Understanding the Limits of Deleterious Materials of Aggregates for Airfield Pavement Job Specifications

ACPA 54th Annual Meeting
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Three Types of Concrete

- Labcrete
- Fieldcrete
- Legalcrete
Definition of Deleterious

[del-i-teer-ee-uh s]

*adjective*

- Causing harm or damage
- Harmful often in a subtle or unexpected way
2.3.2.4 Deleterious Materials – Airfield Pavements

- The amount of deleterious material in each size group of coarse aggregate shall not exceed the limits shown in Table 5, determined in accordance with the test methods shown.
### Table 5 – Limits of Deleterious Materials in Coarse Aggregate for Airfield Pavements

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage by Mass (Severe Weather)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Lumps &amp; Friable Particles (ASTM C142)</td>
<td>0.2</td>
</tr>
<tr>
<td>Shale (ASTM C295)</td>
<td>0.1</td>
</tr>
<tr>
<td>Material Finer than 0.075 mm (No. 200 sieve) (ASTM C117)</td>
<td>0.5</td>
</tr>
<tr>
<td>Lightweight Particles (ASTM C123)</td>
<td>0.2</td>
</tr>
<tr>
<td>Clay Ironstone (ASTM C295)</td>
<td>0.1</td>
</tr>
<tr>
<td>Chert &amp; Cherty Stone (less than 2.4 Sp. Gr.) (ASTM C123 &amp; ASTM C295)</td>
<td>0.1</td>
</tr>
<tr>
<td>Claystone, Mudstone, and Siltstone (ASTM C295)</td>
<td>0.1</td>
</tr>
<tr>
<td>Shaly and Argillaceous Limestone (ASTM C295)</td>
<td>0.2</td>
</tr>
<tr>
<td>Other Soft Particles (COE CRD-C130)</td>
<td>1.0</td>
</tr>
<tr>
<td>Total of all deleterious substances exclusive of material finer than 0.075 mm (No. 200 sieve)</td>
<td>1.0</td>
</tr>
</tbody>
</table>
ASTM C117, Material Finer than 0.075 mm (No. 200 sieve)

- Silt, clay, and loose dust may form a coating the aggregate particles.
- Weaken the bond between the cement paste and aggregate.
- Increases water demand
ASTM C142, Clay Lumps & Friable Particles

- Clay lumps present in concrete may absorb some of the mixing water
- Cause pop outs in hardened concrete
- Affect durability and wear resistance
- Can break up during mixing and increase the mixing water demand
ASTM C123, Lightweight Particles

- Coal, lignite, chert
- Low density materials such as wood or fibrous materials
- Excessive amounts will affect durability
- If impurities are near the surface, pop outs or staining can occur
Shale

- Identified by ASTM C295
- Fine-grained, thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.
Clay ironstone

- Identified by ASTM C295
- Defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand.
- It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors.
- Other names are commonly used for clay ironstone are “chocolate bars” and limonite concretions.
Chert and Cherty Stone

- Identified by ASTM C295
- Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica.
- It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye.
- Its hardness is such that it scratches glass but is not scratched by a knife blade.
- It may contain impurities such as clay, carbonates, iron oxides, and other minerals.
- Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone.
Claystone, mudstone, and siltstone

- Identified by ASTM C295
- Defined as a massive fine-grained sedimentary rock that consists predominantly of indurated clay or silt without laminations or fissility.
- It may be indurated either by compaction or be cementation.
Shaly and argillaceous limestone

- Identified by ASTM C295
- Defined as limestone in which shale occurs as one or more thin beds or laminae.
- These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch.
- Argillaceous limestone is defined as limestone in which clay minerals occur disseminated in the stone in the amount of 10-50 % by weight of the rock: when these make up from 50-90%, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).
CRD-C 130, Soft Particles

- Cause pop outs
- Affects durability
Punch line – Prevent FOD

Foreign Object Debris
2.3.2.5 Testing Sequence / Deleterious Materials – Airfields Only

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 90 kg [200 lb] for the 19 mm [3/4 in] and larger maximum size and 12 kg [25 lbs] for the 4.75 to 19 mm [No. 4 to 3/4 in] coarse aggregate.
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Testing Sequence

- Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.
- Step 2: Test remaining full sample for clay lumps and friable particles and remove.
- Step 3: Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.
- Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other materials less than 2.40 specific gravity to the sample.
- Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and argillaceous limestone, and remove.
- Step 6: Test a minimum of one-fifth of remaining full sample for other soft particles.
Pros & Cons

**Pros**
- Careful and strict testing will minimize pop outs.
- Lower water demand during fabrication.
- Strong aggregate to paste bond to increase stiffness

**Cons**
- More stringent than most specs
- More expensive
- Longer turn around time for results
- More labor intensive