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Experimental Investigation on Strength Properties of Concrete Using Silica Flour

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Abstract: *In the world, Durability of reinforced concrete structures is one of the major studies in construction industry. It is one of the major responsibilities for all the civil engineers in the world. Such idea is a kind of case dependent. If we analyze this problem in a correct manner, these factors along with the knowledge of chemistry will help us to enhance the performance of the concrete and maximize the material exploitation. In that manner, silica flour has been incorporated to the concrete. Silica is a byproduct of metal silicon and ferrosilicon alloys. It is in powder form and it is composed with amorphous silicon–di-oxide. This amorphous nature material will helps to form a structural phase of the hardened concrete. This silica flour allows to improve the result in early resistant and impermeability. This is the primary reason why silica flour is been widely used as supplementary cementitious additional material in the construction field of all types of structures and even used in repair of damaged structures. This kind of activity will be significant to influence the economy and environmental aspects of the construction industry. In this research silica flour is added in the concrete with various mix proportion and find out the strength properties of the concrete.*

Keywords: *Silica flour, compressive Strength, Strength properties.*

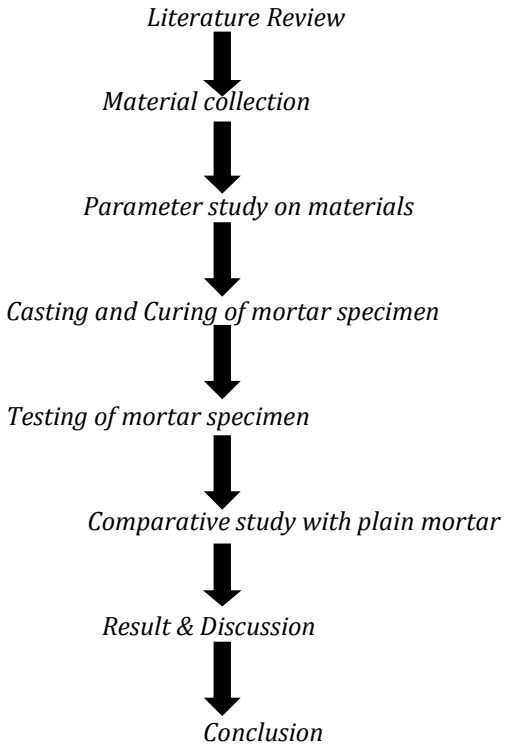
1. INTRODUCTION:

Silica flour concrete can be used in severe exposure conditions where there is a danger to concrete by chlorides or sulphates or other aggressive agents as they ensure very low permeability. Silica flour concrete is mainly used to increase the durability is not just a problem under extreme conditions of exposure but under normal circumstances also, because carbon di oxide is always present in the air .This results in carbonation of concrete which destroys the reinforcement and leads to corrosion. Aggressive salts are sometimes present in the soil, which may cause abrasion. Silica flour concrete can be used to prevent deterioration of concrete. Deterioration of concrete mostly occurs due to alternate periods of rapid wetting and prolonged drying with a frequently alternating temperatures. SinceSilica fume concrete has got low permeability it ensures long life of a structure exposed to such conditions.

2. NEED OF THE STUDY

Silica flour is a by-product of steel manufacturing industry. These waste materials are otherwise not useful and so is been dumped as landfill in the vicinity of the industry. Unprocessed waste can result in environmental issues and consequently waste disposal becomes a major issue. Thus, the effective utilization of this material could bring about economy and will no longer be of environmental concern. This study aims at use of silica flour as an alternative for cement.

3. METHODOLOGY



4. LITERATURE REVIEW

[1]Tahar EI Korchi, Haussom.A, "The influence of silica fume on compressive strength of cement paste and mortar" , Elsevier 1995. This paper explains the compressive strength of silica fume cement paste and mortar evaluated at various

water cement ratio .Silica fume is among one of the most recent pozzolanic material currently used in concrete .In this paper the silica fume is partially replaced by the cement. Upto 25% of silica fume was used .Due to the increse the amount of silica fume the pozzolanic material were affected. With a constant content of silica fume and a constant dosage of superplasticizer, the optimum strength of SF-cement paste and SF-mortar are reached at different water cementitious ratios. Strength increases with increasing silica fume content. This can be attributed to the improved aggregate-matrix bond associated with the formation of a less porous inter-facial zone and a better interlock between the paste and the aggregate [1].

[2]M.S.Morsssy S.H.alsayed, "Effect of evaluated temperature on mechanical properties and micro structure of silica flour concrete", Elsevier 2005. This Paper explains an experimental investigation was conduct to evaluate the temperature on the mechanical properties, phase composition and microstructure of silica flour concrete. The OPC were partially replaced by 0,5,10.15.20% of silica flour. 100 mm cube and 100x200 mm cylinder was prepaired for the examine of result. 0.5wt% is taken. Compressive strength, Tensile strength, Phase decomposition(DSC), Micro structure results were submitted. The study of silica flour has a positive effect on the strength of the concrete. Based on the mechanical acd physical property of silica flour ,it was observed that 20% of silica flour concrete was generally more favourable than 5,10 and 15%[2].

[3]M.J.Shannag, High strength concrete containing natural pozzolan and silica fume, Elsevire , 23 June 2000. This paper explain the Various combinations of a local natural pozzolan and silica fume were used to produce workable high to very high strength mortars and concretes with a compressive strength in the range of 69–ll0 MPa. The mixtures were tested for workability, density, compressive strength, splitting tensile strength, and modulus of elasticity. The results of this study suggest that certain natural pozzolan–silica fume combinations can improve the compressive and splitting tensile strengths, workability, and elastic modulus of concretes, more than natural pozzolan and silica fume alone. Cement, Silica sand, Silica fume, Pozzolan, Water, Superplasticizer were used for this concrete. When the concrete contain 20% of silica fume the compressive strength of the concrete is 95 Mpa. Based on the results of this study, it can be concluded that certain natural pozzolan–silica fume combinations can improve the strength of mortars more than natural pozzolan or silica fume alone[3].

[4]R.Duval and E.H Kadri, Influence of silica fume on the workability and the compressive strength of silica fklour concrete, Elsevier 2005. This paper explains the workability and the compressive strength of silica fume concretes were investigated at low water-cementitious materials ratios with a naphthalene sulphonate superplasticizer. The results show that partial cement replacement up to 10% silica fume does not reduce the concrete workability. Cement, Silica fume, fine aggregate, coarse aggregate and super plasticizer were used the results is compared between experimental and theorical values of the compressive strength obtained. The increase of the compressive strength of sf concretes depends much more on the decrease of the water/cementitious materials ratio than on the replacement of silica fume with cement. The compressive strength increases with the silica fume content up to 20% and reaches a maximum for a 10 to 15% sf level. However the gain in strength compared with reference concrete remains less than 15%[4].

[5]M. Mazloom, Effects of silica fume on mechanical properties of high strength concrete, Elsevier 2005. This paper presents the results of experimental work on short- and long-term mechanical properties of high-strength concrete containing different levels of silica fume. The aim of the study was to investigate the effects of binder systems containing different levels of silica fume on fresh and mechanical properties of concrete. Cement, Silica fume, fine aggregate, coarse aggregate and super plasticizer were used. The compressive test, elastic modulus, swelling, shrinkage, moisture movement, creep were discussed in this paper. The compressive strength of concrete mixtures con-taining silica fume did not increase after the age of 90 days. Silica fume did not affect the total shrinkage; how-ever, as the proportion of silica fume increased, the autogenous shrinkage of high-strength concrete in-creased and its drying shrinkage decreased[5].

[6]Engr. Hazrat Amin "Use of Silica Fume and Marble Dust as Partial Binding Material in Concrete" First International Conference on Emerging Trends in Engineering, Management and Sciences" December 28-30, 2014. The scope of this project work is to determine the combined effect of silica fume and marble dust on concrete and comparing it by using various percentage replacements of silica fume and marble dust with cement in concrete. Nano-silica has gained a lot of attention as an additive agent to the cement for production concrete due to its improving influence on mechanical properties and durability of the concretes. The present review summarized part of studies on the effect of Nano-silica[6].

5. SELECTION OF MATERIALS:

The production of well compressive strength concrete involves the following three important interrelated steps:

- *Selection of suitable ingredients for concrete having the desired rheological properties, strength etc*

- *Determination of relative quantities of the ingredients in order to produce durability.*
- *Careful quality control of every phase of the concrete making process.*

6. MIX DESIGN

The mix design of cement concrete cube is trial and error method. Many reference available for mix proportion of cement concrete cube. In this present study the cement concrete was prepared using cement - sand- coarse ratio of 1:2.4:3.3 by weight with water binder ratio as 0.45.The blended cement used in this investigation be made up of OPC and silica flour .The OPC was partially substituted by silica flour of 10%, 20% 30%and40 % by weight of cement.

Table 6.1-: *Mix Design of 1:2.4:3.3 concrete*

Components	Replacement levels of Silica flour				
	SF-0%	SF-10%	SF-20%	SF-30%	SF 40%
W/C Ratio	0.45				
Cement	1	0.9	0.8	0.7	0.6
Silica Flour	-	0.1	0.2	0.3	0.4
Fine Aggregate	2.4				
Coarse Aggregate	3.3				

7. EXPERIMENTAL INVESTIGATION

Cement Concrete containing SF were prepared with the same flowing capacity through the constant amount of superplasticizer .The water/binder ratio of all mixtures were 0.45, where the binder weight is the total weight of cement and Silica flour (SF). Accordingly, mixing was carried out in a rotary mixer as follows:

- ✓ *The Cement and SF were premixed for 30 s. Then dry mixed cement and SF were added to the mixture. After adding, the mixer was allowed to run for 1 min at medium speed.*
- ✓ *The sand was gradually added at 30s while the mixer was running at medium speed.*
- ✓ *The water were added and stirred at high speed for 30s.*
- ✓ *Then the water+conplast were added to reduce the amount of water.*
- ✓ *The mixture was allowed to rest for 90s. Then mixing was continued for 2 min at high speed.*
- ✓ *After mixing, the samples were cast into the 150x150x150 mm cubes for compressive test, 100×200 mm cylinders for split tension.*

The compressive samples were placed in three layers. Each layer was damped 25 times following the procedure of ASTM C-109. After 24 hours the specimens were removed from the molds and cured in water at 23±2 °C for 7 and 28 days. The cylinders were placed in three layer. Each layer was damped 20times in about 10s using a hard steel rod. After 24 hours the specimen was demoulded and cured at 23±2 °C for 28th day test.

Table 6.2-: *Mix Proportions of concrete*

Proportion	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate(Kg)	Silica Flour (Kg)
S 0%	1.43	3.23	4.34	0.0
S10%	1.29	3.23	4.34	0.14
S20%	1.14	3.23	4.34	0.28
S30%	1.00	3.23	4.34	0.42
S40%	0.86	3.23	4.34	0.560

8. COMPRESSIVE STRENGTH TEST

Fig 7.1-: *Compressie Strength Test*

The compressive strength test is a mechanical test measuring the maximum amount of compression load a

material can bear before fracturing. Due to compression load, the cube or cylinder undergoes lateral expansion owing to poisons ratio effect.

The compressive loading test on concrete cubes were carried out on a compression testing machine of capacity 2000kN.The test piece usually in the form of a cube is compressed between the platens of a compression testing machine by a gradually applied load .The specimen used was 150x150x150mm cube .The test was performed at 7 and 28 days.

Compressive strength = Maximum load / cross section area of the cube N/mm²

9. RESULTS AND DISCUSSIONS

In this study hardened properties and durability of High performance concrete were investigated. The results of hardened concrete tests were conducted on cement concrete cube and cylinder at 7, 28 days water curing compressive strength, Young's modulus test.

Table 8.1-: Compressive Strength Test Result

AMOUNT OF SILICA FLOUR (%)	COMPRESSIVE STRENGTH(N/mm²)	
	7th day	28th day
0	21.82	39.27
10	25.93	39.97
20	26.34	40.75
30	27.76	41.41
40	25.15	40.03

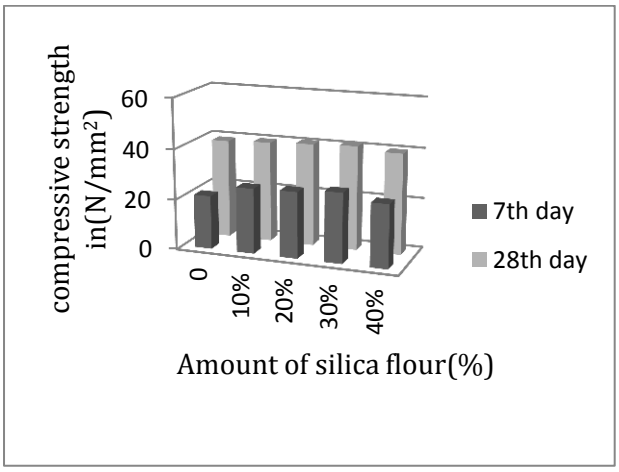


Fig 8.1-: *Compressive Strength Test Result*

10. CONCLUSIONS

The following conclusions can be drawn from the strength studies on high performance concrete mixes using silica flour.

1. *The Mechanical properties such as compressive strength and Young's modulus of concrete can be improved by silica flour.*
2. *The compressive strength of concrete improves when a part of cement is replaced by certain percentage of silica flour.*
3. *A 10% replacement of cement by silica flour appears to increase the compressive and Young's modulus strength at all ages compared to a control mix.*
4. *The compressive strength of cement concrete is decreased when the 40% of amount of cement is replaced by the silica flour.*
5. *The maximum increase in strength is observed at a silica fume content of 30% when cement is replaced by silica flour.*
6. *The optimum replacement of silica flour found was 30%*
7. *Keeping in view of cost cement replacement will be economical.*

References:

[1] Tahar EI Korchi, Haussom.A, "The influence of silica fume on compressive strength of cement paste and mortar" , 1995.

[2] M.S.Morsssy S.H.alsayed, "Effect of evaluated temperature on mechanical properties and micro structure of silica flour concrete", 2005.

[3] M.J.Shannag, High strength concrete containing natural pozzolan and silica fume, 2000.

[4] R.Duval and E.H Kadri, Influence of silica fume on the workability and the compressive strength of silica fklour concrete , 2005.

[5] M. Mazloom, Effects of silica fume on mechanical properties of high strength concrete, 2005.

[6] Engr. Hazrat Amin "Use of Silica Fume and Marble Dust as Partial Binding Material in Concrete" First International Conference on Emerging Trends in Engineering, Management and Sciences", 2014.