Roller-Compacted Concrete Pavements
Design and Construction

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Definition

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

- Zero slump (consistency of dense graded aggregate)
- No forms
- No reinforcing steel
- No finishing
- Consolidated with vibratory rollers

*Concrete pavement placed in a different way!*
Un-compacted RCC
Surface Appearance

- Not as smooth as conventional concrete
- Important to recognize difference
- Similar appearance to asphalt only light grey instead of black
Surface Texture
Engineering Properties

- Compressive strength \((f'_c)\)
  - 4,000 to 10,000 psi

- Flexural strength (MR)
  - 500 to 1,000 psi
  - \(MR = C(f'_c)^{1/2}\) where \(C = 9\) (up to 11)

- Modulus of elasticity
  - 3,000,000 to 5,500,000 psi
  - \(E = C_E(f'_c)^{1/2}\) where \(C_E = 57,000\) (up to 67,000)
Applications
Saluda Dam - Columbia, South Carolina
Dam Crest Raise
Alabama Power - Rattlesnake Hollow

- Crest of Existing earthen dam raised by 30 feet.
- RCC used to provide vertical face due to width restraints.
Log Sort Yards

Vancouver Island, BC, 1978
Military Facilities

Ft. Lewis, WA, 1986

Ft. Drum, NY, 1990

Ft. Carsons, CO, 2008
Intermodal Facilities

Central Station, Detroit, MI

Burlington Northern, Denver, CO
CN Intermodal Yard, Calgary

RCC decreased truck wait time from 8 to 2 hours

Unsurfaced aggregate is difficult to maneuver and presents safety hazard
Port Terminals

Norfolk International Terminal, VA, 2006

Port of Houston, TX, 2007
Distribution Centers

18 acre distribution center in Austin, TX

10 years after construction
GM Saturn Plant
Spring Hill, Tennessee
Honda Plant
Lincoln, Alabama
Mercedes-Benz Plant
Vance, Alabama
Streets & Interchanges

Intersection replacement
Calgary, AB

Residential street
Columbus, OH
Columbus, Ohio Area
Highway Shoulders

I-285 Highway
Atlanta, GA
Subbase/Subgrade Preparation

- Same requirements as conventional concrete.
- Must be stiff to provide full compaction.
- Stable subgrade.
- Non-pumping subbase.
- Moisten subbase prior to RCC placement.
Mixing Plants

Generally three types of available mixing operations:

1. Dry Batch Plant
2. Rotary Drum Mixing Plant
3. Continuous Flow Pugmill
Mixing Plants

Rotary Drum Plant

- Available at some locations.
- Mobilization issues.
- Capacity reduced due to low water content of mixture.
Continuous Mix Pug Mill

- High-volume applications
- Excellent mixing efficiency for dry materials
- 250 to 900+ tons/hr
- Mobile, erected on site
- Mobilization costs
Transporting
RCC Pavement Placement
Placing

- Layer Thickness
  - 4 in. Minimum Thickness.
  - 9 – 10 in. Maximum Thickness in a single lift.

- Timing Sequence
  - Adjacent lanes placed within 60 minutes for “fresh joint”
  - Multiple lifts placed within 60 minutes for “fresh joint”

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

- High density pavers
  - Vibrating screed
  - Dual tamping bars and or pressure bars
  - High initial density, 90-95%
  - Reduces subsequent compaction
  - High-volume placement (1,000 to 2,000 cubic yards per shift)
  - Designed for harsh mixes
  - Smoothest RCC surface
Roller Compaction

(rubber-coated drum)
Compaction-Final Density

- Final density is critical for strength and durability
- Compacted to 98% Modified Proctor
- Dual Steel Drum Roller
- Combination Roller
- Rubber coated steel drum roller
Compaction Very Important

Various RCC Mixes
Various Cement
Various Ash
Various Aggregates

\[ y = -3E-05x^5 + 0.0105x^4 - 1.7042x^3 + 138.45x^2 - 5607x + 90530 \]
\[ R^2 = 0.9786 \]
Transverse Joints
Curing

- Extremely important; Ensures surface durability
- Low moisture content in RCC dictates moisture retention.
- Three methods:
  - Moist Cure
  - Concrete Curing Compound
  - Asphalt Emulsion
Concrete Curing Compound

- White-pigmented concrete curing compounds
- Apply 1 to 1.5 times the normal application rate
Bituminous Curing Compound

- Excellent moisture barrier
- Common compounds: SS-1, RC-250, MC-250
- Clean surface if needed
- Moisten surface
- Apply at 0.15 to 0.30 gal/sy
- Good for asphalt cap
Quality Control
OPENING TO TRAFFIC
Accessibility To Apartment Complex was a Critical Element For This Project
Access Was Provided Directly Behind The ABG Paver-Prior To Roller Compaction
SCDOT Specifications

Traffic:

Protect the RCC from vehicular traffic during the curing period. Completed portions of the RCC pavement may be opened to automotive and light truck traffic as soon as the strength is sufficient to prevent damage to the RCC. The pavement may be opened to unrestricted traffic after 4 days.
Why are we using it?

(Andy Johnson SCDOT State Pavement Engineer)

- Most or all of pavement structure can be placed in one lift.
- Does not require the curing time or adjacent lane encroachment of traditional PCC.
- Can handle heavy loads and high traffic volumes.
- Should be able to bridge poor subgrades effectively, if you can get it installed.
- Overall structure cost is very competitive with other pavement types.
SC Projects

- Powell Pond Rd, Aiken County (Demo. Project)
- SC 5, York County
- US 78, Charleston County
- New State Road, Lexington County
- Greystone Boulevard, Richland County
- S. Beltline Boulevard, Richland County
- Richland Street (US78), Aiken County
- SC 9, Horry County
- S-11-171, Cherokee County
- I-385 Shoulders, Laurens County
- I-385 Shoulders, Greenville County
Projects in SC

- Rt 21 Albright Road  Rock Hill SC
- Rt 72 By Pass  Chester SC
Rt 72 Bypass Chester SC

- Constructed in September 2012
- Milled 10 inches off of asphalt pavement
- Placed 8 inch RCC
- Overlay with 2 inches Asphalt Concrete Surface Course
The Morgan Co
Greenville Co. SC
Morgan Co
Greenville Co. SC
Benefits of RCC Pavements

- Economical (both initial and life-cycle costs)
- High load carrying ability
- Eliminates rutting
- Excellent overall durability
- Simple, fast construction
- No forms or finishing
Roller Compacted Concrete

Questions ???

- Dams
- Intermodal Facilities
- Military Bases
- Port Terminals
- Interstate Shoulders

- Auto Industry Plants
- Streets and Local Rds
- State Highway System
- Nuclear Power Plants
- Logging Yards