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EXPERIMENTAL INVESTIGATION ON STEEL FIBRE REINFORCED CONCRETE BY PARTIAL REPLACEMEMT OF CEMENT BY METAKAOLIN

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Abstract:

In this cutting-edge situation, assumptions from concrete have expanded dramatically. Different actual boundaries of substantial like strength, solidness, workableness and expected assistance life needs improvement. This project manages the investigation of the strength boundaries of cement by halfway substitution of concrete by Metakaolin. The tests were directed according to Bureau of Indian Standards (BIS) to assess the reasonableness of Metakaolin as a halfway substitution of cement. The steel Fibre was utilized to build the durability of the substantial. Various strength parameters such as compressive strength, split tensile strength of concrete for a grade of M50 was tested and recorded. To some extent concrete showed an expansion in strength when contrasted with traditional cement. Various mix combinations with a partial replacement of cement by Metakaolin 0%, 5%, 10%, 15% was taken and 0.5%, 1% and 1.5% steel Fibre of aspect ratio 50- 60 were used. The necessity of metakaolin in steel Fibre reinforced concrete to enhance the strength properties of concrete. In the present day construction industry needs of finding effective materials for increasing the strength of concrete structures. Hence an attempt has been made in the present experimental investigations to study the effect of addition of steel Fibre at a dosage of 0.5%, 1% and 1.5% of the total weight of concrete. Metakaolin was used at 0%, 5%, 10%, 15% of the total weight of cement, and the addition of steel fibres at optimum level of metakaolin were used. Experimental investigation was done using M50 mix and tests were carried out as per recommended procedures by relevant codes. Considering all the test results it can be said that for M50 mix, 15% replacement of cement by Metakaolin and 1.5% Steel Fibre is considered as optimum. From the test results, it was observed that the maximum Compressive strength, Split tensile strength and Flexural strength was obtained for mix M4 it is observed that the percentage increase in strength from 7 days to 28 days is more in mix M4 that is 15% Metakaolin with 1.5% Steel Fibres. Keywords – Metakaolin, Steel Fibres, Fine aggregate, Coarse aggregate, Compressive strength, Split tensile strength, Flexural strength.

1.INTRODUCTION:

General

Concrete is a composite material consisting of coarse and fine aggregates along with cement and water. Cement reacts chemically with water and acts as a binding material to aggregates. Chemical and mineral admixtures are often added to the concrete preparation to enhance its properties. The word concrete is derived from Latin word “concretes” which means compact or condensed. The history of concrete goes back to thousands of years. It has been found that Romans and Greeks have used it for construction extensively between 300 BC and 476 AD. The chemical process which takes place between cement and water which hardens

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the concrete is known as hydration. The hardened concrete is a robust stone like material with a very high compressive strength. But its tensile strength is very low due to which it cracks and fails when subjected to tensile load. 1.2 Concrete Ingredients 1.2.1 Cement: A cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource. Cement is produced by heating lime stone (calcareous material) with clay or shale (siliceous material) to a very high temperature of 1600 0 C, and grinding the clinker with gypsum. It requires very high energy to grind the clinker to fine powder and it releases almost an equal amount of carbon di-oxide to the atmosphere. Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as hydraulic or the less common non-hydraulic, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster). 1.2.2 Water: When water is added to cement, a cementitious paste gets formed due to hydration which fills the voids between the aggregates and glues them. It has been found that a lower water to cement ratio results in stronger and more durable concrete. The water used for concrete should be potable, free from organic and deleterious material. Chloride content, alkali carbonates and bicarbonates may harm the concrete in the later stage and should be avoided. Water with pH value between 6 to 8 is deemed suitable for mixing of concrete. The role of water is important here to accelerate this chemical process by adding 23%-25% of the cement volume. It produces 15% of water cement paste also called gel to fill the voids in the concrete. 3 1.2.3 Aggregates: Natural sands and gravels are conventionally used for concrete. However, due to their unavailability, recycled aggregates and crushed stones are also used in recent times. Aggregates reduce the cost of the concrete and increase the durability and strength. A good aggregate should be strong, free from deleterious material, have good surface texture and high impact and crushing value. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in drainage applications such as foundation and French drains, septic drain fields, retaining wall drains, and roadside edge drains. Aggregates are also used as base material under foundations, roads, and railroads. 1.3 Concrete 1.3.1 Special concrete Special concretes are designed to meet special requirements, enhance the characteristics, compaction, strength, stability, toughness, durability and ease of placement. Some of the special concretes are lightweight concrete, high strength concrete, high performance concrete, no fines concrete, water resistant concrete, self-compacting concrete, fibre reinforced concrete etc. 1.3.2 Fibre reinforced concrete Concrete is a brittle material which could crack and break immediately with the application of tensile load. Micro cracks develop even before the load is applied due to shrinkage, which propagate and open up when loaded. Addition of

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small, uniformly dispersed, randomly oriented fibres arrest the cracks and improve the static and dynamic strength of concrete substantially 1.3.3 Types of fibres Most commonly used fibres in concrete are steel and polypropylene. However, non-metal fibres like asbestos fibres, carbon fibres, organic fibres, vegetable fibres, glass fibres are also used in concrete. Fibres have shown to improve the tensile strength, compressive strength, flexural strength, shear and impact strength, fatigue and durability.

OBJECTIVE:

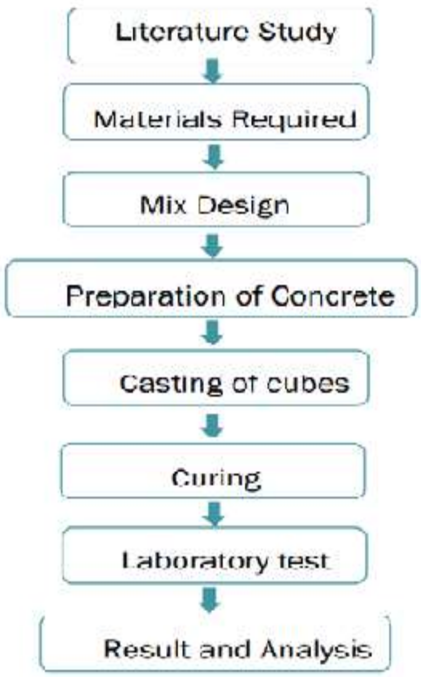
Concrete is the second most consumed material on Earth next only to water and food. The beauty of concrete is its ability to accept everything into it .In the present study, The primary objectives of this study are to improve the strength properties of concrete by partial replacement of cement with Metakaolin. Additionally steel fibre also added, so as to make it suitable for construction of any civil engineering structures. • To study the workability of concrete using cement with Metakaolin, additionally steel fibres. • To study the compressive strength of concrete using cement with Metakaolin as 5%, 10% and 15%. Additionally, 0.5%, 1% and 1.5 % of steel fibres in total volume of concrete. • To study the Split tensile strength of concrete using cement with Metakaolin as 5%, 10% and 15%. Additionally, 0.5%, 1% and 1.5 % of steel fibres in total volume of concrete. • To study the Flexural strength of concrete using cement with Metakaolin as 5%, 10% and 15%. Additionally, 0.5%, 1% and 1.5 % of steel fibres in total volume of concrete.

METHODOLOGY:

General:

To improve the strength properties of concrete by partial replacement of cement with Metakaolin. Additionally steel fibre also added so as to make it suitable for construction of any civil engineering structures. The steel fibres are used improve the tensile strength and flexural strength of concrete and Metakaolin is used to increase the Compressive, Flexural, Tensile strength of concrete and Durability of Concrete. And it reduces the drying shrinkage and creep of concrete.

Flowchart:



Cement:

Cement plays a major role within a concrete mixture and affects most important aspects of the mix, such as: workability, compressive strength, drying shrinkage, and durability. Through the process of hydration, cement particles react with water, binding the aggregate, and the strength matrix develops (Weiss, 1999). Although the terms cement and concrete often are used interchangeably, cement is actually an ingredient of concrete. ... Cement comprises from 10 to 15 percent of the concrete mix, by volume. Through a process called hydration, the cement and water harden and bind the aggregates into a rocklike mass.

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FIG:-1 Properties of Cement

S.No	Properties	Values
1	Cement	OPC 53 grade used
2	Specific gravity	3.12
3	Fineness	8%
4	Normal consistency	33%
5	Initial setting time	30 mins
6	Final setting time	600 mins

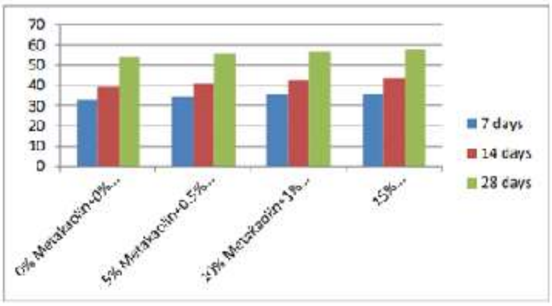
Chemical Composition of Cement

Silica-(SiO_2)	17%to 25%
Alumina-(Al_2O_3)	3%to 8%
Iron Oxide-(Fe_2O_3)	0.5%to 6%
Lime-(CaO)	60%to 67%
Magnesia-(MgO)	1%to 3%
Sulphur Trioxide-(SO_3)	1%to 3%
Miscellaneous	1%

RESULTS:

General In order to facilitate the test results, interpretation of the results was carried out at each phase of the experimental work. This interpretation of the results obtained is based on the current knowledge available in the literature as well as on the nature of test results obtained. The significance of the results is assessed with reference to the standards specified by the relevant BIS codes. 4.2 Compressive strength test Compressive strength test on cubes is the most common test conducted on hardened concrete because it is an easy test to perform and most of the desirable properties of concrete are comparatively related to its compressive strength. The compression test was carried out on cubical specimen of size 150mm in a compression testing machine of capacity 2000 kN. The strength is determined at 7, 14 and 28 days of casting. The variation of compressive strength at the age of 7th and 28th days with optimum percentage of Steel Fibres and Metakaolin were given below in Table 4.2.1. From the test results, it was observed that the maximum compressive strength was obtained for mix M4 it is observed that the percentage increase in strength from 7 days to 28 days is more in mix M4 that is 15% Metakaolin with 1.5% Steel fibres.

Mix	Specification	Mix ratio	Compressive strength (N/mm^2)		
			7th day	14th day	28th day
M1	0% Metakaolin –0% Steel fibre	1 2.01:2.64	33.2	39.4	54.2
M2	5% Metakaolin –0.5% Steel fibre	1 2.01:2.64	34.4	41.2	55.5
M3	10% Metakaolin –1% Steel fibre	1 2.01:2.64	35.5	42.4	56.3
M4	15% Metakaolin –1.5% Steel fibre	1 2.01:2.64	35.8	43.2	57.8



Split Tensile Strength Test The values of split tensile strength of cylindrical specimens subjected to water curing conditions. The variation of split tensile strength at the age of 28th days with optimum percentage of Steel Fibres and metakaolin were given in Table 4.3.1. It was observed that the maximum split tensile strength was obtained for mix M4. Also, the split tensile strength decreases with increase of 1.5% Steel fibre.

Table : Split Tensile Strength Result

Mix	Specification	Mix ratio	Split Tensile strength (N/mm^2)		
			7th day	14th day	28th day
M1	0% Metakaolin +0% Steel fibre	1:2.01:2.64	4.18	4.56	5.92
M2	5% Metakaolin +0.5% Steel fibre	1:2.01:2.64	4.30	5.48	6.24
M3	10% Metakaolin +1% Steel fibre	1:2.01:2.64	4.40	5.54	6.57
M4	15% Metakaolin +1.5% Steel fibre	1:2.01:2.64	4.48	5.72	6.68

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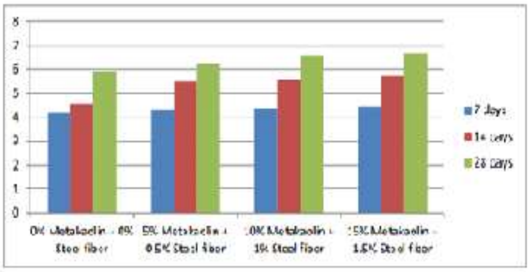

CONCLUSION:

Replacing of natural cement with 5% 10%, 15% of Metakaolin and additionally 0.5%, 1% and 1.5 % of steel fibres in total volume of concrete. The experiment was used to find the optimum possible replacement of cement by Metakaolin and steel fibre in concrete to produce a better concrete. The following are the conclusions made from my experimental studies for M-50 Grade Concrete for 15% Metakaolin and 1.5% of steel fibre with respect to conventional concrete.

• Experimental studies on M50 Grade of Conventional Concrete for Compressive strength, Split Tensile strength and Flexural strength values observed for 28 days are 56.25 N/mm2, 5.5 N/mm2 and 9.5 N/mm2.

• Maximum Compressive strength of 57.8 N/mm2 is achieved at 15% replacement of Metakaolin and 1.5% of steel fibre in concrete.

• Maximum Split Tensile strength of 6.68 N/mm2 is achieved at 15% replacement of Metakaolin and 1.5% of steel fibre in concrete.

• Maximum Flexural strength of 10.2 N/mm2 is achieved at 15% replacement of Metakaolin and 1.5% of steel fibre in concrete.

• The Compressive strength, Split tensile strength and Flexural Strength of concrete increased about 14.5%, 13.8% and 6.48% respectively.

• Considering all the test results it can be said that for M50 mix, 15% replacement of cement by Metakaolin and 1.5% Steel fibre is considered as optimum.

• The partial replacement of cement by Metakaolin and Steel Fibres are not only providing the economy in construction but it also utilization of the Metakaolin which is generated in huge quantities.

REFERENCES:

1. B. Sharath Chandra Kuma (2017). Qualitative and quantitative analysis and identification of flaws in the microstructure of fly ash and metakaolin blended high performance concrete after exposure to elevated temperatures, Construction and Building Materials, Vol. 27, No. 1, pp. 731-741.

2. K. Ramesh (2018). Structural properties of high strength concrete and its implications for precast prestressed concrete, PCI journal, Vol. 30, No. 6, pp. 92- 119.

3. Dhyana R , Arasan G.V (2019). Discussion of "Relationship between splitting tensile strength and the compressive strength" by V. Yerlici and U. Ersoy, IMO Technical Journal, Vol. 1, No. 4, pp. 1059-1062.

4. ASTM C 452(2002). Standard Test Method for Potential Expansion of Portland- Cement Mortars Exposed to Sulphate, ASTM International, West Conshohocken, PA, United States.

5. Arasan G.V (2020). curing temperature and determination of apparent activation energies, Cement and Concrete Research, Vol. 36, No. 1, pp. 434-440.

6. Ganapathy Ramasamy (2020). Microstructures, interfacial effects and micromechanics of Cementous composites, Proceedings of Conference on Advances in Cementitious Materials, The American Ceramic Society, Ohio, Vol. 16, pp. 537-540.

7. Vikas Srivastava Assistant Professor, Department of Civil Engineering, International Journal of Engineering

Research & Technology (IJERT) Metakaolin in Steel fibre Reinforced Portland Pozzolona Cement Concrete - An Experimental Investigation.

8. L. Courard, A., Darimount (2019). Durability of mortars modified with metakaolin. Cement Concrete.

9. Khatib and Wild S (2020), "Pore size distribution of Metakaolin paste in cement and concrete research", ICJ Vol. 26 No. 10, pp 1545-1553.

10. Beulah M (2012), "Effect of Replacement of Cement by Metakaolin on the Properties of High Performance Concrete Subjected to Hydrochloric Acid Attack", IJERA, Vol. 2,Issue 6, pp. 033-038

11 Debnath, S., Talukdar, F.A., Islam, M., 2022, Complete 3D brain tumour detection using a two-phase method along with confidence function evaluation, Multimedia Tools and Applications, 10.1007/s11042-021-11443-5

12 Karuppusamy, L., Ravi, J., Dabbu, M., Lakshmanan, S., 2022, Chronological salp swarm algorithm based deep belief network for intrusion detection in cloud using fuzzy entropy, International Journal of Numerical Modelling: Electronic Networks, Devices and Fields, 10.1002/jnm.2948

13 Prakash, L.N.C.K., Suryanarayana, G., Ansari, M.D., Gunjan, V.K., 2022, Instantaneous approach for evaluating the initial centers in the agricultural databases using k-means clustering algorithm, Journal of Mobile Multimedia, 10.13052/jmm1550-4646.1813

14 Rama Raju, V., Mridula, R.K., Borgohain, R., 2022, Effect of Microelectrode Recording in Accurate Targeting STN with High Frequency DBS in Parkinson Disease, IETE Journal of Research, 10.1080/03772063.2019.1592715