

DYNAMIC COLUMNS

NEWSLETTER FOR THE STRUCTURAL ENGINEERS ASSOCIATION OF ALABAMA

Volume 13, Number 3

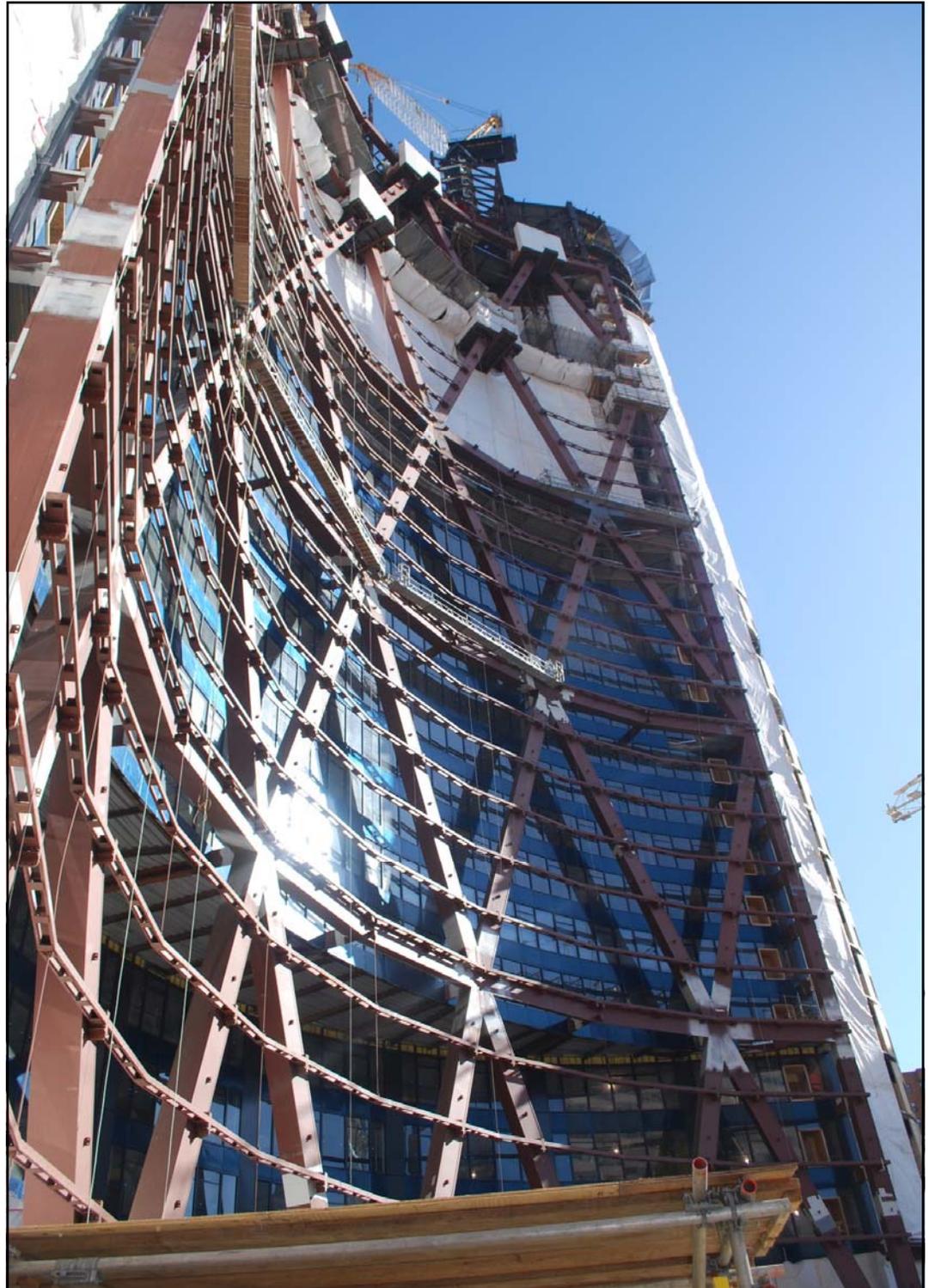
Winter 2011



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Cover: Canada's tallest office tower outside of Toronto: The Bow in Calgary, Alberta, Canada. Photograph courtesy of Walters, Inc. and Robert Whyte.



Welcome

From the President



The end of the year, for many of us, has always been a time to reflect on the past and consider the future. Many times the past is different than I had envisioned it would be. Like many of you, last Christmas I was hopeful that the already long recession would be soon over and the economy would be picking up in early 2011. Even though many experts say the recession did end this year (or even earlier) it has been difficult for me to tell at times. So again, I sit here at Christmas time and wonder if things will be better next year? Will we ever get back to the good years? It is easy to get bogged down in self-pity or wallow around in the “if” or “when” mentality.

When the economy picks up
If I made more money
When my kids get older
If my wife would only do this different

I can dwell a long time on these kinds of questions if I am not careful. But as I reflect on the past year, I can see how blessed I really am. I am blessed with a wonderful wife and three healthy kids. Our company has survived the recession so far and has found ways to trudge thru the tough times and hopefully come out of it stronger than before. It is true that we have had to do with less than before – both personally and as a company. Still, I remind myself that we live in the greatest country on the planet. Our hard times would be over-abundance to most anyone else on earth. I am truly blessed.

It has been an honor and a privilege to serve the SEAoAL these past two years as president. Our organization is better organized and has more momentum than I can ever remember. I wish I could take credit for it. I have to say a big “thank you” to the SEAoAL Board of Directors and Joanne Williamson for all of their hard work over the past two years. They have done a great job.

I hope this newsletter finds you healthy and happy and this Christmas season. I look forward to 2012 - whatever it may have in store.

Bill Wilson, P.E.

From the Editor



Welcome to the Winter Issue of *Dynamic Columns*. This is our third issue of the newly formatted newsletter. I hope you are enjoying each issue. We welcome any comments, questions, or suggestions you may have.

Our News and Events section of this issue announces the new SEAoAL Executive Director as well as highlights recent activities of the SEAoAL Committees. An NCSEA Conference Report by our incoming President, Mark O’Barr, summarizes events from the 19th Annual NCSEA Conference in Oklahoma City. We also have an update from the recently formed Code Advisory Committee.

This issue’s Seminar Preview presents information about our March seminar with Tom Ferrell. Mr. Ferrell will be discussing various steel design topics including connection design. Seminar attendees will receive 6 hours of Florida approved credit.

We also have an advertisement from ACS with an RFQ code. Scan this code with an app on your smartphone to register for a \$100 gift card. Howard Ayers, President of ACS, is a supporter of SEAoAL as an affiliate member.

Our Guest Article is from David Hornsby of Hornsby Steel in Cleveland, Alabama. In this article, you’ll learn the difference between a bender-roller shop and a fabrication shop, tips for engineers and fabricators, and possibilities for bending and rolling steel.

The Technical Article written for this issue covers bolted and welded steel connections. Robert Whyte, an SEAoAL Board member, provided this month’s article based on his extensive experience with steel design. Robert has also been instrumental in organizing the March seminar with Tom Ferrell.

I hope you enjoy this issue of *Dynamic Columns*.

Jason A. Partain, P.E.

News and Events

New Executive Director

At the November 8th seminar, Bill Wilson announced that Joanne Williamson was stepping down from the Executive Director position. Joanne has served SEAOAL for the last 3 years. We really appreciate Joanne and all of her hard work. Bill also introduced our new Executive Director, Rhea Williams. Rhea has served as the Executive Director of the Birmingham Chapter of the AIA for the last 7 years and will continue to serve in that position along with her new position with SEAOAL.

Disaster Assessment Training Seminar A Success

(by Michael Kingsmore)

SEAOAL was proud to host Ed Huston as the speaker for the ATC-20 and ATC-45 training seminar. As Lead Technical Consultant on the ATC-45 Manual, Ed was able to share a broad wealth of history, knowledge and experience with all who attended. Ed specifically discussed some of the damage sustained in recent events such as Japan, Haiti, Tuscaloosa and Joplin. At the end of the seminar, Ed opened up the floor for some informal discussion about storms and the effects on structures. Attendees had an opportunity to share their own experiences with disaster assessments.

We had 52 attendees (a few from out of state) with 15 signing up to volunteer after a storm event. Our SEER committee hopes to use this as a building block for developing a regular training program to document trained professionals and track willing volunteers. We thank everyone who attended the seminar and especially Ed Huston for sharing his time and talent with us.

2012 NCSEA Conference Report

(by Mark O'Barr)

As the incoming SEAOAL President for 2012, I was fortunate to attend the NCSEA national conference in October, which was held in Oklahoma City. The national conference is a unique opportunity for NCSEA Member Organizations (individual SEA's) to meet and to discuss

issues that affect all of us in the structural engineering profession.

The keynote address focused on international structural engineering practice, which was followed by an informative report on forensic investigations of the Oklahoma City bombing and the 9/11 attacks. At one of several break-out sessions on Friday afternoon, an informative presentation on 'How to Make Money in Structural Engineering' was given by Alabama's own Marc Barter, who also received the NCSEA Service Award at the awards banquet held on Saturday night. Other sessions included discussion of the building code process today, specialty structural engineering, renovation projects, and other topics. The dinner on Friday night was held at the Oklahoma City Museum of Art, where we were also treated to some authentic Native American culture including song and dance routines performed by local Native American tribesmen in traditional dress.

At Saturday's business meeting, one of the major issues that was discussed and voted on was the NCSEA proposed policy on separate structural licensing. (A copy of this proposal was included in the October issue of Structure magazine and can also be found on the NCSEA website at www.ncsea.com.) The proposed policy, which passed unanimously, is a general statement of support for separate licensing for structural engineers (as a legal 'practice act') without taking a stance on whether the S.E. license should be obtained in lieu of a traditional P.E. license or as an additional post-P.E. credential (which is ASCE's and SEI's position), an issue which would be left up to individual jurisdictions to decide. The policy statement endorses the new 16-hour NCEES exam as well as the NCEES Model Law Structural Engineer qualifications as the standard for licensure of structural engineers. The policy also encourages an equitable transitioning (grandfathering) clause to allow those currently practicing structural engineering to obtain an S.E. license without additional testing. The consensus of those present was that it was important for NCSEA to support separate

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News and Events

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structural licensing in the interest of public safety without being too specific on how it should be implemented at the local level. The policy statement that was passed does just that, although obviously having no legal force in itself. CASE, ASCE, and SEI have already issued policy statements in support of separate licensure for structural engineers. We welcome feedback from our members on this issue, as the issue of separate structural licensing will undoubtedly continue to be debated at the state level for the foreseeable future as more and more states begin requiring an S.E. license to practice.

The next national conference is scheduled for October 4-6, 2012, in St. Louis, MO, with subsequent conferences planned for Atlanta and New Orleans. I would encourage all our members to attend a national conference at least once if possible, to see what is happening at the national level and to make important contacts with other structural engineers throughout the country.

Website Committee

(by Cheryl May)

The newly formed website committee has been busy behind the scenes. We are in the process of changing providers and testing new features including online seminar registration, membership renewal and credit card payment through PayPal. We hope to be ready for online registration in time for our next seminar. As we prepare to go public with our new features, we would welcome another member or two on the committee – no website development experience required. If interested, please contact Cheryl May at Cheryl@christycobb.com or 205-933-1080.

Younger Member Group

(by Jason Partain)

Our new YMG held its first event in October. Bhate Geosciences, a geotechnical and testing company, hosted our group at its Birmingham office. Chuck Burgin, Vice-President, presented “How to Interpret a Geotechnical Report” which was followed with a tour of the testing lab and two test demonstrations. We had 11 young engineers attend the lunch and learn with participants from 5 different companies representing 4 months to 7 years of experience

We had a lunch and learn planned for December 13th which was unfortunately cancelled by the provider. We are currently in discussions to plan a Habitat for Humanity

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News and Events

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work day in coordination with the Birmingham AIA Emerging Professionals for early 2012. We will also be planning our next lunch and learn which will likely be in February. If you are interested in participating in the group, please contact Jason Partain at jpartain@sdg-us.com or (205) 380-3832 for more information.

Code Advisory Committee

(by James Russell)

The Alabama Residential and Energy Codes Board (RECB) recently considered public comments on the adoption of a new statewide Residential Building Code. The legislation as proposed would adopt the 2009 International Residential Code along with various proposed amendments. The proposed legislation does not replace any existing codes already in effect by various municipalities, counties, etc. However, upon execution, the legislation would become effective in areas with no formally adopted code. It would also become the model code for municipalities and counties across the state as they adopt newer building codes in the future.

In light of this proposed legislation, the Structural

Engineers Association of Alabama formed an Ad hoc Code Advisory Committee. The committee is made up of five practicing engineers from across the state and it serves in monitoring legislation that relates to the practice of structural engineering. The first task undertaken by the committee was to establish a line of communication with the RECB and to offer them our comments concerning the proposed legislation. By all accounts, the RECB welcomed our participation.

One significant issue included in the proposed amendments under consideration was in relation to the wind load provisions of the residential code. Through the influence of the Alabama Home Builders Association, the primary amendment attempted to delete the wind provisions of the 2009 IRC and replace them with the wind provisions of the 2012 IRC. This involved new wind speed maps, revised be required for residential structures.

Upon review of the legislation and related amendments the committee issued a position statement to the RECB. The committee commended the RECB for their efforts in seeking a statewide residential building code. However, the committee recommended that the RECB reject the

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Chuck Burgin addresses the SEAoAL Younger Member Group at the Bhate Geosciences office in Birmingham.

News and Events

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proposed amendments related to the changes in the wind design provisions. There were a number of reasons listed in our position statement to back our recommendation but the primary reason was that mixing of various codes (2009 IRC and 2012 IRC) should be avoided. In our opinion, this would result in unnecessary complications as it relates to code interpretation, enforcement, and would potentially result in inconsistent structural designs.

After issuing our position statement, the Joint Engineers Council of Alabama (JECA) -which is comprised of a number of affiliate engineering organizations – offered their general support of the SEAoAL Code Advisory position statement regarding the legislation.

The RECB will be meeting again in January, 2012 to further consider the proposed legislation. Although we don't know exactly how they will vote in relation to these matters, they certainly know our position on the matters affecting the practice of structural engineering. In the interim, we will keep in touch with RECB and also keep the SEAoAL membership informed of any developments.

Members in Motion

Congratulations to **Marc S. Barter, P.E., S.E., SECB** for being awarded the 2011 NCSEA Service Award!

Have members news, announcements, etc. you would like to share? Please email Jason Partain at jpartain@sdg-us.com.

2012 Membership Dues

If you have not already paid your 2012 membership dues, you can do so now using one of the following methods:

1. Go to www.seaoal.com and click on the link for membership renewal. Follow the instructions on the application for payment methods.
2. Contact Rhea Williams at rhea@karmamanagementinc.com for a renewal form.

Calendar of Events

- **MARCH 8, 2012:**
SEAoAL Seminar at the Associated General Contractors Building in Irondale, AL. Topics to include Structural Steel Design with planned guest speaker Tom Ferrell
- **AUGUST 21, 2012:**
Second Annual SEAoAL Conference and Expo at the Pelham Civic Complex in Pelham, AL. Conference topic to be Cold-Formed Steel.
- **SEPTEMBER 28, 2011:**
SteelDay. Location: National. Log onto www.steelday.org for more information.
- **OCTOBER 3-6, 2012:**
NCSEA 20th Annual Conference at Hilton St. Louis Frontenac St. Louis, MO.
- **FALL 2012:**
SEAoAL Seminar at the Associated General Contractors Building in Irondale, AL. Topics to include Changes to ASCE 7-10 Wind Design and AISC Steel Manual Updates.

Structural Engineers Association of Alabama www.seaoal.com

Rhea Williams, Executive Director

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Dynamic Columns is published for members of the SEAoAL. For information about article submissions, news submission or advertising, please contact Jason Partain at (205) 380-3832 or jpartain@sdg-us.com or Rhea Williams at (205) 601-2345 or rhea@karmamanagementinc.com

Structural Steel Connection Design

Thursday, March 8, 2012

Alabama AGC Conference Center

5000 Grantswood Road

Irondale, AL 35210

(205) 451-1422

Registration

SEAOAL member price: \$175 early registration / \$205 late registration

Non-member price: \$215 early registration / \$245 late registration

Schedule

8:00 am– 8:25 am	Registration
8:30 am – 11:30 am	Morning Session
11:30 am - 12:30 pm	Lunch
12:30pm - 3:30pm	Afternoon Session

Seminar Overview

This presentation will include the history of structural steel connection design along with AISC specification improvements that have made use of structural steel more economical but have increased the necessary connection design requirements over my 40+ year career. This presentation includes recommendations for use of W-shape slender columns, recommendations for use of HSS members, economy of connections as well as requirements for detailing and fabricating high seismic in accordance with AISC Seismic Provisions, 2005. The presentation also includes a summary of changes from AISC Specification, 2005, to AISC Specification 2010.

Attendees will gain 6.0 Florida approved continuing education hours for this program.

Seminar includes a binder of complete course notes and example problems worked during the course. Those who register after Wednesday, February 29th, 2012, will not be guaranteed a copy of the notes the day of the seminar. Notes & books can be shipped after the seminar at the late attendees expense. Also included are morning breakfast snacks w/ coffee, breaks, lunch with dessert & drinks.



Tom Ferrell is President of Ferrell Engineering, Inc., a specialty structural engineering firm with offices in Birmingham, AL and Columbia, SC. Ferrell Engineering provides structural engineering services to the steel fabrication industry and structural design firms. Ferrell Engineering specializes in job standards, connection designs and stair/handrail design. Mr. Ferrell began his career in steel erection and steel fabrication over 40 years ago. His experience includes steel erection, structural steel estimating, project management, detailing and engineering services. He is a licensed engineer in 32 states along with Puerto Rico and the Province of Alberta, Canada. Mr. Ferrell serves as a member of the AISC Manual Committee, the AISC Specification Task Committee on Connections (TC6) and the ASCE Committee on Design of Steel Buildings.

CURVING STEEL

by David Hornsby

Introduction

As the popularity of using curved steel in the building industry has risen, so has the need for shops that specialize in bending and rolling steel. Since opening Hornsby Steel nearly six years ago, we've succeeded in creating a niche for ourselves within the fabricating industry by developing an expertise in spirals and other complicated shapes. Our formula for doing so has been rather simple: find the right equipment, hire the right people, add a touch of innovation, then do what it takes to get the job done. I like to think of us as a modern-day blacksmith shop. We just use hydraulic power instead of the old heat-and-beat method.



Bender-Roller Shop

The difference between a bender-roller shop and a standard fabrication shop is specialized equipment such as angle rolls and beam rolls. A fabricator needs access to such equipment maybe once a month, so it's not cost-effective for them to keep it sitting around. By providing this service to fabricators, we use the equipment all day

every day, which makes it cost-effective for us. We do not fabricate anything. All we do is bend and roll material and furnish parts to the fabricator.

Another difference between a bender-roller and a standard fabrication shop is the size of our equipment and the amount of room required to process material. For example, to curve a 60-foot beam, you need room for 60 feet into the machine and 60 feet out. And if you're curving it to a relatively tight radius, you could need 40 to 50 feet across from it, so you must have an area that's 50 by 120 feet just to roll a 60-foot beam.

How We Operate

Good operators are priceless in this business because every piece of steel rolls a little differently. You can use readouts on machinery to get somewhat of a repeat, but even then, the next piece might roll too tight or not quite tight enough. Actual strength differs from piece to piece, which becomes apparent when you start yielding the steel and curving it into a shape. An experienced operator makes all the difference in getting a job done right.

As far as being a high-tech operation, in many ways we are, and in others, we aren't. Digital readouts on many of the machines help improve repeatability, and we use computers to develop the layouts. The layouts on drawing are vague at best, and that's where using technology is beneficial. But most jobs are completely different, and because a lot of the benefit of using technology depends on repeatability, it's not always helpful.

We don't transfer data from one machine to another in the curving operations in our shop. If we were doing the same thing day in and day out, that might be something we'd look into. But as a general rule, we're not repeating the same thing often enough.

There are obvious advantages to curving a large quantity of pieces the same way, rather than just doing one or two. The digital readouts allow us to set a machine to reproduce a piece we rolled previously, and that certainly speeds things up. And the advantage on the material handling side is it doesn't take any longer to bring a stack of material up to the shop than it takes to bring a single piece.

Tips for Designing and Detailing

On preliminary drawings, we need five things from the

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Guest Article

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detailer: quantity, radius, direction of the roll, material size and arc length. If uncertain about arc length, the detailer should add a few inches or even a foot to allow the fabricator to pre-order enough material. Amounts don't have to be exact on the preliminary drawing, but having that leeway helps.

When designing and specifying curved steel, engineers and architects need to understand that when you go tight on a radius, you frequently have to increase the thickness of the material to prevent wrinkling or collapsing the member. But this is improving as time goes by. Today you can use a lighter member than before, so design professionals need to remain flexible on increasing the thickness on items that are being curved. There is no universal rule of thumb because each bender-roller's capability is somewhat different. Big material is limited as to how tight it can go, so the smaller the material, the tighter the allowable radius.

A cost relationship exists between radius and member size. If you attempt to roll something too big into too tight a radius, the cost will skyrocket. If you can stay smaller on the tight radius and increase the size as the radius increases, the cost drops dramatically. This is the kind of thing architects and engineers should discuss with bender-rollers in order to come up with optimal solutions.

Possibilities

Whether the work we do is on the lighter end or the heavy end depends on the application. We're not the biggest roll shop by any means, but we can manage some pretty heavy stuff. Most of what we do, however, tends to be light, and on that end of the spectrum, we've developed a niche curving spirals and rolling conical-type tubes. Some of the things we see on drawings today, spirals and so forth, are approaching impossible, and for us, that's where the fun begins. We welcome the challenge.

We had a job about two years ago for a jewelry store in North Carolina involving a staircase with both sides flaring out, which is basically opposite hand spirals put together. The nosing on the stair treads were curved out as well. At first, we couldn't figure out how to do it, but we finally came up with the idea of creating a die that allowed us to curve the nosing out on the stair treads. It worked beautifully, and the staircase is the centerpiece of the store.

We also created twin spiral staircases for the University of Alabama and Troy University. While those weren't as

complicated as the jewelry store staircase, they still required a fair amount of effort and ingenuity to create.

But some of the harder things to produce are conical rolled tubes, which are technically rolled in two directions. To maintain quality, you have to rigidly hold a piece to maintain its shape. But you can't do that in two directions; you can only do it in one. We developed a method to roll a tube in two directions and maintain quality at the same time. It's those little challenges that add interest to my day. Figuring out something like that is a lot of fun for us.



Summary

Including spirals, bends or rolled steel can certainly create a new dimension to an otherwise ordinary design. Having the right shop bending or rolling the steel to arches, curves or other shapes can also lessen the concerns in making design decisions involving complex curves, bends or rolls. At Hornsby Steel, we strive to use innovation and our experienced operators to meet all design needs.

David Hornsby is President at Hornsby Steel in Cleveland, Alabama. He can be contacted at david@hornsbysteel.net.

TIDBITS ON BOLTS AND WELDS

by Robert Whyte, P.E., S.E.

INTRODUCTION

Even though bolts and welds are the very basic components of the structural steel industry, certain aspects of their design may often be overlooked or taken for granted.

The summary presented in this article is by no means an 'all that you need to know' about bolts or welds, but hopefully a nice 'refresher'. References will be presented at the bottom; however some of the tidbits are rules of the thumb that are not likely to be found in any one reference material.

TIDBITS ON BOLTS

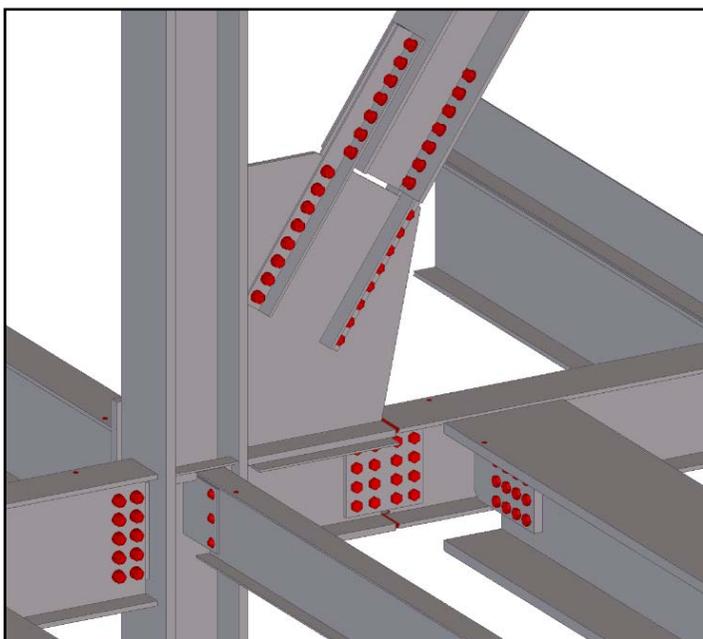


Figure 1: The Bow – Calgary (Compliments of Walters, Inc.)

There are two types of high strength bolts: A325 & A490.

(Design values for A307 bolts are given in the AISC 13th Edition but are very rarely used – they are not considered high strength bolts).

Ultimate tensile strength values for A325 & A490 bolts are 120 ksi & 150 ksi, respectively.

The yield point for high strength bolts is not well defined, as a result design strength expressions for bolts use the UTS as the basic parameter.

When bolts are loaded in shear there are two ways of transferring load: by bearing or friction (slip-critical).

There are two formulations for bearing bolts:

- N-Bolts: When bolt threads are INCCLUDED in the shear plane.
- X-Bolts: When bolt threads are EXCLUDED from the shear plane.

And, two formulations for slip-critical bolts:

- Class A: Slip coefficient = 0.35.
- Class B: Slip coefficient = 0.50.

(Class C which was for galvanized steel has been absorbed into Class A)

For bearing bolts no special steel-to-steel faying surface conditions are required. However for slip-critical bolts special surface conditions are needed to produce the required slip coefficient. Blast cleaning of the steel in the 'connection areas' is often used to achieve this.

Slip-critical bolt shear values are attained by a combination of faying surface conditions and the clamping force of the bolts when adequately pretensioned. More on this later...

Installation methods of high-strength bolts are: snug-tight, turn-of-the-nut, calibrated wrench, tension control, and using direct tension indicators.

A snug-tight condition is attained by the full effort of an ironworker using a spud wrench. In a lab test it was shown that tensile preloads ranged from 5-10 kips for a 7/8"Ø A325 bolt, using this method. This is still very far from being considered a 'pretensioned' bolt.

A pretensioned condition can only be obtained by the other methods mentioned above.

In turn-of-the-nut installation the bolt is first snug-tightened; it is match marked and then turned a certain amount (1/3, 1/2, or 2/3 of a turn depending on bolt

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Technical Article

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diameter and length). As the nut turns the bolt elongates, thus turn-of-the-nut is an ‘elongation method of controlling bolt tension’.

Calibrated wrench installation requires that a sample number of bolts be tested in a hydraulic load cell (called Skidmore-Wilhelm) to determine the amount of torque required to obtain the minimum specified pretension for a given bolt grade, diameter and length. This ‘target torque’ would be used for installation of the rest of the bolts from that lot. Jobsite conditions as well as variation in geometric factors from the bolt manufacturing process will invariably have a likely negative effect on this torque vs. tension relationship. Therefore care must be exercised when using this method. An interesting YouTube video shows how a properly lubricated bolt easily reaches the minimum specified pretension value, while a bolt that had some rust on it couldn’t reach 40% of this value.

Tension control (TC) bolts come as an assembly (bolt, nut, and washer). The bolt has a splined end that is ‘sheared off’ when torqued by a special wrench that has two coaxial chucks – an inner chuck that engages the splined end and an outer chuck that envelopes the nut. Even though these bolts are subject to the same pre-installation requirements as for calibrated wrench installation, there is less variability in target pretensions due to the quality of the lubricant used by the manufacturer.

Direct tension indicators (DTI) are bolt washers with arc-shaped protrusions that compress when the bolt is tightened. A number of feeler gage refusals are required to consider the bolt pretensioned. Like with turn-of-the-nut, DTIs provide an elongation method of controlling bolt tension.

Pretensioned bolt values are grade and diameter specific. For example, 39 kips of pretension is the minimum specified value for a 7/8” A325.

Bearing bolts don’t (necessarily) require a pretension; they can be installed using the snug-tight method. Slip-critical bolts must be pretensioned.

The great majority of connections in a building will use bearing bolts. Slip-critical connections however do provide specific joint performance characteristics, like preventing slip which would otherwise be detrimental to the structure, or allowing erection tolerance by using oversize or slotted holes (i.e. bracing connections, shear

plates with axial load.)

Other examples where slip-critical bolts are used: connections where load is repetitive and changes from tension to compression (splices), connections subject to fatigue (bridges) and seismic connections.

A word on washers: Not required for snug-tightened joints, and, not required for pretensioned & slip-critical joints with bolts installed using turn-of-the-nut method, if: there are no sloping surfaces, and no oversized or slotted holes, and if A490 bolts on $F_y = 40$ ksi or less material is not being used.

MISCELLANEOUS TIDBITS

A325 bolts may be ordered fully threaded (A325T). These bolts must not be used in X-type connections.

A490 bolts are not available fully threaded.

If necessary, A325 bolts can be re-tightened with the permission of the EOR.

A490 bolts cannot be re-tightened.

A490 bolts cannot be galvanized.

Thread lengths are constant for a given bolt diameter.

Nut height is approximately equal to the bolt diameter.

The washer’s outside diameter is approximately equal to two times the bolt diameter.

TIDBITS ON ECONOMY

Never use the same diameter bolts with different strengths in the same project.

If two diameters are necessary on the job use 3/4”Ø & 1”Ø, or 7/8”Ø & 1 1/8”Ø -

Ex. don’t use 3/4”Ø & 7/8”Ø in the same job.

Use bearing joints & snug-tight bolts when allowed by the job Specification. Use X-Type bolts whenever possible.

TIDBITS ON WELDS

The most frequently used weld types in the structural steel industry are: fillet welds, partial joint penetration (PJP)

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Technical Article

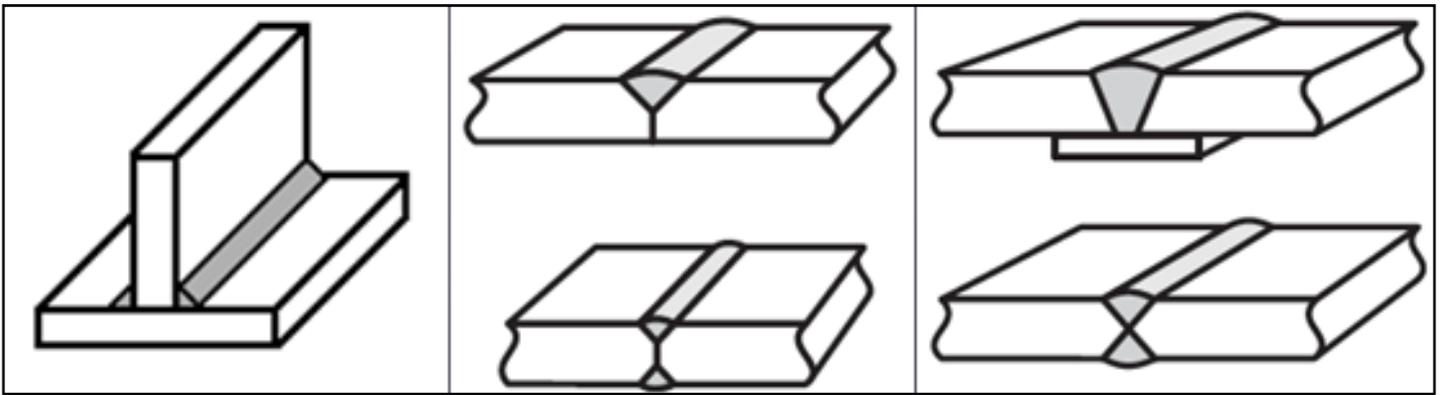


Figure 2: Fillet Weld, PJP Weld and CJP Weld.

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welds, complete joint penetration (CJP) welds & flare-bevel groove welds. Among these, by far the most commonly used are fillet welds.

The most common electrode used is an E70XX, for which the tensile strength of the weld deposit material is 70 ksi. The XX symbols are reserved for position and type of coating and (electrical) current.

Commonly used arc welding processes are shielded metal arc welding (SMAW), flux core arc welding (FCAW) & gas metal arc welding (GMAW). The type of joint and weld position (flat, horizontal, vertical, and overhead) are dependent on these processes.

Basic weld symbols are better explained with a sketch: See Figure 3.

ABOUT FILLET WELDS

The weakest segment of a fillet weld is assumed through the effective throat, E, which is 0.7071 times the weld size (or weld leg, D). Strength calculations are therefore based on an area equal to E times the effective length of the fillet weld, L.

In ASD, the strength of a fillet weld in shear is 21 ksi (which represents a 70% hit from the electrode's strength of 70 ksi). In LRFD the shear strength is 31.5 ksi.

Gaps in fillet welded connections are permitted up to 3/16" however, the strength must be reduced proportionally to the amount of gap.

In lapped plate connections fillet weld sizes are permitted to equal the thickness of the lapped plate up to 1/4" thick, after that the plate must be at least a 16th of an inch thicker than the required weld size (i.e. 1/4" weld on 1/4" thick plate is ok, but for 5/16" thick plate the maximum fillet weld allowed is 1/4").

(Continued on page 13)

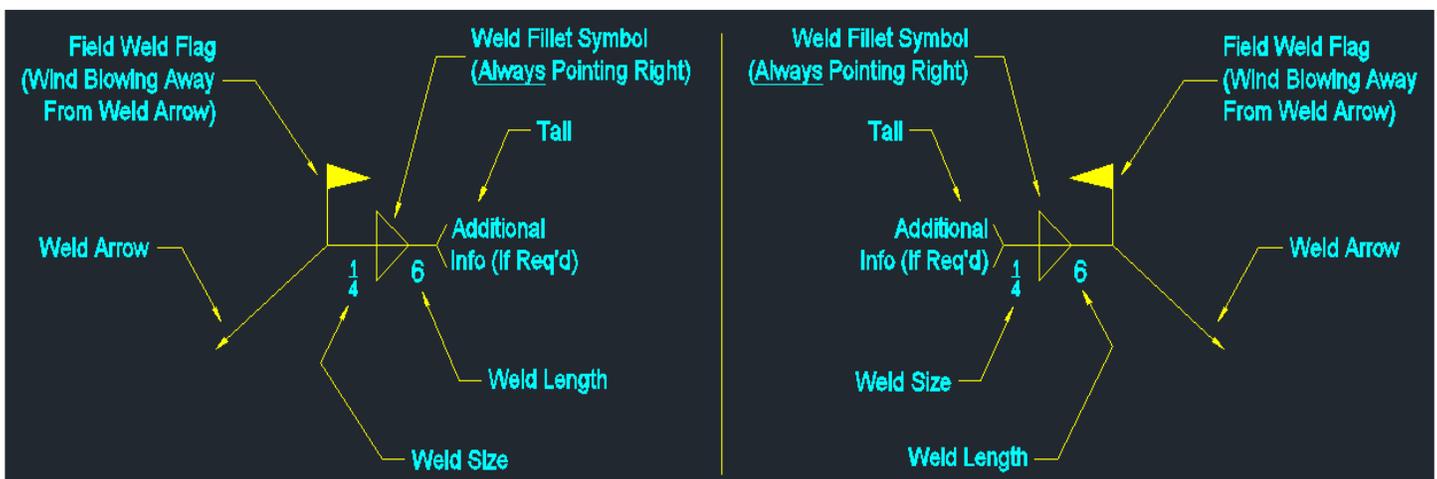


Figure 3: Basic Fillet Weld Symbols

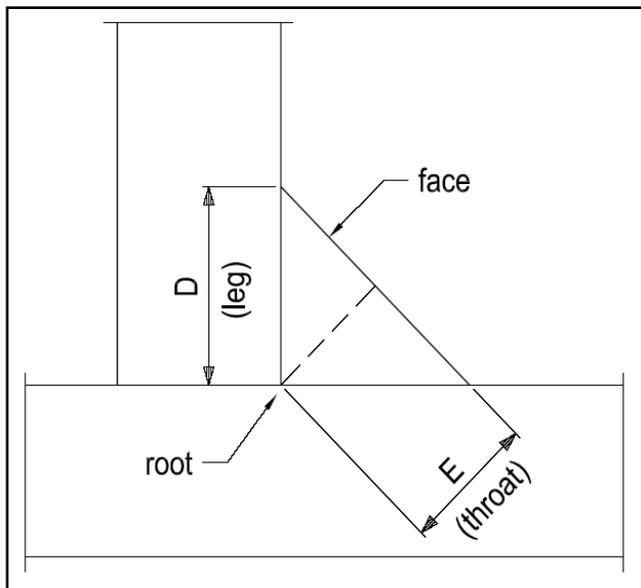


Figure 4: Fillet Weld.

(Continued from page 12)

Single fillet welds in tension are not allowed. A fillet weld must never be loaded with a moment about its longitudinal axis:

Fillet weld sizes up to and including 5/16" can be made by a 'one-pass' weld. 3/8" and greater size welds are 'multi-pass' welds.

Fillet welds are more economical than PJPs and CJPs.

Size of fillet weld before considering going to a PJP: Some fabricators say 5/8", others 3/4".

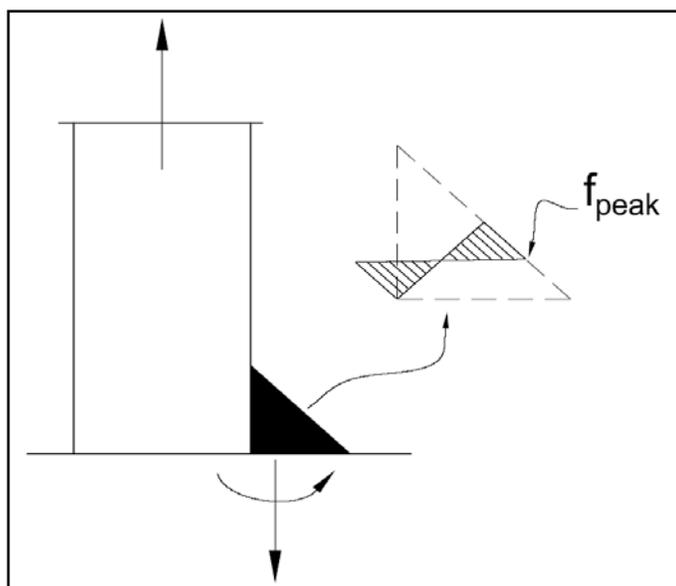


Figure 5: Single Fillet Weld in Tension

For PJPs: 'Two welds are better than one' – an effective throat, E, of 3/4" will have the same strength as (2) 3/8", however the latter will require a 1/3 less total amount of weld deposit than the former.

For CJPs the weld strength will equal the strength of the lesser material grade joined. Increasing the thickness of the lesser grade material will not increase the strength of the welded joint.

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