Built-Up Tension Members

1. TENSILE STRESS

The simplest type of loading on a member is tension. A tensile load applied (axially) in line with the center of gravity of the section will result in tensile stresses distributed uniformly across the plane of the cross-section lying at right angles to the line of loading. The formula for the stress is—

$$\sigma_t = \frac{P}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where:

P = the tensile force applied to the member

A = area of cross-section at right angles to line of force

σ_t = unit tensile stress

A tensile load that is not applied in line with the center of gravity of the section, but with some eccentricity, will introduce some bending stresses. These must be combined with the original tensile stresses.

2. TENSILE STRAIN

The unit elongation or strain of the member under tension is found by the following relationship:

$$\epsilon = \frac{\sigma_t}{E} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where:

ϵ = unit elongation (tensile strain)

σ_t = unit tensile stress

E = modulus of elasticity (tension)

The total elongation or displacement is equal to this unit strain (ϵ) multiplied by the length (L) of the member.

$$\text{Elongation} = \epsilon \cdot L$$

Problem 1

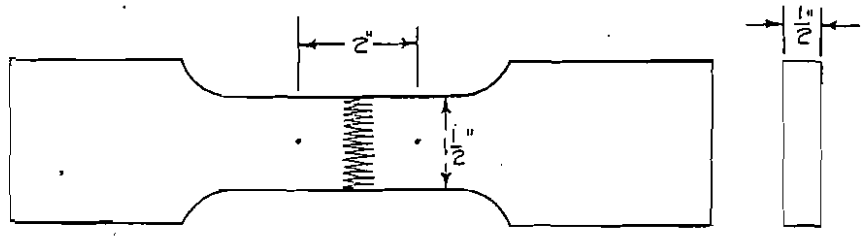

FIGURE 1

A welded tensile coupon (test specimen) measures ½" x 1½" at the reduced section, and has two punch marks 2" apart with which to later measure elongation. Just after the test is started, a load of 10,000 lbs is reached.

Find (1) the unit tensile stress on the reduced section, and (2) the total elongation as measured within the two marks.

(1) $$\sigma_t = \frac{P}{A} = \frac{10{,}000}{½ \cdot 1½}$$

$$= 13{,}333 \text{ psi}$$

(2) $$\epsilon = \frac{\sigma_t}{E} = \frac{13{,}330}{30{,}000{,}000}$$

$$= 0.000444 \text{ in./in.}$$

and elon. $= \epsilon \cdot L = 0.000444 \cdot 2"$

$= 0.00089"$ in 2"

In any calculation for strain or elongation it is understood that the stresses are held below the yield point. Beyond the yield point, the relationship of stress to strain is no longer proportional and the formula does not apply.

3. WELDING OF BUILT-UP TENSION MEMBERS

AISC Section 1.18.3 has established the requirements illustrated in Figure 2.

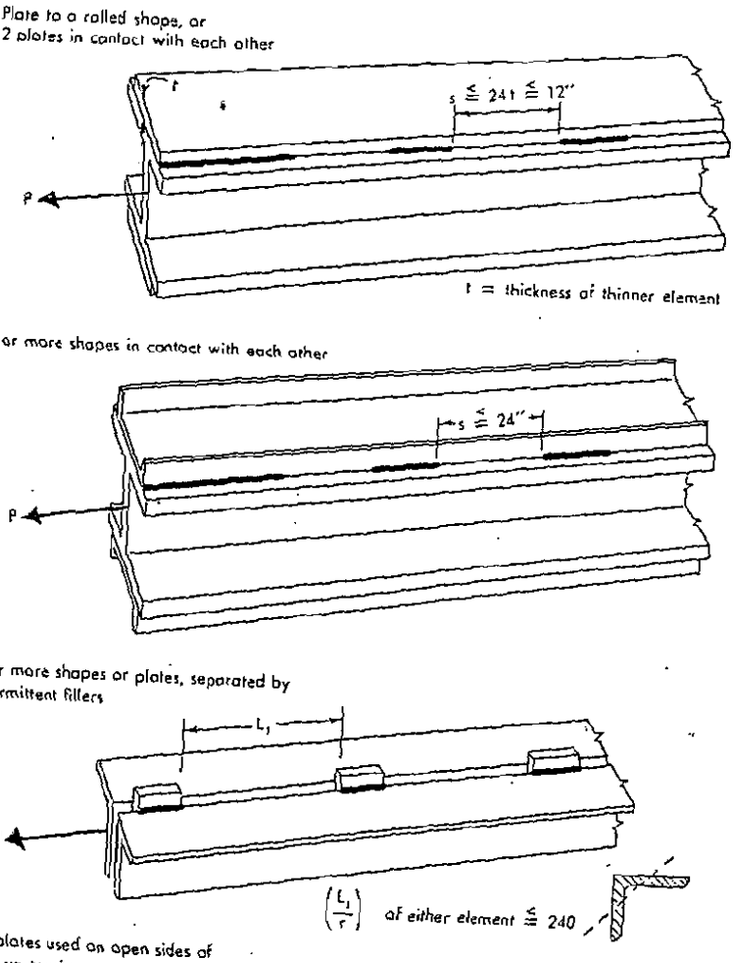

FIGURE 2—Welding of Built-Up Tension Members