2008

Exploring Ferrocement
Exploring Ferrocement

Ferrocement Workshop

2008
Exploring Ferrocement

Ferrocement Workshop

18th – 19th December 2008

conducted by

Dr. Anupama Kundoo

Faculty members

Ms. Mona Chandra
Mrs. Manjushree Golhar

Editorial Team

Prayash Giria
Rimeka Ranee
Surjmani Laishram
Swagata Paul
Vejendla Ratnakiran
Udit Mittal

Photography team

Satish Rawtani
Aditi Gupta
Kushagra Keshav
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction - Workshop</td>
<td>4</td>
</tr>
<tr>
<td>Introduction - Ferrocement</td>
<td>5</td>
</tr>
<tr>
<td>Day 1</td>
<td>6</td>
</tr>
<tr>
<td>Day 2</td>
<td>7</td>
</tr>
<tr>
<td>Works</td>
<td>8</td>
</tr>
<tr>
<td>Photos</td>
<td>22</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>30</td>
</tr>
</tbody>
</table>
Introduction

Workshop
Introduction

Ferrocement

Ferrocement is a building material composed of cement, sand, water, aggregates and metallic mesh and rods. The metallic mesh can be replaced by jute or wooden or bamboo mesh. It is strong, economic, fireproof, earthquake resistant, rust-free and does not rot or blow down in storms.

Ferro cement has a broad range of applications which include construction, sculpture, repair of existing artefacts and boat-building. It is also used in the construction of roof channels, doors, water tanks, toilet pans, slabs and biogas plants.

Ferrocement can’t strictly be classified as a sustainable material, but it is highly efficient and cost-effective.

The ACI Committee 549 has given the following definition for Ferrocement in their report in 1988:

“Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh and/or small diameter rods completely infiltrated with, or encapsulated in, mortar.”

Construction

The desired shape may be built from a multi-layered construction of chicken wire, and if needed reinforced with steel wire or steel bars. Over this finished framework, an appropriate mixture of cement, sand and water is spread out. During hardening, the ferrocement is kept moist, to ensure the cement is able to set and harden.

The wall thickness of ferrocement constructions lies in general between 10 and 30 mm. Like other applications of cement, a
considerable amount of time may be necessary for the material to fully cure and reach its final strength. Curing time is dependent upon the span or application load, and ferrocement can take a month before it is ready for use.

One who wishes to accomplish a smooth, finished surface will find that 10 - 30 millimetres is a highly technical and extremely difficult task suitable only for boats or small sculptures. Ten millimetres is nearly impossible unless one has a laboratory or supporting moulds. Robert Maillart’s ul ferrocement bridges are approximately 200 millimetres thick, for example. There are at least two reasons why sculptors and builders who build for the long term avoid zinc coated wire:

1) Galvanized steel used for animal cages is not required to be high quality steel.
2) Zinc is similar to copper chemically; it dissolves slowly in the concrete matrix.

Ferro cement artefacts utilizing zinc within the concrete matrix are only acceptable for the short time horizon of modern buildings or boat hulls. Sculptors and builders who build for a future of many centuries use uncoated high quality steel. A small quantity of galvanized wire is not harmful as the outer armature layer to hold fresh plaster in place.

**Economics**

The economic advantage of ferrocement structures is they pay for themselves. Houses pay for themselves with almost zero maintenance and insurance requirements. Water tanks pay for themselves by not being replaced periodically.

A ferrocement structure which encloses above 50 cubic meters is economically superior to almost any building material. However, Chicken Wire should not be used with residential structures as it is not strong enough.

**Application**
In India, ferrocement is used often because the constructions made from it are better resistant against earthquakes. In the 1970s, designers adapted their yacht designs to the then very popular backyard building scheme of building a boat using ferrocement. Its big attraction was that, for minimum outlay and costs, a reasonable application of skill, an amateur could construct a smooth, strong and substantial yacht hull.

Some important uses of ferrocement are as follows:

- Ferro cement planks & panels can be used for construction of beams, columns, floor, roofs, walls, chajjas and lintels.

- It can be used in combination with plain cement concrete or reinforced cement concrete.

- Ferro cement being a thin material single piece panel of size up to 4.5m x 4.5m or more can be manufactures as floors and walls. Large span beams, roofs can also be constructed.

- Ferro cement being crack resistant and anticorrosive material lasts much more than R.C.C.

- Quantity requirement of ferrocement in building construction is much less as compared to R.C.C. Therefore dead load of ferrocement building is reduced by at least 50%. Consequently the foundation cost gets reduced.

- Ferro cement membrane lining is used for water proofing of terraces, basements, tanks.

- Ferro cement water proofing is the only treatment where reinforcement is used in the form of wire mesh layers and vibrations are provided in the matrix layers. Therefore ferrocement water proofing treatment should generally last longer than conventional.
Ferro cement anticorrosive protective lining for rehabilitation is far better the gunting. In the case of Gunting there is generally one layer of weld wire mesh with wires at 3” to 6” spacing and the dia. of wires is form 1.5mm to 2.5mm. In the case of ferrocement galvanised wire mesh layers with small dia. wires 18 swg to 20 swg, spacing about 12mm center to center are used. Therefore unreinforcement and consequently least possibility of crack formation.

Ferro cement is a good material for elevation treatment. Since it is constructed in these sections, it contributes negligible dead weight, and at the same time it is crack resistant, water proof and strong.

Ferro cement is a very good fire resistant material having capacity to resist fire up to 750°C for long period of 48 hours and even more. Ferro cement can be modified to resist even high temperatures, say 1200°C to 1500°C.

Ferro cement buildings are better pollution and fire resistant as compared to RCC. Therefore, ferrocement buildings are preferable to RCC for functional VIP and strategic buildings.

**Advantages**

The advantages of a well built ferrocement construction are the low weight, maintenance costs and long lifetime in comparison with steel constructions. However, meticulous building precision is considered crucial here, especially with respect to the cement composition and the way in which it is applied in and on the framework.

When a ferrocement sheet is mechanically overloaded, it will tend to fold instead of crack or rupture. The wire framework will hold the pieces together, which in some applications (boat hull, ceiling and roof) is an advantage. A ferrocement construction has 10 to 25% of the weight of a comparable construction made of bricks.
Another important advantage is the ease of construction. Concrete is referred to as "mud," in central North America. People have been building with mud and sticks since moving out of caves. An armature of reinforcing steel and wire replaced organic reinforcing material during the industrial revolution.

Ornamental elements can be manufactured in factory during the construction of building simultaneously without losing time and fixed immediately. It has added advantages when no of repetition are in building.

### Advantages of Ferro cement with Conventional (RCC)

- It is cheaper in constructions and lighter than RCC.
- Its Strength to weight ratio higher than RCC
- It has less thermal conductivity as compared to RCC
- It is thin and more aesthetic.

### Disadvantages

The disadvantage of ferrocement constructions is the labour intensive nature of it, which makes it expensive for industrial application in the western world. This "disadvantage" is the primary advantage for those who compete with world corporations. High labour content fosters small-scale enterprises by employing low-cost marginal labour to fabricate artefacts which require large labour inputs. When large industrial corporations are outside their own economic system they must compete directly without government protection. Highly motivated ferrocement entrepreneurs build aqueducts, drainage systems, water and septic tanks, large
flower pots for hotels and parks, water troughs, shade roofs, small houses, etc.
Day 1

18th Dec 2008, Thursday

The day started with an introductory lecture on Ferrocement by Dr. Anupama Kundoo, accompanied by Ms. Mona Chandra and Ms. Manjushree Golhar. The participants were then asked to develop and make sketches of their designs, in groups of three or four. By lunch, the fifteen groups had put up their designs for display. Post-lunch, following a design discussion, groups proceeded to make framing structures using steel rods (6 mm) and chicken mesh, with frequent help from Mr. Shekhar and Mr. Kumar. The framing was completed by late evening.
Day 2

19\textsuperscript{th} Dec 2008, Friday
Work

Group 01 -
The shell is a derivative of sphere. Two spherical sections with one end and centers displaced, as shown in the section, are combined to create a fluid form that can enclose a shop or a kiosk.
Work

Group 03 -
Work

Group 04 -
Work

Group 05 -
Work

Group 06 -
Work

Group 07 –

[Image of a hand-drawn sketch with measurements and annotations]

[Image of a construction site with students working on a project]
Work

Group 08 -
Work

Group 09 -

[Image of a hand-drawn diagram with labels and notations]
Work

Group 10 -
Work

Group 11 -
Work

Group 12 -
Work

Group 13 –
Work

Group 14 -
Work

Group 15 -
Photos
Acknowledgement

We thank Dr. Anupama Kundoo for her experimental project with us and for encouraging us to experiment with our mind and skills.

Our faculty Ms. Mona Chandra and Mrs. Manjushree for giving us this opportunity to attend this workshop and stand by us helping all the way throughout the project.

Mr. Shekhar and Mr. Kumar for guiding us in various cementing techniques.

Also, this workshop couldn’t be completed without the enthusiasm of the 1st, 2nd and 3rd year students.

And finally, Prof. Neerja Tikku, HOD, Department of Architecture, for everything. Without her support and encouragement this workshop wouldn’t have been possible.