Open-Web Bar Joists

1. BAR JOISTS

Several available types of bar joists of patented design are fabricated by welding. Where design permits, it is usually more economical to use these standard bar joists than to fabricate special joists. However, to meet special design requirements bar joists can be quickly and easily fabricated. In some cases, this may be done on the construction site.

Figure 1 shows the framework of a factory building. Joists are spaced between beams and support the metal roof deck. The deck is plug welded to the joists by welding at intervals through the 20-ga metal.

Arc welding also provides an efficient means for securing bar joists to their supporting members. A short tack weld on each side of the bearing plate at the ends of the bar joist permanently joins the joist to the framework. Figure 2 shows bar joists arc welded in place. Thus, use of arc welding stiffens the entire structure by actually tying in the framework.

FIG. 2 Open-web bar joists are welded to beams and girders which support them. This stiffens the entire structure.

2. STANDARD SPECIFICATIONS

The Steel Joist Institute, and the American Institute of Steel Construction have set up standard specifications for the design of Open Web Steel Joists (High Strength Longspan or LH-Series). The following requirements are adapted from these (1962) specifications:

Allowable Stresses for Welds

E70XX manual electrodes or equivalent weld metal shall be used; E60XX electrodes or equivalent weld metal may be used on steels having a specified yield point of 36,000 psi.

fillet welds

	Shear at Throat of Weld Metal	Unit Force
E60XX	$\tau = 13{,}600$ psi	$f = 9{,}600\ \omega$
E70XX	$\tau = 15{,}800$ psi	$f = 11{,}200\ \omega$

groove welds

Tension or compression, same as connecting material.

FIG. 1 Metal roof deck is plug welded to the open-web bar joists below.

Allowable Stresses for Members

The allowable stresses shall be based on yield strengths from 36,000 to 50,000 psi.

tension

$$= 0.60\ \sigma_y$$

compression

If $L/r \leqq C_c$

$$= \frac{\left[1 - \frac{1}{2}\left(\frac{(L/r)}{C_c}\right)^2\right]\sigma_y}{\frac{5}{3} + \frac{3}{8}\frac{L/r}{C_c} - \frac{1}{8}\left(\frac{(L/r)}{C_c}\right)^3}$$

If $L/r \geqq C_c$

$$= \frac{149{,}000{,}000}{(L/r)^2}$$

where:

$$C_c = \frac{23{,}900}{\sqrt{\sigma_y}}$$

L = length of member or component, center to center of panel point

r = least radius of gyration of member or component

L/r of web members may be taken as $\frac{3}{4}\cdot(L/r_x)$ or L/r_y, whichever is larger; r_x is in the plane of the joist, and r_y is normal to it.

bending

for chords and web members	$= 0.60\ \sigma_y$
for bearing plates	$= 0.75\ \sigma_y$

Maximum Slenderness (L/r) Ratios

Top chord interior panels	90
Top chord end panels	120
Other compression members	200
Tension members	240

Other Requirements for Members

The bottom chord is designed for tension.

The top chord is designed as a continuous member subject to axial compression stresses (σ_a) and bending stresses (σ_b). The sum of the two ($\sigma_a + \sigma_b$) $\leqq 0.60\ \sigma_y$ at the panel point.

The quality

$$\frac{\sigma_a}{\sigma_a} + \frac{C_m\ \sigma_b}{\left(1 - \frac{\sigma_a}{\sigma'_e}\right)\sigma_b} \leqq 1.0 \text{ at mid-panel}$$

where:

$C_m = 1 - 0.3\ \sigma_a/\sigma'_e$ for end panels

$C_m = 1 - 0.4\ \sigma_a/\sigma'_e$ for interior panels

σ_a = calculated axial unit compressive stress

σ_b = calculated bending unit compressive stress at joint under consideration

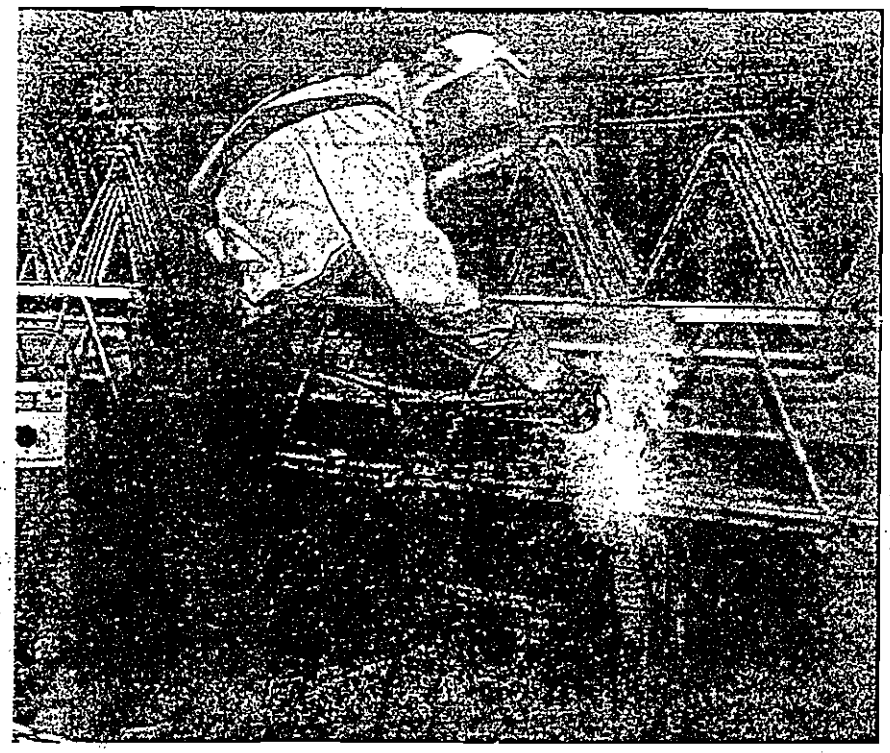
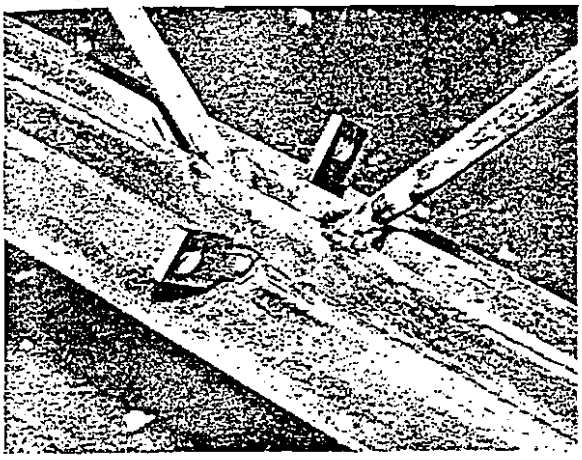


FIG. 3 In the fabrication of these bar joists, semi-automatic welding with self-shielding cored electrode substantially increased the arc speed over previous practice.



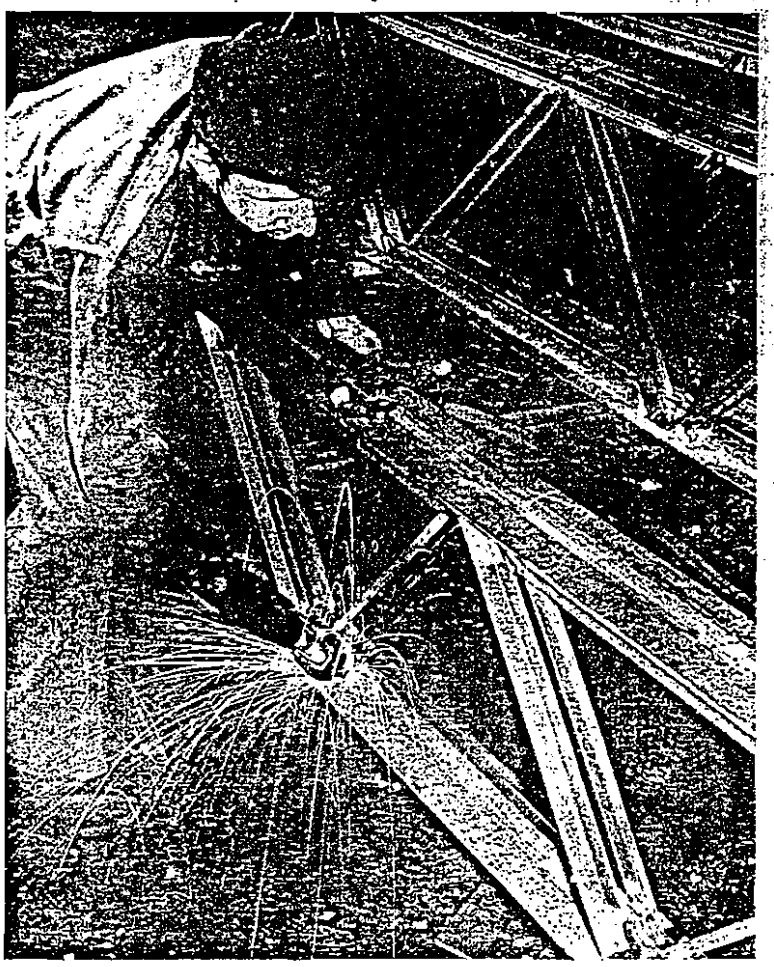


FIG. 4 Bar joist studs are quickly welded in place by means of efficient portable stud welders. The studs shown are used to anchor cross-bracing rods running from top chord of one joint to bottom chord of another, to increase torsional resistance and prevent buckling.

σ_a = allowable axial unit compressive stress based upon (L/r) for the panel length, center to center of panel points

σ_b = allowable bending unit stress, 0.60 σ_y

$\sigma'_e = \frac{149{,}000}{(L/r_x)^2}$ where (L) is the full panel length, center to center of panel points

r_x = radius of gyration about the axis of bending

The radius of gyration of the top chord about its vertical axis $\leqq$ L/170, where L is the spacing in inches between lines of bridging.

Chord Size	Minimum Spacing of Lines of Bridging
No. 02 to No. 08 incl.	11′
No. 09 to No. 14 incl.	16′
No. 15 to No. 19 incl.	21′

The top chord shall be considered to have lateral support if it is properly attached to the floor or roof deck at distances not to exceed 36".

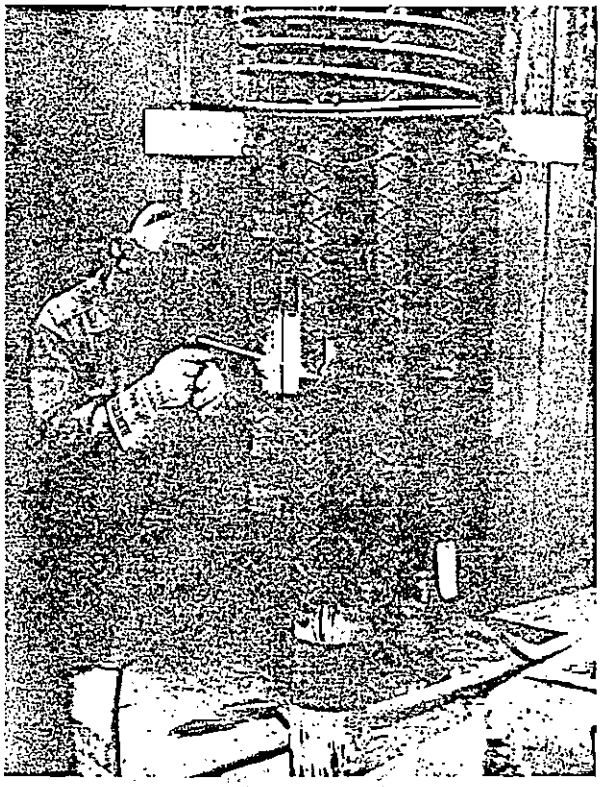
The vertical shear values to be used in the design of web members shall be determined from full uniform loading, but shall not be less than 25% of the rated end reaction.

Chord and web members in compression, composed of two components separated one from another, shall have fillers spaced so that the L/r ratio for each component shall not exceed the L/r ratio of the whole member; if in tension, the L/r ratio of each component shall not exceed 240. Fillers may be omitted in chords having interior panel lengths not over 24" and in webs of joists not over 28" in depth. In all of these cases, the least radius of gyration (r) is used.

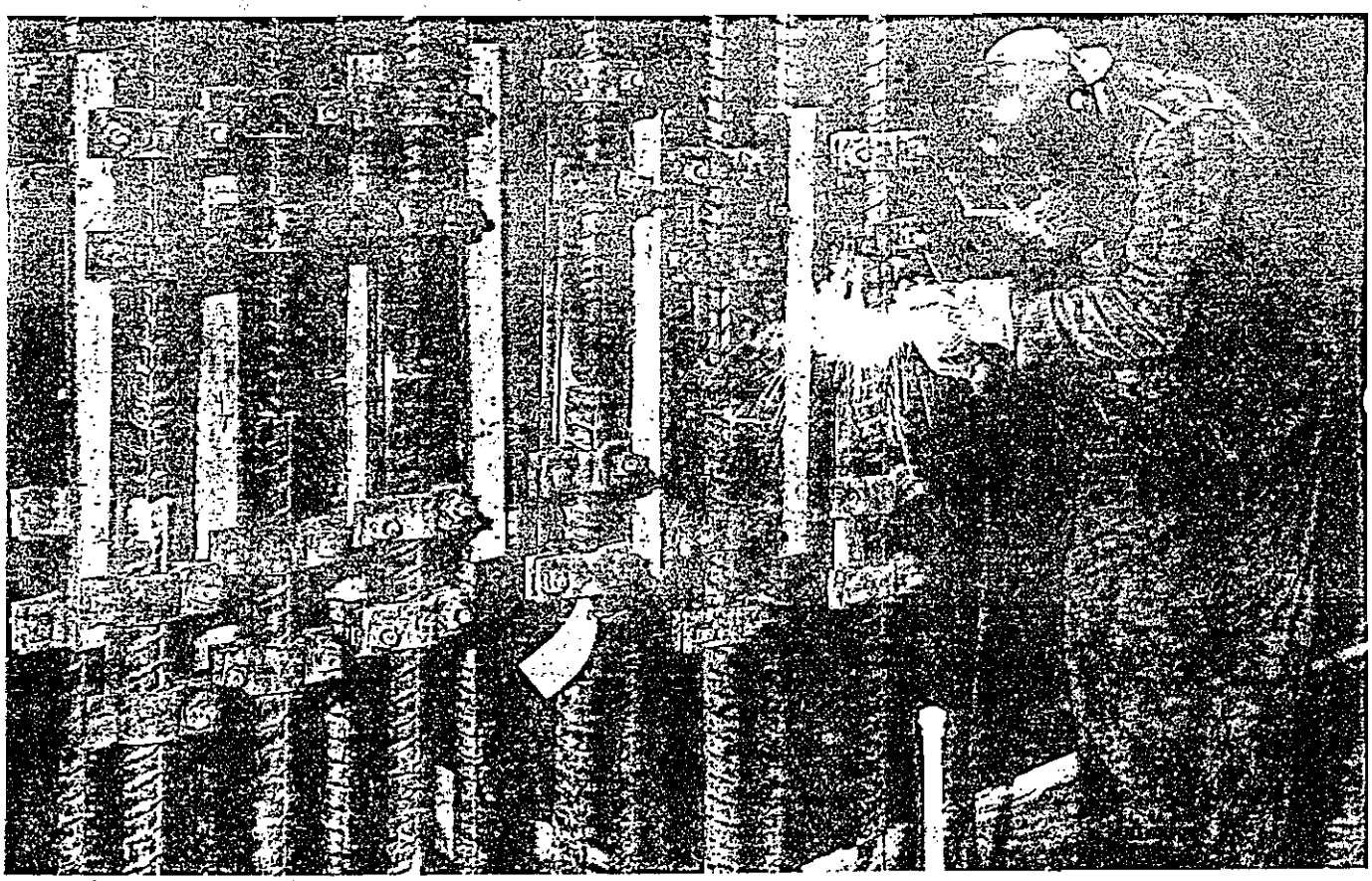
Connection Requirements

Connections shall be designed to carry the design load, but not less than half of the allowable strength of the member. Butt welded joints shall be designed to carry the full allowable strength of the member.

Members connecting into a joint shall have their centers of gravity meet at a point, otherwise the bending stresses due to eccentricity shall be taken into account. Eccentricity on either side of the neutral axis of the chord members may be neglected if it does not exceed the distance between the neutral axis and back of the chord. When a single angle compression member is attached to the outside of the stem of a Tee or double angle chord, the eccentricity shall be taken into account.



High-strength steel reinforcing bars for concrete column verticals in the Washington National Insurance Bldg., Evanston, Ill., permitted reduction of column size and savings in floor space.



Reinforcing bars in concrete columns are field spliced. Simple positioning jig maintains proper alignment during welding. These large size AISI 4140 alloy steel bors were welded with low-hydrogen electrodes.