CEEN 3320 - Behavior & Properties of Engineering Materials
Laboratory Experiment No. 6 - Sieve Analysis & Aggregate Blending, Uncompacted Voids of Fine Aggregates, Sand Equivalent Test, Binder Viscosity

OBJECTIVE: To determine relevant properties and specification compliance of aggregates and binders used in the making of hot mix asphalt (HMA).

EQUIPMENT: A set of sieves (1", 3/4", ½", 3/8", Nos. 4, 8, 16, 30 50, 100 & 200, and pan), brushes for cleaning sieves, balance, sieve shaker, uncompacted voids apparatus, sand equivalent apparatus, Brookfield rotational viscometer.

ASTM REF: C 29, C 127, C 128, C 136, C 1252, D 2419

PROCEDURES:

Part A - Sieve Analysis & Aggregate Blending

1. Weigh to the nearest 0.1 g each sieve to be used and record on data sheet. Make sure each sieve is cleaned of loose particles prior to weighing. Weigh to the nearest 0.1 g a representative 500 g specimen of selected aggregate.

2. Separate the aggregate through a nest of sieves using the mechanical shaker. At least 5 minutes of mechanical shaking is desirable. Determine the mass of each sieve plus accumulated aggregate to the nearest 0.1 g.

3. Repeat steps 1 - 4 for each remaining aggregate.

Part B - Uncompacted Void Content

1. Thoroughly clean and dry the cylindrical measure and obtain the mass to the nearest 0.1g. Prepare a 190 g standard graded sample of the natural sand based on the following size fractions: P_8 - R_{16}: 44g; P_{16} - R_{30}: 57g; P_{30} - R_{50}: 72 g; P_{50} - R_{100}: 17g

2. Thoroughly mix the sample and place in the sample jar positioned above the cylindrical measure, using your finger to block the opening of the funnel. Level the material in the funnel and remove your finger to allow the sample to fall freely into the cylindrical measure. Strike off the excess heaped sand, taking care to avoid vibrations or any disturbance that could cause compaction of the aggregate. After strike-off, the cylinder may be tapped lightly to compact the sample, making it easier to transfer the measure to the balance.

3. Brush adhering grains from the outside of the measure and determine the mass of the cylinder and contents to the nearest 0.1g.

4. Recombine the sample and repeat steps 2 - 3 two additional times to obtain three separate filled masses. Average the results of these three tests.

5. Repeat steps 1 - 4 for the manufactured sand.

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Part C - Sand Equivalent Test

1. Prepare a 1500 g sample of material passing the No. 4 sieve and thoroughly mix. Form the material into a cone with a trowel. Take a tin measure a push it through the base of the pile. Press firmly with the palm of the hand to compact the material in the tin. Strike off excess material flush with the top of the tin.

2. Siphon 4 inches of working calcium chloride solution into the plastic cylinder. Pour the sample into the cylinder and tap several times to release entrapped air. Allow to soak for 10 minutes. After soaking, stopper the cylinder and then loosen the material from the bottom. Hold the cylinder in a horizontal position and shake vigorously 90 cycles (back and forth) in approximately 30 sec, using a throw of 9 inches.

3. Irrigate the specimen until the liquid level is at the 15 inch mark. Allow the cylinder to stand undisturbed for 20 minutes. Read and record the level of the top of the clay suspension (clay reading). Gently lower the weighted foot assembly until it touches the top of the sand. Tip the assembly forward until it touches the side of the cylinder. Subtract 10 inches for the indicated reading and record this value as the sand reading.

Part D - Viscosity Measurements

1. Prepare a vial of binder and place in thermocell chamber and bring the temperature up to to 135 ^{o}C.

2. Collect viscosity readings in Pa-s at two or more rotational speeds.

3. Elevate the binder temperature to approximately 160 ^{o}C.

4. Collect viscosity readings in Pa-s at two or more rotational speeds.

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Calcuations

Part A - Sieve Analysis & Aggregate Blending

1. Determine the percent passing each sieve for all aggregates tested and prepare a plot of the grain size distributions using a semi-log plot of percent passing versus the log of grain size, in mm.

2. Develop an aggregate blend that meets all WisDOT requirements for an E-3 upper pavement layer gradation.

Part B - Uncompacted Void Content

1. Determine the fine aggregate angularity (FAA) for each aggregate sample tested.

2. Using the blend proportions determined in Part A, check to ensure WisDOT requirements for an E-3 upper pavement layer are satisfied.

Part C - Sand Equivalent Test

1. Calculate the sand equivalent (SE) to the nearest 0.1% as follows:

   SE = (sand reading / clay reading) x 100%

   If the calculated SE is not a whole number, report it as the next highest whole number, i.e., 41.2 = 42.

2. Using the blend proportions determined in Part A, check to ensure WisDOT requirements for an E-3 upper pavement layer are satisfied.

Part D – Binder Viscosity Test

1. Using the viscosity data from Part D, prepare a plot of viscosity versus temperature and provide recommendations for HMA mixing and compacting temperatures.

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Part A – Sieve Analysis

Sieve Size	Sieve Wt, g	Natural Sand	Manufactured Sand	Large Coarse Agg	Small Coarse Agg
		Agg + Sieve Wt, g	Agg + Sieve Wt, g	Agg + Sieve Wt, g	Agg + Sieve Wt, g
1"					
3/4"					
1/2"					
3/8"					
No. 4					
No. 8					
No. 16					
No. 40					
No. 100					
No. 200					
Pan					

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Part B – Uncompacted Void Content

Aggregate Type	Trial No.	Volume of Measure, cc	Mass of Measure, g	Mass of Measure + Sand, g
Natural Sand	1	100		
	2			
	3			
Manufactured Sand	1	100		
	2			
	3			

Part C – Sand Equivalent Test

Specimen	Clay Reading	Sand Reading

Part D - Viscosity Readings

Test Temperature, ^{o}C	Rotational Speed, RPM	Viscosity, Pa-s