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

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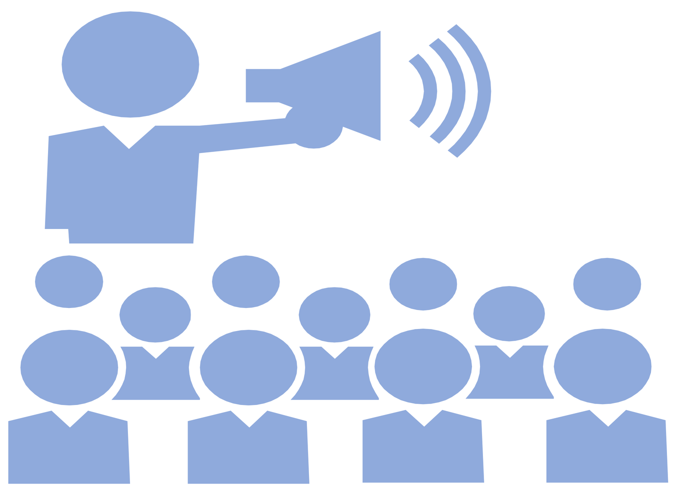
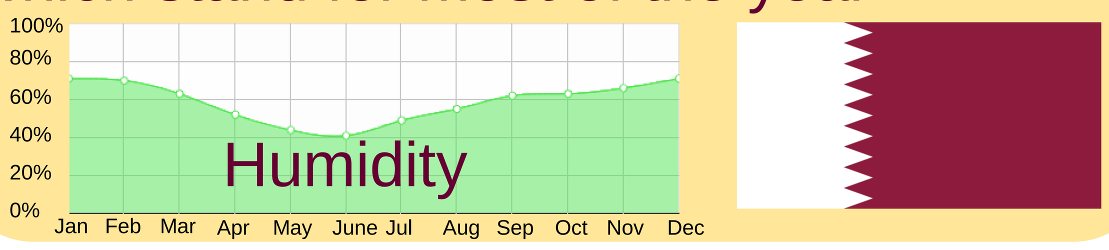
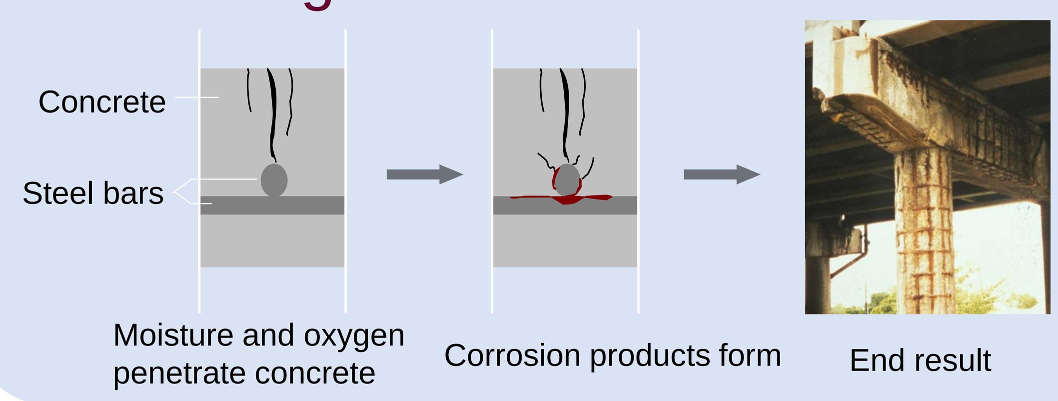
Background



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

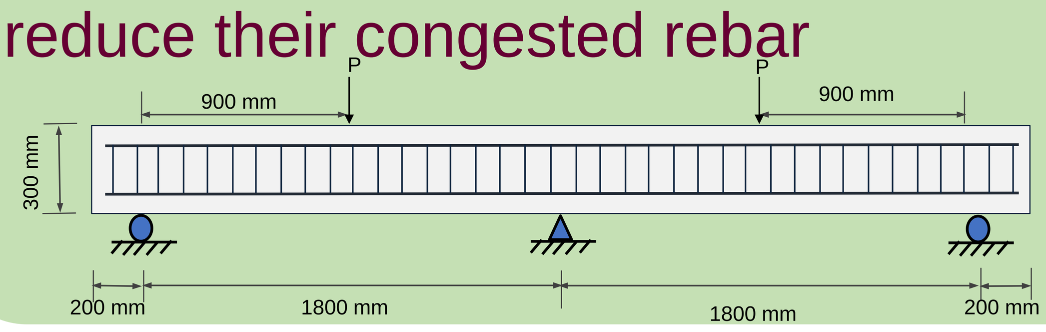


RC degradation due to corrosion

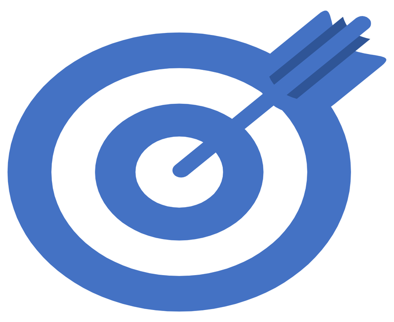


Therefore, there is a necessity to replace conventional steel reinforcement with fiber-reinforced polymers (FRP) and steel fibers with basalt fibers.

Moment redistribution enhances the ductility of continuous beams and reduce their congested rebar



Objective



The main objective of this study is to experimentally and numerically investigate the moment redistribution of fiber reinforced concrete continuous beams with basalt FRP bars

Methods

1. The experimental program consists of ten 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 (0.3-3.9pfb) were considered at both top and bottom sections to allow for moment redistribution of 0% to 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 on the tested beams
6. A linear regression analysis was performed using Minitab 17 software to generate a formula that predict moment redistribution

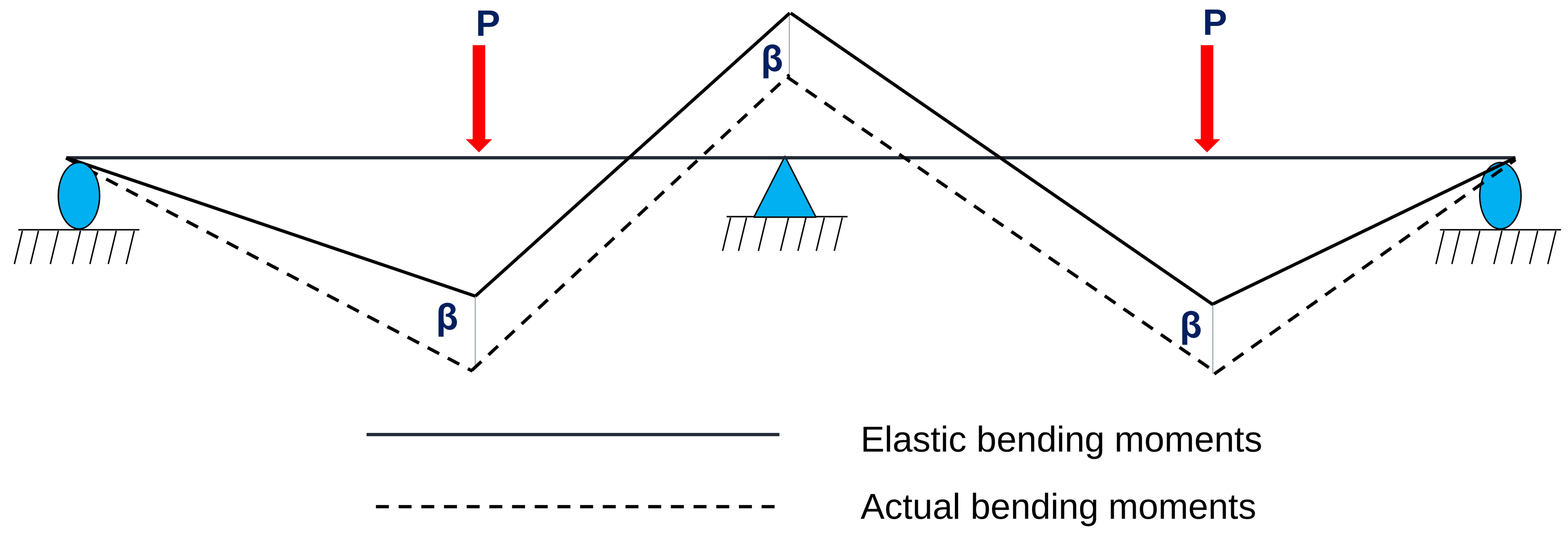


Figure 1. Elastic and actual bending moments of the beams

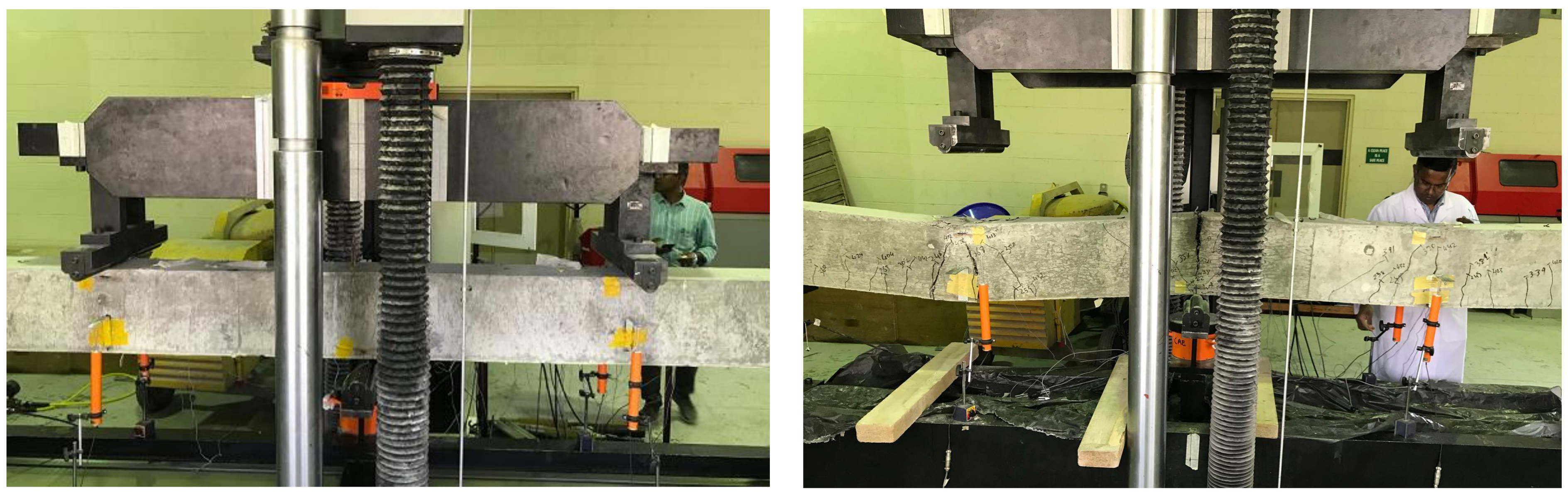


Figure 2. Experimental test setup and loading pattern

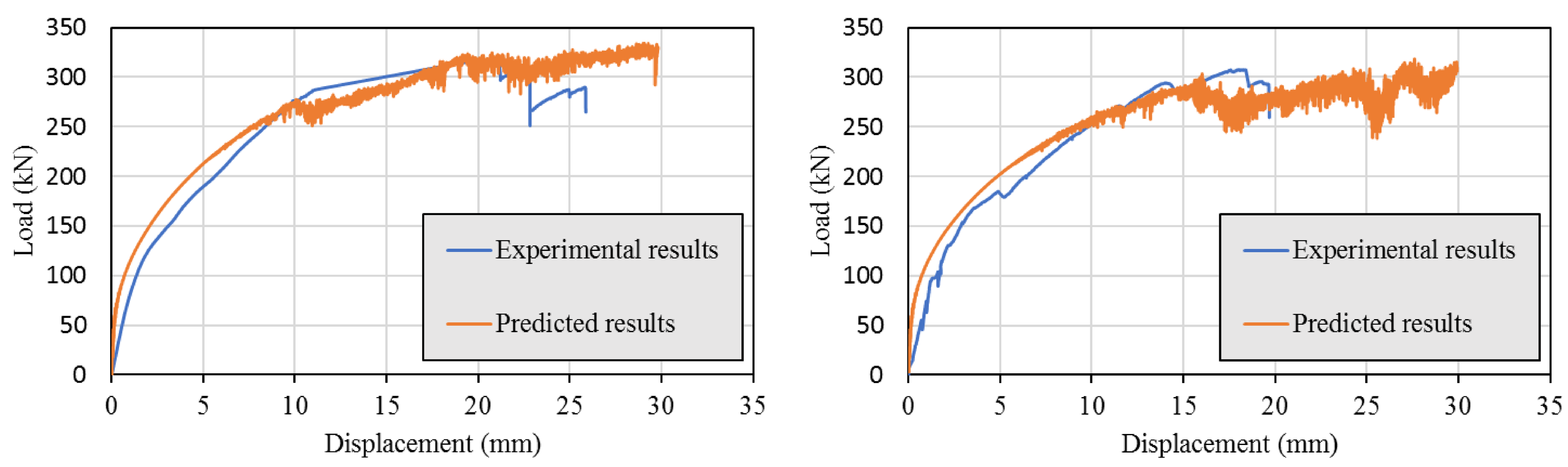


Figure 3. Experimental and predicted load-displacement diagrams for test beams

Results

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

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 (R^2=87.28%)

Table 1. Moment redistribution of the tested beams

Beam	Moment redistribution (%)	
	Bottom	Top
1	11.81	19.59
2	12.71	21.09
3	13.78	22.86
4	16.64	27.61
5	16.72	27.75
6	17.40	28.87
7	17.62	29.24
8	11.88	19.72
9	8.30	13.78
10	-8.95	-14.85

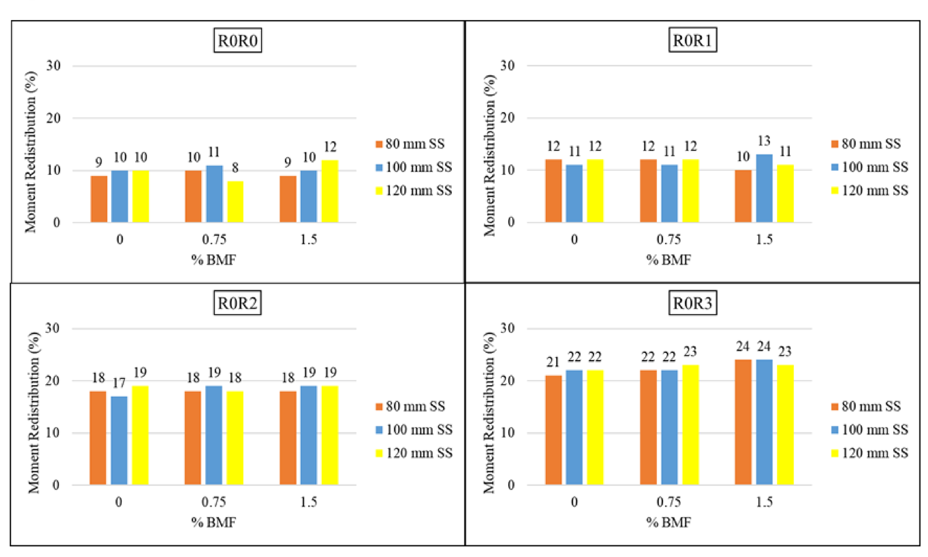


Figure 3. Numerical moment redistribution

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

Acknowledgement

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