

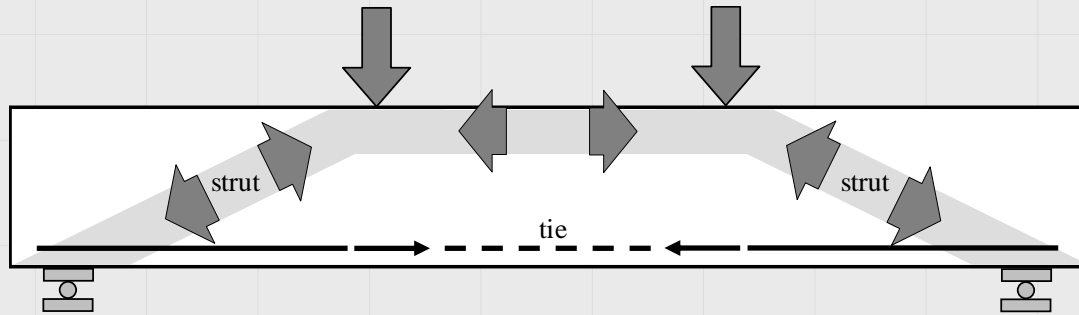
# SHEAR DESIGN EQUATIONS FOR FRP RC BEAMS

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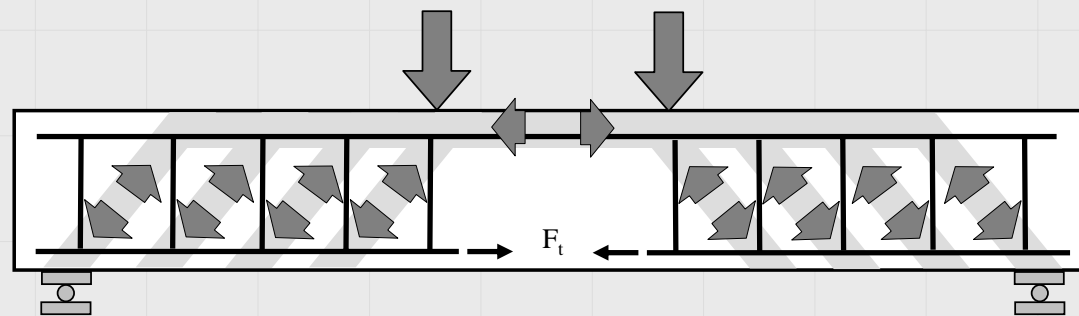
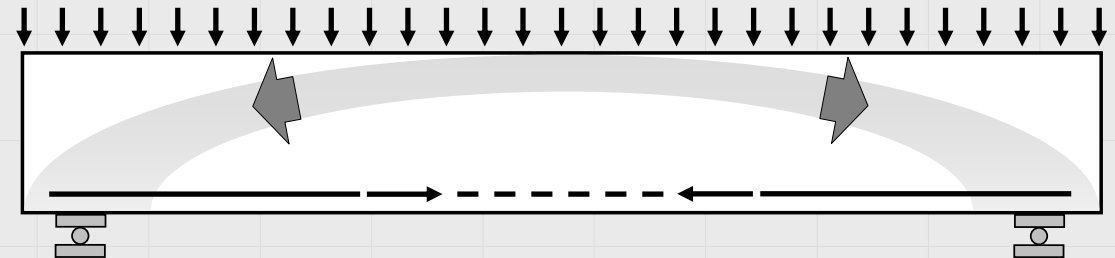


- **Shear resistance**
- **Predictive approaches**
- **Experimental investigation**
- **New approach**
- **Validation**
- **Conclusions**



**Strut and Tie**

**Arch**



**Truss**

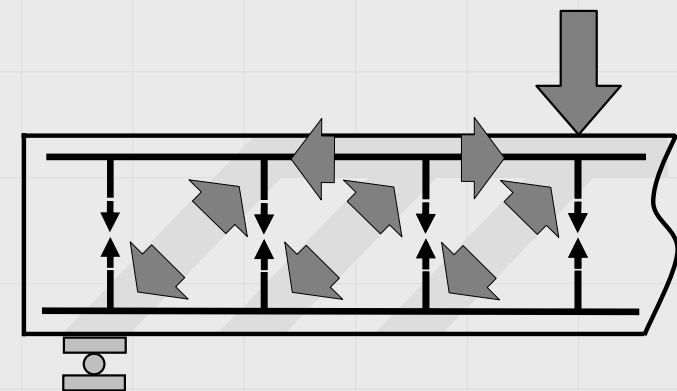
$$V = V_c + V_s$$

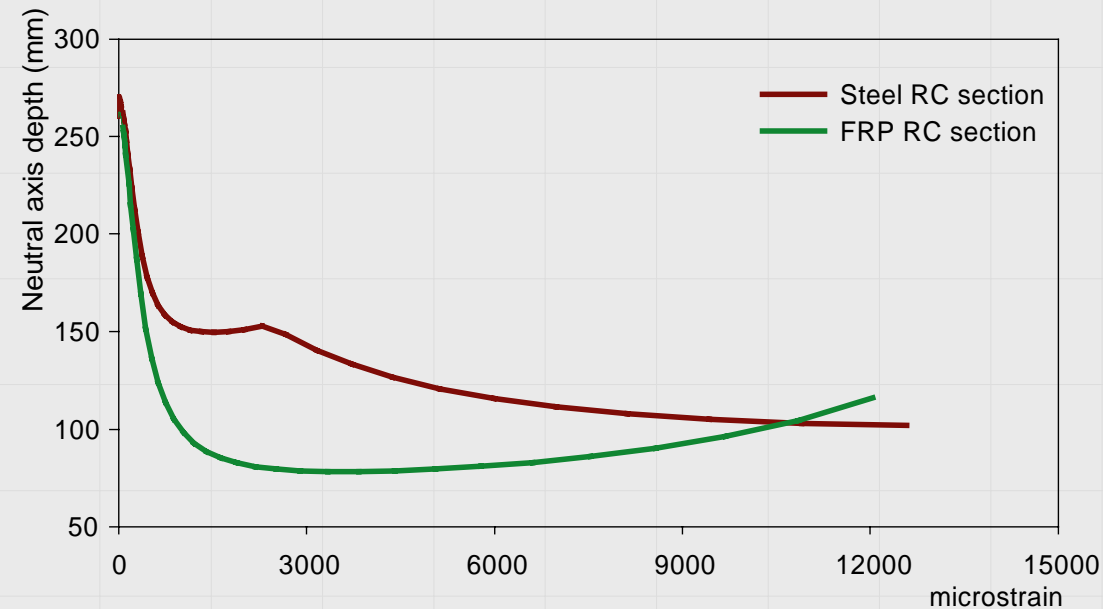
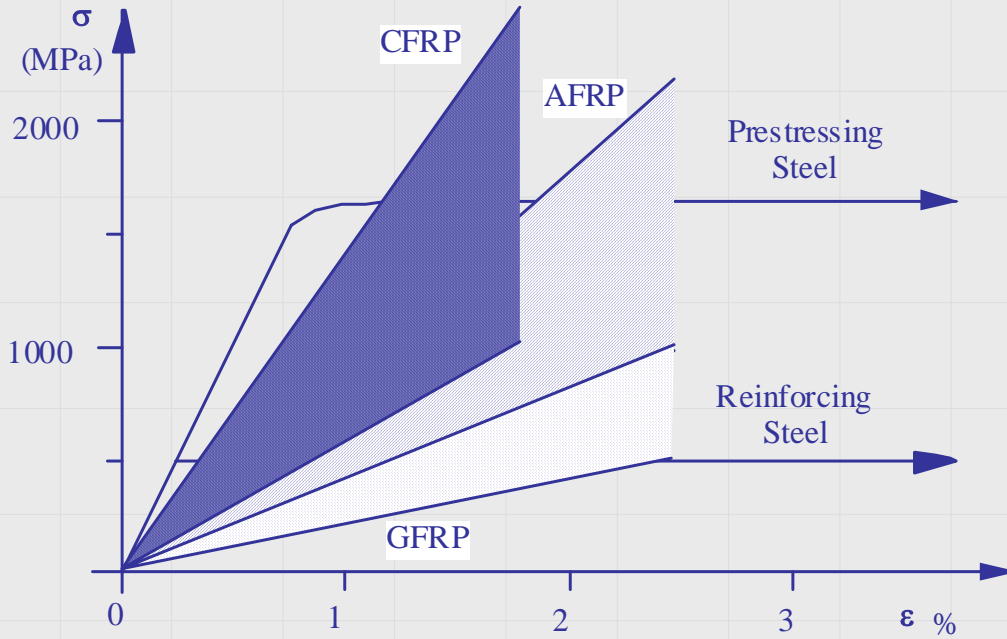
Concrete  
contribution

+

Contribution of  
shear r/ment

Empirical equation  
concrete in compression  
aggregate interlock  
dowel action



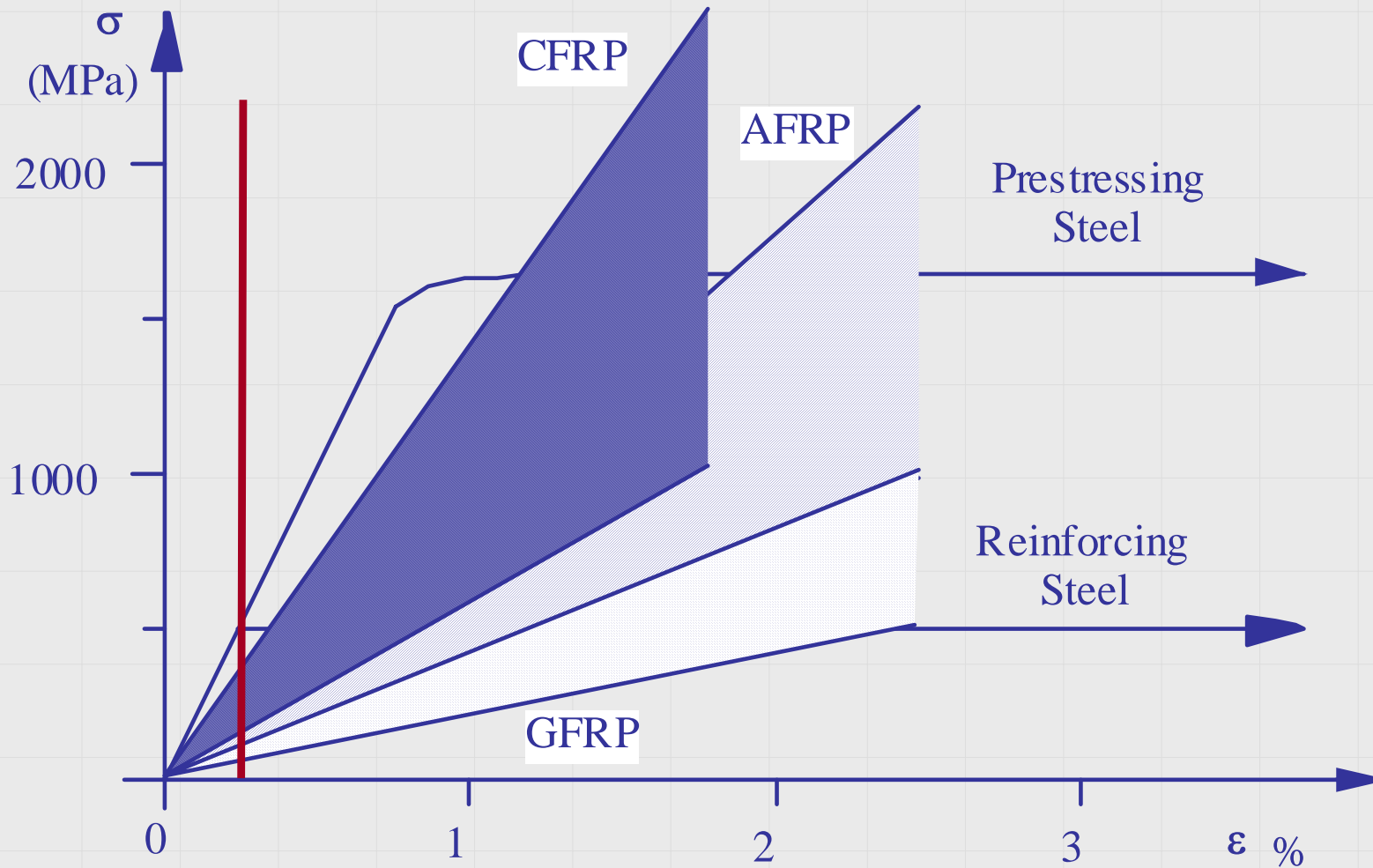


$$\varepsilon_{FRP} = \varepsilon_S \qquad F_{FRP} = F_S$$

$$F_{FRP} = \varepsilon_{FRP} \cdot E_{FRP} \cdot A_{FRP} = \varepsilon_S \cdot E_S \cdot A_S = F_S$$

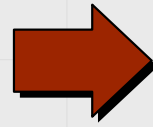
$$A_e = A_{FRP} \cdot \frac{E_{FRP}}{E_S}$$

## Limiting Strain = 0.2% - 0.25%



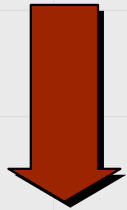
- **Are the shear mechanisms for steel and FRP RC similar?**
- **Is it correct to simply add the separate shear contributions from the concrete and reinforcement?**
- **Is the limiting strain concept valid?**

1<sup>st</sup> phase of  
testing

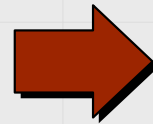


$V_c$

Concrete  
shear  
resistance

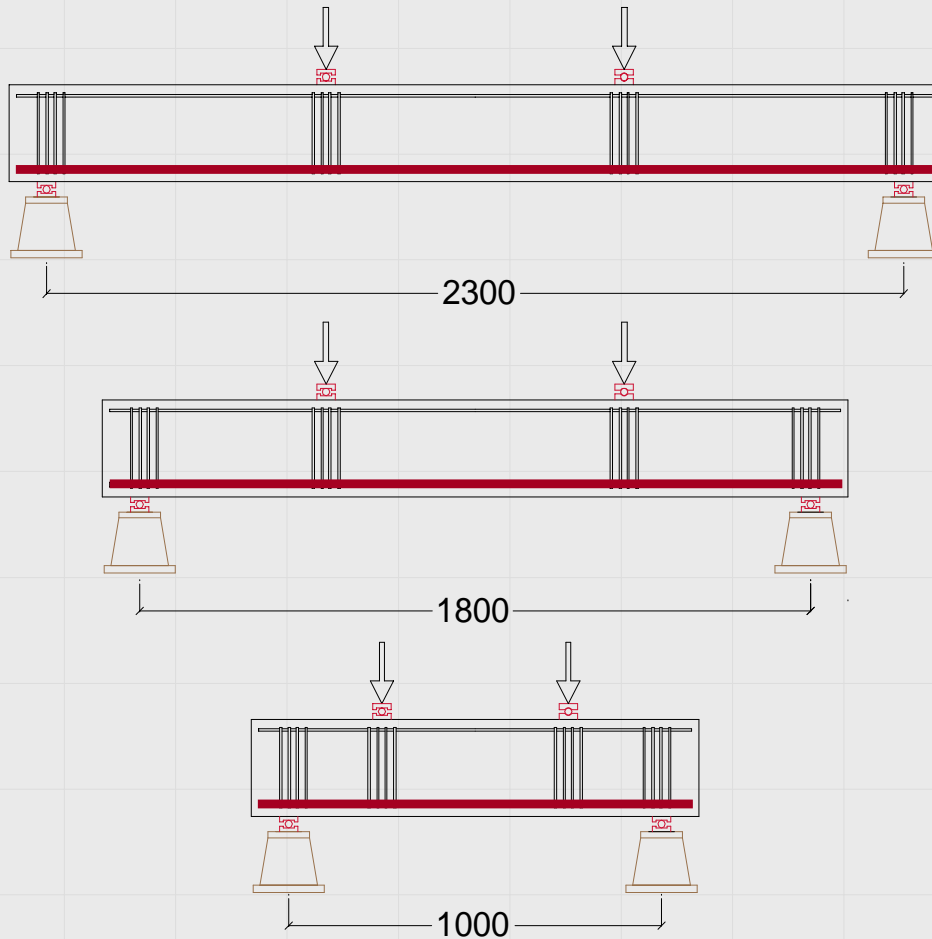


2<sup>nd</sup> phase of  
testing



$V_s$

Shear link  
contribution

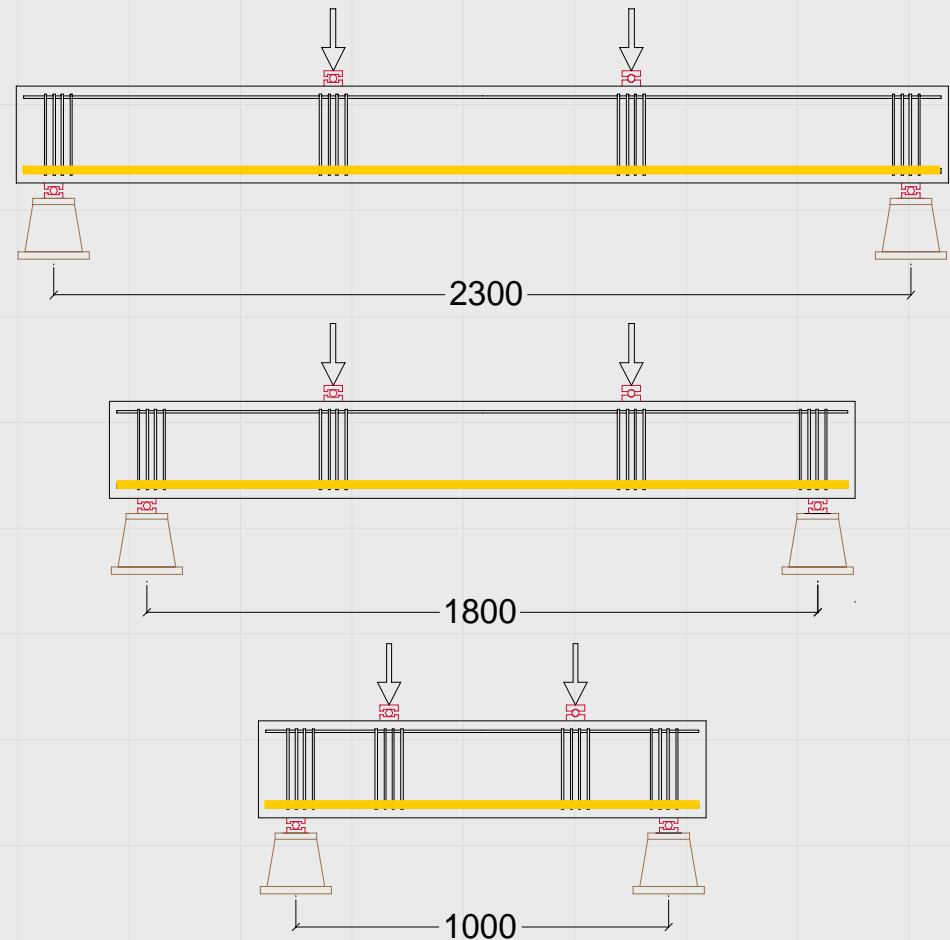


## Steel RC Beams

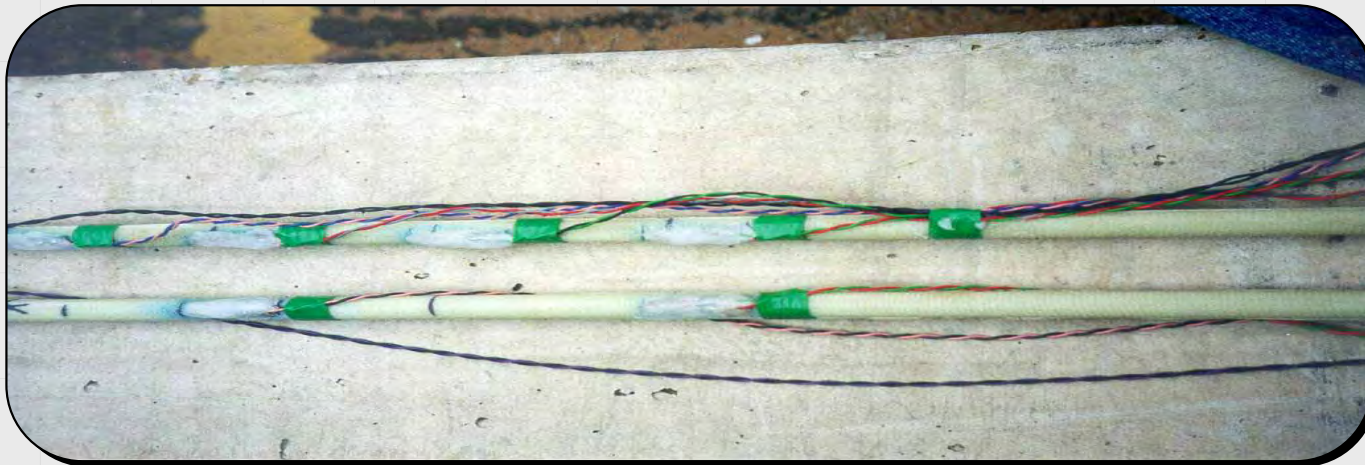
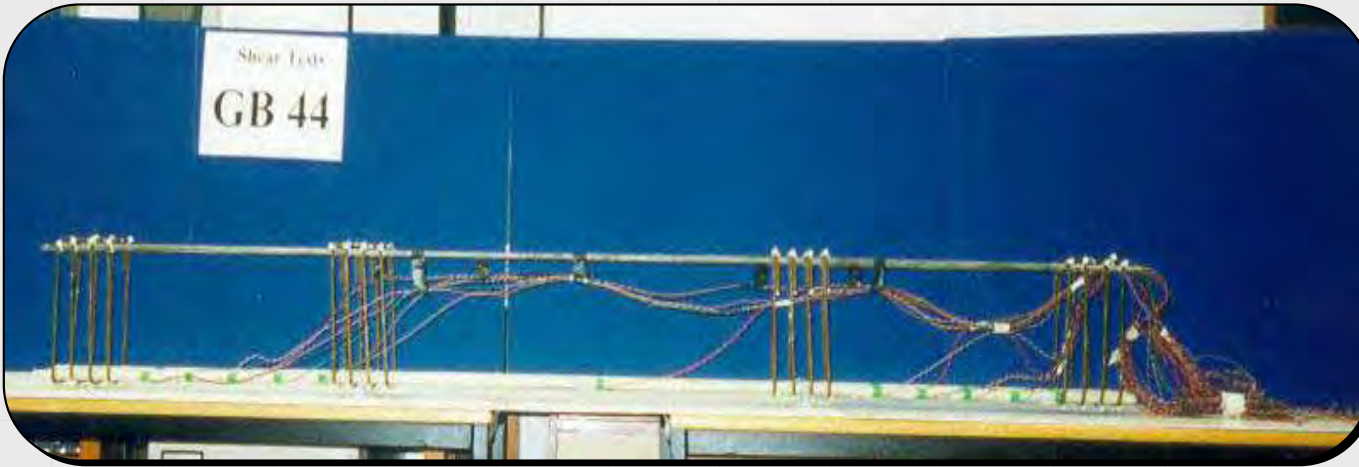
$$A_s = 434 \text{ mm}^2$$

## GFRP RC Beams

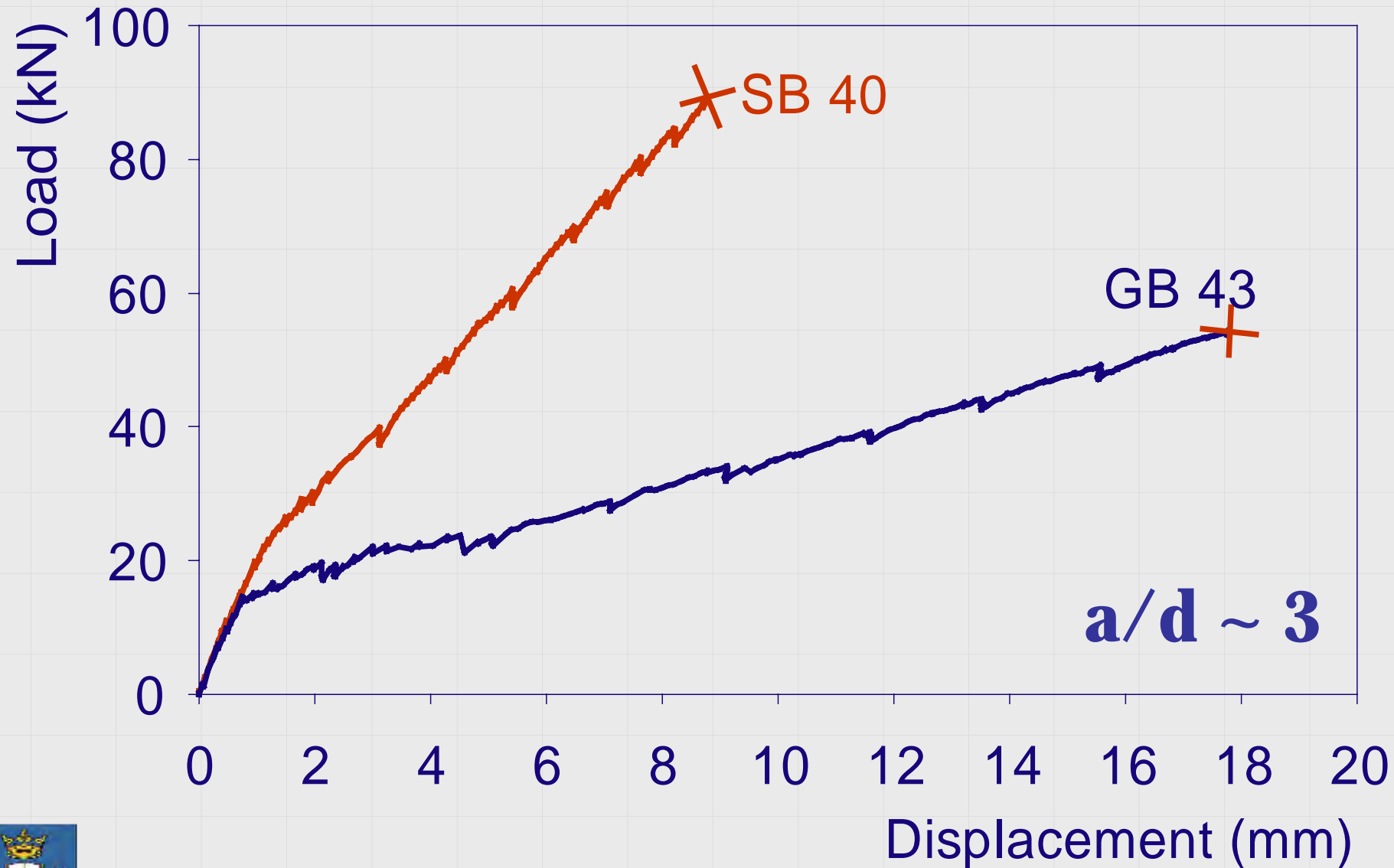
$$A_{FRP} = 452 \text{ mm}^2$$

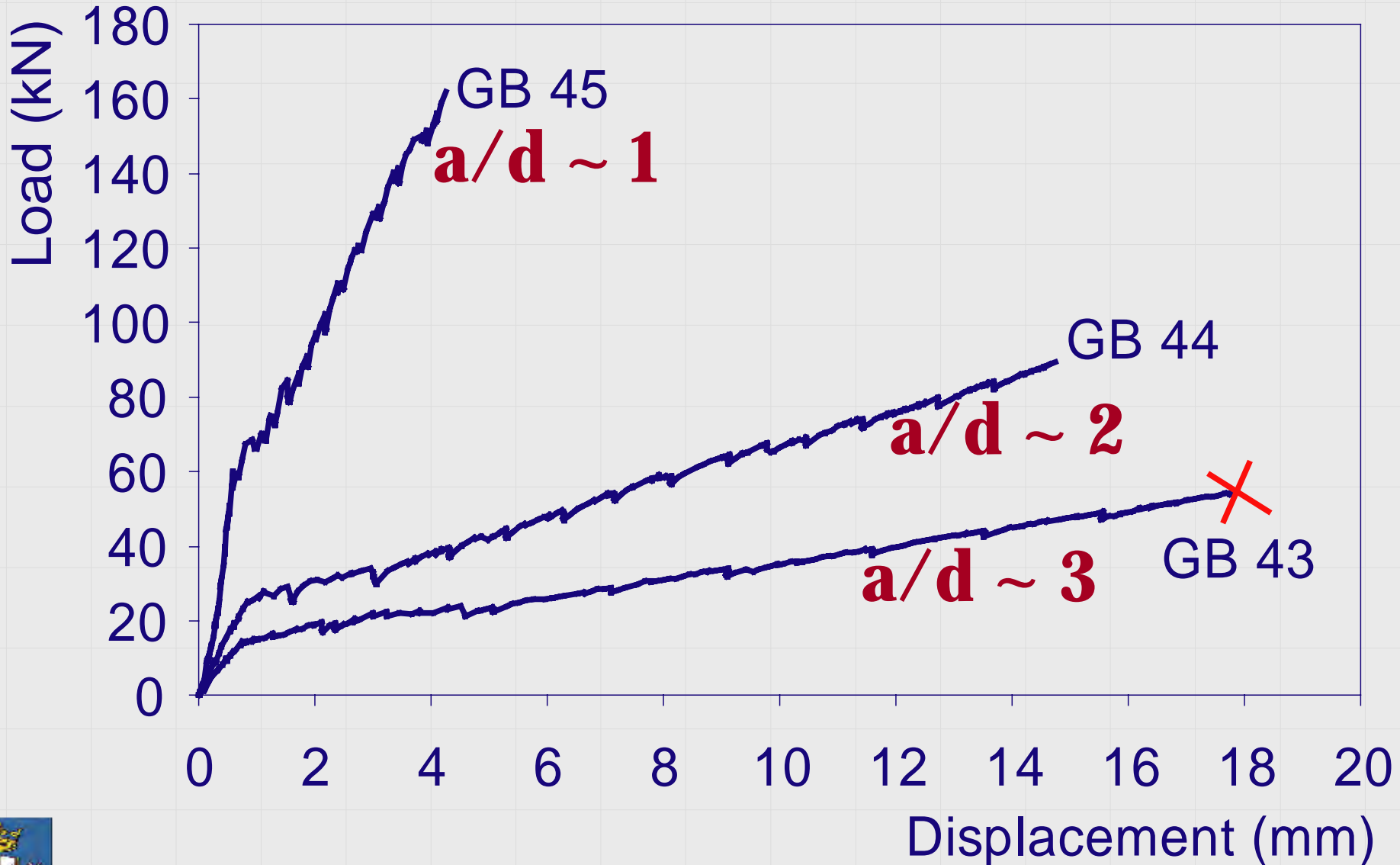


# 1<sup>st</sup> phase of testing

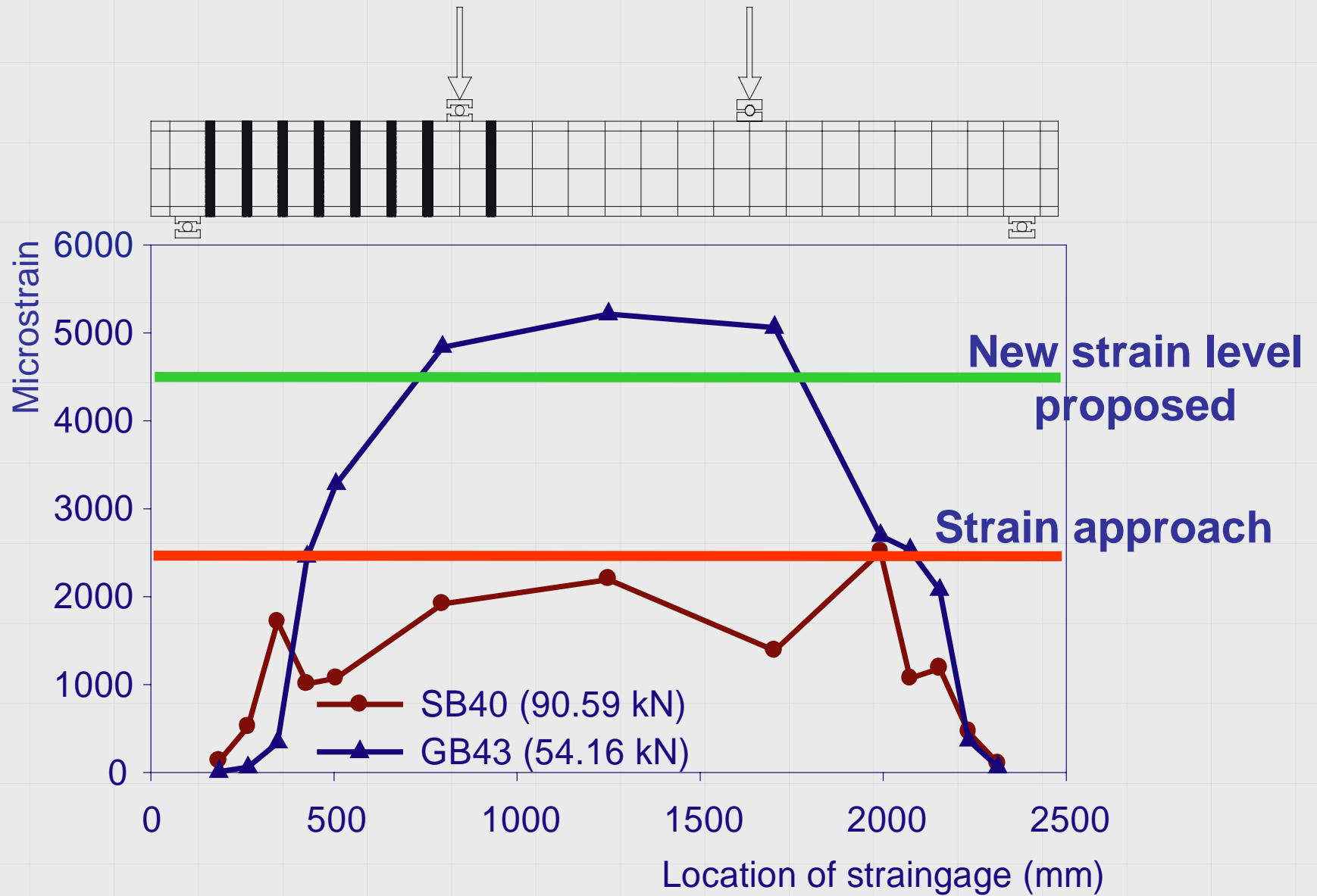






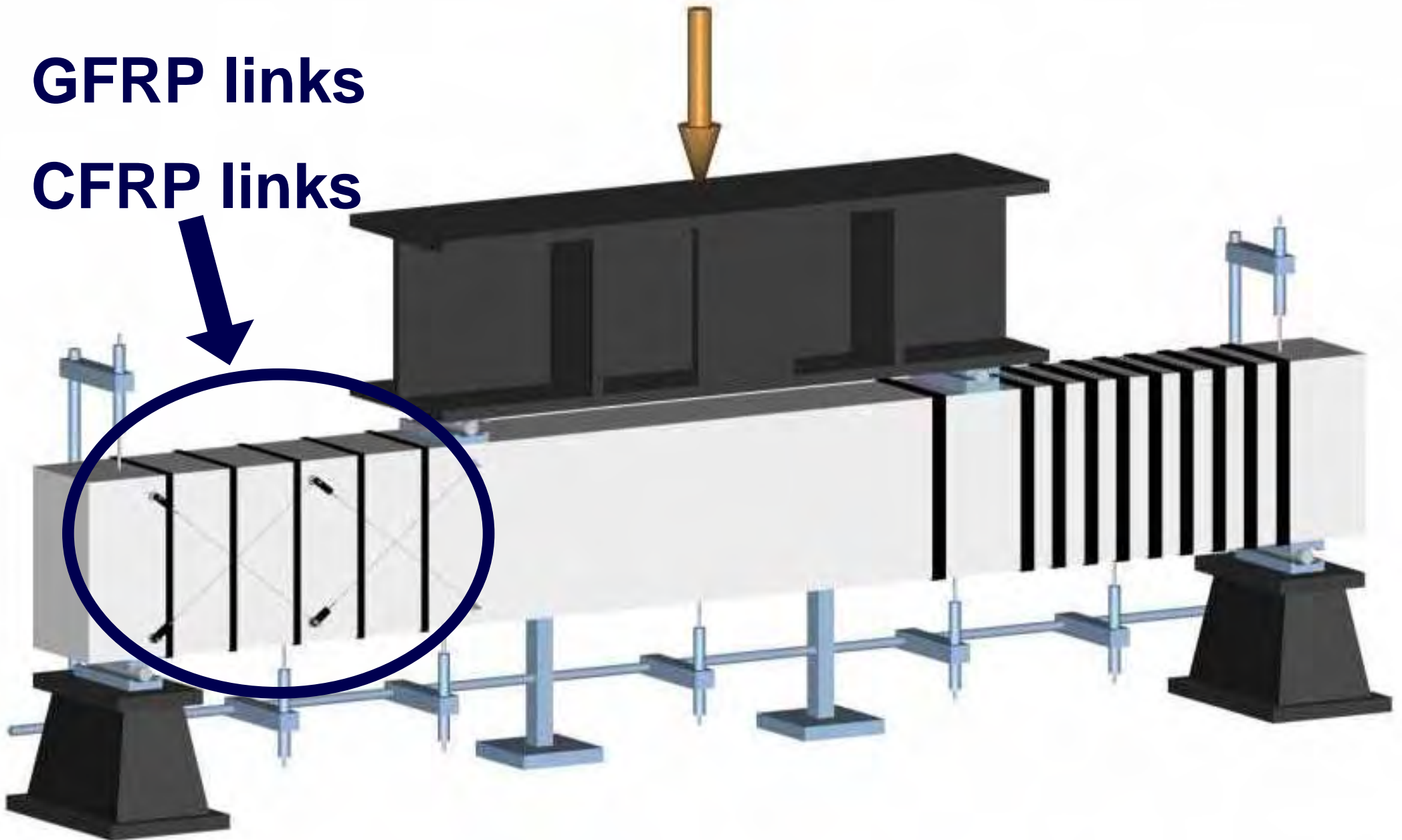


 = shear diagonal failure



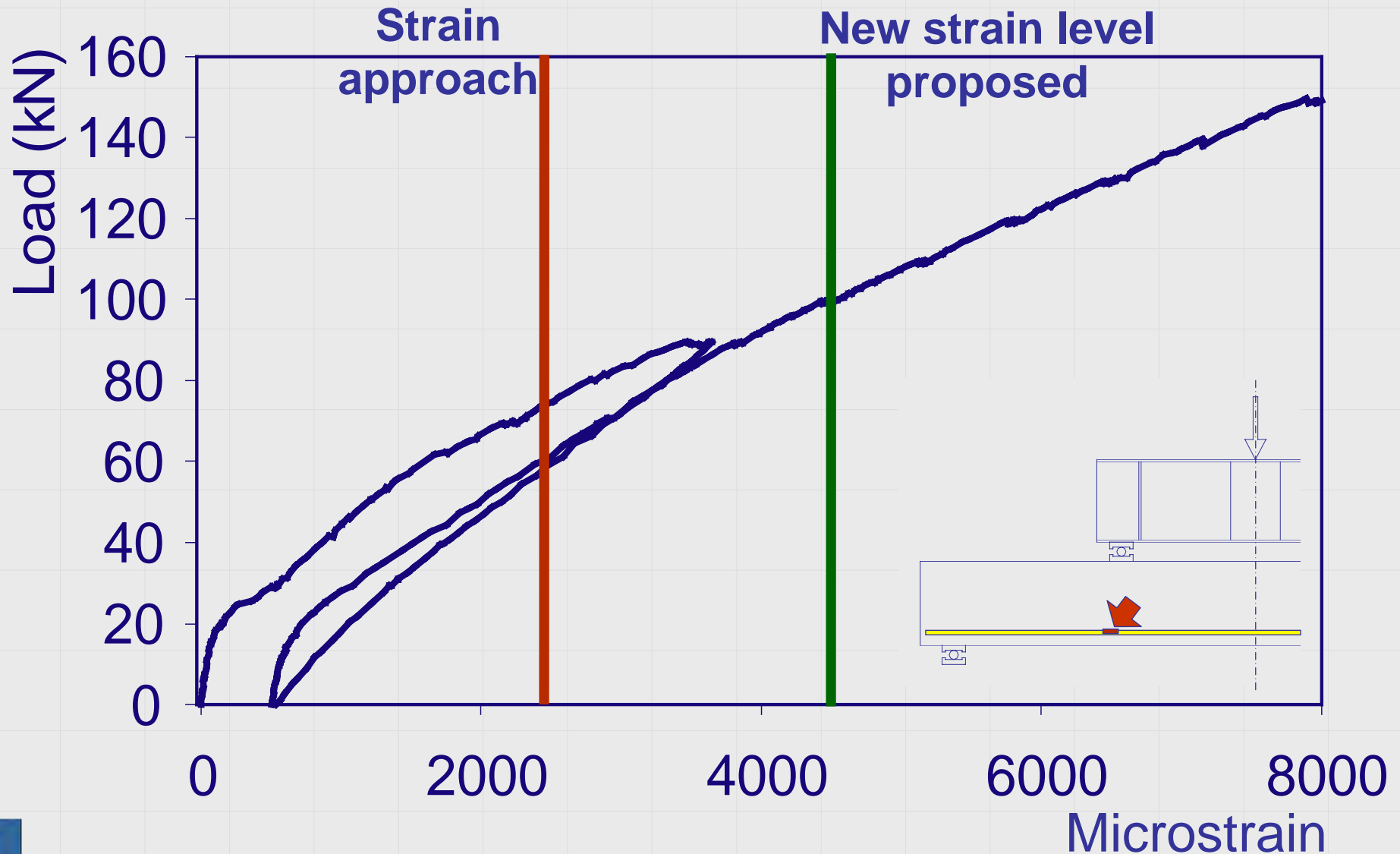
**GFRP links**

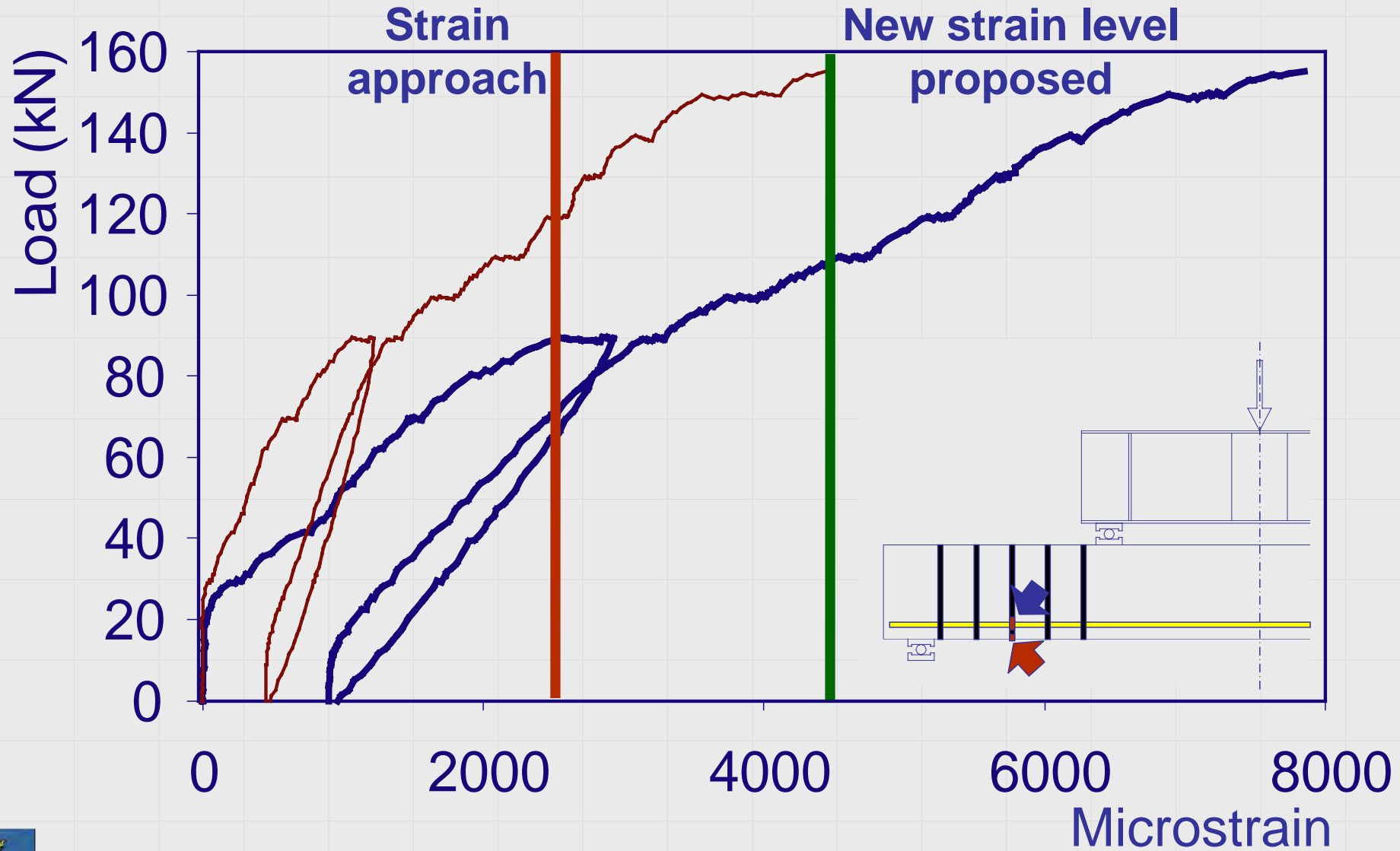
**CFRP links**



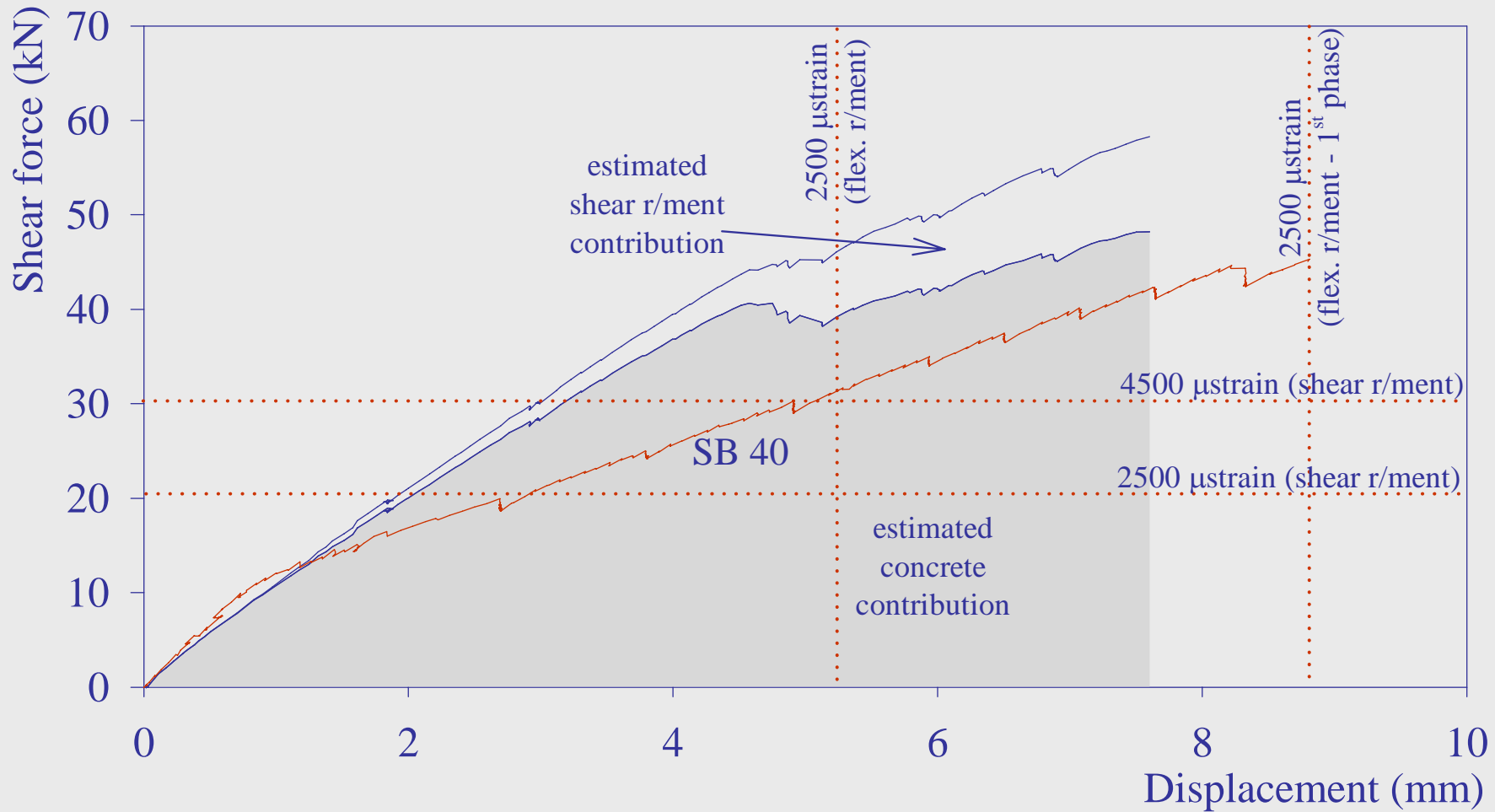




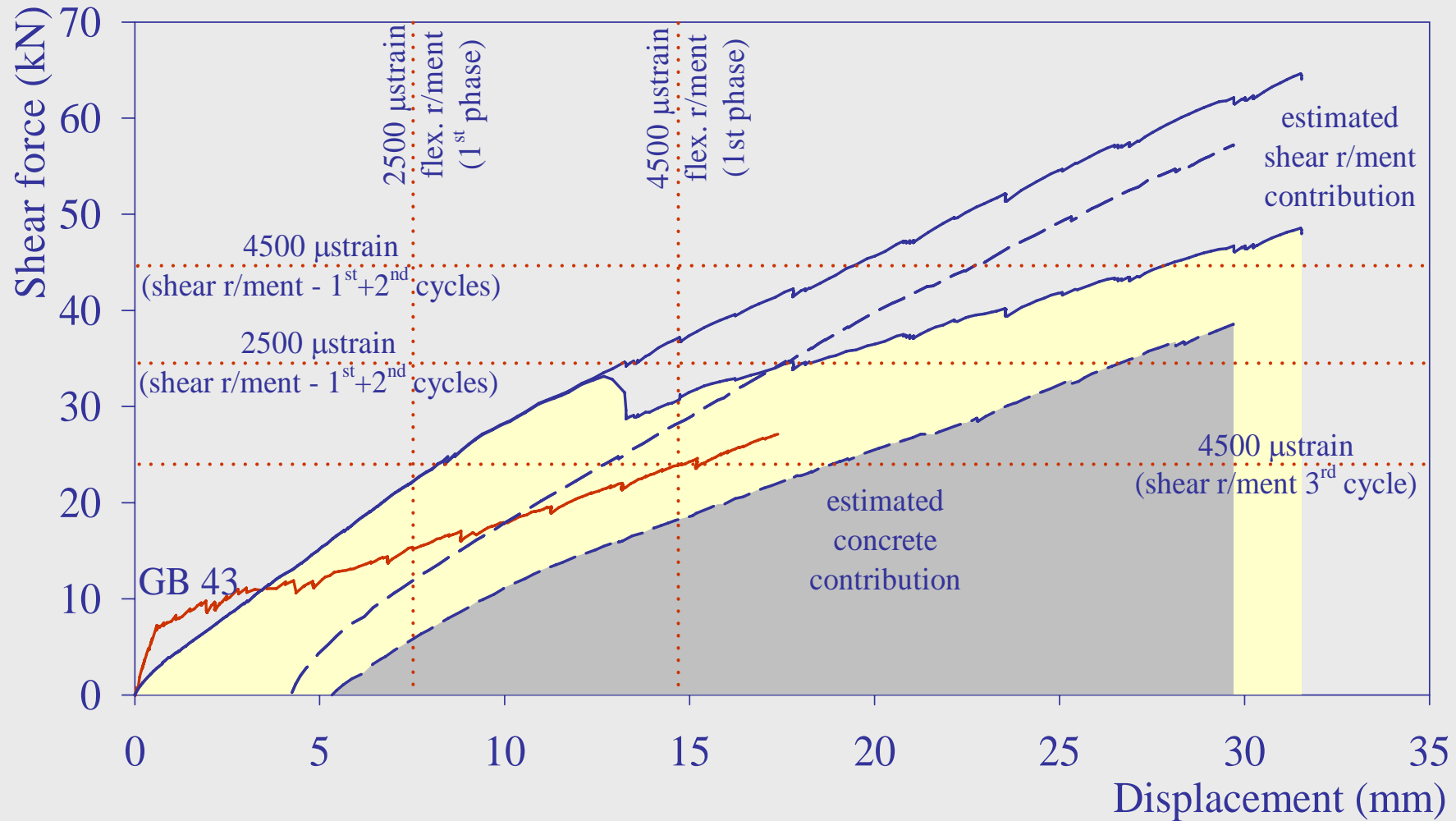


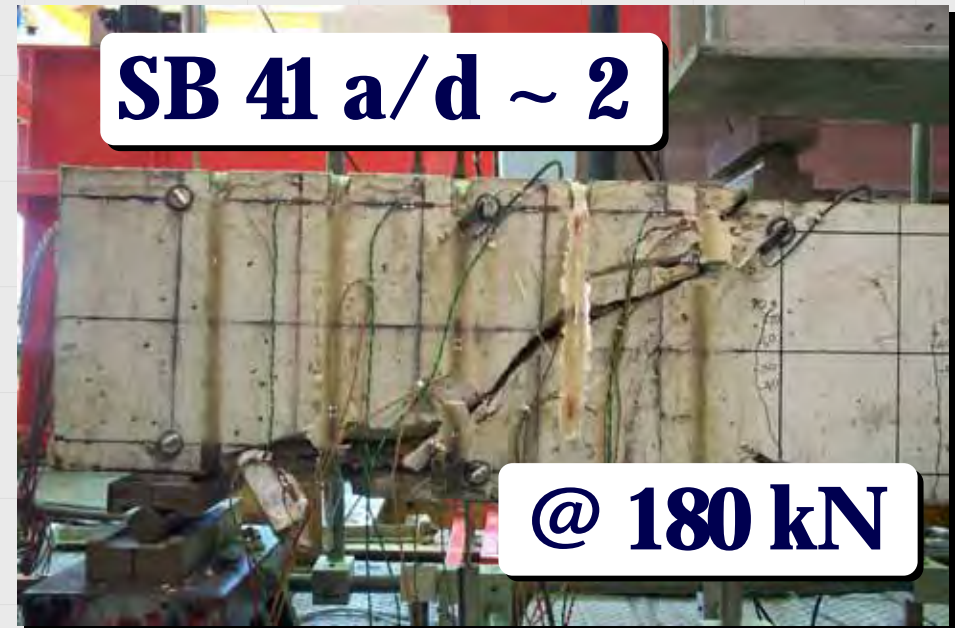


## Beam SB40R

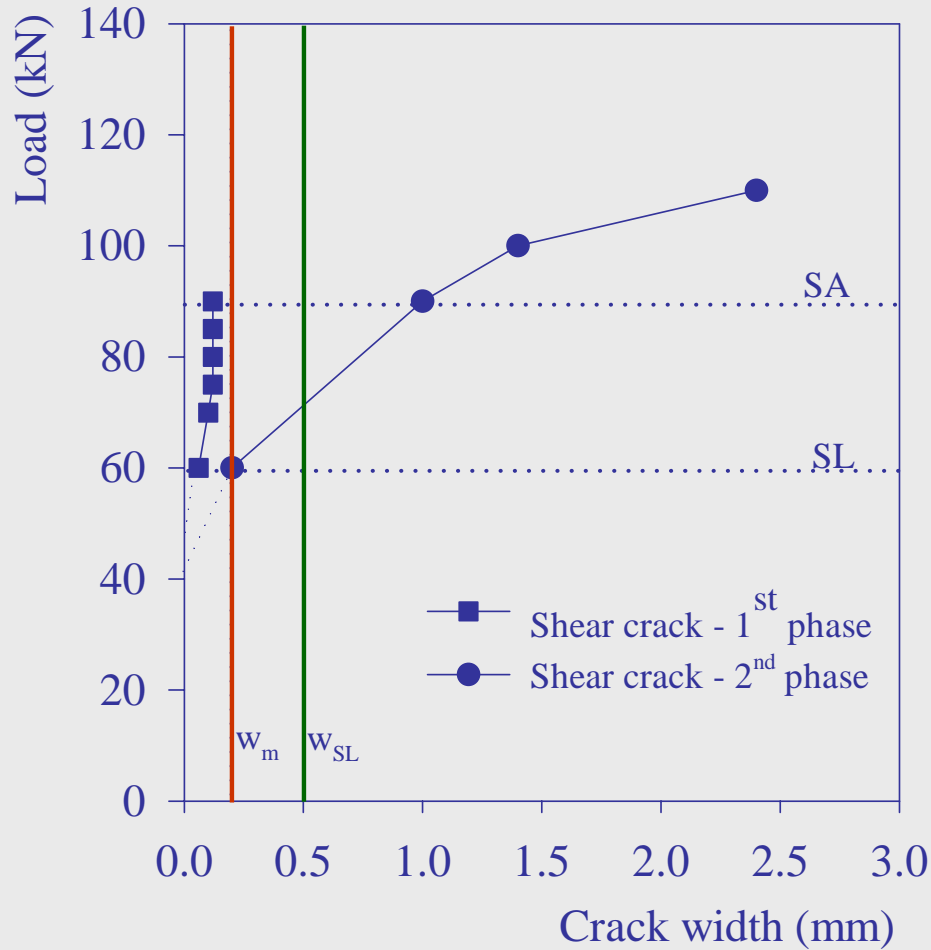


## Beam GB43R

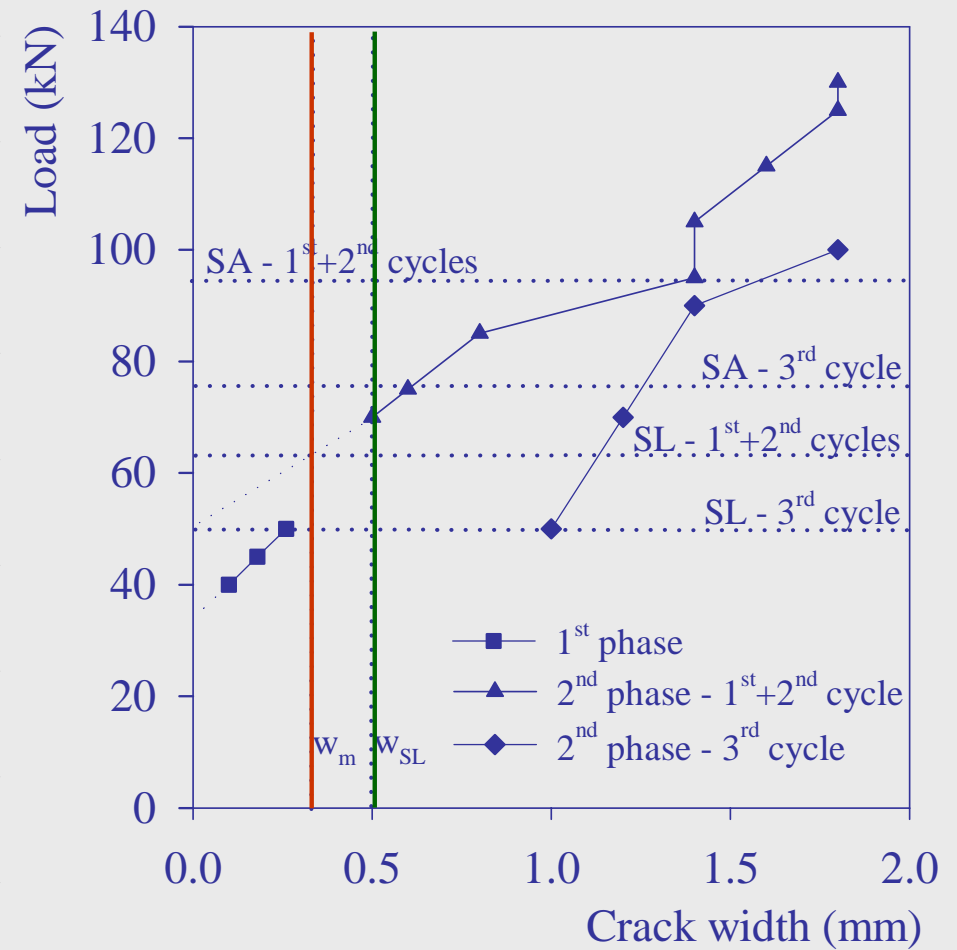


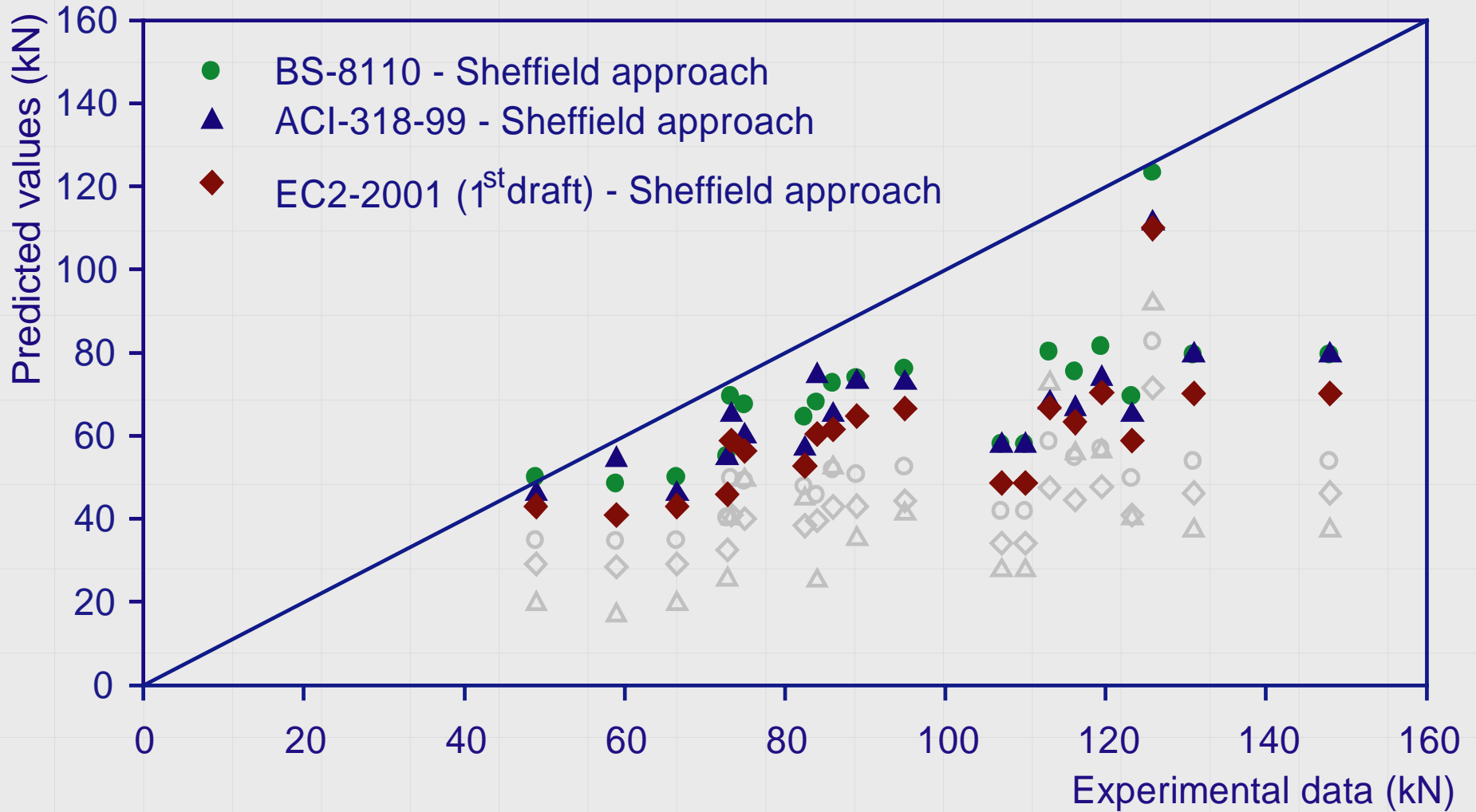


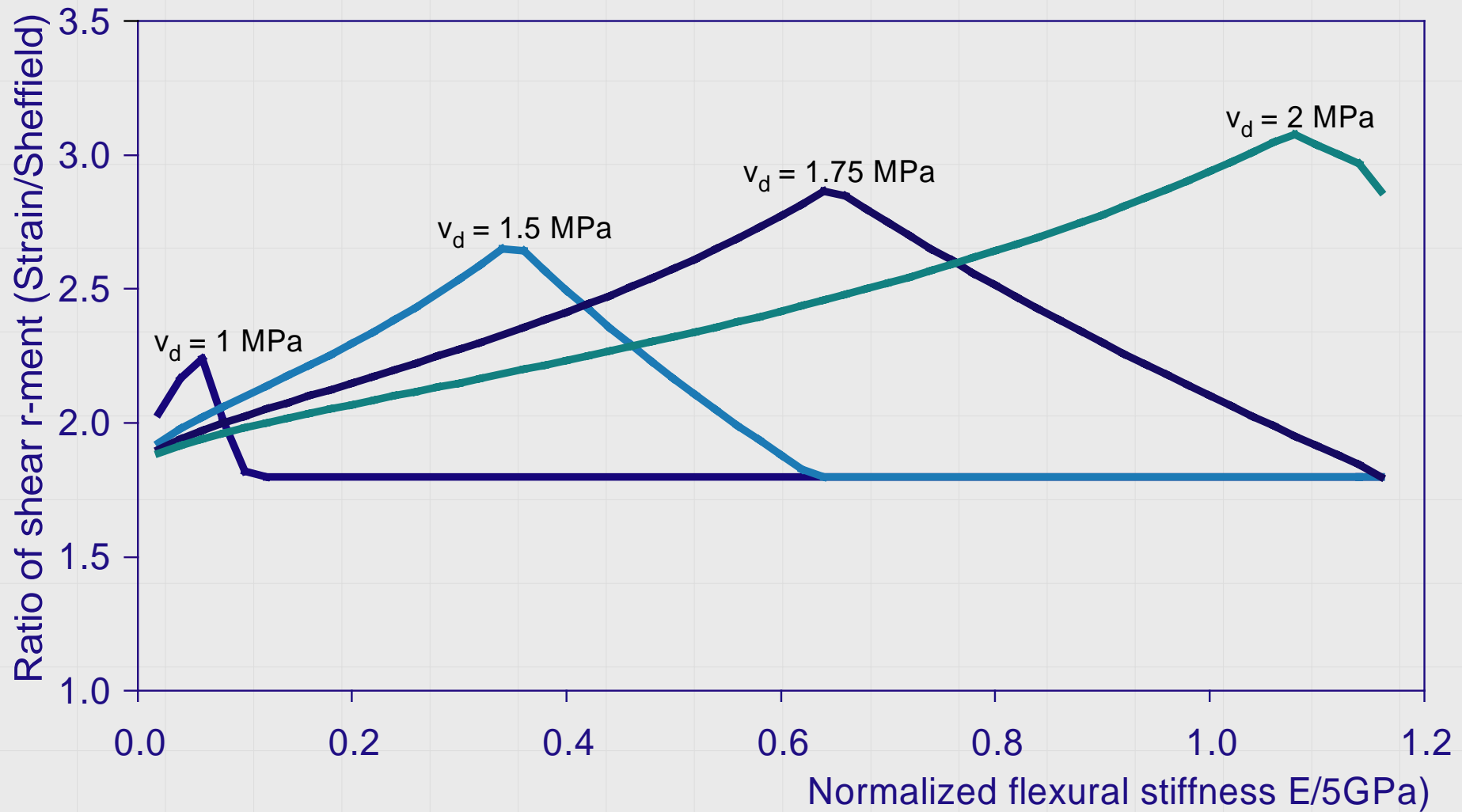
## Beam SB40/R



## Beam GB43/R







- The strain in both the flexural and shear FRP reinforcement can reach values that are much higher than those currently adopted
- Shear resisting mechanisms are mobilised in a similar way in both GFRP and steel RC beams and failure modes are characterised by similar behaviour
- The principle of strain control is accepted, but a new limit of  $4,500 \mu\epsilon$  is proposed