THE 2002 SJI CATALOG WHAT'S NEW

James M. Fisher

James M. Fisher is vice president of Computerized Structural Design (CSD), a Milwaukee, Wisconsin, consulting engineering firm. He received a Bachelor of Science degree in civil engineering from the University of Wisconsin in 1962. After serving two years as a Lieutenant in the United States Army Corps of Engineers, he continued his formal education. He received his Master of Science and Ph.D. degree in structural engineering from the University of Illinois in 1965 and 1968 respectively. Prior to joining CSD, he was an assistant professor of structural engineering at the University of Wisconsin at Milwaukee. He is a registered structural engineer in several states.

Fisher has specialized in structural steel research and development. He has spent a large part of his career investigating building systems and the study of economical structural framing systems. He was a former chairman of the American Society of Civil Engineers Committee on the Design of Steel Building Structures.

Fisher is a member of the American Iron and Steel Institute (AISI) Committee on Specifications, and a member of the AISC Specification Committee for the Design Fabrication and Erection of Structural Steel Buildings.

Fisher is the co-author of seven books, as well as the author of many technical publications in the field of structural engineering.

He is a member of the American Society of Civil Engineers and honorary fraternities Tau Beta Pi, Sigma Xi, Chi Epsilon and Phi Kappa Phi.

Fisher received the 1984 T.R. Higgins Lectureship Award presented by the American Institute of Steel Construction.

SUMMARY

This paper covers both the seismic behavior of industrial trussed girder structures and highlights of the new Steel Joist Institute (SJI) specification. Recent research from Georgia Tech offers insight on assessing the efficacy of current design provisions for joist girder buildings. Recommendations on guidelines for the use of a weak column-strong beam mechanism, which can lead to ductile behavior and good energy dissipation, are provided. The paper also touches on changes and new features in the updated Steel Joist Institute Specifications and Load Tables. Information is provided on substitutes, standing seam roofs, and the new OSHA rules.

An SJI Presentation

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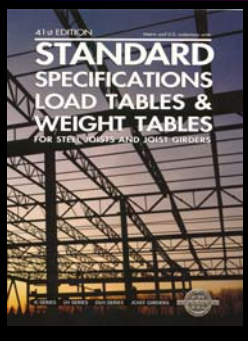
The SJI 2002 Catalog



What's New?

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2002 Catalog - Contents

- 2002 Revisions
- History
- Policy
- Membership
- Steel Joist Institute Publications
- Fire Resistance Ratings with Steel Joists
- Specifications for:
  - K & KCS- Series
  - LH & DLH- Series
  - Joist Girders
  - KCS Joist
  - Recommended Code of Standard Practice for Steel Joists and Joist Girders
  - Referenced Specifications, Codes and Standards
- Appendices

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Historical Development

- **1928: First Standard Joist Specifications**
- **1929: First Load Tables (SJ- Series)**
- **1953: Longspan Steel Joists (L- Series)**
- **1959: S- Series (Replaced the SJ- Series)**
- **1961:**
  - J- Series (Replaced S- Series)
  - LA- Series (Replaced L- Series)
  - H- Series (50 ksi Steel)
- **1962: LH- Series (50 ksi Steel)**

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Historical Development

- **1965: Single Specification J- and H- Series**
- **1966: LJ- Series (Replaced the LA- Series)**
- **1970: LH- Series and DLH- Series**
- **1971: 8J3 and 8H3 added**
- **1972: Single Specification for LJ-, LH-, DLJ- and DLH- Series Joists**
- **1978: Elimination of J-, LJ-, and DLJ- Series and Introduction of Joist Girders**

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Historical Development

- **1986: K- Series (Replaced H- Series)**
- **1994:**
  - KCS Joists added to the K- Series
  - Metric Nomenclature Introduced
  - Revised Stability Criteria
- **2002: (Major revisions)**
  - Joist Substitutes Added
  - American National Standards Approval of K, LH/DLH and JG
  - Revisions to Conform with OSHA Steel Erection Standard
  - Addition of Standing Seam Roof Specification
  - Definition for Parallel Chord Sloped Joists – K- Series
  - 7.5 in. seat depth as standard for joist girders

What's New (General and K- Series Joists)

Fire-Resistance	Updated listing of Assemblies Ratings
Joist Substitutes	Added section on Joist Substitutes.
Section 2.	Revised definition for "Yield Strength " to agree with ASTM A370.
Section 3.1	Revised materials listing to conform with 2001 ASTM Specifications.
Section 3.2	Updated ASTM materials listing
Section 3.3	Paint – revised wording..
Section 4.2(b)	Added wording for crimped,first primary compression web.
Section 5.6(a)&(b)	Revised wording to conform to OSHA standard.
Section 5.8(g)	New paragraph for using joists with Standing Seam Roofing (SSR).
Section 5.13	New Section - Parallel sloped joists, K- series
Section 6.(a)(1)	Revised to require bolts used in bolted seat connection to be tightened to a minimum tight condition.

What's New (LH- Series Joists)

Section 101.	Revised definition for "Yield Strength " to agree with ASTM A370.
Section 102.1	Revised Materials listing to conform with 2001 ASTM Specifications.
Section 102.2	Updated ASTM Material listings.
Section 102.3	Updated AWS electrode listing.
Section 102.4	Paint – revised wording..
Section 103.2(d)	Updated AWS electrode listing.
Section 104.7(a)&(b)	Revised wording to conform to OSHA standard.
Section 104.9(g)	New paragraph for using joists with Standing Seam Roofing (SSR).
Section 104.14	New Section – Parallel sloped joists, LH- series
Section 105.(A)(1)	Revised to require bolts used in bolted seat connection to be tightened to a minimum snug tight condition.

What's New (Joist Girders)

JG Introduction	Revised all Joist Girder seat depths to 7.5 inches.
Section 1001.	Revised definition for "Yield Strength " to agree with ASTM A370..
Section 1002.1	Revised Materials listing to conform with 2001 ASTM Specifications.
Section 1002.2	Updated ASTM Material listings.
Section 1002.3	Updated AWS electrode listing.
Section 1002.4	Paint – Revised wording..
Section 1003.2(d)	Updated AWS electrode listing.
Section 1004.6(a)&(b)	Revised wording to conform to OSHA standard.

What's New

References:

Appendix "A "	New - Steel Joist Institute "Bay Length Definitions "
Appendix "B "	New - OSHA Steel Erection Standard 29 CFR Part 1926, Safety Standards Erection, Paragraph §1926.757 Open Web Steel Joists.
Appendix "C "	New - OSHA Appendix "C " Illustrations of Terminus Points

Joist Substitutes

Joist substitutes are 2.5 inch deep sections intended for use in very short spans (less than 8 feet) where Open Web Steel Joists are impractical.

Typical Joist Substitute
2 ½ in. deep

Joist Substitutes

- The 2002 Specification is the first joist specification to include joist substitutes. Prior to this Specification the load capacity, and the fabrication of joist substitutes were at the discretion of each joist manufacturer, thus many different types and load tables existed.
- As indicated on the previous slide joist substitutes have a standard 2.5 in. deep seat; however they can be manufactured with other seat depths.

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Joist Substitutes

- Joist substitutes are typically manufactured by connecting two angles to one another to form a 2.5 in. deep C-section.
- Joist substitutes are more economical than short joists and should always be used for spans under 8 ft. in length.
- The current load tables contain fewer section types than previously offered by some manufacturers; however, the specifier should use the new standard sizes.

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Joist Substitutes

2.5 Inch K-Series Joist Substitutes

Designation	2.5K1	2.5K2	2.5K3
Span (ft)	Allowable Uniform Load (plf)		
4	550	550	550
5	550/338	550/465	550
6	374/189	519/260	550/354
7	270/116	375/160	540/218
8	204/76	284/105	408/143

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American National Standards

Approval of:
K, LH / DLH and JG

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Revisions to Conform with OSHA Steel Erection Standard

There are many new items in the OSHA 1926.757 rules, only those items that may have an effect on the structural engineer of record are discussed here.

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1926.757(a) General

- General
- (1) Except as provided in paragraph (a)(2) of this section, where *steel joists* are used and columns are not framed in at least two directions with solid web structural steel members, a steel joist shall be field-bolted at the column to provide lateral stability to the column during erection. For the installation of this joist:

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.757(a)(1), cont.

(i) A vertical stabilizer plate shall be provided on each column for steel joists. The plate shall be a minimum of 6 inch by 6 inch (152 mm by 152 mm) and shall extend at least 3 inches (76 mm) below the bottom chord of the joist with a 13/16 inch (21 mm) hole to provide an attachment point for guying or plumbing cables.

.757(a)(7)

- **No modification that affects the strength of a steel joist or steel joist girder shall be made without the approval of the *project structural engineer of record*.**

.757(a)(8)

- **Field-bolted joists.**
  - (i) Except for steel joists that have been pre-assembled into panels, connections of individual steel joists to steel structures in bays of 40 feet (12.2 m) or more shall be fabricated to allow for field bolting during erection.
  - (ii) These connections shall be field-bolted unless constructibility does not allow.

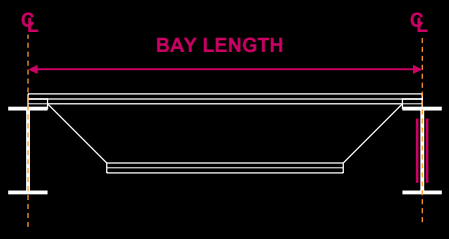
Holes in Beams

- **Since holes must be provided in the supporting steel beams for joists over 40 ft. in length, and permanent bolts may or may not be installed, check AISC requirements for net section.**
- **What about lateral support for the beam?**

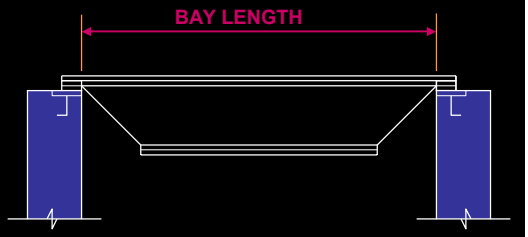
SJI Definition of Bay

- **For the purpose of steel joist erection, bay dimensions are measured as follows:**
  - 1) The centerline of a steel beam, joist girder, or column.
  - 2) The inside face of masonry or pre-cast concrete.

SJI Bay Length – Beams & Joist Girders



SJI Bay Length – Masonry or Tilt-up



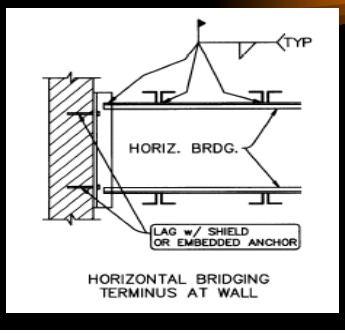
.757(a)(10)

- A *bridging terminus point* shall be established before bridging is installed. (See Appendix C to this subpart.)

Bridging Terminus Points

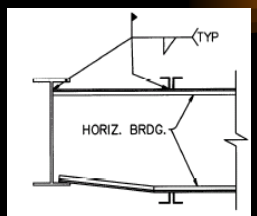
- The following details are taken from the non-mandatory Appendix C of Subpart R and illustrate means of establishing Bridging Terminus Points as required by 1926.757(a)(10) and 1926.757(c)(5).

OSHA Appendix C



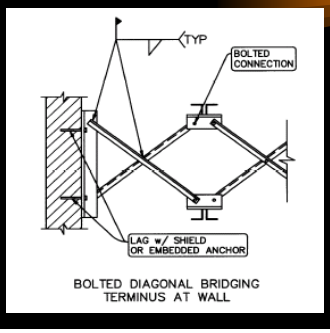
HORIZONTAL BRIDGING TERMINUS AT WALL

OSHA Appendix C



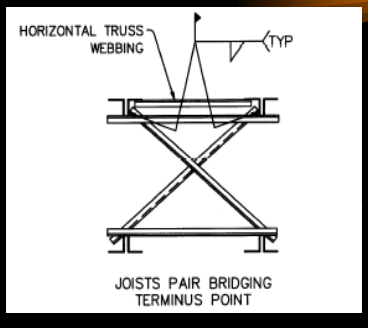
HORIZONTAL BRIDGING TERMINUS AT STRUCTURAL SHAPE

OSHA Appendix C



BOLTED DIAGONAL BRIDGING TERMINUS AT WALL

OSHA Appendix C



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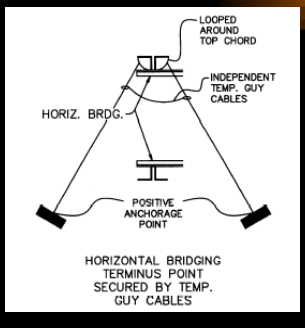
OSHA Appendix C



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.757(d)(5)

- **Where any steel joist specified in paragraphs (c)(2) and (d)(1), (d)(2), and (d)(3) of this section is a bottom chord bearing joist, a row of bolted diagonal bridging shall be provided near the support(s). This bridging shall be installed and anchored before the hoisting cable(s) is released.**

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New SJI Section on Standing Seam Roofs - 5.8(g)

The stiffness and strength of standing-seam roof clips varies from one manufacturer to another. Therefore, some roof systems cannot be counted on to provide lateral stability to the joists which support the roof.

- Sufficient stability must be provided to brace the joists laterally under the full design load.
- The compression chord must resist the chord axial design force in the plane of the joist (i.e., x-x axis buckling) and out of the plane of the joist (i.e., y-y axis buckling).
- Out-of-plane strength may be achieved by adjusting the bridging spacing and/or increasing the compression chord area, the joist depth, and the y-axis radius of gyration.
- The effective slenderness ratio in the y-direction equals $0.94\ l/r_y$; where l is the bridging spacing.

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Standing Seam Roofs

- The maximum bridging spacing may not exceed that specified in Section 5.4(c).
- Horizontal bridging members attached to the compression chords and their anchorages must be designed for a compressive axial force of 0.0025nP, where n is the number of joists between end anchors and P is the chord design force.
- The attachment force between the horizontal bridging member and the compression chord is 0.005P.
- Horizontal bridging attached to the tension chords shall be proportioned so that the slenderness ratio between attachments does not exceed 300.
- Diagonal bridging shall be proportioned so that the slenderness ratio between attachments does not exceed 200.

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Standing Seam Roofs

- **The standing seam roof provisions are based on the accumulation of bracing forces in all of the joists.**
- **It is assumed that all joists buckle in the same lateral direction.**
- **The value "n" is the number of spaces between end anchors, or between braced joist spaces, i.e. X-bridging points or horizontal bracing trusses.**

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New Section 5.13 and 104.14

PARALLEL CHORD SLOPED JOISTS

The Span of a parallel chord sloped joist shall be defined by the length along the slope. Minimum depth,load-carrying capacity, and bridging requirements shall be determined by the sloped definition of span. The Standard Load Table capacity shall be the component normal to the joist.

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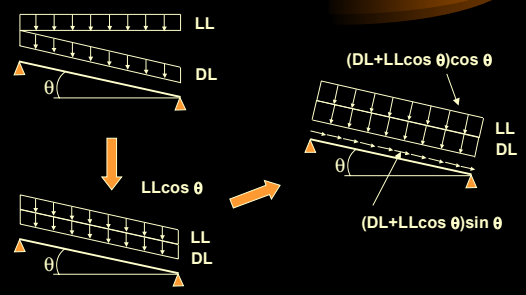
Sloping Joists



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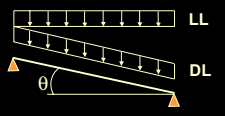
Sloping Joists - Example

Determine the joist to be specified for the following:

Roof slope = 6:12
Plan dimension of bay, L_p = 39′ – 0″
Typical joist spacing = 5′ – 0″

LL = 14 psf
DL = 22 psf



$\theta = \tan^{-1}(6/12) = 26.6^{\circ}$
$LLcos^2\theta$ x joist space = 56 plf
DLcos θ x joist space = 99 plf
Actual joist length, L_s = 43′ – 7″

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Sloping Joists - Example

The Steel Joist Institute Specifications for short span joists limits the length of joists to 24 times the joist depth. Therefore, the minimum joist depth for this situation is 22 inches.

Enter the joist load table using: TL = 155 plf, LL = 56 plf, joist length = 43' – 7"
Specify a 22K5 (for 44' – 0" span, allowable uniform total load = 157 plf, live load that produces a deflection of L/360 = 76 plf).

In addition, the manufacturer will need to design this joist for the effects of the load parallel to the the joist. This load is:

$$[(LLcos\,\theta) + DL]\sin\theta = 77\ plf$$

This load will be applied as an additional top chord axial force in the joist by the manufacturer.

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Current Usage

- K Series (Includes KCS)
- LH Series
- DLH Series
- Joist Substitutes
- Joist Girders

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KCS Series Joists

- Constant Moment Capacity
- Constant Shear Capacity

Diagonals designed for stress reversal, except end diagonal which is 100% tension only

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Current Usage

Standard Seat Depths:

- **K- Series: 2.5"**
- **Joist Substitutes: 2.5"**
- **LH and DLH Series:**
  - 5" up to #17 chords
  - 7.5" for #18 and # 19 chords
- **Joist Girders: 7.5"**

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SJI Load Tables

Series	Depth Inches	Span feet	Load, Max lbs/ft
K	8 - 30	8 - 60	Varies w/ Span
KCS	10 - 30	8 - 60	In terms of moment and shear
LH	18 - 48	25 - 96	Varies w/ Span
DLH	52 – 72	61 -144	Varies w/ Span
Substitutes	2.5	4 - 8	Varies w/ Span

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Current Joist Girder Usage

- **Spans: 20 ft. to 60 ft.**
- **Depths: 20" to 72"**
- **Standard Seat Depth: 7.5"**
- **Various Web Configurations**

Note: It is not necessary to use only the depths, spans, and loads shown in the SJI weight tables. Consult individual joist manufacturers for joist girders outside these ranges.

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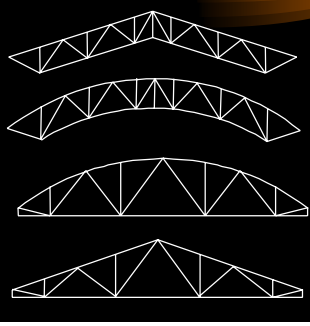
Special Profile Joists



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Updated ASTM materials listing

SECTION 3. MATERIALS

3.1 STEEL

The steel used in the manufacture of chord and web sections shall conform to one of the following ASTM Specifications:

- Carbon Structural Steel, ASTM A36/A36M.
- High-Strength, Low-Alloy Structural Steel, ASTM A242/A242M.
- High-Strength Carbon-Manganese Steel of Structural Quality, ASTM A529/A529M, Grade 50.
- High-Strength Low-Alloy Columbium-Vanadium Structural Steel , ASTM A572/A572M, Grade 50.
- High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) minimum Yield Point to 4 inches (100mm) thick, ASTM A588/A588M.

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Updated ASTM materials listing

- Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Corrosion Resistance, ASTM A606.
- Steel, Sheet, Cold-Rolled, Carbon, Structural, High- Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, ASTM A1008/A1008M.
- Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High- Strength Low-Alloy with Improved Formability, ASTM A1011/A1011M.

or shall be of suitable quality ordered or produced to other than the listed specifications, provided that such material in the state used for final assembly and manufacture is weldable and is proved by tests performed by the producer or manufacturer to have the properties specified in Section 3.2.

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Referenced Specifications, Codes and Standards

The following documents are referenced in these Specifications and Code

ASTM A6/A6M -00a
ASTM A36/A36M -00a
ASTM A242/242M -00a
ASTM A370 -97a
ASTM A529/A529M -00
ASTM A572/A572M -00
ASTM A588/A588M -00
ASTM A606 -98
ASTM A1008/A1008M -01
ASTM A1011/A1011M -00
AWS A5.1 -91
AWS A5.5 -96
AWS A5.17 -97
AWS A5.18 -93
AWS A5.20 -95

Referenced Specifications, Codes and Standards

American Institute of Steel Construction Specification for Structural Steel Buildings (Allowable Stress Design and Plastic Design) – June 1, 1989, Ninth Edition.

American Iron and Steel Institute Specification for Design of Cold-Formed Steel Structural Members – 1996, Supplement #1, Approved July 30, 1999 – Printed June 2000

29 CFR Part 1926 Safety Standards for Steel Erection, – §1926.757 Open Web Steel Joists - January 18, 2001

SJI Technical Digest #3 – Structural Design of Steel Joist Roofs to Resist Ponding Loads – May 1971.

Referenced Specifications, Codes and Standards

SJI Technical Digest #5 – Vibration of Steel Joist-Concrete Slab Floors, Revised March 1988.

SJI Technical Digest #6 – Structural Design of Steel Joist Roofs to Resist Uplift Loads, July 1998.

SJI Technical Digest #8 – Welding of Open Web Steel Joists, August 1983.

SJI Technical Digest #9 – Handling and Erection of Steel Joists and Joist Girders, July 1987.

SJI Technical Digest #11 – Design of Joist-Girder Frames, July 1999

Steel Structures Painting Council – SSPC Paint Specification No. 15, May 1, 1999

Education

You should also be aware that the SJI is presenting a series of lectures around the country on various topics associated with the design and manufacture of Steel Joists and Joist Girders.

Seven lecture modules exist:

- Module #1 – Introduction and Responsibilities
- Module #2 – Design
- Module #3 – Specification of Components
- Module #4 – Lateral Load Systems
- Module #5 – Special Topics
- Module #6 – OSHA Regulation 29 CFR Part 1926.757 – Open Web Steel Joists
- Module #7 – Practical Applications, Case Studies, and recently installed steel joist and joist girder projects

Future Developments

Future developments include:

- LRFD Specifications for the design of Open web steel joists and joist girders.
- A Specification for the design of Composite Joists.
- New Technical Digest on Fire Provisions (Technical Digest #10)
- Completing research to comply with the OSHA requirement: "Where steel joists at or near columns span 60 feet (18.3 m) or less, the joist shall be designed with sufficient strength to allow one employee to release the hoisting cable without the need for *erection bridging*."
- 75 Year Digest

SJI ANNUAL DESIGN AWARD

SPEED OF CONSTRUCTION

FLEXIBILITY

VALUE OF AESTHETICS

2001 SJI DESIGN WINNER
-- UNIQUE APPLICATIONS CATEGORY --

Northwest World Gateway at Detroit Metropolitan/ Wayne County Airport

- **Smith Group, Inc.**
- **Havens National Riggers & Erectors**

2001 SJI DESIGN WINNER
-- INDUSTRIAL CATEGORY --

Teksid Aluminum Components "TAC II" in Sylacauga, Alaska

- **Marshall Construction, L.L.C.**
- **Professional Group Engineering, Inc.**

2001 SJI DESIGN WINNER
-- NON-INDUSTRIAL CATEGORY --

Huron Valley Family YMCA in Millford, Michigan

- **Smith Group, Inc.**
- **Ross Structural Steel**

Gymnasium and Natatorium Roof Joists with Decking

An SJI Presentation

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