

Designing on Existing Bridges: A Paradigm of Sustainability Applied to Civil Engineering

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Abstract

One of the areas where the bridge designer has a real influence on the sustainability of the performance is in the widening of existing bridges. The use of the structure is always beneficial from an environmental point of view as the life span of the bridge is increased by using the existing structure. A good example of this is the widening of bridges. The article includes examples of the widening of three different structural types: a stone arch bridge, a prestressed concrete bridge with box section and a cable-stayed bridge. In all three cases, the existing structural systems have been used thanks to the team's willingness and knowledge of the techniques associated with bridge maintenance and preservation.

Keywords: Sustainability; widening; vaulted bridge; concrete box deck; external prestress; cable-stayed bridge.

1 Introduction

The concept of sustainability is closely related to the optimisation of resources. In engineering, once it has been decided to build a project (the what), it is necessary to move on to the how. This how will always involve CO₂ emissions over which the engineer has minimal control. Saving materials is always a condition for any project that can be called an engineering design. Engineers understand nature's resources are scarce and that it is our duty to optimise their use. The bridge designer has a minimum palette of materials to use: concrete, steel or a combination of both. Sustainability will be determined by the logical use of these materials according to the span of the bridge and its type. Therefore, the mere accounting and comparison of CO₂ emissions will not help us to analyse sustainability, which includes the long-term use of the structure.

The control of CO₂ emissions is in any case one of the basic premises of any current design, however, the control or reduction possibilities, in bridge engineering is minimal because only two basic materials are available. It is the manufacturing processes of these materials that are the fundamental aspect that can be influenced. The designer's task will be to choose from the range of concretes, for example, those with the lowest CO₂ emissions.

However, there are other factors that are often not included in the analysis of the sustainability of a project, and which are much more important, as they can condition the future of an area and therefore of part of the local population. For example, the position of the piers of a bridge over a river or a vertical clearance that limits navigation in the medium and long term can have a negative influence on local development and can therefore make the project unsustainable in the not too