ENGINEERING JOURNAL

Third Quarter 2007 Article Abstracts

The following papers appear in the third quarter 2007 issue of AISC's *Engineering Journal*. *EJ* is also available online to AISC members and ePubs subscribers at www.aisc.org/epubs.

Development of a Cast Modular Connector for Seismic-Resistant Steel Moment Frames, Part 1: Prototype Development

ALI SUMER, ROBERT B. FLEISCHMAN, AND BLAKE E. HOSKISSON

A cast modular connector (MC) has been developed for use in seismic-resistant steel moment frames. The MC is a field-bolted beam flange connection intended to serve as the frame's special energy-dissipating detail. The connector is specifically configured for optimal seismic performance through a casting process. The MC possesses inherent ductility through variable-section arms that minimize plastic strain demand and a reliable yet economical fastening method through a base end-region that virtually eliminates prying forces on bolts. This paper focuses on the development of a Beta prototype design for the MC. This development process focused on the isolated connector rather than full-connection behavior. The MC Beta prototype design was developed using a comprehensive analytical investigation of trial configurations and key parameters using nonlinear (material and geometry) finite element analysis. Lessons were learned from an Alpha prototype. Designs were alternately evaluated for structural performance and castability through the electronic exchange of solid model files with steel foundry industry partners. The analytical results indicate the potential for excellent ductility and energy dissipation characteristics in the MC Beta prototype. A subsequent companion paper will describe the creation of a physical prototype and the experimental program that provides verification of the analytical results presented here.

Topics: Seismic design, connections-moment

Development of a Cast Modular Connector for Seismic-Resistant Steel Moment Frames, Part 2: Experimental Verification

ALI SUMER, ROBERT B. FLEISCHMAN, AND NATHAN J. PALMER

A companion paper describes the development of a prototype design for a cast modular connector (MC) for seismic-resistant steel moment frames. The eventual design, termed the MC "Beta" prototype design, was developed through a comprehensive analytical program that focused on the monotonic response of isolated connectors. Analyses of the MC Beta prototype design indicate the potential for excellent ductility and energy dissipation characteristics. This paper focuses on the prototyping and experimental verification of the MC Beta prototype. Steel foundry industry partners cast the MC Beta prototype at approximately half-scale. The scaled MC Beta prototype was tested in isolated fashion under monotonic and cyclic loading. The experimental results confirmed the performance of the analytically-based designs. The MC Beta prototype exhibited exceptional performance in terms of stable energy dissipation, far exceeding qualifying rotational ductility capacities. In direct comparisons to a WT (structural tee) section of similar stiffness and strength, the MC Beta prototype possessed greatly enhanced ductility and energy dissipation characteristics. With the MC Beta prototype developed and experimentally verified under isolated conditions, future work involves comprehensive analytical evaluation and full-scale experimental verification of beam-to-column joints containing the MC using accepted testing protocols and developing a design procedure for moment frames using the MC.

Topics: Seismic design, connections-moment, research

Seismic Design of Steel Joist Girder Structures

UKSUN KIM, ROBERTO T. LEON, AND THEODORE V. GALAMBOS

Current seismic design provisions emphasize detailing that results in large system ductility and energy dissipation. This may not be the best approach for flexible structures that may be able to withstand large earthquakes in the elastic range or with very limited inelasticity. Among these types of structures are tall one-story frames often constructed utilizing joist girder systems. The main objective of this study is to provide a safe and efficient seismic design methodology for steel joist girder structures—typically one-story industrial or commercial structures intended primarily to carry light roof loads. A new design procedure based on the weak column–strong beam concept is developed, and experimental and analytical verification studies are described. A full-scale cyclic test and pushover analyses show that the intended mechanism can be achieved if the required design strength of the joist girder members and connection to column are based on a column flexural strength of $1.2R_yM_{pc}$. This design requirement is needed in order to avoid a buckling failure of the compression angle members of a joist girder and failure of connections at the end of the joist girder.

Topics: Seismic design, connections-moment, structural and building systems

Behavior of Steel Joist Girder Structures with PR Column Bases

UKSUN KIM, ROBERTO T. LEON, AND THEODORE V. GALAMBOS

Little guidance is provided by current building codes for the seismic design of one-story, frame-type industrial buildings. This paper describes tests and companion analytical studies on the behavior of a full-scale, one-bay, two-frame joist girder structure aimed at developing seismic design guidelines for joist girder frames. Two issues are highlighted: the use of a capacity approach for seismic design and the influence of both the girder-to-column and column base-to-foundation connections on the seismic performance of these structures. The cyclic test results indicated that the beam-to-column connections can be considered as rigid when properly detailed and that a simplified model based on the "component method" approach can provide good estimates for both column base stiffness and strength. The companion analytical studies with different column base fixity indicated that the roof drift decreased and base shear increased appreciably when the effect of the column base fixity was accurately modeled. Finally, a practical method that considers the effects of column base fixity and a modified column base design procedure are described.

Topics: Seismic design, structural and buildings systems, base plates

Geometric Formulas for Gusset Plate Design

JANICE J. CHAMBERS AND TONY C. BARTLEY

Common approaches to compute the yield and buckling resistances of gusset plates require knowledge of the lengths y_c, y_{cf}, y_b, y_{bf}, L_1, L_2, and L_3. While numerical values for these resistances have been presented in the literature, formulas for y_c, y_{cf}, y_b, y_{bf}, L_1, L_2, and L_3 have not been published. This paper presents the derivation and validation of equations to compute these lengths. The equations are summarized in flow charts that can be incorporated into software for practical applications. The formulas provided for y_c, y_{cf}, y_b, y_{bf}, L_1, L_2, and L_3 enable optimization of gusset plate design.

Topics: Connection design-simple shear, detailing

Modified Slenderness Ratio for Built-up Members

ATSUSHI SATO AND CHIA-MING UANG

Based on a review of theory, background for the historical development of the AISC specifications, and an updated experimental database, a simple model—which maintains the accuracy for the calculation of the modified slenderness ratio of built-up members with closely spaced individual components (for example, double angles and double channels) that are connected by welded or pretensioned bolted connectors—is proposed.

Topics: Columns and compression members, built-up members

Current Steel Structures Research

REIDAR BJORHOVDE

This regular feature of the *Engineering Journal* provides information on new and ongoing research around the world. In the 11th installment, research projects are summarized on the following topics: analytical studies of the behavior of welded T-stub moment connections, composite construction for buildings, modeling elements for steel frames, seismic response of steel structures, and fire resistance of steel structures and bridge structures, as well as steel towers for wind turbines.

Topics: Research

EDUCATION PROGRAM

AISC Launches Service Center Program

Dozens of architects, contractors, engineers, and consultants in the San Antonio area turned out in June for the inaugural presentation of AISC's new Service Center program. The program is designed to explain to fabricators and designers the importance of service centers to the steel supply chain. The program, which included a one-hour presentation and service center tour, was hosted at Triple-S Steel Supply Co.'s new showplace office-showroom-warehouse location on the site of the former Kelly Air Force Base in San Antonio.

Conducted by Chris Moor, AISC's industry mobilization director, the presentation discusses the structural steel market, structural steel manufacturing process, and distribution through steel fabricators and service centers, and the critical role that the steel service center plays in today's structural steel supply chain. The program, which is registered for two continuing education credits with the American Institute of Architects, is important because 70% of the structural steel in U.S. is supplied by steel service centers, and many project team members are unaware that service centers even exist or that they are a vital and available source of structural steel for building projects. This is particularly important today, since too many architects mistakenly believe that steel is difficult to obtain—when in reality service centers around the country have more than 750,000 tons of structural steel currently available for delivery. (For a list of AISC service center members, please vist **www.aisc.org/servicecenter**.)

More service center programs are being planned throughout the country. For more information, please contact Chris Moor at moor@aisc.org.

Following the service center program, AISC presented the facility's design and construction team with awards in recognition of the project's selection as a National winner in AISC's 2007 Innovative Design in Engineering and Architecture with Structural Steel (IDEAS^2) awards program.

The project, whose warehouse features a structural steel exoskeleton and whose office and showroom use architecturally exposed structural steel and a winged roof reflective of its airfield location, was honored in the "less than $15 million" category. The project team included: Triple-S Steel Supply Co., owner; Lake/Flato Architects, San Antonio, architect; Steve G. Persyn, P.E., Consulting Engineers, San Antonio, structural engineer; and Hooker Contracting Co., San Antonio, general contractor. (See the May issue of *MSC* for more on the project, or visit **www.modernsteel.com**.)

At the conclusion of the presentation, AISC and Triple-S Steel President Gary Stein announced the creation of the Johnny Stein Award for architecture, which will be given to an architect in recognition of his or her body of work for the innovative and visual use of exposed structural steel. A $25,000 cash prize will accompany the award.

LEGAL NEWS

Sending Contract Notices by E-mail

Notice is an important concept in construction. Many construction contracts permit or require all notices to be in writing with some specified means of delivery, such as U.S. Mail, fax, or FedEx.

In recent years, more and more project communications are occurring via e-mail, instant message, or some other electronic means. Can such electronic communications serve as "notice" in lieu of a communication in writing? Under the Uniform Electronic Transaction Act, the answer is yes.

The Uniform Electronic Transaction Act (UETA) is a uniform law that is designed to facilitate the conduct of business transactions electronically and to make electronic records and signatures as equally binding as paper and manually signed signatures.

As of 2005, 46 states, along with the District of Columbia and the U.S. Virgin Islands, have enacted the UETA. Only Georgia, Illinois, New York, and the state of Washington have not enacted it.

The UETA provides that where parties have agreed to conduct transactions by electronic means, electronic signatures or electronic notifications are as equally binding as paper. This means that in an UETA-governed transaction, a notice that is emailed and signed electronically is equally as valid and binding as one that is set out on paper and mailed.

The key concept in determining whether the UETA applies is "agreement," since it only applies to those transactions where the parties have "agreed" to conduct transactions by electronic means. While such an agreement may be contained in the contract itself, Section 5 of the UETA also provides that parties may implicitly agree to conduct transactions electronically from their own conduct and course of dealing on a project.

So if it can be shown that parties to a contract have customarily communicated with each other via email or other electronic means, the UETA will likely permit and enforce electronic notices even where the contract contains no specific provisions addressing them.

In light of this, it is best to eliminate uncertainty and include contract provisions either permitting or precluding electronic notice prior to starting a project. This will allow the project participants to know ahead of time whether electronic notice is effective, and not argue about it later in court.

Whether electronic notice is specified or precluded, the UETA will provide the legal framework to assure that each party's choice is enforced.

—By Ronald J. Stay, associate, Stites & Harbison PLLC

Correction

The SteelWise article from January 2007 titled "Prequalified Sesimic Moment Connections" contains a typographical error. In the section titled "Variables and Definitions" under "User Notes," the third bulleted point should read:

➜ The effective beam flange width for compactness can be taken as $b_{bf} - 2[c - R + (R^2 - b^2/9)^{0.5}]$ per 358-5.3.1(6).