HANDS-ON TRAINING:
MATERIALS AND MIX DESIGN

LEARNING OBJECTIVES

Upon completing this program, the participant should be able to:
1. Identify the common materials used for concrete
2. Know the various ways to proportion concrete mixtures
3. Proportion concrete mixtures
4. Calculate parameters for the mixture as directed by the instructor

NOTE

- This session is an overview of the constituent materials and mixture proportioning process for concrete.
- This session does not address all materials that can be used to produce concrete or their respective characteristics.
- This session does not address all of the mixture proportioning methods which can be used to determine mixture quantities.

OUTLINE

- Welcome and Safety.
- Overview of Constituent Materials.
- Overview of the Proportioning Process.
- Proportioning Methods.
- Selection of Proportions.
- Preparation and Mixing of Materials.
- Test Concrete.
- Compare and Discuss Results.

OVERVIEW OF CONSTITUENT MATERIALS

CLINKER

- Material from cement kiln.
- About ¼ in. to 1 in. in size.
- Calcium silicates and calcium aluminates.
- Is ground with gypsum to produce portland cement.
GYPSUM
- Ground with clinker to produce portland cement.
- Used to help control the rate of reaction between portland cement and water.

PORTLAND CEMENT
- Ground clinker and gypsum.
- Five basic types (I - V)
- Chemically reacts with water to harden and develop strength.
- Binder in a concrete mixture.

SUPPLEMENTARY CEMENTITIOUS MATERIALS
- Used to modify the performance or a property of fresh or hardened concrete.
- Powder form.
- Fly ash, slag, silica fume, others.

COARSE AGGREGATE
- Generally inert filler.
- Crushed stone or rounded gravel.
- Sizes larger than a No. 4 sieve (4.75 mm).
- Occupies largest proportion of a concrete mixture.
- Adjusted for moisture condition.

FINE AGGREGATE
- Generally inert filler.
- Natural and manufactured.
- Sizes smaller than a No. 4 sieve (4.75 mm).
- Fills spaces between coarse aggregate particles.
- Adjusted for moisture condition.

WATER
- Generally municipal water.
- If you can drink the water, you can use it to make concrete.
- Quantity is critical to the strength and durability of concrete.
CHEMICAL ADMIXTURES

- Used to modify the performance or a property of fresh or hardened concrete.
- Generally liquids.
- Air entrainer, water reducer, accelerator, retarder, hydration stabilizer, viscosity modifier, etc.

FIBERS

- Used to address early age cracking.
- Improves tensile strength of hardened concrete.
- Synthetic or steel.
- DOES NOT replace structural reinforcement (rebar).

OVERVIEW OF THE PROPORTIONING PROCESS

- Identify constituent materials.
- Obtain characteristics of each constituent.
- Identify known constraints.
- Identify performance criteria.
- Determine quantity of each constituent.
- Produce trial batch.

GENERAL PROCESS

- Measure performance values.
- Compare measured values to the performance criteria.
- Modify proportions based on results of the trial batch.
- Repeat testing and evaluation process until all performance criteria are met.
- Consider producing a large trial batch.

PROPORTIONING METHODS
ACI 211.1-91

- Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- Addresses Absolute Volume and Mass Methods.

PROPORTIONING METHODS

- Trial and adjustment.
  - add water until desired consistency is achieved
- Absolute mass.
  - total mass of all constituents not to exceed a predetermined value
- Absolute volume.
  - total volume of all constituents not to exceed 1 cy
  - accounts for different material densities

ABSOLUTE VOLUME METHOD

1 Cubic Yard = 3ft x 3ft x 3ft = 27 Cubic Feet

ABSOLUTE VOLUME METHOD

<table>
<thead>
<tr>
<th>Material</th>
<th>Mix No./Accel. Design</th>
<th>Target</th>
<th>Actual</th>
<th>Note Jogs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberty</td>
<td>2 1/3/0.80 1556</td>
<td>1496</td>
<td>1496</td>
<td>4756 LD - +--- 1</td>
</tr>
<tr>
<td>PO2087</td>
<td>1 409</td>
<td>263</td>
<td>263</td>
<td>780 LD + +--- 2</td>
</tr>
<tr>
<td>Pavelet</td>
<td>24.8:32:12 29.0 Ga</td>
<td>8.6 Ga</td>
<td>8.6 Ga</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>0.108</td>
<td>0.108</td>
<td>0.108</td>
<td></td>
</tr>
<tr>
<td>Wet Mixing</td>
<td>3:14</td>
<td>3:14</td>
<td>3:14</td>
<td></td>
</tr>
<tr>
<td>Total Mixing</td>
<td>2133</td>
<td>2133</td>
<td>2133</td>
<td></td>
</tr>
<tr>
<td>Total Moisture:</td>
<td>25.8</td>
<td>27.4</td>
<td>97.5</td>
<td></td>
</tr>
<tr>
<td>Water/Cement:</td>
<td>0.286</td>
<td>0.286</td>
<td>0.286</td>
<td></td>
</tr>
</tbody>
</table>

TYPICAL BATCH TICKET

SELECTION OF PROPORTIONS
TEAM MIXTURES

<table>
<thead>
<tr>
<th>Team</th>
<th>Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>Base Mixture (max w/c)</td>
</tr>
<tr>
<td>Team 2</td>
<td>Base Mixture with Recycled Water</td>
</tr>
<tr>
<td>Team 3</td>
<td>Base Mixture with Hot Water</td>
</tr>
<tr>
<td>Team 4</td>
<td>Base Mixture with (min w/c)</td>
</tr>
<tr>
<td>Team 5</td>
<td>Base Mixture with HRWRA</td>
</tr>
<tr>
<td>Team 6</td>
<td>Base Mixture with Fly Ash (25%)</td>
</tr>
<tr>
<td>Team 7</td>
<td>Base Mixture with Fibers</td>
</tr>
<tr>
<td>Team 8</td>
<td>Base Mixture</td>
</tr>
<tr>
<td>Team 9</td>
<td>Base Mixture with HRWRA</td>
</tr>
<tr>
<td>Team 10</td>
<td>Base Mixture with Fly Ash (50%)</td>
</tr>
</tbody>
</table>

PREPARATION OF MATERIALS

- Follow the procedures on the handout provided to produce a small quantity of concrete.
- Referring to the following slide, Groups 1 through 10 will make slight modifications to the basic concrete mixture for comparison purposes.

TEST CONCRETE

- Follow the procedures on the handout provided to measure the "slump" of the concrete mixture.
- Follow the procedures on the handout provided to measure the density of the concrete mixture.
- Report both values to the instructor.

COMPARE AND DISCUSS RESULTS

<table>
<thead>
<tr>
<th>Team</th>
<th>Mix</th>
<th>Measured &quot;Slump&quot; (in)</th>
<th>Measured Density (lb/ft³)</th>
<th>Yield (ft³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>Base (max w/c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 2</td>
<td>Base w/ Recycled Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 3</td>
<td>Base w/ (Hot Water)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 4</td>
<td>Base w/ (min w/c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 5</td>
<td>Base w/ HRWRA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HANDS-ON EXERCISE RESULTS

- Follow the procedures on the handout provided to produce a small quantity of concrete.
- Referring to the following slide, Groups 1 through 10 will make slight modifications to the basic concrete mixture for comparison purposes.
HANDS-ON EXERCISE RESULTS

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<tr>
<td>Team 6</td>
<td>Base w/ Fly Ash 25%</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>Base</td>
<td></td>
<td></td>
<td></td>
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<td>Base w/ Fly Ash 50%</td>
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</tr>
</tbody>
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THANK YOU!

Any Questions?

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NOTE

- This session is an overview of the practices and test methods used to test fresh concrete in the field.
- This session does not address all aspects or requirements of the practices and test methods discussed.
- Participants should be properly trained and ACI certified before conducting any tests in the field.

PROGRAM OVERVIEW
PROGRAM OVERVIEW

- Standard field practices and test methods.
  - how to read and interpret a standard
- Filling a container with concrete.
  - procedures common to several field tests
- Hands-on practice.
  - C231 Air Content by the Pressure Method

STANDARD FIELD PRACTICES AND TEST METHODS

C172 - SAMPLING

- Methods for sampling from:
  - stationary mixers
  - revolving drum mixers
  - paving mixers
  - volumetric mixers
  - other delivery modes

C1064 - TEMPERATURE

- Test measures temperature at a specific moment in time.
  - doesn't account for changing temperature
  - No need to rod or vibrate.

C143 - SLUMP

- Used as an indicator of the workability of a mixture.
  - Rod only.
  - Don't tap sides.
  - Must be completed in 2½ minutes.
  - Measure to displaced original center.

C231 - AIR CONTENT, PRESSURE

- Used for dense aggregates only.
  - aggregate correction
- Pressure applied to concrete in mold.
- Rod or vibrate.
- Can also be used to determine density and yield.
C173 - AIR CONTENT, VOLUMETRIC

- Used for any type of aggregate.
- Water, alcohol, and concrete mixed together.
  - Alcohol correction
- Rod only.
- Air bubbles rise to the top of the mixture.
- Lengthy to complete.

C138 - DENSITY AND YIELD

- Yield is the volume of concrete produced.
- Have to determine the volume of the mold.
- Mold size varies with aggregate size.
- Rod or vibrate.

C31 - TEST SPECIMENS

- Specimens for strength testing.
- Poor fabrication negatively impacts the measured strength.
- Rod or vibrate.
- Not a measure of the strength of the concrete in the structure.

ANATOMY OF AN ASTM STANDARD

- Purpose of Standards.
  - Consistency in a material, in preparing a test specimen, in testing
- Practice vs. Test Method.
  - A practice does not produce a measured value, test methods produce measured values
- Written in mandatory language.
  - Shall, will, must

ASTM STANDARDS

- What to do, otherwise not permitted.
  - Standards tell you what must be accomplished and how
- Notes
  - Not an official part of the practice or standard, are for information only
SECTIONS OF A STANDARD

- Scope.
  - purpose of standard, Go/No Go information, safety information, units information
- Reference Documents.
  - list of other standards referred to in the given standard
- Terminology.
  - list of terms, with definitions, that are specific to the standard, general terms in C125

SECTIONS OF A STANDARD

- Apparatus.
  - list of required equipment with important dimensions or other measurable properties
- Sample.
  - procedure for obtaining and preparing a sample
- Procedure.
  - step by step method to perform a test
SECTIONS OF A STANDARD

• Calculations.
  • if necessary, equations to compute appropriate values, i.e. density of concrete
• Report.
  • list of information to be reported, units of values, tolerance on values as necessary
• Precision and Bias
  • repeatability of the test method, is there a bias in the test

FILLING A CONTAINER WITH CONCRETE

• Obtain a representative sample of concrete according to ASTM Practice C 172.

GENERAL PROCEDURE

• Dampen the interior of the mold.
• Place mold on a flat, level, and firm surface.
• Use a scoop to place concrete in the mold.
• Move the scoop around the mold opening so concrete is evenly distributed.
• Determine the number of layers for filling the mold based on the method of consolidation.
**GENERAL PROCEDURE**

- Fill molds in three layers of approximately equal volume.
- Consolidate the concrete using the rounded end of the tamping rod.
  - uniformly distribute the rodding strokes over the cross section of the measure
  - rod the bottom layer through its depth
  - rod each upper layer through its depth and into the layer below approximately 1 inch.

- After rodding each layer, tap the outside of the mold 10 to 15 times with a mallet.
  - this closes voids left by the rod and releases large air bubbles
  - Avoid overfilling the measure when adding the final layer of concrete.
  - Strike-off excess concrete so mold is level full.

**Hands-on Practice**

Questions?

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**Testing Fresh Concrete in the Field**

Dr. John Schemmel, Texas State University