



Structural Reliability Levels For FRP RC Structures



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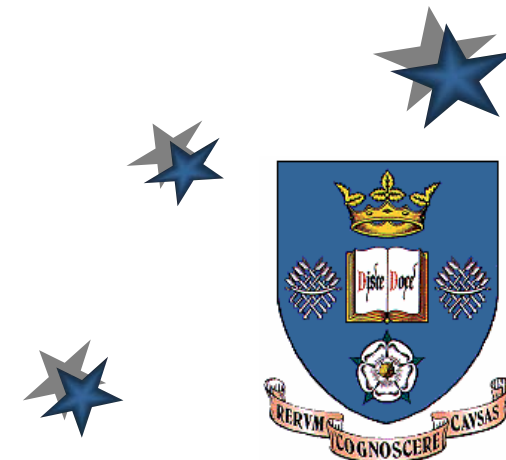
<http://www.shef.ac.uk/~tmrnet>



Outline



- ◆ **Introduction**
- ◆ **Assessment methodology**
- ◆ **Results**
- ◆ **Conclusions**



Introduction

- ◆ **EU TMR network “ConFibreCrete”**
fib Task Group 9.3
- ◆ **DSP of existing FRP RC design guidelines not clear**
- ◆ **FRP RC differs from steel RC**

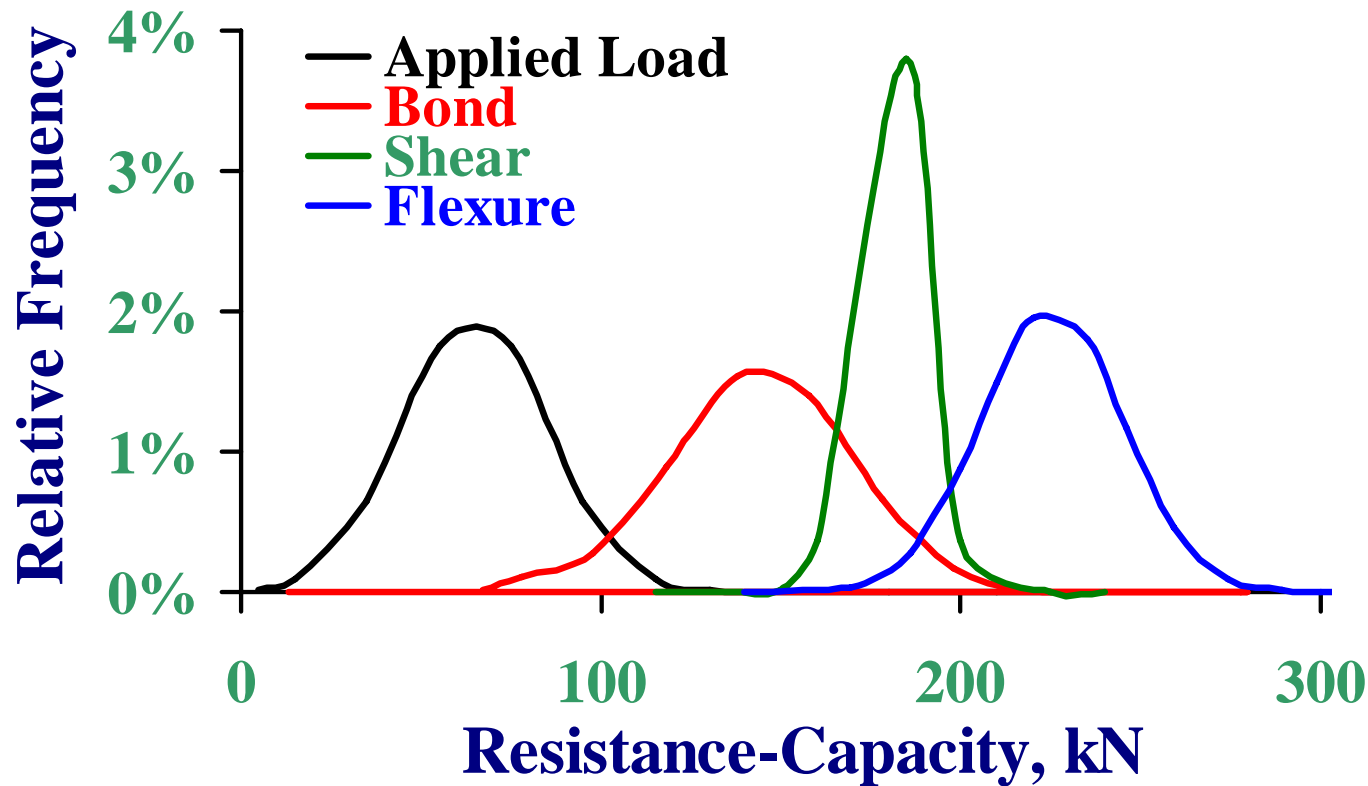


Concrete Crushing



Bar Fracture

Introduction



- ◆ Notional structural reliability levels (P_f) for FRP RC beams for given γ_m unknown

Assessment Methodology

◆ Assessment of flexural and shear P_f



GB1: Flexure



GB2: Shear

◆ Eurocrete resistance-capacity models

Flexure: Strain Control

$$\varepsilon_{FRP} * E_{FRP} \geq f_{FRP} / \gamma_{FRP}$$

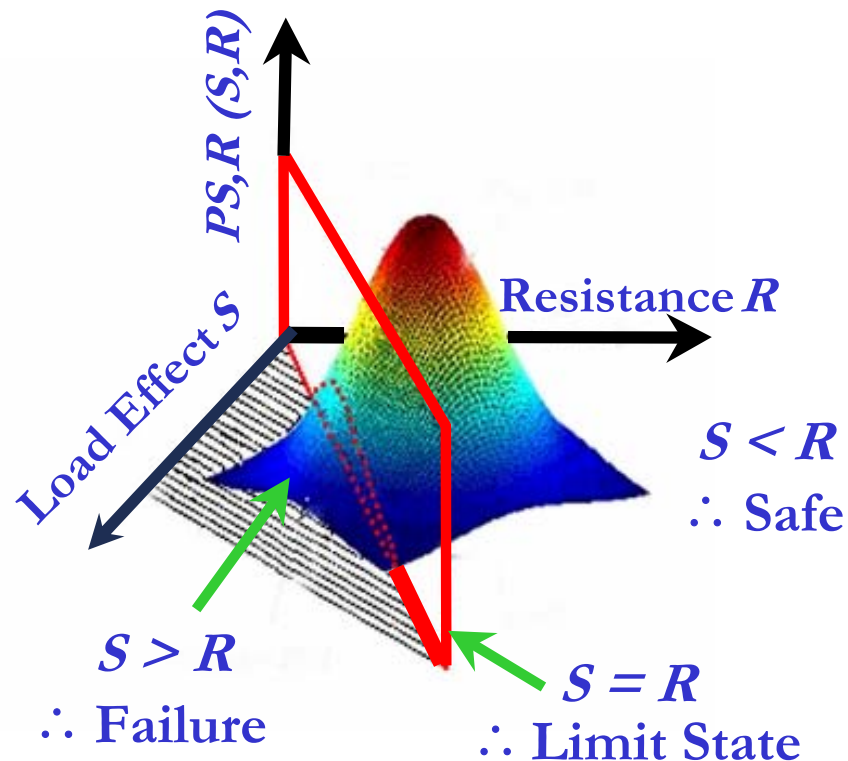
Shear: Modified reinforcement ratio

$$\rho^e = \rho * E_{FRP} / E_{steel}$$

Assessment Methodology

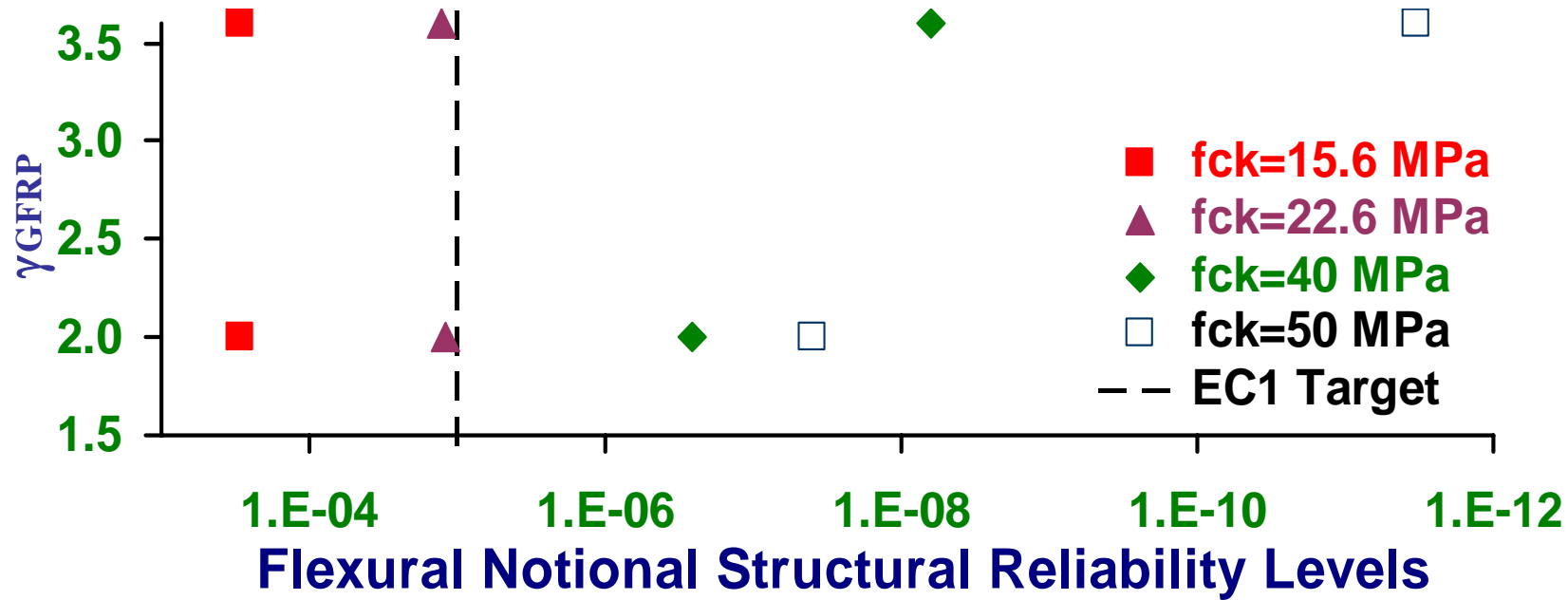
◆ Structural reliability assessment:

Monte Carlo Simulation method
with **Latin Hypercube** and
Conditional Expectation
variance reduction
techniques



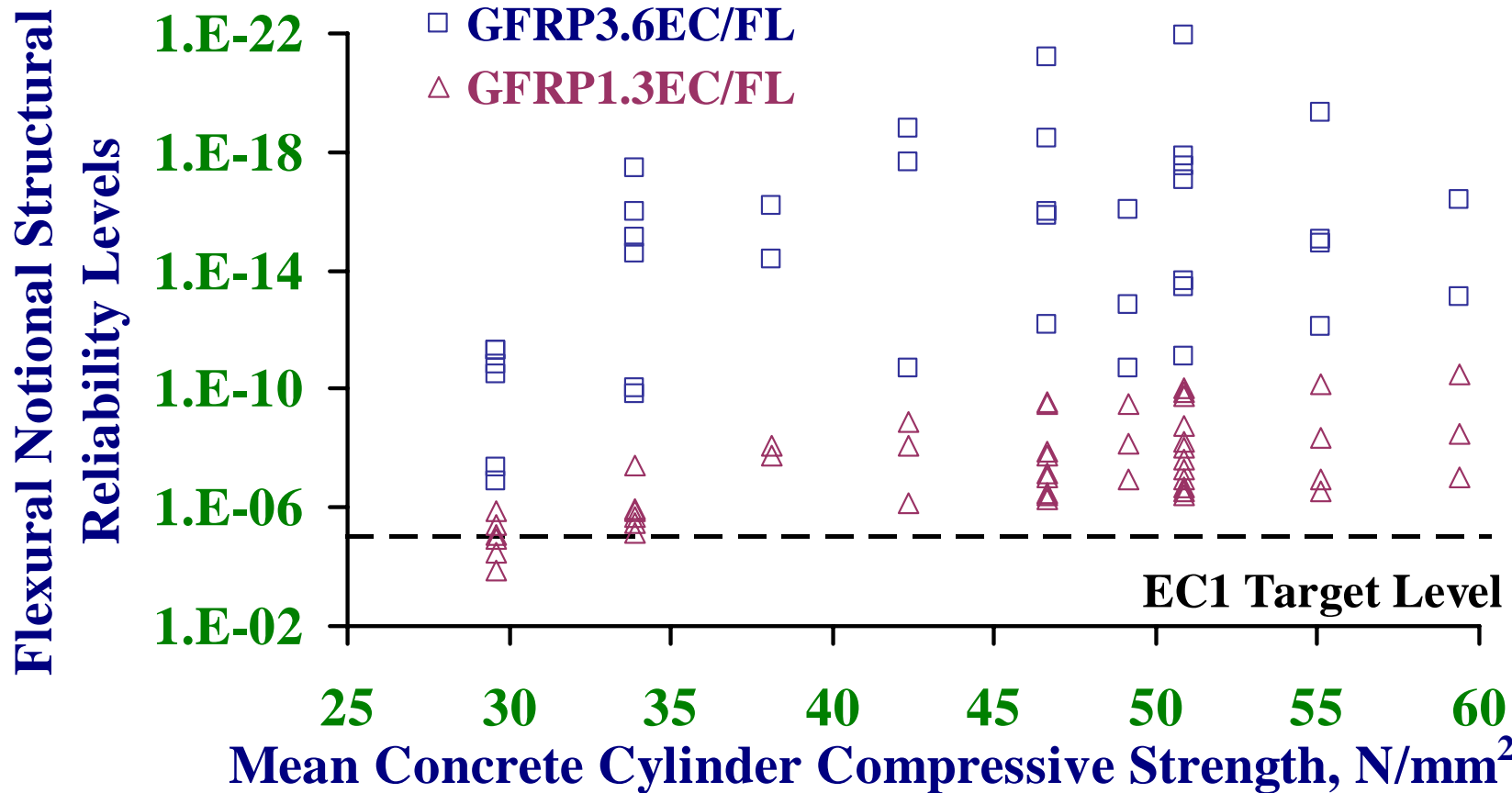
Flexural Results

◆ P_f decreases as f_{cy} increases



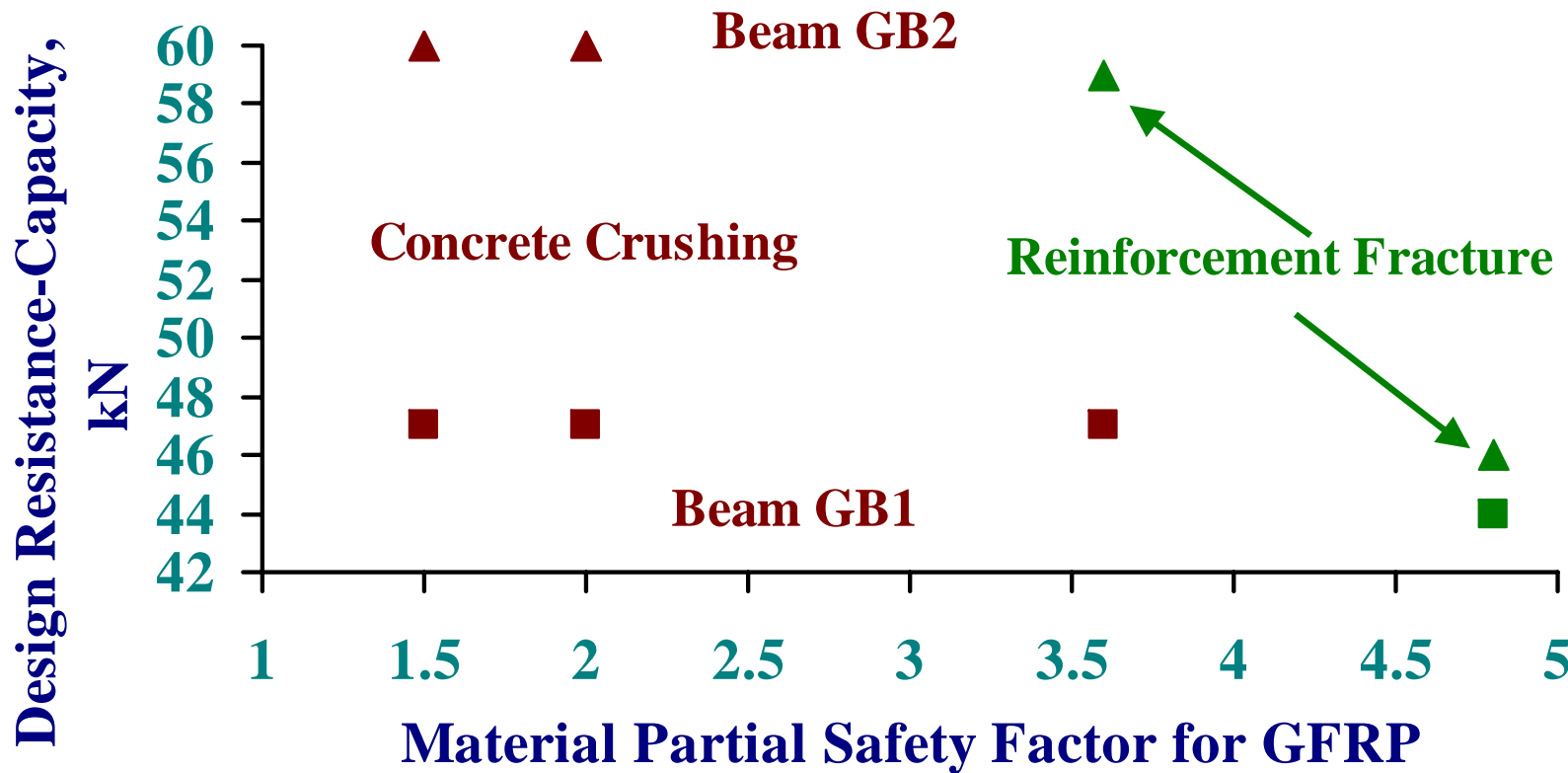
Flexural Results

- ◆ Most P_f conform to EC1 target P_f



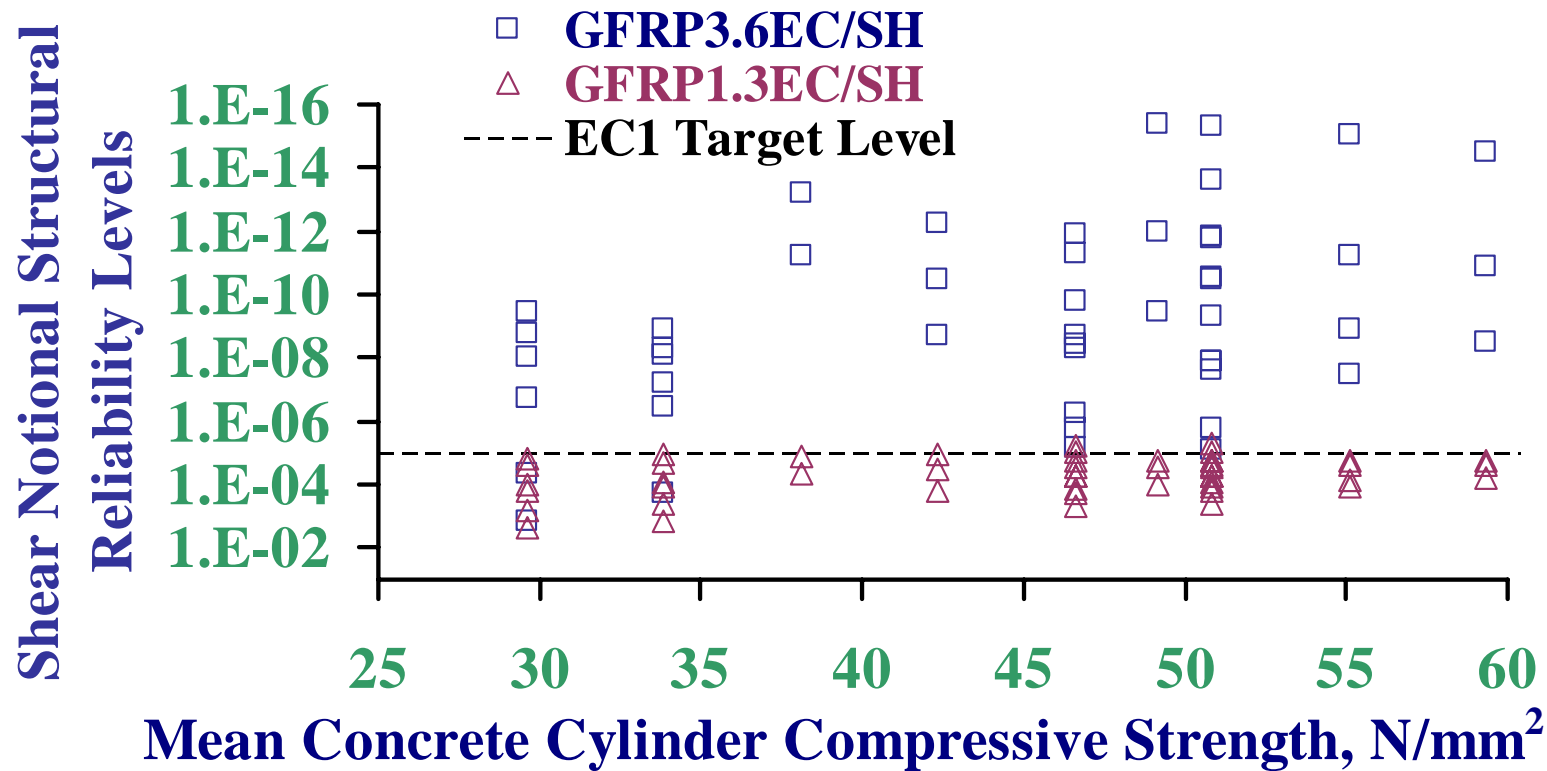
Flexural Results

- ◆ γ_{GFRP} does not affect design capacity
- ◆ Use of γ_{GFRP} may not lead to the desired type of flexural failure



Shear Results

◆ P_f for high γ_{GFRP} conform to the EC1 target P_f

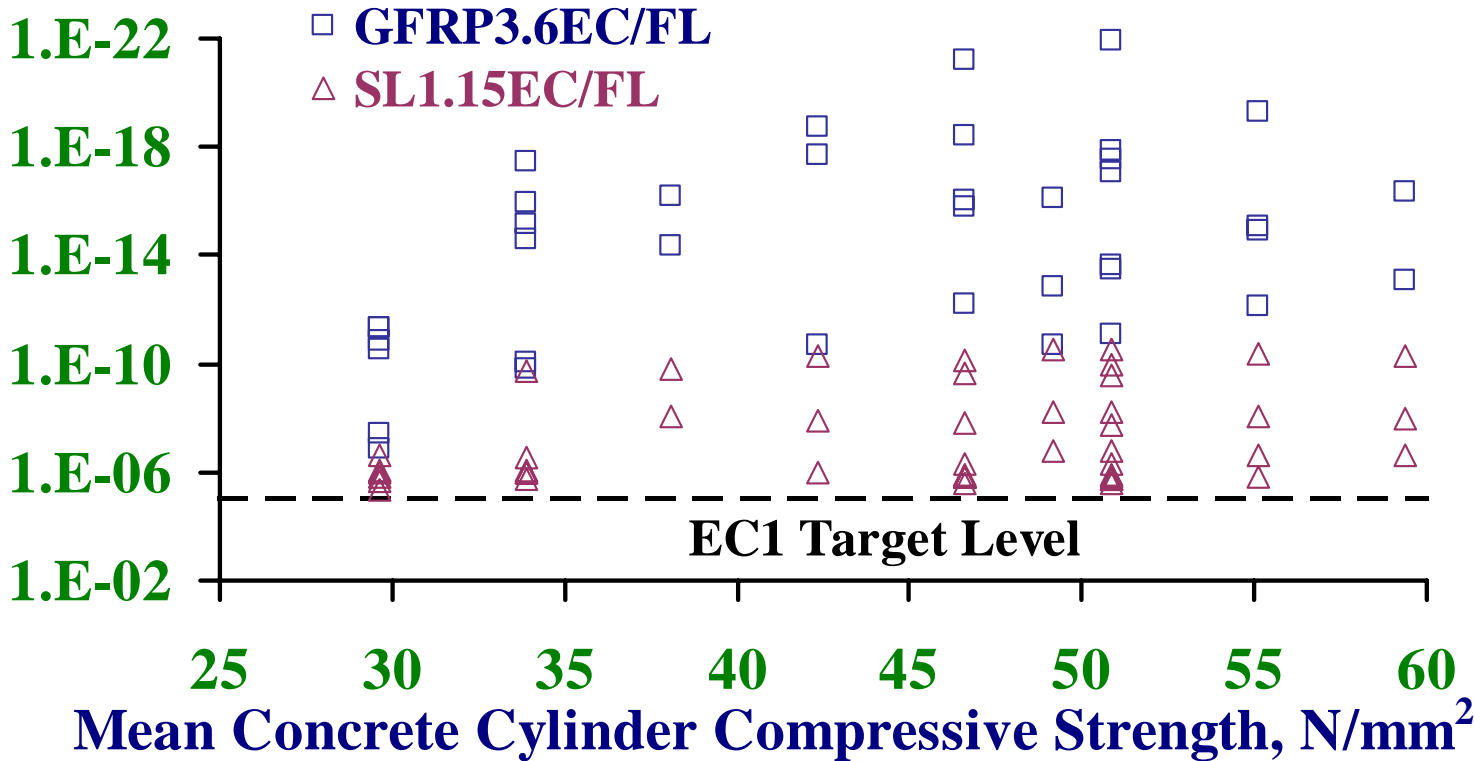




Comparison of Steel - Glass Flexural Results

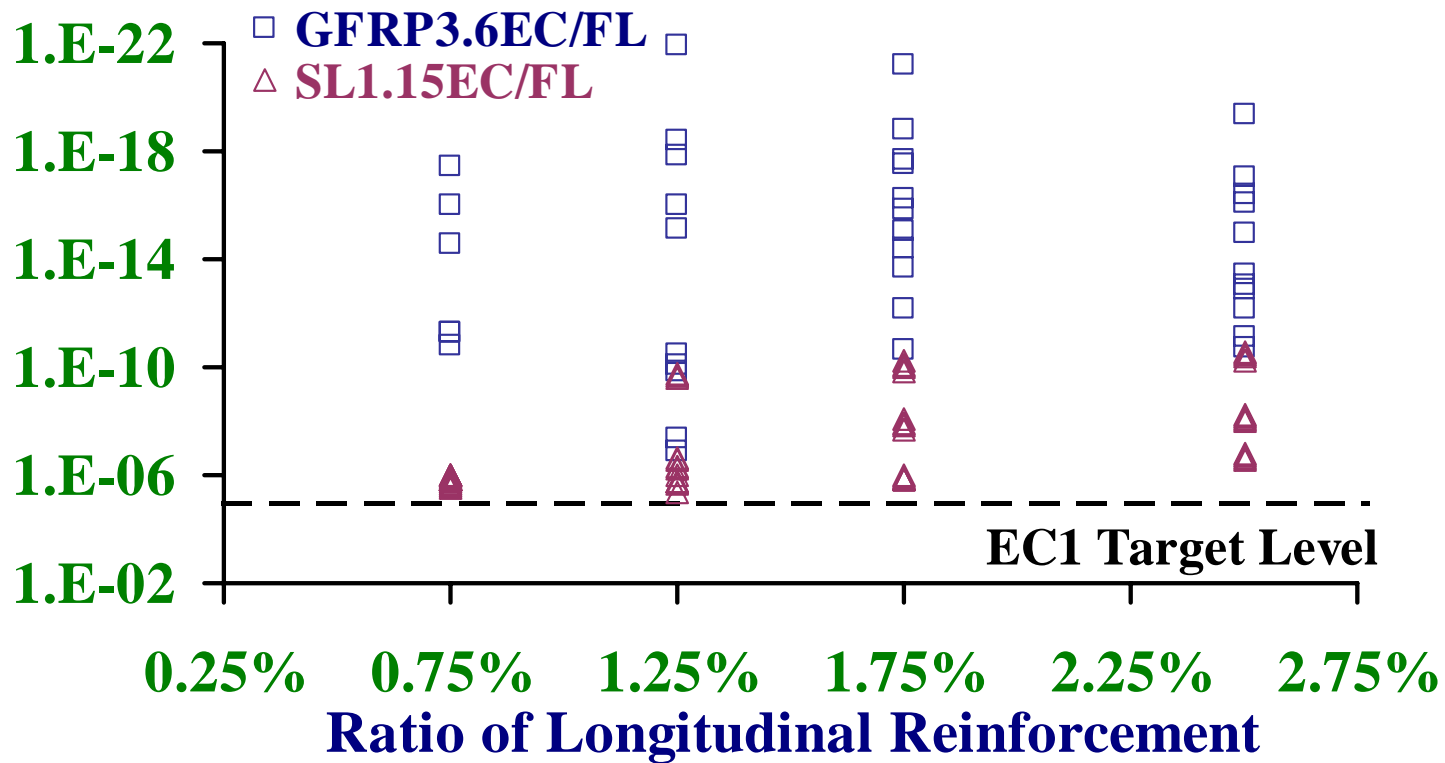


Flexural Notional Structural Reliability Levels



Comparison of Steel - Glass Flexural Results

Flexural Notional Structural
Reliability Levels



New Design and Safety Philosophy (DSP)



◆ Use of γ_i and design restrictions:

Primary Failure Mode	Bond	Flexure reinforcement	Flexure concrete	Shear concrete	Shear reinforcement
Bond	1.2^1	1.8^3	1.5^2	1.5^4	2^5
Flexure reinforcement	1.4^5	1.6^1	1.5^2	1.5^3	2^4
Flexure concrete	1.4^3	1.8^4	1.25^1	1.5^2	2^5
Shear concrete	1.4^2	1.8^4	1.5^3	1.25^1	2^5
Shear reinforcement	1.4^3	1.8^2	1.5^4	1.5^5	1.5^1

(Possible FMH)



Conclusions



- ◆ Design should differ as mechanical behaviour differs

- ◆ New DSP required:

Attainment of failure mode hierarchy and target P_f

- ◆ Define appropriate material partial safety factors

