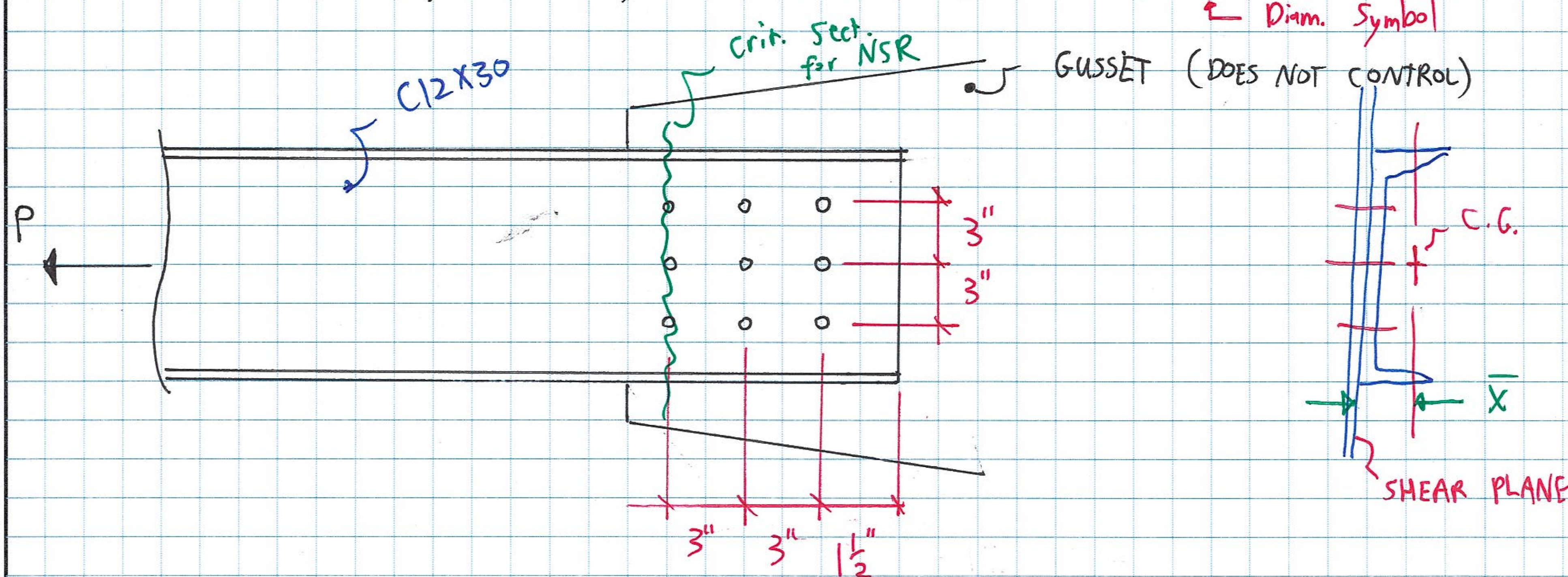
EXAMPLE

GIVEN: A SINGLE C12X30, A36 STEEL, CONNECTED TO A PL W/ 3/4" ϕ BOLTS

← Diam. Symbol



REQ'D: COMPUTE THE DESIGN TENSILE STRENGTH OF THE CHANNEL

SOLN: C12X30: $A_g = 8.81\ in^2$ A36: $f_y = 36$ ksi

$t_w = 0.51\ in^2$ $f_u = 58$ ksi

$\bar{X} = 0.674"$

GSY: $\phi P_n = \phi f_y A_g = 0.9(36^{ksi})(8.81 \text{ in}^2) = \underline{285.4^k}$

t_w damage tolerance

NSR: $\phi P_n = \phi F_u A_e$

$A_n = A_g - \Sigma A_{holes} = 8.81 \text{ in}^2 - (3 \text{ holes})(0.51")\left(\frac{3}{4}" + \frac{1}{16}" + \frac{1}{16}"\right)$

$= 7.471 \text{ in}^2$

$A_e = UA_n = 0.887(7.471 \text{ in}^2) = 6.632 \text{ in}^2$

CASE 2 "General Case"

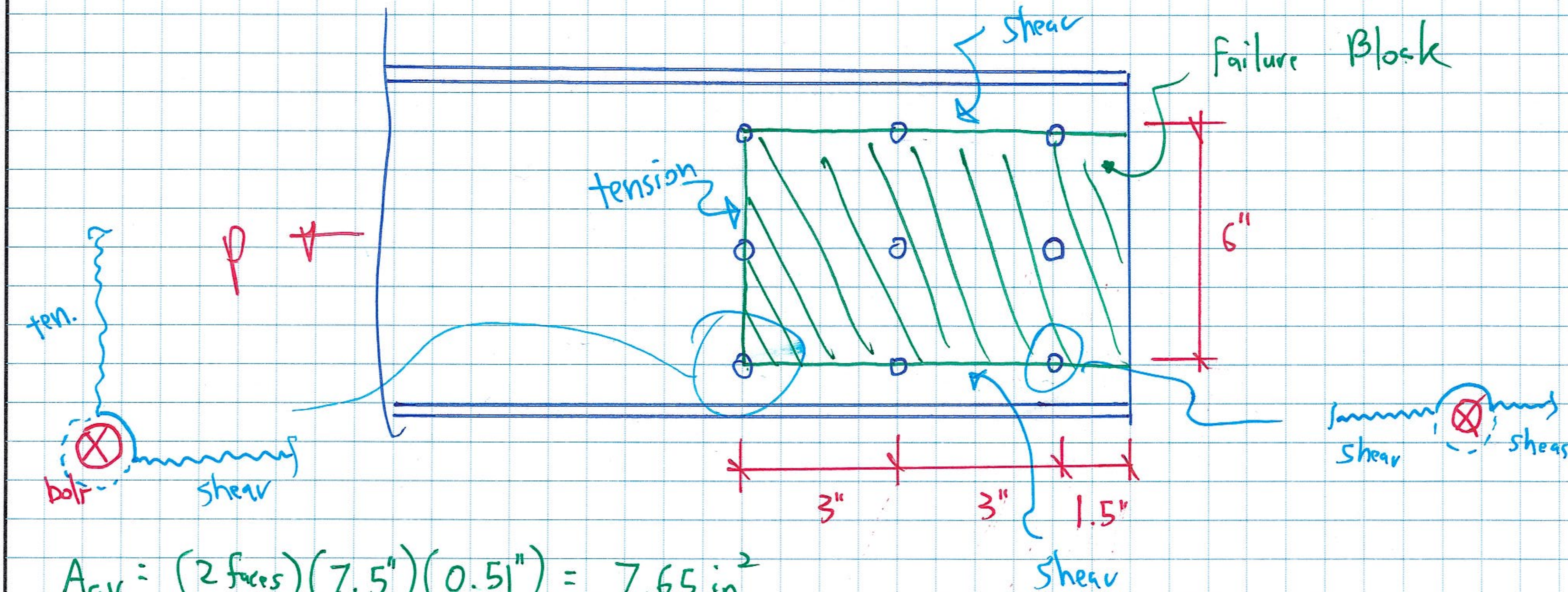
$U = 1 - \frac{\bar{x}}{\ell} = 1 - \frac{0.674"}{6"} = 0.887$

$\phi_t P_n = 0.75(58^{ksi})(6.632 \text{ in}^2) = \underline{288.5^k}$

BSR

$$\phi R_n = \phi\left[0.6F_u A_{nv} + U_{bs} F_u A_{nt}\right] \leq \phi\left[0.6F_y A_{gv} + U_{bs} F_u A_{nt}\right]$$

minimum of the two eqns.



$$A_{gv} = (2\text{ faces})(7.5'')(0.51'') = 7.65\text{ in}^2$$

$$A_{nv} = A_{gv} - \sum A_{holes} = 7.65\text{ in}^2 - (2\text{ faces})(2.5\text{ holes})\left(\tfrac{3}{4}'' + \tfrac{1}{8}''\right)(0.51'') = 5.42\text{ in}^2$$

$$A_{nt} = (6'')(0.51'') - (2\text{ holes})\left(\tfrac{3}{4}'' + \tfrac{1}{8}''\right)(0.51'') = 2.1675\text{ in}^2$$

$$\phi R_n = 0.75\left[0.6(58)(5.42\ in^2) + 1.0(58)(2.168\ in^2)\right]$$
$$\leq 0.75\left[0.6(36\ ksi)(7.65\ in^2) + 1.0(58\ ksi)(2.168\ in^2)\right]$$

$$\phi R_n = 236^k \leq 218^k$$

controls

LIMIT STATES

GSY $\phi_t P_n = 285^k$

NSR $\phi_t P_n = 288^k$

BSR $\phi R_n = 218^k$ ← CONTROLS

$$\boxed{\phi P_n = 218^k}$$

DESIGN OF TENSION MEMBERS

APP. LIMIT STATES

1) GSY
2) NSR
3) BSR

SERVICEABILITY CHECK: $\left(\frac{L}{r_{min}} \leq 300 \right)$ { PREVENT EXCESSIVE DEFORMATIONS, VIBRATIONS, DAMAGE IN TRANSPORT. CONSTRUCTION

where L is the overall length (in.)

r_{min} is the minimum radius of gyration $\sqrt{I/A}$

DESIGN PROCESS (Recommendation)

1) Determine $(A_g)_{req'd}$ based on GSY

$$(A_g)_{req'd} \geq \frac{P_u}{0.9 f_y} \leftarrow \text{factored controlling LC}$$

2) Select a member w/ $A_g \geq (A_g)_{req'd}$ from Sect. Properties

3) Compute A_n, U, A_e, & check NSR

4) Check BSR, compute, A_{nt}, A_{gv}, A_{nv}

5) Check $\frac{L}{r_{min}} < 300$

6) Revise member size as necessary by controlling Limit State

* CVEN 446 → Select the lightest section

Assume lightest is cheapest

EXAMPLE

GIVEN: A 20-ft Long W-Section, A992 Steel

$$\left.\begin{array}{l} P_L = 20^k \\ L_L = 75^k \end{array}\right\} \quad P_u = 1.2(\cancel{40}\ 20^k) + 1.6(75^k) = 144^k$$

REQ'D: Select the lightest W8X_ to carry the load, assume BSR & NSR do not control.

SOLN: A992:

$$\left.\begin{array}{l} f_y = 50\ ksi \\ f_u = 65\ ksi \end{array}\right\} \quad \text{Table 2-4, p2-48 AISC}$$

$$(A_g)_{req'd} = \frac{P_u}{0.9 f_y} = \frac{144^k}{0.9(50\ ksi)} = 3.2\ in^2$$

try W8X13: $A_g = 3.84\ in^2 \geq (A_g)_{req'd} = 3.2\ in^2$ ∴ GSY OK

$$r_y = r_{min} = 0.843''$$

$$\frac{L}{r_{min}} = \frac{(20')(12)}{0.843''} = 284.7 < 300 \ \checkmark$$

"SERVICEABLE CHECK"