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Substructuring exercises on combinations of steel and aluminum components of the Benchmark Structure of the Technical Division on Dynamic Substructuring

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Extended Abstract

Much research has been carried out within experimental-analytical substructuring in recent history. Methods for coupling as well as decoupling in the frequency domain, i.e. Frequency Based Substructuring (FBS), the modal domain, known as Component Mode Synthesis (CMS) techniques and in the state-space domain have been proposed. [1]

A need for a simple yet challenging benchmark structure for experimental-analytical substructuring exercise was recognized within the Society of Experimental Mechanics' (SEM's) Technical Division on Dynamic Substructuring. The previous benchmark structure is detailed in [2]. A team with members from many research institutions was formed. Setting out from a number of desirable properties, a unit-frame structure was designed to form the base. The benchmark structure is built up by a frame and different kinds of plates. Together, they can represent structures from a variety of fields; automotive frames, wing-fuselage structure as well as building floors are examples of assemblies possible to represent by the benchmark structure. The frame is made as a one-piece structure, it consists of four units and includes 10/32 tapped holes that can be used to attach other components. In addition, 10/32 tapped holes are made on the side of the frame to attach impedance heads or force transducers.

The benchmark structure's components were designed to be made out of aluminum with threaded inserts. Sandia National Labratories has manufactured a number of frames intended to represent fuselages together with a number of plates representing a thin rectangular as well as thick rectangular wing. At Linnaeus University one set of components; a fuselage, a rectangular wing and a swept wing were also manufactured. These components were made from steel. Although that was not according to the design, it broadens the variety of the components available. Figure 1 shows the benchmark structure hardware during an experimental performed at Sandia National Laboratories.

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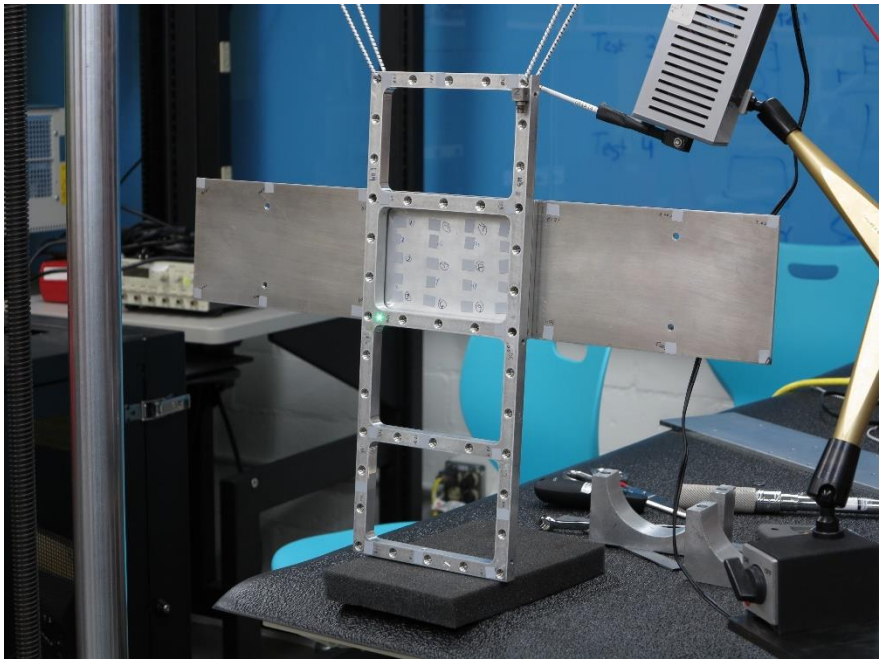

Figure 1. Benchmark Experimental Test

The success of experimental substructuring techniques are evaluated on different combinations of components. An assemble consisting of a steel fuselage with a rectangular steel wing is used to decouple the rectangular wing. The resulting data representing the decoupled fuselage are then coupled to data representing an aluminum rectangular wing, a steel swept wing and an aluminum swept wing in turn. The data representing the three thereby coupled structures are compared with test data from tests on the actual assemblies. The procedure is repeated although now setting out from an aluminum frame. Dynamic substructuring was first completed with all pieces developed at one vibration laboratory. This initial partnership is meant to be a representative example for future collaborations in the field of dynamic substructuring.

References

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