**A Study on Rigid Pavement Strength using Glass Fibre as a Reinforcing Agent**

**Harish Dhondhiyal**

**Himalayiya University, Dehradun**

**ABSTRACT**

Rigid pavements mostly fail in bending, that result the cracks are developed in rigid pavements. There is also a problem of corrosion of steel reinforcement in rigid pavement which also boosts more thickness of slab and raises the material requirement. So in this project work we are using glass fibres as reinforcing agent in concrete. Randomly spread glass fibres in concrete grasps the concrete and improves its ductility features. Owing the glass fibre in concrete, the thickness of concrete wedge becomes less as the glass fibre rises the strength characteristics of concrete is increases, due to which material requirement in construction on rigid path also decreases.

**INTRODUCTION**

India’s Ministry of Road Transport and Highway has decided to move towards making rigid pavement the default mode of construction on national highways. The decision, taken after considering factors related to service life, fuel consumption, weather conditions, maintenance cost and natural resources, primarily aims to promote environment friendly construction practices in execution of road projects. India´s road system is the third largest road network in the world. Only 2% road length in the country that is composed of concrete roads and the remaining are made of unbound aggregates surfaced with bitumen or asphalt based surface courses. The main reason behind that, the initial cost of rigid pavement is much more than the flexible pavement. The cost is not the single parameter for such less construction but also the main failure such as mud pumping, sagging of slabs due to less flexural strength, concrete is brittle etc. is liable. But the concrete roads construction shows to be better as compared to flexible pavement in long term maintenance, design life, riding quality etc. An example of such benefits is that, the concrete roads in some sites of Kanpur or Gujarat which are built at the time British rule are still in use (source: Wikipedia).As the concrete is hard in nature it wants some supporting agent like steel bars. Steel bars reinforcement to increase its ductility. But the conventional steel reinforcement boosts more thickness which in turn becomes uneconomical. In order to make concrete capable of carrying tension at better strain, at which the cracks starts to develop, we have risen the tensile strength. To increase the tensile and flexural strength, glass fibres are added in concrete. The adding of fibre will result in complexes material which has the properties altered from un-reinforced concrete. The amount of variation in strength will depend upon the type of fibres and on the amount of fibre. The mixture of fibres in brittle concrete can have the result of controlling the propagation of cracks as well as the fibres helps in rising the tensile strain. The usage of fibres in concrete has increased with the development of fast way construction. Different varieties of fibres are available in shop such as steel fibres, glass, acrylic, polyester and some natural fibres such as sisal, jute, cellulose etc. are also used. From the above stated fibres, glass fibre is gaining additional popularity day by day.

**OBJECTIVES OF STUDY**

* The properties of specific materials to be used in concrete are examined.
* Different properties of reference concrete and concrete with adding of glass fibres in different proportions by volume of concrete fraction are examined.
* To examined the optimum percent of glass fibre in concrete on the basis of strength parameters.
* To work out the thickness of rigid pavement on the basis of strength parameters.

**MATERIAL USED IN STUDY**

Different material such as coarse aggregate, fine aggregate, cement (OPC) was collected from local market. Glass fibre was purchased from a Delhi based industry.

1. **CEMENT**

Birla gold Ordinary Portland cement of 43 grade (IS: 8112-1989) locally available in the market is used in this study .Various test were performed on the cement such as fineness test, consistency test, initial & final setting test, soundness test and compressive strength test.

|  |  |
| --- | --- |
| **Particulars of test** | **Result** |
| Fineness test (%) | 3 |
| Soundness test (mm) | 2 |
| Initial setting time (min) | 30 |
| Final setting time (min) | 578 |
| Consistency (%) | 31 |
| Compressive strength (7 days, N/mm2) | 28.4 |
| Compressive strength (28 days , N/mm2) | 43 |

1. **COARSE AGGREGATE**

Crushed angular, passing through 20 mm sieve aggregate is used in this study. The aggregate is free from powder and impurities. Various test were performed on coarse aggregate such as aggregate impact test, aggregate crushing value test, los angeles abrasion test, flakiness index test, elongation index test, specific gravity and water absorption test.

|  |  |
| --- | --- |
| **Particulars of test** | **Result** |
| Nominal size (mm) | 20 |
| Aggregate impact value (%) | 12.33 |
| Los Angeles abrasion value (%) | 28.44 |
| Aggregate crushing value (%) | 23.30 |
| Water absorption (%) | 0.685 |
| Specific Gravity | 2.73 |

**3. FINE AGGREGATE**

River sand passing through 4.75 mm is used as fine aggregate in this study. Sand is also free organic matter. Various test were performed on fine aggregate such as specific gravity and sieve analysis of sand

|  |  |
| --- | --- |
| **Particulars of test** | **Result** |
| Zone | 3 |
| Specific gravity | 2.44 |
| Water absorption (%) | 1.3 |

**4. GLASS FIBER**

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Glass fibre used in this study was imported from Monarch Trading Company in Delhi. The glass fibre used in this study is of 12 mm length and having a specific gravity of 0.91.

|  |  |
| --- | --- |
| Cost (Rs./ kg) | 200 |
| Length (mm) | 12 |
| Density(gm/cm3) | 0.91 |
| Melting point (degree C) | 1200 |
| Acid & Alkali resistance | Strong |
| Tensile strength(Mpa) | More than 600 |
| Elastic Modulus(Mpa) | More than 3500 |
| Water Absorbency | No |

**5. WATER**

Water used in this study is normal tap water which is supplied in College.

**METHODOLOGY**

Different experiment was done on plain concrete and concrete with different percent such as 0.1% 0.2 %, 0.3 % etc. of glass fibre by volume of concrete fraction was which are as follows:

* Workability or slump test (IS:516-1959)
* Flexural strength test (ASTM c293)
* Compressive strength test (IS:516-1959)
* Split tensile test (IS 5816:1999)
* Ultra sonic pulse velocity (IS:13311 part 1 1989)
* Modulus of elasticity(IS 516:1959)
* Water absorption test(IS:1558:2006)

**MIX PROPORTIONING**

The concrete mix design of M30 grade concrete was done according to IS: 10262-2009 and IS: 456-2008. A total of 8 mixes were prepared with addition of glass fibre by volume of concrete fraction viz. 0%,.1%,.15% .2% etc.

**Design Mix Proportions for (M30 mix) for 1m3 of concrete**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Water** | **Cement** | **Coarse Aggregate** | **Fine Aggregate** |
| **By Weight**  **(Kg)** | 186 | 395.4 | 1188.54 | 587.64 |
| **By volume**  **(m3)** | 0.47 | 1 | 3.0 | 1.49 |

**RESULT & DISCUSSION**

**1. SLUMP TEST**

Slump test was conducted on M30 mix with different % of glass fibre by volume of concrete fraction. It is observed that the slump value decreases as the percentage of glass fibre increases.

**2.COMPRESSIVE STRENGTH**

The cubes were tested in compression testing machine at 7 days and 28 days for different mix. It is observed that the compressive strength at 7 days and 28 days increases as the % of glass fibre increases.

1. **SPLIT TENSILE STREGTH TEST**

The split tensile strength was obtained from apply the transverse loading on cylinder by the compression testing machine. Split tensile test use to check edge of pavement is strong or not. In this test I found, increase of glass fibre in concrete mix increase the split tensile strength that means increase the load carrying of cylindrical specimen in transverse direction.

1. **FLEXURAL STRENGTH**

The flexural strength was obtained from the centre point loading system and the result of test for various % of glass fibre by volume of concrete fraction. It is observed that the flexural strength at 28 days increases with increase in percent of glass fibre**.**

**5. WATER ABSORPTION TEST**

The result of test for various % of glass fibre by volume of concrete fraction. It is observed that the water absorption at 28 days increases with increase in percent of glass fibre**.**

**6. ULTRASONIC PLUS VELOCITY**

**7. MODULUS OF ELASTICITY**

Modulus of elasticity of concrete increases with increase in percent of glass fibre. Here we find the secant modulus of concrete a strain is measure with the help of extensometer. In this study I found the maximum modulus of elasticity on 0.5% glass fire concrete and the value is 3.4×105kg/cm2 and minimum value is on 0% of glass fibre concrete and the value is 2.9 ×105 kg/cm2.

**8. SLAB THICKNESS**

**CONCLUSIONS**

From the different laboratory test conducted on concrete with different % of glass fibre by volume of concrete results are:

* The slump value (workability of concrete) of concrete decreases with increase in % of glass fibre..
* The compressive strength at 7 days and 28 days increases with increase in % of glass fibre by volume of concrete fraction. The maximum increase in compressive strength is 32% and 13% at 7days and 28 days respectively.
* The flexural strength increases with increase in percent of glass fibre up to 0.5 % glass fibre
* Split tensile strength increase with percent of glass fibre increases. Split tensile strength at 0% and 0.5% of glass fibre is 3.24 and 4.30 respectively.
* Water absorption test was performed on hardened concrete at 28 days and found percent of water absorption increase with increase in percent of glass fibre
* Modulus of elasticity increases with increase in glass fibre. The value modulus of elasticity of concrete mix at 0% glass fibre is 3.04\*10^5 kg/cm2 and 0.5% glass fibre concrete mix is 3.40\*10^5.
* There is reduction in slab thickness of rigid pavement from 30 cm at 0% glass fibre to 24 cm at 0.5% glass fibre and 0.4% glass fibre concrete have 25 cm thickness, so It is recommended to use 25 cm.

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