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# STANDARD SPECIFICATION

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June 1, 1923



AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.



In 1923 the American Institute of Steel Construction undertook the work of promoting uniform practice in the industry, and in order that its efforts would not be interpreted as being unduly influenced by commercial interests it selected a committee from among the leading talent in the academic, engineering and architectural professions to prepare a Standard Specification on the Design, Fabrication, and Erection of Structural Steel. This committee represented a combined experience of approximately one hundred and fifty years in an industry which is not more than thirty-five years old. The personnel was as follows:

GEORGE F. SWAIN: M. Am Soc C E—M. Am Soc M E—M. Inst C E  
M. A R E A—Past President, A S C E—Professor  
of Civil Engineering, Harvard University

MILO S. KETCHUM: M. Am Soc C E—M. A R E A—Dean of the College  
of Engineering, and Director of the Engineering  
Experiment Station of the University of Illinois

E. R. GRAHAM: of Graham, Anderson, Probst & White, Architects,  
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W. J. THOMAS: M. Am Soc C E—Chief Engineer, Geo. B. Post &  
Sons, Architects, N. Y.

WILBUR J. WATSON: M. Am Soc C E—M. A R E A—President, Watson  
Engineering Company, Cleveland, Ohio



# STANDARD SPECIFICATION

## AMERICAN INSTITUTE OF STEEL CONSTRUCTION

Gentlemen:

After careful deliberation the Committee selected to prepare a Standard Specification for the design, fabrication and erection of structural steel for buildings, submit the accompanying Code for your adoption.

The present Specification contemplates that the inspection, is such that improper material containing defects which should cause rejection is not used. It is not intended to cover material salvaged from previous construction, which should not be used except under rigid supervision and inspection.

It is also understood that the proper loads are taken and that impact is allowed for in each case by adding a proper percentage to the stresses produced by static live loads so that the total stress found in any member is an equivalent static stress. This Specification does not attempt to state definitely what the live, dead, or wind loads should be, or what percentage should be added for impact, as these are factors which should receive the careful consideration of competent engineers for each case. The question of corrosion under unusual conditions should have careful consideration by the engineer.

The question of design is all-important. It necessarily presupposes that the design is good, made by and executed under the supervision of competent structural engineers; that proper provision is made for secondary stresses, excentric loads, unequal distribution of stresses on rivets, etc.; that the details are suitable and that the workmanship is high grade.

It is recommended that the American Institute of Steel Construction maintain a Committee whose function shall be that of keeping such a Code as we submit consistent with the changing conditions of manufacture, design, and erection. Under these conditions, the Committee considers the unit stresses herein specified are proper.

Respectfully submitted by the Committee:

GEORGE F. SWAIN  
MILO S. KETCHUM  
E. R. GRAHAM  
W. J. THOMAS  
WILBUR J. WATSON

June 1st 1923

# STANDARD SPECIFICATION FOR STRUCTURAL STEEL FOR BUILDINGS

As adopted by the  
American Institute of Steel Construction

1. This Specification defines the practice adopted by the American Institute of Steel Construction for the design, fabrication, and erection of structural steel for buildings.

## 2. GENERAL

To obtain a satisfactory structure, the following major requirements must be fulfilled.

(a) The material used must be suitable, of uniform quality, and without defects affecting the strength or service of the structure.

(b) Proper loads and conditions must be assumed in the design.

(c) The unit stresses must be suitable for the material used.

(d) The workmanship must be good, so that defects or injuries are not produced in the manufacture.

(e) The computations and design must be properly made so that the unit stresses specified shall not be exceeded, and the structure and its details shall possess the requisite strength and rigidity.

## 3. MATERIAL

Structural steel shall conform to the Standard Specifications of the American Society for Testing Materials for Structural Steel for Buildings, Serial Designation A 9-21, as amended to date.

## 4. LOADING

(a) Steel structures shall be designed to sustain the dead weight imposed upon them, including the weight of the steel frame itself, and, in addition, the maximum live load as specified in each particular case. Proper provision shall be made for temporary stresses caused by erection.

(b) In cases where live loads have the effect of producing impact or vibration, a proper percentage shall be added to the static live load stresses to provide for such influences, so that the total stress found in any member is an equivalent static stress.

(c) Proper provision shall be made for stresses caused by wind both during erection and after completion of the building. The wind pressure is dependent upon the conditions of exposure, but the allowable stresses specified in section five (5), paragraphs (f) and (g), are based upon the steel frame being designed to carry a wind pressure of not less than twenty (20) pounds

per square foot on the vertical projection of exposed surfaces during erection' and fifteen (15) pounds per square foot on the vertical projection of the finished structure.

(d) Proper provision shall be made to securely fasten the reaction points of all steel construction and transmit the stresses to the foundations of the structure.

**5. ALLOWABLE STRESSES**

All parts of the structure shall be so proportioned that the sum of the maximum static stresses in pounds per sq. in. shall not exceed the following:

(a) **Tension.** Rolled Steel, on net section..... 18,000

(b) **Compression.** Rolled Steel, on short lengths or where lateral deflection is prevented..... 18,000

On gross section of columns,

$$1 + \frac{18,000}{18,000r^2}$$

with a maximum of..... 15,000

In which *l* is the unsupported length of the column, and *r* is the corresponding least radius of gyration of the section, both in inches.

For main compression members, the ratio *l/r* shall not exceed 120, and for bracing and other secondary members, 200.

(c) **Bending.** On extreme fibres of rolled shapes, and built up sections, net section, if lateral deflection is prevented..... 18,000

When the unsupported length *l* exceeds 15 times *b*, the width of the compression flange, the stress in pounds per sq. in. in the latter shall not exceed

$$1 + \frac{20,000}{2,000b^2}$$

The laterally unsupported length of beams and girders shall not exceed 40 times *b* the width of the compression flange.

On extreme fibres of pins, when the forces are assumed as acting at the center of gravity of the pieces..... 27,000

(d) **Shearing.** On pins..... 13,500

On power-driven rivets..... 13,500

On turned bolts in reamed holes with a clearance of not more than 1/50 of an inch.. 13,500

On hand-driven rivets..... 10,000

On unfinished bolts..... 10,000

On the gross area of the webs of beams and girders, where *h*, the height between flanges in inches, is not more than 60 times *t*, the thickness of the web in inches..... 12,000

On the gross area of the webs of beams and girders if the web is not stiffened where  $h$ , the height between flanges in inches, is more than 60 times  $t$ , the thickness of the web, the maximum

shear per square inch,  $\frac{V}{A}$  shall not exceed

$$1 + \frac{18,000}{7,200t^2}$$

In Which  $V$  is the total shear, and  $A$  is gross area of web in square inches.

		Double Shear	Single Shear
(e) <b>Bearing.</b>	On pins.....	30,000	24,000
	On power-driven rivets.....	30,000	24,000
	On turned bolts in reamed holes....	30,000	24,000
	On hand-driven rivets.....	20,000	16,000
	On unfinished bolts.....	20,000	16,000
	On expansion rollers per lineal inch 600 times the diameter of the roller in inches.		

(f) **Combined Stresses.** For combined stresses due to wind and other loads, the permissible working stress may be increased 33⅓%, provided the section thus found is not less than that required by the dead and live loads alone.

(g) **Members Carrying Wind Only.**

For members carrying wind stresses only, the permissible working stresses may be increased 33⅓%.

**6. SYMMETRICAL MEMBERS.**

Sections shall preferably be symmetrical.

**7. BEAMS AND GIRDERS.**

(a) **Rolled beams** shall be proportioned by the moment of inertia of their net section. Plate girders with webs fully spliced for tension and compression shall be so proportioned that the unit stress on the net section does not exceed the stresses specified in section five (5) as determined by the moment of inertia of the net section.

(b) **Plate girder webs** shall have a thickness of not less than 1-160 of the unsupported distance between the flanges.

(c) **Web splices** shall consist of a plate on each side of the web capable of transmitting the full stress through the splice rivets.

(d) **Stiffeners.** Stiffeners shall be required on the webs of rolled beams and plate girders at the ends and at points of concentrated loads, and at other points where  $h$  the clear distance between flanges is greater than  $85\sqrt{18,000(A/V)-1}$ , in which  $t$  is the thickness of the web. When stiffeners are required, the distance in inches between them shall not be greater

than  $85t\sqrt{18,000(A/V)-1}$ , or not greater than 6 feet. When  $h$  is greater than 60 times  $t$  the thickness of the web of a plate girder, stiffeners shall be required at distances not greater than 6 feet apart. Stiffeners under or over concentrated loads shall be proportioned to distribute such loads into the web.

Plate girder stiffeners shall generally be in pairs, one on each side of the web, and shall have a close bearing against the flange angles at points of concentrated loading; stiffeners over the end bearings shall be on plate fillers. The pitch of rivet in stiffeners shall not exceed 6".

(e) **Flange plates** of all girders shall be limited in width so as not to extend more than 6" or more than 12 times the thickness of thinnest plate beyond the outer row of rivets connecting them to the angles.

(f) **Crane runway girders** and the supporting framework shall be proportioned to resist the greatest horizontal stresses caused by the operation of the cranes.

(g) **Rivets** connecting the flanges to the web at points of direct load on the flange between stiffeners shall be proportioned to carry the resultant of the longitudinal and transverse shears.

(h) **Rivets** connecting the flanges to the webs of plate girders and of columns subjected to bending shall be so spaced as to carry the increment of the flange stress between the rivets.

## 8. COLUMN BASES.

(a) Proper provision shall be made to distribute the column loads on the footings and foundations.

(b) The top surface of all column bases shall be planed for the column bearing.

(c) Column bases shall be set true and level, with full bearing on the masonry, and be properly secured to the footings.

## 9. EXCENTRIC LOADING.

Full provision shall be made for stresses caused by excentric loads.

## 10. COMBINED STRESSES.

(a) Members subject to both direct and bending stresses shall be so proportioned that the greatest combined stresses shall not exceed the allowed limits.

(b) All members and their connections which are subject to stresses of both tension and compression due to the action of live loads shall be designed to sustain stress giving the largest section, with 50% of the smaller stress added to it. If the reversal of stress is due to the action of wind, the member shall be designed for the stress giving the largest section and the connections proportioned for the largest stress.

**11. ABUTTING JOINTS.**

Compression members when faced for bearings shall be spliced sufficiently to hold the connecting members accurately in place. Other joints in riveted work, whether in tension or compression, shall be fully spliced.

**12. NET SECTIONS.**

(a) In calculating tension members, the net section shall be used, and in deducting the rivet holes they shall be taken  $\frac{1}{8}$  inch greater in diameter than the nominal diameter of the rivets.

(b) Pin-connected tension members shall have the section through the pinhole 25% in excess of the net section of the member, and a net section back of the pin hole equal to 75% of that required through the pin hole.

**13. RIVETS AND BOLTS.**

(a) In proportioning rivets, the nominal diameter of the rivet shall be used.

(b) Rivets carrying calculated stresses, and whose grip exceeds five diameters, shall have their number increased 1% for each additional  $\frac{1}{10}$  inch in the rivet grip. Special care shall be used in heating and driving such rivets.

(c) Rivets shall be used for the connections of main members carrying live loads which produce impact, and for connections subject to reversal of stresses.

(d) Finished bolts in reamed holes may be used in shop or field work where it is impracticable to obtain satisfactory power-driven rivets. The finished shank shall be long enough to provide full bearing, and washers used under the nuts to give full grip when turned tight.

Unfinished bolts may be used in shop or field work for connections in small structures used for shelters, and for secondary members of all structures such as purlins, girts, door and window framing, alignment bracing and secondary beams in floor.

**14. RIVET SPACING.**

(a) The minimum distance between centers of rivet holes shall be three diameters of the rivet; but the distance shall preferably be not less than  $4\frac{1}{2}$  inches for  $1\frac{1}{4}$  inch rivets, 4 inches for  $1\frac{1}{8}$  inch rivets,  $3\frac{1}{2}$  inches for 1 inch rivets, 3 inches for  $\frac{7}{8}$  inch rivets,  $2\frac{1}{2}$  inches for  $\frac{3}{4}$  inch rivets, 2 inches for  $\frac{5}{8}$  inch rivets, and  $1\frac{1}{4}$  inches for  $\frac{1}{2}$  inch rivets. The maximum pitch in the line of stress of compression members composed of plates and shapes shall not exceed 16 times the thinnest outside plate or shape, nor 20 times the thinnest enclosed plate or shape with a maximum of 12 inches, and at right angles to the direction of stress the distance between lines of rivets shall not exceed 30 times the thinnest plate or shape. For angles in built sections with two gage lines, with rivets staggered, the maximum pitch in the line of stress in each gage line shall not exceed 24 times the thinnest plate with a maximum of 18 inches.

(b) In tension members composed of two angles, a pitch of 3'-6" will be allowed, and in compression members, 2'-0", but the ratio  $l/r$  for each angle between rivets shall not be more than  $\frac{3}{4}$  of that for the whole member.

(c) The pitch of rivets at the ends of built compression members shall not exceed four diameters of the rivets for a length equal to  $1\frac{1}{2}$  times the maximum width of the member.

(d) The minimum distance from the center of any rivet hole to a sheared edge shall be  $2\frac{1}{4}$  inches for  $1\frac{1}{4}$  inch rivets, 2 inches for  $1\frac{1}{8}$  inch rivets,  $1\frac{3}{4}$  inches for 1 inch rivets,  $1\frac{1}{2}$  inches for  $\frac{7}{8}$  inch rivets,  $1\frac{1}{4}$  inches for  $\frac{3}{4}$  inch rivets,  $1\frac{1}{8}$  inches for  $\frac{5}{8}$  inch rivets, and 1 inch for  $\frac{1}{2}$  inch rivets. The maximum distance from any edge shall be 12 times the thickness of the plate, but shall not exceed 6 inches.

## 15. CONNECTIONS.

(a) Connections carrying calculated stresses except for lacing, sag bars, or angles, hand rails, or beam connections, shall not have less than 2 rivets; or for field connections not less than 3 rivets.

(b) Members meeting at a joint shall have their lines of center of gravity meet at a point if practicable; if not, provision shall be made for any excentricity.

(c) The rivets at the ends of any member transmitting the stresses into that member should have their centers of gravity in the line of the center of gravity of the member; if not, provision shall be made for the effect of the resulting excentricity. Pins may be so placed as to counteract the effect of bending due to dead load.

(d) When a beam or girder "A" is connected to another member in such a manner that "A" acts as a continuous or fixed end beam, proper provision shall be made for the bending moments at such a connection.

(e) Where stress is transmitted from one piece to another, through a loose filler, the number of rivets shall be properly increased; tight-fitting fillers shall be preferred.

## 16. LATTICE.

(a) The open sides of compression members shall be provided with lattice having tie plates at each end and at intermediate points if the lattice is interrupted. Tie plates shall be as near the ends as practicable. In main members carrying calculated stresses the end tie plates shall have a length of not less than the distance between the lines of rivets connecting them to the flanges, and intermediate ones of not less than one-half of this distance. The thickness of tie plates shall not be less than one-fiftieth of the distance between the lines of rivets connecting them to the segments of the members, and the rivet pitch shall not be more than four diameters. Tie plates shall be sufficient in size and number to equalize the stress in the parts of the members.

(b) Lattice bars shall have neatly finished ends. The thickness of lattice bars shall be not less than one-fortieth for single lattice and one-sixtieth for double lattice of the distance between end rivets; their minimum width shall be as follows:

For 15" channels, or built sections with  $3\frac{1}{2}$ " and 4" angles— $2\frac{1}{4}$ " ( $\frac{3}{4}$ " rivets), or  $2\frac{1}{2}$ " ( $\frac{7}{8}$ " rivets).

For 12", 10", and 9" channels, or built sections with 3" angles— $2\frac{1}{4}$ " ( $\frac{3}{4}$ " rivets).

For 8" and 7" channels, or built sections with  $2\frac{1}{2}$ " angles— $2\frac{1}{4}$ " ( $\frac{5}{8}$ " rivets), or  $2\frac{1}{4}$ " ( $\frac{3}{4}$ " rivets)

For 6" and 5" channels, or built sections with 2" angles— $1\frac{1}{2}$ " ( $\frac{1}{2}$ " rivets), or  $1\frac{3}{4}$ " ( $\frac{5}{8}$ " rivets).

(c) The inclination of lattice bars to the axis of the members shall generally be not less than  $45^\circ$  but when the distance between the rivet lines in the flanges is more than 15 inches, the lattice shall be double and riveted at the intersection if bars are used, or else shall be made of angles.

(d) Lattice bars shall be so spaced that the ratio  $l/r$  of the flange included between their connections shall be not over  $\frac{3}{4}$  of that of the member as a whole.

## 17. EXPANSION.

Proper provision shall be made for expansion and contraction.

## 18. MINIMUM THICKNESS.

No steel less than  $\frac{5}{16}$  inch thick shall be used for exterior construction, nor less than  $\frac{3}{4}$  inch for interior construction, except for linings or fillers and rolled structural shapes.

These provisions do not apply to light structures such as skylights, marquees, fire-escapes, light one-story buildings, or light miscellaneous steel work.

For trusses having end reactions of 35,000 pounds or over, the Gusset Plates shall be not less than  $\frac{3}{8}$  inch thick.

## 19. ADJUSTABLE MEMBERS.

The initial stress in adjustable members shall be assumed as not less than 5,000 lbs.

## 20. WORKMANSHIP.

(a) All workmanship shall be equal to the best practice in modern structural shops.

(b) Drifting to enlarge unfair holes shall not be permitted.

(c) The several pieces forming built sections shall be straight and fit close together; and finished members shall be free from twists, bends, or open joints.

(d) Rolled sections, except for minor details, shall not be heated.

(e) Wherever steel castings are used, they shall be properly annealed.

(f) **Punching.** Material may be punched  $\frac{1}{16}$  inch larger than the nominal diameter of the rivets, whenever the thickness of the metal is equal to or less than the diameter of the rivets, plus  $\frac{3}{8}$  inch. When the metal is thicker than the diameter of the rivet, plus  $\frac{3}{8}$  inch, the holes shall be drilled, or sub-punched and reamed.

(g) Rivets are to be driven hot, and wherever practicable, by power. Rivet heads shall be of hemispherical shape and uniform size throughout the work for the same size rivet, full, neatly finished, and concentric with the holes. Rivets, after driving, shall be tight, completely filling the holes, and with heads in full contact with the surface.

(h) Compression joints depending upon contact bearing shall have the bearing surfaces truly faced after the members are riveted. All other joints shall be cut or dressed true and straight, especially where exposed to view.

(i) The use of a burning torch is permissible if the burned metal is not carrying stresses during the burning. Stresses shall not be transmitted into the metal through a burned surface.

## 21. PAINTING.

(a) Parts not in contact, but inaccessible after assembling, shall be properly protected by paint.

(b) All steel work, except where encased in concrete, shall be thoroughly cleaned and given one coat of acceptable metal protection well worked into the joints and open spaces.

(c) Machine finished surfaces shall be protected against corrosion.

(d) Field painting is a phase of maintenance, but it is important that unless otherwise properly protected, all steel work shall after erection be protected by a field coat of good paint applied by a competent painter.

## 22. ERECTION.

(a) The frame of all steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment, and the operation of same. Such bracing shall be left in place as long as may be required for safety.

(b) As erection progresses the work shall be securely bolted up to take care of all dead load, wind and erection stresses.

(c) Wherever piles of material, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from the same.

(d) No riveting shall be done until the structure has been properly aligned.

(e) Rivets driven in the field shall be heated and driven with the same care as those driven in the shop.

**23. INSPECTION.**

(a) Material and workmanship at all times shall be subject to the inspection of experienced engineers representing the purchaser.

(b) Material or workmanship not conforming to the provisions of this Specification shall be rejected at any time defects are found during the progress of the work.

(c) The Contractor furnishing such material or doing such work shall promptly replace the same.

(d) All inspection as far as possible shall be made at the place of manufacture, and the Contractor or Manufacturer shall co-operate with the Inspector, permitting access for inspection to all places where work is being done.