Static, free vibration and underwater sound radiation of stiffened plates by ES-FEM using triangular element

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Abstract

In this paper a three-node Mindlin plate element (MIN3) combined with a thick beam element incorporating with discrete shear gap (DSG) method into the edge-based smoothed finite element method is introduced for the static, free vibration and underwater sound radiation of eccentric and concentric stiffened plates. In this model, a simplified three dimensional thick beam element is adopted with the plate element (ES-MIN-DSG3) to analyze the vibration of stiffened plate under the condition of single side immersion. The compatibility of deflection and rotations of stiffeners and plate is assumed at the contact positions. By incorporating Green function into wet modal method, the added water mass of stiffened plates when only immersed with single side into ideal fluid (incompressible, irrotational and inviscid) could be obtained. By using Rayleigh integral, it is possible to obtain the sound radiation resistance of stiffened plates. A relatively "softer" model can be constructed by employing edge-based gradient smoothing technique into the calculation of numerical integration over the edge-based smoothing domain. By means of DSG technique, this model is consequently free of transverse shear-locking. With the help of the Green function and wet modal method, it is easy to integrate the added water mass matrices into the system mass matrix for S-FEM model through programming. From several examples, it is obvious that the present results perform good agreement with the existing analytical and other numerical solutions.

Keywords: The edge-based smoothed finite element method (ES-FEM); the stiffened plates;simplified three dimensional beam;discrete shear gap technique (DSG); Added water mass;Green function;Wet modal;Rayleigh integral.