Specifications – What Do They Really Mean

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SPECIFICATIONS:

A detailed, exact statement of particulars, especially a statement prescribing materials, dimensions, and quality of work for something to be built, installed or manufactured.

What does this mean?

How do airfield concrete pavement specifications fit into this definition?
Specifications – What do the really mean?

- Dimensions?
- Quality?
- Materials?
Materials

- **Cement**
  - C 150 Portland Cement – Type I, II, III, IV
  - C 595 Blended Cement – blended type IP, IS
  - ASTM C 1157 – High early, sulfate resistance, high sulfate resistance, low heat of hydrations

- **Admixtures**
  - C 618 Fly Ash, C 989 Slag, C 1240 Silica Fume
  - C 260 Air Entraining Agent

- **Aggregate**
  - C 33
Quality Is Inherent in The Specifications

Design Not Related to Surface Defects

The Contractor Did It

The Engineer ain’t got a clue
SPECIFICATIONS?

Strength and Thickness

Durability Measurement of Quality?
How do we build quality?

- Consistency

- Desired Characteristics
  - workability
  - strength
  - durability
We All Intend to do GOOD!

- Quality is not about Strength
- Quality is not about proper air content
- Quality is not about “slump” of plastic concrete
- Quality is not about 100% Inspection

Quality is about:
- Consistency
- Trends Analysis
- ID of Critical Variables Before They Become Statistics
- Quality is not Obtained Through Duplicative Testing
Stakeholders

- Owner
- Engineers
- Contractors
- Concrete Suppliers
- Others

> Each wants quality
> Quality finished product
> Reputation/Perception
> Full Payment for work
Engineer of Record

- Creates Detailed and Executable plans and specifications (to meet owners needs)
- Reviews Shop Drawings
- Ensures Compliance with Specs
- Manages Liability
- Makes a little profit
Contractor

- Good Craftsmanship
- Needs Concrete that Satisfies Owner
  - Engineer (Technical)
  - Architect (Appearance)
  - Crew (Place and Finish)
- Profitable
  - Not always the Cheapest
  - Informed Purchaser
Will Specifications written for this work for:

Should we have the construction method in mind during development of specifications?

Guide or boilerplate specifications?
Aircraft Loading

- Important to remember that one aircraft wheel load can easily exceed the total gross weight of many vehicles, including semi-tractor trailers.
- Aircraft wheel loads are approaching 65,000-lbs and tire pressures exceed 200 psi.
Pavements conforming to these specifications are generally more challenging to construct than typical state highway pavements.

The specification has evolved over the years to keep pace with operational characteristics required to support commercial aircraft traffic.

High quality is desired and achieving quality is the responsibility of both Contractor and Engineer.
Using P-501 & 32 13 11

- Rigid Pavement Guide Specification
- Difficult to meet
- Contradictions
- Notes to the engineer
- Need to understand the intent
- Once under contract – rule of law
  - If not well-written can create disputes
32 13 11 - 3.9.5 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Slabs containing weak surfaces less than 1/4 inch (6 mm) thick shall be diamond ground to remove the weak surface. Diamond grinding shall be in accordance with paragraph: *Diamond Grinding of PCC Surfaces in PART 1*. All ground areas shall meet the thickness, smoothness and grade criteria of paragraph: *Acceptance Requirements in PART 1*. Slabs containing weak surfaces greater than 6 mm 1/4 inch thick shall be removed and replaced.

**Diamond Grinding of PCC Surfaces in Part 1:**
- Discussed in terms of smoothness and plan grade
- No more that ¼ inch depth
- No more than 10% of any sub lot
501-2.3 CEMENTITIOUS MATERIALS.

a. Flyash or Natural Pozzolan. Flyash shall meet the requirements of ASTM C 618, Class F or N with the exception of loss of ignition, where the maximum shall be less than 6 percent. [The following tests in Supplementary Optional Physical Requirements of Table 3 contained in ASTM C 618 shall apply: Select the appropriate tests when project specific conditions or exposures dictate (Increase of drying shrinkage of mortar bar); (Effectiveness in Contributing to Sulfate Resistance Procedure A) or (Effectiveness in Contributing to Sulfate Resistance Procedure B). Select either sulfate resistance test, but not both.] Class F or N flyash for use in mitigating alkali-silica reactivity shall have a Calcium Oxide (CaO) content of less than 13 percent and a total equivalent alkali content less than 3 percent. Flyash such as is produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C-618 reports for each source of flyash proposed in the mix design, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Engineer.

- How does this provision relate to 501-2.1 AGGREGATES (reactivity)?
- What specific test procedure is used to compute the total equivalent alkali content?
The percentage of wear shall be no more than [] when tested in accordance with ASTM C 131 or ASTM C 535.

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The Engineer shall specify the percentage of wear. It should not exceed 40 percent. In certain cases where aggregate of this quality cannot be obtained economically, aggregate with a higher percentage of wear may be used if a satisfactory service record of at least 5 years’ duration under similar conditions of service and exposure has been demonstrated.
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Paragraph 501-2.1 Aggregates

- Reactivity
  - Standard ASR testing on individual aggregates
  - ASTM C 1260 and ASTM C 1567
  - If deicers are used, EB # 70 applies (note)
  - Combined materials test?

- ASTM C 666 – Rapid Freeze/Thaw Test (note)

- Percentage of ware <40 in LA Abrasion test (note)
<table>
<thead>
<tr>
<th>Sieve Designations (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>in. mm</td>
<td>2&quot;-1/2</td>
</tr>
<tr>
<td>2-1/2</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>50.8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>38.1</td>
</tr>
<tr>
<td>1</td>
<td>25.0</td>
</tr>
<tr>
<td>3/4</td>
<td>19.0</td>
</tr>
<tr>
<td>1/2½</td>
<td>12.5</td>
</tr>
<tr>
<td>3/8</td>
<td>9.5</td>
</tr>
<tr>
<td>No. 4</td>
<td>4.75</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.36</td>
</tr>
</tbody>
</table>

**TABLE 2. GRADATION FOR COARSE AGGREGATE**

**ASTM C 33**

**Percentage by Weight Passing Sieves**

<table>
<thead>
<tr>
<th>Sieve Designations (square openings)</th>
<th>From 2&quot; to No. 4 (50.8 mm - 4.75 mm)</th>
<th>From 1-1/2&quot; to No. 4 (38.1 mm - 4.75 mm)</th>
<th>From 1&quot; to No. 4 (25.0 mm-4.75 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>in. mm</td>
<td>#3</td>
<td>#57</td>
<td>#4</td>
</tr>
<tr>
<td>2-1/2</td>
<td>63</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>50.8</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2</td>
<td>38.1</td>
<td>35-70</td>
<td>100</td>
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<tr>
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<td>25.0</td>
<td>0-15</td>
<td>95-100</td>
</tr>
<tr>
<td>3/4</td>
<td>19.0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1/2</td>
<td>12.5</td>
<td>0-5</td>
<td>25-60</td>
</tr>
<tr>
<td>3/8</td>
<td>9.5</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>No. 4</td>
<td>4.75</td>
<td>---</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.36</td>
<td>---</td>
<td>0-5</td>
</tr>
</tbody>
</table>

Aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations may be substituted for the requirements of Tables 1 and Table 2 with prior approval of the Engineer and the FAA. The contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture.

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Aggregate Grading (Optimize)

Gap-graded

Well-graded
Combined Aggregate Grading

- Proportioned for:
  - Workability
  - Finishibility
- Percent Combined Aggregate Retain

Figure 3.5 “Haystack” Particle Distribution for a Uniformly Graded Mixture

Figure 3.1 Percent Combined Aggregate Retained
NOTES:

1. COARSENESS FACTOR = \( \frac{\% \text{ RETAINED ABOVE 9.5mm SIEVE}}{\% \text{ RETAINED ABOVE \#8 SIEVE}} \times 100 \)

2. WORKABILITY FACTOR = \% PASSING \#8
Aggregate Proportioning Guide

Figure 3.3 Workability Box Within Aggregate Proportioning Guide
Paragraph 501-3.1 Proportions

- Minimum cementitious material content – 564 pounds
  - Is this necessary
  - Optimized mixtures may not require this much
- Maximum w/c ratio – 0.45
- Should a minimum be specified?
  - w/c < 0.38 tends to experience uncontrolled early-aged cracks
The Engineer may specify the use of a central plant mixer if deemed necessary for a particular project.

**c. Finishing Equipment.** The standard method of constructing concrete pavements on FAA projects shall be with an approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2200 lbs. per foot of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width. On projects requiring less than 500 square yards of cement concrete pavement or requiring individual placement areas of less than 500 square yards, or irregular areas at locations inaccessible to slip-form paving equipment, cement concrete pavement may be placed with approved placement and finishing equipment utilizing stationary side forms. Hand scr eeding and float finishing may only be utilized on small irregular areas as allowed by the Engineer.

**d. Vibrators.** Vibrator shall be the internal type. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025-0.05 inches (0.06-0.13 cm). The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of ACI 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer. Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309, Guide for Consolidation of Concrete.
Paragraph 501-4.20 Existing Concrete Pavement Removal and Repair

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NOTE: It is imperative that sufficient exploration be made (not just reference to as-built drawings) so that the designer knows exactly what the existing (in place) pavement is at the jointing area—dowels, keys, tie bars, etc. and its condition. Normally the joint between the new pavement and existing pavement should be made at an existing joint in the old pavement.
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If this isn’t done then expect a change order. If existing condition is different that shown on the plan, then the contractor may be due additional compensation based on actual conditions.
Problem with this provision

- What is the intent? Slip form as standard?
- Then why is side forms described in section f?
- Paragraph 501.4.8 Placing Concrete gives the option – side or slip form
  - Note to the engineer give the engineer the choice
  - Needs to be consistent with the intent in 4.1
- Leads to confusion
Paragraph 501-5.2 Acceptance Criteria, Item 3 - smoothness

Use of the profilograph to measure pavement smoothness is optional and will be approved on a case-by-case basis. Use of a profilometer may not be practical for all construction. However, the profilograph is useful for new construction or overlays designed to correct grade and smoothness deficiencies. If the profilograph is to be included, straightedge requirements need only apply in the transverse direction. To include profilograph requirements delete paragraph (5.2e3) and replace with the following:

(3) SMOOTHNESS. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested in the transverse direction with a 16-foot straightedge or other specified device. Surface smoothness deviations shall not exceed 1/4 inch from a 16-foot straightedge at any location, including placement along and spanning any pavement joint or edge.

- The criteria is the 16 foot straight edge
- ¼ inch deviation along the entire straightedge
- California Profilograph is optional on case by case basis on approval by FAA
- Is meaningless to aircraft response
- therefore the PI cannot reflect smoothness as used in P-501
Method of Payment - PWL

Today’s requirements

Quality vs. cost

Boiler Plate Specs shift
Risk to the Contractor

P-501 was developed to share risk

Strength vs. Thickness – should one offset the other?
In summary

- Understand concrete basics
- Compile specs to meet projects requirements within the basics
- Avoid Surprises
- Communicate & Coordinate & inform
- Pre-paving conference
- Keep current with basics
- Be flexible when it really doesn’t matter
- Stand firm when it does
- Use common sense – we are trying to build something in the real world
- Sometimes we have to do more than just “READ” the spec and enforce them
THANK YOU!

Please contact Gary L. Mitchell with questions or comments:
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