Concrete Roads

Technology Roller Compacted Concrete RCC

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Roller Compacted Concrete

Affordable and Sustainable Road Solution

- ✓ What is RCC
- ✓ Common Uses
- ✓ Key Elements
- ✓ Mix Design
- ✓ Structural Design
- ✓ Maintenance Cost

What is RCC?

- ✓ “Roller-Compacted Concrete (RCC) is a no-slump concrete that is compacted by high density pavers and vibratory rollers.”
  - Negative Slump
  - No reinforcing steel
  - No finishing
  - Consolidated with vibratory rollers
- ✓ Concrete pavement placed in a different way!

What is RCC?

- ✓ Consistency is stiff enough to remain stable under vibratory rollers
- ✓ Wet enough to permit adequate mixing and distribution of paste
- ✓ Typically placed with asphalt-type paver equipped with standard or high-density screed
- ✓ Final compaction obtained by a combination of passes with roller compactors

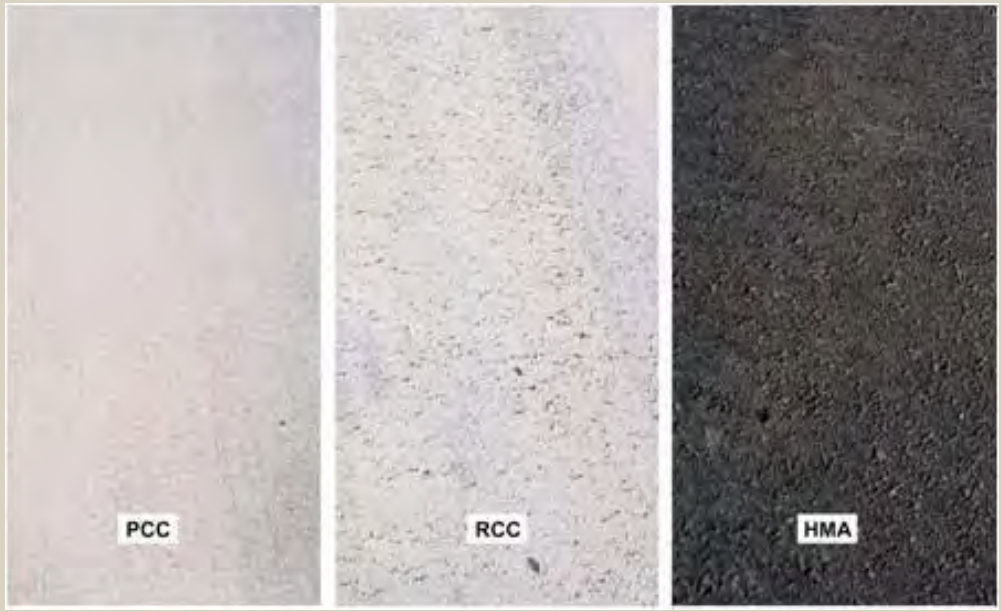
What is RCC?

- ✓ Final compaction is generally achieved within one hour of mixing.
- ✓ RCC pavements are constructed without forms, dowels, or reinforcing steel.
- ✓ Joint sawing is not always required, but when sawing is specified, transverse joints are spaced farther apart than with conventional concrete pavements.

What is RCC?

Surface of RCC

- ✓ More of an open surface texture after rolling similar an asphalt pavement surface.
- ✓ Quiet pavement due to “negative texture.”
- ✓ Can lose fine aggregate from their surface within to four years service
- ✓ Surface is treated by diamond grinding or an overlay when speed exceed 45 mph



What is RCC?

Benefits of RCC

- ✓ Primary benefit of RCC is that it can be constructed quickly and cost-effectively.

- ✓ Savings associated with RCC primarily due to:
  - ✓ Reduced Cement Content
  - ✓ Standard finisher placement
  - ✓ Reduced Construction Time
- ✓ Can be designed to have high flexural, compressive, and shear strengths, which allow it to support heavy, repetitive loads
- ✓ RCC needs no forms or finishing.
- ✓ No dowels, tie rods, or steel reinforcement

Demonstrated service life of 40+ years in harsh environments.

What is RCC?

Benefits of RCC (cont.)

- ✓ Less concrete shrinkage and thus less cracking
- ✓ Low permeability
- ✓ Provides excellent durability and resistance to chemical attack, even under freeze-thaw conditions.
- ✓ Eliminates rutting and subsequent repairs.

What is RCC?

Potential Limitation of RCC

- ✓ Pavement edges are more difficult to compact
- ✓ Due to relatively low water content, hot-weather RCC paving requires extra vigilance to minimize water loss to evaporation.
- ✓ Due to the dryness of the RCC mixture, admixture dosage requirements can be higher for RCC than for conventional concrete.

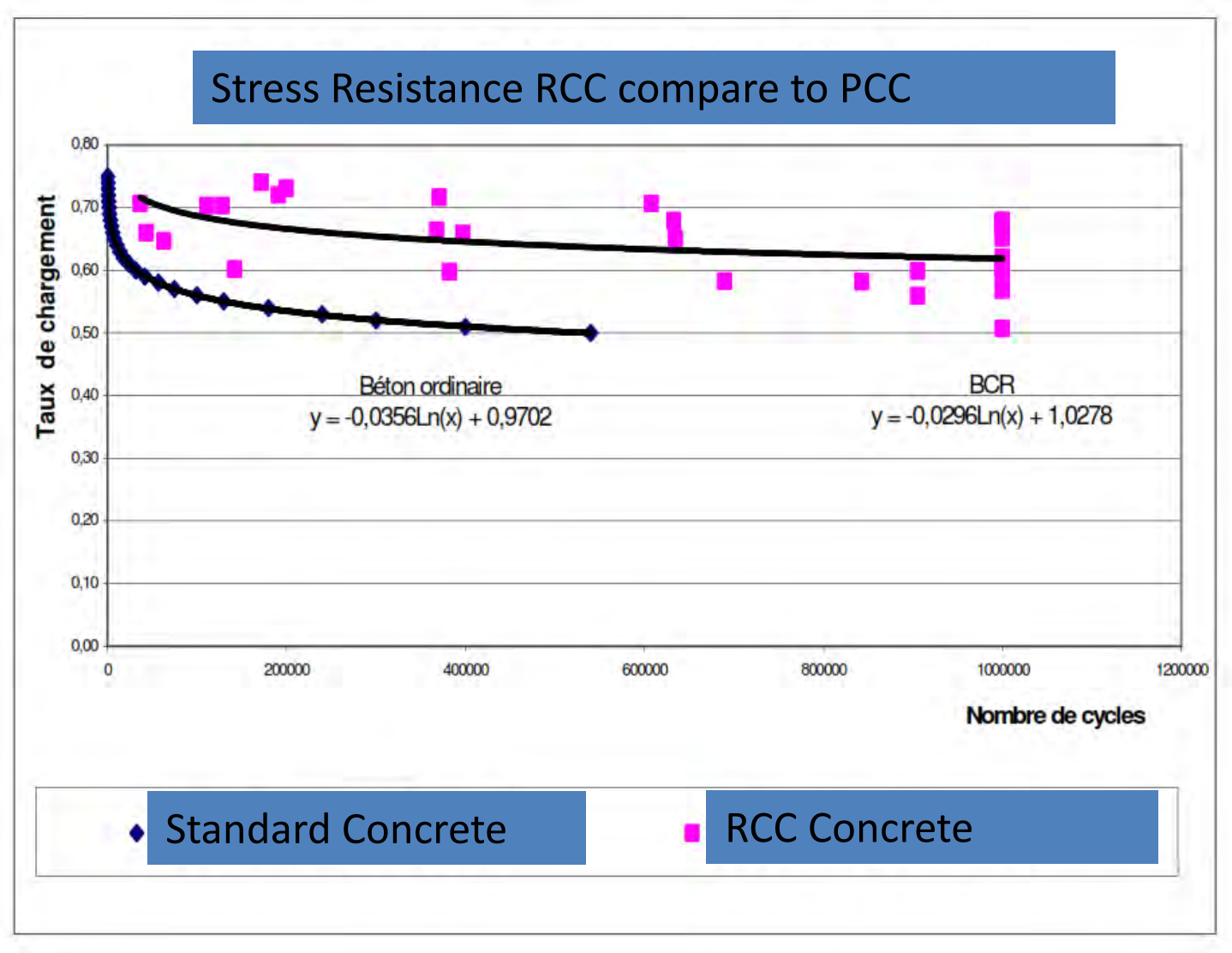
Common Uses of RCC Pavements

- ✓ Ports/Heavy Industry
- ✓ Haul Roads
- ✓ National Roads
- ✓ Airports
- ✓ Local Streets
- ✓ Urban Streets
- ✓ Rural Roads
- ✓ Base for Overlay
- ✓ Highways

RCC Properties

- ✓ Compressive strength
- ✓ Flexural strength
- ✓ Modulus of elasticity
- ✓ Bond strength
- ✓ Freeze-thaw durability
- ✓ Shrinkage
- ✓ Permeability
- ✓ Fatigue cycles to Failure
  - Similar to PCC

RCC Properties Versus PCC



RCC Engineering Properties

- ✓ Compressive Strength (f'c) = 25 to 45 MPa
- ✓ Flexural Strength (MR) = 3.5 to 8.45 MPa

$$MR = C\sqrt{f'c}$$

where C ranges from 8 to 12

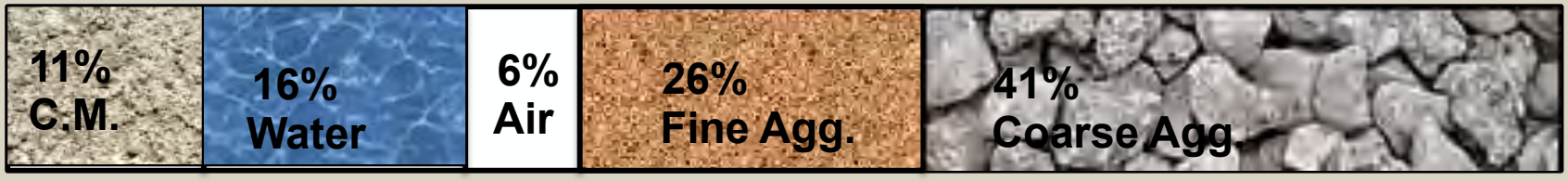
- ✓ Modulus of Elasticity (E) = 29 000 to 35 000 MPa

$$E = CE\sqrt{f'c}$$

where CE ranges from 57,000 to 67,000

Mix Design Conventional PCC versus RCC

✓ Conventional PCC



✓ Roller Compacted Concrete

Typical Mix Design

Several Methods of mix design can be used but the key criteria are specific for RCC :

- ✓ Maximum Compactness obtained at zero slump under high mechanical energy (vibration and pressure)
- ✓ Low amount of cementitious paste (less than 280 liters)
- ✓ High flexural strenghts (min 5.5 MPa for standard RCC)
  - ✓ 60 to 320 kg/m3 Cementitious Material.
  - ✓ 700 to 1000 kg/m3 Sand
  - ✓ 680 to 1200 kg/m3 Coarse Aggregates
  - ✓ 80 to 125 liters/m3 Effective Water.
  - ✓ W/C Ratio usually between 0.3 – 0.45.
  - ✓ Water amount dictated by Moisture/ Density/Compaction Relationship.

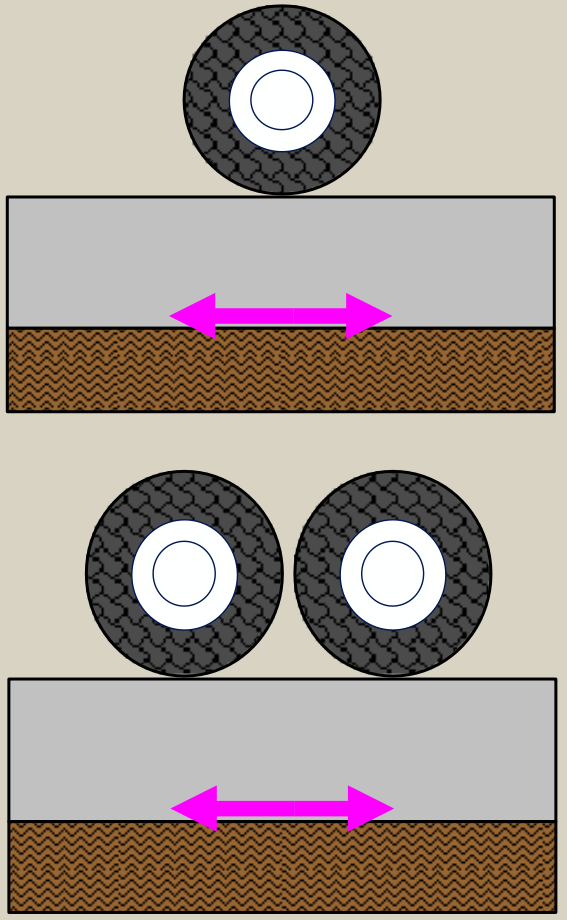
Pavement Design Methods

Design : Minimise Slab Tensile Stress

Stress is affected by:

- Load
- Tire pressure and spacing
- Slab thickness
- Subbase support
- Concrete stiffness

Slab thickness is increased and/or RCC strength is increased to ensure appropriate stress ratio.

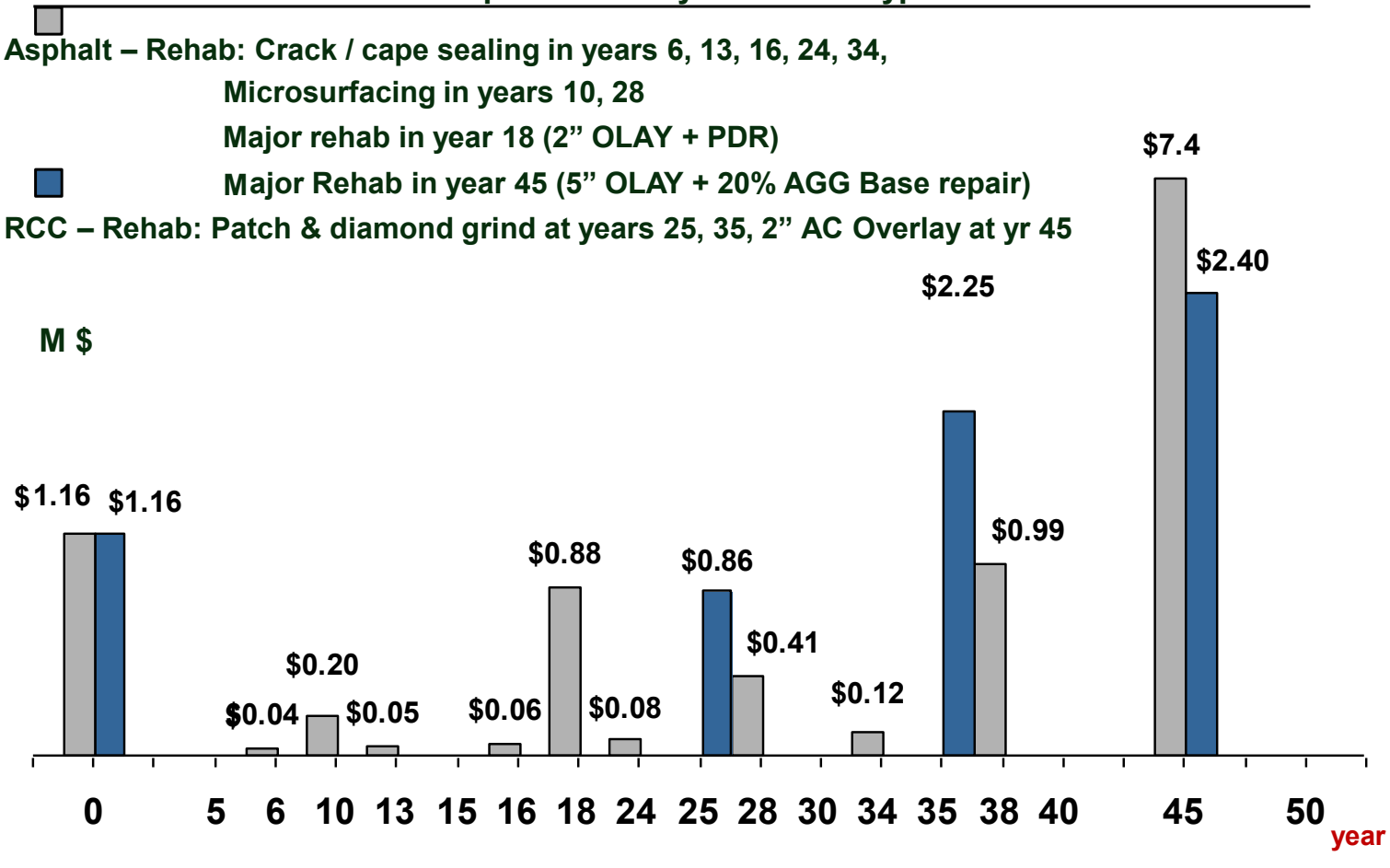


Maintenance Cost (USA)

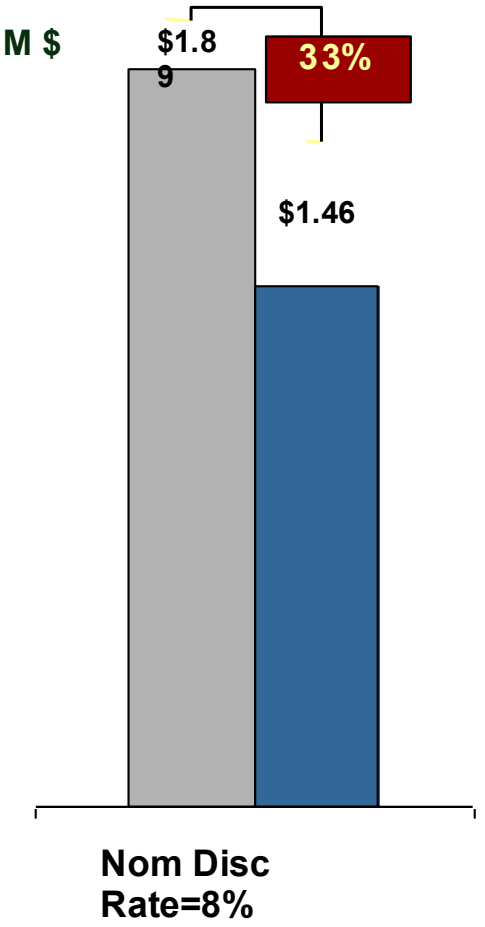
Nominal Expenditures by Pavement Type

Asphalt – Rehab: Crack / cape sealing in years 6, 13, 16, 24, 34,
Microsurfacing in years 10, 28
Major rehab in year 18 (2" OLAY + PDR)
Major Rehab in year 45 (5" OLAY + 20% AGG Base repair)

RCC – Rehab: Patch & diamond grind at years 25, 35, 2" AC Overlay at yr 45



Total Cost Net Present Value

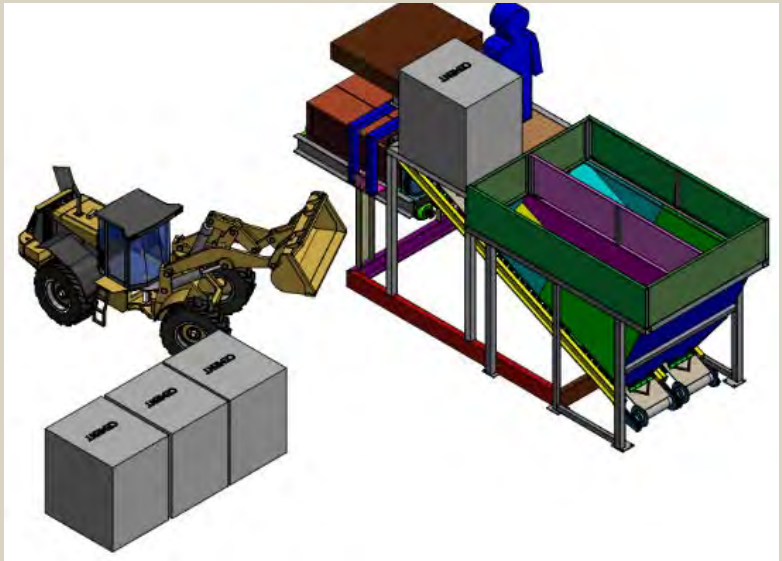


Asphalt is 50% more expensive than RCC throughout the life cycle of the road

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

Continuous Mix Pug Mill

- High-volume applications
- Excellent mixing efficiency for dry materials
- 80 to 200+ tons/hr
- Mobile, erected on site
- Mobilization costs



Transporting & Placement

Placing Equipment

High performance pavers

- ✓ Vibrating screed
- ✓ Dual tamping bars and or pressure bars
- ✓ High initial density, 90-95%
- ✓ Reduces subsequent
- ✓ compaction
- ✓ High-volume placement (200 to 400 m3 per shift)
- ✓ Designed for harsh mixes
- ✓ Smoothest RCC surface

Compacted Edges through the use of Edging Shoes

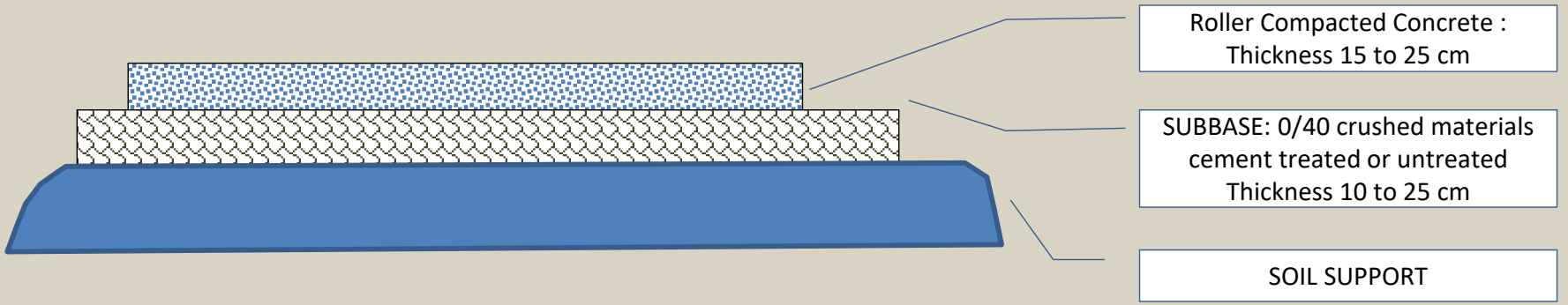
Compaction-Final Density

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

Concrete Curing Compound

- ✓ White-pigmented concrete curing compounds
- ✓ Apply 1 to 1.5 times the normal application rate

Typical RCC Composite Pavement Cross-Section



Madagascar Implementation 2015

- Project started March 2015

Madagascar Implementation 2015

- Trials April and May 2015

Madagascar Implementation 2015

- Official Inauguration May 2015

Madagascar First Contract 2016/2017

- ✓ First Public Road RCC approved and financed by European Union
- ✓ 250 to 350 m half road per day
- ✓ 120 heavy trucks per day
- ✓ Trucks have been allowed to circulate on RCC pavement after 7 days
- ✓ Road Specfications
  - ✓ Size : RCC 7.5 m large
  - ✓ Shoulder : RCC 0.8 m large, left and right side
  - ✓ Water Colector : RCC extruded profile

Madagascar First Contract 2016/2017

- ✓ Cost of construction 10% cheaper than equivalent asphalt road
- ✓ Fast building process
- ✓ No major quality problems
- ✓ Capital expenditure low level and equipment easy to implement
- ✓ 95 % local work force

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Madagascar MSC Container Platform 2019

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