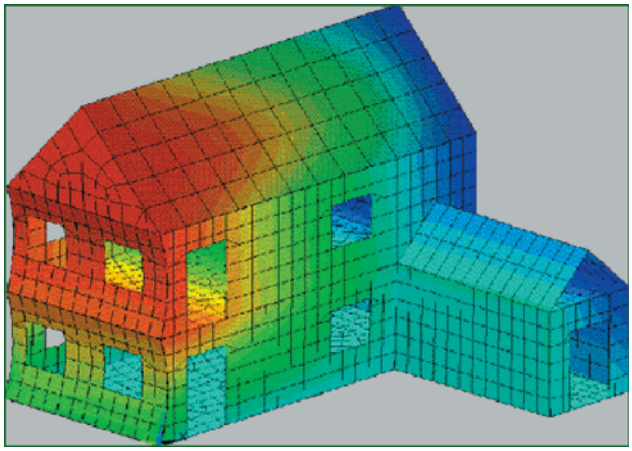
RESEARCH in Progress

Forest Products Laboratory

Simplified Analysis of Light-Frame Wood Buildings Under Wind Loads

More than 90% of all residential structures in the United Sates are built as light-frame wood buildings (LFWBs). These structures perform relatively well under earthquake loads because of their low masses. However, performance of LFWBs under wind loads is not satisfactory. Every year, wind events result in damage exceeding tens of millions of dollars. Wind causes pressures and suctions on parts of buildings that last significantly longer than do forces from earthquake events and cause gradual degradation of connections and subsequent failures.



Finite element model of a two-story house loaded by a hurricane wind force.

Background

Forces in a LFWB loaded by wind are currently estimated using a tributary area method that completely disregards the stiffness of the structure and uses only geometry to estimate forces in load-bearing elements. The tributary area method assumes that all loads are transmitted to the foundation through the shear walls and that each shear wall carries a load that is proportional to the areas associated with the wall. Such assumptions violate the principles of mechanics in which forces are distributed based on stiffness of the load-bearing elements. More sophisticated methods take various stiffnesses into account, but these methods are complicated to use, require sophisticated software, and are thus impractical. Engineers need simplified methods that provide a more accurate yet reasonably simple tool for safe and economical designs. An accurate estimate of actual forces within a LFWB subjected to wind loads is essential to ensuring the safety of residential construction in wind events such as hurricanes.

Objective

The objective of this research is to develop a simplified method that can be used to estimate shear forces in shear walls of light-frame wood buildings so that safer and more efficient designs can be achieved.

Approach

The research will be based on previous theoretical work and will expand to two-story buildings the model that was developed for single-story buildings. The structure will be regarded as a rigid beam in an inelastic foundation; this concept will be extended to a two-story building for which reactions calculated from the upper level will be brought into the first level as applied forces. This will result in a set of nonlinear algebraic equations that must be solved simultaneously.

Laboratory test of an irregular one-story house loaded by horizontal forces simulating wind load.

The challenge will be in finding the solution strategy that will yield rapid convergence and stability.

Expected Outcomes

This research will result in an analytical model that will permit more accurate estimate of reaction forces in shear walls of LFWBs subjected to wind loads. In this phase, a computer program will be developed that will permit a static analysis of a rectangular building (one or two story) subjected to wind pressures. This will permit more accurate design of wind-resisting elements within LFWBs and thus increase safety and reduce the risks of potential damage.

Timeline

This project will be completed by 2006. The work will be followed by more thorough study investigating the stochastic nature of the problem.

Cooperators

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