Practical Modeling Methods For Light-Frame Structures

LATERAL LOAD PATH ANALYSIS

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Introduction

Typical engineering design methodology includes the determination of loads on the structure and consequently, the design of members to adequately withstand these loads. There are two essential concepts in design that this modeling method directly addresses.

The first of these is the requirement of a continuous load path so that the structure can adequately transfer any load on a structural element safely into the foundation. Second, system effects in the structure, such as load sharing, also must be included in a practical method.

Wolfe (1998) found that wind was the most common (and costly) cause of damage to all structures in the U.S., resulting in over $41 billion dollars in damage between 1986 and 1993 compared to $6.8 billion, the total for all other natural hazards combined. Updated codes in response to the destruction caused by Hurricane Andrew (1992) and Hurricane Katrina (2005) have helped to address the risk of damage in newer buildings. However, since a majority of single-family residences were built before these code updates, there still exists a substantial concern for wind damage on light-frame buildings. Moreover, the prevailing source of damage in light-frame structures was because of insufficient strength in the connections to transfer uplift loads.

Past Research and Validation
Simple Rectangular Box Building

The modeling procedure was developed by Martin and was validated on a 1/3 scale model built and tested in a wind tunnel at the University of Florida by Datin (2009) (Figure 2a). The structure itself was relatively simple (Figure 2b) with only 2 sheathing types and no geometric irregularities.

The structural modeling method devised was validated for the following:
- 2D Individual Truss Behavior
- 3D Roof Assembly Behavior
- 2D Shear Wall Behavior
- 3D Influence Functions for the Entire Building

Martin explored load cases of uniform uplift, simulated hurricane uplift, and ASCE 7-05 Wind Pressures.

More Realistic L-Shaped Structure

Pfretzschner used and further developed the modeling techniques of Martin; this effort was to further the applicability of the method and validate load sharing and system behaviors in a more complex and realistic model (Figures 3a and 3b).

The validation procedure involved:
- 2D Truss Behavior
- 3D Roof Assembly Behavior
- 2D Shear Wall Behavior
- 3D L-Shaped House Behavior

Pfretzschner similarly investigated uniform uplift and wind loads developed using ASCE 7-05 Main Wind Force Resisting System procedures.

Citations


Nairn, John A. OSULaminates. Corvallis: Oregon State University, 18 Nov. 2011. JAR.
