**MATERIALS OF CONSTRUCTION LABORATORY   
 DEPARTMENT OF CIVIL ENGINEERING, M.E.T.U.**



**CE344 MATERIALS OF Construction, GROUP 5**

**TESTS ON AGGREGATES**

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## Question 1:

Unit weigth is the amount of mass of a portion volume material. It can be calculated by deviding the whole aggregate weigth in to its volume. Two types of unit weights are compact and loose aggregate unit weigths.

1. Using the Tamping Rod

(G-T)/V = (7.654-2.8)/2.8 = 1.734kg/lt

1. Without using the Tamping Rod

(G-T)/V = (7.32-2.8)/2.8 = 1.614kg/lt

## Question 2:

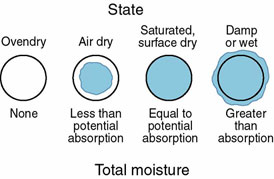
a)

Since the density of water can be taken as 1, the density of a substance is equal to its specific gravity. In concrete technology, specific gravity is used to refer to the density of the individual particles, which means the volume of a sample includes only the particles, not the spaces between them. This is the distinction in concrete technology between the two terms: specific gravity and bulk density.

Absorption capacity refers to the amount of water/moisture aggregate particles can hold. Knowing the absorption capacity, one can decide which state a sample is in. If the state of the sample is known, the amount of water to be used can be calculated more precisely. Therefore, water/cement ratio can be controlled.

Saturated-surface-dry condition is the condition when the all permeable pores of aggregate are full of water, however the surfaces of the aggregate is dry.

Damp condition is the condition when the all permeable pores of aggregate are full of water and there is a thin film of water on the surfaces.



1. For fine aggregate:

Dry weight of the sample: 496 g

Saturated surface dry weight of the test sample: 525g

Weight of the test sample: 1033g

Weight of flask filled with water: 710g

Apparent specific gravity : 496/ (496+710-1033)=2.86

Dry bulk specific gravity: 496/(525+710-1033)=2.46

SSD bulk density specific gravity: 525/(525+710-1033)=2.6

Absorption capacity: 100\*(525-496)/496= 5.85

For coarse aggregate:

Dry weight of the sample: 2253 g

Saturated surface dry weight of the test sample,in air: 2630g

Saturated surface dry weight of the test sample,in water: 1650g

Apparent specific gravity : 2253/ (2253+710-1650)=1.72

Dry bulk specific gravity: 2253/(2630+710-1650)= 1.33

SSD bulk density specific gravity: 2630/(2630+710-1650)= 1.56

Absorption capacity: 100\*(2630-2253)/2253= 16.73

## Question 3:

3 important properties of aggregates are shape, size gradiation and moisture content.

Shape effects fresh concrete more than hardened concrete. Concrete is more workable when smooth and rounded aggregate is used instead of rough angular or elongated aggregate. Crushed stone produces much more angular and elongated aggregates, which have a higher surface-to-volume ratio, better bond characteristics but require more cement paste to produce a workable mixture.

Size gradiation determines the paste required for workable concrete and thus effects the cost since cement is the most expensive component.

The moisture content of an aggregate is an important factor when developing the proper water/cementitious material ratio. All aggregates contain some water acording to their porosity level. Moisture content can differ from 1 percent to 40 percent so it is important to use the aggregates with the desired moisture content.

## Question 4:

Grading is the operation in which aggregates are divided into various groups according to their sizes.

Maximum aggregate size is the smallest size of the sieve which the whole particles of the aggregate sample can pass through. This value is determined by sieve analysis.

The choice of maximum aggregate size is directly related with where the concrete will be utilized. There are some limitations which are set to determine the maximum aggregate size:

It must be smaller than:

* 1/5 of the narrowest dimension of the form,
* ¾ of the minimum clear spacing between the reinforcement bars
* 1/3 of the thickness of the slab.

A good gradation is needed to obtain workable and uniform concrete. Therefore, there are some standards adjusting the grading limits. The reason for having limits instead of more specific numbers is there is not a single ideal gradation curve. A suitable gradation curve should be between the curves that are set as upper and lower bounds.

## Question 5:

The grading of aggregate is important when adjusting the desired amount of workability of the fresh concrete. To obtain concrete with the desired workability, the aggreagates must have good gradation. In a case of having concrete with undesired workability, if extra water is added to adjust workability of the concrete, it will lead to some problems in hardened concrete although desired workability is reached.

## Question 6:

Shape of aggregates can be relevant to the properties of hardened concrete because they improve physical characteristics of the concrete. It can affect the compressive and flexural strength as well as the abrasion resistance of the concrete.

## Question 7:

If the largest possible maximum sized aggregate is used in producing concrete, water requirement in a concrete mix will decrease, which will reduce the shrinkage of the concrete. The less the shrinkage is, the better workability gets.

## Question 8:

If the aggregates water state is oven dry, when added water it will absorb too much and this will decrease the workability of the concrete, but the w/c ratio will be low and it will increase the strength of the concrete, but since the hydration may not be completed properly it may cause the strength to drop instead of increase. If the aggregates water state is wet, then when the water is added to the concrete mix, it will cause an increase in the workability but decrease in the strength.

## Question 9:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sieve Size(mm)** | **Retained** | **% Retained On** | **Cum %Retained** | **Cum % Passing** |
| 9,5 | 0 | 0 | 0,222 | 99,778 |
| 4,75 | 68 | 7,789232532 | 7,789232532 | 92,21076747 |
| 2,38 | 153 | 17,5257732 | 25,31500573 | 74,68499427 |
| 1,19 | 264 | 30,24054983 | 55,55555556 | 44,44444444 |
| 0,595 | 185 | 21,19129439 | 76,74684994 | 23,25315006 |
| 0,297 | 203 | 23,25315006 | 100 | 0 |
| pan | 0 | 0 | 100 | 0 |

* The sample is suitable for ASTM Standard gradiation curves it can be said that it is fine aggregate.

Fineness Modulus = = 3.34  
 The fineness modulus for fine aggregate should be between 2.15 and 3.38. Since our FM is 3.34 we can consider our sample as fine.

* Fines modulus is used to understand how fine the aggregate is. Which helps the engineer understand how much paste etc. He will use with the aggregate he has.

## Question 10:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sieve Size(mm)** | **Retained** | **% Retained On** | **Cum %Retained** | **Cum % Passing** |
| 50 | 0 | 0 | 0 | 100 |
| 37,5 | 65 | 5,090054816 | 5,090054816 | 94,90994518 |
| 19 | 185 | 14,48707909 | 19,57713391 | 80,42286609 |
| 9,50 | 650 | 50,90054816 | 70,47768207 | 29,52231793 |
| 4,75 | 341 | 26,70321065 | 97,18089272 | 2,819107283 |
| 2,38 | 36 | 2,819107283 | 100 | 0 |
| pan | 0 | 0 | 100 | 0 |

= 50mm (smallest sieve size which all of the particles can pass)

## Question 11:

Original dry mass of sample (B = 294)

Dry mass of sample after washing (C =248)

The amount of material ( A ) finer than No.200 sieve shall then be calculated as :

%A= (B-C)/B\*100

%A=(294-248)/294\*100 = 15.64

According to ASTM C117 it is not suitable.

## Question 12:

Alkali–aggregate reaction is a term mainly referring to a reaction which occurs over time in [concrete](http://en.wikipedia.org/wiki/Concrete) between the highly alkaline [cement](http://en.wikipedia.org/wiki/Portland_cement) paste and non-crystalline [silicon dioxide](http://en.wikipedia.org/wiki/Silicon_dioxide), which is found in many common [aggregates](http://en.wikipedia.org/wiki/Construction_aggregate). This reaction can cause expansion of the altered aggregate, leading to [spalling](http://en.wikipedia.org/wiki/Spalling) and loss of strength of the concrete and crack occuring.

|  |  |  |  |
| --- | --- | --- | --- |
| **time (days)** | **Length(mm)** | **Elongation(mm)** | **%elongation** |
| 0 | 285 | 0 | 0 |
| 5 | 285,65 | 0,65 | 0,227551199 |
| 9 | 285,789 | 0,789 | 0,276077806 |
| 11 | 286,23 | 1,23 | 0,429724348 |
| 14 | 286,34 | 1,34 | 0,467975134 |

According to ASTM C227 the first 6 months linear expansion should not exceed 0.5%, and our data shows that it is 0.0468 so the specimen can be used.

## Question 13:

Soundness is the abilitiy of the aggregate to resist large changes in the volume when it is subjected to destructive physical actions.

The sieve size through which the aggregate passes = 4 32 16 2” 30 3/8” 8 50

After 5 repetitions of the test, loss in weight;

Treated with magnesium sulfate solution, % = 10

Treated with sodium sulfate solution, % = 14

After 5 repetitions of the test, lost in weight should not exceed these values;

|  |  |  |
| --- | --- | --- |
| Type of aggregate | Treated with magnesium sulfate solution | Treated with sodium sulfate solution |
| Fine Aggregate | 10% | 15% |
| Coarse Aggregate | 12% | 18% |

According to the sieve sizes, it can be seen that the sample type is fine aggregate. Since it does not exceed the values given in the table (i.e standards) it is suitable.

## Question 14:

The weight of the test sample before the test 5000

The weight of the test sample after 100 revolutions = 4650

The weight of the test sample after 500 revolutions = 3988

% of wear = (B-A)/B\*100 = 7% (100 revolutions)

% of wear = (B-A)/B\*100 = 20.24% (500 revolutions)

According to the standards the % wear should not exceed

- 10 % at the end of 100 revolutions  and

- 50 % at the end of 500 revolutions.

Since both of these conditions are satisfied the sample is resistant to abrasive forces.

## References:

* ASTM standards.
* Erdoğan, T. Y. (2009). *Materials of construction*. Ankara: METU PRESS.