An equivalent continuum of gridshell model

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Abstract

In this work, an equivalent continuum of gridshell is proposed through two different constitutive identification procedures. These are both based on the selection of a Reference Elementary Volume (REV), used to obtain the small scale equivalent elastic constants. In the first procedure a flat REV is considered, on the contrary a second identification procedure considers the REV as curved.

Having an equivalent continuum of a gridshell could be advantageous for better understanding of the global mechanical behaviour of the gridshell, in relation with its final shape (that could be obtained by means of a form finding process or defined by an analytical surface). For instance, in the literature the equivalent continuum approach is used to evaluate the global buckling load of the gridshell [1], and the same approach has been used to design the Mannheim Multihalle one [2]. Furthermore, an equivalent continuum model could be used for exploring, in a more efficient way, a design space of target shapes or, once the shape is fixed, to study the optimal directions of the grid lines, with respect to the principal lines of the surface.

Several approaches to identify an equivalent continuum have been developed in the literature, as referenced in [3], and include equivalent stiffness, split rigidity, orthotropic equivalent continuum.

This work is focused on the identification procedure based on a variational approach. The flat and curved REVs are compared, in order to discuss the effect of the surface curvature in the constitutive coupling between the membrane and bending behavior of the equivalent shell.

The numerical validation of the identification procedure is made through different examples, by comparing the gridshell response and the equivalent shell response in terms of mechanical work.

References

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