**MIDDLE EAST TECHNICAL UNIVERSITY**

**DEPARTMENT OF CIVIL ENGINEERING**

**CE 344: MATERIALS OF CONSTRUCTION**

**LABORATORY REPORT 1: TESTS ON AGGREGATES**

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**1. Object and Scope**

The purpose of this test is to determine the particle size distribution of fine and coarse aggregates by Sieve analysis and to interpret the aggregate sample according to the results.

**2. Preliminary Remarks**

Aggregates those are using for concrete are granular materials. Crushed stone, sand, gravel, burned clay are the most well-known aggregates in concrete production. Aggregates form approximately ¾ of the entire volume of concrete alone. Behavior of concrete mostly affected by properties of own aggregates' properties. A well graded aggregate sample means a uniform distribution of grains in concrete can say that a well graded aggregate sample and this situation provides low permeability. On the other hand, there is not a well graded aggregate sample means that there is a non-uniform distribution in concrete and it might lead to some problems such as segregation.

According to sieve analysis, how much coarse or fine the aggregate is determined then results are named as fineness modulus.

Grain Size Distribution is mostly used for classification of aggregate sample, it is particle size versus of sample finer than that size.

3. Test Specimen

* Total 116 g of aggregate.

Table 1 : The Mass Retained for Each Sieve

|  |  |  |
| --- | --- | --- |
| Sieve | Sieve Opening (mm) | Mass Retained (g) |
| #4 | 4,75 | 0 |
| #8 | 2,36 | 4 |
| #16 | 1,18 | 19 |
| #25 | 0,71 | 29 |
| #30 | 0,6 | 25 |
| #50 | 0,3 | 28 |
| #100 | 0,15 | 6 |
| #200 | 0,075 | 3 |
| Pan | - | 2 |

**4. Apparatus**

* Balances
* Sieves
* Mechanical sieve shaker
* Oven ( Capable of creating temp. 110 ± 5 °C)

5. Test Procedure

1. Dry the sample to constant mass at a temperature of 110 ± 5 °C
2. Weigh the sample in accordance with standard requirements
3. Sort the sieves in order of decreasing size of opening from top to bottom. The sizes of the sieves are given in the test specimen part
4. Sieve the sample
5. After compilation, remove each sieves carefully and determine the mass of each on a balance. This readings are available in test specimen part

6. Calculation

g

Cumulative percent retained is total percent of mass retained values above sieve.

***For #4 Sieve :***

***For #8 Sieve :***

***For #16 Sieve :***

***For #25 Sieve :***

***For #30 Sieve :***

***For #50 Sieve :***

***For #100 Sieve :***

***For #200 Sieve :***

***For Pan :***

ASTM C136-14 stated that, the fineness modulus is calculated by adding the cumulative percentage by mass retained on some specified sieves which are #4, #8, #16, #30, #50 and #100 sieves.

**7. Results**

Table 2 : The Cumulative Percent Retained and Percent Passing Percentages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sieve | Sieve Opening (mm) | Mass Retained (g) | Cumulative Percent Retained(%) | Percent Passing (%) |
| #4 | 4,75 | 0 | 0,00 | 100,00 |
| #8 | 2,36 | 4 | 3,45 | 96,55 |
| #16 | 1,18 | 19 | 19,83 | 80,17 |
| #25 | 0,71 | 29 | 44,83 | 55,17 |
| #30 | 0,6 | 25 | 66,38 | 33,62 |
| #50 | 0,3 | 28 | 90,52 | 9,48 |
| #100 | 0,15 | 6 | 95,69 | 4,31 |
| #200 | 0,075 | 3 | 98,28 | 1,72 |
| Pan | - | 2 | 100 | 0,00 |

Fineness Modulus = 2,76 ( Between 2.15 and 3.38, so aggregate is fine)

Figure 1 : Gradation of Aggregate A

**8. Discussion of Results**

**a-)** 4,75 mm sieve opening is the limit for fine aggregates, as shown in the table below, both Aggregate X and Aggregate Y couldn't pass bigger sieves. Therefore, it can be said that both Aggregate X and Aggregate Y are coarse aggregates.

Table 3 : Aggregate X and Aggregate Y's Percentages

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Mass Retained (%) | | Cumulative Percent Retained(%) | | Percent Passing(%) | |
| Laboratory Sieve (mm) | Aggregate X | Aggregate Y | Aggregate X | Aggregate Y | Aggregate X | Aggregate Y |
| 100 | 0 | 0 | 0 | 0 | 100 | 100 |
| 90 | 0 | 0 | 0 | 0 | 100 | 100 |
| 75 | 0 | 0 | 0 | 0 | 100 | 100 |
| 63 | 0 | 0 | 0 | 0 | 100 | 100 |
| 50 | 7 | 0 | 7 | 0 | 93 | 100 |
| 37,5 | 38 | 0 | 45 | 0 | 55 | 100 |
| 25 | 41 | 8 | 86 | 8 | 14 | 92 |
| 19 | 8 | 61 | 94 | 69 | 6 | 31 |
| 12,5 | 5 | 25 | 99 | 94 | 1 | 6 |
| 9,5 | 1 | 4 | 100 | 98 | 0 | 2 |
| 4,75 | 0 | 2 | 0 | 100 | 100 | 0 |
| 2,36 | 0 | 0 | 0 | 0 | 100 | 100 |
| 1,18 | 0 | 0 | 0 | 0 | 100 | 100 |
| 0,3 | 0 | 0 | 0 | 0 | 100 | 100 |

**b-)** Size number of Agg.X is determined as 3 and Aggregate Y's size number is determined as 5 according to Table 3 in ASTM C33-18.

**c-)**

Table 4 : The Percentage Passing of Aggregate Z

|  |  |  |  |
| --- | --- | --- | --- |
|  | Percent Passing (%) | | |
| Laboratory Sieve (mm) | Minimum limits for Size Number 4 | Aggregate Z | Maximum limits for Size Number 4 |
| 100 | … | 100 | … |
| 90 | … | 100 | … |
| 75 | … | 100 | … |
| 63 | … | 100 | … |
| 50 | … | 94,75 | 100 |
| 37,5 | 90 | 66,25 | 100 |
| 25 | 20 | 33,5 | 55 |
| 19 | 0 | 12,25 | 15 |
| 12,5 | … | 2,25 | … |
| 9,5 | 0 | 0,5 | 5 |
| 4,75 | … | - | … |
| 2,36 | … | - | … |
| 1,18 | … | - | … |
| 0,3 | … | - | … |

Aggregate Z can not satisfy the grading requirements for the aggregate with size number 4 according to ASTM C33-18 says that the percentage of passing mass of 37.5 mm should be in the between 90 and 100. On the other hand, aggregate Z couldn't satisfy this condition.In order to satisfy this requirement, grinding may be used, Yet it is not an economical choice. Besides, if sieve limits will be checked before, different and finer aggregate can be used.

**d-)**

**9. Conclusion**

Table 5 : The Comparison of Aggregate A and ASTM C33 Grading Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Aggregate A | | [Sieve (Specification E11)](https://compass.astm.org/EDIT/html_annot.cgi?E11) | Percent Passing |
| Sieve | Percent Passing (%) |  | 100 |
| #4 | 100,00 | 4.75-mm (No. 4) | 95 to 100 |
| #8 | 96,55 | 2.36-mm (No. 8) | 80 to 100 |
| #16 | 80,17 | 1.18-mm (No. 16) | 50 to 85 |
| #30 | 33,62 | 600-μm (No. 30) | 25 to 60 |
| #50 | 9,48 | 300-μm (No. 50) | 5 to 30 |
| #100 | 4,31 | 150-μm (No. 100) | 0 to 10 |
| #200 | 1,72 | 75-μm (No. 200) | 0 to 3.0A,B |

According to ASTM C33 Standard , Aggregate A satisfies all grading requirements.

**10. References**

CE344 Lecture Notes

ASTM. (n.d.). *Designation: C33/C33M-18*. Retrieved 04 22, 2019, from American Society for Testing and Materials: https://compass.astm.org/EDIT/html\_annot.cgi?C204+18#s00040

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