VERIFICATION OF MECHANICAL SUPPORT FOR CABLES USED ON BRIDGE STRUCTURES AT DILATION POINTS

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ABSTRACT

This paper describes a series of experiments developed to evaluate the mechanical performance of a cable-supporting transition structure designed to accommodate bridge structure dilation. A full size prototype of the bow spring structure was commissioned and a series of experiments were undertaken to study the mechanical behaviour of the structure. In addition to generating essential data for validating the design of the structure, the experiments yielded valuable results relating to the mechanical behaviour of the structure as well as the effects of dilation on the mechanical integrity of the cable.

KEYWORDS

Transition structure, dilation, cable, curvature.

INTRODUCTION

One of the most significant challenges for cable performance and reliability is where there is a change of condition. Examples are where cables are jointed and terminated, transferred from direct buried to in-duct, from in-air to in-ground, horizontal to vertical etc. One of the most difficult conditions is often where cable might be subjected to additional forces such as bridge structure dilation. In such cases, the uniqueness of the structure calls for a unique solution. In the case presented here, the original bridge design did not include the possibility of additional loads to be carried by the installation of cables onto the structure. A special steel structure, to support a double circuit with 1600mm² 132kV XLPE cables across the entire span of the bridge, was designed to be suspended from the bridge.

At the bridge expansion points where bridge dilation occurs, a structure was specially designed as a pair of pin-jointed curved beams. In order to validate various design criteria, as well as to better understand the mechanical behaviour of such a unique structure, a series of original experiments were designed and undertaken. The experiments were aimed at investigating the effects of dilation on the forces and bending moments generated within the structure as well as the forces transmitted to the bridge structure under a range of conditions were studied. The effect of repeated applications of full extension-contraction cycles, representing deformations due to annual extremes in temperature, to the structure and the cables was investigated. In addition, the flexural characteristics of the cable were investigated and the paper shows how cable curvature was used to estimate the bending strains and stresses within the cable.

Finally, experiments aimed at characterising the vibratory behaviour of the transition structure as well as recommending and validating a practical and effective vibration mitigation strategy.

EXPERIMENTAL ARRANGEMENT

A full size prototype of the transition structure (fig. 1) was commissioned to experimentally validate the design analysis. Two specially designed frames were fabricated to provide a rigid support for each extremity of the bow spring. One frame (located at the dead end of the loading frame) was firmly anchored to the laboratory's concrete floor and the other (located at the live end of the loading frame) was

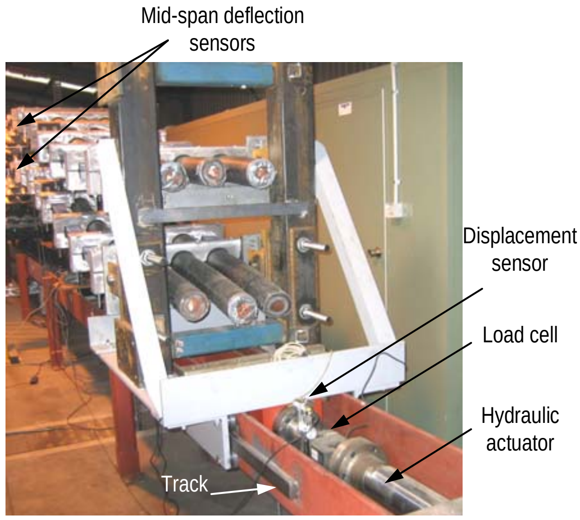

Figure 1: Prototype and test rig.

mounted on low-friction tracks and connected to a hydraulic actuator via a force sensor. Both frames were designed so as not to deflect more than 0.5 mm at full load. This was verified experimentally using dial gauges which indicated deflections inferior to 0.3 mm (longitudinally and laterally) at a height corresponding to the load axis of the bow spring. Longitudinal deformation simulating dilation was applied using the hydraulic actuator.

The prototype transition structure and the supporting frame were fitted with an array of strain gauges and displacement sensors in order to determine their mechanical behaviour under simulated dilatation of the bridge structure (fig. 2).