MASS CONCRETE
Introduction

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Introduction

- What is it?
- Why we care?
- How we know?
- What can be done?
- What is necessary?
- Did it work?
What Is It?

- ACI 207.1 definition of mass concrete, “Any large volume of cast in place concrete with dimensions large enough to require that measures be taken to cope with generation of heat and attendant volume change to minimize cracking.”
Why Is It a Concern

- Delayed Ettringite Formation (DEF)
  - Results in high sulfate concentration in the pore liquid.
  - Sulfate has expansive reaction with calcium- and aluminium-
Why Is It a Concern

- **Self-desiccation**

- **Self-drying**
  - Resulting in
    - Impeded hydration
    - Voids
    - Increased shrinkage
    - Lower ultimate strengths
Why Is It a Concern

- Thermal cracking
  - Caused by excessive temperature differential
  - Increase permeability

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• What controls are necessary?
• How do you know they work?
How Do We Know?

- Standard Specs
  - Cast-in-place Piles
    - 8ft Dia and Greater
  - Special Provisions
    - Generally smallest dimension exceeding 7ft
How Do We Know?

- Other risk factors need to be considered
  - High ambient temperature
  - Higher cement content
  - Lightweight Concrete
  - Long haul times
  - Etc.
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What Can Be Done?

□ Controls
  □ Passive
  □ Active
Passive Controls

- Actions taken before placement
  - Includes
    - Use of SCM’s
    - Low CTE Aggregate
    - Lowering initial concrete temp
Passive Controls

- Use of FA and GGBS
  - 60%-75%
- High performance SCM’s like Silica Fume and Metakaolin do not substantially lower heat of hydration
Passive Controls

- Lower Placement Temp.
- Ambient Concrete
Active Controls

- Actions taken after concrete is placed.
  - Includes
    - Cooling the surface
    - Insulating the surface
    - Cooling pipes
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Cooling Tubes
What Is Necessary?

- IT DEPENDS
  - Max temp 160 deg F
  - No crack parameter
What Is Necessary?

- Thermal Control Plan
  - Includes
    - Calculations showing
      - Hottest point in the mass
      - Maximum allowable temp differential
    - Mix design
    - Curing method and duration
    - Peak and differential temperature controls
Did it Work?

- Temperature monitoring and recording.
  - Included in the thermal control plan
    - Monitoring
      - Hottest calculated point
      - At least two
        - Outer faces
        - Top surface
        - Two corners
    - Recording
      - Hourly
      - Stop when core temp starts to drop.

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Summary

- 160 deg F max is the Department’s determination acceptable risk.
- There are a multitude of factors that impact concrete temperature during hydration.
- Many ways to mitigate.
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- Deck thickness 10”
- Stem thickness 1’ – 10”
- Lightweight Concrete
- 980lb/cy
- 5% Flyash
What Is It?

- Benicia martinez superstructure
What Is It?

- **Specific heat**
  - The amount of heat required to raise 1 gram of material 1 degree.

- **Coarse aggregates**
  - $S_{H\text{lightweight}} = S_{H\text{normal weight}}$
  - Total mass of concrete reduced 15%
  - Peak Temperature increased 15%
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