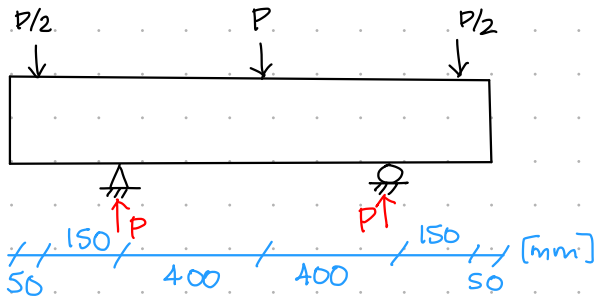
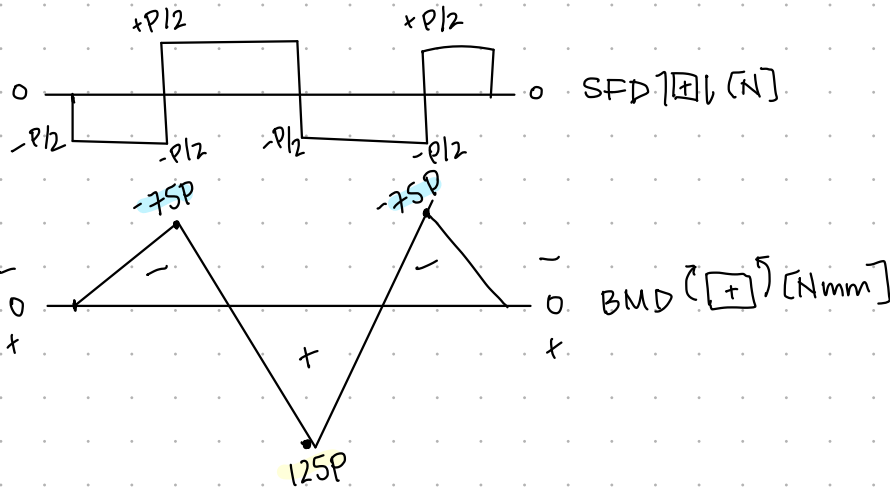


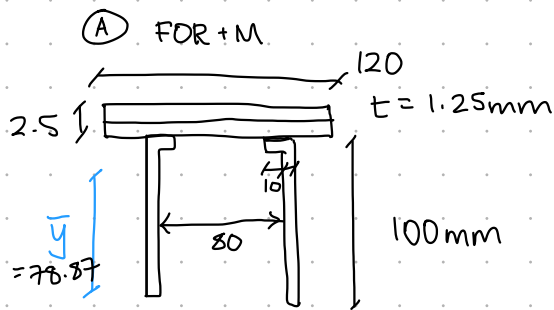
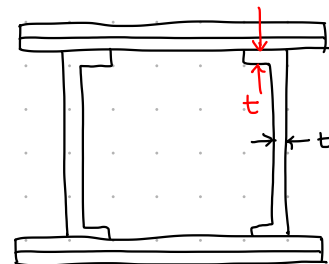
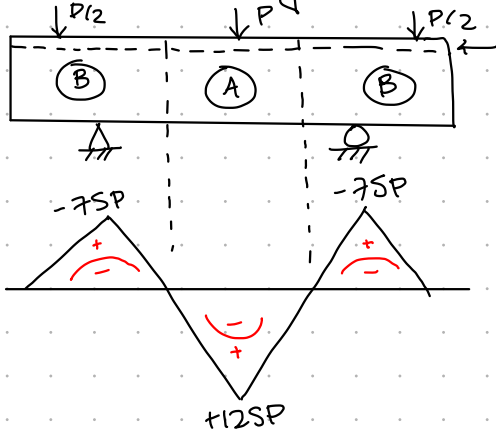
# MATBOARD (PROJECT) EXAMPLE



material properties :  $\sigma_c = -6 \text{ MPa}$  } matboard  
 $\sigma_t = 16 \text{ MPa}$  }  
 $\tau = 4 \text{ MPa}$  }  
 $\tau = 2 \text{ MPa}$  } glue



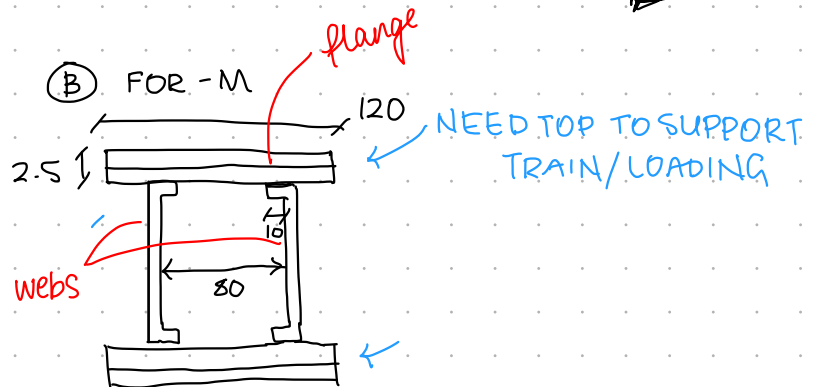
Since we have a high +M and high -M... need to design  $\geq$  cross sections



$$A = 575 \text{ mm}^2$$

$$\bar{y} = 78.87 \text{ mm}$$

$$I = 577.3 (10^3) \text{ mm}^4$$



$$A = 875 \text{ mm}^2$$

$$\bar{y} = 52.5 \text{ mm}$$

$$I = 1907 (10^3) \text{ mm}^4$$

## ① flexural failure

ZONE A  $M = 125P$   
(+M)

$$\sigma = \frac{My}{I} = \frac{(125P)y}{I} \rightarrow P = \frac{I\sigma}{125y}$$

COMPRESSION (USE COMP. PROPERTIES)

(1)  $P = \frac{(577.3 \times 10^3)(6)}{(125)(23.63)} = 1173 \text{ N}$

$\sigma_{\text{allow comp.}}$   
 $y_c$  (dist. from centroid to extreme comp. fibre)

TENSION

(2)  $P = \frac{(577.3 \times 10^3)(16)}{(125)(78.87)} = 937 \text{ N}$

$\sigma_{\text{allow tens.}}$   
 $y_t$  (dist. from cent. to tens. fibre)

ZONE B  $M = 75P$   
(-M)

$$\sigma = \frac{My}{I} = \frac{(75P)y}{I} \rightarrow P = \frac{I\sigma}{75y}$$

COMPRESSION

(3)  $P = \frac{(1907 \times 10^3)(6)}{(75)(52.5)} = 2906 \text{ N}$

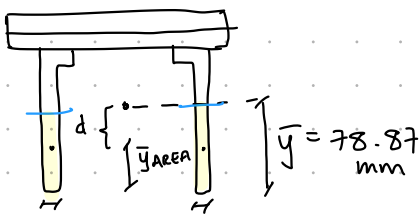
TENSION

(4)  $P = \frac{(1907 \times 10^3)(16)}{(75)(52.5)} = 7749 \text{ N}$

## ② Shear failure

→ ZONE A & B HAVE SAME  $V (=P/2)$

→ ONLY CHECK ZONE A (\* MORE CRITICAL ... SMALLER  $I$ )



$$b = 2.5 = 2t$$

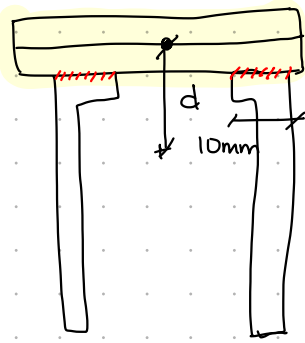
$$Q = (2 \times 1.25 \times 78.87)(78.87/2) = 7775.6 \text{ mm}^3$$

(5)  $\tau = \frac{VQ}{Ib} = \frac{(P/2)Q}{Ib} \rightarrow P = \frac{2\tau Ib}{Q} = \frac{2(4)(577.3 \times 10^3)(2.5)}{7775.6}$

$$P = 1485 \text{ N}$$

$\tau_{\text{allow matboard}}$

glue shear failure



$$b = 2 \times 10 \text{ mm} = 20 \text{ mm (bonded distance) }$$

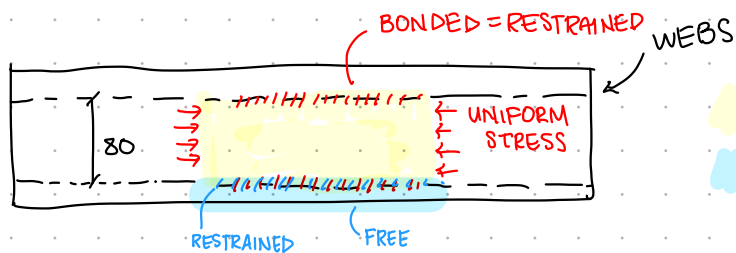
$$Q = (2.5 \times 120) \left( \left| 11.25 - (102.5 - 78.87) \right| \right) = 6714 \text{ mm}^3$$

$$(6) \quad P = \frac{2 \tau I b}{Q} = \frac{2(2)(577.3 \times 10^3)(20)}{6714} = 6879 \text{ N}$$

### ③ Buckling

Check flange

TOP VIEW



BC #1  
BC #2

→ CONSIDER ZONE A, SINCE ZONE B HAS LARGER  $I$  + SMALLER  $M$  } NOT CRIT.  
( $\therefore$  SMALLER  $\sigma_c$ )

$$\sigma_c = \frac{M_y}{I} = \frac{(12SP)(23.63)}{(577 \times 10^3)} = 0.005116SP \text{ in compression}$$

→ PLATE BUCKLING @ TOP

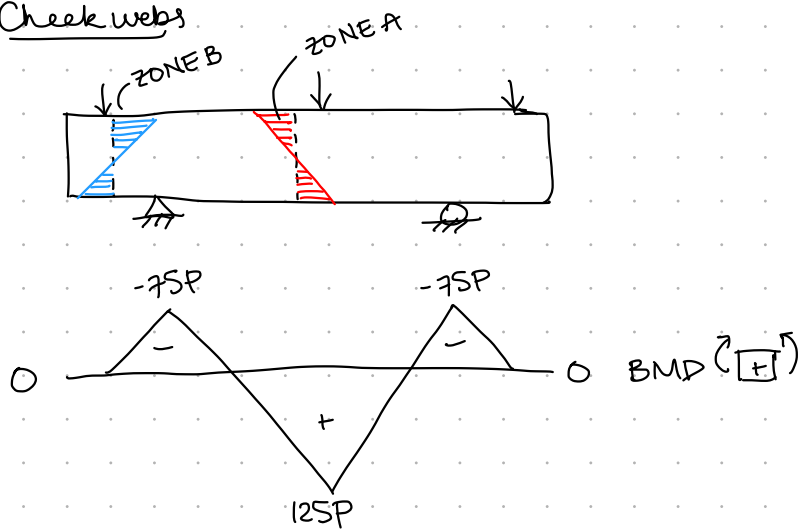
$$\text{BC \#1} \quad \sigma_c = \frac{4\pi^2 E}{12(1-\nu^2)} \left( \frac{t}{b} \right)^2 = \frac{4\pi^2 (4000)}{12(1-0.1^2)} \left( \frac{2.5}{80} \right)^2 = 12.98 \text{ MPa}$$

$$(7) \quad P = \frac{12.98}{0.0051165} = 2537 \text{ N}$$

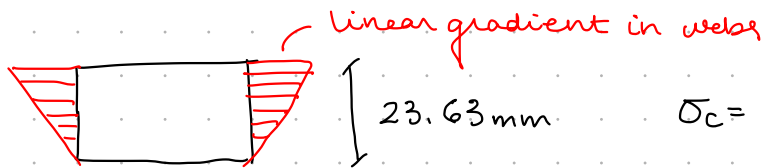
$$\text{BC \#2} \quad \sigma_c = \frac{0.425\pi^2 E}{12(1-\nu^2)} \left( \frac{t}{b} \right)^2 = \frac{0.425\pi^2 (4000)}{12(1-0.1^2)} \left( \frac{2.5}{20} \right)^2 = 22.07 \text{ MPa}$$

$$(8) \quad P = \frac{22.07}{0.0051165} = 4313 \text{ N}$$

Cheek webs



ZONE A



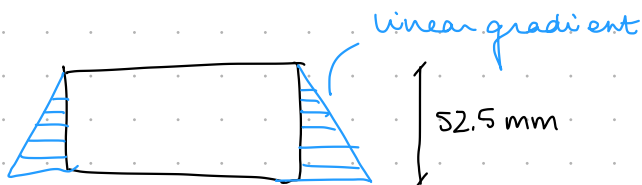
$$\sigma_c = \frac{My}{I} = 0.0051165P \quad y = 23.63 \text{ mm}$$

$$\sigma_{crit} = \frac{6\pi^2 E}{12(1-\mu^2)} \left(\frac{t}{b}\right)^2 = \frac{6\pi^2(4000)}{12(1-0.1^2)} \left(\frac{1.25}{23.63}\right)^2 = 55.79 \text{ MPa}$$

(9)

$$P = \frac{55.79}{0.0051165} = 10909 \text{ N}$$

ZONE B



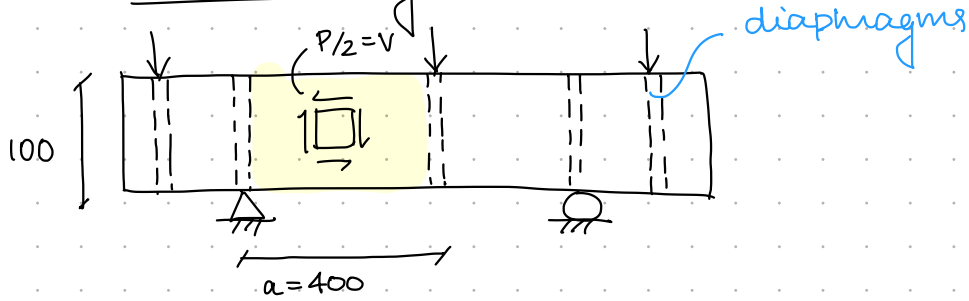
$$\sigma_c = \frac{My}{I} = \frac{(75P)(52.5)}{1907 \times 10^3} = 0.00206P \quad y = 52.5 \text{ mm}$$

$$\sigma_{crit} = \frac{6\pi^2 E}{12(1-\mu^2)} \left(\frac{t}{b}\right)^2 = \frac{6\pi^2(4000)}{12(1-0.1^2)} \left(\frac{1.25}{52.5}\right)^2 = 11.3 \text{ MPa}$$

(10)

$$P = \frac{11.30}{0.00206} = 5487 \text{ N}$$

Check shear buckling



$$\tau_{crit} = \frac{5\pi^2 E}{12(1-\mu^2)} \left( \left( \frac{t}{a} \right)^2 + \left( \frac{t}{h} \right)^2 \right) = \frac{5\pi^2 (4000)}{12(1-0.1^2)} \left[ \left( \frac{1.25}{400} \right)^2 + \left( \frac{1.25}{100} \right)^2 \right] = 2.758 \text{ MPa}$$

(11)

$$P = \frac{2\tau I_b}{Q} = \frac{2(2.758)(577 \times 10^3)(2.5)}{(7775.6)} = 1024 \text{ N}$$

## SUMMARY

#	METHOD	P <sub>fail</sub> (N)
1	Bending (COMP) - A	1173
2	Bending (TENS) - A	937 ← FAILURE MODE + LOAD
3	Bending (COMP) - B	2906
4	Bending (TENS) - B	7749
5	Matboard Shear	1485
6	Glue Shear	6879
7	Plate Buckling BC#1	2537
8	" " BC#2	4313
9	Web Buckling - A	10904
10	" " - B	5487
11	Shear Buckling	1024