

DEVELOPMENT OF FINITE ELEMENT MODELING MESH GENERATION AND ANALYSIS SOFTWARE FOR LIGHT WOOD FRAME HOUSES

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ABSTRACT

This thesis presents the development of an automatic mesh generator, named WoodFrameMesh, using object oriented C++. The program developed is capable of generating complete finite element models of wooden houses incorporating frames, linear links, springs, nodal loads and restraints at the desired locations. The finite element mesh generated by the program may be triangular or quadrilateral. The triangular mesh can be generated over any arbitrary domain with multiple openings and line constraints. The program implements the advancing front method for triangulation as discussed by Lee and Hobbs. The difference is made by implementing the algorithm using object oriented concepts and the extensive use of the powerful C++ Standard Template Library (STL). Quadrilateral mesh generation is limited to simple quadrilateral domains with no openings or constraint lines. A simple structured technique is implemented to generate the quadrilateral mesh. The amount of time spent in manual generation of the complete finite element model of wooden houses has been considerably reduced by automating the modeling process. Overall, the use of object oriented design has facilitated the code development and has provided a platform for further additions. The program relies on the use of STL as it provides dynamic data structures, algorithms for storage, searching, sorting, etc. Efficiency of the program is improved by the use of the in-built features in STL instead of developing new code.

Analysis of the finite element models generated by the automatic mesh generator is performed using SAP 2000 and WoodFrameSolver. WoodFrameSolver is a finite element analysis engine for WoodFrameMesh, which was developed at Virginia Tech by a group of graduate students (including the author) and professors as a separate project. A chapter discussing the WoodFrameSolver architecture, its extensibility features and its verification is also presented in this thesis. The solver performance and accuracy are similar to those of SAP 2000, which was chosen as the benchmark for testing the analysis results.