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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF HIGH GRADE CONCRETE USING FIBER REINFORCEMENT AND METAKOALIN

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ABSTRACT: Concrete is probably the most extensively used construction material in the world. The main ingredient in the conventional concrete is Portland cement. The amount of cement production emits approximately equal amount of carbon dioxide into the atmosphere. Cement production is consuming significant amount of natural resources. That has brought pressures to reduce cement consumption by the use of supplementary materials. Availability of mineral admixtures marked opening of a new era for designing concrete mix of higher and higher strength. Metakolin is a new mineral admixture, whose potential is not fully utilized. Moreover only limited studies have been carried out in India on the use of slag for the development of high strength concrete with addition of steel fibers the study focuses on the flexural strength performance of the blended concrete containing 20% percentage of Metakolin and different %s of steel fibers as a partial replacement of OPC. The cement in concrete is replaced accordingly with the percentage of20% by weight of Metakolinand1%, 2%, 3% by weight of steel fiber. Concrete Samples are tested at the age of7 and 28 days of curing. Finally, the strength performance of slag blended fiber reinforced concrete is compared with the performance of control mix. From the experimental investigations, it has been observed that, the optimum replacement of 20% of Metakolin Slag to cement and steel fiber of 2% with respect to the weight of cement showed improved better results in flexural strength and proved to be optimum proportion when compared with other proportions with respect to strength and economy.

1 INTRODUCTION: Concrete construction was already known to the Romans, and possibly also to other ancient peoples, but apparently it later fell into disuse. Although the Romans made cement called pozzolana by mixing slaked lime with a volcanic ash from Mount Vesuvius and used it to make concrete for building, the arts were lost during the Dark Ages and were not revived until the eighteenth and Nineteenth centuries. A deposit of natural cement rock was discovered in England in 1796 and was sold as “Roman cement.” Various other deposits of natural cement were discovered in both Europe and America and were used for several decades.The real breakthrough for concrete occurred in 1824 when an English bricklayer named Joseph Aspdin, after long and laborious experiments, obtained a patent for cement which he called “Portland cement” because its color was quite similar to that of the stone quarried on the Isle of Portland off the English coast. He made his cement by taking certain quantities of clay and limestone, pulverizing them, burning them in his kitchen stove, and grinding the resulting clinker into a fine powder. During the early years after its development, his cement was primarily used in stucco. This wonderful product was very slowly adopted by the building industry and was not even introduced into the United States until 1868. The first Portland cement was not manufactured in the United States until the 1870s.Most of concrete usage is in the form of reinforced concrete. The beginnings of reinforced concrete go back to 1850, when Lambot constructed a small boat of cement which was shown at the World Fair in Paris, 1855, and is still floating in the Parc de Miraval. In England, W.B. Wilkinson patented a true reinforced concrete floor slab in 1854. Seven years later, F. Coignet published his statement on the principles of the new construction, defining the principles of reinforced concrete and describing the proposed construction of girders, vaults and pipes. He exhibited these structures at the Exhibition of 1867. In 1861, J. Moneir, a Paris gardener, used metal frames as reinforcement for garden tubs and pots. In the same year he took out his first patents.

In the United States, the pioneering efforts were made by Thaddeus Hyatt, originally a lawyer, who conducted experiments on reinforced concrete beams in1850s. In a perfect correct manner the iron bars in Hyatt's beams were located in tension zone, bent up near the supports, and anchored in the compression zone. Additionally, transverse reinforced (known as vertical stirrups) was used near the supports. However, Hyatt's experiments were unknown until 1877 when he published his work privately. As head of the Concrete-Steel Company of San Francisco, E.L. Ransome apparently used some form of reinforced concrete in the early 1870s. He continued to increase the application of wire rope and hoop iron to many structures and was the first person to use and have patented in 1884; the deformed (twisted) bar.

HIGH PERFORMANCE FIBRE REINFORCED CONCRETE (HPC)

High Performance Fiber Reinforced Concrete (HPFRC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituent sand normal mixing. This leads to examine the admixtures to improve the performance of the concrete.

Advantages of using HP-FRC

The advantages of using high strength HP-FRCs often balance the increase in material cost. The following are the major advantages that can be accomplished.

- Reduction in member size, resulting in increase in plinth area or useable area and direct savings in the concrete volume saved.
- High strength allows the use of smaller columns and therefore a reduction in weight and hence a lower load on the foundation.
- Reduction in the self-weight and super-imposed dead load with the accompanying saving due to smaller foundations.

- Reduction in form-work area and cost with the accompanying reduction in shoring and stripping time due to high early-age gain in strength
- Construction of high rise buildings with the accompanying savings in real estate costs in congested areas.
- Longer spans and fewer beams for the same magnitude of loading.
- Reduced axial shortening of compression supporting members.
- Reduction in the number of supports and the supporting foundations due to the increase in spans.
- Reduction in the thickness of floor slabs and supporting beam sections which are a major component of the weight and cost of the majority of structures.
- Superior long term service performance under static, dynamic and fatigue loading.
- Low creep and shrinkage.
- Greater stiffness as a result of a higher modulus.
- Higher resistance to freezing and thawing, chemical attack and significantly improved long-term durability and crack propagation.

2. LITERATURE REVIEW:

D.NEERAJA investigated on Strength characteristics on GGBS as Partial Replacement of Steel fiber reinforced concrete. Experiment was conducted on concrete prepared by partial replacement of cement by GGBS. The GGBS was replaced by 0%, 20%, 40%, 60%, 80% to the weight of the cement and steel fibers from 0% - 2% and the mix design was prepared. The physical and chemical characteristic was studied and the chemical components of the GGBS used in the concrete were also determined**.** Compressive strength in concrete enhances up to 1% Of steel fiber and then decreases gradually. Addition of steel fibers with cement by 0.5%, 1%, 1.5%, 2% increases the flexural strength. Steel Fibers increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete.

3. MATERIAL PROPERTIES:

Cement: The physical property of the cement is determined by considering codal provisions. Fineness of cement, normal consistency, specific gravity, setting time, soundness test, and compressive strength of cement, is determined.

Table-1 physical properties of OPC-53grade cement

PROPERTITES	OPC 53
Fineness of cement	8%
Standard consistency	32%
Specific gravity	3.15
Initial setting time	40 minute
Final setting time	330 minute
soundness	2mm

Fine Aggregate: The sand which is used is comes under Zone –III as per IS 383-1970. The physical properties like zoning of sand, bulk density, specific gravity are determined according to the codal provisions

Table -2 physical properties of fine aggregate:

Properties	Test results
Specific gravity	2.52
Fineness modulus	2.2
Bulk density	1.69

Coarse Aggregate: The coarse aggregate used is from well-established quarry, satisfying the code IS 383:1970. The mixture of coarse aggregates is used of only 20 mm .the material is of uniform color and has good angular shape. The physical properties like fineness- modulus, specific-gravity bulk-density, water-absorption, aggregate-impact, and crushing value.

Table -3 determined physical compositions of coarse aggregate:

Properties	Test values
Specific gravity	2.73
Bulk density	1.67
Water absorption	0.5
Fineness modulus	6.6
Aggregate impact value	24%

STEEL FIBRES

Table 4Physical compositions of STEEL FIBRES

Sno	Properties	Description
1	HOOKED END	BOTH SIDES
2	DIAMETER	0.3 – 0.7 mm
3	LENGTH	35 mm
4	DENSITY	7900 kg/mm^3
5	YOUNGS MODULUS	21*105 N/mm^2
6	RESISTENCE TO ALKALIES	GOOD
7	RESISTENCE TO ACIDS	POOR
8	HEAT RESISTIVITY	GOOD
9	TENSILE STRENGTH	500 – 2000 N/mm^2
10	SPECIFIC GRAVITY	7.90
11	ASPECT RATIO	60
12	ELONGATION	5% - 35%

4. RESULTS AND DISCUSSIONS:

COMPARISION OF COMPRESSIVE STRENGTH

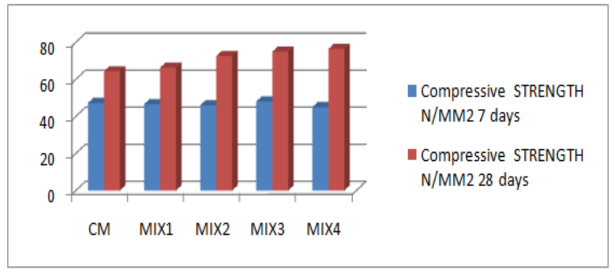

Fig 1 Variation of Compressive strength with Metakolinand STEEL FIBRES

Note: CM Means the ordinary concrete, M1is 20% Metakolin**+0%SF,M2is 20%** Metakolin**+1%SF,M3Means 20%** Metakolin**+2%SF,M4IS 20%** Metakolin**+3%SF**

The above graph is drawn for the 7 days & 28 days compressive strength of conventional concrete & Mix Designation M1 in which the1.48% of Compressive Strength is decreased for the mix M1 than the conventional concrete for 7 days and the3.11% of Compressive Strength is increased for the mix M1 than the conventional concrete for 28 days. And 2.54% Compressive Strength is decreased for the mix M2 than the conventional concrete for 7 days and 12.75% Compressive Strength is increased for the mix M2 than the conventional concrete for 28 days. And 1.69% Compressive Strength is increased for the mix M3 than the conventional concrete for 7 days and 16.48% Compressive Strength is increased for the mix M3 than the conventional concrete for 28 days. And 4.66% Compressive Strength is decreased for the mix M4 than the conventional concrete for 7days and 18.81% Compressive Strength is increased for the mix M4 than the conventional concrete for 28days.

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COMPARISION OF FLEXURAL STRENGTH

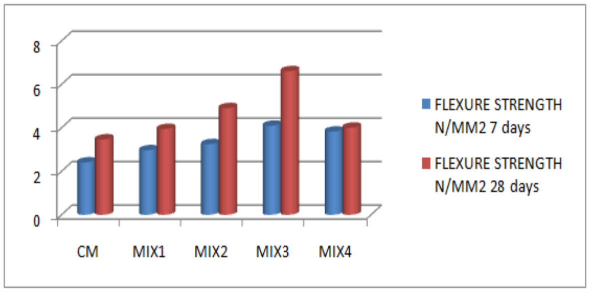

Fig 2 Variation of Flexural strength with Metakolinand STEEL FIBRES

The above graph is drawn for the 7 days & 28 days flexural strength of conventional concrete & Mix Designation M1 in which the23.2% of Flexure Strength is increased for the mix M1 than the conventional concrete for 7 days and the13.83% of Flexure Strength is increased for the mix M1 than the conventional concrete for 28 days. And 34.85% Flexure Strength is increased for the mix M2 than the conventional concrete for 7 days and 41.45% Flexure Strength is increased for the mix M2 than the conventional concrete for 28 days. And 70.12% Flexure Strength is increased for the mix M3 than the conventional concrete for 7 days and And 90.4% Flexure Strength is increased for the mix M3 than the conventional concrete for 28 days. And 59% Flexure Strength is increased for the mix M4 than the conventional concrete for 7days and 15.56% Flexure Strength is increased for the mix M4 than the conventional concrete for 28days.

5. CONCLUSION

Based on the experimental investigations carried out, the following conclusions are drawn

- The Flexural strength of HPC where Metakolinis added as admixture with partial replacement of cement has shown increase in Flexural strength as the amount of admixture is increased when compared to a control mix
- The flexural strength of concrete goes on increasing with the increase in fiber content up to the optimum value. The optimum value for flexural strength of steel fiber reinforced cement concrete was found to be 2 %.
- The percentage increase in the Flexural strength of admixture mixed concrete(Metakolin20%) and 2% steel fiber with the control mix for 7 days and 28 days is 41.18% and 47.5% respectively
- The percentage increase in the Flexural strength of FRC of 1% SF with the Metakolin20% mixed concrete for 7 days &28 days is 25.73% and 29.35% respectively
- The percentage increase in the Flexural strength of FRC of 3% showed decreased results than optimum value of 2% steel fibers
- Finally the proportion of 20% Metakolinwith 2% steel fibers is recommended with respect to flexural strength and economical FRC mix
- The percentage increase in the compressive strength of admixture mixed concrete(Metakolin20%) and 2% steel fiber with the control mix for 7 days and 28 days is 48.2% and 51.2% respectively
- The percentage increase in the split tensile strength of admixture mixed

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concrete(Metakolin20%) and 2% steel fiber with the control mix for 7 days and 28 days is 15.5% and 18.3% respectively

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