEDM)'**. The sixth batch of the programme is currently carrying out their dissertation. Four students have joined for Ph.D. in Engineering Sciences and two students in Physical Sciences in August 2016. Presently total 17 Ph.D. students are enrolled in AcSIR at CSIR-CBRI. Two of the scientists of CSIR-CBRI earned their Ph.D. degree from IIT-Roorkee and AcSIR for their thesis dissertation in Architecture & Planning and Geotechnical Engineering.

The Institute registered an external cash flow of nearly Rs. 11.28 crore during 2016-17, earned through contract R&D, grant-in-aid, consultancy assignments and technical services, carried out for government, public and private sector agencies/organization. This is 21.125 % of the total budget of CSIR-CBRI. During the period, a total of 97 research papers have been published in various journals as well as conference proceedings.

The Institute observed open days on the occasion of National Technology Day, World Environment Day and CSIR-CBRI Foundation Day to make the students and general public aware with the R&D activities of the Institute. The Platinum Jubilee Foundation Day of CSIR was celebrated with great enthusiasm at CSIR-Central Building Research Institute, Roorkee on September 29, 2016. Apart from keeping the Institute open for general awareness, different programmes, foundation day lectures and lectures by eminent personalities on different National days to make people aware of the importance of the National days were also arranged.

The Institute also organized various motivational, awareness and educational programmes for teachers and students under the CSIR Scheme 'Faculty Training, Motivation and Adoption of Schools & Colleges by CSIR Labs' to make science education rewarding in job opportunities, raise the standard of science education in schools and undergraduate colleges and popularize science among young people.

The Institute observed the International Yoga Day on June 21, 2016 highlighting the important role healthy living plays in the realization of the sustainable development goals. The Institute observed Sadbhavna Diwas with a view to promote harmony amongst people of all religion, languages and states and goodwill towards everyone. The Institute also celebrated Hindi Week with great zeal and enthusiasm. During the Vigilance Awareness Week, various programmes were organized to sensitize the employees, students, public and society at large about the necessity of public participation in promoting integrity and eradicating corruption.

CSIR-Central Building Research Institute, Roorkee got an opportunity to become the theme coordinator for Engineering and Infrastructure pavilion in the India International Trade Fair (IITF-2016) organised at Pragati Maidan, New Delhi during November 14-27, 2016 and actively participated and showcased in it. The theme **'Engineering and Infrastructure'** where CSIR-CBRI participated as the theme coordinator lab, bagged the **'Gold'** medal in the CSIR Pavilion. This adds to the achievement of CSIR itself having been bestowed with **'Platinum'** medal in the overall IITF. The Institute also participated in the 2nd India International Science Festival (IISF-2016) at National Physical Laboratory, New Delhi, during December 7-11, 2016 and displayed four of its shortlisted technologies; C-Brick Machine, Liquid Fire Extinguisher, Structural Health Monitoring System, and Floor Cleaning Robot during the event. A press meet was organized on November 2, 2016 to apprise the public about it. As a prelude to the IISF event, a science fest, open day, and technical exhibition were organized on November 3, 2016 for students, teachers, public and user agencies at the Institute. Two young scientists of the Institute bagged the best presentation and best poster publication in IISF and received the prizes from the Hon'ble Minister of Science & Technology. The Institute also participated in the Destination North East 2017 at Chandigarh held during March 6-8, 2017 and displayed the products developed based on the R&D activities under CSIR-800 program.

Our Director General, CSIR and Secretary, DSIR, Govt. of India, Dr. Girish Sahni, visited the Institute on January 10, 2017 and reviewed the R&D activities of CSIR-Central Building Research Institute, Roorkee and encouraged the scientists, staff, and students to respond to the Hon'ble Prime Minister's call of "Make in India" by delivering their vast knowledgebase in the domains of their operation.

To maintain regular interaction and communication with the people of India and abroad, the Institute attended various inquiries pertaining to various problems of Building and Construction sector. Demonstration cum training programmes, technical exhibitions etc. were also organized to create awareness for general public about the new research and technologies in the field of building sector.

We have released several publications including a book giving a comprehensive coverage of **'Confined Masonry'** with easy-to-implement illustrations and worked out design examples, two compendiums on the **'Patents'** and **'Research & Business Profiles'** of CSIR-CBRI, technical brochures on **'Liquid Extinguishant Fire Extinguisher for Common Man's Fire Safety'**, **'Nano-Engineered Concrete'** and **'Building Construction Machineries'**, and two Institute bilingual brochures, **'CBRI Ek Jhalak'** and **'CBRI at a Glance'** apart from quarterly bilingual **'CBRI Newsletter-Bhavnika'**.

The Institute along with its extension centre at New Delhi continued to maintain liaison with Central, State, public/private sectors throughout the country. Though this has been a year of challenges and achievements, we are not complacent with our attainments but are ever keen to meet the forthcoming challenges and responsibilities.

It is an honour to present the scientific research output and related achievements. The volume of high quality work reported goes to the credit of the sincere and honest efforts made by fellow scientists, technical officers and administrative staff who worked hard in successfully completing the works assigned to them. I record my deep appreciation and best wishes to all of them. The Chairman and the Members of our Research Council deserve special thanks for their valuable advice, guidance and support. I extend my sincere thanks to Director General, CSIR and other colleagues from CSIR Headquarters for their continuous support and guidance. I wish to acknowledge with gratitude the unstinted co-operation of my colleagues which has helped me to conduct my duties to the best of my ability. I wish to record my sincere appreciation and gratitude to my immediate predecessors Prof. S.K. Bhattacharyya, Dr. Girish Sahni, Sh. Y. Pandey and Prof. Satish Chandra for their valuable contribution to the Institute.

I am pleased to welcome the young new additions to our Institute. With these young blood infused in the system, we look forward to work with synergy for serving the nation and mankind. I thank my colleagues for providing the necessary inputs. I also thank the editor for bringing out this annual report on time and in an elegant manner. Last but not the least, it is a happy moment for me to remember the support and co-operation provided by our valued customers, sponsors, well-wishers and ex-colleagues of CSIR-CBRI.

With the unprecedented growth in the building and infrastructure industry, we are looking forward to an exciting future.

Dated: June 9, 2017

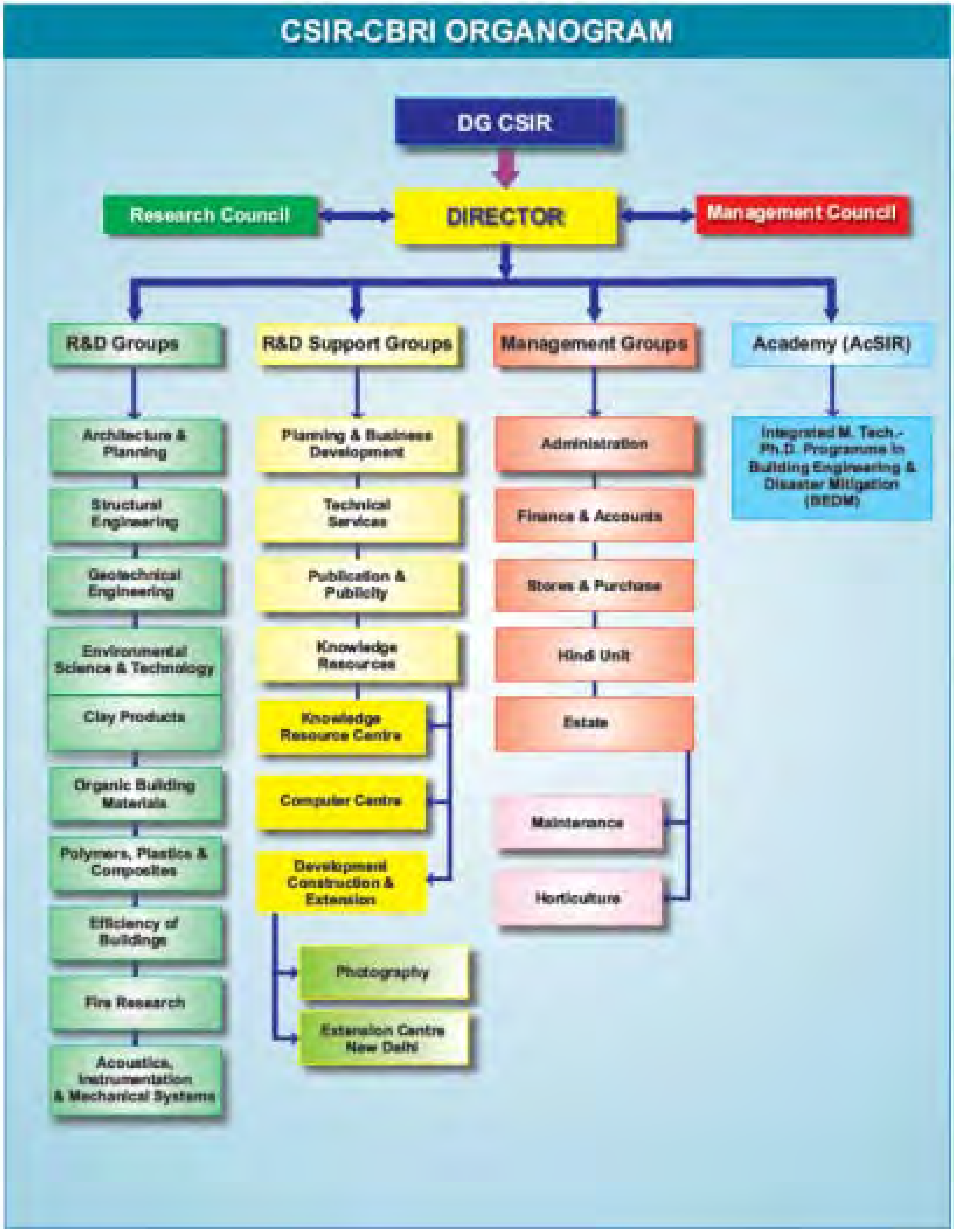
(Dr. N. Gopalakrishnan)

OUR VISION

To be a world class research & knowledge center of National importance for providing innovative solutions to all aspects of building science & technology.

OUR MISSION

Devotion to research, development and innovation (RD&I) in solving National challenges of planning, design, materials, capacity building and construction including disaster mitigation in buildings to achieve safety, sustainability, resilience, smartness, comfort, functional efficiency, speed, productivity in construction, environment preservation, energy efficiency and economy.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Administrative Officer
CSIR-Central Building Research Institute, Roorkee

Supra Institutional Network Projects

Innovative Materials & Technologies for Next Generation Green Buildings (INMATE)

Innovative Materials & Technologies for Next Generation Green Buildings (INMATE)

WP-1: Performance Enhancement of Materials through Nanotechnology
PI: L.P. Singh

- Quantification and Characterization of C-S-H in Nano-Engineered Concrete
  PI: L.P. Singh
- Development of Multifunctional Coatings using Nanotechnology
  PI: P.C. Thapliyal
- Investigation of Thermal Conductivity of Incorporated Microencapsulation of Phase Change Materials into Mortar
  PI: Srinivasarao Naik B.

WP-2: Next Generation Concrete for Sustainable Construction
PI: S. K. Singh

- Plastic Optical Fiber Reinforced Translucent Concrete
  PI: B. Singh
- Bio Concrete as Self-Healing Material
  PI: Leena Chaurasia

WP-3: Green Building Technologies
PI: Ashok Kumar

- Green Retrofit Strategies for Office Buildings
  PI: Ashok Kumar
- Development of Solar Window System for Cold Climatic region
  PI: Neeta Mittal & B.M. Suman
- Demolition Wastes as Raw Materials for Sustainable Construction Products
  PI: A.K. Minocha
- Solar Thermal Air Conditioner
  PI: Nagesh Babu Balam
- Technology Packages for Mass Housing in Urban Areas
  PI: Ashok Kumar
- Development of a Hollow Gypsum Panel Making Machine
  PI: S.K. Panigrahi
- Development of Anti-Termite Barrier for New Buildings
  PI: B.S. Rawat

WP-4: Materials & Technologies for Hazard Reduction
PI: S.R. Karade

- Development of Indigenous Cathodic Protection System for RC Structures
  PI: S.R. Karade
- Development of Fire Safe Polymeric Composite Panels
  PI: Harpal Singh
- A Performance Based Design Method for Impact Resistant RC Beams
  PI: A.K. Mittal & M.M. Dalbehera
- Improved Ventilation System for Cleaner Built Environment
  PI: Shailza Singh

WP-1 Performance Enhancement of Materials through Nanotechnology

L. P. Singh

Quantification & Characterization of C-S-H in Nano-Engineered Concrete

L.P. Singh & Team

Cement hydration is a complex chemical phenomenon and despite the availability of vast amount of literature on cementitious materials, the structure of C-S-H is still of scientific interest. Over the past two decades, spectroscopic methods, mainly 29_{Si}-nuclear magnetic resonance spectroscopy (29_{Si}-NMR), have provided a reasonably clear picture of C-S-H structure at sub-nanometer scale. Experimental results show that initially C-S-H grows as a loosely packed assembly of nano crystalline region, wherein the calcium silicate layers are well stacked with inter-layer water. Further, the amount and size of large capillary pores decreased rapidly and once the size reaches around 10 nm, the number of gel pores in the C-S-H no longer increased, even though CH and C-S-H with inter-layer water continue to form. Nano-indentation technique also has been widely used for the characterization of C-S-H in hydrated cement paste. Several studies based on nano-indentation of cement pastes have shown that nano-indentation can be used to map mechanical properties of multiphase materials. Possible interaction of different phases (e.g. C-S-H) using statistical nano-indentation and micro-mechanical property mapping techniques have shown the possible existence of more hydrate phases than the commonly reported Low Density (LD) and High Density (HD) C-S-H and CH phases. Recently, silica nanoparticles (SNPs) have received widespread attention in cementitious system due to their high reactivity. These ultra-fine material, not only reduces the calcium leaching but also improves the packing density of C-S-H in harden paste. Early age hydration process of cementitious system incorporating SNPs show that due to the formation of additional C-S-H seeds, denser and compact microstructure was formed at 24 h of hydration. The influence of SNPs on hydration of C_3S at early stage was studied using FTIR and TGA techniques. Statistical nano-indentation testing was performed to determine the micro-mechanical property values, such as Young's modulus and hardness of the individual hydrated phases using an Agilent NanoIndenter® G200 system.

Tricalcium silicate (C_3S) was prepared in the laboratory using calcium carbonate and silica in a molar ratio 3:1 and heated at ~1500°C. For the hydration studies, 10% SNPs were added by the weight of C_3S and first mixed in dry form and later hydrated with a w/C_3S ratio 0.4. After 24h of hydration, the samples were cured in water at room temperature. For the determination of SNPs reactivity in lime paste, samples were prepared by mixing hydraulic lime (calcium hydroxide) (95% purity) and SNPs in different molar C/S ratio (0.5, 1.0, 1.5 and 2.0) using water to solid ratio of 2.0. Nanoindentation studied were performed on C_3S pastes prepared by adding 10% SNPs by the weight of C_3S using fixed w/C_3S ratio of

0.4 hydrated up to 24 h. All the paste specimens (typically 10×10×10 mm³ cubes) were kept in the lab (20±3°C) in a sealable mould until the targeted hydration age was achieved.

Degree of SNPs reaction was determined by the following equation(eq. 1):

$$X(\%) = 100 \times \left[1 - \frac{X_1 - 0.9\,(X_2)}{0.1\,X_3}\right] \qquad \text{eq.. 1}$$

Degree of hydration was calculated using CH content formed in hydrated samples at different time intervals and the amount of CH was calculated directly from the TG curves using the following equations (eq. 2 & eq. 3):

$$CH(\%) = WL_{CH}(\%) \times \frac{MW_{CH}}{MW_H} \qquad \text{eq..2}$$

$$\text{Degree of Hydration } (\alpha) = \frac{CH_t}{CH_\infty} \qquad \text{eq..3}$$

Fig. 1 shows that SNPs accelerates the hydration rate of C_3S maximum during acceleration period (4-8 h) showing the nucleation effect of additional C-S-H seeds formed on the surface of SNPs during pre-induction period of hydration. SNPs shows dominant nucleation effect at 8 h of hydration because at this time of hydration the amount of hydrated products was higher (~85% additional C-S-H and ~60% more CH) than the control. At 24 h of hydration, the amount of C-S-H was higher (~43%) and CH content was lower (~25%) than the control, indicating the pozzolanic reactivity of SNPs. Mass fraction distribution of hydrated and unhydrated products during early stage hydration process show that C_3S hydration rate accelerate ~80% at 8 h of hydration, while ~51% at 24 h of hydration. Further, it was observed that in control sample steady state hydration rate achieve after 15 h of hydration, while in SNPs incorporated samples, this stage was observed after 8 h of hydration. Selective dissolution results indicate that SNPs completely reacted within 24 h of hydration and it was evaluated experimentally that 0.38 moles of SNPs consumed 0.57 moles of CH which are 1.5 times of SNPs content. Similar results were observed in SNPs and lime paste samples. These results show that SNPs reactivity increase with C/S ratio. At 24h of reaction in lower C/S ratio (0.5 and 1.0) ~83% SNPs is reacted while with high C/S ratio mixture i.e. 1.5, SNPs reacted almost completely. SNPs accelerate the polymerization of silicate chain in C-S-H gel (presence of Q^2 peak and small Q^3 peak) which leads to the formation of tobermorite like structure at 24 h of hydration (Fig. 2). Nano-indentation results clearly show that SNPs not only accelerate the hydration rate but also improved the packing density of C-S-H particles. At 24 h of hydration, in SNPs incorporated samples LD C-S-H reduces ~52% while HD C-S-H content is increased by ~40% compare to pure C_3S paste indicating the formation of more compact and dense microstructure (Fig. 3).

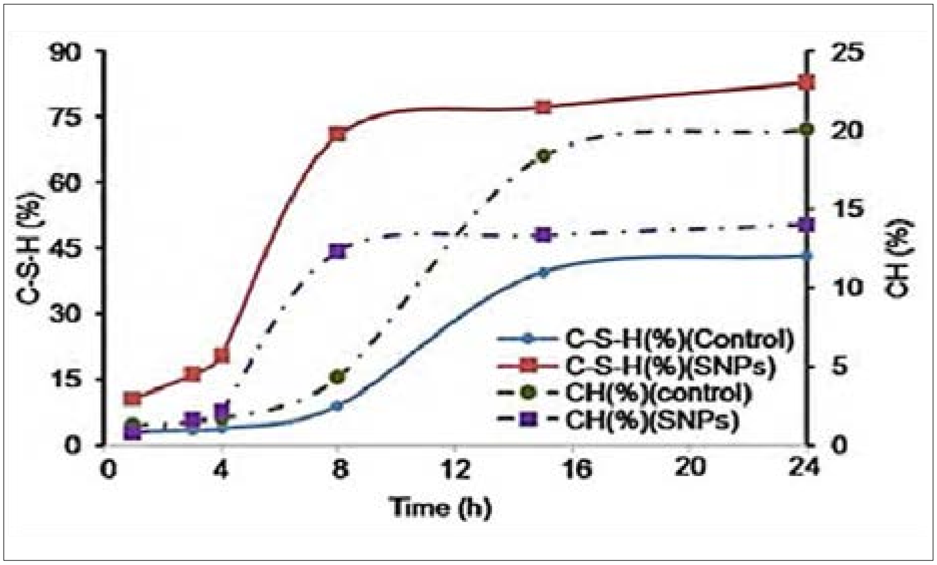


Fig. 1: Percentage of C-S-H and CH formed during hydration of C_3S and SNPs incorporated C_3S samples at different time intervals

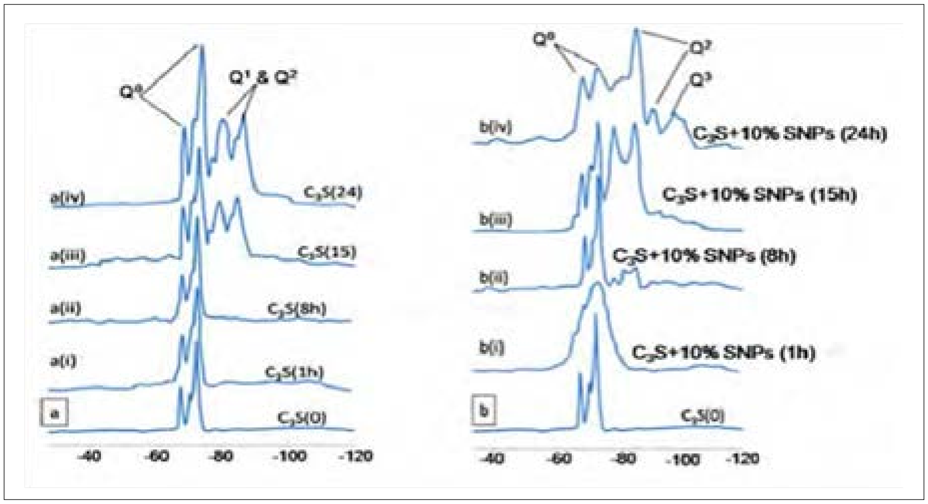


Fig. 2: 29_{Si} mass NMR of hydrated C_3S (a) and C_3S+10%SNPs (b) at different time intervals

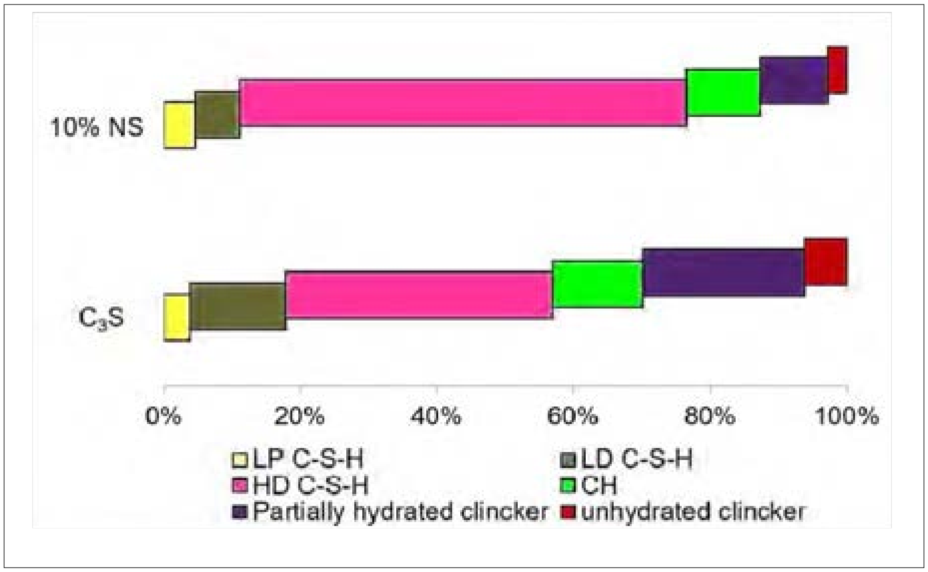


Fig. 3: Phase contents plots for all pastes; (a) relative phase content of the hydration phases; (b) phase content of the full-range

Development of Multifunctional Coatings using Nanotechnology

P.C. Thapliyal, S.R. Karade & Team

Objectives

- Development of multifunctional coating using nanotechnology for concrete structures

Work done

Under this project on multifunctional coatings, R&D work was initiated to prepare coatings by modifying acrylic resin, for the protection against corrosion and enhancing the durability of concrete structures. Besides addressing the problem of environmentally harmful coatings, care was taken in the work to enhance and strengthen the existing dominating status of our institute in the area of coatings. Multifunctional coatings was developed having following salient features:

- Anti-corrosive
- Water resistant
- Energy efficient
- Temperature difference upto 5°C
- Nanotechnology based

Under this work, effect of the size of additives on the performance of developed multifunctional coatings was also studied and results were published. Further, performance evaluation of developed coatings is still in progress to optimize the coating compositions.

Status of Process/Technology

Non-multifunctional coatings are meant for single end user while multifunctional coatings have many features. Field survey and queries from clients indicate demand is there for multifunctional coatings having many features with more improved properties at one place.

After the completion of project, multifunctional coatings are still in developmental phase as results of performance evaluation are awaited. Hence it is not possible to calculate exact price and affordability of the developed coating. But it is certain that once developed, multifunctional coatings will save materials, energy and time.

Conclusion

It was seen that addition of nano-additive influenced the properties of coatings especially in terms of heat build-up and performance evaluation of coatings for corrosion resistance and water resistance. Some of the observations and results obtained have resulted in sixteen publications and one book chapter and some more are being communicated for publication in reputed research journals and conferences.

There is need for development of new coatings formulations and to continue further studies so that the effect of shape of nano-additives on coatings can be established. We are initiating the process to contact different paint companies to sponsor the further R&D work so that technology can be transferred in near future.

Investigation of Thermal Conductivity of Incorporated Microencapsulation of Phase Change Materials into Mortar

Srinivasarao Naik B. & Team

Microencapsulation of Phase Change Material (MPCM) has been prepared with selected PCM as core and Melamine-Formaldehyde polymer as a shell by in-situ polymerization technique. The volume fraction of core, shell, and thickness of the shell were determined by instrumental techniques such as electron microscopy and thermogravimetric analysis (TGA). Effective thermal conductivity of incorporated Micro-Encapsulated Phase Change Material (MPCM) mortar has been calculated according to Maxwell model without considering the thermal conductivity of the shell and Felske model for considering thermal conductivity of the shell.

1. Field Emission Scanning Electron Microscope (FE-SEM)

The obtained dried microcapsules were coated with gold sputter coater and the surface morphology of microcapsules was observed by FESEM (make: TESCAN and model: MIRA 3). Fig. 1 shows that, fatty acid mixture as a core is encapsulated with MF polymer. The microcapsules are spherical and have more or less uniform size. The diameter of 10 randomly selected microcapsules were evaluated. The mean diameter (D) of microcapsules is found to be 2.89±0.24 μ.

1.1 Thermogravimetry Analysis of MPCM

Thermal analysis of MPCM has been conducted by TG/DTA (make: Perkin Elmer & Model: Pyris Diamond) to determine weight loss of core and shell material. In Fig. 2 two distinct weight losses are observed at distinguish temperature ranges. 63.6% weight loss is observed in the temperature range 140 – 220°C, which is due to the volatilization of PCM. In the temperature range 250-380 °C, 21.4% weight loss is observed due to the thermal decomposition of MF polymer. The remaining weight loss is 15% residue.

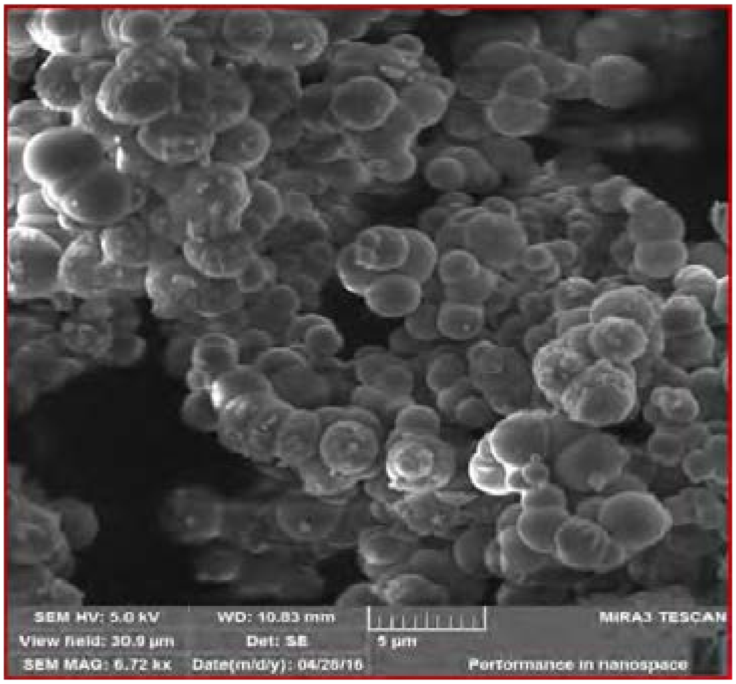


Fig. 1: FE-SEM micrograph of MPCM

The volume fraction of core material is found on the basis of avoiding low molecular weight loss. The weight portion of the core (W_w) and shell (W_s) is found to be 0.636, 0.364 respectively.

The volume portion of the core (Φ_w) in MPCM is calculated according to equation (eq. 2):

$$(\Phi_w) = 1/(1+\rho_w (1-W_w)/(\rho_s W_w)) \qquad \text{eq..2}$$

$\tilde{n}_w$ density of core 0.765 g/cm^3 and $\tilde{n}_s$ density of the shell 1.2 g/cm^3

The volume fraction of the core and shell are Φ_w=0.732, Φ_s= 0.267 repectively.

The thickness of the shell (Δ) is found from the following equation (eq. 3):

$$\Delta = 0.5\, D\,(1-\Phi_w^{1/3}) \qquad \text{eq..3}$$

The thickness of the shell (Δ) is obtained 0.14µ

1.3 Effective Thermal Conductivity of the Mortar

1.3.1. Maxwell Model

The Maxwell model describes about effective thermal conductivity of two components. It is used on the basis of two assumptions; the particles (MPCM) are randomly distributed in homogenous medium (mortar) and no interaction between particles and medium. The following equation (eq. 4) is used for effective thermal conductivity (k_{eff})

$$k_{eff} = km\,\frac{kpcm+2\,km+2\,\Phi\,(kpcm-km)}{kpcm+2\,km-\Phi\,(kpcm-km)} \qquad \text{eq..4}$$

where k_m is the thermal conductivity of the medium 1.75 W/m.K. k_{PCM} is the thermal conductivity of PCM 0.14 W/m.K. Φ is volume fraction of PCM

1.3.2. Felske Model

The Felske model describes about the effective thermal conductivity of monodisperse spherical capsules randomly distributed in a continuous matrix equation (eq. 5).

$$k_{eff} = \frac{[illegible]}{(2+\phi_c+\phi_s)\left[3+2\frac{\phi_s}{\phi_c}+\frac{\phi_s k}{\phi_c k_s}\right]+(1-\phi_c-\phi_s)\left[\left(3+\frac{\phi_s}{\phi_c}\right)\frac{k}{k_m}+2\frac{\phi_s k_s}{\phi_c k_m}\right]}$$

eq..5

Where k_c, k_s, and k_m are the thermal conductivities of the core (fatty acid mixture, 0.14 W/m. K), shell (MF polymer, 0.5 W/m. K), and matrix (mortar, 1.75 W/m.K) materials, respectively. Similarly, Φ_c, Φ_s, and Φ_m are the volume fractions of the core, shell, and matrix materials, respectively. The volume fraction of MPCM is varied from 5% to 30%.In which effective thermal conductivity of mortar was calculated with considering thermal conductivity of MF polymer by Felske model and without considering thermal conductivity of MF polymer by Maxwell model.

In both models Fig. 3 effective thermal conductivity of the mortar decreases by increasing the volume fraction of MPCM. Effective thermal conductivity of the mortar is increased by the Felske model at different volume fraction of MPCM as compared to the Maxwell model. Thermal conductivity of the shell has significant role in application of MPCM into the building components.

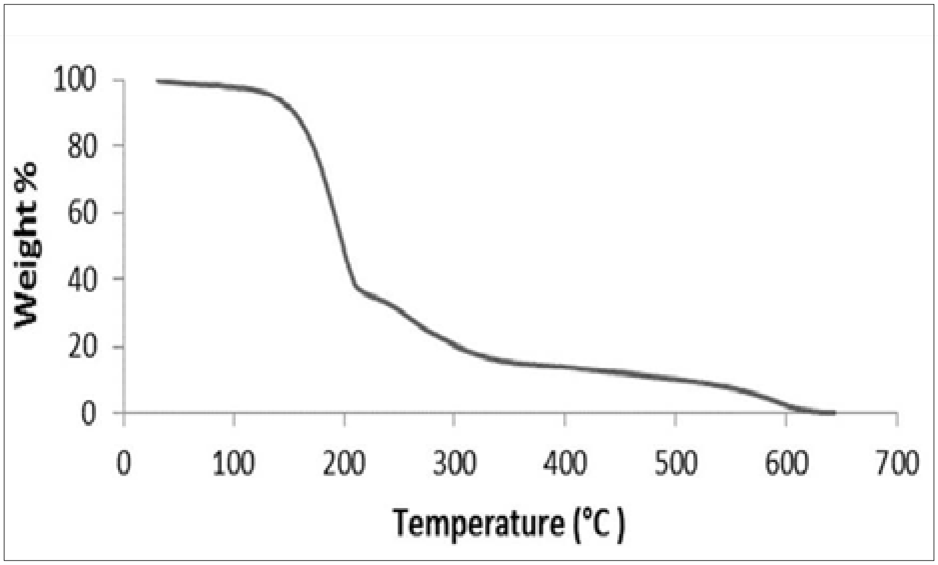


Fig. 2: Thermal analysis of MPCM

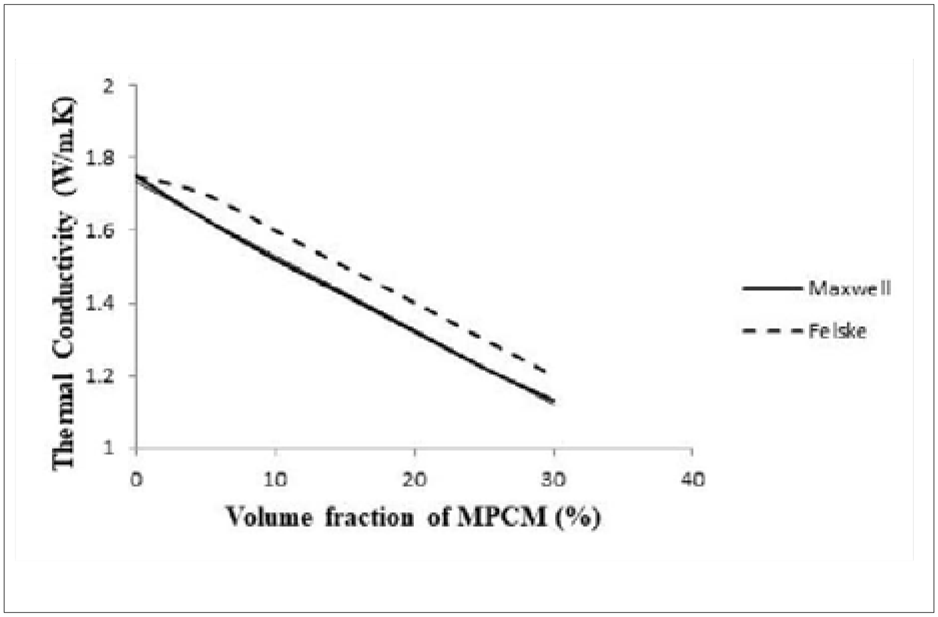


Fig. 3: Effective thermal conductivity of mortar

WP-2 Next Generation Concrete for Sustainable Construction

S. K. Singh

Plastic Optical Fiber Reinforced Translucent Concrete

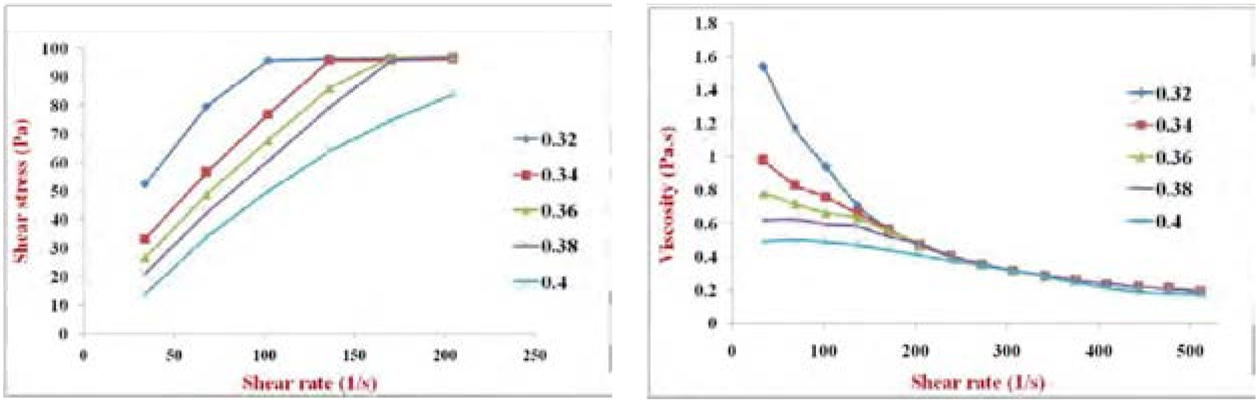
B. Singh, Humaira Athar, Reyazur Rehman, Rakesh Paswan & Ishwarya G.

Translucent concrete is a white architectural concrete which permits light to filter inwards and outwards in the buildings ensuring desired translucency with an adequate mechanical strength. Generally, the brightness of indoor environment of buildings is entirely maintained by the artificial lighting which has consumed a large amount of resources. Currently, emphasis is given to level out the electricity consumption of ~10 kWh/m^2 per year compared with the normal annual lightning electricity consumption of 20-50 kWh/m^2 per square meter of buildings. One possible way is to reduce lighting energy by exploiting sunlight through the use of energy efficient materials like transparent concrete. Such kind of newer concrete for use as building elements (facades, interior wall claddings, partition walls, blocks etc.) saves operational cost of 10-12% by providing natural light instead of artificial power consumption for illumination. This can integrate the concept of green energy with the usage of self-sensing property of functional materials.

Flowable mix suitable for translucent concrete were proportioned and its rheological properties was studied as a function of water-cement ratio and superplasticiser dosages. Fuller's ideal grading curve was used to proportion aggregates. It was observed that the pastes behaved like a Bingham fluid (Fig. 1). The higher yield stress of pastes indicated its low workability (stiff mix). As would be expected, the yield stress and viscosity of pastes exhibited a dependence on SP dosages (Fig. 2). Above 100 shear 1/s, the shear stress of super plasticized pastes (0.2, 0.4 and 0.6% SP) was higher than the control probably due to more solid contacts of particles. It was noted that the yield stress of super plasticized paste was 27% lower than the unplasticized paste. These results can be modelled using a Herschel- Bulkley equation for describing the rheology of pastes because the paste behaves as power law fluid (eq. 1)

$$\tau = \tau_0 + \mu\gamma^n \qquad \text{eq..1}$$

where, τ is the shear stress (Pa), τ_0 is the yield stress (Pa), μ is the paste consistency, γ is the strain rate and n is the shear thinning index (n < 1 represents shear thinning whereas n > 1 denotes shear thickening). It can be seen that for control and paste with 0.2% SP dosage, the value of n was less than 1 which indicated shear thinning behaviour of pastes. At 0.4% and 0.6% SP dosages, the value of n was greater than 1 which indicated shear thickening of the cement pastes. It was noted that the yield stress of pastes decreased from 13.5 Pa to 1 Pa when SP dosage increased to a level of 0.8%. The best fit of model with the experimental results (control, 0.2% and 0.8% SP dosage) in shear thinning part of the curve led to the rheological parameters of



(a) (b)

Fig. 1: Rheo curve of white cement pastes at different w/c ratio (a) Shear stress Vs shear rate (b) Viscosity Vs shear rate

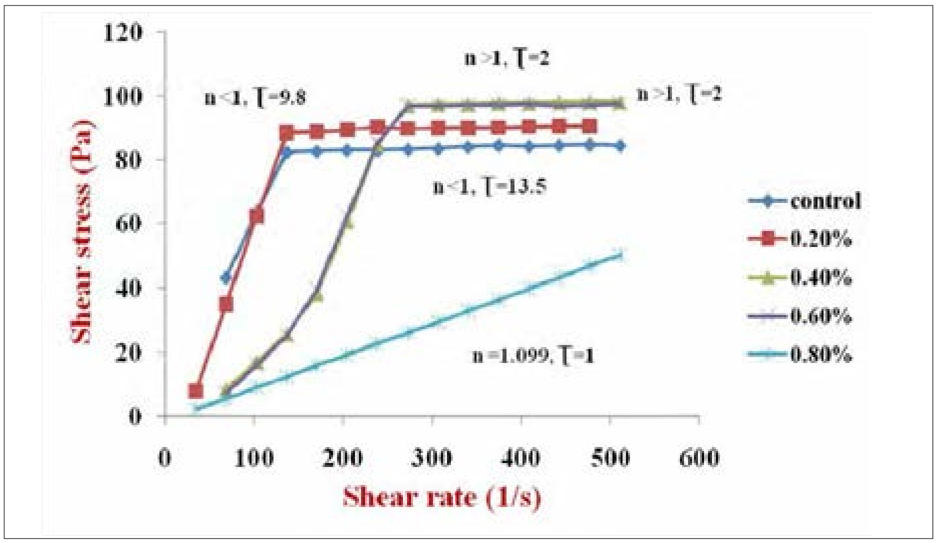


Fig. 2: Rheo curve of white cement pastes as a function of SP dosage at 0.34% w/c ratio

the paste including yield stress, consistency and the shear thinning index. It is concluded that more than 0.8% SP dosage can be considered for optimum results because minimal stress is required to initiate flow. The paste may consolidate by its weight itself and suited for making translucent concrete.

The engineering properties of translucent concrete made with POF and white cement mortar/concrete were evaluated in terms of fiber spacing and fiber content. The stress-strain curve of fiber concrete was less steep than the plain concrete (Fig.3). Its descending part indicated that fiber concrete retained more post-peak load than the control. It was found that increasing fiber spacing increased compressive strength and modulus of elasticity of the resulting translucent concrete. The compressive strength of translucent concrete decreased with the increase of fiber content. Correlation between modulus of elasticity and compressive strength showed a linear behavior with 0.9 regression coefficient. The specimens containing fibers aligned in the load direction had higher compressive strength than the specimens containing fibers in perpendicular direction to load. The translucent concrete made with fine aggregates had lower compressive strength than those mixes made with fine and coarse aggregates. The fractured surfaces of SEM images showed that bond between untreated fiber and cement paste was not adequate. Voids existed at the fiber-matrix interface. When treated optical fibers were used in the concrete, the treated fibers showed good interfacial bonding with the cement paste which is responsible for higher strength over the untreated ones.

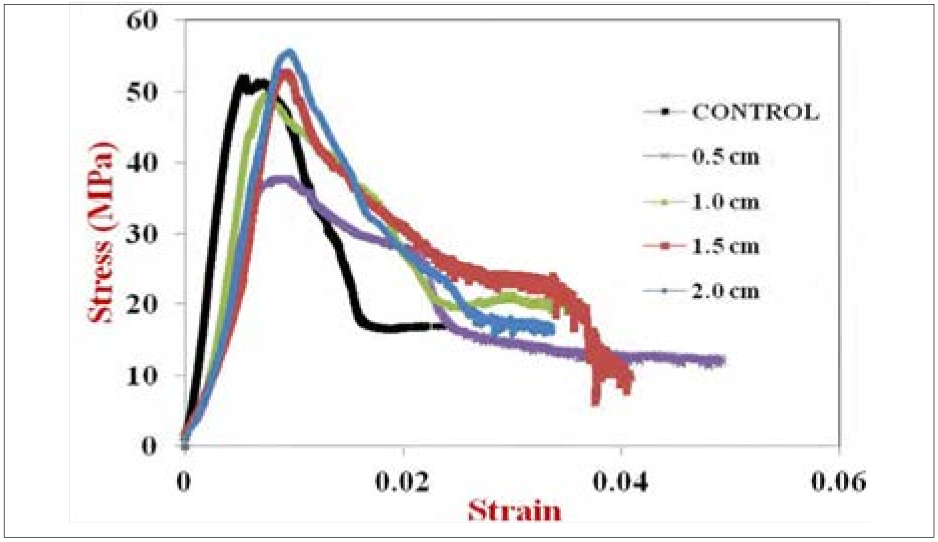


Fig. 3: Stress-strain curves of translucent concrete in compression

The maximum transmittance of ~7% was obtained at a level of 5 mm fibre spacing under a collimated light. The diffused light transmittance of translucent concrete in 600x600x600 mm box was ~ 1.2% which had an adequate "seeing effect". The solar irradiance measured by a Pyranometer was ~ 148 W/m^2 for 5 mm spacing, in which 4-5% light transmittance was observed. Lumen grid method has been used for calculation of average daylight illuminance of the work plane. The average value of measured illuminance throughout was 75 lux. This value is nearly equivalent to the criteria specified (80 lux) for illumination for circulation. The total annual illumination energy load of a room (3000x3000x3000 mm) using one side translucent concrete was 162.36 kW compared with the energy load of 249.75 kW for a room without translucent concrete. The energy saving on an account of power consumption of illumination was found to be ~25%. The view of developed translucent concrete is shown in Fig. 4.

Fig. 4: View of translucent concrete

Bio Concrete as Self-Healing Material

Leena Chaurasia

Objectives

- Development of bio-concrete as self-healing material for RC structure.

Significant Achievements

- Species of Calcifying Bacteria have been maintained for study
- Study of Acid Attack on Bacterial Mortar-under progress

This study is undertaken for 30,60, 90 and 120 days respectively, and bacterial specimen are showing significant results in comparison with control specimen (Fig. 1 and Fig. 2).

Fig.1: Bacterial and control specimens immersed in acid

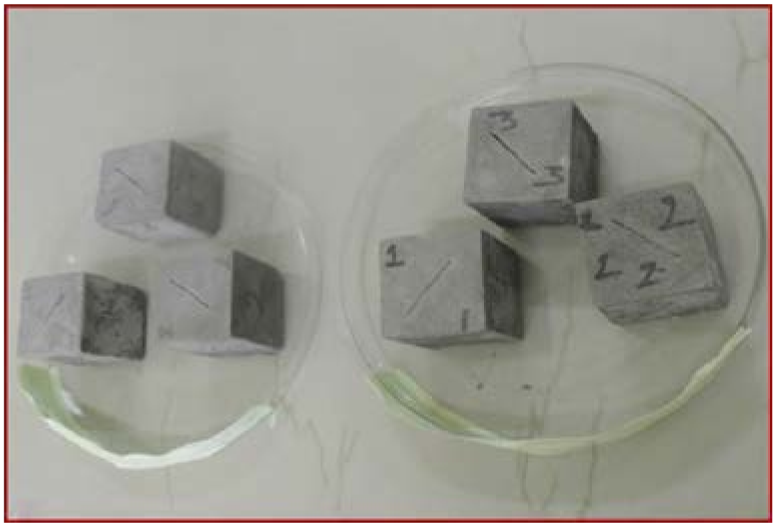


Fig.2: Bacterial and control specimens immersed in water

- **Preparation of Control & Bio-Admixture Incorporated Disc for Different Parameters**

  Concrete discs were prepared in 392.85 cm^3 disc mould, composed of 1 part of cement, 1.75 part of fine aggregate/sand, 3 parts of coarse aggregate by mass and (P/4 + 3) per cent (of combined weight of cement and sand) water. Control concrete discs and bacterial specimens were casted. After casting, the prepared treated and non-treated discs were kept for curing for 28 days.

Tests Procedures

After casting of concrete discs and curing for 28 days, the discs were tested for water absorption, bulk density, apparent density, volume of permeable voids, % porosity (ASTM C642-13).

- **Oven Dry Mass**:
  The last value was designated as 'A'.

- **Saturated Mass after Immersion:**
  The final surface-dried mass was designated as 'B'.

- **Saturated Mass after Boiling**:
  The soaked, boiled, surface dried mass was designated as 'C'.

- **Immersed Apparent Mass:**
  The specimen was suspended, after immersion and boiling by a wire and the apparent mass was determined in water. The apparent mass was designated as 'D' (**Table 1** and **Table 2**).

Apparent mass (D) = dry mass - volume of specimen *x* density of water

Volume of specimen = $\pi r^2 h$

Here, r =5 and h = 5

Therefore, volume of specimen = 392.85 cm^3

ρ = density of water =1 Mg/m^3= 1 g/cm^3

Characteristic Techniques Used

The morphology and mineralogical composition of the deposited $CaCO_3$ crystals were analyzed using field emission scanning electron microscopy and X-ray diffraction.

Table 1: Values of weight of control and bio-admixture specimens after different treatments

A		B		C		D	
Control	**Bio-admixture**	**Control**	**Bio-admixture**	**Control**	**Bio-admixture**	**Control**	**Bio-admixture**
C1= 820	B1= 835	C1= 900.5	B1 = 887	C1= 874	B1= 885.5	C1= 492.65	B1=481.15
C2= 822.5	B2= 840	C2= 877.5	B2 =891.5	C2= 876.5	B2= 864.5	C2= 471.65	B2=483.65
C3= 826	B3= 845	C3= 884.5	B3= 898	C3= 882.5	B3= 868.5	C3= 475.65	B3=489.65

Table 2: Control and bio-admixed concrete disc values of different parameters

Specimens	Absorption after immersion of specimens (%)	Absorption after immersion and boiling (%)	Bulk density, dry (g1)	Bulk density after immersion	Bulk density after immersion and boiling	Apparent density (g2)
Control	7.9	6.0	2.03	2.25	2.22	2.36
Bio-admixture	6.1	5.0	2.13	2.26	2.23	2.34

FESEM/XRD Analysis

Microbial calcite precipitation in concrete was visualized through FESEM analysis (Fig. 3).

The most abundant component was clearly quartz, as indicated by the longest peak. The calcite peaks and vaterite peak are observed at 2θ= 29.5º and 42.5º respectively. At 2θ= 29.5º the intensity of calcite in control, bacterial and bio-admixed sample is found to be 812.5, 1815 and 1915 respectively, it represents calcite is being deposited by the microbial activity. Similar results are observed at è angle 42.5º, validating enhanced calcium carbonate precipitation, which was evident through EDX (Fig. 4).

Future work

- Comparison and interpretation of results – Compressive Strength, SEM, EDX, XRD, XRF.
- Identification of other new efficient Calcifying Bacteria.
- Standardization of methodology for estimation of calcium carbonate precipitation (Carbonatogenesis Activity).
- Resistance of bacterial concrete against corrosion of steel bar.
- Response of Bio-concrete to different calcium feeds/ compounds.
- Research Publication.

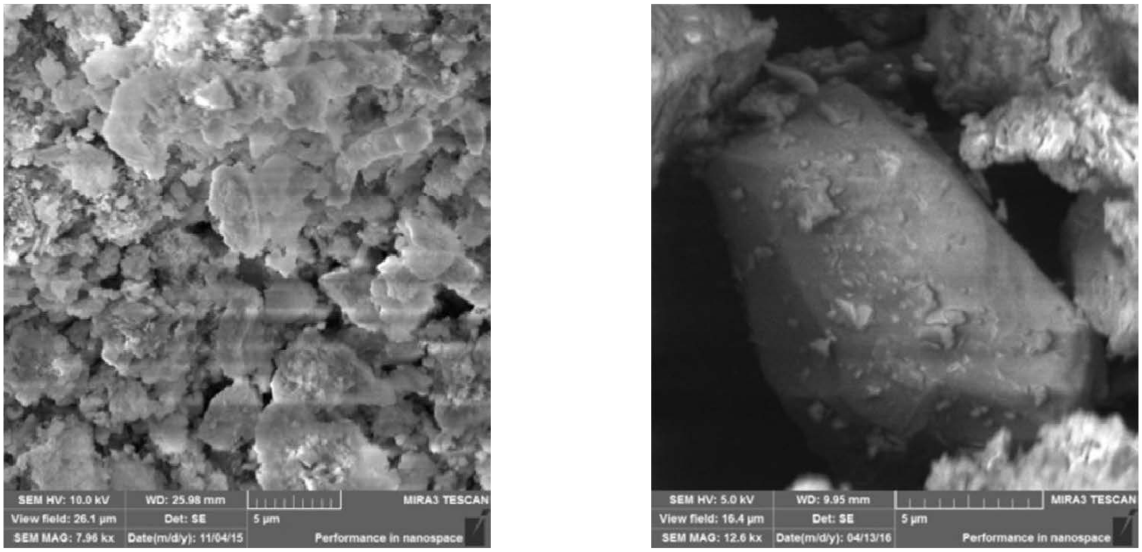


Fig 3: Scanning electron micrograph showing calcite crystals embedded in (a) cement-sand matrix and (b) on the surface of bacteria.

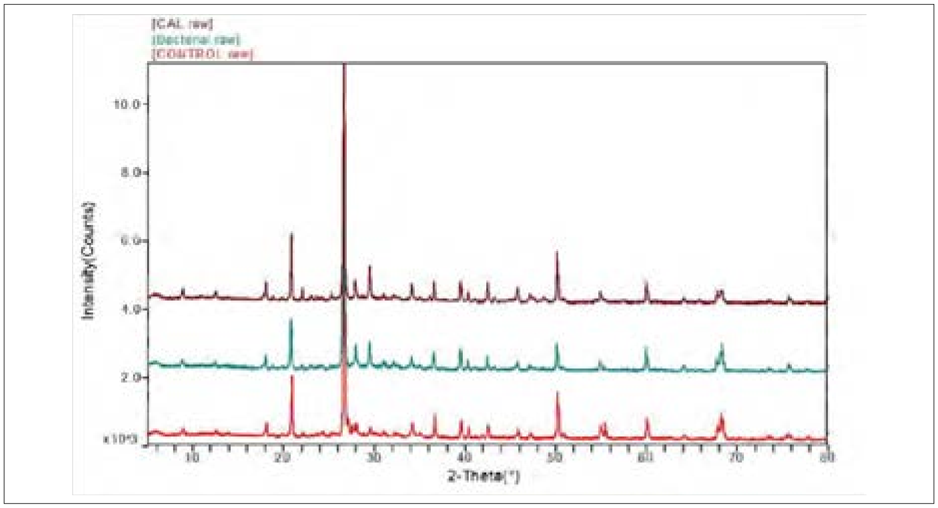


Fig 4: X-ray diffraction analysis showed calcite and vaterite peaks, confirming the occurrence of MICP inside the cement sand matrix.

WP-3 Green Building Technologies

Ashok Kumar

Green Retrofit Strategies for Office Buildings

Ashok Kumar, R. Deoliya, Rajni Lakhani, B.M. Suman & Team

Objectives

- Development of green retrofit methodologies for existing office buildings in composite climate.

Significant Achievements

The full-scale experimental studies performed on two prototype Test-Beds (one base model and the other retrofit model) have established the impact of each retrofitting intervention in improving the thermal and energy performance as compared to baseline model without retrofit (Fig. 1). It is observed that in both the test rooms, the indoor air temperature at 600mm above the floor level is in close agreement with each other.

During summer, the heat flow through the roof and severely exposed walls in south-east, south-west and north-west directions was quite significant compared to north-east and the remaining surfaces. The peak heat flux at 20.00 hours through north-west wall (229 mm thick) is reduced by about 35% by providing external wall insulation (polyurethane foam) of 50 mm thickness finished with cement plaster and white reflective paint and by keeping an air gap of 20 mm between the existing wall assembly and retrofit insulation panels. This signifies that external insulation is quite effective in reducing both inside surface temperature and heat flux.

The results indicate that 100 mm thick precast RC planks and joists roof along with retrofit wall insulation externally and over deck insulation on roof plus vermiculite tiles and reflective coating finish in retrofit model seem to be adequate and no great advantage accrues if the thickness of walls is increased from 229 mm to 345 mm. It is also established that green roofs with grass carpets are suitable for reducing the energy demand for space cooling during hot summer. Green roof retrofits can be used efficiently in existing buildings in India, where the additional load carrying capacity of buildings about 100 – 130 kg/m^2 is permissible. Therefore, the prototype study is used to retrofit the Library Block of the Main CBRI building.

Green Retrofit Interventions in Library Block at CSIR-CBRI

The building is situated in CSIR-Central Building Research Institute, Roorkee, Uttarakhand, Longitude: 77.90028N, Latitude: 29.85954E. The building is two storeyed and library is on the first floor. There are two Wings 'A' and 'B' in the Library (Fig. 2). The mechanical ventilation of this block is maintained by 24 fans of 50 W maximum. The external walls are 345 mm thick and window-to-wall ratio for all the walls are approximately 12%.

Fig. 1: Prototype test-beds (one baseline model and the second retrofit model)

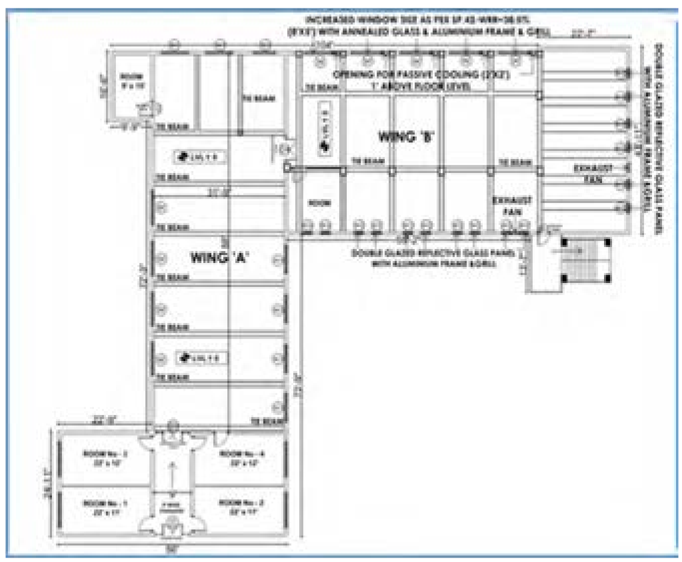


Fig. 2: First floor plan of energy retrofit of library block at CSIR-CBRI

The energy simulation exercise was done using TRANSYS 16.0 software considering the layer of roof as brick tiles, mud phuska, and reinforced cement concrete. After doing the conceptual energy analysis, various design alternatives were considered for optimized energy retrofit design. Based on the comparative analysis, the energy retrofit interventions for Library Block proposed are as follows:

- Energy efficient lighting fixtures in false ceiling of gypsum panels.
- Double glazing (sliding) using reflective glass of 6 mm thickness on south and west facades and annealed glass 6mm thick on north and east façade.
- 3-Star split Air Conditioners.
- Occupancy Sensors on Wing–B for lighting.
- Exhaust fans for removing hot air.

The energy retrofit work of Library block is in progress.

Development of Solar Window System for Cold Climatic Region

Neeta Mittal & B.M. Suman

The objective of solar window design is to use the freely abundant renewable solar energy in extreme cold climatic region for increasing the indoor room temperature. The experimental setup has been developed at CSIR-Central Building Research Institute (CBRI), Roorkee to evaluate thermal performance of solar passive window. The solar energy coming from the sun incidents on the window glass and passing through it is absorbed by black coated perforated metal sheet. Greenhouse effect of glass is utilized in this process. The performance has been evaluated by recording indoor temperature difference between room with solar passive window and the room without solar window having same size of window. As it is recorded, the solar passive window is very much effective and the air temperature of room with solar window system is 3.5°C to 8.8°C higher than the air temperature of reference room with use of different metal sheets. Performance of solar passive window depends upon sunshine duration, thermal properties of metal sheet. The developed solar window, with perforated Aluminum sheet is installed after experimentation in EB, CSIR-CBRI Roorkee, in a room of size 300 x 270 cm, window size 150 cm x 130 cm on the top floor (Fig. 1). The window is installed on southern wall for the best performance.

Fig. 1: Solar window with aluminum sheet

Demolition Wastes as Raw Materials for Sustainable Construction Products

A.K. Minocha & Team

This study investigates the effect of using various treated recycled concrete fine aggregates on the properties of concrete. The concrete mix proportions were selected from a trail mix of concrete made with natural coarse and fine aggregates on the basis of achieving the target strength of 50 MPa for 28 days. The mix proportions used in concrete mixes are mentioned in Table 1. The maximum size of aggregates used in this study was 12.5mm. Various concrete mixes were designed with 100% replacement of various treated RCFA. Meanwhile, another type of concrete was prepared with 100% replacement of untreated RCFA. As a measure of concrete workability, the vee bee seconds for fresh concrete was found out using vee bee consistometer according to IS 1199-1959. The compressive strength of 150 mm cubes for 7,28 and 56 days for various mixes was determined according to IS 516 (1959). The splitting tensile strength of 150 mm*300 cylinders for 28 days for all concrete mixes was determined according to IS 5816 (1999) method. The modulus of elasticity of 150 mm*300 cylinders for 28 days was determined according to IS 516 (1959). The micro structural aspects of concrete mixes were studied with the help of SEM.

The mix details of various concrete mixes are presented in Table 2. The fresh and mechanical properties of various concrete mixes were studied and described below. The workability of concrete mixes made with untreated RCFA/treated RCFA is low as observed in this study. As a measure of low workability, the Vee bee second was determined using Vee bee consistometer. The Vee bee test results for various concrete mixes are presented in Table 2. The vee bee seconds for RFAC is 25, which is extremely dry condition. It is because of that, the untreated RCFA usually has the tendency to absorb water from the water cement ratio used in concrete mixes, which ultimately affect its workability. From Table 2, the overall vee bee test results indicate that there is a significant difference of workability between concrete mixes containing thermo-chemically treated and untreated RCFA. There is no effect of using thermal / chemical treated RCFA on the workability of concrete mixes. Thus, the workability is greatly influenced by water absorption of RCFA samples.

The compressive strength and modulus of elasticity results for various concrete mixes are presented in Fig. 1. From Fig. 1, it can be seen that the wide variation in the values of compressive strength as well as modulus of elasticity among various concrete mixes is mainly due to its using various quality of fine aggregates. As can be seen in Fig. 1(a), the 28 days strength and modulus of elasticity of RFAC were decreased by 39.76% and 44.16% respectively, comparing with those of controlled concrete. From Fig. 1(a), it can be ascertained that the strength development of RFAC is lower than that of controlled concrete. The strength reduction of RFAC was attributed to high water absorption of RCFA and porous structure of RFAC. As revealed in Fig. 1(b) and Fig. 1(c), there was no effect of using thermal /chemical treated RCFA on the compressive strength and modulus of elasticity of concrete mixes due to the inferior quality of thermal /chemical treated RCFA samples.

Therefore, the properties of concrete made with either treated RCCA or treated RCFA are mainly influenced by the quality enhancement of aggregates. From Fig. 1(d), it can be ascertained that the thermo-chemically treated RCFA experiences the satisfactory performance on the compressive strength and modulus of elasticity of concrete mixes as well. Particularly, the compressive strength of RFAC-(600^{o})$_{0.7M}$ mix at 28 days was increased by 29.39% as compared to those of RFAC. Meanwhile,

Table 1: Mix proportions used in concrete mixes

Materials used	Cement	Fine aggregate	Coarse aggregates	SP	Water-cement ratio
Quantity	450kg/m^3	636kg/m^3	1200kg/m^3	1% by weight of cement	0.38

Table 2: Mix proportions used in concrete mixes

Concrete mix No	Details of concrete mixes	Mix designation	Vee-bee (Sec)
1	Cement + NCA (100%) + NFA (100%) + Water + SP	Controlled concrete	10
2	Cement + NCA (100%) + untreated RCFA samples (100%) + Water + SP	RFAC	25
3	Cement + NCA (100%) + RCFA samples treated by thermal treatment at 300°C (100%) + Water + SP	RFAC (300°)	25
4	Cement + NCA (100%) + RCFA samples treated by thermal treatment at 400°C (100%) + Water + SP	RFAC (400°)	25
5	Cement + NCA (100%) + RCFA samples treated by thermal treatment at 500°C (100%) + Water + SP	RFAC (500°)	25
6	Cement + NCA (100%) + RCFA samples treated by thermal treatment at 600°C (100%) + Water + SP	RFAC (600°)	25
7	Cement + NCA (100%) + RCFA samples treated by soaking in 0.1M of HCl (100%) + Water + SP	RFAC $_{0.1M}$	25
8	Cement + NCA (100%) + RCFA samples treated by soaking in 0.4M of HCl (100%) + Water + SP	RFAC $_{0.4M}$	23
9	Cement + NCA (100%) + RCFA samples treated by soaking in 0.7M of HCl (100%) + Water + SP	RFAC $_{0.7M}$	23
10	Cement + NCA (100%) + RCFA samples treated by pre-heating at 300°C with soaking in 0.1M of HCl (100%) + Water + SP	RFAC -$(300^o)_{0.1M}$	19
11	Cement + NCA (100%) + RCFA samples treated by pre-heating at 300°C with soaking in 0.4M of HCl (100%) + Water + SP	RFAC -$(300^o)_{0.4M}$	19
12	Cement + NCA (100%) + RCFA samples treated by pre-heating at 300°C with soaking in 0.7M of HCl (100%) + Water + SP	RFAC-$(300^o)_{0.7M}$	18
13	Cement + NCA (100%) + RCFA samples treated by pre-heating at 400°C with soaking in 0.1M of HCl (100%) + Water + SP	RFAC-$(400^o)_{0.1M}$	19
14	Cement + NCA (100%) + RCFA samples treated by pre-heating at 400°C with soaking in 0.4M of HCl (100%) + Water + SP	RFAC-$(400^o)_{0.4M}$	18
15	Cement + NCA (100%) + RCFA samples treated by pre-heating at 400°C with soaking in 0.7M of HCl (100%) + Water + SP	RFAC-$(400^o)_{0.7M}$	18
16	Cement + NCA (100%) + RCFA samples treated by pre-heating at 500°C with soaking in 0.1M of HCl (100%) + Water + SP	RFAC -$(500^o)_{0.1M}$	18
17	Cement + NCA (100%) + RCFA samples treated by pre-heating at 500°C with soaking in 0.4 M of HCl (100%) + Water + SP	RFAC -$(500^o)_{0.4M}$	17
18	Cement + NCA (100%) + RCFA samples treated by pre-heating at 500°C with soaking in 0.7M HCl (100%) + Water + SP	RFAC -$(500^o)_{0.7M}$	17
19	Cement + NCA (100%) + RCFA samples treated by pre-heating at 600°C with soaking in 0.1M of HCl (100%) + Water + SP	RFAC -$(600^o)_{0.1M}$	18
20	Cement + NCA (100%) + RCFA samples treated by pre-heating at 600° with soaking in 0.4M of HCl (100%) + Water + SP	RFAC -$(600^o)_{0.4M}$	16
21	Cement + NCA (100%) + RCFA samples treated by pre-heating at 600°C with soaking in 0.7M of HCl (100%) + Water + SP	RFAC -$(600^o)_{0.7M}$	14

the modulus of elasticity of RFAC $(600^o)_{0.7M}$ mix at 28 days was increased by 24.99%. In all the cases, the compression strength is almost relative to the value of the modulus of elasticity as noticed in this study.

The tensile strength of various concrete mixes is shown in Fig. 2. As can be observed in Fig. 2, the tensile strength of RFAC at 28 days was decreased by 29.39% as compared to those of controlled concrete. The bond stress between aggregate and cement paste was reduced due to fine aggregate fractions, which is unfavourable to the tensile strength of concrete. From the Fig. 2, the overall tensile strength results indicate that there is a significant difference between concrete mixes containing thermo-chemically treated and untreated RCFA. Particularly, the tensile strength of RFAC -$(600^o)_{0.4M}$ was increased by 22.87% as compared to those of RFAC.

The microstructure of various concrete mixes is shown in Fig. 3. It is well established that the controlled

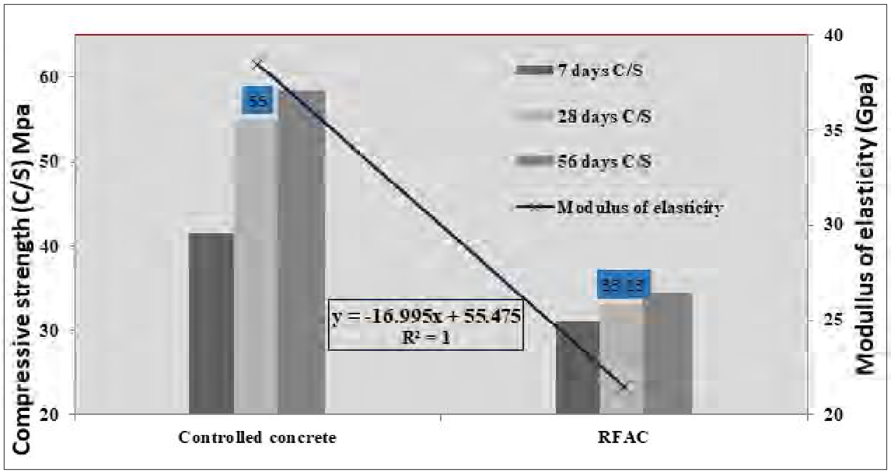


Fig. 1: (a) Influence of NFA and untreated RCFA on compressive strength and modulus of elasticity of concrete mixes

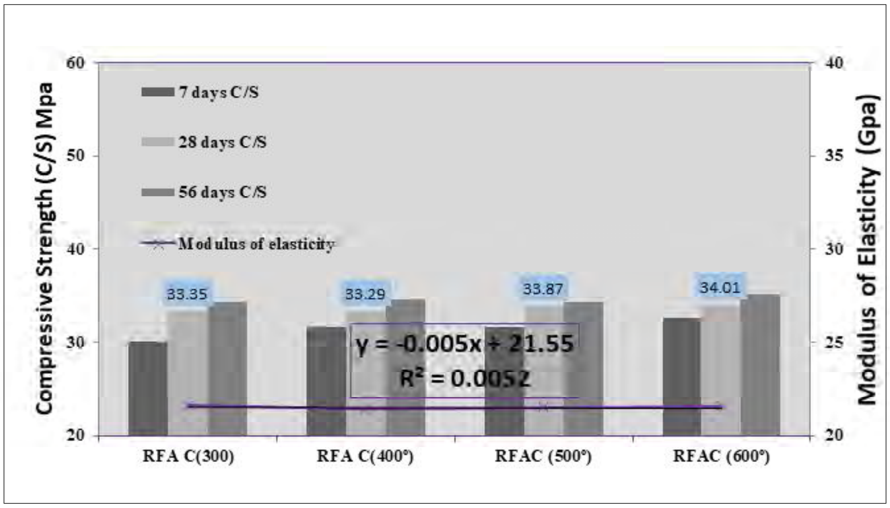


Fig. 1: (b) Influence of thermal treated RCFA on compressive strength and modulus of elasticity of concrete mixes

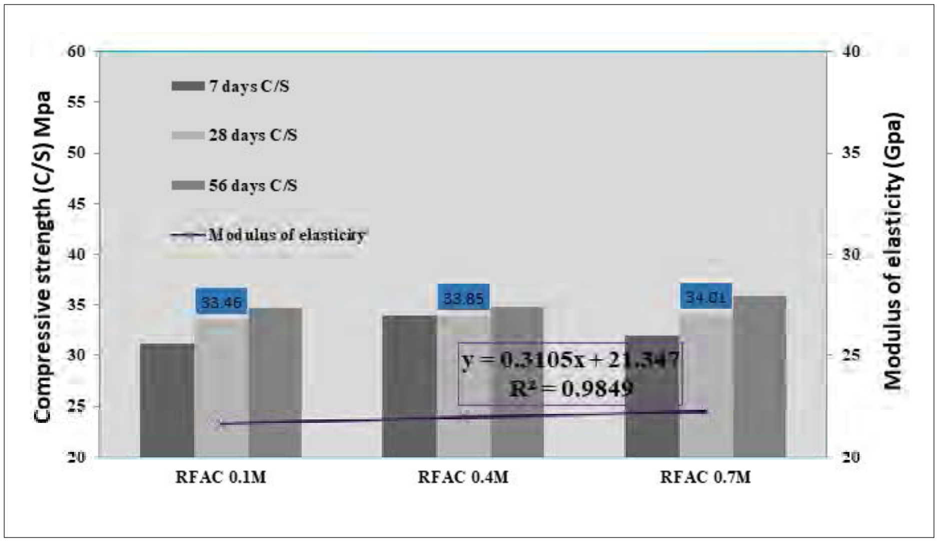


Fig. 1: (c) Influence of chemically treated RCFA on compressive strength and modulus of elasticity of concrete mixes

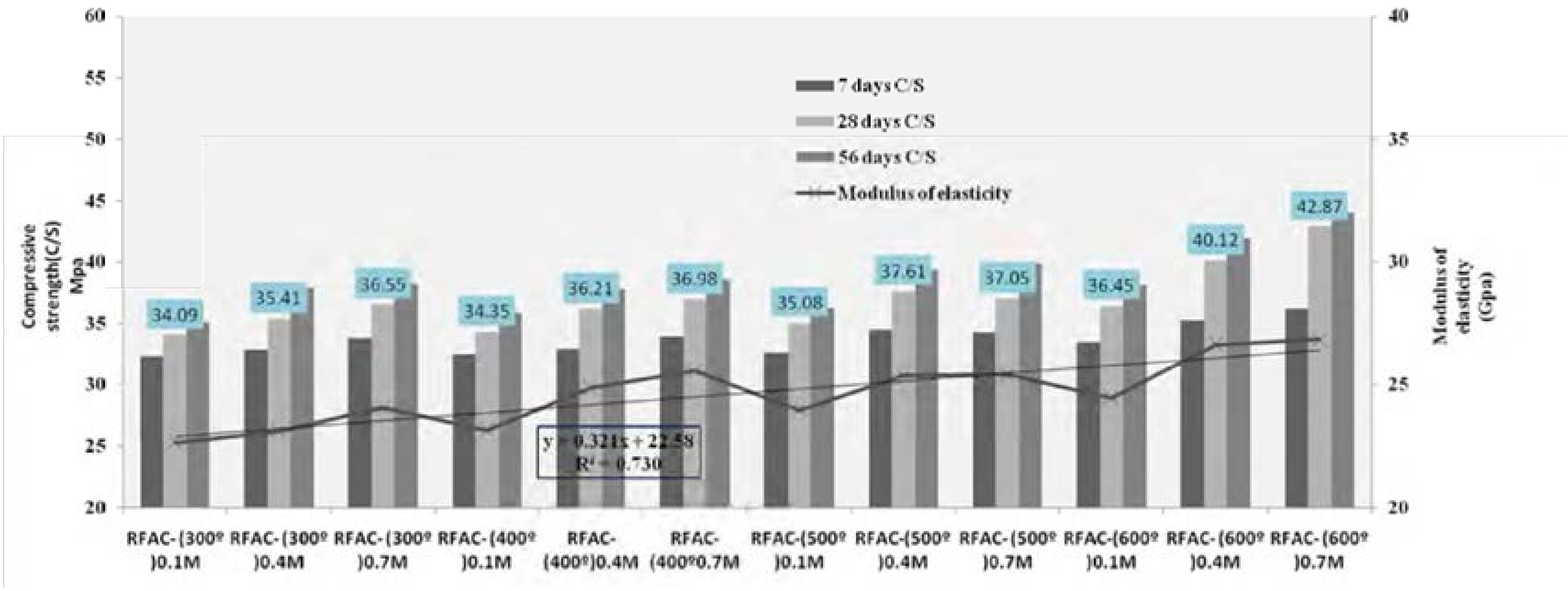


Fig. 1: (d) Influence of thermo-chemically treated RCFA on compressive strength and modulus of elasticity of concrete mixes
Fig. 1: Compressive strength and modulus of elasticity of various concrete mixes

concrete is usually failure at the interfacial transition zone (ITZ) between aggregate and cement matrix (Fig. 3(a)). As can be seen in Fig. 3(b), the RFAC is quite porous, observing poor interfacial bond between aggregate and cement matrix. The high water absorption of RCFA causes the formation of larger pores after evaporation otherwise, it reduces the rate of hydration and formation of an immature microstructure.

As observed in Fig. 3(a) and Fig. 3(b), the ITZ of RFAC is too wide as compared to those of controlled concrete. As can be seen in Fig. 3(c), it can be visualized that the RFAC - $(600^{o})_{0.7M}$ is somewhat dense, forming a mature microstructure as compared to those of RFAC. As revealed in Fig. 3(c), the thermo-chemically treated RCFA used in concrete mixes results in enhancing the hydration process, improving the bond between aggregate phase and matrix phase and reduction of the porosity of matrix phase.

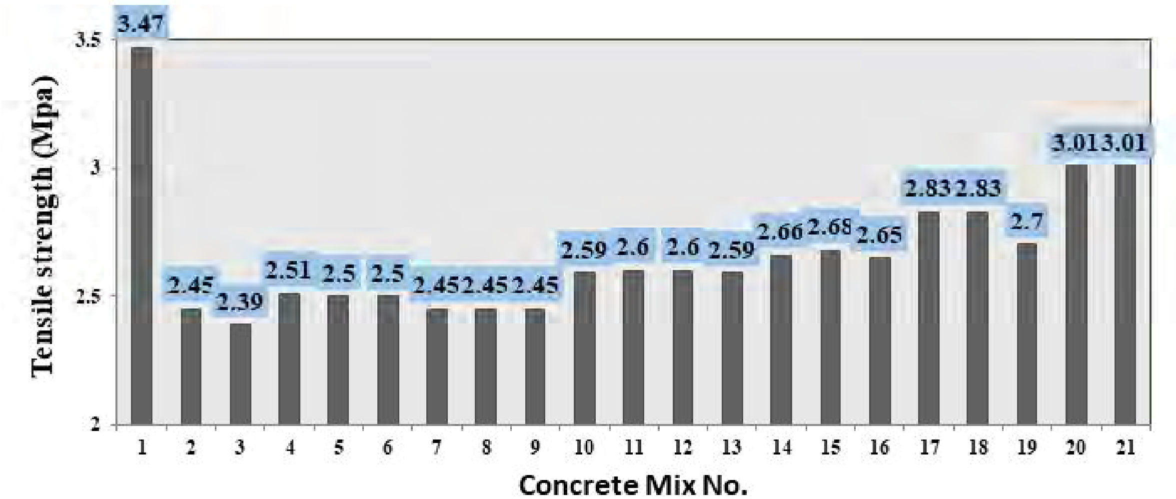


Fig. 2: Tensile strength of various concrete mixes

Fig. 3: (a) Controlled concrete

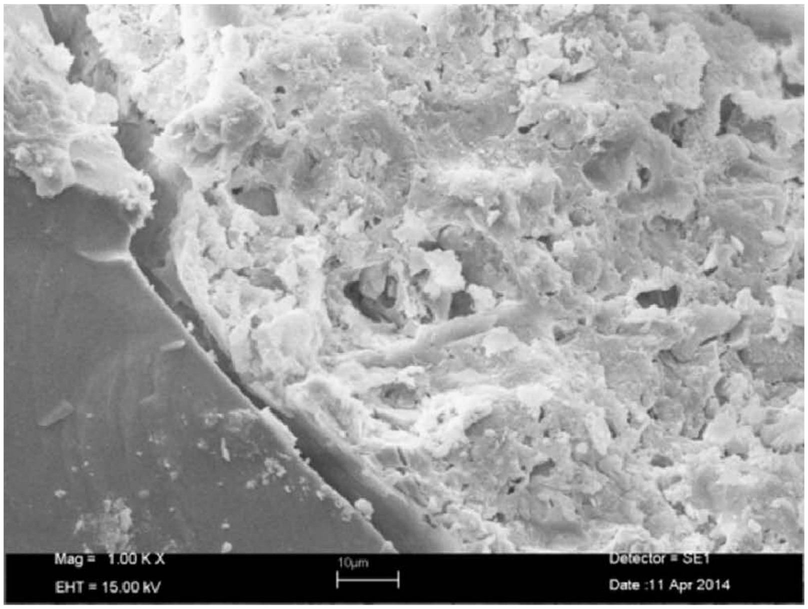


Fig. 3: (b) RFAC

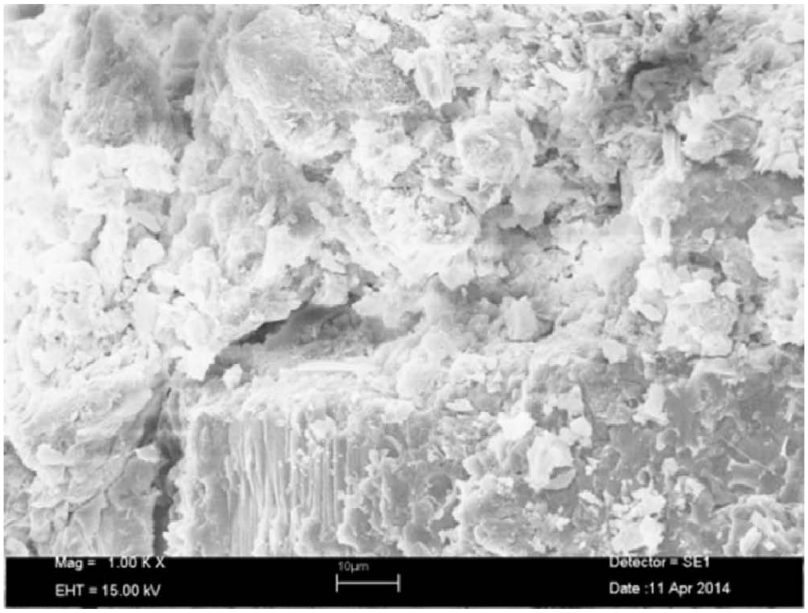


Fig. 3: (c) RFAC - $(600^{o})_{0.7M}$

Fig. 3: Microstructure of concrete mixes

Solar Thermal Air Conditioner

Nagesh Babu Balam, B.M Suman, S. Maiti & Somya Srivastava

Objective

To design and develop an air conditioner energized by solar energy for residential buildings

The design of Solar Thermal Air Conditioner (STAC) is shown in the Fig. 1.

The STAC shall have three main parts

i. Evacuated Flat Plate Solar collector
ii. Desiccant Wheel
iii. Indirect Evaporative Cooler

The design of each part is described below

1) Evacuated Flat Plate Solar Collector

The front view of Design of Evacuated Solar Flat Plate Solar Collector is shown in Fig. 2. The solar collector absorber sheet is made of SS sheet coated with black chrome paint with high absorptivity (>0.8) and low emissivity (<0.2). Solar Absorber sheet is covered with Toughened low iron ultra-clear glass with high transmittivity (>0.9) in-order to prevent the absorption heat loss. The entire metal casing is evacuated to minimize the convection loss. A novel sealent material consisting of Poly-sulphide and Butyl sealent is developed to create vacuum inside the solar collector and reduce the air pressure below 100 KPa. Vacuum Flanges are shown in Fig. 3. The assembled Solar Collector is shown in Fig. 4.

2) Desiccant Wheel

The desiccant rotor (the large rotating drum at the heart of the dehumidifier) has two different zones – a "process zone" which makes up about 75% of the area of the rotor and a "recharge zone" which makes up the remaining 25% of the rotor. The working of desiccant rotor is shown in Fig. 5. The warm humid air that enters the dehumidifier is pulled through the process zone. Here, moisture is adsorbed by the desiccant material. The incoming humid air goes through the process zone and immediately exhausts out of the dehumidifier. Covering the recharge zone of the rotor is a heater. It warms circulated humid air which is pulled back through the desiccant drum in the opposite direction of incoming humid air. This warm

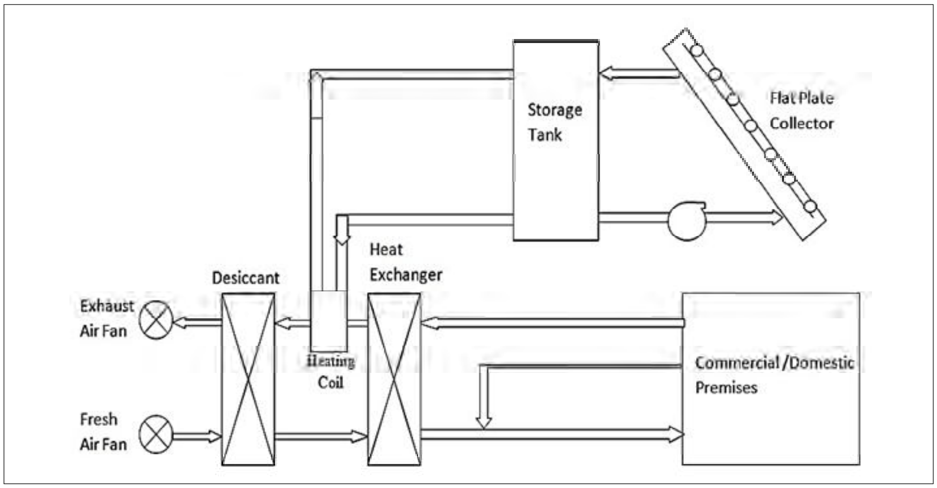


Fig. 1: Solar thermal air conditioner

air (heated by the heater) liberates moisture from the desiccant. Thus, moisture is transferred from the desiccant to the air. The warm humid air that leaves the recharge zone enters the condenser on the front of the dehumidifier. Here warm humid air condenses at room temperature. The condensate drips down into a condensate collection bucket, much the same way as it does in a compressor based dehumidifier.

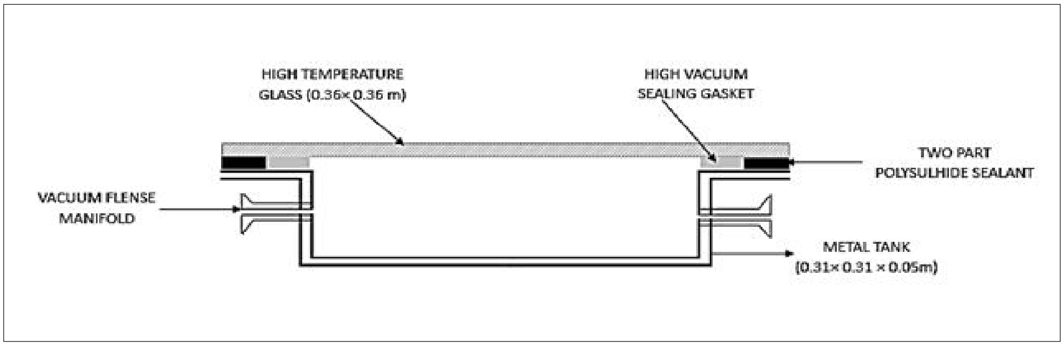


Fig. 2: Vacuum solar collector front view

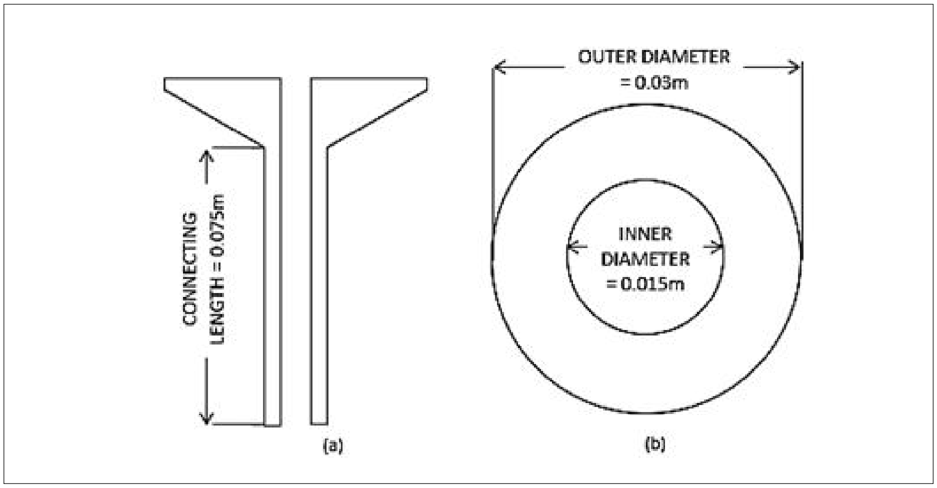


Fig. 3: Welded vacuum flange manifold (a) front view (b) top view

Fig. 4: Top view and side view of evacuated solar flat plate collector

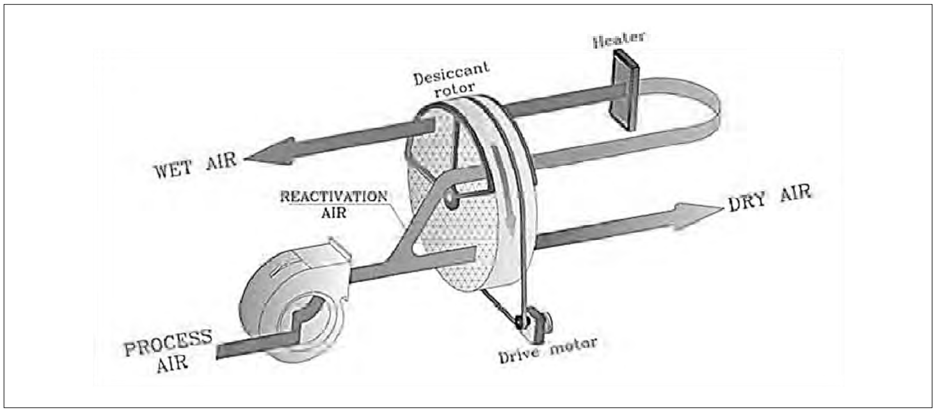


Fig. 5: Desiccant dehumidifier working principle

Mechanical Design of desiccant rotor is shown in Fig. 6, The following are the specifications of Desiccant Wheel: Adsorbent material- Silica gel

Air flow rate- 600 cfm, Diameter-0.443m, Depth- 0.2m. The fabricated desiccant wheel is shown in Fig. 7.

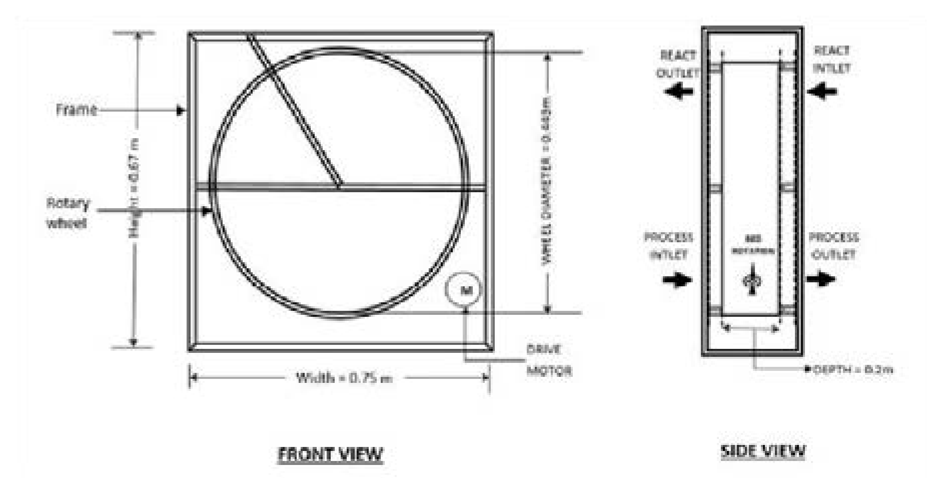


Fig. 6: Mechanical design desiccant rotor wheel with its frame

Fig. 7: Front and back view of fabricated desiccant wheel

Technology Packages for Mass Housing in Urban Areas

Ashok Kumar, Ajay Chourasia, Sayantani Lala, Shailza Singh & Team

Objective

Development of technology packages for mass housing in composite climatic region of India.

Significant Achievements

During the period, a study on the thermal behaviour of building envelope of the four storeyed and eight storeyed blocks of houses in composite climate was carried out to optimize the thermally efficient building envelopes. In composite climate, cooling load is maximum and the major amount of energy in naturally ventilated building is used to regulate the convective cooling (using fans, doors, windows etc.) or to cool down the indoors (evaporative coolers or air-conditioners). The simulation results (using Design Builder v.1.6.9.003) have indicated that the source of heat gain/ loss can help in identifying the design parameters that need to be considered to optimize energy use and thermal comfort.

The thermal properties of the conventional construction (burnt clay bricks walls and RCC roof) were simulated and compared with alternatives to analyse the effective reductions in the energy consumption and subsequently its effect on heat gains/ loss through the building envelope. It is notable that only wall assemblies were altered in order to evaluate the overall heat conduction flows, which considerably influence the energy-use and thermal environment of the buildings. The results show that in composite climate, use of Extruded Polystyrene in brick wall reduces the heat gain with significant reduction in energy consumption (up to 4%), as shown in Fig. 1. Design parameters like orientation, WWR, building form etc. are important variables as these significantly control the thermal behaviour of a building and therefore, it is imperative to consider these parameters at the early design stage.

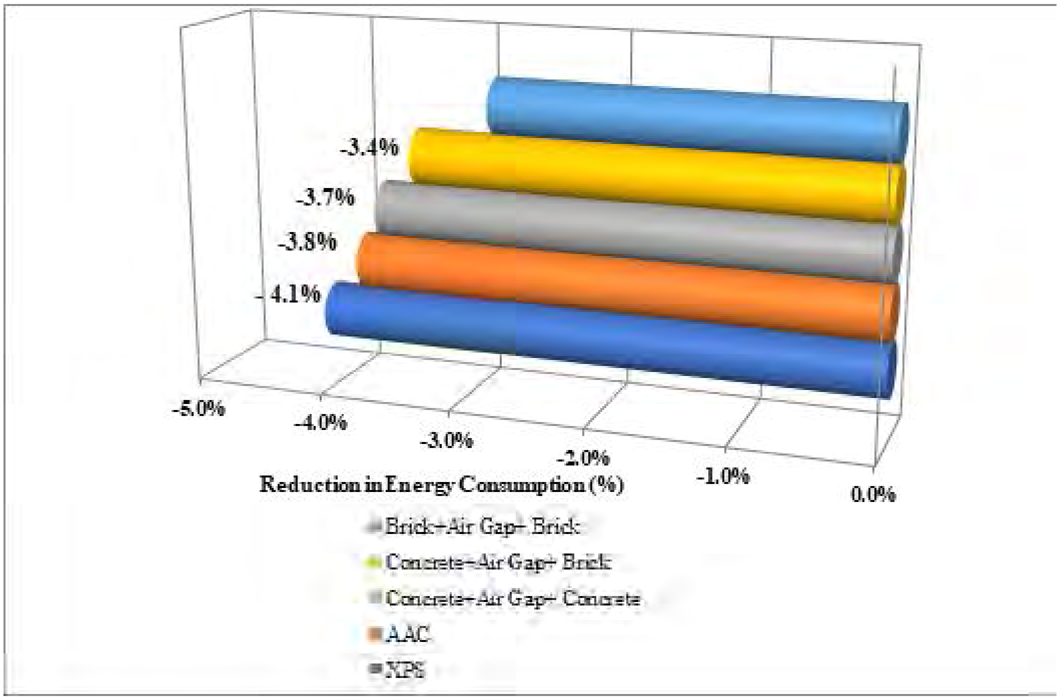


Fig. 1: Reduction in energy consumption by using alternative building systems

Development of a Hollow Gypsum Panel Making Machine

S.K. Panigrahi & Team

A machine for production of hollow gypsum panels has been developed at the Institute (Fig. 1). The raw material used the production of panel is Fluoro-Gypsum which is a waste of hydrofluoric acid industries. The developed machine is capable of producing five panels per batch presently and can be extended to ten panels per batch. The machine works on the principle of vibro-compaction technique. Pressure is applied by Hydraulic jacks and vibration is provided by vibrators mounted both on the mould and inside the cores for better flow of material. The panels produced are of superior in quality and look with accurate dimensions. The size of the panel is of 600 mm (length), 300 mm (height) and 150 mm (thickness) (Fig. 2). The weight of the panel is 40 kg and can be easily lifted by two persons. The compressive strength of the panel is 25 MPa. The panels are of interlocking type and after placing the panels the cylindrical openings are concentric. Reinforcement with suitable building materials inside the openings may be provided for the stability of the wall. The holes can also be used for channelizing water pipe lines and electric lines. The panels may be used in construction of inside walls of buildings and may be used in outer walls by applying proper coating/painting to protect it from water. The placement of developed panels for making walls is shown in Fig. 3.

Fig.1: Gypsum panel making machine

Fig. 2: Fluoro gypsum panels

Fig. 3: Proposed wall from inter locking fluoro gypsum panels

Development of Anti-Termite Barrier for New Buildings

B.S. Rawat

A method for preparation and processing of material for development of anti-termite barrier for buildings, structures and homes etc. and installation guidelines are disclosed, where the buildings or structure comprises an aerial structure and a foundation or structural units etc., which remain in contact with soil and extend upwards to structure. The particulate termite controlling composition of granular, graded, optimized and engineered material is developed, which is applicable inside as well as outside of buildings and/ or structural units, where they are in contact with surrounding soil. The developed material is solid, hard enough, non-degradable, non- biodegradable and non-pesticidal, therefore safe for humans, pet animals and provides long-term protection to buildings from crawling insects, white ants, and termites etc. The material is suitable and applicable for all foundation types/construction types and environmental conditions of India. The barrier is defined as anti-termite physical barrier which incorporate single or combination of one or more suitable inert raw material. The crawling insects and/or other insects are deterred and prevented from entering into buildings by creating suitable thick/thin layer of impenetrable material. In insect controlling process; a layer of developed material in desirable thickness is applied on the path or route of insect from where it enters into buildings. The use of developed material effectively controls incursion of crawling insects e.g. termites in treated buildings. The invention is particularly suitable for new buildings, construction sector, slabs, buried walls, block / stone walls/ foundations slabs especially for Indian climatic conditions. It creates an impenetrable barrier between crawling insects present in soil and its food present in buildings. The present invention also relates to the development of a physical barrier or composition to protect a site or building from ingress or attack of crawling insects present in the soil e.g. termites and guidelines for installing or creating the same (Fig.1).

Fig. 1: Termite and its damage in buildings

The main advantages of the present invention are as follows:

- The developed anti-termite barrier is environment friendly and does not employ toxic chemicals, insecticides, pesticides or other hazardous substances. Therefore, it is safe for health aspect.
- Sharp edged particles become interlocked with minimum interstitial spaces when compacted. Therefore, termite cannot pass through it.
- The material is highly durable, non-compressive. It neither degrades nor decomposes in the soil. It is engineered to give life- long protection to buildings.
- It gives long term protection than all other conventional anti-termite treatment measures including pesticides and baiting system etc.
- The developed barrier is permanent and does not require retreatment or reapplication.
- The developed anti-termite barrier does not substantially increase the complexity and cost of construction.
- The developed anti-termite barrier is easily installed in buildings, multifunctional and improves over the state of the art.
- The developed anti-termite barrier plays an important role to minimize industrial waste.
- Raw material is freely available in India. Therefore, it is cheaper than any other alternative for termite management in buildings.
- It supports superstructure and helps in Radon mitigation.
- It is installed with the original building or retrofitted, variety of forms and configurations, including in combination with other construction materials.
- It is adaptable to a wide variety of construction types and locations of India.
- It has flexibility to adapt to different engineering designs.
- It is a part of the construction material.
- It obviates the need for additional cost and material for example specialize drainage materials, insulation materials, radon mitigation systems and termite protection etc.

WP-4 Materials & Technologies for Hazard Reduction

S.R. Karade & Team

Development of Indigenous Cathodic Protection System for RC Structures

S.R. Karade & Team

Objectives

- To formulate procedures for designing Cathodic Protection (CP) system using indigenously available/ new components for RC structures
- To implement the technology in real/live RC structure and assess effectiveness.

Significant Achievements

Corrosion causes loss of about 4 % of India's GDP annually. Approximately Rs. 2 lakh crores is lost due to corrosion and Rs. 13,500 crores particularly in RC structures. To control and mitigate corrosion of steel in RC structures, an indigenous cathodic protection (CP) system has been developed in this Task. CP is an electrochemical technique to control corrosion and most effective in chloride affected RC structures. In developed countries it is widely used, but in India it is not popular yet due to lack of skills.

In this project, a cementitious anode overlays have been developed as auxiliary anodes using carbon based fillers such as coke breeze, graphite powder, pyrolytic carbon black and carbon fibre for cathodic protection. Out of these, carbon fibre showed the best results in terms of bond strength with the substrate and electrical conductivity. Also, a power supply unit and monitoring system have been designed and fabricated. First the system was implemented on slab specimens in the laboratory. After successful experimentation, it has been implemented on live RC structures. For this purpose, 3 RC columns were constructed (Fig. 1). One column for Impressed Current Cathodic Protection (ICCP) system, one for Galvanic Anode Cathodic Protection (GACP) and one without any protection for comparison purpose.

In all the 3 columns during casting the concrete was contaminated with 3% common salt by weight of cement. Each column has a permanent reference electrode (Ag/AgCl) embedded in it for monitoring purpose (Fig. 2). The corrosion is being monitoring in these columns through the permanent reference electrodes, external half-cell potential and LPR measurement. The data of half-cell potential of steel obtained by the embedded reference electrodes in the columns is shown in Fig. 3. The data show that the steel is going towards passivation and all the three columns are showing similar potential as the composition of the three columns is same. However, before application of cathodic protection it was appropriate to bring the steel in active state i.e. in corroding state. Therefore, the corrosion rate was accelerated through supply of current in reverse direction of ICCP.

Fig. 1: Three RC columns for experimental CP application. Placement of conductive overlay on middle column (ICCP) in process

Fig. 2: Placement of embedded permanent reference Ag/AgCl electrode before casting of columns

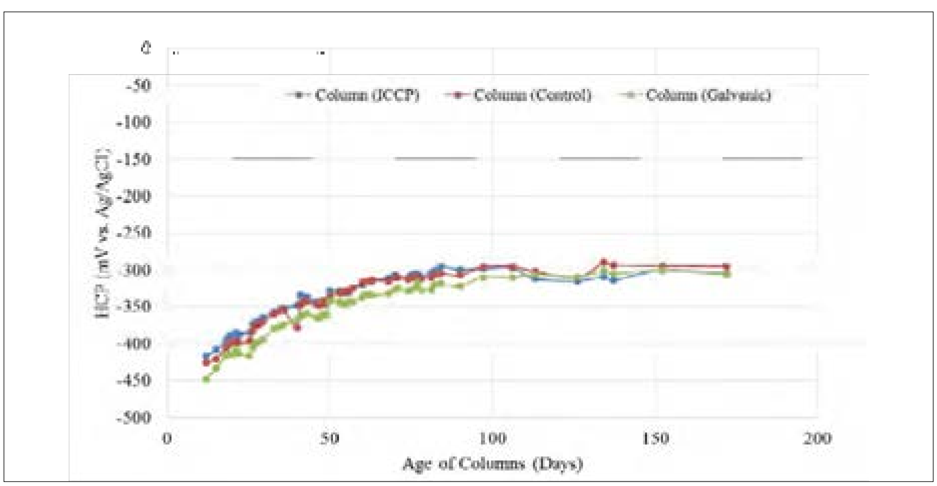


Fig. 3: Half-cell potential obtained from embedded reference electrodes

When the half-cell potential reached more negative than 400 mV w.r.t. Ag/AgCl reference electrode, the current supply was stopped. Afterwards the current has been supplied in the ICCP column and galvanic anodes were connected to steel rebars in GACP column. The CP system is being monitored continuously (Fig. 4). So far the CP system is performing well and responding as per expectations.

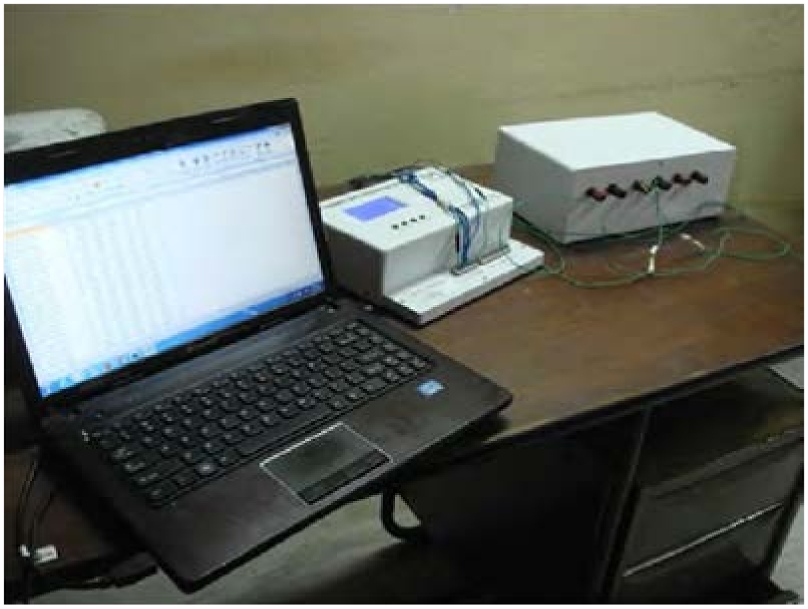


Fig. 4: CP monitoring system

Development of Fire Safe Polymeric Composite Panels

Harpal Singh

Objective

To develop fire retardant composite panels with reduced smoke and toxicity.

A composite panel consists of two thin and stiff outer and inner face sheets bonded to a thick low-density core, forming a lightweight efficient structure. The preparation of core (rigid polyurethane foam) requires two main liquid components such as polyol and polyisocyanate. The blowing agent is added to the polyol together with further auxiliary components such as catalyst, surfactant, chain extender and fire-retardant additives. The polyaddition reaction that takes place when the polyol and polyisocyanate are mixed together results in macromolecules with urethane structures. During the reaction process a considerable amount of heat is released which is used partly to evaporate readily blowing agents and as a result, the reaction mix is expanded to form a foam. This foam is used as a core material during the preparation of composite panels. The final properties of a composite panel depend on the core type, outer and inner face sheets type and face-to-core bonding. Rigid polyurethane foam is the first choice as core material in a composite panel due to its predominately low-density cellular structure, diffusion proof, low thermal conductivity and good dimensional stability. The properties of composite panel having rigid polyurethane foam as core material need to be improved are its flammability, smoke and toxicity. The applications of such composite panels are in the building construction and industries as lining material and panels. The other important applications are in telecommunication shelters, defense shelters and cold storage industry etc. Some significant achievements on the important properties of composite panels such as fire retardancy and toxicity index are presented.

Flammability of Composite Panel

The flammability performance of prepared composite panels was investigated as per BS 476 part 7. It specifies a method of test for measuring the lateral spread of flame along the surface of a specimen orientated in the vertical position under opposed flow conditions, and a classification system based on the rate and extent of the spread of flame. It provides data suitable for comparing the end-use performances which are used primarily as the exposed surfaces of walls or ceilings. Panels were prepared in the size of 900x270x50 mm and conditioned to constant mass at a temperature of 25^{0}C and a relative humidity of 50% and maintained in this condition until required for test. Prior to the test, the exposed face of panel was marked on its surface with vertical and horizontal reference lines along its length and 95 mm above its bottom edge for the observation of flame travel and classification. Pilot burner of 100 mm luminous flame was ignited after mounting the panel in the test position. Pilot flame was extinguished after start of the test. panel was exposed to 35 kW/m2 radiant heat source either for 10 min. or when the flame front reaches 825 mm reference line. After complete exposure, it was observed that control sample start burning after some time and then flame also spread on its surface whereas, core material of fire retardant composite panel did not burn and only turned into char residue. This char residue acts as insulating blanket and reduces the flame spread rate significantly on the surface of composite panel having fire retardant core material. The flammability and flame spread test results are presented in Fig. 1. These results showed that fire performance of prepared composite panels was increased significantly.

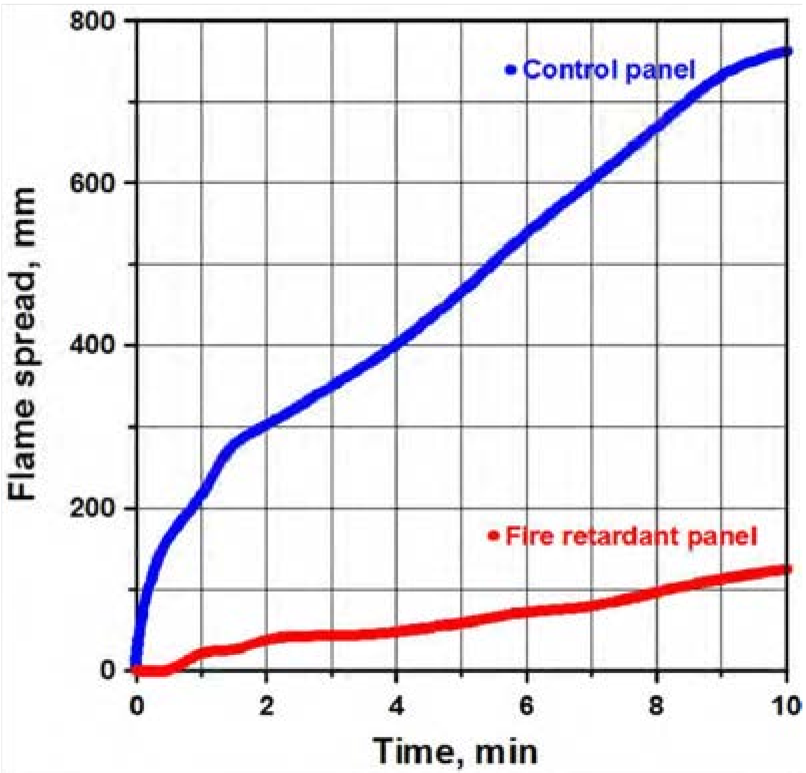


Fig. 1: Fire performance of control and fire resistant composite panels under standard test

Combustion Products & Toxicity Index Investigation

The toxicity of control core material and comparison with fire retardant samples was investigated according to NES-713. The NES-713 gives the requirements of one of a series of test methods for determining the combustion characteristics of materials. The NES-713 has been offered the concentration from 14 different toxic gasses expressed as a factor of the concentration fatal to human at a 30-min exposure time. Specimens of the size of 20×20 mm were entirely engulfed in flame during the test. A total of three samples for each material were used for toxicity test. The mass of the test specimen is 0.05–0.5 g and is chosen to provide optimum analytical precision. The test specimens are to be conditioned at 25^{0}C ±2^{0}C and 50 ± 10%RH for 24 h before testing. The burner is to be capable of achieving a flame approximately 100 mm in height and having a temperature of 1150^{0}C ±50^{0}C to finish complete combustion from adjusting methane and air flow rates of 2 l and 10 l/min respectively. The various colorimetric gas reaction tubes were used to measure toxic constituents and contents, and obtain the background correction factor about the concentrations of carbon monoxide, carbon dioxide and oxides of nitrogen for 1 min, 2 min and 3 min in separate determinations. The various colorimetric gas reaction tubes were used to measure toxic constituents and contents. Toxicity index (TI) was then calculated to evaluate the combustion characteristic of the specimens. The influences of toxic constituents and contents on the toxicity characteristic of testing materials were examined. It was found that significant differences existed between control core material and fire retardant additives added core material samples. The results showed that the toxicity of control core material was much higher than that of fire retardant core material samples. The toxicity index of control and fire-retardant core material samples is shown in Fig. 2.

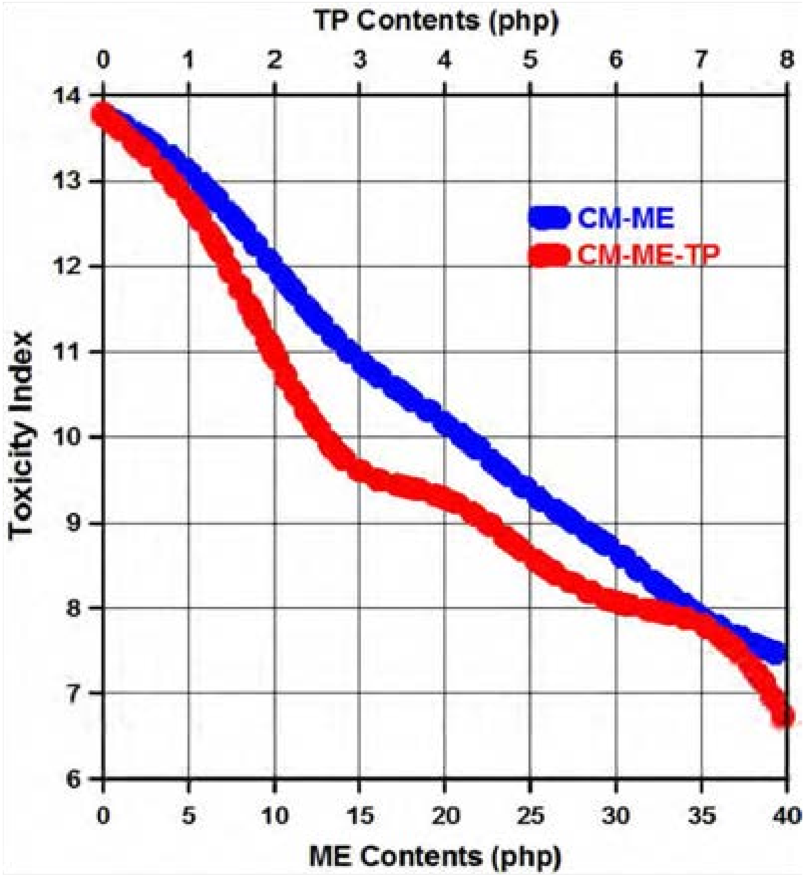


Fig. 2: Toxicity index of control and fire-retardant core materials

Overall it is concluded that the flammability and flame spread performance of composite panels having fire retardant core material than the composite panels with flammable core material is enhanced significantly. It is also concluded that composite panels with fire retardant core generate less toxic combustion products as compare to the composite panel with flammable core materials. Thus, developed composite panels can be used safely in many applications without any adverse effect on the environment.

A Performance Based Design Method for Impact Resistant RC Beams

A.K. Mittal, M.M. Dalbehera, Bharat Bhusan & Jalaj Parashar

Objective

- Experimental study of impact behaviour of RC Beams by drop weight impact tests.
- Prediction of impact behaviour of RC beams by non-linear FEM analysis.
- Establish relationship between impact energy, flexural capacity, maximum and residual deflection for RC Beams for Performance Based Design (PBD).

Significant Achievements

- The amount of longitudinal reinforcement affects the failure modes of RC beams under multiple impact loading.
- The RC beam with comparatively lower amounts of longitudinal steel reinforcement exhibits only overall flexural failure, while the RC beam with the comparatively higher amounts of longitudinal reinforcement exhibited not only the overall flexural failure but also local failure located near impact loading zone, because of concentration of stresses.
- When subjected to multiple impacts, beams with high amount of tensile reinforcement causes local failure near the impact loading point, while the amount of longitudinal compressive reinforcement tends to affect the degree of the local failure in the beam. This may be because of the fact that, while tension reinforcement is increased, the beam become stiffer and it is not able to dissipate the impact energy coming from the impactor in a ductile manner.
- Longitudinal compressive reinforcement affects the degree of local failure. This is because, though cracks in the RC beam subjected to impact loading starts from the bottom of the section (as in the case of static loading), but a significant amount of force needs to be absorbed by the compression reinforcement at the top of the section (right at the time of the impact). Here the amount of compression reinforcement plays a crucial role in restricting the extent of local damage the beam can undergo. Local failure is reduced when compression reinforcement of higher percentage was provided.
- The maximum displacement is inverse proportional to the mean impact force. The maximum displacement is in proportional relation to the value of the mean impact force divided by impact energy.
- Maximum displacement of the beam is proportional to the impact energy divided by the static ultimate bending capacity.
- Relationship between Impulse (Ip) and momentum at the time of Collision has been found out to be Ip = 1.43 Mcol, whereas relationship between Max. Deflection and Ecol/ Mean Impact force has been found out to be Max. Deflection= 0.45(Ecol/Pm). Where Ecol represent Kinetic energy at the time of collision, Mcol is Momentum at the time of collision and Pm represents Mean Impact force.

Improved Ventilation System for Cleaner Built Environment

Shailza Singh, Syed Ibrahim Sohel and A.K. Minocha

Objective

To design and develop an Improved Ventilation System to reduce inhalable particles in built environment.

Introduction

This project aims at developing an improved ventilation system to curb inhalable particulate matter in the breathing zone (indoor) of the buildings. To achieve this, experimental data on indoor particle dynamics under the influence of human activities and ventilation was studied with the aim to develop a model which will help in designing an improved ventilation system.

Summary of Work Done

- Design and construction of test facility to study particle dynamics in indoor environment has been developed.
- Data generated on effect of human walking induced disturbance at a point on movement of $P_{2.5}$.
- Vertical profiling of the particulate matter (seasonal, outdoor/indoor) for exposure assessment and to identify the potential hotspots of PM2.5.
- Particle capturing efficiency of commercial devices available in market is investigated.

Experimental Description:

The vertical profiling of air velocity and particle concentration was carried out. The layout of the room is presented below (Fig. 1 and Fig. 2). The room has two AC's & one doors with the working desk in the middle. A multi-channel hotwire anemometer with 3 uni-directional probes & 1 Omni-directional probe is used for measuring air velocity. Aerosol spectrometer is used to measure the particle counts and mass concentration by applying Kinetic sequential sampling (KSS) system. The measurements were taken with both AC's on and off conditions.

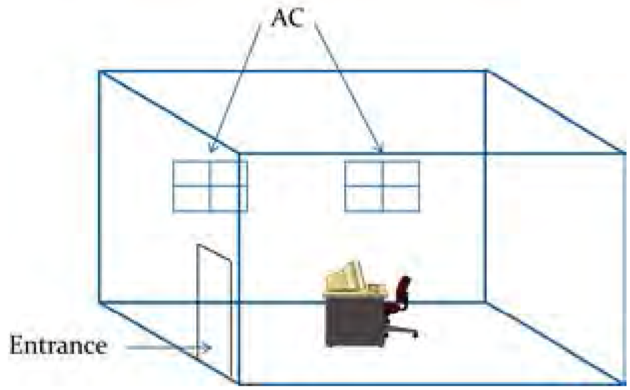


Fig. 1: Experiment site

Model	SHARP FU-A80E-W
Area Coverage	300 sq. ft.
No. of Air Purifiers used	2

Fig. 2: Air purifier used for investigation

Experimental Setup

- Multi-channel hotwire anemometer with 3 uni-directional probes and 1 omni-directional probe
- Aerosol spectrometer measuring particle counts and mass concentration
- Test Conditions – with and without AC operation.

Efficiency or Effectiveness of Commercially Available Air Purifier Device

The particle capturing efficiency of commercially available air purifiers are investigated for the experimental site. Indoor particle concentration is measured Aerosol Spectrometer for AC on and AC off condition at different vertical levels i.e. 0.1 m, 0.8 m, 1.3 m and 1.75 m. Commercially available air purifier (SHARP FU-A80E-W) with an area coverage of 300 sq. ft. is used for the study. The area of the experimental site is around 600 sq. ft. and therefore, two air purifiers are used. Each set measurement is run for almost 30 minutes continuously to count the PM 2.5 at different vertical level. In total1 runs were done for each vertical height (0.1 m, 0.8 m, 1.3 m and 1.75 m) for air conditioner on and off conditions. Following observations are made:

- The concentration of PM 2.5 under AC OFF condition is higher as compared to AC ON condition due to pollutant build-up and less turbulence.
- A considerable decrease is observed in the PM2.5 level at 0.8m level when AC and air purifier ON (Fig. 4)
- ACs OFF and Air Purifier ON: critical heights are 0.8m, 1.3m and 1.75m (Fig. 4)
- ACs ON and Air Purifier ON: critical heights are 1.3m and 1.75m.

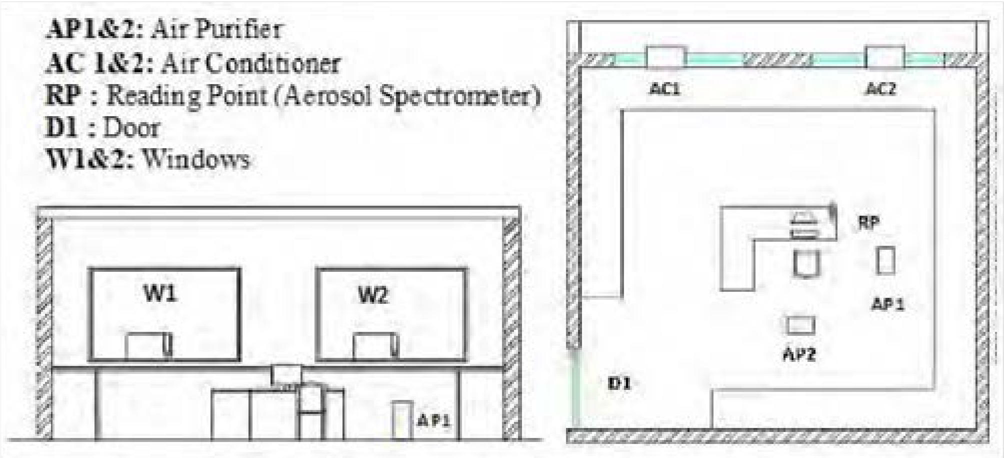
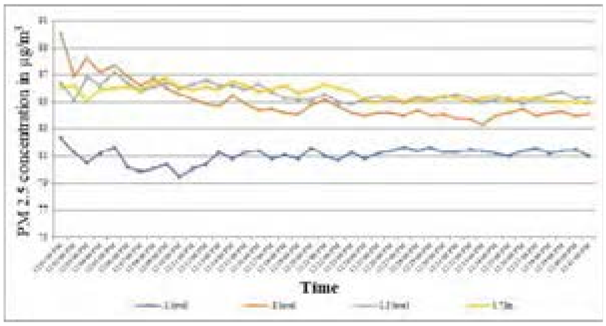
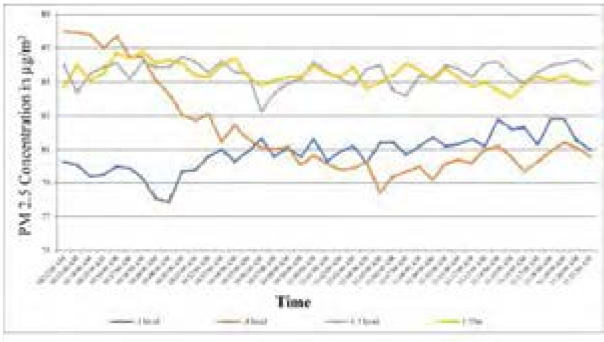


Fig. 3: Layout of the experimental site (Room 226)



a. ACs off and air purifier on



b. ACs on and air purifier on

Fig. 4: Indoor particle concentration at 0.1 m, 0.8 m, 1.3 m and 1.75 m level

Summary of Results

- Effect of human activities plays an important role in re-suspension of particles from surfaces.
- Indoor particle concentration increased due to pollutant build-up inside the room when there is no ventilation and no occupancy.
- Vertical profiling of particulate level is done to assess the potential hazard at various levels for indoor (using Kinetic Sequential Sampling System) and outdoor (using CALINE model) conditions.
- Seasonal monitoring of indoor and outdoor $PM_{2.5}$ levels is done for a period of 10 months from November 2014 (an average of 8 hours monitoring for 6-10 times a month).
- Design and fabrication of an experimental setup is completed to study the re-suspension of particulate matter.
- The concentration of PM 2.5 under AC off condition is higher as compared to AC ON condition due to pollutant build-up and less turbulence. Critical heights identified are as follows:
  - AC's off and Air Purifier ON: 0.8m, 1.3m and 1.75m
  - ACs ON and Air Purifier ON: 1.3m and 1.75m.

Network Projects

(ESC 0102)

Engineering of Disaster Mitigation & Health Monitoring for Safe & Smart Built Environment (EDMISSIBLE)

Engineering of Disaster Mitigation & Health Monitoring for Safe & Smart Built Environment (EDMISSIBLE)

WP-1: Engineering of Landslide Disaster Mitigation
PI: S. Sarkar & D.P. Kanungo

- Landslide Hazard and Risk Assessment in Chamoli-Joshimath Region of Garhwal Himalaya
  PI: D.P. Kanungo & S. Sarkar
- Early Warning Instrumentation & Decision Package for a Landslide in Chamoli-Joshimath Region of Garhwal Himalaya
  PI: D.P. Kanungo & S. Sarkar
- Comprehensive Geo-Investigation and Control Measures for a Landslide in Chamoli-Joshimath Region of Garhwal Himalaya
  PI: S. Sarkar

WP-2: Engineering of Earthquake Disaster Mitigation
PI: Ajay Chaurasia & P.K.S. Chauhan

- Seismic Microzonation of Srinagar, Uttarakhand
  PI: P.K.S. Chauhan
- Seismic Behaviour of Piles under Dynamic Lateral Loading
  PI: S. Ganesh Kumar & M. Samanta
- Performance of Confined Masonry Buildings under Quasi-Static Condition
  PI: Ajay Chourasia

WP-3: Engineering of Fire Disaster Mitigation
PI: Chimote & Suvir Singh

- Development of Low Ozone Depletion Potential (0.01-0.5) Innovative Fire Suppression System
  PI: R.S. Chimote

WP-4: Post Disaster Shelter Planning
PI: S.K. Negi

- Post Disaster Shelter Planning for Rural Areas in Western Himalayan Region
  PI: S.K. Negi

WP-5: Health Monitoring of Buildings using Wireless Sensor Network
PI: Ajay Chaurasia & Soju Alexander

- Development & Validation of Health Monitoring Approach using Wireless Sensor Network for Steel & Reinforced Concrete Buildings
  PI: Ajay Chourasia

WP-6: Intelligent Building System for Model Residential Unit
PI: R.S. Bhisht & Achal Mittal

- Architectural Planning and Design of a Residential Unit integrating Intelligent Building Features
  PI: Ashok Kumar
- Intelligent HVAC & Lighting Controls in Response to Ambient Environment
  PI: Nagesh Babu Balam
- Glass Facade Cleaning Robot
  PI: R.S. Bisht

WP-1 Engineering of Landslide Disaster Mitigation

S. Sarkar & D.P. Kanungo

The occurrence of landslides is a common phenomenon in the Himalayas which presents rock types, tectonic zones, topographic reliefs and slopes of diverse nature. In recent years, implementation of a number of hydro-electric schemes, large scale construction activities as well as indiscriminate mining and quarrying have further aggravated the problem manifold. These landslide incidences have been of serious concern to the society due to loss of life, natural resources, infrastructural facilities, etc. and also posing problem for future urban development. With this in view a project on "Engineering of Landslide Disaster Mitigation" has been undertaken under the 12th Five Year Plan. The objectives of the project are as follows:

- Landslide hazard and risk assessment of Chamoli-Joshimath region
- Development of a landslide early warning system
- Comprehensive geo-investigation for design & development of cost effective landslide control measures

Landslide Hazard and Risk Assessment in Chamoli-Joshimath Region of Garhwal Himalaya

D.P. Kanungo & S. Sarkar

The proposed task is focused on large scale landslide hazard and risk mapping in Chamoli-Joshimath region of Garhwal Himalaya.

Various thematic data layers pertaining to the causative parameters for landslides in the Chamoli-Joshimath road corridor of NH-58 along the Alaknanda valley of Garhwal Himalayas have been prepared using high resolution GeoEye remote sensing data (0.5m spatial resolution) and field information. The thematic data layers such as slope, slope aspect, geology, drainage, drainage buffer, road buffer, land use land cover and landslide layers (Fig. 1) have been prepared in GIS. These thematic data layers are integrated to spatially classify the study area into different zones of landslide susceptibility. The landslide density values as observed in different categories of various causative factors of landslide occurrences are given in Table 1.

Table 1: Landslide densities in different categories of causative factors

Factor	Categories	% Area	% Landslide Area	Landslide Density	Factor	Categories	% Area	% Landslide Area	Landslide Density
Lithology	Dolostone	45.85	96.2	2.10	**Slope (deg)**	0-20	22.55	2.13	0.09
	Quartzite	49.58	3.8	0.08		20-30	22.89	2.22	0.10
	Crystalline	4.56	0	0		30-40	22.56	9.90	0.44
Land use Land cover	Sparse forest	25.11	2.73	0.11		40-50	20.88	0.16	0.01
	Barren land	13.84	80.25	5.80		50-60	8.01	70.30	8.78
	Agriculture	27.38	1.49	0.06		>60	3.11	15.30	4.92
	Shrub/grass	14.08	7.45	0.53	**Aspect**	N	88.49	91.22	1.03
	Thick Forst	16.61	8.07	0.49		NE	1.50	0.58	0.38
	Habitation/Buildup	2.98	0	0		E	0.40	0.02	0.04
Drainage Buffer (m)	0-50	28.77	56.46	1.96		SE	0.06	0.01	0.08
	50-100	18.99	2.92	0.15		S	0.39	0.03	0.07
	100-300	27.85	38.18	1.37		SW	1.27	0.60	0.47
	300-500	15.39	2.45	0.16		W	4.00	1.81	0.45
	500-1000	7.42	0	0		NW	3.90	5.75	1.48
	1000-3000	1.58	0	0					

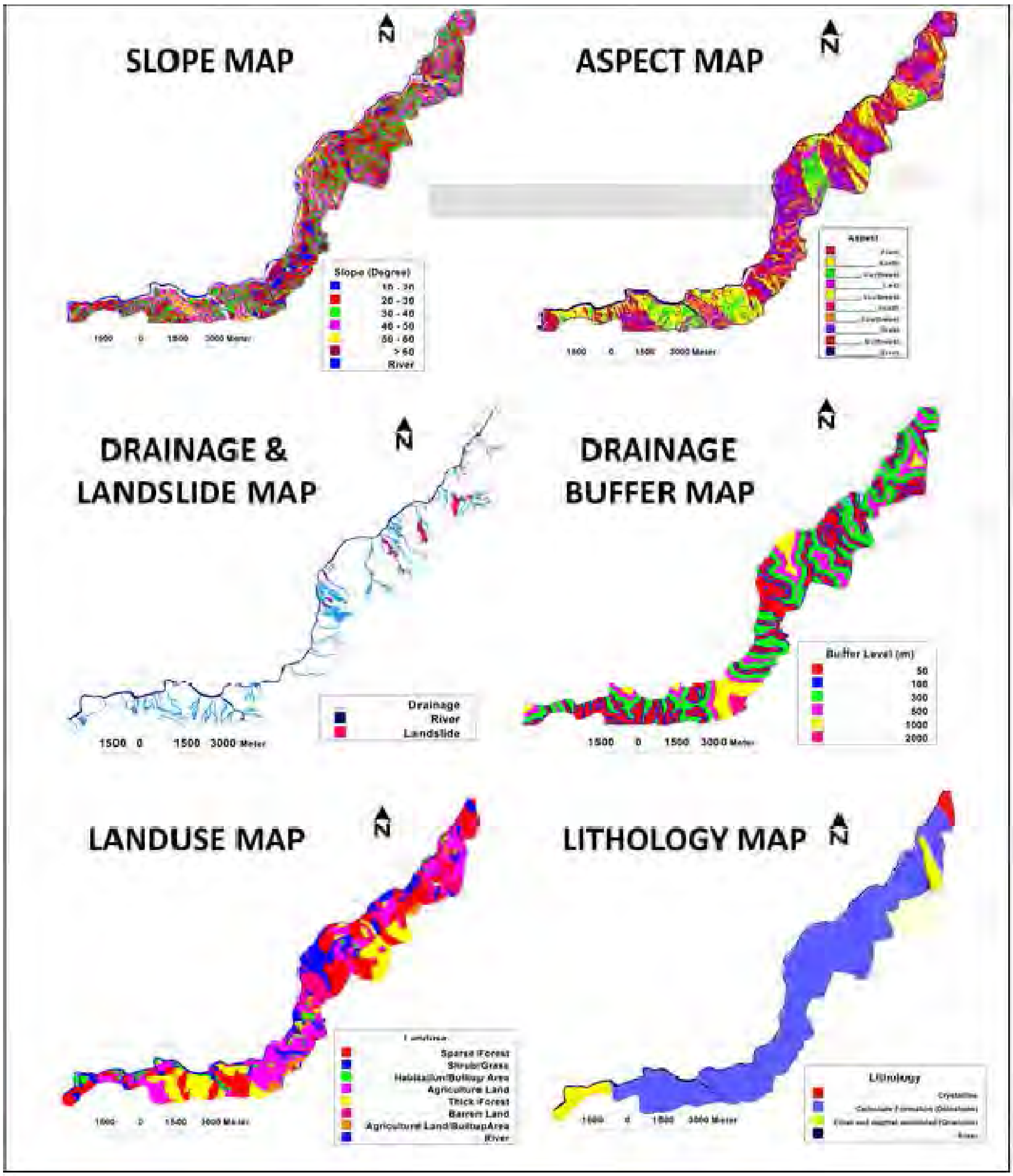


Fig.1: Thematic data layers prepared in GIS pertaining to landslide causative factors

Early Warning Instrumentation & Decision Package for a Landslide in Chamoli-Joshimath Region of Garhwal Himalaya

D.P. Kanungo & S. Sarkar

The objective of this task is to develop a region specific operational Landslide Early Warning System based on multi parameter trigger thresholds. The system will include sensing instruments, real time data transfer system, decision making mechanism & the multi-level alarm signal dissemination.

The proposed project aims at the development of a landslide early warning system (LEWS) based on multi-parametric real-time monitoring through suitable field instrumentation.

In this direction, a Landslide Observatory with wireless instrumentation for real time monitoring of ground deformation and hydrologic parameters has been established at Pakhi Landslide along the Alaknanda Valley of Garhwal Himalayas, India. This observatory is one of its first kind in Northwest Himalayas of India for real-time monitoring of an active landslide.

In this attempt, both surface and sub-surface sensors were installed on the landslide area. Two types of information such as actual displacements/ movements at different locations in the landslide area and environmental/weather conditions that affect the sliding activity have been targeted with the combination of surface and sub-surface mounted monitoring sensors. Surface sensors include wire-line extensometers (WLE) and automatic weather station (AWS). Three numbers of wire-line extensometers have been installed across the radial tension cracks developed on the landslide body to monitor the detachment/displacement of the downhill block from the uphill block of the landslide mass. Automatic weather station includes different instruments/sensors to measure rainfall, air temperature, relative humidity and wind velocity and direction. Sub-surface sensors include biaxial in-place inclinometers (IPI) installed at different depths within a particular material and in the interface zones down the bore hole (BH) to measure the sub-surface displacements/movements and vibrating wire piezometers (VWP) in the bore holes to measure the variation in pore water pressure. Depths of these sensors were decided on the basis of bore hole geological logging information. In total, 16 in-place inclinometer sensors and 4 piezometric sensors were installed in total 8 different bore holes (Table 1). The suitable casings for installation of IPI sensors are placed in all the boreholes beyond the interface of greatly weathered bedrock and unweathered bedrock for accurate measurements except borehole 3 due to site constraints. The surface sensors are particularly subject to disturbance by animals; theft etc. and hence, are protected by providing wire mesh cages around the sensors at the site.

Table 1: Sensor details in different boreholes

Borehole No.	Type of Sensor	No. of Sensor	Sensor Depth (m)	Material at Sensor Depth	Displacement (mm)	
					A-axis	B-axis
1	Vertical Biaxial In-place Inclinometer	4	2.92-3.32 6.17-6.57 9.67-10.07 13.02-13.42	Colluvium Colluvium Colluvium Interface between colluvium and unweathered bedrock	0 0 1 2	0 0 0 0
2	Vibrating Wire Piezometer	1	17.60-18.0	Interface between greatly weathered bedrock and unweathered bedrock	-	-
3	Vertical Biaxial In-place Inclinometer	5	0.90-1.30 3.00-3.40 6.60-7.00 10.05-10.45 13.50-13.90	Colluvium Colluvium Colluvium Interface between colluvium and greatly weathered bedrock Greatly weathered bedrock	0 0 1 3-4 6	0 0 0 3-4 1
4	Vibrating Wire Piezometer	1	7.6-8.0	Interface between greatly weathered bedrock and unweathered bedrock	-	-
5	Vertical Biaxial In-place Inclinometer	3	1.07-1.47 3.57-3.97 7.02-7.42	Colluvium Colluvium Interface between colluvium and unweathered bedrock	1-2 5-6 2-4	2-10 2-4 1-4
6	Vibrating Wire Piezometer	1	10.1-10.5	Interface between greatly weathered bedrock and unweathered bedrock	-	-
7	Vertical Biaxial In-place Inclinometer	4	2.30-2.70 5.29-5.69 10.95-11.35 14.45-14.85	Colluvium Greatly weathered bedrock Greatly weathered bedrock Interface between greatly weathered bedrock and unweathered bedrock	0 2-4 6-8 2-3	0 1 8-9 3-4
8	Vibrating Wire Piezometer	1	8.1-8.5	Interface between greatly weathered bedrock and unweathered bedrock	-	-

All these surface and sub-surface sensors except AWS are connected through wire to the specific nodes placed in close proximity to the sensors. These nodes are communicating wirelessly with the gateway placed in the field control station. AWS is connected to the data acquisition system (DAS) also placed in the field control station to store the data. The data from the field control station are being transferred on real-time to the control computer at CSIR-CBRI, Roorkee through web server using ARGUS monitoring software. The commercially available ARGUS software designed for landslide monitoring is used for data analysis and visualization. The reference reading for all the sensors corresponds to 29th September 2014 (i.e., the date on which the monitoring system made operational).

The annual cumulative rainfall at the landslide site during 2015 was recorded 1388 mm with the cumulative monsoon period (June to September 2015) rainfall of 823.5 mm. During monsoon period, there were two occasions with somewhat higher intensities of rainfall during 25th June to 12th July having around 350mm and during 6th August to 14th August having about 175mm of rainfall (Fig. 1).

The extent of displacements in IPI sensors along different boreholes on both A-axis (aligned in the slope direction) and B-axis (perpendicular to A-axis) are also given in Table 1. Fig. 1 and Fig. 2 demonstrate the displacements measured by IPI sensors in different boreholes along both A-axis and B-axis respectively except those measurements with zero displacement (refer to Table 1). From the IPI data (BH-1) at the crown of the landslide beyond the main scar, it is observed that there is negligible displacement on sub-surface sensors along both the axes (Table 1, Fig. 1 and Fig. 2) which was as expected being the stable part of the slope.

On the uphill slope at the boundary of main scar, displacements of the order of 3-4mm in both axes at a depth of 10.45m (i.e., interface between colluvium and greatly weathered bedrock) and of about 6mm along A-axis at a depth of 13.9m (i.e., within greatly weathered bedrock) in borehole 3 (BH-3) are observed (Fig. 1 and Fig. 2). At the middle portion of the landslide left to the central drain in borehole 5 (BH-5), maximum cumulative displacements of about 10mm along B-axis at a depth of 1.47m (Fig. 2) and about 5-6mm along A-axis at a depth of 3.97m (Fig. 1) within the colluvium are observed. At this location, the interface between colluvium and

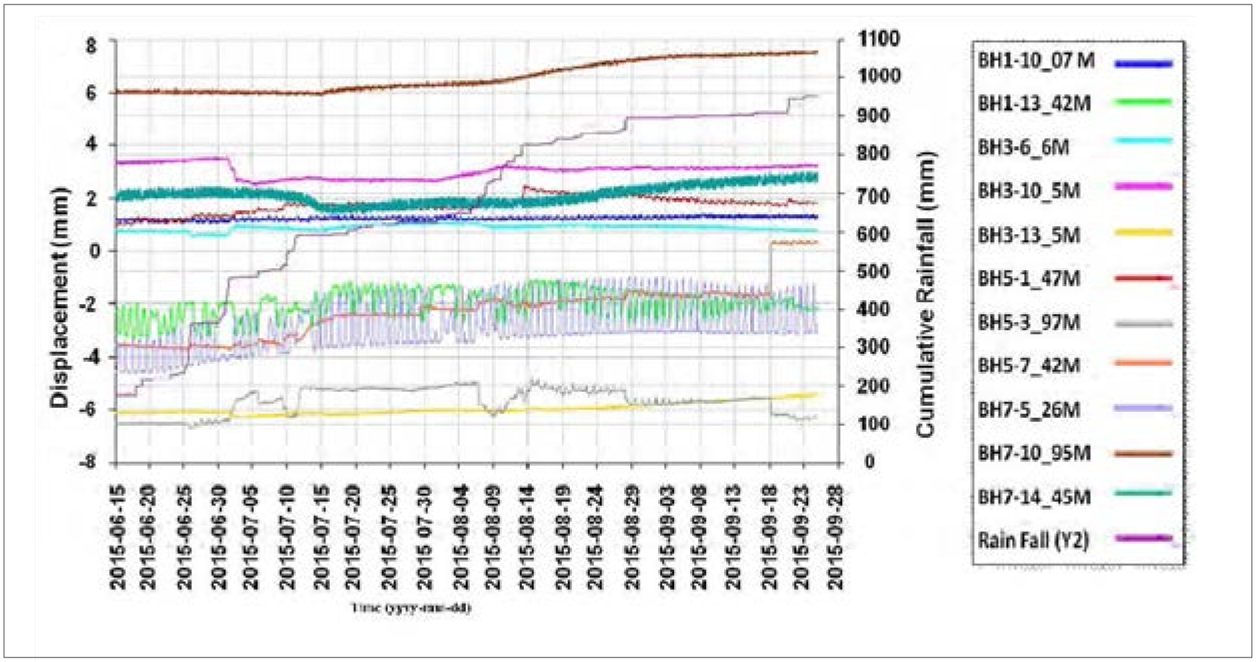


Fig. 1: Cumulative displacement (mm) as observed from IPI sensors (A-axis) in boreholes during monsoon period

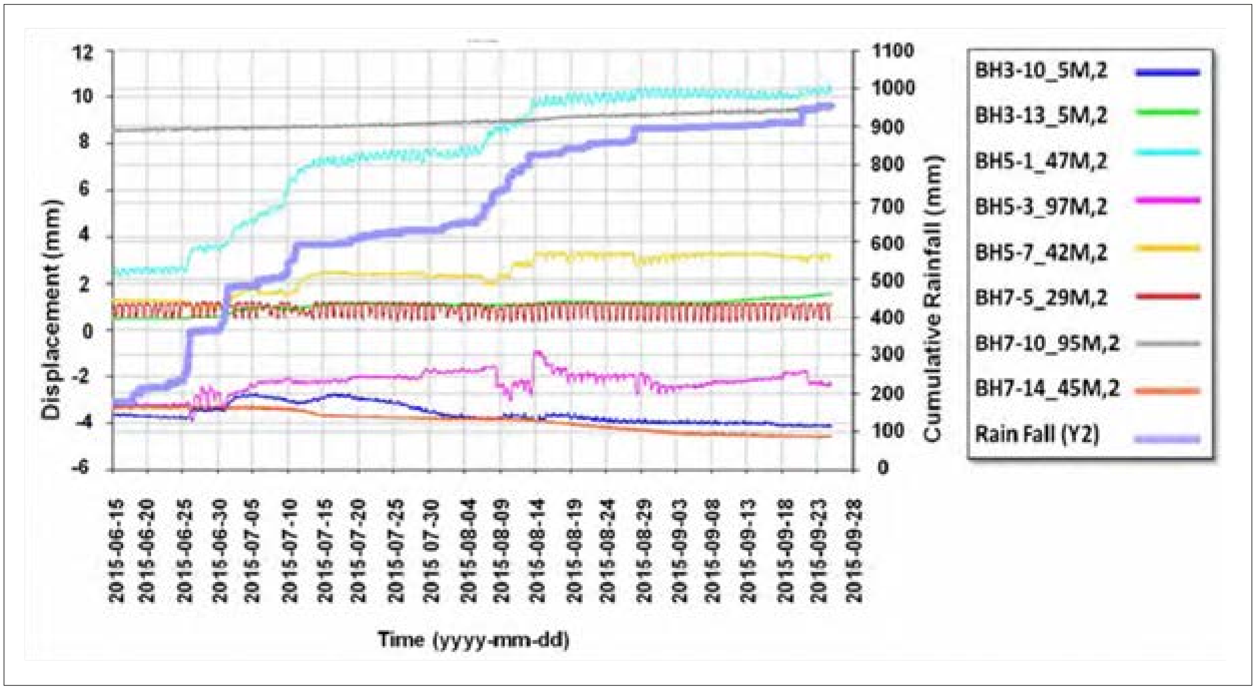


Fig. 2: Cumulative displacement (mm) as observed from IPI sensors (B-axis) in boreholes during monsoon period

unweathered bedrock has observed a displacement of the order of 2-4mm along both axes (Fig. 1 and Fig. 2). In borehole 7 (BH-7), the interface between greatly weathered bedrock and unweathered bedrock (at a depth of 14.85m) witnessed a displacement of about 3-4mm along both axes; whereas within the greatly weathered bedrock a maximum cumulative displacement of the order of 6 to 9mm is experienced along both axes at a depth of 11.35m (Fig. 1 and Fig. 2). There exists some ambiguity in the displacement data of borehole 3 as it could not be drilled and casings are not laid beyond the interface of greatly weathered and unweathered bedrock. However, the extreme end of the casings has been grouted properly.

Comparing rainfall events with the displacement patterns of all IPI sensors (Fig. 2 and Fig. 3), it can be observed that during 25th June to 12th July and 6th August to 14th August with higher intensities of rainfall

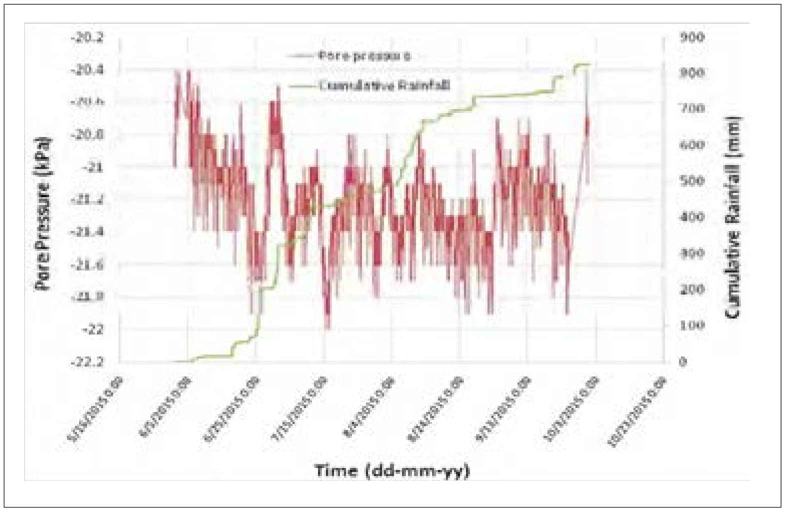


Fig. 3: Pore pressure (kPa) variations as observed from VW piezometric sensor in BH-2 during monsoon period

there are increase in displacement rates at borehole 3 (at 10.5m depth), borehole 5 (at 1.47m, 3.97m and 7.42m depths) and borehole 7 (at 14.45m depth). These displacements are observed to be higher along B-axis as compared to the A-axis of the sensors. This indicates a bearing of rainfall on the displacement in different sub-surface strata. However, such pattern and extent of movement activities can only be ascertained with future datasets of monsoon seasons.

It is further observed from the vibrating wire piezometric sensors installed in the bore holes (BH-2,4 & 6) at different depths at the interface between greatly weathered bedrock and unweathered bedrock that negative pressures of the order of -20 to -22 kPa during monsoon season have been developed (Fig. 3). This indicates that the strata has not attained the saturation level during monsoon. It may be inferred that the rain water could not infiltrate up to the unweathered bedrock level percolating through the greatly weathered bedrock. Hence, the installation of piezometric sensor at the interface between colluvium and greatly weathered bedrock would have been more useful to capture the pore pressure.

An initial displacement of the order of 2-4mm has been observed from the surface installed wire line extensometer (WLE-1) till 13th September 2015. A sudden increase in displacement up to 14mm has been observed on 13th September 2015 which can not be correlated with the intensity of rainfall on this particular day (Fig. 4). Such type of sudden surficial movement may be attributted to the antecedent rainfall prior to the event which needs further in-depth study.

It can further be inferred from these discplacement measurements that the strata within colluvium and greatly weathered bedrock have experienced higher displacements compared to the interface between greatly weathered and unweathered bedrock. Though the displacement at the interface between greatly weathered and unweathered bedrock was presumed and expected to be high, only a nominal displacement of maximum 2-4mm is observed across the boreholes (BH-1, 5 & 7). This may be attributed to lack of sufficient data at this interface over the landslide area and specifically borehole 3 could not be drilled beyond this interface due to unforeseen site constraints. Such negligible or less displacement at the interface may further be attributed to lack of infiltration of rain water up to this depth which restrained mobilisation of movement (also complemented by the piezometric sensor data with negative pore pressures). Hence, future measurements during monsoon seasons with sufficient displacement data will help in addressing such issues with more clarity.

From the above observations, it can be deciphered that local slip surfaces exist within the colluvium and greatly weathered bedrock. However, this can be ascertained only after further data interpretation of later periods. But, it can be stated from the ground measurements that the Pakhi landslide is a very slow moving landslide.

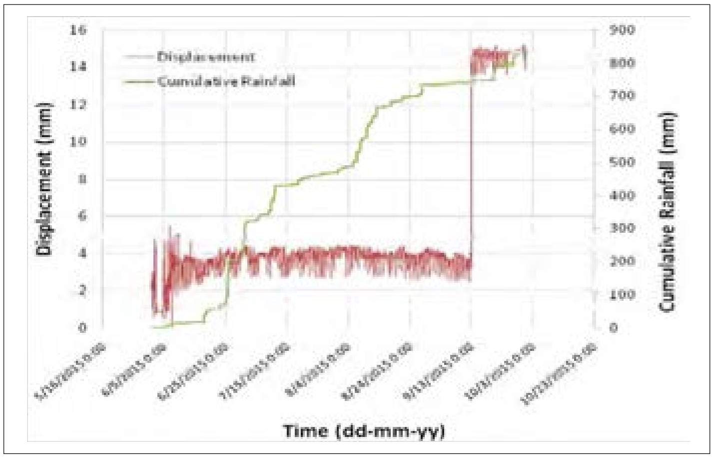


Fig. 4: Cumulative displacement from the surface installed wire line extensometer (WLE 1) during monsoon period

Comprehensive Geo-Investigation and Control Measures for a Landslide in Chamoli-Joshimath Region of Garhwal Himalaya

S. Sarkar, M. Samanta, Koushik Pandit, Mahesh Sharma & Ajay Dwivedi

Objective

The objective of the present study aims to carry out a comprehensive study of an active landslide (Fig. 1) of Chamoli-Joshimath region of Garhwal Himalaya to arrive at design and implementation of suitable control measures.

Stability Analysis with Slope Reinforcement

Slope stability analysis was carried out to determine the present stability condition of the slope and the stability it achieves after inclusion of suitable control measures. The analysis used limit equilibrium method for untreated and treated slopes with soil nails and/or pile reinforcements as the slide-arresting remedial measures. Different in-plane and out-of-the-plane spacing of the soil nails and/or piles have been tried out (Fig. 2) for different combinations of debris material properties varying with water content. Table 1 shows the material properties of soil nails and piles modelled in this study for improving the overall factor of safety of the slope section chosen for analysis. The limit equilibrium analysis results are presented in Table 2 for the untreated slope section and slope treated with soil nails at top of the road-cut.

Fig. 1: Panoramic view of landslide

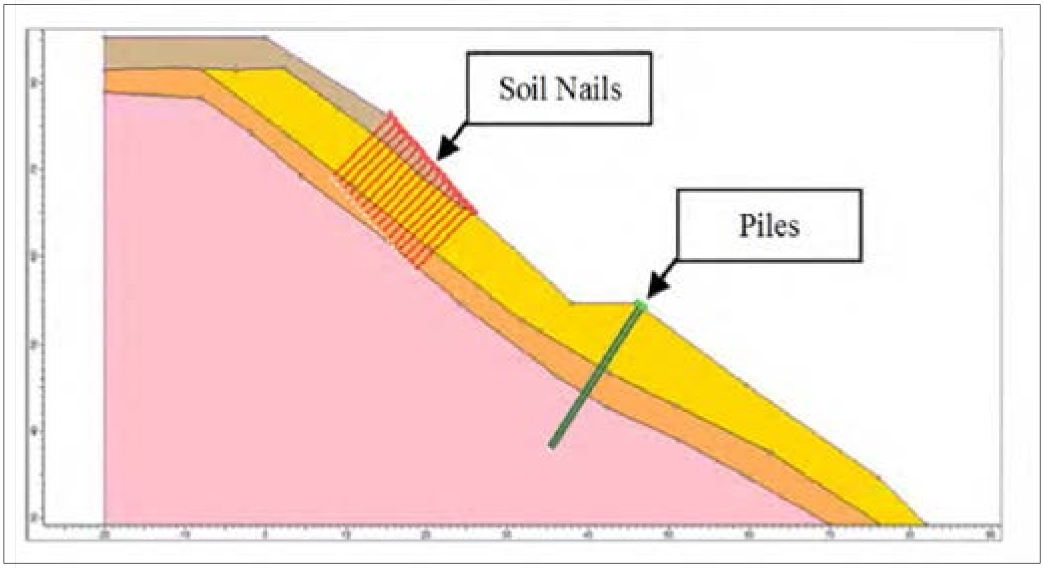


Fig. 2: Stability analysis with soil nails and piles

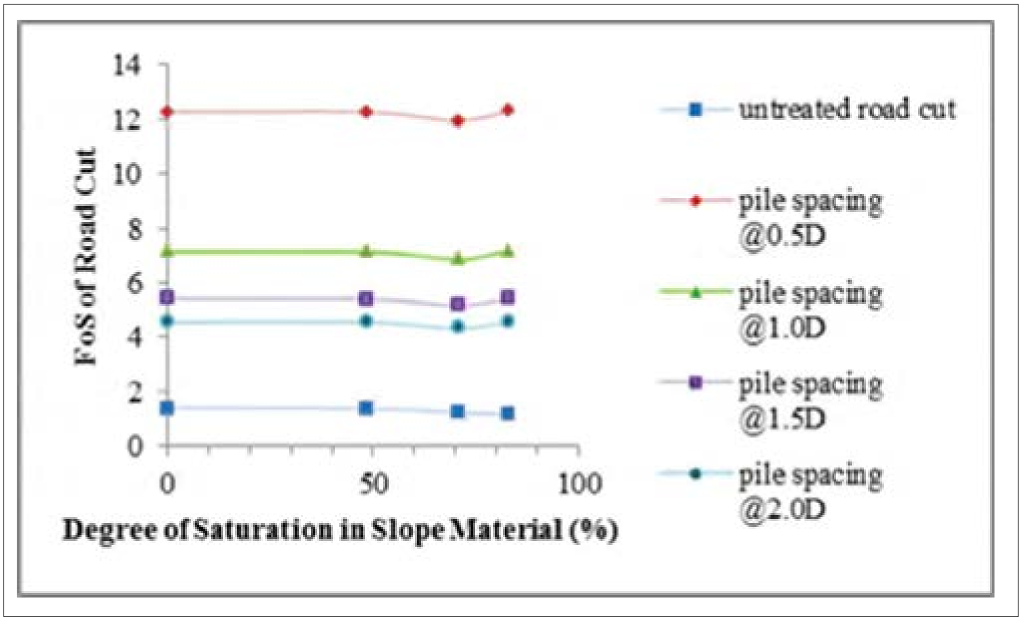


Fig. 3: FoS values for different spacing of pile at different moisture contents

In this study the slope portion immediately below the road-cut section is installed with concrete piles of 20m length, with varying spacing (0.5, 1.0, 1.5, 2.0 times diameter of piles) which act as a cantilever beam, being fixed at the socketed end in the bedrock of dolomite. Different spacing in between the piles has been tried. Fig. 3 shows variation in the obtained FoS values of the road-cut when in and out-of-plane spacing between pile varies as 0.5, 1.0, 1.5 and 2.0 times the pile diameter (D), where, D = 0.3 m has been selected. It was found from the study that the FoS value of the road-cut section is varying linearly with the number of rows of piles installed in the slope with 2D array spacing. Further it was also found that the FoS of the piles against the shearing on the slipping plane of the slope intersecting the array of piles doesn't change much for varying moisture content in the debris material for the same spacing in between the installed piles. It emphasizes that spacing between the piles is the most governing factor rather than the variations in the shear strength parameters of the debris material which surrounds the pile perimeter. The study also indicated that the safety factor of the pile-reinforced slope portion decreases non-linearly as spacing between the piles increases for the same number of rows, whereas the safety factor increases linearly with increase in rows of piles for the same spacing between piles.

Table 1: Properties of soil nails

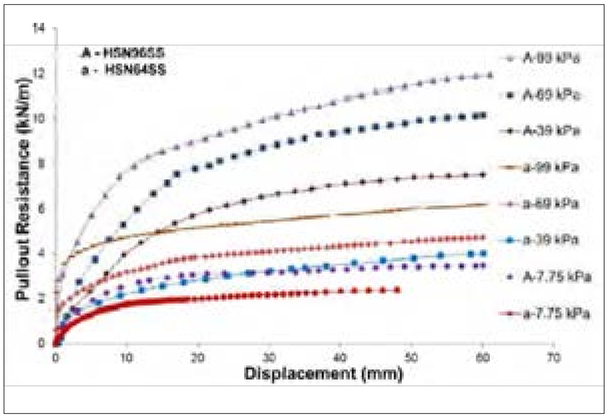
Properties	Reinforcing Scheme	
	Soil Nails	Piles
Diameter(mm)	25	300
Length (m)	10	20
Tensile Capacity (kN)	122.72	-
Compressive Str. (MPa)	-	30
Elastic Modulus (kN/m^2)	200e6	273.8e5
Poisson's Ratio	0.29	0.20
Side Shear Resistance (kN)	-	4193.5
Unit Weight (kN/m$^{3)}$	78.5	240
Modelled as	End-Anchored soil nails	Standard Bernoulli beams

Table 2: FOS values in different combinations by LEM piles considered in the analysis

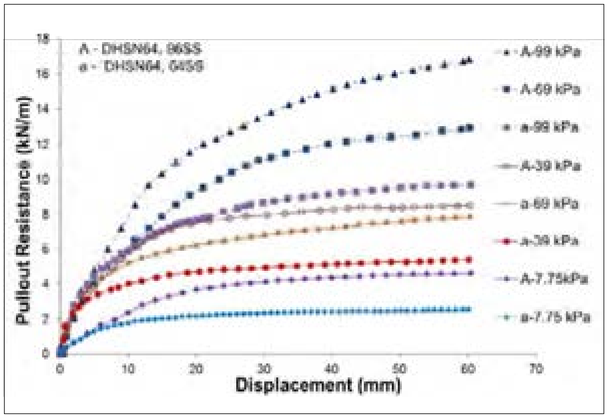
Set	Description	Saturation (%)	Top of Road-cut	Road-cut
1A	Untreated slope	0.0	1.18	1.40
1B		48.6	1.18	1.39
1C		70.5	1.08	1.25
1D		82.8	1.03	1.18
2A	Soil nails at top of road-cut, in-plane and out-of-plane spacing of 1.0 m	0.0	1.78	1.40
2B		48.6	1.77	1.39
2C		70.5	1.65	1.25
2D		82.8	1.66	1.18
3A	Soil nails at top of road-cut, in-plane and out-of-plane spacing of 2.0 m	0.0	0.0	0.0
3B		48.6	48.6	48.6
3C		70.5	70.5	70.5
3D		82.8	82.8	82.8

Soil Nail as Remedial Measures

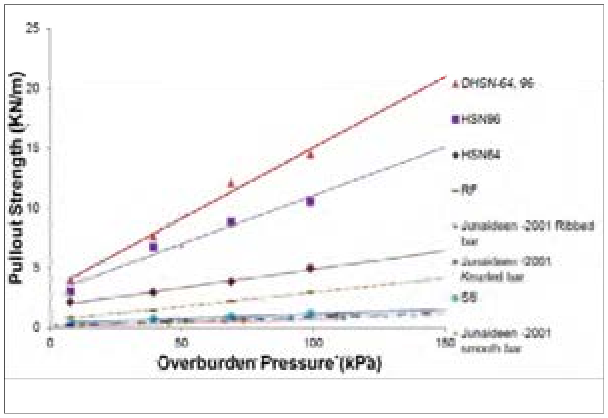
A few more experimental studies were carried out in the laboratory in continuation with the earlier study of soil nails of different types. A series of laboratory pull-out tests were conducted to investigate the pull-out behaviour of helical soil nails in different conditions. Comparisons have been made between helical and driven and grouted soil nails. The results were also compared with the similar experiments by various workers Fig. 4. It was found that in all the cases performance of helical soil nails is always superior than conventional soil nails. Hence application of helical soil nails for slope stabilization is a better option than conventional nails.



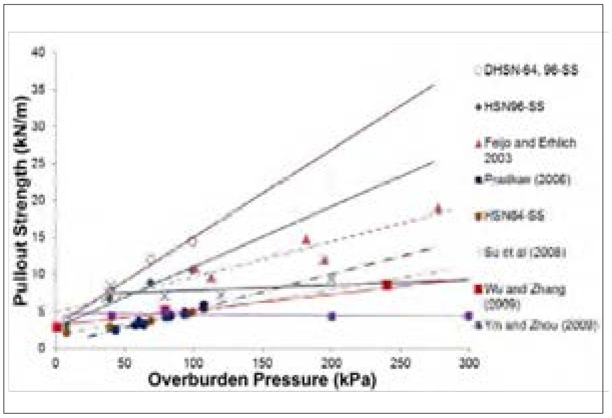
(a) Pull-out displacement curves for helical soil nails



(b) Double helical soil nails



(c) Comparison of helical and driven soil nails



(d) Comparison of helical and grouted soil nails

Fig. 4: Results of laboratory experiments on helical soil nails

WP-2 Engineering of Earthquake Disaster Mitigation

Ajay Chourasia & P.K.S. Chauhan

Seismic Microzonation of Srinagar, Uttarakhand

P.K.S. Chauhan, Abha Mittal & Gayatri Devi

Seismic Microzonation of Srinagar (Uttarakhand) has been initiated in March 2012 under the Engineering of Earthquake Disaster Mitigation (EEDM) in the 12th Five-year plan with the following objective. Seismic Microzonation of Srinagar, Uttarakhand using geological, geophysical, geotechnical, seismological and liquefaction studies. Highlights of the progress of the project is as follows:

1. Strong Motion Accelerographs have been installed at eight locations of the Srinagar city at both banks of the river Alaknanda (Fig. 1).

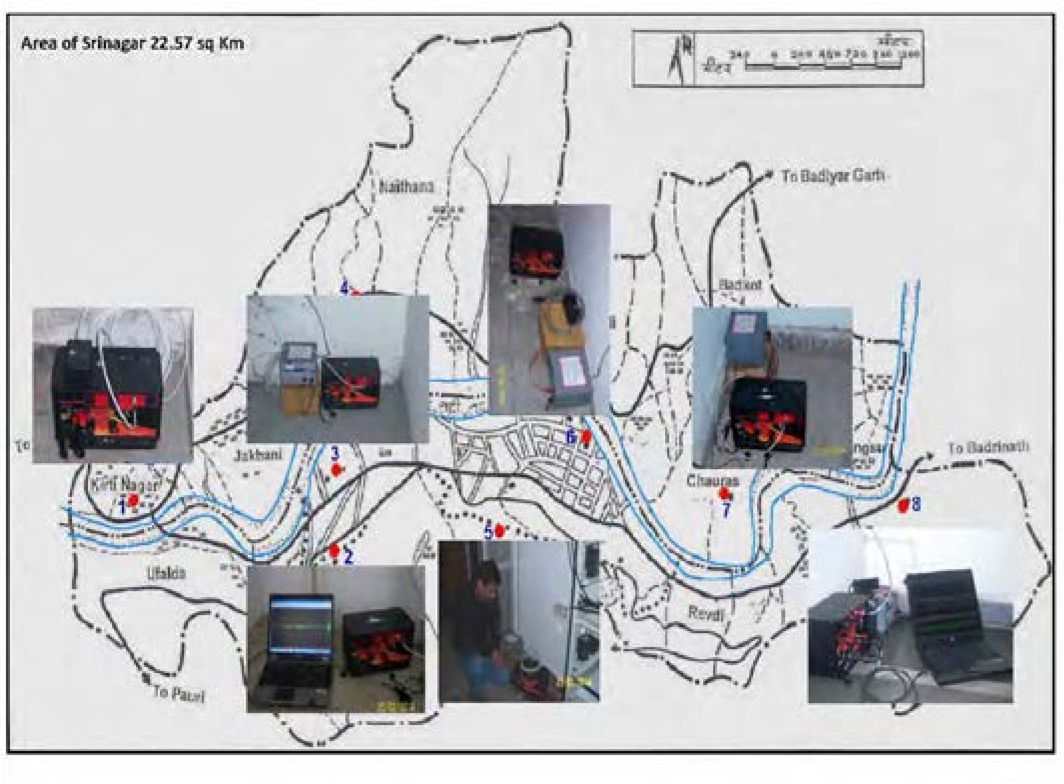


Fig 1: SMA network installed at Srinagar

Locations are listed as below:

- Tehsil Kirti Nagar
- Tehsil Srinagar
- SSB Srinagar
- HAPPRC HNBG Univ.
- GGIC Srinagar
- Geology Deptt. Univ.
- Medical College, Srinagar

2. Geophysical investigation using Seismic and Electrical methods were carried out at the both banks of the river to delineate the subsurface structure. The depth of investigation in these methods depends upon the length of the profile used and the impact of source in the case of Seismic method. The data processing and interpretation has provided the sub-surface information up to the depth of 20m (Fig. 2 and Fig. 3). After comparison it is clearly indicated that three layers are there (Layer-I: Sand (Valley); Layer-II: Conglomerate; Layer-III: Clay + Sand + Pebbles) at HNB Garhwal site (Fig. 4).

Fig. 2: Subsurface model of vs based on seismic refraction survey at left side of river at Srinagar

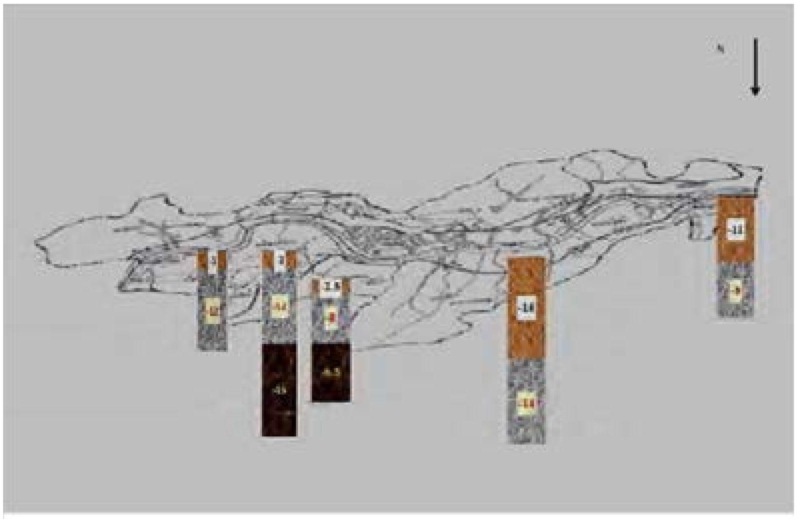


Fig. 3: Subsurface model of vs based on seismic refraction survey at right side of river at Srinagar

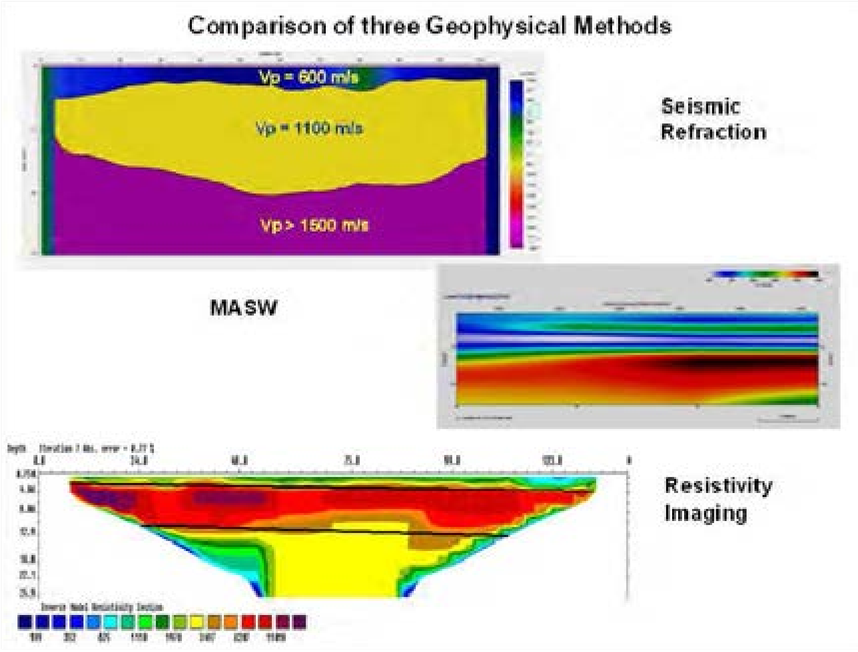


Fig 4: Comparison of three geophysical methods

After comparison it is clearly indicated that three layers are there (Layer-I: Sand (Valley); Layer-II: Conglomerate; Layer-III: Clay + Sand + Pebbles) at HNB Garhwal site (Fig. 4).

3. Micro-tremor data has been collected at 48 locations and SMA threshold was kept at 0.005% of full scale. On this basis natural frequency and ground amplification maps of Srinagar have been prepared (Fig. 5, Fig. 6 and Fig. 7).

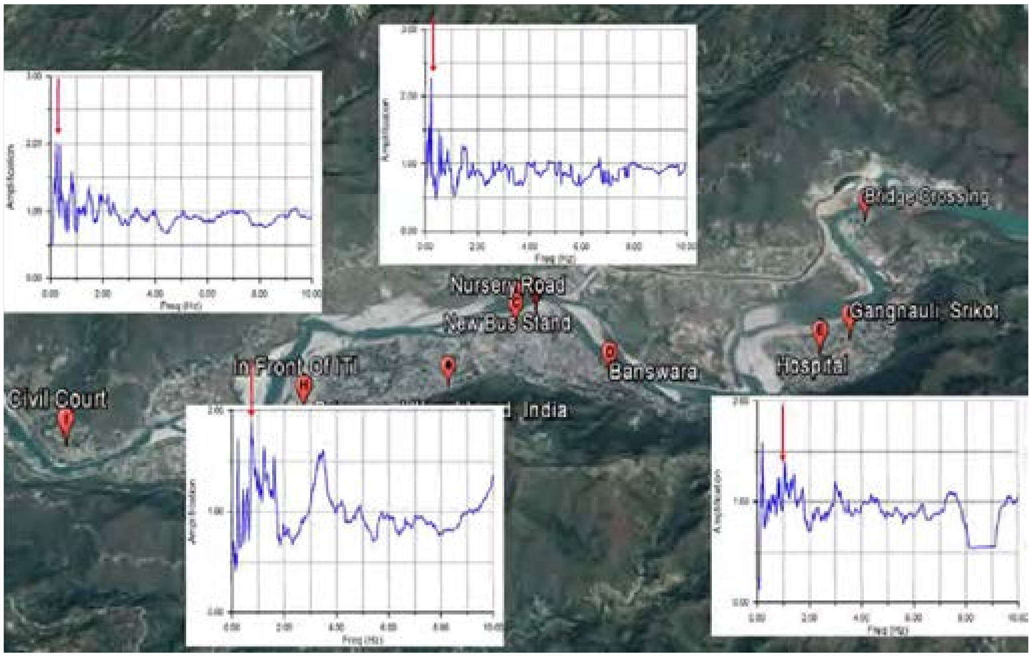


Fig. 5: Micro-tremor data collection at various locations

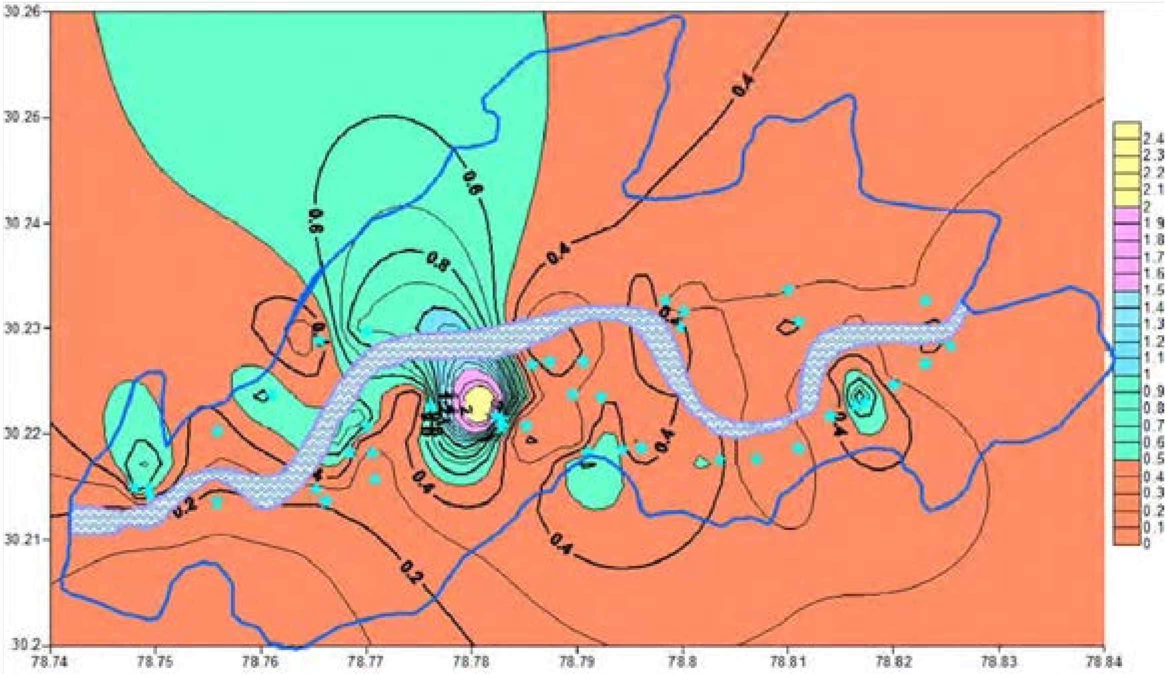


Fig. 6: Natural frequency map of Srinagar

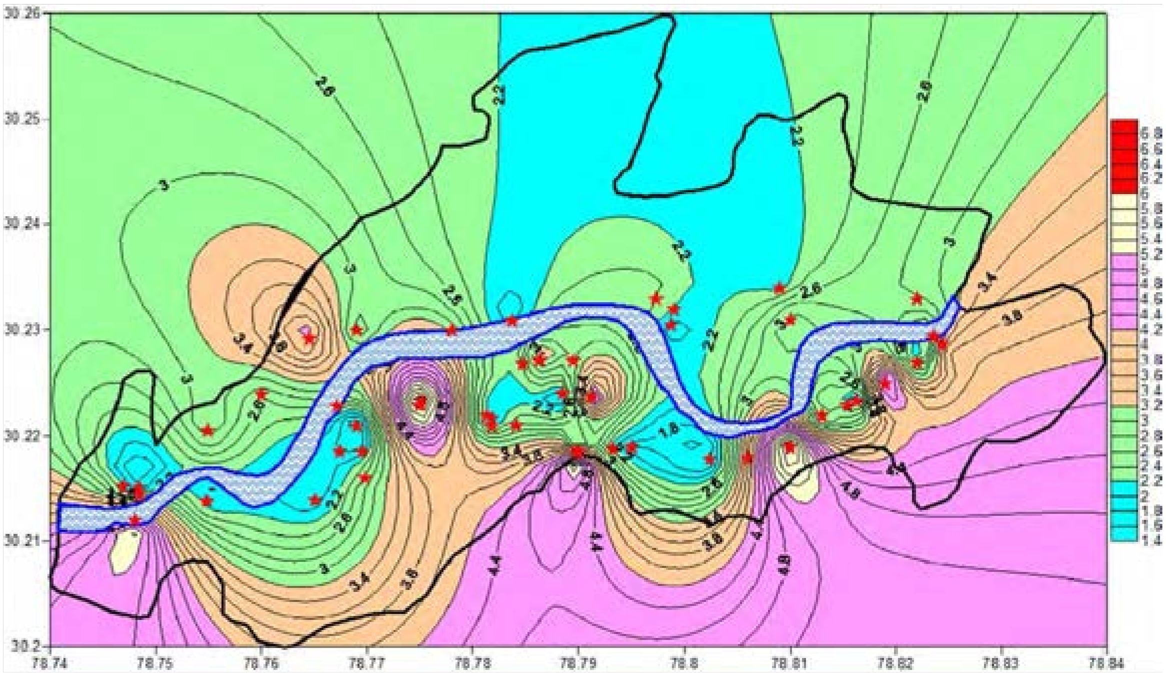


Fig. 7: Ground amplification map of Srinagar

Geotechnical investigations have been carried out and liquefaction studies are in progress and all the objectives of the project have been completed. After compiling all the data final micro-zonation map will be prepared. This study will be of great use for civil administration and building planners for expansion of Srinagar city.

Seismic Behaviour of Piles Under Dynamic Lateral Loading

S. Ganesh Kumar & M. Samanta

Objectives

I. To investigate the seismic behavior of piles subjected to dynamic lateral loading through numerical analysis and experimental model testing.

II. To investigate the influence of various soil and pile parameters on the seismic behaviour of piles under dynamic lateral loading. The influence of liquefiable soil layer on the behavior of piles will also be studied.

III. Development of methodology for seismic design features of piles in layered sandy soils.

Deliverables of the Project

1. Seismic design features of piles for liquefiable sandy soil
2. Seismic design features of piles due to liquefaction of layered sandy soil
3. Design package and numerical model tool for seismic design features of piles in Indian conditions

Progress of the Project

Combined numerical and experimental studies were performed during the research period. The numerical study was carried out with the help of FE package PLAXIS 3D. Firstly, the validation of the numerical built on this platform was carried out with the published results. For numerical validation, research work done by Farouk et al. 2014 was adopted. A 2×2 pile group with 5D spacing was selected for the study with loose and dense soil condition. The validation of the test results with the FE package is given in Fig. 1.

For clays, works of Ercan (2010) was validated. The configuration consists of 4×4 pile group with 3D spacing. The validation of test result is shown in Fig. 2.

Guided by numerical validation for both clay and sand, a layered soil profile consisting of loose to medium dense sand underlined with stiff clay was selected. The pile and soil properties are tabulated in Table 1 and Table 2.

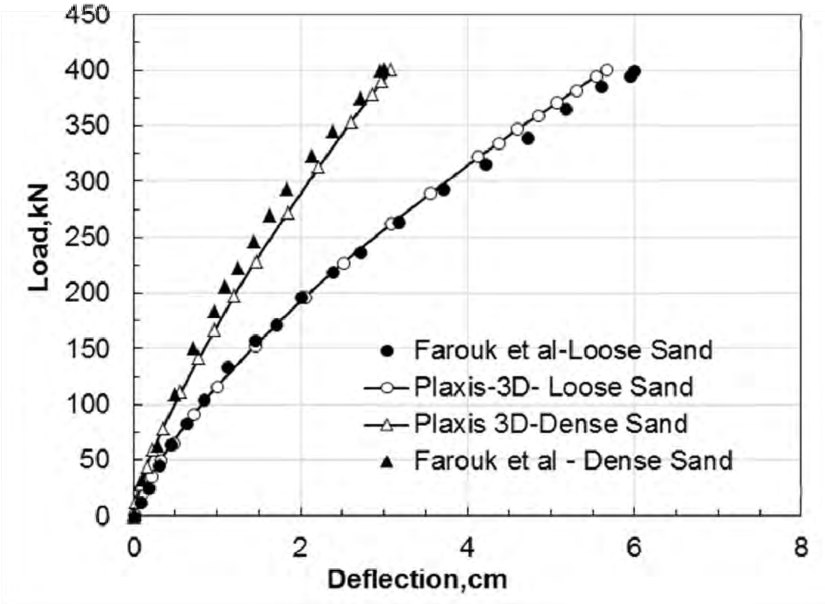


Fig. 1: Load vs. Deflection for 2 x 2 pile group in loose and dense sand (numerical validation)

Table 1: Pile properties selected for numerical analyses

Pile	
Diameter	0.5 m
Length	15 m
Modulus of elasticity	28.5 GPa
Pile Spacing	1. 4×4 at 3D spacing 2. 4×4 at 6D spacing 3. 4×4 at 8D spacing

Table 2: Soil properties selected for numerical analyses

	Sand (0-10 m)	Clay (10-15 m)
Unit weight	14.05 kN/m3	19
Cohesion	-	25 kPa
Friction	30	-
Elastic Modulus	40000 kPa	40000 kPa
Poisson ratio	0.3	0.3
Soil behaviour	Mohr-Coulomb	Hardening soil

The numerical model was subjected to dynamic loading and behaviour of pile group subjected to dynamic loading was studied. The parameters varied include spacing with liquefiable soil with different densities at top to understand the lateral response of pile group in layered soil. The pile group adopted for the numerical study is shown in Fig. 3 and typical displacement profile is given in Fig. 4.

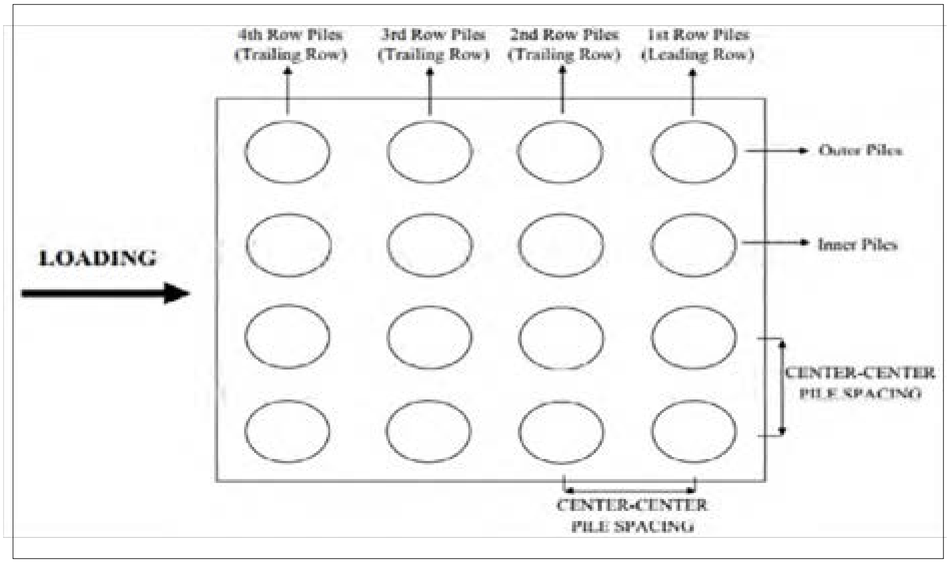


Fig. 3: Pile group used for numerical studies

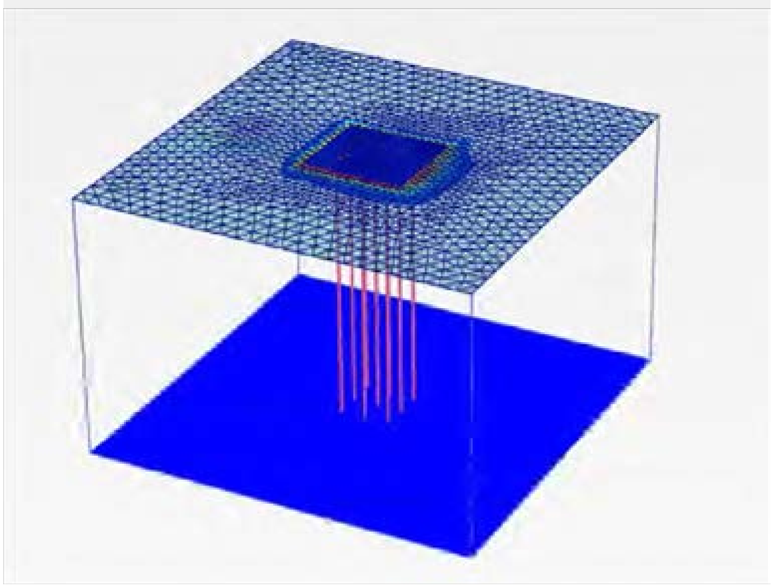


Fig. 4: Typical displacement profile for 4 x 4 pile group

From the numerical analysis, it was observed that lateral deflection increased considerably as pile spacing decreased from 8D to 3D in case of pile group installed in clay soils. Larger deflection occurs for pile groups at closer spacing (3D) due to pile-soil-pile interaction. The calculated increment in deflection, when pile spacing decreases from 8D to 6D and 6D to 3D was about 67% and 50% respectively. Also, Pile spacing affects lateral load distribution in pile groups significantly. Typical lateral deflection distribution profile for the pile group in layered soil is given in Fig. 5.

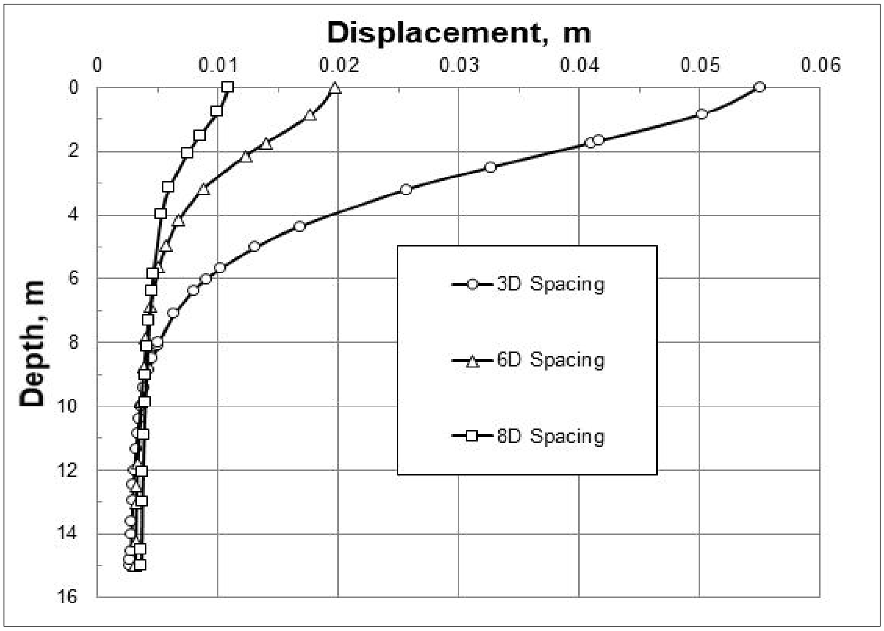


Fig. 5: Lateral deflection distribution profiles for clay soil

In case of layered soils, an increase in lateral displacement of 33% for 3D, 20% for 6D and 15% for 8D spacing was observed when subjected to dynamic loading. Presence of loose sand at top causes reduction in skin resistance and creates lesser lateral resistance during loading with reduced pile-soil interactions. Typical lateral deflection profile for layered and uniform soil profile is shown in Fig. 6.

In addition to this, bending moment profile for the pile group in uniform clay soil layer inferred that, *Load carried by each pile in the group reduces with a decrease in the spacing in comparison to the single pile. This reduction is more for groups with 3D spacing.* Lead row pile develops the maximum bending moment when comparing with the trailing row piles under the same applied load. Also, the large difference in the bending moment for 3D spacing is credited to the pile-soil-pile interaction due to the shadowing effect. Typical bending moment profile for lead row pile and rear row pile with different spacing is given in Fig. 7 and Fig. 8.

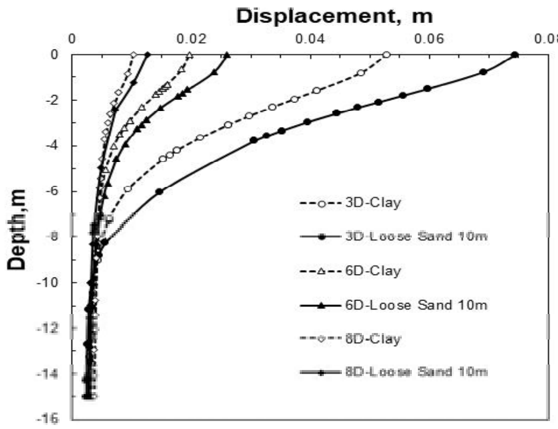


Fig. 6: Lateral deflection distribution profiles for layered and uniform clay soil

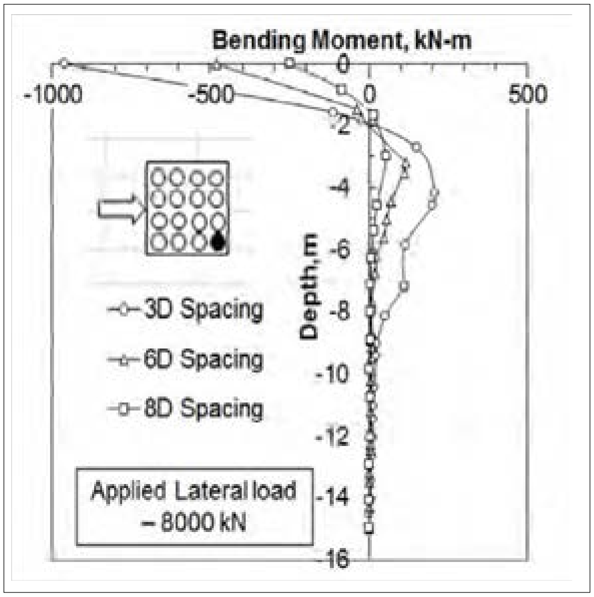


Fig. 7: Bending moment profile for leading pile with different spacing

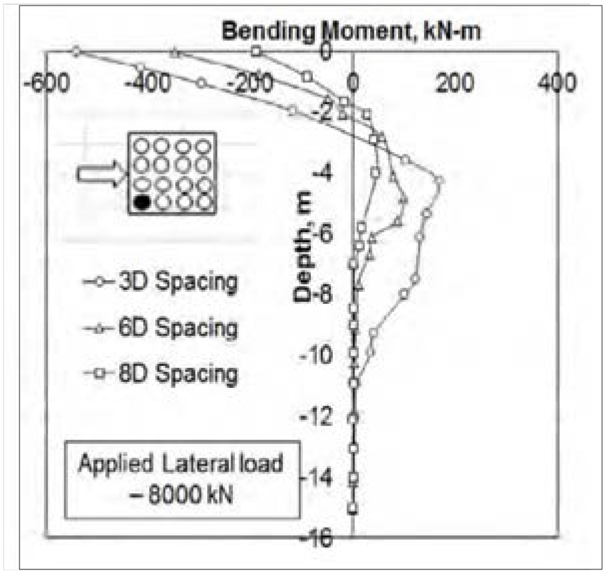


Fig. 8: Bending moment profile for rear pile with different spacing

When comparing with uniform soil profile, the magnitude of maximum bending moment of leading pile in layered soil is found to be 57% higher than that of uniform clay layer with 4× 4 spacing. The increase in bending moment and deflection needs attention when pile group installed in layered soil with liquefiable soils at top. Typical bending moment distribution for pile in layered soil is shown in Fig. 9.

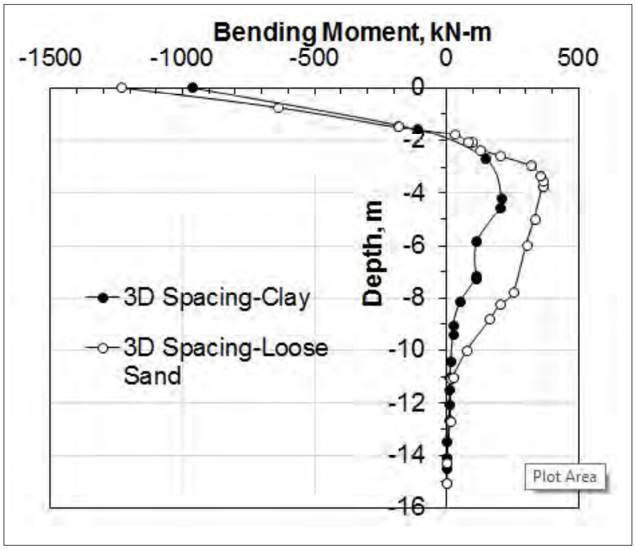


Fig. 9: Bending moment profile for lead pile in layered and uniform soil layer

Conclusion

Incidence of lateral spreading in liquefiable soils can results in pile failure in shear and bending mainly due to the development of unexpected large pressures in soil due to dynamic loading. Hence it is essential to develop analytical design solution incorporating the factors affecting the performance of pile group in case of layered/liquefiable soil which will helpful for optimum design, installation and effective performance in field.

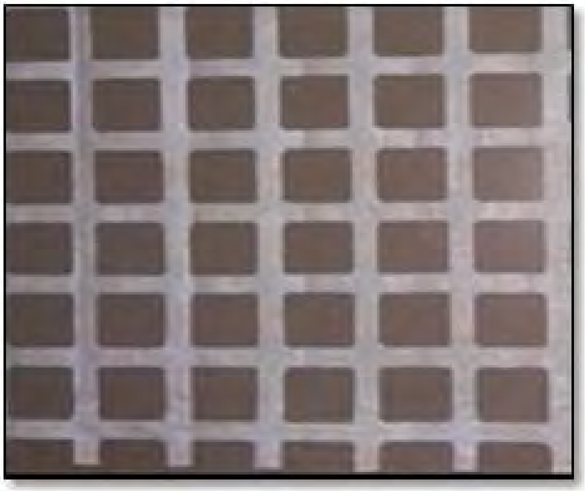
Performance of Confined Masonry Buildings under Quasi-Static Condition

Ajay Chourasia, Jalaj Parashar & Shubham Singhal

Since the dawn of civilization, masonry is the most commonly used material in building industries, especially for low to medium rise buildings due to several advantages such as resistance, acoustic and thermal insulation, simple and economic construction etc. However, Unreinforced masonry (URM) buildings, have proven vulnerable in seismic events, with significant building damage and numbers of fatalities, world-over. To improve the seismic resistance of masonry buildings, different methods have been attempted over the years, and led to the concept of reinforced masonry (RM) and confined masonry (CM) systems.

Quite often, the vulnerable/damaged buildings are required to be strengthened or retrofitted. It is pertinent that the safety of such buildings be assessed objectively based on experimental verifications. Thus, to study the seismic performance of different masonry building typologies, an experimental study was performed on full-scale single room masonry buildings measuring 3.01 x 3.01 m in plan and 3.0 m in height with similar geometry, material properties and construction practices for all the building typologies. Unreinforced (URM), reinforced (RM) and confined masonry (CM) were tested under quasi-static cyclic loading and data was recorded in terms of displacement capacity at corresponding load. CM building performed significantly well when compared to URM and RM buildings demonstrating high displacement capacity, along with high initial stiffness, ductility, energy dissipation with relatively lower structural damage. There is a need to explore the effective and efficient retrofitting measure for damaged CM building so as to improve its behaviour when subjected to lateral loading. To explore the best suitable retrofitting technique, various alternate options viz. Welded Wire Mesh (WWM), Chicken Mesh (CM), Nylon Mesh (NM), Industrial Geo-grid (IG), Polypropylene Band (PB) and Plastic Cement Bag (PCB) were evaluated for retrofitting of masonry prisms and wallets. The results showed Plastic Cement bag mesh was the most effective strategy as retrofit measure. In addition, this material has advantages like low cost, high flexibility, minimum thickness, non-corrodible nature, adequate grip and reuse of waste material. Fig. 1 presents the preparation of mesh from empty plastic cement bags and cementitious grouting for filling the cracks in masonry walls of CM. Subsequently, plastic mesh was fixed on both faces of masonry wall by means of epoxy and nails, which were later embedded in 15 mm thick cement: sand (1:4) mortar.

(a) Preparation of plastic cement bag mesh



(b) Cementitious grouting

(c) Plastering and curing

(d) Jacketing using plastic cement bag

Fig. 1: Strengthening of damaged CM building

Fig. 2: Full-scale retrofitted confined masonry building subjected to lateral cyclic load

Fig. 3: Damage pattern for retrofitted confined masonry building subjected to lateral cyclic load

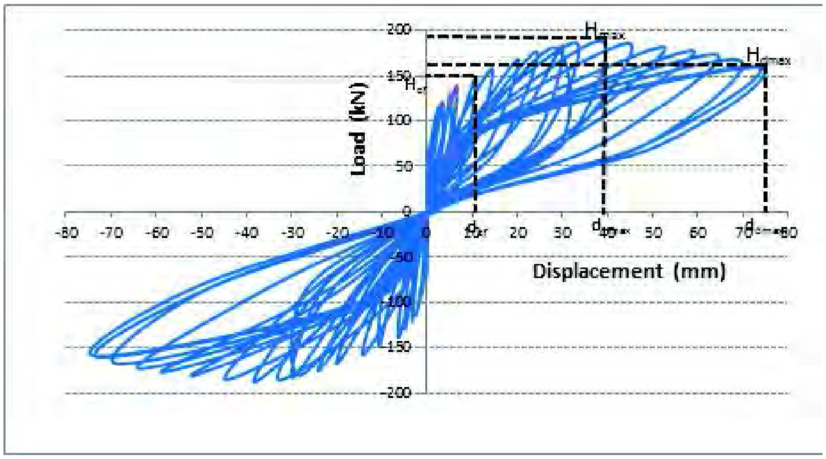


Fig. 4: Hysteretic curve for CM_RET building

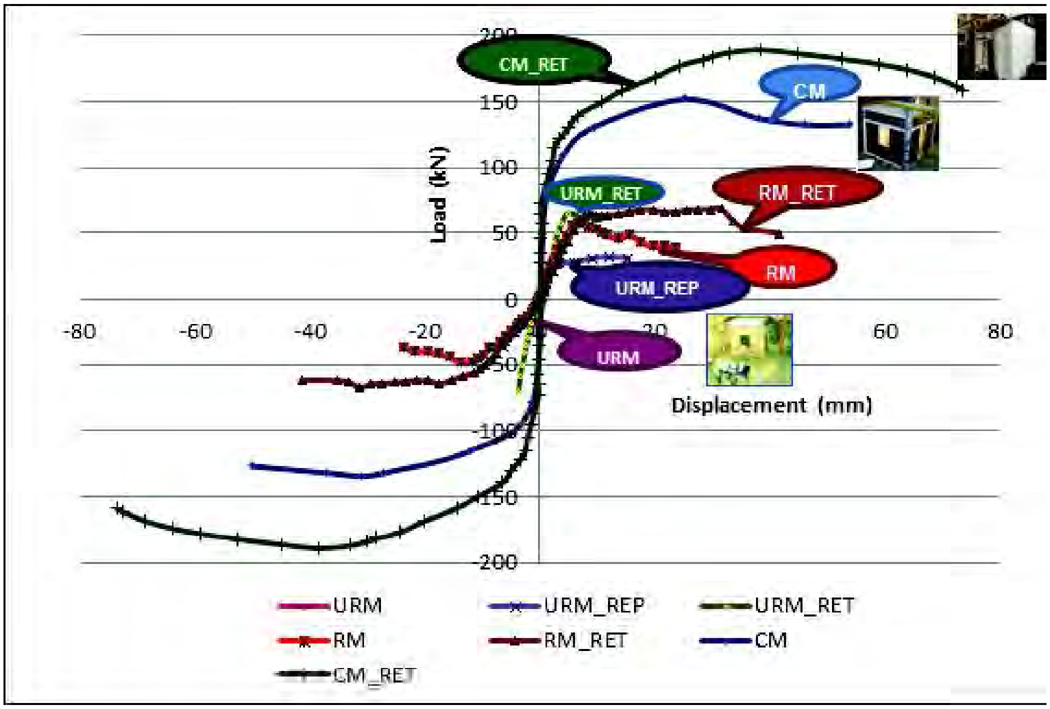


Fig. 5: Comparison of lateral load-deformation envelope for different masonry systems and its retrofit

Fig. 4 shows the hysteresis curve of CM_RET building, which was used to draw load-displacement envelop. The figure also illustrates the lateral load and displacement corresponding to occurrence of first significant crack (H_{cr} and d_{cr}), maximum resistance (H_{max} and d_{max}), and maximum lateral displacement (H_{dmax} and d_{max}). Fig. 5 shows the comparison of load-displacement curve of CM_RET with earlier tested URM, URM_REP, URM_RET, RM, RM_RET, and CM.

The comparison showed that the CM_RET building exhibited higher strength and ductility as compared to URM, RM and CM buildings. The performance of CM_RET over URM, RM and CM in terms of strength demonstrated about 4.25, 3.27 and 1.24 times improvement respectively. Increase in initial stiffness was reasonable i.e. 4.27, 4.14 and 1.12 times respectively for URM, RM, CM as compared to CM_RET building. Similarly, substantial increase in ductility was also noted i.e. 446%, 42.7% and 23.19% respectively for URM, RM, CM as compared to CM_RET building. Maximum drift calculated for CM_RET building was 2.48% in comparison to 1.8% for CM building. Energy dissipated was 7804 kN-mm for CM_RET, while that for CM building was calculated to be 4250 kN-mm. Thus, through experimental results, it can be concluded that the retrofitting of CM using mesh of plastic cement bag was more effective technique for masonry buildings.

WP-3 Engineering of Fire Disaster Mitigation

R.S. Chimote & Suvir Singh

Development of Low Ozone Depletion Potential (0.01-0.5) Innovative Fire Suppression System

R.S. Chimote, Manju Mittal, Shorab Jain & A. Arvind Kumar

Objective:

- Development of water-mist based fire extinguisher
- Development of evaluation facilities for fire extinguishing system

Progress Highlights/ Significant Achievements:

- **Revalidation of design guidelines-related field trial experiments on novel water-mist and/or low ODP extinguishant fire suppression system:**

  The design guidelines-related field trial experiments with novel water-mist and/or low ODP extinguishant fire suppression system based on water-mist technology has been carried out on a working space of 3m(L) x 2m(W) x 2.75m(H) as depicted in the following Fig. 1.

- **Development and Fabrication of Innovative Mini Water–Mist fire Tender:**

  The design details for the development and fabrication of an innovative Mini Water–Mist fire Tender out of the condemned mini bus has been finalized, as shown in Fig. 2, for combating the large-scale fires efficiently and effective in water scarce fire situations as well as firefighting skill development.

The water-mist fire tender is fabricated as a product/ technology for IPR and Technology Transfer for societal benefits.

Fig. 1: Design guidelines-related field trial experiments on novel water-mist and/or low ODP extinguishant fire suppression system based on water-mist technology, carried out on a working space of 3m(l) x 2m(w) x 2.75m(h).

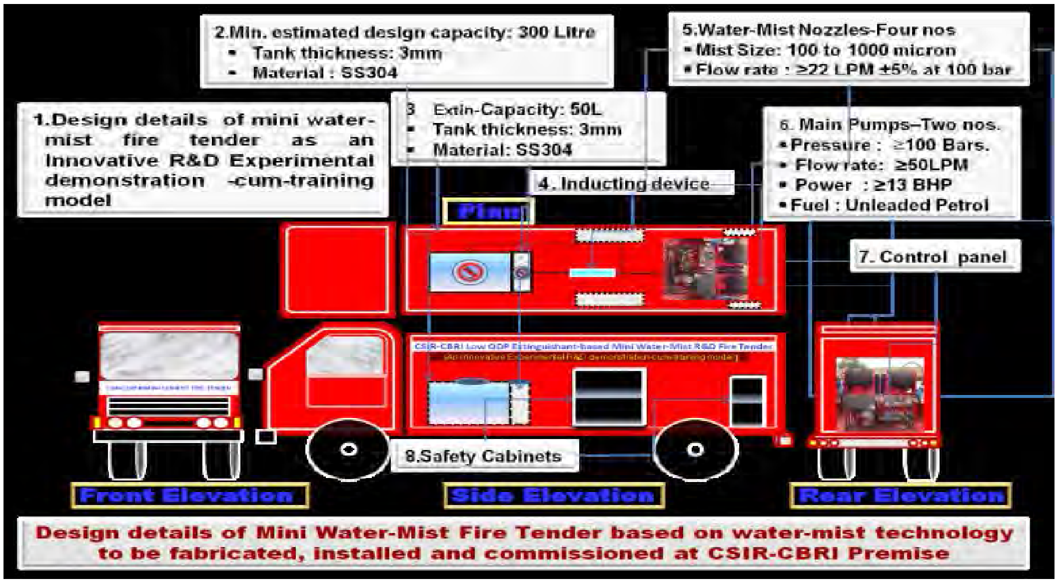


Fig. 2: Design details for the development of mini water mist fire tender

- **Revalidation of CFD modeling results of interaction of water mist fire suppression system under fire condition:**

The CFD Modeling of interaction of water mist fire suppression system with 2.45m, 2.50m and 2.55m ceiling heights were repeatedly carried out for revalidating the experimental fire suppression time of 10 to 15 seconds with 100% fire suppression efficiency by bringing down the fire temperature in the range of 90 to 100deg. C with fire control time from 5s to 10s as shown in the following Fig. 3, Fig. 4 and Fig.5, respectively.

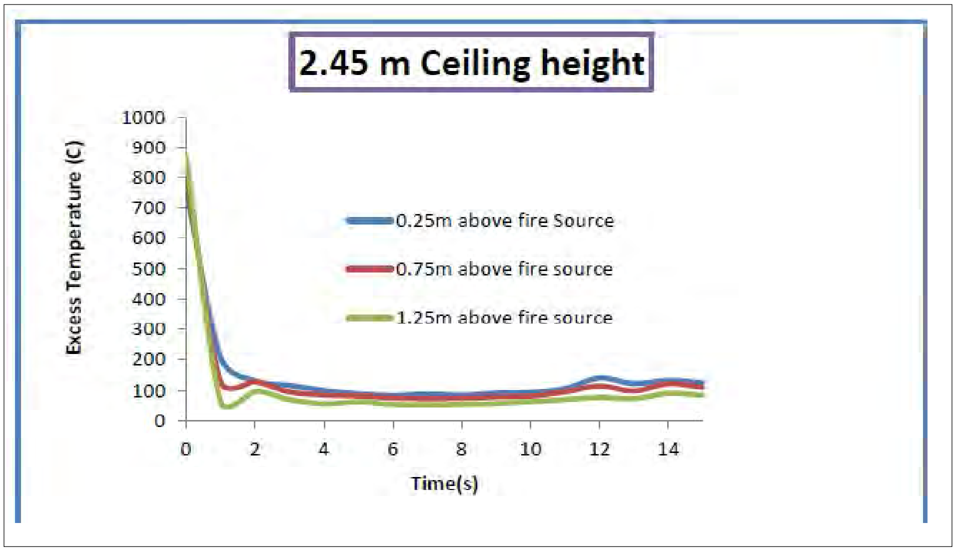


Fig. 3: CFD modelling for validation of fire extinguishing performance of an innovative zero ("O")ODP fire extinguishant material composition with 100% fire suppression efficiency in 10 to 15s on 1000cm^2 fires for a water-mist nozzle discharge at a ceiling height of 2.45m.

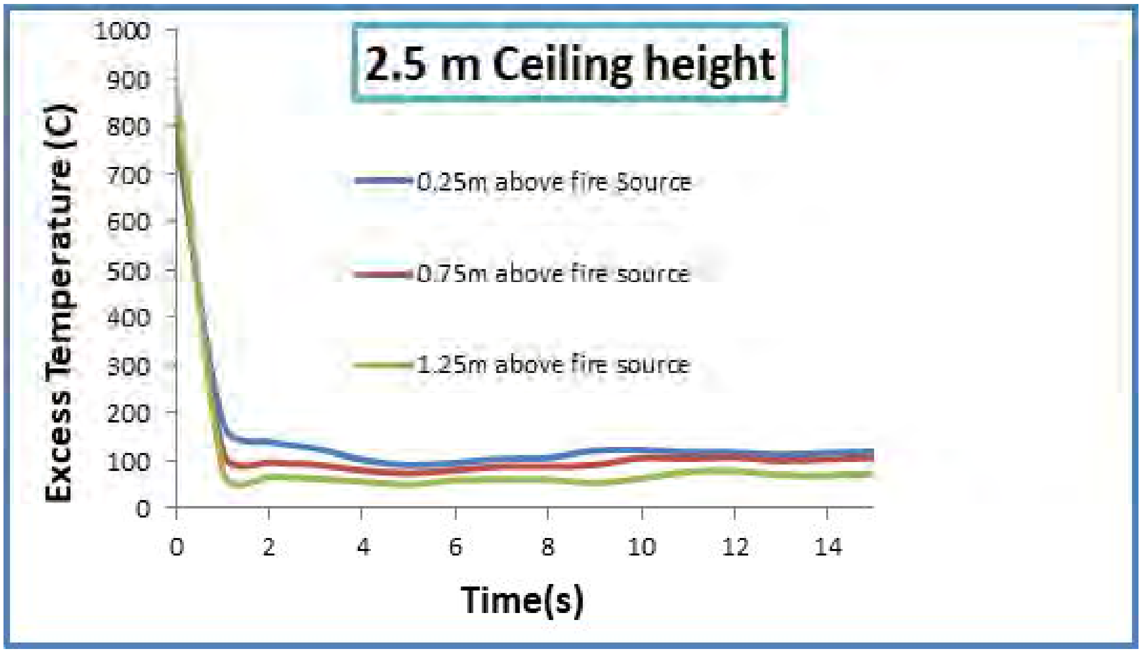


Fig. 4: CFD modelling for validation of fire extinguishing performance of an innovative zero ("O")ODP fire extinguishant material composition with 100% fire suppression efficiency in 10 to 15s on 1000cm^2 fires for a water-mist nozzle discharge at a ceiling height of 2.5m.

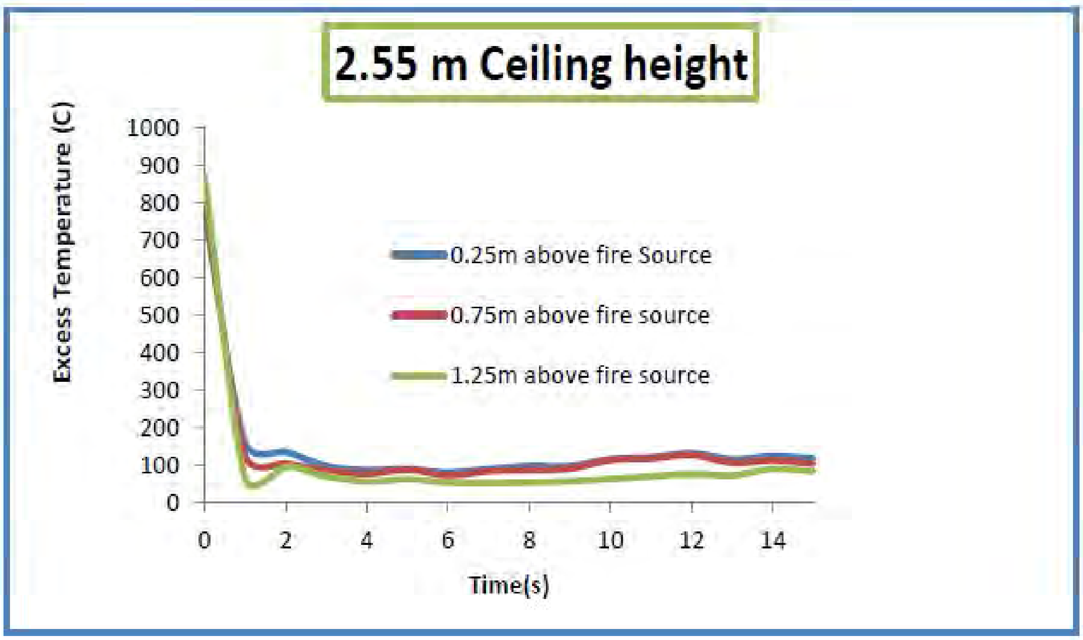


Fig. 5: CFD modelling for validation of fire extinguishing performance of an innovative zero ("O") ODP fire extinguishant material composition with 100% fire suppression efficiency in 10 to 15s on 1000cm^2 fires for a water-mist nozzle discharge at a ceiling height of 2.55m.

WP-4 Post Disaster Shelter Planning

S.K. Negi

Post Disaster Shelter Planning for Rural Areas in Western Himalayan Region

S.K. Negi, Ajay Chaurasia, Swati Kulashri & Vandana Singh

Objectives

To develop a technology package for Disaster Resistant Transit Shelters for Western Himalayan Region.

Deliverables

- Prototype Development and the validation of Transit Shelters
- Field Demonstration of Prototype design
- Detailed Project Report

Design

Once in every few years almost all parts of India suffer from various natural disasters like earthquakes, floods and landslides. Even with adequate preparedness and mitigation measures, the uncertainty of the occurrence of disasters makes people vulnerable to loss and chaos. After the occurrence of disasters, there is a need to provide 'Post-Disaster Shelters' to serve a large number of victims with immediate shelter response. These are household shelters, designed as rapid shelter solutions which prioritize the speed and costs of construction. The Central Building Research Institute of the Central Scientific and Industrial Research (CSIR- CBRI) has come up with a light weight foldable post-disaster shelter that can be transported to the site of disaster to provide instant shelter for the victims, till permanent houses are constructed.

The shelters consist of prefabricated aluminium frames that fold into a small size that can be easily transported to remote sites of disaster even by head load. The components of the frame fold into a size not exceeding 2.1m or 7 feet and weigh only 16 kilograms each. Two or more folded frames are unfolded at site and joined together using nuts and bolts (Fig. 2 and Fig. 3). A two bay unit built using three frames provides a covered space of about 20 square meter which is sufficient for a family in the hour of distress.

Fig. 1: Prototype developed at CSIR-CBRI Rural Park

If a larger space is required more bays can be added. A two bay shelter can be erected at site in one day with complete cladding by two skilled fitters, one semiskilled helper and the help of the beneficiaries. The total weight of the aluminium framework for a two bay unit is about 120 kg. The structure requires 75 square meter of cladding for walls and roof. Thus about 100 shelters with cladding material can be transported in one truck of 15 tonnes capacity. The cost of the transit shelter is around Rs. 85,000 with canvas cladding in the plains, and is subjected to change with the change in geographical location. The post-disaster shelter which is designed is a transitory shelter to provide affordable shelter solution for the victims of disasters. It provides safety, security and a better living environment for a family of five members at the hour of need. These pre- fabricated structures not only excel in rapid installation with minimum assistance and equipment but are also easy to store and transport, cost-effective, extendable, with a long life span up-to 5 years.

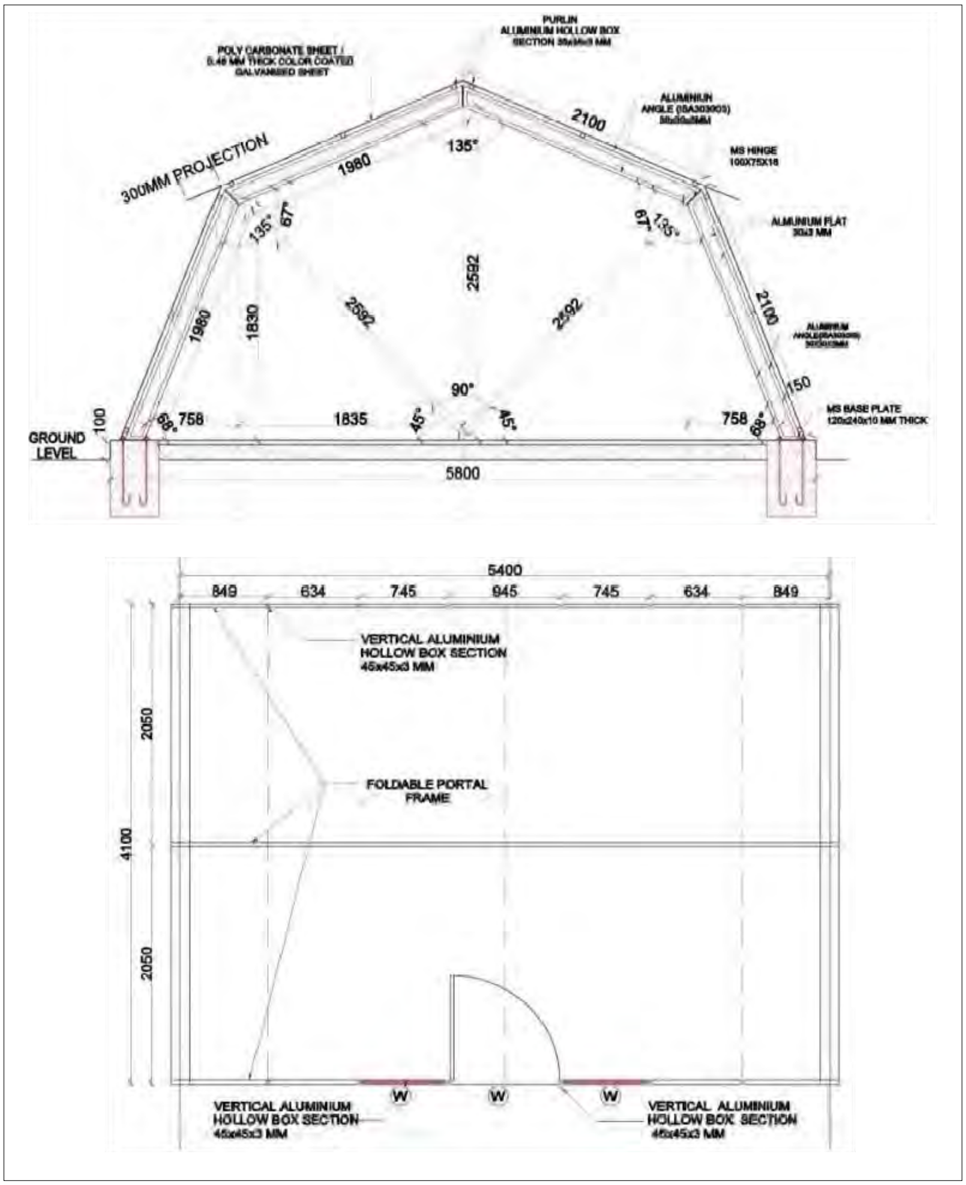


Fig. 2: Plan and section of the designed shelter

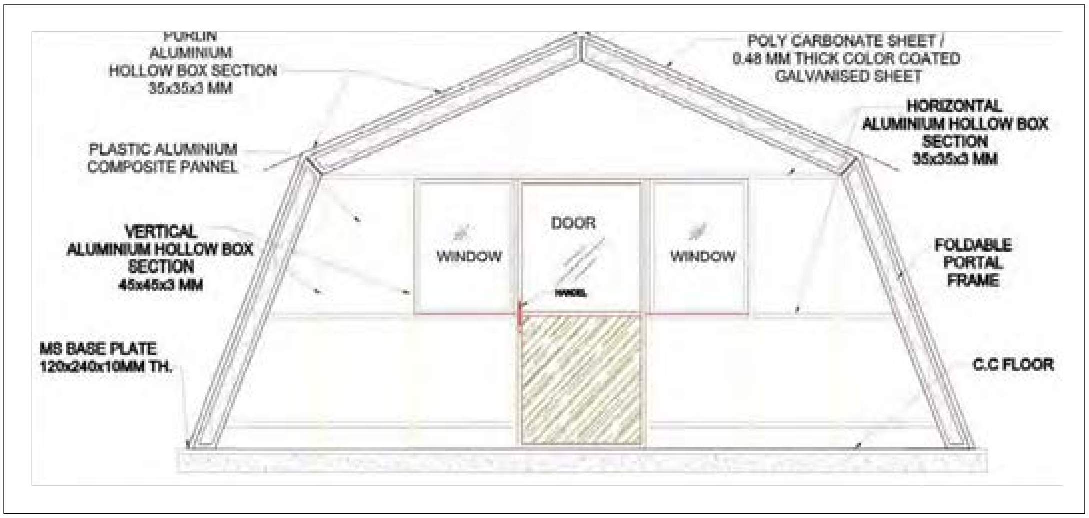


Fig. 3: Elevation of the designed shelter

The additional features include anti-ultraviolet nature to protect the people from harmful U-V rays, multipurpose usage of space, high structural performance and construction from water and wind resistance, fire retardant, durability, renewable and anti-bacterial materials. The Disaster management authorities can keep such frame shelters ready and transport them to the site of disaster for immediate relief to the victims. By adding more bays immediate shelters can be constructed for medical teams, godowns, schools, rest houses and also tourist huts in peace time. The shelters can be folded back and stored easily for any future eventuality.

WP-5 Health Monitoring of Buildings using Wireless Sensor Network

Ajay Chaurasia & Soju Alexander

Development & Validation of Health Monitoring Approach using Wireless Sensor Network for Steel & Reinforced Concrete Buildings

Ajay Chourasia, S.K. Panigrahi, Soju Alexander, Jalaj Parashar, Shiv Singh Patel, Monu Kumar & Nishat Parvez

Structural health monitoring (SHM) of civil structures has received significant attention in order to assess the safety and reliability of structures during their service life. The objective of SHM is to identify the location and evaluate the severity of any structural damage that has occurred due to a severe loading event, such as earthquake or long term deterioration. Traditionally, structures have been monitored using various non-destructive testing (NDT) techniques, which are costlier and time consuming. Further, these NDT techniques require location of damage to be known at prior. In contrast, SHM techniques using vibration measurements allow for quick and global damage identification at a relatively lower cost. These vibration based SHM techniques rely on the fact that any change in physical parameters of building structure (e.g. stiffness) caused by damage in the building leads to change in modal parameters of the structure such as natural frequencies, mode shapes and damping.

The present study was focussed on developing a robust structural health monitoring for damage identification in buildings using wireless sensor network. Lab scales models of steel beam, framed steel structure, reinforced concrete beam, six storey reinforced concrete building and full scale eight storey mock-up steel building have been instrumented with wired and wireless sensors for acquisition of vibration signatures. Physical parameters of test structures were varied during the experimental setup for development of SHM methodology.

The test setups were instrumented with wired velocity sensors and wireless accelerometers. These sensing devices were fixed along the length in beams and at floor level in buildings. Excitation was done using impact hammer and long stroke shaker. Acceleration-time histories and velocity-time histories have been recorded from beams and buildings in ambient and excited states in intact and damaged stages. Fig. 1 shows different sensing and excitation devices used in the study.

Vibration signatures acquired using sensing devices have been processed with Fourier transformation and wavelet transforms. Fast Fourier transform reveals spectral information contained in the time-histories where wavelet transform keeps the time and frequency relation intact. The mode shapes and damping was obtained for structures from the processed data.

Various damage identification algorithms including frequency change, mode shape change, mode shape curvature, curvature damage factor (CDF) and wavelet transform (WT) have been applied to check the accuracy and reliability in detecting the incorporated change in building. It has been observed with experimental validation that curvature damage factor approach is more reliable as compared to its predecessors. Further, wavelet transform based technique proved to be robust in detecting damage in the structures.

Fig. 2 shows mounting of wireless tri-axial accelerometers on beam (Fig. 1(a)), failure observed in different beams under 4-point loading (Fig. 2(b)) and CDF & WT values plotted against length of beam.

It is evident from the (Fig. 2(c)) that CDF approach could detect the location of cracks induced under the load points very well, however, failed to detect the exact damage location. Further, WT approach utilizing complex Gaussian (cgau) wavelet transformation and complex frequency b-spline (fbsp) wavelet transforms could detect the exact location of damage induced in RC beam under testing (Fig. 2(b) and Fig. 2(d)). Similar behaviour was observed for different beam cases.

Further, experiments were performed on 5-storey steel frame model, 8-storey steel building and 6-storey 1:3 scale down framed RC building (Fig. 3). After successful implementation of developed SHM methodologies on steel structures, experiments were performed on 6-storey RC building, which has a plan dimension of 1.5x2.0 m and storey height 1.1 m. Accelerometers and velocity sensors were fixed on the floor level. Harmonic excitation was provided using long stroke shaker and harmonic signal generator. Vibration responses were obtained in ambient and damaged stages. Damage was introduced by changing mass and varying stiffness. Stiffness variation was done by confining columns using steel plates and by constructing masonry wall on floor 2 along the shorter direction. Fig. 4 shows mode shapes of RC building in ambient condition and variation of frequency with increasing mass. CDF and WT approaches were applied on the recorded responses to identify the location of damage in the structures. Sensitivity of both approaches to detect minimum variation in load was identified with various experiments.

(a) Harmonic function generator

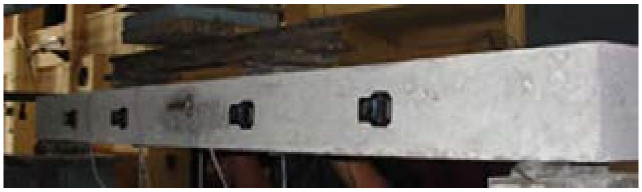
(b) Wired velocity sensor

(c) Long stroke shaker

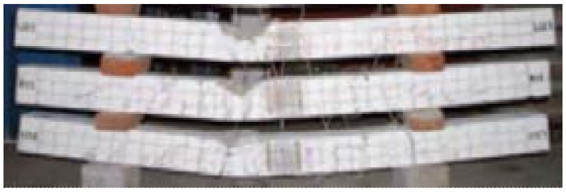
(d) Node commander

(e) Wireless accelerometer

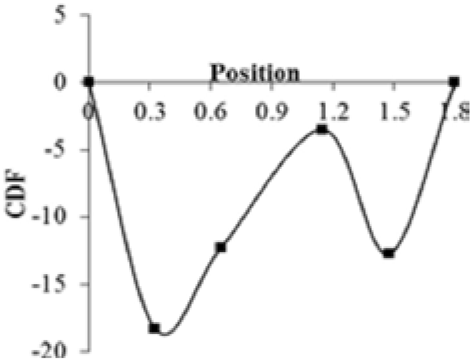
Fig. 1: Instruments for sensing and excitation



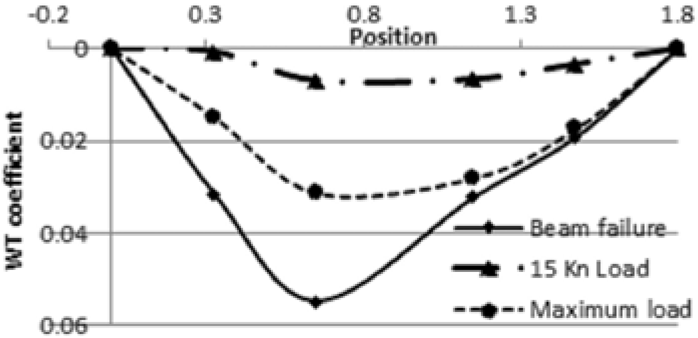
(a) Testing and monitoring of RC beams



(b) Failure pattern of RC beams under 4-point load



(c) CDF values for damaged state of beam



(d) WT coefficients for damaged state of beam

Fig. 2: Testing monitoring and damage identification in reinforced concrete beams

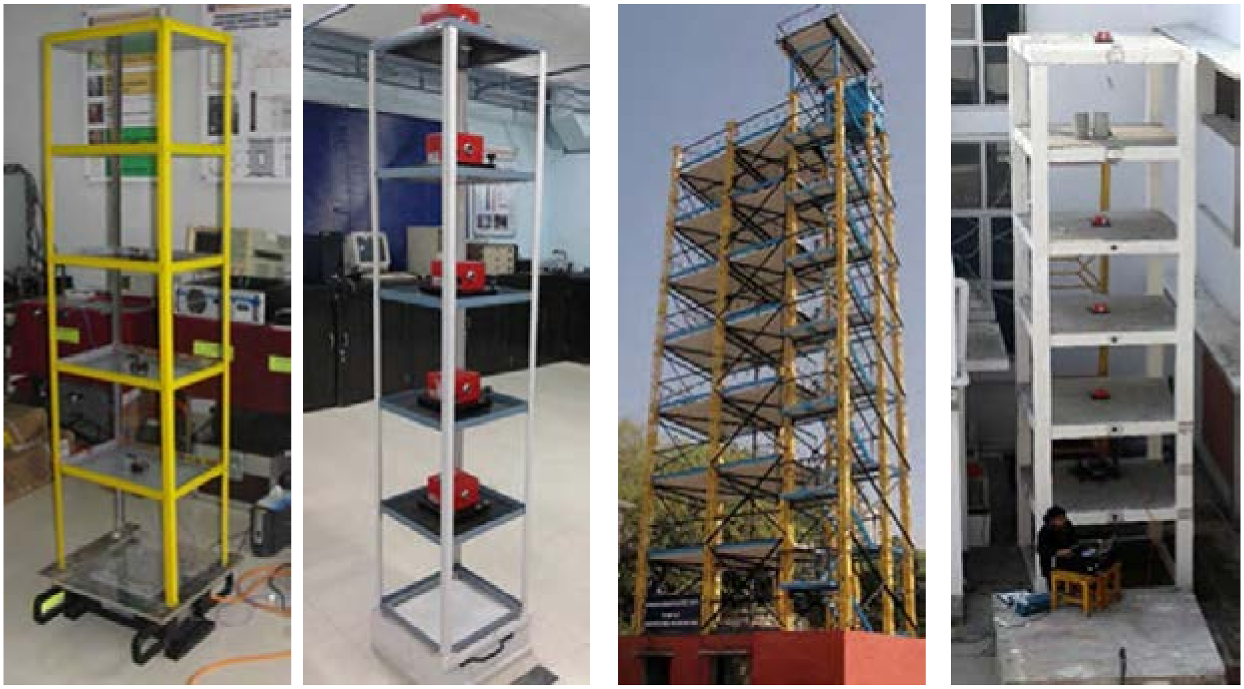


Fig. 3: Lab scale models of 5-storey steel frame, 8-storey steel building and 6-storey RC building

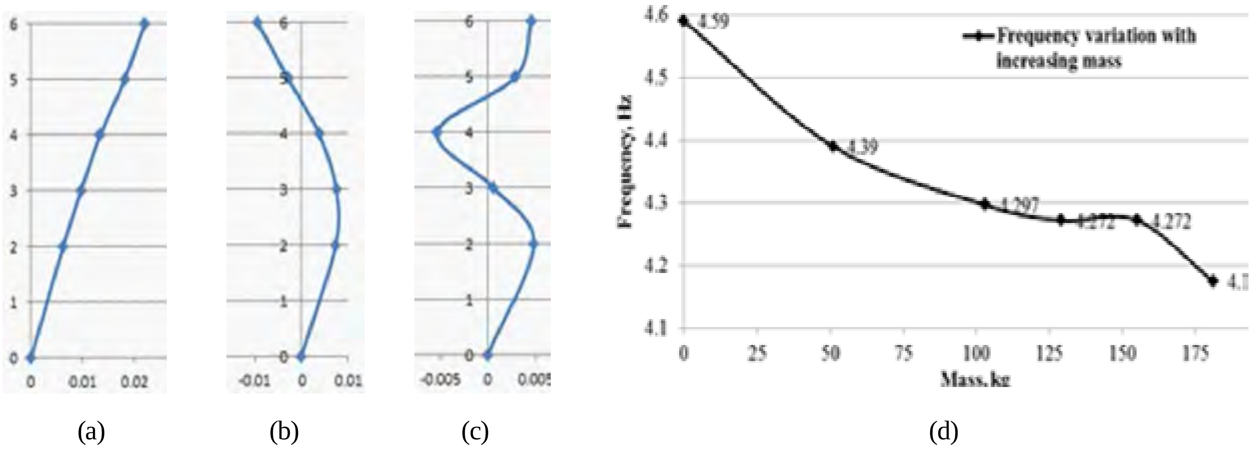


Fig. 4: (a) First mode shape, freq. 4.61 Hz (b) Second mode shape, freq. 14 Hz (c) Third mode shape freq. 25.1 Hz along shorter direction and (d) decrease in freq. with increasing mass in RC building

It has been established that for steel structure, the CDF approach was sensitive to change in mass variation beyond 0.8% of floor mass and minimum reduction of stiffness by 5% of element/floor stiffness whereas for RC structure, the CDF approach was sensitive to change in mass variation beyond 2.74% of floor mass while the wavelet approach was sensitive to 0.93%. Further, it has been established that wavelet transformation technique using fbsp 2-1-1, has been identified as an appropriate technique for health monitoring of buildings using WSN.

During study, it was observed that noise from wireless sensors is a key issue in addressing the health monitoring of structures in ambient conditions. Future work may be focussed on hardware or software part to arrive at wireless sensors with desired accuracy.

WP-6 Intelligent Building System for Model Residential Unit

R.S. Bisht & Achal Mittal

Architectural Planning & Design of a Residential Unit integrating Intelligent Building Features

Ashok Kumar & Team

The objective is to develop a cost-effective and energy efficient intelligent residential unit. Therefore, in continuation to the work reported in the previous years, the building is under final stages of construction (Fig. 1 and Fig. 2) and will solve the energy efficiency challenge, converge data, security, HVAC, lighting on a single network platform. The building has many innovative features.

Fig. 1: Front (north) facade of the building with proposed tempered glass for glass cleaning robot

Fig. 2: Rear side (south-west facade) of the building with recessed openings and locating toilets and staircase for minimizing heat flux to rooms

Intelligent HVAC & Lighting Controls in Response to Ambient Environment

Nagesh Babu Balam, Soju Alexander, R.S. Bisht & Deepak Kumar

Objective

To identify, develop and integrate the intelligent features into a model house making it a fully automated residential unit which is occupant friendly, safe, secure, eco-friendly as well as energy efficient.

Electrical Design of Lighting, Fans & HVAC Connections in Intelligent Buildings

The performance of various types of occupancy sensors is reported in the previous review. The different type of occupancy sensors tested include:

i. PIR

ii. Microwave

iii. Ultrasonic

iv. Dual Technology (PIR + Microwave)

It was concluded that ceiling mounted dual technology type occupancy sensors would perform optimally in the area where the movement is not so frequent like in office and bed room. For corridor or the area of frequent movement, we would use wall mounted PIR technology sensor with minimum time setting.

Fig. 1 shows the control circuit of smart loads with the occupancy sensor. Smart loads include Lighting load, Fans and HVAC load controlled by the occupancy sensors. The same electrical design is implemented for all the occupancy sensors which are connected to the smart loads.

Electrical design of intelligent building is complemented and is under construction phase. The Intelligent building shall cater to various smart loads such as Lighting load, Fans and HVAC. The following sensors are planned to be installed in the intelligent buildings

i. Occupancy Sensors

ii. Smoke Detectors

iii. Glass Break Sensors

iv. LPG Gas leakage detector

v. Security Camera

vi. CCTV camera

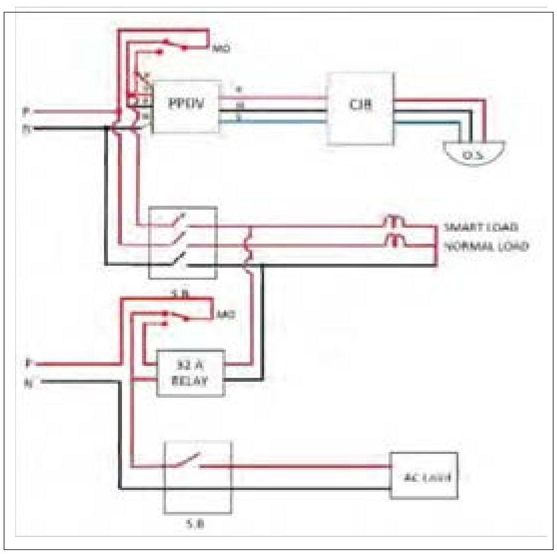


Fig. 1: Occupancy sensor connection diagram for smart loads and normal loads

These sensors operate on various protocols. So a common open platform type protocol has to be designed for operation of all these sensors. Measures have been taken to integrate all these features at the construction stage of the intelligent building. Fig. 2 shows the widget table for colour codes for electrical Single Line diagram. Fig. 3 shows the communication diagram between a room and the control room of the intelligent building. The same Networking architecture is followed in the entire intelligent building complex including common places and lobby areas as shown in Fig. 4 and Fig. 5. The networking architecture followed in the building can support LAN, WIFI or Hybrid network for communication interface. The electrical design supports IEEE 1451 Open standard for smart sensor interfaces and other building standard protocols such as BACnet, etc.

AC Power Line	DB-SB(AC)-AC
230 V AC line	DB-JB
Load Line	CSB-SB-SMART LOAD
AC/DC line	CSB-DB
signal line	JB-SENSORS
DB	DISTRIBUTION BOARD
SB	SWITCH BOX
CSB	CONTROL SWITCH BOX
CJB	CONTROL JUNCTION BOX

Fig. 2: Widget showing various colour codes for electrical single line diagram

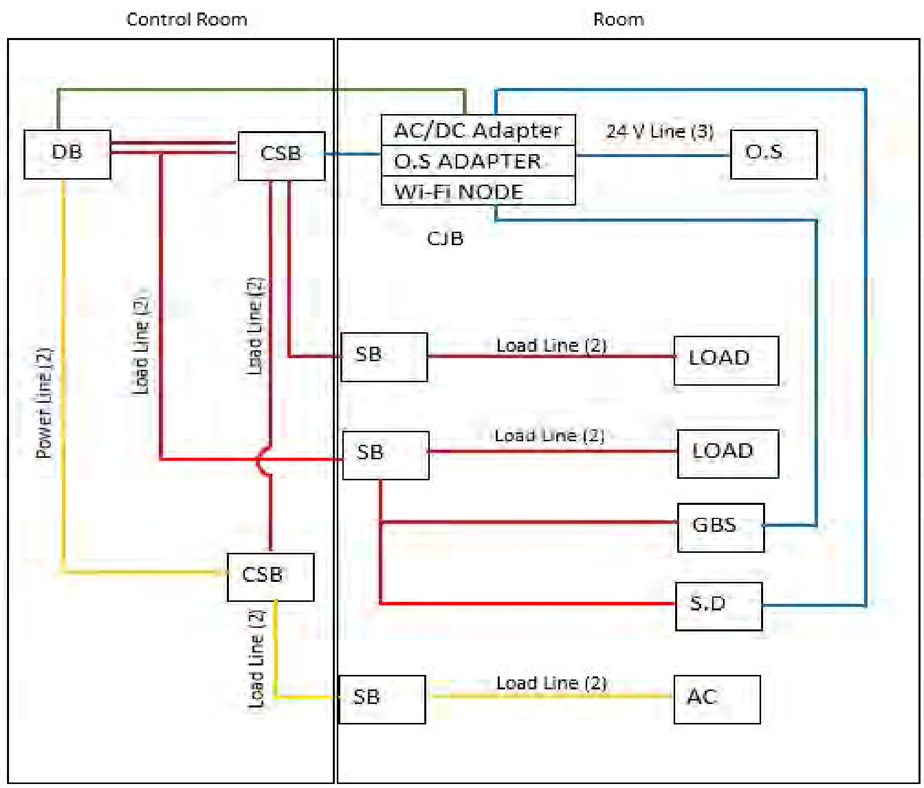


Fig. 3: Electrical connections and communication interface between a typical room and control room

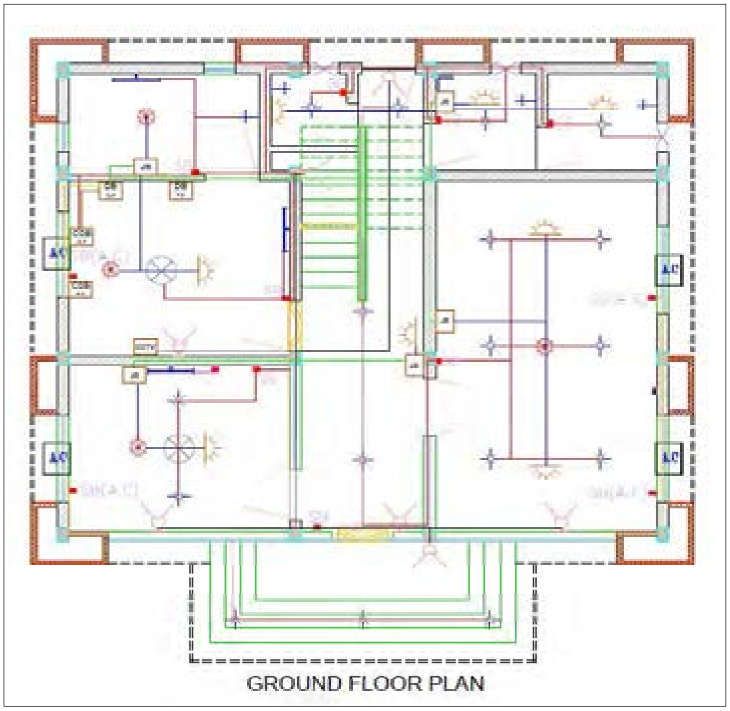


Fig. 4: Lighting, HVAC and sensor connections of ground floor, intelligent building

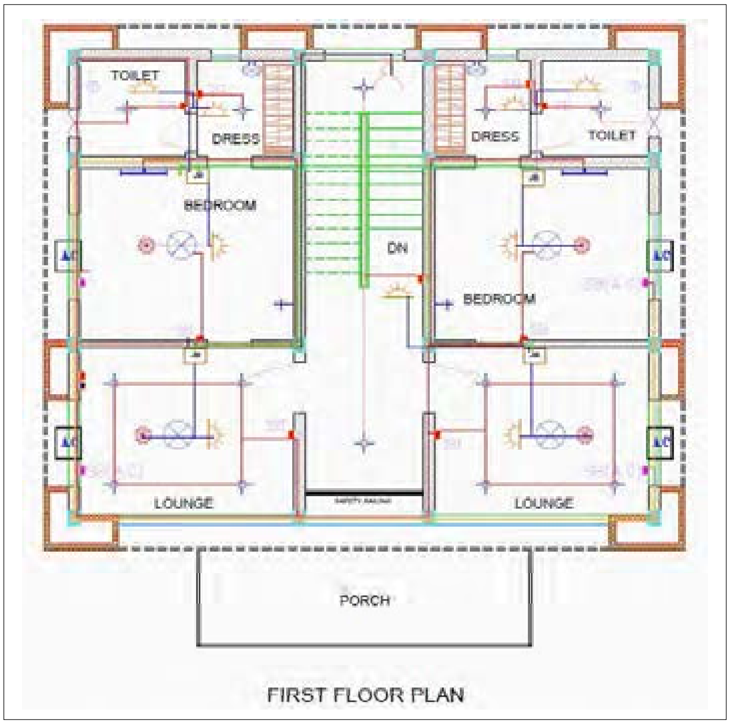


Fig. 5: Lighting, HVAC and sensor connections of 1st floor, intelligent building

Glass Facade Cleaning Robot

R.S. Bisht, Soju Alexander, S.K. Panigrahi and Nagesh Babu Balam

Objective

Design and development of a service robotic system for cleaning of glass façade

Progress Highlights

- Mechanism has been developed for simultaneous locomotion and adhesion of robot on glass facade
- Basic control and communication system has been developed for various motions of robot for path planning on glass façade
- Completed design layout of cleaning robotic system and assembly of the robot is under laboratory trails

Design & Development of Glass Facade Cleaning Robot

1. Mechanisms for Glass Façade Cleaning Robot:

Actuation and De-actuation of multi-suction cups are generally performed by individual solenoid valves connected through pneumatics tubes from vacuum pump supply unit. The devised solenoid valves on suction cups increase weight in the system as well as electrical power requirement. The multi-suction cups with solenoid valves for vacuum control will restrict application where weight and electrical power is a major concern, such as in climbing robot and in pneumatic gripper used as an end-effecter of mobile manipulator. The developed mechanism can be used for simultaneous locomotion and adhesion of moving object against gravity. This concept has been used in developing climbing robot for glassy wall surface applications for cleaning of large solar panels and glass façade of multi-storey buildings.

A mechanism has been designed and developed for automatic actuation and de-actuation of pneumatic based multi-suction cups mounted on robot locomotion. Testing, design and development of adhesion mechanism for glass façade cleaning robot is shown in Fig. 1.

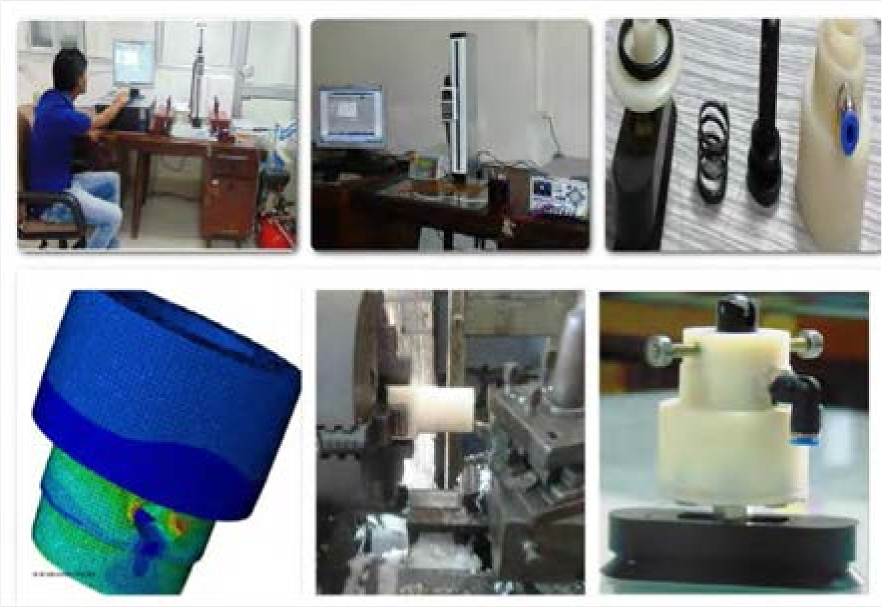


Fig. 1: Testing, design and development of adhesion mechanism for glass facade cleaning robot

1. Laboratory Testing & Assembly of Glass Façade Cleaning Robot:

The prototype of glass façade cleaning robot shown in Fig. 2 is developed based on a pair of track mechanism for simultaneous locomotion and adhesion of moving robot on vertical/inclined wall. Two front wheels used in track system are connected with individual DC geared motor, and the two rear wheels of track system are ideal for free rotation provided by pillow block bearing support system with the robot frame. PWM technique is used in the control algorithm for varying speed as well as direction control of the DC Motors. Payload testing of robot in the laboratory is to be done and working trials of mechanism for motion testing while assembly of the glass façade cleaning robot is shown in Fig. 2. There are two track systems used in the assembly of the robot for forward, backward and turning motion. The robot is powered by an on-board DC power system.

(a)

(b)

(c)

Fig. 2: Robot components, assembly and working trials of glass facade cleaning leaning robot

Network Projects

(CSIR-CBRI as a Participating Laboratory)

Network Projects
CSIR-CBRI AS A PARTICIPATING LABORATORY

Removal of Heavy Metals from Water Using Fly Ash and its Subsequent Use in the Production of Value added Building Components

PI: S. Maiti

[CL: CSIR-NEERI, Clean Water: Sustainable Options]

Estimation of Crustal Deformation of Garhwal Himalaya

PI: S. Sarka

[CL: CSIR-4PI, Advance Research in Engineering & Earth Sciences (ARiEES): Data Intensive Modelling & Crowd Sourcing Approach]

Analysis of Underground Coal Mines & Strengthening Strategies for Coal Pillars

PI: Ajay Chourasia

[CL: CSIR-CIMFR, Dhanbad]

Energy Efficient Seed Storage Structures

PI: Nagesh Babu Balam

[CL: CSIR-CSIO, Advanced Instrumentation Solutions for Health Care & Agro–based Applications -ASHA]

Robotic Technology for Periodic Inspections of Civil Infrastructures

PI: R.S. Bisht

[CL: CSIR-CMERI, Micro Machines & Robotics]

Removal of Heavy Metals from Water using Fly Ash and its Subsequent use in the Production of Value added Building Components

S. Maiti & A.K. Minocha

Objective

Main objectives of this project are:

- Design and construction of a packed bed reactor for removal of heavy metals from waste water by using fly ash and optimization of process variables.
- Use of the altered sludge for production of building component.

Removal of heavy metals from waste water is one of the most challenging environmental problems faced by several researches around the world. Unlike other organic pollutants, degradation rate of heavy metals is very slow thus these metals become a part of the food chain and accumulated in the body of living organism. Some of these heavy metals are very toxic even in low concentration. Copper, the metal consider in this study, is widely used in various industrial process such as electroplating, paint, pulp & paper mill, printed circuit board and the fertilizer industry. A recent study conducted showed that too much consumption of copper throughout life may cause Alzheimer's disease. That's why it is very much essential to treat copper containing waste water before it was discharged into the environment. Because of these reason world health organization and Indian standard recommends the maximum permissible concentration of copper in drinking water is 1.5 mg/dm^3 (IS 10500: 2012). Fly ash, one of the most abundant waste materials from the combustion of coal is a potential material for the adsorption of heavy metal contaminates in wastewater. It has alkaline property and its surface is negatively charged at high pH. In present work, fly ash collected from RenuSagar, Uttar Pradesh has been used as adsorbent for removal of copper ions from contaminated water. Then this adsorbed fly ash can be utilized to developed unconventional building component so that the possibility of leaching can be avoided. In this way the altered sludge can be safely disposed.

Fly ash used in this study was collected from power plant located at Renusagar (India). Chemical composition of this fly ash was SiO_2:56.73%, Al_2O_3: 25.64, Fe_2O_3: 5.47, SO_3: SO_3, Na_2O: 2.84, K2O: 1.93 etc. The results specify that it is class F type fly ash as combined weight percentage of SiO_2 and Al_2O_3 is more than 70% according to ASTM classification C 618. The pH of 2% solution of this fly ash was found 8.4.

Batch study was undertaken for removal of copper from contaminated water. Stock contaminated water of 1000 ppm was prepared synthetically in laboratory by dissolving cupric nitrate tri-hydrate salt in distilled water. Then 50 ml of these solutions were mixed with fly ash in a conical flask and placed in water shaker bath for proper mixing. Then the samples were taken out of the stirrer and filtered. The filtrate thus obtained was tested for the remaining copper ion concentration using inductively coupled plasma-optical emission spectrometry (ICP-OES). The removal efficiency of the process was determined by using equation (**eq. 1**).

$$E = \frac{C_i - C_o}{C_i} \text{ x } 100 \qquad \textbf{eq..1}$$

Where, E is metal removal efficiency (%), C_i is initial copper concentration in contaminated (mg/dm^3), C_o is final copper concentration in treated water (mg/ dm^3), m is the mass of fly ash and V is the volume of solution.

Effect of Initial Copper Ion Concentration & Fly Ash Dosage on Removal Efficiency:

From Fig. 1, it was observed that at a particular fly ash dosage the removal efficiency shares an inverse relationship with copper concentration as it increases with decrease in copper concentration and vice-versa. At particular fly ash dosage, total active sites available for sorption of metal ion is constant as result with increase in metal ion concentration removal efficiency decreases.

Effect of pH on Removal Efficiency:

Fig. 2 shows the influence of pH on removal efficiency. In this study pH of the solutions were varied in between 2-12 and metal ion concentration, fly ash dosages are kept constant at 100 mg/l and 40 g/l respectively. At pH values lower than the point of zero charge the adsorbent surface is positively charged thus favouring the adsorption of anions and for pH values greater than the point of zero charge the surface is negatively charged which favours the adsorption of cations. For the Renusagar fly ash, the pH of point of zero charge is 7.8. On increasing the pH beyond this value the removal efficiency increases significantly, reaches 100% at pH 9 and afterwards it becomes constant.

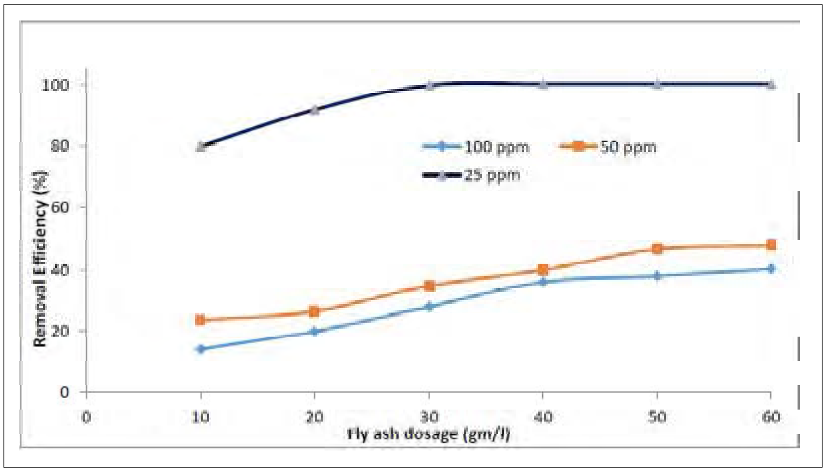


Fig. 1: Effect of fly ash dosage and metal ion concentration on removal efficiency

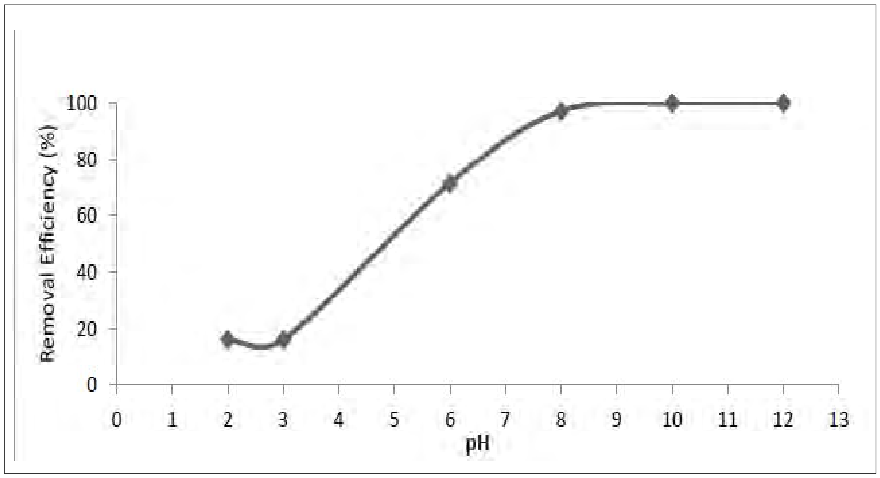


Fig. 2: Effect of pH on removal efficiency

Effect of Contact Time:

Contact time is another important factor that affects the adsorption of copper to a large extent and shown in Fig. 3. It was found from the figure that, with increase in contact time the adsorption capacity as well as removal percentage increases initially but after some time equilibrium is attained and thus removal percentage becomes constant. In present work, equilibrium was attained at 2h as on increasing the contact time upto 2 h, the removal efficiency increases, after that it becomes almost constant.

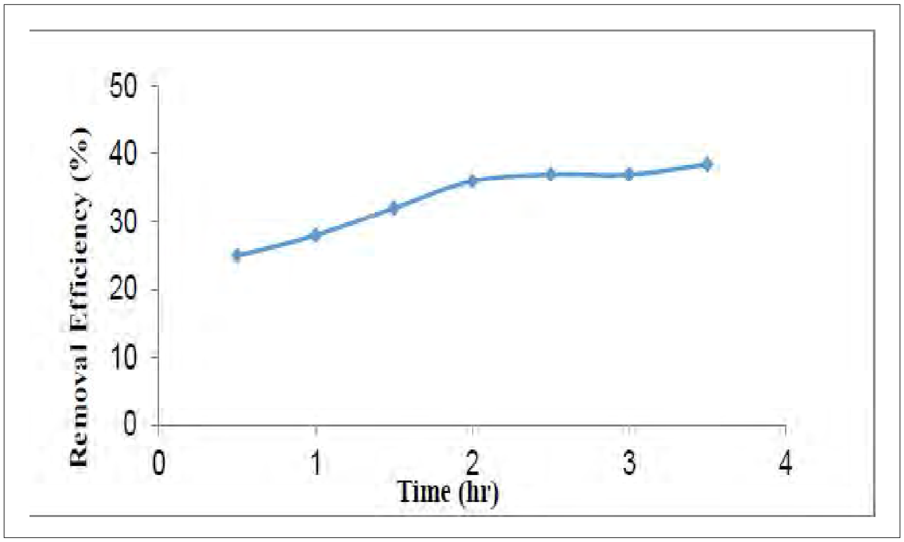


Fig. 3: Effect of contact time on removal efficiency

Experimental Design:

From the above study, it was found taht, the copper uptake predominantly influenced by four independent process variables namely initial metal concentration, pH, fly ash dosage and contact time. The individual and interactive effect of the four process variables (initial metal concentration, pH, fly ash dosage and contact time) on copper uptake are investigated using Central Composite Design model by conducting 30 experiments and presented in Table 1. The ranges of variables are chosen as initial metal concentration (10-90 mg/l), pH (2-10), fly ash dosage (20-100 g/l) and contact time (1-5 h). A four factorial five level Central Composite Design was developed using Design Expert software (6.08, 2002, state-ease inc. Minnepolis) in RSM for this study.

Based upon the calculation of regression co-efficient removal efficiency of copper in terms of coded factor is modelled as:

Removal Efficiency (%) = $59.55 + 8.29\,X_1+16.29X_2+8.87\,X_3+1.12\,X_4+7.19\,X_1X_2+1.69X_1X_3-2.94X_1X_4-6.44X_2X_3+0.19X_2X_4-0.81X_1X_4+5.50X_12+2.00\,X_22+2.12X_32+1.12X_42$

Statistical significance and model adequacy of the predicted model was analysed by employing the ANOVA and presented in Table 2. As evident from this table, model F-value is 31.88 confirmingthe model is very much significant. This model has also very low probability value (p>F value less than 0.0001)which implies that there is only 0.01% chance that Model F-Value this large could occur due to noise. R^2valueof the model is 0.9675, indicates that only 3.25% of total variation can not be explained by this model. The adequate precision value of the model measures the signal to noise ratio. For a significant model, it is desirable that this should be greater than 4. The value of Adequateprecision of this model is 21.29, indicates anadequate signal of the model.The lack of fit F-value of 101.02 implies the Lack of Fit is significant. There is only a0.01% chance that a lack of fit F-value this large could occur due to noise.In this study, X_1, X_2, X_3, X_1X_2, X_2X_3 and X_1^2 are significant model terms as their “prob>F” values are less than 0.0500 while values greater than 0.0500 implies model terms are not significant (In this case, X_4, X_1X_3, X_2X_4, X_3X_4, X_2^2, X_3^2, X_4^2 are not significant).

Table 1: Actual and predicted values of copper uptake and removal efficiency by fly ash based on CCD matrix

Run	X_1: Initial Metal Concentration (ppm)	X_2:pH	X_3:Fly ash dosage (gm/l)	X_4:Time (hr)	Y: Removal Efficiency (%)	
					Actual	Predicted
1	50	6	60	3	59.8	59.55
2	50	6	20	3	45	50.29
3	70	8	40	2	85	82.16
4	50	6	60	3	59	59.55
5	90	6	60	3	62	64.96
6	50	6	100	3	87	85.79
7	30	8	40	2	87	81.87
8	70	4	40	2	21	22.71
9	30	4	80	2	72	80.04
10	30	4	80	4	89	86.16
11	70	8	80	4	90	87.16
12	70	4	80	4	46	52.71
13	70	4	40	4	21	20.33
14	50	6	60	3	59	59.55
15	30	4	40	2	54	51.16
16	50	10	60	3	93	100
17	30	8	80	4	92	91.87
18	30	8	40	4	90	92.04
19	10	6	60	3	97	98.12
20	30	8	80	2	90	85
21	70	8	80	2	90	92.04
22	70	4	80	2	66	58.33
23	50	6	60	3	60	59.55
24	50	6	60	3	59	59.55
25	50	6	60	1	58	61.79
26	50	2	60	3	38	34.96
27	50	6	60	5	66	66.29
28	50	6	60	3	60.5	59.55
29	30	4	40	4	61	60.54
30	70	8	40	4	87	80.54

Conclusion:

- Fly ash used in this study was class F-type and point of zero charge of this fly ash was 7.8.
- It was found that, model obtained by CCD showed high co-relation between experimental value (Actual value) and model predicted value.
- RSM employed for optimization and to study the interactive effect between process variables and copper uptake was adequate in assessing the fly ash as potential adsorbent.
- A maximum copper uptake of 1.43 mg/gm was achieved at Initial metal concentration = 70 ppm, pH = 8, Fly ash dosage = 40 g/l and Contact time = 2 hr.
- Fly ash was found to be a potential low cost adsorbent for copper removal.

Table 2: Analysis of variance of the quadratic model for removal efficiency

Source	Sum Squares	df	Mean Square	F-value	p>F	Remarks
Model	12535.55	14	895.40	31.88	< 0.0001	Significant
X_1-Initial Metal Conc	1650	1	1650.04	58.74	< 0.0001	Significant
X_2-pH	6370	1	6370.04	226.79	< 0.0001	Significant
X_3-Fly ash	1890	1	1890.37	67.30	< 0.0001	Significant
X_4-Time	30.38	1	30.38	1.08	0.3194	
X_1X_2	826.56	1	826.56	29.43	< 0.0001	Significant
$X1X_3$	45.56	1	45.56	1.62	0.2222	
X_1X_4	138.06	1	138.06	4.92	0.0425	Significant
X_2X_3	663.06	1	663.06	23.61	0.0002	Significant
X_2X_4	0.56	1	0.56	0.020	0.8893	
X_3X_4	10.56	1	10.56	0.38	0.5489	
X_1^2	829.09	1	829.09	29.52	< 0.0001	Significant
X_2^2	109.49	1	109.49	3.90	0.0671	
X_3^2	123.61	1	123.61	4.40	0.0533	
X_4^2	34.59	1	34.59	1.23	0.2846	
Residual	421.33	15	28.09			
Lack of fit	419.25	10	41.93	101.02	< 0.0001	Significant
Pure Error	2.07	5	0.41			
Cor total	12956.87	29				

Estimation of Crustal Deformation of Garhwal Himalaya

S. Sarkar, D.P. Kanungo, P.K.S. Chauhan, Anil Maletha & Neelu Sharma

Crustal deformation of Garhwal Himalayan belt using GPS study is being carried out with the CSIR-4PI under the 12th Five Year Plan project on "Data Intensive Research for Earthquake Hazard Assessment by Modelling the Solid-earth (DREAMS)". The main objective of the project is the eestimation of the ongoing tectonic deformation of Garhwal Himalayas by establishing a real time GNSS network.

In this project a permanent GPS station has been established at CSIR-CBRI where GPS data are being collected in a continuous mode throughout the year. A few reference stations have been chosen in Garhwal Himalaya to estimate the crustal deformation. The GPS data are being collected at permanent GPS station at CBRI Roorkee continuously and in campaign mode at selected locations in Garhwal Himalayas such as Pipalkoti, Auli, Malari, Tungnath, Sukki, Chamba and Lansdown (Fig. 1 and Fig. 2). The data are being analysed with CSIR-4PI for estimating the crustal deformation by determining the extension as well as subtraction of the selected segments in Garhwal Himalaya.

The GPS data so far collected and analysed are integrated with the earlier data collected by CSIR-4PI since 1995 to determine the long term deformation rates (1995-2014) per year in this region. The analysis has shown that the location AULI, CHAMBA and LANSDOWN show deformation to the order of 5 to 10mm. It has been also inferred from analysis of the periodic data tha AULI-TUGN baseline indicates an extension of 8 mm/yr while the rest of the baselines between other stations indicate shortening of 5 to 10 mm/yr.

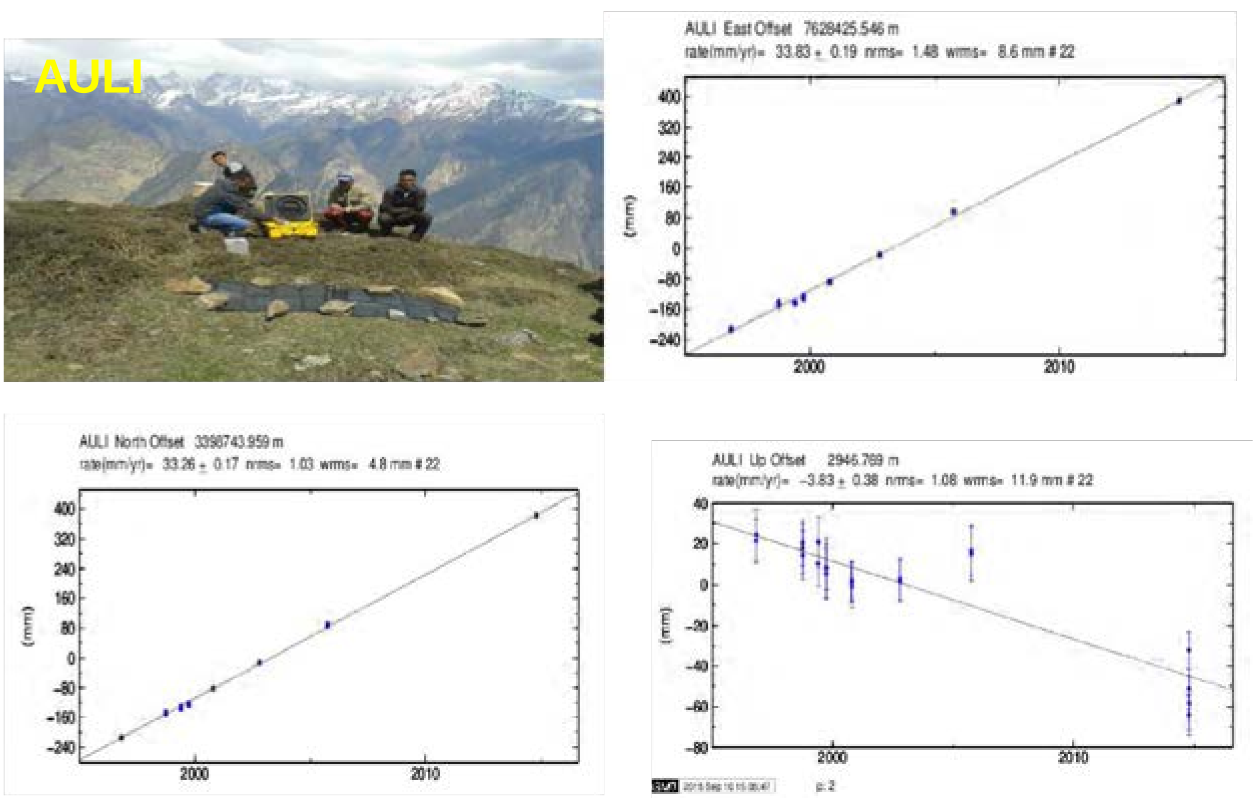


Fig. 1: Time series data of Auli station

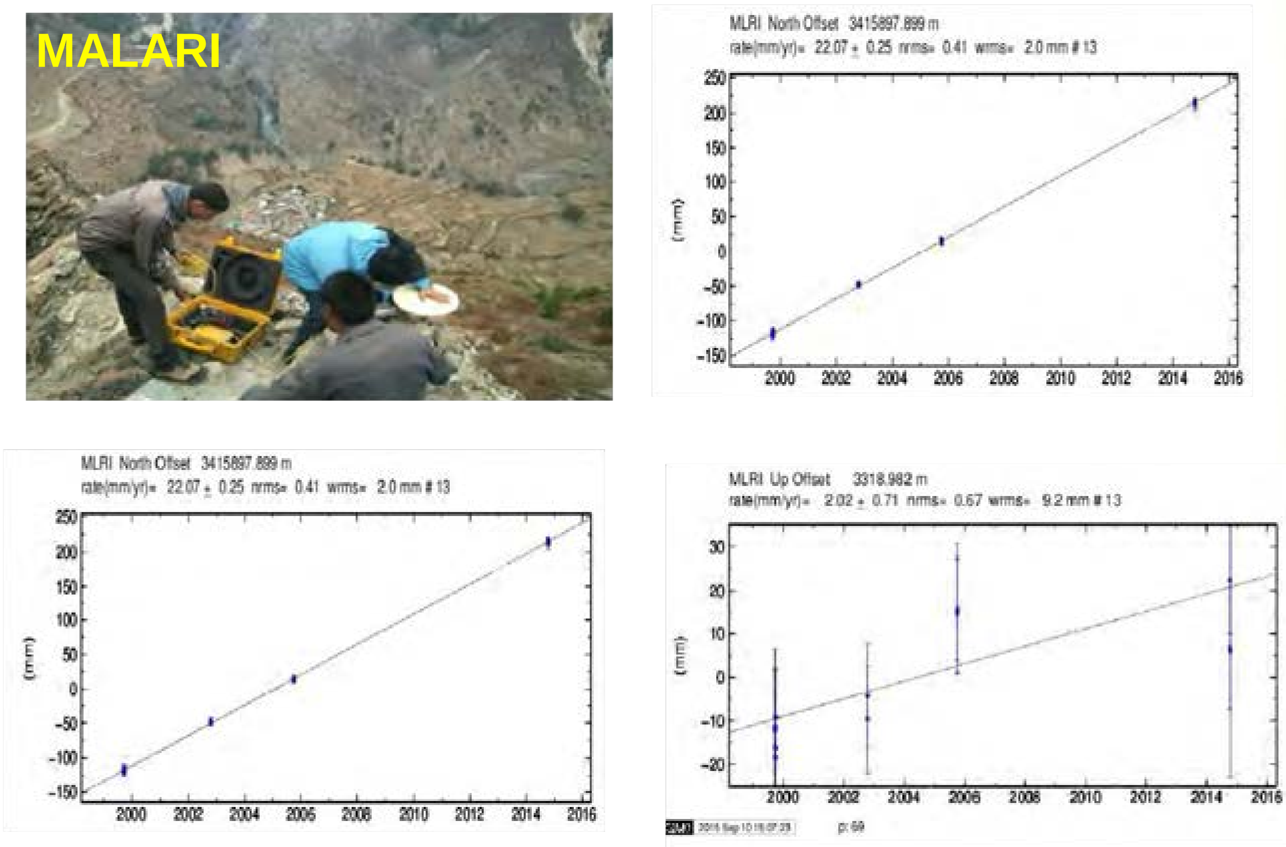


Fig. 2: Time series data of Malari station

The GPS data collected so far are being analysed collectively to estimate the ongoing crustal deformation of this part of Garhwal Himalaya to know the stress build-up for earthquake hazard assessment.

Analysis of Underground Coal Mines and Strengthening Strategies for Coal Pillars

Ajay Chourasia, Kaushik Pandit & Jalaj Parashar

With the progress of human civilization and industrialization, energy demand has been increasing since past few decades and it is expected to continue its growth at an exponential rate for future. Coal is still a primary source of energy generation worldwide and is the backbone of modern civilization. Coal currently supplies around 30% of primary energy and 41% of global electricity generation. Coal use is forecasted to rise over 50% by the year 2030, with developing countries responsible for 97% of this increase, primarily to meet improved electrification rates. Coal can be extracted from opencast mines and underground mines.

Bord-and-pillar mining technique is the most commonly adopted method of underground mining in any deep mine with coal seam thickness preferably more than 2m. It starts with the formation of bords (larger bords are called rooms) or galleries while coal pillars are left as natural support during the development stage (Fig. 1). Coal pillars are critical structural element in terms of roof stability as well as to improve coal production. If the pillar dimensions are increased, the strength or load carrying capacity of it also increases, but more amount of coal remains as locked-up pillars and therefore, productivity of the mining operations in terms of recovery of coal and cost of excavation is hampered. In contrary to that, lesser dimensions of coal pillars may be inappropriate to sustain the overburden load and thus will increase risk of pillar failure by lowering overall factor of safety of mines. Hence, determining the optimum pillar sizes based on technical, economical and performance parameters is very important.

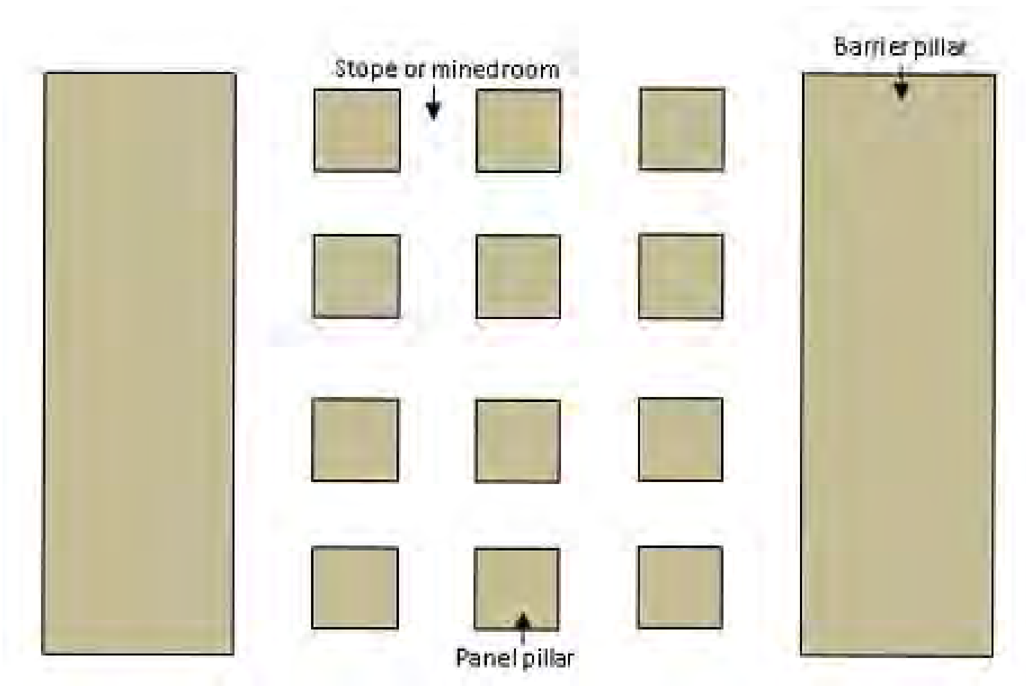


Fig. 1: Layout of barrier pillars and panel pillars in a coal mine developed by room-and-pillar method

During development stage, about 15-20 % of the total coal reserve is extracted and the remaining reserve could not be extracted due to different constraints like presence of surface/sub-surface features required to be protected from damage and collapse due to ground subsidence, presence of massive and strong overlying strata, lack of proper extraction and support methodology, scarcity of suitable filling material, environmental issues, etc. As a result, a huge quantity of good quality coal, estimated to be more than 3000 MT is locked-up in pillars for many years in India alone. These pillars are slowly becoming unapproachable due to increasing time-dependent complexity in geotechnical conditions of them. Hence, there is a necessity to study the underground coal mine stress behaviour to improve design of coal pillars and to strengthen the coal pillars to increase its structural load bearing capacity. All these will reduce coal pillar sizes and will eventually boost up coal extraction ratio from the mines.

Keeping in view the practical challenges in underground mining practices, the primary objectives of the defined research problem are depicted below,

- To improve coal production in bord-and-pillar method by optimizing coal pillar sizes without compromising in factor of safety against coal pillar failure, and permissible ground subsidence;
- To find a suitable, economically viable and structurally safe methodology to strengthen the coal pillars and to extract locked-up coal from the stationary pillars to maximize coal production.

Numerical Analysis of Coal Mines for Pillar Size Optimization

Stresses on coal pillars have been estimated using tributary area method and then compared with those obtained by 2-D FE analysis done. The stress values against varying (w/h) ratios were plotted, from which it can be inferred that the pillar stresses computed from conventional methods are far conservative than that of computed from numerical analysis. This incongruity in estimated pillar stress values results in a practice of leaving coal pillars of excessively larger dimensions in underground mines, such as for Morganpit (Salarjung, India) coal peat wherein tributary stress on pillar is almost 2.5 times than that of computed by numerical analysis and thus leads to bigger pillar sizes. Thus, there is a great possibility in economically reducing size of pillars through proper numerical modelling, thereby increasing coal recovery while ensuring safety with respect to strength and permissible ground subsidence.

The primary focus was to investigate behaviour of coal pillars under different geo-mining conditions with respect to influential factors like (i) mine geometry parameters: mining depth (D), width (w) and height (h) of pillars, gallery opening size (B); and (ii) mechanical properties of coal and in-situ rock: elastic modulus (E), uniaxial compressive strength (UCS). Finally, outcomes have been envisaged in terms of evaluating stress-strain relations, peak strength (S_m) and factor of safety (FoS) of pillars; and establishing correlations between non-dimensional elements. Finally, an algorithm has been formulated which leads to optimum dimensions not only of coal pillars but also of galleries and therefore, defines complete geometry of the excavated coal seam, incurring a substantial growth in coal recovery as compared to traditional pillar design and mining technique followed in bord-and-pillar methodology.

Numerical Analysis of FRP/Steel Jacketed Coal Systems

FRP-wrapping and steel jacketing can considerably improve the axial compressive strength and ductility of coal cylinders subjected to lateral confinement. Thus a numerical analysis approach to evaluate the effectiveness of FRP or steel sheet in confinement applications is presented. The proposed models are capable of representing the micro-cracking in coal and interface de-bonding phenomenon. The FRP or steel jackets are reported to fail if the maximum interfacial shear and peel capacity at the free edge of the composite wrapping are exceeded.

Based on the numerical analyses, the following conclusions may be drawn:

- Effective strain in the confining material decreases as thickness of it increases.

- Confinement efficiency improves as the confinement lateral pressure increases. The increment rate in confinement lateral pressure decreases nonlinearly with the jacket thickness.
- In steel encased cylinders, higher interfacial bonding strength is found than that in FRP confinement system and hence it results in higher compressive strength and ductility of the coal cylinder.
- For single and double wrapping layers, the CFRP confinement provides a greater increase in strength and ductility to coal cylinder than GFRP confinement as observed from the slopes of the trend line of the stress-strain curves.

Numerical Analysis of Unstooked Mines and Externally Strengthened Stooked Coal Pillars

This section encompasses induced stress computations in the mines at first developmental stage, modelled and developed in the finite element code, according to the Directorate-General of Mines Safety (DGMS), India guidelines. Further, the pillars have been suitably depillared or stooked with an importance implied on the symmetry in geometry of stooking action to facilitate symmetric load distributions from mining roof to its floor bed. The scooped pillars are then externally wrapped with carbon FRP of single layer and the entire arrangement has been subjected to the overburden load of modelled mining depth. This led to the computation of stresses induced on top of the coal pillars and at their bottom, i.e. at the pillar-to-floor interfaces. Correspondingly, peak strength of these individual stooked pillars with external CFRP wrappings are computed by the finite element code by utilising a displacement control loading approach on top of the pillars. Finally, factor of safety values as a ratio of the peak strength to the induced mining stresses on top of these strengthened coal pillars have been measured.

Following conclusions may be drawn from the above study:

- Strength of coal pillars increased significantly when they are externally wrapped or laterally confined.
- Confined strength of coal pillars which are rectangular in shape, exhibits lesser peak strength than that of those pillars having same cross-sectional area in plan but are square in shape. Reason may be confinement effect reduces for rectangular sections than that in square sections due to the reduction in contact surface area between the external wrapping and the coal pillar itself. Another reason may be the unsymmetrical stress distribution in rectangular sections.
- The confinement effect increases as the central core zone of the coal pillar is approached. Hence the confined strength increases from the edges to its central portion.
- Laterally unconfined or unwrapped strengths of coal pillars, computed from the empirical formula, increases linearly as (w/h) ratio increases. In contrary to that, peak strength of laterally confined coal pillars, as computed from the numerical analyses does not increase linearly with increasing (w/h) ratios.
- Lateral confinement restricts formation of plasticity in coal and its spread.
- The peak strength of laterally confined coal pillars are constrained by the coal itself as at failure load, most of the coal elements fail while CFRP elements were still intact. Thus, it can be concluded that the stresses are concentrated at the pillar corners and this affects the CFRP elements adjoined to the corners.
- Coal extraction ratio can be boosted up as seen from the observations. It is quite possible to achieve the required coal pillar strength for reduced dimensions of pillars if they are laterally confined by exterior wrapping of CFRP or similar materials.

Energy Efficient Seed Storage Structures

Nagesh Babu Balam, Somya Srivastava & B.M. Suman

Objectives

To develop energy efficient seed storage structure with controlled environment to avoid spoilage and deterioration of quality of seeds

Experiments have been carried out at CSIR - CBRI to test the performance of Double-Deck Roof (DDR) structure to passively cool the seed storage structures. The experimental double deck roof structure is shown in the Fig. 1. It consists of Thermocol sheets placed above an RCC roof with a variable air gap between the RCC roof and the thermocol sheets. The air gap is varied from 0 to 40cm and an optimized air gap is determined based on the maximum reduction of the roof temperature. Similar experiments were also carried out by replacing the thermocol sheets with GI sheets and an optimized air gap is determined.

Fig. 1: (a) Experimental room with double deck roof (b) Close up view of DDR with air gap

Ambient Temperature from 6th to 12th June

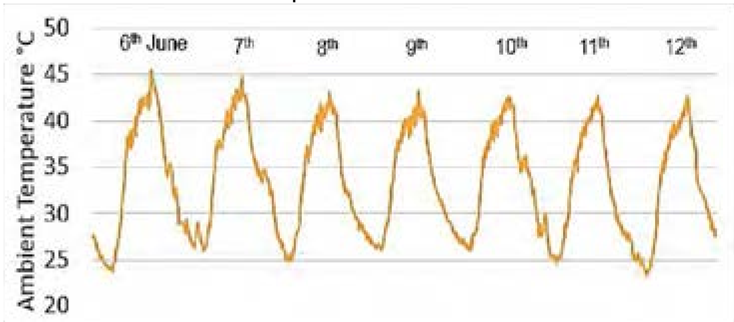


Fig. 2: Uniform temperature cycles during the peak summer season

The experiments were carried out during summer season due to two reasons

1) Cyclic temperature conditions are uniform from June 6th to 12th as shown in Fig. 2.

2) The performance of the DDR structure is very effective during the peak summer season.

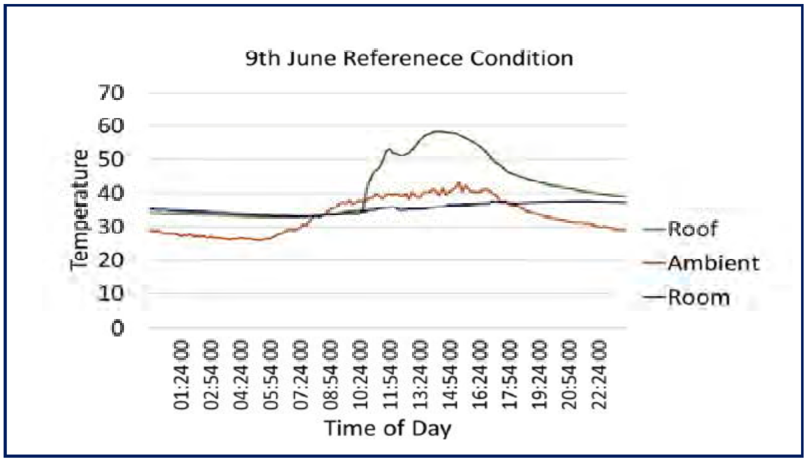


Fig. 3: Roof, ambient and room temperatures on 9th June of the reference room

Fig. 3 indicates the temperature of the roof, ambient and room without DDR structure. The temperature of the roof without DDR structure reaches to about 58 °C at around 2:30 PM on a peak summer day (9th June)

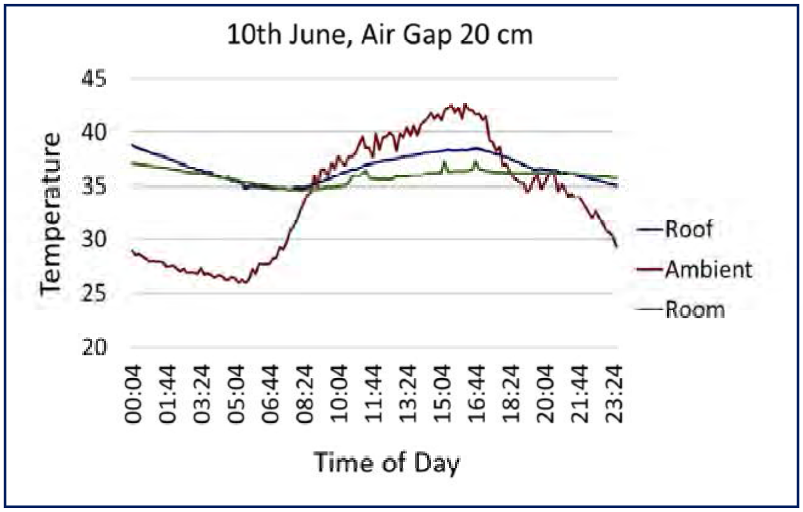


Fig. 4: Roof, ambient and room temperatures on 10th June with DDR structure

Fig. 4 indicates the temperature of the roof, ambient and room with DDR structure on 10th June. The temperature of the roof with DDR structure reaches to about 38 °C at around 5:30 PM on a peak summer day (9th June).

Air Gap Optimization:

An optimum air gap (between roof and DDR structure) is determined based on the conduction and convection heat transfer through the air gap. It is observed that increase in air gap from 20cm to 36cm not only reduces the peak room temperature but also is effective in nocturnal ventilation (night cooling of the roof due to radiation heat transfer) as shown in Fig. 5.

Experiments with GI Sheet:

Similar experiments were carried out with GI sheet during the month of August from 23rd to 27th and the results were shown in Fig. 6 and Fig. 7.

Inferences:

- Double deck roof can reduce roof temperatures by 15 to 20 °C and room temperatures by 3 to 4 °C
- Heat transfer in Insulated sheets is by convection and in GI sheet. It is both by convection and conduction.

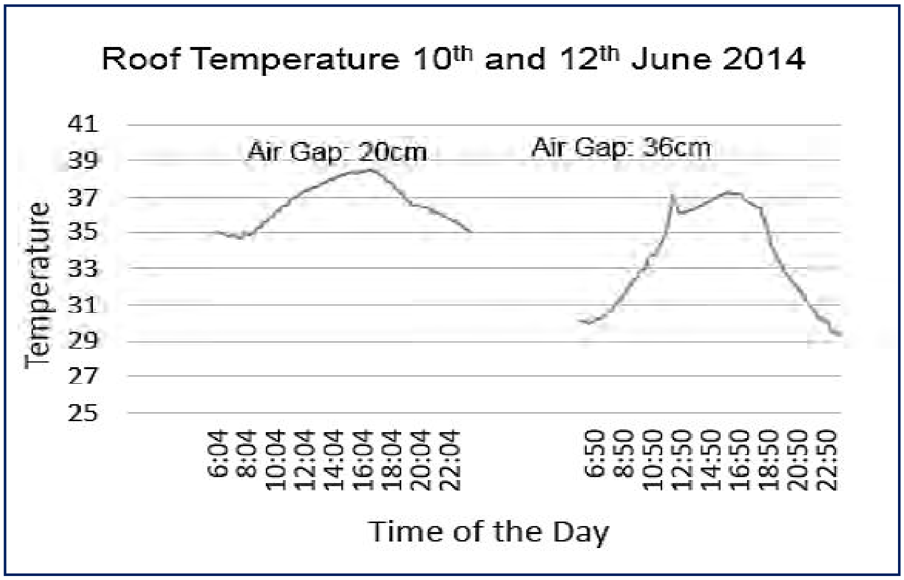


Fig. 5: Comparison of air gap on 10th and 12th June

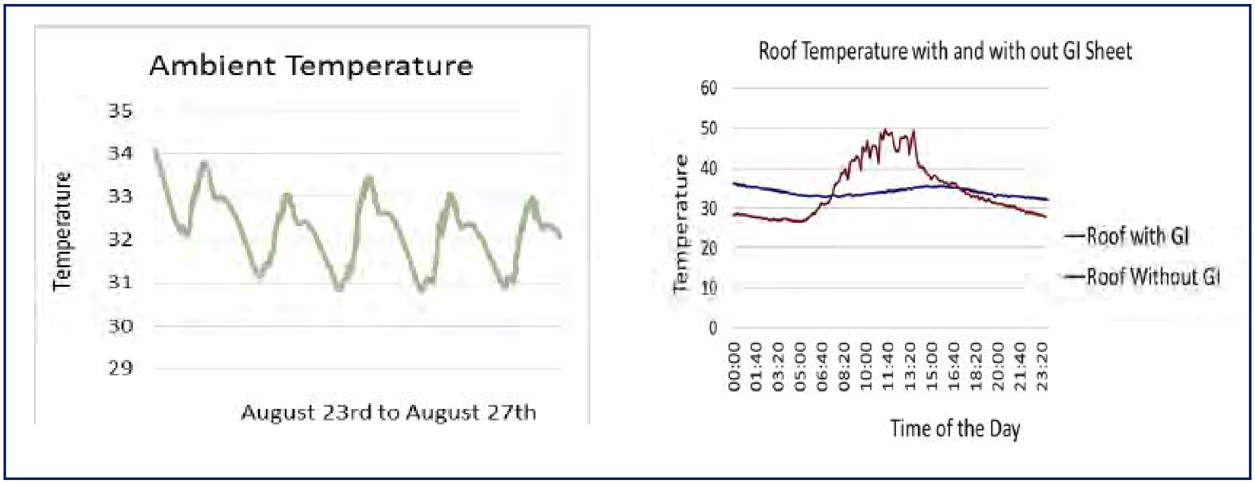


Fig. 6: (a) Ambient temperature from 23rd to 27th August (b) Hourly variation in roof temperature with and without GI Sheet

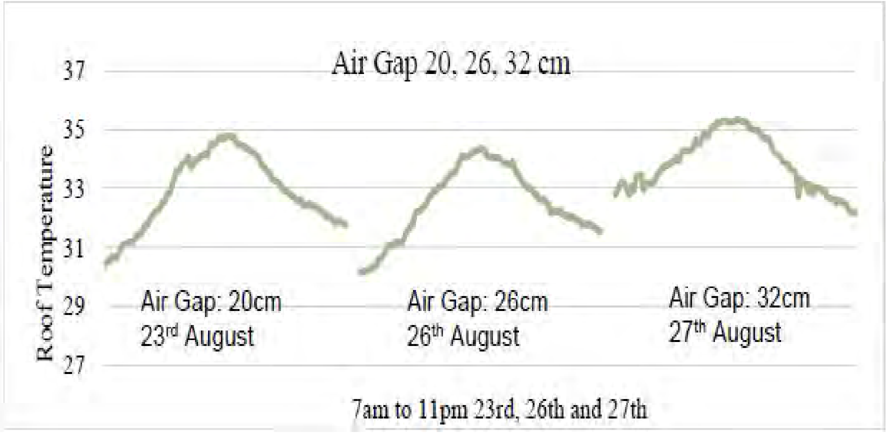


Fig. 7: Comparison of roof temperatures with the air gap of 20, 26 and 32cm

- GI sheets are more effective for nocturnal ventilation than EPS insulated sheets.
- Increasing the air gap increases the cooling rate of roof during nights.
- An optimized air gap for metallic sheets is approximately 25cm above which the air gap does not significantly reduce the roof temperature.

Heat Transfer Analysis:

In-order to understand the heat transfer and convection air current flow mechanism within the air gap between the roof and the DDR structure heat transfer analysis is carried out to determine the overall heat transfer coefficient 'U value' and parameters effecting the 'U' value. The heat transfer due to convection is modelled using Laminar 2-D double-diffusive convective flow (humid air - considering condensation during night). The governing equations for the problem under consideration are as follows.

Conservation of Mass:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \qquad \textbf{eq..1}$$

Conservation of X-directional Momentum with Boussinesq Approximation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + v\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) - g\beta_T(T - T_C)sin\alpha + g\beta_c(c - c_1)sin\alpha \qquad \textbf{eq..2}$$

Conservation of Y-directional Momentum with Boussinesq Approximation:

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + v\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) + g\beta_T(T - T_C)cos\alpha + g\beta_c(c - c_1)cos\alpha \qquad \textbf{eq..3}$$

Conservation of Energy:

$$\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \alpha_c\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \qquad \textbf{eq..4}$$

Species Conservation Equation

$$\frac{\partial c}{\partial t} + u\frac{\partial c}{\partial x} + v\frac{\partial c}{\partial y} = D\left(\frac{\partial^2 c}{\partial x^2} + \frac{\partial^2 c}{\partial y^2}\right) \qquad \textbf{eq..5}$$

Average Nusselt Number:

$$\overline{Nu} = -\frac{1}{L}\int_0^L \frac{\partial T}{\partial x}dy \qquad \textbf{eq..6}$$

Boundary conditions for a rectangular domain with Aspect Ratio A = 10 are as follows:

$$= x, y = 0: u = 0, v = 0, T = T_{h,}\ c = c_h$$

$$x = x, y = H: u = 0, v = 0, T = T_{c,}\ c = c_1$$

$$x = 0, y = y: u = 0, v = 0, \frac{\partial T}{\partial x} = 0, \frac{\partial c}{\partial x} = 0$$

$$x = W, y = y: u = 0, v = 0, \frac{\partial T}{\partial x} = 0, \frac{\partial c}{\partial x} = 0$$

T_h value is the roof temperature. c_h value is the percentage humidity of air for the day under consideration and other terms have their standard CFD naming conventions.

The governing equations (eq 1-6) are solved in a rectangular domain (simulating the air gap between roof and DDR structure) having Aspect Ratio A = 10. (30 cm Air gap and 3m roof width). Vorticity-Stream function formulation is used for solving the Governing equations. Obtained Partial differential equations for Stream function, vorticity, Temperature and Concentration are converted to Algebraic equations using Finite difference method. 1st order Upwind scheme is used for discretization of convective terms. 2nd order Central difference scheme is used for discretization of diffusion terms. Alternate Direction Implicit (ADI) scheme is used to discretize the transient term. The obtained coefficient matrices are in implicit line Tri-diagonal form and are solved using Thomas algorithm. The numerical computations are carried out for 31 X 41 grid nodal points for a time step of 10^{-5}. The convergence criterial required that the difference between the current and previous iterations for all of the dependant variable be less than 10^{-5}. The average Nusselt number is calculated at the Roof. Following parameters are used during simulation

Aspect ratio of the Air Gap: A = 10

Natural Convection of air inside Air gap: Rayleigh Number Ra = 10^5

Angle α = 90^o constitute the simulation of horizontal roof

Angle α = 0^o constitute the simulation of vertical wall

Observations

Rayleigh–Bénard convection heat transfer is observed when angle α > 70^o which is a typical characteristic of convection heat transfer in the double layer structure as shown in streamline contours in Fig. 8. A single large Convection cell is seen for Vertical DDR structure (Double Deck Wall: α = 0^o) whereas multiple Rayleigh Bernard Convection cells are seen in the case of horizontal DDR structure (α = 90^o). Single Rayleigh Bernard Convection cell corresponds to higher heat transfer coefficient because of the increased amount of time obtained for the streamlines to transfer heat from the bottom roof to the DDR structure. The following observation is also validated by the calculated average Nusselt number at the roof and observing the Isothermal contours seen in Fig. 9.

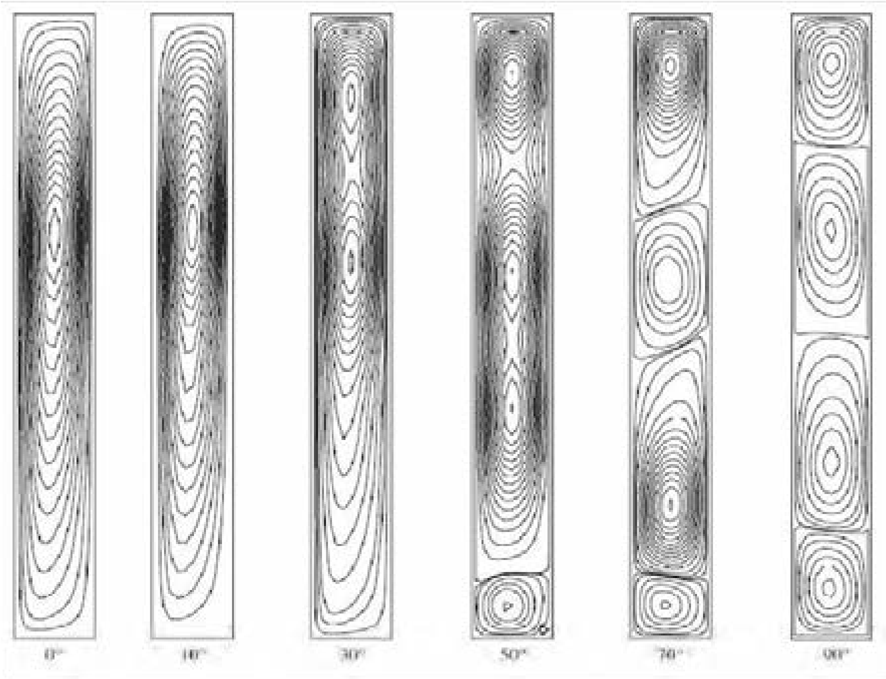


Fig. 8: Stream line contours with aspect ratio A = 10 and Rayleigh number Ra = 10^5

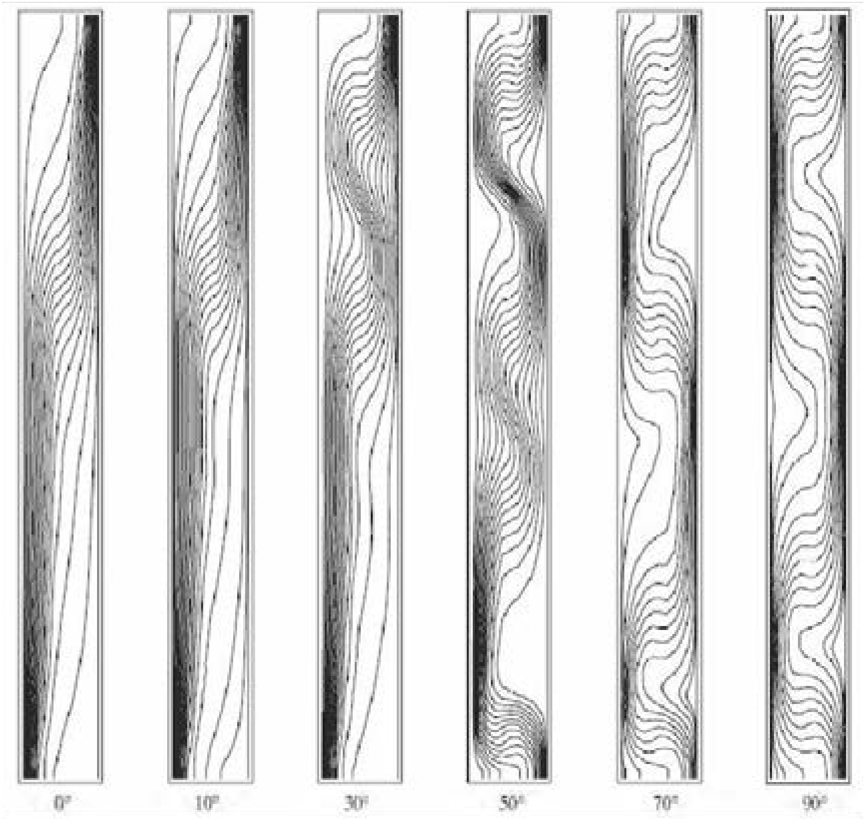


Fig. 9: Isotherm contours with aspect ratio A = 10 and Rayleigh number Ra = 10^5

Robotic Technology for Periodic Inspections of Civil Infrastructures

R.S. Bisht, S.K. Panigrahi & Soju Alexander

Objective

- To design and develop a service robot with manipulator for precise inspection of desired surface of the civil structure.
- The precise inspection will be carried out by vision and NDT sensors mounted on the service robot.

Progress Highlights

- Mechanism has been developed for crawling of robot on ferrous surface and attempt has also been made to develop mechanism for other surface applications.
- Basic control and communication system has been developed for various motions of the robot on vertical and inclined wall.
- Prototype of autonomous climbing robot for ferrous surface application has been developed and conducted laboratory trials for performance testing of the climbing robot.

Development & Performance Testing of Four-Wheeled Magnetic Climbing Robot

The prototype autonomous climbing robot shown in Fig. 1 is developed based on four magnetic wheel rubber grip mechanism. Two front wheels are connected with individual DC geared motor, and the two rear wheels are ideal for free rotation provided by pillow block bearing support system with the robot frame.

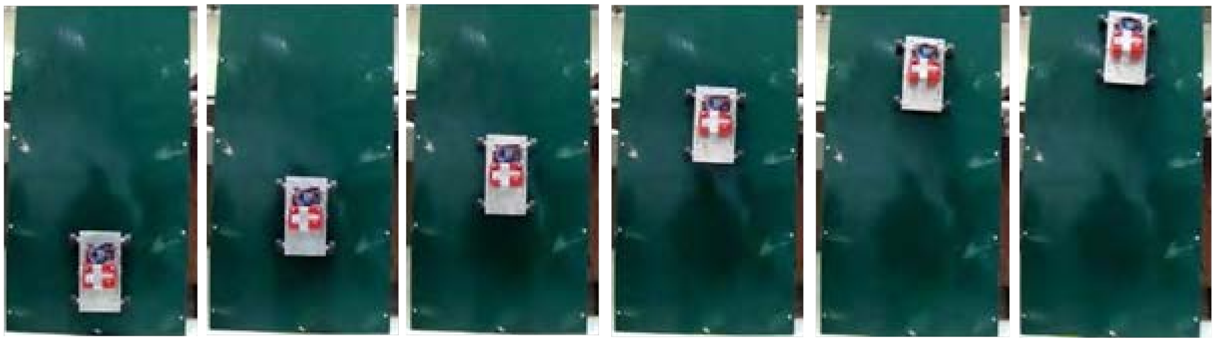
The main technical specifications of the climbing robot are listed in Table 1. The laboratory experiments and analysis indicted that the magnetic wheel with rubber grip thickness (0.5 mm) is found most suitable and used for the design of prototype robot deployed for trail testing. In Fig. 2, working trails for climbing action from (a) to (f) show that the autonomous climbing robot is perfectly crawling without slipping and toppling on a green painted thin ferrous surface of thickness =1 mm.

It is found from the laboratory trials shown in Fig. 3 (a) to (f) and Fig. 4 (a) to (f) that the robot does not have a major problem in left and right turnings on a vertical wall, since we are controlling differential derive motor speed using PWM control algorithm techniques by varying speed of an individual DC motor of the differential wheeled locomotion mechanism. There is slippage of rear wheels while spinning of the robot, hence, steering is a major problem of the robot on vertical wall. It has been further investigated for left and right spin motion of robot on vertical wall and now this is improved by connecting all four wheels by individual DC motors.

Fig. 1: Developed autonomous climbing machine

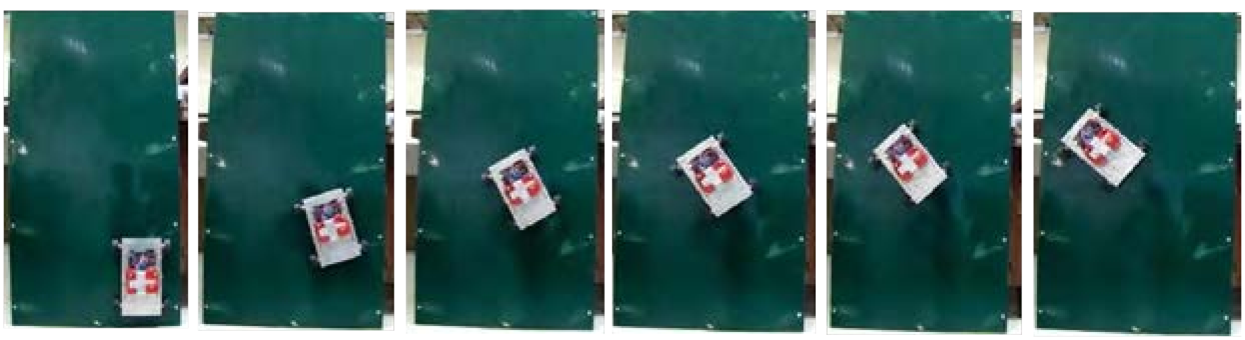
Table 1: Main specifications of the climbing robot

Weight	3.2 Kg
Size (mm^3)	250(L) X 150H)(W) X 150(H)
Speed of robot	18 m/min (max)
Adhesion mechanism	Wheel based on magnetic adhesion technique
Additional payload	1.8 Kg



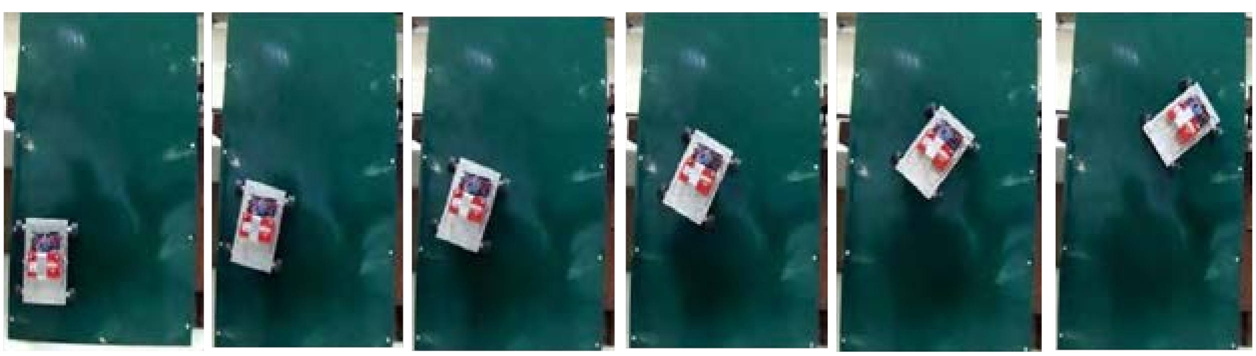
(a) (b) (c) (d) (e) (f)

Fig. 2: Working trials of an autonomous climbing robot for climbing action from (a) to (f) on vertical thin ferrous surface



(a) (b) (c) (d) (e) (f)

Fig. 3: Working trials of an autonomous climbing robot for left turn action from (a) to (f) on vertical thin ferrous surface



(a) (b) (c) (d) (e) (f)

Fig. 4: Working trials of an autonomous climbing robot for right turn action from (a) to (f) on vertical thin ferrous surface

CSIR Fast-Track Translation Projects

CSIR Fast-Track Translation (FTT) Project

Building Products using Kota Stone Cutting and Slurry Waste (MLP 0511)

PI: Rajni Lakhani & Rajesh Kumar

Foundation System for Light Structures (MLP 0512)

PI: M. Samanta , Ajay Dwivedi & S. Sarkar

Development of a Boring Machine Based on Trenchless Technology (MLP 0513)

PI: S K Panigrahi & Narendra Kumar

Building Products using Kota Stone Cutting & Slurry Wastes (MLP-0511)

Rajni Lakhani & Rajesh Kumar

Objectives

- To develop the formulation for tiles using Kota stone cutting/slurry waste
- To develop the formulation for light weight blocks and its optimization
- Scale up of the developed process up to pilot level

Introduction

Kota and Jhalawar districts of Rajasthan is abound with about 100 million tonnes of split able type of decorative grade flooring limestone. Its deposits are also found in Ajmer, Swai-Madhopur, Rajsamand, Udaipur, Banswara but major deposits are found in Kota district and hence the name Kota stone. The year wise production of Kota stone is almost continuously increasing.

Every year about 10 MT of stone waste is generated from processing of Kota stone for making different items. CSIR-CBRI has developed a process know-how for recycling and utilization of slurry wastes in making tiles, pavers and blocks. The developed items meet the requirements of Indian Standard Specification. The utilization of high volumes of Kota stone slurry waste in lightweight concrete leads to higher strengths than that of normal lightweight blocks.

Progress

After crushing & beneficiation of Kota stone waste (KSW) materials; the physico-mechanical characterization has been done to develop cement concrete flooring tiles and paver blocks as per IS: 383, IS: 2386 (Part- I, II, III & IV) and IS: 4031 with the following observations:

1. As per IS: 383-1970; KSW manufactured sand (as fine aggregates), was classified as fine aggregate of grading Zone-1 having fineness modulus of 3.68 (Fig. 1).
2. The fineness modulus of KSW coarse aggregate was 6.18.
3. As per IS: 2386 (Part-I), the percentage of combined flaky & elongation indices should be limited to 30 %. Therefore, coarse aggregate maximum size (MSA) has been adjusted at 10 mm sieve size because the percentage of combined flaky & elongation indices was 8% at 10 mm MSA, 34% at 12.5 mm & 65% at 16 mm. Also, as per IRC SP-63 specification; the MSA for coarse aggregate is 12 mm i.e. well suited with aforesaid.
4. The crushing blades of Jaw crusher were so adjusted through iterations-cum-trials that the particle size

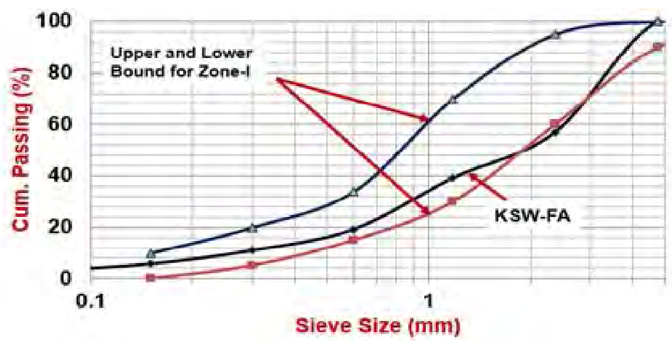


Fig.1: Grain size distribution curve for Kota stone waste fine aggregate.

distribution curve for KSW All-in-Aggregates (Size- 10 mm to 75 µm) was nearly close to Fuller's curve which provides maximum density aggregate grading. The fineness modulus was 4.66 which is in the range from 3.5 to 6.5 as per the literature (Fig. 2).

After doing physico-mechanical characterization; the concrete casting for various mix-designs are in process as per IRC SP: 63, IS: 10262 & IS: 15658.

Following are the critical observations:

1. With water curing, up to 55 MPa compressive strength can be achieved by taking 19% OPC, 43% KSW Fine aggregate (without slurry), 30% coarse aggregate (Total aggregates-73%), Super plasticizer dosage was up to 0.8% of OPC; with w/c 0.36.

   However, to decrease the quantity of OPC; mix design-trials by addition of fly ash are in progress to achieve strength up to 55 MPa.

   Note: As per Annex. A of IS: 10262, approx. 14% OPC is required to make M 40- Grade concrete.

2. In above mix proportion; replacement of KSW FA with KSW slurry has been done up to 20% (Approx. 10% of whole concrete making raw materials). 28 days' compressive strength was obtained up to 45 MPa with water curing. However, to increase the amount of stone slurry; mix design-trials is in progress to achieve maximum compressive strength.

3. With water curing, up to M30 grade of concrete can be made by taking 12.5% OPC, 43% KSW Fine aggregate (without slurry), 35% coarse aggregate (Total aggregates-78%), Superplasticizer dosage up to 0.7% of OPC; with w/c up to 0.37.

Also, as mentioned in Point no. 1; to decrease the quantity of OPC; mix design-trials by addition of fly ash is in progress to make concrete of Grade M30 and M35 (Table 1).

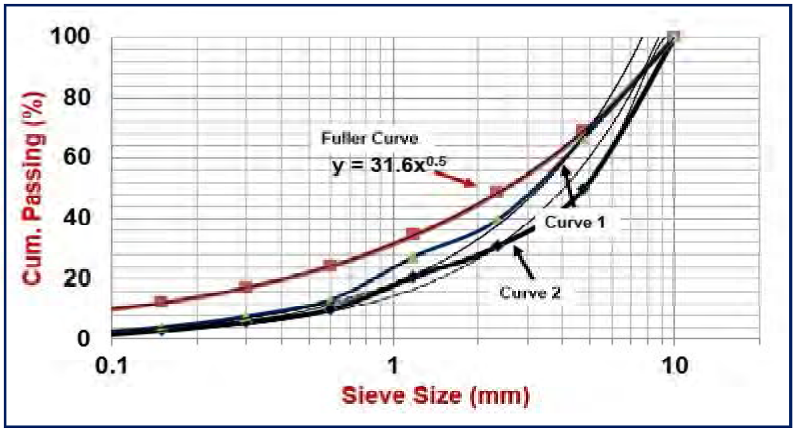


Fig. 2: Grain size distribution curve for Kota stone waste all-in-aggregate

Table 1: Mix design incorporating fly-ash with cement replacement.

Mix	Binder: Aggregate	OPC kg/m³ (%)	Weight (kg/m³)			Fly Ash	SP	w/c ratio	SP %
			KSWFA	KSWCA	Water				
M30	1: 4.6	320 (13.4%)	1093	733	152	80	3.2	0.38	0.8
	1: 4.9	304 (12.6%)	1122	752	145	76	3.0	0.38	
M35	1:4.2	340 (14.5%)	1024	739	145	85	3.4	0.34	0.8
	1: 4.5	324 (12.7%)	1065	744	146	81	3.2	0.36	

For all mix-proportions, slump was taken in the range from 0-5 mm (Harsh mix) as per IS:15658 (Fig. 3).

By using the above mix-proportions, apart from strength cubes (100mm) casting; cement concrete tiles with compaction as well as vibration are being cast.

For all mix-proportions; water, moist & ambient curing was adopted (Fig. 4).

Strength testing was done using 100T UTM for concrete cubes & paver blocks (Fig. 5).

Fig. 3: Slump value - 0 mm.

(a) Water curing

(b) Ambient air curing

(c) Moist curing

Fig. 4: Different curing conditions

(a) Cement concrete paver block

(b) Cement concrete cube

Fig. 5: Compressive strength testing

Foundation System for Light Structures (MLP-0512)

M. Samanta, Ajay Dwivedi & S. Sarkar

Objectives

A pre-engineered foundation system with better compressive and tensile load capacity with less construction time and minimum soil disturbance.

Introduction

Foundation systems for light structures are usually isolated footing which need excavation and minimum curing period for strength gain to support the structures. The proposed foundation system for light structures (Immediate/intermediate and transit shelter for post disaster shelter, canopy structures, storage structures etc.) will be helpful to construct the foundation within hours and without any excavation. The proposed foundation scheme will minimize the excavation cost and construction time. The developed anchors foundation system contains openable leaves which remains close during installation, and after installation to a required depth, the leaves can be opened from the top. The advantages of the proposed foundation system are that, it requires less installation energy compare to final leaves open conditions, creates minimum disturbance to surrounding soil, easy to use in limited access sites, high water tables and installed in any weather conditions.

Progress

The conceptual foundation system is shown in Fig. 1. Fig.1 shows a helical anchor presently design and fabricated to support the lightly loaded structures. Fig. 1(a) shows the leaves closed conditions during installation and Fig. 1(b) shows the leaves open condition after installation to a required depth. As the foundation system are installed in leave close condition, it required less installation torque. Opening of leaves after installation to desired depth increases the area and provide greater uplift/ compressive/lateral load capacity. Various model foundation system based on the same mechanism and principle have been designed and fabricated as shown below in Fig. 2. A field pull-out test setup has also been designed (Fig. 3) and fabricated to carry out pull-out test of these anchor system to prove the efficacy of design. Fig. 4 shows the installation of anchors in the field. Fig. 5 shows the filed pull-out test of helical anchors in progress.

(a) Leave closed condition during installation

(b) Leave open condition after installation

Fig. 1: Fabricated end openable helical anchor

Fig. 2: Various model developed as foundation system for lightly loaded structure

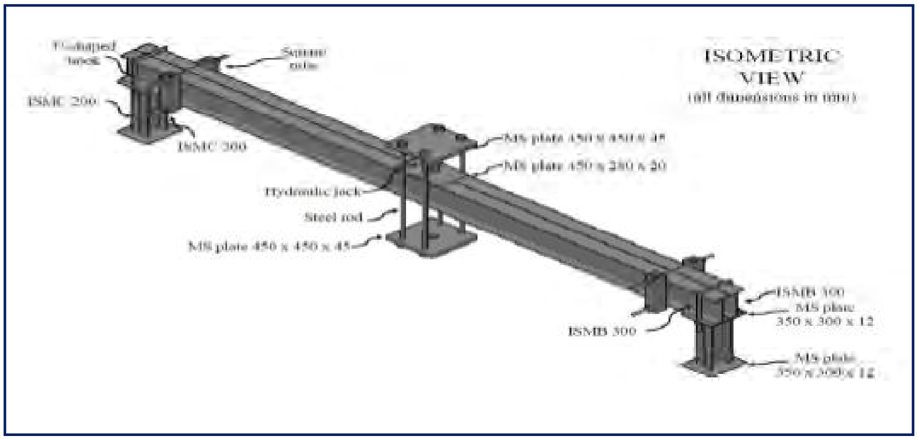


Fig. 3: Experimental setup for fabricated foundation system

Fig. 4: Installation of openable helical foundation system

Fig. 5: Pull-out system of openable helical foundation system (in progress)

Development of a Boring Machine Based on Trenchless Technology (MLP-0513)

S.K. Panigrahi & Narendra Kumar

Objectives:

To develop a Boring Machine for making bores under the ground for installing services like electric cables, drainage pipes etc. without disturbing the surface structures under trenchless technology

Work Done:

Design and drawings of the following mechanisms completed:

1. Cutter rotation mechanism for both dry and wet boring.

a. Selection of bearings, chain and sprocket and other standard items completed

b. Drawings of the cutter sub-assembly along with part details completed.

2. Forward and backward movement mechanism.

a. Selection drive system, Rack and pinions etc.

b. Drawings of the movable trolley along with part details – partially completed.

R&D Projects

R&D Projects

1. Study of Carbonation of Reinforced Structures
2. Uplift Capacity of Shallow Strip Anchors under Static & Seismic Conditions
3. Preparation of Hand Book in the Area of Heat Transfer in Building
4. Development of Engineered Lightweight Mud-Phuska Composite using Industrial-cum-Agricultural Wastes
5. Studies on Consolidation & Deformation Characteristics of Ordinary & Geosynthetic Encased Stone Column Improved Soft Soil
6. Feasibility Studies on Utilization of ETP Sludge for Development of Value Added Building Materials
7. Technical Assistance, Support & Guidance to Panchayati Raj Department Odisha for the Implementation of Rural Housing Programmes
8. Design & Development of Rural Housing Typologies for Thirteen States under PMAY-G
9. Dissemination, Training, Demonstration & Improvement of Appropriate Rural Housing Technologies
10. Study the Effect of Temperature on Thermal Behaviour of AEROLAM XLPE Insulation keeping Density Constant

Study of Carbonation of Reinforced Structures (OLP-0387)

M.M. Dalbehera & Achal Mittal

Objective

I. Experimental study on accelerated carbonation taking into account cyclic relative humidity, CO_2 con and grade of concrete.

II. Study of Initiation and propagation period in RC element.

III. Study of Corrosion current in the concrete element subjected to carbonation.

Significant Achievements

From the result obtained from the experimental study it was seen that relative humidity plays a critical role in carbonation in reinforced concrete elements. To understand the propagation of moisture in the carbonated concrete a numerical modeling for moisture profiling was carried out in the MATLAB. The moisture transport was described by a diffusion model with different diffusivities for drying and wetting phases.

Some of the assumptions taken are as follows:

i. The dying-wetting processes are isothermal.

ii. The external hydraulic pressure and gravity are both neglected compared to capillary absorption for the moisture uptake during wetting.

iii. Hysteresis is not taken into account for the moisture transport during the drying-wetting cycles.

The basic equation of diffusion for moisture transport in concrete is

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left(D(\theta)\frac{\partial \theta}{\partial x} \right)$$

ô - water saturation in the concrete pores

X - coordinate (mm), t -time (s),

D - moisture diffusivity (m^2/s).

$$D(\theta)=\begin{cases} D_d(\theta), & \text{during drying;} \\ D_w(\theta), & \text{behide the wetting front during wetting} \end{cases}$$

For Wetting Phase (Fig.1)

The Initial conditions were taken as

Completely dry concrete, i.e.,

$\theta = 0$

Boundary Conditions

The surface is assumed to be fully saturated while wetting and thus

$\theta = 1$ at surface.

The diffusivity of wetting phase was computed by

$D_w = D_w^0 \exp(n\theta)$

D_w^0 is the wetting diffusivity for a totally dry state and n is the regression coefficient with value taken as 6 as suggested by Leech et al. (2003)

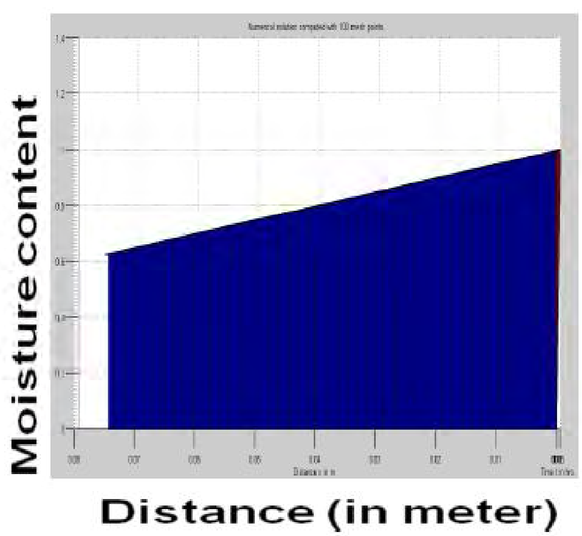


Fig. 1: Moisture profiling in concrete in wetting phase

Drying Phase (Fig. 2)

The Initial conditions taken were

Completely saturated concrete, i.e., the initial water saturation

$\theta_{ini} = 1$

for every point @ time t=0, and the boundary conditions,

the saturation at surface is assumed constant at

$\theta = 0.6$ @ time = 24 hrs.

The governing equation for diffusivity for drying phase has been taken as given by Bazant & Najjar (1972)

$$D_d = D_d^s \left(\alpha_0 + \frac{1-\alpha_0}{1+\left(\frac{1-\theta}{1-\theta_c}\right)^N} \right)$$

Where,

$D_d^{\ s}$ is the concrete diffusivity when totally saturated (m^2/s),

α_0 = ratio of minimum to maximum water diffusion coefficient

θ_c, and N are experimental parameters.

For concrete sample with W/C ratio of 0.4,

$\alpha_0 = 0.025$, $\theta_c = 0.792$, $N = 6$.

The Relative Humidity (RH) in nature changes constantly, so it is difficult to simulate in an accelerated environment. In addition, the RH is related to the ambient temperature. In an accelerated environment, it is difficult to control both the temperature and RH at the same time that because RH takes time to come to equilibrium, and the amount of time required depends on the humidification capacity of the machine used. These difficulties may explain why most previous studies on concrete carbonation involved the use of constant temperatures and constant RHs in accelerated environments

Therefore, special attention in this investigation has been given to study the effect of cyclic relative humidity (RH) on the properties of concrete.

The carbonation of concrete was studied using an accelerated approach with 5% CO_2 by volume and various RHs at a constant ambient temperature of 25°C. The results showed that the carbonation of concrete is influenced by the ambient humidity, humidity cycling. The maximum depth of carbonation occurred at the RH cycle of 50-90%, followed by constant 65% RH, and the coefficient of carbonation decreased with humidity cycling in the range of 70-90%RH. It may be possible to

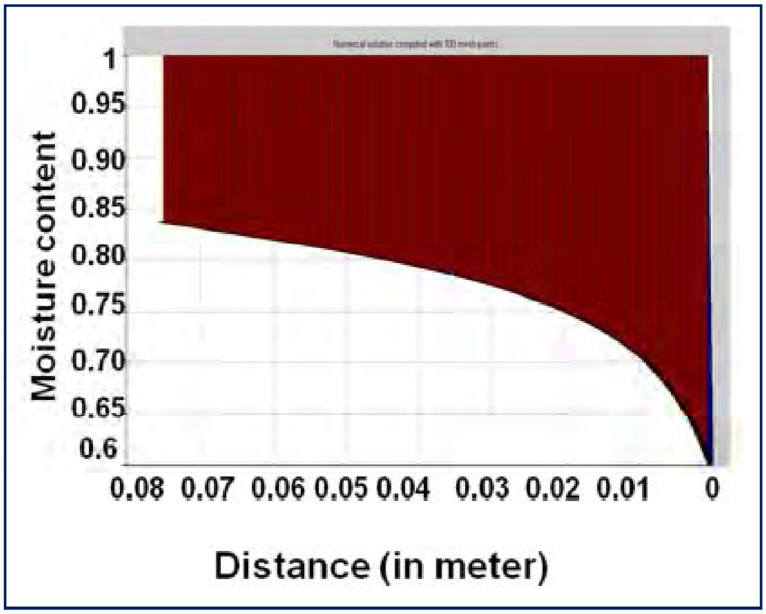


Fig. 2: Moisture profiling in concrete in Drying phase

predict on-site carbonation of concrete from accelerated carbonation results with adequate information about the CO_2 concentration, humidity cycles. It has been observed that Water–cement ratio has an inverse effect on the carbonation resistance of the concrete. An increase in water-cement ratio (w/c) causes higher porosity, which leads to a coarser pore structure of the concrete. Higher values for w/c reduce the carbonation resistance in an exponential manner. This effect is more pronounced for concretes that have low potential resistance due to the binder type (e.g. slag cements).

Determination of appropriate humidity cycles and rate of change of RH in cyclic loading for this type of testing is an issue that has rarely been discussed in the literature. The approach taken to accelerated carbonation in this study was based on an assumption that the time required to induce a certain depth of carbonation is inversely proportional to the CO_2 concentration. An increase in cement content increases the binding capacity which improves the carbonation resistance. On the other hand, an increase in cement content will also increase the amount of permeable cement paste, leading to a higher effective diffusion coefficient and thus reduced carbonation resistance.

Uplift Capacity of Shallow Strip Anchors under Static & Seismic Conditions (OLP-0389)

Anindya Pain

In earthquake prone areas, understanding of the seismic passive earth resistance is very essential for the design of different foundation systems. Solution of seismic passive earth pressure is one of the important problems in geotechnical engineering. Determination of bearing capacity of foundation and pull-out capacity of anchors are two of the important problems associated with earth pressure. In this study limit equilibrium method is used for estimation of critical seismic passive earth resistance for an inclined wall supporting horizontal cohesion less backfill. Failure surface is considered to be a composite one (Fig.1). Seismic forces are computed assuming the backfill soil as a visco-elastic material overlying a rigid stratum and the rigid stratum is subjected to a harmonic shaking. Present method satisfies the boundary conditions.

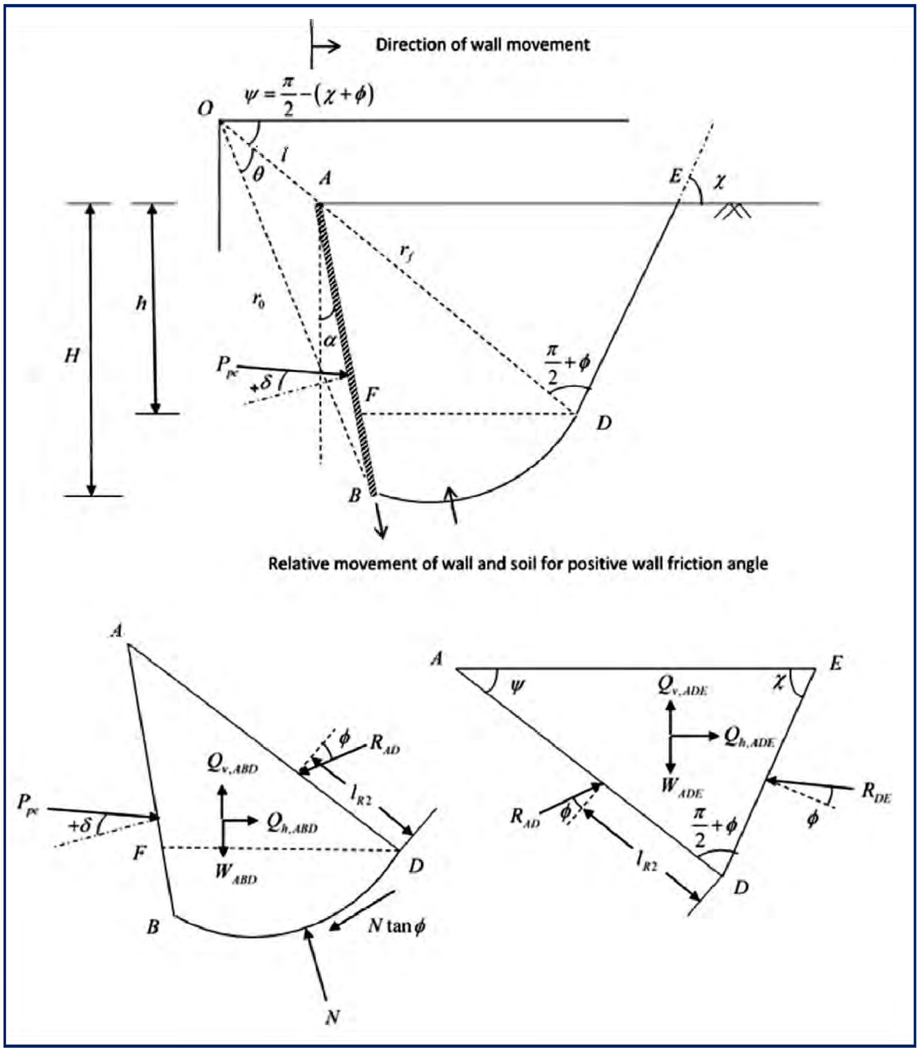


Fig. 1: Composite failure surface and free body diagram

A computer program is developed in MATLAB platform for computations. During optimization, Ψ is varied between 0 to, $(\frac{\pi}{2}-\phi)$ because the exit angle χ cannot be negative. è θ and t/T have been varied in the range of 0 to $(90-\Psi-\alpha)$ and 0-1 respectively. The value of passive earth pressure is minimized with respect to the optimizing variables mentioned above.

Comparison of present K_{pe} values with the literature is shown in Fig. 2 for the mentioned set of input parameters. Assumption of planar failure surface may be attributed for the higher values as compare to Ghosh (2007). Ghosh and Saha (2014) used the method of horizontal slices with pseudo-dynamic seismic forces. The values reported by Ghosh and Saha (2014) are slightly lower than those reported by Ghosh (2007), and the difference may be attributed to the non-linear failure surface used by Ghosh and Saha (2014). Despite the difference in the amplification factor value, f_a there is a very marginal difference in the values reported by Basha and Babu (2010) and Ghosh and Kolathayar (2011). The values reported by Ghosh and Kolathayar (2011) are slightly lower than those reported Basha and Babu (2010). The difference in the assumption point of application of seismic passive earth pressure is the main reason behind this difference.

From the present it is observed that acceleration distribution in the backfill soil may or may not be in-phase for the minimum value of seismic passive earth pressure. Angular frequency of input harmonic excitation and seismic wave velocities in the backfill soil is extremely important for the solution of passive earth pressure problems. Critical direction of the seismic inertia forces is time dependent.

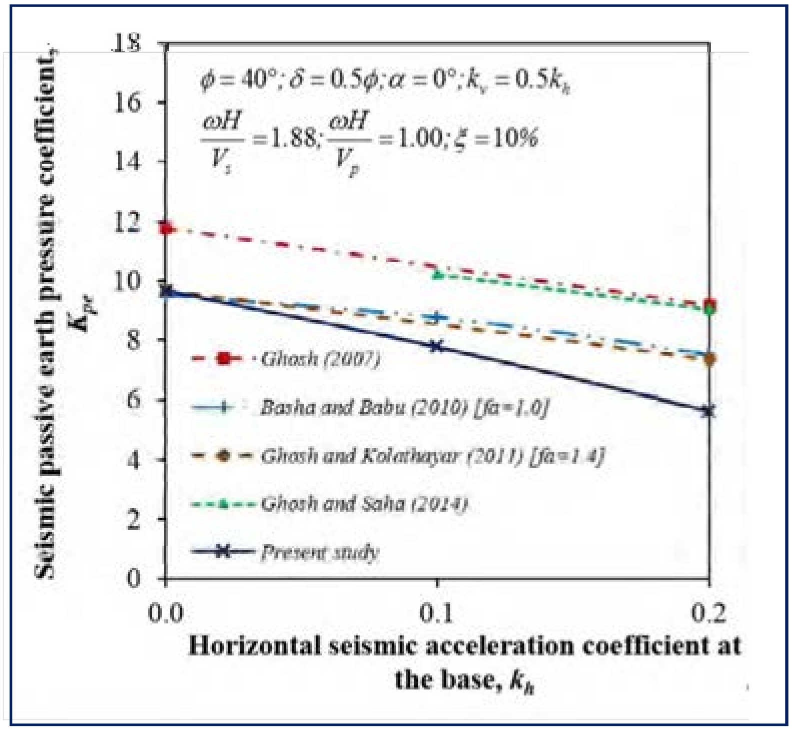


Fig. 2: Comparison of seismic passive earth pressure coefficient (K_{pe}) values with other literature

Preparation of Hand Book in the Area of Heat Transfer in Building (OLP-0391)

B.M. Suman, P.K. Yadav & Nagesh Babu Balam

Objective

Objectives of this project is to compile and update theoretical and experimental work carried out in the area of Heat Transfer in Building and energy efficient building in the Institute and put them in the form of a Hand Book

Significant Achievements

The typescript of the book on Heat Transfer in Building is under publication. It will be helpful for designing energy efficient building. Energy conservation of building needs to design energy efficient building components. Knowledge of heat transfer process through building walls, roof, window etc. is essential for design of energy efficient building. Energy saving by reducing heating and cooling load in air-conditioned building is very important whereas, indoor comfort in building is also important for non-AC building. This book consists of eight chapters dealing with introduction of building heat transfer, prediction of indoor temperatures, estimation of cooling and heating load, thermal indexes developed at CSIR-CBRI, passive systems for building, different building codes for building application, methods to reduce energy consumption in buildings and Fuzzy logic approach to predict indoor thermal comfort level.

Development of Engineered Lightweight Mud-Phuska Composite using Industrial-cum-Agricultural Wastes (OLP-0393)

Rajesh Kumar & Rajni Lakhani

Significant Achievements

The existing mud phuska treatment techniques (Bunker fill roof, Arch or vault roof etc.) require lot of time, resource & skilled labor. Also, due to shrinkage problem; many cracks are observed after drying; which causes poor performance (Thermal/Durability) of Mud phuska roof tiles. Thus, proposed research work had following activities:

i. Development of precast mud phuska composite roof tile using different wastes

ii. Remedial measures to overcome the problem of shrinkages in traditional mud-phuska techniques

Further, the aim of the experimental study was to develop the precast mud phuska tiles by using soil, wheat straw (WS), crumb rubber, bagasse fibre as primary raw materials (Fig. 1). Soil used was stabilized in the view of plasticity index (PI) as per IS: 2115-1980 recommendations, which gives specification for PI up to 10-15 %. Therefore; firstly, soil was stabilized by adding cement up to 10%. After adding cement; water binder ratios were optimized for each mix proportions.

(a) Baggase fibre

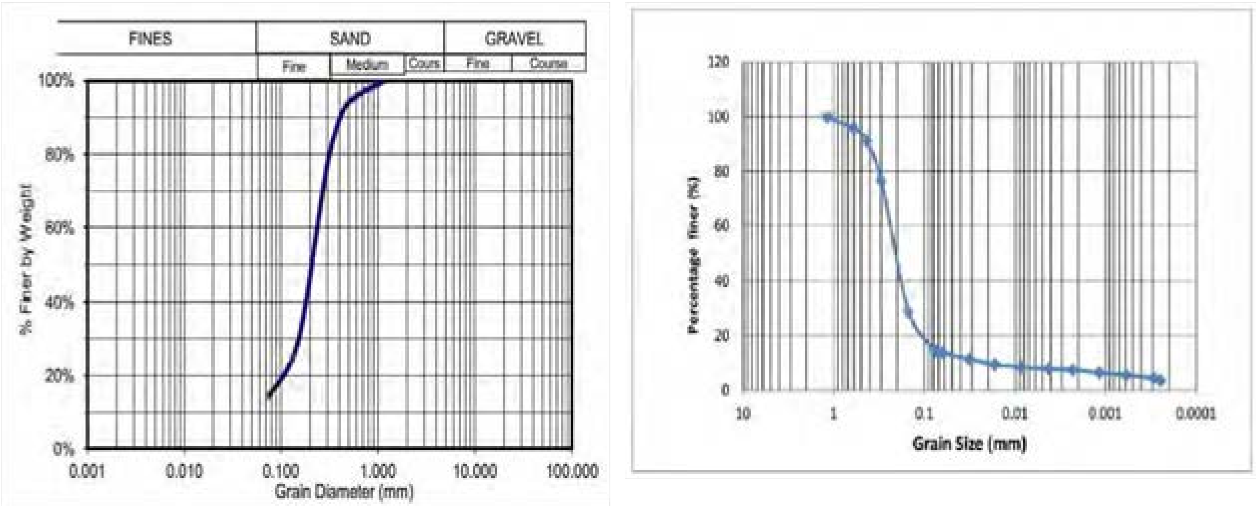
(b) Wheat straw

(c) Less cohesive soil

(e) Rubber tyre waste

(d) Footwear industry waste

Fig. 1: Constituent materials for casting



(a) (b)

Fig. 2: Grain size analysis for local soil sample (a) Sieve analysis (b) Hydrometer analysis.

Liquid limit (LL) of local soil was determined by Digital cone penetrometer as shown in Fig. 3.

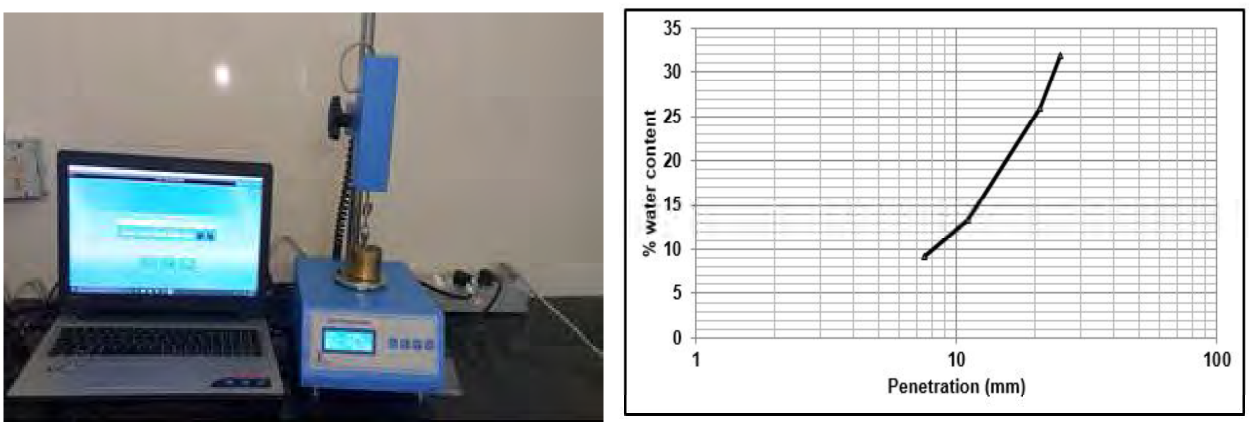
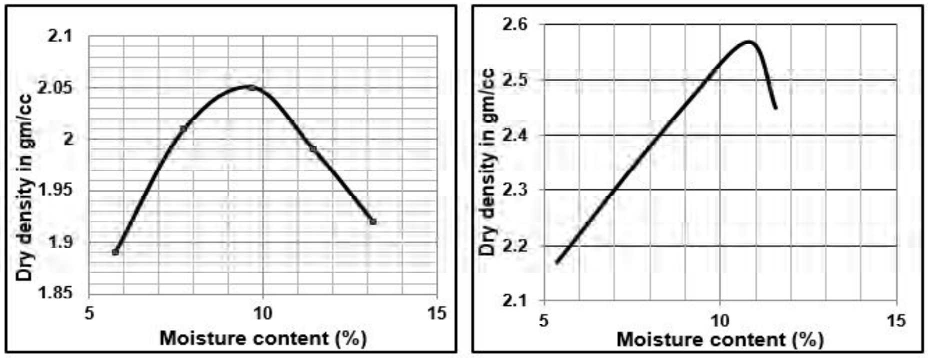


Fig. 3: Digital cone penetrometer for determination of liquid limit after adding 8% cement

Plastic limit (PL) was 13% and thus PI (LL-PL) calculated was 11%. Thus, after making three sample of different soil-cement ratios; it was concluded that 8% of cement was enough to stabilize less cohesive soil. Standard compaction test was also performed to understand the compaction characteristics of different soil with change in moisture content (%). Curves were drawn between moisture content (%) and dry density (gm/cc) to obtain the maximum dry density (MDD) and the optimum moisture content (OMC%) (Fig. 4).

In total, 30 Nos. of Mix-proportions were made by replacement and addition of WS, crumb rubber and bagasse (Fig. 5). Further, for making such tile, the mix design was prepared by targeting lower k- value and compressive strength. Four numbers of cubes were cast to check the Compressive strength, Green-Dry density and thermal conductivity (k) value for each mix proportion. Two types of curing were performed i.e. water curing and moist curing.

After 7 and 28 days, it was observed that the sample in which crumb rubber was added; gives acceptable k-value of 0.29 W/m.K but the specimens were not light weight i.e. to targeted value. The mix proportion in which crumb rubber and wheat straw were added in soil and



Optimum Moisture Content = 9.50 %
Maximum Dry Density = 2.05 g/cm^3

Optimum Moisture Content = 10.90 %
Maximum Dry Density = 2.57 g/cm^3

(a) (b)

Fig. 4: Standard compaction test (a) Soil without cement (b) Soil with 8% cement.

Fig 5: Mixing of raw materials

cement was mixed up to 8%, has desired compressive strength (2.65 MPa) and k value (0.25 W/m.K having dry density of 1020 kg/m^3).

For small scale field testing; two model houses (LxBxH = 430x510x330 mm) were made as shown in Fig. 7 (One conventional house and other precast mud composite house). To make conventional house; at top and bottom 2 slabs of M30 Grade (Thickness: 70 mm) were cast and walls were made by using ordinary bricks. Mud phuska house was made by giving treatment of mud phuska precast tile of 50 mm thickness as roof thermal insulation material with cement stabilized mud wall blocks; made by waste agricultural fibers (Fig. 6).

(a) (b)

Fig. 6: Stabilized mud composites (a) mud phuska roof tile (b) wall blocks

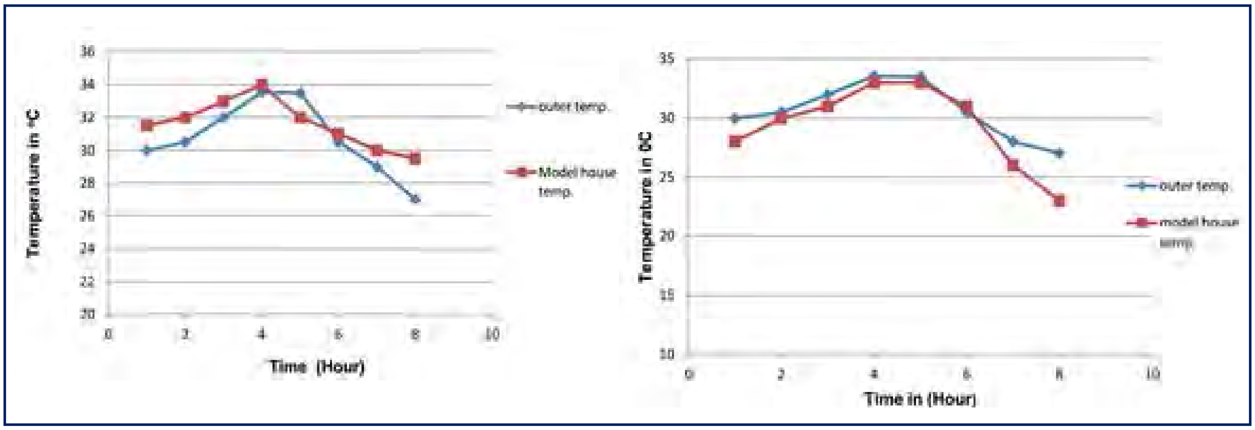
(a) (b)

Fig. 7: Small scale model house (a) conventional using bricks and concrete (b) mud composite.

After construction of both the model houses, temperature and humidity monitoring up to 7 days were done by the use of electronic thermo-humidity meter & compared with each other to see the effect of using mud composite in place of conventional brick (Fig. 8). After analysis it was found that conventional brick house becomes more heater during day time and temperature inside the house was more than the outside temperature. While, in the evening when outside temperature decreased slowly, the temperature in house were still more and it takes significant time to cool down.

Fig. 8(b) shows that the mud phuska as the thermal insulating medium makes house cooler as compared to the conventional model house. It was concluded further that the mud phuska roof tile house has significantly better thermal insulation properties as compare toconventional model house and average temperature difference was up to 4-6^{0} C.

Thus, this technique not only gives good thermal comfort but also contribute less dead load for superstructure that will impart less load on columns, beams and foundations etc. In conclusion, indigenous materials have significantly better thermal properties as compared to contemporary building materials. Further advanced tests on full scale wall and roof assemblies will prove to be more valuable in this regard.



(a) (b)

Fig. 8: Temperature versus time graph of model house made of (a) bricks and concrete (b) mud composite.

Studies on Consolidation & Deformation Characteristics of Ordinary & Geosynthetic Encased Stone Column Improved Soft Soil (OLP-0395)

S. Ganesh Kumar & M. Samanta

Objectives

Evaluation of load-settlement and consolidation characteristic (compression index, recompression index, co-efficient of vertical consolidation, co-efficient of radial consolidation and co efficient of compressibility) of ordinary and encased stone column improved soft soil.

Progress of the Project

Main objective of the present study is to improve the load carrying capacity of soft soil treated with ordinary and encased stone columns. In addition, the load sharing between the soil and stone column was also studied to evaluate the stress concentration ratio between the surrounding soil and stone column when subjected to external loading. The effect of stress concentration ratio will give the clear guidelines for predicting load improvement and settlement factors which makes the treatment method economically beneficial. The details of the laboratory tests performed are explained as follows:

Model Test:

Usually the stone columns are installed in triangular or square pattern in such a manner that each column influences certain area of soil, called unit cell. As unit cell is representative of an area treated with stone columns, it was decided to carry out unit cell experiments in the present study. The experiments were carried out to estimate the load carrying capacity of ordinary and encased stone column installed in soft clay. For this laboratory investigations, unit cell having inner diameter of 185 mm and height of 600 mm height was used.

Three stone column diameters having 63 mm, 76 mm and 88 mm diameter with an area replacement ratio of 11.6 %, 16.9 % and 22.6 % respectively were selected for evaluating the load carrying capacity of stone columns and stone column improved soft soil. The clay soil used for the study was classified as CL as per IS classification system. The liquid limit and plastic limit of the soil are 34.5 % and 23.5 % respectively. The stone aggregates used to form the stone columns are angular in nature and size of 2 to 10 mm and having uniform gradation. The stone aggregate in all the tests was compacted to a dry unit weight of 16.2 kN/m3 corresponding to a relative density of 60 % representing field situation.

Based on the unconfined compression tests on clay samples, water content of 28 % was selected for meeting the required shear strength of 15 kPa which simulates the soft clay characteristics in field conditions. The clay was dried for 24 hours and then pulverized and mixed with required quantity of water and finally filled in the test tank. The soil was then filled inside the test tank in 5 layers and each layer was properly compacted with a hammer of 4.5 Kg to achieve a compacted height of 120 mm with uniform density. After the preparation of clay bed, installation of stone column was performed. The installation procedure begins with bore-hole formation, which involves removal of soil from unit cell by placing a casing pipe having diameter equal to that of selected stone column diameter. Then the pipe was pushed vertically inside the prepared clay soil and the soil inside the tube was removed carefully leaving hole at the centre. Then the bore hole gets replaced with stone chips filled in stages to 120 mm thickness and compacted to achieve a dry unit weight of 16.18 KN/m3. The completed view of constructed stone column is shown in Fig. 1. For measuring load distribution mechanism two earth pressure cells were used. One earth pressure cell was placed at the centre of stone column and other one at soil surface. The position of earth pressure cells is shown in Fig. 2. After placing earth pressure cells, sand cushion having thickness of 30 mm was placed before staring load tests (Fig. 3). Then load tests were performed to evaluate the load carrying capacity of stone columns.

Two types of tests were performed viz. Column alone loading where the stone column get loaded with a plate having diameter equal to that of column diameter and other one is surface loading in which the entire cell is loaded with a loading plate having diameter equivalent to that of cell diameter. Typical photograph showing the details of surface loading is shown in Fig. 4. Settlement during loading is measured using dial gauges having 0.01 mm accuracy. Fig. 5 shows the surface load test results of 63 mm, 76 mm and 88 mm. At a settlement of 10 mm the increase in load carrying capacity for the corresponding diameter of stone columns of 63 mm, 76 mm and 88 mm is found to be 2, 3.6 and 5.1 times respectively for the untreated clay soil. Similarly, the increase in ultimate load carrying capacity is found to be 2, 2.45 and 3.1 times with that of untreated clay soil. It can be seen that both load carrying capacity and stiffness increases with increase in diameter of stone columns. Further test is in progress.

Fig. 1: View of stone column and unit cell

Fig. 2: View of stone column and location of earth pressure cells

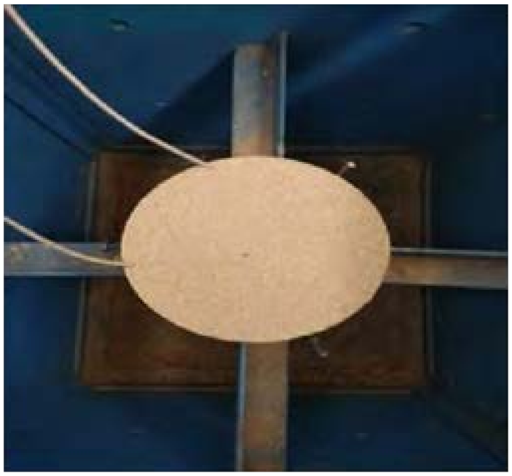


Fig. 3: Granular blanket for load distribution

Fig. 4: View of complete load test set-up

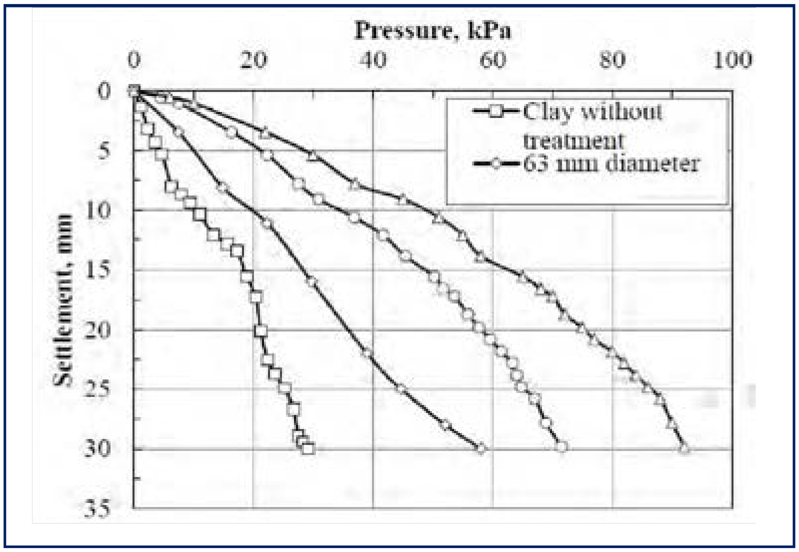


Fig. 5: Load test results for different stone columns (surface loading)

Feasibility Studies on Utilization of ETP Sludge for Development of Value Added Building Materials (SSP-0755)

Neeraj Jain, L.P. Singh & Team

M/s. Tata Motors Ltd., Pimpri, Pune an automobile industry is generating about 700 MT/Annum of ETP sludge as a by-product of effluent and sewage treatment plant and thus facing the disposal and pollution hazards associated with it. Considering the environmental concern, the use of ETP sludge as a partial supplement to building materials plays an important role and it is gaining a great momentum. To get a techno-economic solution of the problem, Tata Motors Ltd, Pune sponsored a project to CSIR-CBRI for the utilization of ETP sludge as a part of raw material for making value added building components like road paving blocks, bricks and tiles.

Survey & Collection of Samples

A team of Scientists visited manufacturing plant and effluent treatment plant (ETP) of M/s. Tata Motors Ltd., Pimpri, Pune. A unit of paving blocks manufacturing plant was also visited in Pimpri utilizing stone dust (crushed stone) as fine aggregate and OPC (53 Grade) as a binder in addition to fly ash as mineral additive. It is observed that paving blocks have been manufactured without use of coarse aggregate having a compressive strength of about 25-30 MPa and Indian Standard practices for manufacturing were not adopted. After survey sample of ETP sludge was collected from ETP.

Binder & Aggregates

Ordinary Portland cement (43 Grade) was used as a binder material for development of paving blocks and was analysed as per Indian Standards IS: 4031(1988) and 4032 (1985). The sample of ETP was dried at 50 ± 2°C in trays, cooled to room temperature, ground in a ball mill to a fineness of passing 300 µm sieve. This material was analysed for various physical properties and chemical properties were determined by Wavelength Dispersive X-Ray Spectrophotometer Fluorescence (WDXRF) spectrophotometer. The ETP sludge was used as a replacement of fine aggregate (stone dust) for the development of paving blocks. The locally available natural crushed stone, generally of quartzite type was used as coarse aggregate of maximum 10 mm size for development of paving blocks. Stone dust complying with the particle size requirements of IS 383: 1970 was used as natural fine aggregates (NFA) for fabrication of blocks and bricks using OPC.

Fabrication of Paving Blocks

The fabrication 200 x 120 x 80 mm paving blocks was carried out using compaction method following the procedure and specifications described in IS: 15658: 2006: Precast concrete blocks for paving-specifications. Two layered paving blocks were fabricated using cement, coarse aggregates, stone dust as fine aggregates and water. The top layer was prepared using cement and stone dust in a proportion of 2:1 and required quantity of water was added. For fabrication of bottom layer, various concrete mixtures were tried using cement (OPC 43 Grade) as binder varying from 20-25 %, ETP sludge as a replacement of fine aggregate (stone dust) ranging from 10-15 % and coarse aggregate ranging from 37.5 to 50 %. Water was added as per requirement to achieve zero slump. All the trial mixtures were expected to achieve a compressive strength of 10-15 MPa after 28 days of curing. After filling the mould, a hydraulic pressure of 50 tonnes was applied for 15 seconds on the mixture for compaction. After releasing the pressure, the paving block was removed from the mould and then cured at a relative humidity of over 90 % at room temperature (25±2°C) for 28 days.

Engineering Properties of Paving Blocks

The physical and mechanical properties of paving blocks like water absorption and compressive strength were determined after 28 days curing period of all the mixes and compared with control. The cured blocks were tested for physical and mechanical properties as per IS: 15658: 2006 and results are shown in Table 1. The photographs of fabrication of paving blocks have been shown in Fig. 1(a) and Fig. 1(b).

Conclusion

The results of water absorption show that only mix A1 is satisfying the requirements (<6 %) of IS: 15658 for water absorption. It has also been observed that the compressive strength of all the blocks prepared decreases from 22.50 to 8 MPa with increase in sludge content from 10 to 15 %. due the presence high organic matter and phosphate content in the sludge which is very much deleterious for strength development reactions of cement. The maximum compressive strength is observed for mix A1 (22.50 MPa) and is recommended for blocks manufacturing which can be utilized for internal paving purpose. The results TCLP studies show most that most of hazardous elements present in ETP sludge were immobilized in cement matrix and the metals coming in leachate (Ni and Cu) were well below the prescribed limits of US EPA.

Table 1: **Engineering properties of paving blocks**

Mix designations	Water absorption (%) (28days)	Compressive strength (MPa) (28 days)	Remark
A0 (Control)	2.0	62.50	
A1	**5.20**	**22.50**	**Recommended**
A2	8.50	19.25	
A3	10.00	16.25	
A4	18.75	8.00	
B0 (Control)	2.80	50.50	
B1	9.00	18.00	
B2	12.75	16.50	
B3	16.55	14.25	
C0 (Control)	3.20	5.00	
C1	15.50	13.25	
C2	20.00	10.00	

(a)

(b)

Fig. 1: Fabrication of road paving blocks

Technical Assistance, Support & Guidance to Panchayati Raj Department Odisha for the Implementation of Rural Housing Programmes (SSP-0756)

S.K. Negi, R. Dharmaraju, Swati Kulashri & Team

Objective

To aid the state government in converting all the kutcha houses into pucca house in rural areas in a fixed time frame in a mission mode approach.

Envisaged Deliverables

- To develop architectural designs with alternative affordable and locally built materials and technologies improving upon the conventional designs of PMAY(G), Biju Pucca Ghar Yojana (BPGY) and other Rural Housing Schemes implemented by Odisha Government.
- To train and demonstrate the uses of various sustainable alternative affordable materials and technologies for better implementation of Rural Housing Schemes qualitatively and quantitatively.
- To provide practical guidelines regarding execution and construction to supervisory staff during the period of training and construction on selected sites.

Scope

- To study various designs of housing typologies from different regions of Odisha developed by the State Government and other agencies and to suggest appropriate affordable building materials and technologies for overall improvement in the construction cost, functional efficiency, comfort, energy efficiency and durability against prevalent natural disasters like cyclones, floods, earth quakes etc., by the use of possible alternate and local materials.
- To provide architectural, structural drawings and necessary technical details and support as per the requirements of the State Government for the specific area or problem.
- To train stake holders involved in implementation of Rural Housing Schemes in the training camps organized by CSIR CBRI.
- To visit construction sites during the project period for providing on-site training-cum-guidance on execution and construction to supervisory staff.
- To provide technical support to CBOs/ Entrepreneurs willing to manufacture alternative affordable building components and materials which are considered useful and feasible for the specific regions of the Odisha state.

Envisioned Outcome

- Mass adaptability of rural housing designs suggested and developed by CSIR – CBRI in the state of Odisha.
- Dissemination of appropriate region specific rural housing technologies at grass root level.

Design & Development of Rural Housing Typologies for Thirteen States Under PMAY-G (SSP-0766)

S.K. Negi, R. Dharmaraju, Swati Kulashri & Team

Objective

To develop designs by suggesting appropriate building techniques and construction technologies as S&T interventions to make houses more durable, resistant to natural disasters and comfortable to live in using locally available materials and skills within the financial assistance provided under PMAY-G.

Envisaged Deliverables:

- Review of plans submitted by UNDP in terms of architectural and structural validation of drawings (Fig. 1).
- Development of housing designs with appropriate rural technologies and construction techniques (Fig. 2 and Fig. 3).
- Suggesting alternatives using locally available materials
- Suggesting technologies developed by CSIR CBRI for mass applicability
- Details Rural housing report for thirteen states of India.

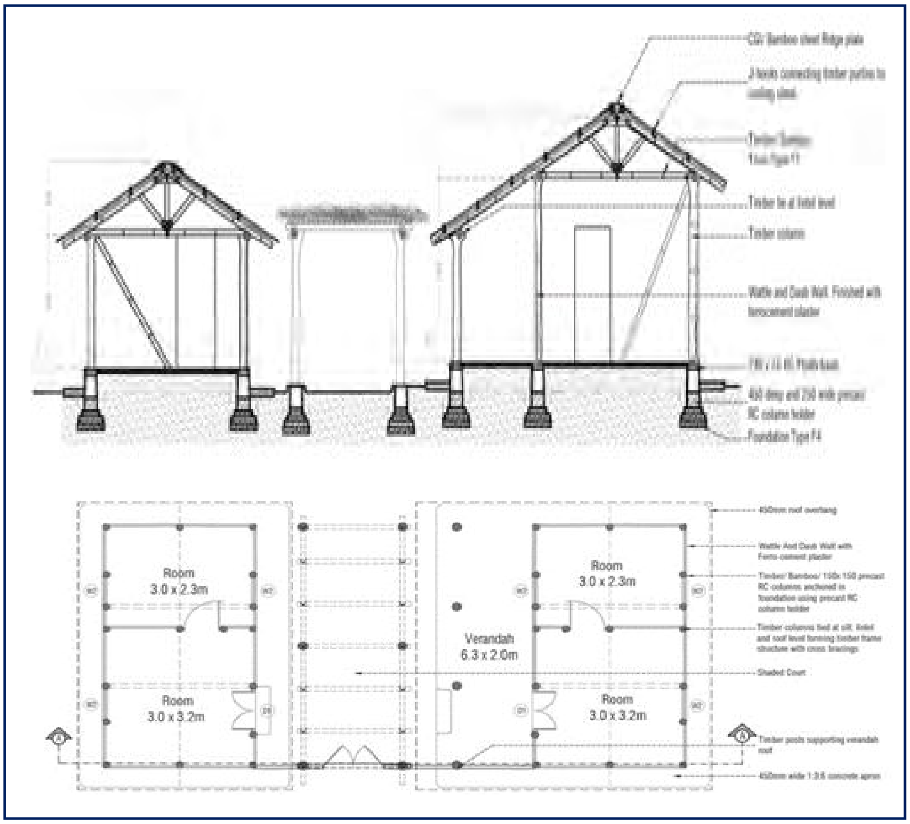


Fig. 1: A prototype for Chhattisgarh

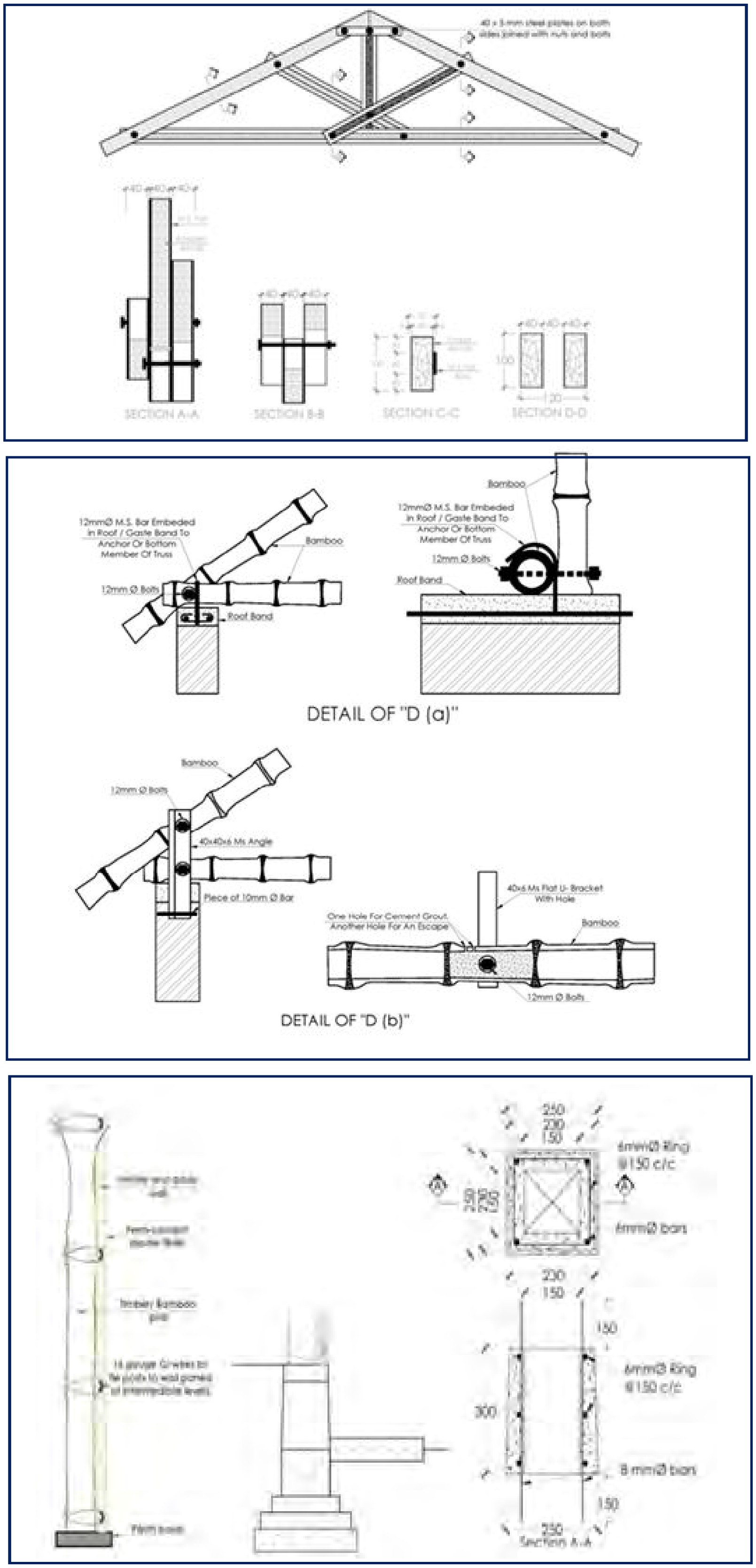


Fig. 2: Proposed construction techniques and technologies

Current Status

Design development and details of 09 housing typologies of Chhattisgarh, and 08 housing typologies of Jharkhand. Design development of 11 states in pipeline are: Assam, Bihar, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Odisha, Sikkim, Tripura, Uttar Pradesh and West Bengal.

Salient Features

The following techniques have been incorporated in the designs which were found appropriate to reduce cost and time of construction, and to improve durability, safety and living comfort;

✓ Stone Masonry Blocks*	✓ Under reamed piles*
✓ Solid Concrete Blocks*	✓ Nail jointed trusses*
✓ RC Plank and RC Joist roof*	✓ Protection of mud walls*
✓ Brick Panel and RC Joist*	✓ Two pit latrine systems*
✓ Precast Channel Unit roof*	✓ Waste water disposal system*
✓ C-bricks*	✓ Rat-trap Bond
✓ Confined Masonry*	✓ Ferrocement Channels
✓ L Panels*	✓ MCR Roofing tiles
✓ Pyramidal roofing*	✓ CSMB blocks

*Technologies developed by CSIR-CBRI

Envisioned Outcome:

- Mass adaptability of rural housing designssuggested and developed by CSIR-CBRI.
- Knowledge proliferation by detailed state-wise rural housing report developed by CSIR-CBRI.

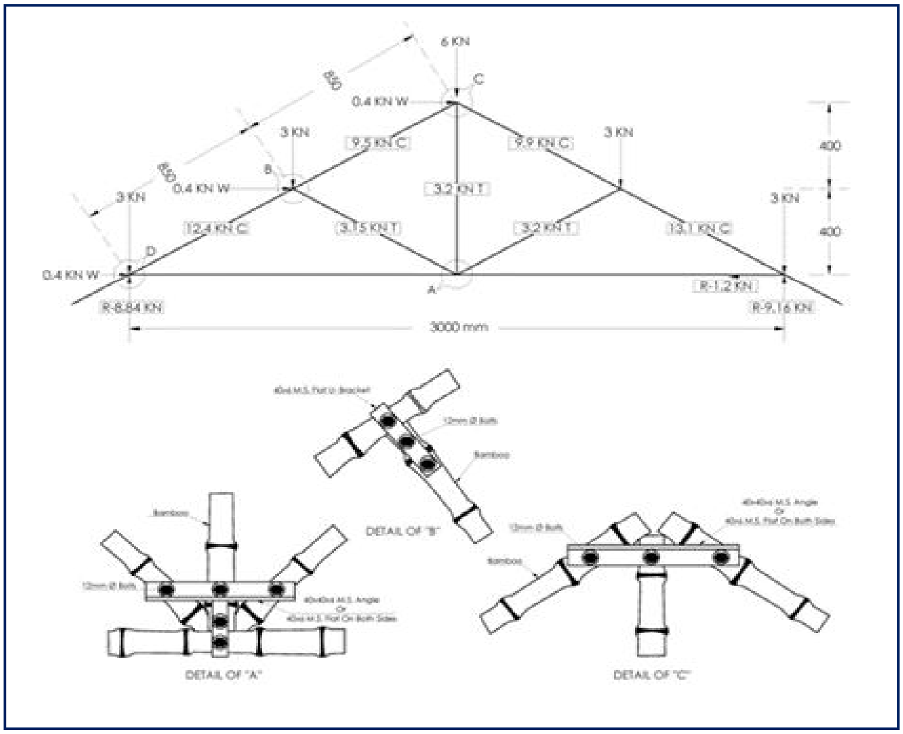


Fig. 3: Construction techniques and fixing details.

Dissemination, Training, Demonstration & Improvement of Appropriate Rural Housing Technologies (RSP-4051)

S.K. Negi, R. Dharmaraju & Team.

The ancient constructions in Himalayan regions are the finest examples of the traditional architecture, providing sufficient thermal comfort and earthquake resistant construction under extreme geo-climatic conditions of the region. These indigenous construction practices include the use of locally available materials such as wood, stone etc. The construction techniques that has been practiced in the state of Uttarakhand architecture is created with a mesh of interlocking horizontal sleepers and is dressed or raw stones are packed without any mortar. The designs of such houses are best suited for the harsh geo-climatic conditions of the region. The present state of knowledge reveals that usage and construction of such houses are not in practice due to non-availability of timber and modern architecture. However, such kind of houses can be strengthened and preserved by deploying affordable S&T inputs.

Objectives

- To disseminate, promote and extend appropriate rural housing technologies to improve conditions of rural and urban masses and entrepreneurship development in rural/urban society in the production of building materials and components.
- Documentation of traditional house in rural areas in hills of Uttarakhand & J&K State.
- Identification of niches where S&T intervention is needed.
- Production of short video films on traditional architecture of rural buildings.
- Development of display materials like charts, models, samples etc. for the technical museum of building science being developed in the Institute.
- Improvement of Rural Sanitation Techniques.
- Development of engineered lightweight mud-phuska composite waterproofing treatment using less cohesive soils for rural houses.

Significant Achievements

- About 60 traditional architectural styles of rural houses in Uttarakhand have been studied and documented. Subsequently, S&T interventions are being suggested to strengthen and maintain the traditional architecture of rural houses based on the gaps identified.
- Development of improvement of rural sanitation techniques and engineered lightweight mud-phuska composite waterproofing treatment using less cohesive soils are under progress.
- About 700 officers/grass root level functionaries of different states have been trained/demonstrated on the innovative rural housing technologies developed by the institute for its implementation at local levels.
- Two days Mass awareness programme on Low Cost Housing and Skill Development for Masons conducted at Mandi (Fig. 1), was organized on the request district Administration and read cross society of Mandi in Himachal Pradesh.

- The training programme at Bharatpur was organized on the request of Lupin Human Welfare and Research Foundation (Fig. 2), that has done many developmental, employment generation, income enhancing and health related programmes in the rural areas of the District. As a skill development initiative, the programme was organized in a village in Pahari Tehsil for working masons. The programme was meant to sensitize the masons about good construction practices and train them in the construction of earthquake resistant houses using locally available materials and construction of sanitary latrine in villages.

Fig. 1: Training Programme Mandi

Fig. 2: Training Programme Bharatpur

- A two-day Training Programme on Design and Construction of Earthquake Resistant Houses in Kangra region of Himachal Pradesh (Fig. 3) was organized at Palampur, Kangra, HP, jointly with the HP State Council of Science, Technology and Environment (HPSCST&E).

Fig. 3: Extension & dessiminatopn at Kangra, Himachal Pradesh

Study the Effect of Temperature on Thermal Behaviour of AEROLAM XLPE Insulation keeping Density Constant (TSP-0456)

B.M. Suman, Chandan Swaroop Meena, Shailza Singh & Nagesh Babu Balam

Objective

Study the thermal behaviour of AEROLAM XLPE insulation with varying mean temperature for fix density.

Significant Achievements

AEROLAM thermal insulation has been evaluated at room temperature and below and above the room temperature. Thermal properties of the AEROLAM insulation products are evaluated as a function of density and mean temperature.

Thermal insulating material for any particular application is decided mainly from its thermal conductivity. For equivalent thermal efficiency, cost may be one of the important factors for selecting suitable insulating material. The performance wise criteria of thermal insulation material would always be lower value of thermal conductivity and low moisture content. In general, for masonry building materials, thermal resistance increases with decrease of density but this criterion does not remain same for AEROLAM insulation.

From the study made in this project, it is found that with rise in mean temperature, thermal conductivity of AEROLAM insulation also increases. A graph has been plotted between mean temperature and corresponding thermal conductivity. The result can be observed from the graph depicted in Fig. 1.

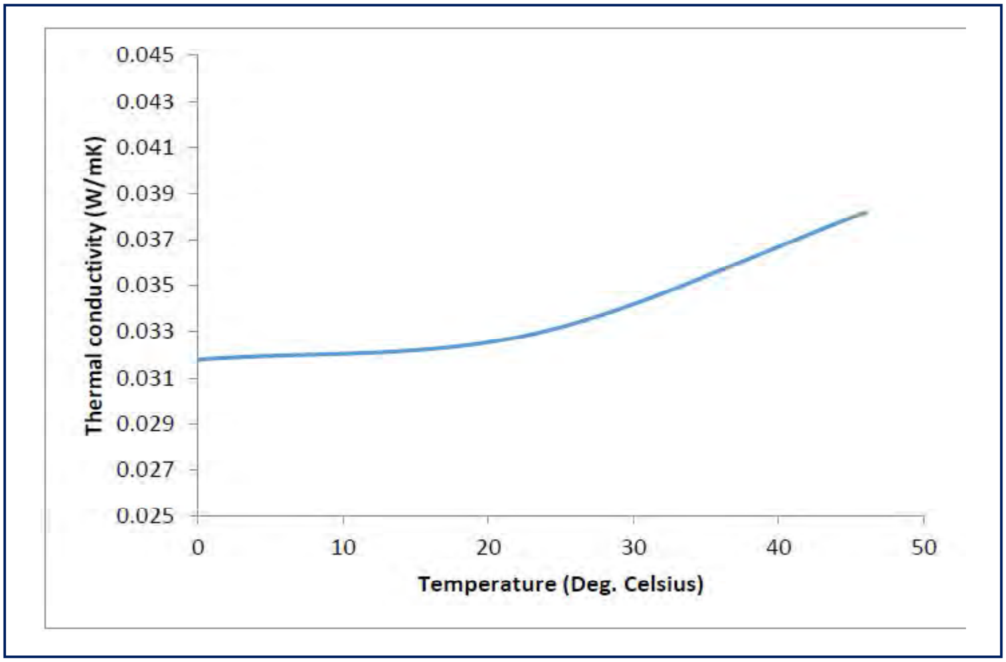


Fig. 1: Effect of mean temperature on thermal conductivity of AEROLAM insulation product

AcSIR

AcSIR

The Institute is conducting an integrated M.Tech.-Ph.D. (IMP) programme under the aegis of Academy of Scientific and Innovative Research (AcSIR) since 2010 in 'Building Engineering and Disaster Mitigation (BEDM)'. The Institute is also taking Ph.D. students in Engineering Sciences, Chemical Sciences, and Physical Sciences. The details of different batches are given below:

M.Tech.

- 1st Batch (2010-12) - 6 Students completed
- 2nd Batch (2011-13) - 8 Students completed
- 3rd Batch (2012-14) - 8 Students completed
- 4th Batch (2013-15) - 5 Students completed
- 5th Batch (2014-16) - 5 Students completed
- 6th Batch (2015-17) - 5 Students in the 4th Semester

Ph.D.

- 4 Students joined for Ph.D. in Engineering Sciences and 2 students in Physical Sciences in August, 2016 including one overseas student.
- 1 Student of Engineering Sciences, Mr. Anindya Pain submitted and successfully defended his Ph.D. thesis.
- 1 Student of Chemical Sciences Ms. Usha Sharma submitted her Ph.D. thesis.
- Presently total 17 Ph.D. students are enrolled in AcSIR at CSIR-CBRI.

Term paper review of the M.Tech. Students (2015-17 batch) by the Director and Faculty Members

Ph.D. Viva-Voce examination of Mr. Anindya Pain on March 2, 2017

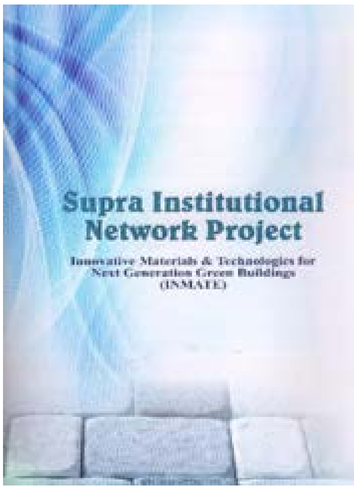
Information, Extension & Project Management

Publication Group

The Publication Group continued to serve as the nerve centre of the Institute conducting and coordinating multifarious activities, such as, collection, storage and dissemination of R&D information; handling scientific and technical enquiries; publicity and public relations, compilation, editing and publication of Annual Report to meet the inter and intra-institutional information needs, editing and publication of Bilingual CSIR-CBRI Newsletter and Bhavanika, periodically publication of Building Research Notes, Project Profile, Technical and Divisional Brochures etc., preparation of other scientific/technical reports and filling up of questionnaires/organizations; providing inputs for CSIR Annual Report as well as for CSIR News and CSIR Samachar; reporting of the scientific and technical work carried out at the Institute in Hindi and English and Publicity of the Institute's R&D capabilities through Print Media.

1. CSIR-CBRI Annual Report

- R&D Highlights
- Research Output
- Glimpse of Activities
- R&D Projects
- Consultancy Projects
- Sponsored Projects
- Information, Extension and Project Management
- CBRI Family
- Visits, Lectures, Meetings etc.
- Date Line



Tasks Involved: Manuscript evaluation, editing, proof-reading, graphic design, layout, illustration, print production, binding, publishing, dissemination and feedback

2. CBRI in CSIR Newsletter

Tasks Involved: Plan, schedule and organize the publication of highlights of CBRI achievements /activities in CSIR Newsletter

S. No.	Title	Volume	Page	Month
1.	CSIR-CBRI Organises Training Programme on Design of Disaster Resistant Housing and Risk Mitigation	Volume 66 No. 7 and 8	84-85	April 2016
2.	CSIR-CBRI celebrates its Foundation Day	Volume 66 No. 9 and 10	110-112	May 2016
3.	Round Table Conference on Structural Issues in Prefab Housing Organised by CSIR-CBRI, Roorkee	Volume 66 No. 11 and 12	130	June 2016
4.	Demolition Wastes as Raw Materials for Low Cost Construction Products	Volume 66 No. 15 and 16	173-176	August 2016
5.	Dr. N. Gopalakrishnan takes over as Director, CSIR-CBRI	Volume 66 No. 15 and 16	191	August 2016
6.	Structural Behaviour of Reinforced Geo-Polymer Concrete: CSIR-CBRI	Volume 66 No. 17 and 18	195-198	September 2016
7.	Training Programme on Construction of Affordable Housing	Volume 66 No. 17 and 18	211-213	September 2016
8.	MoU between CSIR-CBRI and NRDC	Volume 66 No. 21 and 22	255	November 2016
9.	CSIR-CBRI Organises Workshop-Training-Cum-Motivational Programme for Teachers	Volume 66 No. 21 and 22	257-259	November 2016
10.	CSIR Foundation Day Functions CSIR-Central Building Research Institute, Roorkee	Volume 66 No. 21 and 22	263-264	November 2016
11.	CSIR-CBRI Awakens Scientific Temper in Young Minds	Volume 67 No. 1 and 2	9-11	January 2017
12.	Science Fest, Open Day, and Technical Exhibition at CSIR-CBRI	Volume 67 No. 1 and 2	15-17	January 2017
13.	Development of Pervious Concrete: CSIR-CBRI	Volume 67 No. 3 and 4	28-29	February 2017
14.	Seismic Behaviour of Piles under Dynamic Lateral Loading in Layered Sandy Soil: CSIR-CBRI	Volume 67 No. 3 and 4	30-32	February 2017
15.	CSIR-CBRI, Roorkee Reaches out to Young Minds	Volume 67 No. 5 and 6	55-57	March 2017
16.	Dr. Girish Sahni, DG-CSIR Visits CSIR-CBRI	Volume 67 No. 5 and 6	69-72	March 2017

3. CBRI in CSIR Samachar

1.	lh,lvkbvkj&lhdvkjvkb] :Mdh e LFkkiuk fnol lekjkg dk vk;ktu	o"k 4] vd 6	87&88	tu 2016
2.	lh,lvkbvkj&lhdvkjvkb] :Mdh e ,Qvkjih }kjk ln<hdr icfyr ddhV chek d LFkf;Ro ,o vufd;k dk eY;kdu	o"k 4] vd 7	105&108	tykb 2016
3.	lh,lvkbvkj&lhdvkjvkb] :Mdh e fMtk;u vkQ fMtkLVj jfILV gkÅflx ,M fjLd fefVx'ku ij if'kk{k.k dk;de dk vk;ktu	o"k 4] vd 7	109	tykb 2016
4.	Mk ,u- xkikyd".ku u lh,lvkbvkj&lhchvkjvkb] :Mdh d fun'kd in dk dk;Hkkj lEHkkyk	o"k 4] vd 9	147	flrEcj 2016
5.	lh,lvkbvkj&lhdvkjvkb] :Mdh e ,uVhihlh fyfeVM d lkFk le>kr ij gLrk{kj fd,	o"k 4] vd 10	156	vDVcj 2016
6.	lh,lvkbvkj&lhdvkjvkb] :Mdh e lLr vkokl k d fuek.k ij if'k{k.k dk;de	o"k 4] vd 10	159	vDVcj 2016
7.	lh,lvkbvkj&lhchvkjvkb] :Mdh }kjk ihQc gkmflx e ljpukRed fo"k;k ij xkyet lEeyu dk vk;ktu	o"k 4] vd 10	161	vDVcj 2016
8.	lh,lvkbvkj&lhdvkjvkb] :Mdh e fgUnh lIrkg dk vk;ktu	o"k 4] vd 12	197&198	fnLkEcj 2016
9.	lh,lvkbvkj&dUnh; Hkou vuql/kku lLFkku] :Mdh e lh,lvkbvkj dk lyfVue tcyh LFkkiuk fnol lekjkg vk;ftr	o"k 4] vd 12	210&211	fnLkEcj 2016
10.	lh,lvkbvkj&lhdvkjvkb] :Mdh e f'k{kdk d fy, dk;'kkyk if'k{k.k&lg&ijd dk;de	o"k 5] vd 1	9&12	Tkuojh 2017
11.	lh,lvkbvkj& lhchvkjvkb }kjk çoS'; dØhV dk fodkl	o"k 5] vd 2	18&19	Qjojh 2017
12.	lh,lvkbvkj&lhdvkjvkb }kjk ijrnkj jrhyh feêh e xfrd ik'koHke.k d vrxr ikbyk dk HkdEih; 0;ogkj v/;;u	o"k 5] vd 2	26&27	Qjojh 2017
13.	lh,lvkbvkj&lhdvkjvkb u ;okvk e txkb oKkfud pruk	o"k 5] vd 3	34&36	ekp 2017
14.	lh,lvkbvkj&dUnh; Hkou vuql/kku lLFkku] :Mdh e bLikr icfyr ddhV ljpukvk d fy, Lon'kh dFkfMd lj{k.k i.kkyh dk fodkl	o"k 5] vd 3	38&40	Ekkp 2017
15.	lh,lvkbvkj&lhdvkjvkb e foKku mRlo] vkiu M ,o rduhdh in'kuh	o"k 5] vd 3	41&42	Ekkp 2017

4. Bilingual CSIR-CBRI Newsletters/Hkofudk- Newsletters in Hindi

Bhavnika/ CBRI Newsletter January –March 2017

Bhavnika/ CBRI Newsletter October-December 2016

Bhavnika/ CBRI Newsletter July-September 2016

Bhavnika/ CBRI Newsletter April-June 2016

Four Issues

5. CBRI in National Media

6. News-items/R&D Stories in Media covering Events, Conferences, Workshops etc.

7. Technology and Informnation Brochures

8. Publicity through Advertisement in Conference/ Souvenir/Symposium Proceedings etc.

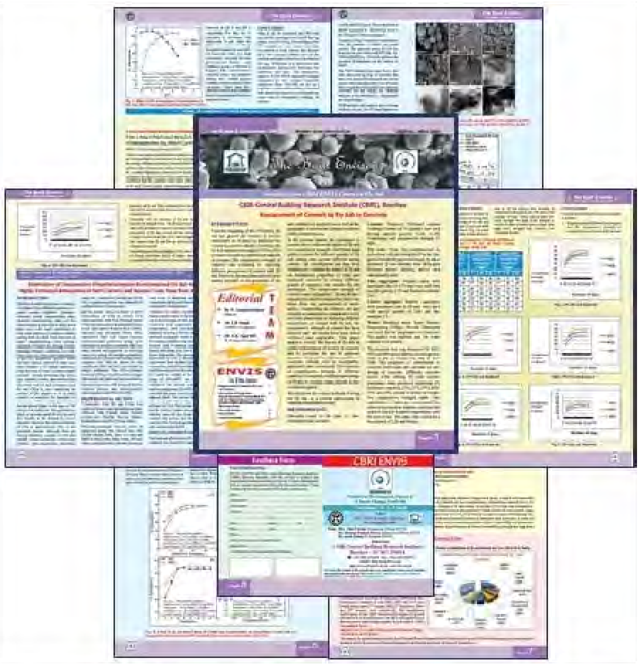
9. R&D highlights/Research output of CSIR-CBRI in CSIR Annual Report

- Contribution to Science
- Contribution to Economy/Society
- S&T Services and Facilities
- Awards/ Recognition
- Academy of Scientific and Innovative Research
- Extra-mural Human Resource Development
- Dateline

10. Outreach through Articles in Magazines, Periodicals etc. including Everyman's Science, Vigyan Pragati, Sacred News Times etc.

11. ENVIS Newsletter (2 Issues)

Vol. 12, Issue 2, July-December, 2016



Vol. 12, Issue 1, January-June, 2016

12. Press Meet

A press meet was organized on November 2, 2016 to apprise the public about the 2nd India International Science Festival (IISF-2016) held during December 7-11, 2016 at the CSIR-NPL, New Delhi. IISF is a flagship programme of the Ministry of Science and Technology and Ministry of Earth Science to show case Indian science achievements and innovation for the students, young researchers, and public.

As a prelude to the event, a science fest, open day, and technical exhibition was organized on Thursday, November 3, 2016 for students, teachers, public and user agencies at CSIR-CBRI, Roorkee.

Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee chaired the press meet and briefed about the programme. Press Representatives from Amar Ujala, Dainik Jagran, Hindustan, Rashtriya Sahara, Uttaranchal Deep, Awam-e-Hind, Jan Bharat Mail etc. attended the meet.

13. Faculty Training, Motivation, and Adoption of Schools and Colleges by CSIR-Central Building Research Institute, Roorkee

During this period, various motivational and educational programmes were organised for teachers and students under the CSIR Scheme, "Faculty Training, Motivation and Adoption of Schools and Colleges by CSIR Labs to motivate the teachers, inspire students, rekindle their interest towards science, provide them with appropriate resources and raise the standards of science education in schools and colleges.

a. October 5, 2016: Workshop-Training-cum-Motivational Programme for Teachers

b. November 30, 2016: Workshop-cum-Training Programme for Students

c. February 10, 2017: Science Exhibition by Students

d. February 23, 2017: Workshop-cum-Training Programme for Students

e. February 27, 2017: Workshop-Training-Motivational Programme for Teachers

f. March 28, 2017: CSIR-CBRI organized Student Awareness Programme

Development, Construction & Extension Group

Dissemination, Promotion & Extension Activities:

- Awareness on Innovative Building Technology Products was spread amongst 75,000 persons at CSIR Platinum Jubilee Techno-Fest, for 15 days, during India International Trade Fair at Pragati Maidan, New Delhi.
- Displayed Building Technology Products at India International Science Festival-2016 organized by Ministry of Science and Technology and Earth Sciences and Vigyan Bharati, held at CSIR-NPL, New Delhi.

- Participated in CSIR Hall of Pride Stall at Indian Science Congress-2017 Exhibition held at Tirupati (A.P.), organized by Indian Science Congress Association witnessed by 50,000 persons.
- Participated as Special Invitee in Indian Engineering and Technology Fair-2017 organized by Confederation of Indian Industry (CII), held at Pragati Maidan, New Delhi.
- Technology/Products were demonstrated for about 50,000 persons at Odisha MSME Trade Fair - 2017 held at Bhubneshwar, organized by Govt. of Odisha.
- Participated in 4th National Conference on Innovations in Indian Science, Engineering and Technology organized by Vigyan Bharati at CSIR-NPL, New Delhi.
- Participated in "CSIR Touching Lives in North East" at Destination North East 2017 organized by Ministry of Development for North East Region at Chandigarh.

- Organized three-day Orientation Programme for newly recruited scientist of CSIR-CBRI at CSIR-CBRI, Roorkee.
- Organized one-day Training Programme on 'Low Cost Construction Technologies and Waste Water Disposal System' for Fisheries Department and Haridwar District Administration at Daulatpur.
- Organized a Workshop on 'Durable Eco-Friendly & Affordable Housing' under rural housing schemes for Panchayat Raj Department of Odisha at Bhubneshwar.
- Organized five-day National Training Programme on 'Control Measures for Landslides' at CSIR-CBRI, Roorkee in collaboration with NIDM, New Delhi.

- A two-day Training Programme on 'Design and Construction of Earthquake Resistant Houses in Kinnaur region of Himachal Pradesh' was organized at Reckong Peo, Kinnaur, Himachal Pradesh, jointly with the Himachal Pradesh State Council of Science, Technology and Environment (HPSCST&E), at Bachat Bhawan, Reckong Peo, and was attended by more than 150 trainees consisting of Junior engineers and about Masons/contractors. The programme was inaugurated by Mr. Jagat Singh Negi, Hon'ble Dy Speaker, Himachal Pradesh Government in the presence important officers of CSIR-CBRI, Roorkee, the Himachal Pradesh State Council of Science, Technology and Environment (HPSCST&E) and District Administration.

The following important officers along with their colleagues were present in the inaugural function:

- Mr. Ajay Kumar Lal, Director (Env) Government of Himachal Pradesh and Member Secretary (EC) State Council for Science, Technology and Environment (HPSCST&E), Himachal Pradesh.
- Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee
- Mr. Yadvendra Pandey, Chief Scientist, CSIR-CBRI, Roorkee
- Mr. Kunal Satyarthi, IFS, Chief Scientific Officer-cum-Joint Member Secretary.
- Dr. N K Lath, Dy. Commissioner, Kinnaur.

Technical & Educational Visits of Professionals & Students:

Knowledge Resource Centre (Library)

'Knowledge Resource Centre' (KRC) of CSIR-CBRI is actively engaged in acquisition, technical processing, updating the collection and providing the platform for e-access of information sources to expand the horizon of information base to the scientific community. Now it is fully automated and RFID enabled systems and services.

Acquisition:

- **Books:** KRC added 316 numbers of books.
- **Journals:** The library has subscribed 52 (29 foreign and 23 Indian) journals. 191 volumes of journals were got bound.

Library Statistics:

The present position of library Collection:

- Books including reports, standards, conference proceedings; theses and maps: **44712**
- Bound Periodicals: **20680**

Institutional Membership:

KRC renewed the membership of learned national/ international professional societies and received their publications against the membership.

- **National (India):** Indian Building Congress (IBC), Delhi; Indian Geotechnical Society (IGS), Delhi; Institute for Steel Development and Growth (INSDAG), Kolkata; Indian Science Congress Association (ISCA), Kolkata; Life Member of The Institution of Engineers (India), and Indian Green Building Council (IGBC), Hyderabad.
- **International / Foreign:** International Union of Laboratories and Experts in Construction (fib), Lausanne, Switzerland; and American Concrete Institute (ACI), USA

Exchange of Publications: Besides membership, the library received Annual Reports, News Letters, Technical Reports, Reprints, and other materials in exchange from National and International Organizations.

Resource Sharing and Local Networking: CBRI-KRC is maintaining continuously good relationship with the libraries located in Roorkee viz. Indian Institute of Technology; National Institute of Hydrology library; and providing resource sharing through inter library loan. Besides the local network, KRC is maintaining the liaison and relationship with the KRC's of CSIR Laboratories/ DST Labs and other academic/research institutions.

Services: KRC is playing a coordinating role between users and the literature, providing personal Information service through Current Awareness (CAS) and Selective Dissemination of Information (SDI) using modern information technology. Besides the day to day circulation, reference, and xeroxing services, KRC is also rendering the following services:

- **Documentation:**

  a) Paper Clipping Service (PCS): PCS is continued through scanning nine no. of newspapers in English and Hindi. The topics of the interest of the Institute under eleven major heads like-Building Materials; Structure and Foundation; Disaster Management: Earthquake and Landslides; Shelter Planning and Policy; Environment Science and Technology; Fire Research; CSIR/ CBRI etc. The paper clippings are kept in classified order for providing current awareness service to users.

  b) List of Latest Addition: KRC is bringing out a quarterly list of latest arrivals of books for the general awareness of library users.

  c) Bibliographic Service: KRC is providing bibliographic service to users on demand on the subject of interest from in house data base as well as international databases.

  d) Current Contents Page (CCP): CCP of print journals is providing through attachment of mass e-mail to S&T members for current awareness.

- **Web-OPAC Search:** KRC has created a bibliographic database of documents and providing search facility through computer. Users can search any document through any access point like author, class no., subject, title, keyword, and combination of search (Boolean search).

- **CD-ROM:** CD-ROMs are available in KRC viz. CIB Conference Proceedings, ACI Manual, Pate state: a database of CSIR patents; heritage buildings and sites.
- **In-house Database:** KRC is maintaining in-house bibliographic database of books and bound volumes of journals.
- **Internet Facility:** KRC has internet connectivity node with PC's as well as Wi-Fi connectivity for users to access of e-resources.
- **Access of E-Journals:** Now, access to over 2000 full text of e-journals of leading S&T publisher's viz., ASCE, full text of ASTM Standards, Elsevier (selected), Emerald, ICE (UK), IEEE, Nature, OUP, RSC, T&F, Wiley, science databases like Web of Science (WoS), and patent database viz. QPAT/ORBIT are available online under National Knowledge Resource Consortium (CSIR-DST E-journals Consortium) as well as direct subscription.
- **Knowledge Repository:** KRC has created Institutional Repository (IR) through dspace software. Large number of records has already uploaded contains full text database along with metadata of published research papers of S&T staff members of the Institute as well as all Building Research Notes (BRN), Project Profiles, Annual Reports of CSIR-CBRI since 1953, and conference proceedings volumes, organized by CBRI. This database can be accessed at http://krc.cbri.res.in/dspace.
- **Book Exhibition:** KRC has organized a book exhibition and displayed the latest Hindi books from own collection during the celebration of Hindi Week.

Planning & Business Development (PBD)

PBD Group acts as the main facilitator of the Institute for effective planning, monitoring, evaluation and project budgeting of all R&D and externally funded projects such as consultancy projects, sponsored projects, grant–in-aid projects and testing projects etc. Important documents like annual plan document of the Institute, manpower deployment, externally funded projects for MC agenda and R&D agenda for the Research Council are also dealt with by PBD group. Besides this, PBD group manages technology transfer to the industries, IPR management activities and execution of agreements and MoUs with various industries/ institutes/organisations.

PBD group monitors and compiles the Monthly Progress Report (MPR) and Quarterly Progress Report (QPR) of the research activities of the Institute as well as the Research Utilization Data (RUD) for onward transmission to CSIR, New Delhi. The group regularly maintains and monitors the project records in terms of physical and financial recommendations of internal monitoring committees, Research Council (RC) and Management Council (MC).

R&D Projects:

Internal review meetings and meetings with external experts are organized for review of new R&D projects. The ongoing projects are monitored for progress and/ or mid-course corrections. Comments of experts are conveyed to concerned PIs and it is ensured that the same are incorporated before the projects are placed before the RC. R&D projects were processed under the four R&D areas of the institute, namely, new construction material, health monitoring rehabilitation & strengthening, disaster mitigation and energy efficient system.

Project Evaluations & Peer Reviews:

Internal and external peer review meetings and project evaluation meetings were organized for new and on-going In-house R&D projects as well as for the 12thFive Year Plan Projects during the year. PBD group coordinated the scheduling of presentations and interacted with the project leaders for putting up the relevant documents. The inputs as an outcome of the meetings were incorporated in the projects and placed before the Research Council.

Research Council Agenda:

Research Council Meetings are held to monitor the progress of R&D projects of the Institute. The R&D agenda of 53rd RC meeting were prepared. The agenda covered the progress of ongoing projects as well as completed projects during the period and new projects taken by S&T staff. The outcome in terms of suggestion/direction/ guidance was communicated to the concerned project leaders.

Externally Funded Projects:

The Institute has undertaken various externally funded projects on the basis of the expertise in different areas in the form of Consultancy, Sponsored, Grant-in Aid and Testing.

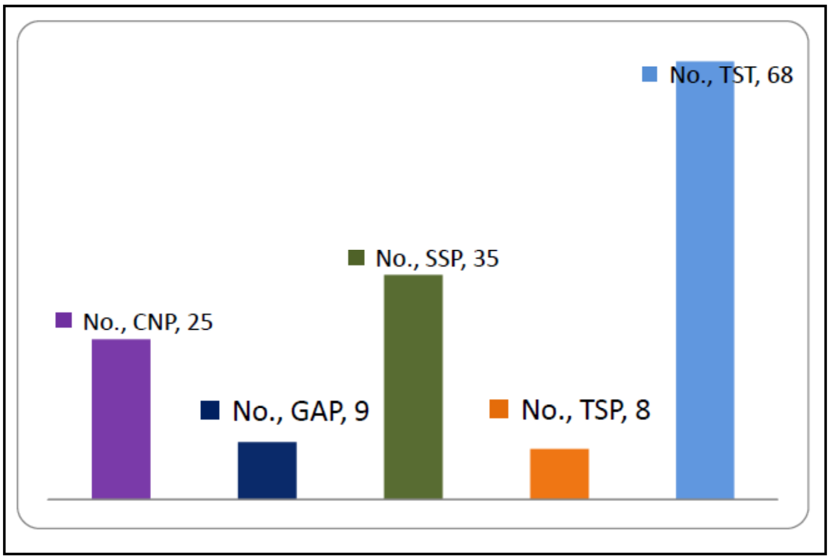
A Database of all the externally funded projects was maintained which helps in effective monitoring of these projects. Necessary record and receipts of Service Tax & TDS collection was maintained. Service tax was deposited with the authorities and Form-16 sent to CSIR for recoupment of tax deducted at source by the sponsors of various projects.

Manpower Planning & Deployment:

Human Resource Management lays special emphasis on planning for optimal deployment of the scientific, technical, non-technical and administrative staff of the Institute. The group gathers information regarding deployment from various groups for the preparation of manpower planning and deployment.

Management Council Agenda & Other Documents:

Prepared agenda items related to externally funded projects and action taken for MC meeting. The group also coordinated replies to various audits (CAG, CSIR and Service Tax), attended to RTI and Parliament questions.



Budget and ECF

CSIR Resource Input		External Cash Flow	
Revenue	2299.493 Lakh	Private	92.095 Lakh
Capital	472.533 Lakh	Government	764.096 Lakh
Special Projects	305.894 Lakh	Testing	272.522 Lakh
Total	**3077.920 Lakh**	**Total**	**1128.712 Lakh**

Special Events

Dr. N. Gopalakrishnan takes over as Director, CSIR-CBRI

Dr. N. Gopalakrishnan, Chief Scientist, CSIR-Structural Engineering Research Centre, Chennai took over as Director, CSIR- Central Building Research Institute, Roorkee on May 26, 2016. Dr. N. Gopalakrishnan did his B.E. Civil Engineering from Anna University in 1984, M. Tech. Structural Engineering from IIT, Madras in1986 and Ph.D. in Structural Engineering from Indian Institute of Science, Bangalore in 2009. He worked as Design Engineer in Tata Consulting Engineers (TCE) during 1986 to 1987. He joined CSIR-Structural Engineering Research Centre on April 27, 1987 as Scientist 'B' and continued as Chief Scientist.

Specialist in the areas of Mechanics, Materials and Engineering, Dr. N. Gopalakrishnan has provided his expertise in various areas such as Structural Dynamics, Soil Dynamics, Earthquake Engineering, System Identifications and Structural Health Monitoring, Experimental methods in Engineering and Sensors, Reinforced Concrete Structures and Structural Design of Steel and Concrete Structures. Dr. Gopalakrishnan along with his colleagues has filed patents including the patent for 'A Process for the manufacture of a Passive Energy Device (PED) from Hysteretic Shear Polymer' in 2008, 'Earthquake Protection Device for Bridges' in 2010 and 'Energy harvesting Device for SHM' recently.

He has received several awards, including the UNDP fellowship in 1994. He was also awarded Dr. M. Ramaiah's Prize for the Best Technical Paper for the year 2003 and again in 2008. Dr. Gopalakrishnan has authored 61 papers, published in numerous national and international journals.

Prior to the joining of Dr. N. Gopalakrishnan, Prof. Satish Chandra, Director CSIR-Central Road Research Institute (CSIR-CRRI), New Delhi took over the additional charge of Director CSIR-Central Building Research Institute (CBRI) on April 18, 2016 and continued till May 25, 2016.

National Technology Day

CSIR-Central Building Research Institute Roorkee celebrated the National Technology Day on May 11, 2016. On this occasion, Dr. Girish Sahni, Director General CSIR, addressed the scientist and staff of all the 38 laboratories of CSIR through video call and stressed on the importance of working towards social issues.

Dr. Girish Sahni said that every day is Science Day in CSIR. Although every day should be Technology Day, this day has been chosen as to commemorate India's coming of age in terms of a global impact that our scientists made in 1998.

Describing himself as the first servant of CSIR, Dr. Sahni explained his 25-year scientific journey as a spiritual roller coaster and encouraged young scientists to have great experience serving the country with a positive attitude.

Dr. Girish Sahni, Director General CSIR, informed that he made a presentation on the positioning of CSIR, its recent contribution, some of its history and its services to its divergent stake holders in the CSIR Society Meeting, presided by the President of CSIR, the Hon'ble Prime Minister of India Mr. Narendra Modi, held on April 6,

2016. Dr. Sahni informed that the meeting had great insights and guidance by Prime Minister Mr. Modi with a single vision “Use of Science for the poorest of the poor of the country”. Dr. Sahni said that the Hon’ble Prime Minister Mr. Narendra Modi has appealed to all the scientists to bear in mind the struggles of the poorest sector and use the science and knowledge to provide solutions to the problems of the society and for the service of the nation. Consequently, the Prime Minister has given a clear mandate to identify 100 problems of society, take them as challenges and use all the knowledge, education, smartness, facilities and focus to provide the solutions. He essentially asked the scientists to shift the focus from individual project centric, individual glory centric work to become a mission centric, committed, focused problem solving organisation.

Dr. Sahni said that CSIR has had a great history with its 37 labs and diverse knowledge and talents panning medicine, drugs, aeronautics, biology, marine-science, bio-technology, every discipline of science and technology. He said that these temples of modern India should become the field in which solutions come out. He informed that in the last decade CSIR has become a very strong scientific base in terms of impact factors, AcSIR, patents, quality of Ph.D. students etc. CSIR is the only R&D organisation in the country which finds place in the top 100 in the World Ranking List at the 84th position. CSIR also holds the highest number of patents in the country and has converted over 8-10 % of these patents into technologies in comparison to the 3-4% rate around the globe.

Dr. Sahni informed that CSIR had asked all the labs to hold open brainstorming marathons to provide an open forum to discuss the direction in which science & technology has to take the vision & mission of each lab. Consequently, a Director’s Meeting was held to narrow down three low hanging fruits or projects that can be delivered on a fast track in the next 12 months. He proudly informed that there were over 80-90 technologies ready for exploitation.

He asked the scientists to work towards the philosophy, the joint vision set by the President of CSIR, Hon’ble Prime Minister Mr. Narendra Modi; Vice President Dr. Harsh Vardhan & Mr. Y.S. Choudhary to deliver solution to societal problems and to undertake transitional research activities in a significant & time bound manner, achieve proof of concepts, build prototypes, incubate the start-ups and if need be, invite industry in campus so that there is a close hand holding relationship and convert some of the campuses to technology parks.

Dr. Sahni brought the fundamental message to respect every member of the society irrespective of his position, to change the passion for science into compassion for society, leading to the alteration in the mind-set of the scientists which the Prime Minister called as ‘Parivartan’. He asked the scientists to build up new technologies by following the vast vistas of opportunities opened by works of Nobel Prize winners and use it for uplifting the society. He said that to convert science for others, it has to go through the pathway of technology which is slightly different from the path that most of the scientists are accommodated to. He congratulated the scientists on doing exceptional scientific work and urged to take a pledge to collectively work as a team and become a solution provider to the problems and issues of the common man.

In the end, he appealed every individual to take an oath with him to put an end to the complaint and negativity and to stand shoulder to shoulder, brothers and sisters; and work for the country forever and for the students to transform this organization to scientifically smart to technology smart organization.

Training Programme on Construction of Affordable Housing

CSIR-CBRI conducted a one-day training programme on ‘Construction of Affordable Housing’ on May 13, 2016 at Mysore in association with Mysore Nirmithi Kendra for Junior Engineers, Supervisors and Masons. The training programme aimed to create awareness on planning and designing, construction techniques and quality control, innovative building materials and low cost sanitation systems and affordable housing/building construction practices to the field level machineries. The programme was attended by more than 150 participants covering all over Karnataka state. Mr. M.T. Manjunath, Project Director, Mysore Nirmithi Kendra welcomed the dignitaries of the programme and subsequently, the training programme was inaugurated with lighting the lamp by the Chief Guest Mrs. C. Shika, IAS, Deputy Commissioner of Mysore; the Guest Dr. C.G. Betsurmath, Commissioner of Mysore City Corporation (MCC); Mr. Y. Pandey and Dr. B. Singh of CSIR-CBRI.

Mr. Y. Pandey, Chief Scientist said that CSIR-CBRI has been providing new technologies to central government sponsored programme for construction of affordable houses at low cost and the awareness of the same has been planned to provide across the country for the construction of safe and affordable houses. Speaking on the occasion, MCC Commissioner Dr. C.G. Betsurmath said that the MCC under the 'Housing for All' schemes had planned to construct of a total 2,700 houses with the approval of the council and added that Rs.15, 000 was being spent on construction for a toilet. He sought the help of CSIR-CBRI in bringing down the expenditure with the help of new technologies to construct good quality toilets.

Mrs. C. Shika during her inaugural speech stated that the BPL families were being provided with individual houses in rural areas and apartments in urban areas. She urged CSIR-CBRI to provide the district administration with new technologies to construct good quality houses at affordable areas. She also mentioned that the tribal in forest areas were being provided housing facilities using bamboo technology which was implemented by Nirmithi Kendra. Lastly, Dr. R. Dharmaraju, Coordinator from CSIR-CBRI proposed the vote of thanks.

A short film on Role of CSIR-CBRI in Building Construction Technology was Screened to the participants. Mr. S.K. Negi, Senior Principal Scientist, interacted with participants regarding the Planning and Designing of affordable housing. He also discussed the effectiveness and benefits of the CBRI building technologies in safe construction and cost reduction.

Subsequently, the session on Cost Effective Building Materials and Construction Techniques was taken by Dr. B. Singh, Chief Scientist, in which he explained the use of local materials as alternate wood substitute for the production of composite from natural fibres, door shutters, jute frames, roofing sheets and composite shuttering plates etc. Further, he discussed the innovative technologies developed by the Institute for use of industrial/demolition waste for the production of different types of bricks such as fly-ash bricks, clay fly-ash bricks etc. for the sustainable development.

Mr. H.K. Jain, interacted with participants on the issues related to quality in construction, maintenance and repair of buildings. He mainly apprised the participants about the inspection and maintenance, repair and rehabilitation methods, repair of cracks and use of fibre reinforced polymer composite in rehabilitation and retrofitting of buildings to enhance the safety. The low cost sanitation systems developed by the Institute were also discussed with participants in detail. Apart from this, the participants also visited the CSIR-CBRI technologies displayed through charts and products at the venue.

The training programme concluded after obtaining feedback from the participants. The participants expressed that the training programme would enable them to improve their scientific knowledge and adaptation of building technologies at grass root level, with the technical support of CSIR-CBRI scientific community.

The CSIR-CBRI scientific team that visited Mysore Nirmithi Kendra reported that they have developed and adopted several new technologies such as concrete blocks, low cast sanitation systems, concrete windows & door frames, bench for schools, steel frames etc. in their projects. The low cost houses constructed under 'Jawaharlal Nehru National Urban Renewal Mission' (JnNURM) for the people shifted from slum areas and Vivekananda Girijan Kalyan Kendra (VGKK), are the major projects where typical low cost CSIR-CBRI technologies have widely been adopted.

World Environment Day

The CSIR-Central Building Research Institute, Roorkee celebrated the World Environment Day on June 5, 2016 to promote awareness on the importance of preserving our bio-diversity, the need to identify problems related to the environment and ways to take corrective action. It was on this day in the year 1972 that the United Nations Conference on the Human Environment was formed. First celebrated in 1973, World Environment Day, also popularly known as Environment Day, is a means to tackle environmental challenges that include climate change, global warming, disasters and conflicts, harmful substances, environmental governance, eco-system management and resource efficiency.

On the occasion, Dr. N. Gopalakrishnan, Director CSIR-CBRI, planted trees in CSIR-CBRI Campus as a gesture of harmonious living with nature. He said that conservation and protection of environment and love for nature have always been part and parcel of Indian ethos and culture. He also said that every human being should contribute a little in their own personal way to protect the environment.

Dr. Gopalakrishnan awakened the young scientists to plant greater number of plants in the Institute campus and colony. He said that the Institute should continue its activity to develop environment-friendly technologies, pursue research to protect the environment and work for conservation of biodiversity of the region.

International Yoga Day

Yoga, an ancient physical, mental and spiritual practice that originated in India, symbolizes the union of body and consciousness.

Recognizing its universal appeal, the UN proclaimed June 21 as International Day of Yoga to help raise awareness of the many benefits of practicing Yoga. The observance of the International Yoga Day worldwide highlights the important role healthy living plays in the realization of the Sustainable Development Goals, adopted last year by all United Nations Member States.

With this overall objective, the CSIR-Central Building Research Institute Roorkee observed the International Yoga Day on June 21, 2016. The main function, organized at CSIR-CBRI Museum Hall, comprised of a meditation session, involving practice of asanas, wherein the staff of CSIR-CBRI participated in a big way.

Training Programme on Control Measures for Landslides

Landslides problem in hilly terrains are one of the major concern in India which gets triggered by natural causes including substantial rainfalls, cloud bursts, earthquakes, etc. However, the occurrence of landslides has increased in magnitude due to human activities. In terms of developmental actions over unstable slopes; landslides pose increasing risk to human life, buildings, structures, infrastructure and environment. As individual landslides usually affect limited local areas and residents, damage resulting from landslide hazards has not generally been recognized as a problem of national importance and has not been addressed on a national basis. The absence of coordinated national approach to mitigate the detrimental effects of landslides has resulted in a reduced ability of the states and local government agencies to apply the important lessons learnt, often at considerable expense, in other parts of the country.

National Disaster Management Authority have recently prepared national disaster policy and guidelines to tackle the national landslides problem that arise from both the regional considerations and of the considerable variations in the institutional capability. Thus, responsibility at regional and local levels and inputs from a wide variety of stakeholders are essential. Strengthening the process of landslide assessment, investigation, mapping and management will have far reaching effects in reducing landslide losses. In this direction, several institutions like NIDM, CBRI, CRRI, WIHG, IITs and other organizations in the country have been conducting landslides studies for stabilization of landslide prone areas. NIDM has extensively organizing training and capacity building activities on landslide risk management in association with various institutions in the country. CSIR-CBRI has also conducted considerable studies on landslide risk mitigation since last two decades.

With this background NIDM and CSIR-CBRI had jointly organized a five days national training programme on 'Control Measures for Landslides' during July 18-22, 2016. This training programme was particularly aimed at enhancing knowledge and skills of the implementing agencies to incorporate control measures techniques for stabilization of landslides areas and mitigation of associated risks through lectures, demonstrations and hands-on exercises. The programme was attended by thirty-one officers from different states of the country including Tamil Nadu, Karnataka, Madhya Pradesh, Nagaland, Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Chandigarh and Delhi.

The programme was inaugurated by Dr. R.K. Bhandari, Geo-hazards Expert & Former Director CSIR-CBRI by lighting up the lamp. Dr. N. Gopalakrishnan, Director CSIR-CBRI, Mr. Y. Pandey, Chief Scientist CSIR-CBRI, Dr. Surya Prakash, NIDM and other staff of the Institute graced the occasion.

The Chief Guest, Dr. R.K. Bhandari shared his vast experience on geo-hazards with the participants and suggested them to focus more on prevention of hazards instead of managing the hazards. According to him, the state of Uttarakhand is a live laboratory of nature, which must be utilized to its full potential for exploration of more and more possibilities towards solution of geo-hazards.

Dr. N. Gopalakrishnan insisted on the necessity of structural health monitoring using sensors & other latest technologies. He requested everyone to learn from past experiences and work towards a better tomorrow.

Mr. Y. Pandey dwelt upon the need of such training programmes. Later, Dr. R. Dharmaraju, Senior Principal Scientist, CSIR-CBRI proposed the vote of thanks.

During the five days of training, 24 technical sessions were conducted on different aspects of landslides mainly on global and national scenario, losses to life and property, causes, hazard mapping and risk assessment, investigation methods (geological, geo-morphological and geotechnical features and parameters), instrumentation and monitoring for predication of slope failures, and different methods of control measures for stabilization problematic landslides with case studies. The technical sessions were delivered by the external resource persons, and in-house faculty of CBRI, Roorkee. Also, the participants were taken to Narendra Nagar landslide site to understand the ground reality of the landslide problems.

The concluding session of training programme was held on July 22, 2016. The session was chaired by Prof. P.K. Garg, Vice Chancellor Uttarakhand Technical University, as Chief Guest and Prof. Bhanvani Singh, Rtd. Professor, IIT, Roorkee, as Guest of Honour. During the concluding session, participants shared their experience about the programme.

Prof. P.K. Garg, in his address suggested that mass movements have increased tremendously in hills and, this is one of the biggest causes of many problems related to landslides. Thus, it has become very necessary in current scenario to stay updated on better options for prevention and management of such hazards; and these training sessions can work as an effective tool for the betterment of skills of people working on the grass root level.

The Guest of honour, Prof. Bhavani Singh, also requested the participants to monitor the landslides, so that their root cause can be assured and more realistic control measures can be designed and applied. Mr. Y. Pandey also enlightened the participants with his experience and guidance.

The session was concluded with the distribution of certificates to the participants. At the end, Dr. R. Dharmaraju thanked the dignitaries, NIDM and the participants for the successful completion of training programme.

Independence Day

The Independence Day was celebrated with a deep sense of patriotism combined with gaiety on August 15, 2016 in CSIR-CBRI Main Lawns of the Institute. Dr. N. Gopalakrishnan, Director, CSIR-CBRI hoisted the National Flag,addressed the gathering and took the salute at the March Past performed by the security guards. The school children from Bal Vidhya Mandir and CBRI Junior High School presented various cultural programmes on patriotic themes.

Sadbhavna Diwas

The Institute observed Sadbhavna Diwas on August 20, 2016 with a view to promote harmony amongst people of all religion, languages and states and goodwill towards everyone. Dr. N. Gopalakrishnan, Director, CSIR-CBRI administered the Sadbhavna Pledge to all the staff members of the Institute.

Hindi Week

Hindi Week was observed at the Institute during September 14-21, 2016 with great zeal and enthusiasm. Mr. Subhash Pant, renowned hindi writer, poet, anecdotist and litterateur graced the inaugural function as Chief Guest and Dr. N. Gopalakrishnan, Director, CSIR-CBRI, presided over the function.

Mr. Subhash Pant stressed on the use of Hindi in day to day work and appealed to all officials to do proactive work in Hindi. Dr. N. Gopalakrishnan said that it is our constitutional duty to do our work in Hindi language and we should follow it religiously. He also inspired the scientists to write scientific articles in Hindi language so that it is easily accessible to the general public. On this occasion, the latest edition of the quarterly bilingual CBRI Newsletter, Bhavanika was also released.

Mr. Yadvendra Pandey, Chief Scientist and Incharge, Official Language Implementation Committee welcomed the gathering and introduced the Chief Guest. On the occasion, a Hindi Books Exhibition was organized in the Knowledge Resource Centre (Library) of the Institute. On September 15, 2016, Dr. Dharmendra Singh, Senior Professor, IIT Roorkee presented an interesting technical lecture on “The Possibility of Water on Moon: The Special Initiative of Chandrayaan I”.

On September 20, 2016, Padma Shree Dr. Liladhar Jagudi graced the valedictory function as Chief Guest and informed about the diversity of language. He said that our country is spiritual but physicism and materialism is blamed. We need to attain a hylozoistic approach to understand the concept of physicism and by understanding other languages, we will come to understand their ideas. He asked the officials to learn new languages and adopt their words to enrich our language. The Closing Ceremony was chaired by Dr. N. Gopalakrishnan, Director, CSIR-CBRI.

In his Presidential Address, Dr. N. Gopalakrishnan said that this is a linguistic festival of our country and called upon everyone for the combined responsibility to accept Hindi as the official language of our country for a comprehensive growth and development.

Mr. Yadvendra Pandey, welcomed the gathering and introduced the Chief Guest. The Bilingual Technical Charts reflecting the scientific research, and activities of the Institute, were also released by the Chief Guest.

A Hindi Poetry Session was organized in the Institute auditorium where senior poet Mr. Naresh Rajvanshi, Mr. Krishna Sukumar, Mrs. Seema Safaq from Haridwar and eminent composer Padama Shree Dr. Liladhar Jagudi from Dehradun presented their compositions.

Mr. Suba Singh, Hindi Officer presented details of the activities held throughout the week. Winners of various competitions including hindi noting and drafting, poetry recitation and speech competition were felicitated. Mr. Mehar Singh, Hindi Officer presented a vote of thanks.

CSIR-CBRI Celebrates CSIR Platinum Jubilee Foundation Day

The Platinum Jubilee Foundation Day of CSIR was celebrated with great enthusiasm at CSIR-Central Building Research Institute, Roorkee on Thursday, September 29, 2016. Mr. Rajeev Goel, Chairman and Managing Director, Hindustan Prefab Limited, New Delhi graced the occasion as Chief Guest and Mr. M. Manjunath, Project Director, Mysore Nirmiti Kendra, Mysore, Karnataka as Guest of Honor. Dr. N. Gopalakrishnan, Director, CSIR-CBRI presided over the function.

The Chief Guest Mr. Rajesh Goel, in his speech said that the development in the field of building construction has still not reached its expected growth. Since building and construction is one of the largest growing sectors, we need to work on it from the bottom of the pyramid to achieve set goals. It is our responsibility to percolate the benefits of the R&D achievements up to the grass root level. Referring to the 'Housing for All' by 2022 scheme, he said that to achieve the goal, we need to create 5 million houses each year for which we need to double the pace. Stating CSIR-CBRI as the highest standard in the building sector, he emphasized that the new technologies would be acceptable on the ground only when certified by CBRI, then the consumer will accept. The going is tough but we have to get going. He informed that in the event of disaster as earthquake, special attention is required towards the unorganized sector. We should endeavour that in case of a disaster, transit shelters should immediately arrive at the place of need. He appreciated the contributions made by scientists of the Institute and encouraged them. Earlier, the Chief Guest planted trees in the CSIR-CBRI campus as a gesture of harmonious living with nature.

Addressing the gathering, Mr. M. Manjunath said that CSIR-CBRI technologies are very useful in the construction sector but there is a shortage of skilled labour in the construction sector. He expressed his satisfaction with the technology developed by CSIR-CBRI, Roorkee and informed that the technology was used to construct affordable houses in 30 square meters area in Mysore and were greatly appreciated.

Earlier, Mr. Yadvendra Pandey, Chief Scientist in his welcome address highlighted the glorious past of CSIR and its ongoing works. Dr. N. Gopalakrishnan, Director, CBRI, said that it is a day of introspection and self-evaluation. We need to introspect and think about every citizen of the country. He said that CSIR-CBRI has a rare communion of scientists, engineers and experts that should be exploited to develop newer technologies.

On this occasion, the latest edition of Central Building Research Institute Annual Report and Nirmanika were also released. Dr. Suvir Singh, Chief Scientist proposed the vote of thanks. A cultural programme was also organized in the evening.

Students and citizens were invited being an Open Day and an orientation programme was organized for the visiting students from various schools and colleges. The students and their teachers visited various laboratories of the Institute and had interesting interactive sessions with the scientists.

CSIR-CBRI staff members who have completed twenty five years' service in CSIR were felicitated by the Chief Guest by presenting them a watch. Also, scientists/staff of CSIR-CBRI superannuated during the year, were honoured by presentation of a shawl and watch. There have been several activities including essay competition for staff members and students of classes 6 to 12 in several categories on various topics including 'Role of CBRI in Housing for All', 'Contribution of CBRI in Nation Building', 'Vision and Direction of CBRI', 'Rio Olympics', 'Namami Gangey' and 'Alternative Energy Sources' etc. The winners of the activities were also awarded on the occasion. Meritorious students were awarded with scholarships for getting admission in IIMs. The superannuated staff of the Institute also graced the occasion besides other dignitaries.

Diwali Mela

The Diwali Mela was organized jointly by CSIR-CBRI Staff Club and Shanti Nagar Ladies Club Roorkee on October 27, 2016 at Shanti Nagar Colony ground. Dr. N. Gopalakrishnan, Director, CSIR-CBRI inaugurated the Mela and visited all the stalls organized by the members of CBRI Ladies Club. Stalls offering wide variety of delicious traditional food, handicraft items, fun games and swings for kids etc. were highly appreciated.

This annual festival was fun for the CSIR-CBRI family and the visitors alike. The entertaining activities like dance competition, theme based fancy dress competition, tambola, and lucky dip etc. were appreciated by audience, and judges. Prizes were distributed to the winners of all the competitions including Lucky Dip. Viewers appreciated the whole programme and perceived the importance of 'Festival of Light' in life.

Science Fest, Open Day & Technical Exhibition

CSIR-Central Building Research Institute, Roorkee organized a science fest, open day and technical exhibition for school children, college students, teachers, industry personnel, media and public as a precursor event of 2nd India International Science Festival (IISF-2016) on Thursday, November 3, 2016 at CSIR-CBRI, Roorkee.

The program was organized in two sessions. The morning session was attended to by school children, teachers, and public whereas the afternoon session witnessed a wide participation by college students, teachers, industry personnel, media and public.

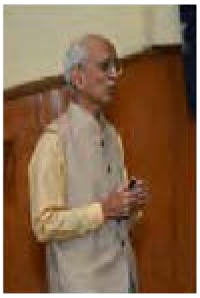
Inaugurating the forenoon session, Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee welcomed the school children and said that a calm mind is a sponge that absorbs knowledge easily. He encouraged the students to relax their mind and have an interactive and educational session with scientists and experts.

On the occasion, Prof. Dharmendra Singh, IIT Roorkee presented an interesting lecture on 'Hidden Fun in Science' and said that we must adopt a scientific approach to our thinking process. He explained that science plays an important role in every particle, and aspect of nature, and to understand this, science must not be learned, instead scientific thinking should become our habit.

In the afternoon session, Professor Gopal Ranjan, D.G., RCE presented an intriguing lecture on 'Think India, Total Innovation' and encouraged the college students to bring about a new thought and build on it to create new innovations. Prof. Rajesh Chandra emphasized on the importance of the questioning, curiosity, quality of life and presented an interactive lecture on important issues of 'Waste Management and Sustainable Development'. Dr. S.C. Handa, Director, Quantum Global Campus, Roorkee presented an enlightening lecture on the 'Impact of Pollution on the Taj Mahal'.

Earlier, Dr. A.K. Minocha, Chief Scientist and Nodal Officer, welcomed the gathering and gave an overview about India International Science Festival and the programme. Dr. P.K.S. Chauhan presented a formal introduction of Prof. Dharmendra Singh. A film highlighting the research and development work being carried out at CSIR-Central Building Research Institute, Roorkee was also screened.



The programme ended with a vote of thanks proposed by Dr. Atul Kumar Agarwal, Senior Principal Scientist, and Information Officer, CSIR-CBRI, Roorkee. He sparked the students by quoting various examples and said that these temples of learning should be a home to only those who wish to serve the nation by contributing their knowledge and hard work in solving the problems of the poorest of the poor and not just for earn a living.

Later, the participants visited the enriched labs of CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the Institute. They also had an interactive session with the Institute's scientists where they put their curiosity to rest and quenched their thirst for knowledge.

The programme was attended to by more than 200 college students along with the faculty members from schools and colleges of Roorkee including KLDAV (PG) College, SSDPC Girls (PG) College, Greenway Modern Senior Secondary School, and Children's Senior Academy.







Vigilance Awareness Week

The Vigilance Awareness Week was observed at the Institute during October 31, 2016 to November 5, 2016 with fervour and exultation. The week started with the Inaugural Ceremony in which a Pledge was administered by Dr. N. Gopalakrishnan, Director CSIR-CBRI to all the employees of the Institute.

During the Vigilance Awareness Week, various programs were organized to sensitize the employees, students, public and society at large about "Public Participation Essential in Promoting Integrity and Eradicating Corruption", the theme of the awareness week. Dr. Ashok Kumar, Senior Principal Scientist, CSIR-CBRI read the messages of President, Vice President and Prime Minister, Government of India on Vigilance Awareness Week which was attended by staff, Ph. D. scholars and students. He gave an overview of the week long activities.


Various activities were organized during the Vigilance Awareness Week including debate competition for CSIR- CBRI staff, essay competition for CSIR staff children of 8th -12th standard and poster competition for CSIR staff children of 5th -7th standard.

Mr. Arun Kumar, AGM, BHEL Haridwar delivered a lecture on November 4, 2016 and quoted an example of recently happened '2011 Public Participation Corruption Movement' which helped in getting awareness on corruption among the common man. He mentioned that the Corruption Perceptions Index (CPI) of India has fallen to 76th in 2016 as compared to 85th in 2011. He also talked about the benefits of practicing Yoga in life for on eradicating corruption.

In his Presidential Address, Mr. Yadvendra Pandey, Chief Scientist, stressed on the importance of public participation in promoting integrity and eradicating corruption. Mr. Y. Pandey and Mr. Arun Kumar gave away the prizes to winners.

Mr. Parag Saxena, Administrative Officer proposed a vote of thanks and acknowledged everyone particularly Mr. Ajay Dwivedi, Dr. Kishor S. Kulkarni, Mr. Sushil Kumar and jury members who directly or indirectly helped in organizing the activities and programmes. He also thanked Mr. Arun Kumar for delivering an illuminating lecture.

CSIR-CBRI Participated in the India International Trade Fair

The CSIR Platinum Jubilee Techno Fest pavilion was adjudged First (Gold Medal) for excellence in display in the category "Ministries and Departments" at the 36th IITF-2016. The Gold Medal was presented by the ITPO Chairman, Mr. L.C. Goyal.

India International Trade Fair (IITF-2016) was organised at Pragati Maidan, New Delhi during November 14-27, 2016 by India Trade Promotion Organisation (ITPO). CSIR alongwith all its 38 laboratories actively participated and showcased in it. Different laboratories based on their work field, were provided themes such as Engineering and Infrastructure, Aerospace and Strategic Sector, Mining, Minerals and Materials, Chemicals & Petrochemicals, Energy, Ecology and Environment, Leather, Water, Agriculture and Floriculture, Food and Nutrition, and Healthcare etc.

CSIR-Central Building Research Institute, Roorkee got an opportunity to become the theme coordinator for Engineering and Infrastructure pavilion and coordinated with CRRI, SERC, AMPRI, CMERI and NPL. During the theme day dedicated to CSIR-CBRI and Engineering and Infrastructure pavilion, the scientists of CSIR-CBRI interacted with school children and motivated them to work for the benefit of science through interactive session and demonstrations.

During the India International Trade Fair, two Memorandum of Understanding were signed and one technology got transferred to industry for public use commercialization.

The India International Trade Fair got a very positive and interesting response from the audience. Thousands of people visited Engineering and Infrastructure pavilion daily and raised their queries along with valuable feedbacks. Important dignitaries including Hon'ble Minister of Science & Technology and Earth Sciences, Dr. HarshVardhan; Dr. Girish Sahni, DG CSIR; eminent scientists and students visited the pavilion and had a glance of various technologies developed.

As a sign of good efforts placed by all laboratories of CSIR, India Trade Promotion Organisation selected CSIR pavilion as the best among the entire theme pavilion present in India International Trade Fair, and CSIR got awarded as the Gold certificate. Among all the CSIR theme laboratories, Engineering & Infrastructure pavilion was selected as the best and was awarded with a certificate. Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Mr. Y. Pandey, Mr. R. S. Chimote, Mr. S.K. Negi, Dr. R. Dharmraju, Dr. Ashok Kumar and Mr. Ashish Pippal scientists were present at the India International Trade Fair.

CSIR-CBRI Participated in the India International Science Festival

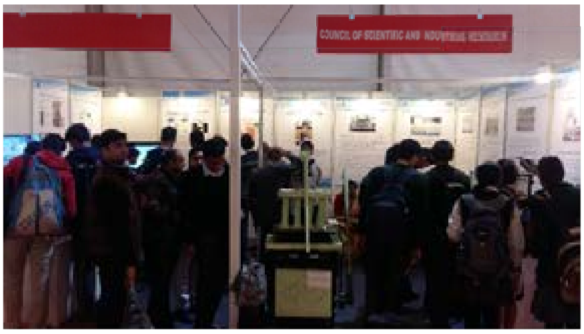
CSIR-CBRI participated in the 2nd India International Science Festival (IISF-2016) and displayed four of its shortlisted technologies; C-Brick Machine, Liquid Fire Extinguisher, Structural Health Monitoring System, and Floor Cleaning Robot during the event.

Ministry of Science & Technology and Earth Sciences, in collaboration with Vijnana Bharati (VIBHA), organized the 2nd India International Science Festival at National Physical Laboratory, New Delhi, during December 7-11, 2016. India International Science Festival is a flagship programme of the Ministry of Science & Technology and Ministry of Earth Science to showcase Indian science achievements and innovation for the students, young researchers and general public.

The event kicked off on December 7, 2016 with the inauguration of the Mega Science Technology and Industry Expo by Hon'ble Minister of Science & Technology and Earth Sciences, Dr. Harsh Vardhan. Mr. Y.S. Chowdary, Hon'ble Minister of State graced the Expo during the event. Speaking at the event, Dr. Harsh Vardhan said, 'Any new and innovative idea will be appreciated and supported by our Science Department and the Government'. Let us learn Science in a more creative way, he added.

Inaugurating the 'Young Scientists' Conclave on December 8, 2016 Hon'ble Union Home Minister Mr. Raj Nath Singh appealed to the youth to take Pime Minister Shri Narendra Modi's S&T programmes such as Digital India, Make in India, Skill India, Stand Up India – Start Up India to the common man. He said he would not like India to emerge as a 'Super Power', but rather aim to be the world's "Guru" or teacher, as it will be enlightening rather than being intimidating.

During the event almost 25,000 students of various schools visited the exhibition and clarified their doubts about various technologies. Dr. A.K. Minocha, Mr. R.S. Chimote, Mr. S.K. Negi, Dr. R. Dharmaraju, Mr. R.S. Bisht and Mr. Ashish Pippal were present at the 2nd India International Science Festival.



Training Programme on 'Earthquake Resistant Housing and Sanitary Latrine for the Rural Areas of Mandi, Himachal Pradesh'

The State Government of Himachal Pradesh has taken up housing activities in the rural and sub-urban areas of District Mandi and construction of low-cost sanitary latrines in large numbers. The state of Himachal Pradesh lies in the seismically most sensitive Zone IV and Zone V. The traditional houses being constructed there, are prone to earthquake damages and need special interventions to improve earthquake resistance. Similarly, construction of latrines, sewer lines, septic tanks etc is also difficult in the rocky hilly terrain. On the request of Deputy Commissioner, Mandi, a two days training programme on Earthquake Resistant Housing and Sanitary Systems for the Rural Areas has been organized during December 30-31, 2016, in collaboration with District Administration of Mandi, HPSDMA, Red Cross Society and UNDP.

The programme was formally inaugurated by the Deputy Commissioner of Mandi and subsequently technical sessions were delivered on techniques and precautions required for the construction of earthquake resistant houses using locally available materials by Mr. S.K. Negi and Mr. H.K. Jain. Later, use of stone masonry blocks as a safer and economical alternative of random rubble masonry was demonstrated along with use of plate vibrator for casting blocks and RCC roof slabs for better performance. About 50 masons and other officials participated in the programme.

The Red Cross Society, Mandi is working in the rehabilitation of leprosy patients. The Society has constructed houses for the families of the patients and now wishes to construct sanitary latrines for the families. A design of such latrines was provided to the officials of the Society and the construction work was started.

Dr. Girish Sahni, DG CSIR visits CSIR-CBRI

Dr. Girish Sahni, Director General, CSIR and Secretary, DSIR, Govt. of India, reviewed the R&D activities of CSIR-Central Building Research Institute, Roorkee during a recent visit on January 10, 2017 and encouraged the scientists, staff, and students to respond to the Hon'ble Prime Minister's call of 'Make in India' by delivering their vast knowledgebase in the domains of their operation.

Addressing the gathering, Dr. Sahni acknowledged that CSIR and CSIR-CBRI have a very long and glorious history of producing strategically and socially important technologies and it is our responsibility to work hard to live up to the proud heritage. He said that CSIR has always played a key role in the nation's socio-economic development and asked CBRI to contribute its efforts to further strengthen it. He advised that CSIR sister labs should work together in cooperation and in networking mode by sharing of ideas, co-ordinated planning and carrying forward the Government of India initiatives as outlined by the Hon'ble Prime Minister.

Apprising the scientists and staff of the Institute about the meeting with the Hon'ble Prime Minister of India, Mr. Narendra Modi, Dr. Sahni informed that the Prime Minister has congratulated CSIR and have asked to positively reinvent the Institute's image. Change is the law of nature and if we do not bring the change then change will be forced on us. He said that the warning is on the wall to bring about the change that is required and expected from the Institute by the people and the leaders of the nation.

The Director General in his address asked the Institute to do a "Manthan" brainstorming session and identify 20-25 big or small societal or intellectual problems, define them, create a team, if necessary, outsource resources and solve them. He urged the scientists and technologists to promote their research output in terms of innovative technologies in building construction, measures for achieving savings in depleting aggregates by using waste materials in construction and measures for enhancing building safety as per Indian standards.

Interacting with the scientists and staff of the Institute, Dr. Sahni asked them to examine ways to quickly transfer the technologies developed in the Institute to the common masses of the country. He advised the scientists and staff to work together as a team and said that when people work together they produce a unique positive energy. He said that creativity may be the seed of an individual entity but several multi disparity people must work together as a team to interpret, prototype, model that creation and make it a reality. There should be sense of focus, flexibility, and internal push to work and collaborate with industries to develop new technologies and deliver them to the poorest of the poor.

Dr. Sahni encouraged the scientists of the Institute to develop technologies and contribute in the various schemes started by our Prime Minister including Digital India, Make in India, and Skill India etc.He encouraged young scientists to play a key role in India's march to become a technology power and senior scientists to mentor them. He said that the Institute is a mine of potential teachers and should recruit more students and researchers to have innovative discussions. The nation is on the crust of innovation not only in the material but also the spiritual front.

Addressing himself as the servant of the people, Dr. Sahni asked the CBRI family to share their problems, dreams, and their disappointments with him. He said that every person needs a boost to their self-esteem through encouragement. Every type of labour, be it research and development work, management or contract etc. are necessary and should get encouragement and recognition. He called for pursuing those R&D activities on priority which would lead to the development of world class technologies with a focus on affordability and environment friendliness. Dr. Sahni planted trees in the Institute campus and encouraged green living.



Earlier, Dr. N. Gopalakrishnan, Director, CSIR-CBRI, welcomed the Director General and said that he is honoured and humbled by his presence and inspiration. He admired Dr. Sahni for his leadership, kindness, knowledge, and tireless efforts towards making the life of the poorest of the poor more comfortable. He advised scientists of the Institute to strengthen the hands of the DG by doing exemplary research and development works and developing latest technologies for the average person so that he can proudly present our humble contributions to the Prime Minister and the nation. Later, Dr. Gopalakrishnan gave a brief presentation on the R&D activities, public interactions and novel products developed by the Institute. He presented a brief account of the Institute's facilities, laboratories, ongoing work, and CBRI's plan for the next few years to come.

Mr. Yadvendra Pandey, Chief Scientist, presented a formal introduction of Dr. Sahni and welcomed him to the institute. He applauded Dr. Sahni for his passion and curiosity about innovations and knowledge on building sciences. On behalf of the Institute, he promised the Director General to work for the poorest of the poor and work to bring CSIR-CBRI on the national front as the highest authority in building sector.

On the occasion, Dr. Sahni inaugurated the 'Fire Research Laboratory', an experimental facility for building fire research, where studies on the negative impact of the actual use of fire will be carried out. Also, the 'Display Centre' exhibiting the capabilities of the Institute was inaugurated on the occasion. The display centre exhibited the Institute's research and development work through various technical charts and products.




The technologies developed by the Institute including rice husk plastic wood, pine needle boards and panels, Kota stone tiles, paver blocks from C&D waste, fire and water retardant canvas, transit shelter for disaster victims, lig house, Navodaya Vidhyala complex for earthquake prone areas, solar water distillation system for residential building, intelligent building system for model residential building, fire resistant door, pervious concrete, phospho-gypsum blocks, self-healing bio-concrete blocks and fly ash bricks etc. were displayed through models. Dr. Sahni took a keen interest in the Display Centre and applauded the efforts put in by the scientists and emphasized that all scientists should have a dream and transform lives of the common masses of India by developing innovative building technologies.




Republic Day

The Republic Day of the Nation was celebrated with a deep sense of patriotism combined with gaiety on January 26, 2017 at CSIR-Central Building Research Institute main lawns. Dr. N. Gopalakrishnan, Director, hoisted the National Flag, addressed the gathering and took the salute at the March Past performed by the security guards. The school children from Bal Vidya Mandir and CBRI Junior High School Shanti Nagar presented various cultural programmes on patriotic themes.






Training Programme on 'Design & Construction of Cost-effective & Earthquake Resistant Houses in Bharatpur Region of Rajasthan'

A two-day training programme on 'Design and Construction of Cost-effective and Earthquake Resistant Houses' was organized at Bharatpur during January 30-31, 2017 on the request of Lupin Human Welfare and Research Foundation, that has done many developmental, employment generation, income enhancing and health related programmes in the rural areas of the district. As a skill development initiative, the programme was organized in a village in Pahari Tehsil for working masons. The programme was meant to sensitize the masons about good construction practices and train them in the construction of earthquake resistant houses using locally available materials and construction of sanitary latrine in villages.

The programme was inaugurated by the local dignitaries on the dais, expressed their happiness that CSIR-Central Building Research Institute, Roorkee team has come to such a remote location and is being led by senior officer like Mr. Y. Pandey. They expressed their desire in joining hands with CSIR-CBRI, Roorkee for the conduct of similar programmes in Madhya Pradesh as well.

Mr. S.K. Negi, Senior Principal Scientist, Dr. Ajay Chaurasia, Principal Scientist, Mr. H.K. Jain delivered technical presentations on various topics related to appropriate rural housing, earthquake resistant design and construction of rural houses, durability, safety, and functional efficiency of houses in Bharatpur region. Mr. Sitaram Gupta, Executive Director, Mr. J.P. Singh, Programme Manager, Mr. Hemant Sharma, Programme Coordinator, Mr. Vinod Kumar, Senior Block Coordinator (Vil Kamara) and Mr. Shyam Singh, Block Coordinator (Vil Pahari) participated from the Lupin Human Welfare and Research Foundation.

About 130 practicing masons from Vilages Thekri, Dahana, Thalchaana, Maujpur, Somka, Gopalgarh, Samler Pahari, Dhausija, Satpura, Burana, Kathol, Jasoli, Burani, Sahsan, Papda, Badoli Dahar, Nagar kala, Aichwat, Gavdi, Jurhara, Acheda, Bhandara, Kanwadi, Kama, Sablala and Udaypur Nihal actively participated in the programme.

The participants showed keen interest in the demonstration session on concrete stone masonry blocks and most of the masons were willing to start casting of these blocks for making rural houses. Certificates were given to the participants and a booklet was also provided on the use of appropriate technology in the design and construction of earthquake safe, affordable, and comfortable houses.

CSIR-CBRI Celebrates its Foundation Day

CSIR-Central Building Research Institute (CBRI), Roorkee celebrated its 71st Foundation Day on February 10, 2017. Prof. Ajit Kumar Chaturvedi, Director, Indian Institute of Technology, Roorkee graced the occasion as Chief Guest and Prof. Prem Krishna, Chairman, Research Council, CSIR-CBRI, Roorkee was the Guest of Honor. Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee presided over the function.

Dr. N. Gopalakrishnan addressed the gathering and highlighted the glorious past of CSIR-CBRI, which was established on February 10, 1947. Since then it has been contributing in the development of the country and carrying out R&D on all aspects of housing and assisting the building industry in solving problems of planning, designing, foundations, materials and construction including disaster mitigation in all kinds of buildings, environment preservation and energy conservation. He informed that CSIR-CBRI, having aided in rehabilitation of Chamoli earthquake, damage assessment of education and health buildings in earthquake affected Uttarkashi, landslide zonation of Garhwal districts, strong motion seismic instrumentation, development of solar timber seasoning kilns, building construction of Navodaya Vidyalaya complexes etc. and has been intensively involved in addressing these specificity related items. The Institute has also taken up projects for conservation of nationally important heritage structures such as Taj Mahal, Konark Temple, Chittaurgarh Fort, Kashi Vishwanath Temple and Qutab Minar. He talked about the major R&D projects, newer areas of research such as sustainability, nanotechnology, use of Kota stone dust, EPS Door shutters, nano-concrete, bio-concrete, geopolymer, etc. and C&D waste utilization in the production of construction materials and products. He also informed about the involvement of CSIR-CBRI in 'Housing for All' Mission and 'Make in India'.

Prof. Ajit Kumar Chaturvedi in his address complimented CSIR-CBRI for its efforts and achievements, especially for its role in the country's economy by providing one of life's three necessities. He expressed his desire for IIT, Roorkee and CSIR-CBRI, Roorkee to work together in much closer quarters to achieve greater scientific excellence. He talked about the diverse focus areas of the Institute and stated that CSIR-CBRI provides sublime work in several departments along with the Civil Department. Prof. Chaturvedi also presented a technical lecture on "Structural Health Monitoring: Signal Processing". He explained the various challenges in structural health monitoring including cracks, vibrations, pressure, moisture, and corrosion etc. and the various methods to extract health information of a structure using the reliable, simple, functional and cost effective technique of signal processing.

Speaking on the occasion, Prof. Prem Krishna congratulated the institute on its 70 years of glorious service to the nation and requested CBRI staff to take the lead in the Prime Minister's Make in India movement. He said that as a part of the Institute, he has been privy to its growth, research works and contributions. He said that he has witnessed the transition of the Institute from independent research to selected, directed and focused research work, solving challenges and progressing, and its contributions in national programmes such as 'Housing for All', 'Smart City' and 'Swatcch Bharat Abhiyan'. He said that research is a long term process and outcome must reach the poorest of the poor through industries and government policies.

On this occasion, Diamond Jubilee Director's Best Paper Award of Rs 15000/- was awarded to Dr. Ajay Chaurasia, Dr. N.M. Bhandari, Prof. S.K. Bhattacharyya, and Dr. Pradeep Bhargava. Diamond Jubilee Director's Award for Development of best Technology which has maximum impact on the Society of Rs. 20,000/- was awarded to Dr. B. Singh, Ms. Ishwarya, Mr. Rakesh Paswan and Mohd. Riyazul Rehman. Several CSIR-CBRI publications including 'Design Guidelines for Confined Masonry Buildings', 'Nirmanika', 'CSIR-CBRI Research and Business Profile', 'CSIR-CBRI Annual Report' and 'CBRI Newsletter-Bhavnika' were released.

Mrs. Jaishree Gopalakrishnan and Mrs. Prem Krishna also graced the occasion with their presence. Dr. A.K. Minocha, Chief Scientist conducted the proceedings and presented the formal introduction of Prof. A.K. Chaturvedi. Mr. Y. Pandey, Chief Scientist presented the formal introduction of Prof. Prem Krishna. Dr. Ashok Kumar proposed a vote of thanks. The students of various schools, superannuated staff of CSIR-CBRI and all staff members of the Institute also witnessed the occasion besides other dignitaries.







Training Programme on 'Design & Construction of Earthquake Resistant Houses' In Kangra Region of Himachal Pradesh

A two-day training programme on 'Design and Construction of Earthquake Resistant Houses' in Kangra region of Himachal Pradesh was organized jointly with the HP State Council of Science, Technology and Environment (HPSCST&E) at Palampur, Kangra, Himachal Pradesh during February 21-22, 2017.

The Program was inaugurated by Kangra divisional commissioner Ms. Nandita Gupta and other dignitaries were present. She emphasized the urgent need for training the local manpower and adaptation of latest building technologies for the construction of disaster resistant houses in a state like Himachal Pradesh which is frequently visited by earthquakes, landslides, cloud burst, hail and snow storms.

Mr. Y. Pandey, Chief Scientist, highlighted the building technologies developed by CSIR-CBRI to the participants and assured to provide the technical support in build the sustainable built environment. Subsequently, different technical sessions were delivered by Mr. S.K. Negi, Dr. R. Dharmaraju, Mr. H.K. Jain, Dr. Sunil Bhardwaj and Dr. S.S. Randhawa on various topics including landslide control, appropriate rural housing, earthquake, wind and snow resistant design of rural houses, durability, safety and functional efficiency of houses in hills.

The participants were also shown the films on different technologies developed by the CSIR-CBRI. Later, different methods of construction practices were demonstrated to the participants and they practiced the same as well. The programme was attended by more than 120 engineers and masons/contractors covering Kangra, Una, Hamirpur and Chamba districts. Ms. Swati Kulashri and Mr. Vishal Singh were also present during the programme.

Destination NORTHEAST 2017

Ministry of Development of North Eastern Region has organized a three-days event on ‘Destination North East 2017’ at Chandigarh held during March 6-8, 2017. CSIR has showcased the technologies developed under CSIR-800 program for the benefit of the north eastern region in which CSIR-CBRI participated by displaying the products developed based on the R & D activities.

The event was inaugurated by Hon’ble Minister Dr. Jitendra Singh and other dignitaries. Subsequently, a parallel technical session on Appropriate Technologies for North East India was chaired by Dr. Girish Sahni, DG, CSIR in which several presentations were made by the CSIR laboratories.

Dr. N. Gopalakrishnan Director, CSIR-CBRI made a presentation on ‘Appropriate Building Materials & Technologies for North Eastern Region’ and discussed on the possibility of implementation of some of the technologies of CSIR-CBRI in north eastern region. Hon’ble Minister Dr. Jintendra Singh, Mr. Naveen Verma, Secretary, MoDNER and other dignitaries visited the stall and the details of products were explained to them.

Most of the visitors shown their interest on the products like Bricks made by C&D waste and Wood without tree etc. During the event Dr. R. Dharmaraju, Senior Principal Scientist and Mr. Manoj Tyagi, Technician were also present.

Women's day Celebration

CSIR-CBRI celebrated the International Women's Day on Wednesday, March 8, 2017. On the occasion, Dr. N. Gopalakrishnan Director, CSIR-CBRI addressed the panel and shared his inspiring views on women's empowerment. He said that it is the time to uphold women's achievements, recognize challenges and focus greater attention on women's rights and gender equality to mobilize all people to do their best. The women scientists and other ladies staff member sof the Institute also attended the programme and expressed their views.

Faculty Training, Motivation and Adoption of School & Colleges

Faculty Training, Motivation and Adoption of Schools & Colleges by CSIR-Central Building Research Institute, Roorkee

To build a strong foundation for the future and scientific-and-industrial development of the country, it is imperative to arouse curiosity and passion for science in children from an early age through interactions, experiments and better understanding of the basic science.

All the evidence from different education systems around the world shows that the quality of teachers and teaching plays a vital role in developing a child's mental and intellectual growth. Motivated teachers not only cater to a student's academic growth but also stand as an additional source of encouragement and inspiration in the life of a child. They have the ability to make a positive impact on their students by setting high expectations and motivating the students to achieve them. As students strive for excellence, teachers assist students in meeting their highest potential. They contribute to society by preparing the students for their real world endeavors and are instrumental in shaping the country's future.

With the vision to achieve excellence in science education for an innovative India, the Hon'ble Prime Minister of India and President of the Council of Scientific and Industrial Research, Shri Narendra Modi entrusted CSIR, New Delhi with the responsibility to motivate the teachers, inspire students, rekindle their interest towards science, provide them with appropriate resources and raise the standards of science education in schools and colleges.

Working in this direction, to make science education rewarding in job opportunities, raise the standard of science education in schools and undergraduate college and popularize science among young people, CSIR-Central Building Research Institute, Roorkee organized various motivational and educational programmes for teachers and students under the CSIR Scheme, "Faculty Training, Motivation and Adoption of Schools & Colleges by CSIR Labs".

October 5, 2016: Workshop-Training-cum-Motivational Programme for Teachers

CSIR-Central Building Research Institute, Roorkee organized a Workshop-Training-cum-Motivational Programme for teachers on October 5, 2016.

The objective was to promote interest, excitement, and excellence in science education at the school and under graduate level for science teachers to upgrade their knowledge base in new and emerging areas of science and to provide an opportunity for interaction and exchange of ideas with the scientific community.

Speaking on this occasion, Dr. A.C. Dwivedy, Programme Director, HRDG, CSIR, New Delhi motivated the teachers and advised them to work as fountain heads as well as brand ambassadors and spread this message to all the schools. He explained the qualities of a good teacher such as empathy, positive attitude, role model, creativity, sense of humor, dress sense, body language, effective communication, efficiency, effectiveness, time management etc. and suggested the way of teaching so that students may dream how to think instead of what to think. Emphasizing on the importance of motivation, goals, and objectives in life, he said that we should set measurable, attainable, realistic, and timely goals while battling every possible challenge it poses. He also gave a detailed overview about the schemes to raise the standards and achieve excellence in science education for an innovative India.

In his Inaugural Address, Mr. Yadvendra Pandey, Chief Scientist, CSIR-CBRI, Roorkee informed that as a pioneer in the building sector, Institute has developed new, organic, environment-friendly building materials and about the latest developmental schemes such as the 'Rural & Urban Scheme' which works towards development of all sectors of people in the building area. He urged the teachers to utilize the resources & scientific knowledge pool of the Institute for the education of students efficiently &

effectively and to encourage the students to have interactive hands-on experience sessions with the scientists by organizing educational programmes in their institutes. He also assured that the Institute will provide its full cooperation by providing all the necessary resources to increase the students' passion towards science. He informed that CSIR-CBRI will provide laboratory facilities to students to pursue their dreams and convert them into reality.

Earlier, Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee and Programme Coordinator while welcoming the faculty members of all 8 schools and colleges at the inaugural function ignited the mind by an example of 1893, one monk and the other, an industrialist, two great Indians, met for the first time on a boat, both travelling from Japan to Chicago. As they got talking, Vivekananda (High Touch) explained his mission of going for preaching in the U.S., the University of all religions, while Jamshed Ji Tata (High Tech) said that he was in search of an equipment and technology that would build the steel industry and make India a strong Industrial Nation. Vivekananda blessed Jamshed Ji and said that if people of India could be taught and trained such modern science and skills, half of the problems will be solved. In fact, how a spark from Saint Vivekananda given to JRD Tata build IISc, Bangalore, The Pride of Nation, TIFR, TISS etc. Though, they never met again in life. He also gave several examples of technologies of CSIR that touched upon the life of common man.

During the programme, Mr. S.K. Negi delivered a lecture on "Rural Technologies", Dr. S. Sarkar on "Natural Disasters", Dr. B.S. Rawat on "Management of Pest Control" and Dr. L.P. Singh on "Nanotechnology & Building Materials".

The participants visited the enriched labs of CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the Institute. A Science film featuring CSIR-CBRI scientific innovations and success stories was also screened. They also had an interactive session with the Institute's scientist where they put their curiosity to rest and quenched their thirst for knowledge. The programmes got positive feedbacks from the participants and were defined as motivating, inspiring and interesting.

The programme was attended to by 27 faculty members from 8 schools and colleges of Roorkee including Methodist Girls PG College, KLDAV (PG) College, SSDPC Girls (PG) College, Greenway Modern Senior Secondary School, Children's Senior Academy, CBRI Junior High School, and Mount Litera Zee School.

The certificates were also distributed to the participants and the programme was ended with a vote of thanks proposed by Dr. Abha Mittal, Senior Principal Scientist, CSIR-CBRI, Roorkee.

बच्चों में वैज्ञानिक सोच विकसित करें शिक्षक

सीबीआरआई की लैब देखेंगे स्कूली बच्चे

शिक्षकों के लिए प्रशिक्षण कार्यक्रम आयोजित

बच्चों में वैज्ञानिक चेतना जगाना जरूरी

Public Awareness through Newspapers

November 30, 2016: Workshop-cum-Training Programme for Students

CSIR-Central Building Research Institute, Roorkee organized a Workshop-cum-Training Programme under the CSIR Scheme, "Faculty Training, Motivation & Adoption of Schools & Colleges by CSIR Labs", for diploma and intermediate students on November 30, 2016 to generate scientific thinking in the younger generation and create the foundation of a strong mind contributing to the development of the country.

Speaking on this occasion, Dr. R.K. Goel, Chief Scientist and Scientist-in-Charge, CSIR-CIMFR Regional Centre, CBRI Campus, Roorkee enlightened the students on the requirement and importance of education, goals, orientation, and training programmes. He presented an interesting lecture on "Tunneling in Rocks" and informed about the various types of tunnels, their excavation process, equipment used construction challenges and the key safety features during the process.

He advised the students to discover their talents, have presence of mind and work hard to achieve their dreams. Dr. R. K. Goel also motivated the students to learn from rocks and nature to discover new horizons.

Earlier, Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee and Programme Coordinator welcomed the students of all schools and colleges at the inaugural function and motivated them. Quoting the example of a dog and a lion, he explained that when a problem strikes, we should not run away from it like a dog from a stone instead face it like a lion and solve it.

He motivated the students to develop a scientific outlook and consciousness. Quoting Dr. A.P.J. Abdul Kalam, he said that dreams are not those that we see whilst sleeping instead dreams are things that do not let us sleep. So, we should have leads to the development a strong nation and beautiful future. He also gave a detailed overview of the CSIR scheme of Faculty Training, Motivation & Adoption of Schools & Colleges by CSIR Labs.

In his Presidential Address, Dr. A. K. Minocha, Chief Scientist, CSIR-CBRI, Roorkee enlightened the students about the research and development work being carried out at CSIR-Central Building Research Institute, Roorkee and other laboratories of CSIR. He motivated the students to participate in the programme actively and interactively. He mentioned that Dr. N. Gopalakrishnan, Director CSIR-CBRI is not here today otherwise he would have encouraged the students to question and imagine, as curiosity has its own reason for existing and imagination crosses the limits of knowledge to encircle the world.

Later, Dr. Neeraj Jain, Senior Scientist, CSIR-CBRI, Roorkee presented an informative lecture on "Building Materials and the Negative Impact of Ordinary Brick Kilns on the Environment". He informed the students about

the research and development work, innovations and the building materials and technologies developed by the Institute. He also informed about the Institute's works to solve the problem of air pollution by high suspended particulate matter generated by ordinary brick kilns.

The participants visited the enriched labs of CSIR-CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the institute. A Science film featuring CBRI scientific innovations and success stories was also screened. They also had an interactive session with the Institute's scientist where they put their curiosity to rest and quenched their thirst for knowledge. The programmes got positive feedbacks from the participants .

The programme was attended to by more than 200 diploma and science students along with their faculty members from Motherhood University, Doon Public School and Shivalik Ganges Public School. The programme ended with a vote of thanks proposed by Dr. Abha Mittal, Senior Principal Scientist, CSIR-CBRI, Roorkee.

तीन विद्यालय के बच्चों में रुचि पैदा करेगा सीबीआरआई

प्रशिक्षण कार्यक्रम में दी छात्रों को विज्ञान की जानकारी

अब नई तकनीकों से रूबरू हो सकेंगे छात्र

छात्रों में वैज्ञानिक बनने को जोश भरा

प्रकृति से सीख ले करें नई खोज

जीवन में प्रगति का आधार विज्ञान : डा. गोयल

Public Awareness through Newspapers

February 10, 2017: Science Exhibition by Students

CSIR-Central Building Research Institute, Roorkee organized a Science Exhibition for students on its Foundation Day, February 10, 2017, to provide students with the opportunity to apply and display their scientific knowledge through live models and determine their scientific merit through interactive sessions with scientists.

On the occasion, students from various schools of Roorkee and adjoining areas displayed their grasp and understanding of scientific principles through live demonstrations. Prof. Ajeet Kumar Chaturvedi, Director, Indian Institute of Technology, Roorkee graced the occasion as the Chief Guest and reviewed the presentations by the students. Prof. Prem Krishna, Former Chairman, Research Council, CSIR-CBRI, Roorkee, graced the occasion as the Guest of Honor and encouraged the students. Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee admired the works of the students, looked over the students' written reports and briefly questioned them to clear up unanswered questions. The scientists and experts talked to the students, suggested shortcomings, discussed alternatives, and provided encouragement for further research.

Students from Shivalik Public School presented intriguing live models from various fields of science and explained their necessity. Arpit Kumar presented a demonstration on “Matchbox Microphone” that uses sound signals for security purposes. He explained that in case of a forced entry on any check post, the security guards can use this matchbox microphone to covertly send an immediate sound signal to the main security center for an emergency backup. Dhruv Mishra exhibited a live model displaying “Types of Sensors”. Emphasizing the need of applying the technology in residential buildings for increased safety, he discussed the use of light sensors for protection against theft, smoke sensors for detecting smoke and fire sensors for fire safety. Firdaus Hayat through a working model of “Hydraulic J.C.B.”, explained the need for environment friendly alternatives in construction equipment and machinery. She gave a detailed description of the working process of various pistons in lifting heavy load using hydraulic power. Aman Kumar presented a working model of “D.C. Generator” and explained the science involved in a very simple and effective way. Kamal Kant displayed a demonstration on “Water Level Indicator” and explained how it can be used to monitor the water level and be used to assess the risk of flood or drought.

Students from Anand Swaroop Arya Saraswati Vidya Mandir demonstrated scientific working models and gave detailed information about them. Divyansh while presenting his model on “Reusable Resources”, emphasized on the need of green living and explained the concept of hydroelectricity production from dams using a working model.






Students of Doon Public School also actively participated and exhibited various scientific working models. Chahhat and Sunny presented a working model of "J.C.B." and gave a detailed explanation on its working process. Shaleen Shameem and Vishakha Dhimaan created a mini city model to explain the concept of "Air Pollution" and its negative impact on the ozone layer. Riya and Tanishq exhibited a working model of "Barrier Crossing" and gave an in depth explanation of the technology of motion sensors and their use in development of an automated railway barrier. Hrittik and Rishi through their model on "Communication Systems" demonstrated the scientific concept of different kinds of signal waves used for communication. Mariyam and Stuti exhibited a working model of a "Sewage Treatment Plant" and gave a detailed explanation on the various stages involved in purifying rain water and making it consumable for humans. Junaid and Anaas through their innovative concept of "Electricity Generation by Speed Breakers", gave an intriguing concept to use the kinetic energy of the vehicles passing over the speed breakers to generate electricity.

Mrs. Prem Krishna and Mrs. Gopalakrishnan also graced the occasion and applauded the students' efforts. Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee and Programme Coordinator welcomed the students and motivated them. He assured that to spark interest among students and spread awareness about CBRI technologies and achievements, public lectures, quiz, and public speaking competitions will also be organized for students.

More than 100 students from various schools including Shivalik Public School, Anand Swaroop Arya Saraswati Vidya Mandir, Children's Senior Academy and Doon Public School visited the Institute and learned from their peer's presentations. The students also visited the enriched labs of CSIR-CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the institute. They also had an interactive session with the institute's scientist where they put their curiosity to rest and quenched their thirst for knowledge.


कर्मियों की सुरक्षा को निकाली तरकीब

छात्रों के लिए खुला रहेगा सीबीआरआई

सीबीआरआइ में छात्र होंगे नई तकनीकों से रूबरू

विद्यार्थियों ने वैज्ञानिक प्रतिभा का किया प्रदर्शन

Public Awareness through Newspapers

February 23, 2017: Workshop-cum-Training Programme for Students

CSIR-Central Building Research Institute, Roorkee organized a Workshop-cum-Training Programme for students on February 23, 2017, to generate scientific thinking in the younger generation and create the foundation of a strong mind contributing to the development of the country.

On the occasion, Dr. Gopal Ranjan, Director General, Roorkee College of Engineering, Roorkee motivated the students and presented an enlightening talk on “Career Opportunities”. He encouraged the students to aspire for the top slot and prepare by tying up loose ends and refining preparation strategies.

He taught the students the golden rules to combat stress by properly organizing the time, setting realistic goals, understanding one's work process, avoiding burnout, changing revision methods, taking care for oneself and not worrying. A fair evaluation of the self and the world around helps in making a wise and realistic career choice. He said that education should be such which forms character, increases strength of mind, expands intellect, and enables one to stand on one's own feet. He explained that in the present day scenario one must face many challenges such as independent living, work commitment, grasping new ideas & concepts and a competitive life, for which one must decide the priorities. He told the students to remember the choice of career while keeping a watch on subjects of their choice and remember their weak points while choosing a stream. He informed the students about numerous professional courses, open and distance learning system, and a vast sea of career opportunities in every lifestyle including advertising to animation, banking to bio-technology, computer training, distance learning, engineering to event management, fashion designing to finance, hotel management, information technology to interior design, languages, law, mass communication to medicine, photography, sales to service and tourism etc. He said that one should not follow the herd in choosing a career but go by instinctive fondness for a subject. Entrepreneurship & self-employment are also a huge field of opportunity for which proper vocational education can develop the required attitude, knowledge, and skills.

Speaking on this occasion, Dr. R.K. Goel, Chief Scientist and Scientist-in-Charge, CSIR-CIMFR Regional Centre, CBRI Campus, Roorkee enlightened the students on the requirement and importance of education, goals, orientation, and training programmes. He said that these orientation programs expose and educate the young minds to different possibilities and applications of science. He advised the students to discover their talents, have presence of mind and work hard to achieve their dreams. Presence of mind is the most important factor. Leave all the worries behind while entering in the class room. He said that everyone has some or the other quality in them. It is important to know that, discover it and work on it. If you dream of something, believe in it and work for it sincerely with dedication, it will surely happen. He asked the students to not shy away from failure but to learn from them. If you are prepared to learn from failures, you can reach where you want to reach. He presented an informative and interactive lecture on "Tunneling in Rocks". He educated the young minds about the various types of tunnels such as water conductor tunnels for power projects, underground power stations, road tunnels, rail tunnels, underground shelters, and half tunnels. He told the students that a good rock mass with known geology, a good excavation practice and effective and timely installation of support system are the major elements for successful rock tunnelling. He informed about the different types of rocks, tunnel excavation process, the effect of weathering on tunnels, equipment used construction challenges and the key safety features during the process. He also motivated the students to learn from rocks and nature to discover new horizons.

Earlier, Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee and Programme Coordinator welcomed the students of all schools and colleges at the inaugural function and motivated them. Emphasizing on the need to awaken a scientific temper through questions and interactions, he said that Keenness is the Key which when turned in the right direction, Kicks out all the negativity and makes us the King of knowledge. He also gave a detailed overview of the CSIR scheme of Faculty Training, Motivation & Adoption of Schools & Colleges by CSIR Labs.

In his Presidential Address, Dr. N. Gopalakrishnan, Director, CSIR-CBRI, Roorkee enlightened the students about the research and development work being carried out at CSIR-Central Building Research Institute, Roorkee and other laboratories of CSIR. He motivated the students to participate in the programme actively and interactively. He encouraged the students to question, understand, learn, and adopt the mantra of "What, Why and How" in their lives.

Dr. Abha Mittal, Senior Principal Scientist, CSIR-CBRI, Roorkee presented a formal introduction of Dr. Gopal Ranjan and Dr. R.K. Goel. A Science film featuring CBRI scientific innovations and success stories was also screened.

The participants visited the enriched labs of CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the Institute. They also had an interactive session with the Institute's scientist where they put their curiosity to rest and quenched their thirst for knowledge.

The programme was attended to by more than 250 science students along with their faculty members from Kendriya Vidyalya No. 1, Kendriya Vidyalya No.2, Shivalik Public School Laksar Road Roorkee, Children's Senior Academy, Mangalore and Anand Swaroop Arya Saraswati Vidya Mandir, Roorkee. The programme got a positive feedback from the participants and was defined as motivating, inspiring and interesting. The programme ended with a vote of thanks proposed by Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee.

चरित्र निर्माण वाली हो शिक्षा : डा. रंजन

विज्ञान के प्रति खुद में जिज्ञासा पैदा करें छात्र : डा. कृष्णन

छात्रों को देंगे वैज्ञानिक प्रशिक्षण

रुचि के अनुरूप चुनें कॅरियर : डॉ. रंजन

बच्चों में वैज्ञानिक सोच विकसित करें

प्रशिक्षण कार्यक्रम

सीबीआरआई में प्रशिक्षण आज

चरित्र का निर्माण करे शिक्षा : रंजन

व्यक्तित्व निर्माण वाली हो शिक्षा: डॉ. गोपाल रंजन

Public Awareness through Newspapers

February 27, 2017: Workshop-Training-cum-Motivational Programme for Teachers

CSIR-Central Building Research Institute, Roorkee organized a Workshop-Training-cum-Motivational Programme for Teachers on February 27, 2017. The objective was to promote interest, excitement, and excellence in science education at the school and under graduate level for science teachers to upgrade their knowledge base in new and emerging areas of science and to provide an opportunity for interaction and exchange of ideas with the scientific community.

Speaking on this occasion, Dr. A.C. Dwivedy, Programme Director, HRDG, CSIR, New Delhi motivated the teachers and presented an inspiring talk on "Motivation- A journey to Excellence" and said that only a motivated teacher is an asset of any educational institute. Demotivation is an infection that should be nipped in the bud.

He quoted various examples including passages from Mahabharata & Ramayana and emphasized that every person has an incredible potential and must believe in himself. He said that a quality of a nation depends on the quality of its citizens, the quality of citizens on their quality of education, the quality of education on the quality of teaching, the quality of teaching on the quality of a teacher and a quality teacher is highly motivated. A motivated teacher is therefore the key to build a strong and inspired nation.

In his Inaugural Address, Dr. Suvir Singh, Chief Scientist, CSIR-CBRI, Roorkee informed that as a pioneer in the building sector, Institute is dedicated to research, development, and innovation (RD&I) in finding timely, appropriate, and economical solutions to the problems of Building Materials, Health Monitoring and

Rehabilitation of Structures, Disaster Mitigation, Fire Safety, Energy Efficient Rural and Urban Housing.The Institute through its extensive research and development works has made tremendous efforts and has evolved technologies, to apply the scientific knowledge in the advancement of housing sector through efficient planning and utilizing sustainable, environment friendly, advanced materials to improve environment through proper waste utilization, management, and disposal. He briefly discussed the various technologies and processes developed by the Institute including wood substitute building materials, polymeric building materials, prevention from building pests, use of nanotechnology, building materials from industrial, agro-industrial, and C&D wastes, disaster mitigation and rehabilitation of heritage structures like Sun Temple Konark, Chittorgarh Fort, Qutab Minar, Taj Mahal etc. He also informed about the various exhibitions, seminars, workshops, awareness camps, live demonstrations, training, skill development, and outreach programmes organized by the Institute for teachers, students, and public at large. He urged the teachers to utilize the resources & scientific knowledge pool of the Institute for the education of students efficiently & effectively.

Earlier, Dr. Atul Kumar Agarwal, Senior Principal Scientist, CSIR-CBRI, Roorkee and Programme Coordinator welcomed the teachers and informed how starting with the indelible ink, the hallmark of the nation's fabric, CSIR has left an indelible mark on every sphere of life. With an all-round approach towards R&D, CSIR reflects India in its diversity and heterogeneity. From agriculture to aerospace, bio-sensors to bio-pharmaceuticals, chemicals to climate change, drug development to deep sea explorations, earth sciences to energy, food to fragrance, glass to genomics, housing to health care, instrumentation to informatics, leather to light combat aircraft, microbes to mining to materials, optics to optical fibers, pigments to power electronics, road to robotics, sensors to solar energy, tractors to transport, UAV to under water vehicles, water to weather forecasting, CSIR has registered its presence. Swaraj, the first tractor, baby milk powder and first super computer are some of the most applauded accomplishments of CSIR. He inspired the teachers by quoting various examples and said that these temples of learning should be a home to only those who wish to serve the nation by contributing their knowledge and hard work in solving the problems of the poorest of the poor and not just earn a living. He expressed his concern on the lack of scientific approach in young minds today and the lack of quality science education in the educational institutes. Since Sir C.V. Raman received the Nobel Prize for Physics in 1930, India has yet to receive a Nobel Prize in science. It is therefore the responsibility of teachers too that they inspire scientific thinking and passion in students from a young age.

Dr. S. Sarkar, Senior Principal Scientist, CSIR-CBRI, Roorkee presented an enlightening technical lecture on "Natural Disasters" and "Transit Shelters for Disaster Victims". He informed about the Institute's works in pre and post disaster management regarding cyclones, earthquakes, landslides, and tsunamis.

He discussed instant, temporary and permanent shelters for disaster prone areas, geological and geophysical investigation, studies, application of remote sensing and GIS. Dr. Abha Mittal, Senior Principal Scientist, CSIR-CBRI, Roorkee presented a formal introduction of Dr. A.C. Dwivedy.

Later, the participants visited the enriched labs of CBRI, Roorkee including Rural Park, Organic Building Materials, Efficiency of Buildings, Fire Research, and Environment Science & Technology-Clay Products etc. and learned about the newest developments and technologies by the Institute. They also had an interactive session with the Institute's scientist where they put their curiosity to rest and quenched their thirst for knowledge.

The programme was attended to by more than 30 faculty members from over 10 schools and colleges of Roorkee including Kendriya Vidyalya No. 1, Kendriya Vidyalya No. 2, Shivalik Public Senior Secondary School, Laksar Road, Roorkee, Espee Global School, Children's Senior Academy, Roorkee and Children's Senior Academy, Mangalore. The programme received a positive feedback from the participants and was defined as motivating, inspiring and interesting.


सीबीआरआई में विज्ञान विषय के शिक्षकों के लिए गोष्ठी-प्रशिक्षण- सह प्रेरणा कार्यक्रम आज

विज्ञान में नोबेल प्राइज लाने वाली प्रतिभाएं करें तैयार

प्रेरित शिक्षक दे सकता है उत्कृष्ट शिक्षा

बचपन से वैज्ञानिक जुनून पैदा करें शिक्षक

प्रेरित शिक्षक ही विद्यार्थियों को कर सकता है उत्कृष्ट शिक्षा प्रदानः डॉ. अविनाश

Public Awareness through Newspapers

March 28, 2017: CSIR-CBRI Organized Student Awareness Programme

CSIR-Central Building Research Institute, Roorkee organized a Student Awareness Programme under the CSIR Scheme, "Faculty Training, Motivation & Adoption of Schools & Colleges by CSIR Labs", on March 28, 2017 to generate scientific thinking in the younger generation and create the foundation of a strong mind contributing to the development of the country.

The B.Tech students of Quantum School of Technology, Rurkee visited the enriched labs of CSIR-CBRI, Roorkee and learned about the newest developments and technologies by the Institute. They also had an interactive session with the Institute's scientists where they put their curiosity to rest and quenched their thirst for knowledge.

Mr. R.S. Chimote, Chief Scientist, CSIR-CBRI Roorkee informed the students about the comprehensive R&D works done by the institute in the field of fire research and shown the Fire and Oil Explosion System technique of the Institute. They explained in detail the fire hazards in buildings and various fire hazard mitigation techniques developed by the Institute, the fire resistant building elements and passive fire protection systems, fire behavior of building materials, fire retardant coatings, fire extinguishment etc.

Mr. D. K. Sehgal, Principal Technical Officer, CSIR-CBRI, Roorkee enlightened the students to the research and development work done by the Institute in solar energy and gave them a tour of the Solar Power Plant of the Institute.

Ms. Sayantani Lala, Scientist, CSIR-CBRI, Roorkee explained the students the various transit shelters for disaster victims, economical rural and urban

building techniques depending upon the varied geographical features and environmental factors, through the live demonstration models in the Rural Park of the Institute.

The programme was attended to by more than 100 B. Tech 1st year students of Quantum School of Technology, Roorkee. Dr. Pradeep Bhargava, Professor, Quantum School of Technology and Former Chief Scientist, CSIR-CBRI along with Dr. Renu Chaudhary, Dr. Ashok Seth, Mrs. Gunjan Agarwal, Mr. Nadesh and Mr. Vipin, accompanied the students on behalf of the faculty of Quantum School of Technology. The programme received a positive feedback from the participants and was defined as motivating, inspiring and interesting.

छात्र-छात्राओं ने भवन निर्माण की नई-नई तकनीकें जानी

विद्यार्थियों में वैज्ञानिक जुनून का विकास होना अति आवश्यक- डॉ. अतुल अग्रवाल

क्वांटम स्कूल ऑफटैक्नोलोजी द्वारा सीबीआरआई में भ्रमण

Public Awareness through Newspapers

Projects

In-house R&D Projects

Sl. No.	Project No.	Title of the Project	Principal Investigator/ Co-Investigator	Duration
New Construction Materials				
1	OLP 0393	Development of engineered light weight mud-phuska composite using industrial-cum-agricultural wastes	Mr. Rajesh Kumar Dr. Rajni Lakhani	0816-0317
2	OLP 0394	Decentralized management of domestic waste water for rural areas	Mr. S. Maiti Mr. S.K. Negi	0916-0317
Health Monitoring, Rehabilitation & Strengthen				
3	OLP-0389	Uplift capacity of shallow strip anchors under static and seismic conditions.	Mr. Anindya Pain	0415-0317
4	OLP 0395	Studies on consolidation and deformation characteristics of stone columns with and without geo-synthetic encasement in soft clay	Dr. S. Ganesh Kumar Mr. M. Samanta	0716-0618
Disaster Mitigation				
Energy Efficient System & Other Projects				
5	OLP 0390	Documentation & S&T intervention in the traditional architecture of rural areas of the western Himalayan region	Mr. S.K. Negi	1015-0316 -0916
6	OLP 0391	Preparation of a hand book in the area of heat transfer in buildings	Dr. B.M. Suman	1115-1016 -0317 -
7	OLP 0392	Dissemination, training, demonstration of improvement of appropriate rural housing technologies	Mr. S.K. Negi Dr. R. Dharmaraju	1016-0917

CSIR Fast-Track Translation (FTT) Project

Date of Commenced: July 20, 2016

Sl. No.	Project No.	Title of the Project	Principal Investigator Co-Investigator	Duration
1.	MLP 0512	Foundation system for light structures	Mr. M. Samanta Mr. Ajay Dwivedi	1 year
2.	MLP 0511	Building products using Kota stone cutting and slurry waste	Dr. Rajni Lakhani Mr. Rajesh Kumar	2 years
3.	MLP 0513	Development of a boring machine based on trenchless technology	Dr. S.K. Panigrahi Mr. Narendra Kumar	2 Years

12th Five Year Plan Projects

S.No.	Project	Project Title, PI & Details
01	ESC0301 (SINP)	**INNOVATIVE MATERIALS & TECHNOLOGIES FOR NEXT GENERATION GREEN BUILDINGS** **WP-1: Performance Enhancement of Materials through Nanotechnology** PI: L.P. Singh; Task: 4 **WP-2: Next Generation Concrete for Sustainable Construction** PI: S.K. Singh; Task: 4 **WP-3: Green Building Technologies** PI: Ashok Kumar; Task: 6 **WP-4: Materials & Technologies for Hazard Reduction.** PI: S.R. Karade; Task: 4
02	ESC0102 Network Project	**ENGINEERING OF DISASTER MITIGATION & HEALTH MONITORING FOR SAFE & SMART BUILT ENVIRONMENT** **WP-1: Engineering of Landslide Disaster Mitigation** PI: S. Sarkar & D.P. Kanungo; Task: 8 **WP-2: Engineering of Earthquake Disaster Mitigation** PI: P.K.S. Chauhan & Ajay Chaurasia; Task: 3 **WP-3: Engineering of Fire Disaster Mitigation** PI: R.S. Chimote & Suvir Singh; Task: 3 **WP-4: Post Disaster Shelter Planning** PI: S.K. Negi; Task: 2 **WP-5: Health Monitoring of Buildings Using Wireless Sensor Network** PI: Ajay Chaurasia & Soju Alexander; Task: 5 **WP-6: Intelligent Building System for Model Residential Unit** PI: Achal Mittal & R.S. Bisht; Task: 8
03	05- Network Projects (CSIR- CBRI Participating Laboratory)	**Removal of Heavy Metals from Waste Water using Fly Ash & Secured Disposal of the Sludge** PI: S. Maiti, ESC 0306 [CSIR-NEERI] **Estimation of Crustal Deformation of Garhwal Himalaya** PI: S. Sarkar, ISC 0301 [CSIR-4PI, Advance Research in Engineering & Earth Sciences (ARiEES): Data Intensive Modelling & Crowd Sourcing Approach] **Energy Efficient Seed Storage Structures** PI: Nagesh B. Balam, PSC0103 [CSIR-CSIO, Advanced Instrumentation Solutions for Health Care and Agro – based Applications - ASHA] **Development of Appropriate Support System for Artificial Pillars for Optimal Extraction of Locked-Up Coal from Underground Mines** PI: Ajay Chaurasia, ESC0105 [CSIR- CIMFR, Dhanbad] **Service Robot for Building & Other Structures** PI: R.S. Bisht, ESC 0112 [CSIR-CMER, Micro Machines and Robotics]

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
1.	CNP0026	S.K. Singh	SE & Project Manager, CPWD, BHU Project Unit, Behind Central Office, BHU, Varanasi	Technical Advice on Rehabilitation Measures of Roofs of Old Hostel Buildings of BHU
2.	CNP 0085	S. Sarkar	Director, CSIR-CIMFR, Dhanbad	Slope Stability Analysis and Control Measures of Landslip at Oil Drilling Site, Mizoram
3.	CNP0096	A.K. Mittal	Executive Engineer, President's Estate Division, CPWD, Rashtrapati Bhawan, New Delhi	Health Assessment and Suggesting Strengthening Measures for Resident Quarters at G.Point
4.	CNP0245	Ajay Chourasia	Col. Ajay Kothiyal, Nehru Institute of Mountaineering, Uttarkashi	Technical Advice on Construction of Ghat, 3 Tier Security Measures against Delvge, 120 Cottage for Pilgrims
5.	CNP0276	A.K. Mittal	G.E. (A), Suratgarh HQ, Chief Enginner, Bhathinda Zone, Bhathinda Mil. Station	Assessment of Work and Rendering of Technical Advice for Wk at Suratgarh Mil. Station
6.	CNP0286	A. K. Mittal	G.E. (A), Bikaner HQ, Chief Enginner, Bhathinda Zone, Bhathinda Mil. Station	Assessment of Work and Rendering of Technical Advice for Wk at Bikaner Mil. Station
7.	CNP0466	A. K. Mittal	Additional Secretary, Rural Development Department, 4, Subhash Road, Uttrakhand Secretariat, Dehradun	Preparation of Integrated Cluster Action Plan (ICAP) under Rurban Mission for Uttrakhand State
8.	CNP0496	S. K. Singh	CMD, CEL, 4, Industrial Area, Sahibabad, Ghaziabad	Condition Assessment of SPV Building and Suggesting Strengthening Measures
9.	CNP0566	Ajay Chourasia	M/s Brij Gopal Construction Co. Pvt. Ltd., 4th Floor, Vikas Surya Shopping Mall, Sector-3, Rohini, New Delhi	Expert Advice on Structural Design of Proposed Multi-storied Dwelling Units for in-site Rehabiliation of Slum Dwellers at Jailorwala Bagh, New Delhi
10.	CNP0595	D. P. Kanungo	GM (Water), Moradabad Nagar Nigam, Moradabad (UP)	Investigation on Damage to a Building in Himgiri Colony, Moradabad Due to Operation of Tube Well
11.	CNP0596	S. K. Singh	General Manager, UPRNN Ltd., E-34, Nehru Colony, Dehradun	Technical Advice on Condition of Combined Building Hospital, Mussorie, Uttrakhand
12.	CNP0616(A)	S. K. Singh	Superintending Engineer, CPWD, Shimla Central Circle, Kennedy Cottage, Shimla	Technical Advice on BOQ of Restoration of Gorton Castle Building (AG Office) at Shimla - Package II
13.	CNP0625	A. K. Mittal	Executive Engineer, 'C' Mandal. I.P. Bhawan, Central Public Works Department, New Delhi	Rehabiliation and Retrofitting of National Gallery of Morfern Art (jaipur House), New Delhi
14.	CNP0675	B. Singh	M/s Skipper Limited, 3A, Loudon Street, 1st Floor, Kolkata	Evaluation of Skipper Brand CPVC Pipes and Fittings for Hot and Cold Potable Water Supply in Buildings
15.	CNP0685	B. Singh	M/s Skipper Limited, 3A, Loudon Street, 1st Floor, Kolkata	Evaluation of Skipper Brand Lead Free PVC Pipes and Fittings for Potable Water Supply in Buildings

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
16.	CNP0696	B. Singh	M/s Fusion Industries Ltd., Plot No. 1 & 4, Block H, NH-2, Opp. F.C.I. Godown, NIT, Faridabad	Evaluation of Fusion Brand Poly Propylene Random Coploymer (PPR-C) Pipes & Fittings for Hot and Cold Water Supply
17.	CNP0705	Ajay Chourasia	E.E., Navodaya Vidyalay Samiti, B-15, Sector 62, Institution Area, Noida	Retrofiting Measures for JNV at Pankyong & Rathak Distt., Sikkim
18.	CNP0706	Ajay Chourasia	Executive Engineer, Western Division-8, DDA, Sector-5, Dwarka, Delhi	Expert Advice on Structural Detailing of Proposed Multi-Storied Buildings at Dwarka
19.	CNP0715	S. K. Negi	Unit Incharge (Unit I), UPRNN Ltd., Ambala Road, Pilakhani, Saharanpur	Feasibility Studies for Construction of Sports College, Behut
20.	CNP0735	Ajay Chourasia	UPRNN, Unit-4, Sakarita Bhawan, Vishnu Vihar, Deep Nagar, Dehradun	Expert Advice on Structural Drawing of Integrated Housing of MDDA, Dehradun
21.	CNP0776	A. K. Mittal	Director (GW & UD), Lok Sabha Secretariat, Parliament House Annexe, New Delhi	Technical Examination of the LSS, Staff Quarter Complex, Sector 2, RK Puram, New Delhi
22.	CNP0796	Manojit Samanta	Director, IDEMI, MSME Govt. of India, Mumbai	Assessment of Geotechnical Investigation Report and Foundation Schemes for Proposed Technological Centre of MSME at Greater Noida, UP
23.	CNP0866	B. S. Rawat	Siromani Gurudwara Prabandhak Committee (SGPC), Amritsar, Punjab	Installation and Monitoring of Termite Bait Stations in Golden Temple, Amritsar
24.	CNP0886	S. K. Singh	GM (NZ), UPRNN Ltd., E-34, Nehru Colony, Dehradun	Condition Assessment & Quality Assurance of School Buildings of Jakholi, Rudraprayag and suggesting Technical Measures
25.	CNP0896	A. K. Mittal	Director General (Health Services), Sector 6, Panchkula, Haryana	Structural Health Assessment and Structuring Remedial Measures
26.	GAP0016	Priyanka Tomar	Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi	Effects of Hypromellose and Polyacrylamide of Hydrolysed Polyvinylacetate on Rheological and Microstructural Studies of Macro-defect free Cement (MDF) Concrete
27.	GAP0024	L.P.Singh	Jt. Director, Ministry of Environment & Forests (EI Division), Paryavaran Bhawan, CGO Complex, Lodhi Rd., New Delhi-3	Capicity Enhancement Programmes on Fly Ash Utiliation

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
28.	GAP0035	Rajiv Kumar	Department of Science and Technology, Mehrauli Road, New Delhi	Burning Behaviour of Various Materials in Enclosure Fires - Development of Evacuation Strategies for Fire Affected upto Four Storey Row Buildings
29.	GAP0075	Leena Chourasia	State Biotechnology Dpt., Govt. of Uttrakhand, Biotech Bhavan, P.O. Haldi, U.S. Nagar, Uttrakhand	Studies on Bio-based Calcareous and Siliceous Construction Materials
30.	GAP0605	A. K. Mittal	Under Secretary (HFA-IV) Ministry of Housing and Urban Poverty Alleviation, New Delhi	Development of Implementation Manual for Expand Polystyrene(EPS) Core Panel System
31.	GAP0635	S. Sarkar	Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi	Large Scale Geological-Geotechnical Mapping from Rudraprayag-Sonprayag and Sonprayag-Kedarnath
32.	GAP0695	A. K. Mittal	Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi	Design of Low Speed Wind Tunnel
33.	GAP0725	S. K. Panigrahi	Internation Division, Department of Science & Technology, Technology Bhavan, New Mehrauli Road, New Delhi	Structural Health Monitoring of Tall Buildings Using Vibration based Techniques
34.	GAP0806	Ashok Kumar	Indo-Us Joint Clean Energy Research Center (JCERDC), Indo-US Science & Technology Forum, Fulbright House, 12, Hailey Road, New Delhi	An Integrated and Collaborative India-US Research Program: Improving Building Energy Efficiency (IBEE)
35.	SSP0045	A. K. Mittal	Dy.GM (O&M-Civil) NTPC, NCPS, Vidyut Nagar, Dadri (UP)	Health Assessment of the Drift Structures for Natural Draft Cooling Tower at NCPS, Dadri
36.	SSP0086	S. K. Negi	UPRNN Ltd., Dehradun Unit-2, Ayurvedic Vishva Vidhayalya Campus, Harrawala, Dehradun	Quality Control & Checking of Architectural & Structural Drawings
37.	SSP0105	Rajesh Deoliya	Er. Binod Kumar, Exectuive Engineer, PWD Division M-423, Govt. of Delhi, Sukhdev Vihar, New Delhi	Third Party Inspection / Quality Assurance for the work of C/o Pucca Building for Govt. Sr. Sec. School at Madanpur Khadar, Phase-II, New Delhi
38.	SSP0106	S. K. Singh	General Manager, UPRNN Ltd., E-34, Nehru Colony, Dehradun	Technical Advice and TPQC of District Level Sports Complex Building at Haldwani, Uttrakhand
39.	SSP0115	Rajesh Deoliya	Er. Binod Kumar, Exectuive Engineer, PWD Division M-423, Govt. of Delhi, Sukhdev Vihar, New Delhi	Third Party Inspection / Quality Assurance for the work of C/o Pucca Building for Govt. Sr. Sec. School at Madanpur Khadar, Phase-III, New Delhi

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
40.	SSP0125	Rajesh Deoliya	Er. Binod Kumar, Exectuive Engineer, PWD Division M-423, Govt. of Delhi, Sukhdev Vihar, New Delhi	Third Party Inspection / Quality Assurance for the work of C/o Pucca Building for Govt. Sr. Sec. School at Kalkaji, New Delhi
41.	SSP0164	A. K. Mittal	Director (Planning), Army Welfare Housing Orgn (AWHO), South Hutment, Kashmir House, Rajaji Marg, New Delhi	Structural Checking of AWHO Group Housing Project at Pachkula
42.	SSP0176	A. K. Mittal	Executive Director (Works), Amber Development and Management Authority, Jaipur	Health Assessment of Amber palace, Jaipur
43.	SSP0186	Y. Pandey	Suprintending Archaelogist, Archaeological Survey of India, Bhubaneswar Circle, Bhubaneshwar	Study and Advise on Air Circulation and other Comfort/Safety Issues at Lord Jagannath Temple, Puri, Orissa
44.	SSP0205	P. C. Thapliyal	KRIBHCO, Surat Hazira Road, Kribhco Nagar, Surat, Gujarat	Health Assessment of Product Handling Plant (Bagging Plant) and Allied Structures of KRIBHCO, Surat
45.	SSP0206	Ajay Chourasia	Chambal Fertilizers & Chemicals Ltd., Gandepan, Kota, Rajasthan	Life Assessment of UPH Civil Structures at CFCL, Gadepan, Kota
46.	SSP0254	S. Sarkar	Airport Authority of India, Rajiv Gandhi Bhawan, Safdarjung Road, New Delhi	Instrumentation and Monitoring of Buildings and Reinforced Soil Structure at Greenfield Airport at Pakyong, Sikkim
47.	SSP0265	S. K. Singh	Member Secretary, Uttrakhand Environment Protection & Pollution Control Board, 29/20, Chandra Villa, Nemi Road, Dehradun	Third Party Quality Assurance and Monitoring of Proposed HQ Building at Dehradun
48.	SSP0324	Rajesh Deoliya	Executive Engr., Civil Buildings Maintenance Division, M-431, Near Gate No. 6, J. L. Nehru Stadium, New Delhi	Third Party Quality Assurance for the Civil Construction Work of Redevelopment of 'C' Block at High Court, New Delhi
49.	SSP0333	Ashok Kumar	Director, Central Statistics Office (National Accounts Division-4), Ministry of Statistics & Programme Implementation, Sardar Patel Bhavan, Sansad Marg, New Delhi-1	Study of Improvement in Rates and Ratios used in the Estimates of Gross Value added in Construction Sector and Capital Information
50.	SSP0396	B. Singh	M/s NTPC Energy Technology Research Alliance (NETRA), NTPC Ltd., E-3, Ecotech-II, Udhyog Vihar, Greater Noida	Application of Fly Ash Based Geoploymer Concrete in Road Construction

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
51.	SSP0416	A. K. Mittal	Executive Engineer, President's Estate Division, Central Public Works Department, Rashtrapati Bhawan, New Delhi	Comprehensive Study of Rashtrapati Bhawan, New Delhi
52.	SSP0424	A. K. Mittal	Sh. Ajay Kr. Awasthi, Chief Executive Officer, Shri Kashi Vishwanath Mandir, Varanasi	Investigation of Kashi Vishwanath Mandir, Varanasi
53.	SSP0434	Manojit Samanta	Punjab State Transmission Corporation Ltd., Mall Road, Patiala	Assessment and Strengthening of Existing Pile Foundation of 220 KV Transmission Line Tower, Punjab
54.	SSP0465	B. S. Rawat	Dr. K. P. Jayanth, V.P. Pest Control (I) Pvt. Ltd., Araker Post, Bangalore	Structural Termite Management of an Insect Growth Regulator (Difunbenzuron 0.025%)
55.	SSP0556	S. K. Singh	Dy. Chief Engineer (E), Life Insurance Corporation Ltd., 25, Kasturba Gandhi Marg, New Delhi	Condition Assessment & Detailed Non-Destructive Testing of Jeevan Prakash Building at 25, KG Marg, New Delhi & suggesting Appropriate Rehabiliation / Strengthening Measures
56.	SSP0575	Rajesh Deoliya	Executive Engineer, Building Project Division B-234, L. N Hospital, New Delhi	Third Party Inspection / Quality Assurance for the Civil Work of c/o Extension of Maulana Azad Dental Institute of Dental Sciences, Phase II at Bahadur Shah Zafar Marg, New Delhi
57.	SSP0576	A. A. Ansari	M/s Paramount Intercontinental Pvt. Ltd., 56-B, Block-ED, Madhuban Chowk, Pitampura, New Delhi	Reaction to Fire Characteristic Studies on Paramount Insulation Foams for various Insulation Applications
58.	SSP0585	Rajesh Deoliya	Executive Engineer, Building Project Division B-232, Sector-9, Dwarka, New Delhi	Third Party Quality Assurance for the Civil Construction Work of 700 Beds Indira Gandhi Hospital, Sector 9, Dwarka, New Delhi
59.	SSP0605	A. K. Mittal	Under Secretary (HFA-IV), Ministry of Housing and Urban Poverty Alleviation, Room No. 323-C, Nirman Bhawan, New Delhi	Development of Implementation Manual for Expanded Polystery Core Panel System
60.	SSP0634	B. M. Suman	Manager - Marketing & Business Development, UP Twiga Fiberglass Ltd., Twiga House, 3 Community Centre, East of Kailash, New Delhi	Study the Effect of Density on Thermal Behaviour of Twiga Fiberglass at Mean Temperature remains Constant for Five Mean Temperatures
61.	SSP0645	Suvir Singh	M/s Siporex India Pvt. Ltd., 72-76 Industrial Estate, Mundhwa, Pune	Fire Resistance Evaluation of Siporex Reinforced Slab Under Uniform Loading

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
62.	SSP0655	A. K. Mittal	Director (GW & UD), Lok Sabha Secretariat, Parliament House Annexe, New Delhi	Technical Examination of the Extension Building to PHA, New Delhi
63.	SSP0656	Ajay Chourasia	Chambal Fertilizers & Chemicals Ltd., Gadepass, Kota (Rajasthan)	Health Checkup of Ammonia Storage Tank FDN (02 Nos)
64.	SSP0666	B. M. Suman	Manager-Marketing & Business Development, UP Twiga Fiberglass Ltd., Twiga House, 2 Community Centre, East of Kailash, New Delhi	Study of Effect of Rising Temperature on Thermal Behaviour of Twiga Fiberglass Wool Insulation keeping Density as Constant Parameter for Six Densities
65.	SSP0755	Neeraj Jain	Sr. Manager, H-06, Construction Division, Tata Motors Pimpri, Pune	Feasibitiy Studies on use of ETP Sludge for Development of Value Added Building Materials
66.	SSP0756	S. K. Negi	Commissioner-cum-Secretary, Panchayati Raj Department, Govt. of Odisha, Bhubaneshwar	Technical Support under Rural Housing Scheme to Panchayati Raj Department, Odisha
67.	SSP0766	S. K. Negi	United Nations Development Programme, 55, Lodhi Estate, New Delhi	Architectural and Structural Validation of Rural Housing Designs Developed by UNDP for the Pradhan Mantri Awas Yojana-Gramin (PMAY-G)
68.	SSP0816	A. K. Mittal	Superintending Archaeologist, Archaeological Survey of India, Bhubaneshwar Circle, Bhabaneshwar	Investigation of Sun Temple Konark Phase-II
69.	SSP0856	Ajay Chourasia	M/s UP Rajkiya Nirman Nigam Ltd., Dehradun Unit-II, Ayurvedic Vishvidhayala, Harawala, Dehradun	Quality Control & Checking of Architectural & Structural Drawings
70.	TSP0355	Rajni Lakhani	M/s Goldcoin Industries Pvt. Ltd., 601, Kingston, Tejpal Road, Vile Parle (East), Mumbai	Evaluation of Chemically Crosslink Foam (XLPE)
71.	TSP0456	B. M. Suman	Managing Director, Aerolam Insulations Pvt. Ltd., Ahmedabad	Study the Effect of Temperature on Thermal Behaviour of Aerolam XLPE keeping Density Constant
72.	TSP0536	A. A. Ansari	M/s Aerolam Insulations Pvt. Ltd., B-103, Elanza Crest, B/S. Sigma Corporates, Nr. HOF living, Sindhu Bhavan Roa d, Off S. G. Road, Bodakev, Ahmedabad	Reaction to Fire Characteristic Studies on Aerolam XLPE
73.	TSP0646	Suvir Singh	M/s Vijay System Engineers Pvt. Ltd., 35, Chandivali Village, Off Sakivihar Road, Andheri (E), Mumbai	Fire Performance Assessment of Cable Fire Sealing System
74.	TSP0686	A. A. Ansari	M/s Everest Industried Ltd., Raheja Revanta, Sector 78, Village Shikohpur, Near Siddhant Tirth Kshetra, Gurgaon	Studies of Everest Repicon System for Reaction to Fire Charateristics

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
75.	TSP0746	Suvir Singh	M/s Swadeshi Civil Infrastructure Pvt. Ltd., 302, DLF Tower-B, Jasola, New Delhi	Fire Performance Assessment of Fire Door
76.	TSP0836	A. A. Ansari	M/s UP Twiga Fiberglass Ltd., Twiga House, 3 Community Centre, East of Kailash, New Delhi	Determination of Limiting Oxygen & Smoke Index of MFMB
77.	TSP0846	Suvir Singh	M/s Integrated Cleanroom Technologies Pvt. Ltd., #303, Surabhilotus, Nagarjuna Nagar Colony, Ameerpet, Hyderabad, Telangana	Fire Performance Assessment of Composite Panels
78.	TST0036	Suvir Singh	M/s Kone Elevator India Pvt. Ltd., India Land Tech Park Tower-B, 3rd Floor No. 14, 3rd main Road, Ambattur Industrial Estate, Chennai	Fire Performance Assessment of Elevator Landing Door
79.	TST0046	Suvir Singh	M/s Navair International Ltd., 59/17, 2nd Floor, Kalka Ji Extension, Guru Ravi Dass Marg, New Delhi	Fire Performance Assessment of Fire Doors
80.	TST0056	Suvir Singh	M/s Caire Consult, B-23/A, Udyog Kendra Extn-1, Greater Noida (UP)	Fire Performance Assessment of Fire Dampers
81.	TST0066	Suvir Singh	Executive Engineer (Housing)-3, PWD, Bhai Nihal Singh Marg, Lajpat Nagar-IV, New Delhi	Fire Performance Assessment of Fire Doors
82.	TST0076	Suvir Singh	M/s Saint Gobain India Ltd. - FYPROC Business, 5th Level, Leela Business Park, Andheri-Kurla Road, Andheri East, Mumbai	Fire Performance Assessment of Suspended Ceiling Systems
83.	TST0116	Suvir Singh	M/s Radiant Passive Fire Systems, F-1, 1st Floor, Vijay Plaza Complex, Near Parsi Agyari, Opp. ABAD Dairy, Kankaria Road, Ahmedabad	Fire Performance Assessment of Fire Door
84.	TST0126	A. A. Ansari	M/s Andhra Polymers Pvt. Ltd., Plot No. 2, Phase-V, IDA, Jeedimetla, Hyderabad	Reaction to Fire Characteristics Studies on Aerolite Calcium Silicate Tile
85.	TST0136	Suvir Singh	M/s Metro Tunneling Chennai, L&T-SUGGJV, Nehru Park, Opp. Sangam Theatre, Ponnamalle High Road, Kilpauk, Chennai	Fire Performance Assessment of Fire Door
86.	TST0146	Suvir Singh	M/s Kone Elevator India Pvt. Ltd., 50 Vanagaram Road, Ayanambakkam, Chennai	Fire Performance Assessment of Kone Elevator Landing Door

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
87.	TST0156	Suvir Singh	M/s Vijay System Engineers Pvt. Ltd., 35, Chandivali Village, Off Sakivihar Road, Andheri(E), Mumbai	Fire Performance Assessment of Cable Fire Sealing System
88.	TST0166	Suvir Singh	Office of Asstt. Engineer-III, Education-IV (Project) PWD, Haiderpur Shalimar Bagh, Delhi	Fire Performance Assessment of Fire Door
89.	TST0175	Suvir Singh	M/s Trio Elevators Co. (I) Ltd., 824, Kothari Industrial Estate, Kothari Cross Road, Santej, Dist. Gandhinagar	Fire Performance Assessment of Elevator Door
90.	TST0185	Suvir Singh	M/s Iclean Hollow Metal Systems Pvt. Ltd., Survey No. 21/3 & 26/3, Gankapadu Village, Anumanchipali Panchayant, Jaggaiahpet Mandal, Krishna District, AP	Fire Performance Assessment of Fire Door
91.	TST0196	A. A. Ansari	M/s Paramount Polytreat Chemicals Pvt. Ltd., 2/10, IInd Floor, Opp. Crown Plaza Hotel, New Friends Colony, New Delhi	Reaction to Fire Characteristics Studies on StarCoat CRC on GI Sheet
92.	TST0216	A. A. Ansari	M/s RINAC India Ltd., Survey # 2, Tavarekere Hobli, Marenahalli Village, Magdi Road, Bangalore	Reaction to Fire Characteristics Studies of R Puff
93.	TST0226	Suvir Singh	M/s Multicolor Steels (I) Pvt. Ltd., White House, 1/18-20, Rani Jhansi Road, New Delhi	Fire Performance Assessment of Prefab Rock Wood Panel
94.	TST0236	Suvir Singh	M/s Paras Buildtech India Pvt. Ltd., 11 Floor, Paras Twin Tower (Tower B), Sec 54, Golf Course Road, Gurgaon	Fire Performance Assessment of Fire Check Door
95.	TST0246	Suvir Singh	M/s Ahlada Engineers Pvt. Ltd., SY#66-68, Bahadurpally (V), Qutbullapur Mandal, R.R. Dist, Hyderabad	Fire Performance Assessment of Fire Check Door
96.	TST0256	Suvir Singh	M/s GWS Engineers & Fabricators Pvt. Ltd., A-512, TTC Industrial Area Mahape, Navi Mumbai	Fire Performance Assessment of Fire Rated Metal Door
97.	TST0266	A. A. Ansari	M/s Larsen & Toubro Ltd., Safdarjung Hospital Campus, Behind Trauma Centre Building, New Delhi	Reaction to Fire Characteristic Studies of Chemically Cross Linked Closed Cell FR-XPE Polyethylene Insulation Material
98.	TST0285	Suvir Singh	M/s Tufwood Doors & Accessories, 139, Rajdanga Main Road, Near Kasba New Market & UCO Bank, Kolkata	Fire Performance Assessment of Fire Door

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
99.	TST0296	Suvir Singh	M/s Metaflex Pvt. Ltd., 8A, Udyog Vihar Part I & II, Greater Noida	Fire Performance Assessment of Fire Doors
100.	TST0306	Suvir Singh	M/s Vijay System Engineers Pvt. Ltd., 25, Chandivali Village, Off. Sakivihar Road, Andheri (E), Mumbai	Fire Performance Assessment of Cable Fire Sealing Systems
101.	TST0316	Suvir Singh	M/s OTIS Elevator Company (India) Ltd., No.92, KIADB Indl. Estate, Phase-II, Jigani Indl. Area, Anekal Taluk, Banglore	Fire Performance Assessment of Elevator Door
102.	TST0326	Suvir Singh	M/s Metecno (I) Pvt. LTd., No. 138/30, 2nd Floor, Florida Towers, Neslon Manickam Road, Chennai	Fire Performance Assessment of Sandeich Rock Wood Panel Partition
103.	TST0336	Suvir Singh	M/s Signum Fire Protection (I) Pvt. Ltd., 225 B, WHC Road, Opp. Times of India, Gokulpeth, Nagpur	Fire Performance Assessment of Fire Door
104.	TST0346	Suvir Singh	M/s Gannon Dunkerley & Co. Ltd., C/o SBI Data Centre Project Site, Gachibowli, Opp. Hyderabad University, Hyderabad	Fire Performance Assessment of Fire Rated Doors
105.	TST0356	Suvir Singh	M/s USG Boral Building Products (I) Pvt. Ltd., (Formerly Boral Gypsum Pvt. Ltd.), Vipul Trade Centre, 610-613, Sicth Floor, Sohna, Gurgaon	Fire Performance Assessment of Gypsum Board Partition Systems
106.	TST0366	Suvir Singh	M/s Iclean Hollow Metal Systems PVt. Ltd., Survey No. 21/3 & 26/3, Gankapadu Village, Anumanchipali Panchayant, Jaggaiahpet Mandal, Krishna District	Fire Performance Assessment of Fire Doors
107.	TST0376	Suvir Singh	M/s HIL Ltd., (Formerly Hyderabad Industries Ltd.), Behind FCI Godown, Erragadda, Hyderabad	Fire Performance Assessment of Partition
108.	TST0385	Suvir Singh	M/s Consolidated Construction Consortium Ltd, ONGC-Rajiv Gandhi Urja Bhawan Project, Plot No. 5A & 5B, Nelson Mandela Marg, New Delhi	Fire Performance Assessment of Fire Door
109.	TST0386	A. A. Ansari	M/s Alexia Panels, 999, Central Hopetown, Jamanpur Road, Selaqui Industrial Area, Selaqui, Dehradun	Reaction to Fire Characteristic Studies on Aluminium Composite Panels

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
110.	TST0395	Suvir Singh	M/s Bhawani Fire Protection Pvt. Ltd., 63, Rural Industrial Estate, Arya Nagar, Loni, Ghaziabad	Fire Performance Assessment of Fire Door
111.	TST0406	Suvir Singh	M/s Bhawani Steel Fabricators, 63, Rural Industrial Estate, Arya Nagar, Loni, Ghaziabad	Fire Performance Assessment of Fire Door
112.	TST0415	Suvir Singh	M/s Lloyd Insulations (I) Ltd., Kalkaji Industrial Area, New Delhi	Fire Resistance Evaluation of Lloyd Firestop Sealing System
113.	TST0425	Suvir Singh	M/s Shakti Hormann Ltd., (Formerly Shakti Met-Dor Ltd.), Regd. Office Plot No. 20, Sripuri Colony, Karkhana, Secunderabad	Fire Performance Assessment of Fire Doors
114.	TST0426	A. A. Ansari	M/s HIL Ltd., (Formerly Hyderabad Industries Ltd.), R&D Building, Behind FCI Godown, Erragadda, Hyderabad	Reaction to Fire Characteristic Studies on Non Asbestos Aerocon Panels (NT)
115.	TST0436	A. A. Ansari	M/s Shree Ram Equitech Pvt. Ltd., Opp. Bank of Baroda, Ganj Para, Durg, Chattisgarh	Reaction to Fire Characteristic Studies on Rockwoool Slab
116.	TST0445	Suvir Singh	M/s GWS Engineers & Fabricators Pvt. Ltd., A-512, TTC Industrial Area Mahape, Navi Mumbai	Fire Performance Assessment of Fire Door
117.	TST0446	Suvir Singh	M/s Sehgal Doors, B-133, Phase-1, Industrial Area, Mayapuri, New Delhi	Fire Performance Assessment of Fire Door
118.	TST0455	Suvir Singh	M/s GWS Engineers & Fabricators Pvt. Ltd., A-512, TTC Industrial Area Mahape, Navi Mumbai	Fire Performance Assessment of Fire Door
119.	TST0475	Suvir Singh	M/s Metecno India Pvt. Ltd., No. E-11, SIPCOT Industrial Area, NH-4, Mambakkam Sriperumbudur, Tamilnadu	Fire Performance Assessment of Partitions System
120.	TST0476	Suvir Singh	M/s Ozone Overseas Ltd., Trilokpur Road, Kheri, Kala Amb, Nahan, Dist. Srimour (HP)	Fire Performance Assessment of Fire Door
121.	TST0485	Suvir Singh	M/s Sehgal Doors, B-133, Phase-1, Industrial Area, Mayapuri, New Delhi	Fire Performance Assessment of Fire Door
122.	TST0486	Suvir Singh	M/s Fujitech India Pvt. Ltd., Plot No. P-52, Ist Cross Road, 8th Avenue Mahindra World City, Chengalpattu, Kancheepuram	

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
123.	TST0506	B. M. Suman	GM (Works), Andhra Polymers Pvt. Ltd., SPAN Solitaire, 6-3-1090/B/5, Raj Bhavan Road, Hyderabad	Thermal Conductivity Test of Aerolite
124.	TST0516	A. A. Ansari	M/s Vikram Sarabhai Space Centre, Thiruvananthapuram	Reaction to Fire Characteristic Studies on Flameproof Material Impregnated Foam Samples
125.	TST0525	Suvir Singh	M/s Delhi Metro Rail Corporation Ltd., Opp. Frank Anthony Publlic School, Lala Lajpat Rai Marg, Lajpat Nagar-IV, New Delhi	Fire Performance Assessment of Fire Door
126.	TST0526	Suvir Singh	Asst. Engineer-I Education, O/o Executive Engineer, EPD-III, PWD Vikas Bhawan 2, GF., Civil Lines, Delhi	Fire Performance Assessment of Fire Door
127.	TST0535	Suvir Singh	Executive Engineer, IIT Patna Project Division, CPWD Patna, Patna	Fire Performance Assessment of Fire Door
128.	TST0545	Suvir Singh	M/s Bhawani Fire Protection Pvt. Ltd., 63, Rural Industrial Estate, Arya Nagar, Loni, Ghaziabad	Fire Performance Assessment of Metal Fire Door
129.	TST0546	Suvir Singh	M/s Everest Industried Ltd., Genesis A-32 Mohan Cooperative Industrial Estate, Mathura Road, New Delhi	Fire Performance Assessment of Smart Wall and Rapicon Wall
130.	TST0555	Suvir Singh	M/s Chempharm, C-71, Sector-63, Noida	Fire Performance Assessment of Steel Fire Door
131.	TST0565	Suvir Singh	The Divisional Engineer (C-II), Greater Mohali Area Development Authority (GMADA), PUDA Bhawan, Sector-62, SAS Nagar, Punjab	Fire Performance Assessment of Fire Door
132.	TST0586	Suvir Singh	M/s Exch Therm Engineering Company, C-10, Ashoka Tower, C-Block Community Center, Janak Puri, New Delhi	Fire Performance Assessment of Fire Door
133.	TST0606	Suvir Singh	Executive Engineer, Supreme Court Project Division-1, Gate No. 9, Pragati Maidan, New Delhi	Fire Performance Assessment of Fire Doors
134.	TST0615	A. A. Ansari	M/s UP Twiga Fiberglass Ltd., Twiga House, 3 Community Centre, East of Kailash, New Delhi	Reaction to Fire Characteristic Studies on MFMB

External Funded Projects

S.No.	Project No	PI	Sponsoring Agency	Title
135.	TST0626	Suvir Singh	M/s Ultimate Safety Metal Doors, H.No. 5-5-36/26/A, Ayyana's Industrial Part, Prashanth Nagar, Kukatpally, Hyderabad	Fire Performance Assessment of Fire Door
136.	TST0636	Suvir Singh	M/s Techno Doors Pvt. Ltd., Plot No.-LI, Sipcot Industrial Park, Mambakkam & Pondur A Village, Sriperumbudur Taluk, Kancheepuram District	Fire Performance Assessment of Landing Door
137.	TST0665	Suvir Singh	M/s Sukriti Doors & Hardware Pvt. Ltd., 380, Ground Floor Chirag Delhi, New Delhi	Fire Performance Assessment of Glazed Fire Door
138.	TST0676	Suvir Singh	M/s Avians Innovations Technology Pvt. Ltd., 615/25, Pradhikaran, NIGDI, Pune	Fire Performance Assessment of Sliding Door
139.	TST0716	Suvir Singh	M/s Envirotech Systems Pvt. Ltd., B-1A/19, First Floor, Commercial Complex, Sector 51, Noida	Fire Performance Assessment of Fire Door
140.	TST0726	Suvir Singh	M/s Ameetuff Technical Paints Industries, I-8, DLF Industrial Estate No. 1, Faridabad, Haryana	Fire Performance Assessment of Fire Retardant Coating on Steel Structure
141.	TST0736	Suvir Singh	M/s Kone Elevator India Pvt. Ltd., India Land Park Tower-B, 3rd Floor No. 14, 3rd Main Road, Ambattar Industrial Estate, Chennai	Fire Performance Assessment of Elevator Landing Door
142.	TST0745	Suvir Singh	M/s Koleshvari Steel Industries, Plot No. 298, Road No. 4, GIDC, Kathwada, Ahmedabad	Fire Performance Assessment of Fire Door
143.	TST0786	Suvir Singh	M/s Steel Tech Industries, R.S. No. 60, Pattanpur Village, Pondy-Tindivanam Main Road, Auroville P.O., Tamil Nadu	Fire Performance Assessment of Fire Door
144.	TST0826	Suvir Singh	M/s Falcon Doors & Windows Pvt. Ltd., Gala No. 1, Bhoir Compound, Opp. Shatabdi Hospital, W.T. Patil Marg, Chembur, Mumbai	Fire Performance Assessment of Fire Door
145.	TST0876	B. M. Suman	GM (Works), Andhra Polymers Ceiling Tiles Aerolite Ceiling Systems, PLot No. 2, Plase-V, IDA Jeedimetta, Hyderabad	Thermal Conductivity Test of Aerolite Tile

CBRI Family

CBRI Family

Group-IV-Scientific Staff

S. No.	Name	Designation
1.	Dr. N. Gopalakrishnan	Director
2.	Mr. Y. Pandey	Chief Scientist
3.	Dr. A.K. Minocha	Chief Scientist
4.	Dr. Brijeshwar Singh	Chief Scientist
5.	Mr. R.S. Chimote	Chief Scientist
6.	Dr. Suvir Singh	Chief Scientist
7.	Dr. Manju Mittal	Sr. Principal Scientist
8.	Dr. (Mrs.) Abha Mittal	Sr. Principal Scientist
9.	Dr. Ashok Kumar	Sr. Principal Scientist
10.	Mr. S.K. Negi	Sr. Principal Scientist
11.	Dr. Shantanu Sarkar	Sr. Principal Scientist
12.	Dr. R. Dharma Raju	Sr. Principal Scientist
13.	Mrs. Neeta S. Mittal	Sr. Principal Scientist
14.	Dr. Harpal Singh	Sr. Principal Scientist
15.	Dr. Pardeep Kumar-I	Sr. Principal Scientist
16.	Dr. Atul Kumar Agarwal	Sr. Principal Scientist
17.	Mr. A. A. Ansari	Sr. Principal Scientist
18.	Dr. D.P. Kanungo	Sr. Principal Scientist
19.	Dr. Achal Kumar Mittal	Sr. Principal Scientist
20.	Dr. Rajni Lakhani	Sr. Principal Scientist
21.	Mr. S.K. Singh	Sr. Principal Scientist
22.	Dr. S.R. Karade	Sr. Principal Scientist
23.	Mr. Nadeem Ahmed	Principal Scientist
24.	Dr. Rajesh Deoliya	Principal Scientist
25.	Dr. Sujit Kumar Saran	Principal Scientist
26.	Dr. Navjeev Saxena	Principal Scientist
27.	Dr. A.P. Chaurasia	Principal Scientist
28.	Dr. P.C. Thapliyal	Principal Scientist
29.	Dr. B.S. Rawat	Principal Scientist

30.	Dr. L.P. Singh	Principal Scientist
31.	Dr. Shorab Jain	Principal Scientist
32.	Dr. S.K. Panigrahi	Principal Scientist
33.	Dr. Rajesh K. Verma	Principal Scientist
34.	Dr. P.K.S. Chauhan	Principal Scientist
35.	Mr. H.C. Arora	Sr. Scientist
36.	Dr. Leena Chaurasia	Sr. Scientist
37.	Dr. Neeraj Jain	Sr. Scientist
38.	Mr. Vineet Kumar Saini	Scientist
39.	Mr. Ravindra Singh Bisht	Scientist
40.	Mr. Nagesh Babu Balam	Scientist
41.	Mr. Manojit Samanta	Scientist
42.	Mr. Soju Joseph Alexander	Scientist
43.	Mr. Soumitra Maiti	Scientist
44.	Mr. Srinivasrao Naik B.	Scientist
45.	Mr. Subash Chandra Bose Gurram	Scientist
46.	Dr. A. Aravind Kumar	Scientist
47.	Mr. Anindya Pain	Scientist
48.	Mr. Mickey Mecon Dalbehera	Scientist
49.	Mr. Piyush Mohanty	Scientist
50.	Mr. Siddharth Behera	Scientist
51.	Ms. Ishwarya G.	Scientist
52.	Ms. Monalisa Behera	Scientist
53.	Mr. Rajesh Kumar	Scientist
54.	Mr. Rakesh Paswan	Scientist
55.	Mr. Chanchal Sonkar	Scientist
56.	Mohd. Reyazur Rahman	Scientist
57.	Mr. Santha Kumar G.	Scientist
58.	Mr. Koushik Pandit	Scientist
59.	Ms. Sayantani Lala	Scientist
60.	Ms. Hina Gupta	Scientist
61.	Mr. Debdutta Ghosh	Scientist

62.	Ms. Surya M.	Scientist
63.	Ms. Swati Kulashri	Scientist
64.	Ms. Shailza Singh	Scientist
65.	Mr. Ashish Pippal	Scientist
66.	Ms. Shermi C.	Scientist
67.	Mr. S. Ganesh Kumar	Scientist
68.	Mr. Chandan Swaroop Meena	Scientist
69.	Mr. Banti A Gedam	Scientist
70.	Mr. Kishore S. Kulkarni	Scientist
71.	Mr. Mohammad Jeeshan Khan	Scientist
72.	Mrs. Aswathy M.S.	Scientist
73.	Mr. Tabish Alam	Scientist
74.	Mr. R. Siva Chidambaram	Scientist
75.	Mrs. Hemlata	Scientist

Group III Technical Staff

76.	Dr. Rajiv Kumar	Principal T.O.
77.	Mr. D.K. Sehgal	Principal T.O.
78.	Dr. S.K. Senapati	Principal T.O.
79.	Mr. Narendra Kumar	Principal T.O.
80.	Dr. B.M. Suman	Principal T.O.
81.	Mr. Rajesh Kumar	Principal T.O.
82.	Mr. Jaswinder Singh	Principal T.O.
83.	Dr. P.K. Yadav	Principal T.O.
84.	Mr. Dalip Kumar	Sr. T.O. (3)
85.	Mr. Rajeev Kumar Sharma	Sr. T.O. (3)
86.	Mr. Sushil Kumar	Sr. T.O. (3)
87.	Dr. M.K. Sinha	Sr. T.O. (2)
88.	Mr. Zamir Ahmad	Sr. T.O. (2)
89.	Mr. Rakesh Kumar –II	Sr. T.O. (2)
90.	Mr. Vivek Sood	Sr. T.O. (2)
91.	Mr. Jalaj Parashar	Sr. T.O. (2)
92.	Mr. Ram Ashray Rai	Sr. T.O. (2)

93.	Mr. Bharat Bhushan	Sr. T.O. (2)
94.	Mr. Naresh Kumar	Sr. T.O. (1)
95.	Mr. Rajesh R. Ghadse	Sr. T.O. (1)
96.	Mr. B.K. Kalra	Sr. T.O. (1)
97.	Mr. Itrat Amin Siddiqui	Sr. T.O. (1)
98.	Mrs. Gayatri Devi	Sr. T.O. (1)
99.	Mr. Amit Kush	Sr. T.O. (1)
100.	Mr. Ajay Dwivedi	T.O.
101.	Mr. Sameer	T.O.
102.	Mrs. Deepti Karmakar	T.O.
103.	Mr. D.S. Dharamshaktu	T.O.

Group II

104.	Mr. Rizwanul Hasan	Sr. Tech. (2)
105.	Mr. Rishi Pal Singh	Sr. Tech. (2)
106.	Mr. Sushil Kumar	Sr. Tech. (2)
107.	Mr. Himanshu Sharma	Sr. Tech. (2)
108.	Mr. Rajinder Kumar	Sr. Tech. (2)
109.	Mr. P.K. Yadav	Sr. Tech. (2)
110.	Mrs. Neelam Gupta	Sr. Tech. (2)
111.	Mrs. Sangeeta Sharma	Sr. Tech. (2)
112.	Mr. Sheeraj Ahmad	Sr. Tech. (2)
113.	Mrs. Saroj Rani	Sr. Tech. (2)
114.	Mr. Anil Kumar Sharma	Sr. Tech. (2)
115.	Mr. Jameel Hasan	Sr. Tech. (1)
116.	Mr. U.C. Bhatnagar	Sr. Tech. (1)
117.	Mr. Manmeet Singh	Sr. Tech. (1)
118.	Mrs. Urmila Kotnala	Sr. Tech. (1)
119.	Mr. Amar Singh	Sr. Tech. (1)
120.	Mr. B.S. Bisht	Sr. Tech. (1)
121.	Mr. Rajeev Bansal	Sr. Tech. (1)
122.	Mr. Pradeep Kr. Kapooria	Sr. Tech. (1)
123.	Mr. Arvind Saini	Sr. Tech. (1)

124.	Mr. Harish Kumar	Sr. Tech. (1)
125.	Mr. Sukhbir Sharma	Sr. Tech. (1)
126.	Mr. Arvind Kumar	Sr. Tech. (1)
127.	Mr. Sharad Kumar	Sr. Tech. (1)
128.	Mr. Mam Chand Agarwal	Sr. Tech. (1)
129.	Mr. Arvind Kumar Sharma	Sr. Tech. (1)
130.	Mr. Tahir Husain	Sr. Tech. (1)
131.	Mr. Francis Charles	Sr. Tech. (1)
132.	Mr. Ghanshyam Mittal	Sr. Tech. (1)
133.	Mr. Kedar Nath	Sr. Tech. (1)
134.	Mr. Santosh Kumar Mishra	Sr. Tech. (1)
135.	Mr. Iqubal Ahmed	Sr. Tech. (1)
136.	Mr. Manoj Kumar Tyagi	Sr. Tech. (1)
137.	Mr. Jai Pal	Sr. Tech. (1)
138.	Mr. Shorab Khan	Sr. Tech. (1)

Group I Supporting Staff

139.	Mr. D.P. Yadav	Lab. Asstt.
140.	Mr. Amar Singh (SE)	Lab. Asstt.
141.	Mr. Gurucharan Singh	Lab. Asstt.
142.	Mr. Rajeshwar	Lab. Asstt.
143.	Mr. Rishi Pal (SE)	Lab. Asstt.
144.	Mr. Vijay Kumar	Lab. Asstt.
145.	Mr. Vishwas Kumar	Lab. Asstt.
146.	Mr. Jagdish Pal	Lab. Asstt.
147.	Mr. Deepak Kumar	Lab. Asstt.
148.	Mr. Subhash Chand	Lab. Asstt.
149.	Mr. Rajesh Kumar	Lab. Attd. (2)

Administrative Staff /House-Keeping

150.	Mr. Vinod Kumar	A.O.
151.	Mr. Ajay Kumar Sharma	S&PO
152.	Mr. J.K. Chaurasia	F&AO

153.	Mr. R.C. Saxena	Sr. H.O.
154.	Mr. Sukhvir Singh	S.O. (S&P)
155.	Mr. S.K. Jakhwal	S.O. (G)
156.	Ms. Rashmi Devi	S.O. (G)
157.	Mr. V.K. Sharma	S.O. (G)
158.	Mr. Constan Kujur	S.O. (G)
159.	Mr. K. Arora	P.S.
160.	Mr. Satya Pal	P.S.
161.	Mr. V.P.S. Rawat	Security Officer
162.	Mr. Naresh Yadav	Sr. Steno
163.	Mrs. Archana	Sr. Steno
164.	Mr. Arvind Kumar	Sr. Steno
165.	Mr. Dalpat Singh	Sr. Steno
166.	Mr. Dharam Singh Negi	Sr. Steno
167.	Mr. Mehar Singh	Hindi Officer
168.	Mr. Suba Singh	Hindi Officer
169.	Mrs. Nisha Tyagi	Asstt. (G) Gr. I
170.	Mrs. Sarita Khanna	Asstt. (G) Gr. I
171.	Mrs. Sheema Farhat	Asstt. (G) Gr. I
172.	Mr. R.K. Johar	Asstt. (G) Gr. I
173.	Mr. Sudhir Kumar	Asstt. (G) Gr. I
174.	Mr. Shiv Kumar	Asstt. (G) Gr. I
175.	Mrs. Sunita	Asstt. (G) Gr. I
176.	Mr. Pawan Kumar	Asstt. (G) Gr. I
177.	Mrs. Mamta Sharma	Asstt. (G) Gr. I
178.	Mr. Dharam Pal Singh	Asstt. (G) Gr. I
179.	Mr. Virendra Singh	Asstt. (F&A) Gr. I
180.	Mr. Aman Kumar	Asstt. (F&A) Gr. I
181.	Mr. Vipin Kumar Sharma	Asstt. (F&A) Gr. I
182.	Mr. Suraj Pal Singh	Asstt. (F&A) Gr. I
183.	Mr. Satyarth Prakash	Asstt. (F&A) Gr. I
184.	Mrs. Rubina Zaidi	Asstt. (F&A) Gr. I

185.	Mr. Sanjeev Bansal	Asstt. (S&P) Gr. I
186.	Mrs. Anju Rani Simon	Asstt. (S&P) Gr. I
187.	Mr. Arpan Maheshwari	Asstt. (S&P) Gr. I
188.	Mr. Kalam Singh Chauhan	Asstt. (S&P) Gr. I
189.	Mr. Vishwash Tyagi	Asstt. (S&P) Gr. I

Group C

190.	Mrs. Arun Lata	Asstt. (G) Gr. II
191.	Mr. Sushil Kumar	Asstt. (G) Gr. II
192.	Mr. Sanjay Kr. Tyagi	Asstt. (G) Gr. II
193.	Mrs. Seema Ahuja	Asstt. (G) Gr. II
194.	Mr. Ravinder Kumar	Asstt. (G) Gr. II
195.	Mr. Radhey Shyam	Driver (NT)
196.	Mr. Satya Pal	MTS
197.	Mr. Raj Kumar	MTS
198.	Mrs. Usha	MTS
199.	Mr. Mukesh Kumar	MTS
200.	Mrs. Kusum Lata	MTS
201.	Mrs. Bala	MTS
202.	Mr. Subhash Chand	MTS
203.	Mr. Inder Pal (ACP)	MTS
204.	Mr. Desh Raj	MTS
205.	Mr. Rakesh Kumar	MTS
206.	Mr. Ramesh Kumar	MTS
207.	Mr. Santosh Kumar	MTS
208.	Mr. Rakesh Kumar	MTS
209.	Mr. Krishna Gopal Thakur	MTS
210.	Mr. Mani Ram	MTS
211.	Mr. Rohitash Kumar	MTS
212.	Mr. Radhey Shyam	MTS
213.	Mr. Ranbeer Singh	MTS
214.	Mr. Devendra Kumar	MTS
215.	Mrs. Prakash Kaur	MTS

216.	Mrs. Anju	MTS
217.	Mr. Khalil Ahmad	MTS
218.	Mr. Subhan Singh	MTS
219.	Mr. Anit Kumar Pal	MTS
220.	Mr. Pritam Giri	MTS
221.	Mr. Pooran Vassi	MTS
222.	Mr. Kirat Pal	MTS
223.	Mr. Kiran Pal	MTS
224.	Mr. Rajesh Kr. Yadav	MTS
225.	Mr. Jai Prakash	MTS
226.	Mr. Ranjeet Singh	MTS
227.	Mr. Satya Pal	MTS
228.	Mr. Satya Pal Singh	MTS
229.	Mr. Mehraj Deen Khan	MTS
230.	Mr. Dharam Singh	MTS
231.	Mr. Sunil Kumar	MTS
232.	Mr. Rakesh	MTS
233.	Mr. Arun Kumar	MTS
234.	Mr. Ravinder Kumar	MTS
235.	Mr. Dil Bahadur	MTS
236.	Mr. Rajinder Pal	MTS
237.	Mr. Malkhan Singh	MTS
238.	Mr. Dheer Singh	MTS

Appointments

1.	Dr. N. Gopalakrishnan	Director	26.05.2016
2.	Ms. Swati Kulashri	Scientist (Architecture)	01.04.2016
3.	Mr. Ashish Pippal	Scientist (Civil Engineering)	04.04.2016
4.	Ms. Shermi C.	Scientist (Civil Engineering)	21.04.2016
5.	Dr. S. Ganesh Kumar	Scientist (Civil Engineering)	09.05.2016
6.	Mr. Chandan Swaroop Meena	Scientist (Physics)	19.05.2016
7.	Dr. Banti A. Gedam	Scientist (Civil Engineering)	01.06.2016

8.	Ms. Aswathy M.S.	Scientist (Civil Engineering)	01.11.2016
9.	Dr. Tabish Alam	Scientist (Physics)	24.11.2016
10.	Mr. R. Shiva Chidambaram	Scientist (Civil Engineering)	15.12.2016
11.	Mrs. Hemlata	Scientist (Chemistry)	28.12.2016

Transfer & Posting

1.	Mr. Vinod Kumar	Administrative Officer	01.04.2016
	From CSIR- CRRI, New Delhi to CSIR-CBRI, Roorkee		
2.	Mr. S. K. Singh	Store & Purchase Officer	05.04.2016
	From CSIR-CDRI, Lucknow to CSIR-CBRI, Roorkee		
3.	Mr. S. K. Gupta	F&AO	08.08.2016
	From CSIR-CSIO, Chandigarh to CSIR-CBRI, Roorkee		
4.	Mr. Parag Saxena	A.O.	24.11.2016
	From CSIR-CBRI, Roorkee to CSIR-CSIO, Chandigarh		
5.	Mr. Sunil Kumar Gupta	F&AO	02.12.2016
	From CSIR-CBRI, Roorkee to CSIR-CSIO, Chandigarh		
6.	Mr. S.K. Singh	S&PO	30.12.2016
	From CSIR-CBRI, Roorkee to CSIR-IITR, Lucknow		
7.	Mr. J.K. Chaurasia	F&AO	26.12.2016
	From CSIR-CSMCRI, Bhavnagar to CSIR-CBRI, Roorkee		
8.	Mr. Ajay Kumar Sharma	S&PO	27.12.2016
	From CSIR-CSIO, Chandigarh to CSIR-CBRI, Roorkee		

Promotion

1.	Dr. D. P. Kanungo	Senior Principal Scientist	24-08-2012
2.	Dr. Achal Kumar Mittal	Senior Principal Scientist	08-09-2013
3.	Dr. (Mrs.) Rajni Lakhani	Senior Principal Scientist	30-12-2013
4.	Mr. S. K. Singh	Senior Principal Scientist	01-01-2014
5.	Dr. Sukhdeo Rao	Senior Principal Scientist	19-03-2014
6.	Dr. P. K. S. Chauhan	Principal Scientist	10-12-2013
7.	Mr. M. Ramakrishna	Driver	13.03.2015

Technical Resignation

1.	Mr. R. K. Manjhiwal	F&AO	04.07.2016
		To join as Dy. Registrar, MNIT, Jaipur	

Resignation

1.	Mr. Syed Ibrahim Sohel	Scientist	8.04.2016

Superannuation

1.	Mr. Harpal Singh	Technician	30.04.2016
2.	Mr. Khalil Ahmad	Farrash	31.05.2016
3.	Mr. Hira Lal	Lab Assistant	30.06.2016
4.	Mr. Kailash Chand	MTS	30.06.2016
5.	Mr. Shiv Kumar Verma	MTS (V.R.S.)	01.05.2016
6.	Mr. Bhupal Singh	Sr. Principal Tech. Officer	31.07.2016
7.	Mr. Shiv Prakash Tyagi	Senior Technician	31.08.2016
8.	Mr. Prakash Chand	Principal Technical Officer	30.09.2016
9.	Mr. Rajeev	Principal Technical Officer	31.10.2016
10.	Mr. Sudhir Sharma	Principal Technical Officer	31.10.2016
11.	Mr. Deepak Singh	Technician	30.11.2016
12.	Mr. Sushil	Driver (V.R.S.)	31.12.2016
13.	Mr. Gopal Chand	Tech.	31-01-2017
14.	Mr. M. Ramakrishana	Driver	31-01-2017
15.	Dr. Pradeep Kumar	Senior Scientist	31-01-2017

Obituary

1.	Mr. Ram Samuj	MTS	25.04.2016
2.	Mr. Yogesh Kumar	Asstt. Gr. I	01.11.2016

Research Papers

Research Papers

Foreign Journal

1. A. Pain, D. Choudhury and S.K. Bhattacharyya, "Seismic Rotational Stability of Gravity Retaining Walls by Modified Pseudo-Dynamic Method", Soil Dynamics and Earthquake Engineering, Vol. 94, 2017, pp. 244-253, DOI: 10.1016/ j.soildyn.2017.01.016.

2. A. Pain, D. Choudhury and S.K. Bhattacharyya, "Closure to Seismic Uplift Capacity of Horizontal Strip Anchors Using a Modified Pseudo-Dynamic Approach", International Journal of Geomechanics, 2017, DOI: 10.1061/(ASCE)GM.1943-5622.0000471.

3. A. Pain, D. Choudhury and S.K. Bhattacharyya, "Seismic Rotational Displacement of Retaining Walls: A Pseudo-Dynamic Approach", Innovative Infrastructure Solutions, Vol. 1, No. 22, 2016, DOI: 10.1007/s41062-016-0023-x.

4. Ajay Chourasia, S.K. Bhattacharyya, Pradeep Bhargava and N.M. Bhandari, "Seismic Performance of Different Masonry Buildings: A Full-Scale Experimental Study", International Journal of Performance of Constructed Facilities, 2016, ISSN: 0887-3828, DOI: 10.1061/ (ASCE)CF.1943-5509.0000850.

5. Akash Kumar, Chandan Swaroop Meena and Arup Kumar Das, "Interaction of Asymmetric Films Around Boiling Cylinder Array: Homogenous Interface to Chaotic Phenomenon", Journal of Heat Transfer, 2017, 139(4):041502-041502-11.

6. Ashok Kumar, Ajay Chourasia, Sayantani Lala, Aditya Kumar and Vijayraj, "Prefabricated Foundation System for Single Storey Houses", International Journal for the Advancement of Performance Information & Value, Vol. 8, No. 2, January 2017, pp. 78-91.

7. Changqing Qi, Jimin Wu, Jin Liu and D.P. Kanungo, "Assessment of Complex Rock Slope Stability at Xiari, Southwestern China", Bulletin of Engineering Geology and Environment, Vol. 75, No. 2, 2016, pp. 537-550.

8. D. Ghosh, A.K. Mittal and S.K. Bhattacharyya, "Multiphase Modeling of Tsunami Impact on Building with Openings", The Journal of Computational Multiphase Flows, DOI: 10.1177/ 0010836716653881.

9. Harendra Kumar, Nutan Kumari Chauhan and P.K. Yadav, "Dynamic Tasks Scheduling Algorithm for Distributed Computing Systems under Fuzzy Environment", International Journal of Fuzzy System Applications, Vol. 5, No. 4, 2016, pp. 77-95, ISSN: 2156-177X, EISSN: 2156-1761, DOI: 10.4018/IJFSA.

10. J. Liu, Y. Wang, Y. Lu, J. Wei and D.P. Kanungo, "Application of Distributed Optical Fiber Sensing Technique in Monitoring the Ground Deformation", Journal of Sensors, 2017, DOI: 10.1155/ 2017/6310197.

11. J. Liu, J. Wei, H. Hu, J. Wu, S. Sun and D.P. Kanungo, "Research on the Engineering Geological Conditions and Stability Evaluation of the B2 Talus Slide at the Jinan Bridge Hydropower Station, China", Bulletin of Engineering Geology and Environment, 2017, DOI: 10.1007/s10064-017-1005-8.

12. Kranthi Kumar, V.A. Sawant, Pradeep Kumar and S.K. Shukla, "Numerical and Experimental Investigations of Granular Anchor Piles in Loose Sandy Soil Subjected to Uplift Loading", International Journal of Geomechanics, published online, July 7, 2016, ISSN: 1532-3641, Ref Paper No. MS GMENG-1459R2- [EMID :8617ccd195fd661b].

13. K. Lakshmi, A. Rama Mohan Rao and N. Gopalakrishnan, "Singular Spectrum Analysis combined with ARMAX Model for Structural Damage Detection", Structural Control and Health Monitoring, published online, November 8, 2016, DOI: 10.1002/stc.1960.

14. K.V. Kumar, T.J. Saravanan, R. Sreekala, N. Gopalakrishnan and K.M. Mini, "Structural Damage Detection through Longitudinal Wave Propagation using Spectral Finite Element Method", Geomechanics and Engineering, Vol. 12, No. 1, 2017, pp. 161-183.

15. L.P. Singh, D. Ali and U. Sharma, "Studies on Optimizations of Silica Nanoparticles in Cementitious Material", Cement Concrete Composites, Vol. 70, 2017, pp. 60-68.

16. L.P. Singh, S.K. Bhattacharyya, S.P. Shah, G. Mishra and U. Sharma, "Studies on Early Stage Hydration of Tricalcium Silicate incorporating Silica Nanoparticles: Part II", Construction and Building Materials, Vol. 102, 2016, pp. 943-949.

17. L.P. Singh, W. Zhu, T. Howind and U. Sharma, "Quantification and Characterization of CSH in Silica Nanoparticles incorporated Cementitious System", Cement and Concrete Composites Vol. 79, 2017, pp. 106-116.

18. M. Mittal, "Explosibility of Hydrogen-Air Mixtures in Large Spherical Vessel", International Journal of Innovative Research and Advanced Studies", Vol.4, No.3, 2017, pp. 160-165.

19. M. Mittal, "Explosion Pressure Measurement of Methane-Air Mixtures in Different Sizes of Confinement", Journal of Loss Prevention in Process Industries, Vol. 46, March 2017, pp. 200-208.

20. P. Punetha, P. Mohanty and M. Samanta, "Microstructural Investigation on Mechanical Behavior of Soil-Geosynthetic Interface in Direct Shear Test", Geotextiles and Geomembranes, 2017, DOI: 10.1016/ j.geotexmem.2017.02.001.

21. R. Gupta and P.K. Yadav, "Reliability Analysis of Distributed Computing System using Fault Tree Analysis", CiiT International Journal of Networking and Communication Engineering, ISI Vol. 8, No. 8, August 2016, pp. 286-291, ISSN: 0974 – 9713.

22. R. Palla, S.R. Karade, G. Mishra, U. Sharma and L.P. Singh, "High Strength Sustainable Concrete using Silica Nanoparticles", Construction and Building Materials, Vol. 138, 2017, pp. 285-295.

23. Santha Kumar G and A.K. Minocha, "Studies on Thermochemical Treatment of Recycled Concrete Fine Aggregates for Use in Concrete", Journal of Material Cycles and Waste Management, Springer, March 2017, published online, DOI 10.1007/ s10163-017-0604. ISSN: 1438-4957.

24. Surendra Beniwal, Debdutta Ghosh and Abhijit Ganguli, "Ultrasonic Imaging of Concrete using Scattered Elastic Wave Modes", NDT & E International, Vol. 82, 2016, pp. 26-35, DOI: 10.1016/ j.ndteint.2016.04.003.

25. S. Patel, Ajay Chourasia, S.K. Panigrahi, J. Parashar, N. Parvez and M. Kumar, "Damage Identification of RC Structures using Wavelet Transformation", Procedia Engineering, Vol. 144, pp. 336-342, published online.

26. S. Rajput, L.P. Singh, C.U. Pittman and D. Mohan, "Lead (Pb^{2+}) and Copper (Cu^{2+}) Remediation from Water using Superparamagnetic Maghemite (ã-Fe_2O_3) Nanoparticles Synthesized by Flame Spray Pyrolysis (FSP)", Journal of Colloid and Interface Science, Vol. 492, 2017, pp. 176-190.

27. T.J. Saravanan, G.V.R. Rao, J. Prakashvel, N. Gopalakrishnan, N. Lakshmanan and C.V.R. Murty, "Dynamic Testing of Open Ground Storey Structure and In-Situ Evaluation of Displacement Demand Magnifier", ASCE Journal of Performance of Constructed Facilities, Vol. 31, No. 5, 2017, 04017055-1: 20.

28. T.J. Saravanan, N. Gopalakrishnan and N.P. Rao, "Experiments on Coupled Axial-Flexural Wave Propagation in a Sagged Rod with Structural Discontinuity using Piezoelectric Transducers", Journal of Vibration and Control, 2017, pp. 1- 15, DOI: 10.1177/ 1077546317693431.

29. T.J. Saravanan, N. Gopalakrishnan and N.P. Rao, "Detection of Damage through Coupled Axial-Flexural Wave Interactions in a Sagged Rod using Spectral Finite Element Method", Journal of Vibration and Control, 2016, pp. 1-20, DOI: 10.1177/ 1077546316630855.

National Journal

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Agreement
Signed

Agreement Signed

CSIR-CBRI, Roorkee signed an agreement with NTPC Ltd. on June 7, 2016 for utilization of fly ash through geo-polymer technology in the construction sector (buildings/roads). Dr. N. Gopalakrishnan, Director CSIR-CBRI emphasized on the implementation of geo-polymer concrete technology in the field. The main aim is to upscale the lab scale development of fly ash- based geo-polymer concrete and also to implement it in the field as an alternative to cement concrete. Geo-polymer concrete with target strength of M 30, M 40 and M 50 will be used in the work. Fresh & hardened properties, leaching and durability studies of these design mixes will be studied. Based on the lab scale developed know-how, field trial of geo-polymer concrete pave at NTPC, Dadri will be undertaken to demonstrate its suitability in the field.

Earlier, the Institute undertook a systematic study on the development of heat and ambient cured geo-polymer using fly ash as a precursor. In view of variability in the constituents of fly ash, the property optimization of geo-polymeric pastes was carried out as a function of activator concentration and its dosage, water-geo-polymer solid ratio, curing time and curing temperature. Geo-polymerisation reaction, thermal stability, identification of bond linkages and micro structural features were analysed by various techniques such as quasi isothermal DSC, TGA, FTIR and FESEM. The durability of geo-polymer pastes/concrete was also studied in terms of aggregate reactivity and deterioration against acidic and sulphate attacks. The suitability of these geo-polymer pastes was assessed in making various geo-polymeric products such as mortars and concrete, bricks, solid and hollow blocks, insulation concrete, foam, sandwich composites and temperature resistant coatings. The technology is ready for commercialization.Considering the “zero waste objective”, geo-polymer technology is capable of utilizing huge amount of fly ash as it can be produced from the fly ash as a major constituent. The concrete is cured at ambient condition and also requires no water during curing. The main advantages of using geo-polymer concrete are its high early compressive strength, low permeability, good chemical resistance and excellent fire resistance behaviour. Because of these properties, geo-polymer is a promising candidate for producing building materials, concrete, structural elements etc.

Technology Transferred

TECHNOLOGY TRANSFERRED

- CSIR-CBRI, Roorkee has developed the technology for the manufacture of a 'Metallic Composite Fire Door' for up to two-hours fire resistance rating. Uninterrupted spread of fire in buildings is one of the major issues responsible in increasing the quantum of direct and indirect fire losses. Door openings, by necessity breach compartment walls allowing failure of integrity and insulation causing fire to spread uninterrupted. It is therefore essential to restrict spread of fire to achieve the required degree of containment. Failure to do so may cause considerable loss of life and property. A fire door with a specific fire-resistance rating is used as part of a passive fire protection system to reduce the spread of fire from one compartment to other and to enable safe egress from occupancy. The Fire Resistant Door developed by the Institute meets all the three criteria i.e. stability, integrity and thermal insulation of fire resistance rating as per BS 476 Pt. 20 & 22, IS 3614 Pt 2. It has low thickness and the materials used in the development are indigenously available. The major application of the technology is in buildings and industries for the confinement of fire and providing fire safe escape routes to the occupants. The Fire Resistant Door is a powerful societal impact with its usefulness in fire loss minimization in different types of occupancies and in the reduction of the fatal injuries to occupants by providing safe escape routes. CSIR – Central Building Research Institute, Roorkee transferred the technology of Fire Resistant Door for commercialisation to M/s Shakti Hormann Limited, (Regd Office Plot No-20, Sripuri Colony, Karkhan, Secunderabad-500 015) on a non-exclusive basis for a period of ten years in India only on July 27, 2016.
- CSIR – Central Building Research Institute, Roorkee transferred the technology of 'Ambient Cured Geopolymer for making Concrete & Building Materials' for commercialization to Kiran Global Geocements Limited, Chennai.

Patents Granted

PATENT GRANTED

S. No	Title	Inventors	Application No.	Grant Date	Patent No.
1.	A Process for the Manufacture of Rice Husk-Thermoplastic Composites, Composites made thereby for making Extruded Sheets / Profiles and Products thereof	Dr. Brijeshwar Singh, Dr. Manorama Gupta	2193DEL2008	September 27, 2016	275932
2.	A Process for the Manufacture of Pine Needle Isocyanate Prepolymer Composite Boards/Panels and Products thereof	Dr. Brijeshwar Singh, Dr. Manorama Gupta, Ms. Monika Chauhan, Ms. Naseeba Khatoon	0531DEL2010	November 28, 2016	277636

Students' Visits

Students' Visits

S. No.	Details	Date
1.	20 Civil Engineering Students, G.B. Pant University, Pantnagar	April 1, 2016
2.	55 Soldiers of Gorkha Regiment of Indian Army	April 4, 2016
3.	42 Civil Engineering Students, Roorkee Institute of Technology, Roorkee	April 11, 2016
4.	9 Civil Engineering Students, Mehar Chand Polytechnic College, Jalandhar	August 11, 2016
5.	30 Participants of Institute of Technology, Roorkee attended a workshop on "Earthquake Resistant Low Cost Houses"	September 20, 2016
6.	12 Students / Research Scholars, TERI University, Delhi	October 3, 2016
7.	12 Architecture Students, RIMT College of Architecture	October 6, 2016
8.	23 Civil Engineering Students, Stalion College of Engineering, Saharanpur	October 18, 2016
9.	25 B. Arch. Students, Department of Architecture, Indian Institute of Technology, Roorkee	October 20, 2016
10.	22 Engineering Students, NITTTR, Chandigarh	October 20, 2016
11.	120 Students, Kendriya Vidyalya No. 1, Roorkee	October 20, 2016
12.	120 Students, Kendriya Vidyalya No. 1, Roorkee	October 21, 2016
13.	33 M. Tech Students, NITTTR, Chandigarh	October 21, 2016
14.	120 Students, Kendriya Vidyalya No. 1, Roorkee	October 24, 2016
15.	20 Students, NIIT, Najibabad	November 4, 2016
16.	44 Students, Roorkee College of Engineering, Roorkee	February 3, 2017
17.	51 Civil Engineering Students, Roorkee College of Engineering, Roorkee	February 10, 2017
18.	51 Civil Engineering Students, Roorkee College of Engineering, Roorkee	February 13, 2017
19.	37 Engineers, UPRNN Ltd.	February 23, 2017
20.	30 Architecture Students, Ansal School of Architecture	March 1, 2017
21.	55 Civil Engineering Students, SSVGI, Bareilly	March 6, 2017
22.	10 M. Arch. Students and Faculty, Department of Architecture, Indian Institute of Technology, Roorkee	March 29, 2017

Training Programmes Organized

TRAINING PROGRAMMES ORGANIZED

S. No.	Programme	Organized at	Participating Institute/Organization	No. of Participants	Date of Programme
1.	Orientation Programme	CSIR-CBRI, Roorkee	For newly recruited Scientists of CSIR-CBRI, Roorkee	15 Scientists	April 7-9, 2016
2.	Training Programme on "Low Cost Construction Technologies & Waste Water Disposal System"	Daulatpur	For Fisheries Department and Haridwar District Administration	95	April 16, 2016
3.	Training Programme on "Construction of Affordable Housing"	Mysore	In association with Mysore Nirmiti Kendra	150 Junior Engineers, Supervisors, and Masons from all over Karnataka	May 13, 2016
4.	Workshop on "Durable Eco-friendly and Affordable Housing under Rural Housing Schemes"	Bhubaneshwar	For Panchayat Raj Department of Odisha	70	May 18, 2016
5.	National Training Programme on "Control Measures for Landslides"	CSIR-CBRI, Roorkee	In collaboration with NIDM, New Delhi	33 Officials from Tamil Nadu, Karnataka, Madhya Pradesh, Jammu & Kashmir, Chandigarh, and Delhi	July 18-22, 2016
6.	Training Programme on "Design and Construction of Earthquake Resistant Houses in Kinnaur Region of Himachal Pradesh"	Bachat Bhawan, Reckong Peo, Kinnaur, Himachal Pradesh	In collaboration with the Himachal Pradesh State Council of Science, Technology, and Environment (HPSCST&E)	150 trainees consisting of Junior engineers and Masons/ Contractors.	July 27-29, 2016
7.	National Workshop on "Advances in Repair and Rehabilitation of Concrete Structures"	CSIR-CBRI, Roorkee		230	September 22-23, 2016
8.	Workshop-Training-cum-Motivational Programme for Teachers	CSIR-CBRI, Roorkee	Methodist Girls PG College, KLDAV (PG) College, SSDPC Girls (PG) College, Greenway Modern Senior Secondary School, Children's Senior Academy, CBRI Junior High School, Kendriya Vidyalaya No. 2 and Mount Litera Zee School	27 Faculty Members	October 5, 2016
9.	Science Fest, Open Day, and Technical Exhibition	CSIR-CBRI, Roorkee	KLDAV (PG) College, SSDPC Girls PG College, Greenway Modern Senior Secondary School, and Children's Senior Academy	200 College and School Students along with their Faculty Members	November 3, 2016

S. No.	Topic of Programme	Organized at	Participating Institute/Organization	No. of Participants	Date of Programme
10.	Workshop-cum-Training Programme for Students	CSIR-CBRI, Roorkee	Motherhood University, Doon Public School, and Shivalik Ganges Public School	200 Diploma and Science Students along with their Faculty Members	November 30, 2017
11.	Mass Awareness Programme on "Low Cost Housing and Skill Development"	Mandi, Himachal Pradesh	for Masons	60 Masons	December 29-30, 2016
12.	Training Programme on "Earthquake Resistant Housing and Sanitary Latrine"	Rural Areas of Mandi, Himachal Pradesh	in collaboration with District Administration of Mandi, HPSDMA, Red Cross Society and UNDP	About 50 Masons and other Officials	December 30-31, 2016
13.	Training Programme on "Design and Construction of Cost-Effective and Earthquake Resistant Houses"	Bharatpur, Rajasthan	Lupin Human Welfare and Research Foundation, working masons from 30 adjoining Villages	130 Masons of about 30 Villages and Officials from Lupin Human Welfare and Research Foundation	January 30-31, 2017
14.	Science Exhibition by Students	CSIR-CBRI, Roorkee	Shivalik Public School, Aanand Swaroop Arya Saraswati Vidya Mandir, Children's Senior Academy and Doon Public School	100 Science Students	February 10, 2017
15.	Residential Capacity Building Programme on "Good Construction Practices for Assistant Resident Engineers(ARE) of UPRNN Ltd., Lucknow"	CSIR-CBRI, Roorkee	UPRNN Ltd.,	38 Assistant Resident Engineers	February 20 - March 06, 2017
16.	Training Programme on "Design and Construction of Earthquake Resistant Houses in Kangra region of Himachal Pradesh"	Palampur, Kangra, Himachal Pradesh	(in collaboration with the Himachal Pradesh State Council of Science, Technology, and Environment (HPSCST&E))	110	February 21 - 22, 2017
17.	Workshop-cum-Training Programme	CSIR-CBRI, Roorkee	Kendriya Vidyalya No. 1, Kendriya Vidyalya No.2,	250 Science Students along	February 23, 2017

S. No.	Topic of Programme	Organized at	Participating Institute/Organization	No. of Participants	Date of Programme
18.	Workshop-Training-cum-Motivational Programme for Teachers	CSIR-CBRI, Roorkee	Kendriya Vidyalaya No. 1, Kendriya Vidyalaya No. 2, Shivalik Public Senior Secondary School, Laksar Road, Roorkee, Espee Global School, Children's Senior Academy, Roorkee and Children's Senior Academy, Mangalore	30 Faculty Members	February 27, 2017
19.	Student Awareness Programme	CSIR-CBRI, Roorkee	Quantum School of Technology, Roorkee	100 B. Tech 1st year Students along with their Faculty Members	March 28, 2017

Honours & Awards

HONOURS & AWARDS

1. Dr. Ashok Kumar, Senior Principal Scientist, was
   - Awarded Doctor of Philosophy (Ph.D.) on his thesis entitled "Performance Evaluation and Green Retrofit Strategies for Buildings in Composite Climate" from IIT Roorkee on September 30, 2016.
   - Nominated by International Energy Agency, France as Member of the Reputed Panel of Experts from India to review a "Special Report on the Energy Efficiency Outlook for India – Sizing up the Opportunity", September 5, 2016.
   - Nominated by International Institute for Management Development (IMD), Lausanne, Switzerland as Member of the Reputed Panel of Experts from India for the IMD World Competitiveness Yearbook 2016.
   - Nominated by Director, CSIR-CBRI, Roorkee as Member of the reputed Panel of Experts to prepare "Building Byelaws/Regulations for the Vulnerable Regions", for the state of Uttarakhand during September, 2016. The scope of the Committee was to suggest Policy Recommendations and Reforms in the Existing Scenario.
   - Received Architectural Engineering Division Prize for the Best Paper published in The Refereed SCI Journal of The Institution of Engineers (India) for the paper "Evaluation on Thermal Behavior of a Green Roof Retrofit System Installed on Experimental Building in Composite Climate of Roorkee, India" published in the Series 'A' Journal of IEI, Vol. 96, Issue 4. The Certificate and the Medal was presented during the Prize Distribution Ceremony in the 31st Indian Engineering Congress held at Kolkata on December 16, 2016.
2. Mr. R.S. Chimote, Chief Scientist received a token appreciation of "Distinguished Services" by Standing Fire Advisory Committee during its meeting held on January 6-7, 2017 at Mumbai under the auspices of Secretary (FS, CD &HG), Ministry of Home Affairs, New Delhi and Directorate of Fire Services, Mumbai.

3. Dr. S.R. Karade, Senior Principal Scientist, received "Best Paper Award" for the paper entitled "Performance of Cementitious Anodes for Cathodic Protection of RC Structures", presented in Cathodic Protection Summit, New Delhi, on May 27-28, 2016.
4. Dr. Ajay Chourasia, Principal Scientist, was awarded "Eminent Engineer-2015" by Hon'ble CM Mr. Harish Rawat on December 14, 2016 at 6.00 pm in Dehradun for his significant R&D contribution in civil engineering and transforming it into the field. The award was declared by Uttarakhand State Center of The Institution of Engineers, Dehradun on the occasion of 49th Engineer's Day. The formal announcement was made by Hon'ble Speaker Uttarakhand Legislative Assembly Mr. G.S. Kunjwal and Mr. Narendra Singh, Chairman CVDB and Council Member IEI.

Services Rendered & Visits Abroad

SERVICES RENDERED

- A team of researchers consisting of Dr. Anuj Kumar, Mr. Y. Pandey, Dr. Ashok Kumar, and Mr. Abhishek Singh have worked on the "Ventilation Management System of Shree Jagannath Temple, Puri, India" to avoid malfunctioning and failure of the exhaust fans provided at top of the temple, approximately 61m high from the ground. To overcome this problem, a wireless sensor network based ventilation management system in compliance with IEEE 21451 and ASHRAE 62 standards is developed. The ZigBee communication module for transmitting the real-time data to control room is used. The machine-to-machine communication of the exhaust fans and PC with the sink node is implemented. The developed system is capable of real-time monitoring of exhaust fans running information parameters such as air flow, vibration, rpm, and load, etc. Visual Studio C# language is used in the development of Graphical User Interface (GUI) apps. The exhaust fans real-time information and environmental parameters values are displayed on the GUI. The system is low cost, energy efficient, and easy to operate with high accuracy.

VISITS ABROAD

- Mr. R.S. Chimote, Chief Scientist visited USA during October 4-7, 2016 to take up new challenges and follow-up for capacity/capability building at CSIR-CBRI, Roorkee for societal Benefits through innovative fire loss prevention R&D through rapid fire extinguishment technology development with local logistics support from USA.
- Dr. Ajay Chourasia, Principal Scientist visited Concordia University, Montreal, Canada during February 22-March 5, 2017 for structural health monitoring of tall buildings using vibration based techniques.
- Dr. Ajay Chourasia, Principal Scientist as a Member of EdCIL, Ministry of HRD visited Nepal during November 21-25, 2016 to explore possibility for reconstruction of schools in Nepal.
- Dr. L.P. Singh, Principal Scientist visited U.K. during August 2016 to present the outcome of the Indo-UK project entitled "Studies on Nano-Engineered Cementitious and Polymeric Binders in developing High Performance Building Materials" during the 13th International Congress on the Deterioration and Conservation of Stone, University of the West Scotland, Paisley, Scotland, U.K.

Lectures Delivered

LECTURES DELIVERED

1. Mr. R.S. Chimote, Chief Scientist, delivered lectures on

    - "Fire Fighter's Safety" as an invited panelist at the "Fire Safety India Conclave and International Exhibition" held at Goregoan, Mumbai during April 21-23, 2016.
    - Various issues of National Building Code of India and Water-Mist Technology, as an invited panel member on Fire Loss Prevention Forum of India Meeting held at Mumbai during April 29-30, 2016.
    - "Active Fire Protection Measures in Hospital Fire Safety", at AIIMS, New Delhi in January, 2017.

2. Dr. Ashok Kumar, Senior Principal Scientist, delivered lectures on

    - "Green Retrofit Strategies and Present Scenario" at Engineering & Technology of Tamil Nadu state, on August 22, 2016.
    - "Green Retrofitting of Existing Buildings" at Gitam University, Vishakhapatanam (A.P.), on September 15, 2016.
    - "Low Cost Housing" at National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh on September 28, 2016.
    - "Building Byelaws and Development Control Regulations", during a Training Programme organized at CSIR-CBRI, Roorkee on February 23, 2017.
    - "Affordable Housing" at Quantum School of Technology, Bhagwanpur, Roorkee on March 29, 2017.
    - "Urban Planning & Sustainable Development", during a Workshop organized by Uttarakhand Regional Chapter of the Institute of Town Planners, India, on October 20, 2016.

3. Dr. Rajni Lakhani, Senior Principal Scientist, delivered a lecture on "Value added Products using Kota Stone Cutting and Slurry Waste" to the members of the Rajasthan State Pollution Control Board, Jaipur August 22, 2016 and made them aware about the products developed at CSIR- CBRI, Roorkee using Kota stone cutting and slurry waste.

4. Dr. L.P. Singh, Principal Scientist, delivered lectures on

    - "Nanotechnology Application in Construction: A Solution for Sustainable Building" at Ambuja Foundation, Kolkata
    - "Nano-engineered Concrete for High Performance and Durability" at Government College of Technology, Coimbatore, India.
    - "Nano-Bio-Inspired Construction Materials"at Sardar Bhagwaan Singh Post Graduate Institute of Biomedical Science and Research, Dehradun.
    - "Studies on Early Hydration of Tricalcium Siicate" at International Conference on Advanced Materials for Energy, Environment and Health, IIT Roorkee.

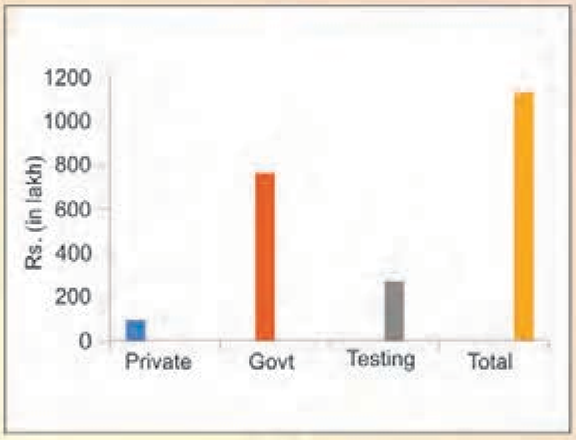
5. Dr. B.M. Suman, Principal Technical Officer, delivered a lecture on, "Control of Heat Gain and Thermal Comfort in Building" on February 28, 2017 at CSIR-CBRI, Roorkee.

Date Line

Date Line

1.	May 11, 2016	National Technology Day
2.	May 13, 2016	Training Programme on 'Construction of Affordable Housing'
3.	May 26, 2016	Dr. N. Gopalakrishnan takes over as Director, CSIR-CBRI
4.	June 5, 2016	World Environment Day
5.	June 21, 2016	International Yoga Day
6.	June 18-22, 2016	Training Programme on 'Control Measures for Landslides'
7.	August 15, 2016	Independence Day
8.	August 20, 2016	Sadbhavna Diwas
9.	September 14-21, 2016	Hindi Week
10.	September 22-23, 2016	National Workshop on 'Advances in Repair and Rehabilitation of Concrete Structures
11.	September 29, 2016	CBRI Celebrates CSIR Platinum Jubilee Foundation Day
12.	October 5, 2016	Workshop-Training-cum-Motivational Programme for Teachers
13.	October 27, 2016	Diwali Mela
14.	October 31, 2016-November 5, 2016	Vigilance Awareness Week
15.	November 3, 2016	Science Fest, Open Day & Technical Exhibition
16.	November 14-27, 2016	CBRI Participated in the India International Trade Fair
17.	November 30, 2016	Workshop-cum-Training Programme for Students
18.	December 7-11, 2016	CBRI Participated in the India International Science Festival
19.	December 30-31, 2016	Training Programme on 'Earthquake Resistant Housing and Sanitary Latrine for the Rural Areas of Mandi, Himachal Pradesh'
20.	January 10, 2017	Dr. Girish Sahni, DG CSIR Visits CBRI
21.	January 26, 2017	Republic Day
22.	January 30-31, 2017	Training Programme on 'Design & Construction of Cost-effective & Earthquake Resistant Houses in Bharatpur Region of Rajasthan'
23.	February 10, 2017	CSIR-CBRI Celebrates its Foundation Day
24.	February 10, 2017	Science Exhibition by Students at CSIR-CBRI
25.	February 21-22, 2017	Training Programme on 'Design & Construction of Earthquake Resistant Houses' in Kangra Region of Himachal Pradesh
26.	February 23, 2017	Workshop-cum-Training Programme for Students
27.	February 27, 2017	Workshop-Training-Motivational Programme for Teachers
28.	March 6-8, 2017	CSIR-CBRI participated in Destination NORTHEAST 2017
29.	March 8, 2017	Women's day Celebration
30.	March 28, 2017	CSIR-CBRI organized Student Awareness Programme

Performance/Projects/Human Resource



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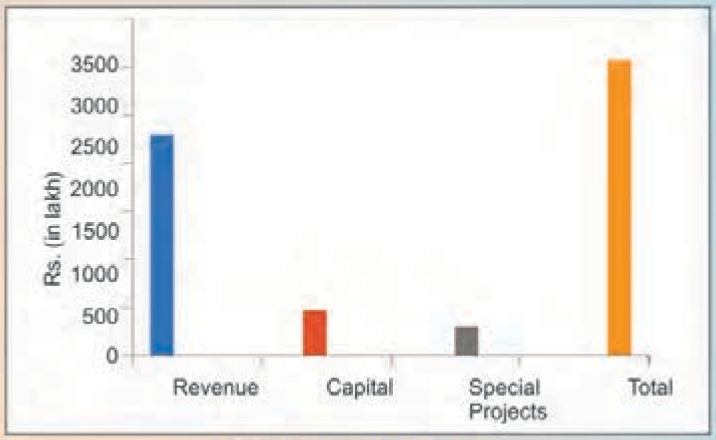
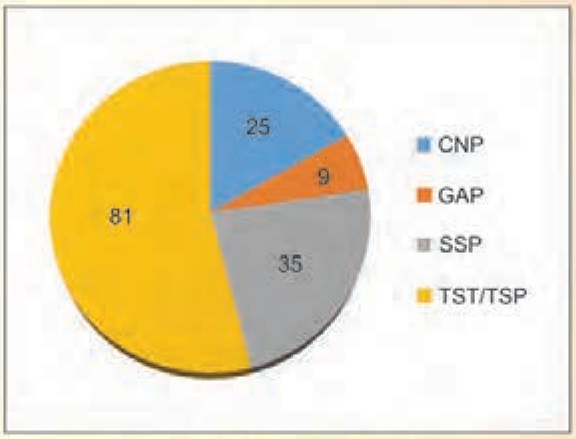
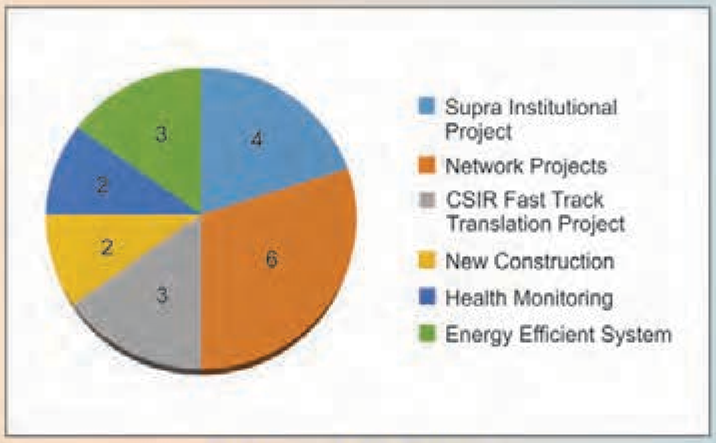


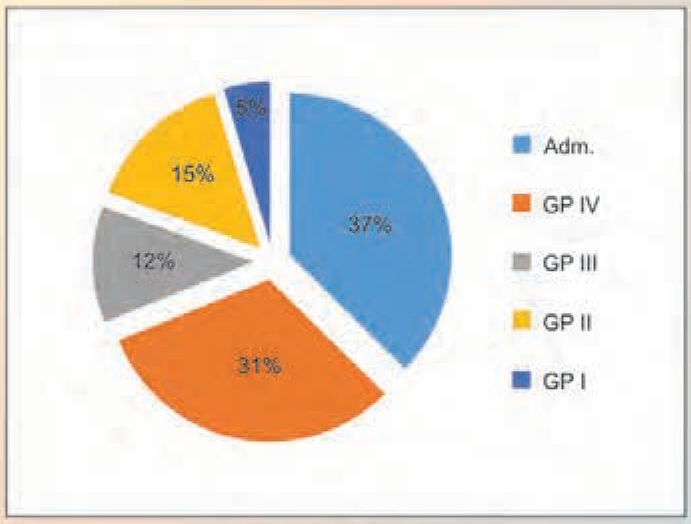
CSIR Resource Input



Externally Funded Projects



In-house R&D Projects



Human Resource

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