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PGD-VIRTUAL CHARTS FOR STRUCTURAL DESIGN

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Despite constant progress in computing power over the past years, experimental testing is still essential during design stage of industrial structures because numerical resolution of high sized complex models often remains out of reach. And even when it is possible, each new structure is considered as a new problem, and treated independently of cases previously studied. Therefore, a very large number of simulations have to be computed. The use of experimental testing combined to the calculation of many simulations increases time and financial costs. Hence, the reduction of these costs is a crucial industrial issue.

The idea is to create a numerical decision support tool, called "Virtual Charts", for structural design. For this purpose, similar structures, which differ from each other in the value given to a set of parameters, are put together into "families" and the full parametrized solution is computed offline for each family. Due to the fact that only some quantities of interest are needed for design, the problem is solved locally thanks to adjoint problems. The quantities of interest are, then, stored in "Virtual Charts", which will be used in real-time by the engineer during the design stage.

However the construction of these charts is still out of reach of standard Finite Elements methods. Therefore it was decided to build these charts thanks to a reduction model technique called *Proper Generalized Decomposition* (PGD). This method was introduced for the first time in 1985 by P. Ladevèze under the name "Radial Approximation" [1] in order to deal with time-dependent non-linear problems. It allows to generate the solution of a problem for a whole set of parameters and its efficiency was proven for time-space [2], multiscale [3], multiphysics [4] and parametrized problems [5]. An extended presentation of the PGD method can be read in [6] and a detailed bibliography in [7]. In the framework of this study in partnership with ASTRIUM-ST, the Virtual Charts are created to take into account geometry variations, which are a key point of the design process.

Here the geometry variations are considered as parameters in the PGD method [8]. Thanks to isoparametric elements, the problem is studied on a reference structure and a separated variable representation of the displacement is obtained through a progressive Galerkin algortihm. Promissing results were obtained on academical examples and on an industrial case, a filament-wound structure in composite material with metallic parts. Virtual charts were constructed for quantities of interest thanks to the PGD technique.

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