

# Study of partial replacement of cement by barite powder and silica fume in self compacting concrete

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**Abstract** - In the present world, concrete has become a vital part of our lives. Barite is a soft crystalline mineral form of barium sulphate. Barite powder mostly used in oil well drilling industry and paint industry Silica fume is a by-product obtained from an electric arc furnace used in manufacture of silicon metal. Barite powder and silica fume can be used as a best supplementary cementitious material. Self compacting concrete invention makes a significant turning point in the history of construction sector. In this project experimental program carried out to explore mechanical properties of self compacting concrete as partial replacement of cement by barite powder and silica fume. Compare the compressive strength, split tensile strength of M30 grade self compacting concrete. Cement is partially replaced by 0%, 5%, 10%, 15%, 20% and 25% by barite powder and silica fume by one by fourth of barite powder.

**Key Words:** Barite powder, Supplementary cementitious materialsilica fume, Self compacting concrete, Compressive strength, Tensile strength.

## 1.INTRODUCTION

Construction industry is a fastly growing industry. Concrete is the main made material used for construction. Concrete is mainly composed of cement, aggregate and water. Cement manufacturing produce high amount of CO<sub>2</sub> emission. CO<sub>2</sub> emission will cause environmental problems. Researchers starts to find a good alternative to cement in concrete. The demand for cement is increase with global rise of urbanization and challenging the environment. The availability and quality of cement manufacturing are decreased by use of waste materials from different industries in concrete production and also reduce the environmental problems.

Self compacting concrete that has an ability to fill the form work without any vibration. Self compacting concrete flow under flow under its own weight. The benefits of using self compacting concrete are reduce labour and machine equipment cost, easy and quick placement of concrete, enhance strength and durability. Barite is a soft crystalline mineral form of barium sulphate. Silica fume is a by-product obtained from electric arc furnace used in manufacture of silicon metal. Barite and silica fume can be used as a best supplementary cementitious material. In this study cement is partially

replaced by combine barite powder and silica fume, that is 0%,5%,10%,15%,20% and 25% barite powder and silica fume added one by fourth percentage of barite powder.

## 2. MATERIALS USED

### 2.1 Barite Powder(BP)

Barite is a soft crystalline mineral form of Barium sulphate Baso<sub>4</sub>. Approximatly 80% of the barites produce worldwide is used for oil and gas drilling. Among the states in India, Andhra Pradesh alone accounts for 92% of country's barites resourses. Barites is used as filler and extender in rubber products. It is added to rubber compounds to impart resilimey and durability and it is used as filler in paper industry. In order to enhance the value of barites there is a need to explore the possibilities of using barites in the production of valuable material concrete is universal material and barite powder can be use in cement concrete.

Barite (BaSO<sub>4</sub>) gets its name from its high density, in fact, barite comes from the Greek "barys" which means heavy. This is due to value of 4.48 at 26°C this value is close to that of some iron or lead ores, such as hematite or galena. Global consumption is driven mainly by oil and gas industry, which is the main end use sector for barite; it accounts about 85% of global demand for the product which is used in powder form . The other applications concern chemical industry and radiological protection.

### 2.2 Silica Fume(SF)

Silica fume is an amorphous poly-morph of silicon dioxide and silica. It is highly pozzolanic material and it is used to enhance the strength and durability properties of concrete. Silica fume also be added to the concrete as admixture. Silica fume increases compressive strength and abrasion resistance of concrete. It reduces bleeding because the free water is consumed wetting of large surface area of silica fume. Silica fume also blocks the pores in concrete and water holding capacity of concrete is increased.

Initially silica fume added to the concrete it remain inert. But water added to the cement the silica fume is reacted with water and forms calcium silicate hydrate and calcium hydroxide. Formation of these two by products are acts a

filler material to the pores in the concrete. Due to the additional formation of calcium silicate hydrate increase the bond strength in concrete.

Table- 1: Chemical and Physical Properties of Barite Powder

Chemical analysis	Mass percentage	Physical analysis	Magnitude
BaO	65.7	Specific Gravity	4.5
SO <sub>3</sub>	34.3	Colour	Grey

Table -2:Chemical and Physical Properties of Silica Fume

Chemical analysis	Mass percentage	Physical analysis	Magnitude
CaO	0.49	Density(kg/m <sup>3</sup> )	2180
SiO <sub>2</sub>	92.26	Fineness(%)	2
Al <sub>2</sub> O <sub>3</sub>	0.89	Specific gravity	2.2
Fe <sub>2</sub> O <sub>3</sub>	1.97	D10(µm)	2
MgO	0.42	D50(µm)	8.5
Na <sub>2</sub> O	1.31	D90(µm)	18

### 2.3 Cement

Cement act as a binder material in concrete, Different types of cements are available in market. Most commonly used cements are ordinary portland cement and portland pozzolana cement. In this experimental study use portland pozzolana cement.

Table- 3: Properties of Cement

Properties	Results	Technical reference
Fineness of cement(%)	6.33	IS 4031:1984
Standard consistency(%)	34	IS 4031(IV):1984
Specific gravity	3.06	IS 4031(II):1984
Initial setting time(min)	80	IS 12269:2013

### 2.4 Fine Aggregate

Fine aggregate means material that passing through 4.75 IS sieve. In old days river sand is used as fine aggregate in concrete. Reduction in rate of availability of river sand, a new alternative for fine aggregate is find out. Now a days manufacture sand are commonly used fine aggregate in concrete.

Table -4: Properties of Fine Aggregate

Properties	Results	Technical reference
Fineness modulus	2.9	IS 383( I ):1970
Zone of aggregate	II	IS 2386(1):1963
Specific gravity	2.574	IS 2386( I ):1963

### 2.5 Coarse Aggregate

Coarse aggregate which means particle retained on 4.75 mm IS sieve. Coarse aggregate imparts strength, toughness and hardness to concrete. Coarse aggregate size commonly varying from 10 to 40 mm in size. Coarse aggregate can be obtained by crushing of natural stones.In this experimental study 12.5 mm ize aggregate is used. Size of aggregate satisfied the Indian codal provisions.

Table -5:Properties of Coarse Aggregate

Properties	Results	Technical reference
Specific gravity	2.7	IS 2386( I ):1963
Fineness modulus	4.25	IS383( I I I ): 1970 table 2

## 3. SPECIMENS DETAILS

For finding the mechanical properties of self compacting concrete of M30 grade 6 cubes and 3 cylinders for each percentage of replacement of cement in concrete is used. Cube of size 150mm x 150mm x 150mm is used and size of cylinder is 150mm diameter and 300 mm height were used. Cubes are casted for testing after 7day and 28 days compressive strength. Cylinders are casted to obtain the split tensile strength after 28 days.

### 3.1 Preparation of specimen

First prepare a control specimen with 0 % replacement of cement in concrete. Super plasticizer and required quantities for obtain a good concrete is calculated as Indian standards. Mixing of concrete is done using mixer machine. Initially the cement and fine aggregate is placed in the mixer machine and rotate. After well mixing barite powder and silica fume is added. After that coarse aggregate and required amount of water is added and turn the mixer machine till obtain a good concrete. Mouldes are cleaned and oiled. Then concrete is transported and placed in to the mouldes. After 24 hours unmoild the specimen and kept for curing. After 7 day and 28 days curing specimens were ready for testing.

### 4 .RESULTS

After 7 days and 28 days curing 3 cubes are tested and note the compressive strength value for each percentage of replacement of concrete. Compare the compressive strength value with the control specimen compressive strength.

Table 6: Compressive Strength and Split Tensile Strength

Mix	Splittensile strength(N/mm <sup>2</sup> )	Compressive strength(N/mm <sup>2</sup> )	
		After 7 days	After 28 days
Controlspecimen	2.5	21.26	36
5% BP+ SF(1/4 <sup>th</sup> BP)	2.45	23.13	40.13
10%BP+ SF(1/4 <sup>th</sup> BP)	3.17	25.89	42.93
15%BP+ SF(1/4 <sup>th</sup> BP)	3.54	34	48.26
20%BP+ SF(1/4 <sup>th</sup> BP)	3	28.29	43
25%BP+ SF(1/4 <sup>th</sup> BP)	2.3	22.73	39

For obtaining the split tensile strength after 28 days 3 cylinders are tested for each percentage of replacement of cement with barite powder and silica fume. Compare the result with control specimen.

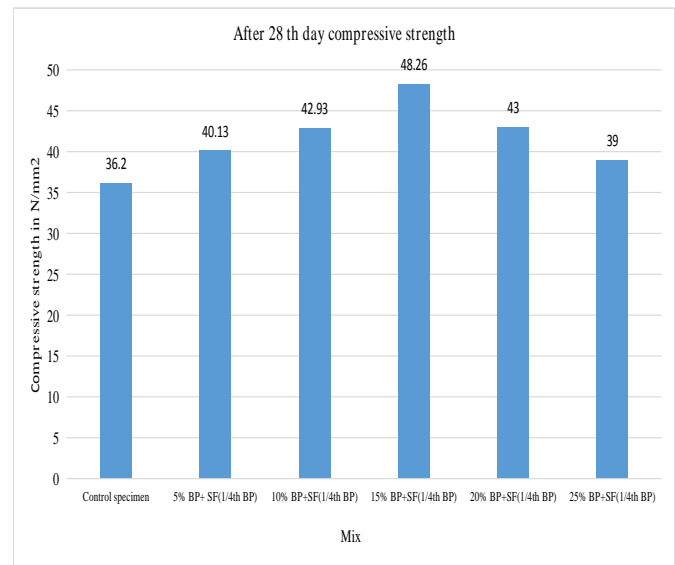


Chart -2: Compressive Strength of Different Replacement Percentage After 28 days

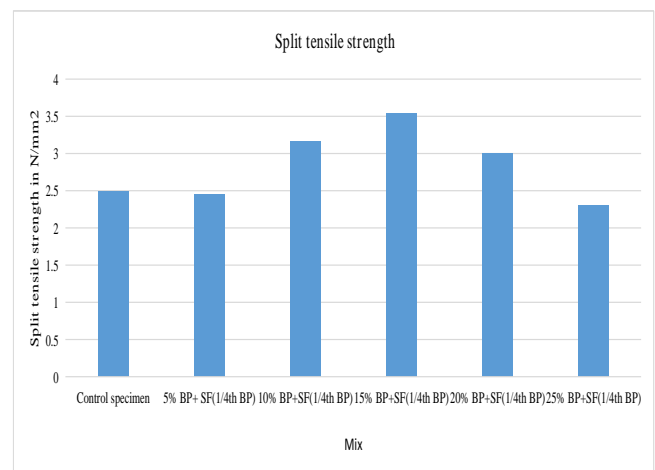


Chart -3: Split Tensile Strength of Different Replacement Percentage After 28days

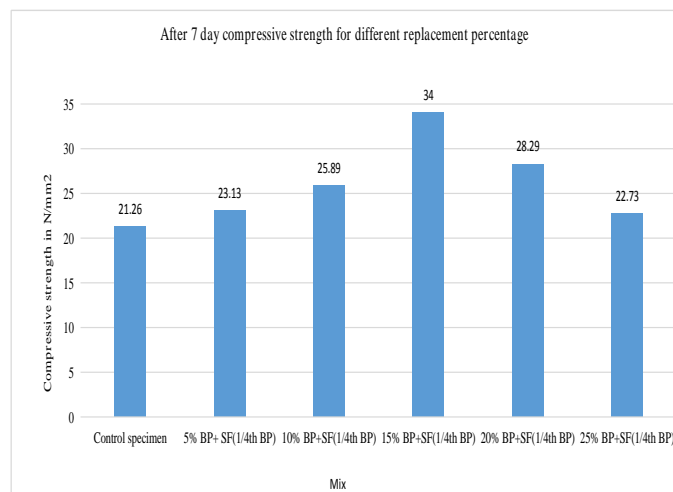


Chart -1: Compressive Strength of Different Replacement Percentage After7 days

### 5.CONCLUSIONS

Self compacting concrete with 15% replacement of barite powder and silica had more compressive strength and split tensile strength. The strength of self compacting concrete after replacement barite powder and silica fume shows a sudden increase in strength. Barite powder has high specific gravity so the pores in the barite powder is filled by fine silica fume particles it will helps to increase the strength in concrete. Combination of barite powder and silica fume replacement cement in concrete is a better alternative to cement in self compacting concrete.

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