NOVEL TYPE OF INERER BASED VIBRATION ABSORBER: CONCEPTUAL DESIGN AND PRACTICAL REALIZATION

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1. Motivation

According to territorial limitations, mainly in Asia, cities have to be built even on adverse environment. Moreover in Asia one have to take into accout the possibility of the earthquakes during design of the structure. Typically it is impossible to create structure capable to resist all external excitation without additional damping device. Nowadays studies concerns possibility to use optimized tune mass dampers (TMD) [1, 2]. Nevertheless TMD has finite effectiveness which depends from excitation frequency. Unfortunately non-constant excitation frequency reduces its' performance. In order to overcome that weakneses we propose new type of vibration absorber with inerter [3, 4]. Characteristic feature of the device is ability to stepless changes of inertance. The response adjustment is possible due to use of continuously variable transmission and gear ratio control. Presence of both systems gives accurate changes of inertance.

2. Main results

We examine the damping properties of the proposed tuned mass damper with respect to one-degree-of-freedom harmonically forced oscillator. Our investigation concerns numerical modelling and real laboratory tests. General performance of the device is proved by considering three different stiffness characteristics of damped structure i.e. linear, softening and hardening. We use the frequency response curves to present how considered devices influence the dynamics of analysed systems, demonstrate their capabilities and broad spectrum of applications. Numerical results show excellent level of vibration reduction in an extremely wide range of forcing frequencies (for details and equations of motion see [4]). Addition of additive and parametric noise has no influence on the device performance and leads to real application possibilities. Results for the system with vibrational absorber and presence of additive and parametric noise can be seen in Fig. 1.

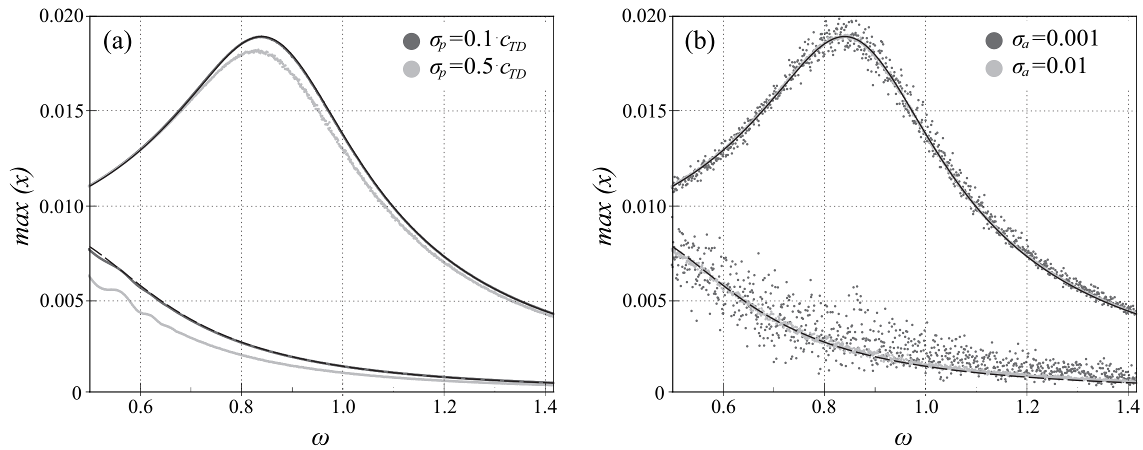

Figure 1. The response of system with softening spring characteristic (a) parametric noise and (b) additive noise. The black lines indicate the FRCs for system with vibrational absorber fitted. Light and dark gray dots correspond to response under presence of noise.

3. Vibrational absorber design

The body of the device presented in Fig. 2 is constructed as a combination of the two parallel plates - namely plate (1-p1) and (1-p2)- positioned vertically and integrated with two smaller parallel plates: (1-p3) and (1-p4) positioned horizontally. Lower horizontal plate (1-p3) is used to mount the device on a structure that vibrations we want to mitigate. The upper horizontal plate (1-p4) has a handle that is used to mount spring (2). The other end of the spring (2) is anchored to plate (3). This plate (3) is connected to gear rack (4) guided in two sliding supports (5) that are mounted in vertical body plates. Thanks to that, massive plate (3) together with gear rack (4) can move in direction of the axis of the device and function as a moving element of TMD. Gear rack (4) cooperates with toothed gear (6) that is affixed on the drive shaft (7) of CVT (8). Flywheel (9) that accumulates energy is mounted on the driven shaft (10) of the CVT. Bearings (11) of both transmission shafts are mounted in vertical body plates.

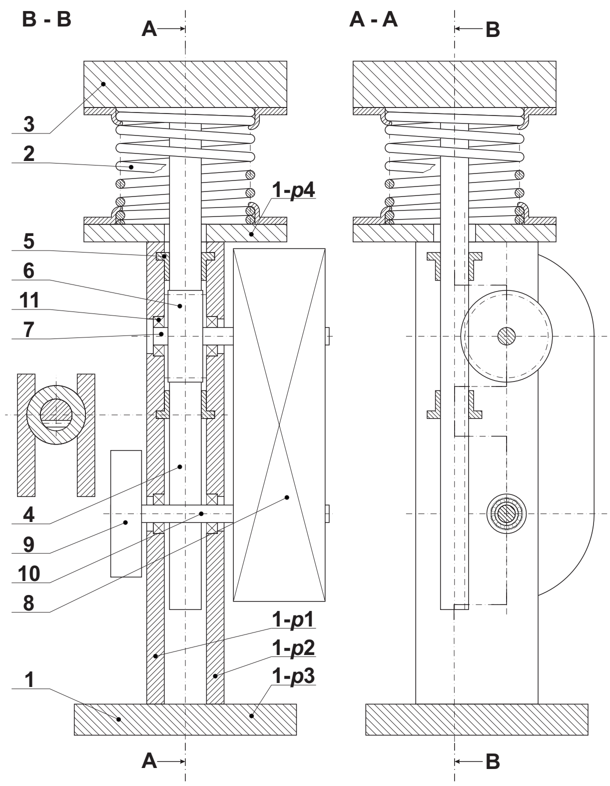

Figure 2. Assembly drawing of the proposed vibration absorber.

4. References

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