2013/14 Undergraduate Research Grant Scheme – Executive Summary

Project title:
Developing of pretensioned RC beams with BFRP reinforcement

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Project summary:
Traditional steel reinforcement is widely used for production of reinforced concrete (RC) elements. However the corrosion of the steel, which reduces dramatically the lifespan of RC structures and the high CO2 footprint during their production are few of the reasons for looking for possible replacement.

The most attractive alternative till the moment are fibre reinforced polymer (FRP) materials and especially basalt FRP (BFRP). The main obstacle to use widely BFRP bars is the relatively low modulus of elasticity, which results in higher deflections and cracking of RC. One possible solution to reduce the deformations is to develop pre-stressed BFRP reinforced elements. The aim of this project is to design and develop formwork, prestressing devices and equipment to pre-tension BFRP in RC beams. The first part of the work on the project consists of series of experiments focused on testing of different types of clamping/anchoring devices for prestressing. It was concluded that anchoring cannot be done using anchoring devices for steel reinforcement because the BFRP bars crush due to relatively small strength in transverse direction. As result of testing of 5 different types of connections it was concluded that sufficient capacity is possible to be achieved via using of 200mm long steel tubes, attached at the end of the bars via adhesive.

Second part of the work was directed towards design and construction of prestressing equipment. The initial design development was focused on design of self-balanced unit consisting of load bearing steel formwork and prestressing jacks. Further consideration in aspect financial constrains and avoiding using different mixes of concrete for variety of samples directed us to move to design of set of 6 timber formwork units with common anchoring of the prestressing reinforcement via steel angles fixed to existing reaction flooring system. The method of prestressing was choosen to be via mechanical jacking with aim of achieving better control over the process of prestressing. The prestressing force is controlled via doughnut load cells and via the readings from the strain gauges attached to the longitudinal reinforcing bars.

To check the expected effects of prestressing and to improve the design of the samples including consideration of range of prestressing forces and expected deformations finite element modelling software ANSYS is used to analyse the beams theoretically. The developed models were verified with the available test results.

The work is in process of continuation and several more undergraduate and PG project are planned to be conducted using the developed equipment.