Comparitive Study Between The Strengths Of Ordinary Reinforced Concrete And Carbon Sheeted Reinforced Concrete

Dr.M.Mageswari[1] , M.Harika Reddy[2],R.Padma priya[3]
DEPT OF CIVIL ENGINEERING
PANIMALAR ENGINEERING COLLEGE

ABSTRACT

Increasing the strength of structure and maintaining it in a good condition with in its life time poses challenges for civil engineers. In recent decades, carbon fibers have found wide applications in construction field too to improve the strength. It is commonly used as reinforcement in the structures. Now a day need to repair and rehabilitate has increased a lot in every structure. So to reduce the maintenance and increase the strength of concrete Carbon fiber sheets can be used.., but our project is all about comparative study between the strengths of Ordinary reinforced concrete and Carbon fiber sheeted reinforced concrete where we use carbon fiber sheets stuck over the surface of members of the structure like beams columns etc…, to compare the strength variation between Ordinary and Carbon fiber sheeted reinforced concrete and by how much Carbon fiber sheets have increased the strength. By carrying out several tests the analysis of strength of both ordinary and carbon fiber sheeted reinforced concrete will be tested.

INTRODUCTION

Here we perform the main part of our project that is all experimentation, calculations, performing the manual works etc. of our project. The experiment and the process of work is carried out in a Test center mentioned below under the instructors supervision. In this section we look into the usage of materials, performing experiments, carrying out the work process and at last noting down the values of various tests performed with the desired results in the form of tables and graphs. The main focus is on the experimental process, materials and tests (both preliminary and main) to be performed.

MATERIAL DETAILS:

CEMENT:It is produced by heating limestone and clay to very high temperatures in a rotating kiln. Cement is produced by grinding the resulting clinker to a fine powder. The cement used in this project is 53 grade Ordinary Portland Cement. Ordinary Portland Cement (OPC) of 53grade is used.

AGGREGATES: Natural aggregates consist of sand, gravel, stones and crushed stone. Construction aggregates make up more than 80 percent of the total aggregates market and are used mainly for road base, rip rap, cement concrete and asphalt. They are usually described as inert "filler" material of either the fine (sand) or coarse (stone) variety. The shape, size density and strength of aggregate particles can vary significantly, and can therefore influence the properties of the concrete. Aggregate tends to represent a relatively high volume percentage of concrete, to minimize costs of the material. Aggregates are divided into two distinct categories fine and coarse.

FINE AGGREGATE: Sand purchased from local vendors. Sand passing through 4.75mm sieve is taken as fine aggregate.

COARSE AGGREGATE: Coarse aggregate passing through 40mm sieve and retained in 20mm sieve is taken, which is purchased from local vendors

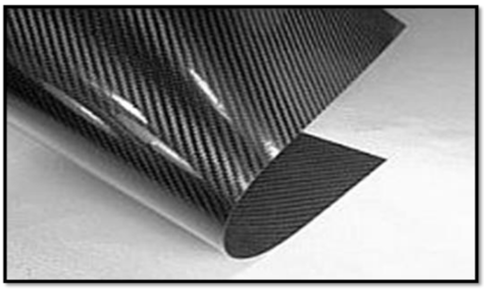
WATER:This reacts chemically with cement to form the cement paste, which essentially acts as the "glue" (or binder) holding the aggregate together. The reaction is an exothermic hydration reaction. The water: cement ratio is an important variable that needs to be "optimized". High ratios produce relatively porous concrete of low strength, whereas too low a ratio will tend to make the mix unworkable.Fresh wateristaken from the laboratory and the water cement ratio is taken as 0.5.

REINFORCEMENTS BARS:TOR steel bars of grade 415 is used,which is purchased from local vendors.

CARBON FIBRE SHEET: Carbon fiber sheets are ideally suited to applications where strength, stiffness, lower weight, and outstanding fatigue characteristics are critical requirements.

PROPERTIES:

Fiber orientation	-	Unidirectional
Weight of fiber	-	200 g/m^2
Density of fiber	-	1.80 g/cc
Fiber thickness	-	0.30mm
Ultimate elongation (%)	-	1.5
Tensile strength	-	3500 N/mm^2
Tensile modulus	-	285x103N/mm^2



LOKFIX:

It is cement and resin based product (Polyester resin anchoring grout) to fill the voids and pores in concrete.

PROPERTIES:

Chloride ion content	-	0.00%

Compressive strength	-	100MPa (28 days)
Flexural strength	-	19 MPa
Reaction to fire	-	Class B s1 d0
Tensile strength	-	11 MPa (28 days)

NITOWRAP 30, PRIMER:

It is used to give a glossy finish to the smoothened surface of the member.

PROPERTIES:

Density - 1.14 g/cc

Pot life - 25 min. @ 270C

Full cure - 7 day

Colour - Clear

NITOWRAP 30 PRIMER

NITOWRAP 410 PRIMER:

It is a saturant used to stick the carbon fiber sheets over smoothen surface of the member.

PROPERTIES:

Colour	-	Pale yellow to amber
Application temperature	-	150C - 400C
Viscosity	-	Thixotropic
Density	-	1.25 - 1.26 g/cc
Pot Life	-	2 hours at 300C

NITOWRAP 410 SOLVANT

BEAM DETAILS:

Size of beam – 150 mm x 150 mm x 700 mm

Number of beams – 12

- Ordinary reinforced concrete beam- 6
- Carbon fiber sheeted reinforced concrete beam - 6

Steel rods:Steel rods 4 numbers of 10 mm diameter bars in each beam are used

Stirrups: Size of stirrups is 5 numbers of 8mm diameters each of spacing 125mm c/c.

PRELIMINARY TEST CARRIED:

SPECIFIC GRAVITY TEST:

PROCEDURE:

Specific gravity tests are performed with the help of the pycnometer where a pycnometer glass bottle is initially weighed as W_1, filled with cement and weighed as W_2, kerosene is mixed well with cement up to the marking and weighed as W_3 and the bottle filled with only kerosene is weighed as W_4. Using these values the specific gravity is determined with formula.

Formula:

Specific gravity $=(W_2 - W_1)/ ((W_4 - W_1) - (W_3 - W_2))$

Sand - 2.51

Coarse Aggregate -2.67

Cement - 3.2

FINENESS TEST FOR CEMENT:

PROCEDURE:

100g of cement is sieved on IS 90 micron sieve by breaking the air set lumps. After 15 minutes of sieving the residue left in the sieve is weighed as calculated as fineness percentage

W_1 = Weight of cement taken

W_2 = Weight of cement retained in 90 micron sieve **Formula:**

Fineness percentage $= (W_2/W_1) \times 100$

= 7 %

TESTS ON CONCRETE:

SLUMP CONE TEST:

PROCEDURE:

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. Workability of concrete is mainly affected by consistency i.e. wetter mixes will be more workable than drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches. The test is carried out using a mould known as a slump cone or Abrams cone. The cone is placed on a hard non-absorbent surface. This cone is filled with fresh concrete in three stages, each time it is tamped using a rod of standard dimensions. At the end of the third stage, concrete is struck off flush to the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone. Concrete subsides. This subsidence is termed as slump, and is measured in the scale and the height is noted in mm It is carried out to find the consistency of concrete.As per the code IS 456-2000 the consistency of the concrete is calculated from the height of the slump.

COMPACTION FACTOR TEST:

PROCEDURE:

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test. The sample of concrete is placed in the upper hopper up to the brim and trap-door is opened so that the concrete falls into the lower hopper. The trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades. The concrete in the cylinder is weighed. This is known as weight of partially compacted concrete. The cylinder is filled with a fresh sample of concrete and vibrated to obtain full compaction. The concrete in the cylinder is weighed again. This weight is known as the weight of fully compacted concrete. This test works on the principle of determining the degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height.

PROCESS OF WORK:

PROCEDURE :

The initial procedure and steps are the same as in normal casting of a beam. First of all, the beam moulds are prepared then iron rods for reinforcement are prepared and installed. Then the three admixtures Cement, Sand and Coarse aggregate are mixed to get a M_{20} grade concrete in proper ratios. After concrete is ready it is poured into the moulds installed with iron rods of 10mm diameter size and the moulds are brought to proper finishing look after being compacted nicely both with hands and vibrators. After 24 hours the moulds are dismantled and are kept in curing tank for 15 days. After 15 days of curing all the moulds are taken out of the curing tank and are kept for drying till 28th day and till then Carbon fiber reinforced sheets (CFRS) are cut into suitable lengths and primers both Nitowrap 30 Primer and Nitowrap 410 Solvant are also bought. One or two days before 28th day the surface of beams on which CFRS is to be stickedis smoothened using grinding machine. After grinding machine is used over the surface few pores and holes are seen which is filled using Lokfix and filler. Then Nitowrap 30 Primer is spread all over the smoothened surface to give it a glossy look and the beams are left for 24 hours of drying. After 24 hours of drying CFRS is sticked on the glossy surface using Nitowrap 410 Solvant. After CFRS is sticked over the surfaces of the beams then experimental tests are performed and the values are noted down. Then a comparative study for beams with and without CFRS is carried out.The step by step process which we have done is explained below: a.Mould of beam used to prepare beam: These are the moulds prepared by us for our project. The size of each beam is 150x150x750 mm. Totally 12 numbers of beams were prepared. Then rodsfor reinforcement were prepared and installed with suitable size of stirrups.Then concrete of grade M20 was prepared with proper ratios of the admixtures (Cement, Sand and Coarse aggregate). After concrete is prepared, it is poured into the moulds to get RMC beams. **b. Beam after it is taken out of mould: c.Curing process**: This shows the beams kept inside the Curing tank. After 15 days of curing the beams are taken out and are kept for drying till 28th day. One or two days before the 28th daythe beams over which Carbon fiber Sheets are to be sticked are taken out separately. The later process is explained next. **d.Surface smoothening process:**

The surfaces of 6 beams taken out separately to stick Carbon fiber sheets over it are smoothened using grinding machine. After smoothening the surfaces pores and holes are seen on the surfaces.

e. After filling the pores with lokfix.

The pores and holes seen on the smoothened surfaces of beams are filled with Lokfixand filler to give a plain surface to apply Nitowrap 30 Primer.

f.Application of nitowrap30 primer:

After filling the pores with Lokfix and filler, Nitowrap 30 Primeer is applied All over the smoothened surfaces of the beams. Nitowrap 30 Primer gives a glossy look to the surface.

g. Nitowrap 30 Primer provides a glossy look to the surface over which it is applied that is the smoothened and filled surfaces of beams. Then the beams are left for one dayfor drying.

h. Application of carbon fiber sheet:

After the beams are left for drying Carbon fiber sheets are cut into the size of smoothened surfaces of the beams i.e. – 150 x 700 mm and are sticked over it using Nitowrap 410 solvant.

1) Flexure test for beam with Carbon fiber sheets:

Placing of beam

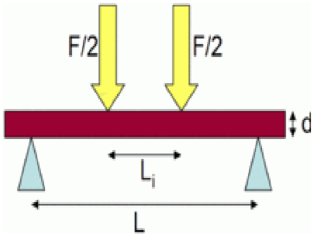
Beam starting to develop cracks at loads

The above pictures both left and right shows the placing ofCarbon fiber sheeted concreteand also shows the development of cracks at various loads.Flexure test for beam without Carbon Fiber Sheet:The above pictures both left and right shows the placing of RMC and also shows the development of cracks at various loads and how it breaks at the Ultimate load.

FLEXURAL TEST:

.**Flexural strength**, also known as **modulus of rupture**, **bend strength**, or **fracture strength** a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol σ.

Sample number	Peak or ultimate load (KN)	Flexural strength (N/mm^2)
Sample 01	80.07	14.23
Sample 02	77.95	13.85
Sample 03	79.10	14.06



The above diagram shows who the **Two point load** acts beam

$$\sigma = \frac{3F\,(L - L_i)}{2bd^2}$$

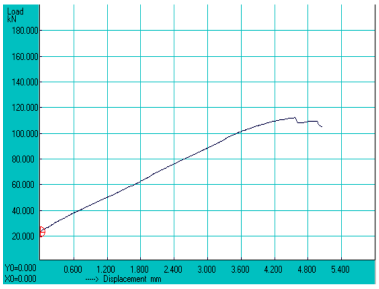
Sample Number	Peak or ultimate load(KN)	Flexural strength (N/mm^2)
Sample 01	111.15	19.76
Sample 02	112.25	19.96
Sample 03	97.80	17.39

Formula to find flexural strength

- Beam with 10mmdiameter rod flexural test without **CFRP** (2 numbers of 10mm diameter rod provided at tension zone)
- Beam with 10mm diameter rod flexural test with **CFRP** (2 numbers of 10mm diameter rod provide at tensionzone)

DEFLECTION TEST:

Reinforced concrete under service load cracks. Concrete in the tension zone ceases to provide strength (and

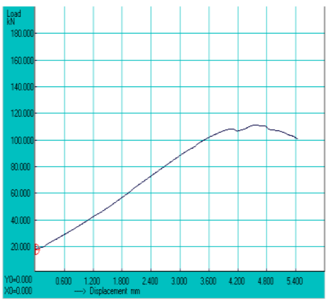


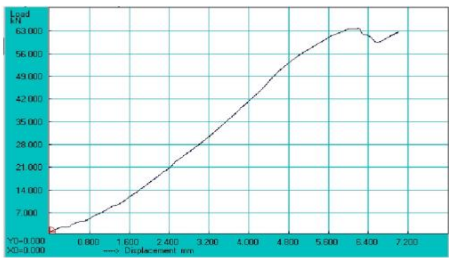
stiffness, via the Moment of Inertia) and the beam actually becomes less stiff. The Moment of Inertia of a cracked section might be a fourth, or fifth, or less, of an un-cracked section. And so, at least at that section, the beam is a fourth, or fifth, or so, as stiff. But not our entire beam is that cracked.The test procedure is same as flexural test. The only difference being the dial gauge, which is kept near the beam just touching it. With the varyingload on the beam there is deflection on beam which can be seen on the dial gauge. When the load reaches its peak there is a indication just before the beam breaks, simultaneously the deflection on the dial gauge is noted. The values are obtained in the form of graph using software which is installed in the system which is attached to the UTM.

DEFLECTION for Beam Sample-01with **CFRP:**

The graph is between Load and Displacement.Where Load is in "KN" and Displacement in "mm"The graph is obtained from the varying load on the beam and the deflection that occurs in

From the above graph we get the following values: ULTIMATE LOAD =111.150 KN DEFLECTION =4.53mm





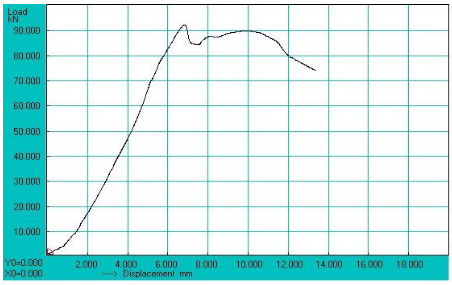
DEFLECTION for Beam Sample-02with**CFRP:**

The graph is between Load and Displacement. Where Load is in "KN" and Displacement in "mm" The graph is obtained from the varying load on the beam and the deflection that occurs in the beam with the respective loads

From the above graph we get the following values: ULTIMATE LOAD =112.250 KN DEFLECTION =4.56mm

DEFLECTION for Beam Sample-03 with **CFRP:**

The graph is between Load and Displacement. Where Load is in "KN" and Displacement in "mm"The graph is obtained from the varying load on the beam and the deflection that occurs in the beam with the respective loads From the graph we get the following values: ULTIMATE LOAD =92.15 KN DEFLECTION =6.80mm

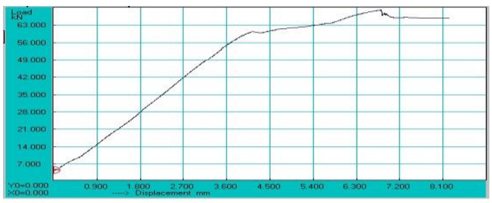


DEFLECTION for Beam Sample-01 without **CFRP:**

The graph is between Load and Displacement.Where Load is in "KN" and Displacement in "mm"The graph is obtained from the varying load on the beam and the deflection that occurs in the beam with the respective loads From the graph we get the following values: ULTIMATE LOAD =63.85 KN DEFLECTION =6.190mm

DEFLECTION for Beam Sample-02 without **CFRP:**

The graph is between Load and Displacement. Where Load is in "KN" and Displacement in "mm"The graph is obtained from the varying load on the beam and the deflection that occurs in the beam with the respective loads From the above graph we get the following values: ULTIMATE LOAD =69.10 KN DEFLECTION =6.80mm



CONCLUSION:

Thus, comparative study between the strengths of Ordinary reinforced concrete and Carbon fiber sheeted reinforced concreteand the increase in strength due to usageofcarbon fiber is plotted in graphs.

Reference:

1. Basanbul, I.A., Gubati, A., Al-Sulaimani, G.J., and Baluch, M.H. (1990), "Repaired Reinforced Concrete Beams," ACI Material Journal, Vol. 87, No. 4, August, pp. 348-354.

2. Lub and Van Wainroi (1989), "Test on Strengthening of RC Beam by Using Shotcrete Ferrocement," Journal of Ferrocement, Vol 19, No. 4, October, pp. 363-370.

3. Masukawa, J., Akiyama, H., and Saito, H. (1997), "Retrofitted of Existing Reinforced Concrete Piers by Using Carbon Fiber Sheet and Aramid Fiber Sheet", Proceedings of the Third International Symposium on Non-Metallic (FRP) Reinforcement for Concrete Structures, October, pp. 411-418. 8]