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Evaluation of aggregate physical properties and durability in Al Dakhiliyah area- Oman

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Abstract. *The evaluation of the aggregate properties used for the concrete mixes and highway courses materials are of highly important requirements for engineering design. The determination of properties for the coarse and fine aggregates selected from four different locations covering Al-Dakhiliyah Governance Area - Omanis considered. Grain size, specific gravity, absorption, and durability the including Los Angeles, impact value and soundness by chemical agent are considered. The selection of the proper location of aggregates is recommended based on the British and AASHTO Standards.*

Keywords: *Aggregates, durability, specific gravity, absorption, flakiness, elongation, impact value.*

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I. INTRODUCTION

The structural design of most of the civil engineering Projects are influenced by the behavior and properties of the construction material. It is highly recommended to use the locally available materials in constructionin order to minimize the cost [3 - 22]. The natural aggregates are formed by disintegration of the rocks due to weathering conditions. Most of the natural aggregates are rounded in shapes due to the effect of transportation from the formation location to the deposition place, providing that a loss of grain irregularities due to the abrasion on hard ground surfaces [1]. The aggregates are forming the main Skelton of the concrete and highway courses [2].

In this study the evaluation of properties of the fine and coarse aggregates selected from four different locations in Al-Dakhiliyah - Sultanate of Oman is conducted. The evaluations are included the physical properties and the durability of aggregates in particular.

The main objectives of this study can be summarized as:

1- To determine the aggregates physical properties for the materials selected four locations.
2- To determination the durability of aggregates using different methods of evaluation and analysis.
3- To show the satisfaction of the results with engineering standers B.S and AASHTO.
4- To give a recommendation for the proper location of the materialsamong the study area to be used for engineering works.

II. MATERIALS AND METHOLOGY

Materials

Coarse and fine aggregates were selected from four different locations covering Al-Dakhiliyah area - Sultanate of Oman. These locations are Nizwa, Izki, Sumail and Adam. The materials were brought to the laboratory from different quarries and licensed aggregate crushers from each location. A representative samples for evaluations were selected for each location.

Methodology

All the physical properties; grain size, specific gravity, absorption, flakiness, elongation index and shapes were determined according to the British Standard (B.S) and AASHTO. In addition, the durability tests including Los Angeles abrasion test, impact test and aggregates soundness were conducted according to same standards.

III. RESULTS AND DISCUSSION

Fine and coarse aggregate samples were selected from four locations in Al Dakhiliyah region, namely; Nizwa, Izki, Sumail and Adam. Properties and behavior in addition to durability of these aggregates are investigated using sieving analysis, specific gravity, water absorption, elongation index, aggregate shapes, Los Angeles Abrasion, impact and hardness tests. The results of these necessary properties were obtained and discussed in the following articles.

Gradation of aggregates

The B.S was used for the gradation limits of coarse and fine aggregates [23].

Gradation of coarse aggregates

The results of gradation for coarse aggregates of 10 mm from different locations are shown in Figure1. It can be seen thatthe middle size of all locations are coarser than the limit. Accordingly, these gradations are not satisfying the standard requirements.

Gradation curve of the coarse aggregates 20mm for different locationsare given in Figure 2. These figures indicate that the gradation of all location was not compiling the limits. Most of the aggregate sizes were in general coarser than the required standard limits especially the larger sizes.

The coarse aggregates are blended using the ratio of (40%+60%) for (10mm+20mm) to make coarse aggregates used in concrete (this proportion isused in general in most cases). Figure 3 shows the summary of the gradation for all locations. It can be seen that the gradations of all locations are not compiling the limits except Izki location. The middle aggregate sizes are in general coarser than standard requirements.

Gradation of fine aggregates

Gradation curves of the fine aggregates for different locations are shown inFigure 4. It can be seen from these curves that gradation of the aggregates in all locations is within the limits. Accordingly, these gradations were satisfying the standard requirements. Izki location was showing the most proper gradation within the limits since it has equal margins.

Gradation of coarse and fine blended aggregates to meet specifications

The coarse and fine aggregate from each selected location is blended to be used for concrete mix. The blend proportions are determined using the graphical mix method for B.S limits [23]. Accordingly, the following proportions arefound for the different locations.

- Nizwa location - (% passing of coarse × 0.7 + % passing of fine × 0.30)
- Izki location - (% passing of coarse × 0.58 + % passing of fine × 0.42)
- Samail location - (% passing of coarse × 0.52 + % passing of fine × 0.48)
- Adam location - (% passing of coarse × 0. 54 + % passing of fine × 0.46)

Thegradation curves of blended aggregates for the different locations are shown in Figure 5. It can be seen that aggregates of all locations are within the limits.

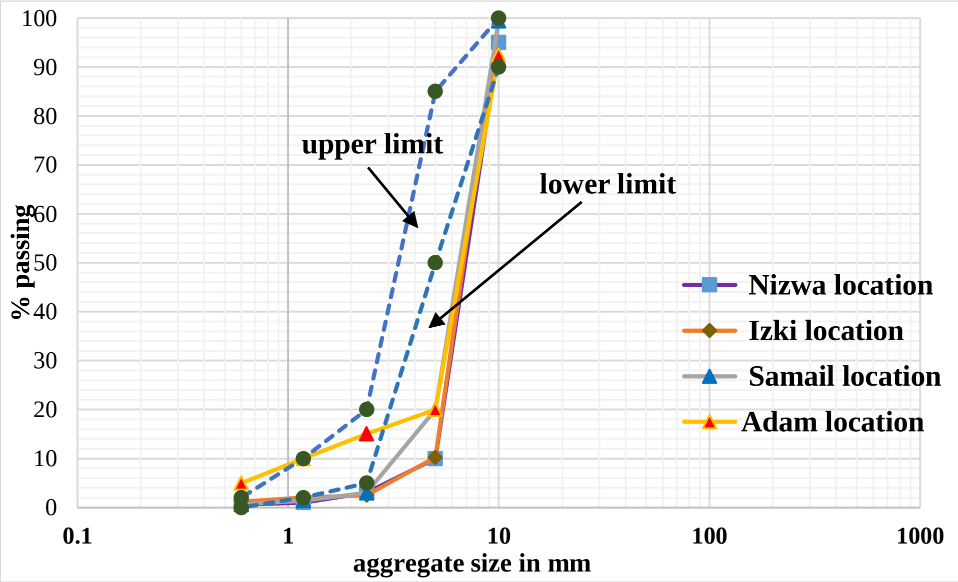

Figure 1. Gradation curve of coarse aggregates size 10 mm for different locations

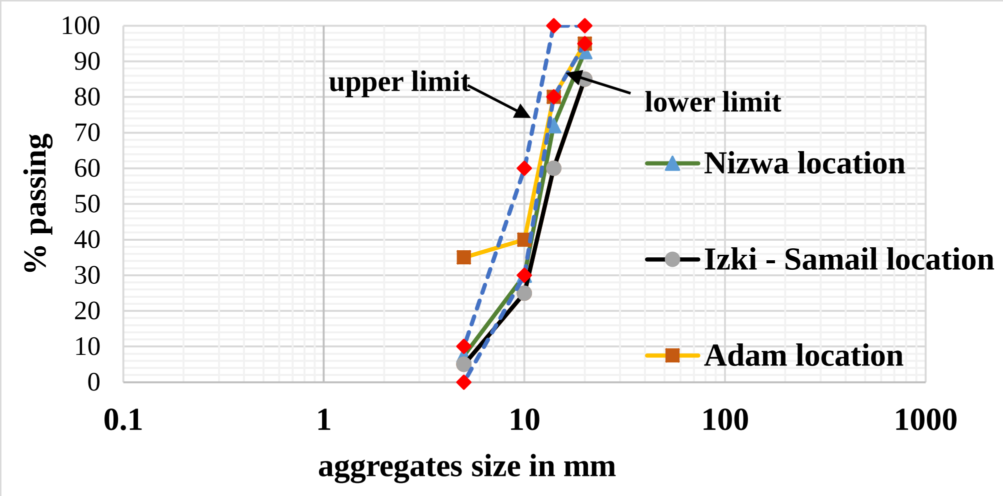

Figure 2.Gradation curve of coarse aggregates, size 20 mm for different locations

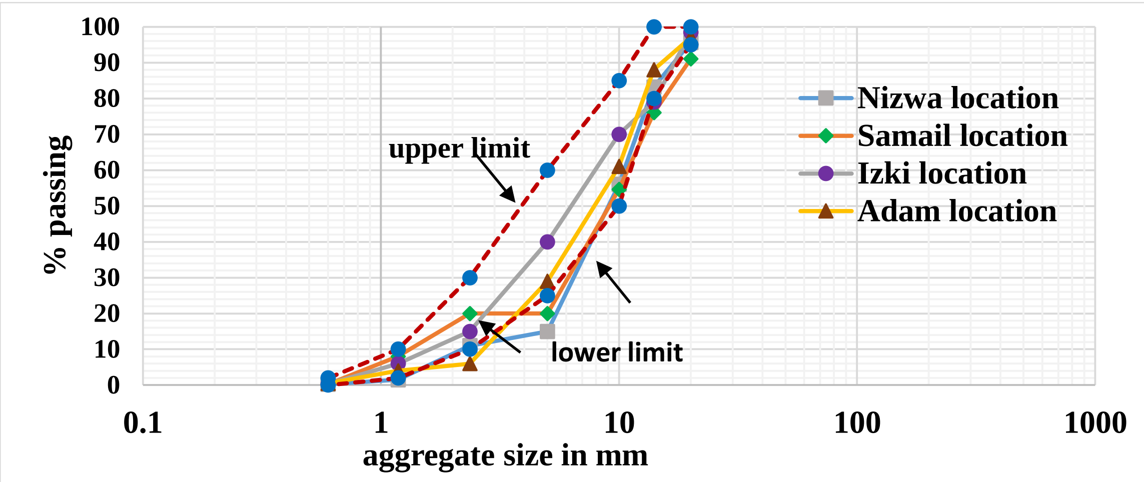

Figure 3. Gradation curve of blended coarse aggregate for different locations

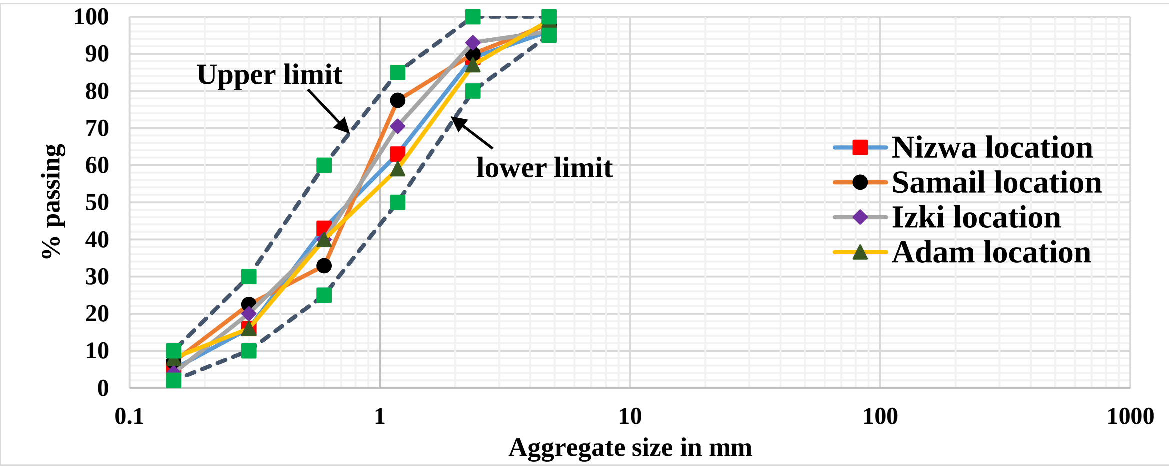

Figure 4. Gradation curve of fine aggregate for different locations

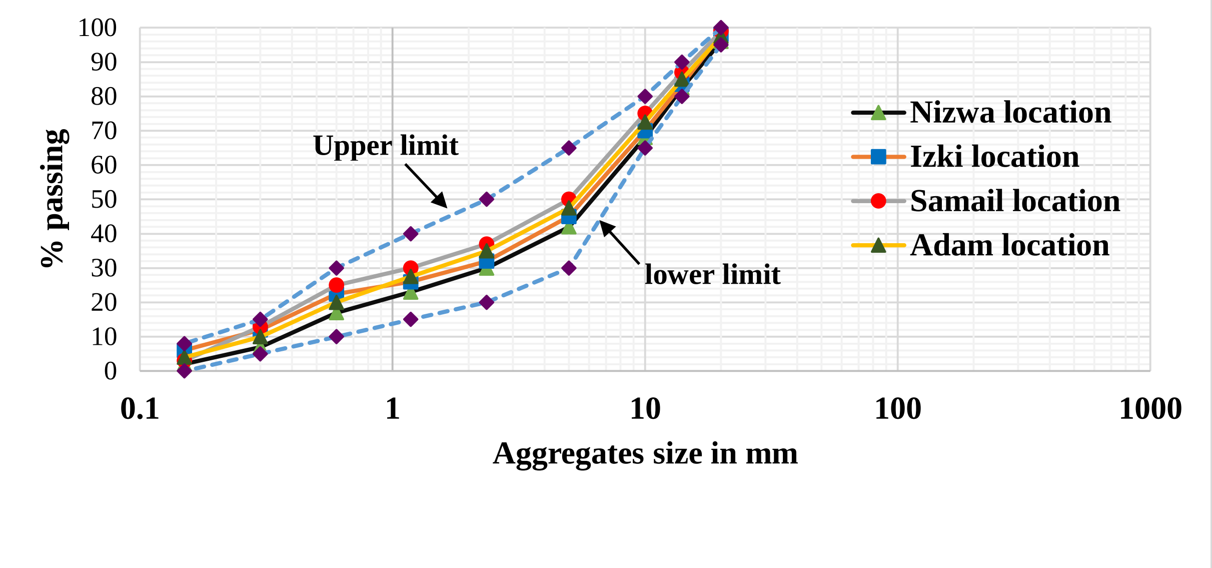

Figure 5. Gradation curves of blended aggregatesfor different locations.

Specific gravity of aggregates

The specific gravity of the aggregates was determined in saturated surface dry condition since it is the condition used in engineering applications. Figure 6 shows the specific gravity of aggregate for different locations and for coarse, fine and blended aggregate. It shows that the fine aggregates in all locations having a higher value than the coarse aggregates. This is maybe due to probability of presence the voids inside the fine aggregateless than that in coarse aggregate. In general; the specific gravity of fine aggregates ranges between (2.6-2.66) for all locations. Regarding the coarse aggregates, the range of the specific gravity is between (2.559-2.616). Accordingly, the range of the weighted average of the specific gravity is between (2.575-2.633). The aggregate from Adam location is indicated the higher value of specific gravity of fine, coarse and blended conditions.

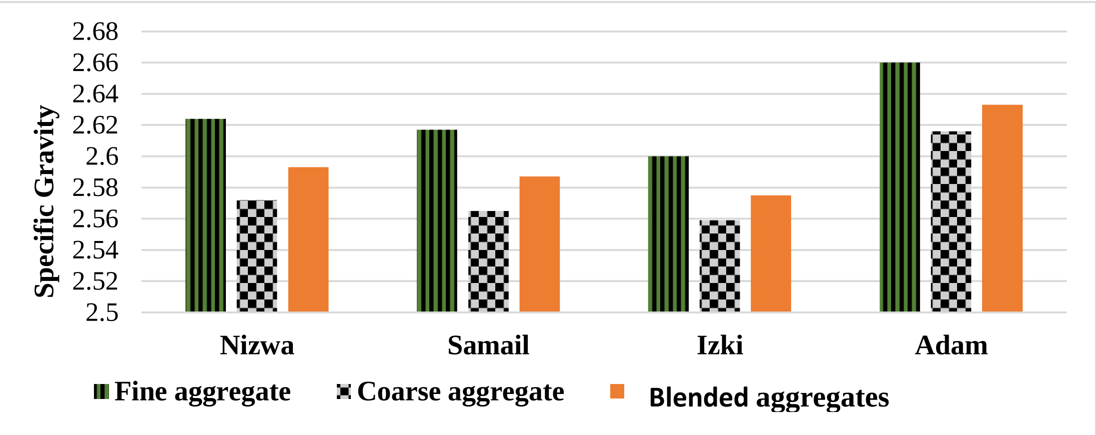

Figure 6. Specific gravity of various aggregates for different locations

Absorption of aggregates

The absorption of fine and coarse aggregates was determined according to the BS812 2:2003 and AASHTO (T 84). For coarse aggregates the tests were conducted using thenormal method of immersion in water for 24 hr., while for fine aggregates the frustum of cone method was used. Figure 7 shows the specific gravity value for all locations for coarse and fine aggregates. It can be seen that the absorption of fine aggregates is higher than coarse aggregates for all locations and making about 3-4 folds. This may be attributed to the fact that fine aggregates are resulted from disintegration and crushing of rocks having different forming minerals from those of the coarse aggregates. In addition; the grains surface area for the fine aggregate is higher than the coarse aggregates relatively. The range of the absorption for fine aggregates is between (1% -3%) while for coarse aggregates is between (0.35% -1.0 percent). The aggregates from Adam location is indicated the lowest absorption for both fine and coarse aggregates.

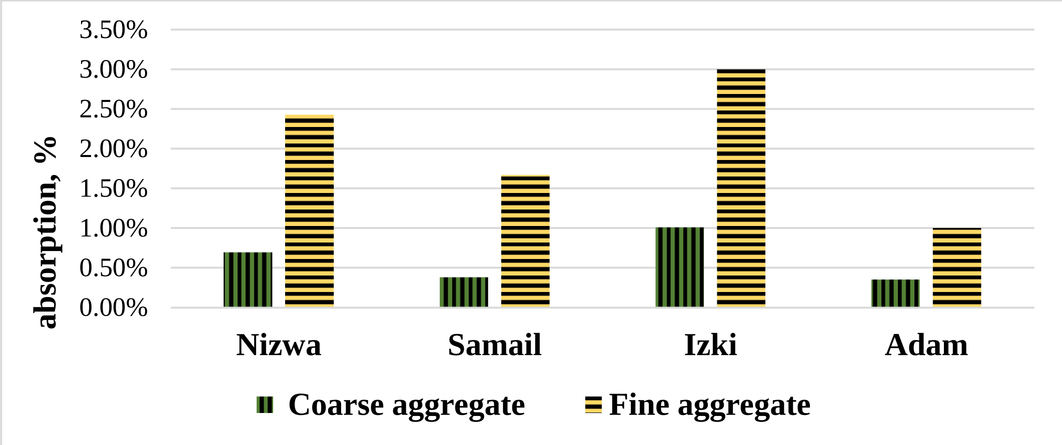

Figure 7. Absorption of aggregates for different locations

Elongation and Flakiness Index

The Elongation and Flakiness index were determined for all location; results are shown in Figure 8. Elongation and Flakiness considered being a measure of the degree of crushing and abrasion of the aggregates used in highways and airports courses materials.The Elongation index varied from (3.30-4.32%) while Flakiness index varied from (2.90-5.10%). The lowest value for both index obtained for Adam location. In general, these values indicated that the Elongation and Flakiness of all aggregates are low enough to be used in engineering purposes. Aggregates from Adam location indicateda higher resistance tocrushing and abrasion under highways and airports dynamic loading, and it is worth to mention here that the durability of the aggregates from Adam location found to bethe highest one as will be discussed later.

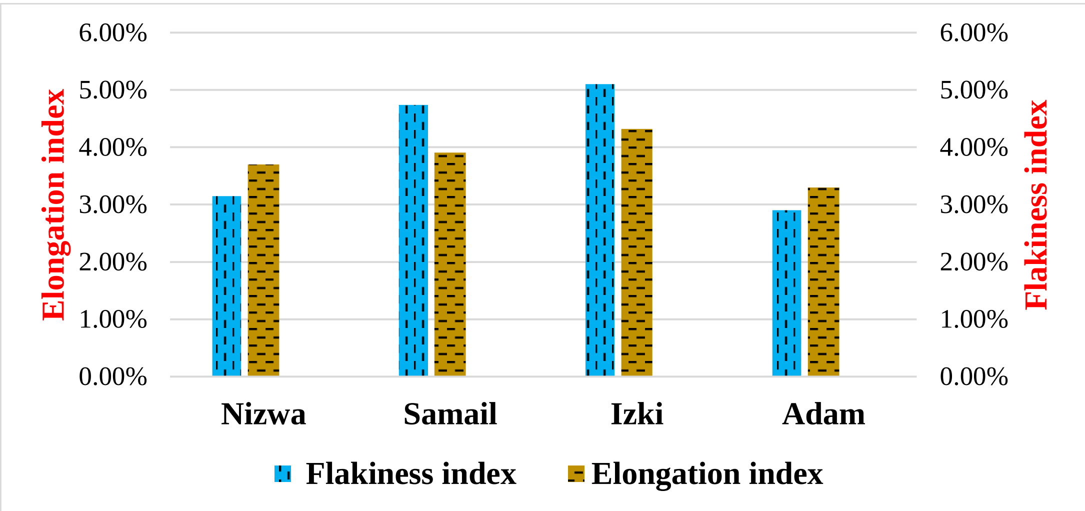

Figure 8. Elongation and Flakiness index of aggregates for different locations

Aggregate shapes

The aggregate shapes were described by using visual examination, it was found that most aggregates in the four locations having a shapes of angular and sub-angular. This ispartly due to the crushing process in producing these aggregates.

Aggregates Durability

Los Angeles Abrasion test

Using the Los Angeles abrasion method, theabrasion values for coarse aggregates obtained for all locations were determined. Figure 9 shows the results and comparison of aggregates percent loss between the four locations. It is clear that the percent loss is ranging within (20-23%) for all locations. The lowest value for percent loss is obtained from Adam location. Accordingly, aggregates from Adam location showed a higher abrasion resistance and durability.

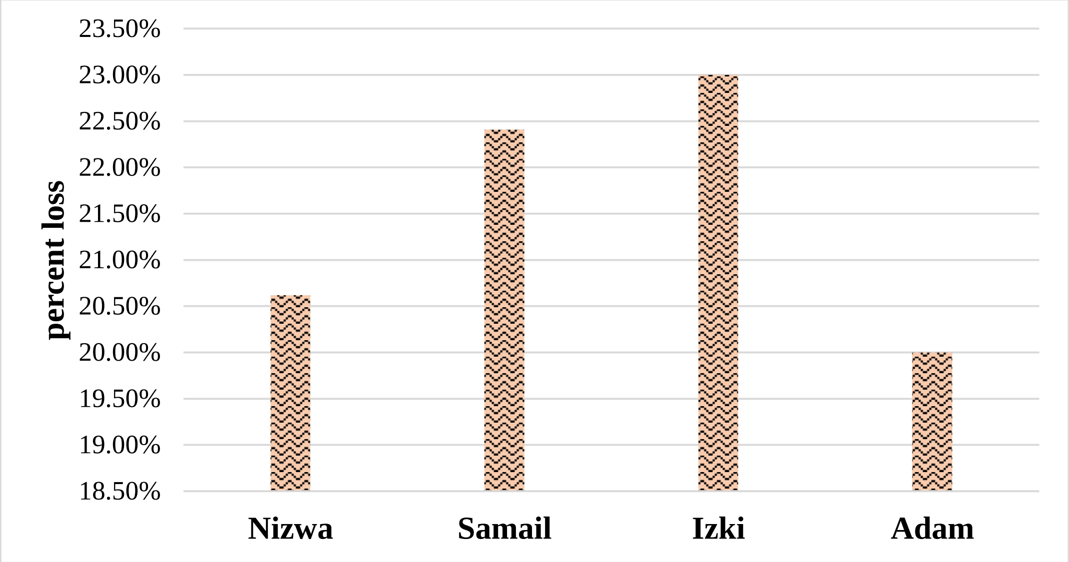

Figure 9. Los Angeles loss of coarse aggregates for different locations

Impact value of coarse aggregates

The aggregates impact values were determined for all location using the impact test. Figure 10 shows the results for all locationsand gives a clear comparison between them. The impact value as a percent of lossvaries from (4.058 to12.266%). The aggregates taken from Adam location show the lowest impact value. Accordingly; aggregates from this location indicated a higher resistance tothe application of dynamic loading.

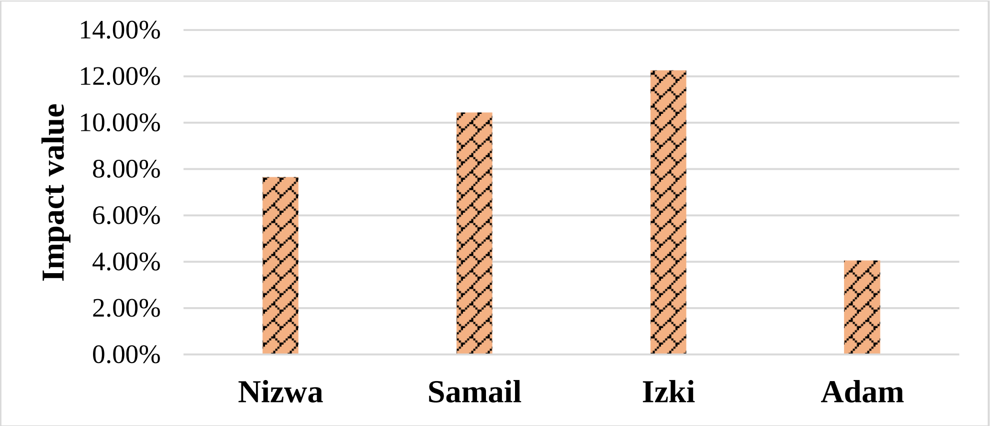

Figure 10. Impact values test of coarse aggregates for different locations

Soundness behavior of coarse aggregates

The aggregates soundness using Magnesium Sulfate was determined for the aggregates from all locations. Figure 11 shows the results and a clear comparison. It can be seenthat the percent of loss varies from (1.315 to 6.14%). The lowest value is obtained for aggregates of Adam location. In this case aggregates from Adam location indicated a higher resistance to weathering condition effects.

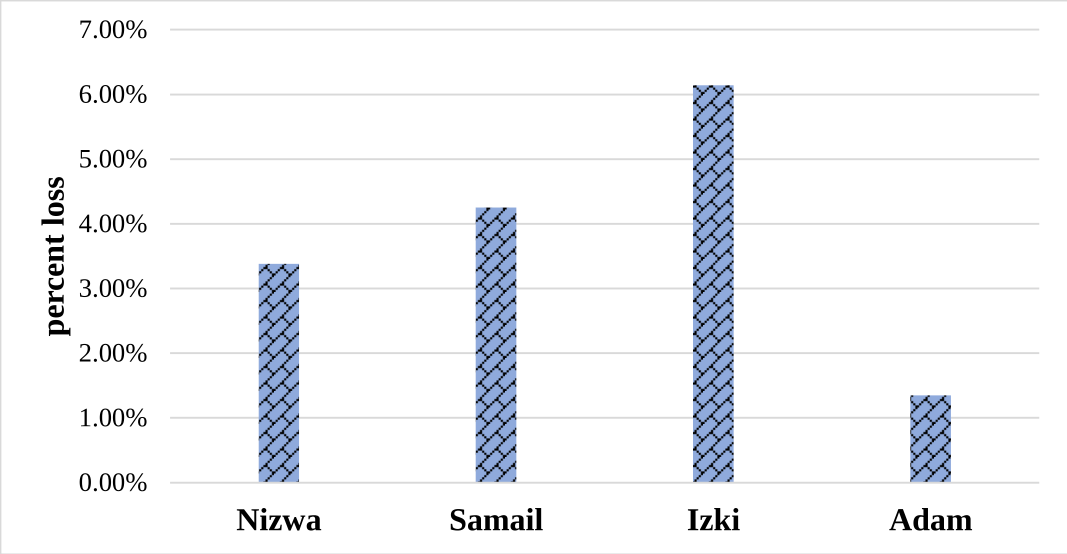

Figure 11.Results of soundness of coarse aggregates for different locations

Comparison between durability results of all locations

The durability results of aggregates selected from different locations and considering the resistance to Los Angles abrasion, Impact and soundness are shown in Figure 12. It can be seen that the durability of aggregates taken from Adam location is higher than other locations, while aggregates from Izki location gives the lowest durability. This conclusion is matching results of all assessments of the aggregates regarding specific gravity, elongation and flakiness.

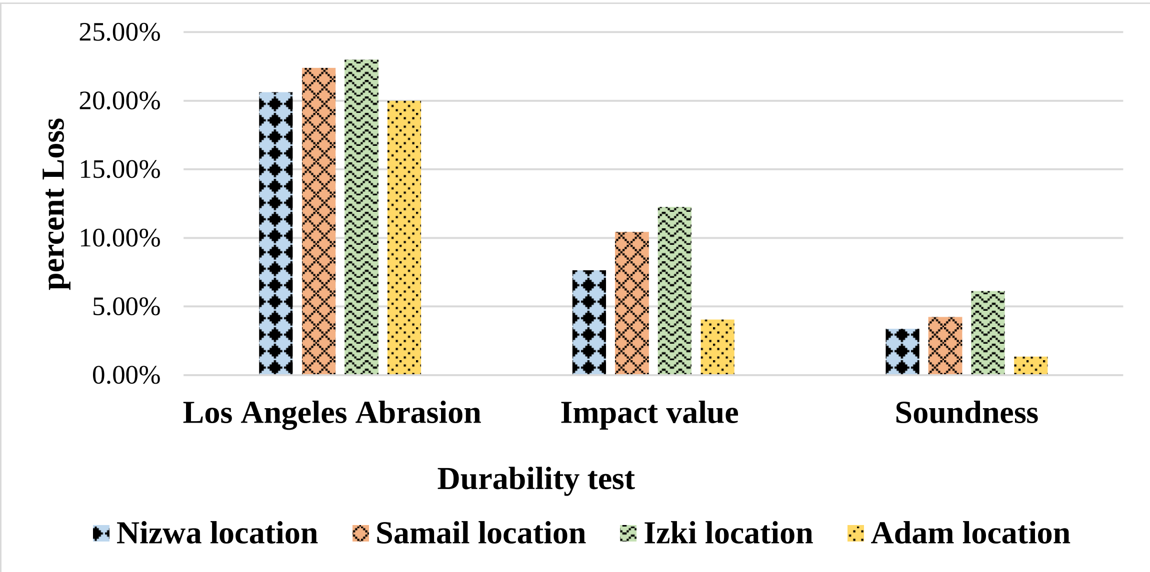

Figure 12. Comparison of durability results between different locations

IV. CONCLUSIONS

1-The aggregates selected from Adam's location are the most suitable to be used for engineering purposes as a concrete mixes and highways courses.

2- The physical properties and durability of aggregates selected from the Izki's location shown to be weaker than other locations.

3- Aggregates of a higher specific gravity indicated a higher soundness.

4- In spite of the low durability obtained in Izki's aggregates location, the valuesare still within the specifications limits.

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