MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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REDUCTION OF PROCESSING TIME AND HUMAN FACTOR EFFECTS DURING THE STRENGTH ASSESSMENT OF THE SPACECRAFT STRUCTURE

Abstract

A typical spacecraft structure has thousands of inserts and bolted connections, large number of secondary structure components such as brackets, supports, cleats etc. During the development phase a detailed analysis of each structural component shall be conducted in accordance with standard procedures considering large set of load cases. For a scientific mission this set may exceed 10,000 load cases when taking thermal loads into account.

Usually, bolts, inserts and other structural members are calculated separately using different tools and spreadsheets not connected between each other. In order to simplify the processing, some conservative assumptions are made, e.g. enveloping of the loads or grouping of the fasteners considering the worst case parameters; and then during the strength assessment some of these conservatisms are sequentially taken out when necessary. Since the analysis routines are independent, they are performed sequentially or in parallel with very limited interaction. In this case changes in the input parameters due to a conservative assumption are made only for the routine where the issue is detected.

This approach works well in theory. In reality the following factors are not considered:

- Due to the large dataset, the input is prone to human errors. The majority of the errors are identified during different steps; therefore changes of the input need be propagated in both forward and backward directions to other analysis steps. These changes might require reiteration of the entire procedure, causing schedule delays.
- Assessment of some parts involves interpolation of the forces for which both bolts and insert verification are required. Since no direct interfaces exist between the tools, these connections need to be either artificially created or simplified procedures are used. In either case it affects the overall consistency and input sensitivity.

In order to account for these problems, a systematic object oriented approach is proposed. The approach is based on two principles:

1. All different calculations shall be performed under supervision of a higher level procedure which allows interconnections between the subroutines.
2. The components should be grouped in accordance with their real application. For example, cleat verification comprises cleat strength calculation and assessment of the related inserts and bolts. It allows for consistent use of the verification procedures and reduced sensitivity of the inputs by excluding the necessity of the changes propagation.

The proposed approach is suitable for the strength verification of any type of space structures.