Experimental Investigation on Partial Replacement of Cement with Silica Fume in M_{20} and M_{30} Grades

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Abstract

Concrete is most widely used material in construction industry among the world. The use of cement and its production creates more environmental issues and much costlier. To get better results out of this, different types of Admixtures are added to concrete to achieve or modify its properties. This consequent modification adopts durability, workability or strength of given concrete. The main use of Admixture (Silica Fume) as replacement of cement in present days is to acquire concrete strength. In this paper, an experimental study on the nature of mineral admixture (silica fume) which influences the properties of fresh or hardened concrete is studied. This attempt was made to examine strength parameters of concrete made with partial substitution of cement by Silica fume (0%, 5%, 10%, 15% and 20%) for 3,7,28 and 56 days for both M20 and M30 grade concrete and to compare both the test results. It is casted for 150mm*150mm*150mm cubes for Compression strength and Cylinder of size 150mm diameter and 300mm height for tensile strength and 500mm*100mm*100mm beam mould for flexural strength.

Keywords: Cement of Grade 53, Silica Fume, Water, Sand and Coarse Aggregate

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I. INTRODUCTION

Concrete is most commonly used material in our modern technology. Among all the building materials life span of concrete building can be double or triple. From many years, several steps were taken to enhance the performance of concrete in construction field. Concrete is a material which is mix of cement, water and aggregates.

The agenda here is to study the features of Silica fume by replacing it with cement without reducing the strength and workability.

Silica fume is one of the important usages and gives good properties when mixed with concrete. Concrete which is mixed with Silica fume can attain high strength and durable because of chemical and physical properties.

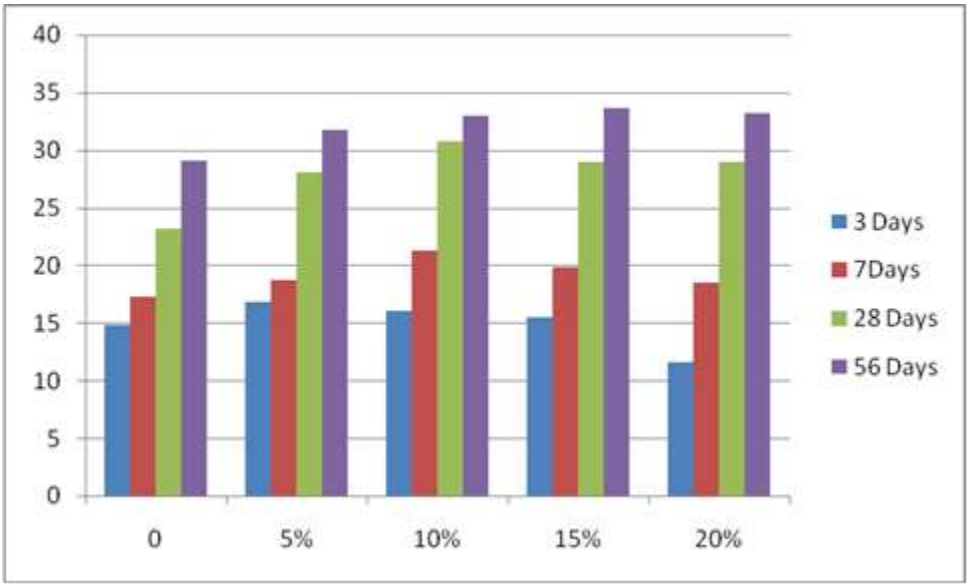
Silica fume is essential in production of high strength concrete in current environment. The main usage of Silica fume as pozzolanic material has expanded worldwide attention in recent years because of its enhancing mechanical properties. When it is suitably used it correct proportions, it can attain various properties of concrete in both fresh and hardened state like cohesiveness, strength, permeability and durability. Silica fume reduces bleeding as free water is used for wetting. Hence free water in the mix which was left causes decreasing in bleeding.

II. RESULTS AND DISCUSSIONS

A. Compression Test Results:

Table - 5.3
Values for Compression strength of concrete for M20 grade

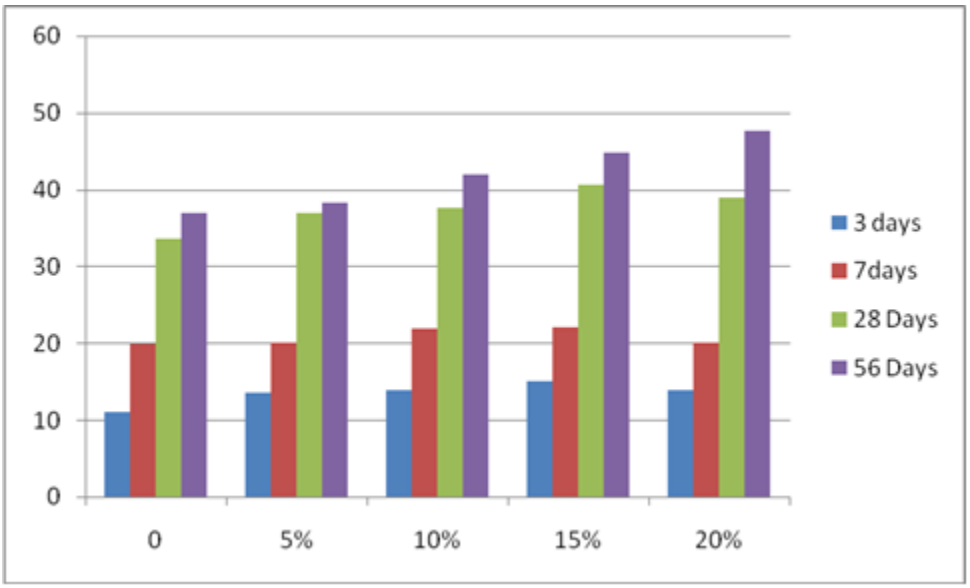
S.No	*% replacement of Silica Fume for M20 grade*	*3 days*	*7days*	*28 Days*	*56 Days*
1	*0*	*14.78*	*17.23*	*23.13*	*29.06*
2	*5%*	*16.84*	*18.74*	*28.03*	*31.78*
3	*10%*	*16.02*	*21.28*	*29.01*	*32.99*
4	*15%*	*15.53*	*19.81*	*29.51*	*33.65*
5	*20%*	*11.60*	*18.48*	*28.92*	*33.20*



Graph 5.1: Compression strength values for M20 grade of concrete at different % of Silica Fume

Table - 5.4
Values for Compression strength of concrete for M30 grade

S.No	*% replacement of Silica Fume for M30 grade*	*3 days*	*7days*	*28 Days*	*56 Days*
1	*0*	*11.07*	*19.94*	*33.55*	*36.89*
2	*5%*	*13.58*	*20.07*	*36.98*	*38.30*
3	*10%*	*13.84*	*21.89*	*37.64*	*42.01*
4	*15%*	*14.96*	*21.99*	*40.62*	*44.87*
5	*20%*	*13.90*	*19.98*	*38.97*	*47.64*



Graph 5.2: Compression strength values for M30 grade of concrete at different % of Silica Fume

B. Split Tensile Results

Table - 5.5
Values for Split tensile Strength of concrete for M20 grade

S.No	*% replacement of Silica Fume for M20 grade*	*3 days*	*7days*	*28 Days*	*56 Days*
1	*0*	*1.62*	*2.05*	*2.78*	*3.32*
2	*5%*	*1.84*	*2.54*	*3.01*	*3.51*
3	*10%*	*1.95*	*3.01*	*3.36*	*3.75*
4	*15%*	*1.71*	*2.40*	*3.49*	*3.90*
5	*20%*	*1.25*	*2.18*	*3.41*	*3.82*

Table - 5.6
Values for Split Strength of concrete for M30 grade

S.No	*% replacement of Silica Fume for M30 grade*	*3 days*	*7days*	*28 Days*	*56 Days*
1	*0*	*1.29*	*2.01*	*3.39*	*3.87*
2	*5%*	*1.49*	*2.25*	*4.02*	*4.44*
3	*10%*	*1.57*	*2.38*	*4.45*	*4.76*
4	*15%*	*1.68*	*2.40*	*4.60*	*5.59*
5	*20%*	*1.59*	*2.28*	*3.92*	*4.53*

III. FLEXURAL STRENGTH RESULTS

Table - 5.7
Values for Flexural Strength of concrete for M20 grade

S.No	*%replacement of Silica Fume for M20 grade*	*3 days*	*7days*	*28 Days*	*56 Days*
1	*0*	*2.69*	*2.97*	*3.31*	*3.92*
2	*5%*	*2.97*	*3.01*	*3.40*	*4.14*
3	*10%*	*3.05*	*3.26*	*3.65*	*4.72*
4	*15%*	*3.78*	*3.37*	*3.99*	*4.93*
5	*20%*	*2.64*	*3.19*	*3.71*	*4.11*

IV. CONCLUSIONS

- Workability of slump cone test decreases as % replacement increases
- As per investigating, compression strength with addition of Silica Fume increased to certain limit (at 15%). After increasing to 20%; strength decreased.
- At 20% increment of SF, there is decrement in both flexural and split tensile strengths.
- Appropriate percentage of Silica fume should be added to attain required strength; as % increases, strength decreases. It is observed that adding 15% of Silica Fume increases strength and upon increasing to 20% decreases in strength range. It is observed in all the 3 cases.
- Silica fume can be added to attain strength in concrete.
- Cost of cement may be reduced by replacing some quantity with Silica Fume as it helps in attaining good strength.
- Consistency is important factor of cement. As Silica Fume is ultra-fine material; on adding it consistency increases as % increases.
- By adding SF we can attain early strength which is useful in constructions of high rise buildings, bridges, dams etc.