CHAPTER - V

5. DISCUSSION ON THE TEST RESULTS

5.1. PHYSICAL PROPERTIES OF MATERIALS

5.1.1. Properties Of Cement

Table 4.1.1 gives the physical properties of the ordinary portland cement used in the present investigations and they confirm to IS specifications. The 28 Days Compressive Strength of cement used is 54 Mpa.

5.1.2. Properties Of Coarse And Fine Aggregate Materials

Table 4.1.2, 4.1.3, and 4.1.4 gives the properties of aggregates used in the present investigations. The fineness modulus of the coarse aggregate is found to be 7.13. The fineness modulus of fine aggregate is found to be 3.25 which indicates medium sand. Fine aggregate (sand) is having a bulk density of 1590 kg/m$^3$ (loose). Coarse aggregate is having a bulk density of 1500 kg/ m$^3$ (loose), respectively.

5.1.3. Glass Fibre

Table 4.1.5 gives the properties of the glass fibre obtained from St.Gobain Vetro Tex Limited. The glass fibre used are of Cem-FIL Anti-Crack HD with modulus of elasticity 72 GPA, filament diameter 14 microns, specific gravity 2.68, length 12mm and having the aspect ratio of 857.1. The numbers of fibres per 1 kg are 212 million fibres.
5.2 MIX PROPORTIONS AND MIX DESIGN OF ORDINARY AND GLASS FIBRE CONCRETE

5.2.1. Mix Proportions Of Various Ordinary And Glass Fibre Concrete Mixes

Table 4.2.1 gives the ratios of mix proportions by weight of the ordinary and glass fibre concrete mixes of various grades of M20, M30, M40 and M50. After conducting the tests on cement and aggregates mixes are designed by using IS code method.

5.2.2 Quantities Of Materials Required Per 1 Cum Of Ordinary And Glass Fibre Concrete Mixes

Table 4.2.2 gives the quantities of material required for M20, M30, M40 and M50 grade of both ordinary and glass fibre concrete mixes used in the present investigations.

5.2.3. Water Cement Ratio Of Ordinary And Glass Fibre Concrete Mixes

Table No 4.2.1 gives the water to cement ratio used in the design mixes by weight. The water to cement ratio of ordinary and glass fibre concrete mixes of various grades of M20, M30, M40 and M50 varied from 0.55 to 0.36.

5.2.4. Impact Of Glass Fibres On Workability Of Glass Fibre Concrete.

The workability of concrete for grades M20, M30 in terms of compaction factor was determined for different proportions of Glass fibre. It was observed that the addition of Glass fibres shows the medium workability. The output is given in Table 4.3.
5.3 STRENGTH STUDIES OF ORDINARY AND GLASS FIBRE CONCRETE

5.3.1 Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes

Table 4.4.1 gives the compressive strength, flexural strength and split tensile strength values of different grades of concrete mixes of M 20, M30, M40 and M50 with various percentages of Glass fibres.

From the table we observed that the strength values are found optimum at 0.03% when compared with 0 %, 0.06 % and 0.1 % of addition of Glass fibres

Table 4.4.2 gives the compressive strength values of various grades of ordinary concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 36.60 to 54.18 N/mm² for 28 days, 39.25 to 59.96 N/mm² for 56 days, 43.23 to 64.37 N/mm² for 90 days and 44.12 to 66.09 N/mm² for 180 days. These variations are observed in Fig 1.0.

Table 4.4.3 gives the compressive strength values of various grades of glass fibre concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 42.46 to 62.31 N/mm² for 28 days, 45.92 to 69.55 N/mm² for 56 days, 51.01 to 77.24 N/mm² for 90 days and 51.74 to 78.61 N/mm² for 180 days respectively. These variations are observed in Fig 2.0.
5.3.2 Split Tensile Strength Of Ordinary And Glass Fibre Concrete Mixes

Table 4.4.2 gives the split tensile strength values of various grades of ordinary concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 3.62 to 5.56 N/mm$^2$ for 28 days, 4.05 to 5.89 N/mm$^2$ for 56 days, 4.33 to 6.39 N/mm$^2$ for 90 days and 4.45 to 6.65 N/mm$^2$ for 180 days respectively. These variations are observed in Fig 3.0.

Table 4.4.3 gives the split tensile strength values of various grades of glass fibre concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 4.20 to 6.34 N/mm$^2$ for 28 days, 4.74 to 6.66 N/mm$^2$ for 56 days, 5.02 to 7.54 N/mm$^2$ for 90 days and 5.25 to 7.65 N/mm$^2$ for 180 days respectively. These variations are observed in Fig 4.0.

5.3.3 Flexural Strength Of Ordinary And Glass Fibre Concrete Mixes

Table 4.4.2 gives the flexural strength values of various grades of ordinary concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 3.52 to 5.42 N/mm$^2$ for 28 days, 3.96 to 5.80 N/mm$^2$ for 56 days, 4.18 to 6.43 N/mm$^2$ for 90 days and 4.29 to 6.57 N/mm$^2$ for 180 days. These variations are observed in Fig 5.0.

Table 4.4.3 gives the flexural strength values of various grades of glass fibre concrete mixes of M20, M30, M40 and M50. These values are observed to be varied from 4.08 to 6.23 N/mm$^2$ for 28 days, 4.59 to 6.79 N/mm$^2$ for 56 days, 4.85 to 7.52 N/mm$^2$ for 90 days and
5.02 to 7.56 N/mm² for 180 days respectively. These variations are observed in Fig 6.0.

5.3.4. Variation Of Compressive Strength, Split Tensile Strength And Flexural Strength Of The Glass Fibre Concrete Mixes Compared With 28 Days Strength

Table 4.4.5 gives the increase in compressive strength, split tensile strength and flexural strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 compared with 28 days strength.

The increase in compressive strength for all the grades of concrete mixes at 56, 90, 180 days are observed to be 8 to 27 % when compared with 28 days strength. The flexural strength and split tensile strength for all the grades of concrete mixes at 56, 90, 180 days are observed to be 9 to 25 % and 5 to 25 % respectively when compared with 28 days strength.

The glass fibres suppress the localization of micro cracks into macro cracks. The strength increased continuously for all mixes at all ages because of the reason that is at the interfacial zone of matrix and fibre is under debonding as well as compressive force, when subjected to compressive load. This effectively increases the bonding characteristics of the fibre. The elastic modulus of Anti Crack High Dispersion fibre is significantly greater than that of hardened concrete. Therefore it is able to provide reinforcement not only during the setting process, but also to the hardened concrete.
5.3.5. Variation Of Compressive Strength, Split Tensile Strength And Flexural Strength Of The Glass Fibre Concrete Mixes Compared With Ordinary Concrete Mixes.

Table 4.4.4 gives the increase in compressive strength, split tensile strength and flexural strength of various grades glass fibre concrete mixes compared with ordinary concrete mixes of M20, M30, M40 and M50.

The variation in compressive strength of glass fibre concretes is observed to be varied from 15 to 20 % when compared with ordinary concretes. The variation in flexural strength of glass fibre concrete is observed to be varied from 14 to 19 % when compared with ordinary concretes. The variation in split tensile strength glass fibre concrete is observed to be varied from 13 to 18 % when compared with ordinary concrete.

The increase in compressive strength, flexural strength and split tensile strength for various grades of glass fibre concrete mixes in comparison with 28 days strength are 8 to 27 %, 9 to 25 % and 5 to 25 % respectively. These variations are given in fig 7.0 to 9.0.

5.3.6. Relationship Between Compressive Strength, Split Tensile Strength And Flexural Strength Of Glass Fibre Concrete Mixes

Mathematical equations were obtained expressing compressive strength, split tensile strength and flexural strength for Glass fibre concrete mixes. Fig 10.0 to 19.0 shows the mathematical behaviour of compressive strength, split tensile strength and flexural strength which depicts the relation between compressive strength – split tensile
strength and compressive strength – flexural strength of Glass fibre concrete is obeying Power Law

The relation between compressive strength – split tensile strength is given by

\[ f_{t28} = 0.09f_{ck}^{1.02} \text{ for 28 days} \]
\[ f_{t56} = 0.19f_{ck}^{0.84} \text{ for 56 days} \]
\[ f_{t90} = 0.12f_{ck}^{0.95} \text{ for 90 days} \]
\[ f_{t180} = 0.17f_{ck}^{0.87} \text{ for 180 days} \]

The following is the generalized equation for compressive strength – split tensile strength for all the above days is given by

\[ = 0.13f_{ck}^{0.94} \]

The relation between compressive strength - flexural strength is given by

\[ f_{cr28} = 0.08f_{ck}^{1.06} \text{ for 28 days} \]
\[ f_{cr56} = 0.12f_{ck}^{0.96} \text{ for 56 days} \]
\[ f_{cr90} = 0.09f_{ck}^{1.02} \text{ for 90 days} \]
\[ f_{cr180} = 0.12f_{ck}^{0.96} \text{ for 180 days} \]

The following is the generalized equation for compressive strength – flexural strength for all the above days is given by

\[ = 0.10f_{ck}^{0.10} \]
5.3.6. Secant Modulus Of Elasticity

Table 4.4.6 gives the secant modulus of elasticity of concrete mixes of M20, M30, M40 and M50 of both ordinary and glass fibre concrete.

These values are observed to be varied from 23206 to 36345 N/mm$^2$ for 28 days, 24842 to 38876 N/mm$^2$ for 90 days and 25762 to 40358 N/mm$^2$ for 180 days for ordinary concrete. These variations are given in Fig 20.0.

These values are observed to be varied from 26224 to 40354 N/mm$^2$ for 28 days, 27839 to 42384 N/mm$^2$ for 90 days and 28088 to 43982 N/mm$^2$ for 180 days for glass fibre concrete. These variations are given in Fig 21.0.

5.4 THERMAL STUDIES OF ORDINARY AND GLASS FIBRE CONCRETE MIXES

5.4.1 Effect On Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes Subjected To Different Thermal Cycles At 50° C And 100° C.

5.4.1.1 Compressive Strength Of Ordinary And Glass Fibre Concrete At Zero Thermal Cycles

Table No 4.5.1 & 4.5.2 gives a comparative study on compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 investigated at zero thermal cycles at 50° C and 100° C. These values are observed to be varied from 36.6 to 54.2 N/mm$^2$. 
Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 investigated at zero thermal cycles at 50°C and 100°C. These values are observed to be varied from 42.5 to 62.3 N/mm². These variations are given in Fig 22.0 to 23.0.

5.4.1.2. Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 28 Thermal Cycles

Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 investigated at 28 thermal cycles at 50°C and 100°C. These values are observed to be varied from 31.1 to 46.1 N/mm² and 29.3 to 43.4 N/mm² respectively.

Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of glass fibre concretes of M20, M30, M40 and M50 investigated at 28 thermal cycles at 50°C and 100°C. These values are observed to be varied from 36.6 to 53.6 N/mm² and 34.9 to 51.1 N/mm² respectively.

5.4.1.3. Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 56 Thermal Cycles

Table No 4.5.1 & 4.5.2 gives a comparative study on compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 investigated at 56 thermal cycles at 50°C and 100°C. These values are observed to be varied from 30.0 to 44.4 N/mm² and 27.8 to 41.2 N/mm² respectively.
Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of glass fibre concretes of M20, M30, M40 and M50 investigated at 56 thermal cycles at 50\(^0\) C and 100\(^0\) C. These values are observed to be varied from 35.7 to 52.3 N/mm\(^2\) and 33.2 to 48.6 N/mm\(^2\) respectively.

### 5.4.1.4. Compressive Strength Properties Of Ordinary And Glass Fibre Concrete Mixes At 90 Thermal Cycles

Table No 4.5.1 & 4.5.2 gives a comparative study on compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 investigated at 90 thermal cycles at 50\(^0\) C and 100\(^0\) C. These values are observed to be varied from 28.9 to 42.8 N/mm\(^2\) and 26.7 to 39.6 N/mm\(^2\) respectively.

Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 investigated at 90 thermal cycles at 50\(^0\) C and 100\(^0\) C. These values are observed to be varied from 34.0 to 49.8 N/mm\(^2\) and 31.9 to 46.7 N/mm\(^2\) respectively.

### 5.4.1.5. Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 180 Thermal Cycles

Table No 4.5.1 & 4.5.2 gives a comparative study on compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 investigated at 180 thermal cycles at 50\(^0\) C and 100\(^0\) C. These values are observed to be varied from 28.5 to 42.3 N/mm\(^2\) and 25.6 to 37.9 N/mm\(^2\) respectively.
Table No 4.5.3 & 4.5.4 gives a comparative study on compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 investigated at 180 thermal cycles at 50°C and 100°C. These values are observed to be varied from 33.6 to 49.2 N/mm² and 30.6 to 44.9 N/mm² respectively.

5.4.1.6 Variation Of The Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes Compared With Zero Thermal Cycles

Table No. 4.5.5 gives % decrease in compressive strength of various grades of ordinary concrete mixes in comparison with zero thermal cycles for 50°C is observed to be varied from 14 to 23 % and for 100°C, 19 to 31 % for 28, 56, 90, and 180 thermal cycles respectively.

Table 4.5.6 gives % decrease in compressive strength of various grades of glass fibre concrete mixes in comparison with zero thermal cycles for 50°C and 100°C. These values are observed to be varied from 13 to 22 % and 17 to 28 % for 28, 90, and 180 thermal cycles respectively. The variations are observed in graphs 22.0 & 23.0.

The adverse effect of thermal cycles on the studied properties of concrete is probably due to thermal incompatibility of concrete constituents. Investigations have shown that micro cracks exist at the interface between coarse aggregate and cement paste even prior to the application of load on concrete. In the case of concrete subjected to thermal cycles, the micro cracks further increase probably due to the different coefficient of thermal expansion of cement matrix and aggregates. Internal stresses created due to unequal expansion or
contraction of the concrete constituents might lead to an increase in the micro cracks.

5.5 COMPRESSIVE STRENGTH, PULSE VELOCITY AND PERCENTAGE WEIGHT LOSS OF ORDINARY AND GLASS FIBRE CONCRETE MIXES SUBJECTED TO ELEVATED TEMPERATURES.

5.5.1. Variation Of Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes

Table 4.6.1 gives the compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 at room temperature. These values are observed to be varied from 36.60 to 54.18 N/mm$^2$.

Table 4.6.1 gives the compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 at room temperature. These values are observed to be varied from 42.46 to 62.31 N/mm$^2$.

The variations in compressive strength for both ordinary and glass fibre mixes are given in figure 24.0.

5.5.1.1 Variation Of Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 200° C

Table 4.6.1 gives the compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 200°C for 12 hrs duration. These values are observed to be varied from 28.55 to 42.26 N/mm$^2$. 
Table 4.6.1 gives the compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 200°C for 12 hrs duration. These values are observed to be varied from 33.13 to 48.78 N/mm².

5.5.1.2 Variation Of Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 400°C

Table 4.6.1 gives the compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 400°C for 12 hrs duration. These values are observed to be varied from 26.90 to 38.70 N/mm².

Table 4.6.1 gives the compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 400°C for 12 hrs duration. These values are observed to be varied from 31.90 to 45.13 N/mm².

5.5.1.3 Variation Of Compressive Strength Of Ordinary And Glass Fibre Concrete Mixes At 600°C

Table 4.6.1 gives the compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 600°C for 12 hrs duration. These values are observed to be varied from 23.42 to 35.91 N/mm².

Table 4.6.1 gives the compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing
the specimens to 600°C for 12 hrs duration. These values are observed to be varied from 28.62 to 41.90 N/mm².

5.5.2 Variation Of Pulse Velocity Of Ordinary And Glass Fibre Concrete Mixes

5.5.2.1 Variation Of Pulse Velocity Of Ordinary And Glass Fibre Concrete Mixes At Room Temperature

Table 4.6.2 gives the pulse velocity of various grades of ordinary concrete mixes of M20, M30, M40 and M50 at room temperature. These values are observed to be varied from 4350 to 4450 m/sec.

Table 4.6.2 gives the pulse velocity of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 at room temperature. These values are observed to be varied from 4360 to 4480 m/sec.

The variation of pulse velocity of both ordinary and glass fibre concrete mixes are given in fig 25.0.

5.5.2.2 Pulse Velocity Of Ordinary And Glass Fibre Concrete Mixes At 200°C

Table 4.6.2 gives the pulse velocity of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 200°C for 12 hrs duration. These values are observed to be varied from 4002 to 4010 m/sec.

Table 4.6.2 gives the pulse velocity of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the
specimens to 200°C for 12 hrs duration. These values are observed to be varied from 4006 to 4015 m/sec.

5.5.2.3 Pulse Velocity Of Ordinary And Glass Fibre Concrete Mixes At 400°C

Table 4.6.2 gives the pulse velocity of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 400°C for 12 hrs duration. These values are observed to be varied from 3400 to 3415 m/sec.

Table 4.6.2 gives the pulse velocity of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 400°C for 12 hrs duration. These values are observed to be varied from 3415 to 3424 m/sec.

5.5.2.4 Pulse Velocity Of Ordinary And Glass Fibre Concrete Mixes At 600°C

Table 4.6.2 gives the pulse velocity of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 600°C for 12 hrs duration. These values are observed to be varied from 2700 to 2745 m/sec.

Table 4.6.2 gives the pulse velocity of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 600°C for 12 hrs duration. These values are observed to be varied from 2720 to 2785 m/sec.
The reason for reduction in pulse velocity is due to the improved density of ordinary and glass fibre mixes.

5.5.3 Percentage Weight Loss Of Ordinary And Glass Fibre Concrete Mixes

5.5.3.1 Percentage Weight Loss Of Ordinary And Glass Fibre Concrete Mixes At 200° C

Table 4.6.3 gives the percentage weight loss of various grades of ordinary concrete mixes of M20, M30, M40, and M50 after exposure of the specimens to 200° C for 12 hrs duration. The percentage weight loss is observed to be varied from 4.1 to 4.5 %.

Table 4.6.3 gives the percentage weight loss of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 200° C for 12 hrs duration. The percentage weight loss is observed to be varied from 3.5 to 4.0 %.

The variation in percentage weight loss for both ordinary and glass fibre concrete mixes are given in fig 26.0.

5.5.3.2 Percentage Weight Loss Of Ordinary And Glass Fibre Concrete Mixes At 400° C.

Table 4.6.3 gives the percentage weight loss of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 400° C for 12 hrs duration. The percentage weight loss is observed to be varied from 4.2 to 4.6 %.

Table 4.6.3 gives the percentage weight loss of various grades of glass fibre concrete mixes of M20, M30, M40, and M50 after exposure
of the specimens to 400°C for 12 hrs duration. The percentage weight loss is observed to be varied from 3.8 to 4.4 %.

**5.5.3.3 Percentage Weight Loss Of Ordinary And Glass Fibre Concrete Mixes At 600°C.**

Table 4.6.3 gives the percentage weight loss of various grades of ordinary concrete mixes of M20, M30, M40, and M50 after exposure of the specimens to 600°C for 12 hrs. The percentage weight loss is observed to be varied from 4.5 to 4.9 %.

Table 4.6.3 gives the percentage weight loss of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 600°C for 12 hrs. The percentage weight loss is observed to be varied from 4.2 to 4.6 %.

**5.5.4 Percentage Decrease Of Compressive Strength Of Ordinary And Glass Fibre Concrete Compared With Room Temperature.**

**5.5.4.1 Percentage Decrease Of Compressive Strength Of Ordinary And Glass Fibre Concrete At 200°C Compared With Room Temperature.**

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 200°C for 12 hrs compared with room temperature. 22% variation was noticed.

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40, and M50 after exposure of the specimens to 200°C for 12 hrs compared with temperature. A change of 22 to 24 % was detected.
The variation in percentage decrease in compressive strength of both ordinary and glass fibre concrete mixes are given in fig 27.0.

5.5.4.2 Percentage Decrease Of Compressive Strength Of Ordinary And Glass Fibre Concrete At 400°C Compared With Room Temperature.

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 400°C for 12 hrs compared with room temperature. 27 to 32 % deviation was observed.

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposure of the specimens to 400°C for 12 hrs compared with room temperature and the difference was noted as 25 to 28 %.

5.5.4.3 Percentage Decrease Of Compressive Strength Of Ordinary And Glass Fibre Concrete At 600°C Compared With Room Temperature.

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 600°C for 12 hrs duration compared with room temperature. The variations are observed to be 30 to 36 %.

Table 4.6.5 gives the percentage decrease in compressive strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after exposing the specimens to 600°C for 12 hrs
duration compared with room temperature. The variations are observed to be 33 to 35%.

5.5.5 Percentage Increase In Compressive Strength Of Glass Fibre Concrete Mixes Compared With Ordinary Concrete Mixes.

5.5.5.1 Percentage Increase Of Compressive Strength Of Glass Fibre Concrete Compared With Ordinary Concrete Mixes At Room Temperature.

Table 4.6.4 gives the percentage increase in compressive strength of M20, M30, M40 and M50 grades of glass fibre concrete over ordinary concrete is observed to be 13.05 to 16.66 % at room temperature. The variation is given in fig 28.0.

5.5.5.2 Percentage Increase Of Compressive Strength Of Glass Fibre Concrete Compared With Ordinary Concrete Mixes At 200°C.

Table 4.6.4 gives the percentage increase in compressive strength of M20, M30, M40 and M50 grades of glass fibre concrete over ordinary concrete is observed to be 11.92 to 14.89 % after exposure of the specimens to 200°C for 12 hrs.

5.5.5.3 Percentage Increase Of Compressive Strength Of Glass Fibre Concrete Compared With Ordinary Concrete Mixes At 400°C.

Table 4.6.4 gives the percentage increase in compressive strength of M20, M30, M40 and M50 grades of glass fibre concrete...
over ordinary concrete is observed to be 14.25 to 24.24 % after exposure of the specimens to 400° C for 12 hrs.

5.5.5.4 Percentage Increase Of Compressive Strength Of Glass Fibre Concrete Compared With Ordinary Concrete Mixes At 600°C.

Table 4.6.4 gives the percentage increase in compressive strength of M20, M30, M40 and M50 grades of glass fibre concrete over ordinary concrete is observed to be 14.30 to 18.17 % after exposure of the specimens to 600° C for 12 hrs.

The thermal pressures are unable to relieve and hence spalling of concrete is taking place when exposed to high temperatures

5.6 DURABILITY STUDIES OF ORDINARY AND GLASS FIBRE CONCRETE MIXES

5.6.1 Studies On Loss Of Weight Of Ordinary And Glass Fibre Concrete Mixes In Different Solutions.

5.6.1.1 Loss Of Weight Of Specimens After Immersing In 5% Hcl Solution.

Table 4.7.1 gives the percentage weight loss of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after immersing in 5 % Hcl solution. The variations are observed to be varied 2.38 to 2.55 % for 28 days, 4.72 to 5.31 % for 56 days, 11.98 to 12.56 % for 90 days, 13.02 to 13.81 % for 180 days respectively.

Table 4.7.1 gives the percentage weight loss of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after immersing
in 5 % Hcl solution. The variations are observed to be varied at 28 days from 2.37 to 2.53 % for 0.03 % and 2.32 to 2.50 % for 0.06 % and 2.15 to 2.45 % for 0.10 %, At 56 days 4.29 to 5.21 % for 0.03 % and 3.99 to 4.99 % for 0.06 % and 3.66 to 4.30 % for 0.10 %, At 90 days 11.75 to 12.47 % for 0.03 % and 11.54 to 12.46 % for 0.06 % and 11.45 to 12.28 % for 0.10 %, At 180 days 12.92 to 13.59 % for 0.03 % and 12.58 to 13.81 % for 0.06 % and 12.59 to 13.38 % for 0.10 % respectively.

The percentage weight loss of M20, M30, M40 and M50 grades of ordinary and glass fibre concretes after immersing in 5 % HCL solution increases corresponding to the time.

5.6.1.2 Loss Of Weight Of Specimens After Immersing In 10% Na₂SO₄ Solution.

Table 4.7.1 gives that there is no weight loss for the specimens immersed 10 % Na₂SO₄ solution of various grades of ordinary concrete mixes of M20, M30, M40, and M50 at 28, 56, 90 and 180 days.

Table 4.7.1 gives that there is no weight loss for the specimens immersed 10 % Na₂SO₄ solution of various grades of glass fibre concrete mixes M20, M30, M40 and M50 at 28, 56, 90 and 180 days.

The percentage weight loss of M20, M30, M40 and M50 grades of ordinary concretes and glass fibre concretes after immersing in 10 % Na₂SO₄ is observed to be nil for any period of time. This shows that ordinary concretes and glass fibre concretes of all the grades can have the resistance against Na₂So₄ solution.
5.6.1.3 Loss Of Weight Of Specimens After Immersing In 5% H$_2$SO$_4$ Solution.

Table 4.7.1 gives the percentage weight loss of various grades of ordinary concrete mixes of M20, M30, M40 and M50 after immersing in 5 % H$_2$SO$_4$ solution ranges from 13.1 to 14.7 % for 28 days, 26.86 % to 30.24 for 56 days, 36.85 % to 41.25 % for 90 days, 40.16 % to 45.37 for 180 days respectively.

Table 4.7.1 gives the percentage weight loss of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 after immersing in 5% H$_2$SO$_4$ solution ranges, at 28 days from 12.9 % to 14.5 for 0.03 % and 12.7 % to 14.3 for 0.06 % and 12.5 % to 14.3 for 0.10 %, at 56 days 26.70 % to 30.02 for 0.03 % and 27.03 % to 30.42 for 0.06 % and 27.36 % to 31.17 % for 0.10 %, at 90 days 35.75 % to 40.75 % for 0.03 % and 35.25 % to 40.15 % for 0.06 % and 34.80 % to 39.15 % for 0.10 %, at 180 days 38.97 % to 44.42 % for 0.03 % and 38.42 % to 44.16 % for 0.06 % and 38.28 % to 42.67 % for 0.10 % respectively.

The percentage weight loss of M20, M30, M40 and M50 grades of ordinary concretes and glass fibre concretes after immersing in 5 % H$_2$SO$_4$ solution increases corresponding to the time.
5.6.1.4 Percentage Increase In The Resistance Of Glass Fibre Concrete Against The Weight Losses In Comparison With Ordinary Concrete

Table 4.7.2 gives the percentage increase in the resistance in the weight loss of Glass fibre concrete in comparison with ordinary concrete.

This is due to in active effect of Glass fibres when immersed in solutions. The Glass fibres are alkali resistant glass fibres.

5.6.1.5 Rapid Chloride Permeability

With reference to Table : 4.7.3, it was noticed that the chloride permeability as per ASTM1202-94 (RCPT) for glass fibre concrete shows less permeability of chlorides into the concrete when compared with the ordinary concrete without glass fibres. It was noticed that optimum usage of glass fibres enhances the durability of concretes and referred to in Fig. 29 to 37.

5.7. STUDIES ON IMPACT STRENGTH ORDINARY AND GLASS FIBRE CONCRETE.

5.7.1 Impact Strength Of Ordinary And Glass Fibre Concrete Mixes.

Table 4.8.1 gives the impact strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50. These values are found deferred from 259 to 356 blows for 28 days, 284 to 392 blows for 56 days, 297 to 421 blows for 90 days, 305 to 432 blows for 180 days.
Table 4.8.1 gives the impact strength of various grades of Glass fibre concrete mixes of M20, M30, M40 and M50. These readings from 295 to 407 blows for 28 days, 321 to 445 blows for 56 days, 345 to 488 blows for 90 days, and 352 to 492 blows for 180 days, were observed varied changes.

The variation of impact strength of both concrete and glass fibre concrete mixes are given in Fig 38.0.

5.7.2 Variation Of Impact Strength Of The Ordinary And Glass Fibre Concrete Mixes Compared With 28 Days Impact Strength.

Table 4.8.2 gives the impact strength of various grades of ordinary concrete mixes of M20, M30, M40 and M50 compared with 28 days impact strength. It was seen that the figures were 15 to 19 % for 90 days and 18 to 23 % for 180 days.

Table 4.8.2 gives the impact strength of various grades of glass fibre ordinary concrete mixes of M20, M30, M40 and M50 compared with 28 days impact strength. The test assessed figures were indicated to be 17 to 21 % for 90 days and 19 to 23 % for 180 days.

5.7.3. Variation of impact strength of glass fibre concrete in comparison with ordinary concrete mixes.

Table 4.8.3 gives the increase in impact strength of various grades of glass fibre concrete mixes of M20, M30, M40 and M50 in comparison with ordinary concrete mixes at 28, 56, 90 and 180 days and the resulted figures were to be 13 % to 19 % .
From the failure pattern of both ordinary and glass fibre concrete specimens, it was noted that all the cracks are brittle failure cracks. The variation are given in fig 3.0.

It is observed from the failure pattern of both ordinary and glass fibre concrete specimens that all the cracks are brittle failure cracks.

5.8. FLEXURAL BEHAVIOUR OF REINFORCED ORDINARY AND GLASS FIBRE REINFORCED BEAMS.

5.8.1. Beam Designations Of Reinforced Ordinary And Glass Fibre Reinforced Concrete Mixes.

Tables 4.9.1 to 4.9.4 gives the central deflections of M20, M30, M40 and M50 grades of reinforced concrete concrete and glass fibre reinforced concrete beams over the full depth. The beam designations 1 to 4 are of M20 grade reinforced ordinary concrete beams with 0 %, 0.03 %, 0.06 % and 0.1 % of glass fibres, whereas 5 to 8 are of M30 grade reinforced concrete beams with 0 %, 0.03 %, 0.06 % and 0.1 % of glass fibres. The designations 9 to 12 are of M40 grade reinforced concrete beams with 0 %, 0.03 %, 0.06 % and 0.1 % of glass fibres. Similarly, the designations 13 to 16 are of M50 grade reinforced concrete beams with 0 %, 0.03 %, 0.06 % and 0.1 % of glass fibres.

5.8.2 Flexural Strength Of Ordinary Reinforced Concrete Beams.

The beam 1 (M20, 0 % fibre) failed at a load of 74 KN and the first crack observed to be at 45 KN. The beam 5 (M30, 0 % fibre) failed at a load of 76 KN and the first crack observed to be at 45 KN. The beam 9 (M40, 0% fibre) failed at a load of 67 KN and the first crack
observed to be at 40 KN. The beam 13 (M50, 0 % fibre) failed at a load of 67 KN and the first crack to be observed at 50 KN.

5.8.3 **Flexural Strength Of Glass Fibre Reinforced Concrete Beams.**

5.8.4 **Flexural Strength Glass Fibre Reinforced Concrete Beams Of M 30 Grade.**

The beam 6 (M30 + 0.03 % fibre) failed at a load of 90 KN and the first crack to be observed at 50KN. The beam 7 (M30 + 0.06 % fibre) failed at a load of 77KN and the first crack observed to be at 55 KN. The beam 8 (M30 + 0.1 % fibre) failed at a load of 55KN and the first crack observed to be at 50 KN.

The ultimate Flexural load of the beam 6 (M30 + 0.03 % fibre) is more than that of beam 5 (M30 + 0 % fibre). Ultimate flexural strength was noticed in a beam with 0.03% glass fibres (M30 + 0.03 % fibre) is 90 KN.

5.8.5 **Flexural Strength Glass Fibre Reinforced Concrete Beams Of M 40 Grade.**

The beam 10 (M40 + 0.03 % fibre) failed at a load of 95 KN and the first crack observed to be at 55 KN. The beam 11 (M40 + 0.06 % fibre) failed at a load of 60 KN and the first crack observed to be at 50 KN. The beam 12 (M40 + 0.1 % fibre) failed at a load of 58 KN and the first crack observed to be at 45 KN.

The ultimate Flexural load of the beam 10 (M40 + 0.03 % fibre) is more than that of beam 9 (M40 + 0 % fibre). Ultimate flexural
strength was noticed in a beam with 0.03% glass fibres (M40 + 0.03 % fibre) is 95 KN.

5.8.6 Flexural Strength Of Glass Fibre Reinforced Concrete Beams Of M 50 Grade.

The beam 14 (M50 + 0.03 % fibre) failed at a load of 87 KN and the first crack observed to be at 45 KN. The beam 15 (M50 + 0.06 % fibre) failed at a load of 69 KN and the first crack observed to be at 45 KN. The beam 16 (M50 + 0.1% fibre) failed at a load of 75 KN and the first crack observed to be at 50 KN.

The ultimate Flexural load of the beam 14 (M 50+ 0.03% fibre) is more than that of beam 13 (M50 + 0 % fibre). Ultimate flexural strength was noticed in a beam with 0.03% glass fibres (M50 + 0.03 % fibre) is 87 KN.

5.8.7 Load Deflection Characteristics Of Reinforced Ordinary And Glass Fibre Reinforced Concrete Beams.

Table 4.91 to 4.94 gives experimental investigation of the load deflection behavior and failure characteristics of 1200 x 150 x 100 mm reinforced concrete and glass fibre reinforced concrete beams. The variation of both reinforced beams and glass fibre reinforced beams are given in fig 40.0 to 43.0.

Table 4.9.5 gives ultimate load and deflections at maximum load for both reinforced concrete and glass fibre reinforced concrete beams. By observing the behaviour of cracks it can be seen that the load carrying capacity of glass fibre reinforced beams at 0.03 % are on higher side when compared with other beams with 0 %, 0.06 % and
0.1 % glass fibres. This is almost a fact upto the failure though identical deflection in certain loads was noted.

However, the failure patterns of the beams are shown in Photographs, Load Vs Deflection curves for the beams over full depth are shown in the graphs.

It can be seen that the presence of glass fibres in reinforced ordinary concrete beams is no more advantage in respect of ductility. The ultimate load carrying capacity of glass fibre reinforced ordinary concrete beams are more than reinforced ordinary concrete beams with 0.03% glass fibres. However, development of multiple cracks and micro cracks is prevented with the use of glass fibres.