CSIR-CBRI Newsletter

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Research in Progress

Experimental and Theoretical Study of Masonry Walls subjected to Blast Loading

Objectives of this project is to study masonry properties required for constitutive modelling for blast loading and perform parametric studies for behaviour of confined masonry under blast loading using nonlinear finite element analysis. This is also aimed in the project to study retrofitting techniques to enhance the performance of brick masonry under blast loading. IS-4991-1968 requires that a building may be designed for a bare charge of 100kg at distance of 40 m for residential building, 30 m for community buildings and 20 m for buildings housing services. Calculations for blast pressures and positive phase duration have been made using developed software for blast of 100 kg at a detonation distance of 20, 30 and 40m.

Masonry walls are the weakest link in a framed structure in resisting the forces during a blast event. Masonry is very weak in tension because it is composed of two different materials distributed at regular intervals and the bond between them is weak. Therefore, masonry is normally provided and expected to resist only the compressive forces. The uniaxial monotonic compressive behaviour and other characteristics of masonry prisms and wallettes and its constituents, viz. clay brick and mortar, have been studied by laboratory tests. Bricks were also tested for splitting tensile strength test as per ASTM standards (Fig. 1).

It is found that for the bricks and mortar of comparable strength, the compressive strength of masonry is less than both of its constituents. Based on the results and observations of the comprehensive experimental study, nonlinear stress-strain curves have been obtained for masonry. Poisson's ratio has been obtained and it is found that final failure of masonry specimens in compression mostly occurred by vertical splitting of bricks. Splitting Tensile strength of bricks has been found to be 6.8% of its compressive strength. Vertical splitting failure of bricks in masonry compression and splitting tensile strength of brick has been related to explain the failure mechanism.

During blast loading flexural strength of brick masonry is an important parameter and flexural strength test of the brick masonry panels (1:3, 1:4.5 and 1:6 mortar) has been

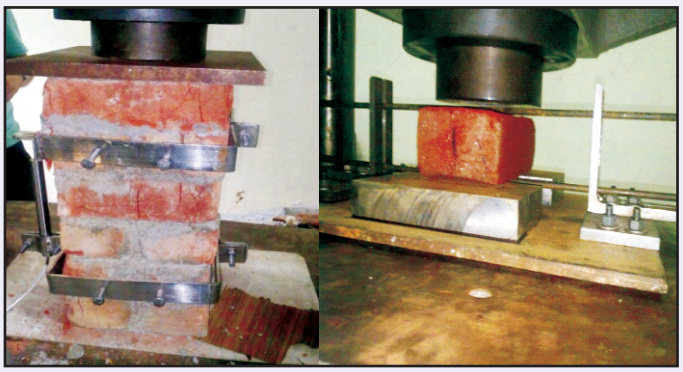

Fig. 1 : Testing of Bricks for splitting tensile strength test as per ASTM standards

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determined as per ASTM standards. The failure of the masonry panels indicate that bond failure occurs during the flexural test. The results indicate that average flexural bond strength for 1:6, 1:4.5 and 1:3 mortar brick masonry are 0.16, .0.19 and 0.26 MPa respectively. As flexural strength of the brick masonry panel is very little and it is an important parameter for blast resistance, retrofitting techniques for improving the flexural strength will help in blast resistant performance and these are being studied experimentally.

It is concluded from the linear analysis of confined masonry panels for the blast loading that boundary conditions have impact on the response as the behaviour may change from impulsive to dynamic. The flexural stresses are higher indicating requirement of nonlinear analysis. The study of the confined brick masonry has been made with elasto-plastic strain hardening models using Mohr-Coulomb yield and failure criterion and contact algorithm for the boundary conditions. The nonlinear analysis indicate that for blast pressure of 1.02 kg/cm^2 of duration 18 ms (surface blast of 100 kg TNT at distance of 30 m) by changing contact friction between RC beam/column and masonry from 0.0 to 0.3 and 0.5 the peak deflection reduces from 4.1 cm to 2.8 and 2.5 cm respectively and peak velocity reduces from 1.7 to 1.4 and 1.25 m/sec.

-Dr A.K. Pandey

Surface Treatment of Weak Mortar

Cement Mortar, need for masonry construction, is the most susceptible link for pollutants like sulphur oxides, nitrogen oxides and carbon dioxide present in the environment and responsible for the initiation of deterioration of mortar. These pollutants in association with water give rise to an acidic solution. The acidic solution thus generated reacts with calcareous materials of mortar and convert it into fragmented wet mass. This process weakens the cement mortar substantially. In most of the cases it has been observed that this deteriorated mortar absorbs water, which attracts microorganisms, insects, biological growth etc. This is the initial stage for the deterioration of the cementitious materials (Fig.1). Weathering action of water is mainly dependent upon the hygroscopic nature of the mortar and extent of its ingress into the mortar and their retention.

In order to obtain a compact and stable material which can withstand environmental effects, a good surface treatment is needed to improve the properties of the weak mortar. The surface treatment should have two properties in particular it should be able to penetrate into the substrate on which this is applied and the same should not degrade under highly alkaline condition.

Fig.1: Initial stage for the deterioration of the cementitious materials

In this project, weak mortar samples with cement & sand (1:8) were prepared and cured using water. The surface of the cured mortar samples was prepared for applying the treatment. Different diluted formulations of Consolidants viz. (A). Polyurethane resin. (B) Polyvinyl acetate, (C) Epoxy resin (D) Poly methyl methacrylate and (E) polyvinyl alcohol were used. The treated and untreated mortar samples were subjected to different experimental tests in the laboratory under simulated Environment-Water absorption by total immersion; Capillary Water Absorption; Liquid Water Penetration, Alkali immersion test, Depth of Penetration, Durability and Compressive Strength test as per Indian standard. Perusal of the results showed that the values of all the treated samples are better than untreated samples. The mechanism behind this is that surface treatment in a fluid state is sucked into the critical surface volume of the substrate by capillary forces. The solvent evaporates and the polymer hardens and forms an elastic, hydrophobic layer on the inner surfaces of the substrate, without closing the capillary pores (Fig. 2a & 2b).

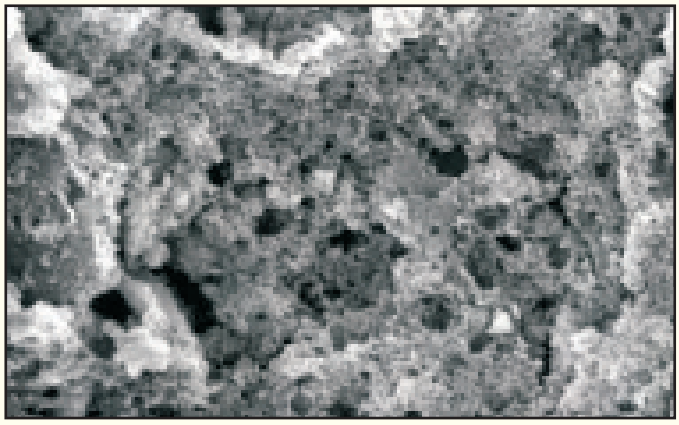


Fig. 2a: Micrograph showing Untreated Surface

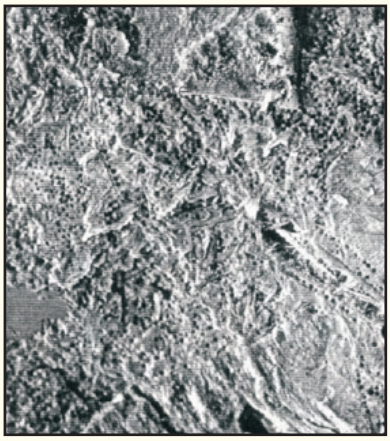


Fig. 2b: Micrograph showing Treated Surface

Table 1: Water absorption data for different samples

Sample No	Water Absorption (%)				
	1hr.	7hrs.	24hrs.	48hrs.	72hrs.
Polyurethane resin	0.20	0.80	1.90	3.50	4.50
Polyvinyl acetate	0.30	0.50	1.10	2.00	2.80
Epoxy resin	0.20	0.20	0.50	1.40	1.55
Polymethylmetha crylate	0.20	0.60	1.20	3.90	6.00
Polyvinyl alcohol	0.10	0.50	1.10	3.90	3.90
Untreated	12.40	12.40	12.90	13.00	14.60

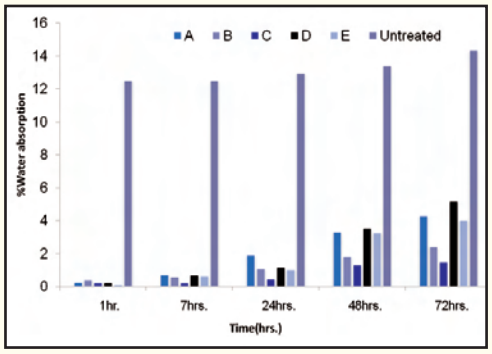


Fig.3: Water absorption of treated samples

Table 2: Water absorption data of samples after exposure studies*

	Water Absorption (%)				
	A	B	C	D	E
Controlled Treated	1.90	1.10	0.50	1.20	1.10
After Alkali immersion Test	7.10	8.20	1.80	2.11	1.80
After Heating & Wetting cycles (treated)	5.10	8.00	0.80	1.80	0.40
After Heating, Wetting & Drying cycles (treated)	3.70	4.80	0.60	0.80	0.60

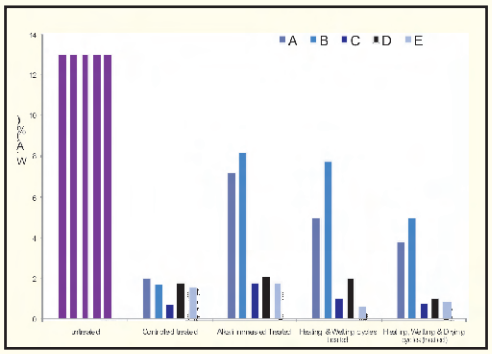


Fig. 4: Comparative effectiveness of the applied treatments

* Water Absorption of untreated samples = 12.90

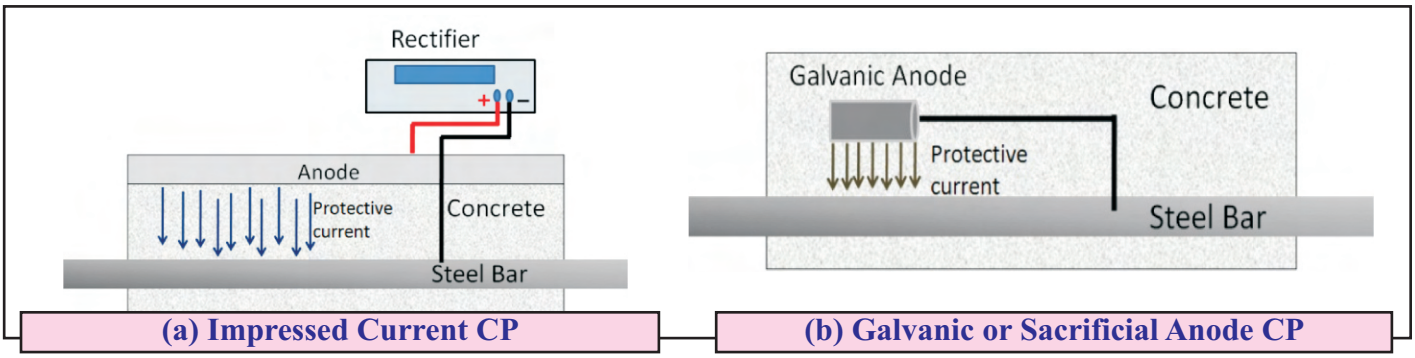
The surface treatments investigated in this study were effective in reducing the water absorption in mortar. Due to consolidation of weak mortar after treatment, compressive strength increases in comparison to untreated mortars. However, the compressive strength of specimens treated with epoxy is appreciably higher than others. This increase may be attributed to an initial densification of mortar due to the formation of secondary calcium silicate hydrate, formed by the reaction between the surface treatment material and calcium hydroxide. Similarly % water absorption of treated samples after 24 hrs. was reduced in all the cases. The reduction in case of epoxy was very high i.e. approximately 96% (Fig.3) revealing that it consolidates the loose matrix to the maximum extent. It has been observed that after durability cycling test, the water absorption in the treated specimens increased to certain extent due to moisture variations. However, epoxy was not much affected by hot weather condition than other treatments. For the comparative effectiveness of the applied treatments, epoxy was found to be the best (Fig.4). The reason for this is that epoxy behaves better as compared to other treatments because it is a cross-linked type of polymer and has excellent adhesion to concrete.

-Dr Rajni Lakhani & Team

Corrosion Mitigation in RC Structures through Cathodic Protection

Corrosion of the reinforcing steel is known to be the main cause of deterioration of reinforced concrete (RC) structures, which is initiated mainly through carbonation and chloride attack. Chloride induced reinforcement corrosion is considered to be the most common and severe degradation mechanism in the steel reinforced concrete structures. To prevent and to reinstate the corrosion protection in RC structures, Cathodic Protection (CP) is widely used as an effective method in developed countries. This method involves an application of electrical current applied from an anode system through the concrete to the steel reinforcement. Due to this current, the steel bars polarise into the negative direction, electrochemical reactions take place at the electrodes and ion transport accelerates in the concrete pore solution. All these result in reduction of corrosion rate to a great extent. The distribution of current and potential depend upon the polarisation resistance of the steel and the electrolytic resistance of the concrete.

There are two basic methods used for implementation of CP: impressed-current cathodic protection (ICCP) system and galvanic or sacrificial-anode system. In ICCP, a direct current is supplied by an external power source, generally



(a) Impressed Current CP

(b) Galvanic or Sacrificial Anode CP

Fig.1: Two types of CP system

a rectifier, at low voltage from an anode material through the concrete (electrolyte) to the reinforcing steel (cathode) as shown in Fig.1a. The galvanic CP system works on the principle that when a more active metal connected to more noble metal, the active metal degrades and protects the nobler metal (Fig. 1b). For making galvanic anodes to protect steel, metals such as zinc, aluminum, magnesium, and their alloys are commonly used. In this system, there is no need of any power source as the current is driven by the natural potential differences between the anode and the steel bars. The leading researchers in this area are currently focusing on development of anode with newer materials and innovative configurations; cost reduction and optimisation of current and potential distribution through numerical models.

Presently, in India, CP of concrete structures is not used much and therefore the nation lacks expertise and skilled manpower in this field. In developed countries, such as USA and UK, CP has been applied on various concrete structures successfully for more than last 30 years. While in India, some of the critical components of the CP system such as anodes are not widely available. The imported anodes are very costly and therefore need to be replaced with some cost effective alternative materials. The main objectives of the current research in progress in CSIR-CBRI are to identify and install the required infrastructure/

Fig. 2: Casting of RC specimen with galvanic anode

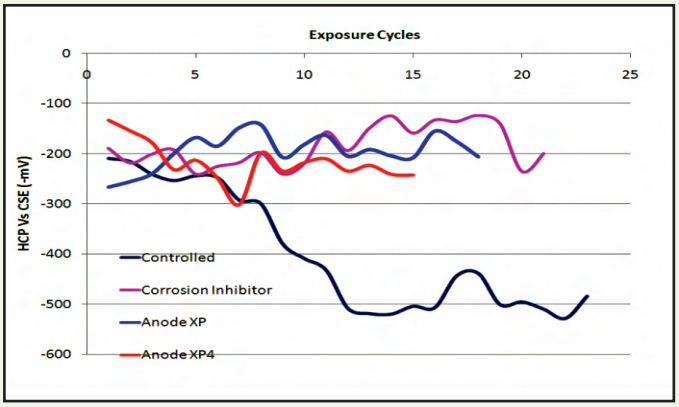


Fig. 3: Change in HCP of steel w.r.t. exposure cycles in Type-I RC specimens with different treatments

equipment for CP; to conduct studies for identifying the design parameters; to verify the efficiency of various anode materials and to examine the utility of CP technology and its cost effectiveness with respect to the conventional repair methods for RCC structures. During the 12th Five Year Plan, the aim will be to make the technology more economical and to demonstrate its implementation on live structures for wider applications in India.

To meet some the important objectives of this research, collaboration has been made with BDS Project Pvt. Ltd., Mumbai, who has tie-up with 'Vector Corrosion Technologies (USA & Canada)'. In this effort, more than 60 reinforced concrete specimens have been cast with and without different corrosion protective measures like coatings, inhibitor and galvanic anode CP, and exposed to salt solution (Fig. 2). The effectiveness is being measured by continuously monitoring the change in half cell potential (HCP) of the bars (Fig. 3), and current & potential difference between the reinforcing steel bars. The results of the study conducted so far indicate CP is very effective in controlling corrosion of the steel bars in concrete. Further research work on galvanic anode CP and ICCP is in progress. During and on completion of this study efforts will be made to increase awareness of CP system among the Civil Engineers/ Contractors in India.

-Dr S. R. Karade & Team

Republic Day

The Republic Day of the Nation was celebrated with a deep sense of patriotism combined with gaiety on January 26, 2012 in CSIR - CBRI Main lawns of the Institute. Prof S.K.Bhattacharyya, Director, hoisted the National flag and addressed the gathering and took the salute at the March Past performed by the security guards. The school-children from Bal Vidya Mandir and CBRI Junior High School presented various cultural programmes on patriotic themes.

National Science Day

CBRI celebrated National Science Day (NSD) by organizing the National Science Day Lecture on 28th February, 2012 to commemorate Raman Effect of the Nobel Laureate Sir C.V. Raman. The day celebration offered an opportunity to bring issues of science in the centre stage and provide awareness about such issues. This results into purposeful interaction between the science fraternity and the common people for mutual benefit.

Prof. S.K. Bhattacharyya, Director, CSIR-CBRI, Roorkee narrated the contribution of Sir C.V. Raman in the field of Spectroscopy for a wide range of scientific investigations and industrial applications. He stressed the role of National Science Day's objectives in transforming our society under the theme **"Clean Energy Option and Nuclear Safety"**. He felt that it is an opportunity to take stock on the status of science in India. Such introspection is necessary as science and technology have become the most important drivers of the economy of the country.

Prof. Jagdish Rai, Department of Physics, IIT, Roorkee has delivered National Science Day lecture on "Lightning and its Applications". He enlightened on earlier beliefs of Lightning, lightning discharge phenomena, cloud formation, Boy's Camera, electric and magnetic fields from Lightning, current and velocity of red Sprites, electric and magnetic fields of Sprites. He informed that earth and ionosphere act as a very good electrical conductors at extremely low frequency (ELF) and very low frequency (VLF) and form a Earth-ionosphere waveguide. Dr B. Singh, Sr Principal Scientist introduced Prof Jagdish Rai and Sri S.G. Dave, Chief Scientist proposed a vote of thanks.

On this occasion, laboratories of the Institute were kept open for school children to get awareness about the recent developments in the S&T. A CD of training on construction of rural village housing was also released.

Foundation Day

66th CSIR-CBRI Foundation Day 2012 was celebrated at Central Building Research Institute, Roorkee on February 10, 2012.

The whole campus wore a festival look and the main function was organized in the morning. Mr. R.S.T. Sai, Chairman and Managing Director, Tehri Hydro Development Corporation, Rishikesh was the chief guest while Prof. S.K. Bhattacharyya, Director, CSIR-CBRI presided over the function. Prof. D.K. Paul, Deputy Director, IIT Roorkee and member, RC, graced the occasion besides other dignitaries.

Chief Guest Mr. R.S.T. Sai, all the dignitaries, superannuated staff of CBRI and all the staff members of the institute were welcomed by Mr. R.K.Garg, Chief Scientist & chairman of the organising committee and reminded the golden history of the Institute.

Prof. S.K. Bhattacharyya, Director, CBRI addressed the gathering and highlighted the glorious past of the institute, achievements and some of the major contributions made especially in past few years. He mentioned about the Ph.D programme, the institute is going to start besides PGRPE programme. Major focus areas and R&D activities for the Twelfth Five Year Plan were elaborated and MoU recently signed were also highlighted. He emphasized that the earthquake resistant techniques would help in reducing the loss of life and scientists are engaged in R&D work in this area and projects such as Sarva Shiksha Abhiyan have been undertaken.

Mr. R.S.T. Sai, Chairman and Managing Director, Tehri Hydro Development Corporation appreciated the work done by CBRI for economically weaker section of the society, rural people and stressed the need to develop technologies that are cost effective and affordable in the rapidly changing scenario. He suggested that infrastructure development such as China should be developed in our country also.

Diamond Jubilee Directors Award for development of best Technology/ Innovation/Know-how which had maximum impact on the society was given on "Modified Epoxy-Cardinal IPN Coating Protective System for Concrete Structures" jointly to Dr. P.C. Thapliyal, Dr. L.K. Aggarwal & Dr. S.R. Karade. The award comprises of a citation and cash award of Rs 5000/-.

On this occasion, Institute publications viz. 'CBRI News Letter' and 'Bhavnika' were released. A Dictionary of technical words from English to Hindi and T-shirt designed by PGRPE students were also released. Shri S.G. Dave, Chief Scientist explained the highlights of CSIR-800 Programme and also proposed a vote of thanks.

The CBRI Foundation Day Lecture was delivered by Mr. R.S.T. Sai on 'Tehri Dam - Technical Aspects', attended by all the staff members of the institute.

There have been a number of activities organized to celebrate CSIR-CBRI Foundation Day 2012 including outdoor games such as badminton, tug of war, races and indoor games like table tennis in which ladies club, children and staff participated and the prizes were distributed. On 26th January, a friendly cricket match was also organized. A cultural programme was organized in the evening by the staff club and ladies club of the institute which was enjoyed and appreciated by one and all.

Research Council Meeting

The 45th meeting of Research Council (RC) was held during 15-16 March, 2012 in the institute. At the outset, Prof. S.K. Bhattacharyya, Director, extended a warm welcome to Prof. Prem Krishna, Chairman and the Members of the Research Council namely Prof. D.K. Paul, Dr. Nagesh Iyer, Prof. B.Bhattacharyya, Dr. S. Gangopadhyay, Shri P.R. Mehta and Dr. S. Chowdhury.

The meeting was started with the welcome address of the Chairman and remarks of RC members. Various agenda items were discussed. The Minutes of the 44th RC meeting was also confirmed. On-going, Supra Institutional, Network, MLP and Other Lab Projects were critically reviewed to shape the deliverables. The Director presented XII Five Year Plan project to apprise the RC Members. The members also visited various laboratories to get awareness about recent developments in the institute.

Prof. S.K. Bhattacharyya, Director thanked the Chairman and Members of the Research Council for their kind co-operation, support and active involvement in the proceedings. He also thanked to his colleagues and urged to work considering the views expressed by the RC Members.

Annual Flowers & Vegetables Show

CSIR-CBRI Staff Club organized 45th Annual Flowers & Vegetables Show at CSIR- CBRI Roorkee premises on 17th March, 2012. CBRI and various Organisations located in Roorkee such as IIT, NIH, BEG&C etc, participated in the Flower Show. In addition to this, many individual participants and staff of CBRI participated. Six types of categories were made for participants for gardens, pot plants, cut flowers, vegetables and flower arrangements etc.. The provision of category (i) for all institutions, offices, clubs and nurseries; category (ii) for all individual' participants; category (iii) exclusively for CBRI staff; category (iv) for Mallies; category (v) for Queen & King of the Show and category (vi) for flower arrangement were made for participants. More than 1600 entries in various categories of pot plants, cut flowers and vegetables were received.

show. Family members of staff of CBRI, their friends and relatives were also present on this occasion.

Convener of the show Dr. P.K.Bhargava chief scientist informed that the flower Rose of Mr. Amit Chatkara and the flower Dahelia of Prof. Pradipta Banerjee, Director IIT Roorkee won the prizes of King & Queen of the show respectively. Brigadier Suresh Sharma, Commandant BEG&C won the Dinesh Mohan Trophy for overall performance in all categories. Mrs. Aruna Bhargava won the Shankar Kapse Memorial trophy, restricted to CBRI staff for best performance in cut flower & pot plants together. Mrs. Laxmi Rao won the best vegetable and flower garden trophies. Km Mahalaxmi and Km. Megha Panigrahi won the Rangoli and miniature flower arrangement trophy in children category.

The show was inaugurated by Prof. S.K. Bhattacharyya, Director CSIR-CBRI and the prizes were distributed by the Chief Guest Brigadier Suresh Sharma, Commandant BEG&C and the Guest of Honour Mrs. Kajal Bhattarcharya. Prof. Prem Krishna, Chairman Research Council, Prof. D.K.Paul, Dy Director, IIT, Mrs. Pradipta Banerjee, Mrs. Simmi Sharma and many other dignitaries visited the flower

The judges who judged the beauty of flowers and gardens include Mrs. Pratibha Arya, Mr. T.C. Phatak, Mr. K.D.Dhariyal, Mrs & Mr. A. Siddiqui and Mrs. Rashmi Bhargava.

The event was also sponsored by State Bank of India, CBRI Branch and Bank of Baroda, Roorkee.

Colloquium

4th January 2012 Characterization of FRP Wrapped Concrete Elements	**Prof. S K Bhattacharyya,** Directer, CSIR-CBRI, Roorkee
25th January 2012 Disposal/Utilization of Broken Pitcher Waste of Sanitaryware Industry	**Shri H K Jain** Principal Technical Officer CSIR- CBRI Roorkee
7th March 2012 Advances in Solar Photovoltaics	**Shri Nagesh Babu Balam** Scientist, CSIR-CBRI Roorkee

Lecture Delivered

Shri Ashok Kumar, Sr Principal Scientist delivered a lecture to the delegates/ participants of workshop on **"Urban Risk - Need for Resilience",** at Lucknow organized by Uttar Pradesh State Disaster Management Institute, Lucknow on 24 Feb. 2012.

Paper Published

Richa Singh and **S. P. Agrawal,** Review on bio-degradable composites for buildings, Journal of Civil Engineering & Construction Review, New Delhi, October 2011, Vol. 24, No. 10, pp 100-106.

Sapna Ghai, Rajni Lakhani, and **S. P. Agrawal,** A review on consolidants for repair of deteriorated structures, in New Building Materials & Construction World, Februray 2012, pp 190-196.

P.C. Thapliyal, Nanotechnology based coatings: Innovation & collaboration, Nano Digest, 3(5), 46, 2011.

S.K. Agarwal, L.P. Singh, V.Sood, G. Mishra and **S. Ahalawat**, Effect of blended flyash on the compressive strength of cement paste, Concrete Research letter, Dec. 2011, No. 4, Vol. 2, pp336-345.

Forthcoming Events

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

Construction of energy efficient buildings today will continue to save energy for coming decades making energy conservation in building a central plank in the country's long-term growth planning. The Efficiency of Building Group at CSIR-Central Building Research Institute Roorkee, therefore, finds it appropriate to organize a conference on Emerging trends of Energy conservation in Building to summarize the present status of research in the stated area to cause a significant impact on building energy consumption. In this conference building energy professionals and stakeholders are expected to share their experiences, expertise and S&T options for the integration of renewable energy and energy efficient devices and processes for energy conservation in building.

The National conference on **"Emerging Trends of Energy Conservation in Building (EECB-2012)"** 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 from **1st to 3rd November, 2012 by CSIR – CBRI,** at Roorkee. The institute is actively engaged in research activities related to all aspects of buildings including heat transfer, solar energy, ventilation & lighting. The conference is expected to provide valuable opportunity for experience sharing among the experts who have been actively involved in these fields.

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

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

Buildings are responsible for more than 40% carbon emission through embodied energy in construction materials and products, energy consumed during construction processes and energy used by the building habitats. The housing sector is witnessing accelerated growth creating demand and acute pressure on the resources of building materials. Extensive exploitation of resources is adversely tempering the ecology and sustainability. Therefore, need to develop advanced materials with less embodied energy or reduced energy requirement of the buildings is essential. The present energy situation also warrants the adoption of low energy production processes and use of energy efficient advanced materials.

International conference on **"Advanced Materials for Energy Efficient Buildings (AMEEB- 2013)"** is aimed to cover the recent advancements and trends in the area of advanced building materials vis à- vis energy efficiency in buildings to share and networking on the emerging and futuristic challenges. This conference is scheduled to be held from **13th to 15th February, 2013 by CSIR – CBRI,** at IHC, New Delhi. The conference will deliberate on building materials including nanomaterials, energy efficient systems, health monitoring of structures and newer construction technologies. Technical Programme of AMEEB will comprise invited lectures with contributed presentations.

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

Staff News

Transfer

Sh. Vineet Kumar Saini, Scientist joined CSIR-CBRI Roorkee on 19.03.12 on transfer from CSIR-CMERI, Durgapur.

Welcome!

Promotion

Sh. Rajesh R Ghadse	Sr Technical Officer I	31.01.2011
Sh. Rakesh Kumar II	Sr Technical Officer II	01.11.2010
Sh. Vivek Sood	Sr Technical Officer II	25.01.2011
Sh. Jalaj Parashar	Sr Technical Officer II	08.02.2011

Congratulations!

Superannuation

Sh. R K Yadav	Principal Technical Officer	31.01.2012
Sh. N S Tyagi	Principal Technical Officer	31.01.2012

We wish a peaceful and happy retired life!

Kind Attention to Our Readers:

The achievements and work done in or out side CSIR-CBRI, by all S&T staff are always welcome. They may send their brief write-up with photograph to the editor for inclusion in CSIR-CBRI Newsletter.

Editor

Dr Atul Kumar Agarwal

Principal Scientist

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