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Suitability of Umuahia Sand for Field Compaction Quality Control: A Mechanical Sieve Approach

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Abstract: *The suitability of Umuahia sands as field compaction quality control is investigated in thi9s research work. Seven samples were collected from seven different sites in Umuahia Nigeria. Samples NT-2 and ET-6 were collected form river bed, on the other hand other samples were collected from sand deposits. Mechanical sieve analysis was carried out on each of the samples and their percentages passing and that Ottawa sand (the standard material) were plotted on the same graph sheet against the particle sizes. The nature of graphs obtained showed that none of the samples can be used as a replacement for Ottawa sand in field compaction quality control.*
Keywords: *Umuahia sands, Ottawa sands, sieve analysis, Compaction, Quality control*

I. Introduction

Compaction control for construction is always based on a requirement that the contractor meet a certain percentage of maximum dry density, as obtained by some standard test procedure such as ASTM D698. To ensure that the field compaction is standard with respect to documents, consultants embark on field compaction quality control. This compaction quality control to check the maximum dry density (MDD) can be obtained using any of the following methods: sand cone method, rubber balloon method and nuclear methods [3]

The sand cone device (ASTM D-1556) consists of a glass or plastic jar with a metal cone attached at its top. The weight of the jar, the cone and the sand filling the jar is determined (W_1). In the field, a small hole is excavated in the area where the soil has been extracted from the hole (W_2) is determined and the moisture content of the excavated soil is known, the dry weight of the soil (W_3) can be found as [1, 6]

$$W_3 = \frac{W_2}{1+\frac{w(\%)}{100}}) \text{..} \quad 1.1$$

Where w = moisture content

After excavation of the hole, the cone with the sand-filled jar attached to it is inverted and placed over the hole. Sand is allowed to flow out of the jar attached to it. It is inverted to flow out of the jar into the hole, and the cone. Once the hole and the cone are filled, weight of the jar, the cone, and the remaining sand in the jar are determined (W_4). Therefore

$$W_5 = W_1 - W_4 \text{..} \quad 1.2$$

Where W_5 = weight of sand to fill the hole and cone.
The volume of the hole excavated can now be determined as

$$V = \frac{W5 - W_C}{\gamma d(\text{sand})} \text{..} \quad 1.3$$

Where Wc=weight of sand to fill cone only
γd(Sand) = dry unit weight of Ottawa sand used.

The values of Wc and γd (sand) are determined form the ccalibration done in the laboratory. The dry weight of compaction made in the field can now be determined as

$$\gamma d = \frac{\text{dry weight of the soil excavated}}{\text{volume of hole}} = \frac{w_3}{v} \text{.............................} 1.4 \qquad \text{(M. D. Braja 2005)}$$

In all available literature Ottawa sand is recommended for the field test detailed above. Moreover, because of the non availability of Ottawa sand in this area, sands available are tested to ascertain if they can replace the said sand in field compaction quality check.[5]

II. Ottawa Standard Sand

The Ottawa quartz sand consists of rounded grains of clear colourless quartz, which have diamond like hardness and are pure silica (silicon dioxide SiO_2) uncontaminated by clear, loam, iron compounds, or other foreign substances.

It is a naturally occurring very homogenous, inorganic material formed because of geologic processes. This sediment has a definite chemical composition (SiO_2) and ordered atomic arrangement in its mineral. The Ottawa sand should meet the grading requirements which are described in table 2.1 below

Table 2.1 Grading requirements of Ottawa sand.

Square mesh size (mm)	Cumulative Passing (%)
4.750	-
2.000	-
1.180	-
0.600	96 – 100
0.425	65 – 75
0.150	20 – 30
0.075	0 – 4

III. Materials And Methods

The soil samples used for the test were collected from seven sites located at the central and Northern parts of Abia state, Nigeria. The sand samples for laboratory Investigation and field test were collected from Imo River (IR), Nkwoegwu town (NT), Ude mmiri (UM), Mfuru town (MT), Eme River (ER), Ecomurg Pit (EP) and Onu-Imo River (OR). These samples were taken from different locations of Umuahia and respectively designated by (IR-1), (NT-2) (UM-3), (MT -4), (ER-5) (EP-6), (OR-7) respectively.

The samples other than (NT-2) and (ET-6) were collected from the riverbed that crosses the town. Whereas the samples (NT-2) and (ET-6) where collected from natural sand deposits. [2].

A sieve analysis was carried out on each of the samples according to BS 1377: part 2 1990.[4]
The results obtained were plotted alongside the particle size analysis results of Ottawa sand in figures 3.1 -3.7 below.

IV. Results And Discussion

Table 3.1 grain size analysis result of sample IR-1

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	12	3	97	-
2.000	44	11	86	-
1.180	77	19.25	66.75	-
0.600	117	29.25	37.5	96-100
0.425	52	13	24.5	65-75
0.150	91	22.75	1.75	20-30
0.075	6	1.50	0.25	0-4
Pan	1	0.25	0	-

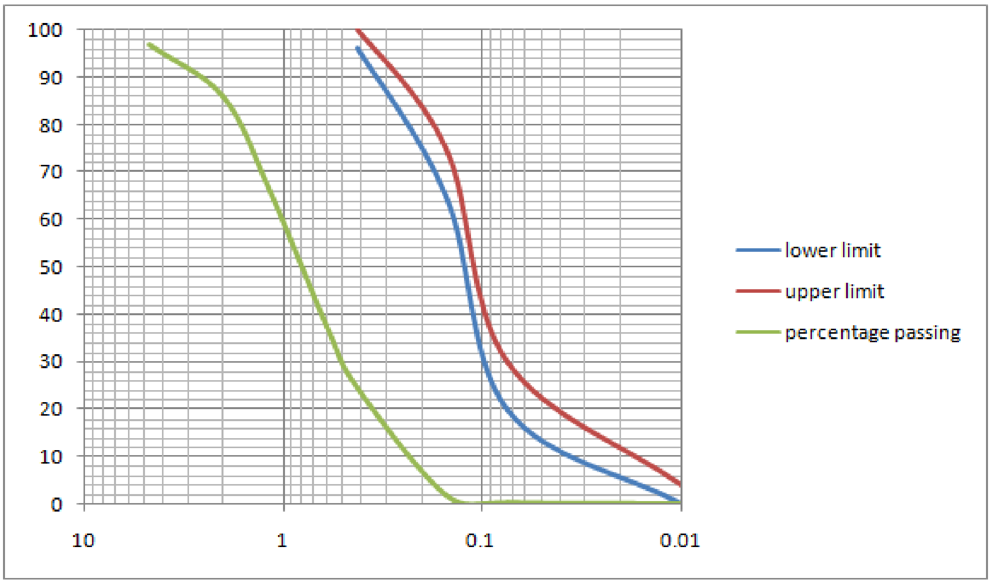

Fig 3.1 particle size distribution curve of sample IR-1 compared against Ottawa specification limit

Table 3.2 grain size analysis result of NT-2

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	1	0.25	99.75	-
2.000	4	1	98.75	-
1.180	36	9	89.75	-
0.600	174	43.5	46.25	96-100
0.425	110	27.5	18.75	65-75
0.150	69	17.25	1.50	20-30
0.075	5	1.25	0.25	0-4
Pan	1	0.25	0	-

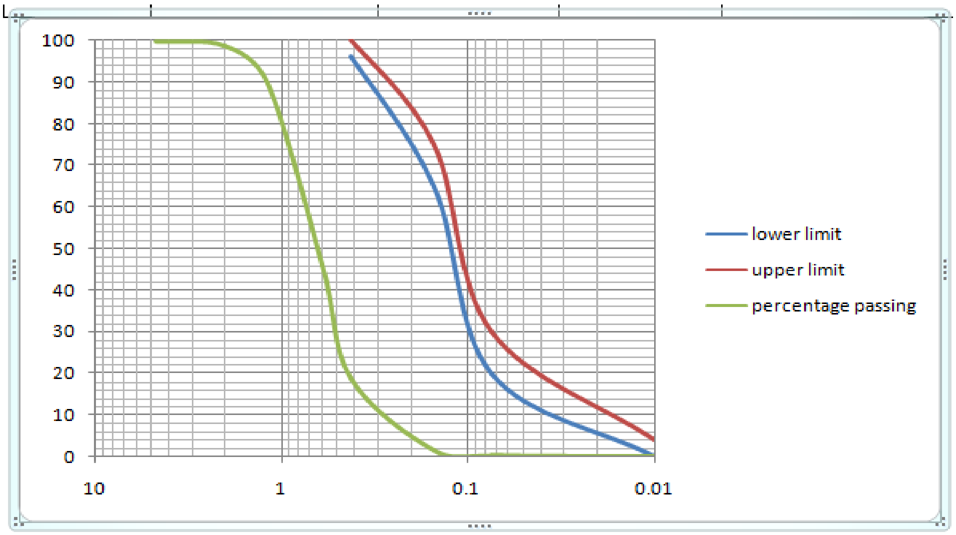

Fig 3.2 particle size distribution curve of sample NT-2 compared against Ottawa specification limit

Table 3.3 Grain size analysis result of sample UM-3

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	13	3.25	96.75	-
2.000	18	4.50	92.25	-
1.180	25	6.25	86	-
0.600	76	19	67	96-100
0.425	74	18.50	48.5	65-75
0.150	185	46.25	2.25	20-30
0.075	8	2	0.25	0-4
Pan	1	0.25	0	-

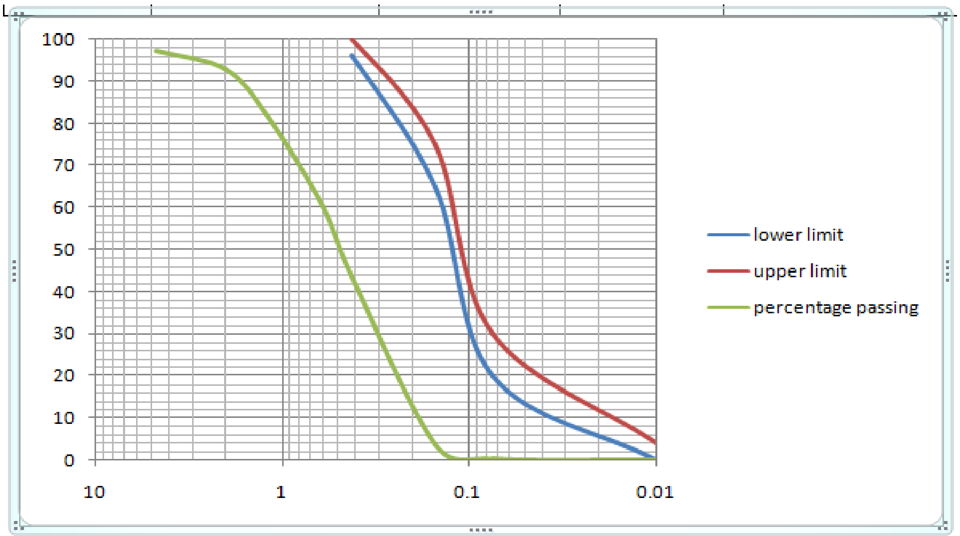

Fig 3.3 particle size distribution curve of sample UM-3 compared against Ottawa specification limit

Table 3.4 Grain analysis result MT-4

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	11	2.75	97.25	-
2.000	28	4.50	92.75	-
1.180	45	11.25	81.50	-
0.600	86	21.5	60.0	96-100
0.425	66	16.50	43.50	65-75
0.150	160	40	3.50	20-30
0.075	13	3.25	0.25	0-4
Pan	1	0.25	0	-

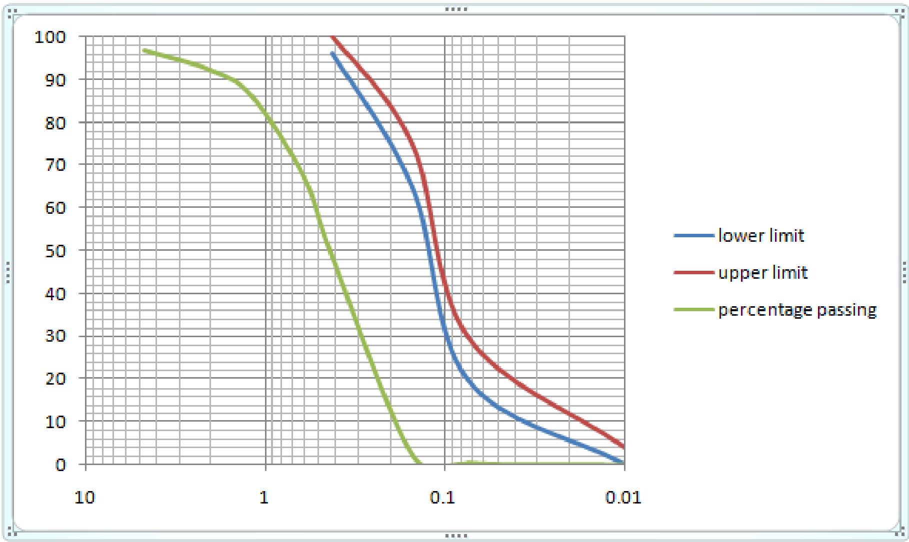

Fig 3.4 particle size distribution curve of sample MT-4 compared against Ottawa specification limit

Table 3.5 grain size analysis result of sample ER-5

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	46	11.50	88.50	-
2.000	54	13.50	75.00	-
1.180	133	33.25	41.75	-
0.600	134	33.50	8.25	96-100
0.425	7	1.75	6.5	65-75
0.150	20	5	6.5	20-30
0.075	4	1	0.5	0-4
Pan	2	0.5	0	-

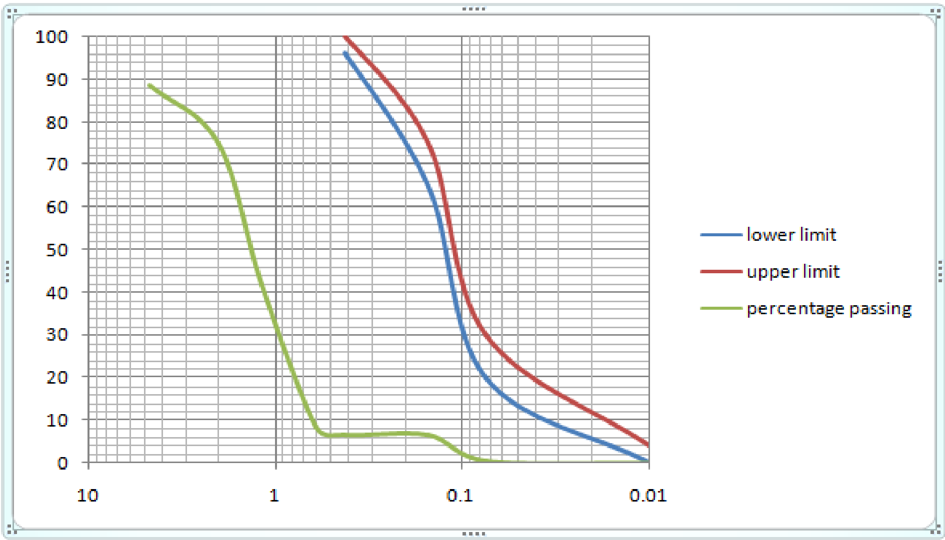

Fig 3.5 particle size distribution curve of sample ER-5 compared against Ottawa specification limit

Table 3.6 Grain size analysis result of sample EP-6

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	17	4.25	95.75	-
2.000	41	10.25	85.5	-
1.180	119	29.75	55.75	-
0.600	89	22.25	33.50	96-100
0.425	47	11.75	21.75	65-75
0.150	61	15.25	6.50	20-30
0.075	25	6.25	0.25	0-4
Pan	1	0.25	0	-

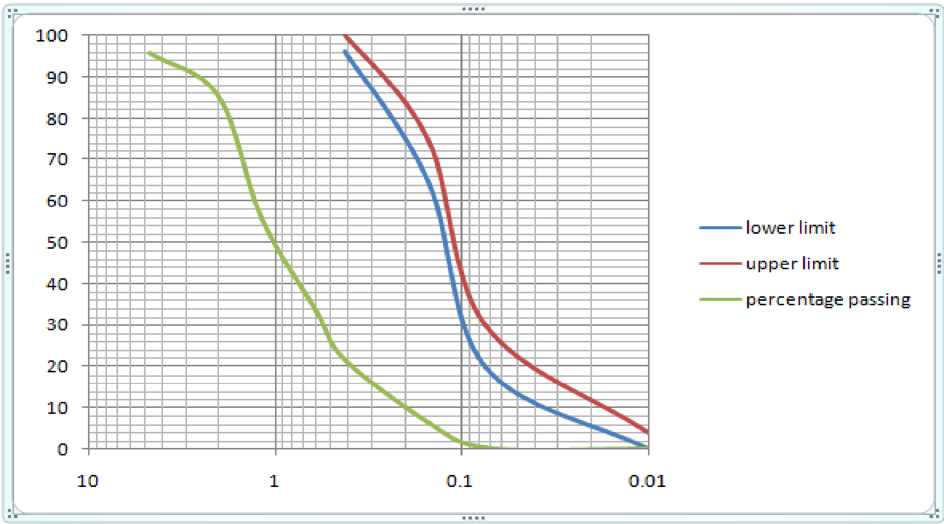

Fig 3.6 particle size distribution curve of sample EP-6 compared against Ottawa specification limit

Table 3.7 Grain size analysis result of sample OR-7

Sieve size (mm)	Weight retained (g)	Percentage retained (%)	Percentage passing (%)	Cumulative passing (%) – Ottawa sand
4.750	13	3.25	96.75	-
2.000	22	5.5	91.25	-
1.180	49	12.25	79	-
0.600	118	29.5	49.5	96-100
0.425	55	13.75	35.75	65-75
0.150	119	29.75	6.00	20-30
0.075	22	5.50	0.50	0-4
Pan	2	0.50	0	-

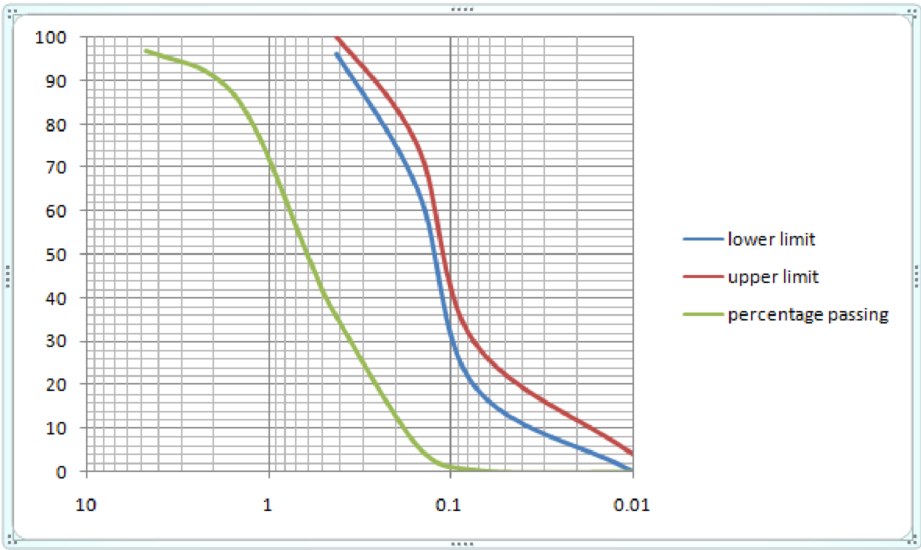

Fig 3.7 particle size distribution curve of sample OR-7 compared against Ottawa specification limit

- Curves for all the samples were outside the minimum and maximum value of Ottawa sands.

V. Conclusion And Recommendation

From the results obtained, none of the sand samples can be used in-place of Ottawa sand in field compaction quality control judging by mechanical sieve analysis approach. This serves a as a warning to local contractors that use any type of sand available to them to carry out sand cone method and rubber balloon method of field compaction quality control that required Ottawa sand their results that required Ottawa, that their results are likely to be wrong. Where the standard material is no available it is recommended that the contractor should use nuclear method which does not require Ottawa sand for its operation.

Reference

[1]. American society for testing and materials (2004). ASTM Standards, vol 04.08, west Conshokocken, PA.
[2]. Arinze E. E and Egbuna I. C "Suitability of Umuahia sands as backfill materials for vibroflotation compaction of cohesionless soil" Electronic Journal of Geotechnical Engineering 2014 vol. 19 bund.
[3]. Braja M. D (2005) "Fundamentals of geotechnical engineering" Thompson, Toronto, Canada.
[4]. B S 1377: part 2: of 1990 "sieve analysis"
[5]. BS EN 196-1, methods of tests for soils for civil engineering practice.
[6]. Lee, K. W and Singh A. (1971) "Relative Compaction" Journal of the soil mechanics and foundations division, ASCE, vol. 97, no SMT, 1049-1052.