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The Impact of Gradation and Fineness Modulus of Recycled Mortar Sand on the Performance of Cement

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ABSTRACT
The fine coefficient is one of the physical properties of the fine aggregate. The fineness modulus (FM) is obtained by adding the total percentage of sand retained on each sieve and dividing by 100. The fineness factor varies depending on the resources available. Sand is widely used in construction. Due to excessive use, the supply of sand is decreasing day by day, is it necessary to find an alternative material for sand in the future? And on the other hand, the amount of construction and demolition waste is increasing every day and is still underutilized, and this is the main focus of research on the use of C and D waste mortar material in conventional construction. To analyse the waste mortar material, a material sample is collected from the site and the physical properties of the sand are checked and compared with the standard zones of sand according to the compressive strength IS using C and D waste mortar mixture in a ratio of 1:3 Casting. The 7.06 cm cube size is compared to 3-day and 7-day strength.
Keywords: Fineness modulus, FRA Fine recycled aggregate, Construction & Demolition waste

1. Introduction

Sand is a naturally available material composed by finely divided rock and mineral particle. Commercial sand obtained from river beds or sand dunes that are formed by wind action. As per technical definition of sand according to size the aggregate passing from 4.75 mm IS Sieve is known as fine aggregate or sand. The particle size of sand is ranges from 0.075 mm to 4.75 mm with coarse sand ranging from 2 mm to 4.75 75 mm, medium sand ranging from 0.42 mm to 2 mm and fine sand ranging from 0.075 mm to 0.075 mm to 0.075 mm.[1] Natural sand reserves are depleting in India and this is posing a threat to the environment. This has caused many environmental problems which have led the government to ban the unrestricted use of natural sand. This has led to a significant increase in the scarcity and price of natural sand. Therefore, an alternative to river sand has become the need of the future.[2] Generally fine aggregate are made by rock dust rather than silt and clay as in the case of natural sand. Due to the presence of high fines content, M sand has a significant effect on water demand and mortar performance.[3] It has been pointed out that manufactured sand is ever better than river sand. The particle size is solid, which is close to spherical river sand. Another problem associated with river sand is obtaining the required grading with a fineness modulus (FM) of 2.4 to 3.1. Generally the FM of 2.2 to 2.6, 2.6 to 2.9 and 2.9 to 3.2 indicates that the sand is fine, medium and coarse which confirms the gradation zone of class IV to I (IS383). It has been verified and found at various places in India that grading is essential[4] Crushed sand has some drawbacks when used in fresh concrete compared to natural sand. To counter the negative shape and texture of the particles, a higher amount of admixture is needed. For each combination of sand and cement, the ideal dosage must be determined[5] The compressive strength of concrete was found to be near the mix design target for Sylhet sand but decreased for Rangamati, Rangunia, and Kalurghat sand as the Fineness Modulus (FM) value decreased. This is because the various sources of fine aggregate had a strong influence on the compressive strength of concrete due to the difference in aggregate size distribution. FM is a measure of the grading of particle size, with higher values indicating coarser aggregate [6] By analyzing the fine aggregate samples, we determined that particles created by impact crushing had intermediate values of sphericity and aspect ratio when compared to the natural fine aggregate and cone-crushed material, with the latter producing the flakiest material. Additionally,

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particle shape was seen to be dependent on particle size, with flakiness increasing as size decreased for cone-crushed material, and to a lesser extent for impact-crushed material while remaining relatively constant for the natural aggregate [7] After analyzing all the data, we determined that the combination of dune sand and crushed sand (in ratios of 20-60%) yielded the best results in terms of compressive strength. The standard modulus of fineness of the corrected sands ranged from 2.20 to 2.86, and the granular distribution was diffuse, resulting in high resistance. Previous studies had already demonstrated that concrete with no admixtures or additives had a compressive strength of over 40 MPa after 28 days [8] The results of the experiments showed that the strength of concrete increases with the fineness of the material. The regression curve suggests that M sand is more beneficial than the river sand, which could help protect the environment. Further research should be conducted to determine the effect of fineness on durability [9] By adding different percentages of various fractions of crusher fines to fine-graded (unsuitable) sands, it is possible to optimize them and improve their gradation, fineness modulus, and compressive strength, making them suitable for use in concrete. The optimized sands have been shown to increase concrete strength by 8-39% [10]

2. Experimental study:-

The goal of our study was to analyze the influence of varying fineness modulus of Recycled fine aggregate (Sand) on the mechanical characteristics of cement. The gradation of coarse aggregate and fine aggregate were determined by sieve analysis as per IS 383:1970 [11] Sample collection from Tapi river sand and other recycled sample collected from one site Sample Number -1 is collected from Tapi River and sample-2 Recycled fine aggregate collected from demolished building site in Shirpur Maharashtra.

Grading Limits of Fine Aggregate as per IS 383-1970				
Sieve Size (mm)	% Passing			
	Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
10	100	100	100	100
4.75	90-100	90-100	90-100	95-100
2.36	60-95	75-100	85-100	95-100
1.18	30-70	55-90	75-100	90-100
600	15-34	35-59	60-79	80-100
300	5-20,	8-30,	12-40,	15-50,
150	0-10,	0-10,	0-10,	0-15,
Pan	0	0	0	0
Classified	Coarse Sand	Medium Sand	Mild Sand	Fine Sand

Table No.1

Rang of Fineness Modulus as per IS 383-1970	
Type of Sand	Fineness Modulus range
Fine Sand	2.2 to 2.6
Medium Sand	2.6 to 2.9
Coarse Sand	2.9 to 3.2

Table No.2

Cumulative Sieving rate and Fineness modulus							
Sample	4-75 to 2.36	2.36-1.18	1.18-0.6m	0.6m-0.3m	0.3m-0.15m	0.15m-.075m	Fineness Modulus
1 - (Natural Sand)	7	19	45	65	85	100	3.21

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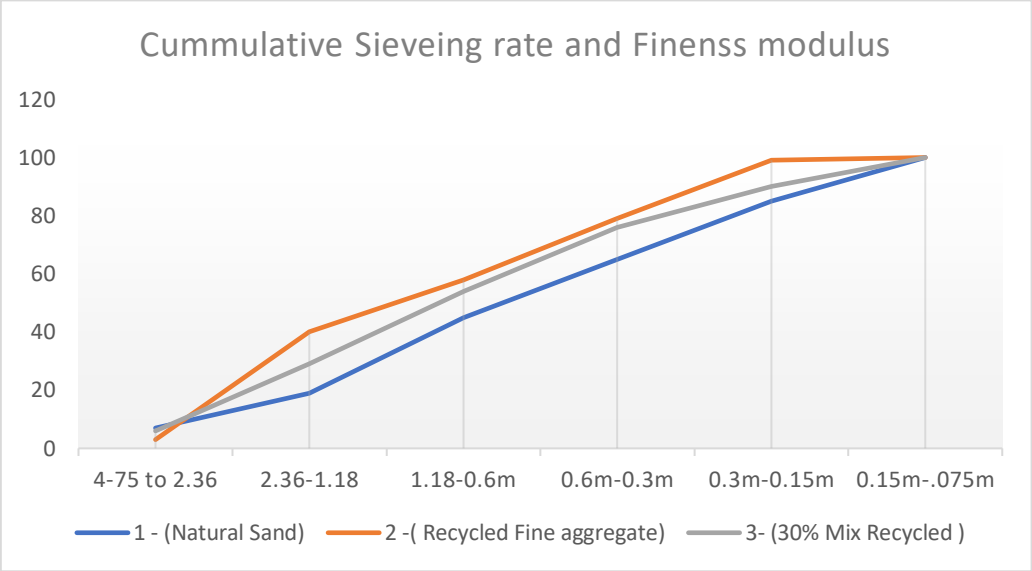
2 -(Recycled Fine aggregate)	3	40	58	79	99	100	3.79
3- (30% Mix Recycled)	6	29	54	76	90	100	3.55

Table No.3



Graph No.-1

3. Compressive strength of cement:

It is not unexpected that cement is always tested for its compressive strength in a laboratory before it is used in important projects, since this is the most significant of all the cement properties. Testing neat cement paste for strength is difficult due to the excessive shrinkage and cracking that can occur. The strength of cement is instead determined indirectly by testing cement-sand mortar cubes in specific proportions. The cubes are then placed in a compression testing machine and tested on three sides without packing after three and seven days. The test was conducted on as per IS 4031-1988 guidelines [12] IS 269 (1967) states that ordinary Portland cement must have a compressive strength of at least 16.3 N/mm2 after 3 days and 22.4 N/mm2 after 7 days. In case Standard sand is not available for test you can use ordinary sand but result variation occurs around 65 to 70% to the standard result [13]

4. Result:

Sample No	Tapi River	Recycled sand	30% mix Sand	No. of Days
1	11.7	8.9	10.4	3 days
2	10.5	7.8	11.2	
3	12.3	8.1	10	
Average Strength	11.50	8.27	10.53	
Sample No	Tapi River	Recycled sand	30% mix Sand	7 days
1	15.2	14.2	13.9	
2	14.5	12.1	12.8	
3	16.8	10.5	12.7	
Average Strength	15.50	12.27	13.13	

Table No.4

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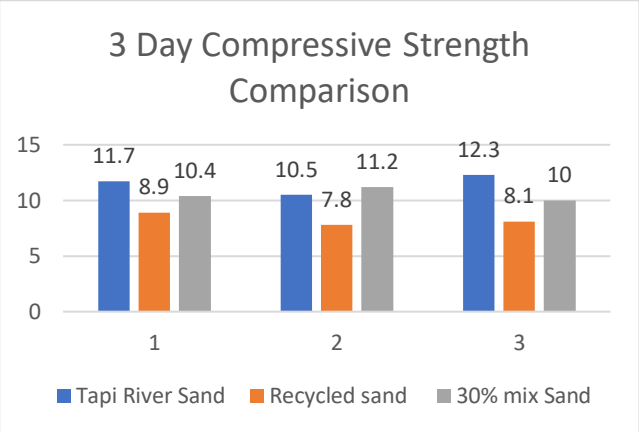
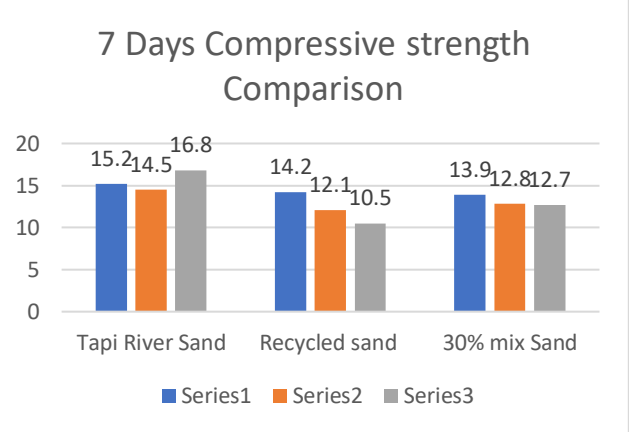


Graph No.2



Graph No.2

5. Conclusion

1)From the above experiment work recycled fine aggregate fineness modulus not satisfied the IS limit due its particle size variation but if it is mixed with natural aggregate some absent particle included then the fineness modulus satisfied. Clearly shown in Table No.3

2) For compressive strength observation shows the 30 % mix recycled fine aggregate not more affects the 3 days and 7 days strength Table No-4 shows the result

3)By adding 30% of fines recycled aggregate to fine sands, it is possible to optimize them, resulting in improved gradation, increased fineness modulus, and increased compressive strength, thus making them suitable for use in concrete.

4) According to IS 269 (1967), ordinary Portland cement must have a minimum compressive strength of 16.3 N/mm2 after 3 days and 22.4 N/mm2 after 7 days. If standard sand is not available for testing, ordinary sand can be used, although the results may vary by 65 to 70% compared to the standard results.

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