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Compressive Strength Of Concrete Made From Demolished Concrete Materials As Partial Replacement Of Coarse Aggregate

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Abstract
This study has been conducted to ascertain the usability potential of demolished concrete materials as a replacement for coarse aggregate in concrete. Demolished concrete was obtained from beureau of History and culture, Sokoto from the exhumed underground manhole during open drain construction in march 2021. Crushed into appropriate sizes, sived and washed;, it was used in replacing coarse aggregate in concrete in the various percentages of 0%, 5%, 10% and 15% respectively. A total of forty-eight (48) cubes were produced and were tested for compressive strength at 7, 14, 21 and 28 days of curing. It was observed that the strength of all the percentage replacement rises progressively through the curing period, with 5% replacement having 16.13N/mm^2 at 28 days and 15% replacement having 14.0N/mm^2 at 28 days. It was concluded that demolished concrete materials are still suitable for use as areplacement for coarse aggregates in concrete but 5% replacement has been recommended for suspended members while 10 and 15 % can be employed for foundations and walls.

Keywords: *Demolished concrete, Compressive strength, Curing period*

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I. Introduction

Concrete is a combination of cement, fine and coarse aggregates and water, which is mixed in a particular proportion to get aparticular strength. The cement and water react together chemically to form a paste, which binds the aggregate particles together. The system sets innto a rock-like solid mass, which has considerable compressive strength but little resistance in tension (Agbede & Manasseh, 2009). Kabiru and Saleh, 2010 explained that concrete is an artificial material similar in appearance and properties to some natural limestone rock. It is a man-made composite, the major constituents being natural aggregate such as gravel, or crushed rock, sand and fine particles of cement powder all mixed with water.

In heterogeneous materials like concrete, quality of the constituents, proportions in which they are mixed determine the strength and properties of the resultiong product (Agbede & Manasseh, 2009). A good knowledge of the properties of cement aggregates and water is required in understanding the behaviour of concrete.

Aggregates are innert materials which are used as binding materials in concrete production. The aggregates occupy about 70 to 75% of the volume of the hardened mass, which is about three quater ot the volume of concrete (Neville, 1996). Aggregate is classified broadly into two categories which are fine and coarse aggregates. Fine aggregate is generally natural sand and is graded from particle 5mm in size down to the finest particle but excluding dust. Coarse aggregate is also natural gravel or crushed stone usually larger than 5mm and usually less than 16mm in ordinary structure.

As the society develops challenges are posed on the protection of environment with respect to reduction of energy consumption, and natural raw materials used in construction processes. Based on this, attention has been focussed on the environment and safeguarding of natural resources and recycling of wastes in building materials.

In recent times, a lot of work concerning the use of urban construction wastes in building materials have been published. The use of waste materials has however shown a prospective application in construction industry as alternative to conventional materials. Such practices according to Mangit and Sanjeev, (2012) conserves natural resources and reduces the space required for disposal of waste material. Anagha and Naik, 2015 asserted that the strength of concrete developed using demolished concrete wastes was lower, but still within the acceptable value.

Recycled concrete aggregate according to (CCA, 2008) is defined as a product derived from the processing of materials previously used in a product and / or in construction which include recycled concrete

from construction and demolition waste materials (C & D). Recycled concrete aggregate (R C A) is a coarse recycled concrete aggreggate which contains clean demolition waste of at least 95% by weight of concrete, and having a total contaminant level typically lower than 1% of the bulk mass.

In Nigeria, especialy places like Sokoto State North western Nigeria, most demolition waste have been treated just as municipal waste and sometimes useless in construction sites. Experience has shown that most demolition wastes have been employed as filling materials while in some cases have been neglected to constitute nuisance within our environment thereby costing more money for its disposal.

Demolished concrete materials is therefore viewed to be of more important than backfilling materials if properly processed and reused. This therefore form the basis on which this research stands with a view to using demolished concrete as partial replacement of coarse aggregate in concrete making and examine the strength of the resulting concrete.

II. Materials and Method

a. **Materials.**

For the purpose of this work the materials used are as listed below;

i. **Demolished concrete material**. This was obtained at a demolition site along the NEWMAP stormwater drainage construction in Sokoto, Sokoto state. The concrete is that of manholes used for wastewater sewers constructed in 1980's in the area, but due to the construction of open drains in the Mabera stormwater management project, they were all removed.

ii. **Cement:** Ordinary portland cement with brand name (Sokoto Cement) was obtained at a distribution shop at Arkilla area of Sokoto city.

iii. **Aggregates:** Both the coarse and fine aggregates were purchased at the back of Umaru Ali shinkafi Polytechnic Sokoto

iv. **Water:** Potable water, fit for drinking, was obtained at the Umaru Ali Shinkafi Polytechnic, concrete laboratory, Sokoto.

figure 1. a & b

Figure 1a is the new coarse aggregate and 1b is the demolished concrete aggregate.

2.2 Method.

Four sets of concrete cubes of 150mmx150mmx150mm were produced in consonance BS1881:102, 1983 with a mix ratio of 1:2:4. A total of 48 nos of cubes were produced altogether i.e 12 cubes each for 0%, 5%, 10% and 15% demolished concrete replacement respectively.

The cubes were removed from the moulds and were immersed in the curing tank and were taken for compressive strenght tests at interval of seven days in accordance with BS1881:124, 1988.

III. Results

The results of the slup test conducted on the mixes and that of the compressive strength tests have been presented as shown below.

Table 3.1: Slump Test Result

SAMPLES	% OF REPLACEMENT	SLUMP VALUE (mm)
A	0	42
B	5	39
C	10	36
D	15	33

Source: (Lab. Work, 2021)

The results of the compressive strength carried out at 7, 14, 21 and 28 days on samples of the repconcrete made with various percentage replacement have been presented in the sections that follow.

Table 3.2 : Compressive Strength Test results for Seven days (7) curing period

Age (days)	Strength 0% (N/mm^2)	Strength 5% (N/mm^2)	Strength 10% (N/mm^2)	Strength 15% (N/mm^2)
7	c/0/1 = 13.4 c/0/2 = 13.0 c/0/3 = 12.9	c/5/1 = 12.3 c/5/2 = 12.1 c/5/3 = 12.2	c/10/1 = 11.9 c/10/2 = 10.3 c/10/3 = 11.0	c/15/1 = 9.8 c/15/2 = 10.2 c/15/3 = 10.8
Average	13.1	12.2	11.1	10.2

Source: (Lab. Work, 2021)

Seven days strength of concrete with 0, 5, 10 & 15 % replacement were 13.1, 12.2, 11.1 and 10.2 N/mm^2 respectively.

Table 3.3: Compressive Strength Test results for fourteen days (14) curing period.

Age (days)	Strength 0% (N/mm^2)	Strength 5% (N/mm^2)	Strength 10% (N/mm^2)	Strength 15% (N/mm^2)
14	c/0/4 = 14.3 c/0/5 = 14.6 c/0/6 = 14.3	c/5/4 = 13.0 c/5/5 = 13.6 c/5/6 = 12.9	c/10/4 = 12.0 c/10/5 = 11.9 c/10/6 = 11.8	c/15/4 = 11.5 c/15/5 = 11.7 c/15/6 = 10.8
Average	14.57	13.2	11.7	11.6

Source (Lab.,Work, 2021)

Fourteen days strength of concrete with 0, 5,10 & 15 % replacement were 14.57, 13.2, 11.7 and 11.6 N/mm^2 respectively.

Table 3.4: Compressive Strength Test results for Twenty-one days (21) curing period.

Age (days)	Strength for 0% (N/mm^2)	Strength 5% (N/mm^2)	Strength 10% (N/mm^2)	Strength 15% (N/mm^2)
21	c/0/7 = 16.5 c/0/8 = 17.5 c/0/9 = 17.9	c/5/7 = 14.3 c/5/8 = 15.3 c/5/9 = 14.9	c/10/7 = 14.0 c/10/8 = 13.9 c/10/9 = 12.9	c/15/7 = 14.0 c/15/8 = 13.9 c/15/9 = 12.9
Average	17.3	14.8	13.33	12.9

Source (Lab. Work, 2021)

Twenty-one days compressive strength for the concrete with 0%, 5%, 10% and 15% replacement were 17.3, 14.8, 13.33 and 12.9N/mm^2 respectively.

Table 3.5: Compressive Strength Test results for twenty-eight days (28) curing period.

Age (days)	Strength 0% (N/mm^2)	Strength 5% (N/mm^2)	Strength 10% (N/mm^2)	Strength 15% (N/mm^2)
28	c/0/10 = 19.2 c/0/11 = 18.3 c/0/12 = 17.5	c/5/10 = 16.2 c/5/11 = 15.9 c/5/12 = 16.3	c/10/10 = 15.0 c/10/11 = 14.9 c/10/12 = 15.0	c/15/10 = 13.9 c/15/11 = 14.3 c/15/12 = 13.9
Average	18.33	16.13	14.97	14.0

Source (Lab.Work, 2021)

Table 3.5 shows that the average 28days strength of concrete with 0% 5%, 10% and 15 % replacement were 18.33, 16.13, 14.87 and 14.0 N/mm^2 respectively.

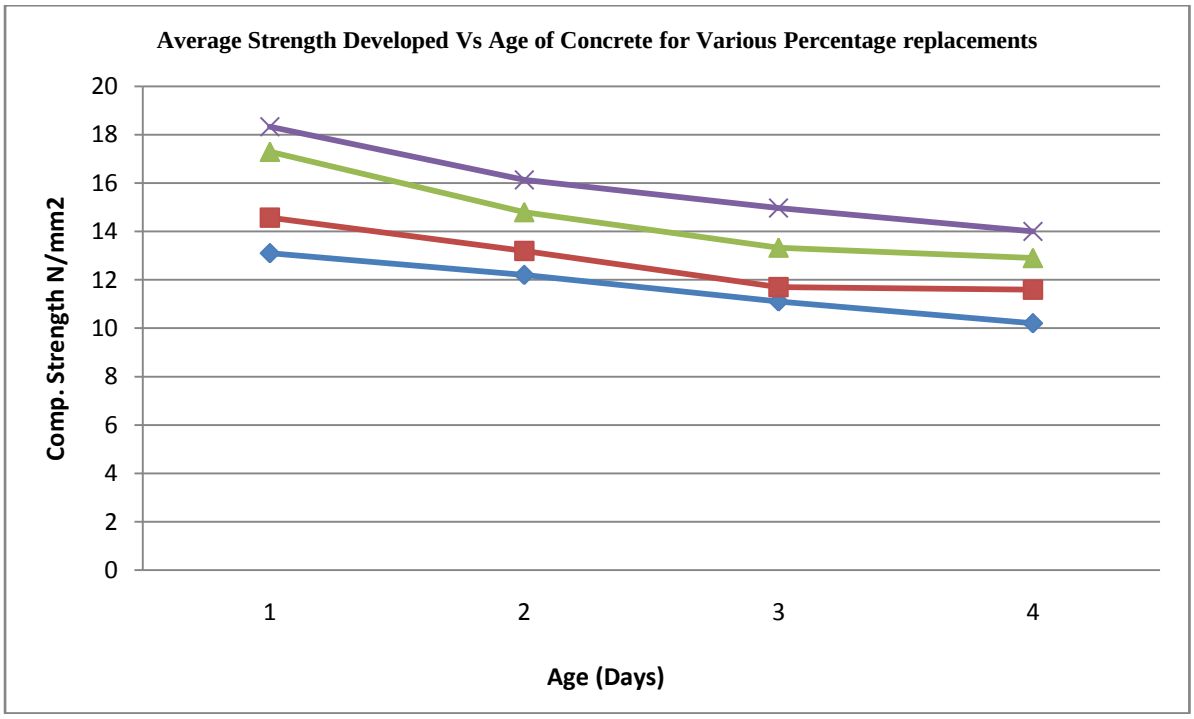

Figure 3. chart of Strength developed for different percentage replacement with age of concrete produced.

IV. Conclusion and Recommendation

4.1 Conclusion.

From the results of the research the following can be deduced;

i. The used demolished concrete performed well all the concrete produced.

ii. the strength developed by all concrete from 0 – 15% replacement increased progressively from low to a high value.

iii. 5% replacement has the highest 28 days compressive strength of 16.8 N/mm^2 which is in consonance with the BS standard of 1:2:4 concrete.

iv. 15% replacement has the lowest 28 days compressive strength of 14.0N/mm^2.

4.2 Recommendations

Going by the conclusions drawn, the following recommendations were made:

i. Demolished concrete are adequate to be used for partial replacement of coarse aggregates in concrete.

ii. 5% replacement of coarse aggregate with demolishe concrete is recommended for use in slabs and beams.

iii. 10 and 15% replacement are thereby recommended for floor and othe ground members.

iv. More research should be carried out on the use of demolished concrete materials as a replacement for coarse aggregate in concrete.

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