STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

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METHOD OF TEST FOR OPERATION AND CALIBRATION OF THE MECHANICAL COMPACTOR

A. SCOPE

This test method describes the procedure for operation and calibration of the mechanical compactor used for fabricating stabilometer, moisture vapor susceptibility, and swell specimens of treated or untreated soils and bituminous mixtures.

B. REFERENCES

California Test 301 — Resistance "R" Value of Treated and Untreated Bases, Subbases and Basement Soils by the Stabilometer
California Test 304 — Preparation of HMA for Test Specimens

C. APPARATUS

1. A mechanical compactor and accessories are required. See Figures 1, 2, and 3.

2. A load-indicating device must be capable of measuring applied dynamic loads up to 2000 lb. The device must be accurate to the nearest 50 lb.

D. PRINCIPAL OF OPERATION

1. The mechanical compactor is used to fabricate stabilometer test specimens of soils or bituminous mixtures. See Figure 1. Compaction is accomplished by applying a "kneading-like" pressure to the specimen through a tamping foot. See Figure 2. It is controlled by a slow speed dynamic force balanced by air pressure, and cushioning actions of a helical spring.

2. A kinetic energy system is used to compact samples. See Figure 3. It uses a toggle press principle in connection with an electric motor, a gear reduction device, a crank and a connecting rod to achieve compaction. The force applied to the ram from the upper link through the racks and gear is proportional, and nearly equal, to the load transmitted to the pressure regulating cylinder.

3. The tamper foot is raised and lowered through a distance of about one foot by lowering and raising the piston with compressed air. To lower the foot from raised position, the valves are arranged so the chamber above the piston in the pressure regulating cylinder is open to atmospheric pressure and the air pressure increases on the hydraulic fluid in the oil reservoir. The pressure on the hydraulic fluid is transmitted through the adjustable needle valve (B) to lower chamber of the pressure regulating cylinder. Sufficient pressure will raise the piston and consequently lower the ram. When the tamper foot engages the test specimen on the turntable, the valve (B) is manually closed allowing air pressure to be transmitted by means of the hydraulic fluid through the bypass valve (D) which is adjusted to a fixed opening by prior calibration. With the

motor running, the compactor foot travels up and down through a distance of about 4 in., alternately applying and releasing a pressure on the specimen according to a fixed cycle.

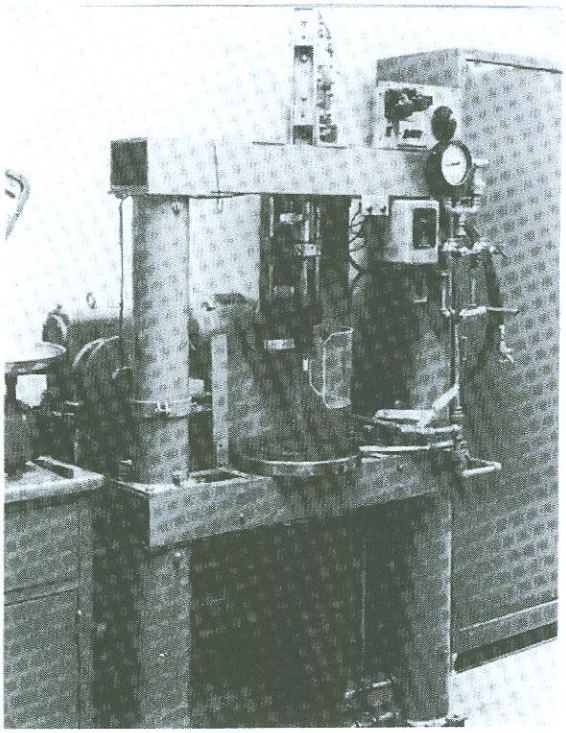

FIGURE 1. California Mechanical Compactor

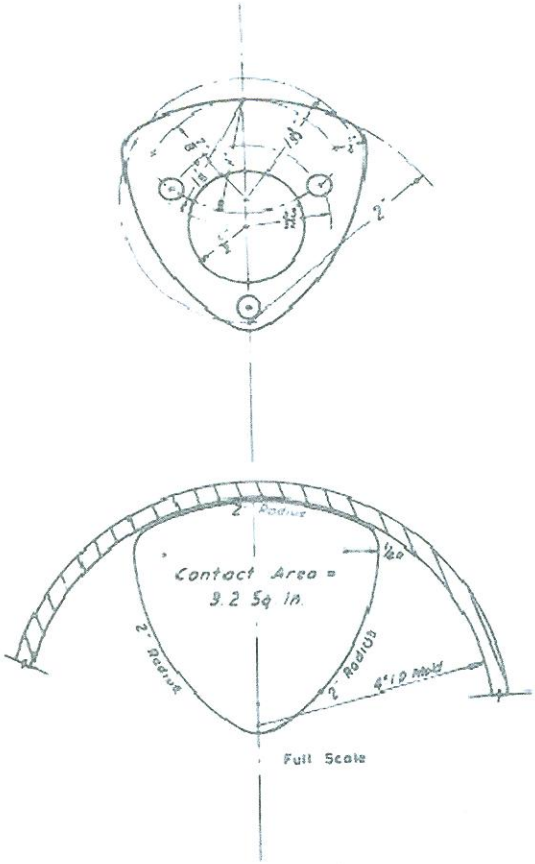

FIGURE 2. Tamper Shoe for the Mechanical Compactor

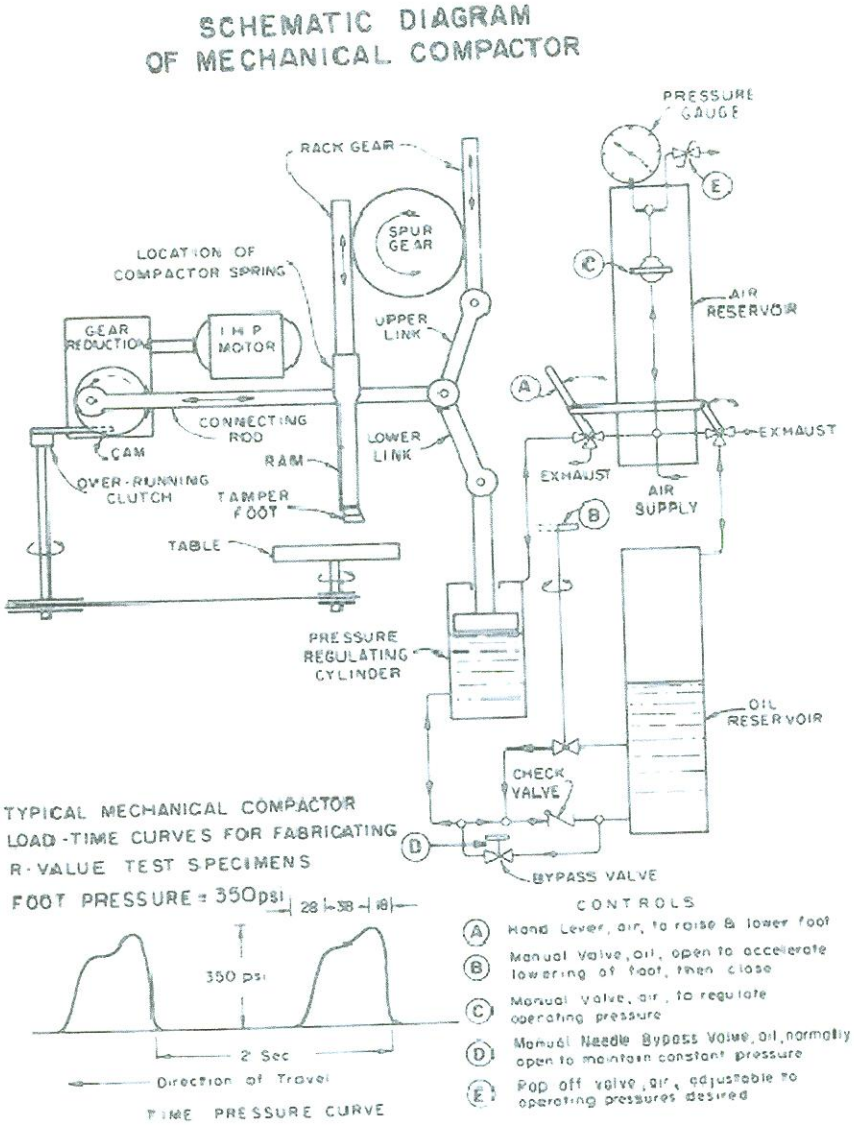

FIGURE 3. Schematic Diagram of the Mechanical Compactor

4. The complete time cycle for each stroke is about 2 s. The piston offers resistance due to the restriction of the flow of hydraulic fluid and the air pressure opposing it. The actual stress at the tamper foot can therefore be controlled by the amount of air pressure in the oil reservoir and the amount of restriction at the valve (D).

5. During compaction there is controlled interchange of fluid between the pressure regulating cylinder and the oil reservoir. This is to compensate for the slight displacement of the piston. This distance is approximately ¼ inch. The fluid is forced into the oil reservoir through the check valve, and it returns, at the release of stress, through, the by-pass valve (D). In this manner, each stroke

encounters the same movement and resistance in the pressure regulating cylinder, and any slight adjustments necessary to compensate for change in height of the specimen due to compaction are automatically accommodated.

6. The kneading action is developed by the application of pressure to a small area (3.2 sq. in.) of the specimen while the remainder of the specimen is free to move. Damaging or abnormal impact is avoided by the slow speed of the ram at the time of contact with the specimen.

7. The raising of the tamper foot at the completion of compaction requires the exhaust of the air in the oil reservoir. At the same time air pressure is applied to the chamber above the piston in the pressure regulating cylinder. This causes the piston to drive the hydraulic fluid into the oil reservoir by way of the check valve, thus lowering the piston and raising the foot.

E. PROCEDURE OF OPERATION

1. Swing the safety guard into test position.

2. Start the motor to operate the equipment.

3. Push the hand lever (A) to the forward position.

4. Adjust the manual valve (C) to give the desired air pressure on the pressure gage.

   NOTE: The air pressure for any tamper foot pressure is determined in the calibration procedure.

5. Open the manual valve (B) to rapidly lower the tamper foot.

6. When the tamper foot makes contact with the surface of the specimen, close the manual valve (B).

7. Compact the specimen in accordance with California Test 301 for bases, subbases, and basement soils and in accordance with California Test 304 for bituminous mixes.

8. When compaction is completed, stop the motor and pull the hand lever (A) to the backward position to raise the tamper foot. Swing the safety guard to a clear position.

F. PROCEDURE FOR CALIBRATION

1. The calibration of the mechanical compactor covers the proper adjustment and control of the equipment necessary to obtain both the 350 psi foot pressure that is specified for soils, sands, gravel or crushed stone and the 500 psi foot pressure that is specified for bituminous paving mixtures.

2. For the purpose of calibrating the compactor, some load-indicating device must be placed under the tamper foot to register the true applied dynamic loading

during the adjustments. The two devices acceptable for this purpose are: a calibrated spring deflection device and SR-4 load cell (with a matching strain indicator or an electronic strain analyzer with a recording oscillograph).

3. To prepare the compactor for calibration, disengage the spring on the over running clutch and tie or wedge the clutch back so that it cannot engage the cam. See Figure 3. This prevents the turntable from rotating during the calibration operation.

4. The calibration procedure consist of starting the compactor, after the above preparations have been made, and lowering the tamper foot until it touches the load-indicating device in the same manner as prescribed for compacting a test specimen in accordance with Section D. There are two main controls used on the mechanical compactor to adjust for the correct foot pressure in calibration. These are the manual needle valve (D) and the manual air valve (C). These valves are commonly referred to as the "by-pass valve" and the "air pressure regulator," respectively. An air pressure of 20 to 24 psi, with the 7 in. diameter cylinder, is required when the 350 psi foot pressure is desired. With the air pressure set to a fixed value, the by-pass valve is adjusted so that the peak momentary reading on the load-indicating device coincides with the predetermined reading necessary to represent a 350 psi foot pressure. The by-pass valve will then be from one-half turn to two turns open, depending on the particular characteristics of the individual compactor. When this setting is established, tighten the packing nut on the by-pass valve to maintain this adjustment. The air pressure required to produce the tamper load should then be used when compacting soil specimens. To obtain the 500 psi foot pressure used for bituminous materials, increase the air pressure (generally about 11 psi) to approximately 32 psi or until the desired reading is indicated on the load device.

   Caution – Do not make any adjustments of the by-pass valve. Take note of the air pressure at which the 500 psi is attained and use this to compact bituminous specimens.

5. Compactors that are equipped with a signal light mechanism should have this device checked, and adjusted if necessary, during calibration. This mechanism consists of a limit switch assembly and a signal light panel. Two types of limit switches are presently in use. Type 1 actuates the signal lights when electrical contacts are engaged and Type 2 operates the lights by means of micro switches. Both types are in proper adjustment if the load light (green) goes on at 15 psi under the specified pressure and the overload light (red) goes on at 15 psi over the specified pressure. Adjustment of both types of limit switches is affected by changing the size of a gap. This adjustment is most quickly and easily accomplished while the compactor is in operation.

   a. Type 1. The electrical contacts are mounted at the top of the ram. When the foot applies a pressure to the specimen, the spring inside the ram deflects and thus, the gap between the electrical contacts is closed. With the long bottom contact turned upward, the gap between the contacts should be such that the load and overload lights go on at applied loads of 1070 lb and 1170 lb, respectively. With the short bottom contact turned upward, the load and overload lights should go on at 1550 lb and 1650 lb, respectively. Adjustment of the gap for the load light is accomplished

by loosening and moving the entire lower assembly as required. For the overload light, the upper brass tab is merely bent up or down to alter the gap.

b. Type 2. The limit switch, composed of a switch bracket and an anvil turret, is mounted at the top of the ram by means of hose clamps. See Figure 4. Two pairs of anvils are mounted vertically on the turret. They are a north-south pair and an east-west pair. One pair is used to obtain 350 psi tamping pressure and the other is used to obtain 500 psi tamping pressure. Rotation of the turret through 90° affects the change from one pair to the other. The switch bracket holds two micro switches which operate the signal lights. The front switch operates the load light and the read switch operates the overload light. When the foot applies a pressure to the specimen, the spring inside the ram deflects and thus the gap between the micro switch and anvil is closed.

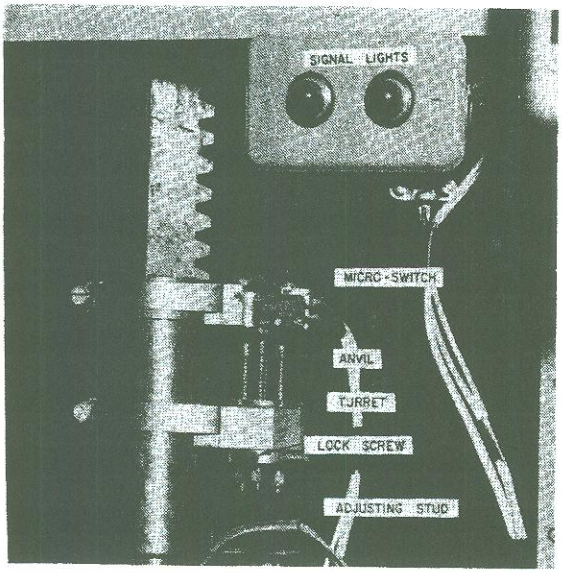

FIGURE 4.

This gap should be such that the load light goes on for applied loads of 1070 lb and 1550 lb. The gap is adjusted by loosening the Allen lock screw, advancing or unscrewing the stud at the bottom of the anvil, and then tightening the Allen lock screw.

The signal lights are advantageous in that the foot pressure will always be correct regardless of whether a soft or hard specimen is being compacted. For example, a soft resilient soil specimen will require a somewhat higher air pressure (possibly 4 to 5 psi higher) to attain a compaction pressure of 350 psi. Since the compactor spring constant remains essentially the same for all conditions of loading and the signal lights depend entirely on the deflection of this spring they will always be more reliable than the air pressure being registered.

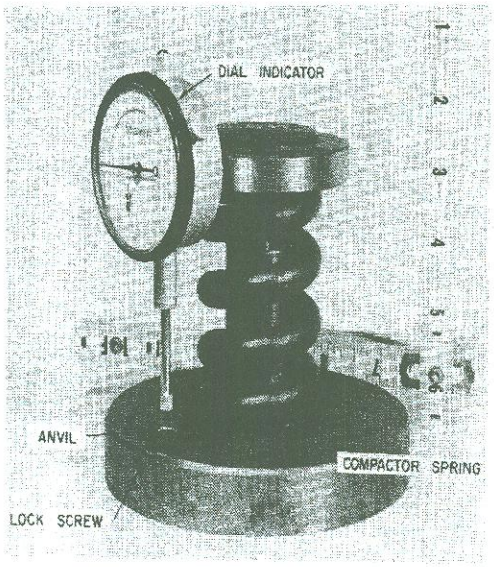

FIGURE 5.

A spring deflection device is used to calibrate the compactor. See Figure 5. This device consists of a dial indicator an adjustable anvil, a standard compactor spring, and a base unit on which these items are mounted. After the compactor has been calibrated, place the spring deflection device in position under the compactor foot. Read and record the spring deflection registered on the dial for loads of 1070 lb, 1170 lb, 1550 lb, and 1650 lb. The deflection readings should be taken at the first instant that the signal light indicates that the proper load is being applied. The air pressures required to transmit the above loads will be 3 to 5 psi higher than those pressures encountered when using the load cell. The spring deflection device can now be used to calibrate the compactor. If, in the future, the compactor is out of adjustment, the signal lights may be reset by use of this device. The limit switch is adjusted so that the signal lights go on when the proper deflection is being registered on the dial indicator. Take care

that the lock screw holds the anvil securely in place. If the anvil is allowed to move, a new set of deflection readings must be taken before the device can be used for compactor calibration.

G. PRECAUTIONS

Caution must be exercised when compacting test specimens so as not to allow any object other than the sample itself to intercede between the compactor foot and the mold at any time while the ram is in motion. The clearance between the inside edge of the mold and the compactor foot is approximately $^{1}/_{16}$ in. The applied shearing load of 1,100 to 1,600 lb could cause severe injury if an operator's hand was caught between the compactor foot and the mold. A clear plastic guard has been designed for the California Compactor and should be used as an aid in safe-guarding against this hazard.

H. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 101 contains 9 pages)