Welded Continuous Frames and Their Components

A BRIEF SURVEY OF U.S. STRUCTURAL STEEL TYPES

by

M. G. Lay

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Lehigh University
Bethlehem, Pa.

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1. INTRODUCTION

As part of a projected research study a survey was made of all U.S. producers of rolled structural shapes. Manufacturers were asked what range of steel types they used in producing these shapes. This report is a summary of the findings of the survey. Twelve replies were obtained and the latest AISI Directory lists the producers replying as manufacturing 94% of the U.S. output.

The steels produced by these companies are listed below. Where a company's products are covered by ASTM specifications it may use the specification number as its sole designation. Other companies prefer to retain their tradenames.

The following lists are intended to give only an indication of available steels, they are not comprehensive lists of steel properties. These properties may be obtained from the references quoted for each steel. Only steels suitable for structural use have been considered, steels produced only in plates and/or bars have been specifically excluded. Thickness limitations have only been noted where they are less than 1-3/4".

The following identifications are used for those companies producing tradename steels:
BS...Bethlehem
GLS...Great Lakes Steel
INL...Inland
J&L...Jones & Laughlin
KSC...Kaiser Steel Corporation
PSC...Phoenix Steel Corporation
USS...United States
WSC...Weirton Steel Company

The groupings used are:


GROUP II, Named Steels Similar to Group I, page 4.

GROUP III, Medium Range Steel (40 - 90 ksi), page 6.

GROUP IV, High Range (above 90 ksi) Heat Treated Alloy Steel, page 10.

Data on the Group I steels can be obtained from the latest ASTM Book of Standards, (Part I) or from the BSC Booklet 569 which reprints the relevant specifications. These steels are also the six structural steels approved by the 1961 AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
2. LISTING

GROUP I

THE ASTM RECOGNIZED STEELS

(1) ASTM A7

Originally issued for structures with riveted joints. No chemical or thickness requirements. 33 ksi yp. (1936).

(2) ASTM A373

Carbon (0.28%) and manganese (0.46-0.94%) controlled for weldability. 32 ksi yp. (1954).

(3) ASTM A36

Increased strength with weldability by controlling carbon (0.28%). 36 ksi yp. (1960).

(4) ASTM A440

Higher strength for non-welded structures. Carbon (0.28%) and manganese (1.60%). 50-42 ksi yp. (1959).

(5) ASTM A441

Higher strength for welded structures. Carbon (0.22%) and manganese (1.25%). 50-42 ksi yp. (1960).

(6) ASTM A242

Original high strength structural steel. Carbon (0.22%) and manganese (1.25%). Weldable in some instances. 50-42 ksi yp. (1941).
NAMED STEELS SIMILAR TO GROUP I

(7) **BSC MAYARI-R**

Meets ASTM A242, with higher corrosion resistance and fully weldable.

(8) **USS COR-TEN**


(9) **J&L COR-TEN**


(10) **INL HI-STEEL**

Meets ASTM A242. 50 ksi yp. 70 ksi uts. Ref: Project 10-61-1.311.

(11) **GLS N-A-X HIGH TENSILE**


(12) **USS MAN-TEN (A440)**


(13) **INL HI-MAN (A440)**

Meets ASTM A440. Ref: as for (10).

(14) **USS TRI-TEN**

Meets ASTM 441. Ref: ADUCO 02471.
(15) **BSC-MEDIUM MANGANESE**  
Meets ASTM A440.

(16) **BSC MANGANESE VANADIUM**  
Meets ASTM A441.

(47) **PSC CLAYLOY**  
Meets ASTM A441.

(48) **PSC PX50**  
Meets ASTM A242.

Note: There are also steels in Group III which may be modified to fit ASTM classifications. These steels are (28) and (32).
GROUP III

MEDIUM RANGE STEEL (40-90 ksi)

(17) **BSC V45**

45 ksi yp. 65 ksi uts. 18% elongation. Weldable.
C 0.22% Mn 1.25% Vanadium steel. Ref: BSC Booklet 1855.

(18) **BSC V50**

50 ksi yp. 70 ksi uts. 19-18% elongation. Weldable
C 0.22% Mn 1.25% Vanadium steel. Ref: as for (17).

(19) **BSC V55**

55 ksi yp. 80 ksi uts. 17-14% elongation. Weldable
C 0.22% Mn 1.25% Vanadium steel. Ref: as for (17).

(20) **BSC V60**

60 ksi yp. 75 ksi uts. 16-15% elongation. Weldable.
C 0.22% Mn 1.25% Vanadium steel. Ref: as for (17). 3/4" thickness.

(21) **BSC V65**

65 ksi yp. 80 ksi uts. 15% elongation. Weldable.
C 0.22% Mn 1.25% Vanadium steel. Ref: as for (17). 3/8" thickness.

(22) **USS MAN-TEN**

50-40 ksi yp. 75-65 ksi uts. 20-22% elongation. Weld
with care. C 0.25%. Mn 1.10-1.16%. Ref: AHDUO 02042.

(23) **USS EN-TEN**

45 ksi yp. 60 ksi uts. 19% elongation. Weldable.
(24) **USS EX-TEN 50**

50 ksi yp. 65 ksi uts. 18% elongation. Weldable.
Up to 3/8" thick. Columbium steel. Ref: as for (23).

(25) **J6L JLX-45-W**

45 ksi yp. 60 ksi uts. 24% elongation. Weldable.
Columbium steel. C 0.20%. Up to 5/16" thick.
Ref: AD-295-6-61.

(26) **J6L JLX-50-W**

50 ksi yp. 65 ksi uts. 22% elongation. Weldable.
Columbium steel. C 0.20%. Up to 5/16" thick.
Ref: as for (25).

(27) **J6L JLX-55-W**

55 ksi yp. 70 ksi uts. 20% elongation. Weldable.
Columbium steel. C 0.20%. Up to 5/16" thick.
Ref: as for (25).

(28) **J6L JLX-60-W**

60 ksi yp. 75 ksi uts. 18% elongation. Weldable.
Columbium steel. C 0.20%. Up to 5/16" thick.
Ref: as for (25).

(29) **J6L Ni-Cu-Ti**

50-47 ksi yp. 70-65 ksi uts. 22% elongation. Weldable.
C 0.15% Mn 1.00%. Up to 1-1/2" thick. Can be modified to meet ASTM A242. Ref: AD-296-6-61.
(30) J&L JALTEN #1
50 ksi yp. 70 ksi uts. 22% elongation. Weldable. C 0.22%. Mn 1.25%. V. 07%.

(31) J&L JALTEN # 3R
50 ksi yp. 70 ksi uts. 22% elongation. Weld with care. C 0.25%. Mn 1.60%, (semi-killed).

(32) J&L JALTEN # 3S
50 ksi yp. 70 ksi uts. 22% elongation. Weld with care. C 0.25%, Mn 1.60% (Fully killed-more uniformity).

(33) INL TRI-STEEL
50-42 ksi yp. 70-63 ksi uts. 22-24% elongation. Weldable. C 0.22%. Mn 1.25%. Can be modified to meet ASTM A242, and A441. Ref: Project 10-61-13M.

(34) INL HI-MAN
50-40 ksi yp. 75-65 ksi uts. 18-19% elongation. Weld with care. C 0.25%. Mn 1.10-1.60%. Ref: as for (33).

(35) INL INK-45
45 ksi yp. 60 ksi uts. 18% elongation. Weldable. Columbium steel, up to 3/8" thick. C 0.20%.
Ref: 54-61-15M.

(36) INL INK-50
50 ksi yp. 65 ksi uts. 16% elongation. Weldable. Columbium steel, up to 3/8" thick. C 0.22%. Ref: as for (35).
(37) **INL INX-55**
   55 ksi yp. 70 ksi uts. 14% elongation. Weldable Columbium steel. Up to 3/8" thick. C 0.24%.
   Ref: as for (35).

(38) **INL INX-60**
   60 ksi yp. 75 ksi uts. 12% elongation. Weldable. Columbium steel. Up to 3/8" thick. C 0.26%.
   Ref: as for (35).

(39) **KSC**
   45 ksi yp. Weldable.

(40) **KSC**
   50 ksi yp. Weldable.

(41) **KSC**
   60 ksi yp. Weldable.

(42) **KSC**

(43) **KSC**
   70 ksi yp. Weldable. Up to 1/2" thick.

(44) **GLS GLX-W (from Weirton Steel)**
   40-60 ksi yp. 70 ksi uts. Weldable. C 0.16%. Mn 0.68%.
   Obtainable in shape only from WSC.
GROUP IV

HIGH RANGE (above 90 ksi) HEAT-TREATED ALLOY STEELS

(45) USS T-1

100-90 ksi yp. 115-105 ksi uts. 18-16% elongation.
Weldable with care. C 0.10-0.21%. Mn 0.60-1.00%.
Ref: ADUCO-01042 and 01101.

(46) USS T-1A

100 ksi yp. 115 ksi uts. 18-16% elongation. Weldable
with care. C 0.12-0.21%. Mn 0.70-1.00%. Up to 1"
thick. Cheaper than T-1 but with same structural
properties. Ref: ADUCO-01114 and 01101.
3. **NOTES**

(1) Other steels than those listed above are available but are not listed for obvious reasons, for instance:
   
a.. Low temperature steels such as ASTM 201 and the 9% nickel steels.
   
b.. Corrosion resistant steels such as the copper steels.
   
c.. Military steels such as HY-80. These steels are usually too expensive for structural use.
   
d.. Stainless steels which are not generally available in structural shapes (see for instance USS ADUCO-3092).
   
e.. Customer tailored steels such as an ASTM A440 steel in which corrosion resistance is not required allowing the copper percentage to be reduced.

(2) Proposed ASTM changes would eliminate A7 and A373 steel and replace these two steels and A36 by a single new A36 steel.

(3) Additional general references are:


   ii) BSC Folder 773.


   iv) **The Fourth Dimension in Design**, Gilligan, J. USS ADUCO-04004.

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<td>Title</td>
<td>Steel for bridges &amp; steel for buildings</td>
<td>Structural steel</td>
<td>Structural steel</td>
<td>High strength low alloy structural steel</td>
<td>High strength low alloy structural steel</td>
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<tr>
<td>Date of issue</td>
<td>1936</td>
<td>1954</td>
<td>1960</td>
<td>1959</td>
<td>1960</td>
<td>1941</td>
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<td>Delivery</td>
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<td>Defects by ASTM A233</td>
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<td>but characteristics vary.</td>
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<td>Manganese (max)</td>
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<td>1.25%</td>
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<td>0.04%</td>
<td>0.04-0.06%</td>
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</tr>
<tr>
<td>Sulphur (max)</td>
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<td>0.05%</td>
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<tr>
<td>Copper (max)</td>
<td>0.20% for copper steel</td>
<td>0.20% for copper steel</td>
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<td>0.20%</td>
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<td>Silicon (max)</td>
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<td>(ksi)</td>
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<td>0 to 3/4&quot;</td>
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<td>32</td>
<td>36</td>
<td>50</td>
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<td>32</td>
<td>36</td>
<td>46</td>
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<td>1-1/2 to 4&quot;</td>
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<td>32</td>
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<td>42</td>
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5. ACKNOWLEDGEMENTS

This study is part of a general investigation "Welded Continuous Frames and Their Components" currently being carried out at Fritz Engineering Laboratory of the Civil Engineering Department of Lehigh University under the general direction of Lynn S. Beedle. The investigation is sponsored jointly by the Welding Research Council, and the Department of the Navy, with funds furnished by the American Institute of Steel Construction, the American Iron and Steel Institute, Lehigh University Institute of Research, the Bureau of Ships, and the Bureau of Yards and Docks. The Column Research Council acts in an advisory capacity.

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