

*Innovative strategies for
the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve
the fatigue behaviour of connections between elements*

José David Jiménez Vicaria

Civil Engineering PhD Student, Universidad de Cantabria

Technology Center, ACCIONA Infrastructure



Supervisors:

Daniel Castro Fresno. GITECO



M. Dolores G. Pulido. IETcc



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

1. BACKGROUND

A. Problem: Existing railway metallic bridges are aging
70% more than 50 years and still in service!



B. Causes of degradation:

- Lack of maintenance
- Corrosion
- Traffic increase
- Fatigue

C. Strengthening strategies:

Bolted/welded steel plates

- Corrosion and fatigue
- Further loads
- Difficult to weld
- Traffic disruption

Fibre reinforced polymers (FRP)

- No corrosion
- Lightweight
- Bonded joints
- Rapid installation



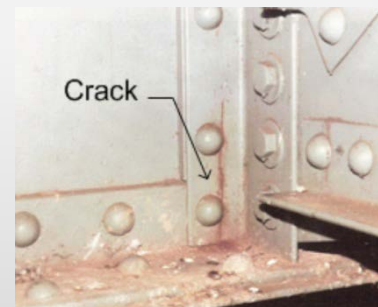
Fibre + Resin

Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

2. OBJECTIVE

Main objective:

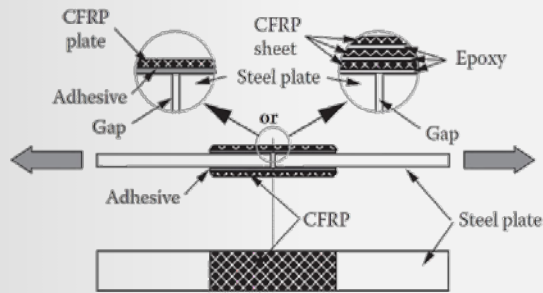
The development and validation of **FRP strengthening new solutions** for **metallic** bridges for the wide implementation of the technique in full-scale field structures.



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

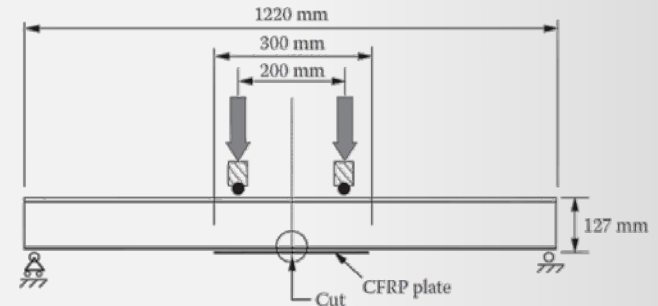
3. WORK PLAN

1. Bond strength between FRP and metal



Double shear pull tests to determine bond between steel and CFRP ⁽¹⁾

2. Stress reduction in fatigue critical regions

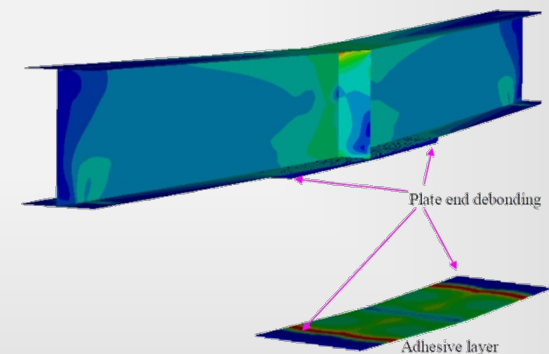


Bending tests of fatigue strengthened steel I-section beams ⁽¹⁾

3. Strengthening a metallic railway bridge



4. Numerical simulation



FEM of FRP-strengthened steel beam ⁽²⁾

⁽¹⁾ Reference: FRP-Strengthened Metallic Structures, Xiao-Ling Zhao, 2013

⁽²⁾ Reference: Bond behaviour and debonding failures in CFRP-strengthened steel members, N. D. Fernando, 2010



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

4. SCIENTIFIC ACTIVITY

Conference papers

Jiménez-Vicaria, J. D. and Paulotto, C. *Evaluation of anchoring strategies for improving the efficiency of fiber reinforced polymers (FRP) strengthening of concrete structures.* 6th Euro-American Congress on Construction Pathology, Rehabilitation Technology and Heritage Management, 24-27 May 2016, Burgos (Spain). Status: Accepted.

Jiménez-Vicaria, J. D., Sánchez-Sierra, P., Navarro-Lera, E. and Paulotto, C. *Experimental and numerical analysis of an FRP lighthouse subjected to free vibrations.* 8th International Conference on Fibre-Reinforced Polymer (FRP) Composites in Civil Engineering (CICE 2016), 14-16 December 2016, Hong Kong (China). Status: Under review.



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

4. SCIENTIFIC ACTIVITY

Seminars

JEC World 2016 Composites & Conferences. JEC Group, 8-10 March 2016, Paris (France).

National Event on Technological Innovation. Global ImasT. eGauss Business Holding I+T, 25 November 2016, Casa del Estudiante - Edificio Tres Torres, Santander (Spain).

Strengthening of a metallic bridge using FRP. Adif, 9 October 2015, Madrid (Spain).

Application of FRP materials in construction. ACCIONA Infrastructure Technology Center, 16 July 2015.

Training courses

Statistics for Research in Construction Engineering I and II (January 2016). Duration: 20 hours. Organiser: Construction Technology Applied Research Group (GITECO).

EDUC Advanced Course Training (November 2015). Duration: 40 hours. Organiser: EDUC

EDUC Basic Course Training (December 2014). Duration: 40 hours. Organiser: EDUC.



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements

5. EVALUATION GUIDE

Basic competences	Science and Technique	Technology	Training courses	Results	SWOT analysis	Work plan	Mobility	Funding	Ethics
CB11	X	X	X						
CB12				x		X	x		
CB13				x					
CB14					X				
CB15				x			x		
CB16				x					X

Capacities and personal skills	Science and Technique	Technology	Training courses	Results	SWOT analysis	Work plan	Mobility	Funding	Ethics
CA01	X	X	X						
CA02				x					
CA03						X		X	
CA04			X				x		
CA05	X	X	X						
CA06					X				



Innovative strategies for the strengthening of railway metallic bridges
using fibre reinforced polymers (FRPs) to improve the fatigue behaviour of connections between elements



[*jose-david.jimenez@alumnos.unican.es*](mailto:jose-david.jimenez@alumnos.unican.es)

[*josedavid.jimenez.vicaria@acciona.com*](mailto:josedavid.jimenez.vicaria@acciona.com)