Int. j. adv. multidisc. res. stud. 2025; 5(5):958-959

Received: 21-08-2025
Accepted: 01-10-2025

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

The Water Cement Ratio Suitable for Combining Recycled Aggregate Concrete with Natural Coarse Aggregate

[1] Ogidikpe Oyeinpereyi Abu Mola, [2] Ukpaka Chinedu

[1, 2] Lecturer 3, Civil Engineering Technology, Bayelsa State Polytechnic Aleibiri, Aleibiri Ekeremor, Nigeria

DOI: https://doi.org/10.62225/2583049X.2025.5.5.5039
Corresponding Author: **Ogidikpe Oyeinpereyi Abu Mola**

Abstract

This scientific experimentation investigates the water cement ratio that will be satisfactory on the workability and compressive strength of concrete produced by combining recycled aggregate concrete with natural coarse aggregate. The outcome for the workability gotten from a w/c ratio of 0.6 for recycled aggregate concrete was 20mm, 34mm, 80mm, 24mm, 6.5mm, 17.5mm, 27.5mm, 26.5mm and 6mm at 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, and 50% of combining recycled aggregate concrete with natural coarse aggregate respectively. Meanwhile the workability procured from a 0.7w/c gave 80mm, 34mm, 190mm, 100mm, 135mm, 145mm, 162.5mm, 66.5mm, and 35mm at 0%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, and 50% correspondingly of percentage replaced recycled aggregate concrete. For a water cement ratio of 0.6, we have an optimum cube strength of 37.3mpa at 25% recycled aggregate concrete combined in with natural aggregate for 28 curing days, and the worst-case of 14.5mpa at 50% recycled aggregate concrete. Whereas the water cement ratio of 0.7 secured a maximum cube strength of 29.6mpa at 0% recycled aggregate concrete that is a hundred percent natural aggregate at 28 curing days and the poorest cube strength of 11.6mpa at 50% recycled aggregate concrete in 28 curing days.

Keywords: Cement, Natural Coarse Aggregate, Nigeria

1. Introduction

According to the American society for testing and materials (ASTM) aggregates are defined as granular materials such as sand, gravel, crushed stones or other minerals particles [1] that are used in construction of civil engineering purposes. Aggregates form a large proportion of concrete, they define the stability of concrete and are essential in the production of concrete. Based on their sizes aggregates are classified in two groups. The first is coarse aggregate with particle size greater than 4.75mm, it is also known as the size retained on a number four sieve. Secondly, we have the fine aggregate with particle size less than 4.75mm, passing number four sieve. Locally shingles are grouped based on their sizes, some examples are three-eight, three-quarter etc. other local materials include sea shell example perewingle shell, palm nut shell etc. recycled aggregate concrete are manufactured aggregates obtained from demolished structures [2] they are of low quality compared to those produced by natural coarse aggregate [3-6]. knowing the water cement ratio that will be suitable for concrete mixing using natural aggregate and recycled aggregate concrete will improve the strength of the mix, it will be economical and ensure good workability. Good workability sees to it that concrete is mixed, placed, consolidated and finished without segregation or excessive bleeding,[7] it ensures productive construction.

2. Experimental Methodology

- Fine aggregate
  River sand was gotten from Choba River in Port Harcourt rivers state Nigeria and was used as fine aggregate for this research.
- Coarse Aggregate
  Gravel was used as natural coarse aggregate for this experimental work.

- Water
  Clean tap water free from impurities was used for this experiment.
- Cement
  Ordinary Portland lime stone cement bought at the building material market in Port Harcourt from local distributors.
- Manufactured Aggregates
  Recycled aggregates was used as manufactured aggregate obtained from crushed test cubes.
- Compressive strength
  The result for the compressive strength and workability for 0.6w/c ratio and 0.7w/c ratio are shown below.

Table 1.1: Computed compressive strength and slump with 0.6w/c

%RCA	7days cube strength mpa	14days Cube strength mpa	28days Cube strength mpa	Workability mm
0	31.1	30.7	29.8	20
5	24.4	27.5	33.8	34
10	22.0	23.6	26.7	80
15	28.7	29.1	29.8	24
20	20.0	22.2	26.7	6.5
25	28.4	31.4	37.3	17.5
30	19.9	24.4	15.3	27.5
40	22.9	28.3	24.2	26.5
50	16.5	14.5	25	6

Table 1.2: Computed compressive strength and slump with 0.7w/c

%RCA	7days cube strength mpa	14days Cube strength mpa	28days Cube strength mpa	Workability mm
0	25.3	26.7	29.6	80
5	26.7	24.3	19.6	34
10	21.8	21.2	20	190
15	24.4	23.9	22.9	100
20	20.0	20.9	22.7	135
25	14.7	19.1	28.0	145
30	15.6	12.2	15.9	162.5
40	18.7	25.5	22	66.5
50	19.4	27.2	11.6	35

3. Results and Discussion

3.1 Compressive strength of concrete with w/c of 0.6

The result of the compressive strength test for a w/c ratio of 0.6 is found in Table 1.1. From the table, the maximum cube strength is at 5%RCA, with a compressive strength of 33.8mpa for 28 curing days, while the least compressive strength is at 50%RCA with a cube strength of 14.5mpa. The compressive strength seems to vary with the percentage increase in recycled aggregate concrete, at 15%RCA the compressive cube strength for 7days, 14days and 28days is higher than 25mpa with a drop at 20%RCA for 7days and 14days giving us 20.0mpa and 22.2mpa respectively and at 28 curing days it is 26.7mpa.

3.2 Compressive strength of concrete with w/c of 0.7

The result for the compressive strength test for w/c of 0.7 is in Table 1.2. From Table 1.2, the optimum compressive strength is 29.6mpa at 0%RCA for 28 curing days, whereas the worst compressive strength was gotten from 50%RCA at 28 curing days with a value of 11.6mpa.

3.3 Slump for w/c of 0.6

The slump test for 0%RCA from Table1.1 is 20mm, this is a low slump that is stiff, suitable for structures with low reinforcements. While the 5%RCA to 50% RCA has workability that ranges from 6mm to 80mm, which falls between low slump to high slump. This is suitable for general construction as well as complex reinforment.

3.4 Slump for w/c of 0.7

The slump test for 0.7 workability is found in Table 1.2. The 0%RCA, has a workability of 80mm which is a high slump, good for congested reinforcement. However, the 10%RCA, 20%RCA, 25%RCA and 30%RCA presents very high slumps of 190mm, 135mm, 145mm, and 162.5mm respectively. This shows that the concrete is very flowable and may not be suitable for low reinforcement use, general construction and congested reinforcement.

4. Conclusion

The subsequent conclusions were reached

1. The concrete produced with 0.6w/c ratio gives a good workability that is standard.
2. The slump for 0.7w/c ratio is very high, indicating that concrete is very flowable.

5. Contribution to knowledge

The water cement ratio suitable for combining recycled aggregate concrete with natural aggregate in the production of concrete is 0.6, according to Table 1.1 above.

5.1 Limitation

This research was limited to only two water cement ratios namely, 0.6w/c and 0.7w/c

5.2 Potential area for future research

I recommend that a mathematical model should be carried out based on the parameters obtained.

6. References

1. ASTM International. Standard Specification for Concrete Aggregates (ASTM C33/C33M-20), 2020.
2. Ogidikpe OAM, Nwofor TC. Recycled Concrete Aggregate as part Replacement of Natural Coarse Aggregate, 2025, 545-547.
3. George RO. A Solution to the Problem of Recycled Concrete Aggregates. International Journal of Engineering and Technology Research. 2014; 2.
4. Chen HJ, Yen T, Chen KH. Use of building rubbles as Recycled Aggregate, 2003.
5. Khalaf FM, Devenny AS. Recycling of Demolished Masonry Rubble as coarse Aggregate in Concrete, 2004.
6. Hoffmann C, Schubert S, Leemann A. Influence of Variations in Composition on the Concrete Properties and their use as Structural material, 2012.
7. Mehta PJK, Monteiro PJM. Concrete Microstructure, Properties and Materials, 2014.