



ARCHITECTURAL/ENGINEERING BULLETIN

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Bulletin Topic: 35% Fly Ash Content in Concrete

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GENERAL:

This A/E Bulletin sets out goals for fly ash usage for Los Angeles Community College District (LACCD) construction projects.

This bulletin should be read in conjunction with the LACCD letter from Thornton Tomasetti, dated March 4, 2008, attached for reference, regarding fly ash use in concrete. Use of higher volumes of fly ash in concrete and specification modifications are noted below.

LACCD Proposes to use 35% Class F Fly Ash replacement in concrete structural elements and 50 % in site work.

BACKGROUND:

The LACCD has conducted two complete trial batch tests of 50% replacement Class F fly ash concrete mixes. The test data meets the strength requirements of the CBC with DSA amendments. One trial batch used a low-range water reducer to achieve 4000 psi compressive strength in 56 days and the other used a mid-range water reducer to achieve 5000 psi in 56 days. Twining Labs in Long Beach performed the testing and the data is available from the LACCD.

Cement mixed with water creates calcium silicate hydrates, and fly ash reacts with the by products of that process to create more calcium silicate hydrates. In other words, Portland cement and fly ash at these high volumes create sound structural concrete. It should also be noted that the DSA has approved 35% Class F fly ash replacement.

GUIDELINES – REPLACE PORTLAND CEMENT / ELEMENTS WITH STRENGTH REQUIREMENTS:

The following points should be considered when implementing 35% or higher replacement of Portland cement on a project because fly ash can affect the rate of strength gain of concrete. See also the recommended specification clauses following this letter.

1. For columns and walls, the mix should reach a sufficient strength (at least 900 psi) for stripping forms in time to maintain project schedule. Typically, column and wall forms are stripped in 1-2 days, but this should be confirmed with the project's contractor. The 900 psi rule of thumb is for walls with chamfers. If sharp corners are specified, the strength at form stripping should be tested in a mock-up.
2. For beams and slabs, a discussion should take place with the contractor regarding methods. If several stories of reshores are to be left in place as props, it should give the high volume fly ash concrete time to gain strength at its rate. However, if flying forms are used without reshores, the concrete mix probably needs to attain sufficient strength, typically 75% of specified compressive strength, in 3-7 days in order to be self-supporting when forms are stripped.
3. For slabs, a concrete mock-up is recommended because high volumes of fly ash can affect the way concrete finishes. A mock-up allows the concrete subcontractor to familiarize themselves with the amount and timing of bleed water. Curing is crucial for high volume fly ash concrete. See the recommended specification sections below.
4. For retaining walls, backfilling schedule should be discussed with the contractor and the concrete mix should attain its strength fast enough to allow for timely backfilling.
5. Class F fly ash contains varying amounts of carbon, which can affect air entraining admixtures. If the concrete is to be air-entrained, a conversation with the concrete ready mix plant is recommended to confirm adjustments of air entraining admixture dosages.
6. Post-tensioned concrete has high early strength requirements, such as 3000 psi in 48 hours. This is difficult, though not unattainable for high volume fly ash concrete. The early strength gain should be verified in trial batch tests.
7. Thin concrete elements such as slabs on grade or slab on metal deck should be tested in a mock-up to insure that the fly ash's effect on the heat of concrete hardening does not impact strength gain in the field.

GUIDELINES – ELEMENTS WITHOUT EARLY STRENGTH REQUIREMENTS:

For concrete elements that do not have early strength requirements, such as foundations or columns and walls, specification of concrete compressive strength at 56 days or longer is recommended. This allows the fly ash to contribute more to the strength and results in more economical mixes. CBC 2007 refers to ACI 318-05, which in Section 5.1.3 allows specification of compressive strength at other ages than 28 days provided it is designated on the structural drawings.

Class F fly ash can lighten or darken the color of concrete depending on the source and also the particular cement. A mock-up can be used to demonstrate the color for the architect's approval.

Caution and consultations with experts in high volume fly ash concrete are recommended where cold weather concreting or de-icing salts are likely to occur. However, these circumstances are not anticipated for LACCD projects.

RECOMMENDED 03300 CAST-IN-PLACE CONCRETE SPECIFICATION:

The following clauses are recommended for the 03300 Cast-In-Place Concrete specification for projects with fly ash proportions of 35% and higher.

General/Submittals Depending on type of concrete element as discussed in points 1 and 2 in the above.

- Submit copies of mix designs and final batch test results of strength (ASTM C39) at 1, 3, 7, 28 and 56 days.

Products/Concrete Materials/Admixtures.

- Where more than one admixture is used, they shall be compatible. Use of admixtures shall be consistent throughout Work, and shall be present in approved Mock-up.

Products/Concrete Materials/Admixtures.

- Fly Ash: ASTM C618, Class F. Maximum 50% replacement of Portland cement by weight. The fly ash producer shall have a minimum of 5 years experience in the production of acceptable fly ash and shall practice an effective quality control program to guard against contamination of the fly ash. Fly ash used shall be from one source throughout the project. Substitution of sources will be acceptable only if physical testing of concrete mixes containing the substituted material show similar test results and if the color of concrete produced with the substituted material matches the color of previously poured concrete to the satisfaction of the architect.

Products/Concrete Materials/Admixtures.

- Air Entrainment Admixtures: ASTM C260, certified by manufacturer to be compatible with other admixtures including fly ash at a 35% (50%) rate of replacement.

Products/Concrete Mixes

- Where fly ash replacement is 35% or higher, maximum water: cement ratio shall be 0.45.

Execution/Mockup

- Provide a Mock-up for any concrete exposed in the final condition. Use the same materials (including percentage of fly ash specified), forming systems, installation methods, finishing and curing in the mock-up as intended for the final work. The mock-up should simulate likely conditions during construction including temperature, humidity, solar exposure and timing of placement. Schedule the installation time so that the Mock-up may be examined, and any necessary adjustments made, prior to commencing work for architectural concrete. Replace unsatisfactory items as directed. When accepted, Mock-up shall serve as the standard for materials, workmanship, and appearance for such work throughout the project.

Execution/Curing.

- Where fly ash replacement is 35% or higher, floor slabs shall receive a 3-day moist cure and then 1 coat of approved curing compound. All other surfaces, with the exception of foundations, shall receive a coat of approved curing compound immediately after removal of formwork.

Execution/Testing and Inspection.

- If air entrainment is used, test air content twice daily in accordance with ASTM C173.

LACCD - FLY-ASH USAGE GOALS:

The LACCD's objectives for replacement of Portland cement by weight by Class F fly ash are given by type of concrete element. The fly ash usage goals are as follows.

Reinforced concrete elements	<u>% fly ash</u>	<u>Compressive strength by weight</u>	
Foundations, including mats, spread and strip footings, grade beams, thicken slabs & piles	Normal weight Conc. (145lb/cu ft)	35%	4,000 psi at 56 days 4,500 psi at 56 days
Lean concrete, unreinforced/non-Structural concrete.	Normal weight Conc. (145lb/cu ft)	35%	1500 psi at 56 days
Columns	Normal weight Conc. (145lb/cu ft)	35%	4,000 psi at 56 days 5,000 psi at 56 days
Shear walls	Normal weight Conc. (145lb/cu ft)	35%	4,000 psi at 56 days
Retaining walls	Normal weight Conc. (145lb/cu ft)	35%	4,000 psi at 28 days 4,500 psi at 28 days
Beams & slabs, including slabs on metal deck, slabs on grade & stairs on grade, curbs, pads	Normal weight Conc. (145lb/cu ft)	25%	3,000 psi at 28 days 4,000 psi at 28 days 5,000 psi at 28 days
Slabs on metal deck	Lightweight Conc. (110 lb/cu ft)	15%	3,000 psi at 28 days 4,000 psi at 28 days
Post tensioned concrete elements	Normal weight Conc. (145lb/cu ft)	15%	5,000 psi at 28 days