UTCRCP – Recent experience RPF Feedback

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CAD MONKEY, DID YOU FINISH THE DESIGN FOR TOMORROW?
NO.
I'M WAITING UNTIL THE LAST MINUTE SO YOU WON'T HAVE TIME TO ASK FOR UNNECESSARY CHANGES.
I'M A STEP AHEAD OF HIM – THE DESIGN ITSELF IS UNNECESSARY.

Background

- UTCRCP = **U**ltra **T**hin **C**ontinuous **R**einforced **C**oncrete **P**avement
  - 50 mm thick concrete pavement
  - Concrete strength:
    - 90 MPa minimum Compressive (cubes)
    - 10 MPa minimum Flexural (beams)
    - 700 Joule Flexural Toughness (circular panels)
  - 5.6 mm mesh (50 x 100 mm) – approximately 6% steel
  - 100 kg steel fibre per cube
  - Polypropylene fibre (2 kg)
- Contract: N1/1 Rehabilitation & Widening (NRA N001-010-2008/2)
  - Between Toll Gate and Huguenot Tunnel (Short section on Worcester side)

Background continued

- Initial specifications provided by SANRAL (Louw Kannemeyer)
- These included
  - Project Specification (Section B7700)
  - Details (joints, anchor beams, etc.)
- Included in project specification are details of the concrete mix
  - Details on
    - Strength requirements
    - Mix proportions
  - These details guided the mix design process

Mix Design

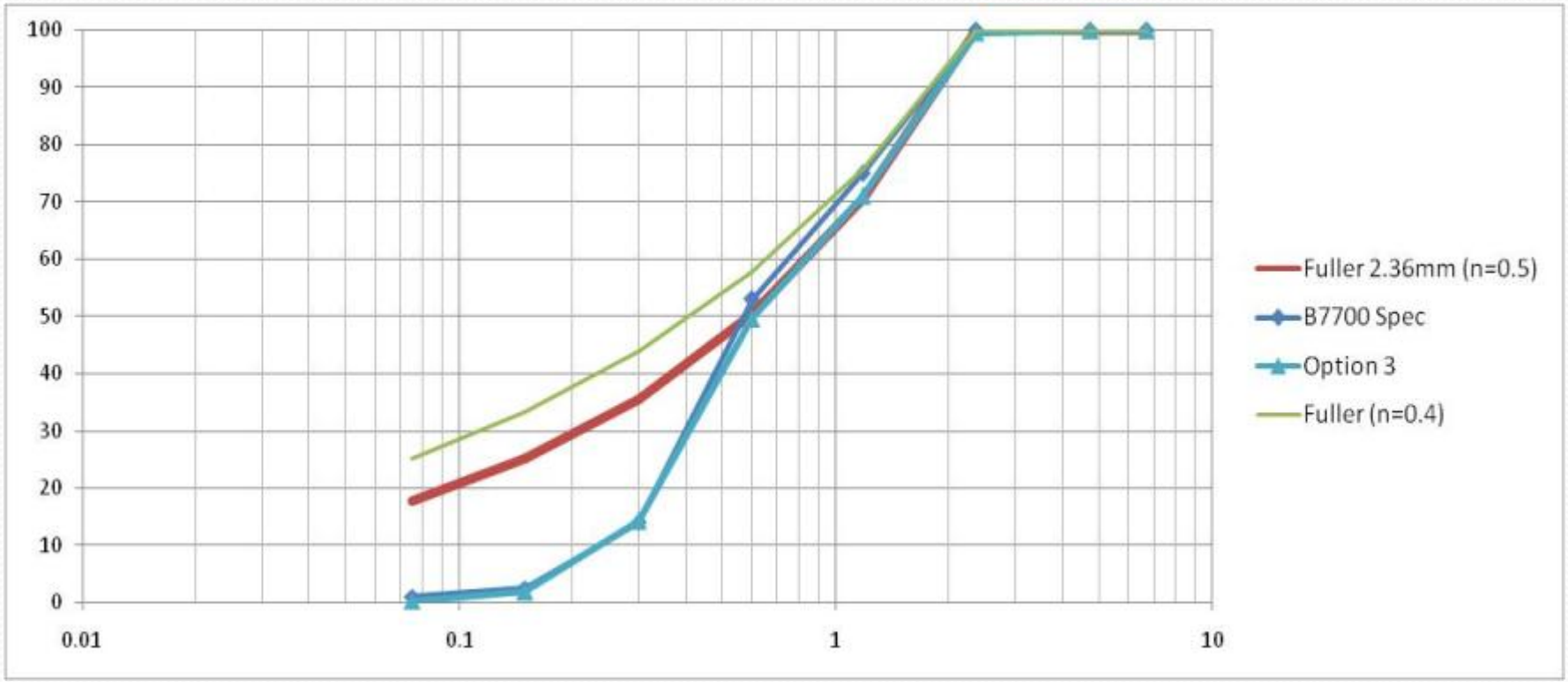
- Mix proportions provided in project specification

Material	(kg/m^3)
Cement	480
Fly Ash	87
Condensed Silika Fume	72
Stone	972
Water	175
Sand 1	257
Sand 2	257
Sand 3	170
Chryso Premia 100* (litre)	4 *l*
Chryso Optima 100* (litre)	2.4 *l*
Polypropylene Fibre	2
Steel Fibre	100

- Indication from different sources was to not change this
- Rather, local materials had to be sourced, conforming to specifications
  - Sand (Phase 1)
  - Stone (Phase 2)

Mix Design

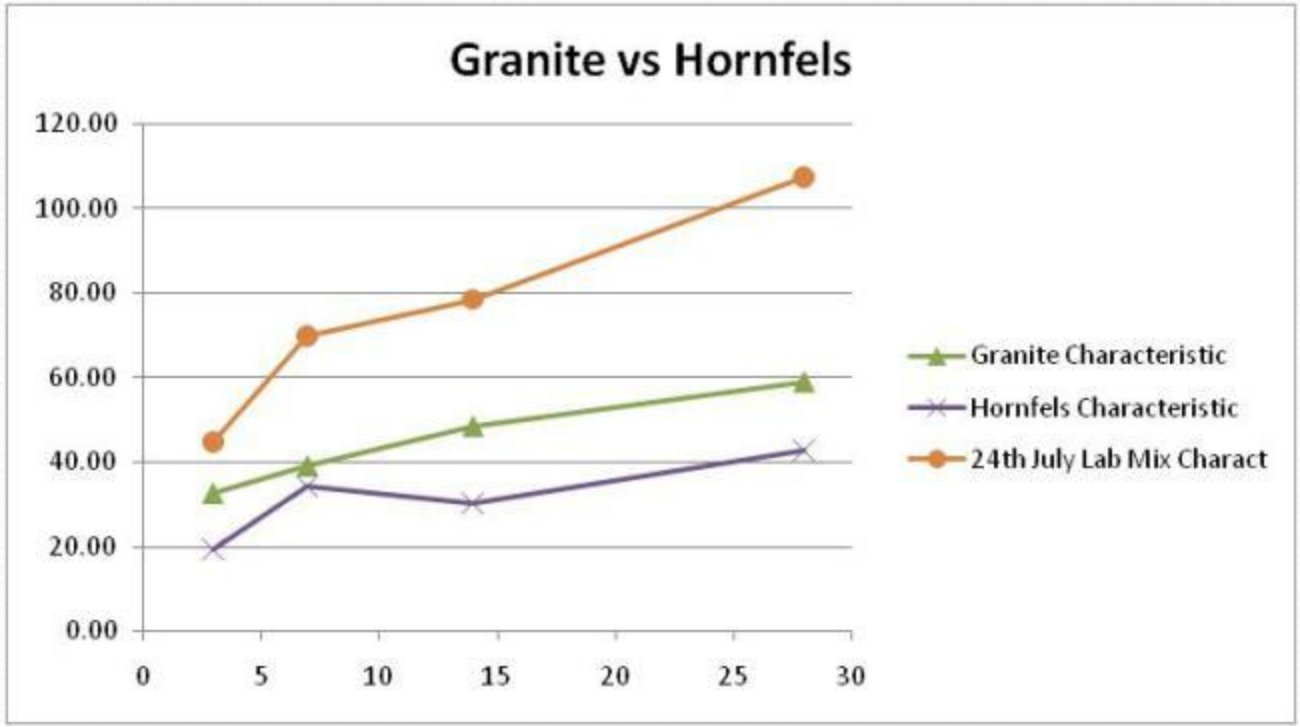
- Phase 1 mixes used the same coarse aggregate (Hornfels)
- Varied sand sources (3) & W/C ratios (3)
- Varied sand sources and Water/Cement ratios
- Obtained promising results with Consol sands at 0.3 W/C ratio
  - Consol Unscreened Millfeed @ 76% + 1.2-2.4 Sand @ 24%
  - Strengths
    - Compressive: 80.65 MPa (90.67 average)
    - Flexural: 10.65 MPa (12.27 average)


100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
Fuller 2.36mm (n=0.5)
B7700 Spec
Option 3
Fuller (n=0.4)

Mix Design

- Phase 2 varied the stone (6.7 mm aggregate)
  - Granite
    - Flakiness: 8.2 %
    - ALD: 4.8 mm
  - Hornfels
    - Flakiness: 30.2
    - ALD: 3.4
- Granite gave best results
  - Compressive strength
  - Flexural strength
  - Flexural toughness (circular panels, energy absorption)

MPa


Granite vs Hornfels
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
5
10
15
20
25
30
Granite Characteristic
Hornfels Characteristic
24th July Lab Mix Charact

Days

Mix Design

- Circular Panels
  - Requirement is 700 Joules energy absorption at 25 mm deflection
  - Granite: 6 out of 6 panels
  - Hornfels: 3 out of 6 panels

Mix Design – Trial Sections

- Purpose is to develop Method Statement and to test construction procedures with selected mix
  - With Trial Sections pre-mixed dry components were used for the first time
    - Silica Fume, Fly Ash, part of Cement and Polypropylene
  - Compressive strength results much higher than trial mixes
    - Average compressive strengths exceed 90 Mpa
    - Laboratory mix made achieved 108 MPa

Construction

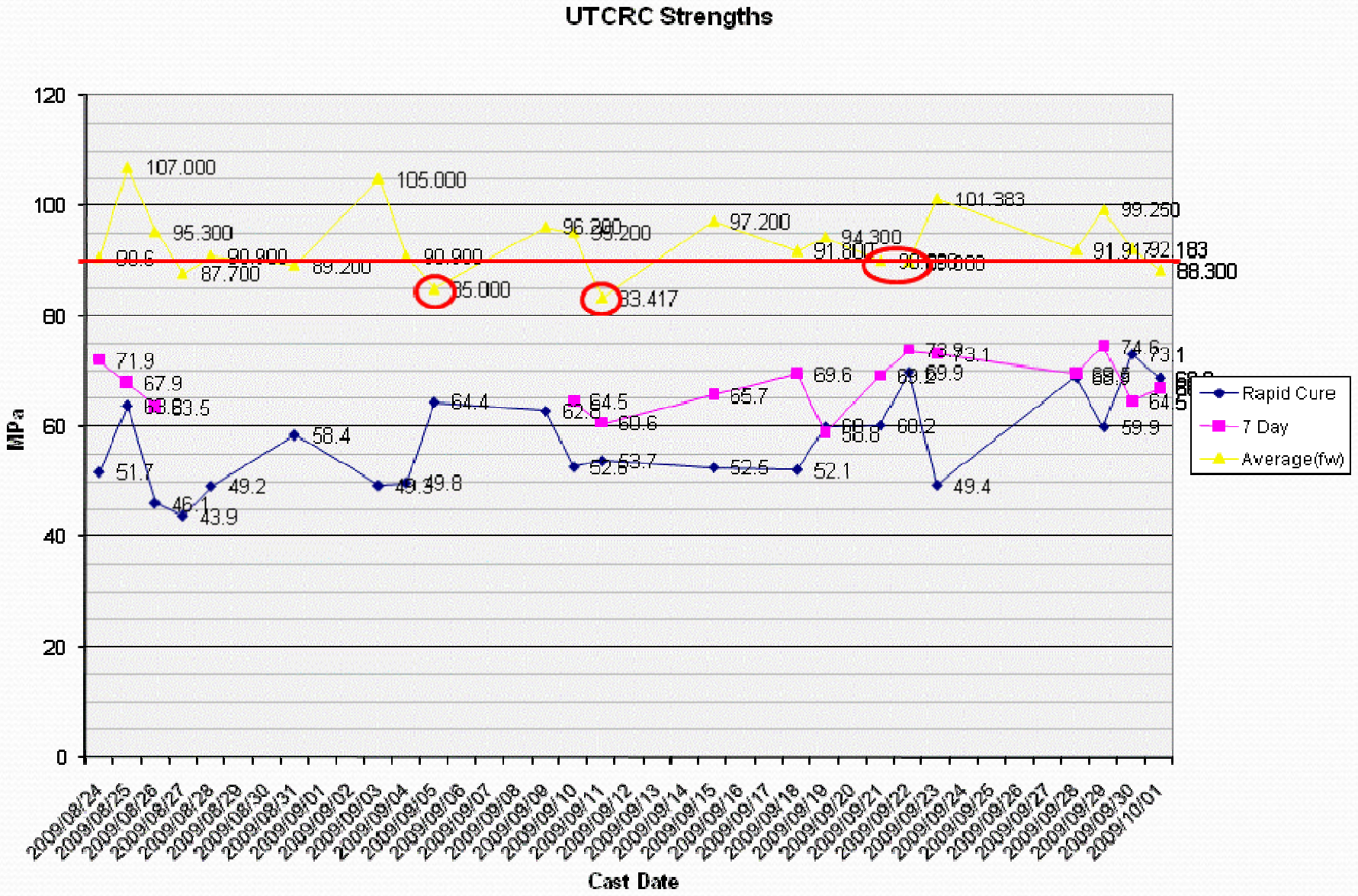
- Curing
  - Wax based curing compound – better performance indicated
  - Also plastic sheeting for 7 days
- Day Joint
  - Insert within mesh; no lapping of mesh through joint
  - Plane of weakness – problem position at Heidelberg TCC
- Texturing
  - 26 mm random spacing tine grooving device; at 60° angle
- Asphalt joint
  - Wooden joint former; apply compound to prevent asphalt adhesion

Construction

- To date, we have 4 instances where reduced payment may be applicable
  - Judgment scheme considers both strength (f) and thickness (d)

$$P = \frac{(dw)^5 (fw)^4}{(ds)^5 (fs)^4} \times 100$$

  - No outright rejection (fw < 82.35 MPa; dw < 46.55 mm)


UTCRC Strengths
MPa
Cast Date
Rapid Cure
7 Day
Average(fw)
107.000
105.000
101.383
99.250
97.200
95.300
94.300
91.800
90.900
88.300
87.700
85.000
83.417
71.9
67.9
64.4
64.5
65.7
69.6
73.1
74.6
59.9
58.4
51.7
49.2
49.8
52.6
53.7
52.5
52.1
49.4
46.1
43.9

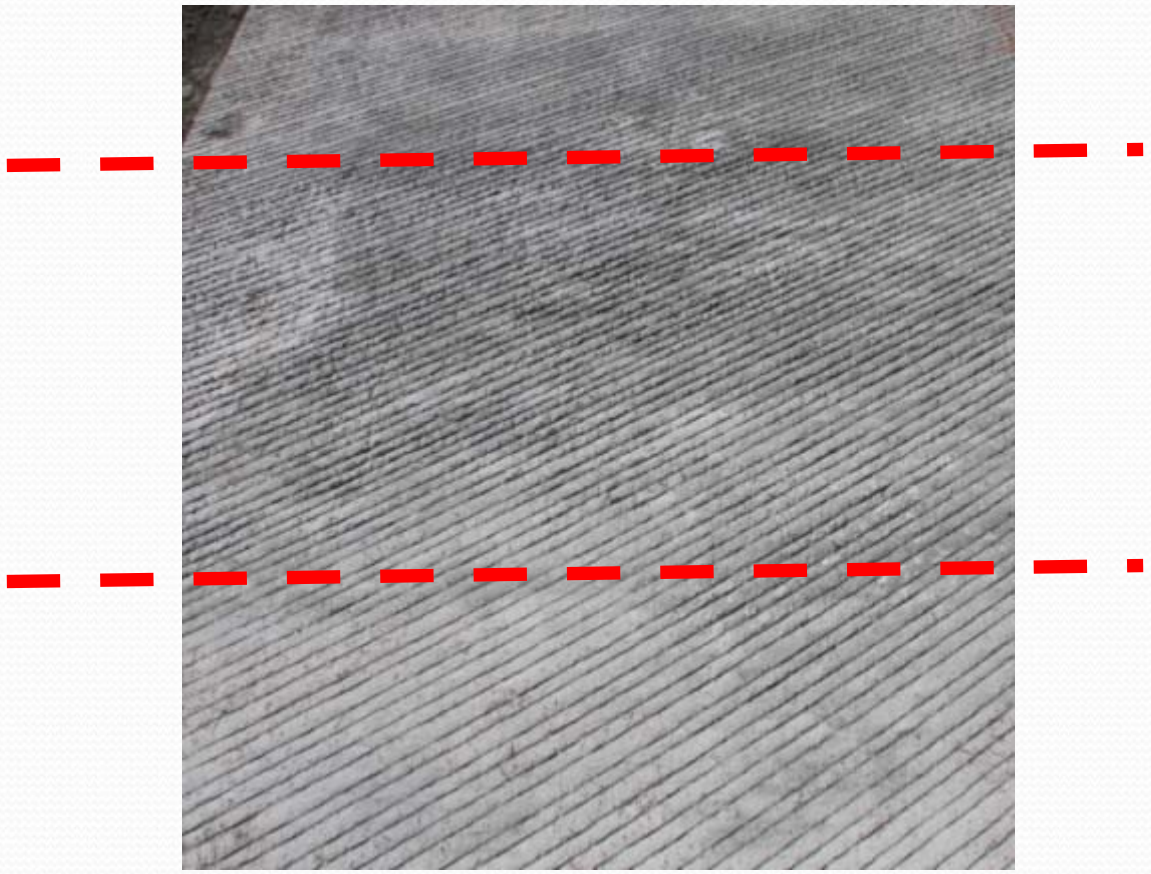

Day joint
Heidelberg TCC
Plane of weakness
due to reduced
cover (?)

Construction

- Achieving approximately 50 linear meters per day
- Texture
  - Specification requires 1 -2 mm texture depth (minimum) - TMH6
  - This is achieved (different measurements)

Construction

- Timing of tine grooving is very important



Construction

- Steel fixing


300 m

Construction

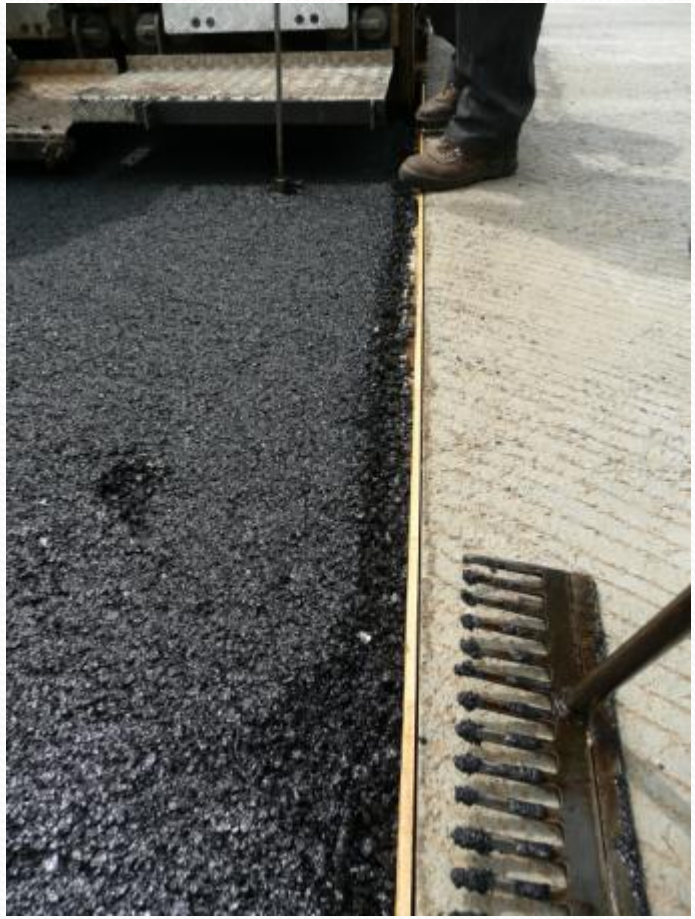
- Vibration pattern

Construction

- “Paving train”

Construction

- Asphalt joint



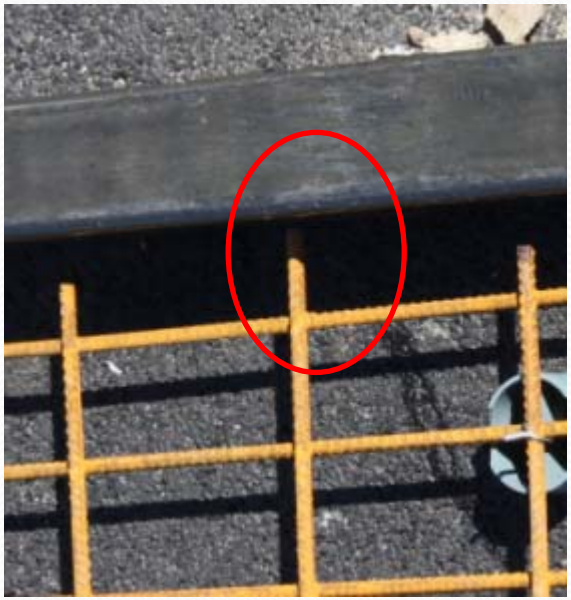
Construction

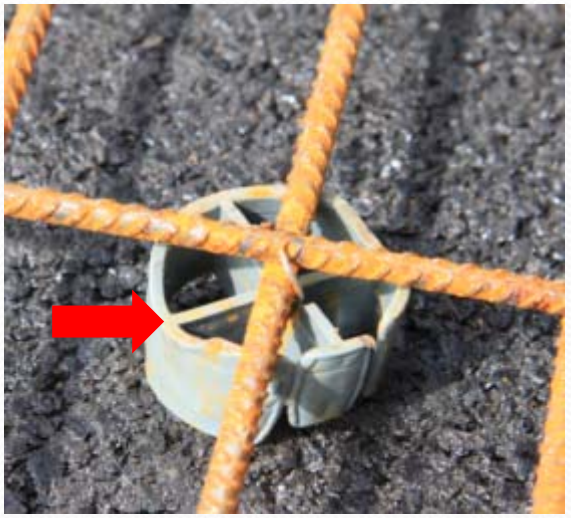
- Asphalt joint

Lessons learnt

- Stick to the “recipe”
  - Sand grading is extremely important
    - Also moisture
  - Stone – as cubic as possible (Spec on ALD and Flakiness?)
- Define early strength requirement for acceptance control
  - Rapid curing/1 day/3 day/7 day strengths?
- Indication that pre-mixing of dry components also improves strength development; also mixing method
  - Pan mixer – size & energy
- Work as a team
  - Client/Consultant/Contractor
- Ask questions – get as much information as possible
- Attention to detail, e.g. sample preparation

Attention to detail





Attention to detail

Thanks for sharing your knowledge

- Louw Kannemeyer
- Prof Kearsley & D Mostert (UP)
- Prof van Zijl (US)
- Prof Alexander (UCT)
- Kevin Pickard
- Johan Dercksen

The End