A Parametry Study on the Dynamic Behavior of Cable Supported Bridges Under Moving Loads Affected By Accidental Failure Mechanisms

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Abstract

The dynamic behavior of cable supported bridges subjected to moving loads and affected by corrosion and accidental failure mechanism in the cable suspension system is investigated. The different types of cable supported bridges are distinctively characterized by the configuration of the cable system [1]. The suspension system comprises a parabolic main cable and vertical hanger cables connecting the stiffening girder to the main cable. The cable stayed system contains straight cables connecting the stiffening girder to the pylon (Figure 1 and Figure 2). Both system are frequently employed in the context of long spans, leading to slender structures, in which, typically, the dead loads are comparable with those involved in the live load configuration. As a consequence, the external loads are able to produce high amplifications of the main bridge kinematic and stress design parameters, leading to non-standard excitation modes and unexpected damage mechanisms in the structural components of the bridge [2,3]. As a matter of fact, cable-supported structures are, typically, affected by degradation effects such as corrosion, abrasion, and fatigue, which may cause a reduction of the stiffness properties or, in extreme cases, the complete failure of a single or multiple cable elements [4-5]. The main aim of the paper is to quantify, numerically, the dynamic amplification factors of of cable supported bridges subjected to moving loads and affected by an accidental failure in the cable suspension system. In particular, a parametric study of typical design bridge variables is developed in terms of the structural property of the bridge components and failure mode characteristics. The basic formulation is based on a tridimensional schematization by using a finite element approach. It is developed by using a geometric nonlinear formulation in which the effects of local vibrations of the cables as well as of large displacements in the girder and the pylons are taken into account. Explicit time dependent damage laws, reproducing the corrosion phenomena and the failure mechanism in the cable system, are considered to investigate the influence of the damage mode characteristics on the dynamic bridge behavior. Moreover, the analysis focuses attention on the influence of the inertial characteristics of the moving loads, by accounting coupling effects arising from the interaction between bridge deformations and moving system kinematic. Sensitivity analyses have been proposed in terms of dynamic impact factors comparing the dynamic behavior between cable-stayed bridges and suspension bridges. In particular, the effects on the dynamic bridge behavior produced by the external mass of the moving system, the tower typologies in the case of the cable-stayed bridges as well as the damage mode characteristics involved in the cable system are investigated by means of comparisons between damage and undamaged bridge configurations. Finally, the study has focused the attention on the

possibility of using a combined suspension and cable stayed system to improve the structural performance of existing suspension bridges.

Reference

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Figures used in the abstract

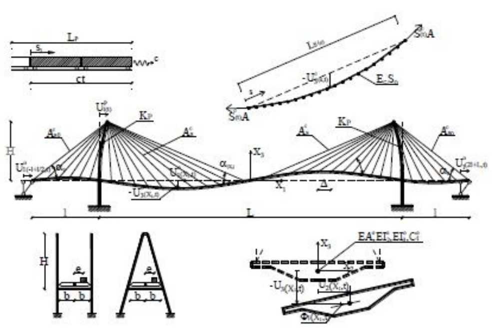

Figure 1: Cable stayed bridge scheme: bridge kinematic, pylon, girder and cable system characteristics.

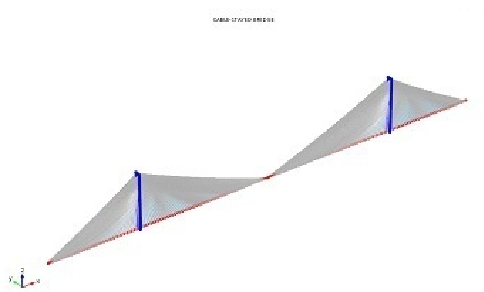

Figure 2: Cable-Stayed Bridge: COMSOL finite element model.