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Assessment Of The Suitability of Water Resources Qualities ForConsumption AndConstructionPurposes : A Case Study Of Some Selected Towns In Owerri West L.G.A , Imo State, Nigeria.

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ABSTRACT
This research work is aimed at assessing the suitability of groundwater and surface water qualities in selected towns in Owerri West L.G.A of Imo state, Nigeria for consumption (drinking) and construction purposes. Samples of water resources (groundwater and surface water) from Umuguma, Avu, Obinze, Nekede and Ihiagwa towns in Owerri West L.G.A of Imo state, Nigeria were collected and analyzed inaccordance with APHA, AWWA and WPCF (2005) guidelines, in order to evaluate their physico-chemical parameters /qualities in relation to World Health Organization (WHO) standard. Another samples were also collected from these sources and used as component of concrete mixture in order to determine their impact in the compressive strength of concrete used inthe construction industry. The compressive strength test was carried out in accordance with BS 1881 – Part 116 (1983). From the physico-chemical analyses, it is confirmed that the surface water in these selected town are slightly acidic. The cation concentrations for both the surface water and groundwater falls within the WHO recommended standard. Again, the anions concentrated and Total Dissolved Solids (TDS), fall within the WHO recommended standard. However, owing to the slightly acidic content of these water resources coupled with the relatively hardness recorded from the analysis, the water resources (especially the surface water) from these towns may not be useful for domestic (drinking) purposes. Similarly, the 28th compressive strength results showed that water from the surface water source from the five towns may not be suitable for mixing concrete as the strengths are below the recommended limit of 20 to 35 MPa (or 20 to35 N/mm^2) specified by the American Concrete Institute (ACI). The strengths from concrete cubes cast using water from the groundwater sources from the five selected towns fall within the ACI limit, though not as high as those obtained from concrete cubes that were mixed with potable (treated) water . There may be need for proper treatment of the surface waters from these towns beforeused forboth consumption and construction purposes.

Keywords: Water Resources, Consumption/drinking/domestic purpose, Physico-chemical parameters, Concrete, Compressive strength

I. INTRODUCTION

Water resourcesrefer to natural resources of water that are potentially useful as a source of water supply .Water resources, as natural elements are very essential and precious to life. They also represent important stake for the society. There are two main classes of water resources, namely; Groundwater and Surface water. According to Akpobori and Nfor (2007), groundwater remains the cornerstone of all rural water supply development in Nigeria. Most urban centres also rely to a large extent on groundwater resources.

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Agunwamba (2000) identified two major sources of groundwater. Those that are formed by rain fail which permeates into the ground through the pores of rock formation and finally reached the underground water table, and the water from streams, lakes, and reservoirs which percolate through the soil to the underground water table. All these give rise to Shallow well, Deep well and Boreholes as major sources of groundwater. Similarly, Surface water is water that is open to the atmosphere and fed by runoff from the land surface.Rivers, Lakes, Dams, Ponds, Streams and Impounded reservoirs are classified under Surface water.

In general, water remains essential for livelihood as well as socio-economic development of any town, community, state or nation. The importance of water to mankind cannot be over emphasized. It is used for domestic/drinking purposes. Many major cities and towns in Nigeria depend on groundwater for water supplies. In the area of agriculture, it is used for irrigation and in the field of construction; it is a widely used raw material, second to none while concrete is only second to water.Water is an important ingredient of concrete and plays a key role in wetting the surface of aggregates to develop adhesion, in concretesetting, hardening, curing, workability, strength and durability. It is a common knowledge that the strength and durability of concrete is always reduced whenever there is presence of chemical impurities in water. This is one of the reasons why most of the specifications recommend the use of potable (treated) water for making concrete. Thus the quality of water used for consumption purposes and in the construction industry is very important and need to be assessed and this forms the background of this work.

Owerri is the capital city of Imo state , Nigeria. Itconsists of three local government areas (LGA), namely, Owerri Municipal, Owerri West and Owerri North, with OwerriMunicipal as the center of attraction.. Owerri West headquarters are in the town of Umuguma and a very large portion of the local government constitute the capital city of Imo State, Nigeria. It has an area of 295 km2 (114 sq mi) and a population of 99,265 , using the 2006 census as a reference data. Its latitude and longitude are as described in Figure 1(map of Imo state showing Owerri West L.G.A.).Among the five towns listed as case studies, Ihiagwa seems to be the one that is most far away from the main capital city. It is located 12 km (7.5 mi) south of the capital city of Owerri. With the presence of three federal institutions viz; Federal University of Technology, Owerri, Federal Polytechnic Nekede, Owerri, and Federal College of Land Resources Technology,Owerri, as well as other notable industries and establishment in the Owerri West L.G.A., the area has become one of the fastest developing LGA of the state. Thus there is increase in the economic activities prompting the increase in water demand for both consumption and construction purposes. The urbanization going on in Owerri West is not without many challenges, ranging from building collapse andmany reported health challenges which may be attributed to poor state of drinking water. Though many factors may be responsible for building failures and collapse, the impact of poor water cannot be ruled out. As opined by Saravanakumar and Dhinakaran(2010), the use of poor quality of water in concrete leads to corrosion and ultimately causes failure in concrete, while use of saline water in concrete affects the properties of fresh and hardened concrete. Thus, the essence of this work is to further create awareness to all residents as well as stakeholders in the construction industryin Owerri West to be mindful of the type and source of water they use for both domestic and construction purposes.

Water Quality Assessment is the overall process of evaluation of the physical, chemical and biological nature of the water resources. Water Quality Assessments are normally based upon five broad types of monitoring data: biological integrity, chemical, physical, habitat, and toxicity. This explains why the assessment of water qualities is of interest to many researchers across different field of endeavor/discipline. The Geologists, Biologists, Crop Scientists/Technologists, Chemists, Civil 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. However, for the Civil Engineer, his interest is mainly for consumption and construction purposes. Many researchers have done related works on the subject matter, but none has been able to carry out detailed assessment on the five mentioned towns for consumption and construction purposes. For instance, Ijeh (2014) carried out an assessment on groundwater quality in different parts of Owerri. His work is limited to groundwater water 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. Also 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

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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. On the effect of water sources on concrete and other construction materials, some authors have equally contributed enough to literature. Al-Jabri and others (2011) have carried out research on the effect of using waste water on the properties of high strength concrete. Nikhil and others (2014) have determined the impact of water quality on strength properties of concrete. Their source of water was perhaps from the Indian country. Saravanakumar and Dhinakaran (2010) carried out a work on the effect of acidic water on strength, durability and corrosion of concrete. 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. Hence forth, it has become important to further the frontiers of knowledge in the strategic area of WaterResources QualityAssessment, by exploring and intensively analyzing its suitability for use as potable water as well its impact on the strength of construction materials, especially concrete using cutting edge facilities and best practice models. The scope of the present study willbe thefive selected towns, namely, Umuguma, Avu, Obinze, Nekede and Ihiagwa, all in Owerri West L.G.A. of Imo state, Nigeria.

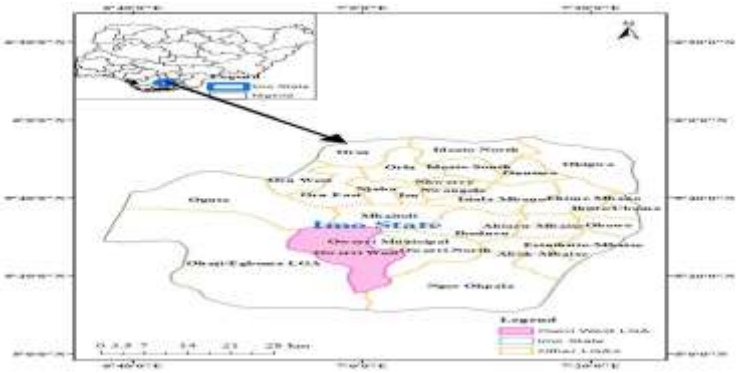

Fig. 1 : Map of Imo state showing the location of Owerri West.

II. MATERIALS AND METHODS

2.1.DATA COLLECTIONAND WATER RESOURCES SAMPLING

The primary data (water resources quality parameters in this work were got through laboratory analysis ofthe water resources from the selected towns in Owerri West L.G.A. of Imo state.These physico-chemical parameters/data include the pH, Sodium (Na), Potassium (k), Calcium (Ca), Magnesium (Mg), Chloride (Cl), Nitrite (NO_3), Bicarbonate (HCO_3), Sulphate (SO_4)Total Hardness (TH), Total Alkalinity (TA) and Total Dissolved Solids (TDS).Similarly secondary data were also obtained from literature and reports from agency like WHO (World Health Organization). From these reports, the recommended standard for each water resources for a particular purpose was selected as a standard measure. It is noteworthy thatin this research work, two types of water resource are adopted for study. They are surface water (in the forms ofPonds, Streams and Impounded reservoirs) and groundwater (mainly in the form of Boreholes) for each of the five (5) selected towns in Owerri West.

For assessment of the water for consumption purpose, a 2-litre polythene bottles which is expected to introduce minimal contamination, was used to fetch two sample water from the groundwater and surface water (stream) respectively. Thus a total of 4 (Four) bottle water was fetched for each town, making a total of 20(twenty) sample bottle water for the 5(five) selected towns. The samples were stored in well-drained clean polyethylene bottles already rinsed out with the same water sample in each case. They were also stored in a refrigerator at temperature below 20^{o}c in order to prevent changes in the

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water sample between the time of collection and analysis.

For assessment of the water for construction purpose, two samples each for groundwater and surface water respectively per town were obtained for use in the mixing of concrete so as to determine their impact on the strength of concrete used for construction. Then two samples of potable (treated) water were also collected for use in concrete mixture .

2.2. Laboratory analysis/ procedure/calculation

2.2.1. For assessment of water resources for consumption (domestic) purposes.

The physico-chemical analyses carries out on the water samples are $_{P}H$, Sodium (Na^{+}), Potassium (K^{+}), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Chloride (Cl^{-}), Sulphate (SO_4^{2-}), Nitrite (NO_3^{-}), HCO_3, Total Hardness(TH), Total Alkalinity(TA), and Total Dissolve Solids (TDS).The $_{P}H$ was determined using a $_{P}H$ meter. The cation concentrations were determined using atomic absorption spectrophotometer.. Nitrate and

$$\left(\frac{M_{eq}}{L_C}\right)_J = \left(\frac{M_{eq}}{L_A}\right)_j \quad \textbf{(1)}$$

$$\sum_{j=1}^{NC} \qquad \sum_{j=1}^{NA}$$

Where N_C and N_A are the number of cations and Onions respectively. However, these two cannot be equal because of the presence of some undetectable elements or compounds.

vi. Therefore, the analysis is accepted or rejected if the percentage of the ratio of the difference to the sum of the total Meq is less than or greater than 3% respectively.

vii. Other calculations

1. Total Alkalinity is calculated as follows:

Total alkalinity = Meq/L of HCO_3^{-}x Equivalent Wt. of $CaCO_3$**(2)**

2. Total Hardness = Hardness caused by Ca^{2+} and Mg^{2+}= (Ca^{2+} + Mg^{2+}) x Equivalent wt. of $CaCO_3$**(3)**

3. Total dissolved solids (TDS)=cation conc.+ anions conc. (expressed in Mg/L) **(4)**

2.2.2. For assessment of water resources forconstruction purposes.

In this section, the materials underinvestigation are the mixture of cement, fine and coarse aggregate and water from the groundwater and surface water sources under assessment, as well as potable water sulphate concentrations were determined turbid metrically using a spectro-photometer at wavelengths of 410nm and 420nm, respectively. Analyses of all other parameters were done using the various standard methods for water analysisand in accordance with APHA, AWWA and WPCF (2005) guidelines.

The correctness of chemical analysis of these water resources is ascertained by ensuring equality of sum of the cations and anions expressed in terms of milliequivalents per litre to satisfy the principle of electroneutrality. The steps are as follows.

i. Determine the molecular weight (Mol. wt) of each ion.
ii. Find the ionic valency
iii. Divide the mol. wt by the corresponding valency to obtain the Mg/M_{eq} (ie mass/milliequivalents).
iv. Divide the concentration of each ion by mg/meg to obtain the milliequivalent per litre (Meg/L).
v. Now, the analysis is correct ifis correct if

from notable clean source..Our major aim here is to determine the compressive strength of concrete cubes.Total of twenty-two (22) cubes were prepared., out of which , twenty were from the water drawn from groundwater and surface water sources .

Procedure for compressive strength testing was done in accordance with BS 1881 – part 116 (1983) - Method of determination of compressive strength of concrete cube .. Two samples were crushed for each mixture with groundwater, and surface water respectively for each town and two samples crushed from mixture with potable water sample for comparison. In each case, the compressive strength was calculated using Equation (5)

Compressive Strength =

$$\frac{\text{Average failure Load (N) P}}{\text{Cross- sectional Area (mm}^2\text{)}} \quad \textbf{(5)}$$

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III. RESULTS AND DISCUSSION

3.1 PRESENTATION OF RESULTS

3.1.1PHYSICO-CHEMICAL ANALYSIS RESULTS FOR THE GROUNDWATER SAMPLING

The result of the physico-chemical analysis obtained for the five selected towns in OwerriWest L.G.A of Imo state for groundwater sampling is presented in Table 1.

Table 1: Presentation Of Results Of Physico-Chemical Analysis Of The Groundwater Samples.

S/NO	TOWN/SAMPLE		Ca^{2}+	Mg^{2+}	Na^{+}	K+	HCO_3^-	Cl^-	NO_3^-	SO_4^{2}-	pH
1	UMUGUMA	Sample A	40.0	11.5	62	2.6	118.0	120.0	8.0	13.0	6.5
		Sample B	41.0	11.4	62	2.5	119.0	120.0	8.1	13.1	6.5
		Average	40.5	11.5	62	2.6	118.5	120.5	8.1	13.1	6.5
2	AVU	Sample A	38.0	8.5	61	3.1	114.0	110.0	7.5	12.0	6.7
		Sample B	37.5	8.6	61	3.2	115.0	110.0	7.4	12.1	6.6
		Average	37.8	8.6	61	3.2	115.0	110.0	75	12.1	6.7
3	OBINZE	Sample A	35.0	9.2	62	3.2	116.0	110.0	9.4	11.0	6.8
		Sample B	36.0	9.3	62	3.3	116.0	110.0	9.5	11.1	6.8
		Average	35.5	9.3	62	3.3	115.0	110.0	95	11.1	6.8
4	NEKEDE	Sample	40.0	13.4	61	2.9	120.0	120.0	12.0	8.9	6.7
		A Sample	41.0	13.3	61	3.0	120.0	120.0	12.1	8.8	6.7
		B	40.5	13.4	61	3.0	120.0	120.0	12.1	8.9	6.7
		Average									
5	IHIAGWA	Sample A	40.0	10.9	67	3.5	121.0	120.0	8.2	9.4	6.5
		Sample B	39.5	10.9	63	3.6	121.0	118.0	8.3	9.3	6.4
		Average	39.8	10.9	62	3.6	121.0	119.0	8.3	9.4	6.5

i. CHECKING THE ACCURACY OF THE ANALYSIS

Using the average values, the accuracy of this analysis is shown in Table 2for Umuguma town. We shall use Umuguma town as a case study.

Table 2: Checking The Accuracy Of The Physico –Chemical Analysis Of Groundwater Sample In UmugumaTown.

CATIONS	CONC	Mg/Meq	Meq/l	ANIONS	Conc.(mg/l)	Mg /Meq	Meq/l
Ca2+	40.5	20	2.025	HCO_3^-	118.5	61	1.94
Mg2+	11.5	12.2	0.94	Cl^-	120.5	35.5	3.39
Na+	6.2	23.0	2.695	NO_3^-	8.1	62	0.13
K+	2.6	39.1	0.07	SO_4^{2-}	13.1	48	0.27
Total	116.6		5.731		260.2		5.730

1. For calcium ion, Ca^{2+}

a. Mg/Mq =mol.wt/ionic valency =40/2 =20

b. Meq/L = conc/(mg/Meq) = 40.5/20 =2.025

2. For Mg^{2}+

a, Mg/Meq= 24.4/2 =12.2

b, Meq/L = Conc/(Mg/meq) =11.5/12.2 = 0.94

3. All other ions are calculated in the same manner and presented in Table 3

4. The total Meq/L for the cations is

$\left[\frac{\text{Meq}}{\text{Lc}}\right]_i$ = 025 + 0.94 + 2.695 +0.07 = 5.731

$$\sum_{i=1}^{4}$$

5. Similarly, the total Meq/L for the anions = 1.94 + 3.39+0.13+ 0.27 = 5.730

6. Based on Eqn.(1) we can check the correctness of the analysis by finding the difference between the two ions

Here, the difference between the two ionsis 5.731–5.730 = 0.001 <3%

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∴The result of the analysis is accepted.The results are also accepted for all other four towns as depicted in Table 4.

ii.**CALCULATING THE VALUES OF TA ,TH AND TDS**

We shall use Umuguma town (Table 3) as a case study.

a, Total Alkalinity (TA)

Using Eqn.(2)

TA=Meq/L of HCO_3 * equivalent wt. of $CaCO_3$

Where Equivalent weight of $CaCO_3$= 100/2 = 50mg/Meq.

Therefore TA = 1.94 x 50= 970mg/L as $CaCO_3$

b. Total Hardness (TH)

From Eqn.(3)

TH = hardness caused by Ca^{2+} and Mg^{2+}

= (Ca^{2+} + Mg^{2+}) x Equivalent wt of $CaCO_3$.= (2.025 +0.09) * 50 =148.25mg/L as $CaCO_3$

c. Total Disolved Solids (TDS)

From Eqn.(4)

TDS =Cations conc. + Anions Conc. (expressed in mg)= 116.6 + 260.2= 376.8 mg/l.

For the rest towns ,the final results of Physico – chemical analysis of the groundwater samples are shown in Table 3

Table 3:FINALRESULTS OF PHYSICO- CHEMICAL ANALYSIS OF THE GROUNDWATER SAMPLE

S/NO	TOWN/SAMPLE	Ca^{2+} Mg/L **(NA/*100-300)**	Mg^{2+} **(50)**	N^{a+} **(NA/*200)**	K^{+} **(NA)**	HCO_3^{-} **(<600)**	Cl^{-} **(250)**	NO_3^{-} **(50)**	SO_4^{2-} **(NA/ *250)**	TA Mg/ $CaCo_3$ **(200)**	TH Mg/L $CaCo_3$ **(NA/ *100-500)**	TDS Mg/L $CaCo_3$ **(500)**	pH **(6.5 – 8.5)**
1	UMUGUMA	40.5	11.5	62	2.6	118.5	120.5	8.1	13.1	97.0	148.25	376.8	6.5
2	AVU	37.8	8.6	61	3.2	115.0	110.0	7.5	12.1	94.5	129.5	355.2	6.7
3	OBINZE	35.5	9.3	62	3.3	115.0	110.0	9.5	11.1	94.5	127	355.7	6.8
4	NEKEDE	40.5	13.4	61	3.0	120.0	120.0	12.1	8.9	94.5	156.15	378.9	6.7
5	IHIAGWA	39.8	10.9	62	3.6	121.0	119.0	8.3	9.4	99.0	144	374	6.5

Note: The values in bracket represent WHO Standard. NA implies that no health based guideline value has been derived and * indicate the taste threshold values

3.1.2.PHYSICO-CHEMICAL ANALYSIS RESULTS FOR THE SURFACE WATER SAMPLING.

The finalresult of the physico-chemical analysis obtained for the five selected towns in Owerri West L.G.A. of Imo state for surface water sampling is presented in Table 4. The procedure for analysis is the same as that of groundwater sampling.

Table 4:FINAL RESULTS OF PHYSICO- CHEMICAL ANALYSIS OF THE SURFACE WATER SAMPLE

S/NO	TOWN	Ca^{2+} (Mg/L)	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	TA Mg/L $CaCO_3$ **(200)**	TH Mg/L $CaCO_3$ **(NA/**	TDS Mg/L $CaCo_3$	pH

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		(NA/ *100-300)	(50)	(NA /*200)	(NA)	(<600)	(250)	(50)	(NA/ *250)		*100-500)	(500)	(6.5 – 8.5)
1	UMUGUMA	23.5	7.3	14.5	0.20	38.0	45.0	6.0	21.2	31.15	88.65	155.7	6.1
2	AVU	23.0	6.3	11.4	0.6	35.0	40.0	6.2	20.2	28.5	83.5	142.7	5.7
3	OBINZE	22.0	7.4	14.0	0.20	36.4	42.0	6.8	20.0	30	85.5	148.8	6.2
4	NEKEDE	24.0	7.0	10.5	0.4	35.1	39.0	8.0	20.5	29	88.5	248.4	6.4
5	IHIAGWA	23.2	7.2	14.0	0.2	37.0	43.0	6.1	21.4	30.5	87.5	152.1	6.4

3,1.3. COMPRESSIVE STRENGTH FROM CONCRETE MADE USING DIFFERENT SOURCES OF WATER IN THE FIVE SELECTED TOWNS

The compressive strength results are shown in Table 5.

Table 5:28th Day Compressive Strength (N/mm^2) From Concrete Cube Prepared Using Different Sources of Water From The Five Towns In Owerri West L.G.A.

S/N	WATER SOURCES TOWN	GROUNDWATER SAMPLE			SURFACE WATER SAMPLE			POTABLE WATER		
		A	B	AV.	A	B	AV.	A	B	AV.
1	UMUGUMA	21.32	21.53	21.43	18.91	18.21	18.56	24.50	24.30	24.40
2	AVU	20.15	21.00	20.58	16.00	16.23	16.12	24.50	24.30	24.40
3	OBINZE	22.16	22.92	22.54	17.22	17.96	17.59	24.50	24.30	24.40
4	NEKEDE	21.82	21.54	21.68	16.18	16.36	16.27	24.50	24.30	24.40

5	IHIAGWA	20.82	20.75	20.79	17.02	17.32	17.17	24.50	24.30	24.40

3.2. DISCUSSION OF RESULTS

The results of the phycico-chemical analyses for groundwater samples are depicted in Tables 1 and 3. The pH values range from 6.5 to 6.8. This indicates a slightly acidic situation for the groundwater and compare favorably with the WHO stipulated standards. The TDS valuesrange between 355.2 to 378.9. This is also within the WHO recommended limit.For the anions, chloride concentration ranges from 119.0 to 120.5 mg/L, nitrate (($N0_3$) ranges from 7.5 to 12.1 mg/L; Sulphate (SO_4), ranges from 8.9 to 13.1 mg/L and HCO_3 ranges from 115.0 to 121.0 mg/L. Thus, the level of the anions in the groundwater samples are generally lower than the prescribed threshold level recommended by the WHO standard. The same goes for the cations. For the surface water(Table 4), it was observed that the pH values range from 5.7 to 6.4, showing that itis more acidic and unfit for human consumption. TDS valuesrange from 142.7 to 248.4mg/L. For the anions, chloride shows a range 39.0 to 45.0 mg/L. The values recorded for these anions fall within the stipulated limits by the WHO. For the cations, Ca^2+ values range from 22.0 to 24.0 Mg/L, Mg^2+ from 6.3 to 7.4mg/L, Na+ , 10.5 to 14.5mg/L and K+ from 0.20 to 0.6 mg/L. Generally, these values also fall within the WHOstipulated standards. Though the values of TH in both sources fall within the WHO Taste Threshold stipulated standard , there is still presence of hardness in these water sources, even though consumers can tolerate hardness up to 500mg/L. Similarly, the maximum compressive strength for the groundwater source is 22.54 N/mm^2at Obinze town, while the minimum value was obtained as 20.58 N/mm^2 at Avu town. Thus, water from the groundwater sources in these areas, when used to mix concrete can positively impact the strength of concrete cubes. For the surface water, the highest compressive strength was obtained as 18.56N/mm^2 atUmugumawhile the lowest value was obtained as 16.12 N/mm^2at Avu town.

IV. CONCLUSION

Samples of water resources (groundwater and surface water) from the selected town in Owerri West L.G.A of Imo state, Nigeria have been analyzedfor both consumption and construction purposes.From the physico-chemical analyses, it is confirmed that both the groundwater and surface water in these selected town are slightly acidic, but that of groundwater is better off and can be managed. The cation concentrations for both the surface water and groundwater falls within the WHO recommended standard. Again, the anions concentrated and total dissolved solids (TDS), fall within the WHO recommended standard However, owing to the slightly acidic content of the surface water, it cannot be recommended for consumption purposes.. There may be need for proper treatment of the surface waters before use. From the construction perspective, only the compressive strength of concrete cubes mixed with water from the groundwater sources meet up with the minimum requirement of 20N/mm^2 as stipulated by ACI. Thus, water from the surface water sources in the selected towns need to be treated before their uses for construction purposes.

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