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Experimental Investigation of the Static and Dynamic behaviors of 3D-Printed Shell Structures

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Over the last years, several optimization strategies were conducted to find the optimal shape minimazing internal stress or total weight (volume) of shallow grid shells and vaults [1]. In recent times, this structure typology gained a great importance among researchers and the scientific community for the renowed interest in the form-findind optimization of column-free space solution for large span roofing construnctions [1]. In the present paper, a form-finding of a shollow grid shells was introduced basing on the multy-body rope approach (MRA) for the definitions of vaults with optimized shape and different hole percentage. In order to obtain an experimental validation, a physical model was reproduced at the laboratory scale performing ad hoc measurements to compare the observed respect to the simulated behavior. A 3D printing procedure based on the Fuse Deposition Modeling (FDM) technique in polylactide (PLA) material was used to realize formworks of the cement based blocks of the scaled prototype [2-3]. Several statical and dynamic load configurations are investigated, collecting into a sensitivity analysis the parameters which mainly affect the structural behavior [4,5]. To simulate earthquake ground motion an assigned frequency range as dynamic input to the structure was provided by a shaking table [4]. Statycal and dynamic monitoring of the vault prototype was performed using 2 USB (2 Mpx – 165 Hz) and 4 GO-PRO full HD (8 Megapixel) frame rate 100 fps. DIC measurements were used in order to validate the vibration modes of the vault obtained by the dynamic simulations. Finally, some preliminary considerations of the dynamic response of the model were provided testing the robustness of the form-finding approach when horizontal load are taken into account.

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