Developments in stress-laminated arch construction for footbridges

Abdy Kermani & Geoff Freedman

THE CENTRE FOR TIMBER ENGINEERING

Forestry Civil Engineering

Edinburgh Napier UNIVERSITY

Stress-laminated arch construction for footbridges

Arched profile – using timber in compression

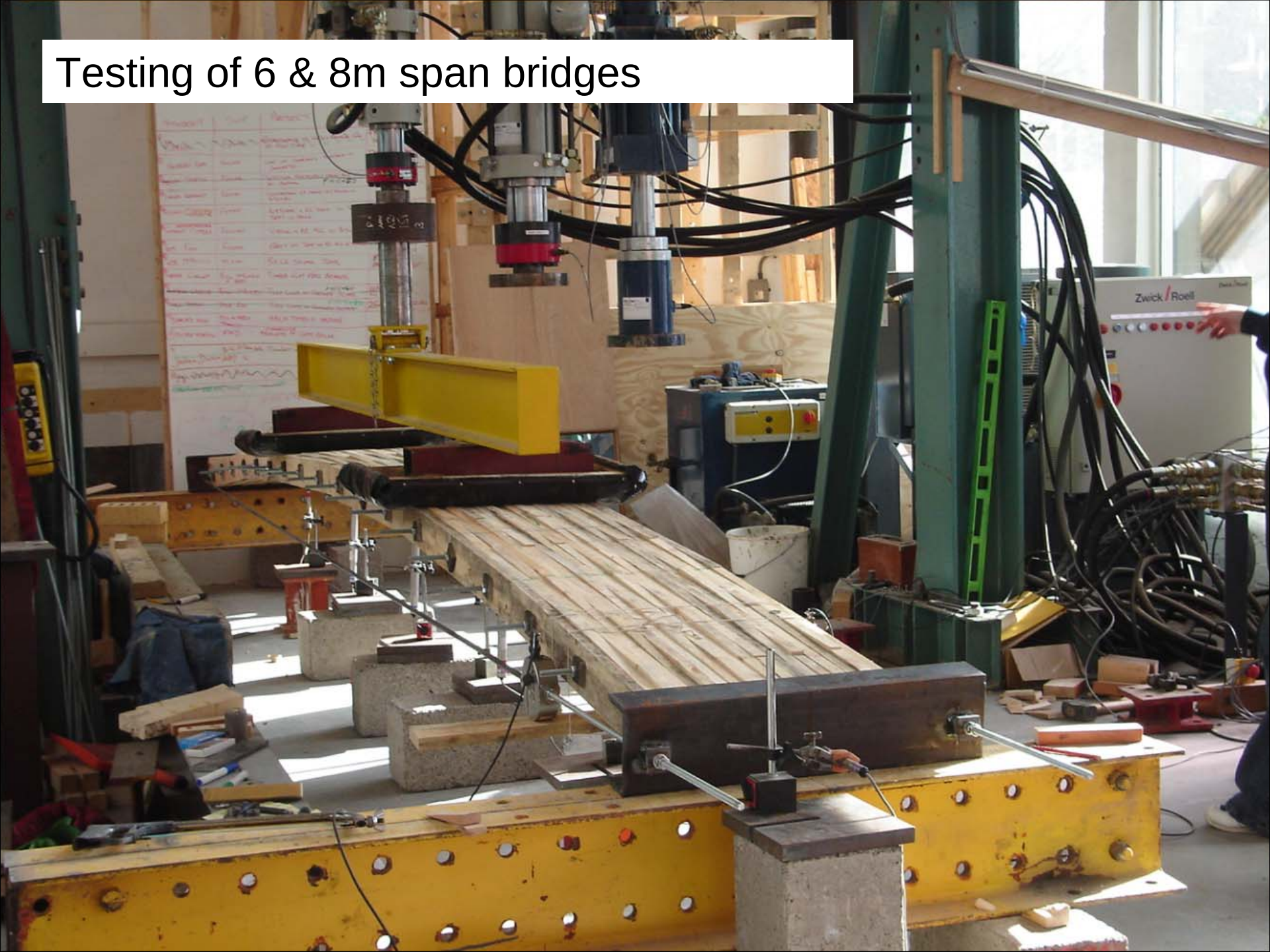
Testing of 2.1m span bridges

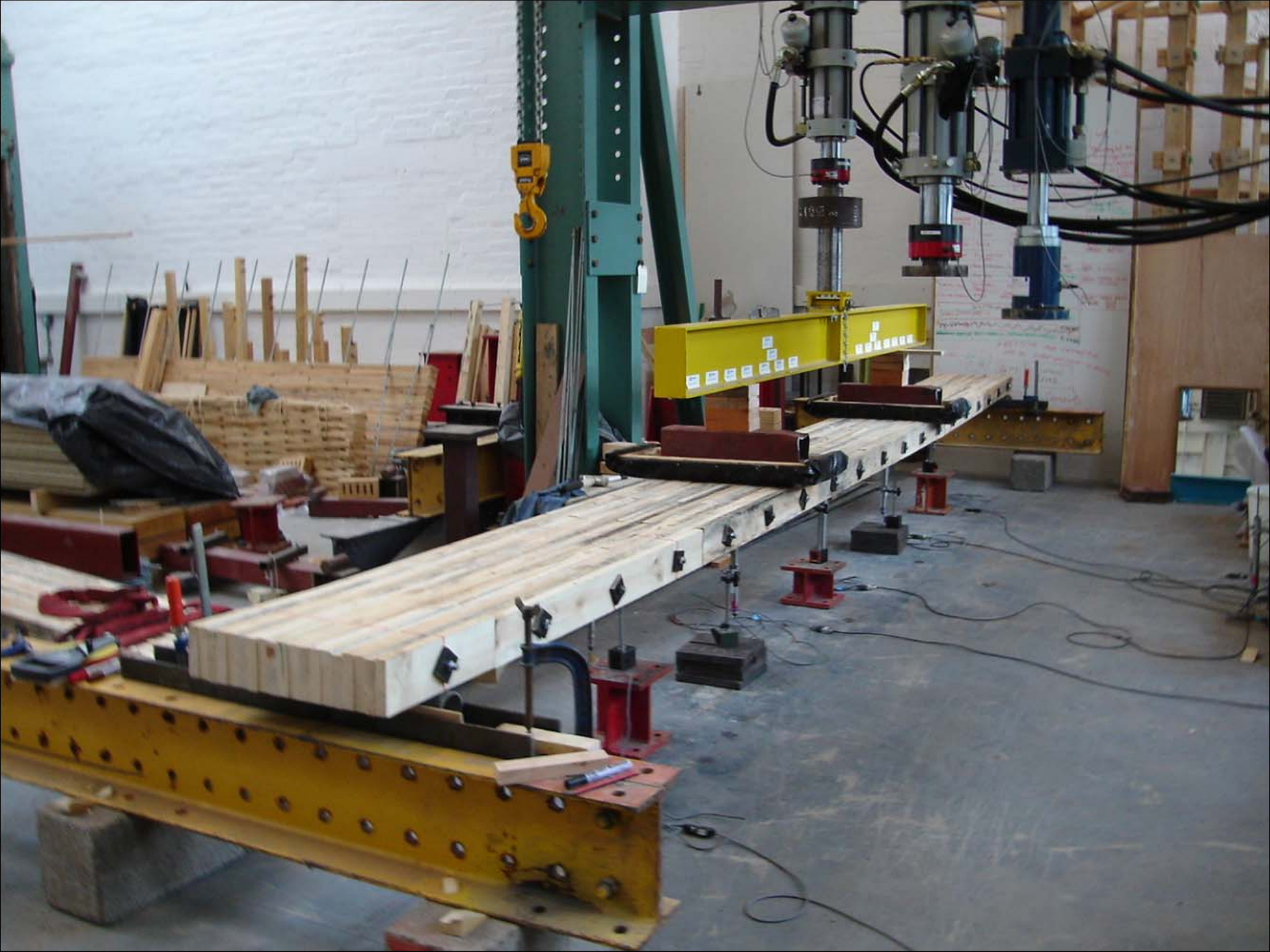
Stress-laminated arched timber bridges

Extensive analytical and laboratory work:

- Arch profile (rise)
- Stress level (loss of tension in stressing bars)
- Support settlement
- Dynamic response
- Fatigue/cyclic behaviour

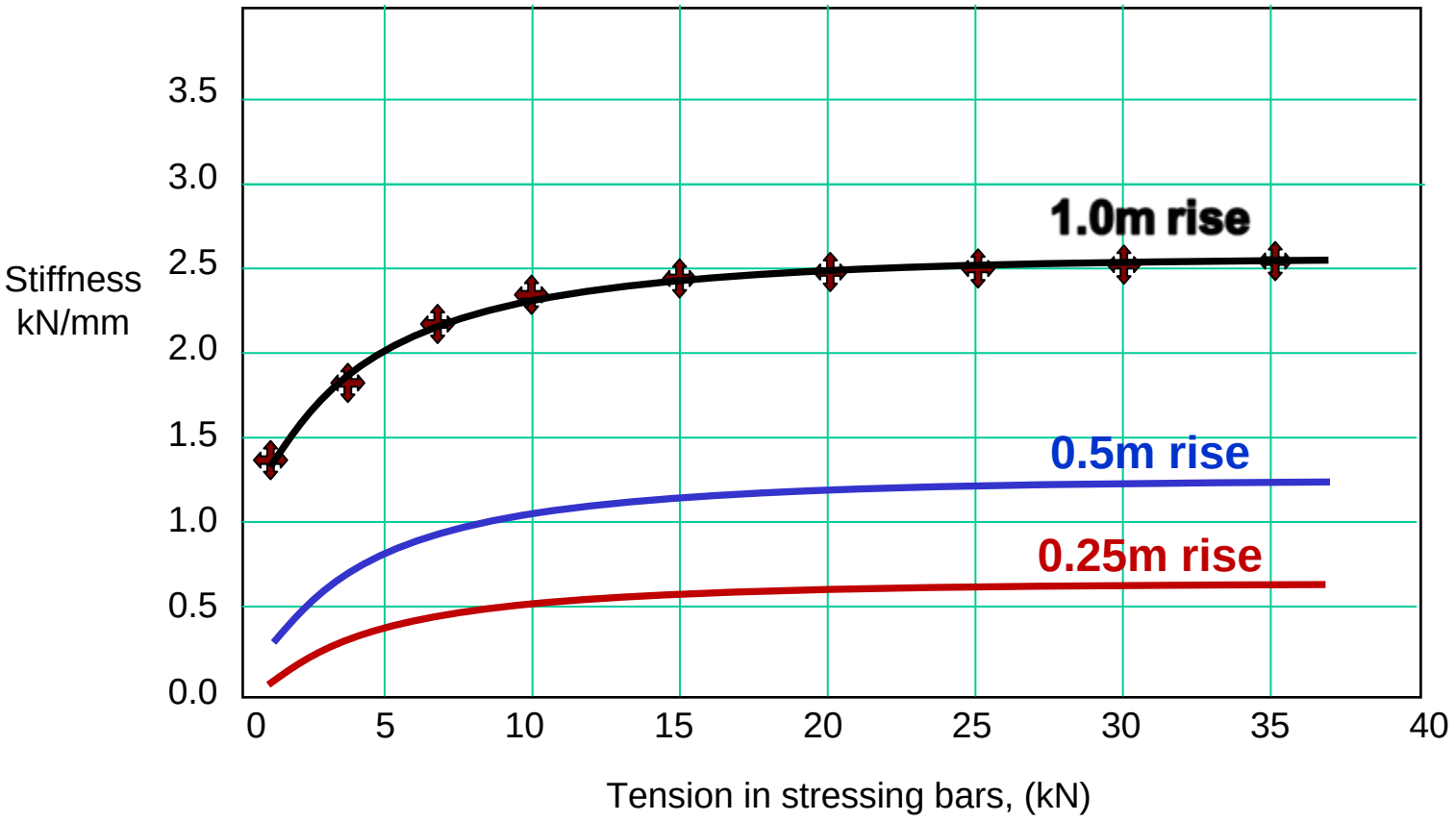
Testing of 6 & 8m span bridges





Effect of stress level on stiffness of arch

(6m arch with 1m rise under four-point loading)




15m span test bridge
R195 FFS


PARA
GROUP
BUILDERS' SUPPLY CO
BUILDERS MERCHANTS


RESERVED FOR
CAR PARK
CLOSED

Test bridge after final assembly at Red Rose, Manchester, UK

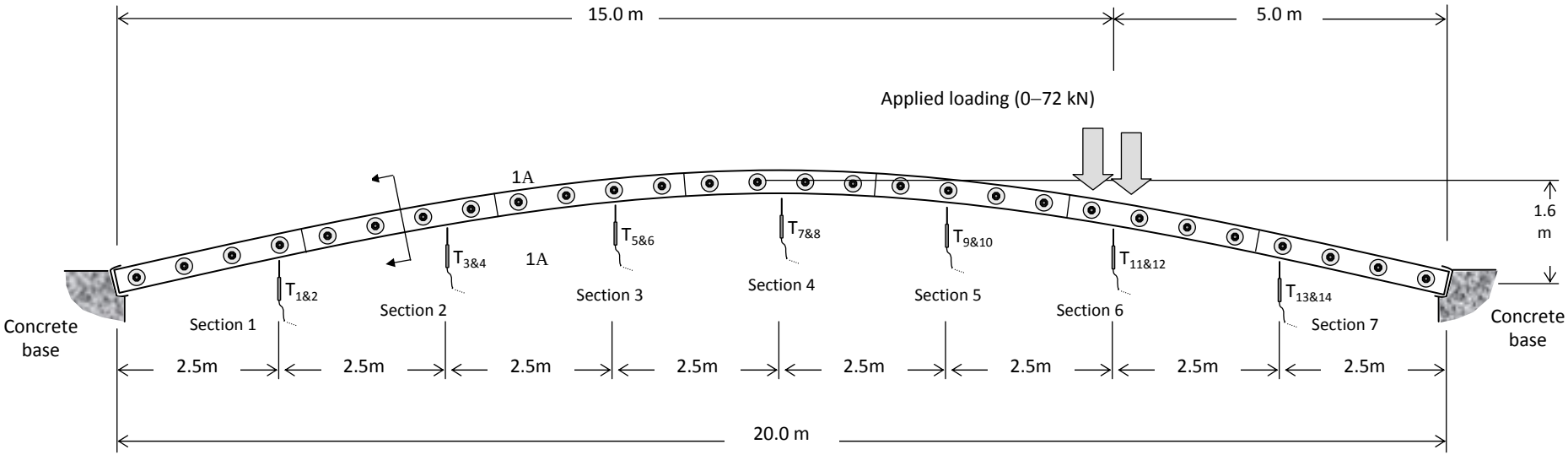

20m span arch at Glentress, Scotland


JEWSON
JEWSON
JEWSON
JEWSON
JEWSON
ATLAS

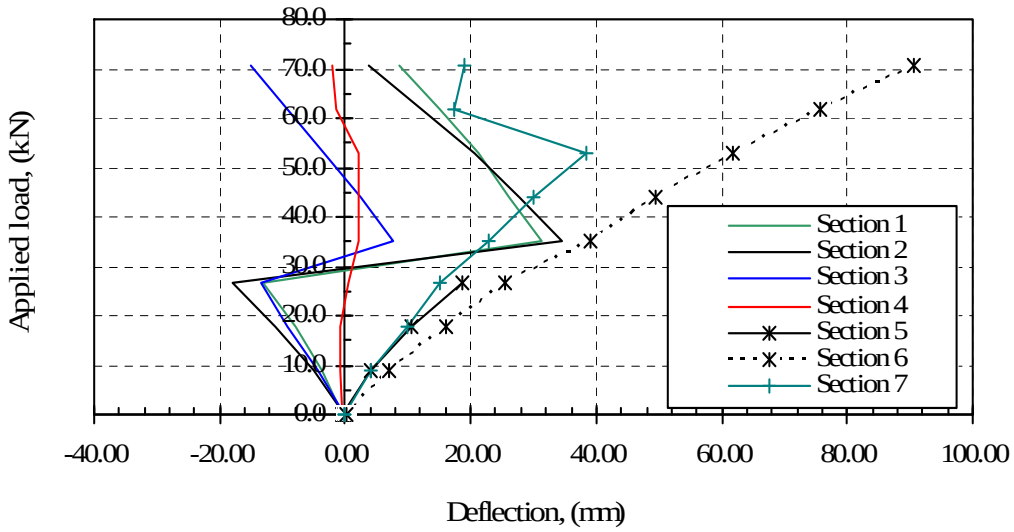

ATLAS
JEWSON
JEWSON
JEWSON
BIL DEPOSIT


ATLAS

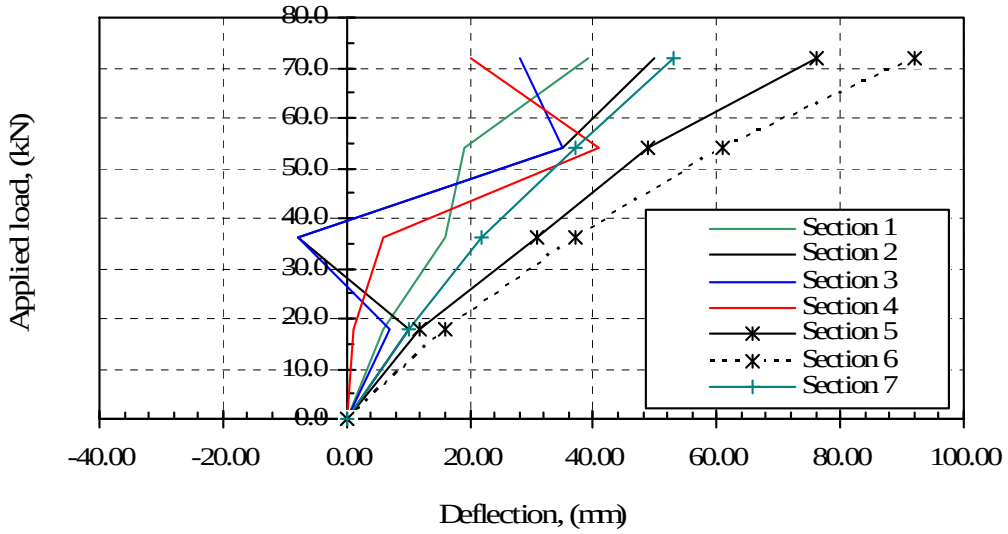

ATLAS



Test set-up: ¼ point loading



1. Load-deformation when half of the stressing bars were randomly selected and tensioned.



2. Load-deformation when all of the stressing bars were tensioned (4 months later).

Dynamic response


TEAC

Stress-laminated arched timber bridges

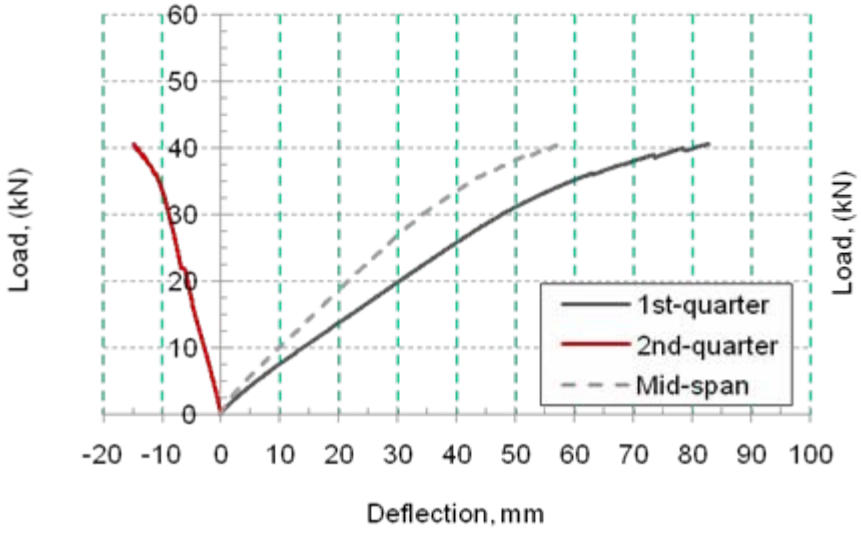
- Fundamental frequency $\simeq$ 3.5Hz - (unsurfaced)
- $\simeq$ 4.4Hz - (surfaced)
- Factor of safety > 4

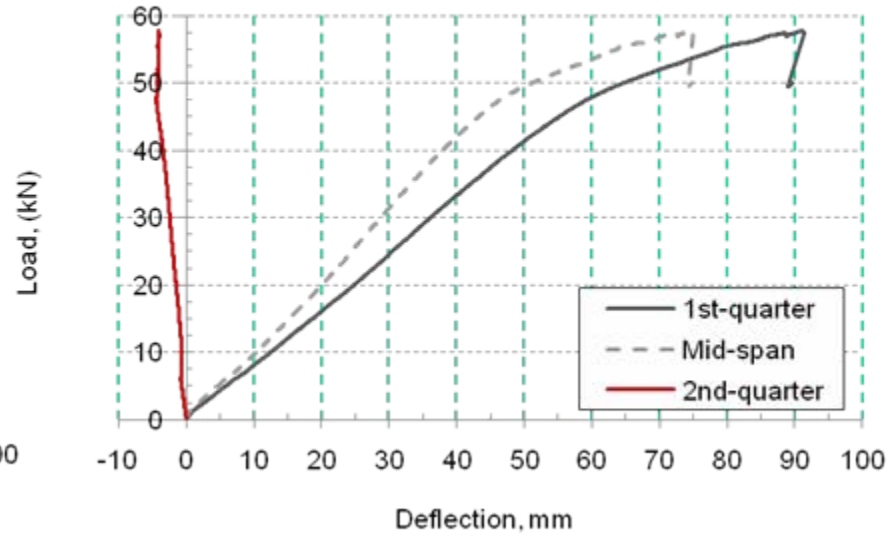

7-8
8-8


6-8
7-8
8-8


G,5
6,5


alpha
crane
alpha
crane
01290
700715





1. Screwed laminated

Stiffness = 0.625 kN/mm

Strength = 40.5 kN

2. Glued & screwed laminated

Stiffness = 0.80 kN/mm

Strength = 57.5 kN

12m span Dalriada Bridge in Argyll, early in 2008

Coignafearn arch

FAR MOOR – NORTH YORKSHIRE MOORS

50m with central span of 24m SLT and screw laminated

Scaffolding and rise formers

End plates for tensioning bars and supports for posts which are structurally connected to the upper deck

First two arches

Springing between arches which provides support for vertical timber wall

End support – note detail to allow drainage

Computer projection of completed bridge (End of September 2010)

Timber walkway and roof - Salcey Forest, England

Summary

- Stress-lamination in arch form is effective, low cost and provide versatile sustainable construction
- Modular construction is a viable option to reduce site costs
- Glued & screwed or screwed laminations provide cost effective and efficient alternatives to SLT arches.

Thank you.

Fatigue test: 8m arch to support 16m flat deck