BYPASS COUVIN
CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS (CRCP)
TWO-LIFT CRCP

ir arch Nathalie Balfroid
Ingénieur conseil infrastructure, FEBELCEM

Thanks to Anne Beeldens and Luc Rens
CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS (CRCP)

- CRCP Principle
- Concrete Composition
- CRCP Structure
- Active Crack Control
CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS (CRCP)

Belgium is pioneer!
RN 8 – Leuze en Hainaut 1950
CRCP PRINCIPLE

Shrinkage of concrete is controlled by reinforcement bars

- Crack opening is minimal
- Cracks distribution is as uniform as possible

-> Visible cracks
CRCP PRINCIPLE

• CRCPs are characterized by:
  – Absence of sawn transversal joints every 5 m
  – Longitudinal bending joint (sawn and constructed)
  – Shrinkage controlled by longitudinal reinforcement
    • 0.60 to 0.85 %
    • In Belgium today: 0.75 %
  – Network of fine cracks
    • Ideal distance between cracks 0.60 to 2.4 m
    • Crack width limited to 0.50 mm
  – One lift or two lift pavement

• Avantage:
  – minimise as much as possible the problems generated by transverse joints (maintenance, etc.)
CRCP REINFORCEMENT

Longitudinal bars supported by transverse reinforcement

Transverse bars at an angle of 60°

Tie bars

Transverse bars

Longitudinal bars

E = 23 ou 25 cm

$Wa = 0.76\%$

1 Ø 20mm every 17 or 18 cm
CAHIER DES CHARGES TYPE QUALI ROUTES 2016

Figure G. 12.4.1.2.1. Plan des armatures

cotes en mm.
La tolérance sur les écarts entre armatures est de 20 mm. Le diamètre nominal des armatures longitudinales et transversales, ainsi que l’écartement et leur position sont fixés comme suit:

<table>
<thead>
<tr>
<th></th>
<th>200</th>
<th>230</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Épaisseur du revêtement (mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diamètre nominal des armatures longitudinales (mm)</td>
<td>16</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Diamètre nominal des armatures transversales (mm)</td>
<td>12 ou 14</td>
<td>12 ou 14</td>
<td>12 ou 14</td>
</tr>
<tr>
<td>Ecartement (e) des axes des armatures longitudinales (mm)</td>
<td>130</td>
<td>180</td>
<td>170</td>
</tr>
<tr>
<td>Distance entre le nu supérieur des barres longitudinales et la surface du revêtement fini (mm)</td>
<td>70 à 90</td>
<td>80 à 100</td>
<td>80 à 100</td>
</tr>
</tbody>
</table>

Les documents de marché précisent le diamètre des armatures. A défaut, le choix est laissé à l’adjudicataire.
CONCRETE COMPOSITION

Following requirements of CCT-Qualiroutes

- Prescription on composition
- Requirements on hardened concrete (Rc, Wa, etc.)

<table>
<thead>
<tr>
<th></th>
<th>D_{max}</th>
<th>C_{min}</th>
<th>W/C</th>
<th>Air content</th>
<th>Average Compression Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bottom layer</strong></td>
<td>31,5 mm</td>
<td>375 kg/m³</td>
<td>≤ 0,45</td>
<td>-</td>
<td>≥ 60 MPa on cylinders (Ø113 mm, h 100 mm) à 90 days</td>
</tr>
<tr>
<td><strong>Top layer</strong></td>
<td>6,3 mm</td>
<td>425 kg/m³</td>
<td>≤ 0,42</td>
<td>5 ≤ v ≤ 8</td>
<td>≥ 40 MPa on cubes (150 mm) at 28 days</td>
</tr>
</tbody>
</table>

- 2 compositions -> 2 plants (+ 1 back-up) or one mobile plant

Certification WBR01
CONCRETE COMPOSITION

Following requirements of CCT-Qualiroutes

- Discontinous grading curve with more 4-8 mm size aggregates for acoustical reasons
ACOUSTICAL PERFORMANCES

A8 - Froyennes – Lamain

Figure 7 Graphique reprenant des mesures de caractérisation sur différents revêtements - SRTT

Average: 98.7 dB(A)
CRCP STRUCTURE

- Asphalt Sandwich Layer
  - Prevents erosion of the lean concrete base
  - Reduces water infiltration
  - Creates adherence between concrete pavement and base layer
  - Quality platform for positioning of reinforcement bars
CRCP STRUCTURE

ONE OR TWO LIFT

+  
-  

1 composition
1 mixing plant
Classic one layer concrete pouring

High quality material over the thickness of the layer
Acoustic properties depend on the quality of compaction by the slipform paver

High quality materials over thinner layer
Homogeneity and distribution of small aggregates less dependent on the type of paver

2 compositions
2 mixing plants
Added difficulty for the making of the construction joints at the end of the day
“wet-on-wet” pouring

Phasing stages

23 cm
6 cm
17 cm
ACTIVE CRACK CONTROL

Random Cracking

Concrete slabs

CRCP

CRCP with Active Crack Control

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ACTIVE CRACK CONTROL

Geometrical Characteristics

- On the edge of the pavement
- 40 cm length
- 4 cm deep
- Every 1,20 m

Timing !
ACTIVE CRACK CONTROL

• Faster crack development
• Cracks more straight and regular
• Risk of grouped cracks greatly reduced
ACTIVE CRACK CONTROL

Measurements on E17 and E313

- Comparison of cumulative crack spacing distribution at the test sections on E17 and E313 after about 20 months, including 2 winters;
- the arrows represent the percentage of the crack spacings in the preferred range 0.6 – 2.4 m (Belgium)
ACTIVE CRACK CONTROL

Measurements on A11

- Lane 1 – direction Knokke: cuts 20h after pouring
- Other lanes: cuts 16h after pouring

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### ACTIVE CRACK CONTROL

**Measurements on A11**

<table>
<thead>
<tr>
<th></th>
<th>Lane 1 – direction Knokke</th>
<th>Lane 2 – direction Knokke</th>
<th>Lane 1 – direction Antwerp</th>
<th>Lane 2 – direction Antwerp</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of saw cuts inspected</strong></td>
<td>828</td>
<td>773</td>
<td>322</td>
<td>317</td>
</tr>
<tr>
<td><strong>Amount of cracks</strong></td>
<td>426</td>
<td>611</td>
<td>283</td>
<td>278</td>
</tr>
<tr>
<td><strong>Perc. Working crack initiators</strong></td>
<td>36%</td>
<td>65%</td>
<td>75%</td>
<td>68%</td>
</tr>
<tr>
<td><strong>Perc. Cracks at saw cut</strong></td>
<td>69%</td>
<td>83%</td>
<td>86%</td>
<td>77%</td>
</tr>
<tr>
<td><strong>Average distance between cracks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- In tunnel</td>
<td>2,26 m, 2,59 m, 2,16 m</td>
<td>1,58 m, 1,89 m, 1,45 m</td>
<td>1,37 m, 2,17 m, 1,34 m</td>
<td>1,37 m, 1,67 m, 1,40 m</td>
</tr>
<tr>
<td>- In open trench</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Thank you !