5.9.59 FLAT AND ELONGATED PARTICLES IN COARSE MATERIAL TEST
(Kansas Test Method KT-59)

1. SCOPE

This test method covers the determination of the percentage of flat and elongated particles in coarse aggregates. KT-59 reflects testing procedures found in ASTM D 4791.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword
2.2. KT-1; Sampling and Splitting of Aggregates
2.3. KT-2; Sieve Analysis of Aggregates
2.4. AASHTO M 92; Wire-Cloth Sieves for Testing Purposes
2.5. ASTM D 4791; Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

3. DEFINITIONS

3.1. Flat and elongated particles of aggregate—those particles of aggregate having a ratio of length to thickness greater than a specified value.

3.2. A flat and elongated particle exists when the particle’s small ratio (the 1 in 5:1) slides the full length through the opening established by the large ration number (the 5 in 5:1). EXAMPLE: Checking flat and elongated particles requires comparing the length vs. thickness. After setting the large ratio to the maximum length of the particle, attempt to slide the flattest portion of the particle horizontally through the opening of the small ratio. If the particle passes clear through the opening, then the particle is flat and elongated.

4. SIGNIFICANCE AND USE

4.1. Flat and elongated particles of aggregates, for some construction uses, may interfere with consolidation and result in harsh, difficult to place materials.

4.2. This test method provides a means for checking compliance with specifications that limit such particles, or to determine the relative shape characteristics of coarse aggregates.

5. APPARATUS

5.1. Use apparatus suitable for testing aggregate particles for compliance with the definition in Section 3.1 of this test method, at the dimensional ratios desired.

5.1.1. The proportional caliper device illustrated in Figure 1 is an example of all apparatus suitable for this test method. It consists of a base plate with two fixed posts and a swinging arm mounted between them so that the openings between the arms and the posts maintain a constant ratio.
The caliper and pins are to be perpendicular to the base plate and raise at least 2 in (50 mm) in height. Design the caliper to touch the length of the fixed pins simultaneously. Provide a 5:1 ratio between the two fixed pins (or as required by contract documents). Design the center pin so the caliper can be easily locked into position. Make the base plate, caliper and pins of rigid and durable materials.

Figure 1 illustrates a device on which the ratio 5:1 is set.

5.1.2. Balance to meet the requirements of Part V, 5.9; Sampling and Test Methods Foreword, for the class of general purpose balance required for the principal sample mass of the sample being tested.

5.1.3. Drying oven capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C).

5.1.4. Sieves meeting AASHTO M 92.

6. SAMPLING

6.1. Sample the coarse aggregate in accordance with KT-1, Section 3. KT-2, Sections 4.2 and 4.3 provides the mass requirements from the field.

6.2. Thoroughly mix the test sample and reduce it to an amount suitable for testing using the mass desired when dry and as an end result of the reduction. Reduction to an exact predetermined mass is not permitted. The mass of the test sample shall conform to the following:

<table>
<thead>
<tr>
<th>Nominal Maximum Size</th>
<th>Minimum Mass of Test Sample, lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>1 lb (0.5 kg)</td>
</tr>
<tr>
<td>3/8 in (9.5 mm)</td>
<td>2 lb (1 kg)</td>
</tr>
<tr>
<td>1/2 in (12.5 mm)</td>
<td>4 lb (2 kg)</td>
</tr>
<tr>
<td>3/4 in (19.0 mm)</td>
<td>11 lb (5 kg)</td>
</tr>
<tr>
<td>1 (25.0 mm)</td>
<td>22 lb (10 kg)</td>
</tr>
<tr>
<td>1 1/2 in (37.5 mm)</td>
<td>33 lb (15 kg)</td>
</tr>
</tbody>
</table>

7. PROCEDURE
7.1. Oven dry the sample to constant mass at a temperature of 230 ± 9°F (110 ± 5°C).

7.2. Sieve the sample of coarse aggregate to be tested in accordance with KT-2, Section 6. Discard material passing the No. 4 (4.75 mm) sieve. Reduce each size fraction larger than the No. 4 (4.75 mm) sieve present in the amount of 10% or more of the original sample in accordance with KT-1, Section 4 until approximately 100 particles are obtained.

7.3. With the proportional device set at a 5:1 ratio (or as required by the contract documents), test each of the particles in each size fraction for flat and elongated.

7.3.1. Use the proportional caliper device, shown in Figure 1. Set the larger opening equal to the particle length. The particle is flat and elongated if the flattest portion of the particle can be placed through the smaller opening. Determine the proportion of the sample in each group by mass.

8. CALCULATIONS

8.1. Calculate the percent of flat and elongate particles to the nearest 1% for each sieve size greater than No. 4 (4.75 mm).

8.2. When a weighted average for a sample is required, assume that the sieve sizes not tested (those representing less than 10% of the sample) have the same percentage of flat and elongated particles as the next smaller or the next larger size, or use the average for the next smaller and larger sizes, if both are present.

8.3. Calculate the flat and elongated on each sieve:

\[
\% \text{ F&E} \quad d = \frac{c(100)}{b}
\]

Where:
\[
c = \text{mass of flat and elongated particles}
\]
\[
b = \text{mass of 100+/- particles tested}
\]

Calculate the % weighted of F&E on each sieve:

\[
e = \frac{(a)(d)}{100}
\]

Where:
\[
a = \% \text{ of original sample retained on sieve}
\]
\[
d = \% \text{ F&E}
\]
\[
e = \text{weighted %}
\]
Calculate to the % total weighted F&E for a given sample:

\[ \% \text{ total weighted F&E (f)} = \text{sum of all individual weighted percent F&E} \]

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Individual Weight (g)</th>
<th>% Each Size Fraction = a</th>
<th>*Mass of Reduced Fraction (g) = b</th>
<th>Failed Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mass (g) = c</td>
<td>% Failed = d</td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1&quot;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>900</td>
<td>60</td>
<td>150</td>
<td>27</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>400</td>
<td>27</td>
<td>75</td>
<td>8</td>
</tr>
<tr>
<td>#4</td>
<td>50</td>
<td>3</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Original Mass</td>
<td>1500</td>
<td></td>
<td>Total % F &amp; E =</td>
<td>14</td>
</tr>
</tbody>
</table>

*individual mass quantities are after reduction to approximately 100 pieces (Section 7.2, of this test method)

**NOTE:** If percent retained on sieve is less than 10% do not test for flat and elongated.

**NOTE:** If percent retained on sieve is less than 10% use %F&E from adjacent sieve or average of next larger and next smaller sieve.

9. **REPORT**

9.1. Include the following information in the report:

9.1.2. Grading of the aggregate sample, showing percentage retained on each sieve.

9.1.3. Percentages, calculated by mass for flat and elongated particles, for each sieve size tested, and the combined aggregate percent for flat and elongated particles.

9.1.4. When required, weighted average percentages based on the actual or assumed proportions of the various sieve sizes tested. Report the grading used for the weighted average if different from that in Section 9.1.2 of this test method.

9.1.5. Record the flat and elongated particles to the nearest 1%. Report the flat and elongated particles to the nearest 1%.
10. PRECISION AND BIAS

10.1. Precision-The precision of this test method is found in ASTM D 4791.

10.2. Bias-Since there is no accepted reference material suitable for determining the bias for this test method no statement on bias is being made.