9.11.07 Structures Seminar David Thaddeus

- MM (Materials & Methods)
  - Wood
  - Steel } MM + GS
  - Concrete
  - Soils/Foundations - MM, GS, LF

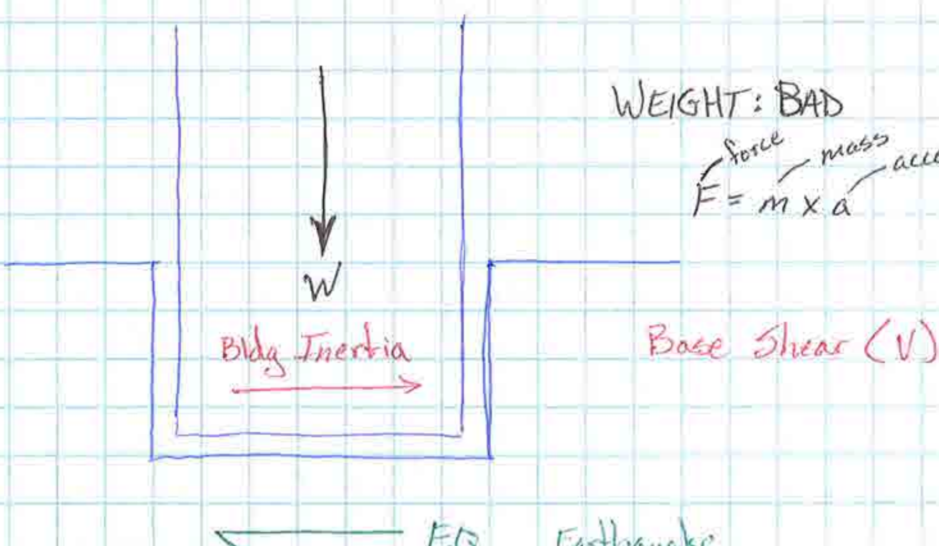
GS (General Structures)
LF (Lateral Forces)

- GS
  - 25-30 - MM
  - 40 * Selection of Systems - also in LF
  - 10-20 - Math - not to important
  - 40 - Structural Concepts
  - Misc

www.pixelzone.net → for download information

Do not get held up with codes

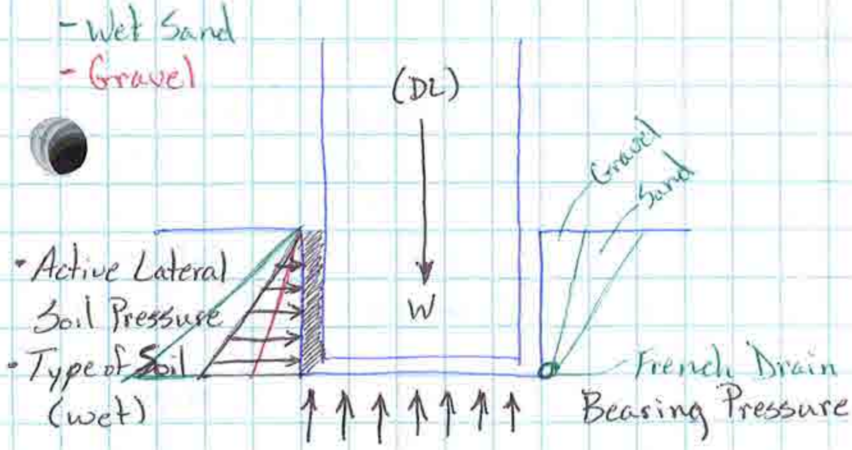
Dead LOAD — Type of Construction Assemblies



WEIGHT: BAD

$F = m \times a$ (F = force, m = mass, a = acceleration)

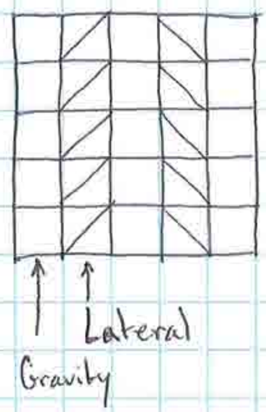
For Earthquake
Concrete: Heavy & Brittle ⇒ Bad
Steel: Light + Ductile → Good



Gravel stack
Sand pushes

Lateral
- Rigidity
- Symetrical

Diaphram
- structural
- Concrete



- Lateral cost ~~more~~ less than Gravity
- Bldgs are typ more gravity than lateral

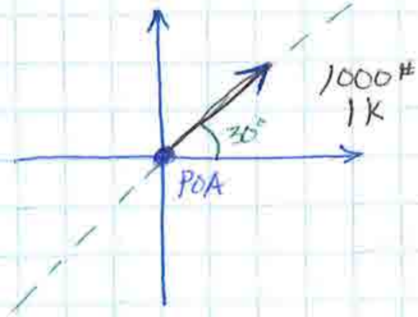
Need depth to span distances

Shear is equal & opposite directions
Deflection is caused by bending

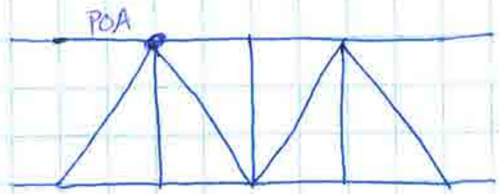
Shear
Bending
Deflection
} result of loading ⊥ to axis

Loads : Force

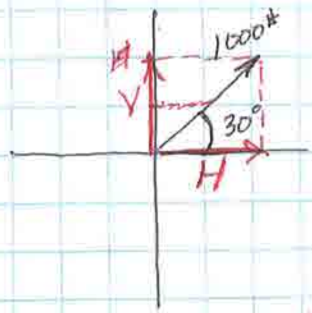
- Point of Application (POA)
- Line of Action (LOA)
  (INCLINATION)
- Magnitude of the Force
- Sense (Arrow Head)

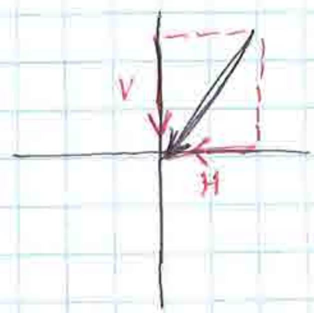


→ (T) ↗ (C)



Force Components
Horizontal, Vertical

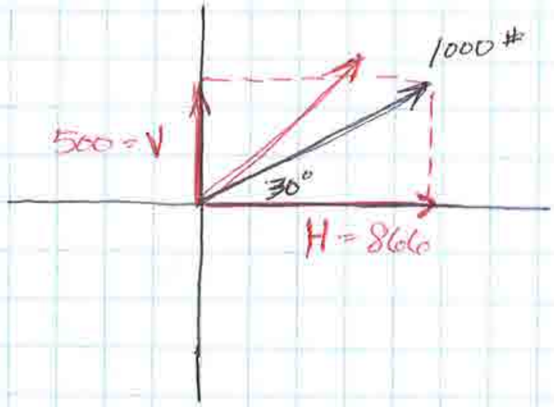




$\sin 30° = 0.5 \cdot 1000\# = 500\#$

$\cos 30° = 0.866 \cdot 1000 = 866\#$

~~1366~~ #



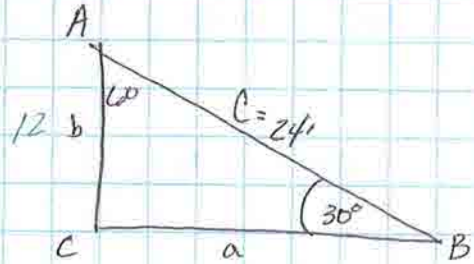
$\sin 30° = \frac{Opp}{Hyp}$ Rise

$\cos 30° = \frac{Adj}{Hyp}$ Run

$\tan 30° = \frac{\sin 30}{\cos 30} = \frac{opp}{Adj}$

$Slope = \frac{Rise}{Run}$

$500^2 + 866^2 = 1000^2$



.5

$\sin 30° = \frac{opp}{hyp} = \frac{b}{24}$

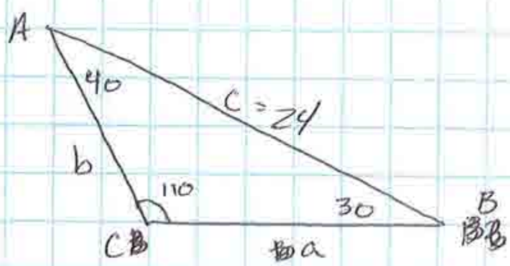
$b = .5 \times 24$

$= 12'$

.866

$\cos 30° = \frac{adj}{hyp} = \frac{z}{24}$

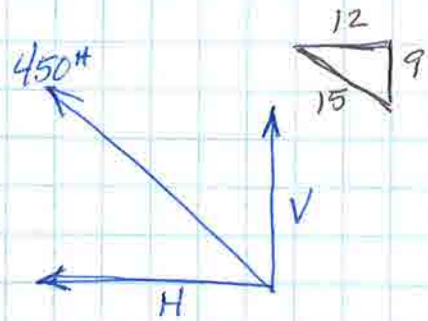
$a = 24 \times .866 = 20.8$



$\frac{\sin 30}{b} = \frac{\sin 110}{24} = \frac{\sin 40}{a}$

Force Addition – Algebraic (H, V Components)
Graphic (head, tell)
Call Engineer

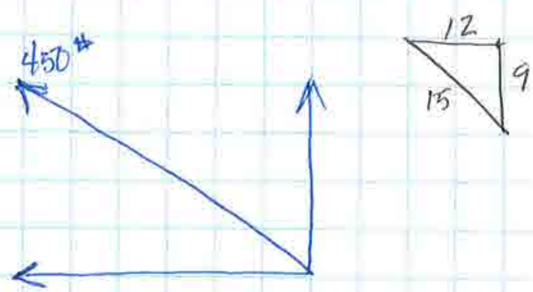
$$\frac{V}{9} = \frac{\overset{30}{\cancel{450^{\#}}}}{\cancel{15}} = \frac{H}{12}$$



$V = 270$
$H = 360$

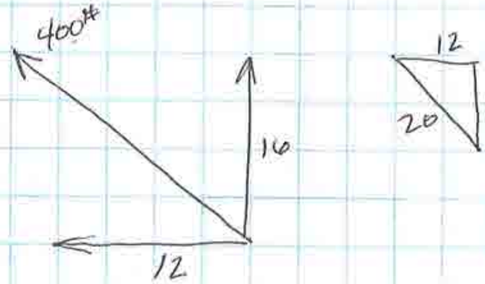
$$\frac{9}{15} \times 450 = 270$$

$$\frac{12}{15} \times 450 = 360$$

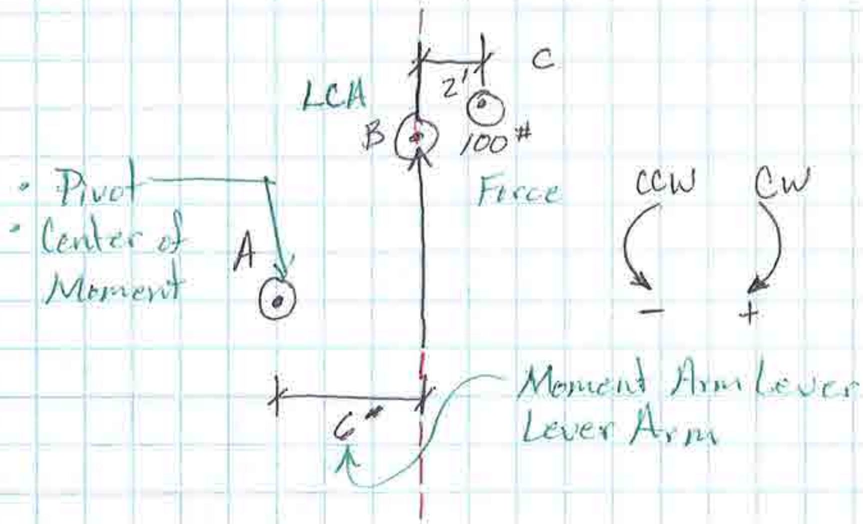


$$\frac{12}{20} \times 400 = 240$$

$$\frac{16}{20} \times 400 = 320$$



Bending/Moment

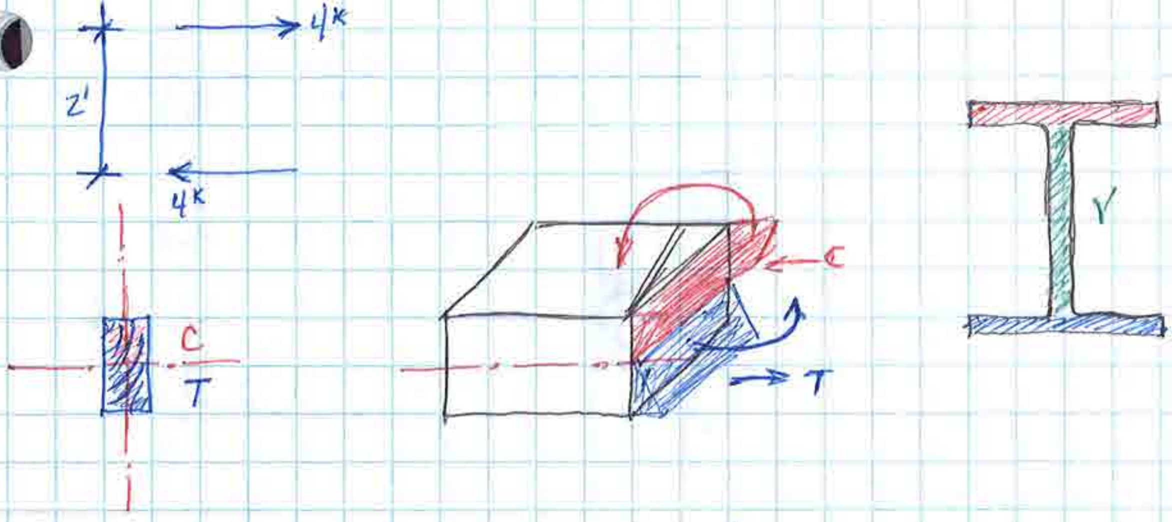


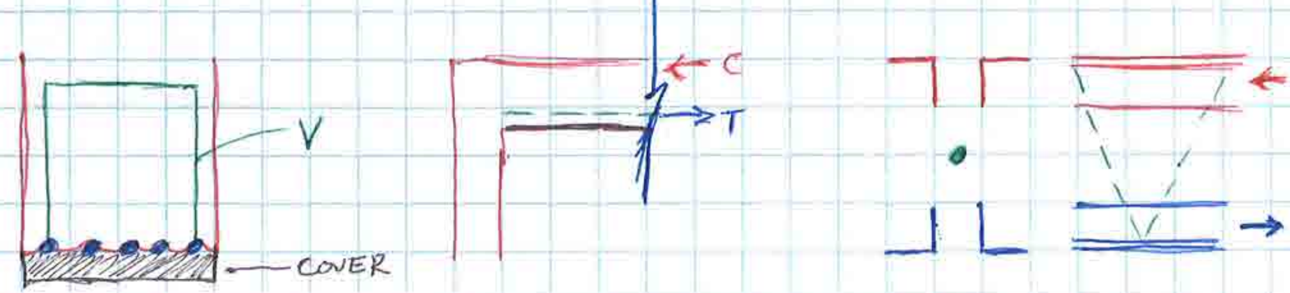
Moment of a force is the tendency of the force to create rotation about a certain point

$$M_A = \text{Force} \times \perp \text{Dist}$$
$$M_A = 100^{\#} \times 6' = 600^{\#}\,\text{Ft} \quad \text{CCW}$$

Couple

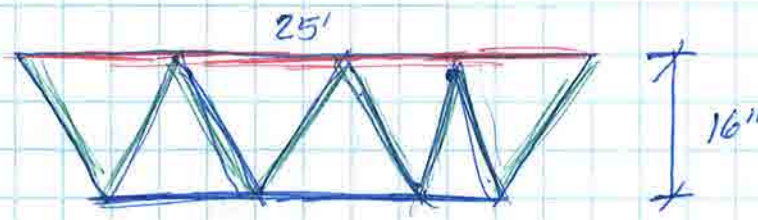
2 = an opposite forces





Moment of Couple

C x distance
T x distance

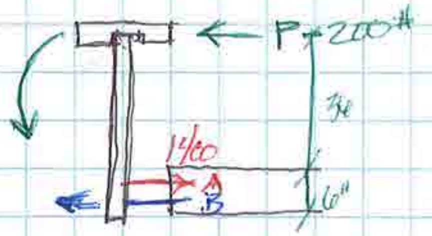


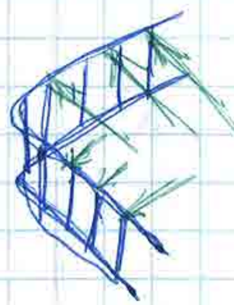
Load on bar joist changes from 125 #/Ft to 215 #/Ft What beam depth is required to keep top & bottom chord at the same force

a) 16" (b) 20") c) 24" d) 32"

Couple = C x 16" = T X 16"

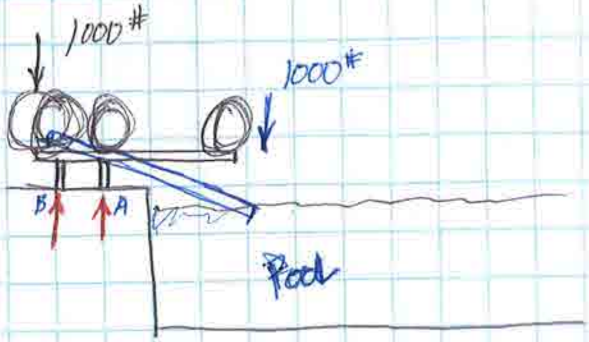
$\frac{215-175}{175} \approx 25\%$





a) A = B
(b) A > B
c) A < B
d) not enough info

Bx6 = 200 x 36
B = 1200



Support Conditions / Reactions

1) Roller / Rocker Support

2) Pin/ Hinge Support

3) Fixed
Moment Resistant
Rigid, Monolithic
Cantilever

$\Sigma F_H = 0$ $\quad$ $\Sigma F_H = 0$ $\quad$ $\Sigma M_{\text{any point}} = 0$

Can calculate up to 3 unknown reactions

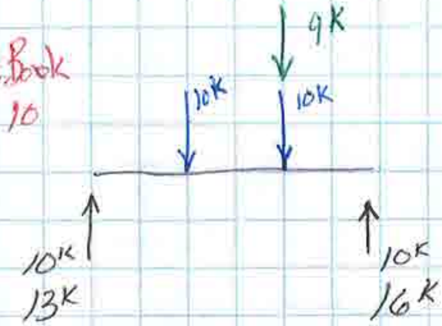
Statically

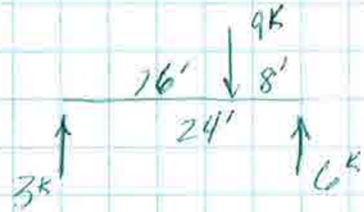
Can not create a moment connections with wood

Steel has moment connections when hardware is touching the web of the beam or column

Rollers are common in long spans

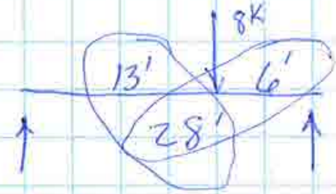
Red Book
Pg 10





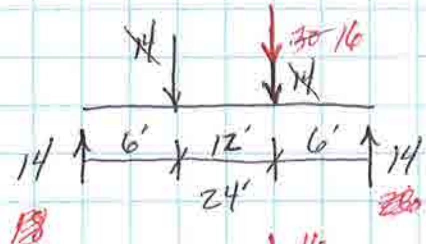
$9^K \times 8/24 = 3^K$

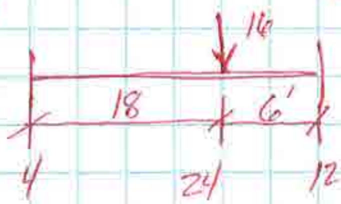
$9^K \times 16/24 = 6^K$



$\frac{18}{24} \times 8 = 6^K$

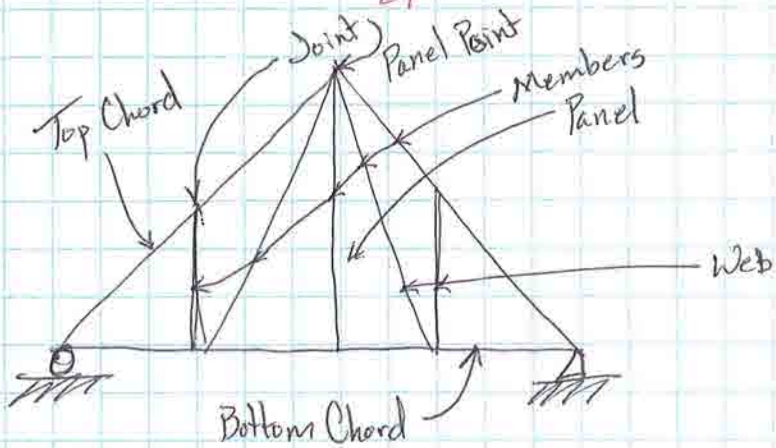
$\frac{6}{24} \times 8 = 2^K$



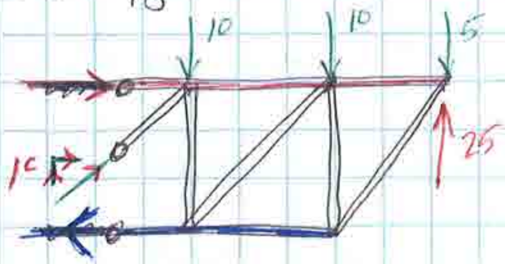


$\frac{6}{24} \times 16 = 4^K$

$\frac{18}{24} \times 16 = 12^K$



Blue Book pg. 30 # 16



1.4 compression

9.13.07

Allowable Stress : Design (ASD)

Materials : Wood - Species
- Pine
  - 1
  - 2
  - 3
- Fir

Steel A36 -
A572 - Grade 50
more carbon

Factor of Safety applied to material stress

Rebar 40 Grade (Smooth)
60 Grade (Deformed)

~~A.S.D.~~

Concrete: Cement, Sand, Gravel, Water

Ultimate (Strength)

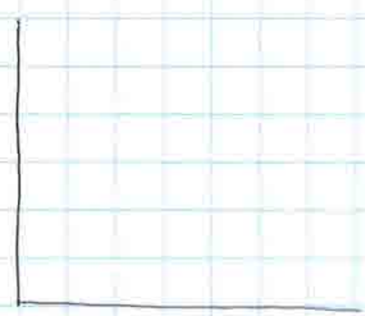
U = 1.4DL + 1.7LL
1.7WL + 1.7 Sesmic
+ 1.7 Hydrostatic

Factor of Safety on load

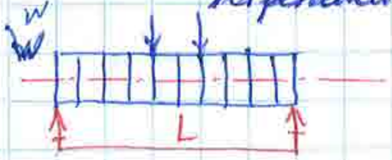
Load Combinations

	α (Coefficient of thermal expansion)
Glass	0.0000044
Aluminum	0.0000120
Wood	0.0000033
Concrete	0.0000055 - 60
Steel	0.0000065

Material



Loading
Free Body Diagram



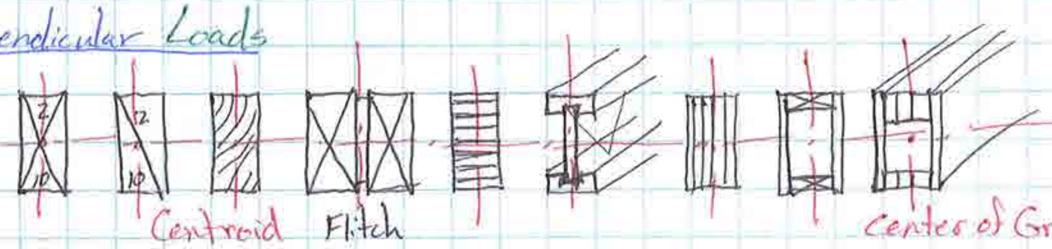
Do Not Study Calculations for concrete beam sizes

L: span
w: uniform Load (#/Ft)(K/Ft)
W: resultant of uniform load (#, K)
P: concentrated load (#, K)

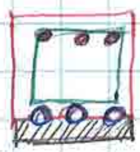
V_{max} —wood, conc→ Area
M_{max} —conc→ Section Modulus
Δ_{max} —steel→ Moment of Inertia

Perpendicular Loads

Wood

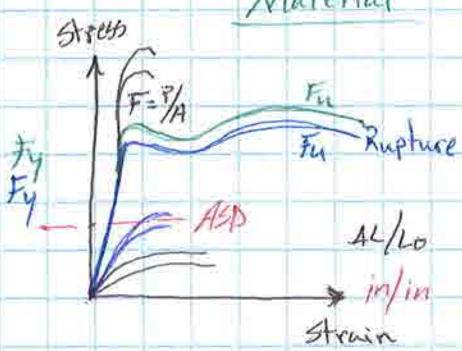


Concrete
→cover



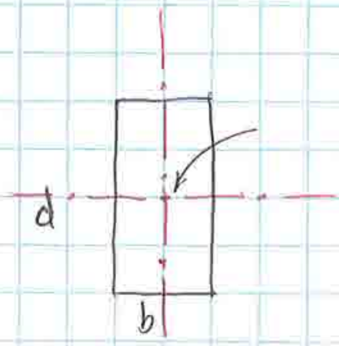
- Fire Protection of Rebar
- Corrosion
- Embedment
- Safety

Material



F_t → Axial Load
F_c
F_B Perpendicular
F_V Loads
$E \rightarrow \Delta$

E = Modulus of Elasticity



(A)

+ Area = b x d (in^2)
(Shear : V)

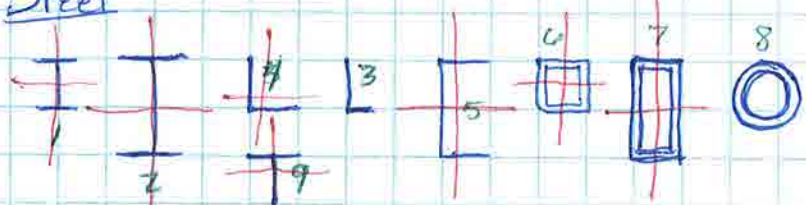
+ Section Modulus $S = \frac{bd^2}{6}$ (in^3)

Bending Moment : Flexure Strength

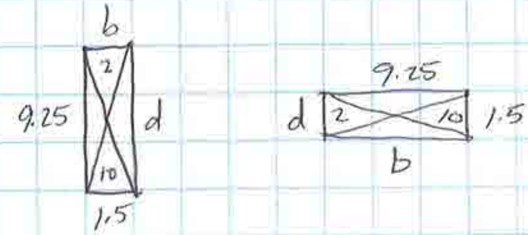
Moment of Inertia $I = \frac{bd^3}{12}$ (in^4)

Deflection : Stiffness

Steel



Beams 2, 7, 9
Columns 1, 6, 8
Pile, Bracing



$A = b \times d = 1.5 \times 9.25 = 13.875 \text{ in}^2$ $\quad$ $A = b \times d = 9.25 \times 1.5 = 13.875$

2x10 & 10x2 Have same Area ⇒ will handle same amount of shear (IF Same Material)

$S = \frac{bd^2}{6} = \frac{1.5 \times 9.25^2}{6} = 21.9 \text{ IN}^3$ $\quad$ $S = \frac{bd^2}{6} = \frac{9.25 \times 1.5^2}{6} = 3.5 \text{ in}^3$

2x10 is approximately 6 times as strong as 10x2 in bending

$I = \frac{bd^3}{12} = \frac{1.5 \times 9.25^3}{12} = 98.9^4$ $\quad$ $I = \frac{bd^3}{12} = \frac{9.25 \times 1.5^3}{12} = 2.6 \text{ in}^4$

2x10 is approximately 40 times as strong as 10x2 in deflection

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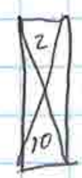
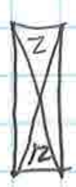


$\rightarrow \Delta = 1$

$I = 98.9 \text{ in}^4 = \frac{bd^3}{12}$

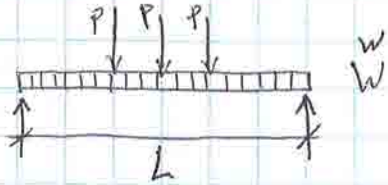
For same species of wood & same loading calculate Δ for the



$I = \frac{bd^3}{12} = \frac{1.5 \times 11.25^3}{12} = 177.9 \text{ in}^4$

$1 \times \frac{98.9}{177.9} = .56''$

Deflection



- Span
  L ↗ Δ ↗↗↗

- Load, W or P
  W ↗ Δ ↗

  P ↗ Δ ↗

- Constant
  - Concentrated load causes ↗Δ than uniform load
  - Cantilever causes ↗Δ than simple support

Material
E ↗ Δ ↘

Moment of Inertia

I ↗ Δ ↘

I ↘ Δ ↗

(#, K) Load → uni, conc → W or P

span → L; Ft → in

$$\Delta = \text{Const.} \frac{(W \text{ or } P)(L \times 12)^3}{EI}$$

Material — E: modulus of elasticity (PSI, KSI) → Stiffness of Material

I → moment of intertia (in⁴) = $\frac{bd^3}{12}$ → Stiffness of Shape

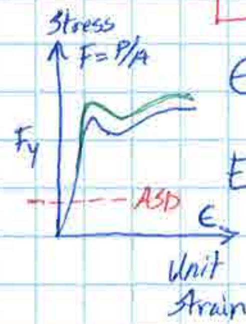
⇓

Stiffness

Axial Loading C T

columns
cables
diagnol bracing
piles

$$F_{T/C} = \frac{P}{A} \quad (1)$$



$\epsilon = \Delta L / L_o$

$E = \text{Rise} / \text{Run}$

Esteel = 29,000,000

$$\Delta L = \frac{P L_o}{AE} \quad (2)$$

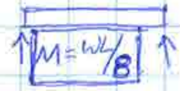
steel
$\alpha = 0.0000065$

$$\Delta L = \alpha (\Delta T) L_o \quad (3)$$

$A = b \times d \; (in^2)$

Perpendicular

floor V
Joist M
Beam Δ
Girder

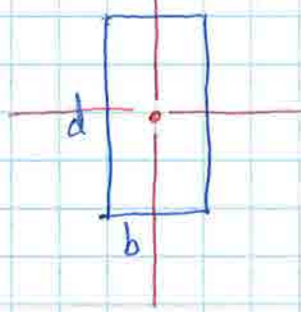


Uniform Load

shear $F = \frac{3}{2} \frac{V}{A}$ wood only

$$F_B = \frac{M}{S} \quad (4)$$

$$\Delta = \frac{\text{Constant} \left(W \text{ or } P \right) (L \times 12)^3}{EI} \quad (5)$$



$A = b \times d \; (in^2) \rightarrow$ shear

$S = \frac{bd^2}{6} \; (in^3) \rightarrow$ bending moment

$I = \frac{bd^3}{12} \; (in^4) \rightarrow$ deflection