# CONTENTS

## CONTENTS

# CONTENTS

# CONTENTS

# fun'kd dh dye l

lh, lvkbvkj&dæh; Hkou vul/kku lLFkku] :Mdh dh o"k 2013&14 dh ok"kd fjikV iLrr djr g, eÖk vR; r g"k gk jgk gA lLFkku u] Hkou rFkk fuek.k m|kxk dh ixfr dk cuk, j[ku d Øe e Hkou vul/kku gr oKkfud vul/kku ,o fodkl] ik|kfxdh fodkl] ik|kfxdh foLrkj] lkekftd xfrfof/k;k] ekuo lk/ku fodkl rFkk jk"Vh; fu;ktu e egRoi.k ;kxnku fn;k gA lLFkku u viuh vul/kku xfrfof/k;k e] miyC/k oKkfud] rduhdh rFkk vk/kkfjd ljpukRed lk/kuk d iu% vkcVu d ek/;e l dN] oLrijd bdkb;k d }kjk oKkfudk dk fopkj&fofue; rFkk rkyey l ifjr dj lex :i l ixfr dh g tk Hkou foKku ,o ik|kfxdh d {k= e cMh pukfr;k dk Lohdkj dju d fy, lLFkku dk ln< dju dk i;kl gA

bl vof/k e lLFkku u nk egRoi.k ifj;ktukvk– ,d lik lLFkxr uVod ifj;ktuk] lLFkku d ie[k leFkrk {k= e rFkk nljk] lLFkku }kjk uVod ifj;ktuk dk leUo; fd;k x;k gA ft le cgr&lh lg;kxh i;kx'kkykvk }kjk ifrHkkfxrk dh xbA ;g lLFkku] nljh lg;kxh i;kx'kkykvk }kjk lefUor dh tku okyh Ng uVod ifj;ktukvk e Hkh ifrHkkfxrk dj jgk gA

fofHkUUk od idtk d ek/;e l uDLV tuj'ku xhu fcÇYMX l **(INMATE)** gr 'uohu lkexh ,o lkefx;k ij **'lik lLFkxr uVod ifj;ktuk ¼SINP½'** dk; fd;k x;kA **'uuk ik|kfxdh d ek/;e l lkexh d fu"iknu e of)'**] bl od idt d vUrxr flfydk uuk d.kk dk feyku l Vkbflfydv dh 'k:vkrh ty;ktu voLFkk ij v/;;u] uuk ik|kfxdh d mi;kx l cg dk;kRed yiuk dk fodkl] Åtk n{k Hkouk gr Qt lkexh ij v/;;u fd, x,A **'l/kkj.kh; fuek.k d fy, uDlV tuj'ku dØhV'**] od idt e] ft;k&ikfyej dØhV e icyu NMk dk vkc/k 0;ogkj ij v/;;u] io'; dØhV d fodkl dk dk; fd;k x;k FkkA **'xhu fcÇYMx ik|kfxfd;k'**] od idt d vrxr] dk;ky;k d Hkouk d fy, xhu jVkfQV uhfr;k ij v/;;u] 'khr tyok; {k= d fy, lkyj ÇoMkfLVe dk fodkl] l/kkj.kh; fuek.k mRiknk gr dPp eky d :i e fo/ol vif'k"Vk dk mi;kx] lkyj Fkey ,;j dMh'uj] Bkl vk|kfxd vif'k"V–flfoy fuek.k gr Hk&lkexh lk/ku] mMu jk[k@/kku dh Hklh@lxejej dh /ky ij vk/kkfjr fofHkUUk vk|kfxd vif'k"Vk d mi;kx l gYd Hkkj oky Cykdk dk fodflr dju dh nf"V l n'k d fofHkUUk Hk&tyok; {k=k gr 'kgjh {k=k e tu vkoklk d fy, ik|kfxdh idt] Lopkfyr [kk[ky ftlle iuy cuku dh e'khu] io fojfpr iuyk rFkk fpukb dk;k e ftlle lheV dk vui;kx] u, Hkouk d fy, nhedjk/kh cfj;j dk fodkl l lcf/kr dk; fd, x, FkA 'tkf[ke e deh dju d fy, lkefx;k',o ik|kfxd;k'] od idt e] LVhy icfyr dØhV ljpukvk d fy, Lon'kh dFkkfMd lj{k.k i.kkyh ij v/;;u] icfyr dØhV ?kVdk dk iHkko 0;ogkj] Qk;j lQ ikfyefjd dEikftV iuy dk fodkl rFkk fcYV ,uok;jueV 'olu d.kk dk de dju d fy, mUukr lokru i.kkyh d vfHkdYi ,o fodkl dju d mÌ'; l Dyhuj fcYV ,uok;jueV gr dk; fd, x,A

fofHkUUk idtk d ek/;e l **'bthfu;çjx vkQ fMtkLVj fefVx'ku ,M gYFk ekuhVçjx Qkj lQ ,M LekV fcYV ,uok;jueV'** ¼**EDMISSIBLE**½ ij uVod ifj;ktuk tkjh jghA **bthfu;jh vkQ yMLykbM fMtkLVj fefVx'ku** e db lg;kxh i;kx'kkyk, lfEefyr gA fofHkUUk ifrHkkxh i;kx'kkykvk }kjk dh xb xfrfof/k;k e % pekyh& tk'kheB {k= ¼x<oky fgeky;½ dk HkL[kyu vkink rFkk tkf[ke fu/kkj.k ¼lh, lvkbvkj&lhchvkjvkb½] pekyh& tk'kheB {k=] x<oky fgeky; e HkL[kyu gr io prkouh midj.k ,o fu.k; idt ¼lh, lvkbvkj – lhchvkjvkb½] pekyh& tk'kheB {k=]

x<oky fgeky; e tkf[ke fu/kkj.k gr] thih,l vk/kkfjr lefUor HkdEi ekMÇyx ¼lh,lvkbvkj&lh,e,e,lh,l½] ,l ,vkj bVjQjkeVh d mi;kx lHkL[kyu ick/ku ¼lh,lvkbvkj&lh,lvkbvk½] HkL[kyu ick/ku d fy, vkflVdy Qkbcj vk/kkfjr eYVhlyDl llj uVod dk fodkl ¼lh,lvkbvkj&,ubvkb,lVh½] pekyh&tk'kheB {k= x<oky fgeky; e cgr Hk&vUo"k.k rFkk HkL[kyu d fu;=.k mik; ¼lh,lvkbvkj&lhchvkjvkjvkb½] HkL[kyu vkink lpuk i.kkyh rFkk HkL[kyu fu;=.k vfHkdYi d vfHkuo mik; ¼lh,lvkbvkj – lhvkjvkjvkb½ ,o igkMh {k=k e HkL[kyu U;uhdj.k rFkk <yku fLFkjrk leL;kvk d fy, Qk;VkjehfM,'ku vkl'ku ¼lh,lvkbvkj&uhjh½ }kjk ifrHkkfxrk dh xb gA

**'HkdEi vkink U;uhdj.k bthfu;jh'**] od idt e Jhuxj d Hkdih; l{e vu{k= ij v/;;u] xfrd ik'oHkkj.k d vrxr ikbyk dk Hkdih; 0;ogkj] v/kLFkfrd fLFkfr d vrxr ifj:) fpukb Hkouk dk fu"iknu fd;k x;k gA **'vfXu vkink U;uhdj.k bthfu;jh**] od idt e] yk vktku fMiy'ku ikVf'k;y bUUkkofVo Qk;j lijLlufllVe] Qk;j ijQkjel boY;,'ku vkQ LVDpjy ,fyeV ,Mfjgfcfy,'ku mik;k dk dk; py jgk gA **'ikLV fMtkLVj 'kyVj lyk¢ux'**] od idt e] if'Pkeh fgeky; e xkeh.k {k=k gr vkink d i'Pkkr vkJ; fu;ktu ¼lh,lvkbvkj&lhchvkjvkjvkb½] ck< ihfMr ykxk d fy, vkink d i'Pkkr vkJ;k ij v/;;u¼lh,lvkbvkj&,ubvkb,lVh] tkjgkV½ tkjh j[k x,A **'gYFk ekuhVçjx vkQ fc¢YMX l ;¢tx ok;jyl llj uVod'** od idt e] ok;jyl llj uVod dk mi;kx djrg,gYFk ekuhVçjx ,ikp d dk;kUo;u ij v/;;u] jh;y&ykbQ fc¢YMX l ij U;efjdy ,ukfyfll ,o ekMy viMÇVx rFkk **'bVfytV fc¢YMx fllVe Qkj ekMy jftMfl;y ;fuV'**] od idt d vrxr bVfytV ,poh,lh ,M ykbÇVx dVkYl bu jlikl V ,fEc,V ,uok;jueV] Xykl QdM Dyh¢ux jkckfVd fllVe ¼lh,lvkbvkj – lhchvkjvkjvkb½ dk dk; ixfr ij gA

uVod ifj;ktuk e] ftle lh,lvkbvkj – lhchvkjvkjvkb lgHkkxh i;kx'kkyk g] mMujk[k dk mi;kx djd ikuh l Hkkjh /kkrvk dk gVkuk rFkk bl mi;kxh Hkou ?kVdk d fuek.k e mi;kx djuk ¼ukMy i;kx'kkyk lh,lvkbvkj&uhjh½ Hkfexr [knkuk e Ql dk;y dh b"Vre fudkl h gr —f=e [kEHkk d fy, lefpr lgk;d i.kkyh dk fodkl ¼ukMy i;kx'kkyk lh,lvkbvkj&lhvkb,e,Qvkj½ ij v/;;u fd, tk jg gA dk;yk [knkuk e Ql dk;y dh fudkl h dh ifj;ktuk ijh gku ij] bl viuku l dkQh le; l pyh vk jgh jk"Vh; leL;k dk fujkdj.k gku dh vk'kk gA x<oky fgeky; dh Hki"Bh; fo—fr dk v/;;u x<oky d igkMh {k=k d fy, fd;k tk jgk g ¼ukMy i;kx'kkyk – lh,lvkbvkj&lh,e,e,lh,l½A flfoy ljpukvk d vuj{k.k ,o l{e fujh{k.k dh nf"V l Hkouk ,o vU; ljpukvk gr l£ol jkckV ifj;ktuk ,d cgr mi;kxh ifj;ktuk g] ukMy i;kx'kkyk lh,lvkbvkj&lh,ebvkjvkb½A

lh,lvkbvkj ukyt xVo ,o vkiu lkl ikboV DykmM bUÝkLVDpj ifj;ktuk ¼ukMy i;kx'kkyk lh,lvkbvkj – fuLd;j½ lpuk foKku DyLVj dh 12 oh ipo"kh; ;ktuk d vrxr] lh,lvkbvkj dh uVoÉdx ifj;ktukvk e l ,d gA

lLFkku Hkou bthfu;jh ,o vkink U;uhdj.k ¼chbMh,e½ d {k= e lefUor Lukrdkÿkj&ih,pMh dk;Øe pyk jgk gA Nk=k d pkFk cp dh d{kk,bl le; lLFkku e py jgh gA bl dk;Øe d rhljcp d Nk= 'kk/k ic/k r;kj dj jg gA

26 flrEcj 2013 dk vk;kftr 71 oLFkkiuk fnol d volj ij gekjk nk lkfFk;k dk] e[;ky; ,o lLFkku dh bvkjh Vhe d lkFk leUo; ,o dBkj ifjJe d fy,] lh,lvkbvkj e[;ky; }kjk 'ikt DV pfEi;u vkQ bvkjh vokM' inku fd;k x;kA

lh,lvkbvkj& lhchvkjvkb u fiNy o"kk dh Hkkfr vud viu lLFkkfud ¼bugkm l½ vul/kku ,o fodkl dk;Øek d lkFk&lkFk cgr lh lfonk vul/kku ifj;ktuk ij ik"k.kh;rk ¼lLVucfyVh½ d lHkh igyvk dk/;ku e j[kr g, dk; fd;kA lLFkku u 16 lLFkkfud vul/kku ,o fodkl ifj;ktukvk] 9 ijke'kh] 9 lgk;rk vunku] 20 ik;kftr ,o

59 ijh{k.k ifj;kstukvk ij dk; fd;kA lLFkku u n'k ,o fon'kk l f'k{kk vkj m|kxk d ifrfuf/k;k dk cMh l[;k e vkdz"kr fd;kA

lLFkku u o"k 2013&14 e ljdkjh] lkotfud ,o futh {k= dh ,tfl;k@ lLFkkuk d fy, lfonk vul/kku ,o fodkl] lgk;rk vunku] ijke'kh dk; rFkk rduhdh lgk;rk inku djd yxHkx 5-00 djkM : i, dh /kujkf'k vkr dhA bl vof/k d nkjku fofo/k tuYl ,o lEeyuk dh dk;okgh e dy 100 'kk/k i= idkf'kr g,A o"k Hkj e lLFkku e lHkk"k.k ¼dkykfDo;e½ cBdk e 23 0;k[;ku fn, x,A Hkfo"; dh pukfr;k dk lkeuk dju d fy, Hkou xfrdh i;kx'kkyk dh oreku voljpukRed lfo/kkvk e c<kÝkjh dh x;hA

Nk=k rFkk vke turk dk lLFkku dh vul/kku ,o fodkl xfrfof/k;k d ifr tkx:d dju d fy, lLFkku e jk"Vh; foKku fnol] fo'o i;koj.k fnol] jk"Vh; ik|kfxdh fnol] lh,lvkbvkj LFkkiuk fnol] lh,lvkbvkj&lhchvkjvkb LFkkiuk fnol dk eä fnol d :i e euk;k x;kA

lLFkku dk tulkekU; d fy, [kyk j[ku d lkFk&lkFk fofHkUUk dk;de] LFkkiuk fnol 0;k[;ku] jk"Vh; fnolk dh egÝkk d fo"k; e ykxk dk tkx:d dju d fy, fofHkUUk jk"Vh; fnolk ij i[;kr 0;fä;k d 0;k[;ku vkfn vk;kftr fd, x,A lLFkku e flrcj ekg e Çgnh llrkg euk;k x;kA bl llrkg d nkjku Çgnh fVli.k ,o elknk y[ku ifr;kfxrk] Çgnh fuc/k y[ku ifr;kfxrk] Çgnh i'ukÝkjh rFkk Çgnh y[ku ifr;kfxrk ¼Çgnhrj Hkk"kh dkzedk d fy,½ vk;kftr dh x;hA n'k&fon'k d ykxk d lkFk fujrj lokn ,o lpkj cuk, j[ku d Øe e lLFkku u cMh l[;k e Hkou ,o fuek.k {k= dh fofHkUUk leL;kvk lc/kh iNrkN d mÝkj fn,A Hkou fuek.k d {k= e]u, vul/kku ,o ik|kfxd;k d fo"k; e vke turk d chp tkx:drk ink dju d mÌ'; l in'ku lg if'k{k.k dk;Øek] rduhdh in'kfu;k vkfn dk vk;ktu fd;k x;kA lLFkku u fnYyh fLFkr viu ilkj dæ d lkFk feydj n'k Hkj e dæh;] jkT;] lkotfud@futh {k=k d lxBuk d lkFk lid cuk, j[kkA ;|fi o"k pukfr;k rFkk miyfC/k;k l Hkjk jgk fQj Hkh ge viuh miyfC/k;k ¼ikflr;k½ l vkRel r"V ugh g cfYd vku okyh pukfr;k ,o nkf;Rok dk lkeuk dju d fy, rRij gA

;g lc oKkfud lkfFk;k] rduhdh vf/kdkfj;k ,o i'kklfud dkzedk d dr0;fu"B ,o lPp i;klk d fcuk lHko ugh gk ikrk] ftUgku lkix, dk;k dk lQyrk iod dju d fy, dfBu ifjJe fd;kA e mu lHkh dh gkznd i'klk djr g, mUg 'kHk dkeuk, nrk gA gekjh vul/kku ifj"kn d v/;{k vkj lnL;x.k viu veY; ijke'k] ekxn'ku ,o lgk;rk d fy, fo'k"k /kU;okn d ik= gA e lh,lvkbvkj d egkfun'kd rFkk lh,lvkbvkj e[;k;y; d viu lkfFk;k dk] ge fujrj lg;kx ,o ekxn'ku dju d fy,] l~koiod /kU;okn nrk gA e] bl okzd"kd ifronu d fy, vko';d lpuk miyC/k djku oky lgdz&e;k rFkk bldh mÝke iLrfr d fy, lEiknd dk Hkh /kU;okn nrk gA

vr e] viu eY;oku xkgdk] ik;kt dk] 'kHkÇprdk rFkk lh,lvkbvkj&lhchvkjvkb d lokfuoÝk dkzedk d lg;kx rFkk lgk;rk dk Lej.k djuk ej fy, il UUkrknk;d iy gA

Hkou fuek.k ,o voljpukRed m|kx e of) d lkFk ge mTtoy Hkfo"; dh vkj vxlj gA

uoEcj 20, 2014

एस.के भट्टाचार्य

¼ik- Jheku dekj HkVVkpk;½

# From the Director's Desk

I am extremely delighted to present the Annual Report of CSIR-Central Building Research Institute, Roorkee for the year 2013-14. The Institute has contributed immensely in scientific research and development, technology development, technology dissemination, societal activities, human resource development and national planning for building research in order to sustain the building and construction industries. The Institute witnessed an all-round progress in its research activities through reallocation of available scientific, technical and infrastructural resources into a few, object oriented units to catalyze increased level of interaction and synergy among the scientists. This is an endeavor to strengthen the Institute to take up larger challenges in Building Science & Technology.

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

A **Supra Institutional Network Project (SINP)** on 'Innovative Materials & Technologies for Next Generation Green Buildings (**INMATE**)' was continued through different work packages. In work package, '**Performance Enhancement of Materials through Nanotechnology'**, Studies on early stage hydration of tricalcium silicate in incorporating silica nano particles, Development of multifunctional coatings using Nanotechnology**,** Studies of phase change material for energy efficient buildings were carried out. In work package, **'Next Generation Concrete for Sustainable Construction',** Studies on bond behavior of reinforcing bars in Geo-polymer concrete, Bio concrete as self healing material, Development of pervious concrete 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, Solid industrial waste – a resource geo-material for civil construction, technology packages for mass housing in urban areas for different geo-climatic regions of the country with a view to develop light weight blocks using different industrial wastes based on fly ash/rice husk ash/marble dust, Development of an automatic hollow gypsum panel making machine, Application of gypsum cement in prefabricated panels and masonry works, Development of anti-termite barrier for new buildings were carried out. In work package, **'Materials & Technologies for Hazard Reduction',** Studies on indigenous cathodic protection system for steel reinforced concrete structures, Impact behavior of reinforced concrete elements, Development of fire safe polymeric composite panel, and improved ventilation system for cleaner built environment with an objective to design & develop improved ventilation system to reduce inhalable particles in built environment have been initiated.

**Network Project on 'Engineering of Disaster Mitigation & Health Monitoring for Safe & 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 are : Landslide hazard and risk assessment of Chamoli-Joshimath region, Garhwal Himalaya (CSIR-CBRI), Early warning instrumentation & decision package for a landslide in Chamoli-Joshimath region, Garhwal Himalaya (CSIR-CBRI), GPS based integrated landslide modeling for hazard assessment in Chamoli-Joshimath region, Garhwal Himalaya (CSIR- CMMACS), Landslide monitoring using SAR interferometery (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, Garhwal Himalaya (CSIR-CBRI), Landslide hazard information system and design of innovative measures for landslide control (CSIR-CRRI), 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 behavior of piles under dynamic lateral loading, Performance of confined masonry buildings under quasi-static condition were continued. In work package, '**Engineering of Fire Disaster Mitigation',** Development of low ozone depletion potential innovative fire suppression system, Fire performance evaluation of structural elements and rehabilitation measures are progressing. In work package, '**Post Disaster Shelter Planning',** post disaster shelter planning for rural areas in the Western Himalayas (CSIR-CBRI), Studies on post disaster shelters for flood affected people (CSIR-NEIST, Jorhat) were continued. In work package, **'Health Monitoring of Buildings using Wireless Sensor Network'**, Studies on implementation of health monitoring approach using wireless sensor network, Numerical analysis & modal updating on real-life buildings & under the work package, **'Intelligent Building System for Model Residential Unit',** Studies on intelligent HVAC & lighting controls in response to ambient environment, Glass facade cleaning robotic system (CSIR-CBRI) are progressing.

In a **Network Project** 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), Development of appropriate support system for artificial pillars for optimal extraction of locked-up coal from underground mines (Nodal lab CSIR-CIMFR) are being carried out . The project on locked up coal is expected to resolve a long standing national problem, if made operational. Estimation of crustal deformation of Garhwal Himalaya (Nodal lab CSIR-CMMACS) is being carried out for the hilly areas of Garhwal. Service Robot for building and other structures (Nodal lab CSIR-CMERI) is also a very useful project for precise inspection and maintenance of civil infrastructure. CSIR Knowledge Gateway & Open Source Private Cloud Infrastructure (Nodal lab CSIR-NISCAIR) is one of the Net working projects of CSIR under 12$^{th}$ Five Year Plan of Information Science cluster.

The Institute is offering Integrated Masters-Ph.D. programme in the area of "Building Engineering and Disaster Mitigation" (BEDM). The fourth batch of the programme is currently undergoing their classes in the Institute. The third batch of this programme is currently carrying out their dissertation.

On the occasion of 71st Foundation Day held on 26th September 2013, two of our colleagues have been awarded with "Project Champion of ERP Award" at CSIR - HQ for the hard work put up for project coordination with ERP team of Head Quarter & the Institute.

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. The Institute handled 16 in-house R&D projects, 9 consultancy, 9 grant-in-aid, 20 sponsored and 59 testing projects. The Institute attracted a large number of delegates from academia and industries from all over the country and abroad.

The Institute registered a cash flow receipt of nearly Rs. 5.00 crores during 2013-14, earned through contract R&D, grant-in-aid, consultancy assignments and technical services, carried out for government, public & private sector agencies/organization. During the period, a total of 100 research papers have been published in various journals as well as conference proceedings. As many as 23 lectures were delivered in colloquia meetings in-house during the year. The existing infrastructural facility of building dynamics laboratory was augmented in order to meet the challenges of the future.

The Institute observed open days on the occasion of National Science Day, World Environment Day, National Technology Day, CSIR Foundation Day, CSIR-CBRI Foundation Day to make the students and general public aware with the R&D activities of the Institute. Apart from keeping the institute open for general awareness, different programmes, foundation day lectures, lectures by eminent personalities on different National days to make people aware of the importance of the National days were arranged. The Institute celebrated Hindi week in the month of September. Hindi noting & drafting competition, Hindi essay writing competition, Hindi quiz & Hindi writing competition (for non-Hindi speaking employees) were organized during the week. 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. 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 & responsibilities.

All could not have been possible without 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 Head quarters for their continuous support and guidance.

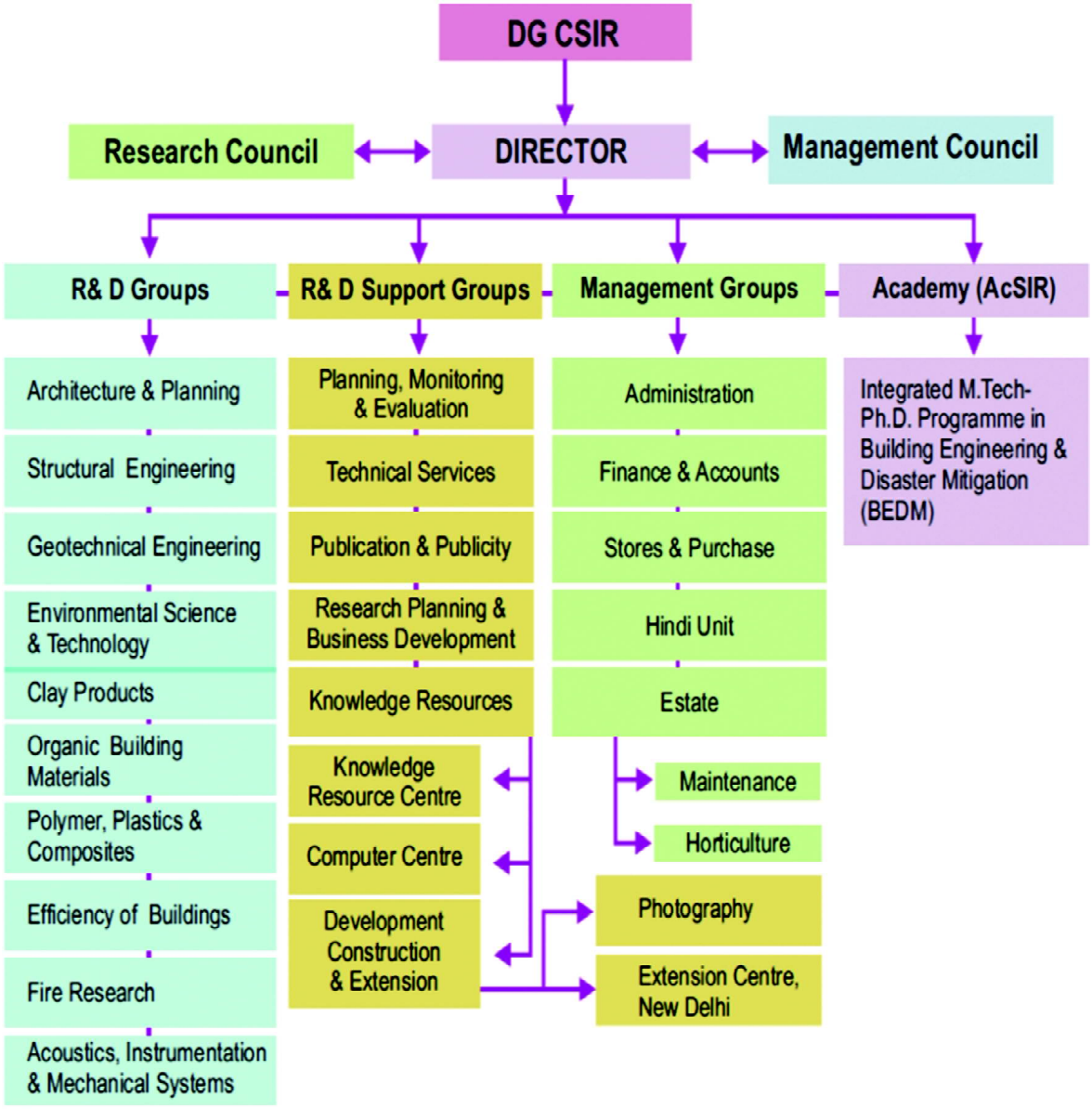
I thank my colleagues for providing the necessary inputs and editor for bringing out this Annual Report in an elegant manner. Last but not the least, it is a happy moment for me to remember the support and co-operation provided by our valued customers, sponsorers, well wishers and ex-colleagues of CSIR-CBRI.

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

Dated: Nov. 20, 2014

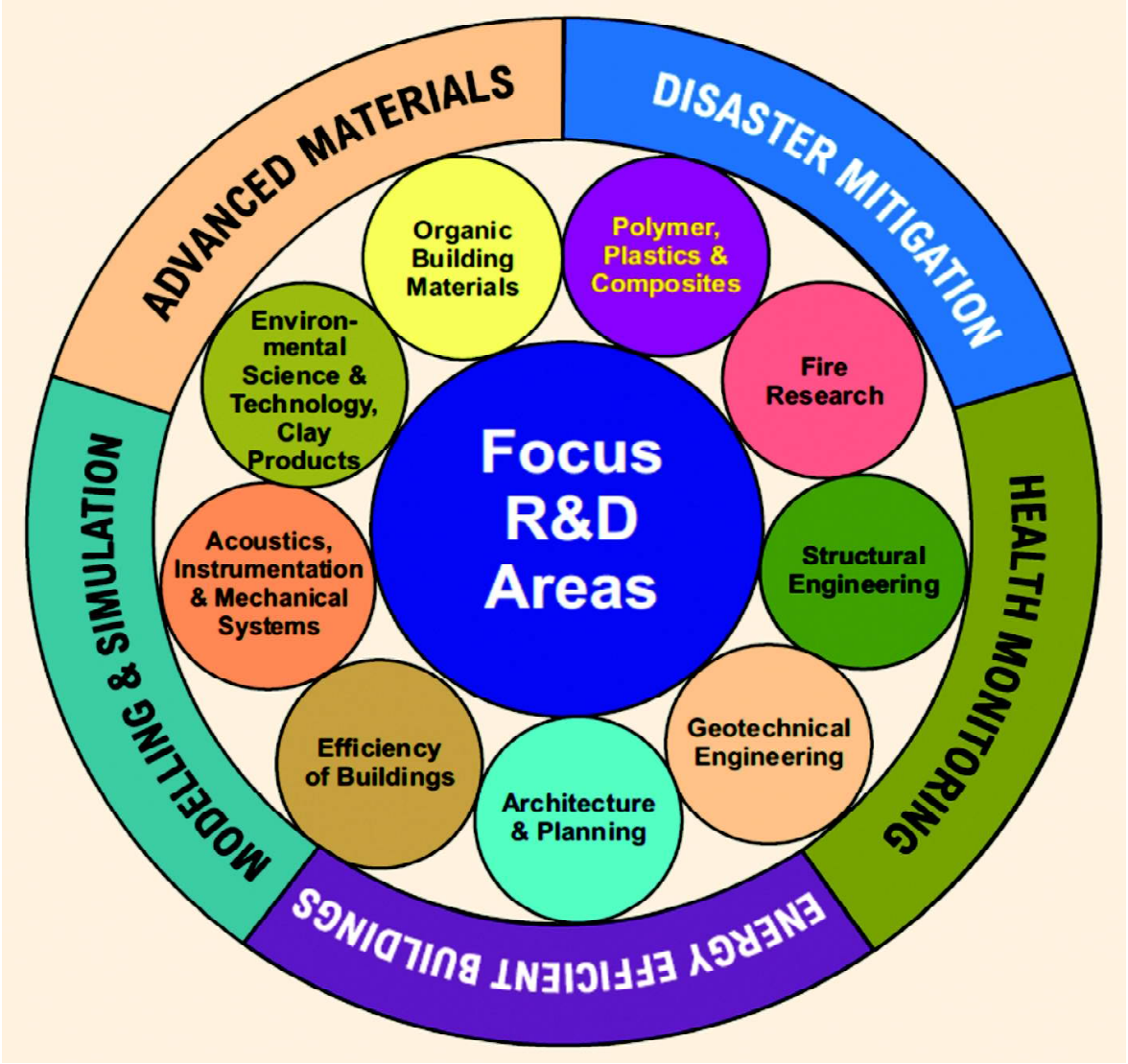
(Prof. S. K. Bhattacharyya)

# CSIR-CBRI ORGANOGRAM



## OUR VISION

CSIR-CBRI 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, fire engineering and disaster mitigation.




## OUR MISSION

To carry 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.

# RESEARCH COUNCIL

## CHAIRMAN

**Prof. Prem Krishna**
Vice President, INAE &
Former Head, Dept. of Civil Engineering, IIT-Roorkee,
61 Civil Lines, ROORKEE

## MEMBERS

**Prof. Bikash Mohanty**
Dept. of Chemical Engineering
IIT- Roorkee
ROORKEE – 247667.

**Prof. Sudhir Mishra**
Dept. of Civil Engineering
IIT- Kanpur
KANPUR–208016.

**Prof. Neelima Risbud**
Head, Dept. of Housing
School of Planning & Architecture
NEW DELHI – 110002.

**Shri P. R. Mehta**
Partner
Design Action Group
NEW DELHI – 110025.

**Dr. Subrato Chowdhury**
Head, R&D, Cement Business
Aditya Birla Group
MUMBAI– 400093.

**Ms. Alpa Sheth**
Partner
Managing Director
VMS Consultants Pvt. Ltd.
MUMBAI – 400020.

**Shri V. P. Baligar**
Chairman & Managing Director
Housing & Urban Development Corp. Ltd.
NEW DELHI – 110003.

**Dr. Nagesh R. Iyer**
Director
CSIR - Structural Engineering Research Centre
CHENNAI – 600113.

**Prof. B. K. Mishra**
Director
CSIR - Institute of Minerals & Materials Technology
BHUBNESHWAR – 751013.

**Dr. S. Gangopadhyay**
Director
CSIR - Central Road Research Institute
NEW DELHI – 110025.

**Prof. S. K. Bhattacharyya**
Director
CSIR - Central Building Research Institute
ROORKEE – 247667.

**Dr. Sudeep Kumar**
Head, Planning & Performance Division
Council of Scientific & Industrial
Research (CSIR)
NEW DELHI – 110001.

## SECRETARY

**Dr. S. Sarkar**, CSIR–CBRI, ROORKEE

# MANAGEMENT COUNCIL

## Chairman

**Prof. S.K. Bhattacharyya**
Director
CSIR - Central Building Research Institute
Roorkee – 247 667

## MEMBERS

**Dr. S. Gangopadhyay**
Director, CSIR - CRRI
Delhi-Mathura Road
NEW DELHI 110 025

**Mrs. Neeta Mittal**
Sr. Principal Scientist
CSIR - CBRI, Roorkee

**Dr. S. R. Karade**
Principal Scientist
CSIR - CBRI, Roorkee

**Dr. P. K. S. Chauhan**
Sr. Scientist, CSIR - CBRI, Roorkee

**Sh. Soumitra Maiti**
Scientist
CSIR - CBRI, Roorkee

**Dr. B. M. Suman**
Pr. Technical Officer
CSIR - CBRI, Roorkee

**Dr. Sunil K. Sharma**
Head PME/RPBD
CSIR - CBRI, Roorkee

**F&AO**
CSIR - CBRI,
Roorkee

## MEMBER-SECRETARY

Administrative Officer
CSIR - CBRI, Roorkee

## INNOVATIVE MATERIALS & TECHNOLOGIES FOR NEXT GENERATION GREEN BUILDINGS (INMATE)

**WP-1: Performance Enhancement of Materials through Nanotechnology.**

**PI: Dr. L. P. Singh** **Task: 04 Nos.**

1.1. Nano-Engineered Cementitious Materials, PI: L. P.Singh, S. K. Bhattacharyya, S. R. Karade & Team

1.2. Multifunctional Coating using Nano-Technology, PI: P.C.Thapliyal & Team

1.3. Enhancing the Fire Retardancy of Polymeric Materials using Nano-Composites, PI: Subham Dastidar, P.C. Thapliyal & L.P.Singh

1.4. Phase Change Materials, PI: Srinivasrao Naik B, L.P. Singh, P. C. Thapliyal & Ashok Kumar

**WP-2: Next Generation Concrete for Sustainable Construction.**

**PI: Er. S. K. Singh** **Task: 04 Nos.**

2.1. Cement free Geopolymer Concrete, PI: B. Singh, M. Gupta & S. K. Bhattacharyya

2.2. Bio-Concrete as Self Healing Material, PI: Leena Chourasia

2.3. Hybrid Fibre Reinforced Concrete, PI: S. K. Singh

2.4. Pervious Concrete for Tropical Climate, PI: R. Deoliya & S. C. Gurram

**WP-3: Green Building Technologies.**

**PI: Ashok Kumar** **Task: 06 Nos.**

3.1. Green Retrofit Strategies for Office Buildings,PI: Ashok Kumar, R. Deoliya, Rajni Lakhani, B.M.Suman & Neeraj Jain

Sub Task 3.1: Development of Solar Window System for Cold Climatic Region, PI: Neeta Mittal & B.M.Suman

3.2. Demolition Wastes, PI: A. K. Minocha, Mridul Garg & Team

3.3. Solar Thermal Air Conditioner, PI: Nagesh B. Balam

3.4. Solid Industrial Waste-Resource Geo–Material, PI: M. Samanta, A. Ghosh, S.Maiti, D. Kumar & Z. Ahmed

3.5. Technology Packages for Mass Housing in Urban Areas, PI: Ashok Kumar, Mridul Garg, R. Lakhani , S.K.Panigrahi, Vivek Sood, B. S. Rawat & Team

Sub Task 3.5.1: To develop light weight blocks using different industrial wastes based on flyash/rice husk ash/marble dust, PI: Vivek Sood & Ashok Kumar

Sub Task 3.5.2: Development of an automatic hollow gypsum panel making machine, PI: S.K.Panigrahi & Team

Sub Task 3.5.3: Application of cement free plaster from fluorogypsum for prefabricated panels and Masonry works, PI: Mridul Garg & Team

Sub Task 3.5.4: Development of anti termite barrier for new Buildings, PI: B.S.Rawat, Ashok Kumar & S. K. Negi.

3.6. Robust foundation for difficult soils, PI: Pradeep Kumar

**WP-4: Materials & Technologies for Hazard Reduction.**

**PI: Dr. S.R. Karade** **Task: 04 Nos.**

4.1. Indigenous Cathodic Protection System, PI: S.R. Karade & Team

4.2. Impact Behaviour of RCC, PI: A.K.Pandey

4.3. Fire Safe Polymeric Composite Panels, PI: Harpal Singh

4.4. Improved Ventilation System, PI: Syed Ibrahim Sohel, A.K. Minocha & Jaswinder Singh

# WP-1

# Performance Enhancement of Materials through Nanotechnology

**L. P. Singh**

**Task 1.1**

## Nano Engineered Concrete: Study on Early Stage Hydration of Tricalcium Silicate in incorporating Silica Nanoparticles.

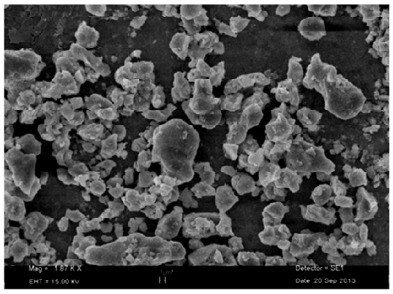
L. P. Singh,
S. K. Bhattacharyya,
S. R. Karade & Team

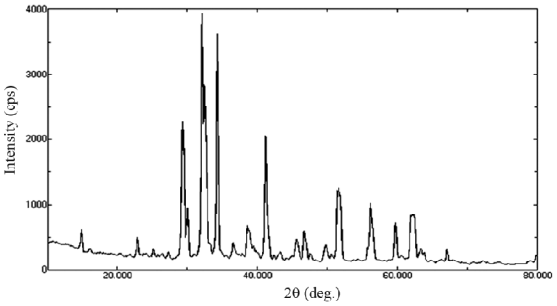
In recent years, applications of nanotechnology in construction sector appear to be a promising approach towards developing high performance cement-based materials. Studies show that the application of nanosilica in cementitious system significantly enhances the compressive strength at early age of hydration. However, the role of nanosilica during the hydration, especially at the induction period of hydration is still not very clear. Therefore, an understanding of the hydration products at the nano-scale is essential for the strategic modification of conventional systems. Several hypotheses have been presented but still no experimental evidences about the role of nanosilica at early stage are available. In the present studies, influence of nanosilica on hydration during pre induction and

induction period of tricalcium silicate ($C_3S$) was carried out.

$C_3S$ was prepared by high-temperature solid-state reaction between calcium carbonate and silicic acid. The starting materials were mixed in the stoichiometric ratio (3:1) and heated up to 1500°C for 12h. The prolong heating at 1500°C is required to obtain a free lime content of ≤0.4 wt. %. Particle size distribution shows that 41% particles having size of 1-10µm, while 59% particles exhibits size of 10-100µm. BET results show that the specific surface area of particles is 3.01$m^2$/g, while XRF analyses show that C/S ratio of particles is 3:1(Fig. 1). SEM results revealed the polygonal structure of particles (Fig. 1), whereas XRD results revealed that the prepared $C_3S$ has triclinic polymorphs (triplet between 2θ = 51-520°) (Fig. 1).

Further, experiments were carried out to study the hydration mechanism at early stage in the presence of nanosilica, by adding laboratory synthesized powder nanosilica (30-70nm) to $C_3S$. The w/c ratio was fixed 0.4 for all the samples. Hydration was stopped at different time intervals starting from 2 to 240 min, which completely covers the pre-induction and induction period of






| | |
|---|---|
| CaO | 74.2% |
| $SiO_2$ | 24.9% |
| 1-10 µ | 40% |
| 10 -100 µ | 59% |
| Specific Surface Area ($m^2$/g) | 3.01 |

**Fig1: Characterization of C3S**

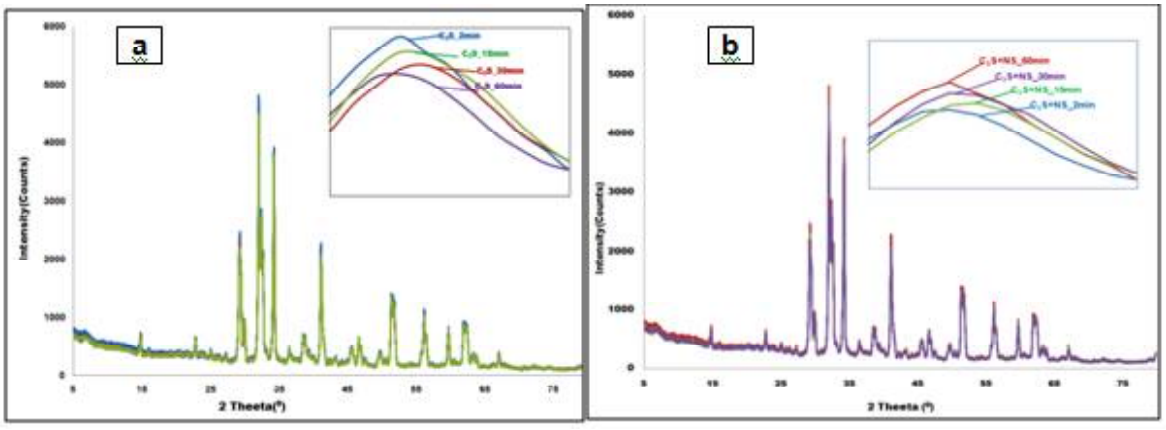



**Fig.2: (a) XRD profile of hydrated pure $C_3S$& (b) Nano silica incorporated hydrated $C_3S$**

hydration at early stage. Detailed XRD studies were carried out for pure and nano incorporated hydrated $C_3S$ system. Each peak shift and intensity was monitored and carefully analyzed (Fig. 2). Characteristic peak of unhydrated $C_3S$ ($2\theta$=~32.0) gets overlapped with the calcium silicate hydrate (C-S-H) peak in hydrated samples. In hydrated $C_3S$ samples the intensity of this peak decreases as hydration proceeds from 2 to 60 min showing the dissolution of $C_3S$ with the time (Fig. 2a). However, in case of nanosilica incorporated hydrated $C_3S$ samples, the intensity of this peak increases with the time (2 to 60min) (Fig. 2b), due to the formation of additional C-S-H, which is not observed during hydration of pure $C_3S$. Therefore, in the presence of nanosilica, a secondary/additional C-S-H is formed at the early stage of hydration as evident by new peak formation and evident for the formation of additional/secondary C-S-H in the presence of nanosilica.

SEM micrographs of hydrated $C_3S$ and nanosilica incorporated C3S samples at different stage of hydration are presented in Fig. 3(a-d). Pure $C_3S$ samples at 30min of hydration shows few hydration products on the surface of $C_3S$ grains (Fig. 3a), and a thin layer is formed around the surface of $C_3S$ grains at 180min (Fig. 3c). In nanosilica incorporated $C_3S$ samples, whole $C_3S$ grain is covered by thin hydrated layer within 30min of hydration (Fig. 3b). At 180min (Fig. 3d) this thin hydrated layer is converted to denser foil like structure. These results revealed that in the presence of nanosilica, hydration process accelerates and more hydrated products are formed due the formation of additional C-S-H, which provides additional nucleation sites during the hydration at early stage.

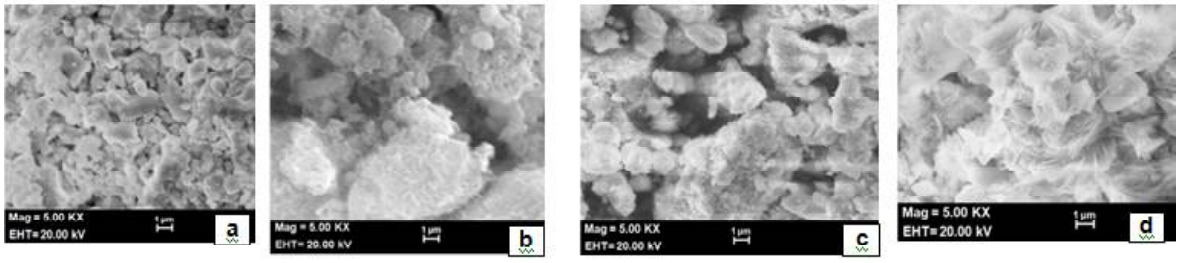



**Fig.3: SEM micrographs of pure $C_3S$ (a&c) and nanosilica incorporated $C_3S$ (b&d) at 30, and 180 min of hydration.**

Task 1.2

# Development of Multifunctional Coatings using Nanotechnology

P.C. Thapliyal

## Progress

**A. Synthesis of nano additives:**

Nano Titania with 40-50 nm size was synthesized using Nano Powder Synthesizer (NPS10) with alkoxide precursor. Further work to reduce the size is in progress.

**B. Preparation of coatings and formulations:**

Preparation of acrylic coatings with/without nano additives - Acrylic coating formulations completed. Work on the preparation of epoxy coatings with/without nanoadditives is in progress. Composition of acrylic coatings formulated is shown below:

- Binder: 30-50%
- Pigments/Fillers: 10-20%
- Mineral system: 10-20%
- Thixotropic agent: 1-2%
- Solvent: 10-20%
- Nano additives: 0-2%

| Coating* | A1 | A2 | A3 | A1N | A2N | A3N |
|---|---|---|---|---|---|---|
| Bond strength (MPa) | 3-3.5 | 3.5-4 | 3-3.5 | 3.5-4 | 3.5-4 | 3.5-4 |
| Tensile strength (MPa) | 10-15 | 15-20 | 15-20 | 20-25 | 15-20 | 15-20 |
| Elongation (%) | 5-10 | 5-10 | 5-10 | 5-10 | 5-10 | 5-10 |
| Water vapour transmission ($mg/cm^2$-mm-24hr) | 0.3-0.4 | 0.3-0.4 | 0.25-0.3 | 0.25-0.3 | 0.25-0.3 | 0.2-0.3 |

*Coatings A1N, A2N and A3N have nanoadditives.

**C. Characterization of coatings:**

The developed acrylic coatings have following properties:

- pH : 7.0-8.0
- Coverage : 5-6 $m^2/l$
- DFT : 150-200 µm

Physico-mechanical properties were determined and mineralogical as well as morphological studies were carried out to establish their structure.

Scratch, abrasion, adhesion & flexibility, IR, thermal insulation, gloss and solar reflectance studies are under progress.

It is observed that addition of nanoadditive is improving the properties of coatings especially in terms of bond strength and water vapour transmission.

## Future Plan

Work on the development of aqueous formulations will be initiated. Formulation & characterization of multifunctional coatings will be continued. Studies will be carried out to see the effect of shape and size of nano additives on performance of multifunctional coatings.

Task 1.4

# Studies of Phase Change Material (PCM) for Energy Efficient Buildings

Srinivasarao Naik B, L. P. Singh,
P. C. Thapliyal & Ashok Kumar

## Preparation of Phase Change Materials and Characterisation

- **Selection of phase change material for building components on the basis of following properties**

  Thermodynamic Properties: High Energy density, Small volume change
  Kinetic properties : High nucleation rate
  Chemical properties: No degradation
  Economic properties: Low cost, Availability

- **Comparison of Eutectic mixture with Paraffin and Fatty acids**

| Paraffin | Fatty Acid | Eutectic mixture |
|---|---|---|
| • Chemically Inert<br>• Low vapour pressure<br>• No phase segregation | • Chemically Inert<br>• Low vapour pressure<br>• High thermal conductivity<br>• High Latent heat of fusion<br>• No phase segregation<br>• Small Volume Change | • Eutectics have sharp melting point similar to pure substance<br>• Volumetric storage density is slightly above organic compounds |
| **Disadvantages** | | |
| • Low Thermal Conductivity<br>• Large volume change | Lack of materials with phase transition around the thermal comfort | Only limited data is available on thermo-physical properties to be used of these materials. |

- **Preparation of Eutectic mixture according to Schroder's equation and determined thermal properties by T-history Method**

## T-history Method

- Thermal properties (heat of fusion, specific heat, degree of cooling, thermal conductivity) can be calculated
- It is especially useful for selection of lots of candidate PCMs or for the preparation of new PCMs
- Kinetics of sensible and latent heat of PCM and Eutectic mixture can be studied

| PCM | Melting Point | Energy Density (MJ/m3) |
|---|---|---|
| 5%Propyl Palmaite + 95%Capric Acid | 23 | 154.4 |
| 15 % Propyl Palmaite + 85% Lauric Acid | 24 | 176.2 |
| 12.5% Propyl Palmaite +87.5 % Stearic Acid | 24 | 191.1 |

## Future Plan

Encapsulation of eutectic PCM by chemical process and its characterisation

Incorporation of PCM into the building components

# WP-2

# Next generation Concrete for Sustainable Construction

**S. K. Singh**

**Task 2.1**

## Geopolymer Concrete

### Alkali-Silica Reaction in Geopolymer Concrete

Ishwarya G, M. Gupta, B. Singh, and S.K. Bhattacharyya

A systematic study was initiated at the Institute to assess the potential reactivity of siliceous and sandstone aggregate in geopolymer concrete using fly ash-GGBS composite mixes under accelerated condition. It is known that alkali-silica reaction (ASR) is one such factor causing gradual but severe deteriorations of hardened cement concrete structure in terms of its strength loss, cracking and volume expansion. Since, aggregates contain some deleterious substances, the knowledge on understanding the reactivity of these aggregates in the geopolymeric alkaline environment should be known for mass utilization. It is expected that unutilized water-soluble alkalis existing in the geopolymer concrete may cause expansion in the concrete through alkali-silica reaction. It involves the reaction between the hydroxyl ion in the pore solution within the concrete matrix and reactive silica in the aggregate causing disruption of their siloxane

bridges. The mix proportioning of mortar bars was carried out as per ASTM C1260 using fly ash/GGBS composite mixes aggregate and activators. The cast samples were immersed in 1N NaOH solution at 80 °C for 90 days. The liquid-solid ratio for geopolymer mortars was kept as 0.47. OPC mortar bars were taken as control specimens (w/c, 0.47). The exposed mortar bars were assessed for their expansion and microstructural changes. A comparison in the expansion of geopolymer concrete was also made with its corresponding OPC concrete.

Visually, the surfaces of both OPC mortar and geopolymer mortar bars were defect-free (no signs of surface fissures, cracks and voids) at the end of 16 days exposure. At 90 days exposure, the OPC mortars showed white exudates along with pores and hair cracks on their surface whereas, the surface of GPC was soft and eroded. Fig. 1 shows expansion of mortar bars increased with increasing exposure time. It was observed that the expansion in geopolymer mortars at 16 days exposure was less than 0.1% as specified in ASTM C1260 whereas OPC mortars expanded beyond the threshold limit. When the exposure period was extended up to 90 days, the expansion in the fly ash based geopolymer (0.12%) approached the threshold (0.1%) while fly ash-GGBS composite mixes exhibited expansion in the range of 0.31-0.56%. It was also noted that fly ash based geopolymer mortars had 60% less expansion than the OPC mortars. Contrary to this, geopolymer mortars made with fly ash-GGBS composite mixes exhibited 23-46% more expansion than the OPC mortars. This can be explained on the basis of unstable co-existence of N-A-S-H and C-S-H gels as a result of exposure at 80 °C for longer period. In addition to expansion test, the reactivity of aggregates in 1 N NaOH was assessed by fitting the experimental data in the standard curve between

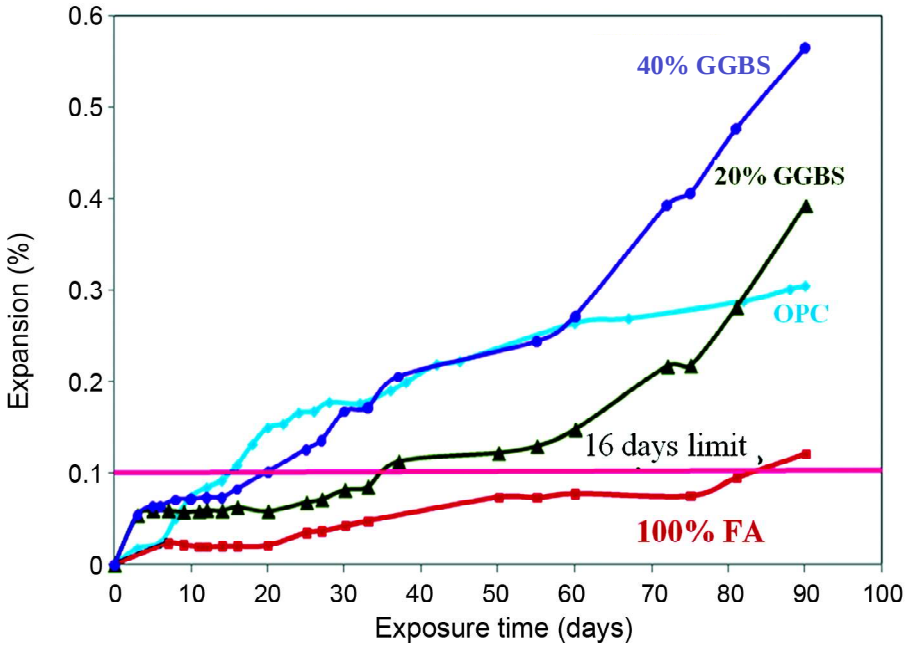



**Fig.1: Expansion of OPC Vs geopolymer mortars bars containing coarse aggregates**

reduction in alkalinity and dissolved silica from aggregate mentioned in the specification (Fig. 2). It was found that the aggregate was falling in the innocuous zone.

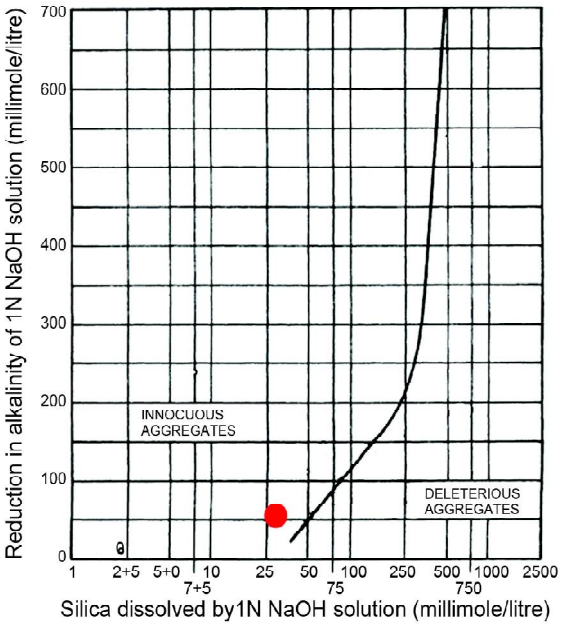



**Fig. 2: Illustration of division between innocuous and deleterious aggregates on the basis of reduction in alkalinity test**

The reduction in alkalinity was ~50 millimole/litre while silica dissolved from aggregate was ~26 millimole/litre. These values were low because sodium hydroxide might have reacted with carbonate of magnesium or ferrous or certain silicates of magnesium (antegorite). This result was quite contradictory with the expansion and petrographic data wherein ASR reaction evidenced.

Evidences of deterioration in the exposed OPC and geopolymer mortar bars were viewed in FE-SEM micrographs. In OPC mortars, a rim of reaction products was observed around the aggregate mainly consisting of sodium, silica and calcium (Fig. 3 a). In the vicinity of interface (Fig. 3 b), matrix had been converted into jelly-fibrous structure with plenty of voids (90 days).The Ca/Si ratio decreased significantly from 0.6-1.2 to 0.4 as observed under EDAX mapping. Sodium existed at a level of ~3% in the matrix suggesting the migration of sodium ions into the specimen during exposure which confirmed the formation of sodium calcium silicate gel triggering the alkali-silica reaction. The fly ash based geopolymer mortar showed an intact interface between the paste and the aggregate at the age of 16 days. EDAX mapping indicated that Si/Al (2.27) and Na/Al (0.76) ratio at the interface were nearly comparable to bulk of the matrix (Si/Al= 2.33, Na/Al= 0.53). The ingress of alkali at the initial stage caused densification of interfacial transition zone (Fig. 4 a) and matrix by further geopolymerization of unreacted particles, thus causing slight expansion.

The growth of crystalline zeolites was viewed in the cavities (Fig. 4 b) which play no role in exerting pressure on the structure. The formation of sodium calcium silicate gel appeared to be minimal due to non-availability of adequate calcium in the system. In the case of fly ash/GGBS based geopolymer (20% GGBS), a clear demarcation between the paste and the aggregate was observed at the interfacial transition zone (16 days). The Si/Al = 3.99 ratio was higher than that of the bulk matrix (Si/Al = 2.35) probably due to reaction between the reactive silica of aggregate and NaOH. At 90 days exposure, wide cracks at the interfacial transition zone and the existence of crystalline zeolites in the matrix were evident. When GGBS content was increased up to 40%, the cavities existed in the matrix was filled with the rod shaped structures (Si/Al = 1.05). A "pseudo rosette" type zeolitic structure were widely scattered throughout the matrix. The presence of excess $Ca^{++}$ ion in the system (from GGBS) had exchanged for sodium ion on silica gel leading to further production

of alkali-silica reaction complexes, thus causing severe deterioration.

It is concluded that geopolymer concrete were less susceptible to the expansive alkali-silica reaction. However, for longer periods, expansion beyond the prescribed limit was observed in the case of fly ash-GGBS composite mix based mortars. The deleterious alkali-silica reaction in geopolymeric environment can be prevented through a dense matrix formation by utilizing/ immobilizing dissolved silica in geopolymer and also by involving CaO in the Na/Ca-A-S-H phase formation through ternary binder system.

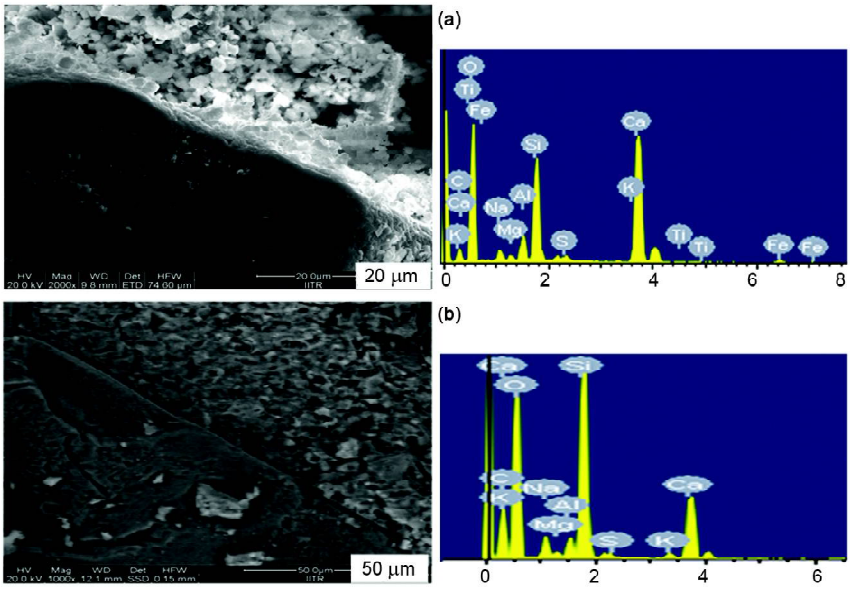



**Fig.3: FESEM images of ITZ of OPC mortars at (a) 16 days (b) 90 days**

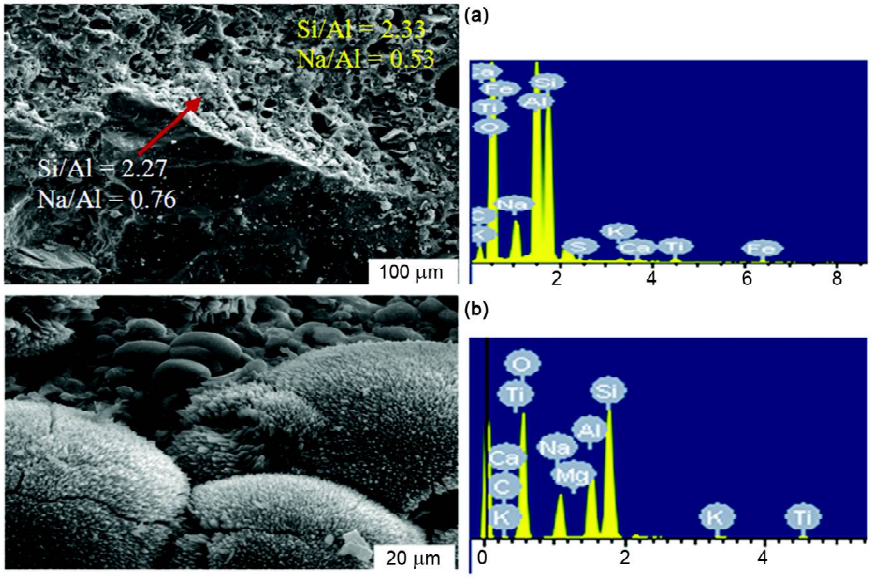



**Fig.4: FESEM images of fly ash based GPC mortars showing (a) ITZ at 16 days (b) Growth of crystalline zeolites at 90 days**

Task 2.2

# Bio-Concrete as Self Healing Material

Leena Chaurasia & Rajesh K. Verma

## • Two new calcifying bacteria

Two new calcifying bacteria were identified and maintained in laboratory for further experimentation.

**Bacterial Cultures**

## • Bacterial Pellets Prepared

The bacteria are grown in culture media. The OD of bacteria culture were determined using UV-spectrophotometer followed by centrifugation on refrigerated centrifuge to get their concentrated bacterial pellets, which was used for casting of bacterial mortar.

**Refrigerated Centrifuge**

**Bacterial pellet**

- ## Prepared 50 mm mortan cubes with collected bacterial pellet

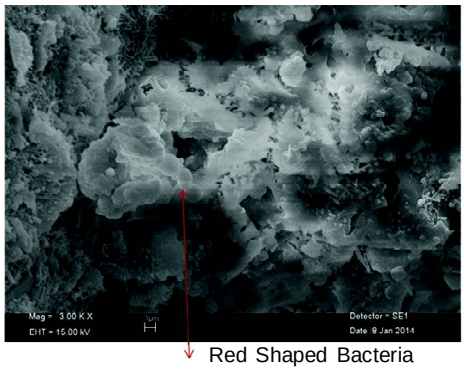
The bacteria embedded mortar cubes (50 mm) with standard size crack were casted using bacterial pellet.

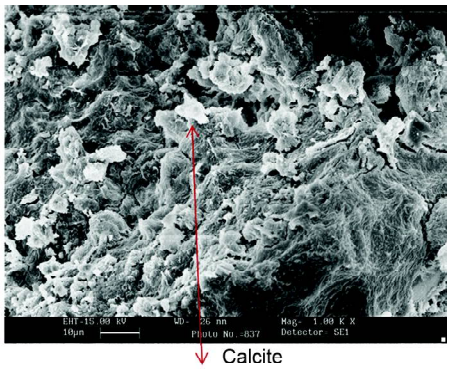
50 mm bacterial mortar cubes

50 mm mortar cubes (control)

- ## SEM Image of bacterial mortar

The mortar samples were examined by scanning electron microscope with various magnifications. The rod shaped bacteria and crystal of calcite are clearly visible in bacteria treated mortar.

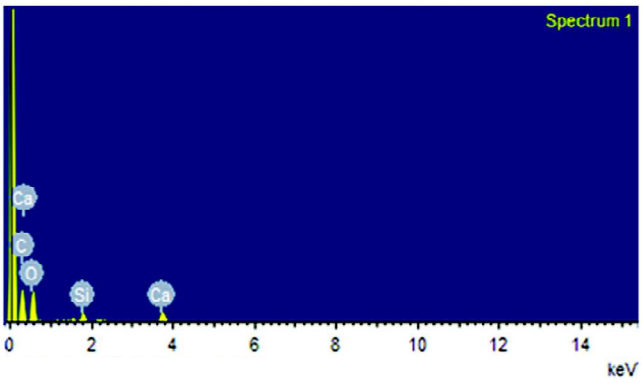


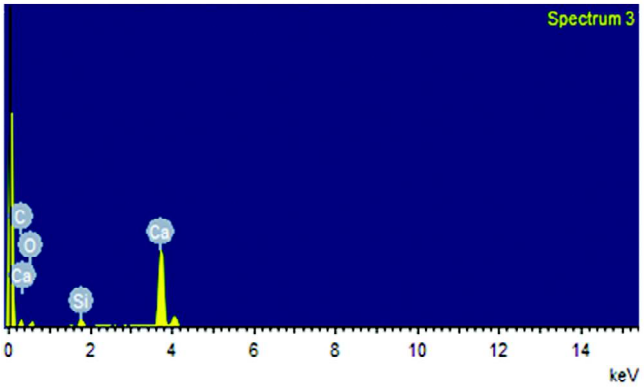

SEM Image of bacterial mortar

- ## EDAX analysis of bacterial mortar

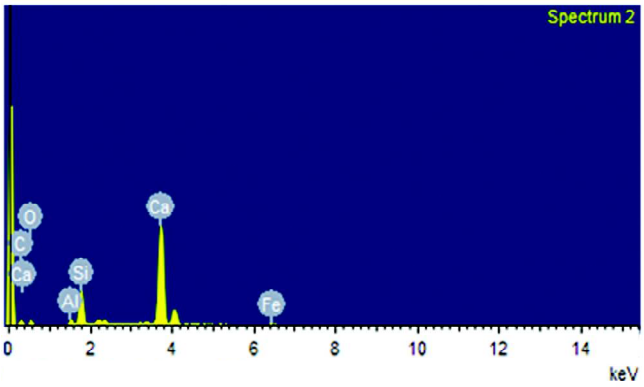
The samples were examined by EDAX, which showed enhancement of calcium ion concentration from 8.99 % (Untreated) to 44.04 % (with bacteria) and 68.88 % (with bacteria and calcium lactate).




**Untreated: Ca - 8.99 %**




**Bacteria treated: Ca - 44.04%**

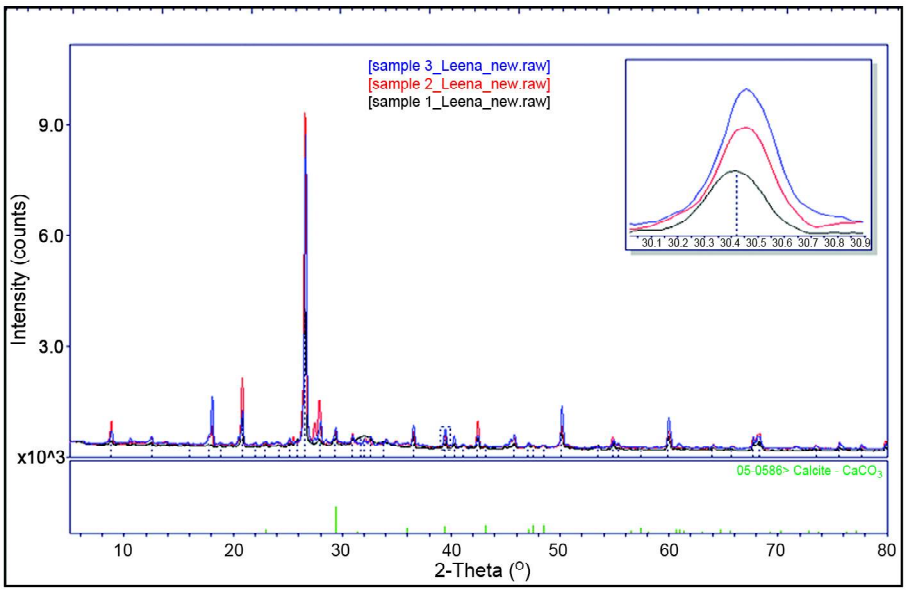



**Bacteria with CL treated: Ca- 68.88 %**

**EDAX spectra of untreated, Bacteria treated and Bacteria with calcium lactate (CL) treated mortar**

- ## XRD Analysis of bacterial embedded mortar

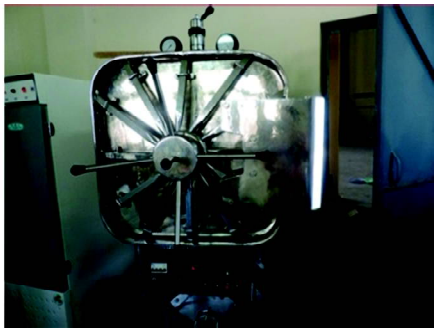
XRD analysis was done to reveal the form of mineral composition formed. The bacterial mortar showed that the majority of carbonate deposits were present as calcite. High calcite peaks were visible in bacteria treated samples.




**XRD spectra of control, bacteria and bacteria with calcium lactate treated mortar.**

The following equipments were procured and installed during this period.

**Refrigerated Centrifuge**



**Autoclave**

**Refrigerated Water Bath**

**Laminar Air Flow Cabinet**

Deep freezer (-20 $^{0}$C)

Deep freezer (-80 $^{0}$C)

BOD

Construction of Bio concrete Laboratory-under progress

## Task 2.4

# Development of Pervious Concrete

Rajesh Deoliya & Subash C. Bose Gurram

Pervious concrete is a special kind of concrete comprising coarse aggregate, cement, water, and admixture. Little or no fine aggregate is used in making pervious concrete. Cement paste should be sufficient enough to coat aggregate particles and to facilitate interconnected pore structure. Because of its high permeability, it is being used mainly in parking lots and pathways to allow rainwater to infilterate the ground.

The main objective of this project is to develop pervious concrete having 10-25% porosity with 25-10MPa compressive strength using locally available materials. Experiments have been carried out to evaluate the effects of mix parameters such as aggregate size, cement content, water-cement ratio and super plasticizer dosage on compressive strength and porosity. Ordinary Portland cement has been used in all the experiments. Since pervious concrete does not have fine aggregate and has to have pores, workability required for making good pervious concrete is generally different from that of normal concrete. Measurement of workability of the mixes has been tried with slump and Vebe time tests, and both the tests have been found unsuitable. Standard cube and cylinder specimens have been cast with increasing cement content while water-cement ratio and aggregate quantity are kept constant at 0.3 and 1532 kg/m$^3$ respectively. Compressive strength and porosity tests have been conducted as per IS 516 and ASTM C1754 respectively. Volume of cement paste increases with increase in cement content and paste occupies the space which is otherwise void. Hence porosity decreases and compressive strength increases with decrease in porosity as shown in Fig. 1.

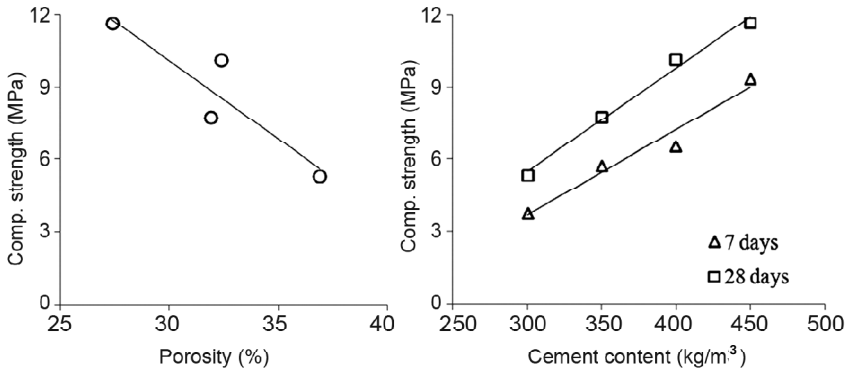



**Fig.1: Effect on compressive strength (a) porosity (b) cement content**

Effects of water-cement ratio and super plasticizer dosage are also investigated while aggregate (6.35-10 mm and 10-12.5 mm mixed in equal proportions by weight) and cement content are kept constant at 1622 kg/m$^3$ and 400 kg/m$^3$ respectively. Porosity decreases with increase in water-cement ratio as observed in normal concrete because of increase in cement paste volume and flow ability. Above 0.36 w/c ratio, cement paste is found to accumulate at the base leaving less pores open. It seems that for w/c ratios above 0.34,increment in strength due to decrease in porosity is more than decrement in strength due to increase in w/c ratio as seen in Fig. 2.It is observed that maximum strength is obtained at 0.34 w/c ratio.

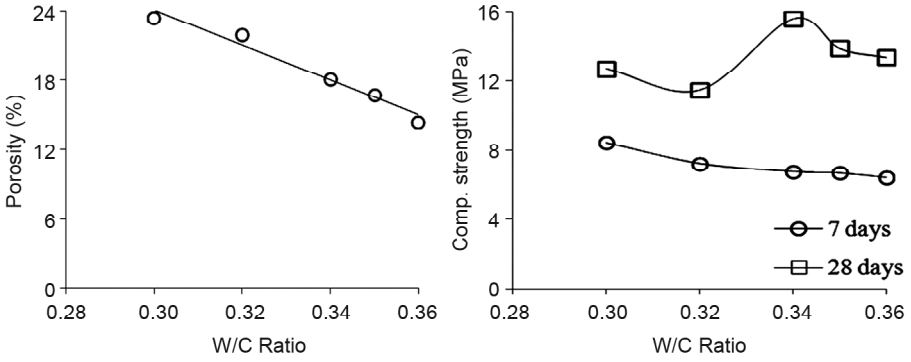



**Fig.2: Effect of water-cement ratio (a) porosity (b) compressive strength**

As super plasticizer improves the flow characteristics of cement paste, porosity has decreased with increase in its dosage. When the dosage is above 0.3% (w/w), cement paste has accumulated at the base closing almost all the pores and pore distribution has also varied along the height of the specimen. Slightly higher strength is observed in the mixes with super plasticizer as shown in Fig.3.

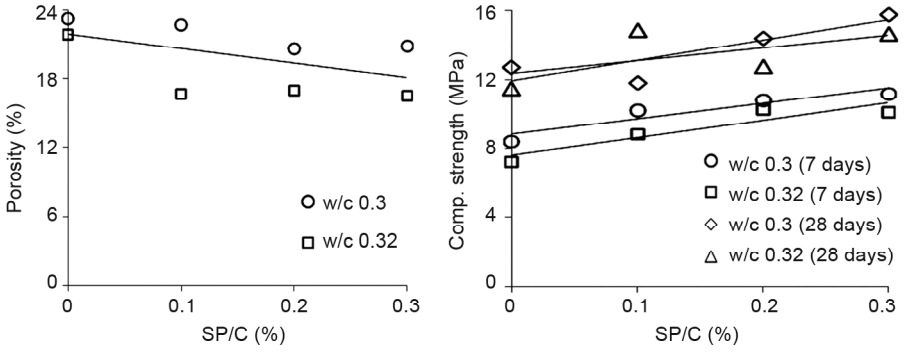



**Fig.3: Effect of super plasticizer dosage (a) porosity (b) compressive strength**

# WP-3

## Green Building Technologies

**Ashok Kumar**

**Task 3.1**

## Green Retrofit Strategies for Office Buildings

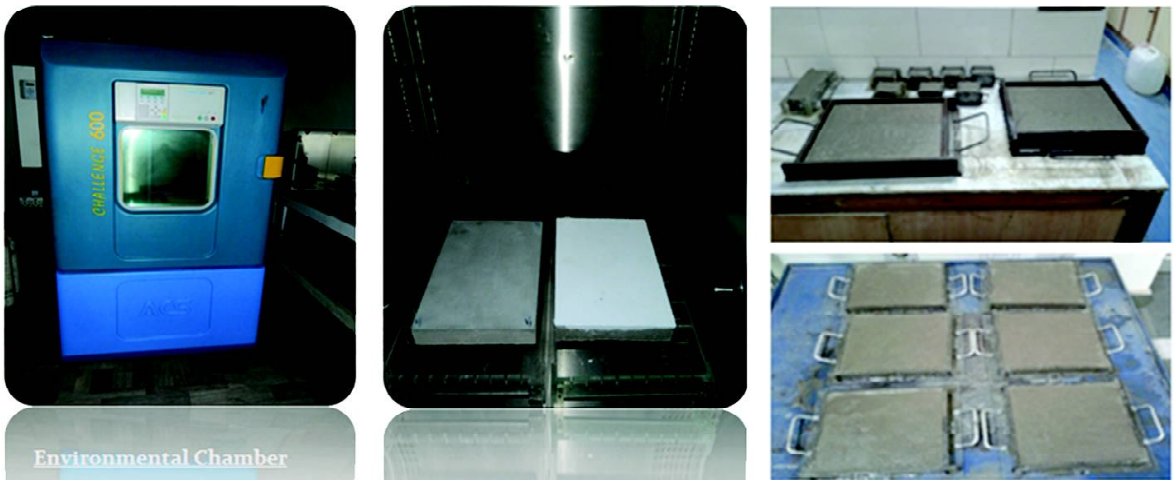
Ashok Kumar, Rajesh Deoliya, Rajni Lakhani, B.M.Suman & Team

A comprehensive study of the existing green rating systems was carried out and the attributes for assessing and retrofitting existing buildings were identified. The Questionnaire was developed for the proposed rating system with an Acronym: GRASS - Green Retrofit Assessment System for Sustainability for making and rating existing buildings as green. The questionnaire was sent to 500 professionals, including engineers, material scientists, architects, students from different disciplines and 85 responses received were analyzed. GRASS will rate a building on the basis of its measured operational impacts on the environment, and will provide a simple indication of how well the environmental impacts are being managed, compared with other similar buildings. This rating is based on actual building performance, along with design, modelling and simulation results.

Analytical Hierarchy Process (AHP) has been used to analyze the questionnaire results. AHP is a mathematical technique which provides an effective means to deal with complex decision-making and gives weightage to each attribute, criterion & sub-criterion based on the surveys. MS Excel spread-sheet & Expert Choice Software is used to compute

the weightages. The results obtained in each assessment item level can be calculated by using the equations:

Similarly,more than 120 combinations of different walling assemblies used in existing buildings have been evaluated for U-values. Different retrofit insulation thicknesses with and without air gap have been analyzed and further analysis is under progress.




**Casting of Vermiculite tiles and samples in Environmental Chamber**

Similarly, to accomplish one of the objectives, the Vermiculite tiles of size 25x25x3.5cm have been developed as one of the project activity and applied on the roof top of the experimental model built at the Institute to see their effectiveness in improving the thermal performance indoors. The physical properties of the tiles are: i) Density: 870 kg/m$^3$; compressive strength: 4.66MPa; Flexural strength: 1.36MPa; water absorption: 30% and thermal conductivity: 0.228 W/mk. The thermal performance indoors is being monitored and the preliminary analysis shows that Vermiculite tiles with white reflective paint on top provide good thermal insulation.

## Sub Task 3.1.1: Development of Solar Window System for Cold Climatic Region

Neeta Mittal & B. M. Suman

The perforated black coated metal Solar Window System has been developed. For fulfilling the minimum requirements of lighting in the room, the area of perforation in metal sheet can be determined by determining size of the hole and their numbers. Determination of size of the hole and their numbers will depend upon the minimum requirement of light

level inside the room which is satisfied by keeping the opening area from 10% to 30% of the floor area of the room. In order to develop the model, following assumptions have been made.

The minimum opening area has been considered as 10% of the floor area of the room.

Length of window : 1500 mm
Width of window : 1200 mm
Gap between window and the black sheet : 100 MM

As per window design the area of black metel sheet is same as the area of window.

**Table 1: Recommended design sky illumination for different Climatic Region**

| Climatic Region | Recommended design sky illumination |
|---|---|
| Cold climate | 6800 Lux |
| Composite climate | 8000 Lux |
| Warm-Humid | 9000 Lux |
| Temperate | 9000 Lux |
| Hot -Dry | 10500 Lux |

(Source: National Building Code 2005)

Let area of floor of the room is 10 Sq. m
Therefore, minimum opening area is 1 Sq. m

Let us consider that there exists one hole in each square centimeter area of the sheet.

The radius of the hole is r, this gives the number of holes per square meter is 10000. According to the modeling, the radius of the holes is obtained as 0.341cm = 0.00341m.

The outdoor design sky Illumination varies for different climatic regions of country.

For composite climate the recommended design sky Illumination is 8000 Lux (Table 1) and corresponding standard of lighting for general building areas were compared with observed illumination level.

**Table 2: Recommended Minimum and Maximun illumination for different locations**

| | |
|---|---|
| General | 200-500 |
| Waiting room | 150-300 |
| Circulation Area | 50-150 |
| Rest-room | 100-200 |
| Washing-Room | 200-500 |
| Store Room | 50-150 |
| Dining room | 150-300 |
| Cooking (Kitchen) | 300-750 |
| Bedroom | 30-100 |
| Bathroom | 50-150 |

(Source: National Building Code 2005)

**Table 3: Level of Illumination during Jan 2014 for clear day**

| Date | Time | Outside | Inside | |
|---|---|---|---|---|
| | | | Ordinary room | The room with Solar window system |
| 07.01.2014 | 10.00 | 1840 | 420 | 50 |
| | 11.00 | 1390 | 660 | 160 |
| | 12.00 | 3160 | 1950 | 200 |
| | 13.00 | 1950 | 242 | 100 |
| 08.01.2014 | 12.00 | 800 | 580 | 110 |
| | 13.00 | 1490 | 900 | 160 |
| | 14.00 | 1360 | 840 | 160 |
| | 15.00 | 1050 | 590 | 102 |
| 09.01.2014 | 10.00 | 880 | 530 | 120 |
| | 11.00 | 1320 | 970 | 320 |
| | 12.00 | 1680 | 660 | 100 |
| | 14.00 | 1971 | 780 | 148 |
| 10.01.2014 | 10.00 | 630 | 470 | 100 |
| | 11.00 | 1660 | 560 | 160 |
| | 12.00 | 1920 | 1300 | 160 |
| | 13.00 | 2000 | 1320 | 160 |
| 21.01.2014 | 10.00 | 716 | 350 | 100 |
| | 12.00 | 840 | 412 | 110 |
| | 13.00 | 890 | 470 | 130 |
| | 14.00 | 989 | 500 | 140 |
| | 15.00 | 1180 | 700 | 180 |
| 23.01.2014 | 10.00 | 1760 | 1400 | 320 |
| | 11.00 | 1965 | 1400 | 340 |
| | 12.00 | 1580 | 1270 | 264 |
| | 14.00 | 1980 | 1200 | 260 |
| | 15.00 | 1570 | 620 | 200 |
| 24.01.2014 | 10.00 | 923 | 733 | 140 |
| | 12.00 | 940 | 760 | 150 |
| | 14.00 | 1680 | 700 | 290 |
| | 16.00 | 1445 | 664 | 260 |
| 30.01.2014 | 9.00 | 1330 | 730 | 290 |
| | 10.00 | 1720 | 688 | 320 |
| | 11.00 | 1980 | 1040 | 345 |
| | 12.00 | 1748 | 840 | 490 |
| | 13.00 | 1990 | 740 | 400 |
| | 14.00 | 1865 | 800 | 400 |
| 31.01.2014 | 9.00 | 580 | 400 | 154 |
| | 10.00 | 672 | 520 | 173 |
| | 11.00 | 827 | 600 | 200 |
| | 12.00 | 915 | 520 | 218 |
| | 13.00 | 1002 | 780 | 220 |
| | 15.00 | 911 | 600 | 190 |
| | 16.00 | 850 | 250 | 150 |
| | 17.00 | 820 | 200 | 140 |

It is clear from recommended illumination level from table 2 and Observed illumination level from table 3, that minimum illumination level required for most of the places in a room is fulfilled except for Kitchen where minimum illumination level is required 300 Lux. Therefore, in the kitchen supplementary (artificial) lighting is required.

Task 3.2

# Demolition Wastes as Raw Materials for Sustainable Construction Products

A. K. Minocha, Mridul Garg and Team

Recycled coarse aggregate of different grades collected from MCD plant, at Burari, Delhi was tested for physical and mechanical properties as per IS 2386-1963. The grading of 20 mm and 10 mm recycled coarse aggregate was carried out as per IS: 383-1970 for minimum and maximum limits. The grading percentage of both sizes of aggregates was within the grading limits specified by the IS: 383-1970. The fineness modulus of recycled aggregate of passing 20 mm and retain on 10 mm sieve and passing 10mm and retain on 4.75 mm sieve were 6.97 and 6.04 respectively which was less than the fineness modulus of natural aggregate (6.98 and 6.37 for 20 mm and 10 mm) respectively. The recycled aggregate of size 20 mm and 10 mm were immersed in water for two hrs.and then heating at different temperatures i.e. 300, 400 and 500°C for one hour and then immersed in HCl solution of different molarity for half an hour followed by washing and drying as illustrated in Fig.1.

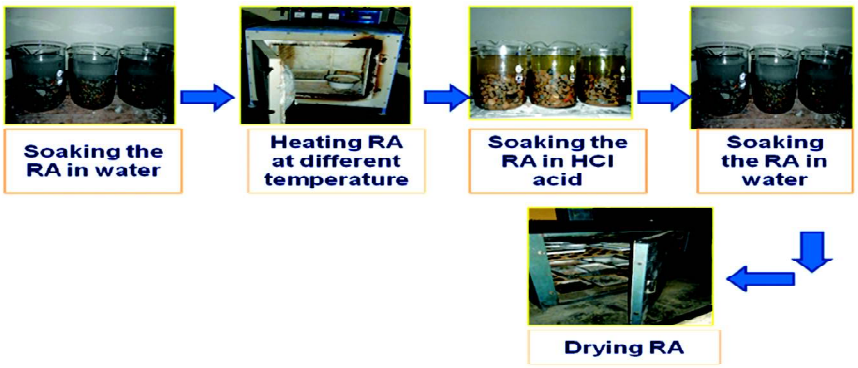



**Fig.1: Preheating along with Acid Soaking**

Considering the two size fractions of recycled aggregates, the graphs (Fig. 2a & b) represents the relationship between adhered mortar loss vs molarity of acid of the aggregate passing 20 mm and retained on 10 mm and 10 mm passing and retained on 4.75 mm sieve respectively. In simply acid soaking, the adhered mortar increases with increase in the molarity of acid due to the process of degradation but at the same time when the molarity exceeds 0.7 M or at 0.9 M it eroded on the surface of the aggregates. Fig.2 (a and b) clearly indicate that with increase in heating temperature and molarity of acid, the removal efficiency of adhered mortar increased. The maximum adhered mortar loss occurred pre-heating at 500°C and 0.7 M HCl.

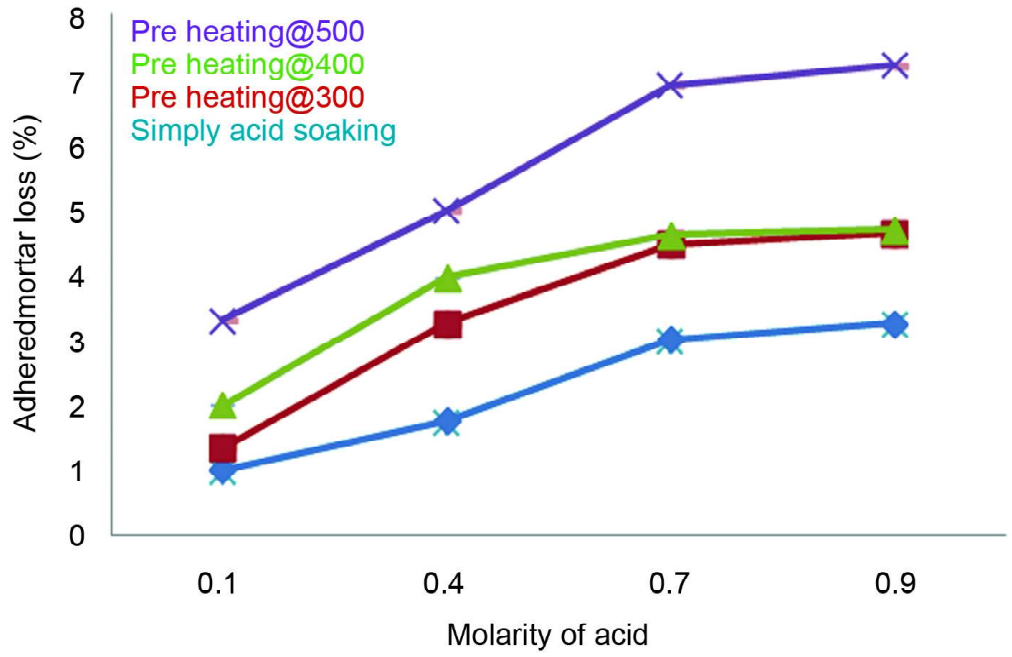



**Fig.2 (a): Aggregate passing 20 mm and retained 10 mm**

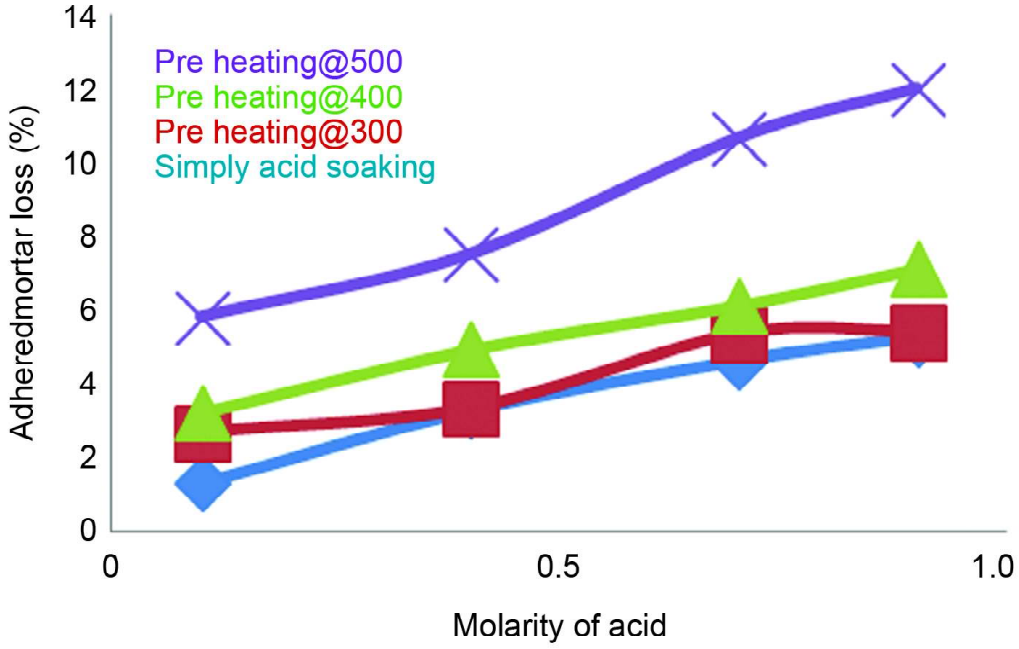



**Fig.2 (b): Aggregate passing 10 mm and retained 4.7 mm**

After treatment, the samples were tested for physical and mechanical properties as per Indian standard and an enhancement in all properties were observed. The interfacial and microstructure studies of influence on molarity on pre heating agreegate at 500$^0$C are depicted in Fig. 3. These studies show that the crystal habit and morphology of aggregates modified with molarity of acid and responsible for improvement of properties of aggregate. It can be further seen that losses increase with increase in the molarity of acid. Heating itself does not produce the loss of dense adhered mortar but heating makes to loosen the bond between aggregate and mortar. Removal of adhered mortar depends on the molarities of acid.

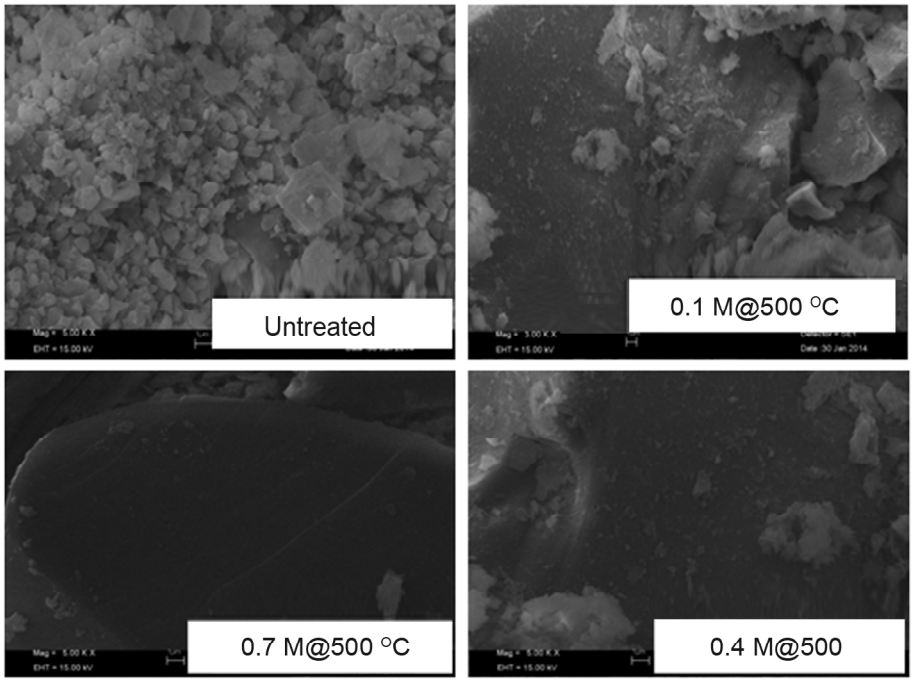



**Fig.3: Microphotographs of aggregates in the presence of different molarity of acid at 500$^0$ C.**

## Task 3.3

# Solar Thermal Air Conditioner

Nagesh Babu Balam

## Objective

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

## Deliverables

- Novel Solar Power Generation System - 30% conversion Efficiency.
- Solar Adsorption Cooling System.

## Progress

A novel thermodynamic Cycle has been employed to achieve higher efficiency which is a combination of Stirling and Ranking cycle. This novel engine has high power to weight ratio and higher achievable theoretical efficiency also. The PV and TS diagram of the thermodynamic cycle are shown in Fig.1.

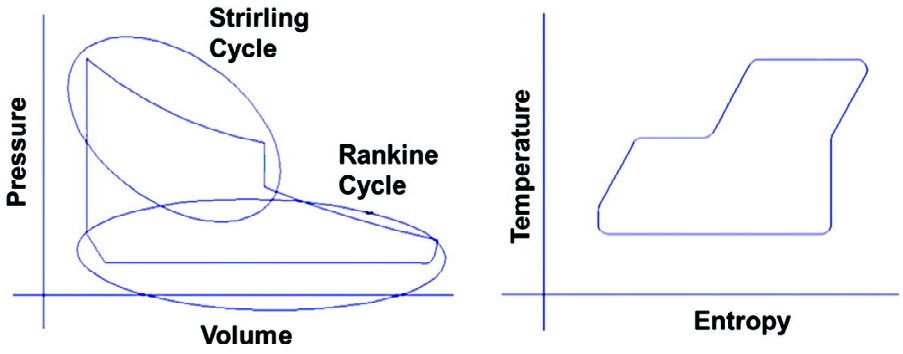



**Fig.1: PV and TS diagram of Novel Thermodynamic Engine**

## Design of Stirling Cycle based solar power generation system

The engine was drawn in SolidWorks software as shown in Fig.2 and is in the stage of fabrication. The preliminary design stage of Stirling Engine is based on Ross-Yoke drive Mechanism. This crank mechanism is chosen to eliminate the lateral forces on displacer and power piston and hence increasing the efficiency of the engine.

## Fabricated Stirling Cycle based solar power generation system

A rapid prototyping model Engine has been fabricated and shown in Fig.3 to verify the working of the Crank (Ross-Yoke) Mechanism, which is working as per design. The fabrication of second version of the engine which shall work both mechanically and thermodynamically is in progress.

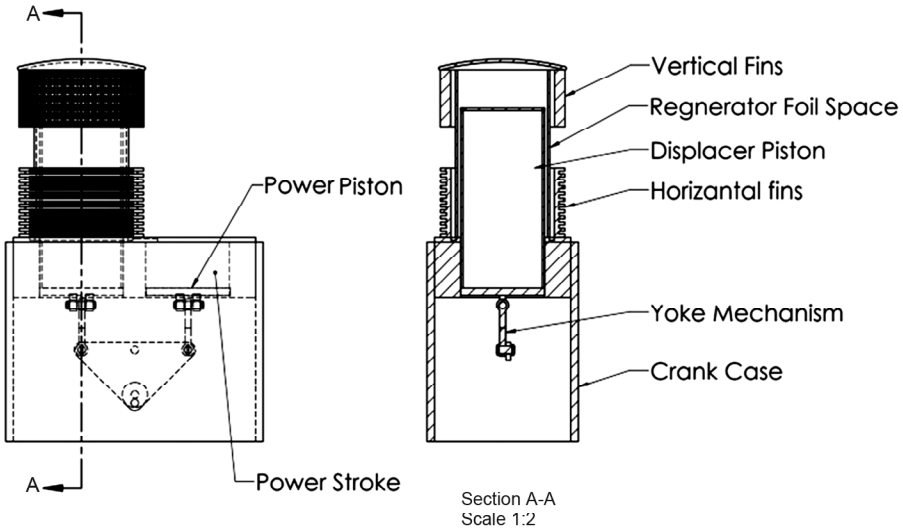



**Fig.2: Design of Stirling Cycle based Solar Power Generation System**

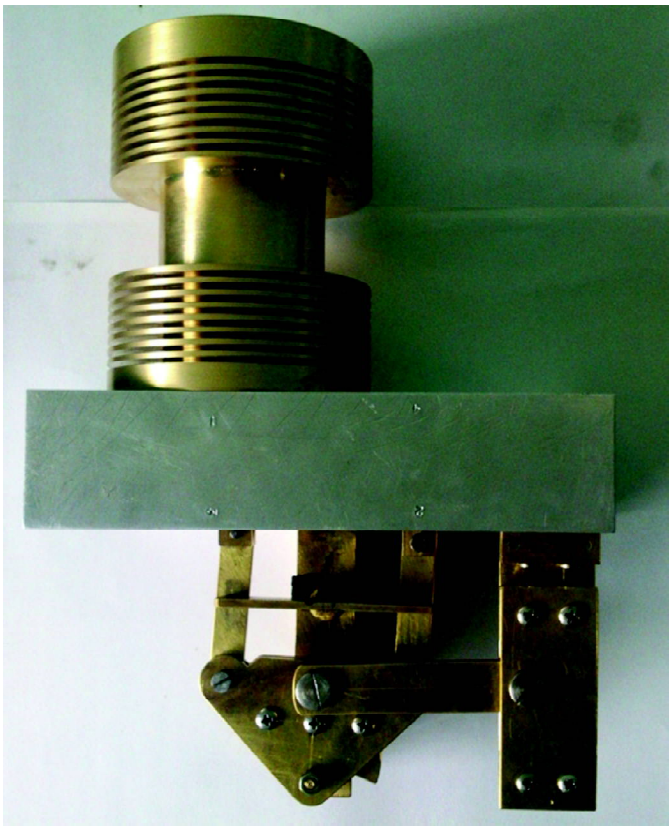


**Fig.3: Rapid Prototype model Engine**

Task 3.4

# Solid Industrial Waste - A Resource Geo-material for Civil Construction

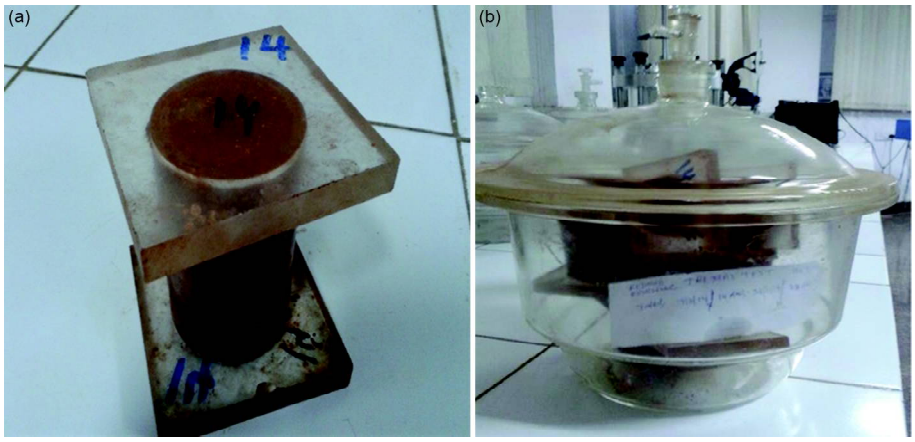
M. Samanta, A. Ghosh, S. Maiti, D. Kumar and Z. Ahmed

## Objective: Strengthening of solid industrial waste deposit for civil infrastructure.

Fly ash and Red Mud are two major solid industrial wastes generated from the coal based thermal power plant and aluminum industry respectively. India produces of about 110 million ton/yr of Fly Ash of which only 33% is utilized in various construction components. The Red Mud which is generated@1.0–1.6 tons/ton of Alumina, is a solid waste from Aluminium Industry. Unfortunately, the Red Mud all over the world has not found any use so far and as a result, it is stored in the red mud pond. Due to the characteristics of fine particle, dumping and storing of these waste material causes environmental and space problem. The recent trend of research is directed to explore the mechanical and environmental suitability of these industrial wastes as a resource material.

The following study investigates the engineering and environmental suitability of Red Mud as resource geo material for civil construction. Strength and compressibility characteristics of stabilized and unstabilized red mud are investigated in the present study.

To increase the strength of red mud, cement was added in percentage of dry weight of red mud. The water content of the mix is kept constant at 40% of the dry weight of red mud. The effect of cement content on strength improvement of stabilized red mud has been investigated for different rest periods. (fig. 1a & b)




**(a) Sample Preparation of Red Mud** **(b) Storing in Dessicator for Different rest period**

**Fig.1 (a) & (b) Sample Preparation for Testing**

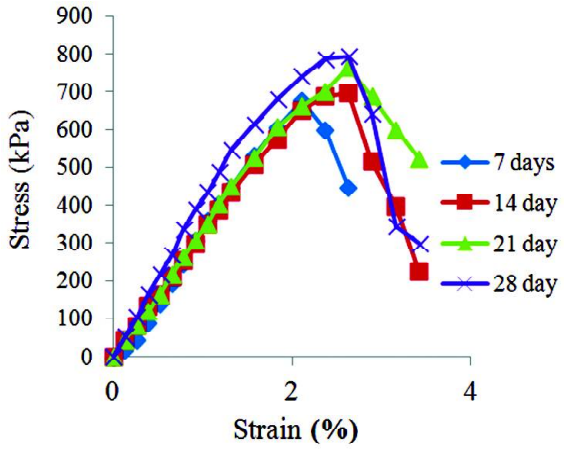



**Fig. 2: Stress vs. Strain of Stabilized Red Mud**

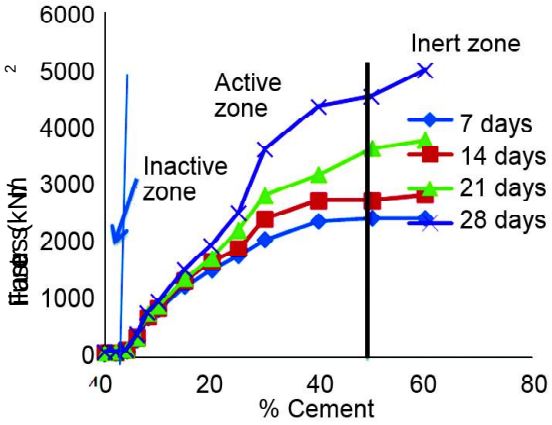



**Fig. 4: Failure stress vs. % of Cement of Stabilized Red Mud.**

**Fig. 3: Failure Pattern of Red Mud with 8% Cement**

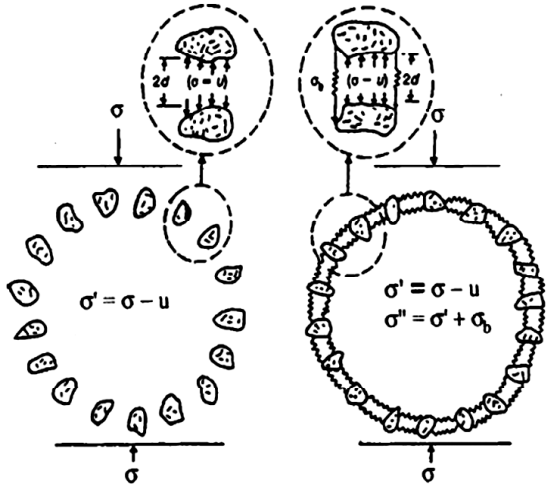



**Fig. 5: Possible Clay Fabric and its Cementation (Nagaraj et al. 1990)**

Fig. 2 shows that increasing % of cement, strength also increases. Strength also observed to increase with increase in the rest period. Fig. 3 shows that stabilized sample fails in shear, whereas unstabilized sample fails in bulging. Fig. 4 shows the strength improvement of stabilized red mud with percentage of cement for different rest periods. Based on the UCS strength of stabilized sample, three zones are clearly identified, (a) Inactive zone- strength does not improve much with addition of cement (0- 4% cement) (b) Active zone – strength improves significantly in this zone with addition of cement (4-50% of cement) (c) Inert zone – strength almost remain constant with increasing the percentage of cement beyond active zone (50 -80% of cement). This behavior is observed for all the rest period under consideration. This behavior is explained with formation of cement matrix in a cement stabilized soil. In inactive zone, due to small amount of cement, the numbers of inter cluster bonds are less and it

does not impart in significant gain in strength. In the active zone, due to availability of cement, significant numbers of intercluster bonds are formed and impart a significant gain in strength of stabilized sample. In inert zone, no more bonds are formed than the active zone and strength remain almost constant with

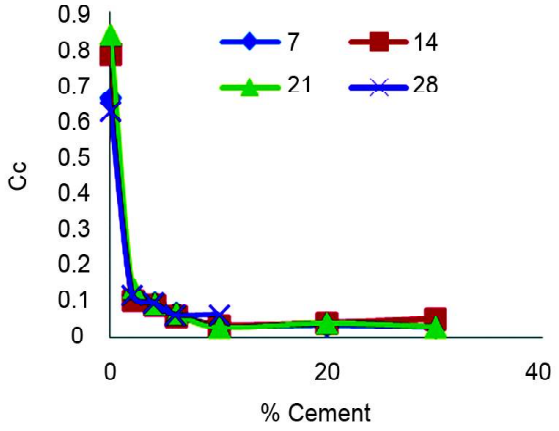



**Fig.6: Compression Index vs. % of Cement**

From Fig. 6 -8 shows the different compressibility characteristics of stabilized red mud. Co-efficient of consolidation decreases with increasing the % of cement which signifies time rate of consolidation also decreases. The co-efficient of compressibility and compression index decreases with increasing % of cement. The compression index almost becomes constant when % of cement

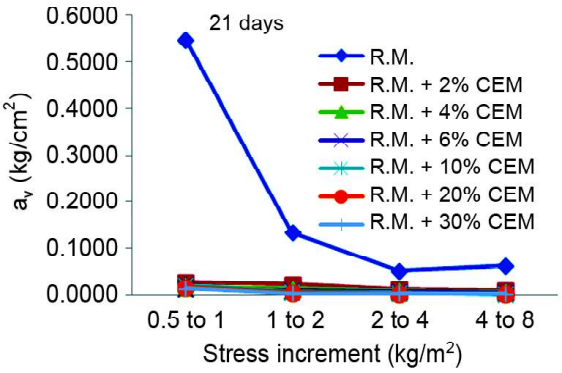



**Fig.7: Co-efficient of Compressibility vs. % of Cement**

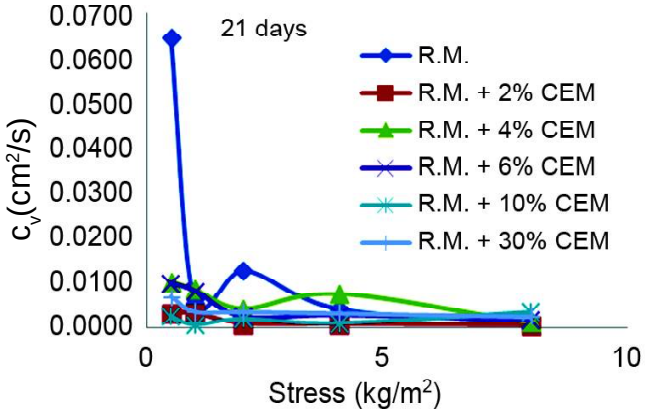



**Fig.8: Co-efficient of Consolidation vs. Stress**

increasing the amount of cement. A similar behavior is observed cement stabilized fly ash. The compressibility characteristics namely the coefficient of consolidation, compression index and co-efficient of compressibility for stabilized Red Mud have been evaluated for different % of cement and rest period.

exceeds 10%. Decreasing trend of compressibility index signifies the magnitude of settlement decreases with increasing % of cement. To find out the environmental suitability leaching of the heavy metals from the stabilized red mud was also carried out. Micro structural analysis of stabilized and unstabilized sample of red mud is also carried out.

Task 3.5

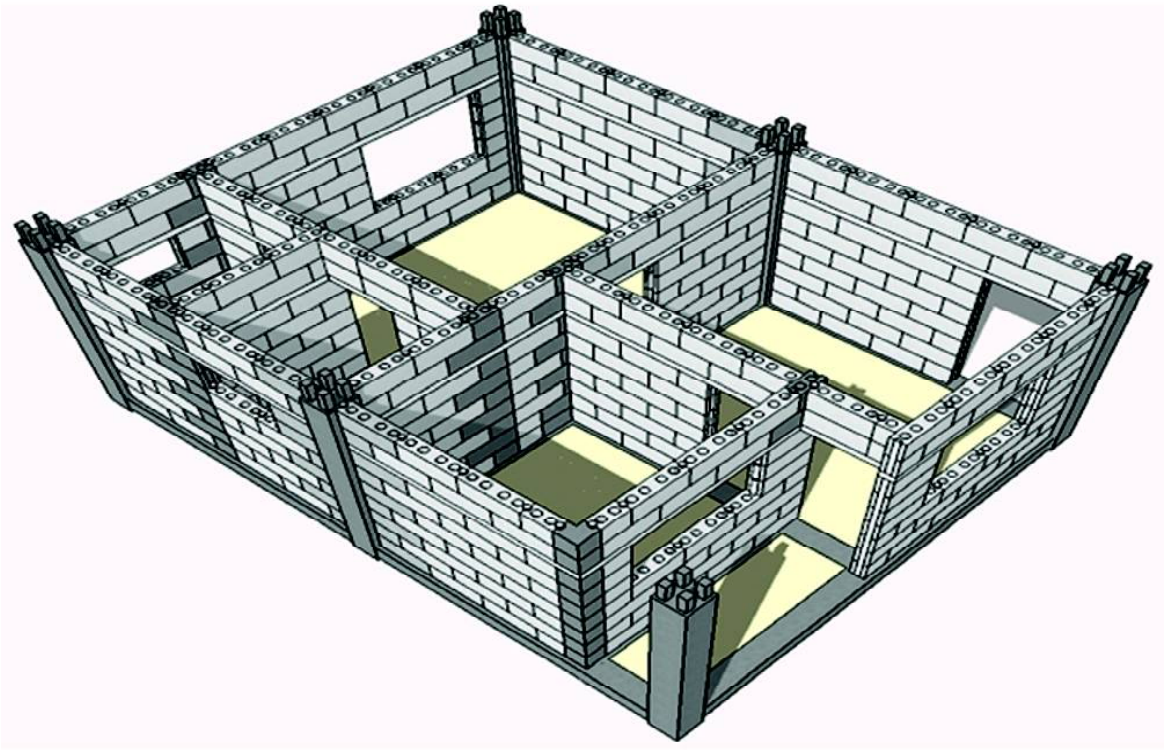
# Technology Packages for Mass Housing in Urban Areas for Different Geo-Climatic Regions of the Country

Ashok Kumar, Mridul Garg, S. K. Panigrahi, B. S. Rawat, Vivek Sood, S.K. Negi, Ajay Chourasia, Rajni Lakhani, B. M. Suman & Team

## Objective

Development of energy efficient and environment friendly sustainable and affordable mass housing.

Based on the proposed hollow gypsum panel block, the house plan has been designed. Different types of joints / connections developed are being evaluated from structural design point of view. The hollow panels may be filled with foam concrete developed at the Institute, if required to improve their thermal performance. The fabrication of panels is under process.



**Schematic view of a Prefab house with Prefab Gypsum Hollow Panel Block**

## Sub Task 3.5.1: To Develop Light Weight Blocks using Different Industrial Wastes-Fly Ash/Rice Husk Ash/Marble Dust

Vivek Sood, Ashok Kumar &
B. M. Suman

### Objective:

To develop light weight building components using industrial wastes.

Different sizes of blocks were developed and the physical properties of blocks developed are:

Range of Densities : 800 – 1800 kg/m$^3$

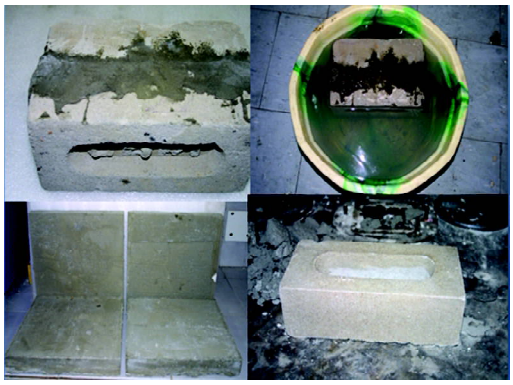
Compressive Strength : 2.2- 23.4 N/mm$^2$

Water Absorption : about 10% at a density of 1200 kg/m$^3$ and 8% at a density of 1600 – 1800 kg/m$^3$

Table shows the thermal properties of the blocks

| Density (kg/m$^3$) | Thermal Conductiviy (W/mK) | U value (W/m$^2$K) | λ - Value |
|---|---|---|---|
| 700 | 0.172 | 2.24 | 0.702 |
| 800 | 0.190 | 2.41 | 0.722 |
| 1200 | 0.254 | 2.85 | 0.746 |

It is evident from the table that the thermal properties of the blocks are improving as density increases.



**Photoplate showing light weight building blocks**

Further analysis is under progress and based on the targeted strengths and other thermophysical properties conforming to Indian standards, the technology will be ready for dissemination and use.

## Sub Task 3.5.2: Development of an automatic hollow gypsum panel making machine

S. K. Panigrahi & Team

### Objective:

To design and develop an automatic machine for producing Hollow Panels

### Scope:

- To produce six panels in one batch
- Automation of the machine
- The machine to be flexible for any changes in panel geometry

The following activities have been carried out

- Fabrication of wooden mould of capacity three panels at a time and steel mould for single panel
- Fabrication of core and modification of core holding arrangement of existing cored unit
- Development of concrete panels to study the shortcomings of the mould and modifications on moulds

**Fig.1. Wooden gang mould and Core withdraw Assembly**

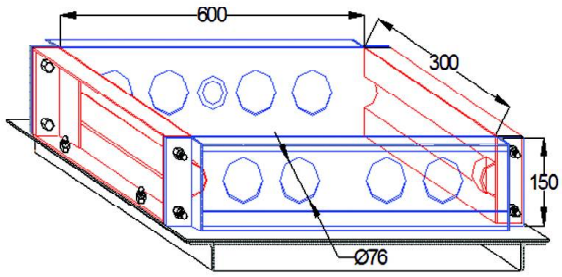



**Fig.2: 3-D Model of Designed Steel Mould**

**Fig.3: Concrete Panel cast on the Cored unit**

## Sub Task 3.5.3: Application of Gypsum Cement in Prefabricated Panels and Masonry Works

Mridul Garg and Team

The production of cement free (CF) binder from fluorogypsum can be considered as a sustainable approach for the construction sector since the internal energy content of this new CF binder is much less than the Portland cement. The reaction products were characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM) techniques. SEM studies showed the appearance of prismatic and needle shaped crystals of variable sizes interspersed with anhydrate fluorogypsum plaster which make the matrix dense and compact (Fig. 1). The change in morphology of the anhydrite plaster is responsible for the reduction in water absorption and porosity of cement free binders.

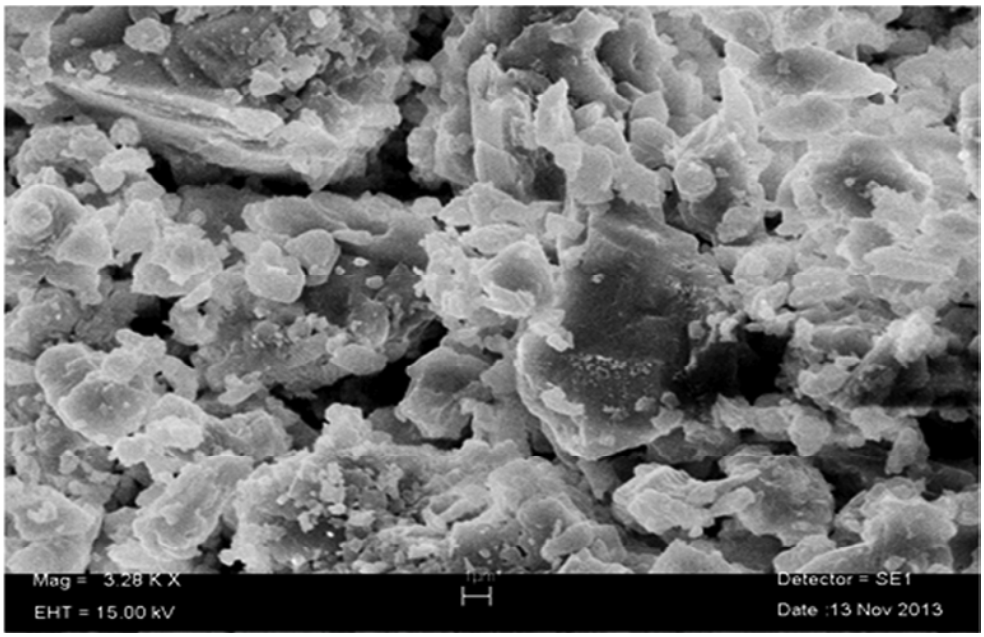



**Fig.1: SEM of hydrated CF Binder**

The mix design of M-20 concrete was prepared as per IS: 10262-2009, by mixing CF binder, gravel (40% passing 20 mm and retaining 10 mm IS sieve plus 60% passing 10 mm and retaining 4.75 mm IS sieves) and sand (fineness modulus 2.20). The concrete cubes of size 150 mm, prisms of size 100 x 100 x 500 mm and cylindrical specimen of size 150 mm diameter x 300 mm height were cast at water cement ratio 0.45. All the specimens were then cured under high humidity up to 28 d and then tested for compressive strength, flexural strength and tensile strength in accordance with Indian standards. The properties of M-20 grade concrete were as follows: Compressive strength (MPa): 3 d-15.2; 7d-19.7; 28d-22.5, Flexural strength (28d): 2.8 MPa and tensile strength (28d): 1.98 MPa.

The bricks of size 190 mm x 90 mm x 90 mm were cast by vibro-comation technique (C-Brick making machine) using a wet mix of CF binder. The bricks were cured under high humidity

for 28 d, dried and then tested for physical properties. The results show that the bricks possess compressive strength: 8.0-9.0 N/mm$^2$, flexural strength 4.5MPa, water absorption: 5% and bulk density 2210 kg/m$^3$. The photographs of CF binder bricks are shown in Fig. 2.

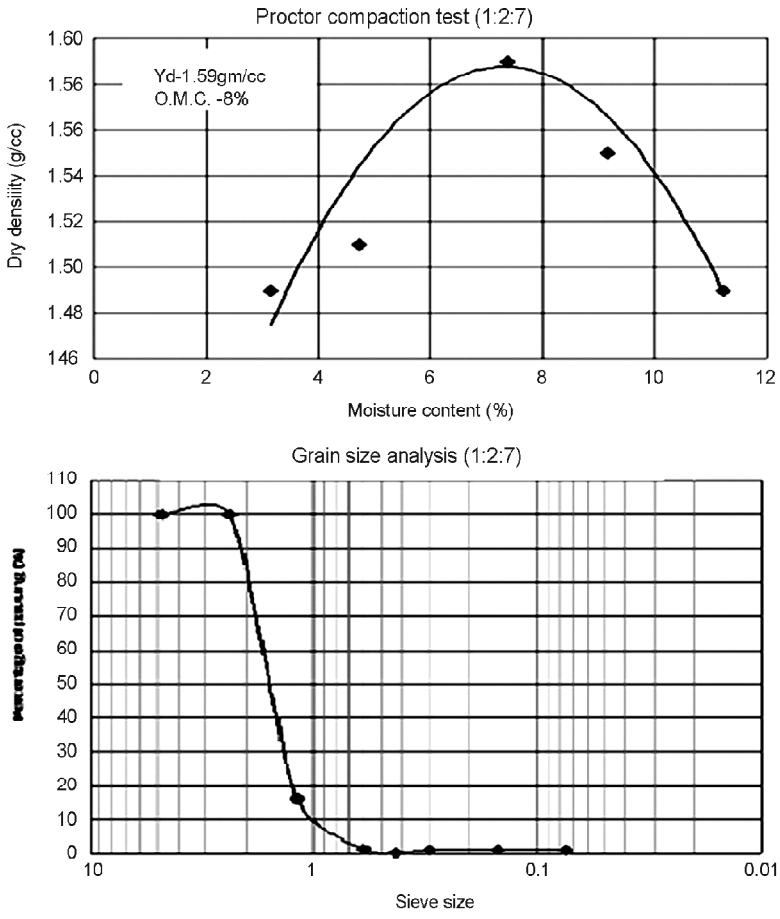
**Fig.2: CF Binder Bricks**

## Sub-Task 3.5.4: Development of Anti-termite Barrier for New Buildings

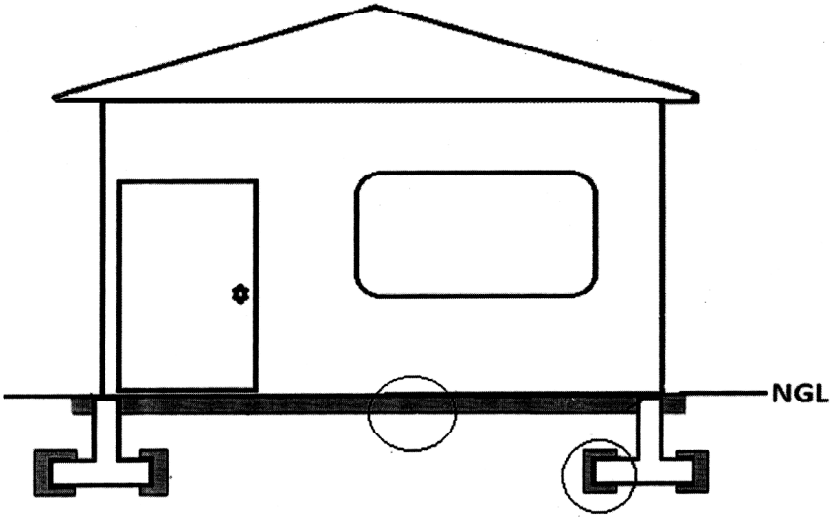
B. S. Rawat, Ashok Kumar,
S. K. Negi & Team

Subterranean termites are most destructive to buildings and account for 95% of the damage. These termites frequently gain access to structures from adjacent earth filled steps, porches, terraces, patios, breezeways and planters. Buildings on concrete slabs offer many opportunities for subterranean termites to pass from soil to wooden materials of buildings. Due to increasing health issues, people are becoming more cautious about the environment around them. One of the major reason for the rising demand of the pest control measures, especially in India, could be attributed to the increasing strict rules and regulations imposed on the commercial segment. Due to these restrictions, the segment has become more aware and is maintaining high safety standards.

The aim of any anti-termite treatment in building is to create a barrier between termite and its food available in buildings. Anti-termite barrier may be chemical or non-chemical. Therefore, objective of this R&D work is to provide completely pesticide free and long lasting anti-termite barrier for new buildings. The proposed anti-termite barrier may be easily installed and does not substantially increase the cost and complexity of construction. In the present work, varieties of inert material were studied. Specific inert material were identified, its particles were prepared, modified, altered, optimized and engineered in the laboratory to support structural units and to protect structure from termites. Further, work on engineering properties and thickness of barrier is in progress.




**Proctor compaction test and grain size analysis of an inert material.**




**The proposed position of anti-termite barrier under the floor.**

# WP-4

## Materials & Technologies for Hazard Reduction

S.R. Karade

Task 4.1

## Indigenous Cathodic Protection System for Steel Reinforced Concrete Structures

S. R. Karade & Team

Corrosion of reinforcement steel bars is one of the major durability issues of reinforced concrete (RC) structures and needs immediate attention. In developed countries, electrochemical repair techniques such as cathodic protection (CP), cathodic prevention, electrochemical chloride removal and electrochemical realkalisation are practiced to protect the structures from harmful effects of corrosion. However, the acceptability of electrochemical repair techniques is low in the developing countries. The high cost associated with the initial installation and lack of expertise in the area of electrochemical repair techniques are the main reasons for its limited applications in India. If the cost can be reduced, CP would be an effective method for the corrosion mitigation for chloride affected RC structures in India. It also extends the service life of the structure and reduces the economic loss associated with the periodical repair and rehabilitation.

The anodes used in CP contribute in total cost of a CP system. Development of a low cost anodic material for CP application can revolutionize this field.

The suitability of a conductive cement mortar overlay which can be used as an anode material is studied in the present project. Conductive fillers can be used in the cement mortar to enhance its electrical conductivity. Carbonaceous conductive fillers such as coke breeze, pyrolytic carbon black and graphite powder along with carbon fiber (CF) are used to make conductive cementitious based mortar. Mechanical, electrical and electrochemical behaviour of the composite mortar are evaluated. Optimized composition is being checked for the suitability in cathodic protection application. The effect of addition of conductive fillers in cement mortar was studied using electrochemical impedance spectroscopy (Fig.1). It is found that the addition of fillers considerably decreases resistance of the composite (Fig. 2). Carbon fiber is found to be the most effective filler to be used in the conductive cement mortar composite.

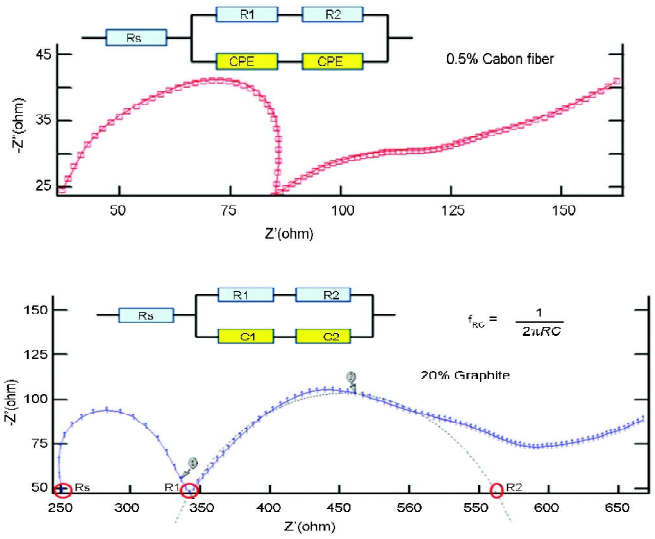



**Fig.1: Impedance spectra and equivalent circuit for carbonaceous fillers with Electrochemical Impedance Spectroscopy (EIS)**

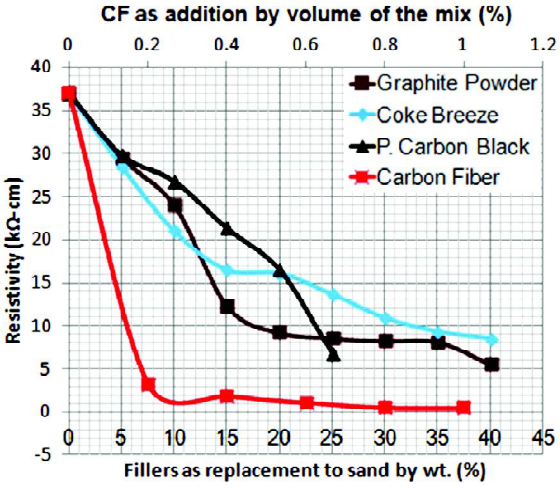



**Fig.2: Resistivity vs filler content**

Mechanical properties of the conductive mortar composites such as compressive strength and flexural strength decrease with increase in conductive filler content (Fig. 3 & 4). Carbon fiber reinforced specimens showed an improved performance in the flexural testing.

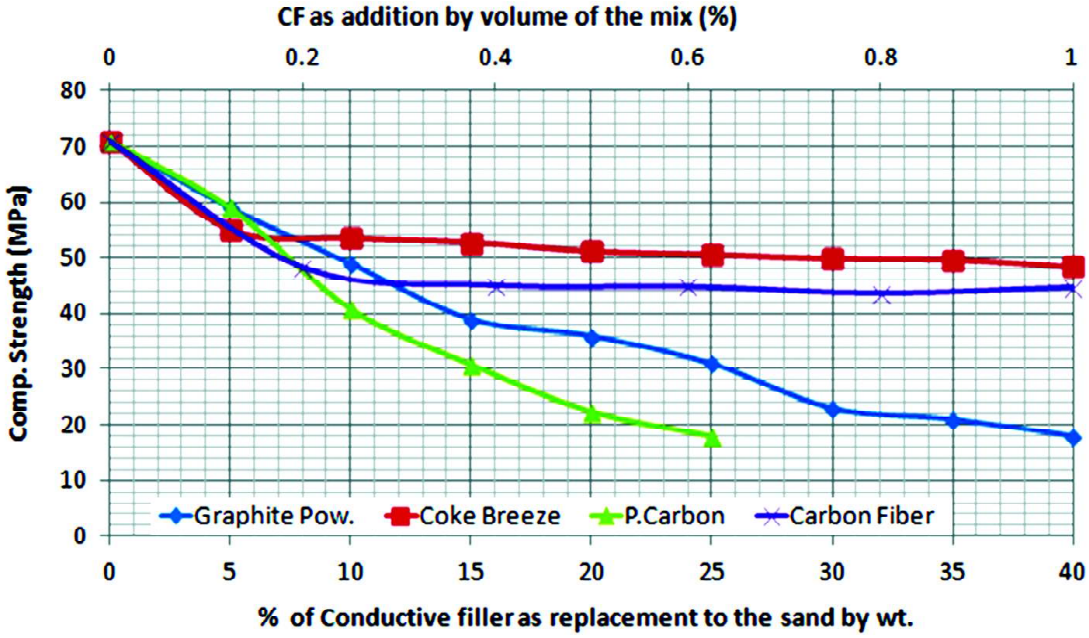



**Fig.3: Compressive strength vs filler content**

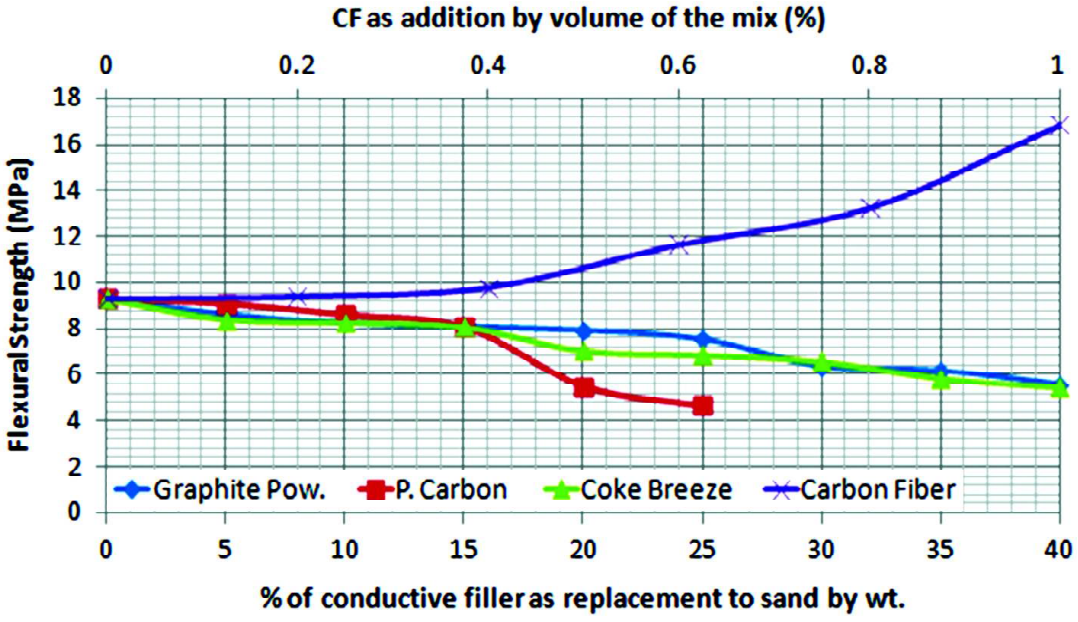



**Fig.4: Flexural strength vs filler content**

Developed composites are being evaluated for their performance in laboratory scale specimens as per the NACE criteria for cathodic protection (Fig.5).

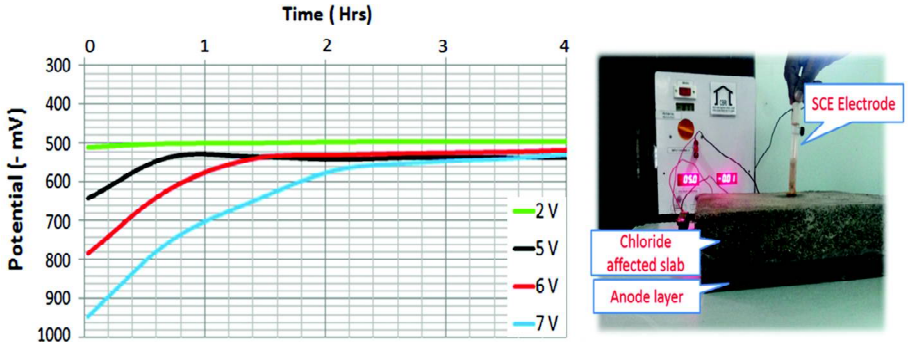



**Fig.5: Driving voltage requirement by graphite powder composite anode**

Task 4.2

# Development of Fire Safe Polymeric Composite Panels

Harpal Singh

## Objective

To develop fire retardant composite panels with reduced smoke and toxicity Composite panels comprising thin flat metal faces and a lightweight structural core are increasingly used as walls and ceilings in industrial buildings where their long-span capabilities, high thermal insulation, clean design, rapid installation and low maintenance often make them the preferred choice of designers and building owners. The other important applications are in telecommunication shelters, defense shelters and cold storage industry. The fire performance of composite panels can be excellent if the correct fire retardant core material of low toxicity index is used. The objective of the study was to prepare a liquid fire retardant additive (LFRA) of low toxicity. Some significant achievements on preparation of liquid fire retardant additive, incorporation into the core material composition at the formulation stage, effect on the properties of core material and toxicity determination are presented.

An aldehyde solution mixed with distilled water was charged in a 1000 ml three-neck round bottom flask equipped with thermometer, stirrer and reflux condenser. The medium of the solution was adjusted to alkaline by adding a few drops of 3N sodium hydroxide solution. The solution was then heated over a water bath until it attains the temperature of 80-85$^0$C. A mixture of nitrogen base additives was then added incrementally with constant stirring over 20 minutes. Upon the completion of the addition, the reaction mixture was allowed to reflux for 10 minutes. The resulting solution was cooled to ambient temperature by putting the flask under cold-water stream. A phosphorus based additive was then added slowly with constant stirring. During the addition of phosphorus based additive, the whole assembly was continuously kept under cold-water stream to avoid the heat up of flask due to the heat generated by the reaction of phosphorus based additive and mixture solution. The final product was a phosphorus-nitrogen based colourless viscous liquid containing 48% solid contents, easily miscible with water, non-flammable in nature and a pot life of 7-9 days. The product is designated as LFRA and chemical composition is presented in Table 1.

**Table 1: Chemical composition of liquid fire retardant additive (LFRA)**

| Ingredients | Molar weight |
|---|---|
| Aldehyde based compound | 3.0 M |
| Water | 7.5 M |
| Nitrogen based compound 1 | 0.25 M |
| Nitrogen based compound 2 | 0.75 M |
| Phosphorus based compound | 1.0 M |

LFRA was incorporated into the core material composition and the samples were prepared through one-shot method. LFRA quantity of 5-25% of total weight of polyether polyol was incorporated into the core material formulation with an increment of 5%. LFRA was mixed with core material ingredients and was well blended manually for 30 seconds in a stainless steel beaker. Then PMDI was added into the blended mixture and mixed for 20 seconds under overhead electric stirrer. The stirrer speed was set at 3000 rpm throughout the mixing. After mixing, the reactants were discharged into an open mould (200 × 200 × 250 mm) lined with paper to produce free-rise core× material which was then cured for 48 hours at room temperature. Some core material processing variables such as cream time, rise time and tack-free time were increased with increase contents of LFRA. This is may be due to the fact that addition of LFRA reduces the rate of reaction between polyether polyol and PMDI. The effect of LFRA on processing variables is presented in Fig.1.

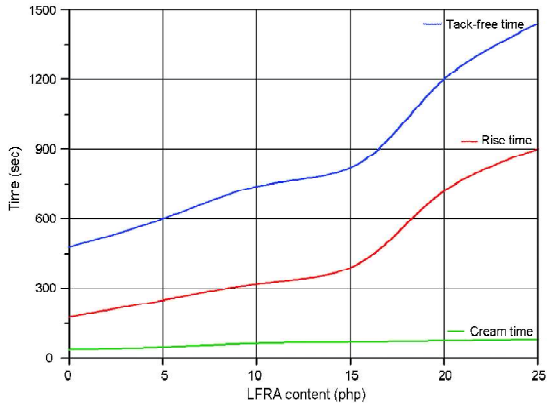



**Fig. 1: Effect of LFRA contents on core material processing variables**

The densities of core material samples incorporated with LFRA were measured as per ASTM D1622. The density of control core material was 48 kg/m$^3$. The density of core material samples incorporated with LFRA was decreased to 30 kg/m$^3$ with 5% contents and then increased with the increase in LFRA contents from 10 to 25%, however density of core material with LFRA is less than the control core material sample. Free water contents with LFRA react with PMDI and generate additional carbon dioxide which acts as blowing agents and further decreases the density of LFRA added core material samples. The effect of LFRA contents on the density of core material is shown in Fig.2.

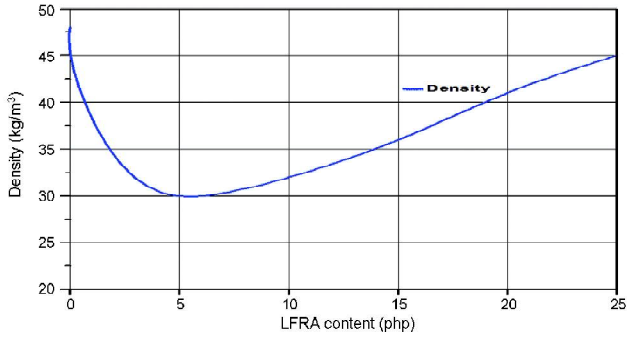



**Fig. 2: Effect of LFRA contents on core material density**

The flammability properties of LFRA added core material samples and their comparison with control samples were evaluated by means of horizontal burning. The parameters which were obtained through burning test were extent burnt, burning rate and percent mass loss (PML). All these parameters were expressed in terms of average values. The results showed that the fire performance is enhanced significantly. The flammability performance results are presented in Table 2.

**Table 2: Flammability performance of control and LFRA added core material samples**

| Properties | Control core material samples | LFRA added core material samples |
|---|---|---|
| Extent burnt (mm) | 125 | 15 |
| Burning rate (mm/s) | 2.51 | 0.6 |
| Mass loss (%) | 100 | 18 |

The toxicity of control core material and comparison with LFRA added 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°C ±50°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 LFRA added core material samples. The results showed that the toxicity of control core material was much higher than that of core material samples incorporated with LFRA. The toxicity index of control and LFRA added core material samples is shown in Fig.3. Overall, it can be concluded that incorporation of LFRA to the core material matrix reduces the flammability and toxicity significantly. It also reduces the density of core material to a desired level; however some little adverse effect is observed on the cream time, rise time and tack-free time.

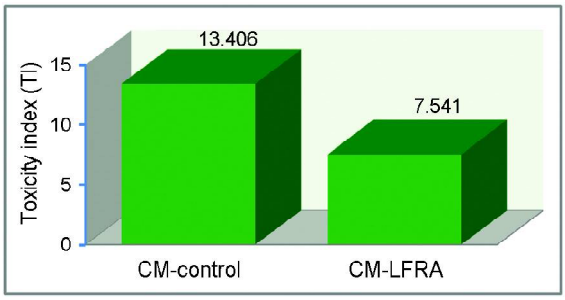



**Fig.3: Toxicity index of control and LFRA added core material samples**

## Task 4.3

# Impact Behaviour of Reinforced Concrete Elements

A. K. Mittal , Mickey Mecon Dalbehera & Team

Reinforced concrete/Prestressed Concrete structures might be exposed sometime in their lives to some extreme dynamic loading conditions owing to impacts. Typical examples include bridge structures subjected to vehicle crash impact, marine and offshore structures exposed to ice impact, rock shed structures subjected to rock fall protective structures under projectile or aircraft impact etc. In recent years the assessment of, performance and vulnerability of concrete reinforced structures under the impact load has become more important. Increasingly engineers are resorting to numerical models to carry out designs, assessments and safety checks, and there is a requirement for high-quality data from physical tests to assist in validation of these models.

The objective of the project is performance based impact resistant design of reinforced Concrete/Prestresed concrete elements. The scope of the project is as follows.

- Experimental study of impact behaviour of RC/PC elements (normal strength concrete) by drop weight impact tests.
- Prediction of impact behaviour of RC elements by non-linear FEM analysis for generation of impact response data which has not been covered in experiments.
- Establish relationship between impact energy, static flexural capacity, maximum deflection and residual deflection for RC/PC elements for Performance based design methodology.

To achieve the above stated objective, an instrumented impact loading test setup for dropping the weights at variable height up to 2.5 meter and recording the impact event (deflection, support reaction and strains vs. time) has been designed. The specially designed support system Fig.1 (a) for loading the beam and installing the strain gauge based load cell has been fabricated. The impact loading system with the data logger, load cell, laser displacement sensors with the beam instrumented for performing the drop weight experiment is shown in Fig.1 (b). As shown in Fig.1 (b), the 100 kg weight is attached with an electro magnet and which in turn is connected to an wire hoist installed on top of a steel portal frame. With help of the wire hoist the weights can be raised to a desired heights i.e up to 2.5 m and can be released with the help of electromagnet. In order to restrict the lateral movement of the electrical wire hoist, a pair of a guiding pipes of 50 mm dia, has been used to raise the hammer just above the test specimen. The drop hammer is rectangular in geometry with a dimension of (520 x 220) mm, with a depth of 70 mm. The striking surface of the hammer is of cylindrical type with, diameter of 90 mm and height of 100 mm. The Deflection of the specimen is measured with the help of laser displacement sensors, which is kept just below and 250 mm from the mid-span of the beam. The maximum deflection which can be measured by laser displacement sensors is 125 mm. The experimental setup includes 2 load cells of capacity

500 kN and 1000 kN to measure the reaction forces and one more 500 kN load cell attached with the impactor to measure contact force. The sensors are connected with a Data Acquisition system from National Instruments, with LABVIEW VI software.


**Fig.1: (a) Support system to support beam and load cell**


**Fig.1: (b) Experimental Setup**

Three grades of concrete i.e M25, M30, M40 and three drop heights i.e 0.65m, 1.0 m, 1.5 m have been considered for experimental programme. For each of the three different grades of concrete three different combinations of top and bottom reinforcement rebars i.e. (6 – 10, 6 – 12, 8 – 12) dia rebars has also been considered.

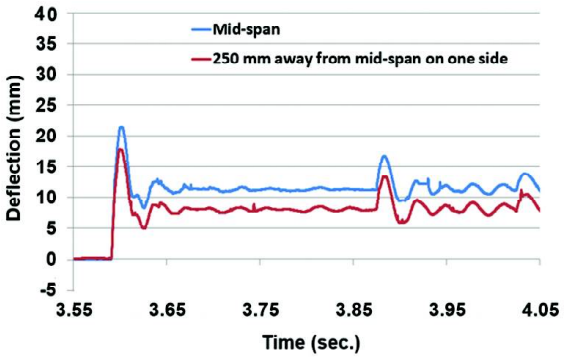



**Fig .2: Typical Deflection-time curve of Beam for 1m fall of impactor mass of 100 kg.**

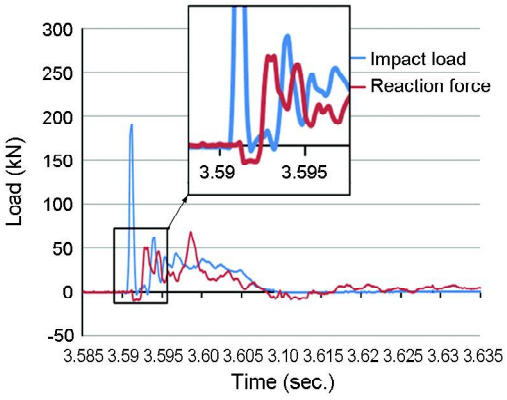



**Fig.3: Typical Impact Load and Reaction Force for beam under 1m fall of impactor mass of 100 kg**

Due to the presence of vibration in the beam after the impact, multiple no of peaks in the graph can be seen. From the Fig.3, it can be seen that, there is a time lag (~ 0.002 seconds) between maximum impact load and maximum reaction force. This may because of the fact that stress wave take some time after the impact to reach the end support. Maximum and residual deflection increase with increase in impact energy and decrease with increase in reinforcement percentage as can be seen from the Fig.4. Maximum impact force increase with increase in reinforcement percentage while the reaction force stabilizes with increase in reinforcement percentage as seen in Fig.5. When subjected to an impact load, a structural member behaves differently compared with those under a static load, owing to the transient and usually localized pattern of impact loading. The dynamic properties of materials can also be different to those under static loading. Investigations have shown that both concrete and steel are stress/strain rate sensitive: both the tensile and compressive strengths and Young's modulus can increase if there is an increase in the stress/strain rate. The scope of further study includes nonlinear FEM analysis for generation of impact response behavior, experimentation on prestressed concrete elements, establishment of relationship between impact energy, flexural capacity, maximum and residual deflection for generating performance based design methodology on Impact behaviour.

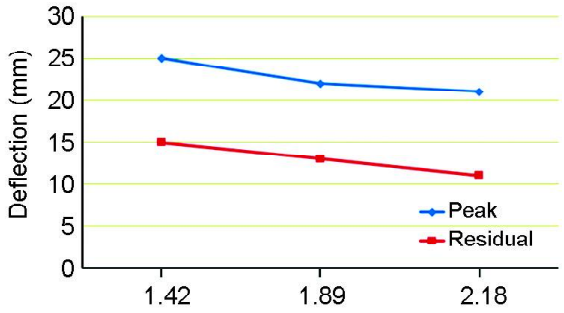



**Fig. 4: Variation of peak deflection and residual deflection with percentage of reinforcement steel for M40 grade of concrete and 1m fall of 100 kg impactor mass**

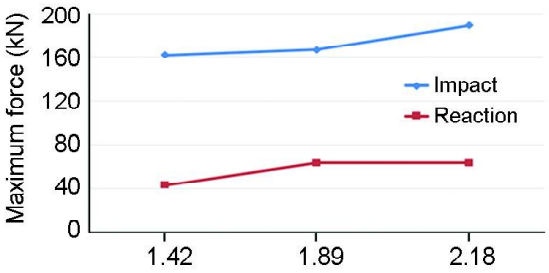



**Fig.5: Variation of maximum impact reaction forces with percentage of reinforcement steel for M40 grade of concrete and 1 m fall. of 100 kg impactor mass**

Task 4.4

# Improved Ventilation System for Cleaner Built Environment

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

## Objective:

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

## Introduction

This project aims at developing an improved ventilation system to restrict the outdoor inhalable particles from entering the enclosure as well as facilitating the exfiltration of the indoor particles. To achieve this, experimental data on indoor particle dynamics under the influence of human activities and ventilation will be studied and a model will be developed which will help in designing an improved ventilation system. The research methodology has been submitted earlier (refer to report OLP 361).

To study the effect of human activities and ventilation, a macro-scale study has been done using a GRIMM particle counter for monitoring 1- 3 micron particles. Total of eight participants were involved and monitoring was done for 65 minutes. The details of experiment are presented below.

## Analysis of Experiments

After performing experiments on particle dynamics in the FFC and ACF, the temporal variations of the particles ranging from 1-3 microns were studied till last RC. Since then, the collected data has been further analyzed for particles ranging from 0.3 - 4 microns. The database generated was utilized to arrive at approximate deposition loss rates of different size particles and fit into a two-compartment model to deduce the Resuspension rates.

## Deposition Loss Rate

The change in indoor particle concentration w.r.t time is equal to sum of infiltration and indoor source contribution minus the deposition and exfiltration (Eq.1).

$$\frac{dC_{in}}{dt} = P\alpha C_{out} + Q_s - (\alpha + k)C_{in} \quad \text{Eq. 1}$$

To reduce the complexity, Resuspension phenomenon was not considered and infiltrations as well as indoor sources were ruled out as, outdoor air was passed through filters in ACs and no significant indoor source was identified. Hence Eq.2:

$$\ln\left(\frac{C_{in}}{C_{in0}}\right) = -(\alpha + k)t \quad \text{Eq. 2}$$

For minimum ventilation conditions, the air change rate á was assumed to be 0.1 per hour. Hence, the deposition loss rate k can be calculated from the slope of curve $ln(C_{in}/C_{in0})$ *Vs t* from Fig.1 & Fig. 2.

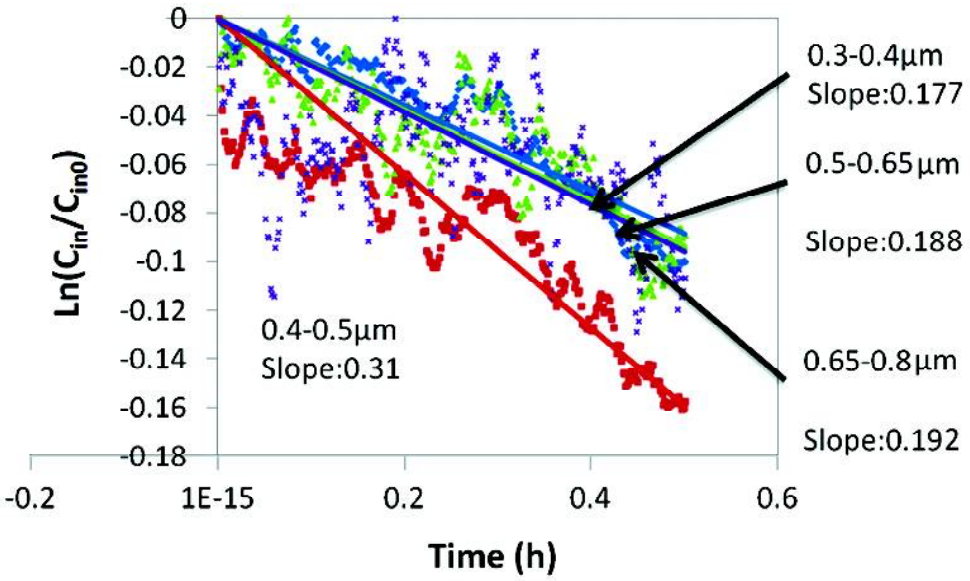



**Fig.1: *ln($C_{in}/C_{in0}$) Vs t* curve for submicron particles**

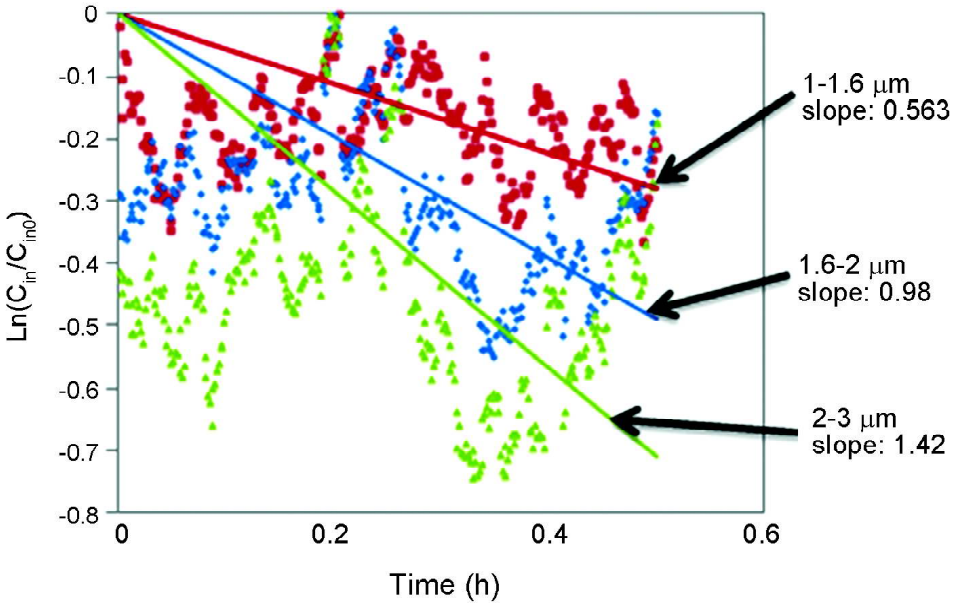



**Fig.2: *ln($C_{in}/C_{in0}$) Vs t* curve for supermicron particles**

Deposition loss rate was found to be higher for larger particles. The variations of deposition loss rate are depicted in Fig.3 (present study) & Fig.4 (literature).

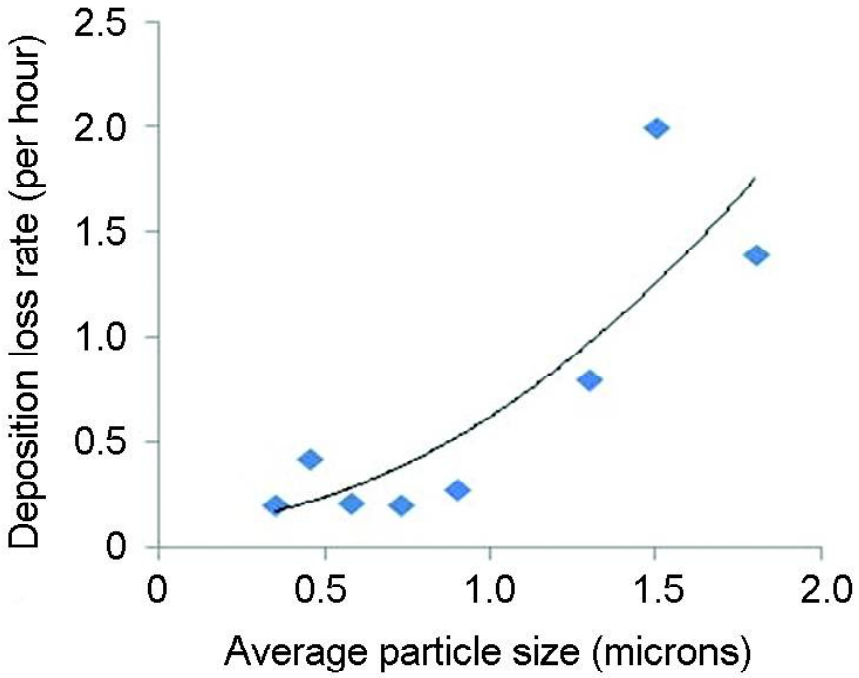



**Fig.3: Deposition loss rate - present study**

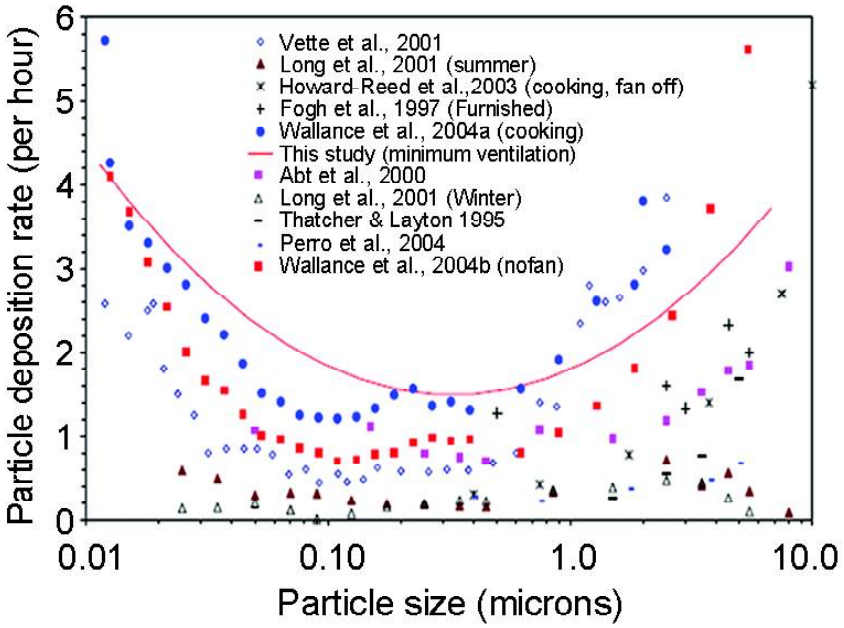



**Fig.4: Deposition loss rate - literature**

It should be noted that particles smaller the 0.1 microns has a higher deposition rate which may be due to coagulation of smaller particles.

## Resuspension Rate

A two-compartment model proposed by Schneider et. al was found to be more generic in nature covering all the phenomena affecting the particle dynamics in indoor spaces like deposition, Resuspension, infiltration, particle track-in, vacuuming etc. The resuspension rate was expressed as Eq.3.

$$r_j(t+\Delta t) = \frac{V}{A_r L_j(t)}\left(\frac{C_{ij}(t+\Delta t) - C_{ij}(t)}{\Delta t} + (a+k_j)C_{ij}(t)\right)$$

Eq. 3

Based on above equations, temporal variation of Resuspension rate was plotted assessing the effect of ventilation and human activity Fig.5.

Evidently, the Resuspension is higher during ventilation and human activities due to the increased aerodynamic effect. Resuspension rates for particles in the range of 1-4 microns are higher than the other lighter particles. This is due to the fact that smaller particles take more time to settle hence making them unavailable for Resuspension.

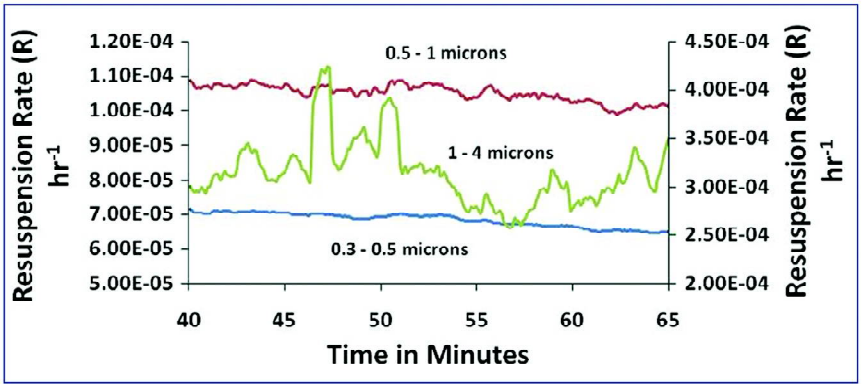



**Fig.5: Box plots of Resuspension rates of particles from 0.3-4 microns with impact of ventilation and activity.**

From the analysis of experimental data and literature, the following parameters (Table 1) are shortlisted for more detailed study under small scale chamber studies.

**Table 1: Parameterization for small scale chamber studies**

| Parameters to study | Options |
|---|---|
| Flooring Material | Carpet/ Hard floor |
| RH | 30-80 % |
| Air Change rate | ASHRAE(Residential) |
| Aerodynamic disturbance | 1 – 5 m/s |

Since the variables involved in real time experiment of conference room were highly uncontrollable, a scheme of controlled chamber studies has been designed, which is presented below in Fig.6.

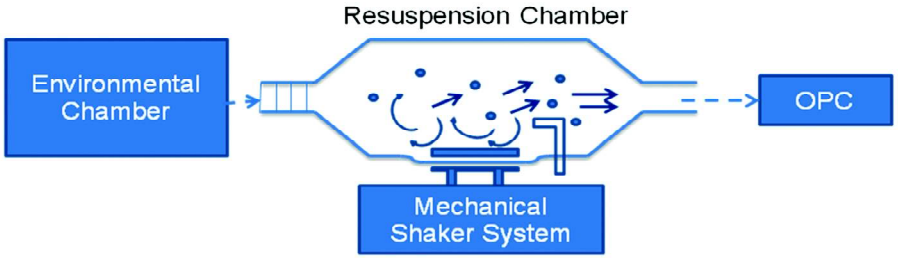



**Fig.6: Scheme of controlled chamber test for Resuspension studies.**

The set up consists of an environmental chamber for supply of a pre-conditioned air, a mechanical shaker system for simulation of floor vibration due to human walking, a set of 6 nozzles for supply of air jet to simulate aerodynamic effect of human walking, a Resuspension chamber for controlled test and optical particle counter for measurement of resuspended particle number.

Based on this scheme, the fabrication of setup has been taken up as can be seen in the following picture (Fig.7). However, a few operational discrepancies were encountered like condensation in Resuspension chamber, loss of heat etc.

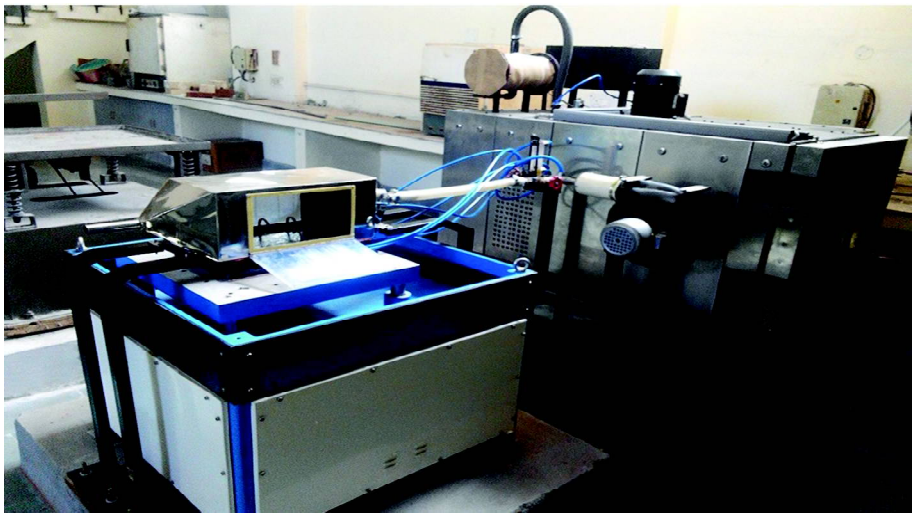


**Fig.7: Fabrication of experimental setup**

Using the 2.5 micron polystyrene latex particles of density 1.05 g/cm$^3$, 2 x 10$^7$ particles were generated, after 10 minutes of operation of aerosol generator, for applying a uniform layer of mono-disperse particles. Generation of multilayer on the floor specimen like carpet has been a challenge. Possible methods are being explored for this.

Experimental runs shall be initiated after the complete installation of setup to examine the Resuspension behavior of 1, 2.5 and 8 micron particles under varying ventilation rates, temperature and relative humidity for flooring materials like carpet and tiles.

## Generation of a Multi-layer Deposit

A scheme to generate a multi-layer deposit has been presented below in Fig.8. A layer of coarser particles (8 microns) shall be deposited first followed by a layer of 5 microns and lastly a layer of finer particles of 2.5 microns. A proper settling time shall be ensured as per the respective settling velocity at each stage.

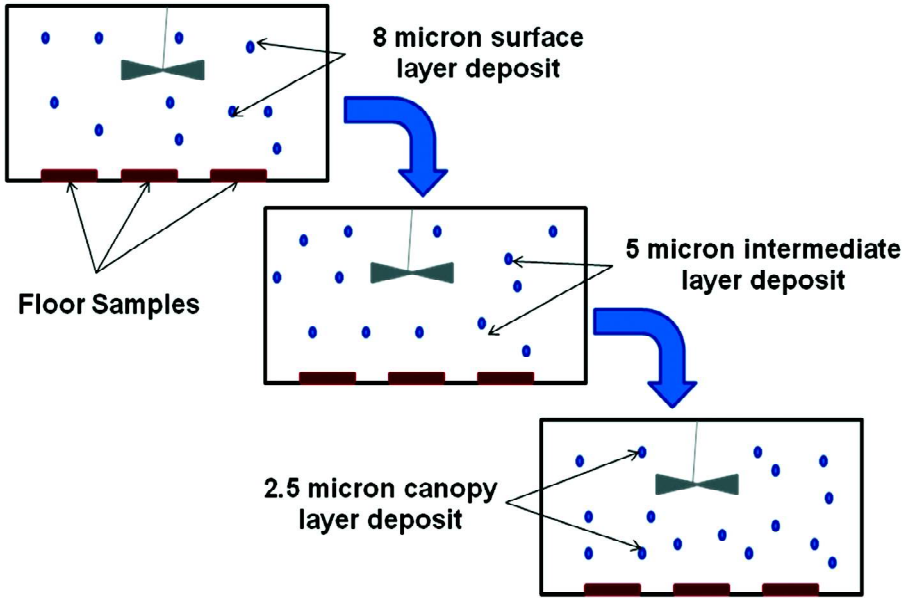



**Fig.8: Scheme of Multi-layer deposit generation**

The following equations are useful in assessing the type of layer deposit.

$$\delta \approx \frac{\lambda}{1-\varepsilon} D \qquad \text{Eq. 4}$$

Where $\lambda = \frac{6m}{\Pi \rho D}$ , δ=layer thickness,

D = diameter of particle and **ε**= porosity

$\delta \le D \Rightarrow Monolayer$

$D < \delta < 2D \Rightarrow Intermediate$

$\delta \ge 2D \Rightarrow Multilayer$

## ENGINEERING OF DISASTER MITIGATION & HEALTH MONITORING FOR SAFE & SMART BUILT ENVIRONMENT (EDMISSIBLE)

**WP-1: Engineering of Landslide Disaster Mitigation.**

**PI: Dr. S. Sarkar & Dr. D.P. Kanungo Task: 08 Nos.**

1.1 Landslide Hazard and Risk Assessment of Chamoli-Joshimath Region, Garhwal Himalaya (CSIR-CBRI),PI: D.P.Kanungo

1.2 Early Warning Instrumentation & Decision Package for a Landslide in Chamoli-Joshimath Region, Garhwal Himalaya (CSIR-CBRI), PI: D.P.Kanungo

1.3 GPS based Integrated Landslide Modeling for Hazard Assessment in Chamoli-Joshimath Region, Garhwal Himalaya (CSIR-CMMACS), PI: Dr. Sridevi Jade

1.4 Landslide Monitoring using SAR Interferometery (CSIR-CSIO), PI: Dr. S.K. Mittal

1.5 Development of Optical Fibre based Multiplex Sensor Network System for Landslide Monitoring (CSIR-NEIST), PI: K. Buragohain

1.6 Comprehensive Geo-Investigation and Control Measures of Landslide in Chamoli-Joshimath Region, Garhwal Himalaya (CSIR-CBRI), PI: Dr. S. Sarkar

1.7 Landslide hazard Information System and Design of Innovative Measures for Landslide Control (CSIR-CRRI), PI: P.Parsad

1.8 Bio-Engineering - A PhytoremediationOption for the Mitigation of Landslide and slope Stability Problems in the Hilly Regions (CSIR-NEERI), PI: Dr. Asha Juwarkar

**WP-2: Engineering of Earthquake Disaster Mitigation.**

**PI: Er. Ajay Chourasia & Dr. P.K.S. Chauhan Task: 03 Nos.**

2.1 Sesmic Microzonation of Srinagar, Uttarakhand (CSIR-CBRI), PI: Dr. P.K.S. Chahuhan

2.2 Sesmic Behaviour of Piles under Dynamic Lateral Loading (CSIR-CBRI), PI: Ms. Parvathi G.

2.3 Sesmic Resistance of Confined Masonary Construction under Different Axial Stress (CSIR-CBRI), PI: Er. Ajay Chourasaia

**WP-3: Engineering of Fire Disaster Mitigation.**

**PI: Sh. R..S.Chimote & Dr. Suvir Singh Task: 03 Nos.**

3.1 Development of Innovative Fire Suppression System (CSIR-CBRI), PI: Sh. R.S.Chimote

3.2 Fire Performance Evalution of Structural Elements and Rehabiliation Measures (CSIR-CBRI), PI: Dr. Suvir Singh

3.3 Development of Fire Resistant Coating on Structural Element (CSIR-CGCRI), PI: Dr. Kaushik Dana

**WP-4: Post Disaster Shelter Planning.**

**PI: Er. S.K. Negi** **Task: 02 Nos.**

4.1 Design and Development of Disaster Resistant Intermediate Shelters for Western Himalyan Region (CSIR-CBRI), PI: Ar. S. K.Negi

4.2 Post Disaster Management- Design and Development of Transitory Houses for Disaster Vulnerable Rural Sectors in North Eastern Region (CSIR-NEIST), PI: Mr. Dipankar Neog

**WP-5: Health Monitoring of Buildings Using Wireless Sensor Network.**

**PI: Er. Ajay Chourasia & Er. Soju Alexander Task: 05 Nos.**

5.1 Development of Fiber Bragg Grating (FBG) Sensors and Interrogator System for Buildings (CSIR-CGCRI), PI: Dr. Somnath Bandhopadhay.

5.2 Development of Wireless Sensors, Interrogator System and Technnique for Wireless Link for Buildings (CSIR-CSIO), PI: Dr. R. Bhatnagar

5.3 Design and Development of ARM and FPGA Processor and Sensor Placement Optimization (CSIR-CEERI), PI: Dr. Kota Soloman Raju

5.4 Development of Statistical / Artificial Intelligence (AI) Models to Quantify the Damage State of Buildings (CBRI-CEERI), PI: Dr. J. L. Raheja

5.5 Collection & Validation of Data Using Developed Sensor, Numerical Modelling, Model Updation and Field Implementation for Building System (CSIR-CBRI), PI: Er. Ajay Chourasia

**WP-6: Intelligent Building System for Model Residential Unit.**

**PI: Er. R.S. Bisht & A.K. Mittal Task: 08 Nos.**

6.1 Architectural Planning and Design of a Residential Unit for Integrating Intelligent Building Features (CSIR-CBRI), PI: Ar Ashok Kumar.

6.2 Intellegent HVAC and Lighting Control in Response to Ambient Environment (CSIR-CBRI), PI: Nagesh B.Balam

6.3 Glass Façade Cleaning Robotics System (CSIR-CBRI), PI: R. S .Bisht.

6.4 Development of Building Energy Management System Software and Interface Instrumentation (CSIR-CSIO, Chennai), PI: Dr. Kota Srinivas

6.5 Remote Control of Home Appliances using Mobile or Web Connectivity (CSIR-CMERI), PI: Dr. Jaydeep Roy Choudhary

6.6 Design and Development of a Communication, Safety and Security System (CSIR-CEERI), PI: Dr. Kota Soloman Raju

6.7 Design and Implementation of Robot for Automatic Floor Cleaner using Wireless Technologies (CSIR-CEERI), PI: Dr. Kota Soloman Raju

6.8 Communication Network Architecture for Intelligent Buildings (CSIR-CEERI), PI: Dr. Kota Soloman Raju

# Project Title: Engineering of Disaster Mitigation and Health Monitoring for Safe & Smart Built Environment

Nodal Scientist: S. Sarkar

Co-Nodal Scientists: D. P. Kanungo, Ajay Chaurasia & S. K. Singh

## Preamble

The safety of the built environment is of paramount importance from the point of view of natural disasters. It is essential to have built environment, which can resist different natural calamities effectively. Living with the risk of natural disasters is a part of everyday life in the Himalayas. The Himalayan region is frequently subjected to several natural disasters like earthquakes, landslides, avalanches, floods due to glacial lake outburst, flooding etc. Landslides, rock fall, avalanches in particular are posing serious problems in the mountainous areas, and the means of mitigation and/or corrective measures are scarce. Hence it is imperative to assess the hazard and risk along with modeling of landslide dynamics for efficient mitigation measures and development of early warning system. As the population of the country is getting agglomerated in the form of urban clusters and cities, the risk of economic and human loss due to seismic hazard is increasing every year. Development of seismic micro-zones and design of safe built forms against earthquake are essential tasks for earthquake disaster mitigation. Although a fire disaster may not necessarily reach to catastrophic proportions all the time, it will present some of the characteristic aspects of a disaster because of destructive action of fire and of considerable losses of life and property. A fire of large proportions can cause damage to the built environment due to massive production of heat and the emanation of burn gases and fumes.

Building, a complex structural system, comprising of different materials, is often subjected to harsh loading scenarios and severe environmental conditions, generally not anticipated during the design stage, resulting in long-term structural deterioration. Therefore, monitoring of health of building is essential from safety, durability, serviceability, and sustainability point of view during its long-term service. Instrumentation plays an important role in the modern building architecture to evolve green buildings by effectively utilizing the resources which are energy efficient and environmental friendly with smart control features by incorporating safety and security measures.

With this in view, CSIR-CBRI has undertaken the assignment related to disaster mitigation, health monitoring of buildings and intelligent buildings by utilising the strengths of different sister laboratories of CSIR in network mode so that individual expertise of laboratories can be utilised in a holistic manner.

# WP-1

# Engineering of Landslide Disaster Mitigation

S. Sarkar, D. P. Kanungo & Team

Indian Himalayas is one of the tectonically most active mountain ranges of the Himalayas and is very prone to different geo-hazards such as earthquakes and landslides. The physical factors of the terrain such as immature geology, unstable geological structures and rugged topography along with the triggering factors like earthquake forces and heavy precipitation during monsoon seasons cause severe land sliding phenomena in the Indian Himalayan region. Landslides of different types occur frequently in geodynamically active domains in Indian Himalayas. 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 taken 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

## Task 1.1

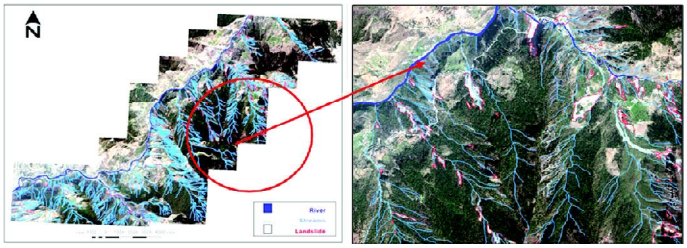
## Landslide Hazard & Risk Assessment

D.P. Kanungo & Team

The study aims at generating a geological and geomorphological database of landslides and their causative factors in parts of Chamoli District of

Garhwal Himalayas based on field investigation and remote sensing and GIS analysis. The landslide hazard maps depicting the existing and potential landslides of different types will be prepared by integrating all the causative parameters. The information pertaining to the travel/flow path and zone of influence of all the landslide hazard zones will also be an integral part of the hazard map. Further, the risk elements in the region such as habitations and infrastructural facilities etc. will be mapped using available information and remote sensing image analysis and interpretation. Risk information will be finally integrated with the hazard maps to produce the landslide risk map for the region.

Presently different causative factor layers are being prepared in GIS environment through field survey and digital image interpretation of high resolution remote sensing satellite data (i.e., Cartosat 1 image with 2m spatial resolution and GeoEye data with 0.5m spatial resolution). These layers will be useful for large scale landslide hazard mapping of the study area. The rock discontinuity parameters are being collected from the road cut slopes to develop the field based slope stability assessment technique.




**GIS maps**


**Field observations of rock discontinuities**

## Task 1.2

# Development of Landslide Early Warning System for a Landslide in Chamoli-Joshimath

DP Kanungo & Team

## Region of Garhwal Himalaya

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.

For field instrumentation program, an active and accessible landslide site 9km ahead of Pipalkoti along Chamoli-Joshimath National Highway section has been selected. The detailed geological and geotechnical investigation of the landslide is

being planned to understand the failure mechanism of this landslide prior to the site instrumentation. A scheme of real time field instrumentation and monitoring of landslide through wireless data communication network is framed. The locations for placement of different surface and sub-surface (borehole) sensors are shown on the landslide area.

Various sensors planned to be placed on landslide site include:

⇒ **Piezometer**: Vibrating wire type (4 nos.)

⇒ **In-Place Inclinometers**:16 nos. (4 per bore hole)

- Biaxial sensor on wheel pair
- Measuring Range ± 15°

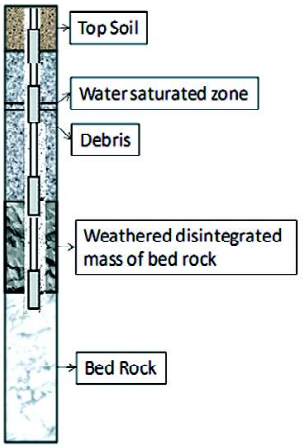
⇒ **Wire line Extensometer** - 3 nos.

- Vibrating wire type

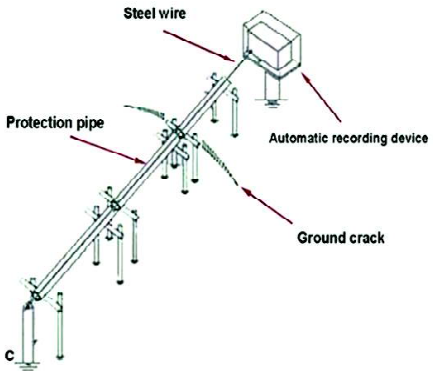
⇒ **Automatic Weather Station (AWS)** - 1 no.

- Rain Gauge – Tipping bucket type
- Wind Velocity Sensor (3-cup Anemometer with Potentiometer)
- Relative Humidity & Temperature Sensor

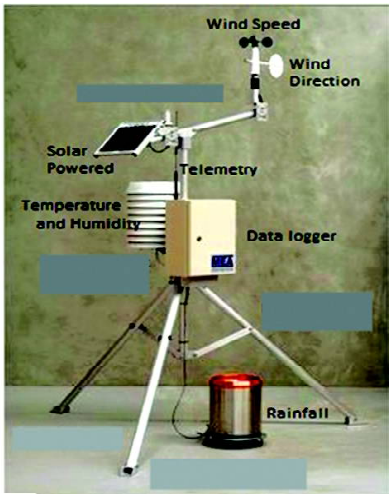

**Scheme of field instrumentation at landslide site**




Scheme for In-place Inclinometer Sensors in the bore hole




Wie extensometer installation plan at landslide site




Automatic Weather Station (AWS)

## Task 1.3

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

S. Sarkar & Team

The objective is to carry out a comprehensive study involving geological, geotechnical and geophysical investigations, and mathematical modeling of an active landslide of Chamoli-Joshimath region of Garhwal Himalaya to arrive at design and implementation of suitable control measures.

The geotechnical investigation of the landslides is in progress. The stability analysis of the landslide is being carried out to know the state of stability condition of the landslide area which will help to design the suitable control measures. The analysis was carried out for different profiles as shown in the Fig.1.

**Fig. 1: Sections for stability analysis**

Factor of safety were calculated using limit equilibrium methods at different moisture conditions varying from dry to 94% saturation (Fig. 2). The factor of safety of a section was found to be 1.3 which decreases to 1.1 under full saturation. The analysis has shown almost the similar results for different slip circles and for other sections also. The factor of safety of a critical slip surface was found to be just 1.00 under saturated condition. It was observed from the analysis that in dry condition a shallow part of the slope mainly comprising sandy silt becomes unstable while under saturated condition a significant portion of slope becomes unstable containing sandy silt and sandy gravel layers. The depth of the slip surface varies from 10-15m in different condition.

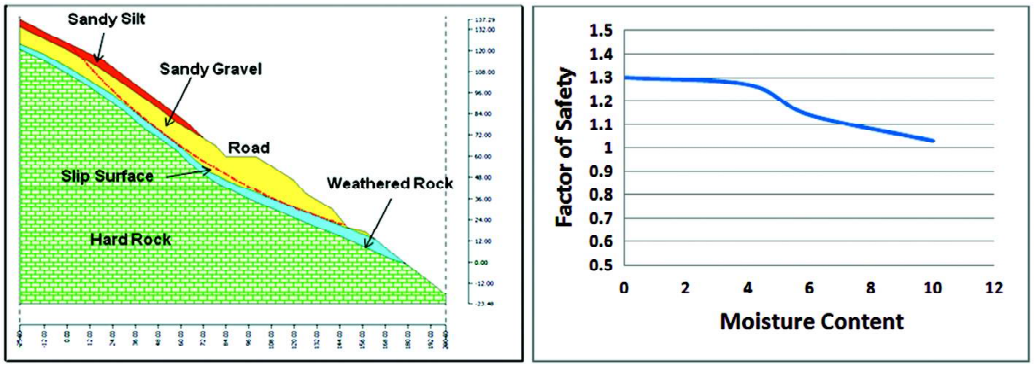



**Fig.2: Stability analysis of landslide slope**

A composite scheme of control measure has been prepared for stabilization of this landslide as shown in the Fig.3. The measures include reinforced soil structure, gabion wall, soil nailing, surface drainage and bio-measure.

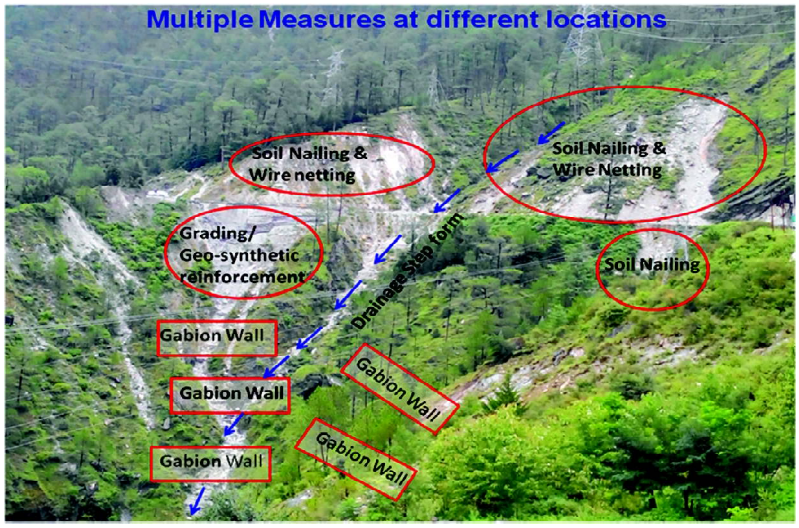



**Fig.3: Scheme of probable measures at landslide site**

# WP-2

# Engineering of Earthquake Disaster Mitigation

Ajay Chourasia &
P. K. S. Chauhan

## Task 2.1

## Seismic Microzonation of Srinagar, Uttarakhand

P. K. S. Chauhan

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. In the year 2013-2014, the following works were completed;

- Strong Motion Accelerographs (SMAs) procured
- Four SMA stations established
- Geophysical Investigation at two sites
- Seismic Hazard Estimation using probabilistic analysis

Nine strong motion Accelerographs (SMA), model Basalt has been procured, and before installation at site, training has been provided by Kinemetrics's engineers about the instrument installation & data acquisition at CSIR-CBRI. (Fig.1)

Out of Nine, four SMAs have been installed at four different location in Srinagar i.e.

- Tehsil, Srinagar
- High Altitude Plant Physiology Research Centre, Srinagar
- Govt. Girls Inter College, Srinagar
- Geology Deptt., HNBG University, Srinagar

All the instruments have been aligned in North direction. SMAs have been installed at ground floor to acquire the data precisely with minimum noise. GPS has been installed for time keeping of the instruments. For better signals receiving from satellites the GPS receivers have been installed at the roof. (Fig.2)

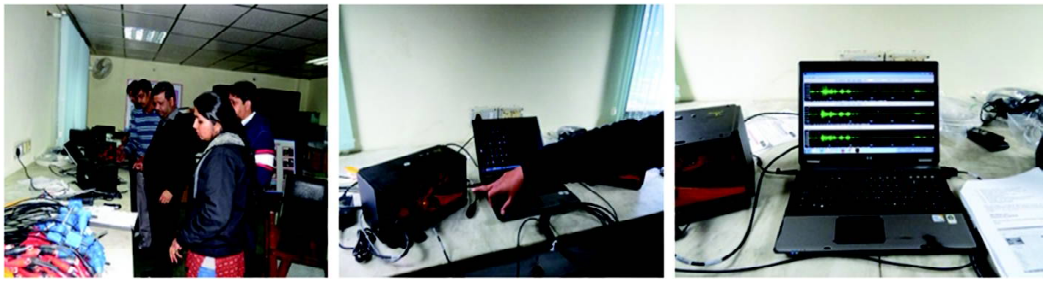


**Fig.1: SMA Installation Training at CSIR-CBRI**


**Fig.2: SMA Stations at Srinagar**

As the city is situated on both side of river Alaknanda therefore geophysical investigations have been carried out on both side of river bank to know the subsurface features. For this purpose resistivity imaging system has been used at HNBG University Campus which is situated at right bank of river. Fig.3 shows the data acquisition and its interpretation. Result shows three distinct layers below the surface.

Similarly at the left bank of the river Alaknanda in the premises of GGIC, Srinagar one profiling using resistivity imaging system has been carried out. The similar results were obtained after processing of the data i.e three distinct sub-surface layers (Fig.4).

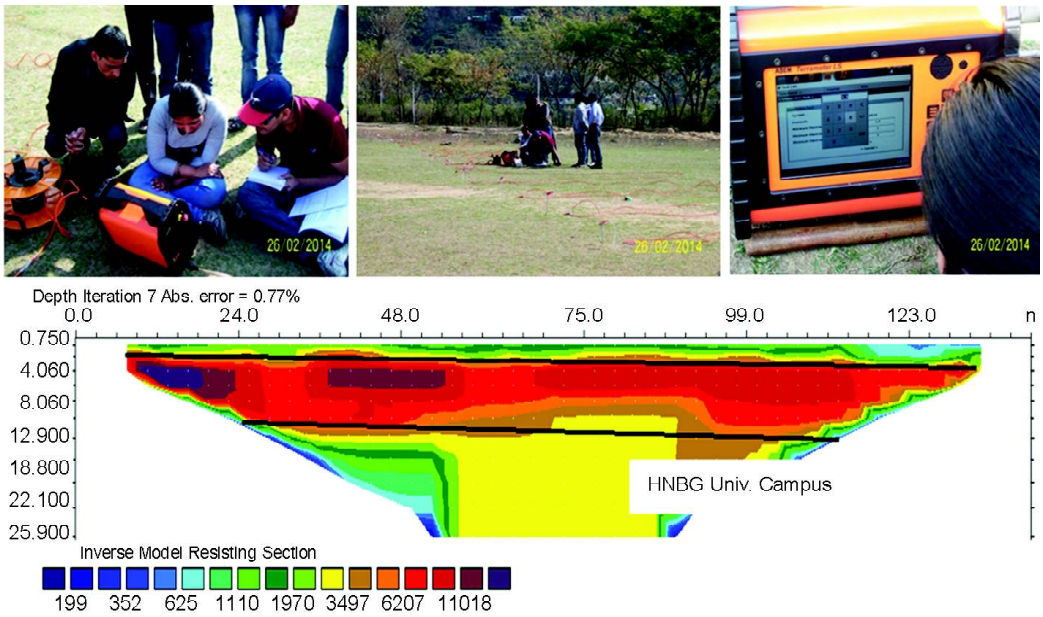



**Fig.3: Geophysical Survey at HNBG Univ.**

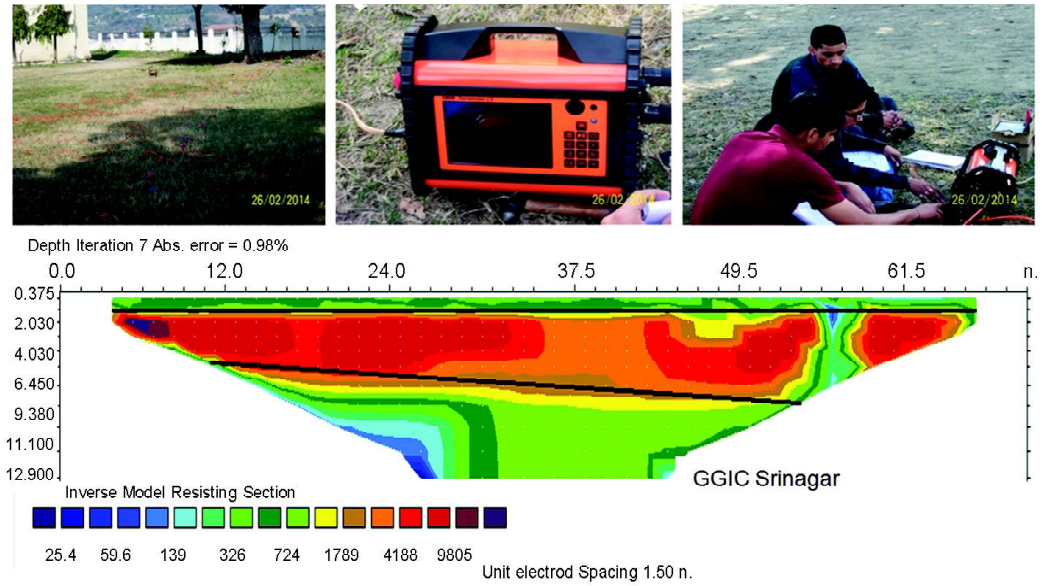



**Fig.4: Geophysical Survey at GGIC Srinagar**

For Seismic Hazard Estimation of the region, the past earthquake data of last 38 years has been collected from USGS and seismicity map of the region has been prepared (Fig.5) Seismic Hazard can be defined on the probability of occurrence of earthquake or earthquake effects of a certain severity, within a specific period of time in a given area. Yearly expected number and mean return period are calculated for different magnitudes as given in Table 1. Seismic activities of Srinagar have also been shown through bar charts in Fig.6.

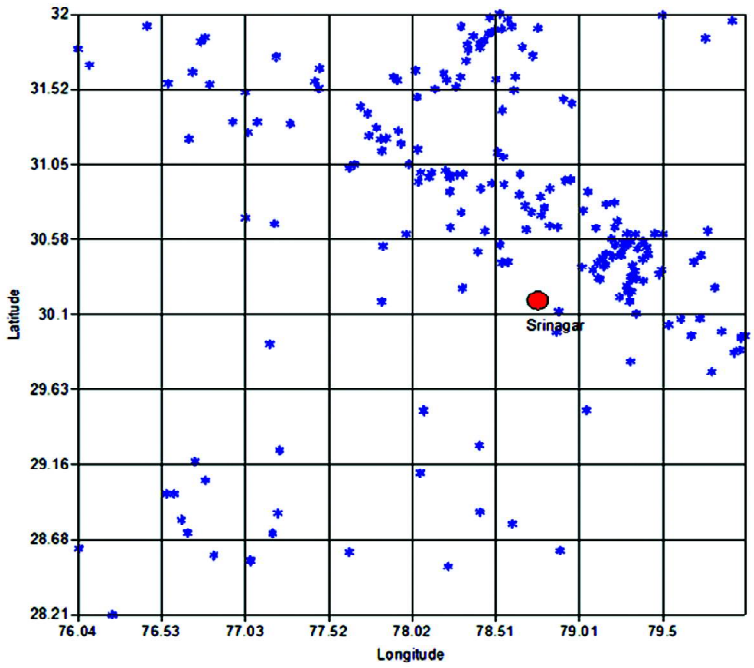



**Fig. 5: Seismicity map of the study area (Source USGS data)**

**Table 1: Probability of Earthquakes for Different Magnitudes and Time Periods**

| Magnitude | Recurrence Interval | Probability of recurrence in the years 2015-25 | Probability of recurrence in the years 2015-65 |
|---|---|---|---|
| > = 6.0 | 20+/- 5 yrs. | 50 - 85 % | 85 – 99 % |
| > = 7.0 | 100+/- 20 yrs. | 7 – 21 % | 25 – 55 % |
| > = 8.0 | 500 +/- 50yrs. | 0.9 – 2 % | 2.0 – 9.0 % |
| > = 8.5 | 750 +/- 70yrs. | 0.3 – 1.1 % | 1.1 – 3.3 % |

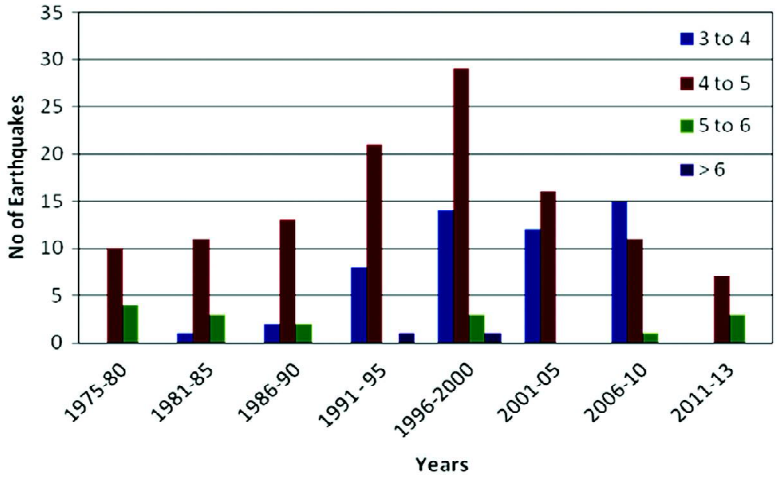



**Fig. 6: Bar chart of Scismic activity in Srinagar region**

## Task 2.2

# Seismic Behavior of Piles under Dynamic Lateral Loading

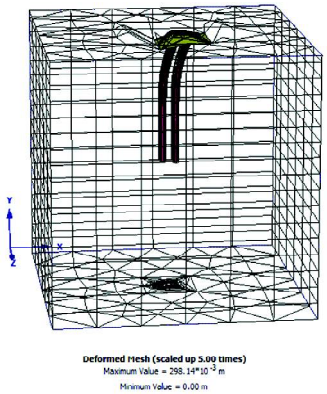
G. S. Parvathi, Manojit Samanta, Piyush Mohanty, Dalip Kumar & Zamir Ahamad

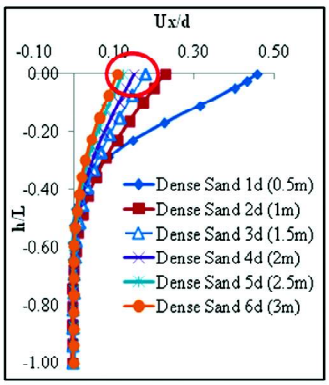
## Objectives:

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 behavior of piles under dynamic lateral loading. The influence of liquefiable soil layer on the behavior of piles will also be studied.
III. Development of a methodology for seismic design features of piles in layered sandy soils.

Validation of software for the numerical analysis of pile on layered sandy soil has been completed. Validation was done using the published work of Karasev et. al.(1997) and Moayed et al.(2012) for single pile subjected to various lateral load combinations.

Numerical analysis of piles in layered sandy soil with combination of loose sand and dense sand, subjected to static lateral loading has been completed. Parametric studies were done for different lateral load-axial load combinations, pile spacing and the depth of the top dense sand layer. From the parametric studies, it has been observed that, the ratio of lateral load capacity to axial load very much depends on the top dense sand layer thickness. But when the dense sand layer thickness is more than 3d, lateral resistance almost remains same. Thus it can be inferred that even if the top dense layer thickness is more than 3d, significant lateral load is taken up by the top 3d only. Critical lateral load was observed to be 50% of the ultimate axial load capacity. Beyond that, pile losses much of its lateral stiffness. The point of bending lies near around 0.4L from the pile top, irrespective of the layering system. Figures showing the deformed mesh and the variation graph of non-dimensional lateral displacement with respect to the non-dimensional depth of pile for varying dense sand layer thickness are shown below.



The analysis of pile in layered sandy soil subjected to dynamic lateral loading has been initiated. Experimental model test design for static and dynamic analysis of piles is completed. This includes the design of testing tank, test pile and shake table. Laboratory model test will be done on a testing tank of size 2x2x1.5m for static analysis and 1.2x0.65x1m for dynamic analysis.

Static case model testing will be done on floating aluminum piles of diameter 25mm and of varying depth of top layer. Test will be done for single as well as group of piles (2x2 and 3x3).For dynamic model study, a 2T uni-axial shake table (1.5x1.5m) will be used to give the dynamic excitation on a laminar shear box. Laminar shear box will substantially reduce the boundary effect of box on the piles, hence reducing the overall payload for shaking. Acceleration time history for Chamoli and Uttarkashi earthquake for the layered sandy soil under consideration will be developed from Shake 2000 software and will be used for the dynamic study.

## Task 2.3

# Performance of Confined Masonry Buildings under Quasi-Static Condition

Ajay Chourasia, S K Bhattacharyya & Jalaj Prashar

Since the dawn of civilization, masonry has been the most commonly used material in building industries, especially low rise. However, Unreinforced masonry (URM) buildings, have proven to be 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 it led to the concept of reinforced masonry (RM) and confined masonry (CM) systems. Further, the performance of CM suffers from variation in material properties and local construction practices. In India, the experimental data on CM buildings using local construction practice is very limited and this lack of knowledge influences the seismic safety and design procedure of CM buildings. This calls for test on real scale CM building model involving all the complexity to evaluate its seismic behaviour in Indian scenario.

In addition, quite often, the vulnerable buildings are also repaired/retrofitted. It is pertinent that the safety of such buildings be assessed objectively based on experimental verifications. Thus, to study the seismic performance of these buildings and their retrofit models, full-scale quasi-static tests were carried out on single storey masonry buildings. To evaluate the performance of indigenously built different types of masonry building construction practices during earthquake, one room- full-scale masonry model 3.01x3.01m in plan and 3 m high, have been tested under quasi-static cyclic lateral displacements (Fig.1).

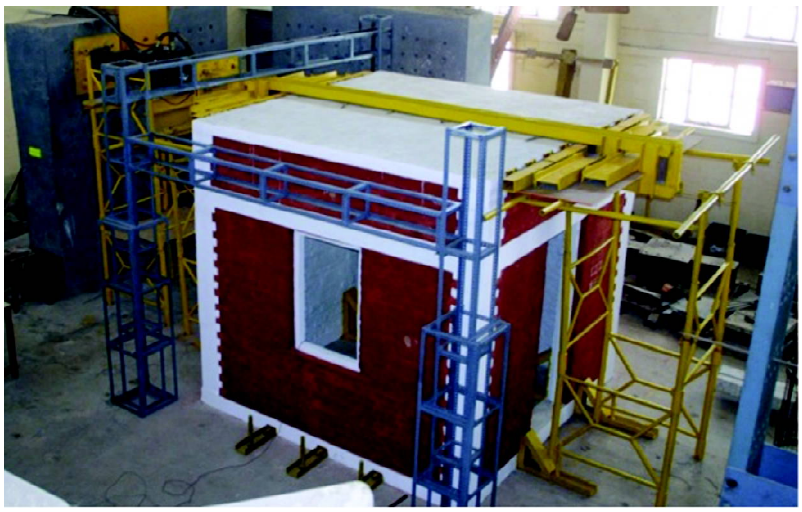


**Fig.1: Full-scale confined masonry building model subjected to lateral cyclic load**

Fig.2 shows the hysteresis curve plotted by taking into account peaks of resisting force and corrosponding displacement amplitude from the measured data during cyclic test on CM building model. These values are average of three repetative cycles of same amplitude in positive (push) and negative (pull) direction of loading at a given displacement amplitude. The figure also illustrates the lateral load and displacement corrosponding to occurrence of first significant crack (Hcr and dcr), maximum resistance (Hmax and dmax), and maximum lateral displacement (Hdmax and dmax). The hysteresis envelope of lateral load – displacement for CM building model have been shown in Fig.3. The hysteresis envelope of the CM building model suggests a considerable ductile behavior before failure.

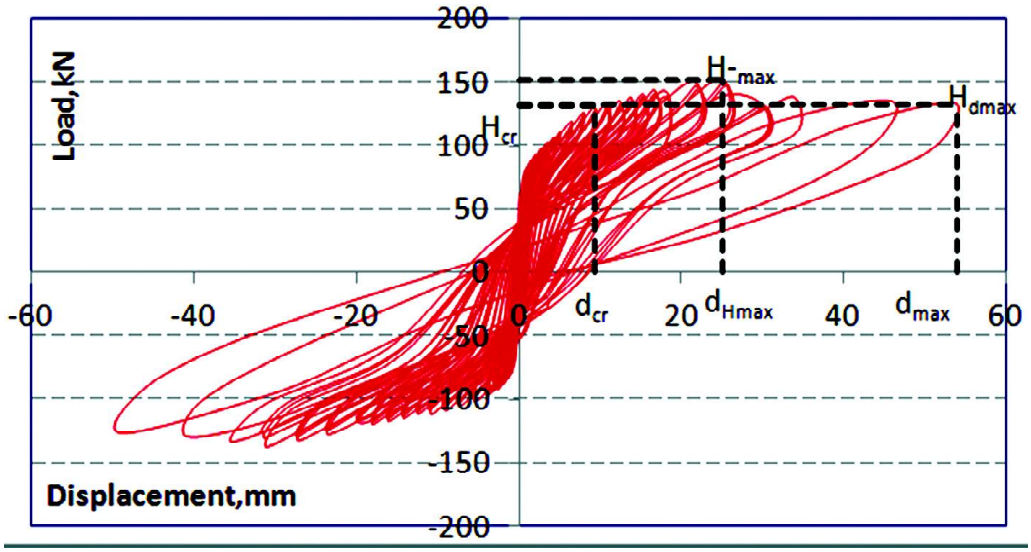



**Fig.2: Hystertic Curve for CM building model**

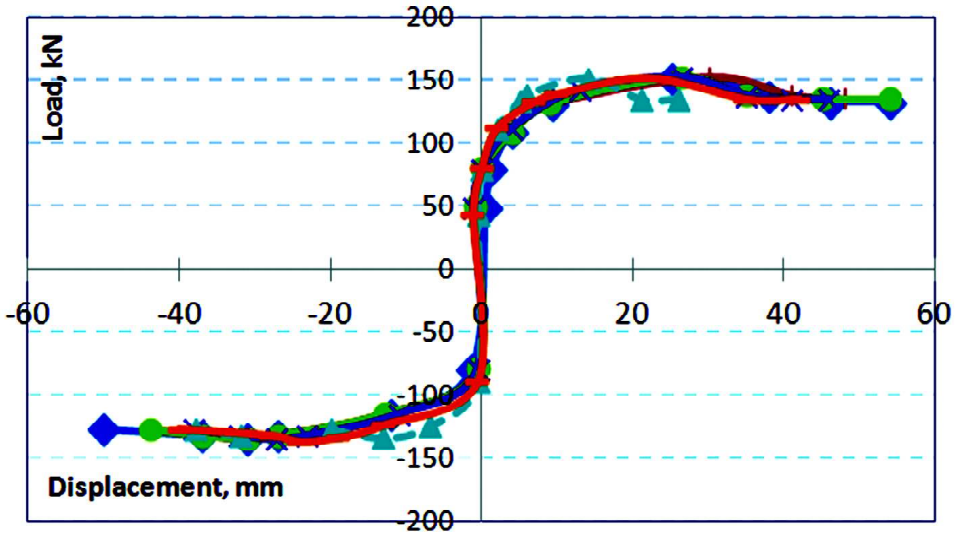



**Fig.3: Average lateral load-displacement envelope for CM building model at different locations**

To investigate the effectiveness of various repair and retrofitting measures, URM and RM models were repaired/retrofitted after first testing and then re-tested. The repair of URM was carried out using concrete stitching across the cracks (URM-REP) and retrofitting of damaged URM model was performed with MS steel twin lintel belt and corner vertical reinforcement (URM-RET). The retrofitting of RM model was performed with 200 mm wide GI welded wire mesh, fixed along the crack to outer face of wall and embedded in 20mm thick, 1:3 cement: sand mortar plaster and cement grout in cracks from inner face (RM-RET). The load-deflection envelope of different masonry models i.e. URM, URM-REP, URM-RET, RM, RM-RET and CM, is shown in Fig.4.

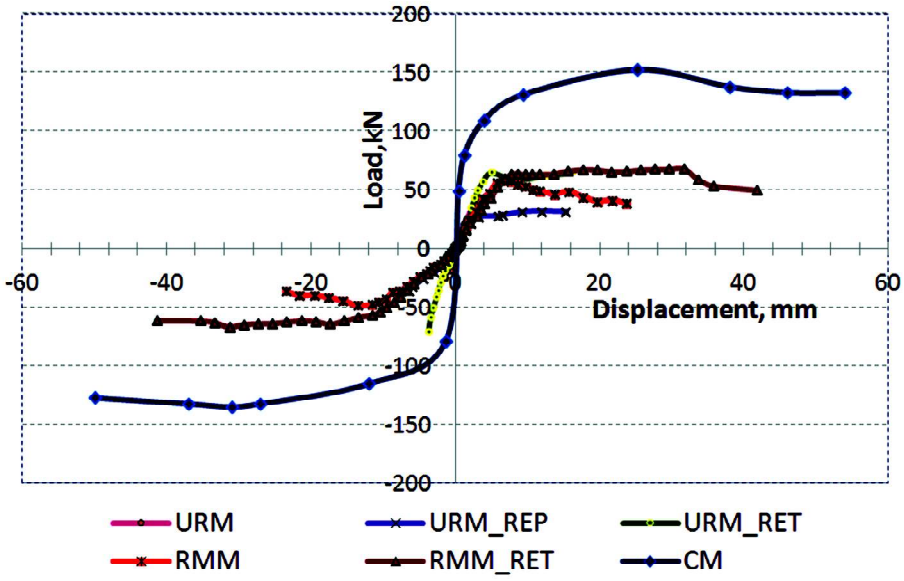



**Fig. 4: Comparison of average lateral load-deformation envelope for different masonry systems**

The tests enabled to obtain the crack patterns and failure mechanisms. Finally, it is concluded that CM building exhibited higher strength and ductility as compared to URM and RM buildings. The performance of CM over URM and RM in terms of strength showed about 3.42 and 2.63 times improvement and increase in ductility by around 4.29 and 1.39 folds respectively. Further, the retrofitted URM and RM buildings have shown improved performance over respective virgin buildings to the tune of 46% and 18% in terms of strength and 0.54% and 1.39% increase in associated drift, respectively.

# WP-3

# Engineering of Fire Disaster Mitigation

R.S. Chimote & Suvir Singh

**Task: 3.1**

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

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

### Objectives

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

### Deliverables

- Experimental design on reduced scale to simulate the turbulent diffusion fires
- CFD modeling & validation based on experimental studies.
- Preparation of micro-size particles and their particle/droplet size analysis in non fire conditions
- Experimental studies on discharge density, particle size distribution and velocity profile in fire conditions
- Characterization of Fire Extinguishing composition

## Significant Contribution

**Transfer of Technology:** On National Technology Day in May 2013, a technology transfer ceremony on the "CSIR-CBRI Liquid Extinguishant Fire Extinguisher", as developed by Sh. R.S. Chimote, Chief Scientist, has been made to the SSI unit: M/s. Aska Equipments Ltd., New Delhi by Prof. S.K. Bhattacharyya, Director with a national focus on "Affordable First-Aid Fire Safety Equipment to the bottom and top of the CSIR 800 Pyramid by Fire Safety S&T intervention/innovation for sustainable inclusive growth", as shown below in the Fig.1.


**Fig.1: Technology transfer ceremony on the "CSIR-CBRI Liquid Extinguish ant Fire Extinguisher" on National Technology Day in May 2013**

## Experimental R&D and CFD Modeling Knowledge Gaps

Challenges in fire measurement

- Extremely harsh thermal environment
- Transient chemical species,
- Soot-laden flows,
- Measurement interference,
- Scaling issues
- Turbulent flow fields

- Lack of knowledge about interacting fire processes that inhibit accurate simulation of suppression
- Halon fire extinguishants (CFC-Based) phase out limit ended in 2010.
- Commercial fixed water mist/aerosol is hardly in use in India. Need low cost water-mist fire extinguisher
- India needs fire extinguishing agents with low ODP (0.01-0.5)
- Class I substances phased out in 2005, Class II substances (Hydro-Chloro Fluro-Carbons) to be phased out 2013 – 2015
- Development of low ODP fire extinguishing systems is required to be rigorously undertaken.
- Worldwide R&D programs on development and characterization of water mist aerosol fire extinguishants are on.

## Scope of Work

- Development of low ODP Fire extinguishing system for water mist of size: 10µ to 1000µ.
- Characterization of fire extinguishing system Particle size distribution, velocity profile, and discharge density for different fires.
- Fire suppression modeling.

## Experimental Measurements

Repeatative developmental experiments were conducted, as shown in Fig.2, with water-mist and other indigenously developed liquid extinguishants in the 18,000nm to 10,00,000nm size range for :

- Determining the effective sauter mean dia of particle size distribution required for effective extinguishment and
- Velocity Profile in the range of 0.4m/s to 20m/s for characterization of Nozzle size and specifications,
- Characterization of compositions against the fire knock-down and complete extinguishment time of ≤30s.
- Particle discharge density
- Simultaneously, CFD modeling is being done for simulating and validating the published data for comparison as well as our experimental results.

**Fig. 2: Experiments with water-mist and other indigenously developed liquid extinguish ants in the 18,000nm to 10,00,000nm size range for determining the effective sauter mean diameter for particle size distribution required for effective extinguishment.**

## CFD Modeling Approach

- Eulerian-Lagrangian Method: 1) Air Ideal Gas Phase (Continuous Phase) will be studied with Eulerian equation and 2) Water Mist (Particle Transport Fluid) with Lagrangian equation.
- Buoyancy effects will be considered.
- Turbulence: The turbulence model $k-\varepsilon$ model will be chosen (equations for the kinetic energy $k$, and the energy dissipation rate $\varepsilon$).
- Droplet size distribution: Uniform diameter/ Variable diameter distribution will be used.
- Velocity: Velocity of water mist and air will be required.
- Particle number: Number of representative particles to be tracked is defined.
- Fluid pair interaction: Interphase Mass transfer Model (Ranz Marshall) taken for the study.
- Particle break-up model: Particle Collision parameters models are considered for the study.

## Numerical Studies:

Several Numerical studies have been performed using ANSYS CFX to validate the data reported in the literature as well as with our experimental facility. The brief description of each case study and the results are presented below in Case Study 1, 2 and 3.

**Case Study 1:** Bjarne Pauls Husted, Experimental Measurement of Water Mist Systems and Implications for Modelling in CFD, Lund University, Sweden, 2003.

The Experimental domain taken for the study is cylindrical with 3.0 m dia. The distance between the nozzle and the fire source is 1.7 m. Dimensions of the fire source is 0.3 m* 0.3 m * 0.3 m. The base of the fire source is 0.7 m above the ground. The spray angle measured is 56 deg. The collapse of the conical spray is taken place at 150 mm below the nozzle. As reported in literature the Particle breakup and Particle collision will take place at within this 150 mm below the nozzle only. The 45 kW heptane pan fire is used as fire source. Measurements of velocity distribution, width of the spray at different heights and droplet distribution are studied for water mist spray. The experimental results of water mist system reported in two phases. Phase one is without fire i.e. only water mist spray characterization. Second phase is fire and water mist multi-phase interaction. Ansys CFX has been used to carry out CFD simulations. Several numerical experiments have been performed varying the Particle fluid (Water) and Continuous bulk fluid (Air) flow properties. These variables have been defined in terms of average velocity, mass flow rate, velocity as three dimensional inputs, velocity as 5$^{th}$ order polynomial equation. After finalizing the best possible input conditions which closely matched with the experimental data, mesh refinement studies have been performed to improve the velocity profiles. It includes rectangular, uniform cone type and non-uniform cone type mesh near the cone and fire and their results compared with the results of experimentally obtained velocity profiles. The results closely matching with those of experiments are those that of non-uniform mesh, some of which are given below in Fig.3.

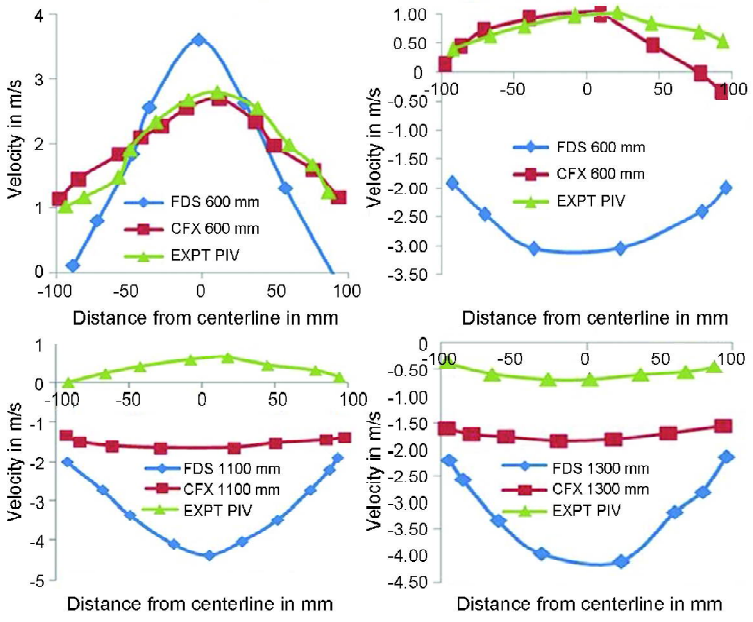



**Fig. 3: Results of water spray and fire interaction with FDS, CFX & Experimental PIV**

**Case Study 2:** S.M. Sumon, "A Numerical study of the Effects of Water Mist Characteristics", Proceedings of the 13th Asian Congress of Fluid Mechanics, 17-21 December 2010, Dhaka.

The domain of the study is 0.3m*0.3m*0.6m with heat source of 0.1m*0.1m as hot plate at 600 K. The point cone nozzle produces 15/30 deg cone angle at a velocity of 60 m/s with a mass flow rate of 0.1/0.05 kg/s. The water particle is of uniform diameter with 0.9/ 0.09 mm taken for the study. The simulated results are compared with the experimental results reported as shown in the following Fig.4.

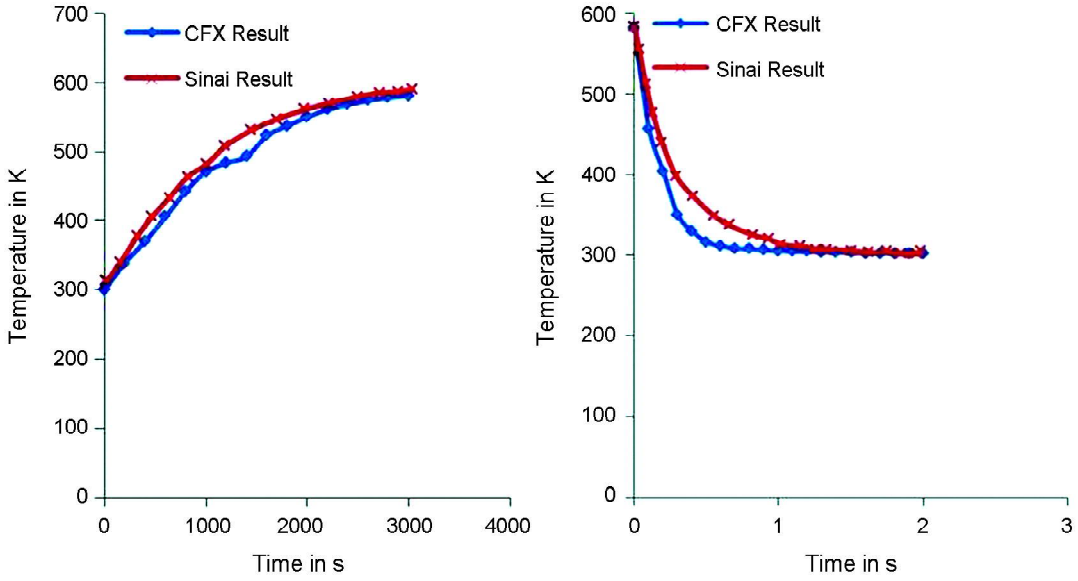



**Fig.4: Comparison of simulated results with the experimental results as reported in Case 2: S.M.Sumon, "A Numerical study of the Effects of Water Mist Characteristics", Proceedings of 13th Asian Congress of Fluid Mechanics, 17-21 Dec., 2010, Dhaka.**

**Case study 3:** Experiments carried out at Fire Research Lab., CSIR-CBRI, Roorkee

The experimental domain is of size 2m*3m*2.75 m with a 1000 $cm^2$ fire size located centrally. Petrol is used as fire source with a mass loss rate of 52 $g/m^2s$ located at 0.25 m above ground. Water mist nozzle is located at 1.7 m above fire source. The water mist data generated and measured at 20 cm below the nozzle with a spray angle of 45 deg and a particle number rate of 21,00,000/s. With this experimental data, simulation studies were performed as water mist simulation under no fire condition, and Fire and water mist interaction simulation. Results of water mist modelling and simulation under no fire condition as in Fig.5 & 6.

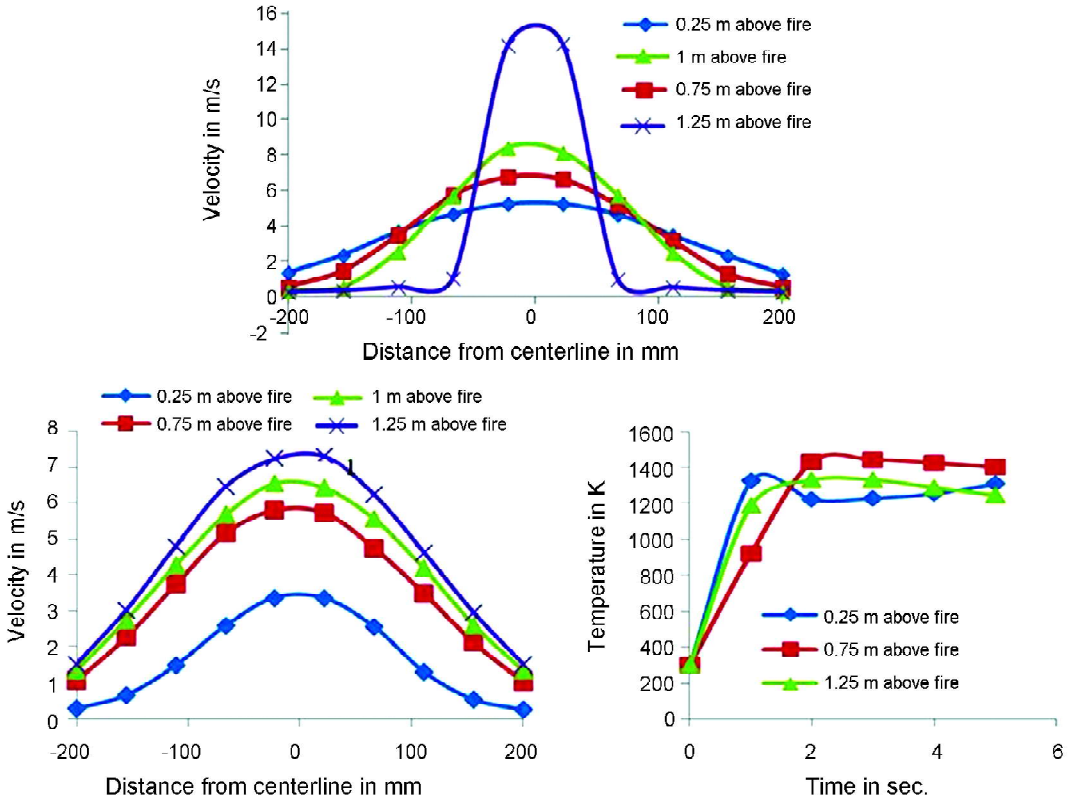



**Fig.5: Results of water mist spray under no fire conditions in Case 3.**

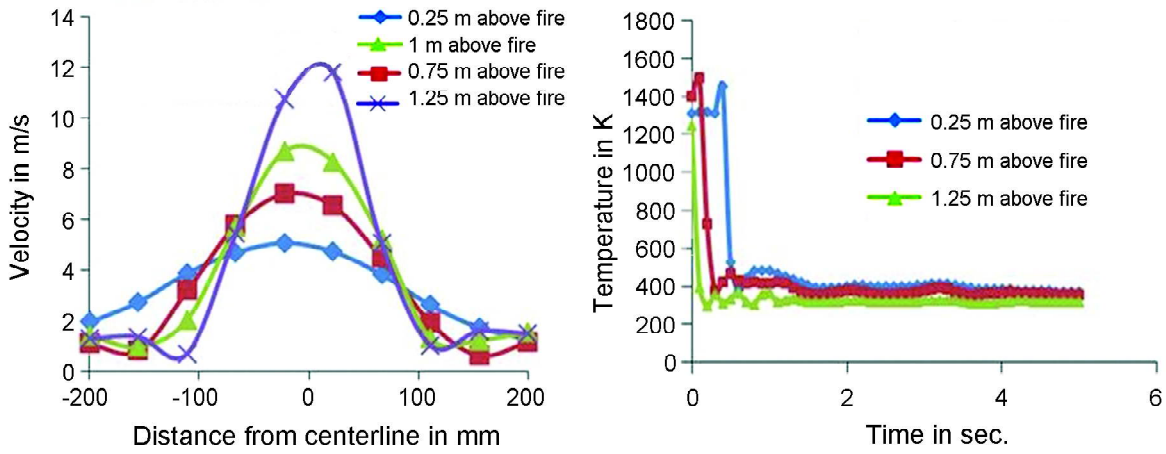



**Fig.6: Results of fire and water mist interaction modelling in Case 3.**

**New Facility added for Water-Mist Fire Extinguishers Characterization:** A new facility for water-mist fire extinguishers characterization of different sizes, as shown in Fig.7, have been created as per IS:15683-2006 on Class B flammable liquid fires as: 1) Class 5B fires, 2) Class 8B fires, 3) Class 13B fires, and 4) Class 21B fires and 5) Class 34B fires.


**Fig.7: A new facility for water-mist fire extinguishers characterization of different size Class B Fires.**

**Characterization of Newly Developed Zero ("0") ODP Fire Extinguishant:** The water-mist composition was characterized, as depicted in Fig.8, with respect to the fire suppression capability in terms of the effective fire extinguishment time of 15s which was brought down from 30s on 1m$^2$ size fire.

**Fig.8: Characterization of newly developed zero ("0") ODP Fire Extinguishant with fire suppression time brought down from 30s to 15s.**

## Task: 3.2

# Fire Performance Evaluation of Structural Elements and Rehabilitation Measures

Suvir Singh

Experimental studies were carried out for the determination of fire resistance of reinforced concrete beams under loaded conditions.

The specimen of beams of 250 x 150 mm in cross section and 2550 mm in span were prepared. The beams were instrumented with high quality instrumentation at various locations: type K thermocouples to measure temperature distribution throughout the cross section and on the reinforcement and electro-mechanical displacement gauges to measure axial displacement and deflections of the specimens.

After curing and ageing of concrete, fire resistance tests on RC beams were carried out using the floor furnace at CBRI. The test furnace has been specially designed to produce conditions, such as temperature, structural loads and heat transfer, to which a member might be exposed during a fire. Fire test were performed, with RC beam placed on the top surface of the furnace such that three faces of the beam are directly exposed to fire. The arrangement of the test set-up is shown in Fig.1.

**Fig.1: Test set up for fire resistance of beam**

The furnace temperature was controlled to closely follow time-temperature curve of standard ISO 834 fire. Beams were preloaded, with two point loads, to a fixed percentage of its room temperature moment capacity. After attaining the steady state with respect to deflection the beam was exposed to standard heating conditions. During the entire period of fire exposure the predefined load was maintained. During fire tests, the temperature of the furnace as well as that in concrete and rebars (at different sections), and mid-span deflection was recorded. The time – temperature curve maintained during the fire exposure is shown in Fig.2.

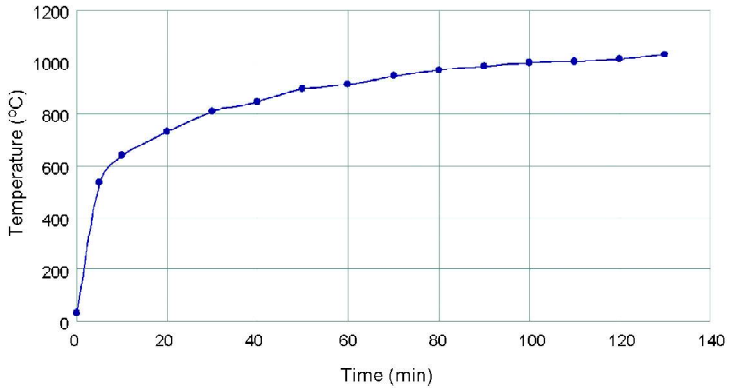



**Fig.2: Furnace time - temperature curve**

During fire exposure the temperature variation at different locations in the beam i.e. on the reinforcing bars and core of concrete was recorded is plotted in Fig.3. The deflection at the centre of beam measured with duration of fire exposure is shown in Fig.4.

After the fire test, the specimen was taken out and visual examination and residual measurements were carried out to determine the extent of fire damage.

It was observed that the temperatures measured at the same location for high strength concrete beam was more as compared to the normal strength concrete.

Similarly the fire resistance rating for the same load was more in normal strength concrete beam as compared to high strength concrete beam.

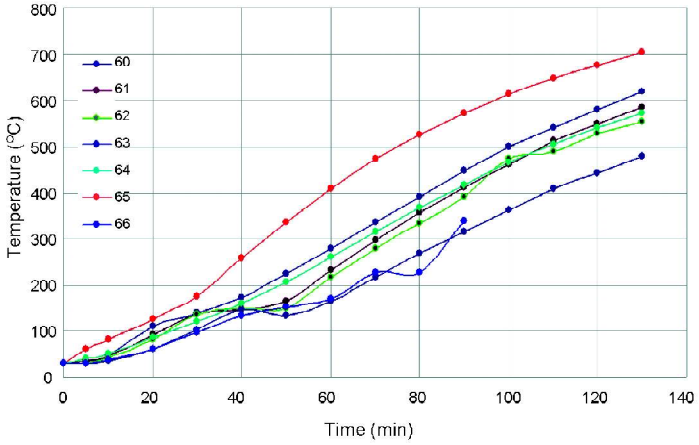



**Fig.3: Temperature variation at different locations in beam**

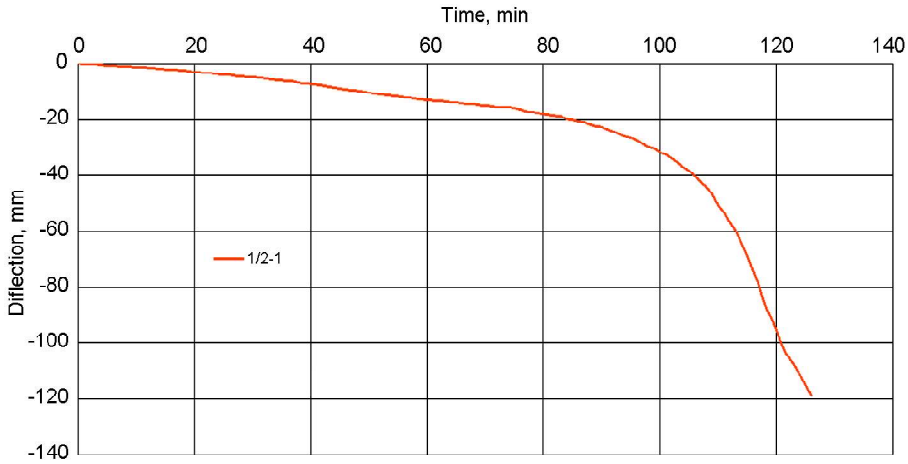



**Fig.4: Variation in deflection at the centre of beam with time of fire exposure**

Further computer modeling was also carried out for the thermal performance as well as structural behavior of beams. The modeling work comprise of tracing the fire response of RC beams. For reliable fire response predictions, all influencing factors including high temperature properties of concrete and steel rebars, fire scenarios, end conditions, reinforcement configuration and failure limits states have been accounted for in fire resistance analysis.

The efforts were made to establish the validity of the computer model by comparing predictions from the model with measured data from fire tests.

WP-4

# Post Disaster Shelter Planning

S.K. Negi & Team

Task 4.1

## Post Disaster Shelter Planning for Rural Areas in the Western Himalayan Region

S. K. Negi, R. K. Garg, Ashok Kumar, Navjeev Saxena, Ajay Chourasia, P. C. Thapliyal & S. K. Panigrahi

### Objective

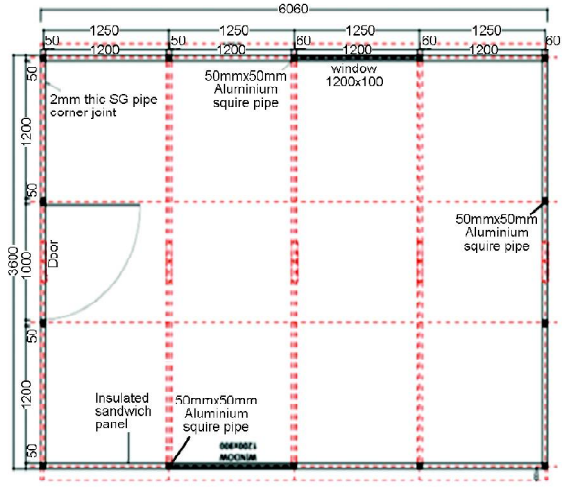
To develop a technology package for Disaster Resistant Transit Shelters for Western Himalayan Region. Design proposal for a transit shelter is quite complex not only from an architecture point of view but also in material specification, structural stability & planning. During the period, the different concept design alternatives of a transit shelter for a family of five members have been developed. The area of each unit varies between 18-20 sqm. With a provision of spaces like living, kitchen and sleeping and with a scope for future expansion for wet services like toilet & bath. The details of one alternative are finalized as shown in Fig.1, 2 & 3. The proposed shelter is expandable and can be multiplied to create bigger community spaces.

The salient features of a transit shelter are:

- Pre cast Concrete foundation which significantly reduces the overall construction period and the concept is simple to erect;
- Main columns are made of aluminum/carbon

steel tubes of 50mm diameter. Which the columns at intermediate connections have the same size but are PVC tube to reduce weight (Further design/detail are being work out.);

- Sandwich panels for walling made of a 30 gauge, 25 mm thick aluminum sheet by suitable filling material like polyurethane or thermo coal;
- The roof is made aluminum/carbon steel tube of 50mm diameter. The initial covering on the truss is canvas sheet or polycarbonate sheet as per site conditions & material availability. It can be later replaced by materials available locally;
- Flooring is with locally available timber planks & wooden battens are proposed.
- Minimum erection time, use of light in weight and durable material, structural stability against hazards, use of minimum skilled man power, tools & equipments for assembling and to knockdown of the shelters and Materials used should be water & wind resistance and fire retardant etc.



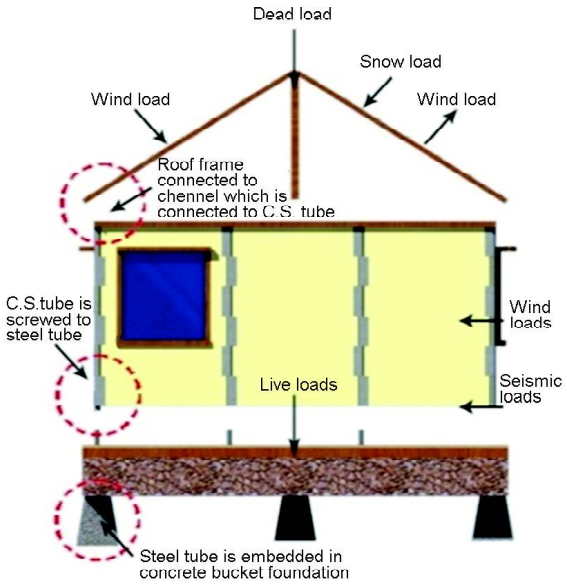




**Fig.2: Sectional view**

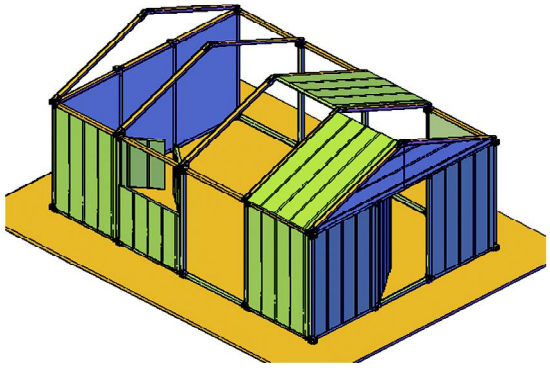


**Fig.3: Detail view**

WP-5

# Health Monitoring of Buildings Using Wireless Sensor Network

Ajay Chourasia
&
Team

Task 5.5

## Implementation of Health Monitoring Approach using Wireless Sensor Network, Numerical Analysis & Modal Updating on Real-Life Buildings

S. K. Bhattacharyya, Ajay Chourasia
S. K. Panigrahi, Soju Alexander &
Jalaj Parashar

### Progress

To assess health of structure, extensive instrumentation, data acquisition, its analysis was carried out on a 8 storey steel frame structure using Wireless Sensor Network (WSN). Two different approaches i.e. by varying mass; and by varying stiffness, were adopted as a scheme for structure health monitoring (Fig.1). The dynamic characteristics of the building were evaluated along with the development of numerical model for damage identification.

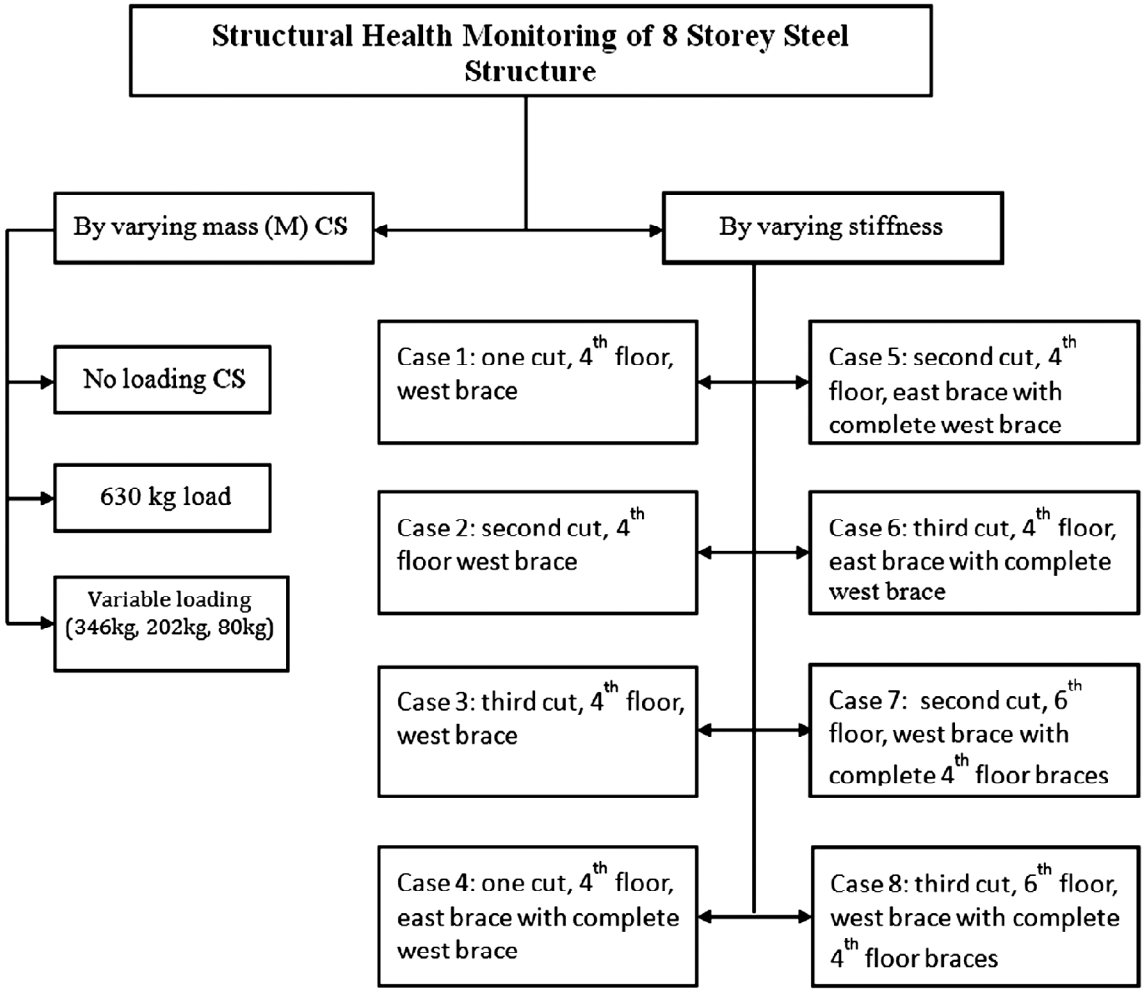
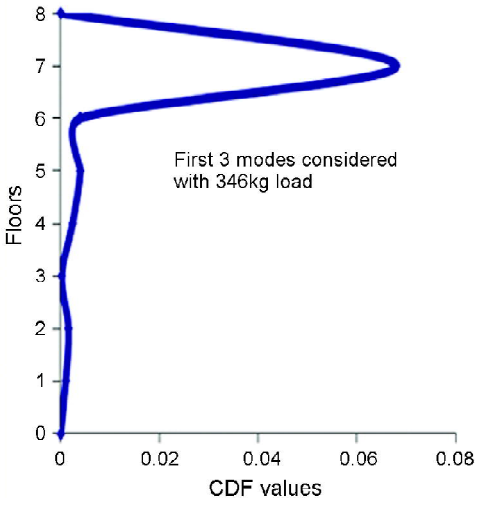



**Fig.1: Approach for Health Monitoring of 8 storey steel structure using Wireless Sensors Networks**

Firstly, Mass variation approach was carried out by gradually increasing the mass on different floors in order to investigate change in the vibration characteristic of the structure. Mass was gradually reduces from 630 kg, 346 kg, 202 kg and 80 kg on 5th & 7th floors. Fig.2 shows the change in mass at 7th floor and corresponding response in terms of Cumulative Damage Factor (CDF) by considering first three modes. While lowering the mass level of 80 kg at 7th floor, the peak indicated by CDF calculation corrosponds to 7th and 3rd floor, which is not true. This shows the inability of the method to detect the lower level of mass i.e. less than 80 kg, which is around 0.8 % of the total structural single floor mass.

(a) Overloading, 630kg at 7th floor



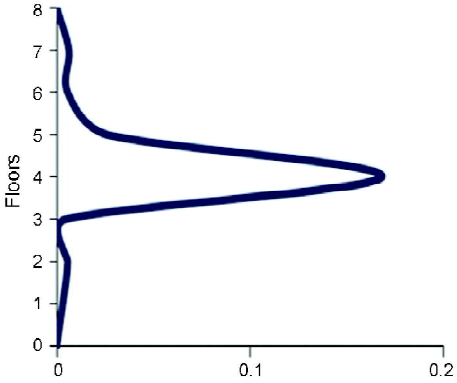

(b) Change in mode shape by varying mass at 7th floor

**Fig.2: Change in mass on structure at different floors.**

Secondly, stiffness of structure was varied and response of the structure under different damaged state was recorded. In order to vary the stiffness, the braces of the building were progressively cut starting from one brace at 2nd floor, one brace at 3rd, two braces at 4th floor and two braces at 6th floor. Fig.3 shows the change in stiffness by cutting one brace at 4th and change in CDF values for 8 storey steel structure.

From the experimental data recorded using WSN and its analysis, it was concluded that the modal curvature method is well suited for identification of damage in precision. This is because the change in frequency is intimately related to the change in curvature. This shows that data acquired using wireless accelerometers are sufficient for damage identification algorithm. However when there is very minute structural variation it is becoming difficult to identify the location of the damage.

(a) Stiffness variation by cutting brace at 4th floor




(b) Change in mode shape by varying stiffness at 4th floor

**Fig.3: Change in stiffness on structure at different floors.**

# WP-6

# Intelligent Building System for Model Residential Unit

R. S. Bisht &
A. K. Mittal

## Task 6.2

## Intelligent HVAC and Lighting Controls in Response to Ambient Environment

Nagesh Babu Balam & S. Alexandar

### 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.

### Progress

**Test setup for electrically characterizing the LED light bulb**

A test setup as shown in the following figure has been setup consisting of DC Power supply, LUX meter and Data logger to measure the temperature across the heat exchangers provided for LED light bulbs. The DC power supply is set to supply voltage from 14V to 28V DC for 6 LED button bulbs (3.3v operating voltage) connected in series. LUX meter is used to measure the Lux level (Lumen/$m^{2)}$ of the bulb at different voltages. Six thermocouples have been soldered to the entire Heat Exchangers of LED bulb and the stabilized temperature (averaged) has been continuously monitored using Data logger.

**Fig.1: LED Bulb Electrical Characterization test setup**

The following graphs indicate the Electrical and Thermal Characteristics of LED bulb.

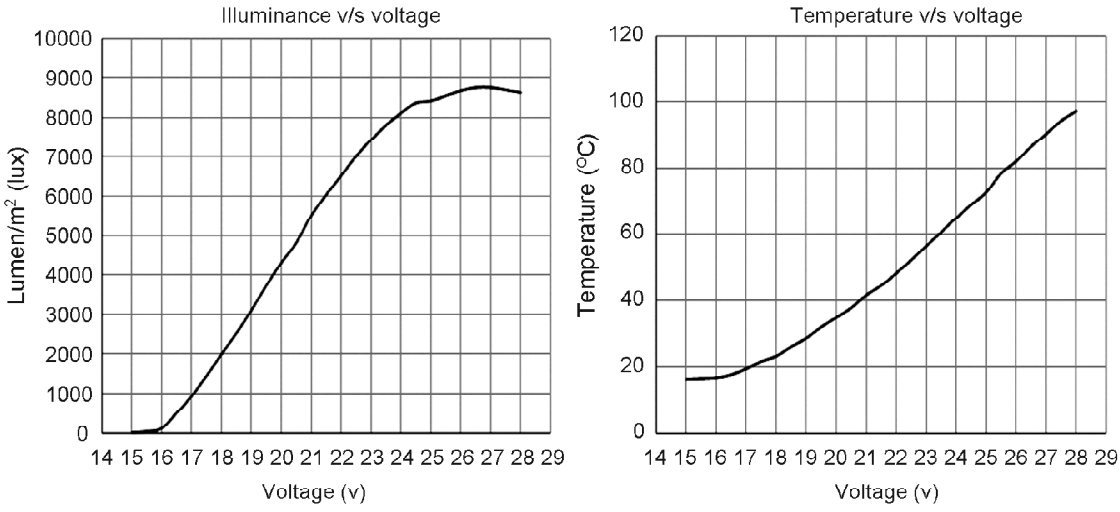



**Fig.2: Temperature and illuminance variation with voltage**

The LED light bulb exhibits a linear increase in lux level for increase in voltage between 16V and 24V as indicated in Fig.2. Any increase in voltage beyond 24V saturates the Lux level without any increase in output lux level. This indicates a maximum voltage limit on the operation on LED light bulb. The Temperature vs Voltage graph as indicated in Fig.2 indicates the linear increase in temperature between 16V and 24V indicating the heat loss is proportional to the voltage of operation.

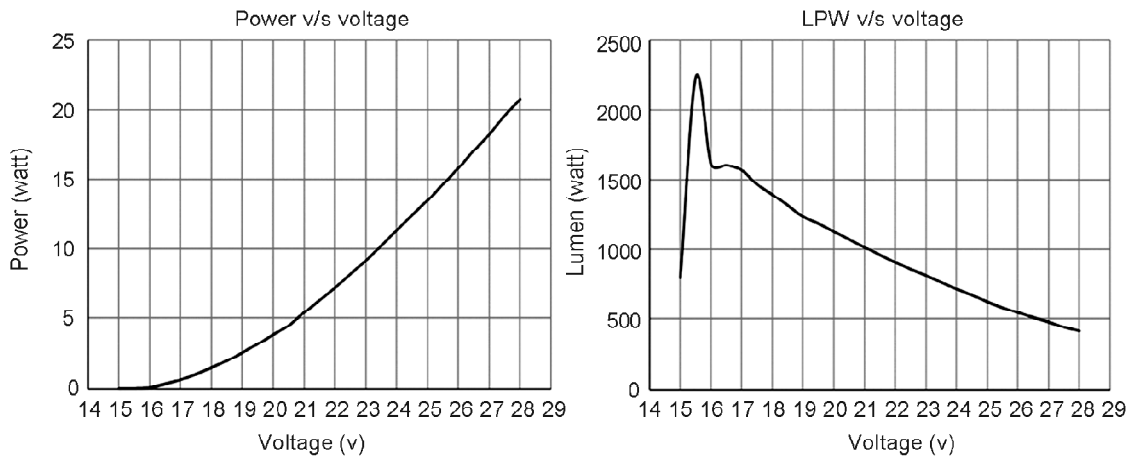



**Fig.3: Lumen per Watt and Power variation with Voltage**

The power input also increases proportionally with voltage as shown in Fig.3 which is responsible for both light (lux) output and heat loss.

The LPW graph as shown in Fig.3 indicates that Lumen per Watt of LED light bulb is continuously decreasing with voltage. Lumen per Watt may also be termed as luminous efficacy of LED light bulb.

## Automatic Lighting System Design for Buildings

The Automatic Lighting system for Building can adjust its lighting output in accordance to the ambient light and solar radiation. The LED bulb characteristics indicate the range of voltage operation to optimize the luminous efficacy.

- Optimal Voltage range 16 to 24 volts
- Optimal Power range 2 to 12 Watts
- By controlling the Voltage and Power consumption within the optimal power and Voltage limits brightness can be controlled using Power Electronic Circuitry.

## Task 6.3

# Glass Facade Cleaning Robotic System

R. S. Bisht & S. Alexandar

Many studies and research interest for the development of various autonomous cleaning robots (ACRs) for both ground and vertical surfaces have been taken up in the recent past. Mobile robots, capable of maneuvering on vertical/inclined wall surfaces such as glass façade and glass windows at higher sites of buildings, could replace humans for autonomous cleaning, considering human safety as well as high productivity/efficiency to these locations. To reach such locations ACRs require both locomotion and adhesion mechanisms.

In the present research work, adhesion mechanisms for mobile robot application have been chosen for its laboratory testing. Details of overall experimental set-up design and development, and testing procedure for two test samples are shown in Fig.1 and 2. The two PCB test samples of adhesion mechanism with different geometrical parameters have been fabricated for laboratory testing and design specifications as shown in Fig.2a & 2b. Laboratory testing for these two cases have been carried out and test results of generated adhesion force for these two cases are shown in Fig.3.

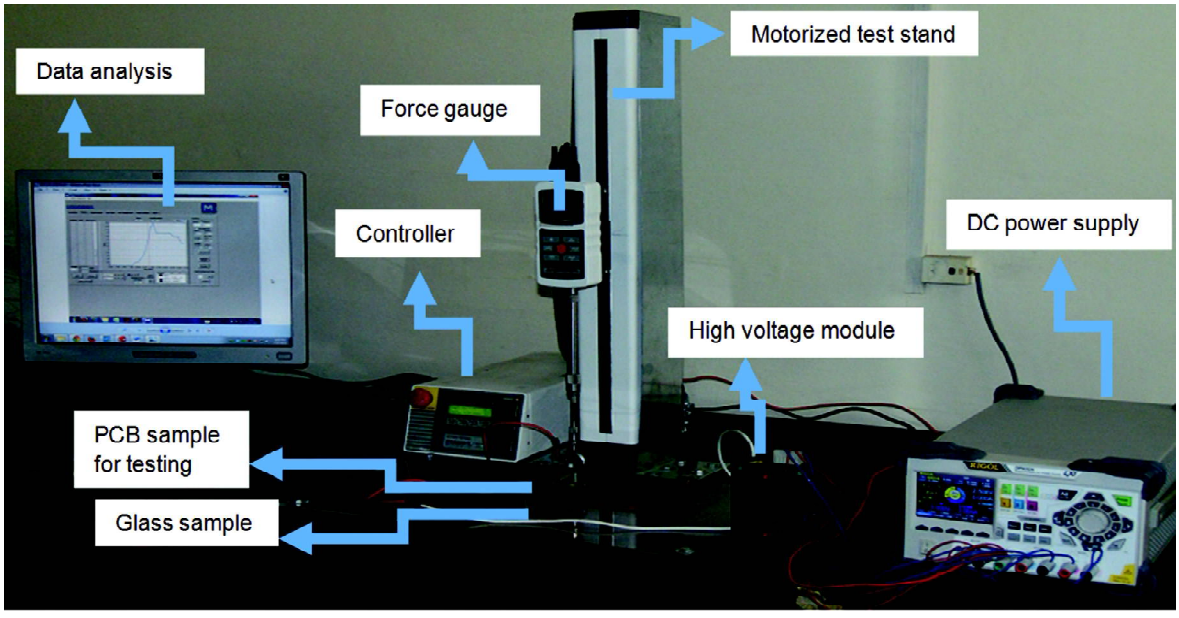



**Fig.1: Overall experimental set-up for mechanism testing**

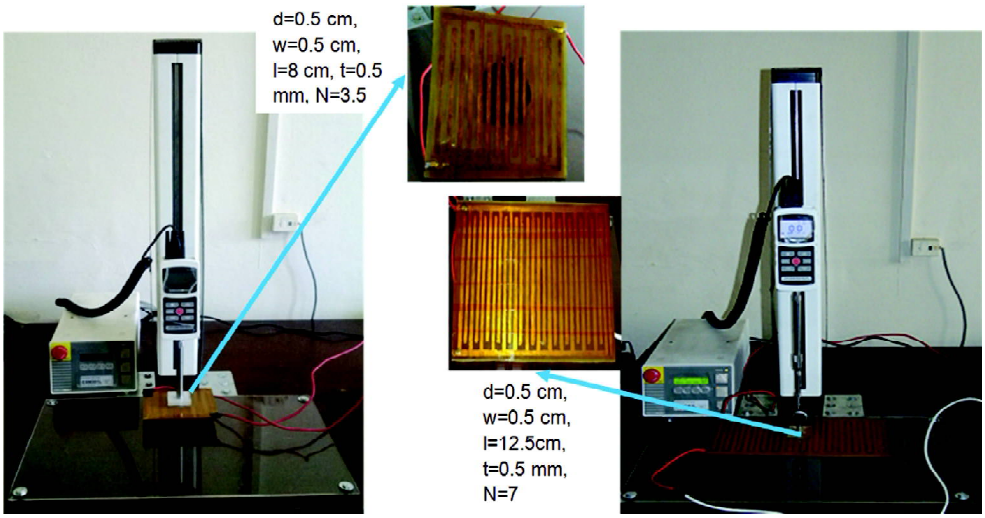



**Fig. 2 (a): Motorised test stand set up with PCB test sample(Case 01)**

**Fig 2. (b): Motorised test stand set up with PCB test sample(Case 02)**

The required holding force is generated by applying a high potential difference between a pair of electrodes which in turn creates an electrostatic field between the mechanism sample and test substrate (glossy surface). Variable high input voltage to the test samples is obtained though high voltage module which is directly connected through a programmable dc power supply. As soon as voltage is provided to the test sample, the electrostatic force is generated between test sample and substrate. The generated force is measured by digital force gauge which is attached to the Motorized test stand. As shown in Fig.3, it has been observed from the test results that for the first case of test sample, as the input voltage increase (5 KV, 7KV, 9KV), the generated forces are 1.6, 1.8 and 2.0 N respectively. Similarly the generated forces for input voltage (2 KV, 4KV, 6KV) in the second case of test sample are 1.6, 3.2 and 3.8 N respectively. These test results for both the cases have been compared via. Input voltages vs generated force plot as shown in Fig.4.

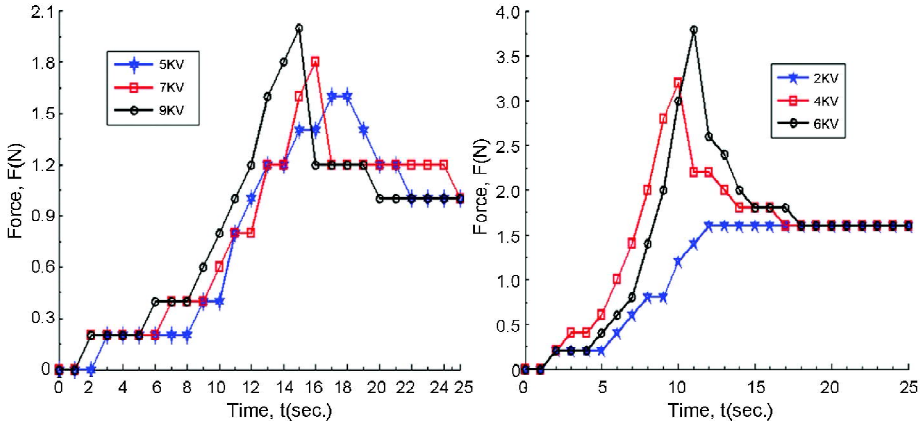



**Fig.3: Test results for Case: 01 and Case: 02 (Generated force, F (N) vs time, t (Sec.))**

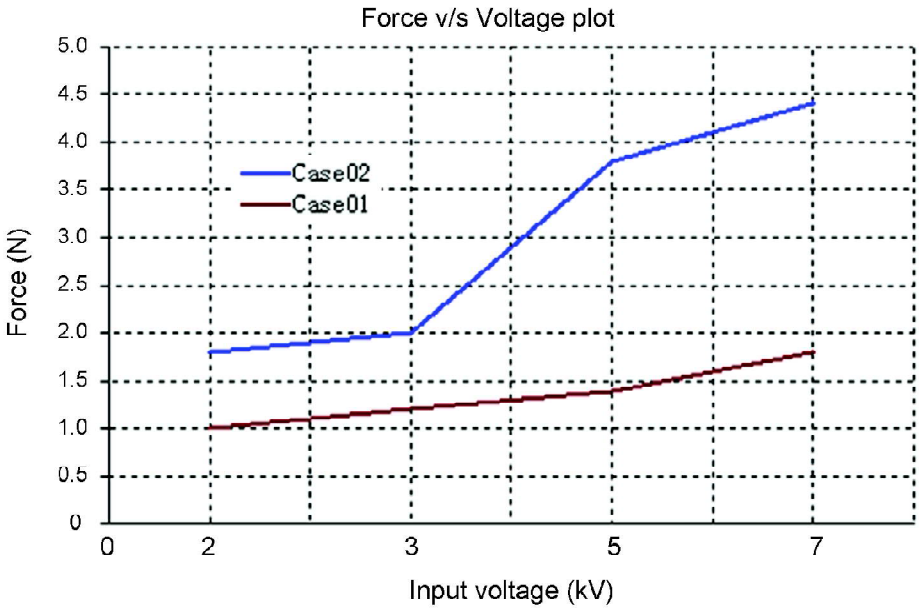



**Fig.4: Test results comparisons for Case: 01 and Case: 02 (Generated force (N) vs Input voltage (kv))**

# Network Projects

## CSIR- CBRI AS A PARTICIPATING LABORATORY

**Removal of Heavy Metals from Waste Water using Fly Ash & Secured Disposal of the sludge.**

PI: Er. S. Maiti

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

**Estimation of Crustal Deformation of Garhwal Himalaya.**

PI: Dr. S. Sarkar

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

**Energy Efficient Seed Storage Structures.**

PI: Er. Nagesh B. Balam

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

**Development of Artificial Pillars for Optimal Extraction of Locked-up Coal.**

PI: Er. Ajay Chourasia

[CSIR- CIMFR, Dhanbad ]

**Service Robot for Building and other Structures.**

PI: Er. Ravindra S. Bisht

[CSIR-CMERI, Micro Machines and Robotics]

**CSIR Knowledge Gateway & Open Source Private Cloud Infrastructure.**

(KNOWGATE),

PI: Dr. S. K. Senapati

***[CSIR-NISCAIR, New Delhi]***

# 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
(ESC-0306)

Soumitra Maiti & A. K. Minocha

Coordinating Lab : CSIR-NEERI, Nagpur
Participating Lab : CSIR-CBRI, Roorkee

### Objective:

- 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.

With the increasing contamination of the natural environment, the problem of safe disposal of heavy metal waste water from industries become more and more challenging. Heavy metal in water refer to heavy, dense, metallic elements that occur in trace levels, but are very toxic and cause serious damage to human life and environment. Major heavy metals

hazardous to human as well as other forms of life are As, Pb, Zn, Cr, Fe, Se, V, Cu, Co, Sb, Ni, Cd, Hg, etc. Toxic heavy metal containing waste are generated from industries like pesticides, pharmaceuticals, photographic chemicals, certain detergents, metallurgical, mining, chemicals, leather, distilleries, sugar, battery, electroplating and pigments. Heavy metals do not degrade with time and thus get carried away to the food chain and finally accumulate in the living organisms, causing several diseases and disorders. Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. Long-term exposure may result in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Thus, reduction of these heavy metals to an acceptable limit is very much essential.

In this study fly ash is used as an adsorbent for removal of heavy metals from waste water. Fly ash has potential application in wastewater treatment because of its major chemical components, which are alumina, silica, ferric oxide, calcium oxide, magnesium oxide and carbon, and its physical properties such as porosity, particle size distribution and surface area. Moreover, the alkaline nature of fly ash makes it a good neutralising agent. Fly ash used in this study was collected from power plant located at Renusagar (India). For continuous removal of heavy metals from waste water a packed bed reactor of 7 litre capacities was used. Table 1 summarized heavy metal removal capacity of Renusagar fly ash.

**Table 1: Summary of adsorption of heavy metals by fly ash**

| Metal ion | Metal uptake (mg/g) | Temp (°C) |
|---|---|---|
| Copper | 0.4-1.9 | 30 |
| Zinc | 1.2-2.25 | 30 |
| Chromium | 0.66-1.1 | 30 |
| Cadmium | 2.8-3.6 | 30 |
| Nickel | 0.4-0.8 | 30 |

From the above study it can be concluded that this fly ash can be effectively used as an adsorbent for removal of heavy metals from waste water. For the safe disposal of the sludge generated from this adsorption process an integrated adsorption and solidification was employed. The aim of this work is to design a process for fixing and immobilizing these toxic heavy metals and to develop unconventional cost-effective building components.

Metal laden fly ash was collected from the packed bed section of the reactor. Then this fly ash was dried in an oven at 105ºC for 2 hr. To assess the possibility of using the metal-laden fly ash as a construction material, the cement-fixed metal-laden fly ash product was tested for compressive strength. The mortar was cast according to IS 4031 (part 6) 1988 in a 70.60 mm specimen cube mould. Ordinary Portland cement was used as the fixation agent. Cement is replaced by metal laden fly ash up-to 30%. Fig.1 is the flowchart of the procedures for cement fixation experiments.

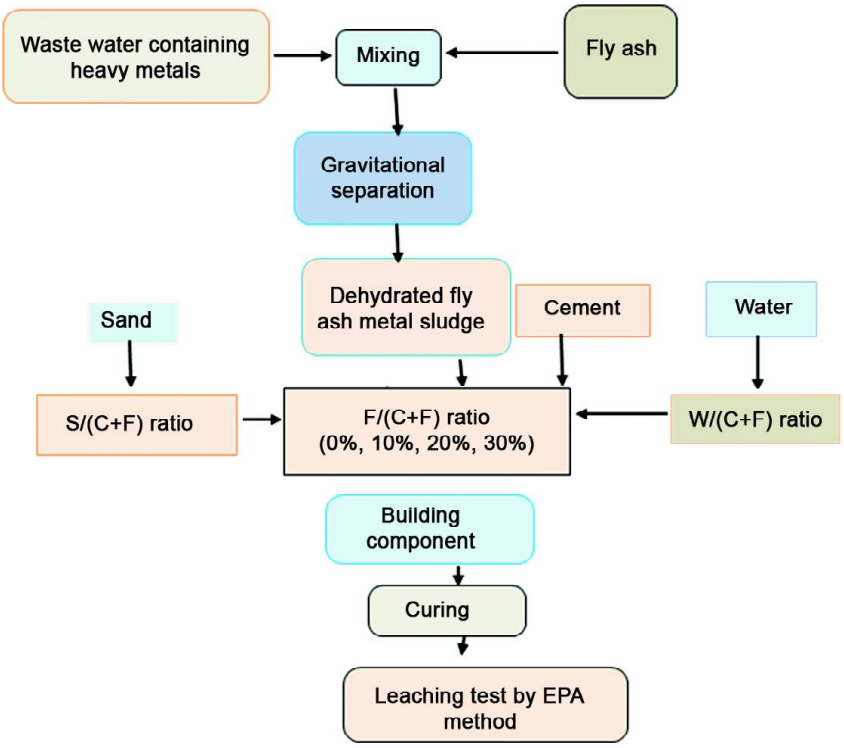



**Fig. 1: An integrated adsorption-solidification/stabilization process for fixing and immobilizing the heavy metals**

Compressive strength of the prepared mortars was determined at the curing age of 7, 14 and 28 days. Fig.2 showed the compressive strength of mortar at different curing days as a function of percentage of fly ash in cement. It was observed from the figure that as the percentage of fly ash increases compressive strength of mortar decreases. The reasons for the slow compressive strength development during the early curing stage for the mortar containing fly ash may be due to the poor contact between the portlandite and the low calcium content of the fly ash.

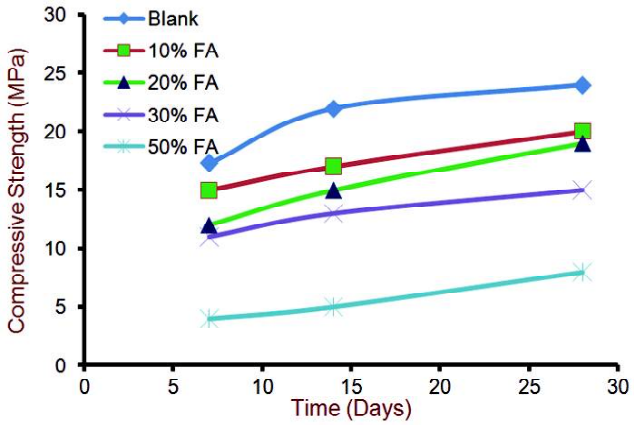



**Fig.2: Compressive strength of mortar with % fly ash in cement**

Fig.3 represents the compressive strength of mortar at different curing days as a function of percentage of metal laden fly ash in cement. The results indicate that, for an extended curing time, it is possible to prepare mortars with metal-laden fly ash that have strength as high as that with cement only.

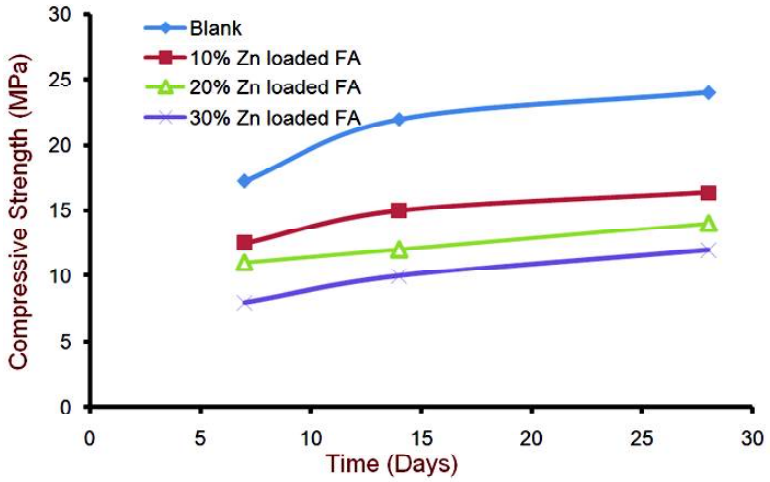



**Fig.3: Compressive strength of mortar with % Zinc laden fly ash in cement**

Leaching study is under progress. This study also can be extended for fixing other heavy metals.

# Estimation of Crustal Deformation of Garhwal Himalaya

S. Sarkar, D.P. Kanungo & P.K.S. Chauhan

Coordinating Lab : CSIR-CMMACS
Participating Lab : CSIR-CBRI

The objective of study aims for estimation of the ongoing tectonic deformation of Garhwal Himalayas by establishing a real time GNSS network.

The activities pertaining to this project is continuous mode GPS measurement throughout the year with every second observation & campaign mode GPS for 3 days with every 30 seconds observation repeating every year in selected locations of Garhwal Himalayas and the data analysis to estimate the ongoing crustal movement. The area selected for the proposed study is Rishikesh-Chamoli-Joshimath region (Fig.1). The area is known to be tectonically active as manifested by past earthquake as well as several faults & many landslides. It is proposed to select about ten campaign stations in the region.


**Fig.1: Study area and locations of GPS stations**

Recently GPS receiver has been installed at CSIR-CBRI, Roorkee for obtaining continuous mode GPS data (Fig.2). The GPS data are being collected in a continuous mode throughout the year. The data are being accessed by the Nodal Laboratory CSIR- 4-PI, Bangalore. A reference station for GPS campaign mode near Pipalkoti, Garhwal Himalaya has also been set up. First set of 3 days continuous data has been collected at this site. GPS data at a few locations from the nearby landslide site has been also collected.

**Fig.2: GPS receiver at CSIR-CBRI**

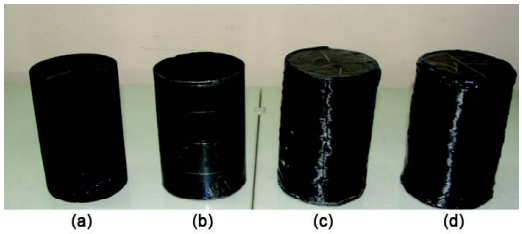
**Fig. 3: GPS campaign reference station near Pipalkoti**

# Development of Appopriate Support System for Artificial Pillars for Optimal Extraction of Locked-up coal from Underground Mines (ESC-0105)

S. K. Bhattacharyya, Ajay Chourasia, B. Singh, Koushik Pandit & Ishwaryya G & Jalaj Parashar

Coordinating Lab : CSIR-CIMFR, Dhanbad
Participating Lab : CSIR-CBRI, Roorkee

The primary objective of underground coal mining is to extract maximum coal from the developed panels without threatening structural safety of surface features like buildings roads, and underground structures like coal pillars. A reduced size of the supporting coal pillars increases coal productivity, but in consequence, enhances the probability of pillar failure mainly by crushing due to overburden load of the rock strata. Therefore, it would be appropriate to strengthen these pillars by suitable means. To investigate strengthening strategy, extensive experimental and numerical analyses of laterally confined NX-size coal cylinders obtained from Indian Coal Mines, subjected to uni axial compression were carried out. Confinement was achieved through external wrapping of coal cylinders by 2 mm thick mild steel plate jacket; by fiber reinforced polymers (FRP) – using wrapping carbon (CFRP), glass (GFRP) in single and double layers (Fig.1). Fig.2 shows the failure mode of NX size coal cylinders under uni-axial compression. Study of stress-strain behaviour of coal cylinders in axial compression shows considerable increase in its axial load carrying capacity. A comparative study of peak strengths attained for various strengthening strategies is illustrated in details at Table-1 (experimental) and Table-2 (numerical) depicting effectiveness of different strategies for four seams.




(a) Bare coal cylinder (b) Coal cylinder strengthened with 2mm thick steel plate jacket (c) Coal cylinder strengthened with 1 layer CFRP/GFRP (d) Coal cylinder strengthened with 1 layer CFRP/GFRP

**Fig.1: Evaluation of strengthening strategies of NX Size Coal Cylinders**


**Fig.2: Failure mode of NX size coal cylinders under uni-axial compression**

Based on the experimental and numerical analysis, the following conclusions are drawn:

(a) The effective strain in the confining material decreases with increase in thickness of FRP. The increment rate in confinement lateral pressure decreases nonlinearly with the jacket thickness.

(b) Confinement efficiency improves as the confinement lateral pressure increases.

(c) In steel encased cylinders, higher interfacial bonding strength is found than that in FRP confinement system as a result, higher compressive strength of the coal cylinder.

(d) For single and double wrapping of FRP layers, the CFRP confinement provides a greater strength to coal cylinder as compared to GFRP confinement.

Further a scheme has been worked-out for refilling of extracted coal space using self-compacting fly-ash geopolymer concrete (SCG). Mix design of SCG being carried out from flow ability, initial/final setting time, viscosity, strength etc., point of view. It is expected that the backfilled SCG material will behave as an artificial support system and will replace the exisiting coal as pillars of SCG hence enhancing the final coal recovery.

**Table. 1 Experimental Results of External Wrapping of Coal Cylinders**

| Confinement Schemes | Maximum Confining Strength (in MPa) | | | |
|---|---|---|---|---|
| | Seam-1 UCS = 15.3 | Seam-2 UCS = 12.82 | Seam-3 UCS = 12.97 | Seam-4 UCS = 13.7 |
| Steel jacket (single layer) | 56.16 (3.7) | 51.32 (4) | 57.79 (4.5) | 53.61 (3.9) |
| CFRP jacket | | | | |
| (a) single layer | 32.50 (2.1) | 30.44 (2.4) | 33.84 (2.6) | 31.31 (2.3) |
| (b) double layer | 42.11 (2.8) | 48.50 (3.8) | 42.91 (3.3) | 40.36 (2.9) |
| GFRP jacket | | | | |
| (a) single layer | 26.04 (1.7) | 20.01 (1.6) | 22.55 (1.7) | 26.07 (1.9) |
| (b) double layer | 51.94 (3.4) | 51.26 (4) | 44.70 (3.4) | 49.56 (3.6) |

*Digits in parentheses indicate ratio of improved UCS (Uniaxial Compressive Stress) to untreated UCS of virgin coal cylinders

**Table. 2 : Numerical Results of External Wrapping of Coal Cylinders**

| Confinement Schemes | Maximum Confining Strength (in MPa) | | | |
|---|---|---|---|---|
| | Seam-1 UCS = 15.3 | Seam-2 UCS = 12.82 | Seam-3 UCS = 12.97 | Seam-4 UCS = 13.7 |
| Steel jacket (single layer) | 42.42 (2.8) | 48.11 (3.8) | 48.13 (3.7) | 42.12 (3.1) |
| CFRP jacket | | | | |
| (a) single layer | 33.22 (2.2) | 32.85 (2.6) | 32.89 (2.5) | 32.99 (2.4) |
| (b) double layer | 46.22 (3) | 46.01 (3.6) | 46.04 (3.5) | 46.16 (3.4) |
| GFRP jacket | | | | |
| (a) single layer | 27.66 (1.8) | 22.53 (1.8) | 22.57 (1.7) | 25.08 (1.8) |
| (b) double layer | 41.60 (2.7) | 41.12 (3.2) | 41.17 (3.2) | 41.29 (3) |

*Digits in parentheses indicate ratio of improved UCS to untreated UCS of virgin coal cylinders

# Service Robot for Building and Other Structures

Ravindra S. Bisht & Team

Coordinating Lab : CSIR-CMERI, Durgapur
Participating Lab : CSIR-CBRI, Roorkee

Robotic system used for precise inspection and maintenance of civil infrastructure called scansorial robots (SRs). To reach higher locations of civil structures, SRs require adhesion as well as locomotion mechanisms. Over the last decade, research on various adhesion mechanisms using bio-inspired methods as well as conventional methods such as pneumatic, electro-adhesive, and magnetic have been carried out to design and develop SRs for the safe and efficient attachment to different material wall surfaces. Comprehensive review of various locomotion and adhesion mechanisms using both conventional and bio-inspired methods for developing SRs have been carried out along with their current research progress. Based on the global status, It has shown that the previously developed mechanisms for SRs have advantage and limitations as well, therefore, design features such as stable transition ability, high speed mobility, payload capability and control simplicity design features are need to be incorporated in order to increase the possible applications of SRs.

In the present study, pneumatic adhesion mechanisms have been chosen for its performance testing under varying wall surface conditions taken as surface: 01 and surface: 02. Wall surface as indicated by surface: 01 is relatively smoother as compared to wall surface: 02. In the case of pneumatic adhesion mechanism, the holding force by the chosen mechanism is generated due to negative pressure created using vacuum supply units. Details of overall experimental set-up design and electric connections for pneumatic mechanism testing are shown in Fig.1 and 2.

Testing results of pneumatic mechanism clearly indicates that the holding force is affected by different wall surface conditions. As shown in Fig. 3(a), it has been observed from the test results that for the first case of test surface, as the different level of vacuum increases (-100 mbar, -200 mbar, -300 mbar, -400 mbar), the generated forces are 51.6, 67.4, 86.2 and 126.8 N respectively. Similarly the generated forces as shown in Fig.3 (b), for different level of vacuum (-100 mbar, -200 mbar, -300 mbar, -400 mbar) are 49.8, 64.6, 75.6 and 94.2 N, respectively for the second case of test surface.

Fig.4 shows comparison of test results on surface: 01 and surface: 02. Results in Fig.4 indicate that the generated force is more in smooth surface: 01 as compared to surface: 02. The mobile robot with more payload can work more effectively on relatively smoother surface due to more force is developed in case of pneumatic mechanism.

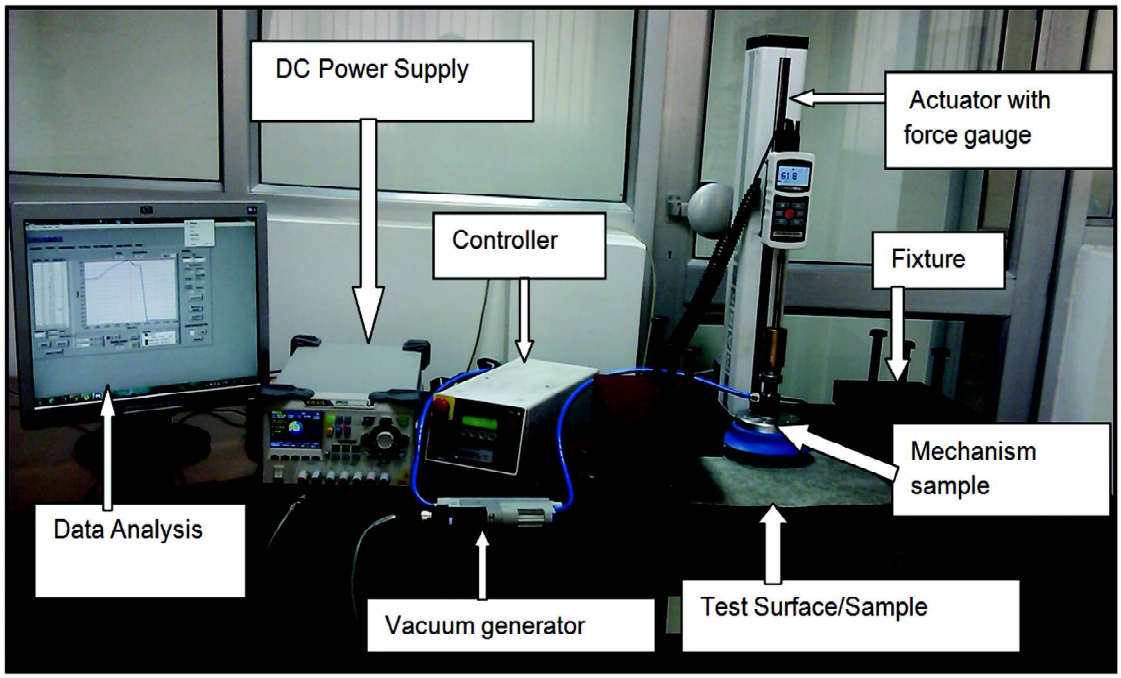



**Fig.1: Overall experimental set-up for pneumatic mechanism testing**

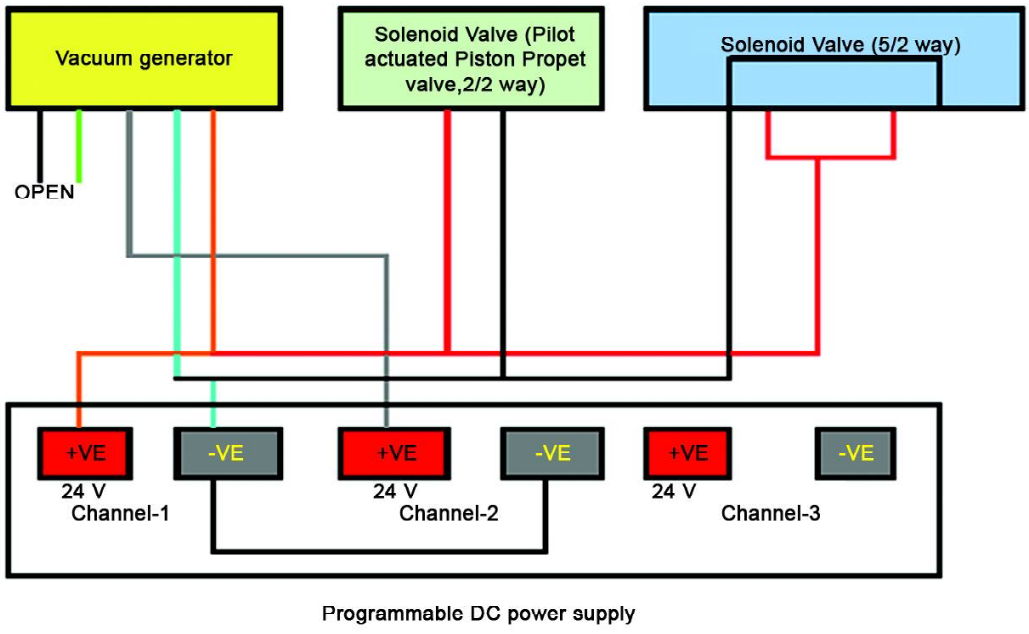



**Fig.2: Electrical connections for pneumatic mechanism testing system**

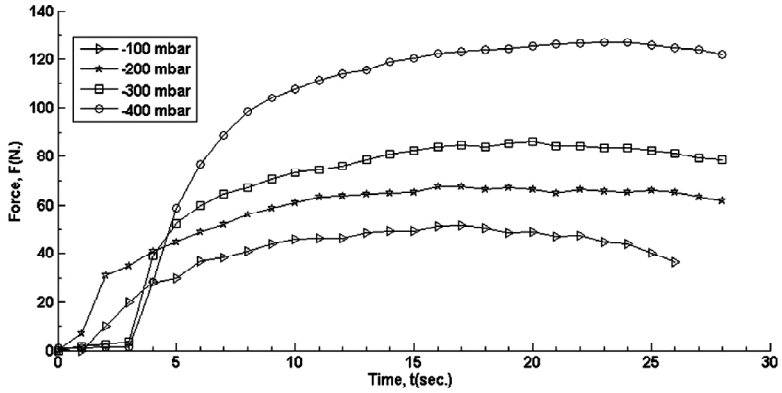



**Fig.3 (a): Pneumatic force characteristics on surface: 01 under different level of vacuum**

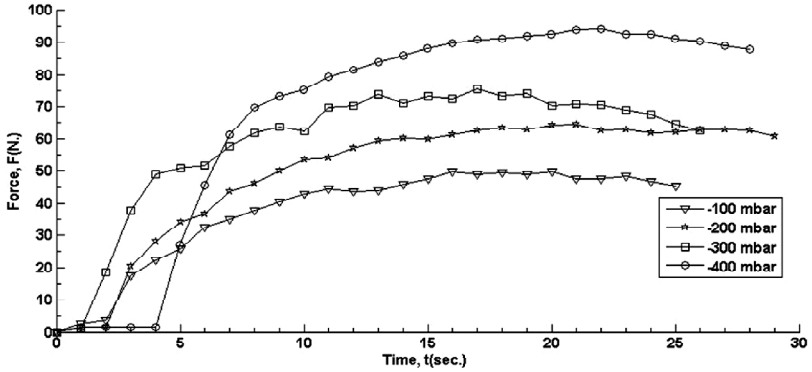



**Fig.3 (b): Pneumatic force characteristics on surface: 02 under different level of vacuum**

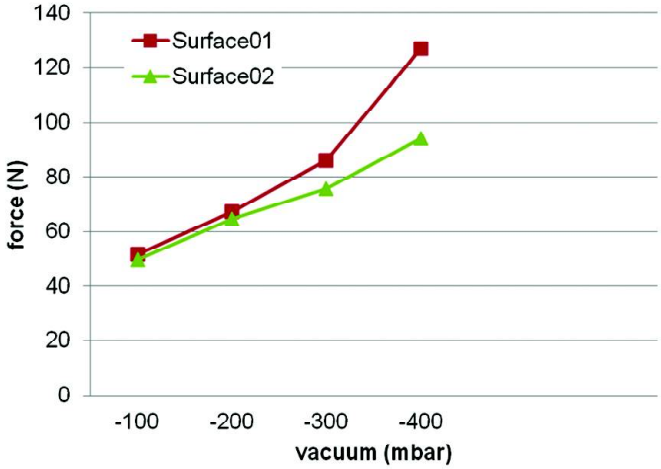



**Fig.4: Comparison of test results for surface: 01 and surface: 02 (Generated force (N) vs different level of vacuum (mbar))**

# CSIR Knowledge Gateway & Open Source Private Cloud Infrastructure KNOWGATE (ISC-0102)

S. K. Senapati & Team

Coordinating Lab : CSIR-NISCAIR, New Delhi
Participating Lab : CSIR-CBRI, Roorkee

CSIR Knowledge Gateway & Open Source Private Cloud Infrastructure (KNOWGATE) is one of the Net working Project (NWP) (ISC0102)of CSIR under 12th Five Year Plan of Information Science cluster as coordinated by the CSIR-NISCAIR, New Delhi (ISC0102). All CSIR labs are the members of the project. By virtue CSIR-CBRI is a member of the project.

This project has three following modules:

| | Description |
|---|---|
| **CSIRCloud** | Capacity and Capability Building: CSIR Open Source Cloud Computing Infrastructure and Open Source Software Technology Solution Cell (OSSTSC) |
| **CSIRCat** | CSIR Distributed Library/Virtualized Union OPAC of CSIR Holdings, using Z39.50 protocol & Open Source Integrated Library Management Software |
| **CSIRTrend** | Multi-dimensional Analysis System (MDAS) -Extended information access for enabling excellence |

Members of CSIR Laboratories have to be provided existing data of KRC for CSIRCat for centralizing union catalogue with a single open sources software and PME data (Patents, research papers and developed technologies) for CSIRTrend for centralized multidimensional analysis. The converted data have to maintain at lab level as well as centralized level for accessing and retrieving data among the CSIR Laboratories through cloud computing.

## Progress in CSIR-CBRI, Roorkee (2013-14):

- Bibliographic data of books of CBRI-KRC has been converted into text form in different segment and sent to CSIR-NISCAIR
- Operating software i.e. CentOS as well as KOHA (library management software) has been uploaded into server
- Converted data of books has been uploaded into new server and customized accordingly
- Data of bound volumes has been sent to NISCAIR into different segments in text form
- Manpower trained for new operating software as well different function of the modules of KOHA software
- Conversion of PME data is under process

# R & D Projects

## Development of Technology for making Flooring and Wall Tiles using Kota Stone Waste (GAP-0132)

Rajni Lakhani & Team

This project has been sponsored by Department of Science & Technology (DST), New Delhi for utilizing dumped Kota stone waste for the development of value added products such as floor tiles, wall tiles and thermal insulated tiles. The funds for setting up the pilot plant have been given by Rajasthan State Pollution Control Board, Jaipur.

This project was started in June 2012. The work for the development of flooring tiles using powdered Kota stone waste obtained from cutting industry has already been reported. In continuation of the earlier work, the use of Kota stone slurry waste has also been studied.

### Kota Stone Sturry Waste

Kota Stone is a fine-grained variety of limestone, quarried at different district of Rajasthan, India. Many hundreds of mines are located in or near the town of Ramganjmandi and Kota district. For example in Hadoti (Bundi district), there is more than 5000 cutting and 300 polishing units which are producing dimensional Kotastone. Form one unit in one month,

1 truck slurry is produced and in each year 30000 ton slurry is being extracted (Fig.1) which pollute the nearby environment and causes following problems to nearby localities such as

**Fig.1: Kotastone slurry waste (Ramaganjmandi, Kota)**

(1) Choking of drains in rainy season
(2) Dust nuisance
(3) Fine particles of slurry (with size less than 363 micron) become air borne and cause air Pollution
(4) Slurry affects productivity of land due to decreased porosity, water absorption and water percolation
(5) Slurry dumped areas cannot support vegetation and remain degraded
(6) Due to long-term deposition of slurry on land, the finer particles block the flow regime of Aquifers. Thus, seriously affecting underground water availability
(7) Slurry affecting the quality of water, reducing storage capacities and damaging Aquifer lives
(8) The heaps of slurry scattered all around an industrial area is an eye sore and spoil the aesthetics of the entire region

So to utilize this huge waste, 1 ton Kota stone waste in dry slurry form was collected from M/s Subhgiri Stones Pvt. Ltd., Kota (Rajasthan). It was dried in oven and pounded first and then physical and chemical analysis was done for further experiments (Table 1 & 2). Fig.2 shows different fractions of the dried slurry waste.

Grading curve of both types of fine aggregates has been shown in Fig.3.


**Fig.2: Different fractions of Kota stone slurry waste**

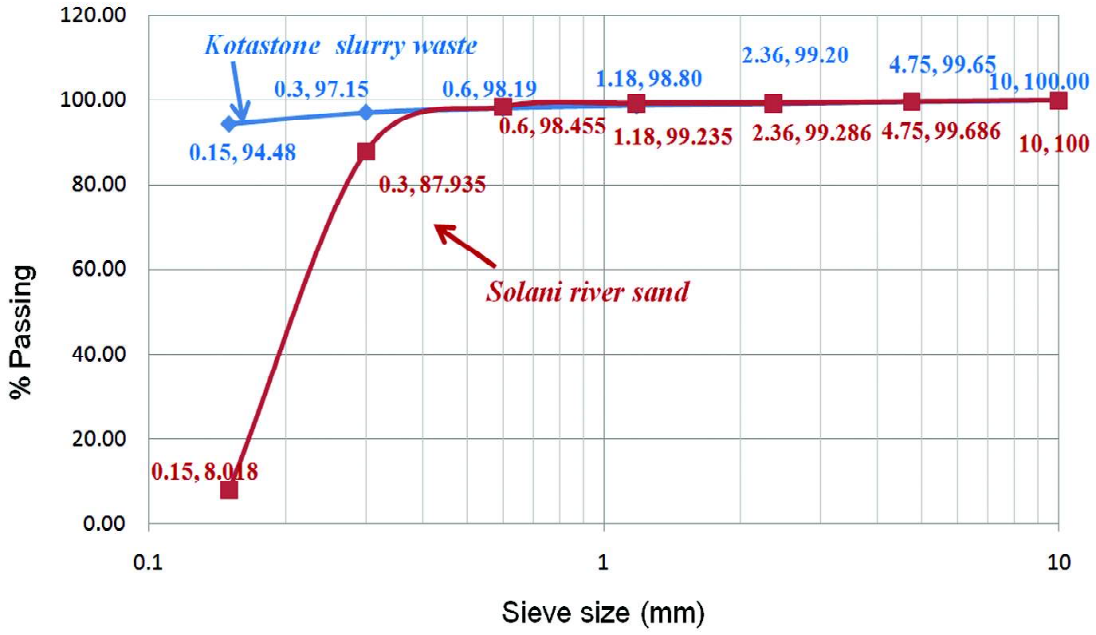



**Fig.3: Grading curve for Kota-stone slurry waste and Solani river sand**

In physical analysis water absorption, moisture content, Percentage of voids etc. were done and XRF-Analysis was done for chemical analysis.

**Table 1: Physical properties of ksslw tested as per IS-code.**

| S.No. | Characteristics | | Value | Code/Method |
|---|---|---|---|---|
| 1 | Fineness | | 275 $m^2/kg$ | IS 4031 (ii)- 1999 |
| 2 | Colour /Appearance | | Greenish-blue | Visual inspection |
| 3 | Bulk density | Wet Condition | 1275 $kg/m^3$ | IS: 2386 (iii)-1963 |
| | | Dry Condition | 1283 $kg/m^3$ | |
| 4 | Specific gravity, $G_s$ (SSD) | | 2.25 | IS: 2386 (iii)-1963 |
| 5 | Apparent sp. gravity (SSD) | | 2.32 | IS: 2386 (iii)-1963 |
| 6 | Water absorption | | 1.42 % | IS: 2386 (iii)-1963 |
| 7 | Percentage of voids | | 43.36% | IS: 2386 (iii)-1963 |

**Table 2: XRF analysis of Kotastone wastes.**

| S.No. | Chemical compounds | Value (%) | |
|---|---|---|---|
| | | Slurry waste | Quarry powder waste |
| **1** | CaO | 66.26 | 66.32 |
| **2** | $SiO_2$ | 23.37 | 22.69 |
| **3** | $Al_2O_3$ | 02.53 | 03.26 |
| **4** | $Fe_2O_3$ | 02.88 | 02.72 |
| **5** | MgO | 00.87 | 00.87 |
| **6** | $SO_3$ | 00.28 | 00.21 |
| **7** | $K_2O + TiO_2$ | 01.33 | 02.09 |
| **8** | $P_2O_5$ | 0.94 | 0.91 |
| **9** | Cl | 0.34 | 0.29 |
| **10** | MnO | 0.11 | 0.14 |

Light weight blocks have been produced using this slurry waste. Different mix designs have been prepared by varying amount of waste, w/c ratio, weight of foam etc. The trials are in process to get the optimized composition for the use of slurry waste in light weight blocks having density 800 Kg/$m^3$ & 1000Kg/$m^3$.

# Evaluation of Durability and Response of FRP Strengthened Reinforced Concrete Beams (OLP-0371)

Harish Chandra Arora

As cities across the world revise their master plans to permit higher floor-area ratios and join the trend towards vertical growth, architects and engineers are faced with new challenges in the strengthening and repairing of concrete structures. Until recently, the accepted methods of strengthening were concrete jacketing, guniting or steel-plate bonding, all cumbersome, labor intensive and problematic. These techniques add to the size of members and increase deadweight. Composite fibre wrapping is one of the most popular techniques in use today. This novel technique of rehabilitation is very effective and fast for earthquake affected structures and also for retrofitting of structures against possible earthquakes. Globally, composite technology and its applications have made tremendous progress during the last two decades or so. A serious matter relating to the use of Fibre reinforced polymers (FRP) in civil applications is the lack of design codes and specifications. For nearly a decade now, researchers from Canada, Europe and Japan have been collaborating their efforts in hope of developing such documents to provide guidance for engineers in designing FRP structures as well as their utilization in repair and rehabilitation projects all over the world.

A large number of field application results where FRP has been used, are still awaited. Research work is continuing to assure the suitability of these materials under different loading and environmental conditions. Durability and long term performance of strengthened structures is a crucial element which governs the life-cycle cost of FRP applied reinforced concrete (RC) structures and is important for structural members requiring a very long design life. Considering this fact, the present in-house R & D project was initiated which will indeed be beneficial for construction and repair society. Getting test results through a extensive experimental research program by investigating the effects of different parameters on the long term performance aspects of FRP strengthened reinforced concrete structural elements are systematically planned. The project is directed towards characterization of FRP strengthened RC structural members with ongoing damages in terms of their durability, structural integrity and performance. Study is expected to contribute to guidelines for FRP-strengthened concrete members, to ensure better long-term performance under service loads and environmental effects.

Earlier in this research program, concrete mix designs were carried out for two target strengths. The mix proportions used are as shown in Table 1. Concrete beams were structurally designed for desired failures. Structural drawings of the beams

are shown in Fig.1. For this study a number of RCC beam specimens of size 100mm x 150mm x 1220mm and 100mm x 100mm x 500mm have been cast. Plain concrete beam specimens of size 100mm x 100mm x 500mm have also been cast.

**Table 1: Concrete Mix Proportions**

| Concrete Type | Type I* | | Type II** | |
|---|---|---|---|---|
| | Weight in Kg/m³ | Mix Proportions | Weight inKg/m³ | Mix Proportions |
| Cement | 400 | 1 | 400 | 1 |
| FA (Sand) | 663 | 1.65 | 607 | 1.52 |
| CA<br>< 20 mm<br>< 10 mm | 1231<br>369<br>862 | 3.078 | 1234<br>617<br>617 | 3.086 |
| Water<br>w/c Ratio | 156<br>– | --<br>0.39 | 210<br>-- | --<br>0.525 |
| SP (% of wt. of cement) | 0.25 | -- | -- | -- |

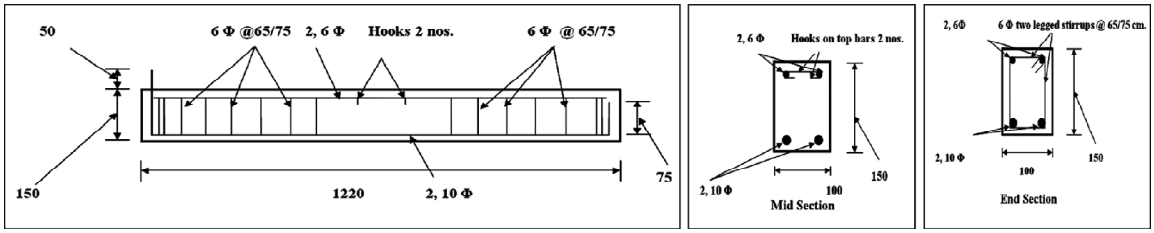



**Fig.1: Beams Details**

In the previous in-house project, a sustained loading system was designed and installed for performing corrosion studies on RC beams. The system is shown in Fig.2 and Fig.3. This system will be used in one of the planned experimental phase of this project.

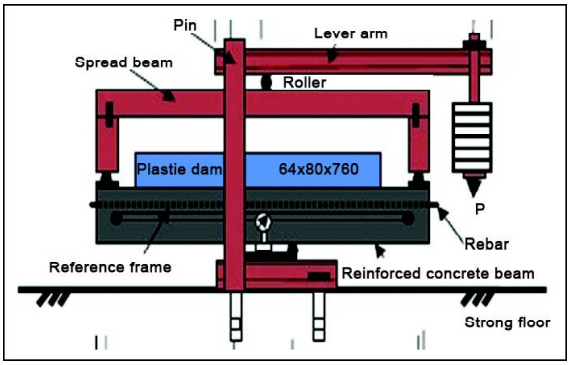



**Fig. 2: Schematic view of test set-up for sustained loading series experiments**

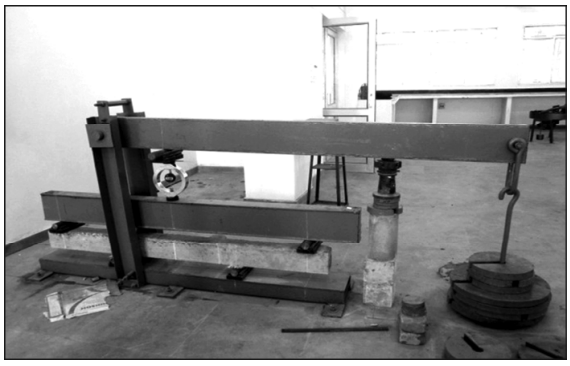


**Fig. 3: Installed sustained loading set-up**

Till now in the present project, initial NDT measurements have been performed on the casted beams for collection of base line data for structural integrity monitoring purpose (Fig.4). The planned accelerated corrosion set-up is schematically shown in Fig.5.

**Fig.4: NDT measurements in progress**

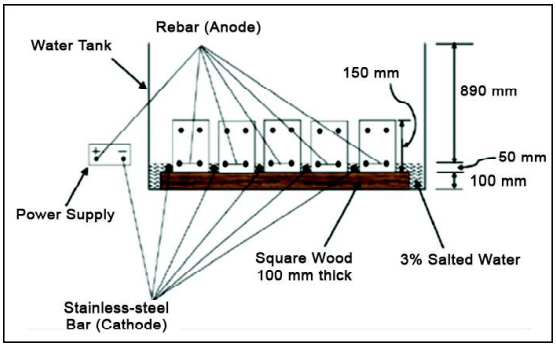



**Fig.5: Scheme for corrosion acceleration**

The procedure followed for FRP application on beams and different FRP strengthening schemes adopted on beams for up-gradations is shown from Fig.6 (a to d) and Fig.7 (a to f).

**Fig.6 (a-d): Procedure for FRP application**

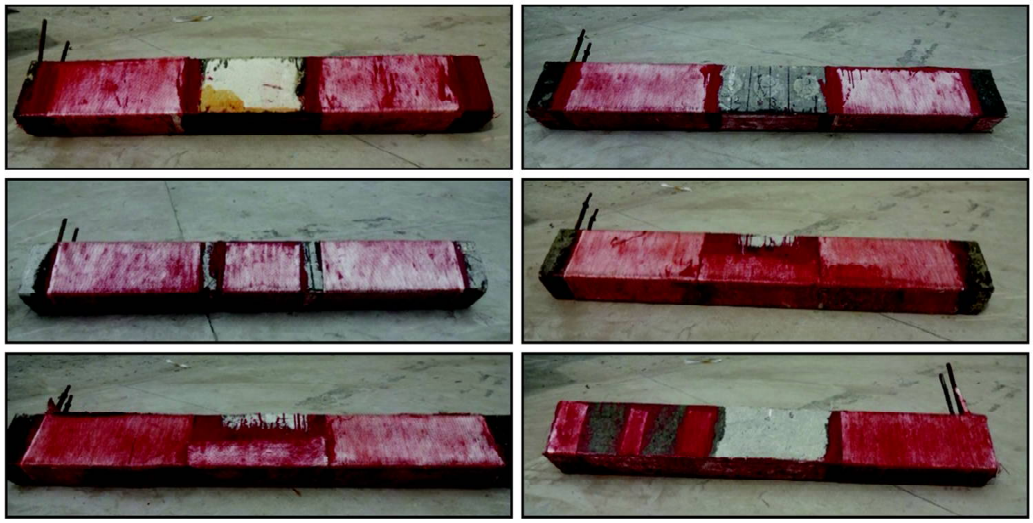


**Fig.7 (a-f): FRP strengthening schemes for beams**

Unexposed unstrengthened and a few FRP strengthened (different FRP schemes) unexposed beams have been structurally tested for flexural study phase. The structural performance of different types of beam specimens is depicted in Fig.8 (a to d) and Fig.9 (a to k). Analysis of experimental data captured during more number of the recently tested beams are in progress.

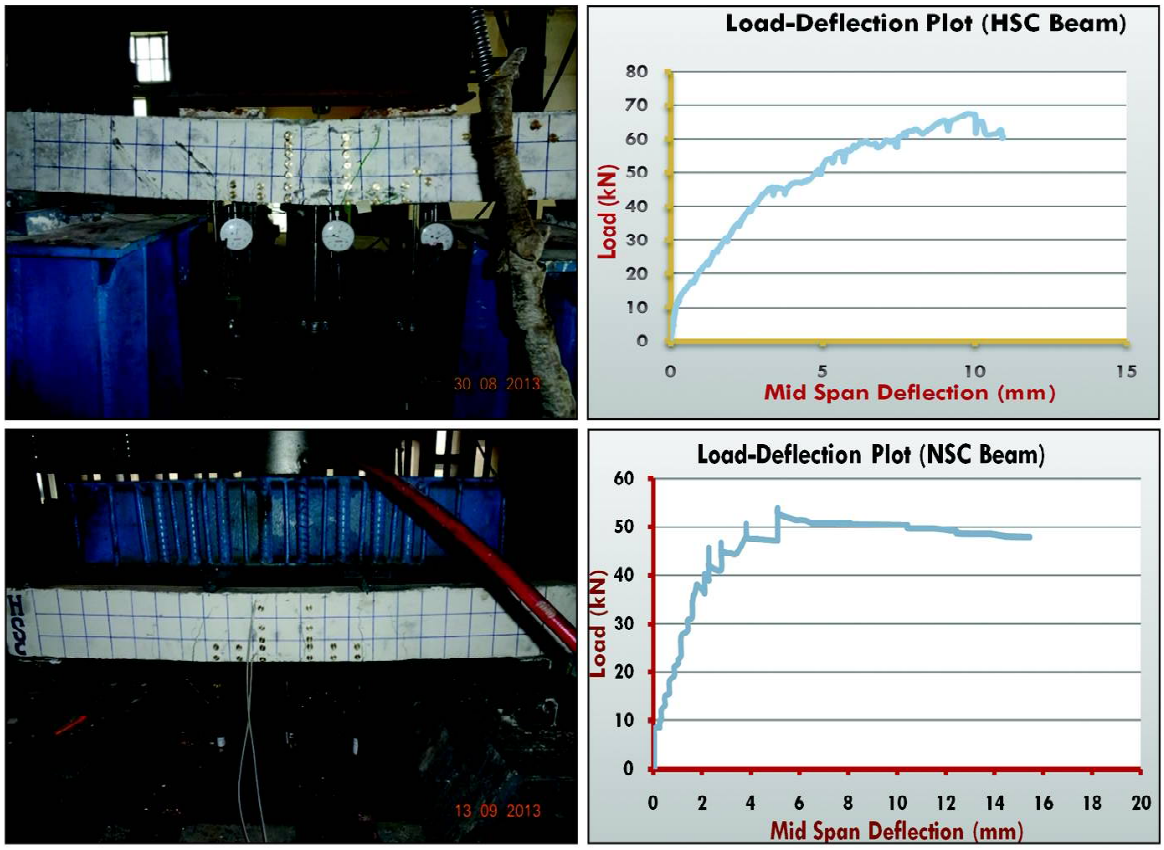



**Fig.8 (a to d): Unexposed unstrengthened beams**

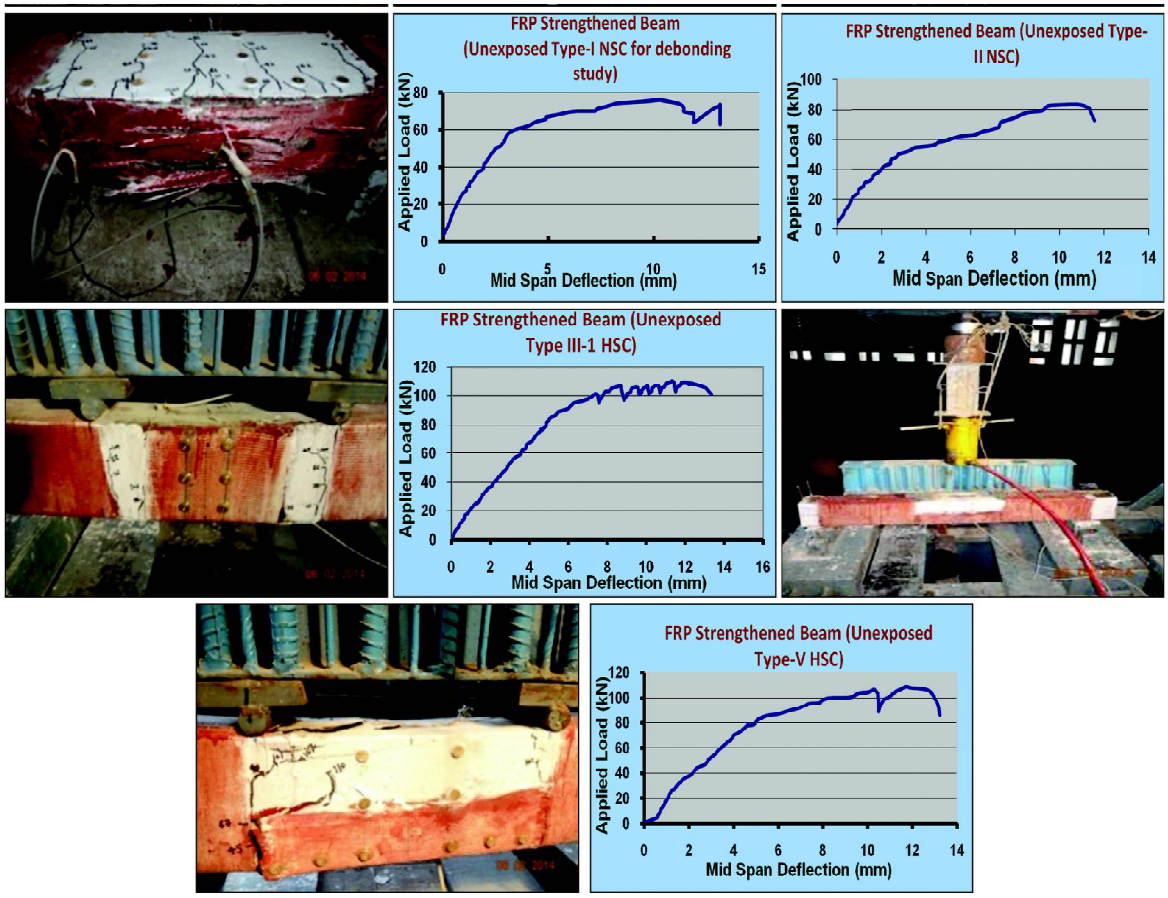



**Fig.9 (a to k): Types of FRP stenghtening schemes and their load-deflection plots**

Systematic accelerated corrosion process was carried out on RCC small beam specimens of size 100mm x 100mm x 500mm (Fig.10 a to g) with unstrengthened and with different types of strengthening over them. The rust stains, crack details and gravimetric testing have been comprehensively performed on these sample corroded beams, the output data of which will be utilized for calibration of corrosion programs in future experiments.

**Fig.10 (a to g): Various phases of corrosion acceleration on beams**

# Investigations of Foundation System through Borehole Radar (OLP-0374)

Ajay Dwivedi, A.K. Sharma & Achal Mittal

## Introduction

The ground penetration radar is used for engineering and environmental site investigations very extensively with accurate information. Due to high cost it was till date used only at large scale projects like underground repositories and mining activities.

For delineation of foundations of heritage building, an effort could be made through dipole mode and cross borehole mode. This can prove to be an effective tool where the excavation of inspection pit around the building is not possible like protected monuments and densely populated areas.

## Borehole Radar

Borehole radar is based on the same principles as ground penetrating radar systems for surface use, which means that it consists of a radar transmitter and receiver built into separate probes. The probes are connected via an optical cable to a control unit used for time signal generation and data acquisition (Fig.1&2).

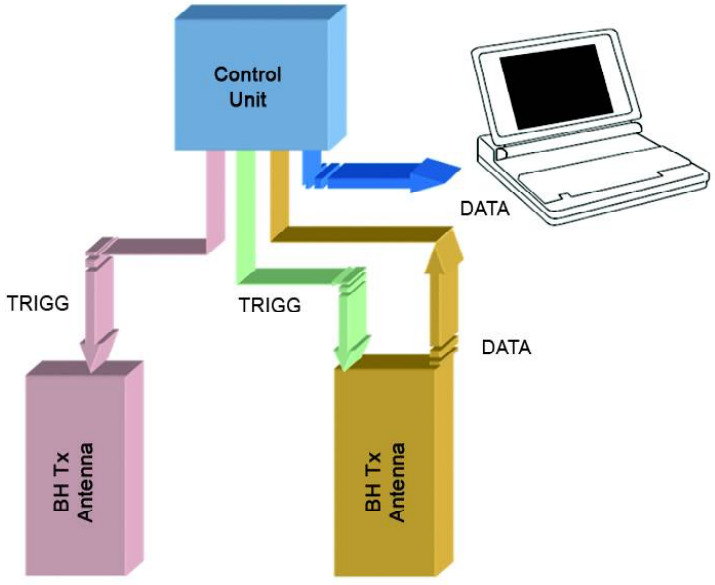



**Fig.1: Borehole Radar setup**

**Fig 2: Borehole Antenna probes with fibre optic cables**

## Dipole Reflection mode

In reflection mode, the radar transmitter and receiver probes are lowered in the same borehole with a fixed distance between them (Fig.3). An optical cable for triggering of the probes and data acquisition is connected to a control unit. The most commonly used antennae are dipole antennae, which radiate and receive reflected signals from a 360-degree space (omni-directional).

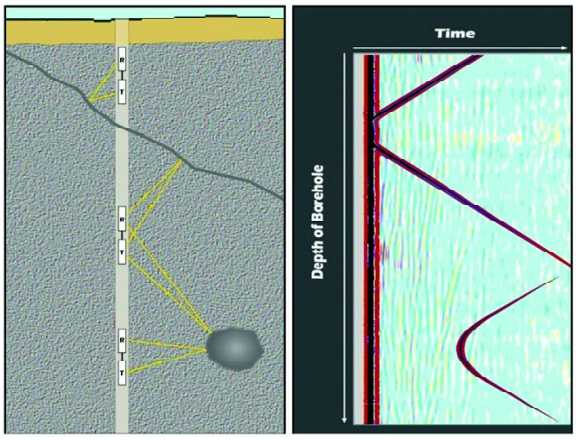



**Fig.3: Borehole Radar investigations in dipole reflection mode and its radargram**

## Methodology

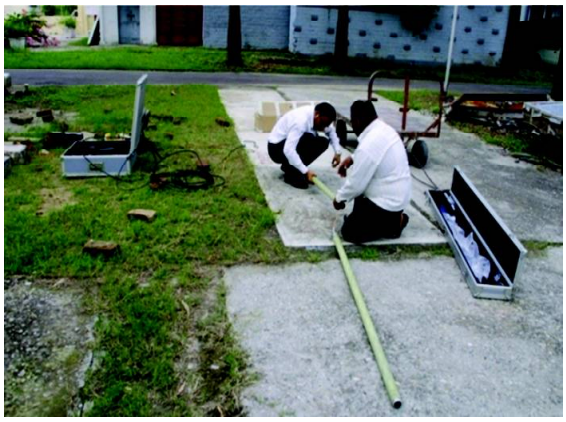
The following work has been envisaged in the project for developing this technique at our institute.

- Sinking of 04 bore holes upto 20m depth one in front of Efficiency of Building group and other three behind Fire Research group building in the institute campus.
- Radar investigation both in dipole mode and cross borehole mode.
- Preparation of crosshole tomography and Data interpretation.

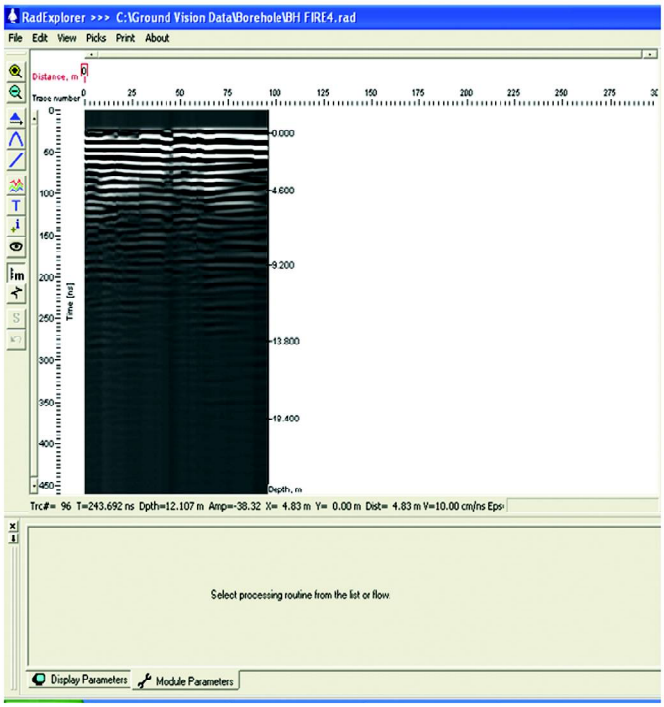
## Progress

- Site selection was carried out in the institute and a site behind the Fire Research building was selected.
- One borehole has been drilled and data has been collected. Analysis of the data is under process.Objectives:

**Drilling of Borehole in progress**



**Assembly of Borehole Radar and its lowering in Borehole**




**Data Acquisition work in progress.**

# Development of Sandwich Soil Technology for Geo Synthetic Reinforced Earth Walls (OLP-0376)

**G. S. Parvathi, Dalip Kumar & Zamir Ahamad**

## Objectives:

The main objective of the study is the Development of sandwiched soil technology for Geosynthetic reinforced earth walls based on numerical modeling and experimental studies.

The use of geosynthetics to reinforce soil masses has been used for the past three decades, and they are now a well – accepted construction material. Geosynthetics are used on many soil structures, such as, reinforced earth walls, reinforced slopes, embankments on soft soils, landfills, and foundation soils. But there has been no Indian guidelines developed till now for the design of reinforced soil structures; except one state of art in IRC guidelines.

The use of reinforcements increase the resisting forces in the soil mass through the tensile force provided by the reinforcement, and consequently reducing the horizontal deformations and increasing the overall stability of the soil structure. In many cases, geosynthetics are not only an engineering solution but an economic and environmental one. Soil-Geosynthetic interaction and its strength mobilization are the important factors which drive the design of these structures. Therefore, the evaluation of soil–geosynthetics interaction coefficients (interface friction angle $\varphi$ and adhesion Ca are so important for the design of reinforced earth structures.

Till now, most of the researches conducted to evaluate the soil – geosynthetic interface have been focused on non – cohesive materials (sands and gravels) with very few researches on cohesive soils. The advantages of using granular materials are their higher frictional resistance, their higher drainage capability. For these reasons, most of the reinforced earth structures are constructed with sands. Since there is abundant cohesive material and not much of in-situ soils are perfectly non-cohesive, it has become a necessity to use cohesive soils as backfill materials. Also, the construction cost of the soil reinforced structures could significantly be reduced by using cohesive soils. This requires the evaluation of interaction between cohesive soils and geosynthetics and its failure mechanism. The cost can be very much reduced if optimum amount of non-cohesive material can also be used along with cohesive backfill in an engineered manner. This also makes easy to adopt reinforced soil wall anywhere across India with not so good soil condition.

Geosynthetic Pull out Machine will be used for testing the interaction behaviour of geosynthetics in different types of soil. This machine includes Test box, load frame, geared system for applications of the pull-out force, and load cells. Large box direct shear equipment with a little modification to clamp

geogrid will be used to check the interface shear properties of the geogrid with different types of soils. Test Planning including the detailed foundation drawing for the pull-out apparatus has been prepared.

Two types of soils will be used for the current study-pure sand and red mud. Index and shear property tests done on these two soils are shown in Table 1.

**Table 1: Soil test results**

| Pure Sand | Red Mud |
|---|---|
| Poorly graded sand (SP) | Grain size Analysis |
| $C_u$ = 1.69 | Sand- 3% |
| $C_c$ = 1.13 | Silt-78% |
| Specific Gravity=2.67 | Clay-19% |
| Maximum dry density=16.6 kN/m$^3$ | Specific Gravity = 2.67 |
| Shear strength parameters from direct shear tests | Maximum dry density=14.7 kN/m$^3$<br>Shear strength Parameters from direct shear test |
| C=0<br>$\varphi$=29.5° | C = 20 kPa<br>$\varphi$= 20° |

FEM modeling was done to evaluate the interaction of geogrid with different soil materials. Plaxis 3D software has been used to do the finite element modeling of the geogrid and soil. Modelling of sandwiched RE wall model has also been initiated. Pure sand was modeled as Linear elastic perfectly plastic Mohr-coloumb model with 10 noded tetrahedron element and the Red mud as Hardening soil with small strain stiffness model with 10 noded tetrahedron element.

Elasto-Plastic model was used for modeling Geogrid. 6 noded triangular surface elements were used for meshing geogrid. Shear interaction between the geosynthetic and aggregate was established by creating two interfaces above and below the geogrid using 12 noded elements. Influence of strain rate of geogrid on the pull-out strength in different soil types are also been studied.

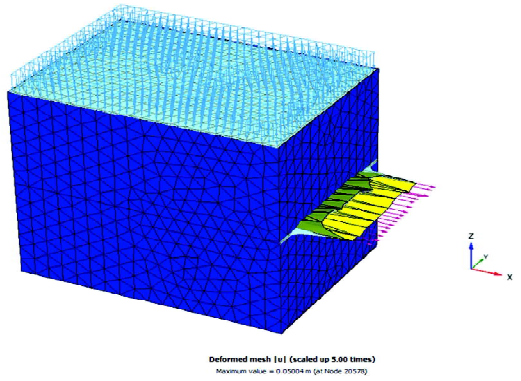



**Fig 1: Typical deformed model used for validation**

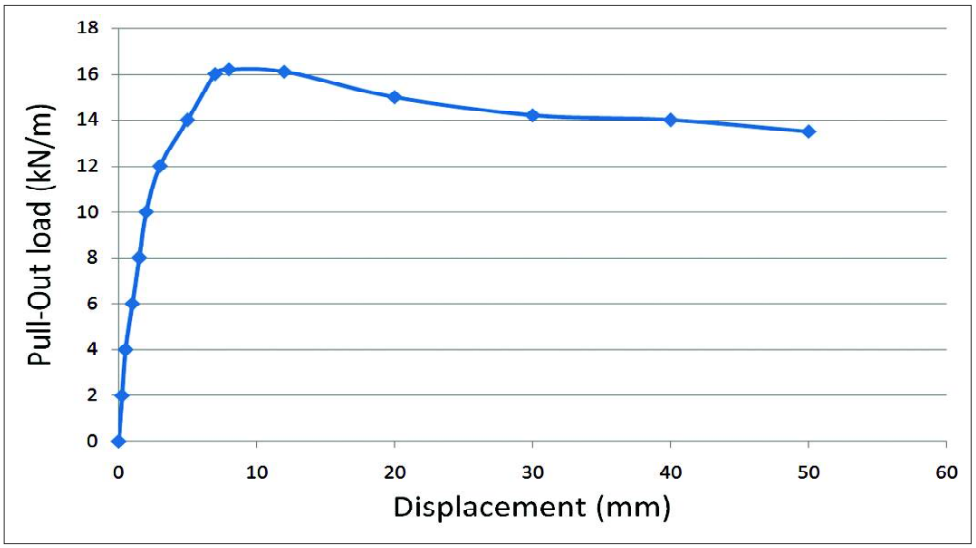



**Fig 2: Pull-out load displacement diagram for uni-axial geogrid of 20kN/m strength embedded in sand for a normal load of 35kPa**

# Seismic Bearing Capacity for Shallow Foundation and Seismic Pull Out Capacity of Shallow Plate Anchors by Pseudo-Dynamic Method (OLP-0377)

**Anindya Pain**

Determination of seismic passive resistance is very essential for safe design of plate anchors and determination of seismic bearing capacity factors in the seismically active regions. The seismic bearing capacity factors are important for the safe design of shallow foundations such as foundation of residential buildings, oil tanks, machine foundations etc. Similarly, ground anchors are commonly used as part of foundation systems for important structures like towers, chimneys, and pipe lines etc., which are required to resist uplift forces.

## Objective:

- Determination of seismic bearing capacity factors with respect to cohesion, surcharge and unit weight components by pseudo-dynamic method.
- Determination of net seismic uplift capacity factor for horizontal shallow strip anchors.

To achieve the above stated objective, analytical models have been developed to determine the safe capacity of the foundations under seismic condition. Limit equilibrium approach with logspiral failure surface together with modified pseudo-dynamic seismic forces has been adopted. In this modified pseudo-dynamic approach, the soil is assumed to behave as a visco-elastic material overlying a rigid stratum and subjected to harmonic horizontal acceleration. This modified methodology satisfies the zero stress boundary condition at the free ground surface. In the present methodology, the amplification of seismic acceleration depends on the soil properties and can be evaluated; hence there is no need for assumption of any amplification value as usually done in literature. It is observed that the seismic acceleration distribution along the depth is highly nonlinear. Results under static and seismic conditions are determined for various combinations of input parameters, like soil friction angle, seismic acceleration, seismic wave velocities, period of lateral shaking, damping ratio of soil etc. Results in terms of non-dimensional factors are prepared in both graphical and tabular form. In addition, the present results are compared and found in good agreement with a very few available similar results in literature. Present study reveals lowest critical design values of seismic uplift capacity factor which may be used in seismic design of shallow strip anchors. And also the bearing capacity factors are critical for the safe design of structures. Also the seismic passive earth pressure coefficient derived in this project may be used for the safe design of rigid retaining walls under seismic condition.

Fig.1 shows the variation of net uplift capacity of shallow horizontal plate anchor ($F_{\gamma}d$) with horizontalseismic acceleration coefficient ($k_h$) for different values of soil friction angle $(\phi)$, with

embedment ratio (ε) = 3, damping ratio (ε) = 20% and period of lateral shaking (*T*) = 0.33 sec. From Fig. 1, it may be observed that for higher soil friction angle, the values of net uplift capacity factor are higher as expected, even for the seismic conditions.

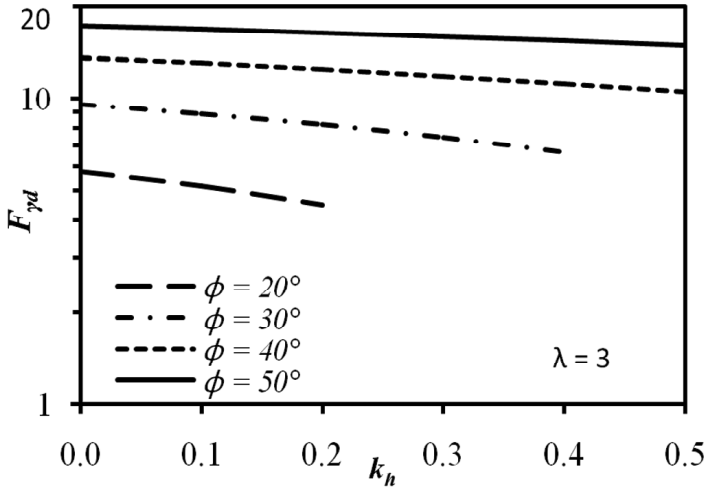



**Fig.1: Variation of net uplift capacity of shallow horizontal plate anchor ($F_\gamma d$) with horizontal seismic acceleration coefficient ($k_h$) for different values of soil friction angle $(\phi)$**

Fig. 2 shows the variation of bearing capacity factor for unit weight ($N_\gamma d$) with horizontal seismic acceleration coefficient ($k_h$) for soil friction angle $(\phi) = 40°$ and period of lateral shaking (T) = 0.33 sec. Fig. 2 gives the comparison of values of the present seismic bearing capacity factors with the available theories for both static and seismic case.

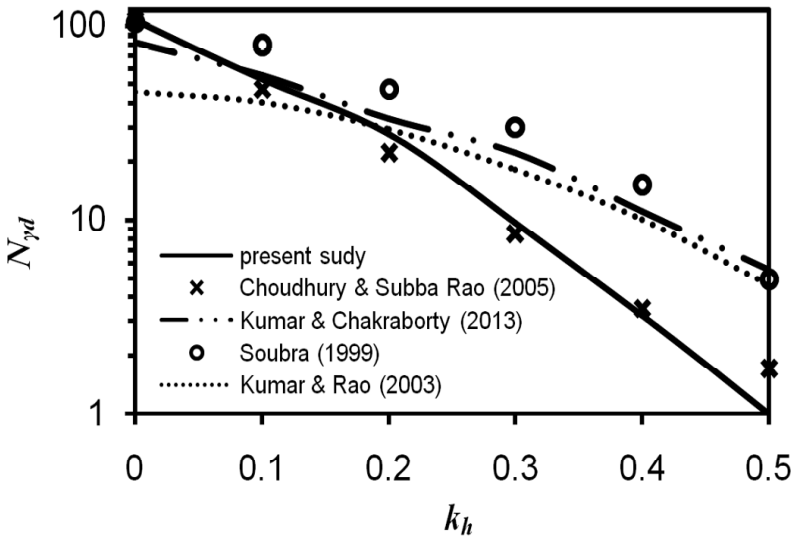
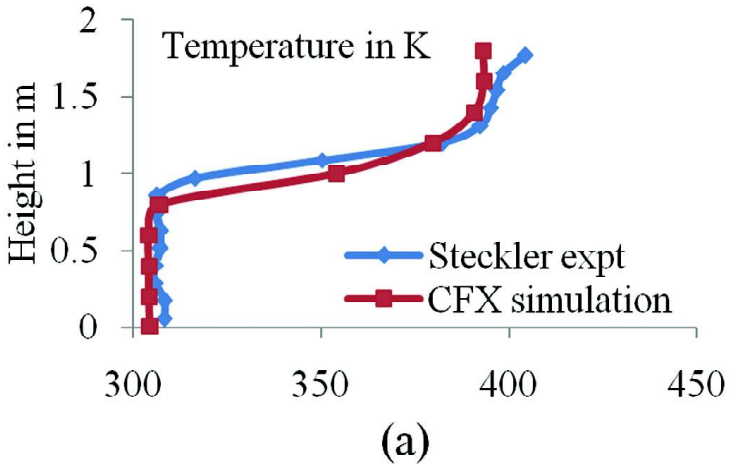



**Fig.2: Variation of bearing capacity factor for unit weight ($N_\gamma d$) with horizontal seismic acceleration coefficient ($k_h$) for soil friction angle $(\phi) = 40°$**

# Optimization of Water Sprays and Location of Sprinkler in an Enclosure Fire (OLP-0383)

**A. Aravind Kumar & Rajiv Kumar**

In this project, compartment fire modelling has been carried out using Computational Fluid Dynamics (CFD) tool of Ansys CFX-5. The predicted results by CFD are compared from literature and as well as from CBRI experimental data using two techniques (i) Heat Release Rate (ii) Combustion Kinetics. Modelling and simulation with CFX using combustion model for data generated in steady state fire of 69.2 kW (Steckler et al.) in a room of 2.8m * 2.8m * 2.18m with the door opening of 1.83m * 0.74m for centrally located methane burner of size 0.3m *0.3m. The results of experimental and simulation are compared as shown in Fig.1 (a-c). Simulation for fire source placed at different locations of 69.2 kW fire has also been carried out for Steckler's data. Transient simulation with CBRI experimental data of benzene fire in a room of size 2.5 m * 2.0 m *1.5 m has been carried out using heat release rate modelling to predict the hot layer temperature near to the ceiling and door. To predict the species concentrations combustion modelling technique has been used. Simulation studies of benzene fire using sprinkler suppression system are under progress.



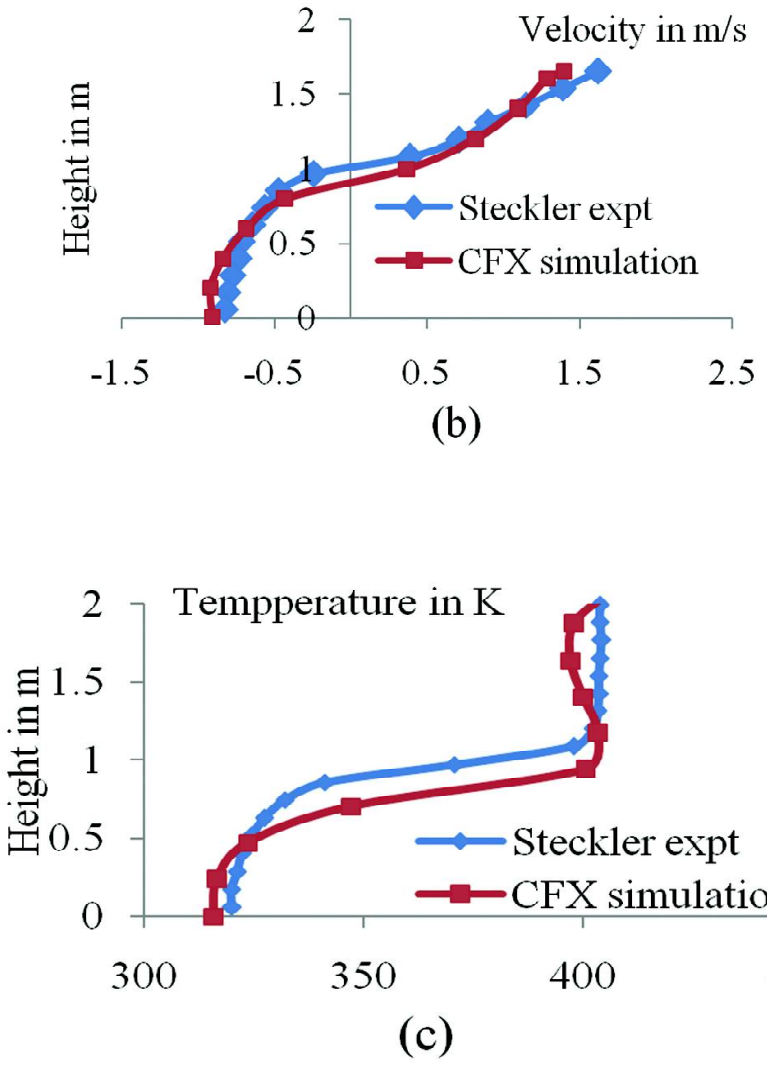



**Fig.1: Comparison of experimental and predicted a) Temperature profiles at door centerline b) Velocity profiles at door centerline c) Temperature profiles at room corner with respect to height above from ground.**

# Development of a Process of Improving Indoor-Thermal Comfort by Exchanging Heat with Ground Water (OLP-0375)

H. K. Jain & Nagesh Babu Balam

The Institute had developed a process of cooling buildings by electronically controlled roof surface evaporative system. The system basically cools the hot roof structure to reduce heat gain indoors through the roof and by cutting heat radiation by hot ceiling towards the occupants. Under this project, a process of cooling indoor air by allowing it to pass through a specially designed heat exchanger cooled by ground water has been developed. The ground water, at any place, remains near the annual mean temperature of that place (23-25°C in Roorkee), it has better thermal conductivity compared to soil (as in earth tunnels) and flows continuously to remove heat. The system was found to work throughout the year by cooling the ambient air during summer and warming up in winter.

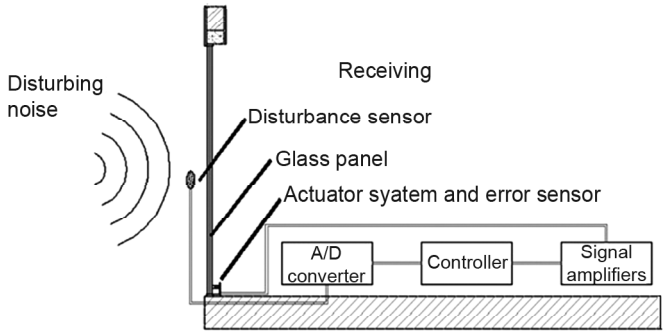
The experimental setup at the Institute consisting of a simple U-shaped heat exchanger was used for exploratory work and later a specially designed parallel channel underground heat exchanger was developed that can be easily integrated with building design. The capacity of the heat exchanger can be easily worked out for cooling different sizes of building enclosures. The system can work using a submersible water pump that can simultaneously supply water to the house and roof surface evaporative cooling system.

**Experimental setup showing air-blower and U-shaped heat exchanger in bore-hole.**

# Active Structural Acoustic Control of Building Service Equipment at the Source (OLP-0385)

**S K Panigrahi and Team**

- Setting up Acoustic Laboratory in 2nd floor of main building Laboratory Construction over and Finalisation of specifications of following noise measurement equipments completed
- Analyzing efficient ways for of noise suppression through the enclosure and material selection (ongoing)
- Selection of actuators is completed.
- Development an analytical model for noise transmission through enclosure plates using feed forward control system is under process.
- Layout of experimental set-up for active noise control through a glass has been Finalized.




# Study of Residential Schools in Composite Climate for Energy Conservation (OLP-0384)

**Neeta Mittal**

The study has been undertaken to evolve a methodology & frame work for energy efficient schools for enhancing the thermal comfort in composite climate and utilize the renewable solar energy in schools.

Education in India is seen as one of the ways to upward social mobility. Good education is seen as a stepping stone to a high flying career. Studies have found that a better physical environment that includes superior energy & thermal performance contributes to increased learning and productivity. Thermal comfort in class rooms can be achieved and significant amount of energy can be saved in these school buildings through proper planning and designing. Navodaya Vidyalayas residential campus which are constructed in each distt. of India have been taken for the evaluation of thermal performance. Jawahar Navodaya Vidyalaya residential schools at district Muzaffarnagar and Chandigarh have been selected in composite climate for the detailed study.

Designs of schools and dormitories are reviewed from thermal performance study point of view and various data, temperature, humidity, air velocity has been collected which affect the comfort. illumination data in classrooms and dormitories is also collected for the study in these schools.

JNV Muzaffarnagar ,UP


JNV Chandigarh

# Academy of Scientific and Innovative Research (AcSIR)

## Integrated M.Tech. - Ph.D. Programme on

## "Building Engineering & Disaster Mitigation (BEDM)"

The two year post-graduate research programme for civil engineering students at CSIR-CBRI under the Academy of Scientific and Innovative Research (AcSIR), which was started in 2010 has completed nearly 4 years now. An Integrated M.Tech – Ph.D. Programe on "Building Engineering & Disaster Mitigation (IMP-BEDM)" of 5 years duration has two parts: (i) M.Tech programme of four semesters (2 years) and (ii) Ph. D. programme (3 years) after successful completion of M.Tech.

Two batches of students have completed the M.Tech programme so far. There were six students in the 1st batch (2010-12) and eight students in the 2nd batch (2011-13), which completed their M.Tech in 2012 and 2013 respectively. The M.Tech degree to the eight students of 2011-13 batches was conferred by Prof. R. A. Mashelkar, Chairman, AcSIR in the 3rd convocation ceremony of AcSIR at CSIR-SERC, Chennai on 24th March 2014.


**The 3rd convocation ceremony of AcSIR at CSIR-SERC, Chennai**

The eight students of the 3rd batch are presently carrying out dissertation work on live projects of the institute. The dissertation topics undertaken by the students of the 2011-2013 batch are as follows:

1. Development of nano-engineered cementitious materials – Ms. Reshmita Palla
2. Investigation on bond behavior of reinforcement with geopolymer concrete under various environments– Mr Rakesh Paswan
3. Use of recycled aggregate for concrete – Mr Santha Kumar
4. Behaviour of reinforced geopolymer concrete beam under static & impact loading – Md Reyazur Rahman
5. Structural analyses and design of precast beam-column joints subjected to static & earthquake loading – Mr Chanchal Sonkar
6. Development of a cement based anode for cathodic protection of RC structures – Mr Eldho C. A.
7. Behaviour of structural element under actual fire – Mr Dharmendra Singh
8. Development of cellular foamed concrete for non-load bearing wall using Kota stone slurry dust – Mr Rajesh Kumar

In August 2013, the following five students of 2013-15 batch joined the course in the category of Trainee Scientists:

1. Ms. Humaira Athor
2. Mr Kritya Nand Jha
3. Mr Mahesh Sharma
4. Mr Ravi Kumar
5. Mr Shiv Singh Patel

**M.Tech students of 2013-15 batch**

Under the Ph.D programme, there are 8 students who have registered for Ph.D. in Civil Engineering, Geology and Chemical Sciences. The following is the list of Ph.D. students:

1. Mrs. Usha Sharma – Chemical Sciences
2. Mr. Davinder Singh – Geology
3. Mr. Piyush Mohanty – Civil Engineering
4. Mr. Anindya Pain – Civil Engineering
5. Mr. Siddharth Behera – Civil Engineering
6. Mr. Micky Mecon Dalbehera -– Civil Engineering
7. Ishwarya G. – Civil Engineering
8. Monalisa Behra – Civil Engineering

Students have been participating in various events organised by the institute. While celebrating the National Science Day on 28th February 2014, the students had participated in a poster competition on "Innovative Ideas in Building Science & Engineering". The titles of the innovative ideas presented by the students were:

- Retractable Petals Building Envelope
- Adaptable House for Flood-prone and Low-lying Areas
- Buildings Inspired by Nature
- Graphene and Spider Silk Composite Fibre
- Magnetic Building

**Students presenting the innovative research themes**

**Annual sports event of CSIR-CBRI**

**Teachers' Day celebration organized by the Student's on 5thSeptember, 2013**

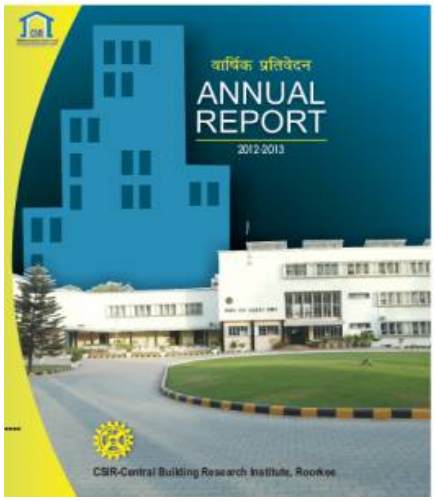
# Information, Extension & Project Management

## Publication Group

The Publication Group continued to serve as the nerve center 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, print-production of quarterly publication of CSIR-CBRI Newsletter and Bhavnika (Bilingual), publication of Building Research Notes, Project Profile, Technical and Divisional Brochures etc., preparation of other scientific/technical reports and filling up of questionnaires, providing inputs for CSIR Annual Report as well as for CSIR News and CSIR Samachar; and repoting of the scientific and technical work carred out at the institute in Hindi and English and Publicity of the Institute's R&D capabilities through print Media for image building.

1. CSIR-CBRI Annual Report (In Hindi & In English)

**R & D Highlights**
**Research Output**
**Glimpse of Activities**
**R & D Projects**
**Consultancy Projects**
**Sponsored Projects**
**Honours & Awards**
**CBRI Family**
**Information, Extension & Project Management**
**Date Line**





Tasks involved : Manuscript evaluation, Editing, Proof-Reading, Graphic Design, Layout, Illustration, Print Production, Binding, Publishing, Dissemination and Feedback


**CBRI in CSIR News**

**CBRI in CSIR Samachar**

**Information Brouchers ( English and Hindi)**


**Newsletters**


**CBRI in Press**


**Building Research Notes**

# Development, Construction & Extension Group

The Development, Construction and Extension Group at the Institute is involved various activities with the objective to disseminate R&D outcomes of the Institute among the user agencies for field implementation. The Group organizes or participates in training programmes related to disaster resistant cost-effective housing, rural housing and creating awareness through exhibitions, visits of students, professionals and related authorities. The group also keeps generating display material, technical videos and manages CSIR Programme on Faculty Training & Motivation and Adoption of Schools and Colleges by CSIR Labs. The Group also takes up developmental activities to develop user friendly systems and their dissemination under the CSIR 800 mission programme. Some of the activities have been highlighted below:

## Exhibitions

1. CSIR participated in the 101st Indian Science Congress Exhibition – India Vision 2020 Expo organized at Jammu during Jan 03-07, 2014. CSIR-CBRI provided matter and photographs on latest technologies developed at the Institute to CSIR for highlighting it in the CSIR pavilion.
2. Managed the Institute stall in the exhibition held at IIT Roorkee during the Annual Geo-technical Conference organized during December, 2013. The stall was visited by a large number of delegates of the Conference, IIT students and faculty members.

## Technical and Educational visits of professionals and students

1. Dr S Mishra, Principal, Techword Institute, Roorkee along with 3 faculty members and about 40 civil engineering students visited CSIR-CBRI on April 02, 2014 along with their faculty. They were taken to various Labs of the Institute and had discussions with scientists. A technical video show was also arranged.
2. Prof Rajat Gupta, Deptt of Civil Engineering, Moradabad Institute of Technology, Moradabad visited CSIR-CBRI on April 09, 2014 along with about 45 students of civil engineering and architecture.
3. Prof (Ms) Radhika Rathore along with a group of about 35 students of B. Arch from School of Architecture, Sadopur, Ambala along with 2 faculty members visited this Institute on Jan 23, 2014 to learn about new materials, building components and work done by CSIR-CBRI on anthropometrics, daylighting, ventilation, fenestration design and passive systems of cooling for use in buildings.
4. Directors and senior officers from various Cooperative Housing Societies of India visited this Institute on March 03, 2014, along with members of the National Cooperative Housing Federation (NCHF), New Delhi. The visitors were taken to various facilities and labs of CSIR-CBRI and had a detailed meeting with Director and

Group Leaders to explore areas of mutual cooperation.

5. A group of 5 final year civil engineering students from University of Petroleum and Energy Studies, Dehradun, visited this Institute on Feb 10, 2014 particularly to learn and discuss Confined Masonry and other EQ resistant housing techniques.
6. About 30 participants of the training course on Capacity Building of Minor Irrigation Organisation organized by IIT-Roorkee visited CSIR-CBRI on Sept 27, 2013. They were taken to various labs and had interactions with scientists. They were impressed by the high quality canal lining tiles developed in CSIR-CBRI and used in the parallel Ganga Canal.
7. Ar. Jagesh Kumar, Director, SBBIA College of Architecture, Meerut visited this Institute along with 3 students of final year B. Arch mainly to learn about static and dynamic testing of Building Components and structures.
8. Shri Sanjay Mahajan, HOD, Deptt of Civil Engineering, Meher Chand Polytechnic, Jallandhar visited this Institute along with about 50 students on Feb 07, 2014.
9. Under the CSIR Programme on Faculty Training, Motivation and Adoption of School and Colleges by CSIR Laboratories, science students from KLDAV PG College, Roorkee, Army School-I, Roorkee Cant and Government Inter College, Roorkee visited CSIR-CBRI on Sept 26, 2013. attended the CSIR Foundation Day Programme organized at the Institute. Students who had done their project work at CSIR-CBRI during the last session under this programme were also awarded certificates on the occasion.

## Extension and Technical Guidance to User agencies

- Shri HK Jain, Pr. Tech. Officer of the DCE Group participated in the Training Programme for the Engineering staff of SSA and RES on 'Repair and Reconstruction of School Buildings in the State of Uttrakhand' organized at Dehradun during 29-30 August, 2013. Smt Radhika Jha, IAS, State Project Director SSA inaugaurated the programme. Dr Kabir Bajpai, Advisor, Ministry of Human Resource Development, Govt of India and CSIR-CBRI scientist - Dr. Achal Mittal lead the CSIR-CBRI team. Technologies suitable for reconstruction of safer schools in the hills were discussed and demonstrated during the training programme.
- Shri Sunil Kumar, BAS, CEO cum DDC, West Champaran, Bihar was provided details of making durable houses using mud, thatch, bamboo etc. protected by ferrocement cover on walls and roof. Technology of making 2 pit latrine, smokeless chullaha and purification of drinking water using clay & mineral filters was also provided. A technical video 'Unnat Gramin Awas' in Hindi was also provided which shows in details the field implementation of these techniques.
- Shri HK Jain, Pr. Tech Officer had participated in the brain storming workshop on 'Technological Intervention for Mountain Ecosystem : Livelihood Enhancement through Action Research & Networking : TIME-LEARN' programme organized by DST during 16-18 July, 2013 at the Forest Research Institute and Colleges, Dehradun. Subsequent to the same concept ideas were invited by Sept 26, 2013. Technological interventions in the area of hill housing were prepared and submitted.

## Production of Technical Videos

- The Group produced a Technical video 'Confined Masonry' of about 23 minutes covering the work done by the Structural Engineering Group of this Institute in the area of Confined Masonry, which is suitable for the construction of earthquake resistant houses. The video has so far been made available to about 300 user agencies.
- Pre-production work is going on for the production of a promotional video on the CSIR CBRI. The video will highlight the laboratories, facilities, achievements and field implementation of CSIR-CBRI technologies in the country.

## CSIR Programme on Faculty Training & Motivation and Adoption of Schools and Colleges by CSIR Labs.

The Human Resource Development Group of the Council of Scientific and Industrial Research (CSIR), New Delhi has been running a very important programme of Faculty Training & Motivation of Science Students and Adoption of Schools and Colleges by CSIR Labs. The CSIR-Central Building Research Institute, Roorkee has been actively participating in this programme ever since its inception by CSIR. The programme supports hands-on-training, experimental techniques, lab facilities, orientation programmes, and orientation on scientific temperament, innovative methods and open ended experimentation.

During 2013-14 the Institute organized various activities like,

i. Demonstration of Projects developed by students and distribution of certificates
ii. Lab visits and Interaction with Scientists
iii. Participation of Faculty and students in the CSIR Foundation Day Function on Sept 26, 2013
iv. Selection of students willing to take up simple science projects under the guidance of CSIR-CBRI scientists
v. Scientific discussion sessions in the areas of interest of the participating students

On the occasion of the CSIR Foundation Day Function at CSIR-CBRI (Sept 26, 2013) Certificates were distributed to the students who had worked at this Institute during the session 2012-13. The students also demonstrated their project work.

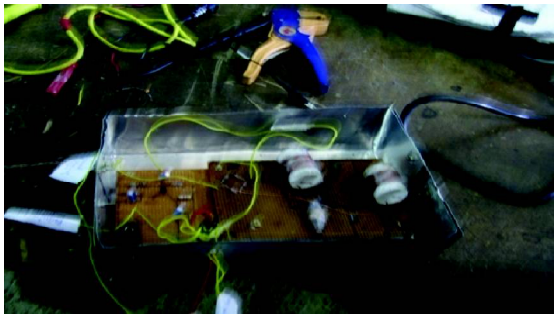
The science teachers and science students from three schools and colleges of Roorkee were provided an opportunity to interact with scientists from various disciplines. They were also shown various facilities like Spectrophotometer, Scanning Electron Microscope, X-ray diffraction, nano-particle synthesizer, latest destructive and non-destructive testing methods, Wind Tunnel, Sun Path Model, Artificial Sky and solar energy application in buildings and advanced R&D facilities in the area of building materials and chemistry. The Fire Research lab was of special interest to the visitors. They were motivated by this new area of science and took special interest in the high level R&D facilities available in the Institute for testing fire behavior of building materials and components.

The visit to Rural Technology Park was conducted by Shri RK Garg and his colleagues. The students were surprised how simple S&T interventions can provide safe durable and cost effective housing to rural poor using locally available materials and skills.

This year 13 science students worked at CSIR-CBRI in the area of analogue and digital electronics. Under this programme the participating students were guided to develop electronic circuits to tackle real life problems using the electronics they have studied at their school/ college level. In this way the students got a chance to understand the basic principles which boosted their confidence. Several discussion sessions were organized in a friendly environment so that the students could open up and participate.

The students worked in two broad areas:

i. **Wireless transmission and Reception of Digital Data**
ii. **20+20watt Stereo Amplifier for PC Audio Card**



# Knowledge Resource Centre (Library)

**CSIR-CBRI** Library is now known as 'Knowledge Resource Centre' (KRC) 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:** The library added 58 books. **Journals:** The library has subscribed 112 (57foreign +55 Indian) journals. 205 volumes of journals were got bound.

**Library Statistics:** The present position of Laibrary Collection: Books including reports; standards; conference proceedings; theses & maps: 43792; Bound Periodicals: 20304

**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

**International / Foreign :** International Council for Research & Innovation in Building and Construction(CIB), Rotterdam, The Netherlands; International Union of Laboratories & Experts in Construction Materials, Systems and Structures (RILEM), Bagneux, France, International Federation for Structural Concrete (fib), Lausanne, Switzerland.

**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 specific services:-

- **Documentation:** Paper clipping service 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 & Foundation; Disaster Management: earthquake & landslides; Shelter Planning & Policy; Environment Science & Technology; Fire Research; CSIR/ CBRI etc. The paper clipping

are kept in classified order for providing current awareness service to users.

- **List of Latest Addition:** KRC is bringing out a quarterly list of latest arrivals of books for the general awareness of library users.
- **Bibliographic Service:** KRC is providing bibliographic service to users on demand on the subject of interest.
- **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 & Access of E-Journals:** Now, access to over 2000 full text of e-journals of leading S&T publisher's viz., AR, full text of ASTM Standards, Elsevier, Emerald, IEEE, OUP, RSC, Sage, T&F, Wiley as well science & patent databases like Web of Science and 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. 1060 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.

# Research Planning & Business Development (RPBD)

## Agreements Signed

- Between CBRI and PWD, New Delhi, for Third Party Inspection/Quality Assurance of Civil Construction work of Redevelopment of 'C' block at Delhi High Court, Sher Shah Suri Marg, New Delhi.
- Between CBRI and Engineering Department, Chandigarh Administration, for structural health assessment, repair and retrofitting of concrete structures for restoration and preservation of Reinforced Concrete Heritage Buildings of Chandigarh.

## MoUs Signed

- With University of Petroleum and Energy Studies, Dehradun
- With CSIR-Tech Private Limited, Pune

# Planning Monitoring and Evaluation

The Planning Monitoring and Evaluation (PME) group acts as the main facilitator of the institute for effective planning, monitoring, evaluation and project budgeting of all the R&D and externally funded projects such as consultancy projects, sponsored projects, grant–in-aid projects etc. Important documents like annual plan document of the institute, manpower deployment document, MC agenda for externally funded projects and R&D agenda for the Research Council are also dealt with by PME Group.

PME monitors and compiles the monthly and quarterly progress of the research activities of the institute as well as the research utilization data for onward processing at PPD, CSIR. The group regularly maintains & monitors the project folder of all the projects and maintains the records in terms of physical and financial recommendations of internal monitoring committees, Research Council & Management Council.

## R&D Projects

Internal review meetings and meetings with external experts are organized for selection of new R&D projects. The ongoing projects are monitored for progress and/ or mid-course corrections. Comments of experts are conveyed and it is ensured that the same are incorporated before the projects are placed before Research Council. Sixteen in-house R&D projects were processed under the four R&D areas of the Institute, namely, new construction material, health monitoring rehabilitation and strengthen, disaster management and energy efficient system.

## Project Evaluations & Peer Reviews

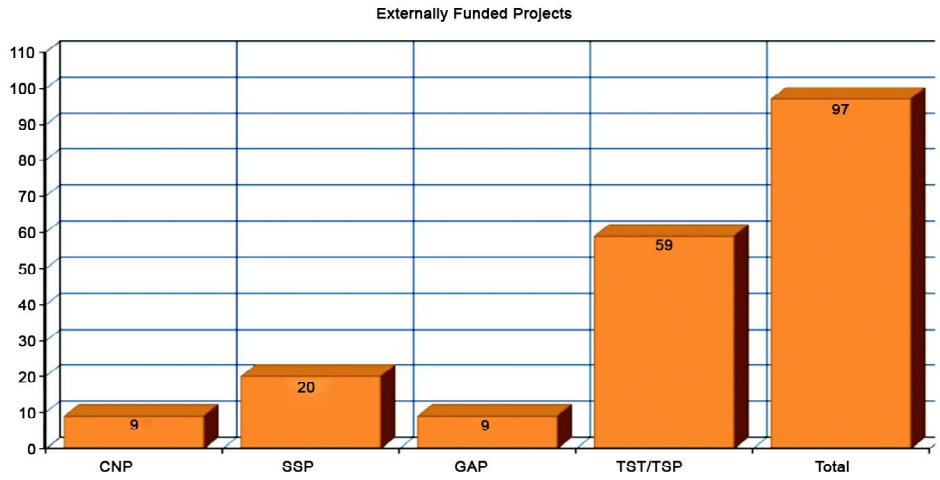
Internal and external peer review meetings and project evaluation meetings were organized for new and on-going In-house R&D projects as well as for the 12$^{th}$ Five Year Plan projects during the year. PME group coordinated the scheduling of presentations & interacted with the project leaders for putting up the relevant documents. The inputs as an outcome of the meetings were incorporated in the projects prior to placing the same before the Research Council.

## Research Council Agenda

Research Council Meetings are held twice a year to monitor the progress of R&D projects of the Institute. The R&D agenda of 48$^{th}$ & 49$^{th}$ RC meeting was prepared. The agenda covers 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.

## External Funded Projects

The Institute has undertaken the externally funded projects on basis of the expertise in different areas in the form of Consultancy, Sponsored, Grant-in aid and Testing. During the period following projects were taken.




A Database of all the externally funded projects is maintained. This helps in effective monitoring of these projects. Necessary record and receipts of Service Tax & TDS collection are maintained. Service tax is 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 Document

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 document. Reporting and reviewing officer are also identified for the staff members as per CSIR norms.

## 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

| | |
|---|---|
| Revenue | 1314.427 Lakh |
| Capital | Nil |
| Special Projects | 610.500 Lakh |
| Total | 1924.927 Lakh |

## External Cash Flow

| | |
|---|---|
| Private | 227.160 Lakh |
| Government | 139.983 Lakh |
| Testing | 134.060 Lakhs |
| Total | 501.203 Lakh |

# 44th SSBMT (Indoor) Finals

44th Shanti Swarup Bhatnagar Memorial Tournament (Indoor) Finals was inaugurated by Padamshree Shri Zafar Iqbal, Former Indian International Hockey player on 5th April 2013 at CSIR-CBRI, Roorkee. Addressing the gathering, Padamshree Shri Zafar Iqbal shared his experiences and created the cheerful atmosphere and infused enthusiasm among the participants during inauguration.

Prof S.K. Bhattacharyya, Director CSIR-CBRI, Dr Ashwani Kumar Minocha, Vice President, and Dr Suvir Singh, Organizing Secretary, CSIR-CBRI staff club, Dr. M. Mohan Rao, Member of CSIR Sports Promotion Board were also present on this occasion.

During the three days tournament, five indoor games - Badminton, Table Tennis, Carom, Bridge and Chess were played and about 180 participants from various CSIR Laboratories have participated. During the tournament, the participants demonstrated qualities of team work, competitiveness, leadership and the zeal to excel against the odds.

Team and Individual events were organised for Badminton, Carom and Table Tennis. For bridge, team event for men and for chess, individual event for men were played.

The results were declared in the Valedictory function held on 7th April 2013. Prof. Vani Brahmachari, graced as Chief Guest and Prof. S.K. Brahmachari, Director General, Council of Scientific and Industrial Research was the Guest of Honour of the function.

While addressing, Prof. Vani Brahmachari, Chief Guest of the function appreciated the efforts made in organizing the tournament and congratulated and gave away the prizes to the winners.

Prof. S.K. Brahmachari, Director General, CSIR and Guest of Honour addressed the gathering which was stirring, truly insightful, encouraging and direction giving.

Prof. S.K. Bhattacharyya, Director, CSIR-CBRI delivered the welcome address. Prof. R.C. Budhani, Director, CSIR-NPL, New Delhi and President Sport Promotion Board also addressed to the participants. Dr Ashwani Kumar Minocha introduced the Chief Guest and Dr Suvir Singh, Organizing Secretary, presented a brief of the sports event and proposed a vote of thanks.

During the function, Dr M.O. Garg, Director CSIR-IIP, Shri D.S. Bedi, Secy SPB, Members of the SPB, Distinguished invitees, guests, participants from different CSIR Labs, members of CSIR-CBRI family were also present.

Earlier Prof. S.K. Brahmachari, Director General, CSIR visited the laboratories of CSIR-CBRI, Roorkee and also inaugurated Main Gate & Various Laboratories of the Institute.









## National Technology Day

CSIR-Central Building Research Institute, Roorkee celebrated National Technology Day on 10th May, 2013. Prof. S.P. Gupta, Dy Director, IIT, Roorkee graced the occasion as Chief Guest and delivered a special lecture on National Technology Day. He highlighted various scientific achievements and motivated the S&T staff for taking interest in understanding the principles and practical applications of science so that the future of our country may be shined. The Chief Guest further stressed that science should be explored for the benefit of the mankind so as to improve health, income and living standard of the common masses.

The Technology Day celebration started with a lighting of lamp by the Chief Guest Prof. S.P. Gupta Dy Director, IIT Roorkee and Prof. S.K. Bhattacharyya, Director, CSIR-CBRI.

Earlier, Prof. S.K. Bhattacharyya, Director CSIR-CBRI, Roorkee in his Presidential address briefed on the importance of National Technology Day to the

gathering. He remarked that May 11 is annually observed as National Technology Day all over India to commemorate technological breakthroughs like mastering of nuclear weapons technology (Pokharan II) through a series of controlled tests at Pokharan, test firing of the indigenously developed Trishul missile and test flight of the indigenous aircraft Hansa-3. These achievements of Indian technology got a further boost with the test firing of indigenously developed Trishul, Agni and Prithvi missile. The day, which proved the technical prowess of Indian scientists, is marked as the National Technology Day to inspire young minds to achieve high goals and excel at innovations. He also highlighted R&D achievements of CSIR and it's contribution in improvement of economy, health and living standard of the masses.

A Technology on "Fire Extinguishments" was transferred to M/s Aska Equipments Ltd. New Delhi. Sri Rajeev Ragav, Chief Marketing Officer have also delivered a Technical presentation. Dr Suvir Singh, Sr Principal Scientist gave a Technical presentation on Cable Penetration Seal System (Cable Fire Stop) who received Diamond Jubliee Technology Award. Dr R S Chmote, Chief Scientist gave a Live Demonstration on Fire Extinguishment Techniques.

Dr Achal Mittal Scientist conducted the celebration of programme, introduced the Chief Guest and proposed a vote of thanks.

**Live Demonstration on Fire Extinguishment Techniques**

## World Environment Day

The CSIR-Central Building Research Institute (CBRI) Roorkee, celebrated the World Environment Day 2013 on June 5, 2013 to promote awareness on the importance of preserving our biodiversity, 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, ecosystem management and resource efficiency. The theme for this year World Environment Day celebrations was **Think, Eat, Save**. Think, Eat & Save is an anti-food waste and food loss campaign that encourages us to reduce our food print. According to the UN Food and Agriculture Organization (FAQ), every year 1.3 billion tonnes of food is wasted. At the same time, 1 in every 7 people in the world go to bed, hungry and more than 20,000 children under the age of 5 die daily from hunger. Given this enormous imbalance in lifestyles and the resultant devastating effects on the environment, this year theme encourages us to become more aware of the environmental impact of the food choices we make and empowers us to make informed decisions.

On 5th June 2013, Dr. Neelima Jerath, Executive Director, Punjab State Council for Science and Technology , Chandigarh, Prof. S.K. Bhattacharyya, Director CSIR-CBRI and Prof. B.R. Gurjar, Chairman

IE(I), Roorkee planted trees in CSIR-CBRI campus as a gesture of harmonious living with nature.

Dr. Neelima Jerath, Executive Director, Punjab State Council for Science and Technology, Chandigarh, delivering her speech as Chief Guest expressed her happiness to be amongst the distinguished scientists and mentioned that every human being should contribute a little in their own personal way to protect the environment and in this connection she appreciated the initiatives taken by CSIR-CBRI for taking environmental issues seriously and also proposed that both CBRI and PSCST can have joint projects on environmental problem of the Uttarakhand.

Earlier, Prof. S.K.Bhattacharyya Director CSIR-CBRI in his Presidential Address apprised that unlike the previous years, the different trees were chosen for plantation. Prof. Bhattacharyya mentioned that CSIR-CBRI will continue its activity to develop environment-friendly technologies and pursue research to protect the environment and work for conservation of biodiversity of the region. On this occasion, **CBRI Publications i.e. Newsletter** and **Bhavnika** were also released by the dignitaries.

Prof. B.R. Gurjar Chairman IE(I), Roorkee Local Centre addressed the gathering about the World Environment Day . Dr. A.K.Minocha, Chief Scientist, in his introductory address pointed out that World Environment Day is an annual event that is aimed at being the biggest and most widely celebrated global day for positive environmental action. The programme ended with a vote of thanks presented by Dr. Shishir Sinha, Hon. Secretary, IE(I), RLC Roorkee.


## Sadbhavna Diwas

The Institute observed Sadbhavna Diwas on August 20, 2013 with a view to promote harmony amongst people of all religion, languages and states and goodwill towards everyone.

Dr. B.K. Rao, Chief Scientist, CSIR-CBRI administered Sadbhavna pledge to all the staff members of the Institute.

## Independence Day

The Independence Day was celebrated with a deep sense of patriotism combined with gaiety on August 15, 2013 in CSIR-CBRI Main lawns of the Institute. Prof. S.K. Bhattacharyya, Director, CSIR-CBRI hoisted the National flag and 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 presented various cultural programmes on patriotic themes.

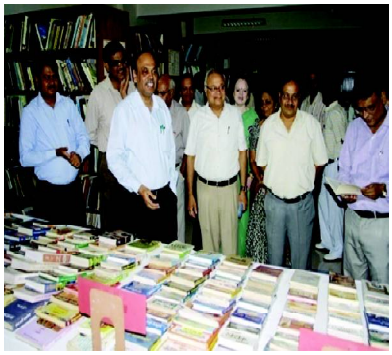
## Hindi Week

The Institute celebrated Hindi week during 9-13 September, 2013 with great zeal and enthusiasm. On 9th Sept Dr. Mahavir Agarwal, Vice-Chancellor, Uttrakhand Sanskrit University, Haridwar graced the inauguration function as Chief Guest. The function was chaired by Prof. S.K. Bhattacharyya, Director, CSIR-CBRI. On 10th September 2013, a scientific lecture was delivered by Prof. Indramani Mishra, IIT, Roorkee on "Pipe line sanraksha: durghatnayen avam unke prabhaav ka aaklan" in

Hindi. A Hindi debate competition was also organized on 10th September on "Uttrakhand ki Aapda ke liye Aniyantrit Vikas Jimmedaar Hai". A Hindi Poster & Slogan Competition was organized on 11th Sept 2013. Another scientific lecture was delivered by Shri Yadvendra Pandey, Chief Scientist, CSIR-CBRI on "Chittaurgarh Qile ka Adhyyan" in Hindi. The lecture was based on studies carried out by Shri Pandey as an expert on the direction of Hon'ble Supreme Court to dispose off the issue of mining in vicinity of Qila. Both the lectures organized on this occasion were on Scientific subjects but the language was so easy, fluent and full of exactness and clarity as all the scientists have realized that even the scientific matters could be presented in Hindi with utmost clarity and exactness. Certainly it would be very helpful in changing their pro English mentality. A Hindi self-written poem recitation competition was also organized. An exhibition on Hindi books was also organized in which the viewers appreciated the Hindi books available in the Library.

Dr. Kamal Kant Budhkar graced the Concluding Ceremony of the Hindi week on 13th September 2013 as chief guest and chaired by the Director, CSIR-CBRI. The Chairman has urged all the employees of the Institute to do their job in Hindi around the year. On this occasion, prizes of Hindi Incentive Schemes & Hindi competitions were given away to Miss Aastha Chaudhury, Miss Lavanya, Mohd. Afzal, Shri Virendra Singh, Shri Sudhir Kumar, Smt. Sunita, Shri Aman Kumar, Mr. Pankaj Verma, Shri Shashank Singh, Shri Arpan Maheshwari, Smt. Gayatri Devi, Shri Randhir Kumar Chaudhury and Mrs. Neeta Mittal.

Hindi Week was organized successfully with the special contribution of the Organizing Committee of which Dr. B. Singh, Chief Scientist and Shri R.C. Saxena, Sr. Hindi Officer were the Chairman and convener, respectively.


## CSIR Foundation Day

71st CSIR Foundation Day 2013 was celebrated at CSIR-Central Building Research Institute, Roorkee on September 26, 2013 with full zeal and enthusiasm. On this auspicious occasion Dr. S.J.Chopra, Chancellor, University of Petroleum & Energy Studies, Dehradun was the chief guest and Prof. S.K.Bhattacharyya, Director, CSIR-CBRI presided over the function. Many dignitaries, superannuated staff members of CBRI, students from local schools and colleges, faculty members, press and media were present on this occasion. The function started with lighting the lamp. Mr. R.K. Garg, Chief Scientist and

chairman of the committee welcomed all the dignitaries and highlighted the achievements of CSIR under the able leadership of Prof. S.K. Brahmachari, DG CSIR and Prof. S.K. Bhattacharyya, Director of the institute.

Prof. S.K. Bhattacharyya, Director, CBRI addressed the gathering and touched upon the glorious journey of CSIR over past seventy one years which started with establishment of five laboratories and have risen to thirty seven labs of different specializations. He said that CSIR has given maximum number of patents to the country and what is practiced today at CSIR is science for engineering and engineering for science. He also said that CSIR-AcSIR will help in the development of the country through knowledge generation and exploring new and innovative ideas through youth of the country. He touched upon the focus areas of R&D in the institute and network projects under the twelfth five year plan and hoped that CSIR-CBRI may be able to serve the society in a more effective manner as Team CSIR.

Dr. S.J. Chopra, Chancellor, University of Petroleum & Energy Studies, Dehradun talked about the 'Leadership and Intellectual Integrity' in decision making. He shared his R&D experiences and stressed the need of honorable behavior and intellectual integrity for the efficient working of an organization.

On this occasion 'CBRI Annual Report' was released by the chief guest Dr. S.J.Chopra and Prof. S.K.Bhattacharyya. The superannuated staff members of CSIR-CBRI in last one year received Samman Patras, shawls and wrist watches. The staff members, who have completed twenty five years'

service in CSIR were presented wrist watches. CSIR prize for securing more than ninety percent marks in three science subjects at intermediate level by the children of staff members was given away by the chief guest.

A number of science projects were prepared and working models were exhibited by local school/ college students under CSIR Programme on 'Faculty Training and Motivation of Science Students' and were highly appreciated. The prizes were given to the winning entries. The prizes were also given to the winners of the essay competition (for children of CBRI staff members), conducted on this occasion. There have been other activities including, visit of school students providing platform for scientist- student interaction and generating interest among the youth for science and technology. Sri R.K.Garg, Chief Scientist & Chairman of the CSIR Foundation Day Committee proposed a vote of thanks.

Foundation Day Lecture was delivered in the afternoon on the topic "Energy: Yesterday, Today and ???" by Dr. S.J. Chopra, Chancellor, University of Petroleum & Energy Studies, Dehradun. He presented the global energy scenario and the trends of energy consumption, leading to critical situation. He also suggested the changes that may be done by individuals in daily routine activities to save energy.

To celebrate CSIR Foundation Day in a befitting manner, a cultural programme was organized in the evening which was enjoyed and appreciated by one and all. The prizes were distributed to the participants by Mrs. Kajal Bhattacharya, Patron of CSIR-CBRI ladies club.

## Vigilance Awareness Week

The Institute celebrated Vigilance Awareness Week during 28th October to 2nd November 2013. Different programmes which includes Oath ceremony, special lectures, poster and essay competition for staff children & debate competition for staff members etc. Have been organized. Prof. S. K. Bhattacharyya, Director, CSIR-CBRI presided over the Valedictory function. Prof. P. K. Ghosh, Dean, Finance & Planning, IIT,Roorkee was the chief guest and gave away the prizes to the winners of different competitions. Dr. Suvir Singh, Senior Principal Scientist & Chairman, Organizing committee presented a brief of the programme organized during the week and the function was concluded by a vote of thanks presented by Sh. R. K. Garg, Chief Scientist.


## Diwali Mela Celebrations at CBRI Campus

The Diwali Mela was organized jointly by CSIR-CBRI Staff club and Shanti Nagar Ladies Club Roorkee on October 29, 2013 at Shanti Nagar Colony ground. Dr. R.D. Singh, Director, NIH, Roorkee graced the occasion as Chief Guest. Prof. S.K. Bhattacharyya, Director, CSIR-CBRI inaugurated the Mela. This annual festival has fun for the entire CBRI family. In this Mela, entertainment programmes viz. traditional singing and dancing performances by artists of different age groups of children's from CBRI staff were organized. Prof. S.K. Bhattacharyya, Director along with chief guest visited all the stalls organized by the members of CBRI Ladies Club. A stall offering wide variety of delicious traditional food was well appreciated. A beautiful group dance "Dandia" was presented by children of the CBRI staff. A huge rush attracted for viewing Fashion Show of different age groups. Baby show was also programmed for 1-2 years babies. In addition to that many other activities like "Hawaii Guitar", Dance Competition, Tambola, Lucky Dip etc. were also appreciated by audience, viewers & judges. Prizes

were distributed to the winners of all the competitions including Lucky Dip. The fun and revelry was accompanied by everyone who was present there. Viewers appreciated the whole programme and perceived the importance of "Festival of Light" in life. In the end "Atishbazi" session was also prevailed and it makes to all people stunned for an instance.

## Republic Day

The Republic Day of the Nation was celebrated with a deep sense of patriotism combined with gaiety on January 26, 2014 in CSIR- Central Building Research Institute main lawns. Prof. S. K. Bhattacharyya, Director, hoisted the National Flag and 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 programme on patriotic themes. A Cricket Match was also arranged.

## CSIR-CBRI Foundation Day

68th CSIR-CBRI Foundation Day was celebrated with great enthusiasm at CSIR-Central Building Research Institute, Roorkee on Monday, February 10, 2014. Mr. Ajai Chowdhry, Padma Bhushan, Founder-HCL & Chairman, Board of Governors, IIT Patna graced as the chief guest and Prof. S.K.Bhattacharyya, Director, CSIR-CBRI presided over the function.

The superannuated staff of CBRI and all the staff members of the institute also witnessed the occasion besides other dignitaries. A welcome address was given by Mr. R.K.Garg, Chief Scientist. He presented a brief introduction of the institute, focus areas of R&D activities and about foundation day celebrations in the institute.

Prof. S.K. Bhattacharyya, Director, CSIR-CBRI addressed the gathering, highlighting 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 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, environment preservation and energy conservation. He intimated that the institute has taken up projects related to conservation of nationally important heritage structures such as Taj Mahal, Chittaurgarh fort and Sun Temple, Konark. He spoke about the CSIR-800 project and role of the institute aiming at the upliftment of the life of poor people in the country. Integrated M.Tech – Ph.D Programme on "Building Engineering & Disaster Mitigation (BEDM)" which CSIR-CBRI has started under the Academy of Scientific and Innovative Research (AcSIR) was also highlighted. He talked about the major focus areas of R&D, newer areas of research such as sustainability, nanotechnology, bio-concrete and waste utilization in the production of construction materials and products. Recent technology transfers, collaborations and MoU signed were also highlighted.

Mr. Ajai Chowdhry, Chief Guest, appreciated the work done by CBRI. He stressed the need of sustainable development and highlighted the role of construction industry in the growth of the country and suggested that in the present age of globalization the new markets are emerging such as Africa, SARC countries etc., where CBRI has a greater role to play in the development process. 'Diamond Jubilee Directors' Award for the best research paper published, selected by the High Power Committee was awarded to paper entitled 'Pine needle/isocynate composites: Dimensional stability, biological resistance, flammability and thermo acoustic characteristics' authored by Ms. Monika Chauhan, Dr. Manorama Gupta, Dr. B. Singh, Mr. A.K. Singh and Mr. V.K.Gupta.

**Address by Prof. S.K. Bhattacharyya, Director, CSIR-CBRI**

**Address by the Chief Guest Mr. Ajai Chowdhry, Padma Bhushan**


**Foundation Day Lecture by Padma Bhushan Mr. Ajai Chowdhry**

'Diamond Jubilee Director' Award for development of best Technology/Innovation/Know-how which has maximum impact on the society was awarded to Mr. R.S. Chimote, Chief Scientist CSIR-CBRI on "Profile of Technology on CSIR-CBRI Liquid Extinguishment Fire Extinguisher for Common Man's Fire Safety".

**Release of 'CBRI Publications'**

**Guests, Scientists and Staff members attending the Function**

**Presentation of Technology Award**

**Presentation of Best Paper Award**

On this occasion a number of CSIR-CBRI publications were released including 'CSIR-CBRI at a glance' in Hindi as well as in English. Bilingual 'CSIR-CBRI News Letter'/ 'Bhavanika' and three Technical Research Publications. Sri R.K. Garg proposed a vote of thanks.

The CBRI Foundation Day Lecture on 'Entrepreneurship' was delivered by Mr. Ajai Chowdhry, attended by all the scientists and technical staff members of the Institute and was highly appreciated.

There have been a number of activities, organized to celebrate CSIR-CBRI Foundation Day 2014 including games such as badminton,chess, carom etc. On 26th January a friendly cricket match was also organized. A cultural programme was organized in the evening by the staff club and ladies club of the institute which was enjoyed and appreciated by one and all. Mrs. Kajal Bhattacharya, Patron, CBRI Ladies Club, distributed the prizes to the participants.

On February 10, 2014, the whole campus had a festive look and the main function was organized in the morning.

## National Science Day

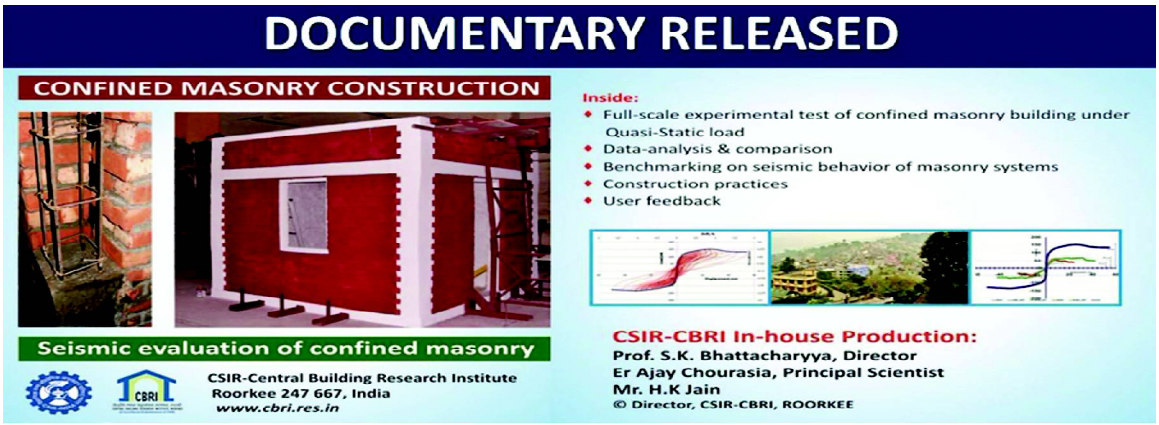
CSIR-CBRI celebrated the National Science Day on 28th February 2014. On this occasion, a poster competition was organised at the institute in the morning session for the young scientists, students and Project Fellows of the institute. The young researchers presented their novel scientific ideas in the field of building science & disaster mitigation through posters.

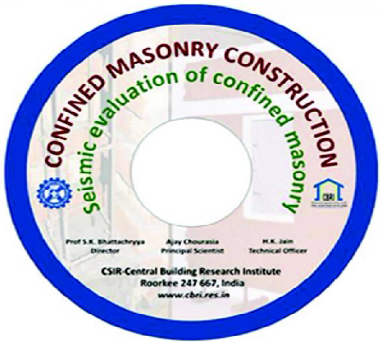
The posters presented includes:

- Retractable Petals Building Envelope: Mahesh Sharma, Sumeet Kumar and Astha Chowdhury
- Adaptable House for Flood-prone and Low-lying Areas: Riya Bhoumik & Manojit Samantha
- Buildings Inspired by Nature: Debdatta Ghosh & Sidharth Behera
- Graphene and Spider Silk Composite Fibre: Venkatesan J, Reshmita Palla and Debdatta Ghosh,
- Magnetic Building: Ravi Kumar & Kritya Nand Jha
- Rain-electro Generator: Kritya Nand Jha, Ravi Kumar and Shiv Singh Patel

The posters were adjudicated by the Chief Guest of the function, Prof. D. Goldar, Former Principal of Delhi College of Engineering, New Delhi and Prof. S.K. Bhattacharyya, Director, CSIR-CBRI. The posters on themes Retractable Petals Building Envelope and Magnetic Building won the 1st and 2nd prize, respectively. The other four presentations got the consolation prize.

In the afternoon, Prof. S.K. Bhattacharyya expressed his views about the National Science Day and the significance of "Fostering Scientific Temper", theme of the year. This was followed by the National Science Day lecture on "Elastic Wave Propagation in Transversely Impacted Beams" by Prof. D. Goldar. A documentary film on "Confined Masonry Construction" by CSIR-CBRI was also released and uploaded at CSIR-CBRI web site www.cbri.res.in. It was widely circulated to all State Secretaries (Housing), DMs, NDMA, SDMAs, CSIR laboratories etc.,




**Content Highlights:**

- **Full-scale experimental test of confined masonry building**
- **Benchmarking on seismic behavior**
- **Construction practices**
- **User feedback**

# Annual Flowers and Vegetables Show

CSIR-CBRI Staff club organized 47th Annual Flower and Vegetable Show at CSIR-CBRI Roorkee premises on 11th March, 2014. Prestigious organisations of Roorkee such as IIT, NIH, BEG&C etc. participated in the Flower Show. Many individual participants and staff of CBRI have also participated in this show. Dr. Pradeep Kumar, Sr. Principal Scientist and convener informed that many types of categories were made for participants in Garden, Pot plants, Cut flowers, Vegetables and Flowers arrangements etc. The categories were (i) for all institutions, office, clubs and nurseries (ii) for all individual' participants (iii) exclusively for CBRI staff (iv) for Mallies (v) for Queen and King of the show and (vi) for flower arrangements.

The show was inaugurated by Prof. S.K. Bhattacharyya, Director CSIR-CBRI and the prizes were distributed by the Chief Guest Prof. Raj Kumar, Director, All India Institute of Medical Sciences (AIIMS), Rishikesh, Uttrakhand and the Guest of Honour Mrs. Kajal Bhattarcharya, Patron CBRI Ladies Club. Family members of staff of CBRI, their friends and relatives were also present during the show.


On this occasion, overall trophies in Institutional category were awarded to Dr. R.D. Singh, Director, NIH, individual Trophy in category II was awarded to Prof. Pradipta Banerji, Director IIT Roorkee, In the III category, Dr. Pradeep Kumar, Sr Principal Scientist, CBRI won the best garden trophy and the overall trophy by Shri S.K. Negi, Sr. Principal Scientist, CBRI.

In the category of Pot plant, Garden, Bonsai, Cut flower, Vegetables, Lawns, Garland, Miniature, Rangoli & Salad Dressing etc. Brigadier Digvijay Setiya, BEG & C, Mrs Aradhna Goel, Dr. Vandna Grover , Prof. S.K. Bhattacharyya, Dr. R.K. Goel, Dalip Kumar, S.P. Singh, Y Panday, Madhu Yadav, Megha Panigrahi, Km Sai, Mamta, Preeti, Mahalakshmi have won various prizes in their respective catagories.

# In-house R&D Projects (2013-14)

| Sl. No. | Project No. | Title of the Project | Principal Investigator<br>Co-Investigator | Duration |
|---|---|---|---|---|
| **Health Monitoring, Rehabilitation & Strengthen** | | | | |
| 1. | OLP 0371 | Strengthening of stone masonry housing constructions against earthquakes. | Sh. H.C. Arora | 1012-0914 |
| 2. | OLP 0374 | Investigations of foundation system through borehole radar. | Sh. Ajay Dwivedi | 1212- 0514 |
| 3. | OLP 0376 | Development of sandwich soil technology for geo synthetic reinforced earth walls. | Ms. Parvathi G.S. | 0413-0315 |
| 4. | OLP 0377 | Seismic bearing capacity for shallow foundation by pseudo-dynamic method. | Er. Anindya Pain | 0413-0315 |
| 5. | OLP 0378 | Experimental evaluation of precast beam-beam connection. | Er. Siddharth Behera<br>Dr. A.K. Mittal | 0413-0315 |
| 6. | OLP 0379 | A probabilistic damage identification approach for building under ambient condition. | Er. R. K. Choudhary (Resigned) | 0413-0315 Closed in Nov., 2013 |
| 7. | OLP 0380 | Earthquake resistant design of the reinforced soil slopes. | Er. Piyush Mohanty<br>Er. Manojit Samanta<br>Er. S. Behera<br>Sh. Ajay Dwivedi | 0413-0314 |
| 8. | OLP 0381 | To improve the bond performance of light weight concrete for pre tensioning. | Er. Mickey Mecon Dalbehera<br>Dr. A.K. Pandey | 0413-0314 |
| 9. | OLP 0382 | Development of latex blend modified high strength concrete composite (LBMHSCC) of strength 60 MPa for structural component. | Er. Tarannum Meraj (Resigned)<br>Dr. A.K. Pandey | 0413-0315 Closed in Oct., 2013 |
| **Disaster Mitigation** | | | | |
| 10. | OLP 0372 | Strengthening of stone masonry housing constructions against earthquakes. | Dr. Navjeev Saxena | 1012-0914 |
| 11. | OLP 0383 | Optimization of water sprays and location of sprinkler in an enclosed fire. | Dr. A. Arviind Kumar<br>Dr. Rajeev Kumar | 0413-0315 |
| 12. | OLP 0373 | Across-wind response of high-rise building models of vertically varying rectangular cross sectional shapes with corner chamfered and corner cut. | Dr. Amrit Kumar Roy | 0912- 0413 Closed in April,2013 |
| 13. | OLP 0370 | Evolution of publication in the area of duct explosion hazard evaluation, prevention and mitigation based on analysis and compilation of information experimental and theoretical work and knowledge from CSIR-CBRI work and relevant uptodate world wide searched work. | Dr. Manju Mittal | 1012-0915 |
| **Energy Efficient System & Other Projects** | | | | |
| 14. | OLP 0375 | Development of a process of improving indoor thermal comfort by exchanging head with underground water. | Sh. H.K. Jain<br>Dr. P.K. Bhargava<br>Er. Nagesh B. Balam | 0113-0614 |
| 15. | OLP 0384 | Study of residential schools in composite climate for energy conservation. | Mrs. Neeta Mittal | 0413-0315 |
| 16. | OLP 0385 | Active structural acoustic control of building service equipment at the source. | Dr. S.K. Panigrahi | 0413-0315 |

# 12th Five Year Plan Projects

| S.No. | Project | Project Title, PI & Details |
|---|---|---|
| 1. | ESC 0301 (SINP) | INNOVATIVE MATERIALS & TECHNOLOGIES FOR NEXT GENERATION GREEN BUILDINGS<br>WP-1: Performance Enhancement of Materials through Nanotechnology.<br>**PI: Dr. L. P. Singh Task: 04 Nos.**<br>WP-2: Next Generation Concrete for Sustainable Construction.<br>**Er. S. K. Singh Task: 04 Nos.**<br>WP-3: Green Building Technologies.<br>**PI: Ar. Ashok Kumar Task: 06 Nos.**<br>WP-4: Materials & Technologies for Hazard Reduction.<br>**PI : Dr S. R. Karade Task : 04 Nos.** |
| 2. | ESC 0102 Network Project | ENGINEERING OF DISASTER MITIGATION & HEALTH MONITORING FOR SAFE & SMART BUILT ENVIRONMENT<br>WP-1: Engineering of Landslide Disaster Mitigation.<br>**PI: Dr. S. Sarkar & Dr. D. P. Kanungo Task: 08 Nos.**<br>WP-2 : Engineering of Earthquake Disaster Mitigation<br>**PI: Dr. P. K. S. Chauhan & Er. Ajay Chourasia**<br>**Task: 03 Nos.**<br>WP-3 : Engineering of Fire Disaster Mitigation<br>**PI: Er. R. S.Chimote & Dr. Suvir Singh Task: 03 Nos.**<br>WP-4 : Post Disaster Shelter Planning<br>**PI: Er. S. K. Negi Task: 02 Nos.**<br>WP-5: Health Monitoring of Buildings using Wireless Sensor Network.<br>**PI: Ajay Chourasia & Er. Soju Alexander**<br>**Task: 05 Nos.**<br>WP-6: Intelligent Building System for Model Residential Unit.<br>**PI: Dr. A. K. Mittal & Er. R. S. Bisht Task : 08 Nos.** |
| 3. | 06- Network Projects [CSIR- CBRI is a Participating Laboratory] | Removal of Heavy Metals from Waste Water using Fly ash & Secured Disposal of the Sludge. PI**: Er. S. Maiti [CSIR-NEERI]** ESC 0306<br>Estimation of Crustal Deformation of Garhwal Himalaya. **PI : Dr. S. Sarkar**, **[CSIR-CMMACS, Advance Research in Engineering & Earth Sciences (ARiEES) : Data Intensive Modelling & Crowd Sourcing Approach]** ISC 0301<br>Energy Efficient Seed Storage Structures. **PI: Er. Nagesh B. Balam,** [**CSIR-CSIO, Advanced Instrumentation Solutions for Health Care and Agro – based Applications - ASHA ]** PSC0103<br>Development of Appropriate Support System for Artificial Pillars for Optimal Extraction of Locked-up Coal from Underground Mines. **PI: Er. Ajay Chourasia,** [**CSIR- CIMFR, Dhanbad ]** ESC0105<br>Service Robot for Building and other Structures. PI**: Er. Ravindra S. Bisht, [CSIR-CMER, Micro Machines and Robotics ]** ESC 0112<br>CSIR Knowledge Gateway & Open Source Private Cloud Infrastructure-KNOWGATE. **PI: Dr. S.K. Senapati,** [**CSIR- NISCAIR]** ISC0102 |

# R&D Support Activities

**(Decision Unit 06)**

| S.N. | Activity No. | Activity | Coordinator |
|---|---|---|---|
| 1 | STS 001 | **Knowledge Resource Centre (KRC)**<br>Library Services, Documentation, Books, Publication and Institutional Depository | Dr. B. Singh<br>Sh. S.K. Senapati |
| 2 | STS 002 | **Planning, Monitoring & Evaluation (PME) & ERP Management Services**<br>R&D Projects, RC Agenda (R&D), Project Deployment & APAR, Project Evaluation, Plan Documents, Project, Costing, Accounting & Budgeting, Expert Panel, QPR, RUD & Monthly Reports, Parliament, CSIR HQ & Audit Replies, Information Collection, Compilation and Backward & Forward Linkages and Management of Scientific & Technical Queries<br>Externally Funded Projects, Service Tax & MC Agenda (Externally Funded Projects) | Dr. Sunil K. Sharma<br>Sh. Nadeem Ahmad |
| 3 | STS 003 | **Research Planning & Business Development (RPBD)**<br>Technology Transfer (Licensing, Patents, Etc), Legal Agreements, Trend Assessment Including Feedback, Marketing, Industrial Liaison, etc and Parliament, CSIR HQ & Audit Replies | Dr. Sunil K. Sharma<br>Dr. P.K. Yadav |
| 4 | STS 004 | **Development Construction & Extension (DC&E)**<br>Inland Liaison Including Exhibitions, Displays, Training, Special Functions & Visitors, Development, Technical Guidance/Aid, & Films, Demonstration, Constructions, Feedback, Human Resource Management, Overseas Collaboration & Deputation and Liaison with BIS & others and Photography Services | GL(DC&E)<br>Sh. H.K. Jain |
| 5 | STS 005 | **Extension Centre, Delhi** | Sh. Rajendra Kumar |
| 6 | STS 006 | **Computer Laboratory Group** | Dr. Abha Mittal |
| 7 | STS 007 | **Institute Publications and Public Relation** | Dr. Atul K. Agarwal |
| 8 | STS 008 | **ICT & NKN (IT Support Activities)** | Sh. H.K. Jain<br>Sh. Soju Alexander<br>Sh. Nagesh B. Balam |

# Support Activities

| Administrative Support Activities (Decision Unit 08) | | Coordinator |
|---|---|---|
| **General Administration & House Keeping** | | **Director** |
| 1. | **Director's Secretariat (DTS)** | Director |
| 2. | **Administration** | COA/AO |
| 3. | **Finance & Accounts** | F&AO |
| 4. | **Store & Purchase** | S&PO |
| 5. | **Security** | Security Officer |
| 6. | **Hindi Unit** | Hindi Adhikari |
| 7. | **Medical Services** | Chairman, Medical Committee<br>Dr. M.K. Sinha (MO I/C) |
| 8. | **Divisional Activities** Including Maintenance of Equp. & Photo Copying Machines, etc | Advisor/Group Leader |
| 9. | **Staff Club** | Sec. Staff Club |
| 10. | **Estate (Civil Works)**<br>Civil Works, New Construction, Maintenance & Cleaning & Sanitation<br>Institute Cleaning Services<br>Horticulture Services<br>Water Supply related Services | Dr. S.R. Karade<br>Incharge (Estate)<br><br>Ar. S.K. Negi<br>Dr. Pradeep Kumar-I<br>Dr. Pradeep Kumar-I |
| 11. | **Technical Services Group (TSG)**<br>Air Conditioning, Workshop and Audio System<br>Electrical Services,<br>Maintenance of Vehicles<br>PABX System | <br>Er. D.K. Sehgal<br>Dr. A.K. Mittal<br>Dr. Rajiv Kumar<br>Dr. A.K. Mittal |

# Externally Funded Projects

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 1. | CNP0030 | Health Assessment and Remedial Measures for the Repair of Cooling Towers of NTPC Simhadri | S. R. Karade | National Thermal Power Corporation, Noida |
| 2. | CNP0053 | Assessment of Commutative Impact of Vibration Induced by Mining Activities and the Machines used on Chittorgarh Fort | Y. Pandey | Birla Corporation Ltd., Chittorgarh |
| 3. | CNP0203 | Evaluation of Geotechnical, Geological, Structural and Environmental Aspects of Proposed Slum Rehabilitation Project at Malabar Hills, Mumbai | A. Ghosh | I) M/S Pandya & Poonawala, Advocates & Solicitor, Mumbai; II) M/S Federal & Rashmikant (Rgd), Mumbai |
| 4. | CNP0273 | Evaluation of Cumulative Effect of Mine Blasting on Chittorgarh Fort Structures & its Environment | Y. Pandey | Birla Cement Works, Chittorgarh |
| 5. | CNP0343 | Distress Survey and Repairs / Strengthening of two Buildings of Doon School | A. K. Pandey | The Doon School, Dehradun |
| 6. | CNP0372 | Active Fire Protection Measures for National Institute of Hydrology, Roorkee | R. S. Chimote | National Institute of Hydrology, Roorkee |
| 7. | CNP0381 | Investigation of the Distressed Parts/Components of Parliament House Building and Suggestions for Repair and Rehabilitation | Rajesh Deoliya | CPWD, Parliament House Division, New Delhi |
| 8. | CNP0421 | Rehabilitation of Fire Damaged Collectorate Building at Nainital | Suvir Singh | Public Work Department Nainital |
| 9. | CNP6317 | Third Party Quality Assurance of Civil Construction Work Of Doon University Dehradun at its Kedarpuram Site | A. K. Pandey | Project Manager, UPRNN Ltd., Dehradun |
| 10. | GAP0032 | Performance Enhancement of Cementitious and Polymeric Materials through Nanotechnology | Lok Pratap Singh | Uttarakhand State Council for Science & Technology, Dehradun |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 11. | GAP0062 | Health Monitoring of Buildings using Wireless Sensor Network | A. P. Chourasia | Department of Science & Technology, New Delhi |
| 12. | GAP0072 | Demolition Wastes as Raw Materials for Low Cost Construction Products | A. K. Minocha | Department of Science & Technology, New Delhi |
| 13. | GAP0132 | Development of Technology for Making Flooring and Wall Tiles Using Kota Stone Waste | Rajni Lakhani | Department of Science & Technology, New Delhi |
| 14. | GAP0213 | Fire Center for Advancing Research and Education in Structural Fire Engineering | S. K. Bhattacharyya | Indo-US Science & Technology Forum, New Delhi |
| 15. | GAP0251 | Development of Landslide Prediction Models using Numerical and Statistical Approaches | Shefali Sharma | Department of Science & Technology, New Delhi |
| 16. | GAP0433 | Studies of Nano-Engineered Cementitious and Polymeric Binders in Developing High-Performance Building Materials | L. P. Singh | Department of Science & Technology, New Delhi |
| 17. | GAP0451 | Real Time Surface Movement Instrumentation and its Integration with Existing System (Armol) at Tangni Landslide Site | Y. Pandey | Defence Terrain Research Laboratory (DTRL), DRDO, Delhi |
| 18. | GAP3522 | Capacity Enhancement Programme on Fly Ash Utilisation | Lok Pratap Singh | Environmental Management Capacity Building Technical Assistance Project (EMBCTA Project), Ministry of Environment & Forests, New Delhi |
| 19. | SSP0103 | Toxological and Flame Spread Studies on Coated Cables | Suvir Singh | Stanvac Chemicals (India) Ltd., New Delhi |
| 20. | SSP0133 | Foundation of Oil Exploration Well Sites, Cambay Basin, NTPC Sites | A. Ghosh | NTPC Ltd., Noida |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 21. | SSP0152 | Spalling Behaviour of Tunnel Lining Concrete under High Temperature Loading | Suvir Singh | IRCON International Ltd. , Banihal, J & K |
| 22. | SSP0162 | Investigation at Sun Temple Konark | A. K. Mittal | Archaeological Survey of India, Bhubaneshwar |
| 23. | SSP0173 | Studies & Advice on Safety of Patal Bhubaneshwar Cave, Pithoragarh (Uttrakhand) | Y. Pandey | Archaeological Survey of India, Dehradun |
| 24. | SSP0181 | Design and Construction Monitoring of School Buildings Under Sarva Shiksha Abhiyan | A. K. Mittal | Sarva Shiksha Abhiyan, Dehradun |
| 25. | SSP0182 | Capacity Augmentation of Rmp-4 At Muri Works, Hindalco Muri | A. Ghosh | Hindalco Industries, Renukut |
| 26. | SSP0242 | Energy Simulation of Potato Cold Storage using Different BASF Insulation Products and Recommendation of Measures for Reducing Energy Consumption | B. M. Suman | BASF India Limited, Mumbai |
| 27. | SSP0290 | Physical Structural and Material Study of Qutub Minar | Y. Pandey | Archaeological Survey of India, New Delhi |
| 28. | SSP0302 | Comprehensive Geotechnical and Structural Investigation of Taj Mahal | A. K. Mittal | Archaeological Survey of India, Agra |
| 29. | SSP0333 | Study of Improvement in Rates and Ratios used in the Estimates of Gross Value Added in Construction Sector and Capital Information | Ashok Kumar | Ministry of Statistics & Programme Implementation, New Delhi |
| 30. | SSP0362 | Study on Thermal Behaviour of Twiga Rb Fiber Glass With Increasing Temperature at Six Densities taking as Fix Parameter | B. M. Suman | UP Twiga Fiberglass Limited, New Delhi |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 31. | SSP0382 | Bio Efficiency Studies of Premise Foam Lmidacloprid (0.05%) for Termite Management in Buildings | B. S. Rawat | Bayer Cropscience Ltd., Mumbai |
| 32. | SSP0392 | Fire Extinguishment Studies of Murli Techno Water-Mist Fire Extinguishers | R. S. Chimote | Murli Techno Pvt. Ltd., Thane(W) |
| 33. | SSP0401 | Remaining Service Life and Health Assessment of Stage I, Steel and Concrete Structures | A. K. Pandey | NTPC Limited, Rihand Super Thermal Power Station, Rihand Nagar |
| 34. | SSP0472 | Bio-Efficacy Studies on Sentricon Termite Colony Elimination System for Termite Management in Buildings | B. S. Rawat | Dow Agroscience India Pvt. Ltd., Mumbai |
| 35. | SSP0491 | Technical Advice on ongoing Rehabilitation and Strengthening Work of Janak Setu Flyover, New Delhi | S. K. Singh | Municipal Corporation of India, New Delhi |
| 36. | SSP0510 | Post Fire Investigation of Fire Damaged Area of Collectorate Building and Remedial Measures | Suvir Singh | Public Works Department, Nainital |
| 37. | SSP0939 | Comprehensive Study for Rehabilitation of People affected by Max Pond Level of 1108m Joshiyara Barrage, Uttarkashi | A. K. Sharma-I | Pala Maneri Project, Uttarakhand Jal Vidyut Nigam Limited, Uttarkashi |
| 38. | TST0013 | Impact & Reaction to Fire Characteristic Studies of Puf Panels | A. A. Ansari | Synergy Thrislington, Mohali |
| 39. | TST0023 | Fire Performance Assessment of Fire Door | Suvir Singh | Vijay System Engineers Pvt. Ltd., Mumbai |
| 40. | TST0033 | Fire Performance Assessment of Cable Fire Barrier | Suvir Singh | Hilti India Pvt Ltd., New Delhi |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 41. | TST0043 | Preparation and Testing of Extractor Concrete Cores for Compressive Strength (14nos.) | Bhupal Singh | HNBGU, Srinagar, Garhwal |
| 42. | TST0063 | Evaluation of SFMC Brand PPR Pipes & Fittings for Potable Water Supply | B. Singh | Savoir-Faire Manufacturing Co. Ltd., Delhi |
| 43. | TST0073 | Fire Performance Assessment of Fire Door | Suvir Singh | Consolidated Construction Consortium, CMRL, Chennai |
| 44. | TST0082 | Fire Performance Assessment of Steel Fire Door | Suvir Singh | Ahura Mazda Mfg Co. Pvt. Ltd., Mumbai |
| 45. | TST0083 | Thermal Behaviour of Expanded Perlite Powder with Varying Density at Freezing Point | B. M. Suman | Keltech Energies Limited, Vishwasnagar, Karnataka |
| 46. | TST0092 | Fire Performance Assessment of Fire Door | Suvir Singh | M/S Delhi Estate Industrial & Infr. Development Corporation Ltd., Delhi |
| 47. | TST0093 | Fire Performance Assessment of Fire Door | Suvir Singh | Greenply Industries Ltd., New Delhi |
| 48. | TST0102 | Fire Performance Assessment of Fire Door | Suvir Singh | Futura Door Products Pvt. Ltd., Pimpri,Pune |
| 49. | TST0112 | Fire Performance Assessment of Fire Door | Suvir Singh | Air Master Equipment India(P) Ltd., Bangalore |
| 50. | TST0113 | Fire Performance Assessment of Fire Rated Door | Suvir Singh | Kutty Flush Doors And Furniture Co. Pvt. Ltd., Chennai |
| 51. | TST0122 | Fire Performance Assessment of Fire Doors | Suvir Singh | Airport Authority of India, Kolkata |
| 52. | TST0123 | Fire Performance Assessment of Fire Door | Suvir Singh | Vishnu Door Industries Ltd., New Delhi |
| 53. | TST0142 | Fire Performance Assessment of Motorised Rolling Shutter | Suvir Singh | Avions Innovations Tec. Pt. Ltd., Pune |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 54. | TST0143 | Fire Performance Assessment of Fsc Fire Retardant Coating for Cable | Suvir Singh | Ekta Power & Insulation Services, New Delhi |
| 55. | TST0153 | Fire Performance Assessment of Fire Door | Suvir Singh | Shakti Met-Dor Limited, Secunderabad |
| 56. | TST0163 | Fire Performance Assessment of Fire Door | Suvir Singh | Airport Authority of India, Coimbatore |
| 57. | TST0183 | Fire Performance Assessment of Fire Damper | Suvir Singh | Air Master Equipment India (P) Ltd., Bangalore |
| 58. | TST0192 | Fire Performance Assessment of Firex EC 43 Ablative Coated Cable | Suvir Singh | Stanvac Chemicals(I) Ltd., New Delhi |
| 59. | TST0193 | Fire Performance Assessment of Shreeji Fire Retardant Door | Suvir Singh | Shreeji Wood Craft Pvt. Ltd., Mumbai |
| 60. | TST0202 | Fire Performance Assessment of M.S. Fire Door | Suvir Singh | Decora Point Pvt. Ltd., Ahmedabad |
| 61. | TST0212 | Fire Performance Assessment of Fire Door | Suvir Singh | Randiant Safedoors Pvt. Ltd., Ahmedabad |
| 62. | TST0222 | Fire Performance Assessment of Elevator Door | Suvir Singh | Kone Elevators India Pvt. Ltd., Chennai |
| 63. | TST0223 | Reaction to Fire Characteristic Studies on FRP Pultrded Panel | A. A. Ansari | Agni Fiber Board Pvt. Ltd., Vadodara |
| 64. | TST0232 | Fire Performance Assessment of S.S. Fire Door | Suvir Singh | Radiant Safedoors Pvt. Ltd., Ahmedabad |
| 65. | TST0233 | Determination of Limiting Oxygen Index & Smoke Index of MFMB | A. A. Ansari | UP Twiga Fiberglass Ltd., New Delhi |
| 66. | TST0243 | Fire Performance Assessment of Fire Door and Partition | Suvir Singh | CPWD, Mandi (HP) |
| 67. | TST0252 | Fire Performance Assessment of Penetration Seal System | Suvir Singh | Vijay System Engineers Pvt. Ltd., Mumbai |
| 68. | TST0253 | Fire Performance Assessment of Steel Glazed Fire Door | Suvir Singh | Navair International Ltd., New Delhi |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 69. | TST0262 | Fire Performance Assessment of Fire Door | Suvir Singh | Signature Interiors Pvt. Ltd., Secunderabad |
| 70. | TST0263 | Determination of Fire Propagation Index & Surface Spread of Flame for Flexyemang Access Floor | A. A. Ansari | Yemag Network Equipment, Bangalore |
| 71. | TST0282 | Fire Performance Assessment of Fire Door | Suvir Singh | Swadeshi Civil Infrastructure Pvt. Ltd., New Delhi |
| 72. | TST0283 | Fire Performance Assessment of Steel Fire Rated Doors | Suvir Singh | Navair International Ltd., New Delhi |
| 73. | TST0293 | Fire Performance Assessment of Wooden Fire Door | Suvir Singh | R K Inovattive Doors, Pune |
| 74. | TST0303 | Fire Performance Assessment of Fire Door | Suvir Singh | GWS Engineers & Fabricators Pvt. Ltd., Navi Mumbai |
| 75. | TST0312 | Fire Performance Assessment of Fire Door | Suvir Singh | Ahura Mazda Mfg. Co. Pvt. Ltd., Mumbai |
| 76. | TST0313 | Fire Performance Assessment of Fire Door | Suvir Singh | Mitsubishi Elevator Eta India Pvt. Ltd., Chennai |
| 77. | TST0322 | Fire Performance Assessment of Fire Rated Doors | Suvir Singh | Kutty Flush Doors and Furniture Co. Pvt. Ltd., Chennai |
| 78. | TST0323 | Determination of Fire Propagation Index of FRP Pulterded Panel | A. A. Ansari | Agni Fiber Board Pvt. Ltd., Vadodara |
| 79. | TST0332 | Fire Performance Assessment of Wooden Fire Door | Suvir Singh | Kindle Fire Protection, New Delhi |
| 80. | TST0342 | Fire Performance Assessment of Fire Door | Suvir Singh | Synergythrislington, Vill. Bedplasi, Tehsil-Nalagarh, Distt. Solan, H.P. |
| 81. | TST0352 | Fire Performance Assessment of Fire Dampers | Suvir Singh | Ruskin Titus India Pvt. Ltd. |
| 82. | TST0353 | Reaction to Fire Characteristic Studies on Flameshield | A. A. Ansari | Berger Paints (I) Ltd., Kolkata |

| S.No. | Project No. | Project Title | PI | Sponsoring Agency |
|---|---|---|---|---|
| 83. | TST0363 | Fire Performance Assessment of Filing Cabinet | Suvir Singh | Super Steel Industries, New Delhi |
| 84. | TST0373 | Fire Performance Assessment of Elevator Door | Suvir Singh | Omega Elevators, Ahmedabad |
| 85. | TST0383 | Fire Performance Assessment of Fire Retardant Cable Coating | Suvir Singh | CTR Manufacturing Industries Ltd., Aurangabad |
| 86. | TST0393 | Fire Performance Assessment of Fire Door | Suvir Singh | Galaxy Fire Protection Co., New Delhi |
| 87. | TST0402 | Fire Performance Assessment of Elevator Door | Suvir Singh | Kone Elevators India Pvt. Ltd., Chennai |
| 88. | TST0403 | Fire Performance Assessment of Fire Door | Suvir Singh | IIT Hyderabad |
| 89. | TST0412 | Fire Performance Assessment of Protected Steel Sections | Suvir Singh | Carboline(I) Pvt. Ltd., Navi Mumbai |
| 90. | TST0413 | Fire Performance Assessment of Fire Rated Steel Door | Suvir Singh | ONGC Ltd., New Delhi |
| 91. | TST0423 | Fire Performance Assessment of Fire Rated Glass Door | Suvir Singh | ONGC Ltd., New Delhi |
| 92. | TST0432 | Performance Evaluation of IPNet System to be used in PSC Girders across Godavari Bridge at Vijaywada-Vishakhapatnam Section, Andhra Pradesh by South-Central Railway, Rajahmundry | P. C. Thapliyal | Kotson Engineering Corporation, Tenali |
| 93. | TST0443 | Fire Performance Assessment of Landing Door | Suvir Singh | Fujitec India Pvt. Ltd., Chengalpattu, Kancheepuram Dist. |
| 94. | TST0453 | Fire Performance Assessment of Elevator Landing Door | Suvir Singh | Kone Elevator India Pvt. Ltd., Chennai |
| 95. | TST0462 | Performance Evaluation of IPNET Paints to be used in Shornur - Mangalore Section Construction between Elathur and Quilandi Stations | P. C. Thapliyal | Southern Railway, Calicut |

# COLLOQUIUM

| | |
|---|---|
| **3rd April 2013,** Recycling of domestic waste water | Mr. Soumitra Maiti |
| **10th April 2013,** Nano clay in building application | Mr. Subham Dastidarr |
| **10th April 2013**, Introduction of ERP application | Mr. Soju Joseph Alexandar |
| **17th April 2013**, DEBRIS–Flow hazard analysis | Ms. Shaifaly Sharma |
| **29th April 2013**, A waste management- oriented life cycle perspective of sustainable Building materials selections | Dr. Brijesh Dubey (University of Guelph, Canada) |
| **22nd May 2013,** Available E-resources in CSIR-CBRI | Dr. S. K. Senapati |
| **12th June 2013**, High Strength light weight pre stressed concrete | Mr. Mickey –Mecon Dalbehera |
| **19th June 2013**, Ground Engineering using geo synthetics | Mrs. Parvathi G. S. |
| **07th August 2013** , Aspects of Autonomous Business Unit | Dr. B. K. Rao |
| **14th August 2013 ,** R&D achievements on Organic Building Materials | Dr. Rajni Lakhani |
| **18th September 2013 ,** An overview of vibration-based damage identification methodologies | Mr. Randhir Choudhary |
| **26th September 2013**, ENERGY: Yesterday, today and??? | Dr. S. J. Chopra (University of Petroleum & Energy Studies) |
| **9th October 2013**, Characterization of Water Spray for Fire Suppression | Mr. Sudhir Sharma |
| **27th November 2013**, Contract R&D Projects | Mr. Vineet Kumar Saini |
| **1st January 2014,** Effect of Fire on Structures – Research Issues | Prof. S. K. Bhattacharyya, Director, CSIR-CBRI, Roorkee |
| **8th January 2014,** Current Requirements in Environmental Impact, Assessment Process and Procedures (As per MoEF Guideline) | Mr. Syed Ibrahim Sohel & Mr. Soumitra Maiti |
| **13th January 2014,** Micro/ Nano- Mechanical Characterization of Materials | Dr. Wenzhong Zhu (University of West Scotland) |
| **15th January 2014,** It's A Tough Job, but someone has to do it .... Aspect of Heritage Science Research | Dr. John J. Hughes (University of West Scotland) |
| **22nd January 2014,** Design of Piles in Liquefying Soil | Mr. Piyush Mohanty |
| **10th February 2014,** Foundation Day Lecture | Mr. Ajay Choudhary |
| **28th February 2014,** Science Day Lecture Elastic Wave Propagation in Transverly Impacted Beam | Prof. D. Goldar |
| **05th March 2014,** KNOWGATE Project and CSIR-Central | Dr. S. K. Senapati |
| **26th March 2014,** Wind Forces on Inclined Solar Panels in Flat Roof | Mr. Siddharath Behera |

# CBRI Family as on 31 March 2014

## Group-IV-Scientific Staff

| Sl.No. | Name | Designation |
|---|---|---|
| 1. | Prof. S.K. Bhattacharyya | Director |
| 2. | Sh. A. Ghosh | Chief Scientist |
| 3. | Dr. Sunil K. Sharma | Chief Scientist |
| 4. | Sh. R.K. Garg | Chief Scientist |
| 5. | Sh. Y. Pandey | Chief Scientist |
| 6. | Dr. A.K. Minocha | Chief Scientist |
| 7. | Dr. Brijeshwar Singh | Chief Scientist |
| 8. | Sh. R.S. Chimote | Chief Scientist |
| 9. | Dr. Manju Mittal | Sr. Principal Scientist |
| 10. | Dr. (Ms.) Abha Mittal | Sr. Principal Scientist |
| 11. | Dr. Suvir Singh | Sr. Principal Scientist |
| 12. | Dr. N.K. Saxena | Sr. Principal Scientist |
| 13. | Smt. Neeta S. Mittal | Sr. Principal Scientist |
| 14. | Sh. Ashok Kumar | Sr. Principal Scientist |
| 15. | Sh. S.K. Negi | Sr. Principal Scientist |
| 16. | Dr. Shantanu Sarkar | Sr. Principal Scientist |
| 17. | Dr. (Ms.) Mridul Garg | Sr. Principal Scientist |
| 18. | Dr. Harpal singh | Sr. Principal Scientist |
| 19. | Dr. Atul Kumar Agarwal | Sr. Principal Scientist |
| 20. | Dr. Pardeep Kumar-I | Sr. Principal Scientist |
| 21. | Sh. A. A. Ansari | Sr. Principal Scientist |
| 22. | Dr. R. Dharma Raju | Principal Scientist* |
| | *On deputation in Disaster Management Centre, Mysore w.e.f. 09.4.2008 | |
| 23. | Sh. A.K. Sharma-I | Principal Scientist |
| 24. | Dr. Rajni Lakhani | Principal Scientist |
| 25. | Dr. D.P. Kanungo | Principal Scientist |
| 26. | Dr. Achal Kumar Mittal | Principal Scientist |
| 27. | Dr. S.R. Karade | Principal Scientist |
| 28. | Sh. Nadeem Ahmed | Principal Scientist |
| 29. | Dr. Sujit Kumar Saran | Principal Scientist |
| 30. | Dr. Rajesh Deoliya | Principal Scientist |

| Sl.No. | Name | Designation |
|---|---|---|
| 31. | Dr. Navjeev Saxena | Principal Scientist |
| 32. | Sh. A.P. Chourasia | Principal Scientist |
| 33. | Sh. S.K. Singh | Principal Scientist |
| 34. | Dr. P.C. Thapliyal | Principal Scientist |
| 35. | Dr. B.S. Rawat | Principal Scientist |
| 36. | Sh. Shorab Jain | Principal Scientist |
| 37. | Dr. S.K. Panigrahi | Principal Scientist |
| 38. | Dr. Pradeep Kumar II | Sr. Scientist |
| 39. | Dr. Rajesh K. Verma | Sr. Scientist |
| 40 | Sh. H.C. Arora | Sr. Scientist |
| 41. | Dr. P.K.S. Chauhan | Sr. Scientist |
| 42. | Dr. Leena Chaurasia | Sr. Scientist |
| 43. | Dr. L.P. Singh | Sr. Scientist |
| 44. | Dr. Neeraj Jain | Sr. Scientist |
| 45. | Sh. Vineet Kumar Saini | Scientist |
| 46. | Sh. Syed Ibrahim Sohel | Scientist |
| 47. | Sh. Ravindra Singh Bisht | Scientist |
| 48. | Sh.Nagesh Babu Balam | Scientist |
| 49. | Sh. Manojit Samanta | Scientist |
| 50. | Sh.Soju Joseph Alexander | Scientist |
| 51. | Sh. Soumitra Maiti | Scientist |
| 52. | Sh. Srinivasa Rao Naik B | Scientist |
| 53. | Sh. Subash Chandra Bose Gurram | Scientist |
| 54. | Dr. A. Aravind Kumar | Scientist |
| 55. | Ms. Parvathi G.S. | Scientist |
| 56. | Sh. Anindya Pain | Scientist |
| 57. | Sh. Micky Mecon Dalbehera | Scientist |
| 58. | Sh. Piyush Mohanty | Scientist |
| 59. | Sh. Siddharth Behera | Scientist |

## Group III Technical Staff

| | | |
|---|---|---|
| 60. | Dr. Rajiv Kumar | Principal T.O. |
| 61. | Sh. H.K. Jain | Principal T.O. |
| 62. | Sh. Ramesh Chandra | Principal T.O. |
| 63. | Sh. D.K. Sehgal | Principal T.O. |
| 64. | Sh. Sudhir Sharma | Principal T.O. |
| 65. | Sh. Narendra Kumar | Principal T.O. |
| 66. | Dr. B.M.Suman | Principal T.O. |
| 67. | Sh. Rajesh Kumar | Principal T.O. |

| Sl.No. | Name | Designation |
|---|---|---|
| 68. | Sh. Prakash Chand | Sr.T.O. (3) |
| 69. | Sh. Rajeev | Sr.T.O. (3) |
| 70. | Sh. Jaswinder Singh | Sr.T.O. (3) |
| 71. | Dr. P.K. Yadav | Sr.T.O. (3) |
| 72. | Sh. Bhupal Singh | Sr.T.O. (3) |
| 73. | Dr. S.K. Senapati | Sr. T.O. (3) |
| 74. | Sh. Dalip Kumar | Sr.T.O. (3) |
| 75. | Sh. Rajeev Kumar Sharma | Sr.T.O. (2) |
| 76. | Dr. M.K. Sinha | Sr.T.O. (2) |
| 77. | Sh. Sushil Kumar | Sr. T.O. (2) |
| 78. | Sh. Zamir Ahmad | Sr. T.O. (2) |
| 79. | Sh. A.K. Jain | Sr. T.O.(1) |
| 80. | Sh. Rakesh Kumar –II | Sr. T.O.(1) |
| 81. | Sh. Vivek Sood | Sr. T.O.(1) |
| 82. | Sh. Jalaj Prashar | Sr. T.O.(1) |
| 83. | Sh. Naresh Kumar | Sr. T.O.(1) |
| 84. | Sh.Ram Ashray Rai | Sr. T.O.(1) |
| 85. | Sh. Bharat Bhushan | Sr. T.O.(1) |
| 86. | Sh. Rajesh R. Ghadse | T.O. |
| 87. | Sh. B.K. Kalra | T.O. |
| 88. | Sh. Itrat Amin Siddiqui | T.O. |
| 89. | Sh. Amit Kush | T.O. |
| 90. | Mrs. Deepti Karmakar | T.O. |
| 91. | Sh. Ajay Dwivedi | T.O. |
| 92. | Mrs. Gayatri Devi | T.O. |
| 93. | Sh. Sameer | T.O. |
| 94. | Sh. D.S. Dharamshaktu | T.A. |

## Group II

| | | |
|---|---|---|
| 95. | Sh.Shiv Dass | Sr. Tech. (2) |
| 96. | Sh Rizwanul Hasan | Sr. Tech. (2) |
| 97. | Sh Rajinder Kumar | Sr. Tech. (2) |
| 98. | Sh Govind Singh | Sr. Tech. (2) |
| 99. | Sh Gopal Chand | Sr. Tech. (2) |
| 100. | Sh Har Sagar Sharma | Sr. Tech. (2) |
| 101. | Sh P.K. Yadav | Sr. Tech. (2) |
| 102. | Smt.Neelam Gupta | Sr. Tech. (2) |
| 103. | Sh Prem Singh | Sr. Tech. (2) |
| 104. | Smt Sangeeta Sharma | Sr. Tech. (2) |

| Sl.No. | Name | Designation |
|---|---|---|
| 105. | Sh Sheeraj Ahmad | Sr. Tech. (2) |
| 106. | Smt. Saroj Rani | Sr. Tech. (2) |
| 107. | Sh Anil Kumar Sharma | Sr. Tech. (2) |
| 108. | Sh Manmeet Singh | Sr. Tech. (1) |
| 109. | Smt. Urmila Kotnala | Sr. Tech. (1) |
| 110. | Sh Rishi Pal Singh | Sr. Tech. (1) |
| 111. | Sh Sushil Kumar | Sr. Tech. (1) |
| 112. | Sh Himanshu Sharma | Sr. Tech. (1) |
| 113. | Sh Amar Singh | Sr. Tech. (1) |
| 114. | Sh Shiv Prakash Tyagi | Sr. Tech. (1) |
| 115. | Sh B.S. Bisht | Sr. Tech. (1) |
| 116. | Sh Rajeev Bansal | Sr. Tech. (1) |
| 117. | Sh Pradeep Kr. Kapooria | Sr. Tech. (1) |
| 118. | Sh Arvind Saini | Sr. Tech. (1) |
| 119. | Sh Ashwani Kumar Mishra | Sr. Tech. (1) |
| 120. | Sh Harish Kumar | Sr. Tech. (1) |
| 121. | Sh Sukhbir Sharma | Sr. Tech. (1) |
| 122. | Sh Arvind Kumar | Tech. (2) |
| 123. | Sh Kedar Nath | Tech. (2) |
| 124. | Sh Santosh Kumar Mishra | Tech. (2) |
| 125. | Sh Sharad Kumar | Tech. (2) |
| 126. | Sh Mam Chand Agarwal | Tech. (2) |
| 127. | Sh Arvind Kumar Sharma | Tech.(2) |
| 128. | Sh Tahir Husain | Tech. (2) |
| 129. | Sh Ghanshyam Mittal | Tech. (2) |
| 130. | Sh Francis Charles | Tech. (2) |
| 131. | Sh Iqubal Ahmed | Tech. (2) |
| 132. | Sh Manoj Kumar Tyagi | Tech. (2) |
| 133. | Sh Jai Pal | Tech. (2) |
| 134. | Sh Shorab Khan | Tech. (2) |
| 135. | Sh Jameel Hasan | Tech. (2) |
| 136. | Sh U.C. Bhatnagar | Tech. (2) |

## Group I Supporting Staff

| | | |
|---|---|---|
| 137. | Sh Harpal Singh | Lab. Asstt. |
| 138. | Sh D.P. Yadav | Lab. Asstt. |
| 139. | Sh Yakub Ali | Lab. Asstt. |
| 140. | Sh Amar Singh (SE) | Lab. Asstt. |
| 141. | Sh Deepak Singh | Lab. Asstt. |

| Sl.No. | Name | Designation |
|---|---|---|
| 142. | Sh Vijay Kumar (SE) | Lab. Asstt. |
| 143. | Sh Shyam Lal (SE) | Lab. Asstt. |
| 144. | Sh Gurucharan Singh | Lab. Asstt. |
| 145. | Sh Rajeshwar | Lab. Asstt. |
| 146. | Sh Rishi Pal (SE) | Lab. Asstt. |
| 147. | Sh Vijay Kumar | Lab. Asstt. |
| 148. | Sh Vishwas Kumar | Lab. Asstt. |
| 149. | Sh Jagdish Pal | Lab. Asstt. |
| 150. | Sh Deepak Kumar | Lab. Asstt. |
| 151. | Sh Hira Lal | Lab. Asstt. |
| 152. | Sh Subhash Chand | Lab. Asstt. |
| 153. | Sh Shiv Kumar (SE) | Lab. Asstt. |
| 154. | Sh Rajesh Kumar | Lab. Attd.(2) |

## Administrative Staff / House-Keeping

| | | |
|---|---|---|
| 155. | Sh Anil Kumar | A.O. |
| 156 . | Sh Parag Saxena | A.O. |
| 157. | Sh R. K. Manjhiwal | F&AO |
| 158. | Sh S.P.Singh | S&PO |
| 159. | Sh R.C. Saxena | Sr. H.O. |
| 160. | Sh Sukhvir Singh | S.O. (S&P) |
| 161. | Sh Babu Ram | S.O. (F&A) |
| 162. | Sh J.K. Chaurasia | S.O. (F&A) |
| 163. | Sh Dheeraj | S.O. (F&A) |
| 164. | Sh Alok Sharma | S.O. (G) |
| 165. | Sh S.K. Jakhwal | S.O. (G) |
| 166. | Ms. Rashmi Devi | S.O. (G) |
| 167. | Sh S.P. Kapil | P.S. |
| 168. | Sh K. Arora | P.S. |
| 169. | Sh V.P.S. Rawat | Security Officer |
| 170. | Sh Satya Pal | Sr.Seno |
| 171. | Sh Naresh Yadav | Sr.Steno |
| 172. | Sh Rajinder Kumar | Sr.Steno |
| 173. | Smt. Archana | Sr.Steno |
| 174. | Sh Arvind Kumar | Sr.Steno |
| 175. | Sh Dalpat Singh | Sr.Steno |
| 176. | Sh Dharam Singh Negi | Sr.Steno |
| 177. | Sh V.K. Sharma | Asstt. (G) Gr.I |
| 178. | Sh Constan Kujur | Asstt. (G) Gr.I |

| Sl.No. | Name | Designation |
|---|---|---|
| 179. | Smt. Nisha Tyagi | Asstt. (G) GR.I |
| 180. | Smt. Sarita Khanna | Asstt. (G) GR.I |
| 181. | Smt. Sheema Farhat | Asstt. (G) GR.I |
| 182. | Sh. R.K. Johar | Asstt. (G) GR.I |
| 183. | Sh. Sudhir Kumar | Asstt. (G) GR.I |
| 184. | Sh. Yogesh Kumar | Asstt. (G) GR.I |
| 185. | Sh. Shiv Kumar | Asstt. (G) GR.I |
| 186. | Smt. Sunita | Asstt. (G) GR.I |
| 187. | Sh. Pawan Kumar | Asstt. (G) GR.I |
| 188. | Smt. Mamta Sharma | Asstt. (G) GR.I |
| 189. | Sh. Dharam Pal Singh | Asstt. (G) GR.I |
| 190. | Sh. Virendra Singh | Asstt. (F&A) GR.I |
| 191. | Sh. Aman Kumar | Asstt. (F&A) GR.I |
| 192. | Sh. Vipin Kumar Sharma | Asstt. (F&A) GR.I |
| 193 | Sh. Suraj Pal Singh | Asstt. (F&A) GR.I |
| 194. | Sh. Satyarth Prakash | Asstt. (F&A) GR.I |
| 195. | Smt. Rubina Zaidi | Asstt. (F&A) GR.I |
| 196. | Sh. Sanjeev Bansal | Asstt. (S&P) GR-I |
| 197. | Smt. Anju Rani Simon | Asstt. (S&P) GR.I |
| 198. | Sh. Arpan Maheshwari | Asstt. (S&P) GR.I |
| 199. | Sh. Kalam Singh Chauhan | Asstt. (S&P) GR.I |
| 200. | Sh. Vishwash Tyagi | Asstt. (S&P) GR.I |
| 201. | Sh. Mehar Singh | Hindi Officer |
| 202. | Sh. Suba Singh | Hindi Officer |

## Group C

| | | |
|---|---|---|
| 203. | Smt. Arun Lata | Asstt.(G) GR.II |
| 204. | Sh Sushil Kumar | Asstt.(G) GR.II |
| 205. | Sh Sanjay Kr. Tyagi | Asstt.(G) GR.II |
| 206. | Smt. Seema Ahuja | Asstt.(G) GR.II |
| 207. | Sh Ravinder Kumar | Asstt.(G) GR.II |
| 208. | Sh Vijay Kumar-II | Driver (NT) |
| 209. | Sh Rajendra Singh | Sr. Tech. (1) |
| 210. | Sh Radhey Shyam | Sr. Tech. (1) |
| 211. | Sh Sushil Kumar | Sr. Tech. (1) |
| 212. | Sh M. Ramakrishna | Driver (NT) |
| 213 | Sh. Satya Pal | MTS |
| 214. | Sh.Naresh | MTS |
| 215. | Sh.Sant Ram | MTS |

| Sl.No. | Name | Designation |
|---|---|---|
| 216 | Sh.Ram Samajh | MTS |
| 217. | Sh.Raj Kumar | MTS |
| 218 . | Sh.Lakshmi Chand | MTS |
| 219. | Sh.Kailash Chand | MTS |
| 220. | Smt.Usha | MTS |
| 221. | Sh.Mukesh Kumar | MTS |
| 222. | Smt.Kusum Lata | MTS |
| 223. | Smt. Bala | MTS |
| 224. | Sh.Subhash Chand | MTS |
| 225. | Sh.Inder Pal (ACP) | MTS |
| 226. | Sh.Desh Raj | MTS |
| 227. | Sh.Rakesh Kumar | MTS |
| 228. | Sh.Ramesh Kumar | MTS |
| 229. | Sh.Santosh Kumar | MTS |
| 230. | Sh.Rakesh Kumar | MTS |
| 231. | Sh.Krishna Gopal Thakur | MTS |
| 232. | Sh Mani Ram | MTS |
| 233. | Sh.Rohitash Kumar | MTS |
| 234. | Sh.Radhey Shyam | MTS |
| 235. | Sh.Ranbeer Singh | MTS |
| 236. | Sh.Devendra Kumar | MTS |
| 237. | Smt. Prakash Kaur | MTS |
| 238. | Smt. Anju | MTS |
| 239. | Sh.Khalil Ahmad | MTS |
| 240. | Sh.Subhan Singh | MTS |
| 241. | Sh.Anit Kumar Pal | MTS |
| 242. | Sh.Pritam Giri | MTS |
| 243. | Sh.Pooran Vassi | MTS |
| 244. | Sh.Kirat Pal | MTS |
| 245. | Sh.Kiran Pal | MTS |
| 246 | Sh.Rajesh Kr. Yadav | MTS |
| 247. | Sh.Jai Prakash | MTS |
| 248. | Sh.Ranjeet Singh | MTS |
| 249. | Sh.Satya Pal | MTS |
| 250. | Sh.Satya Pal Singh | MTS |
| 251. | Sh. Satish Kumar | MTS |
| 252. | Sh.Mehraj Deen Khan | MTS |
| 253. | Sh.Dharam Pal | MTS |
| 254. | Sh.Sunil Kumar | MTS |

| Sl.No. | Name | Designation |
|---|---|---|
| 255. | Sh. Dharam Singh | MTS |
| 256. | Sh.Rakesh | Tea Maker (ACP-I) |
| 257. | Sh.Arun Kumar | Bearer ACP-II |
| 258. | Sh.Ravinder Kumar | Bearer-ACP |
| 259. | Sh.Dil Bahadur | Bearer-ACP |
| 260. | Sh.Rajinder Pal | Bearer-ACP |
| 261. | Sh.Malkhan Singh | Wash Boy / Bearer |
| 262. | Sh.Dheer Singh | Wash Boy-ACP |

## Superannuation

**Following Staff members superannuated from CSIR-CBRI family during the year**

| | | |
|---|---|---|
| Dr. Pradeep Kumar Bhargava | Chief Scientist | 31.05.2013 |
| Sh. Jaipal Singh | Technician | 31.05.2013 |
| Sh. S.K. Jain | Principal Scientist | 30.06.2013 |
| Sh. Sita Ram | Technician | 30.06.2013 |
| Sh. S.K. Gupta | Ex. Engineer | 30.06.2013 |
| Sh. Baljeet Singh | Counter Clerk ACP -II | 31.07.2013 |
| Sh. Rajender Kumar | Principal Scientist | 31.10.2013 |
| Sh. R.P. Gupta | Sr. Tech. (2) | 30.11.2013 |
| Smt. Saroj Sethi | Assistant (Gen.) | 30.11.2013 |
| Sh. B.K. Sharma | Security Officer | 30.11.2013 |
| Dr. S.P. Agarwal | Chief Scientist | 30.11.2013 |
| Dr. (Smt.) Manorama Gupta | Sr. Principal Scientist | 31.12.2013 |
| Dr. B. Kameshwara Rao | Chief Scientist | 31.12.2013 |
| Sh. Nanak Chand | Safaiwala | 31.01.2014 |
| Sh. Virender Singh | Sr. Tech. | 28.02.2014 |
| Sh. Bishan Lal | Sr. Tech. | 28.02.2014 |

## Transfer

| | | |
|---|---|---|
| Sh. R. K. Manjhiwal<br>(CSIR Hqrs., New Delhi to CSIR-CBRI, Roorkee) | F. &.A.O. | 18.04.2013 |
| Sh. Parag Saxena<br>(CSIR-IMTECH, Chandigarh to CSIR-CBRI, Roorkee) | A.O. | 03.06.2013 |
| Sh. Amarjeet<br>(CSIR-CBRI, Roorkee to CSIR-IHBT, Palampur) | S.O. | 31.05.2013 |
| Sh. Sukhvir Singh<br>(CSIR-HRDC, Ghaziabad to CSIR-CBRI, Roorkee) | Section Officer (S&P ) | 21.11.2013 |

| | | |
|---|---|---|
| Sh. Salaudin Ansari<br>(CSIR-CBRI, Roorkee to CSIR-IMMT, Bhubaneswar) | Section Officer (S&P) | 23.12.2013 |
| Smt. Padma Kumary<br>(CSIR-CBRI, Roorkee to CSIR-IIP, Dehradun) | Sr. Stenographer | 23.12.2013 |

## Promotion

| | | |
|---|---|---|
| Dr B. Singh | Chief Scientist | 04.01.2012 |
| Sh. R. S. Chimote | Chief Scientist | 01.01.2013 |
| Sh. Narender Kumar | Principal Technical Officer | 24.05.2011 |
| Dr. B.M. Suman | Principal Technical Officer | 05.10.2011 |
| Sh. Rajesh Kumar | Principal Technical Officer | 11.11.2011 |
| Sh. Ajay Dwivedi | Technical Officer Gr.III (3) | 21.07.2010 |
| Smt. Gayatri Devi | Technical Officer Gr.III (3) | 08.09.2010 |
| Sh. Sameer | Technical Officer Gr.III (3) | 01.06.2011 |
| Sh. Anil Kumar Sharma | Sr. Technician 2 | 18.06.2011 |
| Sh. Rajeev Bansal | Sr. Technician 1 | 24.09.2011 |
| Sh. Shiv Prakash Tyagi | Sr. Technician 1 | 24.09.2011 |
| Sh. B.S. Bisht | Sr. Technician 1 | 24.09.2011 |
| Sh. Pradeep Kr. Kapooria | Sr. Technician 1 | 17.10.2011 |
| Sh. Arvind Saini | Sr. Technician 1 | 29.10.2011 |
| Sh. Ashwini Kr. Mishra | Sr. Technician 1 | 29.12.2011 |
| Sh. Harish Kumar | Sr. Technician 1 | 29.12.2011 |
| Sh. Sukhbeer Sharma | Sr. Technician 1 | 29.12.2011 |
| Sh. D.K.Chopra ( Retd.) | Sr. Technician 1 | 24.09.2011 |
| Dr Pradeep Kumar | Sr Principal Scientist | 26.06.2011 |
| Sh. A A Ansari | Sr Principal Scientist | 01.01.2013 |
| Sh. Shorab Jain | Principal Scientist | 24.09.2012 |
| Dr S K Panigrahi | Principal Scientist | 28.09.2012 |
| Sh. Mehar Singh | Hindi Officer | 20.03.2012 |
| Sh. Suba Singh | Hindi Officer | 03.09.2012 |
| Sh. Dhram Pal Singh | Astt. Gen. Gr. I | 19.02.2014 |

## Resignation

| | | |
|---|---|---|
| Sh. Subham Dastidar | Scientist | 04.09.2013 |
| Ms Tarannum Miraj | Scientist | 31.10.2013 |
| Dr. Shailesh Kr. Agarwal | Sr. Principal Scientist | 16.01.2011 |
| Sh. Randhir Kr. Choudhary | Scientist | 09.12.2013 |

## Obituary

| | | |
|---|---|---|
| Sh. Kripal Singh | Electrician | 19.07. 2013 |
| Sh. Abhay Dass | Lab.Astt. | 11.02.2014 |
| Sh. Rajender Kumar Arya | Lab.Astt. | 19.02.2014 |
| Dr. A.K. Pandey | Sr.Principal Scientist | 28.03.2014 |

# Research Publications

## International Journal

1. Ashok Kumar, P.S. Chani & Rajesh Deoliya, Green Retrofit Potential in Existing Research Laboratories and Demonstration of Energy Efficient and Sustainable Technologies: Case Study, International Journal of Science, Engineering and Technology Research, Volume 3, Issue 3, March 2014, 400-405.
2. Ashwani Kumar Minocha & M. K. Goyal, Effect of Immobilization of Cadmium Ions on the Hydration of Ordinary Portland Cement, Chemical Engineering & Process Technology 4(7), 2013(ISSN:2157-7048.1000170).
3. Ashwani Kumar Minocha & M.K. Goyal, Immobilization of Molybdenum in Ordinary Portland Cement,Chemical Engineering & Process Technology 4(5), 2013 (ISSN:2157-7048.1000162).
4. A. Chourasia, S.K. Bhattacharyya, P. Bhargava & N. M. Bhandari, Ínfluential Aspects on Seismic Performance of Confined Masonry Construction, Natural Science, Vol. 5, No. 8A1, 56-62, 2013.
5. A. K. Pandey, Flexural Ductility of RC Beam Sections at High Strain Rates, Computers and Concrete, Vol. 12(4), 2013, 537-552.
6. A. Pain, D. P. Kanungo & S. Sarkar, Rock Slope Stability Assessment using Finite Element based Modeling – Examples from the Indian Himalayas, Geomechanics and Geo engineering, 2014, (DOI: http://dx.doi.org/10.1080/17486025.2014.883465).
7. D. P. Kanungo, A. Pain & S. Sharma, Finite Element Modeling Approach to Assess the Stability of Debris and Rock Slopes - A Case Study from The Indian Himalayas, Natural Hazards, 2013, Vol.69(1), 1-24 (DOI: 10.1007/s11069-013-0680-4).
8. D.P. Kanungo, S. Sharma & A. Pain, Artificial Neural Network (ANN) and Regression Tree (CART) Applications for the Indirect Estimation of Unsaturated Soil Shear Strength Parameters. Frontiers of Earth Sciences, 2014, (DOI: 10.1007/s11707-013-0146-5).
9. D. P. Kanungo & S. Sharma, Rainfall Thresholds for Prediction of Shallow Landslides around Chamoli-Joshimath Region, Garhwal Himalayas, India. Landslides, (DOI 10.1007/s10346-013-0438-9, 2013).
10. Deepankar Choudhury, Amey Deepak Katdare & A. Pain, New Method to Compute Seismic Active Earth Pressure on Retaining Wall Considering Seismic Waves, Geotechnical and Geological Engineering, Vol. 32 (2), 391-402, 2014 (DOI: 10.1007/s10706-013-9721-8).
11. L.P. Singh, S.R. Karade, S. K. Bhattacharyya, M. M. Yousuf & S. Ahalawat, Beneficial Role of Nanosilica in Cement Based Materials – A Review, *Construction & Building Materials*, Vol. 47, 1069-1077, Oct, 2013.
12. Mridul Garg & Aakanksha Pundir, Investigation of Properties of Fluorogypsum-Slag Composite

Binders-Hydration, Strength and Microstructure, Cement and Concrete Composites, Vol. 45,227-233, 2014.

13. M. Mittal, Explosibility of Micron and Nano-Size Aluminum Powders, Chemical Engineering World, Vol.48, No.6, 38-47, June 2013.
14. M. Mittal, Explosion Hazards and Safety in Industries Handling Grain Products, Journal of Engineering Research and Studies, IV/III, 1-11, July-Sept. 2013.
15. M. Mittal, Study of Explosibility Data of Coal Dust for Designing Explosion Safety Measures, International Journal of Advanced Engineering Technology, Vol. IV/III, 82-91, July-Sept. 2013.
16. M. Mittal, Limiting Oxygen Concentration for Coal Dusts for Explosion Hazard Analysis and Safety, Journal of Loss Prevention in the Process Industries, Vol. 26, Issue 6, 1106-1112, Nov. 2013.
17. M. Mittal, Explosion Characteristics of Micron- and Nano-Size Magnesium Powders, Journal of Loss Prevention in the Process Industries, Vol. 27, 55-64, Jan. 2014.
18. M. Mittal, Experimental Study of Pyrolysis Gases for Thermo-Kinetic Modeling of Dust Explosions, Chemical Engineering World, Vol. 49, No.1, 49-53, Jan. 2014.
19. M. Mittal, Models for Minimum Explosible Concentration of Organic Dust Clouds, International Journal of Advanced Engineering Research & Studies, Vol. III, Issue II, 124-129, January-March, 2014.
20. M. Mittal, Measures to Prevent Sugar Dust Explosion, Chemical Engineering World, Vol.48, No.4, 60-66, April 2013.
21. Monika Chauhan, M. Gupta, B. Singh, A. K. Singh & V. K. Gupta, Effects of Functionalized Lignin on the Properties of Lignin-Isocyanate Prepolymer Blends and Composites, European Polymer Journal, Vol. 52, 32-43, 2014.
22. P.C. Thapliyal & Kirti Singh, Aerogels as Promising Thermal Insulating Materials: An Overview, Journal of Materials, Article ID 127049, 10, 2014, (DOI:10.1155/2014/127049).
23. P. Dhoke, R. Bhargava, & S. Jain, A Comparative Analysis of the Provisions of Smoke Control Systems in Buildings of National Building Code of India with other International Building Codes, International Journal of Engineering and Scientific Research (IJSER), Vol. 4(2), 2013.
24. Rajiv Kumar and M. P. Singh, Correlations among Signatures for Detection of Different Types of Fires, Fire Technology, Published online, 5th July, 2013.
25. Rajiv Kumar & Vatsal Agarwal, Species Concentrations, Temperatures and Velocities in Fire Plumes, Journal of Applied Fire Science. Vol. 22(3), 239-258, 2013.
26. Rajiv Kumar, R.K. Sharma, P.K. Yadav & A.K. Gupta, Use of Fire Models in Post Fire Investigations-A Case Study, Journal of Applied Fire Science, Vol. 22(3), 259-277, 2013.
27. Sun Shaorui, Xu Penglei, Wu Jimin, Wei Jihong, Fu Wengan, Liu Jin & D.P. Kanungo, Strength Parameter Identification and Application of Soil–Rock Mixture for Steep-Walled Talus Slopes in South-Western China, Bulletin of Engineering Geology and Environment, 73(1),123-140, 2014
28. Sun Shaorui , Sun Hongyi , Wang Yajie , Wei Jihong, Liu Jin & D.P. Kanungo , Effect of the Combination Characteristics of Rock Structural Plane on the Stability of a Rock-Mass Slope, Bulletin of Engineering Geology and Environment, 1-9,30 March, 2014, (DOI:10.1007/s10064-014-0593-9).

29. S. Sarkar, D. P. Kanungo & S. Sharma, Landslide Hazard Assessment in The Upper Alaknanda Valley of Indian Himalayas, Geomatics, Natural Hazards and Risk, (http://dx.doi.org/10.1080/19475705.2013.847501), 2013.

30. S. K. Senapati, Knowledge Resource Sharing among The Building Research Institutes at a Global Level, International Research Journal of Library & Information Science (ISSN: 2249-0213) , No. 3, 448-558, 2013.

31. V. K. Gupta, S. Kumar, R. Singh, L. P. Singh, S. K. Shoora & B. Sethi, Cadmium (II) Ion Sensing through P-Tert-Butyl Calix [6] Arene Based Potentiometric Sensor, Journal of Molecular Liquids, 195, 65–68, 2014.

## National Journal

1. A. K. Mittal, N. Agrawal & V. K. Gupta, Wind Induced Mean Interference Effects on Tall Rectangular Buildings, Journal of Wind and Engineering, 10(2), 1-17, 2013.

2. D. P. Kanungo, A. Pain & S. Sharma, Stability Assessment of a Potential Debris Slide in Garhwal Himalayas, India, Indian Landslides, Vol. 6 (2), 9-20, 2013.

3. Harpal Singh, A Review of Fire Retardants for Commercially Important Polyurethane Foams, Journal of Construction Engineering, Technology & Management, STM Journals, Vol. 3, No. 3, 1-36, 2013

4. Harpal Singh, Effect of Isocyanurate and Carbodiimide Groups towards the Flammability of Polyurethane Foams, Polyurethanes, Vol. 7, No. 1, 30-37, 2013

5. Harpal Singh, Effect of Synergism and Char Formation on the Fire Retardant Properties of Rigid Polyurethane Foam, Fire Engineer Journal, Vol. 38, No. 2, 7-10, April-June, 2013

6. Harpal Singh, Impact of Nitrogen and Silicone Containing Additives on the Fire Retardancy of Polyurethane Foams, Polyurethanes, Vol. 8, No. 4, 45-49, 2013.

7. Harpal Singh, Investigation on Ignition, Pyrolysis and Combustion of Commercially Important Polyurethane Foams, Fire Engineer Journal, Vol. 39, No. 1, 7-11, January-March, 2014.

8. Mithalesh K. Dwivedi, Suresh Jain & Neeraj Jain, A PVC-Based Crown Ether Membrane Sensor for $Cu^{2+}$, Journal of Chemistry and Environment, 17(9), 13-18, 2013.

9. Neeraj Jain & Jaswinder Singh, Mass Balancing and Life Cycle Assessment of Municipal Solid Waste, Journal of Chemistry and Environment, 17(5), 13-18, 2013.

10. Neeraj Jain, Immobilization of Hazardous Cr (VI) in Blended Cement: XRD and Leaching Studies, Journal of Chemistry and Environment, 17(10), 28-34, 2013.

11. N.K.Saxena & Sunil K. Sharma, Studies on Generation of Smoke and Toxic Combustion Products from Fire Retarded Materials, Indian Journal of Environmental Protection, 33(2), 145-151, 2013

12. N.K.Saxena & Sunil K. Sharma, Metal Complex Based Coating for Fire Protection of Electric Cables, Paint India, 63 (8) , 53-55, 2013

13. P.C. Thapliyal, Nano Coatings and Paints for Green Future, Nano Digest, 5(4), 42, 2014.

14. Rajni Lakhani, S.P. Agrawal, Sapna Ghai & R.K.Saxena, Å"ek jk/ku gr ofeD;ykbV lheV Vkby, Bharatiya Vaigyanik Evam Anusandhan Patrika, Vol 20, Issue - II, 246-250, 2013.

15. Rajni Lakhani & Priyanka Tomar, Studies on Polymer Blend for Repair Applications, New Building Materials & Construction World, Vol 20, Issue-8, 144-147, February 2014.

16. Rajiv Kumar & M.P. Singh, Correlations among Fire Signatures for Detection, Fire Engineer, 39(1), 29-34, January-March, 2014.
17. S. Rukhaiyar, M. Singh & A. Pain, A Study of Numerical Modeling of a Rock Slope Based on Modified Mohr-Coulomb Criterion, Journal of Rock Mechanics and Tunneling Technology, Vol. 19(2), 81-98, 2013.
18. S. K. Panigrahi, S. Chakraverty & B. K. Mishra, Damage Assessment in Beam with Sparse Modal Information, *Advances in Vibration Engineering,* Vol. 12, No.4, 2013.
19. S. K. Singh, D. Singh & C. Sonkar, Chemical Admixture in Concrete: A State of the Art Report, New Building Materials & Construction World, Vol.19, No. 6, 84-106, December, 2013.

## Papers in Conference/Workshop/ Seminars

1. Anirudh Jain, Nivedita Sharma & Ashok Kumar, Restructuring Trees to Accommodate Human Habitat, International Conference on Future Build 2013, University of Bath, United Kingdom, Sept. 4 – 6, 2013, 160-166.
2. Ashok Kumar, Research on Building Materials & Technologies at CSIR-CBRI: An Overview and Possible Areas of Cooperation with BMTPC, National Workshop – cum- Brain Storming Session on Possible Areas of Cooperation on Alternate and Emerging Housing Technologies with BMTPC, New Delhi, June 12, 2013.
3. Ashok Kumar, Alterative and Innovative Technologies for Social Housing, National Conference on Punchayati Raj and Rural Development, Gujarat State Govt., August 17, 2013.
4. Ashok Kumar, Low Cost Housing, National Workshop on Cost Effective Building Practices, Dept. of Architecture, Giani Zail Singh PTU Campus, Bathinda, March 14, 2014.
5. Ashok Kumar, Cost Effective and Innovative Technologies for Housing, National Workshop on Cost Effective Building Practices, Dept. of Architecture, Giani Zail Singh, PTU Campus, Bathinda, March 14, 2014.
6. A. K. Sharma, A. Dwivedi, P. Chand & S. Singh, A Comprehensive Geotechnical Investigation in Boulder Deposit, Indian Geotechnical Society Conference, IGC 2013 (ISBN : 978-81-925548-1-5)
7. A. Dwivedi & P. K. S Chauhan, Delineation of Distress Area in Mosque using GPR, Indian Geotechnical Society Conference, IGC 2013 (ISBN : 978-81-925548-1-5)
8. A. K. Mittal , Prefabricated Technologies for Sustainable Technologies in Hilly Regions, India Prefab, Institute of Engineers (IE), Uttarakhand State Centre, Dehradun, March 8-9 , 1-12, 2014.
9. Abha Mittal, Gayatri Devi & P.K.S.Chauhan, Seismic Hazard Estimation of Jammu Region Using Probabilistic Approach, Indian Geotechnical Conference –2013, IIT- Roorkee, December 22-24, 2013.
10. Abha Mittal, Gayatri Devi & P. K. S. Chauhan, Application of ANN to Predict Liquefaction Potential of Soil Deposits for Chandigarh Region, India, 3rd International Conference on Soft Computing for Problem Solving (SocPros-13), Greater Noida Extensiion Centre of IIT, Roorkee, December 26-28, 2013.
11. Ajay Chourasia, Development of Generic Engineering Guidelines for Confined Masonry at IIT Gandhinagar, Organised by CEERI (CM Network); IIT Gandhinagar and IIT Kanpur, Feb. 22-23, 2014.

12. A. K. Pandey, Impact Response of RC Beams in Flexure, International Conference on Trends and Challenges in Concrete Structures, Indian Concrete Institute, Ghaziabad, UP India, December 19-21, 2013.
13. A.K.Mittal, D. Ghosh, S. Behera, I.A. Siddiqui & D. Dharmshaktu , Wind Flow Simulation in the Vicinity of Tall Buildings through CFD , 8th Asia-Pacific Conference on Wind Engineering (APCWE-8), Dec. 10-14, 682-690, 2013, Chennai, India.
14. A.K. Mittal, S. Behera & D. Ghosh , Role of Tall Buildings in Urban Infrastructure: Research Issues, National Conference on Sustainable Infrastructure Developement (NCSID) jointly organised by Civil Engineering Department of National Institute of Technical Teachers Training and Research (NITTTR), Chandigarh and Chitkara University, Himachal Pradesh , 43-50, March 13-14, 2014.
15. Singh, Natural Fiber Composites for Building Application, International Conference on Composite Materials and Technology, Feb 7-8, 2014, ATIRA, Ahmedabad.
16. Chhavi and B. M. Suman, Determination of Cooling Load of a Building and Effect of Heat Reflective Paint, 8th USSTC – 2013, Doon University, Dehradun, Dec. 26-28, 2013.
17. C.A. Eldho & S.R. Karade, Cement Based Anodes – Future of Electrochemical Repair Techniques, International Conference on Trends and Challenges in Concrete Structures, organized by Indian Concrete Institute, 714-722, Dec. 19-21, 2013, Ghaziabad, U.P., India
18. D. Ghosh, A.K. Mittal, S. Behera & A. Gupta , Wind Flow Characteristics around Rooftop Solar Array - A Numerical Study, 8th Asia-Pacific Conference on Wind Engineering (APCWE-8), Dec 10-14, 674-681, 2013, Chennai, India.
19. G. Lavanya, T. Meraj, A. K. Pandey & B. Singh, Developments in SBR Latex Modified Concrete for Structural Applications- A Critical Review, International Conference on Trends and Challenges in Concrete Structures, Indian Concrete Institute, 19-21 December, 2013, Ghaziabad, UP, India.
20. G. Tiwari, N.K. Samadhiya & A. Pain, Stress Strain Distribution with in Geosynthetic Reinforced Slopes: A Parametric Study, International proceeding of Indian Geotechnical Conference, IIT Roorkee, India , 2013 (Paper ID: 06088101820130429).
21. G. Tiwari, N.K. Samadhiya & A. Pain, Study of Effect of Bolt Anchorage Parameters on Rock Slope Stability by FEM, International proceeding of 4th Indian Rock Conference, 431-439, Solan, India.
22. G. S. Parvathi & P. K. Basudhar, Visco Elastic Foundation Model Parameter Estimation Using Inverse Analysis Technique, Indian Geotechnical Conference, Dec. 22-24, 2013, IIT, Roorkee
23. Harpal Singh, Effect of Phosphorus-Nitrogen Synergism towards the Flammability of Rigid Polyurethane Foam, National Conference on Fire Research and Engineering (FiRE 2014), Department of Mechanical & Industrial Engineering, Indian Institute of Technology Roorkee, 36, March 1-2, 2014
24. Harpal Singh, Preparation and Properties of Fire Retardant Rigid Polyurethane Foam with Synergistic Charring Agent, International Conference on Polyurethane, PUTECH-2014, India Expo Centre, Greater Noida (New Delhi), India, 2-8, March 12-14, 2014.
25. Koushik Pandit, Ajay Chourasia & S. K. Bhattacharyya, Algorithm Developed by Numerical Approach for Improving Underground

Coal Recovery, Indian Geotechnical Conference 2013, IIT, Roorkee, December 22-24, 2013.

26. L.P. Singh, Microstructure Improvement of Cementitious Systems Using Nanomaterials: A Key for Enhancing the Durability of Concrete, during CONCREEP@9 at MIT, USA, Sept. 22-25, 2013.
27. L.P. Singh, Preparation of Nanoparticles using Nano-Powder Synthesizer, 8th Uttarakhand State Science Technology Congress, Dec 26-28, 2013, Dehradun.
28. M. Samanta, R. Bhowmik & P. Mohanty, Analysis of Pile Group Subjected to Embankment Induced Soil Movement, Indian Geotechnical Conference, Dec. 22-24, 2013, IIT, Roorkee
29. Mridul Garg and Aakanksha Pundir, Towards Maximizing the use of Fly Ash as Cementitious Material for Sustainable Building Components, 8th Uttarakhand State Science Technology Congress, 187, 26-28 Dec. 2013, Dehradun
30. N. K.Saxena, Sunil K. Sharma & Sushil Kumar, Fire and Smoke Retardant Compositions for Cotton Fabrics, Fire India 2013, 9th International Conference and Exhibition, Fire Risk Mitigation: The Global Trends, October 24-26, 2013, Mumbai
31. N. Saxena, C. Sonkar & S. Saxena, An Improved Strengthening Scheme for Stone Masonry Buildings, International Conference on Trends and Challenges in Concrete Structures, organized by ICI, India, 2013, 678-684.
32. N. Saxena, Webbed Slab Substituting Flat Slab & Lintel Band as a Seismic Disaster Reduction Measure, International Conference on Trends and Challenges in Concrete Structures, Organized by ICI, India, 520-529, 2013.
33. P. Kakarla, S. Sharma, D. P. Kanungo, A. Pain & R. Anbalagan, Artifical Neural Network Approach Based Indirect Estimation of Shear Strength Parameters of Soil, Indian Geotechnical Conference 2013, IIT Roorkee, India (Paper ID: 0301774620130328).
34. P. K. S. Chauhan & A. Dwivedi, Investigation for Foundation of a Mosque Minar using GPR, Indian Geotechnical Conference 2013, IIT Roorkee (ISBN: 978-81-925548-1-5)
35. P. Chand, , R. Chandra, A.K. Sharma, A. Dwivedi & K.G. Garg, Control of Heave in Expansive Clays by in-situ Reinforcement, Indian Geotechnical Conference 2013 (ISBN : 978-81-925548-1-5) IIT Roorkee
36. P. C. Thapliyal**,** Innovations in Advance Materials for Inclusive Development, Proc. National Conference on Innovations in Science and Technology for Inclusive Development, IL-2, 49, 2014.
37. P. C. Thapliyal, N. Dabas, S. Tewatiya & K. Singh, Nanotechnology for Sustainable Development, National Conference on Innovations in Science and Technology for Inclusive Development, 72-110, 2014.
38. Ravindra S. Bisht & Soju J. Alexander, Mobile Robots for Periodic Maintenance and Inspection of Civil Infrastructure: A Review, Proceedings of the 1st International and 16th National Conference on Machines and Mechanisms, IIT Roorkee, India, Dec 18-20, 2013.
39. Ravindra S. Bisht & Soju J. Alexander, Design Parameter Analysis of Adhesion Mechanisms for Climbing Robots, 8th Uttarakhand State Science and Technology Congress, Dehradun, Dec. 26-28, 2013.
40. R. Bhowmik & M. Samanta , Numerical Analysis of Piled-Raft Foundation under Vertical Load in Stone Column Improved Soil, IGC-2013, Roorkee, 112, 22-24 December.

41. S. K. Panigrahi, A. Chaurasia, S. K. Bhattacharyya, Alexander Soju & Jalaj Parashar, Noise Influence on Condition Monitoring of Structures, 8th Uttarakhand State Science and Technology Congress, Dehradun, Dec 26-18, 2013

42 S. Sarkar, D.P.Kanungo, S. Sharma & D. Singh, Potential Landslide Zones along Pipalkothi - Joshimath Road, Alaknanda Valley, Indian Geotechnical Conference, Dec. 22-24, 2013, Roorkee, India

43. S. Behera, A.K. Mittal, S.K. Bhattacharyya, A. Gupta & D. Ghosh, Wind Forces on Inclined Solar Panels on Flat Roofs , 8th Asia-Pacific Conference on Wind Engineering (APCWE-8), Chennai, India, 527-532, Dec 10-14, 2013

44. S. Saxena, C. Sonkar & N. Saxena, Distress Diagnosis by Dynamic Characteristics, International Conference on Trends and Challenges in Concrete Structures, organized by ICI, 598-609, 2013, India.

45. S. S. Pawar, N. Saxena & R. N. Dubey, Design of Earthquake and Wind Resistant High Rise Composite and RC Building Systems, International Conference on Trends and Challenges in Concrete Structures, organized by ICI, 530-539, 2013, India.

46. S. Rukhaiyar, N. K. Samadhiya & A. Pain, Artificial Neural Networks as a Basis for Predicting Polyaxial Strength of Intact Rock, International proceeding of 4th Indian Young Geotechnical Engineers Conference, 29-32, 2013, IIT Madras, India.

47. S. Jain, A. Arvind Kumar & R. S. Chimote, Numerical Simulation of Water Mist Velocity Distribution using Computational Fluid Dynamics, National Conference on Fire Research & Engineering: FiRE 2014, Department of Mechanical & Industrial Engineering, IIT Roorkee, March 1-2, 2014, Roorkee

48. S. K. Singh, S. K. Bhattacharyya & D. Singh, The Structural Behaviour at Elevated Temperature: An Overview, International Conference on Trends and Challenges in Concrete Structures, CPWD Training Institute, Ghaziabad organized by Indian Concrete Institute, 19-21 December, 723-738, 2013.

49. S. K. Singh, Post fire Assessment and Rehabilitation of Structure- A Case Study, Workshop on Structural Rehabilitation and Retrofitting using Construction Chemicals (WSRR13), IIT Mumbai, 37-54, 24-25 September, 2013.

50. S. K. Singh, A. Chourasia & Y. P Kajale, Prefab Building Construction: A Sustainable Approach, India Prefab-2014, IEI, Dehradun, March 8-9, 2014

## Contribution to Book Chapter

1. L. P. Singh, Applications of Nanotechnology in Construction, **Nanotechnology Construction Engineering Book** published by Studium Press LLC, USA , Vol 9, 43 – 67, 2013.

# Lectures

**Dr. S. R. Karade, Scientist** delivered lectures on:

- "Corrosion Protection Measures" in a course on "Retrofitting of Reinforced Concrete Structures" organized by IIT, Roorkee during 23-27 April, 2013.
- "Corrosion Protection of Steel Rebars in Concrete" in a course on "Retrofitting of Reinforced Concrete Structures" organized by IIT, Roorkee during 20-24 July, 2013.
- "Corrosion and its Control Measures in RC Structures" at Rajasthan Technical University, Kota on 16th Sept., 2013.

**Dr. Abha Mittal, Scientist** delivered a key-note lecture on "Different Mathematical Modeling Techniques and its Application in the Field of Earthquakes and Landslides" in 2nd National Conference on Application of Mathematics in Science, Technology and Management (NCAMSTM-2014) from January 24 to 25, 2014

**Dr. L. P. Singh, Scientist** delivered invited lecture on "Industrial Waste Utilization in Developing Building Products: Indian Scenario" at MIT, Bostan, USA, 23rd Sep., 2013.

**Er. Ajay Chourasia, Scientist** delivered invited lecture on "Seismic Performance of full-scale Confined Masonry Buildings" in a Workshop on Development of Generic Engineering Guidelines for Confined Masonry, Organised by EERI (CM Network); IIT Gandhinagar and IIT Kanpur, during Feb. 21-22, 2014

**Dr. P.C. Thapliyal, Scientist** delivered invited lecture on "Innovations in Advance Materials for Inclusive Development" during National Conference on 'Innovations in Science and Technology for Inclusive Development at Department of Chemistry, CCS University, Meerut from 22 to 23 March, 2014.

**Dr. S. Sarkar Scientist** delivered invited lectures on:

- Natural Disasters: Issues, Challenges & Mitigation Indian Medical Association, Roorkee, 29th June, 2013.
- Natural Hazards for school children as a Chief Guest on the occasion of Disaster Day on 9th October 2013, Institution of Engineers, Roorkee.
- Landslide Risk Assessment Discussion Meet at Disaster Mitigation and Management Center, Dehradun on 10th January 2014.

**Er. S. K. Singh, Scientist** delivered invited lectures on:

- Post Fire Assessment and Rehabilitation of Structure- A Case Study Workshop on 'Structural Rehabilitation and Retrofitting using Construction Chemicals (WSRR13)', September 24-25, 2013, IIT Mumbai.
- Advances in Concrete Technology, National Conference on Emerging Trends in Engineering Science & Technology, CoER, Roorkee, March 29-30, 2014.

# Honours and Awards

**Dr. Abha Mittal, Dr. Mridul Garg, Mrs. Neeta Mittal and Dr. Rajni Lakhani,** scientists, CSIR-CBRI were honoured as most inspiring women scientists and engineers on the occasion of International women's day celebration on 8th March 2014 by Engineers Watch. Er. Raghav Mittal, Executive Director, Engineering watch has inaugurated the programme organized at Scope Convention Centre, Lodhi Road, New Delhi. He welcomed the dignitaries Mrs. Gian Sudha Mishra Chief Justice,Supreme Court, Mrs. Smirti Irani, National President, Mahila Morcha, BJP, Dr. Grace Pinto, founder member of Ryan's Academic Institution, Prof. Nupur Parkash, Vice Chancellor of Indira Gandhi Delhi Technical University, Prof. Balvinder Shukla, Vice Chancellor, AMITY University, Noida, and Dr. Madhu Chitkara, Vice Chancellor of Chitkara group of colleges present on the dias. All the learned women scientists and engineers have received a token of appreciation who were arrived from different parts of the India on this special occasion.





**Sri R.S. Chimote,** Chief Scientist received "Engineering Watch's Engineering Excellence Award 2013 in Public Choice Category" from the Secretary, Department of Public Enterprises, Ministry of Heavy Industries & Public Enterprises, Govt. of India on 24th October, 2013 at SCOPE Complex, New Delhi.

**Dr. (Mrs.) Mridul Garg and Ms. Aakanksha Pundir** received the 'Mahila Vishesh Puruskar' comprising of Rs. 2500/- along with Memento and Certificate for their paper entitled 'Phosphogypsum dwara paryavaran anukul abhinav bhavan saamgriyon ka nirmaan' in Hindi Vaigyanik Lekh Pratiyogita conducted by Kendriya Sachivalaya Hindi Parishad, New Delhi on 13th August 2013. The award was given by Sh. A.K Jain, Secretary, Rajbhasha Vibhag, Ministry of Home Affairs, Govt. of India.


On the occasion of 71st Foundation Day held on 26th September 2013 at CSIR, New Delhi, Sh. **Aman Kumar,** Assistant Gr-I, (F&A) & Sh. **Pawan Kumar Sharma,** Assistant Gr-I, (General) CSIR-CBRI Roorkee honored with "Project Champion of ERP Award" at CSIR - HQ for their hard work for project, coordination with ERP team of Head Quarter & LAB, encourage support and assist to other staff of CSIR-CBRI.


Department of Scientific and Industrial Research
Ministry of Science and Technology
Government of India

Outstanding Achievement Award

Conferred on

M. Aman Kumar

For distinguished contribution and meritorious achievement as Project Champion for the CSIR Transformation Initiatives and Enterprise Application for Automation of Operations

On the Occasion of 71st Foundation Day of CSIR
26 Sept 2013

CSIR

Prof Samir K Brahmachari
Secretary

**Mr. Ravindra Singh Bisht**, Scientist received Young Scientist Award for best oral presentation in 8th Uttarakhand State Science & Technology Congress 2013, Doon University, Dehradun held during December 26-28, 2013

# Distinguished Visitors

| Date of Visit | Distinguished Guest | Remarks |
|---|---|---|
| 16.08.2013 | Miko Mazveeuw &<br>Aditya Barve<br>MIT Architecture<br>Civil Engineer<br>Material Sciences | Thank you so much for sharing your fantastic research. It has been a very educational day and we look forward to future possible collaborations. |
| 24.03.2014 | Prof. R. N. Iyengar | I am visiting this lab after nearly 14 years; when I returned to IISc Banglore having served this institute as its Director. I feel happy to have come back to witness the progress in R&D here. It is wonderful to see a new Director who has a vision for the lab. The scientists whom I met are enthusiastic and energetic.<br>I wish all the best for CBRI!!! |

## Upgradation of Building Dynamics Laboratory and Visit of Prof. R.N. Iyengar, Ex-Director, CBRI to the Lab.

# Date Line

| S.No. | Date | Salient Details |
|---|---|---|
| 1. | April 5, 2013 | 44th SSBMT (Indoor) Finals held at CSIR-CBRI |
| 2. | May 10, 2013 | National Technology Day. |
| 3. | June 5, 2013 | World Environment Day. |
| 4. | August 15, 2013 | Independence Day. |
| 5. | August 20, 2012 | Sadbhavna Diwas. |
| 6. | September 9-13, 2013 | Hindi Week. |
| 7. | September 26, 2013 | CSIR Foundation Day. |
| 8. | October 28-02 Nov. 2013 | Vigilance Awareness Week. |
| 9. | October 29, 2013 | Diwali Mela Celebration at CBRI Campus |
| 10. | January 26, 2014 | Republic Day |
| 11. | February 10, 2014 | CSIR-CBRI Foundation Day |
| 12. | February 28, 2014 | National Science Day. |
| 13. | February 28, 2014 | Confined Masonry System – Documentary Released |
| 14. | March 11,2014 | Annual Flower and Vegetables Show. |
| 15. | March 24,2014 | Upgradation of Building Dynamics Laboratory |