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EFFECTS OF PARTIAL REPLACEMENT OF RIVER SAND WITH STONE DUST IN CONCRETE PRODUCTION

Eze, O. O; Aguwa, J. I. and Auta, S. M.

Civil Engineering Department, Federal University of Technology, Minna, Nigeria
* ezeogbonna38@gmail.com

ABSTRACT
This paper investigates the effects of partial replacement of conventional river sand with crushed rock dust in concrete production. To achieve this, different preliminary tests were performed on the two sources of aggregate (river sand and crushed rock dust) to determine their physical properties before using in the production of concrete cubes and beams to determine their compressive and flexural strengths. Hence, the percentage replacement of conventional river sharp sand with crushed rock dust at 0%, 10%, 20%, 30%, 40%, 50%, and 100% to evaluate the optimum compressive and flexural strengths of concrete produced. The water-cement ratio used is 0.5 while the mix ratio is 1: 1.397:3.419. To determine the compressive and flexural strengths, concrete cubes and beams of sizes (150 x 150 x 150) mm and (100 x 100 x 500) mm respectively were prepared and cured for 7days and 28days and its compressive and flexural strengths determined. The result shows that concrete produced with 0% replacement of conventional river sand with crushed rock dust attain the highest compressive strength at 7 and 28days curing ages while concrete produced with crushed rock dust has a lower compressive strength. Also, the optimum compressive strength was achieved at 40% replacement of conventional river sharp sand with crushed rock dust while the concrete attains its maximum flexural strength at 30% replacement level. At 28day, the concrete produced with river sharp sand attain its optimum compressive and flexural strengths of 31.72% and 6.72N/mm^2 respectively, while the maximum compressive and flexural strengths was achieved at 40% replacement level.

Keywords: *Compressive strength, Concrete, Crushed rock dust, Flexural strength and River Sharp sand.*

1 INTRODUCTION

One of the major characteristics of a developing nation is rapid growth in infrastructural development. Concrete plays a major role in any infrastructural development. One of the basic constituents of concrete is aggregate as it constitutes approximately 75% of total volume of concrete. Aggregate can either be coarse or fine, both been naturally occurring rock materials. In major cities in Nigeria, the most widely used fine aggregates are conventional river sand and crushed rock dust. While conventional river sand is traditionally derived from natural sources in the form of river sand, Crushed rock dust is a process controlled crushed fine aggregate produced from quarried stone by crushing or grinding and classification to obtain a controlled gradation product that completely passes the 4.75 mm sieve. However, in recent years, the scarcity of clean river sand has led to a sharp increase in the use of the readily available crushed stone dust as fine aggregate. While some companies involved in concrete production replace the conventional river sand with crushed rock dust at arbitrary percentage. Others use solely crushed rock dust as fine aggregate in concrete production. Therefore, it is very important to investigate the effect of partial replacement of river sand with crushed rock dust in concrete production. Moreover, there is the need to determine the optimum percentage replacement of conventional river sand with crushed rock dust (stone dust). Hitherto, different researchers have examined the properties of concrete using Natural River sand and Crushed Rock dust. (Ilangovana, Mahendrana, & Nagamanib, 2008), crushed rock dust is residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. These researchers carried out a research on Strength and durability properties of concrete containing quarry rock dust as fine aggregate and concluded that the strength of Crushed Rock Dust concrete is comparatively 10-12 percent more than that of similar mix of Conventional Concrete. (Sanjay, Sindhib, Vinay, Ravindra, & Vinay, 2016), investigated Crushed rock sand-An economical and ecological alternative to natural sand to optimize concrete mix and concluded that partial replacement up to 30% leads to decrease in slump value, a significant improvement in compressive, flexural strength and impact resistance. Hence, the properties of concrete (Compressive and flexural strength) made with partial or full replacement with crushed rock (stone dust) are comparable to natural sand results. (Rameshwar & Shrikant, 2017), carried out a research on Replacement of Natural Sand by Crushed Sand in the Concrete and concluded that concrete with crushed sand performed better than concrete with natural sand as the property of crush sand is better than that of natural sand. They further stated that different Crushed sand gives different results for compressive strength depending on different quarries and from study of different research paper at 40% to 50% replacement of crushed sand the maximum compressive strength is obtained. (Lalit & Arvinder, 2015) examined the strength of concrete using crushed stone dust as fine

aggregate concluded that the compressive strength, flexural strength and split tensile strength of concrete for grade M25 and M30 with stone dust as fine aggregate were found to be comparable with the concrete made with the river bed sand. They further concluded that increase in compressive strength of concrete with 20% replacement and 50% replacement of fine aggregate with stone dust is found to be 8 to 10%, hence, stone dust can effectively be used in plain cement concrete in place of fine aggregate. (Chijioke, Igwegbe, Ibearugbulem, Okoye, & Oke, 2015) on their research stated that the gradual shift from conventional river sand to Crushed Rock Dust as an alternative and suitable source of fine aggregate is as result of scarcity in conventional river sand. They compared the compressive strengths of concrete made with river sand and quarry dust as fine aggregates and concluded that Crushed Rock Dust can effectively be used to replace river sand and reduce the negative impact this causes our environments due to constant plunging of our rivers and coastal areas in the name of extracting river sand for construction purposes.
This present research work seeks to further examine the effect of percentage replacement of conventional river sand with crushed rock (stone dust) in other to obtain a satisfactory compressive, and flexural strength. The aim of this research work is to evaluate effects of partial replacement of river sand with stone dust in concrete production. The main objectives of the research are (1) to determine the physical properties of fine aggregate (river sharp sand and crushed rock dust) and Coarse aggregate (2) to evaluate the percentage replacement of conventional river sand with crushed rock (stone dust) in other to obtain a satisfactory and optimum compressive and flexural strengths of concrete. The compressive and flexural strength at 7 and 28 days will be determined while the percentage replacement will be at 10% intervals.

2 MATERIALS AND METHOD

2.1 MATERIALS

The materials used for this research work for the production of concrete (cubes, beams and cylinders) include; fine aggregates (river sand and crushed rock dust), coarse aggregate (granite), water and cement. The river sharp sand was sourced from Chanchaga River, while crushed rock was obtained from Maikunkele Quarry. Both purchased locally from Minna, Niger state. It shall be tested in accordance with BS 882 (1992) requirements. The coarse aggregate used for the concrete production is crushed aggregate (granite) with its maximum size of 20mm. The coarse aggregate was locally sourced from within Minna metropolis in Niger state and complies with the requirements of BS882 (1992).The quality of water that used in the concrete production is portable water free from impurities, organic matter, dissolved salts or any form of chemical impurities in compliance to BS EN 1008 (2002) requirements. The source of water is Federal University of Technology, Minna water tap. This is to ensure that the concrete meets its specification. The type of cement used for the production of concrete is Ordinary Portland Cement (OPC) and of the brand of Dangote cement. The physical properties of this cement conform to the requirements of Ordinary Portland Cement as prescribed in British Standard, BS EN 197-1: 2000.

2.2 METHODS

The methods adopted in this research work before the concrete production and casting of the concrete cubes and beams includes; sieve analysis, specific gravity and natural moisture content. These methods were effectively carried-out at the structural and material laboratory of the Civil Engineering Department, Federal University of Technology Minna, Niger state. In order to achieve the primary objectives of this research work, the methods adopted was carried-out in accordance to British Standard codes. For the purpose of this research work, the mix design method adopted in the concrete mix design was the Standard British Method of concrete mix design popularly known as (DOE) first published in 1975 and revised in 1998. This method was used in batching out the entire ingredient used in concrete production and this is done in compliance with the relevant British Standards codes. The steps outlined in this method for the calculation of the constituent materials were carefully followed to arrive at the results.

Crushed rock dust were used to replace conventional river sharp sand at 0%, 10%, 20%, 30%, 40%, 50%, and 100%. Batching by weight was used as shown in Table 1. The British Standard Method of Mix Design was adopted and used to carry out mix design on the constituent materials after preliminary tests to determine the physical properties of constituent materials. Using the British Standard Method, a mix ratio of 1: 1.397:3.419 and water cement ratio of 0.5 was used in producing the concrete. Concrete cubes and beams were cast using 150mm x 150mm x 150mm and 500mm x 100mm x 100mm steel moulds. Prior to mixing of the fresh concrete, the concrete cube and beam moulds were assembled, firmly secured with bolts and nuts, well lubricated with engine oil for easy removal of the concrete cubes and beams after it must have hardened. The concrete was mixed using a concrete mixer. Part of the mixing water was introduced into the mixer, followed by fine aggregate and cement in their respective quantities by weight and allowed to mix homogenously before putting the coarse aggregate and the remaining water. The mixer was allowed to rotate severally until a homogenous mix is obtained. Afterwards, each mould was filled with the fresh concrete in three layers of about 50mm thick with each layer tampered with a 16mm tamping rod using thirty five (35) strokes uniformly distributed across the concrete mould. The top of each mould was smoothened and leveled with hand trowel and then the outside surface cleaned. After 24hours after casting the concrete, when the concrete cubes and beams must have set, they were removed and kept in a curing tank filled with fresh tap water for 7 and 28days curing respectively.

3 RESULTS AND DISCUSSION

3.1 PHYSICAL PROPERTIES

Table 1 shows the results of physical properties of the fine and coarse aggregates used. These physical properties includes; Specific gravity, Sieve analysis, Bulk relative density and Natural moisture content. The specific gravities of Natural river sand, crushed rock dust and coarse aggregate were found to be 2.65, 2.69 and 2.66 respectively. Their specific gravities falls within the range of specific gravities as contained in (Neville, 2011) and in accordance with the requirements in British Standard (BS) 1377(1990). The sieve analysis results for both natural river sand and crushed rock dust shows that both fine aggregates are in Zone I and also satisfies the overall grading limit and also the medium grading in compliance with BS EN12620: 2002. The coarse aggregate also satisfies the fineness modulus requirement for concrete works which ranges from 2.5 to 3.5 as stated by (Akinboboye, Adegbesan, Ayegbusi, & Oderinde, 2015). Moreover, the coefficient of uniformity (Cu) is > 4 and the coefficient of curvature (Ccr) is more than 1.0, the two types of fine aggregate used in this research work are well graded sand. The graphical representation is shown in figure 1.

TABLE 1: PHYSICAL PROPERTIES OF CRUSHED ROCK DUST AND NATURAL RIVER SAND.

Property	Natural River Sand	Crushed Rock Dust	Coarse Aggregate	Test Method Used
Specific gravity	2.65	2.69	2.66	(ASTM) C 127-04
Bulk relative density (kg/m^3)	1720.00	1715.93	-	ACI (1999)
Water Absorption (%)	23.88	23.48	0.32	
Natural Moisture content (%)	3.97	0.49	0.59	BS 812-109 (1990).
Sieve analysis (Fineness modulus)	Zone I (2.81)	Zone I (3.07)	2.94	BS 410-1 and 2:2000
Coefficient of Uniformity (Cu)	5.67	6.50	-	(ASTM) D 2487 and
Coefficient of curvature (Ccr)	1.42	1.63	-	AASHTO

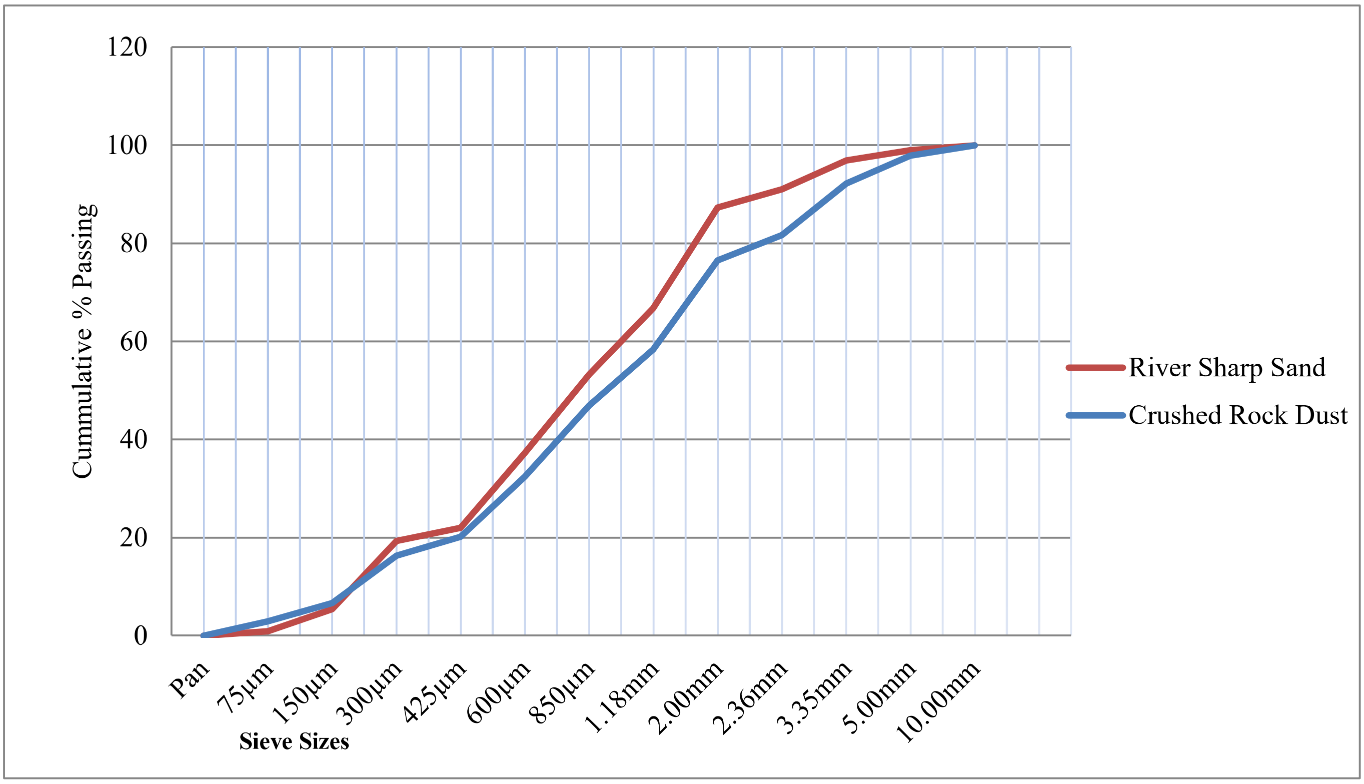

FIGURE 1: SIEVE ANALYSIS GRAPH FOR CRUSHED ROCK DUST AND RIVER SHARP SAND

3.2 COMPRESSIVE STRENGTH

The compressive strength of the concrete cubes at 7 and 28 curing days for different percentage replacement of conventional river sand with crushed rock dust are presented in Tables 2 and 3 respectively. The graphical presentation is shown in the figure 2. The result shows that the concrete cube produced with conventional river sand (0% replacement) attains the highest compressive strength of 28.80N/mm^2 and 31.73N/mm^2 at 7 and 28days curing age respectively while concrete produced with crushed rock dust (100% replacement) attains its maximum compressive strength of 24.03N/mm^2 and 28.49N/mm^2 respectively. This shows 13.35% decrease in compressive strength of concrete produced with crushed rock dust when compared with the compressive strength of concrete produced with natural river sand. This is consistent with (Thushar & Balakrishna, 2015). The result also shows that at 40% replacement of natural river sand with crushed rock sand the optimum compressive strength of the concrete cubes was obtained. This is in agreement with (Rameshwar & Shrikant, 2017). Moreover, it was observed that the lowest compressive strength was obtained at 10% replacement of conventional river sand with crushed rock dust. The tables and figure is shown below.

TABLE 2: COMPRESSIVE STRENGTHS FOR DIFFERENT PERCENTAGE REPLACEMENTS AT 7DAYS.

S/No	Sample No	Weight of sample (kg)	Area of sample (mm^2)	Crushing load (N)	Compressive strength (N/mm^2)	Average Strength (N/mm^2)
7days compressive strength for 0% replacement						
1	X_{0-1}	9.63	22500	580	25.78	
2	X_{0-2}	9.01	22500	680	30.22	
3	X_{0-3}	9.57	22500	610	27.11	28.80
4	X_{0-4}	8.60	22500	690	30.68	
5	X_{0-5}	9.05	22500	680	30.22	
7days compressive strength for 10% replacement						
1	A_{10-1}	9.00	22500	380	16.89	
2	A_{10-2}	9.26	22500	420	18.67	
3	A_{10-3}	9.20	22500	450	20.00	20.18
4	A_{10-4}	9.30	22500	550	24.44	
5	A_{10-5}	9.28	22500	470	20.88	

		7days compressive strength for 20% replacement				
1	B_{20-1}	8.42	22500	580	25.78	
2	B_{20-2}	9.11	22500	540	24.00	
3	B_{20-3}	9.14	22500	490	21.78	24.09
4	B_{20-4}	9.13	22500	510	22.68	
5	B_{20-5}	9.25	22500	590	26.22	
		7days compressive strength for 30% replacement				
1	C_{30-1}	8.73	22500	540	24.00	
2	C_{30-2}	9.31	22500	510	22.67	
3	C_{30-3}	8.97	22500	610	27.11	23.38
4	C_{30-4}	9.34	22500	480	21.33	
5	C_{30-5}	9.42	22500	490	21.78	
		7days compressive strength for 40% replacement				
1	D_{40-1}	8.70	22500	530	23.56	
2	D_{40-2}	8.91	22500	540	24.00	
3	D_{40-3}	9.18	22500	620	27.56	25.37
4	D_{40-4}	9.22	22500	570	25.33	
5	D_{40-5}	8.96	22500	590	26.40	
		7days compressive strength for 50% replacement				
1	E_{50-1}	9.23	22500	380	16.89	
2	E_{50-2}	9.33	22500	390	17.33	
3	E_{50-3}	9.28	22500	570	25.33	21.33
4	E_{50-4}	9.26	22500	570	25.33	
5	E_{50-5}	9.32	22500	490	21.78	
		7days compressive strength for 100% replacement				
1	Y_{100-1}	8.73	22500	570	25.33	
2	Y_{100-2}	8.95	22500	530	23.56	24.03
3	Y_{100-3}	8.19	22500	590	26.40	
4	Y_{100-4}	9.23	22500	460	20.44	
5	Y_{100-5}	8.58	22500	550	24.44	

TABLE 3: COMPRESSIVE STRENGTHS FOR DIFFERENT PERCENTAGE REPLACEMENTS AT 28DAYS.

S/No	Sample No	Weight of sample (kg)	Area of sample (mm^2)	Crushing load (N)	Compressive strength (N/mm^2)	Average Strength (N/mm^2)
		28days compressive strength for 0% replacement				
1	X_{0-6}	9.61	22500	610	27.11	
2	X_{0-7}	8.89	22500	850	37.78	
3	X_{0-8}	9.54	22500	610	27.11	31.73
4	X_{0-9}	9.37	22500	680	30.22	
5	X_{0-10}	8.92	22500	820	36.44	
		28days compressive strength for 10% replacement				
1	A_{10-6}	8.85	22500	590	26.22	
2	A_{10-7}	8.66	22500	670	29.77	
3	A_{10-8}	9.17	22500	720	32.00	27.39
4	A_{10-9}	9.21	22500	490	21.77	
5	A_{10-10}	9.15	22500	600	26.67	
		28days compressive strength for 20% replacement				
1	B_{20-6}	8.82	22500	670	29.78	
2	B_{20-7}	8.64	22500	650	28.89	
3	B_{20-8}	8.99	22500	640	28.44	27.73
4	B_{20-9}	9.22	22500	480	21.33	
5	B_{20-10}	9.22	22500	680	30.22	
		28days compressive strength for 30% replacement				
1	C_{30-6}	8.89	22500	550	24.44	
2	C_{30-7}	9.32	22500	660	29.33	

3	C_{30-8}	9.34	22500	700	31.11	27.73
4	C_{30-9}	9.09	22500	610	27.11	
5	C_{30-10}	8.84	22500	600	26.67	
		28days compressive strength for 40% replacement				
1	D_{40-6}	8.92	22500	640	28.44	
2	D_{40-7}	9.51	22500	760	33.78	
3	D_{40-8}	9.40	22500	690	30.67	29.60
4	D_{40-9}	9.45	22500	520	23.11	
5	D_{40-10}	9.29	22500	720	32.00	
		28days compressive strength for 50% replacement				
1	E_{50-6}	9.18	22500	600	26.67	
2	E_{50-7}	9.06	22500	670	29.78	
3	E_{50-8}	8.99	22500	620	27.56	27.82
4	E_{50-9}	8.89	22500	560	24.89	
5	E_{50-10}	9.16	22500	680	30.22	
		28days compressive strength for 100% replacement				
1	Y_{100-6}	9.00	22500	640	28.44	
2	Y_{100-7}	9.32	22500	530	23.56	
3	Y_{100-8}	8.55	22500	770	34.22	28.49
4	Y_{100-9}	9.02	22500	680	30.22	
5	Y_{100-10}	9.02	22500	540	24.00	

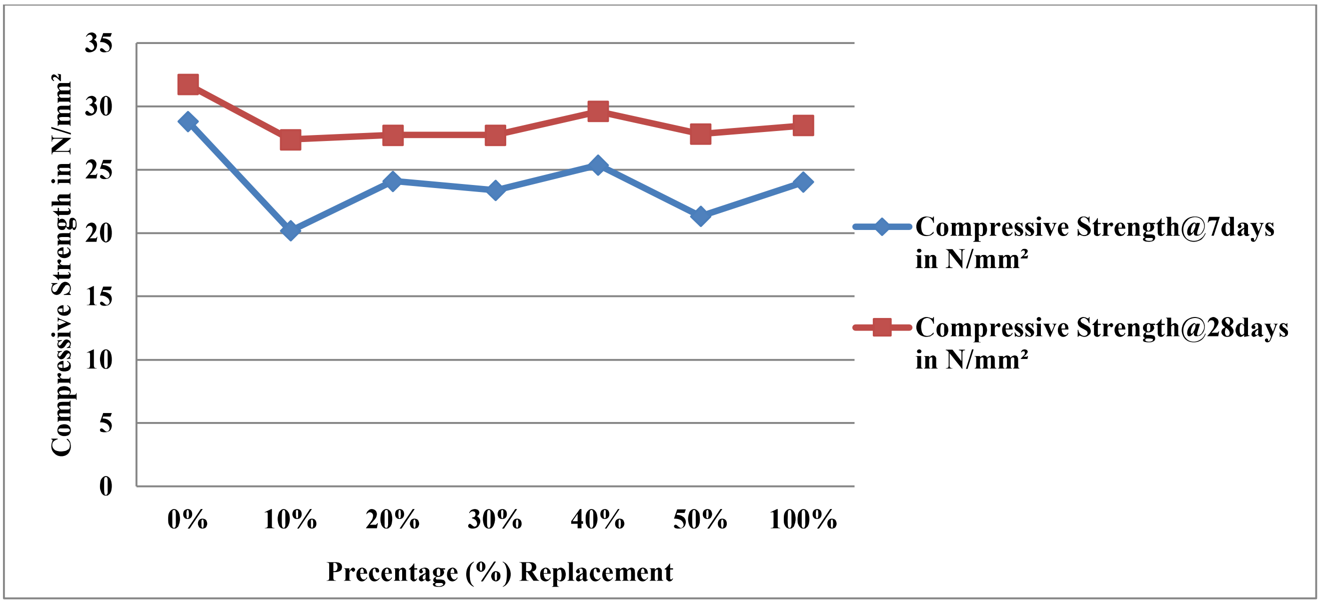

FIGURE 2: COMPRESSIVE STRENGTH OF THE PERCENTAGE REPLACEMENT AT 7 AND 28DAYS CURING DAYS.

3.3 FLEXURAL STRENGTH

Tables 4 and 5 shows the results of the flexural strength of the concrete beams at 7 and 28days curing ages for varying percentage replacement of conventional river sand with crushed rock dust. The result shows that the concrete beams produced with conventional river sand (0% replacement) attains the highest compressive strength of 4.13N/mm^2 and 6.72N/mm^2 at 7 and 28days curing age respectively while concrete produced with crushed rock dust (100% replacement) attains its maximum compressive strength of 3.71N/mm^2 and 5.98 N/mm^2 respectively.

This shows an average of 0.58% decrease in flexural strength of concrete produced with crushed rock dust when compared with the compressive strength of concrete produced with natural river sand. The result also shows that at 30% replacement of natural river sand with crushed rock sand the optimum flexural strength of the concrete beams was obtained. The tables and figure are shown below.

TABLE 4: FLEXURAL STRENGTHS FOR DIFFERENT PERCENTAGE REPLACEMENTS AT 7DAYS.

S/No	Sample No	Weight of sample (kg)	Area of sample (mm^2)	Crushing load (N)	Flexural strength (N/mm^2)	Average Strength (N/mm^2)
7days compressive strength for 0% replacement						
1	X_{0-1}	13.26	10000	77	3.85	
2	X_{0-2}	12.98	10000	90	4.50	
3	X_{0-3}	13.45	10000	81	4.05	4.13
4	X_{0-4}	13.07	10000	86	4.3	
5	X_{0-5}	12.76	10000	92	3.95	
7days compressive strength for 100% replacement						
1	A_{10-1}	12.96	10000	84	4.20	
2	A_{10-2}	13.23	10000	66	3.85	
3	A_{10-3}	12.78	10000	77	3.35	3.64
4	A_{10-4}	12.32	10000	67	3.50	
5	A_{10-5}	13.95	10000	70	3.30	
7days compressive strength for 20% replacement						
1	B_{20-1}	13.98	10000	73	3.65	
2	B_{20-2}	13.04	10000	72	3.60	
3	B_{20-3}	13.88	10000	66	3.33	3.59
4	B_{20-4}	12.97	10000	75	3.75	
5	B_{20-5}	12.77	10000	73	3.65	
7days compressive strength for 30% replacement						
1	C_{30-1}	12.54	10000	72	3.75	
2	C_{30-2}	12.89	10000	68	3.85	
3	C_{30-3}	13.08	10000	76	4.05	3.84
4	C_{30-4}	13.77	10000	68	4.05	
5	C_{30-5}	12.90	10000	66	3.5	
7days compressive strength for 40% replacement						
1	D_{40-1}	14.02	10000	75	3.40	
2	D_{40-2}	13.88	10000	77	3.80	
3	D_{40-3}	13.67	10000	81	3.40	3.53
4	D_{40-4}	12.98	10000	81	3.60	
5	D_{40-5}	13.65	10000	70	3.45	
7days compressive strength for 50% replacement						
1	E_{50-1}	13.45	10000	62	3.10	
2	E_{50-2}	12.79	10000	60	3.00	
3	E_{50-3}	12.89	10000	68	3.40	3.24
4	E_{50-4}	13.76	10000	61	3.05	
5	E_{50-5}	13.93	10000	73	3.65	
7days compressive strength for 50% replacement						
1	Y_{100-1}	13.56	10000	76	3.80	
2	Y_{100-2}	12.98	10000	71	3.55	
3	Y_{100-3}	12.54	10000	78	3.90	3.71
4	Y_{100-4}	13.22	10000	61	3.05	
5	Y_{100-5}	13.55	10000	85	4.25	

TABLE 9: FLEXURAL STRENGTHS FOR DIFFERENT PERCENTAGE REPLACEMENTS AT 28DAYS.

S/No	Sample No	Weight of sample (kg)	Area of sample (mm^2)	Crushing load (N)	Flexural strength (N/mm^2)	Average Strength (N/mm^2)
28days compressive strength for 0% replacement						
1	X_{0-1}	12.78	10000	122	6.10	
2	X_{0-2}	12.54	10000	142	7.10	
3	X_{0-3}	11.98	10000	128	6.40	6.72

4	X_{0-4}	12.66	10000	135	6.75	
5	X_{0-5}	11.77	10000	145	7.25	
		28days compressive strength for 10% replacement				
1	A_{10-1}	12.56	10000	120	6.60	
2	A_{10-2}	13.07	10000	113	5.25	
3	A_{10-3}	13.28	10000	123	6.10	5.98
4	A_{10-4}	12.70	10000	108	5.35	
5	A_{10-5}	12.90	10000	134	5.55	
		28days compressive strength for 20% replacement				
1	B_{20-1}	12.86	10000	132	5.80	
2	B_{20-2}	12.65	10000	105	5.70	
3	B_{20-3}	12.95	10000	122	5.25	5.70
4	B_{20-4}	13.08	10000	107	5.95	
5	B_{20-5}	13.11	10000	111	5.80	
		28days compressive strength for 30% replacement				
1	C_{30-1}	13.78	10000	114	5.95	
2	C_{30-2}	13.29	10000	108	6.10	
3	C_{30-3}	12.25	10000	120	6.40	6.07
4	C_{30-4}	12.48	10000	108	6.40	
5	C_{30-5}	13.35	10000	105	5.50	
		28days compressive strength for 40% replacement				
1	D_{40-1}	12.08	10000	116	5.70	
2	D_{40-2}	13.80	10000	114	5.40	
3	D_{40-3}	12.78	10000	105	6.00	5.69
4	D_{40-4}	13.72	10000	119	5.40	
5	D_{40-5}	12.95	10000	116	5.95	
		28days compressive strength for 50% replacement				
1	E_{50-1}	13.78	10000	119	4.95	
2	E_{50-2}	13.85	10000	122	4.80	
3	E_{50-3}	12.75	10000	128	5.40	5.16
4	E_{50-4}	12.92	10000	128	4.85	
5	E_{50-5}	13.95	10000	111	5.80	
		28days compressive strength for 50% replacement				
1	Y_{100-1}	13.90	10000	99	6.00	
2	Y_{100-2}	13.79	10000	96	5.65	
3	Y_{100-3}	12.85	10000	108	6.15	5.98
4	Y_{100-4}	13.76	10000	97	5.40	
5	Y_{100-5}	12.54	10000	116	6.70	

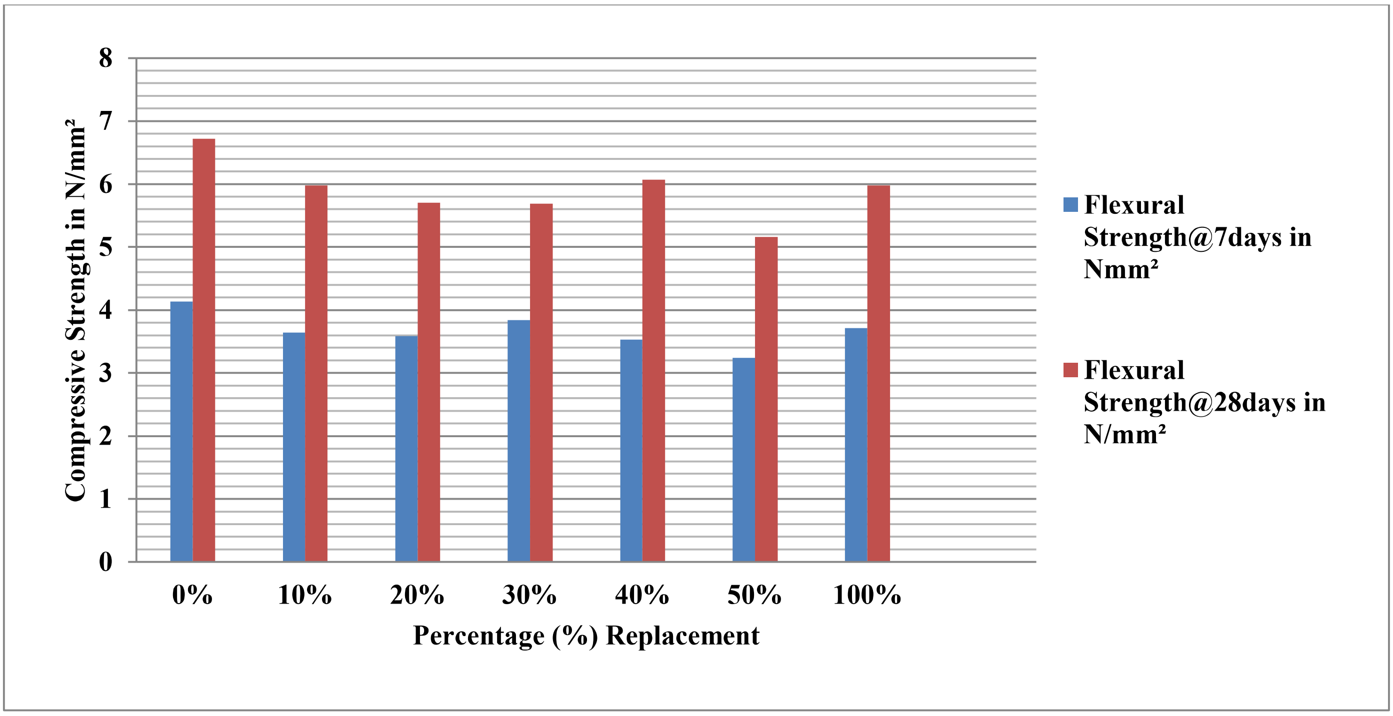

FIGURE 3: FLEXURAL STRENGTH OF THE PERCENTAGE REPLACEMENT AT 7 AND 28DAYS CURING DAYS.

TABLE 5: BATCHING INFORMATION.

S/No	% replacement of crushed rock dust with river sand	Cement (kg)	Natural river sand (kg)	Crushed rock dust (kg)	Coarse aggregate (kg)	Water (kg)	water-cement ratio(w/c)
1	0	7.65	10.67	0	26.18	3.83	0.5
2	10	7.65	9.605	1.065	26.18	3.83	0.5
3	20	7.65	8.535	2.134	26.18	3.83	0.5
4	30	7.65	7.47	3.201	26.18	3.83	0.5
5	40	7.65	6.402	4.268	26.18	3.83	0.5
6	50	7.65	5.335	5.335	26.18	3.83	0.5
7	100	7.65	0	10.67	26.18	3.83	0.5

4 CONCLUSION

The effect of partial replacement of conventional river sand with crushed rock dust has been investigated and the results obtained. From the results, it was observed that the physical properties (Table 1) of River sharp sand sourced from Chanchaga River and the Crushed Rock Dust sourced from Maikunkele Quarry are nearly same and satisfies the requirements of the Standard Codes Provision for the physical properties of fine aggregate for normal weight concrete production. However, Crushed rock dust when solely used as fine aggregate in concrete production gives a satisfactory result in terms of compressive and flexural strengths when compared with concrete produced with the conventional river sand.

Conversely, the conventional river sand when used as fine aggregate gives higher compressive and flexural strengths in the production of normal weight concrete. Moreover, each percentage replacement of conventional river sand with crushed rock dust gives a different compressive and flexural strength with the optimum compressive and flexural strengths obtained at 40% replacement respectively. It was also observed that the rate of strength gain increases as the age of concrete curing increases.

5. ACKNOWLEDGEMENTS

From this research work, the following recommendations are made:

That the physical properties of the fine and coarse aggregates be tested before being used to determine their suitability in concrete production.

For optimum compressive and flexural strengths, 40% replacement level of conventional river sand with crushed rock as fine aggregate in the production of normal weight concrete should be adopted.

Full percentage replacement is also recommended in area where there is scarcity or limited supply of the conventional river sharp sand.

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