WOOD MATERIAL SCIENCE & ENGINEERING
https://doi.org/10.1080/17480272.2025.2469711

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

Check for updates

Basic evaluation and restoration process for the structural characteristics of historically significant timber bridges in Türkiye: case studies in Eastern Black Sea Region

Zeliha Tonyali[a]*, Fatma Birinci Kayaalp[b]*, Adnan Kiral[a] and Ali Ozesen[c]

[a]The Faculty of Engineering and Architecture, Department of Civil Engineering, Recep Tayyip Erdogan University, Rize, Türkiye; [b]The Faculty of Engineering, Department of Civil Engineering, Eskisehir Technical University, Eskişehir, Türkiye; [c]Department of Structures, Historical Bridges Division, General Directorate of Highways, 10th Regional Directorate, Trabzon, Türkiye

ABSTRACT

Timber bridges have existed for nearly as long as mankind and they have experienced through various designs influenced by their time and place's cultural features and innovations in technology. Ancient bridges have played a crucial role in transportation and community connectivity throughout history and are characterized by their elegant designs and robust construction. They stand as permanent reminders of the region's rich cultural and architectural legacy, emphasizing their unique architectural and mechanical features. The present study discusses the various types of timber bridges built around the world and provides a historical overview of timber bridges in Türkiye. This study examines a general architectural feature of historical timber bridges constructed in the region Eastern Black Sea, highlighting their significance within the context of cultural heritage and engineering practices. The study also draws attention to the sustainability of cultural heritage in the conservation and restoration of these historic timber bridges, to raise awareness about the preservation of such buildings and to encourage the transfer of traditional construction technology to future generations. This integration of historical context with contemporary engineering concerns presents a fresh perspective on the preservation and restoration of these cultural heritage structures.

ARTICLE HISTORY
Received 20 November 2024
Revised 4 February 2025
Accepted 17 February 2025

KEYWORDS
Historical timber bridges; restoration; architectural heritage preservation; Türkiye's cultural heritage; traditional timber bridge engineering; Eastern Black Sea region

1. Introduction

In the history of humanity, bridges have always held immense significance. Each bridge that is constructed enables people to connect with one another; thus, it becomes a symbol and an integral aspect of the community (Wittfoht 1984, Mahnert and Hundhausen 2018, Niu and Fink 2019, Kiral *et al.* 2024). Globally, bridges can be made from various materials, including steel, concrete (reinforced or unreinforced), stone, timber, or a combination of composites. The most traditional materials are stone and wood, as they are readily available and easy to work with using basic hand tools (Partov *et al.* 2016, Miebach 2018). Stone bridges tend to be more expensive to construct, while timber bridges are more susceptible to environmental factors such as decay and fire (Fernandez-Cabo *et al.* 2010, Meyer-Veltrup *et al.* 2018, Singh and Page 2018).

Timber has been one of the most frequently used construction materials for various structures throughout history (Bertolini *et al.* 2002, Giachi *et al.* 2003, Kouris and Kappos 2012, Tampone and Ruggieri 2016, Riggio *et al.* 2018, Romão *et al.* 2024). It was likely the first material employed by humans to construct bridges since the Neolithic period (Smith and Snow 2008). The earliest bridges were probably made by extending tree trunks in the form of beams across waterways. Following this, numerous timber bridges were built worldwide, utilizing diverse designs (i.e. cantilevers, beams, trusses, and arches) (Yılmaz *et al.* 2018). As a construction material, timber has several advantages, including being a sustainable and renewable resource, ease of use, and natural aesthetic appeal, along with several disadvantages, such as vulnerability to pests, decay, and fire, as well as the requirement for regular maintenance and treatment (Saribiyik and Akgül 2010, Detkin 2016, Woodard and Milner 2016, Asdrubali *et al.* 2017), as listed in Table 1. These characteristics should be carefully evaluated when considering their use in construction projects.

Timber bridges are among the oldest forms of engineering structures, with a history that spans thousands of years. Their construction is a fundamental subject of inquiry within civil engineering and architecture. These bridges have historically served as a crucial element of transportation, owing to their accessibility, ease of construction, and versatility (Mettem 2013, Robbers *et al.* 2018, Tenório *et al.* 2024). The extensive use of timber is largely due to its ready availability, superior mechanical characteristics—such as inherent strength and flexibility—low thermal conductivity, and aesthetic qualities (Brozovsky *et al.* 2008, Asif 2009). Timber constructions are typically lighter and more flexible than their stone counterparts (Tosi 2010). Additionally, timber is optimally utilized in construction when it bears a significant portion of its weight, thanks to its high strength-to-weight ratio (Ramage *et al.* 2017). Even in contemporary contexts, timber bridges are

CONTACT Zeliha Tonyali zeliha.tonyali@erdogan.edu.tr The Faculty of Engineering and Architecture, Department of Civil Engineering, Recep Tayyip Erdogan University, 53100, Rize, Türkiye
*Both authors are co-first authors

© 2025 Informa UK Limited, trading as Taylor & Francis Group

PROOF