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Study of Glass Fibre Wrapped Concrete Column under Axial Compression

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Abstract **:Fibre – Wrapping using Fibre – Reinforced Plastic (FRP) shells is one of effective methods, significantly enhances the strength and ductility of concrete columns. The analysis is based on the behavior of the GFRP wrapped concrete columns under uniaxial compression. The compressive strength characteristics will consider for the study. The cross section of the concrete columns will be circular with diameter of 150mm and height 300mm. The strength determination is done experimentally and the results are verified by analytical method using ANSYS Civil FEM.**

Keywords— Glass fibre wrapped concrete,uniaxial testing, compressive strength and Ansys.

I. INTRODUCTION

In recent decades the existing columns are undergoing retrofitting and which has become an indispensable requirement. Retrofitting of concrete columns by wrapping and bonding of fibre– reinforced plastic (FRP) sheets, straps, belts, or procured shells around the columns has become increasingly popular. Studies of concrete columns confined with glass, aramid, or carbon fibres have been used successfully to retrofit building columns, bridge or express way piers, and chimneys.

Glass fibre is a material consisting of numerous extremely fine fibers of glass. GFRC is concrete that uses glass fibres for reinforcement instead of steel. It is typically cast in a thin section of around 1/2" to 3/4". Since the fibres cannot rust like steel, there is no need for a protective concrete cover thickness to prevent rusting. With the thin, hollow construction of GFRC products, they can weigh a fraction of the weight of traditional precast concrete.

Glassmakers throughout history have experimented with glass fibres, but mass manufacture of glass fibre was only made possible with the invention of finer machine tooling. In 1893, Edward Drummond Libbey exhibited address at the incorporating glass fibres with the diameter and texture of silk fibres. This was first worn by the popular stage actress of the time Georgia Cayvan. Glass fibres can also occur naturally, as Pele's hair.

Glass wool, which is one product called fiberglass today, was invented in 1932–1933 by Russell Games Slayter of Owens-Corning, as a material to be used as thermal building insulation. .

Here is an investigation on the comparison of strengths obtained when glass fibres mixed with concrete as well as the glass fibre wrapping with the concrete columns to the results obtained from the analysis using ANSYS software. Compressive strength of columns are tested under the compression testing machine. The effectiveness of glass fibre in concrete is analysed. The compressive strength of concrete obtained from the experimental method is compared with the results obtained from software analysis.

II. METHODOLOGY

The methodology adopted for the present experimental investigation is as follows:

A. Literature Review

B. Selection Of Materials

- Cement(Ordinary Portland Cement), Blast Furnace Slag, Coarse Aggregate, Weathered crystalline Rock Sand as fine aggregate, Super Plasticizer.

C. Determination of Material Properties

- Cement:-Specific gravity, initial setting time, final setting time, standard consistency
- Glass fibre:- Physical and chemical properties, specific gravity
- Fine aggregate:- Specific Gravity, water absorption, sieve analysis, bulk density and percentage of voids
- Coarse Aggregate:-Specific gravity, water absorption, sieve analysis, aggregate crushing value
- Water
- Super Plasticizer

D. Preparation Of Specimen

- Preparation of M25 Mix
- Preparation of mix with coarse aggregate and fine aggregate and suitable proportion of cement and water.
- Preparation of concrete with different percentage of glass fibre.
- Cube of size 150×150×150mm, and cylinder of size300×150mm are casted to conduct test for compressive strength of mixes. Age for compressive strength is 3,7 and 28 days .

E. Laboratory Tests

- Study on fresh state properties by conducting slump and compaction factor test.
- Study of hardened state properties by conducting tests for Compressive strength and water absorption.

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III. MATERIAL CHARACTERIZATION

A. *Cement*

OPC 53 grade concrete was used in this study

TABLE.1 PROPERTIES OF CEMENT

Test	**Values**
Standard Consistency	35%
Initial Setting Time	240 min
Specific Gravity	3.125
Fineness	5%

B. *Fine Aggregate*

M-Sand was used for the study

TABLE.2 PROPERTIES OF FINE AGGREGATE

Test Conducted	Values Obtained
Specific Gravity	2.69
Fineness	2.59%
Water Absorption	1.5%
Bulk Density	1.13 kg/l
Percentage voids	54.44%
Water Content	2.2%

C. *Coarse Aggregate*

Coarse aggregate conforms to table 2 of IS 383-1970

TABLE.3 PROPERTIES OF FINE AGGREGATE

Test	Values
Specific Gravity	2.67
Fineness	7.45%
Water Absorption	0.8%
Bulk Density	1.25 kg/l
Percentage Voids	50.41%
Aggregate Crushing Value	28.66%

D. *Glass fibre*

TABLE.4 PROPERTIES OF GLASS FIBRE

Property	Value
Length	12 mm
Product form	Monofilament as a result of dispersal of fibres bundle on contact with moisture.
Aspect ratio	857:1
Number of fibres	>200million/kg
Specific surface area	105 m^2/kg
Typical addition rate	0.6kg/m^3 of concrete

E. *Super Plasticizer*

TABLE.5 PROPERTIES OF SUPER PLASTICIZER

Property	**Value**
Aspect	Light brown liquid
Relative Density	1.08 ± 0.01 at 25°C
pH	> 6
Chloride ion content	< 0.2%

IV. MIX DESIGN

A. *CONTROL MIX*

TABLE.6 MIX PROPORTION

Mix Proportion	
Cement	315.2 kg/m³
Water	179.64 kg/m³
Super Plasticizer	0.788 kg/m³
Fine Aggregate	880.9 kg/m³
Coarse Aggregate	1103.79 kg/m³

I. TEST FOR FRESH STATE PROPERTIES

TABLE.7 FRESH PROPERTIES OF CONCRETE

Test	**Control Mix**
Slump	110mm
Compaction Factor	0.934

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II.TEST FOR HARDENED STATE PROPERTIES

TABLE.8 RESULTS

Sl.No	Type	Age on testing	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
1	Control mix	3 days	12.44	12.82
2			12.44	
3			13.58	
4		7 days	16.97	*16.78*
5			16.97	
6			16.41	
7		28 days	17.54	17.16
8			16.41	
9			17.54	
1	0.1 % Glass fibre	3 days	13.86	12.82
2			12.16	
3			12.44	
4		7 days	14.14	14.70
5			14.14	
6			15.84	
7		28 days	18.10	17.06
8			17.82	
9			15.27	
1	0.15 % glass fibre	3 days	15.27	13.95
2			14.14	
3			12.44	
4		7 days	18.67	16.59
5			15.27	
6			15.84	
7		28 days	18.67	17.72
8			16.41	
9			18.10	
1	0.2 % glass fibre	3 days	23.76	23.57
2			22.63	
3			24.33	
4		7 days	28.86	29.04
5			28.86	
6			29.42	
7		28 days	38.48	38.10
8			38.48	
9			37.34	

V .EXPERIMENTAL TEST RESULTS

Compressive Strength of Wrapped Cylinders

The concrete cylinders after uniaxial testing are wrapped with glass fibre wrapping materials. The damaged cylinders are allowed for retrofitting using glass fibre wrapping and then the tests were conducted under uniaxial compression testing.

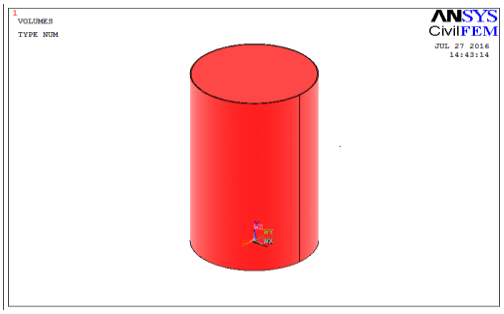
Figure 1 Wrapped concrete specimens

TABLE 9 COMPRESSIVE STRENGTH OF WRAPPED CYLINDERS

SL.NO.	**TYPE**	**Compressive strength (N/mm^2)**
1	Control mix (curing 7 days)	18.67
		17.54
		17.54
2	Control mix (curing 28 days)	26.59
		24.89
		25.46
3	0.1% glass fibre reinforcement	27.72
		27.72
		27.16
4	0.15% glass fibre reinforcement	28.86
		28.29
		28.29
5	0.2% glass fibre reinforcement	29.42
		29.99
		29.42

VI. ANALYTICAL STUDY

The numerical analysis investigations were performed with commercial software ANSYS Civil FEM. 12



2.Model of specimen

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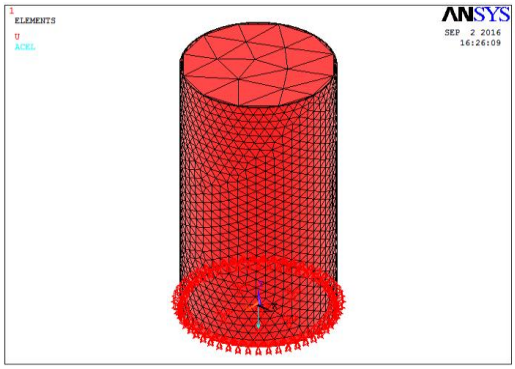
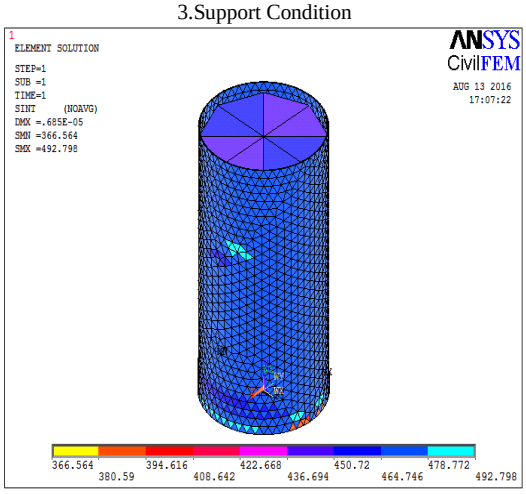
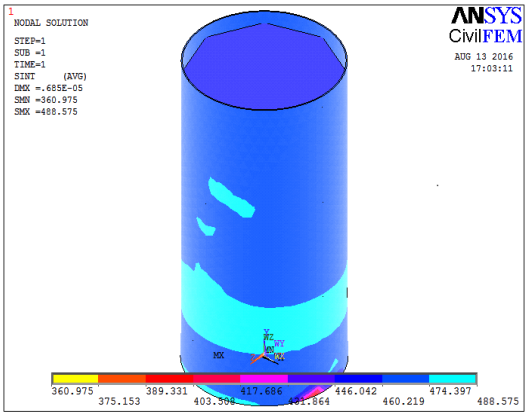


3.Support Condition



4.Elemental Stress intensity



5.Nodal stress intensity

TABLE 10 COMPARISON OF EXPERIMENTAL AND ANALYTICAL RESULT

Sl.NO.	TYPE	Experimental stress intensity (N/mm^2)	Software results	
			Elemental stress intensity	Nodal stress intensity
1	Control Mix 28 day curing	26.59	27.08	26.83
		24.89	25.81	25.14
		24.89	25.81	25.14
		17.54	17.82	17.71
		17.54	17.82	17.71
		18.67	18.9	18.82
2	0.1% of glass fibre	27.72	28.08	27.89
		27.72	28.08	27.89
		27.72	28.08	27.89
3	0.15%of glass fibre	28.86	29.20	29.02
		28.29	28.56	28.39
		28.29	28.56	28.39
4	0.2% of glass fibre	29.42	29.79	29.59
		29.99	30.35	30.15
		29.42	29.79	29.59

From the above results it is very clear that the results of both experimental and analytical analysis obtained are almost similar so that the results can be verified in both the cases.

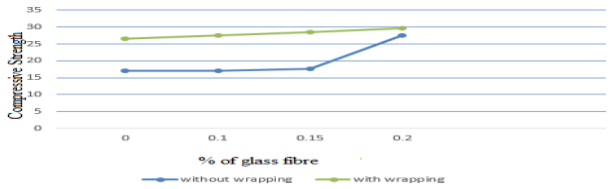


Figure 11 Comparison of compressive strength of cylinder with wrapping and without wrapping

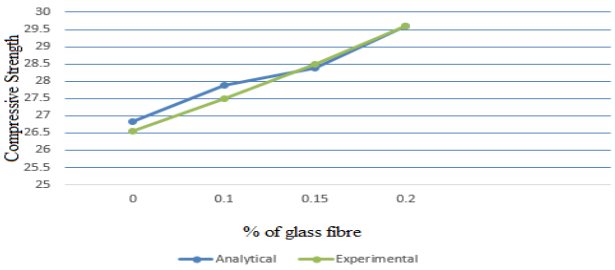


Figure 12 Comparison of compressive strength wrapped cylinders in experimental and analytical method

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VII.CONCLUSIONS

- With increase in the percentage of glass fibre the characteristic compressive strength of glass fibre also increased.
- The characteristic strength can be varied with the amount of glass fibre add to concrete mix.
- Glass fibre addition does not effect on workability of concrete.
- The experimental results as well as the analytical results are almost same in sense.
- Compressive strength of wrapped cylinders are higher than that of the cylinders without wrapping.
- By comparing results from both experimental and analytical methods the variation was very less and it is negligible.

VIII. REFERENCES

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