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Shear Performance of GFRP RC Beams

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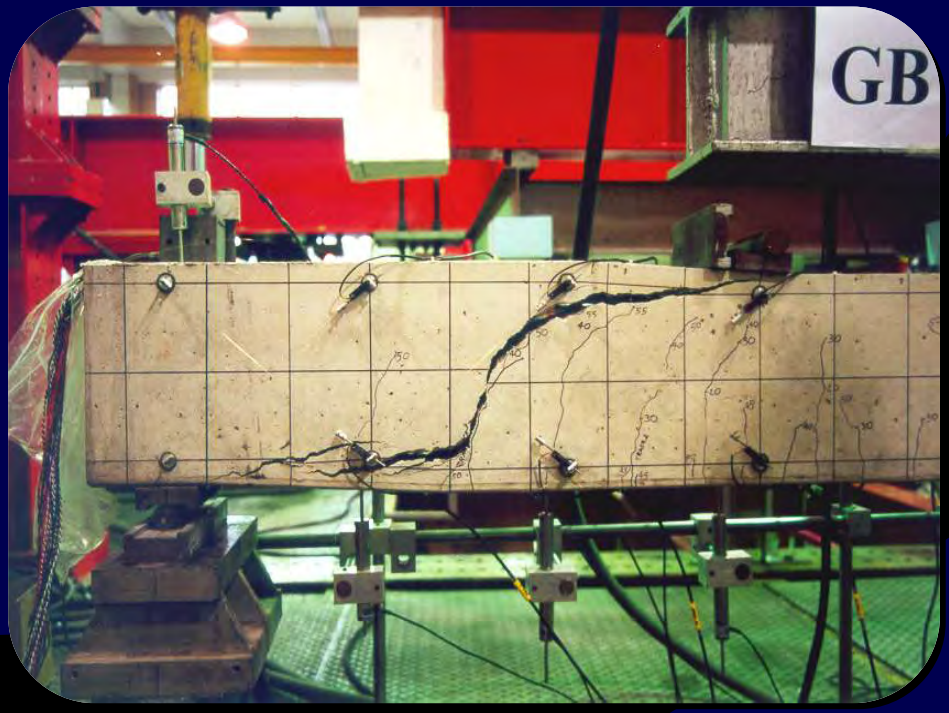
Outline

- Shear resistance
- Experimental investigation
- Predictive approaches
- Validation
- Conclusions

Shear Resistance

$$V = V_c + V_s$$



Shear Carrying Mechanisms

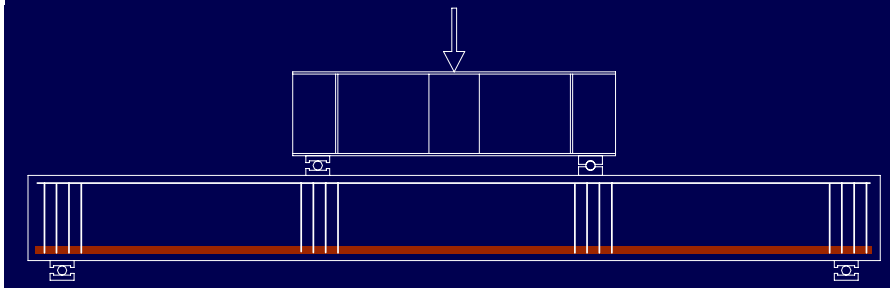
- Concrete in Compression
- Shear Reinforcement
- Aggregate Interlock
- Tooth Bending
- Dowel Action

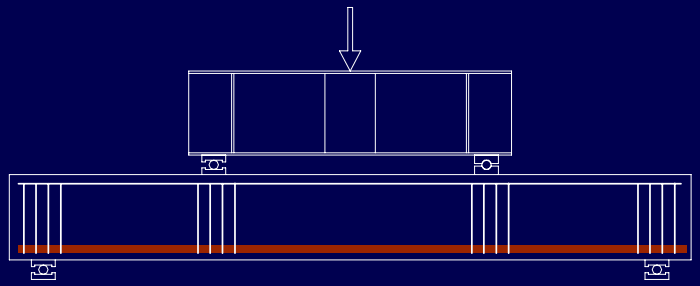
Experimental programme

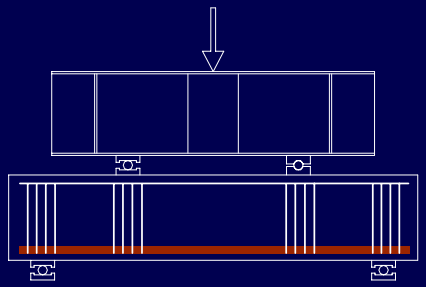
1st phase of testing → V_c → Concrete shear resistance

2nd phase of testing → V_s → Shear link contribution

1st Phase of testing





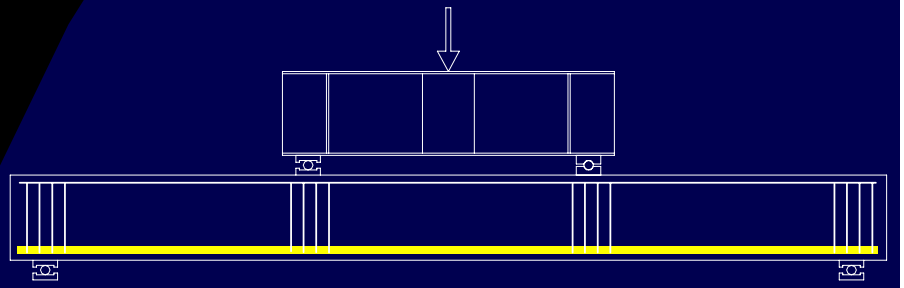


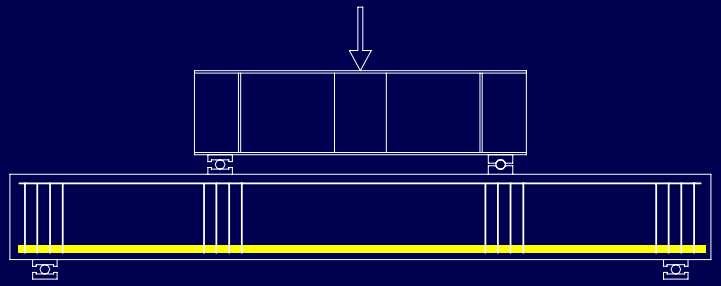
Steel RC Beams

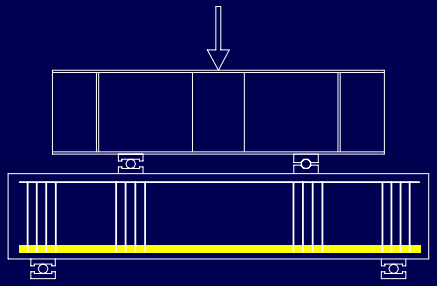
$A_S = 434\ mm^2$

GFRP RC Beams

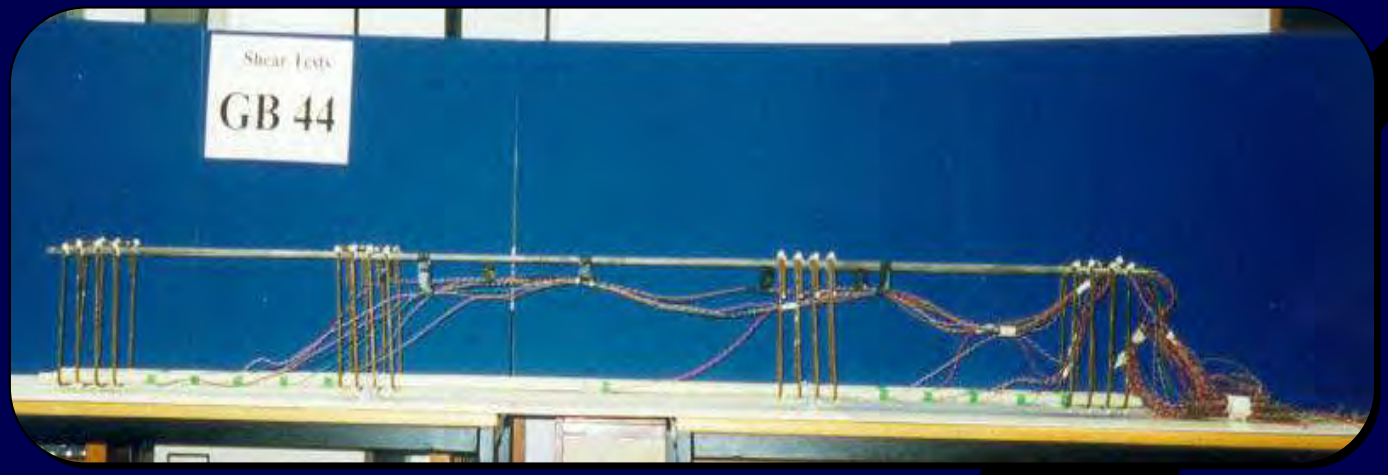
$A_{FRP} = 452\ mm^2$

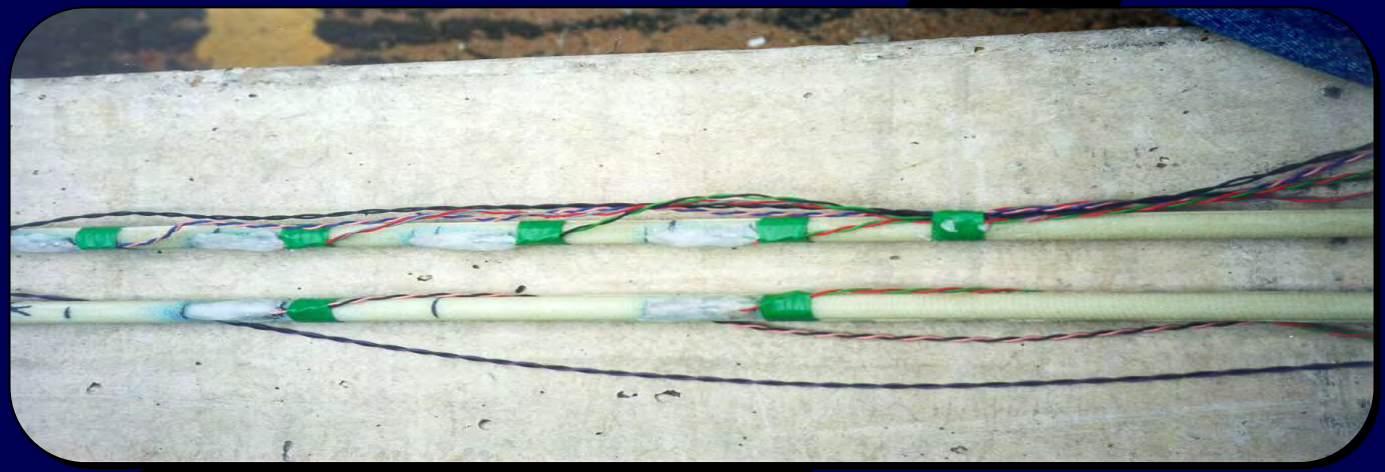






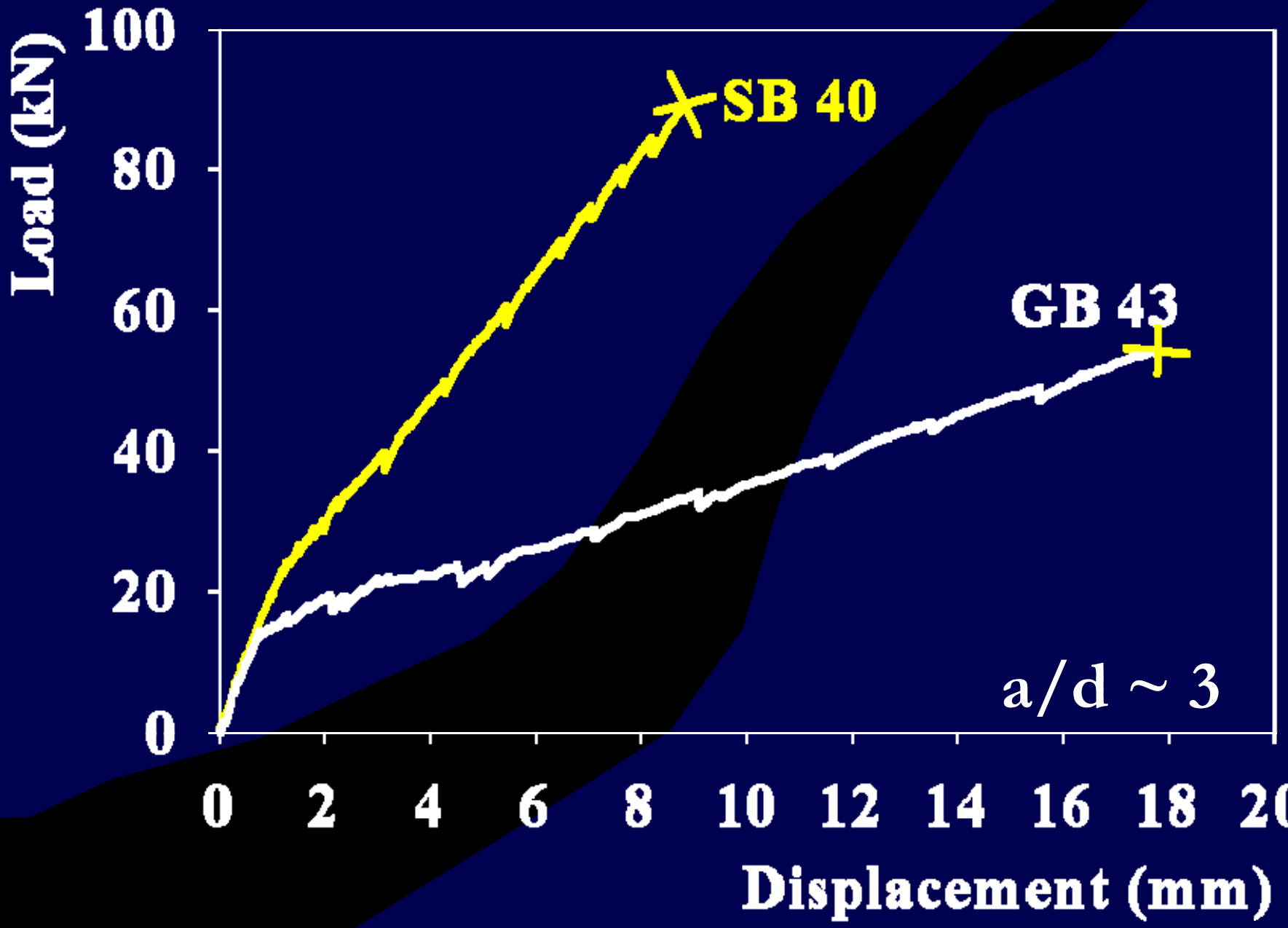
1st phase of testing



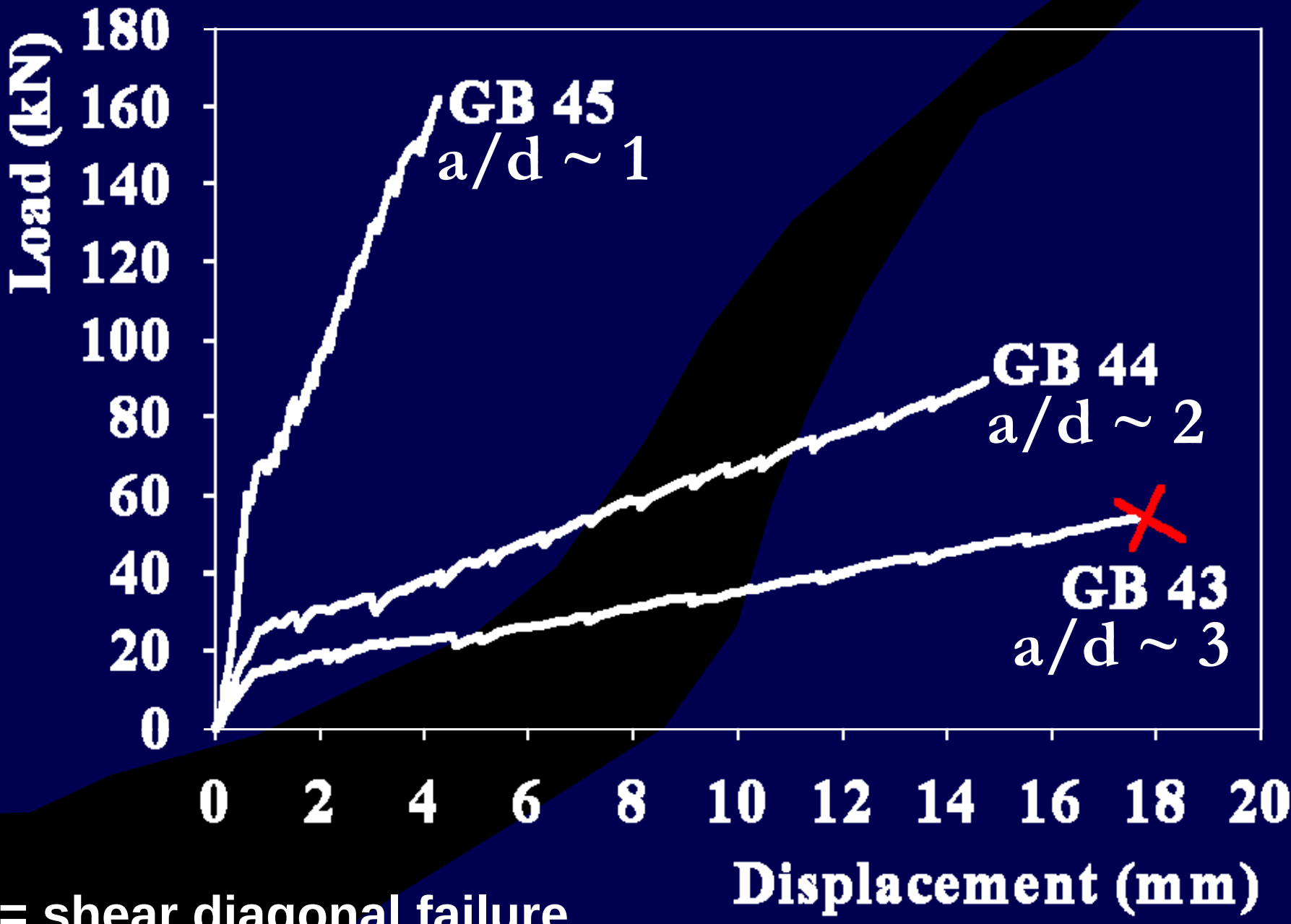


Experimental set-up

Typical Load-displacement response

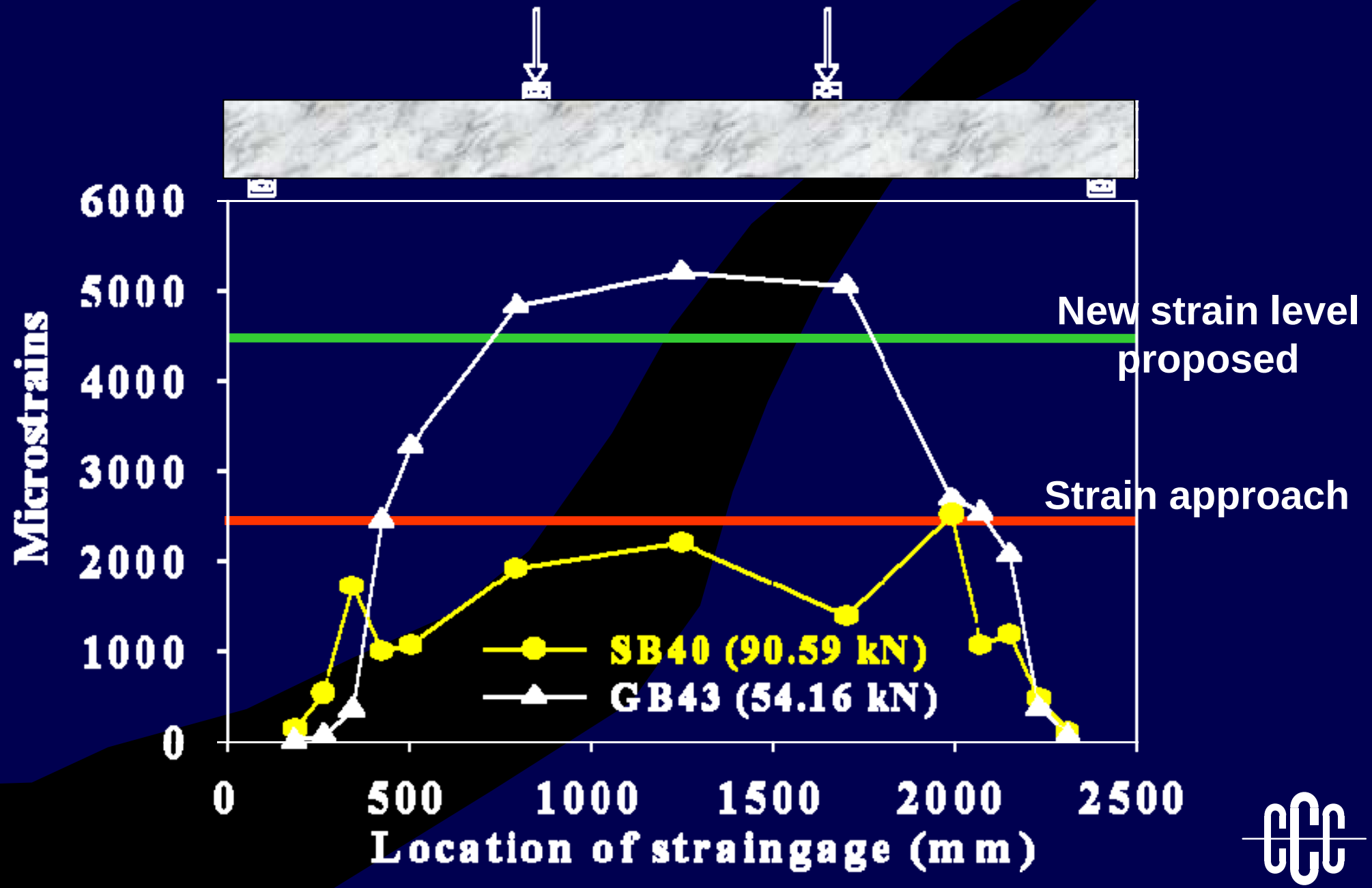


Load-displacement response for GFRP reinforced beams

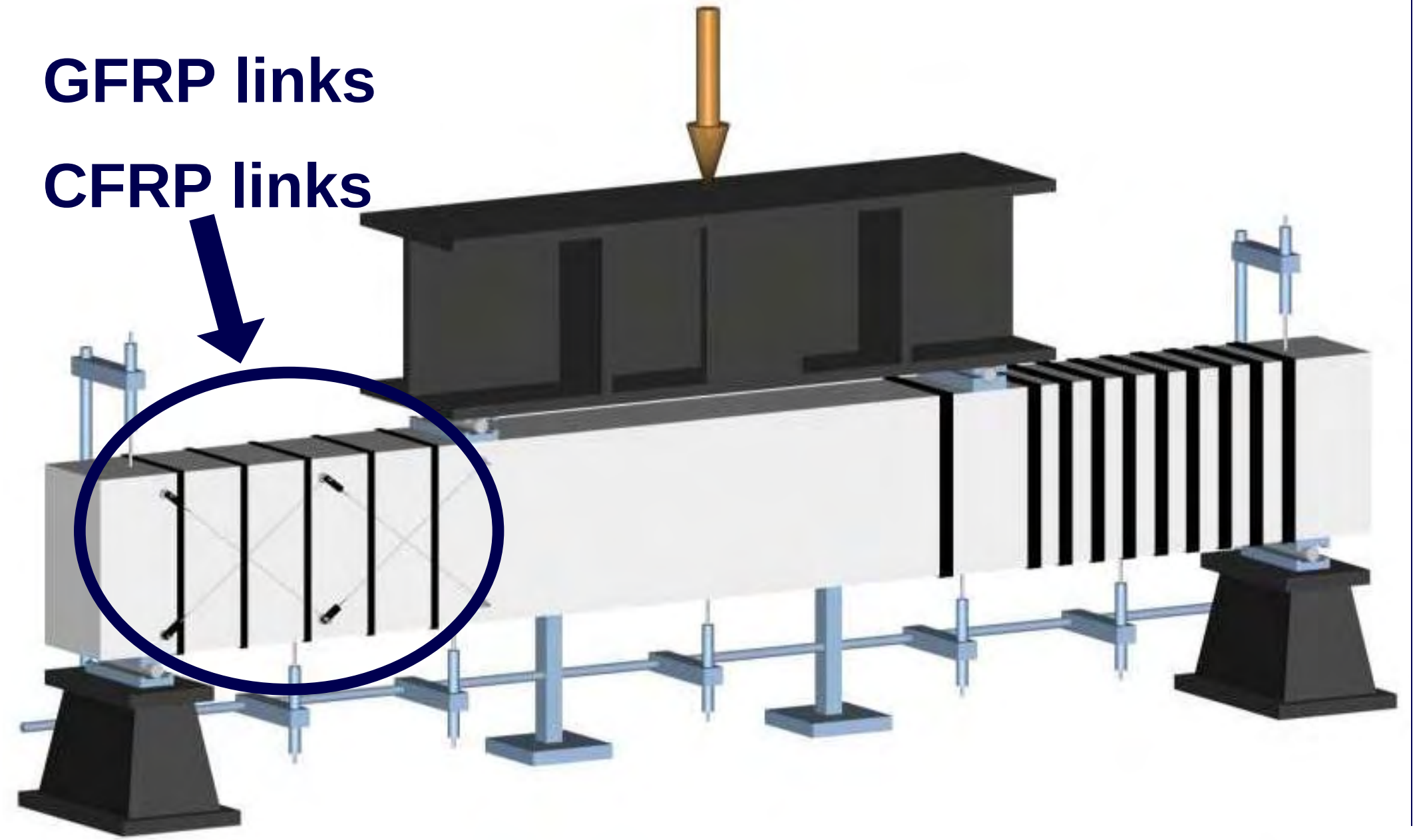


X = shear diagonal failure

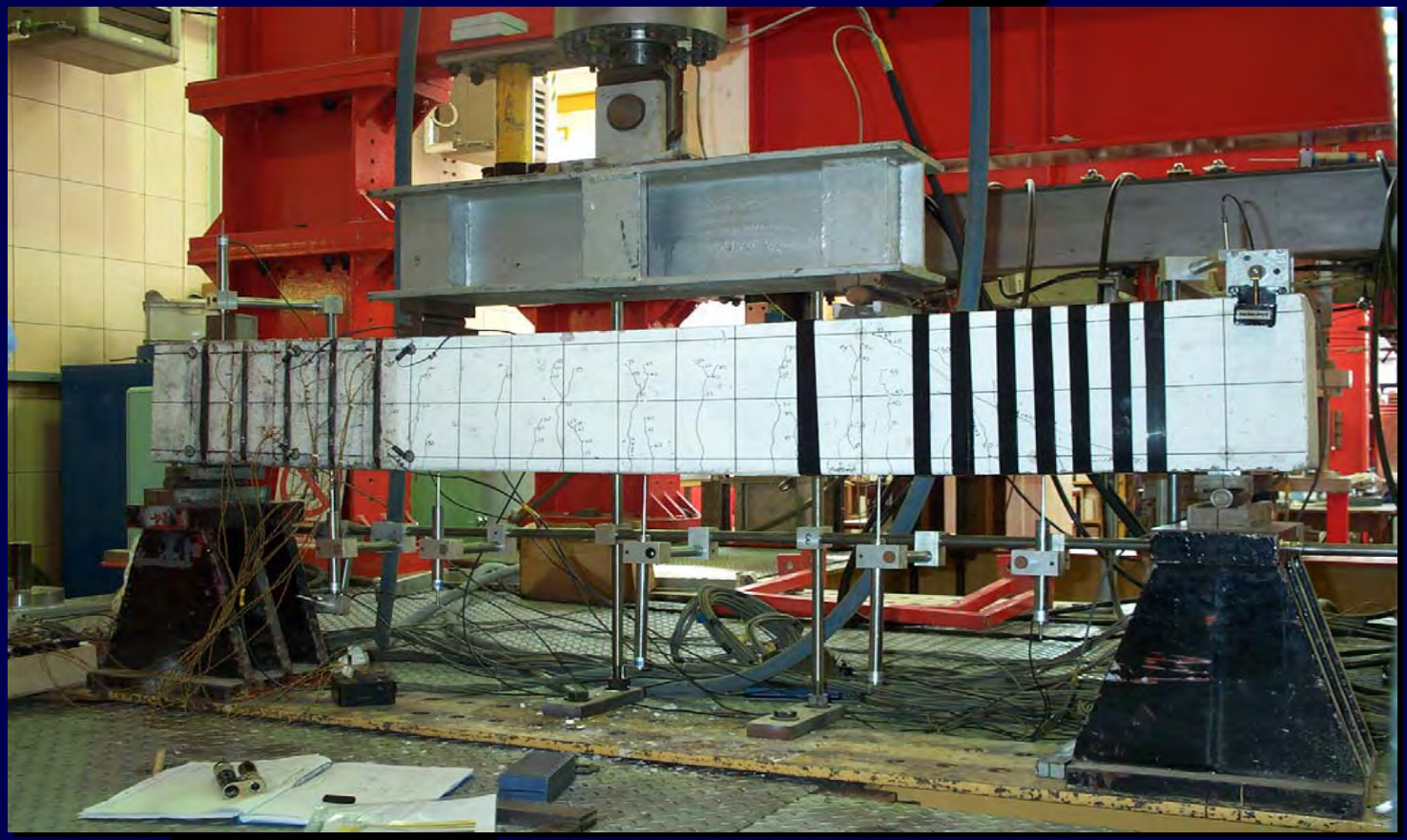
Strain distribution along the flexural reinforcement



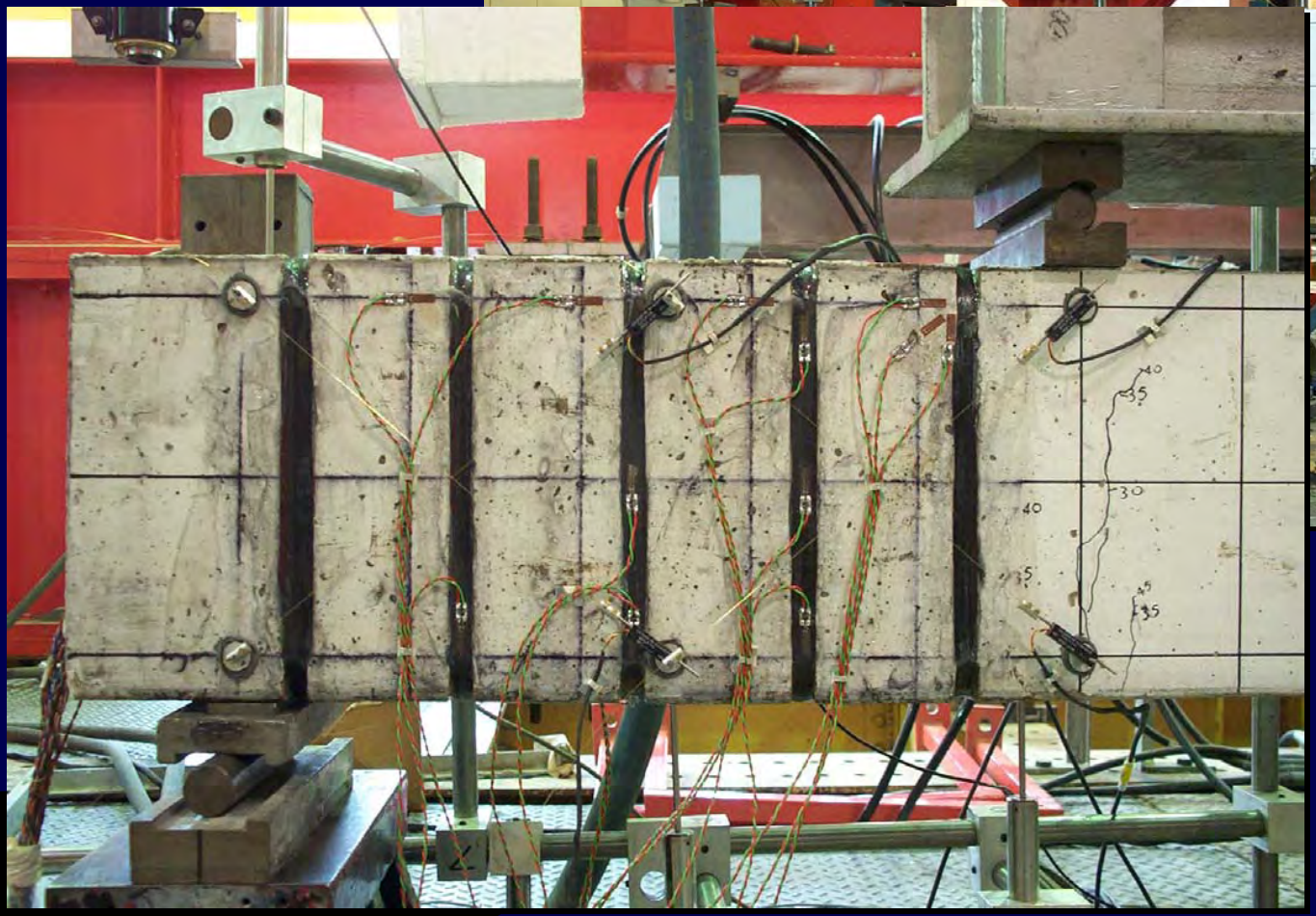
2nd phase of testing



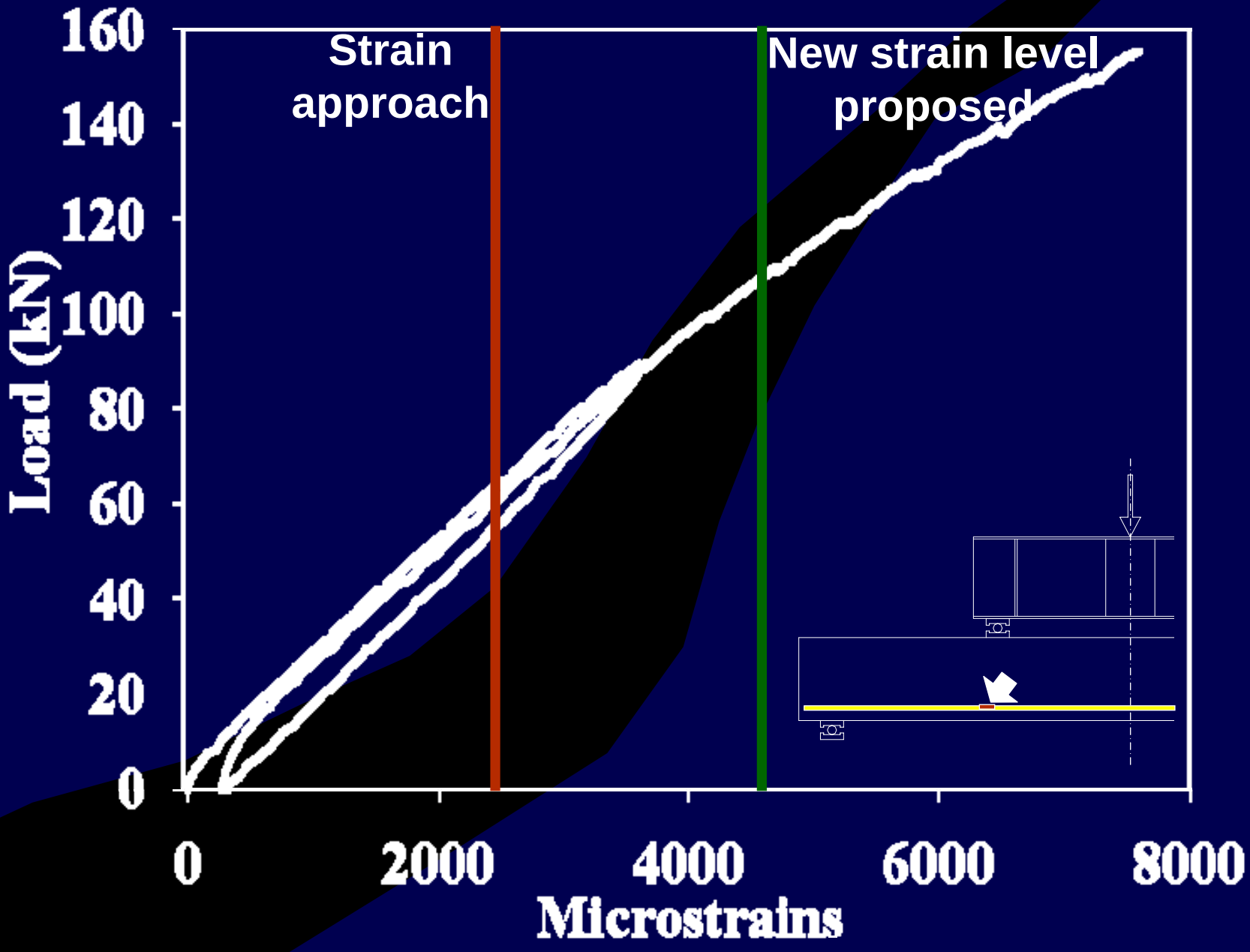
Experimental set-up



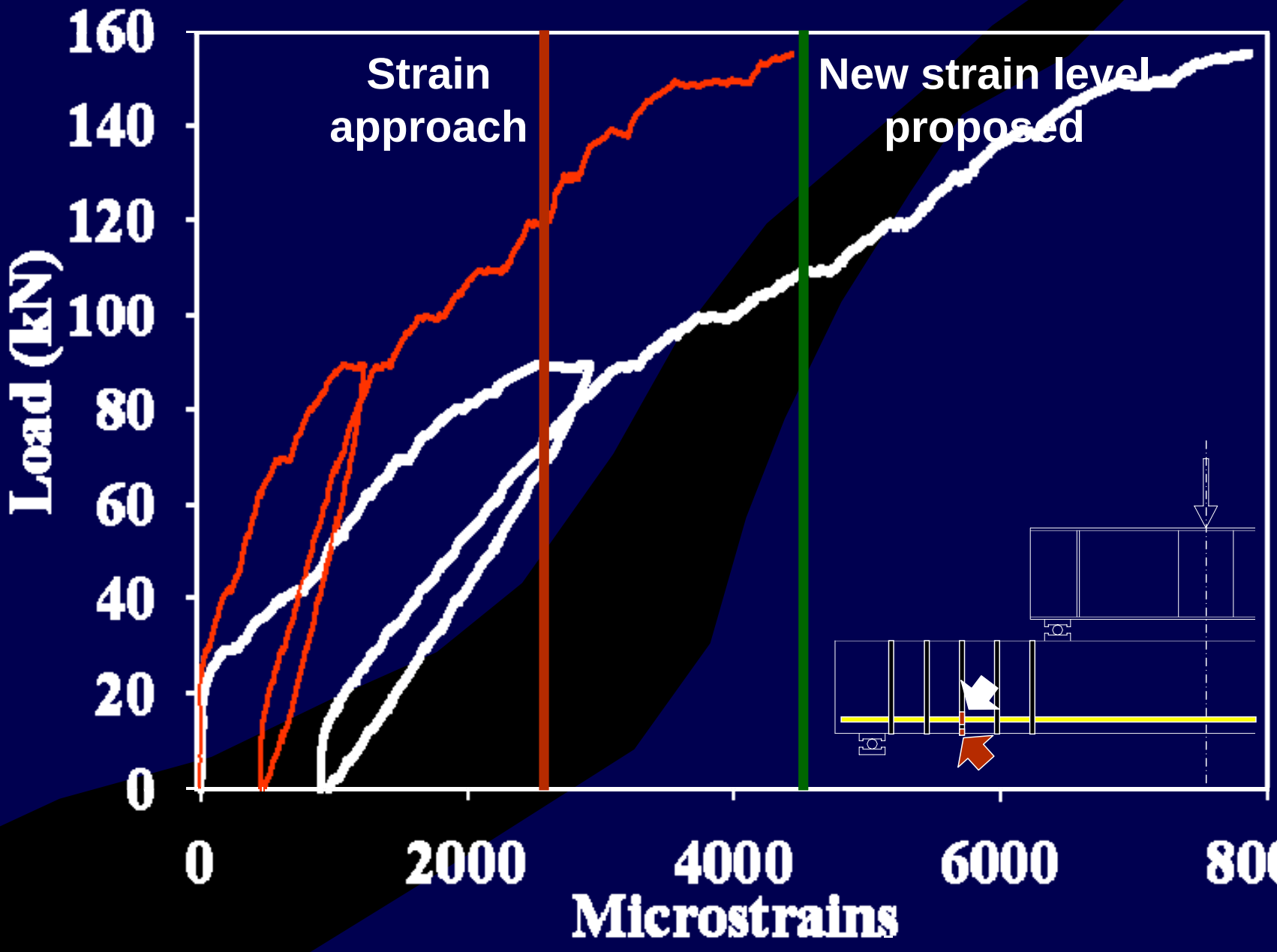
Experimental set-up



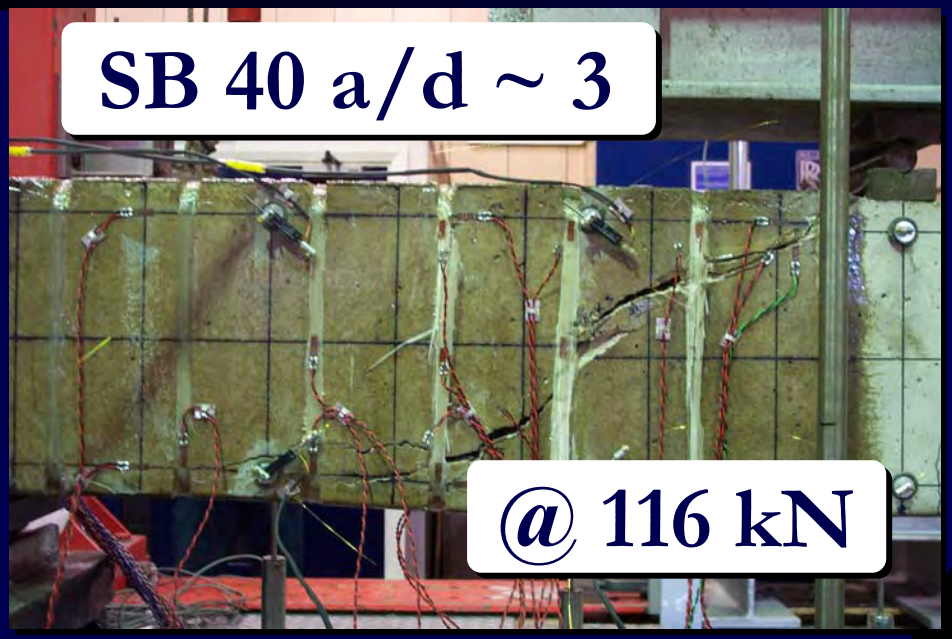
Strain in the flexural reinforcement

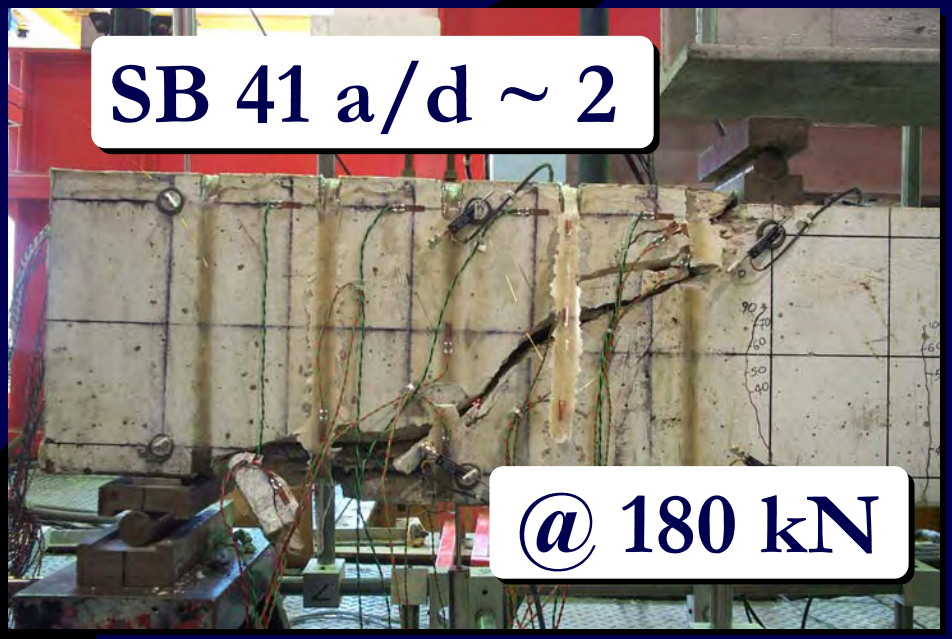


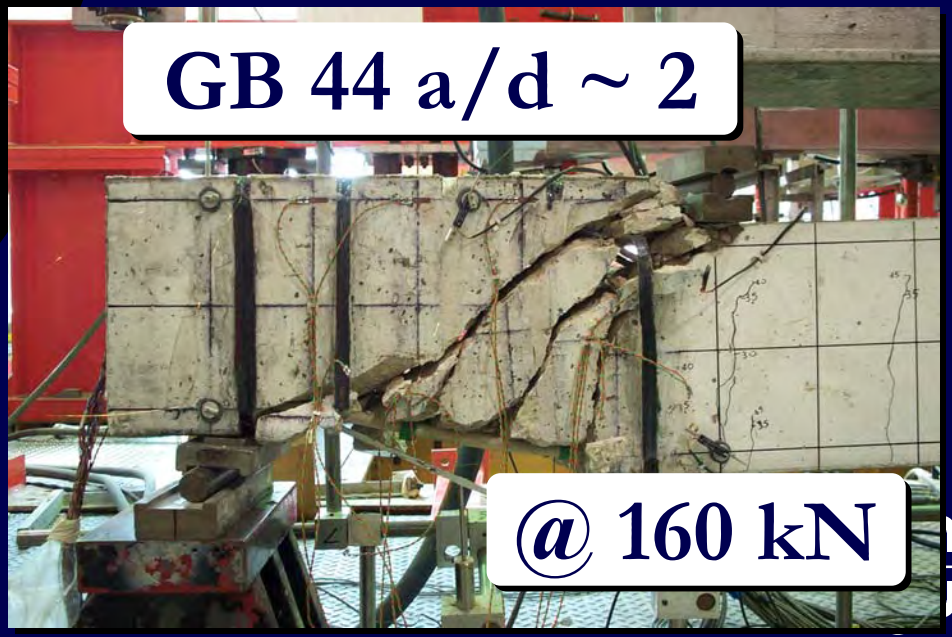
Strain in the shear reinforcement



Summary of results







Predictive approaches

Strain Approach

$$F_{FRP} = F_{steel}$$

$$\varepsilon_{FRP} = \varepsilon_{steel} = 0.0025$$

$$A_e = A_{FRP} \cdot \frac{E_{FRP}}{E_{steel}}$$

Sheffield Approach

$$\varepsilon_{\max,FRP} = 0.0045$$

$$\phi = \frac{\varepsilon_{\max,FRP}}{\varepsilon_{y,steel}}$$

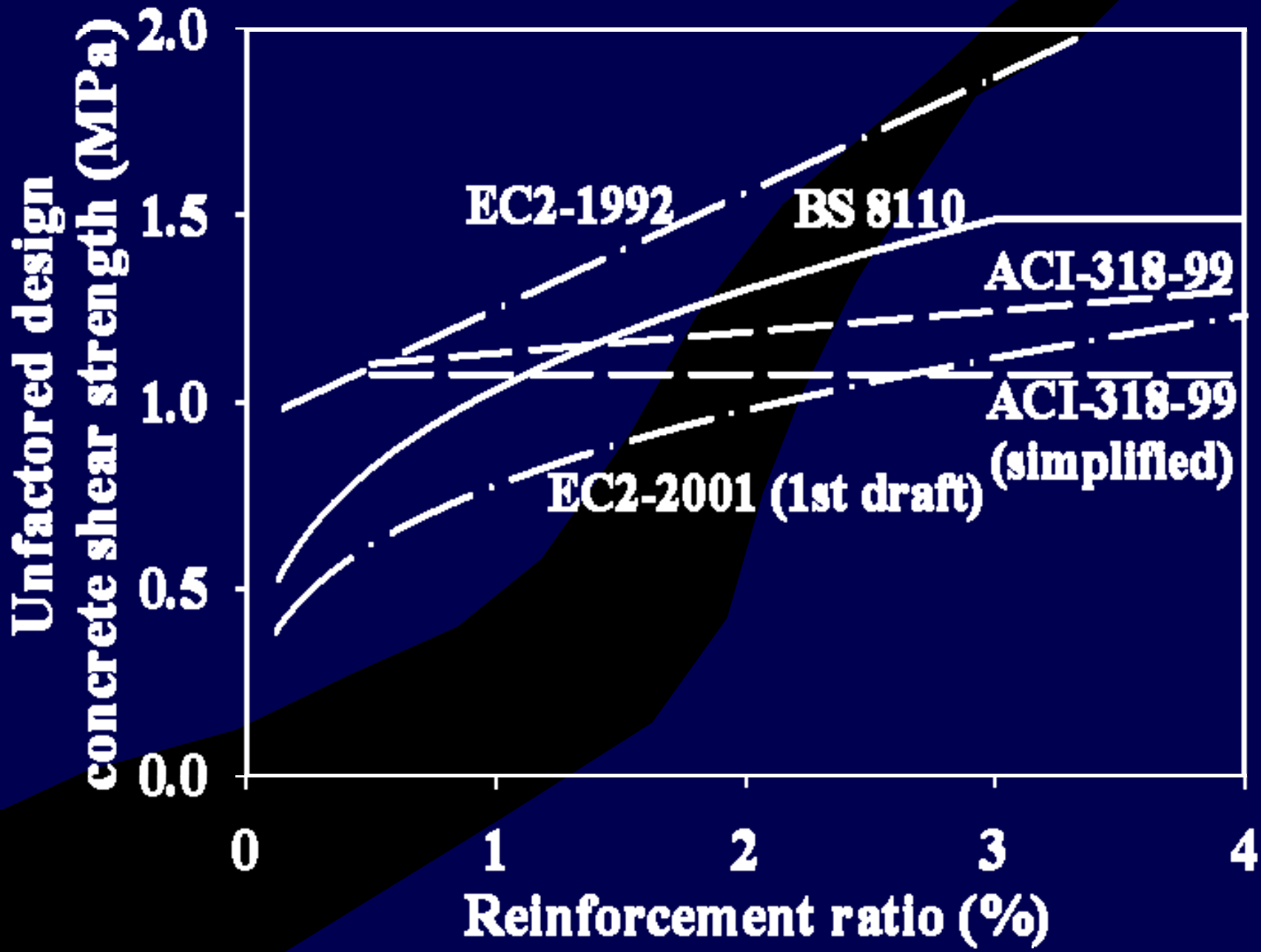
Stress Approach

$$F_{FRP} = F_{steel}$$

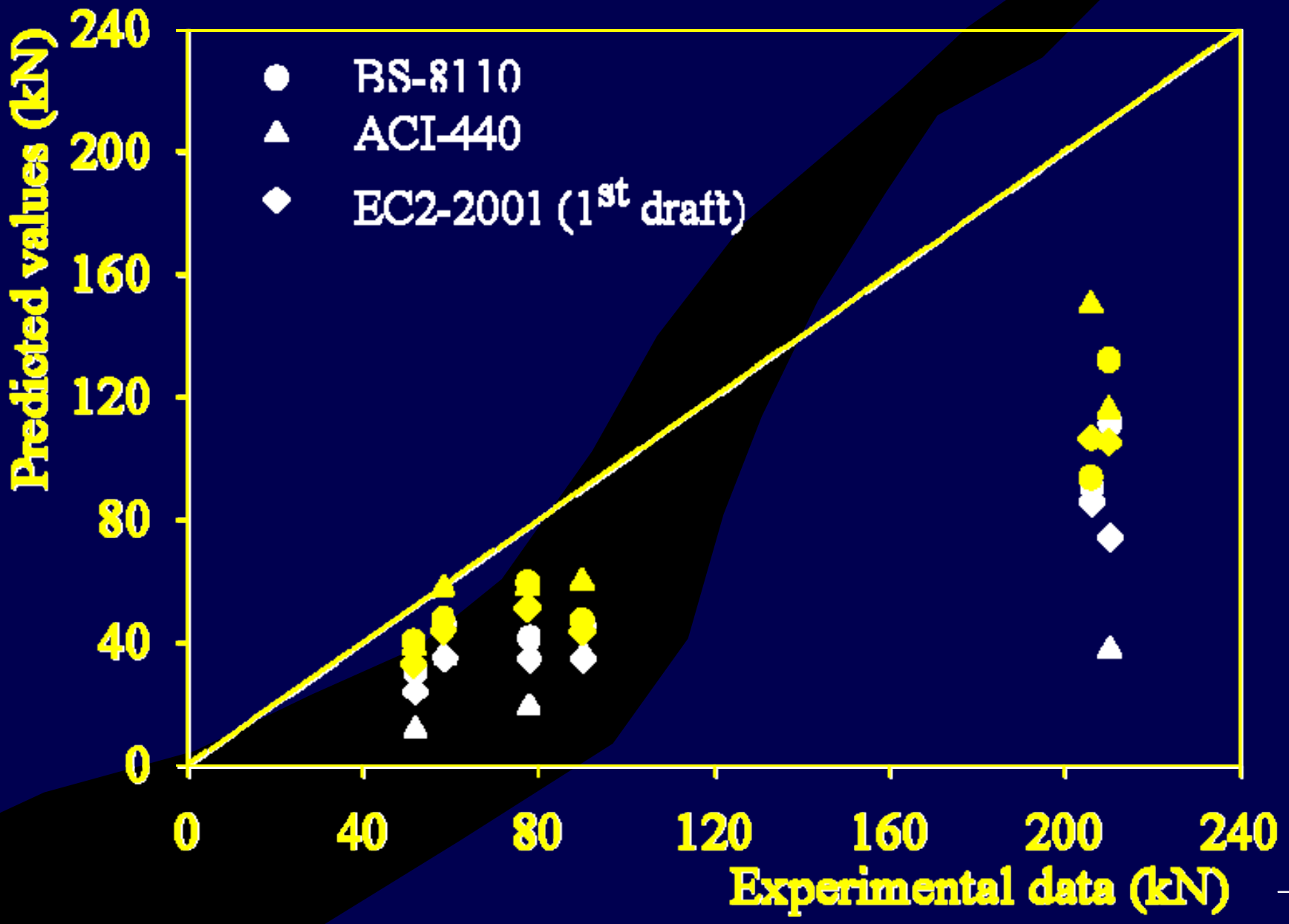
$$\varepsilon_{FRP} \neq \varepsilon_{steel}$$

$$A_e = A_{FRP} \cdot \frac{\sigma_{FRP}}{\sigma_{steel}}$$

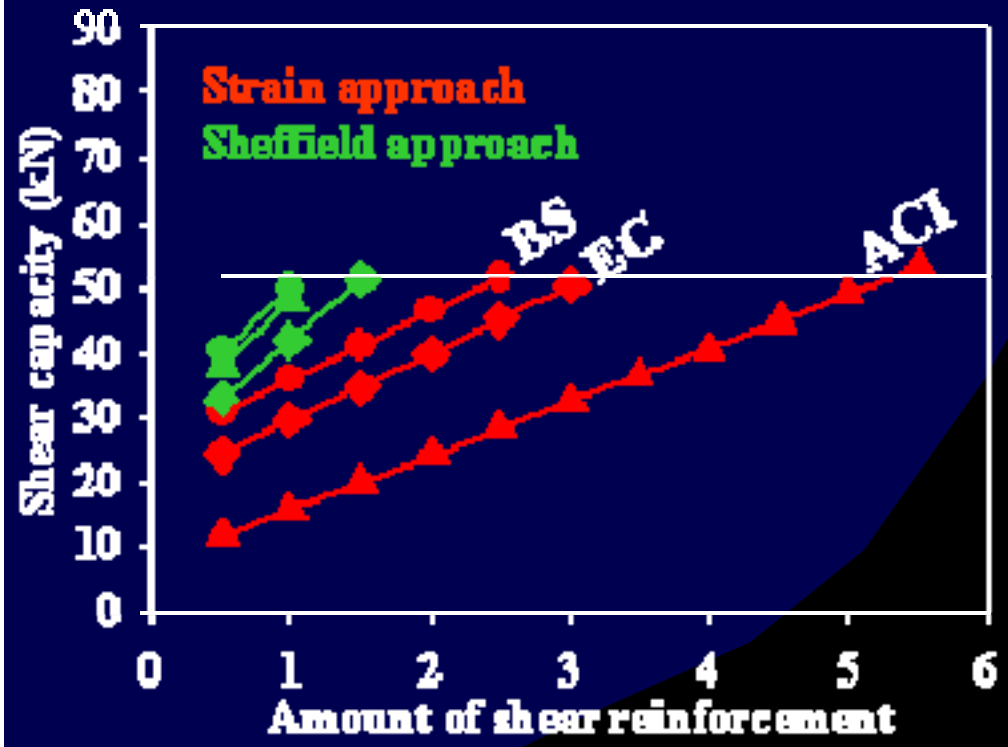
Concrete shear resistance



Strain Approach & Sheffield Approach



Strain Approach & Sheffield Approach



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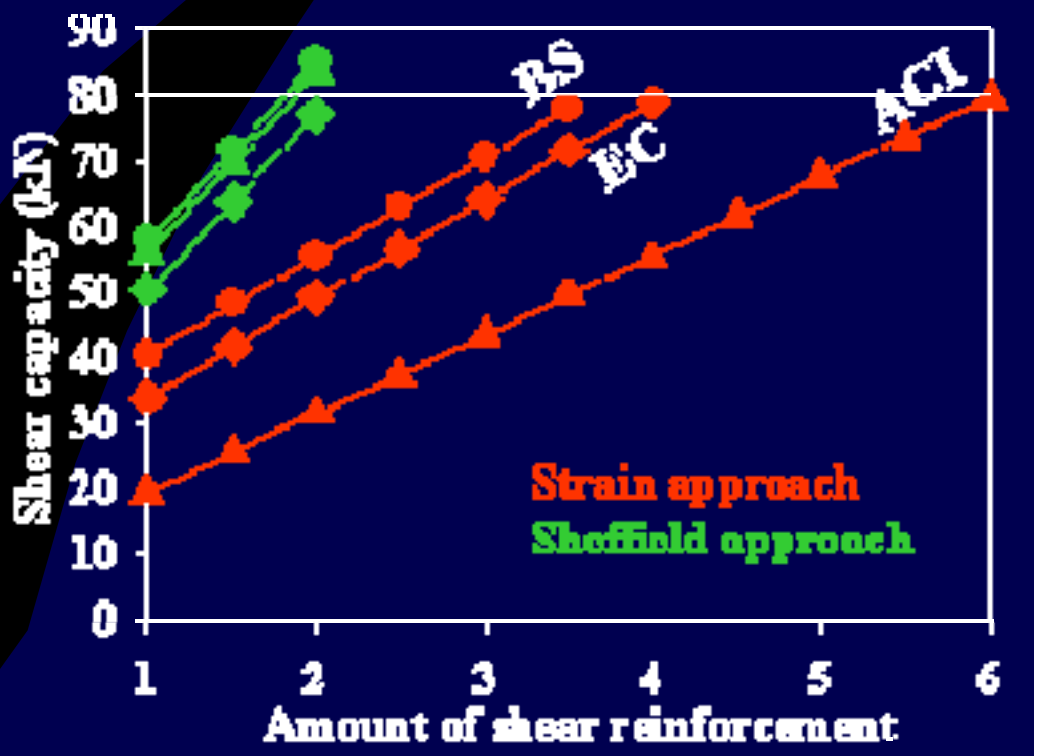

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Conclusions

- Current modifications underestimate shear resistance of FRP RC elements
- Different approaches are needed for different codes
- Improved predictive approaches