When Worlds Collide

Project Specifications vs. Sustainability Initiatives

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General Overview

- General design philosophy
- Sustainable initiatives
- Conflicts

Sustainability from Two Perspectives

PRODUCT

- Raw materials
- Composite materials
- Recycled content
- Design decisions

PROCESS

- Materials storage
- Manufacturing
- Transportation
- Waste management

SUSTAINABILITY IN CONCRETE

Another viewpoint to consider

$$\int_{boundary\ \ conditions}^{\#\ of\ \ years} f(x)dx$$

- **Where *x* is the:**
  - Sustainability of the material(s) such as the mix design?
  - Resiliency of the project?

Sustainable Product Design Philosophy

$$Sustainability = \frac{\text{Design Requirement} > \text{Design Function}}{\text{Time}}$$

- **Design Requirement**
  - Specified level of performance necessary
- **Design Function**
  - Specified intent for use of the structure from the Owner

Sustainable Design Philosophy

Design Requirement = PERFORMANCE

Sustainable Design Philosophy

$$Sustainability = \frac{\text{Performance} > \text{Function}}{\text{Time}}$$

- **Performance**
  - Expected result from the design as measured by a standard method
- **Function**
  - Intended use of structure or structural element

What about…

- **Resilience**
  - Ability to recover from or survive difficult and/or negative conditions.

$$Resilience = \frac{\text{Design} > \text{Function} + f(\text{Negative Conditions})}{\text{Time}}$$

Design

Specified level of performance necessary

- **Negative (or Difficult) Conditions**
  - Flood, wind, rain, tornado, hurricane, etc.

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- **Performance**
  - Expected result from the design as measured by a standard method
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- **Negative (or Difficult) Conditions**
  - Flood, fire, tornado, hurricane, wind, rain, etc.

Concrete Design Philosophy

PRESCRIPTION ≈ PERFORMANCE

- **Generally accepted design approach**
- **Supported by Codes and Standards**
- **Don’t have to exercise judgment**
- **Perception that it minimizes liability**

Conflicting Design Philosophies

$$Resilience = \frac{\text{Performance} > \text{Function} + f(\text{Negative})}{\text{Time}}$$

- **Does a traditional design approach create an inherent conflict with resilient and/or sustainable design?**
- **How do we alter the design approach?**
- **How do we solve the conflict in the field?**

RESILIENCE > SUSTAINABILITY

Traditional design approach (criteria)	Resilient and/or Sustainable design criteria
Slump	Recycled content (rate)
Max. aggregate size	Emissions footprint
Water content	Extraction and/or production proximity
Air content	Survivability
w/c ratio	Durability
Coarse agg content	Cost (first and life cycle)
Fine agg content	EPD (It is HERE!)

Traditional or Prescriptive Elements

- **By the Code, or generally accepted design methods:**
  - Maximum w/cm
  - Minimum cement content
  - Limitations on pozzolanic replacement
  - Air content
  - Slump ranges not determined by Contractor
  - Time and drum revolution limits
- **None of these are “performance” based**

Technology Example - HVFA

- **What happens over 30%?**
  - History is not kind…
- **Why not 40%, 50%, 60%?**
- **Equal performance**
  - Set time, strength, etc.
- **Changes in contracting**
  - Finishing, curing, etc.
- **Proprietary Mix Designs**

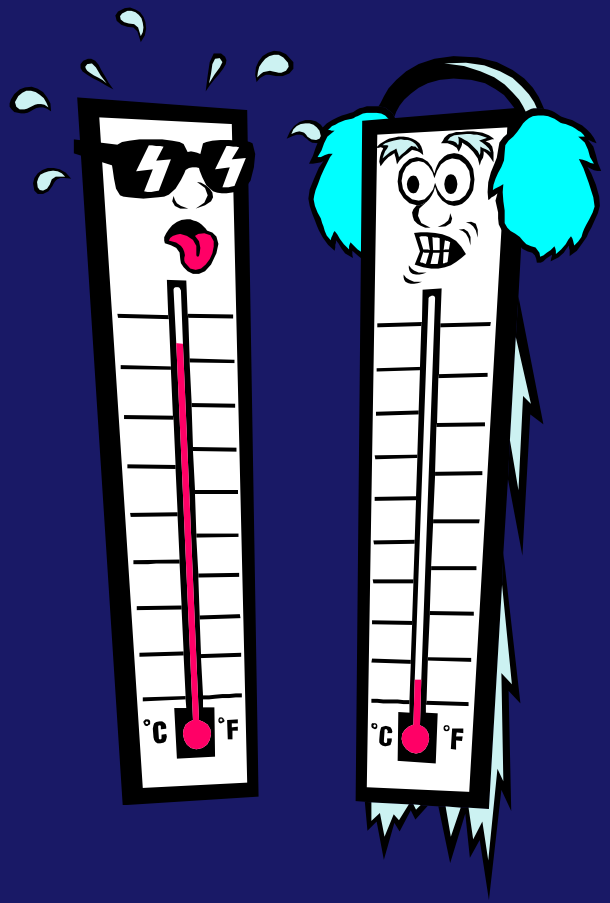
Pervious Concrete

- No fines, porous
- Mono-sized
- %15 to 35% voids
- 8 to 20 gal/min/ft^2
- 2000 to 4000 psi
- Fixed proportions?

Video provided by: http://www.chargerconcrete.com/perviousconcrete.htm, August 2004

Reflective Concrete…Cool Pavements

- **Higher reflectivity reduces air temperatures**
  - 0.1 increase ≈ 10°F decrease
  - Heat island effect
- **“Albedo” is unit of measurement**
  - ASTM C1549
  - When is it measured?
- **Function of available materials**
  - Test panels are critical.
  - What if it does not work?



Innovation: Self Compacting Technology

- Placement without segregation
- Non-segregating
- Free flowing
- Not a new concrete!
- Energy reduction???

Recycled Water and Stormwater

- The problem we all have…
- …we are at zero discharge
- Why would a specification not support its use?
- Batch panel controls
- Document each load

Issues and Challenges: Engineers

- **Green Building = Performance**
- **What performance is needed?**
  - Verification of performance
  - Do your homework
- **Be explicit, not implicit!**
  - Set time
  - What strength at what day?
- **Must see the mix design…why?**

Issues and Challenges: Architects

- Often don't understand own specification
- Material experience is rarely first hand, based on last major problem…
- What is the metric for performance?
- Cost awareness is essential!

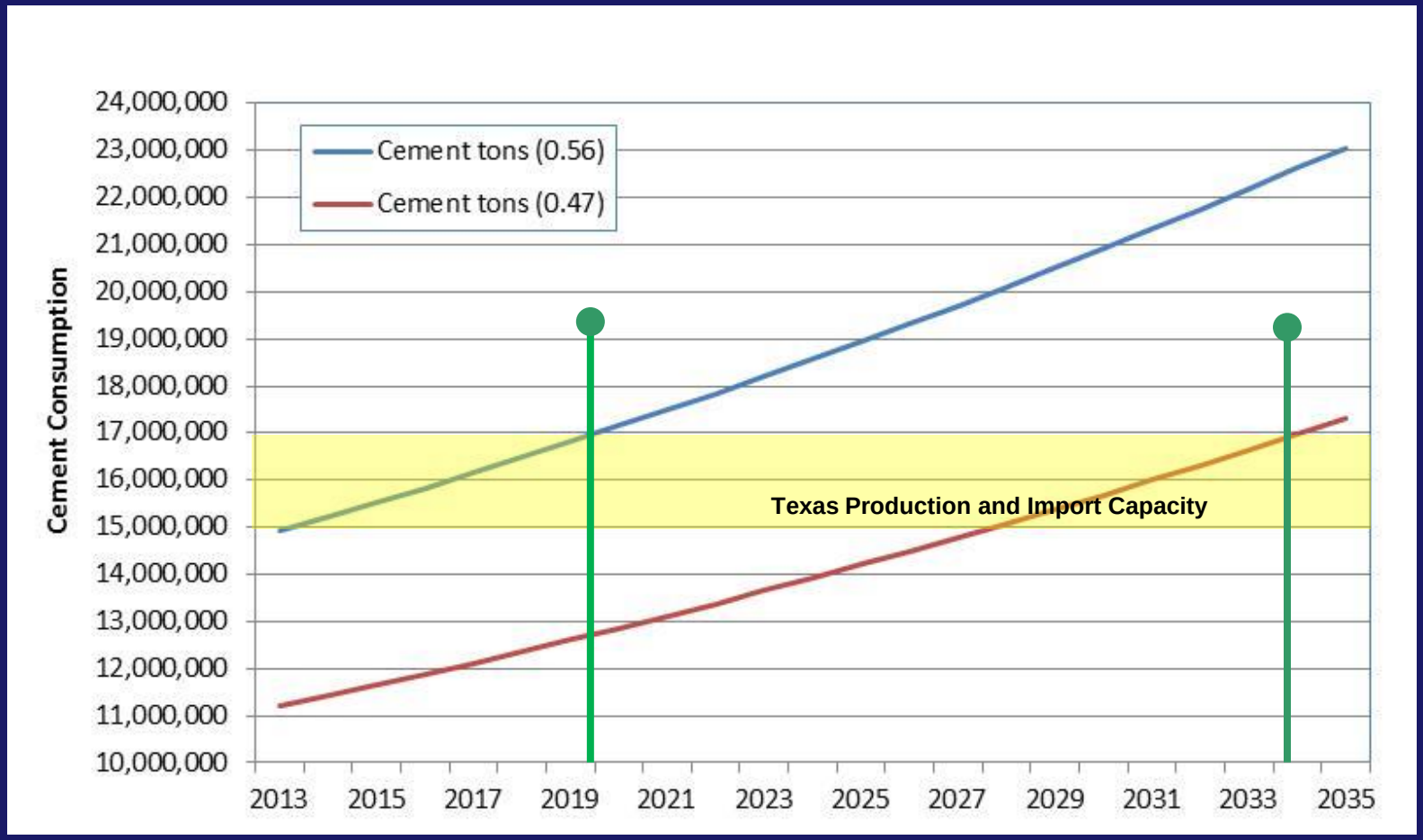
Issues and Challenges: Contractors

- **"Any change is a bad change"**
  - Changes in placing
  - Changes in finishing
- **Someone else is the expert**
- **$/ft^2 can be the deal breaker**
- **Performance is too good?**
- **Contradictions?**
  - Remove the Environmental fee?!?

Issues and Challenges: Testing Labs

- **Verify performance for owner**
  - Based on job specs (explicit!)
  - **NOT** based on speculation or assumption
- **New concrete and old assumptions = problems**
- **Mix design?**
- **When to include in process**

The Coming Apocalypse



Questions

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