

**KTMR-05 PERMEABILITY FOR BASE COURSE MATERIAL (Kansas Central Lab Test KT-MR-05)**

**a. SCOPE.**

This test method is used to determine the permeability of unbound and bound aggregate base material. Bound base material will use Portland Cement, Fly Ash or Asphalt as a cementing agent.

**b. UNBOUND BASE AND BASE BOUND WITH FLY ASH OR PORTLAND CEMENT.**

**b.1. Apparatus**

**b.1.a. Mold:** A cylindrical metal mold with an approximate inside diameter of 6" (152 mm) and a minimum height of 6" (152 mm). The mold shall be equipped with a removable collar at least 2" (51 mm) in height and a removable base plate. The base plate may be used as part of the permeability test equipment. If so, the base plate must exceed the permeability of the material being tested. Place a No. 40 (425 µm) screen on top of the base plate to prevent test material from being lost thru the base plate during compaction and permeability testing.

**b.1.b. Standpipe:** A standpipe with the same diameter as the removable collar for the mold with a minimum height of 8.5" (216 mm). The standpipe shall be equipped with an overflow outlet.

**b.1.c. Rammer:** A mechanically operated metal rammer equipped to control the height of drop to 12" (305 mm) plus or minus 1/16" (2 mm) above the elevation of the sample. The rammer shall be equipped to distribute the blow uniformly over the sample surface. The rammer shall have a rigid flat faced "pie shaped" foot and a nominal weight of 5.50 lbs. (25 kg). The "pie shaped" foot shall be a sector of a 6" (152 mm) diameter circle and shall have an area equal to that of a 2" (51 mm) circular foot.

**b.1.d. Rigid steel straight edge** with one edge beveled, at least 8" (203 mm) in length.

**b.2. Sample Preparation.**

**b.2.a.** Obtain a 50 lb. (22.7 kg) to 60 lb. (27.2 kg) sample, dry if necessary

**b.2.b.** Mix a sufficient amount of aggregate and cementing agent, if required, to fill the mold 1 and 1/2 times.

**b.2.c.** Add the appropriate amount of water and thoroughly mix.

**b.2.d.** Place the assembled mold on the rigid base and fill approximately 1/2 full of the loose moist material. Compact the layer with 25 blows of the rammer with the blows being distributed uniformly over the surface of the layer. Place three additional approximately equal layers of material in the mold and compact each layer in a similar manner (four layers total).

**b.2.e.** After the fourth layer has been compacted, remove the collar and trim excess material level with top of the mold.

**b.2.f.** Cure Portland Cement and Fly Ash treated specimens by covering with plastic, to prevent drying for 3 days at room temperature.

**b.2.g.** Unbound specimens do not need to be cured before testing.

### **c. ASPHALT BOUND AGGREGATES.**

#### **c.1. Apparatus:**

**c.1.a.** Mold: A cylindrical mold with an inside diameter of approximately 6" (152 mm) and a minimum length of 4.5" (114 mm). The mold is open at each end and is equipped with a removable collar and a base plate about 0.5" (13 mm) thick.

**c.1.b.** Specimen Mold Holder: The specimen mold holder has a semi circular base and a flanged top to hold the specimen mold in place during the compaction process. Any equivalent hold down device, which performs the same function, is satisfactory.

**c.1.c.** Compaction Hammer: The compaction hammer consists of a hammer having a flat circular tamping face 5.88" (149 mm) in diameter and appropriate extension rod with handle which acts as guide for a free falling weight. The weight shall weigh 22.5 lb. (10 kg) and have a free fall of 18" (547 mm) plus or minus 0.1" (2 mm). The hammer may be operated manually or be driven with a motor.

**c.1.d.** Compaction Pedestal: The compaction pedestal is a wood block approximately 12"x12"x18" (305 mm x 305 mm x 457 mm). A 12"x12"x1" (305 mm x 305 mm x 25 mm) steel plate is securely fastened to the top of the block. The pedestal is set on and securely fastened to a solid concrete slab with the vertical axis plumb and the top level.

**c.1.e.** Heating Equipment: Ovens or hot plates for heating aggregates, bituminous material, specimen molds, compactions hammers and other associated items required for mixing and molding. It is recommended that, when possible all heating units be thermostatically controlled to maintain the required temperature within  $\pm 5^{\circ}\text{F}$  ( $2.8^{\circ}\text{C}$ ). Suitable shields, thick steel plates or pans of sand shall be used on the surfaces of hot plates to minimize localized overheating.

**c.1.f.** Mixing Apparatus: Mechanical mixing is recommended. Any type of mechanical mixer may be used provided it will produce a well coated, homogeneous mixture of the required amount in the allowable time and further that the mixing paddle or whip does not fracture or pulverize aggregate fractions during the mixing process. The bowl employed with the mixer shall be of such a nature that essentially all of the batch can be removed. More than one mixing bowl is recommended unless the mixer is equipped with a heating jacket to keep the bowl heated during the mixing process.

#### **c.2. Determination of Mixing and Compacting Temperature:**

**c.2.a.** The temperature to which the asphalt cement must be heated to produce a viscosity of 85 plus or minus 10 SFS shall be the mixing temperature.

**c.2.b.** The temperature to which the asphalt cement must be heated to produce a viscosity of 130 plus or minus 15 SFS shall be the compacting temperature.

**c.3. Sample Preparation for Laboratory Prepared Mix:** Combine the dry individual aggregates to produce the desired-combined aggregate with a batch weight of approximately 8.9 lb. (4050 grams). This should be sufficient to produce a compacted specimen  $3.75 \pm 0.125$  inches ( $95 \pm 3$  mm) thick. Adjust the weight of the batch as needed to produce a compacted specimen of  $3.75 \pm 0.125$  inches ( $95 \pm 3$  mm) thick.

Prepare a minimum of two aggregate and asphalt specimens. The first specimen shall be mixed and thrown away. This sample is to "butter" the mixing bowl and paddle and thus reduce material loss when mixing the test specimen.

Heat the aggregate and asphalt within the limits of mixing temperature determined in b.1. Charge the mixing bowl with the heated aggregate and form a crater in the top. Add the required amount asphalt and mix the aggregate and asphalt until coated at least 2 minutes. Care should be taken to keep the entire sample in the mixing bowl during this process.

#### **c.4. Compaction of Specimen:**

Prior to the addition of the asphalt to the batches, thoroughly clean the specimen mold assembly and the face of the compaction hammer and heat the mold assembly and hammer to a temperature between 200°F (93.3°C) and 350°F (176.7°C). Assemble the mold, base plate and collar and place a paper disc cut to size in the bottom of the mold.

Place the hot batch of aggregate-asphalt mixture in the mold, spade vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior of the mold. Smooth the surface of the mix to a slightly rounded shape. The temperature of the mix prior to compaction shall be within the limits in b.2. Place a paper disc on top of the mix.

Place the mold assembly, including the collar, on the pedestal, fasten securely with the mold holder and apply 20 blows with the compaction hammer. Each blow must have the prescribed free fall of 18" (457-mm) with the axis of the compaction hammer held perpendicular to the base of the mold assembly during the compaction process. Remove the base plate and collar, and reverse and reassemble the mold. Apply the specified number of blows to the reversed specimen. After compaction remove the mold assembly from the pedestal, remove the collar and base plate and cool the specimen in the mold until the mold can be handled comfortably with bare hands. Asphalt treated samples do not need to be cured before testing, only cool to the touch.

#### **d. TEST PROCEDURE.**

**d.1.** Assemble test equipment, base plate, mold with specimen, and standpipe. See figure 1 for example of typical setup.

**d.2.** Prior to conducting the test allow a sufficient amount of water to pass thru the specimen to cause all air to be expelled from the specimen. (Establish reservoir around the base with water open to atmospheric pressure.)

**d.3.** Conduct Falling-Head or Constant-Head Permeability test and report coefficient of permeability "k" in meters (feet) per day. Repeat a minimum of two additional times until two runs agree reasonably well.

**d.4. Constant-Head Permeability:**

$$k = \frac{QL}{Aht}$$

- Q = quantity of water discharged (volume)
- L = length of specimen
- A = cross-sectional area of specimen
- h = hydraulic head (height column of water above discharge)
- t = elapsed time of test
- k = coefficient of permeability (length/time)

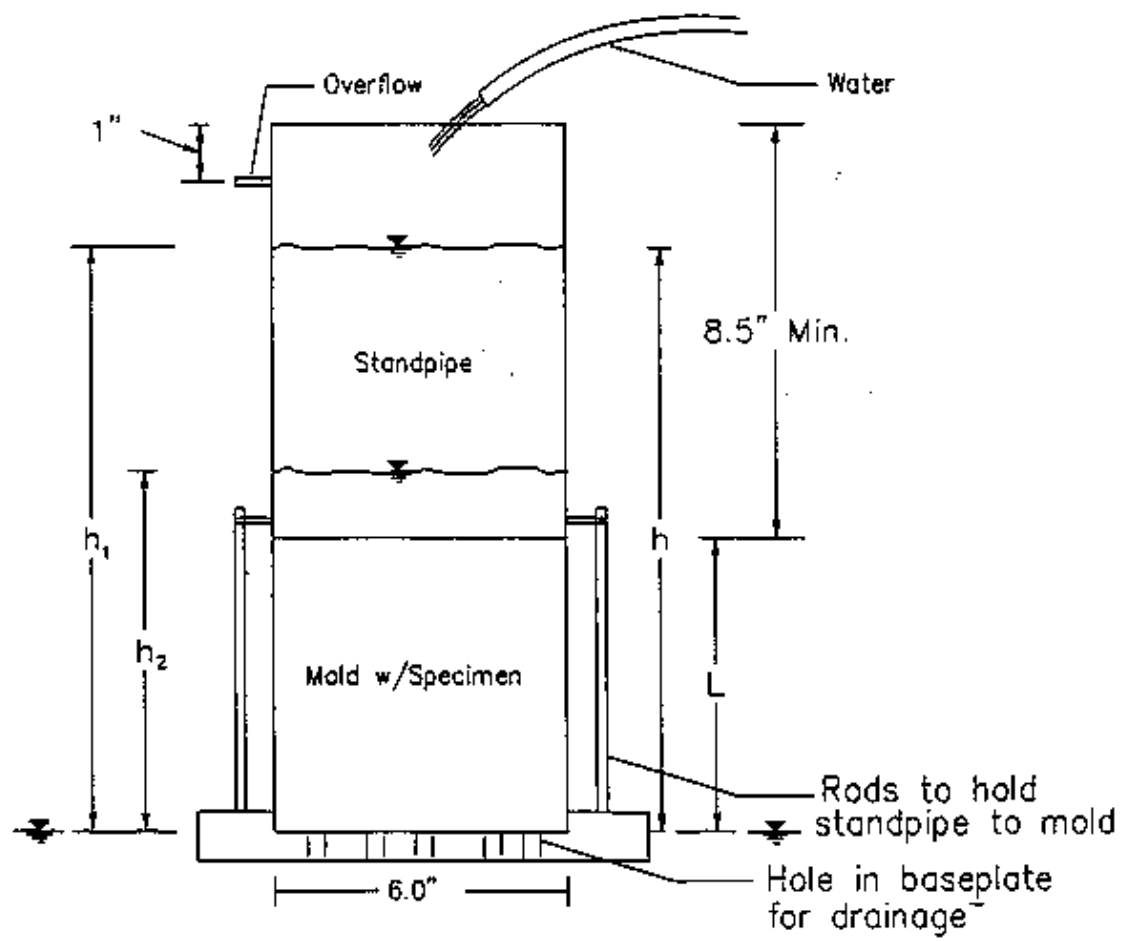
NOTE: For very permeable materials maintain elevation of water above the sample for 3 minutes then measure Q (flow).

**d.5. Falling-Head Permeability:**

$$k = \frac{2.3aL}{At} \log \frac{h_1}{h_2}$$

- a = cross-sectional area of standpipe
- L = length of specimen
- A = cross-sectional area of specimen
- t = elapsed time of test
- h<sub>1</sub> = hydraulic head across specimen at the beginning of the test (t=0)
- h<sub>2</sub> = hydraulic head across specimen at the end of the test
- k = coefficient of permeability (length/time)

FIGURE 1  
PERMEABILITY TEST SETUP



Note: Seal joints with silicone or any other similar material to prevent leakage.