Gauteng Department of Roads and Transport,
RCCM Technologies
CSIR
Cosal Consulting

Presents

Roller Compacted Concrete
A Value Proposition for South Africa

CSIR International Conventional Centre, Pretoria
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ROLLER COMPACTED CONCRETE (RCC)
CONCRETE PLACED IN A DIFFERENT WAY!

BUILDING ROADS WITH ZERO SLUMP CONCRETE

- In conjunction with the Gauteng Department of Roads and Transport and Cosal Consultants CC in South Africa, the CSIR Built-Environment has been evaluating the applicability of Roller Compacted Concrete (RCC) as an option for the upgrading and rehabilitation of low-volume residential and provincial roads.

BACKGROUND

- Roller Compacted Concrete (RCC) gets its name from the heavy vibratory steel drum and rubber-tired rollers used to compact it into its final form. RCC has similar strength properties and consists of the same basic ingredients as conventional concrete such as graded aggregates, cement and water but has different mixture proportions (3). The largest difference between RCC mixtures and conventional concrete mixtures is that RCC has a higher percentage of fine aggregates, which allows for tight packing low void content and consolidation. Fresh RCC is stiffer than typical zero-slump conventional concrete. Its consistency is stiff enough to remain stable under vibratory rollers, yet wet enough to permit adequate mixing and distribution of paste without segregation. The use of RCC on roads can potentially offer multiple benefits by comparison with more conventional approaches. RCC is typically placed with an asphalt-type paver equipped with a standard or high density screed, followed by a combination of passes with rollers for compaction. Final compaction is generally achieved within one hour of mixing.

WHAT IS RCC

- ■ Zero slump (consistency of dense graded damp gravel)
- ■ No forms or finishing
- ■ No reinforcing steel
- ■ High production
- ■ Pavers or earth moving equipment
- ■ Consolidated with vibratory rollers

“ROLLER-COMPACTED CONCRETE (RCC) IS A NO-SLUMP CONCRETE THAT IS COMPACTED BY VIBRATORY ROLLERS.”

BENEFITS OF RCC PAVEMENTS

- Fast construction
- Economical
- Early load carrying capacity
- Supports heavy loads
- Low maintenance
- Durable
- Light surface reduces lighting requirements and Urban Heat Island effects

- ■ Originally used for heavy-duty pavements
- ■ Growth has accelerated in last seven years
- ■ Increase in private & non military public use
- ■ Emergence of asphalt contractors placing RCC

RCC – GROWTH HAS ACCELERATED EXPERIENCING A REVIVAL

- Ports, intermodal yards and
- military hard stands
- Warehouse facilities
- Parking areas
- Maintenance & storage yards
- Airport service areas
- Arterial roads
- Highway shoulders
- Local streets & intersections

APPLICATIONS

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

PROJECT CONSIDERATIONS

- Structural behaviour similar to unreinforced,
- undoweled conventional concrete pavements
- Reduced shrinkage as compared to PCC
- Monolithic slab action for multi-layer construction
- Load transfer across joints/cracks
- Thickness
- 4-inch minimum lift
- 10-inch maximum single lift

DESIGN CONSIDERATIONS

TEST SECTION DESIGN SPECIFICATION

- The design specifications for the RCC test section were:

- Subgrade: Min. CBR of 25 at 95% Mod AASHTO, PI<12, Max swell 1%;
- Subbase: 150 mm thick in situ material compacted to 93% Mod AASHTO;
- Base: 150 mm thick in situ material stabilized with 3% cement (of which 20% was replaced with fly-ash), compacted to 95% Mod AASHTO, and
- RCC: 150 mm thick layer mix design according to consultant's specification.

- D1814 Tachi-Rayton Road Rev 1.pdf

- Subgrade support (modulus of subgrade reaction, k)
- Vehicle characteristics
- Wheel loads
- Wheel spacing
- Tire characteristics (contact area, tire inflation
- pressure)
- Number of load repetitions during design life
- RCC flexural strength, fs
- RCC modulus of elasticity, E

DESIGN PROCEDURES

- Determine the required RCC thickness given the following:
- Straddle carrier
- Axle load = 60,000 lbs
- Tire inflation pressure = 100 psi
- k = 100 psi/in.
- Flexural strength, fs = 650 psi
- E = 4,000,000 psi
- Load repetitions = 30 per day
- Design life = 20 year

DESIGN EXAMPLE

- Test section
- Subgrade preparation
- Mixing process
- Transporting
- Placing
- Compacting
- Curing

CONSTRUCTION PROCEDURES

Figure 1Mixing plant

- Train contractor and testing personnel
- Demonstrate workability and appearance of mix
- Demonstrate equipment capabilities
- Demonstrate construction details Joints, bonding, compaction, etc.
- Develop rolling requirements/pattern
- Test RCC and develop correlation
- factors for density and f’c vs. MR

TEST SECTIONS

Figure 5HVS Test Rayton D1814 Test Section

- Must be firm
- Check with proof roller or compact to 95% min. density
- Replace unsuitable materials
- Shape to proper lines and grades

SUBGRADE PREPARATION

Figure 4Preparation of sub grade

PLACING

- Production should match paver capacity
- Layer Thickness 4" minimum thickness 9" – 10" maximum thickness
- Timing Sequence
- Limited time (generally 60 minutes max.) for placement of adjacent lanes to maintain "fresh joint"
- Multiple lifts placed within 60 minutes for "fresh joint"

Figure 3Placement of RCC material

- Conventional asphalt pavers
- Provide some initial density 80-85%)
- Thicknesses < 6 in.
- Relatively smooth surface
- May require some equipment modification

PLACING EQUIPMENT

- High density pavers Vibrating tamping screed
- High initial density, 90-95%
- Less roll-down
- Thicknesses < 10 in.
- High-volume placement (1K to 2K cubic yards per shift)

PLACING EQUIPMENT

- Proper compaction is critical for strength and durability
- Compact to 98% Modified Proctor (ASTM D1557)
- Vibratory roller Pneumatic tire or rubber coated steel drum to smooth surface

COMPACTION

RCC PROJECT TEAM

- Mr Eddy Sikaala, PrTechEng, Chief Engineer-Khato Civils
- Mr Khuselo Mngaza, Chief Director – GDRT
- Mr Steve Musundi, Proprietor, RCCM & Cosal
- Mr Louw Du Plessis, Research, CSIR
- Mr George Rugodho, Engineer – Materials, GDRT
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THANK YOU