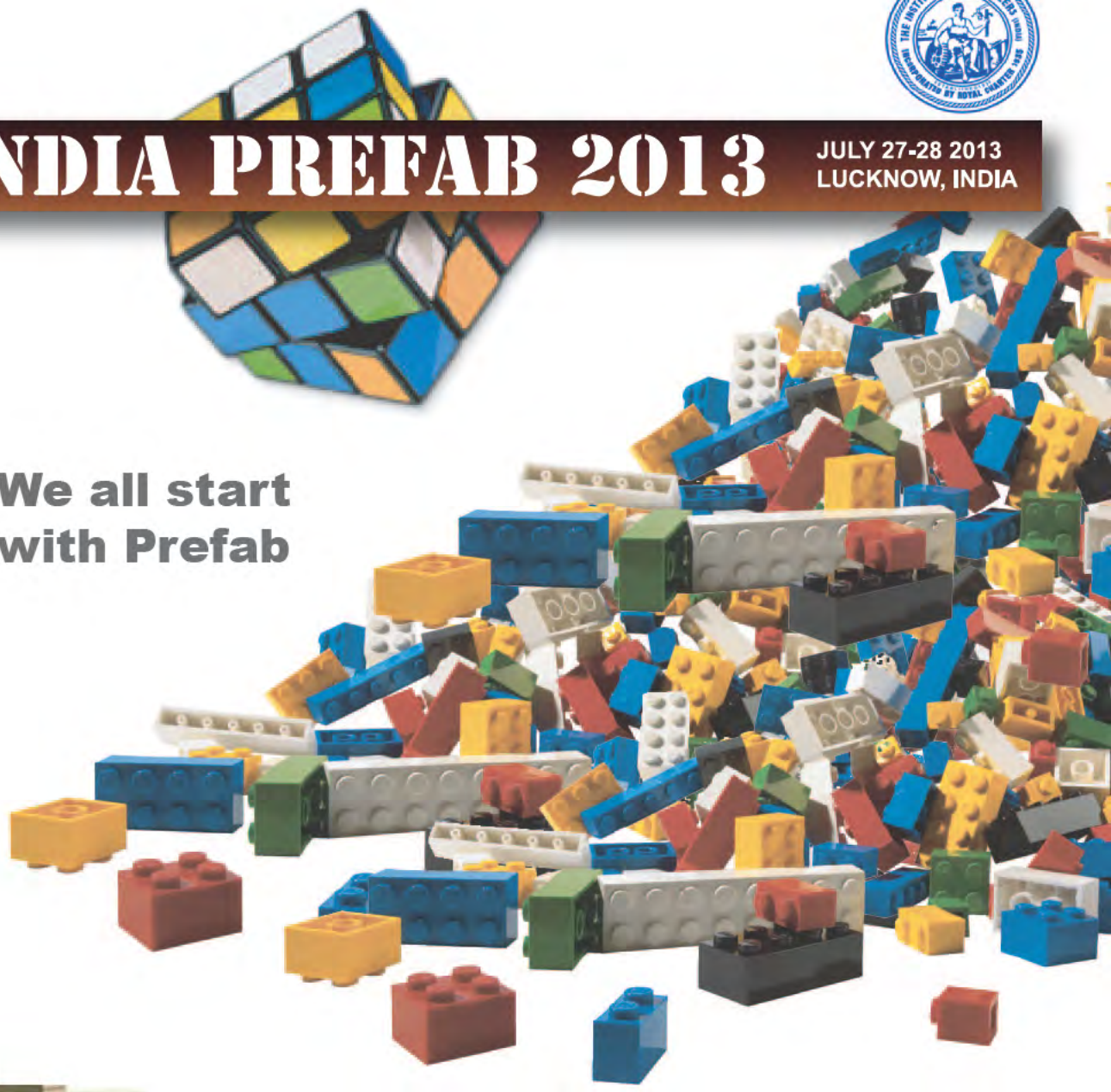
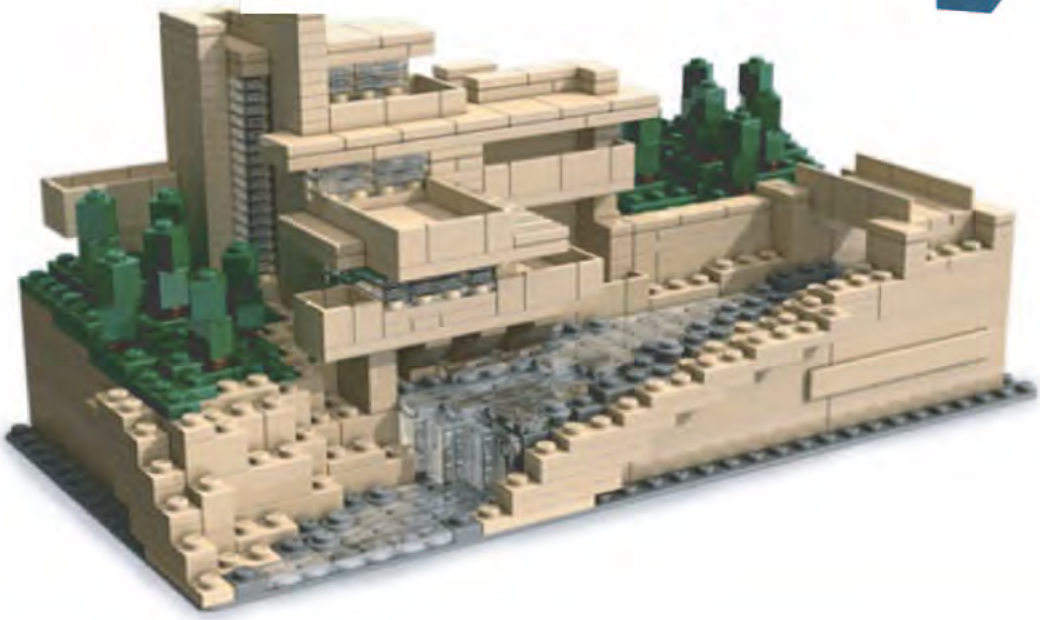
INDIA PREFAB 2013

JULY 27-28 2013
LUCKNOW, INDIA



We all start with Prefab



Then loose it somewhere along the way

Organized by:
The Institution of Engineers (India)
Uttar Pradesh State Centre
Under the aegis of:
Civil Engineering Division Board, IE(I)

SYNERGY PARTNERS
The Institution of Engineers (India)
Allahabad Local Centre

FERROCEMENT SOCIETY
PUNE

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Estd. - 1905

INDIA PREFAB 2013 JULY 27-28 2013 LUCKNOW, INDIA

PROCEEDINGS OF THE SEMINAR ON

PREFABRICATION TECHNOLOGY IN CIVIL ENGINEERING

Compiled by
Mr. Sumit Kumar Agarwal
Er. Ashok Kumar Jain

Organized by:
The Institution of Engineers (India)
Uttar Pradesh State Centre
Under the aegis of:
Civil Engineering Division Board, IE(I)

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"The time taken for construction of houses and buildings may be cut down to several weeks or a few months instead of years. This would be achieved through the use of prefabricated structures and various other factory manufactured parts".

A P J Abdul Kalam
India Vision 2020

B. L. Joshi
Governor, Uttar Pradesh

सत्यमेव जयते

Raj Bhawan
Lucknow - 227 132

Date : 23 July, 2013

Message

I am happy to know that the Institution of Engineers (India), U.P. State Centre is organizing an All India Seminar on "Prefabrication Technology in Civil Engineering" on 27th and 28th July, 2013 at Lucknow.

I extend my best wishes to the organizers and the entire participant and wish the seminar all success.

(B.L. Joshi)

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मो. आज़म ख़ाँ
मंत्री
संसदीय कार्य, मुस्लिम वक्फ,
नगर विकास, जल सम्पूर्ति,
नगरीय रोजगार एवं गरीबी उन्मूलन,
शहरी समग्र विकास,
अल्पसंख्यक कल्याण एवं हज, उ०प्र०

कक्ष सं. 101-102
मुख्य भवन (विधान भवन)
दूरभाष : 2238217 (का.)
: 2213273 (का.)
: 2235446 (आ.)
लखनऊ

दिनांक 26/7/13

MESSAGE

I am, indeed, very much pleased to learn that The Institute of Engineers (India) is organizing an All India Seminar on "Prefabrication Technology in Civil Engineering" on July 27-28, 2013.

I hope that the seminar will meet its objectives and through a powerful delegation of speakers and well known experts, attention will be drawn towards global materials technology and management principles of prefabrication. I also hopefully feel that efforts as such will open new avenues in material technology in India.

I wish all the success for coming events.

Mohammad Azam Khan
24.7.2013
(MOHAMMAD AZAM KHAN)

Shri V.B.Singh,
Chairman.
The Institutions of Engineers (India)
Uttar Pradesh State Centre,
Engineers Bhawan,
River Bank Colony
Lucknow (U.P.)

प्रो० अभिषेक मिश्र
राज्य मंत्री
विज्ञान एवं प्रौद्योगिकी
उ०प्र० शासन

16 नवीन भवन
उ०प्र० सचिवालय
लखनऊ
दूरभाष : 0522-2238980
CH : 2213591

संदेश

मुझे यह जानकर अत्यन्त हर्ष हो रहा है कि दि इन्स्टीट्यूशन आफ इंजीनियर्स (इण्डिया) की उत्तर प्रदेश राज्य शाखा द्वारा "Prefabrication Technology in Civil Engineering" विषय पर आल इण्डिया सेमिनार का लखनऊ में दिनॉक 27–28 जुलाई, 2013 को आयोजन किया जा रहा है। मुझे पूर्ण आशा है कि उक्त सेमिनार इन्जीनियर्स, आर्कीटेक्ट्स, निर्माण कार्यदायी संस्थाओं के विशेषज्ञ, एकेडेमिक, प्रोफेशनल एवं इण्डस्ट्रियल आर्गेनाईजेशन्स के लोगों के लिए अत्यन्त उपयोगी एवं ज्ञानवर्द्धक होगी।

कार्यक्रम की सफलता हेतु मेरी हार्दिक शुभकामनायें एवं बधाई स्वीकार करें।

25.07.2013
(प्रो० अभिषेक मिश्रा)
राज्य मंत्री
विज्ञान एवं प्रौद्योगिकी
उत्तर प्रदेश शासन।

श्री वी०बी० सिंह,
चेयरमैन,
दि इन्स्टीट्यूशन आफ इंजीनियर्स (इण्डिया)
उत्तर प्रदेश स्टेट सेन्टर,
इंजीनियर्स भवन, रिवर बैंक कालोनी,
लखनऊ–226018

The Institution of Engineers (India)

AN ISO 9001 : 2008 CERTIFIED ORGANIZATION
(ESTABLISHED 1920, INCORPORATED BY ROYAL CHARTER 1935)
HEADQUARTERS: 8 GOKHALE ROAD, KOLKATA 700 020, INDIA
Web Site: http://www.ieindia.org

"93 Years of Relentless Journey Towards Engineering Advancement for Nation Building"

S S Rathore, FIE
PRESIDENT

Message

It is heartening to learn that Uttar Pradesh State Centre of The Institution of Engineers (India) is organizing an All India Seminar on "Prefabrication Technology in Civil Engineering" under the aegis of Civil Engineering Division Board of IEI during 27 - 28 July 2013 at Lucknow.

I understand that the deliberations on the topic would cover all aspects of modern systems for construction and allied industries. I am confident that the Seminar will offer opportunity for mutual sharing of knowledge, expertise and experience amongst the participants. I trust, the recommendations, so arrived at out of the deliberations, would help participants in updating themselves on various ways of civil engineering.

I convey my hearty greetings to the organizers and wish the Seminar a great success.

(S S Rathore)

The Institution of Engineers (India)

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http://www.ieindia.org

"93 Years of Relentless Journey Towards Engineering Advancement for Nation Building"

Mr H C S Berry, FIE
Chairman
Civil Engineering Division Board

MESSAGE

It gives me immense pleasure to learn that The Institution of Engineers (India), U.P. State Centre is organizing All India Seminar on "Prefabrication Technology in Civil Engineering" on July 27-28,2013 at Lucknow under the aegis of Civil Engineering Division of IEI.

I hope that the deliberations on the subject will cover disaster mitigation & infrastructural speedy development apart from urban &rural housing needs etc. I am confident that the Seminar will provide a unique platform to the participants from various parts of the country and it will help the professionals in updating themselves on the issues and the latest approaches on Prefabrication technology.

I wish the Seminar a great success and convey my hearty greetings to the organizers.

H.C.S. Berry

The Institution of Engineers (India)
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Maj Gen R K Sanan, VSM (Retd)
Secretary & Director General

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Fax : (91) (33) 2223 8345
E-mail : sdg@ieindia.org

"93 Years of Relentless Journey Towards
Engineering Advancement for Nation-building"

MESSAGE

It is heartening to learn that Uttar Pradesh State Centre of The Institution of Engineers (India) is organising All India Seminar on "Prefabrication Technology in Civil Engineering" during 27 - 28 July 2013 at Lucknow under the aegis of Civil Engineering Division Board of our Institution.

I am sanguine the Seminar will provide a forum for effective interaction and diffusion of knowledge & experience amongst the fraternity of engineers. The recommendations so arrived at out of the deliberations at this Seminar will benefit the policy makers, implementing agencies and all concerned stake-holders on the subject.

I wish the Seminar a great success.

Maj Gen R K Sanan, VSM (Retd)

The Institution of Engineers (India)
(Established 1920, Incorporated by Royal Charter 1935)
UTTAR PRADESH STATE CENTRE, ENGINEERS BHAWAN, RIVER BANK COLONY, LUCKNOW-226 018
दि इन्स्टीट्यूशन ऑफ इंजीनियर्स (इण्डिया)
उत्तर प्रदेश स्टेट सेन्टर, इंजीनियर्स भवन, रिवर बैंक कालोनी, लखनऊ – 226 018
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: vbsingh51@gmail.com
Website :http://www.ieiup.org
Ref. No. : UPSC/IEI/
Dated :
"93 Years of Relentless Journey Towards Engineering Advancement for Nation Building"

From Chairman's Desk

On behalf of The Institution of Engineers (India), U.P. State Centre, I extend warm welcome to the esteemed guests, speakers & delegates who have converged here on the occasion of All India Seminar on Prefabrication Technology in Civil Engineering.

In view of the repeated onslaught of natural calamities such as earthquakers, cyclones, landslides, floods etc. faced by our country in past has brought need for urgent & speedy rehabilitation of the affected people which is possible only by adopting Prefabrication Technology. This assumes greater significance in view of recent flood fury in Uttrakhand in which sizable number of people lost their lives and thousands were rendered homeless. They can be provided shelter at earliest only with the help of Prefabrication Technology.

The Seminar provides interaction of engineers, academicians & policy makers with each other to understand various problems and latest development in the field of Prefabrication Technology. I am confident that this Seminar would provide an excellent opportunity for exchange of views on the subject matter and will culminate in updating the participants. I hope that the outcome and the recommendations of the Seminar will be of great use to all concerned.

I sincerely thank members of National Advisory Committee, Organising Committee, Synergy Partners, Sponsors & all those who have helped us in organising the Seminar. I especially thank Er. A K Jain, Convener who has relentlessly worked to make this Seminar successful.

(V. B. Singh) FIE
Chairman

PHD CHAMBER
PROGRESS HARMONY DEVELOPMENT
Estd. - 1905

Suman Jyoti Khaitan
President

Message

Prefabrication technology has rapidly gained a strong foothold in the Indian market due to its inherent advantage in several major areas compared to other building techniques; it is affordable, fast, adaptable and safe. Always known for its time saving advantages, the pre-cast industry is now being recognized for being a more resource-efficient and inherently greener process, having made significant advances in implementing processes, technology and materials to build and deliver more sophisticated and complex facility types.

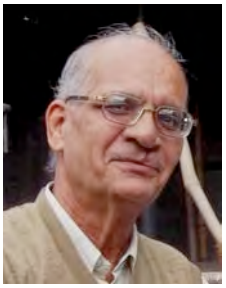
This seminar is a great opportunity for the Prefabrication industry currently concentrated on the "affordable homes" concept to become increasingly popular for commercial projects in the agriculture, rail, aviation & defense sectors also, which are in dire need of relevant, rapid and sustainable infrastructural solutions. The use of prefabricated structures is on the rise in most of these sectors, with more and more customers turning to modular for multi-story, steel framed structures, green houses, stations & platforms, warehouses, health care facilities, educational structures and large-scale military projects.

PHD Chamber of Commerce and Industry is a dynamic and vibrant organisation representing the business community of Northern and Central India. It aims to provide a platform to boost industrial growth and serve various segments of the economy and the policymakers alike.
Being associated with INDIA PREFAB-2013 as a Synergy partner, being organised by The Institution of Engineers (India), Lucknow from July 27-28, 2013 is one such endeavour, which will bring all the relevant stakeholders under one roof of deliberations and discussions, simultaneously aiming to accumulate, process and disseminate knowledge on Prefabrication with emphasis on current Urban, Rurban and Rural needs of our country.

PHD Chamber of Commerce and Industry is proud to be the Synergy Partner for this path breaking seminar-INDIA PREFAB-2013 with The Institution of Engineers (India), Lucknow. I am confident that the ideation that will take place will yield a plethora of innovative and thought-provoking solutions to existing problems, as well as showcase new out of the box technologies and new avenues that the industry could set forth upon, resulting in more convenience to the consumers and good business for entrepreneurs.

I commend all those who have worked tirelessly to put this All India Seminar on Prefabrication Technology in Civil Engineering conference together and I wish it the very best. I am certain it will be a grand success providing a boost to many related industries in India.

(Suman Jyoti Khaitan)



Message

Dr B N Divekar, President, Ferrocement Society, PUNE.

To provide shelter on large scale, in the shortest possible time, for all the classes in Society, is the ”NEED OF THE DAY” Houses for low income group in form of hutments, for the Middle-class in form of flats and for rich in form of row-houses or bungalows must be constructed with the minimum site work.

It is very much possible only by use of precast ferrocement walling and floor panels with their joints made to act as structural members.

Conventional method of RCC framework with filler walls built in them is very clumsy and time-taking. Sequence of operations depend on each other and is repeated for each floor. Majority of the work is done by unskilled workers and the quality of workmanship is not at all assured.

Solution to this problem lies in Industrialised housing. It should be possible to build a house just like a machine, which is built by assembling its spare parts bought from market .On the same lines it is possible to purchase the precast ribbed and stiffened ferrocement walling and floor plates from factory , erect and join them at site, with the joints acting as structural framework for the building.

Ribs provided for stiffening the panels are arranged in such a way, that when jointed, they act as formwork for the joints to be cast at site. Erection and concreting of the joints in form of columns and beams is the only work required to be done at site. Panels of small size of 3m x 1m or of full-size of wall and floor, can be precast and used.

Design, fabrication, precasting, erection, jointing of panels at site, precast ferrocement units as lost formwork, Precast ferrocement stiffened walling and floor panels is the best remedy to solve the problem of mass scale housing.

My greetings to all the delegates of INDIA Prefab-2013.

FOREWORD

Ashok Kumar Jain, Convener

The Institution of Engineers (India) U.P. State centre, Lucknow is organizing a seminar on Prefabrication Technology in Civil Engineering.

The increasing pace of Construction, both in public and private sector, and increasing paucity of coal and brick quality clays is shifting the focus away from conventional construction systems. More and more space is being taken by non conventional construction systems like timber, bamboos, composites, light gauge steel frames, ferrocement technology. As always happens, field initiates the changes followed by academics to support and authenticate the new systems.

The purpose of this seminar is to make this transition / relationship faster, smoother and scientific. The field engineers, industry and academicians are being brought to a common platform, probably for the first time, to start the interaction and allow a understanding of each other's problems and solutions and dovetail a system of confidence between the two sides of the coin.

The recent tragedy in Northern states has brought in a sense of urgency and essentiality. Hence, the importance and tome of this seminar has achieved significance beyond what it was planned with. The endeavour is to cover all new system of constructions, deliberate their pluses and minuses and arrive at an equation which not only serves the purpose but also suited and acceptable to all, specially the biggest critic, the NATURE.

While writing this foreword, a little sense of pride may not be misplaced, as the seminar has attracted delegates from at least seven states other than host state of UP and deliberations would be on all seven construction materials.

As the convener of the seminar, I have been immensely cooperated by and helped by a large number of persons. My heartfelt thanks go to the members of the National Advisory committee, Organising Committee, State Centre Committee and all those who helped and supported me in organizing this seminar. My special thanks are also inevitable to Dr L K Mishra, Ar S B Bhargave and Sri Apoorva Agha without whose help and support this seminar could not have seen the light of the day.

The seminar synergy partners PHD Chamber of Commerce & Industry, New Delhi Ferrocement Society, Pune and Institution of Engineers (I), Allahabad Local Centre find a place of honour in my foreword for having extended all the supports.

I also thank all advertisers, exhibitors and other well wishers who have directly or indirectly helped to arrange the seminar.

My mere thanks may not suffice for the tireless work put in by Sri SumitAgarwal of Tanjun Associates, LLP towards each and everything, from start to finish, from Delhi to Lucknow.

I also extend my thanks to the Media persons, both paper and electronic for covering the seminar.

Date: 24.07.2013 **Ashok Kumar Jain**
Lucknow Convener

An Overview of the Seminar

Er. Ashok Kumar Jain - B. Tech and M. Tech from IIT Kanpur & visiting faculty at MNNIT, Allahabad.

As the white Light of knowledge lamp comprises of lights of seven hues and colours, this seminar in UP has representation from seven states, namely Jammu & Kashmir, Haryana, Delhi, Uttarakhand, Bihar, Gujarat and Maharashtra. All seven mediums of construction will be deliberated in this seminar as shown below.

Fig. 1 Bamboo

Fig. 2 Timber

Fig. 3 Steel

Fig. 4 Composite

Fig. 5 Plastic

Fig. 6 Ferrocement

Fig. 7 Concrete

This seminar focuses on civil engineering construction, which is broadly classified as at site construction and prefabricated construction. The advantages and disadvantages of these constructions are listed below:

At site construction

Done at site
Permanently fixed there
Modular unit small (Brick, Blocks, concrete mix etc)
Site supervision High
Quality control Low
Material wastage high
No portability

Fig.8 Tree root bridge in Assam

Prefabricated construction

Entire structure broken in smaller parts
These parts prefabricated somewhere
Transported to site, and
Assembled
Site supervision Low
Quality control high
Material wastage low
Speedy construction
Portability

Further, advantages of prefab constructions are

Low weight
Smaller seismic impact
Minimal land slides
Structures can be designed to float
Minimal disintegration of structures
Reduced fire damages
Wind friendly designs
Long life of structure
Reduced loss of human life

These advantages make it attractive proposition and must be adopted for mass scale constructions.

For the sake of example, let us consider most natural construction material. Fig. 8 shows a tree root bridge in Assam which is an example of at site construction.

For prefabrication, bamboo is grown through a circular pipe casing to get prefabricated arch which can be used for building construction as shown in Fig. 10.

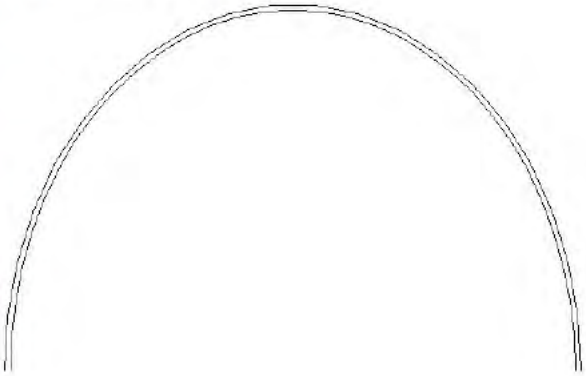


Fig. 9 Shaping the naturally growing Bamboo

Fig. 10 Bamboo Prefab Structure

One can go to the extent of producing even SQUARE Bamboos. These naturally grown bamboo shapes have no stresses. And, stress free life is all we all want in life. Hence, long maintenance free life.

Same CAN BE true of all prefabricated structures. With this concept, the present seminar is planned. We expect to receive innovative ideas for prefabrication which may be translated in field effectively in time, material, labour, energy, carbon footprint and cost.

Hoping to do away with disasters like recently felt.

Ashok Kumar Jain did his B. Tech and M. Tech from IIT Kanpur in 1969 and 1971 respectively. He is self employed since 1972 and has managed a Ferrocement Prefabrication Industry at Lucknow, U P. Presently he is a visiting faculty at MNNIT, Allahabad. His area of interest is prefabricated structures.

OBJECTIVE OF THE SEMINAR

The objective of the "All India Prefabrication Seminar" is to accumulate, process and disseminate knowledge on Prefabrication with emphasis on Urban, Rurban and Rural needs and develop future strategies in the sectors covering housing adequacy, farm & non-farm sector priorities, disaster mitigation and infrastructural speeding-up amongst the attending stakeholders consisting of eminent policy makers, bureaucracy, engineering fraternity, architects and implementing agencies.

The Seminar will also draw focus on global materials technology and management principles of prefabrication for developing countries through a powerful delegation of speakers who are well known experts in their fields.

The Seminar will include an extremely relevant exhibition of various prefab products as well as technology.

The Seminar is intended for all the professionals engaged in the field of Civil/Construction/Structural Engineering, Architectural and Project Management Consultancy. The proceedings of the Seminar will be equally useful to the material technologists, students, researchers and faculty in Civil Engineering, Architecture/built environment, the officials and policy makers associated with Planning Departments, PWDs, Housing Boards, Warehousing Organizations, Infra-designers and other departments of Govt. / Public Sector and Private construction agencies.

KEY PRESENTATIONS & DISCUSSIONS

- Fundamentals of Prefabrication
- Design Philosophy of Prefabricated Structures
- Dynamic structural behavior of Prefabricated Structures
- Materials for Prefabrication :- Ferrocement, Ferro-fibre Composites, LGSF
- Use of Marginal materials, agro- forestry based organic materials
- Modular Coordination & Space Planning for Prefabricated Structures
- Construction Technology for Prefabrication:- Assembly Line Production Transportation, Installation, Safety & Commissioning.
- Joints in Prefabrication
- Life Cycle Evaluation of Prefabricated Structures in terms of Economics, Durabilityand Sustainability
- Applications of Network Techniques for Managing the Construction of Prefabricated Structures.
- Technical Training and Skill Building for Technical Manpower.
- Prefabrication for Housing, Institutional Buildings such as school buildings, hospital buildings, post office / bank buildings, road side shelters for protection of commuters against rains & sun.
- Prefabrication for Water Supply & Sanitation , Grain storage, Warehousing, Cold-chain, Infrastructure, Irrigation, Power Sector & other utilities

The Institution of Engineers (India)

HISTORICAL BACKGROUND

Initially, Indian Society of Engineers was formed on 3rd January, 1919 with its temporary office at New Customs House, Bombay. The Rules were drafted and a constitution drawn up and published in a "Green Book" in March 1919. This Green Book was widely circulated and the movement was warmly supported by Govt. of India. A substantial guarantee fund was readily raised. The subscription was Rs. 15 for Members and Rs.12 for Associate Members per Quarter. Major W.H. Brady was appointed Secretary of the Organizing Committee on 23rd April 1919.

In Shimla Meeting on 16th July, 1919 a revised code for the body was presented for consideration. The Chairman of the drafting Committee was Shri T.RJ. Ward. The name of the Society was changed to 'The Institution of Engineers (India). The revised code was printed in a Brown Book in August 1919 and circulated again to representative Engineers. An executive Committee was thus formed with Major Wills as Chairman. The memorandum of Association, Articles and Bye laws were finally delivered on 3rd November, 1919 and the Registration of which was done in Madras. The Institution was thus registered under the Indian Companies Act of 1913 on 13th September, 1920. Necessary permission was later secured to move the Registered Office to Calcutta and office was opened in rented premises at D-5, Buildings, Clive Street on 11th November 1919.

Sir Thomas Wills who had taken over from Sir Thomas Holland as Chairman of the Organising Committee, became the first President of the Institution but retired from India before the expiry of his normal term of office. He was succeeded by Sir Rajendra Nath Mukherjee in November, 1920.

The Institution was formally inaugurated at an impressive ceremony in the Hall of the Asiatic Society of Bengal on 23rd February, 1921 and was followed by those of South India and North-West India in 1927.

The journal of the Institution has been flourishing since 1921, and a quarterly bulletin was started in June, 1923. The Registered office of the Institution was transferred to 26, Chowringhee Road, on 15t July, 1923 and thereafter to 8-Easpande Row East on 15t July, 1926.

In 1927, the Council announced the first list of accepted educational qualification for exemption from Section A and B of the Associate Membership examination of the Institution. The first examination was held in 1928 where 4 candidates were declared successful.

Lt. Col. RDT. Alexander was mainly instrumental for the Council's decision in 1929 to propose the erection of a suitable Headquarters building and as a consequence, followed the decision to establish permanently the headquarters of the Institution in Calcutta. The

Government of Bengal agreed to lease at a favorable rates suitable plot of land. A building fond was started for the collection of funds for the same.

Lord Erwin the then Viceroy laid the foundation of the Institution of Engineers (India) building on 19th December, 1930. The building after construction on the laid plot was opened by Viceroy Lord Willingdon on 28th December, 1931. The Office of the Institution was moved to 8, Gokhale Road, Calcutta on 15t January, 1932.

On 9th September, 1935, during the Presidentship of Rai Bahadur B.P. Verma, the Royal Charter was granted by His Majesty the King Emperor George V. The grant of Royal Charter in 1935 was an outstanding event in the history of the Indian professional bodies as it was the first Royal Charter given to a body, which had its origin and functions in India. Because of the Royal Charter, now held by the Institution, the Corporate members have right to inscribe "Chartered Engineer (India), after their names. It implies they are qualified engineers and members of the Institution, that owing to its qualities, had been deemed worthy to hold a Charter under the King's hand, it also implies that the Institution was recognized at the time of grant of Royal Charter as the representative body of engineers in India. The Institution was constituted as a body Corporate not withstanding the changes in the Indian constitutional structure after independence since the grant of Charter in 1935 and also the Charter was at the date of the commencement of the Constitution of India a law in force in the territory of India.

The Federation of Engineering Institutions of Asia and the Pacific has awarded 'FEIAP Engineer of the Year Award' for the year 2013 to Mr P Chaturvedi, Council Member of IEI. The Award was presented to Mr. Chaturvedi at the Inaugural Session of the Second Biennial FEIAP Convention 2013 and International Conference on the theme 'Engineering Initiatives for Sustainable Development : Integrating Innovation and Ethics' held during 08-11 May 2013 at Hyderabad (India) organized by the Andhra Pradesh State Centre of The Institution of Engineers (India). Mr. Chaturvedi also holds the posts of Vice Chair, WEEO Committee on Energy and Vice Chair (Asia), WFEO Committee on Engineering for Innovative Technologies.

PRESENT ACTIVITIES

The IE(I) promote and advance the art, science & practice of the myriad field of engineering and technology. Today it is multidisciplinary nationwide organization having an overall membership of over 5.5 lac the largest body of its kind in the whole Asia with international status and bilateral relations with many sister societies round the world. As on today the IE(I) has 103 state & local centers spread all over India.

The IE(I) is the pioneer body of introduce nonformal engineering education programme, successful completion of which is recognized as equivalent to a degree in engineering by Govt. of India, U.P.S.C., State Govts. And Public & Pvt. Sector organizations.

The IE(I) is engaged in dissemination and updating engineering & technological knowledge by organizing seminar, symposia, continuing education course, workshops conferences etc. at national & international level. The IE(I) publishes quarterly journals separately for various engineering disciplines containing R & D papers. It also highlights glimpses of emerging engineering and technological scenario & holistic view of entire profession in various fields & state of art review through TECHNORMA. The EI(I) also published monthly newsletter IE(I) NEWS focusing on new developments techniques, process and other issues of topical interest as well as calendar of technical activities. The IE(I) also extends library services at its all centres.

The IE(I) has Engineering Staff College of India at Hyderabad for continuing education, National Design & Research Forum at Bangalore to encourage design talents, Rural Management Forum at Calcutta to encourage multi-faced development of Rural India. Water Management Forum at Ahmedabad and Sustainable Development Forum at Patna to promote the water resources management and sustainability in totality.

U. P. State Centre

The U.P.State Centre which is the oldest Centre in India was established in 1921. First Annual General Meeting was held on November 10, 1921 at Kanpur which was inaugurated by Mr. A.W.E. Stend1ey, MLC as first Chairman. The State Centre was housed in a rented building in Kaiserbagh, Lucknow. In 1930 a library with a reading room well equipped with technical books was established for members. The present building of U.P State Centre at River Bank Colony, Lucknow was constructed in 1958 and was inaugurated by Shri Hafiz Mohd. Ibrahim, Minister for Irrigation & Power, V.P. Govt. on the occasion of 38th Annual convention of the Institution of Engineers (India). There are 8 Local Centres within U.P State Centre located at Agra, Allahabad, Anpara, Aligarh, Bareilly, Ghaziabad, Kanpur, and Varanasi. At present there are 6786 Corporate Members, 3959 Non Corporate members, and 49960 Senior Technician, Technician members within U.P. State Centre.

Grades of Membership

The Institution of Engineers (India) offers following grades of corporate membership.

(i) Associate Member of The Institution of Engineers (AMIE): Person must be graduate in any branch of engineering or Section 'B' holder of IE(I) with 5 years experience in a position of responsibility related to the engineering work or as an engineering teacher in accredited Engineering (Institution with a minimum age of 26 years.

(ii) Member of The Institution of Engineers (MIE): Minimum experience of 10 years as detailed above with a minimum age of 32 years.

(iii) Fellow of The Institution of Engineers (HE): Person must be an engineering graduate or Section 'B' holder with 15 years experience in the profession of engineering in a

position of high responsibility or should have retired from such a position with a minimum age of 40 years.

Fresh Engineering Graduates or Section 'B' holders with a minimum age of 21 years may be enrolled as Associates. But the Associates are not treated as corporate members.

How does the Institution serve the Engineering Community ?

The services rendered by The Institution of Engineers (India) to its Members are primarily thrnough a variety of technical activities and functions such as :

- Dissemination and updating of engineering and technological knowledge and diffusion among its members, the information on all matters affecting engineering, through Technical Activities, such as seminars, symposia, continuing education courses, workshops, paper meetings, conventions, conferences, etc at both national and international levels;
- Providing access to R & D activities and engineering practices through engineering and technological disciplines;
- Focusing on new developments, techniques, products, processes and other issues of topical interest;
- Highlighting emerging engineering and technological scenario through comprehensive coverage in the tabloid IEI News published monthly along with authoritative discourses and state-of-the-art reviews on specialized engineering issues in the Technorama published annually;
- Extending engineering information and library services at its Headquarters and at the State and Local Centres;
- Inculcating and promoting amongst engineers and technologists a growing commitment to the social objectives of the profession;
- Fostering national and international cooperation in engineering and technology;
- Acting as an accreditation body for courses in engineering;
- Acting as qualifying body and conducting examinations under its non-formal education programme, to cater to the needs and aspirations of prospective entrants to the profession.
- Recording appreciation of and extending recognition to individual achievements and activities in advancing the art and science of engineering and technology.

The Ever-expanding Horizon of the IEI

In order to create sharp focus in national priority areas, The Institution of Engineers (India) has established the following :

- Engineering Staff College of India (ESCI) for providing continuing education;* National Design and Research Forum (NDRF) to encourage design talents in engineering and technology;
- Rural Development Forum (RDF) to encourage and promote multifaceted development of rural India;
- Water management forum (WMF) to promote and advance the engineering and practice of water resources managements in its totality; and
- The sustainable Development Forum (SDF) for expression of authoritative views on technologies for sustainable development and for enunciating practical solutions to the problems faced by India.
- Safety and Quality Forum (SQF) to address the aspect of safety and quality in engineering profession.


MS CERT

Certificate Of Registration

QUALITY MANAGEMENT SYSTEM

This is to Certify that the Quality Management System of:

THE INSTITUTION OF ENGINEERS (INDIA)

Address: 8, Gokhale Road, Kolkata—700 020, West Bengal, India

ANZSIC CODE: 7960

Has been assessed and found to meet the requirements of:

ISO 9001:2008

Clause 7 permissible Exclusions: 7.5.2, 7.6

The certificate is valid for the following scope :

Provision of Services related to Corporate Governance, Examination & Accreditation, Membership Technical & Publications, Int PE/PE Certification, Administration, Finance, IT & Library.

Certificate Number: IN/QMS/00406

Issue no. : 01

Date of approval 04.12.2010 Valid until : 03.12.2013

Revision no: nil Revision date : nil

S. Dutta

Managing Director

JAS-ANZ

IAF

MS CERT

MS CERTIFICATION SERVICES PVT. LTD.

Address: 3/23 R.K.Chatterjee Road, Kolkata-700042, India

Web:www.mscertification.org

The Accreditation Body is Joint Accreditation System of Australia and New Zealand (JAS-ANZ), Canberra, Australia.

The validity of this certificate can be verified at www.jas-anz.org / register

The Certificate is Valid Only if the Annual Surveillance Mark is Signed by Auditor on Original.

Membership of The Institution of Engineers (India)

The Corporate Membership of The Institution of Engineers (India) is open to any person with an accredited engineering degree with prescribed professional experience. With accumulation of continued professional experience and level of responsibilities, the membership of the 'Associate Member' grade can be upgraded to the 'Member' grade and and then to the 'Fellow' grade, subject to strict scrutiny by a nominated high-level peer committee

Chartered Engineer

A Corporate Member with five years relevant professional experience can become a Chartered Engineer.

Professional Engineer

In the light of the authority vested by the Royal Charter for certifying the competency of engineers, the Council of The Institution of Engineers (India) may, at its discretion, approve that a person fulfilling the educational, technical and other experience criteria as prescribed by it, shall be entitled to describe himself as a Professional Engineer.

Privileges of Corporate Members

A Corporate Member of The Institution of Engineers (India) enjoys certain privileges, namely :

- Scope for enhancement of leadership qualities and improvement of skills by participating in continuing education programmes offered at the ESCI as well as at State and Local Centres of The Institution of Engineers (India);

- Opportunities to gain and update knowledge and experience and access to information in a variety of engineering and technology disciplines through participation in seminars, symposia, conventions, work-shops, etc at national, regional and local levels;
- Availability of The Institution of Engineers (India)'s Journals, technical monographs, papers, conference proceedings, etc;
- Entitled to receive 'IEI News' and 'Technorama', the colour supplements to the Journal, free of charge;
- Entitled to receive 'IEI News' and 'Technorama', the colour supplements to the Journal, free of charge;
- Access to the Engineering Information Service Centre at the Headquarters as well as at the State and Local Centres of The Institution of Engineers (India);
- Access to the know-how and ideas from fellow members and professional leaders about ongoing R & D work in various areas and to standards, specifications and codes for development and transfer of technology;
- Opportunities to contribute knowledge and experience as arbitrators in arbitrations relating to engineering jobs / services;
- Opportunities to get facilities and benefits while abroad through other professional bodies with whom institution has bilateral relations;
- Opportunities to participate in international conferences, and meet specialist engineers and technologists from the world over; and
- Facilities of retiring rooms at the Headquarters and at the Centers at concessional rates.

Engineering Divisions of The Institution of Engineers (India)

The various Engineering Divisions established by The Institution of Engineers (India) are as under :

* Aerospace Engineering Division
* Agricultural Engineering Division
* Architectural Engineering Division
* Chemical Engineering Division
* Civil Engineering Division
* Computer Engineering Division
* Electrical Engineering Division
* Electronics and Telecommunication Engineering Division
* Environmental Engineering Division
* Marine Engineering Division
* Mechanical Engineering Division
* Metallurgical and Materials Engineering Division

* Mining Engineering Division
* Production Engineering Division
* Textile Engineering Division

The IEI has its footprint across India and offices as under:

STATE CENTRES	WEBSITES
HEAD QUARTERS	www.ieindia.org
ANDAMAN & NICOBAR	
ANDHRA PRADESH	www.ieiapsc.org.in
ASSAM	www.ieiasc.org
BIHAR	
CHHATTISGARH	www.ieicgsc.org
DELHI	www.ieidsc.com
GOA	www.ieigsc.com
GUJARAT	www.ieigujarat.org
HARYANA	
HIMACHAL PRADESH	
JAMMU & KASHMIR	
JHARKHAND	www.ieijsc.netfirms.com
KARNATAKA	www.ieiksc.org
KERALA	www.ietvm.org
MADHYA PRADESH	www.mpsciel.org.in
MAHARASHTRA	www.ieimaharashtra.org
MANIPUR	
MEGHALAYA	www.ieimeghalaya.nic.in
ODISHA	www.ieiodisha.org
PUDUCHERRY	
PUNJAB & CHANDIGARH	
RAJASTHAN	www.ieirsc.org
TAMILNADU	www.ieitn.org
TRIPURA	www.tripura.nic.in/ieiagartala
UTTARAKHAND	www.ieiuksc.org
UTTAR PRADESH	
WEST BENGAL	

The Springer series journal published by IEI is a much sought after repository of information and networking data that is cherished worldwide. It can be read as an e-magazine for free by all corporate members of IEI.

Website: www.ieindia.org

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PHD CHAMBER OF COMMERCE & INDUSTRY, NEW DELHI

FERROCEMENT SOCIETY

FERROCEMENT SOCIETY, PUNE

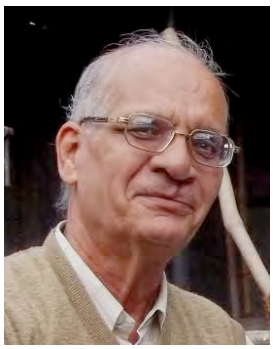
Ferrocement society started working in 2007. The idea of formation was discussed in a meeting at MERI, Nashik after a two day workshop organized by Er. Chandramohan Hangekar, then Joint Director, META, Nashik. Then after all the legal procedures this society came in existence with following objects.

a)	To promote Research, Development application and standardization in Ferrocement Technology.
b)	To arrange seminars, conferences, symposia, workshops and congresses.
c)	To demonstrate people, individuals regarding the advantages and/or benefits of Ferrocement.
d)	To impart training to artist, skilled/semi skilled workers and entrepreneurs about the Ferrocement Technology and arrange to issue licensing and certification.
e)	To interact with educational institutions and universities to promote Ferrocement technology for academic interests.
f)	To publish bulletins, technical papers, journals, books, etc., and to disseminate information through web site and other ways of media.
g)	To make representations, send deputations, arrange discussions with the manufacturers of Ferrocement with a view to promote, improve, maintain, and safe guard the interest of the members of the Society
h)	To encourage the growth of friendly relationship amongst the members and amongst the persons engaged in Ferrocement Technology and especially to encourage co-operation between members and the persons engaged in the said Technology.
i)	To provide information, guidance and consultation regarding activities relating to the Ferrocement Technology.
j)	To collect, maintain and circulate the information affecting the interest of the members.
k)	Generally to do all such other lawful acts, deeds or things as are incidental or conducive to attainment of any/or all of the above aims & objects of the Society.

At present Society has 96 life members, 3 corporate members and 46 student members. A list of all members is available on the website www.ferrocementindia.com.

Some informative bulletins called as “FERROCEMENT NEWS” are published by the society. They are not published after regular period. Very few members are sending photo and news about the ferrocement works for publishing.

Managing Committee (2013-15)



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Dr N.R.Patwardhan
Adviser

J.A. Desai
Adviser

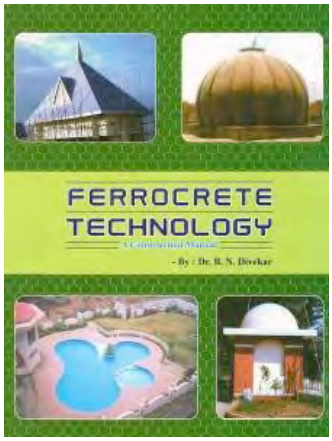
Our flagship publication is the Ferrocement News, which has found wide acceptance and applaud among engineers, students, builders and policy makers.

FIRST NATIONAL CONVENTION FS- 2011

The first National Conference on Ferrocement was organised in Pune, May 13-14, 2011 by the Ferrocement Society, Pune, India. The objective was to provide a forum to architects and civil engineers to present and discuss present and future applications, projects, research and developments of ferrocement technology.

SECOND NATIONAL CONVENTION FS-2013

2nd National Convention was organized on 13-14 July 2013 at Pune. Ferrocement is a material of millennium and an avenue towards Green Technology. This was the SECOND convention on this subject organized by Ferrocement Society that is providing a forum for architects, civil engineers and working professionals across India to present and discuss the projects, research and developments in a broad spectrum regarding applications of Ferrocement technology. Thus the theme for the second National Convention gets composed like-"GO GREEN WITH FERROCEMENT". MIT, Pune was the host and technical partner for this event. Other colleges and organizations also joined us as technical partners. For this we have a committee as below..



PUBLICATIONS CD, VIDEO AND BOOKS

During 1st National Convention in May 2011, a CD produced by Arch. Kiran Kalamdani was published and distributed to delegates.

Proceedings of the FS-2011 and FS-2013 are available for sale at Rs 1000 each.

Dr. B.N.DIvekar has written a Manual of Ferrocement Construction. The book has overwhelming response from all engineers.

Society has published a video CD "What is Ferrocement?" in Marathi and English.

Some videos like DEMO of ferrocement, Pressfill method, Press-Spray method and V.D. Joshi's life are prepared and kept on website and you tube.

NEW RESEARCH GUIDANCE

Ferrocement Society has given inspirations to the research students and PG students for selecting ferrocement as subject. Prof. Archana Tanawade, SSPMS College , Pune, Prof. Gaidhankar, MIT, Pune, Er. Vijay Nalawade, Pune are working on ferrocement research. Amongst ME students are Saurabh Gursale, Er. Ladi, Bhalsing Swayambhu, Sayyad Shoeb, who have taken ferrocement research topic. Some BE students, Abhishek Anand, Vivek Goyal, are working for dissertations. There are so many students in Jerusalem College of Engineering, Chennai where students have research projects under the guidance of Dr. P.B. Sakthivel. Some students in Annamalai University are working

under he guidance of Dr. Antonnie Jeyasehar, and some students are working in Pondicherry College of Engineering under the guidance of Dr. A.Jagannathan.

FERROCEMENT DAY

Our Special Advisor and the Guru of Ferrocement Vishnu D. Joshi passed away on 4 September 2011 at Pune. Here it was decided to celebrate this day as Ferrocement Day all over India on 4 Sept. every year, memorizing Late V.D.Joshi. A prize in the name of V.D. Joshi will be given to a person for the innovative application of ferrocement in India during the year.

R & D CENTER

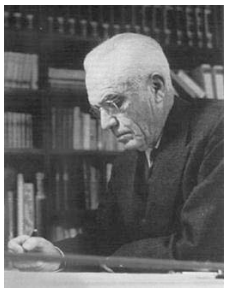
Society is trying to open an R&D Center at Bhugaon, near Pune. Precast applications, innovative products, testing of products, demos for visitors, standard housing plans and modules are planned for this center. Mr. Makarand Patankar, Mumbai is helping in this project.

Pune Office:
Construction Diagnostic Center, Kanchan Bhavan, 5, Shilavihar Colony, Karve road, Kothrud Phata, PUNE 411 038 (MAH) INDIA Phone: 020-25432643, 64009006, 9225606148 E-mail : ferrocement@gmail.com web : www.ferrocementindia.com

P L Nervi - A tribute

Ar. Atul Gupta, Past President, Uttar Pradesh Architects Association

As no function in our Indian traditions start without lighting of lamps, no seminar or discussion on prefab can start or rather should start without paying tribute to the Legend - Pier Luigi Nervi.



Pier Luigi Nervi born on June 21, 1891 was an Italian engineer. He studied at the University of Bologna and qualified in 1913. Dr. Nervi taught as a professor of engineering at Rome University from 1946-61. He is widely known as a structural engineer and an architect, and for his innovative use of reinforced concrete and specially the Prefabricated Concrete.

As a professor at the University of Rome Nervi taught that a designer can develop truthful solutions in three ways:

1. By understanding the pure harmony of the laws of the physical world that regulate the equilibrium of forces and the resistance of materials.
2. By honestly interpreting the essential factors of each problem and
3. By rejecting the limitations of the solutions of the past.

Nervi is internationally renowned for his technical ingenuity and dramatic sense of design, especially as applied to large-span structures built of reinforced concrete. His important works include a prefabricated 309-foot-span arch for the Turin Exhibition (1949–50) and the first skyscraper in Italy, the Pirelli Building (1955) in Milan, a collaborative design.

Pier Luigi Nervi stressed that a close collaboration between Architect, structural engineer, and contractor from start to finish of a project was the key to success.

Nervi said that if these three do not collaborate closely many fine projects will remain only pieces of paper.

Nervi demonstrated the technical innovation of prefabrication had been crucial in winning contracts for contracts among building firms. The main economic advantage of prefab, Nervi explained, is the elimination of the wood formwork to the reinforced concrete. Further construction with prefabricated element is much faster, very exact and of high quality workmanship, Nervi noted.

Another important reason of his adopting prefab was the mass production.

In 1935 the Italian air force held a competition for a series of hangars to be built throughout Italy. Nervi conceived them as concrete vaults, with huge spans, that could be constructed at low cost, and he was commissioned for the project. Between 1935 and 1941 he built hangars in Obertello, Orvieto, and Torre del Lago.

The reasons for him getting the project were Lesser Time and Low cost. When Germans destroyed the hangars during the world war - II, the strength of the prefab interlocking elements was demonstrated by the fact that the rubble had not a single a steel-rod joints that had been broken.

Finally, Nervi argued that by doing a project with traditional formwork had a lot or restrictions and whereas prefabrication permits richness of form, delicate refinement and the possibility of creating rhythms by the repetition of equal elements.

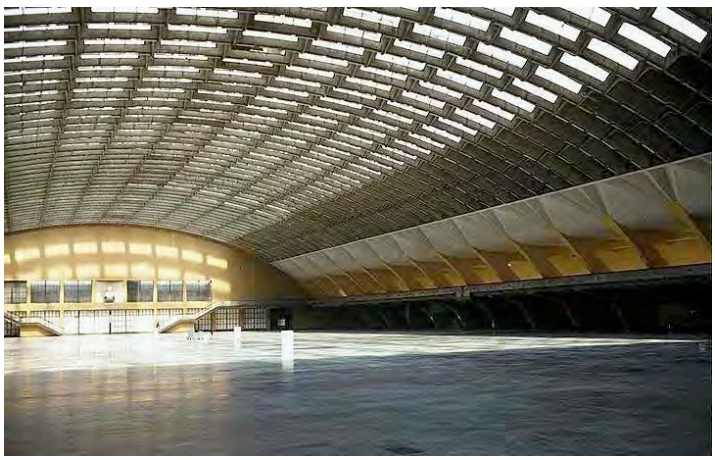
Working on Reinforced Concrete of which he was a true master Narvi invented **Ferrocemento,** a material composed of dense concrete, heavily reinforced with evenly distributed steel mesh that gives it both lightness and strength.

This material was vital in Nervi's design for a complex he built for the Turin Exhibition in 1949–50—a prefabricated structure in the form of a corrugated cylindrical arch, spanning 309 feet (93 m), based on modular components of glass and Ferrocemento. Without the structural properties of this material, the entire conception would have been infeasible.

Nervi the Sensitive Genius designed some of the timeless masterpieces. In 1957 and 1958–59, for the 1960 Rome Olympic Games, Nervi designed two sport palaces.

His first building in the United States was commissioned by the Port of New York Authority: the George Washington Bridge Bus Terminal, in Manhattan, built in 1961–62. Subsequently he designed a precast, vaulted field house for Dartmouth College in New Hampshire (1961–62). He later received the Gold Medal from the American Institute of Architects in recognition of his work.

His buildings achieved remarkable expressive force, as in the geometry of the slabs in the Gatti wool factory (1953), in Rome, and the mezzanine of the Palace of Labour, in Turin. Through his use of interpenetrating planes, of folded and bent plates, and of warping surfaces, Nervi introduced a new three-dimensional vocabulary into architectural design. He reminded architects "materials, statics, the technology of construction, economic efficiency and functional needs are the vocabulary of the architectural speech."



Here I would like to discuss one of the most beautiful buildings of Nervi - Exhibition Building, Turin Commentary.

The hall is rectangular and covers an area of 240 feet x 309 feet. On one of the two shorter sides is a semi-circular apse. Windows are arranged in the corrugation of the prefabricated roof elements.

A semi-circular apse 132 feet in

diameter adjoins the main hall which is 240 feet long. Its roof consists of corrugated pre-cast units. The half-dome roof of the apse is also constructed with prefabricated elements.

The vaulted construction of the hall consists of prefabricated elements, which spring from in situ concrete abutments.

The units are of "ferro-cement" and have a length of approximately 15 feet and a width of 8 feet 3 inches. The thickness of the curved precast parts is less than 2 inches. This small thickness is achieved only by the increased rigidity through the corrugation and the transverse webs at either end. The individual units are joined by in situ concrete.

In his own words Nervi said:

"...two of my most interesting projects, the hangars built of pre-cast elements and the roof for the Turin Exhibition Halls, would have been impossible without a simultaneous invention of the structural method. They would have looked completely different if they had been built on the same principle but in a conventional technique."

In his writings, Nervi constantly reminded readers that 90 percent of his contracts were awarded in competitions where the governing factors were economy and speed of construction. He thrived on these limitations and, indeed, "never found this relentless search for economy an obstacle to achieving the expressiveness of form" desired.

Architecture, for Nervi, was "a synthesis of technology and art." To find the logical solution to a limiting set of factors within a highly competitive situation was, for him, "to build correctly." His mastery of concrete bespoke a love for its adaptability. "Concrete is a living creature which can adapt itself to any form, any need, any stress," he once said.

Pier Luigi Nervi after setting the benchmarks in DESIGN & CREATIVITY left for the heavenly adobe on January 9, 1979. His works and his words will will always be a source of Inspiration to the fraternity of professionals of the building industry.

My tribute to the Great Master.

Atul Gupta, a graduate of Govt. College of Architecture, lucknow, past President, Uttar Pradesh Architects Association. Practicing Architect, winner of many Design Competitions.

Prefabrication in water supply and sanitation

Er K K Srivastava, Superintending Engineer, U P Jal Nigam, Lucknow

U P Jal Nigam has been entrusted with the following

- Design and construction of potable Water supply systems
- Design and construction of Sanitation systems

As regards civil construction, Potable water supply systems comprises of the following:

Construction of potable water storage Tanks both above ground and under ground, construction of Water treatment plants, Pump Houses, Boundary Walls. Installation of Hand-pump platforms drains and soak pits, small Tank type stand posts (TTSP), drains and soak pits.

As regards civil construction, Sanitation systems comprises of the following

Laying of sewer lines, construction of manholes with covers, construction of sewage treatment plants as well as Individual and community toilets.

Four major problems are being encountered in civil construction during last five years

- Rising cost of basic masonry units
- Rising cost of Transportation
- Paucity of skilled labour
- Lack of super vision (More work, less staff, apathy of staff to go to remote sites)

Proper infra structure can be developed at major works like water and sewage treatment plants and large capacity over head Tanks.

But for small structures like small tanks, pump houses, boundary walls, hand pump platforms, toilets etc. it is not feasible and hence the supervision is also wanting.

Prefabrication of these small structures is the only solution to meet the rising demands of these products at the speed they are required. Central yard manufacturing would not only give a uniform quality product under a strict supervision but also reduce the transportation costs as only final product would be transported.

Realizing this, there is an urgent need, on the part of the engineers and architects, to adopt the prefabrication technology in a big way.

Some of the case studies and designs of prefabricated products are given hereunder as a stating point.

Hand pump Platforms

U P jal Nigam has adopted the prefab technology for this product about 20 years ago and has met an acceptable level.

Stand Posts and Platforms: U P jal Nigam has adopted the prefab technology for this product about 15 years ago and has met an acceptable level. It was successfully employed in recent Kumbha Mela.

Drains

So far only small drains are being in U P Jal Nigam. There is ample scope for large prefab drains in half circular, U section and channel section.

Soak Pits

A limited use has been made of prefab soak pits. But the need to eradicate mosquito breeding grounds etc. has attracted the attention for provision of soak pits at almost every stand post and platform. A suitable design is given herunder. Many more designs are possible.

Manhole covers and frames : RCC and Ferrocement Manhole covers and frames are being increasing adopted by U P Jal Nigam, mainly due to increasing cost of steel. An IS code is also available for RCC manhole covers.

Gully Gratings

RCC and ferrocement gully grating is another product which can be beneficially used by U P Jal Nigam for the same reasons.

Dust Bins

Prefab ferrocement / concrete dust bins can also be used with obvious advantages.

Pump Houses

U P Jal Nigam experimented with Prefabricated Ferrocement pump house at Madhoganj, Hardoi in the year 1996 in consultation with IIT/Kanpur. The Pump House serving the public till date. RDSO, Lucknow has adopted the Ferrocement Prefab pump house as a standard and they have four such pump houses.

Boundary Walls

A prefabricated ferrocement boundary wall is a very neat and speedy system of construction. The major advantage is that these can be relocated at a minimal cost.

Toilets

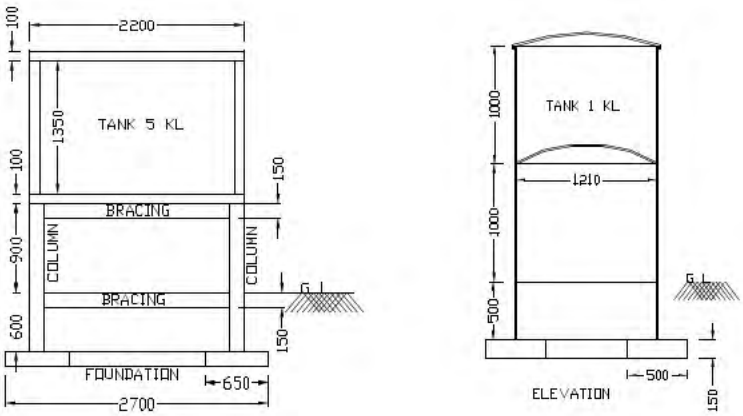
Prefabricated ferrocement components can be assembled at site making the sub structure and super structure of the toilet units, for individual and community use both.

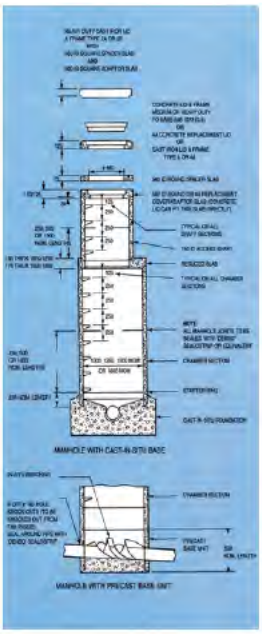
Apart from above prefabricated elements already in use, we suggest use of following products in U P Jal Nigam.

Tank Type stand Posts

There are many districts where tank type stand posts are being provided. The capacity of these tanks varies from 5 to 10 KL and the staging from 1 to 3m.

Plastic tanks of appropriate capacity on a steel staging are being normally provided. There are two points of caution for this system. First, being very light, these tanks are liable to overturn under heavy winds in empty condition and secondly they are not fit for potable water. Prefabricated ferrocement or concrete tanks would be an ideal choice. A tentative design is given here.





Manholes

It is often seen that laying of sewer lines is easier than construction the manholes, specially at busy roads and intersections. Use of prefabricated man holes will be of immense help. A lot of work has to be in this direction, but we feel that right time has come to start.

Er K K Srivastava, Superintending Engineer, U P Jal Nigam, Lucknow carries over thirty seven plus years of experience in design of Government funded projects from Water Supply & sanitation Projects to design & construction of Stadium, Hospitals, Central Schools, Vilkas Bhawans etc.

He has an in-depth knowledge of various facets of Civil Engineering, Architecture & Interior Design.

An Out-of-the-Box thinker with a flair for charting out strategies and completing Challenging Projects successfully in time like Successful Completion Of Kumbh Mela Prayag twice while being officer –In-charge of Water Supply As well as Sanitation. He is an B.E. from M.I.T. Manipal i.e. from Karnataka University with Excellent grades & distinctions and an M.I.E.

Prefabricated Warehouses

Er. Ashok Kumar Jain and Prof. K K Shukla, MNNIT, Allahabad

1. Introduction

The requirement of warehouses is ever increasing with the continued overall development of the national economy. In India, agriculture sector has a major share in Gross Domestic Production (GDP). It is approximately 25% where as manufacturing sector accounts for 27% of GDP. There is a need to store food grains, industrial goods and materials required for services. According to an estimate there is a requirement of 150 million MT storage capacities, considering that food grains are stored for 3 to 4 months, industrial goods for 2 to 3 months and services for 1 to 2 months. The Planning Commission, Government of India (GOI) has estimated that the country needs 35 million MT more warehousing space in next five years. Also, there is a need to improve the quality of warehousing existing at present [1].

Presently, mostly asbestos cement sheets are being used as the sheeting material over the mild steel trusses. Figure 1 depicts the existing system of construction of warehouses of Central Warehousing Corporation (A GOI undertaking), New Delhi, which is the apex body in the country for warehousing. In India, there is a recent trend towards using pre engineered buildings in steel which is extensively used in developed countries. As the use of asbestos cement sheets is to be discouraged on health related grounds and steel is a dear material, there is a need to explore alternatives which are economical as well as easy to use. Ferrocement is one of the answers to this pertinent problem.

Ferrocement is a type of thin walled reinforced concrete. It is commonly constructed as hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials [2]. Compared to reinforced concrete, ferrocement is a thinner material and has distributed reinforcement throughout its thickness. It is reinforced in both the directions. The cement mortar acts as the matrix which is made of fine mortar or paste comprising of fine aggregates only.

Apart from various advantages of ferrocement over conventional reinforced cement concrete in relation to mechanical properties [2], it is advantageous due to thin sections, less mechanization, ease in repair and maintenance resulting in low cost. Ferrocement has found numerous applications in marine and terrestrial applications and also in rehabilitation of structures. A lot of work has been done in the past by various researchers in the design and construction aspects of ferrocement and is being carried out even now. Ferrocement structures have been used extensively for storage of bagged grains etc. in tropical countries like Kenya, which have weather conditions almost identical to India [3].

With the increase in CO_2 emission due to various construction activities, there is an urgent need to go for green construction, minimizing the carbon footprints with concrete construction. Total energy requirements of warehouses can be minimized by reducing the embodied energy of the materials used for construction thus reducing the CO_2 emissions.

Ferrocement construction can be answer to this problem. Gumaste [4] has conducted a detailed study and concluded that roofs made of ferrocement channel type units leads to about 50% saving in energy as compared to RCC roofs and is one of the energy efficient choices.

2. Objective of the Proposed Work

Construction of warehouses is a country wide requirement and each one is a large structure in itself. Time required and control of quality for in-situ construction is often not at desired levels. Therefore, prefabricated technology is preferred for such structures. In the present work, use of prefabricated ferrocement technology is proposed in the construction of warehouses. An attempt is made to design standard ferrocement panels to be used in construction of warehouses.

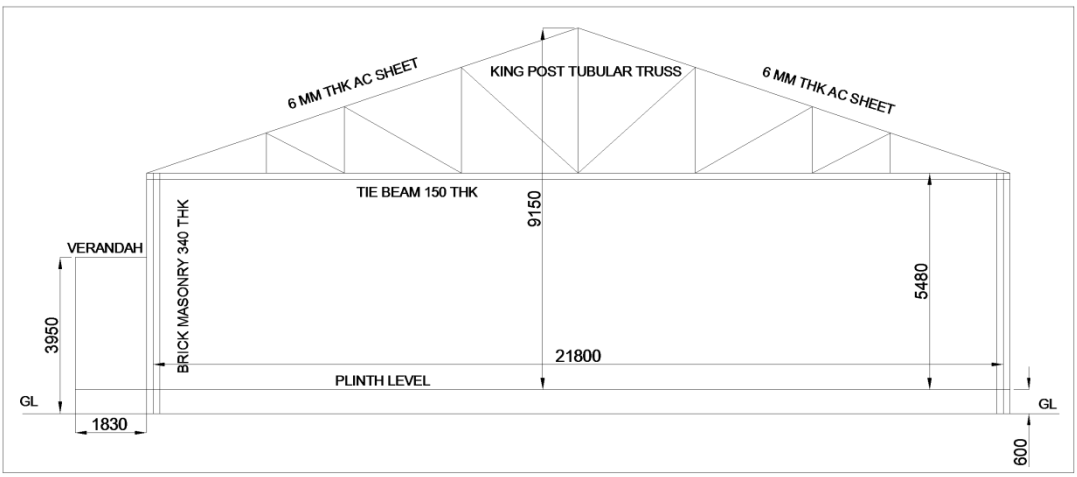


Figure 1. Conventional CWC warehouse design method of construction

3. Outlines of the Present Work

A warehouse of segmental elliptical shape comprising of folded plates made up of ferrocement is proposed. A model in fibre glass and prototype in ferrocement are made and tested in the laboratory and in the field. The deflection pattern of the proposed structure and its individual units are observed. The results are validated by ANSYS.

3.1 Design of Ferrocement Warehouses

RCC folded plates have been in use for last 70 years all over the globe. Ferrocement folded plates are in use since 1970. Folded plates or hipped plates are similar to shells in structural action. They consume a little more material than continuously curved shells but the extra cost on this account is many times offset by the savings affected in shuttering formworks. A folded plate structure is defined as a system of thin plates spanning longitudinally and monolithically joined to each other along longitudinal joints at some angle other than 180 degrees.

Various arch shapes to meet out the space requirements of the existing system are shown in Fig.2. Arches are generally used to cover large spans. Parabolic arches are considered the most appropriate because of smaller bending moments leading to economical sections. But, with large spans, the rise of the parabolic arch also becomes large and about 18.5% covered area near the edges is not usable. Hence, the overall cost of covering the usable area becomes uneconomical. Moreover, a higher cost has to be incurred for making an unyielding foundation support, an essential requirement for reducing the bending moment in the arch. An elliptical arch has been selected for warehousing structures because it is possible to exercise a better control on the rise / span ratio, the usable area is only about 3.4% less than the gross covered area and moreover, the horizontal reaction exerted on the foundation is grossly reduced. Although the bending moment in the arch is little more than that in the parabolic arch, which is easily taken care of by the higher moment of inertia of the folded plate section.

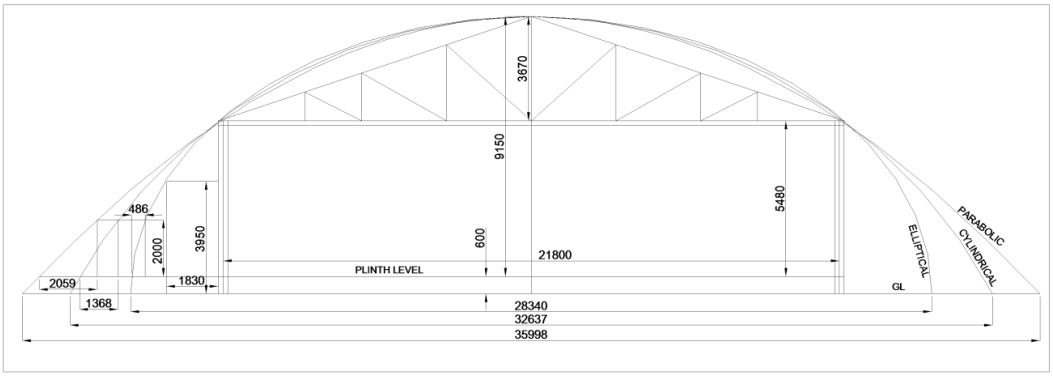


Figure 2. Comparative shapes for parabolic, circular and elliptical arches

The proposed segmental elliptical arches envisage using uniform cross sectional folded plates in standard lengths. Only deviation from the standard folded plates are the lateral joints, which are also prefabricated in mild steel / fiber glass. Therefore, the site work is grossly reduced to mere assembly of standard ferrocement folded plates and the lateral joints using galvanized mild steel nut-bolts. The transportation, handling and erection of prefabricated ferrocement folded plates and the joints is also easy because of their straight symmetrical shape, manageable length and low weight.

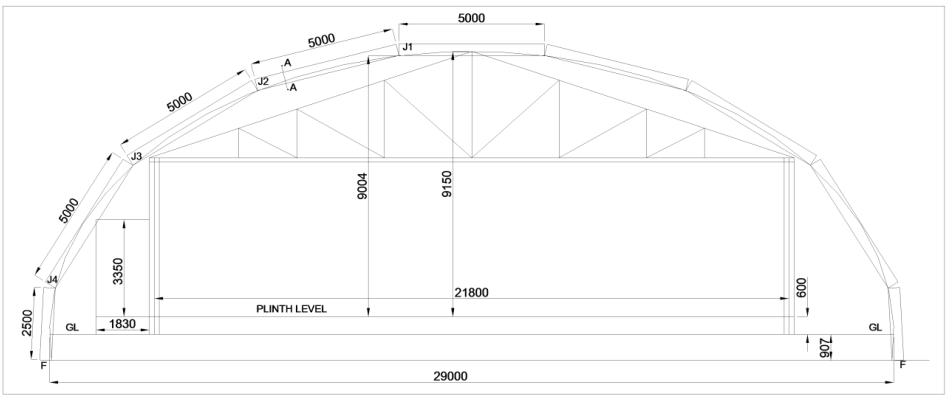


Figure 3. Proposed design of segmental elliptical ferrocement pre fabricated folded plate warehouse

Fig. 3 shows the proposed warehouses made of prefabricated ferrocement panels. Prefabricated segmental elliptical arch constructs the warehouses. The cross-section of the polygonal arch is ferrocement folded plate. The folded plate comprises of two identical channel units (Fig.4), for the ease of prefabrication in a central manufacturing unit, transportation to site, handling and erection at site etc. The weight of individual prefabricated ferrocement channel unit is only about 260 Kg. The four junctions, shown in Figure 5, J1 to J4, are individually shaped and designed to maintain the geometry and strength equilibrium at the joints. These joints are prefabricated in mild steel / fiber glass.

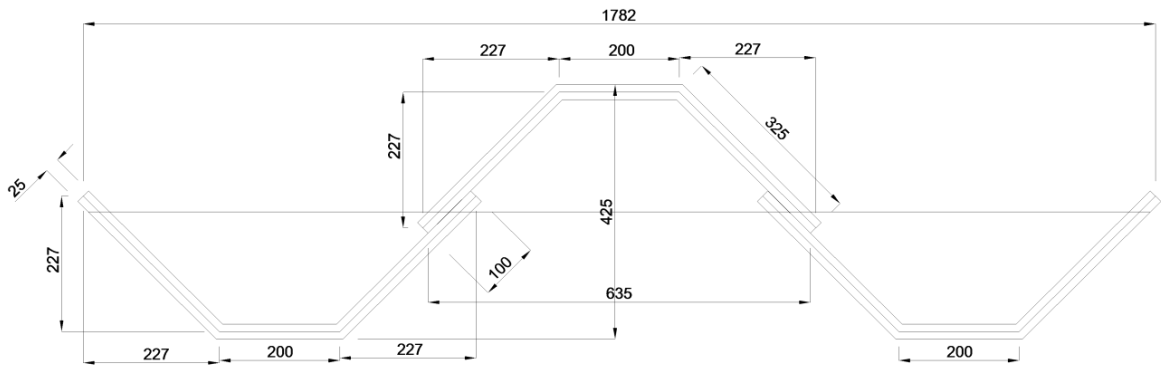


Figure 4. Ferrocement prefabricated folded plates

The overall weight of the individual channel unit has been limited to about 260 Kg and the length to 5 m. The thickness is kept as 25 mm uniformly. The repetitive folded plates comprise of two channel units as shown in Fig 4 with an effective width of 1165 mm. The live load on the folded plate is taken as 750 N/m^2 working downward. With a width of 1.165 m, the live load per folded plate becomes 880 N/m. The self load of a folded plate will be 5200 N because it consists of 2 channel units, meaning thereby that self load is 1040 N/m. Thus total loading is 1920 N/m. The folded plates are to be designed for this design load, which is appreciably low due to reduced self-weight.

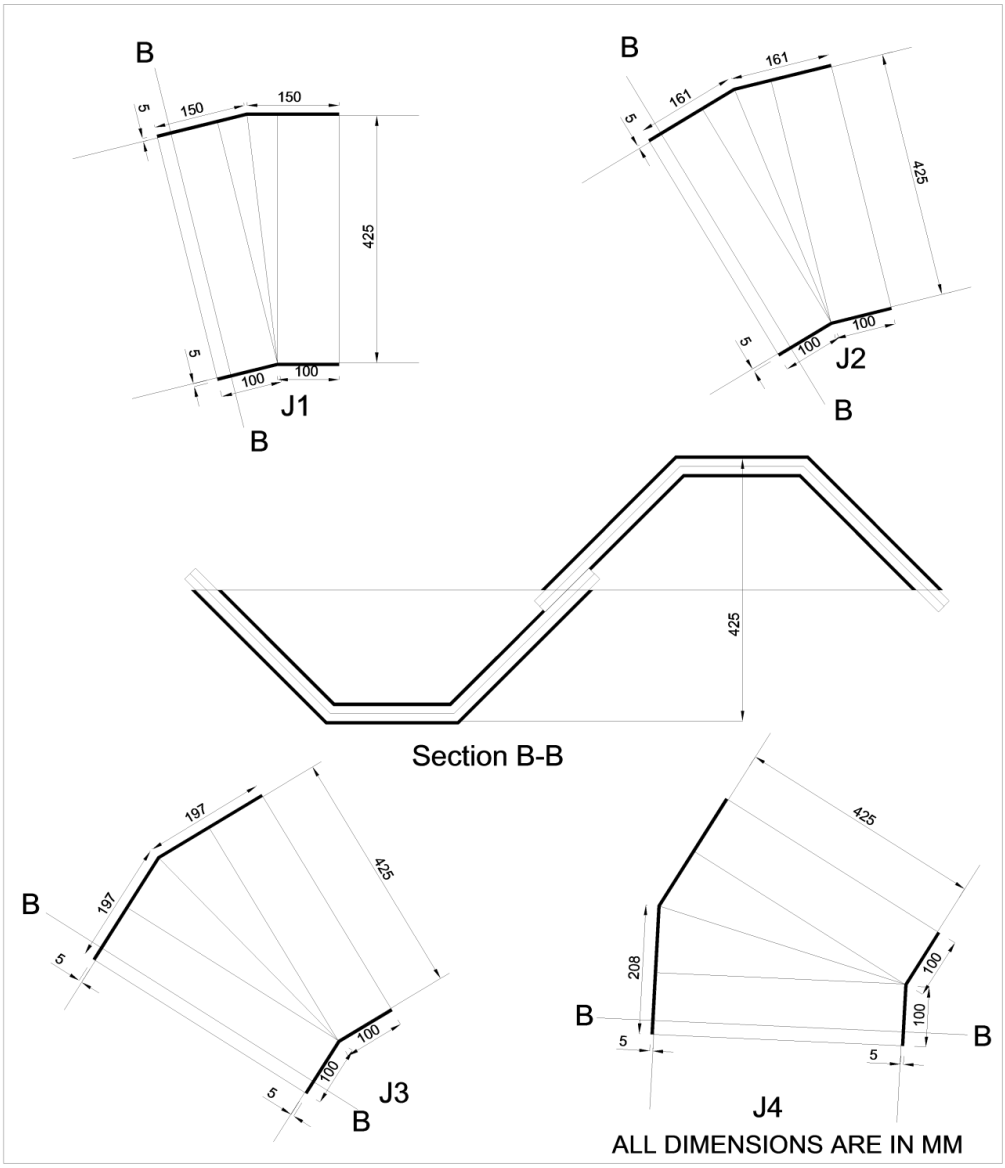


Figure 5. Details of Joints

4. Development and validation of ANSYS Model

ANSYS is one available finite element tool that can be employed to rigorously analyze the segmental arched folded plates. An ANSYS model was developed and verified with a couple of existing solutions for folded plate structures.

5. Experimental validation

The proposed design has been experimentally validated using a one tenth fiber glass model of the segmental elliptical arch using prefabricated fiber glass channels assembled into folded plates and in situ fiber glass joints. The load deflection behaviour of the arch has been compared with the results obtained by finite element analysis using ANSYS.

Fibre glass channel sections were prefabricated. These channels were assembled into folded plates using nut bolts as per Figure 6. The folded plates were assembled into an elliptical arch with in-situ fibre glass joints (Figure 7). Two 150 mm wide M S channel sections were used as foundation support to the elliptical arch. A 10 mm bar was used to connect the two foundation MS channel blocks. Aluminum angle pieces were pasted on the arch as shown, in Figure 7, for placing the dial gauges. Hangars were provided at a few locations for application of point loads. Figure 8 shows the close up of in- situ fibre glass joints and nut bolts.

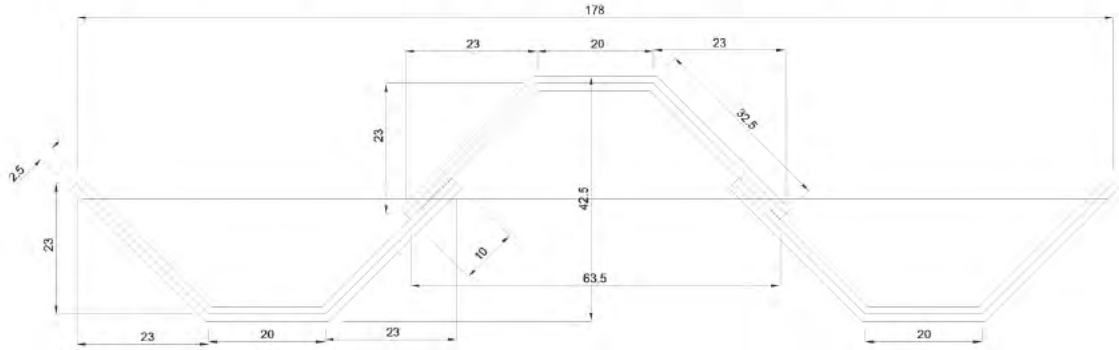


Figure 6. Three fiber Glass channel units assembled in folded plate

Figure 7. Photograph showing the load test set up of polygonal elliptical arch with prefabricated fibre glass folded plates

Figure 8. Photograph showing the close up of fibre glass joints and nut bolts

The basic idea behind this experiment is to verify the suitability of the fibre glass joints in maintaining the geometry and strength equilibrium at the junctions. An apex point load is applied on the arch and the deflections are measured at five points as shown in Figure 9. The loading was gradually increased till the deflection reached about 1.5% of the rise of the arch, the point up to which the arches are considered safe. Figure 10 depicts the deflection pattern of the arch. The load deflection behaviour is linear at all five points.

The load deflection behaviour also demonstrates the fact that the polygonal elliptical arch with standard length straight folded plates and joints behaves like a continuous arch. This behaviour is manifested in full safe deflection range (1.5% of the rise) of the arch. These deflections are compared with those obtained with ANSYS analysis, shown in blue colour.

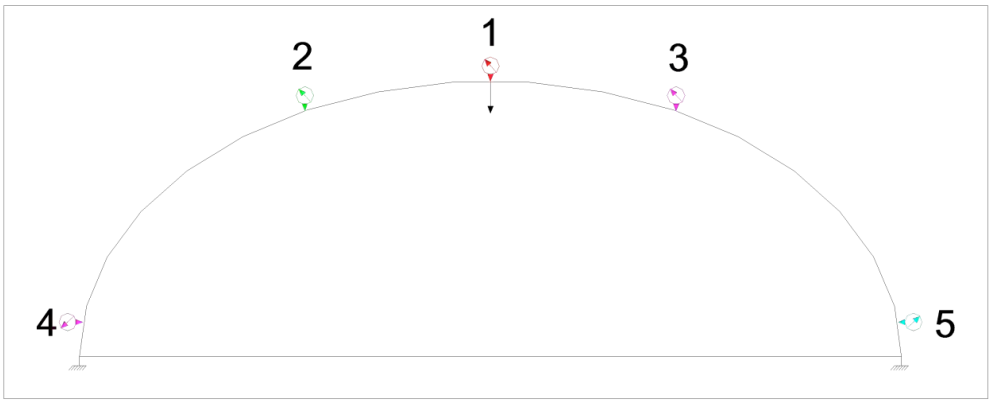


Figure 9(a): Showing the locations of measurement of deflections on fibre glass model

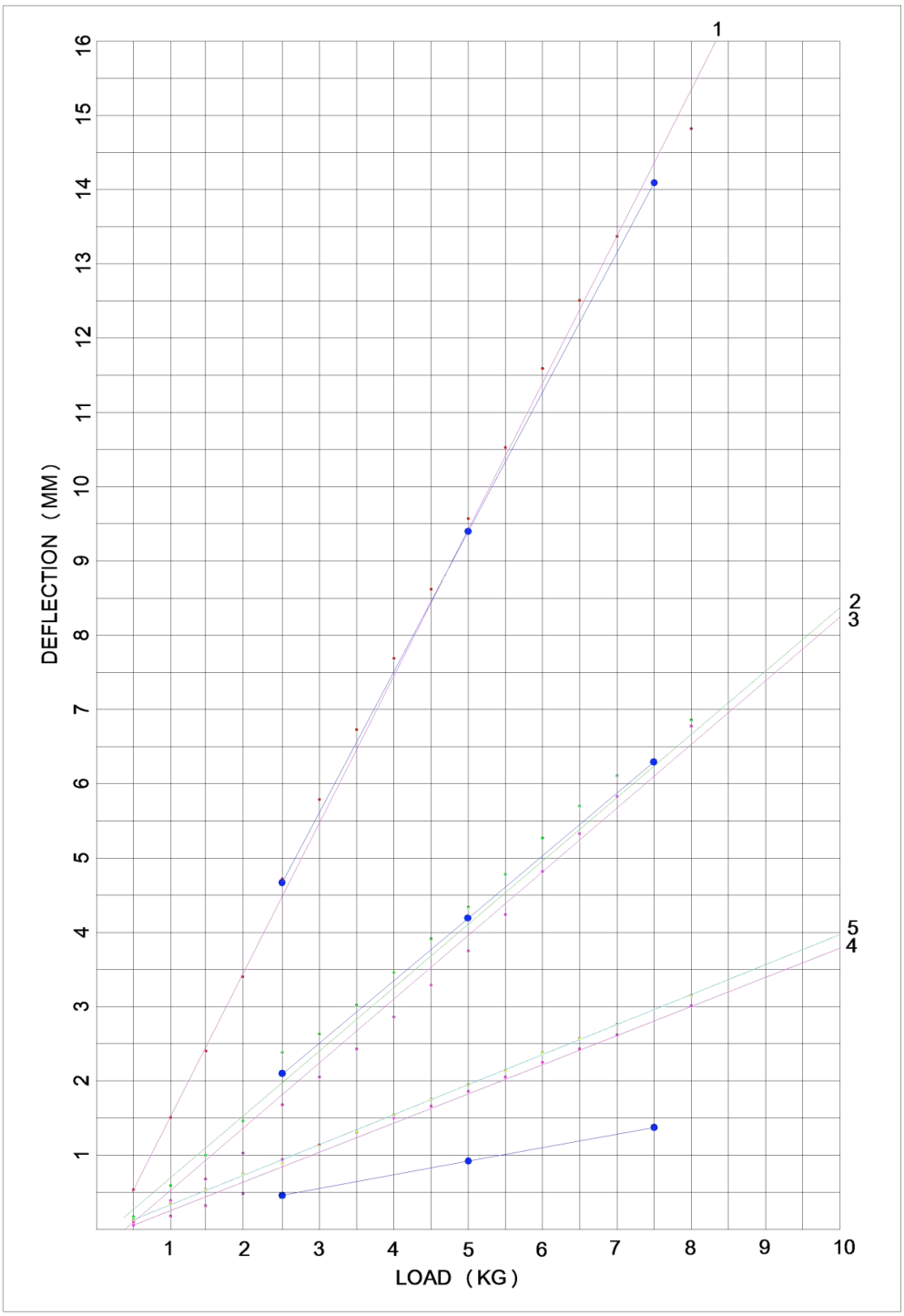


Figure 10: Load deflection graphs for segmental semi-elliptical fibre glass folded plates with apex load

The comparison of deflection at the apex midpoint and two neighbouring points are very good as shown in graph plotted in Fig 10. The results of ANSYS are plotted on the same graph in blue colour. However, the comparison of two lower points near supports is not

good. This is probably due to the fixity in the physical model not being 100%, as assumed for ANSYS analysis.

5.1 Experiments with ferrocement folded plates

An experimental study was undertaken to ascertain the monolithic behaviour of the folded plate section obtained by joining the two channel sections. The joints were by way of 10 mm diameter bolts at 150 mm c/c in the middle of the overlap of 100 mm width. The folded plates were made 5.50 m in length, simply supported at 5 m span. The 38 mm Mild steel pipes were used as supports. Figure 11 depicts the longitudinal view of the folded plates with loading arrangement using paver blocks.

Figure 11. Longitudinal view of the experimental set up

The jointing of the channel units is shown in Figure 12. The load deflection values for the locations shown in Figure 13 for the folded plates are given in Figure 14 along with their comparative values obtained by ANSYS, shown by larger points.

Figure12. Close up of side view showing the jointing of channel units

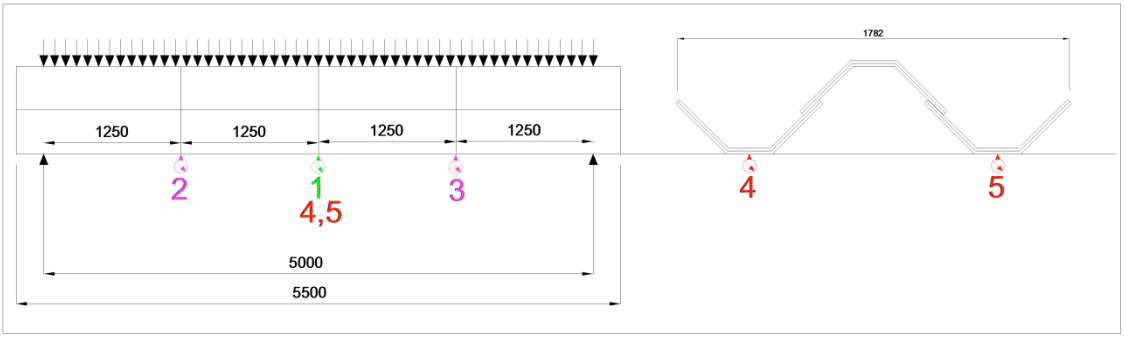


Figure 5.13: Showing the locations of measurement of deflections of folded plates

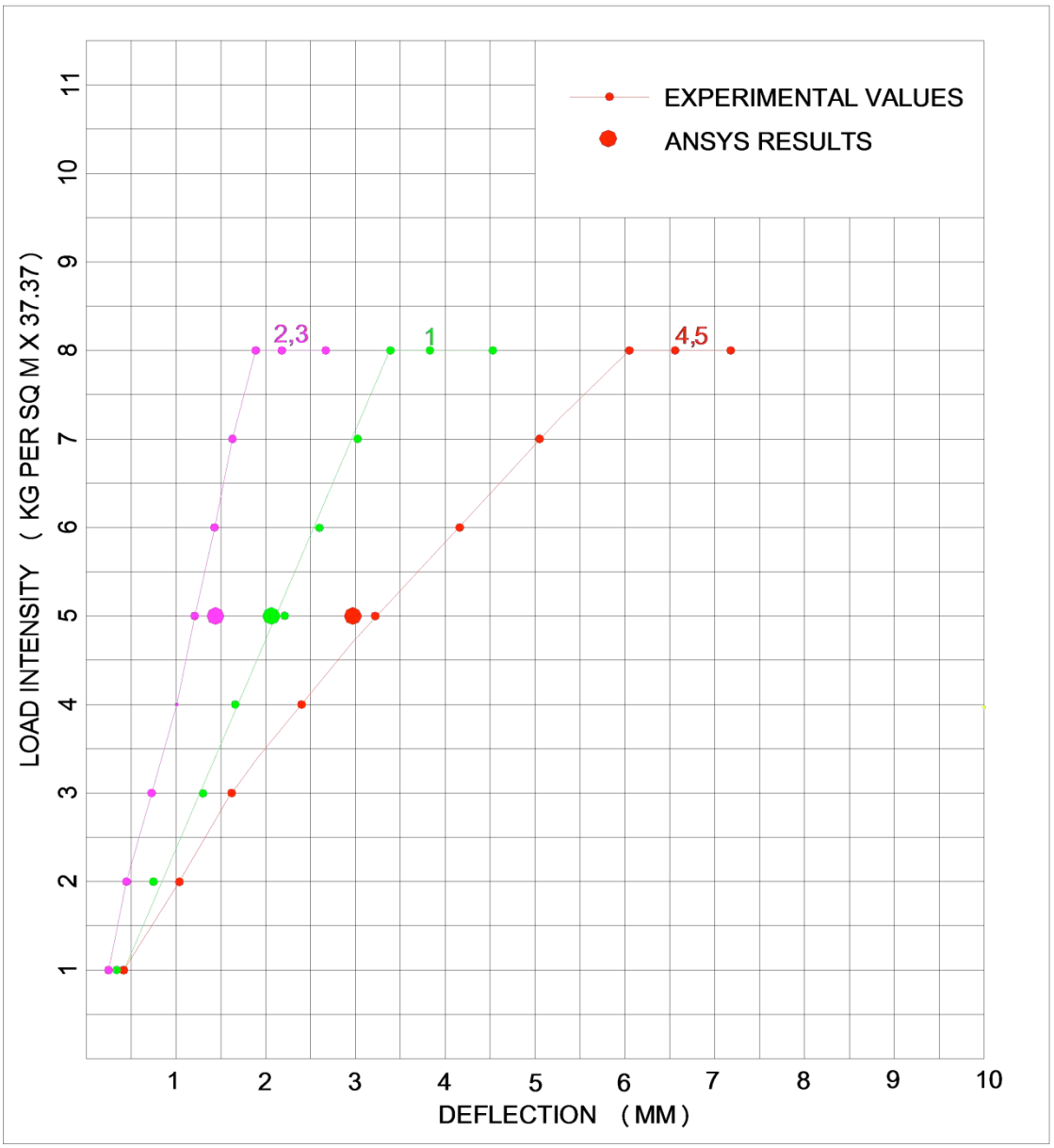


Figure 5.14: Experimental load deflection curve for ferrocement folded plates

6. Embodied Energy & Economy

Embodied energy of the material used in the proposed warehouse is computed and it is compared with the conventional warehouse. It is observed that embodied energy is 47.9% lower in the proposed construction. Similarly, carbon foot print is lower by 53.4%, the overall weight by 41.6% and overall cost by 14%.

Conclusions

Prefabricated ferrocement folded plates consisting of light weight units are proposed to be used in warehouses. Elliptical shape is proposed that will reduce the burden on foundation. Proposed warehouses will be advantageous in terms of consumption of materials, overall cost, supervision and labour at site, time of construction, space utilization and energy consumption.

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SKILL DEVELOPMENT FOR PREFABRICATED CONSTRUCTION

Sumit Kumar Agarwal, Principal Associate, Tanjun Associate LLP, New Delhi

Notwithstanding the current economic slowdown where several developed economies are going through a recession, India as a country is still experiencing sustained growth of 6-7% in its GDP. This growth has created the demand for labour, especially skilled labour. However, in spite of the largest working age (between 15 and 59 years) population in the World, most sectors are struggling to achieve their growth targets because of shortage of skilled labour. On the other hand, our Education system churns out students every year that are not immediately employable and skill up gradation on the job is low; implying that a large section of the currently employed labour possess outdated skills.

As per industry analysis, nearly 75 to 80 million jobs will be created in India over the next five years. The services sector accounts for 53% of GDP, industry sector accounts for 29% and agriculture sector accounts for 18% of the GDP. The share of the services sector is continuously increasing and it is estimated that more than 70% of India's incremental GDP and 60% of new jobs generated over the next five years are expected within the service- sector. Of the five growth sectors analyzed, almost 75 to 90% of all the additional employment will require some vocational training.

It has been envisaged that by 2015, approximately 2.25 million skilled workers are required in the Auto Sector, about 4.5-5 million in the Banking and Finance Service Sector, about 4.5 million in Retail and about **13-15 million in the Construction Sector**. If we do not meet this demand- supply asymmetry by providing good quality skills, it can lead to a slowdown in the country's economic growth and come in the way of our becoming a developed Country. It is broadly estimated that we will need 500 million skilled people in our Country by the year 2022.

Challenges faced by trainees, trainers and employers

Qualitative Aspects

It is reported that the skill shortage has its roots in the education system. High drop-out rates at school level and poor enrolment levels in higher education lead to a sparsely educated work-force. This problem gets further compounded because of the poor infrastructure which colleges and universities provide. More than 60% of colleges and 90% of universities in India are of poor standard[1], resulting in poor quality of students, making them less employable. The curriculum is outdated and there is very little interaction between industry and academics, resulting in widening of the skill gap. Barring notable exceptions, the faculty is of poor quality and is generally absent. The curriculum is primarily bookish and not "hands-on". The content is noticeably outdated.

[1] *Source: Techno Pak Report, "Linking Education to Employability*

Systemic Exclusion of the Unorganized work-force from education and vocational training

In India, 92% of the work-force gets its livelihood from the unorganized sector. The formal sector of the economy employs only 8% of the total workforce. With the exception of some vocational training in poverty alleviation programs, the government and other training agencies "play an insignificant role in the development of the informal sector skills" and are in many instances not very effective for poverty alleviation and employment generation. Training for workers in the unorganized sector so far has mainly been imparted by NGOs and member based organizations (e.g. trade unions or cooperatives) or through traditional forms of skills transfer through master craft men, on-the-job training and training within the family or community outside the formal training system.

Quantitative Aspects

Current Demand-Supply Gap

The current landscape of vocational training in India comprises of 5, 500 Industrial Training Institutes and 1,745 Polytechnics compared to 5,00,000 similar institutes in China. The USA boasts of 1,500 trade training programs compared to India's 171[2]. The current vocational training infrastructure caters to the skill development of 3.1 million persons per year. The 11th Five Year Plan envisions an increase in that capacity to 15 million annually. India has a target of creating 500 million skilled workers by 2022.

It is estimated that only 5% of the youth in India are single skill vocationally trained, as compared to 96% in Korea or even 22% in countries like Botswana. Among persons of age 15-29 years, (as per NSSO data) only 2 per cent are reported to have received formal vocational training and another 8 per cent reported to have received non-formal vocational training. All these statistics clearly reflect the demand supply gap and the need for increasing the capacity and capability of skill development programs.

According to the 2007-08 Economic Survey, 64.8% of India's population would be in the working age of 15-64 years in 2026 up from 62.9% in 2006. Other projections also indicate emergence of young India with 800 million in the productive age group by 2015 compared to 600 million in China.

According to a study conducted by Confederation of Indian Industry and Boston Consulting Group (CII & BCG) India has a large population base of 1.14 billion with demographic shift in favor of working age group (15-59 years) while the overall population is projected to grow at 1.4% over the next five years the working age is expected to grow at 2.15%. If the present trend continues, 109 million persons will attain working age during the period of 2007-2012. The net addition to workforce is, therefore, expected to grow to 89 million of which around 13 million are likely to be graduates/post

[2] *Source: Techno Pak Report, "Linking Education to Employability*

graduates and about 57 million are likely to be school drop outs or illiterates[3]. Taking into account the huge numbers of school drop-outs/illiterates in the future work-force, it is imperative that the current design of vocational training in the country should be altered to accommodate the training needs of this segment and make them competitive as per the global training standards.

Issues in the Unorganized Sector

By international standards, especially of the East and South East Asia, India's 40-42% labour participation rate is not high. However the absolute number of workers is a staggering 457 million in 2004-05.[4] Of this more than 92% are the unorganized[5] and informal workers comprising those who work in the unorganized sector as well as those in the organized sector, but without any job or social security.

If we see the educational profile of the workers in the unorganized sector, they are found to have an average of 5.6 years of schooling as compared to a minimum of 9.0 years of schooling of the organized sector workers[6]. Clearly most of these unorganized workers fall in the bracket of school drop-outs with less than secondary education and are hence unable to utilize the skill training being imparted by the vocational education institutes of the country. Considering their enormous participation in the work-force of the country; it is imperative to focus on the skill needs of this segment to envisage a significant increase in the skilled manpower of the country.

A Profile of the mean years of schooling of workers in the organized and unorganized sector shows clearly that the workers in the unorganized sector are at a disadvantage when it comes to education, especially the casual wage workers with a mean schooling of just 3.5 years (see Table 2) and needs to be paid special attention to be brought into the fold of skill development.

Mean Years of Schooling of Non-Agricultural workers by Employment Status (2004-05)

Employment Status	Rural	Urban	Total
Unorganized Sector :Casual	3.3	3.9	3.5
Unorganized Sector: Regular workers (RW)	6.8	6.7	6.7
Unorganized Sector: (Self	4.7	7.2	5.9

[3]*Source: National Skill Development Policy, March 2009*

[4] *Report on Conditions of work and Promotion of Livelihoods in the Unorganized Sector, National Commission For Enterprises In The Unorganized Sector, Government of India, 2008*

[5] *Informal or the unorganized sector is broadly characterized as consisting of units engaged in the production of goods and services with the primary objectives of generating employment and incomes to the persons concern.*

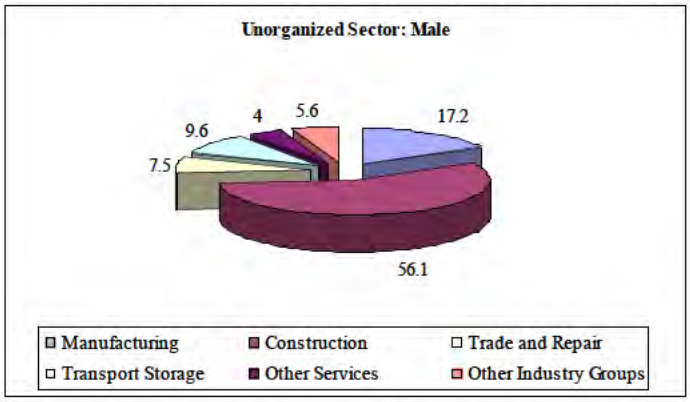
[6]*Report on Conditions of work and Promotion of Livelihoods in the Unorganized Sector, National Commission For Enterprises In The Unorganized Sector, Government of India, 2008*

Employed)			
Unorganized Sector (Total)	4.6	6.6	5.6
Organized Sector (OS) (Total)	7.2	10.1	9.0
All Workers	5.2	7.7	6.5

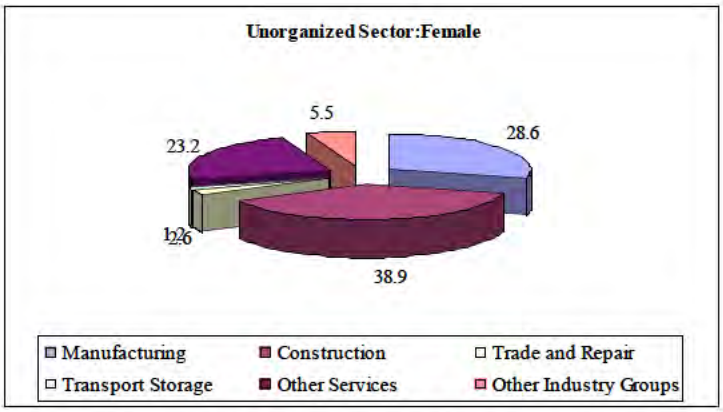
Source: *ibid, Report on Conditions of work and Promotion of Livelihoods in the Unorganized Sector, National Commission for Enterprises In The Unorganized Sector, Government of India, 2008*

Outside agriculture, manufacturing and construction industry are one of the largest employers of the unorganized workers. Among the unorganized workers, casual workers tend to be the least protected and have the lowest level of earnings and they constitute about one –fifth of the total work force. **In 2004-05, about 53% of the casual workers were in the construction sector**, followed by 19% in the manufacturing sector. Within the manufacturing sector, textile industry was the largest employer of casual workers, both men and women as can be seen from the graphs given below:

Percentage Distribution of Unorganized Causal Workers across Industry Groups, 2004-05



Source: NSS 61st Round 2004-05, Employment-Unemployment Survey



Source: NSS 61st Round 2004-05, Employment-Unemployment Survey

Since the largest part of this vulnerable section is employed in the construction sector, it is important to look at the need for well-trained construction workers.

Need analysis for skill training as a whole and prefab in particular

Issues in the Rural Sector

Due to small land holdings, poor productivity, lack of value addition and imperfect market linkages agriculture has failed to keep pace with other industries. As a result even though as many as 600 million people continue to depend on agriculture as a source of livelihood, yet agriculture has been growing at only 3% annually. These households dependent on agriculture earn just a subsistence livelihood and face a slow uncertain path to prosperity. Also due to poor prospects, the country is hollowing out while the urban commercial centers are becoming overcrowded.

Key Skill Development Challenges

1. India as a country has advantage when it comes to absolute number of workforce but the industry is facing a crucial shortage of "skilled" and "qualified" manpower.
2. Current education system is non-responsive to the skill demands of the existing and future industry, leading to a supply-demand gap on various counts.
3. 92% of the work force of India which belongs to the unorganized sector has been more or less excluded from the current vocational training set-up.
4. By 2012, it is estimated that India will have around 57 million people who are school-drop-outs or illiterates and hence this segment needs special focus.
5. Huge demand-supply skill gap. 90% of the jobs in India are "skill based"; entailing the requirement of vocational training. It is estimated that only 5% of the youth in India are vocationally trained
6. The current capacity of institutions and initiatives which are imparting skill development in the country is 3.1 million per annum against country's target of skilling 500 million people by 2022.
7. Most of the Vocational Education Training Institutes are characterized by structurally rigid and outdated centralized syllabi that do not have much sync with the prevailing market conditions.
8. Skill training in the unorganized sector, which forms 92% of our work force is not existent except for that granted by local ustads or family elders. This forms the greatest challenge within the skill development panorama if India.

Focus on unorganized segment

Considering the preponderance of the informal or unorganized sector in India's economy as brought out in Section 1, which in a major way impacts the delivery capability of our organized sector, the proposed project makes a strong point in having a special focus on this segment. Since the unorganized sector is quite heterogeneous and the nature and conditions of work are very different, it leads to a wide range of training needs which is

quite different from that of the unorganized sector. The project would like to stress upon these training needs which have so far been relatively neglected.

The focus will be on the segments of the workforce in the chosen sectors which have comparatively low levels of education (the school drop-outs) and who are currently with or without skills. An analysis of the trades in our chosen sectors identifies the following trades on a prima-facie basis as those in which an intensive effort to expand training would be required. This sample list is based on characteristics like average education level, technical education level (15-29 years), incidence of formal and non-formal skills and growth rate of employment.

Occupation of workers by Education and Skills, 2004-05, Sector Status

Occupation	Mean Years of Education	Any Technical Education (15-29 years), %	Any Skill 1999-2000 to 2004-05	Growth Rate %	% Share
Tailors, Dressmakers, Sewers, Upholsterers, Related	5.7	2.5	44.3	10	2.0
Hotel, Restaurant Keepers	4.7	0.4	12.4	4.2	0.4
House Keepers, Matron, Steward, Cooks, Waiters	4.3	1.6	12.6	6.1	0.6
Stationary Engines, Equipment Operators, Loaders	4.2	1.6	9.8	9.1	0.8
Construction Workers, Stone cutter	3.4	0.4	11.3	9.4	3.6
Building Caretaker, Sweeper, Cleaner, Related	3.2	0.2	3.3	3.0	0.5
House keeping Services and related	2.3	0.8	6.1	7.2	0.9

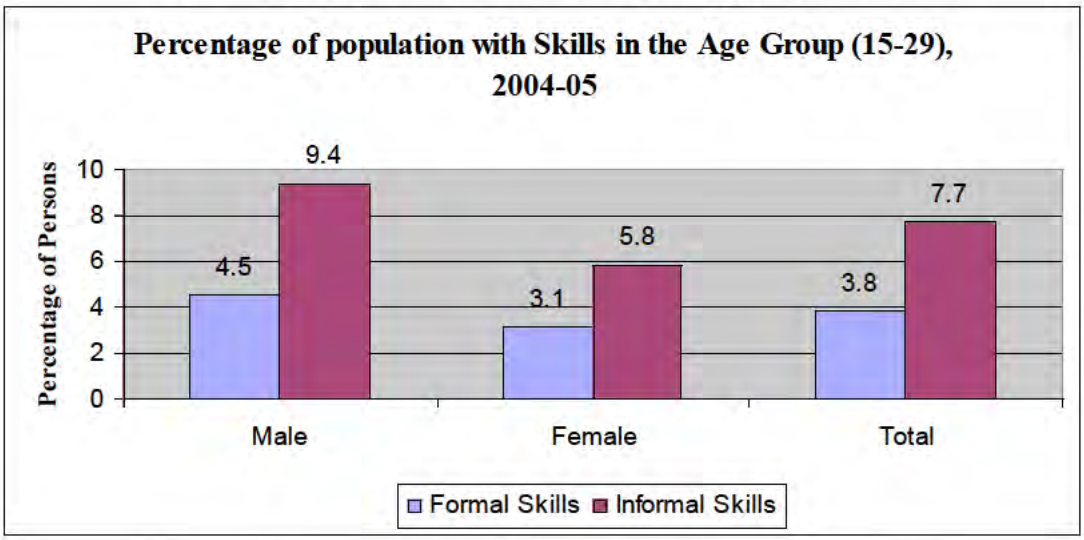
Source: Appendix Table A 3.5, Skill Formation and employment Assurance in the Unorganized Sector", National commission for Enterprises in the Unorganized Sector, www.nceus.gov.in, 2009

The above list shows the occupations in the unorganized sector with low mean years of education (less than middle- 8 years), low technical education (less than 3%), presence of some skills and barring a few, most of them with a high growth rate (above 5%).

In the Unorganized sector, focus will be on the large numbers of people who drop out of the school and do not have the necessary education and the skills to be productively employed in the economy posing a serious challenge to country's growth and development process. The 15-29 years age-group comprised of 27% of India's population in January 2005, which is a total of 1089 million. Of this, only 11.5% have received any

training, formal or informal. And only a 3.8% of the population has received formal training[7] as can be seen by the graph given below:

Percentage of population with Skills in the Age Group (15-29), 2004-05



Source: Computed from unit level data of NSS 61st round 2004-05, Employment-Unemployment Survey

Lifelong Approach to Employability

Another important feature is the concept of "Lifelong Employability". We believe that one-time technical training or imparting of skills is not enough and cannot cater to the skill related problems of a fast changing knowledge economy like that of India. To address this, we need a comprehensive range of skill-sets and processes that can ensure continued employability of the person in the ever-changing macro-economic environment and can contribute to his overall growth.

Besides the Primary Technical Skills, we must develop skills such as ability to create, apply, share and distribute knowledge, to work in teams that may be socially and psychologically heterogeneous, to have the capacity to re-skill and re-train as circumstances demand, to be able to participate in networks and develop the social capital that creates the learning and develops the resilience to cope with change; to cultivate a positive, opportunistic and entrepreneurial orientation to change; and to become committed to continuous and life-long learning far beyond the years of formal education, or first employment.

Apart from low skills, a worker, especially in the unorganized sector who is often a migrant, suffers from lack of social protection, irregular employment, lack of information on jobs and hazardous working conditions. Therefore, a critical dimension of supporting lifelong employability is to build a supporting platform by keeping them connected with

[7] Skill Formation and employment Assurance in the Unorganized Sector", National commission for Enterprises in the Unorganized Sector, www.nceus.gov.in, 2009

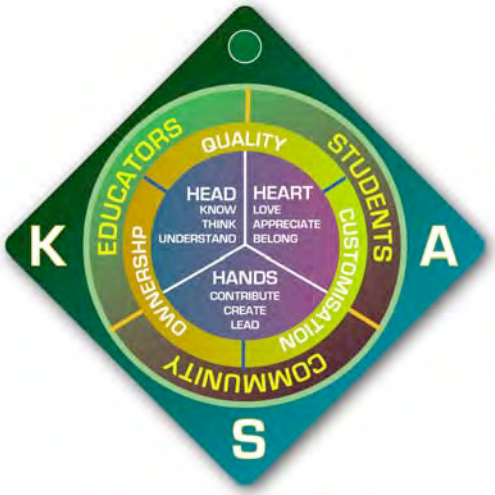
their employers, skill/trade communities and their roots, providing them micro-insurance, micro-finance, banking services etc.

On the employer side, through a combination of apprenticeships and tracking systems, the workers can be brought in for periodic re-skilling to enhance their livelihoods.

Study of methodology and pedagogy that best suits the needs

APPROACH ADOPTED IN BUILDING THE METHODOLOGY

Our approach to skill training has been derived from the ancient Indian methods practiced at the 'Gurukuls'. A gainfully employed citizen of the country can make large contributions to his/her community and the Nation at large. Therefore the Gurukul system of training, we feel, has the maximum relevance in today's circumstances. Primarily the Gurukul system was based on training the Head, Heart and Hands in equal proportions. The head represented knowledge, the heart stood for attitudes and the hands symbolized Skills. All training modules are designed to address these three faculties in a facilitation mode rather than a lecture mode.



This approach puts the KSA (or Knowledge, Skills & Aptitude) system into a doable sphere by defining all the stakeholders and smoothly flowing into a system that allows a very powerful five 'E's system of skill training.

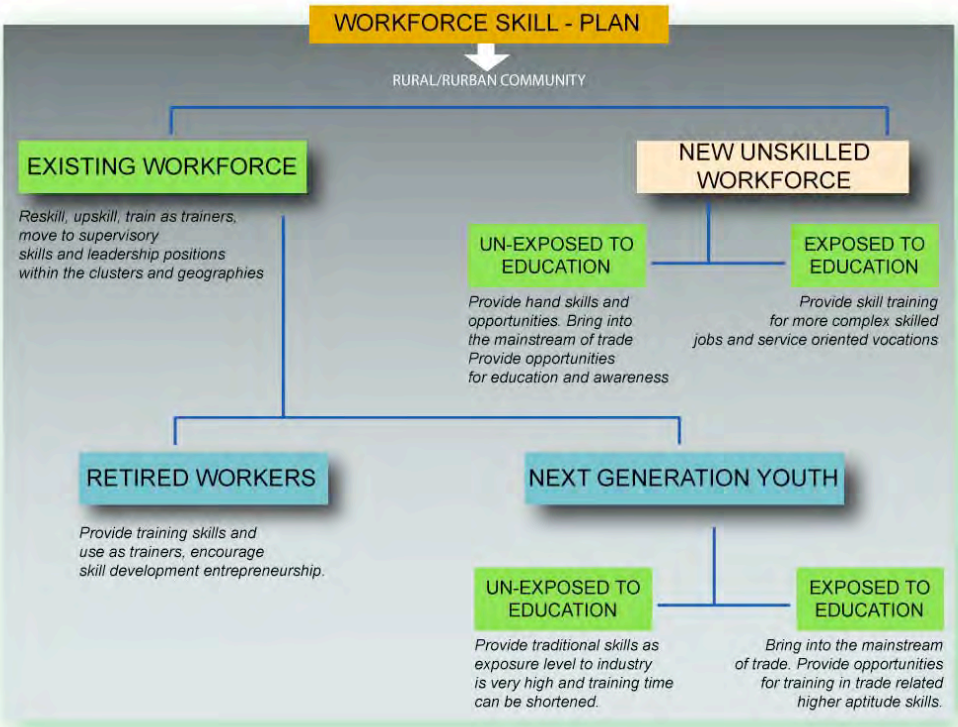
ENABLING and EQUIPPING the educator or trainer, so that they can completely understand this holistic system of imparting skills and approach their respective subjects with the demeanor of a facilitator and guide.

ENGAGING and EMPOWERING the students so that they can not only achieve the greatest amount of skills but also a great deal of confidence, pride and dignity in the profession they have chosen for themselves

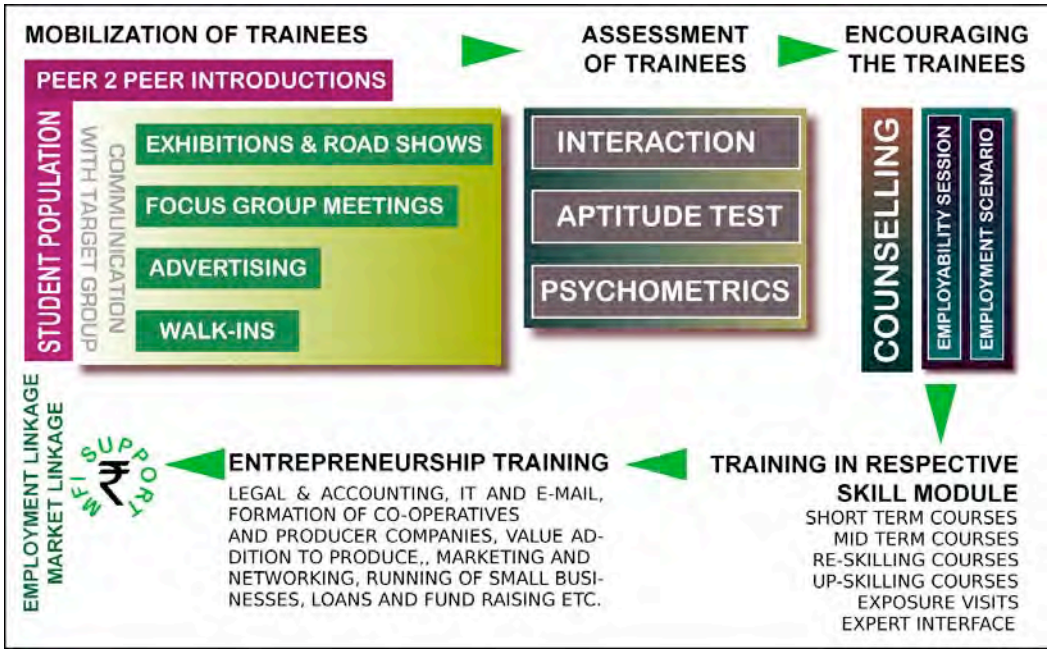
ENHANCING the interaction and understanding between the skill training institute families of the trainees and the local community, so that not only does the trainee benefit from it but also their families must welcome the change and provide dignity and the best opportunities to the newly trained ward. The job of the training faculty does not end in the classroom, but goes beyond into the community. It may be of great value to introduce career guidance towards prefab and the future of construction at the school level from class VII onwards. As we all know most school dropouts take place between class VI-VIII and the single biggest reason is that they see no reason to continue studying, as there

is no scope of a structured career in view. This tendency can be curtailed through counseling and exposure at the right time and by constantly bringing success stories to the notice of young school goers.

Most of the workforce will, we feel, come from the groups indicated in the following diagram.



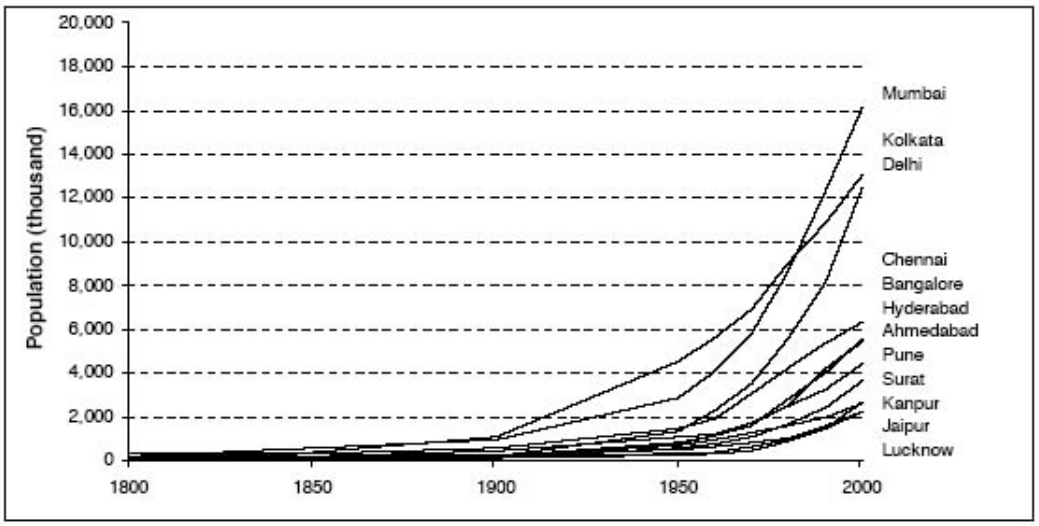
The most innovative methodology of training, in our opinion, is an outcome of long hours of focus group meetings and actual field study. The process starts with matching aptitude to skills and taking the students through psychometric evaluation. Groups are then formed with trainees who can not only learn together, but also eventually earn together as they club their individual strengths into producer groups after the training is over.



Analysis of opportunities and benefits of skill training for prefab construction

NEED ASSESSMENT

At some point during 2008, according to the latest UN statistics, more than half of the world's population will live in urban areas. There are other profound changes underway – for instance, the rapidly growing proportion of the world's urban population and its largest cities located in Africa and Asia, as shown in the figures below. Asia now has half the world's urban population and Africa's urban population is larger than that of Northern America. Europe's dominance has decreased dramatically. In 1910, the nations that now constitute Europe had more than half the world's 100 largest cities; by 2000, they had only ten. Europe has none of the world's 100 fastest-growing large cities (in terms of population growth rates between 1950 and 2000) but has most of the world's slowest growing (and declining cities). Most of Europe's great centres of industry are no longer among the world's largest cities. Asia and Africa have three-quarters of the world's 100 fastest-growing large cities (in terms of population growth rates between 1950 and 2000); China alone has 15 of them, India has eight.



SOURCE: International Institute for Environment & Development

Although it is a widely known fact that the rurban youth is in need of skill training, we find that a large part of them are pursuing their career objectives with a herd mentality. For instance, if one boy from the community gets a computer operators job, every one else wants to learn computers as well, without considering factors like aptitude, longevity, state of the job market, etc. This often requires them to travel into the cities and spend huge amounts to learn a skill that may be the exact opposite of what s/he could naturally excel in doing. On top of that many of them lose their daily earnings in trying to acquire a skill that they may not eventually use.

The above table shows adequately that the next largest job opportunity is going to be in the organized construction sector, which as per all indicators is going to be the prefab industry. Training for prefab could iron out many of the issues as it provides a dignified employment opportunity, at the destination of migration and an opportunity for sustained career growth.

However we must also consider that the training for prefab must adhere to the following critical points to be successful.

1. Employment should be easily and locally available to the trainees
2. Courses should be easily comprehendible by school dropouts
3. There should also be some follow up courses for up skilling and re-skilling
4. The courses must provide for entrepreneurship opportunities
5. Courses must have acceptability within the community
6. Possibilities for the trainee to move between courses smoothly
7. The courses must allow the best use of existing resources and partnerships
8. The courses should be replicable and scalable

A compilation of success stories

There are already a sizeable amount of success stories from the prefab skill sector, which will be chronicled in this section, especially the enormous success with ferrocement training. We would like to illustrate this with pictures.


The team of masons from Nashik Maharashtra, who trained for the first time in using prefabricated foundation cones for a prefabricated and in-situ gunited ferrocement library block.


Skill training need not always happen at the bottom of the pyramid. A willing group of municipal commissioners in Gujarat went through the ferrocement prefabricated sanitation solutions exhibition & training in Ahmedabad.


Er. A.K. Jain skill training local window grill welders from Uttarakhand in making ferrocement prefab moulds and finally fabricating the components for a prefabricated quarter for the UK forest department.


The final house built with prefabricated over-ground foundation cones and prefabricated components bolted together into a beautiful structure and the team of newly trained workers.


Ar. Atul Gupta along with the author re-skilling existing carpenters to build prefabricated bamboo structures that are sustainable and livable in the modern sense. A happy set of trained persons with the final result.

Prefab skill training has allowed people to double their income in a span of six to twelve months in some cases and even more when they have turned entrepreneurs using their newly acquired skills and knowledge.

Ground realities

Most skill institutes today follow a system of instruction that is curriculum and lecture based, which does not allow for adequate hands on training, nor does it keep pace with the rapid changes in the industry.

Given the current situation, skill training in these jobs mainly happens through the "Ustaad-Shagird" system or the mentor disciple system, as we know it. An older and experienced worker usually takes on a few trainees under his/her wing and grooms them to become full time employees. This system has its positives and negatives but the positives are becoming less and less relevant in the work environment today.

For instance, because of the lack of standardization, the disciple not only learns the good things from the mentor but also replicates the faults of his mentor. When the technology

changes rapidly, the mentor is no longer able to keep pace. That's when the mentor and disciple both become learners at the cost of the employer who often pays heavily for the mistakes made by the untrained or semi trained workers.

After many focus group meetings and expert group discussions we have defined the trainee population based on their needs and aspirations as follows:

Educated Skilled Employed
Is not looking for skill building
Educated Unskilled Employed
Will not fall into the circuit easily. Toughest nut to crack
Uneducated Skilled Employed
Will pay for re-skill with a promise for betterment
Uneducated Unskilled Employed
Will expect free training from employer
Educated Skilled Unemployed
Will pay for a sure job, Industry wants them
Educated Unskilled Unemployed
Will pay for skills and a job, Industry wants them
Uneducated Skilled Unemployed
Will pay for a sure job, will remain uneducated though
Uneducated Unskilled Unemployed
This is the myth that everyone is chasing. There is no such thing
At least not in profitable numbers

The above situation and analysis calls for an extremely structured and focused approach to skill development, where the skill provider must decide which of the above groups they will target, and what will be the expected results from such training.

The existing unhealthy and haphazard skill initiatives are a result of our feudal genetics that make us believe that all of the above have only one choice, that of taking up the first job that comes their way at whatever exploitative wages they can.

Well India is changing rapidly from being a rural economy to being a rurban economy and the social dynamics are changing rapidly. This is a trend that must me mapped and captured before it explodes in our faces as it has done in may rapidly developing SE Asian nations.

Recommendations for SKILLING "RURBAN" INDIA

India is experiencing an unprecedented growth in urban infrastructure, which is surely visible to all of us. What may not be visible is the fact that the sheer size of land acquisition itself, is sucking in humungous amounts of rural communities and agricultural

economies into these vast cities. Creating independent socio-economic sacs like suburbs, lal-dora areas, notified sectors and villages within cities.

'Rurban', the new society is emerging rapidly and without warning. This society is neither urban nor rural, yet both.

The point is to draw our collective attentions to the tangible and positive impact of such growth. These 'rurban' sacs, puddles, pockets, bubbles, areas or whatever we choose to call them are teeming with eligible, educated and aware youth who are rearing to go.

These youth are not urban slum dwellers, but affluent 'rurbanites' with substantial buying power. They are not rural anymore, and they are unable to fit into the urban either. They are armed with some education but little else for meaningful or sustainable employment in the modern world. What they are now demanding is skills and employability training to become truly urbanized. They want to be locally employable, nationally valuable and globally acceptable.

There has been little opportunity or access to education or training that could make them skilled and acceptable in the numerous new jobs that are appearing in the adjoining cities and industrial belts.

Businesses have been quick to see the opportunity and colleges have started mushrooming along the National & State highways. Dreams are being recklessly retailed, and India Inc. in ten years, has been brought to its knees by the simultaneous excess of qualified youth but a lack of capable workers. Skill training, might we say, has been missing.

We may need to rapidly prepare our education system, skill training, SME products and development modules to access this population. This time around we might want to give them dignity enough to continue their rural vocations elsewhere with pride, or move into the urban market with their heads held high.

Powerful and innovative initiatives need to be introduced that fill the training gap with a KSA (Knowledge, Skills & Aptitude) approach and a clear focus on developing the 3H: Hands, Head and Heart.

We can use our own huge rurban force, which has the practical knowledge of rural, the futuristic exposure of urban and is suitably based close to the growth centers, to create a new class of workers who will proudly work towards vocations of national Importance such as a stable manufacturing workforce, food security, development initiatives, skill building, financial inclusion and sustainability through design.

1. This could best be achieved by:
2. Counseling and aptitude profiling of the unemployed population
3. Skill development & employability training to the youth
4. Entrepreneurship development and enterprise facilitation

5. Development of trainers for other similar initiatives
6. Mentoring and tracking for lifelong employability of trained alumni
7. Social paralleling and reducing conflict through follow-up & tracking &
8. Last but not the least
9. A reliable connect with rurban banking and credit infrastructure

It seems there might be an urgent need to look at this rapidly growing population, which has a huge storehouse of semi-educated youth, reasonable start-up funds and growth aspirations just like any other urban dweller. This population is moving towards becoming the most powerful force to reckon with, not only within India, but on a global scale as India fulfils its dream of becoming the skill capital of the world by 2022 and putting together 500 million skilled youth.

* Source: Ashoka Changemeakers, Group-Rurban: The emerging society: http://www.changemakers.com/search/changemakers_group/Rurban

Definition of RURBAN: http://www.merriam-webster.com/dictionary/rurban

:of, relating to, or constituting an area which is chiefly residential but where some farming is carried on:-Origin of RURBAN : blend- 'of rural and urban' :First Known Use-1918

Sumit Kumar Agarwal brings with him over 28 years of leading young & energetic teams in General Electric (GE), Sahara India, Media Reach (London), RDA (Afghanistan), Laqshya Media (India, Sri Lanka & Dubai), Appropriate Technology India (High Altitude Himalayas) and Basix (Microfinance leader across 20,000 Indian villages).

Sumit currently heads Tanjun Associate LLP, a social enterprise solutions provider that specializes in the Skill Development space.

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Tanjun is currently the research & knowledge provider for 5 sector skill councils and has proposed over Rs.2000 million worth of Skill Development projects to NSDC.

IMPORTANCE OF PREFABRICATED CONSTRUCTION IN THE AGRI-FARM SECTOR

Yogesh Srivastav, Senior Secretary, PHD Chamber of Commerce & Industry, New Delhi

Introduction

Prefabrication is one of the prevalent practices now days. It is the practice of assembling components of a structure in a factory or other manufacturing site, and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out.

It also applies to the manufacturing of things other than structures at a fixed site. It is frequently used when fabrication of a section of a machine or any movable structure is shifted from the main manufacturing site to another location, and the section is supplied, assembled and ready to fit.

The role of prefabrication in architecture has been lauded for its potential to increase productivity and efficiency while not sacrificing quality. The middle class in developed countries like US, Japan and Europe has been utilizing this for various range of building structures.

With prefabrication, improved working conditions would seem to be agreeable to everyone: instead of building in the weather, international fabricators supply controlled environments with ergonomically considered equipment – and yet in many fabrication environments, reliance on minimal skills, and a disconnect with the community in which workers live, leaves little room for continued fostering of personal and collaborative skills, culture, tradition and community building.

Prefabrication adoption in this culture may definitely suggest ways in which developed countries' architects and local building professionals may take a leadership role in fostering both culture and technology.

Prefabrication in India

Prefabrication in India began with the emergence of the Hindustan Housing Factory. The company was developed by Pandit Jawaharlal Nehru, as a solution to the housing crisis that resulted from the influx of refugees from West Pakistan in the 1950s.

Since the government could not recoup the return on investment for the factory through housing production, prefabrication from HPL began to service other markets including higher dollar civil and larger public and hotel buildings. **Things became diversified then and a new role of prefabrication came into picture.**

The quality of construction is much higher when components are manufactured in a stable environment such as the factory. This is especially true in India where today, prefabrication has become synonymous with durable, modern, and western construction

methods. Materials are used more efficiently, are safer from climatic damage, and can be reused in the material stream.

Because of these benefits, a general consensus in India is to move prefabricated building systems beyond precast concrete for large-scale construction to additional market sectors including a resurgent interest in applying prefabrication technology to housing. Traditional construction techniques involve the use of timber molds or shuttering for roof spans and other structural systems. These temporary timber structures have a short lifespan and due to the volume of construction in the peak seasons of spring and summer for larger well-funded projects are often unavailable. This hinders construction schedules and does not allow projects to be completed before cooler or rainy seasons begin. However, construction does not stop in the summer despite the lack of proper equipment and material. Instead, using makeshift methods for construction on site leads to inappropriate means and hence a substandard quality of construction in finished buildings.

In view of potential, many companies now have ventured into the sector and expanding their operations in fields like housing, railways, agriculture and aviation.

Advantages of Prefabrication

- Self-supporting ready-made components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.
- Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capital invested.
- On-site construction and congestion is minimized.
- Quality control can be easier in a factory assembly line setting than a construction site setting.
- Prefabrication can be located where skilled labor is more readily available and costs of labour, power, materials, space and overheads are lower.
- Time spent in bad weather or hazardous environments at the construction site is minimized.
- Less waste may occur
- Advanced materials such as sandwich-structured composite can be easily used, improving thermal and sound insulation and air tightness.

In general, it can be said that prefabrication is remarkably advantageous and may be leveraged for various sectors besides housing.

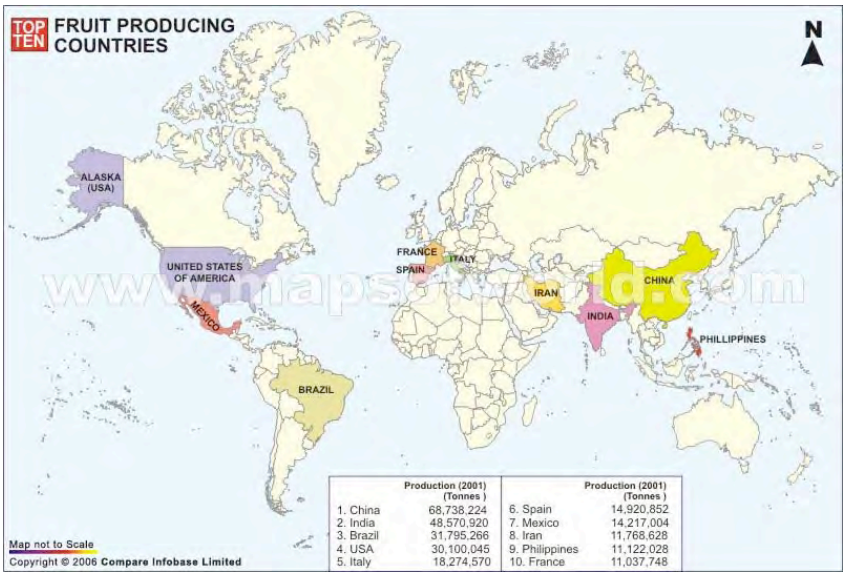
Its benefits for agriculture and farm sector are many. Prefabrication can prove to be a boon for the agri and farm sector also in various ways like:

Mapping the size of the production and logistical inefficiencies that exist within the agri-farm sector in India and bringing focus on the critical need for rapid action in warehousing, storage and transportation between farm to fork

Agriculture is the dominant sector of Indian economy, which determines the growth and sustainability. About 65 per cent of the population still relies on agriculture for employment and livelihood.

India is first in the world in the production of milk, pulses, jute and jute-like fibers; second in rice, wheat, sugarcane, groundnut, vegetables, fruits and cotton production; and is a leading producer of spices and plantation crops as well as livestock, fisheries and poultry. In the past few years, Indian agriculture has done remarkably well in terms of output growth. The 11th Five Year Plan (2007-12) witnessed an average annual growth of 3.6 per cent in the gross domestic product (GDP) from agriculture and allied sector. The growth target for agriculture in the 12th Five Year Plan is estimated to be 4 per cent. Indian agriculture is benefiting huge from rising external demand and the sector's wider participation in the global economy.

India is the world's 2nd largest producer of food next to China, and has the potential of being the largest with the potential of being the largest with the food and agricultural sector.



There is an opportunity for large investments in food and food processing technologies, skills and infrastructure, especially in areas of canning, dairy packaging, frozen food / refrigeration and thermo processing. Fruits and vegetables, milk and milk products, meat and poultry, packaged / convenience foods, alcoholic beverages and soft drinks and grains are important sub - sectors of the food processing industry. Health food and supplements are other rapidly rising segments of this industry.

India is the world's second largest producer of fruits & vegetables, but hardly 2% of the produce is processed. India produces large variety of fruits & vegetables ---- tropical, sub-tropical or temperate. These include mango, banana, apple, orange, chikoo, ber, pomegranates, etc., and vegetables like potato, tomato, onion, cauliflower, cabbage etc.

The total area under fruits and vegetables cultivation is estimated to be at 5.63 and 5.6 million hectares.

India is also the land of spices producing all varieties worth over Rs. 3500 crores (US $ 900million) amounting to 25-30% of world production, which is processed for value-addition and export.

After harvest, perishable foods (e.g. fruits, vegetables, milk, meat, fish,) are liable to accelerated physiological, chemical, and microbial processes that invariably lead to deterioration and loss of wholesomeness. It is then necessary to institute some measure of processing such as reduction in moisture content, denaturation of endogenous enzymes and microorganisms, packaging or arrange post harvest storage in order to curtail perishability.

In the absence of such systems, massive post harvest losses can ensue. In India, nearly 30 per cent of the agricultural and horticultural produce is wasted because of inefficiency in post harvest management. There is a dire need of various storage and systems that varies from the various stages of complete supply chain. Therefore a need analysis is being done and time frame suggestion by plotting the size and effect of the problem against a projected time gap analysis may be done by the research scientists and engineers.

Prefabrication provides scope for study of size of the production and logistical inefficiencies and then design suitable post harvest storage structures then and there from the farm to the markets.

Reducing the load on agro forestry and freeing up prime agricultural land for food cropping.

It is evident that post harvest losses are high in agriculture and horticulture.

According to FAO, emerging global challenges, especially food production and availability needs to increase by 70% by 2050 and the world would need to produce 50% more food and energy by 2030. These production targets can be met sustainably by using production methods that reduce post-harvest loss while guarding against loss of biodiversity**.**

Massive adoption of Agro forestry may be good in the short term but will probably have far reaching effects on the availability of cultivable land in the future, thus putting a large pressure on the food security of the country. Prefab can reduce some of that load. This section will take an objective look at whether it really can.

Mapping the effect of good construction practices on the carbon sequestration pattern of India.

Activities or any action taken to sequester C in biomass and soils, will generally increase the organic matter content of soils and improve soil properties such as nutrient uptake, and moisture retention which in turn will have a positive impact on environmental, agricultural and biodiversity aspects of ecosystems.

Therefore carbon sequestration in soil organic matter pool is increasingly advocated as a potential win-win strategy for reclaiming degraded lands, particularly in semi arid regions

of the developing world, mitigating global climate change and improving the livelihood of resource poor farmers in soil has really been given attention these days.

Carbon sequestration by agricultural land has generated international interest because of its potential impact on and benefits for agriculture and climate change. Where proper soil and residue management techniques are implemented, agriculture can be one of many potential solutions to the problem of greenhouse gas emissions. Additionally, agriculture conservation practices such as the use of different cropping and plant residue management, as well as organic management farming, can enhance soil carbon storage. Farmers, as well as the soil and environment, receive benefits from carbon sequestration. Agricultural ecosystems represent an estimated n% of the earth's land surface and include some of the most productive and carbon-rich soils. As a result, they play a significant role in the storage and release of C within the terrestrial carbon cycle.

Two most important global threat, climate change and population explosion, both can be related to one solution -Carbon Sequestration.

Prefab Structures are most effective and practical, quick to made structures. These are eco friendly and can be very well used for agricultural and horticultural crops. A small but significant part of prefab in the agri-sector will definitely have its effect on the carbon footprint created by energy inefficient construction technologies that serve the humungous agriculture sector of India.

Aggregating synergies and opportunities between the engineering and agriculture communities.

Usage of prefab structures for agri and farm structures can never be limited to one community. It throws ample scope for interaction discussions and planning between agriculture scientists and engineers

Post harvest technology emphasizes the technical need regarding temperature, duration, time, Relative humidity etc for storing a particular perishable crop. Here the research scientists in post harvest technology are involved.

In Prefabrication structuring, engineering experts have an active role. One needs to assess the use of prefabricated concrete and prefabricated steel sections in structures where a particular part or form is repeated many times. It can be difficult to construct the formwork required to mould concrete components on site, and delivering wet concrete to the site before it starts to set requires precise time management. Pouring concrete sections in a factory brings the advantages of being able to re-use moulds and the concrete can be mixed on the spot without having to be transported to and pumped wet on a congested construction site. Prefabricating steel sections reduces on-site cutting and welding costs as well as the associated hazards.

Prefabricated storage and customized buildings for agricultural use, is one of the oldest yet finest products. A wide variety of options are available relevant to customization, in order to ensure that the given structure is optimized for its function.

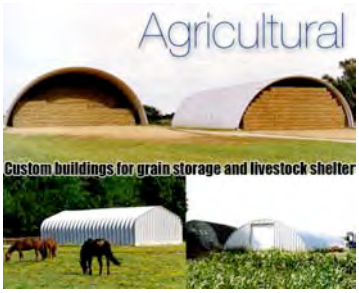
The structure would therefore be an amalgamation of finest expertise between agricultural and engineering communities. The success of the implementation part of the prefabricated

structures in agriculture and farming community touches upon the crux of how and when could the two most important productive communities of India synergize for a crystal-ball discussion on the future of our rapidly growing economy. A large reduction in post harvest losses can be achieved from this synergy.

Showcasing successful examples of prefabricated solutions for the agri-farm sector.

There exist many examples of good solutions which have ventured into solutions for agri-farm sector. The companies range from traditional ones like HINDUSTAN PREFAB LIMITED, Simplex Prefab Infrastructure India Pvt. Ltd to new ones like Finish profiles India and Aakash Enterprise Ltd. They are providing end to end solutions right from agriculture, commercial, government and housing structures.

Some of the pix with respect to the above is also enclosed herewith for your kind reference:



Conclusion

Prefabricated structures have the potential to hit on the most worrisome arena of the Indian agriculture ie the post harvest losses. The opportunity an be well utilized. Amplifying policies should be developed so that more and more companies may venture in to the sector. Also awareness should be created to small entrepreneur groups about such structures so that end-to-end solutions may be provided.

This may really change the face of Indian economy.

Yogesh Srivastav
Senior Secretary, PHD Chamber of Commerce & Industry, New Delhi

PHD Chamber of Commerce & Industry is a 107-year-old apex body of industries and trade chambers working extensively in 13 Indian states on matters of policy, planning and developmental strategies with the state and central governments.

SMALL-PREFABRICATED FERROCEMENT DAMS TO RECHARGE GROUNDWATER

Prof. R. K. Ambegaonkar, Faculty of Engineering University of Pune & Er. Chandramohan Hangekar, Superintending Engineer in Govt of Maharashtra , Water Resources Department

ABSTRACT

Maharashtra recently faced the draught situation in many districts. The groundwater level is reducing every year. Small dams on small natural nallas can recharge the groundwater thereby elevating the water table. Government of Maharashtra is implementing such crash program and the success is seen now. Ferrocement small dams are eco friendly, and acceptable because of use of local material and labour. Different designs are discussed here. The prefabricated skeletons make it easy for transporting and erection at remote villages, thereby saving time.

Key words : Small dams, ferrocement, water conservation, Maharashtra

INTRODUCTION

Ferrocement uses less cement and the thickness is also very small as such intelligent use of this material is possible in water retaining structures. In Mexico ferrocement dams with curved sections and small wall thickness are built very frequently. Small dam is also built near Pune, India. Government officers and JALBIRADARI appreciate the technique also. Due to simplicity villagers and NGOs can easily adopt these designs.

DIFFERENT DESIGNS

Ferrocement can be used in small dams in different ways.

As a core- As ferrocement has a unique property of imperviousness, it can be used a core material surrounded by pervious local and cheap material.

As encasing material- Ferrocement is very resistant to take tensions and flexure. As such boxes of ferrocement filled with pervious material can be a good replacement to masonry and mass concrete construction.

As covering material- The beauty of ferrocement to adopt any shape can be used to cover the loose and KACHCHA BANDHARA. This thin cover acts as a impervious layer and a protection to loose material also.

Ribbed curved walls- Curved ferrocement walls act as arches and the water pressure is taken on convex surface. The downstream surface is strengthened with ribs.

The designs are described below.

SMALL ARCH FERROCEMENT CORE DAMS:

This type of small dam, often called as BANDHARA in Maharashtra is built at Village- Botarwadi, Tal- Mulshi near PUNE, India. The total length of dam is 12 metre. This is

divided into overflow part 6 meter and remaining as non overflow portion. The dam has a core of four ferrocement curved prefabricated segments, each 5 feet long and 0.8 m high as shown in figure 1. the ends of each portion has triangular counterfort. The skeletons of 8mm steel bars wrapped tightly with 3 inch square mesh and 3 layers of half inch chicken mesh are made using welding and wire tightening techniques. The four such skeletons are made in Pune and transported to site, 25 km from Pune. The base of small dam is hard rock and is prepared with plain cement concrete. The skeletons are aligned and tightly fixed together and anchored with concrete below. On sides keys are provided. The cement mortar 1:2 is used by pressfill method. The top edge is strengthened by 3 inch rib. The upstream and downstream portions are filled with local boulders. Local people were involved in all the activities. The banks were protected by soil with core of impervious soil and casing by available murum, dug from the water storage area. The storage of water up to 6 lakh liters was possible. The wells around the dam are getting recharged. Such chain of bandharas on the same nalla will improve the groundwater table dramatically. (Local Name of such bandhara is BALCHANDRA Bandhara)

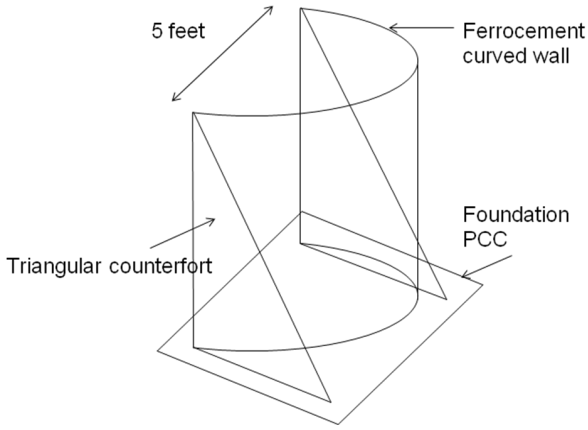
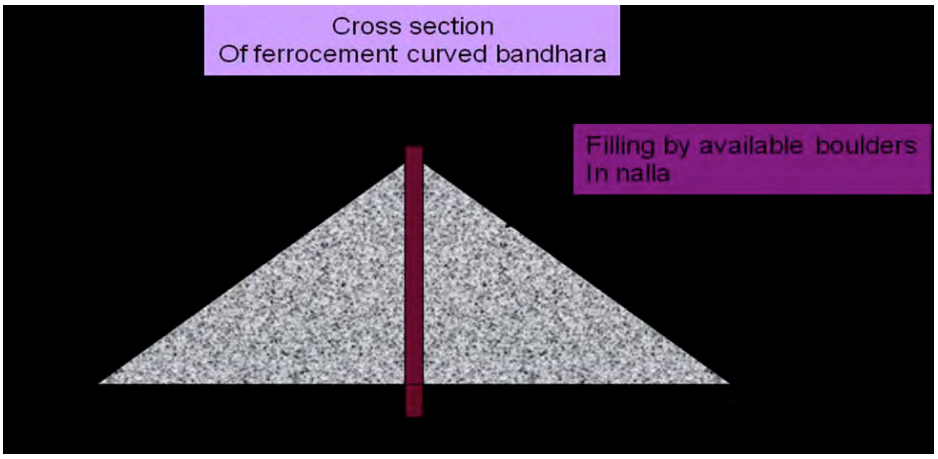


Figure 1 : Arch with counterfort ferrocement skeleton.

The cost of this small dam is around Rs. 80000. Similar small dam in cement concrete would cost Rs 5 lakh. As local people are involved in construction activity, they have a feeling of self creation. Therefore the maintenance of the small dam becomes easy. No maintenance is required for the core ferrocement. But for the coverage of earthwork and rock boulders, people can see that the boulders and earth fill is in tact.



BOX TYPE SMALL DAMS

In this method box type skeletons are prefabricated first throughout the length of the small dam, i.e. the width of the nalla or natural flow channel. If the height is up to 1.5 meter then single box design is suitable (Fig 2). If the height is up to 3 meter then boxes with two heights as shown in fig-3 can be used.

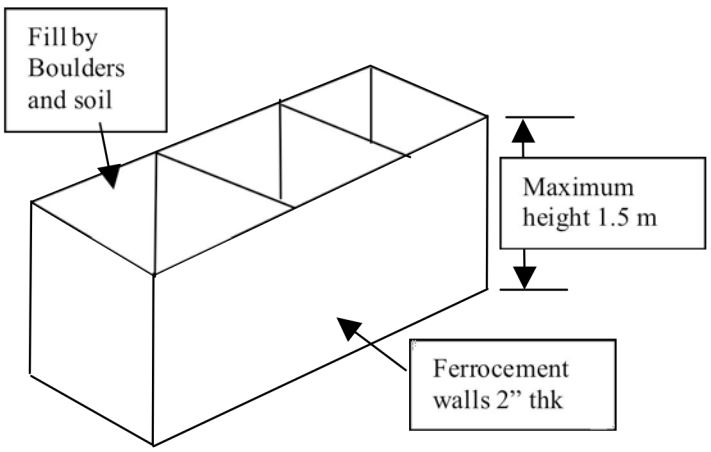


Figure 2 : Small dam with height up to 1.5 meter

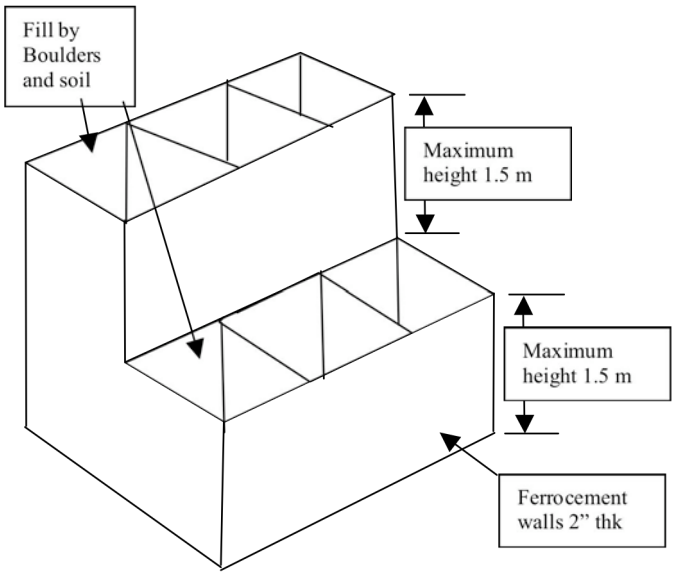


Figure 3 : Small dam with height more than 1.5 meter

The boxes are kept on the nall bed prepared with PCC and anchored to foundation. The boxes are then filled with local material like boulders and loose soil is used as matrix. The boulders are held by the boxes and they increase the dead load to withstand water pressure. For more length the number of boxes can be increased. Normally the size of box in plan is 1 to 1.3 meter each side. The boxes are prefabricated and as such erction of dam at site becomes very easy. Use of local material and labour is possible. The walls of the boxes are 2 inch thick ferrocement with 8 mm steel bars and layers of square mesh and chicken meshes.

RIBBED CURVED FERROCEMENT SMALL DAM

In Mexico such dams are very popular. In this type of construction the wall of the small dam is curved and the downstream part is divided in to vertical and horizontal ribs of ferrocement 2 inch thick. The strength of this dam is achieved through the shape and the ribs. For overflow part the height of the dam is lowered by a measure equal to water flow depth and free board. Saving of material in such dams is enormous.

CONCLUSION

Ferrocement can be used in various ways for prefabricated water retaining structures. For villages facing draught, ferrocement can prove as a magic material.

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During the career as a teacher occupied various academic & administrative positions at Institution & University. Contributed to overall development of engineering students & teachers through various research & training program. Worked on various professional bodies like Indian Institute of Metals, Institutions of Engineers, Society for Bio Medical Engineering, Institute of Indian Foundrymen & strived for closer Industry-Institute Interactions.

Currently more involved in Rural Development and Demand driven Training for Engineers & Foundry Work-Force in particular.

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DISCARD CONCRETE AND USE FERROCEMENT FOR PRECASTING

Dr. BALKRISHNA N. DIVEKAR, President, Ferrocement Society, PUNE.

Abstract

Mass scale housing is the need of the day. To expedite construction and to reduce the site work to a minimum, precast concrete is preferred.

Weakness of concrete in tension is well known. Its cracking behavior is inborn and joints between precast concrete elements, always cause headache. To overcome these shortcomings, we impose prestress on concrete to improve tensile strength, try to reduce weight by hollow cores and use intricate methods of jointing.

Why should not we try to replace concrete by a homogeneous composite like ferrocement which is already strong in tension and compression, which can be cast in thin sections without compromise in strength, which is ductile and has tremendous energy absorption capacity and the cracks in which can be completely controlled?

Being a thin-walled construction ferrocement plates need stiffening ribs against buckling in walls and deflection in slabs. These stiffening ribs cab be provided in such a way that when ferrocement paneled cavity walls and ferrocement boxed hollow floors are formed, the joints between the precast panels act as structural members providing inbuilt RCC framework

Site work is only reduced to erection of walling and floor panels and to concrete the joints in form of columns and beams. The problem of joints which is haunting the designers in precast construction for ages together, is completely solved here. Joints acting as structural members is the special feature of this system.

With ferrocement, casting is easy, needs no high tech and heavy machinery, handling poses no problem due higher tensile strength and equal strength in both directions.

The stiffened ferrocement plates are lightweight and need no heavy cranes at casting yard or worksite. For mass scale housing in India, Ferrocement Technology is the most appropriate technology.

It is therefore strongly recommended that we should discard concrete as material for precasting and adopt the ferrocement in its place.

Key words: precast-concrete, precast-ferrocement, lightweight, joints between precast elements.

1.0: Introduction: Precast concrete for mass scale housing.

1.1: Use of precast reinforced concrete and prestressed concrete products in form of columns, beams and slabs has become very common in mass scale housing. Large scale manufacture of these products of assured strength, under controlled conditions in factory, has a definite advantage over in-built constructions. Saving of time in site work is

substantial, resulting in speedy constructions. But the use of RCC has certain disadvantages.

1.2: Property of concrete of weakness in tension and liable to get cracked easily, increases the size of the member and the percentage of steel reinforcement, particularly, when the designs are to be made for stresses of handling and erection. This adds to the weight and cost of the member.

1.3: Columns, beams and slab elements jointed together provide for the framework of the structure only. The walling elements and their joining with the framework is a job by itself.

1.4: Joints between the precast elements always poses a number of problems. A lot of preplanning in design and very accurate provision of fixtures at the locations of joints in the precast elements is a must.

1.5: In casting of joints at site the bond between fresh and hardened concrete is not strong. Integrity of the structure at joints is not certain.

1.6: Even with all these efforts the fixity at joints is doubtful and the framework is required to be designed as simply supported structure. This results in heavier sections and it adds to the weight of the member.

1.7: By providing crucified columns, an effort is made to achieve continuity between two floor levels. What about the continuity of beams and floors in horizontal plane? There is no provision for it.

1.8: The weights of the conventional RCC members and those of precast elements are same. On the contrary, as the members are required to be designed for handling stresses the sizes may be larger. Heavy machinery for handling and erection of precast RCC members is the result.

2.0: Why ferrocement?

To overcome all these shortcomings, use of ferrocement for precasting is the best solution due to the following special characteristics of the material.

2.1: Ferrocement is a high strength material, both in tension and compression. The design stress in tension is 10 to 15 times that of concrete, which provides for the handling stresses in design and reduces the size of the element.

2.2: Ferrocement is a thin walled construction, with no compromise in strength. The wall thickness may hardly exceed 50 to 60mm.Thin walls reduce the weight to about one-third that of RCC.

2.3: Weight-to-strength ratio of ferrocement cavity walls is more than 80 as against 35 to 40 of conventional concrete. This reduces the section of the member to about half.

2.4: Due to strong bond between meshes and mortar the cracks are completely arrested. The structural elements can be designed for the specified crack widths in ferrocement.

2.5: The mesh reinforcement is thoroughly disbursed and equally spread in both directions in ferrocement and hence it has got equal strength in both directions. This property has advantage in easy and proper handling of the products.

2.6; Ferrocement can be given any shape and size and strength of the element can be achieved through the shape.

2.7: Being thin walled, the casting of ferrocement elements is very easy. Design of moulds is simplified due to it.

2.8: Due to high tensile strength and complete crack control, no prestressing is required with ferrocement. No high-tech in design and casting of ferrocement products is involved in the process.

3.0:Stiffened precast ferrocement plates as basic element of construction:

3.1: Because of thin sections, and slenderness due to it, ferrocement plates will buckle in compression and bend in flexure. They can be stiffened by providing projecting ribs.

3.2 Horizontally placed ribs spaced certain distance apart on a vertical wall panel will reduce the effective length and can be designed accordingly.

3.3: In case of floor elements, the ribs can be provided in form of grid beams in both directions. The size and spacing of grids can be worked out.

3.4: Instead of providing ribs at the edges if the plate, if they are provided at certain distance away from the edges, they can be fruitfully used as formwork for joints between the two plates.

3.5: In case of cavity walls, two ribbed plates are jointed together with their ribs abutting each other. These two jointed plates make one panel of cavity wall. A channel-like section is formed at the edges of the panel due to ribs and edge portion of the plates.

3.6: When two walling panels are kept side by side, these two cannels when jointed from a box-like form for the joint between panels which also acts as a column hidden inside the wall plates. Thus an integral system of wall panels with in-built columns is formed, and a cavity wall is constructed.

3.7: When two ferrocement plates with ribs in form of ribs are kept one above the other with ribs abutting each other, a hollow floor is formed. The box-like section formed between two plates wall will act as formwork for in-built grid beams for the hollow floor of ferrocement.

3.8: At the top of cavity walls, formwork in form of channel is formed for casting wall beams. At the edges of the hollow floors channels are formed to cast edge beams of the hollow floor. When wall beams and edge beams are cast together, they form a “T” shaped beam over the wall and provides a perfect joint between slab and wall.

3.9: Ferrocement cavity wall jointed with columns and hollow floors jointed with grid beams form an in-built RCC framework cast integrally with walls and floors which is an ideal system for the earthquake resisting structures.

3.9: When stiffened plates are used for walls and floors, the work to be done at site is only to erect the panels and concrete the joints, which is hardly 15 to 20 percent of total work. It saves a lot of time of site work.

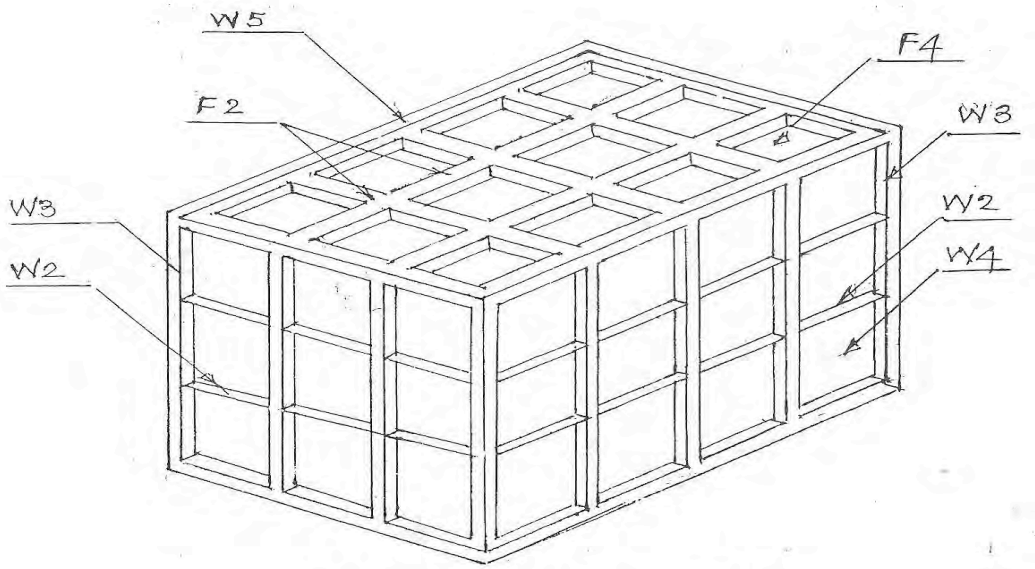
3.10: This system is called “All-in-One” method of construction and is unique of its type. The Author has taken patent for this process.

4.0: Forms in which precast ferrocement panels can be used:

4.1: Single wall and floor panels: In this method single stiffened plates are jointed at the edges with bolts, and concreted. They can be used for site offices, way-side shops, watchman-cabins, stores etc. Projecting edges of the plate are abutted against each other and joined by bolts. Same practice can be followed for roof slabs.

FIGURE G

INBUILT FRAMEWORK



ISOMETRIC VIEW

(FERROCEMENT WALLING AND FLOORING NOT SHOWN)

NAME	ITEM	FIGURE
W2	HORIZONTAL BAND	VI
W3	INBUILT COLUMN	IV
W4	INSULATING PAD	W
W5	INBUILT WALLBEAM	VI
F2	GRID BEAM	F
F4	INSULATING PAD	F

4.2: Paneled cavity walls are formed as described in 3.5.

4.3: Box-sectioned hollow floors are formed as described in art 3.7

4.4: Full-wall-size and full-floor-size single plates. Instead of small size plates of full-wall and full-floor size can be cast and erected and jointed at corners to form a room.

4.5: Full-wall size and full-floor size double walled units. Full-wall size double walled panels can be cast and erected and jointed as is done in cavity walls and hollow floors.

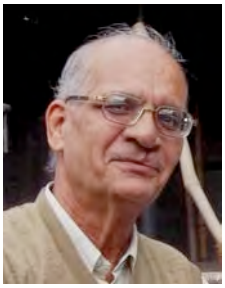
4.6: Full room size ferrocement units of small size like watchman's cabins, latrine units, toilet blocks, wayside side shops etc can be cast as one unit and transported to the site.

4.7: Ferrocement elements in form of lost formwork for RCC framework. Instead of timber forms for beams and columns and centering plates for slabs, thin ferrocement plates can be developed and used as lost forms for RCC framework of a building. When designed as structural members, they effect about 40 to 50 percent saving in quantity of steel, concrete and supporting structure. a separate paper is presented on this topic.

5.0: Conclusions:

Precast ferrocement elements provide the best system for mass scale housing where speed is the guiding factor. The problem of joints in precast concrete industry is completely solved by making them as structural members of the system.

AND THIS IS POSSIBLE ONLY DUE TO RIBBED STIFFENED PLATES IN FERROCEMENT.



Dr.BALKRISHNA N. DIVEKAR

Dr.Balkrishna N.Divekar did his Diploma in Civil Engineering in 1957, ranking first in Maharashtra State. In 1965 he did his Bachelor of Engineering. (Civil) from University of Pune, ranking first and has won the Gold medal. He has completed M.E. (Structures) in 1969 from the Pune University with dissertation on 'Laminated Neoprene Bridge Bearings'.

He did his research work for Ph.D (Engg.) from C.W.P.R.S Khadakwasla, wherein he has developed special types of low modulus concrete named "flexicrete" and established its use as modeling material for Model Analysis of Concrete Structures.

Dr.Divekar worked as a Professor of Civil Engineering for 25 years and has guided 30 research projects in "Ferrocement Technology" at graduate and postgraduate level.

In 1982, he took voluntary retirement to start his own industry "M/s Ferrocrete". For the last 25 years Dr.Divekar has designed and constructed many unique and large size Ferrocement structures like Petal shaped Water Tank of 12 lakh lit. capacity, Soil retaining wall of 6m high and 100m long, 8m Dia.and 15 m. high Silos,3.6m Dia. 210m long Egg shaped pipe to divert Nallah, office buildings of size 40m X 12m by using Ferrocement cavity walls, Hyperbolic Cylindrical shaped fan –ducts for cooling towers for Paharpur.etc.

An innovative method of constructing structures named "ALLI-NONE "is invented and patented byDr.Divekar. Dr.Divekar has published number of research papers and has written a construction manual on Ferrocement which is recently published. His manual is now referred as a text book for Pune University courses.

Dr.Divekar has initiated a "Ferrocement Society" to promote "Ferrocement Technology" to grass root level in India.

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Cast –in –situ Ferrocement

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Abstract

Ferrocement construction technology is quite popular throughout the world. Ferrocement, a thin element, is used as a building construction as well as a repair material. This paper attempts to review the negative aspect of pre cast ferrocement construction & introduce cast in situ joint less , monolithic ferrocement construction specially in building construction . This study brings out the importance of using cast in situ ferrocement construction in building. The study concludes that ferrocement will certainly be one of the best structural alternatives for RCC in the future.

1.1 Ferrocement Technology

Shelter is one of the basic needs of human being. But more than 80 developing countries in the world suffer from housing shortages resulting from population growth, internal migration, war, natural disaster, to mention a few. Most dwellings in rural areas are made of cheap local materials including low quality wood (which is easily attacked by termites), scrap metal, thatch and/or earth products (like clay, mud, sand, rock/ stone) which are temporary and unsafe. There is an urgent need to explore a building material that is structurally efficient but at the same time, should be lightweight, eco-friendly, cost effective, earth quake resistant and especially the ones that can perform the desired functions. Ferrocement is such a material that is slim and slender but at the same time strong and elegant which provides a potential solution to housing problems with an history of ancient and universal method of building huts by using reeds to reinforce dried mud .Ferrocement is more durable than wood/ timber and cheaper than imported steel .

1.2 Uniqueness of Ferrocement

Ferrocement is a thin construction element with thickness in the order of 10-25 mm (3/8–1 in.) and uses rich cement mortar; no coarse aggregate is used; and the reinforcement consists of one or more layers of continuous/ small diameter steel wire/ weld mesh netting. It requires no skilled labour for casting, and employs only little or no formwork. In ferrocement, cement matrix does not crack since cracking forces are taken over by wire mesh reinforcement immediately below the surface. Husain Doshi Gufa, an underground ferrocement shell structure which was built in 1993 at Ahmedabad, India has not only withstood the 2001 earthquake but also has remained crack-free till date (Doshi et al. 2011). Such a structure involving complex curvatures can be constructed in a reliable manner using ferrocement technology, giving free reign to architectural expression. Ferrocement construction technology is being popularized throughout the world in countries like Canada, USA, Australia, New Zealand, United Kingdom, Mexico, Brazil, the former USSR, Eastern European countries, China, Thailand, India, Indonesia, and in

other developing countries due to its uniqueness and versality. Ferrocement is being explored as building materials substituting stone, brick, RCC, steel, pre stressed concrete and timber and also as structural components—walls, floors, roofs, beams, columns and slabs, water and soil retaining wall structures; other applications include window and door frames and shutters. Ferrocement can be fabricated into any desired shape or structural configuration that is generally not possible with standard masonry, RCC or steel.

1.3 Ferrocement Structures World-wide

There are many structures built of ferrocement--housing units, shell roofs, water tanks and swimming pools, biogas digesters, silos, food storage units, and for some specialized applications such as floating marine structures for which reinforced concrete is too heavy, Ferrocement is a preferred choice over reinforced concrete. In the early 1960s, ferrocement construction was widely accepted in Australia, New Zealand, and the United Kingdom. From then on, thousands of ferrocement vessels and structures were built in quite a number of countries. In Israel, ferrocement is used to improve existing houses . Ferrocement houses utilizing local materials such as wood, bamboo or bush sticks as equivalent steel replacement have been constructed in Bangladesh, Indonesia and Papua New Guinea. In Sri Lanka, ferrocement houses resistant to cyclones are developed and constructed. In India, many ferrocement structures implemented by Auroville Centre for Scientific Research (CSR) are testimony of durability of the ferrocement technology.

1.4 Problems in Pre Cast Ferrocement Construction:

It is observed that joints are the main problematic area of pre cast construction , cracks developed at joint with a passage of time and it needs regular treatment of joints.

1.5 Cast in situ Ferrocement Constructions:

Cast in situ ferrocement construction is a joint less, monolithic construction in which reinforcement cage of all the member shall be placed and binded in position (as per drawing) and rich cement mortar is sprayed by guniting machine at a pressure of 3 to 4 kg . Pressure is required to achieve the compaction level. Generally shuttering may not be required but in certain conditions it required.

1.6 Case study of cast in situ ferrocement constructions:

1.6.1 School building at Sumerawand :

Village Sumerawand is situated in Anjar Taluka of District Bhuj . After 2001 earth quake reconstruction of school building is done by us. In this school building we had use cast in situ ferrocement technique. This structure is seismic resistant, structural design had been approved from IIT Roorkee. Twin wall construction with thermocol insulation had been done at site because thermal insulation required (in Bhuj day temperature is very high 45 -50 degree centigrade). RCC column with foundation had been taken to cater psychological requirement of villagers.

Reinforcement cage of ferrocement panels with RCC columns are placed in position and cement mortar is sprayed by guniting machine at 4 kg pressure.

After 11 years of construction there are no problem in structure , it is a zero maintenance structure even life of painted surface is much higher than conventional structure because of water tightness property of ferrocement.

This structure was completed in 45 days.

Work completed on school building in Kutchh (250 Sq mtr)

1.6.2 Soka Ikeda Library, Nasik:

In this structure steel pipe is used as a column, main frame is consist of hollow square MS pipe. Pre cast pedestal is used as a foundation, vertical members of main frame are grouted in pre cast pedestal , reinforcement cage of twin wall with thermocol is welded with main frame , cement mortar is sprayed by guniting machine at a pressure of 4.0 kg.

It is a joint less, monolithic structure, roofing is done by G.I. sheet.

This structure was completed in 25 days

1.6.3 Bio technical lab at Shyampur, Haridwar :

In this structure steel pipe is used as a column, main frame is consist of hollow square MS pile . Pre cast pedestal is used as a foundation, vertical members of main frame are grouted in pre cast pedestal, reinforcement cage of twin wall with thermocol is welded with main frame , cement mortar is sprayed by guniting machine at a pressure of 4.0 kg.

It is a joint less, monolithic structure, roofing is done by G.I. sheet.

This structure was completed in 35 days

1.6.4 Low cast cottage Saharanpur :

In this structure main frame viz horizontal and vertical members are made with 4mm steel wires. It is a non insulated structure shuttering is used during spraying / guniting of mortar. Walls as well as roof are made by cast in situ ferrocement. Brick masonry is used as foundation and raising of plinth. After 10 years of construction there is no problem in structure , it is a maintenance free structure.

This structure was completed in 21 days

1.7 Conclusion:

Ferrocement come into wide spread use in seismic prone area of developing countries. It is a faster construction. Any shape and size can be made effectively without any limitations.

Er. Naveen Kumar Singh, The Head Structural Designer of M/s Designer's wing having sixteen years of experience in the field of Structural Design, Ferro cement Technologies. He has in depth knowledge of RCC framed structures, Ferro cement structures and Portal frames structures. He has successfully designed many multi storied buildings and factory sheds across UP. He has designed more than 50000 tower foundations across India.

PRECAST FERROCEMENT LOST FORMS AS STRUCTURAL MEMBERS

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Abstract:

Innovative method of constructing RCC framework of columns, beams and slabs, with formwork of precast ferrocement elements is detailed below. Precast ferrocrete elements replace timber forms in shape of box section open at both ends for a column, channel section for a beam and stiffened plates of large size as centering plates for slabs. After concreting they become an integral part of the RCC framework. Indirectly they provide a watertight cover to the steel reinforcement.

Being precast, any desired finish can be given to the exposed surfaces and no separate plastering is necessary then. These forms, when designed as ferrocrete members with due consideration to the properties of high tensile strength, ductility and crack control of ferrocrete, can be used as structural members replacing RCC members. Then they take the form of hollow columns and hollow beams (with concrete near neutral axis removed completely) and thin ribbed slabs

About 50% of steel and concrete is saved in it. Even the walls can be replaced by ferrocrete cavity walls. Accordingly material consumption and weight of the structure gets reduced.

When precast ferrocrete forms are used, supporting framework in form of props and scaffolding is not required. The site work reduces only to pouring of concrete in the forms. Integral casting of joints between beams, columns and slabs is possible. The site work is reduced to 20% only and the time saved is enormous.

A case study of 25000 sq. ft of floor actually constructed by using this method is reported.

When designed as structural members, the ferrocrete formwork itself can replace RCC frame completely.

Key words: precast, formwork, ferrocement, RCC framework.

1.0: Introduction: Formwork for RCC framed structures

1.1: In conventional construction, RCC framework of columns, beams and slab is cast first and the filler walls of brick or block masonry are built in it later and plastered. For casting concrete in mould for columns, beams and slabs timber forms and steel centering plates are used. The problems posed in using these forms are as follows.

1.2: The shape of RCC member is restricted to rectangular boxes or plane surfaces. This is due to the plane planks of timber and steel plates available to build the forms. For other shapes specially shaped moulds are required to be designed and formed.

1.3: From the structural drawings, the carpenter works out the sizes and shapes of the forms and fabricates the forms accordingly. Very crude methods of cutting and joining the timber planks are used. Gaps in the joints and leakages of cement slurry through them, is a common feature.

1.4: Reuse of the planks, makes their surfaces rough and the finish of the concrete cast in it is affected and needs patch-up work and plaster finish later.

1.5: Fuel-value of timber makes it a material likely to be stolen from work site on and often.

1.6: Thousands of hectors of jungles are slaughtered to get timber planks. To get a timber plank 30 cm wide, girth of the tree stem cut is more than 40cms. It takes 20 to 25 years for the tree to grow to this size. What a colossal loss to the nature! It must be banned immediately.

1.7: All the work of fabricating and erecting the formwork is required to be done at site. A lot of time of site work is wasted due to it. Timber forms and centering plates need full support and very complicated and clumsy supporting framework and scaffolding is required for it. Slight sinking of one of the props may cause havoc at the time of concreting.

1.8: The operations, of making timber forms, erecting them at site and concreting the members are required to be done in a sequence and this sequence is repeated for each floor. Inter-dependence of all these operations, takes at least 28 days to cast a floor, which delays the project.

All these shortcomings can be overcome if thin-walled ferrocement forms are used.

2.0: Precast ferrocement formwork and centering plates.

2.1: Ferrocement can be easily cast in very thin sections without hampering its strength. Taking advantage of this property, thin walled ferrocement plates can be used to build formwork for RCC framework.

2.2: Due to high strength-to-weight ratio, high tensile and compressive strengths, control on crack widths and equal strength in both directions thin sections of ferrocement in form of plates of 20 to 30mm can be easily precast and used in place of timber planks.

2.3: Formwork in form of thin walled boxes, open at both ends, are used for columns, “U” shaped channels for beams and large size stiffened plates as centering plates for slabs.

2.4: Thin ferrocement plates of the formwork act as cover to reinforcement in RCC. They provide a complete watertight cover to the steel. In addition they save concrete used as cover, which amounts to about 25 percent of the concrete used in RCC member.

2.5: As the ferrocement forms are cast in factory, the desired finish to the surface can be given, This saves the mortar required for finishing the RCC work. Any desired finish with a saving of

about 25 mm thick of plaster over the exposed surface is saved. It amounts to saving of plaster of about 25 to 30 percentage of the volume of concrete used for the RCC member.

2.6: Additional material required for ferrocement plates is meshes only, because the mortar is same as used in cover and plastering and skeletal steel is same as main reinforcement in RCC. Compared to timber, this cost is negligible.

2.7: As ferrocement forms are fabricated by welding the skeletal steel and tying meshes tightly over it, the shape and size of the formwork is not restricted. You can have formwork in any complicated shape.

2.8: Stiffness and the strength of the ferrocement forms can be designed, so that it becomes self-standing, under their self weights and the load of green concrete put in them. The supporting framework for these forms reduces to a few props only.

2.9: Operations of casting forms in factory, erecting them at site and concreting them can be done simultaneously. There is no inter-dependence. On the next day of concreting of a floor, formwork of the upper floor can be started. The idea of "A floor a week" can be brought in practice due to it.

2.10: No wastage of material, no possibility of pilferage and the formwork acting as an integral part of the member are the additional advantages of ferrocement forms.

3.0: Different shapes of formwork:

3.1: Thin plates replacing timber planks: Thin plates with or without stiffening ribs can be used in place of timber planks. They are wrapped round the main reinforcement, held in position by steel clamps and anchored into the member at the time of concreting. Through holes drilled in the

plates, and anchoring bars are inserted in it. They get embedded in the concrete and are held in position by the hardened concrete. These plates act as planks holding the concrete and do not add to the strength of the member.

3.2: Open ended boxes for columns. Open ended rectangular boxes of outer dimensions matching with the finished size of the column and of the height of the column are precast. These boxes are erected in position around the main reinforcement. Putting concrete in boxes is the only work to be done at site. Alternatively the main reinforcement and the links are welded and act as skeletal steel for ferrocement box. Meshes are tied tightly around the skeleton and mortared to form the box. This forms a confining box of high tensile strength and the concrete placed in it has an added advantage of confinement in increasing its strength in compression.

3.3: Channel section for beams: "U" shaped channel section is used as form for beam, Main steel in the beam is used as skeletal steel for bottom flange of ferrocement section. The two side walls act as webs of "U" section and are provided with the shear reinforcement of the beam as skeletal steel. Meshes are wound on the skeleton and mortared to form ferrocement section.

3.3.1: If the tensile strength of ferrocement in the flange portion is considered about 50 percent of steel is saved in the flexural member.

3.3.2: A horizontal band of ferrocement is provided at certain depth, say 150 to 250mm from top edge of section. Concreting is done only in the upper portion of the section and it forms the compression zone of the flexural member. The portion of beam below the band and above the lower flange is a void. Concrete in that portion is removed as the concrete near neutral axis of beam has little contribution in compression zone. Concrete near neutral axis is removed and about 50 percent of concrete is saved in these hollow beams.

3.3.3: Shear in the beam is taken by the tensile strength of the ferrocement webs.

3.3.4: Thus the ferrocement formwork for beam when used as a structural member effects 50 percent saving in weight, steel reinforcement and concrete in the flexural member.

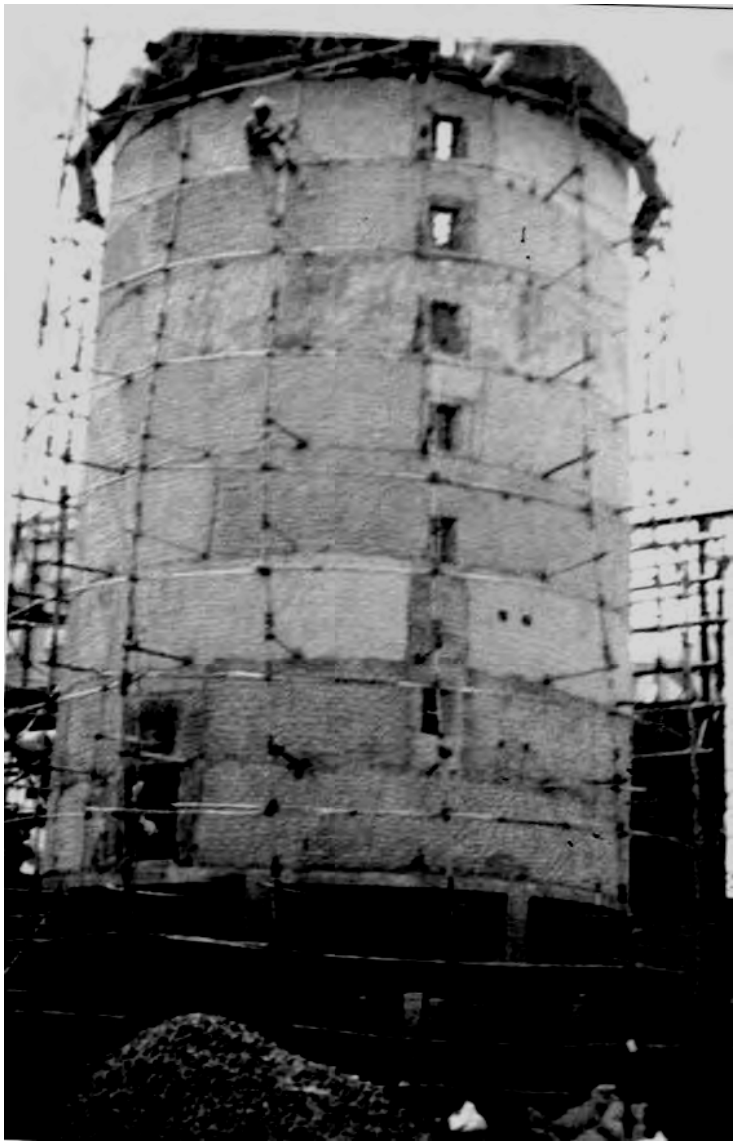
3.4: Stiffened plates as centering plates: Large size stiffened ferrocement plates, with the skeletal steel as the main reinforcement in slab, can be used as centering plates. These plates will work as tensile zone of the slab and will serve as a structural member also. Concrete cast over them will provide the compression zone.

3.5: Ribbed stiffened plates for paneled cavity walls and box-sectioned hollow floors. The walls and floors of a building are divided into panels. Ferrocement ribbed plates of the size of panel are precast. Two plates when jointed with ribs abutting each other form a cavity wall or a hollow floor. A separate paper is presented on this topic in this conference.

4.0: A case study:

Forth floor of a college building is already built by using ferrocement forms. Forms for about 90 columns of size 300mm x 600mm and 2.4m height, 240 forms for beams of size 300 x 750mm and spans varying from 6 to 8 meters and ferrocement centering plates of 1000mm x 3000,, size 750 numbers were used in this work. Details of this study are reported in FS 2011 conference.

4.1: Cast-in-situ double walling used as lost fromwork: A silo 25 ft dia and 50 ft high is built at Basamatnagar, Nanded, for storage of industrial waste. Inner and outer circular face walls of the silo were of 25mm thick ferrocement cast in situ. These thin walls acted as lost formwork. Concrete was pour-cast in the cavity. Use of cavity wall technique to substitute "Slip-form" method of constructing silos, is thus introduced for the first time in construction industry.



5.0: conclusions:

Use of ferrocement forms as structural members has a double advantage. It effects substantial economy in material, labor and time. Speedy construction of high rise buildings will be achieved by using this technique.

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As a managing partner of M/s Ferrocrete, he has constructed large size structures of ferrocement domes, shells, pyramids. He is running the business from last 8 years and constructing innovative structures like 85 feet high ferrocement towers, large size pyramids at heights. A new technique of constructing large size hyperbolic fan duct cylinders for cooling towers was developed by him.

He has presented a paper on "Ferrocrete counter fort soil retaining wall." In CBX2004

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Cellular Lightweight Concrete (CLC) For Prefabrication

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Abstract

Cellular Lightweight Concrete (CLC) has a good potential in prefabricated structures. The various components such as bricks, wall panels, chajjas, slabs etc. can be manufactured with precise quality control in manufacturing plant and readily used on site. The structural behavior of such components is required to be improved with the consistent investigations. Present paper attempts to investigate the flexural behavior of CLC slabs. The CLC slabs were cast in two shapes namely rectangular and corrugated. The flexural strength for these two shapes was determined so as to decide which shape provides optimum results. The effect of addition of fly-ash and polypropylene fibers on flexural strength of slabs was investigated. The percentage of fly-ash and polypropylene fibers were varied in the range of 0-50% and its effect on flexural strength was determined. It was observed that the flexural strength of rectangular CLC slab increases due to addition of fibers. Also, the addition of 30% fly-ash improves the flexural strength of CLC slab. The prefabricated rectangular CLC slabs can be manufactured in plant with strict quality control and used in the field.

Keywords: Cellular lightweight concrete, PP fiber, Fly ash, Foam, Corrugated slab, Flexural strength.

1. Introduction: Cellular lightweight concrete consists of cement paste and voids and the properties of both these components will have a measurable effect on the properties of the combined material. There are two methods of CLC production viz. foamed concrete and autoclaved aerated concrete. Foamed concrete is a cementitious paste of neat cement or cement and fly-ash with a multitude of micro- or macroscopic discrete air cells uniformly distributed throughout the mixture to create a lightweight concrete. Autoclaved aerated concrete (AAC), consists of a mix of lime, sand (or fly-ash), cement, water, and an expansion agent (aluminum powder) that is poured into mould. The reaction between the aluminum powder and cement causes microscopic hydrogen bubbles to form, expanding the concrete to about five times its original volume. After evaporation of the hydrogen, the highly closed-cell, aerated concrete is cut to size and steam-cured in a pressurized chamber (an autoclave).

Chen Bing *et. al.* (1) have done experimental research on properties of high strength foamed concrete. Nambiar, K.,Ramamurthy, K. (2,3,5,6,8,13) and Babu, D.S. ,Babu, K.G. (4) have investigated the structural properties of aerated concrete as well as air-void characterization of lightweight concrete. Kearsley, E.P. and Wainwright, P.J. (9,10,11,12) have presented their work on compressive strength, porosity and permeability of foam concrete.Very few works are available in literature on effect of fibers and fly-ash on

flexural strength of CLC. Also, the CLC slabs of different shapes such as plain, corrugated etc. have not been analyzed for flexural strength. Hence, the present paper aims at investigating these aspects.

2. Experimental study: Experimental studies were carried out in understanding the flexural behavior of cellular lightweight concrete. The studies include preliminary testing on constituents of CLC,i.e. cement, foam, polypropylene fibers and classified fly-ashin first phase and testing of CLC slabs for flexure in second phase..

2.1 Preliminary testing :Cement:Ordinary Portland Cement of Grade 53 confirming to IS 12269-1987 was used in the entire experimental programme. The preliminary tests were conducted on this cement for determination of its physical properties. Table 1 shows the results of these tests on cement.

Table 1: Physical properties of cement

Sr. No.	Particulars	Requirement as per IS 12269-1987	Test result Obtained
1	Fineness (as retained on 90 micron I.S. sieve in %)	Min.0.1	0.04
2.	Initial setting time	Min.30 minutes	78 minutes
3.	Final setting time	Min.600 minutes	380 minutes
4.	Soundness by Le Chartelier	Max. 10 min.	8 mm
5.	Specific gravity	3.15	3.15
6.	Standard Consistency	-	29
7.	Compressive Strength (3 days)		35.59 N/mm^2
	(7 days)		46.54 N/mm^2
	(28 days)		55.03 N/mm^2

Fly-ash- Classified coal fly ash, manufactured by Dirk India Pvt. Ltd. Nashik was used in entire experimental programme. The fly ash was added in cement in the proportion of 0%, 30%, 40% and 50% by weight of cement. The physical and chemical properties of fly ash are presented in Table No.2

Table 2: Physical and chemical properties of fly-ash

Sr.No.	Particular	Result
	Physical Properties	
1.	Fineness(Blaine's permeability method)	367 m^2/ kg
2.	Residue oversize (Sieve No.350)	16.511 %
3.	Lime reactivity	6.42 N/mm^2
4.	Moisture Content	0.267 %
5.	Autoclave expansion	0.03%
	Chemical Properties	
1.	Loss on Ignition	1.1%
2.	$Sio_2+Al_2O_3+Fe_2O_3$	92.651 %
3.	SiO_2	59.360%
4.	MgO	1.526%
5.	SO_3	0.837%
6.	Na_2O	0.506%
7.	Total chlorides	0.029%

Foam- Protein based 100% bio gradable foam concentrate which forms very stable bubbles and imparts necessary porosity to the CLC was used in entire experimental programme. The bubbles are strong enough to last till the CLC is set at required density. The foam concentration used was 1litre for 70litre water. The physical and chemical properties of foam are presented in Table No.3

Table 3: Physical and chemical properties of foam

Sr. No.	Particulars	Results
1	Appearance	Viscous black liquid
2	pH	6.5-7.5
3	Sp. Gravity	1.00-1.02
4	Viscosity	< 1500 CPS max
5	Freezing point	0^oC

Polypropylene fibers- Construction polypropylene fibers confirming to ASTM C-1116 were used in entire experimental programme. The polypropylene fibers were available in the form of monofilaments and 12mm cut in length. The homogeneous base mix was prepared by adding calculated quantity of polypropylene fibers. The proportion was 100gm fibers for 1 bag of cement. As seen, fibers have good effect in all respect, because it reduces thermal cracks, shrinkage cracks, micro cracks, and increases flexural strength, service life of material, and abrasion resistance and impact strength of concrete. The properties of polypropylene fibers are presented in Table No.4

Table 4: Properties of polypropylene fibers

Sr. No	Particulars	Test Results	Sr. No	Particulars	Test Results
1	Form	Monofilaments	10	Modulus (Youngs)	4.0 kN/Sq.mm
2	Colour	Natural	11	Melting Point	>160 Degree Celcius
3	Specific Gravity	0.91 gm/Cu.cm.	12	Ignition Point	600 Degree Celcius
4	Density-Bulk	910 Kg/Cu.m.(Approx.)	13	Alkali Resistance	Excellent
5	Density-Loose	250-430 Kg/Cu.m.(Approx.)	14	Chemical Resistance	Excellent
6	Denier	1050	15	Acid and Salt Resistance	High
7	Dry Tenacity	150 MPa-After Spinning	16	Absorption	Nil
8	Dry Tenacity	850 MPa-After Drawing	17	Fiber-Cut Length(mm)	12
9	Tensile Strength	0.67 kN/Sq.mm	18	Molecular Formula	(C3H6)n

2.2 Mix proportions and mix details- Eight types of CLC mix proportions were designed to investigate the flexural strength of CLC corrugated and plain slabs. The flexural analysis of the slabs was done on the beams of size 500mm x 150mm x 76.2mm. The mix design was carried out for the CLC with and without fibers for the density of 1500 kg/m^3.

2.3 Curing condition: - All the specimens were demoulded 24 hours after the casting and placed in curing tank containing potable water at room temperature in the range of 23 to 29° C. All specimens were cured for 28 days before testing.

2.4 Specimens and testing details: - The CLC specimens of size 500mm x 150mm x 76.2mm were cast for the eight types of CLC mix. The specimens were tested for flexure under flexural testing machine of 100kN capacity with two point load system as shown in Photo1.The average flexural strength of three specimens is presented in Table No. 5

Photograph 1: Details of flexural testing

3. Results and discussions- The flexural strength of cellular lightweight concrete corrugated and plain slabs cast in CLC with and without fibers are presented in Table 5 and 6.

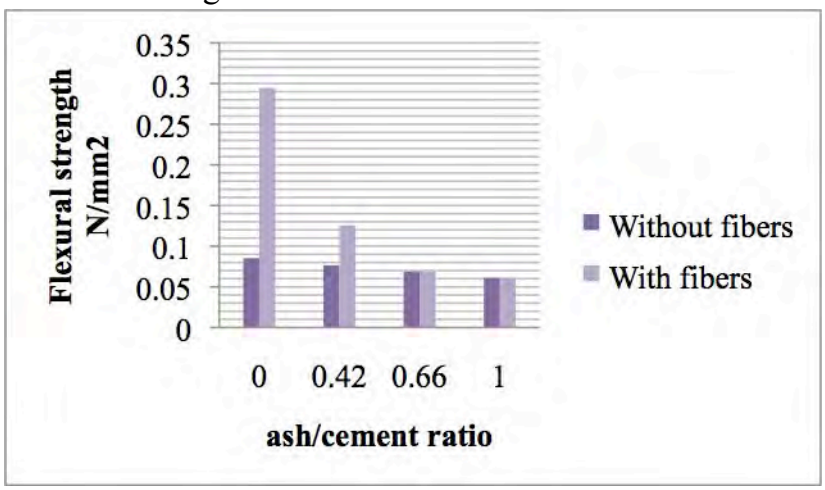
Table 5: Flexural strength (N/mm^2) of Corrugated CLC slab

Sr. No.	Designations	Description	Avg. flexural strength (MPa)
1	MF0A0	Mix design without fibers without fly ash	0.0853
2	MF0A30	Mix design without fibers with 30% fly ash	0.0765
3	MF0A40	Mix design without fibers with 40% fly ash	0.0688
4	MF0A50	Mix design without fibers with 50% fly ash	0.0612
5	MF1A0	Mix design with fibers with 0% fly ash	0.2945
6	MF1A30	Mix design with fibers with 30% fly ash	0.1256
7	MF1A40	Mix design with fibers with 40% fly ash	0.0688
8	MF1A50	Mix design with fibers with 50% fly ash	0.0612

Table 6: Flexural strength (N/mm^2) of Plain CLC slab

Sr. No.	Designations	Description	Avg. flexural strength (Mpa)
1	MF0A30	MF0A30	0.560035842
2	MF1A30	MF1A30	0.720046083

It is observed from the results that the flexural strength of corrugated CLC slab is not improved by adding the fly-ash in it. However, the additions of fibers have significant effect on flexural strength of CLC. When compared to control specimen, the flexural strength has increased by 245.25% due to addition of fibers. Though the flexural strength is enhanced due to fibers alone, the addition of fly-ash along with fibers reduces the overall flexural strength. This trend has been shown in Graph 1.Hence, it is recommended not to use fly-ash in CLC corrugated slabs.



Graph 1: Effect of ash/cement ratio on flexural strength of Corrugated CLC slab

The plain slab of CLC exhibits the same trend of increase in flexural strength due to addition of fibers. The trend of reduction in flexural strength due to addition of fly-ash in corrugated sheets has not been observed in plain CLC slabs. The combination of 30% fly-ash and fibers resulted into increase in flexural strength by 744.07% in plain CLC slab. Compared to CLC plain slab without fibers, the increase in flexural strength was by 28.57% for the same amount of fly-ash i.e. 30%.

It is revealed from the results that the plain slab of CLC offers more flexural strength than corrugated slab. Hence, it can be recommended that prefabricated plain CLC slabs can be promoted in market.

4. Conclusions:The CLC slab of plain shape can be preferred than that of corrugated shape. The addition of 30% fly-ash along with fibers enhanced the flexural strength of CLC plain slab. However, the corrugated CLC slab looses its flexural strength due to addition of fly-ash.

The density of 1500 kg/m^3 of CLC slab offers lightweight and adequate flexural strength and thus, the prefabricated plain CLC slabs can be used in field.

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TILOTHU MAHILA MANDAL:
Successful delivery of affordable, sustainable housing

Er. Ranjit Sinha - Consultant – Advisor: Tilothu Mahila Mandal, Rohtas.

I am said to be an engineer. I had the great opportunity to study Electrical Engineering in IT BHU, now officially called IIT BHU 44 years ago. Since then, I have nothing to really show as an engineer, except for some discipline in my thoughts.

For the last 22 years, I have lived in a village in Bihar, my native place, working with women in helping them improve their lots and thereby change their lives for the better. In the bargain, we also work with their families, their men-folk and children in the fields of employment generation, education, health, housing and sanitation.

Yes, we have an NGO, Tilothu Mahila Mandal,now in its 50th year and run a formal CBSE School for rural children, an eye-hospital, a degree college and a Building Center. The Building Center is the one whose concern I am voicing in this forum.

The Building Center was established 18 years ago with the assistance of HUDCO as apart of the Network of Building Centers to bring technical solutions to affordable housing at Grass Root Levels under an ambitious program called “National Movement for Building Centers”.

It was hoped that the 650+ such units set up with an assistance of Rs. 5 lakhs as Seed Capital each would bring the construction technologies developed in India’s prestigious Research organizations and Premier Engineering Institutions to meet the growing housing demands and shelters for the poorest. This was to be a lab-to-land effort, encouraging training of local artisans, promoting the use of local materials, improving on traditional methods of building in different regions, but basically working toward “Shelter-for-All”.

To put it bluntly, the experiment failed, and there are just a handful of us continuing with the mandate. The excuses were many, too many to be listed here, but the long-and-short of my personal assessment is that there was no will to excel, no thought of environment issues, no concern about the really poor.

Sir, this is not a forum to berate the failed management of the Building Centers. The mission of our NGO is to continue to work to our limited capacity, training construction workers, producing components for the housing industry, meeting at least the housing needs of the rural and urban deprived, promoting local materials, traditions and artisans, and generally improving upon the record of the Construction Industry’s negative record as “Polluters”.

Sir, I come from Bihar, a state that has woken up from deep sleep after 30 years to join the Development Scenario of India. With 9% of India's population and a rich history, it was termed the bane of this country, lawless, incompetent, a drain on India, laughing stock with no roads, no electricity, no industry, no education, high infant mortality, no hospital, etc. etc.

Some degree of change has come, but not nearly enough. We have a long way to go. We at our NGO would like to contribute. The bureaucrats do not understand, the politicians continue to play their chair-games, engineers are afraid to think beyond the SOR, and the public continues to be shelter-less. Why?

A couple of years ago, the quarrying and mining of stone-chips was banned in our state, because our revered CM wanted to preserve the limited hills we were left with after the split into two states, Jharkhand and Bihar. True, it was ecologically the right thing to do. But there was no planning, no alternatives put in place. The result: the cost of stone chips now available only from Jharkhand cost 3 times what they did an year ago. The Government pumped in more money into its own ambitious projects, the middle class downwards had no place to go.

We suggested Ferro-cement, we suggested Filler Slabs, we suggested Reinforced Bricks. All rejected – they do not appear in the SOR, so no technical sanction. We weep.

Now they say burnt brick manufacture will be banned come April 1, 2014. It causes erosion and pollution during manufacture, wastage of precious fossil fuel. What now?

Our NGO had been shouting hoarse for the last 15 years that the burnt clay brick was environmentally bad. Then no one listened. We shifted to PCC Blocks years ago but could only work on private projects, because PCC does not appear in Bihar's SOR.

Now even that option is lost. We have no stone grit available. No change in the offing in the SOR also.

Now we suggest Fly Ash bricks, and even better Fly Ash based inter-locking blocks, and going a little further, CLC and AAC walling materials. Will the powers-that-be listen, incorporate them in the precious SORs? I do not know the situation in the other states, but here, from this august assemblage can a cry go out to our engineer-brethren in Bihar to wake up? Each time a proven technology, not yet in the SOR comes up, we are told testing would have be done in different Engineering Colleges or other "Accredited" institutions of Bihar and the normal result is either a report stating "further authentication required" or just no reply. The red-tape consumes it all.

My impression is they want to re-invent the wheel.

It is at this juncture, when we find ourselves at cross-roads of pollution concerns, nation building, providing shelter-for-all, modern concepts and developments in engineering, making efforts to catch up with the world, and yet not willing to change and accept all the work of our research bodies and engineering institutes, the works of Laurie Baker and Ray Meeker, to name just two, that I have some questions of this assemblage:

1. Do we as the engineering faculty have a role in growth of this nation of 120 crores?
2. Do we as a fraternity, fight shy of developments in civil engineering?
3. Do we have a right to stay away from finding ways to build better, to build economically, to build more, and create a just and equitable society where shelter is available to all?
4. Do we only cater to urban demands, and those too, only of the rich, and of government and private corporates?
5. If we stick to our present ways, do we create safe cities, control urban migration and good healthy environment for all to progress?
6. Do we, as the elite, have the right to live in high-rises or expensive bungalows, surrounded by the worst slums of the world?
7. Do we not try and at least partially switch over to pre-fabs to build quicker, build better?
8. Do we not participate in Skills Development, seeing how there is a shortage of skilled workers in the construction industries?
9. Should we not train more women workers to graduate from manual labor to efficient skilled categories?

In short where do we go from here?

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Ranjit Sinha is a philanthropist and a social entrepreneur.Over the last 20 years, and inspired by Laurie Baker, a pioneer in cost-effective solutions, he has taken a keen interest in studying, developing and implementing cost-effective building technologies, and was a founding member of TMM Nirmiti Kendra, a division of Tilothu Mahila Mandal (an NGO), that was set up in 1996 as part of HUDCO's "building center" initiative.His involvement has propelled TMM Nirmiti Kendra into a successful and nationally recognized organization.

Ranjit is also a regular teacher at Amaltas Niketan, a CBSE-curriculum, English-medium school run by TMM, for the local village children. He teaches English & Social Sciences.

Ranjit started his career with IBM, and is a graduate of IT BHU & Indian Institute of Foreign Trade.

TMM successfully delivered the challenging job of providing shelter to 1906 slum-dwelling families in Hazaribag and Ranchi at a cost not exceeding Rs 200.00 per sq ft. These are 3 storied framed structures with sanitation, electricity and water supply, all within the budget given. They cover a built-up area of 400,000 sq ft and were completed under the watchful eyes of HUDCO in early 2009.

During the years 2011-13, Tm has worked as implementers of an Affordable Rural Housing Project promoted by an Indian-American, Ms Saloni Sinha, to meet the concerns of quality living for the Rural-Middle-Class. Here we have worked with inter-locking Soil-Clay blocks, optimized structural and environmentally friendly technologies including non-electrical wastewater management and recycling and solid waste management. This is an eminently replicable model.

Prefabrication- a Tangible Solution to the Housing Problem of India*

Prof. Subodh Shankar, Amity School of Architecture & Planning, Lucknow
and Former Chief Architect Planner, UP Housing & Dev. Board

All of us are well aware about the gigantic housing problem our country is facing as of now. The housing shortage which for a very long period was being estimated to be 26.4 million at the beginning of 12th five year plan, has due to statistical miracle of the Ministry of Housing and Urban Poverty Alleviation, GOI been pegged at a 18.78 million. Although, this is much lower than the actual shortage but is still astronomical.

It poses a marathon challenge to Planners, Architects, Engineers, Researchers and the Administrators, particularly when with the help of technological advancements we have been able to solve other major problems like food and clothing. In fact in many sectors – specifically IT, we are almost like world leaders. Then, why the problem of housing remains intangible even after 66 years of independence. Do we lack in finances, technology or political will? In my opinion the main hurdle in solving the housing problem of the millions is to provide a shelter within the paying capacity of the needy within a reasonable time. The element of reasonable time is very important because if the needy people are not provided with a decent shelter in time, they have the tendency to occupy any sort of covered space -may be an empty sewer or a drain pipe. This invariably leads to development of slums. Thus, we have got to search for solutions which are time as well as cost effective. Undoubtedly, we shall have to think in terms of industrialized methods of construction.

If we look in to the past then we are constrained to know that efforts towards modernization and industrialization have been extremely meager in this field till 20th. centaury. However, during last couple of years we are able to see some sophisticated construction machinery being deployed at few construction sites. But technological modernization is still not visible across the country, which remain a cause of concern especially when houses have to be constructed in very large numbers.

Prefabrication in its simplest form is the opposite of 'in-situ' meaning thereby that what ever is not made or constructed at the actual time of construction at site comes within the purview of prefabrication. For example, if a door panel is not made at the construction site and brought from a door manufacturing unit then we can say that here prefabrication technique has been adopted. Likewise, the use of factory made door- window frames (chaukhats), grills, RCC Jali etc. also qualify under pre-fabrication techniques. But certainly it does not create any thrill at any national level seminar.

In the better understood meaning of prefabrication, it is that construction technique where we require large scale lifting and transportation equipments besides very sophisticated machinery needed at the place of manufacturing. This is perhaps the other extreme of prefabrication and as a matter of fact has been creating phobias amongst the architects

and engineers. Also, the fear of loss of jobs for unskilled Labour is another factor detrimental to the growth of this technology in India. Truly so, in a country where we are still using primitive tools and construction methods we should not jump to ultimate in any technology. It may perhaps be more prudent to go for partial prefabrication in the initial stages of transition.

As is well known, roofing takes maximum time and involves enormous shuttering and centering costs. Also the limited availability of shuttering material delays the pace of construction. CBRI Roorkee has developed various prefab or partial prefab methods for roofing. The channel unit, L- plan roofing system, brick panel over partial precast joists are some of the practical methods which can be considered for immediate adoption. None of these methods need sophisticated mercenary or, equipments or highly skilled Labour.

The U.P. Housing and Development Board in its scheme at Indira Nagar, Lucknow has quite successfully used the brick panel and joist roofing system for 200 houses way back in 1976.

CBRI Roorkee has also developed prefab walling panels which can, apart from speeding up the pace of construction and maintaining high order of quality control, help in achieving better floor to plinth area efficiency. These panels can be fabricated to such convenient sizes that 2-3 persons can manually place these in position. The use of precast Lintels has now been quite well adopted. However, the use of earthen flooring tiles also developed by CBRI Roorkee is far from practical application in most parts of the country. This is a wonderful material which provides an impervious flooring layer at a much lesser cost and is also 'green'.

It is generally felt that most of the prefab techniques are cement and steel oriented and by adaptation of these techniques dependency on high energy materials will be more. In fact this is true. As we all know in in-situ construction large amount of cement is wasted through spillage and other means. Also lack of technical knowledge of latest design theories to a good percentage of people who undertake construction work particularly in villages and smaller towns leads to the provision of over reinforcement and larger cross sections of lintels and roofs etc. This invariably means that lot of extra cement and steel are unnecessarily dumped or lost in such constructions. On the other hand if the building components are manufactured in factories then with the help of specialized structural design and strict QC measures use of steel and cement can be minimized. Further more due to strict QC measures in factory system, we can even consider to lower the factor of safety – which is extremely high in our country. These will infact effect overall saving of crores of rupees, as well as conserve on scarce building materials, thereby allowing more and more houses for the needy homeless people whose number is swelling beyond the manageable limits.

Another lesser or rather unknown factor which favours prefabrication is the need for lesser number of casual Labour at the place of constructions. It is very common phenomena that the casual Labour starts living in Jhuggi Jhopris near the construction sites and they do not move out after the construction work is over. This leads to the creation of permanent slums at very important locations. Therefore, a construction

method which requires lesser number of casual Labour at the places of constructions will also reduce the chances of creation of slums. For people working in factories pucca houses can be constructed by the factory owners. Factory system will also help in improving the socio economic condition of millions of people as has been made possible in other sectors. Therefore, prefabrication also helps in achieving the major social obligation of the Government. However, adequate care has to be taken for the sustainability of those unskilled people for whom employment opportunities have been temporarily reduced.

We shall have to, therefore, find out ways and means to remove the dilemma between socio economic upliftment and employment- undoubtedly both are equally important in the present scenario. This can possibly be achieved by adopting partial prefabrication- i.e some part of the building continue with traditional methods while elements like roofing, door window frames & shutters, lintels etc be done with prefab techniques. Even in other sectors mixed types are being advocated by the industry pundits.

However, it is abundantly clear that without the adoption of prefab technology the gigantic housing problem of the country can not be solved. Let us therefore, resolve today to adopt this technology without any further delay.

* The article is the updated version of a technical paper of the same author presented during the National Seminar on Performance Orientation in Design & Construction of Buildings organised by the UP State Centre of the Institution of Engineers (I) in Lucknow on 4-5 May, 1987

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Pre-cast technology in water and Sanitation works

Er. Thakur Das Daryana , Executive engineer (Retd) of Uttar Pradesh Jal Nigam

Precast materials and units have been in use in civil engineering works since long. The earliest examples may the concrete building blocks, pre-cast lintels, and such other building materials, and components.

Water Supply

In water supply schemes, some of the parts and components which are often more convenient and useful as pre-cast materials and components rather than those cast-in-situ. These are given below:-

Hand-pump platforms, drains, and standing sills.

Public water supply stand posts.

Small capacity water tanks

Advantages of using the above pre-cast units:-

Uniform quality and controlled conditions of work, allow speedier works without unnecessary interruptions and consequent delays.

Larger number of units can be installed within specified time schedules.

No wastage of material at site of works, which often occurs during the cast-in-situ works.

Saving in cost of works owing to the speed & controlled use of materials without wastage.

While, the use of above materials and component units, has always been made fruitfully, in practice, it warrants for more advanced work in this field to facilitate easier, better and speedier work schedules. In fact this is the time when the work units like the following must be taken up, as pre-cast works to cope up with the increasing developmental needs.

Pump Houses

Small Over Head Tanks with moderate staging heights.

Tank Type Stand Posts.

Sanitation Works

In Sanitation works the following unit components have often been used with advantage, but their use has been quite negligible which needs to be increased and to be popularized.

R.C.C. Leach Pit Lining for Leach Pit type Latrines.

R.C.C. Covers for Leach Pits.

Precast connecting chambers, with covers.

R.C.C. Latrine superstructure components and roof tops.

The construction of Latrine units has been lacking on account of various field obstacles, and it really needs to be regulated for speed of construction which can be done through pre -casting technologies.

Conclusion

The pre-casting technology has by now become quite popular and well known and it hardly needs any explanations.

The only requirement is to adopt and to follow these methods and techniques to take proper advantage for the required developmental of works.

The magnitude of the On-Site-Sanitation works to be done is very large , in view of the situations prevailing here in India. It is there substantially important to adopt the ways and means to achieve sustainable quality works.

Pre-cast technologies offer the most appropriate solutions for these works which need to be adopted, for proper and speedier implementation of works.

Er. Thakur Das Daryana

Member of the Institution of Engineers (India) , is retired executive engineer of Uttar Pradesh Jal Nigam. After retirement he has worked on a number of projects, like SWAJAL, with Env. Das (India), and Urban Services, Environmental Rating Systems Project (funded by UNDP) with TERI. He has been actively working for consultancy works.

Housing Requirements and its possible dimensions in India

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Abstract

India is facing the challenge of providing adequate shelter to 20.5 million households from 2001 for its citizens. The housing sector in India for several decades faced a number of set-backs, such as an unorganized market, development disparities, a compartmentalized development approach and a deterrent rent control system. In this paper it is investigated, commingle these issues and propose a construction strategy for the Indian housing sector. The criteria to measure sustainability in this paper are cost effectiveness, efficient utilization of resources and environment friendliness. Affordability of a house and availability of building materials for its construction are the main determinants of access to shelter. This demands efficient use of resources at low cost. In this paper it is analyze whether it is possible to reduce cost, reduce emissions and generate employment in house construction. Recent Government policy statements have indicated that an annual supply of two million new houses would be required to meet the current shortage of housing in India. The construction technologies that are evaluated are the 'prefabrication' construction technologies as well as low-cost techniques.

Keywords: Housing; Low-cost housing; prefabricated house; India

1. Introduction

In India, at the beginning of 21st century, providing adequate houses and sustainable environment are the major pressing challenges. The problem of proper housing will be removed by developing by strategy of low cost housing. Low cost housing can be considered affordable for low and moderate-income earners if household can acquire a housing unit (owned or rented) for an amount up to 30 percent of its household income (Miles, 2000). Cost effective housing is a relative concept and has more to do with budgeting and seeks to reduce construction cost through better management, appropriate use of local materials, skills and technology but without sacrificing the performance and structure life (Tiwari et al., 1999).

Low cost housing is a new concept which deals with effective budgeting and following techniques which help reducing construction cost through the use of locally available materials along with improved skills and technologies without sacrificing the strength, performance and life of the structure (Kumar, 1999; Civil Engineering Portal, 2008). Low cost housing technologies aim to reduce construction cost and prefabrication technology reduces the construction on site. It is about the usage of local and indigenous building materials, local skills, energy saver and environment-friendly options.

2 .Conventional Construction Methods

Conventional Construction Methods are used are described in the following steps -

- Foundation is the first step of the construction which is provided to distribute loads of superstructure and all others load (dead and live) to the soil thus providing base. Excavation work is first carried out, then earth-work is filled with available earth and ends with watering and compaction in a 6" thick layer.
- After this plain cement concrete is used to form a leveled surface on the excavated soil. The volumetric concrete mix proportion of 1:4:8 (cement: sand: aggregate), with a 6" thick layer for masonry foundation and column footings is used. Plain cement concrete is finished on the excavated soil strata and mixed by manual process.
- Stone masonry for foundation is constructed for outer walls and burnt brick masonry of a 9" thick layer for main walls and a 4 1/2" thick layer for all internal walls. First class bricks are used for the construction.
- The normal procedure to cast reinforced cement concrete slab is to make shuttering and provide reinforcement and concreting. Formwork is used, with proper cover blocks between bars. Both aggregate and sand used are 3/4" graded.
- Plastering is used for the ceiling, inside and outside walls.
- For the flooring, the earth is properly filled and consolidated in the ratio of 1:4:8 (cement: sand: aggregate) concrete.
- After the plastering the painting process is started, for this surface is prepared with putty and primer

These conventional steps take at least 2 to 3 months, however the requirement of houses is much higher than the supply chain. There is requirement of the some alternate method of the construction techniques.

3 .Advantages and disadvantages of Conventional Construction Methods

The design and the construction of the structure are flexible. Depending on house design and the materials specified, construction can be cost effective. It is accepted and understood from designers and builders to lenders, insurers and warranty providers. Materials are readily available from local builder's merchants. Masonry materials are strong, durable and long lasting, spreading their impact (Traditional Housing Bureau) and Good thermal performance. Masonry materials have a high thermal mass, which is their ability to absorb and store heat. In the summer this keeps the building cool and in the winter the heat stored during the day is slowly released back into the house at night leading to a more constant, comfortable environment. When the building has completed of its useful lifespan, bricks and blocks are 100% recyclable (Traditional Housing Bureau).

There are some drawbacks in traditional method of construction which are that progress works can be affected by adverse weather conditions. Materials need to be stored on site and protected from the weather before they are incorporated into the building structure.

4. Prefabrication based Low Cost Construction Technologies

It is found that cost-effective prefabrication construction technologies, which apart from reducing construction cost by the reduction of quantity of building materials through improved and innovative techniques, can play a great role in providing better construction methods and protecting the environment. It should be noted that prefabrication construction technologies do not compromise with safety and security of the buildings. The detail procedures of each step used for the case study are as follow:

- For the construction of the foundation, the use of available materials such as brick or concrete blocks can be made to resist lateral forces buttresses at the corner .Placement of support piers is very important to distribute the weight correctly and level the structure. Foundation must be constructed in such a manner so as to provide a stable environment.
- Prefabricated panels are installed on the foundation according to the given plan. These panels are made at construction unit of factory. Steel, cement, wood and composite materials are used for the construction of prefabricated panel.
- Prefabricated roofing system is used which based on the principle that for roofs which are simply supported, the upper part of the slab is subjected to compressive forces and the lower part of the slab experience tensile forces. Prefabricated panels are very good in withstanding compressive forces and tensile forces.
- Flooring is generally made of terracotta tiles or color oxides. Bedding is made out of broken brick bats. Various patterns and designs are used, depending on shape, size of tiles, span of flooring, and client's personal preference.
- Plastering can be avoided on the walls
- Door and window frames are responsible for almost half the cost of timber used, avoiding frames can considerably reduce timber cost. Door planks are screwed together with strap iron hinges to form doors, and this can be carried by 'holdfast' carried into the wall. A frameless window consists of a vertical plank of about 10" wide set into two holes, one at the top and one at the bottom. This forms a simple pivotal window. Wide span windows can be partially framed and fixed to walls or can have rows of pivotal planks.

5. Material Used for the Prefabricated Panels

Prefabricated housing technology involves use of factory-manufactured components in buildings. Some commonly used prefabrication materials include steel frames for structures, panels made of wood, cement, gypsum and other materials for floors, walls and ceilings, factory-made doors, windows and ventilators.

6. Benefits of Using Prefabricated Low Cost Housing Technologies

In prefabrication method self-supporting ready-made components are used in construction, so the need for formwork, shuttering and scaffolding is greatly reduced. In

this method, Construction time is reduced and buildings are completed in less time, this reduce the cost of labour. On-site construction and congestion is minimized. Quality control can be easier in a factory assembly line setting than a construction site setting. Prefabrication can be located where skilled labour is more readily available and costs of labour, power, materials, space and overheads are lower. Time spent in bad weather or hazardous environments at the construction site is minimized. Less waste may occur. Advanced materials such as sandwich-structured composite can be easily used, improving thermal and sound insulation and airtightness.

According to the Ministry of Housing and Urban Poverty Alleviation, National Buildings Organisation report there is shortage of 26.53 million houses in 2002. If these houses are made by the conventional construction method then this gap will never cover-up. But if use of pre fabrication method of construction will be applied then this will be so much helpful for the removal of shortage of household.

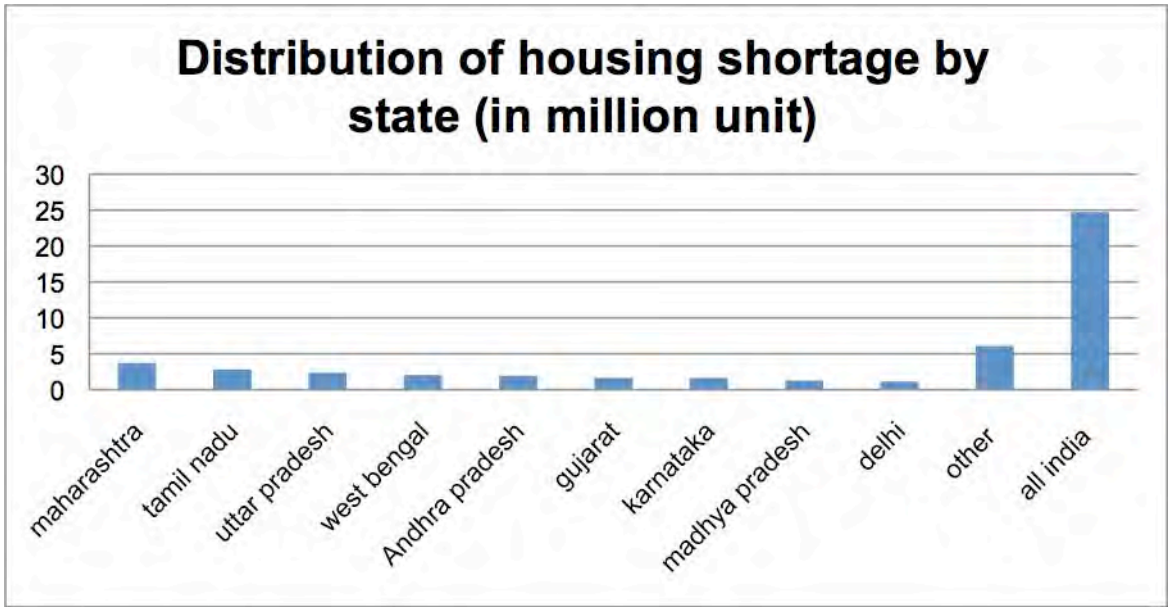

Fig 6.1- Source: Ministry of Housing and Urban Poverty Alleviation September 2007

Table no-6.1 comparisons of cost and time of different methods of construction

Method of construction	Conventional Construction Methods	Prefabricated housing method
Cost of construction	Rs 10000 per sq.m#	Rs 4,000 per sq.m*
Time of completion (100 sq. m)	4 months	1 month

*based on Gujarat government report 2007

#based on the CPWD rate calculations

7. Conclusion

To solve the problem of the housing and providing the shelter to the common people particularly for low-income and middle-income families, it is necessary to adopt low cost prefabrication housing technologies for the construction. This paper examined the cost effectiveness of using prefabrication housing technologies in comparison with the traditional construction methods. It was found that about 66.67% saving in construction cost, and one fourth times saved by using the prefabricated construction method. On the basis of this it is recommended that the prefabrication housing technique should be adopted to remove the shortage of housing in Indian scenario.

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Disaster Mitigation and Prefabrication

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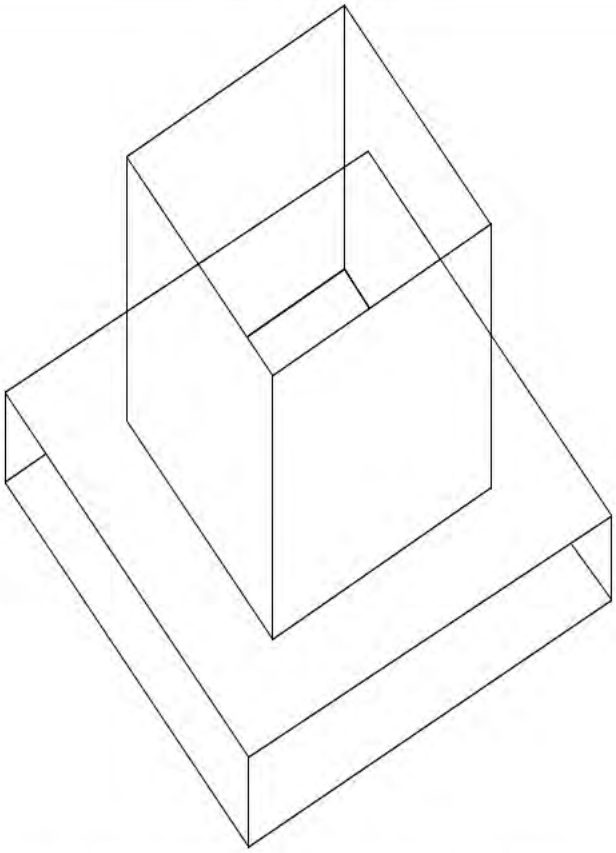
Disaster is a freighting word but lately it is becoming very common in our conversation. Almost everyone seems to be affected by one or the other disaster thru their own involvement or that of their close relatives and / or friends. And, unfortunately, there appears no solution or end to it. Our country cannot or should not live without pilgrimage, which is the backbone of our very existence and culture. And if the word disaster becomes synonymous with pilgrimage, a serious thought by all of us is immediately called for. Even without pilgrimage, most of us live with GOD in our hearts for love or fear. The five basic elements, earth, wind, water, fire and sky give rise to disasters in the form of earth-quakes & landslides, hurricanes, tsunamis, fires and cloud bursts.

Even without a close look at the loss of property and life, one can conclude that the basic reason for this lies in the weight of the structures. Large weights are root cause of landslides and also the high seismic forces exerted on the structures. A major portion of loss of property and life are because of this. As a result, we must reduce the structural weights, not only by using low-density materials of construction but also by adopting smaller and thinner sections in buildings. This will not only save us in higher levels but also give a chance to design floatable structures under tsunamis. Prefabrication construction gives low weight construction and is an ideal choice in the fight against disasters.

Another feature responsible for the heavy losses is the disintegration of structural entities under adverse conditions. But, if structures are made with natural materials like timber and bamboos, which are internally strongly bonded together or with Fiber glass or ferrocement which have a almost continuous fibers or wire meshes causing a strong bond, even under failure conditions, the structures have enough residual strengths to allow enough time to the inhabitants to exit safely. This feature, I term as, wind screen effect is manifested by Car wind screens when struck. Wind screen remains in place in one piece even after becoming non – functional. More or less the same behaviour is observed with ferrocement, fiber glass, timber and bamboo.



AREA OF ROOF AND WALLS = 5 X 3 X 3 = 45 SQ M

AREA OF PLINTH BOX = 2 X 5 X 5 + 4 X 5 X 1 = 70 SQ M

TOTAL AREA = 115 SQ M

TOTAL WEIGHT = 115 X 100 = 11500 KG

PLINTH BOX WOULD SINK IN WATER BY 11500 / 25000 = 0.46 M

As the prefabricated structures are light weight and are assembly of many smaller components strongly jointed together including the walls, floors and roofs, the entire structure behaves like a box. A box structure and that too with low overall weight does not call for a conventional foundation. Small foundation strips at ground level itself are sufficient to support the structures in totality. This avoids the anchorage of the structures to the mother earth. There exists no mechanism for transfer of earth quake forces to the structure from the shaking of the ground. This is the easiest method to safe guard the structures under seismic activity.

The failure of a building results in heavy casualties by impact of roofs and walls falling on the inhabitants. In the case of prefab construction, the overall weight being very low and disintegration being small, the loss of life is greatly reduced. The ratio of dead vs injured gets favourably altered. Because of natural fibers and wire meshes and wind screen effect, the building even after failure gives enough time for occupants to move out before collapse, if at all.

After an earth quake and vast devastation, the removal of debris is a major task and often takes more than a decade. Either the owner is no longer alive or is bed ridden etc. Even the government is busy with rehabilitation and rebuilding at a new site. Debris becomes massive because of the disintegration of the building materials. In case of prefab buildings, the mass is smaller and that too closely knitted with natural fibers or wire meshes. Thus the debris removal is very easy and fast process.

The disasters based on winds are much less in our country and are limited to specific areas only. Hurricanes are just a few that too far between.

Fire break out is quite common after the earth quakes due to damages to pipe lines and electrical faults. Even otherwise fires are a source of loss of property and life. Ferrocement is a material, which is very stable under high temperatures. Many researchers have shown experimentally that ferrocement can safely with stand temperatures as high as 1160 degree Celsius for as long as one and a half hour and do not lose much strength even after this exposure. This makes ferrocement an ideal material of prefabricated construction in seismic hazardous areas.

For areas close to sea and susceptible to high waves and tsunamis, the water tightness of ferrocement becomes a very useful tool. About one meter high plinths with about 1 m projections all around under a building makes it free to float. The total weight of the building along with the occupants and paraphernalia is less than the weight of the water displaced by the plinth thus made. Structures without foundation become a boon in such areas.

The above discussion goes a long way to establish the basic fundamental principal that light weight prefabricated structures with natural fibers or wire meshes, without a foundation can be regarded as structures where loss of life is minimal under disasters. The injured to death ratio is also higher in such buildings. Ferrocement structures are especially beneficial under fire disasters.

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SENSOR SYSTEM FOR HEALTH MONITORING OF PRE-FABRICATED STRUCTURES

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INTRODUCTION

Structural health monitoring (SHM) is a process in which certain strategies are implemented for determining the presence, location and severity of damages and the remaining life of structure after the occurrence of damage. This term is usually referred to aerospace, civil and mechanical engineering infrastructure. It is the continuous measurement of the loading environment and the critical responses of a structural system or its components. Health monitoring is typically used to track and evaluate the performance, symptoms of operational incidents and anomalies due to deterioration or damage as well as health during and after extreme events (Aktan et al. 1998). Damage identification is the basic objective of SHM. There are mainly four levels in damage identification (Rytter, 1993).

Level 1: Determination that damage is present in the structure
Level 2: Level 1 plus determination of the geometric location of the damage
Level 3: Level 2 plus quantification of the severity of the damage
Level 4: Level 3 plus prediction of the remaining service life of the structure

SHM involves the observation of a system over time using periodically sampled dynamic response measurements from an array of sensors, the extraction of damage-sensitive features from these measurements, and the statistical analysis of these features to determine the current state of the system health. For long term SHM, the output of this process is periodically updated to provide information regarding the ability of the structure to perform its intended function in light of the inevitable aging and degradation resulting from operational environments. After extreme events, such as earthquakes or blast loading, SHM is used for quick condition screening and aims to provide, in near real time, reliable information regarding the integrity of the structure. (Doebling et al., 1998). In all Structural Health Monitoring (SHM) techniques, whether global or local, choice of sensors is very crucial. This is because the cost of monitoring system as well as the sensitivity, reliability and utility of the measured data depends on the type of sensors employed. There are numerous sensors available in the market, such as electrical strain gauges (ESG), PZT patches, accelerometers, optical fibre bragg grating (FBG) based sensors and many others. The suitability of sensors depends on the type and characteristics of monitored structure. In general, civil engineers have lack of acquaintance with the principle as well as working knowledge of sensors, especially the new generation smart sensors such as the PZT and the FBG sensors. These sensors can be installed in prefabricated structures very easily and used for SHM very efficiently.

This paper covers a brief description of three major sensor types: ESGs, PZT patches and accelerometers. It reports a comparative study of these three sensors applied on pre fabricated structures: two steel I beams of 2m and 4m lengths and prefabricated concrete structures.

2. SENSOR SYSTEMS FOR STRUCTURAL MONITORING

In this study, three types of sensors were evaluated on beam structures i.e. the ESGs, the PZT patches and the accelerometers. Strain gauges are the most widely used sensors for structural behaviour monitoring. On a structural surface, strains are caused by member deformations resulting from bending, torsion, shearing and elongation/ contraction. Hence, strain measurements can capture an element's behaviour quite well (Sanayei and Saletnic, 1996). An ESG essentially consists of thin metallic foil grids, bonded to a flexible polyimide film, which is bonded to the surface of the monitored. An accelerometer essentially consists of a seismic mass connected to a base (which is attached to the host structure) by means of a spring and a viscous damper. If $\ddot{x}$ denotes the acceleration of the base, z the relative displacement between the host structure and the seismic mass, the acceleration of the host structure is given by

$$\ddot{x} \approx -z\omega_n^2 \tag{1}$$

where, ω_n is the natural frequency of the seismic mass.

Thus, the acceleration of the host system can be determined by measuring the relative displacement, z, between the seismic mass and the base. Eq. (2) is valid for small frequencies, typically lower than the natural frequency ω_n of the spring- damper system.

Piezoelectric materials, are commercially available as ceramics, such as PZT. They exhibit two related phenomena, (i) on application of mechanical stress, they undergo the development of surface charges (**direct effect**), and (ii) on application of electric field, they undergo mechanical strain (**converse effect**). The following equation describes the direct effect, which is used in sensor applications

$$D_3 = \overline{\varepsilon_{33}^T} E_3 + d_{31} T_1 \tag{2}$$

where, D_3 is the surface charge density, E_3 the electric field, T_1 the mechanical stress, $\overline{\varepsilon_{33}^T}$ the complex electric permittivity at constant stress and d_{31} the piezoelectric strain coefficient. Here, the subscript *31* implies that electric field is applied along direction *3* and strain is measured along direction 1, as shown in Fig. 1. In the absence of electric field, E_3 =0. Further,

$$T_1 = \overline{Y^E} S_1 \tag{4}$$

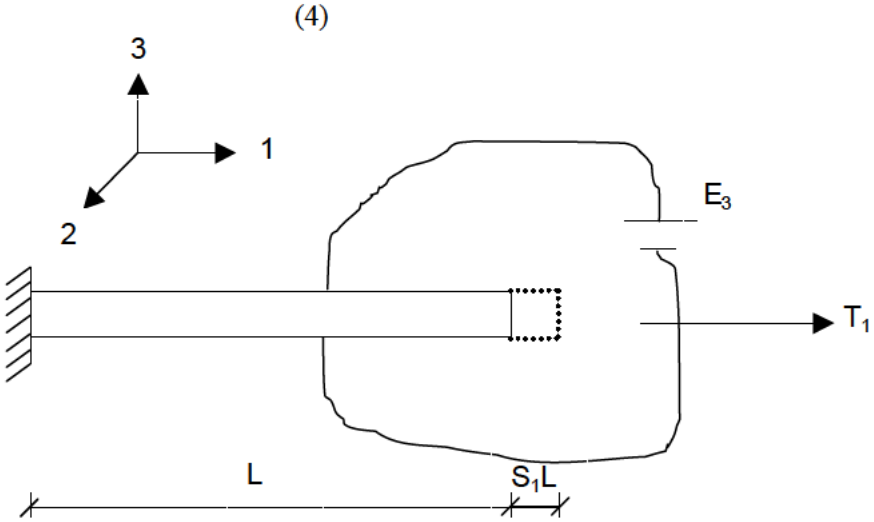


Fig.1 Co-ordinate system for a PZT patch

where, $\overline{Y^E}$ is the complex Young's modulus of elasticity of the PZT material at constant electric field and S_1 the strain of the host structure (and also on the PZT patch). By using the theory of parallel plate capacitors, we can derive

$$D_3 = \frac{\overline{\varepsilon_{33}^T} V}{h} \tag{3}$$

where, V is the potential difference across the terminals of the PZT patch and h the thickness of the patch. Hence, from equations (2) to (4), strain S_1 is related to voltage V *by*

$$S_1 = \left(\frac{\overline{\varepsilon_{33}^T}}{d_{31} h \overline{Y^E}} \right) V = K_p V \tag{4}$$

Thus, the output voltage across the terminals of the PZT patch is proportional to the strain of the host structure. The output voltage can be easily measured by oscilloscopes supported by conditioning circuit (Sirohi and Chopra, 2000b). In this study, Agilent 34411A digital multimeter (Agilent Technologies, 2009) has been used for this purpose.

3. EXPERIMENTAL EVALUATION OF SENSORS

In this investigative study, two steel I beams, both ISMB 150 of lengths 2m and 4m, were instrumented with ESGs, PZT patches and accelerometers. Fig. 2 shows the measurement set up, consisting of the test structure, digital multimeter, a personal computer (PC) and a simple hammer. The structure was excited by striking the hammer and free vibration response was measured using the Agilent 34411A digital multimeter. The same multimeter recorded measurements from all the three sensors one by one. In the case of ESG, the multimeter measured the resistance with time. In the case of the accelerometer and the PZT patch, the instantaneous voltage across the terminals was measured in the time domain. In all the measurements, a sampling interval of 1-milli second was set in the multimeter. After each measurement, the data recorded in the multimeter was transferred to the PC via the USB interface. The data was transformed from the time domain to the frequency domain by carrying out fast Fourier transform (FFT) in the MATLAB environment. Fig. 3 shows the frequencies obtained by this method from the ESG, the PZT patch and the accelerometer for 4m beam. The frequencies of the beams were also determined analytically (for flexure mode) using the theory of dynamics as (Chopra, et al, 2004)

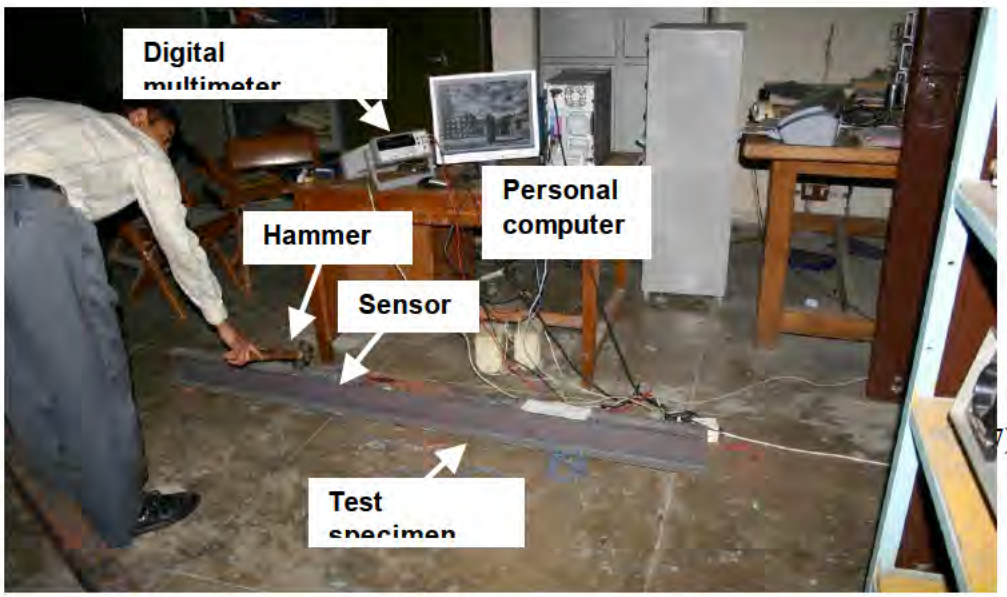


Fig. 2 Experimental test setup.

where, f_n denotes the nth natural frequency, E the Young's modulus of the beam, I the moment of inertia, ρ the density, A the cross-sectional area and L the length between supports. These were determined as 134.65Hz, 538.63 Hz and 1211.94 Hz for 2m beam and 31.96 Hz, 121.84 Hz and 287.63 Hz for the 4m beam. It can be found that the experimental frequencies agree reasonably well with the analytical frequencies.

From Fig. 3, it is observed that the PZT patch identified the first three natural frequencies of the 4m beam as 30 Hz, 128 Hz and 228 Hz respectively (Fig. 4). The accelerometer identified the first three natural frequencies as 51 Hz, 149 Hz and 249 Hz respectively (Fig.4b). The ESG, on the other hand, identified the frequencies as 46 Hz, 146 Hz and 245 Hz respectively (Fig. 4c).

4. COMPARATIVE ASSESSMENT OF SENSORS

It can be observed that all the three sensors have captured the natural frequencies of the experimental structures reasonably well. However, from cost point of view, accelerometers are very expensive as compared to strain gauges and PZT patches. Typically, an accelerometer (1mV/g accuracy), costs around Rs 20, 000 ($ 400) to Rs 30,000 ($ 600). However, the ESGs and PZT patches are much cheaper. An ESG typically costs around Rs 100 ($ 2) and PZT patch costs in the range Rs 75 ($ 1.5) to Rs 500 ($ 10), depending upon its electrodes (PZT patches with electrodes wrapped around are more expensive).

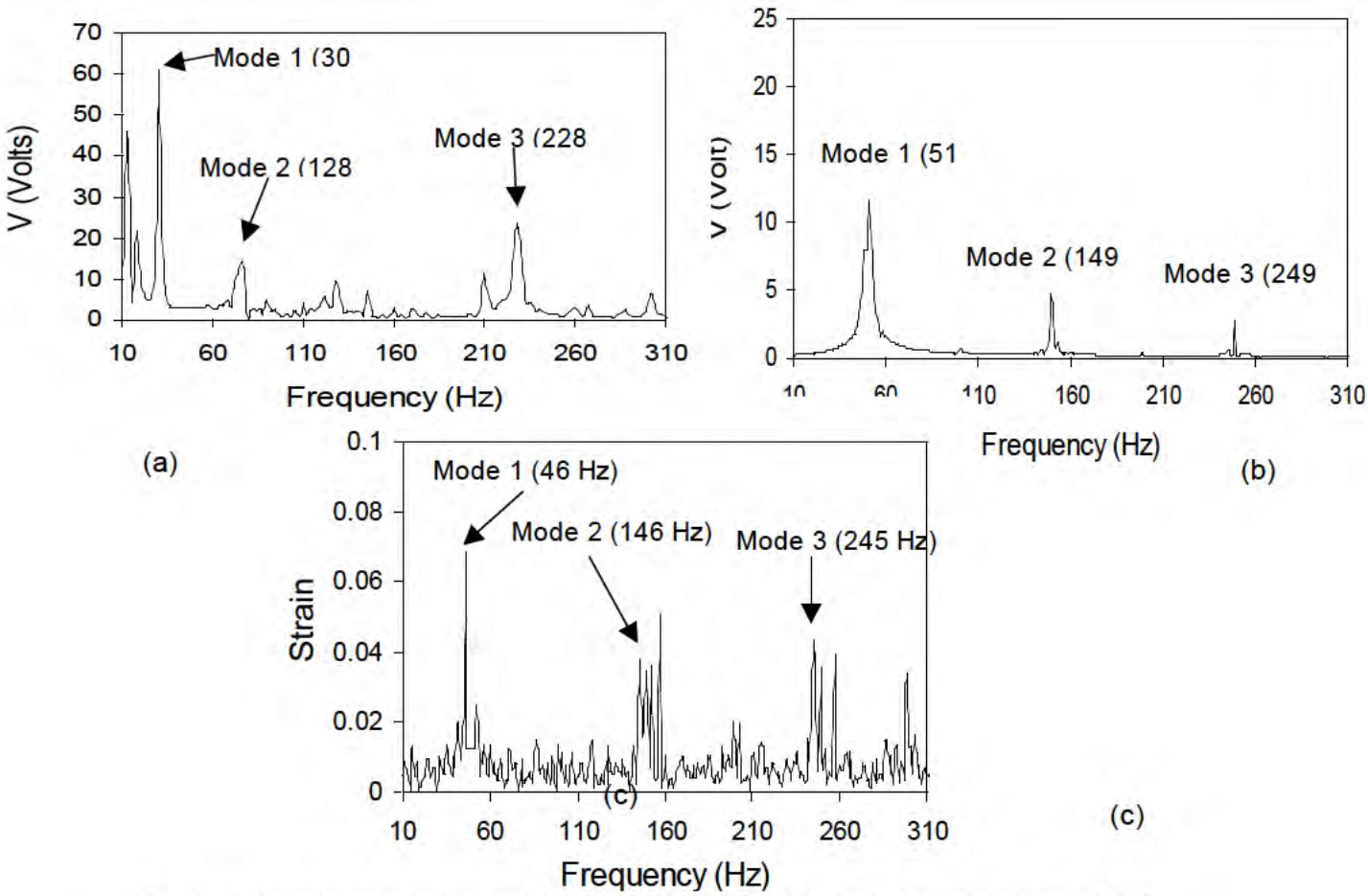
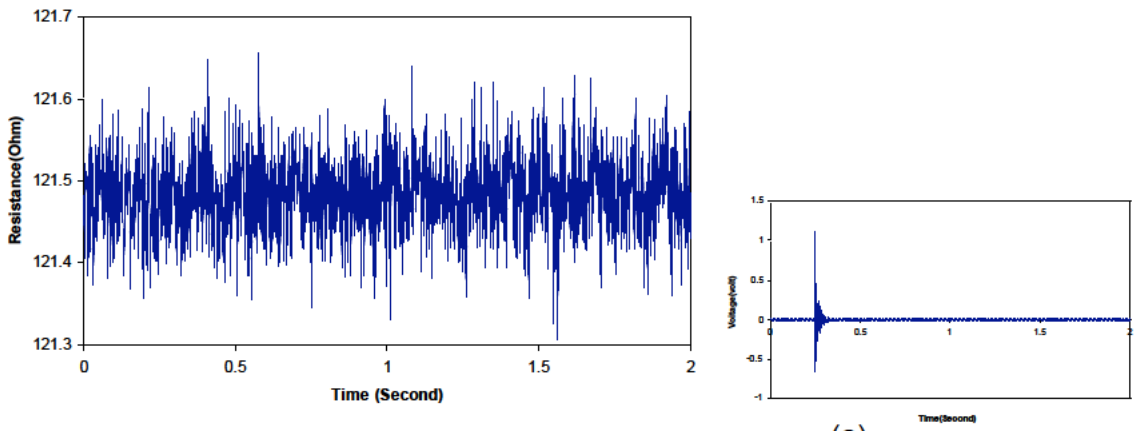


Fig. 3 Frequency responses of 4m beam (a) PZT patch (b) Accelerometer (c) ESG.

Hence, PZT patches are more cost effective. However, these need to be permanently bonded in/on prefabricated structure, which is acceptable keeping in view that they are very low cost and can withstand loads and can function well under extreme conditions. Among the ESGs and PZT patches, it can be observed from Figs. 3 that the signal of the PZT is much better than that of the ESG which is quite prone to noise. This is also evident from time domain response, compared in Fig. 4. Same trends were repeated in frequency response which is shown in Fig. 5.

5. EMBEDDED SENSORS

Performance of the PZT sensors is found better compared to other sensors. Since PZT patches are of very small dimension and made of brittle material, for consistent behaviour, they should be protected from harsh environmental condition and other external disturbance. Hence, embedded PZT patches, which can be installed in prefabricated structure at the time of prefabrication very easily. This PZT sensor was fabricated, and embedded in 2 m reinforced concrete (R.C.) beam and the compared performance with surface bonded PZT sensor. To prepare the embedded sensor, the form work of card board with dimensions 25 x 25 x 25mm was first filled with cement mortar to the half depth. After 14 days curing, the PZT patch was bonded on the top of the surface of the cement block using good quality epoxy.

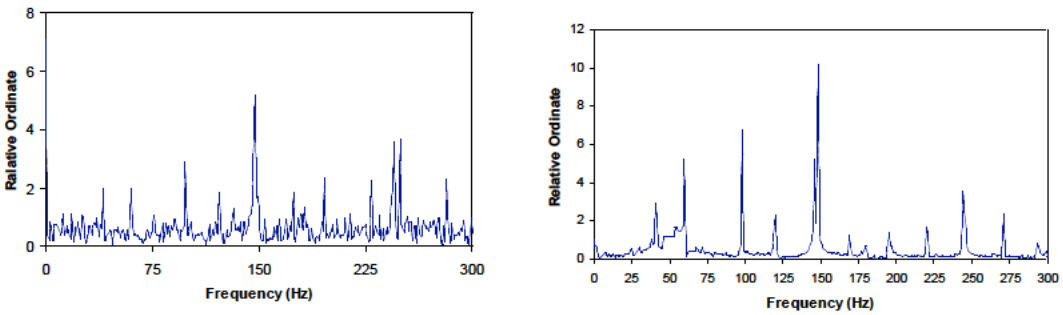


(a)

(b)

Fig. 3.4 Comparison of time domain response (a) ESG (b) PZT

After 48 hours, when found satisfactory, the card board was filled to full depth with the cement mortar. After 14 days of curing, the card board was removed from cement block and was ready to use in any structure under construction. The performance of sensor was studied on the 2m R.C. beam structure as described in the next section.



(a)

(b)

Fig. 5 Comparison of frequency response (a) ESG (b) PZ

6. COMPARATIVE STUDY OF SENSORS IN RC BEAM

An RC beam of dimensions (2×0.2×0.15m) was simply supported and instrumented with the embedded PZT patch at 0.6m distance from left support and the surface bonded PZT patch at exactly same distance, tested under hydraulic loading machine. The beam was loaded at single point load as shown in Fig. 6. The time history at each PZT patch was recorded for two seconds by hammering and the response measured using Agilent 34411A digital multimeter at 200 μs sampling interval. The beam was in unloaded condition during each excitation. All the measurements were made automatically through programs running in the VEE PRO environment. The recorded voltage data was transformed from time domain to frequency domain by carrying out FFT in the MATLAB environment. First, the beam was loaded up to 50 kN and then unloaded so that an incipient damage is created in the beam. To increase the damage severity, again the load was increased to 70 kN and withdrawn. Loading and unloading process continued till failure of the beam, with the maximum load increased in each successive cycle to 50 kN, 70 kN, 80 kN and 110 kN (failure). Applying the above procedure, time history and frequency plots were determined at each load condition of both sensors. Time histories of both sensors are shown in Fig. 7. It is seen from Fig. 7 that the time history recorded by the embedded PZT patch is far more smooth and clear compared to the surface bonded PZT patch. Frequency responses at healthy state are shown in Fig. 8.

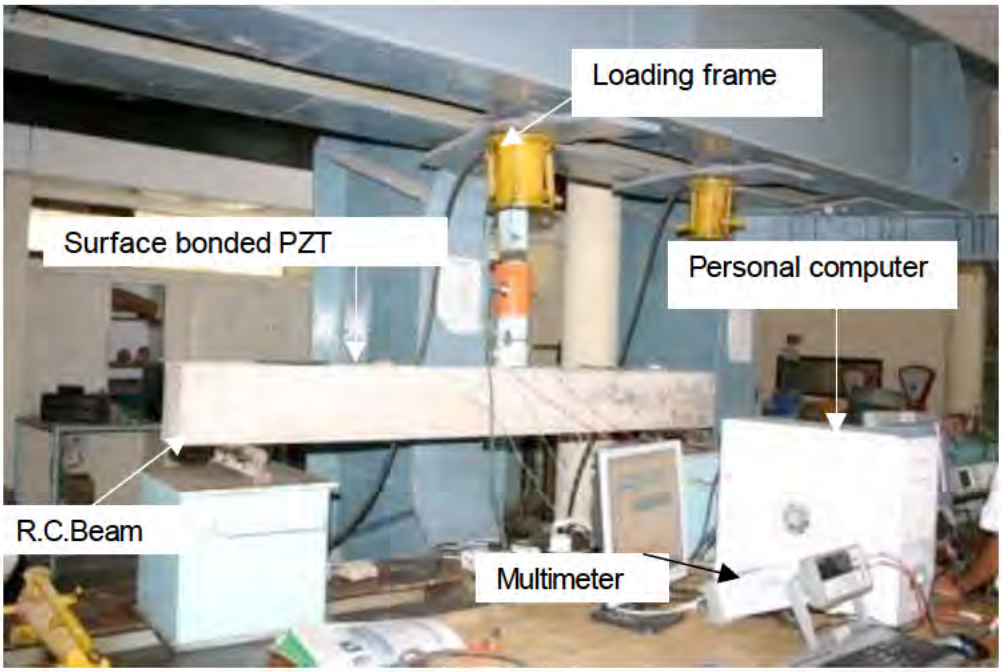


Fig. 6 Experimental setup

Applying the same procedure, frequency domain responses at different loadings were obtained to determine the first three natural frequencies at different loads. Frequencies after subjecting to 50 kN, 70kN, 80kN and failure are compared with undamaged frequencies and comparison are listed in Tables 1 and 2.

It is clear from the table that the percentage change in frequencies at different load of the embedded PZT sensor is higher as compared to the surface bonded PZT sensor. Hence, embedded sensor is more sensitive than surface bonded sensor.

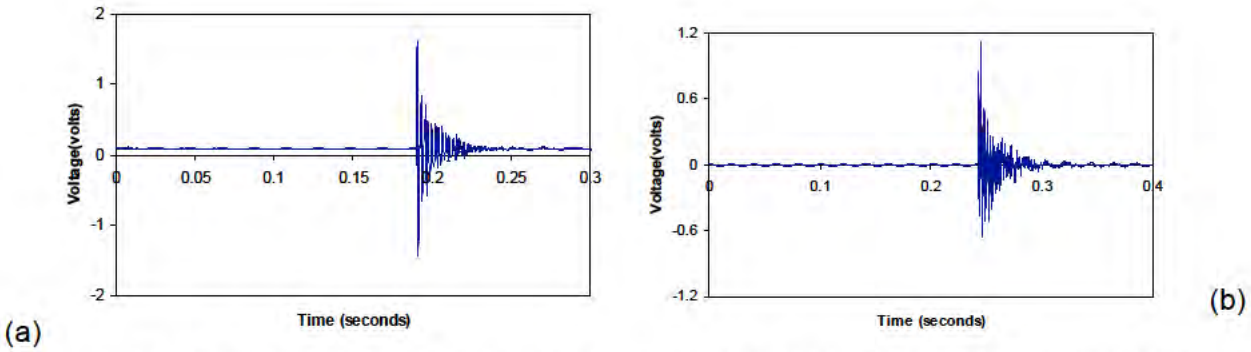


Fig. 7 Time history of sensors (a) Embedded PZT sensor (b) Surface bonded PZT sensor

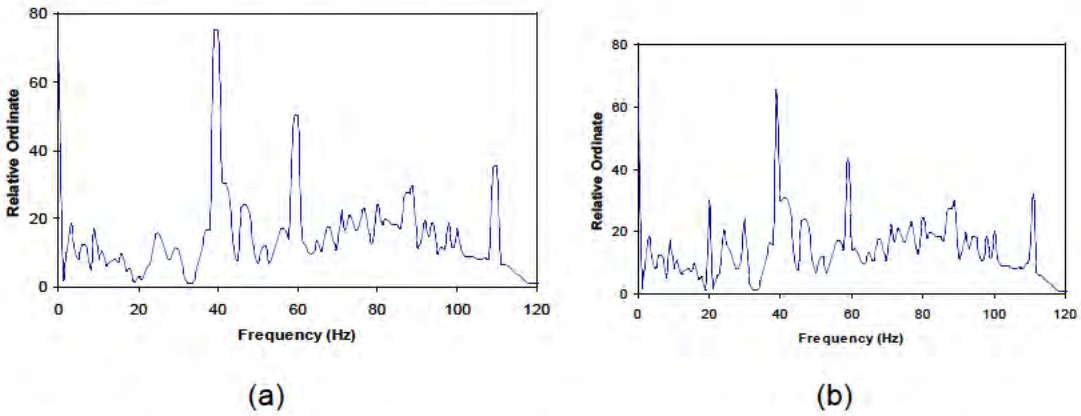


Fig. 8 FRF of sensors (a) Embedded PZT sensor (b) Surface bonded PZT sensor

Embedding the PZT sensor helps in protecting it from the environment outside the structure. It is safe against erosion and other mechanical forces. It is also safe from outer environment noise and electrical disturbance.

Table 1 Comparison of frequencies recorded by embedded PZT sensor

S.No.	Undamaged	At 50 kN		At 70 kN		At 80 kN		110 kN (Failure)	
	Freq. (Hz)	Freq.	%change	Freq.	%change	Freq.	%change	freq	%change
f_1	40.5	40.1	1.06	39.5	2.5	38.5	4.9	35.0	13.6
f_2	60.0	59.8	0.33	58.9	1.8	58.1	3.2	56.4	6.0
f_3	111	111	0.0	110.3	0.6	108.5	2.25	107.0	3.6

Table 2 Comparison of frequencies recorded by surface bonded PZT sensor

S.No.	Undamaged	At 50 kN		At 70 kN		At 80 kN		110 kN (Failure)	
	Freq. (Hz)	Freq.	%change	Freq.	%change	Freq.	%change	freq	%change
f_1	39	38.7	0.77	38.3	1.79	37.5	3.85	35.2	9.75
f_2	59.5	59.30	0.33	58.5	1.68	58.0	2.52	57.0	4.20
f_3	112.5	112.5	0.0	112.5	0.44	111.0	1.33	110.0	2.22

7. CONCLUDING

The performances of different type of sensor are studied. It is found that PZT sensor is better compared to other existing sensors. Hence, PZT patch can be embedded at the time of construction in structure and manufacturing the embedded sensor is simple. It can be used to measure the dynamic response of the structures.

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Efficient Management of Prefabricated Constructions through Line of Balance Technique

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Abstract

Prefabricated structures bring efficiency in utilisation of resources particularly in terms of material, manpower and time. The process involved in creating a prefabricated structure demands detailed planning, close monitoring and resource coordination for providing expected out come.Network Techniques aregraphic – numeric in nature and provide a scientific method for planning, scheduling and control of projects. Line of balance technique is a modified network technique which is suited for construction projects involving repetitive operations on a large scale. The potential of network techniques and LOB for efficient management of projects relating to prefabricated structures is explored.

Key Words : Line of Balance Technique, Network Planning, Pre- fabricated Construction

Introduction

Project management is the art of directing and coordinating human and material resources throughout the project life by using modern management techniques to achieve predetermined objectives of scope, cost,time, quality and participation satisfaction[PMI, Wideman 1986]. According to IS 15883 :2009, Project Management is application of knowledge, skills, tools and techniques to achieve the objectives of a defined project with the aim to ensure that a project is completed within scheduled time, authorized cost and requirements of quality standards. Pre-construction planning is an important stage of construction project and various planning tools such as Work Break Down Structure [WBS], Bar Charts, and Network Techniques are employed for effective management of construction projects.

Line of Balance Technique of project management is based on basic principle of network techniques with presentation through bar chart concept. LOB Technique is a useful tool of planning and management of construction projects involving repetitive type of construction. Prefabricated structures in involve large volume construction with repetitive operations.

The Line of Balance technique is based on an assumption that rate of production of an activity is uniform. The basic concept of LOB was applied in construction industry as planning and scheduling method. [Lumsden 1968]. LOB has been applied to resource scheduling and coordination of sub contractors[Levine et al.,1976],to a highway pavement construction project[Arditi2002], to modelling production activities for multi-facility projects and to construction of multi storey building construction projects [Mendes R., L.Fernado, et al. 1998].Various areas such as housing, transportation structures etc have been identified for the application of LOB [Arditi,D.O. Tokdemir, et al.2002]

Various Network TechniquesFor Construction Projects

Networks are the graphic-numeric representation of project and are developed using Work Break DownStructure[WBS]. WBS of a construction project is a hierarchical system that represents the construction project in increasing in increasing levels of detail to define, organize and display the project work in measurable and manageable components Charles Patrick, 2012]. WBS reflects identification of major work heads defining unique discipline of resource qualification. Work Break Down structure also enables construction engineer to identify associated activities, their quantification, associated resource requirements along with the logic viz interdependencies.. Based upon different considerations, various network techniques are available for construction engineers to apply on construction projects. Some of these are given below in the **Table No.1.**

Table No.1.Various Network Techniques for application on Construction Projects

S. No	Category	Method	Basic Feature
1	Activity On Arrow Diagrams	Critical Path Method [CPM]	Logic [FS] relationships as well as Activity Time Estimates are Deterministic
		Programme Evaluation Review Technique [PERT]	Logic[FS] relationships Deterministic but Activity Time Estimates are Probabilistic
2	Activity On Node Diagrams	Precedence Diagram [PD]	Four Types of Logic relationships[FS,SS,FF, SF] are considered. Logic and Activity Time Estimates alongwith Lead – Lag Factor are also considered are Deterministic
3	Heuristic Modelling	Graphical Evaluation and Review Technique [GERT]	Combination of concepts of network modelling ,probability theory and computer based simulation

Application specific nomenclature such as Ladder Diagram, Master Network Zoned Network, Sub-net, Fragnet is also used by engineers. The network diagrams have multiple applications and depending upon the level of executing staff, simpler presentations can be worked out. For easy understanding of the lower level supervisory staff the information extracted from the network analysis is presented throughappropriately modified bar charts viz. Consecutive – job charts, Cross-connected bar charts, Cascade diagram and Sequenced or float – linked bar charts.

Time scaled diagrams are the analysed network drawn on time scale alongwith associated logic of the network.They are extremely useful in generating resource aggregation profile and performing Time-Cost Analysis.

Line of Balance Technique in Construction

Line of Balance is a planning technique for repetitive work. Its application in association with network concepts generates efficient analytical tool for management. The technique involves assessment of worker-hour estimates and optimum size of crews to develop LOB diagram. These assessments are made in consultation with associated field personnel such as site engineers, subcontractors etc who are knowledgeable and capable of appreciating actual conditions of a project and its constituent activities.

The LOB Technique is superior to other planning methods because it considers an additional dimension [unit of production] in the representation of activities.

Prefabricated structures have standardised design hence efficiency in cost and time can be achieved by designing a crew size so that there is no interference with repetitive operations and target out put is achieved.

LOB technique is efficiently applicable to mass housing projects, high rise buildings, road pavement construction, tunnelling etc. where set of repetitive works may be easily identified. This technique is highly effective in determining areas of weakness and focussing on items requiring immediate attention.

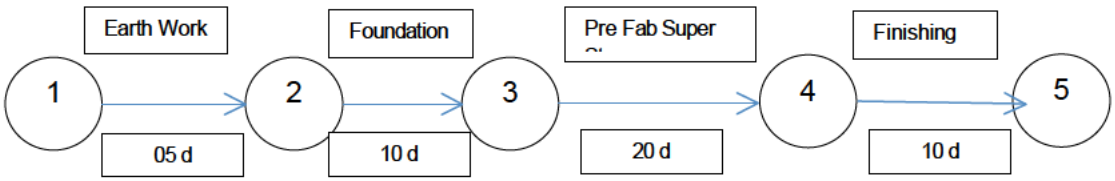
Procedure Involved in Application of LOB Technique

In order to develop LOB Technique following steps are performed:

1. Identification of Milestones in the projects for scheduling and monitoring.
2. Monitoring of progress as per the milestones.
3. Sequencing of activities [in conformation with milestones] for completing a single unit of construction.
4. Estimation of duration to complete each activity.
5. Assumption for buffer time between activities.
6. Computation of required out -put target in order to meet a given project completion date.
7. Complete the LOB schedule.
8. Examine the schedule and work out alternatives to bring a balanced schedule viz. adjustment in crew size for different operations and constraining resources so that continuity in placement of all repetitive elements is ensured for maximum productivity.

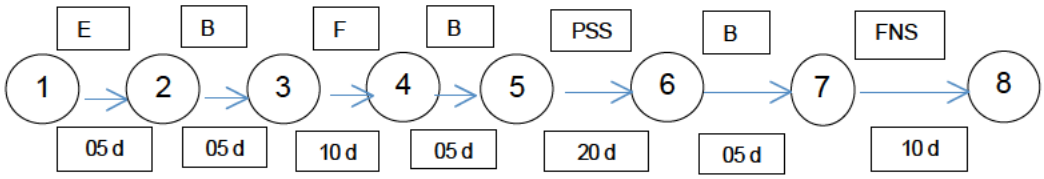
Illustration

A Prefabricated housing project involves construction of 50 houses. The associated logic diagram for completion of one house is given below in Fig No 1. The corresponding logic diagram with assumed buffertime is given in Fig No. 2. The LOB diagram is shown in Fig No.3.



The total time required to complete one unit = 45 days

Fig No.1 Analysed Network Diagram [AOA] For a unit house for Illustrated Problem



The total time required to complete one unit = 60 days

Fig No.2 Analysed Network Diagram [AOA] with Buffer Time for Illustrated Problem

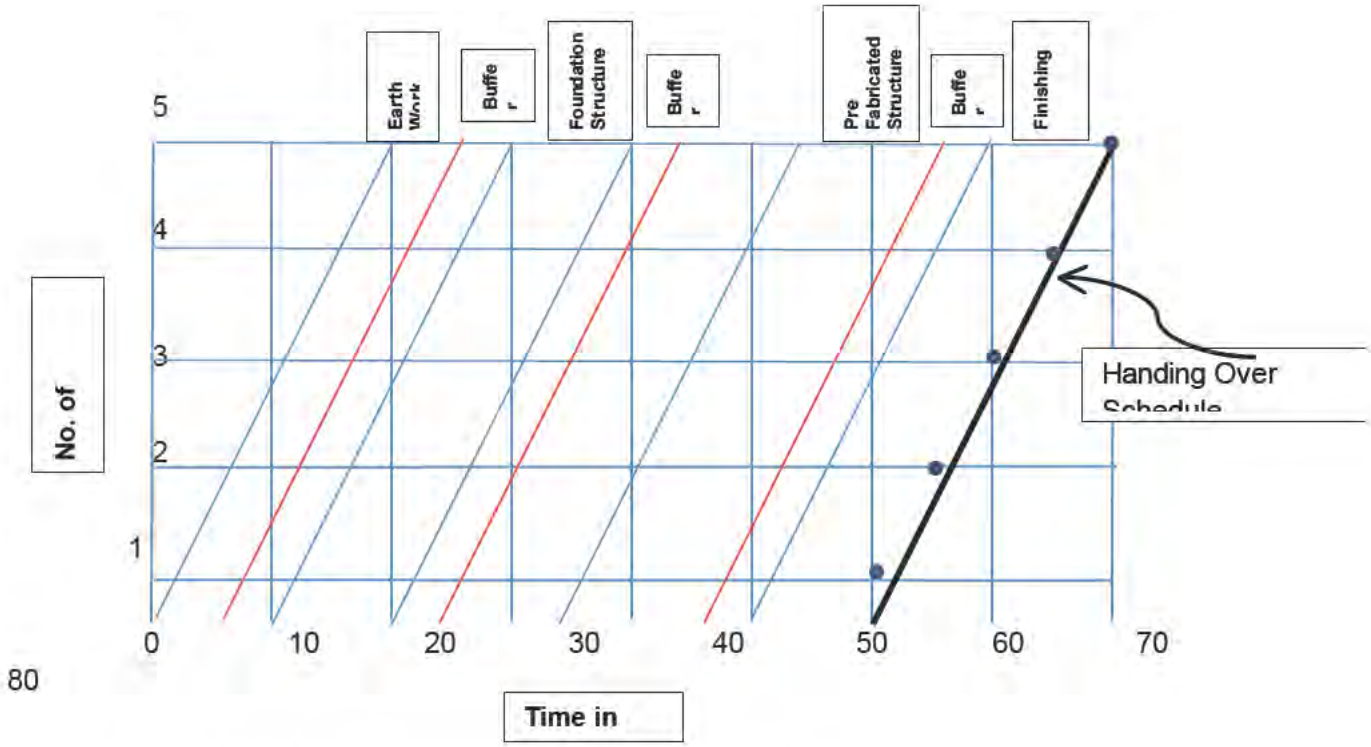


Fig No.3 LOB Schedule for Illustrated Problem

Fig No.3 LOB Schedule for Illustrated Problem

The handing over rate = $\frac{Tf-Ti}{n-1}$ Where Tf = Final Completion Time; Ti= Time required for completing one unit in all respect and n= Nos of Units constructed.

From these diagrams, the completion time for a single pre fabricated house without buffer time is 45 days and 60 days with buffer time. The handing over rate is one unit in every 5 days.

Conclusions

1 Combining the logic of network analysis with principles of line of balance provides a very detailed picture of any repetitive project.

2.LOB Technique reduces the amount of network planning and scheduling

3. Resource planning is done effectively and in simple way.

4. LOB Technique provides productivity based planning and is highly suitable for large volume pre-fabricated assembled structures.

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Dr. L.K.Mishra
Author's Bio -data

Dr. L.K. Mishrais a graduate in Civil Engineering from Delhi College of Engineering, Delhi, post graduate in Building Engineering and Management from School of Planning and Architecture, New Delhi and has obtained his doctoral degree from MNNIT Allahabad. After completing the post graduation, he has worked in various civil engineering consultancy and construction organisations such as Integrated Construction Management Consultants Private Ltd, New Delhi, Spie-Capag/NKK/Toyo Consortium, New Delhi for HBJ Gas Pipeline Project and Recondo Ltd, Mumbai. Subsequently he joined MotiLal Nehru National Institute of Technology, Allahabad (Formerly MNREC, Allahabad) as a faculty member. He has more than twenty three years of teaching, research and consultancy experience and is currently employed as Associate Professor in the department of civil engineering, MNNIT, Allahabad. He is actively involved in application projects on concrete and material evaluation and construction project management, imparting training and conducting technical seminars. He is a member of American Concrete Institute, life member of Indian Concrete Institute,Fellow memberof Institution of Engineers(India), Life member of IGS and member of Indian Society of Technical Education. He had also under taken a technical co-operation training at Liverpool John Moores University, Liverpool (UK) in 1998. He has published more than 25 research papers and guided about 25 M.Tech Thesis.

Dr.L.K.Mishra has been the member of the governing Council of ICI Chennai. He is presently the Chairman IE(I) Allahabad Local Centre and member of the executive committee of IE(I) UP State Centre Lucknow.

Findings and Recommendations of the seminar

Compiled by: Er. Ashok Kumar Jain, Convener

The seminar was a success. Delegates had participated from seven states of the country. In all about 95 delegates registered for the seminar. There were sponsored delegates from Government, both Central and States (UP and Maharashtra), and Semi -Government departments like HUDCO, Airport Authority of India, BSNL, UPPWD, UPHDB, UPRNN, Samaj Kalyan Vibhag. Manufacturers from Jammu, Bihar, Uttaranchal, Maharashtra, Haryana and New Delhi were also represented. Academicians from Nashik Engineering College and MNNIT, Allahabad also graced the seminar. Eminent personalities like Prof. D C Thapar were present almost through the seminar. Deliberations were made on prefabricated structures using wood, light gauge steel frame technology, concrete and ferrocement.

The seminar's technical sessions started with a tribute to all time great P L Nervi, an Italian architect cum engineer who designed and made a large number of large span structures. In his own words, these structures were not feasible but for prefabrication. The tributes were paid by Ar Atul Gupta, past president, U P Architects Association.

In our country, wood is banned by Government order, for use in building construction. However, M/s Wood Barn India constructs prefab wooden houses all over the country using wood imported from Canada and other countries. According to Ar Anurag Khandelwal, CEO of Wood Barn India, buildings made with this wood are fire and termite resistant, water and all weather proof, heat and sound insulated, cost effective and energy efficient. He claims that these buildings are not environment friendly but environment healing. He went on to add that wood performs better than concrete and steel in terms of embodied energy, air and water pollution, carbon foot print and global warning potential.

Light gauge steel frame construction system was termed by Ar Anuj Sharma, as a smarter way of construction, using High tensile steel (550 MPa) and less thickness (0.75 to 0.95 mm) only. Steel was described as durable and safe material with consistent quality, superior seismic and wind performance, dimensionally stable and non-combustible. It gives high strength to weight ratio and complete design flexibility. Light gauge steel was termed as a complete, fast and accurate one stop solution.

Er K K Srivastava, SE and Er T D Daryana, EE(R), both of U P Jal Nigam described the usage of prefabricated structures in their department. They described prefabricated structures not only those being used at present but also made valuable suggestions for future designs and concepts. Prefabricated Tank type stand posts and Manholes were noteworthy suggestions.

Mr Sumit Kumar Agarwal, principal associate, Tanjun Associate LLP had a scheme for skill development for prefabricated structures and also providing employment to the youth of the country. Use of local resources was also emphasized. He also introduced the

Rurban society and its special problems and needs. He stressed the need and urgency to consider this to make it the most powerful force to reckon with.

Mr Yogesh Srivastav, Senior Secretary, PHD Chamber of Commerce and Industry, New Delhi brought out the importance of prefabricated construction in Agri-Farm sector. Apart from discussing the importance , advantages and needs of prefabricated construction systems, he also stressed on aggregating synergies and opportunities between engineering and agriculture communities. He concluded with the remark that prefabricated construction had the potential to minimize post harvest losses and change the face of Indian Economy.

Er Anupam Rawat from MNNIT, Allahabad discussed the housing needs and their dimensions for the country. Prof. Subodh Shankar of Amity considered that prefabrication was a tangible solution to the housing problems of our country. He also brought out the fact that shortage of skilled and unskilled labour can also be addressed by adopting prefabrication. Creation of slums was also associated with in-situ construction.

Use of Cellular light weight concrete (CLC) in prefabrication was discussed by Prof. Sunil Kute of K K Wagh Institute of Engineering, Nashik. This helps in reducing the weight of the prefabricated structures by about 40%. Prof. L K Mishra and Dr Ramashanker of MNNIT, Allahabad stressed the needs for efficient management of prefabricated structures and their health monitoring sensor systems.

The address by Er Ranjeet Sinha, advisor, Tilothu Mahila Mandal, Rohtas, Bihar was thought provoking and an eye opener for the planners and NGO sector. He stressed the point of prefabrication being the only solution after the banning of mining of sand and stone chips and brick kilns for shortage of coal.

Sri Rajesh Bhardwaj of SRG International from Faridabad labeled themselves as the PREFAB PEOPLE of India.

The highlight of the seminar was the number of presentations on prefabrication using ferrocement technology.

Mr Anil Gaind of Ferrocement Cooperative Society, Jammu described in detail the work being carried out in his state using prefabrication ferrocement technology including the awareness and training programs.

Dr B N Divekar, President, Ferrocement Society, Pune advocated discarding of concrete and using ferrocement because of the inherent weakness of concrete in tension. He stressed that ferrocement is strong in tension and compression both, can be cast in thin sections and any shape without compromising the strength, is ductile and has tremendous energy absorption capacity. It is also a crack free construction system. He also delivered the paper of Er P B Divekar, Managing Partner, Ferrocrete, Pune establishing the precast ferrocement lost forms as structural members and resulting economy thereof. A number of case studies reinforced his ideas.

Prof. R K Ambegaonkar of University of Pune and Er C M Hangekar, superintending Engineer, Water Resource Department, Govt of Maharashtra and Vice- President of Ferrocement Society, Pune showed the practice of using small prefabricated ferrocement

dams to recharge ground water and its acceptance there on a large scale. So much so that the Govt. of Maharashtra has provided this in its schedule of Rates.

Er. Naveen Singh of Designer's Wing, Lucknow reviewed the negative aspects of precast ferrocement construction and introduced the concept of cast in-situ joint less monolithic ferrocement construction for buildings. A number of case studies presented by him proved the simplicity and advantages of the system.

The presentations by Er. Ashok Kumar Jain of MNNIT, Allahabad highlighted the advantages of prefabricated ferrocement construction under all forms of disasters. He went to the extent to claim that almost NO LOSS of Life can be guaranteed. According to him this is the safest technology for disaster mitigation. His second paper on prefabricated warehouses brought out the possibilities of using ferrocement in making warehouses of all sizes all over the country speedily and economically with cutting down the carbon foot print to half. The best part of that, if need be, these warehouses could be relocated in totality. The third paper by Er. Jain projected ferrocement as the technology of the future highlighting its properties, advantages, simplicity of fabrication and erection. The low weight of ferrocement made it an ideal material for disaster prone areas like Uttaranchal. A large number of structures made by him in seventies and eighties are almost behaving as new and have further life of at least another 30 years.

Convener

INDIA PREFAB 2013

JULY 27-28 2013
LUCKNOW, INDIA

The Honourable Chief Guest Shri: H.S. Das, Principal Secretary, Department of Science & Technology, lighting the ceremonial lamp to announce the commnecement of the Seminar.

Er. A.K. Jain, Convener, delivering the keynote address.

Er. V.B. Singh, President IE(I):UP State Chapter delivering the inaugural address.

Shri: Yogesh Srivastav, Sr. Secretary, PHD Chamber of Commerce & Industry, New Delhi, our synergy partner, addressing the delegates & guests

Dr. B.N. Divekar, President, Ferrocement Society, PUNE, our synergy partner addressing the delegates & guests

Ar. Atul Gupta, ex-president UPAA setting the pace of the conference with a tribute to P.L. Nervi.

Release of the Seminar publication and souvenir.

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INDIA PREFAB 2013

JULY 27-28 2013
LUCKNOW, INDIA

DAY II-ROUNDTABLE

Er. Chandramohan Hangekar, Superintending Engineer, Water resource department, Govt. of Maharashtra showcasing the success story of innovative check-dams made from ferrocement

Dr. L.K. Mishra, Associate Professor, department of Civil engineering, MNNIT speaking on the need for management of prefab through line of balance technique.

Er. Ranjit Sinha, of the Tilothu mahila mandal spoke passionately about his experiences in successful delivery of sustainable affordable housing.

Er. Ashok K Jain deliberated on the immediate need to induct prefabricated ferrocement technology in warehouse construction.

Dr. B.N. Divekar stressed on the importance and productivity gains of using lost forms as structural members

Dr. Rama Shanker, Assistant Professor at MNNIT spoke about health monitoring of prefab structures.

Er. K.K. Srivastava, Superintending Engineer, UP Jal Nigam focussed on success stories in prefabrication for water supply & sanitation.

Shri: Sumit K Agarwal shared his first hand experience on living in a ferrocement home with one inch walls for the past 12 years.

Er. Anupam Rawat focussed in detail on the requirement and possible dimensions of housing in India.

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Prof. D.C. Thapar, renowned educationist spending a productive breaktime with Engineers at the seminar, Ar. Anurag Khandelwal, and enthusiastic students.

Ar. Atul Gupta in an intense dialogue with engineering students during the break.

Ar. Jayant Patankar, sharing his multi-faceted experience in Architecture, IT and human sciences with engrossed student engineers.

Delegates spend curious hours at the display stand of Ferrocement Society, Pune in the exhibition area.

Engineers intrigued and fascinated by the bamboo-ferrocement composite prefab display and take in the details from Shri: Sumit Kumar Agarwal at the Tanjun Associate stand in the exhibition area.

3D printing and prototype development of prefab components using cutting edge technology at the i-CAD engineering solutions' stand in the exhibition area.

Metal & metal-composite prefab sections showcased by Elemento in the exhibition area.

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LUCKNOW, INDIA

MEDIA COVERAGE OF THE SEMINAR

लखनऊ जागरण

फिर झंझट नहीं रहेगा घर बनाना

इंजीनियर्स भवन में सेमिनार में हिस्सा लेते लोग व संबोधित करते आर्किटेक्ट अनुराग खंडेलवाल — जागरण

जागरण संवाददाता, लखनऊ : मॉड्यूलर किचन की ही तरह अब आप घर भी फटाफट बना सकते है। आपको करना यह है कि बने बनाए दीवार, पिलर, बीम लाकर जोड़ लीजिए। यह जानकारी द इंस्टीट्यूशन ऑफ इंजीनियर्स में पूर्व निर्मित तकनीक पर आयोजित अखिल भारतीय तकनीकी गोष्ठी में शनिवार को दी गई।

गोष्ठी का उद्घाटन करते हुए प्रमुख सचिव विज्ञान एवं प्रौद्योगिकी डॉ.हर शरण दास ने कहा कि इस तकनीक को अपनाने से समय की बचत के साथ संसाधनों की भी बचत होती है। पीएचडी चैंबर ऑफ कामर्स एंड इंडस्ट्रीज के अध्यक्ष सुमन ज्योति खेतान का संदेश देते हुए योगेश श्रीवास्तव ने कहा कि पूर्व निर्मित तकनीक का उपयोग बहुमंजिला भवन, ग्रीन हाउस, स्टेशन, प्लेटफार्म, गोदाम, शैक्षिक भवनों व सैन्य परियोजनाओं के निर्माण में किया जा

• पूर्व निर्मित तकनीक से चंडीगढ़ में बनी थी अनूठी इमारत

रहा है। इस तकनीक से गरीबों को कम लागत वाले मकान कम समय में तैयार कर उपलब्ध कराए जा सकते है।

फेरोसीमेंट सोसायटी के अध्यक्ष डॉ. बीएन दिवेकर ने बताया कि बहुमंजिला इमारतों में अभी तक फिलर दीवारें परंपरागत तकनीक से बनाई जाती है जिसमें काफी समय व लागत लगती है। फेरोसीमेंट दीवारें हल्की, सस्ती, व शीघ्र तैयार हो जाती है। गोष्ठी के संयोजक अशोक जैन ने भवनों के निर्माण में गैर परंपरागत निर्माण सामग्री जैसे बांस, लकड़ी, हल्के स्टील फ्रेम, एवं फेरोसीमेंट तकनीक के इस्तेमाल पर जोर दिया। द इंस्टीट्यूशन ऑफ इंजीनियर्स (इंडिया) के अध्यक्ष वीबी सिंह ने कहा कि उत्तराखंड में हुए विनाश से बेघर हुए लोगों को इस तकनीक की मदद से आवास बनाकर शीघ्र राहत पहुंचाई जा सकती है। गोष्ठी में सात राज्यों के 3 से अधिक लोगों ने भाग लिया।

तकनीक की खासियत

पूर्व निर्मित तकनीक से बने भवन मजबूती में परंपरागत तकनीक से बनाए जाने वाले भवनों से कम नहीं होते। विदेशों में इस तकनीक का प्रयोग कर बहुमंजिला भवनों को कुछ माह के भीतर ही तैयार कर लिया जाता है। कुछ माह पूर्व इसी तकनीक का इस्तेमाल करके चंडीगढ़ में 48 घंटे में दस मंजिला इमारत तैयार की गई थी। विशेषज्ञों का मानना है कि भूकंप, बाढ़ व अन्य प्राकृतिक आपदाओं से नष्ट हुए आवासीय भवनों का पुर्ननिर्माण कुछ ही दिन में संभव है।

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भवन निर्माण प्रीफैब्रिकेशन तकनीक पर गोष्ठी

इंस्टीट्यूट आफ इंजीनियर्स भवन में विमोचन करते अतिथि। फोटो : एसएनबी

लखनऊ (एसएनबी)। भवन निर्माण की पूर्व निर्मित प्रीफैब्रिकेशन तकनीक पर आधारित गोष्ठी का आयोजन इंस्टीट्यूट आफ इंजीनियर्स भवन रीवर बैंक कालोनी में किया गया। इसमें प्रमुख सचिव विज्ञान एवं प्रौद्योगिकी डा. हर शरण दास ने कहा कि विदेशों में इस तकनीक के आधार पर बहुमंजिली इमारतें, भूकम्प, बाढ़ व अन्य प्राकृतिक आपदाओं से नष्ट हुए भवनों का पुर्ननिर्माण सम्भव होता है।

उन्होंने चंडीगढ़ में दस मंजिले भवन का उदाहरण देते हुए कहा कि इस तकनीक में कम लागत में अच्छा काम होता है। पीएचडी चैम्बर आफ कामर्स के अध्यक्ष योगेश श्रीवास्तव ने कहा कि वर्तमान में पूर्व निर्मित प्रीफैब्रिकेशन तकनीक का प्रयोग बहुमंजिले भवन व सैन्य परियोजनाओं में किया जा रहा है।

इस तकनीक को अन्य निर्माण कार्यों में भी अपनाने की जरूरत है। गोष्ठी में डा. बी एन दिवेकर, अशोक जैन, वी बी सिंह, रंजीत सिन्हा सहित अन्य वक्ताओं ने अपने विचार रखे।

कल्पतरु एक्सप्रेस

प्री-फेब्रीकेशन के इस्तेमाल से निर्माण में होगी आसानी

कल्पतरु समाचार सेवा

लखनऊ। 'द इंस्टीट्यूट ऑफ इंजीनियर्स' के 'सिविल इंजीनियरिंग में प्री-फेब्रीकेशन' विषय पर दो दिवसीय अखिल भारतीय सम्मेलन का आयोजन किया। यह आयोजन राजधानी के इंजीनियर्स भवन में शनिवार को आयोजित किया गया। कार्यक्रम के मुख्य अतिथि प्रदेश के विज्ञान एवं तकनीकी विभाग के प्रमुख सचिव डॉ. एचएस दास थे। जिन्होंने वर्तमान परिदृश्य में प्री-फेब्रीकेशन की विशेषताएं बताई। सम्मेलन के पहले दिन इंस्टीट्यूट ऑफ इंजीनियर्स के अध्यक्ष वीबी सिंह व एमएनएनआईटी इलाहाबाद के प्रोफे. नैन आर मौजूद रहे। प्री-फेब्रीकेशन पर बात करते हुए प्रोफे जैन ने कहा कि लागत से निर्माण में सिर्फ इस किसी भी प्रकार का उचित समाधान नहीं दे पाते हैं। उन्होंने कहा कि ज्यादातर योजनाएं डिमांड पर हैं और सीमेंट की मांग इसका मोटा सबूत है। इस परिस्थिति में प्री-फेब्रीकेशन के प्रयोग से पर्यावरण का संतुलन बना रहे और कम किया जा सकता है।

इस कार्यक्रम में प्री-फेब्रीकेशन की तकनीकों के बारे में विस्तार से चर्चा की गई। कृषि के कामों में प्री-फेब्रीकेशन की उपयोगिता पर बात करते हुए पीएचडीसीसीआई, दिल्ली के सेक्रेटरी योगेश श्रीवास्तव ने कहा कि कृषि कामों में प्री-फेब्रीकेशन के इस्तेमाल से खर्चों में कमी के साथ सरलता भी आती है।

प्री-फैब्रीकेशन टेक्नोलॉजी पर सेमिनार

कैनविज टाइम्स ब्यूरो

लखनऊ। राजधानी के रिवर बैंक कॉलोनी स्थित द इंस्टीट्यूशन ऑफ इंजीनियर्स की ओर से शनिवार को सिविल इंजीनियरिंग प्री-फैब्रीकेशन टेक नोलॉजी पर सेमिनार का आयोजन किया गया। इस अवसर पर मुख्य अतिथि के रूप में विज्ञान व प्रौद्योगिकी विभाग के प्रमुख सचिव एचएस दास उपस्थित रहे।

आज

द इन्सटीट्यूट ऑफ इंजीनियर्स की गोष्ठी सम्पन्न

लखनऊ, शनिवार। द इन्स्टीट्यूशन ऑफ इंजीनियर्स (इंडिया), उ.प्र. स्टेट सेंटर द्वारा स्थित इंजीनियरिंग में पूर्व निर्मित तकनीक पर एक अखिल भारतीय तकनीक गोष्ठी का आयोजन किया गया। उ.प्र. शासन के प्रमुख सचिव (विज्ञान एवं प्रौद्योगिकी) डा. हरशरण दास ने मुख्य अतिथि के रूप में बोलते हुए कुछ समय पूर्व चंडीगढ़ में दस मंजिले भवन का पूर्व निर्मित तकनीक के आधार पर 48 घंटों में पूर्ण निर्माण का उदाहरण देते हुए निर्माण की इस नई तकनीक को अपनाने की सलाह दी क्योंकि इसमें निर्माण समय कम हो जाता है साथ ही साथ इस लागत में अच्छी गुणवत्ता का कार्य होता है। उन्होंने पूर्व निर्मित तकनीक का उदाहरण देते हुए कहा कि जिस तरह से आधुनिक घरों में मॉड्यूलर किचन को अपनाया गया है उसी प्रकार इस तकनीक को निर्माण के सभी आयामों में प्रयोग किया जाना चाहिए। विदेशों में इस तकनीक के आधार पर बहुमंजिली इमारतें चन्द महीनों में तैयार हो जाती है। भूकंप, बाढ़ एवं अन्य प्राकृतिक आपदाओं से नष्ट हुए आवासीय भवनों का पुनर्निर्माण इस तकनीक द्वारा कुछ दिनों सम्भव होता है साथ ही रूरल्स उद्योग जगत से भवनों को पूर्व निर्मित निर्माण तकनीक को अपनाने का आवाह किया। योगेश श्रीवास्तव ने पीएचडी चैम्बर ऑफकामर्स एंड इण्डस्ट्रीज के अध्यक्ष सुमन ज्योति खेतान का संदेश को देते हुए कहा कि वर्तमान में पूर्व निर्मित तकनीक का उपयोग बहुमंजिला भवनों, ग्रीन हाउस, स्टेशन प्लेटफार्म, गोदाम, सैक्षिक भवनों एवं सैन्य परियोजनाओं में किया जा रहा है।

अमर उजाला

लखनऊ, 28 जुलाई 2013

प्री-फैब्रिकेटड तकनीक को मिले बढ़ावा

लखनऊ (ब्यूरो)। इमारतों के निर्माण में प्री-फैब्रिकेटेड तकनीक के प्रयोग को बढ़ावा देने के लिए शनिवार को दि इंस्टीट्यूशन ऑफ इंजीनियर्स द्वारा रीवर बैंक कॉलोनी स्थित इंजीनियर्स भवन में सेमिनार हुआ। इसका शुभारंभ प्रमुख सचिव (विज्ञान एवं प्रौद्योगिकी) एचएस दास ने किया। उन्होंने चंडीगढ़ में दस मंजिला बिल्डिंग 48 घंटे में बनाने का उदाहरण देते हुए कहा कि यह तकनीक आज के समय में काफी फायदेमंद है। आपदा की आशंका पर प्री-फैब्रिकेटेड तकनीक से बनी इमारतों को दूसरे स्थान पर भी ले जा जाया सकता है। पीएचडी चैंबर ऑफ कॉमर्स एंड इंडस्ट्रीज के अध्यक्ष ने कहा कि शिक्षा, सेना व रेलवे में इस तकनीक का काफी उपयोग किया जा रहा है।

Organized by:
The Institution of Engineers (India)
Uttar Pradesh State Centre
Under the aegis of:
Civil Engineering Division Board, IE(I)

SYNERGY PARTNERS
The Institution of Engineers (India)
Allahabad Local Centre

FERROCEMENT SOCIETY
PUNE

SYNERGY PARTNER
PHD CHAMBER
PROGRESS HARMONY DEVELOPMENT
Estd. - 1905

FEEDBACK & LETTERS FROM DELEGATES

Thanks and Congrats to shri Ashok Jain for enlightening us.
Chandramohan
Vice President
Ferrocement Society
Pune

Dear Jain Sir & Er. Navin singh ji,
It has been an informative seminar @ precast works in concrete, ferrocement, steel & wood.
The high light of the seminar is the eminent speakers & dignitaries from inaugural session to the end. Though it might seem less attended but it was well attended & participative.
Dr. Das, Dr. L K Mishra, Dr. B N Divekar, Mr. Yogesh Shrivastav, Er. Ranjit Sinha, Dr. Rama Shanker & your works & talks were eye opening.
The works of Mr. Anil Gaind, Mr. Sumit Agrawal & Mr. Mehta (at site visit) were very interesting.
Er. Navin Singh's spirit about slim & cost effective technology may be the approach to propagate the technology.
Food & boarding as well transport facilities provided very ease & comfortable (without worries) stay. Personally Er. Navin Singh got me the medicine & spared his own car to us for three days.
The audio system in the main hall on first day was little inaudible.
I am thankful to you sir, Navin Singh & all the team.
Regards,
D A Patel

Dear Mr. Jain,
I cannot think of too much improvement in hospitality, quality of food served, and other general arrangements. The only comment I would like to offer is: it was missing a woman's touch in so much as I have found that in matters of hospitality, a couple of suave young ladies can make a lot of difference. The time control was surprisingly superb, and this is perhaps one of the very few programs I have attended in India where there was no need to ring the bell.
For me and Shobhana, struggling as we are to control costs and improve efficiency in our construction activities, it was overall very educative. We have come all the richer for it.
Most of the presentations were very good, and gave an insight into the thinking of innovative people across the country in a field that needs real work in changing attitudes.
Now is the time to move ahead out of the seminar rooms and labs not just to address educational needs and sample buildings, but to work on establishing Ferrocement Technology on the Construction Map of India.
I think we have little option but to adopt Ferrocement as the preferred and perhaps the most viable solution to the growing problems. We need to get together with all the people who are passionate about the need to build well, build better, quicker, more economically and show concern towards aesthetics and environment. Ferrocement should never be talked of as Low-Cost, it is not only cost-effective, it is the one great hope of the construction industry. We need to

get more women involved as trained artisans, and feel that the approach of Steve Jobs, outlined in his famous Commencement Speech at Stanford (Please see YouTube) should be applied.
The objections of the conservatives is something we shall have to fight, and fight to win. The lack of concerns among the bureaucrats we shall have to fight.
Let us start now. I shall be seeing you soon. Maybe we can work out a strategy.
Regards.
Ranjit Sinha.

Sir
We would first like to thank you from the core of our hearts for affording us an opportunity to present, whatever little we are doing in ferrocement, to the august gathering at Lucknow, Your single handed effort deserves not only appreciation but something more, which shows that your heart is in this technology. Looking forward for the next such convention. We think that nothing was lacking except we should be in a position to lend a helping hand to your good self for the next meet, if you feel we can be of any help.
Hospitality, meals, time-control were all, excellent.
We feel all speakers should have been present in the concluding session along with the individual sessions in charge for a threadbare discussion to be able to make this technology as popular as a mobile phone. We feel now the time has come to cash on the inroads we have made in the government set up in our state of Jammu & Kashmir and to make this product a house hold name with your active participation. We feel that with our mutual cooperation we can develop production centers all over the country. This can never happen if we keep towing our lines individually.
Actions speak louder than words.
A group photo of all the participants would have been an additional advantage to carry forward the movement of ferrocement stakeholders at the national level and to become an inspiration for the new comers.
Anil Gaind

Dear Sri Jain,
At the outset, I express my sincere gratitude to you for inviting me and providing me an opportunity to participate in the subject conference.
It has been a learning platform for me to get acquainted with innovations and new technologies in pre-fabrication technology.
As a layman, I am of the view that there is an urgent need for interface with policy makers, technocrats and implementers so that a time bound action plan can be worked out to make best use of these innovation for the cause of common man and also to mitigate the ever increasing gap of demand and supply of housing in our country.
I congratulate you for your meticulous planning in all aspects i.e. hospitality, meals, time control, presentation, management etc. and conference went off very well.
I wish you all the best,
with warm regards,
Dr. Indu Chandra Nagar

PRESENTATIONS

WOOD In PREFAB BUILDINGS

Ar. ANURAG KHANDELWAL
Head /Architect CONSULTING ONE
CEO/ Dir. WOOD BARN INDIA
anurag@woodbarnindia.com

Wood Barn India, is the pioneer of Wooden Houses in India.

It was setup in 2006. Wood Barn India became the first Company to offer wooden houses in India.

The Company would be addressing the residential & hospitality requirement of the Indian market in the initial phase of its growth plan. Wood Barn India is making available an exquisite interplay of luxury and nature that invigorates the senses.

Wood Barn, since 2006 has tested the wooden houses under the Indian weather conditions, before deciding to market the houses in India. This is one of the first efforts by any Indian business entity to offer weather resistant dismantle-able wooden houses in the country.

WoodBarn
Eco-Friendly Homes

Log Homes and Wood Framed Houses

Which are :

- ✓ — **Fire Resistant**
- ✓ — **Water proofing–100%**
- ✓ — **Termite resistant**
- ✓ — **Heat & Sound Insulated**
- ✓ — **Environment friendly Wooden houses**
- ✓ — **All weather resistant, perfect Stability. – Already Tried and Tested for last 10 years in Indian conditions and globally these houses are a phenomena.**
- ✓ — **Energy Saving and Environment Healing houses . (A step beyond environment – friendly)**
- ✓ — **Highly cost efficient .-Visit us to understand the economics. Installed In :**
- ✓ — **Required Time for Installation – average of 7-30 days Genreral Information :**
- ✓ — **These houses are flexible and can be modified and re-modelled at any point of time and in no time.**
- ✓ — **The houses if dismantled can be re-fabricated , re-used and have a value at any point of its life span.**
- ✓ — **Kiln dried wood, Canadian Spruce Wood, Quality – 'J–grade' AND**

A Guarantee of 50 (Yes Fifty) years

WoodBarn
Eco-Friendly Homes

WOOD FRAMED HOUSES






WoodBarn
Eco-Friendly Homes

WOOD LOG HOUSES

WoodBarn
Eco-Friendly Homes

PROJECTS

SKI RESORT
at Aulli

WoodBarn
Eco-Friendly Homes

PROJECTS

ClLUB MAHINDRA
at Asthamudi

WoodBarn
Eco-Friendly Homes

PROJECTS

Eminent Clients LIST

Infosys
Club Mahindra
Micasa- Goa
Blue Bay- Chennai
GMNV- Uttrakhand
Nagpal builders- Delhi
Siddh Data Ashram

Mr. Shatughan Sinha
Mr. KPS Gill
Mrs. Nafisa Ali
Mrs Naina Balsawar
Mr. Trilok Dayaram
Mr. Satish Sharma

PREFAB WOODEN BUILDING.

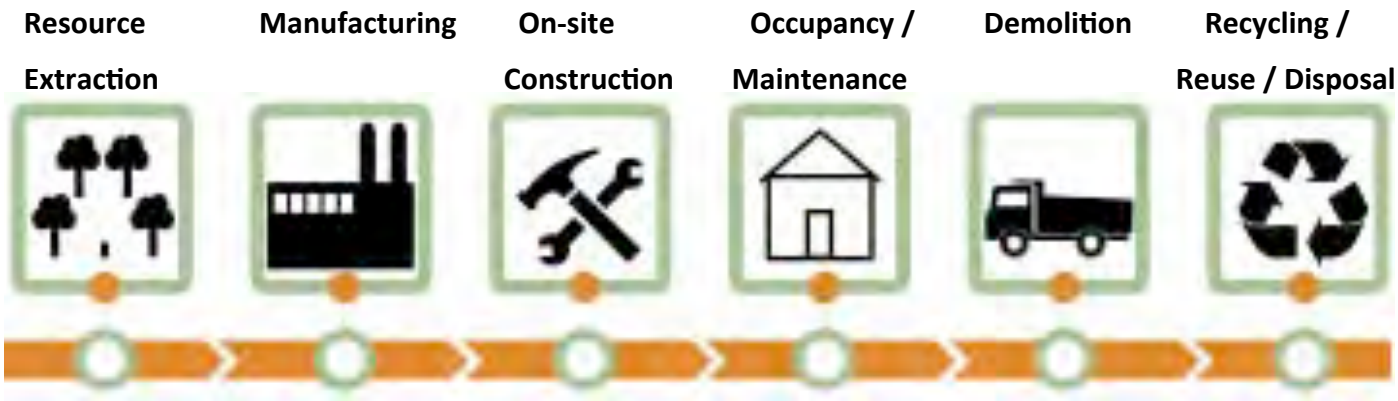
Why Wood to be considered as Material for Buildings.

WOOD: MOST ECO FRIENDLY MATERIAL

When considered over a building's lifetime – from harvest of raw materials through manufacturing, transportation, installation, use, maintenance and disposal or recycling –

wood performs better than concrete and steel in terms of embodied energy, air and water pollution, carbon footprint and global warming potential.

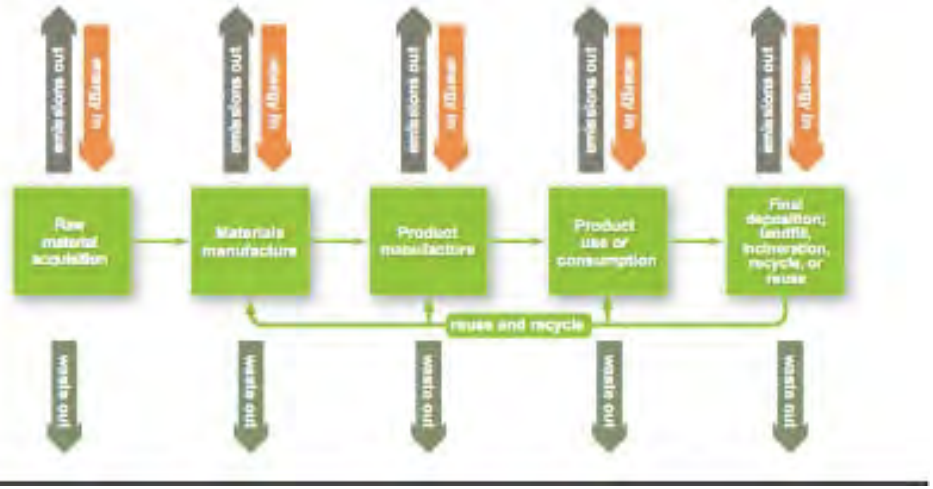
LCA analyzes the impacts of all materials and energy flows, either as input or output, of each component, from raw materials to end-of-life disposal or to rebirth as a new product.

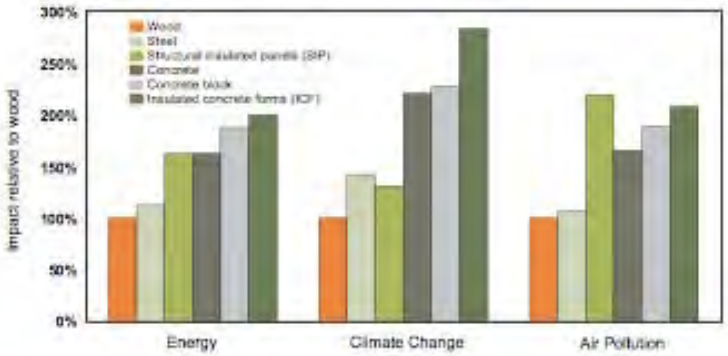


Life Cycle of Building Products

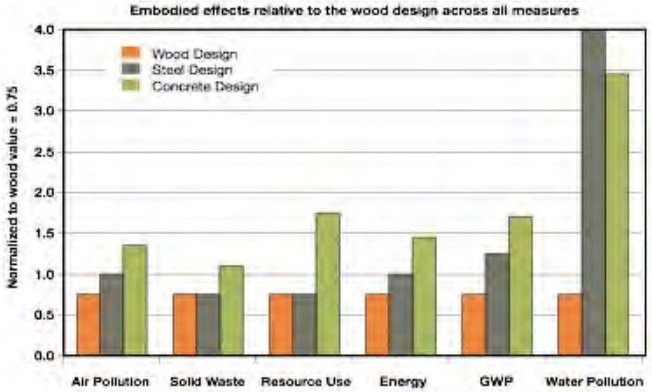
Life cycle assessment considers every input and output

This diagram illustrates the general concept of life cycle assessment, where all of the environmental inputs and outputs are measured at each stage of a product's life.



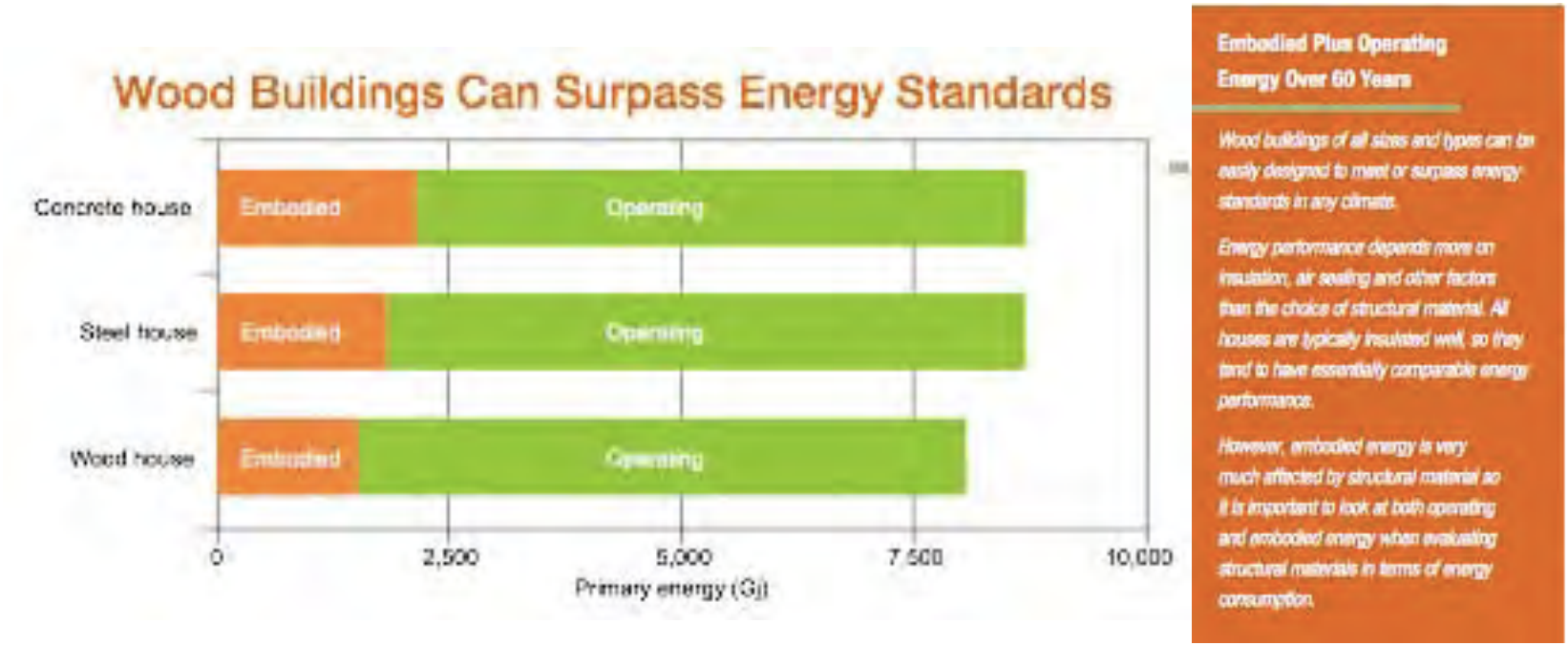


Embodied environmental impacts of various exterior wall assemblies



In this graph, three hypothetical homes (wood, steel and concrete) of identical size and configuration are compared. Assessment results are summarized into six key measures during the first 20 years of operating these homes.

Source: Data compiled by Canadian Wood Council using the ATHENA EcoCalculator with a data set for Toronto, Ontario.



Wood is low in embodied energy. It's produced naturally and requires far less energy than other materials to manufacture into products. Much of the energy used to process wood i such as the energy needed for kiln drying, also comes from renewable biomass,including chips and sawdust– a self-sufficient, carbon-neutral energy source

WOOD: A SAFE AND DURABLE CHOICE

When it comes to safety and durability, wood is a preferred choice In Most Developed Countries for any private or public building project.

Fire

Usually a building's contents such as carpets, curtains and furniture are the first to burn, which means fire safety depends more on the habits of the occupants than on the structural composition. Wood-frame walls, floors, and roofs using conventional wood framing, wood trusses and I-joists can be designed to resisit Fire from 90 Min to 180 Min.by use of chemical coatings

Seismic Performance

Research shows modern wood-frame structures are better able to resist seismic forces than any other form of construction.

Moisture

Unlike other building materials, wood has the ability to release or absorb moisture. Its moisture content always matches that of the air, which results in natural regulation and stabilization of humidity.

The use of wood products can also improve indoor air quality by moderating humidity. Acting like a sponge, the wood absorbs or releases moisture in order to maintain equilibrium with the adjacent air. This has the effect of raising humidity when the air is dry, and lowering it when the air is moist – the humidity equivalent of the thermal flywheel effect.

Accoustics

Privacy is a major issue for building occupants.

Poor acoustic performance is a common problem in buildings with large areas of hard, acoustically reflective surfaces. Such surfaces are frequently found in green buildings where the use of absorbent surfaces is often minimized due to indoor air quality concerns.

Wood is not as acoustically lively as other surfaces and can offer acoustically absorptive qualities. Generally, a wood-finished building is not as noisy as a complete steel or concrete structure.

Thermal Performance

Wood has low thermal conductivity and good insulating properties, and light wood-frame technology lends itself readily to the construction of buildings with low operating energy.

Due to its cellular structure and lots of tiny air pockets, wood is 400 times better than steel and 10 times better than concrete in resisting the flow of heat. As a result, more insulation is needed for steel and concrete to achieve the same thermal performance as with wood framing.

Benefits of Wood

Selecting wood building products offers the following advantages related to resource conservation:

1. Wood is 100 per cent renewable.

2. More than 90 per cent of every tree harvested in DEVELOPED COUNTRIES is utilized.

The fibre is used for the highest-value products possible, and mill residues such as chips, cut-offs and sawdust are used to make high-value composite materials such as pulp, medium-density fibreboard and finger-jointed lumber.

3. Wood has the least embodied energy of all major building materials

the energy consumed to grow, harvest, transport and manufacture wood products is less than for other products. Not only does wood require less energy to manufacture into products, half of that is generated from wood waste such as chipsand sawdust. Burning wood waste for energy is considered carbon neutral because it only releases the carbon sequestered in the wood during the growing cycle.

4. Wood is versatile and adaptable.

A building's structural design and spatial subdivision determines its ability to be flexible in use, and adaptable so it can meet new requirements. Separating these functions makes it easier to reconfigure the space. Wood lends itself to this design approach, especially through the use of post-and-beam structures (in solid sawn lumber or engineered wood) and non-load-bearing partitions made up of smaller members (either solid laminated or in stud frame construction).

5. Wood lends itself to dismantling,

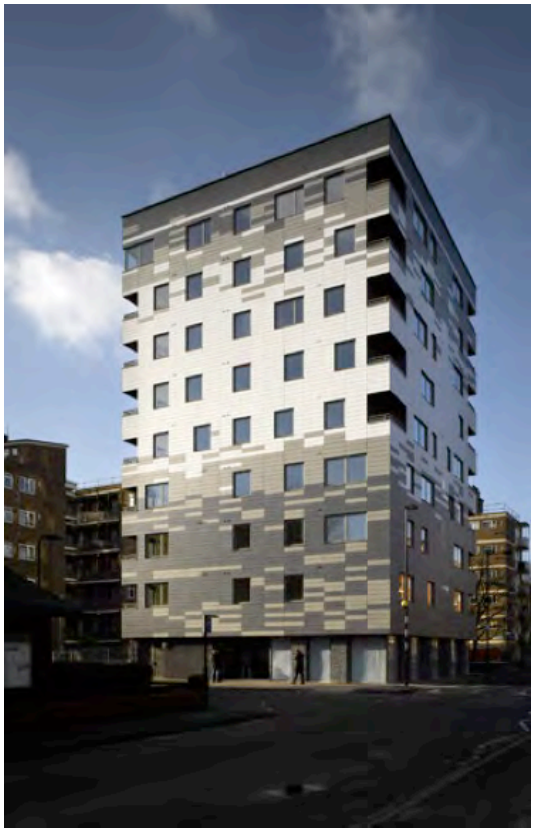
A fact borne out by the continued predominance of wood and wood products in the architectural salvage market. It can generally be reclaimed without diminishing its value or usefulness for future applications. This contrasts with materials like concrete, which is usually crushed for future use as aggregate or ballast, or brick, which can be easily damaged when cleaned for reuse, and which can rarely be reassembled with the original precision.

6. Structural wood members can typically be reclaimed and reused

For the same or similar purpose with only minor modifications or wastage. If desired, the same material can be remilled and fashioned into other products, such as window and door frames, curtain wall components and cladding. A recent celebrated example is the Materials Testing Facility in Vancouver, designed by Perkins+Will Canada Architects Co., which features reclaimed lumber from a demolished warehouse in each of these applications. Short lengths of lumber that may be a byproduct of the remilling process can typically be used for bracing and blocking elements. Wood components too small to reuse and leftover wood chips and sawdust can be processed into mulch for landscape use or to provide organic material to promote decomposition in landfills.

WOODEN MARVELS:
WORLD'S TALLEST TIMBER RESIDENTIAL BUILDING

Murray Grove
The world's tallest modern timber residential building



- In the Borough of Hackney in London stands Stadthaus, the world's tallest modern timber structure.
- Stadthaus is a nine-storey high- performance residential building of which the top eight are constructed from cross-laminated timber and designed according to passive design principles.
- Pre-fabricated timber panels comprise the load-bearing walls and floor slabs as well as the stair and lift cores.
- Each panel is made up of five layers of timber positioned at 90 degree angles and glued over their entire surface, making a panel that could be compared to precast concrete.
- To address global concerns about carbon emissions, the design team made use of pre-fabricated panels that provide several advantages:
- A. improved thermal performance,
- B. a continuous air barrier,
- C. ease and speed of construction, and
- D. waste minimization.

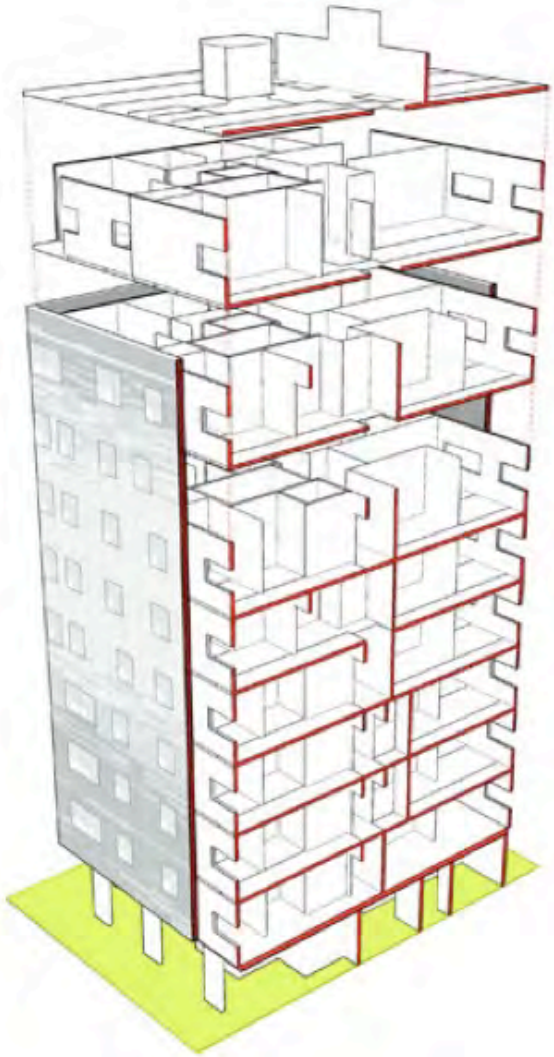
- Because wood products continue store carbon absorbed during the tree's growing cycle, this modern timber building will actually keep 205 tons (186 tonnes) of carbon out of the atmosphere for its entire service lifes—or longer if the materials are reclaimed and manufactured into other products. within its structure over its lifetime.
- CLT construction reduces wetting potential because prefabrication reduces construction time. CLT also provides considerable insulation with an inherent R-value of about R-1.2/per inch resulting in R-4.2 for 3 1⁄2" thick panel. The solid panel also reduces convection in the assembly.

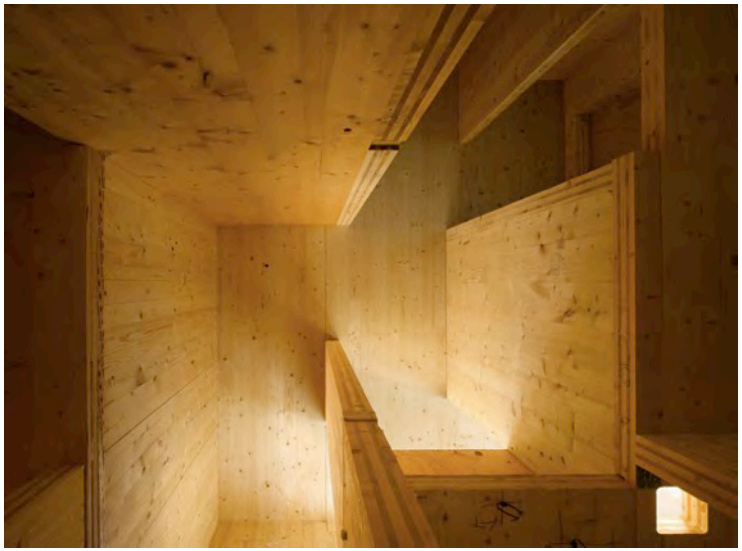
- (http://www. waughthistleton.com)

Murray Grove

On Drawing Board

Typical social housing unit





Murray Grove

Construction Process

Designed by Farrow Partnership Architects Inc, the Carlo Fidani Peel Regional Cancer Centre in Mississauga, Ontario has large arching beams of Douglas-fir that span the main lobby and radiation therapy treatment areas, inviting the natural light to cascade and envelop the patients and families in a healing embrace. The design is simple in terms of function but dramatic in terms of attractiveness.

THANKS

www.woodbarnindia.com
anurag @woodbarnindia.com
+91-9927992009

All Refrences are taken from Forestry Innovation Investment (FII), a Crown Agency of the Province of British Columbia (B.C.), Canada. FII works with the Government of British Columbia, Government of Canada.

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

Presentation by Ferro-cement Cooperative Society Ltd.

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Presentation by Ferro-cement Cooperative Society Ltd.

Training at our works

Our manufacturing unit

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

Presentation by Ferro-cement Cooperative Society Ltd.

Materials used in Ferrocement prefabrication

- Cement
- Sand(coarse,fine,Washed stone dust)
- G.I. Mesh(chicken mesh)
- Steel
- Shuttering in the form of moulds
- Chemicals(Plasticiser,Accelerator etc.)

Reasons for use of Ferrocement in toilets

- Basic raw materials are easily available in the state of J&K.
- Skills of ferro-cement construction can be acquired easily
- Heavy plant & machinery are not involved
- Ferro-cement is easily repaired & virtually no maintenance is required
- Easily handled as light in weight
- Economical & quick construction
- High durability
- Versatility
- Fungus resistant

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

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Sanitation Units

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

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Sanitation Clusters

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

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Railway Ganghut at railroad intersection

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

Presentation by Ferro-cement Cooperative Society Ltd.

Roofing Components

Joists

Planks

Channels

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Other Applications

USE OF FERROCEMENT IN RURAL AREAS OF JAMMU

Presentation by Ferro-cement Cooperative Society Ltd.

Awareness Camps

Buyer/Policy maker awareness

Other Activites

Former CM of J&K

Divisional Commissioner Jammu

BAMBOO

PREFABRICATED PERSONAL SPACES

Bamboo is being celebrated globally as the building material of the future because of its excellent structural properties, sure & sustainable availability and its minimal ecological impact.

This wonder-grass is now available to you as a set of pre-fabricated, pre-engineered pecision-machined, ultra-luxury private spaces with high-end hardware and factory finished joints.

Each bamboo is pressure treated for long lasting life and is monitored strictly during prefabrication to provide a highly durable housing solution.

These structures are waterproof, highly earthquake resistant and can be used under extreme temperature variations.

These naturally insulated cottages are available in stunningly beautiful bamboo finishes or bamboo ferrocemnt composite materials that provide a cozy & conventional masonary feel from inside.

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BAMBOO

Pre-engineered joints form the heart of your personal space. Each joint is treated with moisture curing PU adhesive that foams and gushes into the micro-cracks, sealing the joint permanently.

Each carefully chosen bamboo culm goes through a scientific vaccum/pressure curing process for long-life & durability.

The structure is carefully assembled and checked at our workshop for structural integrity.

Our unique Bamboo-Ferrocement composite technology allows modern living within a bamboo dwelling.

Er. Ashok Kumar Jain : B. Tech and M. Tech from IIT Kanpur, he is the country's foremost authority on Ferrocement Prefabrication and aglobally acclaimed engineer of hight repute. Presently he is a visiting faculty at MNNIT, Allahabad.

Ar. Atul Gupta, a graduate of Govt. College of Architecture, lucknow, past President, Uttar Pradesh Architects Association. Practicing Architect, winner of many Design Competitions.
His expertise lies in designing functional and highly humane spaces.

Sumit K Agarwal, a social entrepreneur with over 28 years with the worlds leading corporates.
He has chosen the alternate life and is working with sustainable livelihood solutions for the rapidly growing rurban population

Tanjun Associate LLP. Livelihood Skills Training & Development Centre, 5-Ikeda Avenue Shivalik Gardens Phase II, P.O. Tanko Sunderpur, Distt: Saharanpur, UP. India. 247662

D 903 Gateway Tower. Sector 4 Vaishali, Ghaziabad. 201010. UP. India. E-mail: associate@tanjun.asia

SRG PREFAB
EASY TO INSTALL • EASY TO USE

Portability to Functionality
The Perfect Construction Solution..

COMPANY PROFILE

In today's age, everyone is looking for innovative, yet economical technological solution to help them keep up with the fast changing demands of work environment. SRG Prefab Portable Cabins are a perfect example of this. It combines a fine blend of innovation and quality to design portable cabins that ensure quality, the synergy achieved between metal and technology assures value for your money. What's more, SRG Prefab Cabins are available in a wide range to suit your needs

Manufacturing , Exporting and Supplying
World class Pre-Fabricated products like Portable Cabin, Cold Room, Pre-Engineered building,Sound proof chamber etc.

SRG International Pvt. Ltd.
An ISO 9001: 2008 Certified Company

Plot No. 13- A, Sector- 4, Industrial Area Faridabad - 121 004, Haryana, India
Telephone: +91-129-2302216, 4069216, 2213947 ; Fax: +(91)-(129)-2211183
Email:info@srginternational.in ;srgprefab@gmail.com
Website : www.portacabinsrg.com, www.srginternational.in

Portable Cabins are extensively use as::

Servant Rooms

Servant room are room use for the accommodation of servant in houses/farm house/ office etc. They are precisely designed and manufactured to suit the varied requirements of the each individual client. These cabins are very easy to install and are available at very reasonable prices. Our exclusive range of Servant Rooms is well known for its designs, durability, looks and quality standards.

Guard Cabins

Pre-fabricated security cabins/guard room are adequate to install at construction sites, offices, hotels, restaurants, educational and residential institutions among other sites. These cabins are well finished and machined using modern equipment to provide precise dimensions. SRG make pre-fabricated security cabins using quality raw material in tandem with industry standards.

Roof Top Cabin

SRG offers a wide range of stylish and highly convenient Roof Top cabins / room these cabins are very easy to install and are of extremely light weight. These are structurally designed to fetch the requirements of the clients and fabricated with qualitative range of materials due to which they are very durable.

Pre -fab Toilets

Modular toilets are adequate for usage at work sites, restaurants, defence and construction applications among other uses. These durable structures are properly finished and machined using quality raw material in compliance to international quality standards. These toilets can be installed anywhere and have provisions to be attached with the external drainage system.

Material thickness required to achieve high level of insulation are:

- 50mm polyurethane Rigid Form
- 80mm Polystrene
- 90mm Mineral Wool
- 100mm Cork
- 130mm Fibre Board
- 200mm Soft Wood

760mm Light Concrete

1720mm Brick Work

1) Internal and external wall having pre painted GI sheet with PU insulation in between.

2) Internal and external wall having GI sheet with insulation in between and after paint on both the surface

3) Internal and external wall have both side cement fiber board, insulation in between and after paint on both the surface

4) Internal wall made of MDF particular board and external wall will be made of Pre painted GI or GI

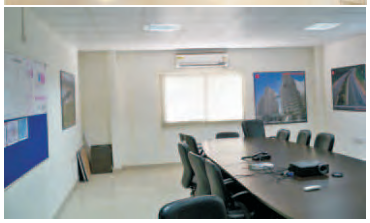
Pre Painted G.I. Cabins

We at SRG offer fully furnished GI portable cables that are extremely easy to assemble and dissemble, with the prime aim of offering efficient work spaces at on-site- locations.

Prominent Features of GI Portable Cabins

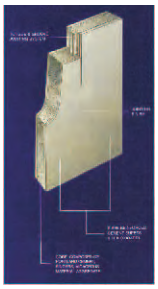
- Our GI Portable Cabins are made of finest materials and are extremely attractive to look
- Cabins made by us are 6” above ground level, which prevents rain water from coming inside the cabin.
- Each & Every electrical point inside the cabin are protected from MCB box from and wiring are exposed with PVC batten cover.
- Our cabins come in various sizes and can be adjusted according to clients' requirements.
- Doors & Windows of the cabins made by us are complimented with shades for additional safety. Also Aluminium foils for window will be provided (optional).

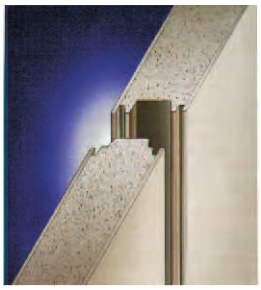
Cement Board Cabins



We offer cement board cabins for the clients in different colors, sizes and interior design. They are compact & have high structural strength.

Cement Board Panel is a sandwich panel made up of two fibre reinforced cement facing sheets on either side of a light concrete core.The light- weight concrete core consists of a mix of Portland cement, binders, siliceous and micaceous material aggregate suitably aerated.





Cement Fiber Board

Light Gauge STEEL

A Smarter way to build in steel

LIGHT GAUGE STEEL ….. A Concept

Light Gauge steel is smarter way of construction in steel with:

Light Gauge Steel Frame (LGSF)
and / or
Conventional / Red Steel

Light Gauge → **Less Thickness (0.75mm /0.95mm)** → **Use of High Tensile Steel (550MPa)**

→ **To Achieve Steel best Strength to weight ratio**

Global Scenario……

Australia

Australia's climate, termites and the threat of bush-fires have contributed to the increased popularity of steel-framing for residential and light commercial construction. Around, 15% of all house-frames across Australia are now made with steel and in South Australia, up to 30% of all homes are now being built with steel-framing.

Japan

The Japan is known for its seismic geographical location. It is not surprising then, that steel-framing is so popular in this country – 150,000 steel-framed homes are built here each year.

USA

Steel-framing is common in homes across the United States – and it has been a popular method of construction for many years. The highest prevalence of steel-framing is found I n warmer states such as Hawaii (approximately 40% of all homes), California and Florida.

New Zealand - A significant industry already operating

New Zealand is an international leader in the roll forming technology behind steel-framing with companies such as Framecad Solutions Ltd, Howick Ltd and Scottsdale Construction Systems, all based here in New Zealand, exporting their machines and technology around the world.

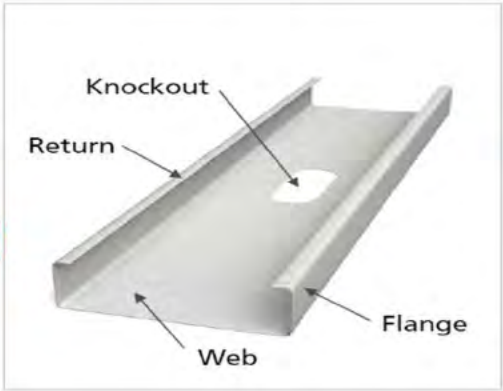
Advantages of Steel :

1) Steel is durable and safe material.
2) Consistent Material Quality.
3) Superior seismic and wind performance.
4) Non-Combustible material.
5) Dimensionally stable.
6) 100% recyclable.
7) Insect and rodent resistant and does not rot.
8) High strength to weight ratio.
9) Ease of handling, transportation and installation.
10) Complete design flexibility.

Technology :

Slitted coils

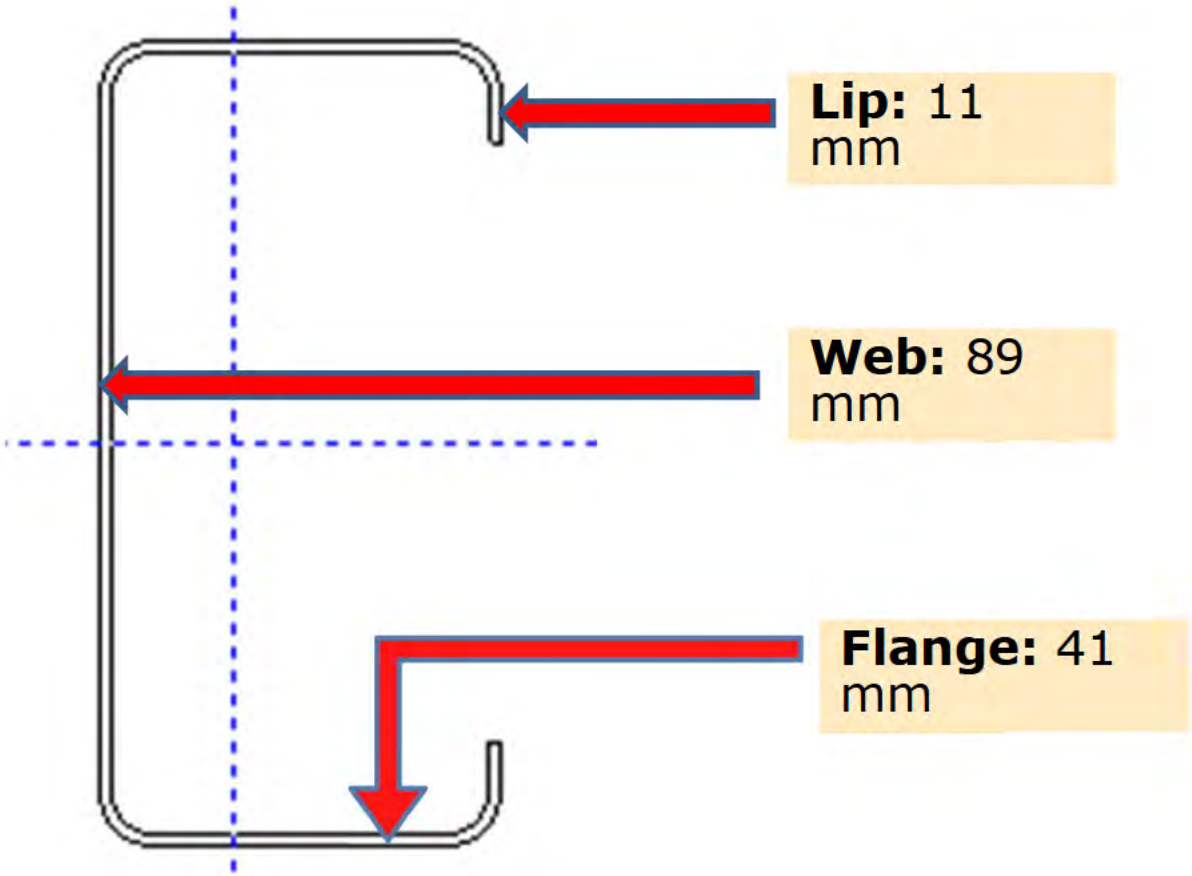
Roll Former



Rolled our section

Assembled to erect structure

Manufacturing :



SECTION PROFILE

Manufacturing :

Swage: A section that fits into another is swaged. This gives a leveled outer surface.

Notch: A section through which another section passes is notched (web is knocked-out) in that portion.

Punch & Dimple: Wherever a screw comes, the section is punched and dimpled. This helps in easy screwing and getting leveled surface after screwing.

What we offer :

3D Modeling

Engineering & Detailing

Manufacture

Services, Expertise, Supply Chain

Training & Enablement

Individual Components

Assembly

Construction

HOW THIS SYSTEM IS DIFFERENT:

1) Light Gauge steel offers completely designed system for variety of structures.

2) Each structure that is constructed is backed by proper design and analysis. All seismic, wind loads, dead and live loads are considered while designing.

3) Complete design is as per International and National Standards.

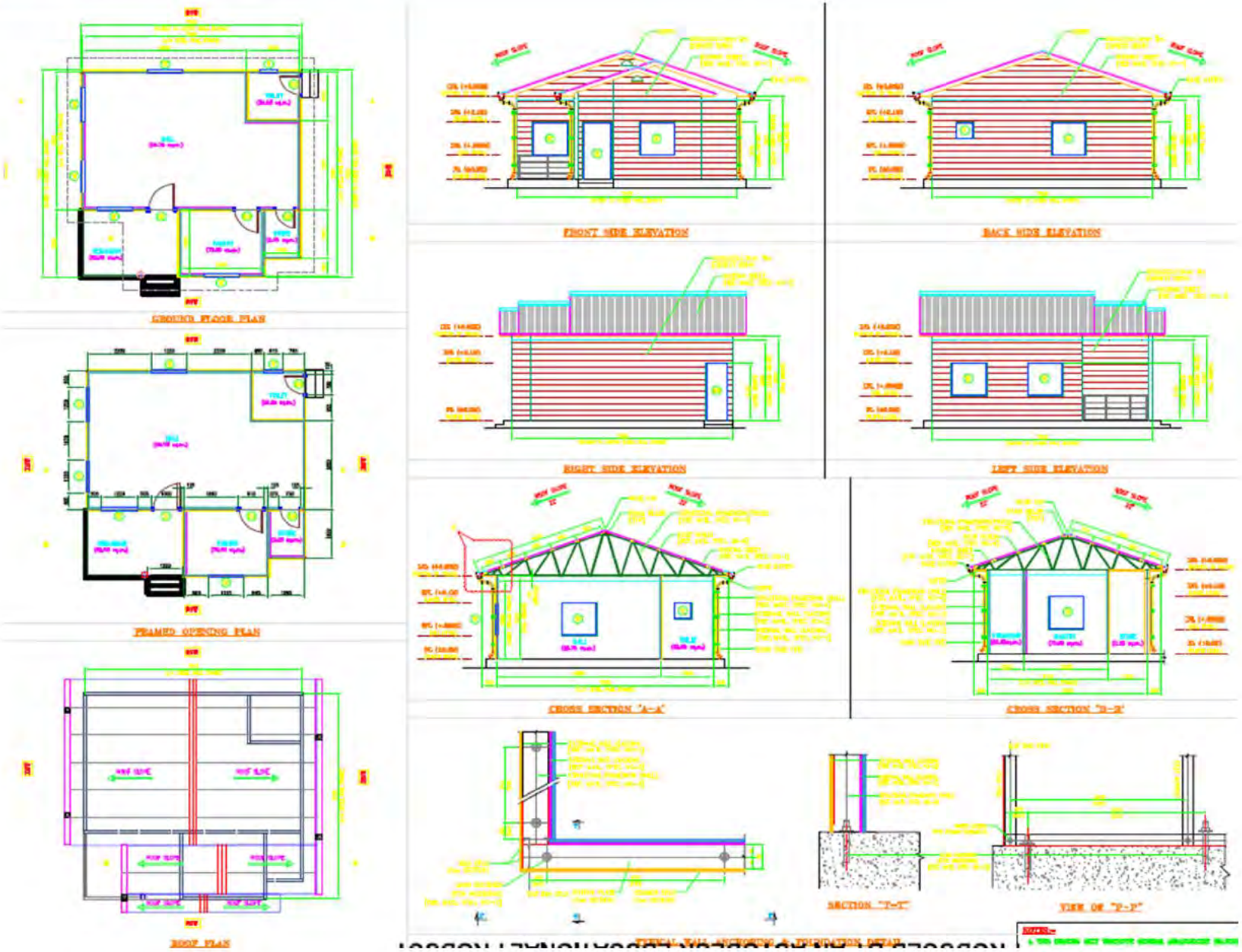
4) Complete back up of all drawings including assembly and erection.

5) This system is completely flexible and customized as per design.

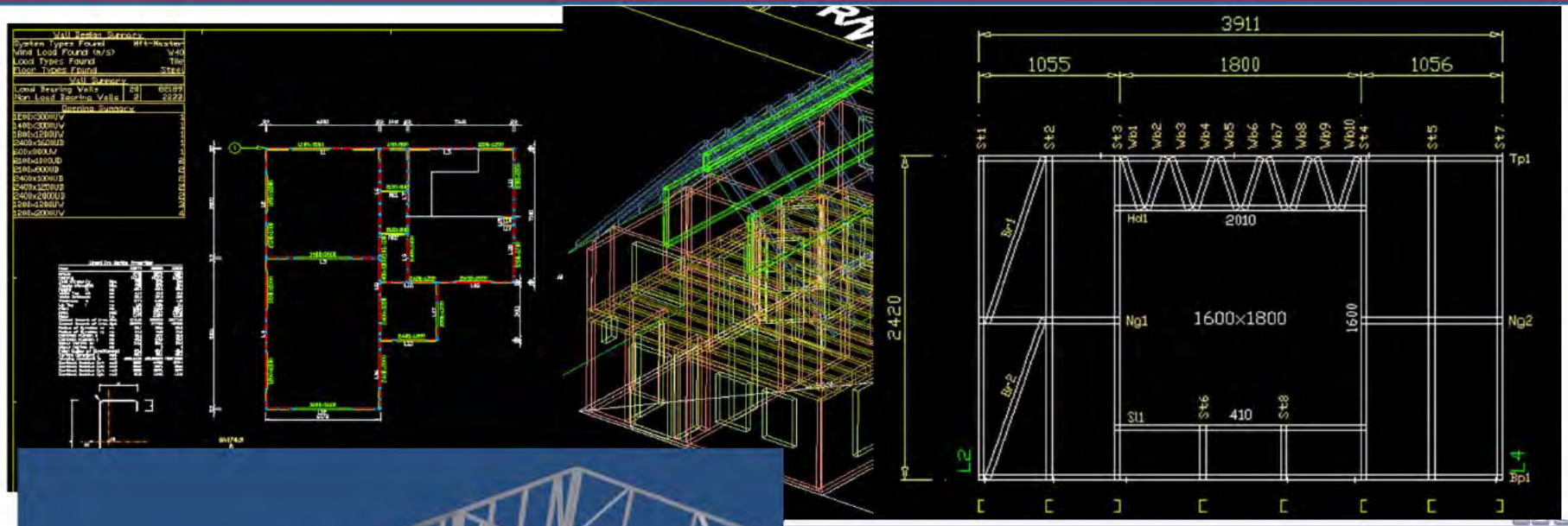
6) Hybrid Steel construction open up options with multi-storeys also.

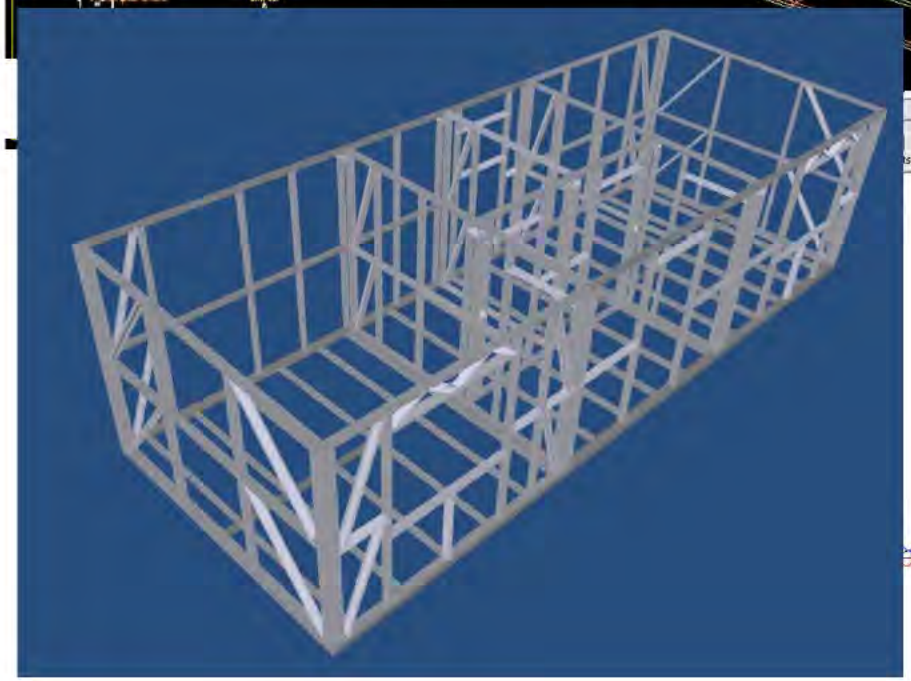
7) COMPLETE, FAST, ACCURATE ONE STOP SOLUTION.

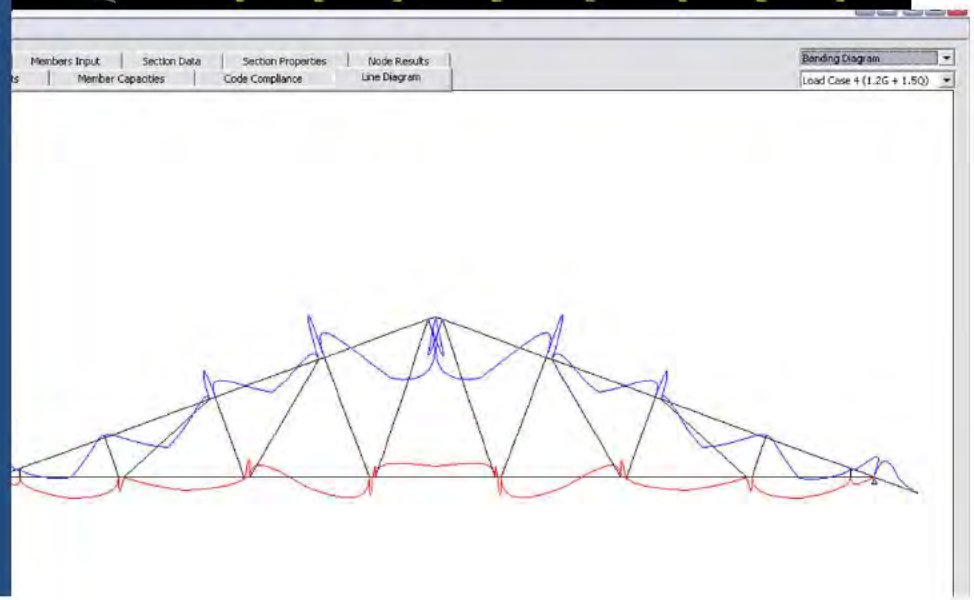
Detailing of a project



SOFTWARE :


3911
1055
1800
1056
St1
St2
St3
Wb1
Wb2
Wb3
Wb4
Wb5
Wb6
Wb7
Wb8
Wb9
Wb10
St4
St5
St7
Tp1
Br1
Hd1
2010
2420
Ng1
1600×1800
1600
Ng2
Br2
St1
St6
410
St8
L2
L4
Bp1




Members Input
Section Data
Section Properties
Node Results
Member Capacities
Code Compliance
Line Diagram
Bending Diagram
Load Case 4 (1.2G + 1.5Q)

Applications :

Infrastructure :

WORK FORCE ACCOMODATION / FIELD HOSTEL – START UP INFRASTRUCTURE

Applications:

Industrial:

EXTERNAL WALLS IN MULTISTORIED STRUCTURES

HIGH RISE PARTITION WALLS IN FACTORY

Proposed market segments :

Commercial:

INSTITUTES / SCHOOL BUILDINGS

Proposed market segments :

Design Flexibility:

Large span trusses

Joists for floor support

Proposed market segments :

Design Flexibility:

Stair Cases

Proposed market segments :

Design Flexibility:

Circular Shapes

Proposed market segments :

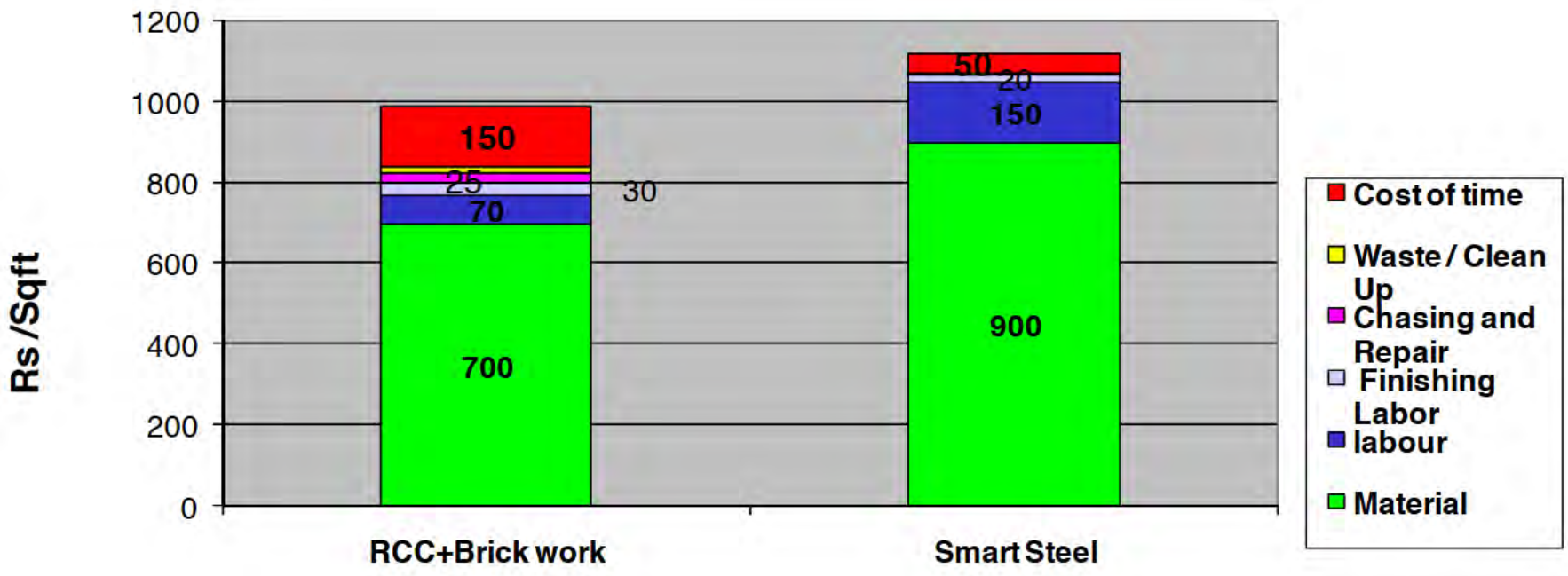
Design Flexibility:

Cantilevered structure

Structure on Stilts

PRICING AND SCOPE:

1) **Price of this system is approx 8-10% higher than conventional**



TOTAL cost : Brick work Rs 990 per sqft

TOTAL cost : Light Gauge Steel Rs 1121 per sqft

Frequently Asked Questions

How safe is it against wind and earthquake?

It is structurally designed by our engineers to withstand wind and earthquake loads as provided by IS Codes.

What is the advantage over brick wall construction?

It is a dry construction. It is factory made. Wall thickness is lesser, and gives you bigger room.

Can I do concrete floor over the LGSF frame?

Yes, you can.

Can we do any kind of finish on the system?

Yes, any kind of finish is possible from simple paint to stone cladding.

What is the life expectancy of the structure?

This system is warranted for structure for 25Years.

How many floors we can construct in Smart steel?

Though this system can be designed for multiple floors in hybrid system, Typically Light gauge steel frame shall take upto G+2 strcutures.

HINDUSTAN TRADERS

Office : 1 / 8-C, Master Zahurul Hasan Road, Katra, Allahabad - 211002 (U.P.) Mob. 9415074321
Works : Near Reliance Petrol Pump, Varanasi-Shakti Nagar Highway, Village : Sinduria, Post - Chopan, Sonebhadra - 231205 (U.P.) INDIA
Mobile : 9795459500, 9795459205, 9795459207
Email : hindustantraders2003@yahoo.in

Manufacturers & Suppliers of

- Interlocking Concrete Block Pavement (ICBP)
- Kerb Stone
- Kilometer Stone
- Hectare Stone
- 5th Kilometer Stone
- Hume Pipe 150-1200 mm, NP- 2, NP- 3
- Stand Post
- Hand Pump Platforms
- Chaukhats (Various sizes, Semicircular)
- Door Shulters
- Windows Chaukhats
- Domestic mainhole covers
- Gully Grating
- Mainhole covers (Medium, Heavy, Light Duty)
- Water Tanks (500, 750 Liters)
- Septic Tanks
- Chemical Storage Tanks
- Drains, Guls
- Channels
- Angles
- Fencing Post
- Tree Guard
- Leach Pit
- Benches
- Latrine, superstructures
- San Shades
- Lintels
- Lofts
- Folded Plate Roofs
- Curved Roofs
- Cylindrical Roofs
- Steps
- Pumps House
- Hutments (India Awas Yojna)
- (Overhead Tanks (5 kl. to 70 kl.) capacity
- Boundary Walls

HITECH PREFAB

315/102-B, ALOPIBAGH, ALLAHABAD, U.P. - 211006
MOBILE : +91-8181971220
Email : hitechprefab2013@yahoo.com

MANUFACTURERS * SUPPLIERS * CONTRACTORS

PRECAST PLATFORMS FOR INDIA MARK II / III HANDPUMPS, STAND POST, PUMP HOUSES, BOUNDARY WALLS, TANK TYPE STAND POST, OVERHEAD TANKS (5 KL. TO 100 KL.) CAPACITY ETC.

PHD CHAMBER

PROGRESS HARMONY DEVELOPMENT

Estd. - 1905

ABOUT THE PHD CHAMBER

PHD Chamber is a 108 years old vibrant and proactive representative organization of business and mercantile community of northern and central India, serving their interest. This apex regional organization plays an active role in India's development and acts as a much needed link between government and industry, serving as a catalyst for rapid economic development and prosperity of the community in the region through promotion of trade, industry and services.

PHD signifies
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With its base in the National Capital, Delhi, the Chamber has Regional offices in States of Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand and the Union Territory of Chandigarh.

Six Thrust Areas

- Industrial Development
- Infrastructure
- Housing
- Health
- Education and Skill Development
- Agriculture and Agribusiness

CSR IMR
India-My Responsibility

PHD CHAMBER OF COMMERCE AND INDUSTRY
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E-mail : phdcci@phdcci.in · Website : www.phdcci.in