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Experimental Studies on Strength of Concrete by Partial Replacement of Cement and Coarse Aggregate with Silica Fume and Road Demolition Waste

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ABSTRACT

The demand for construction materials is increasing rapidly, to meet the demand the waste materials should be replaced based on testing. The Road Waste is generated whenever any demolition or construction of roads, bridges, flyover and remodeling etc. 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 road demolition waste influences on the properties of fresh concrete. These wastes may occupy considerable storage and environmental effect. This study focuses on the compression, split tensile and flexural strength properties of M20 grade concrete. The composite concrete contains different percentage of Silica Fume and road demolition waste, and they were used as partial replacement for cement and Coarse aggregate respectively. The Silica fume is added to the concrete with the percentage of 0%, 5%, 10%, 15% and 20% by the weight of cement and 0%, 10%, 20%, 30% and 40 % of road demolition waste was replaced instead of Coarse aggregates. Concrete specimens casted are cubes, cylinders and beams. After completion of curing process, the concrete specimens are tested at 28 days and the final test results are recorded, analysed and discussed. The strength achieved due to the addition of Silica fume and road demolition waste is compared with the conventional concrete. The experimental results reveal that the compressive strength, split tensile strength and flexural strength test values increases by adding at 10% of Silica fume and 20% of Road demolition waste respectively.

1. Introduction

The quantities of construction and demolition wastes are generated every year in developing countries like India. The disposal of this waste is a very serious problem because it requires huge space and very little demolished waste is recycled or reused. Concrete as a construction material has gained its popularity. Hence, the ingredients for making concrete have reached the demand for hour. As the demand rises, the cost of each material reaches higher prices. In making conventional concrete, the demand for coarse aggregate increase every day. It is necessary to think of possible way on how to avoid these problems under the same time secure, safety and convenience and that is to reuse. Solution to this prevailing condition, the cement and coarse aggregate have been replaced with silica fume and road demolition waste.

In the recent years, the demolished waste is necessary to produce new product suitable for the environment. Demolition waste is the waste debris from destruction of buildings, roads, bridges or other structures. About 90%of construction waste was inert as public fill. One of things builders, developers and contractors must consider during innovation or demolition, construction is where to put all debris. The rise of cost and demand of cement is mainly due to limited production capacity and restricted types of cement produced in the country. 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 behavior is related to the high content of amorphous silica (> 90%). The reduction of high-purity quartz to silicon at temperatures up to 2,000ºC produces SiO_2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica.

During the last three decades, great strides have been taken in improving the performance of concrete as a construction material. Particularly Silica Fume (SF) and fly ash individually or in combination are indispensable in production of high strength concrete for practical application. The use of silica fume as a pozzolana has increased worldwide attention over the recent years because when properly used it as certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. Silica fume concrete may be appropriate in places where high abrasion resistance and low permeability are of utmost importance or where very high cohesive mixes are required to avoid segregation and bleeding.

2. 2. Materials and Methods

3. 2.1 Materials

2.1.1 Cement

Ordinary Portland cement of 43 grades conforming to IS: 8112-1989 was used. The cement was tested as per IS 4031-1968. Table1 shows the physical properties of cement. Physical Properties of Cement

Table 1: Test result on cement

Property	Observed value
Fineness %	5
Initial setting time	48min
Final setting time	242min
Specific Gravity	3.11

2.1.2 Fine Aggregate

Yellow sand of grading Zone II confirming to IS:383-1970 is used that is available commercially.

Table 2: Test result on Fine aggregates

Properties	Results
Specific gravity	2.6
Fineness modulus	2.7
Moisture content	1.40
Bulking sand	4%

2.1.3 Coarse Aggregate

Crushed angular coarse aggregates of 10mm and 20mm nominal sizes are used in the ratio of 40:60 respectively.

Table 3: Test result on Coarse aggregates

Properties	Results
Specific gravity	2.74
Fineness modulus	6.10
Moisture content	15%
Water absorption	2.4%

2.1.4 Silica Fume

Silica fume is a by-product of the manufacture of silicon metal and Ferro-silicon alloys. The process involves the reduction of high purity quartz (SiO2) in electric arc furnaces at temperatures in excess of 2,000°C. Silica fume is also known as micro silica. It is an ultra-fine material with spherical particles less than 1 µm

Table 4: Test result on silica fume

Properties	Results
Specific gravity	2.25
Bulk Density	429 kg/m^3
Particle size	1µm

2.1.5 Road Demolition Waste

The road demolition waste is the partial replacement of coarse aggregate in the concrete mix. The waste materials are collected from the road remodeling process in the nearby highway. It is replaced up to 0 to 40% which is retained from 20mm and 10mm I.S. Sieve. The wastes are crushed, sieved and tested in the laboratory and replaced in the mixture.

2.1.6. Water

The Potable water was used for the blending and curing of the concrete and the pH value of water was below 6. The water used was free from any acid, oils and salt or sugar materials.

2.2 Methods

The ingredients of concrete consist of Cement, fine aggregate and coarse aggregates, water. When the reaction of water with cement takes place hydration process is done and a hard material is formed. Mix design carried out for M20 grade of concrete by IS 10262: 2009 yielded a mix proportion with water cement ratio of 0.45 as shown in table 5. Specimens were prepared according to the mix proportion and by replacing cement with Silica fume and also replacing Coarse aggregate by Road demolition waste in different proportion. The ingredients are used in proper proportion by replacement of cement at 0%, 5%, 10%, 15% and 20 % by Silica fume and by replacement of Coarse aggregate at 0%, 10%, 20%, 30% and 40 % by road demolition waste. To find out the Compressive strength, specimens of dimensions 150X150X150mm were used finally cast and tested using a compressive testing machine for 28 days characteristic compressive, Flexure and Split Tensile strength

Table 5: Mix proportion for M20 grade concrete

Type of component of mix	Weight per m3
Cement	324.38 kg
Silica fume	81.096 kg
Fine aggregate	617.76 kg
Coarse aggregate	900.95 kg
Road Waste	225.23 kg
Water	202.74 lit

3. Results and Discussion

In this chapter, the authors were discussed about the important properties of concrete such as compressive strength, Flexural strength and split tensile strength of conventional concrete in various mixing proportion such as Silica fume and Road demolition waste. The experimental results values are acceptable for M_{20} grade of concrete

Table 6: Investigated Concrete strengths for 28 days

S.No	Road waste (RW) (%)	Silica Fume (SF) (%)	Compressive Strength(N/mm^2)	Flexural Strength(N/mm^2)	Split tensile Strength(N/mm^2)
1	0	0	27.83	3.81	8.84
2	10	5	29.61	3.98	9.11
3	20	10	33.21	4.47	9.72
4	30	15	28.10	3.31	7.89
5	40	20	26.71	3.06	6.42

3.1 Compressive Strength

In this experimental investigation, cubes of 150 mm x 150 mm x 150 mm size were casted and after curing period of 28 days, the cubes were tested in compressive testing apparatus. The cube test was conducted as per IS 516: 1959. The test result is tabulated in table 6 and shown graphically in Fig 1. Compressive strength $= \frac{P}{A}$ N/mm^2

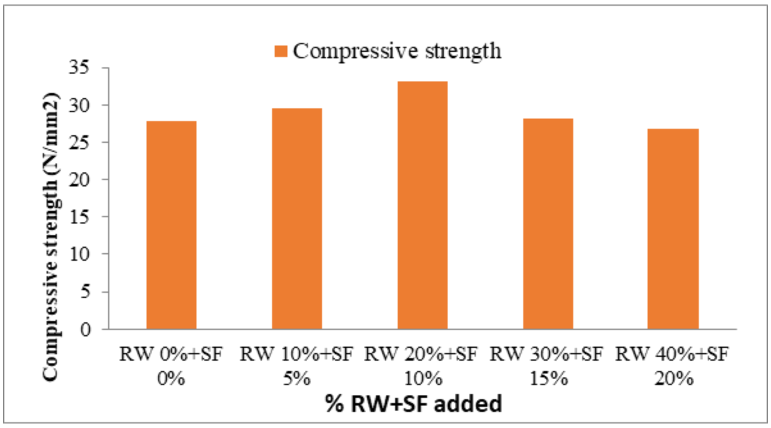

Fig 1: Compressive strength for 28 days strength

3.2 Flexural Strength

In this experimental investigation, beams of 500 mm x 100 mm x 100 mm size were casted and after curing period of 28 days, the beams were tested in universal flexural testing machine. The beam test was conducted as per IS 516: 1959. The test results tabulated are in table 6 and shown graphically in Fig 2. Flexural Strength = pl/bd^2, N/mm

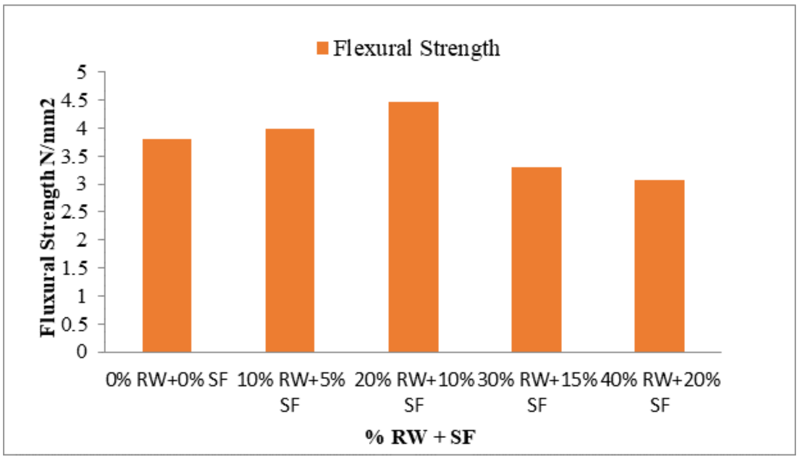

Fig 2: Flexural strength for 28 days strength

3.3 Split Tensile Strength

Strength In this experimental investigation cylinders of 150 mm diameter 300 mm length size were casted and after curing period of 28 days, the cylinders were tested under universal tensile testing machine. The split test was conducted as per IS 516: 1959. The test results tabulated are in table 6 and shown graphically in Fig 3. Split Tensile strength = 2P / π DL, N/mm2

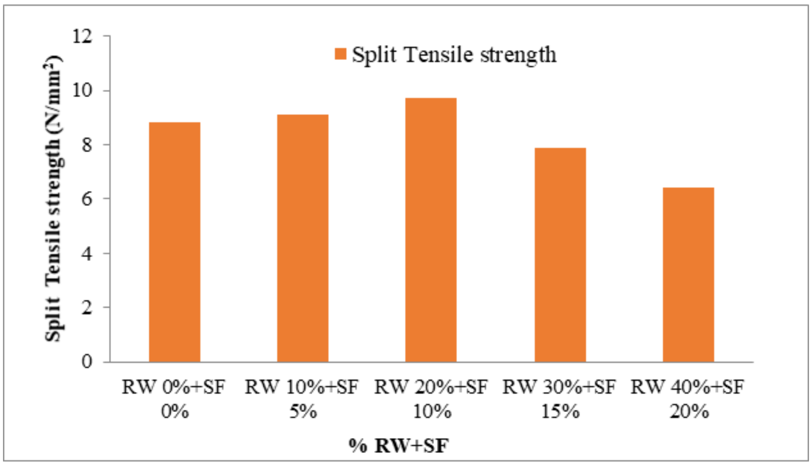

Fig 3: Split tensile strength for 28 days strength

4. Conclusion

On the basis of present experimental study, the following conclusions are drawn:

1. By adding controlled percentage of silica fume and of road demolition waste to the concrete there is increase in strength characteristics of concrete after 28 days.
2. By the addition of 10% Silica fume and 20% road demolition waste, the compressive strength of modified concrete mix (Fig 1) is increased (up to 19.33%) when compared with conventional concrete strength and various percentages of silica fume and road demolition waste in concrete.
3. By the addition of 10% Silica fume and 20% road demolition waste the overall strength enhances particularly the flexure strength and split tensile strength of modified concrete mix is increased (Fig 2: up to 17.32% Flexural strength) and (Fig 3: up to 15.16% Split tensile strength) when compared with conventional concrete strength and various percentage road demolition waste and silica fume in concrete.
4. Silica Fume can impart very high strength and can be used to form High Performance Concrete, Silica fume abundantly available industrial wastes in India and can be effectively used as partial replacement of cement in concrete mix. Even the road demolition waste is being available during remodeling and construction process of road and it is recycled and again used for the road construction activities.

Reference

1. ASTM 2012. Standard Specification for Portland Cement, 2012.
2. Abdullah K.M, Hussein W, ZakariaF, Muhammad R, Abdul Hamid Z (2006). A potential partial replacement of silica fume proceeding of the 6th Asia-Pacific structural Engineering and construction conference (APSEC 2006) kualalumpur, Malaysia.
3. V.C Jayafus Shabah , D. Smiline Shiny " An Experimental Study on Strength of Concrete with Silica Fume and Partial Replacement of Cement by Brick Powder", International Journal of Innovative Science and Research Technology, Volume 3, Issue 5, May – 2018, pp. 786-790
4. Lakhbir Singh1, et.al, "Study of Partial Replacement of Cement by Silica Fume". International Journal of Advanced Research (2016), Volume 4, Issue 7, 104-120.
5. Apoorv Singh et.al. "A Comparative Study on Compressive and Flexural Strength of Concrete Containing Different Admixtures as Partial Replacement of Cement". Int. Journal of Engineering Research and Applications, Vol. 4, Issue 9(Version 5), September 2014, pp.118-123
6. Aitcin, P. C. Hershey, P.A. and Pinsonneault (1981). Effect of the addition of condensed silica fume effect on the compressive strength of mortars and concrete. American Ceramic Society. 22:286-290.
7. Eman K. Jallo. Experimental Study on the Behaviour of High Strength Concrete with Silica Fume under Monotonic and Repeated Compressive Loads, Al-Rafidain Engineering Vol.20 No. 2 March 2012.
8. Gopalakrishnan, Vishoni, R.K., M Tehri dam project (2003). Silica fume in HPC for ensuring Abrasion Erosion resistance
9. M. Kamal Uddin "Use of brick dust in concrete as mineral admixture and partial replacement of cement"Journal of Civil Engineering (IEB),volume 32(1) (2004) 69-78.
10. P Srinivas1, A S SVara Prasad2, S Ashok Kumar3 "experimental study on strength of concrete with partial replacement of fine aggregate with waste clay brick powder" IJSART –volume 2 Issue 8 – August 2016.
11. S.Kranthi kumar1, K.Madhan gopal2, G.Sreenivasulu3 "Experimental investigation on the properties of concrete replacing cement with metakaolin, fly-ash & brick powder" Intentional journals of advance research in science and engineering.vol.no.5 Issue no.8, August 2016

