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Innovative Construction Technique Using Ferrocrete

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Abstract: In recent years, speedy construction is necessary for overall development to satisfy the needs of current population. There is huge mismatch between the infrastructural needs and its development. This study aims to increase the pace of construction using precast ferrocrete mould which would eradicate the use of formwork completely. Significant amount of work has been carried out on confinement of column with ferrocrete laminates for strengthening and jacketing purposes. Use of ferrocrete mould as an external confinement to concrete specimen has been thoroughly studied and investigated in this experimental study. The experimental investigation included casting of six M20 blocks in two batches each having different specifications. All the specimens were tested for direct un-axial compression. The change in stress carrying capacity of confined specimens was compared with that of unconfined specimens having similar size and dimensions. After comparison, the increase in load carrying capacity observed in ferrocrete confined specimens was 71.18%, as compared to the strength of unconfined specimens.

Keywords: - *Confinement, compressive strength, ferrocement, column*.

1. Introduction

The construction industry has walked through many changes in its technology from the time unknown. But the method of construction using RCC (in situ casting) has remained unchanged for last century or so all over the world. The only take over was introduction of precast RCC in place of in-situ RCC casting which could not eradicate in-situ casting completely because of its drawbacks in actual practice.
With the growing demand of infrastructure, it is necessary to have better construction method along with better technology that would at least double the construction speed without compromising the quality. Keeping this in view, a new technique has been proposed that would use FERROCRETE moulds for casting. This will enable the faster construction.

2. Ferrocrete Confinement:

Ferrocrete is a type of reinforced concrete in which thin elements of hydraulic cement are reinforced with thick layers of continuous netting, in wire with a relatively small diameter. Until now ferrocrete was used in construction industry, mainly for retrofitting work and to make members of irregular shape. In this study, suggestion for an innovative technique has been made by doing reverse ferrocreting (i.e. ferrocrete confinement is casted first and then the inner part is filled with concrete). Ferrocrete confinement can be suitably provided for all structural members. And it can eradicate the use of formwork completely. In this study, main emphasis is given to application of ferrocrete confinement on compressive members of rectangular cross- section.

3. Methodology:-

Concrete specimens were casted in two batches each having different specifications as given below:-

1) **Batch 1**:- Size- 150x250x200 mm, unconfined specimen.

2) **Batch 2**:-Size- 150x250x200 mm, confined specimen
   i) Inner area of 100x200 mm is in concrete.
   ii) Remaining external area in plan is ferrocrete confinement.

First a hollow steel mould of external dimensions 150x250x200 mm and internal dimensions 100x150x200 mm was fabricated. Then rectangular steel confinement was prepared using welded steel mesh (250MPa) having diameter 1.6 mm and centre to centre spacing 20 mm and was placed in three layers in the hollow mould (Refer fig.1). Once, the steel

confinement was ready, Portland cement slurry having Cement: Sand ratio 1:4 and with cement grade OPC53 and well graded sand of Zone II was poured into the mould. On pouring cement slurry, the internal rectangular arrangement of steel plates was loosened after an initial setting time of 30minutes and was completely removed after 4 hours. The external plates were removed after 24hours. Once the ferrocrete confinement was ready, a concrete mix of M20 grade was prepared and poured inside it and was left to harden (Refer fig. 2 & 3). When, the concrete got hardened, member of required strength was ready.

Figure 1: Arrangement of mould for casting ferrocrete confinement

Figure 2: Ferrocerete confinement specimen without concrete infill

Figure 3: Ferrocerete confinement specimen with concrete infill

While preparing the moulds by adopting above explained methodology, few observations have been made. These issues are to be taken care of while casting the moulds.

- While concreting, care was taken that, the concrete infill had height slightly greater that the external confinement. This ensured that the load was applied only on the concrete infill and not on the ferrocrete confinement. Hence, confinement resisted the lateral stresses produced as a result of poisson's effect due to vertical load applied on the concrete core [1][2].
- A nominal cover of 3 mm from the edges and a centre to centre distance of 6mm between the layers of steel meshes was maintained.
- The inner walls of rectangular steel arrangement was oiled before concreting.

2.1 Significance of ferrocrete confined members:-

- No skilled labor required (for casting concrete specimens using ferrocrete confinement)
- Enhanced strength
- Exemption from curing
- Reinforcement in ferrocrete confined columns:-

Capacity of Column= Capacity of Concrete + Capacity of Steel [3].

Usually, around 2-3% steel is provided in columns. Concrete contributes to 65% of stress value of column and reinforcement in the column contributes to the rest 35%. But due to the provision of ferrocrete confinement, the compressive strength of concrete jumps up by 71.18% (result value) on applying confining layers i.e. the contribution of concrete in resisting the stress value increases from 65% to 111.267%, hence, the 35% contribution of reinforcement in resisting the stress becomes unnecessary. The load which comes on compressive members is never concentric; therefore, there is always a possibility of bending. Concrete has no tendency to take tension at all and it fails before the load it is actually supposed to take. Hence it is essential to provide reinforcement to resist stresses produced due to both uni-axial and biaxial loading.

5. Testing:-

All the members were tested for direct compression and the load was applied in following manner:

1) For unconfined members:- Load should be applied on the total surface area in plan.
2) For confined members, the load should be applied on the concrete core only as shown in figure.

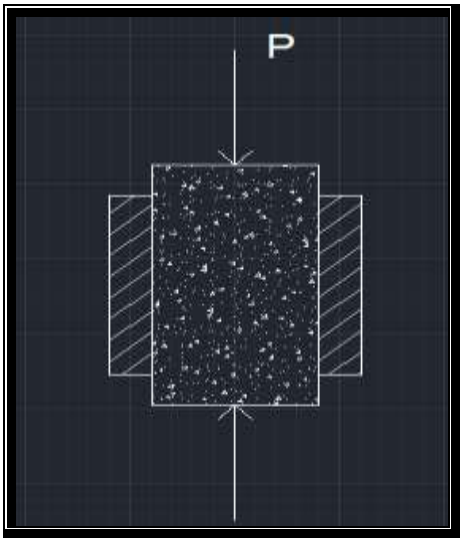

Figure 4: Arrangement for testing confined specimen

6. Results:-

The casted specimens were tested for uni-axial compression under Universal Testing Machine (UTM). The results obtained are as follows.

Table 1:-

Description	Uni-axial compressive strength (MPa)			
Specimen	1	2	3	Mean
Unconfined	9.587	10.283	12.414	10.76
Confined	18.155	16.948	20.173	18.42

The increase in strength due to confinement= 7.66 Mpa
Therefore, percentage increase in strength =71.18% of original strength.

7. Conclusions:-

The grade of concrete used for casting was M20 (as per IS 456). IS 456 recommends that the 150x150x150mm size of specimen gives the maximum strength than any other shape and size for particular grade of concrete [4]. The confined specimen of size 150x250x200 mm shows around 70% increase in strength with respect to the unconfined specimen of same shape and size.
In this work, methodology to be followed for construction of ferrocrete confined columns; its advantages over normal RCC columns, the challenges faced on site during construction of such columns and its practical application have been thoroughly studied. Also, a solution is suggested for the problems faced during removal of steel mould while casting the ferrocrete confinement, i.e. to loosen the steel mould after 4hours, so that bond between steel and concrete is broken and remove it after 6 hours thus making the mould easy to destrip.
Curing of structural members on site may be skipped since the ferrocrete confinement will help to minimise the escape of hydration water into the atmosphere. Effective ways of placing of reinforcements have also been suggested in this study. Reinforcements can be tied together to form a steel cage and can be directly inserted from top into the hollow portion of the compressive member and then concreting can be done. Hence, placing of reinforcements in the columns will not pose any problem on site. Similar technique can be used for casting flexural members in a bit different way by making channel sections. Also, the behaviour of concrete columns with ferrocrete confinement under compressive stresses is studied. Thus, confinement of concrete using Ferro cement can be a better alternative to in-situ and precast construction techniques.

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