WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

TRIAXIAL COMPRESSIVE STRENGTH OF COMPACTED AGGREGATE SPECIMENS

1.0 INTRODUCTION

1.1 This test is designed for determining the friction angle of compacted aggregate specimens where large specimen size is desired due to large top size of material (to 63.5 mm) or for other reasons.

1.2 To establish a friction angle of a material it is required that this test be performed on three specimens split from the same sample. Due to time involved with each specimen (3 days) a technique must be developed to overlap. One of which is after a specimen is removed from the compaction mold (2nd day) another specimen may be constructed in it and so on for other parts of the operation until completion.

2.0 EQUIPMENT

2.1 Compaction Mold - 152 mm diameter 305 mm height, split lengthwise in half with flanges affixed so that it can be firmly bolted back together and attached to a base plate.

2.2 Electric Hammer - fitted with tamping device consisting of 149 mm diameter steel plate 19 mm thick welded on end of an 457 mm steel rod that will fit the hammer.

2.3 Triaxial Cell - sufficient size for specimen, fitted with pressure gauge accurately readable in the 0 through 344 Kpa range, and shut off valves in lid and base.

2.4 Triaxial Membranes - 152 mm diameter 38/mm length.

2.5 Membrane Stretcher - consists of 159 mm pipe 305 mm long fitted with shut off valve about midway its length.

2.6 Porous Stones - carborundum stones 152 mm diameter 9.5 mm and 12.7 mm thick.

2.7 Compressive Strength Machine - capable of supplying load at rate of 226.8 kg per minute or slower until failure occurs.

2.8 Freezer - capable of holding specimen in compaction mold at -17? C.

2.9 Vacuum pump with trap

2.10 Drying oven - 110 ± 5° C.

2.11 Heat gun - hand held electric heater - blower

2.12 Glycerin - 7.57 liters

2.13 Miscellaneous implements: scoop, spatula, mixing pans, scales, stop watch, wastebasket, or pail.

3.0 SPECIMEN PREPARATION

3.1 Acquire sufficient material to split out three test samples each weighing 15 kg ± .5 kg when oven dry.

3.2 Place one sample in pan of sufficient size for mixing sample with water.

3.3 Add 500 ml of water to sample and mix thoroughly; if all water is taken up, add more water in 100 ml increments mixing thoroughly until a small amount of free water occurs in pan. Record the total amount added, which will be used in saturating the remaining samples.

3.4 Pile material in center of pan making an effort to avoid segregation of material sizes.

3.5 Fill mold in three 127 mm lifts, the last will have to be rounded up above top edge of mold to get the 127 mm depth.

3.6 Compact each lift for 15 seconds using electric hammer, holding hammer with just enough force to prevent it from rebounding off the material causing eratic vibration. After compaction is completed, material should fill mold to top edge or slightly above, if not, heap more material and compact another 5 seconds.

3.7 Cover top of specimen to prevent moisture loss and freeze at -17 °C, 10-20 hours.

4.0 TRIAXIAL CELL PREPARATION

4.1 Clean and set out all triaxial chamber components so that a rapid assembly can be made.

4.2 Set chamber base on edge of work surface and support, so that, one chamber hold down bolt can be removed and replaced without having to raise or tilt the base.

4.3 Connect drain lines for upper and lower platens to base and secure out of way.

4.4 Work clean O-rings into lid and base plates, this may require heat gun to warm rings and surface to get rings to fit.

5.0 ASSEMBLING SPECIMEN INTO CHAMBER

5.1 Remove specimen from freezer.

5.2 Use heat gun to thaw top surface and level it off flush with top edge of mold. Any holes caused by plucking of aggregate should be filled with fine material removed during leveling. Entire top surface must be flat. Weigh specimen in mold and record.

5.3 Place a thick porous stone (2 thicknesses) and the lower platen on top of the specimen and carefully invert specimen setting it very near edge of working surface (platen on bottom, porous stone, then specimen).

5.4 Use heat gun to thaw mold base plate and remove.

5.5 Remove holding bolts from split mold and use heat gun to thaw sides until halves of mold drop away under own weight or with a slight downward push.

5.6 Place membrane inside stretcher pulling ends out and over edges of the device, thus holding the membrane in place.

5.7 Connect vacuum to stretcher, open valve, and work wrinkles out of membrane as it is pulled against sides of stretcher.

5.8 Once membrane is stretched against sides, close valve on stretcher and remove vacuum line.

5.9 Carefully lower stretcher over specimen until top is even with top of specimen.

5.10 Slip membrane off lower end and fold down around sides of platen.

5.11 Set thin porous stone on top of specimen and slip membrane off upper end of stretcher.

5.12 Very carefully lift stretcher off specimen now enveloped by membrane.

5.13 Carefully fold membrane down around top end of specimen, place upper platen on specimen and wrap membrane back up around platen. Secure two rubber bands on each platen to hold the membrane in place.

5.14 Carefully lift specimen onto base plate (noting drain hose connection on lower platen should be at 180? from its connection on base plate) and locate on base plate by fitting nub on base plate into indention on platen.

5.15 Connect drain lines to platens.

5.16 Check that O-ring surfaces are clean (lid and base).

5.17 Place triaxial chamber over specimen carefully and turn chamber in back and forth motion on base to seat it against O-ring.

5.18 Make sure drain valve on base is closed and viewing ports snug against O-rings.

5.19 Pour glycerin into chamber quickly (if it begins leaking around base, work faster) until top platen is covered by a thin film.

5.20 Quickly position chamber lid in place and begin tightening into place, after finger tight alternate nuts giving each a quarter turn until all are tight.

5.21 Attach pressure gauge to chamber at lid using a rubber hose from the gauge to the T-fitting at the inlet valve securing hose with hose clamp.

5.22 Charge chamber with 69 Kpa using air and close inlet valve to hold pressure.

5.23 Place chamber where it will not be disturbed and check occasionally to make sure pressure is holding.

5.24 Allow chamber to set 18 to 24 hours in order for specimen to thaw.

6.0 TESTING - BALDWIN COMPRESSIVE STRENGTH MACHINE

6.1 Position chamber on machine.

6.2 Check that pressure has held and adjust to proper level to test (34, 69, or 138 Kpa).

6.3 Set Baldwin machine rate at 3.8 Kg/sec (slower if possible).

6.4 Bring Baldwin head into contact with chamber loading piston.

6.5 Using wax pencil or crayon make a mark on loading piston at top of sleeve (this is a measure amount of compression).

6.6 Commence loading specimen until failure, again mark position of loading piston in sleeve and record load at failure.

6.7 Remove load.

6.8 Return cell to suitable area for clean-up and disassembly.

7.0 CLEAN-UP AND DISASSEMBLY

7.1 Glycerin can be drained from cell by bleeding off pressure then removing a lower viewing port allowing the glycerin to drain into a suitable container, the remainder can be drained by replacing the viewing port, pressurizing the cell and opening the drain on the base plate again catching the glycerin for reuse.

7.2 Remove lid and cell, rinse down specimen and base with water.

7.3 Place majority of specimen in weighed suitable drying pan, weigh and place in oven until dry and weigh.

7.4 Glycerin can be washed off all equipment with water, equipment dried and stored.

7.5 Used glycerin can be stored in closed containers and reused.

8.0 CALCULATIONS

8.1 See attached sheet for necessary calculations.

8.2 Mohr's circles can be constructed from the results of three tests run on the same sample at different confining pressures, as follows:

8.2.1 Construct an x-y axis and number to the highest axial stress recorded (from work sheet) beginning at the intersection and numbering to the right.

8.2.2 Construct a half circle on this by locating the circle's center at $\frac{(s1-s3)}{2}+s3$ with a radius $\frac{(s1-s3)}{2}$.

Construct a circle for each test run on the same axis diagram.

8.2.3 Locate a best fit line intersecting all three circles and passing through or nearly through the origin of the graph.

8.2.4 The angle this line makes with the x-axis is the friction angle for the material tested. This graph should accompany the work sheet.

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GLR:c

Attachment

Test No.	d	A?	L?	? L	∈	A	P	p	$\bar{s}_3$	$\bar{s}_1$	s_1 / s_3	f

d - Specimen diameter -

A? - Crossectional area - Πr^2

L? - Original length - __

? L - Final length - __

∈ - Strain - ? L/L? __ __

A - Average Crossectional area- A? / 1-∈

f - Friction angle- $\frac{s_1/s_{3-1}}{s_1/s_{3+1}}$

P - Applied force - at failure

p - Applied stress - P/A

s_3 - Confining pressure -

s_1 - Axial stress - p + s_3

s_1/s_3 - Intergranular stress $\frac{p \pm s_1}{s_3}$

1) Wt. material wet ________Kg ________Kg ________Kg
2) Wt. material dry ________Kg ________Kg ________Kg
3) Moisture Content ________% ________% ________%
4) Max. Density (dry) ________Kg/m^3 ________Kg/m^3 ________Kg/m^3
5) Actual Density (dry) ________Kg/m^3 ________Kg/m^3 ________Kg/m^3
6) % Compaction ________ ________ ________

1) Weight after test
2) Oven dried after test
3) $\frac{(1)}{(1)-(2)}$ x 100 = %

4) From Humphries or FHWA-RD-72-43 Vibratory Compaction...for Granular Materials
5) (2)X volume of mold
6) (4)/(3) X 100 = %