Design, Implementation and Field Test of the Adaptive Damping System of the Franjo Tudjman Bridge nearby Dubrovnik, Croatia

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Summary

Strong wind combined with wet snow evoked estimated cable vibration amplitudes of the stay cable Franjo Tudjman Bridge nearby Dubrovnik, Croatia, up to 1-2 meters at mid span. The bridge had to be closed and some cables were damaged substantially. The bridge owner decided to install cable dampers in order to prevent cables from premature material fatigue and to ensure high public confidence in the safety of the bridge. Then, the authors started to design, manufacture, install and finally test the adaptive cable damping system which is based feedback controlled magnetorheological fluid dampers. This paper describes all steps required to eventually have a cable damping system that is optimally tuned to the cable properties. The decay measurements clearly demonstrate that MR dampers, whose force is feedback controlled according to the friction force control law, provide mode and amplitude independent damping of 80% efficiency.

Keywords: Cable, control, damper, logarithmic decrement, magnetorheological fluid damper.

1. Introduction

In spring 2005, strong storms with wet snow lead to estimated mid span amplitudes of 1-2 meters of the stay cable Franjo Tudjman Bridge nearby Dubrovnik, Croatia (Fig. 1). The bridge had to be closed for traffic and pedestrians. Moreover, the PE-shell and some strands of some cables were damaged substantially. The bridge owner Croatian Roads then decided to install cable dampers in order to enhance the cable damping. The cable damping system consists of feedback controlled magnetorheological fluid dampers (MR damper) which are mounted on the longest six stays and on all back stays (Table 1). The stays 7-10 are not equipped with dampers due to their shortness and inclination. The bridge owner agreed to connect the dampers 3.5 m above bridge deck to the cables.

Table 1 *Stay cable properties of Franjo Tudjman Bridge.*

stay no.	1	2	3	4	5	6	11	12	13	14-19
L [m]	222	203	185	166	145	131	73	85	99	121
T [kN]	6751	5433	4461	3904	3500	3462	2124	2372	2996	6093
m [kg/m]	87.56	87.56	70.74	70.74	70.74	56.58	39.35	39.35	56.58	87.56
a/L [%]	4.05	4.12	4.25	4.38	4.53	4.58	4.92	4.88	4.78	3.96
δ_{theo} [%]	12.7	12.9	13.4	13.8	14.2	14.4	15.5	15.3	15.0	12.4

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