International Journal of Recent Advances in Multidisciplinary Topics
Volume 4, Issue 4, April 2023
https://www.ijramt.com | ISSN (Online): 2582-7839

Comparative Study of Ferron Panel Building and RCC Building Subjected to Seismic Loading

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***Abstract*: Seismic force is a critical load component while analyzing and designing RCC structure and Ferron panel building. as it results in horizontal displacement. Horizontal Displacement in RCC structure and Ferron panel building due to seismic force results in displacement and additional vibrations in whole structure. Hence there is a need to investigate various methods to minimize this horizontal displacement. Here the objective of the work is to understand the structural behavior of RCC structure and Ferron panel building subjected to seismic force with software a manual calculation. This thesis analyzes different RCC structure and Ferron panel building with different forces with some analytical and experimental projects.**

***Keywords*: Cement mortar, Ferrocement, Mesh, Panels.**

1. Introduction

Ferrocement as a construction material has been in existence for more than 150 years. The properties of this material manifest with small thickness only, usually between 15mm and 40mm. Its properties are uniquely different from those of Reinforced Concrete. Ferrocement generates tensile capacity in the section. This can be of advantage if used in conjunction with a proper design method creating thin sections with large load-bearing capacity. Ferron Panels are designed and manufactured by suitably exploiting these properties. The panels can be used, both for walling, as well as slab units, to replace decking sheets over floor beams.

Ferro build systems was created as a natural amalgamation between our patented Ferron Panels and the ability to design lighter more cost-effective Light Gauge Steel structures using the panels as an integral unit of the structural design. The systems evolved the cladding from non-strength cement board varieties to a concrete panel and the design from a column and beam concept to a load-bearing principle. Ferron Build Systems started as a vision of Er. Dr. Arun Purandare. He questioned the traditional methodology of manual ferro crete technology and its inability to withstand certain codes and testing parameters.

Designing LGS structures (Ferro Build Design Systems) using Ferron panels follows the IS Code 801, that defines the design of LGS as a stiffened section. Ferron, as a wall cladding, creates a composite shear wall, essentially a box structure. The design parameters are those for load bearing walls. This reduces the consumption of LGS by over 45%, reduces the dead load by about 60% and greatly reduces the time and cost required to assemble and erect an LGS structure. Being a pre cured, form finished element, it negates the use of plastering on the wall.

The inherent strength provides easy fixing of items on the internal walls. The 89 mm 'air gap' between the panels prevents water seepage from the external into the internal space and provides a thermal insulation of close to 11-degree centri grade.

2. Literature Review

This section presents a brief review of the terminology and chemistry of the Ferron panel, and past studies on ferro build system. Additional review of ferrocement technology is available elsewhere.

Ferrocement Floor and Roof System for Buildings by T. S. Thandavamoorty and S. Durairaj. A hollow cored ferrocement floor panel of size 900 mm X 600 mm was precast with cement mortar 1:2 and cured for 7 days. Then it was arranged in a loading frame and tested under gradually increasing static loading till failure. The ultimate load sustained by the panel was 85 kN. This load was distributed on the panel with the intensity of 78.7 kN/m^2. As per IS 875 part 2 the live load recommended on floor is only 2 kN/m^2. Going by this consideration ferrocement floor panel is suitable, realistic and feasible.

Flexural Behavior of Flat and Folded Ferrocement Panels by Mohamad Mahmood. The paper describes the results of testing folded and flat ferrocement panels reinforced with different number of wire mesh layers. The main objective of these experimental tests is to study the effect of using different numbers of wire mesh layers on the flexural strength of folded and flat ferrocement panels and to compare the effect of varying the number of wire mesh layers on the ductility and the ultimate strength of these types of ferrocement structure. Seven ferrocement elements were constructed and tested each having (600x380mm) horizontal projection and 20mm thick, consisting of four flat panels and three folded panels. The used number of wire mesh layers is one, two and three layers. The experimental results show that flexural strength of the folded panels increased by 37% and 90% for panels having 2 and 3 wire mesh layers respectively, compared with that having single layer, while for flat panel the increase in flexural strength

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compared with panel of plan mortar is 4.5%, 65% and 68% for panels having 1, 2 and 3 wire mesh layers respectively. The strength capacity of the folded panels, having the particular geometry used in the present study, is in the order of 3.5 to 5 times that of the corresponding flat panels having the same number of wire mesh layers.

Structural Behavior of Ferrocement System for Roofing by Wail N. Al-Rifaie and Muyasser M. Joma'ah. It has become necessary to seek for structural building elements, which have the structural phenomena of prefabricated elements in terms of ease of handling, light, minimum Maintenance and low cost. It is with these in mind, elements of a structural system are made from ferrocement. Ferrocement has been developed mainly during the past twenty-five years and yet has reached a very advanced stage in technique and design. A considerable amount of laboratory testing research and prototype constructions have been completed at the Building and Construction Engineering Department of University of Technology, Iraq for the production of ferrocement members that would be used in the roof /floor/wall of building/housing. By using the unique properties of ferrocement with a relatively low Amount of reinforcement, be composite floor and wall panels can assembled into an effective multi-purpose panel system. The major advantages of this system over current construction methods are mainly due to the reduction in structural dead load and the use of fewer building elements, which are much easier to handle. In the present investigation, four ferrocement plates are cast and tested due to flexural loading. The Structural behavior was monitored by reading the deflection and by observing the crack Patterns. The measured values of deflections and the observations made indicated that ferrocement can be used in construction.

Ferrocement Box Sections-Viable Option for Floors and Roof of Multi-Storeyed Buildings by A. Kumar. Structural Engineering Division, Central Building Research Institute, Roorkee A 5m x 9m size interior panel of a framed structure has been designed as beam-slab construction, flat slab construction and using ferrocement box sections for 5 kN/m^2 live load. The self-weight, floor/ roof height and cost of these options have been compared. It is found that the flat slab option is comparable in weight to the beam- slab option, about 58.2% less in floor height and 17.7% costlier than the conventional beam and slab construction. The ferrocement box section alternative is found to be 56.2% less in weight, comparable in floor height and 15.6% cheaper than the beam - slab construction The ferrocement box sections being light in weight need less strong supporting structures. Being a precast product, they also increase speed of construction and can be used in bad weather conditions. Comparison of Design On the basis of costs for all the three options it is found that the flat slab option and the ferrocement box section option are costlier and cheaper than the beam-slab.

Effect of Wire Mesh Orientation on Ferrocement Element by S. K. Kaushik. The experiment investigated the efficiency of mesh overlaps of ferrocement elements by varying the length of overlap in square woven meshes with different wire diameter and mesh openings. The number of mesh layers has also been varied and tested under flexure. Cement sand mortar mixes of 1: 1.5 and 1:2 were used for the above investigations. They developed an analytical expression for the lap length (L_p) based on the concept that the mesh overlap must be sufficient to develop full bond strength around the surface w that there is no slippage while taking the stress allowed to it. They cast 350 test specimens having 400x200 mm dimensions, with 5 mm cover on all the four sides, with w/c- 0.4. All the specimens were tested under central point loading on a simply supported span of 300 mm. the mortar strength, diameter of reinforcing wire and mesh opening influence the overlap length. Bond failure occurs due to slippage at overlap. when length of mesh overlap is insufficient, with the cracking load much lower than that of a continuous mesh reinforcement. A minimum overlap of 100 mm to be provided.

Performance of Precast Ferrocement Panel for Composite Masonry Slab System by Y. Yardim. This study investigates the performance of inverted two-way ribs precast ferrocement thin panel. The two-way inverted ribs in the ferrocement panel enhanced its flexural stiffness, as well as providing link between the precast layer and the in-situ elements. Flexural behaviors of two precast panels and two composite slabs are investigated under two-line load and distributed load. Test results indicate that the thin panel with suitable ribs layout and support distance can be used as permanent formwork. Typical load from construction worker and in situ elements could be sustained by the panel. The panel also acts as good composite component with in situ brick and concrete Composite full slab can sustain typical design loads for residential buildings and until ultimate load and no separation or any horizontal cracks between the layers were observed. Test Setup Ordinary Portland cement and natural sand were used for concrete in the ratio 1:3 with water/cement ratio of 0.5. The mortar mix was designed to give 28-day cube strength of 30 N/mm^2. The ferrocement reinforcement used in all slabs consisted of high tensile steel bars and galvanized welded square wire mesh of 0.9 mm diameter and 12 mm openings. The tensile strength of the mesh was found 321 N/mm^2.

Applications of Ferrocement in Strengthening of Unreinforced Masonry Columns by Abid A. Shah. The load carrying capacity, ductility and serviceability of unreinforced masonry columns can substantially be improved if encased by ferrocement. The parameters such as cement mortar thickness, gage-wire spacing and bond at the interface of ferrocement and brick columns have effects on overall behavior. In the present experimental study, it was found that the first crack load and ultimate load of a ferrocement encased masonry column was increased by 119% and 121% respectively. Cracks developed in ferrocement encased column were finer and well distributed as compared to plain specimen. However, premature failure is possible when bond at the interface of brick masonry column and ferrocement is poor. At higher reinforcement ratio, severe spalling and delamination is expected. Brick masonry columns are commonly used in rural and urban areas. Because of improper structural design and no maintenance over a period of time, they have lost a major portion of strength and stiffness. Many masonry columns require strengthening due to increase in their share of building loads. Severe cracks due to repeated earthquakes are also very common in these masonry elements. These factors make brick masonry columns unsafe and they require economical, safe and easy remedial measures. Experimental study was made on burnt clay brick column specimens. Locally available burnt clay bricks of 221 mm x 110 mm x 55 mm were used. Ordinary Portland cement and alkaline free sand.

Utilization of Ferrocement as Flexural Building Member: (Applied as a Hollow Box Joist) by R. Abasolo, C. Bandivs. This study focuses on the fabrication and the Maximum Moment Capacity of a Ferrocement beam. There were three batches with 3 specimens each. The beams were casted vertically by plastering. This study used a cement to sand ratio of 1:3 by volume, and a water to cement ratio of 0.5:1 by weight. It also used two layers of # 16 gage wire mesh kept constant on each batch. Tension bars of 8 mm dia. were used, the number of which increases by one on each batch. Nine specimens of 200mm x 200mm x 3000mm hollow box beam with a 25 mm thickness were casted. The Standards and Procedure for each of the beams were based on the ASTM Standards and on the article by J.P. Hartog. The testing of the beam was done after the 28th curing day period, and was conducted to failure in order to determine the Actual Moment Capacity of the design beam. The results show that Maximum Moment Capacity or Flexural Strength of the fabricated Ferrocement beams did not go below the calculated ultimate moment capacity for office occupancy of 5.3792 KN-m. This means that the beams are safe for use as floor joist beams in residential and commercial structures.

Design of College Building with Ferrocement Elements by Arun Purandare. Three elements namely column boxes, channel beams, and a deck slab were used for the entire section. The aim was to crate light weight elements for lifting, eliminate formwork totally and reduce member propping during construction to an absolute minimum. All the three aims have been fulfilled. An engineering college building was under construction for D.Y. Patil Engineering college at Ambi village, Talegaon. The G+4 structure has been constructed by the conventional method of in situ R.C. construction. The column spacing are 7m X 7.5 m. Each floor is about 3000 sq.m. built up area. The foundation and columns were designed for G+8 upper floor building. At this stage of construction, it was decided to add the balance 4 floors with member element made with Ferrocement. The structural frame had to be the same as that used on lower floor. The principal idea was to eliminate formwork and the slab and beam units shall be able to carry all dead loads. The slab and beam had to span between supports without propping. The members therefore eliminated formwork and propping at site. The design of members was also done with ease of construction and lifting to its position as primary consideration. Slab elements span between channel beams. The panels are 3m X 1m wide. The design of panels is done as suggested by ACI. The project has been saving in material cost and significant saving in time. The main advantages seen in the system are: 1) No formwork and minimal scaffolding. 2) Elements casted on ground at site or yard. 3) Very fast erection and reduction in time of construction. 4. Saving in overall cost compared to R. C. system.

3. Conclusion

- After study of this we understand different type of retrofitting techniques.
- We use common type of retrofitting because of these are cheaper.
- We understand/identify the better type of retrofitting (FRP)With the help of retrofitting we provide required amount of strength in structural element.
- With the help of these techniques, we can able to square our historical valuable structure.

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