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Comparative Study of Aggregates for Flexible Pavement

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Abstract: Appropriate design and use quality materials for pavement construction is important in construction of cost-efficient flexible road pavements, where the highest stresses are imposed by the traffic's wheel loads, with a gradual decrease in material quality through the pavement, the poorest quality materials being used deeper in the pavement where the stresses are much reduced [1].

Flexible pavements are the most common type of pavements used in almost all road networks in Jima Zone. And they do have two sources of materials (aggregate) for wearing course. Therefore, this research initiated to determine or to recommend better source of aggregate for wearing course for road construction projects in Jima zone. aggregates from Babu aggregate production site better for road construction projects.

Keywords: Comparison, aggregate, wearing course

I. INTRODUCTION

A. Background

Appropriate design and use quality materials for pavement construction is important in construction of cost-efficient flexible road pavements, where the highest stresses are imposed by the traffic's wheel loads, with a gradual decrease in material quality through the pavement, the poorest quality materials being used deeper in the pavement where the stresses are much reduced [1].

Road Flexible pavements are intended to limit the stress created at the subgrade level by the traffic traveling on the pavement surface, so that the subgrade is not subject to significant deformations.

At the same time, the pavement materials themselves should not deteriorate to such an extent as to affect the riding quality and functionality of the pavement.

These goals must be achieved throughout a specific design period [2].

Flexible pavements are the most common type of pavements used in almost all road networks in Jima Zone. And they do have two sources of materials (aggregate) for wearing course. Therefore, this research initiated to determine better source of aggregate for wearing course for road construction projects in Jima zone.

B. Objective

To determine better source of aggregate for wearing course road construction projects.

Significance

It provides significant information to those construction company to identify sources aggregate during planning phase of their projects.

II. LITERATURE REVIEW

A. Aggregates

Aggregate is a collective term for the mineral materials such as sand, gravel, and crushed stone that are used with a binding medium (such as water, bitumen, Portland cement, lime, etc.) to form compound materials (such as bituminous concrete and Portland cement concrete). By mass, aggregate generally accounts about 95 percent of Bituminous concrete and about 70 to 80 percent of Portland cement concrete.

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1) *Types of Aggregate:* Aggregates can be classified to different categories Based on:
a) *Size of aggregates:* Aggregate is usually described as either coarse aggregate (retained 4.75 mm) or fine aggregate (passing 4.75 mm). Aggregates generally make up about 95 percent of the total mass of hot-mix asphalt mixtures and 80 percent by mass of concrete. Aggregate properties are, therefore, critical for quality hot-mix asphalt or concrete [3].
b) *Source and Mineralogy:* Aggregates are largely obtained from local supplies of natural rock. Among the natural rocks, three main types have been identified by geologists. They are as follows:

Igneous rocks are those which form as a result of cooling from the molten state. These are further classified as:

i) *Intrusive:* when the molten matter cools slowly under the earth's surface, and results in the formation of large rocks with typically large crystals, e.g., Granite, gabbro, pegmatite.
ii) *Extrusive:* when the molten matter cools rapidly on the earth's surface, resulting in the formation of rocks with smaller crystals, e.g., Basalt, andesite, rhyolite.
iii) *Pyroclastic:* these are formed due to the cementation of extremely fine ash deposits which cool very rapidly resulting in an amorphous rock, e.g., volcanic tuff, pumice, breccia.

Sedimentary rocks are deposited in a fluid medium due to lithification of weathered sediments.

Lithification can occur as a result of cementation (common cements being iron oxide, calcite, or quartz), crystallization, or compaction (due to the application of high temperature and pressure). Shale, sandstone, and limestone make up 46, 32, and 22 % of all sedimentary rocks, respectively.

Metamorphic rocks are formed when pre-existing rocks are subjected to heat and pressure.

Recrystallization often occurs, and the resulting rocks have typically large crystals with a well-defined cleavage. For example, marble, gneiss, schist, phyllite, slate, etc.

c) *Gradation or Size Distribution:* The gradation of the aggregates used in bituminous and concrete materials is very important to developing the required engineering properties of the materials and for economical production. Specifications generally permit a fairly broad range in gradation (gradation band) but a high degree of consistency is required during production for mix quality and uniformity. In concrete, the color and texture of the finished product is also largely a function of the aggregate and, particularly, the fine aggregate. The proportion of fine material produced in an aggregate operation depends on several factors, including the deposit geology and degree of crushing. In fine aggregates, the gradation is one of the most important quality factors. If it is controlled, the material is usually acceptable. In coarse aggregate, the desired gradation can generally be controlled by appropriate processing (screening) and the degree of crushing, but many physical and chemical properties must also be satisfied. Various deleterious materials, such as chert, shale and siltstone, may be present in a pit or quarry face, which may restrict or totally preclude the use of such materials. Specifications that do not permit the use of lower quality material result in higher prices. However, the cost of aggregate is usually considered to be a relatively small part of the total construction cost, and compromising the expected life of the finished product by using cheaper materials is rarely good practice.

B. Experimental Procedure

For the purpose of the objective of the research, the researcher extracts appropriate and adequate sample for proper types of research to come up with good conclusion and recommendation. For the construction of road project in Jima zone, Ethiopian road Construction Corporation (ERCC) have two sources of crushed aggregate production sites. Both production sites are found in Jima zone; these are:

1) Babu aggregate production site, found in Limu kosa woreda, which is 35km from Jima city

In Babu Production site, Ethiopian road Construction Corporation produces aggregates for:

a) Wearing course
b) Fine aggregate to which used as filler materials

2) Enkulu aggregate production site, found in mana woreda, which 30 km from Jima city.

In Enkulu Production site, Ethiopian road Construction Corporation produces aggregates for:

a) *Wearing Course:* Based on the production sites the researcher collected aggregate samples from both, for laboratory tests.

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III. SAMPLING PROCEDURE AND TESTING

Aggregate sampling has been conducted according the sampling methods of (ASTM D 75) and (AASHTO T 2).

The following laboratory tests has been taken place in Ethiopian Road Constriction Corporation material and testing laboratory, according to the procedure of Standards. After conducting the tests listed below data was analyzed for further investigation the results,

Table 1 laboratory tests taken place

Tests on Aggregates	Reference to test methods
Flakiness Index (FI)	[4]
Aggregate Crushing Value (ACV)	[5]
Aggregate Impact Value (AIV)	[6]
Los Angeles Abrasion Test (LAA)	AASHTO T 96 ASTM C535-89
Specific Gravity and Absorption of Fine Aggregate	AASHTO T 84
Specific Gravity and Absorption of Coarse Aggregate	AASHTO T 85: BS812: Part 2:1975
Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates	AASHTO T 84 [7]

IV. RESULTS AND DISCUSSION

A. *Aggregates from both Aggregate Production Sites*

Table 2 Sieve analysis or aggregate size distribution from both sites

Sieve (mm)	% of Pass Babu	% of Pass Enkulu	Specification limit
25	100	100.0	100
19	99.02	99.3	92
13.2	81.45	87.0	77
9.5	69.95	81.1	69
4.75	56.26	60.6	51
2.36	43.77	44.8	34
1.18	27.15	28.9	30
0.6	17.55	19.3	22
0.3	12.01	13.4	16
0.15	8.63	9.8	12
0.075	6.66	7.3	7
pan	0	0	

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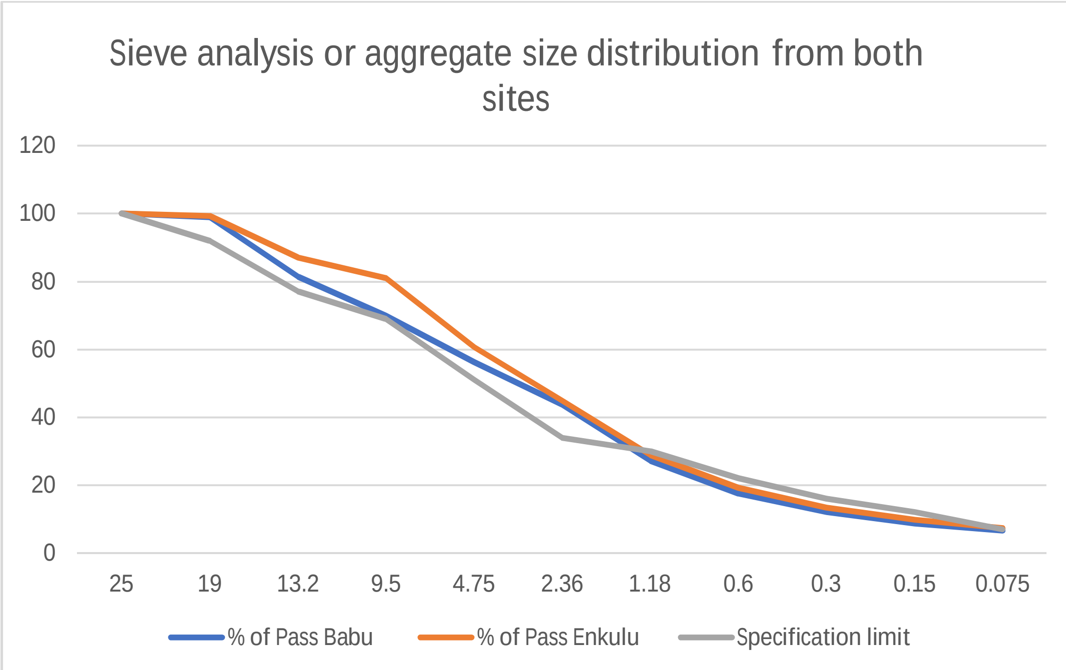

Figure 1 Sieve analysis or aggregate size distribution from both sites

Figure 1, shows the size distribution Comparison of Aggregates from both sites, for construction purpose aggregate should be well graded in order to achieve the desired quality of the project. The fore aggregate from Babu crushing site better than from Enkulu site.

B. Coarse Aggregate Properties From Both site with ERA Standard Specifications

Table 3 Coarse aggregate properties from both site with ERA standard specifications

No	Property	Babu aggregate Coarse aggregates	Enkulu aggregate Coarse aggregates	ERA specification	Remarks
1	Cleanliness	0.4% [8]	0.56% [8]	< 5 per cent passing	Ok
2	Particle shape	35%	22%	< 45 per cent	Ok
3		Strength			
	1 ACV	16%	16%	< 25	Ok
	2 AIV	10%	16%	< 25	Ok
	3 LAAV	12%	15%	< 30	Ok
4	Hardness/toughness or abrasion	12%	15%	<15 or <12 for heavy traffic	Ok
5	Water absorption	2.05	1.99	< 2 per cent	Ok

Table 3 shows, comparison of different Engineering properties of an aggregate from which are from both crushing site or aggregate production sites as well as Ethiopian road Authority standard for aggregates Engineering property.

V. CONCLUSIONS

A. In aggregate size distribution, aggregates from Babu crushing site is better than from Enkulu aggregate production site.
B. In engineering property also, aggregates from Babu aggregate production site better than Enkulu aggregate production sites
C. Therefore, aggregates from Babu aggregate production site better for road construction projects in Jima zone.

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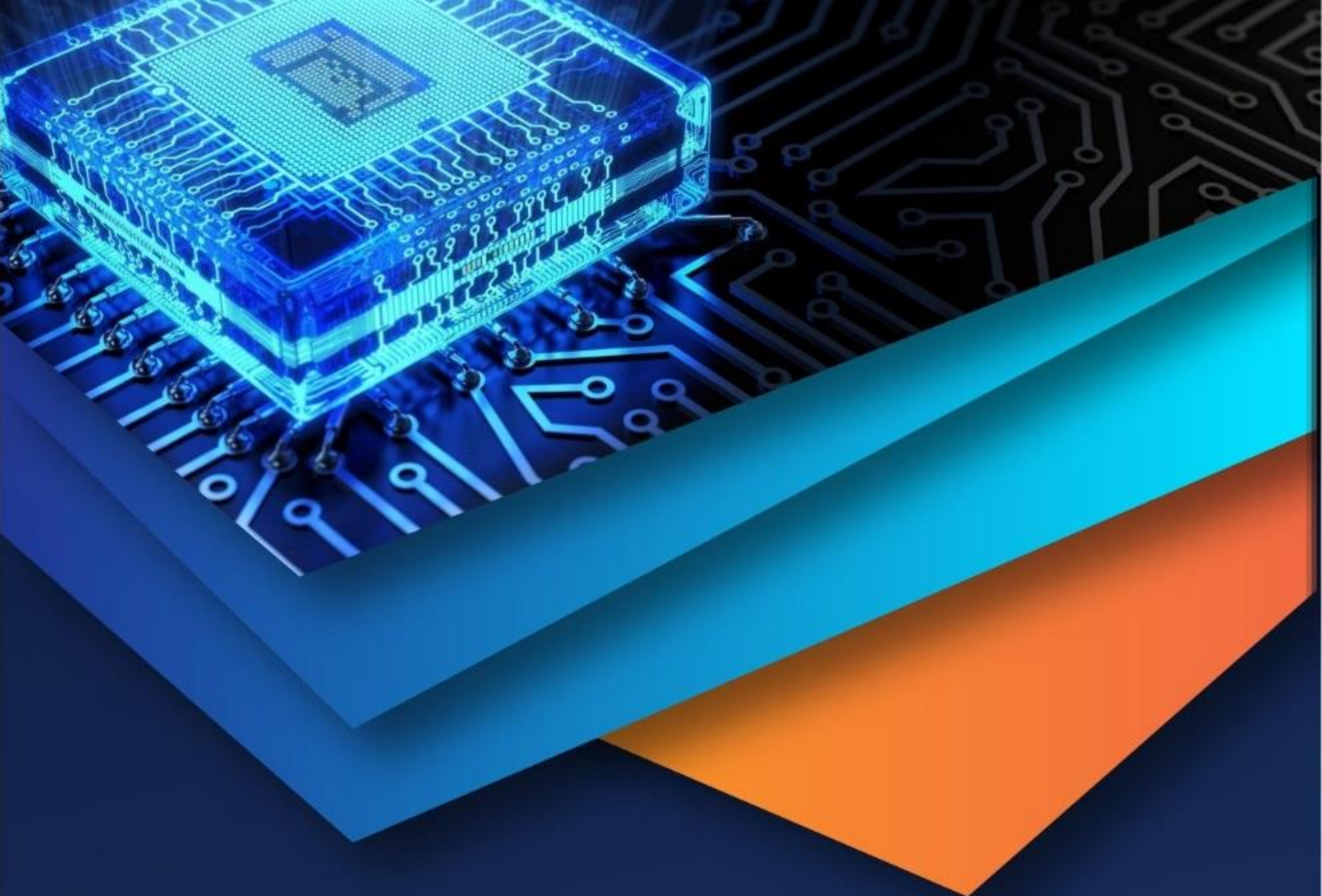

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