RECYCLING OF CONCRETE RUBBLE IN CONCRETE PRODUCTION

Shuaibu, k
Department of Civil Engineering
Kaduna Polytechnic, Kaduna, Nigeria

ABSTRACT

The research work was carried out on both control and recycled concrete samples and three groups of specimen (concrete cubes) were prepared and the workability of each specimen measured using specific standard consistency test, setting time of cement, soundness of cement, compacting factor test, compressive strength of concrete, sieve analysis for the aggregate. Cubes were casted, cured in water and the compressive strength determined at 0%, 10%, and 20% .The concrete were casted and cured for 7, 14, 21 and 28 days and their mean compressive strength for 10% are 13.78 N/mm^2, 16.67 N/mm^2, 18.67N/mm^2 and 21.78 N/mm^2, while that of 20% are: 13.56 N/mm^2, 15.78 N/mm^2 17.56 N/mm^{2,},20.89 N/mm^2 13.78N/mm^2,all from the rubbles.. The following are for the control. They are: 16.23 N/mm^2, 20.22 N/mm^2, 22.45 N/mm^2 and 26.89 N/mm^2.Though, the control has a better compressive strength as expected, it is however clear that even the concrete from recycled rubble have compressive strength that are within the British Standard (BS1881), which stipulate a minimum of 20 N/mm^2 compressive strength for concrete after curing for 28 days.

INTRODUCTION

Rubble is a broken stone of irregular size, shape and texture. This word is closely connected in derivation with rubbish, which was formerly applied to what we now call rubble (Wikipedia, 2011). These rubbles consist of concrete, bricks, tiles, sand and dust of different proportions. Even though rubble is also considered as construction waste, it is however not discarded like other solid wastes, rather in most cases recycled. Construction, demolition, reconstruction and restoration of buildings result in high quantities of constructions and demolition wastes, also known as rubbles (Chesner, 2001). In Nigeria, a huge quantity of construction and demolition waste is always generated or produced every year. The disposal of the waste has become a severe social and environmental problem in the country. In 2009 alone when the Nigerian Railways Corporation (NRC), demolished all the structures near its rail lines, across the country, a lot of wastes was generated. Investigations carried out for the purpose of writing this paper at Unguwar Shanu area of Kaduna town, where the rail line pass through the length of the area, has revealed that more than 95% of the concrete rubble created by the demolition exercise has been re-used. In most parts of the country, landfill space is diminishing, therefore instead of looking for a space to dispose the rubble; it is rather used in building construction works. The problem of landfill sites,, coupled with the fact that the construction materials are rising at alarming rate, that has encouraged the public and Government to use recycled materials, especially material with high potential for reuse such as concrete. However, it is essential to mention here that since recycled aggregate is the result of processing appropriate construction and demolition wastes, there is need to separate between concrete rubble and mineral building material rubble. This processing will lead to crushed sand, crushed stone and crushed gravel, derived from

concrete rubble from building material rubble. In most cases, after demolition a building, the following materials are expected to be obtained.

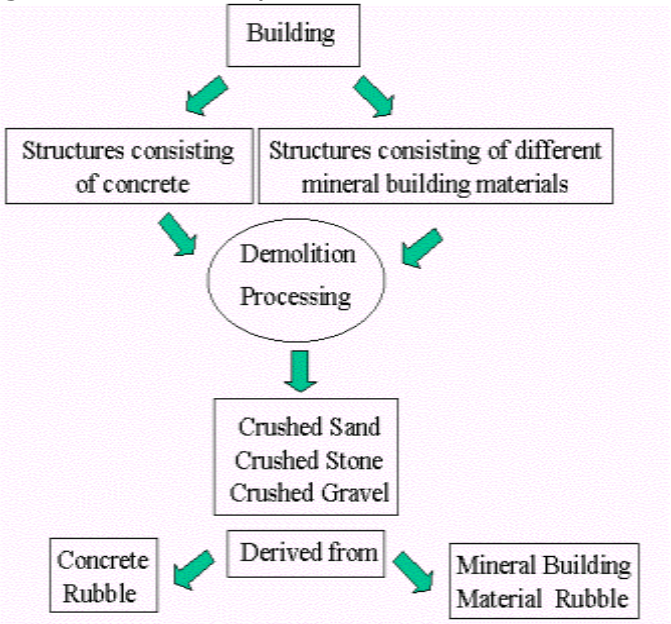

Figure 1: A typical example of denomination of the different types of recycled aggregate from a demolition site.

The possibility of recycling these wastes in the construction industry is thus increased with the increase in the waste It is after been separated from other construction and demolition wastes and sieved, the rubble can be used as a substitute for natural aggregate in concrete (Moxie,2001). It is very important to note that if the rubble contains rebar (metal reinforcing), all rebar should be removed before crushing of the rubble. And not only that, any chemical (including paint) should be removed from the rubble, to avoid chemical reaction during mixing with water. Concrete containing recycled aggregate has to comply with the same requirements as concrete made with natural aggregate. Also building components made of concrete with recycled aggregate, can be designed with the same characteristic values as components of concrete made with natural aggregate. This is due to the fact that the recycled aggregate can only be used mixed with natural aggregate. Even in constructions in which deformations have to be considered, with hardened concrete's properties, resulting from the use of recycled aggregate have to be evaluated by tests. Successful application of recycled aggregate from construction rubbles has been done in some European and American countries (Petraca et al 1989).As for concrete; it is a composite material which consists essentially of a binding medium, within which is embedded particles or fragments of a relative inert filler. In Portland cement concrete, the binder is a mixture of Portland cement, possibly additional cementitious materials such as fly ash and water. The filler may be any of a wide variety of natural or artificial, fine and coarse aggregates; and in some instances, an admixture (Moxie, 2001).

Concrete is presently one of the most popular materials used in building construction and other Civil Engineering works. When reinforced with steel, it has a higher capacity for

carrying loads. Concrete being a heterogeneous material, the quality of the constituents and the proportions in which they are mixed, determine its strength and other properties.

MATERIALS AND METHODOLOGY

Test Methods and Sampling Technique

In the process of preparing this paper, concrete waste was obtained from Unguwar Shanu site of demolition. The waste was hammered, crushed and then some impurities and other particles that stick together with the rubble were removed. It was then taken to then laboratory and sieved. Tests were carried out in line with the following British standards: BS 1881 part 116, BS 8110 part 2 and BS 197 part 1.The following tests were carried out in the soil laboratory of the Department of Civil Engineering of Kaduna Polytechnic, Kaduna, Nigeria.

Setting Time of Cement

The purpose of this preliminary test is to determine the water/cement ratio required to produce a cement paste of standard consistence.

S/NO	weight of cement(g)	volume of water(ml)	depth of penetration(mm)
1	400	126	26.00
2		136	6.00

RESULTS

Of all the tests carried out, this paper will give emphasis on compressive strength, since the aim is to assess the compressive strength of the concrete (part of it which is from rubbles). Also, in terms of curing, the paper will emphasize on 28 days curing as it is the maximum days the concrete was cured in the analysis, which is also expected to have more strength than others cured for 7, 14 or 21 days.

Table 1: Sieve Analysis for Recycled Fine Aggregate

S/N0	SIEVE SIZE (mm)	WEIGHT RETAINED (g)	WEIGT PASSING (g)	% WEIGHT RETAINED	% WEIGHT PASSING	CUMMULATIVE % WEIGHT RETAINED
1	NO7	197	800	19.76	80.24	19.76
2	NO10	110	690	11.03	69.21	30.79
3	NO14	155	535	15.55	53.66	46.34
4	NO18	113	422	11.33	42.33	57.67
5	NO25	135	284	13.84	28.49	71.51
6	NO36	145	139	14.54	13.95	86.05
7	NO52	56	83	5.62	8.33	91.67
8	NO72	23	60	2.31	6.02	92.98
9	NO100	32	28	3.21	2.81	97.19
10	NO150	16	12	1.61	1.20	98.80
11	NO200	10	2	1.00	0.20	99.80
12	PAN	2	O	0.20	0.00	100.00
	TOTAL	997		100.00	304.43	

Table 2 Sieve Analyses for Natural Fine Aggregate

S/NO	SIEVE SIZE (mm)	WEIGHT RETAINED (g)	WEIGHT PASSING (g)	% WEIGHT RETAINED	% WEIGHT PASSING	CUMMULATIVE % WEIGHT RETAINED
1	NO7	116	882	11.62	88.38	11.62
2	NO10	104	778	10.42	77.96	22.03
3	NO14	124	654	12.43	65.53	34.47
4	NO18	152	502	15.23	50.30	49.70
5	NO28	162	340	16.23	34.07	65.93
6	NO36	246	94	24.05	9.42	90.58
7	NO52	53	41	5.31	4.11	95.89
8	NO72	13	28	1.30	2.81	97.19
9	NO100	12	16	1.20	1.60	98.39
10	NO150	10	6	1.00	0.60	99.39
11	NO200	4	2	0.40	0.20	99.79
12	PAN	2	0	0.20	0	99.99
	T0TAL	998				

Table 3 Sieve Analysis for Recycycled Gravel Aggregate

S/NO	BS SIEVE SIZE (mm)	WEIGHT RETAINED (g)	WEIGHT PASSSING (g)	% WEIGHT RETAINED	% WEIGHT PASIING	CUMMULATIVE (%) WEIGHT RETAINED
1	20	417	2579	13.92	86.08	13.92
2	13.20	1104	1475	36.85	46.26	50.77
3	12.70	180	1295	6.01	43.22	56.78
4	9.50	616	679	20.56	22.66	77.34
5	6.35	399	280	13.32	9.34	90.66
6	4.75	158	122	5.27	4.07	95.93
7	3.18	80	42	2.67	1.40	98.60
8	PAN	42	0	1.40	0	100.00
	TOTAL	2996		100.00		

Table 4: Sieve Analysis for Crushed Gravel Aggregate

S/NO	BS SIEVE SIZE (mm)	WEIGHT RETAINED (g)	WEIGHT PASSING (g)	% WEIGHT RETAINED	% WEIGHT PASSING	CUMMULATIVE % WEIGHT RETAINED
1	20	1167	1830	38.94	61.06	38.94
2	13.20	1239	591	41.34	19.72	80.28
3	12.70	114	477	3.80	15.92	84.08
4	9.50	272	205	9.08	6.84	93.16
5	6.35	146	59	4.87	1.97	98.03
6	4.75	31	28	1.04	0.93	99.07

7	3.18	15	13	0.50	0.43	99.57
8	PAN	13	0	0.43	0	100.00
	TOTAL	2997				

Table 5: Compressive Strength

Sample	Curing (days)	Crushing Strength N/mm^2	Average Strength N/mm^2	Remarks
A_1	7	13.78		
A_2	7	13,38	13,56	
A_1	14	16.00		
A_2	14	15.00	15.50	
A_1	21	17.33		
A_1	21	17.78	17.56	
A_1	28	21.33		
A_2	28	20.44	20.89	O,K
B_1	7	13.90		
B_2	7	13.62	13.76	
B_1	14	16.84		
B_2	14	16.50	16.67	
B_1	21	18.89		
B_2	21	18.45	18.67	
B_1	28	21.96		
B_2	28	21.60	21.78	O.K
C_1	7	15.56		
C_2	7	16.89	16.23	
C_1	14	20.00		
C_2	14	20.44	20.22	
C_1	21	23.11		
C_2	21	21.78	22.45	
C_1	28	26.22		
C_2	28	27.56	26.89	O.K

CONCLUSION

The following can be concluded from the results obtained: The effect of rubble waste on the environment can be reduced by converting it into useful aggregate in the production of concrete. Results from the analysis have shown that compressive strength of recycled aggregate, compared to the natural aggregate was found to be virtually the same and fall within the minimum strength accepted by the British Standard, after curing for 28 days. In a situation where rubbles are available, it can be used instead of buying new materials and with that cost of construction can be reduced.

RECOMMENDATION

In view of the above, it is recommended that aggregates from rubbles can be used for construction in place of natural aggregates, especially where solid waste landfill are not adequate or where natural aggregate is in limited supply, recycled aggregate can replace it since it can serve the same purpose But the users of recycled aggregates are advice to study their environment to know the effect of sulphates and alkaline water, and other chemicals, which could attack the efficiency of recycled aggregate. Also there should be a Nigerian Code of Practice on the type of rubble that can be accepted as recycle concrete aggregate.

REFERENCE

British Standards Institute, BS 1881: part 116 (1983): Method of determining strength of concrete cubes. London, BSI.

British Standard Institution, BS 8110 part 2 (1985): Structural use of Concrete: Code of Practice for Design and Construction. British Standard Institution, London.

British Standard Institution, BS 197 par1 (2000): Composition, specifications and conformity criteria for common cements: Codes of Practice for Design and Construction. British Standard Institution, London.

Wikipedia, (2011): "Wikipedia the free encyclopedia", Retrieved September 24, 2011, from http://www.en.wipedia.org/wiki/Cement

Wikipedia, (2011): "en.wikipedia.org/wiki/construction waste", Retrieved September 24, 2011, from

Moxie, (2001): "Moxie international Concrete Admixtures/concrete Sealers and Concrete Waterprofers Glossary", Retrieved October 15, 2011, from http://www.moxie-intl.com/glossary.html

Chesner, P.C (2001): Reclaimed Concrete Aggregate for use as coarse aggregate. 2nd edition. Pp. 12- 15. Macmillan, England.

Petrarca, R, and Vincent, G. (1989): Summary of Testing Recycled Crushed Concrete. 2nd edition. Pp 5- 6. McGraw, England.