Mesh Generation for Arbitrary Domains in GT STRUDL

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Abstract

Mesh generation is commonly one of the most time-consuming activities in the development of finite element models in structural engineering practice. Any efficiency that could be gained from automating certain aspects of the model generation stage would free the engineer to spend valuable mental energy interpreting results as opposed to pre-planning the steps necessary to create a suitable mesh. In many cases, the difficulty in modeling a complex geometry with openings precludes any notion of a mesh sensitivity/convergence study.

This presentation demonstrates a mesh generation pre-processor for GT STRUDL utilizing the open source application EasyMesh, capable of meshing complex geometries with openings. Using this pre-processor, finite element models can be rapidly created and modified, for example, when an opening may need to be moved within a structure or when a particular area requires local refinement.

The demonstrated pre-processor interfaces between EasyMesh and the GT STRUDL construction line feature, such that a user can define a general domain using multi-point construction lines after which the application will automatically discretize the domain into 3-node triangular elements using the Delauney approach. An EasyMesh-generated model can include control points or lines within the mesh, multiple holes/openings of arbitrary shape, material interface boundaries within a structure, and a locally refined/coarsened mesh in selected regions of the domain.

This new pre-processor extends the basic functionality of EasyMesh beyond 3-node triangular discretization, motivated by the inherent disadvantages exhibited by the constant strain triangular element. Meshes comprised of 3-node triangles can be converted to 6-node tri–angular elements, and using two different techniques, triangular meshes can be converted into 4-and 8-node quadrilateral element meshes. Thus, elements supported include plane strain/stress elements such as the CSTG, LST, IPLQ, and IPQQ, plate bending elements such as the BPHT, BPHQ, and IPBQQ, and general shell elements such as the SBHT and SBHQ6.

Additionally, this pre-processor introduces the capability to create general three-dimensional shell meshes with openings for continuous, smooth surfaces in GT STRUDL.

Efficiency in model generation for benchmark problems is demonstrated and quantified. Near-automation of mesh refinement is demonstrated and convergence is evaluated for examples. Example structural models demonstrated include slabs and shear walls with multiple openings and three-dimensional shell structures.

Several representative models will be shown.