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# Evaluation of River Otamiri in FUTO Community for Construction Works Suitability

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**ABSTRACT:** In Civil Engineering profession, water is the most sought and used construction material after concrete and there is a general saying that water that is good for drinking (Potable water) is also good for concrete. Sometimes, due to scarcity of potable water on some Nigerian universities, such as Federal University of Technology, Owerri (FUTO), one can be tempted to look upon nearby river on campus for alternative source of water supply. This work is aimed at evaluating the suitability of FUTO Otamiri River for construction purposes. In order to achieve this objective, some quantities of water from FUTO River Otamiri and borehole were fetched and used to produce concrete cubes using the Handy Developed Empirical **[HDE]** Mix Design Ratios developed by Nwachukwu and others (2025b) in ten trial mixes BASED on conventional mix ratios of **1:2:4.** Thereafter, the concrete produced from River Otamiri **[ROC]** and that produced from borehole water **[BWC]** were subjected to compressive strengths investigations. The compressive strength results show that the maximum compressive strength of ROC cubes and BWC cubes evaluated are **13.95 MPa** and **27.99 MPa** respectively for the 28th day result. Thus based on the minimum value specified by the American Concrete Institute (ACI), as 20 MPa for good concrete and minimum required value (of 30.75MPa) specified by ASTM C 469 and ASTM C 39 for high performance concrete, this means that water from FUTO River Otamiri is not that too suitable for construction work where good and high performance concrete is required without complete treatment. Therefore, there may be need for proper treatment of the Otamiri River situated in FUTO Community before it can be used for horizontal and vertical construction works.

**KEYWORDS**: FUTO Community, River Otamiri, Borehole Water, ROC, BWC, Construction Works, Compressive Strength, HDE

## I. INTRODUCTION

In a typical Civil Engineering set up, construction works, whether horizontal or vertical require the use of potable water. Typical potable water sources usually come from boreholes or other treated sources. But during relative scarcity of potable water resources, there are always urgent need to seek after alternative sources. Such alternatives are usually the nearby surface water. In Federal university of Technology, Owerri [FUTO], River Otamiri is the only surface water source that is located at the heart of the campus, which can act as an alternative water sources. Therefore, this work is aimed at evaluating compressive strengths of concrete produced from River Otamiri water source [ROC] and Borehole Water source [BWC] in order to determine the suitability of FUTO Otamiri River for construction purposes.

Federal University of Technology, Owerri [FUTO] as one of the foremost universities of technology, was established by the Federal Government of Nigeria in 1980 with the major aim of providing technology for service. It has a land mass of about 4000 hectares of land and population of about 25,000 including both the students and staff. FUTO is sited in Owerri metropolitan city located between latitude $5^{0}22^{1}$ N and longitude $6^{0}59^{1}$E as shown in Figure 1. FUTO

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like every other university campus are always full of construction works /activities on daily basis that require the use of water resources. Recall that water resources refer to natural resources of water that are potentially useful as a source of water supply. Already, the importances of each of the classes of water resources ( surface and groundwater) are duly explained by Akpobori and Nfor (2007) and Agunwamba (2000) and the sources of different classes of water resources have been fully detailed by the works of Nwachukwu and others (2022).

Water Quality Assessment/Evaluation is defined as the overall process of evaluation of the physical, chemical and biological nature of the water resources which is based on based upon five broad types of monitoring data: biological integrity, chemical, physical, habitat, and toxicity. Many professionals have developed interests in water quality assessment for different reasons based on professional inclination. This explains why the assessment of water qualities is of interest to many researchers across different field of discipline and human endeavor. The Geologists, Biologists, Crop Scientists/Technologists, Chemists, Civil Engineers/Water Resources Engineers, Environmentalists, Agriculturist/Agricultural Engineers, Physicts, Geographers as well as other water resources agencies have different interest and motive for assessment for water resources qualities. But for the Civil Engineer Professional, his interest is mainly for drinking, domestic and construction purposes. In this present work, the evaluation of River Otamiri water resources is to determine its suitability for construction works.

Many researchers across the globe have done related works on the subject matter, but none has been able to carry out detailed assessment /evaluation. For instance, Ijeh (2014) carried out an assessment on groundwater quality in different parts of Owerri and his work is limited to groundwater and for domestic purposes only. Olasoji and others (2019) assessed surface and groundwater qualities using Water Quality Index Method. Their area of interest was in the South Western Nigeria. The work of Okoro and others (2016) is limited to only groundwater. Eyankwere and others (2015) carried out both Physico-Chemical and bacteriological assessment of groundwater quality in Ughelli and its environ. The work of Ihenetu and others (2020) majored on the pollution and health risk assessment of groundwater sources around a waste disposal site in Owerri West L.G.A. Nwosu and Nwosu (2016) carried out the physico-chemical analysis of surface water and groundwater systems within Federal University of Technology Owerri (FUTO). Their major interest as researchers from physics department was to obtain the available geoelectric survey information. Nwachukwu and others (2020) carried out comparative analysis of water quality from harvested rain and borehole water in Owerri West L.G.A. As expected, their research interest is limited to their field of career, biology. The work of Obi (2017) concentrated only on consumption purposes and in general terms for Owerri west while the present study is specific for FUTO community. Nwachukwu and others (2022) evaluated water resources qualities from some parts of Owerri west LGA of Imo state for both consumption and construction purposes. Again, Nwachukwu and others (2023) evaluated the water resources qualities from Owerri Municipal Council of Imo state for Sustenance and Attainment of Construction (Engineering) Development Goals. Finally, Nwachukwu and others (2025c) assessed the physic-chemical and biological parameters of the FUTO River Otamiri for drinking and domestic purposes. From the foregoing, it can be envisaged that little or no work has been done on the subject matter with respect to the area of study, which is FUTO and in terms of specific purpose of construction. Henceforth, the need for this present work.

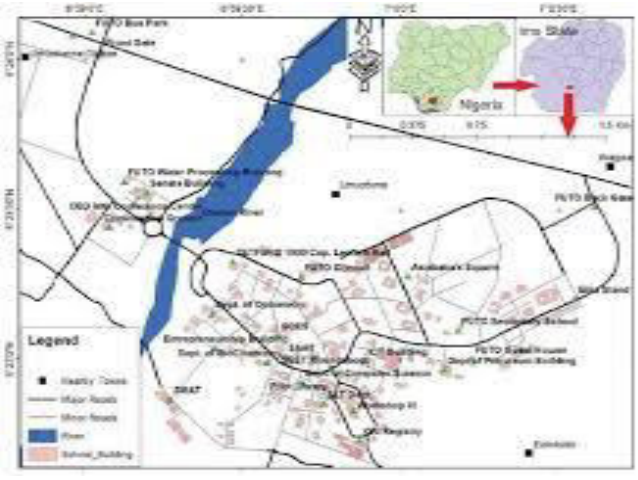


**Fig. 1: Map of FUTO showing geographical locations.**

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## II. METHODOLOGY

### 2.1. MATERIALS FOR ROC/BWC CONCRETE MIXTURE

In this present research work, the component materials under compressive strength evaluation are Water, Cement, Fine and Coarse Aggregates under mix ratio of **1:2:4.** The cement type which is a brand of Ordinary Portland Cement that conforms to British Standard Institution BS 12 (1978) was procured from local distributors. Fine aggregate of sizes that range from 0.05 - 4.5mm was purchased from the local distributor. Granite as a coarse aggregate of 20mm size was purchased from a local stone market. Both fine and coarse aggregates were procured and prepared in accordance with ASTM C33/C33M-18 (2018). For assessment of the water resources for construction purposes, 25–litre jerry can was used to fetch River Otamiri and another 25-litre jerry can used to fetch bore hole water. The borehole water is procured from potable clean water source and was applied in accordance with ASTM C1602/C1602M-22 (2022)..

### 2.2. MIXTURE DESIGN OF THE ROC/BWC CONCRETE

In this work, the Handy Developed Empirical **[HDE]** Mix Design Ratios developed by Nwachukwu and others (2025b) will be used for the mixture design, for compressive strength evaluation of concrete produced using River Otamiri **[ROC]** and concrete produced using borehole water **[BWC].** Here, The HDE has been chosen ahead of Kings-Scheffe's method used in Nwachukwu and others (2025a)

#### 2.2.1. ADOPTED MIX RATIO FOR ROC/ BWC - CS MIXTURE DESIGN

The adopted mix ratio for this work is **1:2:4**. The different water/ cement ratios adopted are **0.5, 0.58, 0.6, 0.63, 0.68, 0.7, 0.73, 0.75, 0.80, 0.85**

#### 2.2.2. CONVENTIONAL MIX RATIOS FOR ROC/BWC - CS COMPONENTS

Using W/C ratio of 0.5, we have new conventional mix ratio as : **0.5:1:2:4.** The rest are shown in Table 1.

#### 2.2.3. MEASUREMENT OF QUANTITY OF ROC / BWC - CS MATERIALS AT THE LABORATORY.

Mathematically, from the works of Nwachukwu and others (2025b), Measured Quantity, $M^Q$ of ROC/BWC Mixture is given by Eqn.(1)

$$M^Q = \frac{X}{T} * W \quad (1)$$

Where, **X** = Individual mix ratio at each point.
**T** = Sum of mix ratios at each point
And **W** = Average weight of Concrete cube/beam/cylinder
For the Compressive Strength concrete cube mould of 15cm*15cm*15cm, Average **W**, from experience = 8kg
Using point 1 mix ratios, we have: **0.5: 1: 2: 4.**
T = 7.5, W = 8
For $X_1$ = 0.5, using Eqn. (1), $Q_1$ = 0.53 etc, and the measured quantity for point mix ratios equals
**$Q_1$ : $Q_2$: $Q_3$: $Q_4$ = 0.53: 1.07: 2.13: 4.27**
For the 10 different trial mix ratios, the measured quantities are displayed in Table 1.

### 2.3. METHODS

#### 2.3.1. ROC/BWC SPECIMEN PREPARATION/BATCHING/CURING FOR COMPRESSIVE STRENGHT TEST

The specimen used for the compressive strength is concrete cube. The concrete were cast in steel mould measuring 150mm*150mm*150mm. The mould and its base were damped together during concrete casting to prevent leakage of mortar and then thin engine oil was applied to the inner surface of the moulds to make for easy removal of the cubes. Batching of all the constituent material was done by weight using a weighing balance of 50kg capacity based on the adopted mix ratios and water cement ratios as depicted in Table 1. The measured actual quantities of ROC/BWC in the laboratory are as shown in Table 1. For the ten experimental tests, a total number of 10 mix ratios were to be used to produce **20 ROC prototype** concrete cubes and **20 BWC prototype** concrete cubes. Curing commenced 24hours after casting. Then, the specimens were removed from the moulds and were placed in clean water for curing. After 28 days of curing the specimens were taken out of the curing tank for the ROC/BWC compressive strength test.

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**2.3.2. ROC/BWC COMPRESSIVE STRENGHT TEST PROCEDURE/CALCULATION**

Compressive strength testing was done in accordance with BS 1881 – part 116 (1983) - Method of determination of compressive strength of concrete cube and ACI (1989) guideline. Two samples were crushed for each mix ratio and altogether, 40 cubes were crushed for ROC/BWC mixtures. In each case, the compressive strength was calculated using Eqn.(2) as:

$$\text{Compressive Strength (MPa) , } G = \frac{\text{Average failure Load, } P}{\text{Cross- sectional Area, } A} \quad \textbf{(2)}$$

**Table 1: The Mixture Design Mix Ratios And The Measured Quantities Of ROC/BWC**

| S/N | REPLICATE | MIX RATIO BASED ON 1:2:4 | | | | | MEASURED QTY AT LAB, $M^Q$ [KG] | | | | CS SYMBOL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $X_1$ W/C | $X_2$ C | $X_3$ FA | $X_4$ CA | TOTAL | $Q_1$ W/C | $Q_2$ C | $Q_3$ FA | $Q_4$ CA | |
| 1. | A | **0.50** | 1 | **2.0** | **4.0** | **7.50** | **0.53** | **1.07** | **2.13** | **4.27** | $G_1$ |
| | B | **0.50** | 1 | **2.0** | **4.0** | **7.50** | **0.53** | **1.06** | **2.13** | **4.27** | |
| 2. | A | **0.58** | 1 | **2.0** | **4.0** | **7.58** | **0.61** | **1.10** | **2.11** | **4.22** | $G_2$ |
| | B | **0.58** | 1 | **2.0** | **4.0** | **7.58** | **0.61** | **1.04** | **2.11** | **4.22** | |
| 3. | A | **0.60** | 1 | **2.0** | **4.0** | **7.60** | **0.63** | **1.04** | **2.11** | **4.21** | $G_3$ |
| | B | **0.60** | 1 | **2.0** | **4.0** | **7.60** | **0.63** | **1.04** | **2.11** | **4.21** | |
| 4. | A | **0.63** | 1 | **2.0** | **4.0** | **7.63** | **0.63** | **1.04** | **2.10** | **4.19** | $G_4$ |
| | B | **0.63** | 1 | **2.0** | **4.0** | **7.63** | **0.63** | **1.04** | **2.10** | **4.19** | |
| 5. | A | **0.68** | 1 | **2.0** | **4.0** | **7.68** | **0.71** | **1.04** | **2.08** | **4.17** | $G_5$ |
| | B | **0.68** | 1 | **2.0** | **4.0** | **7.68** | **0.71** | **1.04** | **2.08** | **4.17** | |
| 6. | A | **0.70** | 1 | **2.0** | **4.0** | **7.70** | **0.73** | **1.04** | **2.08** | **4.16** | $G_6$ |
| | B | **0.70** | 1 | **2.0** | **4.0** | **7.70** | **0.73** | **1.04** | **2.08** | **4.16** | |
| 7. | A | **0.73** | 1 | **2.0** | **4.0** | **7.73** | **0.76** | **1.03** | **2.07** | **4.14** | $G_7$ |
| | B | **0.73** | 1 | **2.0** | **4.0** | **7.73** | **0.76** | **1.03** | **2.07** | **4.14** | |
| 8. | A | **0.75** | 1 | **2.0** | **4.0** | **7.75** | **0.77** | **1.03** | **2.06** | **4.13** | $G_8$ |
| | B | **0.75** | 1 | **2.0** | **4.0** | **7.75** | **0.77** | **1.03** | **2.06** | **4.13** | |
| 9. | A | **0.80** | 1 | **2.0** | **4.0** | **7.80** | **0.82** | **1.03** | **2.05** | **4.10** | $G_9$ |
| | B | **0.80** | 1 | **2.0** | **4.0** | **7.80** | **0.82** | **1.03** | **2.05** | **4.10** | |
| 10. | A | **0.85** | 1 | **2.0** | **4.0** | **7.85** | **0.87** | **1.03** | **2.01** | **4.08** | $G_{10}$ |
| | B | **0.85** | 1 | **2.0** | **4.0** | **7.85** | **0.87** | **1.03** | **2.01** | **4.08** | |
| **TOTAL[KG]** | | | | | | | **14.12** | **21.22** | **41.6** | **83.2** | |

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## III. RESULTS PRESENTATION AND DISCUSSION

### 3.1. RESULTS PRESENTATION

The results of the compressive strength of ROC and BWC are shown in Table 2

**Table 2 : Presentation Of Results Of Compressive Strength Of ROC And BWC**

| | | |
|---|---|---|
| **TITLE:** FUTO RIVER OTAMIRI SUITABILTY FOR CONSTRUCTION WORKS. - LABORATORY EXPERIMENTS FOR 2024/2025/CIE/FUTO/FINAL YEAR PROJECT STUDENTS UNDER ENGR. DR. APOSTLE KINGSLEY CHIBUZOR NWACHUKWU | • DIMESION OF MOULD: 150MM*150MM *150MM<br>• APPROXIMATE. WEIGHT OF CAST CS CONCRETE CUBE, W: 8KG | • MEASURED QTY OF ROC/BWC MATERIAL AT LAB, MQ [KG] :<br>$M^Q = \frac{X\,W}{T}$<br>• X = INDIVIDUAL MIX RATIO<br>• T = SUM OF MIX RATIOS |
| **AIM:** ROC/BWC- COMPRESSIVE STRENGHT[CS] EVALUATION USING HDE MIXTURE DESIGN | • AREA, A : 22500MM$^2$<br>• WEIGHING BAL.: 50KG | • DATE OF CASTING: FRIDAY,JUNE 20, 2025.<br>• DATE OF CRUSHING: FRIDAY,JULY 19, 2025. |

| S/N | REPLICATE | CODING AT THE LABORATORY | | COMPRESSIVE STRENGHT RESULTS G[MPA] | | AVERAGE COMPRESSIVE STRENGHT RESULTS, G[MPA] | |
|---|---|---|---|---|---|---|---|
| | | ROC | BWC | ROC | BWC | ROC | BWC |
| 1. | A | ROC/$A_1$/CS | BWC/$A_1$/CS | 10.22 | 24.56 | 10.23 | 24.94 |
| | B | ROC/$B_1$/CS | BWC/$B_1$/CS | 10.23 | 25.32 | | |
| 2. | A | ROC/$A_2$/CS | BWC/$A_2$/CS | 13.78 | 28.08 | 13.95 | 27.99 |
| | B | ROC/$B_2$/CS | BWC/$B_2$/CS | 14.12 | 27.90 | | |
| 3. | A | ROC/$A_3$/CS | BWC/$A_3$/CS | 12.44 | 25.54 | 12.33 | 25.78 |
| | B | ROC/$B_3$/CS | BWC/$B_3$/CS | 12.22 | 26.02 | | |
| 4. | A | ROC/$A_4$/CS | BWC/$A_4$/CS | 9.19 | 27.05 | 19.20 | 27.07 |
| | B | ROC/$B_4$/CS | BWC/$B_4$/CS | 9.20 | 27.08 | | |
| 5. | A | ROC/$A_5$/CS | BWC/$A_5$/CS | 11.22 | 23.43 | 11.27 | 23.72 |
| | B | ROC/$B_5$/CS | BWC/$B_5$/CS | 11.32 | 24.00 | | |
| 6. | A | ROC/$A_6$/CS | BWC/$A_6$/CS | 12.12 | 21.04 | 12.14 | 21.56 |
| | B | ROC/$B_6$/CS | BWC/$B_6$/CS | 12.16 | 22.07 | | |
| 7. | A | ROC/$A_7$/CS | BWC/$A_7$/CS | 11.11 | 23.32 | 11.12 | 23.20 |
| | B | ROC/$B_7$/CS | BWC/$B_7$/CS | 11.13 | 23.08 | | |
| 8. | A | ROC/$A_8$/CS | BWC/$A_8$/CS | 9.66 | 19.34 | 9.72 | 19.55 |
| | B | ROC/$B_8$/CS | BWC/$B_8$/CS | 9.78 | 19.76 | | |
| 9. | A | ROC/$A_9$/CS | BWC/$A_9$/CS | 9.93 | 26.08 | 9.90 | 26.50 |
| | B | ROC/$B_9$/CS | BWC/$B_9$/CS | 9.86 | 26.92 | | |
| 10. | A | ROC/$A_{10}$/CS | BWC/$A_{10}$/CS | 12.00 | 25.54 | 11.96 | 25.10 |
| | B | ROC/$B_{10}$/CS | BWC/$A_{10}$/CS | 11.91 | 24.65 | | |

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### 3.2. RESULT DISCUSSION

The outcome of the result shows that maximum compressive strength of ROC and BWC evaluated using HDE Mixture Design Method are **13.95 MPa** and **27.99 MPa at $G_2$** respectively for the 28th day result. Based on the minimum value specified by the American Concrete Institute (ACI), as 20 MPa for good concrete and minimum required value (of 30.75MPa) specified by ASTM C 469 and ASTM C 39 for high performance concrete, the implication of the result is that water from FUTO River Otamiri is not that too suitable for construction work where low and high performance concrete is required without complete treatment. The reason behind can be traced to impurities discovered from the physic-chemical and biological parameters assessment of the FUTO River Otamiri. See the works of Nwachukwu and others (2025c).

## IV. CONCLUSION

In this present research work so far, efforts have been made to determine the suitability of FUTO Otamiri River, through the evaluation of the compressive strengths of ROC and BWC using the HDE Method (Nwachukwu and others, 2025b). The results of the compressive strengths are as stated in Table 2. The maximum values of ROC and BWC are as stated in the result discussion session. This shows that during scarcity of potable water on FUTO Campus, stakeholders in the construction industry in FUTO community can rely on the Otamiri River as source of water , provided the quantity required are treated effectively, as the amount BOD and COD are manageable. See the works of Nwachukwu and others (2025c).

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