PhD. Research Proposal (Dr. David BASSIR)

Title : Multicriteria optimization of Functionally Graded Plates under thermomechanical and dynamic loadings with sensitivity analysis of the porosity.

Functionally graded Beam and plate (FGSs) represent a class of novel structure in which compositions/constituents and/or microstructures gradually change along single or multiple spatial directions, resulting in a gradual change in properties and functions which can be tailored for enhanced performance. FGSs are of great interest to a larger range of industrial sectors and applications including automotive, biomedical implants, energy absorbing structures, geological models, and heat exchangers. However, little information in term of numerical analysis is commonly available that would allow engineers to predict the response of FGS such beam, plates and shells subjected to thermomechanical or dynamic non linear loading.

This work involves the multicriteria design optimization of Functionally Graded Plates FGSs through the thickness distribution for example and material selection. The FGSs is subjected first to thermomechanical loadings. The difficulties of such optimization is the nature of the parameters that can varies from integer to real which make the optimization problem non convex and discontinue to solve using common approaches. An efficient hybrid approach using genetic algorithm with parallel selection coupled with a surface response model will be used to overcome these difficulties.

Regarding the constraints, they are related to minimum of the mass and material cost of the FGSs. It is important to built functionally graded structures using adequate definition of the components volume fractions through the thickness direction in order to accomplish a certain structural behaviour. In our numerical model we may consider also the influence of porosity and imperfections. Final, in order to valid our final optimized model, a sample structure will be build and tested using functionally graded additive manufacturing .

Key words: Functionally graded plate, FGS, structural optimization, functionally graded additive manufacturing, dynamic analysis,

Requirements: The above research work will requires simulation and modeling and will be validated using functionally graded additive manufacturing.

References:

[1] S. Guessasma, K. Abouzaid, S. Belhabib, D. Bassir , H. Nouri. Interfacial Behaviour in Polymer Composites Processed Using Droplet-Based Additive Manufacturing. *Polymers*. 14(5):1013, 2022.

[2] Y. Boutahar, N. Lebaal, D. Bassir, A Refined Theory for Bending Vibratory Analysis of Thick Functionally Graded Beams, Mathematics, 9 (12), 1422, 2021.

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[4] F.X Irisarri, D. Bassir, JF Maire, N Carrere, Multiobjective stacking sequence optimisation strategy for laminated composite structures, Composites Science and Technology, 69, 983-990, 2009.

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博士课题研究计划（David BASSIR 博士）

标题：热力学和动态载荷下功能梯度板的多标准优化与孔隙率的敏感性分析

功能梯度梁和板（功能梯度材料，FGSs）代表了一类新型结构，其中的成分/组成和/或微结构沿着单一或多个空间方向逐渐改变进而导致性能和功能逐渐改变，能够实现为提高性能而定制的特性。越来越多的工业领域和应用方向对于 FGSs 技术产生了巨大兴趣，包括航空航天、汽车、生物仿生医学、电子装置、能量吸收结构、地质模型和热交换器。 然而，在数值分析方面，鲜有研究能够让工程师实现对于 FGSs（如梁、板和壳）在热力学或动态非线性负载下的反应的成功预测。

这项研究主要涉及到通过厚度分布和材料选择来优化功能梯度板 FGMs 的多标准设计，而 FGSs 首先受到热力学载荷的影响。这种优化的难点在于，优化参数从整数到实数分布不等进而导致了优化问题非凸性，无法诉诸于现有的常规优化方法。因此，本研究提出一种有效的混合方法，使用遗传算法与并行选择病结合卷积神经网络，以实现 FGSs 多标准设计的高效实现。

此次研究的约束条件主要与 FGSs 的最小的质量和材料成本有关。重要的是，为了实现定制的力学功能，通过厚度方向充分定义组件的体积分数来建立功能梯度结构，并在研究的数值模型中考虑孔隙率和缺陷的影响。最后，为了验证最终的优化模型，我们将使用功能梯度增材制造技术完成样品结构的制造和试验。

关键词：功能梯度板，FGMs，结构优化，功能梯度增材制造，动态分析。

要求：上述研究工作的候选者必须具备熟练数值仿真和 CAD 建模相关知识和技能，并将利用功能梯度的增材制造技术进行验证。

参考文献：

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