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Identification of parameters by inverse analysis using PSO and surrogate models: Kriging and PGD

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1. Abstract

This article presents an elegant and original method of identification of parameters by inverse analysis applied on an assembly with two adhesively bonded joints. The main problem of an inverse analysis using a direct Finite Element Code, FEC, is such that, according to the complexity of the case studied, the time cost consuming is too much important. That problem does not allow any efficient industrial applications applied to any either identification or optimization. Thereby, the solution is to carry out the identification process with an analytical function in lieu of direct FEC. This analytical function is obtained with Surrogate Models, SM. In this paper, a method coupling an optimization algorithm titled Particle Swarm Optimization, PSO, and SM such as either the Kriging Method, KM, or the Proper Generalized Decomposition, PGD, is presented to highlight the efficiency of this approach regards to two criteria: i) the decreasing of the Computational Time Consuming, CTC, and ii) the good accuracy of the identification process.

Inverse analysis is oftenly employed in engineering cases and the use of FEC is intensively increasing due to the complexity of the studied structures. Thereby, traditional inverse is prohibitive regards to CTC. This main drawback is due to the increasing complexity modeling of FE structures. Hence the use of inverse analysis process using the global FE modeling is a limit due to a both acceptable and reasonable CTC. That is why several methods of identification are now applied on analytical problem instead of direct FEC. Thus the idea is to generate a SM, which can provide rapid approximations of more expensive models. One important advantage of the use of SM is that optimization process is quickly performed. However, one drawback is that it will not be as accurate that individual FE simulation regards to the accuracy of the surrogate model.

Several methods to generate SM exist and attempt to direct design evaluation at promising designs trough optimization processes. The KM has been chosen because of the few number of data that are necessary to estimate an accurate SM. In the same way, the PGD have also given really good results in terms of approximated models [1]. This method directly generates an approximation of the solution in a separated form without any prior information. This characteristic is given an interesting advantage and the authors had also chosen and applied this model in this work. Fontan [2] programmed a code of identification of parameters by inverse analysis that is used direct FEC coupling with the PSO. This code has been enhanced by using SM such as either KM or the PGD in lieu of direct FEC.

Applied on an assembly made with 3 structures with two adhesively bonded joints, the objective is to identify the 5^{th} Young modulus by inverse analysis with accuracy. The results highlight that both KM and PGD gave accuracy identification with a few number of direct FEC. The probability of identifying accurate parameters to solve an engineering problem is high and allows an industrial application regards to either optimization or identification cases.

2. Keywords: Identification of parameters, Surrogate models, PSO, PGD, Kriging

3. References

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