# High performance composite bridge concept with cellular decks

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## Abstract

This paper looks at the possibilities that a novel composite bridge concept has to offer for road bridges using high-performance materials and a cellular deck in combination with structural control. Here, live loads dominate the design, with their dynamic actions mitigated through structural control. This is similar to many modern pedestrian bridges that could not function properly without some sort of structural control (usually TMDs), and where we now find elegant large-span designs, which were impossible before. It thus has the potential to build more slender and cost-efficient structures and achieve bridge spans that go beyond those in use today.

**Keywords:** composite bridges; structural control; high performance materials; cellular decks.

## 1 Introduction

A substantial reduction in dead load has the potential of cutting costs and extending spans of road bridges considerably. The latter is of particular importance for elevated roads, where the support structures often dominate the costs: a 50% increase in span without increasing the dead load could easily reduce costs by 40% or even 60% in such cases.

This paper presents an idea how this could be achieved in the future with high performance materials, an innovative cellular deck design and structural control to take care of the inevitable vibrations that accompany such slender designs.

## 2 General concept

The concept is illustrated in Fig. 1 and Fig. 2 using 200 MPa UHPC in a cellular deck in composite action with 685 MPa high-strength steel truss girders. It reduces the dead load for a typical span of 70 m to 64% when compared to a conventional composite bridge. Or it can increase the span 50% without increasing the load on the supports.

The given geometries of the cellular deck and the steel truss are preliminary: They can and should be further optimized.

The steel trusses can serve as rails to support a machine that continuously extrudes the deck, as is done in prefabrication of cellular slab elements. That way, a continuous deck can be produced with a high degree of automation.

## 3 The need for structural control

One likely problem arising from this lightweight design is a vulnerability to dynamic actions: Vehicles are active shakers, having now a much higher mass ratio (live mass / dead mass) than in conventional road bridges. It must be expected that this causes vibrations affecting drivers and reducing the fatigue life of the bridge.

To cope with this, structural control is the obvious choice today. Passive TMDs (Tuned Mass Devices) are now standard solutions in most pedestrian



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