BEHAVIOUR OF SQUARE CONCRETE COLUMN CONFINED WITH CARBON FIBER RIENFORCED POLYMER (CFRP) SHEET

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***Abstract*— An experimental study is conducted on the determination of strengthening reinforced concrete columns using CFRP material. Carbon fiber reinforced polymer sheet (CFRP) is used As externally Bonded reinforcement for concrete structure to improve flexure and Shear strength, retrofitting work and confinement of concrete. The columns are wrapped using carbon fiber sheet impregnated with neat epoxy adhesive. The carbon fiber reinforced is also used for structural repair and Strengthening has continuously increased in recent years. In this method of strengthening and existing reinforced concrete column under different loading condition. Nito wrap (CF) is a carbon fibre composite system for strengthening columns, beams, retaining wall and slabs of load bearing structures particularly where improvement to shear strength and deformation characteristics is required. It is ideal for seismic retrofitting also.**

***Keywords:* Carbon fiber, CFRP, concrete reinforcement, structural repair, and strengthening. External confinement, reinforced concrete columns**

I. INTRODUCTION

Concrete is one of the most widely used construction material. Since the day of its advent, concrete has been undergoing changes as a material and technology. Due to the growing needs of performance and durability of concrete there has been a continuous search for upgrading the properties of concrete. Concrete being the most versatile construction material and is used in a wide range of civil engineering structures and structural elements all over the world. In recent years, the use of externally bonded fiber reinforced polymer (FRP) composites has become increasingly popular for the repair and retrofitting of concrete structures. Many experimental studies have demonstrated that FRP confinement can significantly increase column energy absorption and ductility _ an extensive review of the literature Esfahani and Kianoush (2005) , k p jaya (2012) shows that the behaviour of FRP-confined concrete specimens under concentric load conditions has been studied extensively**.**

I. OBJECTIVES

The objectives of the study are summarized as follows:

- To study the load carrying capacity of columns with slenderness ratio of range 3.0
- To study the failure pattern of wrapped RCC and plain concrete columns.
- To compare the CFRP wrapped column with plain and reinforced concrete columns carrying axial load.
- To study the axial load and axial shortening curve for different slenderness ratios.

II. LITERATURE REVIEW

K.P.Jaya (2012) has conducted experiments on six, one-third scaled columns. The height of the column is 1000mm and of 100 mm x100 mm size. Column is made with M20 grade concrete and Fe-415 grade steel is used for longitudinal reinforcements and Fe-250 grade steel is used for stirrups and lateral ties. The size of the column and the beam are 100x100 mm and 100x 200mm, respectively. The columns are longitudinally reinforced with 4 Nos. of 8mm diameter bars and laterally tied with 6mm diameter bars placed at 100 mm c/c. Three specimens were jacketed externally by 2, 4 and 6 layers of GFRP sheets. Two specimens were jacketed externally by single layer of CFRP sheet.

Esfahani and Kianoush (2005) have studied the axial compressive strength of columns strengthened with FRP wrap. The experimental part of the study included testing 6 reinforced concrete columns in two series. The first series comprised three similar circular reinforced concrete columns strengthened with FRP wrap. The second series consisted of three similar square columns; two with sharp corners, and the other with rounded corners, the corners of one of the square columns were rounded in

order to study the effect of corner shape of square column on load resistance. Axial load and shortening of columns were recorded during tests using a shortening control test set up.

III. METHODOLOGY

The present study investigates the load carrying capacity of the column with dimension 300*150*150 with externally bonded fiber system
Totally 4 columns are casted, columns are made with M20 grade concrete and Fe-500 grade steel
The longitudinally reinforced with 4 Nos. of 8mm diameter bars and laterally tied with 6mm diameter bars placed at 100 mm c/c.
Two are PCC columns under two one is wrapped with CFRP and one as reference
column, 2 are RCC columns one is wrapped with CFRP and 1 as reference

IV. WRAPPING PROCEDURE

APPLICATION INSTRUCTIONS:-

Surface preparation

Concrete surface to be treated shall be free from oil residues, demolding agents, Curing compounds, grout holes and protrusions. In case of distressed structure, the Concrete surface to be wrapped, shall be structurally repaired prior to treatment. corrosion induced damages shall be repaired with renderoc rang of mortars . Structural damages shall be repaired by using epoxy grouting or appropriate mortar from the rendroc range

Mixing

Before mixing the contents of each should be thoroughly stirred to disperse any settlement, which may have taken place during storage. The base and hardener are emptied into a suitable container and the material is thoroughly mixed for at least three minutes.

Primer

The mixed material of Nitowrap 30 epoxy primer is applied over the prepared and cleaned surface. The application shall be carried out using a brush and allowed for drying for about 24 hour before application of saturant.

Saturant

The mixed material of nitowrap 410 saturant was applied over the tack free primer. The wet film thickeness shall be maintained @ 250 microns.

Nitowrap (CF)

The nitowrap (CF) fabric shall be cut required size and then pressed first by gloved hand on to the saturant applied area and then with a stiff spatula or a surface roller to remove air bubbles. one more coat of nitowrap 410 saturant is applied over the carbon

fabric after a minimum time lapse of 30 minutes. The same procedure shall be followed for a multiple layer fiber strengthening. Care shall be taken that the fiber orientation is not disturbed while applying the second coat of saturant.

Carbon fiber cut with required size

Saturant is applied with column surface **C.F is wrapped to the surface** **One more coat saturant is applied**

FIG 1: columns wrapped with CFRP sheet

V. **DISCUSSION OF TEST RESULTS:-**

The specimen is set in the compression testing machine and the dial gauge is attached to the bottom of the plate and the load is gradually applied for the specimen and load is applied for every 100kN and the dial gauge readings are noted . And load v/s deflection curve is plotted.

COMPRESSION TEST ON UNWRAPPED AND WRAPPED RCC COLUMNS

FIG 2:- FAILURE AT MAXIMUM LOAD

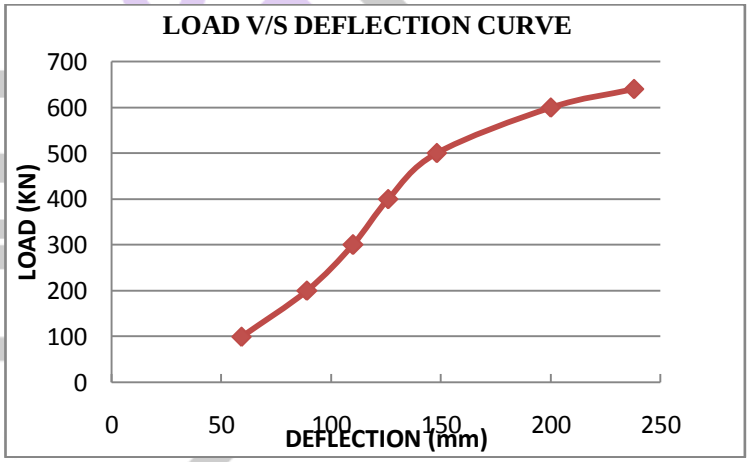
VI. TEST RESULTS :-

For 28 days curing the compressive strength for RCC unwrapped and wrapped columns are listed in below

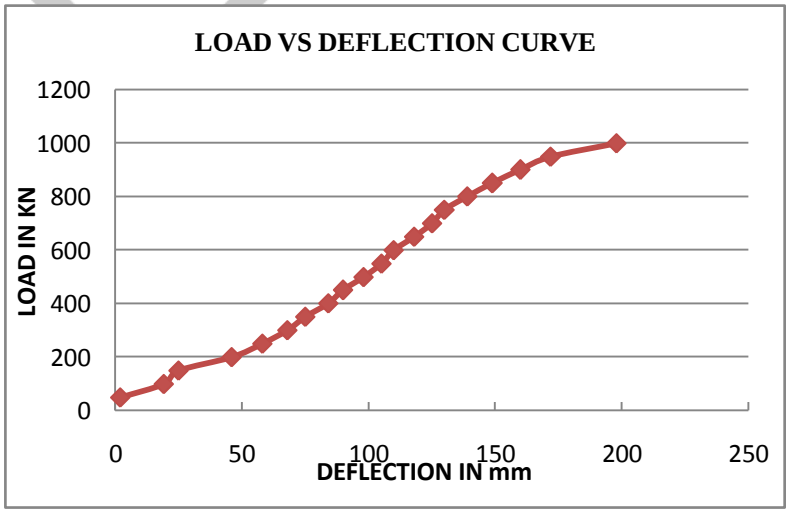
RCC COLUMN (UNWRAPPED)	**36 N/mm^2**
RCC COLUMN (WRAPPED)	**56.29N/mm^2**

- **LOAD V/S DEFLECTION CURVE FOR BOTH UNWRAPPED AND WRAPPED RCC COLUMNS IS PLOTTED BELOW**

DEFLECTION(mm)	LOAD (KN)
59	100
89	200
110	300
126	400
148	500
200	600
238	640



DEFLECTION	LOAD
2	50
19	100
25	150
46	200
58	250
68	300
75	350
84	400
90	450
98	500
105	550
110	600
118	650
125	700
130	750
139	800
149	850
160	900
172	950
198	1000



VII. Advantages of Carbon Fiber

- Very high strength to thickness or weight ratio. Appreciable increase in strength and load carrying capacity without significant increase in dead load.
- Enhanced Stiffness, shear and tensile capacity; increased load carrying capacity and better resistance to seismic forces and deflection.
- Chemical resistant; Excellent resistance to acids and alkalis.
- Flexible; can be applied to any shape.
- Thin sections; can be effectively used in space constrained areas.
- Creep and fatigue resistance; ideal for conditions of sustained loading and repeated loading.

VIII. Applications of Carbon Fibers

- Strengthening of beams for enhanced flexure and shear strengths.
- Strengthening of columns for increased load carrying capacity.
- Strengthening of slabs, retaining walls etc.
- Ideal for Seismic retrofitting.
- Improvement of Blast and impact resistance properties
- Acts as barrier to carbon dioxide, chloride, sulphate etc for RC structures.
- Tunnel lining, airport runways, highways pavements, pre-cast concrete parking areas, concrete piled floors, steel decks strip foundations raft foundations.

IX. CONCLUSION

- The increase in number of FRP layer and FRP contact area with concrete have a considerable increase in stiffness and ultimate load.
- Strengthening the sides of the column will improve with FRP will help in controlling the width and propagation of the shear cracks and providing confinement to the column.
- As the number of layer of CFRP increase the strength of the column increased by 20-25% per layer increased in wrapping.
- The strengthening scheme showed the best results considering all parameters like strength, ductility, toughness and compression strength.
- An improved understanding of the structural behavior of FRP fitted structures along with their failure mechanisms, which are often brittle in nature through experimental and numerical simulation, is necessary.

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