اللجنة الأكاديمية للهندسة المدنية

تلخيص
تحليل إنشائي

مهدي أبو العدوس

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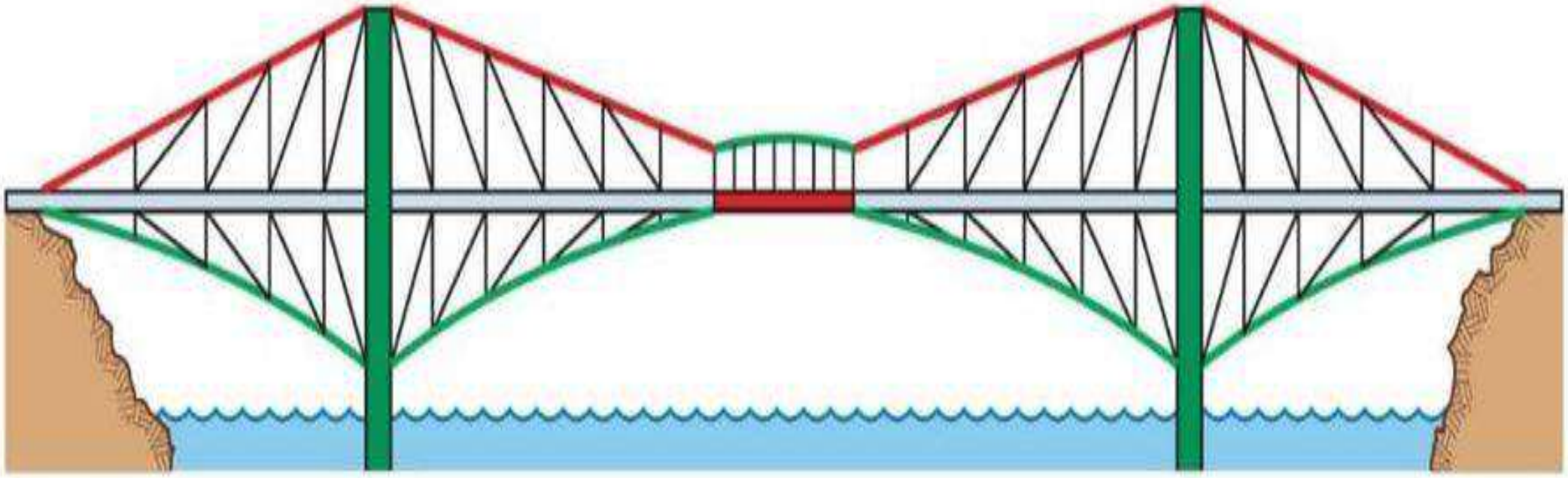
STRUCTURAL ANALYSIS



قبل البدء بدراسة هذا الملخص يرجى العلم:

* هذا الملخص يشمل سلايدات الدكتور إضافة لأبرز الملاحظات أثناء المحاضرة ومجموعة من أسئلة السنوات.
* قد ترد معلومات إضافية ومعلومات ناقصة ولا تتعدى نسبة 4%
* يجب الدراسة أول ب أول وحل كامل الأسئلة لحصد العلامة الكاملة
* في النهاية هذا جهد طلابي فإن وجدتم أي ملاحظة يرجى إبلاغي

- Mahdi Abu Al-Adous

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قد يختلف توزيع العلامات من فصل لآخر

Title	Mark
First Exam (ch1-ch4)	25
Second Exam (ch5-ch7)	25
Final Exam (ch1-ch10)	40
Homework	10

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Chapter(1):Types of structures and loads

في البداية سنتعرف على معظم المفاهيم الأساسية في التحليل الإنشائي:

Structural Elements: Some of the more common elements from which structures are composed are as follows

1)tie rod

2)Beams

3) Columns.

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Types of Structures.: The combination of structural elements and the materials from which they are composed is referred to as a structural system.

1)Trusses

- 2) Cables and Arches
- 3) Frames

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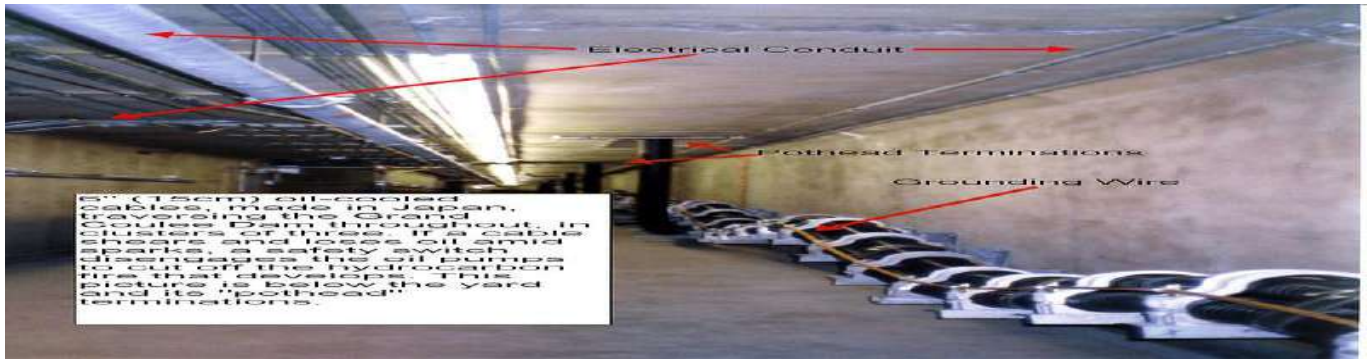
مجموعة من الصور توضح شكل الجسور والكوابل :



سنتعرف على أنواع الأحمال:

- ***Dead Loads:***

الأحمال الميتة هي الثابتة في الموقع وثابتة في القيمة مثال عليها البطون والعقدة ويمكن حسابها عن طريق القانون التالي:

الوزن=الكثافة ×الحجم

سأعرض في السلايد القادم مجموعة جداول للأحمال الميتة

الكود المستخدم (ASCE)

Material	Weight (kg/m^3)
1. Bituminous substances	
Anthracite coal	1500
Peat (dry)	560 to 640
Charcoal (light)	300
Coke	1000
Crude oill	880
Pitch	1010
Coal tar	1000
2. Excavated materials	
Clay (dry, compact)	1440
Clay (damp, compact)	1760
Earth (dry)	1410 to 1840
Earth (moist)	1600 to 2000
Sand (dry)	1540 to 1600
Sand	1760 to 2000
3. Liquids	
Alcohol	780
Gasoline	670
Ice	910
Nitric acid 91%	1510
Sulphuric acid 87%	1790
Vegetable oil	930
Water (fresh)	1000

Material	Weight (kg/m^3)
4. Building materials	
Bricks	1600 to 1920
Cement (ordinary)	1440
Chalk	2240
Glass	2400 to 2720
Lime stone	2400 to 2640
Sand stone	2240 to 2400
Steel	7850
Timber	650 to 720
5. Structural items, ceilings, finishes etc.	
Asbestos cement sheets	12 to 15.6
Brick masonry	1920
Brick wall, 100 mm thick	192
Brick wall, 200 mm thick	384
Brick wall, 300 mm thick	576
Cement plaster, 25 mm thick	52
Concrete, plain	2300
Concrete, reinforced	2400
Dry rubble masonry	2080
Galvanised iron sheet,	
0.50 mm thick	5 (kg/m^2)
1.63 mm thick	13 (kg/m^2)
Mangalore tiles with battens	63 (kg/m^2)

[Note : 1 kg/m^3 ≈ 10 N/m^3

A.1 Dead Loads

Material	Weight (pcf)
Steel	490
Aluminum	171
Reinforced concrete: normal weight	150
lightweight	90–120
Marble	170
Granite	165
Earth, wet loose sand and gravel	125
Brick	120
Water	62.4
Snow: fresh	6
packed	12
wet	50
Lumber	35

مثال على الأحمال الميتة :

- The floor beam in Fig. 1–8 is used to support the 6-ft width of a lightweight plain concrete slab having a thickness of 4 in. The slab serves as a portion of the ceiling for the floor below, and therefore its bottom is coated with plaster. Furthermore, an 8-ft-high, 12-in.-thick lightweight solid concrete block wall is directly over the top flange of the beam. Determine the loading on the beam measured per foot of length of the beam.

- ***SOLUTION:***

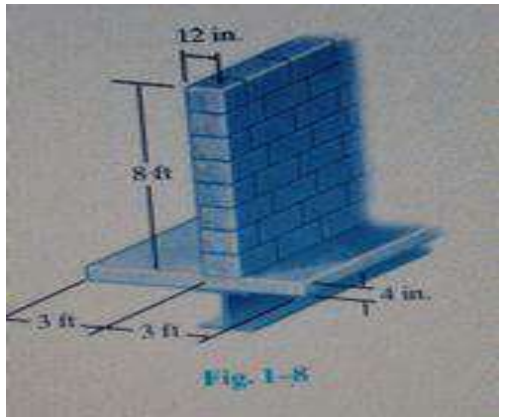


Fig. 1–8

- Using the data in Tables 1–2 and 1–3, we have
- Concrete slab: (8Ib)(4in)(6ft)=192
- Plaster ceiling:(5)(6ft)=30
- Block wall (105)(8)(1)=840/1062=1.06k/ft
- Here the unit k stands for “kip,” which symbolizes kilopounds. Hence,
- 1 k = 1000 lb

Live Loads:

- الأحمال الحية هي متغيرة في الموقع وفي القيمة ولكل مبنى له قيمة معينة مثال عليها الطاولة

TABLE 1–4 Minimum Live Loads*

Occupancy or Use	Live Load psf	Live Load kN/m²	Occupancy or Use	Live Load psf	Live Load kN/m²
Assembly areas and theaters			Residential		
Fixed seats	60	2.87	Dwellings (one- and two-family)	40	1.92
Movable seats	100	4.79	Hotels and multifamily houses		
Garages (passenger cars only)	50	2.40	Private rooms and corridors	40	1.92
Office buildings			Public rooms and corridors	100	4.79
Lobbies	100	4.79	Schools		
Offices	50	2.40	Classrooms	40	1.92
Storage warehouse			Corridors above first floor	80	3.83
Light	125	6.00			
Heavy	250	11.97			

*Reproduced with permission from *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7-10.

Live load reduction:

- For some types of buildings having very large floor areas, many codes will allow a reduction in the uniform live load for a floor, since it is unlikely that the prescribed live load will occur simultaneously throughout the entire structure at any one time. For example, ASCE 7-10 allows a reduction of live load on a member having an influence area (KLL AT2):

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL} A_T}}\right) \quad \text{(FPS units)}$$

$$L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL} A_T}}\right) \quad \text{(SI units)}$$

where

L = reduced design live load per square foot or square meter of area supported by the member.

L_o = unreduced design live load per square foot or square meter of area supported by the member (see Table 1–4).

K_{LL} = live load element factor. For interior columns $K_{LL} = 4$.

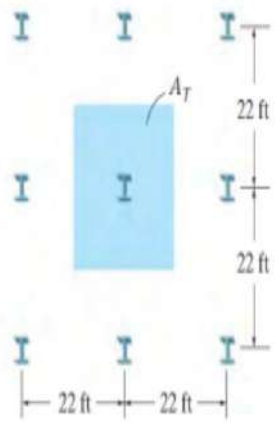
A_T = tributary area in square feet or square meters.*

The reduced live load defined by Eq. 1–1 is limited to not less than 50% of L_o for members supporting one floor, or not less than 40% of L_o for members supporting more than one floor. No reduction is allowed for loads exceeding 100 lb/ft^2 (4.79 kN/m^2), or for structures used for public assembly, garages, or roofs. Example 1–2 illustrates Eq. 1–1's application.

سيتم وضع أكثر من مثال على الأحمال الحية لترسيخ الفكرة:

- A two-story office building shown in the photo has interior columns that are spaced 22 ft apart in two perpendicular directions. If the (flat) roof loading is determine the reduced live load supported by a typical interior column located at ground level:

- ***SOLUTION:***



As shown in Fig. 1–9, each interior column has a tributary area or effective loaded area of $A_T = (22\text{ ft})(22\text{ ft}) = 484\text{ ft}^2$. A ground-floor column therefore supports a roof live load of

$$F_R = (20\text{ lb/ft}^2)(484\text{ ft}^2) = 9680\text{ lb} = 9.68\text{ k}$$

This load cannot be reduced, since it is not a floor load. For the second floor, the live load is taken from Table 1–4: $L_o = 50\text{ lb/ft}^2$. Since $K_{LL} = 4$, then $4A_T = 4(484\text{ ft}^2) = 1936\text{ ft}^2$ and $1936\text{ ft}^2 > 400\text{ ft}^2$, the live load can be reduced using Eq. 1–1. Thus,

$$L = 50\left(0.25 + \frac{15}{\sqrt{1936}}\right) = 29.55\text{ lb/ft}^2$$

The load reduction here is $(29.55/50)100\% = 59.1\% > 50\%$. O.K. Therefore,

$$F_F = (29.55\text{ lb/ft}^2)(484\text{ ft}^2) = 14\,300\text{ lb} = 14.3\text{ k}$$

The total live load supported by the ground-floor column is thus

$$F = F_R + F_F = 9.68\text{ k} + 14.3\text{ k} = 24.0\text{ k} \quad \textit{Ans.}$$

مثال آخر لتمكين الموضوع:

- The unheated storage facility shown in Fig. 1–14 is located on flat open terrain in southern Illinois, where the specified ground snow load is Determine the design snow load on the roof which has a slope of 4%.

Fig. 1–14

SOLUTION:

Since the roof slope is $< 5\%$, we will use Eq. 1–5. Here, $C_e = 0.8$ due to the open area, $C_t = 1.2$ and $I_s = 0.8$. Thus,

$$p_f = 0.7C_eC_tI_sp_g$$
$$= 0.7(0.8)(1.2)(0.8)(15\ \text{lb/ft}^2) = 8.06\ \text{lb/ft}^2$$

Since $p_g = 15\ \text{lb/ft}^2 < 20\ \text{lb/ft}^2$, then also

$$p_f = Ip_g = 1.2(15\ \text{lb/ft}^2) = 18\ \text{lb/ft}^2$$

By comparison, choose

$$p_f = 18\ \text{lb/ft}^2 \qquad \textit{Ans.}$$

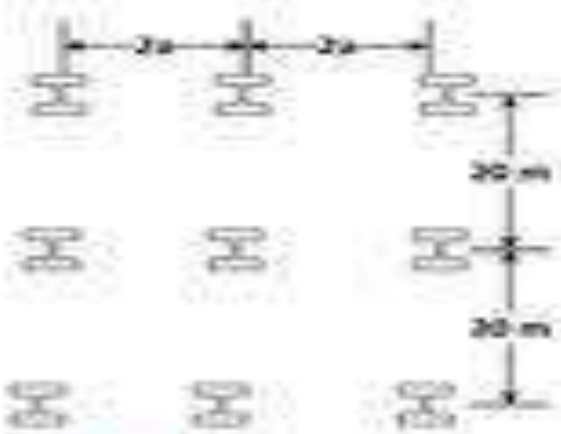
Structural design:

- ***1)Allowable stress:***
- هي الأكثر تكلفة والأكثر أمان
- **Normally strength / factor of safty**
- ***2)ultimate strength:***
- هي أقل كلفة وأقل أمان والأكثر طلب وهي تزيد الأحمال وتقلل المقاومة
- ----------

- ***ملاحظة:التربة الغير صالحة تؤدى الى تشقق الخرسانة***
- ***ملاحظة:الخرسانة بتكسر على زاوية 45***

سؤال سنوات(الفصل الثانى 2020/2021):

The drawings below are the plan and the elevation for a part of a school classrooms. Determine the total reduced live load supported by a typical interior column which is located at the ground level.

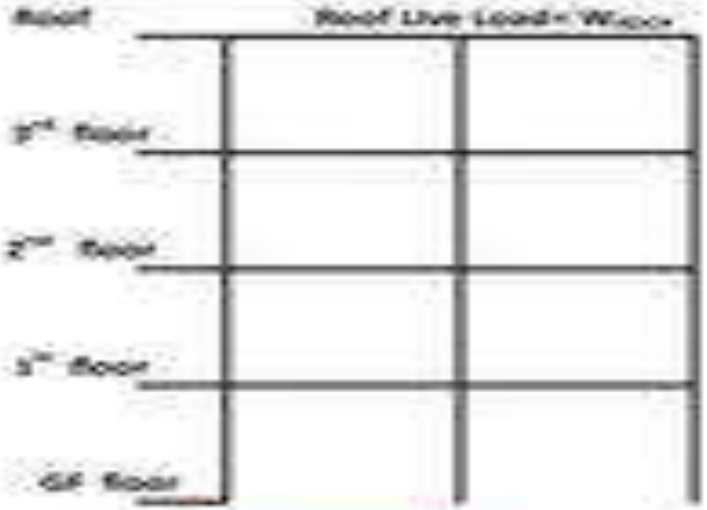


(Select a in (m) to be the last digit of your student ID)

Example (for a):
Student ID: 123456]

Last digit

Note: If your student ID ends with 0, use 2



(Select W in kN/m² to be the last two digits of your student ID)

Example (for W=):
Student ID: 123456]

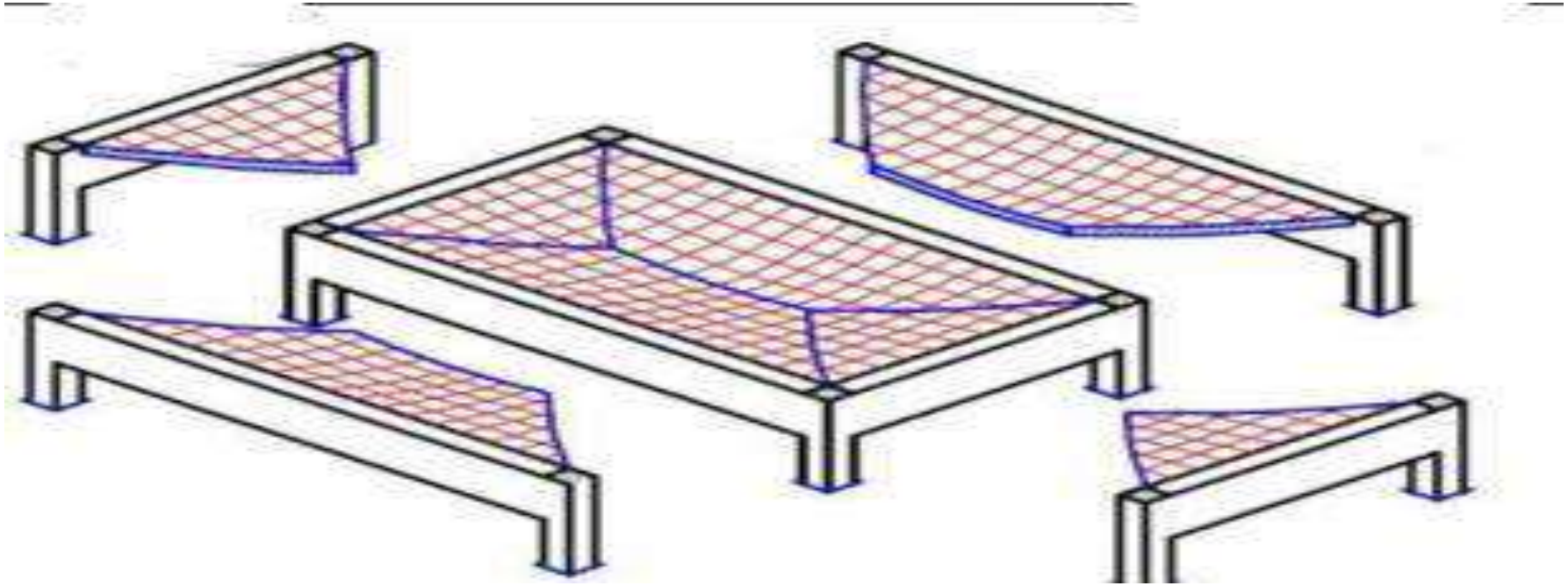
Last two digits

Note: If your student ID ends with 00, use 15

بعد إنهاء الشابتر الأول عليكم بحل أسئلة الكتاب والواجبات التى يطرحها مدرس المساق لتمكين الأفكار

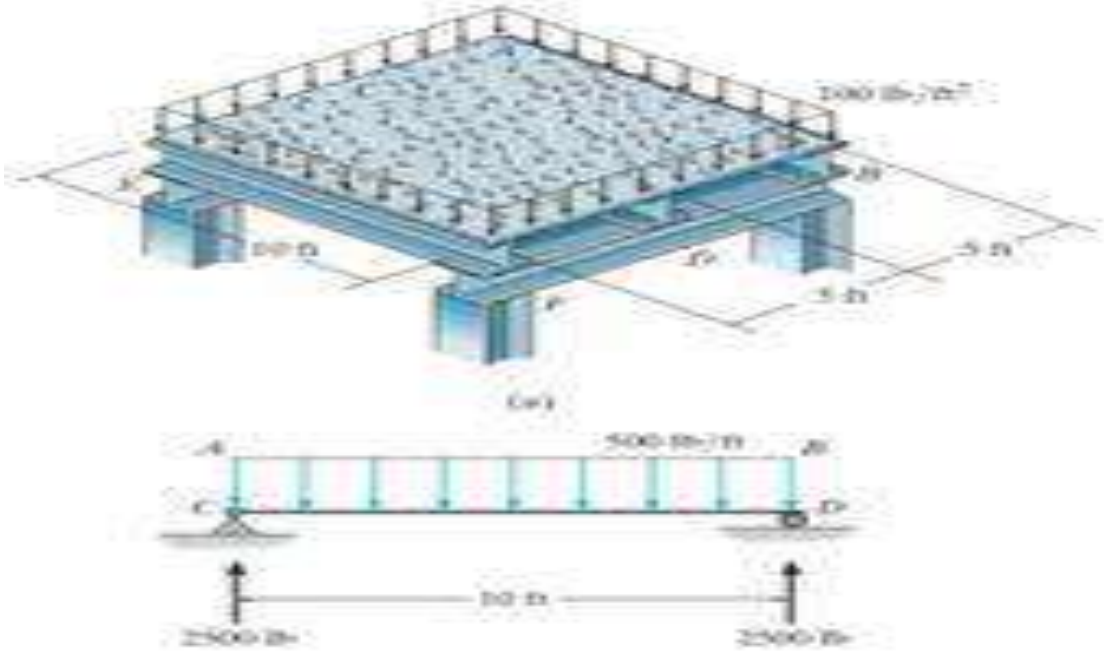
Chapter(2):Analysis of Statically Determinate Structures

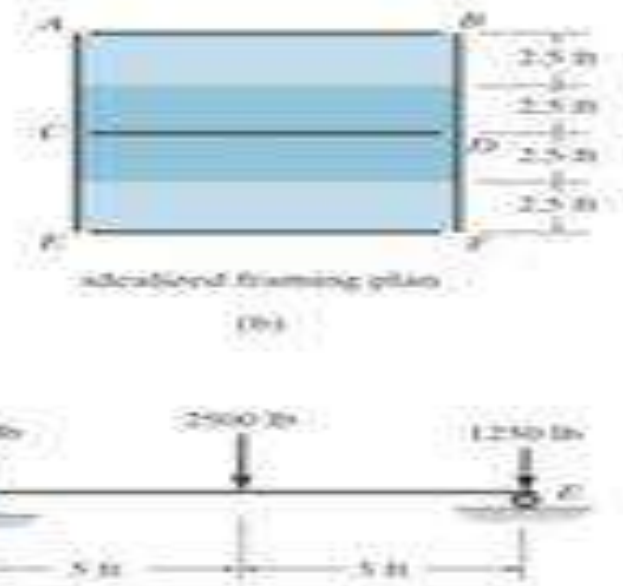
سنتعرف في هذا الشابتر على كيفية توزيع الأحمال وكيفية وحساب ردود الفعل (الرياكشن).



في البداية سنتعرف على كيفية توزيع الأحمال:

- ***One-Way System***. A slab or deck that is supported such that it delivers
- its load to the supporting members by ***one-way*** action, is often referred to as a ***one way slab***





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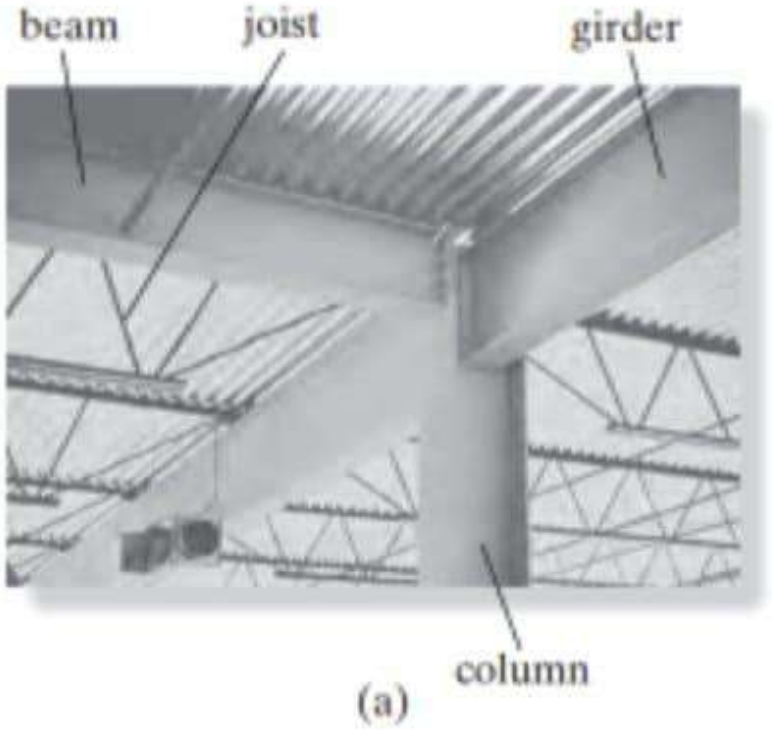
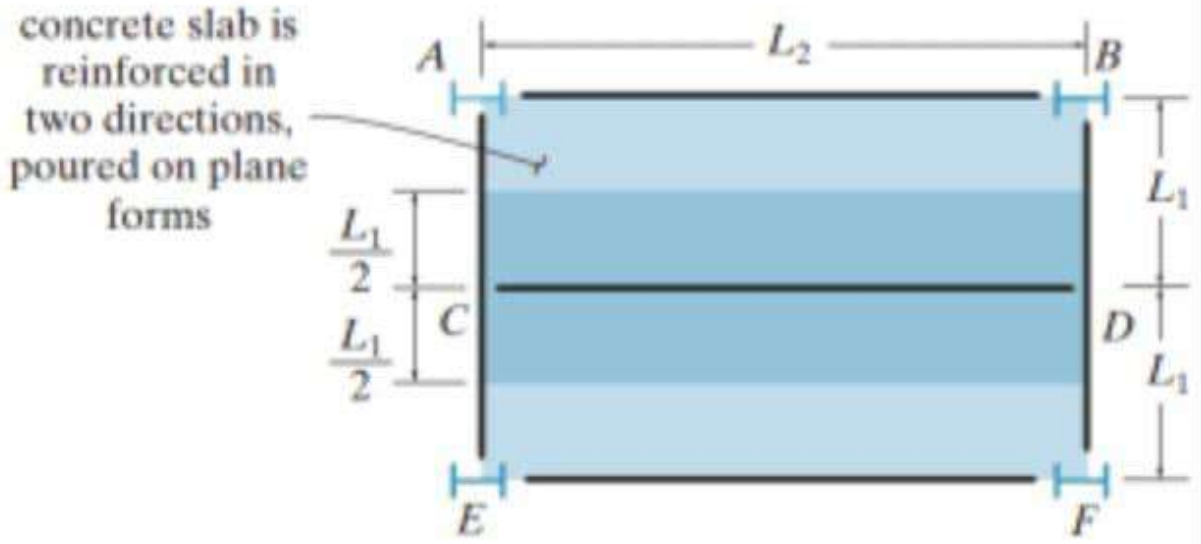
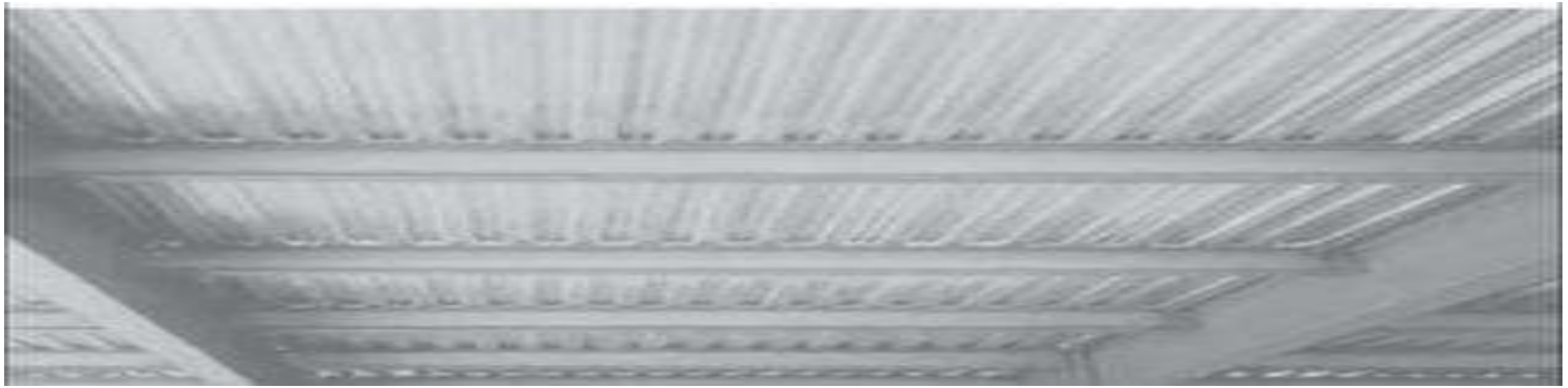


(a)



idealized framing plan for one-way slab action requires $L_2/L_1 > 2$

(b)



An example of one-way slab construction of a steel frame
building having a poured concrete floor on a corrugated
metal deck. The load on the floor is considered to be
transmitted to the beams, not the girders

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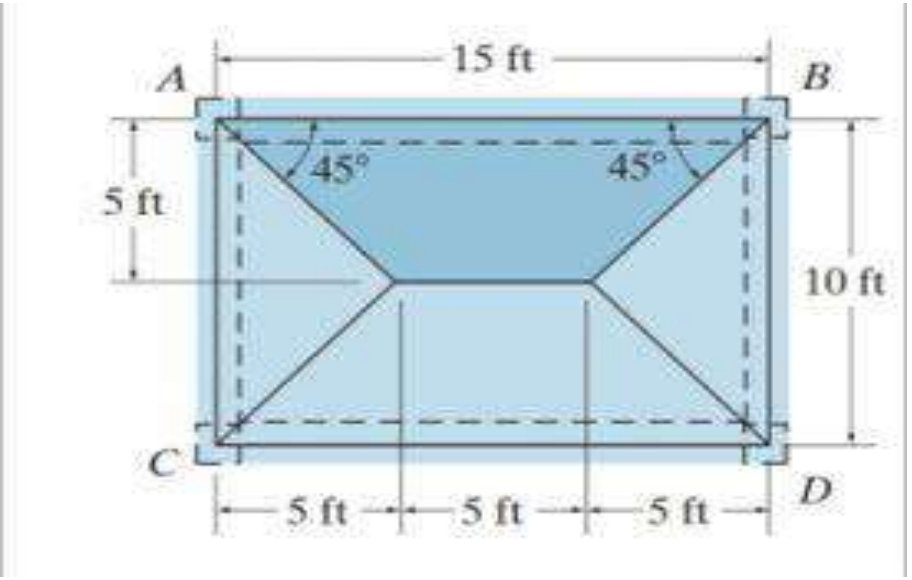
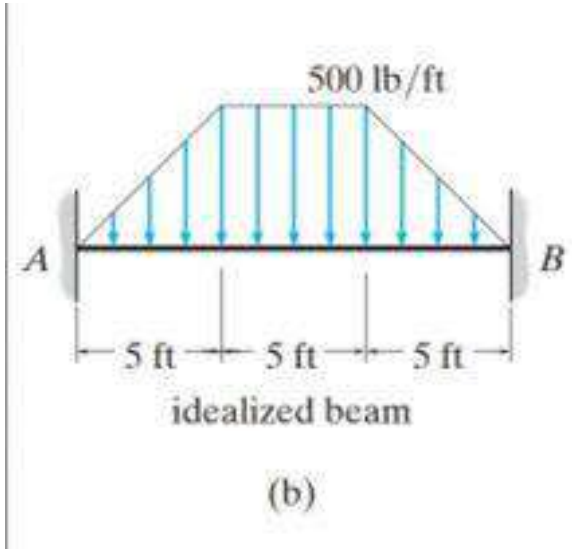
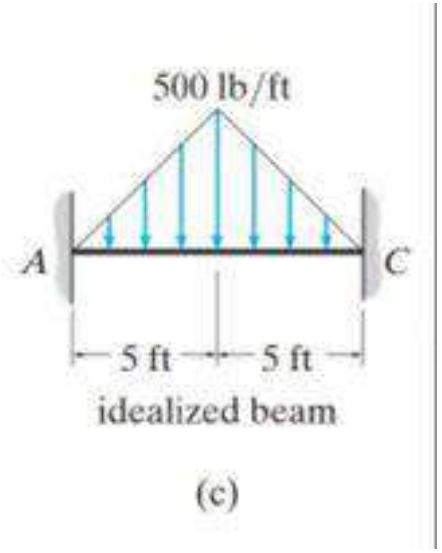
- ***Two-Way System***. If, according to the ACI 318 concrete code the
- support ratio in Fig. 2–12b is**(L2/L1)<2 &(L2/L1)=2**
- the load is assumed to be
- delivered to the supporting beams and girders in two directions. When
- this is the case the slab is referred to as a ***two-way slab***.







سيتم طرح أكثر من مثال على هذا الموضوع لترسيخ الفكرة.

- **Example**:The floor of a classroom is to be supported by the bar joists shown in Fig. 2–15a. Each joist is 15 ft long and they are spaced 2.5 ft on centers. The floor itself is to be made from lightweight concrete that is 4 in thick. Neglect the weight of the joists and the corrugated metal deck, and determine the load that acts along each joist.

SOLUTION:

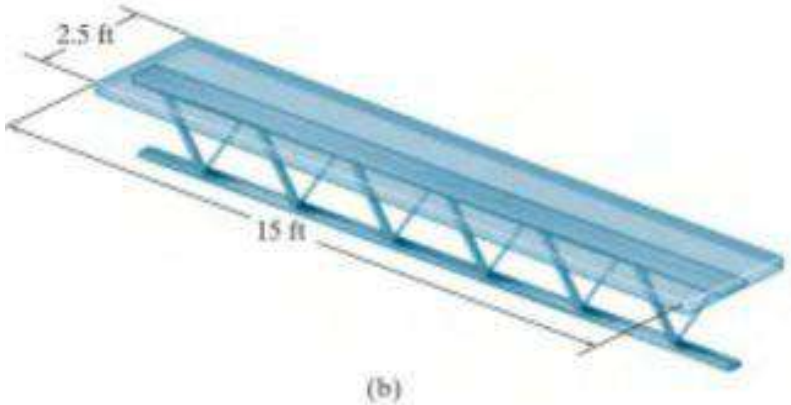
Lighweight concrete it is (4)(8)=32

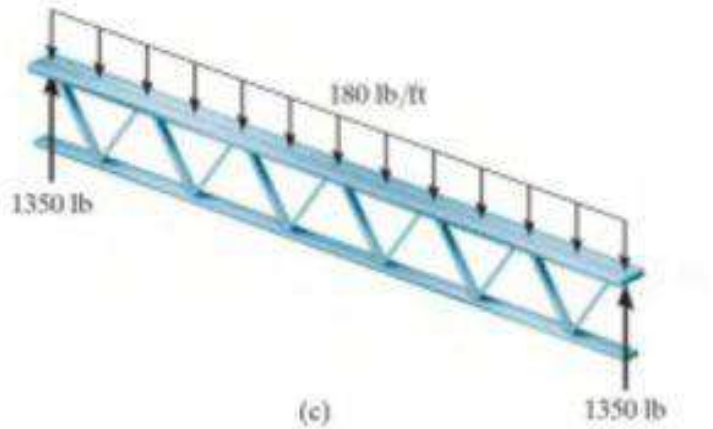
Live load for a classroom is 40

Total :32+40=72

L1=2.5 L2=15 L2/L1>2

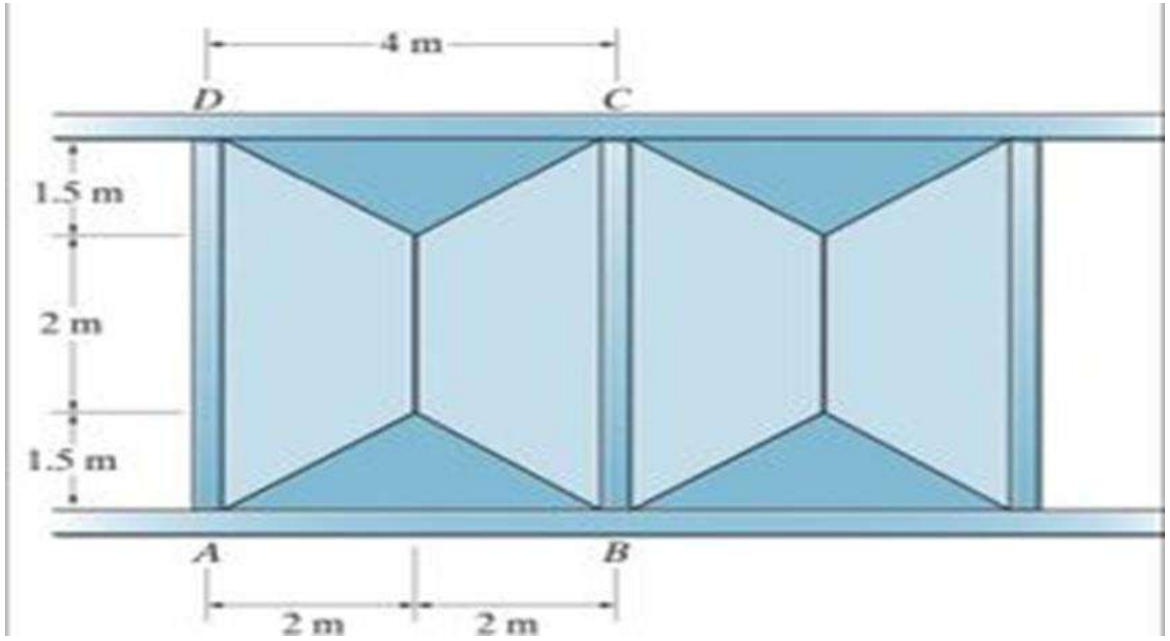
W=72ib/(2.5)ft=180





Example:

- ***The flat roof of the steel-frame building shown in the photo is intended to support a total load of over its surface. Determine the roof load within region ABCD that is transmitted to beam BC:***



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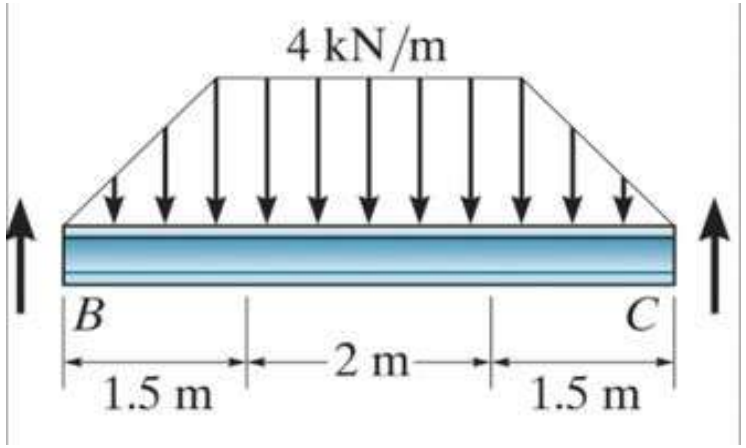
- ***SOLUTION:***
- ***L2=5 L1=4 L2/L1=1.25<2***
- *We have tow way slab action*
- , where the lighter shaded trapezoidal area of
- loading is transmitted to member BC.The peak intensity of this loading ***Is (2)(2)=4kN/m*** As a result, the distribution of load
- along BC is shown in Fig. 2–16b.



Determinacy and stability:

- **R=3n ,statically determinate**
- **R>3n ,statically indeterminate**

- ***تمثل الرياكشن:R***

تمثل عدد الممبر الموجودة بالسؤال:N

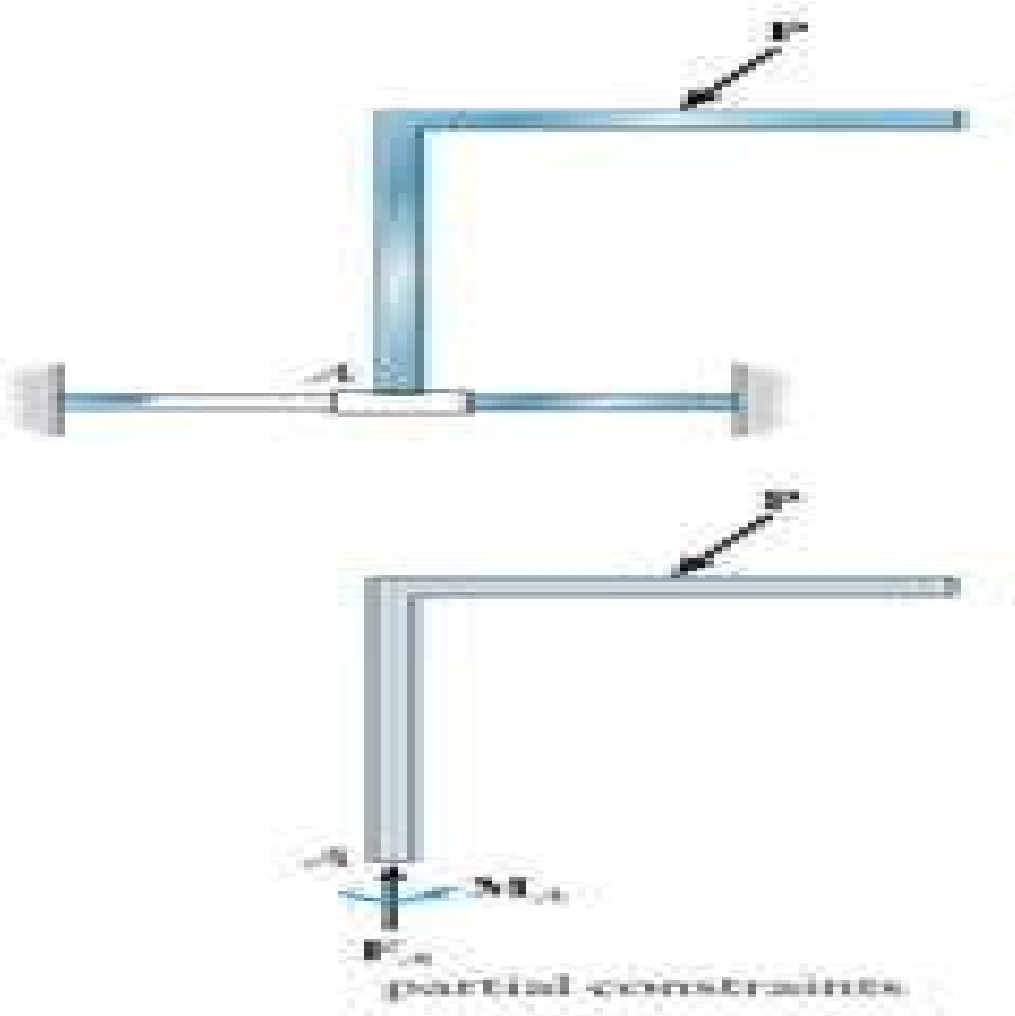
Determinacy: The equilibrium equations provide both the necessary

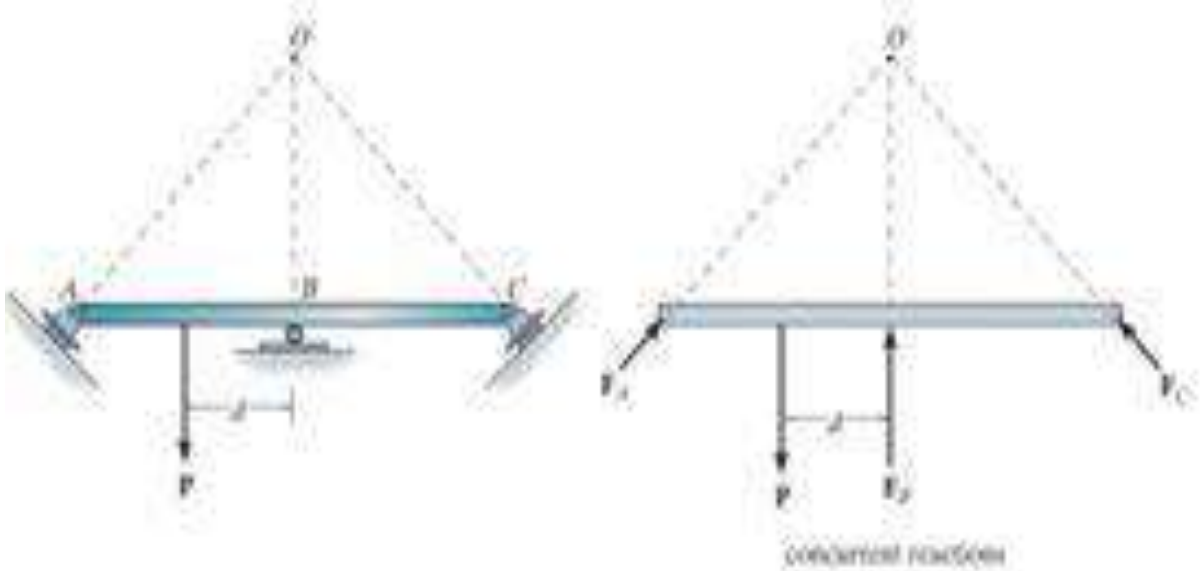
and sufficient conditions for equilibrium

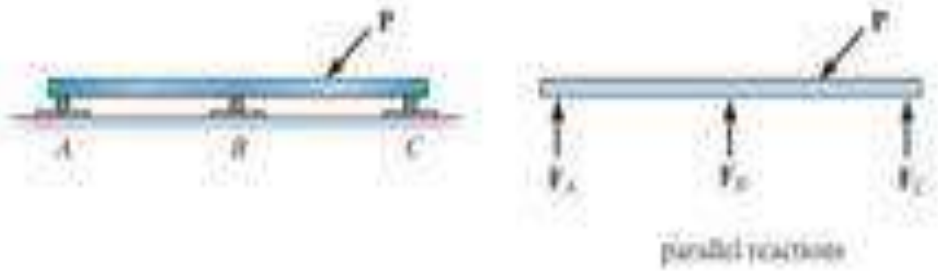
Stability:

- ***To ensure the equilibrium of a structure or its members, it is not only necessary to satisfy the equations of equilibrium, but the members must also be properly held or constrained by their supports. Two situations may occur where the conditions for proper constraint have not been met***
- ***Partial Constraints:*** In some cases a structure or one of its members may have fewer reactive forces than equations of equilibrium that must be satisfied. The structure then becomes only partially constrained. For example, consider the member shown in Fig. 2–22 with its corresponding free-body diagram. Here the equation will not be satisfied for the loading conditions and therefore the member will be unstable
- ***Improper Constraints:***. In some cases there may be as many unknown forces as there are equations of equilibrium; however, instability or movement of a structure or its members can develop because of improper constraining by the supports. This can occur if all the support reactions are concurrent at a point. An example of this is shown in Fig. 2–23. From the free-body diagram of the beam it is seen that the summation of moments about point O will not be equal to zero thus rotation about point O will take place. Another way in which improper constraining leads to instability occurs when the reactive forces are all parallel. An example of this case is shown in Fig. 2–24. Here when an inclined force P is applied, the summation of forces in the horizontal direction will not equal zero.

تمثل الصور تلخيص لشرح السلايد السابق:





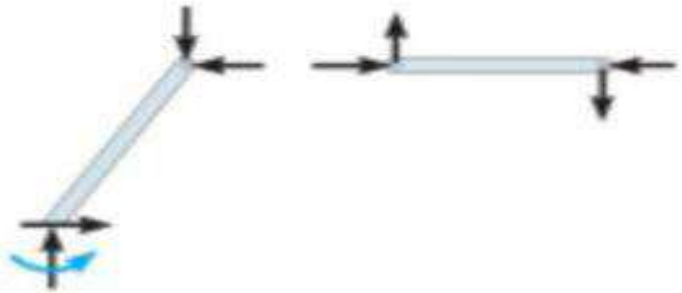


سيتم طرح العديد من الأمثلة لتمكين الموضوع:

(a)

$r = 7, n = 2, 7 > 6$

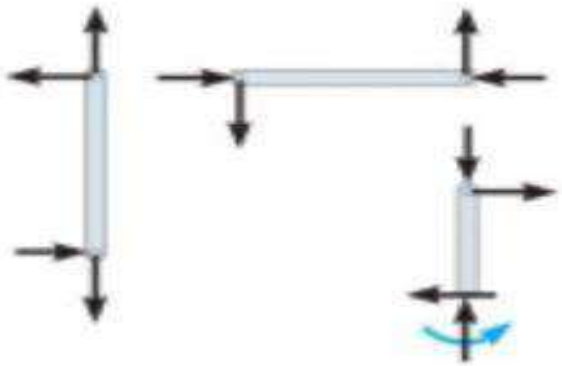
Statically indeterminate to the first degree *Ans.*



(b)

$r = 9, n = 3, 9 = 9,$

Statically determinate *Ans.*



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(c)

$r = 10, n = 2, 10 > 6,$
Statically indeterminate to the fourth degree *Ans.*

(This frame has no closed loops.)

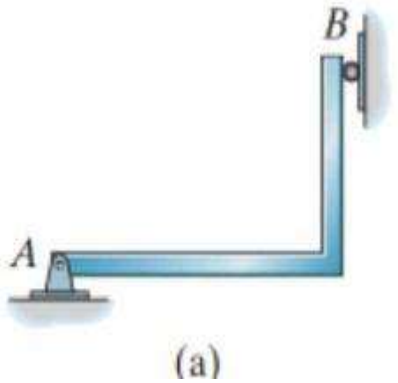
$r = 18, n = 3, 18 > 9,$
Statically indeterminate to the ninth degree *Ans.*

(c)

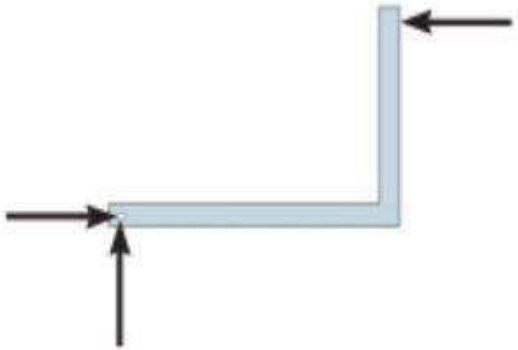
$r = 16, n = 4, 16 > 12,$
Statically indeterminate to the sixth degree *Ans.*

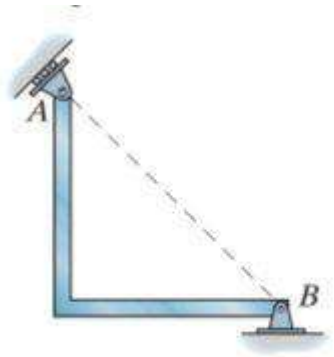
$r < 3n$ *unstable*

$r > 3n / r = 3n$ *unstable if member reactions are concurrent or parallel or some of the components form a collapsible mechanism*

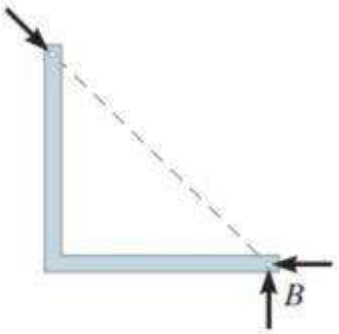


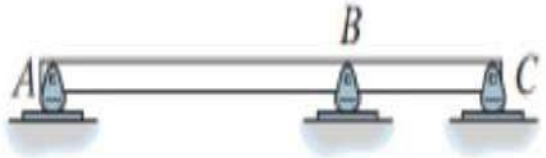
(a)





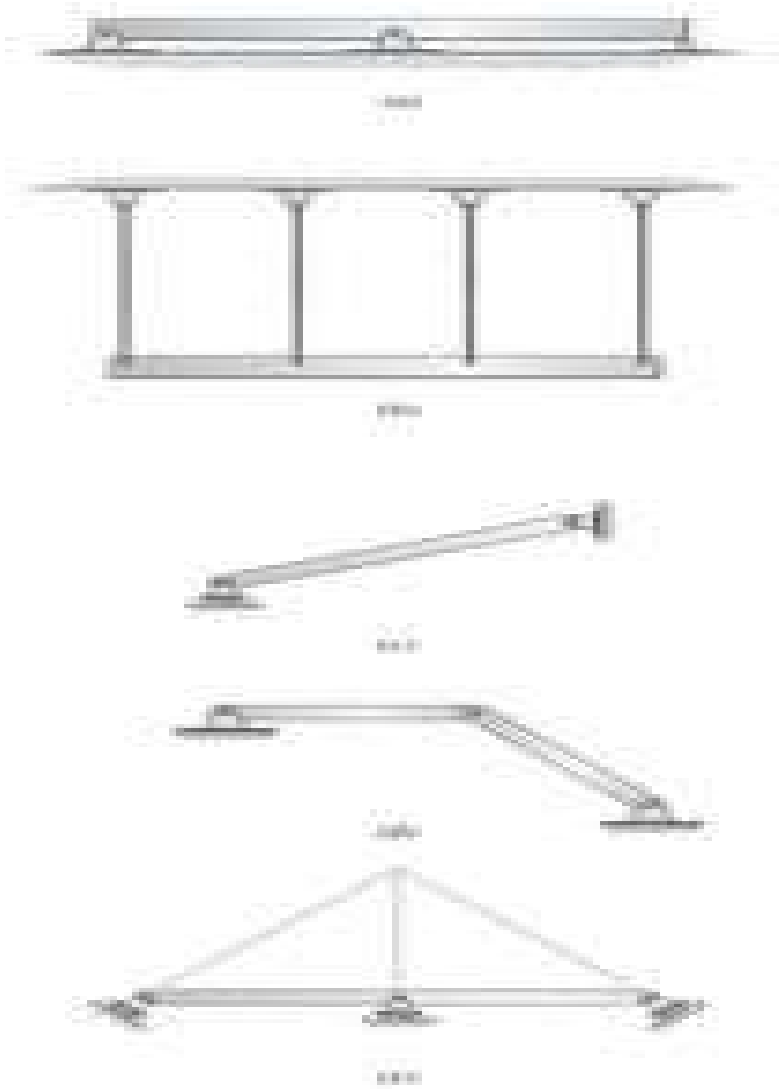
(b)

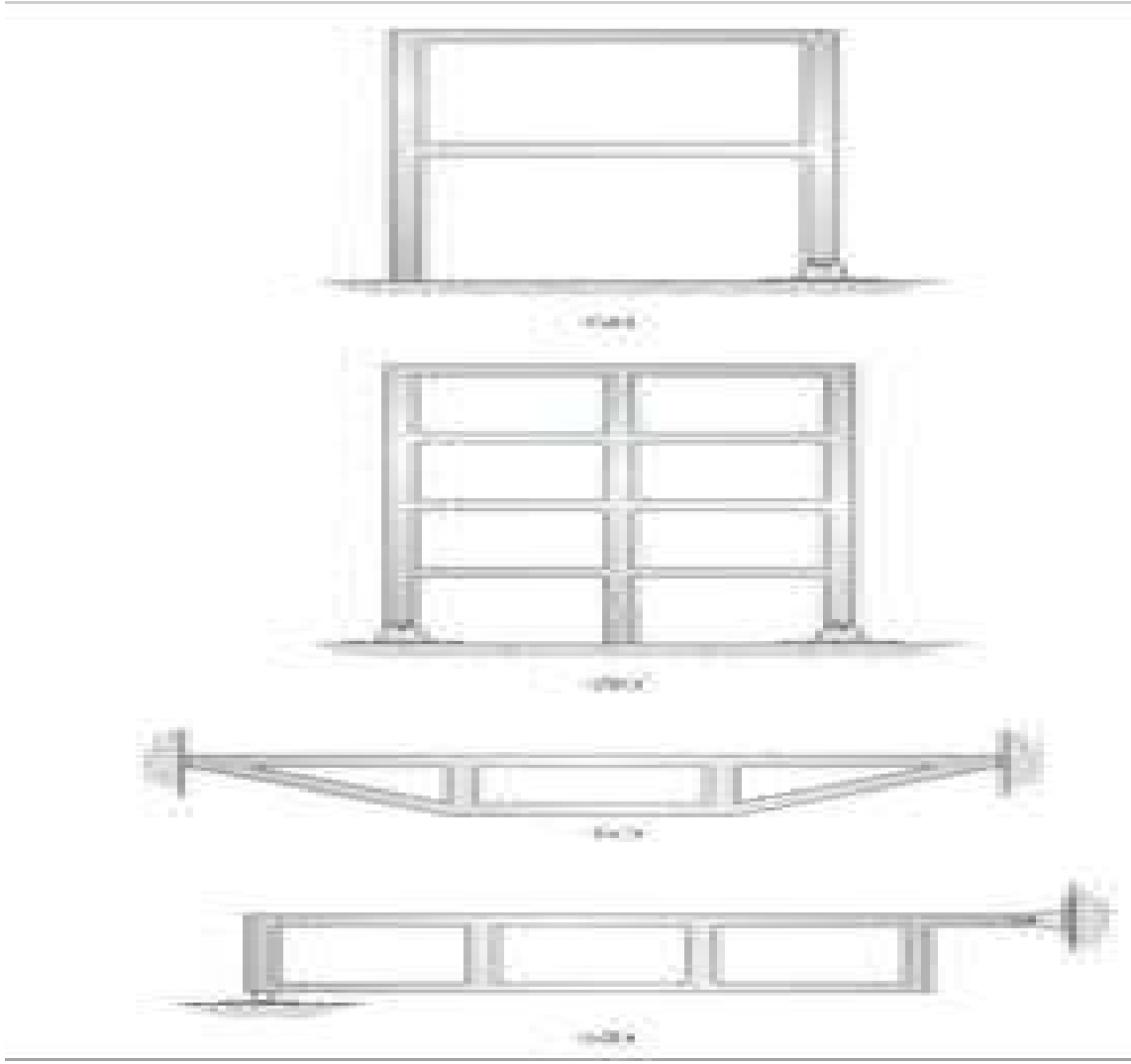




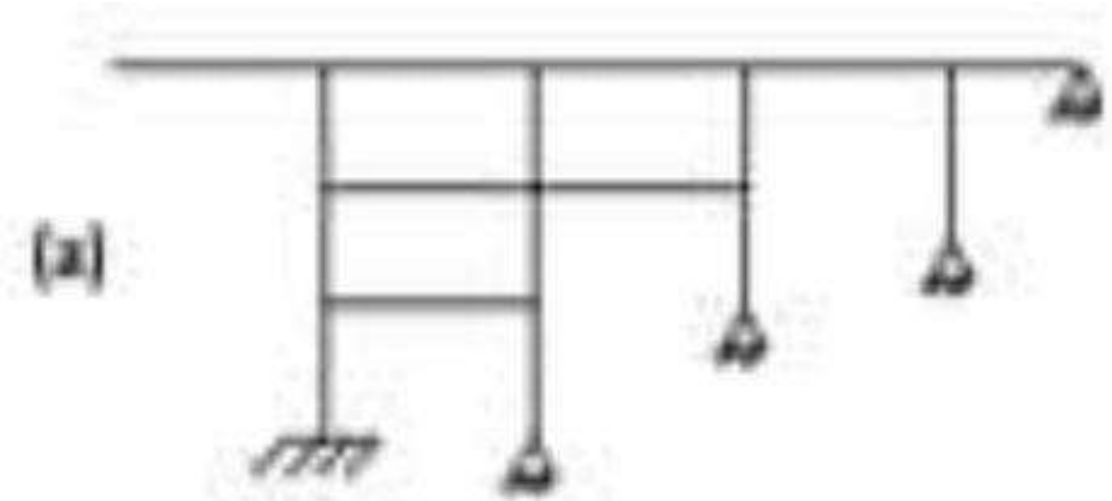
(c)

عليك حل هذه الأسئلة لتزيد مهارتك فى هذا الموضوع:





سؤال سنوات :



Civilittee
اللجنة الأكاديمية لقسم الهندسة المدنية

الآن سنتعلم في الجزئية الأخيرة في هذا الشابتر كيفية حساب ***الرياكشن*** وهي ***الأهم*** على الإطلاق في هذا المساق

معادلات الإتزان:

$$\circledcirc MO = 0$$

$$\circledcirc Fy = 0$$

$$\circledcirc Fx = 0$$

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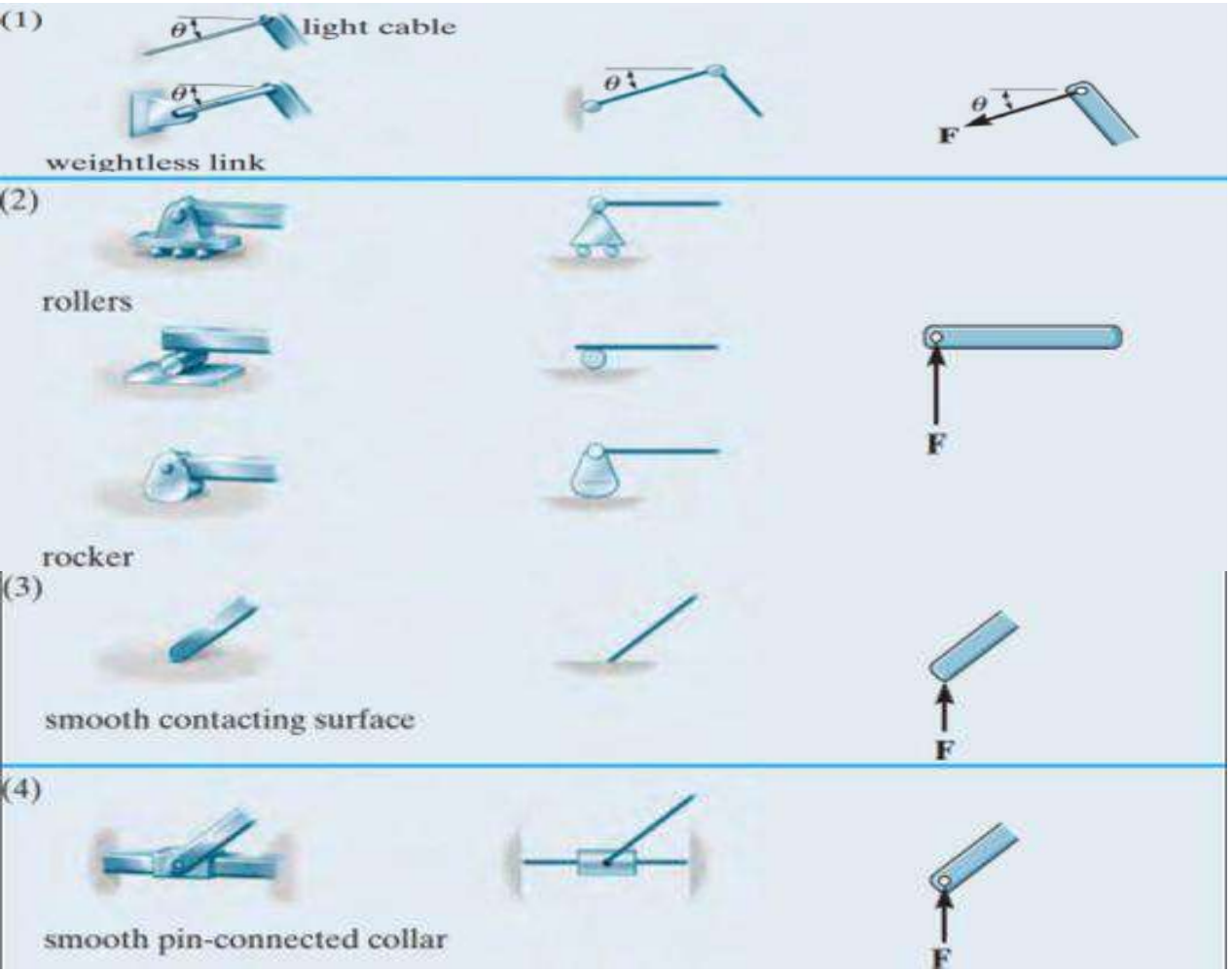
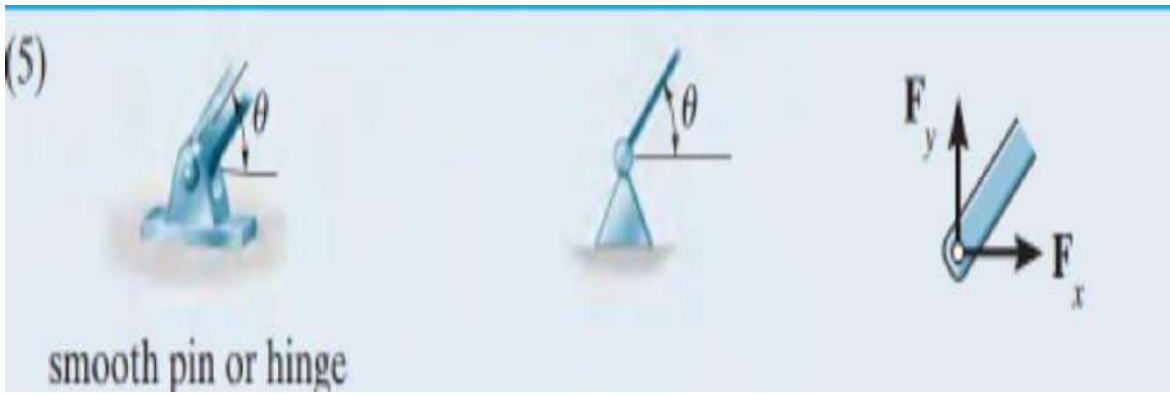
اللجنة الأكاديمية لقسم الهندسة المدنية

يعتبر من أهم الجداول لإيجاد الرياشكن

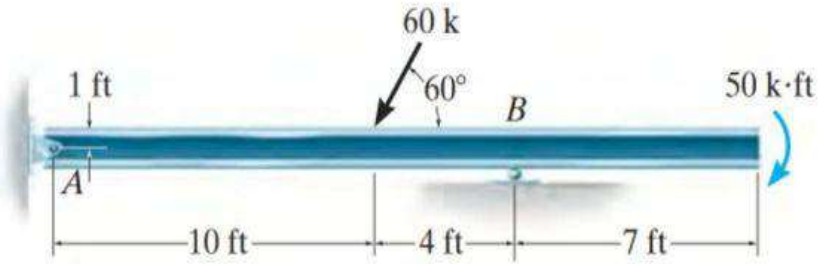




سيتم عرض الأمثلة بالتسلسل من الأسهل الى الأصعب

(فكرة1)

- Determine the reactions on the beam?
- عند وجود أي زاوية نعمل على تحليلها ونطبق معادلات الإتزان



SOLUTION:

©Fx = 0 نعتبر جهة اليمين موجبة

Ax-60cos60=0

Ax=30.0K

©MA = 0 نعتبر عكس عقارب الساعة موجب

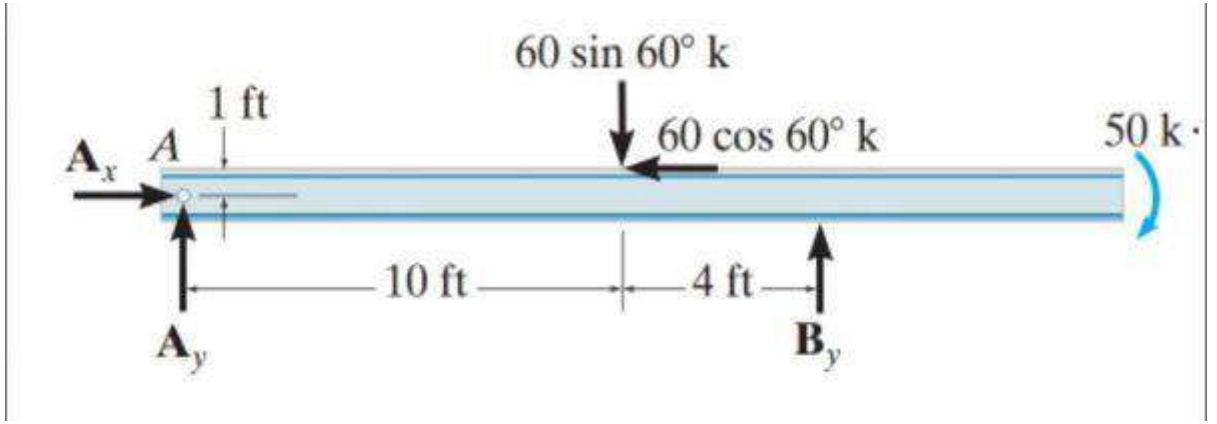
-60 sin 60°(10) + 60 cos 60°(1) + By(14) - 50 = 0

By = 38.5 k

©Fy = 0 نعتبر الأعلى موجب

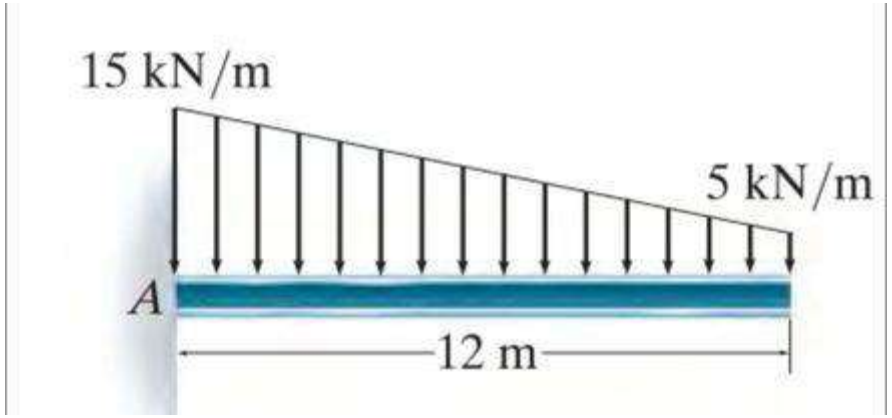
-60sin60+38.5+Ay=0

Ay=13.4K



(فكرة2)

- Determine the reactions on the beam?



SOLUTION:

©Fx = 0 نعتبر جهة اليمين موجبة

Ax=0

©Fy = 0 نعتبر الأعلى موجب

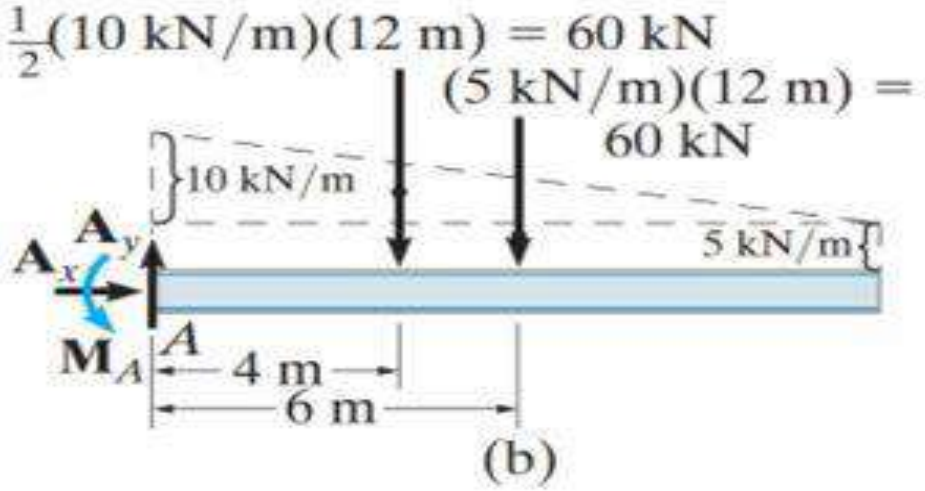
Ay - 60 - 60 = 0

Ay = 120 kN

©MA = 0 نعتبر عكس عقارب الساعة موجب

-60(4) – 60(6) + MA = 0

MA = 600 kN



(فكرة 3)

- Determine the reactions on the beam in Fig. 2–30a. Assume A is a pin and the support at B is a roller (smooth surface)?
- **SOLUTION:**

©MA = 0 نعتبر عكس عقارب الساعة موجب

-3500(3.5)+(4/5)NB(4)+(3/5)NB(10)=0

NB=1331.5ib=1.33K

©Fx = 0 نعتبر جهة اليمين موجبة

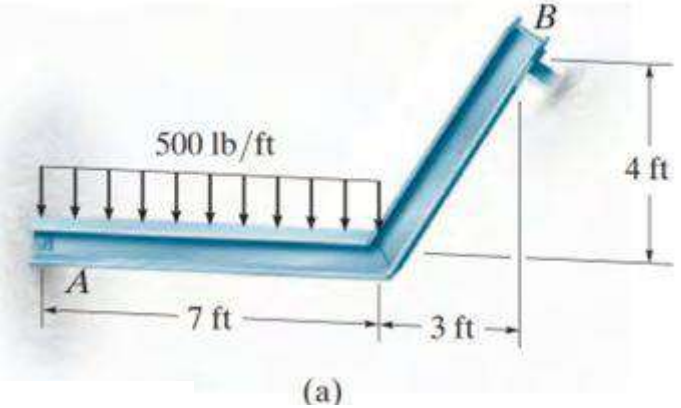
Ax-(4/5)(1331.5)=0

Ax=1.07K

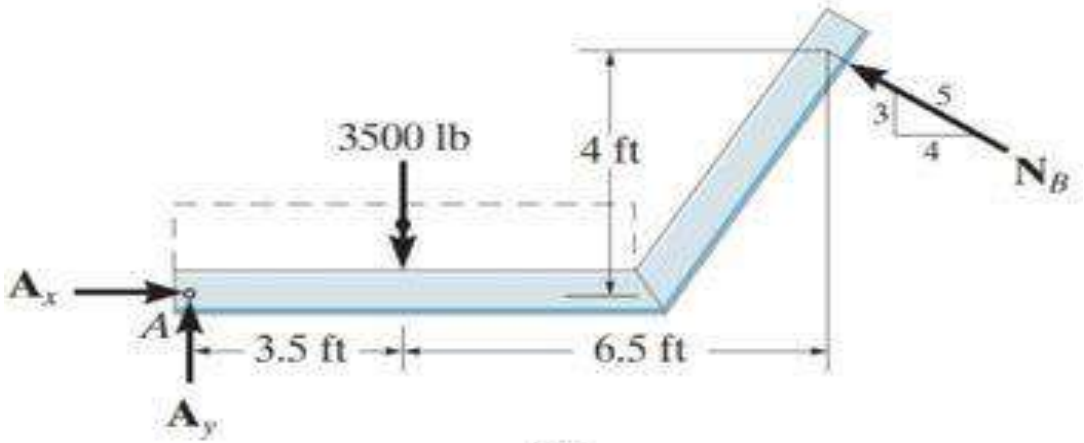
©Fy = 0 نعتبر الأعلى موجب

Ay-3500+(3/5)(1331.5)=0

Ay=2.70K



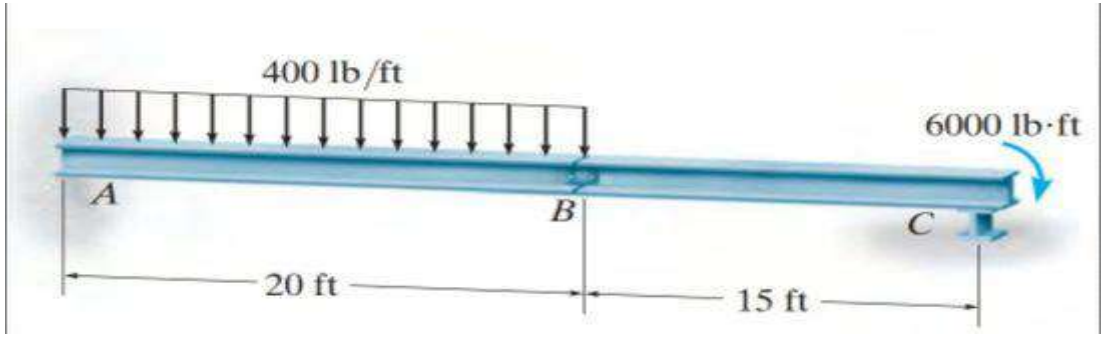
(a)



(b)

(فكرة 4)

- The compound beam in Fig. 2–31a is fixed at A. Determine the reactions at A, B, and C. Assume that the connection at B is a pin and C is a roller?
- **الفكرة في هذا السؤال نجزء الشكل الى قسمين**
- **SOLUTION:**



Segment BC:

$\circlearrowleft + \Sigma M_C = 0;$ $\quad -6000 + B_y(15) = 0$ $\quad B_y = 400\ \text{lb}$

$+\uparrow \Sigma F_y = 0;$ $\quad -400 + C_y = 0$ $\quad C_y = 400\ \text{lb}$

$\pm \rightarrow \Sigma F_x = 0;$ $\quad B_x = 0$

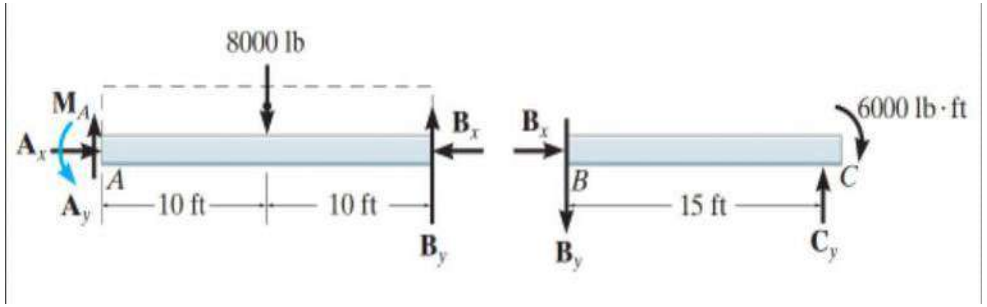
Segment AB:

$\circlearrowleft + \Sigma M_A = 0;$ $\quad M_A - 8000(10) + 400(20) = 0$

$M_A = 72.0\ \text{k} \cdot \text{ft}$

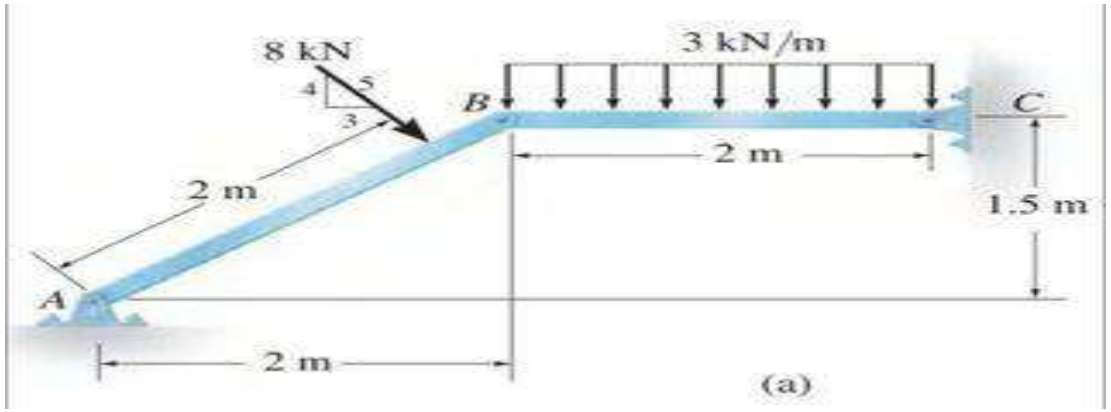
$+\uparrow \Sigma F_y = 0;$ $\quad A_y - 8000 + 400 = 0$ $\quad A_y = 7.60\ \text{k}$

$\pm \rightarrow \Sigma F_x = 0;$ $\quad A_x - 0 = 0$ $\quad A_x = 0$



(فكرة 5)

- Determine the horizontal and vertical components of reaction at the pins A, B, and C of the two-member frame shown in Fig. 2–32a?
- ***SOLUTION:***



Member BC:

$\circlearrowleft +\Sigma M_C = 0;\quad -B_y(2) + 6(1) = 0 \qquad B_y = 3\,\text{kN}$

Member AB:

$\circlearrowleft +\Sigma M_A = 0;\quad -8(2) - 3(2) + B_x(1.5) = 0 \qquad B_x = 14.7\,\text{kN}$

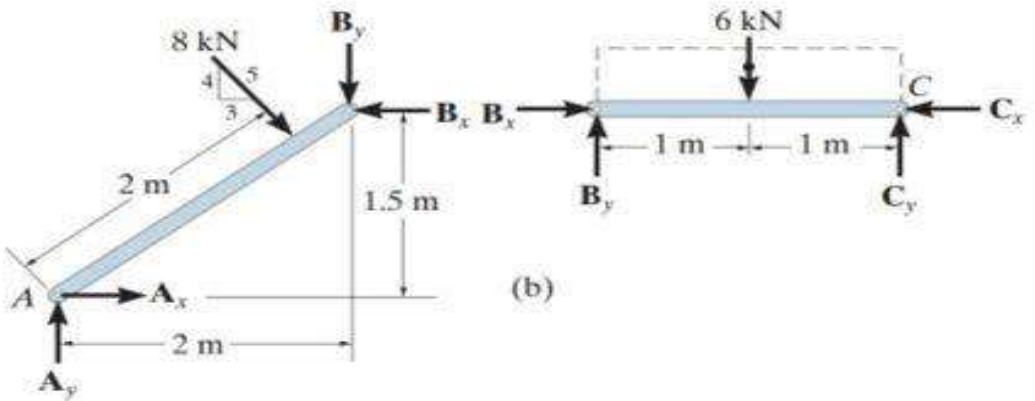
$\pm\rightarrow \Sigma F_x = 0;\quad A_x + \frac{3}{5}(8) - 14.7 = 0 \qquad A_x = 9.87\,\text{kN}$

$+\uparrow \Sigma F_y = 0;\quad A_y - \frac{4}{5}(8) - 3 = 0 \qquad A_y = 9.40\,\text{kN}$

Member BC:

$\pm\rightarrow \Sigma F_x = 0;\quad 14.7 - C_x = 0 \qquad C_x = 14.7\,\text{kN}$

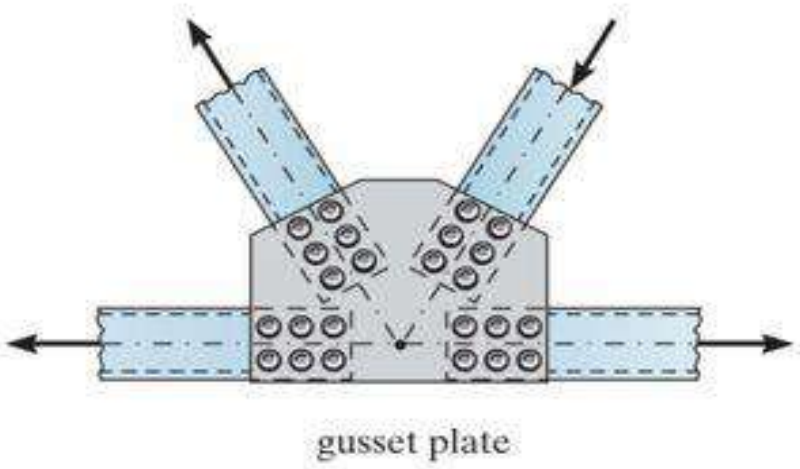
$+\uparrow \Sigma F_y = 0;\quad 3 - 6 + C_y = 0 \qquad C_y = 3\,\text{kN}$

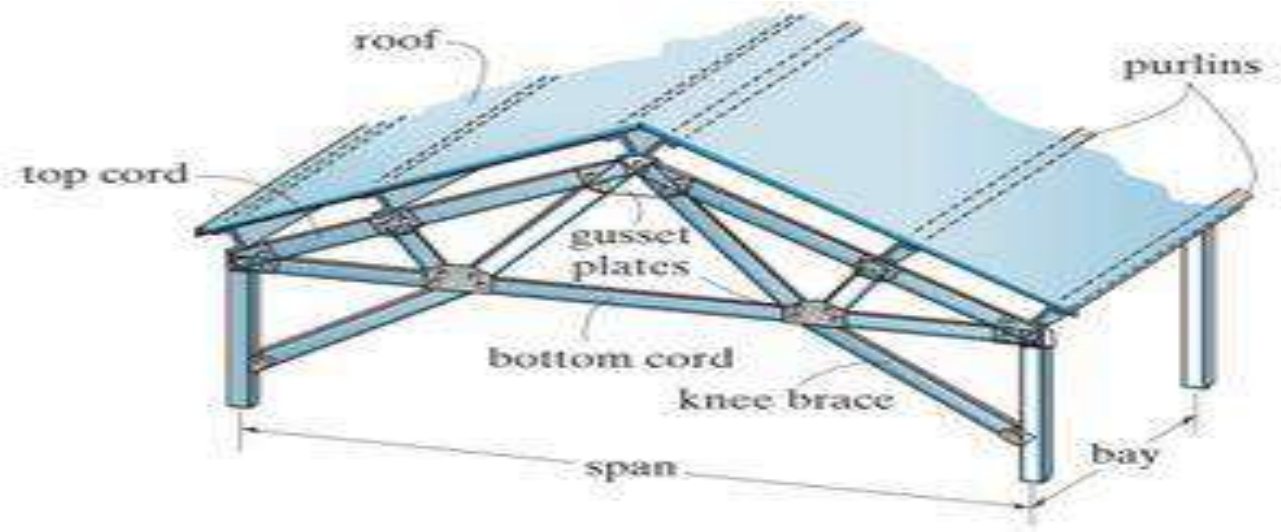


بعد إنهاء الشابتر الثاني عليكم بحل أسئلة الكتاب
والواجبات التي يطرحها مدرس المساق لتمكين الأفكار.

Chapter(3):Analysis of statically determinate trusses

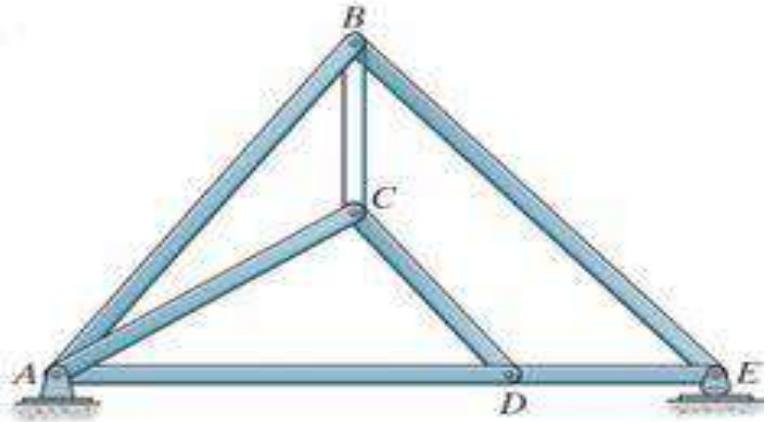
- ***Common types of trusses:***
- ***Roof Trusses:*** Roof trusses are often used as part of an industrial building frame.
- ***Bridge Trusses*** : The main structural elements of a typical bridge truss



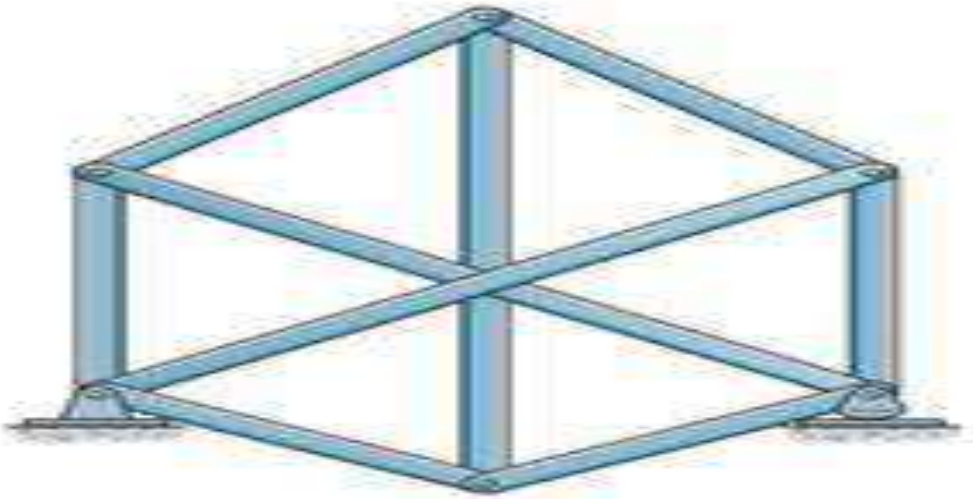


Classification of coplanar trusses:

- ***1)Simple Truss:*** *في الغالب يكون شكله مثلث لأن المثلث اكثر استقرار والباقي من الشكل يكون إضافات*
- ***2)Compound Truss:*** *على شكل اكثر من مثلث يكون*
- ***3)Complex Truss:*** a complex truss is one that cannot be classified as being either simple or compound.



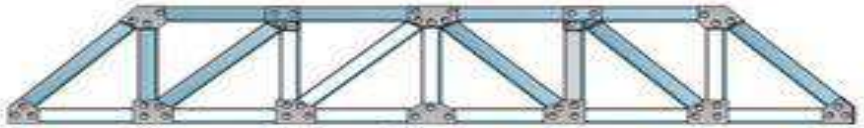
simple truss



Complex truss

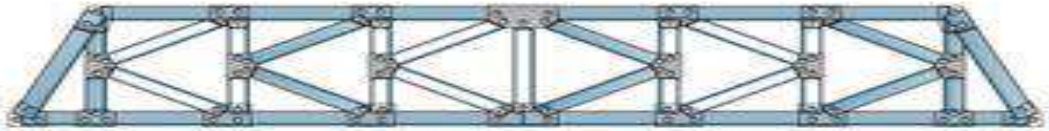
Noor science

Pratt
(a)

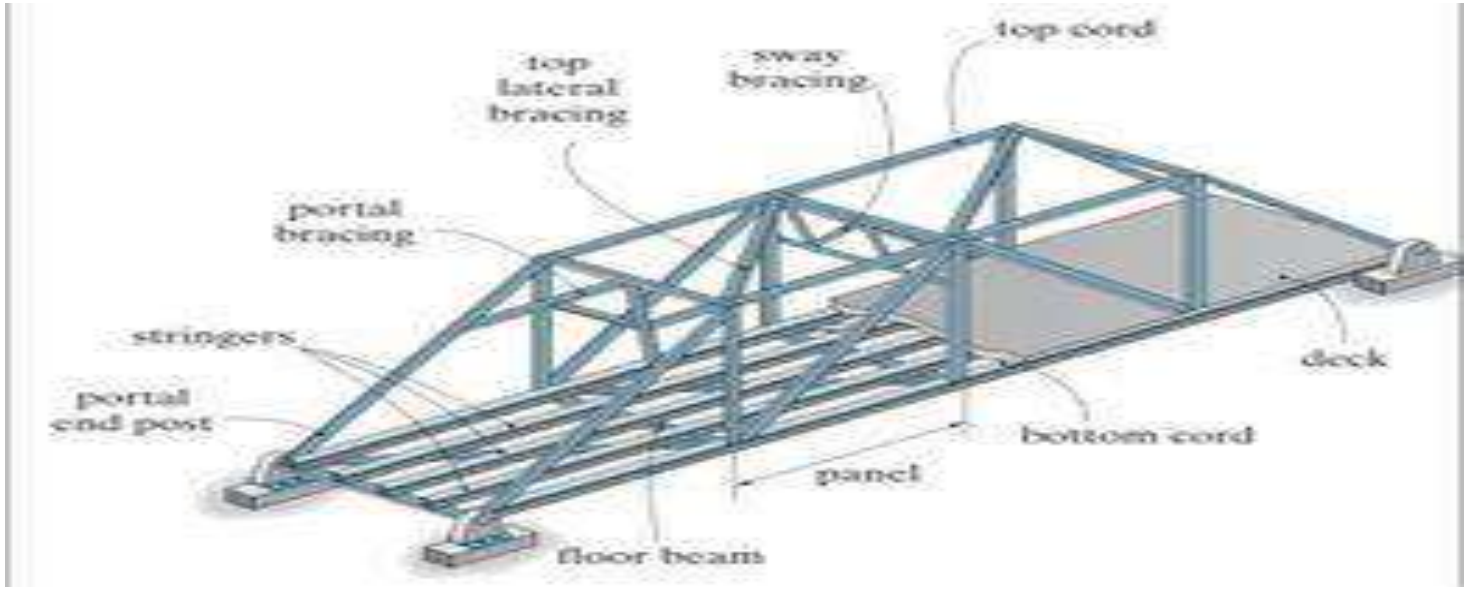


Howe
(b)

subdivided Warren
(f)



K-truss
(g)



Determinacy:

- *b + r = 2j statically determinate*
- *b + r> 2j statically indeterminate*

b + r < 2j unstable

- External Stability: As stated in Sec. 2–4, a structure (or truss) is externally unstable if all of its reactions are *concurrent* or *parallel*.
- Internal Stabilit: The internal stability of a truss can often be checked by careful inspection of the arrangement of its members.

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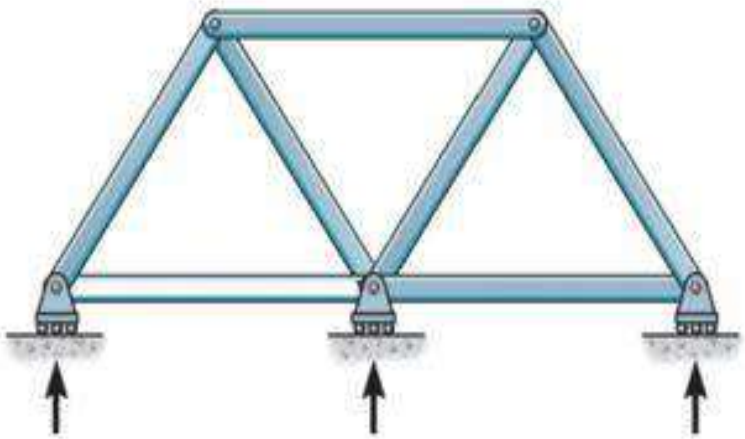
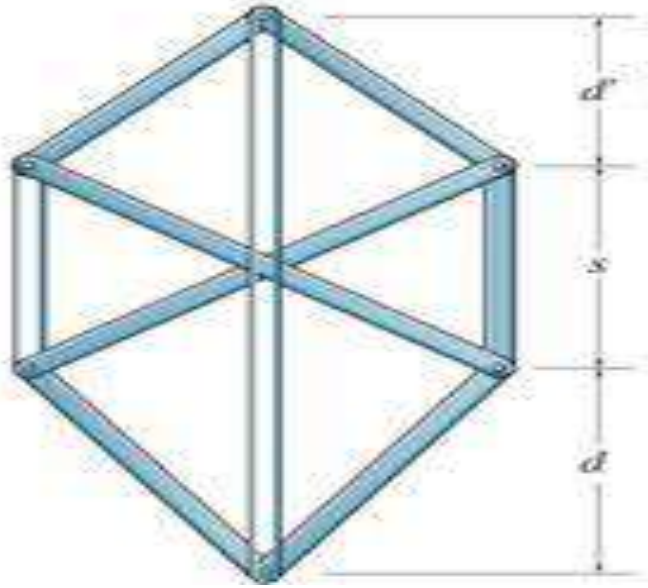
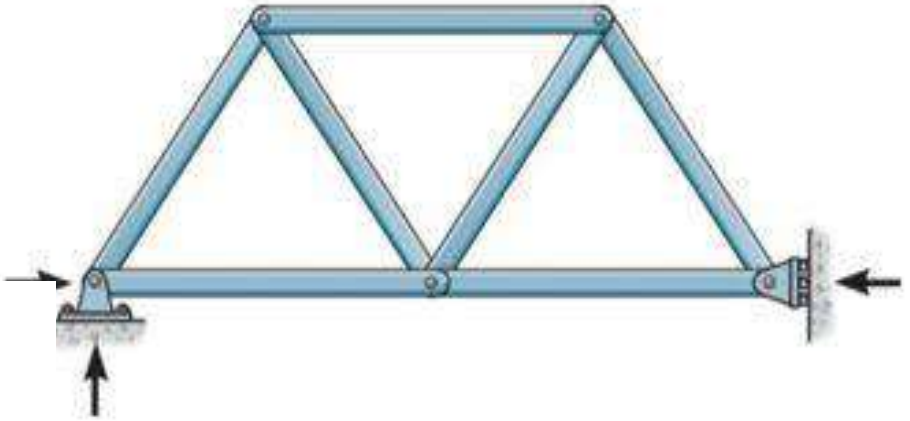
بعض الصور عن هذا الموضوع لتمكين الفكرة.



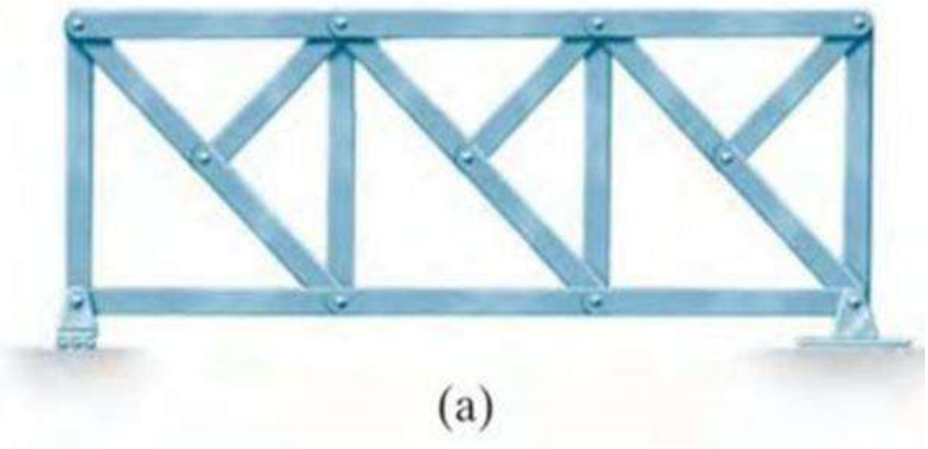
unstable parallel reactions



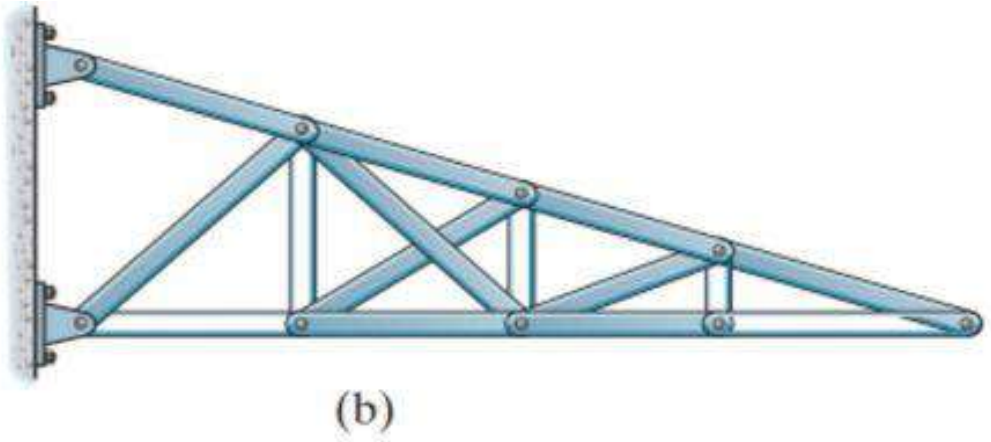


unstable concurrent reactions

سأضع مجموعة امثلة لتمكين الموضوع:

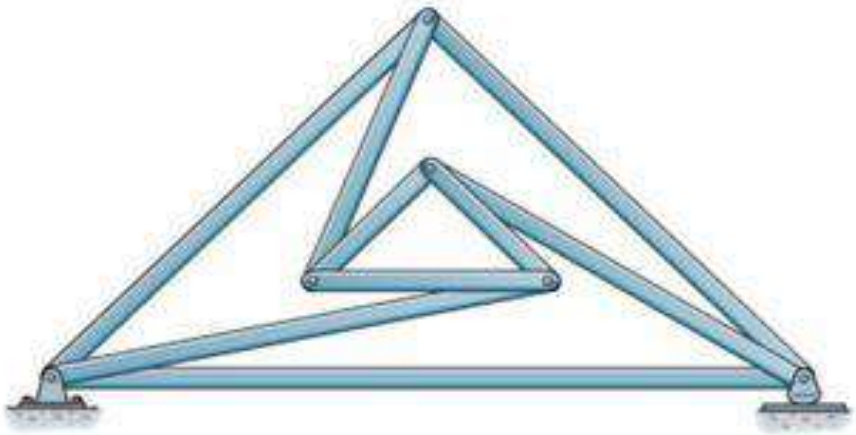


the truss **is statically determinate**. By inspection the truss is internally stable. ***b = 19, r = 3, j = 11, b + r = 2j 22 = 22.***



The truss is statically **indeterminate to the first degree.** By inspection the truss is internally stable.
b=15 r=4 j=9
b + r> 2j
19 > 18.

Mahdi Abu Al-Adous



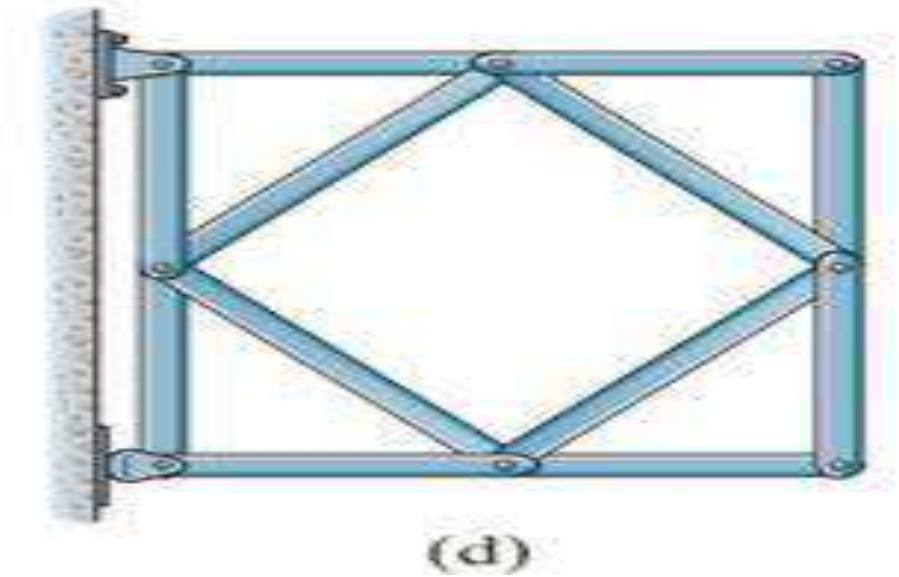
(c)

The truss **is statically determinate**. By inspection the truss is internally stable.

b=9 r =3 j=6

b + r = 2j

12=12



(d)

The truss is internally unstable

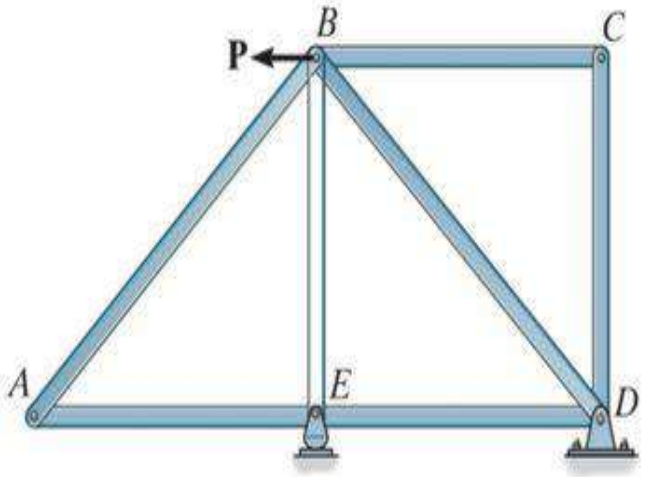
b = 12, r = 3, j = 8

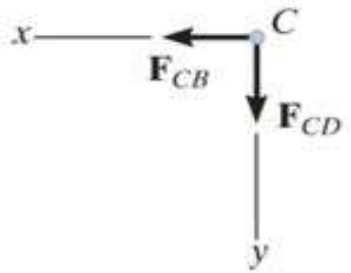
b+r<2j

15<16

Zero force members

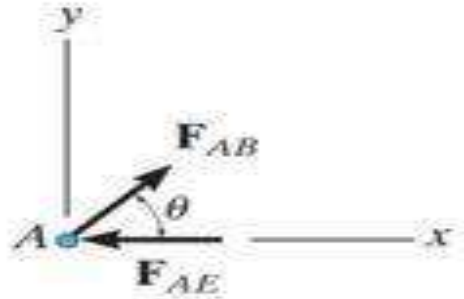
- *Case 1*: Consider the truss in Fig .The two members at joint C are connected together at a right angle and there is no external load on the joint. The free-body diagram of **joint C**, Fig, indicates that the force in each member must be zero in order to maintain equilibrium. Furthermore, as in the case of joint A.this must be true regardless of the angle, say between the members.





$\overset{+}{\leftarrow} \Sigma F_x = 0;\ F_{CB} = 0$

$+\downarrow \Sigma F_y = 0;\ F_{CD} = 0$



$+\uparrow \Sigma F_y = 0;\ F_{AB} \sin\theta = 0$

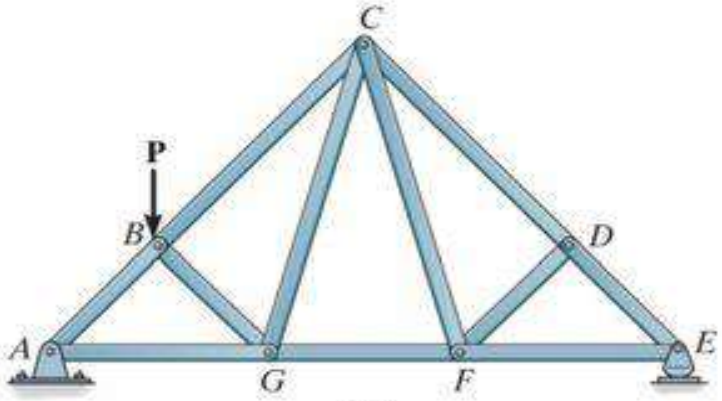
$F_{AB} = 0 \quad (\text{since } \sin\theta \neq 0)$

$\overset{+}{\rightarrow} \Sigma F_x = 0;\ -F_{AE} + 0 = 0$

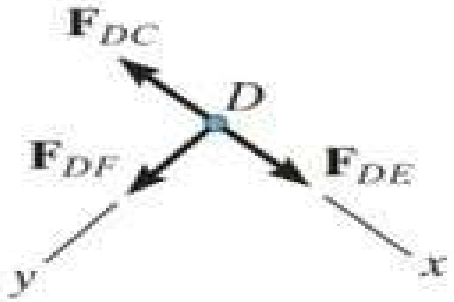
$F_{AE} = 0$

Mahdi Abu Al-Adous

- **Case 2**: Zero-force members also occur at joints having a geometry as **joint D** in Fig. Here no **external load** acts on the joint, so that a force summation in the y direction, which is **perpendicular** to the two collinear members, requires that Using this result, **FC is also a zero-force** member, as indicated by the force analysis of join.

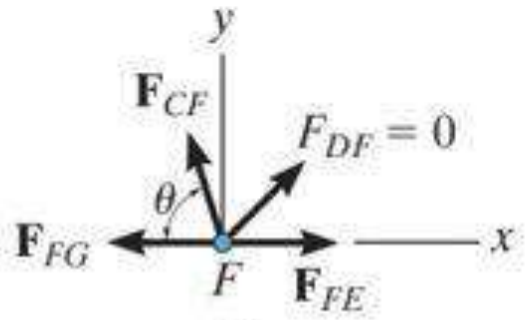


(a)



(b)

$+\swarrow \Sigma F_y = 0;\ F_{DF} = 0$



(c)

$+\uparrow \Sigma F_y = 0;\ F_{CF}\sin\theta + 0 = 0$

$F_{CF} = 0 \text{ (since } \sin\theta \neq 0)$

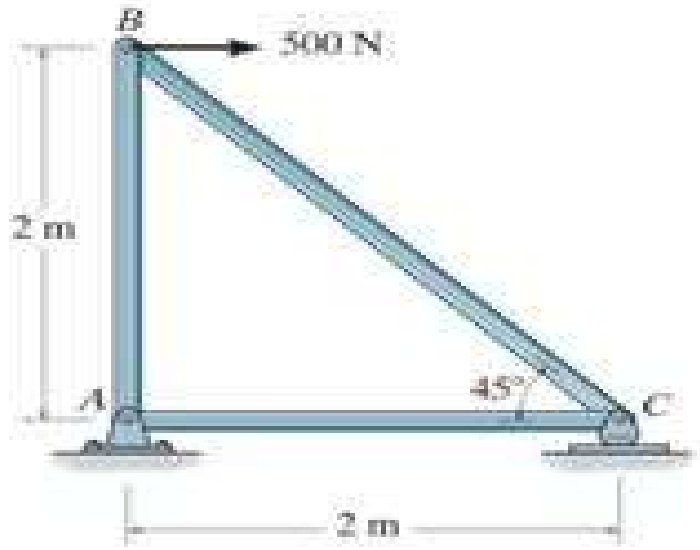
ملاحظات:

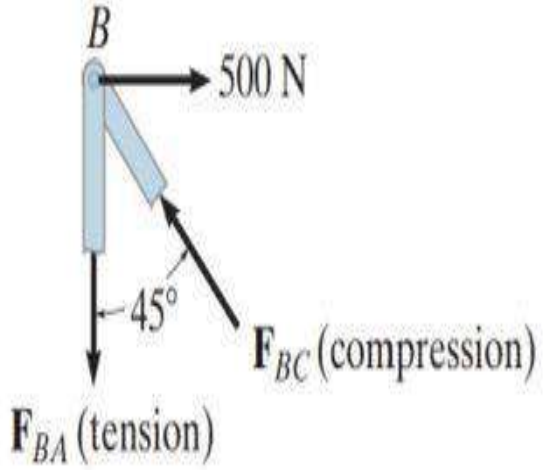
- *Local: تضم منطقة معينة
- *glopal: تضم المنطقة كاملة
- ©: استخدمتها في هذا المساق لتعبر عن المجموع
- **********

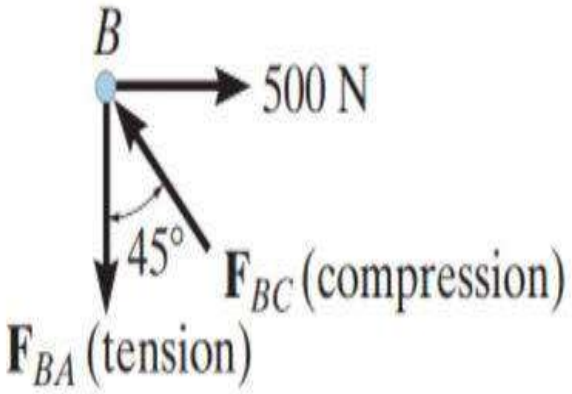
- ©Fx=0 الإتجاه اليمين يكون موجب
- ©Fy=0 الإتجاه للأعلى يكون موجب
- ©M=0 عكس عقارب الساعة تكون موجبة

The method of joints :

- هي طريقة مراجعة لما تم اخذه في مساق الستاتيك
- **Tension:** الإشارة موجبة واتجاهها الى الخارج يكون
- **Compression:** الإشارة سالبة واتجاهها الى الداخل يكون

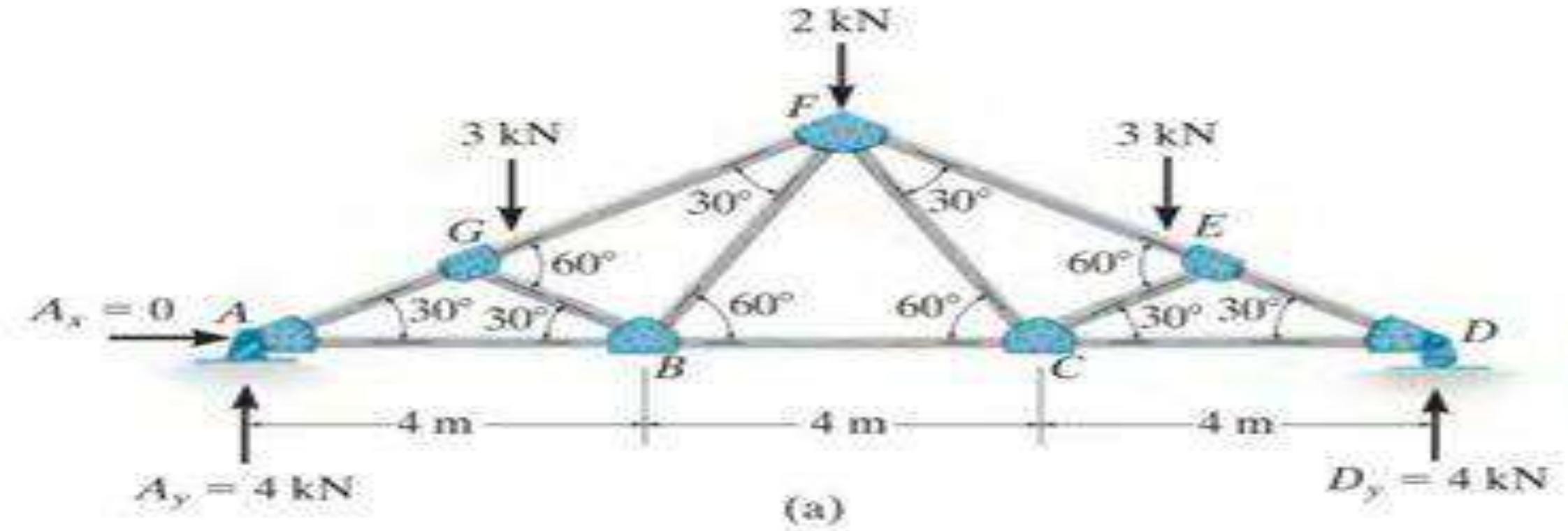






هذا المثال يوضح كل فكرة ممكن أن تأتي على هذه الطريقة:

- *Determine the force in each member of the roof truss shown in the photo:*



SOLUTION:

- ***Joint A:***
- ©Fx = 0; FAB-8cos30=0 ***FAB=6.928KN(T)***
- ©Fy = 0; 4 - FAG sin 30° = 0 ***FAG = 8 Kn(C)***

Joint G:

- ©FY = 0 FGB sin 60° - 3 cos 30° = 0 ***FGB = 3.00 Kn (C)***
- ©FX=0 8 - 3 sin 30° - 3.00 cos 60° - FGF = 0 ***FGF = 5.00 Kn (C)***

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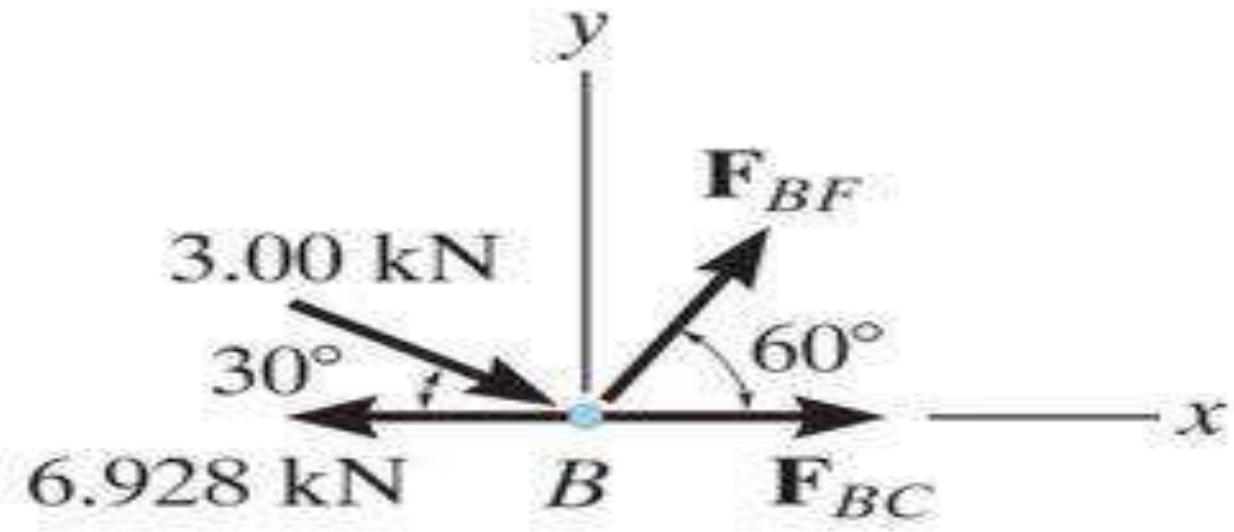
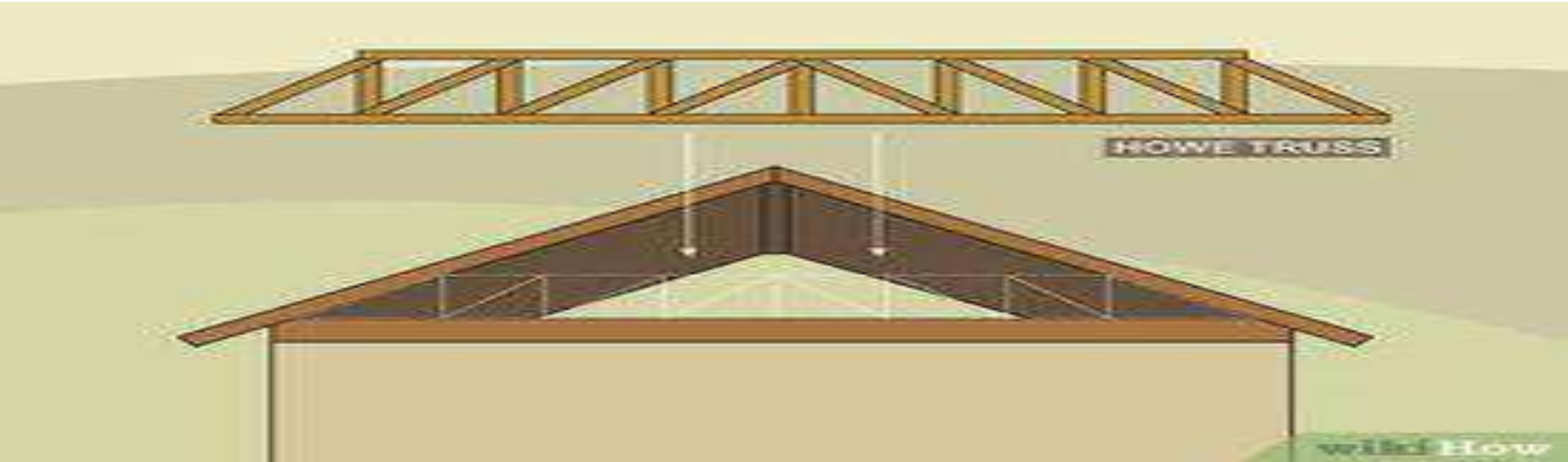
- ***Joint B:***
- **©Fy = 0; FBf sin 60° - 3.00 sin 30° = 0** ***FBf = 1.73 kN (T)***
- ***©Fx = 0;*** **FBC + 1.73 cos 60° + 3.00 cos 30° - 6.928 = 0** ***FBC = 3.46 kN (T)***



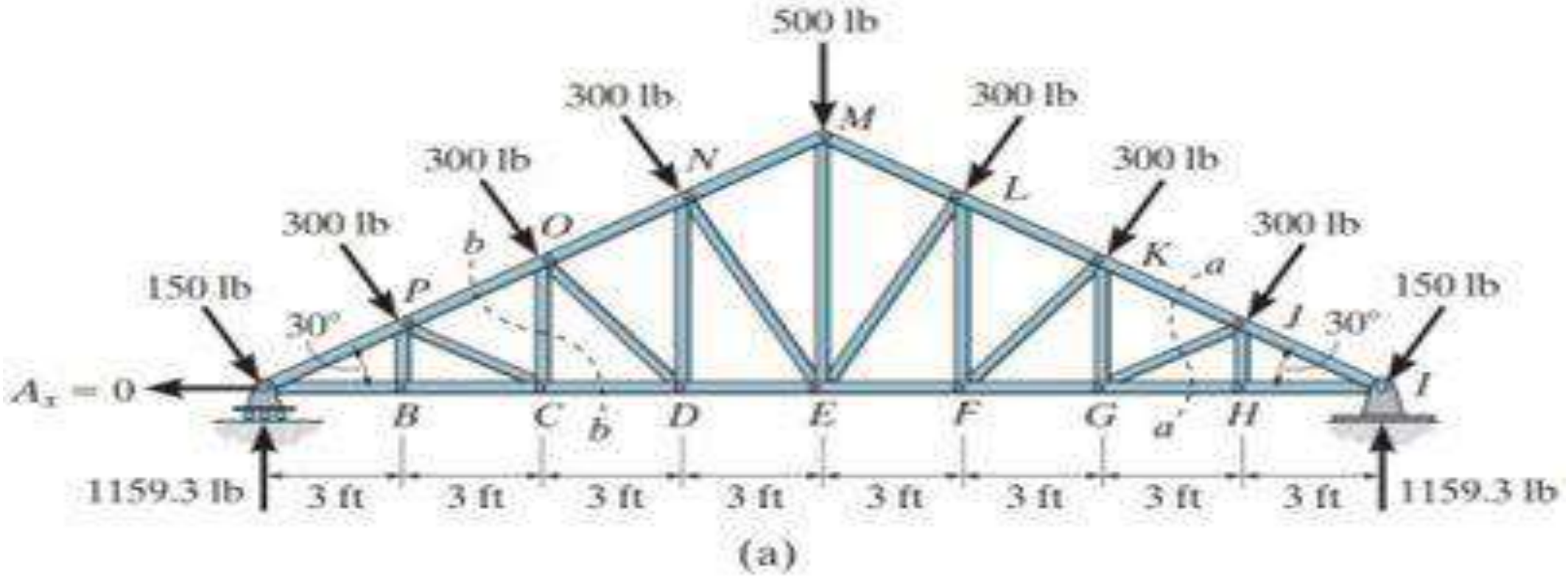
The method of sections:

- هذه هي الجزئية الأهم على الإطلاق ويجب ان تكون عندك مهارة عالية في **تقسيم الشكل** بحيث يكون عدد المجاهيل **3 فقط** وسيتم طرح العديد من الأمثلة حتى يصبح الأمر سهل بالنسبة لك.



EXAMPLE(1):

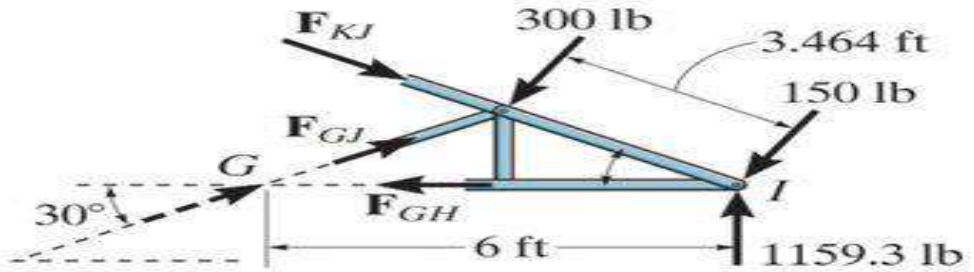
- ***Determine the force in members GJ and CO of the roof truss shown in the photo.***



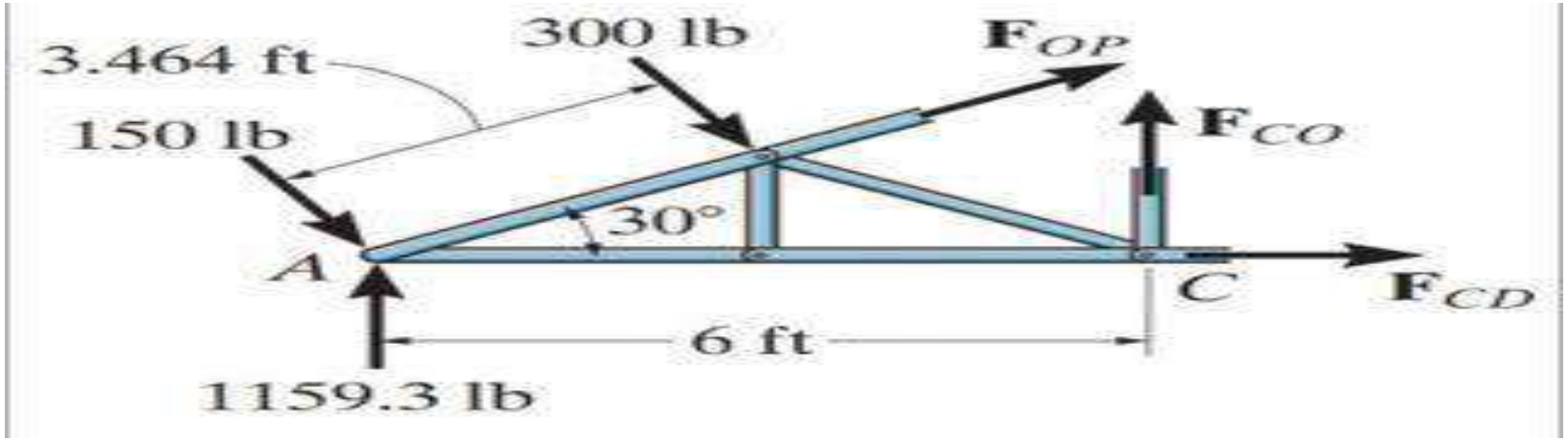
(a)

SOLUTION: اتجاه المومنت عكس عقارب الساعة

- ***Member CF:***
- **©MI = 0;** *-FGJ sin30(6)+300(3.464)=0* ***FGI=346lb (C)***

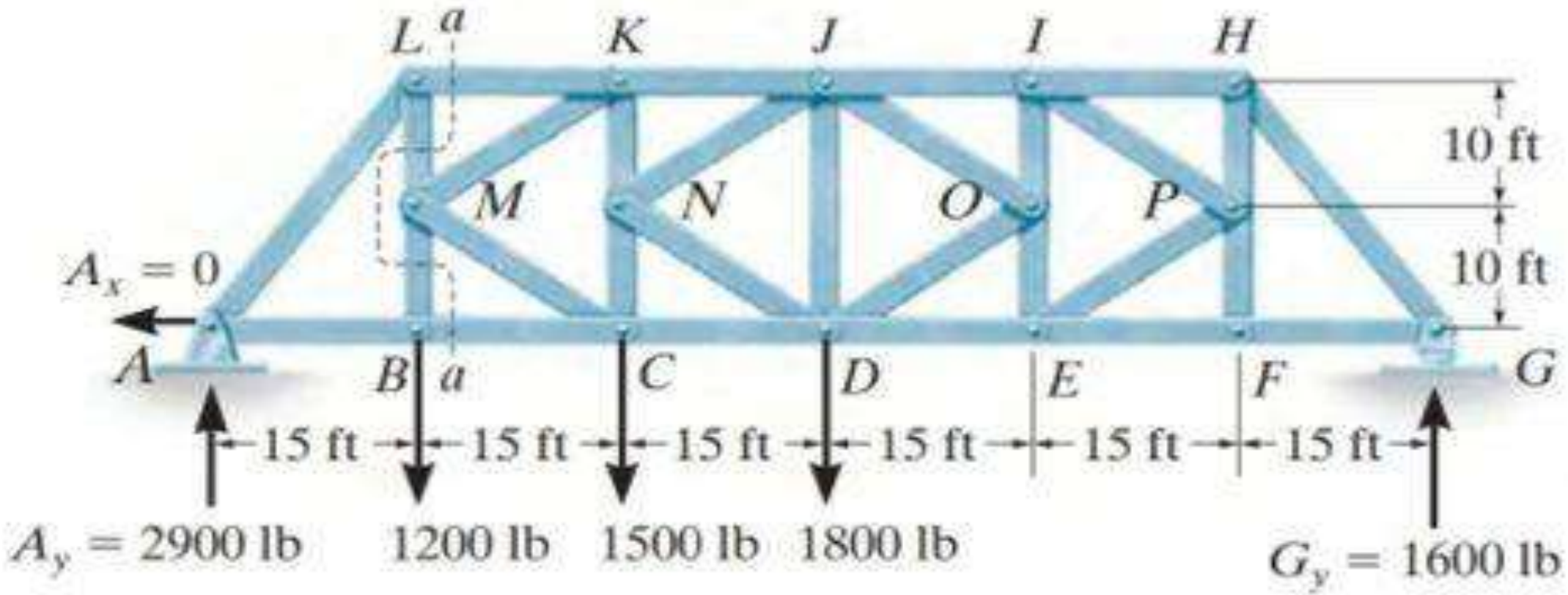


- ***Member GC:***
- ***©MA =0*** ***-300(3.464)+FCO(6)=0*** ***FCO=173lb(T)***



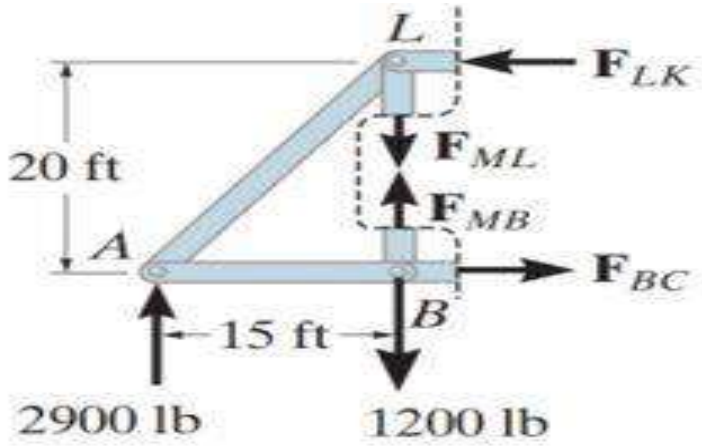
EXAMPLE(2):

- ***Determine the force in members BC and MC of the K-truss***

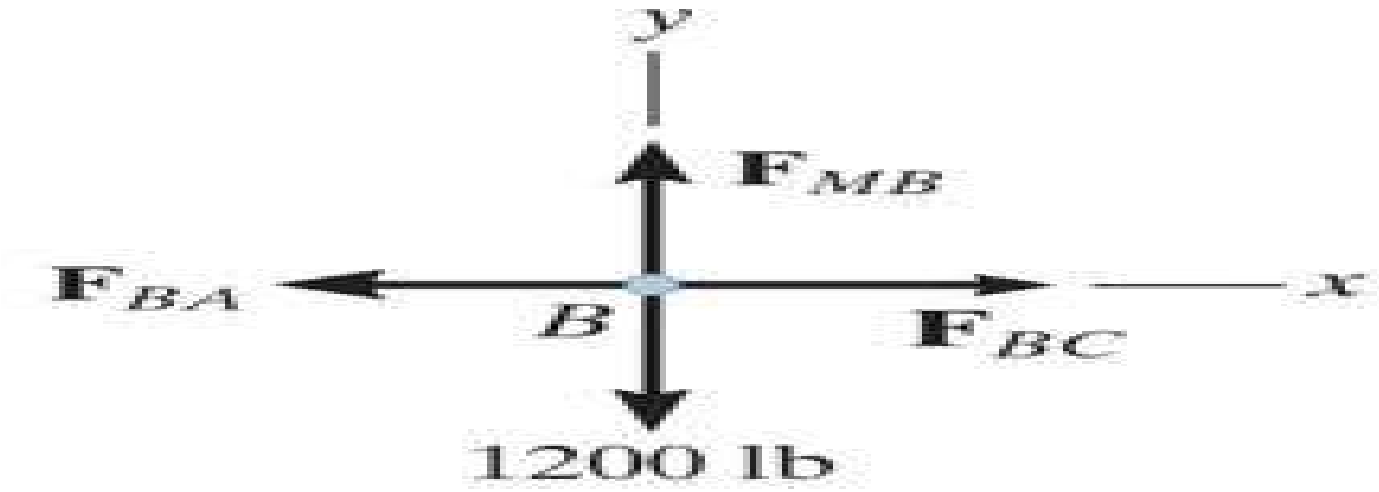


SOLUTION: اتجاه المومنت عكس عقارب الساعة

- ©ML = 0; -2900(15)+FBC(20)=0 **FBC=2175(T)**



- ©FY=0 2900-1200+1200-FML=0 **FML=2900(T)**



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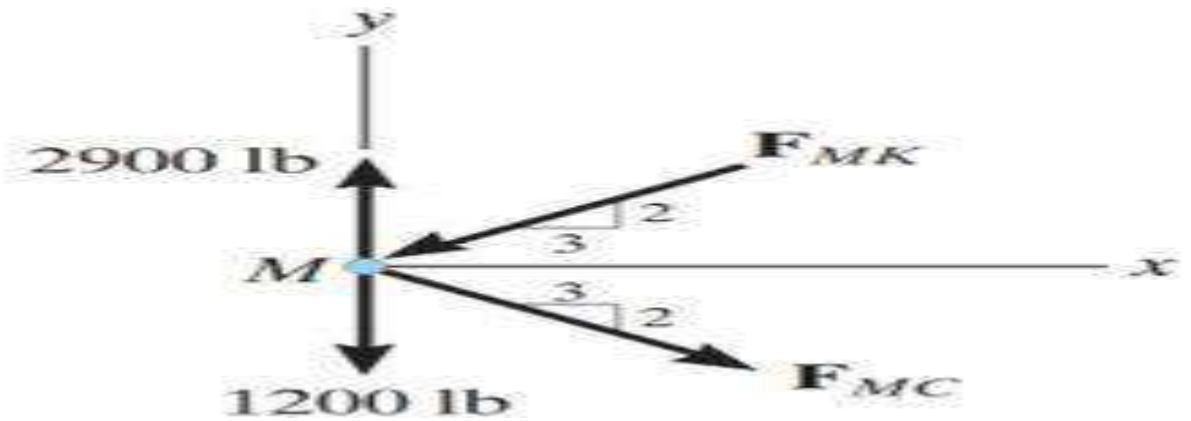
$$\stackrel{+}{\rightarrow} \Sigma F_x = 0; \qquad \left(\frac{3}{\sqrt{13}}\right) F_{MC} - \left(\frac{3}{\sqrt{13}}\right) F_{MK} = 0$$

$$+\uparrow \Sigma F_y = 0; \qquad 2900 - 1200 - \left(\frac{2}{\sqrt{13}}\right) F_{MC} - \left(\frac{2}{\sqrt{13}}\right) F_{MK} = 0$$

$$F_{MK} = 1532 \text{ lb (C)} \qquad F_{MC} = 1532 \text{ lb (T)}$$

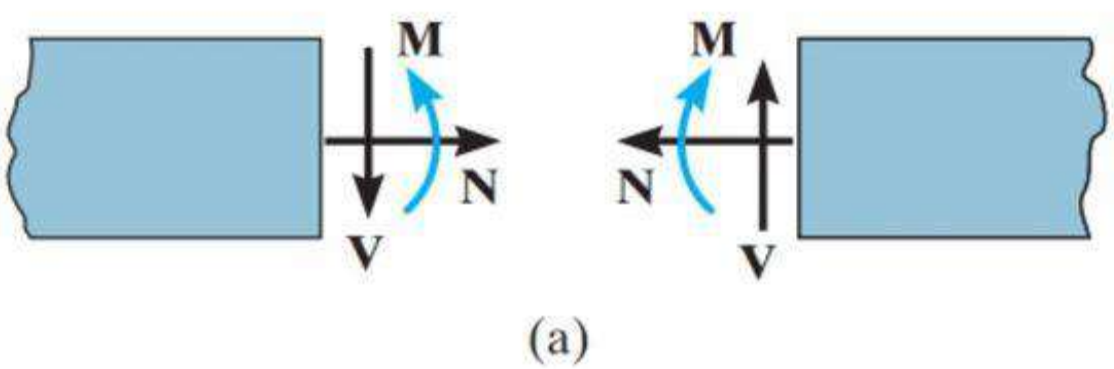


بعد إنهاء الشابتر الثالث عليكم بحل أسئلة الكتاب والواجبات التي يطرحها مدرس المساق لتمكين الأفكار.

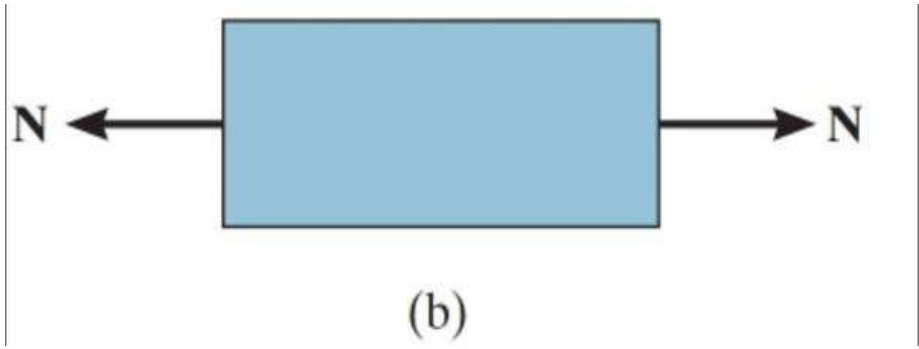
Chapter(4):Internal loadings developed in structural members.

- **في البداية سنتعرف على كيفية حساب القوة الداخلية**

- ***Sign Convention:***



(a)



(b)

(c)

(d)

ملاحظة: عندما يكون المطلوب إخراج **القوة الداخلية** عليك أن تنظر إلى مكان **النقطة المطلوبة** وتعرف أي جزء تختار من حيث **السهولة** وعدد المجاهيل

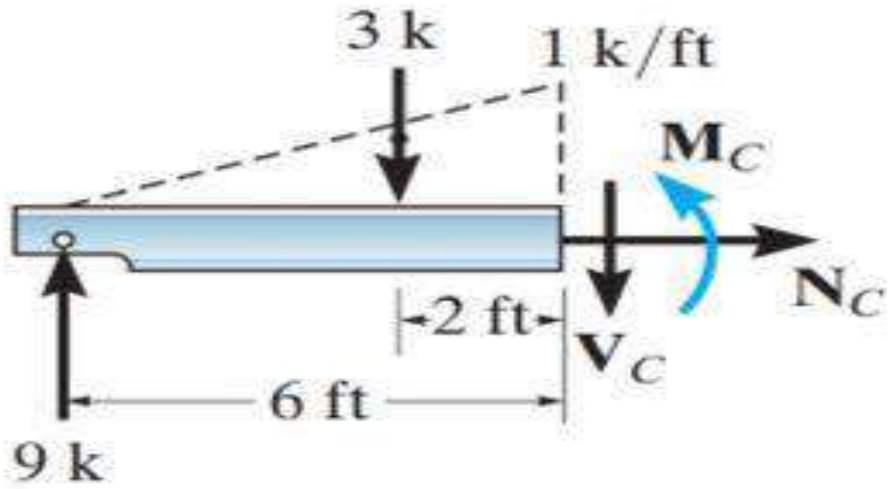
- ***Determine the internal shear and moment acting at a section passing through point C?***

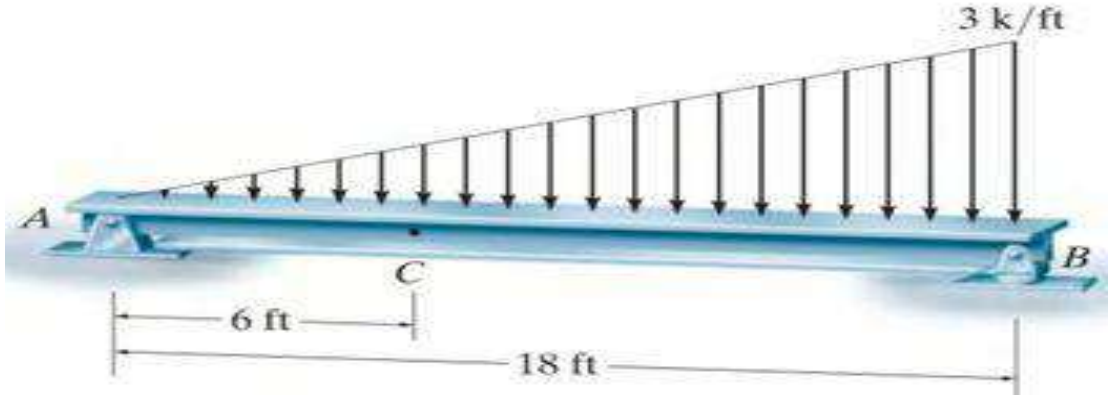
عليك أن تنظر إلى مكان النقطة المطلوبة وتعرف أي جزء تختار

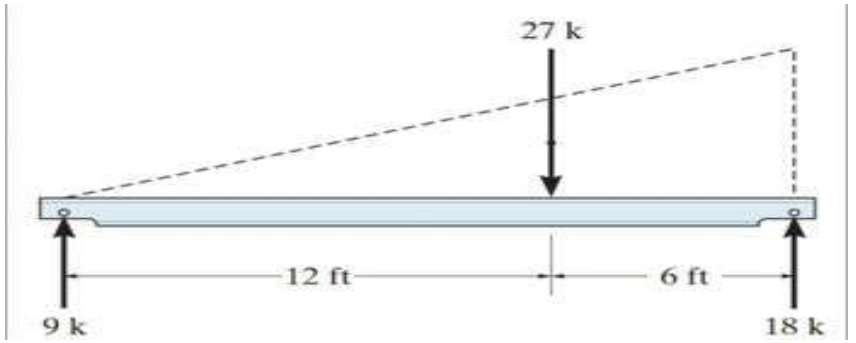
SOLUTION:

©Fy = 0 ; 9 - 3 - VC = 0 VC = 6 k

©Mc=0 -9(6)+3(2)+Mc=0 Mc=48K.ft



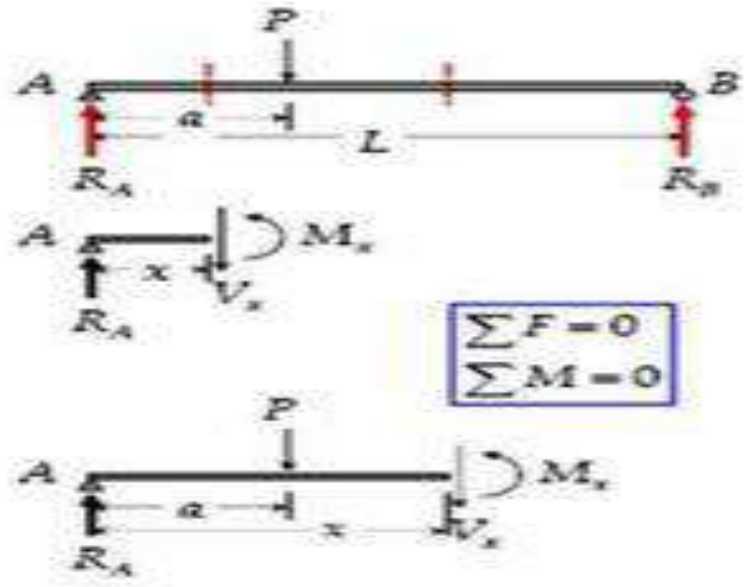




Wc=(6ft/18ft)(3k/ft)=1

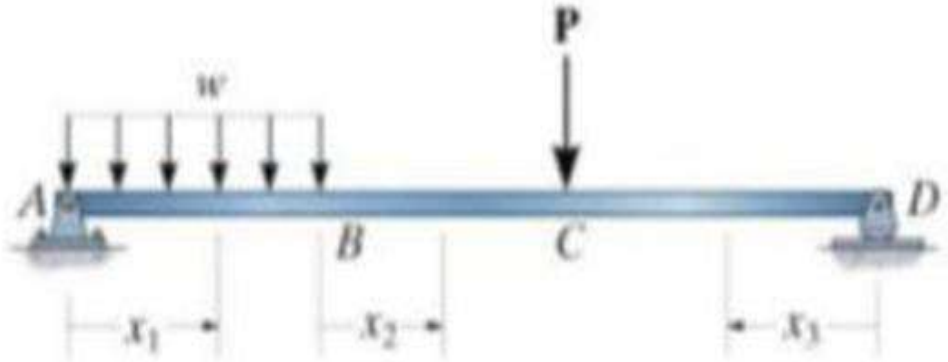
سنتعلم فى الجزئية الثانية من هذا الشابتر كيفية إيجاد معادلة المومنت والشير

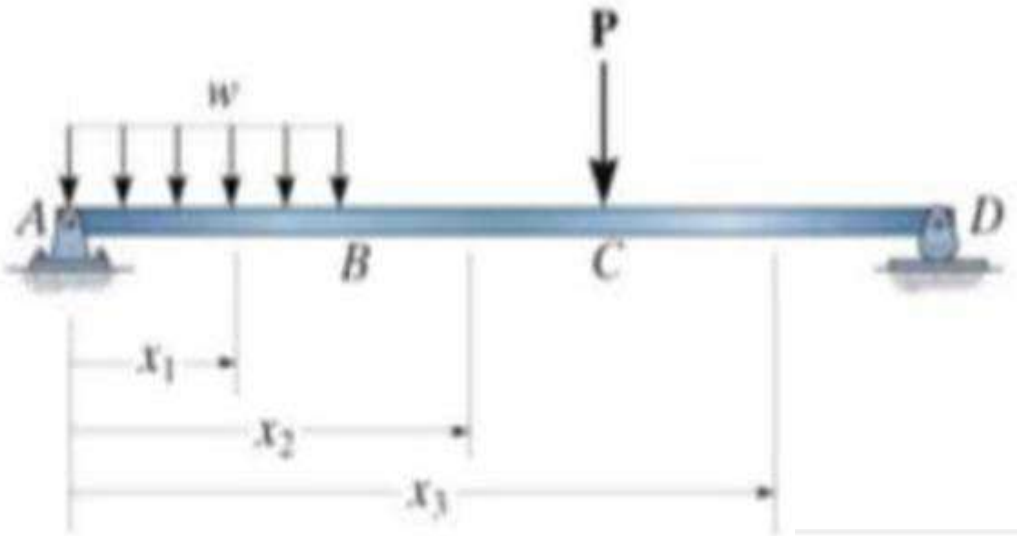
- ***Procedure for Analysis:***
- ***1- Support reaction***
- ***2- Shear & Moment Function***



- ***Specify separate coordinate x and associated origins, extending into regions of the beam between concentrated forces and/or couple moments or where there is a discontinuity of distributed loading.***
- ***• Section the beam at x distance and from the free body diagram determine V and M at section x as a faction of x***

الخلاصة:نبدأ من البيم من أي نقطة نريد ونأخذ **قطعة قطعة** عندما **يتغير الحمل** أو يطرأ **تغير نأخذ خط القطع** ونحسب القوى الداخلية





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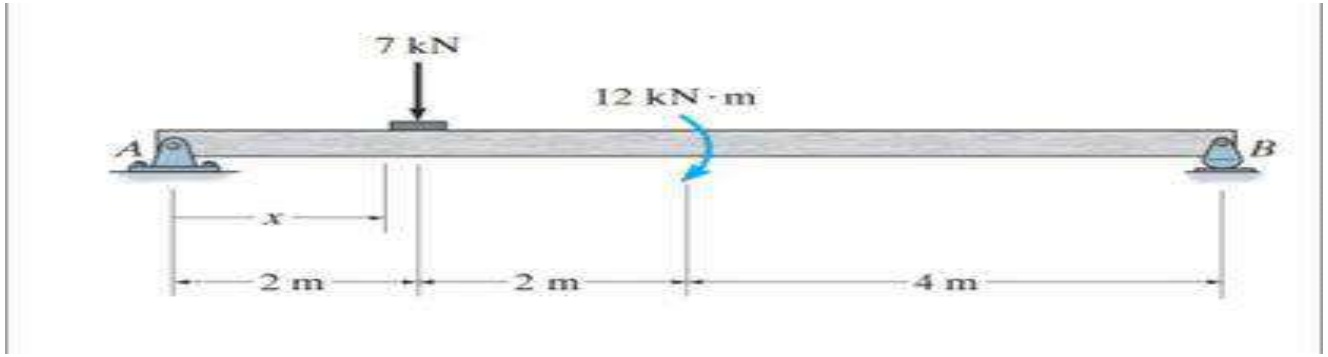
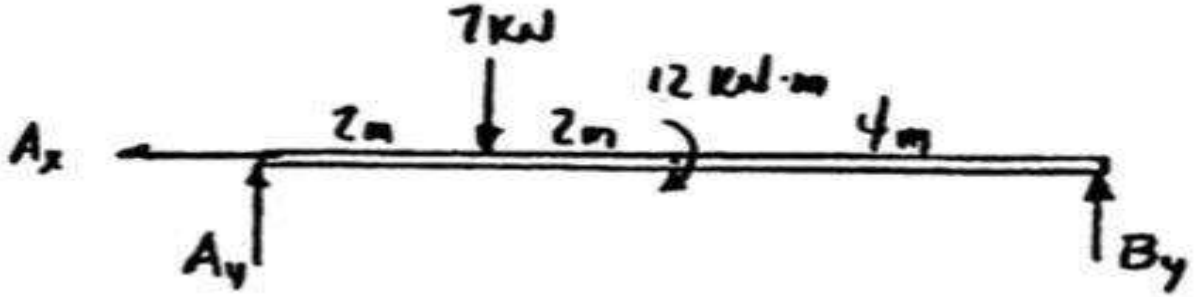
سيتم طرح مثال ليوضح ما تم الحديث عنه فى السلايد السابق:

- Determine the shear and moment throughout the beam as a function of x.?
- ***SOLUTION:***



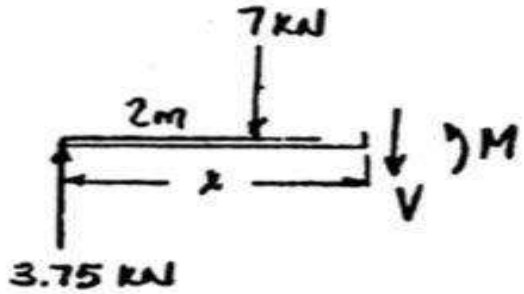
Reaction at A:

- ***©fx=0 Ax=0***
- ***©MB=0*** **Ay(8)-7(6)+12=0** ***Ay=3.75kN*** ***عكس عقارب الساعة الإتجاه***



الإنتباه للفترات:

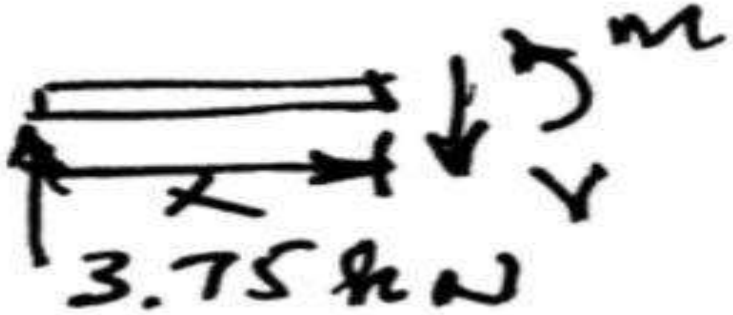
$$0 \le x < 2\ \text{m}$$



- ©Fy=0 3.75-V=0 V=3.75KN
- ©M=0 3.75x-M=0 M=3.75x KN

$$2\ \text{m} < x < 4\ \text{m}$$

- ©fy=0 -V+3.75-7=0 V=-3.25
- ©M=0 -M+3.75x-7(x-2)=0 M=-3.25x+14 عكس عقارب الساعة الإتجاه



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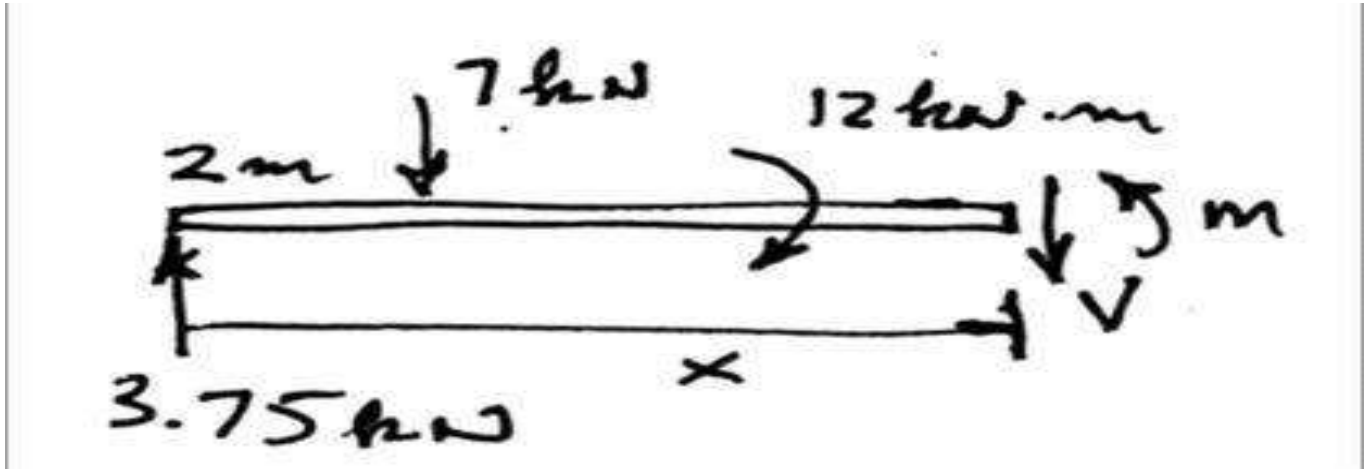
$$4\ \mathrm{m} < x \leq 8\ \mathrm{m}$$

- ©fy=0 3.75-7-V=0 V=-3.25 KN
- ©M=0 -3.75x+7(X-2)-12+M=0 M=26-3.25x عكس عقارب الساعة الإتجاه

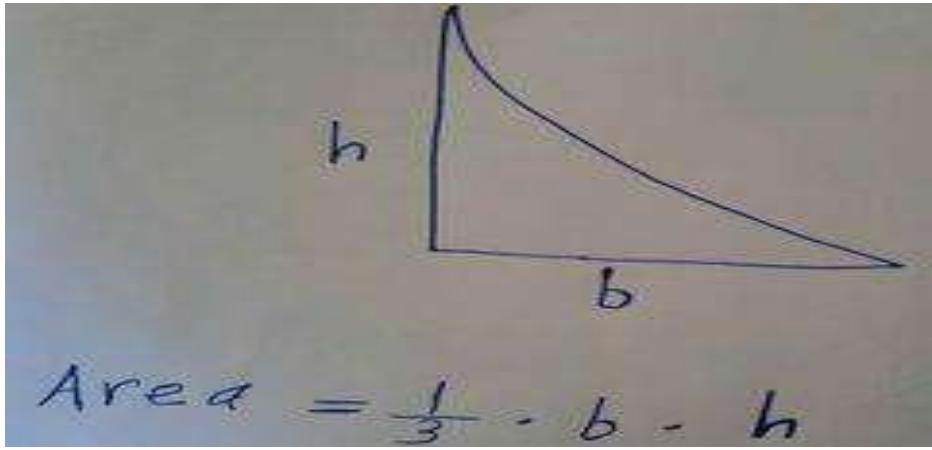


سنتعلم فى الجزئيةالثالثة من هذا الشابتر كيفية رسم المومنت والشير وهى الجزئية الأهم على الإطلاق

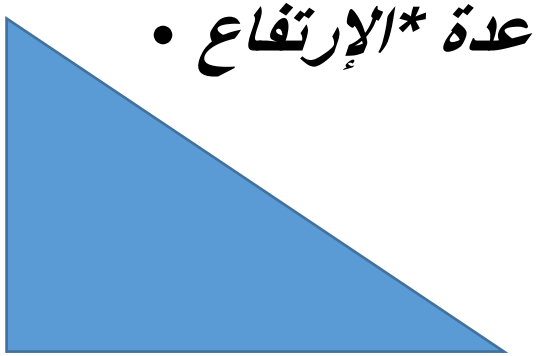
- فى البداية سيتم طرح العديد من الملاحظات لتتمكن من الرسم بسهولة

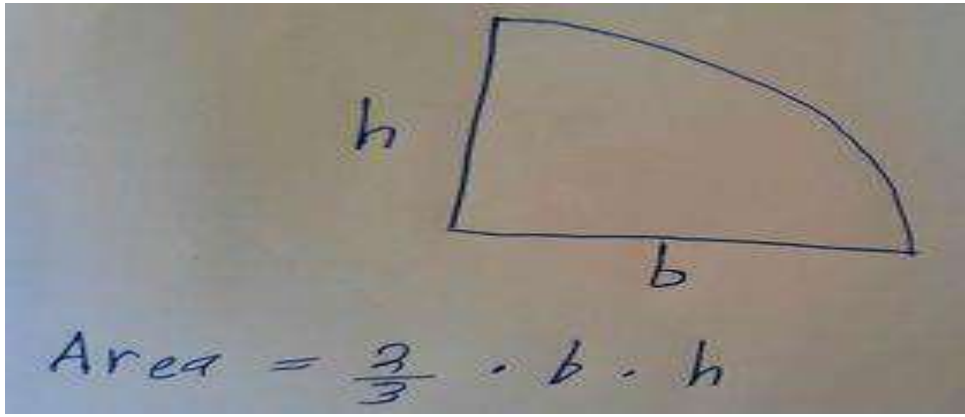
1)مساحة الأشكال:

- المساحة =الطول*العرض



- المساحة=1/2القاعدة *الإرتفاع





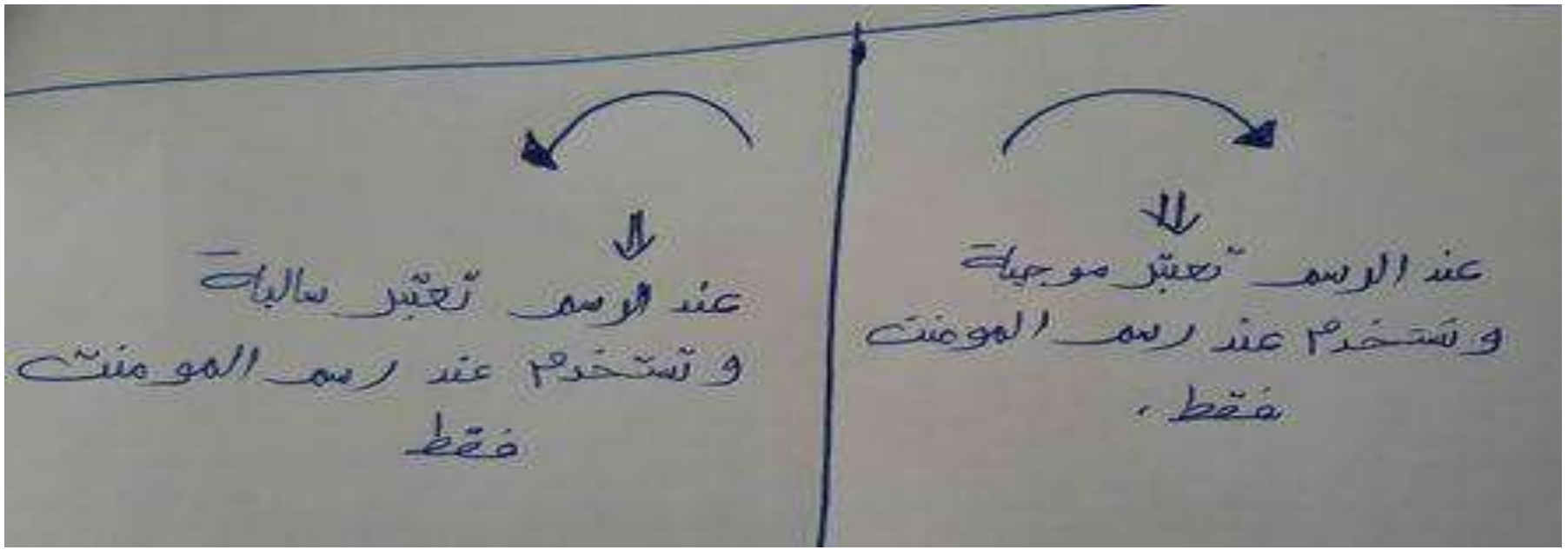
تكامل

Load>shear>moment

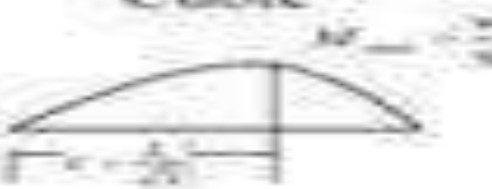
اشتقاق

2)إخراج الرياكشن خطوة مهمة جدا قبل البدء بحل السؤال

3)عليك معرفة إتجاه المومنت عند الرسم:

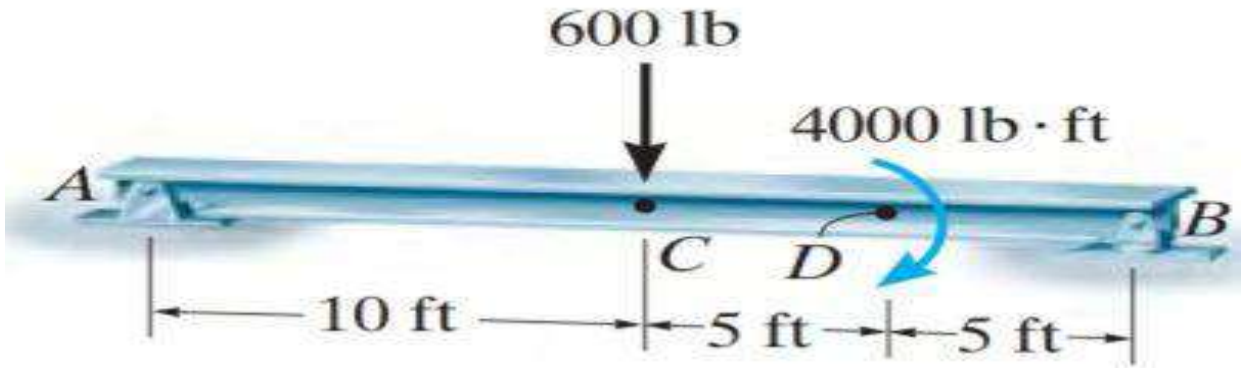


4)

Load	Slope for shear force	Slope for bending Moment
P 	Constant 	Linear 
Uniformly distributed load 	Linear 	Parabolic 
Uniformly varying load 	Parabolic 	Cubic 

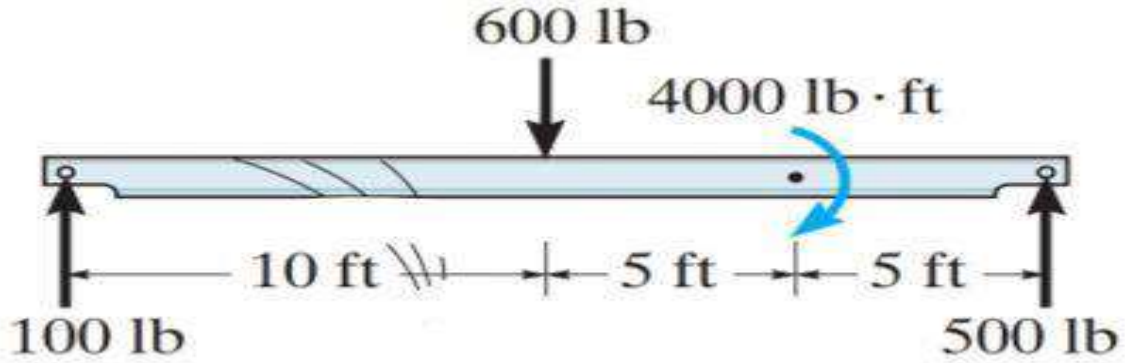
سيتم طرح العديد من الأمثلة حتى تتقن الموضوع:

- ***Draw the shear and moment diagrams for the beam?***

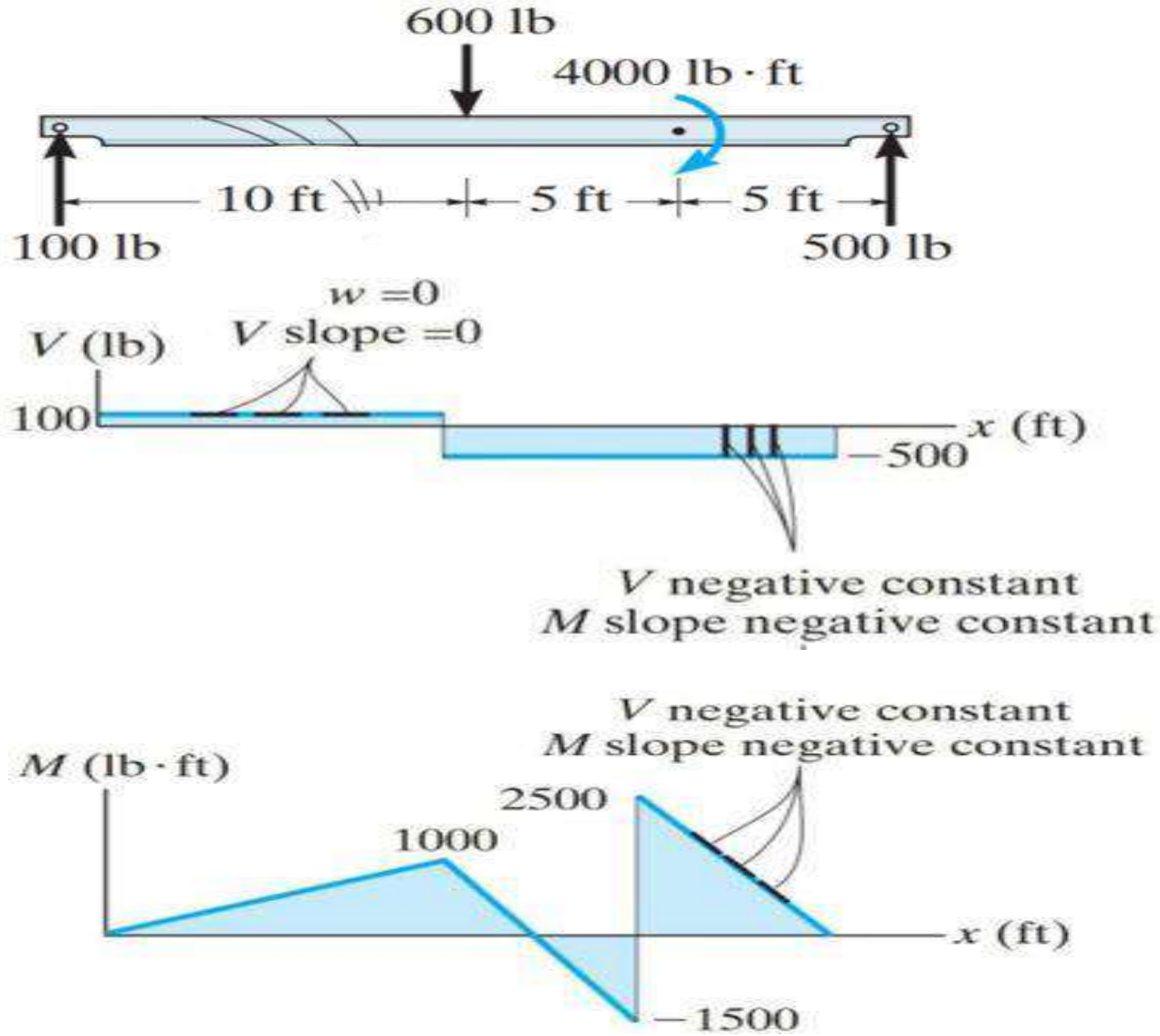


SOLUTION:

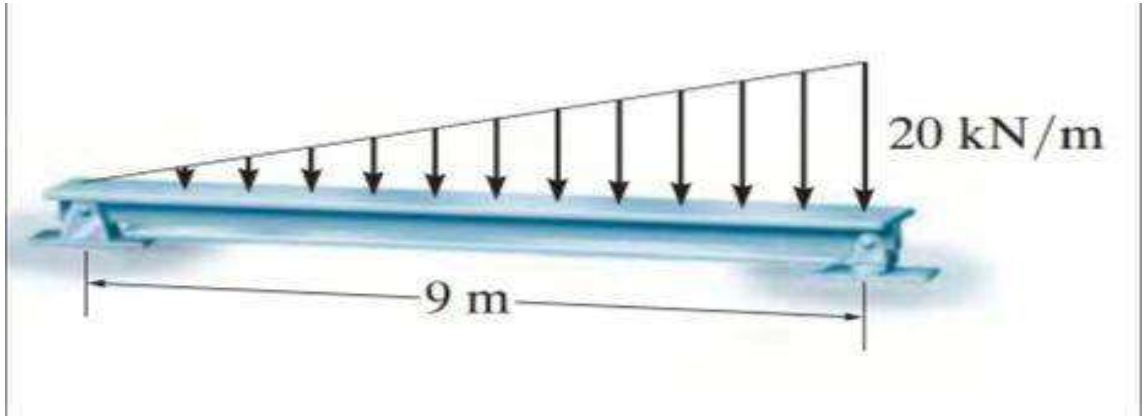
- ***Support Reactions:*** *إخراج الرياكشن في البداية*



ثم نبدأ بالرسم مع مراعاة جميع الملاحظات التى تم طرحها

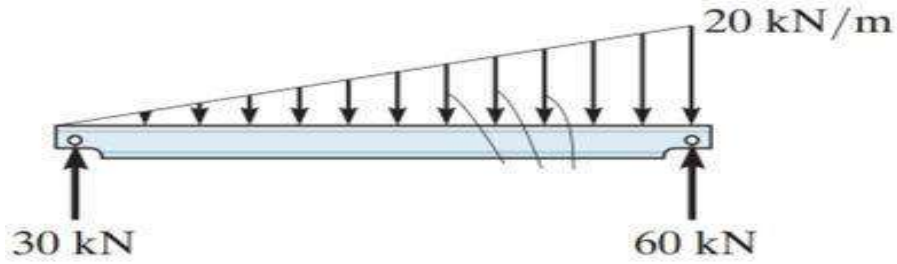


Draw the shear and moment diagrams for the beam?

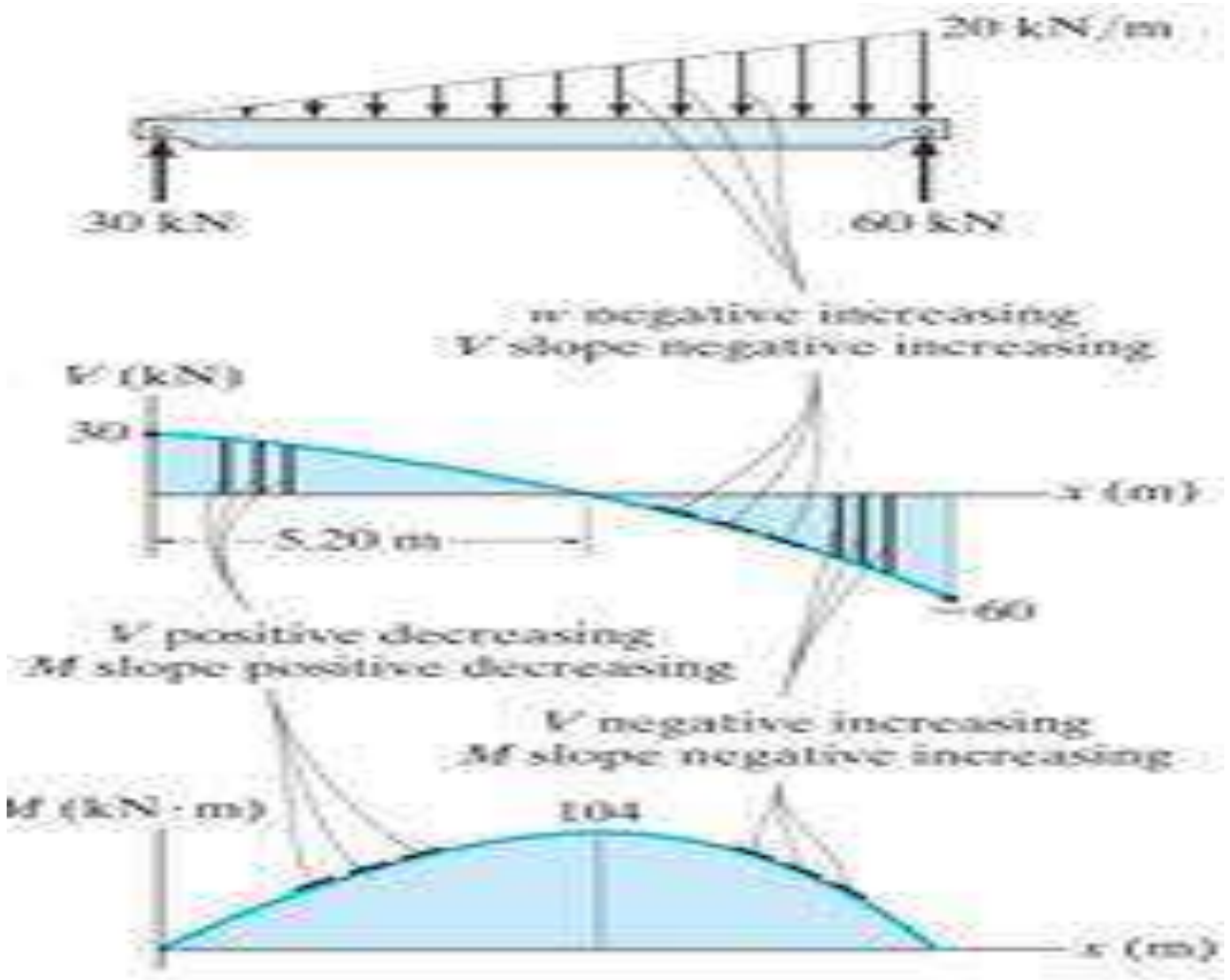


- ***SOLUTION:***

Support Reactions: إخراج الرياكشن في البداية



ثم نبدأ بالرسم مع مراعاة جميع الملاحظات التى تم طرحها



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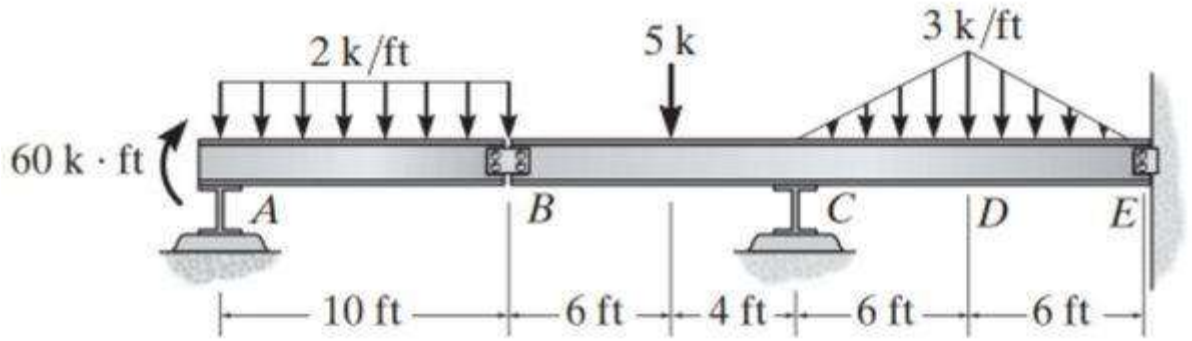
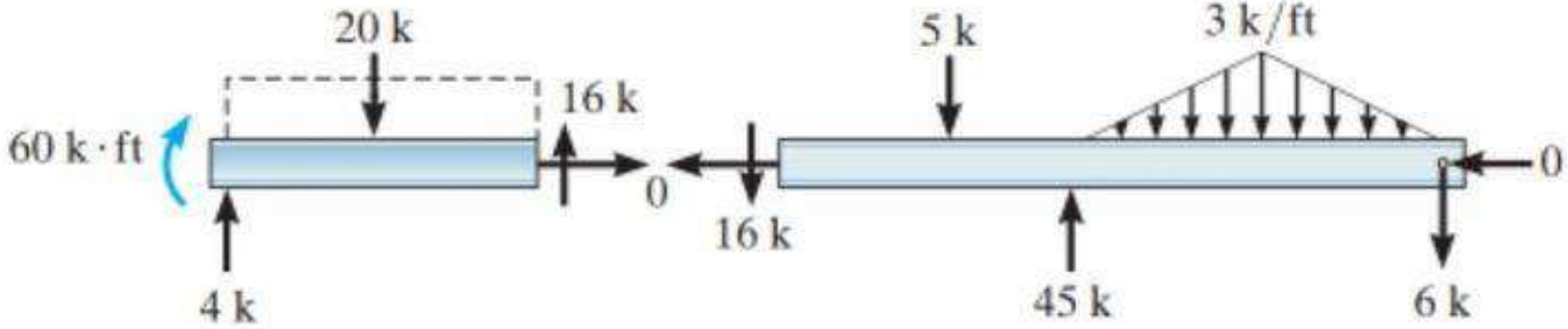
Draw the shear and moment diagrams for the compound beam shown in Fig.Assume the supports at A and C are rollers and B and E are pin connections.?

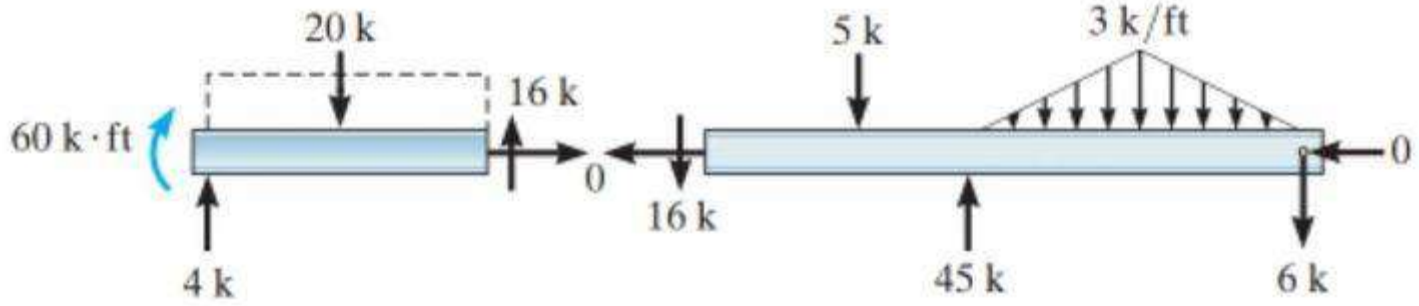


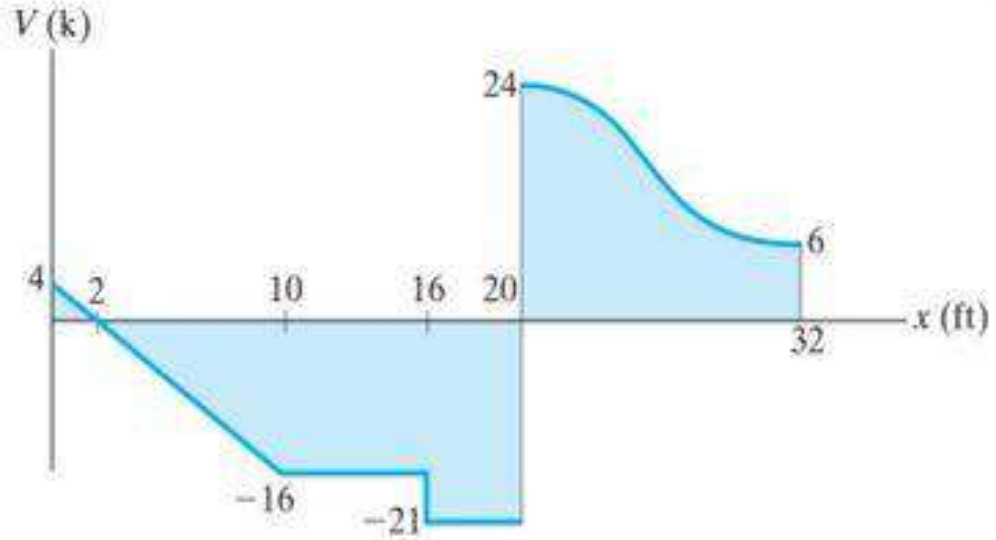
SOLUTION:

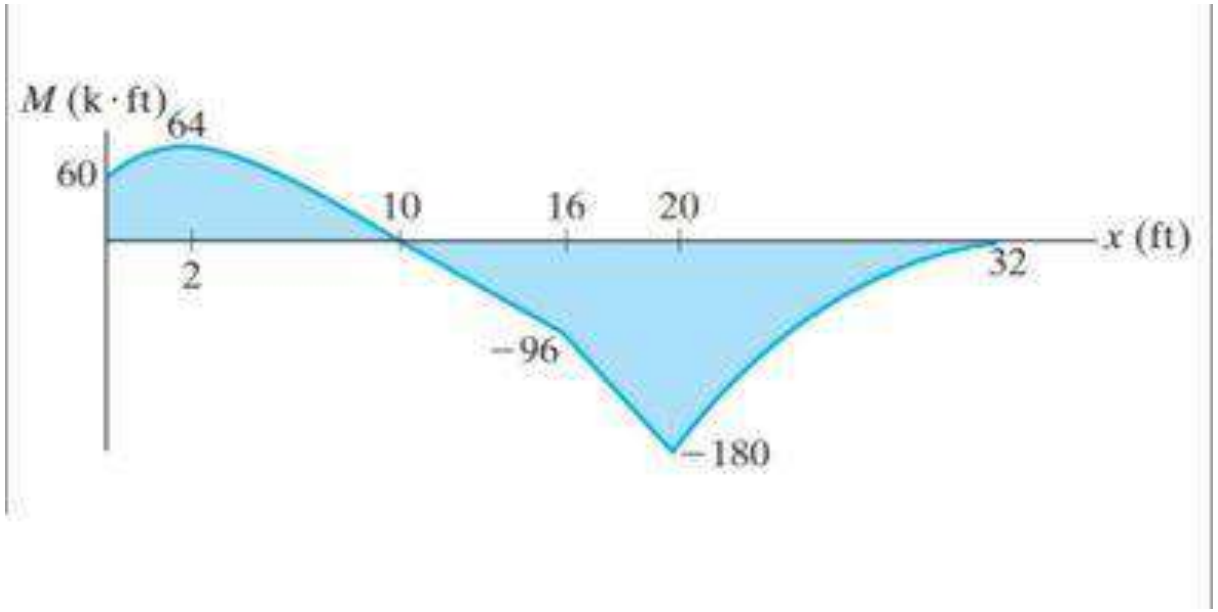
Support Reactions: إخراج الرياكشن في البداية



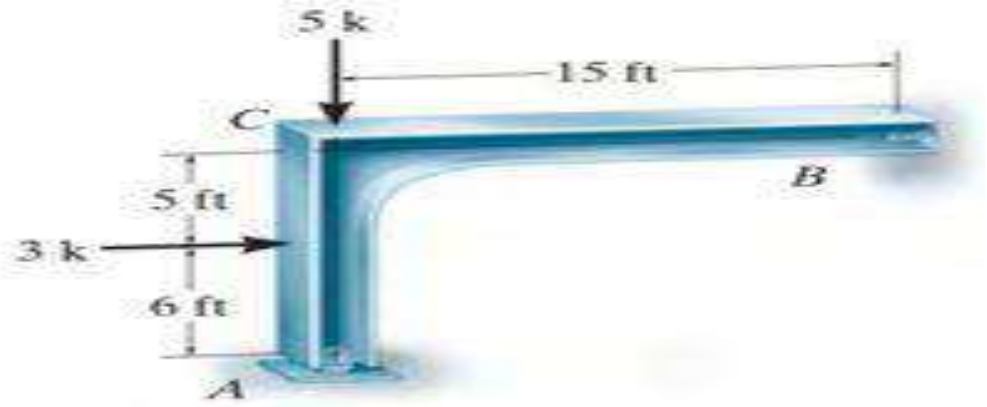
ثم نبدأ بالرسم مع مراعاة جميع الملاحظات التى تم طرحها



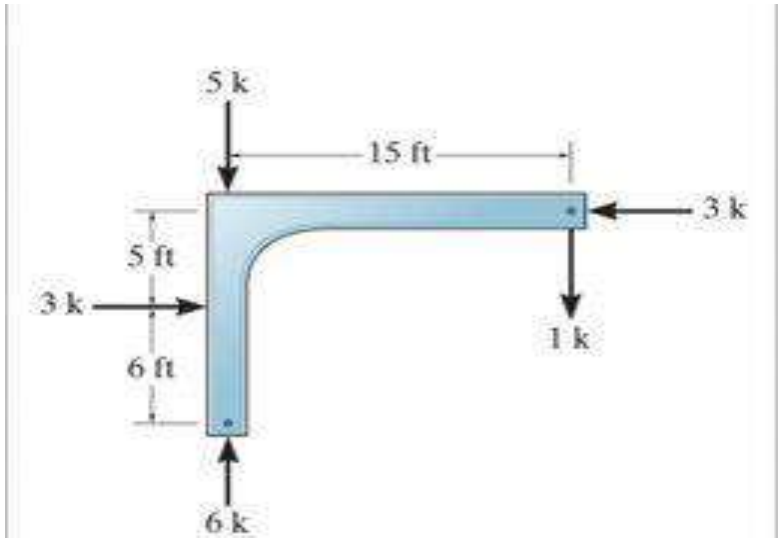


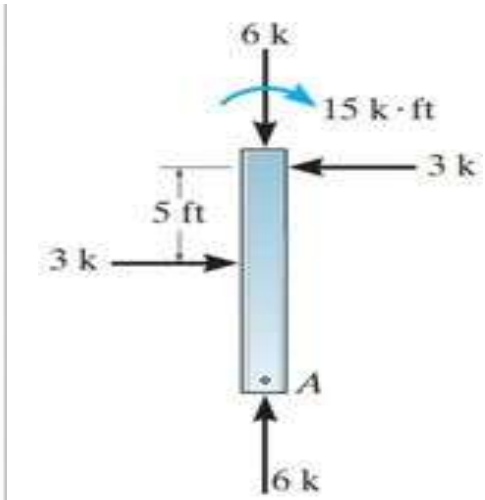


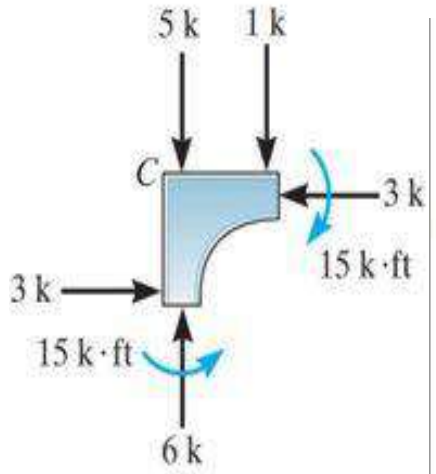
Draw the moment diagram for the tapered frame?

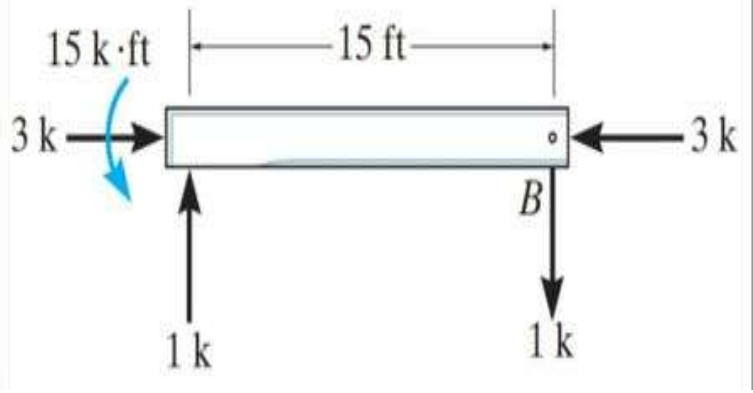


SOLUTION:

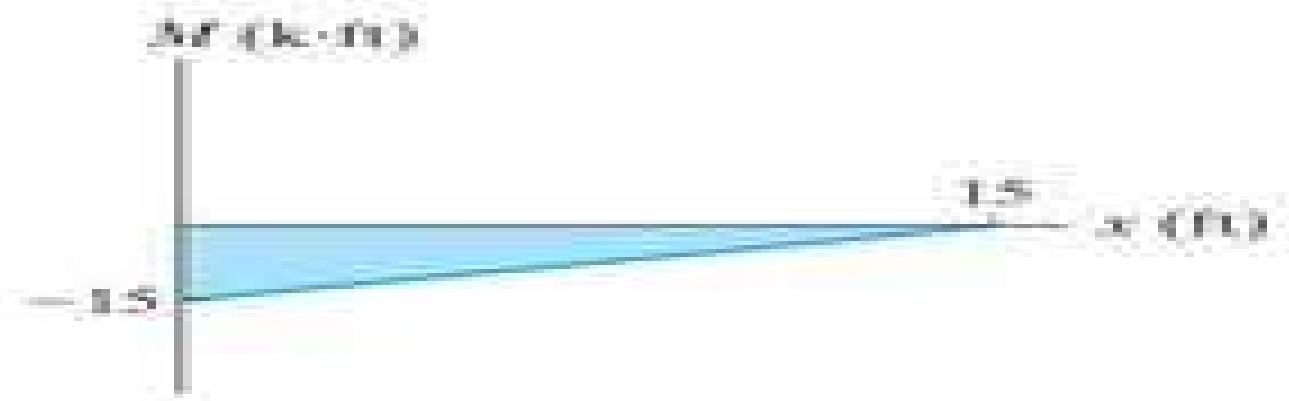




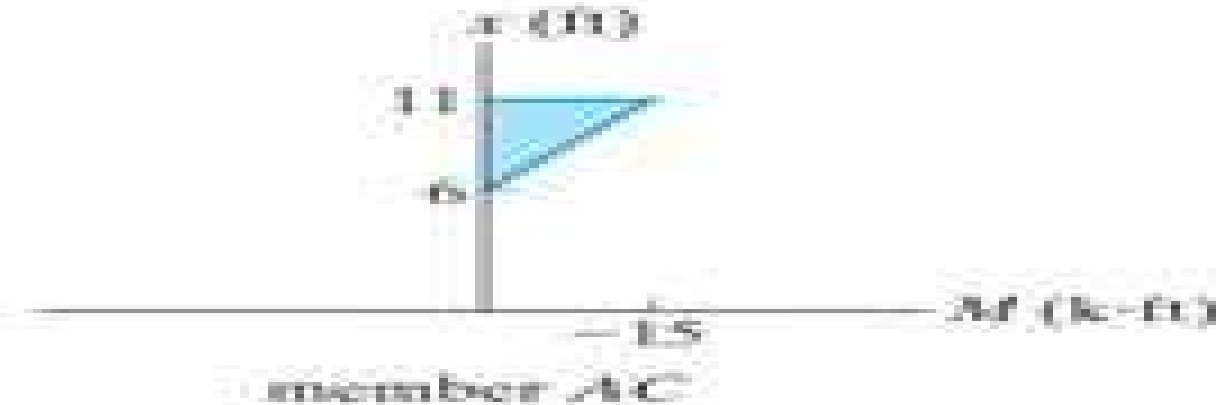




ثم نبدأ بالرسم مع مراعاة جميع الملاحظات التي تم طرحها



member CB



member AC

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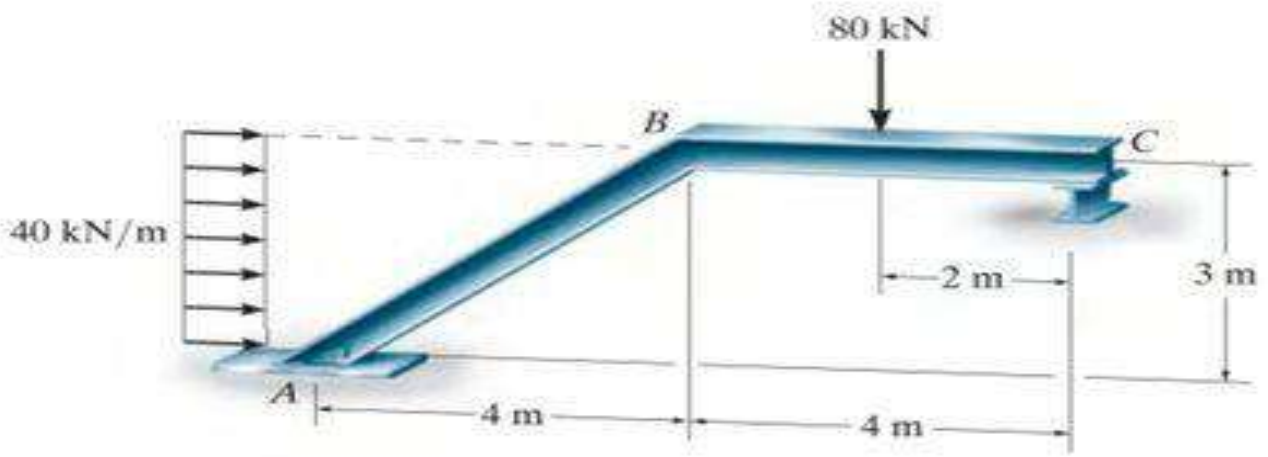
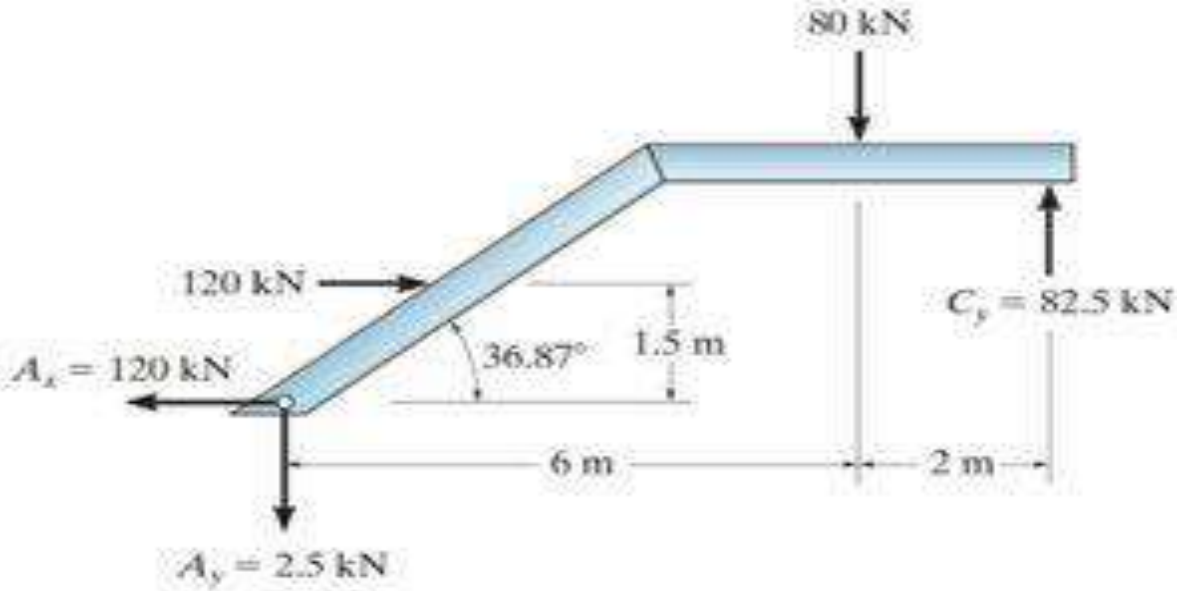
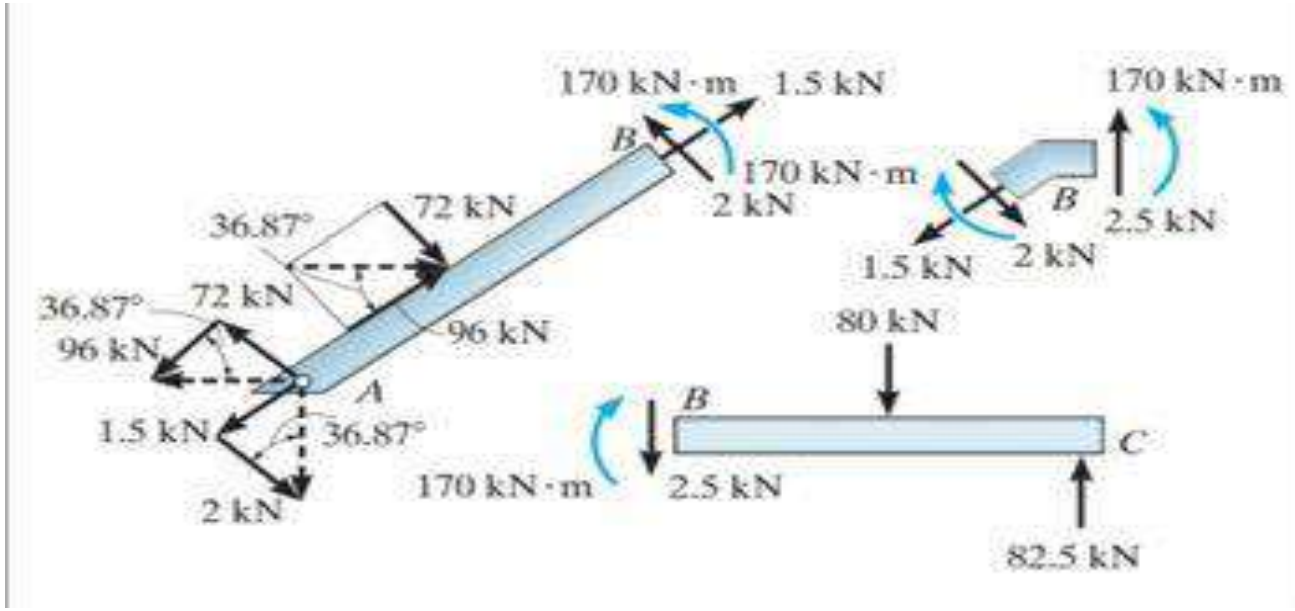
Draw the shear and moment diagrams for the frame shown in Fig. Assume A is a pin, C is a roller, and B is a fixed joint?

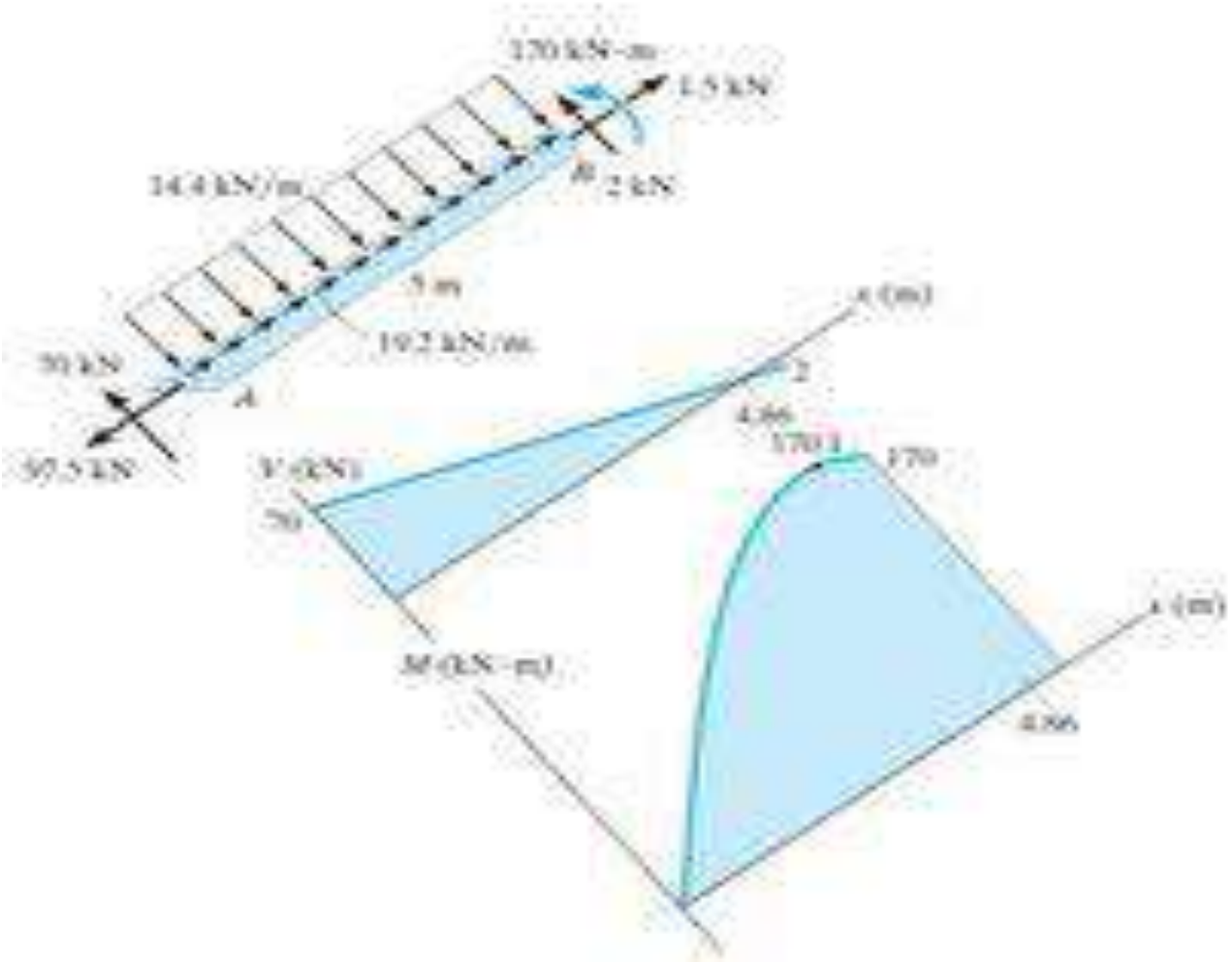


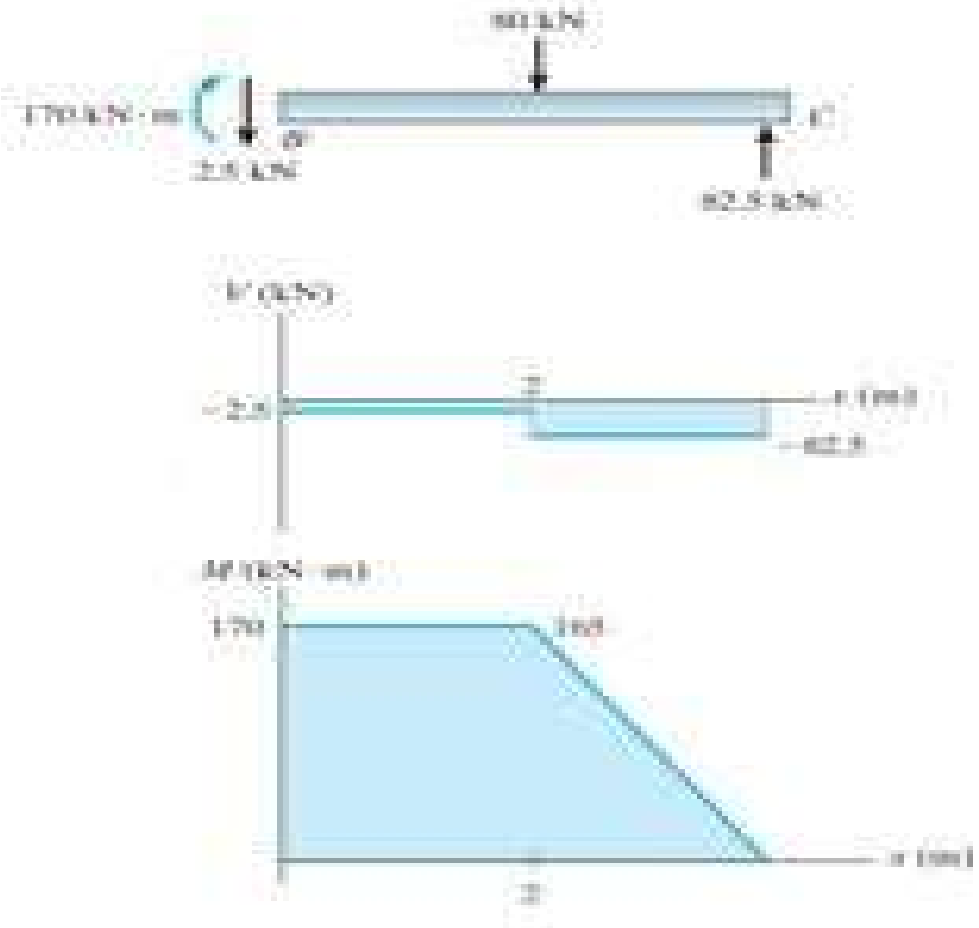
SOLUTION:





ثم نبدأ بالرسم مع مراعاة جميع الملاحظات التي تم طرحها





بعد إنهاء الشابتر الرابع عليكم بحل أسئلة الكتاب
والواجبات التي يطرحها مدرس المساق لتمكين الأفكار.