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# EXPERIMENTAL STUDY ON EFFECT OF GEO-SYNTHETIC FIBRE ON CONCRETE STRENGTH

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**ABSTRACT -** Geosynthetics is the term used to portray a scope of by and large polymeric items used to tackle structural building issues. Geosynthetics are accessible in an extensive variety of structures and materials, each to suit a marginally unique end utilize, they additionally deliver more noteworthy protection from effect, scraped spot and splitting of solid structures.

The purpose of the study is to investigate the strength variation at different percentage of fibers by comparing the results with that of conventional concrete. The fundamental point of the task is to consider the increase in percentage of concrete strengths and obtain optimum percentage of fiber that can be used in the practice.

**Keyword — Geosynthetic fiber (Geonets), Compressive strength and Tensile strength, water absorption, Cost analysis**

## 1. INTRODUCTION

Geo-synthetics have become very good established construction materials for dam construction, bridges, environmental, geotechnical and other construction purposes. Because of their improving properties it is used worldwide and Now a days it has been utilized to carryout to solve each and every critical problem in engineering aspects. The results and research are carried out by various fields and the development of this new technique is carried out. Because of it is significant application of Geo-synthetics this paper focuses on the development of its application in constructions field as the replacement to the steel used in the concrete as a reinforcement.

## 1.1 PROPERTIES OF GEOSYNTHETIC FIBER

Geosynthetic are sheets of malleable components with a standard system of openings, for the most part developed of polyethylene. The most well-known utilize is for fortification of precarious soil and waste masses. Geo-synthetics are engineered items used to balance out landscape. They are for the most part polymeric items used to take care of structural designing issues. This incorporates 8 primary items classifications:- geotextiles, Geo-networks, Geo-nets, Geo-layers, Geosynthetic earth liners, Geo-rage, Geo-cells and Geo-composites. The polymeric idea of the items makes them appropriate for use in the ground where elevated amounts of solidness is required. They can be utilized in uncovered required; they are likewise accessible in extensive variety of structures and materials. Geo-nets/Geo-spacers related by some comprise another particular portion inside the Geo-synthetics. They are framed by the consistent zone, expulsion of parallel arrangements of polymeric ribs at intense edges to each other. They share two composes most practically speaking biplanar or triplanar. They comprises of stub bed, dimpled or cuspate polymer sheets three 3D systems of firm polymer strands in various arrangement and little seepage pipe or spacer inside geotextiles. Fiber supported security (FRC) is concrete containing stringy material which builds up its significant trust esteem. It contains short fibers that are dependably appropriated and erratically arranged. Filaments combine steel strands, glass strands, created strands and typical strands. Inside these indisputable strands that character of filaments strengthened solid changes with fluctuating cements, filaments materials, geometries, dispersing, introduction and densities.The certainties affirm that bond concrete have a low inflexibility. Confined flexibility and little security from breaking. Internal little scale breaks are naturally present in the strong and its poor inflexibility is a direct result of spread of such littler scale parts, at last inciting frail split of the strong. In the past undertaking has been made to import improvement in versatile properties of strong people by strategy for using conventional sustained steel bars and moreover by applying controlling procedures. But both these techniques offer unbending nature to the strong people, they in any case don't grow the inborn versatility of strong itself.

## 1.2 EFFECT OF FIBERS IN CONCRETE

Strands are commonly used in bond to control plastic shrinkage breaking and drying shrinkage part. They in like manner cut down the permeability of concrete and along these lines diminish leaking of water. A couple of sorts of strands make more conspicuous impact, scratched spot and crush restriction in concrete. Two or three strands diminish the idea of bond. The extent of strands included to a blend is assessed as a dimension of the aggregate volume of the composite named volume part. Volume part routinely extends from 0.1% to 3%. Point of view degree (l/d) is figured by isolating the fiber length by its width. Fiber with a non-winding cross territory with a proportionate width for the estimation of point of view degree. In case the modulus of adaptability of the fiber is higher than the blend, they help to pass on the pile by growing the versatility of the material.

Augmentation in the perspective extent of the fiber generally fragments of flexural quality and sturdiness of the mix. Some steady examination shown that using strands in bond has obliged impact on the impact obstacle of strong materials. The results furthermore pointed out that the little scale strands is better in this way restriction isolated and the more drawn out fibers.

## 2. MATERIALS

### 2.1 CEMENT

**Figure 3.2 Cement utilized**

In this present work Ordinary Portland was utilized for the solid blends. The bond is new and free from lumps. The testing of concrete was completed dependent on IS 1489, 1991. The specific gravity of the concrete was discovered 3.05

### 2.2 FINE AGGREGATE

The fine aggregates used in this work is locally available river sand with the maximum of 4.75 mm size as per the IS 383-1970 . The particular gravity of the example is 2.51, water ingestion is 1.0% and fineness modulus is 2.59.

### 2.3 COARSE AGGREGATE

The coarse aggregate utilized in this work is locally accessible coarse total with the Most extreme of 20 mm estimate according to the IS 383-1970. The particular gravity of the example is 2.70, water assimilation is 0.66% and fineness modulus is 7.04.

### 2.4 GEOSYNTHETIC FIBER

The fiber used in this work is brought from the supplier. The specific gravity of the Fiber sample is 1.050 and discrete fibers are used with 1.12 mm diameter, 60 mm length and the aspect ratio of 54.

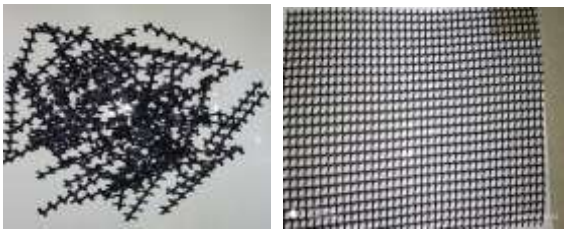


**Figure 3.3: Geo-synthetic fiber**

### 2.5 Water

The water utilized for the readiness of bond solid blend is crisp, perfect and free from any unsafe substances and it will agree to all benchmarks affirming to IS 456:2000

### 2.6 CURING

The cubes and cylinders were kept in water (ponding) for curing upto 28days . After the curing period the specimen was taken out and the testing procedure was carried out

**Figure 3.4 Specimens after curing**

## 3 MIX DESIGN AND MIX PROPORTION

For every concrete work mix of M25 was designed based mix design is the most important preliminary work.

Grade of concrete : M25

Cement : OPC 53 grade

Target strength : f'ck + 1.65 s = 31.8 KN/m$^2$.

Cement content : 426.12 kg/m$^3$

Water-cement ratio : 0.45 (191.6 liter/m$^3$)

Fine aggregate content (sand) : 524.68 kg/m$^3$

Coarse aggregate content : 1172kg/m$^3$.

| Grade | Cement | Fine aggregate | Coarse aggregate | Water |
|---|---|---|---|---|
| **M25** | **1** | **1.23** | **2.48** | **0.45** |

**Table 3.1: DESIGN MIX PROPORTIONS**

Four different mixes are prepared by varying the percentage of Geosynthetic fiber in cement concrete. Four set of mixes are prepared by adding 0.5%, 1%, 1.5%, & 2% of weight Geosynthetic fiber respectively.

CMG – Conventional concrete Mix + Geosynthetic Fiber

**Table 3.2 Mix designation along with variation of Fiber content**

| Mix designation | Description |
|---|---|
| CM | Conventional concrete Mix |
| CMG 1 | CM+0.5% Geosynthetic Fiber |
| CMG 2 | CM+1% Geosynthetic fiber |
| CMG 3 | CM+1.5% Geosynthetic fiber |
| CMG 4 | CM+2% Geosynthetic fiber |

## 4 CHARACTERISTICS OF CEMENTING MATERIALS

This helps us to interpret the nature and behavior of the cementing materials before going for the actual work as well as its experimental use.

## 4.1 PHYSICAL PROPERTIES OF CEMENT

Physical properties of cementing materials play a very crucial role during the production and manufacturing of concrete as well as its quality control. Hence it is very much necessary to test the physical properties before the actual mix design starts.

The testing of cement was carried our based on IS1489 (part I). The specific gravity of the cement was found 3.01

**Table 3.3 Physical Pr0perties of 0rdinary P0rtland cement**

| Sl No. | Particulars | Results obtained based on the experiment | As per standard |
|---|---|---|---|
| 1 | Specific gravity | 3.01 | 3.2 |
| 2 | N0rmal c0nsistency (%) | 32 | 28-35 |
| 3 | Initial setting time | 34 | N0t less than 30 minutes |
| 4 | Final setting time | 540 | N0t more than 600 minutes |

## 4.2 CHARACTERISTICS OF FINE AGGREGATES

The fine totals utilized in this work is locally accessible stream sand with the most extreme of 4.75 mm size and it has a place with Zone II according to the IS 383-1970. The particular gravity of the example is 2.51

**Table 3.4 Gradation/ Sieve analysis of fine aggregate**

| IS Sieve size | Weight retained( grams) | Cumulative weight retained( grams) | Cumulative percentage weight retaine | Cumulative percentage passing |
|---|---|---|---|---|
| 4.75mm | 07 | 07 | 1.4 | 98.6 |
| 2.36mm | 08 | 15 | 03 | 97 |
| 1.18mm | 108 | 123 | 24.6 | 75.4 |
| 600micron | 81 | 204 | 40.8 | 59.2 |
| 300micron | 243 | 447 | 89.4 | 10.6 |
| 150micron | 52 | 499 | 99.8 | 0.2 |
| Pan | 01 | 500 | 100 | 0 |

## 4.3 CHARACTERISTICS OF FINE AGGREGATES

The Coarse totals utilized in this work is locally accessible coarse total with the most extreme of 20 mm estimate according to the IS 383-1970. The particular gravity of the example is 2.70, water ingestion is 0.65%.

**Table 3.5 Gradation/ Sieve analysis of coarse aggregate**

| IS Sieve size | Weight retained(grams) | Cumulative weight retained(grams) | Cumulative percentage weight retained | Cumulative percentage passing |
|---|---|---|---|---|
| 80mm | 0 | 0 | 0 | 0 |
| 40mm | 0 | 0 | 0 | 100 |

| | | | | |
|---|---|---|---|---|
| 20mm | 750 | 750 | 15 | 85 |
| 10mm | 3923 | 4673 | 93.46 | 6.54 |
| 4.75mm | 289 | 4962 | 99.24 | 0.76 |
| 2.36mm | 289 | 4962 | 99.24 | 0.76 |
| 1.18mm | 289 | 4962 | 99.24 | 0.76 |
| 600micron | 289 | 4962 | 99.24 | 0.76 |
| 300micron | 289 | 4962 | 99.24 | 0.76 |
| 150micron | 289 | 4962 | 99.24 | 0.76 |
| Pan | 38 | 5000 | 100 | 0 |

## 5 EXPERIMENTAL INVESTIGATIONS

Testing of prepared concrete cubes and cylinders are done as per IS 516:1959,. The results should be as per the standard specified limits. No less than three examples, ideally from various bunches, will be made for testing at each chosen age. The result analysis of the work carried is play an very important role for judging the work done.

### 5.1 DIFFERENT TESTS CONDUCTED

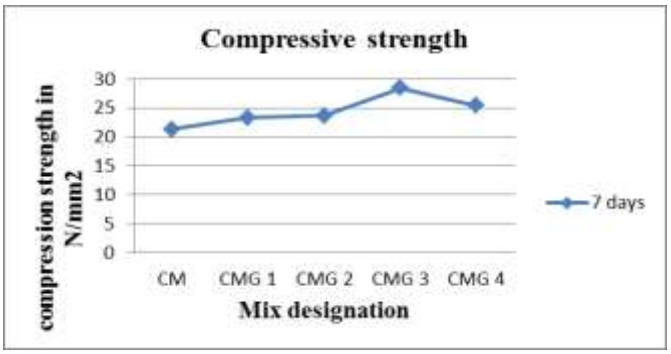
The following tests are conducted to determine the efficiency of the specimen. They are listed below.

1) Destructive test
   i) Compressive strength test
   ii) Tensile strength test
2) Non- destructive test
   i) Rebound hammer test
3) Water absorption test

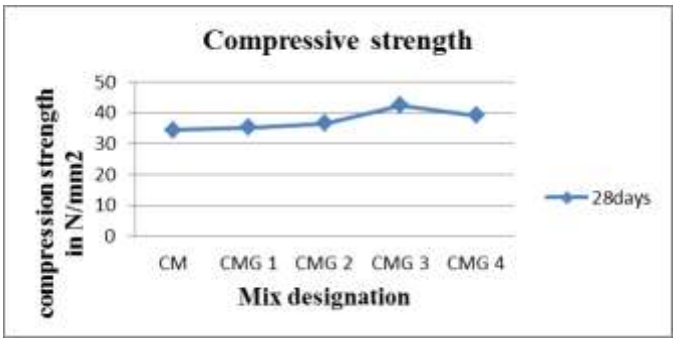
### 5.1.1 COMPRESSIVE STRENGTH TEST

**Table 4.1 Compressive strength of concrete cubes at the age of 7 & 28 days**

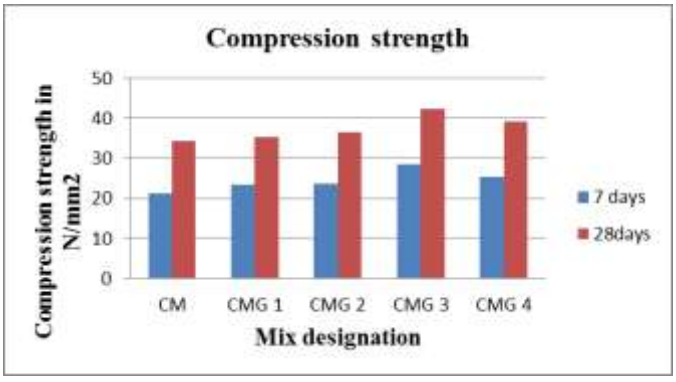
| Mix designation | 7 days compressive strength(N/mm²) | 28days compressive strength(N/mm²) | Fiber composition |
|---|---|---|---|
| **CM** | 21.33 | 34.44 | 0 |
| **CMG 1** | 23.33 | 35.2 | 0.5 |
| **CMG 2** | 23.64 | 36.62 | 1 |
| **CMG 3** | 28.44 | 42.44 | 1.5 |
| **CMG 4** | 25.42 | 39.2 | 2 |




**Graph 4.1 Compression strength for 7 days curing**




**Graph 4.2 Compression strength for 28 days curing**




**Graph 4.3Compression strength for 7 & 28 days of curing**

**Discussion**

The quality parameters in the compressive quality of cement for 7days and 28 days are appeared in the above diagrams. From the chart we can take note of that the compressive

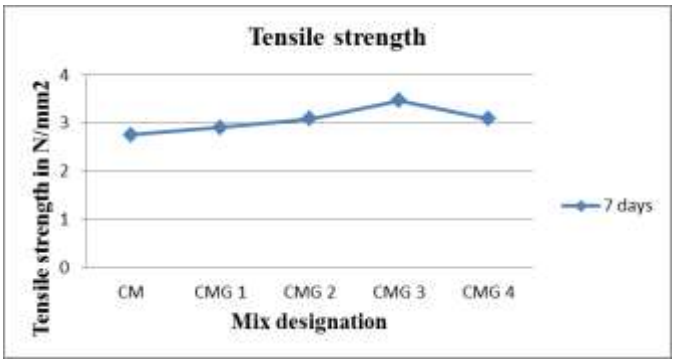
quality increments with 1.5% expansion of Geo-manufactured fiber and further expansion prompts diminish in the compressive quality.

### 5.1.2 TENSILE STRENGTH TEST

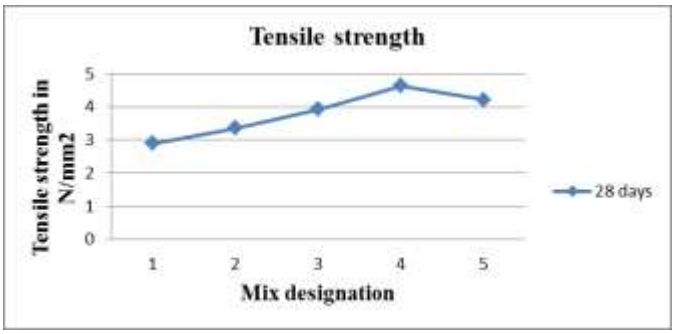
The solid is solid in pressure however frail in strain, so to enhance its elasticity pressure material to be included before cement is setting or while blending. Here in this work Geo-synthetic discrete fiber is used as tensile material. Usually in laboratory split tension test is conducted to check its tensile capacity. The Compressive testing machine (CTM) having 200 ton limit was utilized to decide the quality of solid chambers.

**Table 4.2 Tensile strength of concrete cubes at the age of 7 & 28 days**

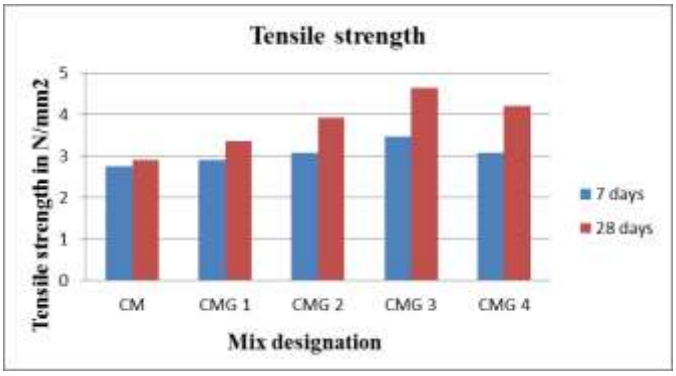
| Mix designation | 7 days tensile strength(N/mm$^2$ ) | 28 days tensile strength (N/mm$^2$) | Fiber composition |
|---|---|---|---|
| **CM** | 2.75 | 2.90 | 0 |
| **CMG 1** | 2.90 | 3.36 | 0.5 |
| **CMG 2** | 3.08 | 3.93 | 1 |
| **CMG 3** | 3.46 | 4.64 | 1.5 |
| **CMG 4** | 3.08 | 4.21 | 2 |




**Graph 4.4: Tensile strength for 7 days**




**Graph 4.5: Tensile strength for 28days**




**Graph 4.6: Tensile strength for 7 & 28 days**

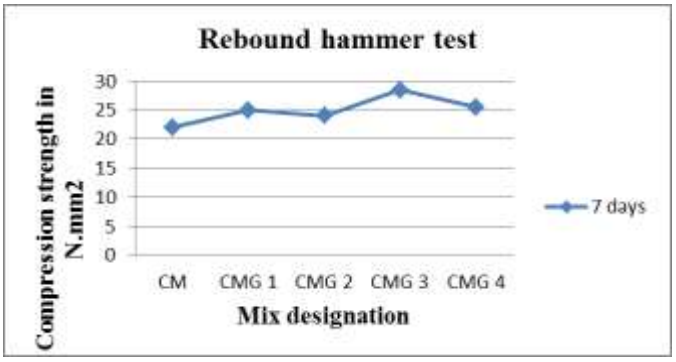
**Discussion**

The strength parameters in the split tensile strength of concrete for 7days and 28 days is shown in the above graphs. From the graph we can note that the split tensile strength increases with 1.5% addition of Geo-synthetic fiber and further addition leads to decrease in the tensile strength of concrete.

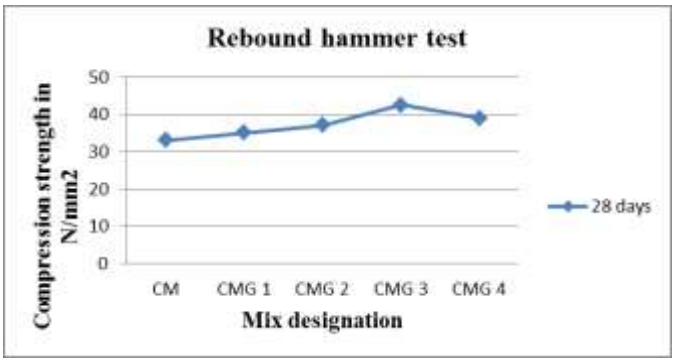
### 5.1.3 REBOUND HAMMER TEST

**Table 4.3 Rebound hammer test for cubes**

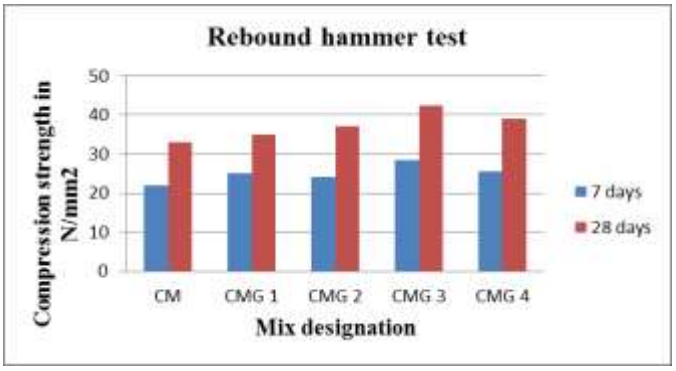
| Sample no. | Rebound number for 7days curing(vertical) | Rebound number for 28days curing(vertical) | Compression strength( Mpa) 7 days ( curing ) | Compression strength( Mpa) 28 days (curing ) |
|---|---|---|---|---|
| **CM** | 26 | 32 | 22 | 33 |
| **CMG 1** | 27.5 | 34 | 25 | 35 |
| **CMG 2** | 27 | 35.5 | 24 | 37 |
| **CMG 3** | 30 | 38.5 | 28.5 | 42.5 |
| **CMG 4** | 28 | 36.5 | 25.5 | 39 |




**Graph 4.7: Compression strength on 7 days curing**




**Graph 4.8: Compression strength on 28 days curing**




**Graph 4.9: Compression strength on 7&28 days curing**

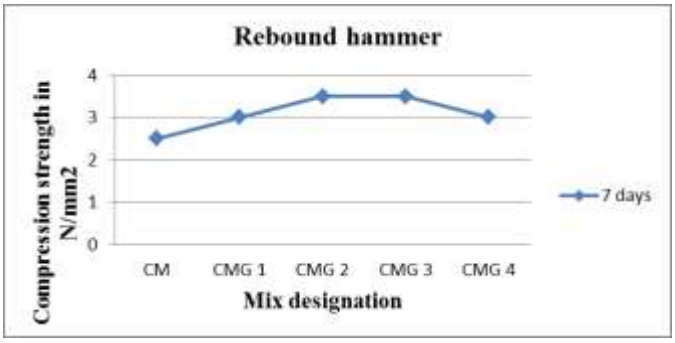
**Discussion**

The above graph shows the Rebound hammer test results for the addition of Geo-synthetic fiber to the concrete mix. From the results obtained it is found that mix containing 1.5% of Geo-synthetic fiber is having optimum strength values for concrete cubes.

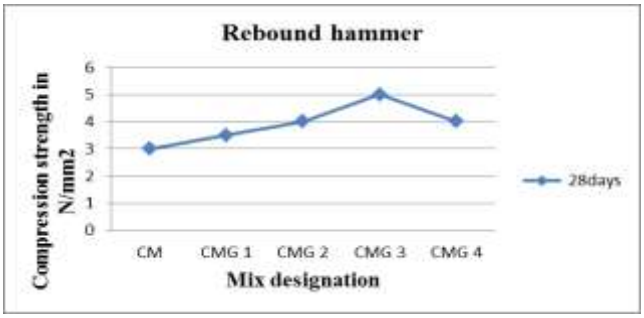
### 5.1.4 Rebound hammer test for cylinder

**Table 4.4 Rebound hammer test for cylinder**

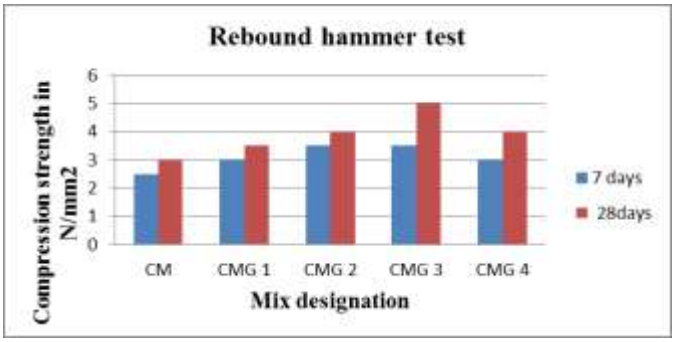
| Sample no | Rebound number for 7days curing(vertical) | Rebound number for 28days curing (vertical) | Compression strth (Mpa) 7days | Compression strength( Mpa) 28days |
|---|---|---|---|---|
| **CM** | 8 | 8.5 | 2.5 | 3 |
| **CMG 1** | 8.5 | 9 | 3 | 3.5 |
| **CMG 2** | 9 | 10 | 3.5 | 4 |
| **CMG 3** | 9 | 12 | 3.5 | 5 |
| **CMG 4** | 8.5 | 10 | 3 | 4 |




**Graph 4.10 Compression strength of cylinder on 7 days curing**




**Graph 4.11 Compression strength of cylinder on 28days curing**




**Graph 4.12: Compression strength of cylinder on 7&28 days curing**

**Discussion**

The above graph shows the Rebound hammer test results for the addition of Geo-synthetic fiber to the concrete mix. From the results obtained it is found that mix containing 1.5% of Geo-synthetic fiber is having optimum strength values for concrete cylinders

### 5.1.5 WATER ABSORPTION TEST

In this particular test, the dry mass of the cube sample with a dimension 0.15m is noted down and those specimens were submerged into water for 24 hours. In the wake of submerging for 24 hours these examples were then expelled from the water and afterward the examples were gauged, before gauging the wet examples they were surface dried and afterward they were gauged. The water absorption is then calculated By using the below formulae

**Table 4.5: Water absorption test results for cubes**

| Sl No. | Mix designation | Fiber percentage (%) | Dry weight of specimen | Wet weight of specimen | Water absorption (%) |
|---|---|---|---|---|---|
| 1 | CM | 0 | 8.22 | 8.32 | 1.21 |
| 2 | CMG1 | 0.5% | 8.28 | 8.36 | 0.96 |
| 3 | CMG2 | 1 | 8.32 | 8.42 | 1.20 |
| 4 | CMG3 | 1.5 | 8.42 | 8.48 | 0.71 |
| 5 | CMG4 | 2 | 8.37 | 8.46 | 1.07 |

**Table 4.6: Water absorption test results for cylinder**

| Sl No. | Mix designation | Fiber percentage (%) | Dry weight of specimen | wet weight of specimen | Water absorption (%) |
|---|---|---|---|---|---|
| 1 | CM | 0 | 16.76 | 16.82 | 0.36 |
| 2 | CMG1 | 0.5 | 16.78 | 16.85 | 0.42 |
| 3 | CMG2 | 1 | 16.82 | 16.88 | 0.35 |
| 4 | CMG3 | 1.5 | 16.92 | 16.8 | 0.35 |
| 5 | CMG4 | 2 | 16.84 | 16.92 | 0.47 |

**Discussion**

From the results it can be seen that as the additional percentage of Geo-synthetic fiber increases the water absorption decreases up to certain limit, on further increment in the addition percentage the water absorption percentage increases. Hence from the results it can be concluded that the addition of Geo-synthetic fiber reduces the percentage of water absorption up to certain limit of concrete.

## 6. COST COMPARISON OF GEO-SYNTHETIC CONCRETE WITH CONVENTIONAL CONCRETE

In the present work cost analysis is carried for conventional concrete and Geo-synthetic fiber reinforced concrete. The cost difference is checked between these two mixes. Cost of the material used in the work is shown in table 4.7

**Table 4.7: Cost of the materials used in present work**

| Sl.No | Materials | Unit | Cost(Rs) |
|---|---|---|---|
| 1 | Cement | Rs/Bag | 350.00 |
| 2 | Fine aggregate | Rs/$m^3$ | 800.00 |
| 3 | Coarse aggregate | Rs/$m^3$ | 1800.00 |
| 4 | Geo-synthetic fiber | Run metre | 70.00 |

The result shows that cost of Geo-synthetic fiber concrete is higher than conventional concrete

### 6.1 COST ANALYSIS FOR 1M³

Mix proportion 1:1.29:2.23

**Table 4.8: Cost of Conventional concrete(CC)**

| Sl.NO | Materials | Quantity(Kg/m³) | Cost(Rs) |
|---|---|---|---|
| 1 | Cement | 492.5 | 3447.5 |
| 2 | Fine aggregate | 634.5 | 380 |
| 3 | Coarse aggregate | 1098.97 | 1275 |
| **Total cost of 1m³** | | | **5102.5** |

**Table 4.9: Cost of one conventional concrete cube**

| Sl.No | Materials | Quantity(Kg/m³) | Cost (Rs) |
|---|---|---|---|
| 1 | Cement | 1.66 | 11.62 |
| 2 | Fine aggregate | 2.41 | 1.26 |
| 3 | Coarse aggregate | 3.70 | 4.29 |
| **Total cost** | | | **17.17** |

**Table 4.10: Cost of one conventional concrete cylinder**

| Sl.No | Materials | Quantity(Kg/m³) | Cost (Rs) |
|---|---|---|---|
| 1 | Cement | 2.60 | 18.26 |
| 2 | Fine aggregate | 3.36 | 1.75 |
| 3 | Coarse aggregate | 5.83 | 6.77 |
| **Total cost** | | | **26.78** |

### 6.2 COST ANALYSIS OF 1M³ GEO-SYNTHETIC FIBER CONCRETE

**Table 4.11: Cost of Geo-synthetic fiber concrete**

| Sl.NO | Materials | Quantity(Kg/m³) | Cost(Rs) |
|---|---|---|---|
| 1 | Cement | 492.5 | 3447.50 |
| 2 | Fine aggregate | 634.5 | 380.00 |
| 3 | Coarse aggregate | 1098.97 | 1275.00 |
| 4 | Geo-synthetic fiber | 11.13Kg | 2000.00 |
| **Total cost** | | | **7102.5** |

**Table 4.12 Cost of Geo-synthetic fiber concrete cube**

| Sl.NO | Materials | Quantity(Kg/m³) | Cost(Rs) |
|---|---|---|---|
| 1 | Cement | 1.66 | 11.62 |
| 2 | Fine aggregate | 2.41 | 1.26 |
| 3 | Coarse aggregate | 3.70 | 4.29 |
| 4 | Geo-synthetic fiber | 390grams | 6.85 |
| **Total cost** | | | **24.02** |

**Table 4.13 Cost of Geo-synthetic fiber concrete cylinder**

| Sl.NO | Materials | Quantity(Kg/m³) | Cost(Rs) |
|---|---|---|---|
| 1 | Cement | 2.60 | 18.26 |
| 2 | Fine aggregate | 3.36 | 1.75 |
| 3 | Coarse aggregate | 5.83 | 6.77 |
| 4 | Geo-synthetic fiber | 598grams | 10.74 |
| **Total cost** | | | **37.52** |

## CONCLUSIONS

- The following conclusion is from the present investigation carried out for the different percentage of fiber added for the concrete in replacement of steel as reinforcement. It gives much better results for the controlled mixes.
- By the observed result it shows much better improvement for the fiber addition up to 1.5%. At each level when increases the fiber contents it shows better compressive as well as the tensile strengths.
- It also shows that as the percentage of fiber increases the slump value decreases gradually. Hence it improves its strength by increasing the percentage of fiber up to certain limits then it may fall. Because of higher the percentage fiber the voids become lesser and concrete obtained is more compact.
- In this present work Compression strength increases up to 42.44 N/mm² for addition of 1.5% Geo-synthetic fiber and tensile strength increases up to 4.64 N/mm² for addition of Geo-synthetic fiber.

- Rebound hammer test results also confirms the increase in compression and tensile strength of concrete for addition of 1.5% of Geo-synthetic fiber.
- Water absorption test results shows 0.71% of water absorption for cubes and 0.35% of water absorption for cylinders for the addition of 1.5% of Geo-synthetic fiber reinforced concrete mix.
- Cost analysis of concrete mix shows that Geo-synthetic fiber concrete is little expensive than the conventional concrete but satisfactory improvement in the strength can be observed.
- This contemplate infers that the expansion in level of fiber can enhance the compressive and rigid qualities of cement yet legitimate consideration and choice must be taken by the architects previously the execution of work.

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