



Applied Plasticity Methods for Design of the Concrete Substructure at Mersey Gateway Bridge

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Abstract

The state of development of FE-programs in practical design of reinforced concrete structures has not yet advanced to such a level that the design and verification of concrete bridges can be carried out solely on the basis of FE-programs. For this reason the approach viaduct substructure of the Mersey Gateway Bridge located in Northwest England was designed by applying plasticity methods, which yielded a cost-effective and intuitive design. The methods which included both lower bound and upper bound solutions, were found to be an effective design tool and resulted in both simple and economical reinforcement designs. This paper presents how these methods have been applied within the Eurocode 2 framework.

Keywords: Concrete, bridges, substructure, plasticity, lower bound, upper bound, design.

1 Introduction

The Mersey Gateway Bridge is a 2,25 km long major estuary crossing of the River Mersey close to Liverpool in UK. The bridge is part of a wider upgrade of the highway network in the area [1], [2].

The bridge consists of a main cable stayed bridge with three mono pylons (spans 181 m + 294 m + 318 m + 205 m) and a North and South Approach Viaduct (706 m and 544 m, respectively). The pylons are supported on spread footings whereas the piers of the approach viaducts are supported on piled foundations. For both the main crossing and the approach viaducts the bridge girder consists of a single cell trapezoidal box.

Both the superstructure and the substructure were designed using reinforced concrete in order

to achieve an economical yet aesthetically pleasing and slender structure – see Figure 1. Its slender appearance and clear visual lines will be a new landmark structure for Northwest England.



Figure 1: Rendering of the substructure (courtesy of MerseyLink)