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Structural Analysis of GFRP Elastic Gridshell Structures by Particle Swarm Optimization and Least Square Support Vector Machine Algorithms

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ABSTRACT

The gridshell structure is a kind of freeform structure, which is formed by the deformation of a flat grid and the final shape is a double curvature structure. The structural performance of the gridshell is usually obtained by finite element analysis (FEA), which is a time-consuming procedure. This paper aims to present a framework for structural analysis based on the machine learning (ML) model in order to reduce computational time. To this aim, design parameters including the length, width, height, and grid size of the structure are taken into consideration as inputs. The outputs are the member-stresses and the ratio of displacement to self-weight. Therefore, a combination of two algorithms, least-square support vector machine (LSSVM) and particle swarm optimization (PSO), is considered. PSO-LSSVM hybrid model is applied to predict the results of the structural analysis rather than the FEA. The results show that the proposed hybrid approach is an efficient method for obtaining structural performance.

Keywords: **Particle swarm optimization, Support vector machine, Machine learning, Gridshell structure, Structural analysis**

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1.INTRODUCTION

Gridshell is a kind of spatial structure that covers large spans with the minimum amount of materials. Elastic gridshell structures have the potential to create different shapes of double-curvature structures. Structural damage reduction is an important concern for curvature structures. Thus, the structural analysis procedure is crucial for preventing structural damages. Several studies on gridshell have shown innovative strategies for designing gridshell structures (1–8). Researchers have conducted several studies in the field of gridshell structural analysis. Du Peloux et al. (9) employed the structural analysis for finding the shape in equilibrium and assess its strength, stability, and stiffness. According to the research on investigated examples, the impact of gravity and residual forces on created structures can be ignored (10). A posteriori simulation can be used to determine the effective mechanical response of the structure. Bouhaya (11) and Baverel et al. (10) demonstrated such formulations. Dimcic (5,12) developed gridshell structure optimization to achieve a stable and statically efficient grid structure. It was discovered that the combination of FEA and design process in an iterative approach might significantly decrease the gridshell structural stresses, displacements, and material of the structure, while enhancing the stability. Mesnil (13) implemented FEA in order to decrease the displacement