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Comparative study on the effects of using natural sand and manufactured sand for the production of C-25 concrete

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ABSTRACT

Manufactured sand is a term used for aggregate materials less than 4.75mm and which are processed from crushed rock or gravel. Due to the booming of construction activities in our country, natural sand resources are increasingly depleted and its cost is becoming increasingly high. This research was, therefore, conducted to study the Effects of Using Natural Sand and Manufactured Sand for The Production of C-25 Concrete and to assess the prospects of using manufactured sand as a replacement of natural sand in Ethiopia. Initially, different natural and manufactured sand samples to be used in the concrete mixes were collected and their physical properties were studied. Fifteen different concrete mixes having five mix proportions for both natural and manufactured sand (i.e. 100%NS+ 0%MS; 75%NS+25%MS; 50%NS+50%MS; 25%NS+75%MS and 0%Ns+100%MS) were prepared for C-25 Concrete strength using EBCS mix design procedure. The properties of these mixes have then been assessed both at the fresh and hardened state. The using of manufactured sand as a fine aggregate has a significant effect on the workability and finishing ability of the concrete, also, the results of hardened properties of the mixes have shown that concrete mixes with partial proportions of manufactured and natural sand achieved a higher compressive strength at all test ages. The result also has shown that using manufactured sand in partial or full replacement to natural sand doesn't cause any significant effect on the compressive strength of concrete. It has been found also that the use of manufactured sand is more suitable for high strength concrete production. It can, therefore, be concluded from the findings of this research that when the availability of natural sand is scarce or in cities where the price of natural sand is as expensive as manufactured one, manufactured sand concrete mix is a viable and better alternative to the use of natural sand.

Keywords— Aggregate, Compressive Strength, Concrete, Cost, Manufactured sand, Workability

1. INTRODUCTION

It is generally known that, the fundamental requirement for making concrete structures is to produce good quality concrete. Good quality concrete is produced by carefully mixing cement, water, and fine and coarse aggregate and combining admixtures as needed to obtain the optimum product in quality and economy for any use [1]. Good concrete, whether plain, reinforced or prestressed, should be strong enough to carry superimposed loads during its anticipated life. Other essential properties include impermeability, durability, minimum amount of shrinkage, and cracking [1].

Sand, as one of the most accessible natural resources, has been used mostly as a construction material since the earliest days of civilization. It is defined as “continuously graded unconsolidated material (sediment) present on the earth's surface as a result of the natural disintegration of rocks” [2].

The main natural and cheapest sources of sand are riverbeds and these natural resources are depleting very fast. Due to various reasons good sand is not necessarily readily available and it should be transported from long distances. Transportation is a major factor in the delivered price of construction sand. Moving construction sand to the market increases the sale price of the market significantly, due to the high cost of transportation. [1]

One possible alternative material that can be used as a replacement for natural sand is the use of manufactured sand. Due to the forecast shortfall in the supply of natural sands and the increased activity in the construction sector, it is apparent that time will come, when manufactured sand may play a significant role as an ingredient in concrete production. To this effect, this research is carried out to study the prospects of the uses of manufactured sand in our country. The research is divided into two sections, which are experimental study and cost comparison. [1]

2. OBJECTIVE

The objective of the study is to investigate the effect of manufactured sand on fresh and harden properties of concrete and compare the result with that of concrete produced using selected river sand.

2.1 Study design

The study was an experimental study on the properties of fresh and harden concrete due to the use of manufactured and compare test result and economical benefit with the use of natural sand. The amount of the ingredient, water cement ratio, mixing procedure is constant through all samples and the study was conducted in different steps. These include material preparation, determining engineering property of materials and production of concrete cube samples then compressive strength test were conducted.

2.2 Sampling procedure and sample size

The sampling procedure was purposive sampling; therefore, the sample size was determined accordingly to the test specimen number required to conduct compressive strength of concrete according to ASTM standard. Therefore, there were (3) samples for compressive strength for each mix and testing age.

Table 1: Number of Sample size

%of Blending	Number of samples			Total
	7th day	14th day	28th day	
100%NS+ 0%MS	3	3	3	9
75%NS+25%MS	3	3	3	9
50%NS+50%MS	3	3	3	9
25%NS+75%MS	3	3	3	9
0%Ns+100%MS	3	3	3	9
				45

2.3 Material preparation

Sample material was prepared or taken from different suppliers for the research purpose.

- Cement: DANGOTE grade 43.5 ordinary Portland cement.
- Manufactured Crushed aggregate (00) (5mm – 0.15mm)
- Natural sand

2.4 Determination of engineering properties

After the preparation of the ingredient, the engineering properties of the ingredients were tested in the material laboratory according to ASTM standard and the result were record for the analyses purpose

2.5 Mix design

By using EBCS (Ethiopian Building Code of Standard) the mix design was prepared and by following all necessary procedure after that by using weight batching the ingredient was introduced to the electrical mixer then the concrete was prepared and concrete cube sample specimen was casted.

2.6 Laboratory test

Before cube sample spacemen was casted there are different testes was conducted on the fresh concrete to determine the workability of the concrete. Then after there were laboratory tests within 7th, 14th and 28th days for the compressive strength of concrete cube sample specimen has been carryout then comparison is made between different mixes and with different standards specification.

3. TEST RESULTS AND DISCUSSION

3.1 Fresh concrete properties

The results of the slump tests carried out on the fresh concrete gave an indication of the workability of the concrete. As can be seen from the trial mix results shown in Table for a water cement ratio of 0.45 a maximum slump of 20mm is observed, which is considered as a low workability.

Table 2: Slump test result

Mix no.	%of Blending	Water Cement Ratio	Slump Result in (mm)
1	100%NS+ 0%MS	0.45	65
2	75%NS+25%MS	0.45	52
3	50%NS+50%MS	0.45	38
4	25%NS+75%MS	0.45	20
5	0%Ns+100%MS	0.45	12

The water cement ratio for all trial mix has a constant value of 0.45 but the workability result show that when percentage of manufactured sand increases, the workability of the mix was decreases because of the rough texture of the manufactured sand. When the percentage of the manufactured sand increases in the concrete mix, due to the low workability the finishing of the concrete had a rough or poor surface finish.

3.2 Compressive strength test result

The compressive strength of the concrete specimens was determined by testing concrete cubes of size 150mm * 150mm. All specimens were weighed and measured to determine the area of the cube and density of the concrete. The hardened properties of

the concrete have been determined at the ages of 7th, 14th and 28th days. At each age a minimum of three specimens were tested to ensure the accuracy of test results. The use of manufactured sand by replacing fully or partially of natural sand had an effect on the compressive strength of concrete. In all the concrete mixes, proportions of natural and manufactured sand except water cement ratio are equal in amount. The results are shown below.

Table 3: Compressive strength test result

Mix no.	%of Blending	Water Cement Ratio	Average Compressive strength test result in N/mm		
			7th day	14th day	28th day
1	100%NS+ 0%MS	0.45	21.92	32.34	36.01
2	75%NS+25%MS	0.45	20.38	32.18	35.73
3	50%NS+50%MS	0.45	22.09	33.02	36.28
4	25%NS+75%MS	0.45	20.85	30.24	34.38
5	0%Ns+100%MS	0.45	19.05	28.67	32.97

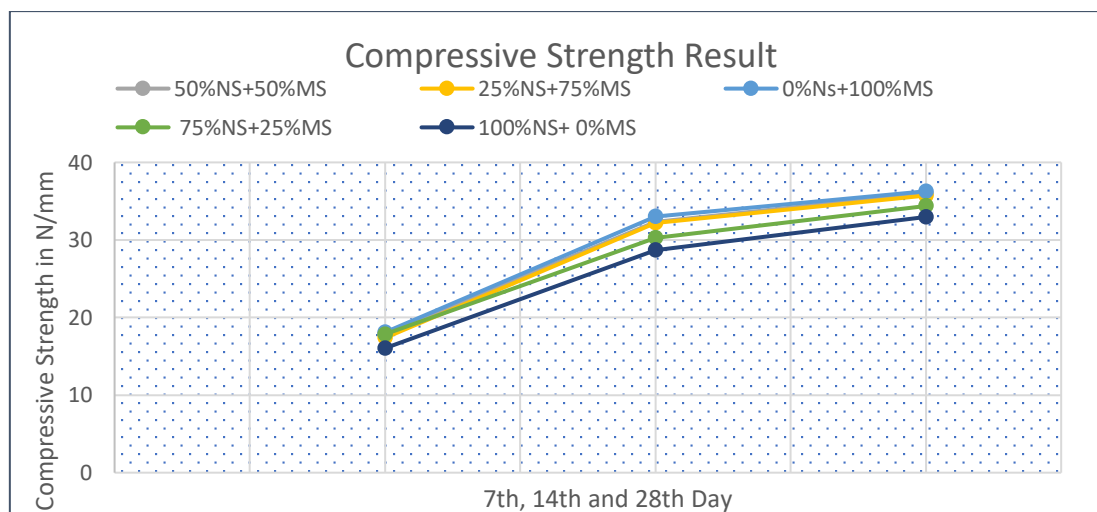


Fig. 1: Compressive strength comparison Vs Age

The compressive strength test results at the 7th day showed about 60% of the 28th day compressive strength and the 14th day result showed 90% of the 28th day compressive strength and the result satisfy the minimum ASTM Standard. And all the 28th day compressive strength has satisfied the required strength. The test results showed that the manufactured sand with 50%MS+ 50% NS was capable of achieving a higher compressive strength than the natural sand control mix. It can be concluded that the use of manufactured sand for high strength concrete production is more useful and we can say that using of manufactured sand as affine aggregate for concrete construction has no significant effect on the compressive strength of the concrete. However, special cares have to be taken to ensure that the concrete mix achieves the desired workability and suitable finish.

4. CONCLUSION

The results of the hardened properties of the mix have shown that the concrete mix with proportion of manufactured and natural sand achieved a higher compressive strength almost at all tested age of concrete. Manufactured sands are made by crushing aggregate to sizes appropriate for use as a fine aggregate. During the crushing process the manufactured sand have irregular shapes and more fine particles contributing to improved compressive strength, compared to natural sand control mix. Due to the irregular particle shape of the manufactured sand, in addition to the reduced amount of water cement ratio, manufactured sand is more important for high strength concrete mixes. Manufactured sand offers a viable alternative to the natural sand if the problems associated with the workability of the concrete mix can be resolved by using superplasticizer. The addition of superplasticizer to a concrete mix with manufactured sand allows the mix to have a better workability.

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