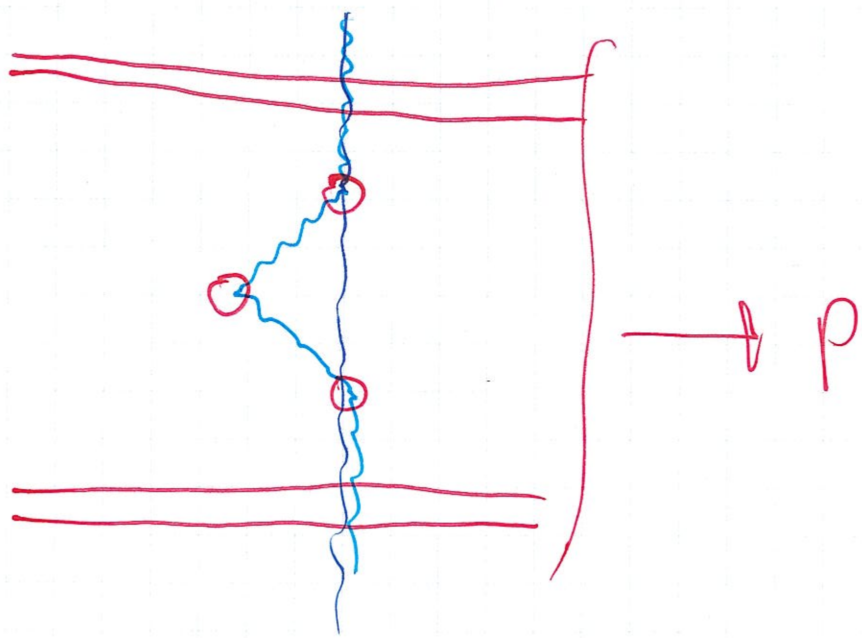
Staggered Fasteners

AISC Manual p16.1-20

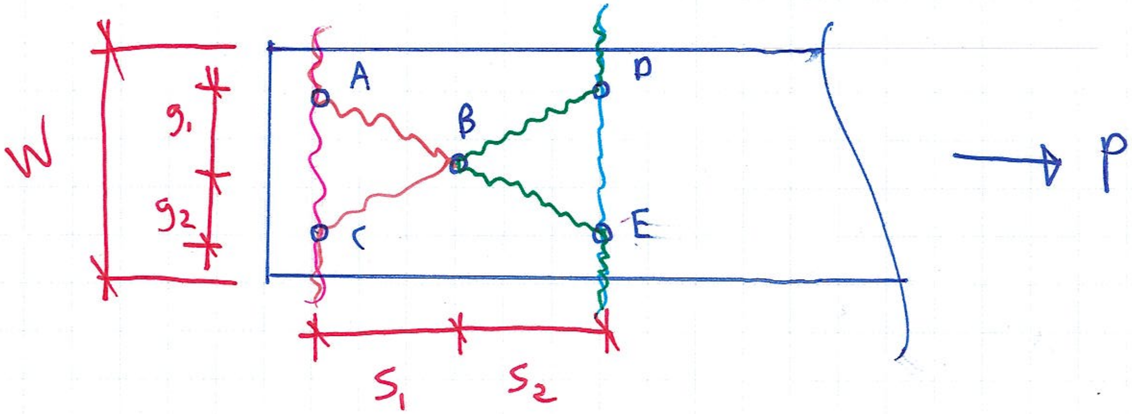
$$\left(\frac{s_i^2}{4g_i}\right)$$

s_i := spacing (pitch) of holes along line-of-loading

g_i := gage, ie spacing of holes transverse to loading



EXAMPLE The flat PL shown has a thickness, t_p, and width W



PATH DE (must resist 100% of applied load)

$$A_n = A_g - \sum A_{hole} = W t_p - (2 \text{ holes})\left(d_{hole} + \tfrac{1}{16}''\right)(t_p)$$

PATH DBE (must resist 100% of load) "no bolts have to shear"

$$A_n = A_g - \sum A_{holes} + \sum\left(\frac{s^2}{4g}\right) t_p$$

$$A_n = W t_p - (3 \text{ holes})\left(d_{hole} + \tfrac{1}{16}''\right) t_p + \underbrace{\left(\frac{S_2^2}{4 g_1}\right) t_p}_{\text{Stagger 1}} + \underbrace{\left(\frac{S_2^2}{4 g_2}\right) t_p}_{\text{Stagger 2}}$$

PATH AC $A_n = Wt_p - (2\text{ holes})(d_{hole} + \frac{1}{16}")(t_p)$

However, NSR of line AC, it is only required to carry $\frac{2}{5}$ of the load. $\frac{3}{5}$ of P_u is carried by bolts B, D, & E

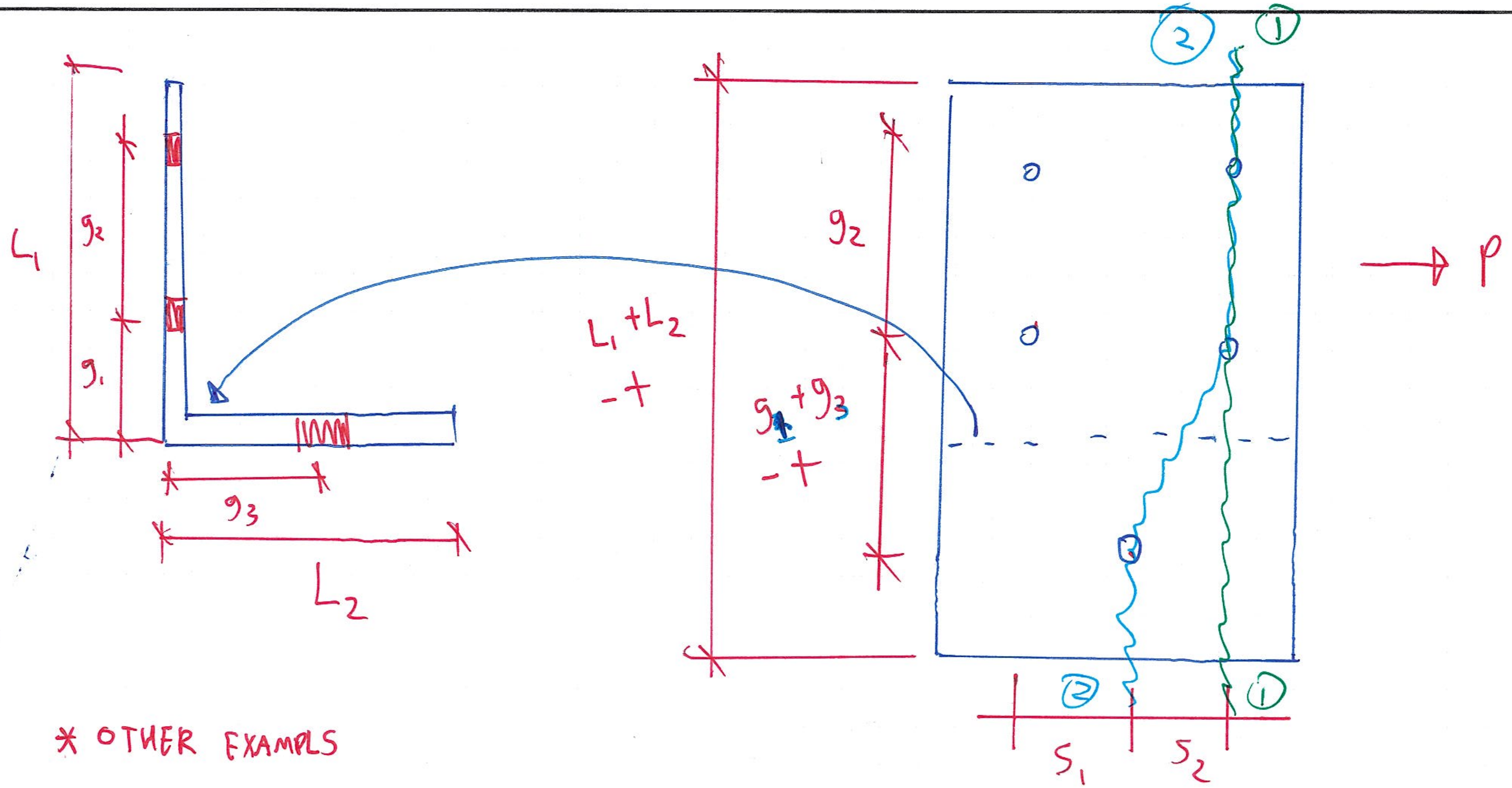
MATHEMATICALLY

$$\frac{2}{5} P_u = \phi F_u A_e \rightarrow P_u = \frac{5}{2} \phi F_u A_e = \frac{5}{2} \phi F_u U A_n$$

$\therefore$ To determine if A_n for this section is critical (ie results in a minimum P_u), must be multiplied by $\frac{5}{2}$.

PATH ABC:

$$A_n = \frac{5}{3}\left[Wt_p - (3\text{ hole})(d_{hole} + \frac{1}{16})t_p + \left(\frac{S_1^2}{4g_1}\right)t_p + \left(\frac{S_1^2}{4g_2}\right)t_p\right]$$



* OTHER EXAMPLS

→ W, C, S start on pg 57

CHAP 4: COMP. MEMBERS

INTRODUCTION: Member subject to axial compression only

APPLICABLE LIMIT STATES:

1) YIELD $f = \frac{P}{A}$
2) BUCKLING
   - inelastic
   - elastic

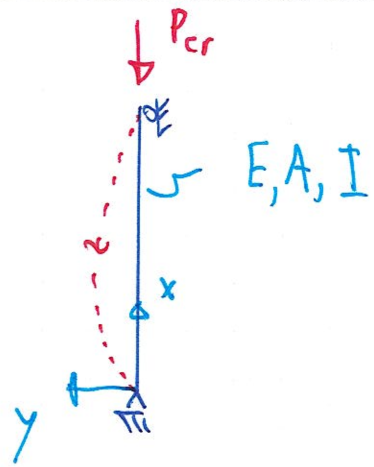
mostly controls

AISC Chap E for all limit states

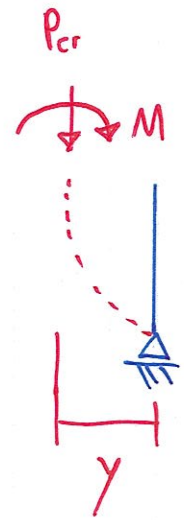
COLUMN THEORY

Elastic Buckling: "Euler" or perfect column

1) Iniatilly Perfectly Straight
2) Pinned End Conditions
3) Homogeneous Material ← constant E over L
4) Prismatic ← Constant A & I over L



Draw F.B.D @ "x" of deformed shape



$$\Sigma M_{cut} = 0 \Rightarrow M = -Py$$

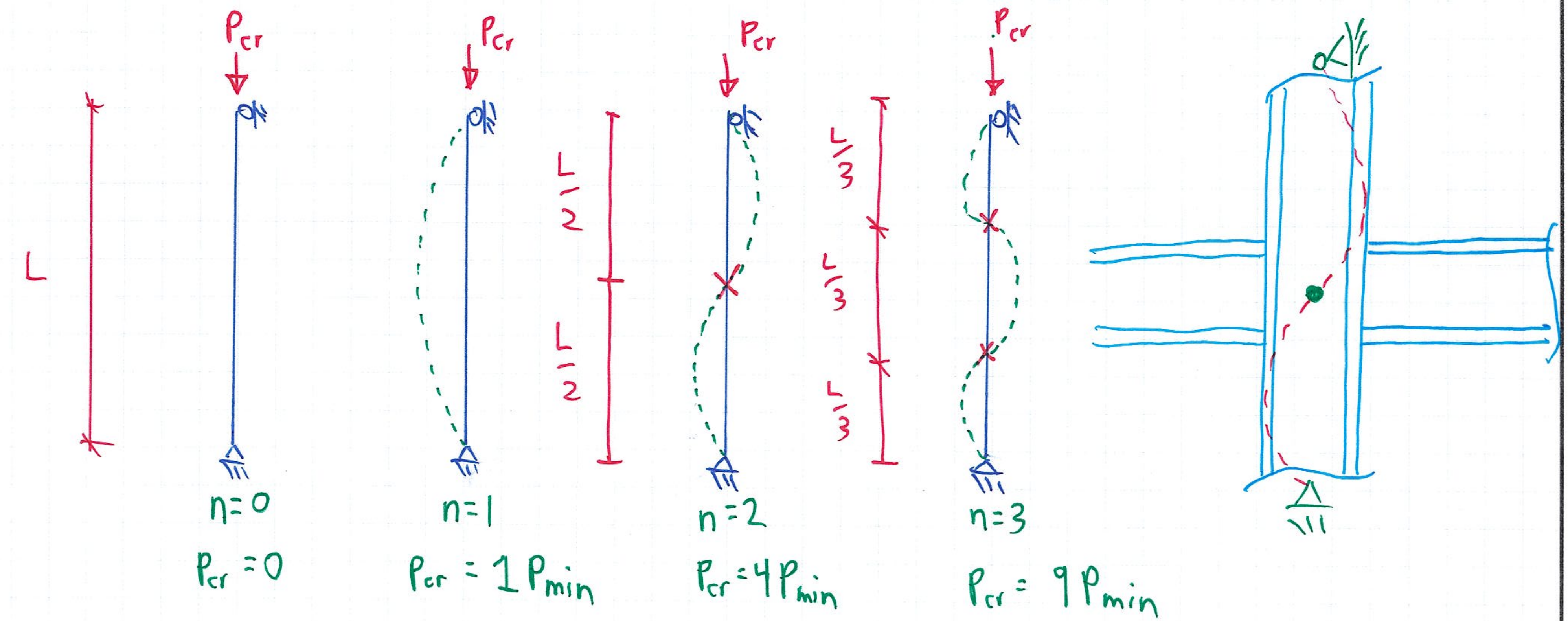
MAGIC

$$P_{cr} = \frac{n^2 \pi^2 EI}{L^2}$$

P_{min} #, $n=1$

$$P_{min} = \frac{\pi^2 EI}{L^2} \leftarrow P_e \qquad (4.3)$$

EULER BUCKLING FORMULA - ELASTIC BUCKLING ONLY



Euler buckling modes higher than 1 cannot occur w/out bracing or dynamic loading

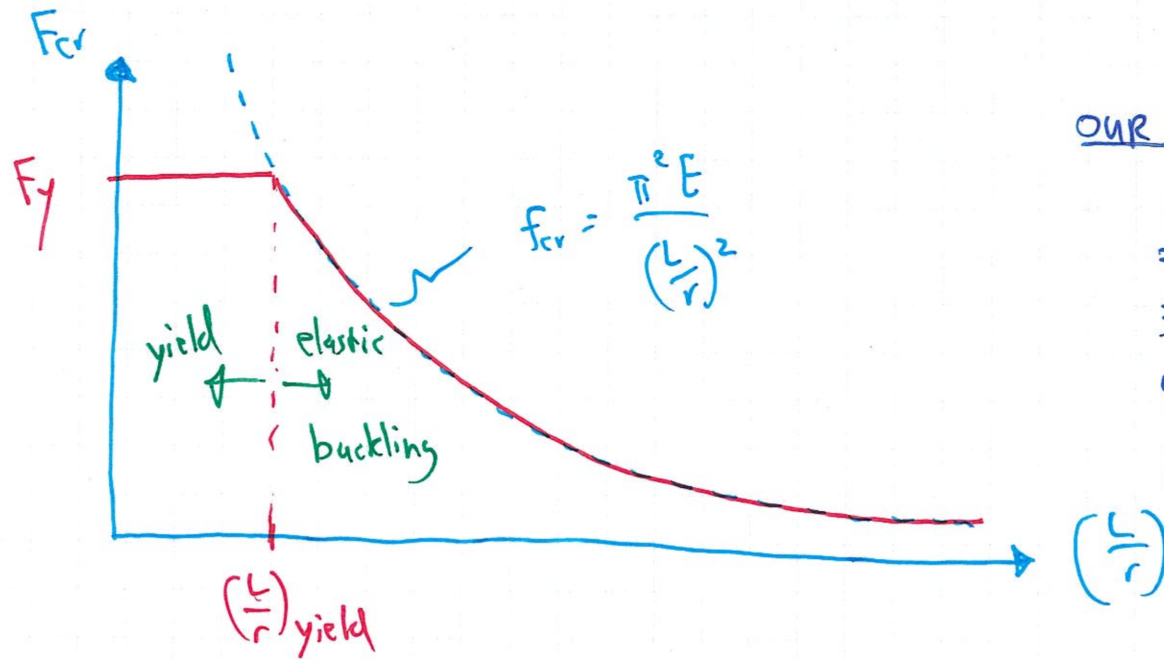
$$r = \sqrt{I/A} \Rightarrow I = r^2 A$$

$$P_{cr} = \frac{\pi^2 E(r^2 A)}{L^2} = \frac{\pi^2 EA}{\left(\frac{L}{r}\right)^2}$$

slenderness ratio

$$F_{cr} = \frac{P_{cr}}{A} = \frac{\pi^2 E}{\left(\frac{L}{r}\right)^2}$$

* $F_{cr} < F_{elastic} \approx F_y$



OUR ASSUMPTIONS

1) perf. straight
2) "prismatic" member
3) homogeneous material
4) pinned end condition
5) only axial load
6) $f_{actual} \leq f_{elastic}$
   * elastic buckling only
7) no initial/residual stresses