

Effect of Fines in Sandstone Manufactured Sand Concrete

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ABSTRACT

Sources of natural sand for use as an aggregate in concrete in construction are becoming scarce as sand pits are exhausted and environmental legislation prevents dredging. So it has become obligatory for us to search for a new feasible solution. In this research proposal an effort has been made to give a viable solution for this problem. Manufactured sand produced from sandstone is used as fine aggregate for concrete. 100% River sand is replaced with M – Sand including microfines. Microfines are the particles of size less than 75µm. M30 grade of concrete is made with varying % of microfines (0%, 5 %, 10 %, 15%, 20% and 25%). Six mixes of M – Sand and one mix of river sand were made for trial and compared. Manufactured sand with appropriate amount of microfines showed increased compressive strength.

Keywords: *Manufactured Sand; Fine Aggregate; Microfine; Workability.*

1.0 Introduction

Concrete is a most widely used material all over the world. Reason behind its huge use is it is easily mouldable in any shape and has good strength. It is also cost effective as compared to steel, wood, aluminium etc. Concrete is made of three basic ingredients cement, aggregate and water. All these ingredients are derived from natural resources directly or indirectly. In cement main ingredients are limestone, silica and alumina and aggregates are produced from rocks and the river sand. It takes thousands of years in development of these rocks which we are getting today. . Demand of concrete increasing day by day due to rise in infrastructure development all over the world. Over exploitation of these natural resources has compelled us to think about the new materials for the concrete. Now a day's waste disposal is a big problem. Wastes are generated from agriculture, industrial and mining Activities. If these wastes are used in making concrete it will not only solve the problem of waste disposal but also decrease the pressure on natural resources. Use of waste material will also reduce the carbon footprint of concrete. Agro waste like rice and wheat straw and husk, baggage, banana stalk, cotton stalk, vegetable residues are being used in concrete. Various industrial and mining waste like coal combustion residues, bauxite red mud, steelslag, construction and demolition waste, overburden mining waste , Tailings of iron, copper, zinc, gold, aluminium industries are being used in concrete. Rajasthan is the largest sandstone producing state of India. It is estimated that 90% of the sandstone in India is produced in Rajasthan. Rajasthan sandstone is found in the main Vindhyan and Trans-Aravalli-Vindhyan sequence. It is spread in an area of about 35,000 sq. km. Covering parts of Dholpur, Bharatpur, Karauli, Sawai Madhopur, Bundi, Jhalawar, Kota, Bhilwara,

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Chittaurgarh Jaisalmer and Baran districts in eastern Rajasthan and in scattered form in Jodhpur, Nagaur and Bikaner districts of western desert plain. Area of jodhpur sandstone belt is small but production of sandstone is maximum here. This huge production leads to lot of waste which needs appropriate utilisation.

As per IS 383: 2016 Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing is known as manufactured sand.

Sand is good for large projects and in mass concreting because sand gradation remains constant. Manufactured sand is usually misunderstood with crusher dust. Manufactured sand is produced in crusher with five stage process while crusher dust is waste produced during manufacturing of coarse aggregates with three stage process.

In the past lot of studies have been done regarding the use of stone waste in concrete. Yilmaz et al. (2012), Determined the effect of different types of sandstone aggregate on concrete strength. Subarkose sandstone has greater strength (Compressive Strength and Split Tensile strength) than other type of sandstone. If clay content is more strength is less while greater carbonate content increases the strength. Kumar et al. (2016d), M30 grade concrete was made using quartz sandstone as coarse aggregate from 0% to 100% in the multiple of 20%. Quartz sandstone can be used up to 40% for the mixes having w/c ratio above 45. Quartz sandstone also showed a considerable amount of carbonation resistance and decreased porosity. Li et al. (2011), Manufactured C30 grade of concrete by varying stone powder content 3%, 7% and 13% and determined the compressive strength at the age of 7d, 14d, 28d, 90d, 120d, 150d and 180d respectively. Stone powder lower than 5% is not suitable for proto machine made sand for C30 grade. Stone powder in between 7% to 13% produced good quality concrete. Shen et al. (2016), Determined the effect of shape, surface texture, stone powder and gradation of manufactured sand on its behaviour in concrete. One river sand and eight sorts of MS were selected. Various physical and chemical properties were determined and checked with respect to compressive strength of concrete. MS-B and MS-C having powder content 16.4 and 16.9 respectively had the maximum strength. While MS-G and MS-H having powder content 0.9 and 0.4 produce low strength of concrete. All the MS concrete have greater strength than river sand. The particle shape and the surface texture of MS has less significant effect on its behaviour in concrete than the stone powder content and the gradation of MS. Zhen et al. (2012), three river sand and ten M Sands of different petrographic origin (limestone, quartzite, Granite, Basalt) were selected. Grading was kept constant. Effect of limestone microfines content, surface roughness, crushing value and SiO₂ content on strength and Abrasion resistance of pavement cement concrete were determined. Strength and abrasion resistance of LSM concrete were determined with varying microfine content (4.3% to 20%). Both compressive and flexure strength increases with increase in microfine content and maximum value was achieved at 10%. Abrasion loss was minimum at 20% microfine content. Both compressive strength and flexure strength increases with increase in surface roughness therefore all the MS perform better than river sand. Flexure strength of all the MS increases with decrease in crushing value while there is no evident relationship between crushing value and compressive strength. There is no evident relationship between SiO₂ content of parent rock of MS on abrasion resistance. Abrasion loss is lower with lower the crushing value of MS. MS with large roughness, low crushing value is suitable for high quality pavement cement concrete. Ding et al. 2016, Influence of powder content on long term compressive strength of concrete is determined by varying stone powder content 5%, 9% and 13% for W/C (.56, .45, .40). MS was obtained by crushing lime stone. Appropriate amount of stone powder influences the long term compressive strength. Effect on compressive

strength due to stone powder depends upon the w/c ratio. To get good compressive strength with MSC 9%- 13% stone powder is suitable. Yamei et al. 2017, studied the Particle shape parameters (Lengthwise ratio, flatness, convexity, sphericity etc.) of natural sand and manufactured sand by the DIP method. Natural sand is close to sphere shape and more smooth, while the MS was more slim, flat and rough. When slump and cement dosage are constant, manufactured sand concrete usages more water but the compressive strength is greater.

Study of this literature suggest that microfines can be used as an important ingredient of concrete. In common practice these microfines are discarded by either washing or sieving. Which is loss both in terms of economy and environment. The present study aims to find out the use of sandstone manufactured sand in concrete including the microfines.

2.0 Experimental Program

2.1 Materials

The Portland pozolana cement confirming to IS 1489 – 1991 was used in the study. The specific gravity, normal consistency, initial and final setting time were 2.90, 31%, 120 min and 340 min respectively. The coarse aggregate of maximum nominal size of 20 mm with basaltic origin were used. Banas river sand was used as fine aggregate. Manufactured sand used for making concrete was made from the mining waste of sandstone. Both river sand and manufactured sand was confirming the zone II of IS 383:2016.

Table 1: Physical and Chemical Properties of Sandstone Manufactured Sand and River Sand

S. No.	Physical Properties of Fine Aggregate			
	M - Sand		River Sand	
1.	Specific Gravity	2.55	Specific Gravity	2.60
2.	Water Absorption	2.5 %	Water Absorption	4.0%
3.	Loose Bulk Density	1691Kg/M ³	Loose Bulk Density	1681.331 Kg/M ³
4.	Packed Bulk Density	1852.66 Kg/M ³	Packed Bulk Density	1818 Kg/M ³

2.2 Mixes

In order to determine the effect of microfines in concrete 6 mixes of concrete with sandstone manufactured sand were prepared with microfines content varying 0%, 5%, 10%, 15%, 20% and 25%. One control mix was prepared with river sand for the comparison. All the mixes were prepared with 0.4 water to cement ratio. Target slump was (100 ± 20) mm. Slump was controlled using water reducing super plasticizer. Detailed mix proportion of different mixes cast is as shown in Table 2.

Table 2: Mix Proportions in Kg/m³

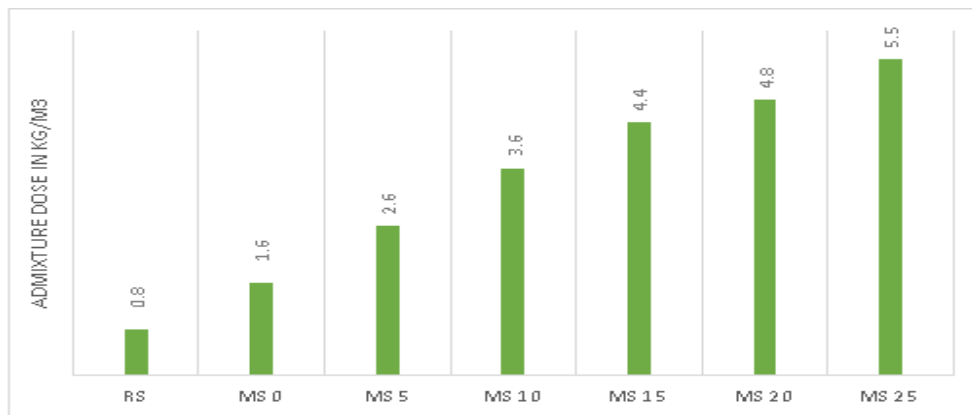
Mix No.	Cement	Water	w/c	Microfines	Fine Aggregate	Coarse Aggregate
RS	361	148	0.4	0	771	1184
MS0	361	148	0.4	0	771	1184
MS5	361	148	0.4	38.5	732	1184
MS10	361	148	0.4	77	694	1184
MS15	361	148	0.4	115	655	1184
MS20	361	148	0.4	154	617	1184
MS25	361	148	0.4	192	579	1184

3.0 Results and Discussion

3.1 Workability

Workability of concrete was measured by slump loss method as described in IS 7320:1974. As the quantity of microfines increases in concrete dosage of super plasticizer increases. This loss of workability may be because of rough surface texture and angular shape of manufactured aggregate. When size of particle decreases its surface area increases which requires more quantity of water to wet the total surface area. Angular particles due to increased friction reduces the workability. The loss of workability may further be attributed due to high water absorption of microfines.

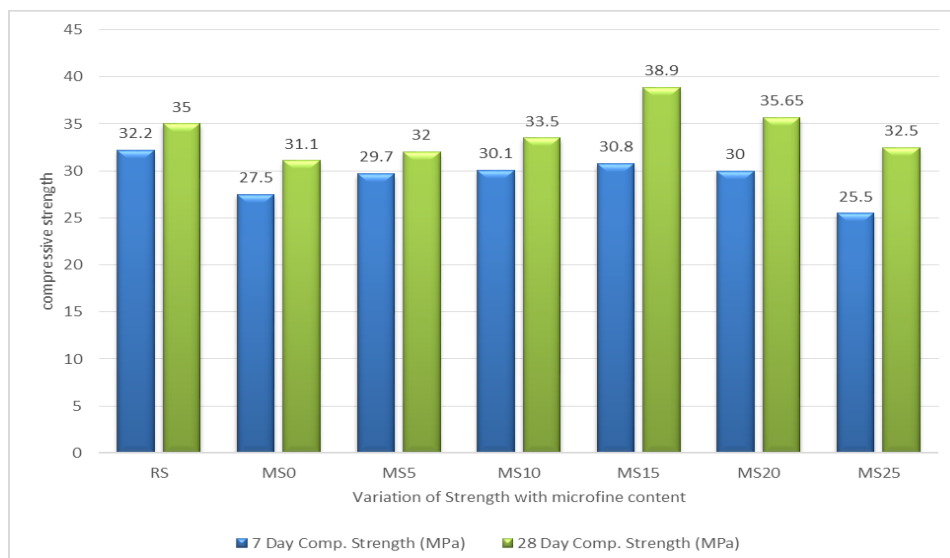
Figure 1: Admixture Dose V/S Microfine Content



3.2 Compressive strength

All the mixes showed good strength which was comparable to control mix. Maximum strength was obtained at 15% microfine content. This increased strength is due to good packing and interlocking between the angular manufactured sand particles. As the microfine content increases void space within the sand get filled by these microfines and the packing density increases which results in good compressive strength. Even at 20% and 25% microfines comparable strength have been obtained

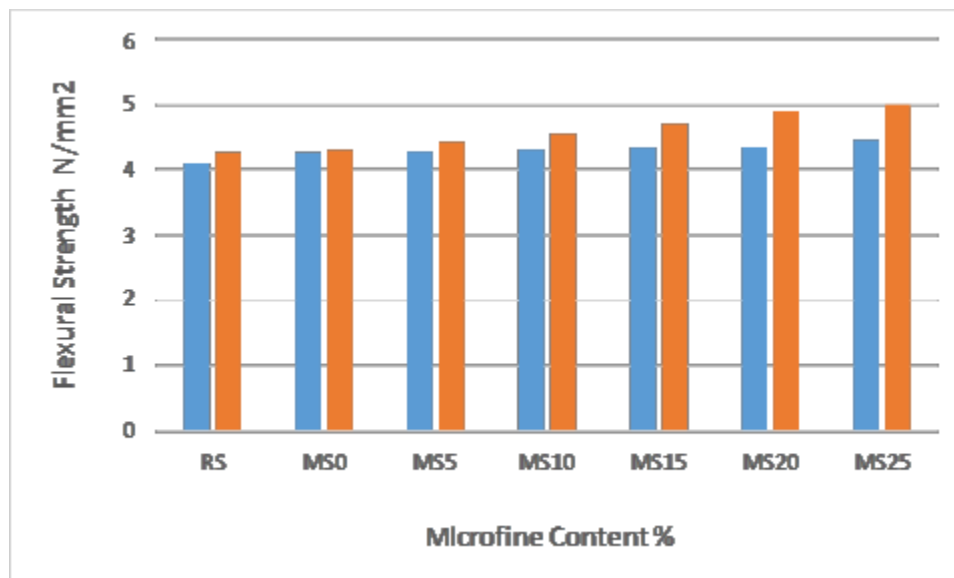
Figure 2: Compressive Strength V/S Microfine Content



3.3 Flexure strength

Flexural strength of concrete with microfines was greater or comparable to control at all the investigated ages. The rough texture of manufactured sand concrete and the angular particles have improved the adherence of aggregate phase to cement paste resulting in enhanced flexural strength.

Figure 3: Flexure Strength V/S Microfine Content



4.0 Conclusion

This study shows that inclusion of microfines in concrete results in better compressive strength and flexural strength compared to control mix. 100% manufactured sand can be used as fine aggregate in concrete. Sandstone made manufactured sand can be a sustainable alternative to the river sand. Microfine which are an unavoidable part of manufacturing process and discarded without any use can be used as an ingredient of concrete. Microfines densify the concrete mix. Voids between the sand particles get filled by these microfines which result in increased packing density. Rough texture and more surfaces area increases the water demand but it can be compensated by using suitable water reducing admixtures. Rough texture result in increased flexure resistance. Western part of Rajasthan is hub of sandstone production. Huge waste which is generated here can be used as manufacture sand. Sand can be made of mining waste and utilized in normal construction works. This study shows that there is no need of removal of microfines at the cost of both environment and economy. For big projects more detailed investigation like durability studies are essential.

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