ISSN: 2278-0181
RICESD - 2015 Conference Proceedings

Experimental Study on Glass Fibre Concrete

Jedulius. G
Anna University
Department of Civil Engineering
Udaya School of Engineering
Vellamodi, Kanyakumari Dsct.

***Abstract:-* Plain concrete possess very low tensile strength, limited ductility and little resistance to cracks are inherently present in concrete and its poor tensile strength is due to propagation of such micro cracks. Fibers when added in certain percentage in the concrete improve the strain properties well as crack resistance, ductility, as flexure strength and toughness. Mainly the studies and research in fiber reinforced concrete has been devoted to steel fibers. In recent times, a glass fiber has also become available, which are free from corrosion problem associated with steel fibers. the present paper outlines the experimental investigation conducts on the use of glass fibers with structural concrete, CEM-FILL anti crack, high dispersion, alkali resistance glass fiber of diameter 14 micron, having an aspect ratio 857 was employed in percentages, varying from 0.33 to 1 percentage by weight in concrete and the properties of this FRC (fiber reinforced concrete) like compressive strength, flexure strength, toughness, modulus of elasticity where studied.**

CHAPTER – I

INTRODUCTION

1.1 GENERAL

The term fiber reinforced concrete (FRC) is defined as a concrete made of hydraulic cements containing fine or fine and coarse aggregates and discontinuous discrete fibers. Inherently concrete is brittle under tensile loading. Mechanical properties of concrete can be improved by reinforcement with randomly oriented short discrete fibers, which prevent and control initiation, propagation, or coalescence of cracks.

FRC can continue to sustain considerable loads even at deflection exceeding fracture deflections of plain concrete. The character and performance of FRC changes depending on matrix properties as well as the fiber material, fiber concentration and fiber distributions.

FRC can be regarded as composite materials with two phases in which concrete represents the matrix phase and the fiber constitutes the inclusion phase. Volume fraction of fiber inclusion is the most commonly used parameter attributed to the properties of FRC.

Fiber count, fiber specific surface area, and fiber spacing are other parameters, which may also be used for this purpose. Another convenient numerical parameter describing a fiber is its aspect ratio, defined as the fiber length divided by its equivalent diameter.

It is possible to make several classifications among fiber types. Fibers can be divided into two groups; those with elastic module lower than the cement matrix, such as cellulose, nylon, and Glass and those with higher elastic module such as asbestos, glass, Glass, and carbon. Another classification can be made according to the origin of the fiber material such as metallic, polymeric, or natural fibers.

There are various applications of FRC. Asbestos fibers have been used in pipes or thin sheet elements for a long time. Glass fibers are also used in thin sheet element production as well as shot create applications. Glass fibers have been used in pavements, in shot create, and in a variety of other structures.

Conventionally Glass fibers are used in concrete at relatively low contents, 0.1 to 0.3% by volume, as a secondary reinforcement to control and reduce the plastic shrinkage cracking of concrete. Glass is hydrophobic due to its chemical structure, which leads to reduced bonding with the cement, and negatively affecting its dispersion in the matrix. In addition Glass has a relatively higher Poisson ratio.
Under tensile loading, the cross section of Glass fibers reduce rapidly and fiber surface is debonded from the matrix. On the other hand, dynamic modulus of elasticity of Glass is much higher when compared with static values. As a result, under dynamic loading can perform with success.

Glass fibers are used to control cracks due to plastic shrinkage. New application areas become available as new fiber types and new FRC production techniques are developed.

1.2 OBJECTIVE AND RESEARCH SIGNIFICANCE

Many times the site requirements demand the use of admixtures for the production of fiber reinforced concrete. For example, in urgent repair work using fiber reinforced concrete, superplasticiser and an accelerator may be used. In addition to this to induce more freeze- thaw resistance, an air-entraining agent may have to be added.

Since systematic laboratory study on the use of admixtures is lacking, it is found necessary to study the properties of fiber reinforced concrete.

Results of this research work showed that Glass fibers could be practical for reinforcing concrete, since Glass is cheap, abundantly available, and possess a consistent quality.

1.3 SCOPE

Manufacturing methods for Glass fibers are explained. Effects of Glass fiber inclusion on concrete in the hardened and fresh states are overviewed.

Durability characteristics of Glass fiber reinforced concrete are briefly mentioned. Mix design recommendations, mixing, placing, compaction, and finishing techniques and partial applications of DSFRC are summarized and deal with the experimental program in this study.

Properties of materials, mixing, casting and curing procedures are explained. Procedures applied to perform related tests are explained. Results of the tests carried out during this study are covered. Analyses of the results are also presented. Concludes the discussion, recommendations for future studies and references are also mentioned.

CHAPTER - II

LITERATURE REVIEW

2.1 GENERAL

A through study has been done to know more knowle3dge about self compaction concrete, its behaviour and the effects of glass fibre on ultimate strength and durability aspects of PMFRC. Many researchers have attempted to determine the flexural as well as compressive strength of fibre reinforced concrete members for many years.

The scope of the present investigation is given at the end of this chapter.

2.2 POLYMER MODIFIED FIBER REINFORCED CONCRETE USING GLASS
FIBRE.

Dr. N. Ganesan, Dr. P.V. Indira, Mr. P.T. Santhosh Kumar (2006), made an attempt to study the effects of Glass fibres on the strength and behaviour of Polymer Modified Fiber Reinforced Concrete elements. Twenty beams were cast for this study. Out of which two were plain PMFRC beams without fibres. The variables in this study were aspect ration (0, 15,25 and 35) and percentage of volume fraction of fibres (0, 0.25, 0.5, 0.75). First crack load and the post cracking behaviour were found to have improved significantly due to the addition of fibres. A marginal improvement in the ultimate strength was observed. The addition of fibres enhanced the ductility significantly. The optimum volume fraction of fibres for better performance in terms of strength and ductility was found to be 0.5 percent.

Glass fibres are added to improve tensile strength and fracture properties of concrete. Such an addition results in imparting ductility to an otherwise brittle material.

The addition increases the strain capacity and imparts improvement in ductility also known as pseudo - ductility. Consequently, flexural strength increases, accompanied by improvements in cracking resistance and toughness characteristics.

The interfacial bond stress of PMFRC with Glass fibres is higher than that of conventional concrete due to the increased paste content of PMFRC.

Strobach, claus Peter, Kurth, Helmut Petrik, Vojtech, Grunret, Jens Peter (2006), performed on precast concrete using Glass fibre reinforced made of self compacting concrete. Four experimental beams were manufactured with various types of Glass fibres and those beams were examined. Results show that priestesses Glass-fiber-reinforced beams made of PMFRC can be manufactured without conventional reinforcement, both for shear resistance and for resisting the bursting stresses in the area where the prestressing forces are introduced. Load tests showed a nearly linear elastic response to a maximum of 2.2 times the service load.

Ding, Yi-Ning, Dong Xiang - Jun, Wang Yue Hua, (2006), experimentally studied the fibre reinforced self compacting high performance concrete. They conducted various test such as workability, strength and toughness of fibre reinforced self compacting high performance concrete. Experimental results show that the FRSCGPC, with the low shrinkage and creep ratio, high strength and toughness, and the same load- bending ability with original members, can be suitable for the repair application of the concrete structures.

Development and application of reinforced modified polymer concretewas investigated by Barragan. B, Gettu. R, De La Cruz. C. Bravo. M (2005). The mix design follows a simple methodology previously applied to high - strength self-compacting concrete, based on optimizing separately the paste and the granular skeleton. Self-compactability is characterized through the slump flow, V-Funnel, L-box, U-Box and J-ring tests. The results are promising, showing that the self-compactability can be obtained even with the incorporation of 40 kg/m^3 of Glass fibre. Further more, the Glass fibre reinforced modified polymer concreteachieved was successfully applied in the construction of slender walls. Grunewald, S. Walraven, J.C (2001), Fibre reinforcement concretefibre - reinforced concrete (SCFRC) is part of the Dutch STW/PPM program - 'cement - bonded materials' - DCT.4010. Subproject III to which the project, SCFRC' belongs deals with the development of new high performance concretes. The project 'SCFRC' aims at investigating the effect of type and content of fibres on the characteristics of modified polymer concretein order to optimize the mixture composition. Fibres are able to bridge cracks and to improve the ductility of otherwise brittle cementations materials. Therefore, the addition of fibers might extend the possible fields of application of self compacting concrete. Besides the properties in the fresh state, while the concrete still flows, the mechanical behaviour will be investigated.

Ganesan, N. Indira, P.V.; Santhosh Kumar, P.T. (2006). An attempt has been made to study the effect of Glass fibres on the strength and behaviour of Polymer Modified Fiber Reinforced Concrete flexural elements. Twenty beams were cast for this study out of which two were plain PMFRC beams without fibers. The variables in this study were aspect ratio (0,15,25 and 35) and percentage of volume fraction of fibres (0,0.25, 0.5 and 0.75). First crack load and the post cracking behaviour were found to have improved significantly due to the addition of fibers. A marginal improvement in the ultimate strength was observed. The addition of fibers enhanced the ductility significantly. The optimum volume fraction of fibres for better performance in terms of strength and ductility was found to be 0.5 percent. Experimental values of the ultimate moment were compared with various analytical models.

Pons, G. Mouret, M.; Alcantara, M.; Granju, J.L. (2007), fibre - reinforced self compacting concretes were developed for precast building components, incorporating either adherent metal fibres or polymeric synthetic slipping fibres or a combination of both. To achieve the warranted workability, compressive and splitting, tensile strengths, compostions were determined by preliminary tests on Fibre reinforcement concrete materials with various proportions of metal fibres. Bending test in controlled deflection confirmed the positive contribution of fibres in the mechanical behaviour of self- compacting concrete. The comparison between vibrated and self-compacting concretes of similar mechanical characteristics indicated a possible better fibre-matrix bond in the case of self-compacting types. The results also showed that the properties of the hybrid fibre-reinforced Fibre reinforcement concrete could be inferred from the properties of the individual single-fibre reinforcements and their respective proportions through simple mix-rules.

Greenhalgh, John (2003), the use of Glass fibers in segmental linings with reinforced concretes is discussed. Glass fibers impart toughness, or ductility, to the otherwise brittle concrete. This minimizes cracking and spalling due to demoulding, handling, transportation and construction underground.

Ferrara, LiberatoMeda, Alberto (2006), A series of 40 precast prestressed roof elements was cast, employing a Modified polymer Glass fibre reinforces concrete .They are being used in an industrial building. The fibre distribution within the roof elements was investigated by means of a suitable test procedure and correlated with results obtained from cube samples drawn from the batches and tested in the fresh state. Companion slabs were also cast and tested under four point bending, in order to study the correlation between fibre distribution and the mechanical properties of the composite. The work presented here analyses the correlation between fibre distribution, workability and mechanical properties of Glass fibre reinforced concrete with the aim of optimizing both its fresh and hardened - state properties for a series production of precast roof elements.

Dr. N. Ganesan, Dr. P.V. Indira, Mr. P.T. Santhosh Kumar (2006), conducted Experiments to study the effect of Glass fibres on the durability parameters of Polymer Modified Fiber Reinforced Concrete such as permeability, water absorption, abration resistance, resistance to marine as well as sulphate attack. The variables considered were aspect ratio (0, 15, 25, 35) and volume fraction (0, 0.25, 0.5, 0.75 percent) of Glass fibres. The water cement ratio of 0.36 by weight and a trinary blend of cement, fly ash and silica fume were used. A total of 244 specimens were cast and tested for this study. It was observed that the coefficient of permeability and wear of were lower than the corresponding moderate strength concrete. Under the marine and sulphate attack, the loss in mass of concrete and compressive strength of cubes were found to be negligible

CHAPTER - III

3.1 General

The production of modified polymer concreteneeds to be carried out in plants where the equipment, operation and materials are suitably controlled. Production should therefore be carried out at ISO 9000 accredited plants or plants with quality systems that conforms to ISO 9000 to similar. It is recommended that production staff involved in the production of modified polymer concrete have been trained and also have experience in self compacting concrete.

3.1.1 Mixing

There is no requirement for any specific mixer type. Forced action mixers, including paddle mixers, free fall mixers, including truck mixers, and other types can also be used.

The mixing time necessary should be determined by practical trials. Generally, mixing time need to longer than for conventional mixes.

Time of addition of admixture is important, and procedures should be agreed with supplier after plant trials. If the consistence has to be adjusted after initial mixing then it should generally be done with the admixtures. If the requirements of EN 206 for the water/cement ratio can be maintained, then the water content can be varied to make the necessary modification.

3.2 CEMENT

The Bureau of Indian Standards (BIS) has classified OPC in three different grades The classification is mainly based on the compressive strength of cement-sand mortar cubes of face area 50 cm2 composed of 1 part of cement to 3 parts of standard sand by weight with a water-cement ratio arrived at by a specified procedure.

The grades are (i) 33 grade (ii) 43 grade (iii) 53 grade. The grade number indicates the minimum compressive strength of cement sand mortar in N/mm2 at 28 days, as tested by above mentioned procedure.

The binding materials used in concrete are Portland pozzolana cement. This cement is of 53 grades conforming to IS 456-2000 and is having desired properties. The compressive strength of cement is checked by casting cube and testing under compressive testing machine and the tensile strength of cement is checked by casting beam and testing under tensile testing machine.

This cement should be cool and stored in dry cool place. The specific gravity of cement should be determined by adopting standard procedure.

3.3 COARSE AGGREGATES

The coarse aggregate for the works should be river gravel or crushed stone. Angular shape aggregate of size is 20mm and below. The aggregate which passes through 75mm sieve and retain on 4.75mm are known as coarse aggregate.
It should be hard, strong, dense, durable, clean, and free from clay or loamy admixtures or quarry refuse or vegetable matter. The pieces of aggregates should be cubical, or rounded shaped and should have granular or crystalline or smooth (but not glossy) non-powdery surfaces.
Aggregates should be properly screened and if necessary washed clean before use. Coarse aggregates containing flat, elongated or flaky pieces or mica should be rejected. The grading of coarse aggregates should be as per specifications of IS 383-1970.

After 24-hrs immersion in water, a previously dried sample of the coarse aggregate should not gain in weight more than 5%. Aggregates should be stored in such a way as to prevent segregation of sizes and avoid contamination with fines.

3.3.1 FINE AGGREGATES

Aggregate which is passed through 4.75 IS Sieve and retained on 75micron (0.075mm) IS Sieve is termed as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture.

Usually, the natural river sand is used as fine aggregate. The moisture content of fine aggregate is determined to apply field corrections in design mixes. Ordinary river sand conforming IS 383-1970.

3.4 GLASS FIBERS

About two decades back, Glass fiber rein-forced shortcrete (SFRC) and Glass fiber rein- forced concrete (SFRC) were considered a new technology for the construction industry. However today this technology has found wider acceptance among the construction industry. Currently, Glass fibers are used in varied segments in many application areas across different segments in the construction industry, especially in tunneling, airport, warehouses, etc.

Time and safety are the main factors are among the various advantages which renders Glass fibers superior to the competing product.

Glass fibers reinforced shotcrete (SFRS) is defined as a mortar or concrete, containing discontinuous discrete Glass fibers, which are pneumatically projected at high velocity onto a surface. Glass fibers are incorporated in the shotcrete to improve its crack resistance, ductility, energy absorption and impact resistance characteristics. Properly designed, SFRS, can reduce, or even eliminate cracking a common cause for concern in plain shot crate.

The most important aspect controlling the performance of Glass fibers in shortcrete (and concrete) is the aspect ratio, Volume concentration, Geometrical shape.

Glass fibers are frequently used at small contents, and the main objective in Glass fiber inclusion is to provide a secondary reinforcement in order to control cracking due to effects like temperature and moisture changes.

In most of these applications fiber content is below the critical fiber volume, and fibers are mixed with the concrete using conventional equipment. Glass fibers are mainly used in shot crating, in blast-resistant structures, and in piling operations.

Figure.3.1 Glass Fiber

3.5 MIX DESIGN PROCEDURE

Mix design selection and adjustment can be made according to the procedure shown in fig.
Set required performance

Select materials (from site)

Design and adjust mix
Composition
Evaluate alternative materials
Not OK

Verify of adjust performance in laboratory

Verify performances in concrete plant or at site

Fig. 3.2: Mix design procedure

In designing the mix it is most useful to consider the relative proportions of the key components by volume rather than by mass.

The sequence is determined as,

- Designation of desired air content (mostly 2%)

- Determination of coarse aggregate volume
- Determination of sand content
- Design of paste composition
- Determination of optimum water/powder ratio and superplasticizer dosage in mortar
- Finally the concrete properties are assessed by standard tests.

Test with flow cone and V-funnel for mortar are performed at varying water/powder ratios in the range of (0.8-0.9). p and dosages of superplasticiser. The superplasticiser is used to balance the rheology of the paste. The volume content of sand in the mortar remains the same as determined above.

Target values are slump flow of 24cm and V-funnel time of 7 to 11 seconds.

At target slump flow, where V-funnel time is lower than 7 seconds, then decrease the water/powder ratio should be increased.

If these criteria cannot be fulfilled, then the particular combination of material is inadequate. A trial with a different superplasticizer is the preferred alternative. Second alternative is a new additive, and as a last resort different cement.

Table:3.1
Final mix proportion of PMFRC (kg/m^3)

Coarse aggregate	706kg
Fine aggregate	912kg
Cement	350kg
Glass fibre	142kg
Water	172kg
Superplasticiser	8.8kg

3.6 WATER

- *Mixing water:*

The water should be fit for drinking. The water should not have high concentrations of sodium and potassium and there is a danger of alkali-aggregate reaction.

Natural waters that are slightly acidic are harmless, but water containing humic or other organic acids may adversely affect the hardening of concrete. Such water as well as highly alkaline water should be tested.

- *Curing water:*

Generally, water satisfactory for mixing is also suitable for curing purposes. However, it is essential that curing water should be free from substances that attack hardened concrete like free CO_2 etc.

3.7 CONCRETE

Concrete is the hardened cement paste. Concrete is one of the most widely used construction material throughout the world. The major advantage is to take required compressive strength. The ingredients for making concrete are cement, fine aggregate, coarse aggregate and water.

Some times certain additives are added to it to improve or alter some properties. Making concrete is an art which one has to be through, otherwise that will end up with bad concrete.

The ingredients for good and bad concrete are same it is only the art of making it. Hence as a civil engineer one should be with the entire factor with which he can produce a good concrete.

CHAPTER - IV

TEST METHODS FOR MODIFIED POLYMER

4.1 SPECIFIC GRAVITY OF CEMENT

The specific gravity of cement is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of cement is obtained as 3.05.

4.2 SPECIFIC GRAVITY OF COURSE AGGREGATES

The specific gravity of coarse aggregate usually called coarse aggregate is the ratio of the weight in air of the given volume of dry coarse aggregate at a stated temperature to the weight in air is equal volume of distilled water at a stated temperature.

The specific gravity of coarse aggregate is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of coarse aggregate is 2.81.

4.3 SPECIFIC GRAVITY OF FINE AGGREGATES

The specific gravity of soil grains (or solids) usually called soil is the ratio of the weight in air of the given volume of dry soil solids at a started temperature to the weight in air of an equal volume of distilled water at a started temperature.

The specific gravity of sand is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of sand is 2.63.

4.4 WATER ABSORPTION OF COARSE AGGREGATES

The water absorption of aggregate is determined by measuring the increase in weight of a dry sample when immersed in water for 24 hours. The ratio of the increase in weight to the weight of dry sample expressed as percentage is known as absorption of aggregate. The water absorption of aggregate is to be found in the laboratory. Values of water absorbing capacity of coarse aggregate are 0.5%.

4.5 ABRASION VALUE OF COARSE AGGREGATES

The abrasion value is to be found in the laboratory by using Deval's abrasion machine and other accessories. Abrasion value of coarse aggregate is 8.6%.

4.6 FINENESS MODULUS

Fineness modulus is a ready index of coarseness or fineness of material. Fineness modulus is an empirical fact or obtained by adding the cumulative percentage of aggregate retained on standard sieves ranging from 80mm to 150μ and dividing thus sum by an arbitrary number 100 and coarse is the material by means of sieve analysis. We can find out fineness modulus of aggregates.

4.7 INITIAL SETTING TIME AND FINAL SETTING TIME

(i) *Initial Setting Time:* The period elapsed between the times when is water added to the cement and the time that the paste starts loosing its plasticity. The needle may penetrate only to a depth of 33-35mm from the top is taken as initial setting time.

(ii) *Final Setting Time:* The period elapsed between the instant of addition of water and the paste has completely lost its plasticity.

4.8 SETTING OF CEMENT

When water is mixed with cement, the paste so formed remains pliable and plastic for a short time. During this period it is possible to disturb the paste and remit it without any deleterious effects.

As the reaction between water and cement continues, the paste loses its plasticity. This early period in the hardening of cement is referred to as 'setting' of cement.

4.9 BULK DENSITY AND PERCENTAGE OF VOIDS

Bulk density the aggregates are filled in the container and then they are compacted in a standard manner.
The weight of the aggregate gives the bulk density calculated in Kg/m^3. Knowing the specific gravity of the aggregate in saturated and dry condition, the void ratio can also is calculated.

Bulk density of aggregate is of interest when we deal with light weight aggregate and heavy weight aggregate. The parameter of bulk density is also used in concrete mix design for converting the proportions by weight into proportions by volume when weigh batching equipment is not available at the site.

4.10 MOISTURE CONTENT

Free moisture is both fine and coarse aggregate affects the quality of concrete in more than one way. In case of weigh batching, determination of free moisture content of the aggregate is necessary and then correction of w/c ratio to be effected in this regard.

But when volume batching adopted, the determination of moisture content of fine aggregate doesn't become necessary but the bulking sand and correction of volume sand to give allowance for bulking becomes necessary.

4.11 PROPERTIES OF CEMENT

The properties of cement tested were listed below in table 4.1, 4.2

TABLE 4.1
PROPERTIES OF CEMENT

Sl.No	Particulars	values
1	Specific gravity	3.05
2	Initial setting time	30min
3	Final setting time	10 hrs

TABLE 4.2
COMPRESSIVE STRENGTH OF CEMENT GRADE

Types of cement	7 days	14 days	28 days
53 grade ordinary Portland cement	30 N/mm^2	44 N/mm^2	53 N/mm^2

4.12 PROPERTIES OF COARSE AGGREGATES

The properties of coarse aggregate tested were listed below in table 4.3

TABLE 4.3
PROPERTIES OF COARSE AGGREGATES

Sl. No	particulars	values
1	Specific gravity	2.81
2	Water absorption	0.5%
3	Deval's abrasion	8.6%
4	Fineness modulus	7.12
5	Bulk density	1.42×10^3 Kg/m^3
6	% of voids	50 %
7	Moisture content	0 %

4.13 PROPERTIES OF FINE AGGREGATES

The properties of fine aggregate tested were listed below in table 4.4

TABLE 4.4
PROPERTIES OF FINE AGGREGATES

Sl.No	particulars	values
1	Specific gravity	2.63
2	Bulk density	1.21 x 10^3 Kg/m^3
3	Fineness modulus	2.46
4	% of voids	54 %
5	Water absorption	1.0 %
6	Moisture content	1.4 %

4.14 PROPERTIES OF GLASS FIBERS

The properties of Glass fibers tested were listed below in table 4.5

TABLE 4.5
PROPERTIES OF GLASS FIBERS

Sl.No	Fiber Properties	Glass Fiber Details
1	Shape	Hooked ends
2	Length (mm)	30
3	Size / Diameter (mm)	0.5
4	Density (Kg /m^3)	7850
5	Tensile Strength (MPa)	532
6	Young's Modulus (GPa)	207.3

CHAPTER - 5

MIX DESIGN PROCEDURE

5. 1 MIX DESIGN

The mix design for M_{25} grade concrete is as follows:

Stipulations for proportioning:

1. Grade designation : M_{25}
2. Type of cement : OPC 43 grade
3. Maximum nominal size of aggregate : 20mm
4. Minimum Cement content : 320kg/m^3
5. Maximum w/c ratio : 0.45
6. Workability : 100 mm (slump)
7. Exposure condition : Severe (RC)
8. Method of concrete placing : Normal pouring
9. Degree of Supervision : Good
10. Type of aggregate : Crushed angular aggregate
11. Maximum cement content : 450 kg/m^3

Test data for materials

1. Specific gravity of cement : 2.98
2 Specific gravity of F.A : 2.5
3. Specific gravity of C.A : 2.83
4. Water absorption of F.A : 1.25%
5. Water absorption of C.A : 0.5%
6. Free surface moisture for F.A : 0.35%
7. Free surface moisture for C.A :0.25%

Design:

1. TARGET STRENGTH

$f'_{ck} = f_{ck} + 1.65\ s$

f'_{ck} =Target average compressive strength at 28 days

f_{ck}= characteristic compressive strength at 28 days and

s = Standard deviation=4 N/mm^2

Target strength =31.6 N/mm^2

2. SELECTION OF WATER -CEMENT RATIO

From table 5 of Is 456:2000, max w/c ratio is 0.45

Based on experience, adopt w/ c ratio is 0.4

0.4<0.45 Hence O.k.

3. SELECTION OF WATER CONTENT

From table 2 of IS 10262:2009, Max water content for 20 mm aggregate is,

186 liters (for 20 mm to 50mm slump range)

Water content for 100mm slump=186+ (186x6/100) =197 liters

4. CALCULATION OF CEMENT CONTENT

W/ c ratio = 0.4

Cement content =197/0.4=492.5kg/m^3

492.5>400 Kg/m^3

Hence adopt 400 kg/m^3

5. VOLUME OF C.A AND F.A

From table 3 of IS 10262:2009, volume of C.A to 20 mm size aggregate and F.A, for w/c ratio of 0.5= 0.64

For change in W/C ratio of 0.1, Aggregate content =0.66

Fine aggregate content =1-0.66=0.34

MIX CALCULATIONS

Volume of concrete = 1m^3

Volume of cement = (Mass of cement/ Specific gravity) x1/100

= 0.13m^3

Similarly, Volume of water = 0.197 m^3

Volume of all in aggregate =1-(0.161+0.197)

= 0.652m^3

Mass of C.A =volume of all in aggregate x volume of C.A x S.G of C.Ax1000

= 0.652x2.83x1000x0.66

= 1217.80 kg

Similarly, Volume of F.A = 554.2 Kg

The ratio becomes,

400: 554.22: 1217.80: 197

1: 1.39: 3.04: 0.5

By, considering the correction factors, the final ratio is 1:1.41:3.02:0.5

CHAPTER 6

TESTS ON FRESH CONCRETE

Fresh Concrete should be stable and should not segregate or bleed during transportation and placing when it is subjected to forces during handling operations of limited nature.

The mix should be cohesive and mobile enough to be placed in the form around the reinforcement and should be able to cast into the required shape without loosing continuity or homogeneity under the available techniques of placing the concrete at a particular job.

The mix should be amenable to proper and through compaction into a dense, compact concrete with minimum voids under the existing facilities of compaction at the site. A best mix from the point of view of compatibility should achieve a 99 percent elimination of the original voids present.

6.1 COMPACTION FACTOR TEST

The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of low workability as are normally used when concrete is to be compacted by vibration. Such dry concrete are insensitive to slump test.

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 - 1959. The apparatus used is Compacting factor apparatus.

The diagram of the apparatus is shown in fig 6.1. The C.F test has been developed at the road research laboratory U.K. and it is claimed that it is one of the most efficient tests for measuring the workability of 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.

The degree of compaction, called the compacting factor is measured by the density ratio i.e., the ratio of the density actually achieved in the test to density of same concrete fully compacted.

Figure.6.1 Compaction Factor Apparatus

The sample of concrete to be tested is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder.

In the case of a dry-mix, it is likely that the concrete may not fall on opening the trap-door. In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades supplied with the apparatus.

The outside of the cylinder is wiped clean. The concrete is filled up exactly up to the top level of the cylinder. It is weighted to the 10 grams. This weight is known as “weight of partially compacted concrete”.

The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep. The layers are heavily rammed or preferably vibrated so as to obtain full compaction.

The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighted to the nearest 10gm. This weight is known as "weight of fully compacted concrete".

The Compacting factor = (Weight of partially Compacted concrete) /
(Weight of fully Compacted concrete)

The weight of fully compacted concrete can also be calculated by knowing the proportion of materials, there respective specific gravities and the volume of cylinder. It is seen from experience, that it makes very little difference in C.F value, whether the weight of fully compacted concrete is calculated theoretically or found out actually after 100 % compaction.

It can be realized that the CF test measures the inherent characteristics of the concrete which relates very close to the workability requirements of concrete and as such it is one of the good tests to depict the workability of concrete

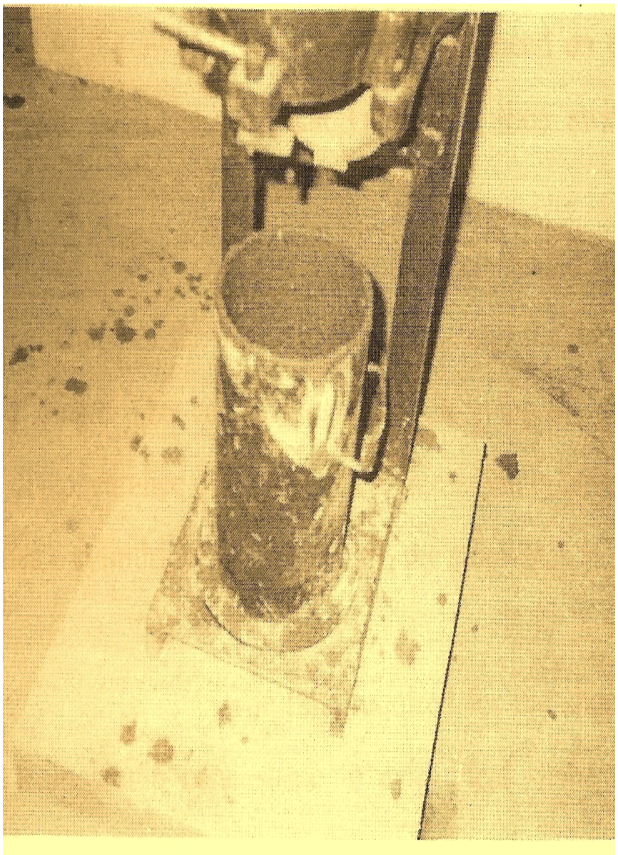

Figure.6.2 Testing Of Compacting Factor

6.2 SLUMP TEST

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 - 1959 is followed. The apparatus used for doing slump test are Slump cone and tamping rod. The slump test is the most widely, primarily because of the simplicity of the apparatus required and the test procedure.

The slump test indicates the behavior of a compacted concrete cone under the action of gravitational forces. The test is carried out with a mould called the slump cone, and filled in three equal layers of fresh concrete, each layer being tamped 25 times with a standard tamping rod. The top layer is struck off level and the mould lifted vertically without disturbing the concrete cone.

The slump measured should be recorded in mm of subsidence of the specimen during the test. Any slump specimen, whom collapses or shears off laterally, gives incorrect result and if this occurs, the test should be repeated with another sample.

If in the repeat test also, the specimen shears, the slump should be measured and the fact that the specimen sheared, should be recorded. This is a site test to determine the workability of the ready mixed concrete just before it's placing to final position inside the formwork, and is always conducted by the supervisor on site.

However in mid of concreting process should the site supervisor visually finds that the green concrete becomes dry or the placement of concrete has been interrupted , a re-test on the remaining concrete should be conducted in particular of the pour for congested reinforcement area.

The apparatus for considering the slump test essentially consists of a metallic mould in the form of frustum of a cone having the internal dimensions as under:

Bottom diameter: 20 cm, Top diameter: 10 cm, Height: 30 cm

Figure.6.3 Slump Cone Apparatus

The thickness of the metallic sheet for the mould should not be thinner than 1.6 cm. Some times the mould is provided with suitable guides for lifting vertically up. For tamping the concrete, a steel tamping rod 16 mm diameter, 0.6 meter along with bullet end is used.

The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.

The mould is then filled in four layers, each ~ ¼ of the height of the mould, each layer being tamped 25 times with a standard tamping rod taking care to distribute the strokes evenly over the cross section.

After top layer has been rodded, the concrete is struck off level with a trowel and tamping rod.

The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allowed concrete to subside. This subsidence is referred as slump of concrete.

The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm. and is taken as slump of concrete. Alkali activated binder is needed.A detailed cost benefit analysis can be undertaken todetermine the financial and environmental impact of the production of AASand geopolymer binder. The study can assess the potential applications of the materials and how widespread their use may be within the construction industry. The analysis should involve the suppliers and manufacturers of replacement materials and precast concrete manufactures.

REFERENCES

[1] A.A.Adam ,tadulakouniversity,Indonesia, "Strength,sorptivity and carbonation of geopolymer concrete" taylor and francis group, London, ISBN-978-0-415-56809-8,2010.

[2] AmmarMotorwala, "Alkali Activated Flyash Based Geopolymer Concrete", ISSN 2250-2459,Vol 3,Issue 1, Jan 2013.

[3] AndiArham Adam, "Strength And Durability Properties Of Alkali Activated Slag And Flyash Based Geopolymer Concrete", Ph.D thesis, RMIT university, Melbourne,Australia. Aug 2009.

[4] Anuar.K.A; "Strength Characteristics Of Geopolymer Concrete Containing Recycled