

---

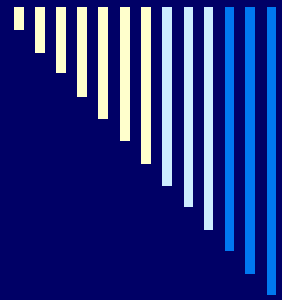


# Monitoring Fatigue Life in Steel-Free Concrete Bridge Decks

David Vines-Cavanaugh

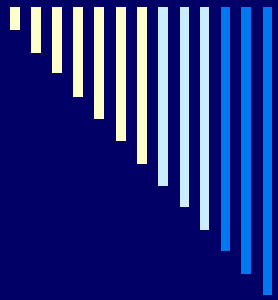
10/06/08

---



# Outline

- Technical Problem
- Steel-Free Bridge Decks
- Fatigue Effects: Steel Vs. Steel-Free
- Research Findings
- Monitoring



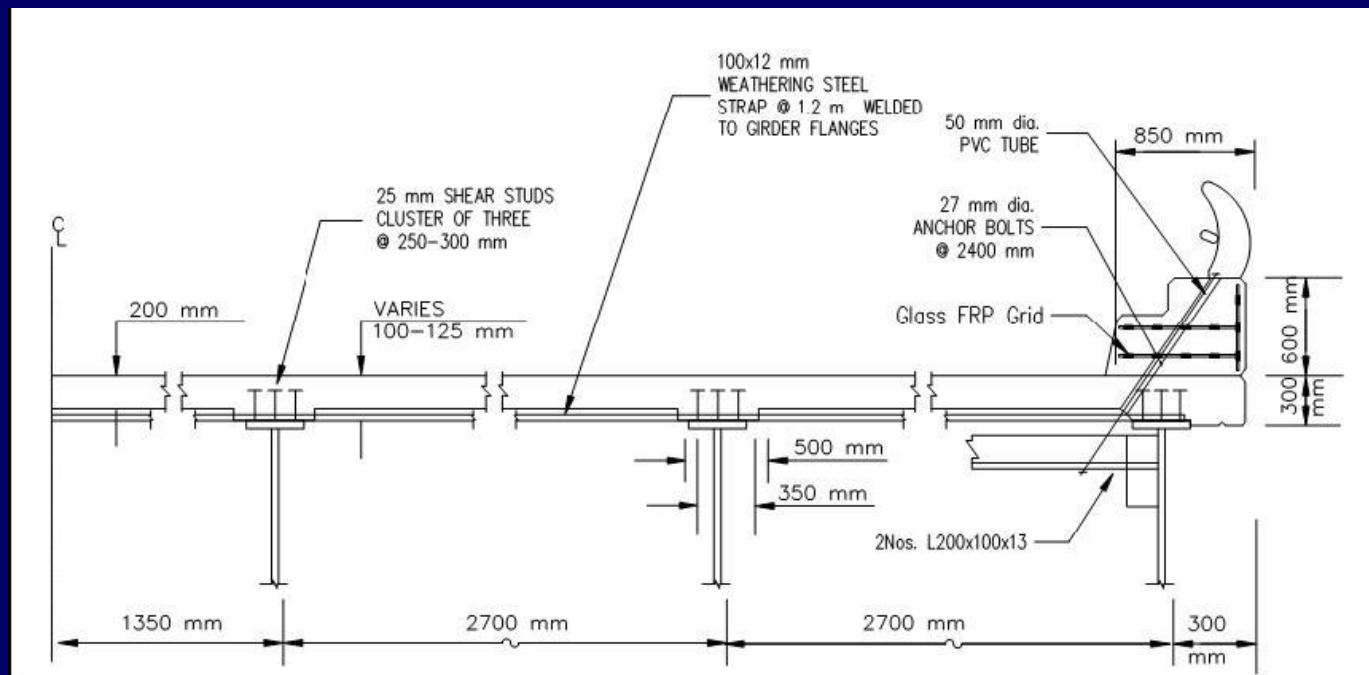
# Technical Problem

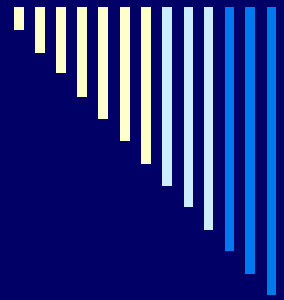
- Technical Problem:
  - Lack of monitoring techniques in the area of steel-free bridge deck fatigue damage
  - Fatigue:
    - Cumulative damage occurring under cyclic loading (seen as cracking in bridge decks)
  - Steel-Free Bridge Decks:
    - Externally braced and void of internal steel rnf.

# Steel-Free Bridge Decks

## □ Design Concepts

- Eliminate Tension
- Enhance Compression



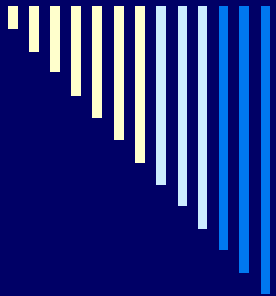


# Salmon River Bridge

## □ Advantages

- Durable
- Material cost savings
- Long-term savings

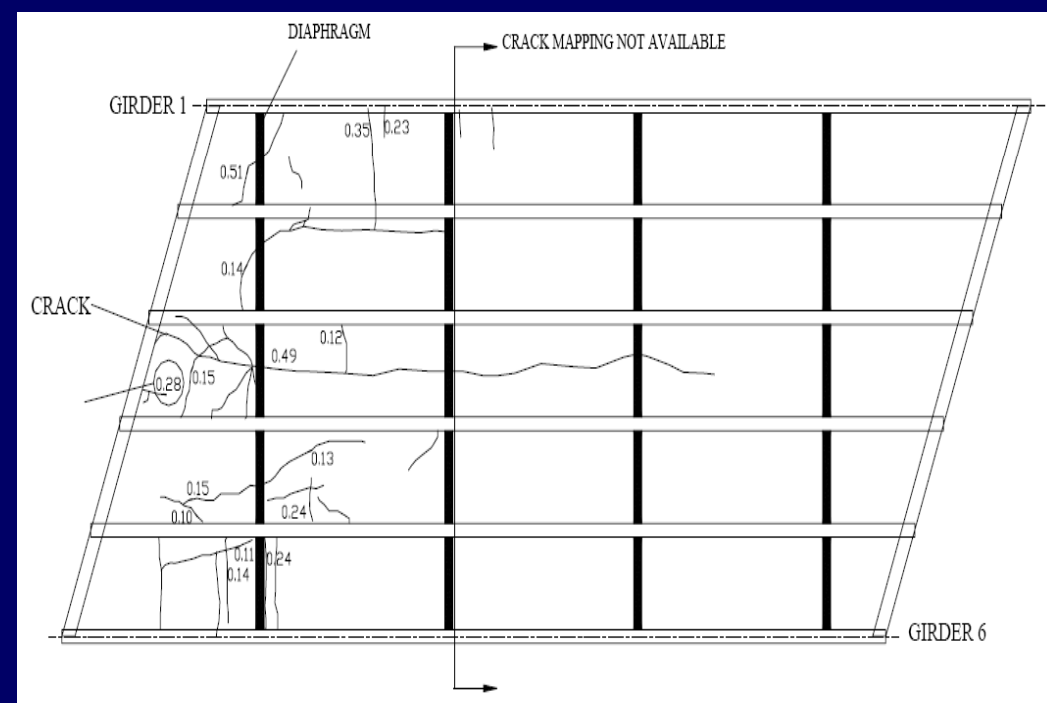




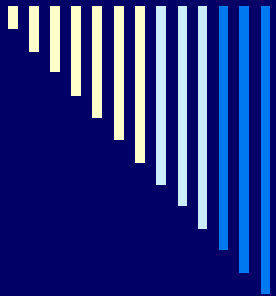
# Fatigue Effects: Steel Vs. Steel-Free

- 10 Year Evaluation of Salmon River Bridge (Newhook)  
Crack mapping and comparison through visual inspection

ACW=0.22 (mm)  
MCW=0.50 (mm)



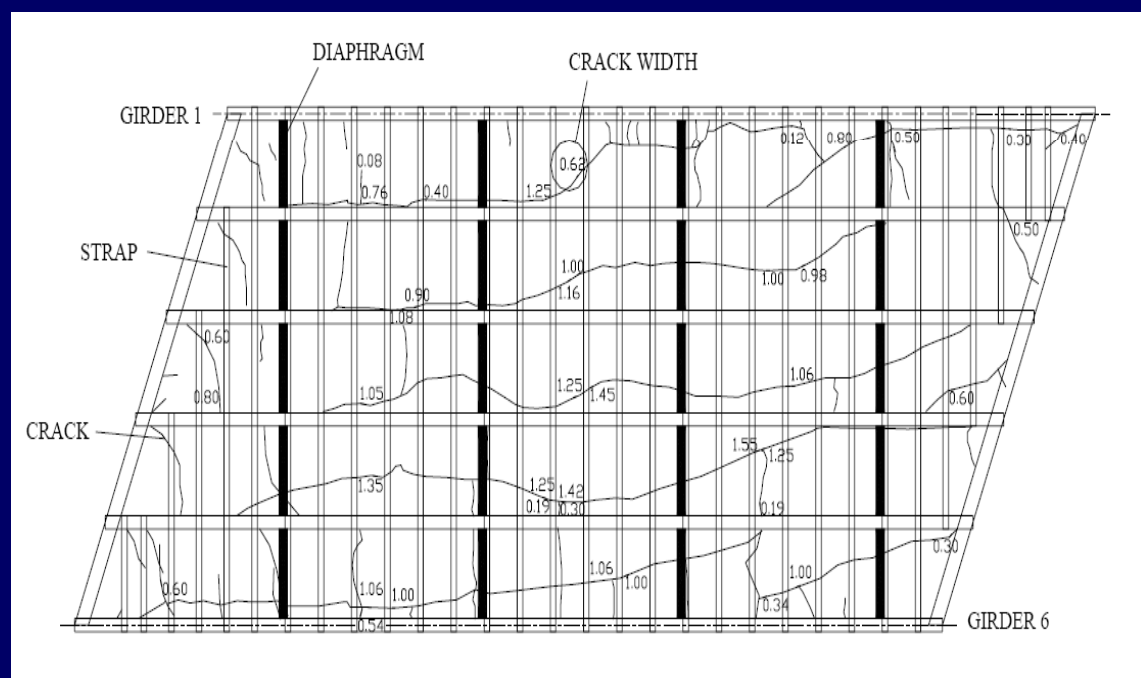
Steel Rnf.



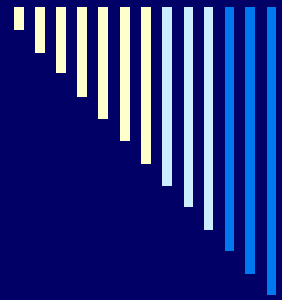
# Fatigue Effects: Steel Vs. Steel-Free

- 10 Year Evaluation of Salmon River Bridge (Newhook)  
Crack mapping and comparison through visual inspection

ACW=1.00 (mm)  
MCW=1.5 (mm)



Steel -Free

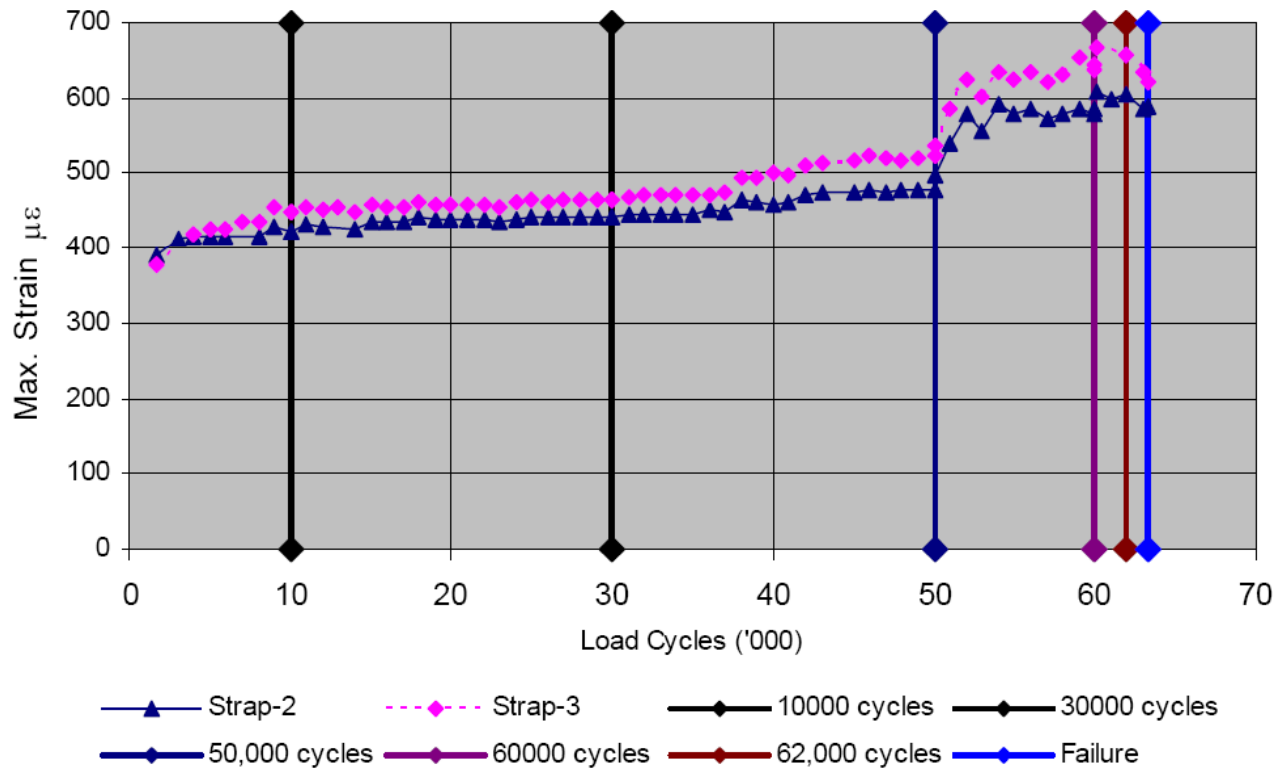


# Research Findings

- Memon: University of Manitoba, Canada
  - Link between crack width, strain, and deflection
  - Damage quantified by crack widths or permanent deflection
- Limaye: Dalhousie University, Canada
  - Fatigue life zones
    - Initial damage zone
    - Stable zone
    - Rapid damage zone

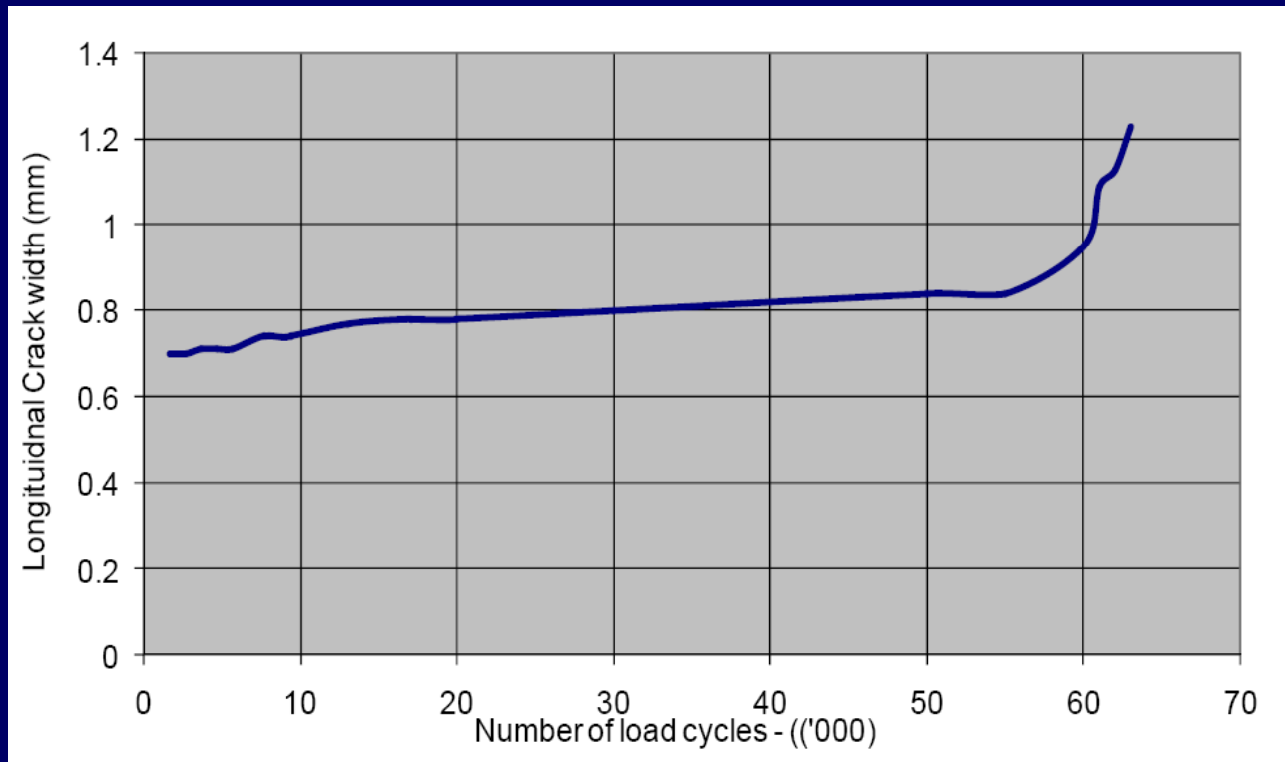
# Fatigue Zones

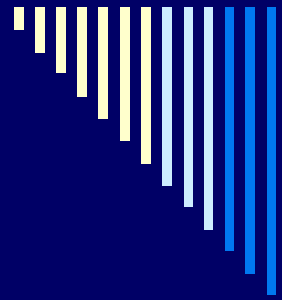
Strain vs. Load Cycles



# Fatigue Zones

Longitudinal Crack Width vs. Load Cycles





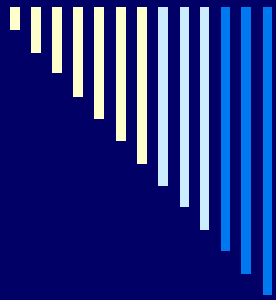
# Monitoring

## □ Current

- Strap strain monitoring
- Crack Gauges
- Visual crack mapping

## □ Future

- Fiber optic sensors
- Cumulative change index



QUESTIONS?



# References

- **Monitoring Fatigue Life in Concrete Bridge Deck Slabs** : J. Newhook and V. Limaye: Proc. Of SPIE Vol. 6531 65310R-8 (2007)
- **“Salmon River Steel-free Bridge Deck – 10 Year Review of Field Performance”**: Gaudet, J. and Newhook, J.P. : *Proceedings of IABMAS'06 - Third International Conference on Bridge Maintenance, Safety and Management: Paper 376*, IABMAS, Portugal, 2006.
- **Static and Fatigue Investigation of Second Generation Steel Free Bridge Decks**: Chad Klowak, Amjad H. Memon, and Aftab A. Mufti

[http://64.233.169.104/search?q=cache:7OLpQk\\_HkMMJ:www.kfupm.edu.sa/publications/ajse/Articles/311C\\_13p.pdf+Comparative+Fatigue+Performance+of+Steel-Reinforced+and+Steel-Free+Concrete+Bridge+Deck+Slabs&hl=en&ct=clnk&cd=3&gl=us](http://64.233.169.104/search?q=cache:7OLpQk_HkMMJ:www.kfupm.edu.sa/publications/ajse/Articles/311C_13p.pdf+Comparative+Fatigue+Performance+of+Steel-Reinforced+and+Steel-Free+Concrete+Bridge+Deck+Slabs&hl=en&ct=clnk&cd=3&gl=us)

- **Tama County’s Steel Free Bridge**: Dunn, Brehm, Klaiber, Phares, Wood: Proceedings of the 2005 Mid-Continent Transportation Research Symposium