International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

An Experimental Investigation on High Strength Concrete with Metakaolin and Glass Fibre

(High strength concrete)

Manoj Kumar.M[1]
Dept of Civil Engineering
Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College
Avadi, Chennai-62.

***Abstract*— High strength concrete (HSC) may be defined as concrete with specified characteristic cube strength between 60and 100N/mm2, although higher strengths have been achieved and used. The use of high - strength concrete (HSC) in structures and bridges has become a common practice worldwide. Industrials by products such as Metakaolin and glass fiber are used to increase the strength of concrete. Physical and chemical properties of materials have been studied. M60grade of concrete is designed as per IS10262:2009. Su-per plasticizers is used to reduce water cement ratio. Cement has been partially replaced by Metakaolin of Constant 1% & 2%and Fine aggregate has been replaced by glass fibre of 0.5%, 1%, and 1.5%. Totally 82 cubes and 82 cylinders and 24 beams are casted and compressive strength and split tensile strength and flexural strength has been conducted for 7,2 8days. T hese replac e ments we re th en compared with conventional concrete and partially replaced concrete.**

Keywords*— Glass Fiber, HPC, Metakaolin

I.INTRODUCTION

Concrete is the second largest material utilized by hu- man being after food and water as per WHO .It is obtained by mixing cement, fine aggregate, coarse aggregate, and after in required proportions. The mixture when placed in forms and allowed to cure becomes hard like stone.The hardening caused by chemical action between water and cement due to which concrete grows stronger with age.

The strength, durability and other characteristics of concrete depend upon the properties of its ingredients, the proportion of the mix, the method of compaction and other controls during placing, compaction and curing. Concrete possess a high compressive strength and is usually more economical than steel and is non-corrosive which can be made with locally than steel and is non-corrosive which can be made with locally availa- ble materials .Hence concrete is used widely in all present and hence, liable to be cracked when subjected to tensile load.

In situations where the tensile stresses are developed, concrete is strengthened by steel bar forming a composite con- struction called Reinforced cement concrete (RCC). Concrete is generally classified as Normal Strength Concrete, High Strength Concrete and Ultra High Strength Concrete.

There is no clear cut boundary and Ultra High Strength Concrete. There is no clear cut boundary for the above classification. Indian Standard Recommended, method of mix Design denotes the boundary at 35Mpa between NSC and HSC.

HSC label was applied to concrete having strength above 40 Mpa. More recently, the threshold rose to 50 to 60Mpa in the world scenario, however in the last 15 years, concrete of very strength entered the field of construction ,in particular construction of high rise buildings and long span bridges. Concrete strengths of 90Mpa to 120Mpa are occasionally used. Strength levels of 80 to100 N/mm^2.

II.NEED FOR INVESTIGATION

A. Super Plasticizers

The super plasticizers permit the reduction of water to the extent up to 30% without reducing workability in contrast to the possible reduction unto 15% in case of plasticizers. The use of super plasticizers is practiced for production of flow- ing , self-leveling and lf-compacting and for the production of high strength and high performance concrete .Only thing is that the super plasticizers are more powerful as dispersing agents and they are high range water reducers. It is the use of super plasticizers which has made it possible to use w/c as low as 0.25 or even lower and yet to make flowing concrete to obtain strength of the order 120 Mpa or more .It is the use of super plasticizer which has made it possible to use glass fiber, slag and particularly to make high performance concrete.

B.Metakaolin

Metakaolin is also one of such waste (or) non – con- ventional material which can be utilized beneficially in the con- struction industry. This paper presents the results of experi- mental investigations carried out to find the suitability of glass fiber and metakaolin combination production of concrete when used as partial replacement of Portland cement. The demand for Portland cement is increasing dramatically in developing country. Portland cement production is one of the major reasons for CO2 emission into atmosphere. it is due to the use of fossil fuels , including the fuels required to generate electricity during

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

manufacturing process. The use of pozzolanans for making the concrete is considered efficient, as it allows the reduction of the cement consumption while improving the strength and durability properties of the concrete. Metakaolin when used as a partial replacement sub- stance for cement in concrete, it reacts with Ca (OH)2 .one of the by-products of hydration reaction of cement and results in additional C-S-H gel which results in increased strength. Metakaolin is obtained by thermal activation of kaolin clay. This activation will cause a substantial loss of water in its constitution causing a rearrangement of its structure.

C.Glass Fibre

Glass fibre is a material consisting of numerous extremely fine fibre of glass. Glassmakers throughout history have experimented with glass fibre, but mass manufacture of glass fibre was only made possible with the invention of finer ma- chine tooling. In1893, Edward Drummond Libbey exhibited a dress at the World's Columbian Exposition incorporating glass fibre with the diameter and texture of silk fibre. This was first worn by the popular stage actress of the time Georgia Cayvan.

Glass fibre can also occur naturally, as Pele's hair. Glass wool, which is one product called "fibreglass" today, was invented in 1932–1933 by Russell Games Slayter of Owens- Corning, as a material to be used as thermal building insulation. It is marketed under the trade name Fiberglas, which has become a genericized trademark.

Glass fibre when used as a thermal insulating ma- terial is specially manufactured with a bonding agent to trap many small air cells, resulting in the characteristically air-filled low-density "glass wool" family of products.

Glass fibre has roughly comparable mechanical properties to other fibers such as polymers and carbon fibre. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many pol ymer products;to form a very strong and relatively lightweight fiber-reinforced polymer (FRP) composite material called glass-reinforced plastic (GRP), also popularly known as "fiberglass".

This structural material product contain little or no air or gas, is more dense, and is a much poorer thermal insulator than is glass wool. Glass fiber also called fiber glass. It is material made from extremely fine fibers of glass Fiber glass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. Glass is the oldest, and most familiar, performance fiber. Fibers have been manufactured from glass since the 1930.

III.MATERIALS USED

A. CEMENT

A cement is a binder, a substance used for a construction that sets,hardness and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate toproduce mortar for masonry or with sand and gravel aggregates to produce concrete.

Good cement possess the following properties:

- Provides strength to masonry
- Stiffens or hardens early
- Possesses good elasticity
- An excellent building material and easily workable

Type of cement used Ordinary Portland cement (OPC 53Grade)

Properties of cement

Fineness of cement

- Soundness
- Consistency
- Strength

B.AGGREGATE

Aggregate is a broad category of coarse to medium grained particulate material used in construction, includ- ing sand, gravel, crushed stone, slag, recycled concrete and geo- synthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material.

IV. Results and Discussion

The mix design for obtaining the amount of cement and Fine Aggregate partial replacement of Metakaolin and Glass Fiber 0.5%, 1%, 1.5% and constant of Metakaolin 1%, 2% fine aggregate and coarse aggregate are calculated based on the code.

TABLE I.MIX PROPRTIONS

Contents	**Mix Proportions**								
	For Cube			***For Cylinder***			***For Beam***		
%	0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
Cement (K.G)	1.64	1.64	1.64	2.71	2.71	2.24	2.24	2.24	2.24
Metakaolin (K.G)	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03
Fine Aggregate (K.G)	2.26	2.25	2.24	3.57	3.38	3.63	3.72	3.70	3.68
Coarse Aggregate (K.G)	3.71	3.71	3.71	6.11	6.11	6.11	6.50	6.50	6.50
Glass Fibre (K.G)	0.01	0.02	0.03	0.08	0.07	0.12	0.01	0.03	0.05
Water Content (K.G)	0.66	0.66	0.66	1.09	1.09	1.09	0.78	0.78	0.78

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

A. Slump Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test per- formed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness.

Workability of concrete is mainly affected by consistency therefore wetter mixes with will be more workable than their drier mixes, but concrete of the same consistency may vary in workability. It is also used to determine consistency between individual batches.

B.Hardened Properties

Fully cured, hardened concrete must be strong enough to withstand structural and service loads will applied must be enough with stand the environmental exposure which is designed. If con- crete is made with high quality material and proportioned, mixed, handled, placed and finished, it will be strongest and durable building material

- Compressive strength

Cube specimens of size 150*150*150mm are to be cast for mix proportion. After curing for some period in the specimen tested using compressive testing machine. The curing periods was 7days, and 28days.Compressive test found by following formula:

Compressive strength (N/mm2) = maximum load (N)/

Cross sectional area (mm2)

Fig I. Casting Of Cylinders

Fig II casting of beams

Fig III Casting Of Cubes, Cylinders and Beams

- Split Tensile Strength

The split tensile strength of concrete is one of the most

important and useful properties of a concrete in most structural applications concrete is used preliminary to resist tensile stress. Tensile strength is also used as qualitative measures for other properties of harden concrete. In practice, the tensile stress in- creases as the specimen size decreases at least three cylinders of 200 mmx150 mm were casted for each age, usually 7 & 28 days. The specimens were cured for one day outside and in water for the rest of days. The specimens were tested in saturated conditions. The cylinders were placed in a manner in testing machine that their line of loading is perpendicular to direction it was casted.

Fig IV Specimen before loading

Fig V Specimen after loading

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 05, May-2021

TABLE II Compressive Strength of Partial Replacement of Mineral Admixtures in Cube at 7Days

S.No	Partial Replacement		Number Of Specimen	Compressive Strength
	Metakaolin	Glass Fibre		
1	2	0.5	3	48.66
2	2	1	3	50.37
3	2	1.5	3	44.27

V .Conclusion

The Study clearly indicates that 2 percentage of re- placement metakaolin by cement and 1 percentage fine aggregate by glass fibre. Metakaolin and glass fiber is encouraging and the compressive strength is higher than the conventional concrete. This glass fiber gives more tensile strength when compared to others. In this weird world spending amount for the construction is increasing day by day.

But the rate of glass fiber is very high when compared to other materials. but adding upon only small amount gives us more tensile strength. If glass fiber is added in excess amount it may result if failure of the structure. According to AR glass fiber it gives max strength when added with of about 90-100gm per gram of cement.

REFERENCES

[1] Dr.D.Suji , G.R.vijay Shankar "Optimum usage of Using Metakaolin and Quarry Dust in High performance Cocrete" Interna- tional Journal of Scientific & Engineering Research, Vol 7 Issue10, pp.1-4.

[2] Dr.Vaishali , G.Ghorpade (2010) "An experimental investigation on class fibre reinforced high performance concrete " International Journal of ChemTech Research, Vol 10 Issue 8, pp.725-731.

[3] A. Mumtaj , T.Subramani (2015) "Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre " Vol 6 Issue 1 ,pp.28-31.

[4] Kasu Naveena and Anantha Lakshimi, K (2017) 'Partial Replacement of Cement with GGBS and Metakaoline', International Journal of Advances in Mechanical and Civil Engineering, 4(2), pp.5-8

[5] Malode Abhishek , Shelorkar Ajay.p(2013) " Experimental Investigation on Steel Fibre Reinforced Concrete Using Metakaolin" Vol 2 ISSN 2319 – 6009

[6] Neel Shah , Dr.N.Patel (2013) " Experimental Investigation High performance Concrete Using Supplementary Cementing Material And Glass Fibre" Vol.2 Issue 5, ISSN No 2277.

[7] Dr.H.Sudarsana Rao , Dr.vaishali (2012) "Durability Studies on Metakaolin Based Glass Fibre Reinforced High Performance Con- crete " Vol 2 Issue 2 ISSN 2249-9954

[8] Dr.P.Muthupriya (2013) "An Experimental Investigation On Effect Of GGBS and Glass Fibre in High Performance Concrete" Vol 4 Issue 4, pp.29-35

[9] Dr.H.M. Somasekharaiah , S.Veena (2015) " Experimental Investigation on Strength Characteristics of Metakaolin Based High performance Concrete With Steel and Polypropylene Fibre" Vol 4 Issue 9 ISSN 2319-8753

[10] K.Anand Kumar , C.Sudha (2017) "Experimental Study on Glass Fibre Reinforced Concrete With Partial Replacement of Cement With GGBS and Fly Ash" Vol 4 Issue 11.

[11] A.jagtap , N,Shirsath (2017) " Effect of Metakaolin on The Properties of Concrete" Vol 04 Issue 07.

[12] P.sumalatha , Dr.M.Vijaya Sekar Reddy(2105) " Incorporation of Waste Glass Powder as Partial Replacement of Fine Aggregate In Cement Concrete" Vol 6 Issue 12.

[13] S.Amulya , S.Ramya (2015) " A Study on Strength Of Fibre Reinforced Concrete With Partial Replacement Of Cement With Quarry Dust and Metakaolin" Vol 2 Issue 6 ISSN 2319-706

[14] P.Banu Priya , S.Suganya (2014) " Use of Glass Powder As Fine Aggregate In High Strength Concrete" Vol 2 Issue 7.