# Research and Practice with Composite Polymer Bridges in Poland

**Henryk ZOBEL**
Professor
Warsaw University of Technology
Warsaw, Poland
*h.zobel@il.pw.edu.pl*

**Wojciech KARWOWSKI**
Assistant
Warsaw University of Technology
Warsaw, Poland
*w.karwowskil@il.pw.edu.pl*

**Marcin WRÓBEL**
Assistant
Warsaw University of Technology
Warsaw, Poland
*m.wrobel@il.pw.edu.pl*

**Przemysław MOSSAKOWSKI**
Assistant
Warsaw University of Technology
Warsaw, Poland
*p.mossakowskil@il.pw.edu.pl*

**Krzysztof ŻÓŁTOWSKI**
Professor
Gdańsk University of Technology
Gdańsk, Poland

**Andrzej KOZAKIEWICZ**
Assistant
Gdańsk University of Technology
Gdańsk, Poland

**Jerzy PIECHNA**
Professor
Warsaw University of Technology
Warsaw, Poland

**Bartłomiej GROTTE**
Architect
Grotte Art
Warsaw, Poland

**Piotr ŻÓŁTOWSKI**
Civil Engineer
Yellow Line Engineering
Warsaw, Poland

## Summary

The paper consists of three topics. First part presents results of investigation of 8 years old FRP truss footbridge working under static and dynamic loads. Second topic is devoted to ongoing research on joints of FRP pultruded profiles in bridge structure. Some kinds of mechanical and glued-mechanical connectors were tested in the laboratory and on real pedestrian bridge. The FEM models for verification are also presented. In the third part of paper, new build inclined steel arch footbridge with composite polymer curved in plane deck is shown. Main girder is filed partly with self-compacted concrete to fulfill dynamic comfort criteria for pedestrian bridges. Special attention is paid to dynamic analysis of the structure with taking into account the simulation of aerodynamic impact from lorries traveling under the bridge. Generally, the paper gives current state of art in design, construction and maintenance of FRP bridges in Poland.

**Keywords:** FRP footbridges, composite polymer decks, joints in FRP bridges, dynamic response.

## 1. GFRP pedestrian bridge

This footbridge is the first and until today the only one fully composite polymer structure in Poland (Fig. 1). The authors decided on carried out some research to check the condition of the structure after eight years of exploitation. It was carried out tests with static loads and what was even more important – with dynamic loads. Dynamic tests were done to check the new dynamic model (Fig. 2) of the pedestrian load.

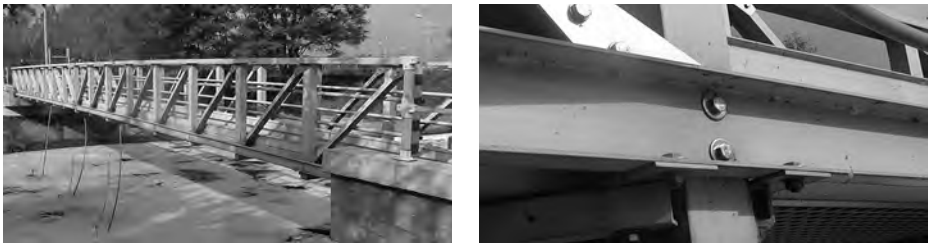

*Fig. 1: Elevation of the footbridge and joints in footbridge across river Ner in Łódź, Poland*

https://doi.org/10.2749/222137908796293938

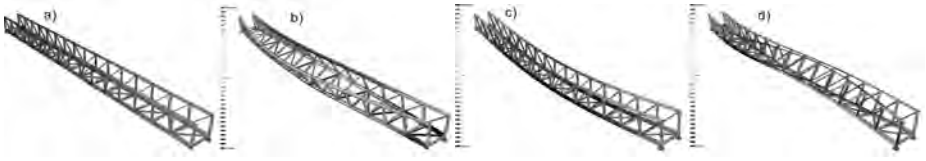


*Fig. 2: FEM model made due to design documentation and geometric forms of natural frequencies for whole footbridge*

## 2. Research on joints of GFRP pultruded profiles in bridge structure

In the research project the theoretical analysis (MES) and laboratory investigation of various types of mechanical and glued joints were done connecting different footbridge elements made of GFRP. Behaviour of separated joints under influence of changing load of set value and frequency and behavior of the whole structure with built in joints under the influence of loads in natural conditions was examined (Fig. 3).

*Fig. 3: Research footbridge – phase zero for comparison (main beams without any joints) and Research footbridge – visualization of main beams with joints - bottom view*

## 3. Pedestrian steel arch bridge with composite polymer deck

The main arch girder of 40 m long with cushion of 16 m has a trapezoidal box cross-section. Main arch is inclined by $17^{o}$ rendering a balance with $28^{o}$ inclined brace. This girder is filled with concrete up to the height of the first hanger to improve dynamic properties. Deck girder has also trapezoidal cross-section. Deck girder does not follow deck centerline. Various axes were tested, and final axis is near the centerline at span ends and near the hanger at mid-span. The main, curved in plane girder is 600 mm deep and thickness of all steel plates is 30 mm. Cross-beams are plate girders specially shaped according to architects vision. The hanger system is considered of steel stressed bars. Every second cross-beam is also supported by a hanger.

*Fig. 4: Visualizations and general view of the complete footbridge Assembling of main span (left) and of composite polymer deck (right)*