Test Procedure for

OPTIMIZED AGGREGATE GRADATION FOR HYDRAULIC CEMENT CONCRETE MIX DESIGNS

TxDOT Designation: Tex-470-A

Effective Date: January 2017

1. SCOPE

1.1 This method outlines the procedure for analyzing combined aggregate gradations for optimized aggregate gradation (OAG) in concrete mix designs.

2. UNITS OF MEASUREMENT

2.1 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

3. APPARATUS

3.1 The apparatus required for sampling aggregates and performing sieve analysis will be as stated in:

- Tex-400-A and
- Tex-401-A.

4. PROCEDURE

4.1 Determine mix design proportions using ACI 211 or other equivalent proportioning procedure prior to performing optimized aggregate gradation analysis. The total volume of aggregate determined from these procedures should equal the combined volume of the coarse, intermediate, and fine aggregates used in the mix design.

4.2 Perform sieve analysis in accordance with Tex-401-A to determine the percent passing for each proposed aggregate stockpile, except use all standard sieves starting with the nominal maximum aggregate size of the proposed coarse aggregate to the No. 200 sieve.

Note 1 — Consider intermediate size aggregates as either coarse or fine aggregate in this test method.

4.3 Determine the cumulative combined percent passing, the cumulative combined percent retained, and the combined percent retained using the equations in Section 5.
Complete the Sieve Analysis Table, based on the example shown in Table 1, with the percent passing and the percent of each aggregate used in the proposed mix design.

Generate the combined Percent Retained Chart described in Section 6. The combined percent retained gradations must meet the following criteria.

- The combined percent retained for each sieve must be within the upper and lower boundaries shown in Figure 1.
- The sum of the percent retained on the No. 8 sieve to the No. 30 must not be less than 15%.
- The sum of the percent retained on the No. 30 sieve to the No. 200 sieve must be between 24% and 34%.

Once the percentage of each aggregate needed to meet the above requirements is determined, use these percentages to complete the mix design proportioning.

**CALCULATIONS**

**5.1** Calculate the cumulative combined percent passing each sieve.

\[
\text{Cumulative Combined % Passing} = \sum \{(A)(B)\}
\]

Where:
- A = % passing
- B = % of aggregate used in proposed mix design.

**5.2** Calculate the cumulative combined percent retained on each sieve.

\[
\text{Cumulative Combined % Retained} = 100\% - C
\]

Where:
- C = Cumulative Combined % Passing.

**5.3** Calculate the combined percent retained on each sieve.

\[
\text{Combined % Retained} = D - E
\]

Where:
- D = Cumulative Combined % Retained and
- E = Cumulative Combined % Retained of next larger size.
Table 1—Example Sieve Analysis Table

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Coarse Aggregate</th>
<th>Fine Aggregate</th>
<th>Cumulative Combined</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agg. 1, % Passing</td>
<td>Agg. 2, % Passing</td>
<td>Agg. 3, % Passing</td>
<td>Agg. 1, % Passing</td>
</tr>
<tr>
<td>2 in.</td>
<td>100</td>
<td>100</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 in.</td>
<td>100</td>
<td>100</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>1 in.</td>
<td>95</td>
<td>100</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>3/4 in.</td>
<td>62</td>
<td>100</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>1/2 in.</td>
<td>35</td>
<td>100</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>3/8 in.</td>
<td>20</td>
<td>95</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>1</td>
<td>65</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>No. 8</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>96</td>
</tr>
<tr>
<td>No. 16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>79</td>
</tr>
<tr>
<td>No. 30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>No. 50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>No. 100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>No. 200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Pan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>% of Aggregate</td>
<td>50%</td>
<td>13%</td>
<td>0%</td>
<td>37%</td>
</tr>
</tbody>
</table>

6. **CHARTS**

6.1 *Percent Retained Chart*—Create the Percent Retained Chart (Figure 1) by plotting the combined percent-retained (y-axis) vs. the sieve sizes (x-axis).
Figure 1—Combined Percent Retained Chart

7. **ARCHIVED VERSIONS**

7.1 Archived versions are available.