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Design, Analysis and Construction of Precast Ferrocement Store Room

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Abstract - The purpose of this project is to explore the Ferrocement building technique in the construction of a Shell structure. Ferrocement is a type of steel-reinforced concrete. Ferrocement involves the use of conventional cement with fine aggregate and several layers of steel, with the advantage of higher strength than conventional reinforced concrete, limited formwork, thinner sections, architectural flexibility, along with energy efficiency, resistance to seismic and tornado events, and durability. It is particularly suitable for thin shell structures, where geometry minimizes bending loads. A major appeal of Ferrocement is that buildings can become very interesting in shape. Taking advantage of shell shapes that naturally place the concrete in compression is a key part of designing with Ferrocement. Shapes such as domes and catenary beams are especially well-suited. This project is based on the designing, analyse of the structure using STADD software, and construction of the Ferrocement Precast store room of dimension 2.4m x 2.4 m in Easwari Engineering College Campus.

Index terms-Ferrocement; shell structure; preacast.

1. INTRODUCTION

Ferrocement is a type of construction which includes steel-reinforced concrete. The basic mixture is Portland cement, fine aggregate and water. For better workability water cement ratio can be reduced by using superplasticizer in desirable quantity. This leads to increase in strength, increase in adhesion, add color and enhance water resistance. Reinforcement includes steel layers in the form of reinforcing bars, welded wires known as mesh. The layers are close to each other, allowing the thin shells to carry loads uniformly. The concrete mixture is poured into the mesh by hand like plaster. Significant labor is required to setup the skeletal steel by attaching the mesh layers, tying it together using binding wires and packing the concrete.

In ferrocement type of construction there is more steel and less concrete used as compared to traditional reinforced concrete. Steel can be replaced by natural fibers such as bamboo and hemp, cement can be replaced with flyash, GGBS, Silica fume and fumed silica etc., fine aggregate can be replaced with copper slag. Precast structure is the recent fast growing idea that makes the structure to be constructed with a very short duration of time and with minimum construction error which can withstand unacceptable situations like formation of cracks, overloading etc.,

2. EXPERIMENTAL WORK

The experimental program includes preparation and testing of four ferrocement slab with different proportions of cement and sand by replacing them with other construction materials under two-point and four point loading.

2.1 Raw Materials used

Raw materials like Portland cement, fine aggregate that passes through the 2.36mm sieve, wire mesh with 3mm diameter and cross section 50mm x 50 mm, wire mesh with diameter 1mm and cross section 10mm x 10mm, GGBS replacing 40% cement , 10% silica fume is used as addition and sand is replaced by 50% copper slag.

2.2 Preparation of Mould

Mould made up of steel, concrete or wood can be used. Considering the ecomical condition concrete mould and wooden mould are used. Concrete mould of dimension 2.360m x 0.760m x 0.050 m is constructed to obtain a wall panel of required size for the construction of the precast ferrocement panel. Concrete mould of dimension 2.760m x 1.380 is constructed to obtain Precast ferrocement roof for the store room. After the ferrocement gets hardened the precast panels are demoulded from the concrete mould and is undergone for curing .

Mould for the construction of roof

Mould for the construction of wall panel

2.3Preparation of Mesh

Weld mesh and wire mesh were cut according to the required dimensions for test specimen of size 600mm x 300 mm. The meshes were straightened using wooden hammers. Then they were used in the ferrocement slab over which the mortar mix was poured. For the construction of ferrocement store room 8 skeletal steel frame using mesh of dimension 2.4 m x 0.8m was prepared.

2.4 Preparation of Mix

Cement and fine aggregate with the ratio of 1:1.5 is measured , taken and undergone to normal hand mixing. Initially dry mix preparation is done and later on water and super plasticizer is added and mixed together to give flowability to the mix.

2.5 Casting of specimen

Eight Ferrocement slabs and one roof were cast using the mould. The mortar is applied from one side through several layers of mesh, held in position against the surface of a closed mould. The mould is treated with mould releasing agents. In this method, the mortar is applied from one side and proceeded toward the other side.

2.6 Curing

Specimens are cast and demoulded after 1 day and then allowed to cure for 28 days. The slabs were laid to rest vertically in the upright position, resting on the longer side and the beams were laid in horizontal position.

2.7 Testing on ferrocement slab

The slab panels were removed from curing after a period of 28 days. White wash was applied to the panels in order to get clear indication of cracks due to bending under service loads. Panels were tested for flexural strength under universal testing machine. The panels were placed on support leaving a space of 50 mm from both ends. Dial gauge was placed below the panel to record the deflection in mm each stage of loading. Cracks are then marked during each loading and corresponding central deflection is also noted down.

3. TESTING PROCEDURE

Flexure testing is carried out in universal testing machine of 1000tonne capacity.

3.1 Flexural strength on slab

Fig.1 Flexure test on Ferrocement slab

Fig.2 Crack pattern on Ferrocement Slabs

Table 1 Flexural Test Results

S.NO	MIX	F.S 1 (KN)	F.S 2 (KN)	GGBS & M.S (KN)	C.S (KN)
1	1:1.5	4.76	4.12	3.06	2.64

4. TEST RESULTS AND DISCUSSION

- The observed ultimate load for cracking of ratio 1:1.5 for Ferrocement Slab are 4.76KN, 4.12KN, 3.06KN and 2.64KN for FS1, FS2, GGBS & Microsilica and Copper slag for Static Loading.
- The observed ultimate load for cracking of ratio 1:1.5 for Ferrocement slab is 74KN for Static Loading and 73KN for Cyclic Loading.
- The number of cracks developed in slab at first cracking is 5, 3, 4 and 7 for ratio 1:1.5
- The crack spacing at ultimate load for Ferrocement slab are 45mm, 71mm, 127mm and 77mm respectively for the Static Loading.
- Finally the observation concludes that the Flexural Behavior of ferrocement slab has gained more strength with mix ratio 1:1.5.

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