Colorado Procedure 63-21

Standard Practice for

The Box Test in Slip Form Paving of Fresh Concrete

1. SCOPE

1.1 This test method describes the workability measurement of hydraulic-cement concrete in slip-formed paving applications, both in the laboratory and in the field.

1.2 The values stated in inch-pound units are to be regarded as the standard.

1.3 The standard does not purport to address all the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before use.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standard:

- T119, Slump of Hydraulic Cement Concrete

2.2 *Colorado Procedures*

- CP 61, Sampling Freshly Mixed Concrete

3. SUMMARY OF TEST METHOD

3.1 This test method composes a two-part measurement to assess the dynamic behavior (ability to flow) of plastic concrete through vibration and the static behavior (ability to hold an edge) of plastic concrete mixtures through the removal of forms.

3.2 First, a sample of unconsolidated concrete is filled into a standard box.

3.3 Second, a vibrator is used to consolidate the concrete using the standard procedure.

3.4 Third, the forms are removed and the number of voids is determined. This the parameter indicates the responsiveness of a mixture to vibration.

3.5 Last, a straight edge is used to measure the top and bottom edge slumping. The parameter indicates the potential of a mixture to edge slump.

4. SIGNIFICANCE AND USE

4.1 This test method provides a simplistic and economic approach to determine the workability of slip-formed paving applications. This test method measures the response of a pavement mixture to vibration and the ability of the concrete to hold an edge.

4.2 This test method is not considered applicable to mixtures with a slump greater than 3 in. as measured with T119.

5. APPARATUS

5.1 The Box Test apparatus is composed of a platform, Box Test Forms, form holders, a vibrator, and a straight edge as shown in Figure 1.

5.2 Box Test forms—for enclosing a 1 ft^3 as shown in Figure 2, shall be made of a 0.5 in or thicker plywood with an inside measurement for length, width, and height of 12 in when connected for a box shape with an open top and bottom. Two form clamps are installed in two of the four corners of the forms to create L-shaped forms as shown in Figure 2.

5.3 Form clamps— two pipe clamps with a minimum span of 14 in. are used to hold L-shaped forms together as shown in Figure 2. These clamps must be strong enough to keep the forms together throughout the testing process.

5.4 Platform— for performing the Box Test on it, shall be made of a 0.5 in or thicker plywood with a minimum length and width of 18 in.

5.5 Vibrator— a portable electrical vibrator with a 1 in. square head and a vibration frequency of 12500 vibrations per minute (vpm)

Note 1—Some examples of electric vibrator motors meeting this include: Wyco 992, Wyco Sure Speed (@12,500 vpm), Wacker M1500, Northrock Pro 1.5, MultiQ Cv2A

5.6 Straight-edge— a 12 in metal tool commonly used in carpentry to measure the vertical alignment of the fresh concrete sample.

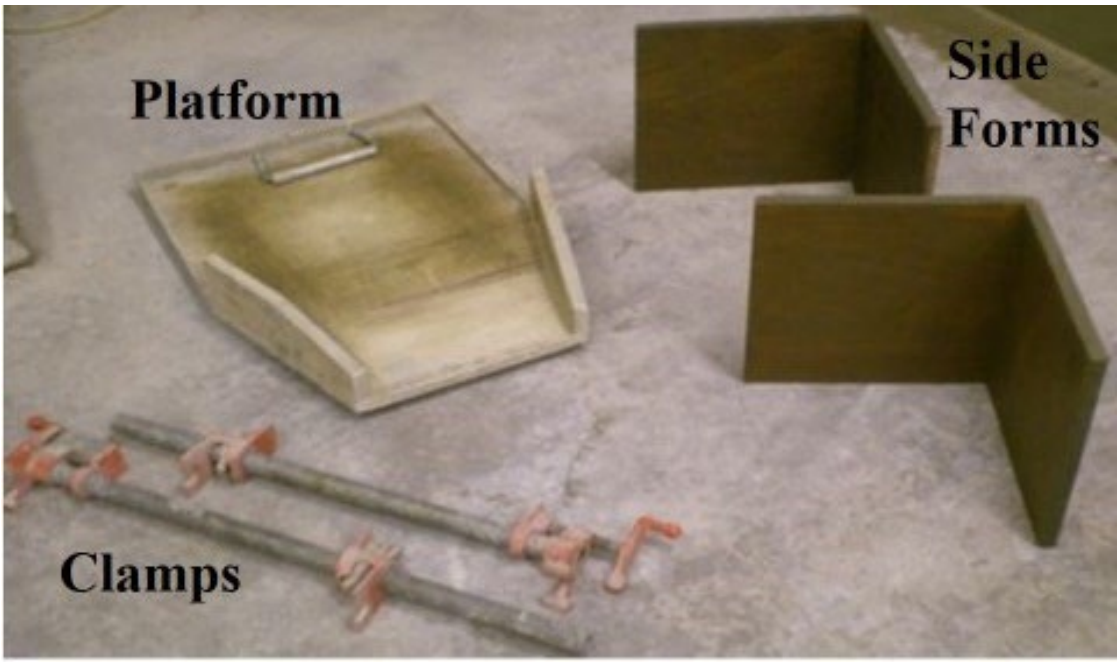

Figure 1 Each Component of the Box Test

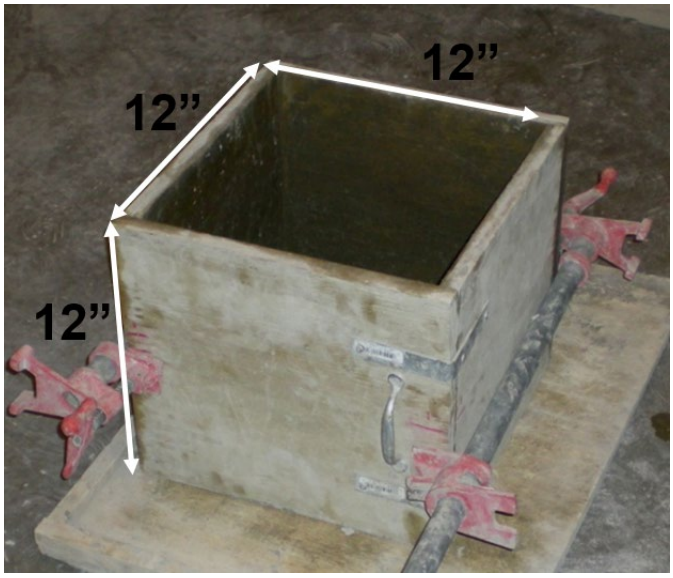

Figure 2 The Box Test Assembled with dimensions of 12 in (305 mm).

6. PROCEDURE

6.1 Sample concrete per CP 61

6.2 This process can be described as four steps as shown in Figure 3

6.3 Dampen the forms with form oil and construct Box Test components on a flat and level surface.

6.4 Using a hand scoop place fresh, unconsolidated concrete in the constructed box forms to a depth of 9.5 in.

6.5 Keeping the head of the vibrator perpendicular to the platform, insert the vibrator head with 12,500 vibrations per minute at the top center of the sample and vertically lower it in a continuous downward direction for three seconds to reach the bottom of the concrete sample. Attention should be taken to ensure the vibrator does not touch the platform.

6.6 Next, move the vibrator in a vertically upward direction to the top of the concrete sample for three seconds while keeping the head of the vibrator perpendicular to the platform.

6.7 Loosen and detach the form clamps. Then remove the Box Test forms in an ascending vertical direction. Care must be taken to ensure the concrete will not stick to the forms.

6.8 Estimating voids– Rank each side based on the number of voids as shown in Figure 4. An average of the four sides should be calculated as described in Section 7 and used as the overall ranking.

6.9 Edge slump– Then vertically align a straight edge onto a corner of the sample and measure the largest extruding length to the nearest 0.25” as shown in Figure 5. This shall be conducted for all four sides of the sample and each value shall be reported.

6.10 The Box Test shall be conducted within 45 minutes after discharging concrete.

	
Step 1	**Step 2**
Assemble the components. Hand scoop mixture into box until the concrete level is 9 in. (240 mm).	From the top surface of the concrete, vibrate straight downward for 3 seconds.
	
Step 3	**Step 4**
Now, vibrate straight upward for 3 seconds. Then remove vibrator.	After removing the clamps and forms, inspect the sides for surface voids and edge slumping.

Figure 3 The Box Test Steps

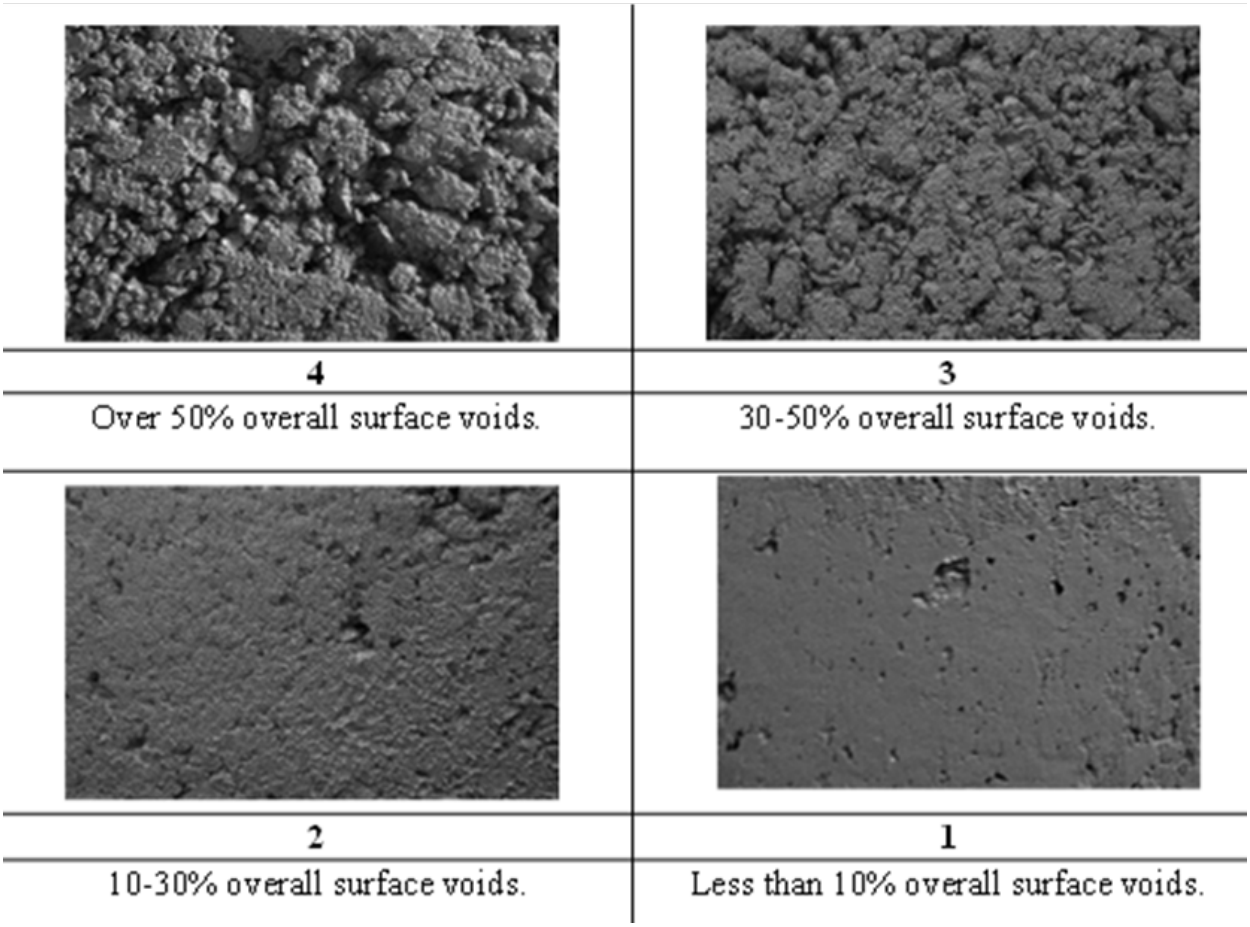

Figure 4 The Box Test Ranking Scale

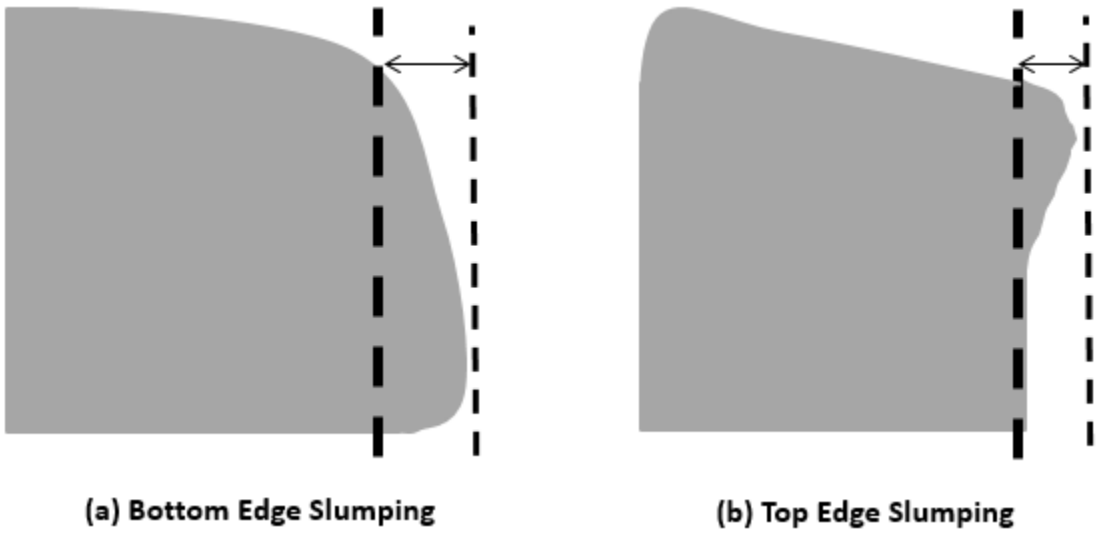

Figure 5 Edge Slump Measurement illustrated for (a) Bottom Edge Slumping and (b) Top Edge slumping.

7. CALCULATION AND REPORT

7.1 Estimating voids– After ranking each side of four sides based in Figure 4, calculate the average and standard deviation of these numbers.

7.2 Edge slump– Report all 4 side measurements.

8. PRECISION AND BIAS

8.1 Precision – The visual rating of voids was evaluated for single and multiple operator repeatability.

8.2 Single-Operator Precision- Ten different mixtures were blindly replicated three times and evaluated each of the three times by a single operator. The standard deviation of the estimated void count was 1.3% and the coefficient of variation was 14.7.

8.3 Multiple-Operator Precision – The different mixtures were blindly replicated three times and evaluated each of the three times by three different operators. The standard deviation of the estimated void count was 2.8% and the coefficient of variation was 21.0.