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# A review on experimental flexural cracking in FRP reinforced concrete members

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## Abstract

This paper aims to assess the relationship among crack width and several influencing parameters of Fibre Reinforced Polymer (FRP) Reinforced Concrete (RC) flexural members. A database with the results of 133 concrete specimens reinforced with different types of FRP bars available in the literature has been collected and analysed. A bond coefficient $k_b$ has been adjusted for the maximum crack width of all specimens by using ACI-440 and ISIS Canada design guidelines in the service range, obtaining a mean bond coefficient of 1.11 and 0.72, respectively. The effect of the surface treatment and modulus of elasticity of the FRP rebar, and the $n{\cdot}\rho$ ratio on the bond coefficient have been studied, obtaining no significant influence of the studied parameters due to the high scatter of results.

**Keywords:** FRP reinforcement; crack width; flexural behaviour; serviceability; bond; experimental study.

## 1. Introduction

Concrete members reinforced in flexure with Fibre Reinforced Polymers (FRP) bars usually suffer from high degrees of deformability, mainly due to the lower modulus of elasticity of FRPs compared to that of steel, leading to wider cracks. Even though corrosion of FRP reinforcing bars may not be a primary concern, crack width in FRP reinforced concrete (RC) structures needs to be controlled in order to ensure other main aspects such as appearance or water tightness. Furthermore, improper control of cracking could lead to excessive exposure of the FRP reinforcement to specific aggressive environments that may affect their performance.

Control of cracking in FRP RC members is likely to be affected by similar parameters as for steel RC elements. However, in this case two main specific factors can cause divergences in the prediction of crack widths. The usual large deformability of FRP bars is obviously a key parameter when evaluating the difference between reinforcement and concrete deformations in a crack. In addition, the diverse surface configurations that can be encountered in commercial available FRP bars can lead to different bond behaviour that may induce differences in the assessment of crack width calculations.

This paper aims at studying the experimental crack width of FRP RC flexural members through an updated experimental database. For that purpose, a brief summary of some expressions to compute the maximum crack width of FRP RC elements is presented. Next, the results of 133 RC specimens reinforced with different FRP types is shown and analysed. The experimental maximum crack width has been used to calibrate a bond coefficient provided by expressions published in the literature. Finally, the effect of the surface treatment of the bar, the modulus of elasticity of the bar, and the $n{\cdot}\rho$ ratio (being $n$ the modular



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