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CSIR-Central Building Research Institute Roorkee-247 667 (UK)

## Research in Progress

### Utilization of Solar Energy in Buildings and for improvement of Built Environment in Cold Climatic Region

The Study has been undertaken with the objective to develop methodology for utilization of solar energy for improved environment in and around residential buildings in cold climatic region.

Developed a new Solar window system for cold climatic region. The sun altitude during winter season is lower towards south direction due to which maximum solar radiation falls on south wall surface of the building. Keeping this in mind a solar window system has been provided in a room to study its thermal performance. Experimental studies has been carried out to determine the thermal performance of new Aluminium solar window (Fig. 1). To study the effect of the solar radiation same size of windows are constructed in two identical rooms.

The room air temperature 3-3.5<sup>0</sup> C higher can be achieved through designed solar window in treated room.



Photo1- South facing treated window in room

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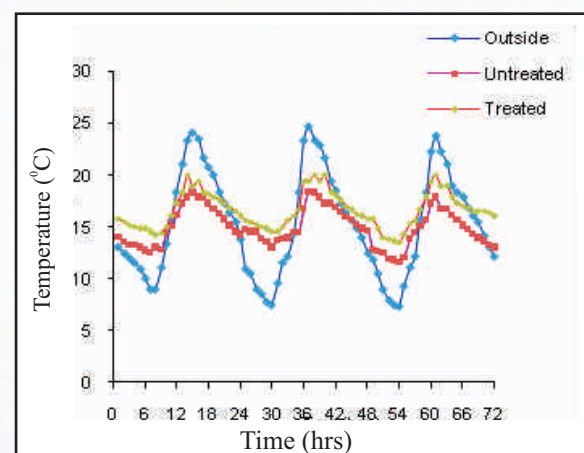


Fig.1 Performance of Aluminium Solar Window System in winter





## Post-Earthquake Reconnaissance Survey – Sikkim Earthquake

An earthquake occurred in eastern Nepal near the Nepal-Sikkim border on 18 September 2011 at 18:11 IST, causing significant damage of the built environment in Sikkim alone, especially roads and buildings. At the outset of National Disaster Management Authority (NDMA), CSIR-CBRI scientists participated in Reconnaissance Team (PERT) to study (A) Structures damaged by the Earthquake (B) Collect perishable data related to the built environment in the affected area; (C) Identify vulnerable construction typologies and their performance; (D) Identify main reasons for damage to masonry, RC frame, traditional construction and other construction; and (E) Evaluate the performance of structural, non-structural and functional elements in major critical and lifeline buildings and facilities, such as hospitals, where feasible.

The built environment in hill areas affected by the earthquake includes mainly four type of building construction practices followed in the affected region, namely RC frame type with infill walls, R/R masonry with stone or wooden post and beam, Shing-Khim (wooden) type construction and Ekra houses. These construction practices are distributed according to the economic development and availability of raw materials. Traditional houses (Ekra houses) are single- or two-storeyed, built with a wood frame from sloping ground

walling. There are numerous variations to this housing typology over time (Figure 1). The urban areas are seen to have RC frame construction along hill slopes up to 6-9 storeys, with RC floor slabs roof (Figure 2).



**Fig. 2: Typical urban landscape along hill slopes of towns, like Gangtok, Darjeeling, Kalimpong and Kurseong**



**Fig. 1: Variations of housing in hill slopes of Darjeeling/Kalimpong (WB) and Sikkim States**

to roof level, light corrugated galvanised iron (CGI) sheet roofing supported on the wood frame, mud walls from plinth to sill level, and cross-woven Ekra or bamboo spilt matting plastered with mud or fine sand with lime as rest of the

Chungthang and Lachung in North Sikkim are two major towns which have suffered maximum damage caused by landslides and poor construction of buildings combined with intense shaking. The maximum intensity of shaking was



**Fig. 3: Damage due to Mudslide at Lachung**

observed to be VIII. In Lachung, rockslides and mudslides the main event caused extensive damage, as shown in Figure 3. Intensity of shaking between VI-VII (MMI) in and around the state capital, Gangtok (e.g. Singtam, Dikchu, Mangan, etc). General damage to buildings was in accordance with the assigned intensity of shaking, except a few, such as the Secretariat building, two multi-storey buildings in Balwakhani, and another five-storey building in Lumshey Bastey, all of which suffered either complete collapse or partial collapse due to faulty construction practices and poor workmanship.

Many RC buildings in Gangtok and most of them in Chungthang suffered damages, the most common being shear and/or flexure failure at column end region, failure of beam-column joints, in-plane failure of weak infills and out-of-plane failure of slender walls. The observation shows that basic requirement for good seismic performance of a RC buildings viz. planning, design, configuration, load path, reinforcement detailing etc., were not followed. Many



**Fig. 4: Typical failure of RC buildings in Chungthang (Sikkim)**



**Fig. 5 : Typical hybrid infill RC construction in Lachung (Sikkim)**

unique and inherently poor construction features such as weak and very slender partition walls in brick/block masonry or in lightly reinforced/plain concrete, extended floor plans in upper stories supported on cantilevered beams and slabs, construction on sloped ground, unstable slopes, weak retaining walls, poor construction material etc., significantly added to the seismic vulnerability of structures. (Figure 4). Examples of unique hybrid construction were also noticed in the region, Fig. 5.

The traditional houses like Ekra and Shing-Khim performed significantly better compared to RC-frame/masonry buildings and suffered only minor damages at ground storey level. Various monasteries all over Sikkim suffered extensive damages, wherein mainly random rubble (R/R) masonry laid in mud/lime mortar was used as construction material. Major civil-engineering projects in the area includes hydel power plants, steel and RC bridges, wherein no significant damage was observed.

The event prominently highlights the presence of vulnerable building stock in Sikkim and adjoining states. The lessons learnt from the event, aiming to proactive role in reduction of seismic damage are briefly mentioned herein:

- ❖ Use of good construction practice and quality of material.
- ❖ Development of typified designs keeping local architecture and use of locally available material reinstated and integrated with modern construction practices. Proven technology, which satisfy all the fronts like confined masonry shall be promoted.



- ❖ Compliance for seismic codes in design.
- ❖ Retrofitting strategies should be outlined specially for lifeline and heritage structures.
- ❖ Need to strengthen the activities of State Disaster Management Authority (SDMA) with a strong group guiding activities on development of technical and administrative personnel.
- ❖ Lack of earthquake engineering education of

stakeholders (like architects, engineers, building owners, quality inspectors, contractors and city building officials) is reflected in poor level of general awareness on earthquake safety.

- ❖ Capacity building for Masons, carpenters and bar benders need to be trained to undertake earthquake-resistant construction in high seismic regions; certified artisans should be given preference over their untrained counterparts to promote quality construction.

## Design and Development Approach of a Prototype Climbing Robot in Building Industry Applications

The design process of climbing mobile robots (CMRs) is primarily dependent on locomotion and adhesion mechanisms and their integration with robotic control module for navigation in man-made environments. In CMRs, locomotion mechanism is for mobility and carrying payloads, and adhesion mechanism is for stability and sticking mobile robots while maneuvering onto the different wall surfaces such as brick, concrete, tile, glass, and steel. Based on locomotion mechanism, CMRs are categorised as follows: wheel-driven, legged, tracked wheel, cable-driven, limbless, translation frames (crawling), and hybrid types. Adhesion method, which is another most important design feature for the development of CMRs, can be categorised such as magnetic, electroadhesion, grippers, active and passive pneumatic methods, propeller, and biomimetic types. As reported in the literature, each of these developed mechanisms has some advantages and limitations as well. Worldwide different technologies by various researchers have been proposed to develop these mechanisms to be used in CMRs for different testing target walls in various applications.

Most of the earlier developed CMRs, which are based on traditional control methods, could possess either high payload carrying capability or high mobility, but they do not possess these features simultaneously. Some current research involves developing CMRs to overcome the limitations, such as inability to carry enough payloads to different material walls, low operational speed and less energy efficient. Thus, it is required to develop reliable mechanisms and their design

process to integrate with suitable control module for the development of CMRs. In India, periodic inspection and manipulation in remote location of different material walls of man-made structures with semi-autonomous or autonomous mobile service robots (MSRs) may find possible applications in the near future. Since, this is the problem where direct access for human operators is mostly difficult and expensive to reach out the remote locations. As yet, human operators used complex access device such as scaffolding, cranes, hydraulic and pneumatic lifts, etc. to reach the specific point in remote locations. Therefore, mobile robotic system may provide more effective solutions from safety, hazard and economic point of view.

The present study aims to design and develop a mobile robotic system for performing periodic maintenance and inspection of civil infrastructure. The dynamic model of wheel mobile robot (WMR) and wheel climbing mobile robot (WCMR) for locomotion study has been carried out to simulate 2D (e.g., as shown in Fig.1) and 3D path planning numerically corresponding to different input parameters in both open and close loop control settings. The basic study on adhesion mechanism based on pneumatic principle for different design parameters is illustrated in Fig.2. Virtual prototyping of CMR and experimental setup design for mechanisms testing and development have also been carried out for further research work in service robotics.

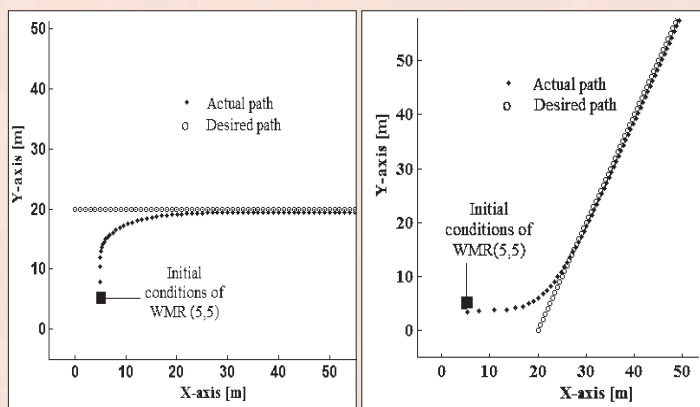


Fig. 1: Trajectory response of WMR {Desired (o) and Actual (.) trajectories, e.g., along straight and inclined path control}

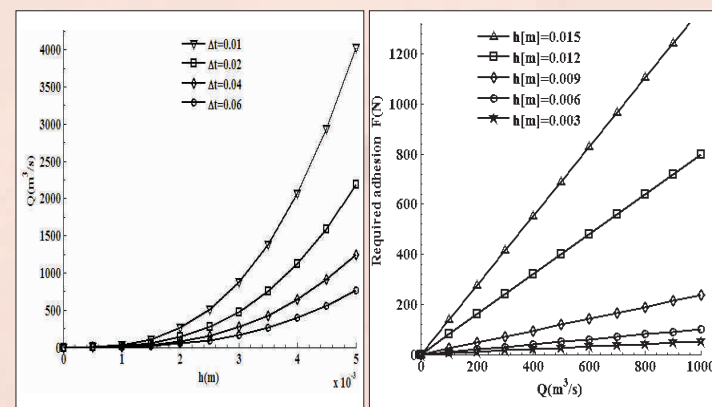


Fig. 2: Adhesion study for different design parameters (Air gap height  $h[m]$  and suction thickness  $\Delta t[m]$ )



## CBRI Organised Composite Panels Manufacturing Industries Meet

An interactive meet with composite panels manufacturing industries was organized on August 30, 2012 at CSIR-CBRI, Roorkee. Leading composite panels manufacturing industries such as ACME Telepower Ltd., Pant Nagar, Uttarakhand; Asawa Insulation Pvt. Ltd., Mumbai; Huntsman International, Pune; Jindal Meetec Pvt. Ltd., Nalagarh, Solan (HP) etc. were participated in the meet. Dr. Sunil K. Sharma, Chief Scientist, welcomed the participating industries and briefly explained the theme of the meet. Prof. S. K. Bhattacharyya, Director CSIR-CBRI addressed the participants and emphasized the need of developing market driven materials/technologies through the feedback of manufacturing industries in the field. M/s. ACME presented the composite panels of dimension 3000x1000x50-250mm having 40 kg/m<sup>3</sup> density rigid polyurethane foam core and metal face bonded with silicone adhesive. These panels are being used in telecom and defence shelters. They also emphasized on the market demand of fire retardant PUF panels with low smoke and toxicity. Repairable, recyclable and biodegradable PUF are also the demand of the market. M/s. Asawa presented the smart composite panels of dimension 4000x1000x50mm with polyisocyanurate (PIR) core having aluminum metal and paper outer and inner faces respectively. These panels have PIR core density 55 kg/m<sup>3</sup>,



95% closed cell content, low water absorption and resistant up to 350°C under fire exposure. M/s. Huntsman emphasized on the usage of metal faced PUF panels in the building industry with adequate balance between energy efficiency and fire retardancy. M/s. Jindal Mectec presented the composite panels having PUF or mineral wool core with pre-painted metal sheets as outer and inner surfaces. The metal faced panels are subjected to corona treatment which further enhances the adhesion between core and face materials. These panels find great demand in cold storage, refrigerated vehicles, telecom and defence shelters, industrial buildings, aircraft hangers, pre-fab houses and offices etc. All the manufacturing industries present in the meet agreed that the



metal faced composite panels having PUF/PIR core have great demand in the market however, the usage of bare PUF core is highly hazardous as it is highly flammable and generates dense black smoke with toxic combustion products. Dr. Harpal Singh, Principal Scientist, presented the R&D effort at CSIR-CBRI on fire retardant rigid polyurethane foam which is a principal component of these composite panels. A live demonstration of the developed material was also arranged at the Fire Research Laboratory of CSIR-CBRI for the participating industries. R&D effort at CSIR-CBRI was highly appreciated as they were awesome by the significant improvement in the fire performance of developed rigid polyurethane foam.



## SADBHAVNA DIWAS

The institute observed Sadbhavna Diwas on August 17, 2012 with a view to promote harmony amongst people of all religions, languages and states and goodwill towards everyone.

Prof. S K Bhattacharyya, Director, CSIR-CBRI administered the Sadbhavna pledge to all the staff members of the Institute.





## HINDI WEEK

The Institute celebrated Hindi Week during September 14-20, 2012. The inauguration function was presided over by the Director Prof. SK Bhattacharyya and Dr. Bichar Das, Former Director, Central Translation Bureau, New Delhi graced the occasion as Chief Guest.

During this period an Hindi Book Exhibition and a workshop on 'Unicode Pranali se Computer par Hindi main Karya' was organized on 17<sup>th</sup> September 2012, which was open for all groups of personnel. About 40 employees were motivated in the workshop. Hindi Noting, Drafting and Translation Competition was held on 18<sup>th</sup> September 2012. First, second and third winners of the competition were Sri Naresh Yadav, Sri Aman Kumar and Shri Sharad Kumar respectively. On 19<sup>th</sup> September, 2012, a Hindi Writing Competition was also held



for non Hindi speaking employees, in which, First, Second and Third prizes were won by Sri Kaushik Pandit, Km. Riya Bhaumik and Km. Monalisa Behera, respectively.

The closing ceremony of the week-long event was organised on 20<sup>th</sup> September, 2012. Dr. Sudha Rani Pandey, Vice Chancellor, Sanskrit Vishwavidyalaya, Haridwar graced as Chief Guest and the Director, Prof. SK Bhattacharyya presided over the function.

The entire programme of the Hindi Week was successfully organized under the chairmanship of Dr. B. Singh and convener Sri R.C. Saxena, Sr. Hindi Officer with the support of Sri Mehar Singh & Sri Naresh Yadav.

## CSIR Foundation Day Celebrations at CSIR-CBRI

70<sup>th</sup> Anniversary of CSIR was celebrated with great enthusiasm at CSIR-Central Building Research Institute, Roorkee on September 24, 2012. Prof. Pradipta Bannerji, Director IIT, Roorkee graced as Chief Guest and Prof. Prem Krishna, Vice President, Indian National Academy of Engineering and Chairman, CSIR-CBRI Research Council as Guest of Honor. Prof. S.K. Bhattacharyya, Director,



CSIR-CBRI presided over the function. The superannuated staff of CBRI and all the staff members of the institute graced the occasion besides other dignitaries. Welcome address was given by Sri S.G. Dave, Chief Scientist and the chairman of the CSIR Foundation Day Committee.

Prof. S.K. Bhattacharyya, Director addressed the gathering and highlighted the glorious past of CSIR, establishment of five labs in the year 1942 and CBRI in 1947. Since then it has grown covering almost all the areas of science and technology, contributing in the development of the country. He mentioned that CSIR is celebrating this year as Green



Operation Initiative. He also talked about the major focus areas of R&D activities for the Twelfth Five Year Plan, CSIR 800 - Tech Vill. Project, under which CSIR technologies will be demonstrated covering the whole country and the role of CBRI in this project. He also mentioned about the activities of AcSIR in the institute and enrollment of M.Tech. and Ph.D. students this year.

Prof. Prem Krishna, Chairman, CSIR-CBRI RC, talked about the need for environment friendly buildings in present scenario and said that CBRI has a bigger role to play as there is a growing awareness about the newly developed technologies. He expressed satisfaction on the activities undertaken under twelfth plan by CSIR-CBRI.

Prof. Pradipta Banerji, Director IIT, Roorkee emphasized that energy efficiency in buildings is very important and



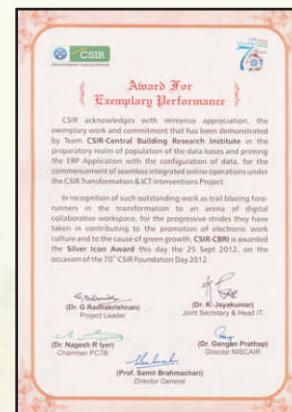
quoted the example of Mughal period buildings, having adequate light and ventilation. He suggested the future R&D in the area of building physics and reuse of waste materials for construction.

Shri Pramod Adlakha, Architect, Consultant & Managing Director, M/s Adlakha Associates Pvt Ltd., New Delhi was felicitated for his notable contributions in promoting CBRI technologies from lab to land. He also delivered CSIR Foundation Day lecture in the afternoon session.

On this occasion 'CBRI News Letter' and 'Bhavanika' were released. Two brochures for

'Architecture and Planning' and 'Organic Building Materials' groups were also released.

There have been a number of activities including essay competition for staff children, visit of school students providing platform for scientist-student interaction and generating interest among the youth for science and technology. The Chief Guest also gave away the prizes to the essay competition winning children of CSIR-CBRI employees i.e. Km Vidhi Arora & Pranjal Bansal in I group (class VI to VIII), Km Anusha Agarwal & Km Prachi Mishra in II group (class IX & X), Paras Bansal & Km Anushka in IIIrd group (class XI & XII). CSIR prize for getting admission in IIT and securing more than ninety percent marks in three science subjects in XII standard to the wards of the staff were also given.



On this occasion, the Chief Guest presented mementoes (wrist watches) to the employees of the institute who had completed their 25 years of service and a wrist watch, shawl and appreciation certificate to those who have retired during the year. A cultural programme was organized in the evening which was enjoyed and appreciated by one and all. Sri R.K.Garg, chief scientist proposed a vote of thanks.

The Institute won Silver Icon Award for exemplary performance in promoting digital work culture at CSIR-CBRI. The award was given by Hon'ble Minister of S&T and VP CSIR on 25<sup>th</sup> September 2012 at CSIR, New Delhi.



## COLLOQUIUM

**18<sup>th</sup> July 2012**

Indoor Air Pollution—Threat or Hype?

**Shri S. Ibrahim Sohel**

Scientist, CSIR-CBRI, Roorkee

**1<sup>st</sup> August 2012**

Health Monitoring of Structural Systems

**Dr S K Panigrahi**

Sr. Scientist, CSIR-CBRI, Roorkee

**24<sup>th</sup> September 2012**

CBRI Cost Effective Technologies: Case Study (CSIR Foundation Day Lecture)

**Shri Pramod Adlakha**

Architect, Consultant & Managing Director, M/s Adlakha Associates Pvt Ltd., Delhi





## Forthcoming Events

National Conference on **Emerging Trends of Energy Conservation in Building (EECB-2012)** at CSIR-CBRI, Roorkee.  
**November 1-3, 2012**

**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.

**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

**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.

**February 13-15, 2013**

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

## STAFF NEWS

### Appointments

Mr. Nagesh Babu Balam	Scientist	08.08.2012	Mr. Syed Ibrahim Sohel	Scientist	08.08.2012
Mr. Srinivasarao Naik B.	Scientist	08.08.2012	Mr. Manojit Samanta	Scientist	13.08.2012
Mr. Ravindra Singh Bisht	Scientist	08.08.2012	Mr. Subash Chandra Bose Gurram	Scientist	16.08.2012
Mr. Soju J. Alexander	Scientist	08.08.2012	Dr. Aravind Kumar	Scientist	05.09.2012
Mr. Soumitra Maiti	Scientist	08.08.2012	Ms. Parvathi G.S.	Scientist	10.09.2012
Mr. Subham Dastidar	Scientist	08.08.2012	<b>Welcome</b>		

### Superannuation

Sh. M.P. Singh	Chief Scientist	31.07.2012	Sh. Dinesh Chandra	Sr. Technician	31.08.2012
Dr. S.K. Agarwal	Sr. Principal Scientist	31.07.2012	Sh. S.G. Dave	Chief Scientist	30.09.2012
Sh. Surender Singh	P.S.	31.08.2012	Sh. Akhtar	Tech. Gr.I	30.09.2012
Sh. Kuldeep	Sr. Technician	31.08.2012	<b>We wish a peaceful and happy retired life!</b>		

### Promotion

Dr. A.K. Minocha	Chief Scientist	01.03.2011
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**Congratulations**

### Resignation

Dr. S. Karthigeyan Principal Scientist 28.09.12  
(To Join Anna University, Chennai as Associate Professor)

### Obituary

It is placed on record the sad and untimely demise of Sri Shiv Kumar, Peon on 29.7.12

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

Editor

**Dr Atul Kumar Agarwal**

Principal Scientist



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