Materials in bridge engineering: creating a more sustainable future

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Abstract

Building infrastructures are essential to the future of cities and urban growth. Since material is the gateway to the realization of bridge design concepts, it plays a vital role in Bridge Engineering. The journey towards future encompasses a key leading driver, Sustainability, that will have an impact on our long-standing engineering practice and shape the future to a more efficient and resilient one.

In this paper, we present principles that show in which direction is the future of materials in bridge construction heading to. For examples, how to optimize materials performance, how materials can contribute positive influence on sustainability, how to reduce materials consumption and how to extend the life span of bridges? Project references based on each principle demonstrate the know-how to create a more sustainable future.

Keywords: Bridge Engineering; Materials; Greenhouse Gas Emissions; Climate Change; Sustainability; Carbon Reduction; Digitalization; Modular Construction; Additive Manufacturing; Rehabilitation.

1 Introduction

1.1 Functions of Materials

Materials contribute not only to the aesthetics of the built structures. They are also characterized by a broad spectrum of properties to serve different structural design purposes. With the right selection and proper utilization of materials in combination with appropriate construction methods, the optimization of structural performance is possible.

Bridges are often perceived as a state-of-the-art landmark that defines the attributes of complexity and elegance. Materials demonstrate architectural possibilities and design versatility through different engineering forms and physical shapes.

The evolution of bridges has come a long way and so does the change of resource availability to construct a bridge. From using local natural materials of timber, stones and clays in the past, we now have wider choices of processed and engineered materials like concrete and steels performing different properties to suit for a specific function. Alongside the benefits of having plentiful material choices, it comes with the need to source and procure the materials on a global scale. The environmental footprint such as embodied carbon (*) becomes a key impact on the environment and our society.

(*) Embodied carbon refers to greenhouse gas emissions produced during a structure's lifecycle. Fundamental stages include: Extraction and Processing of Resources, Manufacturing, Construction, Operation (i.e. Replacement or Maintenance) and Decommissioning.

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