With Best Compliments From

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ANNUAL REPORT
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सी एस आई आर - केंद्रीय भवन अनुसंधान संस्थान, रुड़की
CSIR- Central Building Research Institute, Roorkee

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निदेशक की कलम से

सीएसआईआर-केंद्रीय भवन अनुसंधान संस्थान, रुड़की की वर्ष 2020-2021 का वार्षिक प्रतिवेदन को प्रस्तुत करते हुए मुझे अत्यंत हर्ष हो रहा है। यह रिपोर्ट इस वर्ष के दौरान संस्थान द्वारा की गई प्रगति व कई उल्लेखनीय उपलब्धियों पर प्रकाश डालती है। राष्ट्र की वृद्धि और विकास के लिए बेहतर अनुसंधान और ज्ञान की खोज में इस निरंतर प्रगति से मैं अत्यंत उत्साहित हूँ।

विज्ञान और प्रौद्योगिकी में भवन निर्माण के सभी पहलुओं में एक अग्रणी अनुसंधान एवं विकास संस्थान के रूप में, सीएसआईआर-सीबीआरआई का लक्ष्य दुनिया में सुरक्षा, स्थिरता, पारगम्यता, तीक्ष्णता, आराम, कार्यात्मक दक्षता, गति, उत्पादकता, पर्यावरण संरक्षण, ऊर्जा दक्षता व लागत प्रभावशीलता प्राप्त करने के लिए अभिनव समाधान प्रदान करते हुए एक विश्व स्तरीय अनुसंधान और ज्ञान केंद्र बनना है। संस्थान अपने अनुसंधान, विकास और नवाचार द्वारा भवन नियोजन, अभिकल्पन, सामग्री, निर्माण भवनों में आपदा न्यूनीकरण, क्षमता निर्माण से संबंधित राष्ट्रीय चुनौतियों का हल ढूँढने के लिए समर्पित है।

आने वाले वर्षों में महत्वपूर्ण उद्देश्यों को निर्देशित करने में मदद करने के लिए, हमने अपने मौजूदा लक्ष्यों को नई दृष्टि से पुनर्जीवित करने के लिए एक नई रणनीतिक योजना तैयार करने की प्रक्रिया शुरू की है। यह योजना संस्थान के लिए एक व्यापक रोड मैप के रूप में काम करेगी, आने वाले वर्षों में हमारे द्वारा प्राप्त किए जाने वाले प्रत्याशित प्रभावों को चिह्नित करेगी।

इस संबंध में, संस्थान ने अपने मुख्य योग्यता क्षेत्र में छह प्रमुख क्षेत्रों की शुरुआत की है - आवास-संरचना और नींव, विरासत संरचनाओं का संरक्षण, नवीन निर्माण सामग्री, ऊर्जा कुशल प्रणाली और भवन स्वचालन, आपदा न्यूनीकरण और भवन निर्माण प्रक्रिया और स्वचालन; कि शुरूआत की है।

संस्थान ने वर्ष 2020 -2021 के दौरान सरकारी, सार्वजनिक और निजी क्षेत्र की एजेंसियों/संगठनों के लिए किए गए अनुबंध आर एंड डी अनुदान सहायता परामर्श कार्य और तकनीकी सेवाओं के माध्यम से लगभग 35.88 करोड़ का बाहरी नकदी प्रवाह प्राप्त किया। इस अवधि के दौरान कुल 115 शोध पत्र विभिन्न पत्र-पत्रिकाओं के साथ-साथ सम्मेलन की कार्यवाही में प्रकाशित हुए हैं।

संस्थान वैज्ञानिक तथा अभिनव अनुसंधान अकादमी (एसीएसआईआर)के तत्वाधान में "भवन अभियांत्रिकी एवं आपदा न्यूनीकरण (बीईडीएम)" के क्षेत्र में समन्वित स्नातकोत्तर-पीएचडी कार्यक्रम प्रदान करता है। वर्तमान में कुल 38 पीएच.डी. छात्र सीएसआईआर-सीबीआरआई में एसीएसआईआर में नामांकित हैं।

प्रतिवेदन में उल्लेखित शोध उपलब्धियों के साथ ही, मैं वर्ष के दौरान संस्थान की अतिरिक्त विशिष्ट गतिविधियों पर प्रकाश डालना चाहता हूँ। लगातार, संस्थान ने राष्ट्रीय प्रौद्योगिकी दिवस, विश्व पर्यावरण दिवस, सीएसआईआर स्थापना दिवस और 75वां सीएसआईआर-सीबीआरआई स्थापना दिवस को मनाया।

10 फरवरी, 2021 को संस्थान ने अपनी वैज्ञानिक उपलब्धियों की प्लेटिनम जुबली (75वां स्थापना दिवस) उत्साहपूर्वक मनाई । श्री एम. वेंकैया नायडू, भारत के माननीय उपराष्ट्रपति ने इस अवसर पर मुख्य अतिथि के रूप में भाग लिया और श्री जय राम ठाकुर माननीय मुख्यमंत्री हिमाचल प्रदेश ने अपनी उपस्थिति से इस अवसर की शोभा बढ़ाई। यह समारोह कोविड-१९ महामारी के कारण वर्चुअल माध्यम से मनाया गया।

इसके अलावा, विभिन्न कार्यक्रमों, प्रतियोगिताओं और प्रतिष्ठित हस्तियों के व्याख्यानों का भी आयोजन किया गया। हिंदी सप्ताह, सतर्कता जागरूकता सप्ताह और स्वच्छता अभियान के दौरान महत्वपूर्ण जागरूकता मुद्दों जैसे हिंदी भाषा को प्रोत्साहन, भ्रष्टाचार के खिलाफ लड़ाई, स्वच्छता के महत्व आदि पर जोर दिया गया।

विशिष्ट सरकारी विभागों के अनुरोधों को समायोजित करने के अलावा, संस्थान ने सहायक परियोजना निदेशकों, इंजीनियरों, अधिकारियों, प्रोफेसरों, वैज्ञानिकों और विभिन्न संगठनों के छात्रों के लिए विभिन्न राष्ट्रीय और अंतर्राष्ट्रीय कौशल विकास कार्यशालाओं और प्रशिक्षण कार्यक्रमों का भी आयोजन किया।

संस्थान ने ज्ञान के इष्टतम प्रसार के लिए विभिन्न कार्यक्रमों में भी भाग लिया। भारत और विदेशों के लोगों के साथ नियमित बातचीत और संचार बनाए रखने के लिए, संस्थान ने भवन और निर्माण क्षेत्र की विभिन्न समस्याओं से संबंधित विभिन्न पूछताछों का जवाब दिया।

नई दिल्ली में अपने विस्तार केंद्र के साथ संस्थान ने केंद्रीय व राज्य, सार्वजनिक/निजी क्षेत्रों के साथ संपर्क बनाए रखा। हालांकि यह चुनौतियों और उपलब्धियों का वर्ष रहा है। हम अपनी उपलब्धियों से संतुष्ट नहीं हैं बल्कि आने वाली चुनौतियों और जिम्मेदारियों को पूरा करने के लिए हमेशा तत्पर रहते हैं।

मुझे आशा है कि प्रतिवेदन के द्वारा, आप संस्थान की गतिविधियों की जानकारी प्राप्त करेंगे। निदेशक के रूप में, मैं आश्वस्त करता हूं कि संस्थान अधिक से अधिक ज्ञान, बेहतर कार्यक्रमों और उन्नत अनुसंधान और विकास उत्पादन के लिए अपनी खोज जारी रखेगा। पिछले वर्ष की उपलब्धियाँ और भविष्य की हमारी परिकल्पना संस्थान के समर्पित कर्मचारियों के अमोघ समर्थन और योगदान का परिणाम है। मैं उन सभी व्यक्तियों और समूहों, साथी वैज्ञानिकों, तकनीकी अधिकारियों और प्रशासनिक कर्मचारियों का बहुत आभारी हूं, जिनकी सकारात्मक ऊर्जा और समर्थन हमारा पथ प्रशस्त करता है।

हमारे शोध परिषद के अध्यक्ष और सदस्यों के लिए, उनकी बहुमूल्य सलाह, मार्गदर्शन और समर्थन के लिए मैं अपनी कृतज्ञता व्यक्त करता हूं। मैं महानिदेशक, सीएसआईआर और सीएसआईआर मुख्यालय के अन्य सहयोगियों को उनके निरंतर समर्थन और मार्गदर्शन के लिए हार्दिक धन्यवाद देता हूं।

मैं इस वार्षिक रिपोर्ट को सुरुचिपूर्ण तरीके से प्रस्तुत करने के प्रयासों के लिए संपादक को धन्यवाद देता हूं। अंत में, अपने मूल्यवान ग्राहकों, प्रायोजकों, शुभचिंतकों और सीएसआईआर-सीबीआरआई के पूर्व सहयोगियों द्वारा प्रदान किए गए समर्थन और सहयोग तथा सहायता का स्मरण करना मेरे लिए प्रसन्नता का क्षण है।

बिल्डिंग और इंफ्रास्ट्रक्चर उद्योग में अभूतपूर्व वृद्धि के साथ, हम एक रोमांचक भविष्य की ओर देख रहे हैं।

दिनांक:27.04.2023

(प्रो. आर. प्रदीप कुमार)

From the Director's Desk

It is a great moment and accomplishment that I present the Annual Report of CSIR-Central Building Research Institute, Roorkee for the year 2020-2021. This report highlights many notable marks achieved by the Institute during the year. I am happy to celebrate this continued progress in the pursuit of improved research and knowledge for the growth and development of the nation.

As a leading R&D institute in all aspects of building science & technology, CSIR-CBRI aims to be a world-class research & knowledge centre for providing innovative solutions to achieve safety, sustainability, resilience, smartness, comfort, functional efficiency, speed, productivity in construction, environment preservation, energy efficiency and economy. The Institute continues to dedicate its research, development and innovation in solving National challenges including, but not limited to planning, design, materials, disaster mitigation in buildings, capacity building and construction.

To help direct the critical objectives over the coming years, we embarked on a process to formulate a fresh strategic plan to revitalize our existing goals with a new vision. This plan will serve as a comprehensive road map for the Institute, marking the impacts we anticipate to achieve in the coming years.

In this regard, the Institute has initiated six major thrust areas - Housing-Structure & Foundations, Conservation of Heritage Structures, Innovative Building Materials, Energy Efficient System & Building Automation, Disaster Mitigation and Building process & Automation; in the core competency area of the Institute.

The Institute registered an external cash flow of nearly 35.88 crores during the year 2020 -2021. earned through contract R&D, grant-in aid. consultancy assignments and technical services carried out for government, public and private sector agencies/organizations. During the period, a total of 115 research papers have been published in various journals as well as conference proceedings.

The Institute offers an integrated M. Tech. - PhD (IMP) Programme under the aegis of the Academy of Scientific & Innovative Research (AcSIR) in the area of 'Building Engineering & Disaster Mitigation (BEDM)'. Presently total 38 PhD students are enrolled in AcSIR at CSIR-CBRI.

In addition to the many research accomplishments featured in the report, I would like to highlight additional distinguished activities of the Institute during the year. Consistently, the Institute observed Open Days on the occasion of National Technology Day, and World Environment Day. CSIR Foundation Day and the 75th CSIR-CBRI Foundation Day.

On February 10th, 2021, the Institute enthusiastically celebrated the Platinum Jubilee (75th Foundation Day) of its scientific accomplishments. Shri M. Venkaiah Naidu, Hon'ble Vice President of India attended the occasion as chief guest and Shri Jai Ram Thakur Hon'ble Chief Minister Himachal Pradesh graced the occasion with his presence.

Apart from this, various programmes, competitions and lectures from eminent personalities were also arranged. Important awareness issues such as encouragement of the Hindi language, fight against corruption, cleanliness and hygiene etc. were celebrated throughout the weeks during Hindi Week, Vigilance Awareness Week and Swachhta Abhiyan.

In addition to accommodating the requests from distinguished government departments, the Institute also organized various national & international skill development workshops and training programmes for assistant project directors, engineers, officers, professors, scientists and students from various organizations.

The Institute also participated in various programmes for the optimal dissemination of knowledge. To maintain regular interactions and communication with the people of India and abroad, the institute responded to various enquiries pertaining to various problems of the Building and Construction 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 and responsibilities.

As you read the report, I hope you will gain deeper insights into the Institute's activities. As the Director, I pledge that the Institute will continue its quest for greater knowledge, better programmes, enhanced research and development output. The accomplishments over the past year and the work ahead are the results of the unfailing support and contributions of the dedicated staff. I am immensely grateful to all the individuals and groups, fellow scientists, technical officers and administrative staff, whose energy and support sustain us.

To the Chairman and the Members of our Research Council, I express my deepest gratitude for their valuable advice, guidance and support. I extend my sincere thanks to the Director General, CSIR and other colleagues from CSIR Headquarters for their continuous support and guidance.

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

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

Date: 27.04.2023

(Prof. R. Pradeep Kumar)

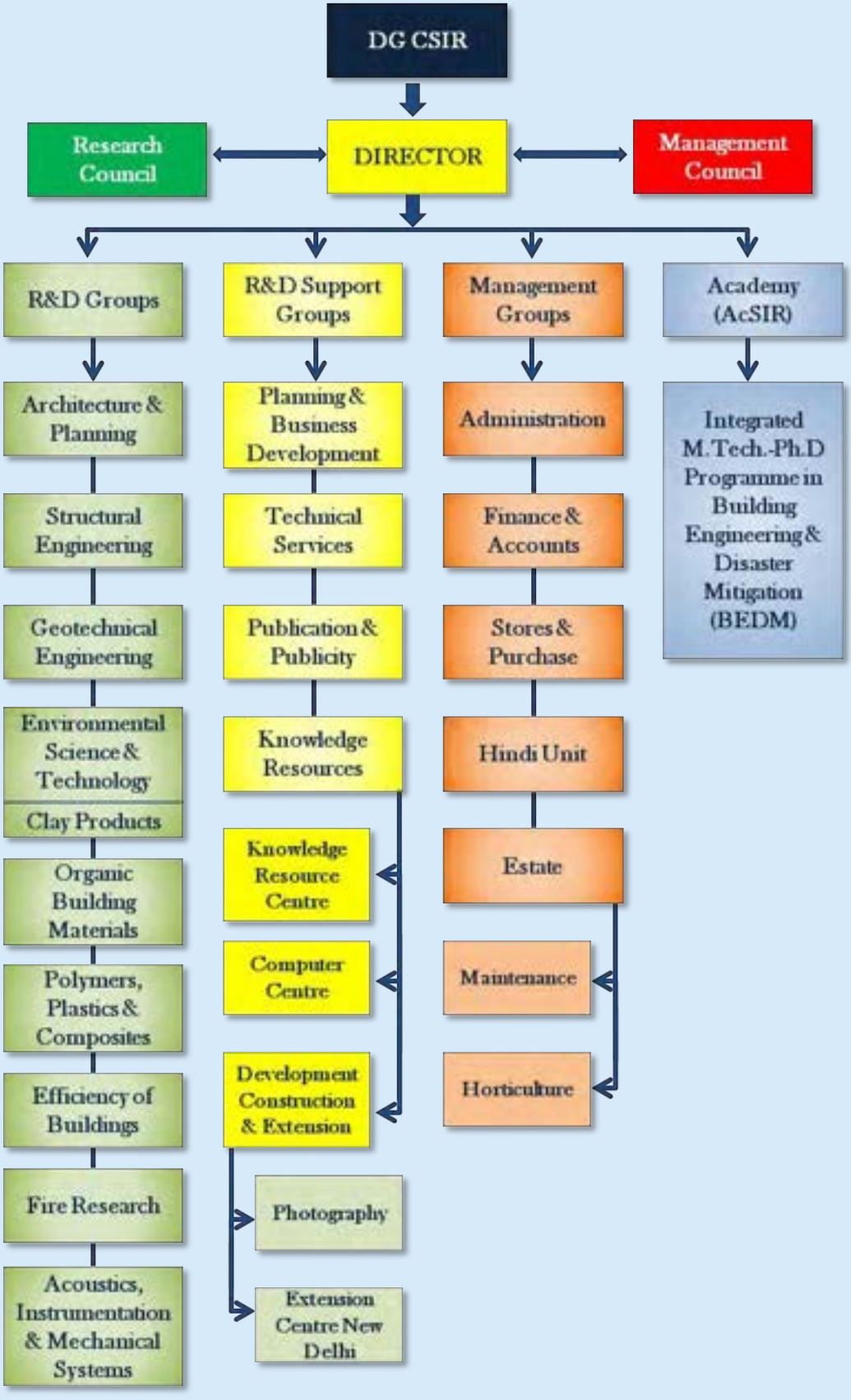
Our Vision

To be a world class research and knowledge centre of national importance for providing innovative solutions to all aspects of building science and technology.

Our Mission

Devotion to research, development, and innovation (RD&I) in solving national challenges of planning, design, materials, capacity building and construction including disaster mitigation in buildings to achieve safety, sustainability, resilience, smartness, comfort, functional efficiency, speed, productivity in construction, environment preservation, energy efficiency and economy.

CSIR-CBRI Organogram



Research Council

Chairman
Prof. Mahesh Tandon
Managing Director
Tandon Consultants Pvt. Ltd., New Delhi

Members

Prof. Manohar Viladhkar
Professor (Retd.), Dept. of Civil Engg.,
Indian Institute of Technology, Roorkee

Dr. P.K Das
Member, National Task Force on
Rural Housing &Habitat
Ministry of Rural Development, New Delhi

Prof. Montomani
Center for Sustainable Technology,
Indian Institute of Science, Bangaluru

Prof. Sharada Shrinivasan
National Institute of Advance Sciences
Bangaluru

Prof. Ranjana Mittal
Head, Dept. of Architecture
School of Planning and Architecture,
New Delhi

Prof. Satish Chandra
Director,
CSIR-Central Road Research Institute,
New Delhi

Lt. Gen. Suresh Sharma
Engineer-in-Chief (Retd)
Indian Army & Corps of Engineer
New Delhi

Dr. N. Gopalakrishnan
Director,
CSIR-Central Building Research Institute, Roorkee

Secretary
Dr. Shantanu Sarkar
Chief Scientist
CSIR-Central Building Research Institute, Roorkee

Management Council

Chairman
Dr. N. Gopalakrishnan
Director
CSIR-Central Building Research Institute, Roorkee

Members

Prof. Satish Chandra
Director,
CSIR-Central Road Research Institute, New Delhi

Mr. Ashish Pippal
Scientist,
CSIR-Central Building Research Institute, Roorkee

Dr. Shantanu Sarkar
Chief Scientist
CSIR-Central Building Research Institute, Roorkee

Dr. Narendra Kumar
Principal Technical Officer,
CSIR-Central Building Research Institute, Roorkee

Dr. Purnima Parida
Senior Principal Scientist,
CSIR-Central Building Research Institute, Roorkee

Head
Planning and Business Development,
CSIR-Central Building Research Institute, Roorkee

Dr. Shorab Jain
Principal Scientist,
CSIR-Central Building Research Institute, Roorkee

F&AO,
CSIR-Central Building Research Institute, Roorkee

Member Secretary
CoA/AO
CSIR-Central Building Research Institute, Roorkee

Research & Development Projects

Development of Low Energy- Low Carbon ECO Cementitious Binders Via Synergistic Use of Low Graded Industrial Wastes for Sustainable Development

Er. Rajesh Kumar

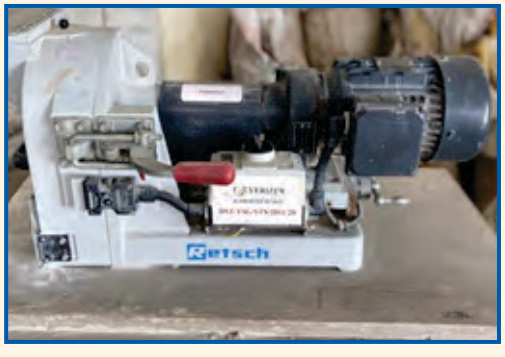
Objective:

- Selection of industrial waste raw materials for primarily feed composition in cement kiln,
- Mix proportion and Time- Temperature optimization for ECO- cements,
- Development of ECO-binders i.e., OPC based and CSAB based cements
- Evaluation of different cement phase formation (C3S/C2S ratio, C3S/C3A ratio, C2S/C4A3S ratio etc.)
- Studies of the thermodynamics of ternary CaO-SiO2-Al2O3 or quaternary system CaO-SiO2-Al2O3-Fe2O3 to understand the cement chemistry.
- Use of the developed ECO binders in certain building applications

Progress Highlights/ Significant Achievements:

Raw materials

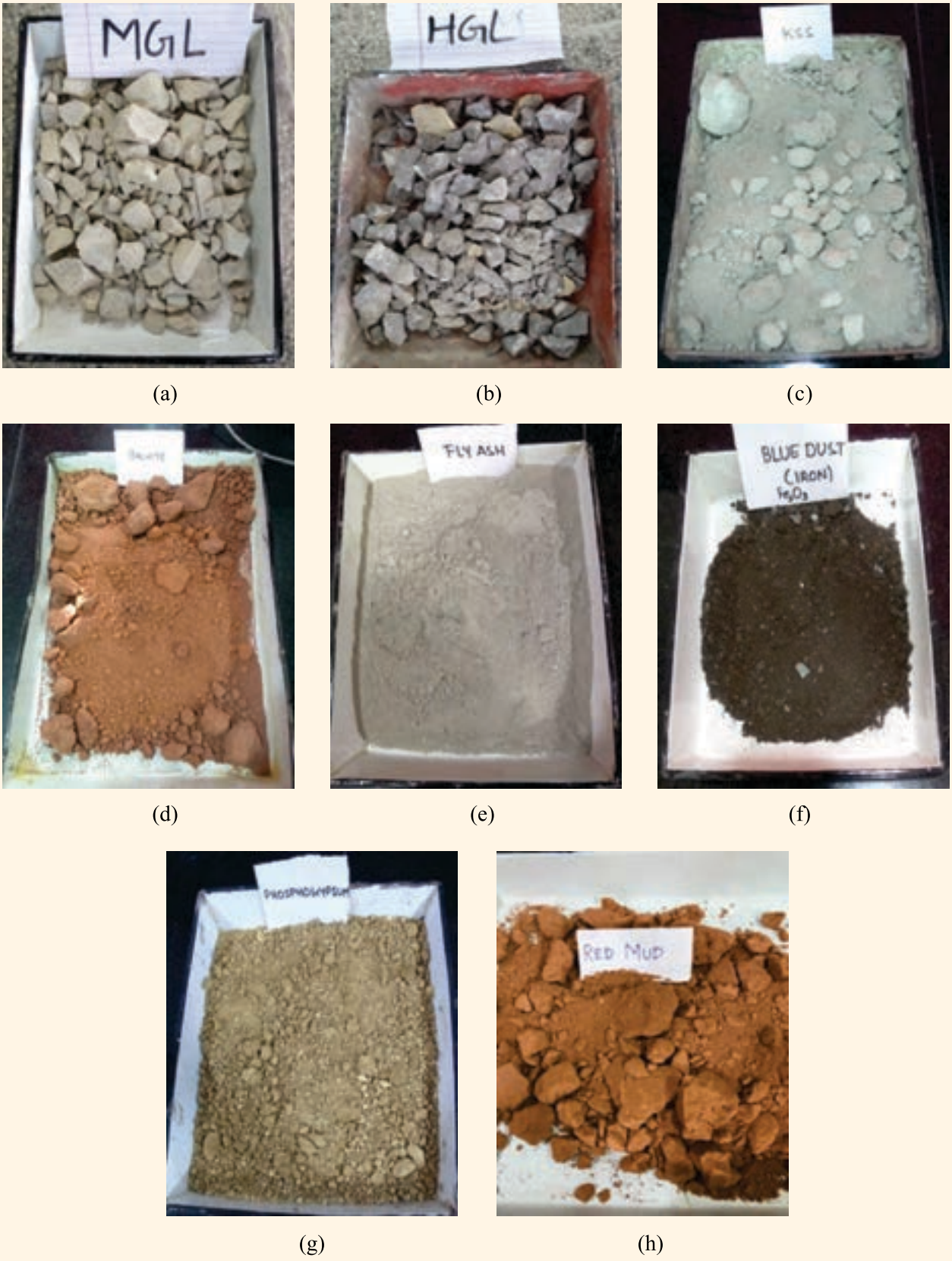
The raw materials used in this project are Morak grade limestone (MGL), High grade limestone (HGL), low grade stone slurry (LgSS/KSS), Class F- Fly ash (FA), Bauxite, Blue Dust, Red Mud and Phosphogypsum. These raw materials were collected from different parts of India. After the procurement of these raw materials, they were thoroughly dried to constant masses in an oven before use in the lab. The raw materials were pulverized using pulverizer and Ball mill as shown in Fig.1 (a, b). Fig.2 shows the pictorial representation of different raw materials. The pulverized raw materials were then sieved for size less than 75 µm using BIS standard sieve.



(a)

(b)

Fig.1 (a) Pulverizer (b) Ball Mill.



(a) (b) (c)

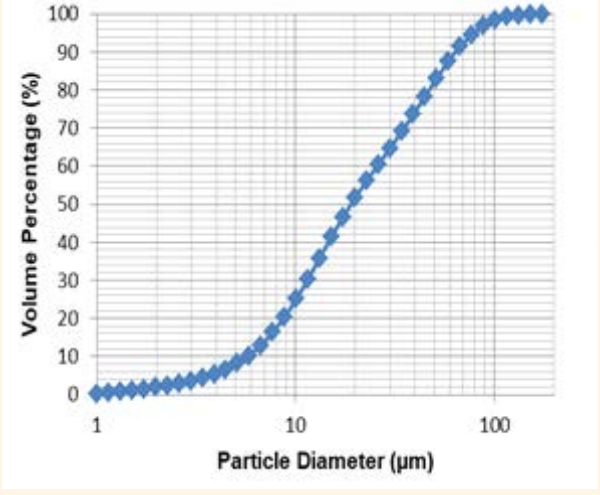
(d) (e) (f)

(g) (h)

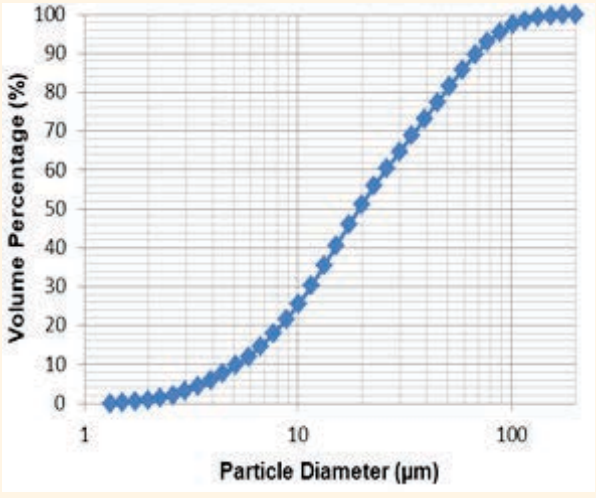
Fig.2. Pictorial representation of raw materials (a-h).

Particle size distribution analysis of the raw material powder was done via laser diffraction using a Horiba LA-920Particle Size Analyzer as shown in Fig.3. The powder sample was dispersed in isopropanol in an ultra-sonic bath for 1 min. Fig.4 (a-h) shows the particle size distribution curve of different raw materials.

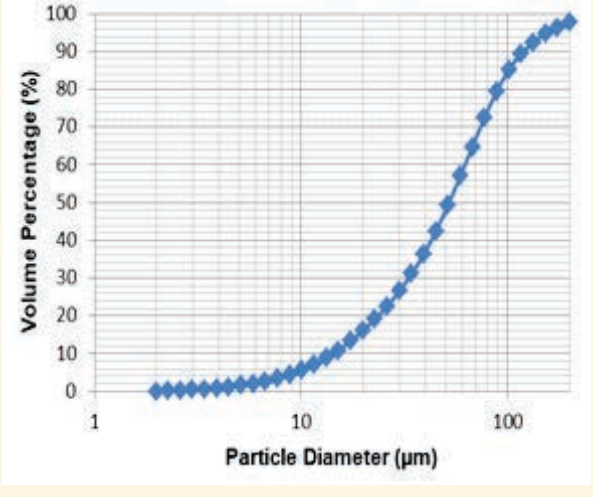
Fig.3. Particle Size Analyzer.



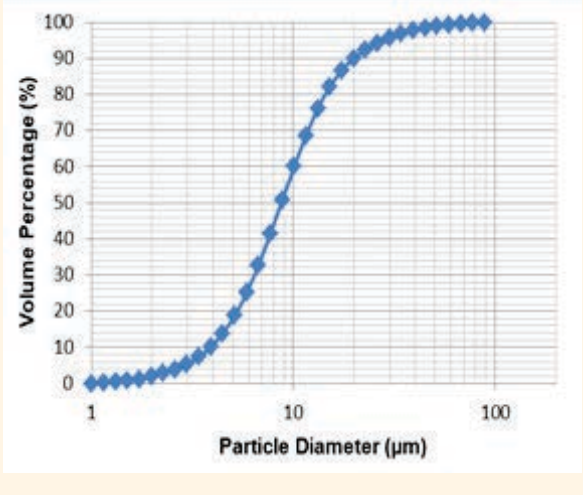
(a) Bauxite



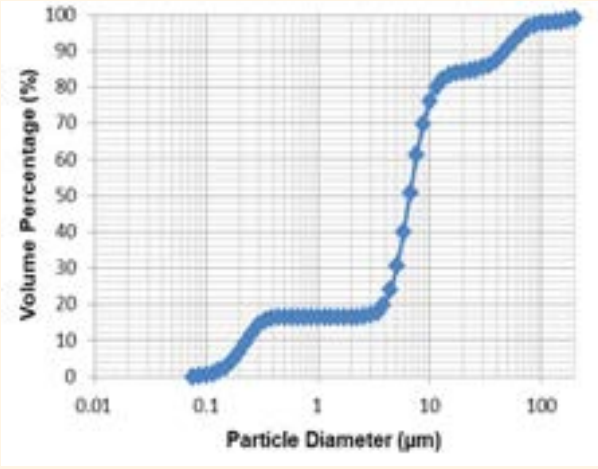
(b) HGL



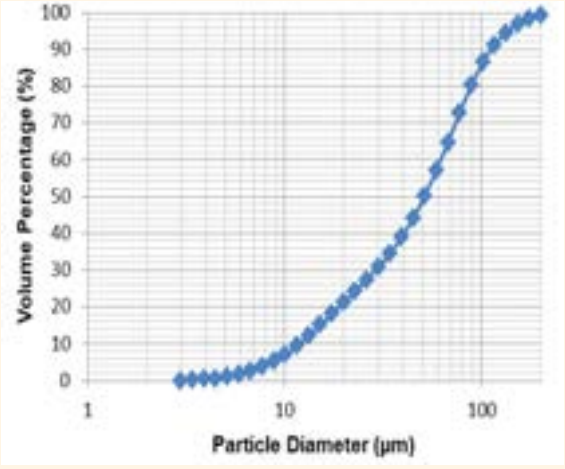
(c) Phosphogypsum



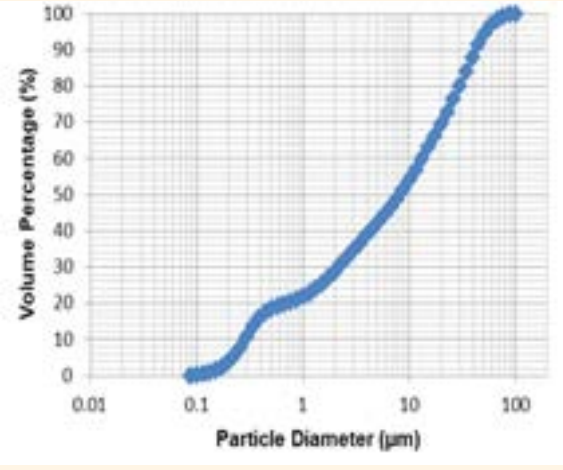
(d) KSS



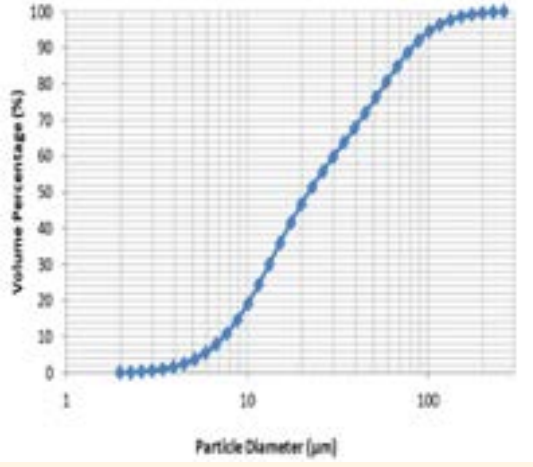
(e) MGL



(f) Blue Dust



(g) Red Mud



(h) Fly ash

Fig.4 Particle size distributionn of different raw material (a-h).

The chemical composition of raw materials was evaluated using X-ray fluorescence spectroscopy (make:Bruker, S4 Pioneer spectrometer). The estimation of chemical composition is important for predicting the possible Bougu's compound that will form during the sintering of raw materials. Table.1 present the oxides present in different raw materials.

Table.1 Chemical composition of raw materials

Compositions (wt%)	Raw Materials						
	MGL	HGL	KSS	Bauxite	Blue Dust	Fly ash	Phosphogypsum
CaO	37.85	57	36.4	0.03	0.5	7.12	31.8
SiO_2	23.5	0.5	29.3	0.36	0.5	57.29	0.5
Al_2O_3	2	0.1	0.8	55	0.2	28.58	0.1
Fe_2O_3	1.5	0.1	0.89	5	97	5.29	0.1
MgO	1.25	0.2	1.7	0.05	0.1	1.44	0.3
SO_3	0.25	0	0	0.1	1.1	0.28	44.9

Experimental trials for OPC

According to the chemical composition of each raw material, the mix proportions of raw material for the OPC preparation were calculated as per standard method (Taylor, 1989). The empirical modulus has been widely used in the cement industry because it is based on stoichiometry (Faure et al., 2019; Taylor, 1997). The quantitative phase composition is estimated using Bogues equation, which is as follows:

$$C_3S = 4.0710CaO - 7.6024SiO_2 - 6.7187Al_2O_3 - 1.4297Fe_2O_3$$

$$C_2S = -3.0710CaO + 8.6024SiO_2 + 5.0683Al_2O_3 + 1.0785Fe_2O_3$$

$$C_3A = 2.6504Al_2O_3 - 1.6920Fe_2O_3$$

$$C_4AF = 3.0432Fe_2O_3$$

The raw meal was mixed for 15 min to ensure that theraw meal was mixed well. Then, the prepare mixture was placed in mould and compressed to form cylindrical pellets. The pellets were dried for 24 h, and then were put into a high-temperature sintering furnace (make: CarboliteHTF 1800, Carbolite-Gero Limited, Hope Valley, UK) in an alumina crucible. The heating cycle involves, firstly, heating from 27°C to 900°C at temperature gradient of 8°C/min, holding the 900°Ctemperature for 30 min, after that, temperature increases from 900°C to target temperature of 1100°C, 1280°C, 1320°C, and 1400°C at 8°C/min and holding it for 90 min. Then the samples were taken out (Fig.5). The clinker was cooled rapidly using compressed air cooling to room temperature to prevent the formation of γ -C2S, which is a nonreactive phase, during the hydration reaction if the cement-clinker cooling is too slow (Cuesta et al., 2012; Wesselsky and Jensen, 2009). The sintered clinkers were ground to powder with the fineness less than 75 µm, being ready for the further characterization. In total; 45 mixes for Eco-cement were cast for further microstructural studies.

Test results

Isothermal calorimetry

The hydration heat evolution was investigated via isothermal calorimetry (make: TAM Air, TA Instruments) over 7 days at 20°C. Approximately, 5 g of powder was prepared in a glass ampule (20 mL) and hand-mixed with distilled water (w/c of 0.48) for 1 min. Subsequently, the sample was sealed and placed into a calorimeter for measurement. The heat release of the cements was monitored via isothermal calorimetry, as shown in Figs. 6 and 7. The exothermic reaction of OPC can be divided into four stages (Bullard et al., 2011): an initial reaction, an induction period, an acceleration period and a deceleration period. The initial reaction is often an exothermic reaction in all cements owing to the rapid reactions between the cement grains and water (Bullard et al., 2011).

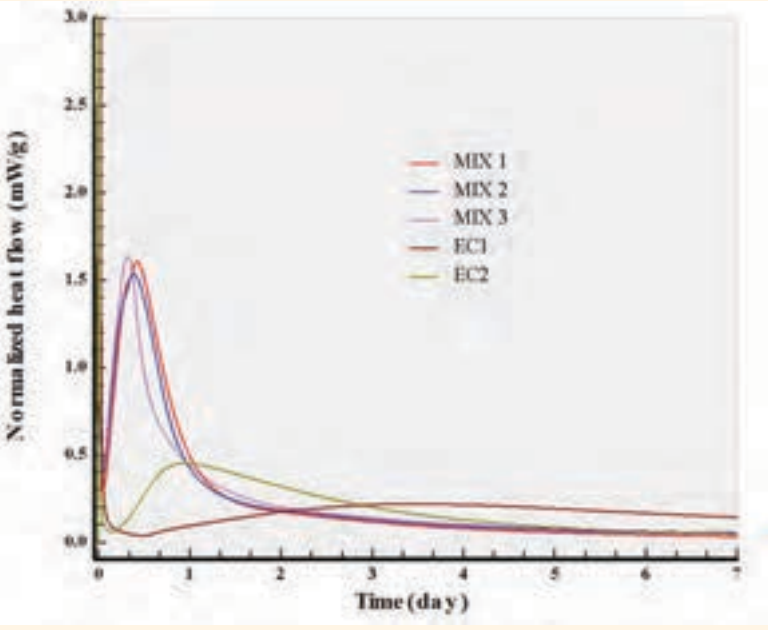


Fig.6 Isothermal calorimetry results for the cements: Rate of heat flow.

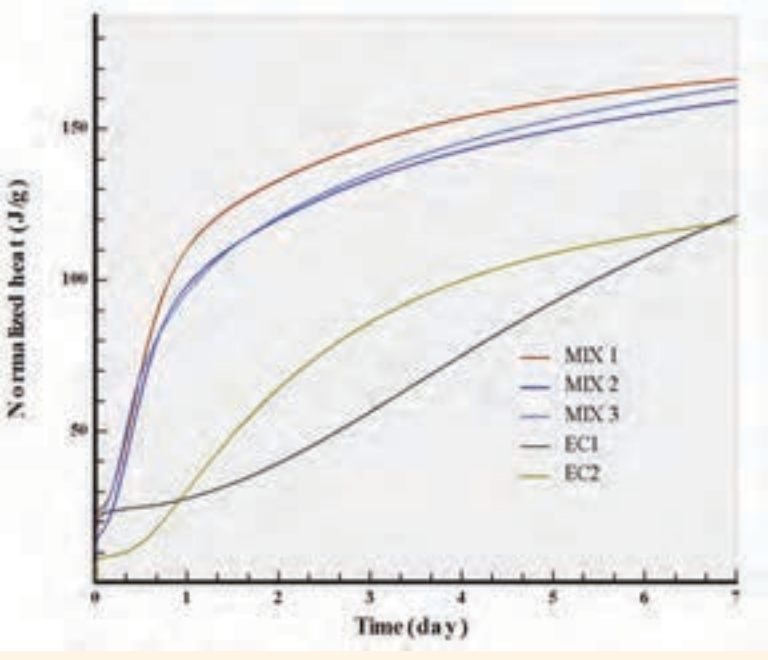


Fig.7. Isothermal calorimetry results for the cements: Cumulative heat released.

Some of the mix-proportions are described as,

EC1-*17% HGL+7.5% LgSS+ 52% MGL + 16% Fly ash+ 3.5% Red mud+ 4% Blue dust (73% Natural resources + 27% waste)*

EC2-24% KSS+ 66% Fly ash+ 5.5% Red mud+ 4.5% blue dust

(*4.5% Natural resources + 95.5 % waste)*

It was observed through Figs. 6 and 7that EC1 and EC2 cements resealed heat of hydration in optimum level and even increased after 7 days also. Further studies are going on.

Development of FBG Long Gauge Sensors for Structural Health Monitoring (Coordinating Lab: CSIR-CGCRI, Kolkata)

Dr. S K Panigrahi (CBRI part)

Objective:

Development of algorithm and implementation for damage identification in buildings using long gauge Fiber Bragg Grating sensors.

Progress Highlights/ Significant Achievements:

Long-gauge fiber optic sensors

The availability of long-gauge Fiber Optic Sensor has opened new and interesting possibilities for structural monitoring. Long-gauge sensors allow the measurement of deformations over measurement bases that can reach tens of meters with resolutions in the micrometer range. Using long-gauge sensors, it is possible to cover the whole volume of a structure with sensors, therefore enabling a global monitoring of it.

Strain Data for Vertical Beam

A vertical beam of cross-section 10,000mmx100mmx30mm is modelled in Ansys for analytical calculations as shown in Fig. 1.1.

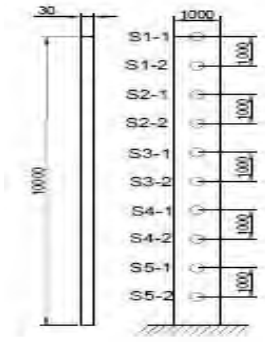


Figure 1.1: All dimension in

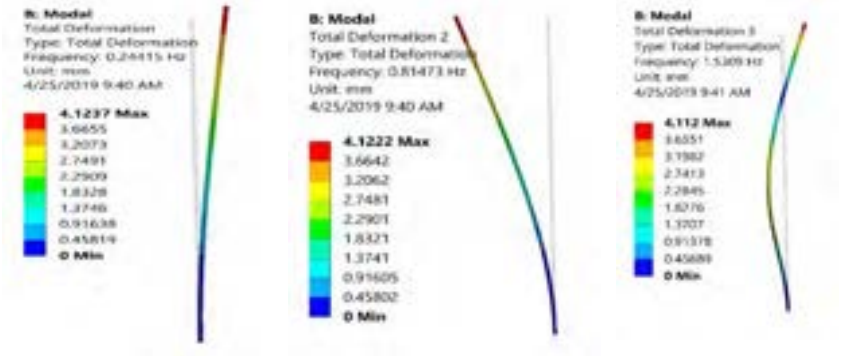


Figure 1.2: Modes shapes of vertical beam by numerical

The model analysis of vertical beam fixed at the bottom is carried out in Ansys and the first three modes shapes for the beam in shown in Fig. 1.2.

Strain Data Simulation for Long Gauge FBG sensors using ANSYS

Analytical strain data simulated using Ansys for the point S1. A damage cut of 100X5X10 mm has been introduced near the second sensor.

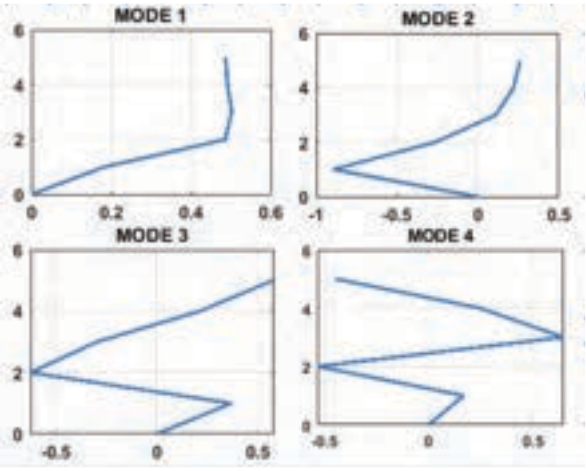


Figure 1.3: Undamaged Case

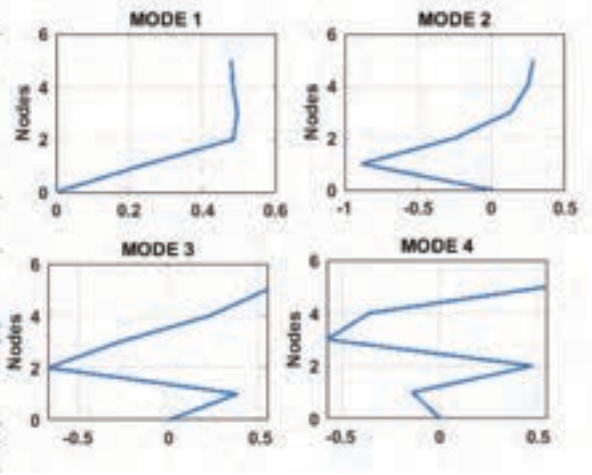


Figure 1.4: Damaged Case

Fig. 1.3 & Fig. 1.4 show the strain mode shapes for undamaged and damaged cases respectively.

Experiment using FBG

Experiment has been done on 8 storey steel structure using FBG sensors for structural Health Monitoring. The structure has been instrumented with FBG sensors to monitor the strain signature.

Instrumentation of Structure

Total height of the structure is 19.25 meter and the height of each floor is 2.75 meter. Instrumentation of the building has been done with a total of 9 FBG sensors. Three series of each FBG array is used on different columns to monitor the strain of the structure. Sensors were mounted on the 1st, 3rd and 5th floor as shown in figure 1.6 and sensor are placed 5.5 meter apart from each other on same column. Temperature-compensated FBG is used to monitor the strain experienced by the structure and extra load has been added to the different floors of the structure in order to change the parameter of the structure.

Figure 1.5: 8 Storey Steel Structure

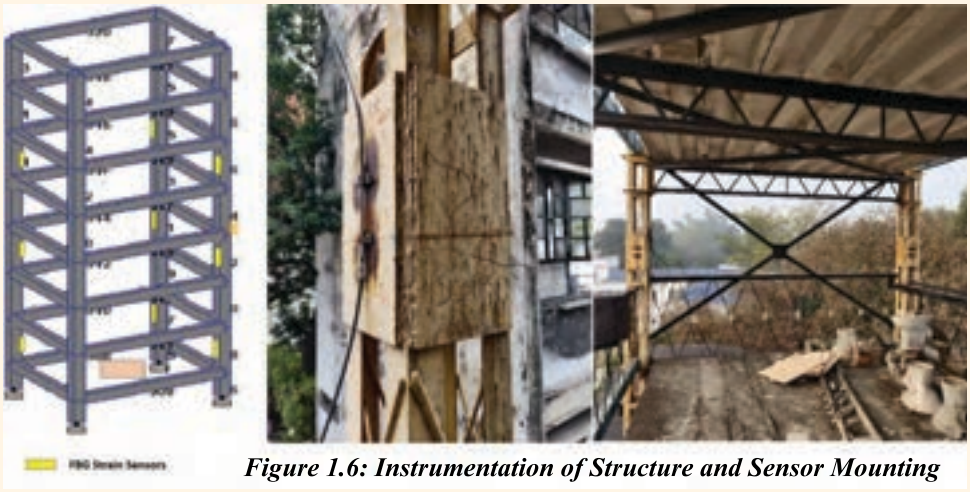


Figure 1.6: Instrumentation of Structure and Sensor Mounting

Experimentation and Analysis

Data has been collected at 500 Hz frequency sampling rate for 30 seconds duration. First strain data signature has been collected on ambient condition i.e., without any loading or excitation. To induce damage in the structure, extra mass of 900 Kg has been added on a floor of the structure. Different trials have been done by varying mass and changing the location.

Development of Innovative Cool Roof with Improved Thermal & Energy Performance

Dr. Kishor S Kulkarni & Dr. Ashok Kumar

Objective:

Development of innovative cool roofs options for improved thermal & energy performance.

Progress Highlights/ Significant Achievements:

- Cool roof is made of earthen pots and filled with lightweight concrete.
- Developed cool roof helps in improving thermal performance and indoor environment of the building and reducing energy demand ranging from 21% to 26% annually as compared to conventional RCC roof.

Experimental Investigation on Application of GGBS and Activated GGBS in AAC Block and Comparison with Conventional Versus Developed AAC Blocks and Its Real Time Thermal Performance

Dr. Ashok Kumar, Dr. Kishor S Kulkarni & Dr. Santa Kumar

Objective:

- To develop samples of AAC blocks on lab scale using different permutations (preferably 6 sets ranging from 15% replacement to 90% replacement) and suggest an optimum replacement level that can be commercialized using GGBS and activated GGBS.
- To test the acoustic, thermal, fire and other properties of the AAC block prepared using the suggested mix (CSIR-CBRI & Tata Steel) and to compare it against the normal AAC block. And also, to carry out performance study of the block.
- To carry out the simulation as well as physical construction of the proposed full-scale building over a period of time across all types of weather using energy simulation software using a normal AAC block supplied by Tata Steel as well as the blocks developed by CBRI using activated GGBS etc.

Progress Highlights/ Significant Achievements:

- Developed AAC blocks using GGBS and activated GGBS.
- Investigated Physical, Mechanical, Acoustic and Thermal Properties of developed AAC blocks.
- Performed energy simulation on the developed AAC blocks and compared with the red clay brick.

DST SHRI sponsored "Creation of Centre of Excellence on Conservation of Indian Heritage Structures at CSIR-CBRI, Roorkee"

Dr. Debdutta Ghosh, Dr. Manojit Samanta, Dr. Achal Mittal, Dr. P K S Chauhan, Dr. L P Singh, Dr. R K Verma, Dr. M. Samanta, Dr. S Maiti, Dr. A Aravind Kumar, Er. Hina Gupta, Dr. Siva Chidambaram & Dr. Santha Kumar

DST sponsored **Centre of Excellence for Conservation of Heritage Structures** at CSIR-CBRI, Roorkee **(under the SHRI programme of DST)** was virtually inaugurated by **Vice President of India, Shri M. Venkaiah Naidu** on Feb 10, 2021. It's a State-of-the-art facility creation conservation of Heritage Structures in India. It's one of its kind in India which will be demonstrating a comprehensive solution for various methodology and techniques to be used to safeguard these old structures. The techniques and methodology developed in the project will be very useful for the analysis, design, monitoring, repair, retrofit of any heritage structure in India. Moreover, the technologies could be used for any modern structure as well.

Objective:

Development of innovative cool roofs options for improved thermal & energy performance.

Objectives of the project:

- Assessment of seismic vulnerability of important structures
- Integrated non-destructive evaluation technique for heritage structure
- Cost-effective digital recreation of heritage structural geometry
- Development of physical twin of heritage structures for monitoring and performance evaluation
- Fire and smoke management inside temples and other crowded monuments
- Development of compatible and sustainable repair materials
- Effects of excavation/construction and exploration of subsurface features
- State-of-the-art facility creation for the center of excellence for conservation of Heritage Structures in India
- Training program on Bhagavan-A Search II

Vice President of India, Shri M. Venkaiah Naidu virtually inaugurating

Aim of the project:

Heritage structures built using traditional methods in the distant past are often prone to dislocation and damage due to natural disasters such as earthquakes, wind, impact, and environmental factors such as climate changes, air pollution, and groundwater pollution. These structures do not correspond to modern technologies, and their architecture and materials deteriorate over time. India, being a tropical nation with a different physical and biological environment than other ancient sites around the world, requires an environment-specific scientific solution for the conservation and restoration of heritage structures.

The Archaeological Survey of India has identified over 3650 historic structures, archaeological sites, and relics of national significance. Various state archaeological agencies, the CPWD, the Railways, and other entities preserve many historical buildings that range from ancient mounds and sites that show evidence of ancient settlements, temples, mosques, tombs, churches, cemeteries, forts, palaces, step-wells, rock-cut caverns, and secular architecture. The government of India considers the preservation of historic architecture as a cultural goal to advance the country's history, civilization, and aesthetic accomplishments.

To preserve these structures, proposed solutions for their conservation and restoration are being field-tested on selected live structures. Criteria and an appropriate restoration plan are being established for clusters of historic sites across India. Guidelines for the systematic conservation and restoration of heritage structures are being prepared based on existing/generated knowledge and created solutions. These guidelines would benefit many government programs such as HRIDAY, and they would also ensure public safety and protection of human life in case of an unexpected collapse of deteriorating cultural structures.

In conclusion, India has a vast number of heritage structures that require conservation and restoration. The development of environment-specific scientific solutions and guidelines is crucial to preserve these structures for future generations and to promote India's rich cultural heritage.

Utilization of Marble Waste to Develop Cost-Effective Sustainable Building Materials

Dr. (Mrs.) Rajni Lakhani

Objective:

- To develop the formulation for Bricks/mosaic/ concrete tiles (flooring/wall) and paver blocks
- To develop the formulation for Autoclaved aerated concrete
- Scale up of the developed process up to pilot level

Progress Highlights/ Significant Achievements:

Experimental Study:

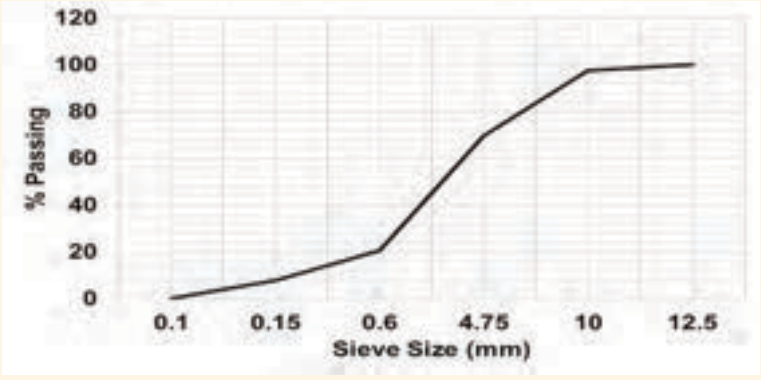
(I) Collection and preparation of Marble waste:

Marble stone waste collected from dumping site where the waste dumped after generated during cutting and shaping of marble blocks; was processed and characterized for the purpose of the replacement of conventional river sand and coarse aggregates in cement mortars and concretes (Fig 1). Particle size analysis was done (Fig. 2). The physical properties were determined, as per IS 2386. Wet marble sludge was acquired from a firm which processes marble slabs in an industrial area of Udaipur. The powder was sundried, hammered to reduce the dried blocks to a powder passing through 0.300 mm sieve. The physical properties like specific gravity, bulk density, water absorption, chemical composition and fineness modulus of powder have been determined (Table 1 and 2).

(a) (b)

Fig. 1 Processed Marble Waste(a)Aggregate and (b) Powder Waste

(a)



(b)

Fig. 2. Particle Size Distribution of (a) Marble slurry (b) All in aggregates

Table1: Physical properties of marble cutting waste

Characteristic		Value	Code/Method
Colour /Appearance		White	Visual inspection
Bulk density	Loose	1.69 kg/L	IS 2386 (iii): 1963
	Rodded	1.83 kg/L	
Specific gravity, G_k (SSD)		2.70	IS 2386 (iii): 1963
Water absorption		0.05 %	IS 2386 (iii): 1963
Impact value		22%	IS 2386 (iv): 1963
Los Angeles abrasion value		34.87%	IS 2386 (iv): 1963
Porosity		45%	----------

Table 2: Physical properties of marble powder waste

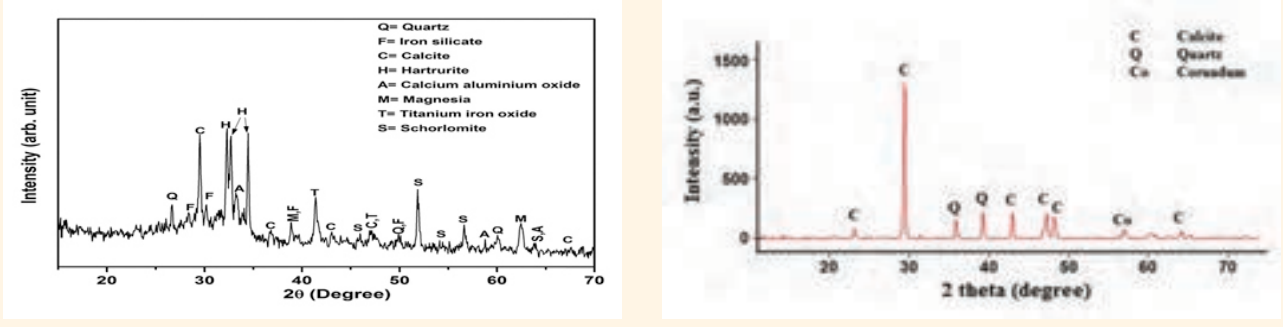
Characteristic	Value
Colour	Light Gray
Specific gravity	2.63
Water absorption (%)	0.97
Fineness modulus	1.45
Bulk density (kg/m^3)	520
Specific Surface Area (kg/m^2)	415

Table 3: Chemical composition of PPC and marble powder

Composite	PPC	Marble Powder
CaO (%)	43.96	55.92
SiO_2 (%)	34.85	25.04
MgO (%)	2.66	5.56
Al_2O_3 (%)	10.65	7.39
Fe_2O_3 (%)	3.56	11.09
K_2O (%)	1.10	4.46
TiO_2 (%)	-	1.03
P_2O_5 (%)	-	0.95

XRD

XRD studies of waste marble powder and PPC was done (Fig 3). XRD determines different phases in anhydrous cementitious materials with a good degree of precision. X-Ray Diffraction analysis, showing the constituent phases of PPC cement are shown against Fig. 3. XRD qualitatively identifies the phases such as calcite, dolomite etc. in the marble powder. However, waste marble powder showed the presence of calcite in a major amount. Presence of quartz and corundum in minor amount was also observed.



(a) (b)

Fig. 3 XRD pattern of (a) un-hydrated PPC cement and (b) marble powder

Achievements:

Non-modular brick

Bricks are the most important building unit which are being used in construction industry all over the world because of their high strength and durability. Bricks are either load bearing or non-load bearing member of the structure. There are two methods of manufacturing of bricks, i.e., fired process or conventional method and unfired process. The conventional method is highly energy consuming method and had large carbon footprints. About 2.0 kWh of energy consumption and 0.41kg of carbon dioxide is being released per brick in clay bricks manufacturing process. The conventional bricks are fired in the kiln at higher temperature (900-1100˚C). To maintain this temperature, large amount of fuel in the form of wood, coal, biomass etc. is needed to be burnt in the kiln causing serious issues of air pollution. The unfired process of bricks manufacturing is being used to mitigate the large carbon footprint. In the unfired process, the bricks are manufactured by the vibro-compaction or compaction only. The Bureau of Indian Standards (BIS) has classified the bricks in different classes depending on their compressive strength. According to IS: 16720 the bricks vary from class 5 to 15, in which every single class denoted their corresponding wet compressive strength (MPa.) (Table 4) The bricks are also classified based on their sizes, modular bricks (190*90*90 mm) and non-modular bricks (230*110*70 mm).

In this study marble waste were used as a replacement of natural aggregate. Mix proportions for the preparation ofnon-modularbrick of size (LxBxH mm) as 230x110x70mm, have been optimized. Different physico-mechanical properties of the non-modular brick have been determined as per IS: 16720 (Table 5). On the basis of average wet compressive strength; non-modular bricks of different class were finalised (Fig 4).

Table 4: Class of pulverised fly ash- cement brick (Cl. 4 and 8.4 of IS: 16720)

Sl. No.	Class designation	Average 28 days - compressive strength (MPa)
1.	15	15
2.	12.5	12.5
3.	10	10
4.	7.5	7.5
5.	5	5

Thus, in the current project; cost effective bricks with crushing strength of 5 to 15 MPa have been developed.

Table 5: Physico-mechanical Properties of non-modular brick

Properties of Tiles	Brick	IS: 16720
Dimensions (LxBxHmm)	230x110x70mm	230x110x70mm
Water absorption (%), as per IS:3495 Part II	10	20% Max. up to class 10; 15% Max. for higher class
Wet compressive strength (MPa), as per IS:3495 Part I	5.5-16.5	Class 5 to Class 15
Drying shrinkage (%), as per IS: 4139	0.04	< 0.05 %

Fig. 4. Developed non-modular bricks using marble waste

Damage Detection, Assessment and Novel Retrofit of Buried Sewerage Systems (Work Package 03)

Dr. R. S. Bisht

Objective:

- To develop damage detection and assessment strategies for buried sewerage systems
- To develop novel retrofitting strategies for buried sewerage systems
- Laboratory trials and field implementation of the developed strategies

Progress Highlights/ Significant Achievements:

The conventional retrofitting method of buried sewer pipe requires heavy machinery, intensive manpower, and a longer time for rehabilitation. Such methods may also damage the nearby infrastructures and landscape. The present study explores an integrated trenchless solution for damage identification and mechanized retrofitting of domestic buried sewerage pipelines of diameters ranging 75 mm to 300 mm. A front-mounted camera of the retrofitting system assesses the damage inside the sewer pipes. The damaged part of buried pipe is retrofitted by impregnating a glass fiber reinforced polymer (GFRP) composite sheet with 100:16 epoxy and hardener ratio. The wrapping of the GFRP sheets on damaged part is done by inflation and deflation technique with a cylindrical rubber bladder connected by a flexible rod to ensure pipe bending. The retrofitted sewer pipe can be resumed after 3-4 hours of applying the impregnated GFRP composite.

Materials and Methods:

Materials

Considering the suitable features of fiber composites wrap for strengthening of civil structure, different fiber composites and epoxy resins are selected to strengthen the buried sewer pipe. Fiber composites are broadly categorized into (i) glass fibers composites (GFRP), (ii) carbon fibers composites (CFRP), and (iii) basalt fibers composites (BFRP). After going through the cost and strength-wise, the GFRP and BFRP are most suited and opted as suggested in the literature. Epoxy resins are generally used as a polymer matrix material for binding the composites with the host pipe for extra strengthening. Epoxy resin can also be effectively used for filling minor cracks. A suitable epoxy resin selection is key in retrofitting buried sewerage pipes. After the extensive comparative study on composites and resigns, the GFRP sheet of 925 GSM and commercially available epoxy GY 250 and hardener K 16 in the ratio of 100: 16 have been used to retrofit the damaged part of the sewer pipe. The impregnated GFRP with epoxy/hardener mix is wrapped manually to evaluate the performance of the mix ratio and GFRP.

The manual retrofitting of epoxy/hardener mix impregnated on GFRP shows good adhesion on the bottom side of the sewer pipe. However, the upper side of the pipe portion showed difficulty in adhesion with frequent delamination and air voids. This is a major drawback of manual retrofitting, which was taken care of using the inflation and deflation-based retrofitting technique discussed in the next section.

Mechanized inspection and retrofitting methods

The impregnated GFRP was applied to the desired location inside the sewer pipe by inflation and deflation technique of rubber bladder. The coated GFRP with epoxy and hardener mix was wrapped on a partially inflated cylindrical rubber bladder. The whole system was inserted inside the sewer pipe and inflated up to 35 psi until the rubber bladder was pushed and in contact with the inner sewer pipe surface. After that the bladder was deflated and the system was retracted from sewer line. Figures 1a and 1b show inflation and deflation of rubber bladder, respectively.

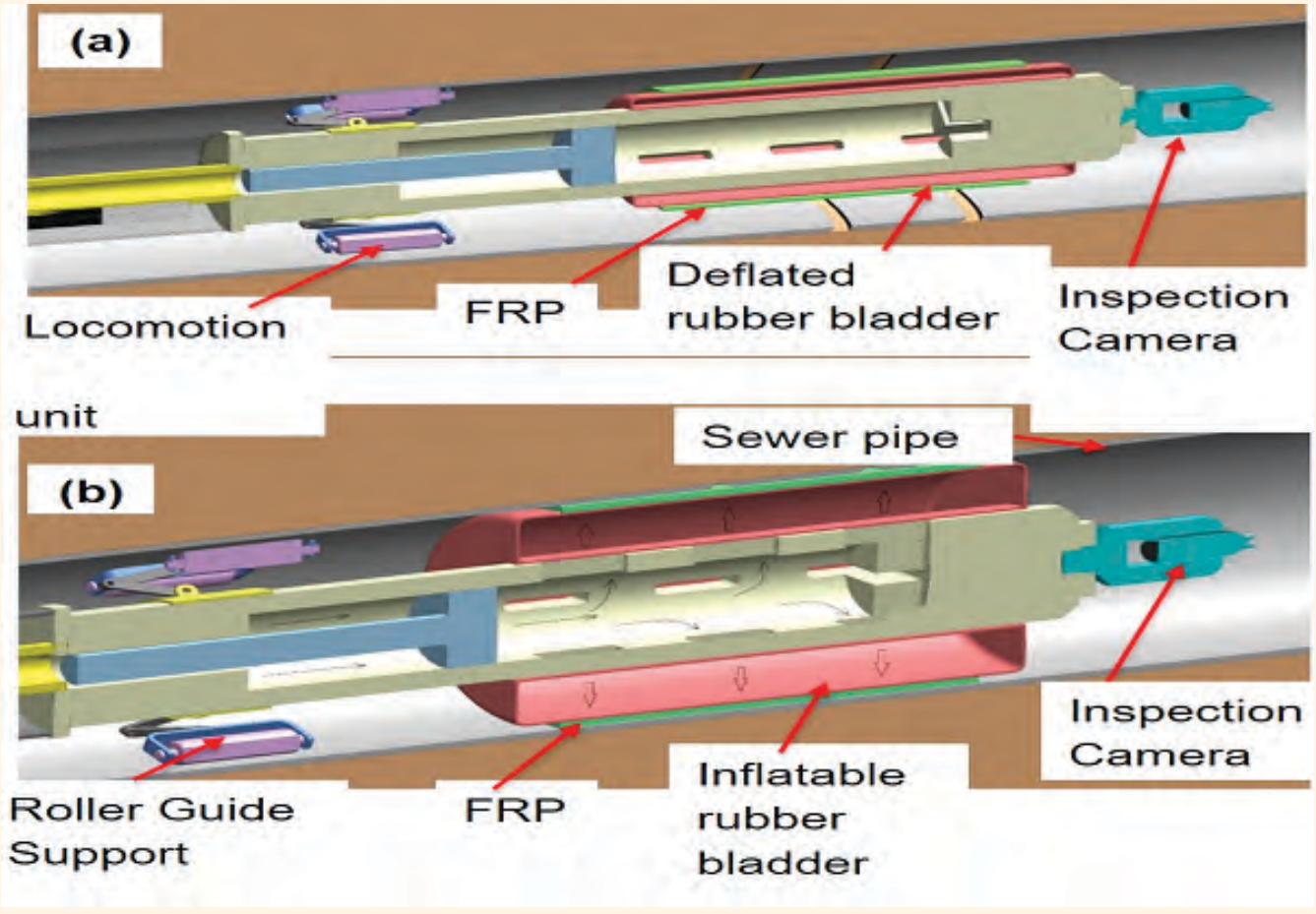


Fig. 1. Inflation and deflation mechanism concept of rubber bladder.

The mechanized platform for damage identification of underground sewer pipelines is shown in Figure2. The platform consists of specially designed wheels to move along a curved surface inside the concrete sewer pipe. The front part has IP 65 rating video camera system for damage location and identification. Figure 3 shows the mechanism for the movement of the retrofitting system inside pipe bends. Figure 4 shows the complete inspection and retrofitting kit for sewerage pipelines.

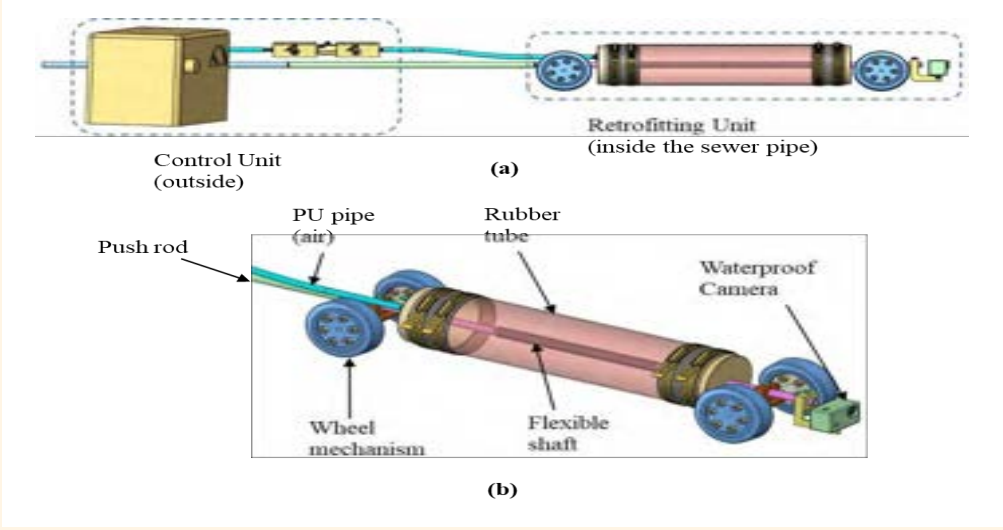


Fig.2. (a) Retrofitting unit and control unit (b) Assembly design of the retrofitting system.

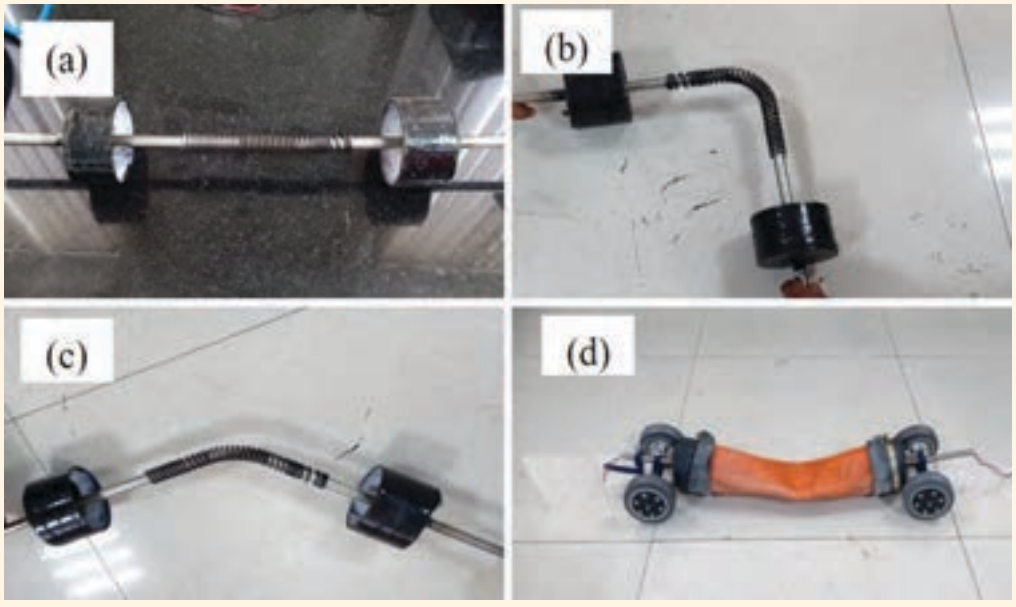


Fig. 3. Flexible shaft incorporation in retrofit mechanism (a) straight, (b) sharp bending, (c) curved, (d)prototype assembled unit.

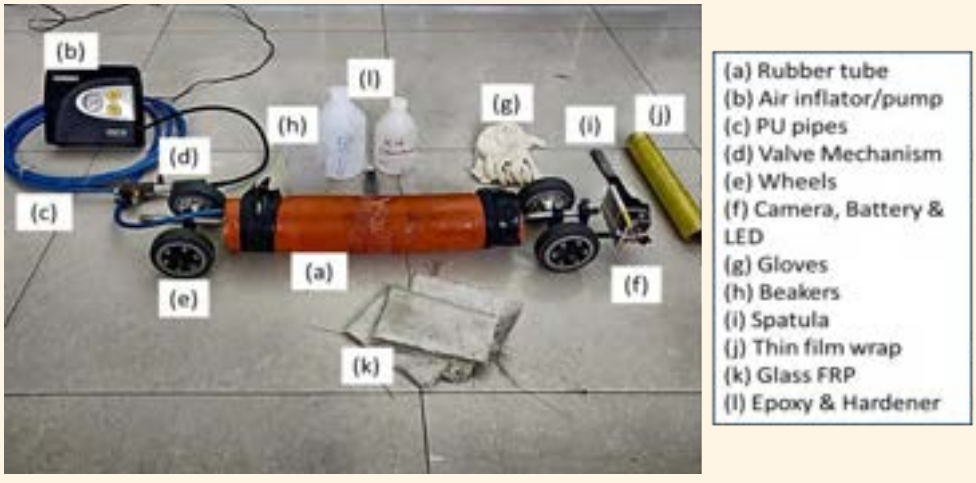


Fig. 4.The integrated mechanized retrofitting system.

Field trial and Implementation

During field trials, the sewer pipe retrofitting requires step-wise step procedures for successful implementation. After cleaning the internal pipe surface, the required FRP mat is impregnated with the specified epoxy resin and hardener ratio (100:16). Then the prepared FRP mat is folded and wrapped around the partially inflated rubber bladder, which is cylindrical in shape. The wheel locomotion system with FRP wrapped bladder is introduced into the host pipe section in the next step. The passive wheel can be easily pushed to the desired fault location of the pipe, and if it is required, a push rod may be additionally used. Then the bladder can be gradually inflated using compressed air to press the impregnated FRP against the host pipe internal wall. The excess epoxy-resin can penetrate into the pipe's cracks and voids, and the remaining one creates a tight-fit, permanent bond against the host pipe. Once the epoxy mixture starts curing, the bladder system is deflated from outside control unit and removed from the host sewer pipe just after the pot time (about 45 minutes). The sewer can be used after the complete curing (3 hours) of the retrofitted portion of the pipe.

Figures 5 and 6 show the mechanized form of wrapping GFRP sheet on cracked/broken surface of a concrete and plastic sewer pipe with the help of inflation and deflation technique by rubber bladder. Figure 5 shows the retrofitting of 250 mm concrete buried sewer pipe, whereas Figure 6 demonstrates the retrofitting of 150 mm PVC pipeline. The setting/curing time of epoxy and hardener mix is 3 hours which has to be given for proper setting of epoxy/GFRP on cracked sewer surface. The results are robust and high-quality retrofitting has been achieved by the developed mechanized retrofitting system. The demonstration and working concept of the developed retrofitting kit has also been conducted as shown in Photo (Figure 7).

Fig. 5. Retrofitting of 250 mm concrete buried sewer pipe

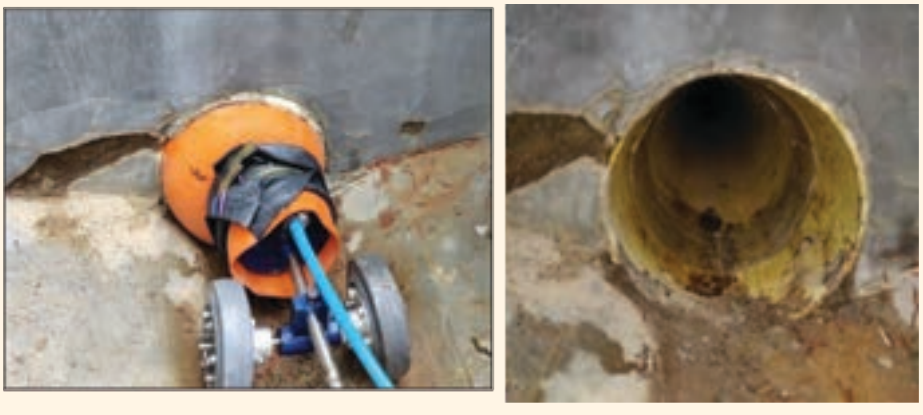


Fig. 6. Retrofitting of 150 mm PVC buried sewer pipe

Fig. 7. Concept demonstration of the developed retrofitting kit

Geotechnical Novel Solutions for Underground Infrastructures

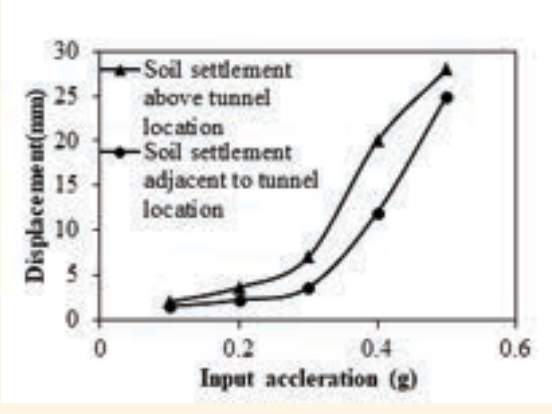
Dr. S. Ganesh Kumar

Objective:

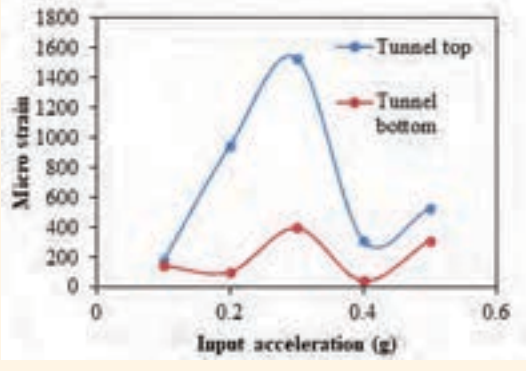
- Assessment of underground soil – structure interaction under seismic conditions

Progress Highlights/ Significant Achievements:

- Studies on Tunnel soil structure interaction for partially saturated ground (50% saturation) was studied under repeated shaking conditions



(a) Soil displacement during testing



(a) Strain development in tunnel model

(c) Tunnel Displacement

(d) Tunnel failure image

- Occurrence of soil densification due to repeated loading induces continuous generation of pore water pressures from bottom to top
- In 50% saturation, generation of pore water pressures were observed from bottom to top having maximum pore pressures at bottom and minimum at top
- Increment in pore pressure generation under repeated loading induces increment in strains in tunnel system
- Comparatively maximum strains were found higher at top than at bottom portion of the tunnel system

Study on Rates and Ratios used in the Construction Sector and Capital Formation/ Improvements in Rates and Ratios used in Estimation of Gross Value Added (GVA) of Construction Sector and Capital Formation

Dr. Ashok Kumar, Dr. Navjeev Saxena & Dr. Kishor S Kulkarni

Objective:

- To study expenditure (or proportions) in respect of various materials (e.g. Cement and cement products, Iron and Steel casting and forging (including steel bars, angles, frames etc.), wood and wood products except furniture, glass and glass products (glass panes, etc.), other non-metallic mineral products excluding cement (such as bricks and tiles etc.), bitumen, marble/Kota stones/ tiles, wooden furniture, iron furniture, and others used in construction sector as well as the factor inputs like labour, hiring charges, rentals for construction related machines / equipment etc. in different regions and/or states;
- To identify certain weights for combining the cost estimates for various types of construction activities to arrive at the cost composition for the estimates for various types of construction activities to arrive at the cost composition for the construction sector;
- To estimate the percentage recycled bricks out of total bricks used in construction;
- To estimate the consumption of various construction materials by different states for state-wise allocation of GVA construction etc. Scope: The scope is limited to cover residential, commercial and other typology of buildings, roads, bridges etc. in different regions and/or states

Progress Highlights/ Significant Achievements:

- The field survey data collected from the 121 representative cities and covers 1276 construction projects located across the Northern, Southern, Eastern and Western regions of India.
- Quantity of construction materials used in buildings, and other infrastructure, etc. and factors / percentages of different components is determined.
- Percentage recycled bricks and other materials used in construction by different states is evaluated.

Assessment of Tunnel Deformation Induced by Adjacent Deep Excavation and Counter Measures

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit
Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR)
& Dr Anil Swaroop (CIMFR)

Objective:

Predicting underground tunnel deformation due to adjacent deep excavation and determine suitable countermeasures to alleviate deep excavation effects on existing tunnel.

Progress Highlights/ Significant Achievements:

A finite element model was built using PLAXIS 3D software to study the objective of the project. Hardening soft soil model was adopted for the analysis. Model parameters was validated using the field data. Comparison of field and calculated settlement on ground surface development is shown in Fig. 1. It shows that developed model is in good agreement with the field values. Therefore, the developed numerical model can be adopted for the study. Furthermore, comparison between calculated settlement profile of the building and greenfield analysis shows that presence of building slightly affects the settlement profile (Fig. 2).

In order to study the response of existing tunnel to adjacent deep excavation under different conditions analysis were carried out. Different conditions that are considered for the study are, soil conditions (homogenous and layered), cover depth to tunnel diameter (Hc/D) ratio and excavation depth to tunnel diameter (Ed/D) ratio.

Boundary conditions considered for the model is 175m×175m×50m, size of the excavation is 25m×25m and maximum depth of excavation varies from 9m to 13m. 800mm thick diaphragm wall has been considered as retaining wall without any support. Soil parameters considered for the analysis is given in Table 1.

Tunnel response by varying Hc/D and Ed/D at invert at crown and at springline are given in Fig. 3 and Fig. 4 respectively. Typical numerical model and tunnel response is given in Fig.5.

Further studies will be done by changing the size of the excavation and introduction of support system to retaining wall.

Table 1. Input parameters for HSS model

Type of soil	N_{55}	γ	γ_{sat}	c_u	Φ'	G_o^{ref}	$\gamma_{0.7} \times 10^{-5}$	ν	$E_{50}^{ref} \times 10^4$ kPa	$E_{oed}^{ref} \times 10^4$ kPa	$E_{ur}^{ref} \times 10^4$ kPa	m	e_0	G	$k_x = k_y$ (m/day) $\times 10^{-2}$	k_z(m/day) $\times 10^{-2}$
ML	44	16.5	18.6	4.6	31.8	459422	4.73	0.3	11.58	11.58	34.75	0.67	0.61	2.63	4.32	1.44
CL	44	17.1	20.0	41.6	30.8	196293	23.2	0.3	2.95	2.06	8.85	1.00	0.56	2.65	0.86	0.29
SM	44	16.4	20.1	0.0	33.2	127970	34.4	0.3	2.98	2.98	8.96	0.67	0.60	2.65	8.64	2.88

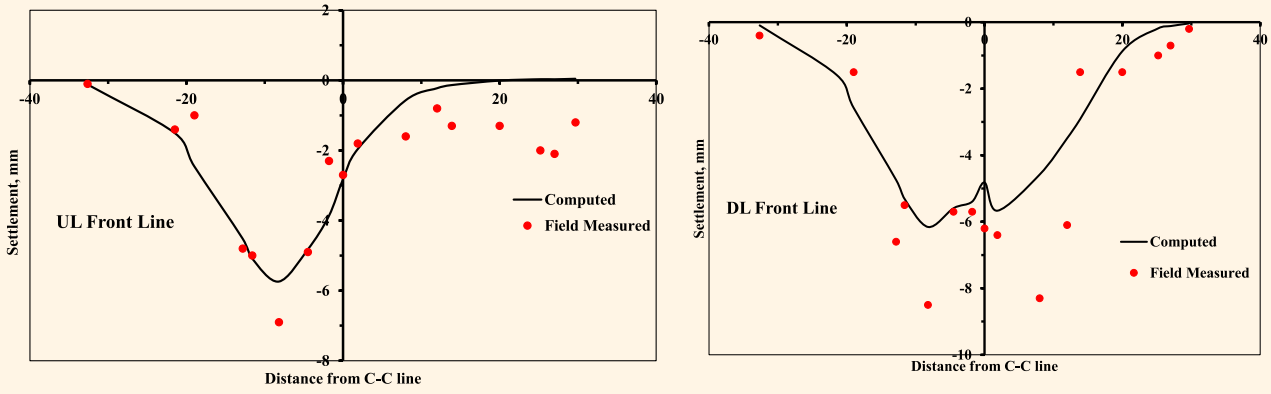


Fig. 1: Comparison of field and calculated settlement on ground surface development

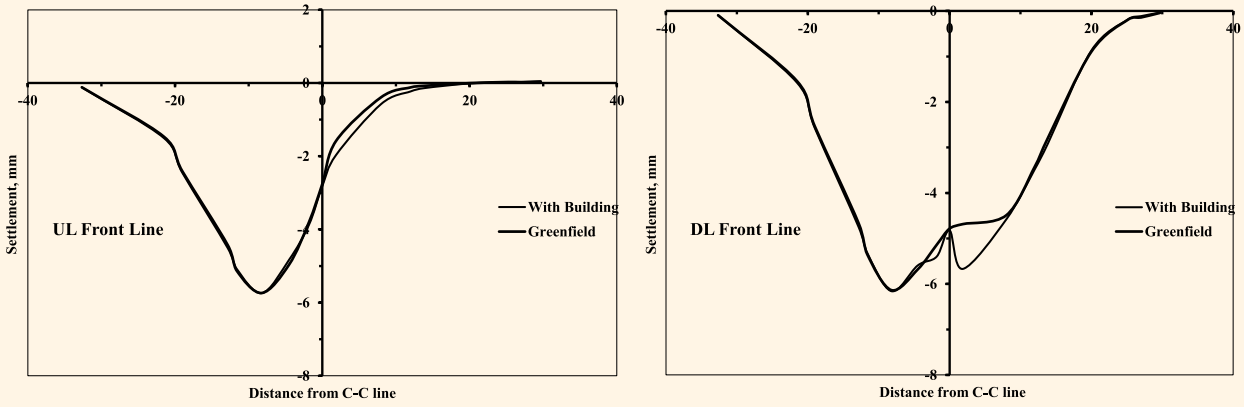


Fig. 2: Comparison between calculated settlement profile of the building and greenfield analysis

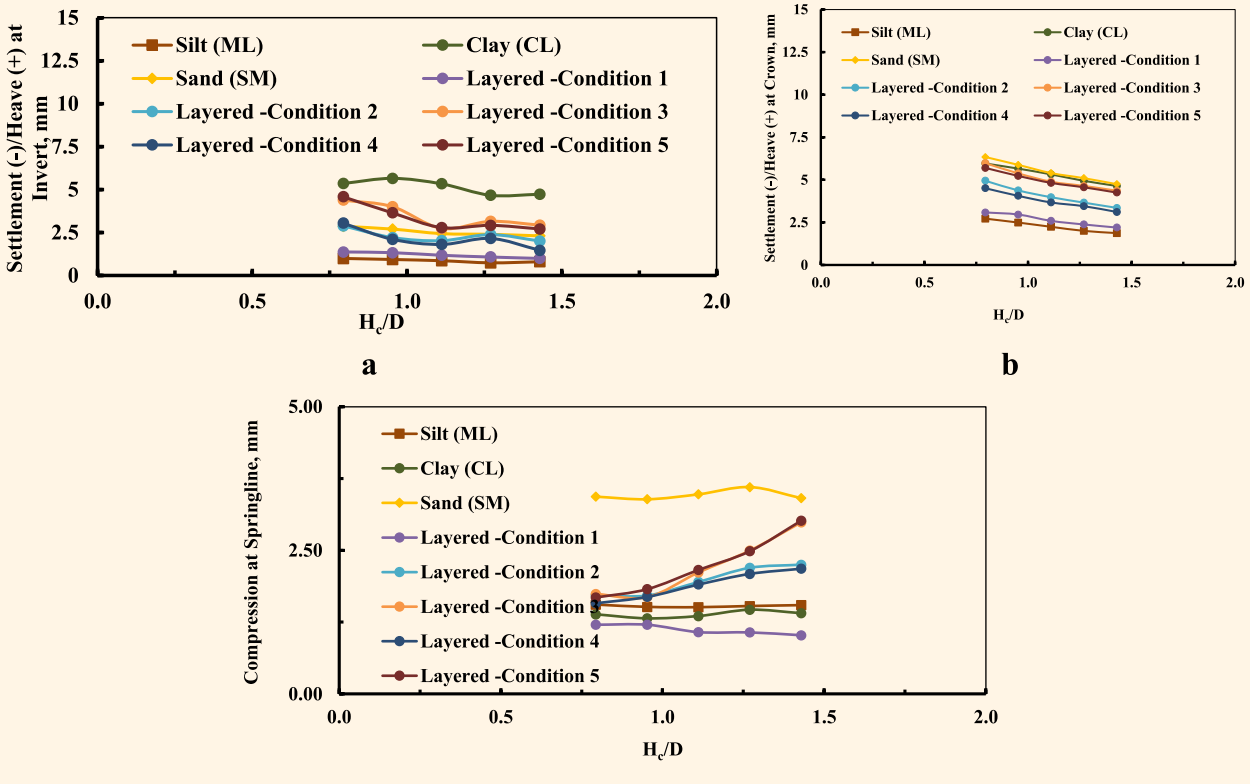
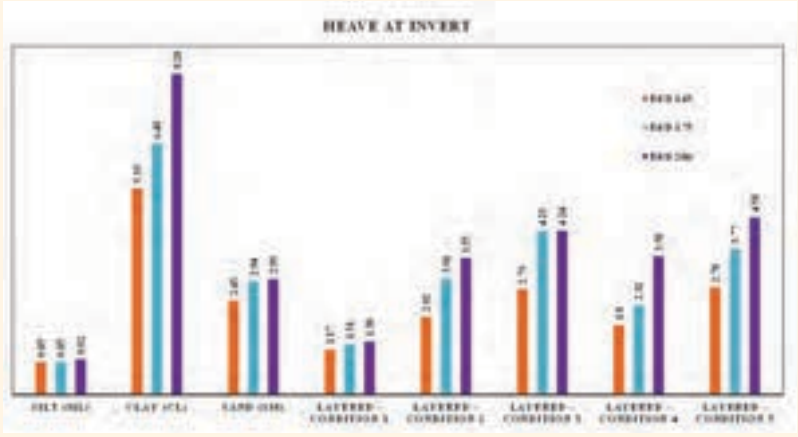
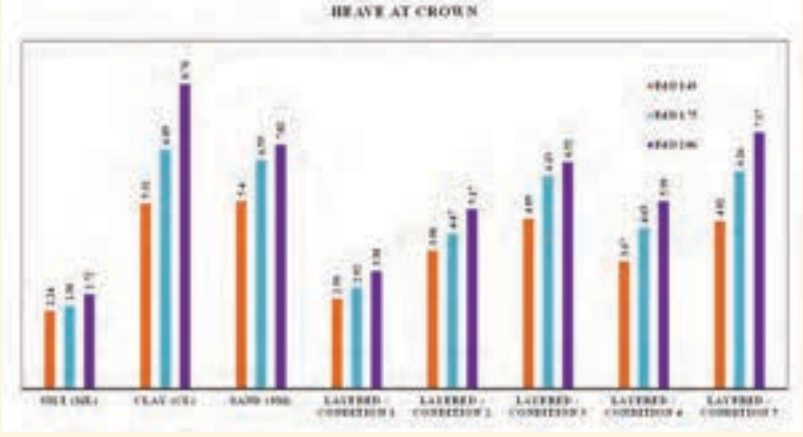


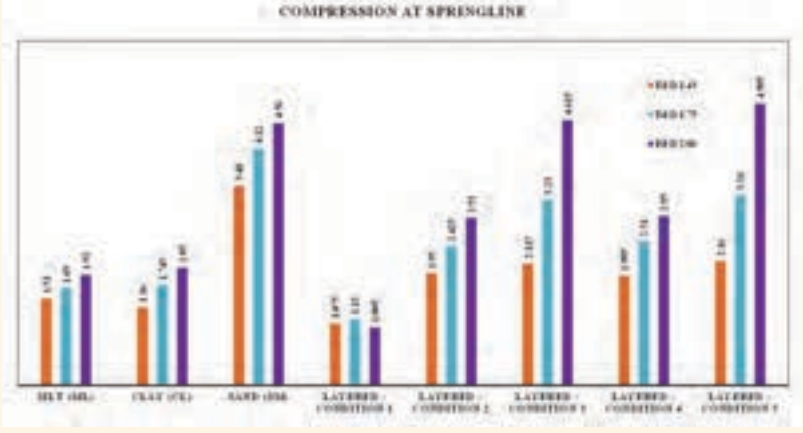
Fig. 3: Tunnel response by varying H_c/D a) at invert b) at crown & c) at springline



(a)



(b)



(c)

Fig. 4: Tunnel response by varying E_d/D a) at invert b) at crown & c) at springline

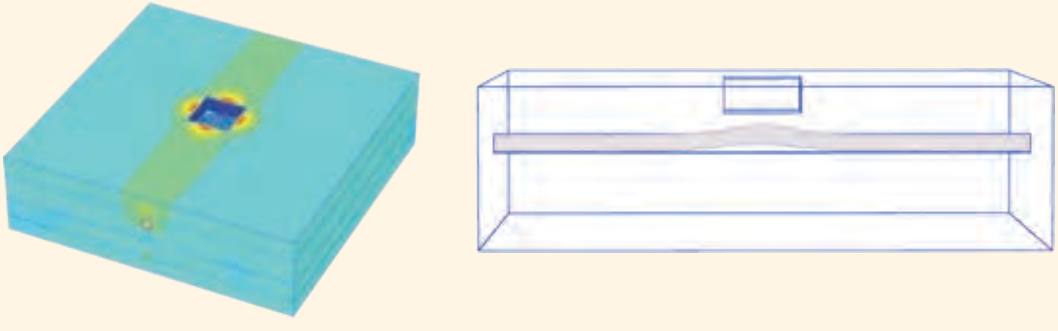


Fig: 5. Typical model and tunnel response

Semiempirical Method for Predicting Tunneling Induced Settlements

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit, Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR) &
Dr Anil Swaroop (CIMFR)

Objective:

Development of a semi empirical method for the prediction of surface settlement due to tunneling.

Progress Highlights/ Significant Achievements:

Numerical model was developed using finite element software [PLAXIS Three Dimensional, 2018]. Considering the symmetry of the tunnel, only one half of the tunnel was modelled in the numerical model. The dimensions of the model were considered as 100mx100mx50m, so the boundary effects can be minimized. The longitudinal and transverse dimensions exceed 15D and in z direction the model extends to more than 5D under the axis of the tunnel. The boundary conditions are such that, lateral movements were restrained in the sides and at the bottom, both horizontal and vertical displacements were restricted. Groundwater flow is open in the vertical boundaries and closed at the bottom. Top plane was kept free from displacement constraint. Coarse mesh size was adopted in this study, as acceptable accuracy and optimal time are achieved.

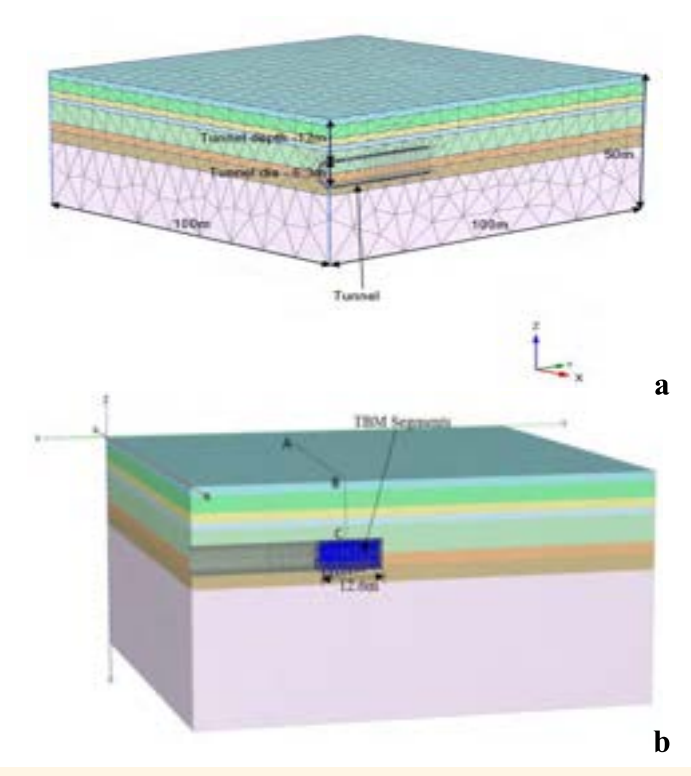


Fig.1.Three-dimensional finite element model

Volume loss due to tunneling

The volume loss due to tunneling is back-calculated from the field settlement values, using equation developed based on equivalent ground loss model (Chi et al., 2001) which is an extension of the model proposed by Loganathan and Poulos (1998).

$$u_y = R^2\left\{-\frac{y-H}{x^2+(y+H)^2} + (3-4\nu)\frac{y+H}{x^2+(y+H)^2} - \frac{2y[x^2-(y+H)^2]}{[x^2+(y+H)^2]^2}\right\} \times \frac{4gR+g^2}{4R^2} \exp\left\{-\left[\frac{3.12x^2}{(R+H\tan\beta)^2} + \frac{0.69y^2}{H^2}\right]\right\}$$

[1]

where, uy is the field settlement value, R is the tunnel radius, H is the depth of tunnel from the ground surface, x and y are co-ordinates, is the poisons ratio, g is the gap parameter and β is the angle of influence zone of settlement. The volume loss is calculated using Equations given below,

$$Volume\ loss = \frac{4gR+g^2}{4R^2}$$

[2]

The results of back calculation of volume loss are summarized in Table 1.

Table 1 Back calculation of volume loss

Tunnel depth, H (m)	Tunnel Diameter, (m)	β (˚)	Settlement, u_z (m)	Gap parameter, g (mm)	Volume loss (%)
15.15	6.3	68	0.0104	0.0156	0.497
			0.0085	0.0141	0.448
			0.0073	0.0162	0.516
			0.005	0.0214	0.679
			0.002	0.0117	0.371
			0.0016	0.0150	0.476
			0.002	0.0249	0.793
			0.0001	0.0080	0.254
	Average Volume loss				**0.50**

The surface settlement profile across the tunnel (Fig. 2) measured at the Grey Metro line (field) using building settlement markers were compared with the numerical output data (section AB in Fig. 1). The settlement profile shown in Fig. 2 reveals that the predicted settlements are in good agreement with the field values of the monitoring points located near the tunnel axis. Settlement boundary line or main influence area are the locations where there is substantial influence of surface settlements and the buildings in this area required to be monitored for any damage. In the secondary area of influence, the settlements are typically less than 3 mm, and have a minor impact on the buildings. In this study, the primary settlement influence zone of the ~2D was observed, beyond which the settlements were less than 3 mm. It is therefore double-proven that the numerical model developed for this study is reliable for determining the settlement and zone of influence.

Comparison of Predicted Numerical Results with Analytical and Empirical Approaches

Table 2 summarizes the maximum settlement of the surface using numerical, analytical and empirical approaches. In Fig. 3, settlement curve of the various approaches for the section A-B is shown. It can be interpreted from the Table 2, that most of the analytical and empirical approaches overpredicted the maximum surface settlement (21% to 79%) for the alluvial deposit considered in the present case study. Furthermore, the numerical model and analytical method developed by Loganathan and Poulousare well-

suited for predicting the maximum surface settlement for the alluvial deposits. From Fig. 3, it could be observed that the empirical results give a narrow settlement curve while the analytical method by Loganathan and Poulousfollows the same trend as that of field observations and numerical results, but with a wider settlement trough. As these empirical methods were developed before 1980 and did not account for the effects related of modern shield tunneling techniques, there predictions were not accurate.

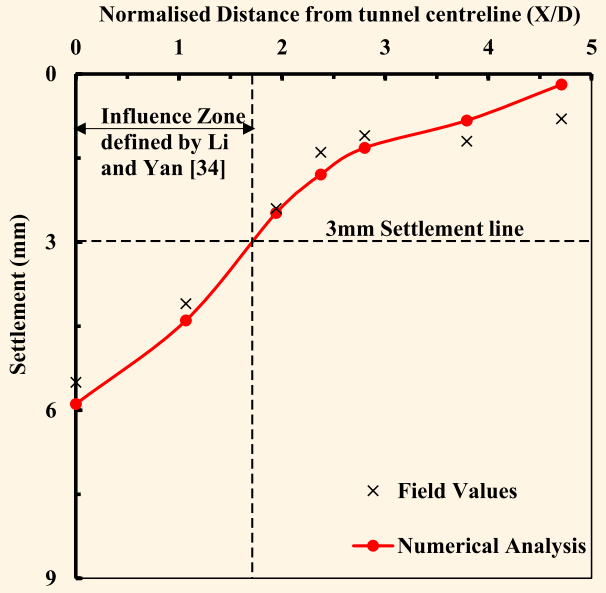


Fig.2. Computed Settlement results compared to the field measurement

Table 2 Maximum surface settlement by various methods

Method	Maximum surface settlement (mm)
Field Observation	5.5
Numerical	5.89
Loganathan and Poulous	6.67
Peck	9.85
Attewell& Farmer	8.28
Mair	8.28
Clough & Schmidt	9.85
O'Reilly & New	8.23

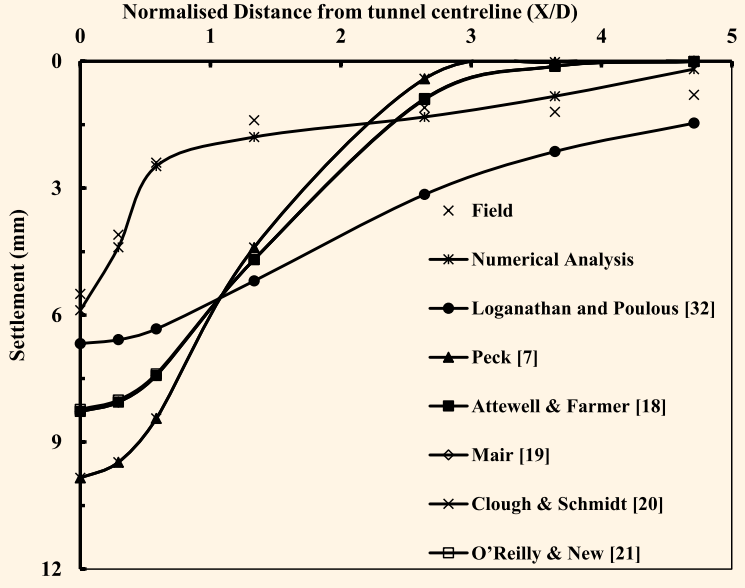


Fig. 3. Settlement comparison between field, numerical, analytical and empirical methods

Influence of staged tunneling on adjacent pile/pile supported buildings

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit, Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR) &
Dr Anil Swaroop (CIMFR)

Objective:

Methodology to assess the damage to the adjacent foundation/structure due to staged tunneling.

Progress Highlights/ Significant Achievements:

An experimental set up to simulate the ground loss phenomenon due to tunneling has been developed. The developed scaled down model is able to simulate the different percentage of volume loss for progressive tunnel construction under 1g. Response of ground has been studied for various volume loss percentages (0.5% - 10%) and different soil covers to diameter (C/D) ratio of tunnel in cohesionless medium. Ground response in terms of maximum surface settlement, width of transverse surface settlement trough, transverse and longitudinal influence zone of surface settlement has been measured and reported. Reasonability of the results demonstrates the applicability of the present method to study the ground response due to staged construction of tunnel. Volume loss of tunnel depends on many factor i.e. soil conditions, equipment, tunnel geometry and construction method etc. Volume loss in homogenous dense sand and stiff ground varies in the range of 0.5 % to 2 %. For soft soil, layered soil conditions and poor construction practices, VL upto 4% has been observed in the field. (Mair& Taylor, 1997). Volume loss around the tunnel during tunnel collapse conditions may go upto 15 to 20%. In the present experimental study, volume loss has been kept in the range of 0.5 % to 10 % to estimate the surface settlement for different condition of tunnel and subsequent hazard to adjacent building infrastructures.

Different laboratory test has been conducted to characterize the test medium. Strength and stiffness parameters of the test medium have been determined through drained triaxial test. Fig. 1 shows the grain size distribution curve. Table 1 shows the different properties of the test medium. Fig. 2 shows the deviatoric stress vs strain response of the test medium at 66 % Relative Density (RD). Fig. 3 shows the strength envelope of the test medium at the same RD. From the Mohr circle strength parameters (Mohr-Coulomb) has been determined. Locally collected river sand has been used as test medium in the present study. Drained triaxial tests are conducted to estimate the strength parameters of sand used in the present study. Shear strength parameters namely cohesion (c′) and angle of internal friction (φ′) are found to be 9 kN/m2 and 35.8° respectively. Cohesion is due to the presence of small amount of fine particles in the tested sample.

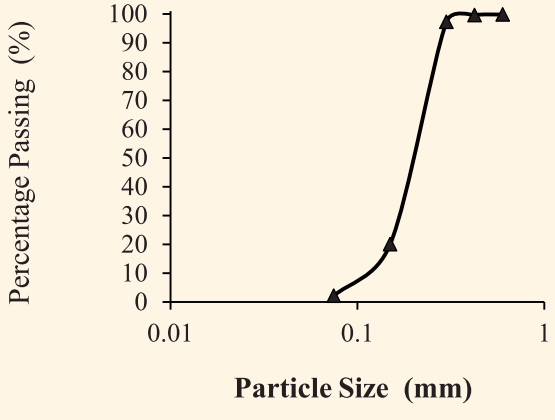


Fig. 1: Particle size distribution curve

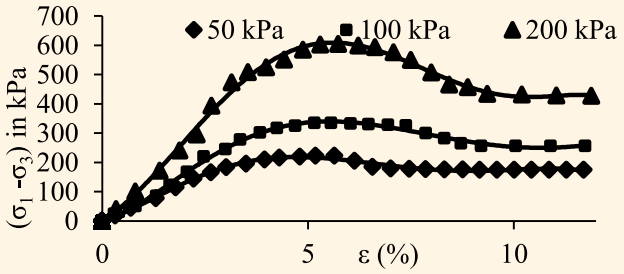


Fig.2: Variation of deviatoric stress with axial strain

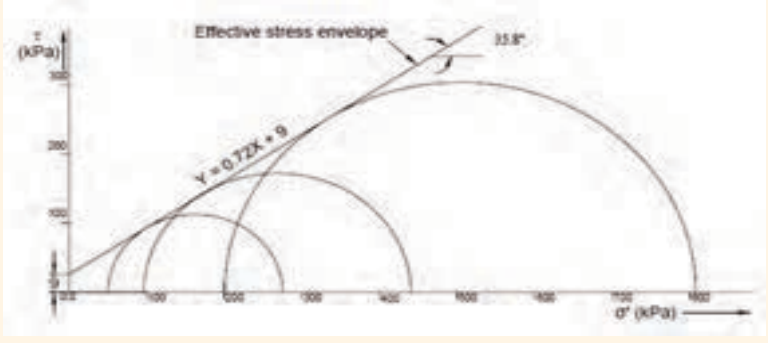


Fig. 3: Mohr circle and failure envelope

Table 1. Properties of sand medium

Description	Value
Sand (%)	98
Silt (%)	2
Clay (%)	0
D_{10}	0.11
D_{30}	0.17
D_{60}	0.22
Coefficient of Uniformity	1.92
Co-efficient of Curvature	1.15
Specific Gravity	2.67
Minimum Density (kN/m^3)	13.90
Maximum Density (kN/m^3)	16.60
IS Classification	SP

The maximum surface settlement results from the model test are obtained and compared with the other published results for different cover to diameter ratio (C/D) as shown in Fig. 4 & 5.

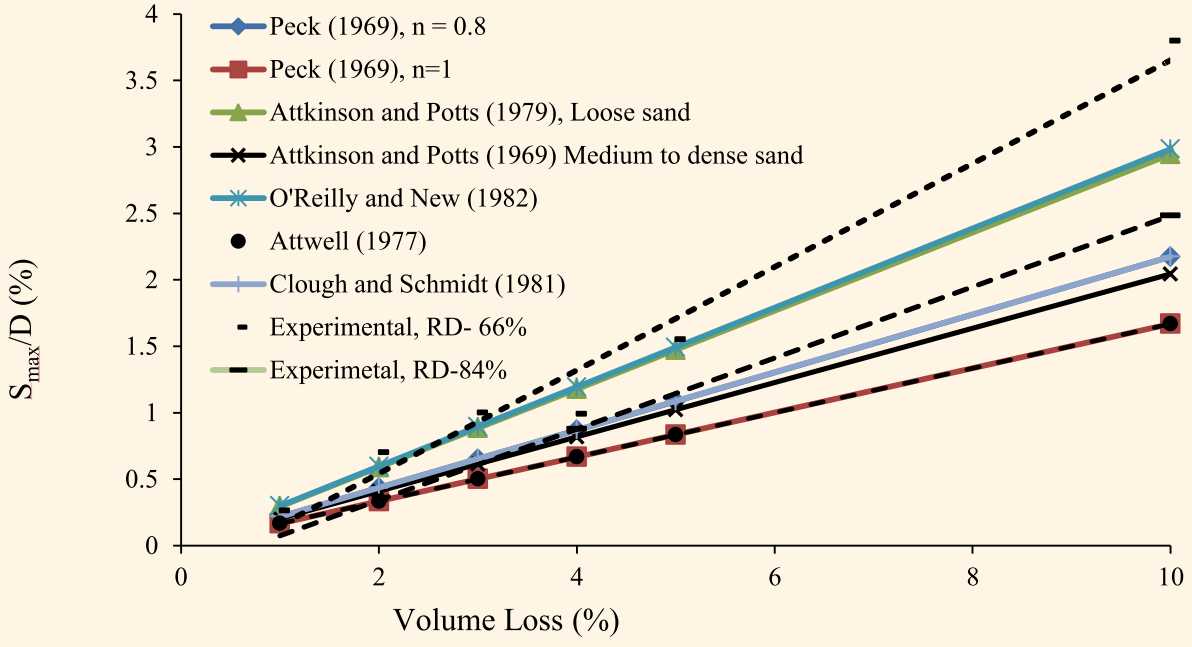


Fig. 4 Comparison of the present results with other published results for C/D -3.5

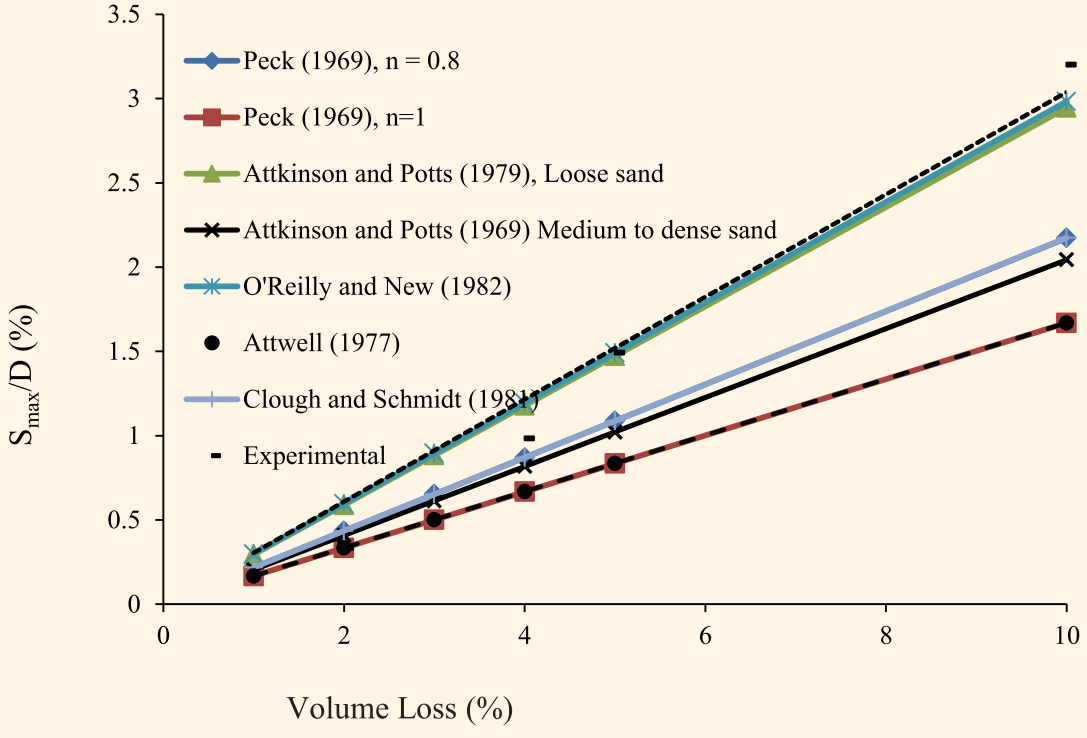


Fig. 5: Comparison of the present results with other published results for C/D -6

Different other works are in progress includes estimation of surface settlement through numerical modelling for a wide range of parameters and estimation of staged tunneling on the pile foundation through physical modelling.

Assessment of Underground Soil – Structure Interaction Under Seismic Conditions

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit, Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR) & Dr Anil Swaroop (CIMFR)

Objective:

Evaluation of seismic response of underground structures.

Progress Highlights/ Significant Achievements:

Scaled down model was developed and its interaction with soil subjected to dynamic loading condition was performed. The tunnel model was scaled down to 1:10 to prototype condition was installed inside the soil having 60% density. Then the model was subjected to a scaled down Uttarkashi earthquake motion and tunnel-soil interaction was studied. For measuring soil response soil pressure transducers were used. The typical instrumentation arrangement for monitoring tunnel performance under dynamic events is shown in Fig.1. For measuring tunnel displacement 2-dimensional digital image correlation system (2 - DIC) was used. The experiments were conducted with repeated shaking conditions and independent shaking conditions. The experimental arrangement is shown in Fig.2. Fig.3 shows the obtained dynamic response of tunnel system subjected to scale down Uttarkashi earthquake motion. Based on the shaking table experiments, following conclusions were made

1. Amplification of the acceleration was observed from bottom to top of the tunnel mainly due to its embedment depth. When tunnel located at shallow depth, larger amplification was observed
2. DIC test results showed that, maximum strains occur near the corner of the tunnel. Application of repeated dynamic loading to underground structures resulting in continuous structural deformations and this cannot be repaired using strengthening techniques. Hence, the design should contain proper ductility characteristics to resist against deformation especially during repeated dynamic loading events.

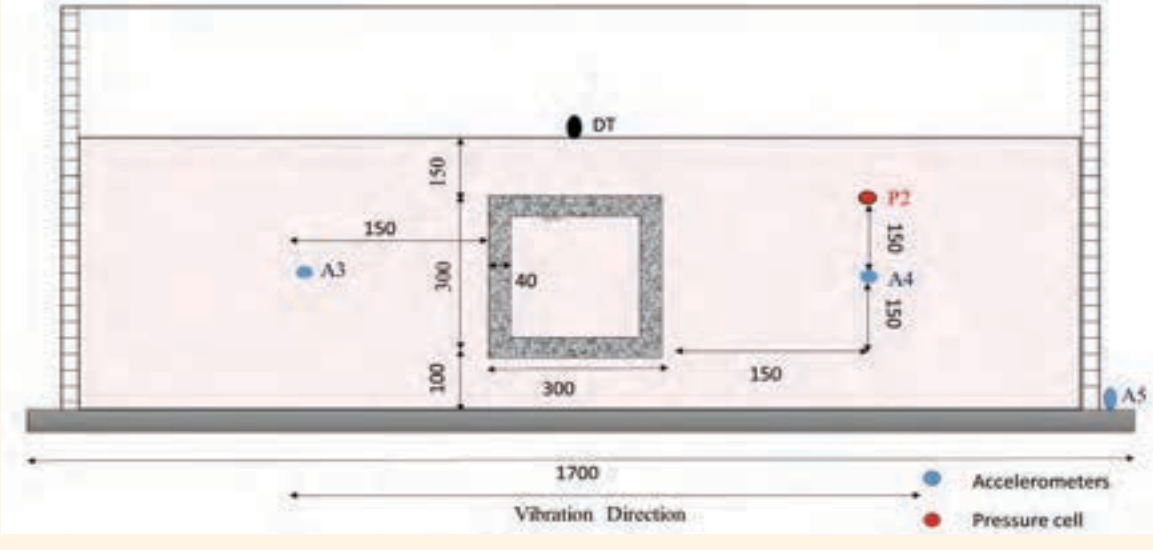


Fig. 1: Instrumentation arrangement selected for the study

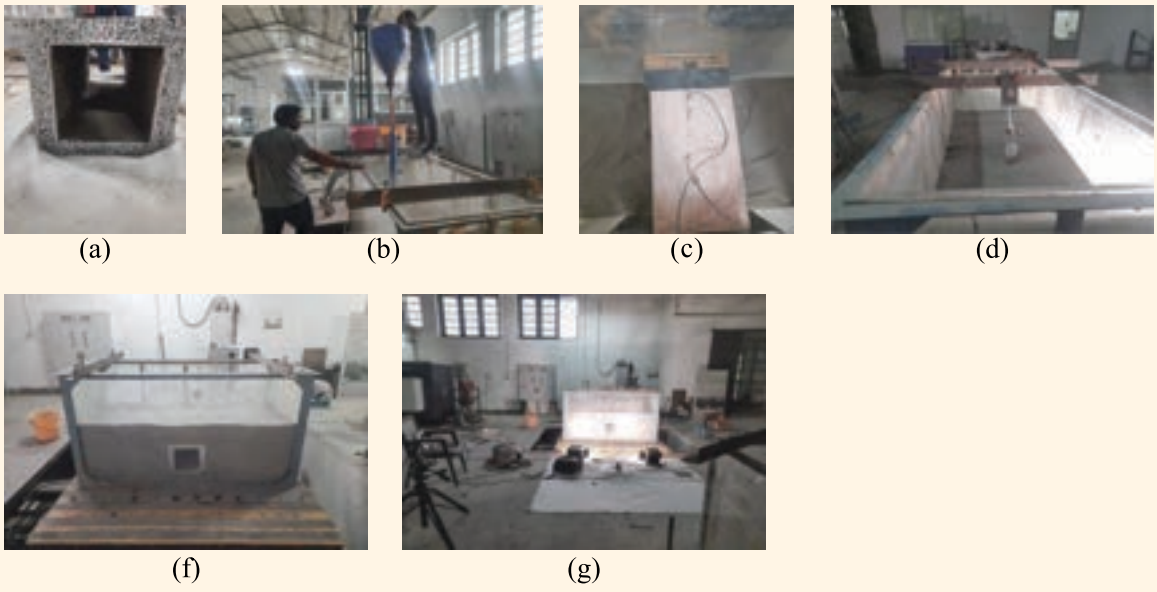


Fig. 2:a)Tunnel which is speckled before installing in test tank b)Sample preperation using dry pulviation techniquec)Instrumentation on tunnel d) - f) preperation of sand bed and placement of LVDT and DIC

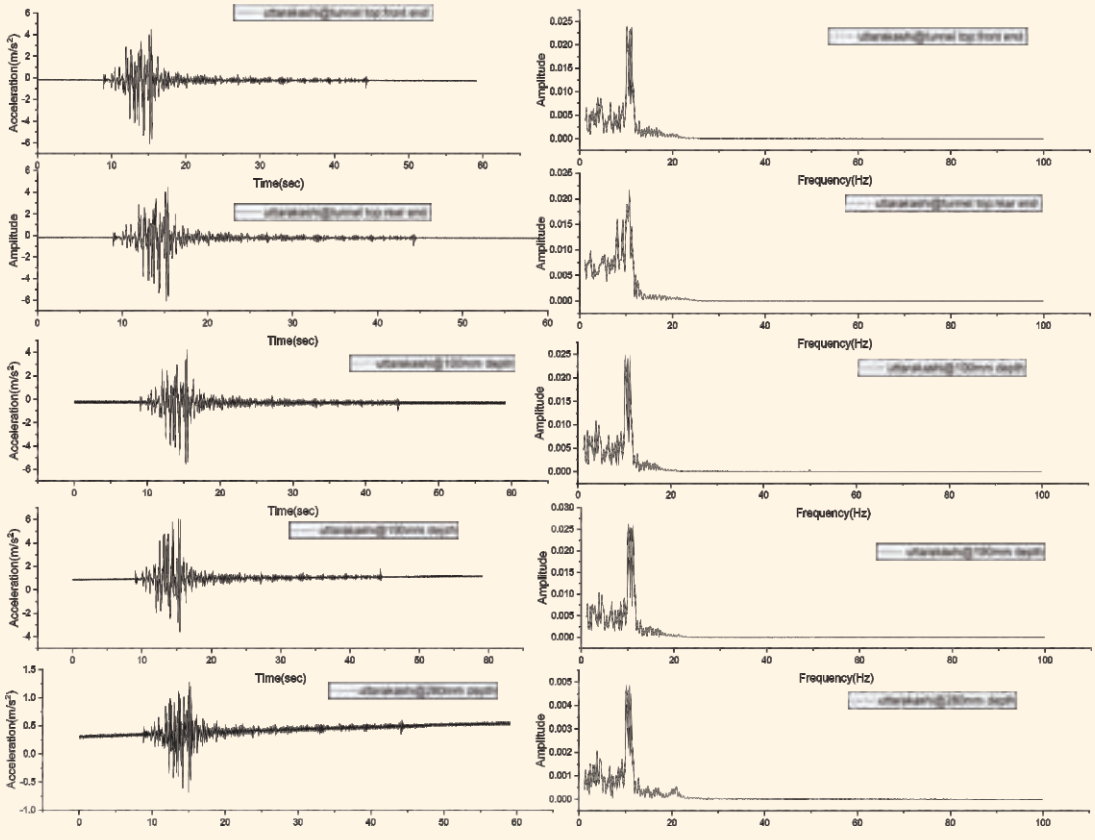


Fig. 3: Obtained acceleration-time histories and Fourier spectra

Probabilistic Analysis of Underground Excavation in Rock

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit, Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR) & Dr Anil Swaroop (CIMFR)

Objective:

Quantification of uncertainties associated in underground rock excavation using advanced probabilistic method and probabilistic analysis of underground excavation

Progress Highlights/ Significant Achievements:

Excavation induced instability in the support system of rock tunnel is analysed using confinement convergence method (CCM) with two different constitutive models namely Mohr-Coulomb criterion (MC) and Generalized Hoek-Brown criterion (GHB). Probabilistic analysis is performed on a circular tunnel with respect to two limiting functions: criterion regarding the radius of plastic zone and criterion regarding the tunnel convergence (Fig.1).

As per the CCM solutions in the present study of the circular tunnel, the performance functions may be defined as:

$$G_1(x) = L - \frac{R^{PL}}{a_0} \tag{1}$$

$$G_2(x) = \varepsilon^{\max} - \frac{u_r^{PL}}{a_0} \tag{2}$$

where, L and $\varepsilon^{\max}$ are the limiting permissible ratios with respect to $\frac{R^{PL}}{a_0}$ and $\frac{u_r^{PL}}{a_0}$ having the values 2 and 2%, respectively. The first performance function denotes the criterion regarding the plastic zone and the second performance function denotes the criterion regarding the tunnel convergence.

Collocation based Stochastic Response Surface Method (CSRSM), Multi-Gene Genetic Programming (MGGP) and Multivariate Adaptive Regression Splines (MARS) are castoff as the surrogate models which are further used in conjunction with the Monte-Carlo simulation (MCS) to calculate the probability of failure (Pf) of tunnel. The results of each methodology are compared with the traditional MCS, regarding the efficiency and the accuracy. Negative correlation between the shear strength parameters in the MC criterion is constructed using Gaussian copula. A detailed comparison is made among all three surrogates based on their efficiencies and accuracy by means of the regression plots.

The closed-form expression for the 3rd order Hermite PCE are used to construct the stochastic response surface. The closed form expression is mentioned in Eq.(3).

$$Y = a_0 + \sum_{i=1}^{n} a_i X_i + \sum_{i=1}^{n} a_{ii}(X_i^2 - 1) + \sum_{i=1}^{n} a_{iii}(X_i^3 - 3X_i) + \sum_{i=1}^{n-1}\sum_{j>i}^{n} a_{ij} X_i X_j + \sum_{i=1}^{n}\sum_{\substack{j=i \\ j\neq i}}^{n} a_{ijj}(X_i X_j^2 - X_i) + \sum_{i=1}^{n-2}\sum_{j>i}^{n-1}\sum_{k>j}^{n} a_{ijk} X_i X_j X_k \tag{3}$$

The collocation points are placed at the roots of the 1-D Hermite polynomials having degree 1 higher than the order of expansion for each random variable. All the possible combinations of roots are considered as the set of collocation points. The collocation points usually have to satisfy the elementary but vital properties,

which plays a key role during their selection. Firstly, the collocation points must consider the regions of high probabilities i.e. whether zero is the part of roots or not, zero must be considered as zero has the maximum probability w.r.t. the standard normal random variable. Secondly, the collocation points are to be symmetrically distributed with respect to zero. Details of the different random variables considered in the study is mentioned in the Table.1.

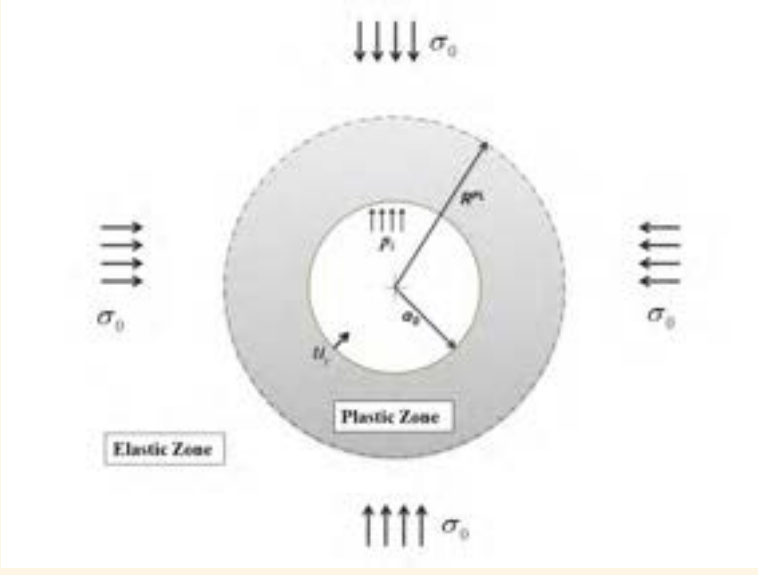


Fig.1 Circular tunnel subjected to a uniform far field stress and uniform internal support pressure.

Table.1 Input variables of M-C and GHB criterion for analysis of tunnel

Mohr – Coulomb criterion				*Hoek – Brown criterion*			
Parameter	Distribution	Mean (μ)	Standard Deviation (σ)	Parameter	Distribution	Mean (μ)	Standard Deviation (σ)
$\phi(°)$	Normal	21.09	2.05	*GSI*	Normal	25	2.5
c (MPa)	Normal	0.287	0.038	m_i	Normal	8	1
$E_{mass}(MPa)$	Normal	373	48	$\sigma_{ci}(MPa)$	Normal	10	2.5
				$E_{mass}(MPa)$	Normal	373	48

* mi is the Hoek–Brown parameter for intact rock and. The mean value of internal pressure pi is considered 0, 0.4 and 0.8 MPa. Coefficient of variation (COV) of internal pressure pi is equal to 0.15.

The results obtained in the current study by both, the classical MCS and the surrogate model based MCS, are compared. One of the comparison for the CSRSM based surrogate model and direct MCS with the literature is presented in Fig.2. The performance function regarding the plastic zone, G1(x) and the performance function regarding the convergence, G2(x) both are plotted.

To incorporate the effect of the epistemic uncertainty, a Gaussian white noise having a specific variance level (p), is introduced and these noisy datasets are engaged by the MARS and CSRSM surrogate models for the probabilistic analysis.

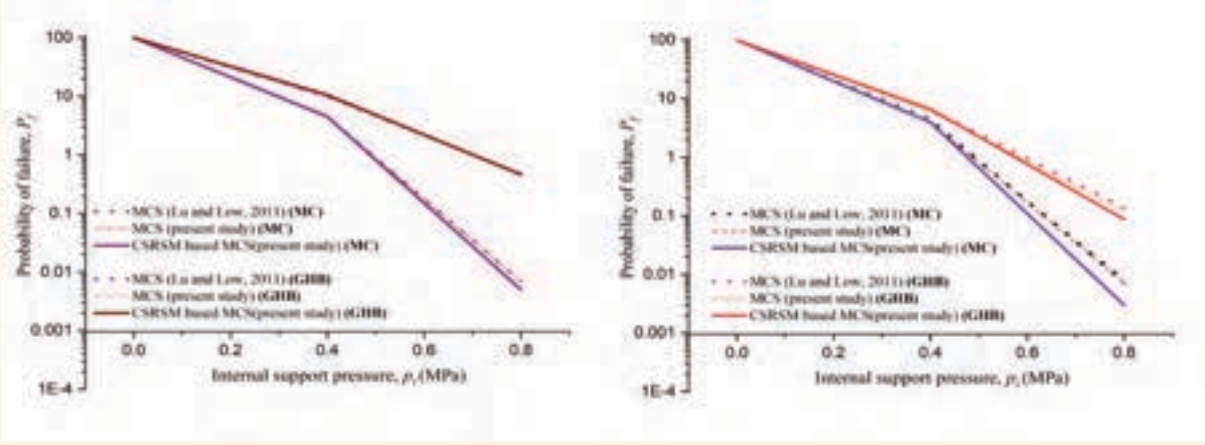


Fig.2 Effect of internal support pressure on probability of failure for $G_1(x)$ and $G_2(x)$ CSRSM

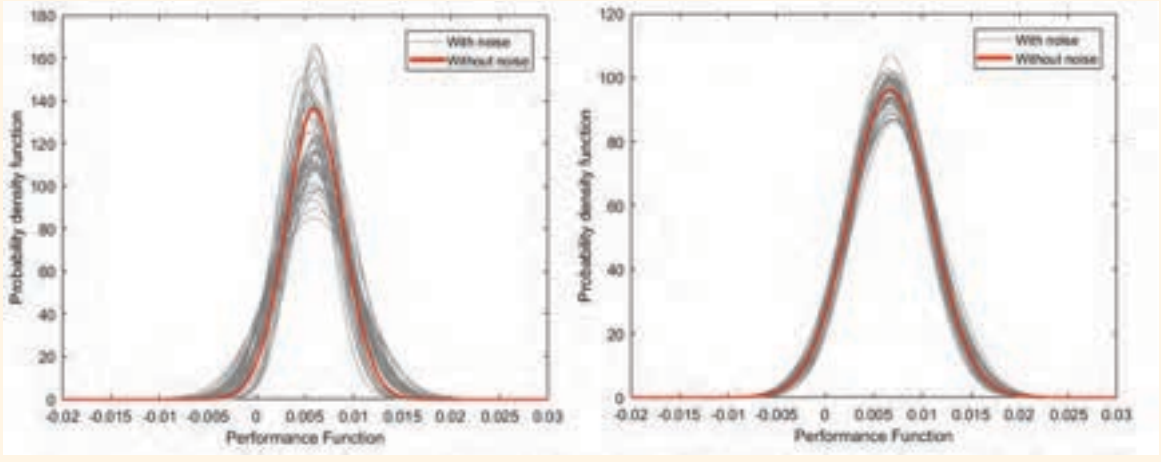


Fig.3 Effect of noise (n = 50) on CSRSM based MCS for MC and GHB at pi =0.4 for G2(x)

However, it is not possible to completely eliminate these sources of uncertainties. But as these types of uncertainties are internal in nature, they can be reduced by making the better prediction models by making use of simulated noisy datasets. To create the simulated noisy dataset from traditional design dataset which is used for the formation of surrogate model, a Gaussian white noise is introduced which have a specific variance level (p), in the set of responses while the inputs are kept unchanged.

$$G_i noise = G_i + p * \zeta \quad (4)$$

where, $G_i noise$ indicates the performance function after the incorporation of noise; G_i is performance function of traditional design dataset; i is denoting the sample number of traditional design dataset; ζ is a function, used for generating the normally distributed random numbers. Since the results of CSRSM and MARS are better than the MGGP, so only these two models are chosen for the purpose of epistemic uncertainty incorporation. The corresponding graph is shown in Fig.3 from which it can be clearly seen that the CSRSM are capable of incorporating the epistemic uncertainty.

Assessment and Support Measures for Tunnel Portals and Rock Slopes in The North-Western Himalayas

Dr. Anindya Pain, M. Vinoth, Manojit Samanta, Koushik Pandit,
Dr. S. Ganesh Kumar, Aswathy. M.S, Ajay Dwivedi, Dr. R.D Dwivedi (CIMFR) &
Dr Anil Swaroop (CIMFR)

Objective:

Assessment of the stability of tunnel portals in rock slopes and providing support design solutions for slope strengthening and portal stability.

Progress Highlights/ Significant Achievements:

In the present study, two locations have been selected for stability assessment of a tunnel portal site near Sohna, Gurugram in Haryana. The rock mass classification such as RMR, GSI and SMR has been used for evaluating strength of the rock mass and stability of the slopes. The rock mass is found to be of good quality that have highly jointed blocky to very blocky structure. According to SMR value, the first location falls under completely unstable category and second location falls under completely stable category of stability grade. Further, finite element analysis is being carried out.

Fig. 1 Slope at location 1 near the Dedicated Freight Corridor (DFC) tunnel portal

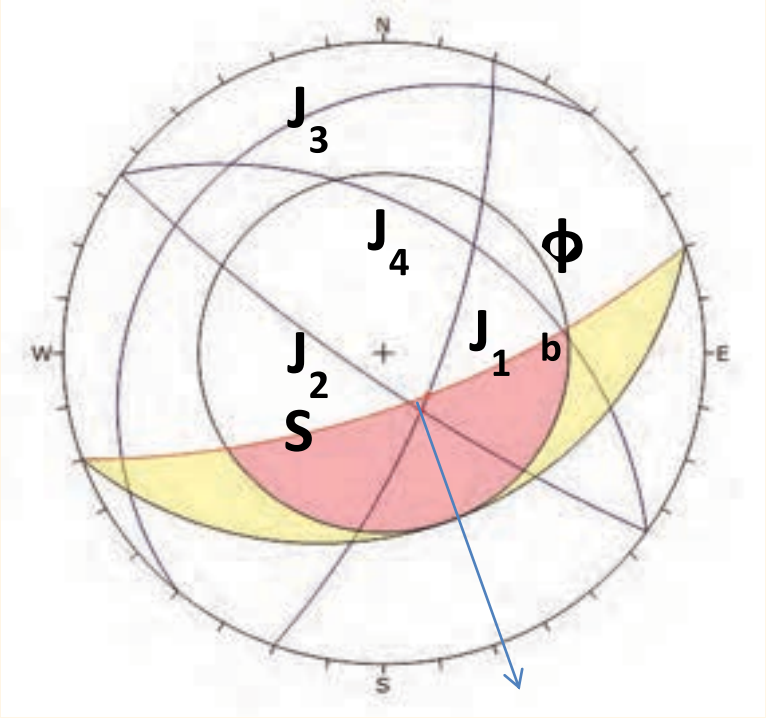


Fig. 2 Kinematic analysis of the slope at location 1

Fig. 3 The proposed tunnel portal (entry) near location 2

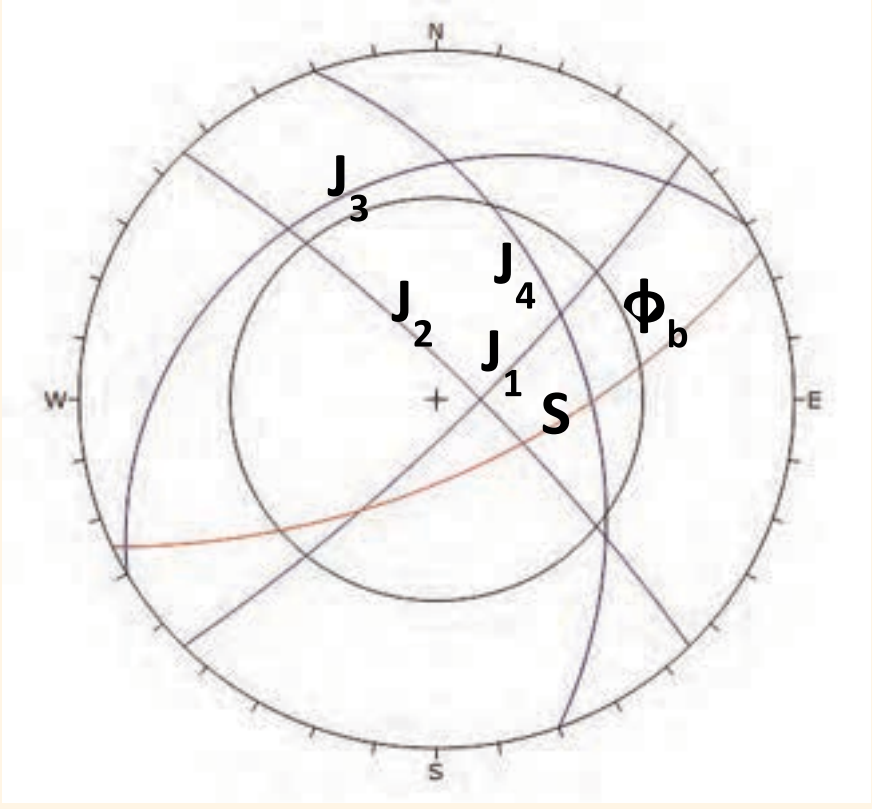


Fig. 4. Kinematic analysis of the slope at location 2

Table 1. Attribute data of discontinuities and slope face

Location No.	Discontinuities	Slope Face
1	J_1-70/N110 J_2-80/N215 J_3-15/N310 J_4-42/N35	S-70/N160
2	J_1-80/N135 J_2-80/N45 J_3-25/N330 J_4-45/N70	S-65/N155

Spalling-mitigation technology for high-strength concrete at elevated temperature

Dr. Banti A. Gedam & Dr. Suvir Singh

Objective:

- Technology for spalling-mitigation in high-strength concrete at elevated temperature.
- Realistic and economical design for achieving required fire resistance rating.

Progress Highlights/ Significant Achievements:

- Technology for spalling-mitigation in high-strength concrete at elevated temperature.
- Realistic and economical design for achieving required fire resistance rating.

Development of Innovative cool roof with improved thermal & energy performance

Dr. Kishor S Kulkarni (PI), Dr. Ashok Kumar (Co-PI)

Objective:

Development of innovative cool roofs options for improved thermal & energy performance.

Progress Highlights/ Significant Achievements:

- Cool roof is made of earthen pots and filled with lightweight concrete.
- Developed cool roof helps in improving thermal performance and indoor environment of the building and reducing energy demand ranging from 21% to 26% annually as compared to conventional RCC roof.

Visual Inspection and Dye Penetration Testing on Selected and Accessible Locations of Steel Truss Connections Vetting of Geo-Technical and NDT Report of the Existing Residential Buildings of RBI colony in Chandigarh

Dr. R. Siva Chidambaram

Objective:

- To Conduct DOPT Test and Visual Inspection on steel truss member
- To vet the NDT report of NITTTR Chandigarh

Progress Highlights/ Significant Achievements:

- Taken three SSP during this Covid Pandemic
- Involved in Make Shift Covid Hospital Work at Safdurjung Hospital at New Delhi
- Involved in Make Shift Covid Hospital Work at Bhatinda
- Delivered More than 15 Key Note, Guest Lectures
- MOU Signed between SR University and CSIR-CBRI

Monitoring of RE Wall at Pakyong Airport, Sikkim

S. Sarkar, DP Kanungo, A. Pain, A. Dwivedi, K. Pandit

Greenfield airport in Sikkim has been constructed recently in the year 2018 by the Airports Authority of India (Fig. 1). The location of the airport is at Pakyong which is situated approximately 33km from the state capital – Gangtok of Sikkim. There was a massive cut and fill of the hill slope for the construction of the airport. A huge Reinforced Soil (RS) structure along with drainage channels has been constructed to retain this earth fill. The height of the RS structure varies from 40m to 80 m depending on the local topography having a length of 1480m (Fig. 2). On request of AAI, CSIR-CBRI undertook a project to assess the distress of the surrounding buildings, monitoring of the RE wall and stability evaluation of uphill slope. In the study, the RE wall was monitored from February 2015 to April 2018. The wall was monitored at five different sections. The study had shown that maximum lateral movements for different sections of the wall ranging from 50 mm to 4000 mm and the maximum vertical movements ranging from 100 mm to 2800 mm in three years of monitoring.

Fig.1. Pakyong airport during construction and after completion

Fig.2. RE wall

The study concluded that the most vulnerable zone is from chainage 1700m to 2000m and it was suggested that monitoring of the wall should be continued.

In the second phase, it was decided to monitor the movement of the RE wall from the airport runway level in addition to the monitoring of existing observation points from the old reference posts at road level. It was further decided to monitor the sub-surface movement of the ground near the base of the RE wall and also near the toe portion of the uphill slope at runway level. Several reference posts and observation posts were established along the roadside and at various levels of the RE Wall. Apart from that, a new monitoring scheme was also implemented by establishing the observation posts at the runway level. The monitoring work was carried out by using an advanced total station known as Automatic Robotic Total Station, and the first set of data was taken in November 2018. The movement data has shown distress of RE wall and ground

movement at certain locations. It can be inferred from the RE wall monitoring data that the section of the wall in between the chainage 1920 and 2100 is showing significant movement. Also, the ground in this zone has shown considerable subsidence affecting the road. The section of the wall till chainage 1500 is in good condition and has not shown any major distress.

Fig. 3. Monitoring of RE wall at different sections using robotic total station

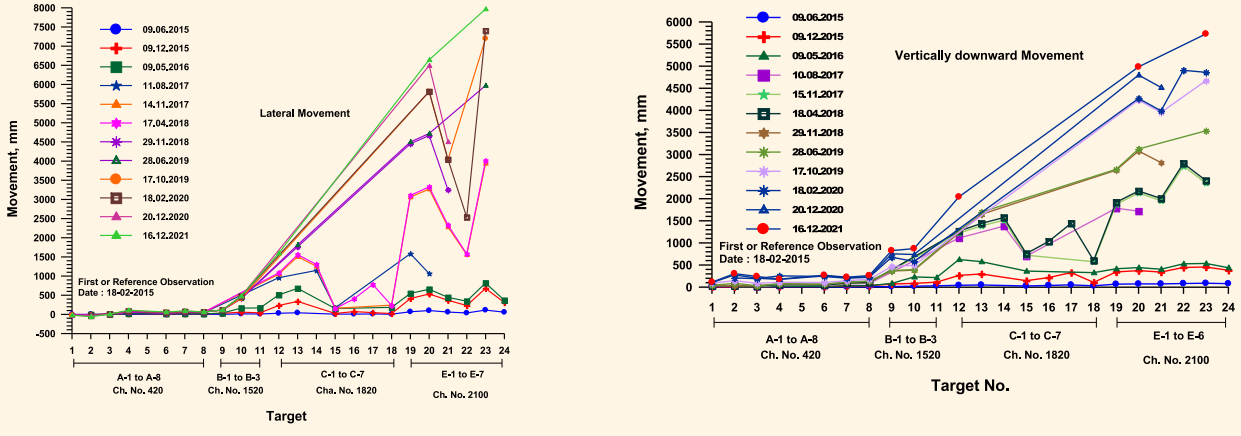


Fig. 4. Lateral and vertical movements of RE wall at different sections

Further, monitoring of RE wall from runway level was also carried out by installing 25 observation posts. These points were established along the fence of the runway to measure the stability of the embankment wall top. The points are established over the filled-up part over the embankment, which forms the part of the fascia. The monitoring of the wall was carried outby observing these new observation posts through the benchmark established by AAI on the runway level (Fig. 5).

Fig.5. Monitoring of RE wall from runway level

The observation taken from the newly installed observation posts located on or adjacent to the RE wall at the runway level shows that there is no significant movement during the period June 2019 to February 2020 till post no. 16. After that, from posts 17 to 20 there is some movement as seen from the Figure 6. Then there is a very significant movement of more than 2m of the posts 23 and 24. The movement of these observation posts occurred mainly during the monsoon period as the initial data was recorded in June 2019 and the subsequent data in October 2019 is showing considerable movement greater than 2m.

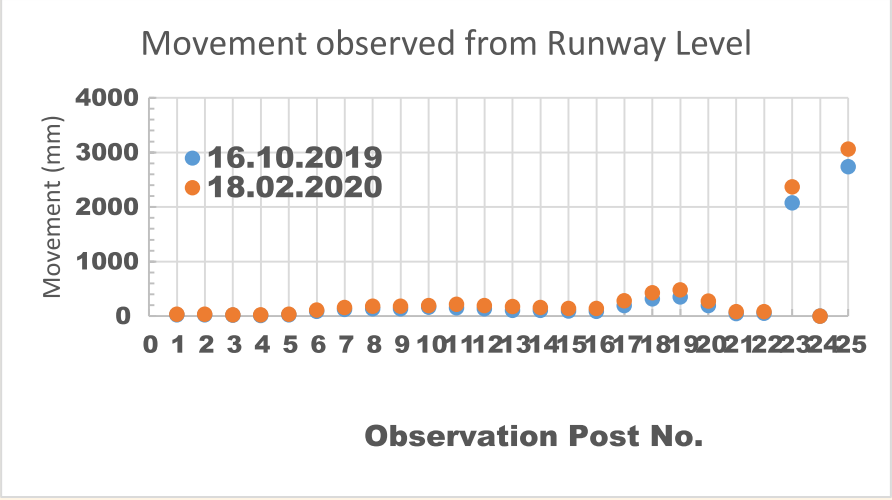


Fig. 6. Movement of observation posts at runway level from October 2019 to February 2020

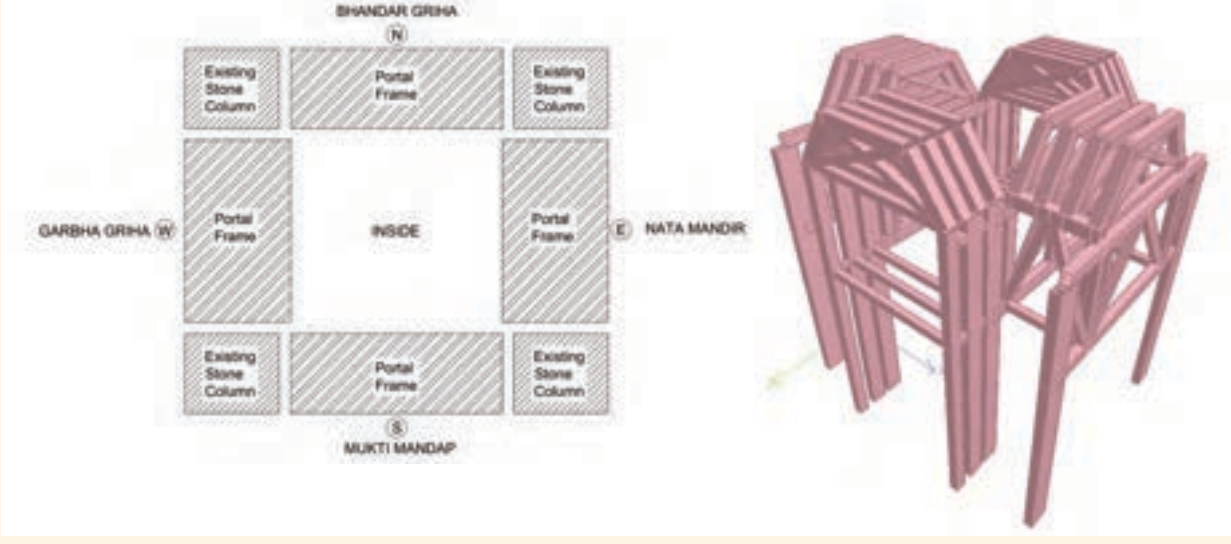
The movement occurred during October 2019 to February 2020 is insignificant. This movement zone at runway level is the Section D (Ch.1920) to Section E (Ch.2100) of the RE wall which has also showed significant movement from the data taken from the road level, showing a clear indication of subsidence along the fence of the wall.

Monitoring of Steel Portal Frame installed in Jagmohana of Shree Jagannath Temple, Puri

Dr. A. K. Mitta, Dr. Debdutta Ghosh, Ms. Hina Gupta,
Sh. Siddharth Behera & Sh. Sachin Kumar

Jagannath Temple is a very big temple and covers an area of 37000m2. It is dedicated to Lord Jagannath, an incarnation of Lord Vishnu, and is one of the Char Dham pilgrimage sites for Hindus. The temple's architecture is a fine example of the Kalinga style of architecture which is a sub-style of the Nagara style of architecture. The temple complex covers an area of around 37000 square meters and includes around 120 smaller temples and shrines within its premises. The main temple is the tallest structure in the complex and is known as the Vimana Gopuram. The curvilinear shape of the temple is a unique feature of the Kalinga style of architecture and is quite different from the typical straight-lined shape of most other Indian temples. The tower of the temple, which is also known as the Shikhara, rises to a height of around 65 meters and is visible from quite a distance. The chakra or wheel of Lord Vishnu that sits atop the temple is made of eight petals and is an important symbol of the temple. It is said to represent the sun, moon, and the 27 constellations of the Hindu astrological system. Overall, the Jagannath Temple is a marvel of architectural and religious significance, attracting millions of visitors and devotees from all over the world each year.

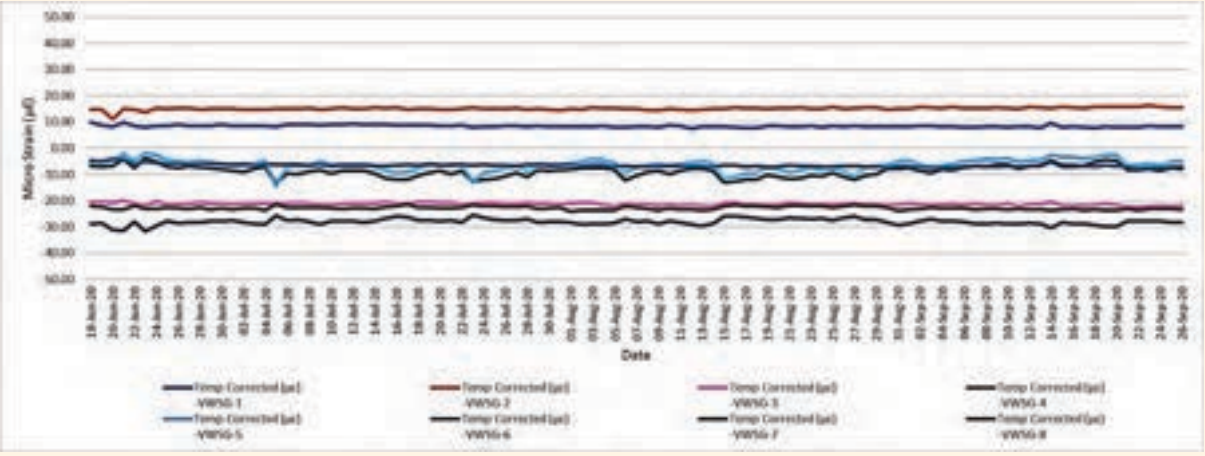
The Archaeological Survey of India, Bhubaneswar Circle approached CSIR-Central Building Research Institute, Roorkee for the Monitoring of Steel Portal Frame installed in Jagmohana of Shree Jagannath Temple, Puri. The term "Jagamohana" refers to the assembly hall of the Jagannath Temple, which is also known as the Mukti Mandap or the Bhoga Mandap. It is a large hall where various rituals and ceremonies are performed. A steel portal frame have been installed in the Jagamohana as a part of some renovation or restoration work carried out in the temple complex.



Schematic diagram showing the plan and isometric view of portal fram installed in the Jagmohana of Shree Jagannath Puri Temple

Vibrating Wire Strain Gauges (VWSG) were installed on the selected locations of steel box portal frame inside the Jagmohana of Shri Jagannath Temple, Puri in July 2018 by CSIR-CBRI team. Total eight (8) VWSG sensors were fixed to the portal frame by arc welding and covered with protection boxes.

The variation of apparent strains (VWSG 1 to VWSG 8) in all the sensors from July, 2018 are recorded in 24-hour interval for all the sensors. The sample of variation of temperature corrected strains (for VWSG 1 to VWSG 8) are presented in Figure below:



Variation of strain in box portal steel frame of Jagamohana at Puri Temple

The following CSIR-CBRI officials are involved in the project and carried out various activities for project work:

Development of cement-admixture system for low temperature concreting

Jeeshan Khan, Ishwariya G. & Santha Kumar G

Objective:

- Study on the effect of various admixture on process of cement hydration at low temperature
- Investigation on improvement of cement paste microstructure under low temperature hydration process
- Performance evaluation of low temperature concrete versus controlled concrete

Progress Highlights/ Significant Achievements:

The cold weather concrete attains substantially inferior performance due to freezing of water during plastic and hardened states and therefore, it requires to be protected from freezing. The incorporation antifreeze admixtures in cold weather concrete are more feasible compared to concreting in enclosures and heating the raw materials. Calcium nitrate and sodium thiocyanate were used as binary antifreeze admixtures. The influence of binary antifreeze admixtures on the strength performance of concrete under freezing and thawing cycles (FT) of cold weather condition was studied. In real practice, the temperature begins to increase, afterwards, the temperature generally falls at night. Keeping these concerns for consideration, the following condition was adopted. Fresh concrete specimens were initially exposed at lower temperature of -5ºC for 12 hours. Then, it was further exposed under temperature of +10ºC for 12 hours. This cycle was repeated up to 28 days in a deep freezer. The influence of freezing and thawing cycles along with water curing at room temperature (water revitalization) on the performance of concrete was also investigated. Two various curing exposures were carried out in water revitalization study. First one was curing exposures of freezing and thawing cycles for 7 days and water revitalization for 21 days (FT7 W21), whereas, other one was freezing and thawing cycles for 28 days and water revitalization for 28 days (FT28 W28).

Mix proportions of concrete are given in Table 1. Two mixes were casted. The one group was control mix (CONT) without binary antifreeze admixture. The other is containing antifreeze admixtures (ADMIX).

Table 1 Mix-proportions for 1M^3 concrete.

BATCH ID/ Materials	Cement (kg)	Coarse aggregate (kg)	Fine aggregate (kg)	Water (kg)	Binary Antifreeze-admixtures (Total kg)	SP 0.75% (kg)	w/c ratio
CONT	390	1158	800	156	-	2.92	0.4
ADMIX	390	1158	800	156	37.05	2.92	0.4

The results of the compressive strength of concrete under different curing exposure of freezing and thawing cycles (FT) are shown in Fig.1. When curing exposures at 7 and 28 cycles of only freezing and thawing, ADMIX (7FT) and ADMIX (28FT) attained 20.92% and 15.26% higher strength than CONT (7FT) and CONT (28FT). The use of antifreeze admixtures was responsible for enhancing the hydration process of ADMIX batch under the curing exposure of freezing and thawing cycles and therefore, the strength of ADMIX batch was slightly higher than that of CONT batch. The other condition water revitalization had a tendency to enhance the strength of concrete after curing exposures of freezing and thawing cycles as ascertained from Fig.1. ADMIX (FT7W21) and ADMIX (FT28W28) attained 31.38% and 30.92% higher compressive strength than CONT (FT7W21) and CONT (FT28W28) respectively. The use of binary antifreeze admixtures was effective for strength enhancement of concrete under curing exposure of freezing and thawing cycles.

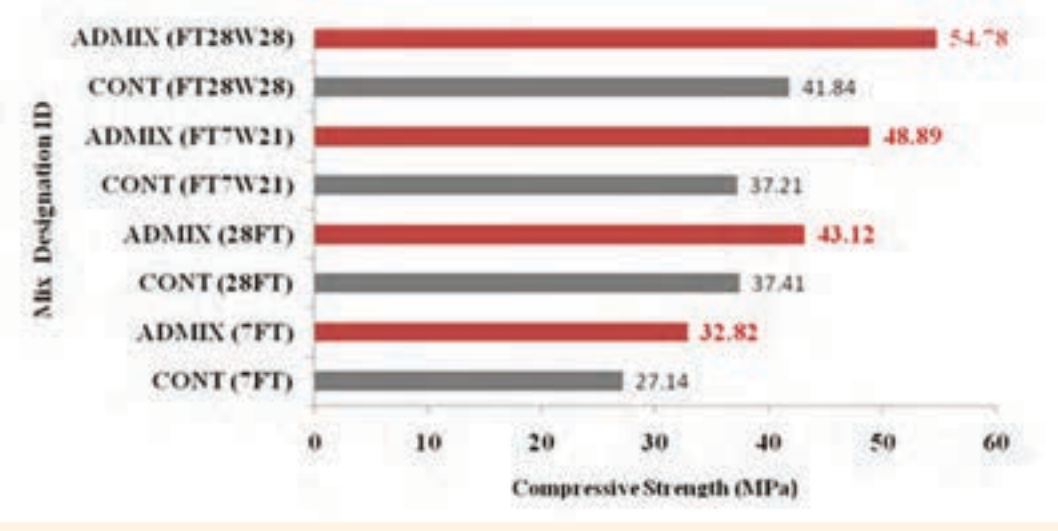


Fig.1. Compressive strength of concrete under different curing exposure of freezing and thawing cycles and freezing and thawing cycles with water revitalization.

AcSIR

AcSIR

The institute is conducting an integrated MTech - PhD (IMP) programme under the aegis of Academy of Scientific & Innovative Research (AcSIR) since 2010 in the area of 'Building Engineering & Disaster Mitigation (BEDM)', which is changed to "Building Engineering & Construction Technology" since 2019.From this year Integrated Dual Degree Programme (IDDP) has been started, in which MTech & PhD degree will be awarded together after completion of the course. The institute is also taking PhD students in the area of Engineering Sciences, Chemical Sciences and Physical Sciences. The details of different batches are given below:

IDDP

- 1st Batch (Aug.'20) –03 students joined
- 2nd Batch (Jan.'21) - 01students joined

PhD

- 04 students joined for PhD Programme in Engineering Sciences, 05 students joined for PhD programme in Physical Science and 2 students joined for PhD Programme in Chemical Sciences in August'20.
- 05 students joined for PhD in Engineering Sciences in Jan.'21.
- Presently total 38 PhD students and 14 IDDP students are enrolled in AcSIR at CSIR-CBRI Lab Roorkee.

Some of the highlights of the student activities in the current year are:

Awards received by Students:


Indian Geotechnical Society Visakhapatnam Chapter &
Department of Civil Engineering,
Andhra University College of Engineering, Visakhapatnam,
Andhra Pradesh, India – 530 003

CERTIFICATE

Awarded to Mr. Ekansh A, Anindya P and Shantanu S for securing Second Prize in Best Paper Prizes sponsored by Springer Nature in the theme(s) Geosynthetics and Reinforced Soil Structures, for the Technical Paper titled "Probabilistic Analysis of Reinforced Soil Retaining Structures using FORM and Surrogate based Monte-Carlo" presented at Indian Geotechnical Conference 2020, organised during December 17-19, 2020.

Prof. C.N.V. Satyanarayana Reddy
Organising Chairman, IGC 2020

[1] (Mr. Ekansh Aggarwal)

- Springer Nature Best Paper Award (Second) - 2020 at the Indian Geotechnical Conference (IGC) 2020, organized during December 17-19, 2020.

[2] **Mr. Anujay Rawat** received NACE Foundation Scholarship Award in March 2021.

[3] **Mr Vaibhav Mittal** received Award DST Inspire Fellowship in November, 2020

[4] **Mr Shubham Chaudhary** received Award DST Inspire Fellowship in September, 2020

Ph.D. Awarded

1. **Ms S K Kirthika** successfully defended his PhD viva-voce examination on 23th Sep., 2020. Her thesis title was "Studies on alternative fine aggregates in concrete as replacement to river sand". She worked under the supervision of **Dr Ajay Chaurasia and Prof S K Singh.**

2. **Ms Monalisa Behera** successfully defended his PhD viva-voce examination on 28th Dec., 2020. Her thesis title was "Influence of recycled fine aggregates on performance of self- compacting concrete". She worked under the supervision of **Dr Gopalakrishan, Dr A K Minocha and Dr S K Bhattacharyya.**

3. **Mr Santha Kumar** successfully defended his PhD viva-voce examination on 13th Nov., 2020. His thesis title was "An investigation on performance enhancement of recycled aggregate mortar". He worked under the supervision of **Dr S R Karade and Dr A K Minocha.**

4. **Mr Chanchal Sonkar** successfully defended his PhD viva-voce examination on 10th March, 2021. His thesis title was "Sheathed cold-formed steel (CFS) wall panels under axial loading: Structural Behaviour". He worked under the supervision of **Dr Achal Kr Mittal and Prof S K Bhattacharyya.**

5. **Mr Falae Philips Omowumi** successfully defended his PhD viva-voce examination on 26th Mar., 2021. His thesis title was "Integrated geo- investigation for landslide assessment". He worked under the supervision of **Dr. D P Kanungo and Dr. P K S Chauhan.**

Information Extension & Project Management

Publication Group

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

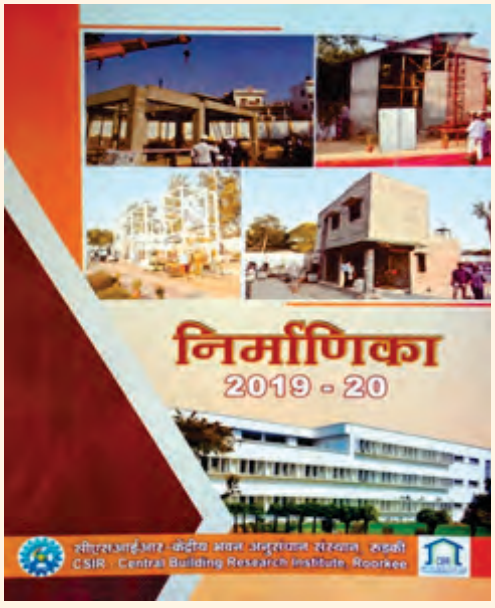
1. CSIR-CBRI Annual Report

- R & D Highlights
- Research Output
- Glimpse of Activities
- R & D Projects
- Consultancy Projects
- Sponsored Projects
- Information, Extension and Project Management
- CBRI Family
- Visits, Lectures, Meeting etc.
- Faculty Training, Motivation and Adoption of Schools & Colleges by CSIR- CBRI Roorkee
- Training Programmes
- Date line

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

2. **CBRI in CSIR News and CSIR Samachar**
3. **News- items/ R & D Stories in Media covering Functions, Events, Conferences, Workshops etc.**
4. **Publicity through Advertisement in Conference/Souvenir/Symposium Proceedings etc.**
5. **Outreach through Articles in Magazines, Periodicals etc. including**

निर्माणिका 2019-20



6. **Press Meet**

   Regular press meets were organized to apprise the public at large about the various technologies and research carried out at the institute.

7. **Faculty Training, Motivation, and Adoption of Schools and Colleges by CSIR- Central Building Research Institute, Roorkee**
8. **Technology and Divisional Brochures**
9. **R&D Highlights/ Research Output of CSIR-CBRI in CSIR Annual Report**

Development, Construction & Extension Group

CSIR Network Project
CSIR Integrated Skill Initiative (NWP-100)

Objective

It aims to equip the target groups with the necessary technological skills, through exposure to innovative building technologies developed by the Institute. It addressed the critical needs for the enhancement of building design/ construction/ technological skills of the individuals etc. It will strengthen the building construction sector by making the individuals more educated and skill oriented for building the sustainable habitat. It is planned to target the people working at all the levels in the society starting from masons to engineers/administrators etc for unified skill development to achieve the task of the programme.

The main objectives of this initiative are:

- To create a certified talent pool;
- To upgrade the knowledge base & skill set of people at different levels.
- To generate better earning options for masses (from Unskilled Manpower to Skilled Manpower and Skilled Manpower to Highly Skilled Manpower)To spread awareness among grass root level workers about engineered structures.

Significant Achievements

CSIR has mandated for the collection and dissemination of information in regard not only to research and development but to industrial matters in general. The tacit knowledge of CSIR laboratories along with the advanced R&D facilities has to be made available to the industry for creating a knowledge driven economy. The emphasis is given to create a robust and sustainable training module that is trans-disciplinary in nature addressing the needs of workforce among various technical areas that enhances multifaceted livelihood skilled workforce generation for industrial requirements. In tune with Government Policy on Skill Mission, CSIR has launched a major programme on CSIR Integrated Skill Initiative in 2016. The skilled/training programmes would also link to possible employment generation including small scale technopreneurship. This ensures a sustained supply of skilled workforce in the country.

With technical and scientific capability possessed by many CSIR institutions excellence in national skill mission in various identified S&T domains can be established which will be a breeding ground for all the Skill/Training initiatives of different laboratories. It will host facilities for providing skill training to grass root level functionaries/ students/ Engineers/ Industry personnel's/ farmers etc. It will also envisage being a hub to connect with industrial people for guiding the skill/ training programme. Further, the CSIR integrated skill/ training programme will also bring in all the CSIR capabilities under one umbrella that will provide a unique knowledge driven platform under National Skill Mission. The programme also has the potential to enhance the CSIR brand image towards its Scientific Social Responsibility contributions by amalgamating its on-going and new skill/ training programmes.

CSIR-CBRI has been actively involved in providing scientific and technological housing solutions for the construction of safe built environment in the service of the nation for more than six decades. The institute has been assisting the building construction and building material industries, rural and urban housing, fire hazards, energy conservation and efficiency, structural and foundation problems and disaster mitigation. The Institute has mandate to transfer the building technologies developed by the institute to the construction industries. In this direction, the institute has been conducting short duration skill development training programmes through in-house training programmes and CSIR-CBRI Webinar series for students, masons, functionaries, engineers, supervisors, work professionals and unemployed youth all over the country on various Building Science Technology related topics with live demonstrations for implementation of building technologies that are cost effective, durable, energy efficient and comfortable for living. CSIR-CBRI, under CSIR Integrated Skill Initiative has planned to regularize its skill development trainings across the country to develop skilled manpower for the construction sector.

During the last FY 2020-21; CSIR-CBRI has provided value addition to the skills and knowledge by training and skill upgradation to more than 2200 persons on housing technologies, disaster awareness and preparedness which resulted in successful enforcement of innovative housing technologies for the societal benefit. The major participating agencies are Uttarakhand State Disaster Management Authority (USDMA), Dehradun, Himachal Pradesh State Disaster Management Authority (HPSDMA), Shimla, UNDP & PRED, Odisha, Jawaharlal Nehru Govt. Engg. College, Sundernagar (Himachal Pradesh) & Local

District Administrations etc. CSIR-CBRI in its each skill development training programme keeps a balance of technical sessions and practical demonstration; in order to generate interest towards science & technology in the trainees. CSIR-CBRI, during its in house training programme, encourages the participants to visit different laboratories of CBRI and allows them to interact with the Scientists & Researchers.

Under CSIR Integrated Skill Initiative and other sponsors from different states, CSIR-CBRI has successfully organized 12 Skill development training programmes including 10 webinars, 01 workshop and 01 in-house training during the financial year 2020-21. A total of 2232 participants were trained during this period and the details of programmes are given below;

S. No	*Sponsoring/ Collaborative Agency*	*Name of Webinar/Training/Workshop*	*Dates*	*No. of Trainees*
1.	CSIR Integrated Skill Initiative	**Webinar 1.0 -** Advances in Building Technology	June 01-05, 2020	222
2.	UNDP & PRED, Odisha	**Webinar 2.0 -** Appropriate Construction Technology for Rural Housing	June 09-17, 2020	1174
3.	CSIR Integrated Skill Initiative	**Webinar 3.0 -** Sustainable Buildings & Future Technologies	July 13-17, 2020	167
4.	CSIR Integrated Skill Initiative	**Webinar 4.0 -** Landslide Disasters – Investigation to Mitigation	Aug 04-08, 2020	166
5.	CSIR Integrated Skill Initiative	**Webinar 5.0 -** Waste to Wealth in Infrastructure Development	Sep 14-18, 2020	80
6.	CSIR Integrated Skill Initiative	**Webinar 6.0 -** Mechanization and Automation in Building Construction & Services	Nov 02-05, 2020	66
7.	Himachal Pradesh State Disaster Management Authority (HPSDMA), Shimla	**Workshop 1.0 -** Improving Disaster Resiliency of Lifeline Buildings	Nov 24, 2020	47
8.	Uttarakhand State Disaster Management Authority (USDMA), Dehradun	**Webinar 7.0 -** Earthquake Resilient Construction Practices	Dec 07-12, 2020	25
9.	Uttarakhand State Disaster Management Authority (USDMA), Dehradun	**Webinar 8.0 -** Earthquake Resilient Construction Practices	Dec 14-19, 2020	35
10	CSIR Integrated Skill Initiative	**Webinar 9.0 -** Disaster Resilient Building Constructions	Jan 27-30, 2021	105
11.	CSIR Integrated Skill Initiative	**Webinar 10.0 -** Advanced Course on Ground Improvement Techniques	Feb 15-17, 2021	125
12.	Jawaharlal Nehru Govt. Engg. College, Sundernagar (Himachal Pradesh)	**Training Programme** on Disaster Resilient Building Construction Practices	Mar 01-06, 2021	20
			Total No. of Trainees Trained	**2232**

Glimpses of Webinar/In-house Skill Development Training Programmes

1) ***Webinar 1.0*** on 'Advances in Building Technology' during June 01-05, 2020 at CSIR-CBRI, Roorkee.

Opening remarks by Coordinator

Media Coverage

2) ***Webinar 2.0*** on 'Appropriate Construction Technology for Rural Housing' for the officer's/grass root level functionaries of PR&DW department of Odisha Govt. during June 09-17, 2020 at CSIR-CBRI, Roorkee.

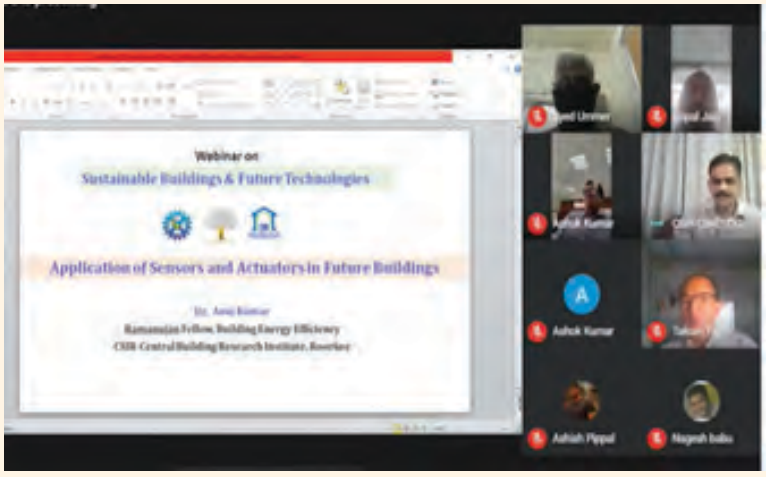
Technical Session by Expert

Live display of webinar sessions at District NIC, Bhubaneswar

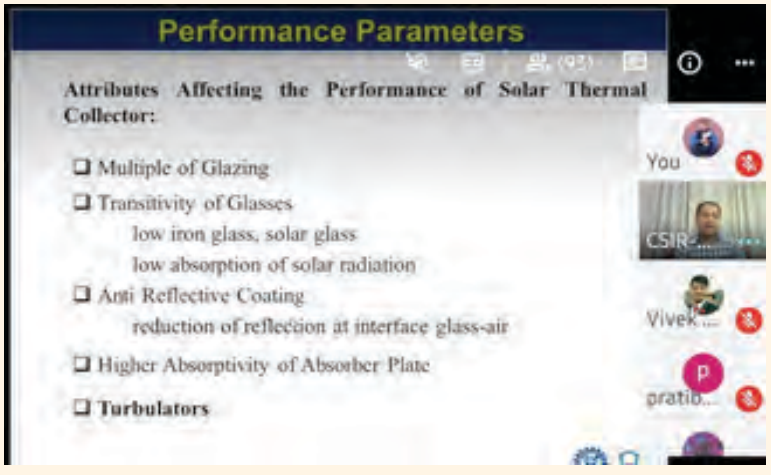
3) ***Webinar 3.0*** on 'Sustainable Buildings & Future Technologies' during July 13-17, 2020 at CSIR-CBRI, Roorkee.

Inaugural Address by Director, CSIR-CBRI

Opening Remarks by Coordinator



Technical Session on Application of Sensors & Actuators

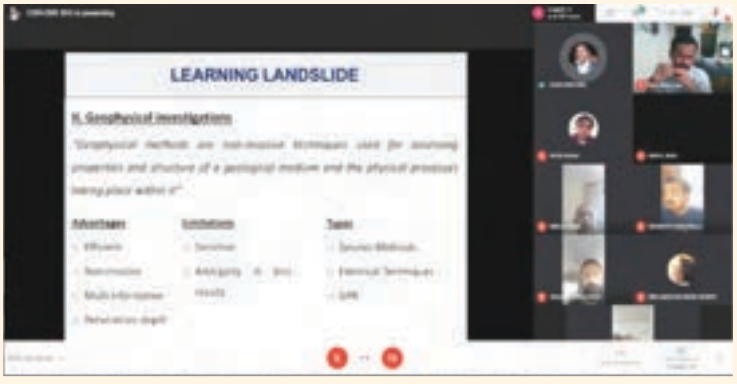


Technical Session on Solar Thermal Collectors in Buildings

4) ***Webinar 4.0*** on 'Landslide Disasters - Investigation to Mitigation' during August 04-08, 2020 at CSIR-CBRI, Roorkee.

Opening Remarks by Coordinator

Technical Session by expert at CSIR-CBRI Studio

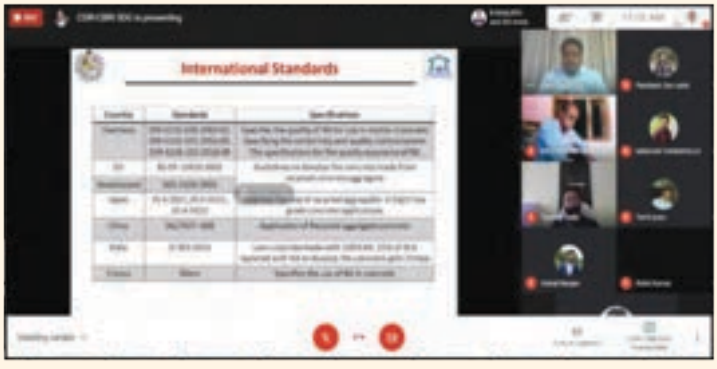


Technical Session on Landslide Early Warning Strategies

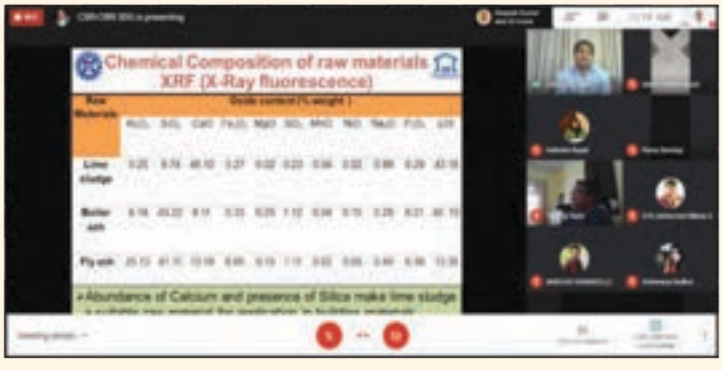
Technical Session on Slope Instability Mitigation

5) ***Webinar 5.0*** on 'Waste to Wealth in Infrastructure Development' during Sep 14-18, 2020 at CSIR-CBRI, Roorkee.

Technical Session on Waste Utilization in Construction



Technical Session on Utilization of C & D Waste

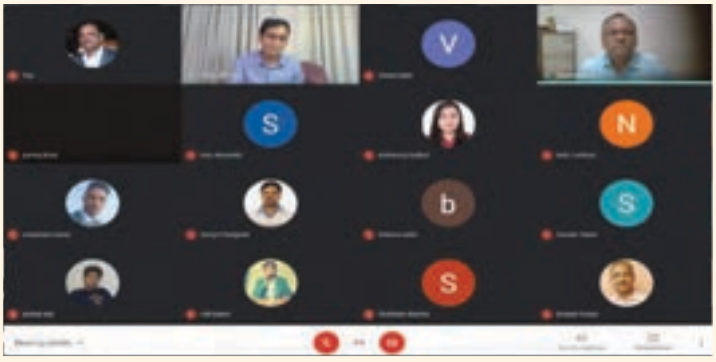


Technical Session on Utilization of Paper Industry Waste

6) ***Webinar 6.0*** on 'Mechanization and Automation in Building Construction & Services' during Nov 02-05, 2020 at CSIR-CBRI, Roorkee.

Technical Session on Mechanization in Construction

Technical Session on Building Automation

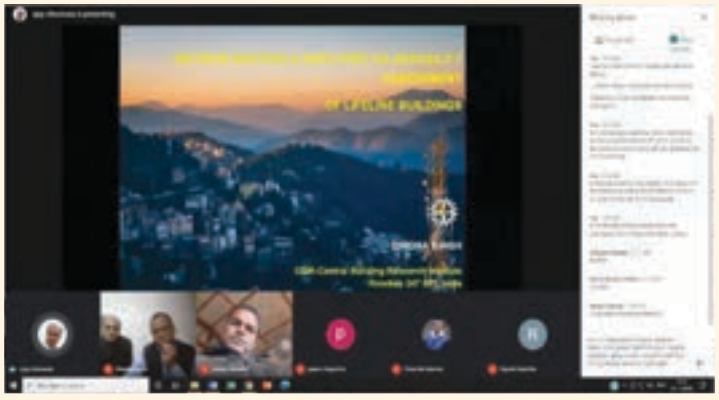


Concluding Session

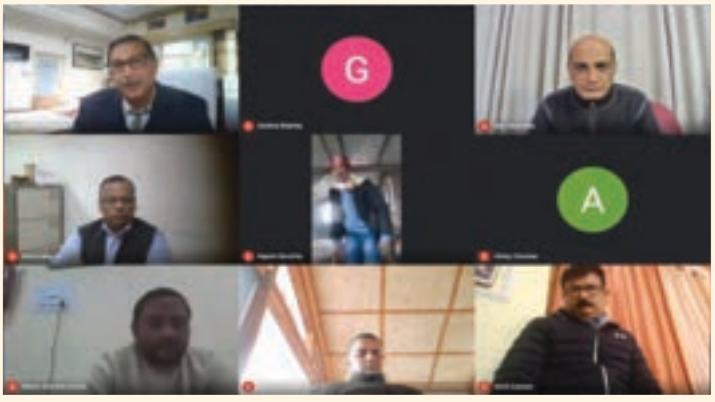
7) ***Workshop 1.0*** on 'Improving Disaster Resiliency of Lifeline Buildings' for the engineers of HPSDMA, Shimla (HP) on Nov 24, 2020 at CSIR-CBRI, Roorkee.

Inauguration of Workshop

Technical Session on Vulnerability Assessment of Buildings



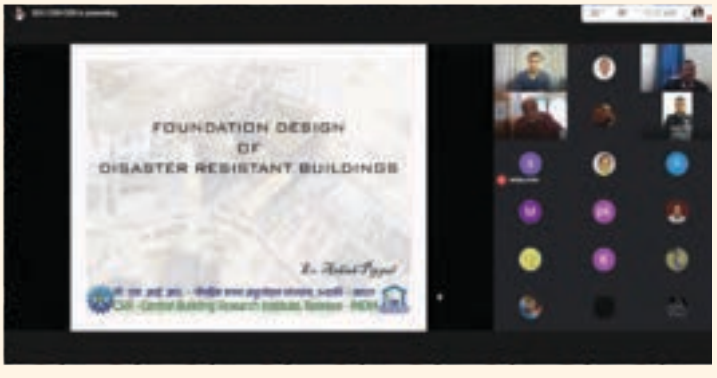
Technical Session on Distress Mapping of Lifeline Buildings



Concluding Discussion with Engineer-in-Chief

8) ***Webinar 7.0*** on 'Earthquake Resilient Construction Practices' for the engineers of Uttarakhand Govt. (USDMA, Dehradun) during Dec 07-12, 2020 at CSIR-CBRI, Roorkee.

Opening Remarks by Coordinator



Technical Session on Foundation Design

Technical Session on Fire Safety in Buildings

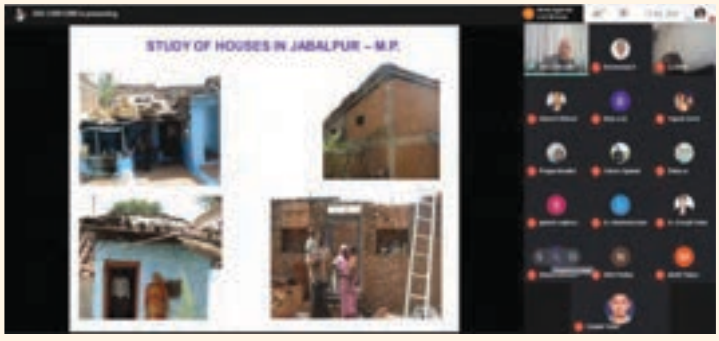
9) ***Webinar 8.0*** on 'Earthquake Resilient Construction Practices' for the engineers of Uttarakhand Govt. (USDMA, Dehradun) during Dec 14-19, 2020 at CSIR-CBRI, Roorkee.

Technical Session on Concepts of Disaster Risk Reduction

Technical Session on Innovative Building Technologies

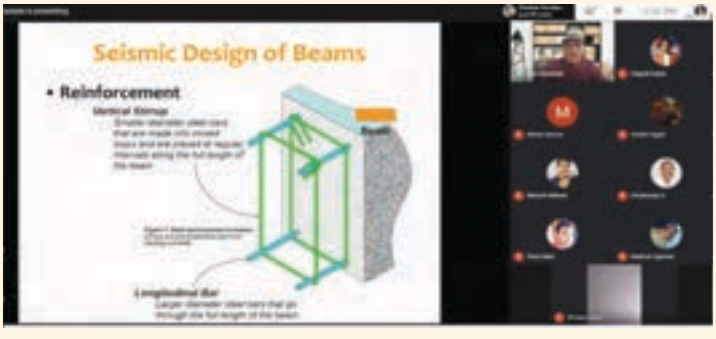
Technical Session on Pre-Fabricated Construction Systems

10) ***Webinar 9.0*** on 'Disaster Resilient Building Constructions' during Jan 27-30, 2021 at CSIR-CBRI, Roorkee.



Technical Session on Architectural Design & Planning

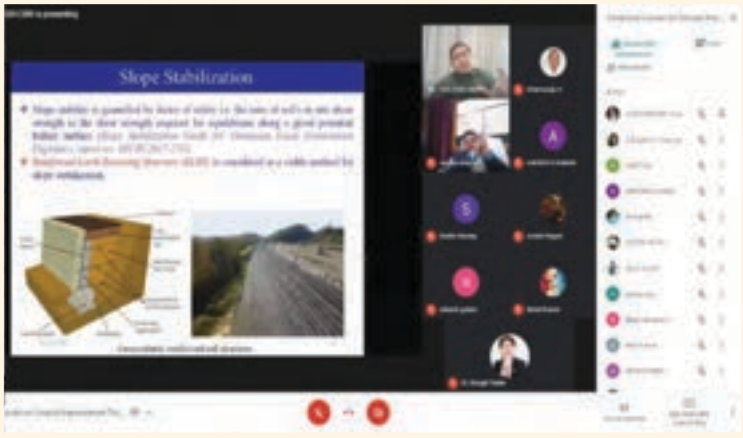
Technical Session on New Building Materials for Construction



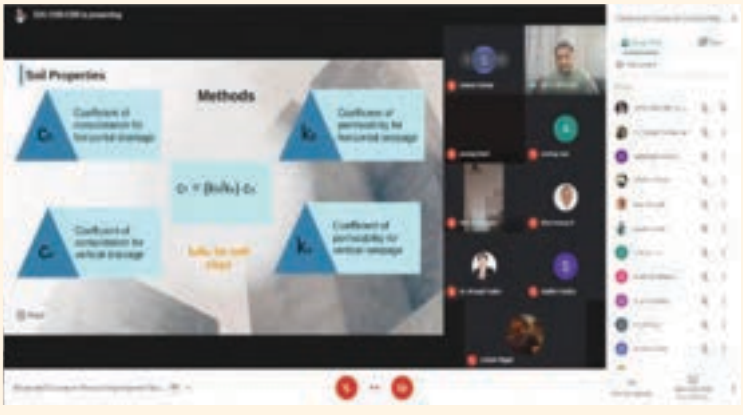
Technical Session on Disaster Resistant Design

11) ***Webinar 10.0*** on 'Advanced Course on Ground Improvement Techniques' during Feb 15-17, 2021 at CSIR-CBRI, Roorkee.

Technical Session on Ground Improvement



Technical Session on Reinforced Soil Retaining Structure



Technical Session on Pre-Fabricated Vertical Drain sys

Live display of webinar sessions to Students at RCE, Roorkee

12) ***Training Programme*** on 'Disaster Resilient Building Construction Practices' organized for the Civil Engineering Students of JNGEC, Sundernagar, Mandi (H.P.) during March 01-06, 2021 at CSIR-CBRI, Roorkee.

Group of Participants

Technical Session on Flood Risk Mitigation & Management

Visit of Participants to various Laboratories

Practical Demonstration of Walling & Roofing Components

Distribution of Certificates


भूकंपरोधी भवन की तकनीक बताई

Media Coverage of Training Activities

Knowledge Resource Centre

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

Acquisition:

- **Books:** KRC purchased 60 numbers of books and received 06 numbers on gratis basis.
- **Journals:** The library has subscribed 47(27 foreign + 06 foreign print and 14 Indian) journals.

Library statistics: The present position of library collection of Books including reports; standards; conference proceedings; theses & maps contains 45294 numbers and 20877 Bound Volumes of journals.

Institutional Membership: CSIR-CBRI is a member of four national and three international professional / learned societies. KRC receive their publications against the annual membership fees.

- **National (India):** Indian Geotechnical society (IGS) Delhi; Institute for Steel Development and Growth (INSDAG), Kolkata; Indian Science Congress Association (ISCA) Kolkata and Indian Building Congress (IBC) Delhi.
- **International / foreign:** International Union of Laboratories & Experts in Construction Materials, System and Structures (RILEM) Bagneux France; International Federation for structural Concrete (FIB) Lausanne, Switzerland and American Concrete Institute (ACI) USA.

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:

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

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

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

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

- **CD-ROM:** CD-ROMs are available in KRC viz. CIB Conference proceedings, ACI Manual, Patestate: a database of CSIR Patents; heritage building and sites.

- **In-House Database:** KRC is maintaining in-house bibliographic database of books and bound volumes of journals.

- **Internet Facility:** KRC has internet connectivity node with PC's as well as wi-fi connectivity for users to access of e-resources.

- **Access of E-Journals:** At present access to over 2000 full text of e-journals of leading S&T publishers viz., ASCE, full text of ASTM Standards, Elsevier (selected), ICE (UK), IEEE Nature, OUP, RSC, T&F, Wiley, science database like Web of science (WOS) and patent database viz. QPAT/ORBIT are available online under National Knowledge Resource Consortium (CSIR-DST E-Journals Consortium) as well as direct subscription.

- **Knowledge Repository:** KRC has created Institutional Repository (IR) through dspace software. Large number of records has already uploaded contains full text database along with metadata of published research papers of S&T staff members of the institute as well as all Building Research Notes (BRN), Project Profiles, Annual Reports of CSIR-CBRI since 1953 and conference proceedings volumes, organized by CBRI. This database can be accessed at http:KRC.cbri.res.in/dspace.

Planning & Business Development

PBD group acts as the main facilitator of the institute for effective planning, monitoring, evaluation and project management of all R&D and Externally Funded Projects such as Consultancy Sponsored Projects, Grant–In-Aid and technical services, etc. Important documents for externally funded projects, MC agenda and R&D agenda for the Research Council are also dealt by PBD group. Besides this, this group manages technology transfer to the industries, IPR management activities and execution of agreements & MoUs with various industries/institutes/organizations

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

R&D Projects

Internal review meetings and meetings with external experts are organized for review of new R&D projects. The ongoing projects are monitored for progress and/or mid-course corrections. Comments of experts are conveyed to concerned PIs and it is ensured that the same are incorporated before the projects are placed to RC. R&D projects were processed under the R&D areas of the institute, namely, Housing- Structure & Foundation, Conservation of Heritage Structures, Innovative Building Materials, Disaster Mitigation, and Energy Efficient System & Building Process & Automation.

During the 2020-21 institute intensely involved in 4 FTT, 3 FBR, 3 NCP, 1 FTC projects.

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 CSIR Coordinated & FTT Projects during the year. PBD 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

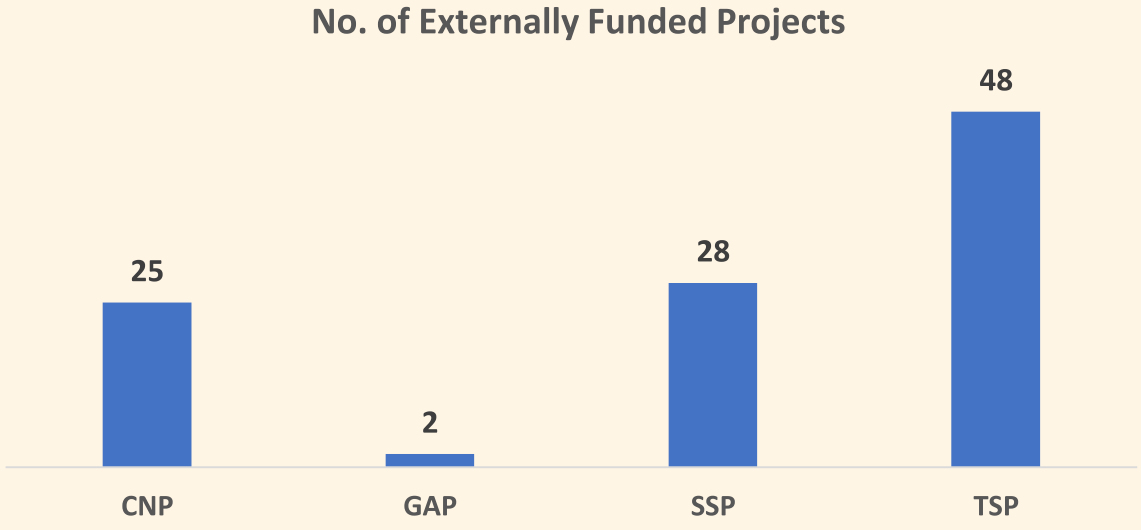
Research Council Meetings are held to monitor the progress of R&D projects of the Institute. The R&D agenda of RC meetings was prepared. The agenda covered the progress of ongoing projects as well as completed projects during the period and new projects taken by S&T staff. The outcome in terms of suggestion/direction/guidance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

Other Documents

The group coordinated replies to various audits (CAG, CSIR and Service Tax), attended to RTI and Parliament questions.

Externally Funded Projects

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



A database of all the externally funded projects is maintained which helps in effective monitoring of these projects. Necessary record and receipts of GST/Service Tax & TDS collection are maintained. GST/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.

Budget & ECF

CSIR Resource Input			External Cash Flow (ECF)	
Revenue	2962.492	Lakh	Govt +PSU+ Private	3588.079 Lakh
Capital	344.882	Lakh		
Special Projects	47.148	Lakh		

Special Events

International Environment Day

(5th June, 2020)

On June 5, 2020 International Environment Day was celebrated at CSIR-CBRI Roorkee in a symbolic manner due to covid pandemic. On this occasion, tree plantation activity was carried out. Trees were planted by Dr. R.S Chimote, Dr. Suvir Singh, Dr. Rajni Lakhani. Dr. N. Gopalakrishnan Director CSIR-CBRI Roorkee graced the occasion and CBRI scientists Dr. Shantanu Sarkar, Dr. S.K. Singh, Dr. B.S.Rawat, Dr. D.P. Kanungo, Dr. S.R. Karade and Dr. P.K.S. Chauhan were present during the activity.

Tree Plantation Activity on International Environment Day

Independence Day

15th August, 2020

On the occasion of 74th Independence Day on 15th august, 2020 CSIR- CBRI organized a Flag raising Ceremony at the institute with a deep sense of patriotism. Dr. N. Gopalakrishnan hoisted the National Flag and took the salute at march-past performed by security guards. He addressed the scientific community on this occasion and ask to work for nation development. Since the ceremony was carried out according to covid protocols, no cultural activities were organized.

Independence Day Celebration

हिंदी पखवाड़ा आयोजन (१४ से २९ सितम्बर, २०२०)

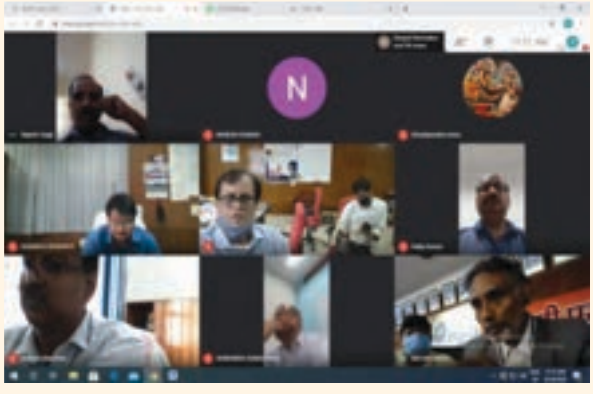
सीएसआईआर – केंद्रीय भवन अनुसंधान संस्थान, रुड़की में संस्थान के निदेशक डॉ. एन. गोपालकृष्णन ने हिन्दी पखवाड़े का ऑनलाइन(गूगल मीट) उदघाटन किया। हिन्दी पखवाड़ा १४ से २९ सितंबर, २०२० के दौरान मनाया गया। इस अवसर पर बोलते हुए डा. गोपालकृष्णन ने सीबीआरआई के सभी अधिकारियों एवं कर्मचारियों को हार्दिक शुभ कामनाएं दीं।

हिंदी पखवाड़ा आयोजन का उदघाटन करते संस्थान के निदेशक डा. एन. गोपालकृष्णन

निदेशक का संदेश

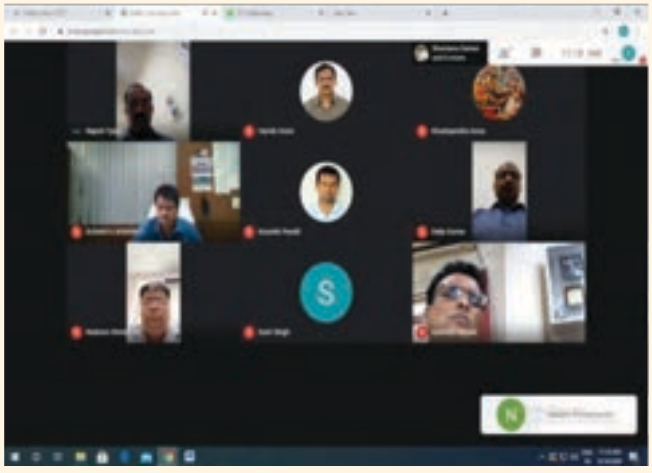
डा. गोपालकृष्णन ने अपने संदेश में कहा कि भाषा किसी भी राष्ट्र की सामाजिक एवं सांस्कृतिक धरोहर की संवाहक होती है। स्वतंत्रता आंदोलन के समय से ही हिंदी सबसे बड़ी संपर्क भाषा के साथ-साथ राष्ट्रीय एकता का मूल स्वर भी रही है। इसीलिए, हिंदी को भारतीय संविधान सभा द्वारा सर्वसम्मति से १४ सितंबर, १९४९ को भारत संघ की राजभाषा के रूप में स्वीकार किया गया था।

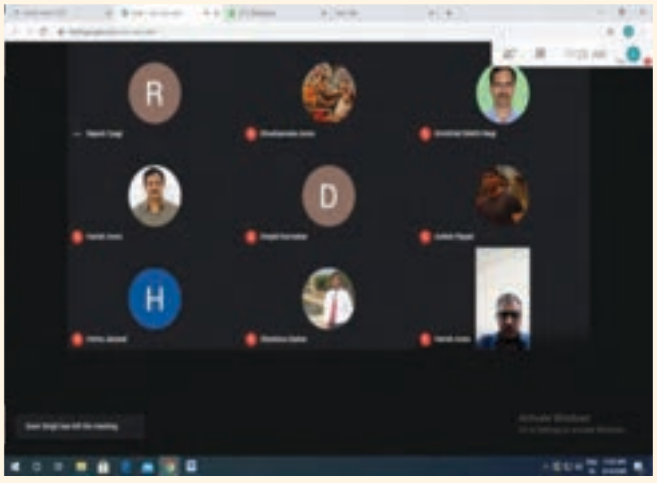
संदेश में डा. गोपालकृष्णन ने कहा कि संघ सरकार की राजभाषा नीति सदभावना, प्रेरणा तथा प्रोत्साहन पर ही आधारित है। हमें हिंदी को भावनात्मक दृष्टिकोण से अपनाना है। जो लोग पहले से ही हिंदी में अच्छा काम कर रहे हैं, हमें उनसे प्रेरणा लेनी है तथा हिंदी को अपने दैनिक सरकारी कामकाज का हिस्सा बनाना है।



उदघाटन समारोह से गूगल मीट के माध्यम से जुड़े हुए मुख्य वैज्ञानिक
डा. सुवीर सिंह, एस.के. नेगी, डा. अशोक कुमार, डा. सुशांत कुमार सेनापति एवं अन्य ।

इसके अलावा डा. एन. गोपालकृष्णन, निदेशक, सीबीआरआई ने भावनात्मक अपील के माध्यम से सभी कार्मिकों से सरकारी कामकाज हिंदी में करने का आह्वान किया ।



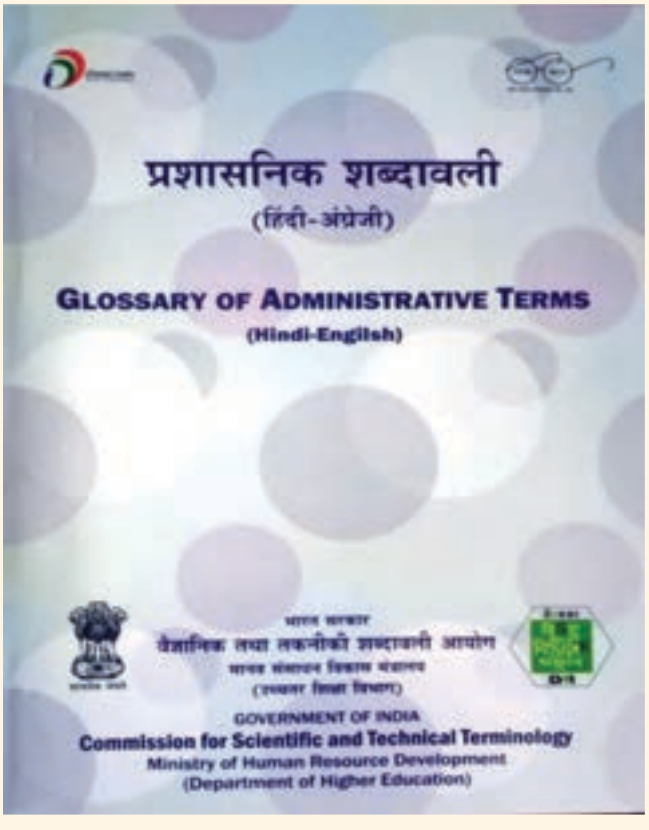


उदघाटन समारोह से गूगल मीट के माध्यम से जुड़े हुए अन्य वैज्ञानिकगण

संस्थान के वैज्ञानिकों/ प्रशासनिक स्टाफ तथा परियोजनाओं में कार्यरत स्टाफ ने **गूगल मीट** के माध्यम से निदेशक महोदय के संदेश तथा अपील को सुना। इस अवसर पर हिंदी पखवाड़ा आयोजन समिति के अध्यक्ष डॉ. प्रदीप चौहान एवं आयोजन सचिव मेहर सिंह एवं हिंदी अधिकारी सूबा सिंह उपस्थित रहे।

प्रशासनिक शब्दावली का वितरण

इसके अलावा संस्थान के विभिन्न समूहों एवं अनुभागों के अध्यक्षों को वैज्ञानिक तथा तकनीकी शब्दावली आयोग, नई दिल्ली द्वारा प्रकाशित '**प्रशासनिक शब्दावली (अंग्रेजी-हिंदी तथा हिंदी-अंग्रेजी)**' का वितरण किया गया। जिससे कि वे मानक शब्दावली का अपने दैनिक कामकाज पर प्रयोग कर सकें।



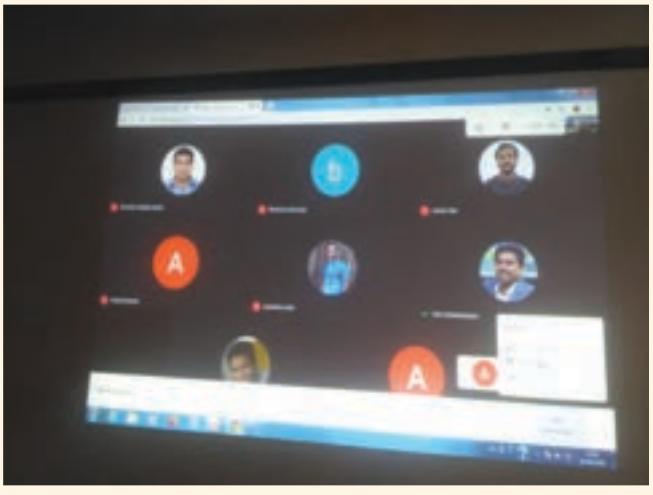
वितरित की गई प्रशासनिक शब्दावली(अंग्रेजी-हिंदी) तथा (हिंदी-अंग्रेजी)

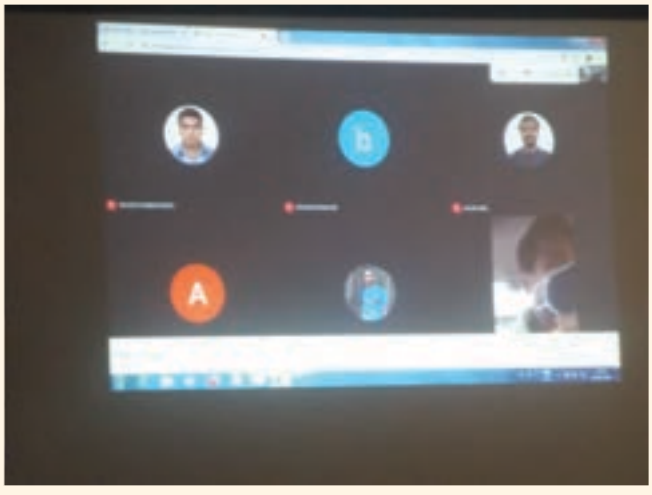
हिंदी निबंध लेखन प्रतियोगिता

हिंदी पखवाड़े के दौरान हिंदी निबंध लेखन प्रतियोगिता का आयोजन किया गया। जिसका विषय था **"प्राचीन भारत में भवन निर्माण"** । इस प्रतियोगिता में श्री सुधीर कुमार, सहायक अनुभाग अधिकारी को प्रथम तथा श्री सुशील कुमार, वरिष्ट तकनीकी अधिकारी को द्वितीय पुरस्कार प्रदान कर सम्मानित किया ।

हिंदी पठन प्रतियोगिता

इसके अलावा २४ सितम्बर, २०२० को 'ग' क्षेत्र के भाषा-भाषियों के कार्मिकों के लिए हिंदी पठन प्रतियोगिता का आयोजन 'गूगल मीट' के माध्यम से किया गया। जिसमें 'ग' क्षेत्र के कार्मिकों ने बढ़-चढ़ कर हिस्सा लिया।



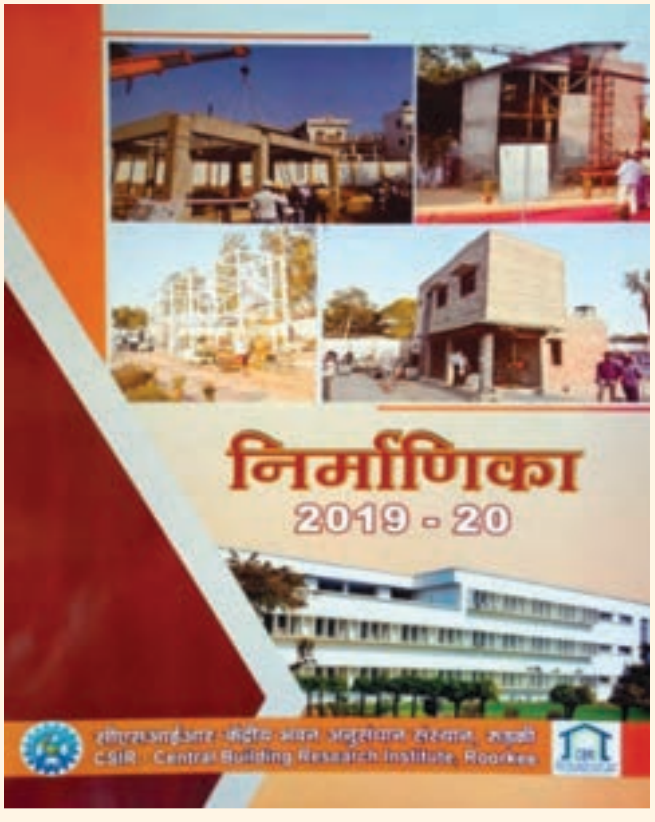


हिंदी पठन प्रतियोगिता में गूगल मीट के माध्यम से जुड़े हुए प्रतिभागीगण

समापन समारोह

सीएसआईआर – सीबीआरआई रुड़की में निदेशक- सीबीआरआई डॉ. एन गोपालकृष्णन ने हिन्दी पखवाड़े के समापन समारोह में संस्थान की वार्षिक पत्रिका "निर्माणिका" का विमोचन किया तथा इस अवसर पर बोलते हुए निदेशक-सीबीआरआई ने सभी अधिकारियों एवं कर्मचारियों को हार्दिक शुभ कामनाएं दीं तथा आगे भी 'हिन्दी' में काम करने का आह्वान किया।

निर्माणिका-2019-20 के अंक का विमोचन करते हुए संस्थान के निदेशक डा. गोपालकृष्णन एवं राजभाषा कार्यान्वयन समिति के सदस्यगण



निर्माणिका-२०१९-२० के विमोचित अंक के आवरण पृष्ठ

सरकारी कामकाज मूल रूप से हिंदी में करने के लिए प्रोत्साहन योजना के अंतर्गत सुशील कुमार एवं अनित कुमार पाल को प्रथम, सुधीर कुमार को द्वितीय तथा शिव कुमार एवं अमित कुमार को तृतीय पुरस्कार प्रदान किया गया।

सरकारी कामकाज मूल रूप से हिन्दी में करने के लिए
प्रोत्साहन योजना के अंतर्गत पुरस्कृत कार्मिक

सरकारी कामकाज मूल रूप से हिंदी में करने के लिए प्रोत्साहन योजना
(2019-20) के अंतर्गत पुरस्कृत कुछ प्रतिभागी

वैज्ञानिक एवं तकनीकी काम-काज के लिए हिन्दी प्रोत्साहन योजना के अंतर्गत डॉ. अतुल अग्रवाल को प्रथम, डॉ. अशोक कुमार को द्वितीय, विनीत सैनी को तृतीय तथा सुशील कुमार, बी एस रावत, नीरज जैन, नरेश कुमार को प्रोत्साहन पुरस्कार प्रदान किया गया।

पखवाड़े के दौरान हिंदी निबंध प्रतियोगिता भी आयोजित की गई जिसमें सुधीर कुमार को प्रथम, सुशील कुमार को द्वितीय प्रदान किया गया।

हिंदी पठन प्रतियोगिता के अंतर्गत पुरस्कृत कुछ प्रतिभागीगण

हिंदी पठन प्रतियोगिता में राजेश दास व भवानी को प्रथम, कौशिक पंडित व डॉ. ए. अरविन्द को द्वितीय, डॉ. शिवा चिदंबरम व नागेश बाबु बालम को तृतीय पुरस्कार प्रदान किया गया।

समापन समारोह के दौरान संस्थान की हिंदी गृह-पत्रिका 'निर्माणिका' का भी विमोचन किया गया जिसके संपादक सूबा सिंह – हिंदी अधिकारी रहे तथा मुख्य संपादक डॉ. प्रदीप चौहान हैं।

इस अवसर पर हिंदी पखवाड़ा आयोजन समिति के अध्यक्ष डॉ. प्रदीप चौहान एवं आयोजन सचिव एवं हिंदी अधिकारी श्री मेहर सिंह, हिंदी अधिकारी श्री सूबा सिंह तथा संस्थान की राजभाषा कार्यांवयन समिति के सदस्य श्री एस.के. नेगी, डा. एस.के. सेनापति, डा. हेमलता, सुश्री हिना गुप्ता, डा. किशोर कुलकर्णी एवं श्री सुशील कुमार आदि उपस्थित थे ।

Anti- Body Testing Drive

(15th September,2020)

In Collaboration with CSIR-IGIB New Delhi & CSIR-CBRI a mass blood sample collection drive was carried out at CSIR-CBRI Roorkee on 15th September, 2020 to check anti-bodies in the blood sample for nationwide data. CBRI- staff along with their family members became part of this mass sample collection drive. The program was successfully coordinated by Dr. B.S. Rawat.

Glimpses of Anti- Body Testing Drive

Swachhata Abhiyan

(2nd October, 2020)

A cleanliness drive was conducted on Gandhi Jayanti on 2nd October, 2020 as part of the Swachh Bharat Mission at CSIR- CBRI Roorkee to raise awareness about the value of cleanliness. CBRI staff actively took part and covered the CBRI Institute and residential campus. More than 100 people participated in this cleanliness drive.

Glimpses of Cleanliness Drive

Vigilance Awareness Week

(27th October to 2nd November, 2020)

A week-long online Vigilance Awareness program was conducted by CSIR-CBRI Roorkee from 27th October, 2020 to 2nd November, 2020 with a theme of "**Vigilant India, Prosperous India"**. The covid epidemic forced the program to be delivered online. Dr. N Gopalakrishnan inaugurated the program with the oath of integrity. Additionally, the participants created posters to convey awareness against corruption.

Glimpses of the Vigilance Awareness Week

Constitution Day

(26th November, 2020)

On 26th November, 2020 Constitution Day was celebrated at CSIR-CBRI Roorkee through online mode. The event started with the oath taking ceremony by honorable President Ram Nath Kovind, in which CBRI staff member actively participated.

Oath taking ceremony on Constitution Day

India International Science Festival 2020

(22nd- 25th December, 2020)

From December 22nd to December 25th, 2020, CSIR-CBRI Roorkee participated in the India International Science Festival on online mode. The focus of the festival was Self-Reliant Global Welfare with a theme of Habitat (Rural & Urban). The event was inaugurated by Chief Guest Shri. Hardeep Singh Puri, honorable union minister of state. Dr. P.S.N Rao, Director SPA New Delhi was the guest of honor for the event. There were two scientific discussions, two plenary sessions, two panel discussions, two webinar sessions, interactive meets in the event. The event was successfully coordinated by Dr. Ashok Kumar and attended by large number of scientists from CSIR-CBRI.

Glimpses of India International Science Festival

Republic Day Celebration

(26th January, 2021)

On the occasion of Republic Day celebration CSIR-Central Building Research Institute Roorkee organized Flag-Raising ceremony on 26th January, 2021 at the institute with a deep sense of patriotism. Dr. N. Gopalakrishnan hoisted the National Flag and took the salute at march-past performed by security guards. He addressed the scientific community on this occasion and ask to work in the sector of building technology specially for rural sector. Since, the ceremony was carried out according to covid protocols, no cultural activities were organized.

Republic Day Celebration

CSIR-CBRI 75th Foundation Day

(10th February, 2021)

On February 10, 2021, the Institute enthusiastically celebrated the Platinum Jubilee (75th Foundation Day) of its scientific accomplishments. Shri M. Venkaiah Naidu, Hon'ble Vice President of India attended the occasion as chief guest and Shri Jai Ram Thakur Hon'ble Chief Minister of Himachal Pradesh graced the occasion by his presence.

Dr. Shekhar C. Mande Director General, CSIR & Secretary, DSIR was also present on this glorious occasion. In his address he appreciated the work carried out by the institute in the service of nation and expressed his best wishes for the future. He congratulated the entire CSIR-CBRI family on this day.

Shri Jai Ram Thakur appreciated the efforts of CSIR-CBRI Roorkee in establishing the Covid Hospital in Himachal Pradesh at Mandi. He highlighted the scientific efforts put by CBRI to fight the covid 19 pandemic specially in the field of hospital construction.

On this auspicious occasion Shri M. Venkaiah Naidu, Hon'ble Vice President officially inaugurated two new laboratories at CSIR-CBRI Roorkee “Center of Excellence on Conservation of Heritage Structures “and “Platinum Jubilee Advanced Pseudo-Dynamics laboratory”. He also unveiled the booklet "Glorious 75 Years of CSIR-CBRI".

Dr. N. Gopalakrishnan, presented a vote of thanks. He expressed his gratitude to Shri M. Venkaiah Naidu, honorable Vice President of India for sparing his valuable time to grace the occasion despite of his busy schedule. He also thanked Shri Jai Ram Thakur Hon'ble Chief Minister of Himachal Pradesh for joining the glorious moment of CSIR-CBRI. He thanked Dr. Shekhar C. Mande Director General, CSIR & Secretary, DSIR for guiding team CSIR-CBRI for making this event a grand success. In last he thanked entire CBRI Family for contributing towards the success of the institute. The function was celebrated following covid 19 pandemic guidelines.

Illumination of the Institute during 75th CSIR-CBRI Foundation Day.

Glimpses of CSIR-CBRI 75th Foundation Day Function.

Glimpses of CSIR-CBRI 75th Foundation Day Function.

Anti- Body Testing Drive

(25th January, 2021)

In Collaboration with CSIR-IGIB New Delhi & CSIR-CBRI a mass blood sample collection drive was carried out at CSIR-CBRI Roorkee on 25th January, 2021 to check anti-bodies in the blood sample for nationwide data. CBRI- staff along with their family members became part of this mass sample collection drive. The program was successfully coordinated by Dr. B.S. Rawat.

Glimpses of Anti- Body Testing Drive

Road Safety Oath

17th February, 2021)

During the National Road Safety month in India with a theme of "Sadak Suraksha – Jeevan Raksha" CSIR-CBRI organized an Oath taking event on 17th February, 2021, with an objective to raise awareness regarding traffic rules. In this event CBRI staff- pledged to follow the safety rules. Due to covid pandemic the event was organized keeping in mind covid guidelines.

Oath taking on Road Safety event

Projects

List of MLP Projects undertaken during 2020-21

Sl.No	Project No	Duration	Name of PI/ Co-PI	Title of Project
1	MLP012002 FTT	15-07-2020 to 31-03-2022	Soumitra Maiti Neeraj Jain	Development of technology for high strength Binder/value added building products using flue gas desulphurization (FGD) gypsum a byproduct of coal based thermal power plants
2	MLP022002 FTT	15-07-2020 to 31-03-2022	L.P.Singh Soumitra Maiti	Technology package for eco-friendly burnt clay brick with low carbon footprints
3	MLP032002 FTT	15-07-2020 to 31-03-2022	S.K.Singh Rakesh Paswan	Valorisation of lime sludge through development of environmental friendly building products
4	MLP042002 FTT	15-07-2020 to 31-03-2022	R.Lakhani Rajesh Kumar	Utilization of marble waste to develop cost-effective sustainable building products
5	MLP52002 FTC Lead CMERI	01-07-2020 to 31-03-2021	R.S.Bisht S.K. Panigrahi	Development of Robotic Inspection and Mechanized sewage cleaning system
6	MLP062002 NCP with CIMFR	01-04-2020 to 31-03-2023	Anindya Pain /M. Vinoth Manojit Samant / Koushik Pandit	Geotechnical Novel Solutions for Underground Infrastructures
7	MLP072002 FBR	01-04-2020 to 31-03-2022	Banti A. Gedam Suvir Singh	Spalling-mitigation technology for high-strength concrete at elevated temperature
8	MLP082002 FBR	01-04-2020 to 31-03-2022	Kishor S.Kulkarni Ashok Kumar	Development of Innovation cool roof with improved thermal & energy performance

9	MLP092002 FBR	01-04-2020 to 31-03-2023	M M Dalbehera Suvir Singh	Structural performance Assessment of Connections in Bamboo Structures
10	MLP102002 NCP	01-04-2020 to 31-03-2023	D P Kanungo Manojit Samanta	Multi-temporal optical Imaging Drone Based Landslide Monitoring and Warning
11	MLP0111 NCP Lead CGCRI	01-04-2020 to 31-03-2022	S.K.Panigrahi Ajay Chourasia	Development of Fiber Bragg Grating Long Gauge Sensors for Structural Health Monitoring

	External Funded Projects undertaken 2020-21			
	Project No	**PI**	**Party Name**	**Title**
1	**CNP0010**	Rakesh Paswan	M/s PES Engineers Pct. Ltd., Plot No. 10, Phase-1, Eldeco-SIDCUL Industrial Park Ltd., Sitarganj	Evaluation of Materials and Mix Proportioning
2	**CNP0020**	A. K. Mittal	Ex. Engineer / CMR-1, RGTPP, Haryana Power Generation Corporation Ltd., Khedar, Hisar	Health Assessment of Cooling Tower at RGTPP, HPGCL, Hisar
3	**CNP0100**	Reyazur Rehman	Ex. Engineer, CPWD, IIT Roorkee Project Division, 11 Niti nagar, Roorkee (M/s Consort Builders Pvt. Ltd, IIT Roorkee)	Evaluation of Materials and Mix Proportioning of SCC-M45
4	**CNP0190**	Neeraj Jain	M/s Team Energy Systems, Sector 4, 2nd Floor, SCO 87, Panchkula	Physical verification of rectangular induced draft zig-zag brick kilns in Punjab state for issue of adequacy cum completion certificate as per CBRI design
5	**CNP0320**	Raskesh Paswan	Ex. Engineer, Uttrakhand Peyjal Nigam Haldwani (Contractor: M/s Aquatech Solutions Pvt. Ltd., Gaujajali Uttar, Kripa Kuthi, Doon Schoolwali Gali, Bareilly Road, Haldwani)	Evaluation of Materials and Mix Proportioning of M25 & M30 Grade Concrete
6	**CNP0600**	S. K. Panigrahi	M/s Medulla Soft Technologies Pvt. Ltd., Plot No.- 04, Sector-132, NOIDA, Gautam Buddha Nagar	Vetting of Design of SHM System for Operation on New Kalwa Bridge in Thane
7	**CNP0690**	Hemlata	Ex. Engineer, Health Project Division (West), PWD, Sector 9, Dwarka, New Delhi	Evaluation of Water Proofing Membrane

8	**CNP0740**	Neeraj Jain	M/s Team Energy Systems, Sector 4, 2nd Floor, SCO 87, Panchkula	Physical verification of rectangular induced draft zig-zag brick kilns in Punjab state for issue of adequacy cum completion certificate as per CBRI design
9	**CNP0850**	Rakesh Paswan	Ex. Engineer, Health Project Division (W), PWD, Sector 9, Dwarka, New Delhi	Evaluation of Crytalline Admixture Performance in Concrete
10	**GAP0090**	Rajesh Kumar	Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi	Development of loe-energy carbon eco cementitious binders via synergistic use of low graded industrial wastes for sustainable development
11	**GAP0120**	Rajni Lakhani	Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi	Development of Performance Improved Precast Lightweight Composite Materials using Solid Waste
12	**GAP0330**	Anindya Pain	Centre for Fire, Explosive & Environment Safety (CFEES), Mininstry of Defence, Brig. S. K. Mazumdar marg, Timarpur, Delhi	Engineering Solution for Soil Erosion Prevention of Traverses
13	**GAP0360**	Santha Kumar	Advanced Construction Technologies Pvt. Ltd., No. 5/55, Forest Range Road, Kuthambakkam Village & Post, Chettipedu, Poonmamallee Taluk, Thiruvallur Dist, Chennai	Construction of Demonstration Building (G+1) using Construction and Demolition Waste
14	**GAP0540**	Suvir Singh	Director Health, Govt. of Himachal Pradesh, Shimla	DESIGN AND CONSTRUCTION OF MAKESHIFT COVID-19 HOSPITAL AT NALAGARH ,HP
15	**GAP0550**	Suvir Singh	Director Health, Govt. of Himachal Pradesh, Shimla	DESIGN AND CONSTRUCTION OF MAKESHIFT COVID-19 HOSPITAL AT TANDA,HP
16	**GAP0560**	Suvir Singh	Director Health, Govt. of Himachal Pradesh, Shimla	Design and construction of makeshift COVID-19 Hospital at Shimla
17	**GAP0570**	Suvir Singh	Director Health, Govt. of Himachal Pradesh, Shimla	Design and construction of makeshift COVID-19 Hospital at Mandi.
18	**GAP0860**	Ashok Kumar	Science & Engineering Research Board (SERB), Vasant Kunj, New Delhi	Thermo-physical Evaluation of Traditional and Contemporary Building Envelope Constructions for Developing Adaptive Model for Thermal Comfort of Naturally Ventilated and Mixed Mode Residential Buildings
19	**SSP0030**	B. S. Rawat	M/s Bayer CropScience Ltd., Mayer House, Central Avenue, Hiranandani Estate, Thane West, Mumbai	Bio-efficacy and persistence studies of Fipronil 2.5% E.C. (w/v) for its suitability through pre-construction anti-termite treatment

20	**SSP0040**	Shorab Jain	M/s Transit Electronics Ltd., A/21, Capital Commercial Center, Ashram Road, Ahmedabad	Vetting of Design of Fire Alarm and Detection System in ONGC Complex at Dehradun and its Testing
21	**SSP0050**	Rajesh Deoliya	Ex. Engineer-cum-Senior Manager-2, Development Project, CPWD, B-115, First Floor, IP Bhawan, New Delhi	Third Party Quality Assurance for the work of: Construction of Grameen Vikas Bhawan (2 Basements + Ground + 9 Floors) for Ministry of Rural Development at KG Marg, New Delhi including Civil, Electrical & Mechanical and Horticulture Works / services on EPC Basis
22	**SSP0150**	Ashok Kumar	M/s Tata Steel Limited, Tata Centre, 43, Jawaharlal Nehru Road, Kolkata	Experimental Investigation on application of GGBS and Activated GGBS in AAC block and comparison with conventional versus developed AAC blocks and its real time thermal performance
23	**SSP0170**	Rajesh Deoliya	Executive Engineer, Central Public Works Department, INA Project Division, (Behind Vikas Sadan), INA, New Delhi	Third Part Quality Inspection / Quality Assurance Services for Atal Akshaya Urja Bhawan, CGO Complex, Lodhi Road, New Delhi. Sub Head: All Civil Works, Internal and External Electrical Works, Firefighting, DG set and Lifts
24	**SSP0200**	Rajesh Deoliya	Executive Engineer, Education Project Division-4, PWD, Govt. of NCT of Delhi, A-Block, 1st Floor, Vikas Bhawan-II, Civil Lines, Delhi	Third Party Quality Control and Quality Assurance (TPQC & QA) for the work of: c/o Stage-1 of Phase-II, Delhi Technological University at Bawana Road, Delhi (Civil, Mechanical, Electrical 9MEP) & all other allied services/works)
25	**SSP0230**	Suvir Singh	Rotary Cancer Hospital, AIIMS, New Delhi	Fire Safety Audit of Rotary Cancer Hospital, AIIMS
26	**SSP0260**	R. Siva Chidambaram	Project Manager, Uttrakhand Pey Jal Nigam Ltd., Rishikesh	Visual Inspection and Dye Penetration Testing on Steel Truss Connections
27	**SSP0350**	A. K. Mittal	Suerintending Archaeologist, Archaeological Survey of India, Bhubaneshwar Circle, Bhubaneshwar	Monitoring of Steel Portal Frame installed in Jagmohana of Shree Jagannath Temple Puri by CSIR-CBRI Phase-II
28	**SSP0430**	Ajay Chourasia	Ex. Engineer, PWD, Guptkashi	Review of Structural Design and Technical Advice of Shri Kedarnath Works
29	**SSP0450**	Neeraj Jain	M/s Team Energy Systems, Sector 4 2nd Floor, SCO 87, Panchkula	Design and Drawing of Air Pollution Control Device for Control of Respiratory Dust Emission from Brick Kilns
30	**SSP0480**	Siva Chidambaram	Project Manager, Uttrakhand Pey Jal Nigam Ltd., Rishikesh	Visual Inspection and Dye Penetration Testing on Selected and Accessible Locations of Steel

				Truss work at Sanskrit Academy
31	**SSP0500**	Rajesh Deoliya	Ex. Engineer, Vikas Pariajana Mandal-1, CPWD, Room No. B-312, I.P. Bhawan, New Delhi	Third Party Quality Assurance and Audit for the Construction of 88 nos. GPRA Type-III Quarters at Probyn Road, Timarpur, New Delhi
32	**SSP0660**	Ajay Chourasia	Himachal Pradesh State Disaster Management Authority, Shimla	Seismic Vulnerability Assessment & Retrofit of Health/lifeline Buildings in Himachal
33	**SSP0680**	R. Siva Chidambaram	Estate Department, Reserve Bank of India, Sector 17, Chandigarh	Vetting of Geo-technical and NDT report of the existing residential Buildings of RBI Colonyin Chandigarh
34	**SSP0780**	Rajesh Deoliya	M/s Artificial Limbs Manufacturing Corporation of India, Kanpur	Third Party Quality Inspection / Quality Assurance Services for Advanced Integrated Welness of Rehabiliation Centre for Artificial Limbs Manufacturing Corporation of India at Nawada, Ballabhgarg, Faridabad (Haryana). Sub Head: All Civil Works, Internal and External Electrical Works, Firefighting, DG Set and Lifts
35	**SSP0810**	L. P. Singh	M/s Asia Pacific Export, F-607/608 & G-627/628, E Pipezone, Boranada Indl. Area, Jodhpur	Development of Expansive Mortar for Silent Cracking of Stones
36	**SSP0840**	A. K. Mittal	M/s Geological Suvey of India, 27, JN Road, Kolkata ; M/s Archeological Survey of India, Office of the Director General, Dharohar Bhawan, 24, Tilak Marg, New Delhi	Structural Assessment of Mahakaleshwar Temple, Ujjain
37	**SSP0870**	Ajay Chourasia	Ministry of External Affairs, Govt. of India, New Delhi	Design & PMC services for post earthquake reconstruction / retrofitting of health buildings in earthquake affected areas of Nepal
38	**TSP0060**	Suvir Singh	M/s Koleshvari Infratech Pvt. Ltd., Plot No. 298, Road No. 4, GIDC, Kathawada, Ahmeddabad	Fire Performance Assessment of Fire Door
39	**TSP0070**	Suvir Singh	M/s NCL Industries Ltd., 6th & 7th Floor, NCL Pearl, S D Road, Secunderabad	Fire Performance Assessment of Fire Door
40	**TSP0080**	Suvir Singh	Ex. Emgineer cum Sr. manager (C) - 1, Development Project Division, CPWD, B-313, IP Bhawan, New Delhi	Fire Performance Assessment of Fire Door

41	**TSP0130**	Suvir Singh	M/s Kalpana Struct Con Private Ltd., 1006-1008, 19th Floor, Cyber One, Plot No. 4 & 6, Sector 30A, Vashi, navi Mumbai	Fire Performance Assessment of Fire Door
42	**TSP0140**	A. A. Ansari	M/s Asian Paints Ltd., Research & Technology Center, Plot No. C3-B1, TTC MIDC Pawane, Post Vashi MDG, Thane-Belapur Road, Navi Mumbai	Fire Performance Characteristic Studies of Fire Retardant Coatings (A-Matt Version and B-Sheet Version) on Concrete Panels
43	**TSP0160**	Suvir Singh	M/s USG Boral Building Products (P) Pvt. Ltd., Vipul Trade Centre, 610-613, 6th Floor, Sohna Road, Sector 48, Gurgaon	Fire Performance Assessment of USG Boral Drywall Systems
44	**TSP0180**	A. A. Ansari	M/s Hira Technologies Pvt. Ltd., Plot No. I-02 (Part 2), Khed industrial Park, DTA Village Kanhersar, Tal-Khed, Dist Pune	Fire Performance Characteristic Studies of Aerosound ESA 180 (Elastomer Sound Absorber)
45	**TSP0210**	Suvir Singh	M/s Office of Executive Engineer & Senior Manager (C) - II, Project Division-II, CPWD, 3 Dr. B. D. Marg, New Delhi	Fire Performance Asessment of Fire Door
46	**TSP0220**	Suvir Singh	M/s Western Infrabuild Products LLP, A-592, TTC Industrial Area, MIDC, Mahape, Navi Mumbai, Mumbai	Fire Performance Asessment of Drywall Partition System
47	**TSP0240**	Suvir Singh	M/s Supreme Metwood, 1043, Housing Board Colony, Sector 20, Faridabad	Fire Performance Asessment of Fire Door
48	**TSP0250**	Suvir Singh	M/s Innovators Façade Systems Ltd., B-65, 204, Sector 1, Shanti Nagar, Mira Road (E), Thane District	Fire Performance Asessment of Fire Door
49	**TSP0270**	Suvir Singh	Executive Engineer, C-4 Division, Nirman Bhawan, GPRA Complex, Thirumangalam, CPWD, Chennai (Contractor: M/s DEC Infrastructure and Projects (I) Pvt. Ltd., #2-1-434/1/1, Street No. 4, Nallakunta, Hyderabad - 500 044)	Fire Performance Asessment of Fire Door
50	**TSP0280**	Suvir Singh	M/s Everest Industries Ltd., Khasra No. 158 & 159, Village Lakesari, Pargana, Tehsil Roorkee, Bhagwanpur	Fire Performance Assessment of Drywall Partition
51	**TSP0290**	A. A. Ansari	M/s Waseer Polymer Pvt. Ltd., 66, Paik Para First Row, Near	Fire Performance Characteristic Studies of Fire X 401 on Masonry

			Ashu Babu Bazaar, Kolkata	Surface
52	**TSP0300**	Nagesh Babu Balam	M/s Visaka Industries Ltd., Mustil Nos. 106, 107 & 115, Jhanswa Village, P.S. & Tehsil Salahawas, Jhajjar	Evaluation of Overlay Heat Transfer Coefficient U Value, Thermal Conductivity K Value and Thermal Resistivity R Value of Visaka Industries Ltd
53	**TSP0310**	Suvir Singh	M/s Halspan Limited, Regent House, Regent Centre, Linlithgow, EH497HU, United Kingdom	Fire Performance Asessment of Fire Door
54	**TSP0340**	Suvir Singh	M/s Kone Elevator India Pvt. Ltd., Plot No. A-28, Sipoot Industrial Park, Pillaippakkam, Sriperumbudur Takuk, Kancheepuram Dist	Fire Performance Assessment of Kone Lift Door
55	**TSP0370**	Suvir Singh	M/s DP Garg & Co. Pvt. Ltd., 287, Phatak Karore, Ajmeri Gate, Delhi	Fire Performance Assessment of Fire Doors
56	**TSP0380**	Suvir Singh	M/s Jagteq Industries Pvt. Ltd., 3, Alexio Apartment I.C. Colony, Borivali (W), Mumbai	Fire Performance Assessment of Fire Door
57	**TSP0390**	Suvir Singh	M/s Greenlam Industries, E-176-179, SP-02, RIICO Industrial Area, Phase-II, Behror-Dist Alwar	Fire Performance Assessment of Fire Doors
58	**TSP0400**	A. A. Ansari	M/s Raj Builtcon, Plot No. 494, B/H J. S. Corrupeck, Near Bautha Bus Stand, Village Bautha, Taluka-Savli, Dist. Vadodara	Fire Performance Characteristic Studies of FRP Pultruded Section
59	**TSP0410**	Suvir Singh	M/s Promat Fire & Insulation Pvt. Ltd., UGFS, Ansal Imperial Tower, C-Block, Community Centre, Naraina Vihar, New Delhi	Fire Performance Assessment of Fire Doors
60	**TSP0420**	Suvir Singh	M/s Narsi & Associates, 522, Laxmi Mall, Laxmi Industrial Estate, New Link Road, Andheri (W), Mumbai	Fire Performance Assessment of Fire Doors
61	**TSP0440**	A. A. Ansari	M/s Alstrong Enterprises India Pvt. Ltd., Phase II, SIDCO Industrial Growth Centre, Samba, Jammu	Surface Spread of Flame Classification of Aluminium Composite Panel
62	**TSP0460**	A. A. Ansari	M/s Visaka Industries Ltd., Visaka Towers, 1-8-303/69/3, S. P. Road, Secunderabad	Fire Performance Characteristic Studies of V Panel (A)
63	**TSP0470**	Suvir Singh	M/s Visaka Industries Ltd., Visaka Towers, 1-8-303/69/3, S. P. Road, Secunderabad	Fire Performance Assessment of Wall Partitions
64	**TSP0490**	Suvir Singh	M/s Navair International Ltd., Plot No. 468, Barhi Industrial Area, Sonipat	Fire Performance Assessment of Fire Door

65	**TSP0510**	Suvir Singh	M/s Everest Industries Ltd., Khasra No. 158 & 159, Village Lakesari, Pargana, Tehsil Roorkee, Bhagwanpur	Fire Performance Assessment of Drywall Partition
66	**TSP0520**	A. A. Ansari	M/s Armacell India Pvt. Ltd., Gate No. 744 & 745, Village Lonikand, Pune-Nagar Road, Pune	Fire Performance Characteristic Studies of Armaflex Class O and Armaflex Class O ALU
67	**TSP0530**	Suvir Singh	M/s Sukriti Doors & Hardware Pvt. Ltd., 380, Ground Floor, Chirag Delhi, New Delhi	Fire Performance Assessment of Glazed Fire Door
68	**TSP0590**	A. A. Ansari	M/s CISCHEM Solutions LLP, G-48, Ground Floor, Near Central Bank, Shaheen Bagh, Okhla, New Delhi	Fire Performance Characteristic Studies on Fire Retardant Intumescent Coating
69	**TSP0610**	Suvir Singh	M/s Everest Industries Ltd., Khasra No. 158 & 159, Village Lakesari, Pargana, Tehsil Roorkee, Bhagwanpur	Fire Performance Assessment of Drywall Partitions
70	**TSP0620**	Suvir Singh	M/s Horizon Chutes Pvt. Ltd., S. No 11/16/2, Nanded Phata, Sinhagad Road, Pune	Fire Performance Assessment of Fire Door
71	**TSP0630**	Suvir Singh	M/s Tristar Aerodynamics Pvt. Ltd., A-155, Sector 83, Noida	Fire Performance Assessment of Fire Dampers
72	**TSP0640**	Suvir Singh	M/s Tata Projects Ltd., CE-340061, CPWD, IIT Jodhpur, Karwar, Nagpur Road, NH--65, Jodhpur	Fire Performance Assessment of Fire Door
73	**TSP0650**	Suvir Singh	M/s Promat Fire & Insulation Pvt. Ltd., UGFS, Ansal Imperial Tower, C-Block, Community Centre, Naraina Vihar, New Delhi	Fire Performance Assessment of Fire Door
74	**TSP0670**	Suvir Singh	M/s Tata Steel Ltd., 43, Jawaharlal Nehru Road, Kolkata (Client: M/s Samrat Irons Pvt. Ltd., Door No.401-402 4th Floor, H.No.8-2-601-A-1-1 and 8-2-603-B-1, Sri Lakshmi Towers, Road No.10, Banjara Hills, Hyderabad, Telangana	Fire Performance Assessment of Fire Doors
75	**TSP0700**	Suvir Singh	M/s Greenlam Industries, E-176-179, SP-02, RIICO Industrial Area, Phase-II, Behror-Dist Alwar	Fire Performance Assessment of Fire Door
76	**TSP0710**	A. A. Ansari	M/s Hira Technologies Pvt. Ltd., Plot No. I-02 (Part 2), Khed industrial Park, DTA Village Kanhersar, Tal-Khed, Dist Pune	Reaction to Fire Characteristic Studies of Aerofoam NBR Foam with Glass Cloth

77	**TSP0720**	A. A. Ansari	M/s Hira Technologies Pvt. Ltd., Plot No. I-02 (Part 2), Khed industrial Park, DTA Village Kanhersar, Tal-Khed, Dist Pune	Fire Performance Characteristic Studies of Aerofoam NBR Foam with Aluminium Foil
78	**TSP0730**	Suvir Singh	M/s South Asian University, Permanent Campus, Gausala Road, Maidan Garhi, Delhi	Fire Performance Assessment of Fire Doors
79	**TSP0750**	Nagesh Babu Balam	M/s Armacell India Pvt. Ltd., Gate No. 744 & 745, Village Lonikand, Pune-Nagar Road, Pune	Evaluation of Thermal Conductivity of Two Types of Nitrile Rubber Ármaflex Class O & Armaflex Class O ALU at three different temperatures
80	**TSP0760**	Suvir Singh	Larsen & Toubro Ltd., India International Convention & Expo Centre, Sector 25, Dwarka, New Delhi	Fire Performance Assessment of Fire Door
81	**TSP0770**	Suvir Singh	M/s Radiant Passive Fire Systems, F-1, 1st Floor, Vijay Plaza Complex, Near Parsi Agyari, Opp. Abad Daisry, Kankaria Road, Ahmedabad	Fire Performance Assessment of Firfe Doors
82	**TSP0790**	Suvir Singh	M/s Cischem Solutions LLP, G-48, Ground Floor, Near Central Bank, Kalindi Kunj Road, Okhla, New Delhi	Fire Performance Assessment of Horizontal Duct
83	**TSP0800**	Suvir Singh	M/s ITD Cementation India Ltd., (Nagpur Metro Rail Project), Cotton Market Chowk, Ghat Road, Nagpur	Fire Performance Assessment of Fire Door
84	**TSP0820**	P. C. Thapliyal	M/s Copco Engineering Pvt. Ltd., 398, Poonamallee High Road, Kilpauk, Chennai	Performance Evaluation of IPNet paints to be used in bridges between Parassala and Nagercoil railway stations
85	**TSP0830**	Suvir Singh	M/s Shobha Limited, Sarjapur-Marthahalli Outer Ring Road, Bellandur-Post, Bengaluru	Fire Performance Assessment of Load Bearing and Non-Load Bearing Wall

Research Papers

Papers Published in Journals

1. A. Badkul, R. Paswan, S. K. Singh, & J. P. Teger (2021), A comprehensive study on the performance of alkali activated fly ash/GGBFS geopolymer concrete pavement" Road Materials and Pavement Design, Taylor and Francis, UK (IF: 3.21) https://doi.org/10.1080/14680629.2021.1926311

2. A.K.Sinha, M. Vinoth, V. G. Havanagi and S. Chandra (2021), Potential Investigation of Stabilised Fuming Furnace Slag for Road Construction, The Journal of Solid Waste Technology and Management, SJR 0.18 (Q4)

3. A. Tripathi, N. Gupta, A. K. Singh, S. P. Mohanty, N. Rai, A. Pain, (2021). "Effects of Elevated Temperatures on the Micro structural, Physico-Mechanical and Elastic Properties of Barakar Sandstone: A Study from One of the World's Largest Underground Coalmine Fire Region, Jharia, India", Rock Mechanics and Rock Engineering, Springer, 54, 1293–1314. [DOI: 10.1007/s00603-020-02315-9] (IF: 6.730/2020)

4. Agarwal, N., Meena, C.S., Raj, B.P., Saini, L., Kumar, A., Gopalakrishnan, N., Kumar, A., Balam, N.B., Alam, T., Kapoor, N.R., Aggarwal, V., 2021. Indoor Air Quality Improvement in COVID-19 Pandemic: Review. Sustainable Cities and Society, Vol. 70, 102942. DOI: https://doi.org/10.1016/j.scs.2021.102942[Impact Factor: 7.587]

5. Aggarwal, V., Meena, C.S., Kumar, A., Alam, T., Kumar, A., Ghosh, A., Ghosh, A., 2020. Potential and Future Prospects of Geothermal Energy in Space Conditioning of Buildings: India and Worldwide Review. Sustainability, Vol. 12, pp. 8428. DOI: https://doi.org/10.3390/su12208428 [Impact Factor: 3.251]

6. Alam, T., Meena, C.S., Balam, N.B., Kumar, A., Cozzolino, R., 2021.Thermo-Hydraulic Performance Characteristics and Optimization of Protrusion Rib Roughness in Solar Air Heater. Energies, Vol. 14, pp. 3159. DOI: https://doi.org/10.3390/en14113159 [Impact Factor: 3.004]

7. Aman Kumar, Harish Chandra Arora, Mazin Abed Mohammed, Krishna Kumar, Jan Nedoma. An optimized neuro-bee algorithm approach to predict the FRP-concrete bond strength of RC beams. IEEE Access, 2021, 10, 3790-3806. (IF = 3.367)

8. Anshul Gaur, Abhishek Singh, Anuj Kumar, Ashok Kumar & Kamal Kapoor., Video Flame and Smoke Based Fire Detection Algorithms: A Literature Review, July 2020, Fire Technology (Impact Factor: 1. 42), Volume 56, Issue 5pp. 1943-1980

9. Anurag Verma Surya Praksh & Anuj Kumar (2020), A Comparative Analysis of Data-Driven Based Optimization Models for Energy-Efficient Buildings, IETE JOURNAL OF RESEARCH," 05 Nov 2020 Art No O4. , Article No. ,44136, 2020

10. Anurag Verma Surya Praksh & Anuj Kumar (2020), ANN-based energy consumption prediction model up to 2050 for a residential building: Towards sustainable decision making, Environmental Progress & Sustainable Energy, 19 October 2020, https://doi.org/10.1002/ep.13544

11. Aravind Kumar. A, Rajiv Kumar (2021), Ansari A. A and Rakesh Kumar, Experimental and numerical simulation studies of liquefied petroleum gas fire in a full–scale compartment, Process

Safety progress, AICHE, Wiley (IF:1.334)

12. Aravind Kumar. A, Rajiv Kumar, Ansari A. A and Rakesh Kumar (2021), Non-isothermal Degradation Analysis of Plywood and Determination of Kinetic Parameters Using Coats–Redfern Method, Journal of Institution of Engineers India Series: E, Springer (IF:0.976) Jun, 2021.

13. Aravind Kumar. A, Rajiv Kumar and Ansari A. A (2021), Room Corner Fire Growth Studies of plywood Lining Material Under Fully Ventilated Condition, Journal of Institution of Engineers India Series: A, Springer (IF:0.507), Vol.102, 2021, pp.545-551.

14. Aravind Kumar. A, Rajiv Kumar, Ansari A. A and Rakesh Kumar, Quasi steady state Liquefied gas pool fire in a full-scale compartment, Advances in Thermodynamics and Heat Transfer, Vol.5, 2020, pp.102-107.

15. Aswathy M.S, M Vinoth and Achal Mittal (2021) "Impact of Governing Factors on Prediction of Tunneling Induced Surface Settlement in Young Alluvium Deposit" published in Indian Geotechnical Journal. Springer link Publication. (SJR: 0.39)

16. Banti A. Gedam (2021), Fire resistance design method for reinforced concrete beams to evaluate fire-resistance rating, Structures, Vol. 33, October 2021, PP. 855-877 (IF2.983).

17. Banti A. Gedam "Fire resistance design method for reinforced concrete beams to evaluate fire-resistance rating." Structures, (2021),33, 855-877. (SCI). DOI: https://doi.org/10.1016/j.istruc.2021.04.046

18. Charu Gupta, R. Siva Chidambaram and A.B. Danie Roy (2021) Shear Resistance Behavior of Exterior Beam-Column Joint with Steel Fiber Reinforced Concrete Adv. Struct. Mechanics Appln. (ASMA), 77,2021Springer Proceedings. (accepted)

19. Chidambaram, R. S., & Agarwal, P. (2020) Seismic Resistant Behaviour of Exterior beam-column joint with Fiber Hybridization. The Indian Concrete Journal ,94(10),20-30.

20. Dheeraj Kumar Singh, Harish Chandra Arora, Rahul Kumar. State of the Art on Relation of Corrosion of Reinforcing Steel with Surface Crack Width in Corroded Reinforced Concrete Structural Elements. International Research Journal of Engineering and Technology, 2021, 8(9), 356-365.

21. E. Agarwal, A. Pain, (2021). "Probabilistic stability analysis of geosynthetic-reinforced slopes under pseudo-static and modified pseudo-dynamic conditions", Geotextiles and Geomembranes, Elsevier (available online with DOI: 10.1016/j.geotexmem.2021.07.005) (IF: 5.292/2020).

22. E. Agarwal, A Pain, (2021). "An efficient probabilistic stability analysis of geosynthetic reinforced slopes using collocation based Stochastic Response Surface", International Journal of Geomechanics, ASCE, 21(10) (DOI:10.1061/(ASCE)GM.1943-5622.0002157) (IF: 3.819/2020).

23. E. Agarwal, A. Pain, S. Sarkar, (2021). "Stochastic stability analysis of geosynthetic reinforced slopes subjected to harmonic base shaking", Transportation Geotechnics. Elsevier, 29, 100562 (IF: 3.293/2020). (DOI: 10.1016/j.trgeo.2021.100562).

24. E. Agarwal, A. Pain, T. Mukhopadhyay, S. Metya, S. Sarkar, (2021). "Efficient computational system reliability analysis of reinforced soil retaining structures under seismic conditions including

the effect of simulated noise", Engineering with Computers, Springer, (IF: 7.963/2020). (DOI: 10.1007/s00366-020-01281-8)

25. F. P. Omowuni, E. Agarwal, A. Pain, R. K. Dash, D. P. Kanungo, (2021). "A data driven efficient framework for the probabilistic slope stability analysis of Pakhi landslide, Garhwal Himalaya", Journal of Earth System Science, Springer, (accepted for publication) (IF: 1.371/2020).

26. Falae, P.O., Dash, R.K., Kanungo, D.P. & Chauhan, P.K.S. (2021), Interpretation on water seepage and degree of weathering in a landslide based on pre- and post–monsoon electrical resistivity tomography, Near Surface Geophysics, DOI: 10.1002/nsg.12142, IF: 1.186

27. Falae, P.O., Dash, R.K., Samanta, M. &Kanungo, D.P. (2021), Geo-Integrated Assessment of Landslide Zone around Gadora along NH 58 of Garhwal Himalayas, India, Near Surface Geophysics, DOI: 10.1002/nsg.12151, IF: 1.186

28. G. Kumar and M. Samanta (2020), Experiemntalevaluation of stress concentration ratio of soft soilreinforcedwith stone column' Innovative Infrastructure Solutions, Springer Publication. 5,18,

29. Gandhi, M.; Ashok Kumar, Elangovan, R.; Meena, C.S.; Kulkarni, K.S.; Kumar, A.; Bhanot, G.; Kapoor, N.R, A Review on Shape-Stabilized Phase Change Materials for Latent Energy Storage in Buildings, October 2020, Sustainability (SCI, IF-3.473), Vol. No. issue 12 (22), Page 9481

30. Gandhi, M., Kumar, A., Rajasekar, E., Meena, C.S., Kulkarni, K.S., Kumar, A., Bhanot, G., Kapoor, N.R., 2020. A Review on Shape-Stabilized Phase Change Materials for Latent Energy Storage in Buildings. Sustainability, Vol. 12, pp. 9481. DOI: https://doi.org/10.3390/su12229481 [Impact Factor: 3.251]

31. Goyal, A., & Karade, S. R. (2020). Efficiency of cathodic prevention to control corrosion in seawater mixed concrete. Journal of Building Pathology and Rehabilitation, 5(1), 1-11.

32. Goyal, A., & Karade, S. R. (2020). Steel Corrosion and Control in Concrete Made with Seawater. Innovations in Corrosion and Materials Science, 10(1), 58-67.

33. Hitesh gaur, Tarun Kumar M, R. Siva Chidambaram and Naveen Kwatra (2021) Hysteretic Performance of Precast Beam-Column Joint with Improved Energy Dissipation Capacity, Adv. Struct. Mechanics Appln. (ASMA), 79,2021, Springer Proceedings. (accepted)

34. Jeeshan Khan and Santha Kumar G. (2021), Influence of binary antifreeze admixtures on strength performance of concrete under cold weather conditions, Journal of Building Engineering, 34 (2021) 102055, 1-8. (I.F. 3.379). DOI: 10.1016/j.jobe.2020.102055

35. Kapoor, N.R., Kumar, A., Meena, C.S., Kumar, A., Alam, T., Balam, N.B., Ghosh, A., 2021. A Systematic Review on Indoor Environment Quality in Naturally Ventilated School Classrooms: A Way Forward. Advances in Civil Engineering, Article ID 8851685. DOI: https://doi.org/10.1155/2021/8851685 [Impact Factor: 1.924 (2020)]

36. Khan J S and Santha Kumar G (2020), Influence of binary antifreeze admixtures on strength performance of concrete under cold weather conditions. Journal of Building Engineering, Elsevier, 102055 (Impact factor: 5.318), (Q1)

37. Kumar, R. (2021). Effects of high-volume dolomite sludge on the properties of eco-efficient

lightweight concrete: Microstructure, statistical modeling, multi-attribute optimization through derringer's desirability function, and life cycle assessment. Journal of Cleaner Production, 307, 127107. https://doi.org/10.1016/j.jclepro.2021.127107 (IF:9.297/2020/Q1).

38. Kumar, G. S., Saini, P. K., & Karade, S. R. (2020). Impact of Mixing Approaches on Properties of Recycled Aggregate Mortar. ACI Materials Journal, 117(6), 201-214.

39. Kurian, R.; Kulkarni, K.S.; Ramani, P.V.; Meena, C.S.; Kumar, A. 2021. Cozzolino, R. Estimation of Carbon Footprint of Residential Building in Warm Humid Climate of India through BIM. Energies, Vol. 14, pp. 4237. DOI: https://doi.org/10.3390/en14144237 [Impact Factor: 3.004]

40. Meena, C.S., Raj, B.P., Saini, L., Agarwal, N., Ghosh, A., 2021. Performance Optimization of Solar-Assisted Heat Pump System for Water Heating Applications. Energies, Vol.14, pp. 3534. DOI: https://doi.org/10.3390/en14123534 [Impact Factor: 3.004]

41. M. S. Aswathy, M. Vinoth and Achal Mittal (2021), Impact of Governing Factors on Prediction of Tunneling Induced Surface Settlement in Young Alluvium Deposit, The Journal of Solid Waste Technology and Management, SJR 0.18 (Q4), Indian Geotechnical Journal, ESCI SJR 0.46 (Q2)

42. M. Samanta and V A Sawant (2021), 'Experimental investigation on Greenfield surface settlement in cohesionless medium due to staged tunneling' Innovative Infrastructure Solutions, Springer Publication. 6, 106, https://doi.org/10.1007/s41062-021-00475-3\

43. M. Vinoth and M. S. Aswathy (2021), Behaviour of Existing Tunnel Due to Adjacent Deep Excavation- A Review, International Journal of Geotechnical Engineering, SJR 0.585 (Q2) 21 Jul 2021

44. M Vinoth and Aswathy M.S (2021) "Behaviour of Existing Tunnel Due to Adjacent Deep Excavation- A Review" published in International Journal of Geotechnical Engineering. DOI: 10.1080/19386362.2021.1952800. Taylor & Francis Publication. (SJR: 0.57)

45. M Zaid, MR Sadique, M Samanta (2020), Effect of unconfined compressive strength of rock on dynamic response of shallow unlined tunnel' SN Applied Science, Springer link Publication, 2, 2131, https://doi.org/10.1007/s42452-020-03876-8

46. M Zaid, MR Sadique, M.M. Alam, M Samanta (2020), Effect of shear zone on dynamic behaviour of rock tunnel constructed in highly weathered granite'Geomechanics and Engineering: An International Journal, Techno Press Publication, 23(3), pp. 245-259, http://dx.doi.org/10.12989/gae.2020.23.3.24

47. Nikhil Jadav, R. Siva Chidambaram (2021) Damage Tolerance Capacity of Exterior Beam Column Joint with HPFRCC, Adv. Struct. Mechanics Appln. (ASMA), 78, 2021 Springer Proceedings. (accepted)

48. Nishant Raj Kapoor, Ashok Kumar, Chandan Swaroop Meena, Anuj Kumar, Tabish Alam, Nagesh B Balam, &Aritra Ghosh., A systematic review on Indoor Environmental Quality in naturally ventilated school classrooms: A Way Forward., Feb. 2021. Advances in Civil Engineering, (SCI) Hindawi, Impact Factor 1.924

49. Padmanabhan, G., and Shanmugam, G. K. (2021). "Liquefaction and reliquefaction resistance of

saturated sand deposits treated with sand compaction piles. Bulletin of Earthquake engineering (https://doi.org/10.1007/s10518-021-01143-8)(SCI, Impact factor 3.827 Q1)

50. Pandit, K., Singh, M., Sharma, S. et al. (2021), Back-Analysis of a Debris Slope through Numerical Methods and Field Observations of Slope Displacements. Indian GeotechJ.https://doi.org/10.1007/s40098-021-00553-4

51. P. O. Falae, R. K. Dash, M. Samanta and D.P. Kanungo (2021), Geo-integrated assessment of the landslide zone around Gadora along NH-58 of the Garhwal Himalayas, India' Near Surface Geophysics, Wiley Publication, 19(2), pp: 183 -198, https://doi.org/10.1002/nsg.12151

52. P. Punetha and M. Samanta (2020), Modelling of shearbehaviour of interfaces involvingsmoothgeomembrane and nonwovengeoetxtileunderdynamic and staticloading conditions' ; Geotechnical and Geological Enginnering. Springer Publication, 38:6313–6327, https://doi.org/10.1007/s10706-020-01437-9

53. Rahul Kumar, Harish Chandra Arora, Vikas Prabhakar, Shobha Ram, Dheeraj Kumar Singh. Assessment of residual shear strength of corroded reinforced concrete beams using analytical modeling. i-manager's Journal on Civil Engineering, 2021, 11(3), 12-22.

54. Raj, B.P., Meena, C.S., Agarwal, N., Saini, L., Khahro, S.H., Subramaniam, U., Ghosh, A. 2021. A review on numerical approach to achieve building energy efficiency for Energy, Economy, and Environment (3E) benefit. Energies, Vol. 14, pp. 4487. DOI: https://doi.org/10.3390/en14154487 [Impact Factor: 3.004]

55. Rajesh Kumar, Rajni Lakhani and Ashok Kumar, "Physico-mechanical and thermal properties of Lightweight Structural Concrete with Light expanded clay aggregate for Energy Efficient Buildings". Lecture Notes in Civil Engineering, Springer, ISSN: 2366-2557 (Scopus indexed) (accepted on 23.04.2021).

56. Rajesh Kumar (2021), Effects of high-volume dolomite sludge on the properties of eco-efficient lightweight concrete: Microstructure, statistical modeling, multi-attribute optimization through derringer's desirability function, and life cycle assessment." Journal of Cleaner Production, Elsevier, 307, 127107. https:/ /doi.org/10.1016/j.jclepro.2021.127107 (Impact Factor:9.297/2020/Q1).

57. Rakesh Kumar. S, Ansari. A. A and Aravind Kumar. A (2021), Fire Safe Interior Surface Finishes, AMC Indian Journal of Civil Engineering, Vol.4(1),2021, pp.29-33.

58. Rakesh Kumar. S, Ansari. A. A. and Aravind Kumar. A (2020), Grooved Building blocks for concealed utility services, AMC Indian Journal of Civil Engineering, Vol.3(2),2020, pp.7-12.

59. Rakesh Kumar. S, Ansari. A. A and Aravind Kumar. A, Grooved Building blocks for concealed utility services, AMC Indian Journal of Civil Engineering, Vol.3(2), 2020, pp.7-12.

60. Rakshana Ponniah, R. Siva Chidambaram (2021) Flexural Behavior of RC Beams Strengthened with Textile Reinforced Concrete, Adv. Struct. Mechanics Appln. (ASMA), 101, 2021 Springer Proceedings. (accepted)

61. Rosaliya K., Kulkarni Kishor S, Prasanna V. R, C. S. Meena, Ashok K., Raffaello C., (2021). Estimation of carbon footprint of residential building in warm humid climate of India through BIM,

Energies, 14(14), 4237. (SCI, Impact Factor-3.004).

62. Rosaliya K., Kulkarni Kishor Sitaram, Prasanna V. R, C. S. Meena, Ashok Kumar., Raffaello C., Estimation of carbon footprint of residential building in warm humid climate of India through BIM, Feb. 2021, Energies (SCI, IF-3.004), Vol. No. Issue 14(14), Page 4237.

63. Rosaliya K., Kulkarni Kishor S, Prasanna V. R, C. S. Meena, Ashok K., Raffaello C., (2021). Estimation of carbon footprint of residential building in warm humid climate of India through BIM, Energies, 14(14), 4237. (SCI, Impact Factor-3.004).

64. Saini, L., Meena, C.S., Raj, B.P., Agarwal, N., Kumar, A., 2021. Net Zero Energy Consumption Building in India: An Overview and Initiative towards Sustainable Future. International Journal of Green Energy. Taylor and Francis. DOI: https://doi.org/10.1080/15435075.2021.1948417 [Impact Factor: 2.459]

65. Santha Kumar G and Aman Kumar (2021), Influence of granite fine powder on the performance of cellular light weight concrete, Journal of Building Engineering, Elsevier 40, 102707 (Impact factor: 5.318) (Q1)

66. SayantaniLala, Kshitij Jain, Ashok Kumar, E. Rajasekar, Kishor S. Kulkarni. Design Aids for Supplementary Lighting Design in India., September 2020, Journal of The Institution of Engineers (India). (Impact Factor: 0.390). Vol. No. 101(4), Page 643-656.

67. Sarkar, S., Pandit, K., Dahiya, N. et al. (2021), Quantified landslide hazard assessment based on finite element slope stability analysis for Uttarkashi–Gangnani Highway in Indian Himalayas. Nat Hazards 106, 1895–1914, https://doi.org/10.1007/s11069-021-04518-xhttps://doi.org/10.1007/s11069-021-04518-x]

68. S. K. Singh, Ashok Kumar, Sara Ali, SayantaniLala. Investigating the Application of Passive Cooling Strategies in Hot-Dry Climate for Energy Efficient Affordable Housing: Case Study, Dec. 2020, Optimization in Building Design, Annual Technical Volume 2020, Architectural Engineering Division Board, The Institution of Engineers, 2020.

69. Song, Z., Liu, J., Bai, Y., Shi, X., Kanungo, D.P., Qi, C. & Bu, F. (2021), Investigation of Temperature Effect on Strength Properties of Polyurethane-Treated Sand, Journal of Materials in Civil Engineering, 33(3):04020482, DOI: 10.1061/ (ASCE)MT. 1943-5533.0003557, IF: 1.984

70. Srinivasaraonaik B, L.P. Singh, S. Shina, I. Tyagi, A. Rawat (2020), Studies on the mechanical properties and thermal behavior of microencapsulated eutectic mixture in gypsum composite board for thermal regulation in the buildings, Journal of Building Engineering 31 (2020) 101400 (I.F.:5.01)

71. Srinivasaraonaik B, L.P. Singh, S. Sinha, I. Tyagi, & G. Mittal (2020), "Studies on thermal properties of microencapsulated eutectic phase change material incorporated different mortar mixes", International Journal of Energy Research 45, 2488-2497 (I.F-3.7).

72. Srivastava A., Kumar R. & Lakhani R. (2021). "Low energy Eco-cementitious binders as an alternative to ordinary Portland cement: A sustainable viable solution for the modern cement industries" in 'Smart Materials, Technologies, and Devices: Applications of Industry 4.0' published by Springer (In Press).

73. Tabish Alam, Chandan Swaroop Meena, Nagesh Babu Balam, Ashok Kumar, and RaffaelloCozzolino., Thermo-Hydraulic Performance Characteristics and Optimization of Protrusion Rib Roughness in Solar Air Heater., March 2021, Energies, (Impact Factor: 3.004). Vol. No. 14, Page 3159.

74. Tabish Alam, Ashok Kumar, Nagesh B. Balam, Thermo-Hydraulic Performance of Solar Air Heater Duct Provided with Conical Protrusion Rib Roughnesses (Chapter no. 16), 2020, Advances in Energy Research, Vol. 2, pp. 159-168, Springer

75. T Alam, CS Meena, NB Balam, A Kumar, R Cozzolino (2021), Thermo-Hydraulic Performance Characteristics and Optimization of Protrusion Rib Roughness in Solar Air Heater" Energies, Vol 14 (11) pp. 3159, 10.3390/en14113159

76. Verma, A; Prakash, S; Kumar (2020), A, AI-based Building Management and Information System with Multi-agent Topology for an Energy-efficient Building: Towards Occupants Comfort, IETE Journal of Research, , 23 Nov 2020

77. V. Mittal and M. Samanta (2021), Causes of Failure and Strengthening Measure of a Pile Foundation Supporting Transmission Line Tower' Journal of Performance of Constructed Facilites, ASCE, 35(4), https://doi.org/10.1061/(ASCE)CF.1943-5509.0001592

78. V. S. Ramakrishna Annapareddy, A. Pain, (2021). “Finite Element Modeling (FEM) vs Simplified Force-based Methods for Rigid Retaining Walls Under Earthquake Excitation”, Journal of Earthquake and Tsunami, World Scientific Publishing Company, (IF: 1.483/2020) (DOI: 10.1142/S1793431121500202)

79. Vivek Agarwal, Chandan Swaroop Meena, Ashok Kumar, Tabish Alam, Anuj Kumar, Arijit Ghosh, & Aritra Ghosh., Potential and Future Prospects of Geothermal Energy in Space Conditioning of Buildings: India and Worldwide Review, Oct. 2020, Sustainability, (SCI, IF-3.473), Impact Factor 2.576

80. Yogesh Yadhav, R. Siva Chidambaram (2021) Performance Evaluation of Retrofitted Exterior Beam Column Joint under Cyclic Loading, Adv. Struct. Mechanics Appln. (ASMA), 78 ,2021 Springer Proceedings. (accepted)

Papers Presented/Published in Conference/Workshop/Seminar etc.

1. Alam, T., Balam, N.B., **Meena, C.S., Kumar,** A., "Parametric Analysis on The Performance of Double Glaze Flat Plate Solar Thermal Collector", in Builder'19, held in India Habitat Center, Delhi, India, December 13-14, 2019.

2. Anurag, Kumar R. & Goyal S. (2021). "Optimization for clinker factor of penta-blended cement mortar using Box Behnken Design of Response Surface Methodology". International Conference on Structures, Materials and Construction, 2021. (Accepted on 16.05.2021)

3. "ANN Model for Predicting Thermally Deteriorated Steel Concrete Bond Strength" published in International Conference on 'International Conference on Advances in Construction Technology and Management (ACTM-2021) 11th -12th March, 2021.

4. Ashok Kumar, Kishor Kulkarni and Team, 6th India International Science Festival 2020, Proceeding on Science for Self-Resilient India and Global welfare Theme Habitat, India, Publisher CSIR CBRI, Roorkee

5. Ashok Kumar, Kishor Kulkarni and Team, Proceedings and Recommendations of the 6th India International Science Festival 2020, Jan. 2021, Proceeding on Science for Self-Resilient India and Global Welfare Theme Habitat, Publisher CSIR CBRI, Roorkee

6. A paper entitled, "Development of Energy Efficient Lightweight Concrete using Lightweight Aggregate" presented in Fifth International Online Conference on Reuse and Recycling of Materials (Polymers, Wood, Paper, Leather, Glass, Metals, Ceramics, Semi-Conductors, Water etc) and their products (ICRM – 2020) Organized by Mahatma Gandhi University, P.D Hills P.O, Kottayam Kerala, India & Wroclaw University of Technology Wroclaw, Poland held from 11th Dec.-13th Dec.'20

7. Balam, N.B., Gupta, A., **Meena, C.S., Kumar,** Alam, T., Kumar, A., Kumar, A., Agarwal, V., "Natural Convection Heat Transfer and Fluid Flow Visualization in Cavities of Double Skin Façade Elements, in Builder'19, held in India Habitat Center, Delhi, India, December 13-14, 2019.

8. **Banti A. Gedam** and Suvir Singh (2021). "A new fire safe design solution for reinforced concrete beams at catastrophic fire conditions." 5th World Congress on Disaster Management (WCDM), Indian Institute of Technology Delhi, 24th-27th November 2021, India.

9. Charu Gupta, R. Siva Chidambaram and A.B. Danie Roy (2022) Shear Resistance Behaviour of Exterior Beam-Column Joint with Steel Fiber Reinforced Concrete, ASMA 2021, NIT Silchar.

10. Chetan Garg, Harish Chandra Arora. Prediction of Residual Flexural Strength of Reinforced Concrete Beams and Slabs. International Conference on Structures, Material and Construction 2021(ICSMC 2021), Lecture Notes in Civil Engineering, November 12-13, 2021.

11. Dheeraj Kumar Singh, Harish Chandra Arora, Vikas Prabhaker, Shobha Ram, Rahul Kumar. Seismic Analysis and Rehabilitation of Corroded Reinforced Concrete Buildings. International Conference on Structures, Material and Construction 2021 (ICSMC 2021), Lecture Notes in Civil Engineering, November 12-13, 2021.

12. Hitesh gaur, Tarun Kumar M, R. Siva Chidambaram and Naveen Kwatra (2022) Hysteretic Performance of Precast Beam-Column Joint with Improved Energy Dissipation Capacity , ASMA 2021, NIT Silchar.

13. "Life Cycle Carbon Emission Assessment for a Residential Building" published in Virtual International Conference on Sustainable Building Materials and Construction (ICSBMC-2021) on 4th - 6thFebruary 2021.

14. Meenu Sunil, Neha, Shivi Nigam, and Navjeev Saxena (2021). SSI Effects on the Behaviour of a Low-Rise Load Bearing Masonry Building Including Foundation. Earthquakes and Structures, Lecture notes in Civil Engineering Vol.188 by Springer from selected proceedings of 7th ICRAGEE 2021, pp. 311-322, https://doi.org/10.1007/978-981-16-5673-6_25.

15. Meena, C.S., Raj, B.P., Agarwal, N., Saini, L., "Boiling Heat Transfer Study on Curve Surfaces", in 26th National and 4th International ISHMT-ASTFE Heat and Mass Transfer Conference (IHMTC-2019), (Abstract Accepted) will be held in IIT Madras, Chennai India, December 17-20, 2021.

16. Meena, C.S., Kumar, Das, A.K., "Numerical Analysis of Boiling Heat Transfer on Horizontal and Inclined Cylinder", in 25th National and 3rd International ISHMT-ASTFE Heat and Mass Transfer Conference (IHMTC-2019), held in IIT Roorkee, India, December 28-31, 2019.

17. Meena, C.S., Kumar, Kumar, A., Aggarwal, V., "Reciprocal Relation Between Collector Efficiency Factor and Overall Heat Transfer Coefficient of Solar Flat Plate Collector", in Builder'19, held in India Habitat Center, Delhi, India, December 13-14, 2019.

18. Meena, C.S., Kumar, Balam, N.B., Alam, T., Kumar, A., Kumar, A., "Performance of Flat-Plate Collector of Direct Expansion Solar Assisted Heat Pump Water Heating System", in Builder'19, held in India Habitat Center, Delhi, India, December 13-14, 2019.

19. Meena, C.S., Kumar, Das, A.K., "Experimental Study of Boiling on Horizontal and Inclined Cylinders", in 7th International and 45th National Conference on Fluid Mechanics and Fluid Power (FMFP), held in IIT Bombay, Mumbai, Maharashtra, India, December 10-12, 2018.

20. Neha, Meenu Sunil, Shivi Nigam, and Navjeev Saxena (2021). SSI Effects on Behaviour of a Low-Rise Load-Bearing Structural Walled Building Including Foundation. Earthquakes and Structures, Lecture notes in Civil Engineering Vol.188 by Springer from selected proceedings of 7th ICRAGEE 2021, pp. 323-334, https://doi.org/10.1007/978-981-16-5673-6_26.

21. Nikhil Jadav, R. Siva Chidambaram (2022) Damage Tolerance Capacity of Exterior Beam Column Joint with HPFRCC, ASMA 2021, NIT Silchar.

22. Padmanabhan G., Shanmugam G.K., Subramaniam S. (2021) Sustainability Approaches in Ground Improvement Measures. In: Ramanagopal S., Gali M., Venkataraman K. (eds) Sustainable Practices and Innovations in Civil Engineering. Lecture Notes in Civil Engineering, vol 79. Springer, Singapore. https://doi.org/10.1007/978-981-15-5101-7_25

23. Padmanabhan G., Shanmugam G.K., Subramaniam S. (2021) Shaking Table Tests on Liquefiable Sand Deposits Treated with Sand Compaction Piles. In: Patel S., Solanki C.H., Reddy K.R., Shukla S.K. (eds) Proceedings of the Indian Geotechnical Conference 2019. Lecture Notes in Civil Engineering, vol 138. Springer, Singapore. https://doi.org/10.1007/978-981-33-6564-3_44

24. Published research article in 'NIRMANIKA' of CSIR-CBRI, Roorkee on 'अपशिष्टसेनिर्माणक्षेत्रकेलिएसामग्रीतैयारकरनेवालीप्रौद्योगिकियोंकेरूपांतरणकाअवलोकन'

25. Rakshana Ponniah, R. Siva Chidambaram (2022) Flexural Behavior of RC Beams Strengthened with Textile Reinforced Concrete, ASMA 2021, NIT Silchar. (Best Paper Award – Recipient)

26. Saha, A., Meena, C.S., Das, A.K., "Numerical Analysis of Nukiyama's Experiment Around a Thin Wire", in 5th International Conference on Computational Methods for Thermal Problems (ThermaComp2018), held in IISc Bangalore, India, July 9-11, 2018.

27. Shivi Nigam, Meenu Sunil, Neha, and Navjeev Saxena (2021). SSI Effects on the Behavior of a Low-Rise RC Framed Building Including Foundation. Earthquakes and Structures, Lecture notes in Civil Engineering Vol.188 by Springer from selected proceedings of 7th ICRAGEE 2021, pp. 299-310, https://doi.org/10.1007/978-981-16-5673-6_24.

28. Sonkar, Chanchal, A. K. Mittal, and Sriman Kr Bhattacharyya. "Comparative study of differential equation of equilibrium method and constrained and unconstrained finite-strip method–Direct strength method for prediction of axial strength of cold-formed steel sheathed wall studs." Practice Periodical on Structural Design and Construction 26, no. 1 (2021): 04020049.

29. Sonkar, Chanchal, A. K. Mittal, and Sriman Kr Bhattacharyya. "Comparative study on cold-formed steel single-stud and multiple-studs wall panels with magnesium oxide sheathing under axial loading: Experimental and analytical." Journal of Structural Engineering 146, no. 11 (2020): 04020224. (Impact Factor – 2.528)

30. Vijay Kumar S.P., Ganesh Kumar S., Anju Mary E. (2021) Earthquake Induced Ground Motion Mitigation Using Geotextile Encased Infill Material System. In: Sitharam T.G., Kolathayar S., Sharma M.L. (eds.) Seismic Hazards and Risk. Lecture Notes in Civil Engineering, vol. 116. Springer, Singapore. https://doi.org/10.1007/978-981-15-9976-7_23

31. Yogesh Yadhav, R. Siva Chidambaram (2022) Performance Evaluation of Retrofitted Exterior Beam Column Joint under Cyclic Loading, ASMA 2021, NIT Silchar.

Book Chapters

1. Ajay Chourasia, S K Panigrahi, Numerical analysis of QutbMinar using non-linearplastic-damage macro model for constituent masonry Modeling and Computation in Vibration Problems, Volume 1, UK, 1st edition, IOP.

2. P. C. Thapliyal & N. Kumar, 'Chapter 15 - Functionalization of Graphene based Biopolymer Nanocomposites for Packaging and Building Applications' in 'Graphene based Biopolymer and Nanocomposites', pp 251-271, 2021, Springer Nature Singapore Pte Ltd.

3. SENAPATI (Susanta Kumar). Green library: Concept to concern. *In*, BHANU PARTAP and NEOGI (Priyanka), *Eds*. Innovative ideas and services in Library and Information services: issues and challenges. New Delhi: Daya Publishing House, 2021, Chap. 1, Pp. 1-12.

4. S K Panigrahi, Ajay Chourasia, A study on mode shape-based approaches for health monitoring of a reinforced concrete beam under transverse loading, Modeling and Computation in Vibration Problems, Volume 1, UK, 1st edition, IOP.

Processes Licensed & Mou Signed

The following processes were licensed/technology transferred during the year:

Name of Technology	Name of Licensee	Date of License
Makeshift buildings for hospitals, housing and other purposes	M/s Janta Tent & Events Shop No.1, Hotel Lake View Ashok Lobby, Shyamla Hills Bhopal – 462 013	29.06.2020 Jointly with CSIR-AMPRI, Bhopal

The following MoUs/Agreements were executed for Contract R&D, Consultancy and Technical Services Projects during the year:

S.No.	Name of Agency	Purpose of MoU	Date of Signing
1.	M/s Bhuj Polymers Pvt. Ltd. (BPPL), Bhuj	Testing, development and dissemination of helical anchors for applications to infrastructures projects.	02.06.2020
2.	Malati Fine Chemicals, A/4, Durvankurdarshan Society-1, Panchwati Area, Pashan Road, Pune	Evaluation of the TiO_2 nano-coating for heritage building protection and depolluting environmental applications.	18.06.2020
3.	Advanced Construction Technologies Pvt Ltd a registered company having its office at Thiruvallur District, Chennai, India	Construction of demonstration building using C&D waste at Mass Housing Site, within CSIR-CBRI campus and evaluation of functional and long-term performance for this demonstration building.	14.08.2020
4.	Patanjali Research Foundation, Haridwar	Evaluation work to characterize the products/ materials/ samples as received from the PRF by Thermogravimetric/ Differential thermal analysis (TG/DTA), X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FE-SEM) and X-ray Fluorescence (XRF).	06.10.2020
5.	Jaypee University of Engineering & Technology, Guna (JUET)	Academic /research interaction with	07.11.2020
6.	Tezpur University	Academic and Research interaction	12.11.2020
7.	IIT, Kharagpur	Academic and Research interaction	25.11.2020

8.	Himachal Pradesh State Disaster Management Authority (HPSDMA) Govt. of Himachal Pradesh, Shimla, HP	Intellectual cooperation, scholarly exchange, and the development of national partnership with leading institutions/parties on Landslide hazard, vulnerability and risk assessment of hilly terrain, Landslide Investigation: Geological, geophysical and geotechnical Investigations etc.	10.12.2020
9.	Rajarambapu Institute of Technology, Rajaramnagar, Islampur, Dist. Sangli, Maharashtra	Academic and Research Interaction	02.02.2021
10.	Ministry of Rural Development, Govt. of India	Training etc. under PMAY-G	03.03.2021
11.	Hindustan Aeronotics Ltd., Bangaluru	20 bedded Makeshift hospital/facility/centre under CSR	16.03.2021
12.	S.R. University, Warangal, Telangana – 506 371	Academic and Research Interaction	26.03.2021
13.	Pradeep Int Udhyog, Roorkee	Manufacturing of bricks with help of extrusion machine and firing of bricks in FCBTK	30.03.2021

Patents & Copyrights

Patents & Copyrights

S.No	FY	Title	Inventors	Filing Date	Grant Date	Patent No.
1	2020-21	A room temperature cured fly ash based geopolymer composition for concrete and building materials and a process thereof	Singh Brajeshwar, Ganesan Ishwarya, Bhattacharyya Sriman Kumar	20-Nov-14	31-Oct-20	350586

PATENTS FILED DURING 2020-21

NIL

Honours & Awards

Honours & Awards

Dr. S.R. Karade:

- Invited as a Panelist, Webinar on "Cathodic Protection of Concrete Structures" organised by Kerala Highway Research Institute (KHRI), 6 May 2020.
- Invited as a Panelist, Webinar on "Repair of Concrete Bridges" organised by Kerala Highway Research Institute (KHRI), 11 May 2020.
- Expert Speaker, Building Materials from Wastes – The Path towards Sustainability, CSIR-IISF, 23 Dec'20

Dr. Ashok Kumar has the honour of being appointed as a Member of the Expert Committee of the following:

- NRDC Awards Committee 2020-21 for the National Meritorious Invention Awards and for the assessment, evaluating, short listing and selection of the proposals.
- Expert Committee of CSIR for Raman Research Fellowship 2020-21.
- AICTE Approval Bureau - SAC Committee 2020-21.
- Expert Committee Member of ECBC, BEE.
- Coordinator, IISF, 2020.
- Jury for PMAY- Smart City Empowering India Awards, CSIR-CBRI being a knowledge Partner

Directors Technology Award 2021 on 'HVAC Ducting System for Intergrading of COVID-19 Disinfectant Solutions' on CSIR-CBRI foundation day. (Dr. Ashok Kumar, Dr. Nagesh Babu Balam, Dr. Tabish Alam, Dr. Chandan S Meena, Dr. Kishor S Kulkarni, Dr. Anuj Kumar, Sh. Nishath Raj Kapoor)

Dr. (Mrs.) Rajni Lakhani:

- Best Women Employee (R&D) is awarded by Director, CBRI on International Women's Day.

Dr. R. Siva Chidambaram

- Received Best Paper Award for the article titled "Tarun Kumar V M & R. Siva Chidambaram (2022) "Role of Coupler in Structural Behaviour of RC Elements – A Review" ICON 2021 organised by VIT Vellore.
- Received Best Paper Award for the article titled Satyanarayana K & R. Siva Chidambaram, K V Naveen Kumar (2022), "Influence of FRP on the Shear Behaviour of RC Rectangular Beam Elements "ICON 2021 organised by VIT, Vellore.
- Received Best Paper Award for the article titled Rakshana Ponniah, R. Siva Chidambaram (2022) Flexural Behaviour of RC Beams Strengthened with Textile Reinforced Concrete, ASMA 2021, NIT Silchar
- Received Diamond Jubilee Best Technology Award for "Multi-Purpose Collapsible Structure" from CSIR-CBRI 2021

Lectures Delivered

Lectures Delivered

1 Dr. Ashok Kumar delivered the following lectures:

- "Energy Efficient Building Systems." Training Course organized by CPWD for Ladakh Region, on 17.12.2020
- "Cillage – City Villages for a New Paradigm in Habitat." IISF organized by CBRI, on 23.12.2020.
- "Lessons Learnt from Damage Assessment of different Disasters – Significance of Planning, Design and Development Control Regulations for Resilience of Houses against Earthquake and Winds." Training course on Design of Disaster Resistant Housing & Risk Mitigation, organized by NDMA & Town & Country Planning Dept., 21.01.2021.
- "Sustainable & Energy Efficient Building Technologies: Current Research, Practices and Future Prospects." Virtual Short-Term Course (STC) "Opportunities & Challenges in Sustainable Construction Practices" Sponsored by AICTE, organized by IIT, BHU, 06.02.2021.
- "Innovative Approaches for Green and Energy Efficient Buildings." Indo-German Forum: Cities and Climate, Panel: Green Buildings for Today's Cities, 17.03.2021.
- "Green Building & Green Retrofitting Strategies for Building" in training Course on "Structural Stability Issues of Building and Possible Solutions" at National Academy of Defence Production, Nagpur on 17th -18th November, 2020.

2. Dr. Banti A. Gedam delivered the following lectures:

- Performance-based fire resistance design of reinforced concrete beams, TEQIP-III Sponsored Online Short-Term Training Program on Advances in Special Civil Engineering Structures & Materials (ASCESM – 2021), Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat, (March 9-13, 2021).

3. Dr. Banti A. Gedam delivered the following lectures:

- Delivered a lecture on "Fundamentals of Promising Renewable Energy Technologies and their application in Buildings" in a 5 days CSIR-CBRI webinar series 3, on "Sustainable Building & Future Technologies" from July 13-17, 2020.
- Delivered a lecture on "Experimental Analysis of the Solar Assisted Heat Pump Water Heating System for Himalayan Region" in YOUNG SCIENTISTS' CONFERENCE (22-24 December) organized by INDIA INTERNATIONAL SCIENCE FESTIVAL 2020 for the theme Frontiers of Science: Engineering Science and Mathematics in Session 7 of Architecture and Infrastructure.
- Delivered a lecture on "Overview of renewable energy and potential in North East and Ladakh region", presentation cum colloquium, organized by CSIR-Central Building Research Institute on 31-December-2021.

3 Dr. Kishor Kulkarni delivered the following lectures:

- "Revised Climate Classification and Impact on Energy Efficient Design", in CSIR-CBRI Webinar Series 3.0 on Sustainable Buildings and Future Technologies, 17th July 2020.
- "Heat Flow in Building and Temperature Monitoring", in AICTE sponsored One Week STTP programme on Low Carbon Energy Buildings, at Mahendra Engineering College, Namakkal Tamil Nadu, 19th September 2020.
- "Heat Flow through Buildings and IoT based Real-Time Temperature Monitoring in Building", in STTP on Innovation and Upgradation in Infrastructural Technology-2020 (IUIT-2020), 27th May 2020 at Terna Public Charitable Trust's Terna Engineering College, Nerul, Navi Mumbai

- "Prefabricated Beam-Column Connection for Dry Construction System" Technical Event on Role of Structural Engineer in Infrastructure Development organized by PDEU, Gandhinagar, 27th March 2021.
- "Application of Artificial Neural Networks for Modeling Concrete Strength" in AICTE, Sponsored Induction Program on "Innovations in Concrete Technology" organized by, YeshwantraoBhonsalePolytechnique, Sawantwadi on 12th - 18th March 2021 (Phase II).
- "Forensic Engineering of Thermally Deteriorated Concrete Using Drilling Resistance Test" in AICTE, Sponsored Induction Program on "Innovations in Concrete Technology" organised by, YeshwantraoBhonsalePolytechnique, Sawantwadi on 12th to 18th February 2021 (Phase I).
- "Revised Climate Classification and Impact on Energy Efficient Design" in Colloquium organised by CSIR-CBRI, Roorkee, 8th January, 2021.
- "Prefabricated Dry Construction Technology in Building Design" in Webinar series on current trends related to Civil Engineering, 8th July 2020 at A. J. Institute of Engineering and Technology, Mangaluru.
- "Climatic classification using clustering method" in Webinar series on "Innovations in Green Building and Sustainable Developments, at RIT, Sangli, on 5th June 2020.
- "Prefabricated Dry Construction Technology in Building Design" in Webinar on 29th May 2020 at AISSMS College of Engineering, Pune.
- "Prefabricated Structures", in student's technical event organized by Terna Public Charitable Trust's Terna Engineering College, Nerul, Navi Mumbai, 13th April 2020.

5. Dr. R S Bisht delivered lecture in a national webinar on,

- "Advances in Mobile Robotics" held at Ramchandra Chandravansi University RCU, Jharkhand on 8th August 2020.

6. Dr. R. Siva Chidambaram delivered the following lectures:

- Delivered more than 15 online lectures in various topics such as Damage Mechanisms of RCC Structures, High Performance Materials, Rebar Coupler, Retrofitting, recent Trends in Civil Engineering, Beam Column Joints, Precast Structures, Make Shift Structures during 2020-2021.
- Delivered Key Note Address in Sustainable Development in Civil Engineering Systems: Advances and Challenges". on January 23, 2021, Thapar University
- Delivered Guest Lecture in AICTE Training and Learning (ATAL) Academy sponsored FDP on "Recent Advances in Earthquake Engineering" wef 20 to 24 September 2021 at M.M.M. University of Technology, Gorakhpur (U.P.
- Delivered a Key Note Lecture titled "Precast Technology for Sustainable Construction" in Workshop organized by Dept. of Civil Engg, Vellammal College of Engineering, Madurai, Tamilnadu.
- Delivered a Guest Lecture in One day Webinar on "Recent advances in Civil Engineering" Organized by Department of Civil Engineering, Chalapathi Institute of Engineering and Technology (Autonomous), Guntur, Andhra Pradesh.

Dr. S. Ganesh Kumar delivered the following lectures:

- "Research Avenues, Field Practices and Case Studies in Geotechnical Engineering" (Webinar), Government College of Technology, Coimbatore
- Ground Improvement Techniques for liquefaction mitigation during earthquake

- Dr. SR Karade delivered the following Invited/Guest/Keynote Lectures:
- "Corrosion and its Mitigation in Steel Reinforced Concrete Structures" in One Week E-Workshop on "Retrofitting and Rehabilitation of Structures" at MIT, UJJAIN" Under TEQIP - III, 29 July 2020.
- "Corrosion Protection in Steel Reinforced Concrete Structures" in the AICTE Sponsored Short Term Training Programme on "Structural Life Assessment and Failure Diagnosis" Phase-I organized by Department of Civil Engineering, MepcoSchlenk Engineering College, Sivakasi. 21 Aug.'20.
- "Corrosion Mitigation in Steel Reinforced Concrete Structures" in the AICTE Sponsored Short Term Training Programme on "Structural Life Assessment and Failure Diagnosis" Phase-II organized by Department of Civil Engineering, MepcoSchlenk Engineering College, Sivakasi. 18 Sept.'20.
- "Durability Issues in Buildings: Corrosion of Steel in Concrete & Its Protection, in online Lecture Series on "Structural Stability Issues of Building and Possible Solutions" organised by National Academy of Defence Production (NADP), Nagpur, 18 Nov. 2020
- "Building Materials from Wastes – The Path towards Sustainability", in the 6th India International Science Festival (IISF), 23 Dec'20.
- "Green Building Concepts and Rating Systems" in the AICTE Sponsored Short Term Training Programme on, "Conservation of Energy and Environment through Sustainable Engineering" Phase-I organized by Department of Civil Engineering, Mepco Schlenk Engineering College, Sivakasi, 9 Jan'21.
- "Green Building Concepts and Rating Systems" in the AICTE Sponsored Short Term Training Programme on, "Conservation of Energy and Environment through Sustainable Engineering" Phase-II organized by Department of Civil Engineering, MepcoSchlenk Engineering College, Sivakasi. 5 Feb'21
- "Corrosion of Steel in Concrete & Its Protection" in Online Short-Term Programme on "Repair and Rehabilitation of Structures", NITTTR Chandigarh, 15 March'21.

Dr. (Mrs.) Rajni Lakhani delivered the following lectures:

- Delivered lecture on "Effect of stone wastes on the properties of developed cement concrete building products" in Gainful Utilization of Dimensional Stone Waste organized by CDOS in Jaipur
- Delivered lecture "Sustainable Rural Habitat – Present & Future" in IISF 2020 on 23rd Dec. 2020
- Delivered lecture on "Development of Energy Efficient Lightweight Concrete using Lightweight Aggregate" Webinar Series 11.0on "Advanced Course on Green Building Material" in CSIR-CBRI.

Er. Rajesh Kumar delivered the following Lectures:

- Delivered lecture on "Eco-cements via Synergistic use of Low Graded Industrial Waste: The Pursuit of an alternative to Portland Cement for 21st century", Organized by- Skill Development Group, CSIR-Central Building Research Institute Roorkee-247667, Uttarakhand, July 16, 2021. (URL: https://cutt.ly/BcisNgi)
- Delivered lecture on "Statistical modelling, temperature sensitivity analysis and performance-based novel mix design of high-volume ultra-fines incorporated concrete composites via the Box-Behnken design approach", Presentation- cum- colloquium Series, CSIR-CBRI, July 01, 202
- Delivered lecture on "Response surface modelling and multi-objective optimization of sustainable low carbon cement concrete with high volume micro-fine sludge", International Conference on Building Materials and Construction Technologies, Dubai, UAE, Supported by- Purdue University, West Lafayette, Indiana, April 08, 2021

CBRI Family

CBRI Family

Group-IV-Scientific Staff

S. No	Name	Designation
1.	Dr. N. Gopalakrishnan	Director
2.	Sh. R.S Chimote	Chief Scientist
3.	Dr. Suvir Singh	Chief Scientist
4.	Dr. Ashok Kumar	Chief Scientist
5.	Sh. S.K. Negi	Chief Scientist
6.	Dr. Shantanu Sarkar	Chief Scientist
7.	Dr. Harpal Singh	Chief Scientist
8.	Dr. R. Dharma Raju	Chief Scientist
9.	Dr. Atul Kumar Agarwal	Sr. Principal Scientist
10.	Sh. A. A. Ansari	Sr. Principal Scientist
11.	Dr. Rajni Lakhani	Sr. Principal Scientist
12.	Sh. D.P. Kanungo	Sr. Pr. Scientist
13.	Dr. Achal Kumar Mittal	Sr. Principal Scientist
14.	Dr. S.R. Karade	Sr. Principal Scientist
15.	Sh. S.K. Singh	Sr. Principal Scientist
16.	Dr. Poornima Parida	Sr. Principal Scientist
17.	Sh. Nadeem Ahmed	Sr. Principal Scientist
18.	Dr. Rajesh Deoliya	Sr. Principal Scientist
19.	Dr. A.P. Chaurasia	Sr. Principal Scientist
20.	Dr. P.C. Thapliyal	Sr. Principal Scientist
21.	Sh. Navjeev Saxena	Sr. Principal Scientist
22.	Dr. B.S. Rawat	Sr. Principal Scientist
23.	Dr. L.P. Singh	Sr. Principal Scientist
24.	Dr. S.K. Panigrahi	Sr. Principal Scientist
25.	Dr. Shorab Jain	Sr. Principal Scientist
26.	Dr. Rajesh K. Verma	Sr. Principal Scientist
27.	Dr. Sujit Kumar Saran	Pr. Scientist
28.	Dr. P.K.S. Chauhan	Pr. Scientist
29.	Dr. H.C. Arora	Pr. Scientist
30.	Dr. Leena Chaurasia	Pr. Scientist
31.	Dr. Neeraj Jain	Pr. Scientist
32.	Dr. Vineet Kumar Saini	Sr. Scientist
33.	Mr. Ravindra Singh Bisht	Sr. Scientist
34.	Mr. Nagesh Babu Balam	Sr. Scientist
35.	Mr. Manojit Samanta	Sr. Scientist
36.	Mr. Soumitra Maiti	Sr. Scientist
37.	Mr. Soju Joseph Alexander	Sr. Scientist
38.	Mr. Srinivasa Rao Naik B.	Sr. Scientist
39.	Mr. Subash Chandra Bose Gurram	Sr. Scientist
40.	Mr. Anindya Pain	Sr. Scientist
41.	Mr. Mickey Mecon Dalbehera	Sr. Scientist
42.	Mr. Siddharth Behera	Sr. Scientist
43.	Dr. A. Aravind Kumar	Sr. Scientist
44.	Mr. Siddharth	Sr. Scientist
45.	Ms. Ishwarya G.	Scientist
46.	Ms. Monalisa Behera	Scientist
47.	Mr. Rajesh Kumar	Scientist
48.	Mr. Rakesh Paswan	Scientist
49.	Mr. Chanchal Sonkar	Scientist

50.	Mr. Mohd. Reyazur Rahman	Scientist
51.	Mr. Santha Kumar G.	Scientist
52.	Mr. Kaushik Pandit	Scientist
53.	Ms. Hina Gupta	Scientist
54.	Mr. Debdutta Ghosh	Scientist
55.	Ms. Surya M.	Scientist
56.	Mr. Ashish Pippal	Scientist
57.	Ms. Shermi C.	Scientist
58.	Mr. S. Ganesh Kumar	Scientist
59.	Mr. Chandan Swaroop Meena	Scientist
60.	Mr. Banti A Gedam	Scientist
61.	Mr. Kishore S. Kulkarni	Scientist
62.	Mr. Mohammad Jeeshan Khan	Scientist
63.	Mrs. Aswathy M.S.	Scientist
64.	Mr. TabishAlam	Scientist
65.	Mr. R. Siva Chidambaram	Scientist
66.	Mrs. Hemlata	Scientist
67.	Mr. M. Vinoth	Scientist

Group III Technical Staff

68.	Sh. Narendra Kumar	Principal T.O.
69.	Dr. P.K. Yadav	Principal T.O.
70.	Sh. Dalip Kumar	Principal T.O.
71.	Dr. S.K. Senapati	Lib Officer-EII, Principal T.O.
72.	Sh. Rajeev Kumar Sharma	Principal T.O.
73.	Sh. Sushil Kumar	Principal T.O.
74.	Dr. M.K. Sinha	Med. Officer Sr. T.O. (3)
75.	Sh. Vivek Sood	Sr. T.O. (3)
76.	Sh. Jalaj Prashar	Sr. T.O. (3)
77.	Sh. Rakesh Kumar –II	Sr. T.O. (3)
78.	Sh. Ram Ashray Rai	Sr. T.O. (3)
79.	Sh. Bharat Bhushan	Sr. T.O. (3)
80.	Sh. Naresh Kumar	Sr. T.O. (2)
81.	Sh. Rajesh R. Ghadse	Sr. T.O. (2)
82.	Sh. B.K. Kalra	Sr. T.O. (2)
83.	Sh. Itrat Amin	Sr. T.O. (1)
84.	Sh. Amit Kush	Sr. T.O. (1)
85.	Mrs. Gayatri Devi	Sr. T.O. (1)
86.	Mrs. Deepti Karmakar	Sr. T.O. (1)
87.	Sh. Ajay Dwivedi	Sr. T.O. (1)
88.	Sh. Sameer	Sr. T.O. (1)
89.	D.S. Dharamshaktu	Sr. T.O. (1)
90.	Sh. Sugam Kumar	T.A.
91.	Sh. Sachin Kumar	T.A.
92.	Ms. Bhawna	T.A.
93.	Sh. Dinesh Kumar	T.A.
94.	Sh. Anil Kumar	T.A.
95.	Sh. Seraj Alam	T.A.

Group II

96.	Mrs. Saroj Rani	N. Sister/ Sr.Tech.(2)
97.	Mrs. Neelam Gupta	Sr. Tech. (2)
98.	Sheeraj Ahmad	Sr. Tech. (2)

99.	Anil Kumar Sharma	Sr.Tech.(2)
100.	Manmeet Singh	Sr.Tech.(2)
101.	Mrs. Urmila Kotnala	Pharamacist/ Sr.Tech.(2)
102.	Rishi Pal Singh	Sr.Tech. (2)
103.	Sushil Kumar	Sr.Tech. (2)
104.	Himanshu Sharma	Sr.Tech. (2)
105.	Amar Singh	Sr.Tech. (1)
106.	B.S. Bisht	Sr.Tech. (1)
107.	Rajeev Bansal	Sr.Tech. (1)
108.	Pradeep Kumar Kapooria	Sr.Tech. (1)
109.	Arvind Saini	Sr.Tech. (1)
110.	Harish Kumar	Sr.Tech. (1)
111.	Sukhbir Sharma	Sr.Tech. (1)
112.	Arvind Kumar	Pharamacist/ Sr.Tech. (1)
113.	Sharad Kumar	Sr.Tech. (1)
114.	Mam Chand Agarwal	Sr.Tech. (1)
115.	Arvind Kumar Sharma	Sr.Tech. (1)
116.	Tahir Husain	Sr.Tech. (1)
117.	Ghanshyam Mittal	Sr.Tech. (1)
118.	Iqbal Ahmed	Sr.Tech. (1)
119.	Manoj Kumar Tyagi	Sr.Tech. (1)
120.	Jai Pal	Sr.Tech. (1)
121.	Sohrab Khan	Sr.Tech. (1)
122.	Jameel Hasan	Sr.Tech. (1)

Group I Supporting Staff

123.	Rajeshwar	Lab. Asstt.
124.	Vijay Kumar	Lab. Asstt.
125.	Jagdish Pal	Lab. Asstt.
126.	Rajesh Kumar	Lab. Asstt.
127.	Satya al	Lab. Asstt.
128.	Usha (smt)	Lab. Asstt.
129.	Subhash Chand	Lab. Asstt.
130.	Desh Raj	Lab. Asstt.
131.	Rakesh Kumar	Lab. Asstt.
132.	Ramesh Kumar	Lab. Asstt.
133.	Santosh Kumar	Lab. Asstt.
134.	Rakesh Kumar	Lab. Asstt.
135.	Krishna Gopal Thakur	Lab. Asstt.
136.	Rohitash Kumar	Lab. Asstt.
137.	Devendra Kumar	Lab. Asstt.
138.	Prakash Kaur (smt)	Lab. Asstt.
139.	Rakesh	Lab. Asstt.
140.	Arun Kumar	Lab. Asstt.
141.	Ravinder Kumar	Lab. Asstt.
142.	Dil bahadur	Lab. Asstt.
143.	Rajinder pal	Lab. Asstt.
144.	Dheer Singh	Lab. Asstt.
145.	Ranbir Singh	Lab. Attd. (2)
146.	Anju (smt)	Lab. Attd. (2)
147.	Anit Kumar Pal	Lab. Attd. (2)
148.	Pooranvasi	Lab. Attd. (2)
149.	Kirat pal	Lab. Attd. (2)
150.	Kiran pal	Lab. Attd. (2)

151.	Rajesh Kr. Yadav	Lab. Attd. (2)
152.	Jai Prakash	Lab. Attd. (2)
153.	Ranjeet Singh	Lab. Attd. (2)
154.	Satya pal	Lab. Attd. (2)
155.	Satya pal singh	Lab. Attd. (2)
156.	Sunil Sumar	Lab. Attd. (2)
157.	Malkhan Singh	Lab. Attd. (2)

Administrative Staff

158.	Sh. Anil Kumar	Sr. COA
159.	S.K. Jakhwal	A.O.
160.	Sh. Ajay Kumar Sharma	S&P.O.
161.	Sh. J.K. Chaurasia	F&A.O.
162.	K. Arora	Pr. P.S.
163.	Sh. Lekh Raj Kaushik	S.O. S&P
164.	Virendra Singh	S.O.(F&A)
165.	Constan Kujur	S.O. (G)
166.	Satya pal	P.S.
167.	V.P.S. Rawat	SEC. OFFICER
168.	Archana	SR. STENO
169.	Arvind Kumar	SR. STENO
170.	Dalpat Singh	SR. STENO
171.	Dharam Singh Negi	SR. STENO
172.	Sheema Farhat	ASSTT(G) GR. I
173.	Sudhir Kumar	ASSTT(G) GR.I
174.	Shiv Kumar	ASSTT(G) GR.I
175.	Pawan Kumar	ASSTT(G) GR. I
176.	Mamta Sharma	ASSTT(G) GR.I
177.	Savita Vishwakarma	ASSTT(G) GR.I
178.	Sushil Kumar	ASSTT(G) GR.I
179.	Sanjay Kr. Tyagi	ASSTT(G) GR.I
180.	Ravinder Kumar	ASO(G)

GROUP – C (Non-Technical)

181.	Aman Kumar	ASSTT(F&A)GR.I
182.	Vipin Kumar Sharma	ASSTT(F&A)GR.I
183.	Suraj Pal Singh	ASSTT(F&A)GR.I
184.	Satyarth Prakash	ASSTT(F&A)GR.I
185.	Rubina Zaidi	ASSTT(F&A)GR.I
186.	Sanjeev Bansal	ASSTT(S&P) GR-I
187.	Arpan Maheshwari	ASSTT(S&P) GR.I
188.	Kalam Singh Chauhan	ASSTT(S&P) GR.I
189.	Vishvash Tyagi	ASST(S&P) GR.I
190.	Mehar Singh	Hindi Officer
191.	Suba Singh	Hindi Officer
192.	Seema Ahuja	ASST(G) GR.II
193.	Subhan Singh	JSA
194.	Mehrajdeen khan	JSA
195.	Mukesh kumar	Asstt . Gr.III

GROUP – D (Non- Technical)

196. Amit Kumar MTS

Promotion

1.	Sh. S. K. Singh	Chief Scientist	01.01.2021
2.	Dr. H. C. Arora	Sr. Principal Scientist	01.01.2021
3.	Sh. Koushik Pandit	Senior Scientist	16.03.2021
4.	Ms. Hina Gupta	Senior Scientist	28.03.2021
5.	Sh. Md. R. Rehman	Senior Scientist	08.01.2021
6.	Sh. Rakesh Paswan	Senior Scientist	08.01.2021
7.	Dr. Monalissa Behera	Senior Scientist	08.01.2021
8.	Dr. Chanchal Sonkar	Senior Scientist	08.01.2021
9.	Sh. Vivek Sood	Principal Technical Officer Gr.III(7)	25.01.2021
10.	Sh. Jalaj Parashar	Principal Technical Officer Gr.III(7)	08.02.2021
11.	Late. Rajesh R. Ghadse	Senior Technical Officer (3) /Gr.III(6)	31.01.2021

Superannuation

1.	Naresh Yadav	Sr. STENO (MACP)	31.05.2020
2.	Radhe Shyam	Driver	30-06-2020
3.	Nisha Tyagi	ASO(G)	31.08.2020
4.	Sarita Khanna	ASO(G)	31.08.2020
5.	Anju Rani Simon	ASO(S&P)	31.10.2020
6.	Radhey Shyam	MTS	30.11.2020
7.	Rajesh Kumar	Principal Technical Officer	30.11.2020
8.	Sh. Pradeep Kumar	Senior Principal Scientist	31.01.2021
9.	Sh. Zamir Ahmad	Senior Technical Officer	31.01.2021

Date Line

Date Line

S. No.	Date	Event
1.	5th June, 2020	International Environment Day Celebration at CSIR-CBRI, Roorkee
2.	15th August, 2020	Independence Day Celebration at CSIR-CBRI, Roorkee
3.	14th – 29th September 1,2020	Observance of Hindi Pakhwada at CSIR-CBRI, Roorkee
4.	15th September,2020	Anti- Body Testing Drive
5.	26th September, 2020	CSIR Foundation Day Celebration
6.	2nd October, 2020	Swachhata Abhiyan
7.	27th October - 2nd November, 2020	Observance of Vigilance Awareness Week at CSIR-CBRI, Roorkee
8.	26th November, 2020	Constitution Day Celebration at CSIR-CBRI, Roorkee
9.	22nd – 25th December, 2020	India International Science Festival 2020
10.	25th January, 2021	Anti- Body Testing Drive
11.	26th January, 2021	Republic Day Celebration
12.	10th February, 2021	CBRI Foundation Day Celebration at CSIR-CBRI, Roorkee
13.	17th February, 2021	Road Safety Oath