
Supplemental Technical Specification for Dowel Bar Alignment

SCDOT Designation: SC-M-504 (01/25)

APPROVED:
Division Administrator

By: _____
FEDERAL HIGHWAY ADMINISTRATION

1. SCOPE

- 1.1. This supplemental technical specification describes the procedures for installation of dowel bars in jointed PCC Pavement. Install dowel bars parallel to the centerline of the pavement and parallel to the proposed pavement surface using either a mechanical dowel bar inserter (DBI) or properly secured dowel bar assemblies.

2. Referenced Documents

- 2.1. SCDOT Standard Specifications Divisions 500 and 700.

3. MATERIAL AND EQUIPMENT

- 3.1. Dowel Bar Assemblies. Provide an assembly that acts as a rigid unit with each component securely held in position relative to the other members of the assembly. Secure the entire assembly in place by means of nails that penetrate the stabilized base/subbase.

Secure the entire assembly with metal stakes instead of nails on soil or granular subbases. Ensure the stakes loop over or attach to the top parallel spacer bar of the assembly and penetrate the subgrade or subbase.

Reshape the subgrade or subbase when necessary at the location of each dowel bar assembly.

Coat all dowel bars in accordance with **501.2.1.2** to break the bond between the steel and concrete.

- 3.2. Dowel Bar Insertion. The dowel bars may be placed in the pavement slab with a mechanical dowel bar inserter (DBI) attached to a formless paver for pavements ≥ 8.0 inches in thickness.

After the concrete has been struck off and consolidated, insert the dowel bars using a DBI that vibrates the dowel bars into the plastic concrete without causing deformation into the slab. Refinish the concrete after the bars have been inserted and ensure that no voids exist around the dowel bars.

Mark the location of each row of dowel bars in a manner to facilitate where to insert the bars, and where to saw the transverse joint.

Provide a mechanical DBI that is self-contained and supported on the formless paver with the ability to move separately from the paver, is equipped with insertion forks along with any other devices necessary for finishing the concrete the full width of the pavement, and has the ability to vibrate at a minimum frequency of 3000 VPM.

4. TERMINOLOGY

- 4.1. Figure 1 illustrates the five types of dowel bar misalignment: horizontal skew, vertical tilt, horizontal translation, longitudinal translation, and vertical translation.

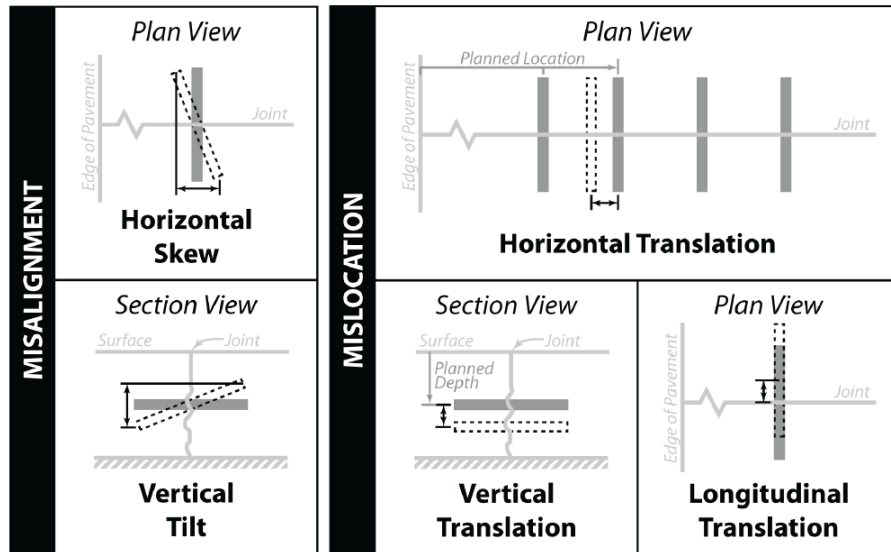


Figure 1. The 5 types of dowel bar misalignment (after FHWA 2007).

5. MEASUREMENTS

- 5.1. Determine a joint score for each scanned joint if a DBI is used. Do not allow the quality control tolerance for vertical tilt or horizontal skew to exceed 0.6 inch and adjust paving operations as necessary if either tolerance is exceeded.
- 5.2. Placement Tolerances for Dowel Bars. Using the DBI, place the dowel bars in the concrete pavement within the following tolerances.

Longitudinal Translation. Longitudinal translation is defined as the position of the center of the dowel bar along the longitudinal axis in relation to the sawed joint. The tolerance for longitudinal translation is ± 2.0 inches.

Horizontal Translation. Horizontal translation is defined as the difference in the actual dowel bar location parallel to the longitudinal or edge joint from its theoretical position. The tolerance for horizontal translation is ± 2.0 inches.

Vertical Translation. Vertical translation is defined as the difference in the vertical position of the dowel bar relative to the theoretical midpoint of the slab. The maximum allowable vertical translation is $\frac{1}{2}$ inch higher than the theoretical midpoint and 1 inch lower than the theoretical midpoint.

Dowel Bar Misalignment. Vertical tilt horizontal skew is defined as the difference in position of the dowel bar ends with respect to each other. Vertical tilt is measured in the vertical axis whereas horizontal skew is measured in the horizontal axis. Misalignment will be measured in terms of a joint score.

The Single Dowel Misalignment (SDM). The Single Dowel Misalignment is defined as the degree of misalignment evaluated for a single transverse joint for each lane of pavement, which is a measure of the combined effects from the dowel's horizontal skew or vertical tilt, and calculated as:

$$\text{Single Dowel Misalignment (SDM)} = \sqrt{(\text{Horizontal Skew})^2 + (\text{Vertical Tilt})^2}$$

The Joint Score (JS). The Joint Score is determined by summing the product of the weight shown in the Table 1 and the number of bars in each misalignment category and adding one, and calculated as:

$$Joint\ Score\ (JS) = 1 + \sum_{i=1}^n W_i$$

Where:

n = number of dowels in the single joint, and

W_i = weighting factor (Table 1) for dowel i .

The vertical tilt and horizontal skew should be evaluated and the greater misalignment will be used to determine the joint score.

Table 1. Tolerance for Dowel Bar Alignment

Single Dowel Bar Misalignment (SDM)	W, Weighting Factor
SDM ≤ 0.6 in. (15 mm)	0
0.6 in. (15 mm) < SDM ≤ 0.8 in. (20 mm)	2
0.8 in. (20 mm) < SDM ≤ 1.0 in. (25 mm)	4
1.0 in. (25 mm) < SDM ≤ 1.5 in. (38 mm)	5
1.5 in. (38 mm) < SDM	10

A joint that has a joint score greater than 10 will be considered locked. More than Three consecutive joints with a score greater than 10 will be considered unacceptable.

- 5.3. Minimum, measure the alignment and location of each dowel bar in the first day of production (or 100% of the joints up to 1000 feet) to establish that the dowel bar inserter are consistently placing the dowel bars at the correct location and meeting the tolerances defined in Table 1.
- 5.4. If the first day of production scans are consistent, the contractor may reduce the percentage of scanned joints to no less than 10%. However, if consistency of the proper dowel bar alignment is not established in the first day of production scans, the RCE may require additional scans to be taken in the next production day until tolerances have been met. If consistency cannot be established within a reasonable time frame, the RCE will have the option of suspending the paving operation.
- 5.5. If any of the tolerances are not within the above-specified ranges, discontinue paving operations and inspect the paving machine along with the DBI and any electronics associated with the DBI mechanism. Make necessary adjustments to the paving operation prior to continuing.
- 5.6. During production RCE to confirm 10% of contractor measurements.

6. TEST REPORT

- 6.1. Provide test reports to the RCE within two working days of completing each day's testing. The test report should include the following.
- 6.2. Contract number, placement date, country-route-section, direction of traffic, scan date, contractor, and name of individual performing the tests.
- 6.3. Provide the standard report generated from the on-board printer of the imaging technology used for every dowel and joint measured.
- 6.4. For every dowel measured, provide the joint identification number, lane number and station, dowel bar number or x-location, direction of testing and reference joint location/edge location, longitudinal translation, horizontal translation, vertical translation, vertical tilt, and horizontal skew. Dowel bars immediately adjacent to tie bar locations will be taken out of consideration due to the tie bar influence when scanning.

- 6.5. Identify each dowel bar with a maximum longitudinal, horizontal, or vertical translation that has been exceeded. Identify each dowel bar with a maximum vertical tilt or horizontal skew deviation that has been exceeded.
- 6.6. Joint Score Details: Provide the joint identification number, lane number, station, and calculated joint score for each joint.
- 6.7. Locked Joint Identification: Identify each Joint with a joint score >10.

7. CORRECTIVE ACTIONS

- 7.1. The maximum allowable locked length of roadway is 60 linear feet. Should a locked joint be encountered, the contractor would scan on either side of the joint in question to ensure that consecutive joints are not locked. If the additional scanned joints are not locked, no additional action is required. If the additional scanned joints are locked, each consecutive joint on either side of the joint would be scanned to determine the length of lane that is locked. If the length of lane exceeds 60 linear feet, plunge cuts will be made on selected bars in order to “free” the locked joint so as to not exceed the maximum allowable locked length.
- 7.2. At each joint, no more than three bars will be cut and no more than two adjacent bars will be cut unless outside of the design critical wheel path.
- 7.3. If the contractor cannot reduce the locked length of roadway under 60 linear feet with plunge cutting dowel bars, the contractor will remove and replace both slabs at full length, width, and depth. The contractor will remove slabs as needed to not exceed the maximum allowable locked length.