



Vol. 33, No. 3, July-September 2013

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



## In This Issue....

Research in Progress

1

➤ Sadbhavna Diwas

4

➤ Independence Day

5

Hindi Week

CSIR Foundation Day Celebrations

6

Inauguration of 300T UTM Test Facility in SE Group

7

➤ Colloquium Staff News

8

## Research in Progress

## Bond Behavior of Reinforcing Bars in Geopolymer Concrete

An optimum mix proportioning of geopolymer concrete for target mean strength 35 MPa was made using Fuller's gradation curve. Based on the aggregate gradation, the mix contains 26.7% 20 mm down coarse aggregates, 50.1% 10 mm down aggregates and 23.2% fine aggregates (sand)

concrete was in the range of 2300-2400 kg/m<sup>3</sup>. The average compressive strength was 37.25 MPa for cube and 33.09 MPa for cylinder. The flexural strength of prism was ~ 4 MPa which lies in the 10-15% of compressive strength. These experimental results were validated through empirical equation for OPC based concrete mentioned

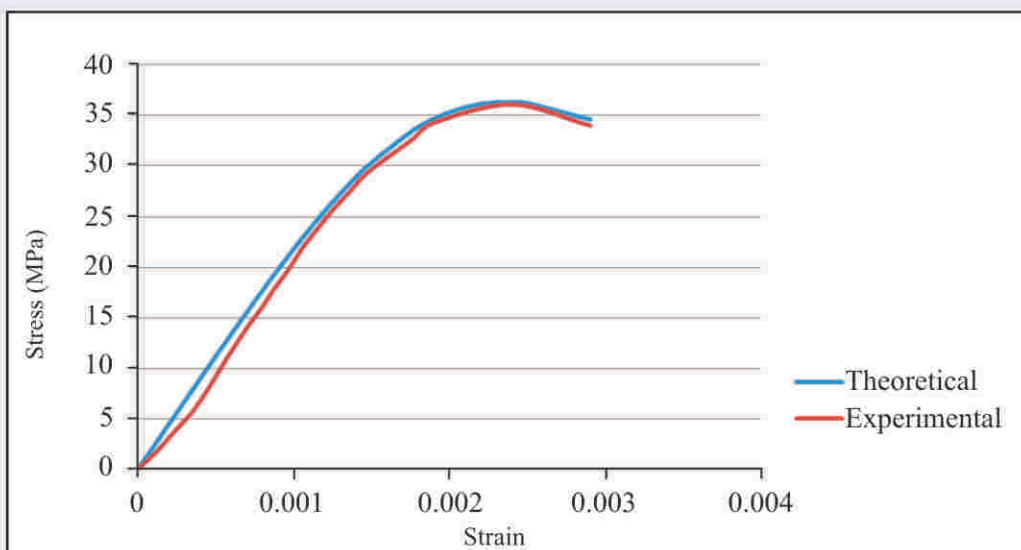
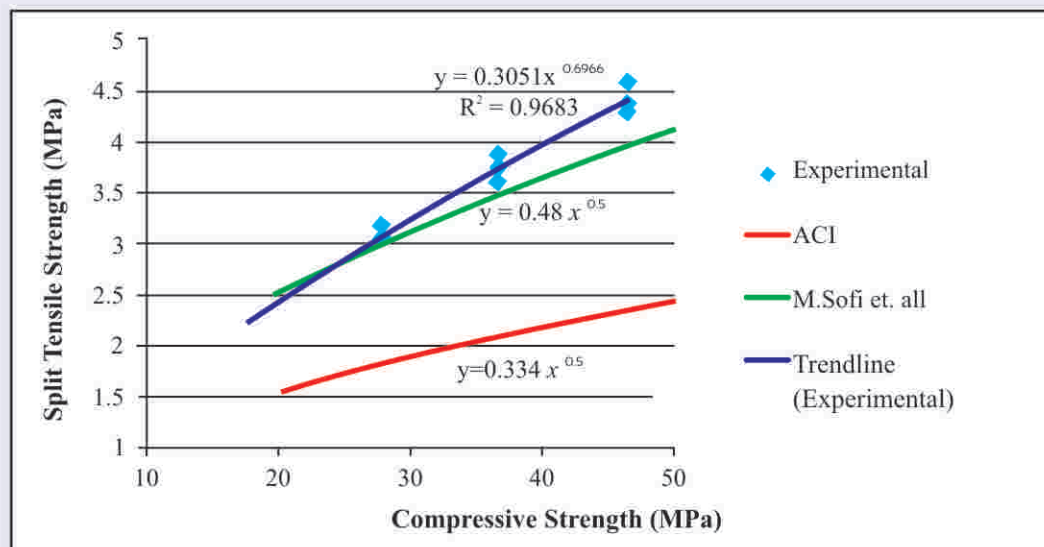


Fig.1: Stress-strain curves of geopolymer concrete

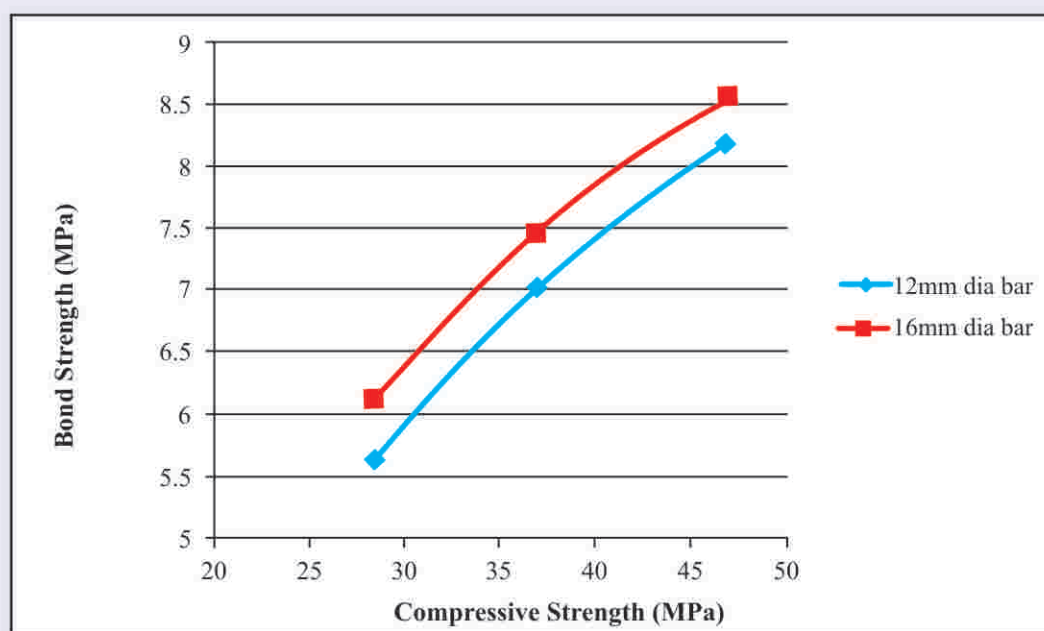
respectively. The water-geopolymer solid ratio was kept at 0.22. The superplasticizer was added at a dosage of 1.5% of the binder. The cubes, cylinders and prisms were cast and tested for their compressive strength, split tensile strength and flexural strength. The density of resulting

in ACI guidelines. The maximum deviation of 5-10% was observed indicating adherence to the theoretical values. The experimental stress-strain curve was theoretically compared with the curve obtained through Collins et. al equation (Fig.1). The deviation from the theoretical curve is attributed mainly to the existence of





**Fig.2: Variation of split tensile strength with compressive strength of geopolymer concrete**



**Fig.3: Bond Strength of geopolymer concrete with respect to its compressive strength**

voids in the samples and also aggregate-geopolymer paste interaction. The peak strain in GPC was found to be  $\sim 0.002$  which is slightly higher than the OPC. The strength of geopolymer concrete increased with increasing molarity of the activators probably due to formation of stable alumino-silicate networks following the dissolution of more silica and alumina in the solution. The strength of geopolymer concrete also increased with decreasing water-geopolymer solid ratio as it is said to analogous to the water-cement ratio in OPC based concrete.

A trend line curve between the compressive strength and modulus of elasticity was plotted and compared

theoretically with ACI guidelines for concrete and Ivan Diaz-Loya et.al equation for geopolymer concrete. As expected, the modulus of elasticity increased as the compressive strength of geopolymer concrete increased. It was found that experimental values were lower (17%) than the predicted by Ivan Diaz-Loya et al. for geopolymer concrete and also the values obtained with ACI guidelines ( $E_c = 3.32 \sqrt{f_{cm} + 6.9}$ ). This is attributed to the type and fracturing of coarse aggregate and geopolymer paste used in the concrete manufacturing. The lower value of modulus of elasticity and a higher value of strain indicates that geopolymer concrete is more ductile than the OPC based concrete. A



relationship between the split tensile strength and compressive strength of geopolymer concrete was also studied and proposed an equation  $f_{st} = 0.305 f_c^{0.69} \text{ MPa}$ . A comparison of values was made with the Sofi et.al empirical equation and ACI guidelines (Fig.2). It was found that the split tensile strength of GPC was more than those of predicted values. This equation had a  $R^2$  (coefficient of determination) of 0.968 which tells that there is a 96.8% probability that the value would lie on this line. The experimental split tensile strength of geopolymer concrete was higher than the cement concrete as per ACI guidelines. The increased strength is accounted for a denser interfacial zone established between the aggregates and geopolymer due to its three dimensional network formation.

The pull-out strength of reinforcing steel bars (6 mm dia standard bar, 12 mm and 16 mm dia deformed bar) in geopolymer concrete was determined. For comparison purpose, the bond strength of reinforcing bars with cement concrete was also tested.

As expected, the bond strength of geopolymer concrete increased with increasing compressive strength (Fig.3). It was noted that the bond strength between geopolymer concrete and reinforcing bars was found to be higher than the cement concrete. This is attributed to the adequate adherence of geopolymer matrix on the surface of steel bars as observed in its fractured surface. Reinforcements were designed as per IS: 456-2000 considering balanced section. The plain and reinforced geopolymer concrete beams were tested under two point loading using 780 mm span. It was found that enhanced concrete strength increases ultimate load carrying capacity, ultimate moment and bearing stress. The flexural response exhibited by reinforced concrete indicated high moment capacity and flexural strength upto 70% of its compressive strength.

- B. Singh, M. Gupta and  
S.K. Bhattacharyya

## Bio-Concrete as Self Healing Material

Development of cracks is a common phenomenon in reinforced concrete (RC) structures during their service life due to several reasons. If left unattended, they can cause structural deterioration with high level of risk and maintenance cost in long term. In order to control the cracks, currently, such issues are addressed using admixtures such as epoxy, resins, epoxy mortar and other synthetic mixtures, which are highly labor intensive and costly. Possible strategies to deal with cracks in buildings is manual inspection and repair, which is time consuming and not always possible. The proposed developed product, 'Bio-concrete' has excellent potential in cementing concrete as well as several other types of structural and nonstructural cracks as self healing material. The present research program attempts to develop a smart material 'bio-concrete', for arresting cracks using environmentally friendly biological activity that is continuous self-remediation process, over and above its economical aspects.

Extremophiles calcifying bacteria are producing urease enzyme which is capable to catalyze hydrolysis of urea into ammonia

and  $\text{CO}_2$ . The bacterial degradation of urea locally increases the pH and promotes the microbial deposition of carbonate as calcium carbonate in a calcium rich environment. These precipitated crystals can thus fill the cracks and enhance the durability. The proposed process to generate 'Bio-concrete' by incorporating very specific extremophiles calcifying bacteria is helpful for cementing concrete as self healing materials. Around 7%  $\text{CO}_2$  is produced during manufacture of cement. The less emission of  $\text{CO}_2$  in environment would also be possible due to reduced utilization of cement for repair of cracks and enhanced durability. The following work has been carried out:

- ✦ Collected & isolated alkaliphilic calcifying bacteria from various potential site.



## CSIR-CBRI Newsletter





# CSIR-CBRI Newsletter



✦ Bacterial cultures were maintained for various experimentation.



✦ Prepared bacteria embedded mortar samples (25x25x25mm) with bacterial broths and with / without chemical feed to evaluate their behaviour.



✦ Standardized methodology for cracks generation.



✦ Study of crack healing capacity on mortar samples are under progress.



The establishment of bio-concrete laboratory was initiated.

- Leena Chaurasia & Rajesh K. Verma

## Sadbhavna Diwas

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

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

## Independence Day



The Independence Day was celebrated with a deep sense of patriotism combined with gaiety on August 15, 2013 in CSIR-CBRI Main lawns of the Institute. Prof. S.K. Bhattacharyya, Director, CSIR-CBRI hoisted the National flag and addressed the gathering and took the salute at the March Past performed by the security guards. The





school children from Bal Vidya Mandir and CBRI Junior High School presented various cultural programmes on patriotic themes.

## Hindi Week

The Institute celebrated Hindi week during 9-13 September, 2013 with great zeal and enthusiasm. On 9<sup>th</sup> Sept Dr. Mahavir Agarwal, Vice-Chancellor, Uttarakhand Sanskrit University, Haridwar graced the inauguration function as Chief Guest. The function was chaired by Prof. S.K. Bhattacharyya, Director, CSIR-CBRI. On 10<sup>th</sup> September 2013, a scientific lecture was delivered by Prof. Indramani Mishra, IIT, Roorkee on "Pipe

the direction of Hon'ble Supreme Court to dispose off the issue of mining in vicinity of Qila. Both the lectures organized on this occasion were on Scientific subjects but the language was so easy, fluent and full of exactness and clarity as all the scientists have realized that even the scientific matters could be presented in Hindi with utmost clarity and exactness. Certainly it would be very helpful in changing their pro English mentality. A Hindi self-written poem recitation competition was also organized. An exhibition on Hindi books was also organized in which the viewers appreciated the Hindi books available in the Library.



line sanraksha; durghatnayen avam unke prabhaav ka aaklan" in Hindi. A Hindi debate competition was also organized on 10<sup>th</sup> September on "Uttarakhand ki Aapda ke liye Aniyantrit Vikas Jimmedaar Hai". A Hindi Poster & Slogan Competition was organized on 11<sup>th</sup> Sept 2013. Another scientific lecture was delivered by Shri Yadvendra Pandey, Chief Scientist, CSIR-CBRI on "Chittaurgarh Qila ka Adhyayan" in Hindi. The lecture was based on studies carried out by Shri Pandey as an expert on

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

Hindi Week was organized successfully



## CSIR-CBRI Newsletter







## CSIR-CBRI Newsletter



with the special contribution of the Organizing Committee of which Dr. B. Singh, Chief Scientist and Shri R C

Saxena, Sr. Hindi Officer were the Chairman and convener, respectively.

### CSIR Foundation Day Celebrations

71<sup>st</sup> CSIR Foundation Day 2013 was celebrated at CSIR-Central Building Research Institute, Roorkee on September 26, 2013 with full zeal and enthusiasm. On this auspicious occasion Dr. S.J.Chopra, Chancellor, University of Petroleum & Energy Studies, Dehradun was the chief guest and Prof. S.K.Bhattacharyya, Director, CSIR-CBRI presided over the function. Many dignitaries, superannuated staff members of CBRI, students from local schools and colleges, faculty members, press and media were present on this occasion. The function started with lighting the lamp. Mr. R.K. Garg, chief scientist and chairman of the committee welcomed all the dignitaries and highlighted the achievements of CSIR under the able leadership of Prof. S.K. Brahmachari, DG CSIR and Prof. S.K. Bhattacharyya, Director of the institute.



Prof. S.K. Bhattacharyya, Director, CBRI addressed the gathering and touched upon the glorious journey of CSIR over past seventy one years which started with establishment of five laboratories and have risen to thirty seven labs of different specializations. He said that CSIR has given maximum

number of patents to the country and what is practiced today at CSIR is science for engineering and engineering for science. He also said that CSIR-AcSIR will help in the development of the country through knowledge generation and exploring new and innovative ideas through youth of the country. He touched upon the focus areas of R&D in the institute and network projects under the twelfth five year plan and hoped that CSIR-CBRI may be able to serve the society in a more effective manner as Team CSIR.

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



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







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

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



the CSIR Foundation Day Committee proposed a vote of thanks.

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

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

## CSIR-CBRI Newsletter



### Inauguration of 300T UTM Test Facility in SE Group



300T capacity UTM test facility has been inaugurated by Prof. Prem Krishna, Chairman RC, CSIR-CBRI, Roorkee on 30<sup>th</sup> September, 2013. The inauguration ceremony was attended by other RC members and staff of the institute.

With the Installation of digitally controlled 300 Ton (3000 kN) capacity UTM (Multi-testing facility) by M/S Instron, UK, now the SE group is equipped to carry out static, fatigue and dynamic testing, This is one of the largest capacity machine in Northern India.





# CSIR-CBRI Newsletter



## Colloquium

Mr. Soumitra Maiti	03.04.2013	Recycling of domestic waste water
Mr. Subham Dastidar	10.04.2013	Nano clay in building application
Mr. Soju Joseph Alexander	10.04.2013	Introduction of ERP application
Miss Shaifaly Sharma	17.04.2013	DEBRIS-Flow hazard analysis
Dr. Brijesh Dubey (University of Guelph, Canada)	29.04.2013	A waste management-oriented life cycle perspective of sustainable Building materials selections
Dr. S.K. Senapati	22.05.2013	Available e-resources in CSIR-CBRI
Mr. Mickey-Mecon Dalbehera	12.06.2013	High Strength light weight pre stressed concrete
Miss Parvathi G.S.	19.06.2013	Ground engineering using geo synthetics
Dr. B.K. Rao	07.08.2013	Aspects of Autonomous Business Unit
Dr. Rajni Lakhani	14.08.2013	R&D achievements on Organic Building Materials.
Mr. Randhir Choudhary	18.09.2013	An overview of vibration-based damage identification methodologies.
Dr. S.J. Chopra (University of Petroleum & Energy Studies)	26.09.2013	ENERGY: Yesterday, today and ???

## Staff News Awards



Dr. (Mrs.) Mridul Garg and Ms. Aakanksha Pundir received the 'Mahila Vishesh Puruskar' comprising of Rs. 2500/- along with Memento and Certificate for their paper entitled 'Phosphogypsum dwara paryavaran anukul abhinav bhavan saamgriyon ka nirmaan' in Hindi Vaigyanik Lekh Pratiyogita conducted by Kendriya Sachivalaya Hindi Parishad, New Delhi on 13<sup>th</sup> August 2013. The award was given by Sh. A.K Jain, Secretary, Rajbhasha Vibhag, Ministry of Home Affairs, Govt. of India.

## Superannuation

Sh. Baljeet Singh Counter Clerk ACP-II 31.07.2013

## Resignation

Sh. Subham Dastidar Scientist 04.09.2013

## Obituary

It is placed on record the sad and untimely demise of Shri Kripal Singh, Electrician on 19.07.2013.

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

Editor

**Dr Atul Kumar Agarwal**  
Senior Principal Scientist



For further details, please contact:



Director

**CSIR-Central Building Research Institute**  
Roorkee-247 667 (Uttarakhand) India

Phone: 01332-272243; Fax: 01332-272543, 272272

E-mail: [director@cbriimail.com](mailto:director@cbriimail.com);

Website: [www.cbri.res.in](http://www.cbri.res.in)