Design Catalog for Adjustable Stiffness, Damping and Impedance elements

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Abstract

This publication presents a design catalog of adjustable stiffness, damping, and impedance elements. Adjustable impedance elements are machine elements that consist of a separately adjustable stiffness mechanism and damping mechanism. The attached selection catalog gives information about installation space, standardized interfaces, degree of freedom, control possibilities, range of frequency, range of stiffness and damping, inertia, load range, displacement, working principle, used material, manufacturing technique, and manufacturing costs. Scientists or developers who are conducting their own research on adjustable impedance elements or who need specific impedance elements for their test benches will be supported in the selection of elements, their design, and their use. Future developers of such elements can extend this catalog but are required to fill in the information on all criteria and adhere to the given standardized interfaces.

Description of the catalog

Adjustable stiffness, damping, and impedance elements are machine elements that are used as interface elements in vibration testing [Hey18]. For this purpose, both the boundary conditions of the test environment and the mechanical characteristics are relevant. The AIE must be mounted between the vibration-exciting structure and the test object. The installation space is limited in most cases. In addition to the installation space used, the standardized interface is necessary to allow combinability and communal use [Kra18]. As shown in figure 1 the elements are standardized at the axis (14 mm outer diameter and M8 internal thread) and the cylinders (60 mm bolt circle with four M6 threads). Furthermore, it is decisive for the elements which degrees of freedom are adjustable and which are guided; here a distinction is to be made between translatory and rotatory properties. The adjustment of the elements can be controlled manually or electronically.

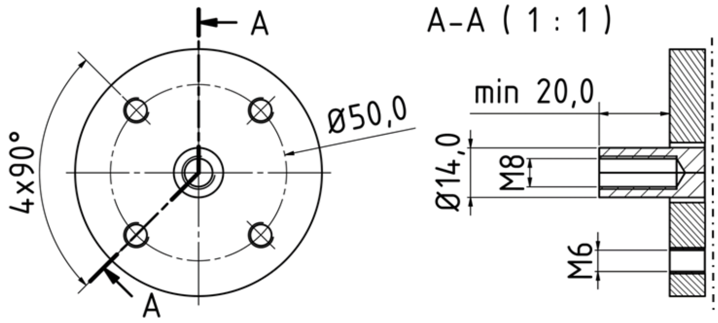

Figure 1: Defined standardized interfaces for ASE, ADE and AIE.

The large number of AIEs developed and their measurement evaluation have made it clear that the setting of an intended mechanical variable usually achieves reliable parameters only for limited ranges. A deviation from reliable behavior can be due to non-linearities caused by friction [Lin22], component vibrations in the adjustment mechanism, or force flow [Hey23], as well as coupling back from attachments.

The mechanical properties of the elements must be specified. For the stiffness elements, the adjustable range of stiffness is decisive; for the damping elements, it is the range of damping; and for the adjustable impedance elements, these are both adjustable properties. For use on vibration test benches, the mechanical properties of the AIEs must be known over wide frequency ranges. Therefore, the AIEs must be examined as accurately as possible. Dynamic calibration of the test bench is therefore strongly recommended [Hey21]. The inertia resulting from the moving mass, the maximum loads, and the possible lifting distances must also be determined.

If the requirements for an AIE to be developed are of a similar order of magnitude to those of already documented and published AIEs, an adaptation can be carried out on the basis of their findings. For users with an understanding of engineering technology, knowledge of the working principle used is important. Furthermore, for the design and manufacture of a comparable AIE, the material used and the associated manufacturing process must be known.

In summary, knowledge of the following properties is necessary for the use of AIE: the installation space, standardized interfaces, degree of freedom, control, range of frequency, range of stiffness and damping, inertia, load range, and displacement. Furthermore, for developers of future elements, information about the working principle, used material, manufacturing technique, and manufacturing costs is of interest.

The selection catalog is attached as csv format to this publication. Future developers of elements that extend this catalog are required to fill in information on all criteria and adhere to the given standardized interfaces.

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