Emerging Trends in Concrete Construction

Presented by:
Kenneth Justice, P.E., LEED® AP
NECSA Promotion Director for NJ/DE

and

William J. Lyons III, FACI
Manager Engineered Sales
USC Atlantic
Cement-Based Pavement Materials

- Roller-Compacted Concrete
- Conventional Concrete
- Soil-Cement
- Flowable Fill
- Recycled Flexible Pavement
- Cement-Treated Base
- Cement-modified Soil

Cement Content vs. Water Content

Cast vs. Rolled

No Wearing Course vs. Wearing Course

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Soil Cement/FDR (Full Depth Reclamation)

- Now more economical
- Environmentally friendly
- Increased use in the Northeast and in New Jersey

**Energy Use and Materials**

*Full-Depth Reclamation vs. New Base*

- Number of Trucks Needed: 12 vs. 180
- New Roadway Material (metric tons): 300 (330) vs. 4,500 (5,000)
- Material Landfilled cubic yard (m³): 0 vs. 2,700 (2,100)
- Diesel Fuel Consumed gallon (liter): 500 (1,900) vs. 3,000 (11,400)

Based on 1 mile (1.6 km) of 24-foot (7.3-m)-wide 2-lane road, 6-inch (150-mm) base
6-Step Process

1. Pulverize the old road or existing subgrade

2. Initial shaping and grading

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6-Step Process

4. Mixing water & cement into the aggregate-soil mixture

3. Spread the cement

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6-Step Process

5. Compaction

6. Curing – water or asphalt primer
Roller-Compacted Concrete Pavements
Definition

“Roller-Compacted Concrete (RCC) is a no-slump concrete that is compacted by vibratory rollers.”

• Zero slump (consistency of damp gravel)
• No forms
• No reinforcing steel
• No finishing
• Consolidated with vibratory rollers

Concrete pavement placed in a different way!
Why Use RCC?

- Low cost
- Easy preparation
- High-volume production
- Minimal labor
- High strength and durability
- Proven performance

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Benefits of RCC

- Economical
- High load carrying ability
- Eliminates rutting and spans weak subgrades
- Excellent freeze-thaw durability
- Simple, fast construction
- No forms or finishing
- Light surface reduces lighting requirements
Off-Highway Applications

• Parking Lots
• Storage/Lay down areas
• Truck terminals
  and distribution centers
• Haul roads
• Military applications
  ➢ Tank hardstands
  ➢ Maintenance yards
• Intermodal shipping
• Airfield apron areas
Streets and Highways

- Industrial access roads
- Residential streets
- Highway inlays
- Fast-track, high-volume intersections
- Shoulders and turn lanes

Industrial Drive
Tennessee DOT

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secondary roads

subdivision streets
Engineering Properties

- **Compressive strength**
  - 4,000 to 10,000 psi

- **Flexure strength**
  - 500 to 1,000 psi
  - \( f_r = C(f'_c)^{1/2} \)

- **Modulus of Elasticity**
  - 3,000,000 to 5,500,000 psi
  - \( E = C_E(f'_c)^{1/2} \)
Mixture Design

Conventional concrete mixture procedures are not appropriate!

- Not air-entrained
- Retarders or water reducers can be used to increase working time
- Lower water content
- Lower paste content
- Larger fine aggregate content
- Nominal maximum size aggregate 3/4” or 5/8”
Important!

- Dry enough to support a vibratory roller
- Wet enough to permit adequate distribution of paste

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Aggregate Selection

- Highway base course, asphalt, or concrete aggregates can be used.
- 3/4” or 5/8” NMSA
  - For smooth surface, lower segregation
- Higher fine aggregate content than conventional concrete mixes
  - For adequate stability under vibratory roller
- 2% to 8% passing #200 sieve
  - Provides paste to fill voids and maintain tight surface

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Basic Construction Sequence

• Produced in a pug mill or central batch plant
• Transported by dump trucks
• Placed with an asphalt paver
• Compacted by vibratory and pneumatic-tired rollers
• Cured with water or curing compound
Continuous Pug Mill

- High-volume applications
- Excellent mixing efficiency for dry materials
- 250 to 500+ tons/hr
- Mobile, erected on site
- Higher mobilization costs

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Central Concrete Batch Plant

- Highly accurate proportioning
- Local availability
- Smaller output capacity
- Longer mix times than conventional concrete
- Frequent cleaning
- Dedicated production
Dry Concrete Batch Plant

- Highest local availability
- 2-step process
  - Feed into transit mixers
  - Discharge into dumps
- Very slow production
- Frequent cleaning
- Segregation
- Least desirable method
Transporting

- Rear dump trucks normally used
- Minimize transport time
- Covers required for long hauls, or hot/windy conditions

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Preparation for Placement

• Simple preparation: no dowels, reinforcing, or forms
• RCC ideal for wide-open, unimpeded placement runs
• Block off fixtures
• Ensure subbase is smooth and at specified grades
• Set up stringlines
• Moisten subbase prior to RCC placement
Placing

- **Layer thickness**
  - 4 inches minimum
  - 8 inches maximum
  - 10 inches with some heavy-duty pavers

- **Timing sequence**
  - Adjacent lanes placed within 60 minutes for “fresh joint”
  - Multiple lifts placed within 60 minutes for proper bonding

- **Production should match paver capacity**
  - Continuous forward motion for best smoothness
Placing Equipment

- High density ABG pavers
  - Vibrating screed
  - Dual tamping bars
  - High initial density (90% to 95%)
  - Reduces subsequent compaction
  - High-volume placement (1000 - 2000 tons/shift)
  - Designed for harsh mixes
  - Smoothest RCC surface
Placing Equipment

• Conventional Asphalt Pavers
  ➢ Provides some initial density (80%-85%)
  ➢ Relatively smooth surface
  ➢ May require modification
  ➢ Increased cleaning and maintenance

NECSA
Compaction

- Proper compaction is critical for strength and durability
- Compact to 98% of Modified Proctor
- Vibratory roller
- Non-vibratory steel wheel roller
- Rubber-tire roller
Curing

- Extremely important; ensures surface durability
- Low moisture in RCC
- Three methods:
  - Moist cure
  - Concrete curing compound
  - Asphalt emulsion
Saw-Cut Joints vs. Natural Cracks

- More aesthetically pleasing
- Soff-Cut very effective, shortly following placement
- Need to saw within 12 hours to avoid uncontrolled cracking

- 30 to 80 ft spacing
- Often first cracks appear within 24 hours
- Narrow crack widths
- Seal if > 1/8 inch
- Best load transfer
- Minimal raveling
Surfacing

- Paver-placed RCC needs no surface for durability
- Adequate for low-speed traffic
- High-density ABG pavers can provide smoothness for medium-speed traffic
- Thin asphalt surface (1-1/2 to 3 inches)
  - Improves surface for high-speed traffic
  - Placed immediately or any time thereafter
Surface Smoothness

- Unsurfaced RCC can be built for low to medium speed traffic
- High density paver achieves good ride quality
- Joints/cracks do not affect ride quality appreciably
Questions???

Concrete home survives Hurricane Ike at Gilchrist, Texas

September 2008