No (3)

after mid. Term.

2,00

Steel Structures

3rd year Civil Eng.

Design of Beams

(B) laterally un Supported Beams
($lu \neq 0$)

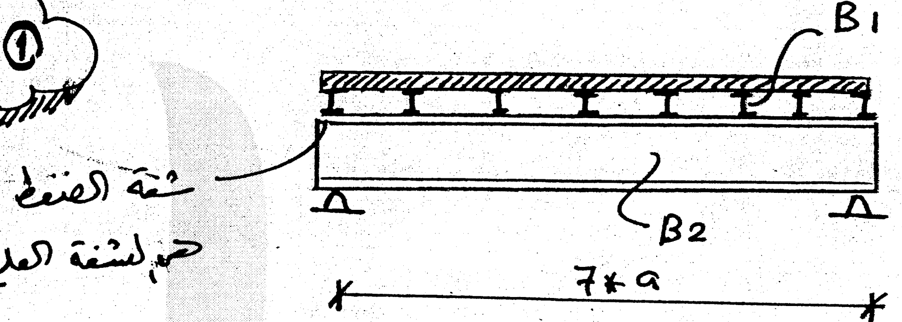
With my best wishes

② Laterally un supported Beams

بالنسبة لهذه الكمرات يجب أولاً تحديد الطول الغير مسنود لشفة الضغط "lu"

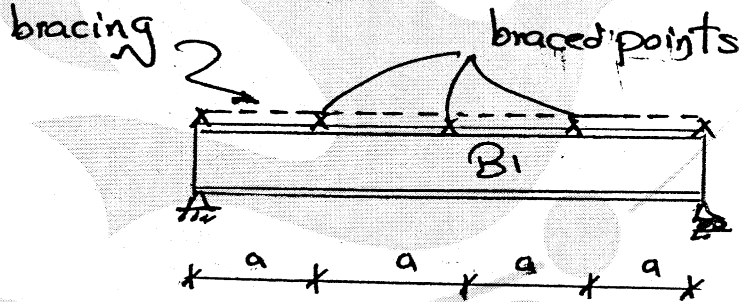
lu = Laterally un supported length of compression flange

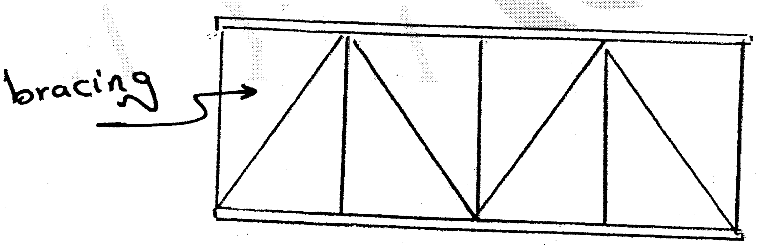
Example ①



* for Beam "B1" ⟶ lu = 0
* for Beam "B2" ⟶ lu = a.

Example ②





Plan

* for Beam B1 ⟶ lu = (a)

المسافة بين النقط المثبتة (braced points)

Allowable Stresses in bending

← يتم أولاً مقارنة قيمة (Lu) بال cm بالقيمتين الآتيتين :-

Lu:

1. $\frac{20\, b_f}{\sqrt{F_y}} = \text{cm}$

2. $\frac{1380\, A_f}{d\, F_y}\, C_b = \text{cm}$

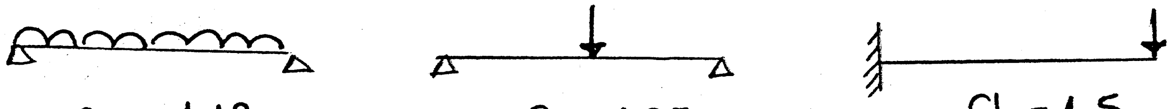
where:-

- b_f = width of flange (from tables) (cm)
- A_f = $b_f \times t_f$ (cm^2)
- d = total hight of section (cm)
- F_y = Yield stress In (t/cm^2)
- C_b = Coefficient of bending (code page 20)

وخلي بالكم من الوحدات

إيجاد قيمة C_b

← C_b هو معامل يعتمد على شكل الحمل ونوعية الركائز ونحصل عليه من جدول في الكود Page (20)



$C_b = 1.13$ — $C_b = 1.35$ — $C_b = 1.5$

← وإذا كان العزم عند أطراف الجزء المراد دراسته غير متساوي أو شكل العزم غير موجود في الجدول نستخدم المعادلة التالية :-

$$C_b = 1.75 + 1.05\left(\frac{M_1}{M_2}\right) + 0.3\left(\frac{M_1}{M_2}\right)^2 \leq 2.3$$

code page (19)

where :-

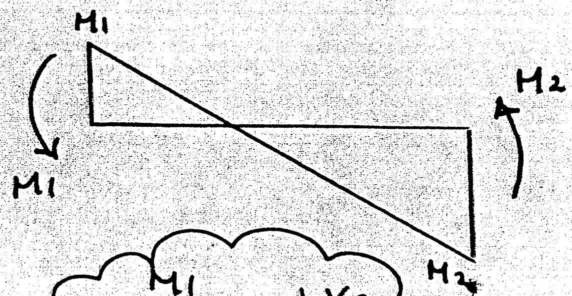
M_1 = Smaller Moment

M_2 = larger Moment

← وتكون إشارة $\frac{M_1}{M_2}$ سالبة إذا كان M_1 و M_2 في نفس الإتجاه

وتكون موجبة إذا كان العزمان M_1 و M_2 متعاكسين في الإتجاه.

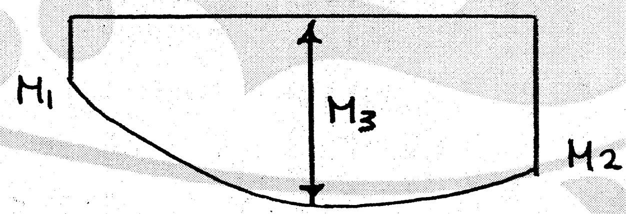
$$\frac{M_1}{M_2} = -ve$$



$$\frac{M_1}{M_2} = +ve$$

← وإذا كان العزم داخل منطقة الدراسة (بيلا) أكبر من العزم

عند الأطراف فإنه $C_b = 1$



$M_3 > M_1$

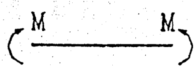
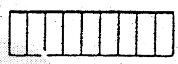
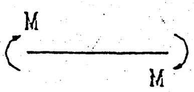
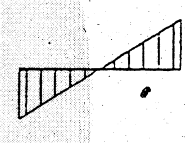
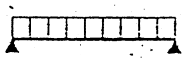
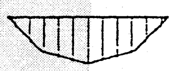
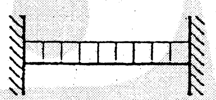
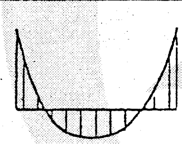
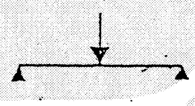
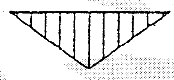
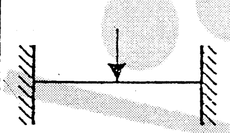
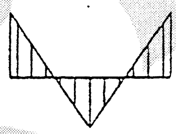
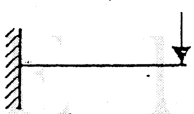
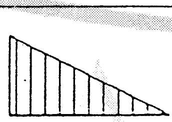
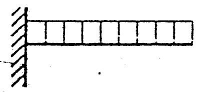
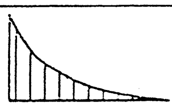
$M_3 > M_2$

$\therefore C_b = 1$

حالة خاصة ←

* if $M_1 = M_2$ (M1 ↶ ——— − ——— ↷ M2) $C_b = 1.0$
* if $M_1 = M_2$ (↶ ——— + ——— ↷) $C_b = 2.3$

Table (2.2) Values of Coefficients K and C_b

Loading	Bending Moment Diagram	End Restraint About Y-axis	Effective Length Factor K	C_b
		Simple Fixed	1.0 0.5	1.00 1.00
		Simple Fixed	1.0 0.5	2.30 2.30
		Simple Fixed	1.0 0.5	1.13 1.00
		Simple Fixed	1.0 0.5	1.30 0.90
		Simple Fixed	1.0 0.5	1.35 1.07
		Simple Fixed	1.0 0.5	1.70 1.04
		Warping Restrained	1.0	1.50
		Restrained	1.0	2.10

← وبمقارنة قيمة lu بالقيمتين

Codepage 16

$$\begin{cases} \dfrac{20\, b_f}{\sqrt{F_y}} \\ \dfrac{1380\, A_f}{d\, F_y}\, C_b \end{cases}$$

← يكون هناك "3" إحتمالات :-

الإحتمال الأول

← هو أن تكون lu أصغر من القيمتين

$$l_u \leq \frac{20 b_f}{\sqrt{F_y}}$$ و $$l_u \leq \frac{1380 A_f}{d\, F_y} C_b$$

← وفي هذه الحالة لا يحدث L.T.b وبالتالي تكون الإجهادات المسموح بها هي نفس القيم للكمرات الـ laterally supported

I- Section (Compact)

Mx → $f_b = \frac{M_x}{Z_x} = ✓ \ngtr 0.64 F_y$

My → $f_b = \frac{M_y}{Z_y} = ✓ \ngtr 0.72 F_y$

Mx , My

$$\frac{M_x/Z_x}{0.64 F_y} + \frac{M_y/Z_y}{0.72 F_y} = ✓ \ngtr 1.0$$

[- Section (Non Compact)

Mx → $f_b = \frac{M_x}{Z_x} = ✓ \ngtr 0.58 F_y$

My → $f_b = \frac{M_y}{Z_y} = ✓ \ngtr 0.58 F_y$

Mx , My

$$\frac{M_x/Z_x}{0.58 F_y} + \frac{M_y/Z_y}{0.58 F_y} \ngtr 1.0$$

الإحتمال الثانى

← هو أن تكون l_u أكبر من القيمة الأولى وأصغر من الثانية

$$l_u > \frac{20\, b_f}{\sqrt{F_y}}$$

&

$$l_u \leqslant \frac{1380\, A_f}{d\, F_y} C_b$$

← وفى هذه الحالة يكون الإجهاد المسموح به يساوى **$0.58 F_y$**

وذلك بالنسبة لجميع القطاعات

[For I-section & [- section]

M_x → $f_b = \dfrac{M_x}{Z_x} = \checkmark \ngtr 0.58 F_y$

M_y → $f_b = \dfrac{M_y}{Z_y} = \checkmark \ngtr 0.58 F_y$

M_x & M_y → $\dfrac{M_x/Z_x}{0.58 F_y} + \dfrac{M_y/Z_y}{0.58 F_y} \ngtr 1.0$

الإحتمال الثالث

← وهو أن تكون L_u أكبر من القيمتين.

$$L_u > \frac{20\, b_f}{\sqrt{F_y}}$$

&

$$L_u > \frac{1380\, A_f}{d\; F_y} C_b$$

← وفي هذه الحالة يكون الإجهاد المسموح به لجميع القطاعات

في حالة M_x هو F_{ltb}

وفي حالة M_y هو $0.58 F_y$ (C) أو $0.72 F_y$ (I)

$$M_x \longrightarrow F_b = \frac{M_x}{Z_x} = \checkmark \ngtr F_{ltb}$$

$$M_y \longrightarrow F_b = \frac{M_y}{Z_y} = \checkmark \ngtr 0.58 F_y$$

$$M_x \,\&\, M_y \longrightarrow \frac{M_x/Z_x}{F_{ltb}} + \frac{M_y/Z_y}{0.58 F_y \;(C) \quad 0.72 F_y \;(I)} \ngtr 1.0$$

حساب قيمة $F_{L.T.b}$

- For [- Section:

$$F_{l.t.b} = \frac{800}{l_u . d / A_f} . C_b = ✓ \leq 0.58 F_y$$

إذا زاد عن $0.58F_y$ ناخذه يساوي $0.58F_y$

- For I- Section:

$$F_{l.t.b} = \sqrt{F_{ltb_1}^2 + F_{ltb_2}^2} = ✓ \leq 0.58 F_y$$

where

* $$F_{ltb_1} = \frac{800}{l_u . d / A_f} . C_b = ✓ \leq 0.58 F_y$$

* F_{ltb_2}

لحساب F_{ltb_2} يجب أولاً حساب قيمة $\frac{l_u}{r_t}$

l_u = unsupported length

r_t = value from tables (موجودة في الجداول)

ثم نحسب قيمتين ← $188\sqrt{\frac{C_b}{F_y}}$, $84\sqrt{\frac{C_b}{F_y}}$

(1) when $\frac{l_u}{r_t} < 84\sqrt{\frac{C_b}{F_y}}$ $\therefore F_{ltb_2} = 0.58 F_y$

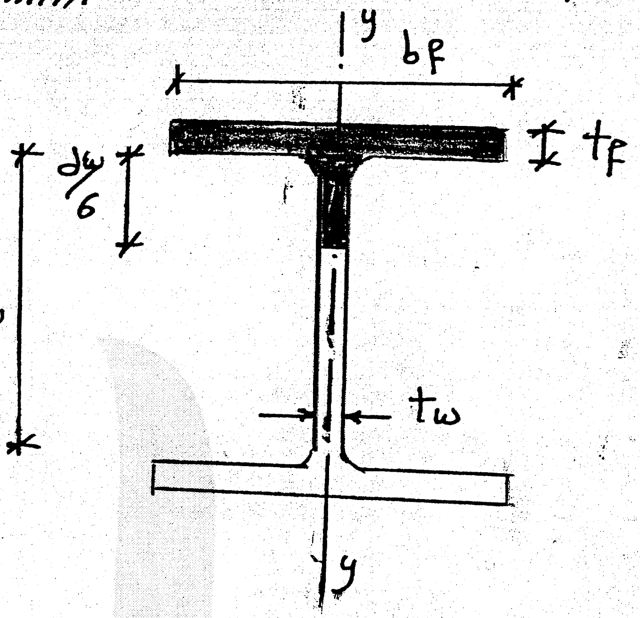
(2) when $84\sqrt{\frac{C_b}{F_y}} \leq \frac{l_u}{r_t} \leq 188\sqrt{\frac{C_b}{F_y}}$

$$\therefore F_{ltb_2} = \left(0.64 - \frac{(l_u/r_t)^2 F_y}{1.176 \times 10^5 C_b}\right) F_y \leq 0.58 F_y$$

(3) when $\frac{l_u}{r_t} > 188\sqrt{\frac{C_b}{F_y}}$

$$\therefore F_{ltb_2} = \frac{12000}{(l_u/r_t)^2} C_b \leq 0.58 F_y$$

حساب قيمة r_t لقطاع ليس موجود فى الجداول



$d_w = h - 2t_f$ or from steel tables

ارتفاع ال web فقط

r_t = radius of gyration about y-axis of (Compression flange + 1/6 web area)

$$\therefore r_t = \sqrt{\frac{I_{yf}}{A}} = \text{?? cm}$$

$$A = b_f * t_f + \left(\frac{d_w}{6}\right) * t_{web} = \text{?? cm}^2$$

$$I_{y_f} = \frac{t_f * b_f^3}{12} + \frac{\left(\frac{d_w}{6}\right) t_w^3}{12} = \text{?? cm}^4$$

$$\therefore r_t = \text{?? cm}$$

2- Compression F_{bc}

I. When the compression flange is braced laterally at intervals exceeding L_u as defined by Equations 2.17 or 2.18, the allowable bending stress in compression F_{bc} will be taken as the larger value from Equations 2.23 and 2.24, 2.25, or 2.26 with a maximum value of 0.58 F_y:

i- For shallow thick flanged sections, where approximately ($\frac{t_f L_u}{b_f d} > 4$), for any value of L_u/r_T, the lateral torsional buckling stress is governed by the torsional strength given by:

$$F_{ltb_1} = \frac{800}{L_u . d / A_f} C_b \le 0.58 \ F_y \quad \text{.......... 2.23}$$

ii- For deep thin flanged sections, where approximately ($\frac{t_f L_u}{b_f d} < 0.40$), the lateral torsional buckling stress is governed by the buckling strength given by:

a- When $L_u / r_T < 84 \sqrt{\frac{C_b}{F_y}}$, **then:**

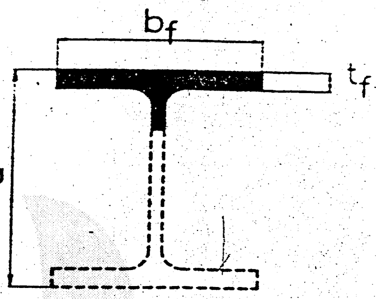
$$F_{ltb_2} = 0.58 \ F_y \quad \text{.......... 2.24}$$

b- When $84 \sqrt{\frac{C_b}{F_y}} \le L_u / r_T \le 188 \sqrt{\frac{C_b}{F_y}}$, then:

$$F_{ltb_2} = (0.64 - \frac{(L_u / r_T)^2 F_y}{1.176 \times 10^5 C_b}) F_y \le 0.58 \ F_y \quad \text{.......... 2.25}$$

c- When $L_u / r_T > 188 \sqrt{\frac{C_b}{F_y}}$, then:

$$F_{ltb_2} = \frac{12000}{(L_u / r_T)^2} C_b \le 0.58 \ F_y \quad \text{.......... 2.26}$$



Alternatively, the lateral torsional buckling stress can be computed more accurately as the resultant of the above mentioned two components as:

$$F_{ltb} = \sqrt{F_{ltb_1}^2 + F_{ltb_2}^2} \leq 0.58\,F_y \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 2.27$$

In the above Equations:

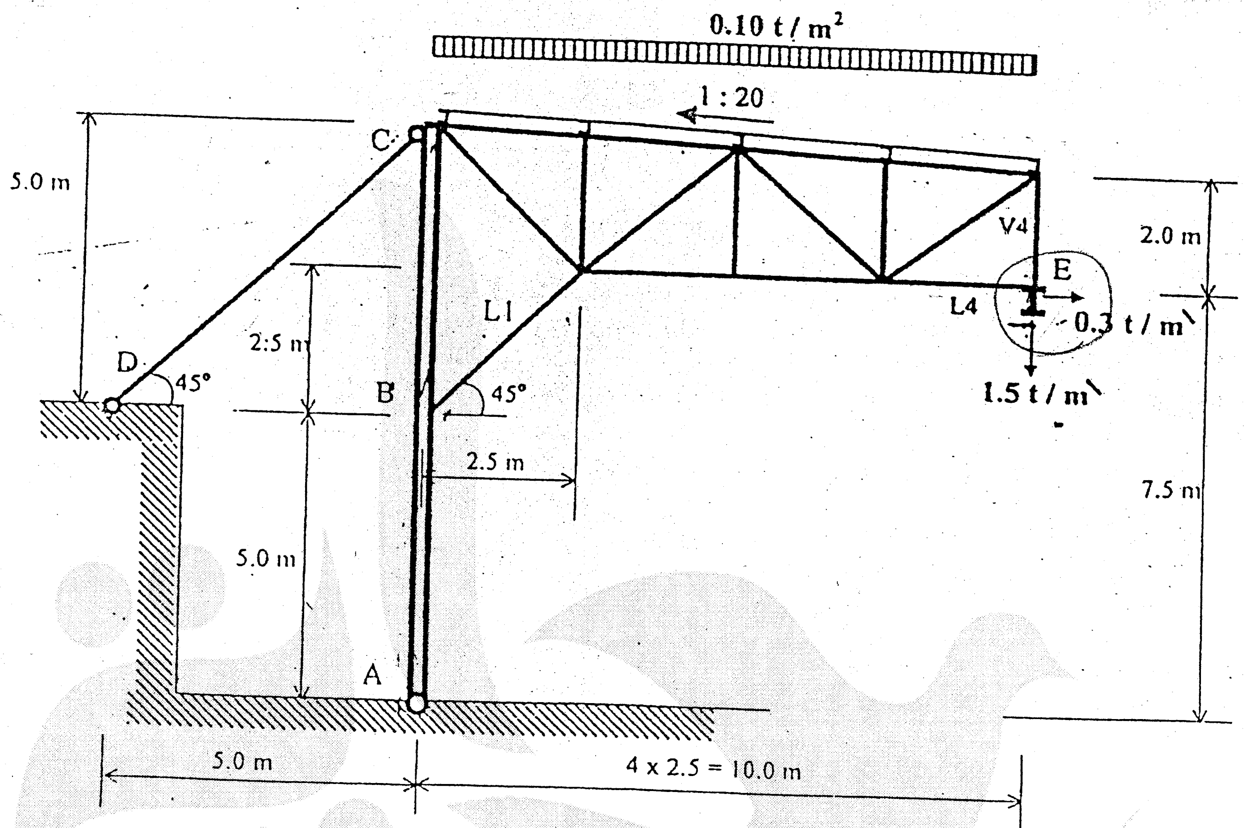
L_u = Effective laterally unsupported length of compression flange.
= K*(distance between cross-sections braced against twist or lateral displacement of the compression flange in cm).
K = Effective length factor (as given in Chapter 4).
r_T = Radius of gyration about the minor axis of a section comprising the compression flange plus one sixth of the web area (cm).
A_f = $(b_f * t_f)$ Area of compression flange (cm^2).
b_f = Compression flange width (cm).
d = Total depth (cm).
F_y = Yield stress (t/cm^2).
t_f = Compression flange thickness (cm).
C_b = Coefficient depending on the type of load and support conditions as given in Table 2.2. For cases of unequal end moments without transverse loads, (C_b) can be computed from the expression:

$$C_b = 1.75 + 1.05\,(M_1/M_2) + 0.3\,(M_1/M_2)^2 \leq 2.3 \quad \ldots\ldots \quad 2.28$$

Example ① Final [Jan 2003]

Question No. 2 (75%)

The Figure shows a cantilever truss connected to a steel column ABC and cover an area of 10.0 m x 24.0 m. The column has a hinged base at A and a pendulum support CD. The truss is spaced at 6.0 m and carry a longitudinal beam at E.



Given:

Total load on the roof (D.L + L.L) = 0.10 t / m²
Total vertical load on the longitudinal beam = 1.5 t / m` (including its own weight).
Horizontal load on the longitudinal beam = 0.3 t / m`
St (37) to be used Bolts M16 (10.9) gusset plate thickness = 10 mm

Max. Deflection for longitudinal beam $\Delta = \frac{5}{384}\frac{w\,s^4}{E\,I}$

• Req.:-

→ check the safty of the longitudinal beam as IPE 450
(Consider Your bracing at point E in the Beam design)

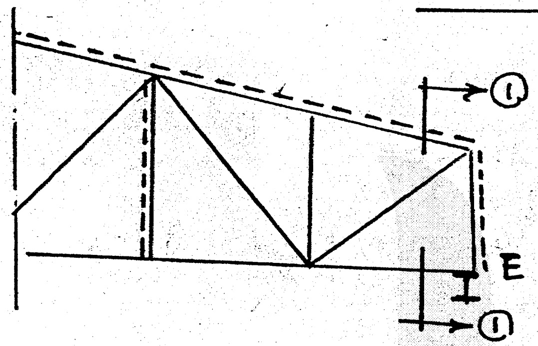
→ Max allawable deflection due to total load = $\frac{\text{span}}{300}$

(15%)

* Solution *

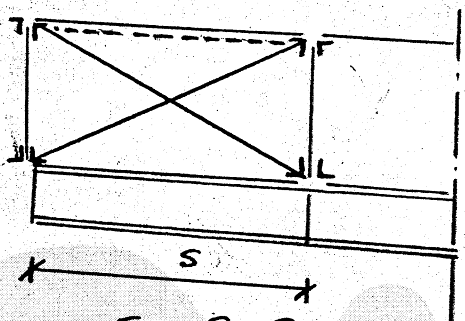
← يلاحظ في هذه المسألة أن الكمرة سوف تتأثر بدرجة كبيرة بشكل الـ bracing وذلك كما يلي :-

أولاً: تأثير الـ vertical bracing عند E :-



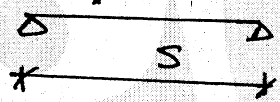
← وهو قد يكون بأحد الشكلين

حل رقم ①



sec ①-①

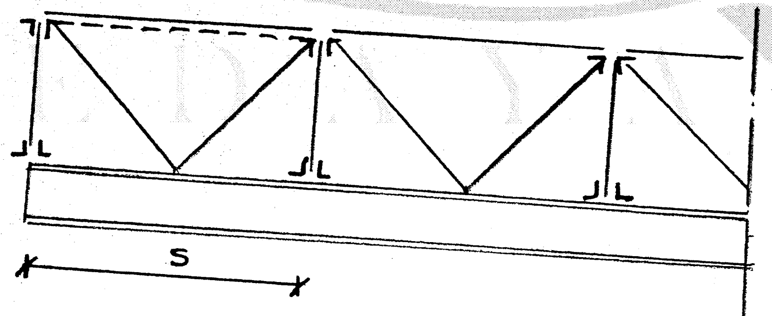
النظام الإنشائي للكمرة



← في هذه الحالة نجد أن الـ bracing لا يؤثر على النظام الإنشائي للكمرة

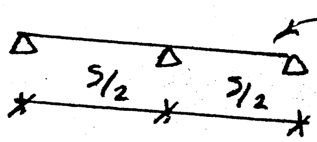
$$\therefore M_x = \frac{w * s^2}{8}$$

حل رقم ②



sec ①-①

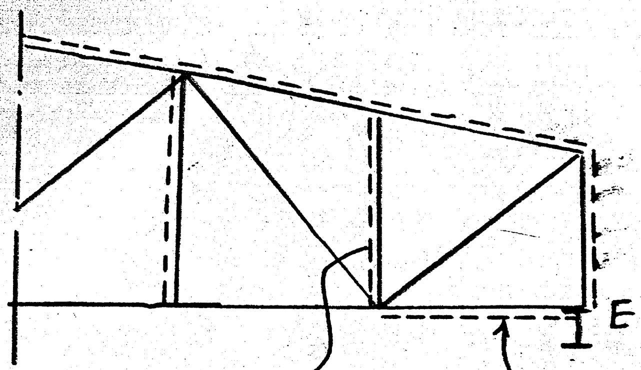
← في هذه الحالة الـ bracing غير النظام الإنشائي للكمرة وبالتالي يجب أن يستمر في جميع البواكي

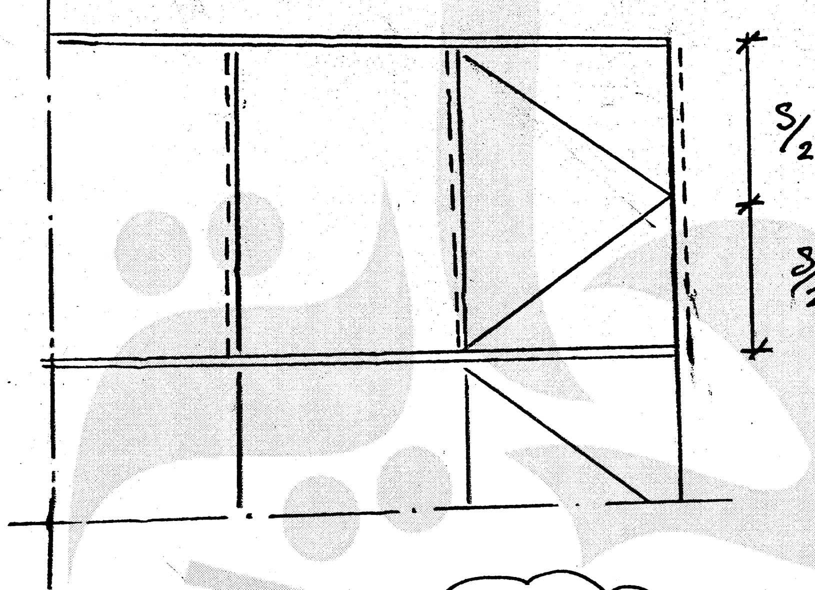


النظام الإنشائي للكمرة

$$\therefore M_x = \frac{w \left(s/2\right)^2}{8}$$

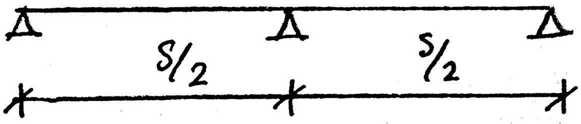
ثانياً: تأثير الـ Horizontal bracing عند E :-



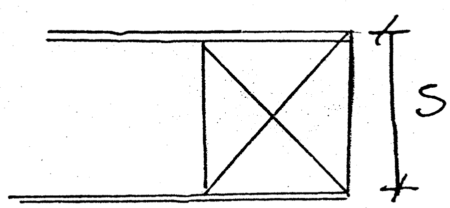


← ومن هذه الحالة نجد أن $l_u = S/2$ كما أن النظام الإنشائي للكمرة في إتجاه y يكون

$$M_y = \frac{w_y (S/2)^2}{8}$$



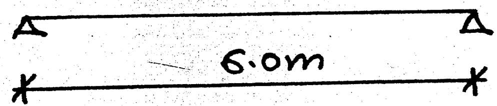
← وقد يكون شكل الـ H^{al} bracing على شكل حرف X في الـ Plan



$$M_y = \frac{w_y (S)^2}{8}$$

وفيما يلي سوف يتم عمل check على الكمرة باستخدام v^{al} bracing
على شكل (X) ولكن نستخدم H^{al} bracing .

① Span and structure system:-



② loading:-

$$w_x = 1.5\ t/m'$$
$$w_y = 0.3\ t/m'$$

③ Straining actions:-

$$M_x = \frac{w_x (S)^2}{8} = \frac{1.5(6)^2}{8} = 6.75\ t.m$$

$$M_y = \frac{w_y (S)^2}{8} = \frac{0.3(6)^2}{8} = 1.35\ t.m$$

$$Q_x = \frac{w_x * S}{2} = \frac{1.5 * 6}{2} = 4.5\ ton$$

④ checks :-

[I] check of bending stress :-

$$l_u = 600\ cm.$$

$$\rightarrow \frac{20\, b_f}{\sqrt{F_y}} = \frac{20 * 19}{\sqrt{2.4}} = 245\ cm$$

$$\rightarrow \frac{1380\, A_f}{d\, F_y} C_b = \frac{1380 * 19 * 1.46}{45 * 2.4} * 1.13 = 400\ cm$$

∴ l_u أكبر من القيمتين [الاحتمال الثالث]

$$\frac{M_x / Z_x}{F_{ltb}} + \frac{M_y / Z_y}{0.72 F_y} \ngtr 1.0$$

For I-section → $F_{ltb} = \sqrt{F_{ltb_1}^2 + F_{ltb_2}^2} < 0.58 F_y$

$$F_{ltb_1} = \frac{800\, A_f}{l_u * d} * C_b = \frac{800 * 19 * 1.46}{600 * 45} * 1.13$$

$$F_{ltb_1} = 0.929\ t/cm^2$$

For IPE 450 → From tables $r_t = 4.93\ cm$

خلي بالك احسبها انت ومتجبهاش من الجدول

$$\frac{l_u}{r_t} = \frac{600}{4.93} \simeq 120$$

$$\rightarrow 84\sqrt{\frac{C_b}{F_y}} = 84\sqrt{\frac{1.13}{2.4}} = 57.6 < 120$$

$$\rightarrow 188\sqrt{\frac{C_b}{F_y}} = 188\sqrt{\frac{1.13}{2.4}} = 129 > 120$$

$$F_{ltb_2} = \left[0.64 - \frac{(l_u/r_t)^2 * F_y}{1.176 * 10^5\, C_b}\right] F_y$$

$$= \left[0.64 - \frac{120^2 * 2.4}{1.176 * 10^5 * 1.13}\right] 2.4$$

$$F_{ltb_2} = 0.91\ t/cm^2$$

$$F_{ltb} = \sqrt{(0.929)^2 + (0.91)^2} = 1.3\ t/cm^2 < 0.58 F_y = 1.4\ t/cm^2$$

o.k

$$\therefore \frac{\frac{6.75 * 100}{1500}}{1.3} + \frac{\frac{1.35 * 100}{176}}{0.72 * 2.4} = 0.79 < 1.0$$

o.k

2 check of shear stresses:-

$$q_{act} = \frac{Q_x}{h * t_w} = \frac{4.5}{45 * 0.96} = 0.106\ t/cm^2 < 0.35\ F_y$$

o.k

3 check of deflection:-

$$I_x = 33740\ cm^4$$

$$E = 2100\ t/cm^2$$

$$\Delta_{act} = \frac{5 * w_{LLx} * L^4}{384 * E * I_x}$$

$$= \frac{5 * 1.5 * 600^4}{384 * 100 * 2100 * 33740} = 0.36\ cm$$

$$\Delta_{all} = \frac{span}{300} = \frac{600}{300} = 2\ cm$$

$$\Delta_{act} < \Delta_{all}$$ o.k

∴ IPE 450 Is Safe

18

Example ② Final [Jan 2002]

Alexandria University
Faculty of Engineering
Structural Eng. Dept.

Steel Structures

3rd Year – Civil Eng.
Final Exam – Jan. 2002
Time Allowed: 3 Hours

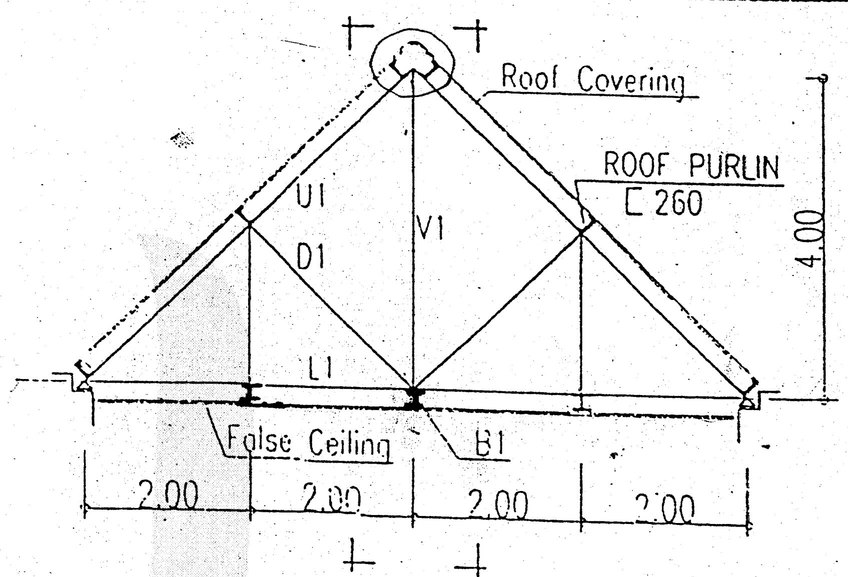


Fig. (1)

Part (A) 65 %

Figure (1) shows the shed covering a passage between two buildings. The main structure is a simply supported truss 8.0 m span and spaced at 6.0 m to cover an area of 8.0 x 24.0 m. The top chords of the truss carry the roof purlins. While the bottom chords carry the false ceiling purlins "B_1".

Given:

Steel wt. (applied on the top chord joints)	= 30 kg / m²
L.L (on the roof)	= 20 kg/ m²
Covering + insulation (on the roof)	= 200 kg / m² (true area)
False ceiling wt. (applied on the bottom chord Joints)	= 50 kg / m²

Member sections:

Upper chord	U1	two back-to-back angles 75 x 75 x 8
Vertical members	V1	two star-shaped angles 50 x 50 x 5
Lower chord and diagonals	L1, D	two back-to-back angles 50 x 50 x 5

Steel (37) to be used. All truss connections are welded. Gusset plate thickness 6.0 mm.
Use H.S. Bolts M12 (8.8) for connections of beams "B_1".
Allowable deflection of beams due to total load = Span / 150

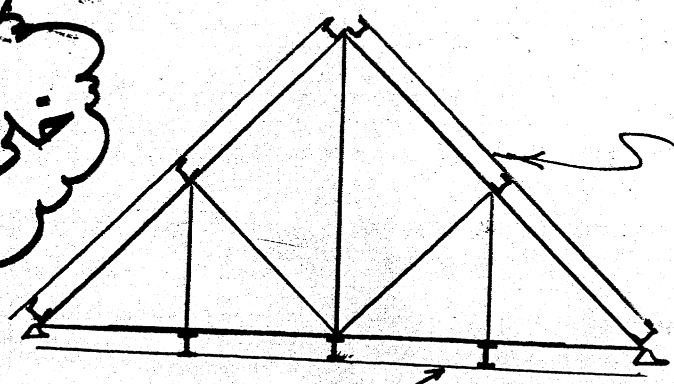
Required:

تتم الإجابة على السؤال الأول و الخامس و السادس بالكامل في اللوحة وباقى الأسئلة فى الكراسة بالترتيب.

1) Draw to scale 1:100 the bracing system required for the structure in three views.
2) Check an intermediate false ceiling purlin "B_1" as IPE 160.
3) Calculate the forces in the truss members U_1, V_1, D_1, and L_1.
4) Check the given sections of the truss members U_1, V_1, D_1, and L_1.
5) Design all the connections in the part enclosed by the rectangle.
6) Draw to scale 1:10 the elevation of the part enclosed by the rectangle.

ملاحظة هامة

هام جداً
خلى بالك



وبالتالى تكون شفة الشد هى الممسوكة.

في هذه المسألة نجد أن مدادات السقف تكون شفة الضغط لها ممسوكة بواسطة الصاج وبالتالى تكون ممنوعة من الحركة الجانبية (laterally supported)

وبالتالى يكون $lu = 0$

بينما نجد أن مدادات السقف الزائف تكون شفة الضغط لها غير ممسوكة (غير ممنوعة من الحركة الجانبية (laterally un supported)) لأن الممنوع من الحركة الجانبية هو شفة الشد وليس شفة الضغط والذى يهمنا هنا هو "شفة الضغط"

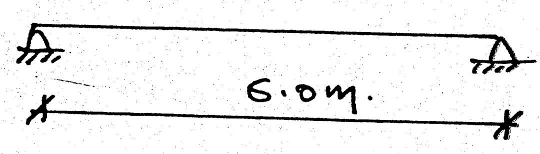
وبالتالى يكون $lu \neq 0$ ⟸ $lu = S$

حيث "S" هى تقسيط ال Truss.

Hashi..!!

Solution

1] span and str. system :-



2] loads :-

- DL { → o.wt ; → cover (False Ceiling)

خلي بالك → - LL → No LL on Falce Ceiling

* owt :- $h = \frac{span}{40}$ ← في هذه الحالة لا نستخدم الفرض وذلك لأنه القطاع given   هام

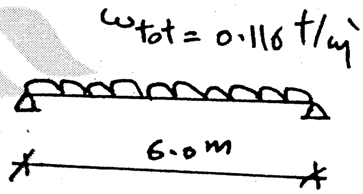
For IPE 160 ⟶ From tables ⟶ $\omega = 15.8\ kg/m'$

$$\therefore \omega_{tot} = 15.8 + 50 * 2$$

$$= 115.8\ kg/m'$$

$$\simeq 0.116\ t/m'$$

3] straining actions :-



$$M_x = \frac{0.116 * 6^2}{8} = 0.522\ t.m$$

$$Q_x = \frac{0.116 * 6}{2} = 0.348\ ton$$

4] checks :-

① Check of Normal Stresses :-

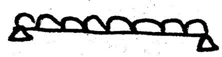
$$l_u = 6\ m$$

$$\rightarrow \frac{20\, b_f}{\sqrt{F_y}} = \frac{20 * 8.2}{\sqrt{2.4}} = 105.8 \text{ cm}$$

(8.2 → Tables)

$$\rightarrow \frac{1380\, A_f}{d\, F_y} C_b = \frac{1380 * 8.2 * 0.74}{16 * 2.4} * 1.13$$

($8.2 = b_f$, $0.74 = t_f$)



Code P 20 $\quad C_b = 1.13$

ـــ وبمقارنة L_u بالقيمتين السابقتين نجد أن

L_u أكبر من القيمتين وبالتالي نحسب F_{ltb}

$$F_{ltb} = \sqrt{F_{ltb_1}^2 + F_{ltb_2}^2} \leq 0.58 F_y$$

→ **F_{ltb_1}:**

$$F_{ltb_1} = \frac{800}{L_u \cdot d/A_f} C_b = \frac{800}{\frac{600 * 16}{8.2 * 0.74}} * 1.13 = 0.57 \text{ t/cm}^2 < 0.58 F_y$$

O.K

ـــ وخلي بالك من الوحدات وانت بتعوض ...!!!

→ **F_{ltb_2}**

depends on $\frac{L_u}{r_t}$

$r_t = 2.16$ cm → from tables

$$\frac{L_u}{r_t} = \frac{600}{2.16} = 277.7$$

$$84 \sqrt{\frac{C_b}{F_{y_2}}} = 57.6 \qquad (C_b = 1.13,\ F_{y_2} = 2.4)$$

$$188 \sqrt{\frac{C_b}{F_{y_2}}} = 129 \qquad (C_b = 1.13,\ F_{y_2} = 2.4)$$

$$\therefore F_{ltb_2} = \frac{12000}{(l_u/r_t)^2} * C_b = \frac{12000}{(277.7)^2} * 1.13 = 0.176\ t/cm^2$$

$< 0.58\ F_y$

o.k

$$\therefore F_{ltb} = \sqrt{F_{ltb_1}^2 + F_{ltb_2}^2}$$

$$= \sqrt{0.57^2 + 0.176^2} = 0.596\ t/cm^2 < 0.58\ F_y$$

o.k

$$\therefore f_{act} = \frac{M_x}{Z_x} = \frac{0.522 * 100}{109} = 0.48\ t/cm^2 < \underset{F_{ltb}}{0.596}\ t/cm^2$$

o.k

② check of shear :-

$$q_{act} = \frac{Q}{h * t_w} = \frac{0.348}{16 * 0.5} = 0.043 < 0.35 F_y$$

o.k

③ Check of deflection :-

← بالرغم من عدم وجود L.L على الـ False Seiling إلا أنه قد ذكر شرط في السؤال وهو

allowable deflection due to total load = $\frac{span}{150}$

وبالتالي يتم عمل Check على الترخيم الناتج عن الحمل الكلي

$$\omega_{tot} = 115.8\ kg/m' = 1.158\ kg/cm'$$

$$\Delta_{tot\ act} = \frac{5}{384} \frac{\omega_t * l^4}{E\ I_x} = \frac{5}{384} * \frac{1.158 * (600)^4}{2.1 * 10^6 * 869} = 1.07\ cm$$

$$\Delta_{all} = \frac{span}{150} = \frac{600}{150} = 4\ cm$$

$\Delta_{act} < \Delta_{all}$ o.k $\therefore$ (Beam is Safe) *