



## POLICY AND PROCEDURE DIRECTIVE

James P. Delton  
Assistant State Engineer

TO: ALL MANUAL HOLDERS	PPD NO. 15
SUBJECT:  SUBMITTAL AND APPROVAL OF PORTLAND CEMENT CONCRETE MIX DESIGNS	EFFECTIVE DATE:  February 27, 2009

### 1. GENERAL

1.1 This Policy and Procedure Directive supersedes P.P.D. No. 07-1.

1.2 This Policy and Procedure Directive outlines the procedure to be followed for the submittal and approval of new, and previously approved or used, Portland cement concrete (P.C.C.) mix designs.

1.3 A previously approved or used mix design is defined as either:

- (a) One that has been approved, or used successfully, on an ADOT project within the past 24 months and is recorded in the ADOT Concrete Cylinder Report (CCR) program.
- (b) One that has been used successfully on a non-ADOT project within the past 24 months, and meets the criteria specified herein.

1.4 A trial batch shall be required for any mix design that does not meet the requirements specified in Section 1.3.

1.5 All mix designs, for other than precast or prestressed concrete, must be approved by the Regional Materials Engineer. See Section 3 for additional information.

1.5.1 The Regional Materials Engineer (RME) will maintain a list of all approved P.C.C. mix designs, for other than precast or prestressed concrete, in the ADOT Concrete Cylinder Report (CCR) program. The RME will also have the responsibility of entering all such approved mix designs in the CCR program for review by project personnel and other authorized individuals.

1.6 All mix designs for precast or prestressed concrete must be approved by the Materials Structural Testing Section. See Section 4 for additional information.

1.6.1 The Materials Structural Testing Section will maintain a list of all approved P.C.C. mix designs for precast or prestressed concrete in the ADOT Concrete Cylinder Report (CCR) program. The Materials Structural Testing Section will also have the responsibility of entering all such approved mix designs in the CCR program for review by project personnel and other authorized individuals.

1.7 Approval of mix designs shall not relieve the contractor of full responsibility for the results obtained.

1.8 Concrete mix design submittals will be required from the prime contractor for the project records. Qualified subcontractors on the project may use mix designs that have been identified by the prime contractor as proposed for use on the project and approved by the Engineer.

1.9 Each new or previously used mix design must include a product code, plant designation, and supplier, along with all data required in Section 1006-3.02 of the Specifications. A single product code may include multiple sources of aggregate, cement, fly ash, natural pozzolan, and silica fume. When multiple sources of material are used under one product code, documentation must be provided which shows similar performance using materials from each source. Multiple sources of material must be listed on the mix design as alternative sources.

1.10 An example of a typical P.C.C. mix design is given in Attachment #3. The actual mix design submittal format from individual concrete suppliers will vary. A checklist is provided in Attachment #4 that may be used to verify that all required items are included in the mix design.

## **2. MINIMUM OVER-DESIGN REQUIREMENTS**

2.1 The minimum over-design requirement for all classes and strengths of concrete shall be established for 28-day compressive strength, unless otherwise specified. Trial batch results, prior to the specified compressive strength acceptance age, may be used if they meet the minimum over-design requirement for the specified acceptance age. When production data is available in accordance with Section 2.1.3, the over-design requirement may be established by either using that data or by adhering to a minimum 20% over-design. When production data is used to determine the over-design requirement, the performance of the proposed mix design must equal or exceed the over-design requirement determined in Table B. When production data is not available, or if otherwise desired, the over-design requirement shall be a minimum of 20% of the specified design compressive strength. Trial mixtures may be from laboratory trial batches or full-scale trial batches. Laboratory trial batches are defined in Note 2 of Attachment #1 and Attachment #2. Full-scale trial batches are defined in Note 1 of Attachment #1 and Attachment #2.

2.1.1 The water/cementitious material ratio (w/cm) and cementitious material content for each class and strength of concrete must be in compliance with the specified requirements.

2.1.2 Trial mixtures shall have slump results within the range specified for the proposed work. When air-entrained concrete is specified, the air content shall be in compliance with the specified requirements.

2.1.3 When a production facility has strength test records from an ADOT approved laboratory, which are not more than 24 months old, a sample standard deviation ( $s_s$ ) may be used to establish the required over-design. Test records shall comply with the following criteria:

- (a) Shall represent materials, quality control procedures, and conditions similar to those expected on the project.
- (b) Shall represent concrete produced to meet a compressive strength, or strengths, within 1000 psi of the specified design compressive strength.
- (c) Shall consist of at least 15 consecutive strength tests that span a period of not less than 45 days. If the test record consists of at least 30 consecutive tests, the standard deviation ( $s_s$ ) of those tests is used. If the test record consists of 15 to 29 consecutive tests, the standard deviation of those tests shall be modified in accordance with Table A.

Table A	
No. of tests *	Modification factor for sample standard deviation †
< 15	Minimum 20% over-design
15	1.16
20	1.08
25	1.03
30 or more	1.00
* For 15 to 29 tests, interpolate for intermediate number of tests. † Modified sample standard deviation, $s_s$ , to be used to determine the required minimum over-design compressive strength, $f'_{cr}$ , in Table B.	

2.1.3.1 The required minimum over-design compressive strength shall be determined by the equations shown in Table B.

Table B	
Specified design compressive strength, psi	Required minimum over-design compressive strength, psi
$f'_c \leq 5000$	Use the larger value computed from these two equations: $f'_{cr} = f'_c + 1.34s_s$ $f'_{cr} = f'_c + 2.33s_s - 500$
$f'_c > 5000$	Use the larger value computed from these two equations: $f'_{cr} = f'_c + 1.34s_s$ $f'_{cr} = 0.90 f'_c + 2.33s_s$
$f'_c$ = Specified design compressive strength. $f'_{cr}$ = Required minimum over-design compressive strength. $s_s$ = Standard deviation, or modified standard deviation, as determined in Section 2.1.3(c) and Table A.	

2.1.4 Trial mixtures with a range of proportions that will produce a corresponding range of compressive strengths encompassing the minimum over-design compressive strength may be used to determine the specified mix design proportions. This will require multiple trial batches with different mixture proportions. Documentation must be submitted which clearly indicates how the compressive strength is related to the different mixture proportions.

### 3. PROJECT/REGIONAL MATERIALS ENGINEER RESPONSIBILITIES

3.1 Attachment #1, "P.C.C. Mix Design Submittal and Approval Process for other than Precast or Prestressed Concrete", provides the submittal and approval process for both new and previously used mix designs for other than precast or prestressed concrete. All mix designs will require approval for the intended use on a project. For previously used mix designs, this will include a check of the intended use as well as a review of the mix history in the CCR program.

3.2 Mix designs, for other than precast or prestressed concrete, must be prepared by or under the direction of, and signed by, an individual with one of the following qualifications:

- (a) A registered professional engineer.
- (b) A NICET (National Institute for Certification in Engineering Technologies) Level III or higher certified technician in the concrete subfield.
- (c) A NRMCA (National Ready Mixed Concrete Association) Level 3 Certified Concrete Technologist.
- (d) An ACI (American Concrete Institute) Certified Concrete Laboratory Testing Technician Level 2 or Grade II.

3.2.1 Individuals preparing and submitting mix designs, for other than precast or prestressed concrete, shall have experience in the development of such mix designs and mix design testing.

3.3 The following outlines the process that is to be followed for submittal and approval of P.C.C. mix designs for other than precast or prestressed concrete:

- (1) The Resident Engineer receives the mix design submittal from the prime contractor. For mix designs that have previously been used successfully on non-ADOT projects within the past 24 months, the mix design submittal must include supporting test data meeting the requirements of Section 2.1.3 from an ADOT approved laboratory. For mix designs that have previously been approved, or used successfully, on ADOT projects within the past 24 months, it may be required that the mix design submittal include supporting data from an ADOT approved laboratory.
- (2) The Resident Engineer reviews the mix design submittal for accuracy, completeness, and identification/appropriateness of its intended use.
- (3) Within two working days after receiving the mix design submittal, the Resident Engineer sends a copy to the Regional Materials Engineer.
- (4) The Regional Materials Engineer reviews the mix design submittal for accuracy and completeness. In addition, the Regional Materials Engineer reviews mix history if available. The Regional Materials Engineer will determine if a trial batch will be required in accordance with Attachment #1. When a trial batch is required, it must meet the requirements of Section 2. The mix design will be approved only after the receipt of all data, including the test results for compressive strength.

- (5) The Regional Materials Engineer will approve or disapprove the use of the mix design and notify the Resident Engineer within five working days of receiving all required information, including the trial batch results.
- (6) The Regional Materials Engineer enters approved mix designs into the CCR program as soon as possible.

3.4 The Resident Engineer may accept a letter listing specific previously approved mix designs that the contractor intends to use on the project. Such a list shall clearly identify the project name and number (including TRACS number), contractor, mix design product codes, intended use, supplier, and primary plant and back-up plants. Such letter shall certify that the current plant production of the mix design proposed for the use does not deviate from the previously approved mix design by more than the limits stated in Section 5. Copies of mix designs and current production plant batch weights are not required to be included with the letter.

#### **4. MATERIALS STRUCTURAL TESTING SECTION RESPONSIBILITIES**

4.1 Attachment #2, "P.C.C. Mix Design Submittal and Approval Process for Precast or Prestressed Concrete", provides the submittal and approval process for both new and previously used mix designs for precast or prestressed concrete. All mix designs will require approval for the intended use on a project. For previously used mix designs, this will include a check of the intended use as well as a review of the mix history in the CCR program.

4.2 Mix designs for precast or prestressed concrete must be prepared by or under the direction of, and signed by, an individual with one of the following qualifications:

- (a) A registered professional engineer.
- (b) A NICET (National Institute for Certification in Engineering Technologies) Level III or higher certified technician in the concrete subfield.
- (c) A NRMCA (National Ready Mixed Concrete Association) Level 3 Certified Concrete Technologist.
- (d) An ACI (American Concrete Institute) Certified Concrete Laboratory Testing Technician Level 2 or Grade II.
- (e) A PCI (Precast/Prestressed Concrete Institute) Quality Control Technician/Inspector Level II or higher.

4.2.1 Individuals preparing and submitting mix designs for precast or prestressed concrete shall have experience in the development of such mix designs and mix design testing.

4.3 The following outlines the process that is to be followed for submittal and approval of P.C.C. mix designs for precast or prestressed concrete:

- (1) The Materials Structural Testing Section receives the mix design submittal from the precast or prestressed manufacturer. For mix designs that have previously been used successfully on non-DOT projects within the past 24 months, the mix design submittal must include supporting test data meeting the requirements of Section 2.1.3 from an ADOT approved laboratory. For mix designs that have previously been approved, or used successfully, on ADOT projects within the past 24 months, it may be required that the mix design submittal include supporting data from an ADOT approved laboratory.
- (2) If the Resident Engineer receives the mix design submittal from the prime contractor, the Resident Engineer sends a copy of the mix design submittal to the Materials Structural Testing Section.
- (3) The Materials Structural Testing Section reviews the mix design submittal for accuracy and completeness. In addition, the Materials Structural Testing Section reviews mix history if available. The Materials Structural Testing Section will determine if a trial batch will be required in accordance with Attachment #2. When a trial batch is required, it must meet the requirements of Section 2. The mix design will be approved only after the receipt of all data, including the test results for compressive strength.
- (4) The Materials Structural Testing Section will approve or disapprove the use of the mix design and notify the Resident Engineer within five working days of receiving all required information, including the trial batch results.
- (5) The Materials Structural Testing Section enters approved mix designs into the CCR program as soon as possible.

## **5. MODIFICATION TO MIX DESIGNS AND PRODUCT CODES**

5.1 Modifications that will not require a change in the product code:

5.1.1 Modifications which do not result in batch target weights for the fine aggregate or combined coarse aggregates changing by more than 5 percent from the original approved mix design.

5.1.2 Modifications to the percentage of coarse aggregate fractions that do not change the total coarse aggregate volume.

5.1.3 Modifications to dosages of chemical or air-entraining admixtures, within the manufacturer's recommendations.

5.2 Modifications that may require a change in the product code or performance verification:

5.2.1 The incorporation or elimination of chemical admixtures which are listed on the mix design to effect a change in the time-of-set (retarders or accelerators).

5.2.2 Modification of the type, or the incorporation or elimination, of a chemical or air-entraining admixture.

5.2.3 Modification to the percentage of fly ash, natural pozzolan, or silica fume.

5.2.4 Modifications made in accordance with the provisions of Section 1.9.

5.3 Modifications that will require a change in the product code and may require performance verification:

5.3.1 Modification to the class of concrete per Table 1006-A of the Specifications.

5.3.2 Modification to the type/class of cement, fly ash, natural pozzolan, or silica fume.

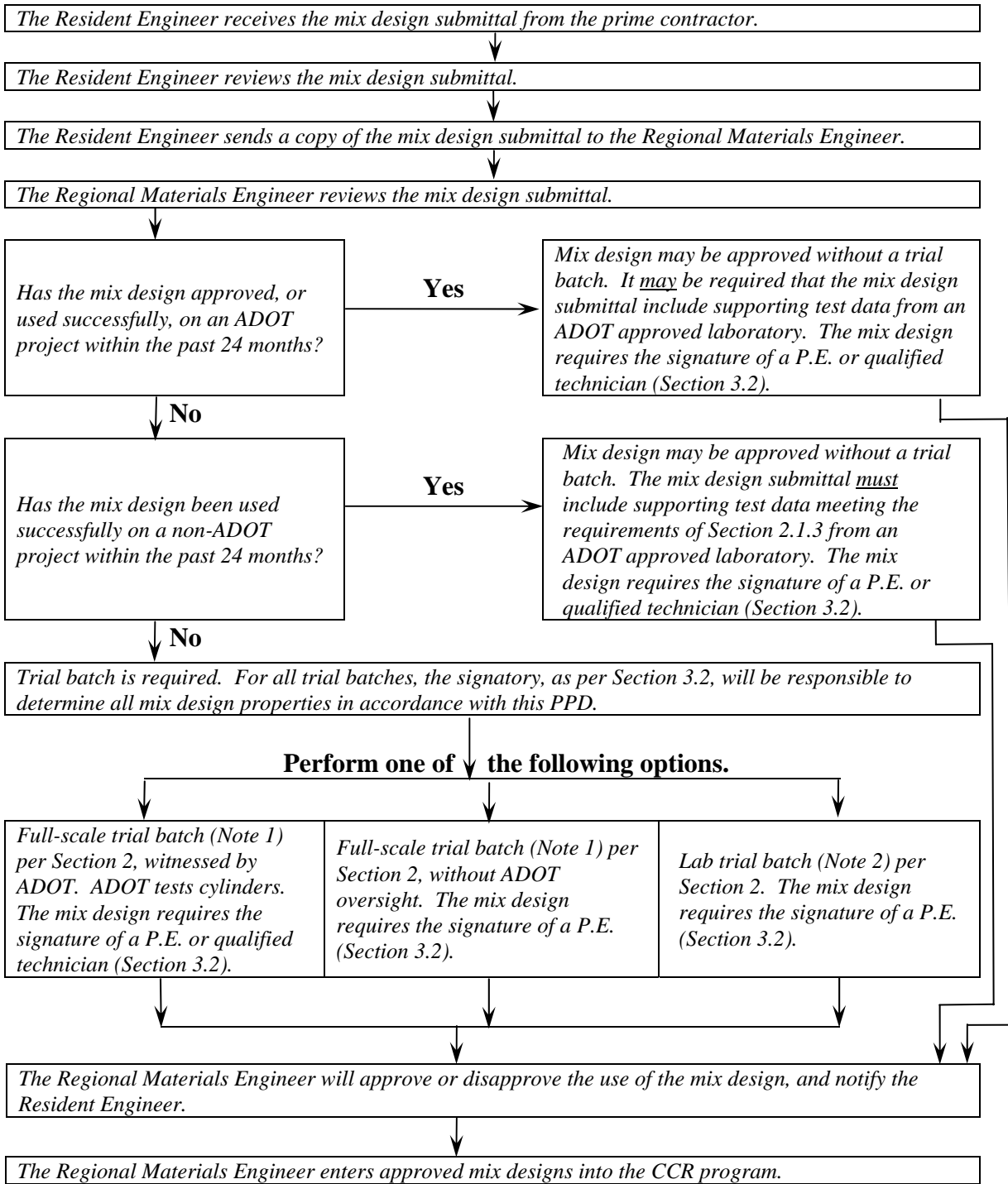
5.3.3 Modification to a coarse aggregate size designation.



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James P. Delton, P.E.  
Assistant State Engineer  
Materials Group

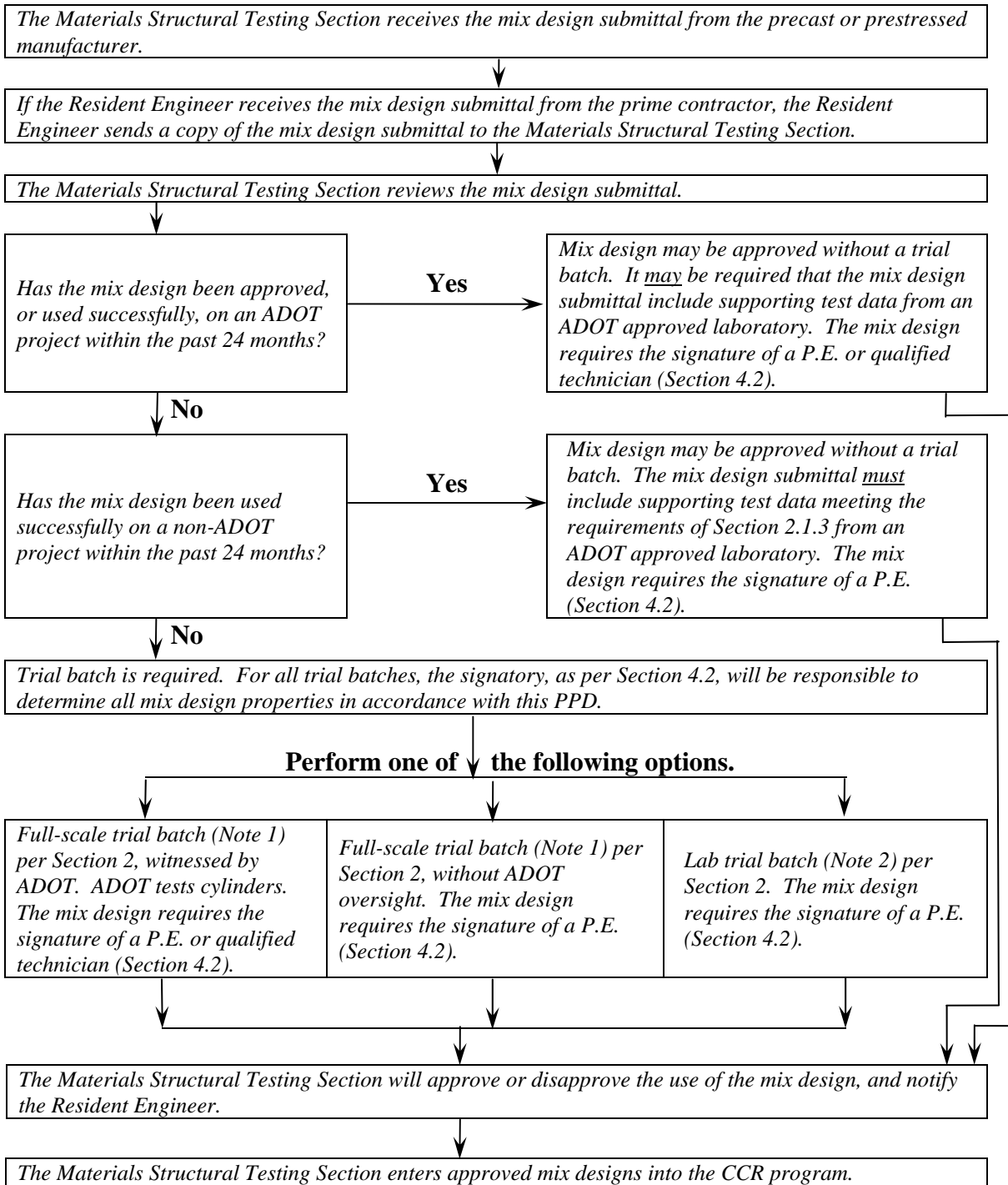




Note 1: The materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in production.

Note 2: Proportionally reduced quantities of the materials that are to be used in production, mixed in a portable or laboratory concrete mixer.

### PCC Mix Design Submittal and Approval Process for other than Precast or Prestressed Concrete



Note 1: The materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in production.

Note 2: Proportionally reduced quantities of the materials that are to be used in production, mixed in a portable or laboratory concrete mixer.

### P.C.C. Mix Design Submittal and Approval Process for Precast or Prestressed Concrete

### XYZ Concrete Ready Mix

Product Code: XYZ123456  
 Class and Strength: ADOT CLASS S -- 4000 psi @ 28 Days  
 Intended Use: Caissons, Columns, Abutments  
 Project Name: Big Head -- Small Feet  
 Project Number: F-099-99(9)  
 TRACS Number: H999901C  
 Contractor: ABC Contracting  
 Ready Mix Plant: XYZ Concrete Ready Mix - Dobson Plant #1  
 Address: 999 E. Happy Days Drive  
 Scottsbluff, AZ 99999

Date: 12/11/08

	<b>E</b>	Weight per Cubic Yard	Specific Gravity	Volume
Cement		494 lbs	3.15	2.51 c.f.
Fly Ash		164 lbs	2.10	1.25 c.f.
Aggregate Ratios:				
50% 1" Coarse Aggregate	<b>X</b>	86%	1412 lbs (S.S.D.)	2.65
8% 3/8" Coarse Aggregate		14%	226 lbs (S.S.D.)	2.65
58% Total Coarse Aggregate (AASHTO Size No. 57)		100%		
42% Fine Aggregate		1186 lbs (S.S.D.)	2.65	7.17 c.f.
Allowable Water: 36 Gallons	<b>A</b>	300 lbs	1.00	4.81 c.f.
Total Weight per Cubic Yard: 3782 lbs				
Admixtures:				
Pozzoloth 220N		20 fl. oz. (3 oz./cwt of CM)		
Pozzoloth NC 534	<b>M</b>	0 fl. oz. (AS NEEDED)		
5% Air - Micro Air (4 - 7%)		8 fl. oz. (1.25 oz/cwt of CM)		1.35 c.f.
				Total Volume: 27.00 c.f.
Slump: 4.0" +/- 1"    W/CM Ratio: 0.46    Unit Weight: 140.1 pcf				

<u>Materials</u>	<u>Source - Type</u>	<b>P</b>
Cement	SRMG Type I/II/V low alkali, Clarkdale Plant	
Fly ash	SRMG Cholla Class F, Joseph City, AZ SRMG Four Corners Class F, Fruitland, NM	
1" Coarse Aggregate	SRMG Dobson Facility, CM2218 SRMG Higley Pit, CM2055	<b>L</b>
3/8" Coarse Aggregate	SRMG Dobson Facility, CM2218 SRMG Higley Pit, CM2055	
Fine Aggregate	SRMG Dobson Facility, CM2218 SRMG Higley Pit, CM2055	<b>E</b>
Pozzoloth 220N	BASF, C494 WRA Type A/B/D (2 - 5 oz/cwt of CM -- AS NEEDED)	
Pozzoloth NC 534	BASF, C494 Accelerating Type C (0 - 45 oz/cwt of CM -- AS NEEDED)	
Micro Air	BASF, C260 Air Entrainment (ADJUST AS NEEDED)	

Mix Designed by: \_\_\_\_\_  
 Hank Concreteman, XYZ Ready Mix  
 Technical Services Manager  
 NRMCA Level 3 Certified Concrete Technologist

### Example of a Typical P.C.C. Mix Design

<b>PCC Mix Design Checklist</b>					
Project Name: Project Number: TRACS Number: Contractor:	Supplier: Product Code: Class/Strength: Date Received:				
Requirement	Basis	Yes	No	N/A	Remarks
Project / TRACS Number	PPD #15				
Contractor	PPD #15				
Supplier Name	PPD #15				
Supplier Address	PPD #15				
Plant Designation	PPD #15				
Product Code	1006-3.02				
Concrete Class & Strength	1006-3.02				
Fine Aggregate Source (CM #)	1006-3.02				
Coarse Aggregate Source (CM #)	1006-3.02				
Coarse Aggregate Size No.	1006-3.02				
Cement Type	1006-3.02				
Cement Source	1006-3.02				
Class of Fly Ash	1006-2.04				
Fly Ash Source	1006-3.02				
Other Supp. Cementitious Mat'l's. Type	1006-2.04				
Other Supp. Cementitious Mat'l's. Source	1006-3.02				
Admixture Type	1006-3.02				
Admixture Source	1006-3.02				
Admixture Dose	1006-3.02				
Volumetrics (27.00 ± 0.05 Recommended)	1006-3.02				
W/CM Ratio	1006-3.02				
Slump Range	1006-3.02				
Air Range (4%-7% for 3000 feet and higher)	1006-3.01				
Intended Use	1006-3.02				
Signature of Qualified Mix Designer	1006-3.02				
Trial Batch / Mix History	PPD #15				
<b>Notes:</b>					