REVIEW PAPER ON COMBINE EFFECT OF SILICA FUME AND METAKAOLIN WITH 1% SISAL FIBER ON CONCRETE

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Abstract - *The influence of replacing conventional concrete material with the waste material, natural fiber and mineral admixture has been studied in different proportions. Replacing cement with mineral admixture upto 20% has increased the strength of concrete. 30% partial replacement of sand with Used foundry sand and 1% Sisal fiber by weight of cement found to be the optimum percentage for replacement. Addition of used foundry sand didn't have any adverse effect on concrete. Addition of sisal fiber has result in reduction in workability. Sisal fiber causes high water absorption in concrete. Adding mineral admixture can help in reducing the water absorption of FRC. In this review paper, it has been found out that an experimental investigation can be done to increase the percentage of mineral admixture to reduce the consumption of cement with replacing the sand by UFS and incorporating the sisal fiber to increase in the strength properties of concrete.*

***Key Words*: Silica Fume, Metakaolin, Used Foundry Sand, Sisal Fiber, Compressive Strength**

1.INTRODUCTION

Concrete is currently the most commonly used construction and Concrete is most used material in the construction industries which comes 2nd after water. It provides excellent properties in terms of strength, durability, adaptability, and user-friendly. It is the mix of cement, fine aggregate, coarse aggregate and water. Yearly, there is an increase of 0.5% production of CO2 mainly because of cement, and sadly, around 8% of the world's CO2 emission is due to cement. In India, 130 metric ton of CO2 produced in year 2020. We are producing 38-40 MM ton of co2 in atmosphere for every 100 MM ton of cement. and its 550kg cement is being produce for every one person on earth. Which creates huge anxiety for degradation of natural resources using in concrete and its huge impact on environment. To reduce this anxiety researchers have studied on utilization of waste material like (silica fume, fly ask, steel powder, foundry sand, rice husk ash, plastic, GGBS, etc…) in concrete for making it eco-friendly. And also reducing the use of natural resources. Concrete has a lot of cracks due to shrinkages and some other reasons, to reduce the cracks and increase the mechanical properties of concrete, some of fibers are suggested from the researcher's like (coconut fiber, sisal fiber, bamboo fiber, etc…) as natural fiber is cheap and easily available as waste material. It enhances the properties of concrete.

2. LITERATURE REVIEW

2.1 T.V. Reshma et al. (2021)

Studies the Effect of waste foundry sand and fly ash on mechanical and fresh properties of concrete. And natural river sand is replaced with waste foundry sand in different percentages 0%, 10%, 20%, 30% and 40%. As well 30% fly ash is kept constant as a partial replacement of cement for M40 grade concrete. Better workability is obtained with increase in WFS and maximum slump value is achieved at 30% replacement of WFS. compressive strength is enhanced with increase in WFS content at each curing period for all the mixes. Maximum strength is observed for 30% WFS replacement. About 8.32% increment in compressive strength is observed.

2.2 Adanagouda et al. (2021)

studied the mechanical properties of HPC with metakaoline as partial replacement and addition of hybrid fibers (steel fiber(SF) and(PF) polypropylene fibers) The test results reveal a maximum increase of 31.83%, 37.05%, and 36.53% in compressive strength for curing periods of 7, 28, and 56 days, at 1.25% (0.25% PF and 1% SF) of hybrid fiber and 10% Metakaolin for Water binder ratio of 0.275.

2.3 Tarun Gehlot et al. (2021)

Did a study on the impact of cement replacement on the development of Ternary Blended Concrete by various percentages (0, 5, 10, 15, and 20) of Metakaolin and fly ash. fibres (0% to 1%) has been added with water cement ratio 0.32. Cubes Samples were being tested for compressive strength at age of 28 days. M60 grade of concrete has been considered. It has been observed that that all combination gives the strength more than control mix. At replacing 10% of cement each with fly-ash and metakaolin and addition of 0.75% of fibres an Increase in compressive strength by 15% was obtained.

2.4 S Jagan (2021)

Experimented on the effect of silica fume on the various properties of concrete. Increase in the percentage of Silica

Fume decreases the workability of concrete as the finer SF has more surface area. Due to this it tends to absorb more water which result in reducing the slump value of the concrete. The optimum strength was obtained at 15% SF replacement. For M25 grade concrete, the maximum compressive strength of 14.68% was observed at 14 days and 13.62% at 90 days. Similarly for M40 grade concrete, the maximum improvement in the strength of 13.01% at 14 days and 12.19% at 90 was observed.

2.5 K. Ambiga (2021)

When pozzolanic materials are included to concrete, the silica present in these materials react with the calcium hydroxide released during the hydration of cement and forms additional calcium silicate hydrate (CSH), which enhance durability and the mechanical properties of concrete. All proportion shown strength greater than control mix. 15% Silica Fume replacement gave the maximum compressive strength.

2.6 Babar Ali et al. (2020)

Silica fume enhances the compressive strength of concrete by more than 10%. This improvement is due to the strengthening of cement paste by the reaction of free Calcium Hydroxide reacts with silica fume resulting in the providing more strength contributing cement paste. Moreover, the filler effect of silica fume can contribute to compressive strength improvement by reducing the total void content of concrete. Silica fume-added FRCs show more net gain in the compressive strength than Ordinary Portland Cement-based mixes at a given age. At 180 days, SFRC, GFRC, CFRC, and PFRC show 6, 14, 12, and 8% more compressive strength.

2.7 Sabrish et al. (2018)

Investigated on OPC concrete with incorporating the sisal. Sisal fiber in addition by 0%, 0.5%,1%,1.5% and 3%. The maximum result was observed at 1% incorporation of sisal fiber by mass of cement. After that the strength parameters decreased. Reduction in strength is due the increase in the fibre percentage and that may lead to porous structure by the agglomeration. Freshly prepared Sisal fibre(SF) contain some gelatinous chemical reagents which may affect the chemical properties of cement in concrete.

2.8 Abass Abayomi Okeola et al. (2018)

Has experimented utilization of Sisal Fiber in Reinforced Concrete. The workability of fresh concrete reduced once sisal fiber was added to the mix due to the hygroscopic properties of the sisal, The free-water cement needed for paste formation is reduced. This resulted in increased pore spaces, and it causes the higher water absorption in concrete. As per CEBFIP, silica fume in concrete can help in reducing the water absorption of fiber reinforced concrete.

2.9 A Supraja et al. (2017)

Analysed the strength properties of concrete with 30% partial replacement of ggbs with varying the percentage of sisal fiber as 0.5%, 1.0%, 1.5%, 2% & 2.5%. GGBS concrete mix has obtained more strength when compared to control mix concrete. With 30% GGBS replacement along with fiber addition of 1.5%, the compressive strength is increased by 33.11%, 25.71% and 24.96% at 3, 7 and 28 days. Workability of M25 grade concrete increased with the addition of fibers till 1.5% along with 30% partial replacement of cement by GGBS and later as the fiber content increased workability decreased. It enhanced the crack resistance.

2.10 Raghu Yadav Golla et al. (2015)

Investigated the properties of concrete mixed with used foundry sand as a partial replacement of fine aggregate. Fine aggregate was replaced with three percentages (10%, 20%, and 30%) of Used Foundry Sand by weight. Tests were conducted for the properties of fresh concrete. Compressive strength is more with increasing percentage of foundry sand. With 30% replacement, an increase of 9.8%, 12.4% and 20% in compressive strength at 28, 56 and 365 days was observed compared to conventional mix. In this research also, addition of UFS has not adversely affected the 28-day compressive strength of concrete mix containing used foundry sand

2.11 Srivastava et al. (2012)

Used a combination of silica fume and metakaolin in Portland cement concrete to study its effect on 7 and 28 days compressive strength. The optimum dose of silica fume and metakaolin for maximum compressive strength was 6% and 15% respectively. It was observed that increasing metakaolin content increased the 28 days compressive strength but decreased the 7 days compressive strength. Addition of metakaolin also reduced the slump value in concrete.

2.12 Rafat Siddique et al. (2009)

Has investigated the properties of concrete containing used foundry sand as a partial replacement of fine aggregate. Fine aggregate was replaced with 10%, 20%, and 30% of UFS by weight. Tests were conducted for the properties of fresh concrete. Compressive strength is increased with increasing percentage of foundry sand. With 30% replacement, an increase of 9.8%, 12.4% and 20% in compressive strength at 28, 56 and 365 days, was obtained compared to conventional mix. In this research also, addition of UFS has not adversely affected the 28-day compressive strength of concrete mixtures made with UFS.

Table -1: Literature review papers and their comparison

No	Year	Author	Partially replacing materials with %	Material used	tests	Result
1	2021	T.V. Reshma et al	Used foundry sand by weight of sand - 0%, 10%, 20%, 30% and 40%. Fly ask – 30% constant by weight of cement.	OPC 53 River sands Coarse aggregate Used foundry sand Fly ash superplasticizer	Compressive strength	Increase
2	2021	Adanagouda et al	Metakaolin by weight of cement - 0%, 10%, 20% & 30%. Steel Fiber -0%, 0.5%, 0.75% and 1.0% and Polypropylene Fiber - 0.25% constant by weight of cement.	OPC 43 River sand Coarse aggregate Metakaolin Steel fiber Polypropylene fiber superplasticizer	Compressive strength	Increase
3	2021	Tarun Gehlot et al	Metakaolin and Fly ask each by weight cement – 0%,5%,10%, 15% ,20%.	OPC 53 River sand Coarse aggregate Fly ash Metakaolin	Compressive strength	Increase
4	2021	S Jagan	Silica fume by weight of cement – 0%, 5%, 10% ,15%.	OPC 53 River sand Coarse aggregate Silica fume	Compressive strength	Increase
5	2021	K. Ambiga	Silica fume by weight of cement- 0%, 5%, 9%, 12% and 15%.	OPC 43 River sand Coarse aggregate Silica fume	Compressive strength	Increase
6	2020	Babar Ali et al	Silica fume – 10% by weight of cement. Volume fraction of fiber (Steel Fiber, Glass Fiber, Carbon Fiber, Polypropylene Fiber) – 0.5.	OPC 53 Silica fume Steel Fiber, Glass Fiber, Carbon Fiber, Polypropylene Fiber Siliceous sand Coarse aggregate superplasticizer	Compressive strength	Increase
7	2018	Sabarish et al	Sisal fiber by weight of cement -0%, 0.5%,1%,1.5% and 3%,	OPC 53 River sand Coarse aggregate , Sisal fiber	Compressive strength	Increase
8	2018	Abass Abayomi Okeola et al	Sisal fiber by weight of cement -0.5%, 1.0%, 1.5%, and 2.0%	OPC 53 Sisal fiber Coarse aggregate River sand	Compressive strength	Desirable

9	2017	A Supraja et al	30% GGBS by weight of cement sisal fiber by weight of cement 0.5%, 1.0%, 1.5%, 2% & 2.5%.	OPC 53 GGBS Sisal fiber Coarse aggregate River sand	Compressive strength	Increase
10	2015	Raghu Yadav Golla et al	1% sisal fiber by weight of cement, Fine waste construction sand -by weight of fine aggregate- 20%, 50%, 80%, 100%.	OPC 53 Fly ash Sisal fiber Fine waste Construction sand, Coarse aggregate River sand	Compressive strength	increase
11	2012	Srivastava et al	5%, 6%, 7%, 8%, 9% and 10% for Silica Fume and 10%, 15%, 20% and 25% for Metakaolin by weight of cement.	OPC 43 Silica fume and metakaolin Coarse aggregate River sand	Compressive strength	increase
12	2009	Rafat Siddique et al	Used foundry sand – by weight of fine sand – 10%, 20%, 30%.	OPC 53 Used foundry Sand River sand Coarse aggregate superplasticizer	Compressive strength	Increase

3. CONCLUSIONS

1. From research paper (K. Ambiaga), (jagan et al), (Babar Ali et al), (Srivastava et al), it has been observed that with replacing the cement content with 10-20% the more strength was obtained than control mix in all paper mentioned above and the workability or slump value reduced.

2. It has found in the paper (Tarun et al), (Aangouda et al), (Srivastava et al), that partially replacing the cement with 15-25%, has given better mechanical strength than controlled mix. And even the strength was enhanced with reducing w/c ratio. Flowabilty increases with increasing amount of Matekoalin.

3. In (Aangouda et al), (Sabarish et al), (Abass Abayomi okeola et al), (Raghu Yadav golla et al), (A supraja et al) papers, incorporating fiber between 1-1.5% has enhanced the properties of matrix. concrete brittleness is reduced. It gives resistance to volume shrinkage of concrete. The compressive strength reduced slightly with addition of fiber , but gave optimum strength at 1% The fiber has high water absorption.

4. Paper of (Rafaf et al) , (Reshma et al),) showed that the partial replacement of used foundry sand gives higher mechanical strength (compressive, tensile and flexural strength).the workability of concrete increased with amount of UFS increases. The optimum strength was obtained at 30%.

5. Percentage weight of mineral admixture (like silica fume and metakoalin) in concrete can be increased with replacing fine aggregate with used foundry sand and sisal fiber as have increased the strenth of matrix.

6. 30% replacement of sand with UFS gave the optimum strength

7. Addition of 1% sisal fiber by weight of cement gave the optimum strength in concrete.

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