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# Experimental Determination of Ferrocast Confined Cylindrical Columns

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**Abstract:**
Methods of construction have changed over ages. As new materials of construction were evolved, new suitable techniques to exploit their use were developed. Similarly, use of ferrocast sections is a recently developed technique which is similar to precast sections. This experimental study analyses the behavior of column in bending as well as under axial compressive loading. This study included total 11 samples of confined columns and were tested for different types of loading cases. Interpretation of the results was carried based on the comparison between cubes without confinement and cylindrical sections with confinement. After comparison, increment in compressive strength was observed in confined sections and development of tensile stress was also observed.

**KeyWord :-**Confinement,Compressive strenth ,Tensile Stress,Column Ferrocast

## Introduction

Ferrocement construction has gained quite a name in special structural shapes. The advantages of this material and its successful use was initiated in Asian developing countries then spread to Europe and eventually to the US. Ferrocast was an invention, which made its wider applications in a different form than originally thought off. Ferrocast is almost similar to Precast, the only difference is, in precast entire member is casted on or off the site as a whole unit of beam, column etc whereas in Ferro cast only formworks of mortar are casted on or off the site for beams, columns, slabs, walls etc. Mortar is used as a formwork in Ferro cast which includes cement, sand, water, wire mesh and admixtures.

## Methodology

Ferrocast confinement sections were casted for three types of loading cases. These cases are as follows:

**Case 1** – Complete section under compression The purpose of this type of loading case was to compare the compressive stresses of concrete cubes with ferrocast confinement sections.

**Case 2** – Only core concrete under compression. The purpose of this type of loading case was to analyze the increment in the compression strength capacity of confined sections compare to standard concrete cubes.

**Case 3** – Eccentric loafing In this type of loading behavior of confined column in bending was analyzed. Determination of compressive stresses as well as tensile stresses was done.

## Modeling

Cylindrical mould of 150mm diameter and 300mm height was used. Ferro cast confinement was of 25mm thick and core concrete of 100mm diameter at the centre of the cylinder. Galvanized Iron mesh was used.

Specifications of the Mesh

Diameter = 1.25mm
Spacing = 20mm X 20mm Square Mesh
3 Layers of mesh were used.
1st layer (Innermost layer) diameter = 106mm
2nd layer (Middle layer) diameter = 125mm
3rd layer (Outermost layer) diameter = 144mm

**Figure 1**: Failure of sections after testing

**Figure 2**: Preparation before Casting

**Figure 3:** Eccentric loading arrangement

**Figure 4:** Testing on UTM

## 1. Results and Interpretations

For the comparison between the compressive strength of cube and compressive strength of cylinder, a factor of 0.8 to the cube strength was applied for normal strength of the concrete. (Al-Sahawneh, 2013).

**Case 1 - Complete section under Compression.**

**Table 1: Results of the test**

| Specimen | Maximum load (KN) | Displacement at Max. load (mm) | Maximum Displacement (mm) | Ultimate stress (Mpa) |
|---|---|---|---|---|
| 1 | 662.300 | 10.54 | 13.13 | 37.00 |
| 2 | 649.300 | 10.61 | 13.39 | 36.25 |
| 3 | 669.450 | 10.67 | - | 37.36 |

Average compressive strength of cubes observed was 39.6Mpa and average compressive strength of confinement cylinder was 37Mpa. So, it can be seen from the results that there is not much of a difference between the compressive stress value for concrete cubes and of confined section when loaded on full face under compression.

**Case 2 (a) – Concrete core in Compression**

Height of the core concrete was extended by 10mm from top as well as bottom so that only core concrete will be under compression.

**Table 2: Results of the test**

| Specimen | Maximum load (KN) | Displacement at Max. load (mm) | Maximum Displacement (mm) | Ultimate stress (Mpa) |
|---|---|---|---|---|
| 1 | 356.65 | 8.98 | 11.020 | 38.00 |
| 2 | 302 | 6.45 | 8.81 | 45.00 |

Average compressive strength of concrete cubes observed was 36Mpa and average compressive strength of confinement cylinder was 41.5Mpa. So, it can be seen that there is an increment in the strength by 5.5Mpa

**Case 2(b) – Concrete core in Compression.**

**Table 3: Results of the test**

| Specimen | Maximum load (KN) | Displacement at Max. load (mm) | Maximum Displacement (mm) | Ultimate stress (Mpa) |
|---|---|---|---|---|
| 1 | 441.40 | 8.890 | 13.140 | 56.20 |
| 2 | 376.05 | 10.580 | 11.130 | 47.88 |
| 3 | 405.95 | 8.840 | 10.410 | 51.68 |

Average compressive strength of concrete cubes observed was 34Mpa and average compressive strength of confinement cylinder was 52Mpa. So there is an increment in the stress capacity by 18Mpa. The main difference between case 2(a) and case 2(b) is, in case 1(a) ties (spacers) were not provided between the mesh layers, whereas in case 2(b) spacers were provided at top as well bottom for all the three layers of the mesh to maintain the spacing between the mesh layers at the time of loading

**Case 3 – Section in Bending**

**Table 4: Results of the test**

| Specimen | Maximum load (KN) | Displacement at Max. load (mm) | Maximum Displacement (mm) | Ultimate stress (Mpa) |
|---|---|---|---|---|
| 1 | 331.20 | 14.990 | 26.120 | 18.74 |
| 2 | 314.65 | 15.320 | 17.220 | 17.80 |
| 3 | 488.95 | 14.010 | 15.040 | 27.66 |

Eccentricity of 30mm was kept.

Average compressive strength of concrete cubes observed was 34Mpa.

Based on Bending Stress formula –

P/A +M/Z = Maximum compressive stress

P = Average maximum force = 378000N

A = cross sectional area = 17671.45 mm2

M = Bending Moment = PXE (eccentricity = 30mm)

Z = section modulus = I/Y

Maximum compressive stress developed was 55.60Mpa which is greater than 34Mpa by 21.60Mpa.

Similarly,

P/A - M/Z = Maximum tensile stress

Maximum tensile stress developed was 12.85Mpa.

## 2. Conclusions

After evaluating the results of all the cases it can be concluded that Ferrocast confined sections are very much suitable compare to standard concrete sections. Case 2 shows significant improvement in compressive strength capacity of confined sections compare to concrete cubes. Case 3 shows the most significant results, in eccentric loading (case – 3) failure on compression side was observed, as section was failed at 55.60Mpa compressive stress but no cracks were observed on tension side even after tensile stress of 12.85Mpa was developed on tension side, hence it can be concluded that confined section is capable of taking minimum tensile stress of 12.85Mpa and even more, as no cracks were observed on tension side.

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