The Big Picture

SBCRI Steering Committee Priorities: Going with the Flow of Loads

by Kirk Grundahl, P.E.

"All knowledge comes from experimentation"
– Richard Feynman,
Nobel Prize winning physicist

This is our industry's first ever issue of ***SBC*** devoted to structural component research and testing. As many of you know, the Structural Building Components Research Institute (SBCRI) was created to give some serious thought to the engineering behind many of the critical decisions affecting our industry. The performance of our finished products has generally been based on small-scale and full scale "single element" testing. This data is then used to create computer models that produce all manner of structural building component designs through solid engineering judgments and extrapolation, deriving safe but conservative engineering design. Yet the reality is that the real answers are far from known quantities.

Several years ago, we did some QC testing that taught us much more than we expected about truss performance in the context of QC criteria. The WTCA Executive Committee believes that this is generally the case with testing; far greater industry benefit comes out of it than is expected.

The knowledge developed by WTCA, TPI and anyone else who desires to be involved in the testing that we do, will add great value to our industry and yield solid returns on investment through improvements made in:

- A much better understanding of flow of loads and internal truss flow of forces.
- Optimizing the resistance to the applied loads by our manufactured components and their related structural connectors.
- Optimizing how the system of components, as they are applied in the field, resist loads that are applied onto them.
- Integrated mechanics of materials performance data that can be used in whole house software, currently under development, to provide accurate resistance models. If we don't know how loads actually flow through a structure, it is hard to develop software that accurately designs the lateral and gravity load resisting system.

The knowledge gained by WTCA staff will have lasting industry value to critical issue problem solving, the code change process, legislative activities and ***SBC Magazine***. Our membership (component manufacturers and suppliers) needs an outlet to be able to find solutions to key industry issues with which they struggle.

The article on page 30 describes a superb example of the value SBCRI brings to component manufacturers and the building construction industry in general. As you'll read in that article, SBCRI staff developed a solution to an engineering problem that traditional analysis techniques would suggest is unsolvable because a buckled truss is a failed truss from the standpoint of its ability to carry its design load. Yet through testing we devised a way for the truss to carry its design loads similarly to the way this set of trusses was expected to perform in the field from a capacity and deformation perspective.

In February, the SBCRI Steering Committee met and began to develop a plan for industry testing. What follows is a brief overview of our industry testing concepts being put into a formal test plan with estimated timelines and costs. TPI and WTCA have committed funding for this work and intend to accomplish as much as we can inside the constraints of time and our industry testing budgets.

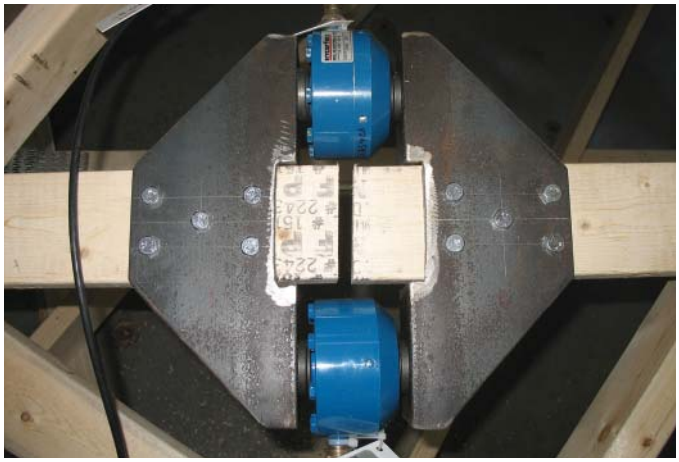
at a glance

- ❑ Single element component testing does not accurately portray the way components resist forces and transfer loads.
- ❑ SBCRI was built to test and analyze the flow of loads through an entire structure, not just through a single component.

Project #1

Our goal is to determine how to accurately measure axial forces in both tension and compression truss webs and chords. There are several ideas regarding how best to do this and we have also developed a new fixture (see figure 1) that has good potential.

If we can accurately measure axial flow of forces internal to the truss, engineering model development will be far more robust.



Project #2

Once we have the ability to accurately assess flow of loads internal to our test trusses, we will assess how the flow of loads changes as we integrate the test trusses into a system through this series of test steps:

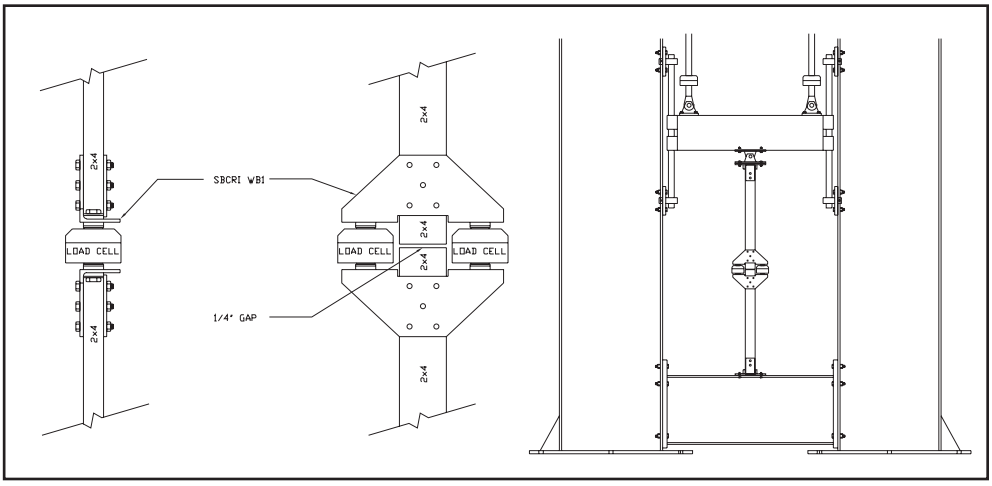


Figure 1. Design drawings for new fixture to be used in project #1. Photo above depicts the completed fixture.

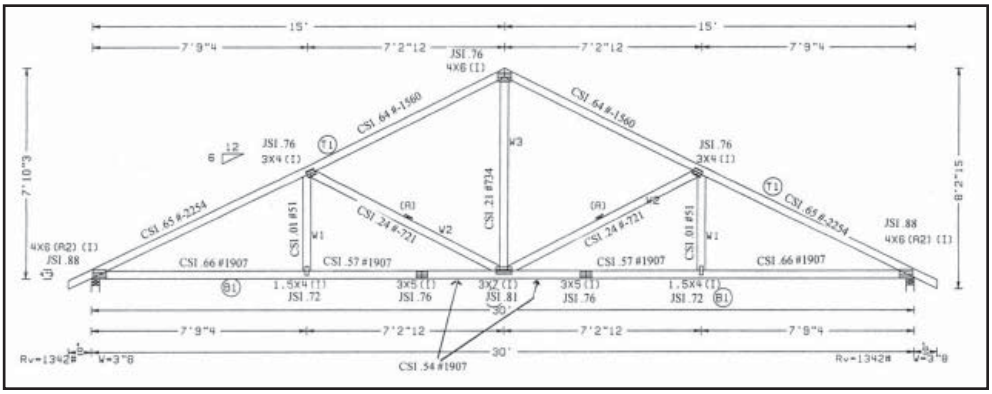


Figure 2. Design drawing for trusses to be tested.

Step 1: Use ten trusses (see figure 2) and test all of them to get precise load-deflection and lateral deformation load data.

Step 2: Systematically place each of the ten trusses into an assembly setup. We will test each truss individually using the same reference deformation (i.e., center of the bottom chord deformation) with typical OSB roof sheathing attached to the top chords and determine the applied load that it takes to achieve identical deformations.

Step 3: Test each truss using the same reference deformation with typical OSB roof sheathing attached to the top chords and a typical gypsum wallboard ceiling. Again, we will determine the applied load that it takes to achieve identical deformations.

Step 4: In Step 1 above we'll load each single truss shown in figure 2 in a series of load increments and measure the lateral forces in each web member under a series of prescribed web member lateral deformations.

Step 5: Integrate the single trusses into the system and proceed with Steps 2 and 3 and develop identical deformation load data to see what change there is in the flow of forces in the web member when it is placed in a roof system.

Step 6: Repeat Step 1 and modify the trusses by placing our axial force measuring devices in the top chord and bottom chord and one web.

Step 7: Proceed again with Steps 2 and 3 with measuring the axial forces generated in the trusses.

Step 8: Finally we will use the trusses on our roof and wall assembly to evaluate the diaphragm performance of the roof trusses with an OSB and gypsum diaphragm. Our goal is to:

A. Determine how the load transfers from the truss to the diaphragm and provide design data that the engineers that are designing diaphragms can benefit from.
B. Evaluate the flow of loads through blocking at the heels. We'll load the end wall of the structure that the truss is bearing which is the shear collector. We'll use our assembly and load the wall perpendicular to the trusses under various load and deformation combinations. We'll evaluate the connection of the truss to the wall and the flow of forces in a standard truss and also a series of

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raised heel trusses. The testing conditions will account for forces in three axes.

a. Wind parallel to the truss.
b. Wind perpendicular to the truss.
c. Uplift and gravity forces with wind parallel and perpendicular to the trusses.

C. We'll also evaluate the lateral load transfer at the truss peak where there is a pitch change. The question is: How much load can the truss plate transfer in shear from one truss to the next through the sheathing? When is blocking required?

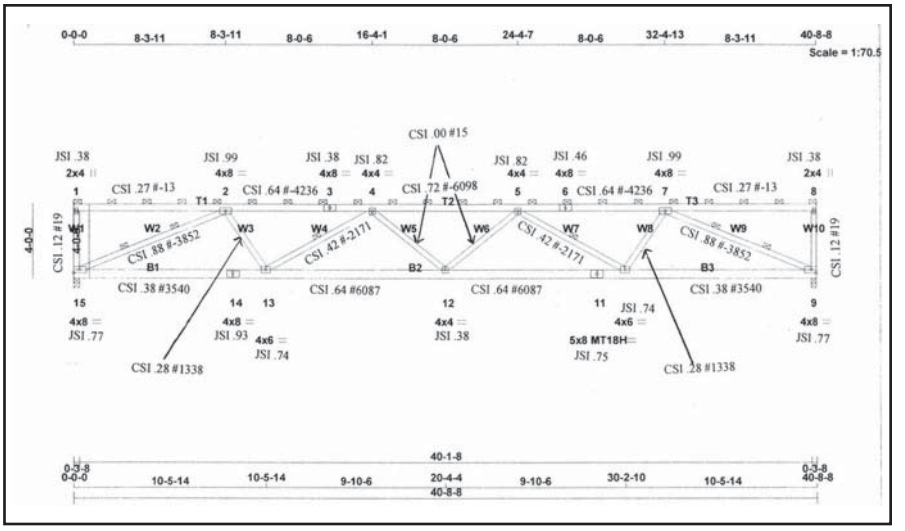

Figure 3. Design drawing of parallel chord trusses to be tested.

We'll use our lateral load application system to evaluate the roof and wall assembly:

A. laterally without sheathing
B. laterally with sheathing on one slope
C. laterally with sheathing to the second slope
D. laterally with sheathing on both slopes and the gypsum ceiling
E. laterally with sheathing on both slopes and the gypsum ceiling and we'll also evaluate various wall assembly bracing configurations.

Project #3

Next we will use ten parallel chord trusses (see Figure 3) and repeat Steps 1 through 7 above.

This will provide us with data on any differences between pitched chord and parallel chord truss system performance as a baseline.

Since we opened in June, we have been working on getting all our systems in place to undertake single element and system testing as efficiently and affordably as possible. We are making systematic progress toward that end. Four proprietary testing projects have allowed us to test elements in unexpected and beneficial ways, which have all proven the value of SBCRI and the testing procedures that we use, particularly our ability to precisely know all the applied loads into the test structure, the flow of loads through the structure and all the loads flowing to reaction load cells. For any testing facility, accuracy of applied loads in and out is a key testing quality control standard and at SBCRI, using our total flow of loads system, we are confident that our testing QC is precise. **SBC**

For more information about SBCRI projects or proprietary testing, visit www.sbcri.info or call 608/274-4849.

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The Mission & Purposes of SBCRI:

SBCRI is a for profit corporation that is wholly owned by WTCA, which is itself a non-profit corporation. SBCRI leases its own facility and all the testing equipment is owned by SBCRI. As is the case with WTCA, Qualtim, Inc. under a written contract manages and provides services, in terms of manpower, to SBCRI. As a point of similarity, many other organizations are managed by management companies, like the National Lumber & Building Material Dealers Association (NLBMDA), Metal Building Manufacturers Association (MBMA), WoodWorks and Wood Promotion Network. Structural components industry testing that is undertaken by SBCRI is funded jointly by WTCA and TPI under the terms of a written Joint Testing Venture Agreement. All of the test data and results from such testing is available to WTCA members. Given this organization, many have inquired about whether or not SBCRI can undertake for hire or proprietary testing, whether requested by a WTCA member or non-member. The answer is: Yes.

For those for hire or proprietary tests that are to be conducted at SBCRI, the person or entity requesting the testing will enter into a written contract with Qualtim that among other things clearly establishes that the testing and the test data and results shall be confidential and shall not be disclosed or used for the benefit of others. Qualtim will in fact contract to use efforts not to disclose such information. Qualtim will also provide and report test data and results only to the person or entity requesting the testing and such test data and results shall become the property of such person or entity and they may use the test data and results in any way they see fit in the conduct of their business.

SBCRI Testing Reports:

SBCRI, in cooperation with Qualtim, Inc., has developed what is being called our Testing and Engineering Report. Our goal in developing this report is to allow all of our SBCRI testing customers to have documentation that they can immediately use to provide product performance credibility in the markets they intend to serve. Since we have control over the contents of this analysis and reporting process, our goal is to have this Testing and Engineering Report completed within 36 hours of the successful completion of testing.

Finally, SBCRI is also working closely with IAPMO and its Evaluation Service program. SBCRI is accredited by IAPMO for performing testing of all types of structural building components for typical structural applications.

In the near future, SBCRI will also be accredited as a testing facility by A2LA, which has been a testing facility accreditation service for over 30 years. For many years they were the only accreditation organization in the U.S. A2LA is the name in accreditation. When completed, SBCRI will be a recognized testing facility for those that recognize the Asia Pacific Laboratory Accreditation Cooperation (APLAC), the European Cooperation for Accreditation (EA), the Inter-American Accreditation Cooperation (IAAC), and the International Laboratory Accreditation Cooperation (ILAC).

Our hope over time is to develop close working relationships with customers and all of the various certification and evaluation organizations around the world. We have a very unique facility that can easily serve a wide variety of needs world-wide.