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COUPLED DYNAMIC LOAD ANALYSIS WITH DIFFERENT COMPONENT DAMPING OF THE SUBSTRUCTURES

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ABSTRACT

The condensation and coupling of mathematical models of damped substructures with different component damping demand for special effort. In the past, several approaches were implemented and tested. However, the coupled structures show a trend to unexpected and strange behaviour concerning the response behaviour. In this paper a new method, called Equivalent Structural Damping (ESD) approach, is presented. This method allows for a consequent introduction of damped substructures and yields well conditioned coupled systems. It includes a coherent condensation, coupling and coupled load analysis. The presented approach deals with simplified procedures for systems with small damping as well as with nonproportional damped systems. The phenomena are illustrated by a simplified example. The application of the ESD approach to the ATV project is presented and demonstrates the benefit of the method.

INTRODUCTION

The coupled dynamic load analysis of space transportation systems like Ariane 5 or the Space Shuttle makes use of the coupling of mathematical models of the substructures (solid propellant booster, liquid propellant stages, structural components, payloads) to build the mathematical model of the complete system that is object of the coupled load analysis.

An established method is the coupling of the undamped mass and stiffness matrices of the substructures and the introduction of diagonal system damping to the coupled system in a subsequent step. The steps are:

1. Condensation of the undamped substructures;