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Studies on Alternative Solution for Sand in Concrete

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ABSTRACT
At present days infrastructure is the backbone of the country. Infrastructure can be developed by several ways such as steel structure, concrete structure, and wooden structure. Among these structure, wooden structure are not used widely, because rapid use of wood leads to cause deforestation. Steel structures are economic and efficient in case of high rise buildings but in case of small structure it is little costlier than concrete. Therefore, concrete structure are mostly used for such type of buildings. Generally concrete compose of cement, coarse aggregate, fine aggregate and water. Nowadays concrete is used widely. It may cause scarcity of certain materials like fine aggregate. So, our main aim of the project is, to overcome the scarcity of the fine aggregate by reducing the usage. This have been achieved by replacing the rice husk based precipitated silica in the concrete at various proportion mixes (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70% and 80%)replacement

KEYWORD:
precipitated silica, cement, river sand.

INTRODUCTION
Concrete is considered as the most widely used and versatile material of construction all over the world. In recent years, concrete technology has made significant advances which have resulted in economical `improvements in strength of concretes. This economic development depends upon the intelligent use of locally available materials. One of the important ingredients of conventional concrete is natural sand or river sand, which is expensive and scarce. In India, the conventional concrete is produced by using natural sand obtained from riverbeds as fine aggregate. However, due to the increased use of concrete in almost all types of construction works, the demand of natural or river sand has been increased. To meet this demand of construction industry excessive quarrying of sand from river beds is taking place causing the depletion of sand resources.

The dwindling sand resources have not only posed the environmental problems but also have caused the rivers to change their flow direction. This fact has forced the Government to lay down restrictions on sand quarrying process resulting in the scarcity and significant increase in its cost. Thus the scarcity of natural sand has forced to find the suitable substitute. There are the lot of materials available to substitute fine aggregate in making concrete such as fly ash, bottom ash, glass powder-sand ,crushed sand, copper slag, tyre rubber, foundry sand, off shore sand, sugar cane bases ash, marble powder, quarry dust, rice husk, sand extraction from soil & saw dust ash. But rice husk based precipitated silica is the one of the eco-friendly materials and it is taken from oil refining industries. This is a waste product, it is directly dumped to the land, it cause to environment pollution and land occupations. In this way we had to use the rice husk based precipitated silica as a fine aggregate in concrete to reduce the usage of river sand and environmental defects. In this waste materials have higher silica content from 80-85%. This is better choice to replacement of fine aggregate.

The standard mix with 100% manufactured sand has exhibited much higher compressive strength 53 MPa. The standard mix with 100% of river sand has exhibited compressive strength of 49MPa, 7.5% lower than that of manufactured sand. The improved properties of MS by the entire process of manufacturing could have resulted in reduced surface area and better particle packing. This contributed to the better binding effect with the available cement paste and improved the compressive strength. The mix with Ms Sand as 100% fine aggregate gives initial workability of 170mm, which is much higher than that of the mixes with 100% river sand (RS) and crusher dust. Higher fineness modulus, particles grading, shape, texture and control of micro fines have contributed to better workability of manufactured sand. The good physical properties of manufactured sand has enabled in reduction of free water as well. Research findings concluded that, Compared to concrete made from river sand, high fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight & lower permeability due to fillings the pores with micro fines. [1]

The variation of compressive strength with respect to type of concrete block made by using natural sand and artificial sand are observed. Result shows that the mixes with the artificial sand with dust as fine aggregate gives consistently higher strength than the mixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand. It was found that the weight loss of artificial sand block is considerably same with respect to natural sand blocks at 20, 40, and 60 and 90 days, immersed in sulphuric acid solution during the experimental period and maintain pH 4 across it. Both concrete made using artificial sand and natural sand are moderate to chloride permeability. In water absorption test we observed after 24 hours curing, the increase in weight of both natural sand and artificial sand blocks are less than 3% that means both concrete are low absorber hence concretes are good quality. The test result obtained from well planned and carefully performed experimental program encourage the full replacement of natural sand by artificial sand with dust considering the technical, environmental and commercial factor.[2]

Manufactured sand is featured with deficiency in medium size, and has poorer shape and surface texture than natural river sand. Use of manufactured sand will increase water demand, and impair pump ability and finish ability of concrete mix. These effects will become more significant in lean mix. It is feasible to use admixture approach to overcome problems resulting from use of manufactured sand in concrete mix. For the particular case in this paper, MIRA 91 works well in concrete mix with 100% replacement of natural river sand by manufactured sand MS2.However, as manufactured sand has great variety in properties from source to source, and concrete mixes have different cement content from mix to mix, it is hardly to use single admixture for all kinds of manufactured sand and concrete mix. Customized admixture approach with particular manufactured sand would be better solution for use of manufactured sand in concrete mix. [3]

Blended cement concrete is developed with the mixture of Ordinary Portland cement, High Alumina cement, M-sand, coarse aggregate with complots SP430 super plasticizer for the purpose of accelerating early strength and prolonged setting time. The initial setting time of this blended cement is extended to 100 minutes permitting enough time for batching, placing and finishing of concrete perfectly at site. This blended cement will set fastly that the time between initial and final set is found to be about 10-12 minutes. Strength development rate after hardening is fast and after 3 days of curing, compressive strength exceeding 28.8 MPa and 26.51 MPa for cube and cylindrical specimens were obtained. This is similar to what the conventional concrete achieves in 28 days. Nearly 20% of compressive strength of Portland cement is increased by using M-Sand for river sand in conventional concrete. [4]

Compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity of fine aggregate (sand) replaced fly ash concrete specimens were higher than the plain concrete (control mix) specimens at all the ages. The strength differential between the fly ash concrete specimens and plain concrete specimens became more distinct after 28 days. Compressive strength, splitting tensile strength, flexural strength, and modulus of elasticity of fine aggregate (sand) replaced fly ash concrete continued to increase with age for all fly ash percentages. The maximum compressive strength occurs with 50% fly ash content at all ages. It is 40.0 MPa at 28 days, 51.4 MPa at 91 days, and 54.8 MPa at 365 days. At all the ages, the maximum splitting tensile strength was observed with 50% fly ash content. It is 3.5 MPa at 28 days, 4.3 MPa at 91 days, and 4.4 MPa at 365 days. The maximum flexural strength has been found to occur with 50% fly ash content at all ages. It is 4.3 MPa at 28 days, 5.2 MPa at 91 days, and 5.4 MPa at 365 days. At all ages, the maximum value of modulus of elasticity occurs with 50% fly ash content. It is 24.5 GPA at 28 days, 28.0 GPa at 91 days, and 29.0 GPa at 365 days. Results of this investigation suggest that Class F fly ash could be very conveniently used in structural concrete. [5]

The review of research work shows that the replacement of natural sand with artificial sand is fissile and behavior and strength of reinforced concrete will improved. Also the use of polypropylene fiber will enhance strength and behavior of reinforced concrete also improves resistance against impact loading and fire. Polypropylene fibers have a positive impact on ultimate strength of heated beams. For a heating duration of 4.5 hours, the residual ultimate strength is larger than the corresponding strength of beams without polypropylene fibers by more than 60 %. No sudden failures are observed in all beams containing polypropylene fibers. [6]

In this project Metakaolin is added by replacing the cement of about 10%, 20%, 30%,40% and 50%. From this case of adding the various mixing of Metakaolin with glass Fibres the strength of the concrete is more than the conventional concrete thus we preferred this project to have more strength and the durability. Thus the structure built using the Metakaolin by replacing would be of good attractiveness to building and also strength to it. The conclusions arrived from the study of the above research work are as follows The use of Metakaolin in concrete as replacement of cement resulted in Pozzlonic materials like Metakaolin when used as cement replacement materials in concrete improves the properties of concrete due to the Early gain of strength, higher pozzolanic reaction and also helps in reducing the consumption of cement. This leads to saving of natural resources and reduction in the emission of green gases like $CO2$.

The main conclusion arrived from this research work is replacement of Metakaolin at 30% would give more strength in 7 days and also 28 days. After that the compressive strength of concrete sample could be decreased. So the optimum percentage of Metakaolin is 30%. [7]

MATERIALS PROPERTIES:

A. **Cement:** Portland pozzlonic cement (Ultra tech cement) of 43 grade confirming to IS: 12269-1987 was used. It was tested for its physical properties as per IS 4031 (part II)-1988.

Table.1 Properties of PPC 43 grade cement

S.no	Descriptions	Value
1	Fineness of cement	98%
2	Consistency of cement	33%
3	Initial setting time	18 mins
4	Final setting time	465 mins

B. Fine Aggregate: The locally available river sand was used as fine aggregate in the present investigation. The sand was free from clayey matter, salt and organic impurities. The sand was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963.

Table.2 Properties of Fine Aggregate

S.no	Descriptions	Value
1	Specific Gravity	2.6
2	Zone Of Sand	II
3	Fineness Modulus	3.923
4	D60	0.967
5	D10	0.236
6	Co efficient of uniformity	4.099
7	Bulk density	1600kg/m^3

C. Coarse Aggregate: Machine crushed angular granite metal of 20mm nominal size from the local source was used as Coarse aggregate. It was free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with **IS 2386 -1963.**

Table.3 Properties of coarse Aggregate

S.no	Descriptions	value
1	Impact value	12.17%
2	Abrasion value	31.20%
3	Attrition value	6.12%
4	Specific gravity	2.44
5	Bulk density	1652kg /m^3
6	Water absorption	1%
7	Grade of Aggregate	'C'

D. Precipitated Silica: Waste Precipitated Silica was obtained locally from Orchard oil extractions Pvt ltd, Kangayam, and Tamilnadu, India. It was used as a replacement of fine aggregate (natural river sand).The precipitated silica was tested for various properties like specific gravity, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate was conforming to standard specification.

Table.4 physical Properties of precipitated silica

S.no	Descriptions	Value
1	Specific Gravity	2.3
2	Fineness modulus	3.638
4	D60	1.785
5	D10	0.810
6	Co efficient of uniformity	2.2
7	Bulk density	1020kg/m^3

Table.5 chemical properties of precipitated silica

S.no	Descriptions	Percentage
1	SIO_2	90.16
2	Fe_2o_3	0.41
4	Al_2o_3	0.11
5	Cao	1.0
6	Mgo	0.27
7	So_3	0.12
8	$Al_2o_3+fe_20_3$	0.52
9	$Sio_2+al_20_3+fe_2o_3$	0.93
10	Na_2o	0.01
11	K_2o	0.65

E. Water: Chloride free water is used for mixing the concrete in which is potable and is free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Table.6 Parameters in Water

S.no	Parameters	Range
1	P_H	6.8
2	Chloride	Nill
3	Sulphate	0.3 ppm
4	conductivity	0.11 ms
5	TDS	8.655ppm

MIX DESIGN

The mix proportion is very important for the strength of concrete structure. The mix design is done to find the accurate ratio of the concrete ingredients as per the IS 10262-(2009).The mix proportion of **M-25** grade concrete was calculated. The following mix proportions is in our project.

Table.7 M-25 mix proportions

S.No	Description	Value(Kg/m^3)
1	Cement	446
2	Fine aggregate	527
3	Coarse aggregate	1085
4	Water	192

MIX RATIO

We are casted the concrete in different mix proportions. First a control standard concrete specimen are casted without adding any replacement materials. Then we added the replacement materials in different percentage in each mix concrete.

Table.8 Different type of Mixes

S.No	Description	Sand (%)	Precipitated Silica (%)
1	Mix-1	100	0
2	Mix-2	90	10
3	Mix-3	80	20
4	Mix-4	70	30
5	Mix-5	65	35
6	Mix-6	60	40
7	Mix-7	55	45
8	Mix-8	50	50
9	Mix-9	45	55
10	Mix-10	40	60
11	Mix-11	30	70
12	Mix-12	20	80

FRESH CONCRETE PROPERTY

Slump Test

The concrete slump test is an empirical test that measures the workability of fresh concrete. This help to found the concrete weather it is suitable or not for handling and placing. There are three stage of slump. Their range is 0 to 40mm represent the true slump and 40 to 90 mm represent the shear, but 90 to 240 mm represent the collapse stage of the concrete. All are done as per IS 7320(1974).

Table.9 Effect on Slump

S.No	MIX-ID	Percentage of Precipitated Silica	Slump(mm)
1	Mix-1	0	61
2	Mix-2	10	59
3	Mix-3	20	56
4	Mix-4	30	58
5	Mix-5	35	53
6	Mix-6	40	55
7	Mix-7	45	52
8	Mix-8	50	56
9	Mix-9	55	50
10	Mix-10	60	49
11	Mix-11	70	46
12	Mix-12	80	48

COMPACTION FACTOR

In this fresh concrete test found the compaction factor value. If the value compaction factor is more than 1 it represent the self-compacting. But normal concrete compaction factor value varying from 0.6 to 0.85.the test were done as per IS1199-1959.

Table.10 Effect on Compaction Factor

S.No	MIX - ID	Percentage of Precipitated silica	Compaction factor
1	Mix-1	0	0.8
2	Mix-2	10	0.796
3	Mix-3	20	0.785
4	Mix-4	30	0.782
5	Mix-5	35	0.790
6	Mix-6	40	0.788
7	Mix-7	45	0.784
8	Mix-8	50	0.786
9	Mix-9	55	0.780
10	Mix-10	60	0.783
11	Mix-11	70	0.779
12	Mix-12	80	0.774

SPECIMEN CASTING AND TESTING

Generally casting and testing of concrete were done as per IS 516 .we choose the dimensions of the specimens are in cube is 150x150x150mm, cylinder is 150mm x300mm and beam is 100x100x500mm.after the completion of final setting time, specimens are submerged into the water for curing. After the completion of 7, 14 and 28 days curing, the specimens were tested using compressive test machines (CTM)

RESULT AND DISCUSSIONS

i] COMPRESSIVE STRENGTH

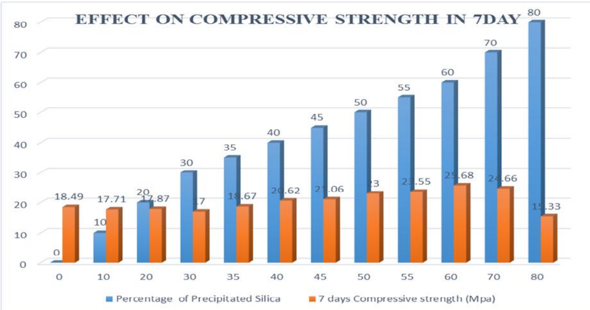

Figure: 1 Effect on Compressive Strength in 7 days

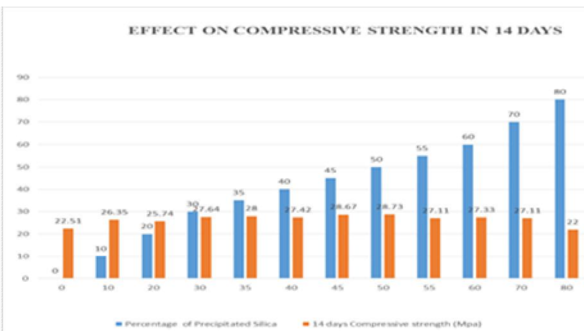

Figure. 2 Effect of compressive Strength in 14 Days

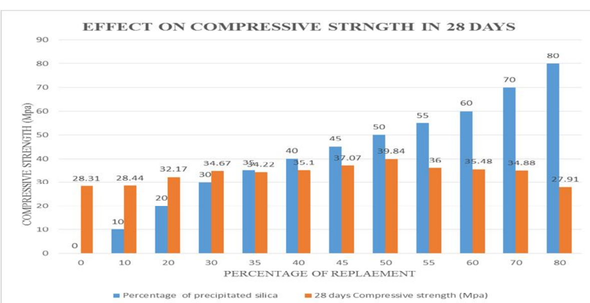

Figure.3 Effect of Compressive Strength in 28 Days

ii] SPLIT TENSILE STRENGTH

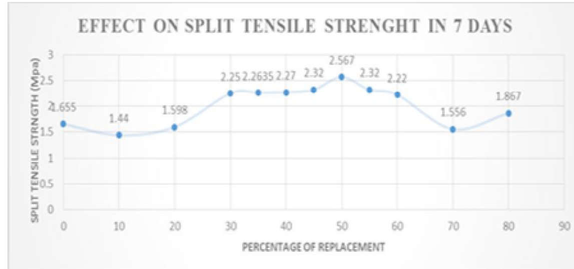

Figure 4: Effect on split tensile strength in 7 Days

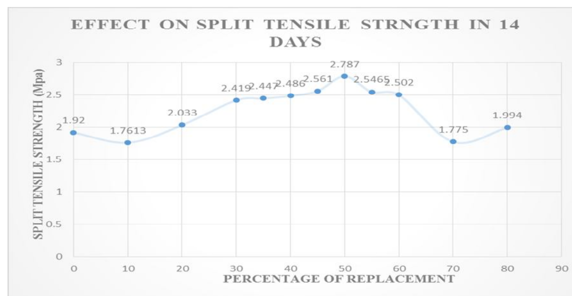

Figure.5 Effect on split tensile strength in 14 Days

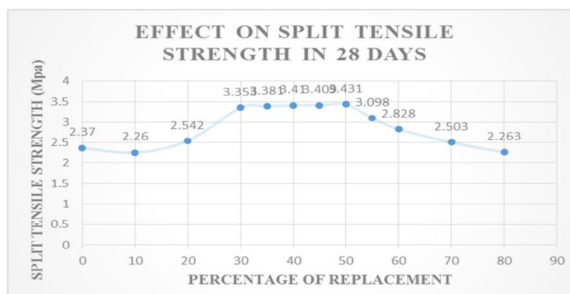

Figure.6 Effect on split tensile strength in 28 Days

iii) FLEXURAL STRENGTH

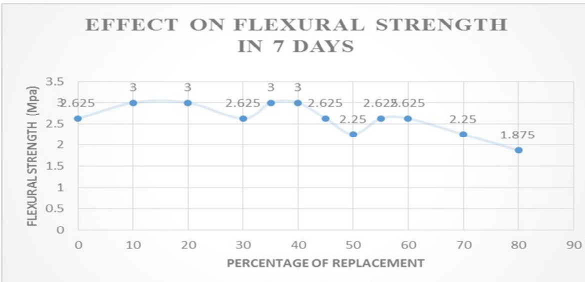

Figure.7 Effect of Flexural strength in7 Days Completed Curing

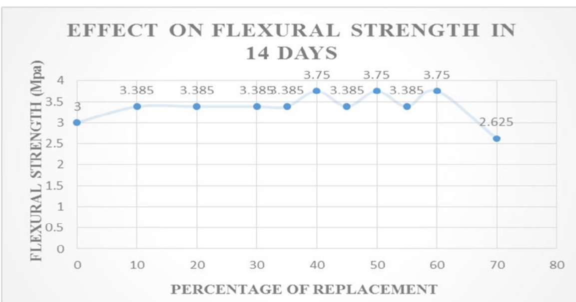

Figure.8 Effect of Flexural strength in14 Days

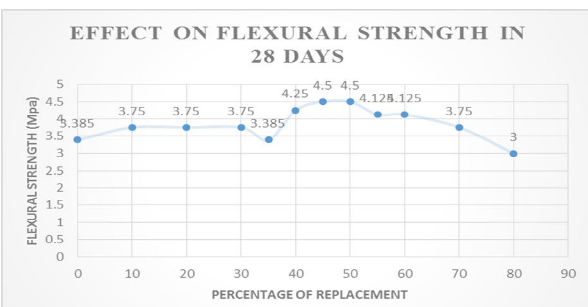

Figure.9 Effect of Flexural strength in 28 Days

CONCLUSIONS

By applying the rice husk based precipitated silica at 50 percentages, the compressive strength for seven days ranges between 18.49 to 25.65 Mpa. The experiment is repeated for fourteen and 28 days are ranges between 22.51 to 28.73 Mpa and 28.31 to 39.84 Mpa respectively. Due to this increase in compressive strength, thickness of the member can be reduced and hence dead load of the member will decrease.

The tensile strength of the concrete is measured at the 50 percentage replacement the values for seven, fourteen and 28 days are 1.655 to 2.567 Mpa and1.92 to 2.787Mpa and 2.37 to 3.431 Mpa respectively.

Similarly the flexural strength is measured at the 50 percentage replacement the values for respective days are 2.62 to 3 Mpa and 3 to 3.75 Mpa and 3.85to 4.5 Mpa.

From this the efficient and effective replacement percentage of the rice husk based precipitated silica is found. This leads to reduction in the cost of manufacturing concrete, Reduction in usage of river sand and environmental pollutions.

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