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A MULTICONTACT PROBLEM: THE VIRTUAL TESTING OF JOINTS FOR THE PREDICTION OF DAMPING

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ABSTRACT

The numerical simulation of multicontact problems plays an important role in many applications in mechanics [1]. However, when the number of contacts increases, their treatment using industrial finite element codes is nearly impossible. This is typically the case when attempting to study the dissipation due to friction contact in bolted assemblies, that are commonly used to join different parts of a structure.

This work is dedicated to the study of joints encountered in the space industry, particularly in the ARIANE 5 launcher, designed by ASTRIUM-ST, with whom this study was performed. Indeed, the modeling and identification of dissipation have become major issues in the dimensioning of space launchers because damping has a significant influence on the response of the structures near their fundamental natural modes of vibration [2]. The dissipation is relatively low in the materials which make up the launcher and is essentially localized in the joints [3]. Therefore, the objective of the present study is to propose a "virtual testing" strategy for the prediction of damping in the joints of the launcher.

The approach consists in the numerical computation of what we call a joint mesomodel possessing most of the actual joint's mechanisms. In this model, the contacts between the different parts of the assembly are described by Coulomb's friction law. The main difficulty of such a simulation lies in the large numbers of contacts and parameters (clearance, prestressing, friction coefficient, loading) that have to be taken into account to predict the dissipation accurately. Because of this, engineering finite element codes do not give satisfactory results either because they are too slow or because they are unable to calculate dissipation accurately.

Therefore, we used an alternative approach based on the LArge Time INcrement (LATIN) method [4] in its multiscale version. The treatment of contact problems using the monoscale version of the approach can be found in [9]. Herein, we focus on the multiscale aspects, using an iterative procedure involving the resolution of problems on both a refined "micro" scale and a homogenized "macro" scale

[5, 6, 7, 8]. Moreover, this approach belongs to domain decomposition methods and then is suitable for parallel computing.

A previous study [10] led to the development of a special experimental approach capable of identifying the damping contributions of several types of joints used in the space industry. This work defined the domain of investigation (strain, frequency, loading) and will be used as our reference to assess the capabilities of our numerical strategy through various simple test cases and one of the joints of the ARIANE 5 launcher.

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