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Study and Behaviour of Prefabricated Composite Cladding

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Abstract. The incessant population rise entailed for an expeditious construction at competitive prices that steered the customary path to the light weight structural components. This lead to construction of structural components using ferrocement. The load bearing structural cladding, sizing 3200x900x100 mm, is chosen for the study, which, is analyzed using the software ABAQUS 6.14 in accordance with the IS:875-87 Part1, IS:875-87 Part2, ACI 549R-97, ACI 318R-08 and NZS:3101-06 Part1 standards. The Ferrocement claddings (FCs) are fabricated to a scaled dimension of 400x115x38 mm. The light weight-high strength phenomena are corroborated by incorporating Glass Fibre Reinforced Polymer Laminates (GFRPL) of thickness 6mm, engineered with the aid of hand layup (wet layup) technique welding epoxy resin, followed by curing under room temperature. The epoxy resin is employed for fastening ferrocement cladding with the Glass fiber reinforced polymer laminate, with the contemporary methodology. The compressive load carrying capacity of the amalgamated assembly, both in presence and absence of Glass Fibre Reinforced polymer laminates (GFRPL) on either side of Ferrocement cladding, has been experimented.

Keywords: Cladding, Ferrocement, Epoxy resin, Glass fibre reinforced polymer laminate.

1. Introduction

Construction is the strategy for development which incorporates connecting segments of a structure in an assembling or construction site, it is method of good outline with present day elite segments and quality controlled assembling methodology. This system may permit work to proceed regardless of poor climate conditions and ought to diminish any waste in time and material at the site. The prefab parts and prefab structures wipe out space and time over traditional developments. In spite of the fact that construction is utilized to a huge degree in a wide assortment of nations, in India, development industry, regardless of its extension keeps on embracing same routine strategies. Typically, post natural disaster demands precast dwellings for rapid repossession, so availability of precast houses will secure them due to its faster construction.

Ferrocement panel, kind of thin fortified cement for the most part with cement mortar strengthened together with firmly set layers having ceaseless. Metallic or other reasonable materials are utilized to build up the mesh. Ferrocement contains a high elasticity to-weight proportion and more noteworthy splitting conduct when contrasted with conventional panel. In this way, the thin



ferrocement structures appear to be relatively light and watertight. Epoxy gum frameworks are concoction blends containing two primary parts, the epoxy and the curing agent (likewise called hardener). Epoxies are additionally used to bond cement to itself, to steel or two dissimilar materials. The preferences of a FRP composites panels are lightweight, high quality and elite, synthetic and erosion safe.

In this study, analysis and experimental work is carried over to find the compressive load carrying capacity of load bearing cladding. Three different cladding panels were considered, 1. R.C.C Cladding, 2. Ferrocement Cladding, 3. Ferrocement Cladding with application of GFRP. Each of 2 panels were fabricated, cured and tested after 28 days under Universal Testing Machine (UTM).

2. Literature Review

To adopt low carbon foot print, fly ash based design mixes are came in to existence. Fly ash based mix increment by 50% compared to control mix. Raise in compressive strength of panel under steam curing by 184kN, with accelerated curing of 142.5kN, steam curing has shown a rapid strength with other curing methods [1]. The precast claddings at the initial phase were made of non-composite mechanism by incorporating insulation in concrete Wythes at obligatory intervals. Idea of precast cladding lead to design as a load bearing cladding which the engineer or architects are advocate to use of these precast concrete sandwich cladding for better execution, ideal for transmitting load to the foundation from superstructure. The integrity action of precast concrete sandwich cladding most part based on type of connection between the concrete Wythes [2]. Construction industry looks after faster, rapid with light weight material with variable considerations in design. Ferrocement cladding is the one for its low cost and light weight being used till now. The tensile crack pattern will not widen further due to the application of chicken wire mesh in mortar mix [3]. Precast sandwich panels comprised of two concrete Wythes which are apart by insulation material such as polystyrene, polyurethane foam and which are joined by a shear connectors to transfer the longitudinal shear on panel. Density of the insulating material also plays a crucial role in transferring the load along the interface of the panel [4]. Under complex and expensive circumstances glass fibre reinforced polymers (GFRP) profiles which enclosure the surface of the building. Building integrity with precast components with lightweight materials tend to ameliorate the manufacturing quality and reduction of building cost [5]. Precast concrete sandwich panel compose two concrete Wythes designed as load bearing and also non load bearing wall. The connection mechanism that adopted the use of continuous shear connector to integrate two structural concrete Wythes which able to transfer adequate shear and full composite action. Load carrying capacity of the sandwich panel depends on life span of shear connector [6]. Behaviour of prefabricated RCC sandwich panels (RCSPs) under simulated seismic loading. RCC sandwich panel (RCSP) contains Expanded Polystyrene core with steel wire mesh reinforcement incorporated between layers of sprayed concrete. Typical wall thickness ranges from 15cm to 20cm based on the thickness of foam [7]. Alternative change that has been found in construction industry in using fibre reinforced plastic materials. Due to its high structural rigidity it used as a barrier. This system provides outstanding thermal performance and reduces work to labour. Thermal resistance of the building mainly depends on the R value which shown a good interest based on material thickness [8]. Retrofitted technique was applied in application of ferrocement with GFRP profiles. Lateral resisting factor increase by 25-32% compared to normal wall, energy absorption increases by 85%.lateral storey drift results shown undesirable. Energy dissipation and load transferring characteristics can be achieved if fabricated properly [9]. Highly versatile ferrocement panel made of cement mortar and inclusion of chicken mesh layers. A polymer modified ferrocement panels are fabricated shown that 12.5% increase in durability. Based on % of fly ash the development of first crack delayed and also 0-12.5% addition of polymers in fabrication. Moisture resisting capacity decreases by increase of fly ash, polymer cement [10].

3. Design of Cladding

Residential building is taken in to consideration to design the conventional wall as load bearing cladding. The maximum axial load carrying capacity of the wall is calculated as per IS: 875(part1)-1987, IS: 875(part2)-1987. The cladding dimension 3200x900mm is taken in to account as per availability in market and thickness is restricted to 100mm for cases 1, 2 and 88mm for case 3 with 6mm GFRP laminates on either side. Three different claddings were designed in ABAQUS bench work.

3.1 Stress and Deformation

Case 1: R.C.C Cladding

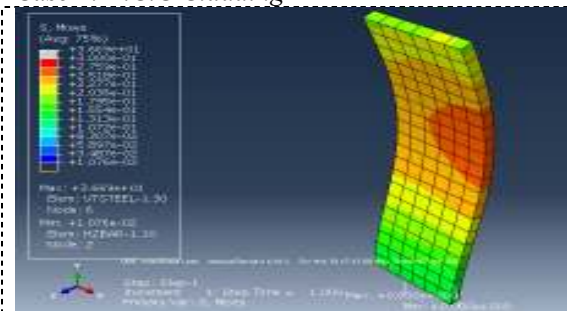


Figure 1. Max. Stress: +3.669e+01N/mm².

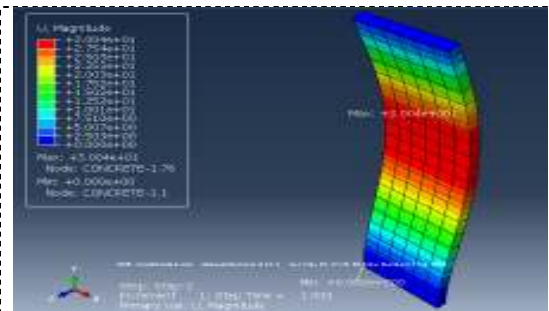


Figure 2. Max. Deformation: +3.004e+01mm.

Case 2: Ferrocement Cladding

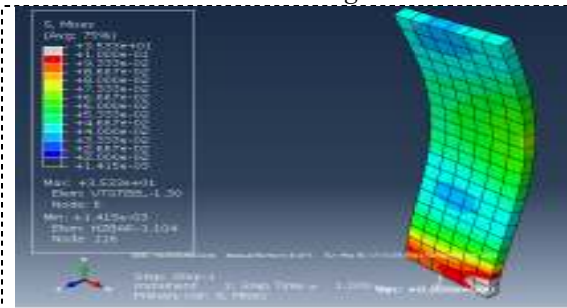


Figure 3. Max. Stress: +3.533e+01 N/mm².

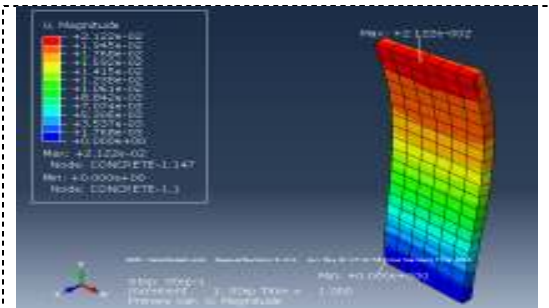


Figure 4. Max. Deformation: +2.122e+01mm.

Case 3: Ferrocement Cladding with application of GFRP Laminates

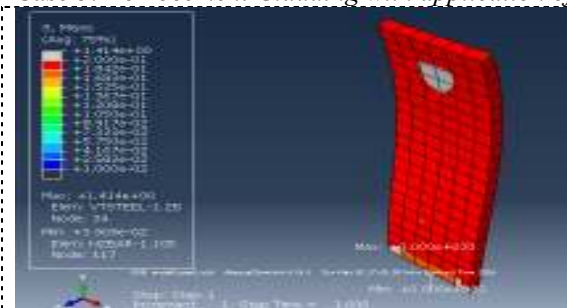


Figure 5. Max. Stress: +1.414e+00 N/mm².

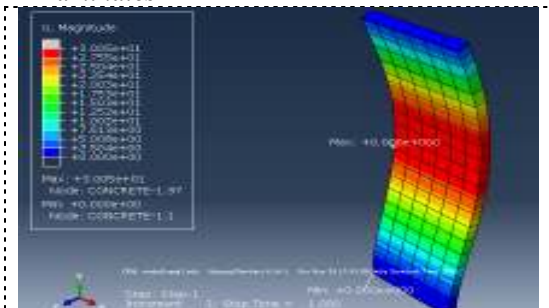


Figure 6. Max. Deformation: +3.005e+01mm.

4. Experimental Study

The prototype was scaled down to study the behaviour of cladding panels dimension 400x115 mm. Where the thickness restricted to 50mm in cases 1, 2 and 38mm in case 3 with 6mm GFRP panels on

either side of cladding. Superplastizer of 0.35% of cement is added to reduce the water content, to achieve higher density. The connection mechanism that is adopted in case 3 by using Epoxy resin which is cured under room temperature. All the panels were tested under compressive load carrying capacity. Experimental considerations were shown in Table 1, 2.

Table 1. R.C.C. Cladding

Mix Design	M25
Reinforcement bars	6mm dia.
Bar Spacing	90mm
Concrete Cover	20mm
W/C ratio	0.4
Cement	975 Kg/m ³
Water	390 L/m ³
Fine Aggregate	1462 Kg/m ³
Coarse Aggregate	2924 Kg/m ³

Table 2. Ferrocement Cement Cladding

Mix Design	1:2
Mesh spacing	12.2mmx12.2mm
Mesh Diameter	1mm
Concrete Cover	20mm
W/C ratio	0.38
Cement	1584 Kg/m ³
Water	602 L/m ³
Fine Aggregate	3168 Kg/m ³
Mesh Layers	2

4.1 Casting and Curing

A total of 5 panels were casted using mix ratio of 1:1.5:3 for R.C.C and 1:2 ratio mortar mix for ferrocement panels. Conventional type of curing is done for 28 days and tested for Compressive load carrying capacity of panels. Figure 7& 8 shows the scaled model after casting and curing of panels.



Figure 7. Scaled Panel.

Figure 8. Conventional Curing.

4.2 Testing

The scaled models of wall cladding were tested for axial load carrying capacity in transverse direction using universal testing machine (UTM). prefabricated composite cladding is fabricated by joining of ferrocement cladding of thickness 38mm with glass fibre reinforced polymer laminates using epoxy resins which cured under room temperature and further achieve the high strength it is examined under 45° C temperature for 4 hours. Prefabricated composite cladding and test setup is shown under figure 9 & 10.



Figure 9. Prefabricated Composite Laminate.

Figure 10. Test Setup.

5. Results and Discussion

Ferrocement cladding of 1:2 mix proportions has shown the axial load carrying capacity of 145kN with deflection of 26.5mm at 100kN load at mid height. Whereas R.C.C cladding with 1:1.5:3 mix gain the strength of 165kN when compared to ferrocement cladding with deflection of 25mm at 100kN load at mid height. In case of ferrocement cladding of 38mm thick with aid of glass Fibre Reinforced Polymer Laminates (GFRP) sustain up to 86kN with a deflection of 28mm at 70kN load, but

delamination of GFRP from ferrocement cladding occur at 75kN load, also bending failure is observed only in ferrocement cladding in application of glass fibre reinforced polymer laminates since thickness of ferrocement cladding is less than 50mm. GFRP laminates shown unique property without failure even after test.

6. Conclusions

Ferrocement cladding under axial load shows the maximum stress of 35.3N/mm² and deflection of 21mm at 100kN load. In case of R.C.C cladding the axial load is raised up to maximum stress of 36.6N/mm² and deflection of 30mm at 100kN load. Ferrocement Cladding with application of GFRP Laminates stress pattern of 1.4N/mm² at 70kN load. Ultimate load carrying capacity of ferrocement cladding is 145kN and for R.C.C cladding is of 165kN but on application of GFRP it resists up to 86kN. Bending failure is observed in composite cladding at 75kN but it reaches ultimate load up to 86kN.

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