



RCC Pavements

- Introduction
- Applications
- Mix Design
- Construction



Definition

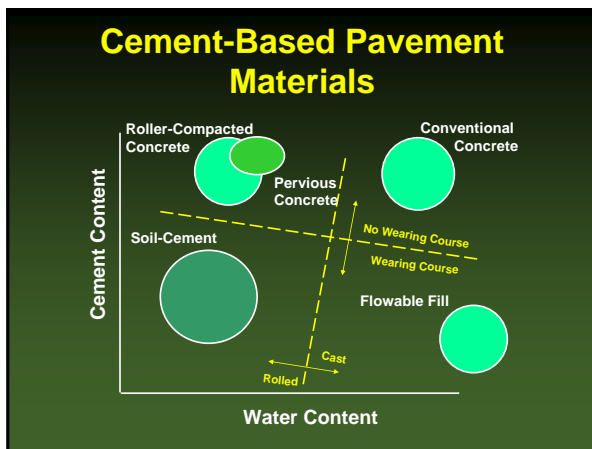
“Roller-Compacted Concrete (RCC) is a no-slump concrete that is compacted by vibratory rollers.”

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

Concrete pavement placed in a different way!

Benefits of RCCP

- Fast construction with minimum labor
- High load carrying ability
- Early strength gain
- Durable
- Low maintenance
- Light surface reduces lighting requirements
- Economical





Project Considerations

- Project size
- Site geometry
- Loading characteristics
- End use
- Client expectations



Surface Appearance

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



Intermodal Facilities



Central Station, Detroit, MI



Burlington Northern, Denver, CO

Port Terminals



Norfolk International Terminal, VA



Port of Los Angeles, CA

Distribution Centers



18 acre distribution center in Austin, TX



10 years after construction

Warehouse Facilities



Interior Floor Lynnterm Terminal
Port of Vancouver, BC



Warehouse, Appleton, WI

Parking Areas



134 acre parking facility at Saturn plant, TN

Honda facility, AL (207 acres)



Streets & Interchanges



Residential Street
Columbus, OH

Intersection Replacement
Calgary, AB



Highway Shoulders



I-285 Highway
Atlanta, GA



Waste Handling Facilities



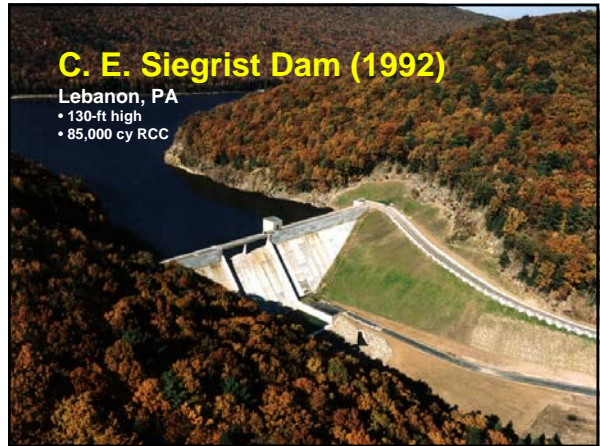
5 acre composting
yard near Toronto

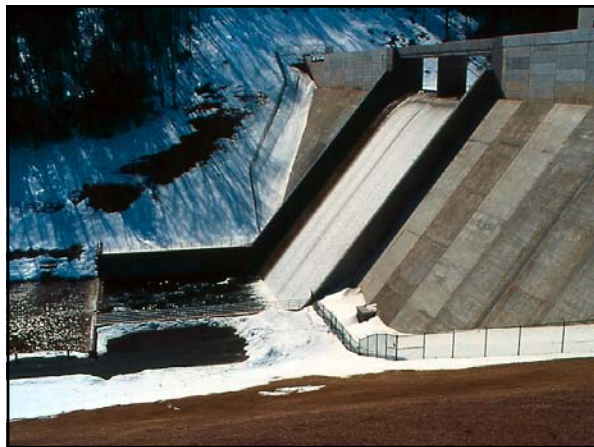


25 acre sludge drying
basins in Austin, TX

C. E. Siegrist Dam (1992)

Lebanon, PA
• 130-ft high
• 85,000 cy RCC





Mixture Design

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



Mixture Design

- Differs from conventional concrete pavements
 - Not air-entrained
 - Lower water content
 - Lower paste content
 - Larger fine aggregate content
 - Nominal max. size aggregate +/- 5/8 in.

Typical Design

- 400 – 600 lb/cy cementitious material
- 3,400 – 3,700 lb/cy combined aggregate
 - 1,700 – 2,200 lb/cy coarse aggregate
 - 1,300 – 1,700 lb/cy fine aggregate
- 170 – 250 lb/cy water (20 -30 gallons)
- W/C ratio usually between 0.3 -0.45

Physical Properties

- Compressive strength: 4000 – 9000 psi
- Flexural strength: 450 – 1100 psi
- Compacted wet density: 145 – 160 lb/cf
- Air content: less than 2.0 percent
- Permeability: 10^{-10} – 10^{-12} cm/sec
- Drying shrinkage: 400 – 500 $\mu\text{m/m}$

Note: Acceptable strengths can be achieved with low cementitious contents, but surface integrity may suffer

Proportioning Methods

- Several methods available:
 - Concrete consistency tests
 - Soil compaction methods
 - Optimal paste volume method
- Always allow time and money for field trial

Aggregate Selection

- Aggregate selection very important
- Responsible for mix workability, segregation, ease of consolidation
- Pre-blended or stored separately



Aggregate Selection

- Highway base course, asphalt or concrete aggregates can be used
- 5/8 in. NMSA
 - Provides smooth surface, reduces segregation
- Higher fine aggregate content than conventional
 - Economic advantage using non-washed and pit-run aggregates including dense graded aggregate base
 - Provide adequate stability under vibratory roller
- 2%-8% passing #200 sieve
 - Supplements paste to fill voids and maintain tight surface

Admixtures

- Retarder or water reducer can be used to increase working time
- Silica fume has resulted in significant strength gains
- Air entrainment not typically used, but
 - Experience has shown RCC can be made freeze/thaw resistant

Freeze-Thaw Durability

- Field performance without air entrainment has been excellent
- Minor surface paste (1/16 in.) erodes, then stabilizes
- RCC results variable under ASTM C666 (F/T) and C672 (Deicer scaling)
- These tests appear to be too severe based on actual experience
- Durability tests used for masonry concrete and precast units possibly more appropriate



Sample RCC Mix Designs

	Units	Port of Tacoma Intermodal Yard	CTL Mix	Canada Mix
Coarse Aggregate	lb/cy	1,700	2,106	2,210
Fine Aggregate	lb/cy	1,700	1,378	1,338
MSA	in	5/8	3/4	1/2
% Finer Than #200	%	3 - 7	2	1
Cement	lb/cy	450	504	470
Fly Ash	lb/cy	100	0	36 (silica fume)
Water	lb/cy	257	211	172
Admixture	oz/cwt	none	none	5 (WR)
w/c ratio	-	0.47	0.42	0.34
Unit Weight	lb/cy	154.3	152.0	153.1
Compressive: 3 day	psi	1,810	5,460	-
Compressive: 28 day	psi	6,050	7,900	-
Flexural: 3 day	psi	525	690	1,205
Flexural: 28 day	psi	770	900	1,640



- ### Construction Requirements
- Subgrade preparation
 - Mixing process
 - Transporting
 - Placing
 - Compacting
 - Jointing
 - Curing



Continuous Pug Mill

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

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 trucks
- Very slow production
- Frequent cleaning
- Segregation possible



Dry Concrete Batch Plant

- Supplementary mixer can aid in thorough mixing and plant throughput.



Mobile Mixers



Transporting

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



Transporting



Load in multiple piles

Placing

- Layer thickness
 - 4 in. minimum
 - 8 in. maximum (10 in. with heavy-duty pavers)
- Timing sequence
 - Adjacent lanes placed within 60 minutes for "fresh joint", unless retarders used
 - Multiple lifts placed within 60 minutes for bond
- Production should match paver capacity
 - Continuous forward motion for best smoothness

Placing Equipment

- High-density pavers
 - Vibrating screed
 - Dual tamping 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



Placement Equipment



Transfer equipment keeps paver fully charged

Placing Equipment

- Conventional asphalt pavers
 - Provide some initial density (80-85%)
 - Relatively smooth surface
 - May require modification
 - Increased maintenance

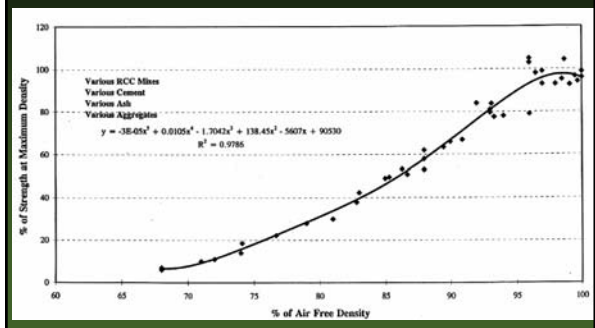


Compaction

- Proper compaction is critical for strength and durability
- Compact to 98% Modified Proctor
- Vibratory roller
- Rubber-tire roller



Compaction Very Important



Construction Joints

- Most critical area of project
- Must be constructed properly for durability
- Ensures bond/interlock, so slab acts monolithically
- Three types of construction joints:
 - "Fresh joints"
 - "Cold joints"
 - "Horizontal joints"

Fresh Joint



Edges Critical

- Compaction more difficult
- Segregation more likely
- Try to minimize number of cold joints
- Care needed to match grade from cold to fresh joint

Cold Joints



Edge Compaction



Typical Cold Joints



Cracking/Jointing

- Saw-cut joints unnecessary for performance
- Natural cracks typically provide adequate load transfer
- Saw-cut joints control cracks for aesthetic purposes



Natural Cracks

- Most economical
- 15 to 60 ft spacing
- Often first cracks appear within 24 hours
- Narrow crack widths
- Seal if > 1/4 in.
- Provide load transfer
- Minimal raveling



New, Unsealed Crack

10-yr Old Sealed Crack

Saw-Cut Joints

- More aesthetically pleasing
- Soff-cut very effective, shortly following placement
- Need to saw within 12 hours to avoid uncontrolled cracking
- 1/3 to 1/4 depth
- Seal joints similar to conventional concrete



Curing

- EXTREMELY IMPORTANT
- Ensures surface durability; reduces dusting
- Low moisture content in RCC; no bleed water
- Three methods:
 - Moist cure
 - Concrete curing compound
 - Asphalt emulsion

Water Cure



Typically 7-day specified



Concrete Curing Compound

- White-pigmented concrete curing compounds
- Application rate depends on surface texture



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



Surface Texture



Intermodal Yard, TX



Sludge Drying Bed, TX



Warehouse Facility, WI



Honda, AL

More Information

www.cement.org/pavements

Questions?

Discover how beautiful concrete can be