American Journal of Science, Engineering and Technology
2020; 5(1): 25-32
http://www.sciencepublishinggroup.com/j/ajset
doi: 10.11648/j.ajset.20200501.13
ISSN: 2578-8345 (Print); ISSN: 2578-8353 (Online)

Assessment on the Quality of Concrete Materials Used in Building Construction Projects: A Case Study in Assosa University

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To cite this article:

Bekele Arega Demissie, Ashebir Belete Werkineh. Assessment on the Quality of Concrete Materials Used in Building Construction Projects: A Case Study in Assosa University. *American Journal of Science, Engineering and Technology*. Vol. 5, No. 1, 2020, pp. 25-32.
doi: 10.11648/j.ajset.20200501.13

Received: December 16, 2019; **Accepted**: December 31, 2019; **Published**: February 11, 2020

Abstract: Concrete is an intimate mixture of Coarse Aggregate, Sand (Fine Aggregate), Cement and Water. In building construction, most of the activities are executed using concrete so that Concrete materials quality is important. Construction materials used in construction determine the behavior of the structure and resulted in any types of failures or defects. The objective of this study was the assessment on the quality of concrete materials used in building construction projects, specifically to identify types of concrete materials used in Assosa University, to determine properties of concrete materials and to compare with standard. The methodologies includes, data collection methods (field observation and laboratory test), and organized data, data-analyzed and conclusion made from the result of data analysis and forwarded recommendations. Based on the findings, the determined properties of materials includes silt content of sands, 4.64%, 3.85%, 9.26%, 11.67%; Gs (ssd), 2.430%, 2.595%, 2.465%, 2.492%; compacted unit weight, 1407.94 Kg/m^3, 1498.00 Kg/m^3, 1348.92 Kg/m^3, 1303.08 Kg/m^3; and Bambasi, Sherkole Kumeruk and Fududu respectively.

Keywords: Concrete, Concrete Material Properties, Concrete Materials Quality

1. Introduction

The construction industry is complex in its nature, because it comprises large numbers of parties as owners (clients), contractors, consultants, stakeholders and regulators. The construction industry is an enormously important part of any economy [9]. Economic growth depends on the physical infrastructure that is delivered by the construction industry and its key participants. It provides a society with delivery mechanisms for many aspects of its needs such as economic, social, political, environmental, public sector reform [10].

Construction works can generally be classified in to two: The building sector overlooks many of the building and related works while the civil works (infrastructure), sector looks over other usually huge and machine intensive works associated to infrastructure delivery such as highways or power supply [11].

Most of Ethiopian building construction projects complained on poor quality of concrete materials many Ethiopian researchers argued that most building defects and collapse recorded due to sub-standard quality of concrete materials. Assosa University building projects exposed to concrete material's quality problem during site observation. It was known that, the materials used in existing buildings and the on-going projects are the same quality of materials. Therefore, this research study attempted to verify the properties of materials if within standard specification or not Examples include the presence of a high-strength rod and (or) spiral reinforcement in a concrete core. To calculate the stresses in such reinforcement, if possible, it is necessary to obtain sample the axial and circumferential deformations. The known calculation methods for the strength of compressed CFTCs do not provide such an opportunity [1]. A layer of epoxy adhesive (TLS-503) was applied by a paintbrush to the surface of the concrete and Aramid Fiber-Reinforced Polymer (AFRP) sheet [4]. The uniaxial concrete

material model adopted follows the well-established modified Kent and Park model [7]. The typical 28-day compressive strength ranges from 5.6 to 21.0 MPa, with void ratios ranging from 14 to 31%, and permeability coefficient varies from 0.25 to 6.1 mm/s [8].

2. Building Projects

Project is 'a temporary industry undertaken to create a unique product or service. Projects are understood to be parts of the main business of organizations with the following identifying characteristics: Temporary mean projects have got a definite start and finish, Unique product implies the deliverables of an individual project are unique in nature and to achieve the unique product or end results different stake holders are participate on the projects. Main stakeholders are Clint or the owner of the project, consultant changes clients' idea into design and contractor changes the design into the reality, Progressive elaboration implies that projects are developed in steps and continue to be elaborated and expanded as the work on the projects progresses [2].

3. Building Quality

Quality can be defined in terms of conformance to the agreed requirements of the customer and a product or service free of deficiencies [3]. In the building construction industry, quality can be defined as meeting the requirements of the designer, constructor, and regulatory agencies as well as the owner. In terms of function, a high quality building project can be described by such terms as ease in understanding drawings, level of agreement in drawings and specifications, economics of construction, ease of operation, ease of maintenance, and energy efficiency [5].

4. Concrete and Concrete Materials

Concrete is an intimate mixture of: Coarse Aggregate, Sand (Fine Aggregate), Cement, Water Materials in addition to above that is. "Admixtures". When cement combined with water produce paste and the strength of the concrete depends on the bond between paste and aggregates. Concrete is initially in plastic stage and immediately begins to develop strength or harden. Fresh concrete is also known as plastic concrete [6].

5. Methodology

The study depends on both primary and secondary data. Primary data had been taken first-hand data collection through field observations to identify the concrete materials used in Assosa University, laboratory test for materials and representative samples had been taken to laboratory and tests for silt content of sands, gradation of aggregates, specific gravity and water absorption of aggregates, unit weigh of aggregates, flakiness index of course aggregates, aggregate. Moreover, results from laboratory tests compared with Standard Specifications. During the field observation taken photo's or pictures, identified and recorded for the documentation and Laboratory test would be conducted in Assosa University.

5.1. Field Operation Sequence

During the field observation, it was curial (most important) to begin by conducting visual Inspection for concrete materials used building projects in Assosa University. During the Observation the researcher observed four different types of sands namely Fududu, Sherkole and Amba 5 sands, coarse aggregate, drinking water for mix and cement national Muger and Dangote cement.

5.2. Laboratory Tests

5.2.1. Silt Content of Sand

This test conducted to determine the silt (finer than No. 200 sieve) content in sand, because Sand is a product of natural or artificial disintegration of rocks and minerals. Sand is obtained from glacial, river, lake, marine, residual and wind-blown (very fine sand) deposits. These deposits, however, do not provide pure sand. According to the Ethiopian Standard it is recommended to wash the sand or reject if the silt content exceeds a value of 6%. The testing procedure was done according to American Society for Testing and Materials (ASTM).

5.2.2. Grain Size Analysis of Aggregate

This test used to determine the particle size distribution of coarse and fine aggregates. Aggregates make up 65% to 75% of the volume of concrete. Therefore the quality of concrete produced is very much influenced by the properties of its aggregates. According to ASTM, the term coarse aggregate is used to describe particles larger than 4.75 mm (retained on No. 4 sieve), and the term fine aggregate is used for particles smaller than 4.75 mm.

5.2.3. Unit Weight of Aggregates

This method is used to determine the unit weight of course, fine and mixed aggregates. Unit weight can be defined as the weight of a given volume of graded aggregate. It is thus a density measurement and also known as bulk density.

5.2.4. Setting Time of Cement

This method is used to determine the initial setting time and final setting time of cement paste with normal consistency. Cement forms a solid and hard mass (or change from fluid to a rigid state) when mixed with water upon hydration. This phenomenon is known as setting of cement.

5.2.5. Moisture Content of Aggregates

This test is carried out to determine the moisture content of fine and coarse aggregates. Design water to cement ratio is usually specified based on the assumption the aggregates are inert (neither absorb nor give water to the mixture).

5.2.6. Specific Gravity and Absorption Capacity of Aggregates

Specific gravity of a substance is the ratio between the weight of the substance and that of the same volume of water. Aggregates, however, have pores that are both preamble and impermeable, whose structure (size, number, and continuity pattern) affects water absorption, permeability and Specific gravity of aggregates.

6. Result and Discussion

6.1. Field Observation Result

During the observation, in actual sites the contractors use different types of sands namely: Sherkole, Bambasi, fududu, and Kumuruk sands and the coarse aggregate used from Amba 14 crusher crushed Course aggregate located 20 kilo meter from Assosa Town. Most projects uses cement Muger OPC Cement and Dangote OPC cement and water drinking water use in the sites.

6.1.1. Sand

Study area sand samples were Sherkole, Bambasi, fududu and Kumuruk sand. Sherkole sand obtained from Sherkole river, fududu sand obtained from fududu river, Bambasi sands obtained from Bambasi river and Kumuruk sands obtained from Kumuruk river. Therefore, all source sand in this study area were Obtained from the rivers. Most widely river sand are used in manufacturing of concrete and it Obtained naturally so, the quality of the sand must be tested before any construction. Construction Materials used in construction determine the behaviour of the structure and resulted in any types of Failures or defects.

6.1.2. Coarse Aggregate

The study area, crushed coarse aggregate located in shosha town, 20 kilo meter far from the Assosa town. During the observation, researcher observed that aggregate in most projects placed in wet area.

6.1.3. Cement

In study area, projects commonly used Muger and Dangote cement types and brands. However, the researcher observed that, most sites on the storage of cements are placed on the surface.

6.1.4. Water

In most sites water used, potable water and it's free from other organic impurities. In all building projects, drinking water could be used for mixing purposes without any test.

6.2. Laboratory Test Result

6.2.1. Fine Aggregate Grain Size Analysis Result

The results of grain size analysis are plotted in Figures below.

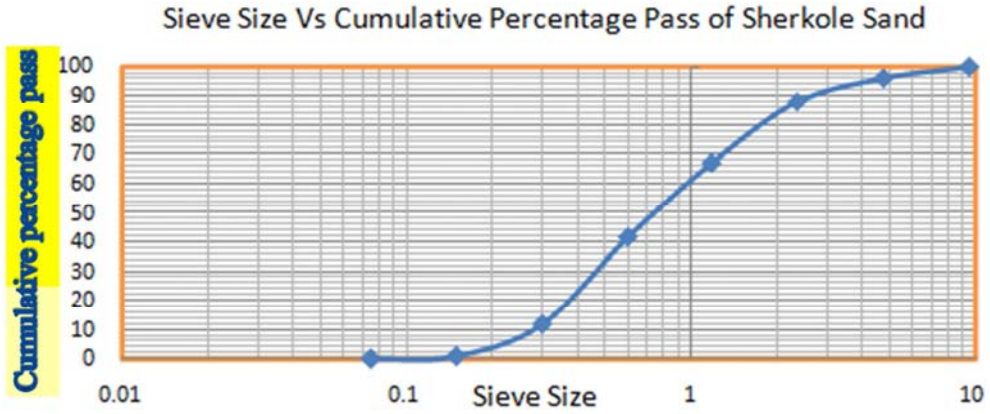

Figure 1. *Grain Size Analysis Aggregate result of Sherkole sand.*

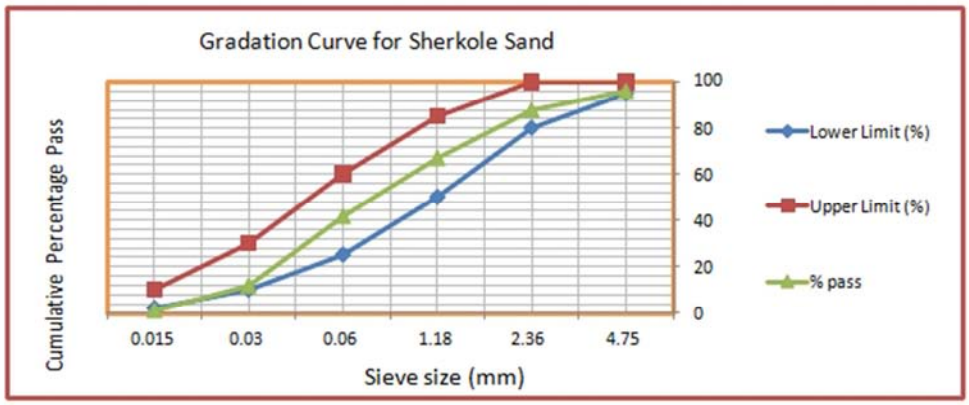

Figure 2. *Comparison of Sherkole sand to ES C. D3.201 limit standards.*

As the Figures 1 and 2 results, describes the sieve size, cumulative percentage pass of Sherkole sand with grade limit for the fine aggregate based on ES C. D3.201 limit standard. Here it explains that, sand lies between the standard limit but there was small amount of fine sand less than 0.015mm compared to the standards.

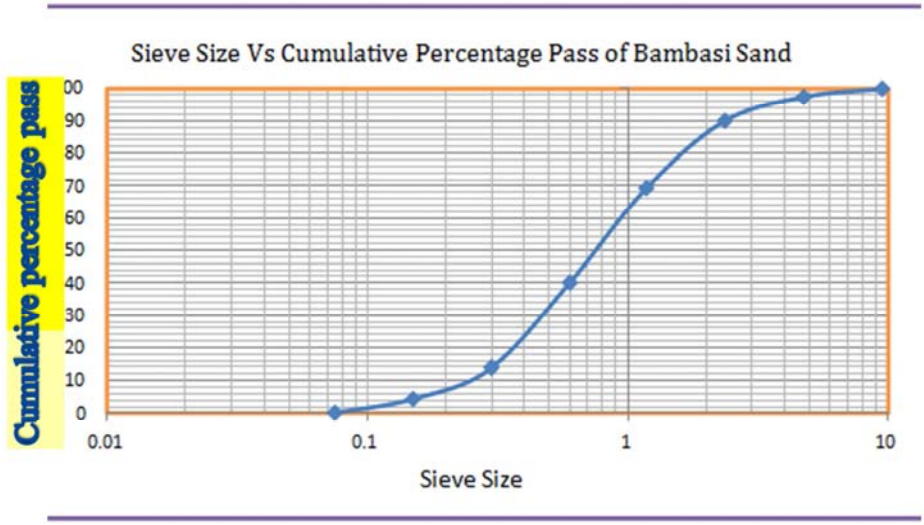

Figure 3. *Grain Size Analysis Aggregate result of Bambasi sand.*

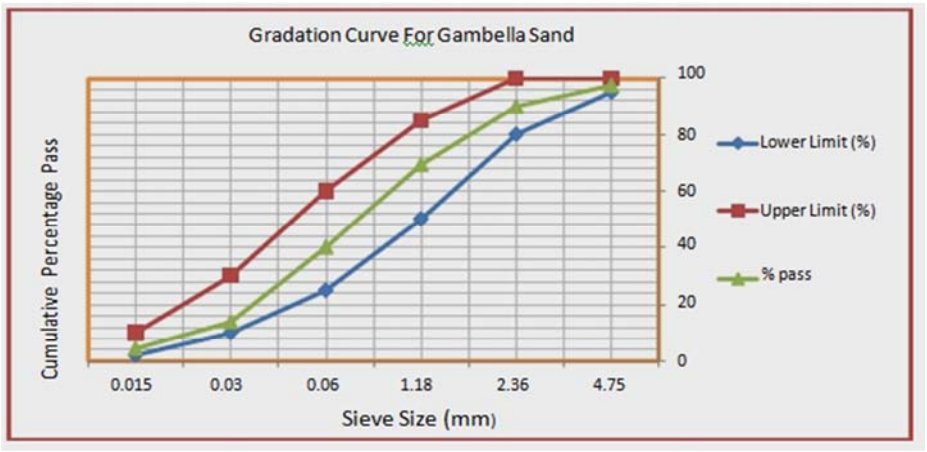

Figure 4. *Comparison of Bambasi sand to ES C. D3.201 limit standard.*

As the Figures 3 and 4 results**,** describes the sieve size, cumulative percentage pass of Bambasi sand with grade limit for the fine aggregate based on ES C. D3.201 limit standard. Here it explain that, sand lies between the standard limit.

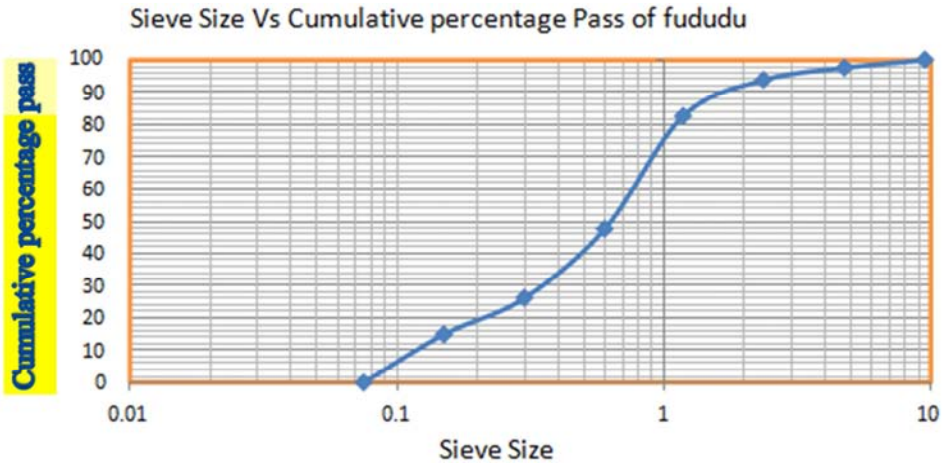

Figure 5. *Grain Size Analysis Aggregate result of fududu sand.*

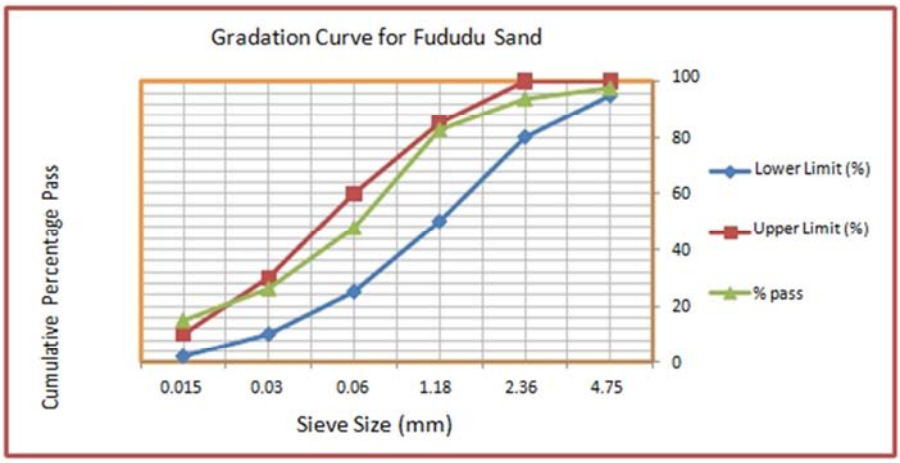

Figure 6. *Comparison of fududu sand to ES C. D3.201 limit standard.*

As the Figures 5 and 6 results**,** describes the sieve size, cumulative percentage pass of fududu sand with grade limit for the fine aggregate based on ES C. D3.201 limit standard. Which explain, the Sand does not lies between the standard limit in some extent, according to the analysis Fududu sand contain more fine particles with the sieve size of 0.015mm above the limit of ES C. D3.201 limit standard.

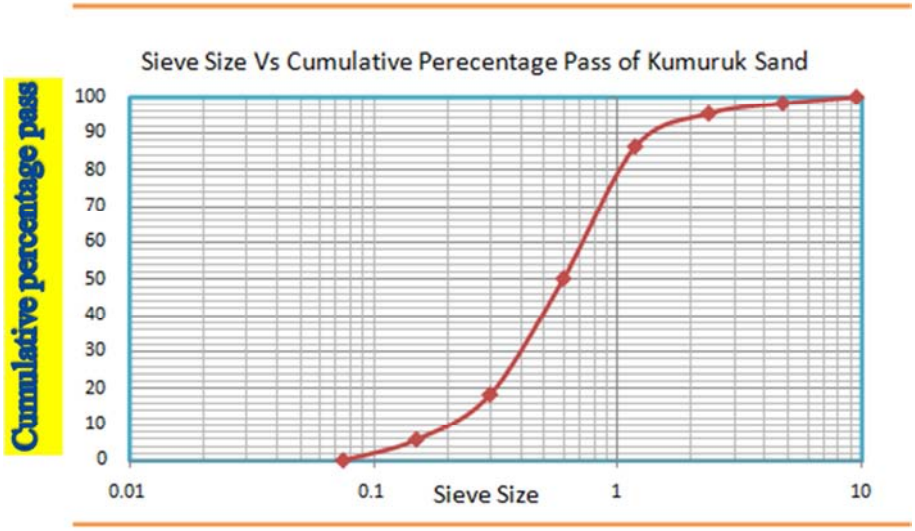

Figure 7. *Grain Size Analysis Aggregate result of Kumuruk sand.*

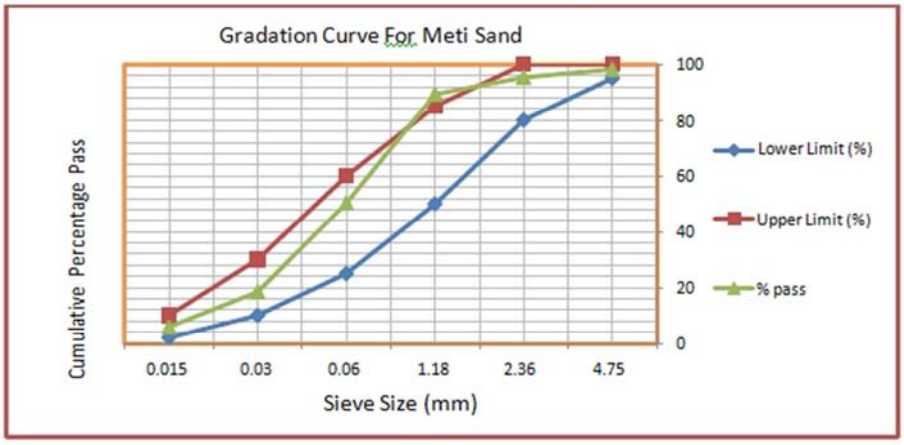

Figure 8. *Comparison of Kumuruk sand to ES C. D3.201 limit standard.*

As the Figures 7 and 8 results**,** describes the sieve size, cumulative percentage pass of Kumuruk sand with grade

limit for the fine aggregate based on ES C. D3.201 limit standard. Here it explain, the Sand does not lie between the standard limit in some extent, according to the analysis Kumuruk sand Contain with the sieve size of 1.18 mm above the limit of code of standard.

From result of fine aggregates, the strength of concrete is mainly depends on the bond between Aggregates and paste or the reaction between cement and water. To make concrete more workable and durable aggregate, well grade or satisfy ASTM standard, because the bondage between ingredients is high when aggregate satisfy the standard limit. Therefore Sherkole sand was well graded but Bambasi, Fududu and Kurmuk sand were not well graded because grading is outside of code standards.

6.2.2. Silt Content of Sand Result

The silt content of different types of sand results in figure below.

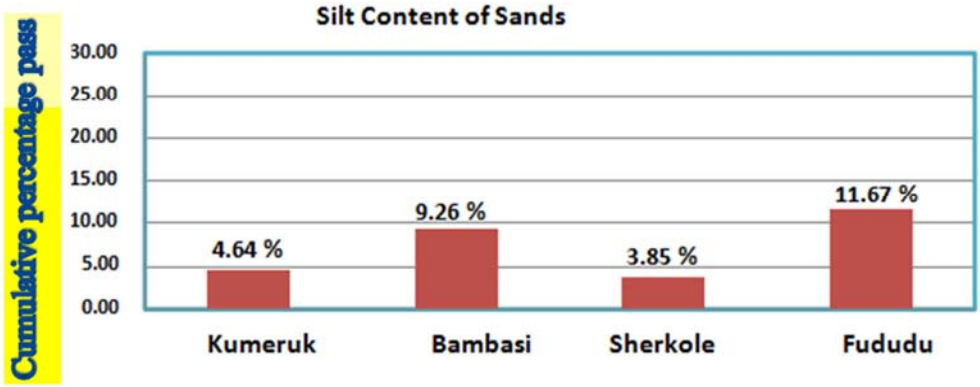

Figure 9. *Silt content of sands.*

As Figure 9 indicated that, y-axis represents the percentage of silt content and X-axis represents different types of sands. Based on the results of silt content, Bambasi and Fududu sands have high silt content than, Kumeruk and Sherkole sands. According to Ethiopian standards (ESC. D3.201) the allowable limit for silt/clay content is recommended not to exceed a value of 6% and in the ASTM C117 states that the allowable limit is maximum 5%. Sand is a product of natural or artificial disintegration of rocks and minerals.

6.2.3. Specific Gravity and Water Absorption Results of Sand

The Specific Gravity and Water absorption results of sand in figure bellow.

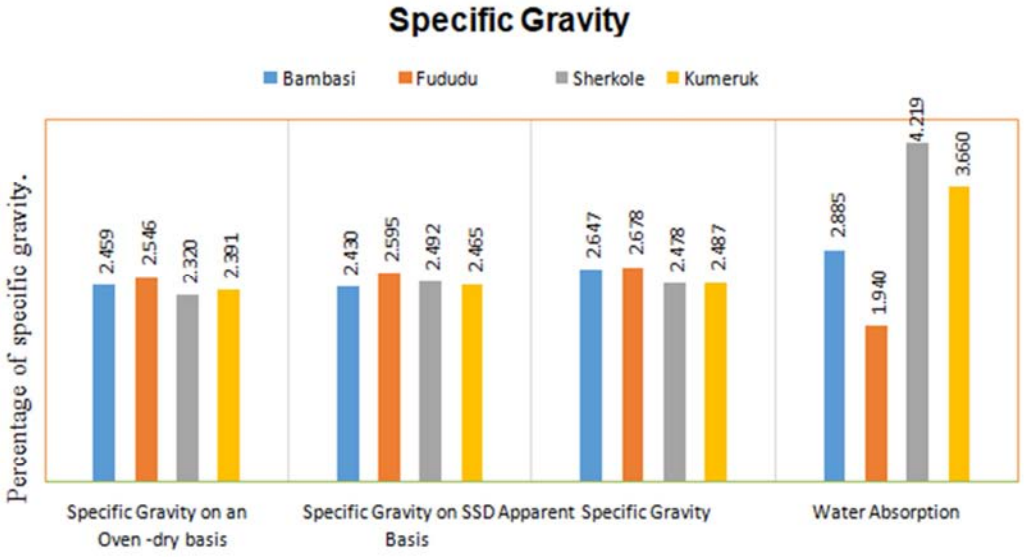

Figure 10. *Specific Gravity and Water absorption of sands.*

As Figure 10, indicated that, y-axis represents the percentage of specific gravity and X-axis represents specific gravity of Bambasi, Fududu, Sherkole and Kumeruk respectively. The specific gravity of an aggregate determined on an oven dry basis or a saturated surface-dry basis.

From above chart the specific gravity of all sand samples collected from sites are within the limit of specification. The specification indicates that most natural aggregates have relative densities between 2.3 and 2.9. Laboratory data shows the relative densities of four sand samples are in between 2.4 and 2.9. So that four of sand samples was satisfied the specific gravity specification. From all four sand samples

Sherkole sand has higher dry and saturated surface dry specific gravity than those three.

6.2.4. Unit Weight of Sand Result

The Unit Weight of Sands results in figure bellow.

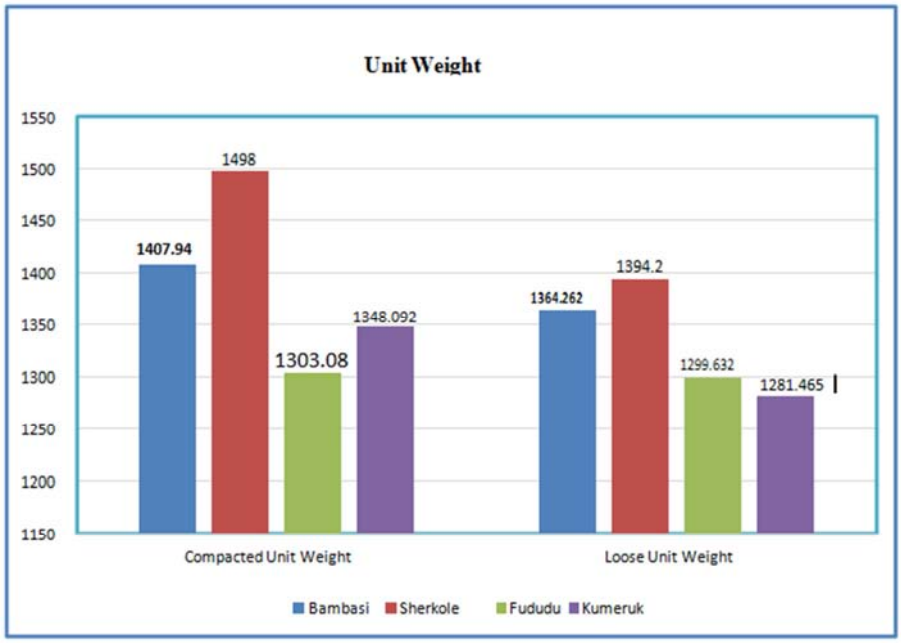

Figure 11. *Unit Weight of Sands.*

As Figure 11, indicated that, Unit Weight of Sand results of Bambasi, Sherkole, Fududu and Kumeruk respectively. The unit weight or bulk density of an aggregate is the mass or weight of the aggregate required to fill a container of a specified unit volume. The volume referred to here is that occupied by both aggregates and the voids between aggregate particles. The approximate bulk density of aggregate commonly used in normal-weight concrete ranges from about 1280 to 1920 kg/m^3.

6.2.5. Grain Size Analysis

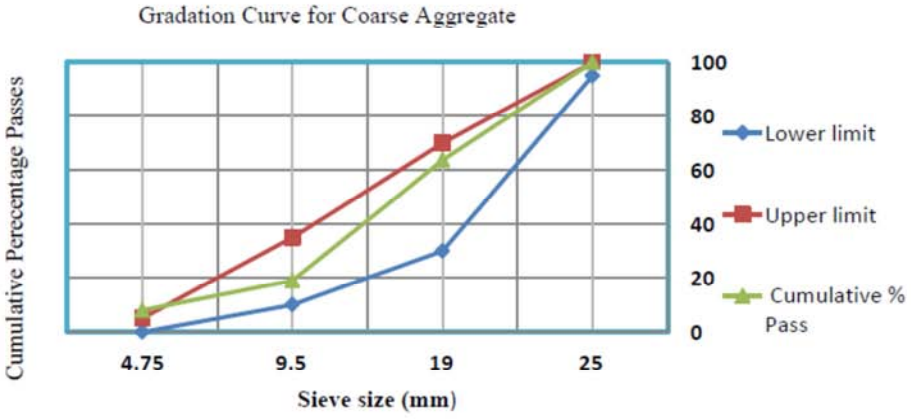

Figure 12. *Comparison of coarse aggregate to ES C. D3.201 limit standard.*

As the Figure 12 results, describes the sieve size, cumulative percentage pass of course aggregate with grade limit for the coarse aggregate based on ES C. D3.201 limit standard. Which explain, the aggregate does not lie between the standard limit in some extent, Coarse aggregate is not well graded one because sieve size in 4.75 mm cumulative percentage pass is the outside of grading system. This leads to the bondage between aggregates is

minimum. The maximum size of aggregate is 25 mm because all particles of aggregates passes sieve number 25mm size.

7. Conclusion

Commonly used concrete materials in building construction projects constructed under the Supervision of Assosa University (ASU) were river sands, crushed stone coarse aggregates, potable water (drinking Water) and Dangote and Muger cement brands. Specifically, from site observation, the projects Used Fududu, Kumeruk, Bambsi and Sherkole sand types and for coarse aggregate, Amba 14 crushed stone Used. Coarse aggregate and fine aggregate samples were carefully collected from crusher and river. To determine those concrete materials quality basic laboratory tests were performed as per Ethiopian, American and British standards. According to the result, numerical result of Amba 14 crushed coarse aggregate sample ACV and AIV were 16.585%, 14.965% respectively. ASTM and BS specify that when aggregate crushing value shall not exceed 30% and 30% for aggregate used in concrete. Specific gravity is the measure of quality and strength of the material. The allowable range limits of specific gravity of aggregates in American Concrete Institute (ACI) 2.3-2.9. The unit weight of natural concrete aggregates is in between 1280 to 1920 kg/m^3.

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