COST Action TU1207

Next Generation Design Guidelines for Composites in Construction

FRP-confined rubberised concrete

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Why rubberised concrete?

- 2.9 billion tyres discarded every year
- Tyres in landfills: major health & environmental risks
- Tyres are made of high quality materials >>> vulcanised rubber, steel and textile reinforcement

- Lightweight
- Higher energy absorption, fatigue resistance and vibration damping capacity
- Higher deformability and ductility compared to conventional concrete (ε_{cu}>>>3500$\mu\varepsilon$)

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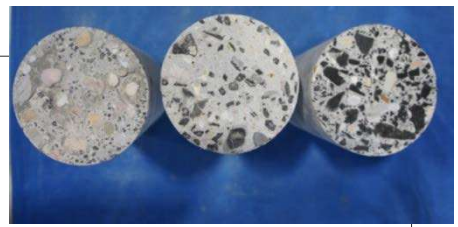
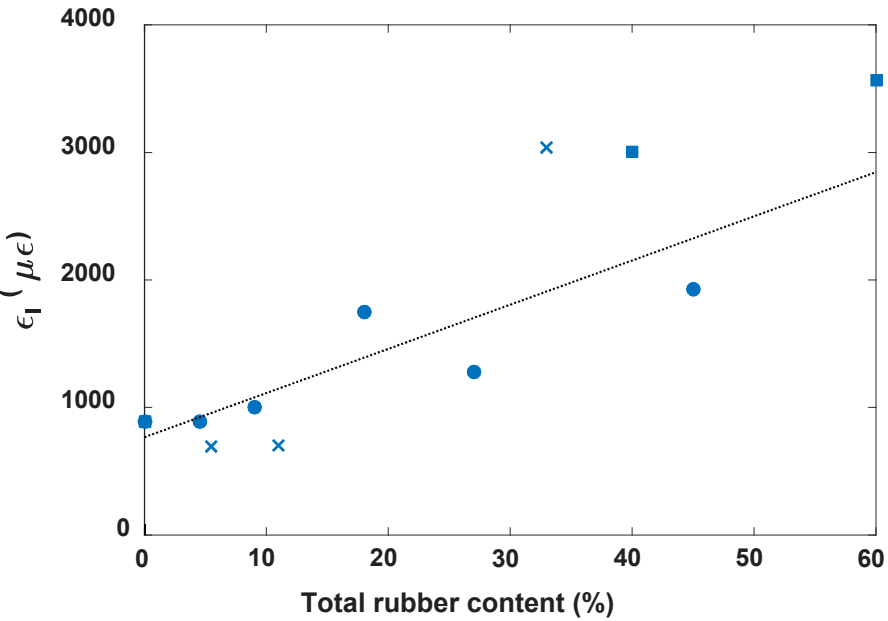
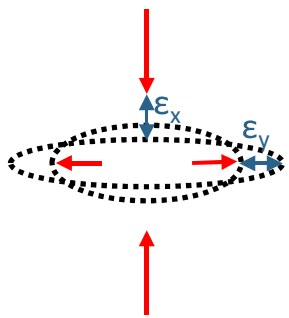
Rubberised concrete





Main reasons behind reduced strength:

- Softness and high Poisson ratio of rubber
- Weak rubber-cement paste bond
- High mix air content
- Segregation and non-homogeneity



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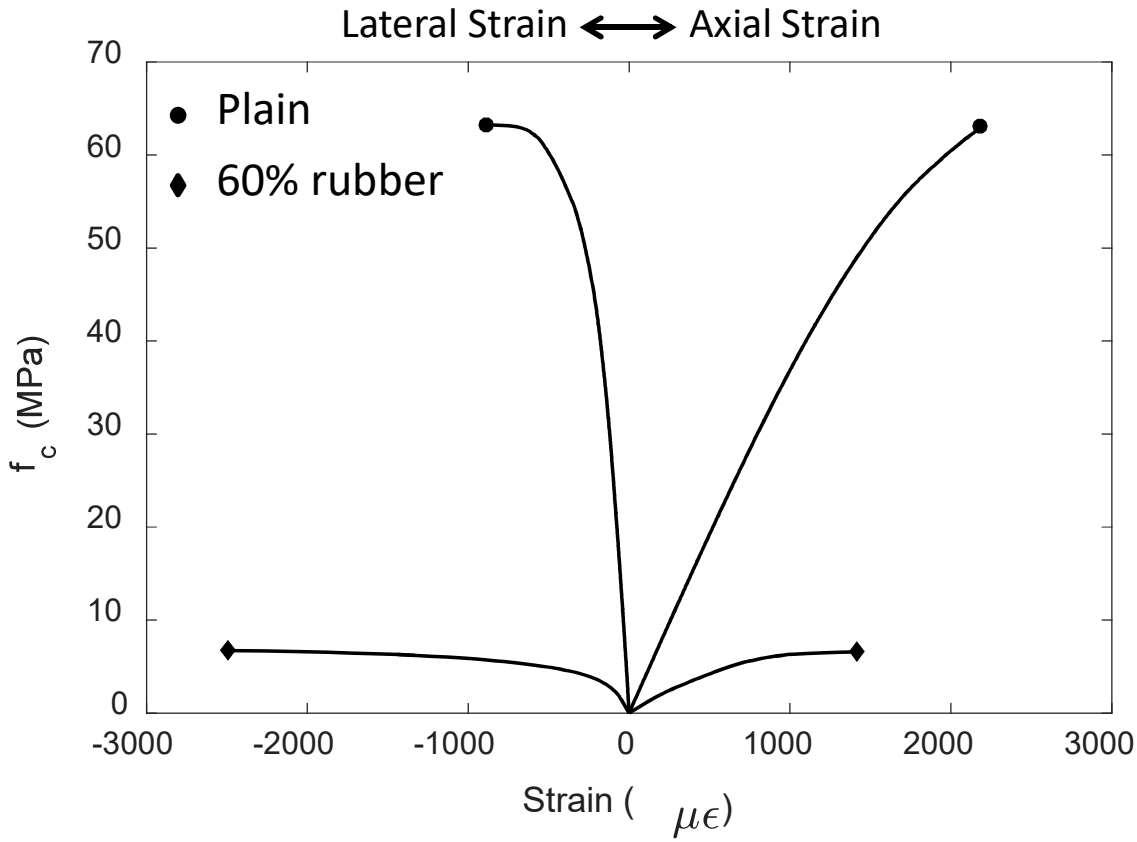
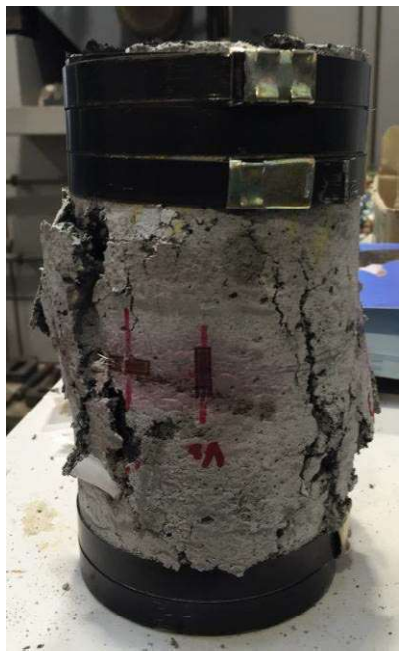
Rubberised concrete





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Experimental programme

- **Rubber content:**
  60% total aggregate replacement
- **Cylinders wrapped with 2,3,4 layers AFRP**
  (5 cylinders per parameter)

E (GPa)	Mean tensile strength (MPa)	Ultimate strain capacity (%)	Thickness (mm)
120	2400	2.5	0.2

Material properties of AFRP sheets (dry)

Top view of RuC cylinder (60% rubber)

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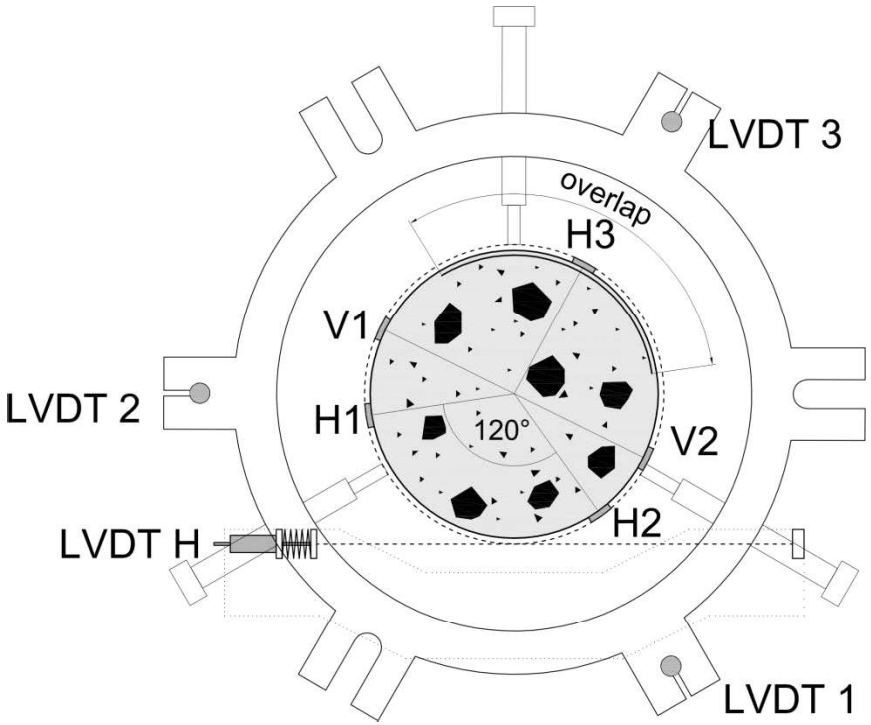
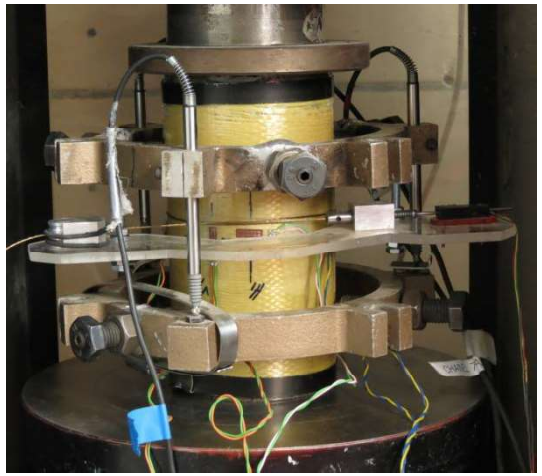
Instrumentation

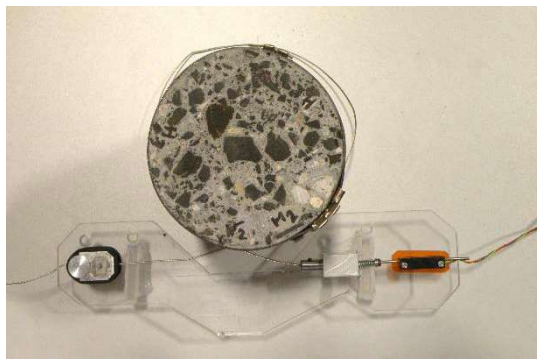
H → Horizontal strain gauge

V → Vertical strain gauge





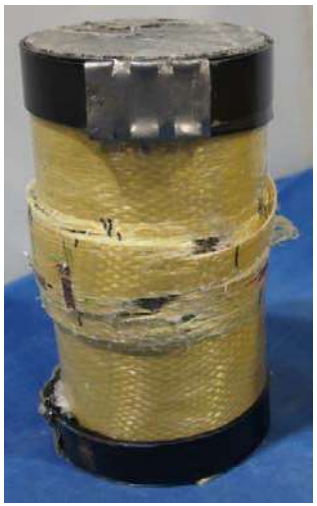
Typical view of test setup

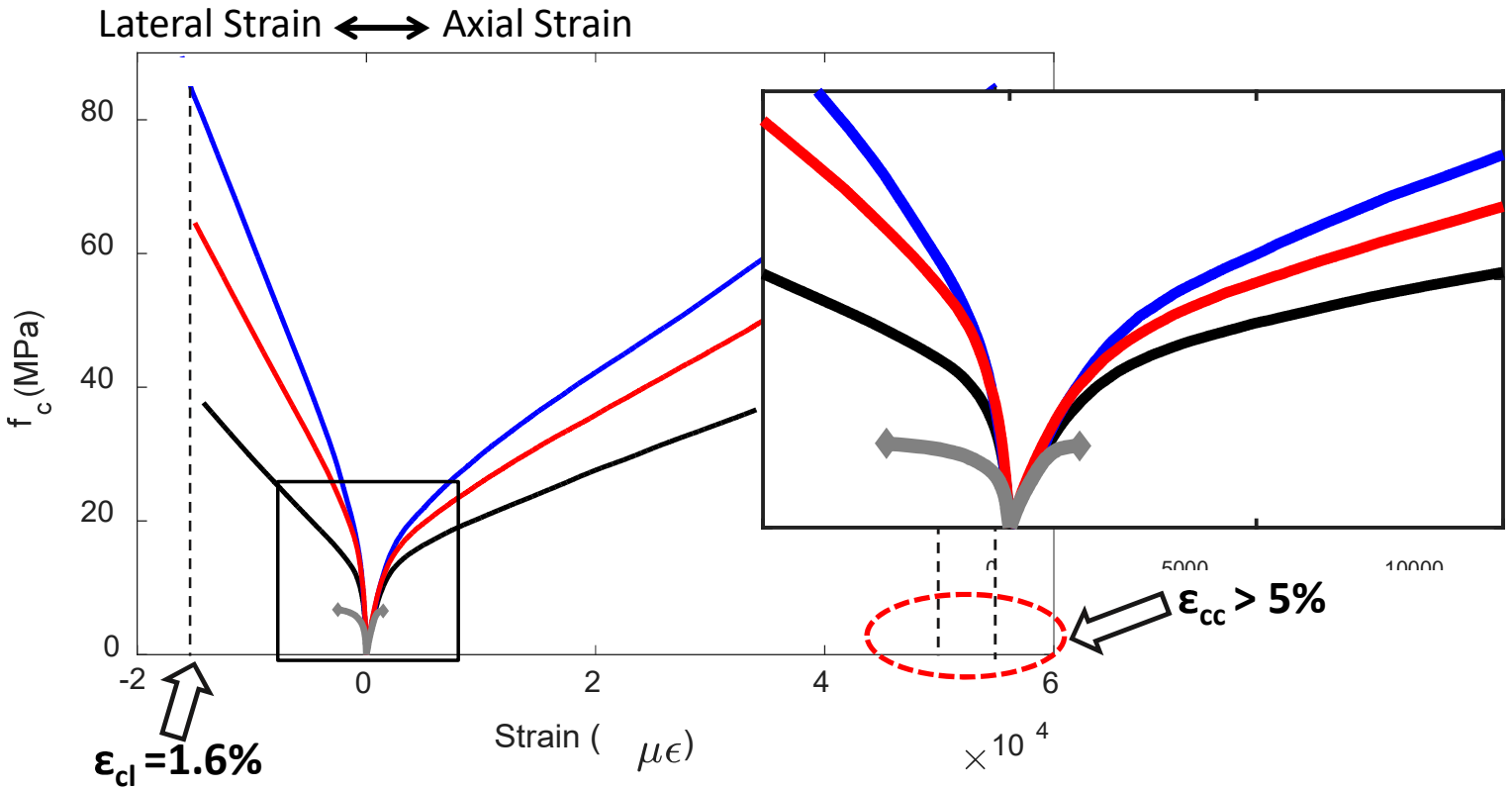


Lateral dilation device

Lateral dilation is measured using a thin wire (attached to LVDT H) placed horizontally at specimen mid-height. Wire displacements measure the specimen lateral expansion.

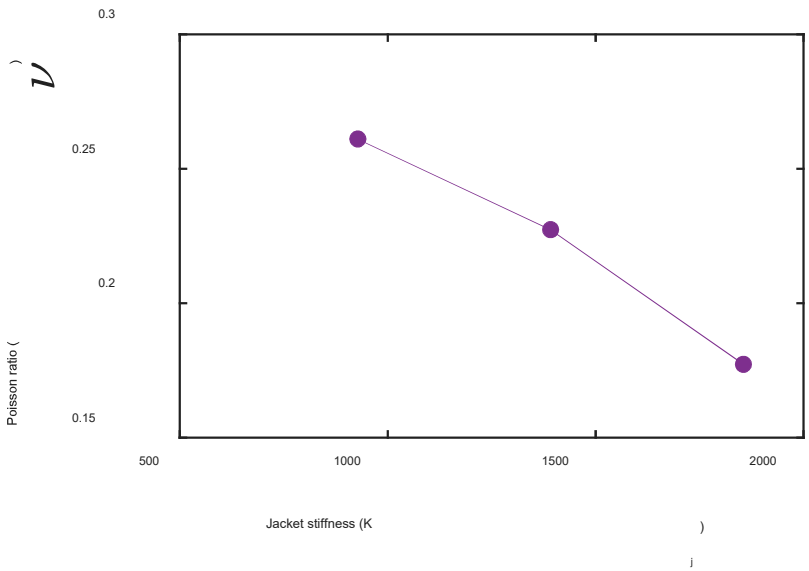
Confined rubberised concrete

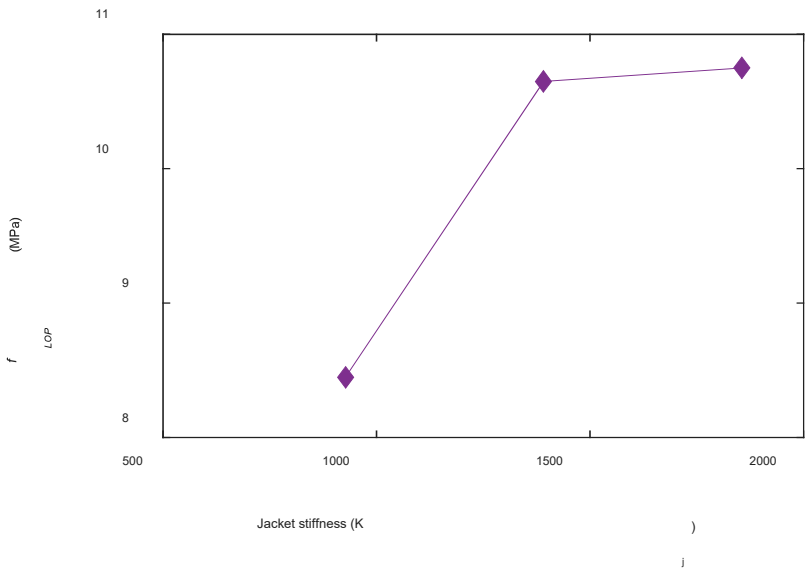




- Mix with 60% aggregate replaced with rubber (f_c=7.5 MPa)
- f_{cc}=55-90 MPa
- **Ultimate axial strains ε_{cu}>5% (+15 times ε_{cu} of conventional concrete)**

Confined rubberised concrete





$$\text{Jacket stiffness, } K_j = \frac{2E_j t_j}{D}$$

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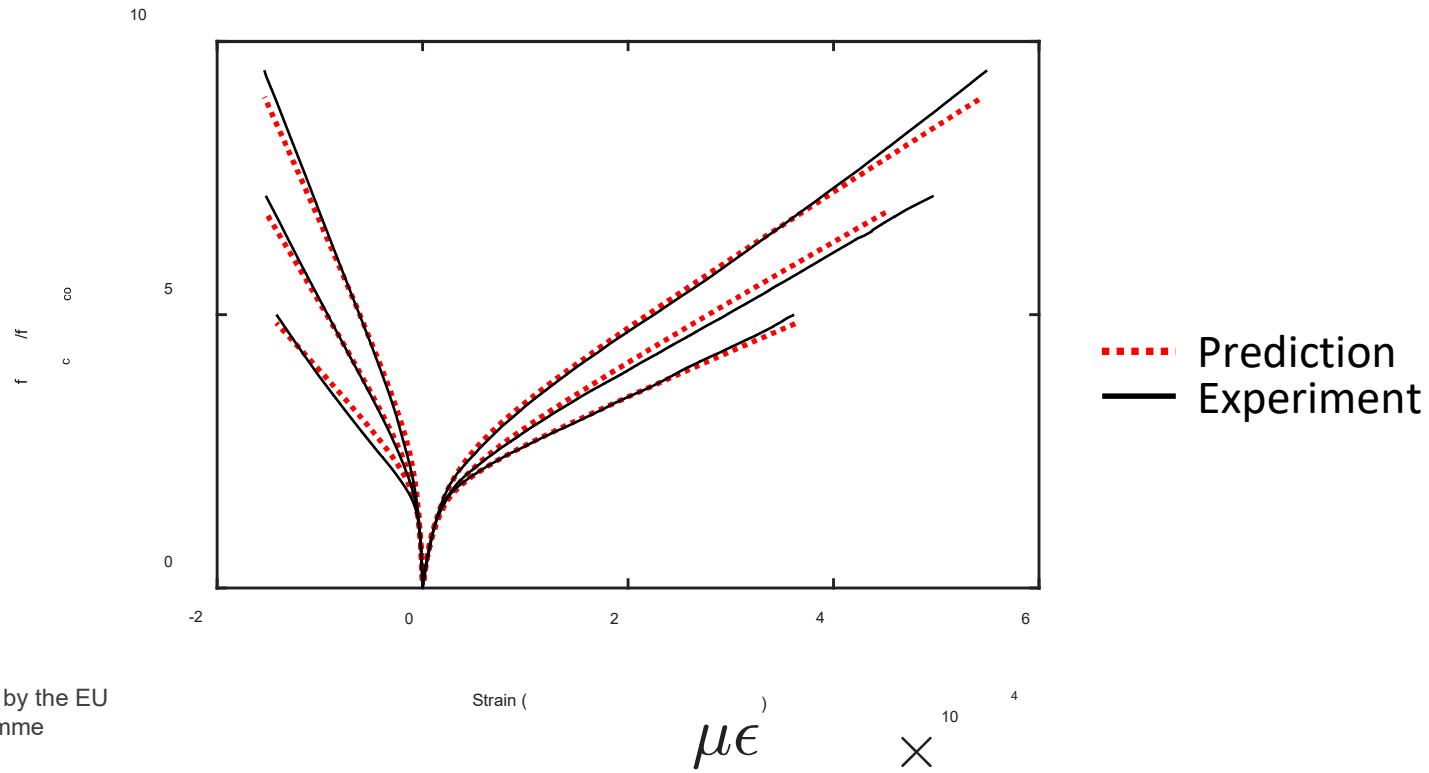
Next….Constitutive modelling

- Active confinement model based on Mander et al. (1988)
- Incremental iterative procedure to predict lateral and axial σ-ε curves.



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Conclusion

- Rubberised concrete exhibits a high lateral expansion, which activates the confinement at earlier stages.
- The confinement of RuC was highly effective with compressive strength up to 90 MPa (f_{cc}/f_c > 10) and ultimate axial strains > 50,000 με.
- Active confinement models for conventional concrete may be calibrated to predict confined rubberised concrete performance.

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Thank you

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