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EXPERIMENTAL INVESTIGATION OF M30 CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND SAND WITH CRUSHED ROCK SAND

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Abstract: This paper specifies the replacement of cement with silica fume and fine aggregate with crushed rock sand. The use of silica fume had major impact on industries, ability to routinely and commercially produce silica fume modified concrete of flow able in nature but yet remain cohesive, which in turn produces high early and later age strength including resistant to aggressive environments. This study is an experimental on the nature of silica fume and its influences on the properties of fresh concrete. The partially replacement of cement by silica fume the strength parameters of concrete have been studied. First the strength parameters of concrete without any partial replacement were studied then strength parameters by partial replacement with silica fume have been studied by placing cube and cylinder on compression testing machine. Silica fume were used to replace 0% to 40% of cement, by weight at increment of 10% for both cube . The results showed that partial replacement of cement with silica fume had significant effect on the compressive strength of cube. The strength of concrete increases rapidly as we increases the silica fume content and the optimum value of compressive strength is obtained at 15% replacement. After 15% its start decreasing under uniform load condition. The use of crushed rock sand as a partial replacement of river sand in concrete production was investigated. The average compressive strength of the control concrete (C20) was 22.5 N/mm2. The effective natural sand (RS) replacement ranged between 0 and 60 % with the best results achieved at 20 % replacement. This experimental work specifies strength properties of concrete i.e., compressive strength and flexural strength of concrete for 7 and 28 days.

Keywords: Concrete, Partial Replacement, Silica Fume, Crushed Rock.

1. INTRODUCTION

Concrete place a crucial role as a major construction material across the world because of having high mechanical properties, now a days the usage of concrete or cement motor is goes on increasing. Concrete is mainly composed of three basic components cement, aggregates (fine, coarse) and water. Silica fume, also known as micro silica is an amorphous (non-crystalline) polymorph of silicon dioxide. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production. It is extremely fine with particles size less than 1 micron and with an average diameter of about 0.1 microns, about 100 times smaller than average cement particles. Its behaviour is related to the high content of amorphous silica (> 90%). The reduction of high-purity quartz to silicon at temperatures up to 2,000°C produces SiO_2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica.

The objective of this study is to find the effect of partial replacement of Silica fume on the strength characteristics of concrete. Three percentage levels of replacement i.e. 10, 20, 30, 40 percent are considered for partially replacing cement with silica fume. M30 concrete grade is initially designed without replacement and subsequently cement is partially replaced with silica fume.

Currently, India has taken a major initiative on developing the infrastructures such as express highways, power projects and industrial structures etc., to meet the requirements of globalization. In recent years, concrete technology has made significant advances which have resulted in economical improvements in strength of concrete. This economic development depends upon the intelligent use of locally available materials. 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.

Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river or pit sand. Now-a-days good sand is not available it is transported from one place to another so it is need of the time to find substitute to natural river sand. Because of limited supply the cost of natural river sand has sky rocketed and its consistence supply cannot be guaranteed. For the purpose of experimentation concrete mix are designed for M30 grade by replacing natural sand with artificial sand at different replacement levels of 0%, 10%, 20%, 30%, 40%.

Use of crushed sand has become a good substitute for natural sand and it has become essential keeping in view of technical, commercial & environmental requirements. The sand must be of proper gradation (it should have particle from 150 micron to 4.75 mm in proper proportion) Fine and coarse aggregate constitute about 75% of total volume. It is therefore, important to obtain right type and good quality aggregate at site, because the aggregate form the main matrix of concrete. For the purpose of experimentation we are going design concrete mixes of M30 grades by different replacement of natural sand to artificial sand. Its mechanical properties namely cube compressive strength; flexural strength. The necessary of civil

engineering work is to maintain at low cost and achieve mechanical properties' based on this my investigation is also based on maintaining at low cost and achieving mechanical properties for these requirements the ingredients used in concrete are just replaced and added with mineral admixtures, chemical admixtures and others.
For achieving the better mechanical properties of experimental concrete the used mineral admixtures. Chemical admixtures and other are adjusted in different percentages. These replacement and addition details are discussed below. As per the present Economic conscience in the construction field in future we are going to face so many problems at present also we are going to so many problems for a normal type of construction there are so many limitations and remedies and for larger structures we are obeying heavy factor of safety and maintenance issue for physical, chemical and temperatures effects these are affecting the life span of industrial structures or heavy structures. To reduce the maintenance issue a have to take care about performance structure in the starting stage only that means from construction of sub structure onwards we have to use H.P.C for the industrial structures and heavy structures.

2. MATERIALS AMD METHODS

The present experimental investigation SILICA FUME is used as an addition material for replaced in cement by partial replacement and CRUSHED ROCK SAND is used to replace in sand by partial replacement the effect of adding and replacing different percentages of silica fume and crushed rock sand and concrete mixes the compressive and flexural properties are studied.

CEMENT (IS12269:2013):
Ordinary Portland of 53 grades are available in stores with different brands. Select the best brand which satisfies physical and chemical properties according to the Indian standard code provisions IS12209.
Fine Aggregates (IS383:1970)

RIVER SAND:
Locally available river sand and crushed rock sand are considered as a fine aggregates in our project. Physically these material are to be free from clay lumps clay particles and organic matter which effects the strength properties of concrete. Fineness modulus and specific gravity of river sand are 2.65 and 2.74 and these value are satisfied as per Indian standard code.

CRUSHED ROCK SAND:
It is by product material from the quarry crushers it is a fine then 4.75 mm size which is similar to river sand but it is a angular shape and the properties are mainly depend on the type of rock. The main usage of this material is to use the construction waste for eco-friendly environment. Fineness modulus and specific gravity of crushed rock sand are 2.71 and 2.65.


Fig.1: Crushed Rock Sand

COARSE AGGREGATE (IS383:1970)
Locally available coarse aggregate is considered physically its shape is free from flaky and alongation which effects the strength properties of concrete , coarse aggregates of size 20mm and 10 mm required and it is blended base on mix design conforming IS 10262-2009. Specific gravity of coarse aggregate is 2.75.

SILICA FUME:
Silica fume is a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. At a temperature of approximately 2000°C the reduction of high-purity quartz to silicon produces silicon dioxide vapor, which oxidizes and condenses at low temperatures to produce silica fume.


Fig.2: Silica Fume

CHEMICAL REACTION FOR SILICA FUME:
Because of its high amorphous SiO2 content silica fume is reactive pozzalonic material in concrete. When the ordinary Portland cement is hydrated then the calcium hydroxide Ca(OH)2 is formed the calcium hydroxide is acted as a binder material in concrete Or cement motor. When the silica fume is added to the fresh concrete mix the addition binder material calcium silica hydrates(c-s-h) and calcium alumimium hydrates(c-a-h) these addition binder are so fine and field in concrete pores and reduces the permeability property and increase the other mechanical properties.

APPLICATION OF SILICA FUME :
1. The harden silica fume concrete enchances the mechanical property as strength modulus of elasticity, reduces permeability, improves durability.
2. High performance concrete with silica fume used to resist from abrasion chemical attacks for highway bridges, parking decks, marine structures and bridges etc.
3. silica fume is also used in high strength concrete structures concrete like industrial structures and heavy structures which reduces the maintaince expense.
4. silica fume concrete is free from chloride attack because of low permeability.

ADMIXTURES (IS9103-(199))
Admixture as a super plasterer (complast SP430) which is locally, superplastizer are used for increased the workability properties mainly its advantages is to delay in initial setting time for transporting of concrete for longer distance Specific gravity at admixtures is 1.145.

WATER :
The locally available water used in concrete mix is free injurious amount of oil, aids alkalies and salts etc. and also satisfies the IS 56. For example potable water is generally considered satisfactory for mixing of concrete and water which is suitable for drinking purpose without addition of minerals is good for concrete or cement motor the PH value of water shall not be less than 6.

COMPRESSIVE STRENGTH:
Compressive strength is the capacity of a material or structure to withstand axially directed pushing forces. When the limit of compressive strength is reached, materials are crushed. Concrete can be made to have high compressive strength, e.g. many concrete structures have compressive strengths in excess of 50 MPa, whereas a Malarial such as soft sandstone may have a compressive strength as low as 5 or 10 MPa. Compressive strength is often measured on a universal testing machine; these range from very small table top systems to ones with over 53 MN capacity. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard that may, or may not, relate to end-use performance.


Fig 3: Workability of concrete


Fig. 4: casting of cubes.


Fig .5: curing of cubes**.**


Fig . 6: compression testing

3. RESULTS & DISCUSSION

EFFECT OF SILICA FUME PROPORTION ON COMPRESSIVE STRENGTH OF CONCRETE:

Concrete is weak in tension and strong in compression so the concrete should be strong to attain high compression. In this study for each mix 3-samples were tested and the strength is compared with nominal mix of M30 Mix. Compressive strength test finds out the high amount of compressive load a material can bear below facture limit. The test was carried out to obtain compressive strength of M30 grade concrete. The compressive strength of concrete is tested for 7 days & 28 days, for 0%, 20%. 30% ,40% replacement of silica fume and the values are presented in table no 4.1 and also graph were plotted below.

Compressive Strength of concrete for M30 with (silica fume)

Table 1 : Compressive Strength at 7& 28 days :

Notations		% of silica fume replaced in cement	Compressive strength at 7 days in N/mm^2	Compressive strength at 28 days in N/mm^2
A	A1	0	21.00	30
	A2	0	21.2	30.18
	A3	0	21.11	30.12
B	B1	10	25.23	38.1
	B2	10	26.00	37.76
	B3	10	25.58	37.80
C	C1	20	27.23	40.12
	C2	20	26.98	40.02

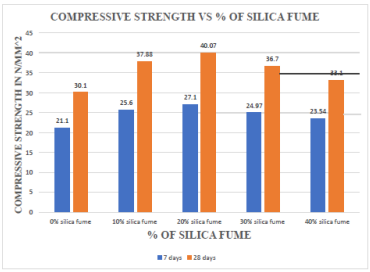

Fig 7: Compressive Strength At 7 & 28 Days

EFFECT OF CRUSHED ROCK SAND PROPORTION ON COMPRESSIVE STRENGTH OF CONCRETE

In this study for each mix 3-samples were tested and the strength is compared with nominal mix of M30 Mix. Compressive strength test finds out the high amount of compressive load a material can bear below facture limit. The results of compressive strength at the age 7thay & 28th days. The compressive strength of concrete is tested for 7 days & 28 days, for 0%, 20%. 30% ,40% replacement of crushed rock sand and the values are presented in table and also graph were plotted below.

Compressive Strength of concrete for M30 (crushed rock sand)

Table 2: Compressive Strength at 7& 28 days :

Notations		% of crushed rock sand replaced in cement	Compressive strength at 7 days in N/mm^2	Compressive strength at 28 days in N/mm^2
A	A1	0	21.00	30
	A2	0	21.2	30.18
	A3	0	21.11	30.12
B	B1	10	36.28	48.6
	B2	10	36.18	47.90
	B3	10	36.25	48.28
C	C1	20	38.61	52.33
	C2	20	38.50	52.25

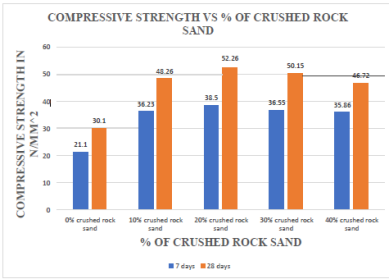

Fig 8: Compressive Strength At 7 & 28 Days

4. CONCLUSIONS

Based on the above discussions, following conclusions are drawn:

From the above study it is concluded that the silica fume and crushed rock sand may be used as a replacement material. Following are some conclusions on Crushed rock sand and silica fume.

Based on the experimental investigation carried out on concrete by using various percentages of silica fumes and crushed rock sand.

Concrete mixtures with different proportions of silica fume & crushed rock sand ranging from 0%, 10%, 20%, 30% and 40% for each three numbers of cube casted with separately.
Compressive strength was increased in silica fume 20% at 7 days 27.1 N/MM^2 and 28 days 40.01 N/MM^2.

Compressive strength was increased in crushed rock sand 20% at 7 days 38.5 N/MM^2 and 28 days 52.26 N/MM^2.

So, the strength was increased in both cases at 20% replacement.

After preparing the specimens of replacement of 20% silica fume in cement and 20% replacement of crushed rock sand in fine aggregates. for mixing of 3-samples were tested and the average strength is compared with nominal mix of M30 Mix.

Compressive strength was increased 54.15 N/MM^2.

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