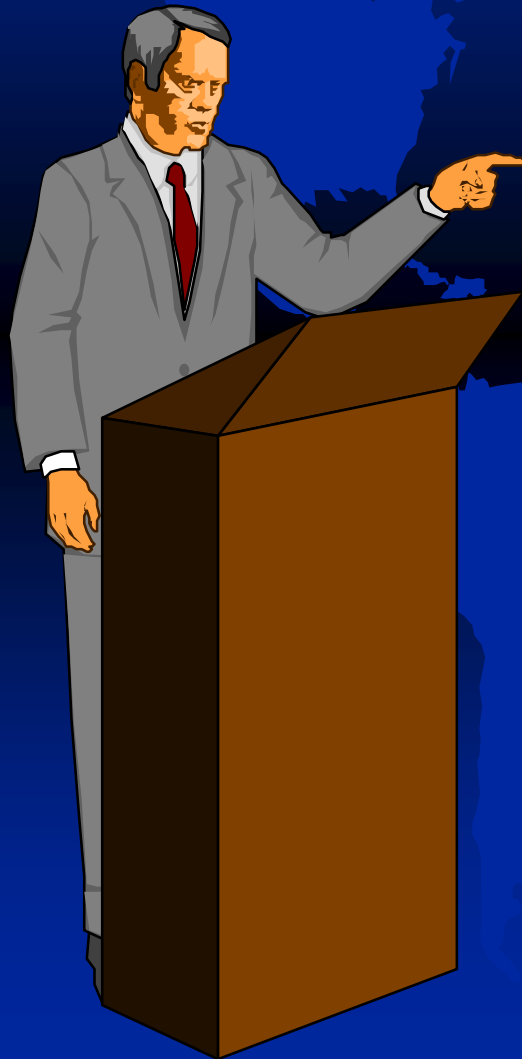




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Cement and Concrete



“FRP reinforced concrete; Cracking behaviour and determination”

Zhao W, Pilakoutas K and Waldron P

Centre for Cement and Concrete

University of Sheffield

Presented by: Dr Pilakoutas

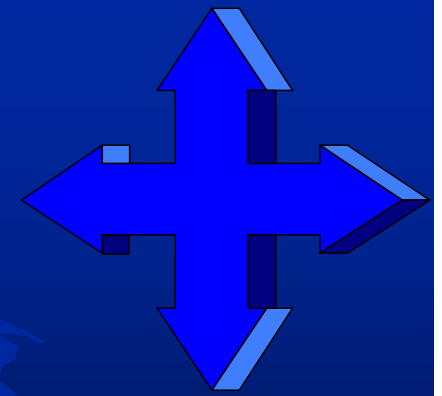
Reader - Civil & Structural Eng Department

Manager - Centre for Cement and Concrete



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OUTLINE



- ◆ **Importance of cracking**
- ◆ **Measurements**
- ◆ **Prediction**
- ◆ **Discussion**
- ◆ **Conclusion**



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Importance of Cracking

- ◆ **Early thermal Cracking**
- ◆ **Shrinkage -FRC?**
- ◆ **Flexural cracking (short term)**
- ◆ **Architectural reasons**
- ◆ **Durability**



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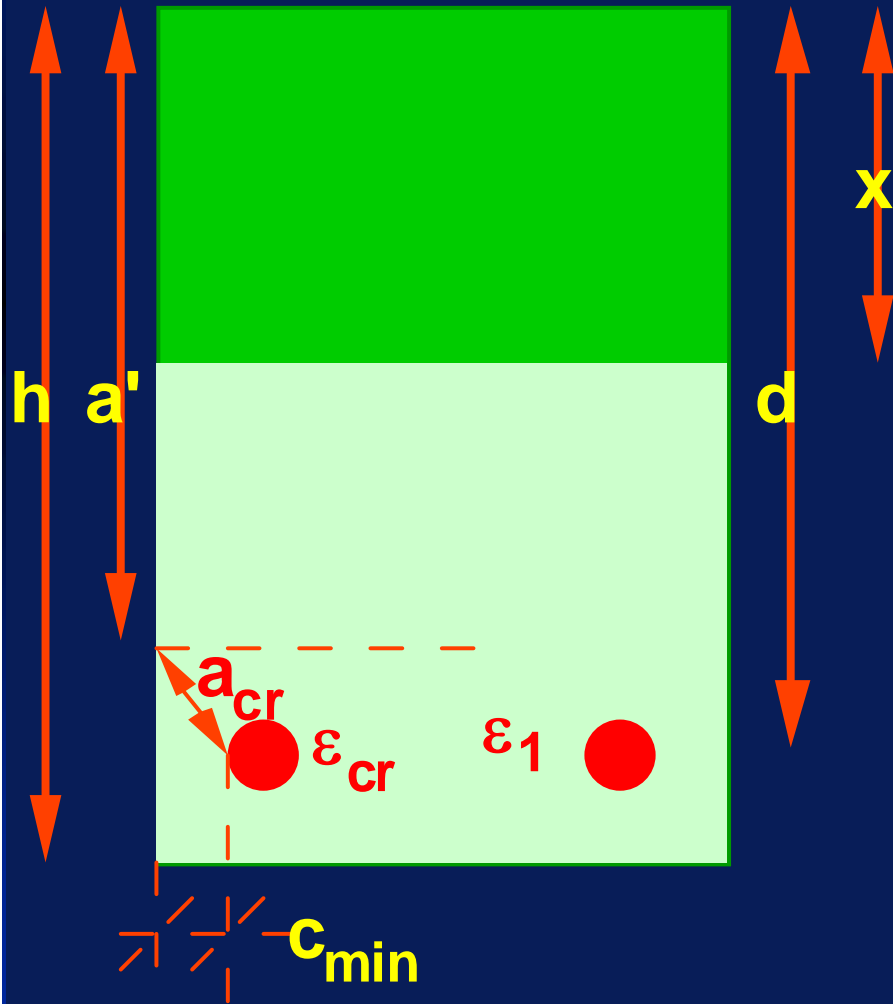
Crack width measurements

Specimen	Reinforcement details	30 kN	50 kN	70 kN	90 kN	Failure mode// load kN
GB 1	3Φ13.5	11	20	32	32	crushing//97.48
GB 2	3Φ13.5	12	18	-	-	shear//52.9
SB 3	2Φ16	6	10	15	18	flexure, steel yield//109
SB 4	2Φ8	5	-	-	-	flexure, steel yield//35.5
GB 5	3Φ13.5	11	16	19(60)	-	crushing //105.11
GB 6	3Φ13.5	8	13 (40)	-	-	shear//43.89
SB 7	2Φ16	9	10	10	10	crushing //126.48
SB 8	2Φ8	7	-	-	-	flexure, steel yield//34.9
GB 9	3Φ13.5	8	13	13	13	crushing //103.6
GB 10	3Φ13.5	8	15	17	19	crushing //103.03
GB 11	3Φ13.5	10	13	13	13	shear//97.95
GB 12	3Φ13.5	8	12	14	-	shear//133.1



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Crack width Prediction (BS8110)



$$W_{cr} = \frac{3a_{cr} \varepsilon_{cr}}{1 + 2 \frac{(a_{cr} - c_{min})}{(h - x)}}$$

$$\varepsilon_{cr} = \varepsilon_1 - \frac{b_t (h - x)(a' - x)}{3E_s A_s (d - x)}$$

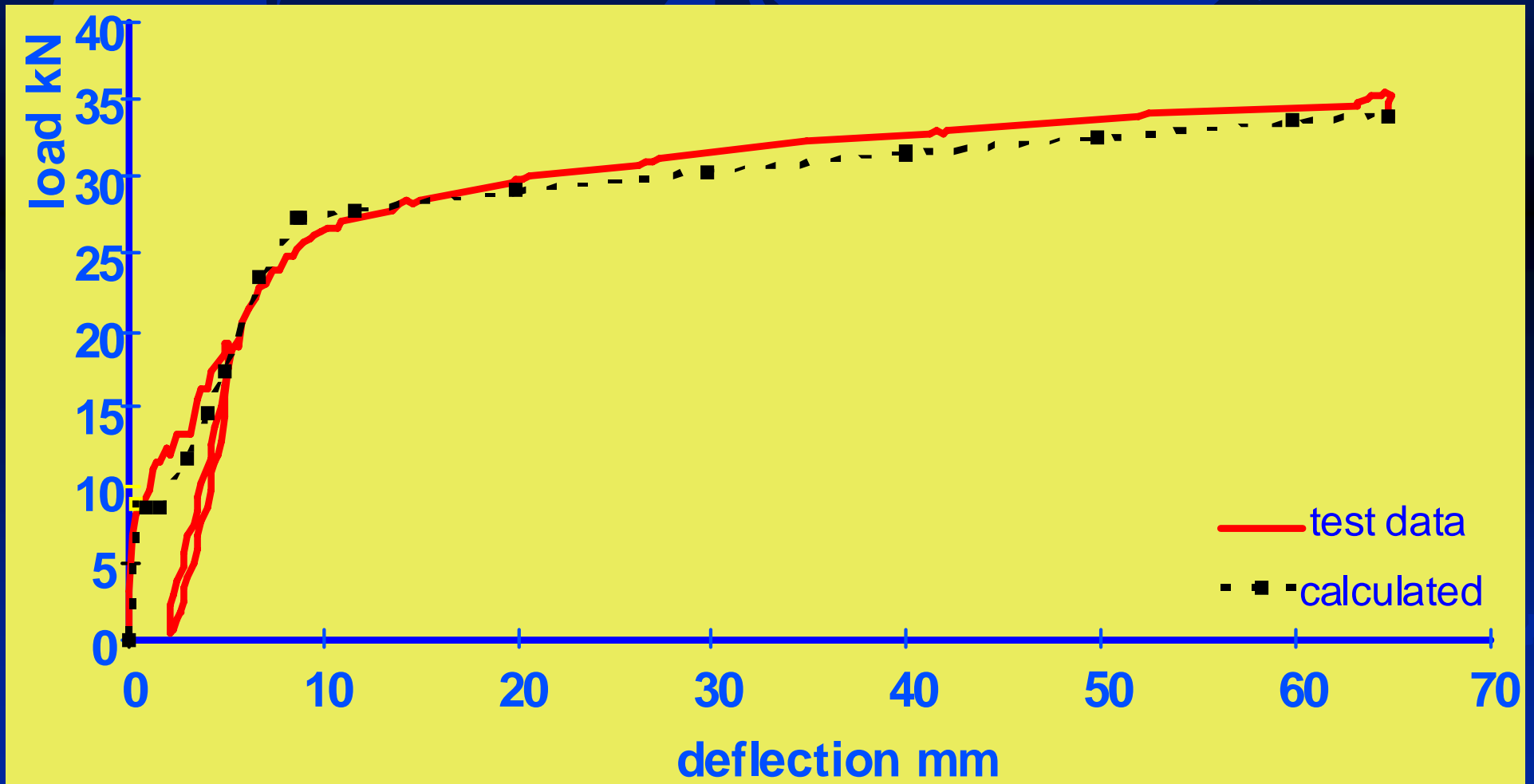
ε_1 = cracked section strain
 ε_{cr} = mean steel strain



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Load vrs Deflection

SB4 2 ϕ 8

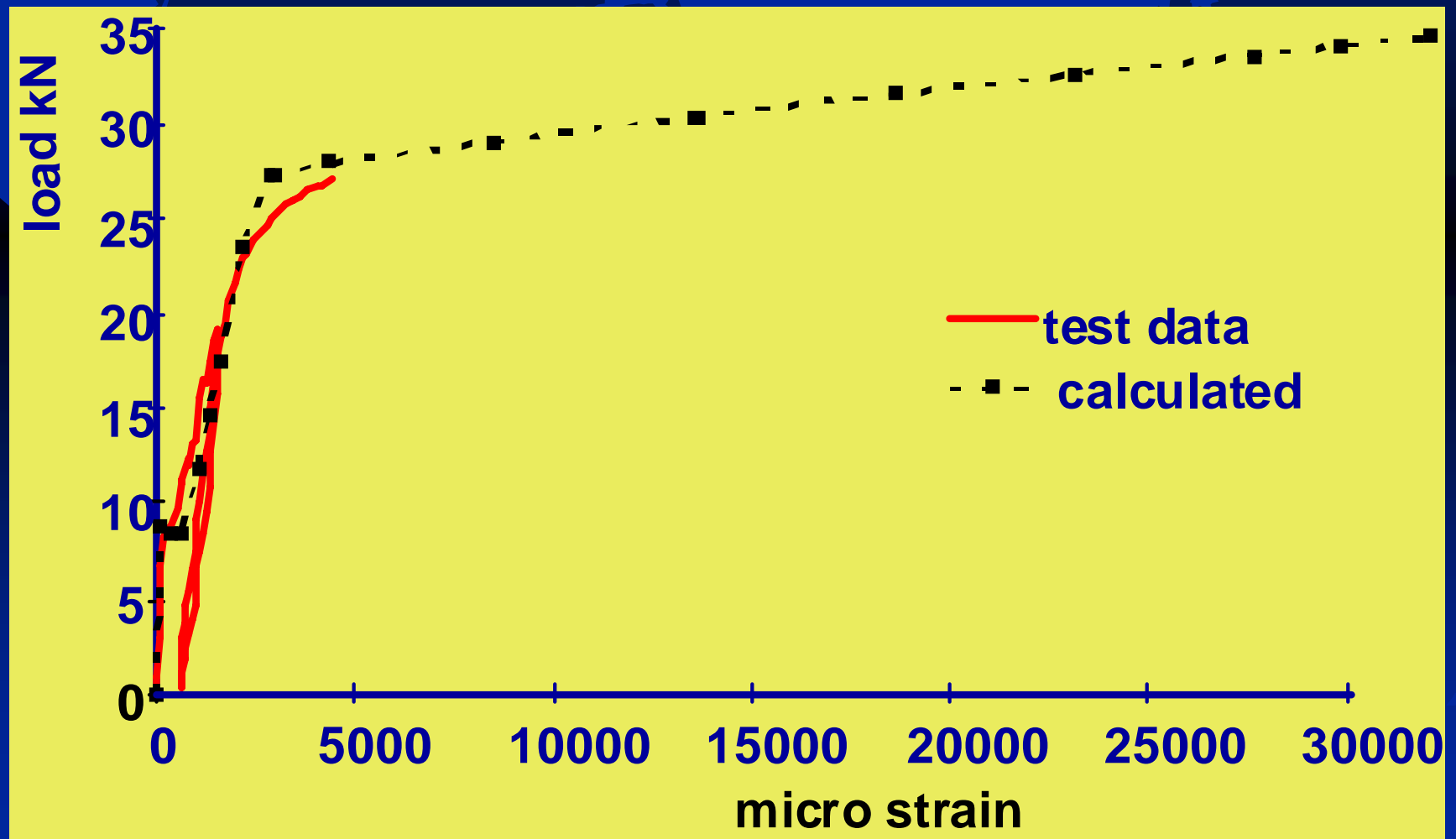




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Load vrs Steel Strain

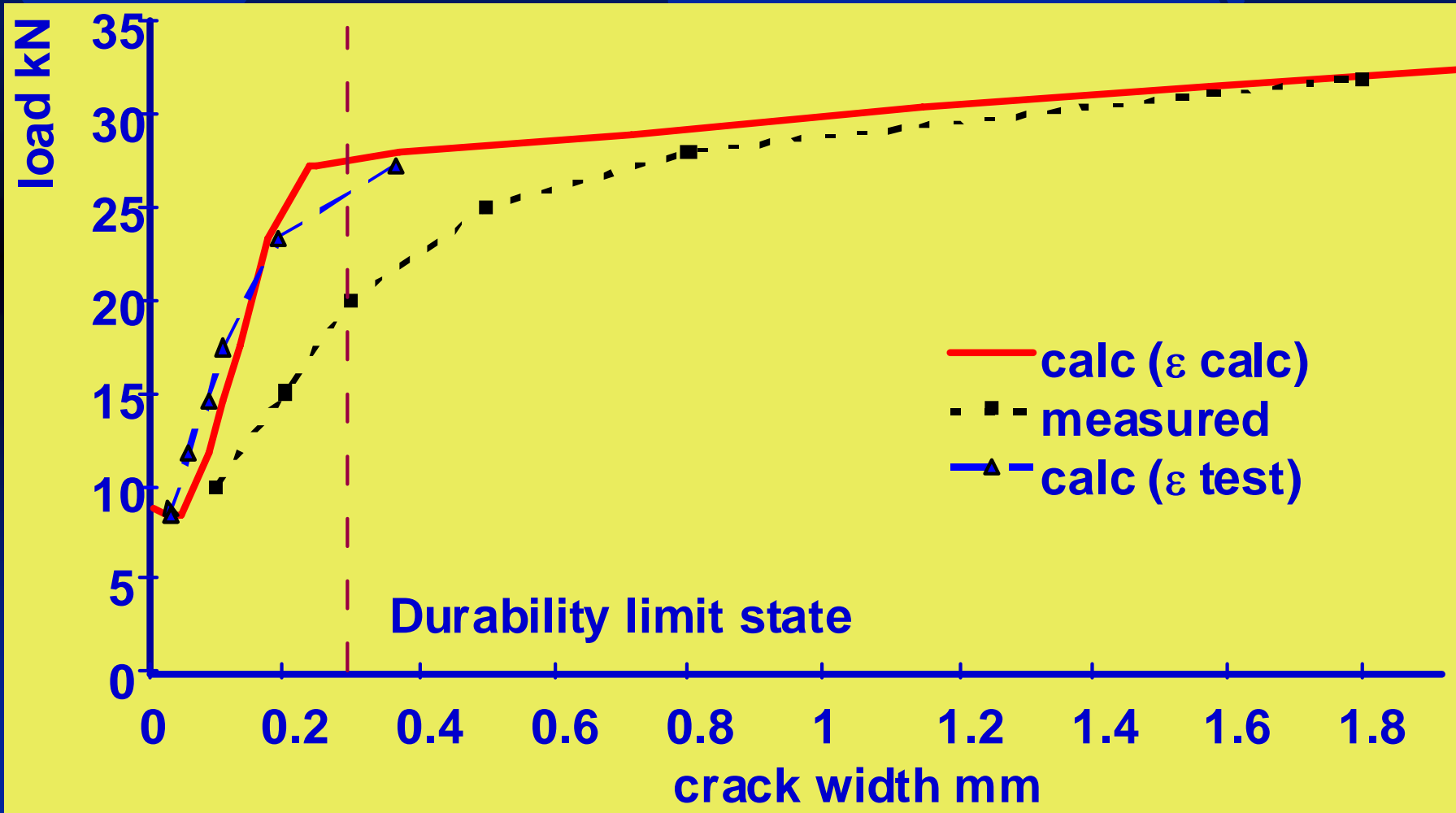
SB4 2 ϕ 8





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Load vrs Crack width SB4 2 ϕ 8

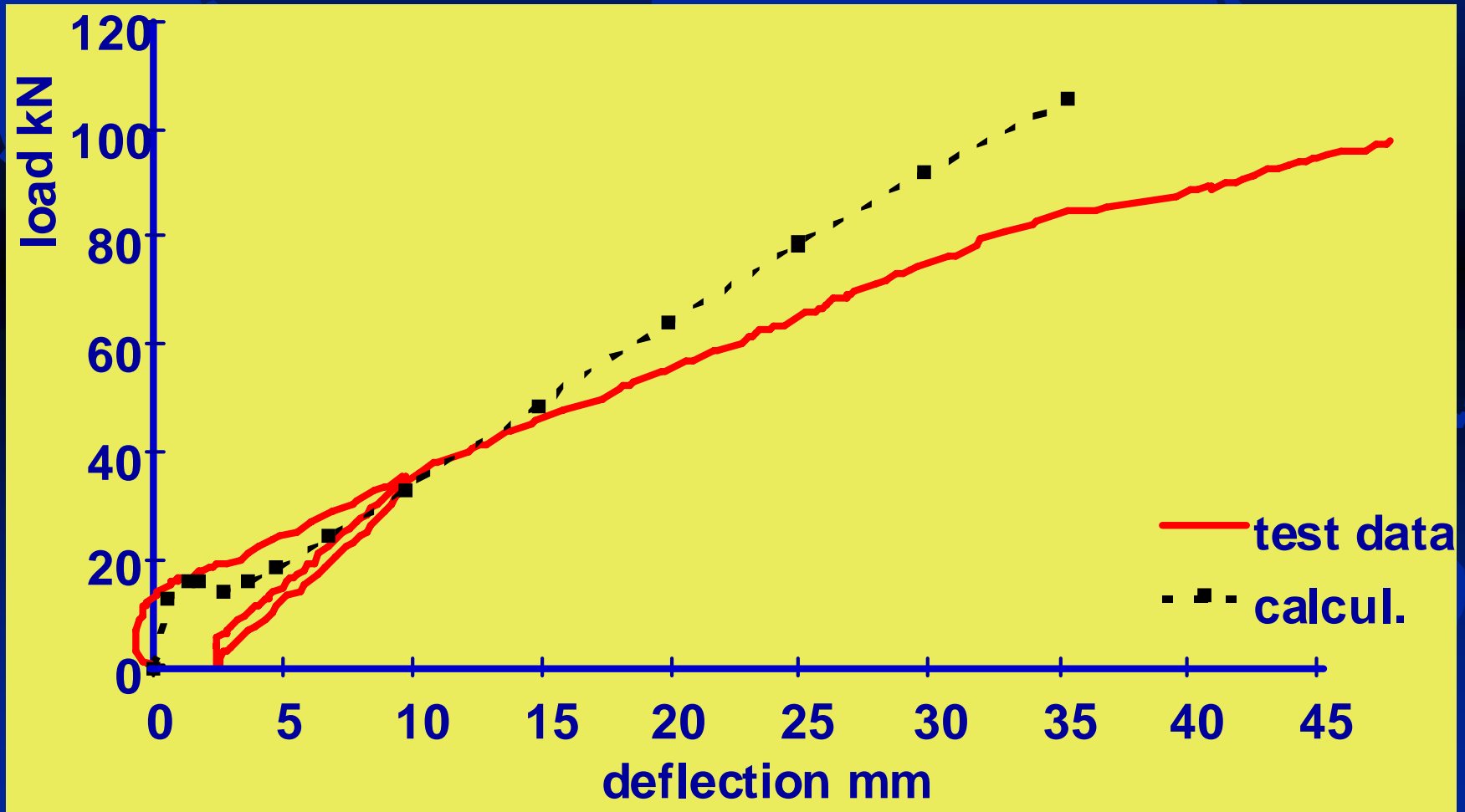




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Load vrs Deflection

GB11 3 ϕ 13.8

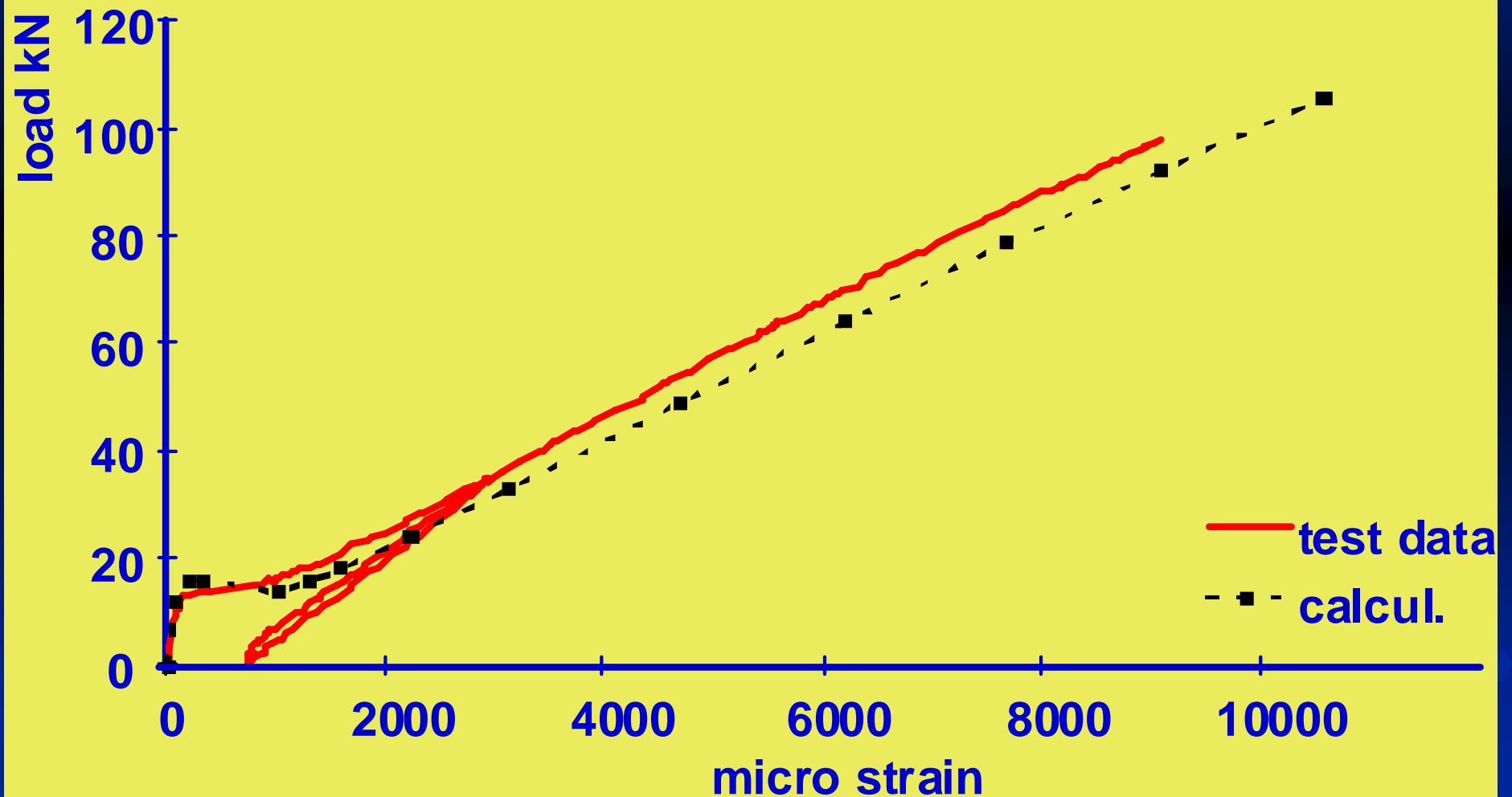




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Cement and Concrete

Load vrs Steel Strain

GB11 3 ϕ 13.8

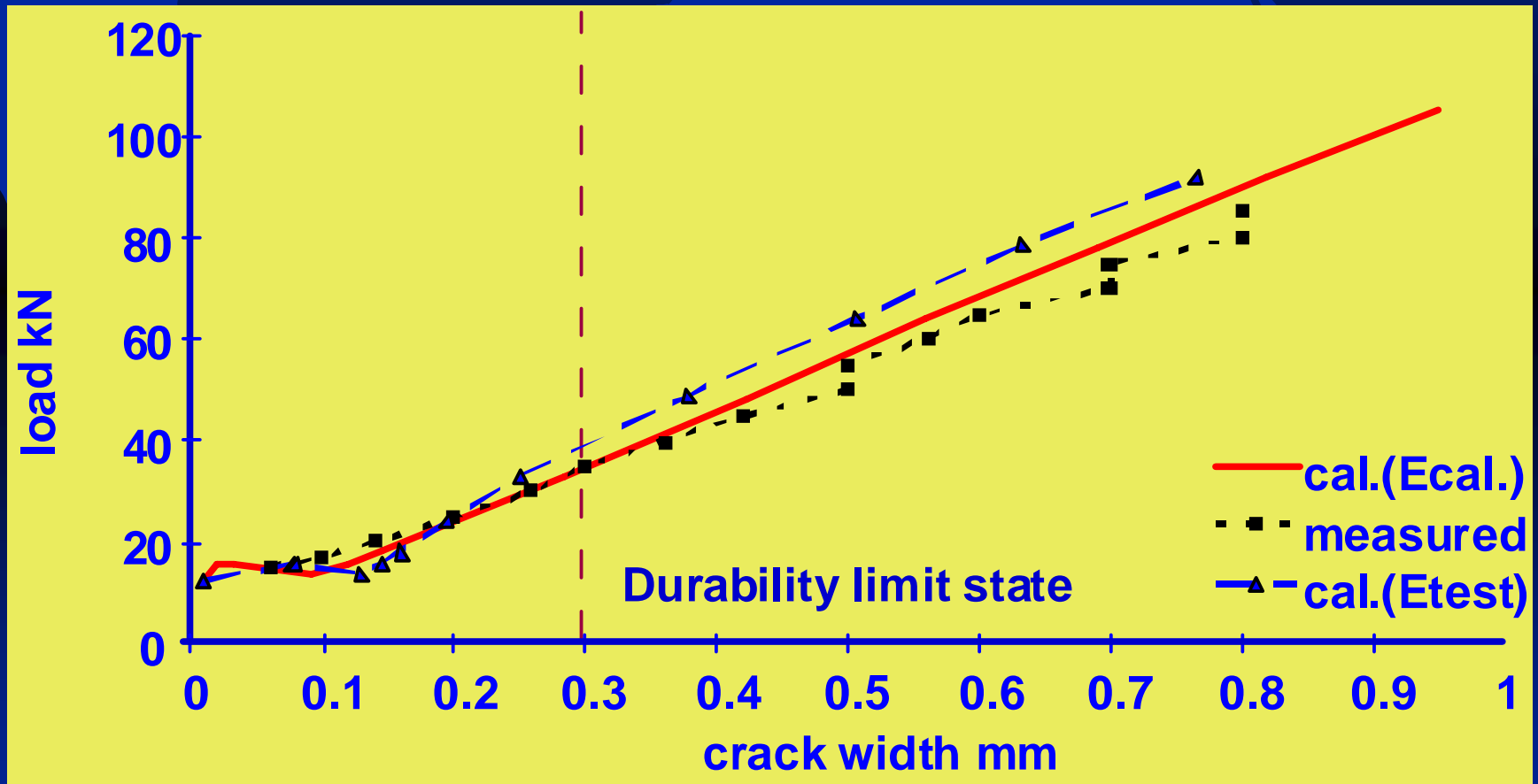




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Load vrs Crack width

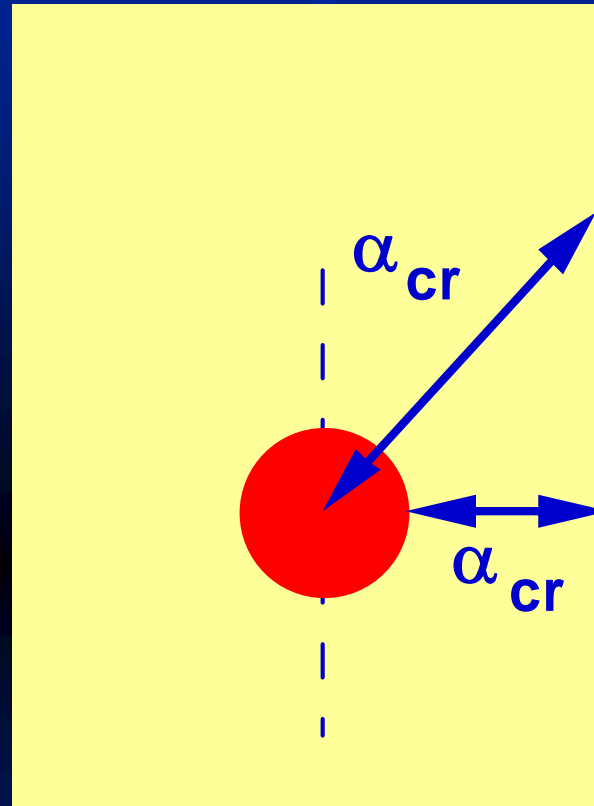
GB11 3 ϕ 13.8





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Discussion



- ◆ distance to reinforcement
- ◆ minimum cover
- ◆ effect of creep



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Conclusions

- ◆ **Crack widths are larger**
- ◆ **Spacing less**
- ◆ **Predictions adequate**
- ◆ **Other effects need to be assessed**
- ◆ **New crack width limitations**