Master's Thesis Engineering Technology

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Load bearing capacity of compound box or I-girders with corrugated steel web

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INTRODUCTION

Since being pioneered in France in 1986, prestressed concrete girder bridges with corrugated steel webs have emerged as one of the most promising forms of steel-concrete compound bridges. To know what properties to use for the composition of the box or I-girders to build these bridges, research to determine the load bearing capacities of the girders is necessary.

PROBLEM STATEMENT

For economic reasons and for optimal use of the available space, architects and engineers continually push the boundaries of construction designs and construction materials. Therefore, it is important to search for innovations that create the possibly to do so.

Figure 1 presents a schematic diagram of a possible corrugated steel web prestressed concrete box girder composition used in bridge constructions. The collaboration of the concrete flanges and the steel corrugated web forms a low self-weight element with a high load bearing capacity and a large possible span.

To know the possibilities of this compound element, research must be conducted into the composition and the associated properties.

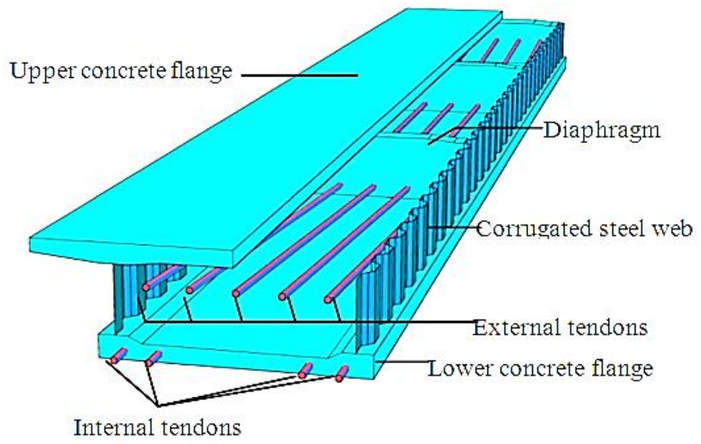

Figure 1: Schematic representation of a corrugated steel web prestressed concrete box girder [1]

OBJECTIVES

The aim of this project is to create numerical models to investigate the structural behaviour of composite and hybrid girders and to define the load bearing capacities with FE simulations. Further aim is the investigation of what influence the web thickness, the load situation and the girder type (hybrid or composite) can have on the load-deflection behaviour and the ultimate loads. Another main objective is predicting the behaviour and the maximum tolerable loads of the specimens during the experimental tests. The experimental setup must be checked and the possibilities of the Structural Laboratory at BME must be verified. A simplified scheme of the load situations used in this project is presented in Figure 2. *L1* and therefore also *L2* define the difference between the load situations.

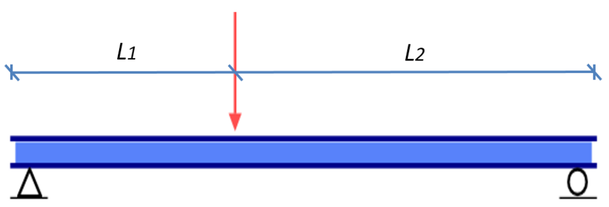

Figure 2: Simplified scheme of the load situations, which differ based on L1 and L2.

METHOD

1. Collection background information
2. Composing capacity formulas
3. Performing hand calculations
4. Creating FE-models
5. FEM analyses
6. Verification of the results
7. Comparing study

RESULTS

Hand calculations: The ultimate loads (crushing of concrete and/or yielding of steel) of all girders according to the Eurocode are calculated (see Figure 3).

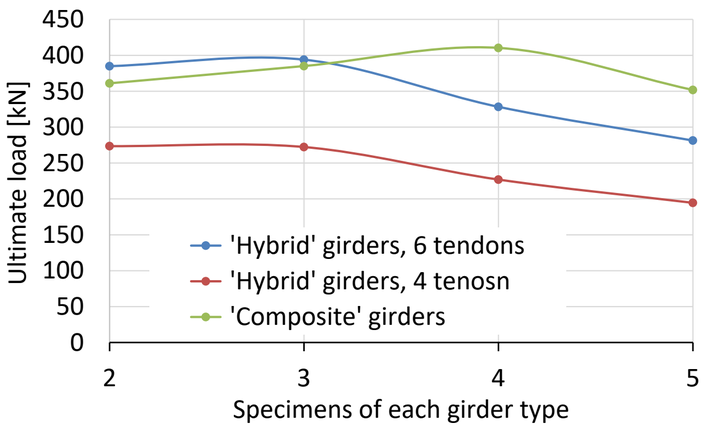

Figure 3: The ultimate loads according to the Eurocode

Numerical models: Models are made for all under investigation hybrid and composite girders. Figure 4 presents a hybrid model fabricated for analysis in ATENA.

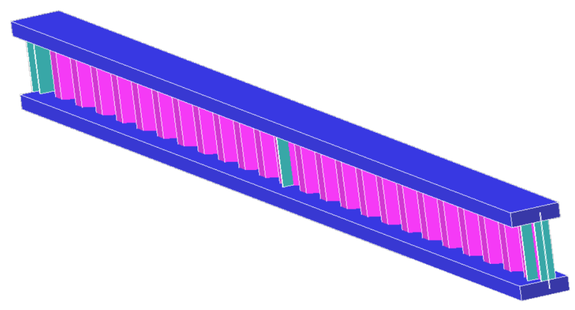

Figure 4: Composite girder modelled in ATENA

FEM analysis: The behaviour of all composite girders is predicted with ANSYS and compared in a combined load-deflection curve (Figure 5).

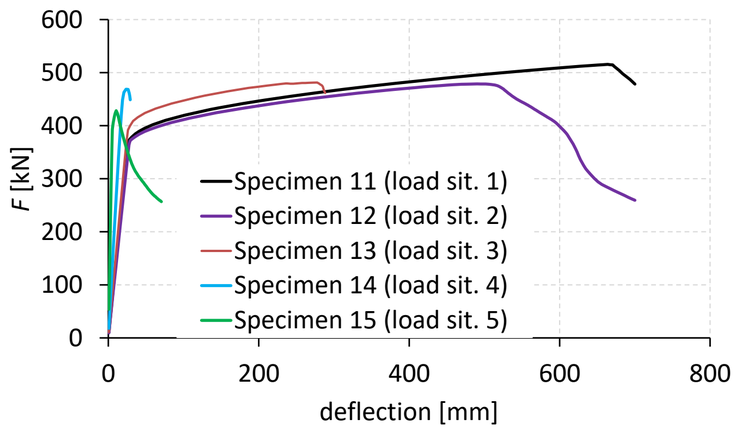

Figure 5: Combined load-deflection curve of the composite girders created in ANSYS

CONCLUSION

The hand calculated ultimate loads are compared with the numerical analyses performed in ANSYS and ATENA. The behaviour of the girders and the maximum loads are discussed and with this information an answer is given to the sufficiency of the Structural Laboratory at BME for the experimental phase.

[1] X. C. C. R. J. J. T. H. Francis T. K. Au, „Full-range and Long-term Behaviour of Prestressed Concrete Bridges with Corrugated Steel Webs," Scientific & Academic Publishing, 2017.

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