Roller-Compacted Concrete-What’s the Future for Airports?

Concrete Airport Pavement Workshop
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Topics to Discuss

- RCC Established Pavement Markets
  - Why not at airports?
- Limited Work at Airports
- RCC Construction Method
  - Is it suitable for airport pavements?
  - What are the limitations?
  - Where are the opportunities?
- Future of RCC at Airports?
  - Choosing the right projects
Is there a Place for RCC on Airport Projects?

How do we go from here to here? Should we?

Yes but very carefully
RCC Pavements
A Quick Introduction
Materials

- Aggregates
- Cementitious materials
- Water
- Chemical admixtures (if used)
- Curing compound
Consistency of Dense Graded Aggregate Base
RCC Mixture Design

- Dry enough to support vibratory roller
- Wet enough to permit adequate distribution of paste
Construction Method Stars at the Mixing Plant
Transporting
Load Carrying Capacity

Conceptual illustration of the load carrying capacity of RCC and conventional concrete immediately following placement.

Suitable for occasional light traffic.

From Guide to RCC Pavements, CP Tech Center
Why RCC?

- Fast construction with minimum labor
- Economical
- High load carrying ability
- Eliminates rutting
- Early strength gain
- Durable
- Low maintenance
- Light surface reduces lighting requirements
A Couple of Case Studies-not at Airports
Value-Engineered RCC Pavements
Ocean Terminal, GA

Phase 1: 48,400 SY
Phase 2: 30,000 SY
Ocean Terminal, GA

- Typical Ocean Terminal pavement
  - Flexible pavement
    - 10” aggregate base
    - 5” asphalt

- Purposes of proposed alternate
  - Provide equal or higher structural capacity using RCC and CTB layers
  - No additional cost
Structural Capacity/Predicted Service Life for Assumed Loadings

- Hot-Mixed Asphalt and RCC equivalent Structural Numbers
- RCC PAVE software predictions
- PCA PAVE Software predictions
Pavement Analysis - Equivalent Structural Number Approach

Asphalt Pavement Design

5” HMAC

10” Aggregate Base

Subgrade

Structural Number = 4.00

Roller Compacted Concrete Design

6” RCC Concrete

6” Cement Treated base

Subgrade

Structural Number = 4.20
RCC PAVE Predictions Using Truck Loads, RCC with CTB Option, 20 Yr

<table>
<thead>
<tr>
<th>Axle Type</th>
<th>Load, lbs</th>
<th>Allowable Repetitions/Day</th>
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<tbody>
<tr>
<td>Single Axle Dual Wheel</td>
<td>18,000</td>
<td>Unlimited</td>
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<tr>
<td>Tandem Axle, Dual Wheel</td>
<td>40,000</td>
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PCA PAVE Predictions Using Semi Trailer Trucks, HMA over GABC, and RCC over CTB Options

- Purposes of proposed alternate
  - Provide equal or higher structural capacity using RCC and CTB layers
  - No additional cost

Total Truck Weight: $12k + 40k + 40k = 92k$ lbs
10 Trucks/day, 5” HMA over 10” GABC, on Sandy Soil

Predicted Damage in percent within its design life

Asphalt Fatigue (Life > 20 yr) Subgrade rutting (Life > 20 yr)

12k+40k+40k = 92k lbs
50 Trucks/day, 5” HMA over 10” GABC, on Sandy Soil

Predicted Damage in percent within its design life

- Asphalt Fatigue (Life: 13.11 years)
- Subgrade Rutting (Life: 11 years)

Failure Level 50.0% Service Life 11.3 years
Failure Level 50.0% Service Life 15.1 years

12k+40k+40k = 92k lbs
100 Trucks/day, 5” HMA over 10” GABC, on Sandy Soil

Predicted Damage in percent within its design life

- Asphalt Fatigue (Life: 8.919 years)
- Subgrade rutting (Life: 6.227 years)

Failure Level: 75.0 %  Service Level: 75.0%

Service Life: 5.2 years

12k + 40k + 40k = 92 k lbs
100 Trucks/day, 6” RCC over 6” CTB, on Sandy Soil

Predicted Damage in percent within its design life

RCC Fatigue (Life > 20 year)
NCHRP CTB (Life > 30 year)
Subgrade rutting (Life > 20 year)

12k+40k+40k = 92k lbs
1000 Trucks/day, 6” RCC over 6” CTB, on Sandy Soil

Predicted Damage in percent within its design life

12k+40k+40k = 92k lbs
Case Study – Ocean Terminal, GA

- Typical Ocean Terminal pavement
  - Flexible pavement
    - 10” aggregate base
    - 5” asphalt

- Phase I As-Built Section
  - RCC/Cement-Treated Soil
    - 9” cement-treated soil
    - 7” RCC

Made possible by value engineered design/mix optimization/recycling of in-situ materials

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<thead>
<tr>
<th>Section</th>
<th>Structural Number</th>
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<tr>
<td>Flexible</td>
<td>4.0</td>
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<tr>
<td>RCC/CTS</td>
<td>5.3</td>
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</table>
Case Study – Ocean Terminal, GA

33% strength

No additional cost
SC Inland Port (under construction)
SC Inland Port (under construction)

Dual Lifts: 94,000 yd²

- Design
  - RCC 14”
  - GAB 3”
  - Prepared Subgrade

- Value Engineered
  - RCC 13”
  - CTSB 6”
  - Prepared Subgrade

Single Lift: 94,000 yd²

- Design
  - RCC 9.5”
  - CTSB 6”
  - Prepared Subgrade

- Value Engineered
  - RCC 10” and 10.5”
  - GAB 3”
  - Prepared Subgrade

GABC: Graded aggregate base  CTSB: Cement treated soil base
SC Inland Port – Benefits of CTS Base

- Structural capacity
- Load transfer at joints and cracks
- Limited downtime after rain events
- Economical
- Sustainability attributes
The RCC Mix

- 4000 psi specified compressive strength at 28 days
- Portland cement: 500 pcy min. required
- Aggregates
  - #67
  - Manufactured concrete sand
  - Granite from Sandy Flats Quarry
Combined Aggregate Gradation

### Suggested Blend Gradation

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<tr>
<th>Size Number</th>
<th>Percent Passing</th>
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<tr>
<td>1-in (25 mm)</td>
<td>100</td>
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<tr>
<td>3/4-in (19 mm)</td>
<td>90-100</td>
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<tr>
<td>1/2-in (12.5 mm)</td>
<td>70-90</td>
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<tr>
<td>3/8-in (9.5 mm)</td>
<td>60-85</td>
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<tr>
<td>No. 4 (4.75 mm)</td>
<td>40-65</td>
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<tr>
<td>No. 16 (1.18 mm)</td>
<td>20-40</td>
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<tr>
<td>No. 100 (150 µm)</td>
<td>6-18</td>
</tr>
<tr>
<td>No. 200 (75 µm)</td>
<td>2-8</td>
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### RCCP Gradation Band

- **0.45 Power, 3/4” MS**
- **Suggested Lower Limit**
- **Suggested Upper Limit**

**PCA suggested limits**
SCIP RCC Placement

RCC Placement - Dual Lifts
Transverse Construction Joint

One day old RCC
SCIP RCC
Established RCC Pavement Markets
Already Established RCC Markets

- Ports and Intermodals
- Automotive Plants
- Heavy Industrial Haul Roads, Maintenance Yards
- Distribution centers
- Highway shoulders
- City Streets and Roads
- Logging Facilities, Composting Areas, and Storage Yards
Owner required heavy duty serviceable pavement but had budget constraints

RCC chosen to save cost not only vs. PCC but also vs. HMA on a first-cost basis
Snow Storage Area, Denver Airport

- 21,000 SY
- 8” RCC on 6” recycled concrete base
- 4,000 psi specified compressive strength at 28 days
- RCC strength per ASTM C1435 averaged 6070 psi
Cemex paved 2 service roads at Sky Harbor Airport.

Both were 24-ft wide, 8-in. thick.
First Service Road, Las Vegas Airport

- 1st road placed with a medium density paver, two 4-inch lifts
- 12-ft wide lanes with fresh longitudinal joints
- Second lift was placed within 1 hr but fresh joint was not
- Raveling is taking place at the fresh joints
- Joints sawcut at 20 and 30 ft. spacing. The 30-ft panels cracked at mid span
- Striped and opened to traffic the following day

Courtesy Cemex
1st Service Road, Las Vegas Airport

Courtesy Cemex
2nd Service Road, Las Vegas Airport

- 2nd road placed with a high density paver
- 24-ft wide, 8” lift in one path
- Joints saw cut at 20 ft.
- Road is performing very well
RCC Challenges For Airport Pavements
Construction Logistics

- Mixing plant location
- Delivery time
- Air traffic delays
- Length of each construction shift
  - Preparing subgrade or subbase
  - Setting up grade controls
  - Paving
  - Compaction
  - Curing
  - Sawing joints
  - Sealing joints
Raveling at Joints
Raveling at Joints

- Consider routing and sealing joints
Joints

Longitudinal

Transverse
Segregation

- Reduce top size
- Choose well graded aggregates
- Require a minimum cement content
- Use proper equipment including gob hoppers and material transfer devices
- Control moisture
Riding Index

- Consider diamond grinding or an overlay
RCC Opportunities at Airport Projects
Opportunities for RCC at Airports

- Dual lift construction
  - Bases and subbases
- Shoulders
- Maintenance yards
- Service roads
- Snow storage areas
- Parking lots
Conclusions

- Yes, RCC can be a valid option on some airport paving applications
- Projects must be selected carefully considering
  - “Imperfections at joints” inherent in RCC construction method
- When used as a surface layer, special emphasis should be placed on limiting segregation, providing durable surface, and reducing potential for foreign object debris
Questions

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