Why structural strengthening?

Worldwide, many existing reinforced concrete structures are in urgent need of structural repair or strengthening due to:

- deterioration and
- growing load capacity demands.

In the UK alone, the vast majority of concrete bridges built since the 1930’s are deemed no longer capable of sustaining increased traffic volumes. It is estimated that there are approximately:

- 10,000 trunk road and motorway bridges;
- 150,000 local road bridges.

Advanced composites offer:

- Innovative and cost-effective design solutions
- Improved traditional repair methods and technologies
- Solutions specific to repair / strengthening project needs
- Prolonged life of existing reinforced concrete infrastructure

Dry fabric cutting

Fabric saturation

Surface preparation

Resin application

FRP detail

Formwork

Casting

Intermediate conclusions:
Advanced composites contribute significantly to the ultimate shear capacity of reinforced concrete elements. Studied parameters greatly influence structural behaviour of strengthening systems.

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Experimental research methodology

A number of tests on realistically sized reinforced concrete elements are necessary in order to develop a reliable composite strengthening system.

Tests include:

- Material tests
- Structural tests
- Bond performance tests

Tested structural elements:

- Push-off specimens
- T-beams

Key parameters:

- Shear capacity of elements
- Load distribution and sharing
- Composite to concrete bond
- Composite bond length
- Size effect

Studied parameters:

- Varying number of shear links
- Varying thickness of composite materials
- Bond length varying from short to fully wrapped
- Load distribution and sharing between components

Commonly used assumption of load sharing in shear:

\[ V_{\text{ultimate}} = V_{\text{concrete}} + V_{\text{steel}} + V_{\text{composite}} \]

Typical structural behaviour in shear – push-off tests:

Studied parameters:

- Concrete modulus strength (MPa)
- VPE (shear strength) of FRP
- Bond shearing of FRP
- Composite to concrete bond: shear strength
- Load distribution and sharing between components

Increase in shear capacity in strengthened elements [%]

Intermediate conclusions:
Advanced composites contribute significantly to the ultimate shear capacity of reinforced concrete elements. Studied parameters greatly influence structural behaviour of strengthening systems.

Future work

Integrated programme:

- Material testing of various carbon fibre-reinforced composites – sheets and bars
- Structural repair and testing of cracked control specimens using Tyfo® composites
- Testing of realistically sized T-beams using various shear-strengthening systems
- Investigation of various anchorage systems for shear-strengthening of T-beams
- Deep embedment shear-strengthening technique for comparison of different schemes
- Development of reliable mechanics-based design guidelines for shear-strengthening

Pre-requisite knowledge and skills:

- Basic knowledge of structural behaviour of concrete and composite materials
- Basic knowledge of composite materials testing
- Basic knowledge of composite materials design
- Basic knowledge of composite materials application in construction
- Basic knowledge of composite materials bonding
- Basic knowledge of composite materials durability
- Basic knowledge of composite materials performance
- Basic knowledge of composite materials strengthening
- Basic knowledge of composite materials repair
- Basic knowledge of composite materials maintenance
- Basic knowledge of composite materials inspection
- Basic knowledge of composite materials life cycle
- Basic knowledge of composite materials cost
- Basic knowledge of composite materials sustainability
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- Sponsors and Project Partners -