STRUCTURAL BUILDING COMPONENTS MAGAZINE

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The Next Generation of Structural Building Components Design (Part 1 of 2) by by Kirk Grundahl, P.E.

Design software technology continues to emerge and evolve. Take a few moments to consider the implications of this new frontier.

In the March 2004 issue of SBC Magazine, Dan Holland reminded us to keep our "heads up" because the way we do business could soon change. In his "Editor's Message," he introduces this issue by considering an important trend in building design and how it could impact the component manufacturing industry. That trend revolves around integrating our industry's truss design work into the building design process, and what that will mean to our industry. You have heard all the terms that are typically used: "whole house design," "whole house software," "whole building design," "parametric design," "integrated design software" and "model the complete structural frame." Based on the feedback we have received from our industry, these concepts have the potential to be very confusing because they can have so many implied meanings. In this article, I will address what these terms mean in a general sense and what impact they could eventually have on our industry.

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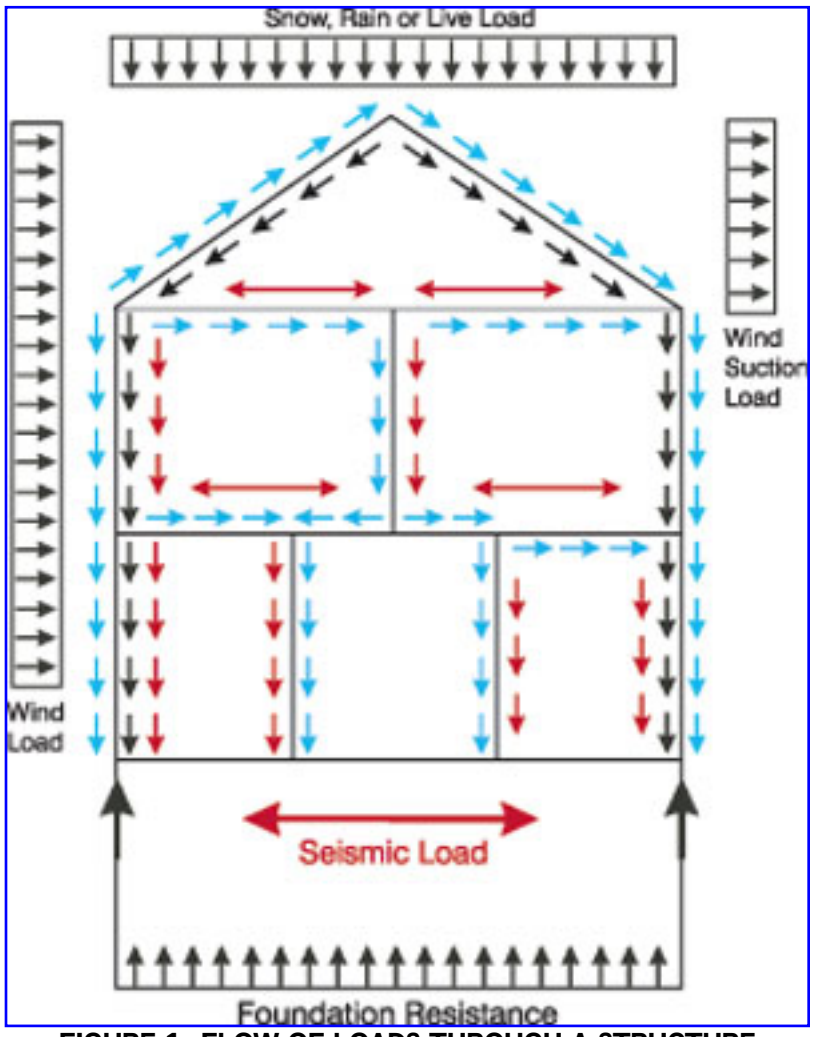

FIGURE 1. FLOW OF LOADS THROUGH A STRUCTURE

DEFINING & APPLYING LOADS

In all structural analysis, the first step that must be taken is to determine all the loads that are going to be applied to the structure. The component manufacturer's hope is that these will be defined in detail by the building designer (building owner, architect, engineer, builder or general contractor). As we know, many times these are left to the builder or framing contractor to define, which means that the local building code or building official defines the loads and how they are applied. Once the loads have been defined, it is quite simple to trace all the loads through the structure to ensure that there are structural elements and connections in place to

adequately resist all the applied loads (see Figure 1).

TRADITIONAL BUILDING DESIGN VS. WHOLE BUILDING DESIGN

Buildings have traditionally been designed as follows:

- The assumed design loads are received from the building designer, building code, local building official or builder.
- From these load conditions:
  - the builder could design each structural element (stud, floor joist, header and rafter) individually using the prescriptive building code tables that provide the load carrying capacity for a given span length, or
  - the builder could design each proprietary structural element (this includes I-joist and propreiatry open-web joists, and all the wood composite headers and proprietary headers) individually using the proprietary code accepted catalogue to obtain the load carrying capacity for a given span length, or
  - a truss designer could design each structural element combining lumber and metal connector plates to produce truss design drawings for floor and roof truss elements.
- The building designer or builder would then review all the reaction loads at each individual structural element and select the proper structural connection from a proprietary code accepted catalogue.

This design process often resulted in:

- The wall elements being designed by a framer based on tradition and the building code. The floor elements and headers being designed by the company supplying lumber floor joists/I-joists and headers.
- The roof elements being designed by the truss designer.
- The structural connectors designed by the framer who selected the appropriate connector from a proprietary catalog.

Each of these elements are being designed or selected in isolation. Yet, the process assumes each element will interact appropriately to transfer all the loads that are being applied to the structure and then resist each one.

In the whole building design concept, this traditional process for determining loads still applies. However, the concept differs from traditional building design as follows:

- First, the individual roof trusses or rafters are designed to resist the specifically-applied loads.
- Next, the actual reaction loads from the roof are applied to the walls and the headers supporting each individual roof element. The individual wall studs and headers are designed to resist the specifically-applied loads and reactions from the roof or floor above.
- Next, the actual wall loads are transferred onto the floor or the foundation. The individual floor or foundation elements are designed to resist the specifically applied loads and reactions from the roof and floor(s) above.

- Simultaneously, all the reactions are reviewed and individual connectors are designed to resist the specifically applied loads and transfer these loads from one structural element to the next on down to the foundation.

Notice that the significant change in the design process is that the flow of loads is a known quantity and can be directly applied to each structural element as it flows down to the foundation. The structural element design process is, however, still designing individual structural elements and individual connections to resist the specific flow of loads at that specific location in the structure.

The building design process described above is not equivalent to a more "integrated building design" concept, where all the individual structural elements would be interconnected and the design would take into account the structural element's resistance, the resistance of the connections between each structural element the permanent bracing or internal system shear resistance and the resistance of the composite action of the sheathing material (top chord and bottom chord). This would then be more of a structural system design. This is a level of complexity that, while possible in the future, still has a great number of variables that must be quantified in order to accomplish effectively.

Additionally, most of the whole house design software that is available in the market today will do complete material take-offs automatically. This can provide a tangible value to the component manufacturer as both the structural engineering and a complete building material list can be done with the click of a button. This will be an instant value-added service all component manufacturers can provide if they choose.

WHOLE BUILDING DESIGN IMPLICATIONS FOR THE INDUSTRY

The changes in traditional building design outlined above would have tremendous implications for the future of our industry. Here are a few things to consider about the component manufacturer's role in the concept of whole building design:

- How may a component manufacturer develop a competitive advantage in the market(s) it serves using improved software technology and its natural evolution? Perhaps the component manufacturer should consider:
  - Adding a building design function to their business.
  - Becoming a more broad-based material supplier.
- How does this software integrate with your existing equipment and the skill set of your personnel to continue building a competitive advantage in the market? How does the software enhance your company's unique sales, design and manufacturing abilities?
- What is the impact of the new software technology on a component manufacturer's product liability? Does it increase or decrease?
- How does a component manufacturer take advantage of all the technology available to provide the best economic structural framing solution for their customers and become the masters of their own destiny?

As you can see, the future of our industry is in the hands of all component manufacturers, and

we are currently inside the whirlwind of change. Few would argue that the choices are difficult and the stakes are high. The key to the puzzle of whole building design is for component manufacturers to integrate the concept into a comprehensive strategy that will provide added value to their customers and, in turn, grow their businesses.

SBC Readers on Whole House Design

The industry we work in is constantly changing. Will the issue of whole house design (WHD) change the face of the industry? We recently asked readers to share their thoughts and opinions on the topic of WHD: How they see it impacting the structural components industry in the short- and long-term and whether it will ultimately harm or help their companies. Reader responses to the WHD question ran the gamut, indicating that many component manufacturers are still coming to grips with all the aspects of this issue.

Marvin Pulaski of Atlantic Building Components voiced largely positive sentiments: "Whole house design would be a plan that is designed by a structural engineer from the peak to the foundation. We have in-house engineers that can do just that, and are finding that this is becoming a great asset when questions arise about an area that may be rather 'vague' without a whole house design."

Others see WHD as a means for component manufacturers to protect their value-added products while keeping the customer's cost in check. John Huck of Home Lumber, LLC said it's all about controlling your destiny: "Whole house engineering to my business means control: control of design, control over costs and control over my existence as a component manufacturer." Huck thinks that by utilizing whole house engineering, component manufacturers can continue to control the design and cost of components. "We have the knowledge to manufacture with customers' best interest in mind. We will become more valuable to our customers than ever before if we help them maintain their costs," he says.

Finally, Huck sees WHD as the means for a now thriving industry to continue its boom well into the future of building construction: "WHD will be the reason component manufacturers remain viable, as we make a value-added product that no one could do better. WHD [means] control, control of our ever-changing future."

While the virtues of WHD might be evident to some, others are skeptical that it will live up to all the hype. Bob Becht questioned whether builders or specifiers would welcome the responsibility involved in component design: "Why would builders or specifiers want the additional responsibility of designing trusses? If WHD becomes big in this industry, builders may insist [component manufacturers] take design responsibility for trusses that others design. What's new about that? Risk management is already one of our biggest problems."

How do you envision the concept of whole building design changing the face of component manufacturing in the future? Please send your feedback to editor@sbcmag.info.

SBC HOME PAGE

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