UPGRADING COMPRESSIVE STRENGTH OF CONCRETE COLUMN USING FIBER REINFORCED POLYMER

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Abstract-

The use of externally wrapped fiber-reinforced polymers (FRP) has become very much popular for civil engineering applications. The Carbon fiber reinforced polymer has significantly increased the strength and ductility of concrete by forming perfect adhesive bond between concrete and the wrapping material. The main objective of this project is to study the effect of reinforced concrete column wrapped with FRPC on split or indirect tensile strength and compressive strength parameter. The experiment will includes number of concrete specimens which will consist of unwrapped and wrapped column .The study will be establish through the results in terms of compressive and tensile strength. The results will show that for concrete specimens the CFRP increase the compressive strength when compared to unwrapped concrete column.

Keywords: Carbon Fiber Reinforced Polymer, Ductility, Concrete Column , Split Tensile Strength, Compressive Strength.

1. INTRODUCTION

Throughout the world many reinforced concrete structures such as bridges and buildings have worsen and became weak to such a degree that strengthening such structures or reducing the load on them is becoming important to increase their life. In the past, various methods have been used to supporting bridges and other types of structures. Traditionally, structural repairing or restrengthening has been accomplished by methods such as introducing additional beams to the structure or by strengthening existing beams with externally post-pensioned cables. In recent years, mechanical attachment of steel plates placed around the inadequate member has been developed to repair many structures. The use of such technique to provide lateral strengthening to the concrete in compression have been studied extensively, and have shown to increase the compression, load carrying capacity and ductility of the concrete columns. However, the use of steel plates has many disadvantages, such as corrosion, difficulty in handling the plates, deterioration of the bond at the steel–concrete interface and the requirement of massive scaffolding during installation.

1.1 General

Fibers

Fibers occupy the largest part in a FRPC and bear the major amount of the load acting on a composite structure. The reinforcing fibers can be arranged during fabrication; thus composites can be made to meet increased load demands in specific directions. The major fibers in use today are glass, carbon (graphite), and aramid.

A)Glass Fiber-Glass fiber is the most common fiber used in FRPCs because its low cost, high strength, high chemical resistance, and good insulating properties. Despite being widely used in marine applications, glass fiber is subjected to strength loss under moisture and load. The main types are E-glass (also called "fiberglass") and S-glass. The E in E-glass stands for electrical as it was originally designed for electrical application. However, it is used for many other purposes now such as decoration and structural application. The S in S-glass stands for higher contents of silica. It retains its strength at higher temperature and has higher fatigue strength, but it is more expensive than E-glass. The glass fibers are usually used for confinement of columns and for improvement in ductility.

B)Carbon (graphite) Fiber-Carbon/graphite fibers have very high specific stiffness, specific ultimate strength and high fatigue strength. Another very unique advantage of carbon fibers is the very low and negative coefficient of thermal expansion. That is why a graphite/epoxy composite can have a very low Coefficient of thermal expansion. The disadvantages include very high cost (10 times of glass fibers), low impact resistance and high electric conductivity. Differences between carbon fiber and graphite fiber are in the carbon content (93%-95% versus >99%) and in the required manufacturing temperature (1300°C versus 1900°C).

C)Aramid Fiber (Kevlar)-Aramid fiber (Kevlar) is a kind of polymer made of carbon, hydrogen, oxygen, and nitrogen. Its advantages are low density, high tensile strength, low cost, and high impact resistance. However, its compressive strength is only about 20% of the tensile strength. Hence , composites containing aramid fibers are not recommended for structural applications involving high compressive loads.

Another drawback of aramid fiber is degradation under sunlight.

Objectives:

1) To study the effect of FRPC on Column by Compressive Strength and Tensile Strength at 7, 14, 21 and 28 days.

2) To check the behavior of unwrapped conventional reinforced concrete columns and FRPC wrapped reinforced concrete columns.

3) To check economic analysis of FRPC with Normal Concrete.

1.2 Scope and objectives:

The main objective of project work is to study the effect of reinforced concrete columns confined with FRPC on strength parameter. The experimental program included number of reinforced concrete specimens which consisted of unwrapped and wrapped circular shape. The effect study is established through the results in terms of the ultimate axial strength, axial and lateral strain. The experimental results showed that for reinforced concrete specimens the shapes significantly increase the confinement effectiveness when compared with wrapped concrete column specimens.

1.2 Discussion

This paper aims to present literature relevant to assessment of CFRP and its impact on the Mechanical Properties of Concrete. This paper will study the effect of CFRP on the Compressive strength, Split tensile strength of the concrete.

Therefore, the study of CFRP is having crucial importance.

After some years the bond between beam and column, the strength of beam and column reduces over period of time And the failure or settlement of structure occurs. To Overcome this problem the strengthening of beam and column connection is necessary.

2. Procedure -

A)Mix Design - The mix design for M20 concrete cube is done and the ratio of 1:1.5:3 is fixed for testing of cubes. Water absorption, Specific gravity Tests were conducted on fine aggregate and coarse aggregate and the mix design was determined.

B)Collection of Material - According to mix design the quantity of required material such as cement, fine aggregate, coarse aggregate, water and FRPC sheet is collected in required amount by conducting test on cement, on fine and coarse aggregate specific gravity test, water absorption test.

Cement:

Type Of Cement: Ordinary Portland Cement grade: 53

Brand of Cement: Ultra Tech Cement

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planets most consumed resource.

Table 2.1: Properties of Cement

Sr. No.	Property	Value
1	Consultancy	37%
2	Specific Gravity	3.2
3	Initial Setting Time	30 Min
4	Final Setting Time	600 Min
5	Fineness By Sieving	1 % residue
6	Soundness	1.5 mm

Aggregate:

Concrete aggregates are composed of geological materials such as gravel, sand and crushed rock. The size of the particles determines whether it is a coarse aggregate (e.g. gravel) or a fine aggregate (e.g. sand). The resulting concrete can be used in its natural state or crushed, according to its use and application. Aggregate materials help to make concrete mixes more compact. They also decrease the consumption of cement and water and contribute to the mechanical strength of the concrete, making them an indispensable ingredient in the construction and maintenance of rigid structures.

Table 2.2: Properties of Aggregate

Sr. No.	Property	Value
1	Specific Gravity	2.65 %
2	Water Absorption	2.05 %
3	Fineness Modulus	1.62

CFRP:

CFRP (Carbon Fiber Reinforced Polymer) are extremely strong and light fiber reinforced plastics that contain carbon fibers. CFRPs can be expensive to produce, but are commonly used wherever high strength-to-weight ratio and stiffness (rigidity) are required, such as aerospace, superstructure of ships, automotive, civil engineering, sports equipment, and an increasing number of consumer and technical applications. The life span of FRPC sheet is generally 40-50 years.

Table 2.3: Properties of CFRP

Sr. NO.	Property	Value
1	Density	1.9 – 2.1 gm/cm3
2	Tensile Strength	3430 Mpa
3	Young's Modulus	392 – 784 Gpa
4	Elongation	0.4 – 1.5 %
5	Coefficient of Thermal Expansion	-1.2 to -0.1 x 106/ 0C

C)Casting Cube / Cylinder - The Material collected is mixed by using tilting mixer and casting of cubes is done following workability test such as slump cone test, compaction factor test.

Slump cone test: After mixing of cement, fine aggregate coarse aggregate and water according to mix design, the mix is filled in slump cone measuring 30cm height, 10cm top diameter and 20cm bottom diameter in three layers tamping each layer 25 times. After filling the slump it is picked up and the settlement of concrete is measured from top of slump cone and workability of mix is determined.

D)Curing for 7, 14, 21, 28, Days - The cubes are kept in water for curing of 7,14,21,28 days period at room temperature.

E) Wrapping of FRPC Sheets - After curing of cubes is completed three cubes are wrapped with FRPC sheets and three cubes are kept unwrapped.

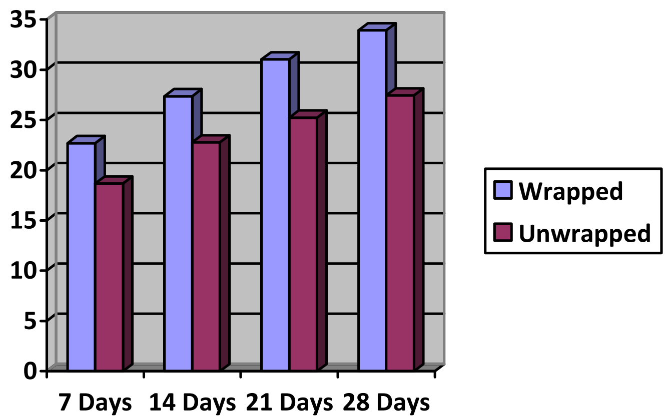
3. Result

Testing and Comparing between Wrapped and Unwrapped.

The cubes both wrapped and unwrapped are undergone compressive strength test on CTM (Compression Testing Machine) after 7,14,21,28 days and the behavior of those cube with respect to compressive force acting on them is compared.

Table 3.1: Compressive Strength of M20 grade of Concrete

Sr. No.	Day	Dimension (mm)	Compressive Strength Mpa			
			Without Wrap		With Wrap	
1.	7th	150x150x150	18.70	18.68	22.60	22.69
			19.21		23.01	
			18.15		22.47	
2.	14th	150x150x150	22.61	22.78	27.53	27.36
			23.30		26.90	
			22.45		27.65	
3.	21th	150x150x150	25.15	25.24	30.52	31.03
			24.90		31.63	
			25.68		30.94	
4.	28th	150x150x150	27.82	27.44	33.12	33.92
			26.98		33.59	
			27.53		35.07	



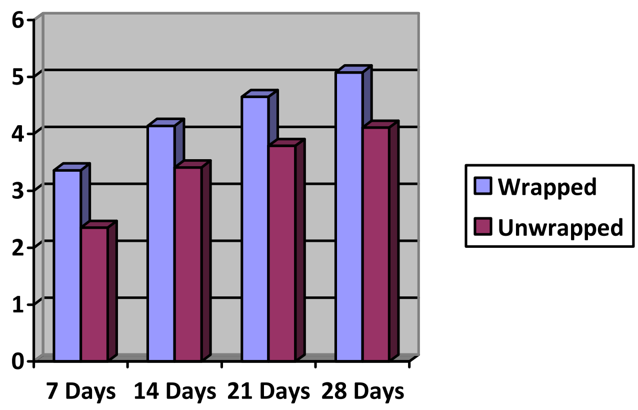
Graph 3.1 Comparison between wrapped and unwrapped concrete cubes

The Increase in the compressive strength of the wrapped column with respect to unwrapped column is about 20-25 % according to readings taken.

Values of Split Tensile Strength

Table 3.2: Split tensile Strength of M20 grade of Concrete

Sr. No.	Day	Dimension (mm)	Split Tensile Strength Mpa			
			Without Wrap		With Wrap	
1.	7th	150x150x150	2.70	2.35	3.60	3.36
			2.21		3.01	
			2.15		3.47	
2.	14th	150x150x150	3.39	3.41	4.15	4.14
			3.48		4.10	
			3.38		4.18	
3.	21th	150x150x150	3.80	3.79	4.57	4.65
			3.73		4.74	
			3.85		4.64	
4.	28th	150x150x150	4.17	4.11	4.96	5.08
			4.04		5.03	
			4.12		5.26	



Graph 3.2 Comparison between Split Tensile Strength of wrapped and unwrapped concrete cubes

The Increase in the Split Tensile strength of the wrapped column with respect to unwrapped column is about 20-25 % according to readings taken.

3. Conclusion

From above test it is observed that the compressive strength of column on 7th , 14th, 21st and 28th day is increased by 20-25 % and the split tensile strength is increased by 20-22 %

By using FRPC Sheets , strength parameters such as Compressive strength and Indirect or Split Tensile Strength Gets Increased.

4. Future Scope

By using FRPC sheets the Strength Parameters are Increased . So it will be helpful to retrofit the structure subjected to failure . The Strength of Structures which are subjected to Heavy load can also Increased by this technique.

Also If the Limitations for area or reinforcements then using FRPC sheet will increase the strength with lesser area or reinforcement .

CFRP wraps can be used for corrosion control and construction of earthquake resistant structures.

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