PROTOCOL FOR THE COMPACTION METHODS
PAVEMENTS MECHANICS LABORATORY
FEDERAL UNIVERSITY OF CEARA - BRAZIL

1. MARSHALL COMPACTION PROCEDURE

The method described is used to prepare standard Marshall Mix Design specimens containing asphalt cement and aggregate up to 25 mm maximum size. Nominal size of the specimens is 101.7 mm diameter by 63.5 mm in thickness. The electric equipment (220V-60Hz) (Figure 1) can apply a load up to 39,2 kN (4tons). The compaction hammer has a flat circular tamping face and a 4,540 g sliding weight with a free fall of 457.2 mm. The compaction pedestal consists of a 203.2 by 203.2 by 457.2 mm wooden post capped with a 304.8 by 304.8 by 25.4 mm steel plate. The wooden post is oak, pine or other wood having an average dry weight of 0.67 to 0.77 g/cm³. The wooden post is secured by four angle brackets and imbedded approximately 10-15 mm into a cylindrical concrete block with minimum dimensions of 400 mm in diameter and 200 mm in height. The steel cap is firmly fastened to the post. The pedestal assembly is installed so that the post is plumb and the cap is level. The mold holder is mounted on the compaction pedestal so as to center the compaction mold over the center of the post. It holds the compaction mold, collar and base plate securely in position during specimen compaction. The preparation of specimens for Marshall Mix Designs requires representative samples of the aggregates to be used. The samples are approximately 1200 g in size and combined to the desired gradation.

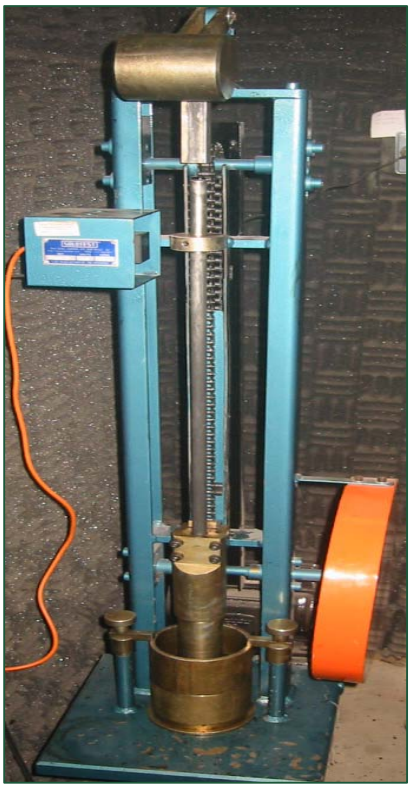

Figure 1: Marshall Compactor, by SOLO TEST (Model 1.033.020)

COMPACTION PROCEDURE: Place the entire batch in a previously prepared mold assembly, spade the mixture vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior. Remove the collar and smooth the surface of the mix with a trowel to a slightly rounded shape. Temperatures of the mix immediately prior to compaction shall be within the limits of the specified compaction temperature.

Place two filter papers on the surface of the mix and replace the mold collar. Place the mold assembly on the compaction pedestal in the mold holder and unless otherwise specified, apply 50 blows with the compaction hammer. In case of manual compaction the operator will hold the axis of the compaction hammer by hand as nearly perpendicular to the base of the mold assembly as possible. Remove the base plate and collar and reverse and reassemble the mold. Apply the same number of compaction blows to the face of the reversed specimen. When compaction is completed, extrude the sample from the compaction mold. Carefully transfer the specimen to a smooth, flat surface and allow it to cool to ambient temperature before testing. The specimen should be extruded using a hydraulic jacking device to provide a gentle and constant pressure. Using hammers or other methods of impact loading to remove specimens from the mold is not acceptable. Mixtures that lack sufficient cohesion to retain the required cylindrical shape on removal from the mold immediately after compaction should be cooled in the mold in air until sufficient cohesion has developed to result in the proper cylindrical shape. Marshall specimens to be tested for stability and flow characteristics will be allowed to stand at room temperature overnight before any testing is conducted. The compacted specimen should be between 62.2 and 64.8 mm high. If the specimens are outside this range, adjust the amount of asphalt mix in subsequent tests.

2. SUPERPAVE COMPACTION PROCEDURE

The Superpave Gyratory Compactor by TROXLER (SGC – Figure 2) is used in the Superpave mixture design system to prepare asphalt concrete specimens for determining volumetric and mechanical properties.

To compact a specimen, an asphalt mixture is placed in a steel mold that has an inside diameter of 150 mm and a steel base plate that serves as a lower platen. The assembly is placed inside the SGC where a load is applied through an upper ram and platen. The bottom of the mold is shifted horizontally along one diameter to provide the required angle of 0.0218 rad (1.25 degrees). The angle is then applied to the mold in a circular manner at a constant speed of 30 gyrations (revolutions) per minute. The platens remain parallel to each other during compaction, but are free to move with respect to the mold as the mixture densifies. Compaction occurs due to the pressure from the ram and the kneading action provided by the revolving angle.

The standard ram pressure is 600 kPa. As the specimen densifies and becomes shorter in height, a pressure gauge signals the loading system to adjust the position of the loading ram so that the 600 kPa pressure is maintained throughout the compaction process. The SGC uses a linear variable differential transformer to record the position of the upper loading ram. The vertical change in ram position provides a measurement of the specimen height during compaction. The SGC methodology uses the change in height to determine the change in density with gyrations. Density is the mass of the specimen by its volume. Thus, the SGC provides a compaction curve, which is the relationship between density and the number of gyrations.

Figure 2: Giratory Superpave Compactor, by TROXLER (Model 4140)

Figure 3 shows the compaction equipments in the Pavements Mechanics Laboratory of Federal University of Ceara, Brazil.

Figure 3: Pavements Mechanics Laboratory

3. COMPACTION TABLE PROCEDURE

The procedure described is based in the French Standard NPF P 98 - Pavement Relative Tests. There are 7 (seven) positions in which the tire is placed to carry out a compaction of 3 (three) samples. The compaction accessories are composed of 3 (three) molds (4500, 9000, 15000 $mm^{3)}$), 3 (three) auxiliary supports and 2 (two) plates-base (Figure 4).

Figure 4: Compaction table developed at UFC

The compaction load can be up to 500 kgf, with an inside tire pressure of 6 bars. To start compaction, the asphalt mixture is placed within the compaction mold. The Compaction table then moves pressing the mixture against the tire. The tire has five main positions related to the moulds of 4500 or 9000 mm^3. Regarding the backward and forward tire movement, the number of passes at the edge of the molds (internal and external edges) is twice the number of passes at the central part of mold. The tire position is tangent to the external or the internal edge. A cover is placed between the tire and the asphalt mixture for the first pass. It protects and saves the tire against wearing due to any cutting piece existing in the mixture surface. All parts that make contact with the asphalt mixture have to be lubricated with diesel oil to facilitate the extraction of the asphalt mixture from the mould.