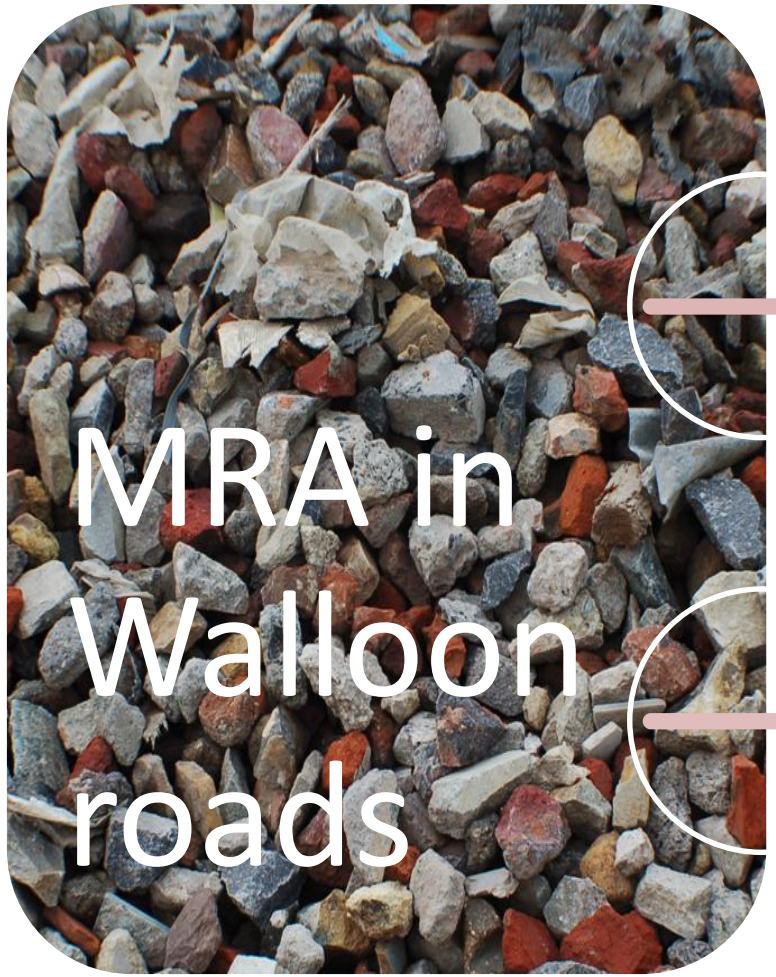
# Use of mixed recycled aggregates for a sustainable road construction

## Final Conference

## *SeRaMCo*

***Secondary Raw Materials for Concrete Precast Products***

Dr. Ing. Audrey Van der Wielen



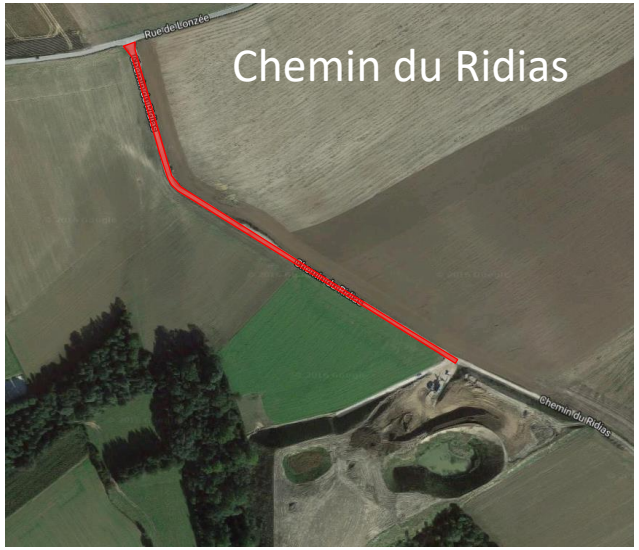

Only allowed in base and subbase layers

Recent limitation: max 30 % masonry

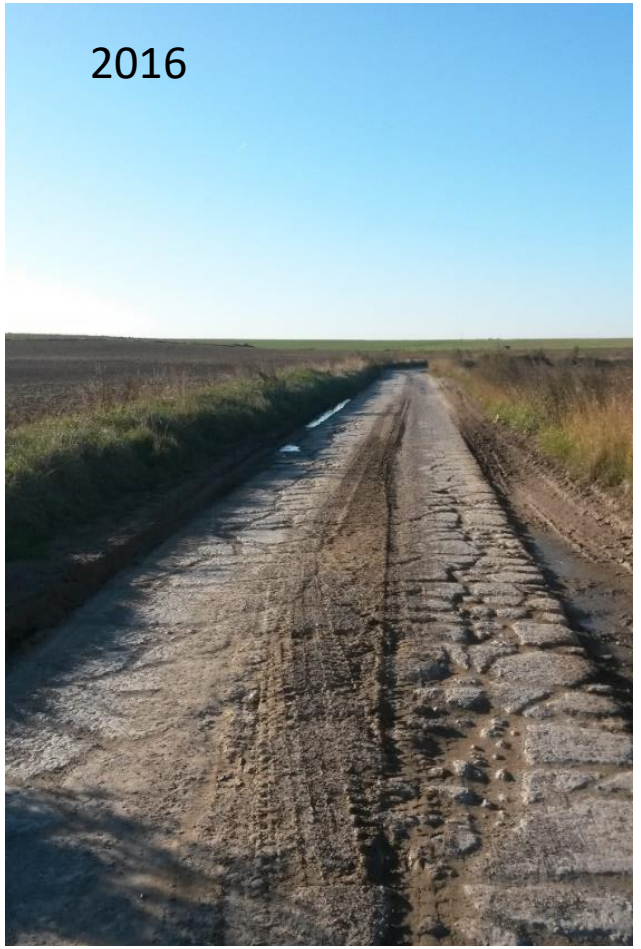
Use of MRA in pavement concrete?

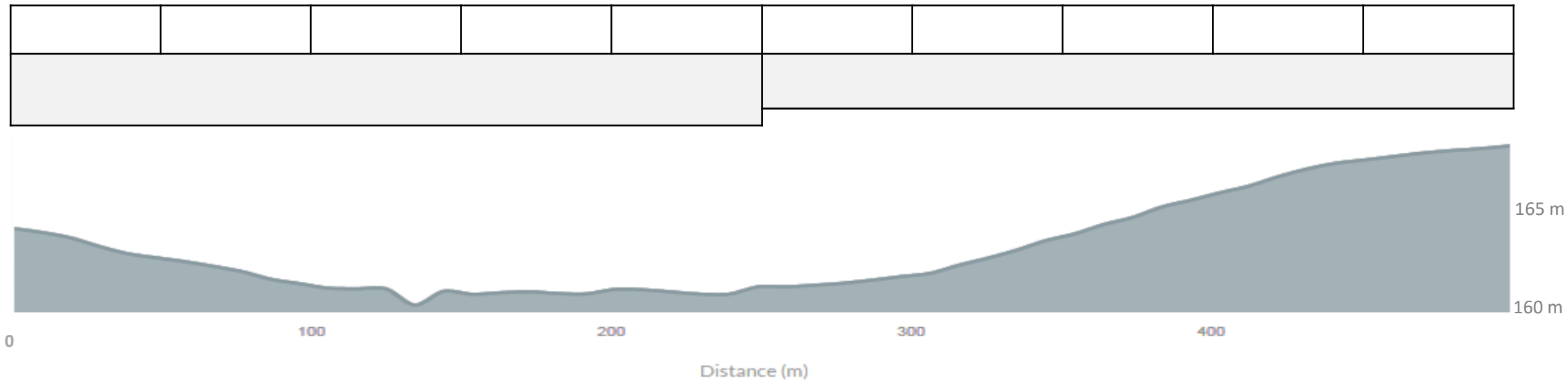
Long-term durability?

Ridias project




TRADECOWALL SCRL





165 m
160 m
0
100
200
300
400
Distance (m)

# Ground preparation

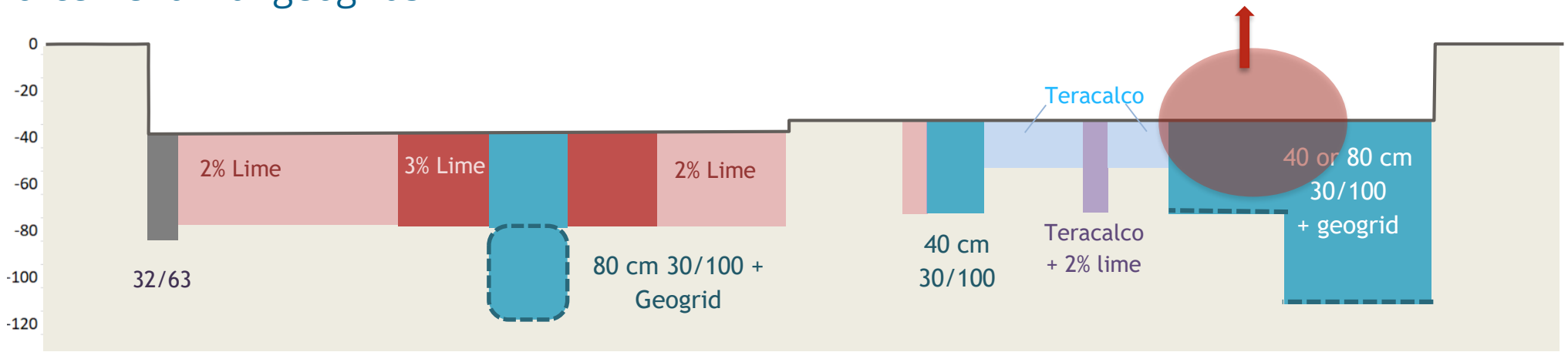
Very low bearing capacity undetected during preliminary tests

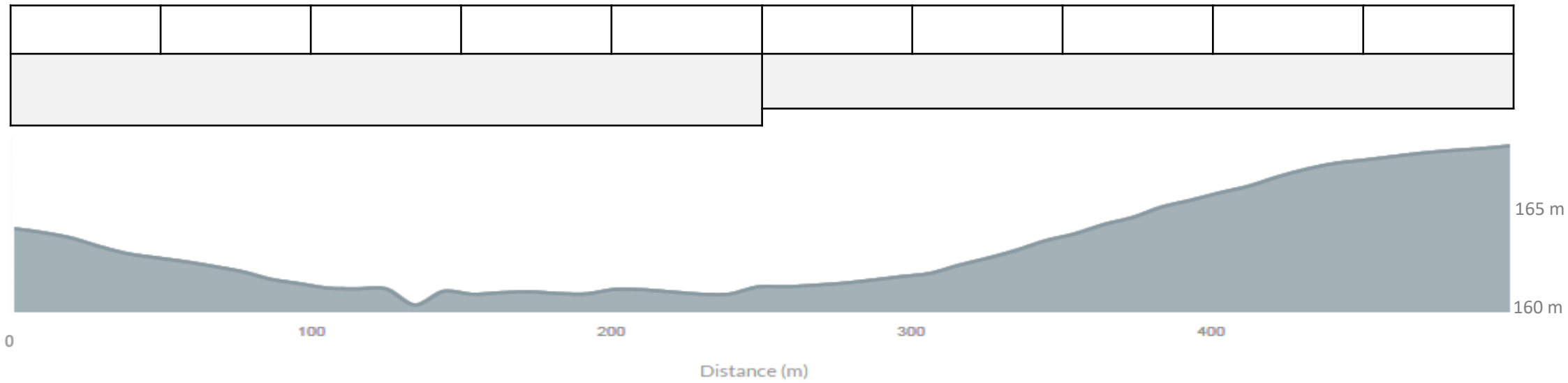
➔ Lime treatment

➔ Substitutions with coarse aggregates

➔ Reinforcement with geogrids

The bearing capacity remains locally low ➔ Worst case scenario

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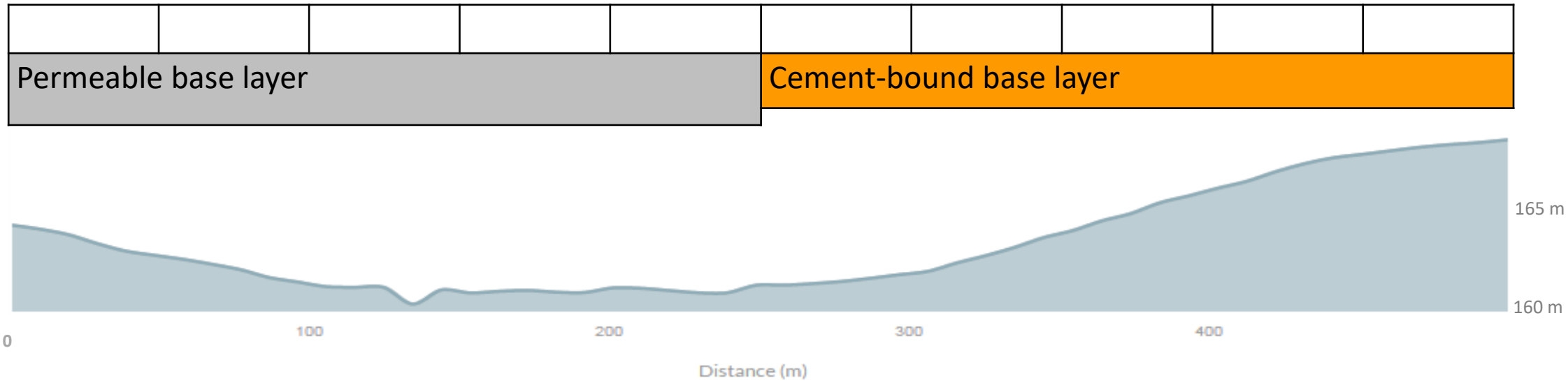
Permeable base layer
Cement-bound base layer
165 m
160 m
0
100
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Distance (m)

# Permeable base layer

20 cm thick

60 % in volume mixed recycled aggregates (0/32 mm)

40 % natural limestone aggregates (32/63 mm)

Final fines content of 2.89%

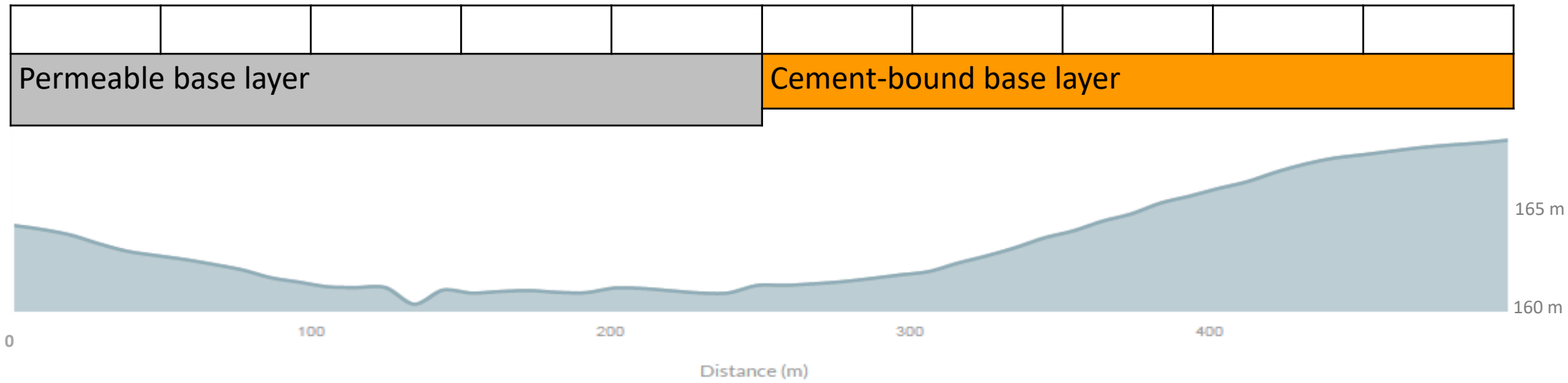
- Good permeability
- Difficult compaction

# Cement-bound base layer

15 cm thick

Mixed recycled aggregates 0/20 mm + 6 % cement

| Individual compressive strength at 90 days (MPa) | 22,2 | 27,7 | 17,6 |
|---|---|---|---|
| Average | | 22,5 | |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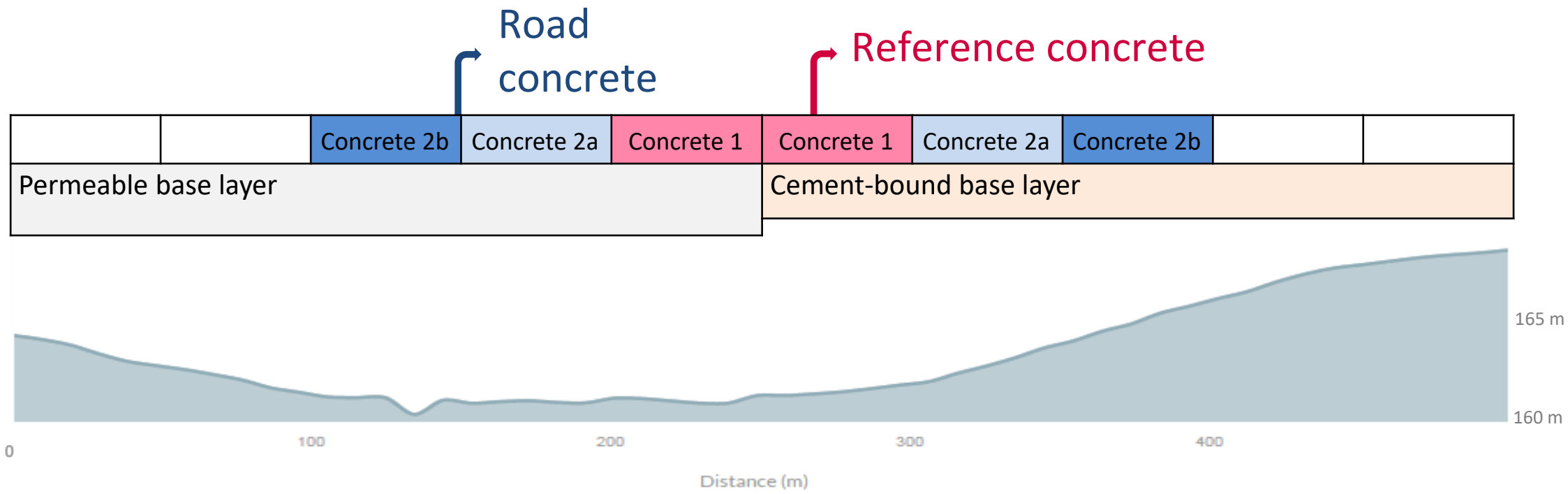
Road concrete
Reference concrete
Concrete 2b
Concrete 2a
Concrete 1
Concrete 1
Concrete 2a
Concrete 2b
Permeable base layer
Cement-bound base layer
165 m
160 m
0
100
200
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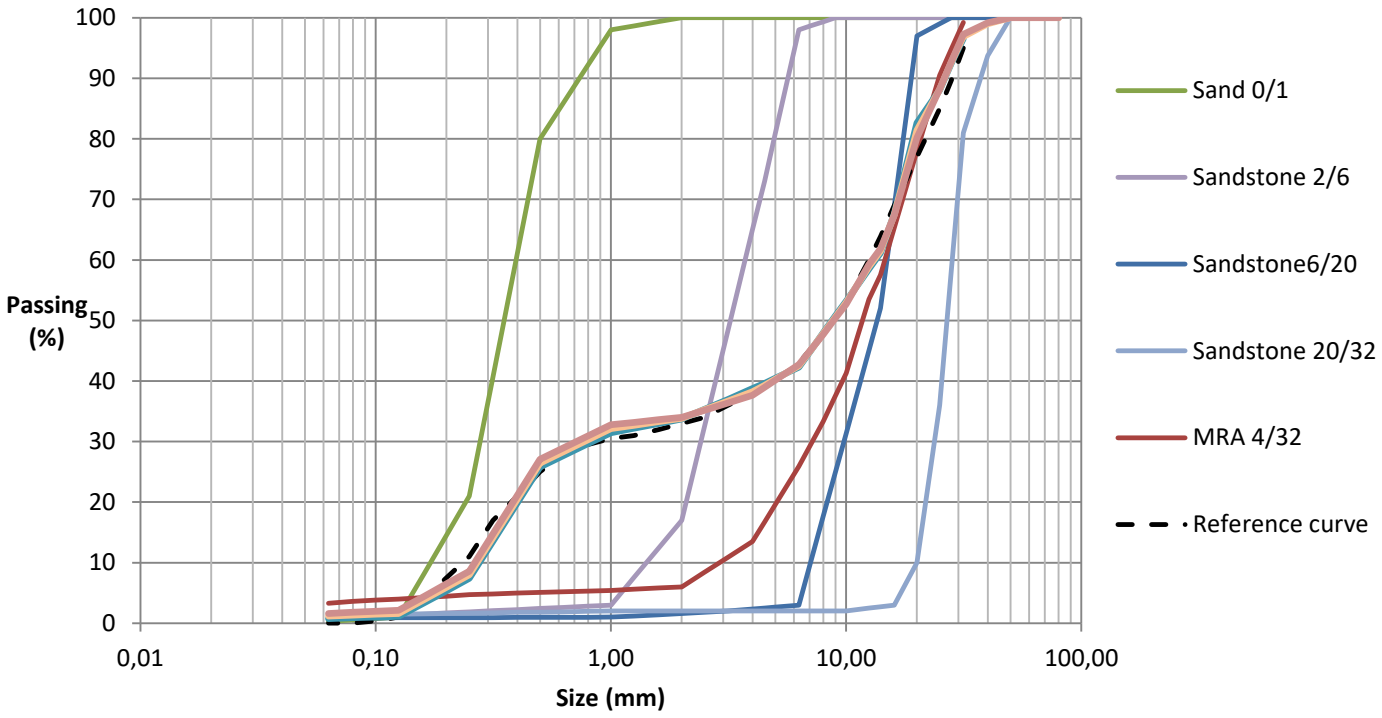
Distance (m)

# Road concrete

Thickness 18 cm, 4 m long slabs

25 % and 50 % substitution in volume of 4/32 agregates




| | Reference concrete kg / m³ | 50% MRA kg / m³ |
|---|---|---|
| Natural sandstone aggregate 2/32 | 1280.6 | 640.2 |
| Mixed recycled aggregates 4/32 | | 531.6 |
| Natural sand 0/1 | 577.5 | 577.5 |
| Cement CEM III/A 42,5 LA | 350 | 350 |
| Useful water | 168 | 168 |
| Absorption water | 9.4 | 44.8 |

# Road concrete

Slip-form placement

# Road concrete

## Fresh concrete properties

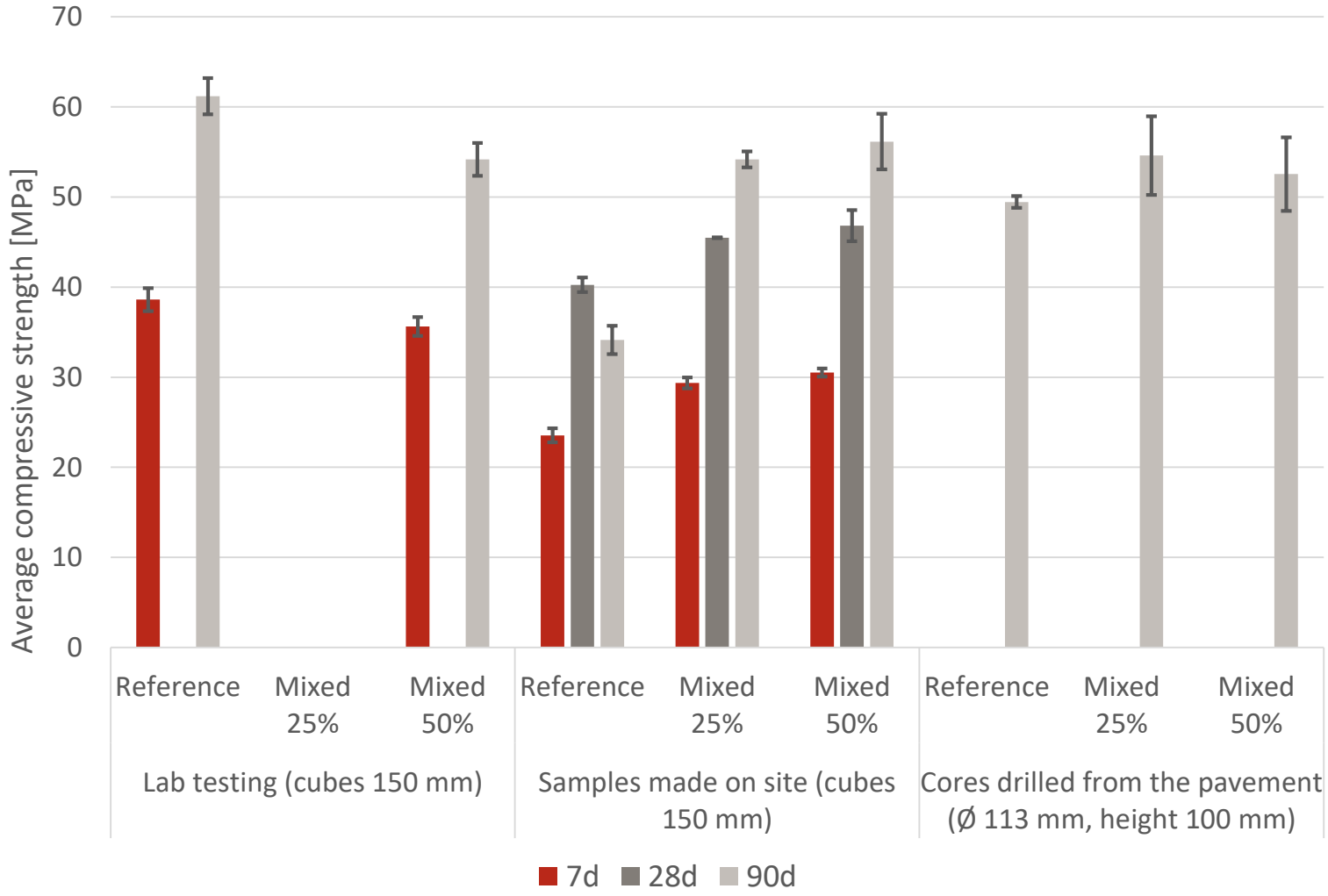
| | Reference | | 25 vol% mixed agg. | | 50 vol% mixed agg. | | Target value |
|---|---|---|---|---|---|---|---|
| | plant | on site | plant | on site | plant | on site | |
| **Slump (mm)** | 35-55 | 25-45 | 30-60 | 15-40 | 30-40 | 15-50 | 25-40 at plant |
| **Air content (%)** | 1.6 | 1.7 | 1.7 | 1.8 | 1.7 | 2.6 | - |
| **Water content (% by heating) (W/C+G)** | 10.0<br>9.8 | - | 10.7<br>9.9 | - | 10.3<br>11.0 | 9.9<br>10.4 | Ref: 8.1<br>25 %: 9.1<br>50 %: 10.1 |

W/C=0,58 instead of 0,48

# Road concrete

Compressive strength

- Low Rc for reference concrete, especially for samples made on site
- Satisfying compressive strength for recycled concretes, but large dispersion

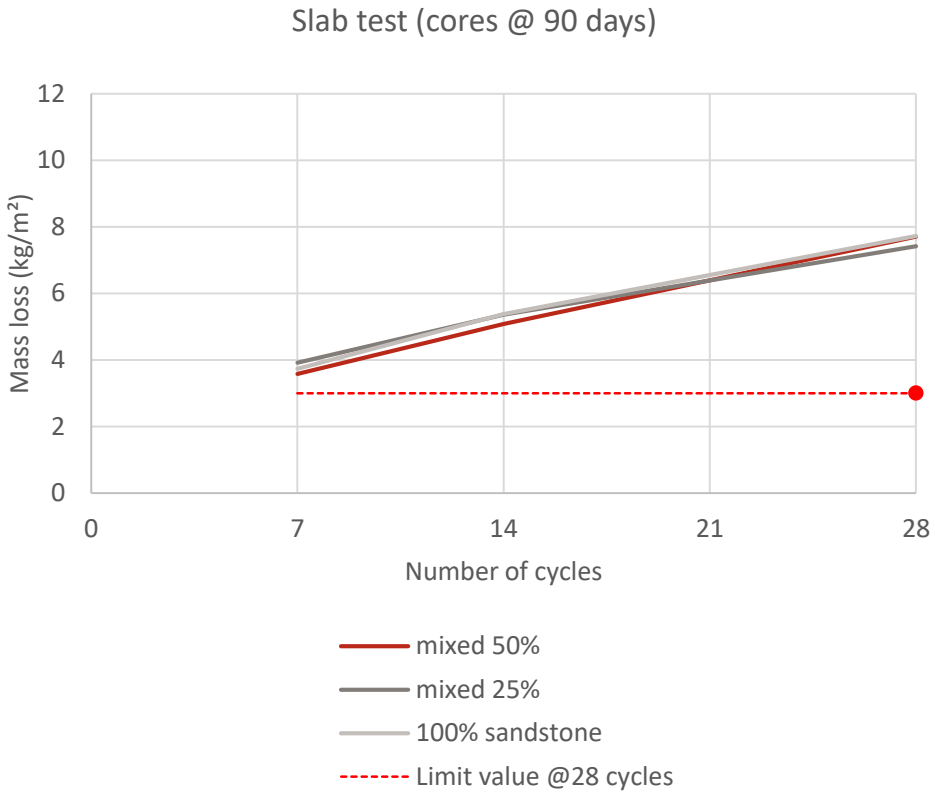


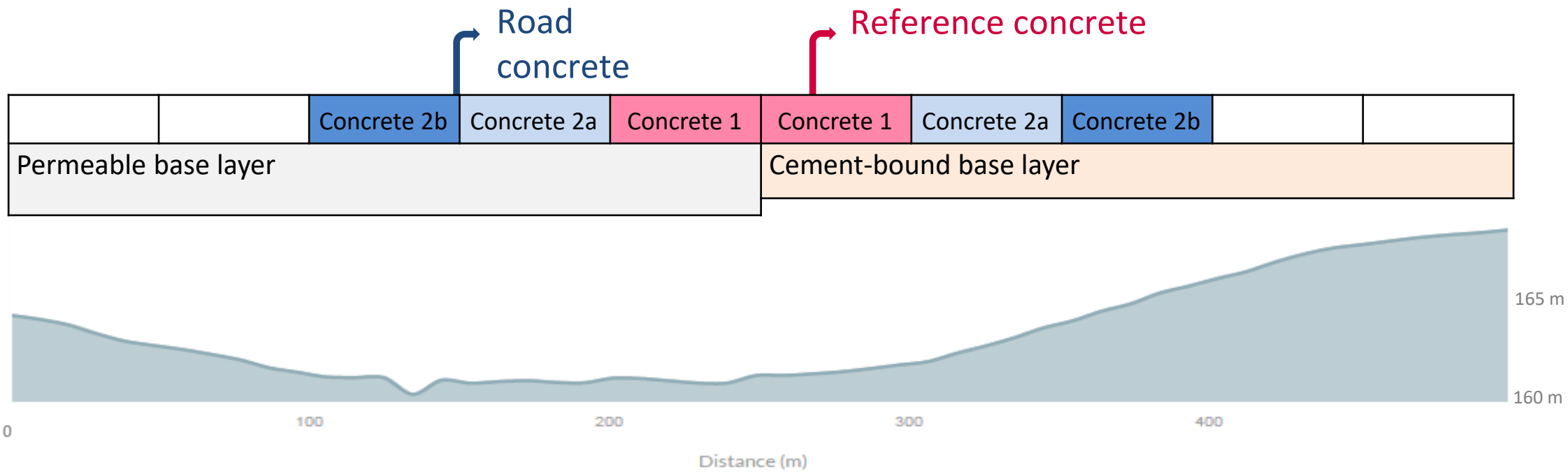
# Road concrete

Freeze-thaw resistance

- Unsufficient results for all concretes
  - ➔ OK because no de-icing salts will be spread on the road
  - ➔ Could be improved with the use of air-entraining agents

- Performances linked to the compressive strength

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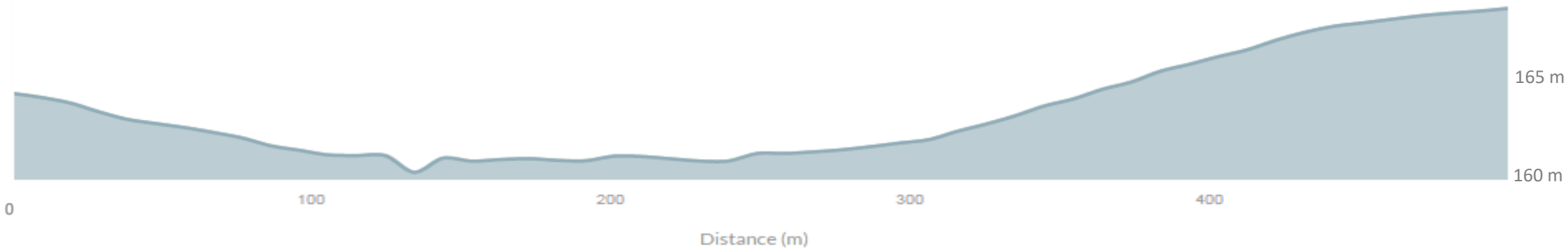
Roller-compacted concrete

| Concrete 3b | Concrete 3a | Concrete 2b | Concrete 2a | Concrete 1 | Concrete 1 | Concrete 2a | Concrete 2b | Concrete 3a | Concrete 3b |
|---|---|---|---|---|---|---|---|---|---|
| Permeable base layer | | | | | Cement-bound base layer | | | | |



# Roller-compacted concrete

Thickness 18 cm, 4 m long slabs

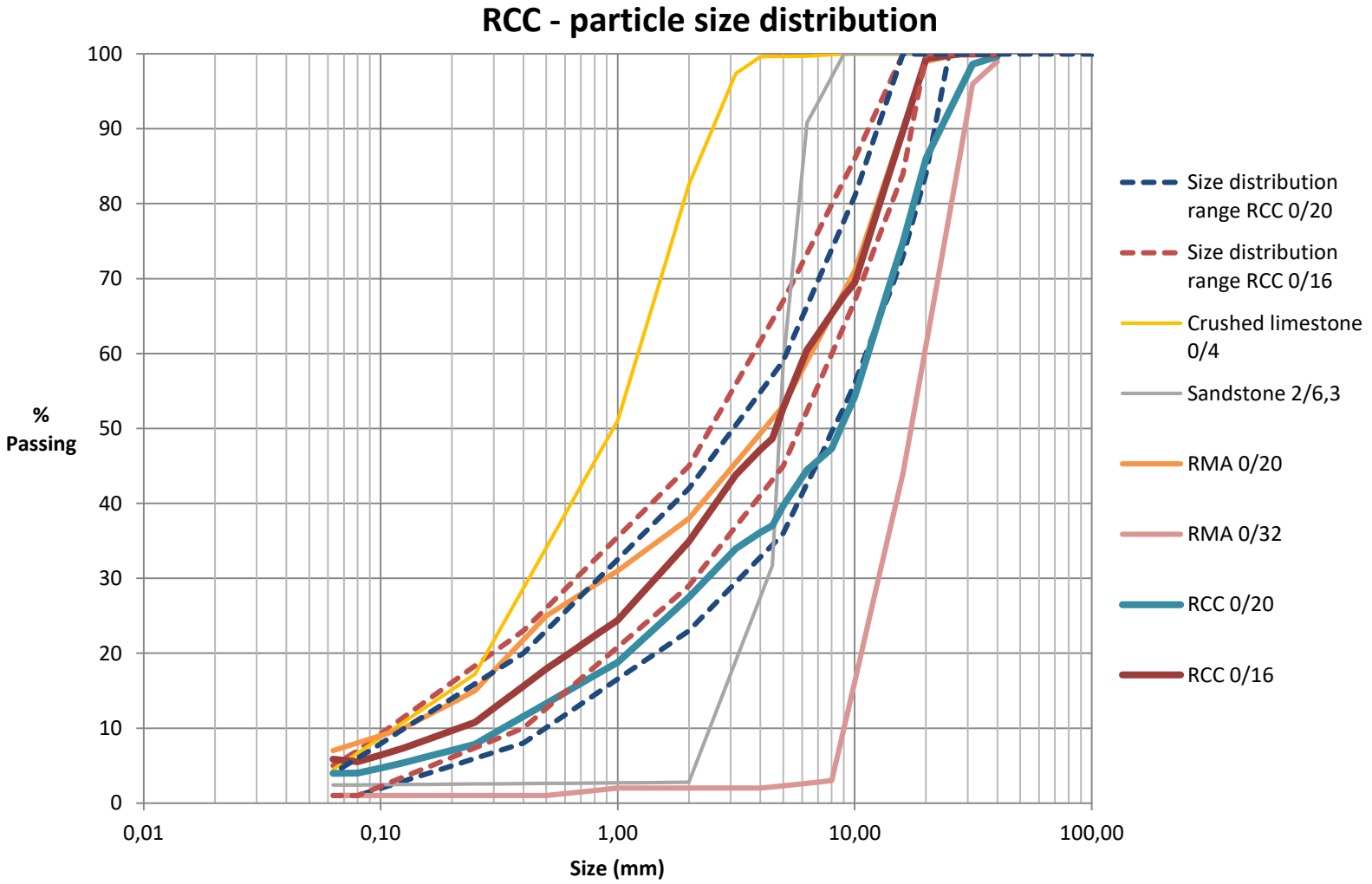
Low-cost solution,
with high substitution rates (> 80 %)

Target compressive strength: 30 MPa

2 particle size distribution curves:

- RCC 0/20 (0/32)
  - ➔ More resistant
  - ➔ Lower fines content

- RCC 0/16 (0/20)
  - ➔ Easier compaction



# Roller-compacted concrete

| | RCC 0/32 | | RCC 0/20 | |
|---|---|---|---|---|
| | % mass | kg/m³ (appr.) | % mass | kg/m³ (appr.) |
| RMA 4/32 | 25.9 | 600.25 | | |
| RMA 0/20 | 25.9 | 600.25 | 47.9 | 1114.59 |
| Sandstone 2/6 | 7.1 | 165.27 | 10.7 | 247.86 |
| Crushed limestone 0/4 | 20.1 | 464.77 | 20.9 | 485.82 |
| CEM III A 42,5 LA (CBR Lixhe) | 12.3 | 285 | 12.3 | 285 |
| Water | 8.6 | 198 | 8.3 | 193 |
| Total | | 2313.8 | | 2325.9 |
| Volume % recycled materials (without sand) | 70 (89.7) | | 65 (84) | |
| Fines content | 3.3 % | | 4.6 % | |

# Roller-compacted concrete

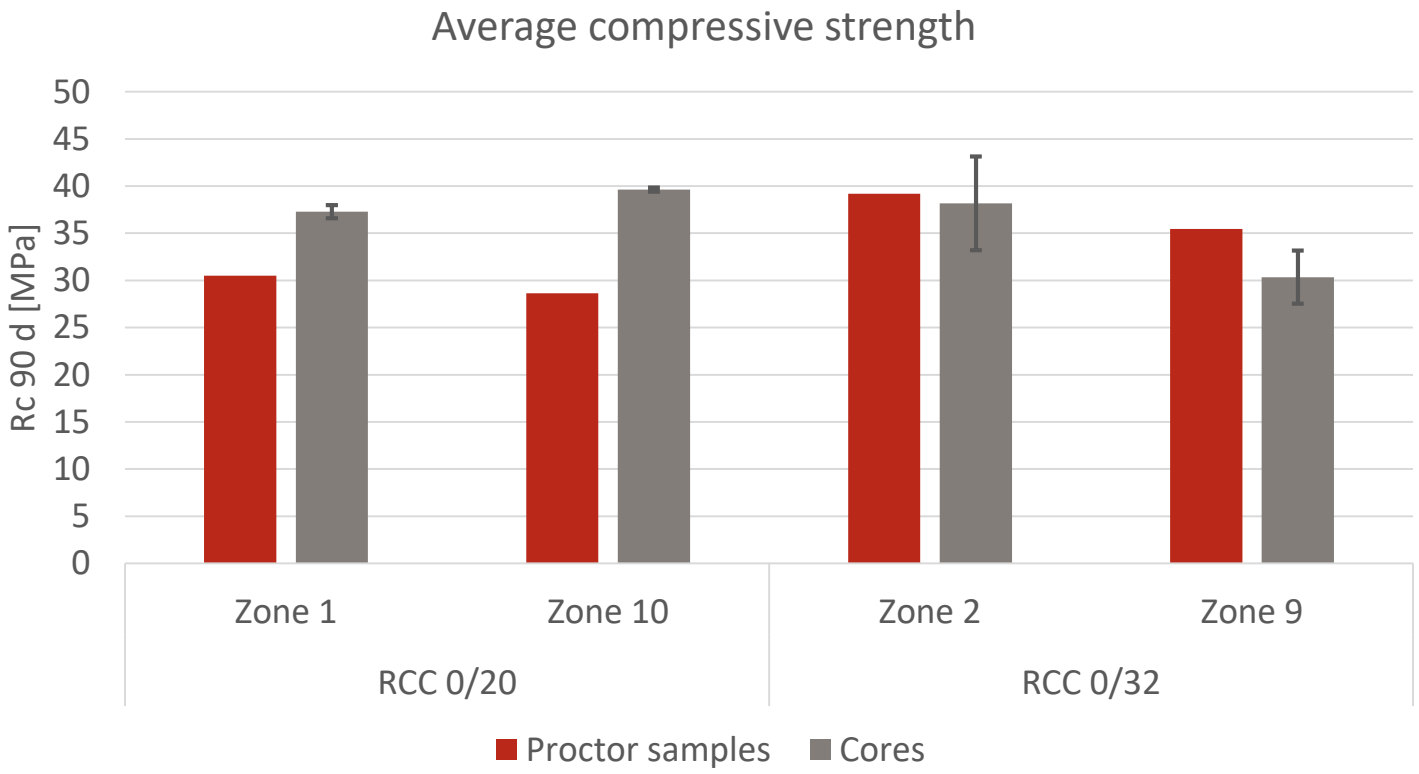


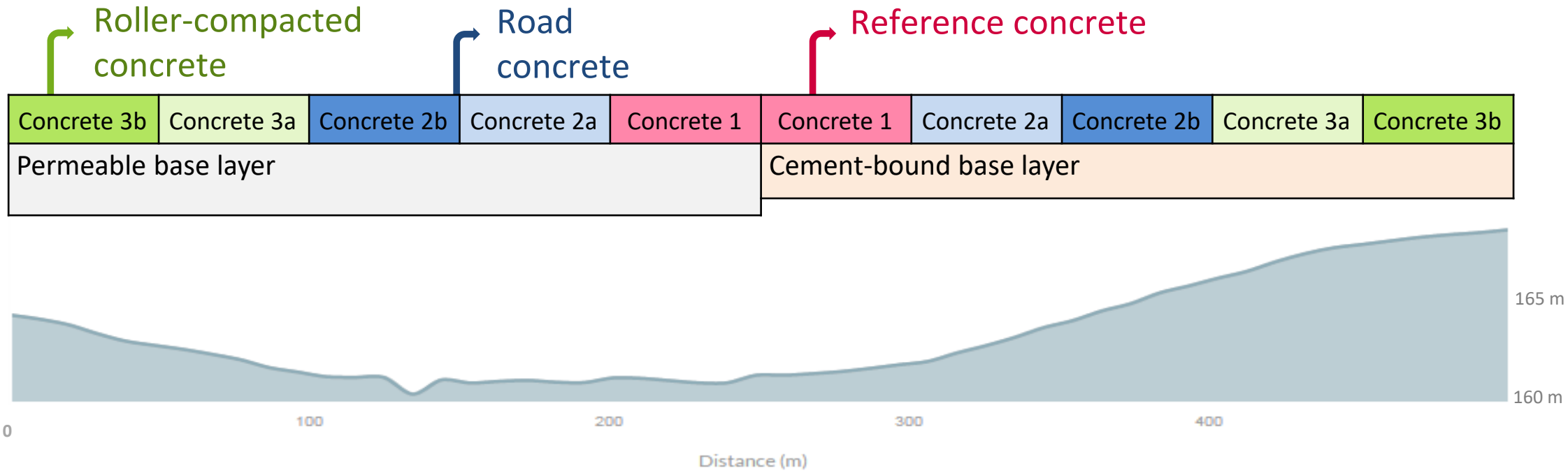
# Roller-compacted concrete

Compaction with both tyre and roller compactor

Single chipping surface dressing (with bituminous emulsion)


# Roller-compacted concrete

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# Conclusions

Different experimental pavement materials containing mixed recycled aggregates have been tested

- Little change in the implementation on site
- Satisfactory short-term performances

Long-term monitoring must confirm the durability of the proposed solutions

➡ Possibility to introduce these applications in the Belgian standard tender specifications

➔ Decrease of the cost of roads for the community (-20 to 30 %)

➔ Reduction of the environmental impact

# Thank you!

Audrey Van der Wielen

a.vanderwielen@brrc.be

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