Figure 1: TrusSteel CFS Truss Bridge over drive-thru bay.

Outside the Box

highlighting the out-of-the-ordinary within the realm of structural engineering

Cold-Formed Steel Bridge Trusses Provide Material Handling Solution

By Sowri Rajan, P.E. and Troy Lutgens

To meet the demands of an increase in business, a major shipping company was faced with expanding an existing complex in Portland, Oregon with a new state of the art facility and an upgrade to their existing package handling facility. The existing facility had multiple truck bays where their delivery trucks entered, offloaded packages and then turned around in the building and exited. The design team was challenged to increase the capacity in the package handling facility, but continue operations during the building expansion. The customer required an increase in the number of conveyor lines, without disrupting the flow of delivery trucks in and out of the facility. The only option for the new conveyor lines was to span the 75-foot drive-through bays.

Material Handling Systems Inc. (MHS), located in Louisville, KY, was the contractor outfitting the new facility, as well as upgrading the existing facility. MHS originally planned to use structural steel bridges to clear span the 75-foot bays. Jennifer St. Clair, a Design Engineer with MHS who lived near a plant that fabricated TrusSteel Cold-Formed Steel (CFS) trusses, became interested in determining if CFS trusses might be a cost effective alternative to structural steel. After doing some research, MHS contacted the truss fabricator, Tri-State CFS Components, Inc. (Tri-State), and set up a meeting to discuss the possibility of using CFS trusses.

When meeting with MHS, Tri-State knew their TrusSteel trusses could span the 75 feet (*Figure 1*), but that was just the initial criteria. Typical CFS roof or floor trusses have loads applied on their top and bottom chords – but not *moving* loads. Fortunately, Tri-State had design software (TrusSteel's steelVIEW) that could analyze for both bottom chord static

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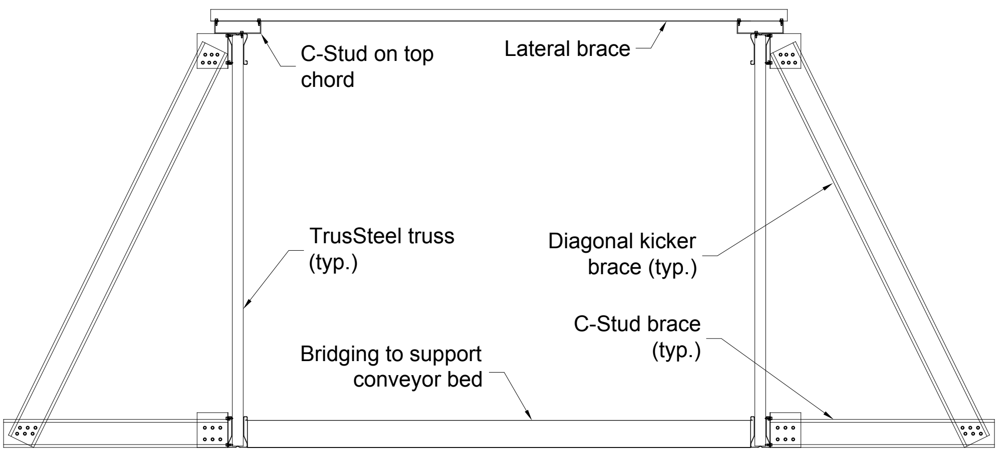

Figure 2: Section view of outrigger brace frame.

Figure 3: C-stud along top chord with lateral brace at stud splice.

Figure 4: Double wide conveyor with lateral braces.

loads as well as moving loads that would mimic the movement of packages.

MHS also had several general conveyor configurations that needed to be met by the truss design: single wide conveyors, double wide conveyors, triple wide conveyors, double stacked conveyors and multiple combinations of some or all of these conveyors. The single wide conveyor was the easiest and most straight forward to design and fabricate. It consisted of two parallel chord flat trusses separated by approximately 5 feet. Bridging between the bottom chords of the two trusses was used to support the 97 mil thick steel plate conveyor bed. The challenge was to brace the top chord of the trusses.

In a traditional truss application, a structural deck or other diaphragm system is used to brace the top chords, but that was not an option in this case. Alpine Structural Consultants (ASC) was added to the design team to develop an efficient bracing method. The first design concept used lateral brace members at certain intervals and diagonal brace members between each lateral brace, creating a zig-zag configuration when viewed from above. However, the design team wanted to minimize the number of brace members crossing the conveyor to reduce the obstacles for maintenance workers; therefore, the lateral-diagonal brace concept was abandoned.

ASC then developed an innovative solution using outrigger brace frames at each lateral brace location to laterally brace the top chord of trusses (*Figure 2, page 13*). The outrigger brace frame consisted of a diagonal kicker

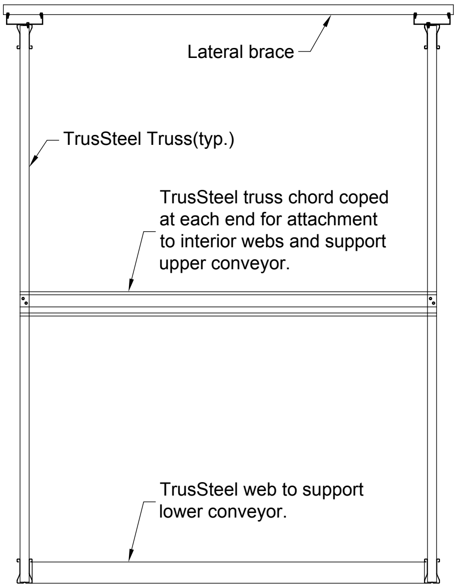

Figure 5: Section view of double stacked conveyor.

Figure 6: Double stacked conveyor.

brace and a C-stud lateral brace. Diagonal kicker braces were designed to transfer the compression buckling force of the top chord to the C-stud lateral brace at the level of the truss bottom chord, which in turn transferred the force to the conveyor bed.

In addition to the lateral braces, a 97 mil thick C-section was attached to the top chord for stiffening and to ensure that a larger spacing of the lateral braces (*Figures 2* and *3*) could be achieved. For the single wide conveyor, this bracing method was relatively straightforward.

The second design challenge was the double wide conveyor, which consisted of two single-wide conveyors running parallel to each other (*Figure 4*). Triple wide conveyors consisted of three single wide conveyors running parallel to each other. The challenge was to brace the top chord of the conveyor assemblies, which consisted of multiple parallel chord trusses, two for each single wide conveyor. A bracing method similar to the single wide conveyor was designed with outrigger brace frames.

The double stacked conveyors condition was basically two single wide conveyors with one conveyor positioned on top of the other (*Figures 5* and *6*). Taller trusses were designed for this condition, allowing for the lower conveyor bed to be supported by the same type of bridging members as the typical single wide conveyor while allowing enough clearance for the additional level. The two conveyors, each with 97 mil thick steel beds, added a significant amount of weight, but the extra depth of the trusses helped keep the top chord compression forces manageable. Top chord bracing was designed in a similar manner as the other conveyors.

ASC also designed multiple combinations of stacked single, double or triple wide conveyors. Some of those assemblies had additional challenges, such as differing elevations and/or sloped conveyor beds near the ends of the bridges. The design team of ASC and Tri-State worked closely with MHS to develop innovative solutions for each bridge assembly.

All trusses were assembled at Tri-State's facility in Shepherdsville, KY and shipped to the customer's package facility in Portland, OR. Due to the lack of space at the package facility, trusses were shipped in three sections of approximately 25 feet each. Each section was labeled left, middle and right for each conveyor. The 25-feet long truss sections were set parallel to each other, and the bottom bridging members were added first between them. The steel plate conveyor bed was then installed before adding the top chord brace and outrigger members. After the three 25-feet sections were fully assembled, they were transferred to their relative box line and connected together to form the complete 75-feet bridge assembly. Field splicing of the sections was easily accomplished with web inserts in the chords (*Figure 7*). The bridge truss assembly was then lifted onto its end support frames.

TrusSteel CFS trusses were light in weight and easy to handle, even after adding the thicker steel conveyor beds. The versatility of the CFS trusses allowed the contractor and owner to successfully expand and upgrade a major shipping facility in a cost effective and efficient manner. Troy Lutgens of Tri-State said: "We have designed trusses for small sheds to large commercial buildings, but this is the most unique truss job we have ever done. Everyone had their own area of expertise, and it all came together perfectly to create the bridge trusses for the customer using cold-formed steel trusses."▪

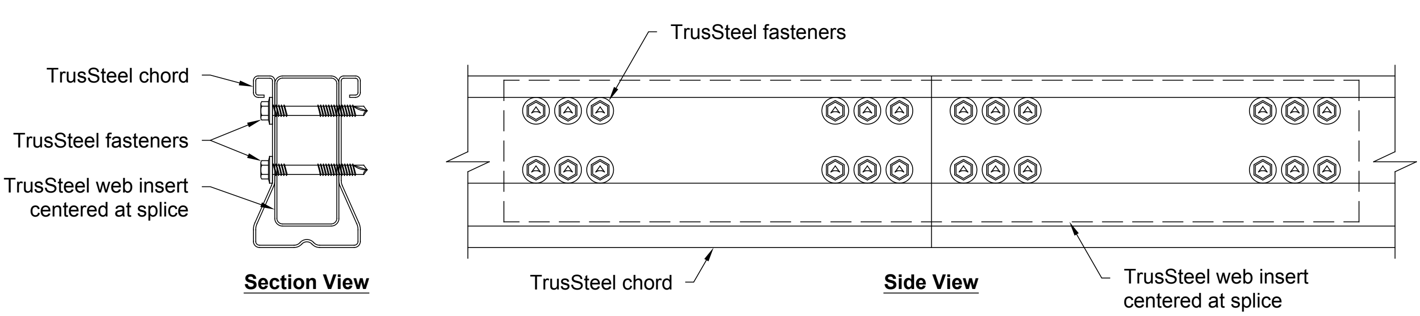

Figure 7: Field splicing of truss chords.