Experimental Characterization and Identification of the Shear Hysteretic Behavior of a Helical Wire Rope Isolator

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Abstract. We experimentally characterize a helical wire rope isolator to study its complex hysteretic behavior along the Shear direction. The asymmetric force-displacement hysteresis loops are simulated by using two different models: a differential one, obtained by a generalization of the Bouc-Wen model, and an exponential one, denominated Vaiana-Rosati model. In particular, their parameters are first identified on the basis of the experimental data; subsequently, the accuracy of the two models is verified by comparing the simulated hysteresis loops with those obtained experimentally.

Introduction

Helical Wire Rope Isolators (HWRIs) are metal devices made up of a stainless steel cable and two aluminum alloy or steel retainer bars where the cable is embedded. They can be effectively adopted for the vibration control of museum artifacts, hospital equipment, electrical transformers, supercomputers, and intermodal containers.

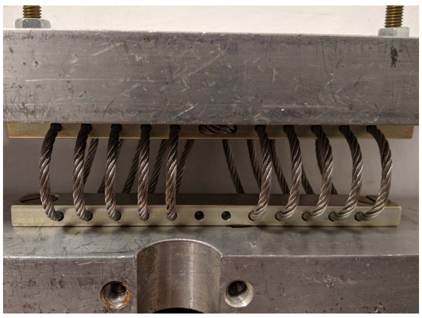
The main aim of this work is to study the experimental behavior exhibited by a HWRI prototype when it is tested along one of its principal transverse directions, denominated Shear direction. In addition, two recently formulated hysteretic models [1, 2, 3] are proposed to reproduce its complex response and the related parameters are identified on the basis of the experimental data.

Experimental tests

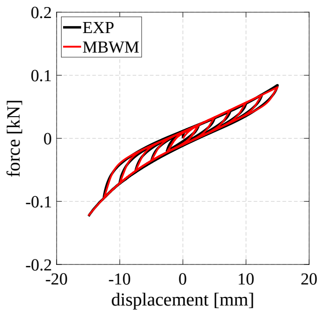
Figure 1a shows the tested HWRI prototype which differs from similar devices, already studied in previous experimental campaigns [4], because of the different way its stainless steel cable is mounted.

The experimental tests have been performed at the Department of Structural and Geotechnical Engineering of the Sapienza University of Rome.

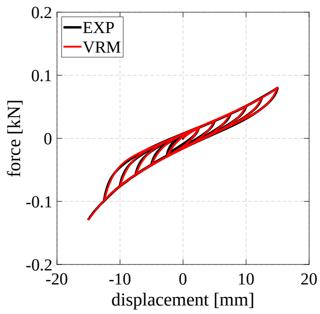
Figure 1b, or equivalently Figure 1c, illustrates the typical asymmetric restoring force-displacement hysteresis loops (black line) characterizing the device response when a transverse displacement is applied, along the Shear direction, for six different values of amplitude.



(a)



(b)



(c)

Figure 1: Tested HWRI (a); comparison between experimental responses and those simulated by the MBWM (b) and VRM (c).

Identification and Simulation

In order to simulate the complex device response, two hysteretic models are proposed. The first one represents a Modified Bouc-Wen Model (MBWM), developed by Carboni et al. [1, 2], whereas the second one is the so-called Vaiana-Rosati Model (VRM), recently formulated by Vaiana and Rosati [3]. The MBWM is a differential model that adopts 11 parameters, whereas the VRM represents an exponential model based on two independent sets of 8 parameters that control, respectively, the loading and unloading phases.

Figure 1b (Figure 1c) compares the experimental hysteresis loops with those simulated by using the MBWM (VRM). Such comparisons confirm the accuracy of both models.

References

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