

Structural Health Monitoring

Elsabé Kearsley

Department of Civil Engineering

University of Pretoria



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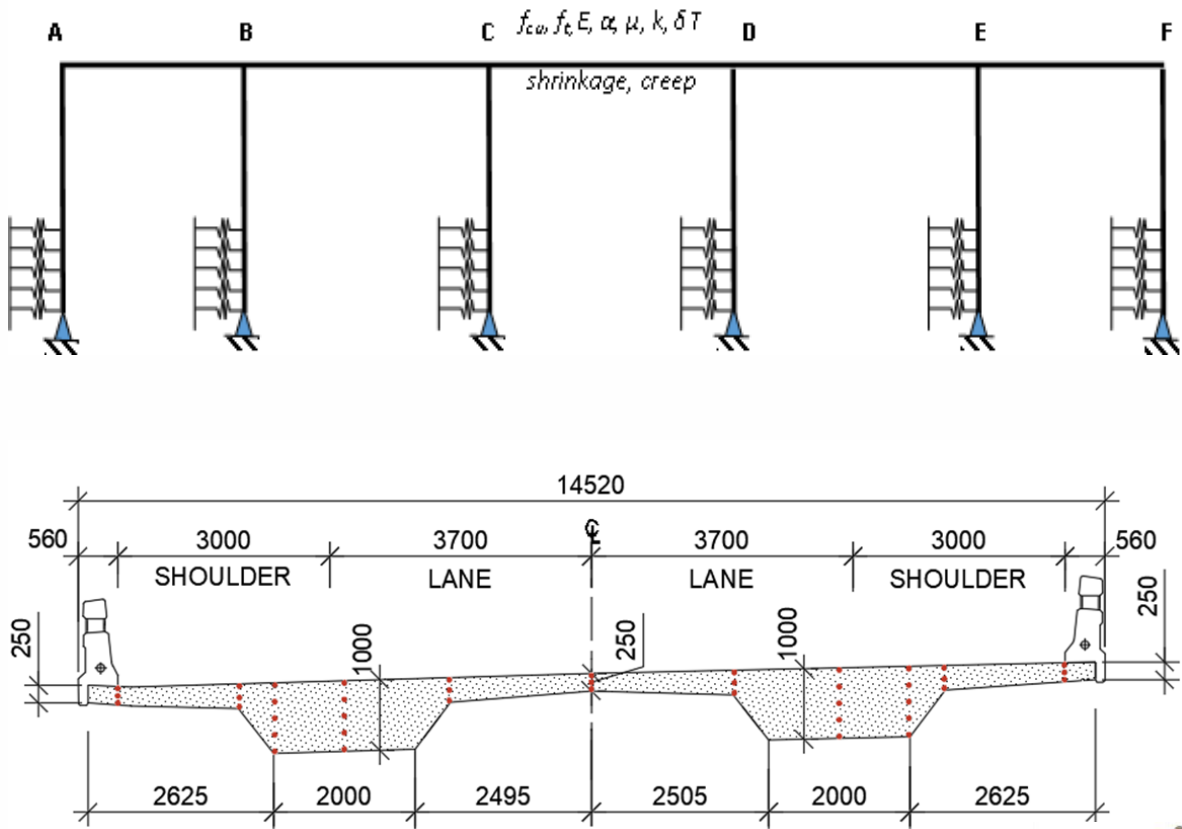
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“Engineering is the art of modelling materials we do not wholly understand, into shapes we cannot precisely analyse so as to withstand forces we cannot properly assess, in such a way that the public has no reason to suspect the extent of our ignorance.”

(Dr AR Dykes, IStructE, 1946)



What is REAL and what is IDEAL?



Structural Health Monitoring

Reinforced Concrete

Length: 90m

Width: 14.5m

5 Spans: 20.7m

Height: 5m

Sensors installed:

110 VW strain gauges

20 rebar strain gauges

44 thermistors

2 Shape Accel Arrays

(22 links each)

8 tilt meters

20 earth pressure cells

10 temperature and

humidity sensors

optic fibres

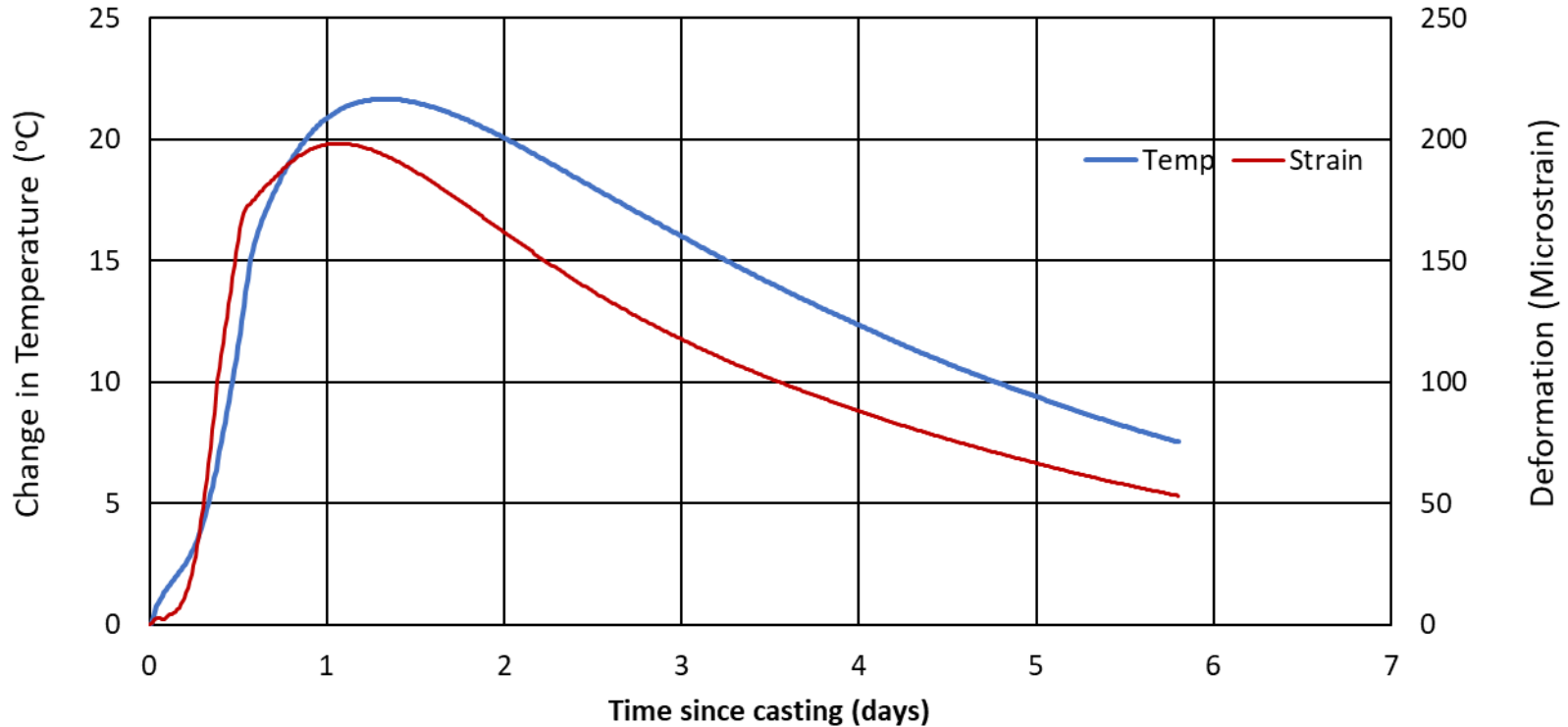
Van Zylspruit: Over 550 channels logging every 15 minutes from 2016

(Skorpen, 2018)

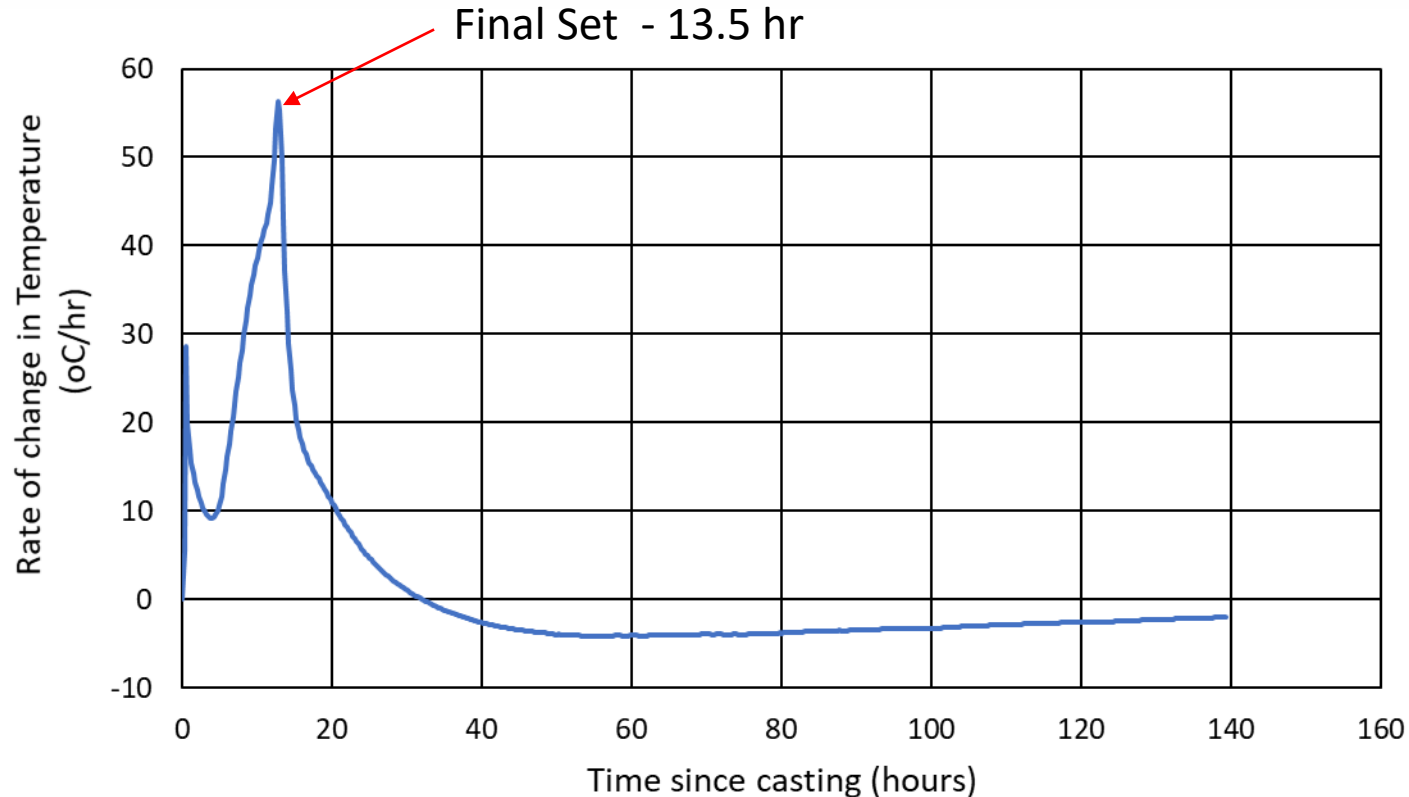
Vibrating Wire Strain Gauges (VWSGs)



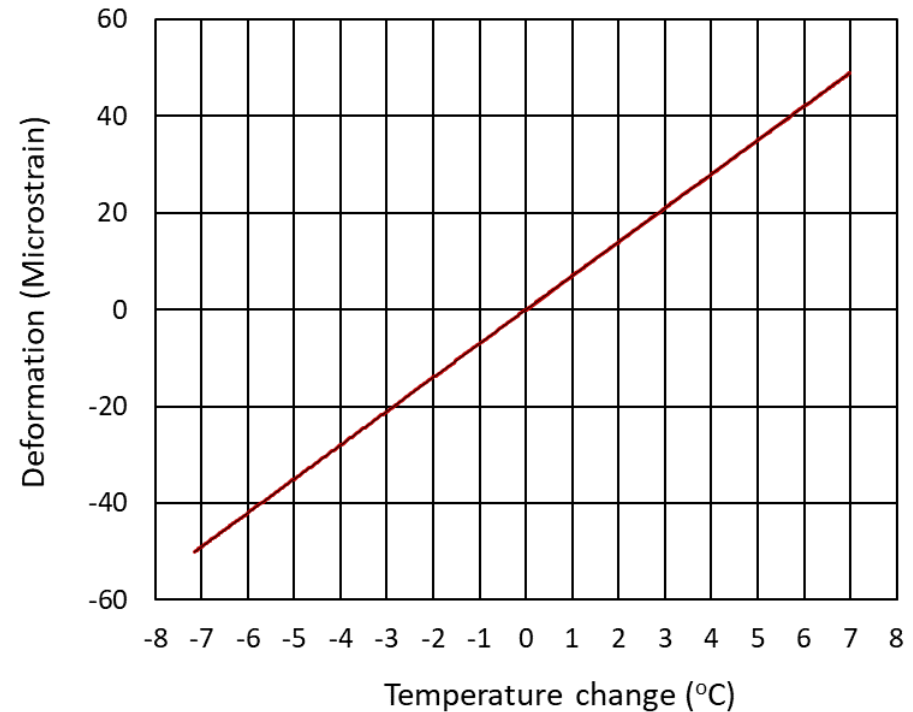
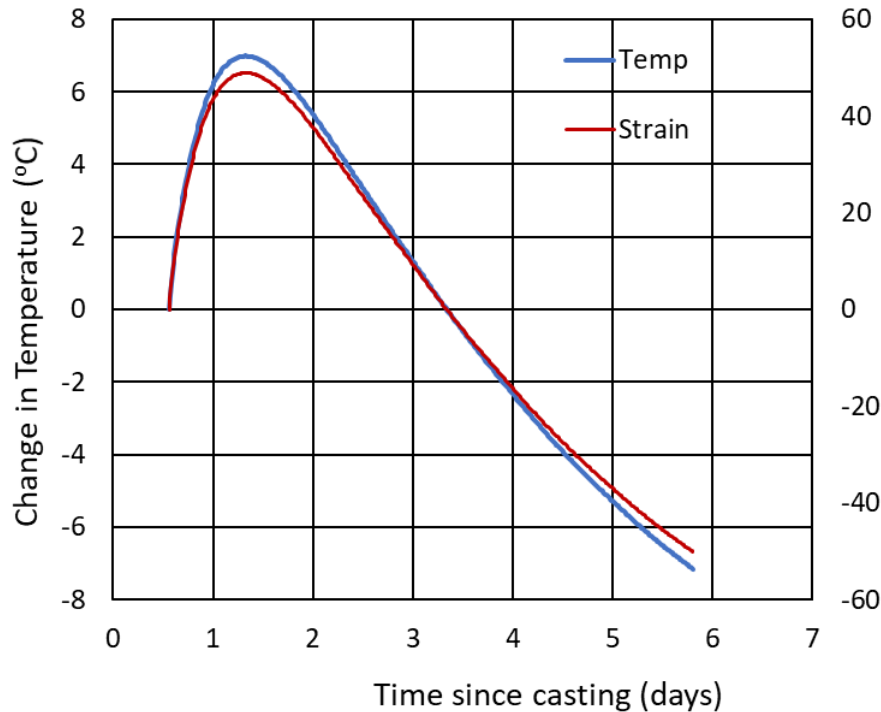
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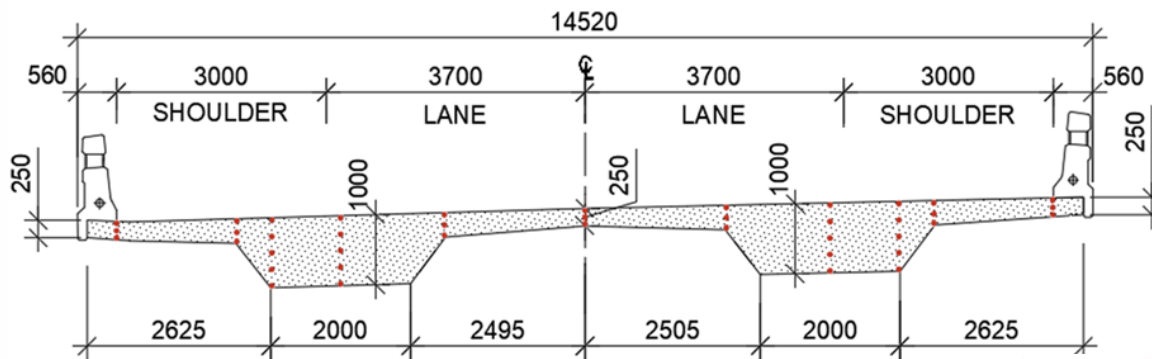
Vibrating Wire Strain Gauges (VWSGs)



Thermal expansion coefficient (α) = $7 \times 10^{-6} / ^\circ\text{C}$



Van Zylspruit bridge



(Skorpen, 2023)

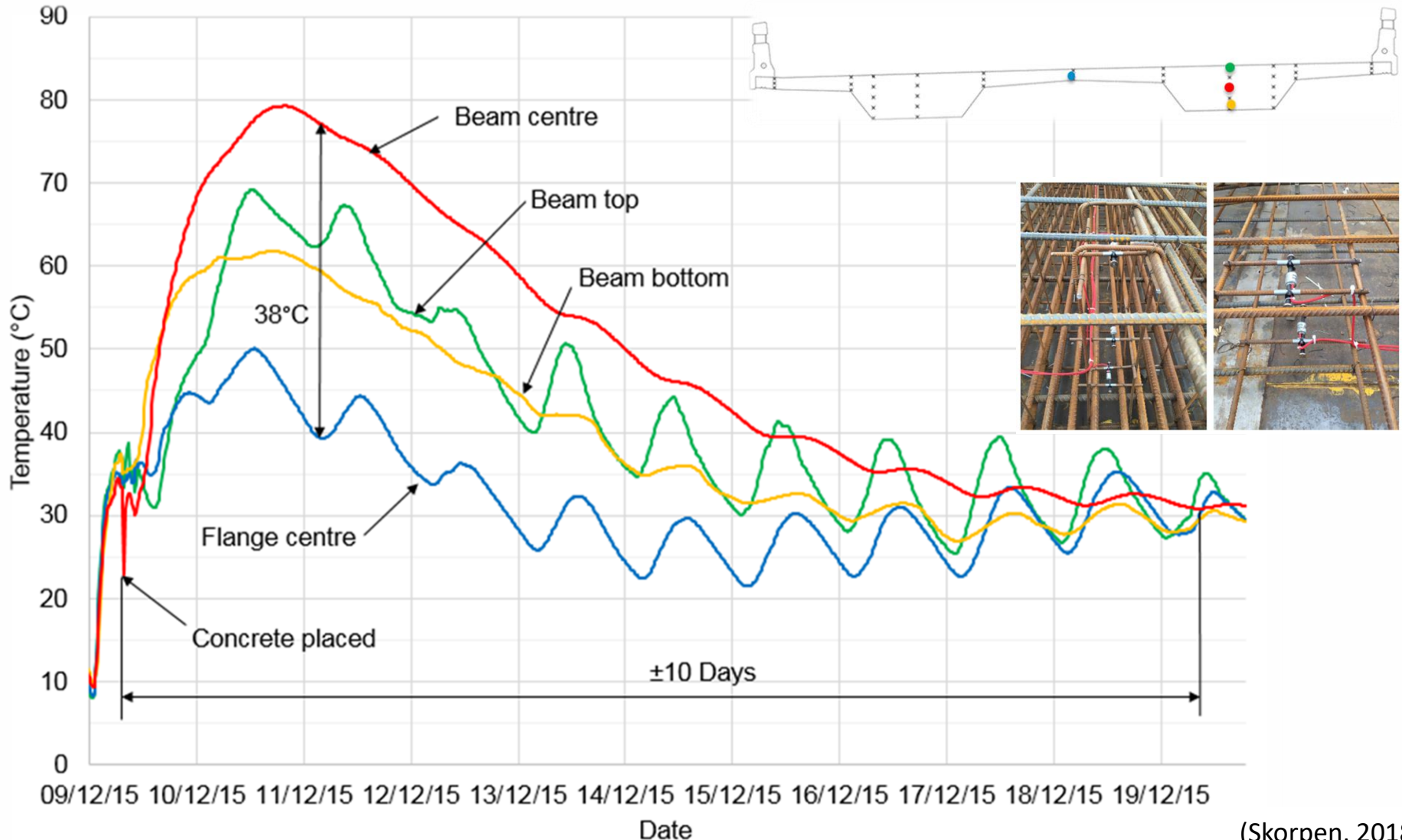


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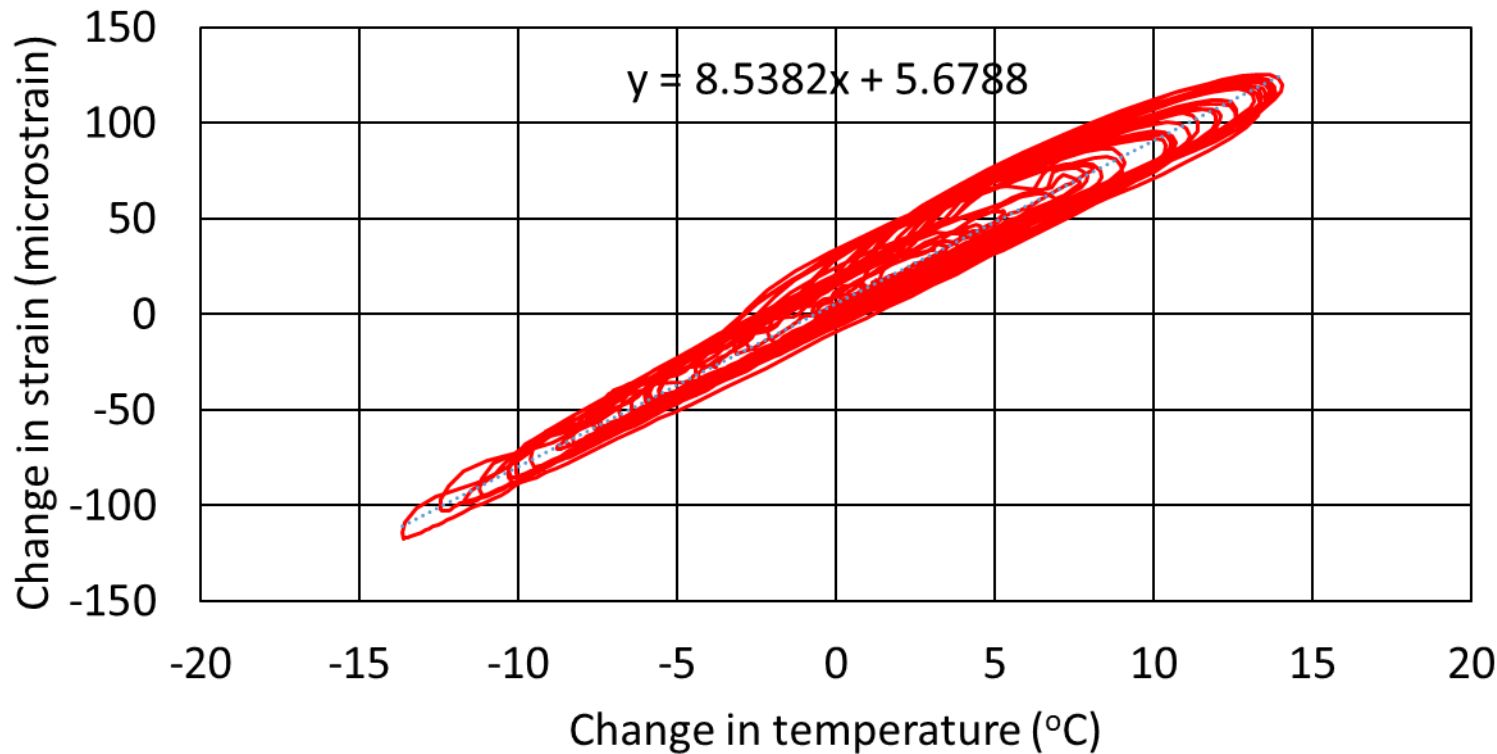
Van Zylspruit heat of hydration



Reference structures - unconfined



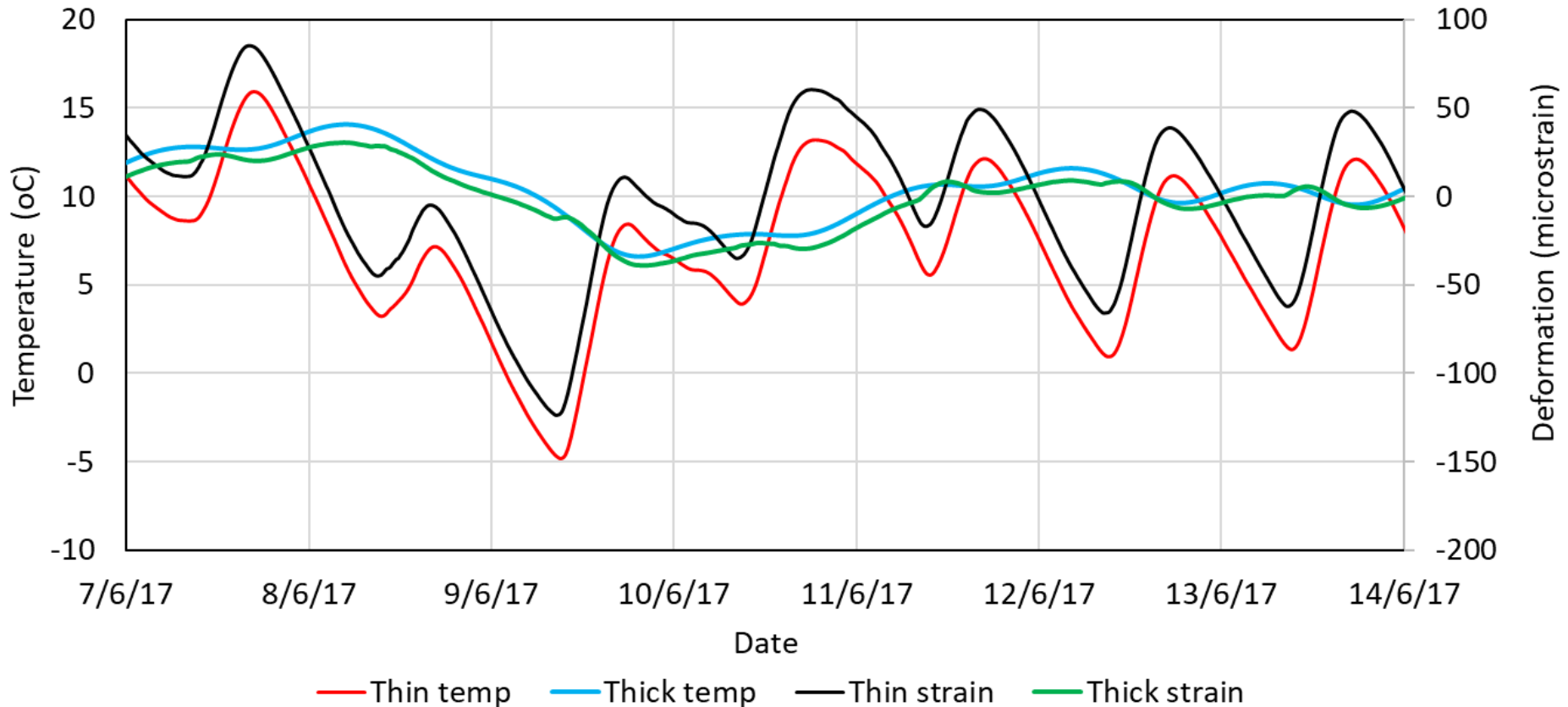
Thermal expansion coefficient



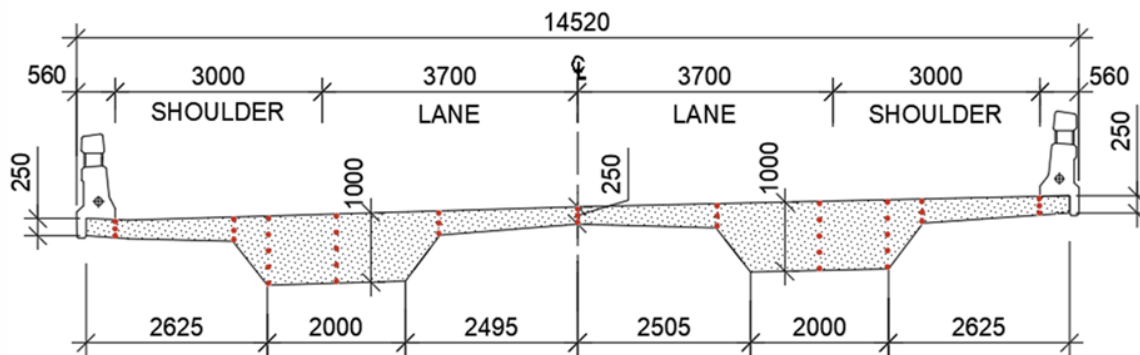
Thermal expansion coefficient
 $8.54 \mu\epsilon / ^\circ\text{C}$



Environmental strain - unconfined



Van Zylspruit bridge



Span CD

(Skorpen, 2023)

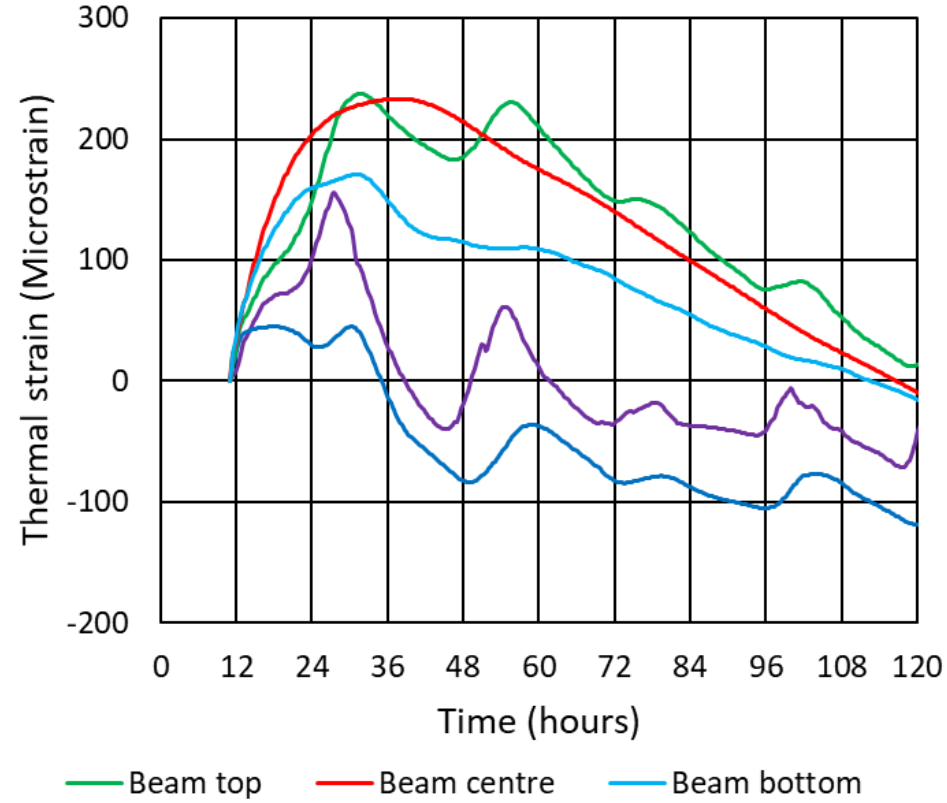
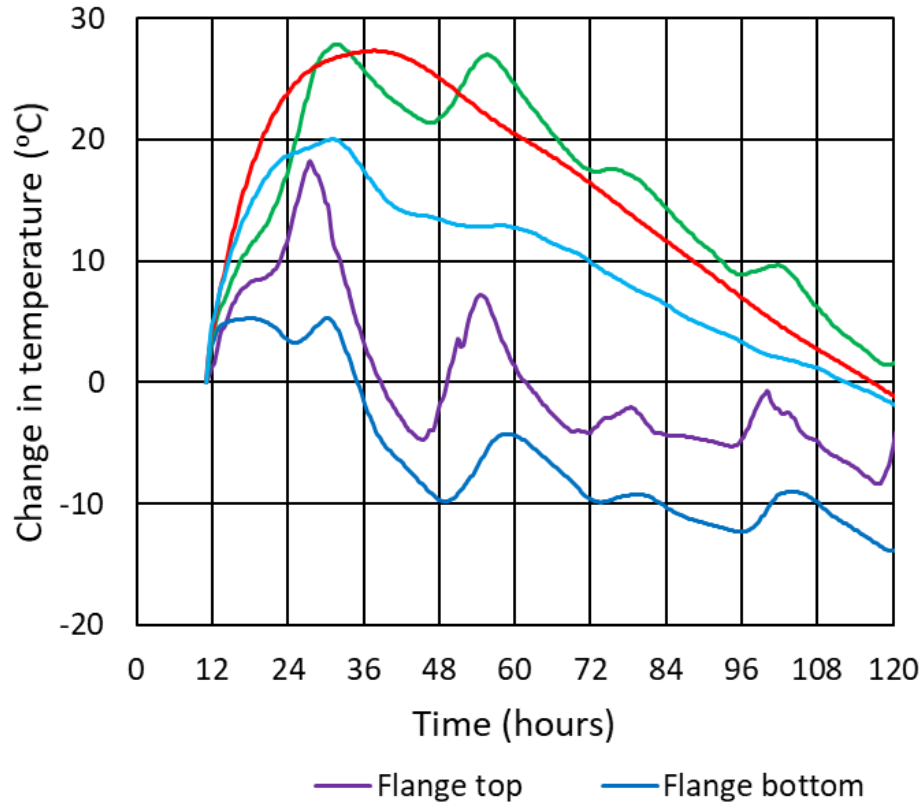


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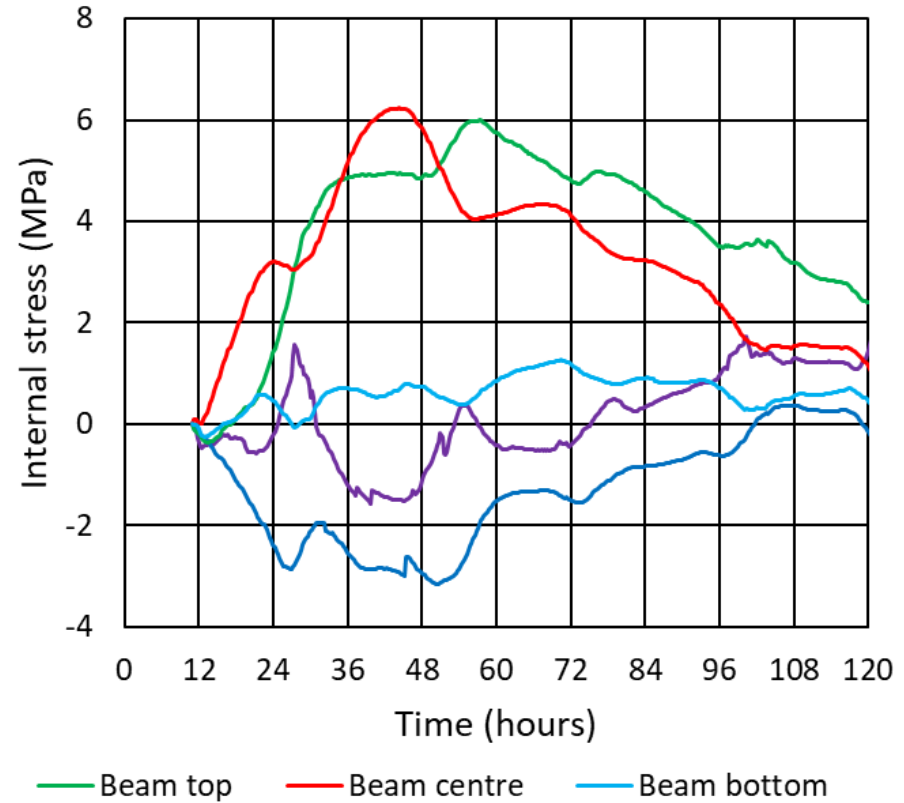
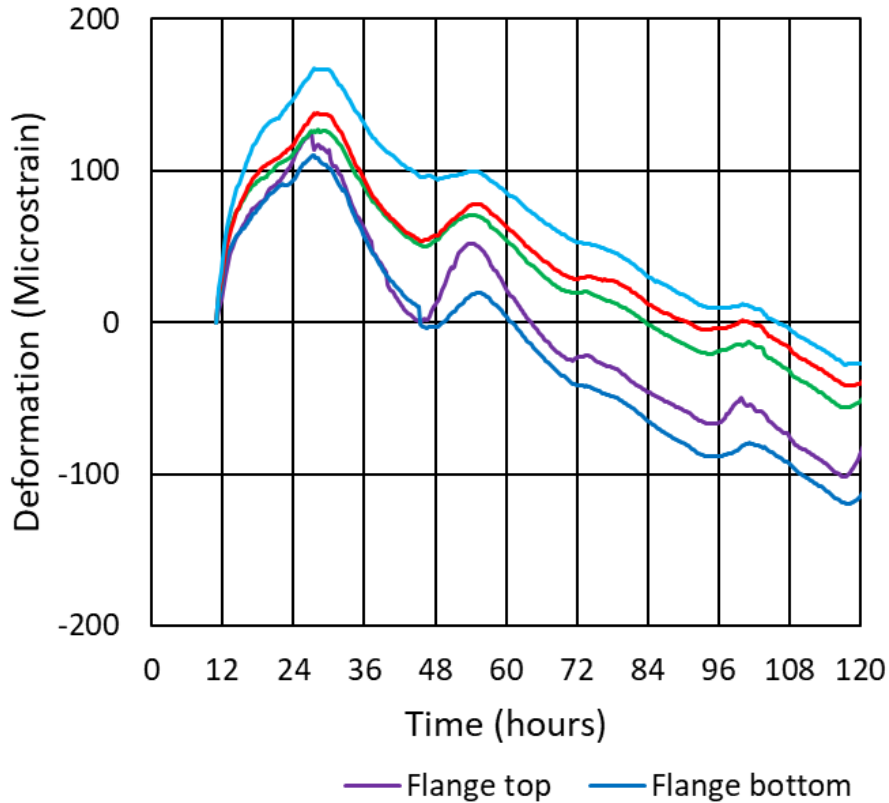
Van Zylspruit heat of hydration



Thermal expansion coefficient $8.54 \mu\epsilon / ^\circ\text{C}$



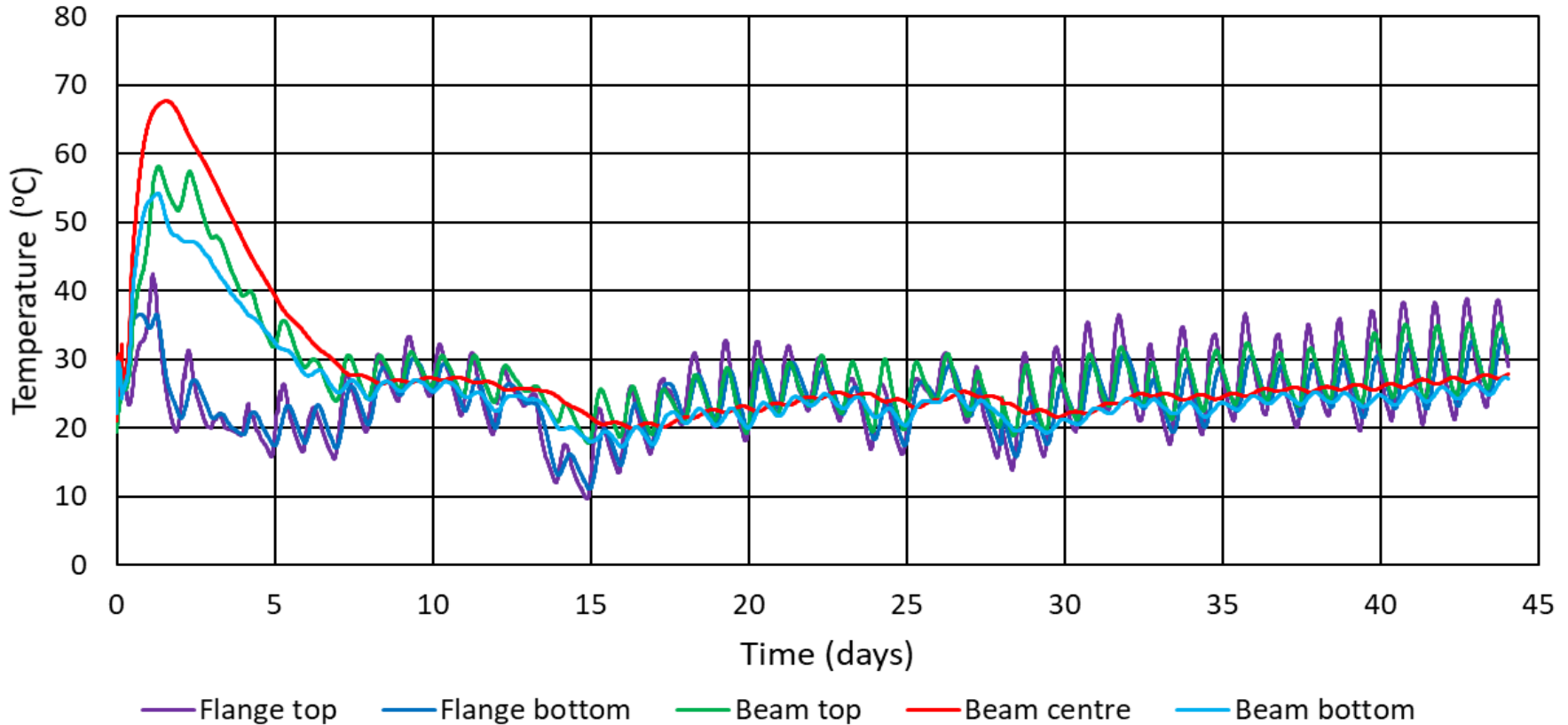
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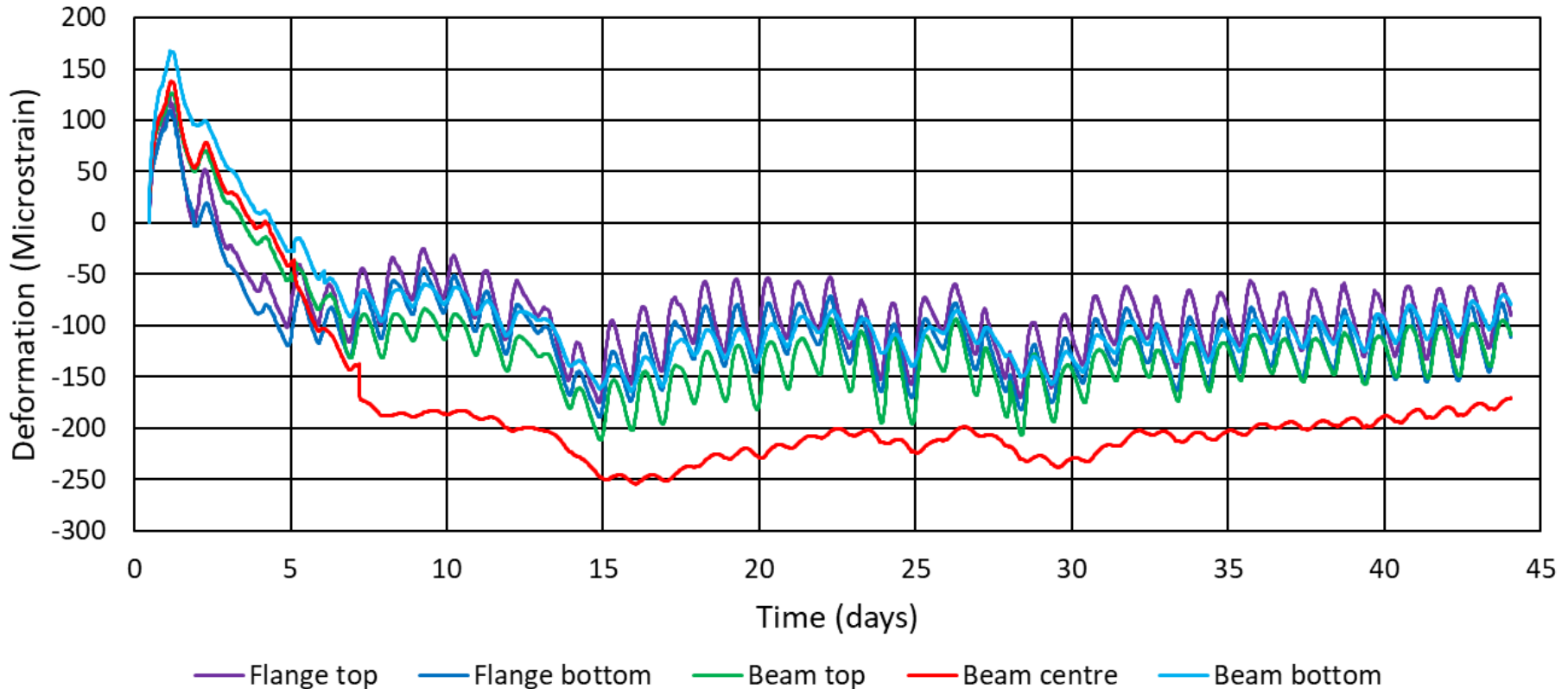
$E = 37 \text{ GPa}$ $f_{t28} = 3.6 \text{ MPa}$



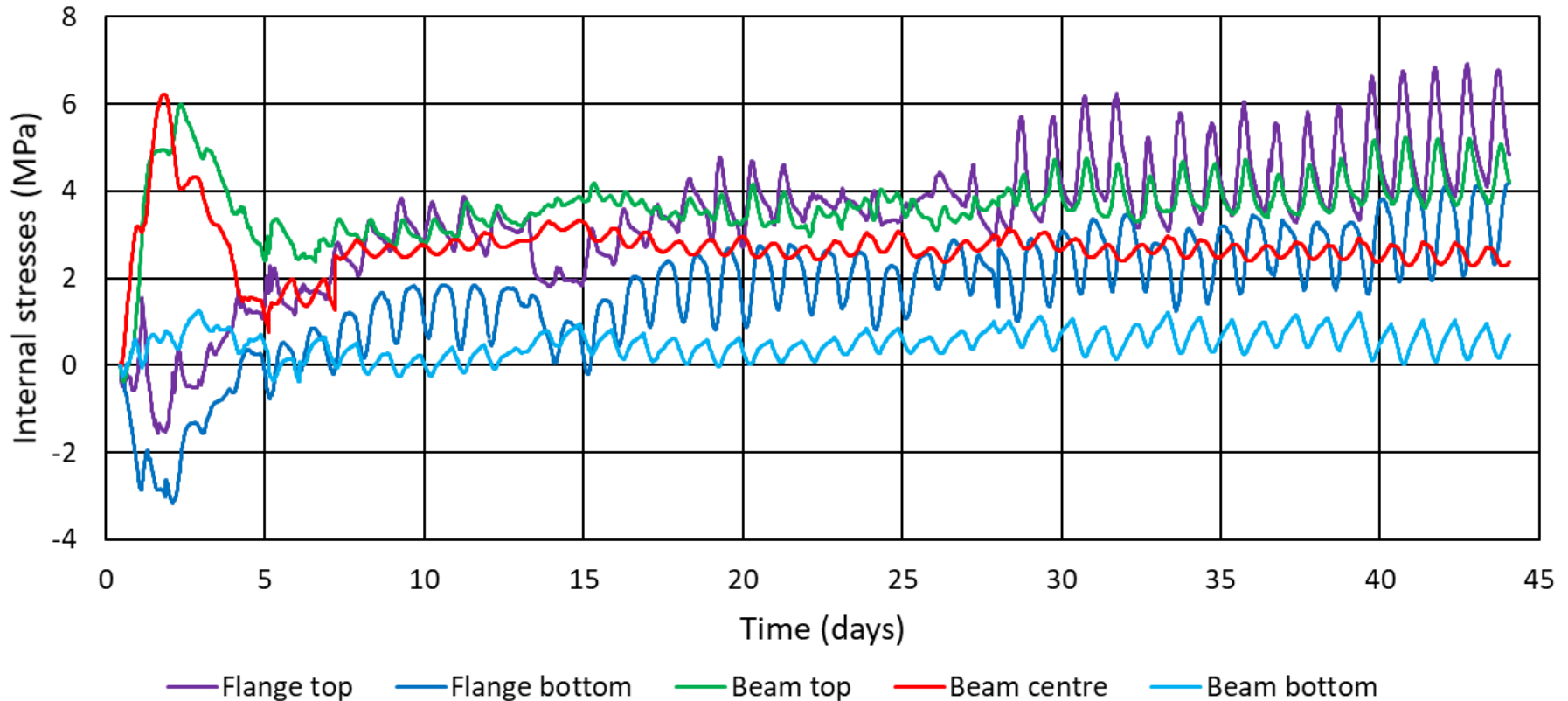
Van Zylspruit measured temperatures



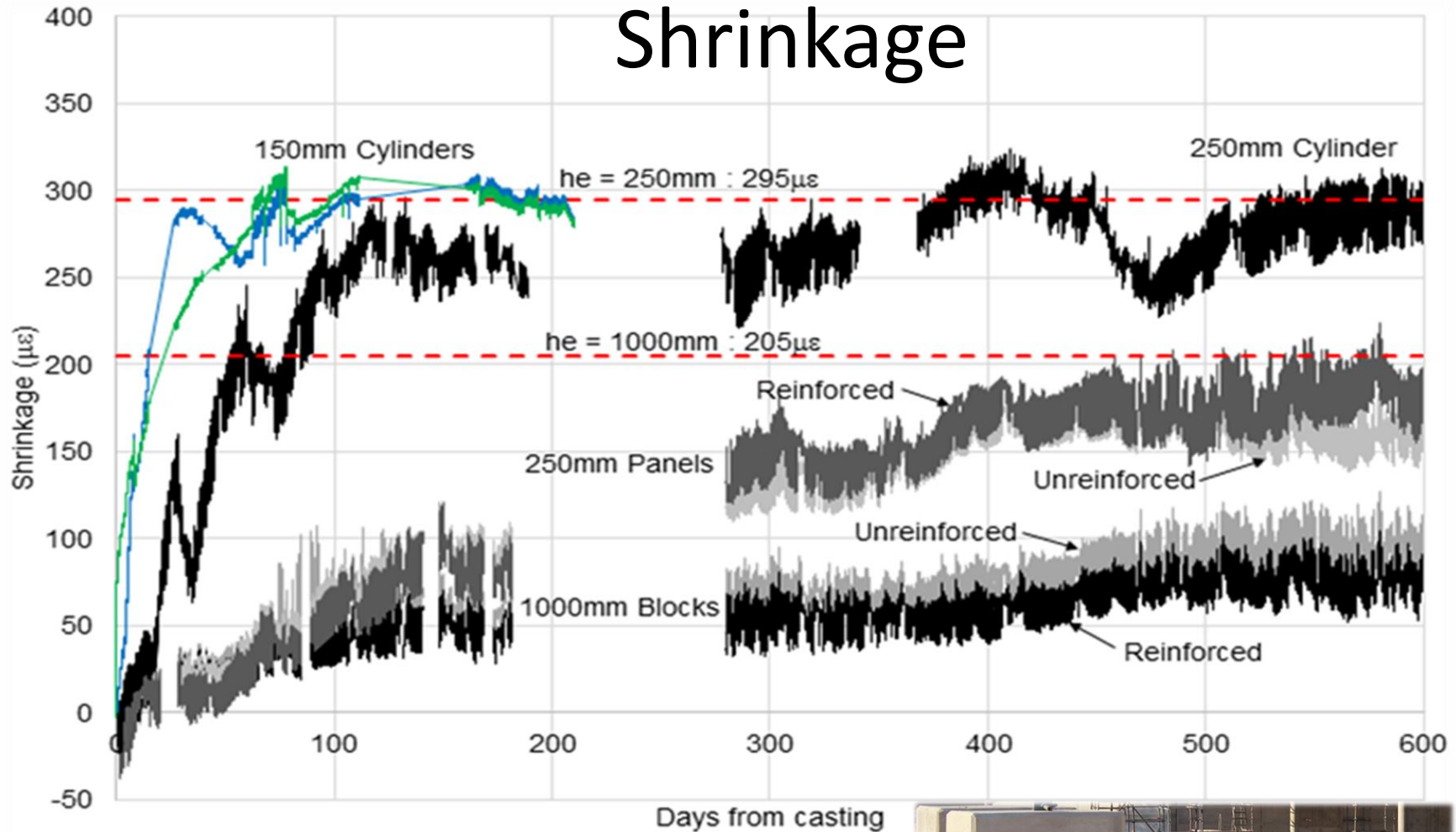
Van Zylspruit measured strain



Van Zylspruit stress development



Shrinkage



(Skorpen, 2019)

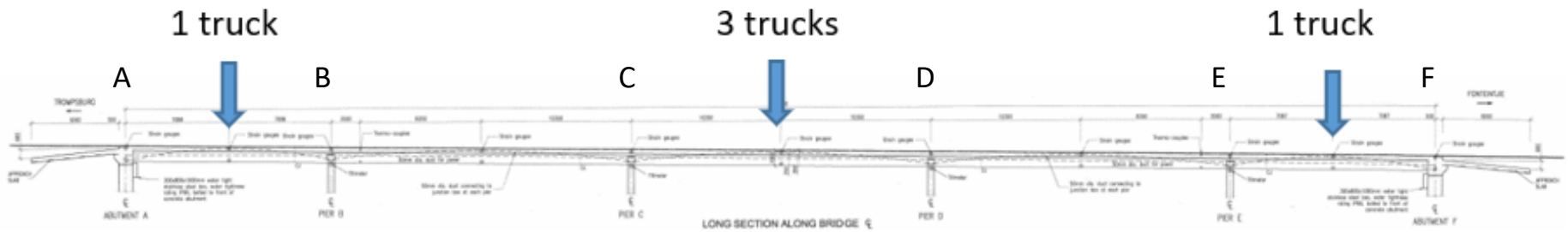


Differential Shrinkage

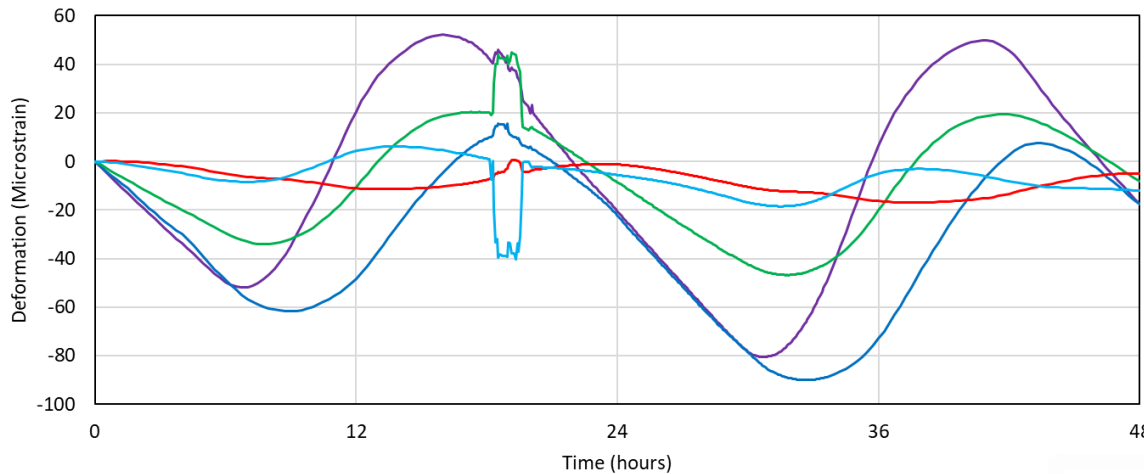
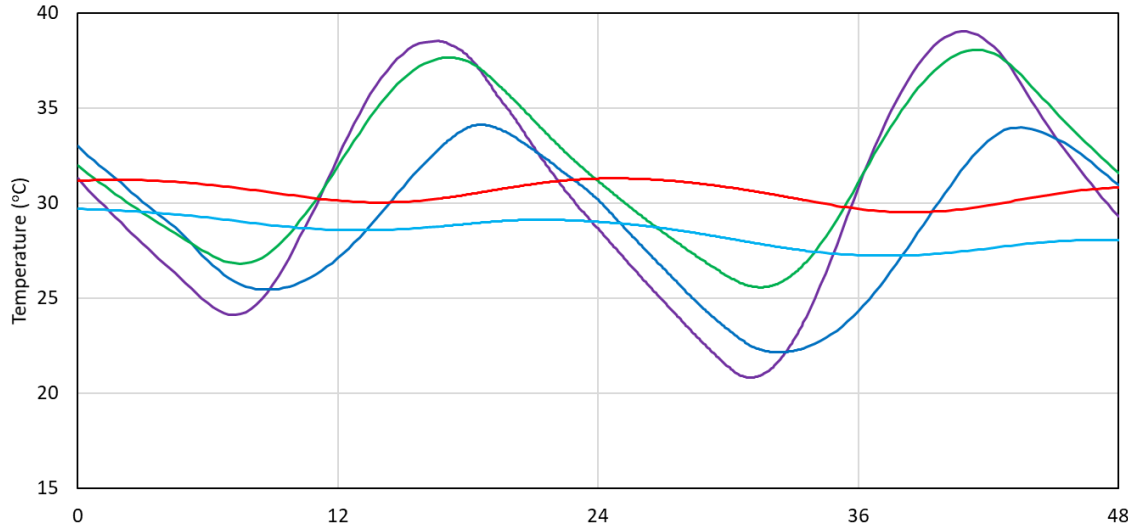


Van Zylspruit bridge Load test

Five fully loaded trucks weighing 34 tons each were used to load the bridge deck



Van Zylspruit bridge Load test – span CD



— Flange top — Flange bottom — Beam top — Beam centre — Beam bottom



Conclusion

Structural Health Monitoring (SHM) can be used to

- Conduct continuous condition assessment of infrastructure » **increase design life**
- Refine design assumptions and improve understanding of actual structural behaviour » **more economic designs**
- Calibrate theoretical models » **more durable designs**
- Highlight design and construction guideline needs » **address climate change, new materials and construction techniques.**

