Proc. 1st International Conference on Structural Engineering Research (iCSER 2017)
20-22 Nov 2017, Sydney, Australia
ISBN: 978-0-6480147-6-8

FRP-strengthened RC Structures: Research, Design and Knowledge Gaps

Scott T. Smith

Foundation Professor of Engineering, Southern Cross University, Australia
E-mail: scott.smith@scu.edu.au

Extended Abstract

Fibre-reinforced polymer (FRP) composite materials can be applied to existing reinforced concrete (RC) structures for a variety of reasons ranging from strengthening and retrofitting to rehabilitation and repair. Experimental and numerical investigations over the last two decades and more have demonstrated the effectiveness of the FRP intervention. By far and large the most commonly investigated scenarios include the flexural and shear strengthening of flexural members such as beams, as well as the confinement of compression members such as columns. As a result of such research advances and understanding, design guidelines have been steadily appearing throughout the world since the middle to late 1990s. Leading design guidelines are now available in their second or third versions (e.g. ACI 440.2R-17, Concrete Society 2012) and some countries are at the stage of developing and publishing standards.

(a) Beam flexural and shear strengthening (Conventional)

(b) Column confinement (Conventional)

(c) Column confinement (Non-conventional)

(d) Wall edge strengthening (Non-conventional)

Figure 1. Conventional and non-conventional applications of FRP strengthening (KL Structures 2017)

The practical applications of FRP strengthening measures have been gaining in popularity over the last two decades too. Figures 1a and 1b show popular applications of flexural and shear strengthening, as well as column confinement. Existing design guides can generally cater for such strengthening scenarios quite well. There are, however, a lot of scenarios that are not explicitly addressed by design guidelines. Figures 1c and 1d provide some examples. In the design of such cases, engineers need to apply guidelines with sufficient interpretation and adaption, and also use their good engineering judgement. In addition, mock-up tests in cases need to be resorted to.

While design guidelines are not meant to be overly prescriptive, they are limited by our current state-of-the-art knowledge. As a result, a greater practical uptake of FRP strengthening measures is inhibited. In some cases industry has pushed ahead and companies have developed their own in-house design guidelines. In a lot of other cases though companies without sufficient resources will not entertain FRP strengthening solutions.

This presentation will provide an overview of design guideline development to date in selected regions of the world, followed by the identification of key knowledge gaps. The identification of such gaps will help inform impactful future research projects and design guideline development. A case study will also be presented that will discuss the synergistic effects of industry demand as well as research interests regarding the design guideline development for anchorage devices. Such devices can be applied to increase the efficiency of externally bonded FRP systems. The author is of the opinion that prescriptive design measures for anchorage devices will provide a tremendous benefit to the industry. The design of anchors will enable the application of FRP to more exotic structure configurations and hence unlock the true potential of the strengthening technology.

REFERENCES

ACI 440.2R-17 (2017). Guide for the Design and Construction of Externally bonded FRP Systems for Strengthening Concrete Structures, American Concrete Institute (ACI), Farmington Hills, MI, USA.

Concrete Society (2012). TR55 Design guidance for strengthening concrete structures using fibre composite materials, 3rd Edition, Concrete Society, UK.

KL Structures (2017). Photographs provided courtesy of KL Structures, USA.
http://www.klstructures.com/