Roller Compacted Concrete

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Asphalt (!) and Surfacing Technical Manager

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- What is RCC
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The use of asphalt in infrastructure is often deemed to be the only option to fulfil the requirements of modern day contracts.
Economic pressures driving ‘More for Less’
Background
Paving Asphalt’s 40-year historical rate is 2 to 4% higher than the general rate of inflation (higher than concrete and cement’s and much more volatile)
So why the reliance on asphalt?

‘Time is Money’

+ 

‘Sticking Plaster’ approach to infrastructure maintenance

+ 

Tradition?
What is RCC?

Definition: “Roller Compacted Concrete is a no-slump concrete placed by an asphalt paver and compacted by rollers”

Materials are same as concrete – well graded, angular aggregates, cement, and water – but different mixture proportions. (Cement content around 300kg/m³)

Zero slump (consistency of damp aggregate)

No pavement formwork, consolidated with paver and vibratory rollers

No reinforcing steel

After curing, RCC properties and performance are similar to PQ concrete
What is RCC?

RCC is a blend of asphalt & concrete Paving technologies

Shared construction characteristics
- Similar aggregate gradation
- Similar placement and compaction

Shared materials characteristics
- Same materials (different proportions)
- Similar curing requirements
Central Mix

- Mid size applications
- 100 to 150 tons/hr
- Not all plants have mixers
- Fixed locations
- Capacity reduced due to low water content of mixture

Continuous Flow Pugmill

- High-volume applications
- Excellent mixing efficiency for dry materials
- Consistent mix properties
- 250 to 600+ tons/hr
- Mobile, erected on site
- Lower mobilization costs
# Installation

## Standard Paver
- Standard paver (80% to 85% initial density)
- Widely available
- High-production (4 to 6 m/min)
- Lift thickness up to 150mm
- May require multiple lift paving
  - Impossible to pave adjacent lanes
- Increased roll down to achieve density (grade control problems)
- Easier to fix segregated areas before compaction

## High Density Paver
- High density screed
- High initial density (> 90%)
- Smoother surface with higher initial density
- Less roll down from to achieve density
- High production (4 to 6 m/min)
- Lift thickness up to 250mm
- Adjacent lanes easily paved
## Compaction

### Initial Compaction
- Initial: 10 - 12 ton static & vibratory roller
  - Thinner lifts may allow smaller roller
- Establish roll pattern (check density a lot!)
- Adjust based on moisture content (visual observation and lab measurements to confirm)
- Compact to 98% of maximum wet density
- Adjust moisture content if needed – impacts smoothness
- Finer mixes achieve density easier

### Finish Rolling
- Final: Combination, dual steel or rubber tired
  - Maximum weight - 6 ton
- Remove roller marks
- NO MORE ROLLING!
Quality Control

Moisture & Density

- Density tested with nuclear gauge in direct transmission mode
- Test density behind paver and after roller to establish rolling patterns to achieve density
- Continuously check density until comfortable
- Achieve 98% of maximum wet density
- Nuclear gauge gives general moisture fluctuation indication

Compressive Strength

- Cubes prepared with vibratory hammer
  - 3 to 4 cubes per set
  - Strength timing depends on traffic opening (1, 3, 7, 28 days)
- Cores can be obtained where density is not being achieved
Finishing Touches

Curing
• Applied at same rate or slightly higher than conventional concrete
• Ensure uniformity with application process
• Apply as soon as possible behind roller operation
• Ensures durable surface

Saw Cut & Fill Joints
• More aesthetically pleasing
• Early entry saw very effective, shortly following placement
• Recommend sawing within 2 - 6 hours to avoid uncontrolled cracking
• Depth: 1” to 1.5”
• Spacing: Maximum 36 times thickness, Max 20 ft
The Difference?
The ‘Time’ Issue

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

Suitable for occasional light traffic.
Applications

- Industrial
- Dockyard
- Container storage
- Airfield refuelling areas
- Roads ?
Pavement Design

HBM (Flexible Composite)  \[\text{Flexible with HBM Base - Bound Base Thickness (mm)}\]

Asphalt (Fully Flexible)

\[\text{Traffic (msa)}\]

\[\text{Foundation Class}\]

\[\text{Asphalt Standard Material Grade}\]

- DBM125
- HRA50
- DBM50/HDM50
- EME2 (see Note 16)
RCC does theoretically fit into the HBM ‘family’ of materials

But.... the compressive strength of RCC is much higher (C32/40+)

Therefore no design option is available for RCC in this methodology
Still a requirement for 100 to 180mm of asphalt overlay
Potential option

Asphalt surface course to achieve:

Skid resistance and noise reduction

Would require formal RCC specification which in turn would allow inclusion in design charts
Benefits of RCC
Rehabilitation – Activities based on Proper Maintenance Cycles for asphalt pavements. Current year costs are inflated at 4%, Rehab costs also include other Incidental Costs (striping, mob, etc) - 40% of material costs, Traffic Control - 5% of material cost, and Engineering & Inspection - 5% of material cost.

### Nominal Expenditures by Pavement Type

- **Asphalt – Rehab**: Crack / cape sealing in years 6, 13, 16, 24, 34, 38
  - Microsurfacing in years 10, 28
  - Major rehab in year 18 (2” OLAY + PDR)
  - Major Rehab in year 45 (Full Replace)
- **PCC – Rehab**: Patch & diamond grind at years 25, 35, 2” AC Overlay at yr 45

### Total Cost Net Present Value

- **Asphalt**: $1.65
- **PCC**: $0.9
- **Nom Disc Rate = 8%**

In this example, Asphalt is 26% more expensive than RCC throughout the life cycle of the road.
Concrete pavements contribute to decarbonising of transport

UP TO 6% FUEL SAVINGS for heavy trucks riding on concrete pavements. This can already make the difference today!
### Added Benefit – Rolling Resistance

**RING ROAD OF ANTWERP**

<table>
<thead>
<tr>
<th>km road</th>
<th>number of heavy vehicles per day</th>
<th>directions</th>
<th>fuel saving</th>
<th>price diesel</th>
<th>CO₂</th>
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**SAVINGS PER DAY**

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<th>costs (7,5 pt)</th>
<th>CO₂ (kg)</th>
<th>NOx (kg)</th>
<th>PM (kg)</th>
<th>HC (kg)</th>
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<td>2 268</td>
<td>4 082</td>
<td>40</td>
<td>0</td>
<td>1</td>
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<tr>
<td>CO (kg)</td>
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<td></td>
<td></td>
<td></td>
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</tr>
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<td>6</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SO₂ (kg)</td>
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**SAVINGS PER YEAR**

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<th>NOx (kg)</th>
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<th>HC (kg)</th>
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<td>827 820</td>
<td>1 490 076</td>
<td>14 625</td>
<td>166</td>
<td>386</td>
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<td>2 208</td>
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<td></td>
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<tr>
<td>SO₂ (kg)</td>
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<td></td>
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</table>

**SAVINGS OVER THE 30 YEAR LIFETIME OF THE ROAD**

<table>
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<th>liter diesel</th>
<th>costs (€)</th>
<th>CO₂ (kg)</th>
<th>NOx (kg)</th>
<th>PM (kg)</th>
<th>HC (kg)</th>
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<tbody>
<tr>
<td>16 556 400</td>
<td>24 834 600</td>
<td>44 702 280</td>
<td>438 745</td>
<td>4 967</td>
<td>11 589</td>
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<td>CO (kg)</td>
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<td>66 226</td>
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<td>1 656</td>
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<td>SO₂ (kg)</td>
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The Noise Issue

Concrete Surface - NGCS

Asphalt Surface – ARFC / OGFC
Advances in Noise Reduction

An innovative, diamond saw-cut surface designed to provide a consistent profile absent of positive or upward texture

- A uniform land profile design with a predominantly negative texture
- A hybrid texture that resembles a combination of diamond grinding (called flush grind) and longitudinal grinding
- Can be done as a single step or a 2 step process
- Visit www.ngcs.info for 25 additional references on the pavement surface type
- Could compete with HRA in terms of noise
US studies have suggested that up to 30% saving in artificial lighting cost can be achieved by using a light coloured surface.
CASE STUDIES
Druids Heath Bus Terminus

- Repeated heavy loading of parked buses
- Oil spillage
- Disruption to public transport, congestion if re-routing employed
- Options were asphalt or RCC

<table>
<thead>
<tr>
<th></th>
<th>Asphalt</th>
<th>RCC</th>
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<tbody>
<tr>
<td>CBR</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Subbase</td>
<td>150mm</td>
<td>150mm</td>
</tr>
<tr>
<td>Pavement</td>
<td>260mm</td>
<td>200mm</td>
</tr>
<tr>
<td>Overall</td>
<td>410mm</td>
<td>350mm</td>
</tr>
</tbody>
</table>
• Transverse joints cut every 4 – 5 metres
• Cut using dry blade to one third of the depth
• Filled with bitumen emulsion prior to rolling
**Impetus Waste Transfer**

- Large storage area for compost waste
- Difficult ground conditions
- Time pressure on program
- No asphalt design option

<table>
<thead>
<tr>
<th></th>
<th>PAV 2</th>
<th>RCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR</td>
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<td>10</td>
</tr>
<tr>
<td>Subbase</td>
<td>150mm</td>
<td>150mm</td>
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<tr>
<td>Pavement</td>
<td>400mm</td>
<td>400mm</td>
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<tr>
<td>Overall</td>
<td>550mm</td>
<td>550mm</td>
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<tr>
<td>Program</td>
<td>16 weeks</td>
<td>6 weeks</td>
</tr>
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Impetus Waste Transfer
Impetus Waste Transfer
Summary

• RCC is not a new product

• Economics are driving contractors to seek ‘more (and more) for less’

• The challenge is to improve understanding and knowledge of RCC

• Specifications and design charts need to include RCC as an option

• RCC has all the attributes of concrete, with the installation speed of asphalt

• Maintenance options as well as new build is key

• Concrete paving is becoming a viable option in many applications
Questions ?