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AXIAL ROTATION OF STEEL TUBULAR ARCH SPRINGS CONNECTED TO CONCRETE ABUTMENT

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SUMMARY

Torsion stiffness of steel tubes connected to concrete remains an issue. Three preliminary experiments, including strip and stud connectors demonstrate the failure mechanisms. From the first loading a composite action of steel and concrete exists. Failure of strip connectors is due to exceeding compression of the surrounding concrete, followed by high pressure in the contact area between both materials and final failure due to yielding of the steel strips as reinforcement of the composite cross-section. Failure of stud connectors occurred prematurely due to concrete splitting at the contact area of the stud shaft. This is avoided by normal reinforcement, provided it interacts with the studs. Application of the test results by scaling to the case of a recently built steel arch shows that its connection with internal headed studs does not contribute to torsion stiffness. However scaling of the test results demonstrates that the arch spring almost behaves as in free torsion condition.

Keywords: *Arch bridge, connector effectiveness, arch spring torsion, torsion stiffness, experiment arch clamping, strips stud connectors, rotational stiffness.*

1. INTRODUCTION

Tubular arch bridges are highly valued for their aesthetical value and structural stiffness. The arch springs are of paramount importance since they transfer the various reactions from the bridge superstructure to the abutments. The most important reaction is the arch thrust force, together with the vertical reactions. Whether bending moments are transferred to the infrastructure at the arch springs, depends on the use of hinges or clamping. A particular reaction is the torsion moment. Since the torsional capacity and stiffness of circular sections are rather high, large torsion clamping may be expected. The experience of Woluwe Lane Bridge near Brussels [1] has demonstrated that torsional clamping may not be entirely efficient and small angular rotations may occur, in case of clamping by prestressing bars. As an alternative, clamping by steel-concrete connectors may be considered. This has recently been applied to 2 bridges, the general idea being to attribute a certain type of connector to resist one or several types of reactions. A picture of this principle is shown in Fig. 1. The strips, welded to the 1.6 m diameter tube are equipped with headed studs and resist tensile force due to bending, whereas the rings effectively resist normal thrust compression force. Shear is transferred from the steel tube to the concrete abutment by the interior concrete and limitation of contact stresses. As for the torsion moment, it is resisted by both the welded strips and the headed studs. In the case of Figure 1 the torsion moment was rather low and the torsion stiffness was not a real issue.

The aim of the current research is to verify the torsion capacity of a steel tube connected in concrete by 2 different types of connectors. In particular, the strip and headed stud types were to be tested. In addition, it was expected that the tests would give useful indication on how to improve the concept of reinforcement at the connection of the tube and concrete abutment.

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