Caltrans Mix Design Requirements, Data Management, and Recent Updates

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Concrete Materials and Testing Branch (CMTB)

Material Engineering and Testing Services (METS)

Statewide Oversight

Conduct Testing

Manage AML

Collaborate & Research

Presentation Overview

1. Caltrans Mix Design Requirements & Approval Procedures

2. Data Interchange for Materials Engineering (DIME)

3. Upcoming updates and current efforts

Caltrans Mix Design Requirements & Approval Procedures

Standard Specifications

- Section 90: Governs all Portland Cement Concrete (PCC)
  - Materials
  - Prequalification
  - Proportioning
  - Mixing
  - Placing
  - Transporting
  - Curing
  - Testing
  - Acceptance
  - Strength
  - Shrinkage
  - Durability

Standard Specifications

- Other sections govern and may supersede Section 90 for specific applications
  - Section 40: Concrete Pavement
    - Requires field qualification or test strip
    - Smoothness and surface finish standards
    - Specifies joint design and construction requirements

Concrete Ingredients

- Covered in Section 90:
  - Cementitious Materials
    - Portland Cement
    - Blended Cement
    - Supplementary Cementitious Materials (SCMs)
  - Aggregates
  - Water
  - Admixtures

Concrete Ingredients – Cementitious Materials

- Must be one of the following:
  1. Combination of Type II or V Portland cement and SCM
  2. Combination of blended cements and SCM
  3. Blended cement

Concrete Ingredients – Portland Cement

- Portland cement must comply with ASTM C150 Type II, III or V
- Additional Caltrans specific requirements:
  - Alkali content

    Must not exceed 0.60 percent by mass of alkalies as $Na_2O + 0.658\ K_2O$
  - Autoclave expansion

    Must not exceed 0.50 percent
  - C_3S content of Type II cement

    Must not exceed 65 percent
  - Type III cement

    May be used only if specified or authorized

Concrete Ingredients – Blended Cement

- Blended cement, including Portland limestone cement, Type IL must comply with AASHTO M 240.
- Additional Caltrans specific requirements:
  - Pozzolan content

    Maximum limits do not apply
  - Sulfate resistance

    Must be moderate (MS) or high (HS)
  - Alkali content

    In cement portion of blended cements must not exceed 0.60 percent by mass of alkalies as $Na_2O + 0.658\ K_2O$

Concrete Ingredients – SCMs

- The following SCMs classes are defined in Section 90:
  - AASHTO M 295
    - Fly Ash Class F
    - Ultrafine Fly Ash (UFFA)
    - Natural Pozzolans (raw or calcined)
    - Metakaolin
  - AASHTO M 302
    - Ground Granulated Blast-Furnace Slag (GGBFS)
  - AASHTO M 307
    - Silica Fume
  - ASTM C 1697
    - Blended SCMs
  - Blends of Fly Ash and Natural Pozzolan

Concrete Ingredients – SCMs

- SCM content must comply with one of the following:
  1. Satisfy both equations below:
     - Equation 1:

       $[(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)]/MC \geq X$

     - *Equation 2:*

       $MC - MSCM - PC \geq 0$

       where,

       UF=SF, Metakaolin, UFFA; FA=NP/FA (CaO<10%);

       FB=NP/FA (10%<CaO<15%); SL=Slag;

       MC=Min Quantity of cementitious materials specified

       X=1.8 for innocuous aggregate, 3.0 for all other aggregate

       MSCM=Minimum sum of SCM satisfying Equation 1

       PC = Quantity of Type IL or PC

Meaning not on AML

Concrete Ingredients – SCMs

- SCM content must comply with one of the following:
  2. Must be:
     - 15% Class F fly ash
     - At least 48 oz of $LiNO_3$ solution added per 100 lb of PC or PLC
     - CaO < 15%

  3. Any combination of cement and SCMs:
     - Either Zone 1 or Zone 2 aggregates under ASTM C1778
     - Satisfying equations 1 and 2 above using X=1.8
     - No more than 0.10% expansion for each individual aggregate with the proposed combination of SCM and cement when tested under ASTM C1567.

Concrete Ingredients – Aggregates

- Authorized Materials Lists (AML):
  - Aggregates on AML are considered innocuous.
  - Aggregates not on AML require increased SCM quantity.
- Aggregates must meet gradation, soundness, and cleanliness requirements as mentioned in Section 90.
- Aggregates must meet any application specific requirements.

Concrete Ingredients – Admixtures

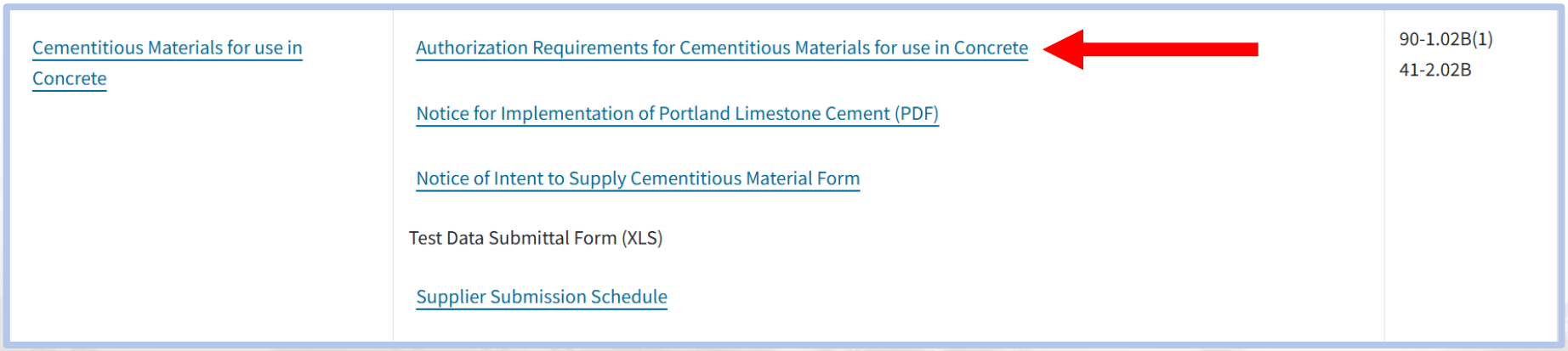
- Admixture type and brand must be on the Authorized Materials Lists (AML) at the time of mix design submittal.
- Must comply with ASTM C494 or C260.
- Lithium nitrate must be in an aqueous solution that complies with the following:
  - $LiNO_3$ = 30% ± 0.5% by weight
  - SO_4 < 1,000 ppm
  - Cl < 1,000 ppm
  - Alkalis < 1,000 ppm

Authorized Materials Lists (AML)

- Caltrans-approved list of products and materials that meet required specifications
  - Caltrans Specs
  - ASTM, AASHTO, CTM
- Type and brand must be on AML at the time of mix design submittal for:
  - Cementitious Materials (PC, Blended, SCMs)
  - Admixtures
- Aggregates:
  - Included on AML are considered innocuous.
  - Not included on AML require increased SCM quantity.

Authorized Materials Lists (AML) Cementitious Materials

- How it works?
  - Go to the AML website and look for the specific material criteria.



Cementitious Materials for use in Concrete	Authorization Requirements for Cementitious Materials for use in Concrete	90-1.02B(1) 41-2.02B
	Notice for Implementation of Portland Limestone Cement (PDF)	
	Notice of Intent to Supply Cementitious Material Form	
	Test Data Submittal Form (XLS)	
	Supplier Submission Schedule	

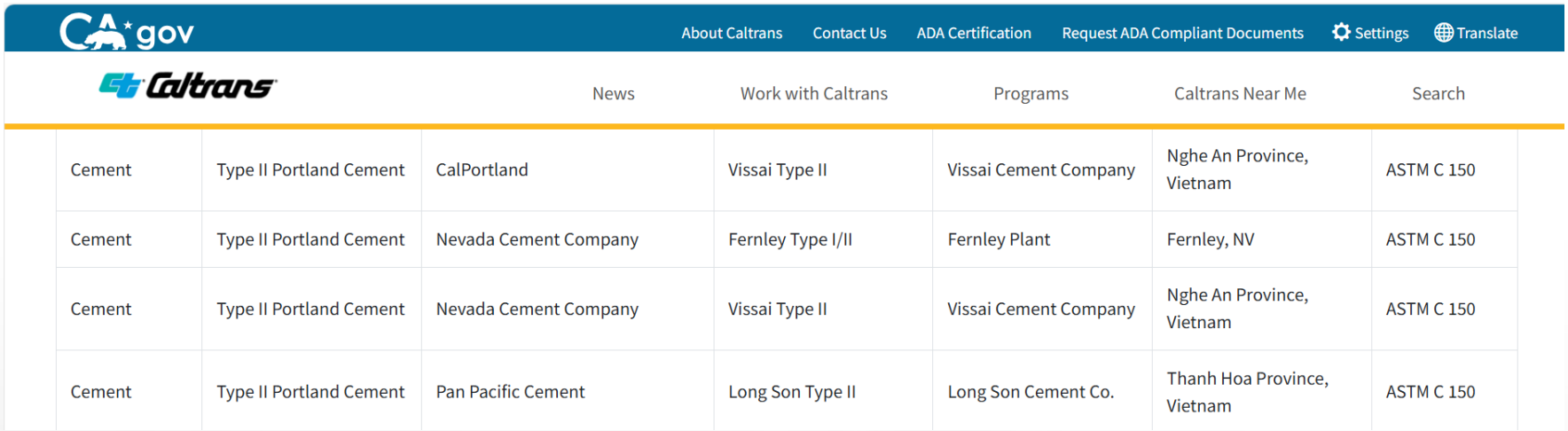
Authorized Materials Lists (AML) Cementitious Materials

- Material categories covered:
  - Blended Cements
  - Portland Cements
  - Fly Ash
  - Pozzolans (Metakaolin, Natural, Blended)
  - Silica Fume
  - Slag Cement
- All materials must conform to:
  - Standard Specifications Section 90
  - Referenced ASTM and AASHTO standards

Authorized Materials Lists (AML) Cementitious Materials

- Submit AML package that includes:
  - Completed application form (TL-9502)
  - Safety Data Sheet (SDS)
  - Six months of prior mill certifications showing compliance
  - Samples for Caltrans testing
  - Test results of the supplier's portion of samples
- Renewals
  - Quarterly reporting requirement
  - Annual renewals

Authorized Materials Lists (AML) Cementitious Materials



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Cement	Type II Portland Cement	CalPortland	Vissai Type II	Vissai Cement Company	Nghe An Province, Vietnam	ASTM C 150
Cement	Type II Portland Cement	Nevada Cement Company	Fernley Type I/II	Fernley Plant	Fernley, NV	ASTM C 150
Cement	Type II Portland Cement	Nevada Cement Company	Vissai Type II	Vissai Cement Company	Nghe An Province, Vietnam	ASTM C 150
Cement	Type II Portland Cement	Pan Pacific Cement	Long Son Type II	Long Son Cement Co.	Thanh Hoa Province, Vietnam	ASTM C 150

Authorized Materials Lists (AML) – Benefits

- Reduces project delays by streamlining material acceptance
- Provides a transparent, accessible record of qualified suppliers and products
- Ensures only pre-approved, specification-compliant materials are used

Authorized Materials Lists (AML) – Current Status

Category	Sub-Category	Quantity	Total Quantity
Aggregates	Coarse	75	121
	Fine	60	
Blended Cement	Type IL	19	26
	Type IP	3	
	Type IT	4	
Portland Cement	Type II	5	35
	Type II/IV	27	
	Type III	3	
Fly Ash	Class F (CaO<10%)	10	14
	Class F (10%<CaO<15%)	4	
Silica Fume	Silica Fume	9	9

Authorized Materials Lists (AML) – Current Status

Category	Sub-Category	Quantity	Total Quantity
Slag	Grade 100	2	5
	Grade 120	3	
Pozzolan	Natural Pozzolan	12	15
	Metakaolin	2	
	Blended Pozzolan	1	
Admixtures	Type A, F, G	75	237
	Type B, D	35	
	Type C, E	25	
	Corrosion Inhibitors	15	
	Special Purpose - Type S	50	
	Air Entraining	37	

What AML is NOT?

- NOT a performance guarantee
  - Doesn’t measure how a material will perform in a specific mix design on a specific project
- NOT a substitute for mix design approval
  - Listed materials must still satisfy project-specific proportioning, strength, and durability requirements

Mix Design Prequalification

Proving a mix design works before it is used on a project.

Mix Design Prequalification

- Prequalification is required if:
  - 28-day compressive strength is greater than 3,600 psi
  - Prequalification is specified

Mix Design Prequalification

- Ensures proposed concrete mixtures meet specified strength and durability requirements.
- Verifies that materials are on the Authorized Materials Lists (AML).
- Reduces risk of non-conforming concrete being placed on a project.
- Establishes a documented, approved mix design for reference.

Mix Design Prequalification

- Two paths to prequalify:

Certified Test Data

- Historical test data
- Acceptable if no changes from historical data
- Must be within one year of proposed use

Trial Batch

- Newly produced trial batch
- Evaluates new or changed mix design
- Must be within one year of proposed use

Mix Design Prequalification

- Both are based on the following proposed for actual project:
  - Materials
  - Mix proportions
  - Mixing equipment
  - Mixing Procedures
  - Batch size

Mix Design Prequalification

- Reports must include:
  - Date of mixing
  - Mixing equipment and procedures
  - Batch size
  - Weight, type, and source for each material
  - Penetration or slump
  - Air content
  - Concrete age at the time of testing
  - Compressive strength for each cylinder tested
  - Signature of an official of the testing firm

Recap

- Standard Specifications:
  - Section 90 governs all PCC. Other sections are application specific.
- Concrete Components:
  - Classifications of concrete components
  - Referenced ASTM and AASHTO standards
- Authorized Materials Lists (AML):
  - Caltrans approved list of materials and products
  - Importance in mix design prequalification
- Mix Design Prequalification
  - Importance
  - Procedure

Data Interchange for Materials Engineering (DIME)

What is DIME?

- A centralized web-based platform for managing:
  - Materials testing data
  - Certifications
  - Quality assurance records
- Who can input data?
  - Caltrans staff
  - Contractors
  - Testing Laboratories

How DIME works?

ASTM C1064-08: Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

Reload Input Form

Tester's fu
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Project te
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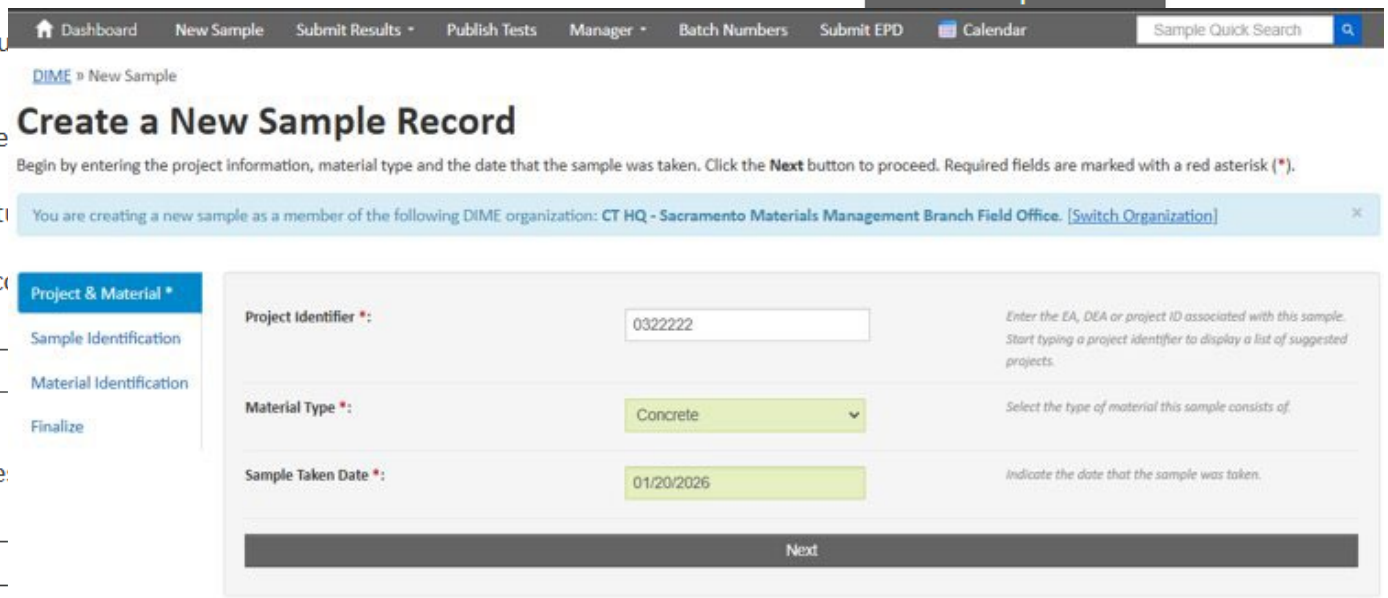
Test result
complies



Using DIME without Login

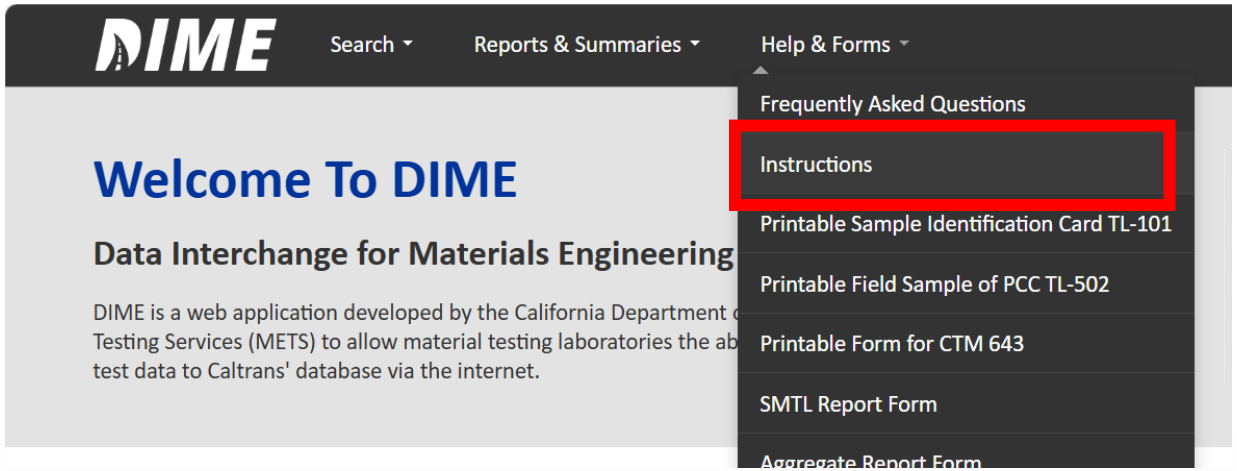
- Public can access DIME, and
  - View published test results including AML split-sample test results
  - Access project information and testing results
  - Browse supported ASTM, AASHTO, CTM testing methods
  - View statewide reports and summaries
    - Annual aggregate source tests
    - Compressive strength tests for each mix design
    - Statistics
- QC data submitted by contractors is not viewable without login

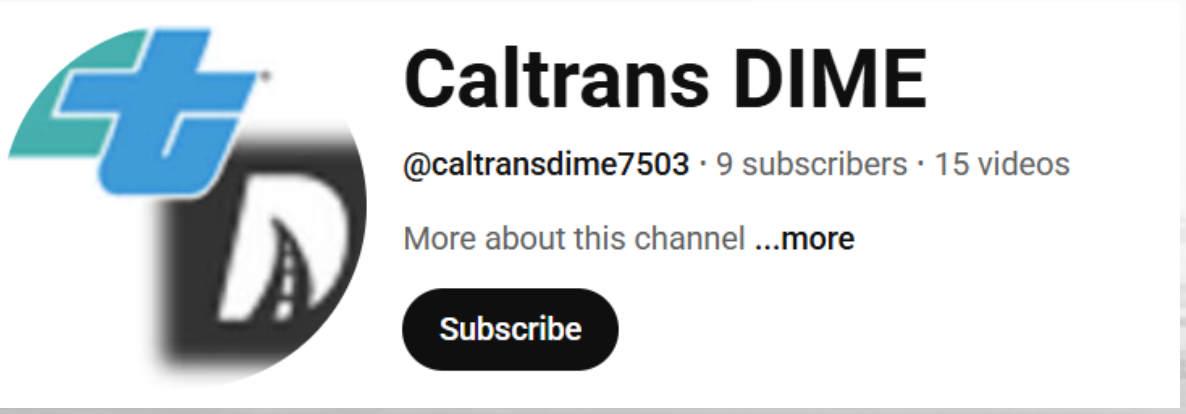
Benefits of DIME

- How DIME supports AML?
  - Caltrans testing results are published on DIME
  - Ongoing compliance tracking
  - Annual split-sample results
  - Early warning if trending towards non-compliance
- Faster material acceptance decisions
- Full audit trail for every material on every project
- Long-term data retention supports research, forensic investigations, spec development

DIME Resources

Dime.dot.ca.gov





Recap

- DIME is a centralized database that connects all key project stakeholders:
  - Contractors submit QC data and mill certs
  - Labs upload testing results
  - Caltrans uploads QA data
- Caltrans engineers review and accept materials
- All of this is done through one shared system tied directly to a specific project down to the sample.

Upcoming updates and current efforts

Upcoming updates and current efforts

1. ASR Testing Criteria
2. Defining Concrete Mix Design Changes
3. Alternative SCMs

1. ASR Testing Criteria for AML

- Why was this effort needed?
  - To refine the ASR testing criteria of coal ashes
    - Including Harvested ash and bottom ash on AML
  - Growing shortage of borosilicate reference aggregates created testing challenges.
  - AASHTO M 295 terminology update from “Fly Ash” to “Coal Ash”.

1. ASR Testing Criteria for AML

- Conclusions:
  - Both borosilicate glass and natural reference aggregates are accepted for ASR testing.
  - Harvested ash and bottom ash are included in the AML.
- The revised specifications are expected to be published in October 2026.

2. Concrete Mix Design Changes

- Why was this effort needed?
  - Does change of source warrant a full prequalification?
  - Improvement needed in current specifications for clarity
- This is an ongoing effort.

3. Alternative SCMs

- A technical study done in collaboration with Oregon State University.
- Why was this effort needed?
  - Traditional SCM shortages are driving demand for A-SCMs to reduce carbon's footprint.
  - To make specs more performance based
- Conclusions:
  - Alternative SCMs demonstrated comparable performance to traditional Fly Ash
  - This research provides technical basis to expand AML under performance-based criteria.

Questions?

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