

## Contents

|                                              |   |
|----------------------------------------------|---|
| Table 2-4 for $F_y$ values.....              | 2 |
| Table 1-3 for S-shapes.....                  | 3 |
| Data for S section.....                      | 4 |
| $h/t_w$ for S24x12.....                      | 5 |
| Required $h/t_w$ value for $F_y=65$ ksi..... | 6 |
| What is $C_v$ value?2010 specs.....          | 7 |
| Value of $V_n$ - Nominal shear.....          | 8 |
| Plot between $h/t_w$ versus $V_n$ .....      | 9 |

CM # 14

Shear Strength

→ 2010

5.8-1

Compute the nominal shear strength of an S24 x 121 of A572 Grade 65 steel.

From Prof. SEGui's Text book

5th edition

Solution:

Table 2-4

Table 2-4

$F_y = 65 \text{ ksi}$

| Table 2-4<br>Applicable ASTM Specifications<br>for Various Structural Shapes |                      |                     |                                             |                                               |                         |   |   |    |   |    |   |                         |
|------------------------------------------------------------------------------|----------------------|---------------------|---------------------------------------------|-----------------------------------------------|-------------------------|---|---|----|---|----|---|-------------------------|
| Steel Type                                                                   | ASTM Designation     |                     | $F_y$<br>Yield Stress <sup>a</sup><br>(ksi) | $F_u$<br>Tensile Stress <sup>a</sup><br>(ksi) | Applicable Shape Series |   |   |    |   |    |   |                         |
|                                                                              |                      |                     |                                             |                                               | W                       | M | S | HP | C | MC | L | HSS<br>Rect. Round Pipe |
| Carbon                                                                       | A36                  |                     | 36                                          | 58-80 <sup>b</sup>                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A53 Gr. B            |                     | 35                                          | 60                                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A500                 | Gr. B               | 42                                          | 58                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      |                     | 46                                          | 58                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. C               | 46                                          | 62                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      |                     | 50                                          | 62                                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A501                 | Gr. A               | 36                                          | 58                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. B               | 50                                          | 70                                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A529 <sup>c</sup>    | Gr. 50              | 50                                          | 65-100                                        |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. 55              | 55                                          | 70-100                                        |                         |   |   |    |   |    |   |                         |
|                                                                              | A709                 | 36                  | 36                                          | 58-80 <sup>b</sup>                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A1043 <sup>d,1</sup> | 36                  | 36-52                                       | 58                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | 50                  | 50-65                                       | 65                                            |                         |   |   |    |   |    |   |                         |
|                                                                              | A1085                | Gr. A               | 50                                          | 65                                            |                         |   |   |    |   |    |   |                         |
| ASTM A572                                                                    | A572                 | Gr. 42              | 42                                          | 60                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. 50              | 50                                          | 65                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. 55              | 55                                          | 70                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. 60 <sup>e</sup> | 60                                          | 75                                            |                         |   |   |    |   |    |   |                         |
|                                                                              |                      | Gr. 65 <sup>e</sup> | 65                                          | 80                                            |                         |   |   |    |   |    |   |                         |

Which table is designated for S shapes?

PART 1 REFERENCES ..... 1-11

DESIGN DIMENSIONS, DETAILING DIMENSIONS, AND AXIAL, STRONG-  
AXIS FLEXURAL, AND WEAK-AXIS FLEXURAL PROPERTIES TABLES ..... 1-12

Table 1-1. W-Shapes ..... 1-12

Table 1-2. M-Shapes ..... 1-32

Table 1-3. S-Shapes ..... 1-34

Table 1-4. HP-Shapes ..... 1-36

Table 1-5. C-Shapes ..... 1-38

Table 1-6. MC-Shapes ..... 1-40

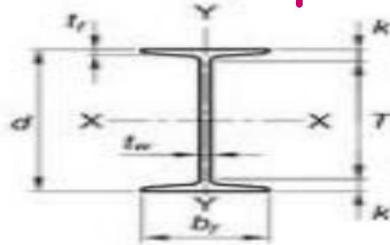
Table 1-7. Angles ..... 1-44

Table  
1-3

Table 1-3 for S-shapes

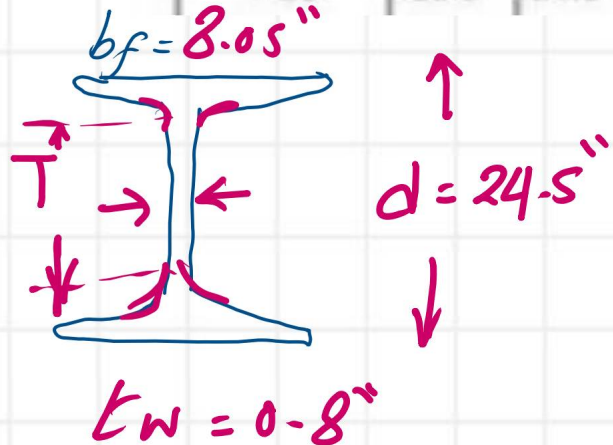
Prepared by Eng.Maged Kamel.

S 24 x 121

 $A = 35.5 \text{ inch}^2$ 

**Table 1-3**  
**S-Shapes**  
**Dimensions**

| Shape   | Area,<br>A       | Depth,<br>d |        | Web                 |       |                 | Flange          |       |                     |        | Distance |        |                  |
|---------|------------------|-------------|--------|---------------------|-------|-----------------|-----------------|-------|---------------------|--------|----------|--------|------------------|
|         |                  |             |        | Thickness,<br>$t_w$ |       | $\frac{t_w}{2}$ | Width,<br>$b_f$ |       | Thickness,<br>$t_f$ |        | k        | T      | Workable<br>Gage |
|         | in. <sup>2</sup> | in.         |        | in.                 |       | in.             | in.             |       | in.                 |        | in.      | in.    | in.              |
| S24x121 | 35.5             | 24.5        | 24 1/2 | 0.800               | 13/16 | 7/16            | 8.05            | 8     | 1.09                | 1 1/16 | 2        | 20 1/2 | 4                |
| x106    | 31.1             | 24.5        | 24 1/2 | 0.620               | 5/8   | 5/16            | 7.87            | 7 7/8 | 1.09                | 1 1/16 | 2        | 20 1/2 | 4                |
| S24x100 | 29.3             | 24.0        | 24     | 0.745               | 3/4   | 3/8             | 7.25            | 7 1/4 | 0.870               | 7/8    | 1 3/4    | 20 1/2 | 4                |
| x90     | 26.5             | 24.0        | 24     | 0.625               | 5/8   | 5/16            | 7.13            | 7 1/8 | 0.870               | 7/8    | 1 3/4    | 20 1/2 | ↓                |
| x80     | 23.5             | 24.0        | 24     | 0.500               | 1/2   | 1/4             | 7.00            | 7     | 0.870               | 7/8    | 1 3/4    | 20 1/2 | ↓                |

 $t_f = 1.09"$ 

Data for S section  
For  $\frac{h}{t_w} \rightarrow$  refer to part-2  
of the same table

Prepared by Eng. Maged Kamel.

This is the second part of table 1-3

**Table 1-3 (continued)**  
**S-Shapes**  
**Properties**



→ S24 x121

| Nom-<br>inal<br>WT. | Compact<br>Section<br>Criteria |                 | Axis X-X                |                         |            |                         | Axis Y-Y                |                         |            |                         | $r_{ts}$ | $h_o$ | Torsional<br>Properties |                  |
|---------------------|--------------------------------|-----------------|-------------------------|-------------------------|------------|-------------------------|-------------------------|-------------------------|------------|-------------------------|----------|-------|-------------------------|------------------|
|                     |                                |                 |                         |                         |            |                         |                         |                         |            |                         |          |       | $J$                     | $C_w$            |
|                     | $\frac{b_f}{2t_f}$             | $\frac{h}{t_w}$ | $I$<br>in. <sup>4</sup> | $S$<br>in. <sup>3</sup> | $r$<br>in. | $Z$<br>in. <sup>3</sup> | $I$<br>in. <sup>4</sup> | $S$<br>in. <sup>3</sup> | $r$<br>in. | $Z$<br>in. <sup>3</sup> |          |       | in. <sup>4</sup>        | in. <sup>6</sup> |
| 121                 | 3.69                           | 25.9            | 3160                    | 258                     | 9.43       | 306                     | 83.0                    | 20.6                    | 1.53       | 36.3                    | 1.94     | 23.4  | 12.8                    | 11400            |
| 106                 | 3.61                           | 33.4            | 2940                    | 240                     | 9.71       | 279                     | 76.8                    | 19.5                    | 1.57       | 33.4                    | 1.93     | 23.4  | 10.1                    | 10500            |

→  $\frac{h}{t_w} = 25.90$

h/tw for S24x12

Prepared by Eng.Maged Kamel.

Relation between  $F_y$ ,  $\frac{h}{t_w}$  for Zone I  $E = 29 \times 10^6 \text{ ksi}$

$$E = 29 \times 10^6 \text{ psi} \quad \frac{h}{t_w} = 2.24 \sqrt{\frac{E}{F_y}}$$

$$F_y = 36 \text{ ksi} \quad \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{36}} = 63.54 \approx 64$$

$$F_y = 42 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{42}} = 58.86 \Rightarrow 58.90$$

$$F_y = 45 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \sqrt{\frac{29000}{45}} = 56.86 \Rightarrow 56.90$$

$$F_y = 50 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{50} \right)^{1/2} = 53.90$$

$$F_y = 60 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{60} \right)^{1/2} = 49.25$$

$$F_y = 65 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{65} \right)^{1/2} \approx 47.30 \leftarrow$$

$$F_y = 100 \text{ ksi} \rightarrow \frac{h}{t_w} = 2.24 \left( \frac{29000}{100} \right)^{1/2} = 38.15$$

Required  $h/t_w$  value for  $F_y = 65 \text{ ksi}$

Prepared by Eng. Maged Kamel.



① Check  $\frac{h}{t_w}$  against  $2.24\sqrt{\frac{E}{F_y}}$   $F_y = 65 \text{ ksi}$

$$\frac{h}{t_w} = 2.24\sqrt{\frac{29000}{65}} = 47.31$$

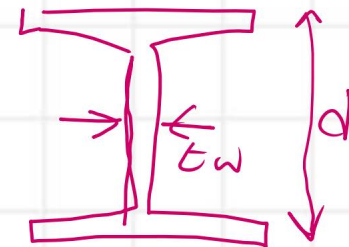
$$\text{Our } \frac{h}{t_w} = 25.90 < 2.24\sqrt{\frac{E}{F_y}}$$

From table

$$C_v = 1$$

$$d = 24.50''$$

$$t_w = 0.80''$$



$$A_w = d t_w = 24.50(0.80) = 19.60 \text{ inch}^2$$

$$, A_w = d t_w \Rightarrow V_n = (0.60 F_y) A_w C_v$$

$$V_n = \underbrace{(0.60)}_{0.6 F_y} (65) \underbrace{(24.50)(0.80)}_{d t_w} \underbrace{(1)}_{C_v} = 764.40 \text{ kips}$$

Value of  $V_n$  - Nominal shear

$$\approx 764 \text{ kip}$$

Plot between  $h/t_w$  versus  $V_n$

Chart Title

S24 X121

$h/w = 25.90$

