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Candidat
MME GAO Sasa
Fonction
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Résumé

The new beam element is an evolution of a two nodes Timoshenko beam element with an extra node located at mid-length. That extra node allows the introduction of three extra strain components so that full 3D stress/strain constitutive relations can be used directly. The second step is to introduce the orthotropic behavior and carry out validation for large displacements/small strains based on Updated Lagrangian Formulation. A series of numerical analyses are carried out which shows that the enhanced 3D element provides an excellent numerical performance. Indeed, the final goal is to use the new 3D beam elements to model yarns in a textile composite preform. For this purpose, the third step is introducing contact behavior and carrying out validation for new 3D beam to beam contact with rectangular cross section. The contact formulation is derived on the basis of Penalty Formulation and Updated Lagrangian formulation using physical shape functions with shear effect included. An effective contact search algorithm is elaborated. And a consistent linearization of contact contribution is derived and expressed in suitable matrix form, which is easy to use in FEM approximation. Finally, some numerical examples are presented which are only qualitative analysis of contact and checking the correctness and the effectiveness of the proposed 3D beam element.