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Study on Performance of Prefabricated Ferrocement Wall Panels

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Abstract:- Ferrocement is found to be an ideal alternative for RCC considering the cost of construction and prefabrication has been found to be an optimum solution for speedy construction over the years. For low cost housing with speedy construction prefabricated ferrocement elements can be a better solution. This paper studies the performance of prefabricated ferrocement wall panels. Ferrocement wall panels of size 1m x 1m with 5cm and 2.5cm thickness were casted and tested in laboratory and their failure load was studied

Keywords:- Ferrocement, Prefabrication, Wall panels, Wire-Mesh, Failure Load

I. INTRODUCTION

The concept of industrialization of the construction technology has emerged as well accepted and preferred option in the field of building construction now days, in order to reduce insitu construction up to maximum extent. This could be achieved by employing a number of strategies including the application of newly developed cement based composites for structural applications. Cement based composites perform better than conventional plain concrete.

Ferrocement is such a material that is slim and slender but at the same time strong and elegant which provides a potential solution to roofing problems. In countries in continuous growth and low resources economic, where the demand of house of low cost is very high, the ferrocement has been used like an effective alternative that, on the one hand, offers durable houses and of good quality, and, on the other hand, it offers a constructive system with base in not described intensive manpower. Prefabrication saves engineering time on the construction site in civil engineering projects. Prefabricated elements and systems offer bridge designers and contractors significant advantages in terms of construction time, safety, environmental impact, constructability, and cost. The use of prefabricated ferrocement components for construction could possibly reduce the cost of construction and time for completion.

A. Ferrocement

Ferrocement is a building material composed of a relatively thin layer of concrete covering a steel reinforcing material such as wire mesh. Since these materials are widely available and are relatively low in cost, and since the building techniques are simple enough to be done by unskilled labour, ferrocement is as attractive type of construction for many developing countries.

B. Prefabrication

Construction waste is considered as one of the main factors having an impact on the environment. Construction waste is defined as the by-product generated and removed from construction, renovation and demolition workplaces or sites of building and civil engineering structure. Prefabrication 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 [1]. Prefabrication techniques are used in the construction of apartment blocks, and housing developments with repeated housing units. The quality of prefabricated housing units had increased to the point that they may not be distinguishable from traditionally built units to those that live in them. Prefabrication saves engineering time on the construction site in civil engineering projects. This can be vital to the success of projects such as bridges and avalanche galleries, where weather conditions may only allow brief periods of construction [2].

II. LITERATURE SURVEY

Studies have shown that ferrocement provides as an ideal alternative towards low cost construction while meeting the desired characteristics and the use of prefabrication reduces the construction time. Hence prefabricated ferrocement is an optimum solution towards the problem of low cost housing with speedy construction.

Daniel BedoyaRuiz et al.[3] concluded based on their work that the prefabricated houses of ferrocement showed a good seismic behavior under static cyclic. The vulnerability analysis conducted showed

that it is an adequate system for strong earthquakes. The state of predominant damage is the minor state. Hence, the houses prefabricated of ferrocement are a good alternative for the house of low cost in developing countries.

Kantharaju, K.Vasudev et al. [4] have concluded based on their studies that, Ferrocement products are an ideal substitute for wood and they can be extensively used in various components of a housing like door, Roofing etc., Indian Experiences have shown that construction cost could be reduced by about 20 to 40% if ferrocement products are used in place of conventional wood or R.C.C. Components. Developing countries where mass social housing projects are being taken up the use of ferrocement components would go a long way in helping them to build houses at economical cost and also at a faster rate.

Wail Nourildean Al-Rifaie et al. [5] have said based on his studies that the use of ferrocement in pre-fabricated buildings provides many advantages in terms of lightness of weight (since its thickness is usually between10 and 50mm), ease of handling, low labour cost in its production and a durable material requiring little maintenance. This would further lead to an "eco-friendly" low cost housing without any loss of structural integrity. Saving in cost is one of the several reasons for the popularity of ferrocement. It is recognized that the economics of ferrocement is dependent on several factors such as costs of raw materials and labour, and the relative cost of competitive materials. In this article a structural system for ferrocement building based on generic services facilities is introduced.

Sayyed Shoheb Navid et al. [6] concluded the use of ferrocement is a promising technology for increasing the flexural strength of efficient reinforced concrete members. They investigated the increase in tension due to increase in contact area between wire meshes and mortar, i.e. increasing the specific surface of ferrocement by increasing the no of layers of meshes needed. So if we use ferrocement in tensile zone of beam, we will be in a position to replace steel bars used in R.C.C.

Xudong Zhao et al. [7] have said that, the key issue for promoting prefabrication is to seek for potential low cost techniques, including using sustainable/recycled materials, such as rammed earth, blast furnace slag, fly ash, or straw, increasing the size and reducing the number of the components used, use of modular design of house components, factory based mass production, advanced machinery technique, as well as intelligent computer aided design.

Waleed K. Ahmed et al. [8] proposed a structural system based on generic services facilities is introduced and prefabricated ferrocement cavity wall and roof panels within the proposed system present a series of possibilities for the solution of building construction at maximum reduction of the electrical energy. The energy required running the building using the proposed ferrocement construction system and the use of traditional method of construction is determined. Also they concluded that the modern method (ferrocement eco-housing system) is able to produce very energy efficient dwellings.

III. EXPERIMENTAL STUDY

A. Materials Used

Ferrocement consisted of cement mortar and wire mesh. The wire mesh acts as the layer of reinforcement in ferrocement. Welded steel wire mesh of aperture size 20mm and thickness 1mm was used for the specimen casting. The cement mortar imparts the compressive strength to the ferrocement structure. The ratio of cement to fine aggregate was 1:3 and the water/cement ratio was taken as 0.45

B. Details of Specimen

The size of the ferrocement wall panel is taken as 1m x 1m x 0.025m and 1m x 1m x 0.05m. Wall panels with single layer of steel mesh. Two specimens of each were casted.

Mould for casting wall panels was made out of timber. For casting wall panels, the mould was placed on a flat surface and water was sprinkled on the base in order to reduce the water absorption. For casting of wall panels with single layer of steel mesh, a first layer of mortar was placed up to half the thickness required. Then the steel mesh was placed over the first layer. The last layer of mortar was placed over the steel mesh, so that the mesh was sandwiched in between the mortar layers.

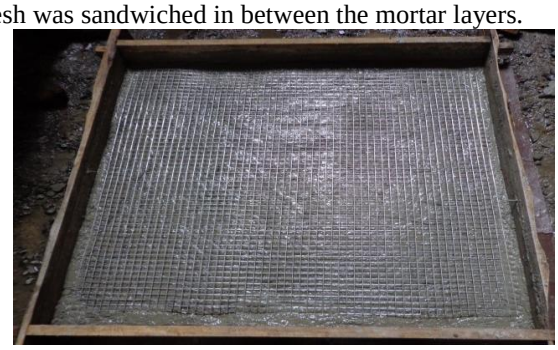

Fig.1: Casting of Wall panel

Fig.2: Finished wall panel placed for curing

C. Testing of Specimen

The specimens casted were tested for their failure load using loading frame of capacity 100 tons after 28 days. For testing of wall panels, hydraulic jack of 50T capacity was used. Load applied was measured using a dial gauge with 0.1T accuracy.

Fig.3: Wall panel placed on loading frame for testing

The wall panel specimens were of size 1000mm x 1000mm x 50mm and 1000mm x 1000mm x25mm with single layer of wire mesh. Two specimens of each were prepared and tested with two ends fixed condition. The specimens were tested after 28 days. The failure load of wall panel obtained after testing is as given in Table I.

Table I: Test results of wall panel

Designation	Type of Slab	Breaking Load	
		Tonnes	Avg (T)
LW2-SM(1")	25mm wall panel with single layer of wire mesh	25	24.5
LW3-SM(1")		24	
LW1-SM	50mm wall panel with single layer of wire mesh	60	59
LW4-SM		58	

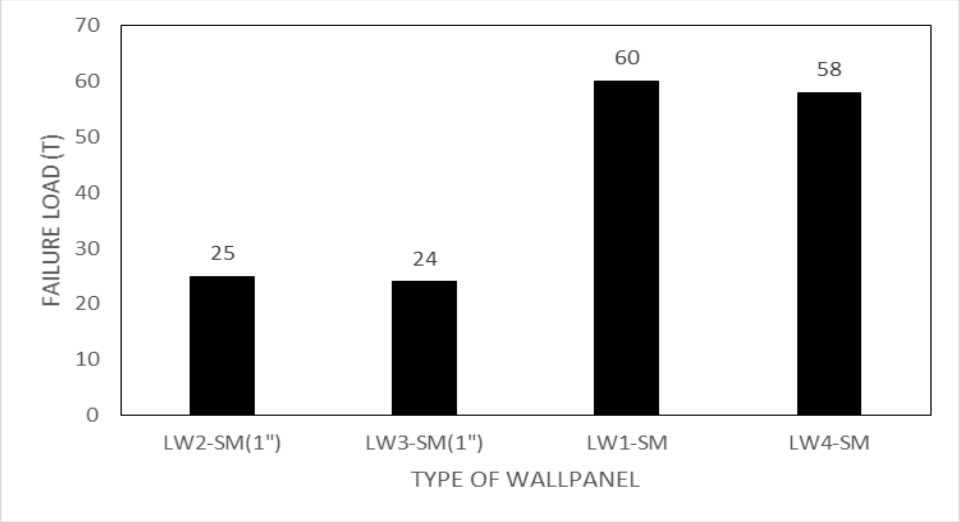

Fig.4: Graph showing failure load of wall panels

Failure pattern after testing is as shown in Fig.5 & Fig.6 for wall panel of 25mm and 50mm with single layer wire mesh respectively.

Fig.5: Crack pattern in slab with single layer of wire mesh

Fig.6: Crack pattern in slab with double layers of wire mesh

During testing it was observed that the wall panel failed due to compression. For 25mm thick wall panel the failure occurred at the center, but the wall panel was whole together by the mesh reinforcement. In case of 50mm thick wall panel the failure occurred at the end surface only. Hence with increase in thickness of wall panel we can increase the performance of ferrocement wall panel.

IV. CONCLUSIONS

In present condition time and price is one of the major factor in construction industry. Buildings have to construct with sufficient capacity in maximum short period and in cheaper price. In such conditions different construction techniques will be applied to obtain the goals like, Ferrocement used for construction solves the problem of cost while prefabrication solves the problem of speedy construction. Combined together prefabricated ferrocement is an amble solution for both the problems. In this thesis work, effort has been made to study the suitability of prefabricated ferrocement columns and wall panels for the construction of low cost buildings..

For the study, model specimens were casted and tested in a loading frame UTM with a capacity of 100T. It was also observed that, the usage of wire mesh as reinforcement in ferrocement increases the crack pattern in the case of slabs. Based on results obtained from the study, it can be concluded that the prefabricated ferrocement hollow wall panels maybe used for the construction of low cost housing and it is also cheaper compared to RCC elements of similar size. With use of ferrocement elements the dead load can be reduced for a building.

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