Parametric study on moment redistribution of fiber reinforced concrete continuous beams with basalt FRP bars

Presented by: Abdulrahman Abushanab, PhD candidate
Supervised By: Dr. Wael Alnahhal, Associate Professor

Background

The State of Qatar is suffering from its harsh environment and coastal condition, which stand for most of the year.

Therefore, there is a necessity to replace the conventional steel reinforcement by fiber-reinforced polymers (FRP).

Objective

To conduct a parametric study, using a validated finite element model, to investigate the moment-redistribution in concrete continuous beams reinforced with Basalt FRP (BFRP) bars which include volume fractions of Basalt macro fibers of 0.75 and 1.5% and stirrups spacing of 80, 100 and 120 mm

Methods

1. The experimental program consists of eleven concrete continuous beams over two spans of 1800 mm each and a rectangular cross-section of 200 x 300 mm

2. Different flexural reinforcement materials (steel and BFRP) with steel stirrups were considered

3. Different flexural reinforcement ratios (0.3-3.9%fb) were considered in both top and bottom sections to allow for moment redistribution of 0 or 20%

4. Volume fractions of Basalt-macro fiber (BMF) of 0.75 and 1.5% were used to enhance the concrete shortcoming properties such as the tensile strength

5. A FEM modeling was conducted using ABAQUS software, release 14. The produced model was utilized to perform a parametric study

6. A linear regression analysis was performed using Minitab 17 software. A formula ($R^2$=87.28%) that predict moment redistribution was generated

During loading, forces were transferred from the low-stiffness section to high-stiffness section. This behavior was observed in the beams that have higher bottom reinforcement

Results

The ratio between bottom reinforcement to top reinforcement should be more than 0.3 to redistribute forces between the critical sections

%Moment redistribution = 3.72 + 0.444 (volume fractions of BMF) + 0.0212 stirrups spacing - 0.02505 top reinforcement + 0.04102 bottom reinforcement

Conclusion

This study is the first of its kind that evaluated the moment redistribution in continuous concrete beams with BFRP bars. Moment redistribution occurs in beams that have at least a ratio of bottom to top reinforcement of 0.3

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