CSIR-CBRI Newsletter

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Research in Progress

Utilization of construction and demolition wastes as secondary resource materials for developing value added building components

The samples of construction and demolition waste collected from Solanipuram and CBRI campus Roorkee are broken into pieces of size smaller than 20 mm. The grading of recycled coarse aggregate are done by sieve analysis as per IS: 383; Indian standard specification for coarse and fine aggregates from natural sources for concrete. The aggregate of different sizes are shown in Photo 1.

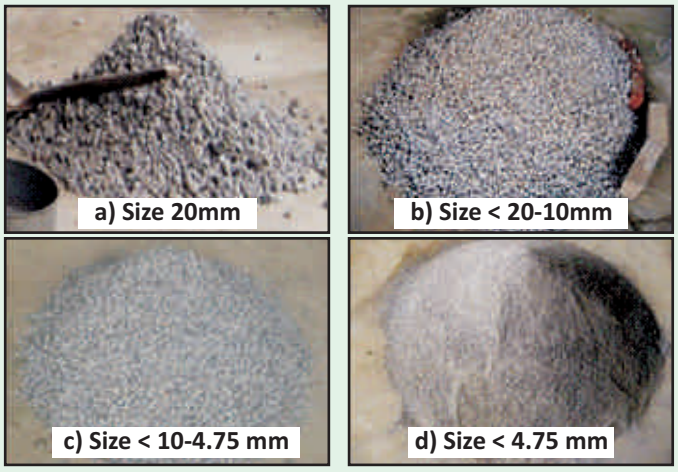
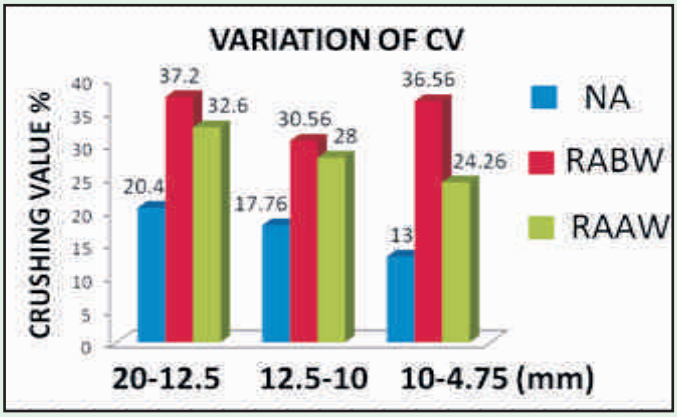
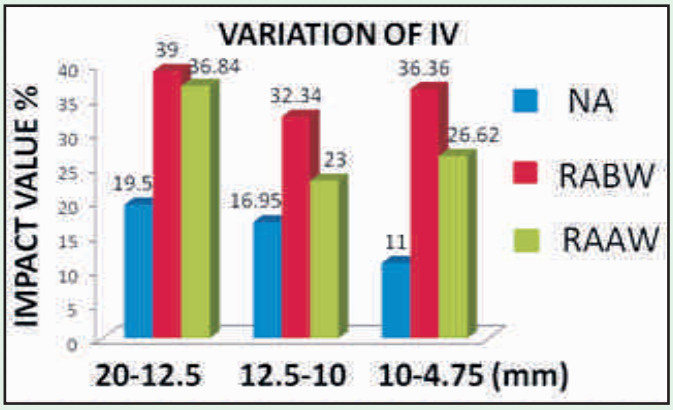


Photo 1: (a-d): Photographs of different particle size fractions of construction wastes

The physical and mechanical properties of Recycled aggregates before washing (RABW), Recycled aggregates after washing (RAAW) are determined in accordance with IS:2386-1963 and compared with Natural aggregates (NA). The properties of aggregates are shown in Fig. 1(a-e).



(a)



(b)

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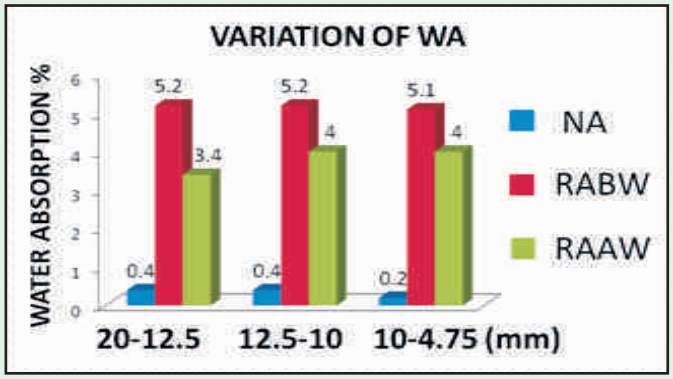
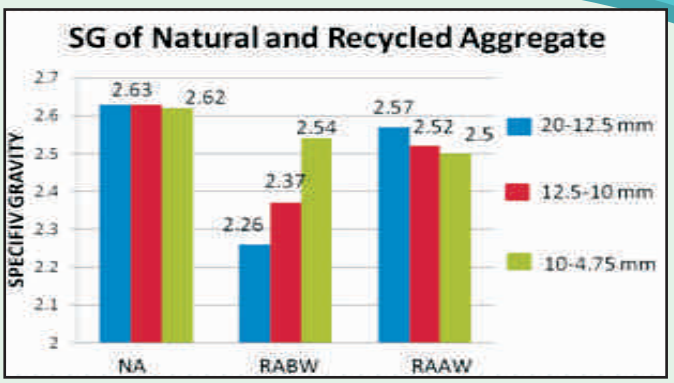
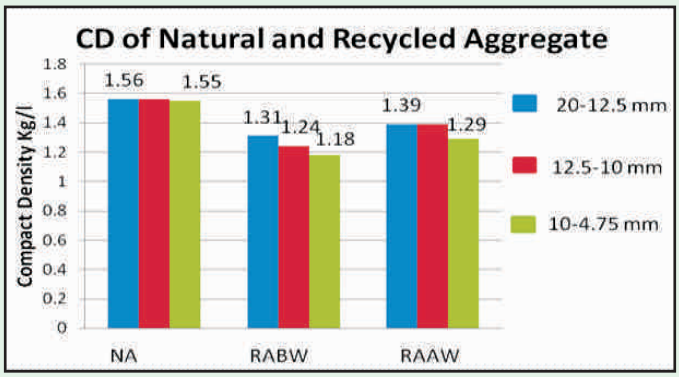


(C)



(d)



(e)

Fig. 1 (a-e): Properties of Natural Fine and Coarse Aggregate and Recycled Coarse Aggregate (Before & After Washing)
(a) crushing value (CV) (b) impact value (IV)
(c) water absorption (WA) (d) specific gravity (SG)
(e) compact density (CD)

It can be seen that the properties of aggregates like crushing value, impact value, water absorption etc. were improved after washing. The properties of aggregates complied the requirements as specified in IS: 283-1970.

Cement Concrete Flooring Tiles

The flooring tiles of 150 x 150 x 20 mm were prepared by compaction technique using cement, sand, natural and recycled aggregates (size; 10 mm down & 4.75 mm retained). The tiles were prepared in two layer system as per conventional practice. A compression force of 50 tonne was applied for 30 seconds to compact the wet mix in the mould. After demoulding, the tiles cured under humidity for a period of 28 days and then tested for physical properties as per IS 1237-1980, specification for cement concrete flooring tiles. The properties of flooring tiles are given in Table 1.

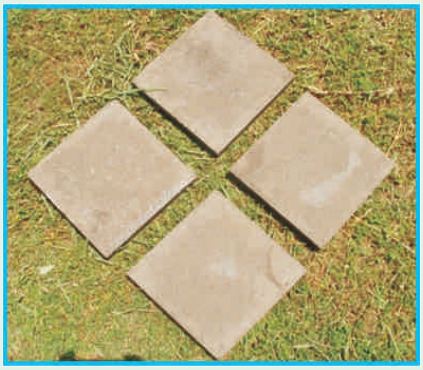
The results show that strength of tiles prepared from washed aggregate was increased up to 16% as compared to unwashed aggregate. The properties of tiles complied the requirement as given in standard.

Preparation of Bricks

The bricks has been prepared by compression technique using 92% recycled aggregate (Size; passing 4.75 mm sieve) and cement designated as 'A' and compared with properties of fly ash bricks of same composition designated as 'B'. Some typical photographs of tiles and bricks prepared from recycled aggregate are shown in Photo 2. The properties of bricks are given in Table 2.

Table 1- Comparison of Properties of Cement Concrete Tiles by Complete Replacement of Natural Aggregate with Recycled Aggregate

Property	Natural Aggregate	Recycled Aggregate		IS:1237-1980 Limits
		Washed	Unwashed	
Perpendicularity, %	0.8	0.85	0.90	Max. 2.0
Straightness, %	0.4	0.42	0.44	Max. 1.0
Flatness, mm	0.5	0.55	0.55	Max. 1.0
Flexural Strength, MPa (28 days)	7.20	5.20	4.50	Min. 3.0
Water Absorption,%	4.5	7.8	8.5	Max. 10.0
Compressive Strength, MPa (28 days)	38.0	32.8	29.7	--



(a)

(b)

Photo 2: (a) Tiles and (b) Bricks

Table 2: Properties of Bricks

Designation	W.A. (%)	C.S. (kg/cm^2)
A	18	70
B	20	45

The results show that bricks developed from recycled aggregate have better properties than fly ash bricks.

(A.K. Minocha, Mridul Garg, L.P. Singh, Neeraj Jain and Jaswinder Singh)

Development of a framework to reduce the carbon footprint and enhance the energy efficiency in buildings

Building design and climate responsive architecture features

Climatic conditions are a major driving force that influence the energy performance of a building. The judicious selection of building materials and technologies for building envelope (roofs, walls & fenestration), correct orientation of building and adequate provision of daylighting etc. can significantly improve the energy efficiency and reduce the carbon footprint of buildings. There are many architectural design features that also impact the energy performance of a building. The major attributes include the building location (climate), shape, size, number of storeys, natural ventilation potential for cooling; glazing types, shading devices, and fenestration size and operable window sizes; local material availability or reuse; landscaping potential to reduce heat island effect or provide natural shading etc. This study outlines the measures for conservation of energy in buildings in composite climatic region of India.

Carbon footprint reduction

In order to reduce the carbon footprint and enhance energy efficiency in buildings, the computations of the embodied energy and CO_2 emissions for different types of materials & technologies developed at CSIR-CBRI were carried out to establish their superiority. The results reveal that there is a huge potential to reduce CO_2 emissions with innovative construction/building systems.

Design guidelines for energy efficient buildings in composite climate of India

Energy consumption for thermal comfort is of the order of 60 percent of total energy consumption in buildings. Conservation of a part of this energy, inside a building is possible by the factors as discussed below:

Building orientation

The orientation of a building has a direct impact on the energy performance primarily due to the orientation of the fenestration and has a significant effect on the ability of a design to provide useful daylight to perimeter zones. Best orientation for thermal comfort is one in which the building receives maximum solar radiations in winters and minimum in summers.

Envelope

The envelope is characterized by the opaque components, fenestration, and reduced thermal transmittance (U-factors), use of thermal mass, and control of solar heat gains etc. Building envelope components and their configuration determines the amount of heat gain or loss and wind that enters inside the building. The primary components of building envelope which affect the performance of a building are: i) Walls; ii) Roofs; and iii) Fenestration.

(a) Walls

Walls are a major part of the building envelope, which are exposed to the external environmental conditions, their heat storing capacity and heat conduction property has a major impact on indoor thermal comfort in naturally ventilated buildings and on cooling loads in air conditioned buildings. The thermal insulation plays an important role in reducing the thermal conductivity of wall. The effect of insulation is to reduce heat gain and heat loss. This can be controlled through economizers in HVAC systems or natural ventilation.

(b) Roofs

The roof of building receives the thrust of heat throughout the day and RCC roof has high thermal

conductivity. If the roof is exposed to solar heat, the temperature inside will also rise as the day progresses which in turn will add to the air conditioning load. When buildings are air conditioned, the purpose of the system is to maintain a lower temperature inside the building, than the ambient. If the roof is protected from heat incidence by suitably insulating the roof from the heat, the conditions inside can be controlled to a large extent so that the atmosphere inside the building remains below the ambient temperature throughout the day. Thermal insulation of roof ceiling is essential to reduce incoming heat flux, since major heat transfer (> 60%) occurs through roof. Use of outside roof insulation is very much effective in composite climate.

Computation of thermal resistance and over all heat transfer coefficients have been carried out for 112 combinations of roof and wall sections. The conventional RCC roof section is considered (100, 120, and 150 mm thickness) along with mud phuska, brick tile and with different thicknesses of thermal insulating materials such as Expanded Polystyrene (EPS), polyurethane foam, foam concrete, fibre glass, Styropor, Peripor, Neopor for determining the R and U- values to satisfy ECBC requirements. Out of the total 38 combinations of roof sections, U- values of 14 sections satisfy the ECBC requirements.

Similarly in wall section, various thicknesses of insulation materials combined with basic conventional wall section (230mm brick with 12.5 mm thick cement plaster on both sides) were studied. Out of total 74 combinations of wall sections, 28 sections satisfy the ECBC requirement of U- value. Perlite Concrete, Expanded Polyethylene, Neopor, Peripor, Isoboard, Styropor, Elastospray, EPS, Fibreglass, and Foam concrete were combined with conventional 230 mm thick brick wall with 12.5mm cement mortar on both sides.

(c) Fenestration

The fenestration has a major impact on the energy savings potential. Glazing also provides daylighting and views for the occupants, connecting them to the outside world and improving occupant comfort and productivity. A fenestration design is important to ensure the proper balance among heating, cooling, and daylighting. While electrical lighting energy can be saved through daylight harvesting, orientation-sensitive Window-to-Wall Ratios (WWRs) are recommended to help control solar heat gains while allowing more visible light at orientations where solar heat gains are not as much of an issue. Use of exterior shading such as overhangs on the south façade helps to control solar heat gains. Other envelope design features to consider include the use of vestibules in order to reduce the introduction of outside air through uncontrolled door usage. Avoid tinted glass, in particular bronze & green-tinted glazing and avoid the use of reflective glass or low-e coatings with a highly reflective component. These reduce transparency significantly, especially at acute viewing angles, but they impact the quality of the view.

Daylighting

Providing daylight is fundamental for an office or residential environment. While the most valuable asset of daylight is its free availability, the most difficult aspect is its controllability, as daylight changes during the course of the day. Daylighting offers a broad range of technologies that provide glare-free balanced light, sufficient lighting levels, and good visual comfort. Daylighting strategies drive building shape and form, integrating them well into the design from structural, mechanical, electrical, and architectural standpoints. Daylighting increases energy performance and impacts building size and costs by downsizing fans, ductwork, and cooling equipment because overall cooling loads are reduced, allowing for trade-offs between the efforts made for daylighting and the sizing of the air-handling and cooling systems. Effective daylighting uses natural light to offset electrical lighting loads.

Design of Windows for Optimum Daylight

Windows are provided for daylight, vision and ventilation. Their percentage area varies from 15 to 40 percent of the floor area. The windows should be located so as to have uniform spread of light in the room. Sill level should be 800 to 1200mm and the height of the window should be 1200mm or more because higher a window, greater is the penetration of light in the room. Using daylight in place of electrical lighting significantly reduces the internal loads and saves cost on lighting and cooling power. The higher the visual transmittance (VT), the more energy can be saved.

Building Shape

The basic shape of the building has a fundamental impact on the overall energy usage of a building. Buildings that are circular, square, or rectangular in plans, result in more compact building forms. Building plans that are H, L, and U shaped, or that have protruding sections and surfaces at angles other than ninety degrees relative to adjacent building surfaces tend to have shallow floor plates where side lighting strategies result in a higher percentage of

day lighted floor area. Less compact forms increase a building's daylighting potential, but they also may magnify the influence of outdoor climate fluctuations. Greater surface-to-volume ratios increase conductive and convective heat transfer through the building envelope. The building shape needs to be designed so that the solar loading is properly managed. Additionally, the shape of a building determines how wind impinges on the outdoor surfaces to assist natural ventilation or creates outdoor microclimates.

Natural Ventilation

Ventilation is an important consideration in the design of buildings. The following guidelines are recommended for designing buildings for the best possible utilization of outdoor wind:

- At least one window should be provided on the windward wall and other on the leeward wall.
- Maximum air movement at a particular plane is achieved by keeping the sill height at 85 per cent of the height of the plane. However, for sitting and bedrooms where the height of the occupied zone varies from 600mm to 1200mm, the optimum sill height is 900mm.
- For a total fenestration area (inlet and outlet) of 20 to 30 per cent of floor area, the average indoor wind velocity is around 27 per cent of outdoor velocity. Further increase in window size increases the available velocity but not in the same proportion. In fact, even under ideal conditions the maximum average indoor wind velocity does not exceed 40% of the outdoor velocity.
- In the regions having fairly constant wind direction, the size of the inlet should be kept within 30 to 50 per cent of the total area of fenestration and building should be oriented perpendicular to the incident wind. Since inlets smaller than outlets are more sensitive to change in wind direction, openings of equal sizes are preferred in the regions having frequent changes in wind direction.
- In the case of a room with only one wall exposed to outside, provision of two widows are preferred to that of a single window.
- Windows located diagonally opposite to each other, with the windward window near the upstream corner give better performance than other window arrangements for most of the building orientations.

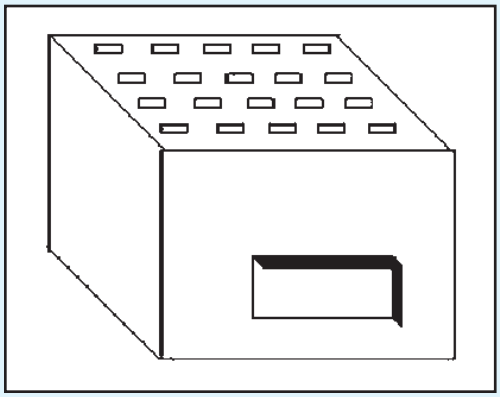


Fig. 1: Provision of L-type louver increasing the room air motion

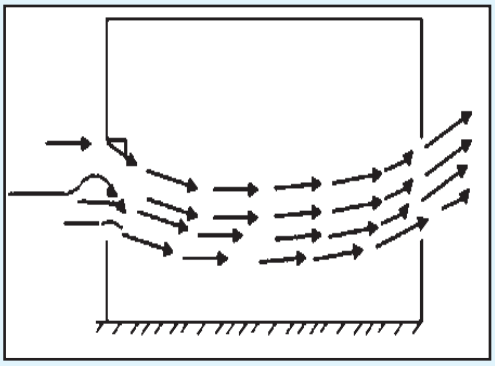


Fig. 2: Windows on opposite walls increase the indoor air speed

- Provision of L type louvers (Fig.1) increases the room air motion, provided that the vertical projection does not obstruct the incident wind.
- Verandah open on three sides is to be preferred since it causes an increase in the room air motion for most of the orientation of building with respect to the incident wind.

The table 1 given below shows the required wind velocity for the given dry bulb temperature and the relative humidity.

Table 1: Desirable wind speed (m/sec) for thermal comfort

Dry Bulb Temperature °C	Relative Humidity (Percentage)						
	30	40	50	60	70	80	90
30	*	*	*	0.06	0.24	0.53	0.85
31	*	0.06	0.24	0.53	1.04	1.47	2.10
32	0.20	0.46	0.94	1.59	2.26	3.04	*
33	0.77	1.36	2.12	3.00	*	*	*
34	1.85	2.72	*	*	*	*	*
35	3.20	*	*	*	*	*	*

(Ashok Kumar, R.K. Garg, B.M.Suman & Rajesh Deoliya)

National Technology Day

CSIR-CBRI celebrated National **Technology Day on 11th May, 2012** by arranging series of a daylong activities.

Dr. Rajendra Dobhal, Director General, State Council for Science and Technology and Director, Science Education and Research Centre Uttarakhand witnessed the programmes as the Chief Guest and delivered a special lecture of Science vs Technology – A critical phase of Indian Science. He highlighted various scientific achievements and motivated the students for taking interest in understanding the principles and practical applications of science so that the future of our country may be shined. The Chief Guest further stressed that science should be explored for the benefit of the mankind so as to improve health, income and living standard of the common masses.

The Technology Day celebration started with a lighting of lamp by the Chief Guest Dr. Rajendra Dobhal, DG, UCOST and Prof. S.K. Bhattacharyya, Director, CSIR-CBRI and followed with the introductory remarks by Shri S.G. Dave, Chief Scientist and the convener of the programme.

Shri Dave informed about various programmes planned for a day with a special emphasis on visit of sixty science students from Kendriya Vidhyalaya-1 and M.Sc. students from K.L.D.A.V. Degree College alongwith their faculty. The students took a round of various laboratories and technology park and also participated in a celebration programme held at Ravindranath Tagore Auditorium of the institute. He also highlighted on CSIR-800 activities organized by the institute of XIth plan period and about future plan of action programme planned for 12th Plan period.

Prof. S.K. Bhattacharyya, Director CSIR-CBRI, talked about the importance of National Technology Day. He remarked that May 11 is annually observed as National Technology Day all over India to commemorate technological breakthroughs like mastering of nuclear weapons technology (Pokharan II) through a series of controlled tests at Pokharan, test firing of the indigenously developed Trishul missile and test flight of the indigenous aircraft Hansa-3. These achievements of Indian technology got a further boost with the test firing of indigenously developed Trishul, Agni and Prithvi missile. He also highlighted R&D achievements of CSIR and it's contribution in improvement of economy, health and living standard of the masses.

A technical film on Incredible India Incredible Engineering brought out as a part of Silver Jubilee celebration of Indian National Academy of Engineering (INAE) was screened in the auditorium. The film highlights history of Indian achievements in the field of engineering. Dr. Prakesh Chand Thapliyal Senior Scientist of the institute made a brief presentation on Modified epoxy cardinal based coating for concrete structure highlighting its important applications, which won a CSIR-CBRI Diamond Jubilee Technology Award for the year 2011.

On this occasion, the Chief Guest released the CSIR-CBRI Annual Report 2010-2011, CSIR-800 RSWNET Achievements, Brochures of **Polymers, Plastics & Composites** and **Structural Engineering** Groups, CSIR-CBRI Newsletter issue Jan-March 2012.

Shri S.G. Dave, Chief Scientist introduced the Chief Guest and proposed vote of thanks.

World Environment Day

The CSIR-Central Building Research Institute (CBRI) Roorkee and The Institution of Engineers (India) Roorkee Local Centre (RLC), Roorkee, celebrated the World Environment Day (WED 2012) on 5th June 2012. The theme for this year was Green Economy: Does it include you? to stimulate awareness of the environment and enhance the political attention and public action. Green Economy which cover one third of the earth's land mass and plays a key role in our battle against climate change, releasing oxygen into the atmosphere while storing carbon dioxide.

Prof. V.K. Jain, Vice Chancellor, Doon University, Dehradun , Prof. Satya Prakash Chairman Institution of Engineer (India), RLC Roorkee & Prof. S.K. Bhattacharyya Director CSIR-CBRI planted trees as a gesture of harmonious living with nature. Prof. Bhattacharyya mentioned that unlike the previous years, the tree chosen for plantation , this year , in CBRI Campus was Neem because of the special significance it bears.

Prof. V.K. Jain, Chief Guest, delivered his speech on the occasion & expressed his happiness to be amongst the distinguished scientists and mentioned that every human being should contribute a little in their own personal way to protect the environment and in this connection, he appreciated the initiatives taken by CSIR-CBRI for taking environmental issues seriously. Prof. Satya Prakash welcomed the Chief Guest .

Prof. S.K. Bhattacharyya, Director, in his presidential address, mentioned that CSIR-CBRI will continue its activity to develop environment friendly technologies and pursue research to protect the environment and work for conservation of biodiversity of the region. He also proposed that CBRI and Doon University can have joint projects on environmental problems of the Uttarakhand.

Dr. A.K. Minocha, Senior Principal Scientist in his Introductory address pointed out that World Environment Day is an annual event that is aimed at being the biggest and most widely celebrated global day for positive environmental action. On this occasion, CBRI Bhavnika- Newsletter in Hindi was also released.

The programme ended with a vote of thanks proposed by Prof. B.R. Gurjar, Hon. Secretary, Institution of Engineer (India), Roorkee Local Centre, Roorkee.

Colloquium

4th April 2012 Protective Coatings- Present Scenario & Future Challenges	Dr. P.C. Thapliyal, Sr. Scientist, CSIR-CBRI, Roorkee
13th April 2012 Strategies for Effective Patent Search	Dr. S. R. Karade, Principal Scientist, CSIR-CBRI, Roorkee
18th April 2012 Advances in Mobile Robotics: Current Research & Applications	Ravindra Singh Bisht, Scientist (Adhoc) , CSIR-CBRI, Roorkee
2nd May 2012 Bio-degradable Eco-pots from Forest Waste	Dr. S. P. Agrawal, Chief Scientist, CSIR-CBRI, Roorkee
9th May 2012 Service Life Prediction of RC Structures in Aggressive Environment	Dr. Rajesh Deoliya, Principal Scientist, CSIR-CBRI, Roorkee
16th May 2012 Landslide Research – Excerpts from 2nd World Landslide Forum	Dr. S. Sarkar, Sr. Principal Scientist, CSIR-CBRI, Roorkee
30th May 2012 Concrete Sustainability & Recycling of C & D Waste	Shri S. K. Singh, Principal Scientist, CSIR-CBRI, Roorkee
6th June 2012 Programme on S &T Communication and Presentation Skills	Dr. R. K. Verma, Sr. Scientist, CSIR-CBRI, Roorkee
20th June 2012 Piles for Stabilization of Slopes	Dr. S. Karthigeyan, Principal Scientist, CSIR-CBRI, Roorkee
26th June 2012 Wind Loads on Tall Chimneys due to Vortex Shedding	Dr. S. Arunachalam, Advisor CSIR-SERC, Chennai

Forthcoming Events

National Conference on Emerging Trends of Energy Conservation in Building (EECB-2012) at CSIR-CBRI, Roorkee.

The Efficiency of Building Group at CSIR-Central Building Research Institute Roorkee is organizing a conference on Emerging trends of Energy Conservation in Building.

It will provide a platform for building energy professionals, researchers, academicians, architects and industrialists to interact and deliberate on pressing issues related to energy conservation in building. This conference is scheduled to be held during November 1-3, 2012 at CSIR–CBRI, Roorkee. The conference is expected to provide valuable opportunity for experience sharing among the experts who have been actively involved in these fields. The institute is actively engaged in research activities related to all aspects of buildings including heat transfer, solar energy, ventilation & lighting.

For details, pl contact: Dr P K Bhargava / Dr B M Suman, CSIR-CBRI, Roorkee.

National Workshop on Engineering Geophysics for Civil Engineering and Geo-Hazards (EGCEG) at CSIR-CBRI, Roorkee.

Geophysical techniques for engineering applications have become important in understanding the subsurface conditions of any site. The geophysical techniques have successfully been used in the engineering projects to solve many engineering problems; for example: locating cavities, tunnels and subsurface voids, determining the thicknesses of soil layers and soil variation, locating faults and fractures, soil moisture, and many other similar aspects. CSIR-CBRI has undertaken scientific studies on engineering projects, Cultural heritage sites and landslide sites for several decades where near surface geophysical methods were used for resolving the issues associated with them.

The aim of this workshop is to exchange professional experiences and recent & advanced technological developments in the area of Engineering Geophysics. The workshop will provide a platform to the professionals, academicians, researchers from different organizations to interact closely. The workshop will be held at CSIR-Central Building Research Institute, Roorkee during November 22-23, 2012.

For details, pl contact: Dr S Sarkar/ Dr PKS Chauhan, CSIR-CBRI, Roorkee.

National Conference on Wind Engineering (NCWE) at CSIR-CRRI, New Delhi

Wind Engineering analyzes effects of wind in the natural and the built environment and studies the possible damage, inconvenience or benefits which may result from wind. Wind engineering may be considered by engineers/ researchers to be closely related to earthquake engineering and explosion protection.

The National Conference on Wind Engineering (NCWE) is the forum to present new knowledge of wind engineering and wind energy and to exchange experiences. Scientists, academicians, technologists, architects and engineers from all over the Nation and world will meet to tackle new challenges regarding sustainability and wind climate. Important themes for the conference include Safety of Structures, Wind Tunnel Testing, Wind Power & Energy, Wind Climate Assessment, Effect of Wind Storm on Tall Building and Tower & Wind Engineering for Bridges.

Some Special topic will also include Computational Fluid Dynamics (CFD) model development and validation, inclusion of boundary layers and turbulence, use in supporting disaster preparedness for wind damage, fire damage, and environmental contamination, and use in developing wind energy systems and their sitting.

The Indian Society for Wind Engineering (ISWE) in association with CSIR-CBRI, CSIR-CRRI and CSIR-SERC is planning to organize a National Conference on Wind Engineering at CSIR-CRRI, New Delhi during December 14-15, 2012.

For details, pl contact: Dr A K Mittal, CSIR-CBRI, Roorkee

International Conference on Advanced Materials for Energy Efficient Buildings (AMEEB- 2013) at India Habitat Centre (IHC), New Delhi.

To cover the recent advancements and trends in the area of advanced building materials vis à- vis energy efficiency in buildings and to share and networking on the emerging and futuristic challenges, an International conference on Advanced Materials for Energy Efficient Buildings is being organized. This conference is scheduled to be held during February 13-15, 2013 at IHC, New Delhi. The conference will deliberate on building materials including nanomaterials, energy efficient systems, health monitoring of structures and newer construction technologies.

For details, pl contact: Dr L P Singh / Dr P C Thapliyal, CSIR-CBRI, Roorkee.

Staff News

Superannuation

Sh. C S Mayal	Sr Tech 2	31.5.2012

We wish a peaceful and happy retired life!

Obituary

It is placed on record the sad and untimely demise of Sh. Surendra Kumar, Sr. Tech. 2 on 01.04.12 and Sh. Shyam Narayan, Farrash on 07.05.2012.

CSIR-CBRI family convey their heartfelt condolences to their bereaved family.

Editor

Dr Atul Kumar Agarwal

Principal Scientist

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