Investigation on the effect of unbalanced actions to the dynamic response of experimental superconducting magnetically levitated bogie

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This article presents the non-linear dynamic analysis on the effect of unbalanced actions to the response of UAQ4 superconducting magnetic levitation experimental vehicle (Fig. 1).

The UAQ4 is an under developing maglev train project, the suspension and propulsion devices of which were developed, patented and successfully laboratory tested at the University of L'Aquila (Italy) [1]. The UAQ4 suspension and guidance are based on the superconducting magnetic levitation (SML) technology that implies the use of bulk high-temperature superconductors (YBa_2Cu3O_X) properly set in the four bogie "skates" interacting with permanent magnets ($Nd_2Fe_{14}B$) distributed on two guide-ways of the track. As a result, the bogie floats in a stable condition above the track without any control system.

The dynamic interaction between vehicle and guideway represents a key and complex phenomenon that can be deeply studied for better understanding unsolved problems that are typical of a new technology development. Previous studies and tests on the dynamic behavior of various configurations of SML experimental systems were also performed by several authors.

The UAQ4 system dynamic behavior was already preliminary studied at standstill condition by performing models with one and two degrees of freedom [2]. Additionally, the dynamic parameters such as damping coefficients and natural frequencies of system were tested by a modal identification method based on the use of an external pulse excitation acting on the bogie.

The non-linear dynamic simulation of the suspended experimental bogie acted by unbalanced forces was conducted by carrying out a six degree of freedom model. The results are presented and discussed in terms of vibrations.

Figure 1. UAQ4 experimental system

[1] Lanzara G, D'Ovidio G, Crisi F. UAQ4 Levitating Train: Italian Maglev Transportation System. IEEE Vehicular Technology Magazine. 2014 9(4):71 -77.

[2] D'Ovidio G, Carpenito A. Dynamic Analysis of High Temperature Superconducting Vehicle Suspension. Journal of Superconductivity and novel Magnetism. 2015; 28(2):591-595