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GUIDANCE FOR COURSE EVALUATION FORM

The Course Evaluation Form on the following page is very important to the continuing improvement and success of this course. The form is included in each Participant Workbook. During the course introduction, the Instructor will call the participants' attention to the form, its content, and the importance of its thoughtful completion at the end of the course. Participants will be encouraged to keep notes, or write down comments as the class progresses, in order to provide the best possible evaluation. The Instructor will direct participants to write down comments at the end of each day and to make use of the back of the form if more room is needed for comments.

On the last day of the course, just prior to the written examination, the Instructor will again refer to the form and instruct participants that completion of the form after their last examination is a requirement prior to leaving. Should the course have more that one Instructor, participants should be directed to list them as A, B, etc., with the Instructor's name beside the letter, and direct their answers in the Instructor Evaluation portion of the form accordingly.

COURSE EVALUATION FORM

The UDOT Transportation Technician Qualification Program would appreciate your thoughtful completion of all items on this evaluation form. Your comments and constructive suggestions will be an asset in our continuing efforts to improve our course content and presentations.

Course Title: _____
Location: _____
Dates: _____
Your Name (Optional): _____
Employer: _____
Instructor(s): _____

COURSE CONTENT

Will the course help you perform your job better and with more understanding?

Yes Maybe No

Explain: _____

Was there an adequate balance between theory and instruction?

Yes Maybe No

Explain: _____

Did the course prepare you to confidently complete both examinations?

Yes Maybe No

Explain: _____

What was the most beneficial aspect of the course? _____

What was the least beneficial aspect of the course? _____

GENERAL COMMENTS

General comments on the course, content, material, presentation method, facility, registration process, etc. Include suggestions for additional Tips!

_____

_____

_____

_____

_____

_____

INSTRUCTOR EVALUATION

Where the objectives of the course, and the instructional and exam approach, clearly explained?

Yes Maybe No

Explain: _____

_____

Was the information presented in a clear, understandable manner?

Yes Maybe No

Explain: _____

_____

Did the instructors demonstrate a good knowledge of the subject?

Yes Maybe No

Explain: _____

_____

Did the instructors create an atmosphere in which to ask questions and hold open discussion?

Yes Maybe No

Explain: _____

_____

COURSE OBJECTIVES AND SCHEDULE

Learning Objectives

Instructional objectives for this course include:

- Becoming proficient in the following test procedures:

  MANDATORY BACKGROUND INFORMATION

  AASHTO T 23
  Making and Curing Concrete Test Specimens in the Field

  AASHTO T 22
  Compressive Strength of Cylindrical Concrete Specimens

  AASHTO T 97
  Flexural Strength of Concrete

  AASHTO T 231
  Capping Concrete Test Specimens

  ASTM C 1231
  Use of Unbonded Caps in Compressive Strength

The overall goals of this course are to understand the basics of concrete strength testing and to be competent with specific quality control test procedures identified for the Utah Department of Transportation (UDOT) Transportation Technician Qualification Program (TTQP).

It is assumed that the student has previously obtained a copy of the manual, and has adequately prepared for the qualification by studying and receiving training from a senior trainer.

Course Outline and Suggested Schedule

Day One

0900	Welcome Introduction of Instructors
0915	Presentations
1200	Lunch
1300	Presentations. Distribute copies of Sample Exams

Day Two

0800	Review Sample Exam and answer questions from the Previous Day
0900	Start of Written Exams
Varies	Practical Exams (After successful completion of written exam)

MANDATORY BACKGROUND INFORMATION

02

Scope

This section of the manual provides mandatory background information that supplements the Field Operating Procedures (FOP's) that follow.

The following AASHTO standard test procedures, practices, and specifications are covered:

03

AASHTO T 24 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

AASHTO R 39 - Making and Curing Test Specimens in the Laboratory

AASHTO M 201 - Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

AASHTO M 205 - Molds for Forming Concrete Test Cylinders Vertically

Each of these will be treated in summary form. Reference to the source documents is recommended when a more complete understanding of the information is required for conducting testing required by the governing agency.

04

Significance

A working knowledge of the critical elements of each of the previously mentioned procedures, practices, and specifications is required for persons conducting strength testing of concrete specimens.

In several cases, information not otherwise provided by strength-testing procedures is included that is required for properly preparing specimens for testing.

05 ## AASHTO T 24 – Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

06 ### Introduction

AASHTO T 24 includes procedures for obtaining cores for the purpose of thickness measurements and splitting tensile strength as well as for compressive strength. It also describes procedures for obtaining and preparing sawed beams for flexural strength testing.

A description of cores for measurement of thickness or determination of splitting tensile strength **is** **not** included in this manual. Refer to the source documents in the current AASHTO publications for these procedures.

07 ### Apparatus

- Cutting edges must prevent overheating or shock to the specimens. Core drills with a diamond cutting edge for cylindrical specimens are required. Saw blades having either a diamond or silicon carbide cutting edge are permitted.

08 ### Sampling

General: Concrete must be sufficiently hardened to avoid damage during cutting and handling. Concrete must generally be at least 14 days old.

Specimens that contain obvious defects or that have been damaged shall not be used.

Specimens used for determining compressive or flexural strength may not contain embedded reinforcement.

09 **Core Drilling:** Locations for obtaining cores should avoid formed joints and obvious edges of a unit of deposit. Ideally, cores should be drilled such that the axis is perpendicular to the bed of the concrete as placed.

Where cores must be drilled perpendicular to a vertical surface or from a surface with a batter, locations should be selected near the middle of a unit of deposit.

10 **Slab Removal:** Slabs must be large enough to yield the required number and sizes of specimens while avoiding cracked, spalled, undercut, or otherwise damaged areas.

11 ## Cores for Compressive Strength

- **Test Specimens**: Minimum nominal diameter shall be 3.75 inches unless it is not possible to maintain a length to diameter ratio (L/D) ≥ 1.0 for compressive strength determinations. When the concrete contains aggregate larger than 1½" the core diameter should preferably be three times, but in no case less than two times the nominal maximum aggregate size.

  The preferred ratio of L/D after capping should be 1.90 to 2.10. Trim longer cores to achieve that ratio. Cores with L/D equal to or less than 1.75 require correction to the measured strength. In no case shall a specimen be tested when L/D is less than 0.95 prior to capping or less than 1.00 after capping.

12 - **End Preparation:** Ends of cores should be smooth, perpendicular to the axis, and of the same diameter as the remainder of the core. Projections may not exceed 0.2 inches beyond the end.

- **Dimensional Tolerance:** Ends shall not depart from perpendicularity to the axis by a slope greater than 1:8*d*, where *d* equals the average core diameter (inches). End diameter shall not depart by more than 0.1 inch from the mean core diameter.

13 - **Moisture Conditioning:** To increase reproducibility and minimize the effects of moisture gradients, cores are to be moisture conditioned.

  After cores have been drilled, surface-dry the specimen by wiping with a cloth and allow surface moisture to evaporate. Within 1 hr of drilling, when surfaces appear dry, seal in separate plastic bags or other non-absorbent containers. Maintain at ambient temperature and protect from direct sunlight.

14 Keep cores in sealed containers at all times except during end preparation. A maximum of 2 hours is allowed to permit capping before testing. If water is used during sawing or grinding, complete this as soon as practicable, but no later than two days after drilling. Wipe off surface moisture from sawing or grinding, allow to air dry, and reseal in plastic bags or non-absorbent containers. Minimize exposure to water during end preparation.

Cores should remain in sealed containers a minimum of five days after last being wetted before testing to reduce moisture gradients caused during drilling, sawing, or grinding.

At the discretion of the specifying agency, other moisture conditions may be required. Consult agency guidelines. Report alternate moisture conditioning when necessary.

15
- **Capping:** Cap according to the applicable provisions of the FOP for AASHTO T 231 (presented later).
- **Measurement:** Measure diameter to the nearest 0.01 inch, and length after capping to the nearest 0.1 inch. Diameter measurements shall be taken at mid-height of the specimen and shall be the average of two measurements at right angles to each other. Do not test cores when the difference between the largest and smallest diameters exceeds 5 percent of their average. Determine cross-sectional area.

16
- **Testing:** Test according to the FOP for AASHTO T 22. Test within 7 days of obtaining the core unless otherwise specified.

17
- **Calculations:** Calculate compressive strength of each specimen, dividing the maximum load by the cross-sectional area. If the ratio of length to diameter (L/D) is 1.75 or less, correct the result by applying the appropriate correction factor from Table 1.

Table – 1 Strength Correction Factors Based on L/D 18

Ratio of Length to Diameter (L/D)	Strength Correction Factor
1.75	0.98
1.50	0.96
1.25	0.93
1.00	0.87

19 The correction factors are applicable for lightweight concrete with density of 100 to 120 lb/ft^3 and normal weight concrete. They apply to both dry and wet specimens for strengths of 2000 to 6000 psi. For high-strength concrete (above 10000 psi) correction factors may be higher than those shown and caution should be exercised in their application.

20 **Report**

- Report as for the FOP for AASHTO T 22 but including the following additional items:
- Specimen length as drilled.
- Specimen length before and after capping.
- Direction of load application in relation to the horizontal plane of the concrete as placed.
- Moisture conditioning history.
- Any deviations from this test method.
- Nominal maximum aggregate size.

Sawed Beams

21 - **Test Specimens**: Beam specimens should normally have nominal width and depth of 6 x 6 inches. Length shall be at least 21 inches. In some cases, other dimensions of width and depth may be dictated by aggregate size and slab thickness from which the specimens were obtained. Consult agency requirements for such conditions.

22 Sawed surfaces shall be smooth, plane and free of steps, ridges and grooves. Take care in handling to avoid cracking or chipping edges.

23 - **Moisture Condition**: Beams shall be subjected to a minimum of 40 hours soaking in lime-saturated water prior to testing. Testing shall be conducted immediately after removal from moist storage, and surfaces shall be kept continuously moist up to the time of testing.

  When the agency permits or requires, moisture condition other than that described may be used prior to testing.

24 - **Capping:** Refer to the FOP for AASHTO T 97 to determine if capping is required. If it is required, do so according to the FOP for AASHTO T 231.

25 - **Testing:** Test according to the FOP for AASHTO T 97. Since sawing may greatly reduce flexural strength, whenever possible orient the specimen for testing with a formed or finished surface as the tension face.

Report

- Report according to T 97 but include the following additional items:
- Moisture condition at time of testing.

Orientation of the specimen's finished, sawed, and tension faces as positioned in the testing apparatus.

26 ## AASHTO R 39 – Making and Curing Concrete Test Specimens in the Laboratory

27 ### Introduction:

AASHTO R 39 includes procedures for making specimens for many tests other than strength (creep, freeze thaw resistance, bond, length change, etc.).

This manual restricts the discussion to making specimens for compressive strength and flexural strength.

28 Much of the methodology described is the same as for molding strength specimens in the field (AASHTO T 23). Duplication of information will be avoided when possible except where clarity would be sacrificed.

Apparatus

29 • **Molds**: Molds shall comply with the applicable testing procedures under which specimens will be tested. Cylinder molds shall comply with AASHTO M 205. Beam molds shall comply with AASHTO T 97. Note that laboratory-molded beam specimens may use molds with cross-section less than six by six inches when allowed by the governing agency. Consult agency specifications for guidance regarding mold dimensions.

30 • **Tamping Rods**: Large rod: 5/8" diameter, approximately 24 inches in length with a hemispherical tip. Small rod: 3/8" diameter, approximately 12 inches in length with a hemispherical tip.

31 • **Mallets:** Mallet with a rubber or rawhide head weighing 1.25 ±0.50 pounds.

• **Vibrators:** Internal vibrators shall operate at a minimum of 7000 vibrations per minute, shall have a length at least 3 inches greater than the concrete layer being consolidated, and shall have a diameter not greater than one-fourth cylinder diameter or beam width.

Table or plank vibrators shall operate at a minimum of 3600 vibrations per minute, and must permit secure clamping of the mold(s) to the apparatus.

32 • **Small Tools**: Shovels, scoops, trowels, etc. necessary for remixing and handling mixtures.

33 • **Slump Apparatus**: Conforming to AASHTO T 119.

• **Wet Sieving Apparatus**: Conforming to AASHTO T 141.

34 • **Air Content Apparatus:** Conforming to AASHTO T 152 or T 196.

35 • **Scales**: Accurate to 0.3% of the quantity of material being weighed.

Note 1: Avoid using scales of large capacity to weigh small material quantities. The smallest quantity weighed should generally be 10% or more of scale capacity, or accuracy of batch proportions may suffer.

• **Temperature Measuring Device:** Conforming to the requirements of the FOP for T 309.

• **Concrete Mixers:** Power operated mixer of the revolving drum, revolving pan, or revolving paddle type. Use size and type of mixer most

36

Specimens

- **General:** Diameter of cylinders or least dimension of beams shall be at least three times the nominal maximum aggregate size. Hand pick occasional oversize pieces from the concrete, or wet sieve according to T 141.
- **Cylindrical Specimens:** Minimum two-inch diameter by four-inch length. When correlation or comparison testing is desired for specimens cast in the field, 6 by 12 inch specimens shall be considered the standard. Specimens shall be cast and hardened in an upright orientation.
- **Flexural Specimens:** Form with long axes horizontal and meet requirements of T 97.
- **Number of Specimens:** Mold at least three specimens from each batch for each test age. Consult agency guidelines for required test ages and series of mixtures required.

37

Preparation of Materials

- **Temperature**: Bring temperature of concrete materials to room temperature (68 to 86° F) prior to mixing.
- **Cement:** Keep cement dry. Remove lumps by passing through a No. 20 screen. Place cement on clean plastic sheet, mix thoroughly, and return to sample containers.
- **Aggregates:** For coarse aggregates, separate into individual size fractions and recombine according to aggregate grading.

  For fine aggregate, keep in a damp condition to prevent segregation unless it will be divided into separate sizes.

  Prepare the aggregate such that a uniform moisture condition is achieved for each aggregate. Absorption of the aggregates must be determined according to AASHTO T 84 and T 85 to permit accurate adjustment of mix water to maintain desired water/cement ratio.

38 ## Aggregate Proportioning

Determine batch weights by one of the following:

1. Low absorption coarse and fine aggregates (less than 1%): Determine mass of aggregates in a "room dry" condition and make allowance for the quantity of moisture that will be absorbed during the mixing process.
2. Weigh increments of coarse aggregates and immerse for 24 hours prior to use. Decant excess water such that no pond or puddle occurs, and calculate combined aggregate and water weights required for the batch.

39 3. Bring coarse and fine aggregates to at least saturated-surface-dry (SSD) condition with the presence of a small amount of surface moisture such that excess water does not drain down from the aggregates. Determine moisture content of the aggregates and make adjustments to the batch to account for free moisture.
4. Bring coarse and fine aggregates to a SSD condition until batched for use. Avoid drying during weighing and use.

40 **Lightweight Aggregates:** Follow well-established procedures for acceptable handling and moisture conditioning of lightweight aggregates. Moisture condition of these aggregates may have important effects on slump loss, strength, etc. of the concrete. In general it is desirable to assure at least partial saturation of the permeable pore spaces to prevent undesirable properties during and immediately after mixing.

41 **Admixtures:** Insoluble powdered admixtures not containing hygroscopic salts may be incorporated with the cement when batching. Those insoluble powdered admixtures containing hygroscopic salts should be incorporated into the sand when batched.

Liquid admixtures should be added in the mixing water. Adjustment to batch water should be made to account for the liquid contained in the admixtures.

42 Pozzolans and other insoluble materials exceeding 10 percent by weight of cement should be batched as separate ingredients.

It is important to consult the admixture manufacturer to determine sequencing of admixture addition, or to determine whether some incompatibility exists between admixtures, as undesirable effects may be noted in the concrete.

43 **Procedure – Mixing Concrete**

Only machine mixing is described. AASHTO R 39 also describes hand mixing for small quantities (less than ¼ cubic foot).

- **General:** Mix concrete of sufficient quantity so at least 10 percent excess remains after casting specimens. Do not vary the mixing procedure from batch to batch unless that is the parameter being studied. Unless otherwise specified, use the following procedure:

44
1. Butter the mixer with a batch of similar proportions and discard the butter batch taking care that an excess of concrete does not remain in the mixer.
2. Add some of the mixing water, coarse aggregate, and the liquid admixture to the mixer.
3. Start the mixer and add the fine aggregate, cement, and remaining water.

45
4. Mix all ingredients for three minutes after addition of the final ingredient. Allow the concrete to rest for three minutes, covering the mixer to prevent evaporation. Restart the mixer and mix for two more minutes.

Note 2: An experienced operator may add the final mix water incrementally to adjust to the desired slump.

46
- **Mixed Concrete:** Select portions of the batch to be used in tests and molding specimens to be representative of the proportions and condition of the concrete. Keep container covered except when remixing or obtaining portions for testing.

47
- **Slump, Air Content, Density, Temperature:** Determine according to AASHTO T 119, T 152 or T 196, T 121, and T 309 respectively.
- **Making Specimens**: Mold cylinders and beams according to AASHTO T 23 and R 39 using the number of layers and method of consolidation specified.

48

- **Curing**

  Protection: Keep specimens covered to avoid loss of moisture. If wet burlap is used, prevent it from contacting the fresh concrete surfaces.

  Removal From Molds: Remove from molds within 24 ±8 hours after casting.

  Curing Environment: Unless otherwise required, continuously moist cure at 73.4 ±3° F until tested. Storage for the first 48 hours shall be in a location free of vibration.

  Flexural Strength Specimens: Cure as described above, but immerse in lime-saturated water for at least the final 20 hours prior to testing.

49 ## AASHTO M 201 – Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

50 ### Introduction

AASHTO M 201 covers the specification for mixing rooms, moist cabinets, moist rooms and water storage tanks for curing hardened concrete specimens up to the time of testing.

51 ### Terminology

- **Mixing rooms** have controlled temperature and relative humidity where cement paste and mortar specimens are prepared.
- **Moist cabinets** are moderately sized storage facilities in which temperature and moisture conditions are closely controlled.
- **Moist rooms** are larger "walk-in" storage facilities also with closely controlled temperature and humidity.

52 ### Requirements for Cement Mixing Rooms

- Air temperature maintained at 73.4 ±7°F, relative humidity not less than 50%.
- Mixing water temperature used to prepare cement paste and mortar specimens shall be 73.4 ±3°F.

53 ### Requirements for Moist Rooms & Cabinets

- **General Requirements for Moist Rooms and Moist Cabinets**: The atmosphere must have a temperature of 73.4 ±3°F and a relative humidity of at least 95 percent. The humidity must be sufficient that all exposed surfaces of test specimens have free moisture on them.

  Records of temperature must be maintained using a recording thermometer, calibrated at a maximum interval of six months or whenever accuracy is suspect. (Verification of the recording thermometer shall be performed using a reference thermometer accurate and readable to 0.9° F.)

54 Verification shall be made according to the following procedure:

1. Position reference thermometer as close as possible to the sensor of the recording thermometer.
2. Close the door to the moist cabinet or room for at least five minutes.
3. Record both the temperature reading of the reference thermometer and the recording thermometer (Take the readings in the moist cabinet or room immediately upon opening the door).

55 4. Compare the results of the two readings. If the difference is greater than 1.8°F the recording thermometer must be adjusted to within 0.9°F of the reference thermometer reading.
5. Archive the recordings of the recording thermometer to document that proper control over curing temperature is being exercised.

Shelves on which fresh specimens are placed must be level.

56 Air temperature must be positively controlled by either heating or cooling as required according to one of the following two methods:

1. Thermostatically control the air inside the storage facility (thermostat must be inside the facility).
2. Thermostatically control the air surrounding the facility and manually control the air temperature inside the facility.

57 • **Moist Cabinets**: Moist cabinets must be constructed of durable materials with a tight-fitting door. They must have at least one or more fog sprays, water sprays, or curtains of water on the inner walls such that water discharge will be collected in a pool near the bottom.

58 • **Moist Rooms**: Walls must be constructed of durable materials with tight-fitting doors, and windows, if any.

Humidity may be achieved in any convenient way (fog sprays, atomizing humidifiers, etc.)

Moist rooms used in cement testing must have durable shelving manufactured in such a way as to prevent droplets of water from falling on freshly made specimens.

Moist rooms used in concrete testing shall maintain atmospheric conditions such that free moisture is maintained on all exposed specimen surfaces. Specimens may not be exposed to running or dripping water.

59 • **Water Storage Tanks**: Tanks must be constructed of non-corroding material. Each tank not contained in a room capable of maintaining the required temperature range shall be equipped with positive temperature controls to maintain 73.4 $\pm 3^{o}$ F, and shall have a recording thermometer with the sensor immersed in the storage water.

60 Recording thermometers shall be calibrated at an interval not exceeding six months. The calibration thermometer shall be placed adjacent to the sensor of the recording thermometer and the temperatures compared. If the recording thermometer indicates a temperature more than 1.8°F different from that of the calibration thermometer, the recording thermometer shall be adjusted such that the readings agree within 0.9°F.

61 Water in the storage tanks shall be saturated with calcium hydroxide such that excess calcium hydroxide is present. This requires use of high-calcium hydrated lime, not calcium carbonate (limestone). Water in the tanks shall be stirred at least monthly and shall be refilled with fresh solution at intervals not exceeding 24 months (The solution must contain at least 3g/L of calcium hydroxide).

To prevent leaching of minerals from test specimens, do not use continuously running water or demineralized water in storage tanks.

62 ## AASHTO M 205 – Molds for Forming Concrete Test Cylinders Vertically

63 ### Introduction

AASHTO M 205 covers the specification for single-use and reusable cylinder molds. Sizes include those with nominal diameters from 2 to 36 inches. The most commonly used sizes for concrete testing have nominal diameters of four and six inches. Cylinder molds are those for forming cylindrical specimens vertically (having an open top for filling with concrete).

64 ### General Requirements

Molds shall be right circular cylinders constructed of materials that do not react with portland cement or other hydraulic cements. Molds must be water tight and strong enough to resist crushing, tearing, or otherwise deforming.

The nominal inside height shall be twice the diameter. Height, consisting of the average of two measurements 180 degrees apart, shall not differ from the nominal height by more than 2%.

65 Diameter at the top of the mold shall not differ by more than 1% from the nominal diameter. Planes of the top and bottom may not deviate from perpendicularity to the axis by more than 0.5 degrees (1/8” in 12”). No diameter of a mold may differ from any other diameter by more than 2%. The bottom inside surface of the mold may not depart from a plane by more than 1% of the mold diameter (approximately 1/16” in 6”).

66 - **Reusable Molds**

  Molds must be made of non-absorptive materials. Many materials are satisfactory provided they meet the requirements. Alloys of aluminum and magnesium are not permitted since they may react with some constituents of portland cement concrete. Molds must be tested for water leakage and strength after every 50 uses or every 6 months, whichever comes first.

Molds must have a base at right angles to the axis. They may be constructed of a single piece, or made from castings with separate detachable base.

67 If an inside fillet is used at the bottom of the sidewall, the vertical and horizontal legs may not have lengths exceeding 1/8” and 3/16” respectively. Molds must be either coated or manufactured of material that will prevent adherence to concrete. Molds must be watertight at time of use.

68 • **Single-Use Molds**

General: Single-use molds may be made of sheet metal, plastic, or other materials. Paper molds shall not be used.

69 Molds shall be equipped with tightly fitting top caps (lids) to maintain the circular shape at the top of the cylinder, and to provide a clearance above the finished concrete surface. Metal caps are required for sheet metal molds; plastic caps are required for plastic molds.

Physical requirements – When tested for water leakage, they shall show no visible leakage.

70 • **Sheet Metal Molds**:

Metal thickness of sidewalls shall be equivalent to can-making blackplate with a minimum metal thickness of approximately 0.0118 in. Minimum metal thickness of the bottom shall be 0.009 in.

Bottom design – The bottom shall be flush with the bottom of the sidewall within 1/16 in. If used, the inside crimp shall produce an indentation not to exceed 3/16 in. horizontally or 1/8 in. vertically.

Top edge – Curled or beaded to strengthen the mold and protect the user from cuts. If the curl or bead extends inside the mold it shall not make an indentation exceeding 1/8” either horizontally or vertically.

Coating – If material used in manufacture will rust or corrode, it must have a protective coating (lacquer or other suitable material).

71 • **Plastic Molds**:

Wall thickness shall be sufficient to meet the strength and dimensional tolerances outlined under **"General Requirements"** above.

Bottom design – Flush with the bottom of the sidewall within 1/16 in. If used, an inside fillet may not result in an indentation greater than 1/8 in. vertically or 3/16 in. horizontally. The bottom must be sufficiently rigid to produce specimens complying with the applicable provisions of T 23 and R 39.

72 **Material –** Maximum water absorption of 0.5% in 24 hours as tested by ASTM D 570; Izod impact toughness of at least 2.2 ft-lb per inch of notch for 1/8 in. thick specimen as tested by ASTM D 256; after holding at 10°F, for 24 hours the plastic shall not fracture when subjected to tapping and jarring considered to be typical when specimens are being molded.

73 ## Test Methods for Molds

• **Test Procedure for Molds**: Subject all molds to the dry rodded coarse aggregate test to evaluate damage during use. After the dry-rodded test, subject molds to the test for leakage. Verify dimensional requirements for all types of molds.

74 **Samples –** Select at least three molds for reusable or single-use molds from each shipment. For single-use molds, do not reuse or retest when conducting the following test methods.

Note: It will probably not be possible to completely penetrate each layer during the rodding process. The effort given in the rodding attempt will suffice for the requirements of this procedure.

75 **Dry-Rodded Coarse Aggregate Test –** Fill the mold with either No. 57 (1" to No. 4) or No. 67 (3/4" to No. 4) crushed coarse aggregate. Use the method of compaction, number of layers, and strokes of the rod as required by AASHTO T 23. After rodding the final layer, empty the material from the mold, wipe the inside of the mold with a dry cloth, and inspect for physical damage.

76 **Water Leakage for Single-use Molds –** After the dry-rodded test, empty the aggregate from the mold and wipe lightly with a dry cloth. Examine mold for damage. Fill molds to a depth of 90 to 95% of the height. Three hours after filling, examine for leakage.

77 **Water Leakage for Assembled Reusable Molds –** Assemble molds with sealant if required. Fill molds to a depth of 90 to 95% of the height and subject the mold to tapping and jarring equivalent to that of molding specimens according to T 23. One hour after jarring and tapping, examine for leakage.

78 ## Dimensional Measurements

Determine dimensions for the following:

- Diameter
- Length
- Perpendicularity of ends to longitudinal axis
- Planeness of ends

79 ## Sampling and Rejection

- At least three single-use and reusable molds shall be randomly selected from each shipment by the purchaser to conduct specified tests for compliance with this specification.
- Failure of any one of the three molds shall be basis for rejection of the shipment.

80 **Report**

- Brand and source of mold.
- Shipment or lot number.
- Date sampled and date tested.
- General mold description: Nominal dimensions, type of mold, materials from which constructed.
- Test results: damage and water leakage.
- For failed molds report the following (if applicable):
  - Average diameter or height, in.
  - Maximum and minimum diameters or lengths, in.
  - Nonconformance with perpendicularity of rim or base to axis
  - Apparent reaction between mold materials and concrete or mortar

81