DMS-4100, Jiggle Bar Tiles

Overview


This Specification governs for the materials, composition, quality, sampling, and testing of ceramic and nonceramic (polymeric or plastic) reflectorized and nonreflectorized jiggle bar tiles, and describes the prequalification procedures and the Material Producer List (MPL).

Material Producer List

The Materials and Pavements Section of the Construction Division (CST/M&P) maintains the MPL of all materials conforming to the requirements of this Specification. Materials appearing on the list of prequalified jiggle bar tiles may require sampling and testing before use. "Tex-729-I, Sampling Traffic Markers" describes the sampling procedure.

Prequalification Requests

Prospective producers interested in submitting their product for evaluation must submit a written request to the Texas Department of Transportation, Construction Division, Materials and Pavements Section (CP-51), 125 East 11th Street, Austin, Texas 78701-2483.

Include the following information in the request:

♦ company name,
♦ physical and mailing addresses,
♦ type of material, and
♦ contact person and telephone number.

Bidders’ and Suppliers’ Requirements

Before any material is considered, it must be of manufacture and product code or designation shown on the MPL.

Prequalification and Performance History

Prequalification

Contact the Texas Department of Transportation, Construction Division, Director of Materials & Pavements Section (CP51), 125 East 11th Street, Austin, TX 78701-2483, to prequalify your product.
Submit 50 tiles of each color and/or type for laboratory testing and evaluation.

Upon successful completion of the laboratory tests and notification of same, submit to the Department 150 tiles of each color and type to perform road tests. The road test period will not exceed 1 yr. and will be performed in accordance with “Road Test” under 'Material Requirements.'

Submit all materials for prequalification tests to the Department at no cost. CST/M&P will notify you after evaluation.

If the material fails to meet any of the requirements, you may submit for re-evaluation after 1 yr. has elapsed from the time of the original evaluation request. CST/M&P may waive this time limit if you submit documentation from an independent testing facility demonstrating that the materials meet all the requirements of this Specification. If after retesting by CST/M&P the materials again fail any of the requirements, the 1-yr. time limit will be enforced from the time of the original evaluation request.

The Department reserves the right to perform any or all tests specified as a check on the tests reported by the manufacturer. In the case of any variance, the Department’s tests will govern.

**Performance History**

Some of the required tests extend over a prolonged period. Therefore, testing for acceptance of materials supplied on any contract or State purchase order will only be considered on those materials that are determined by the Director of CST/M&P as having an established performance history of compliance with the criteria established by this Specification.

**Re-evaluation**

When in the opinion of the Director of CST/M&P changes have been made in the composition or manufacturing process of a prequalified material, a re-evaluation of the performance may be required.

The Department may conduct additional tests to identify changes in the material. Changes detected in the composition or in the manufacturing process, not reported by the manufacturer, may be cause for removal of that material from the MPL.

**Periodic Evaluation**

The Department reserves the right to periodically evaluate the performance of materials. Samples for periodic evaluation of performance will be selected at random from materials submitted to the Department on contracts or direct State purchase orders.

Failure of materials to comply with the requirements of this Specification may be cause for removal of those materials from the MPL.
Sampling and Testing

The Department will sample in accordance with "Tex-729-I, Sampling Traffic Markers" and will test in accordance with the methods listed in “Material Requirements.”

CST/M&P will perform all quality monitoring (QM) tests when applicable. The producer will be responsible for quality control (QC) and independent assurance testing.

The Department reserves the right to conduct random sampling of prequalified materials for testing and to perform random audits of test reports. Department representatives may sample material from the manufacturing plant, the project site, and the warehouse. CST/M&P reserves the right to test samples to verify compliance with this Specification.

Material Requirements

All jiggle bar tiles must meet all requirements, except for specific requirements for ceramic or nonceramic jiggle bar tiles, reflectorized and nonreflectorized:

♦ Reflectorized Types
  • Type I-A must contain 1 face that reflects amber light. The body, other than the reflective face, must be yellow.
  • Type I-C must contain 1 face that reflects white light. The body, other than the reflective face, must be white.
  • Type II-A-A must contain 2 reflective faces oriented 180° to each other, each of which must reflect amber light. The body, other than the reflective faces, must be yellow.

♦ Nonreflectorized Types
  • Type W must have a white body.
  • Type Y must have a yellow body.

Appearance Requirements

The top and sides of the jiggle bar tile must be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration, and any other defects that adversely affect appearance and application.

The bottom of the jiggle bar tile may be of a rough texture and must be free from gloss, glaze, or any other substance that may reduce its bond to the adhesive. Excluding any protrusions intentionally manufactured as functional characteristics of the tile, the base must not deviate from a true plane by more than 2 mm (approximately 1/16 in.).
Color Requirements

The CIE chromaticity coordinates of the material, when determined in accordance with "Tex-839-B, Determining Color in Reflective Materials” must fall within an area having the following corner points:

<table>
<thead>
<tr>
<th>CIE Chromaticity Coordinate Corner Points</th>
<th>x</th>
<th>y</th>
<th>x</th>
<th>Y</th>
<th>X</th>
<th>y</th>
<th>x</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>0.290</td>
<td>0.316</td>
<td>0.310</td>
<td>0.296</td>
<td>0.330</td>
<td>0.321</td>
<td>0.310</td>
<td>0.342</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.435</td>
<td>0.485</td>
<td>0.445</td>
<td>0.435</td>
<td>0.544</td>
<td>0.456</td>
<td>0.516</td>
<td>0.484</td>
</tr>
</tbody>
</table>

Luminosity (Y) requirements are:
- White 70 minimum and
- Yellow 50.0 to 70.0.

Individual yellow jiggle bar tile, in any shipment or lot, must not have a variance in chromaticity coordinates x and y greater than 0.025 units. The variance in reflectance must not exceed 10.0 units.

Optical Requirements

Reflective jiggle bar tiles must have an approved reflective device inserted in a protective ramp and adhered to a recess in the ramp base. The reflective device must be as shown on the plans or the invitation to bid, and be capable of providing reflection of amber or white light as required by the requisition or as shown on the plans.

The reflected light of each reflective face must conform to the minimum reflective intensity requirements as follows:

<table>
<thead>
<tr>
<th>Specific Intensity per Reflective Face at 0.2° Observation Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Entrance Angle</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>4°</td>
</tr>
<tr>
<td>20°</td>
</tr>
</tbody>
</table>

Analysis of Design, Color, and Optical Requirements

The lot passes appearance, color, and optical requirements if a combined total of 21 or less nonconformities are recorded. (Nonconformity is a measurement that fails to meet specified requirements.) If a tile has 2 or more nonconformities, all the nonconformities for that tile would be counted. If 22 or more nonconformities are recorded, the lot fails.
Physical Requirements for Ceramic Jiggle Bar Tiles

The glazed surface top and sides must have a mean thickness not less than 125 mm (0.005 in.) when measured no closer than 5 mm (1/4 in.) from the edge of the tile. The thickness will be measured on a fractured edge with a calibrated scale microscope.

The ceramic glaze, when tested in accordance with "Tex-449-A, Determining Crazing Resistance of Ceramic Raised Pavement Markers," must not discolor, craze, spall, or peel when subjected to one cycle of the autoclave test at 1725 kPa (250 lb. per sq. in.).

The water absorption of the jiggle bar tiles must not exceed 2.0% of the original dry weight when tested in accordance with ASTM "C 373, Standard Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products." The exception to this test is that the specimens must be whole tiles and the glaze is not removed.

The compressive (crushing) strength will be determined on a 25 mm (1 in.) diameter right cylinder test specimen, cut through the center portion of the tile by core drilling.

The specimen ends will be ground or lapped to form plane and parallel faces. The specimen faces will be capped with high-strength capping compound to make them perpendicular to the axis of the specimen.

Five specimens will be loaded in accordance with "Tex-418-A, Compressive Strength of Cylindrical Concrete Specimens."

The average compression results will have a quality index value equal to or greater than 1.23. The quality index value will be calculated from the lower specification limit of 41,380 kPa (6,000 lb. per sq. in.). The following equation is used to determine the quality index value.

\[
Q_L = \frac{X - LSL}{s}
\]

Where:

- \(Q_L\) = quality index value
- \(LSL\) = lower specification limit
- \(X\) = average result from test
- \(s\) = standard deviation from test.
The quality index value is a measure used to determine the percent within limits (PWL) for a given sample size. The PWL is the total percent of the normal distribution curve, calculated from the average and standard deviation from the test that is above or below the specification limit. A quality index value of 1.23 or greater for a sample size of 5 corresponds to a PWL of 90 or greater. This indicates that 90% or greater of the normal distribution curve; therefore, 90% or greater of the lot the sample represents is above or below the specification limit.

**Physical Requirements for Nonceramic Jiggle Bar Tiles**

The body must be made of an approved material and must be uniform in color throughout the entire body.

Stability of the color must be such that the reflectance (Y) change for yellow tiles does not exceed 5 units or 3 units for white tiles after 400 hr. exposure in an Atlas Weather-Ometer. Weather-Ometer exposure will be in accordance with ASTM "G 153, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials," using Exposure Cycle 1 (18 min. for water spray in every 120 min. of light exposure).

A random sample of 5 tiles will be tested in accordance with "Tex-434-A, Breaking Strength of Traffic Buttons."

The average strength of the tiles must be within ±20% of the product average obtained from the prequalification samples.

The nonceramic jiggle bar tiles must show no change in shape or color when subjected to the requirements of "Tex-846-B, Testing the Heat Resistance of Reflective Units." The temperature will be 60°C (140°F) with the tile in a vertical position.

**Road Test**

The road test will be conducted on a 4-lane divided highway with an average daily traffic count of 4,000 to 6,000 vehicles per lane. Ceramic and nonceramic jiggle bar tiles will be road tested concurrently with a set of control bars. The section of roadway will have a straight alignment with as few entrance and exit ramps as possible.

The retention rate of the product must be no less than 5% below that of the control bars.

Jiggle bar tiles, which are road tested, must not exhibit any discoloration or blackening. The visual performance of the test product must be equal to or better than the control bars.

Reflectorized jiggle bar tiles must be functional when viewed at a minimum distance of 60 m (approximately 200 ft.) at night from a standard sedan automobile using the low beam headlight setting. All types of tiles must be functional when viewed at a minimum distance of 120 m (approximately 400 ft.) in the daytime.
After 6 wk., 10 nonadjacent samples will be removed from the pavement and tested unwashed in the laboratory for reflectivity and color. Of the 10 jiggle bars pulled, 5 must pass the following minimum reflective values (crystal value only, based on 0.2° observation angle and 4° horizontal entrance angle).

<table>
<thead>
<tr>
<th>Minimum Retroreflectivity at 6 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tile Type</strong></td>
</tr>
<tr>
<td>Low Volume Tile</td>
</tr>
<tr>
<td>High Volume Tile</td>
</tr>
</tbody>
</table>

Eight jiggle bar tiles must meet color requirements.

If the tiles do not meet these values, they will be retested twice within a 12-mo. period in the same manner as above.

<table>
<thead>
<tr>
<th>Retroreflectivity at 6 and 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tile Type</strong></td>
</tr>
<tr>
<td>Low Volume Tile</td>
</tr>
<tr>
<td>High Volume Tile</td>
</tr>
</tbody>
</table>

If the jiggle bar tiles fail to meet the color requirements at any time, they will automatically fail the road test.

Jiggle bar tiles, which meet the 6-wk. values, will be prequalified on a provisional basis pending the results of the 6-mo. retroreflectivity determination. If the jiggle bar tiles meet or exceed the 6-mo. values, they will be prequalified.

If the 6-mo. reflectivity values are below the minimums, they will be removed from provisional prequalification and will be retested at 1 yr. after the initial submission.

### Quality Monitoring Program (QMP)

#### Producer Requirements

Upon obtaining prequalification, a representative from CST/M&P will inspect the producer’s facilities. The producer must show that it has QC facilities that actively participate in the QC of the product as determined by "Tex-820-B, Accrediting Quality Control (QC) Facilities."
Product Requirements

The product must meet the following requirements:

♦ be of stable design indicating that there have been no substantive design changes (changes in composition or manufacturing process) that might affect the quality of the product

♦ manufactured on a continuous basis for at least 6 mo.

♦ have 10 consecutive lots pass all the 'Material Requirements' and

♦ meet the cumulative sample size in the following table for the last 10 consecutive lots.

<table>
<thead>
<tr>
<th>Nonconformities or Nonconforming Items</th>
<th>Acceptable Quality Level (AQL) 25.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>7</td>
<td>49</td>
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<tr>
<td>8</td>
<td>54</td>
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<td>9</td>
<td>59</td>
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<tr>
<td>10</td>
<td>64</td>
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<td>11</td>
<td>69</td>
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<td>12</td>
<td>74</td>
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<td>79</td>
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<td>14</td>
<td>84</td>
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<td>88</td>
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<td>16</td>
<td>93</td>
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<td>17</td>
<td>98</td>
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<tr>
<td>18</td>
<td>102</td>
</tr>
<tr>
<td>19</td>
<td>107</td>
</tr>
<tr>
<td>20</td>
<td>112</td>
</tr>
<tr>
<td>Each Additional</td>
<td>+ 5</td>
</tr>
</tbody>
</table>

The last 2 lots each must not exceed 17 nonconformities. The minimum cumulative sample size is determined by adding the combined number of nonconformities of the last 10 lots and cross-referencing that number to the AQL of 25. For example, if the combined number of nonconformities for the last 10 lots was 20, then the minimum cumulative sample size required to initiate QM would be 112 samples.

If any of these requirements are not met, then the product cannot be placed on the QMP.
**Sampling Frequencies**

If the product took more than 20 lots to become prequalified for the QMP, the initial sampling frequency will be 1 in 5 lots. If the product was prequalified within 20 lots, the sampling frequency will be determined by the following:

<table>
<thead>
<tr>
<th>Products Prequalified within 20 Lots Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>If . . .</td>
</tr>
<tr>
<td>each of the lots had 17 or less total nonconformities,</td>
</tr>
<tr>
<td>the number of nonconformities for each lot were more than</td>
</tr>
<tr>
<td>17 but less than 22,</td>
</tr>
</tbody>
</table>

The sampling frequency will move to the next lowest level by meeting the following conditions.

- The preceding 10 inspected lots are accepted.
- The cumulative results from the preceding 10 lots satisfy the 'ANSI/ASQC' table.
- Each of the last 2 inspected lots had 17 or less nonconformities.
- The Director of CST/M&P approves lowering the frequency.

CST/M&P or its representative will take a minimum of 2 check samples within a 12-mo. period.

**Probation and Removal**

Once on the QMP, if an inspected lot does not meet any of the 'Material Requirements,' then the product will be placed on probation. During probation, all lots will be inspected. Skip-lot inspections will be reinstated if 4 consecutive lots meet all of the ‘Material Requirements.”

If any of the following conditions occur, the product will be removed from the QMP.

- A lot is rejected during probation.
- QMP requalification is not achieved within 10 lots.
- There is no production activity for 2 mos. (The Director of CST/M&P may waive this requirement.)
- The supplier deviates from supplier requirements or product requirements.
- The Director of CST/M&P decides to return to lot-by-lot inspection.

**Requalification**

Material removed from the QMP may be submitted for QMP requalification after 1 yr. has elapsed from the time of removal. To obtain QMP requalification, the material must pass the material prequalification and QMP requirement phases again.
Archived Versions

The following archived versions of "DMS 4100, Jiggle Bar Tile" are available: