

Title: Strategies for corrosion mitigation in concrete structures

Duration: 3 years (April 2023 to March 2026)

Deliverables:

- *Developed steel-FRP composite rebars*
- Formulation of guidelines for concrete structural members with alternative rebars
- Formulation of guidelines for the use of the rebar connector system in concrete structures

Significant Achievements:

- Developed steel-FRP composite rebar with ductility of steel and superior corrosion resistance.
- Comparative assessment of the bond characteristics of alternate rebars of different diameters with steel rebars is carried out, and the correlated bond behaviour and surface roughness of different alternate rebars. The stainless-steel rebar and coated rebars showed higher slip than steel rebar. GFRP rebar with sand coating and helical reinforcement showed bond performance similar to that of steel rebar.
- The stiffness of GFRP reinforced members, similar to equivalent steel reinforced members, could be achieved by restricting the failure strain of GFRP bars.
- Evaluated tensile strength of GFRP rebar specimens embedded in Geopolymer concrete immersed in sodium chloride solution and found that different environmental conditions do not affect the strength of GFRP rebar.
- Assessed the performance of threaded, grouted, bolted, and crimped couplers with and without corrosion and compared their performance with that of corroded rebars of the same diameter. It is observed that the corrosion leads to a drastic reduction in yield, ultimate strength, and ductility.
- It is observed that at higher levels of corrosion, the failure location shifted from the rebar region to the splice region in the case of threaded, bolted, and crimped couplers.

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Details of work carried out

- Review of literature on different alternate reinforcement bars, such as glass fibre reinforced polymer rebars, SFCR and stainless steel rebars, is carried out.
- Review of literature corresponding to different rebar couplers is carried out, and identified rebar couplers such as Threaded couplers, Grout-filled coupling sleeve coupler, Crimped sleeve coupler, and bolted coupler for the study.
- Studies are carried out to develop Steel-FRP composite rebar
- Arrived special concrete mixes such as Self-compacting concrete, High volume fly ash concrete and Geopolymer concrete.
- Evaluated the mechanical characteristics of GFRP rebars with different types of resin and stainless steel rebars of different diameters.
- Comparative assessment of the bond characteristics of alternate rebars of different diameters with steel rebars.
- Numerical investigations are carried out on slab reinforced with GFRP rebars designed according to five different design philosophies.
- Evaluated the ultimate load capacity of flexural members reinforced with stainless steel
- Assessed the resistance of GFRP rebar in special concrete exposed to various environmental conditions, and evaluated the flexure and shear behavior of GFRP rebar in special concrete.
- Evaluated mechanical properties of corroded rebars of 16mm, 20mm and 25mm diameter.
- Evaluated the mechanical properties of splices with threaded, grouted, bolted, and crimped connections with and without corrosion on 16mm, 20mm and 25mm rebar diameters.

Research/Technology Leads

- *Proof of concept of steel-FRP composite rebar with superior performance is established, and studies could be initiated to optimise FRP layers, improving the bond performance and bringing down the cost.*
- *Stainless steel rebar tested showed a higher ultimate to yield strength ratio, which underlines the need for understanding the seismic performance of stainless steel reinforced structural members.*
- The study indicates that corrosion has a pronounced impact on the performance of coupled rebars and may result in catastrophic failure at higher levels of corrosion. The results highlight the need for further investigation into the long-term corrosion behaviour of coupled rebars and their effect on structural performance.

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