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A quantitative method to determine the optimal assumed stress fields for hybrid stress finite elements

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A quantitative method is developed to determine the optimal stress fields for the hybrid stress element. It provides a straightforward way as to how and why the resulting element can improve its displacement counterpart. A new inner product with material weighting matrix is defined to reveal the relationship in quantity of exact similarity degrees between different stress modes. It is different from the conventional energy product which can only qualitatively determine the orthogonality of stress and strain because they are considered as mathematical vectors without any physical meaning. The strategy includs two steps. Firstly, the basic stress modes are broken into a set of sub-modes. Secondly, in the comparing, the sub-mode with largest similarity degree with the basic mode is selected as the optimal assumed stress mode for hybrid element. The 2D 4-node and 3D 8-node hybrid elements are illustrated by the present approach.

Keywords: hybrid stress element; quantitative method; optimal assumed stress field; material weighting matrix based inner product; largest similarity degree