Reinforcement of Concrete Beams with Continuous Glass Fibre Ropes

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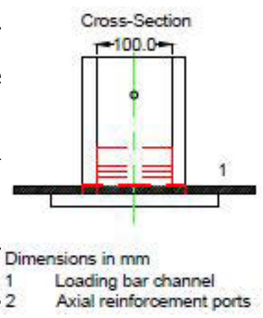
Introduction

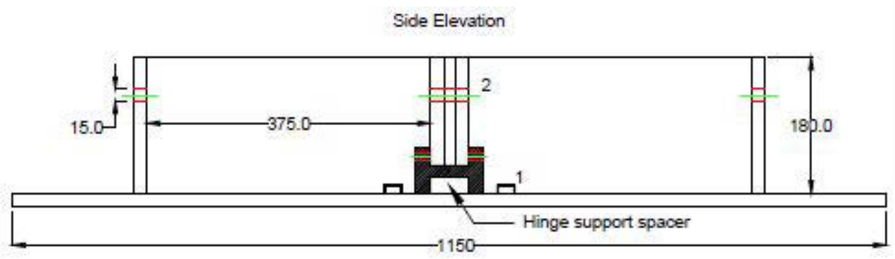
This project aimed to design and produce appropriate apparatus for the production and testing of glass fibre rope reinforced concrete split beams in accordance with BS EN 10080:2005. A split beam consists of two blocks of rectangular cross-section joined by their primary axial reinforcement and a simple steel hinge. The aim for these tests was to determine the behavior of the bond between continuous fibre ropes and concrete under flexure behavior rather than traditional pull-out conditions. LVDTs were to be employed to measure the slip of the axial reinforcement whilst a load was applied.

These aims required the design of new beam formwork, testing equipment, rope clamps, LVDT frames for slip measurement and an appropriate concrete mix.

Beam Formwork and Concrete Mix Design

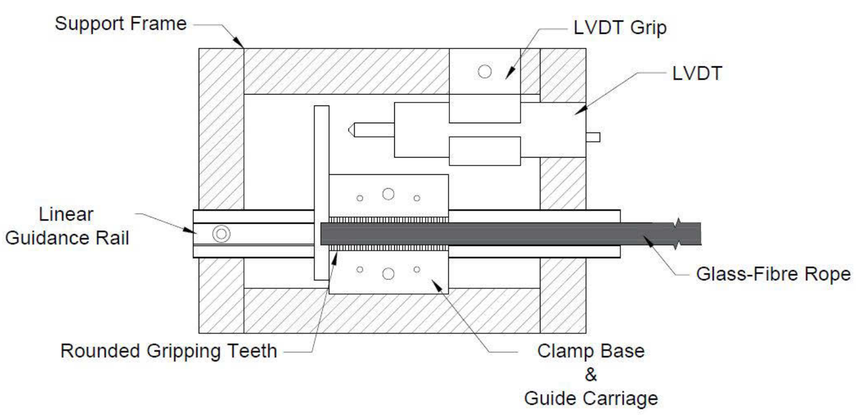
- Formwork was designed and developed for sample preparation.
- Each beam was made up of two 180×375×100mm concrete blocks.
- Formwork was to be re-usable, and be able to accommodate steel rebar cages and rope casings so that the rope embedment length could be controlled
- Glass fibre tows, 2.5m in length were twisted to form a 3-strand 15-tow glass fibre rope to be installed in the formwork.
- A concrete mix with a 28-day cylinder strength of 25±5MPa with a water cement ratio of 0.46 and a high workability to aid in the casting process was developed.





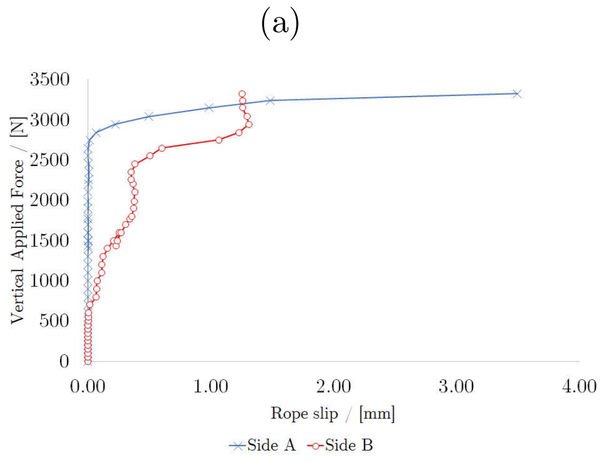
Design of Testing Equipment and Rope Clamps

- An operational steel test rig was designed and developed for use in examining the force- and stress-slip response of continuous glass fibre ropes bonded with concrete.
- A rope clamping system was developed for slip measurement which gripped the rope and provided a means for slip measurement via an LVDT contact plate.
- A linear guide rail and carriage allowed for the transfer of rope slip during loading to the LVDTs positioned on the outer faces of beam (shown here).

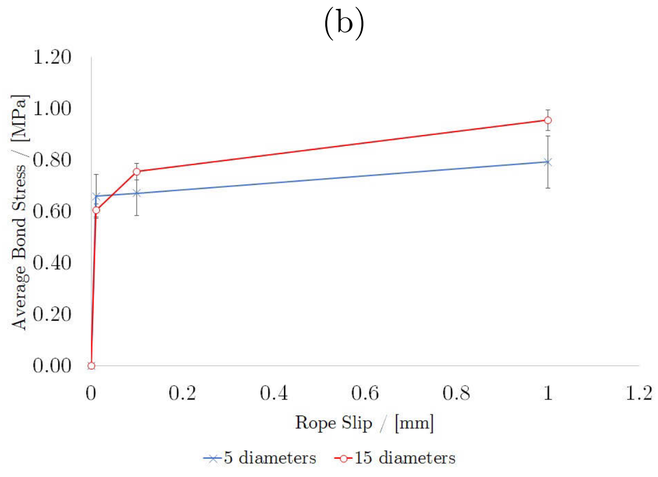


Initial Test Results

(a)



(b)



- A limited number of tests were conducted using both fully-fixed and pinned support conditions.
- The rope-concrete bond has potential for multiple failure modes as shown in Fig(a) by the different load paths taken by the two halves of the beam.
- The effect of bond length on the force and stress responses was investigated. This was found to have a limited effect on bond stress despite a 3.6× increase in applied load.
- The testing rig failed to produce multiple results due to excessive lateral deflection of the support uprights during loading.

Potential Further Work

- Replacement of the support uprights with steel box section to prevent excessive deflections which mask the true slip behaviour of the glass-fibre rope.
- Alteration to the LVDT frame to allow for beam rotations during loading by fixing to the outer faces of the beam halves.
- Development of a rope clamp capable of preventing further slip in a single beam half once failure has occurred so that the test may proceed to failure in the opposing half.

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