IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 4 Ver. VII (Jul. - Aug. 2015), PP 71-75
www.iosrjournals.org

Comparative Study on Strength Properties of Concrete Made With River Sand and Dune Sand As Fine Aggregate

Yusuf, Adamu Yunusa and OLAWUMI, Billihaminu Ayodeji
Department Of Civil Engineering The Polytechnic Of Sokoto State, Sokoto.

Abstract: *This paper helps in providing alternative sand to conventional river sand (fine aggregate) in concrete production. In desert region, dune sand are found deposited in large quantities due to strong and breezy wind peculiar to desert during harmattan and dry season period. The dune sand in most regions is not considered for construction work because it is assumed that dune sand is not good for construction. Thus, this paper reports the average compressive strength of concrete made with river sand (fine aggregate) and the one produced with the dune sand (fine aggregate). A concrete of nominal mix 1:2:4 using w/c ratio of 0.62 were adopted to produce concrete cubes 150mm x 150mm x 150mm. 7, 14, 21, 28 days hydration period was adopted. At each hydration period, three cubes were used each for both concrete produced with river sand (fine aggregate) and that of dune sand (fine aggregate). A total of 24 test samples were produced and crushed at the end of each hydration period. The compressive strength of each was determined after crushing and later the average compressive strength of the three samples at each hydration period was evaluated. At 28 days hydration period, it shows that dune sand can be utilised in concrete production since the average compressive strength of concrete cubes made with dune sand (fine aggregate, i.e. 22.68N/mm^2) is within the range stipulated in British Standard code of practice, BS 8110 (1985) (i.e. 20 – 40N/mm^2)*

Keywords*: concrete, compressive strength, dune sand, hydration period, river sand.*

I. Introduction

Sand is a major component in concrete mixes. Sand from natural gravel deposits or crushed rocks is a suitable material used as fine aggregate in concrete production. It is used with coarse aggregate to produce a structural concrete and can also be used alone with cement for mortals and plastering works (Al-Harthy, et al, 2007). In Nigeria, river sand (sharp) is common in use in concrete production and can be termed as conventional sand for making concrete. The compressive strength of concrete produced with river sand as fine aggregate has been considered suitable. According to Al-Harthy, et al (2007), the amount of fine aggregate constituted about 36% by weight of all the aggregates.

In many desert regions, there is an abundance of very fine natural sand known as dune sand. In Sokoto, Nigeria, dune sand can be found in almost the nooks and crannies of Sokoto town. For instance, Arkilla, Salame area at Old Airport, WAEC office area, trade fair at old Airport all within Sokoto metropolis. There is no doubt, all other places within Sokoto State have deposits of these materials without putting it to use in construction work. This undoubtedly poses serious environmental problem to motorist passing untarred roads covered by dune sand. Hence, this brought about the interest on how the dune sand can be utilised in the production of concrete.

Concrete in the broadest sense, is any product or mass made by the use of a cementing medium and that this medium is the product of reaction between hydraulic cement and water (Neville and Brooks, 2003). Concrete can also be considered no more than a mixture of cement, water, aggregate (fine and coarse) and admixtures (Neville and Brooks, 2003). Oyenuga (2005) described concrete as a composite inert material comprising of binder course (e.g. cement), mineral filler (body) or aggregate and water. He further to say that aggregates on the other hand are two categories of fine (sand) and coarse (gravel or crushed stone) aggregates. Lafe (1986) also opined that concrete is a mixture of cement, fine aggregate (sand), coarse aggregate (gravel) and water.

Okereke (2007) asserted that concreting constitutes between 50% - 70% of the total cost of building and according to Leadership Editorial (2008) which says as at 2005, about six billion cubic meters of concrete are made each year, which equals one cubic meter for every person on earth. This shows that concrete is very important in whatever construction we intend to embark on. And the fact that raw materials used in production of concrete are not inexhaustible, it becomes imperative to look inwards for alternative materials to the conventional materials used in making concrete.

In the northern African, sand (both rolled sand from the river and dune sand) had been used to produce concrete without incorporating coarse aggregate. Guettala, et al (2002) carried out an experiment which shows that sand concrete has almost equal strength to ordinary concrete, mainly in river sand concrete and increasing water/cement ratio increases the cube strength in dune sand concrete. Guettala, et al (2002) therefore established

the fact that the use of additives causes an increase in the strength up to 40% in dune sand concrete while this increase is almost negligible in river sand concrete. The fore-going discussion shows that a lot of research can as well be carried out in this part of the world since dune sand is deposited in large quantities. This will go a long way in making a very good recommendation in the use of dune sand for building construction.

II. Materials And Methods

2.1 Materials

The materials used for the research work are; dune sand, river sand (sharp), cement (OPC), coarse aggregate and water. The nature and quality of these materials are as follows:

1. Dune Sand – the dune sand used was obtained at Arkilla, Wamakko local government area, Sokoto State near The Polytechnic of Sokoto.
2. Cement – Ordinary Portland Cement (OPC) was used. To be precise, Cement Company of Northern Nigeria (Sokoto Cement) was used for the research.
3. Coarse Aggregate – the coarse aggregate used were crushed granite stones obtained from Buzaye, Wamakko local government, Sokoto.
4. River Sand (Sharp) – Clean and air – dried river sand which was obtained from a river in Achida town was used. The range of size of the sand/fine aggregate is from 600micron – 4.75mm on the BS test sieve.
5. Water – The water used was portable water. The water is colourless, odourless and tasteless, free from organic matter of any type.

2.2 Method

The concrete was prepared in nominal mix of 1:2:4 with water/cement ration of 0.62. It was thoroughly mixed before casting inside moulds. The cubes were initially cleaned and light coat of oil was applied on the inner surface of the cubes. The cubes were later placed on smooth horizontal rigid surface. Thereafter, each cube was then cast in three layers with freshly mixed concrete and each layer was tamped 25 times with rounded end rod.

Curing commences the following day after casting. 7, 14, 21 and 28days hydration period was adopted. Three sets of cube were cast for each hydration period. That is, three for concrete of dune sand and three for that of river sand. However, a total of 24 moulds were cast. At the last day of hydration period, the samples were removed from the curing tank and crushed. The compressive strength of each sample was then noted.

III. Results And Discussions

The results of the practical works are presented in both tabular and graphical form as shown below:

Table 1: Compressive Strength Of The Samples After Seven Days Of Hyrdration Period

Sand	Concrete in cubes	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Crushing load (KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
River sand as fine aggregate	A	8000	3375	2.370	340	15.11	14.89
	B	8010	3375	2.373	330	14.67	
	C	8005	3375	2.372	335	14.89	
Dune sand as fine aggregate	A^I	8005	3375	2.372	225	10.00	10.45
	B^I	8010	3375	2.373	220	9.78	
	C^I	8000	3375	2.370	260	11.56	

Source: Lab work (2009)

The mean compressive strength of river sand = 14.89N/mm^2, and that of dune sand = 10.45N/mm^2

The average compressive strength determined from Table 1 indicates that, concrete produced with river sand as fine aggregate has the highest compressive strength of 14.89N/mm^2 at 7 days. Though, concrete produced with dune sand as fine aggregate also shows a significant compressive strength of 10.45N/mm^2 at same days. Also, the difference in weight and crushing load of three samples are not much.

Table 2: Compressive Strength Of The Samples After Fourteen Days Hyrdration Period

1	Concrete in cubes	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Crushing load (KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
River sand as fine aggregate	A B C	8045 8035 8020	3375 3375 3375	2.384 2.381 2.376	430 450 480	19.11 20.00 21.33	20.15
Dune sand as fine aggregate	A^I B^I C^I	8100 8050 8000	3375 3375 3375	2.400 2.385 2.370	350 343 330	15.56 15.24 14.67	15.16

Source: Lab work (2009)

According to Table 2, both concrete produced with river sand as fine aggregate and that of dune sand produced higher compressive strengths compared to that of Table 1. The difference in the average compressive strength of both concrete is given as $4.99N/mm^2$ while the difference in average compressive strength indicated in Table 1 is $4.44N/mm^2$.

Table 3: Compressive Strength Of The Samples After Twenty One Days Hyrdration Period

Sand	Concrete in cubes	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Crushing load (KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
River as sand fine aggregate	A B C	8000 7900 7950	3375 3375 3375	2.370 2.341 2.356	565 535 520	25.11 23.78 23.11	24.00
Dune as sand fine aggregate	A^I B^I C^I	8000 8015 8030	3375 3375 3375	2.370 2.375 2.379	430 440 465	19.11 19.82 20.67	19.87

Source: Lab work (2009)

It was shown in Table 3 that both the weights and crushing loads of concrete samples produced with river sand as fine aggregate have significant differences. The average compressive strength of concrete produced with river sand as fine aggregate is derived to be $24.00N/mm^2$ and that of dune sand is determined to be $19.87N/mm^2$ according to Table 3. This indicates that the compressive strength of concrete samples A, B, C increased by almost $4N/mm^2$ from 14 days to 21 days hydration and that concrete samples A^I, B^I, C^I also increased close to $5N/mm^2$.

Table 4: Compressive Strength Of The Samples After Twenty Eight Days Hyrdration Period

Sand	Concrete in cubes	Weight (g)	Volume (cm^3)	Density (g/cm^3)	Crushing load (KN)	Compressive strength (N/mm^2)	Average Compressive strength (N/mm^2)
River sand fine as aggregate	A B C	7088 7096 8000	3375 3375 3375	2.100 2.103 2.370	625 622 560	27.78 27.64 27.56	27.66
Dune sand fine as aggregate	A^I B^I C^I	8070 8015 7980`	3375 3375 3375	2.391 2.375 2.364	505 511 515	22.44 22.71 22.89	22.68

Source: Lab work (2009)

At 28 days hydration, it was deduced that both concrete samples A, B, C and A^I, B^I, C^I decreased in compressive strength. As such, the average compressive strength of A, B, C were determined to be $27.66N/mm^2$ and A^I, B^I, C^I were derived to be $22.68N/mm^2$. Hence, the increase in the compressive strength of A, B, C and

A^I, B^I, C^I from 21 days to 28 days hydration are not up to 4N/mm^2. Despite that, the highest compressive strengths were recorded at 28 days.

According to BS 8110 (1985), the minimum compressive strength required for structural purposes at 28 days is between 20 - 40N/mm^2. This shows that both concrete produced with river sand as fine aggregate and those produced with dune sand as fine aggregate according to Table 4 conform to the standard stated above.

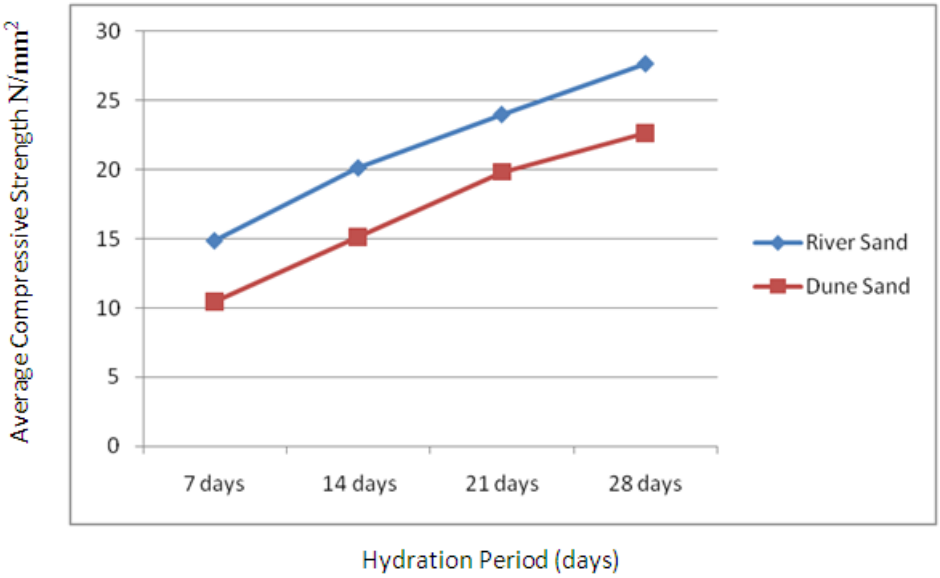

Fig 1: Variation in compressive strength

The graph above shows that concrete produced with river sand as fine aggregate has higher compressive strength in all the hydration period. And all the points on the graph for concrete with river sand as fine aggregate are higher than that of concrete with dune sand.

IV. Conclusion And Recommendations

4.1 Conclusion

The foregoing presentations and discussions indicate that, dune sand can be considered for use in concrete production as an alternative to conventional river sand. Most especially where structure is not expected to serve as suspended structural members. The laboratory work conducted shows that dune sand can serve as an alternative to river sand as fine aggregate in concrete production; since the mean compressive strength of concrete produced after 28days falls within the range specified in British Standard (i.e. 20 – 40 N/mm^2)

4.2 Recommendations

Based on practical conducted with reference to British Standard, the following recommendations were drawn:

1. That dune sand can be considered as an alternative to river sand as fine aggregate in places where it is readily available, such as desert area.
2. Dune sand deposited in an area within Sokoto metropolis was used for the research work. Therefore, it is advisable to conduct this kind of laboratory work before dune sand can be used outside Sokoto State. The reason is, the quality of dune sand deposited by wind varies from a particular place to another.
3. Since the mean compressive strength of concrete produced with dune sand (fine aggregate) after 28days of hydration is not up to the mean compressive strength of those produced with river sand (fine aggregate), it is recommended that concrete produced with dune sand should not be used for suspended structural members.
4. It is suggested that further research be carried out on the effect of additives material on dune sand, so as to ascertain may be the compressive strength of concrete produced with it can improve up to that of concrete made with river sand (fine aggregate).

References:

[1]. Al-Harthy, et al (2007) "The Properties of Concrete made with Fine Dune Sand". A journal of Construction and Building Material (online). Available from: http//www.sciencedirect.com/science. Accessed, 19th April, 2010).

[2]. British Standard Institution, BS 8110 (1985) "Structural Use of Concrete, Code of Practice for Reinforced Concrete Structures". Her Majesty's Stationary Office, London, United kingdom.

[3]. Guettala A., MezGhiche B. and Chebili R. (2003). "Strength Comparisons between Rolled Sand Concrete and Dune Sand Concrete". Civil Engineering Laboratory University of Biskra and Association. Researcher of C.R.S.T.R.A, Biskra, Algeria.
[4]. Lafe O. (1986) "Element of Reinforced Concrete Design". Macmillan Publishers. pp 1 – 11.
[5]. Leadership Editorial (2008) "The Cement Glut". January 28th. Leadership Newspapers Group Limited, Garki, Abuja.
[6]. Neville A.M. (1996) "Properties of Concrete". Longman Limited, Essex, United Kingdom p3
[7]. Neville A.M. and Brooks J.J. (2003) "Concrete Technology". Longman limited, Essex, United Kingdom p3
[8]. Okereke P. (2007) "Concrete and Concreting in Nigeria: Problems and Prospects". A paper presented at a workshop organised by Department of Building A.B.U Zaria. 5th – 7th March, 2007.
[9]. Oyenuga V.O. (2005) "Simplified Reinforced Concrete Design" (A consultant/computer based approach) Asros Limited, Lagos. p5