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Bending Behavior of Confined Ferrocrete Cross Beam.

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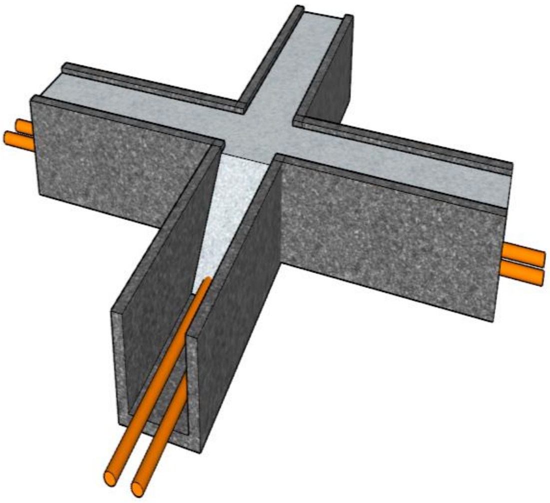
Abstract: ***A ferrocement box beam derives its flexural strength from interaction of the eel (wire mesh), acting in tension and concrete in compression with a moment capacity depending on depth of flange c/s and it also derives its flexural rigidity from structural form of c/s. Even though the thickness of ferrocement section is very small, choosing proper shapes of c/s the flexural rigidity of the section can be increased. Unlike studies on the behavior of ferrocement elements under flexure, very limited research is available on the behavior of compound structural section like I, C, T and L, etc., space in general and core ferrocement compound sections in particular. Hence in the present investigation, 9 ferrocement Cross beams of size 150mmx150mmx1000mm long span Filled with M25 grade of Concrete with Varying Diametere of Fy 500D TMT bar are chosen to study the behavior of ferrocement by Experimental and Analytical method for constant application of loading which will be further validate performing FEM Analysis using Ansys software.***

Keywords: **Cement, Fine Aggregate, Coarse Aggregate, Ferrocement.**

1. INTRODUCTION

In this present study, the study of the ultimate strength and bending behavior of Ferrocrete Cross beam members will be carried out. A total of 3 Sample combinations-for Cross beam sections will be studied by modifying the size of the reinforcement bar which will be further Multiplied 3 times to carry out the average of each specimen. A parametric study of these sections will be carried out using FEM-based ANSYS software. The FEM results will be compared with experimental bending test results in terms of ultimate load-carrying capacity & deflection of the cross beam.

2. EXPERIMENTAL ANALYSIS:



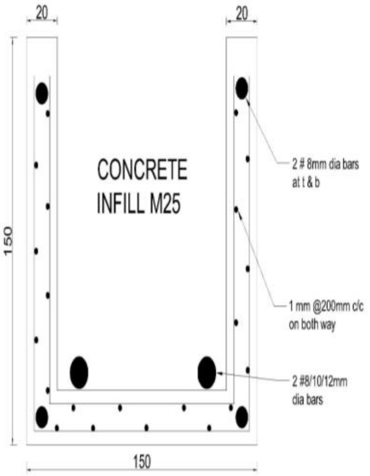


Fig. Cross Beam Ferro-crete Fig. Detail cross-section

An experimental investigation has been carried out on total 9 specimens of Confined Ferrocrete Cross beam specimens to calculate ultimate load carrying capacity & Displacement.

Test Specimens.

The experimental study consists of the casting of three sets of Confined ferrocement cross-beam specimens.

Sample Type	Element Name	Description	Dimensions (mm)	Applied Load
Set I	CB – 8 mm	Ferrocement Cross beam, 8 mm Dia bar	150x150x1000	Ultimate Load
Set II	CB – 10 mm	Ferrocement Cross beam, 10 mm Dia bar	150x150x1000	Ultimate Load
Set III	CB – 12 mm	Ferrocement Cross beam, 12 mm Dia bar	150x150x1000	Ultimate Load

Table: Test Specimen Classification

Test Setup and Procedure:

During the casting of specimens, the preparation of cutting and bending of steel bars, forming of formwork, oiling of formworks, placing steel at standard concrete cover, mixing of concrete, filling of concrete, setting and curing of specimens were done as per standard procedure. All these steps of procedure were followed in common and simultaneously for all the specimens considered in the study.

Fig. Casted Specimens

Test Setup:

All the specimens were tested in the Universal Testing Machine of 600KN capacity. The testing procedure for the whole specimen was the same.

Testing of Specimens up to Ultimate Loading & Displacement:

Before testing the members were checked dimensionally.The Confined Ferrocrete Cross beam specimens were simply supported at ends. The clear/test span was 1000 mm for Cross beam. The centre-to-centre distance between supports/effective span was 600 mm.The experimental study consists of testing of three sets of the Confined Ferrocrete Cross beams specimens (SET I/II/III). The SET I/II/III specimens of 8 mm, 10 mm, 12 mm diameter HYSD steel bars were tested for Ultimate/failure load. The test load was applied manually as a ramped loading with the constant rate of increment. total 9 specimens were tested up to ultimate/failure loads.

Fig. Placing of Cross Beam Specimens over Support System

3. FINITE ELEMENT ANALYSIS:

An attempt has been made in this study to find the strength and failure behavior of Confined Ferrocrete Cross beams specimens using finite element-based ANSYS 19.2 software. The specimens studied were the same as specified in Experimental Analysis. In FEM analysis an attempt has been made to alkalize these specimens as composite materials. The properties and constitutive relations of the materials as used are similar to the experimental study introduced in FEM.

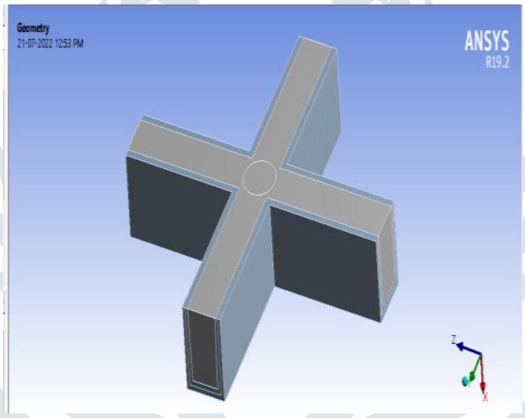


Fig. FEM Model of Confined Ferrocrete Cross beams

Material Modelling:

The proposed numerical model was made by using elements available in ANSYS default library code. For solid objects SOLID 185 3D - 4 node element is used. It is defined by Four nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, hyperelasticity, stress stiffening, creep, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic materials, and fully incompressible hyperelastic materials.

The modelling of the main steel was done by the BEAM188 - 3-D 2-Node Beam, which allow for the configuration of the cross section, enable consideration of the non-linearity of the material and include bending stresses as shown in Figure

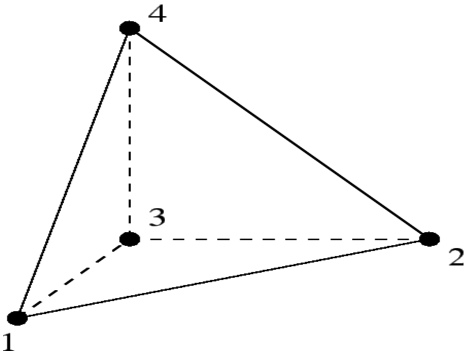


Fig. SOLID185 Homogeneous
Structural Solid Geometry

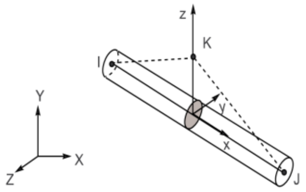


Fig. Beam 188 Element

Geometric Modelling:

- All specimens studied in the experimental analysis were modelled in Auto CADD 3-D, saved in .iges file and imported in Ansys 19.2. Figure shows the models of Confined Ferrocrete Cross beams specimens.

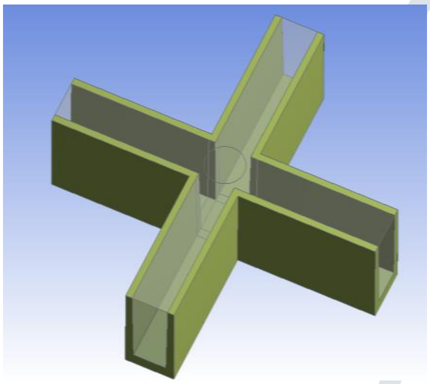


Fig. FEM M30 Mortar Modelling

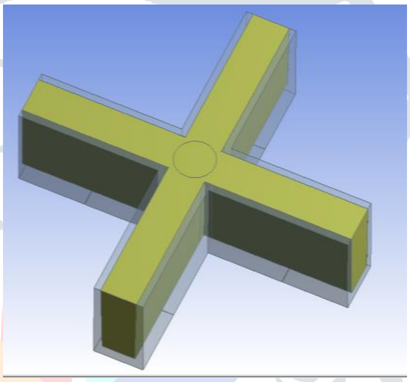


Fig. FEM M25 Core Concrete Modelling

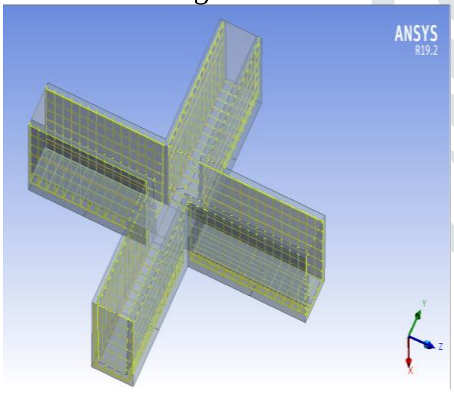


Fig. FEM Welded Mesh Reinforcement

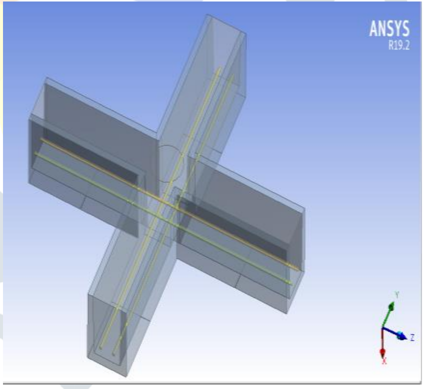


Fig. FEM HYSD bar Modelling

Supports Modelling:

The test specimens were simply supported on the fixed solid steel rods (two inbuilt in UTM and two specially fabricated to support Confined Ferrocrete Cross beams as shown in the Experimental analysis. The support/end condition in FEM was modelled to simulate the test support/end conditions allowing free rotation of the specimens about the longitudinal and lateral axis when undergoes to loading applied. The support system modelled on finite element analysis was as shown in Figure for Crossbeam specimens.

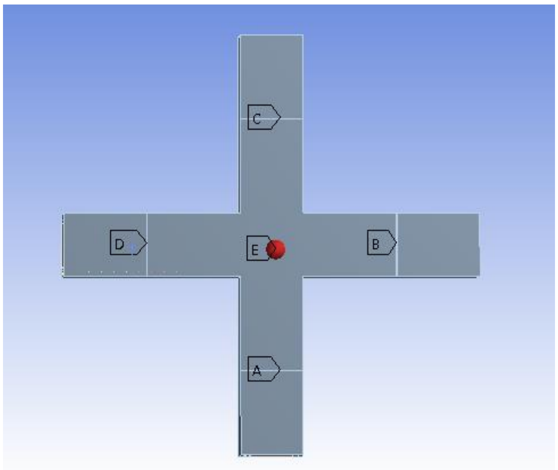


Fig. FEM Support/End Condition Modelling of Cross Beam

Meshing:

As the meshing size directly affects the accuracy of the analysis, it is one of the important factors to be considered in FEM. An adequate mesh density was provided to characterize the static analysis and for resolving displacement and ultimate load carrying capacity of the specimens. To achieve the convergence, the optimum element size is selected through several trials and it was taken as 15 mm for the entire geometry of all studied specimens. The figure shows the meshing of the Confined Ferrocrete Cross beams specimens.

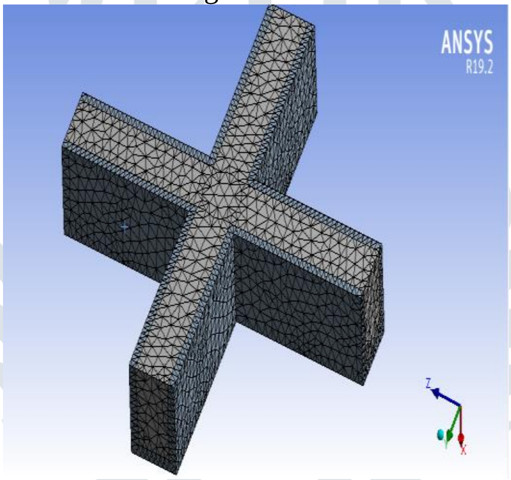


Fig. Meshing for cross beam

Load application in modelling:

When we specify one substep in a load step, the question of whether the loads should be stepped or ramped arises. If a load is stepped, then its full value is applied at the first substep and stays constant for the rest of the load step. If a load is ramped, then its value increases gradually at each substep, with the full value occurring at the end of the load step.

In this research during the experimentation the load was applied with gradual increment, hence ramped loading case has been used in Finite Element Analysis. During tests a concentrated point load was applied at cross beam joint The FEM analysis simulates the loading applied on all specimens studied. Figure shows the FEM loading simulations for Confined Ferrocrete Cross beams

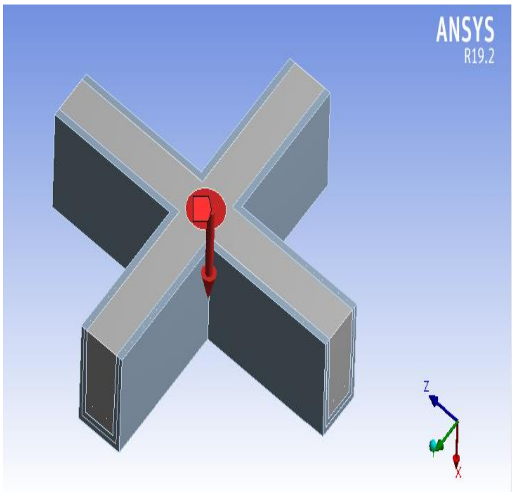


Fig. Load application on cross-beam

Finite Element Analysis Process:

- The properties and constitutive relations of the materials as used, similar to experimental study were introduced in FEM.
- All specimens studied in experimental analysis were modelled in FEM using a typical solid volume model.
- The optimum element meshing size was taken as 15 mm for the entire geometry of all studied specimens.
- The values of loads and displacements extracted from the experimental analysis were given input for the finite element analysis.
- FEM analysis simulates the material properties and composition, support conditions, loading applied and test process for all specimens considered in the study.

4. EXPERIMENTAL RESULTS:

Experimental results have been studied:

i) ultimate loading test results, and ii) Displacement test results

Fig. Ultimate Load Failure of Confined Ferrocement Cross-Beam

Ultimate test results have been studied for SET I/II/III i.e., for Confined Ferrocrete Cross beam of 8 mm / 10 mm / 12mm dia. HYSD 500 bar specimens respectively to know the failure loads at the complete failure of the specimens.

Sr. No.	Sample Type	Element Name	Ultimate Load (KN)	Deflection (mm)	Average Ultimate Load (KN)	Average Deflection (mm)
1.	Set I	CB1 – 8 mm	63.43	22.3	**65.92**	**17.98**
2.		CB2 – 8 mm	65.01	12.9		
3.		CB3 – 8 mm	69.32	18.76		
4.		CB1 – 10 mm	75.3	15.99	**74.33**	**11.32**

5.	Set II	CB2 – 10 mm	68.73	10.42		
6.		CB3 – 10 mm	78.96	7.56		
7.	Set III	CB1 – 12 mm	87.87	5.19	**88.44**	**5.93**
8.		CB2 – 12 mm	90.45	6.54		
9.		CB3 – 12 mm	87	6.06		

Table: Test Specimen Result Experimental

Experimental Average Results Graph:

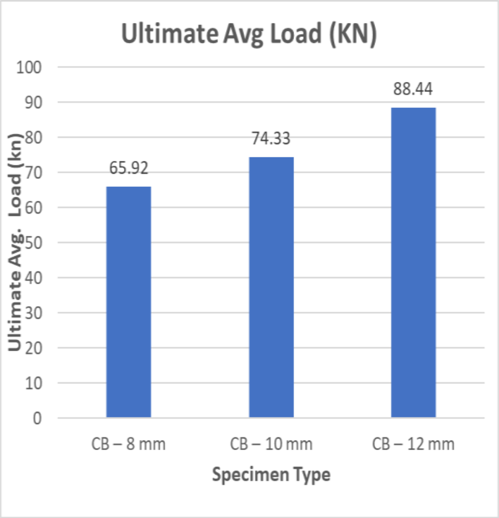


Fig. Ultimate Load(KN) Vs Specimen Type

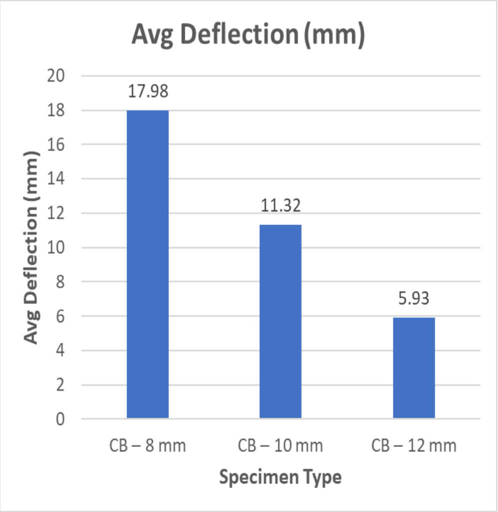


Fig. Average Deflection(mm) Vs Specimen Type

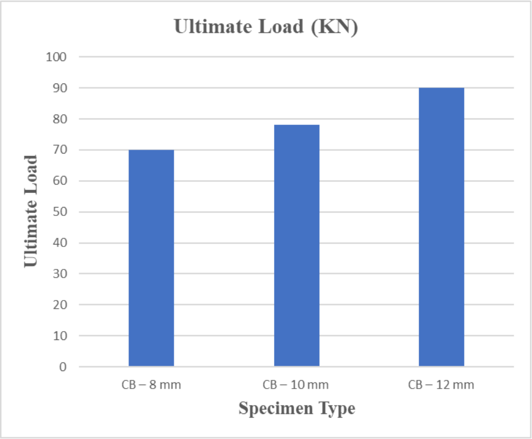
5. ANALYTICAL RESULTS

Analytical analysis was carried out using FEM based Ansys 19.2 software. Ultimate load and respective deflection values of SET I, SET II and SET III were computed for all types of specimens. Show the FEM results of SET I, II and III respectively.

Sr. No.	Sample Type	Element Name	Ultimate Load (KN)	Displacement (mm)
1.	Set I	CB – 8 mm	**70**	**13.608**
2.	Set II	CB – 10 mm	**78**	**8.06**
3.	Set III	CB – 12 mm	**90**	**7.4**

Table: Analytical Results at Ultimate Load & Displacement of SET I/II/III Specimens

FEM Results Graph:



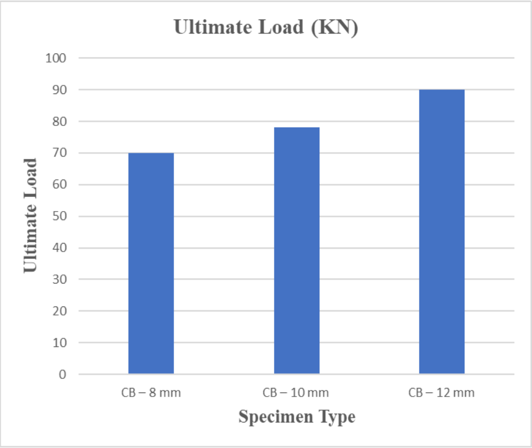


Fig. Ultimate Load (KN) Vs Specimen Fig. Displacement (mm) Vs Specimen

6. COMPARATIVE ANALYSIS: EXPERIMENTAL AND ANALYTICAL RESULTS

- To validate the FEM with experimental analysis, the results of loads and displacements were compared with each other.
- The graph shows the experimental and analytical results of the ultimate loads and displacements of Confined Ferrocement Cross Beam.
- A comparative study between experimental and analytical results shows that the FEM and experimental results of all specimens, in terms of load and displacements are very close to each other; which shows the good agreement of the FEM with experimental analysis in terms of load and displacement.

Comparative Analysis of Experimental and Analytical Results of Deflection:

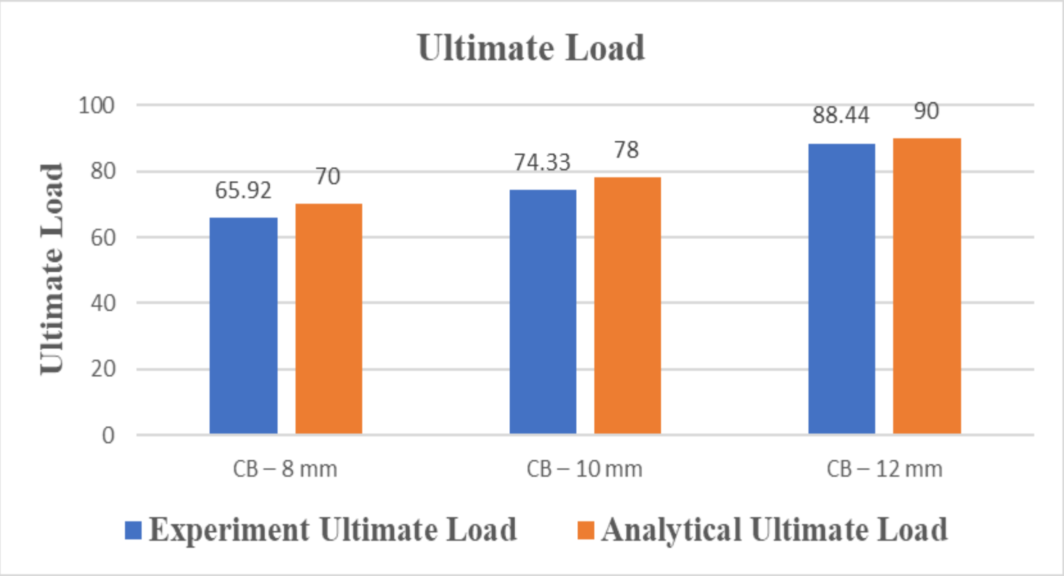


Fig. Comparative Analysis of Experimental and Analytical Results of Ultimate Load

Comparative Analysis of Experimental and Analytical Results of Deflection:

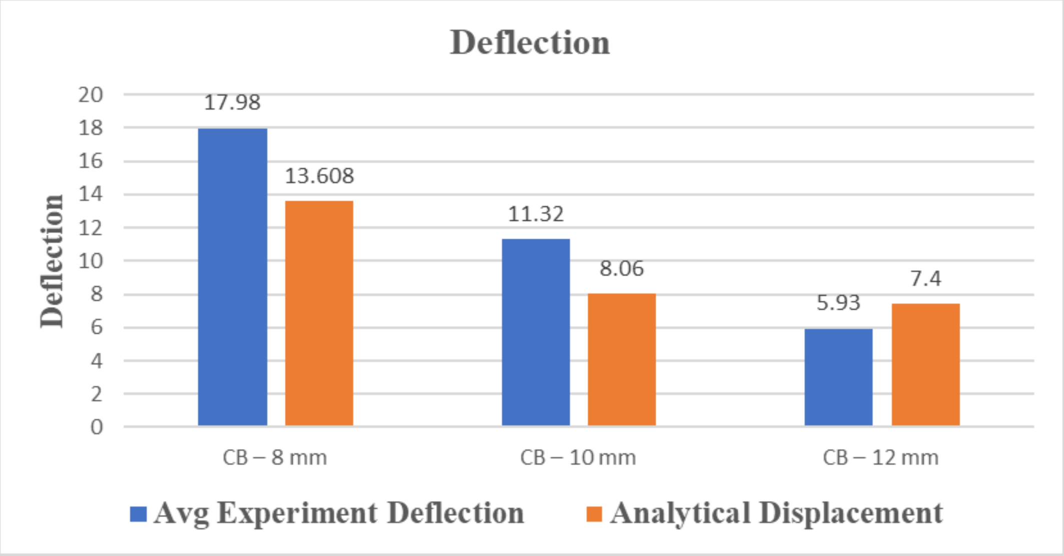


Fig. Comparative Analysis of Experimental and Analytical Results of Deflection

Percentage Variation of load carrying capacity:

8 mm HYSD Dia Sample : 5.82 %
10 mm HYSD Dia Samlpe : 4.70 %
12 mm HYSD Dia Samlpe : 1.73 %

Percentage Variation of Displacement:

8 mm HYSD Dia Sample : 24.31 %
10 mm HYSD Dia Samlpe : 28.79 %
12 mm HYSD Dia Samlpe : 19.86 %

7. CONCLUDING REMARK:

- An experimental investigation was carried out to determine, the load carrying capacity and failure behavior of Confined Ferrocrete Cross Beam specimens of the same dimensions with varying HYSD bar diameters.
- This study also presented the Camparision of experimental results with the analytical and the results showed that the experimental and FEM results are in good agreement with each other.
- The results of the study were established by an experimental and analytical study and the concluding remarks are given on the ultimate load & deflection of Confined Ferrocrete Cross Beam:

A. Experimental Results of Confined ferrocement cross beam.

Ultimate load carrying capacity:

- Ultimate load carrying capacity of 10 mm diameter HSYD bar is increased to 11.31 % as compared to 8 mm diameter HSYD bar.
- Ultimate load carrying capacity of 12 mm diameter HSYD bar is increased to 15 % as compared to 10 mm diameter HSYD bar.
- It is concluded that as the diameter of the bar increases in confined ferrocement cross beam the ultimate load carrying capacity also increases.

Deflection:

- Deflection of 10 mm diameter HSYD bar decreases to 37.041 % as compared to 8 mm diameter HSYD bar.
- Deflection of 12 mm diameter HSYD bar decreases to 47.61 % as compared to 10 mm diameter HSYD bar.
- It is concluded that as the diameter of the bar increases in confined ferrocement cross beam the deflection also decreases.

B. Analytical Ansys Results of Confined ferrocement cross beam.

Ultimate load carrying capacity:

- Ultimate load carrying capacity of 10 mm diameter HSYD bar is increased to 10.25 % as compared to 8 mm diameter HSYD bar.
- Ultimate load carrying capacity of 12 mm diameter HSYD bar is increased to 13.33 % as compared to 10 mm diameter HSYD bar.
- It is concluded that as the diameter of the bar increases in confined ferrocement cross beam the ultimate load carrying capacity also increases.

Deflection:

- Deflection of 10 mm diameter HSYD bar decreases to 40.77 % as compared to 8 mm diameter HSYD bar.
- Deflection of 12 mm diameter HSYD bar decreases to 8.18 % as compared to 10 mm diameter HSYD bar.
- It is concluded that as the diameter of the bar increases in confined ferrocement cross beam the deflection also decreases.

C. Observation.

- While experimentation it is found that the contact/bond between ferrocement and core concrete was not appropriate. In the future need to improve the bond between ferrocement and core concrete.As the point load was applied on the joint of the cross beam, we found that failure occurred diagonally at the joint

REFERENCES

Journal Article

[1] *P. Raghunathapandian, B. Palani, and D. Elango, "Flexural Strengthening of RC Tee Beams using Ferrocement", International Journal of Recent Technology and Engineering (IJRTE)., Vol. 8,* ***(2020)****, pp 4505-4509.*

[2] *. Naveen G.M, G.S. Suresh, "An Study Of Fiber Reinforced Light Weight Ferrocement Beams Under Monotonic And Repeated Loading", International Research Journal Of Engineering And Technology (IRJET)., Vol. 7,* ***(2020)****, pp 41-47.*

[3] *Adheena Thomas, Afia S Hameed, "The Combined Action of Flexure and Torsion on Reinforced Concrete Beams Retrofitted with Ferrocement Jacketing - Experimental Study", International Journal of Science, Engineering and Technology.,* ***(2020)****, pp 1-7*

[4] *Abeer M. Erfan, Taha A. El-Sayed, "Shear Strength Of Ferrocement Composite Box Section Concrete Beams", International Journal of Scientific and Engineering Research Vol. 10.,* ***(2019)****, pp 260-279*