بسم الله الرحمن الرحيم

2nd Civil Engineering

By:....

Eng : Ayman abdo

بســــم اللـــــه الرحمـــن الرحيـــم

Introduction to Deflection

Eng : Ayman abdo

Chapter One : Deflections

فى الجزء ده سيتم بمشيئة الله دراسة التغير النهائى فى شكل المنشأ بعد التحميل النهائى للمنشأ وذلك لمطابقة ما اذا كان الهبوط النهائى للمنشأ فى safe side.

الطرق المستخدمة لحساب الهبوط فى المنشآت :

- ❖ Double Integration Method (2 sections).
- ❖ Conjugate Beam Method (2 sections).
- ❖ Virtual Work Method (2 sections).

Chapter Two : Detergency

يتم دراسة الفرق بين المنشآت المحدده استاتيكيا (determinate structures) والمنشآت الغير محدده استاتيكيا (indeterminate structures) وكيفية تحديد عدد المعادلات والمجاهيل (1 sections) .

Chapter Three : Consistent Deformation

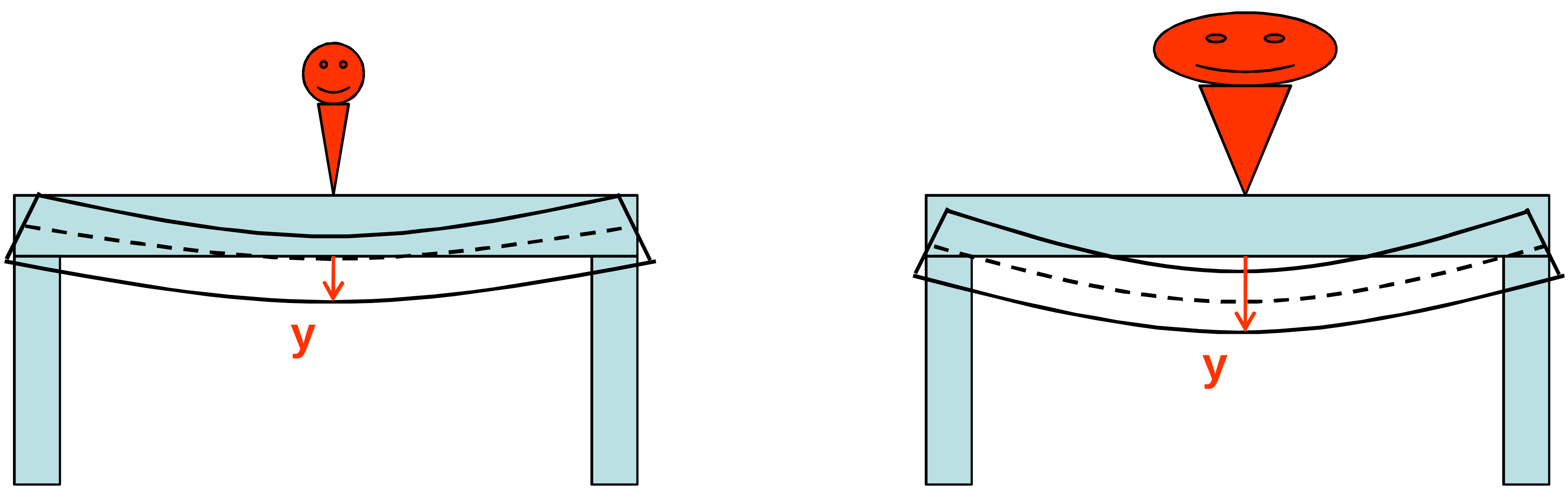
رسم الـ internal force للمنشآت الغير محدده استاتيكيا (5 sections) .

Drawing without calculation (1 sections)

Deflection

يرتبط الهبوط فى المنشآت بالترمين السابقين ارتباطا وثيقا حيث يعتمد اولا على (الاحمال ومدى تأثيرها على العزوم) ثانيا (خواص القطاع والمواد المستخدمة فى الكمرة).

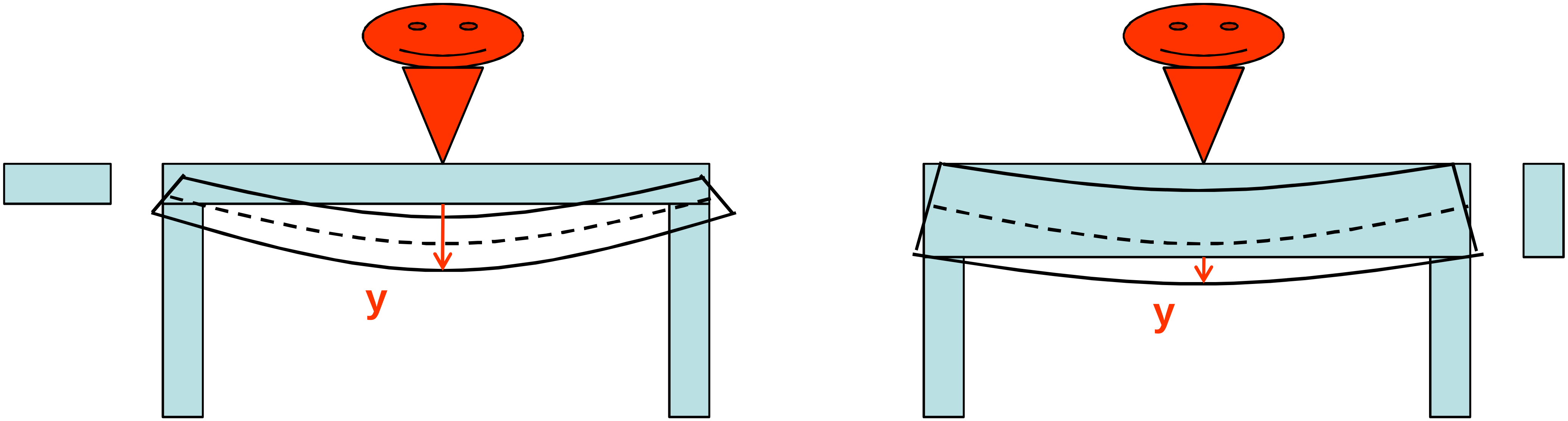
❖ تأثير الاحمال على الهبوط فى المنشآت



الهبوط يزيد بزيادة القوى المؤثرة

❖ تأثير خواص القطاع على الهبوط فى المنشآت

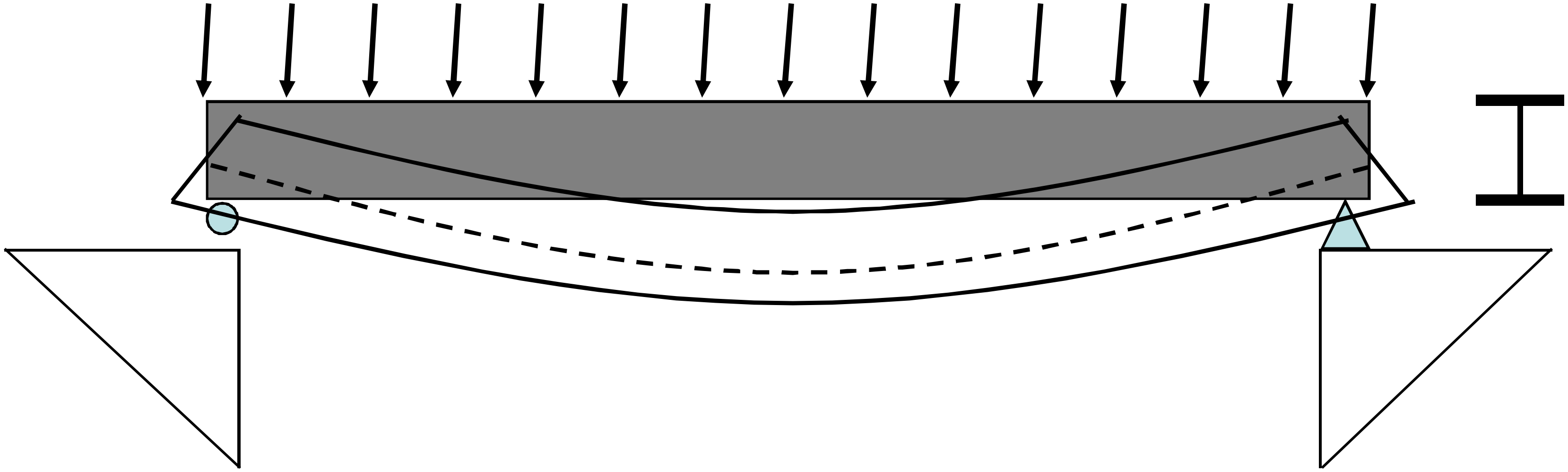
بنفس الاحمال ولكن مع تغيير وضع الكمرة وبالتالى تغيير قيمة الـ inertia



الهبوط يقل بزيادة الـ inertia

ايضا بالتأكيد تتغير قيمة الهبوط بتغيير نوع الماده
الـ modulus of elasticity (E)

Beam
Girder



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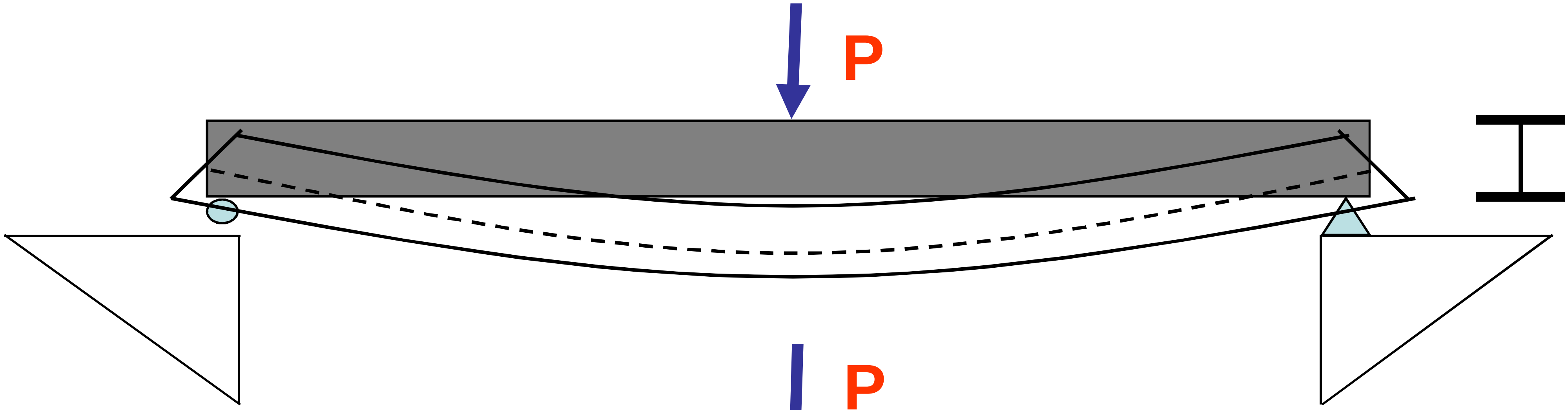
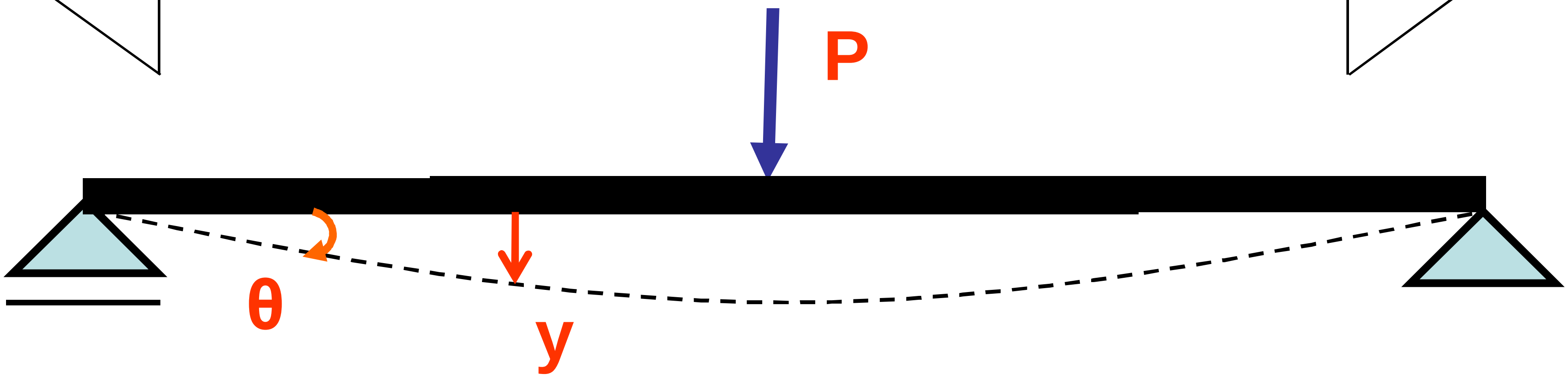




y >>> deflection at any point **الهبوط**

Hinge, Roller and Fixed Support الهبوط يساوى صفر عند الـ

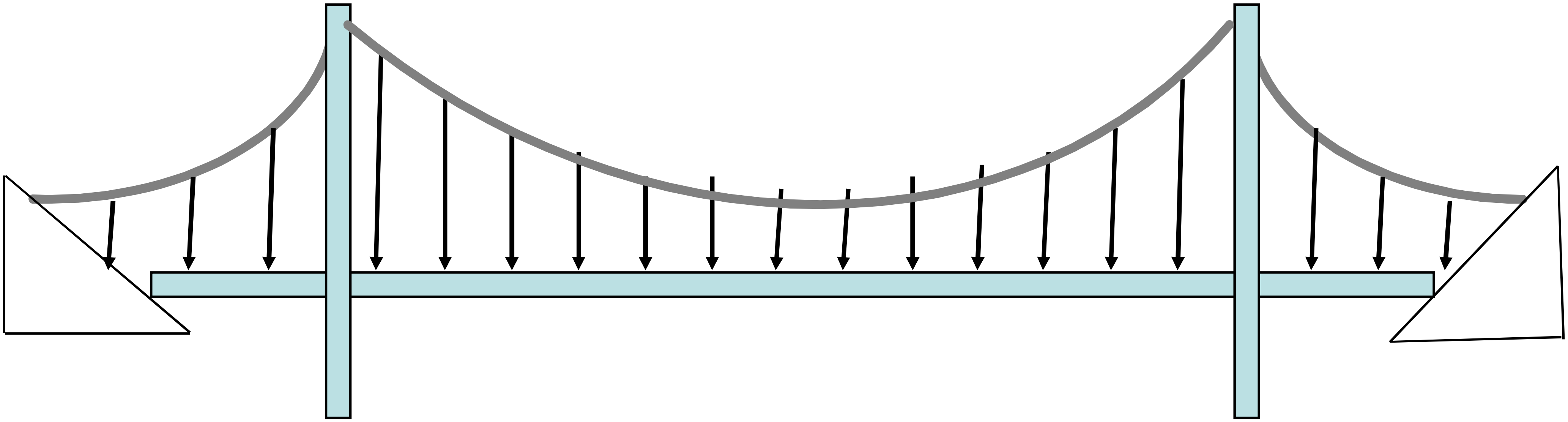
θ >>> rotation or slope at any point الدوران

Fixed Support الدوران يساوى صفر عند الـ

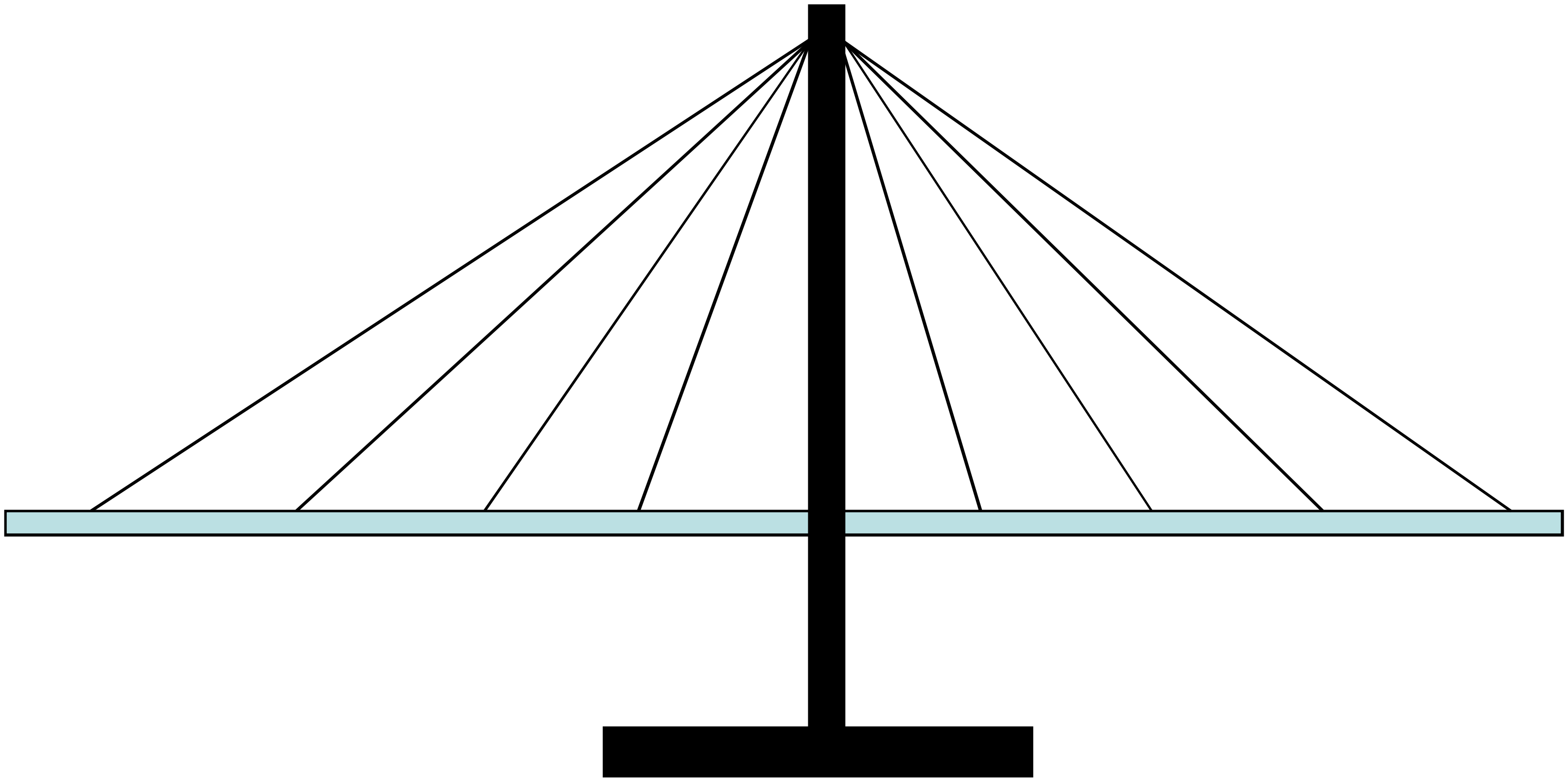
ملاحظه مهمه أن الـ Rotation (θ) = تفاضل الـ Deflection = y ׳

بعض الطرق المستخدمة لتلاشى الهبوط الكبير الناتج عن المسافات الواسعة بين الاعمده

Cable Suspended Structure



Cable Stayed Bridge



مراجعة سريعة لبعض المفاهيم السابق دراستها

Types of Load

1. Dead loads
2. Live loads
3. Dynamic loads (trains, equipment)
4. Wind loads
5. Earthquake loads
6. Thermal loads
7. Settlement loads

Dead Loads

1. **weight of the structure itself**

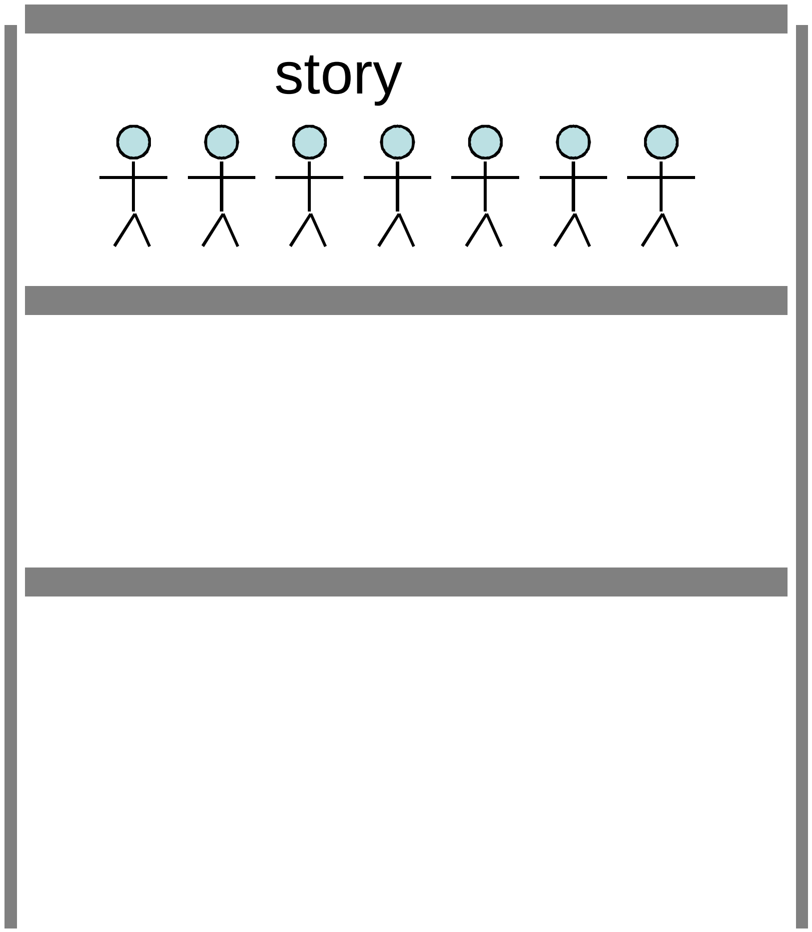
   floors, beams, roofs, decks, beams/stringers, superstructure

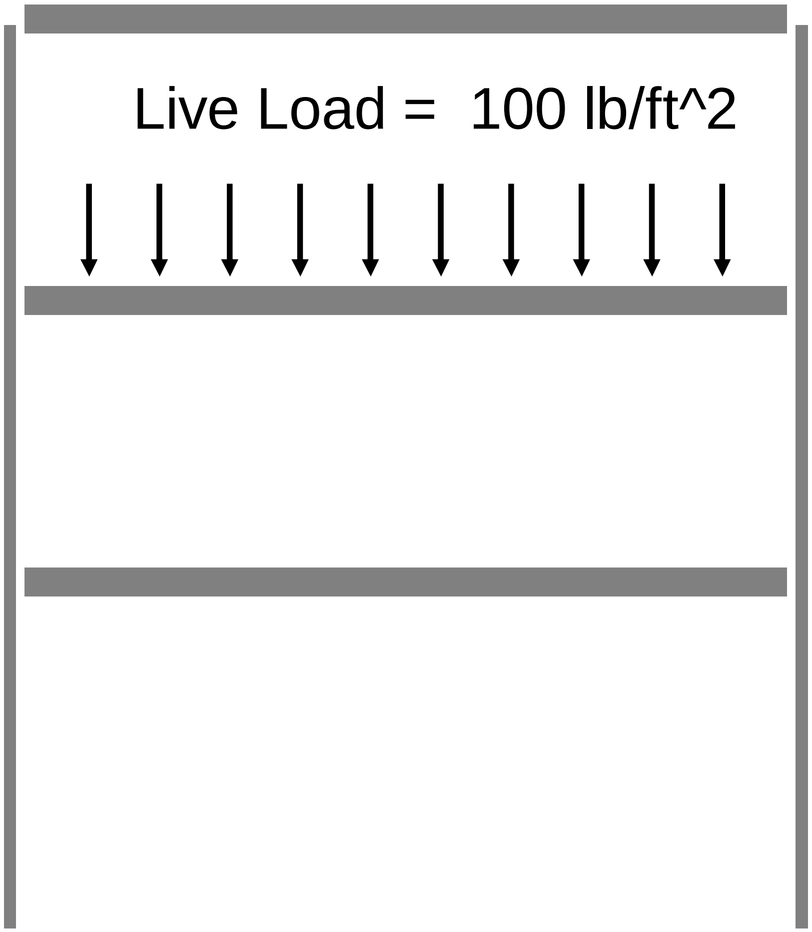
2. **loads that are “always there”**

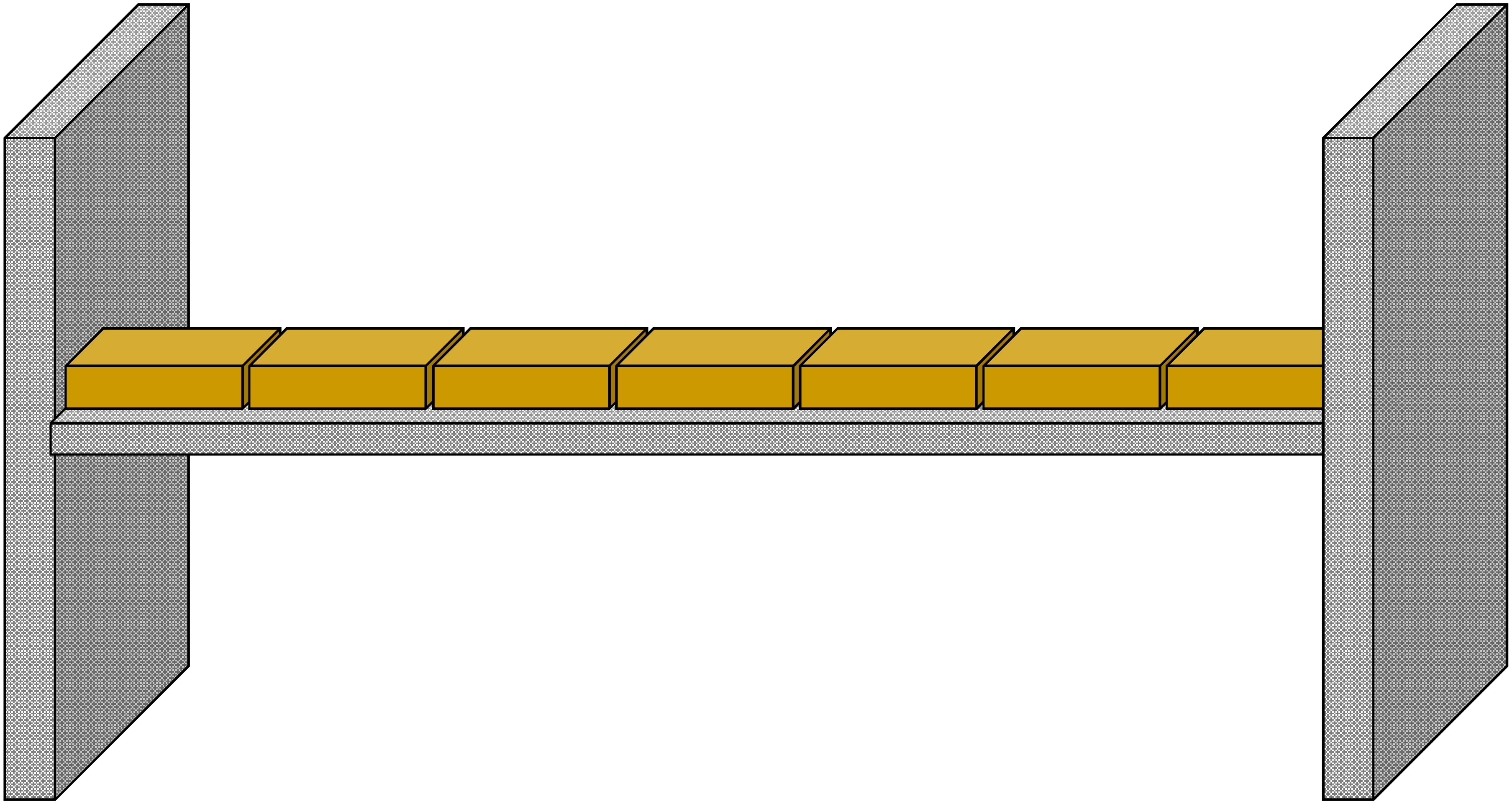
Live Loads

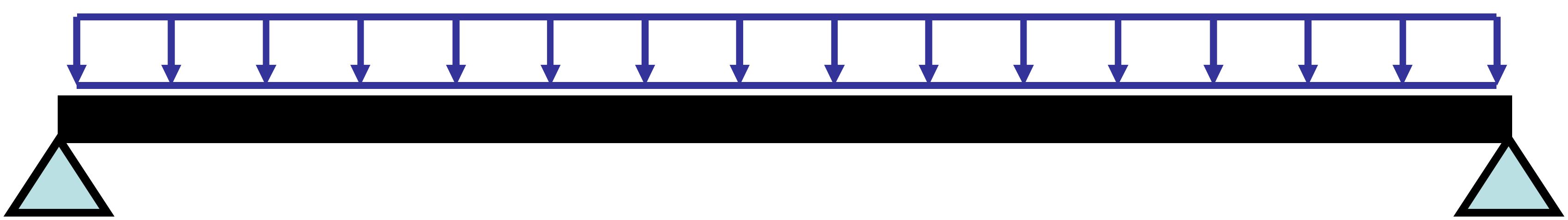
1. People, furniture, equipment
2. Loads that may move or change mass or weight
3. Minimum design loadings are usually specified in the building code

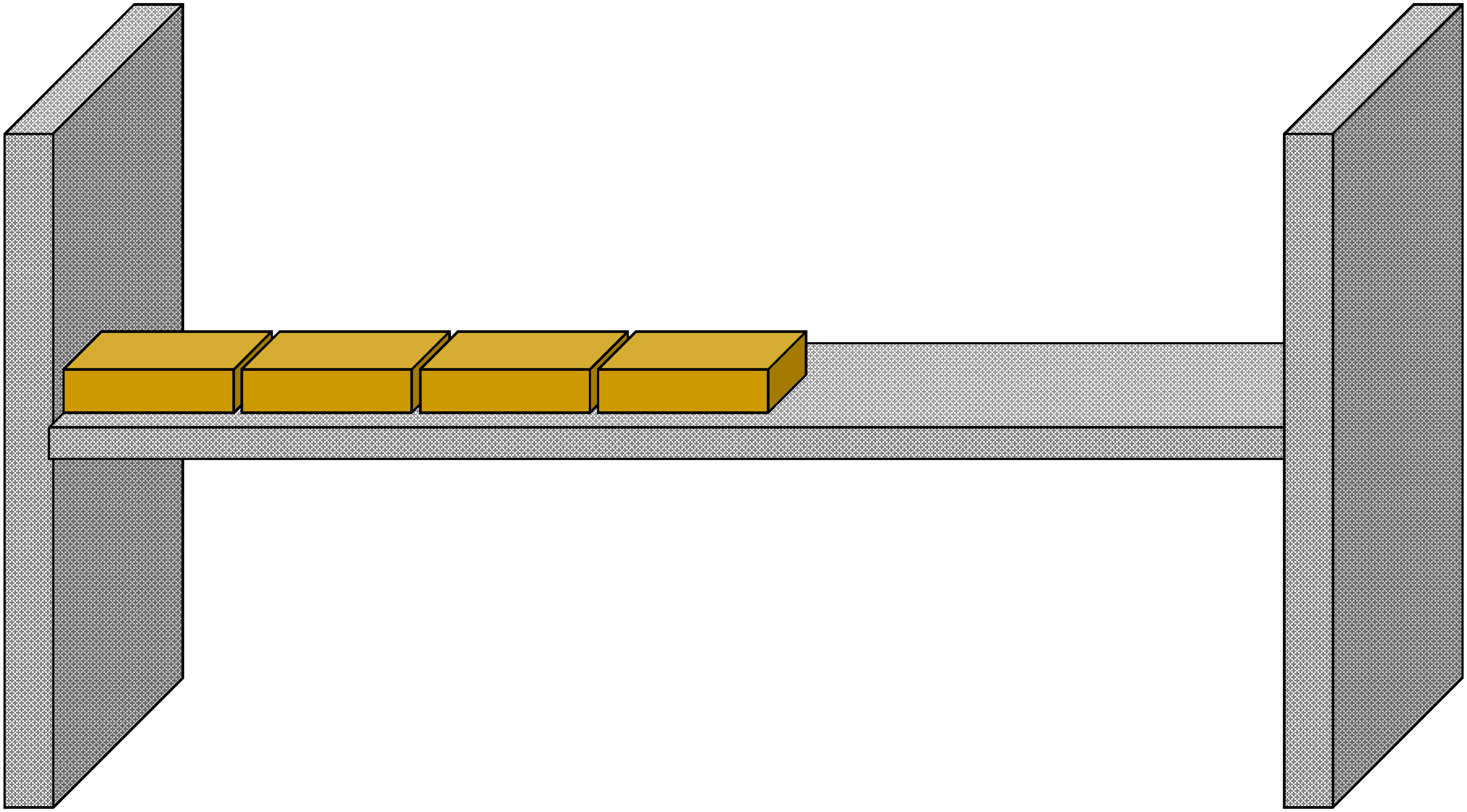
Load Example: Live Load

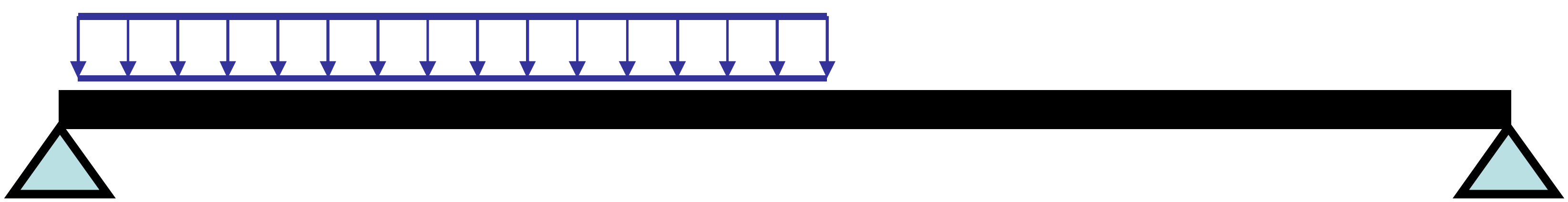


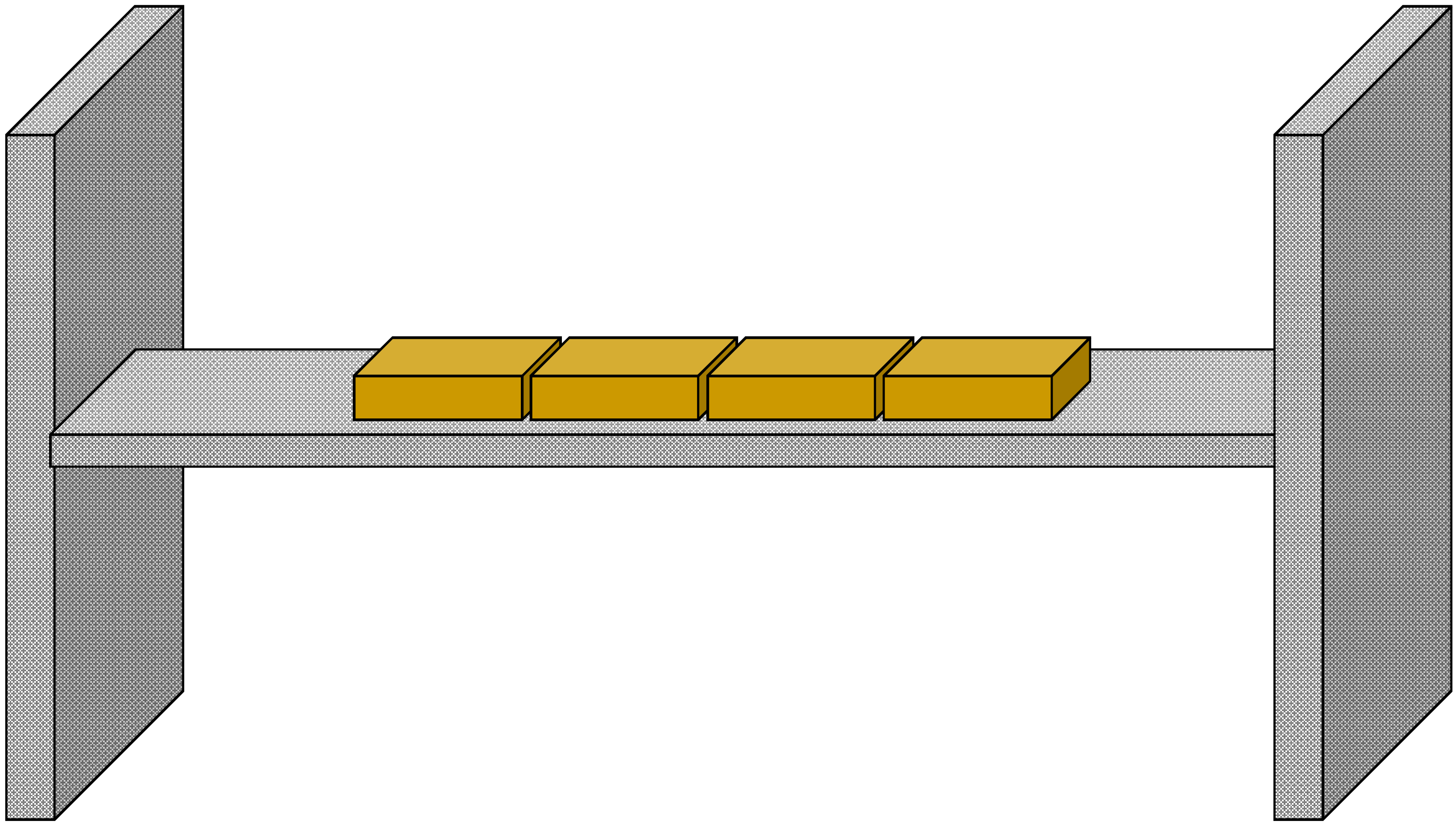


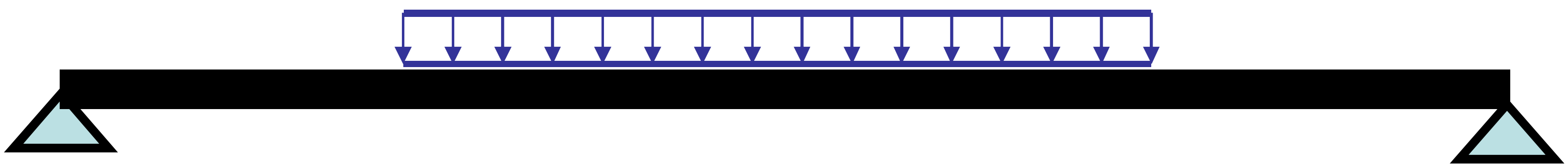


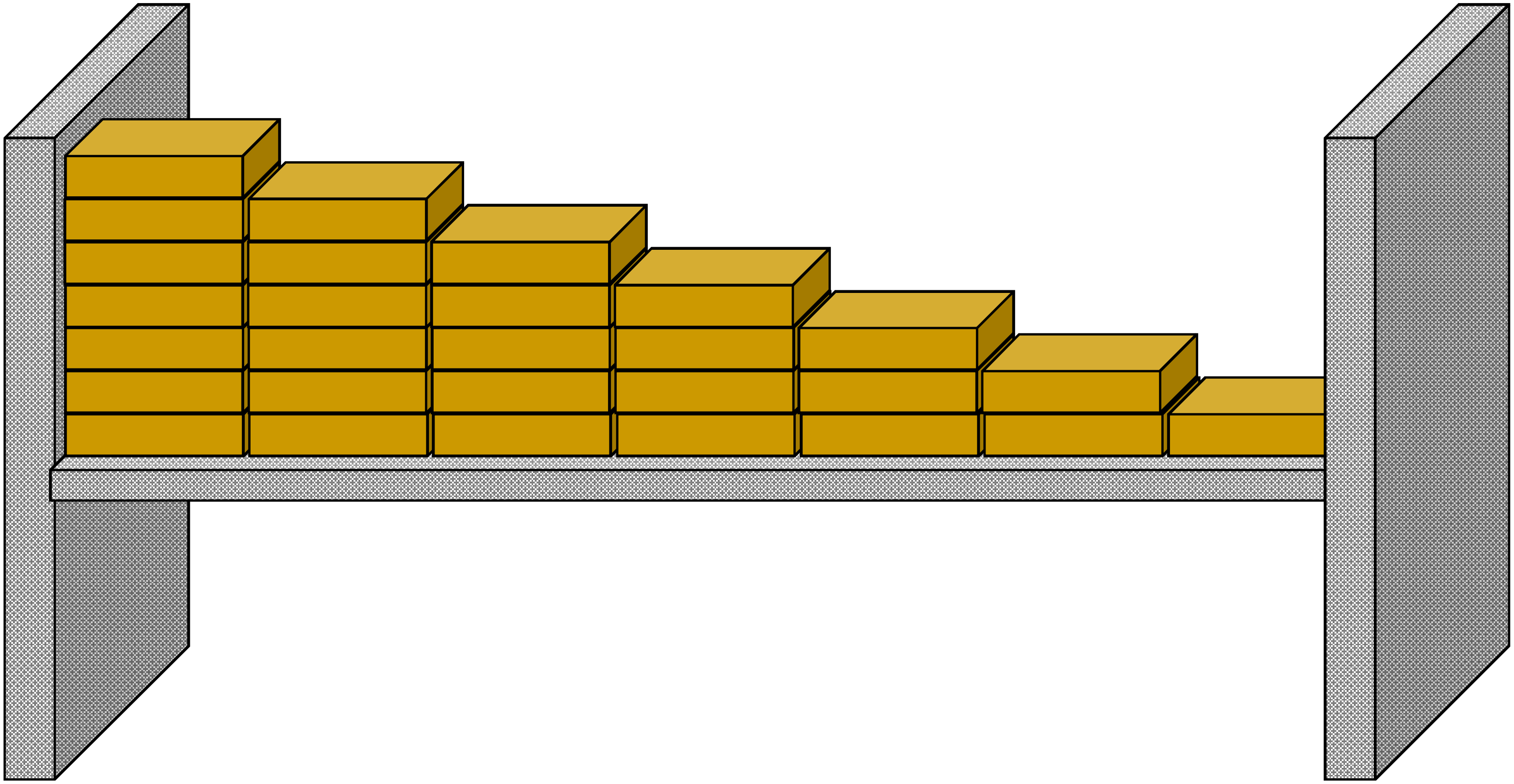


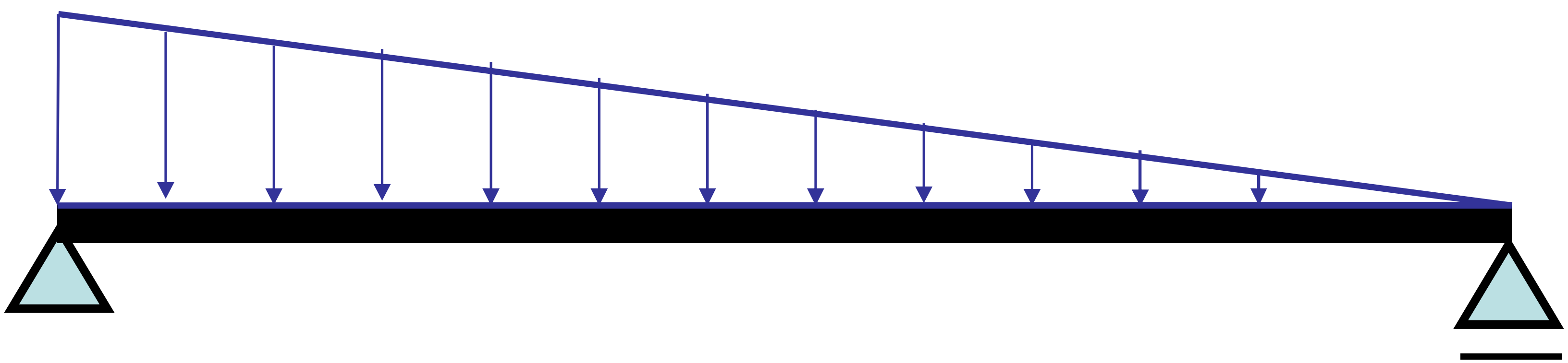


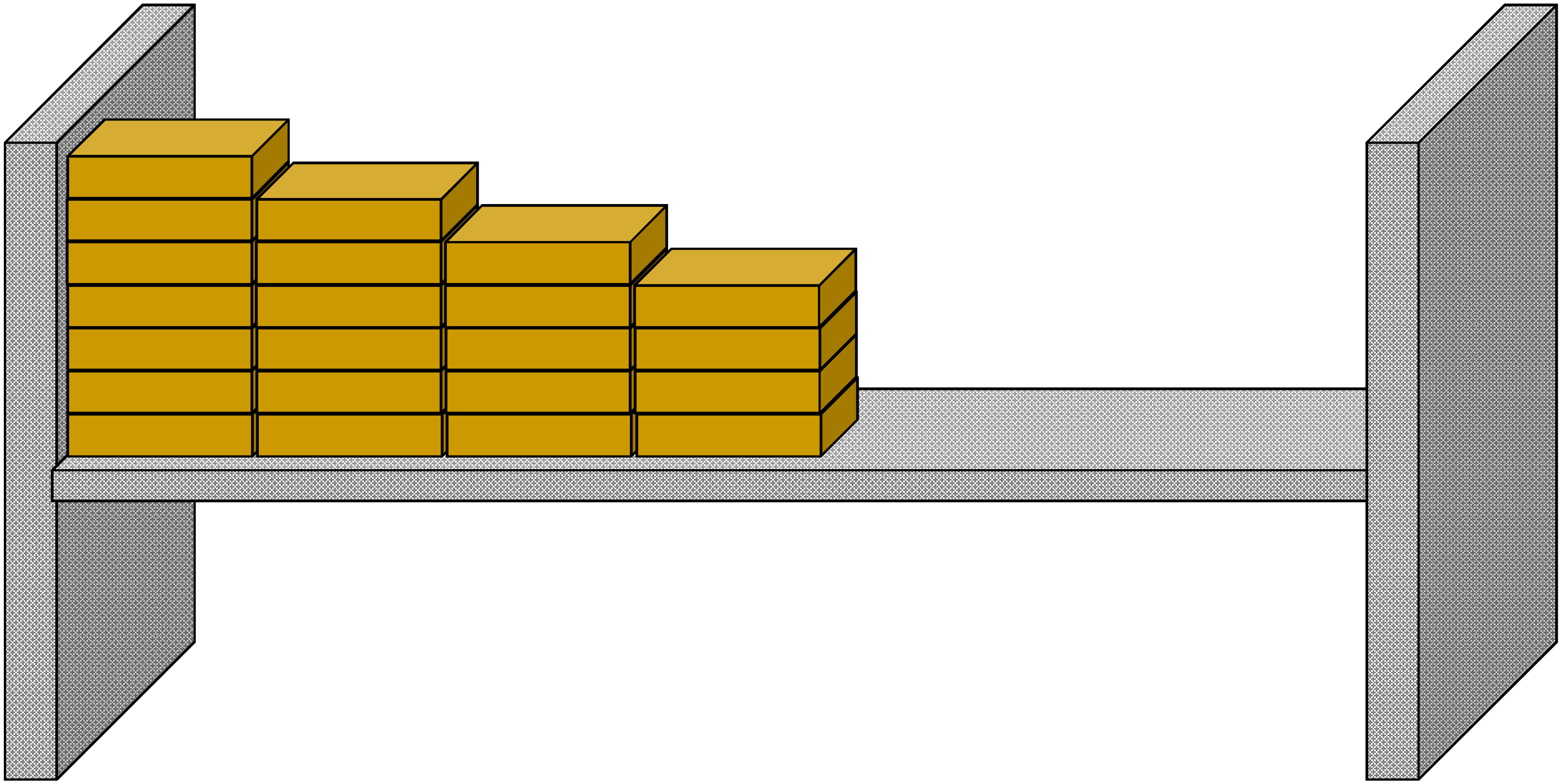


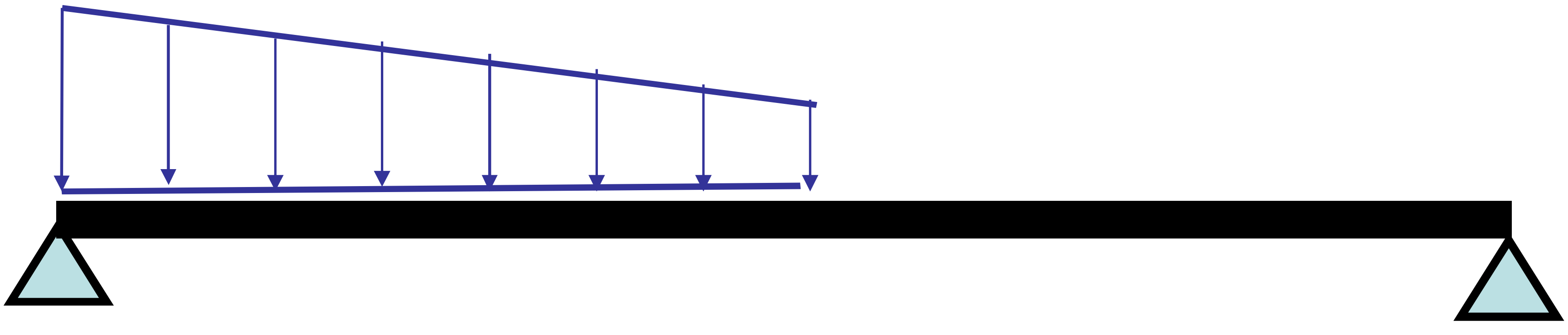


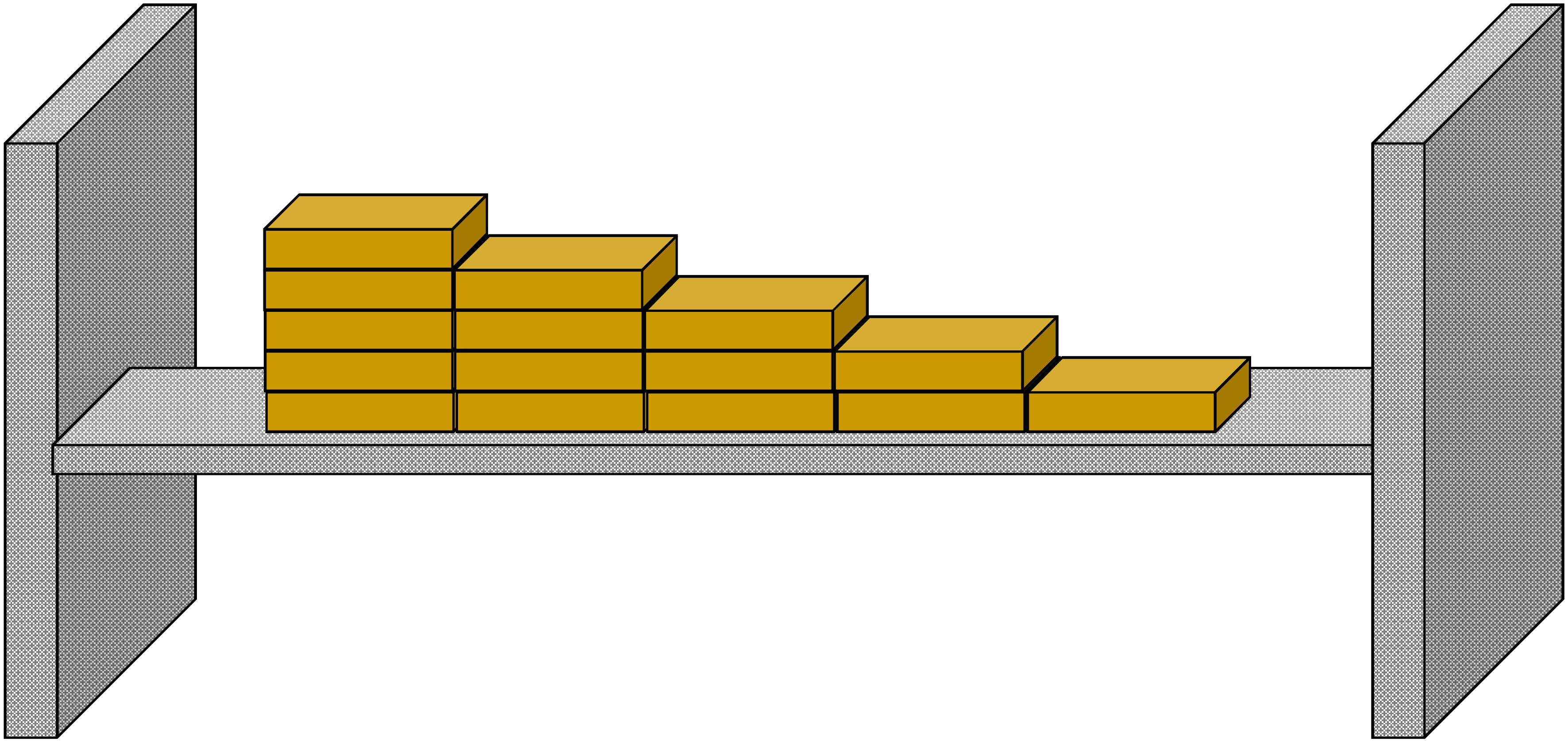


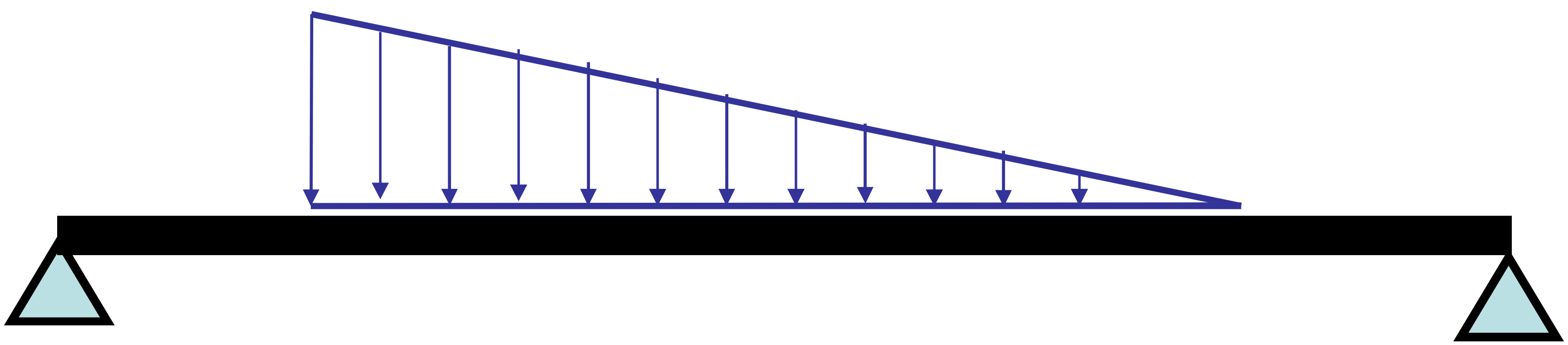


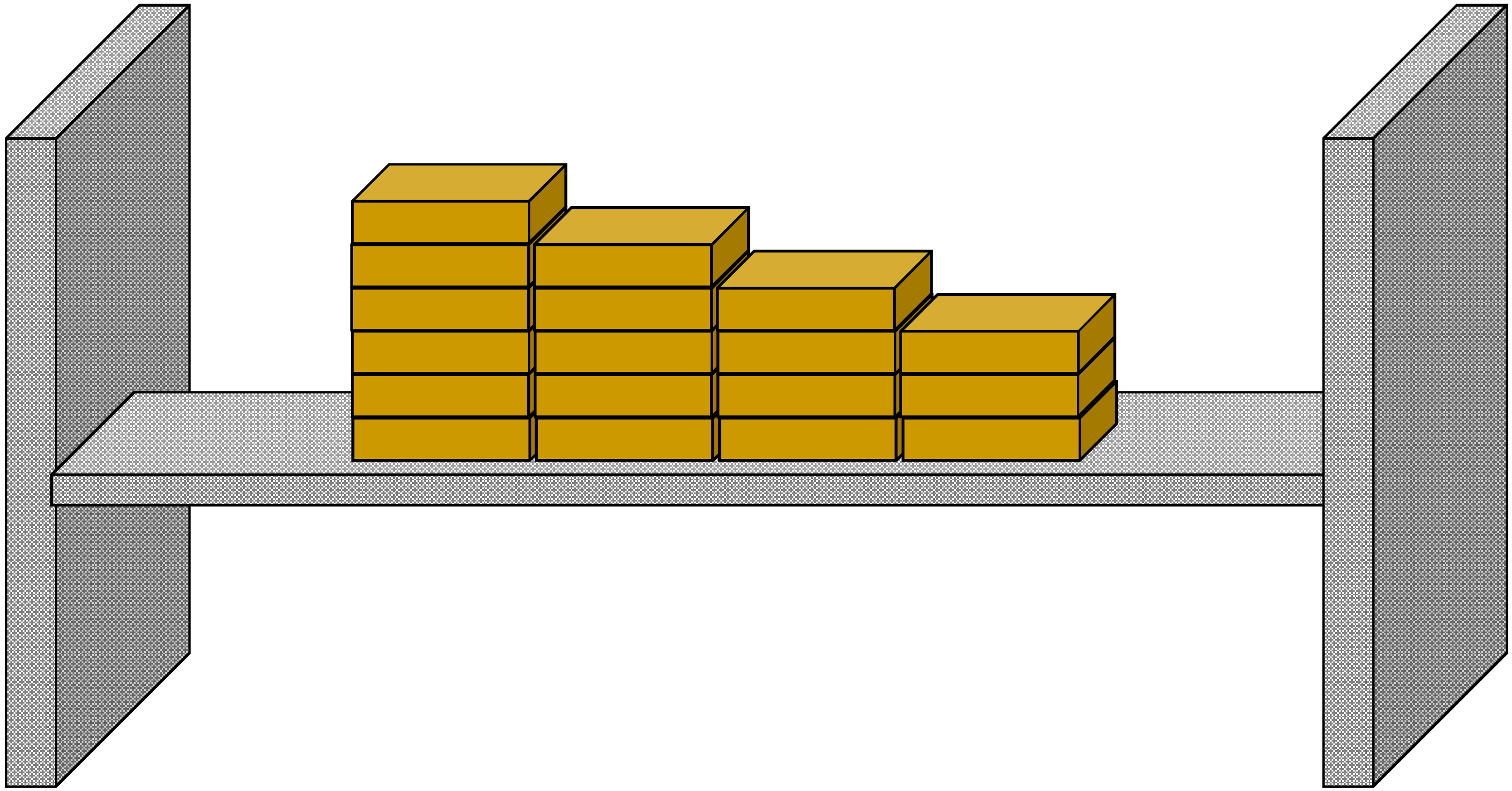


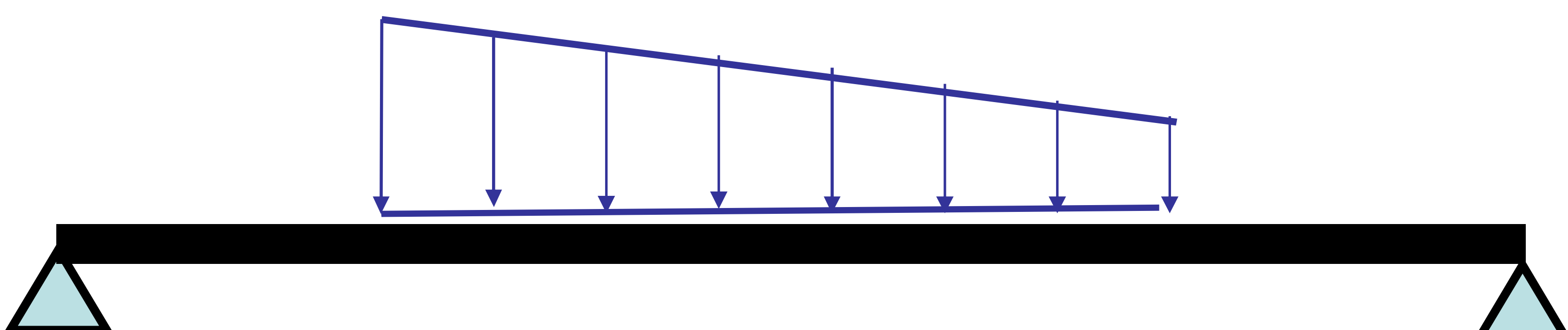




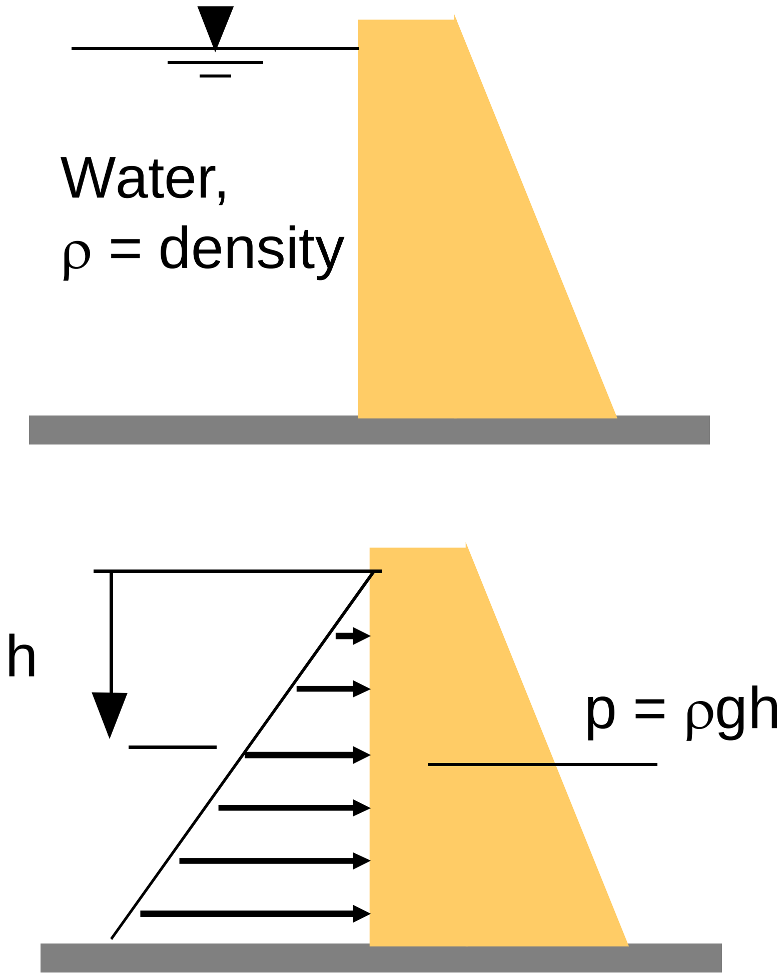








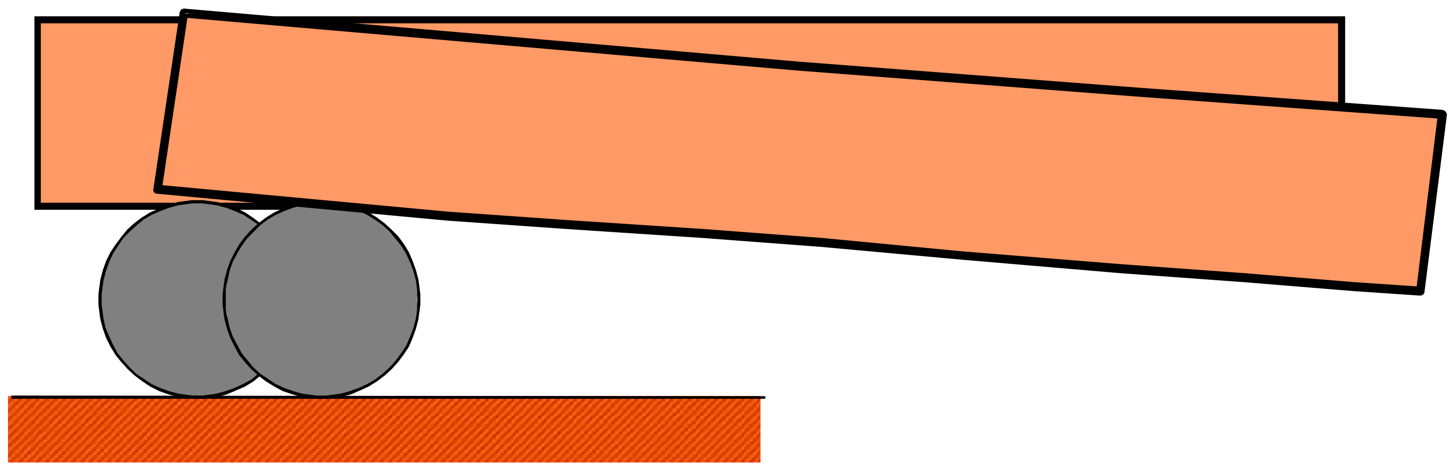
Load Example: Water in a dam



Types of Supports

ROLLER SUPPORT

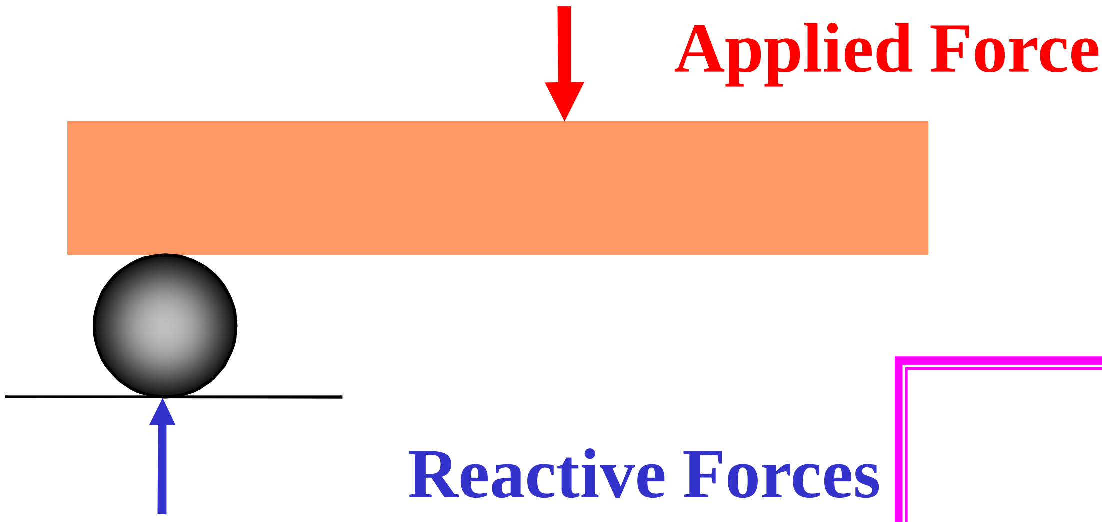
Roller Support

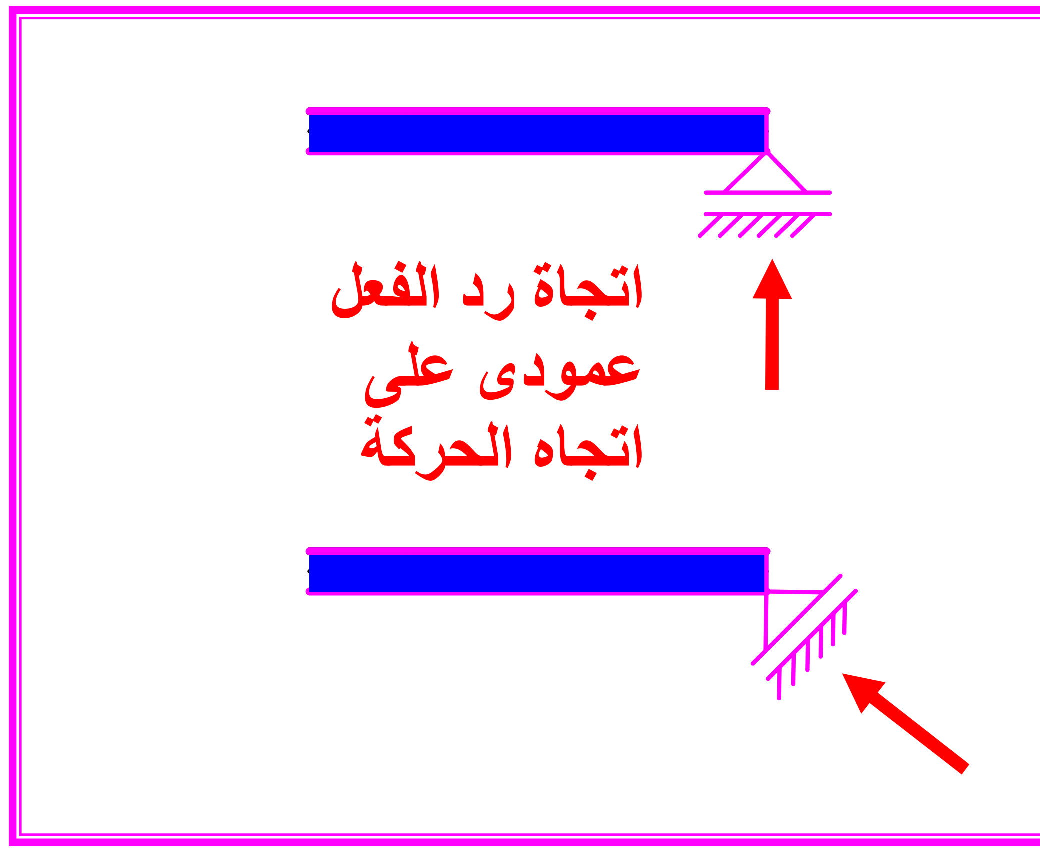


Roller Support

يسمح بالحركة فى احد الاتجاهين والدوران

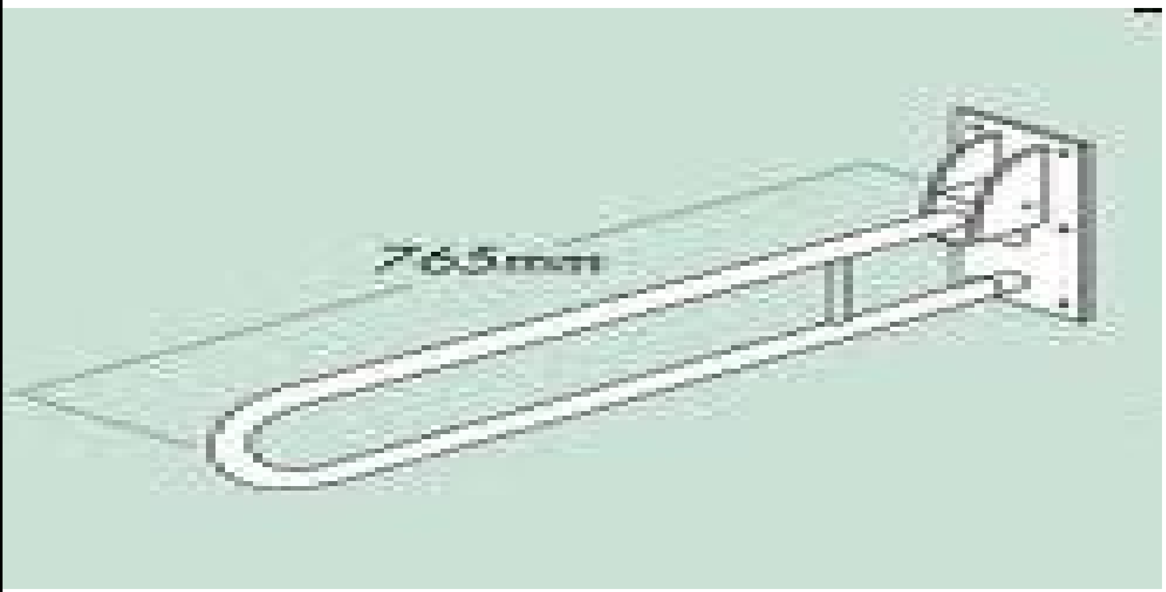
ROLLER SUPPORT





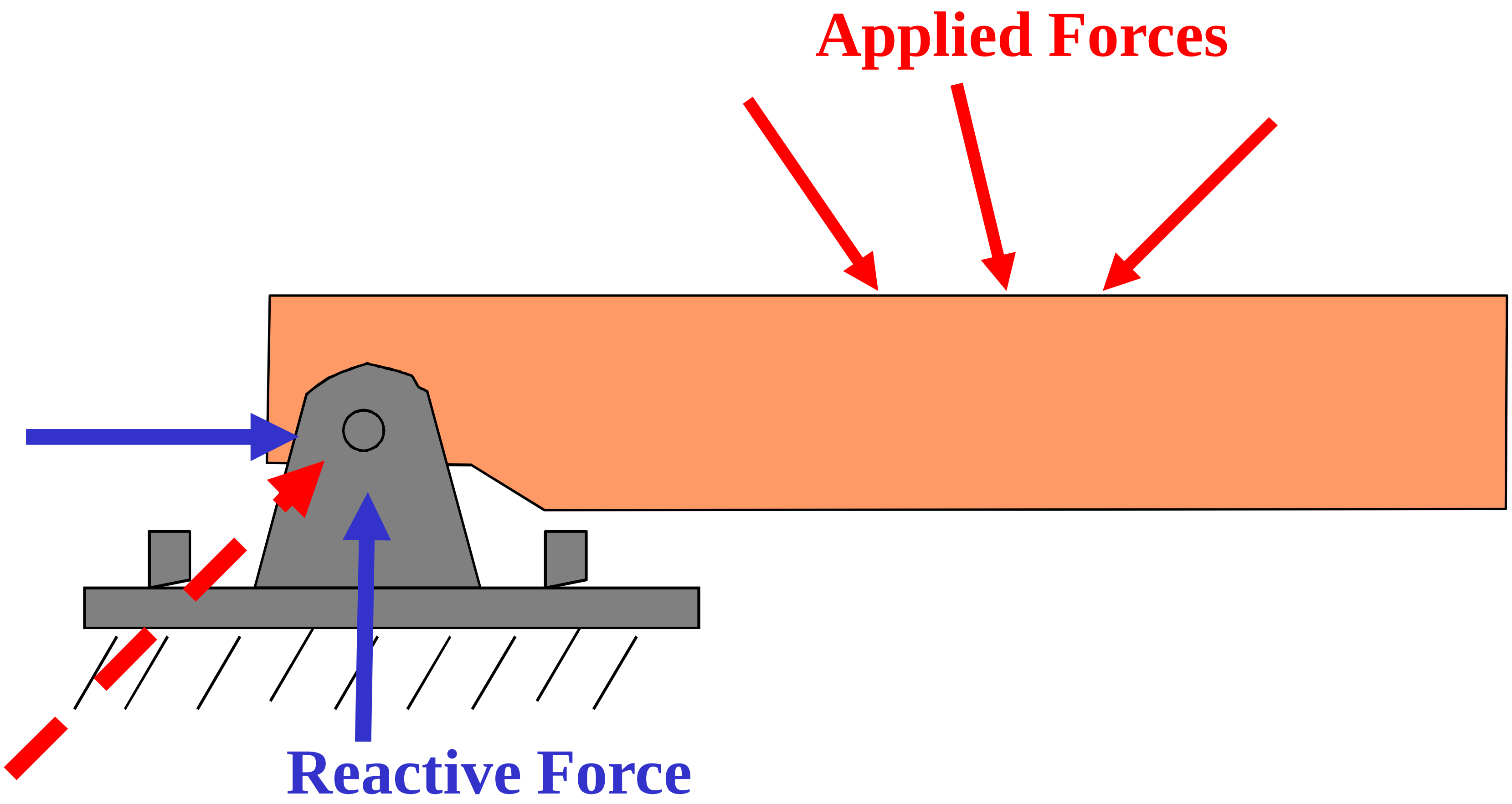
The Reactive Force must always be perpendicular to the surface of Rolling

HINGED SUPPORT

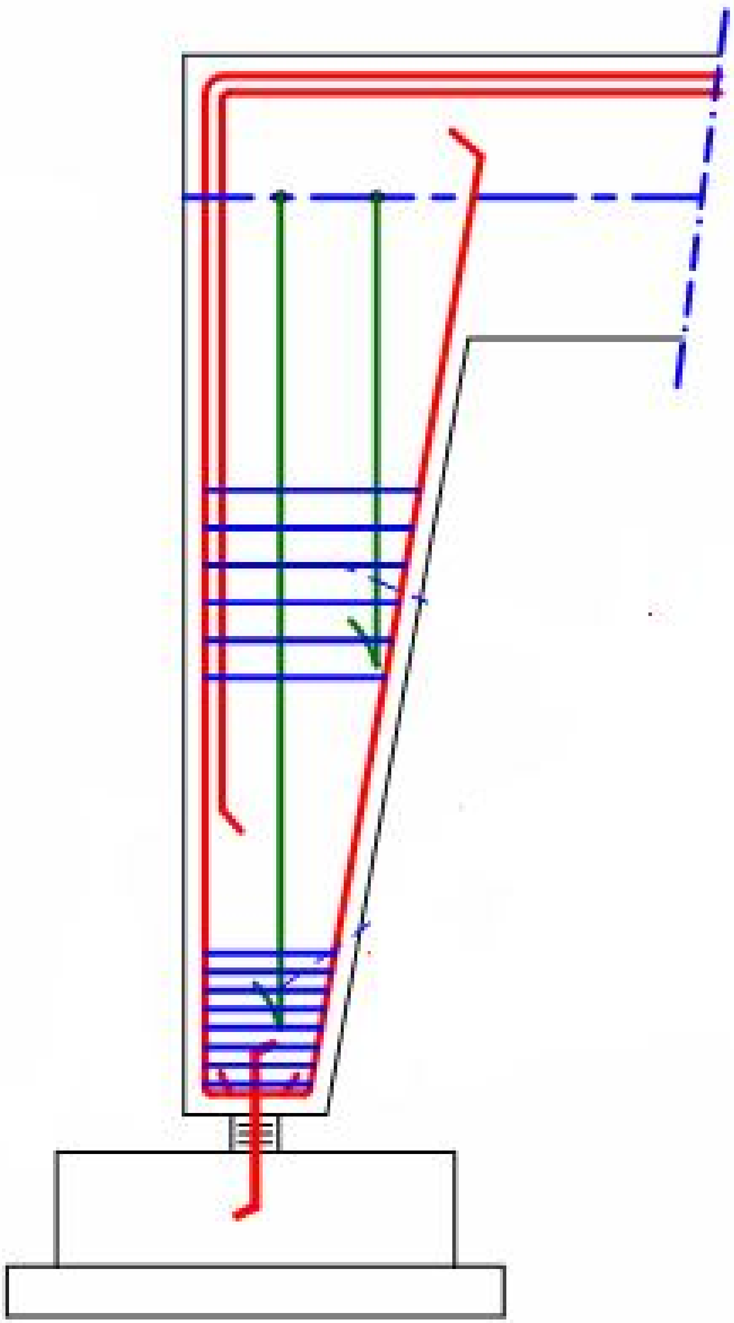


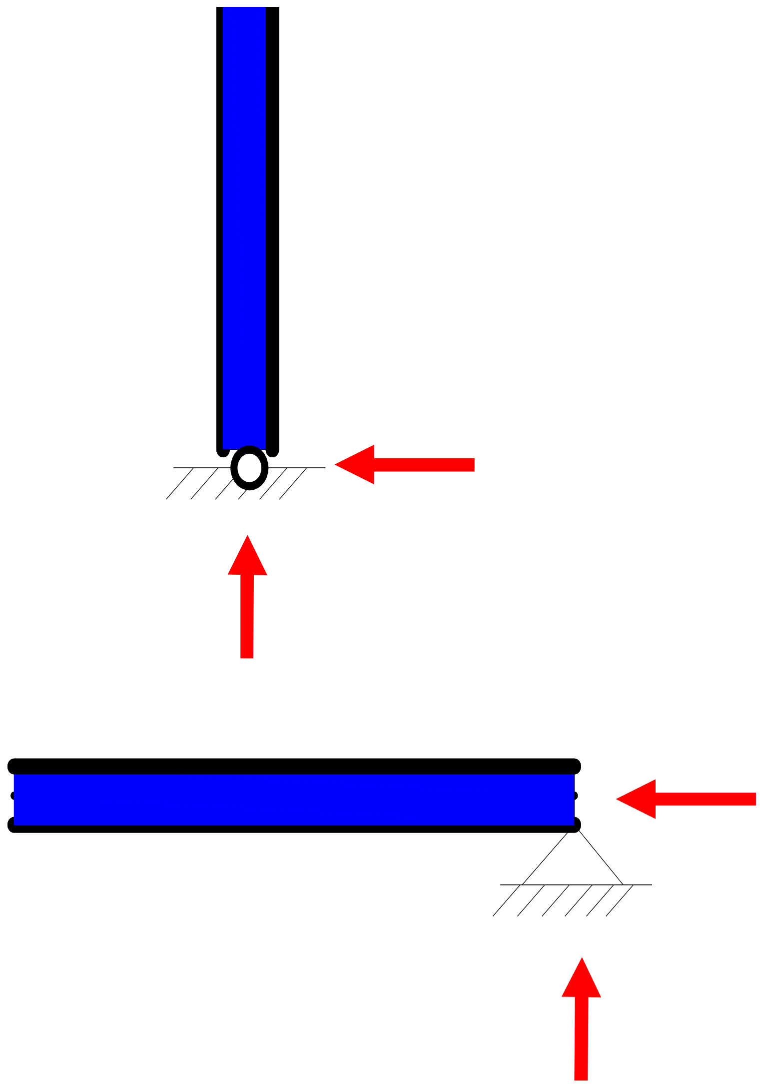
KNEE HINGE

PIN or HINGE SUPPORT

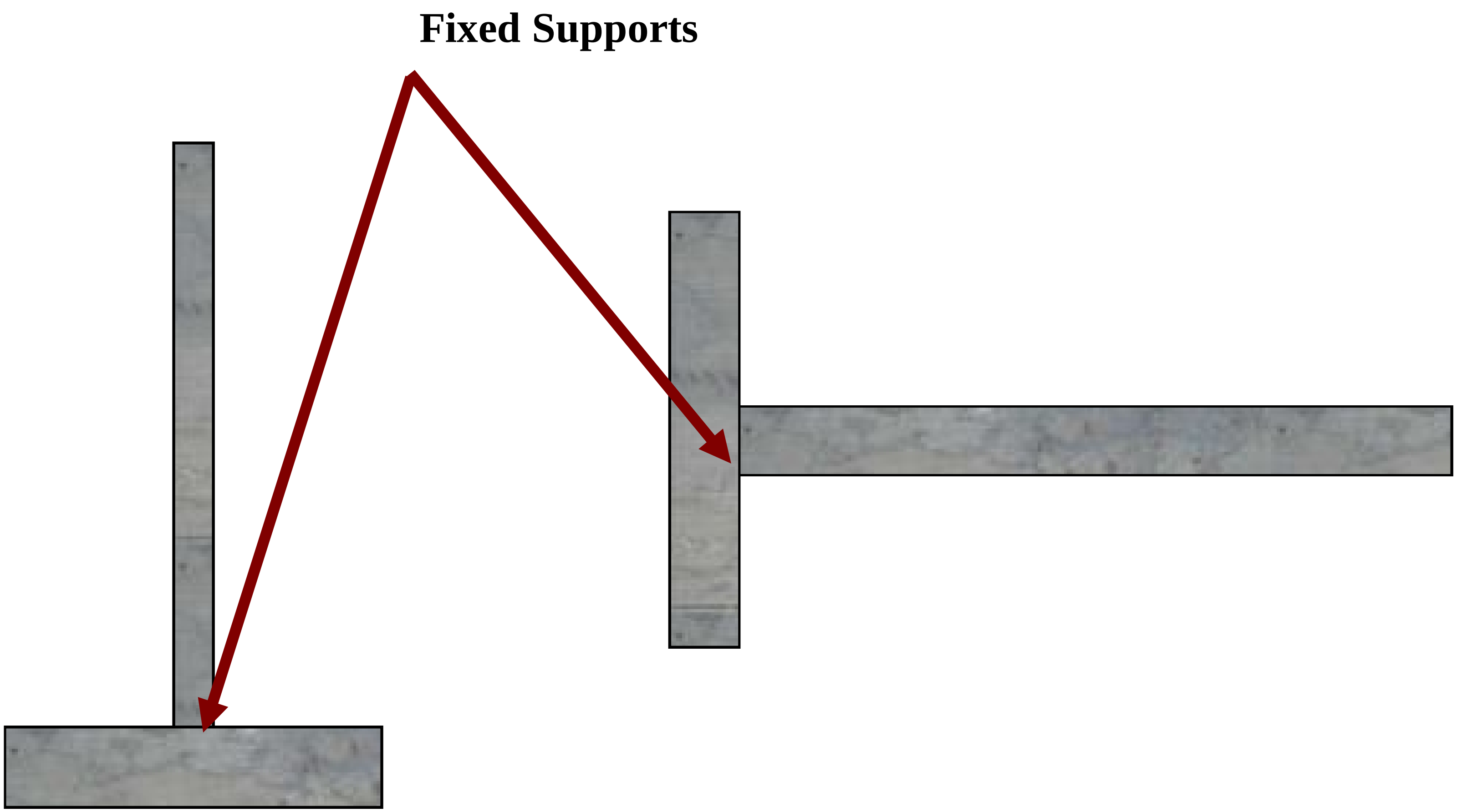


The Reactive Force can be in any direction



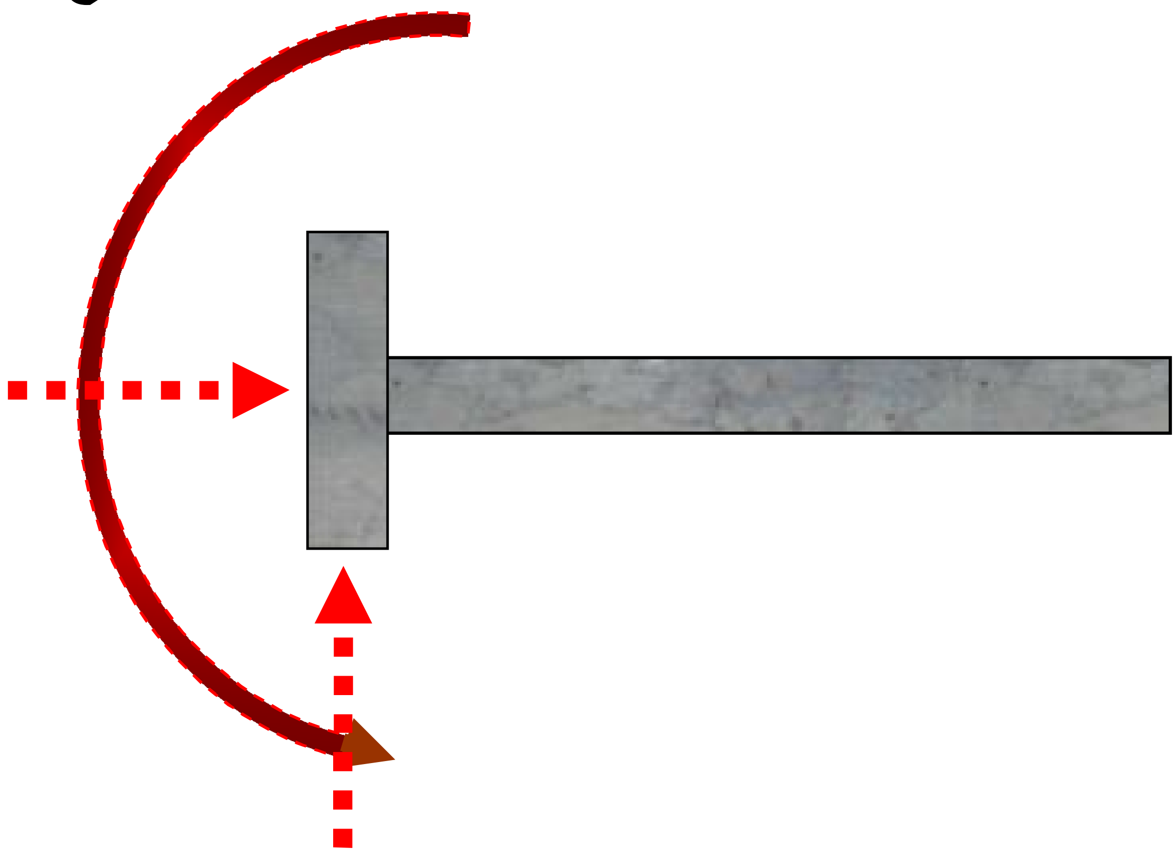


FIXED SUPPORT



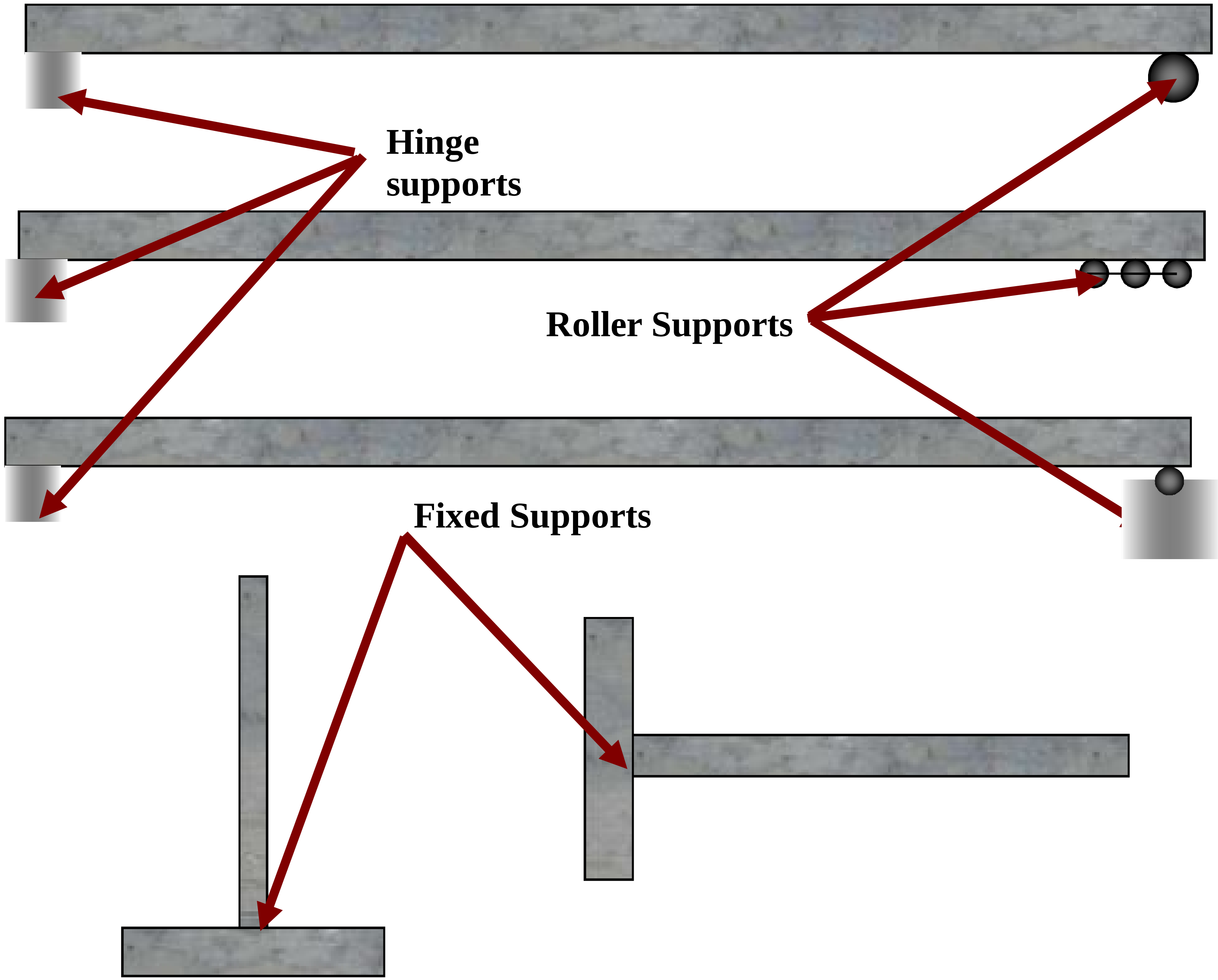
Fixed Support

لا يسمح بالحركة فى الاتجاهين والدوران

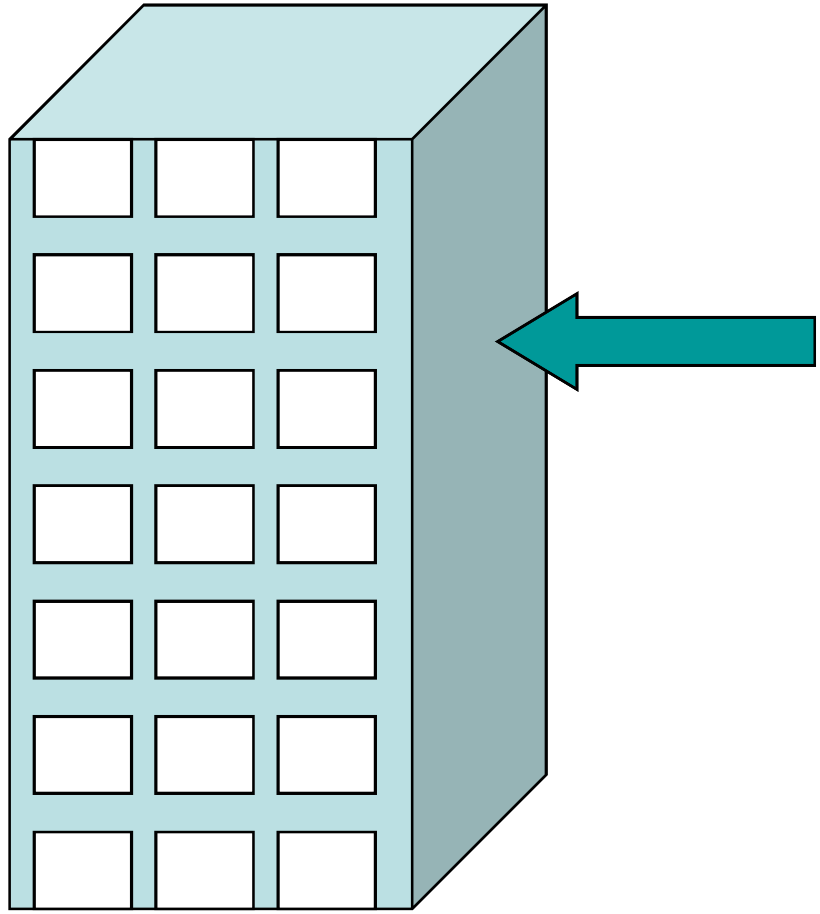


The Reactive Force can be in any direction Also there is reaction in the rotation direction

Roller, Hinge and Fixed Supports



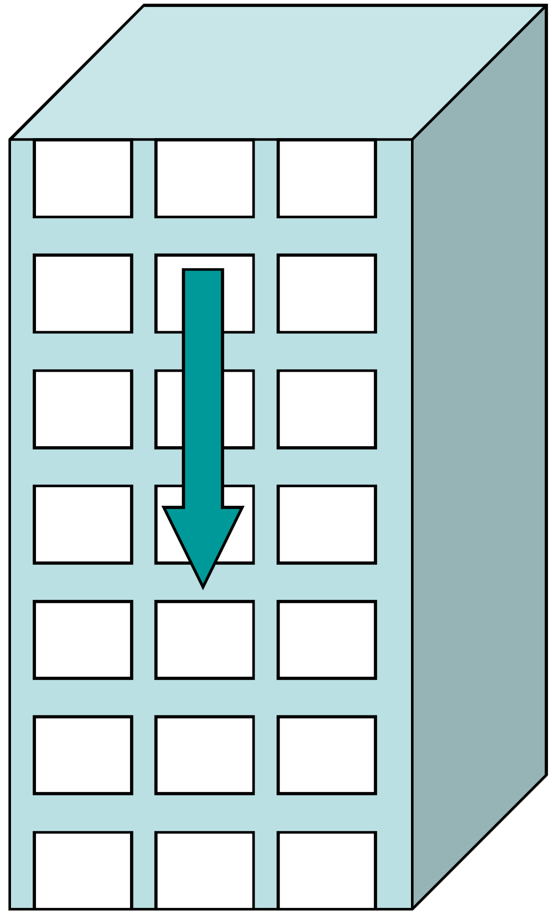
Reactions



LATERAL: WIND, EARTHQUAKE

$$\sum F_x = 0.0$$

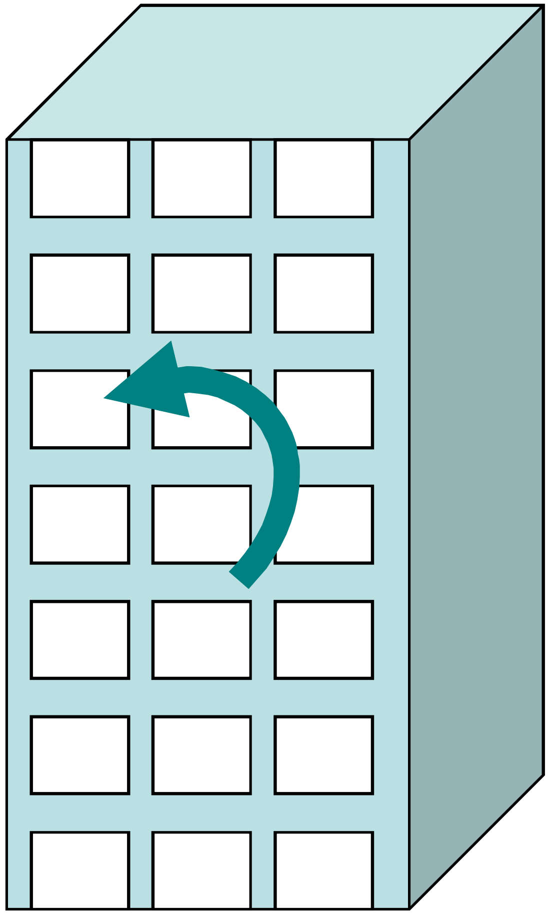
>>>>> = <<<<<



VERTICAL: GRAVITY

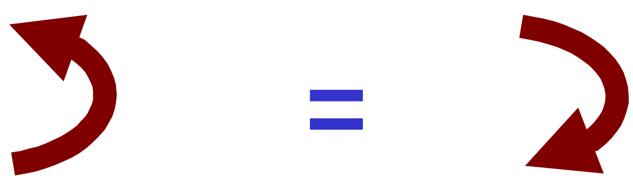
$$\sum \mathbf{F}_Y = 0.0$$

^^^ = vvv

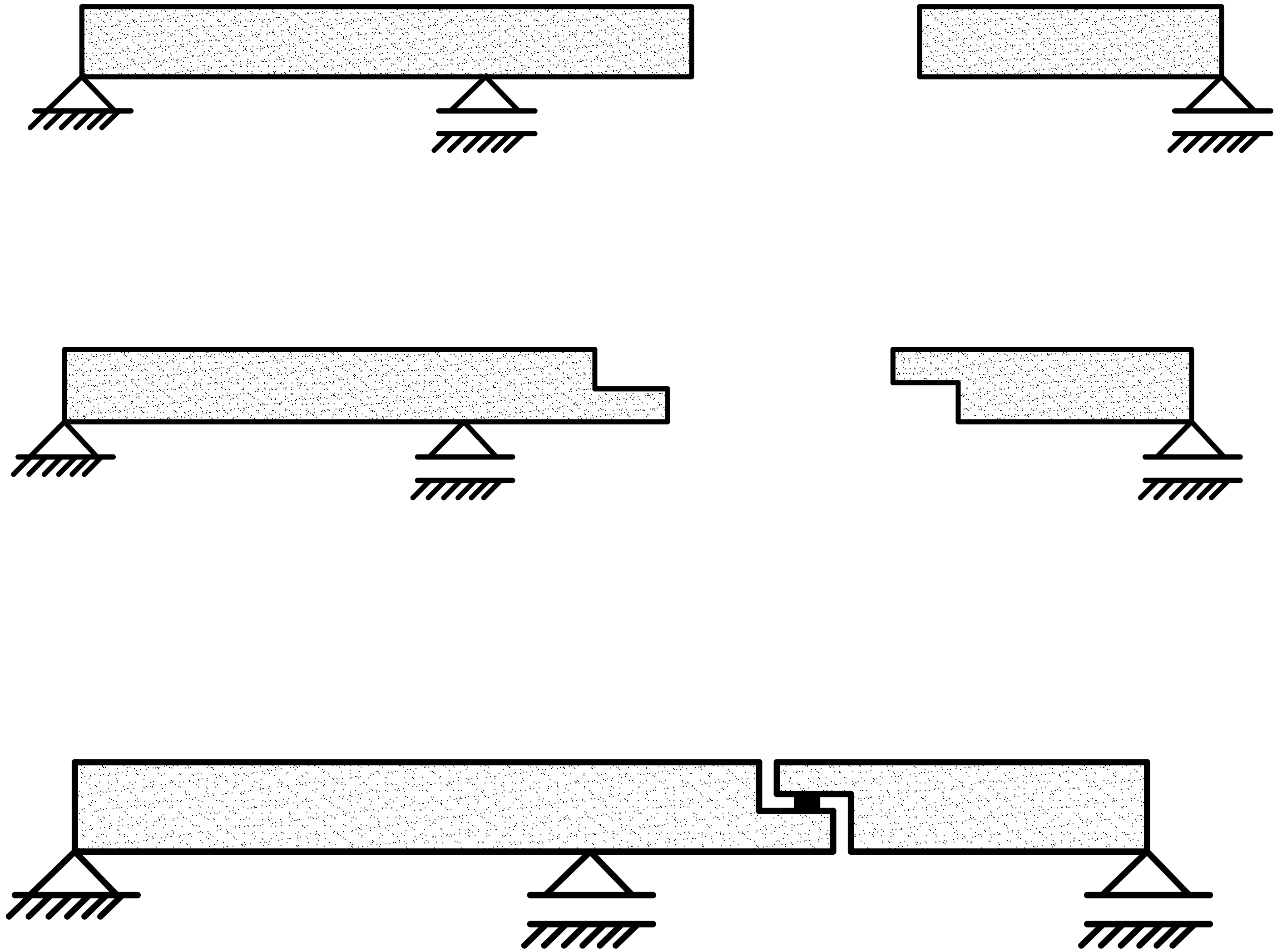


ROTATION: OVERTURNING LOADS

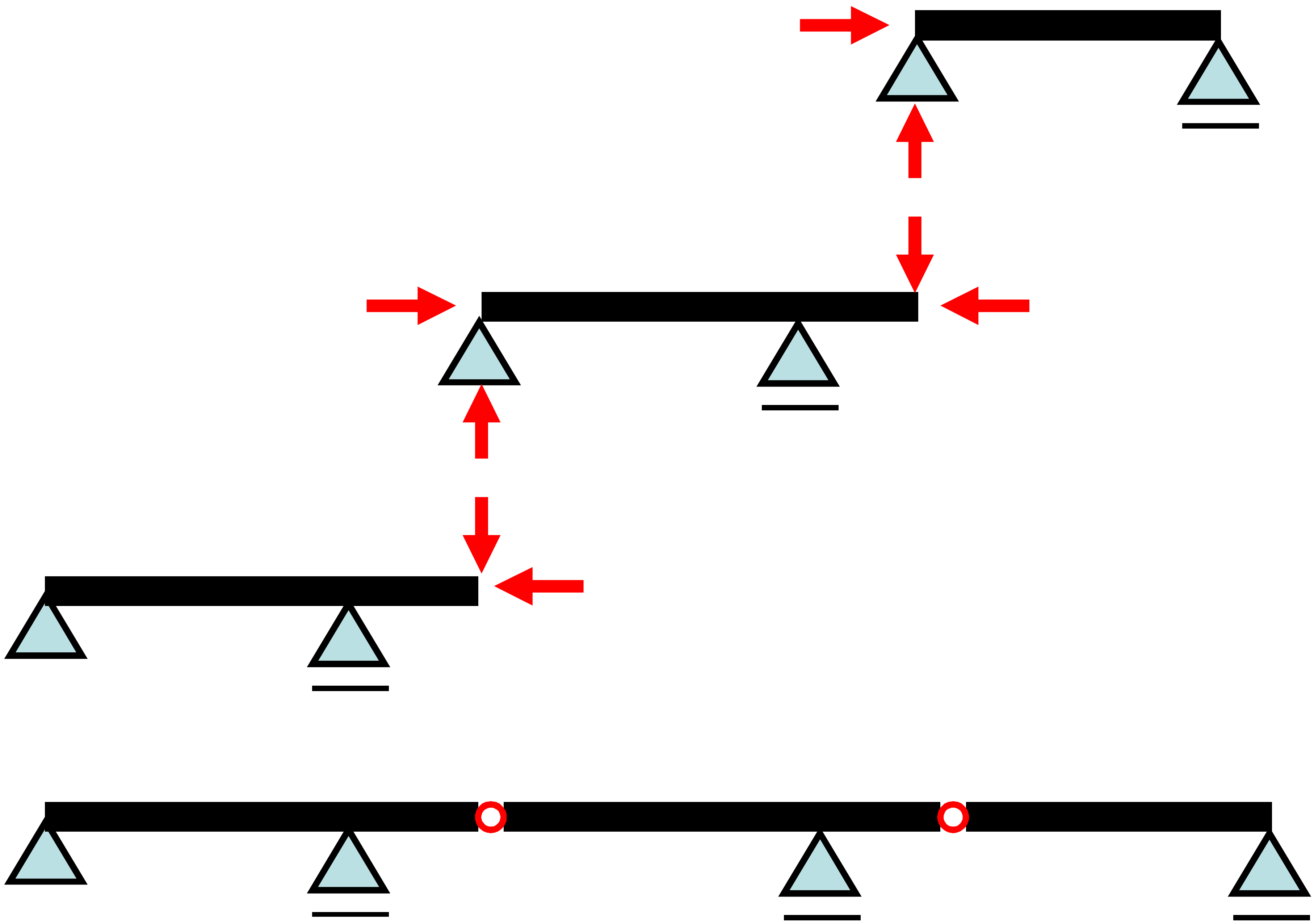
$$\sum \mathbf{M} = 0.0$$

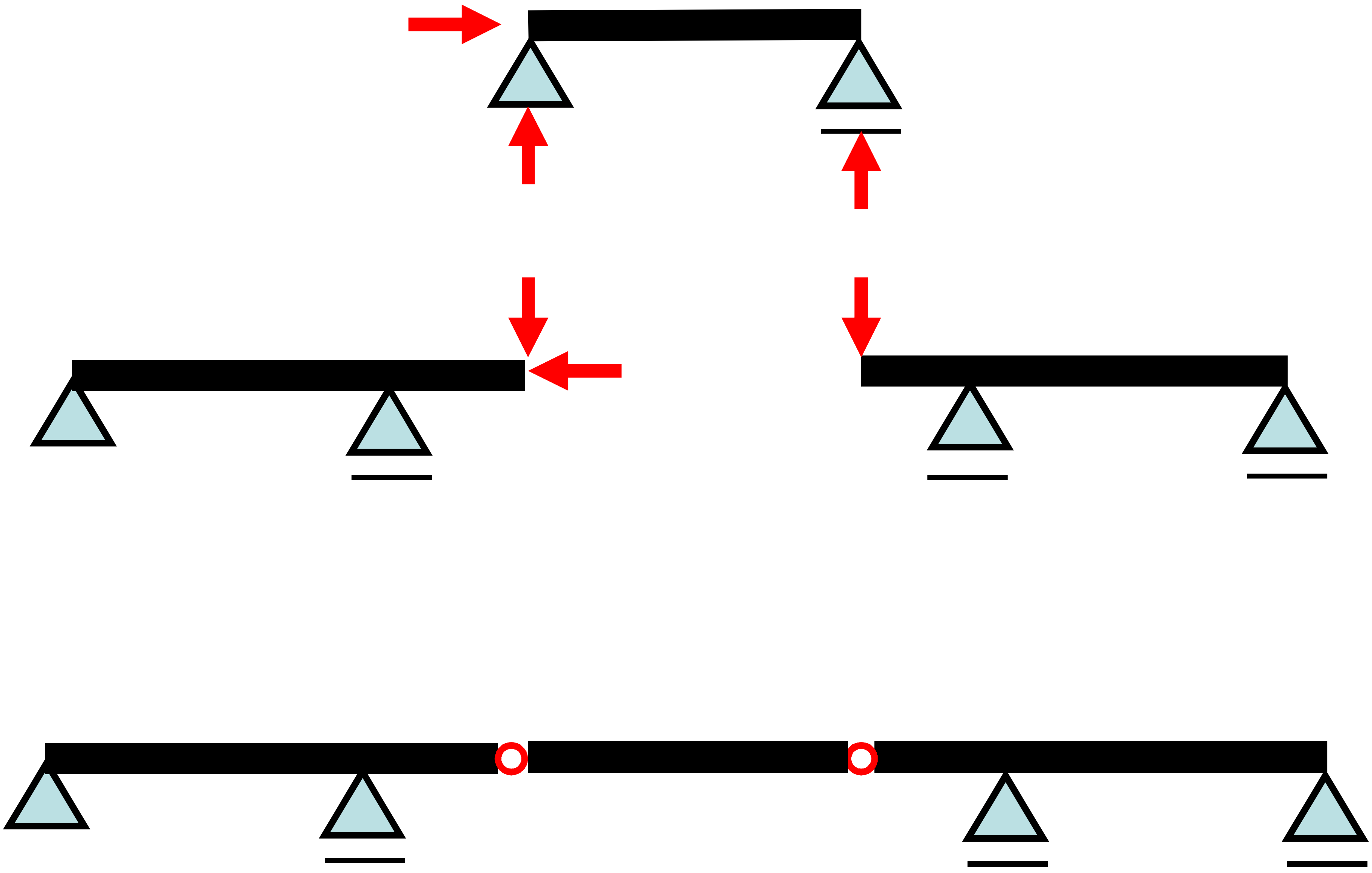


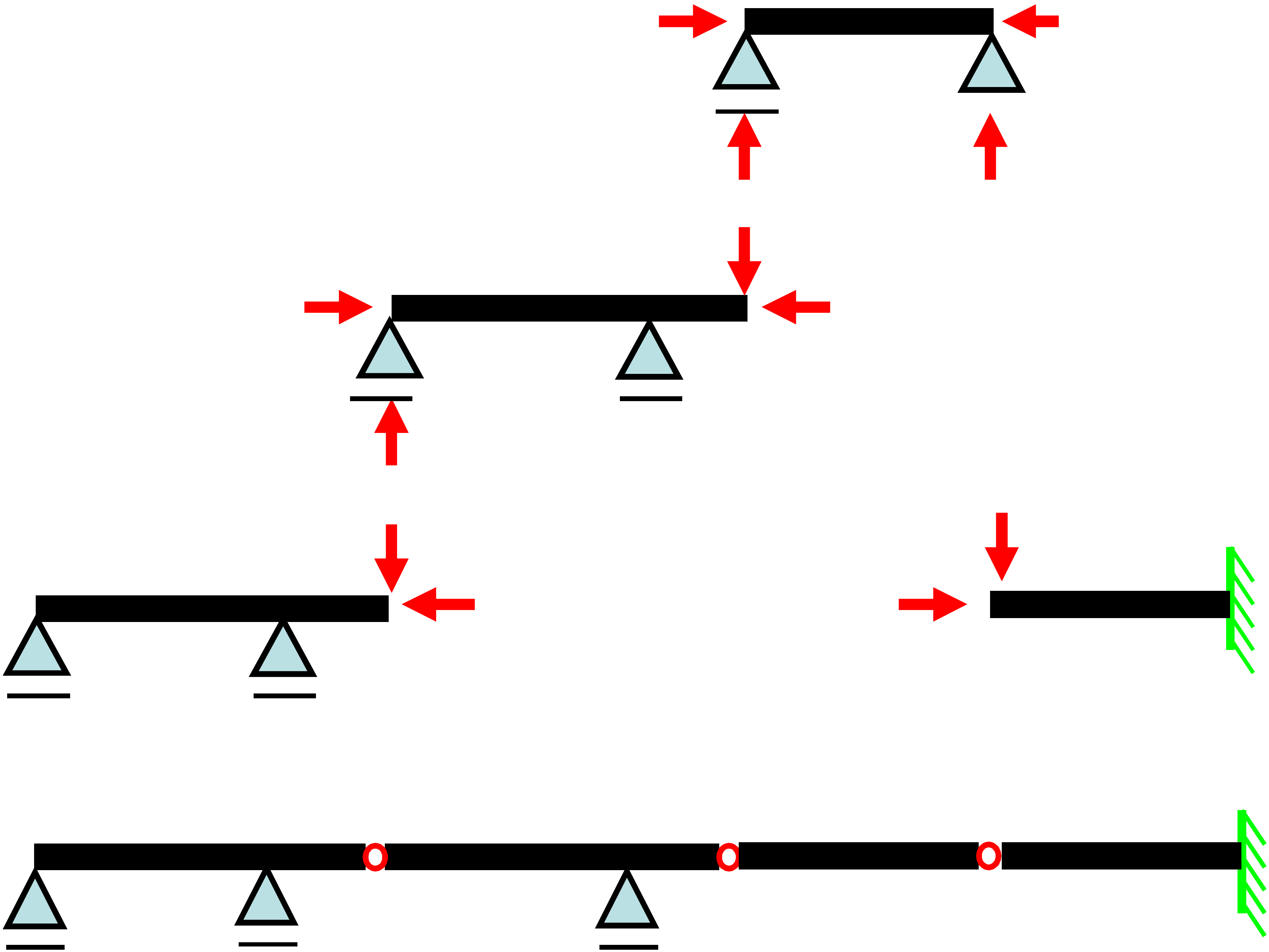
Compined beams with intermidiate hinge



انواع الفصل

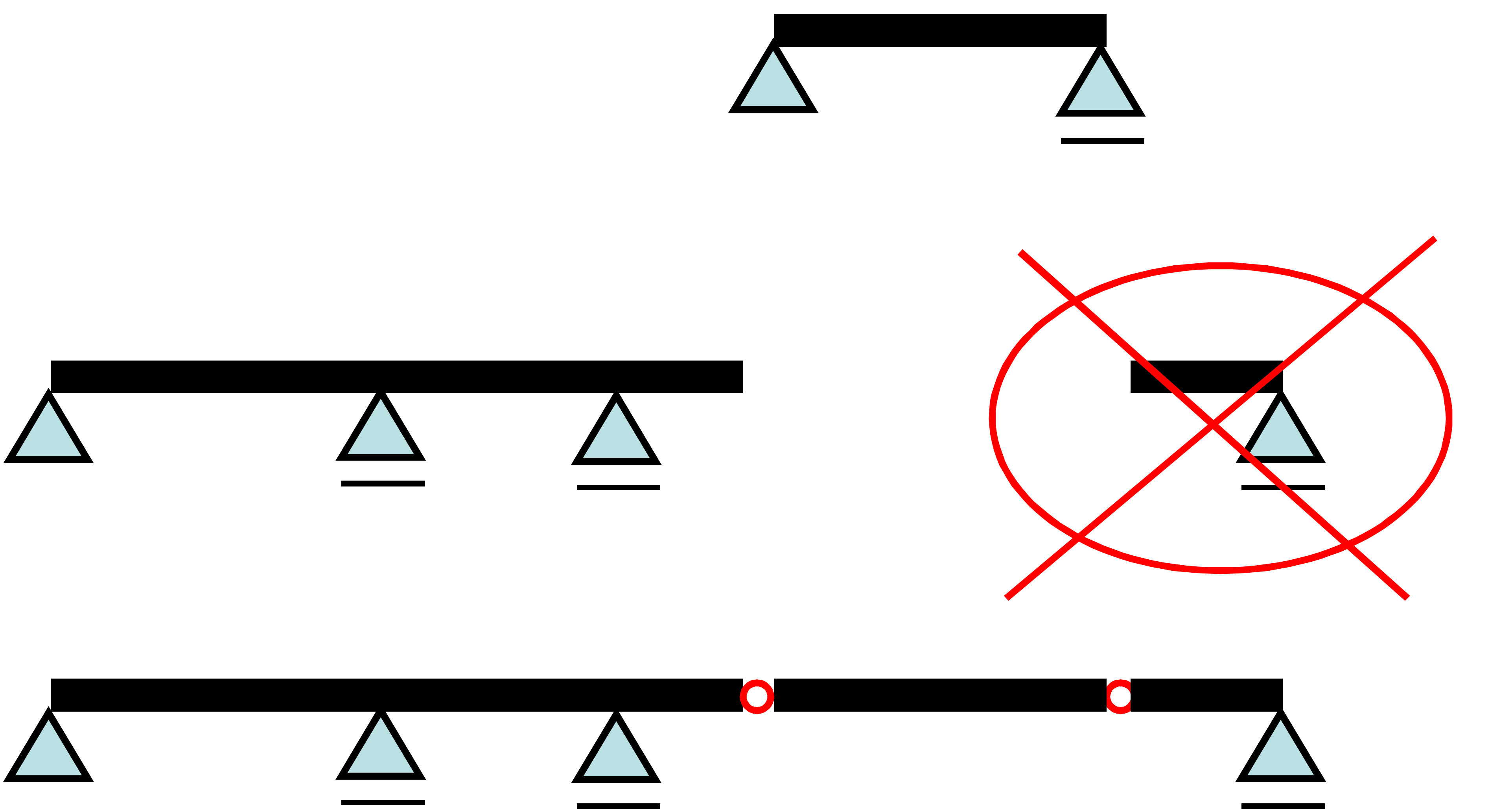


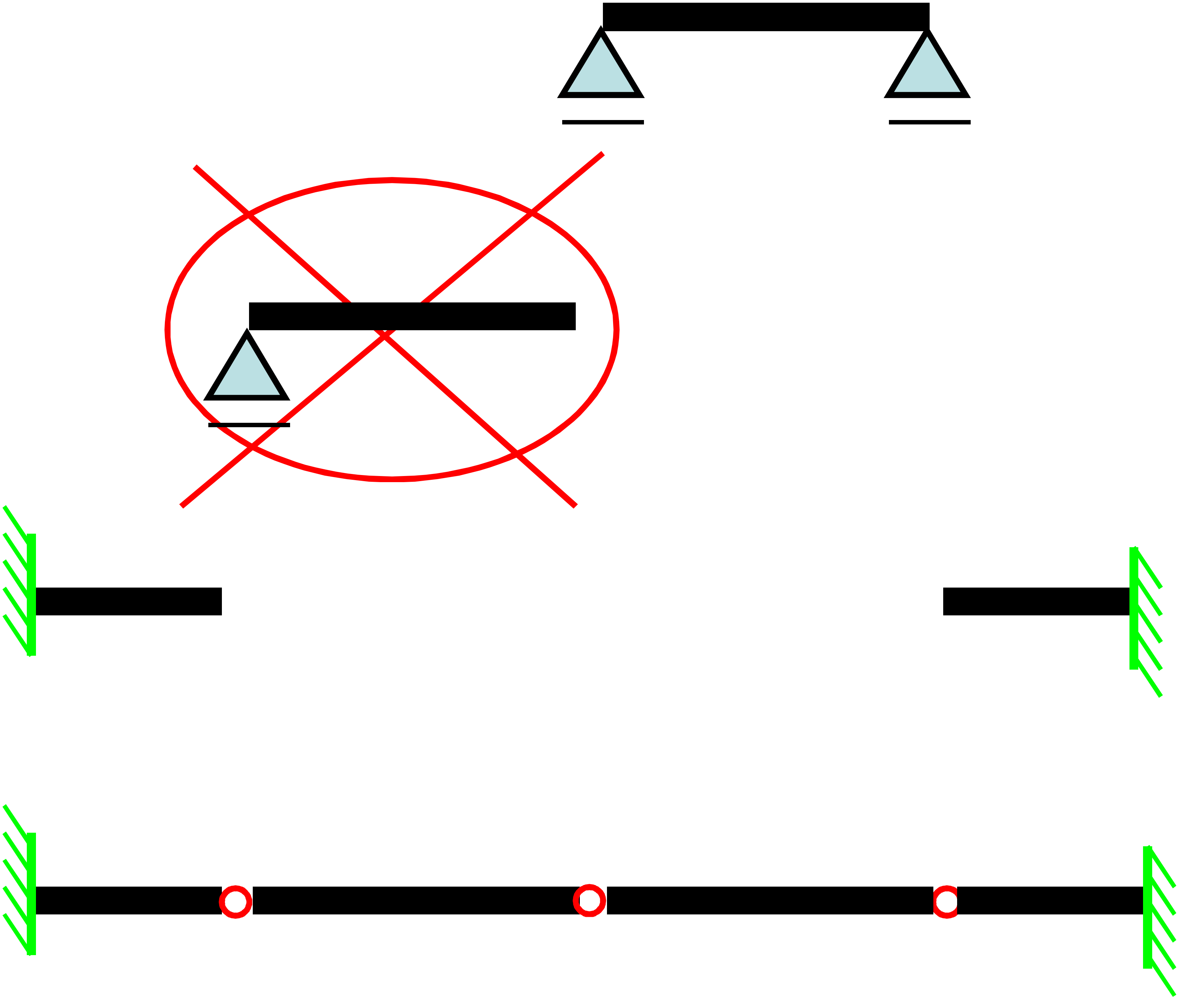




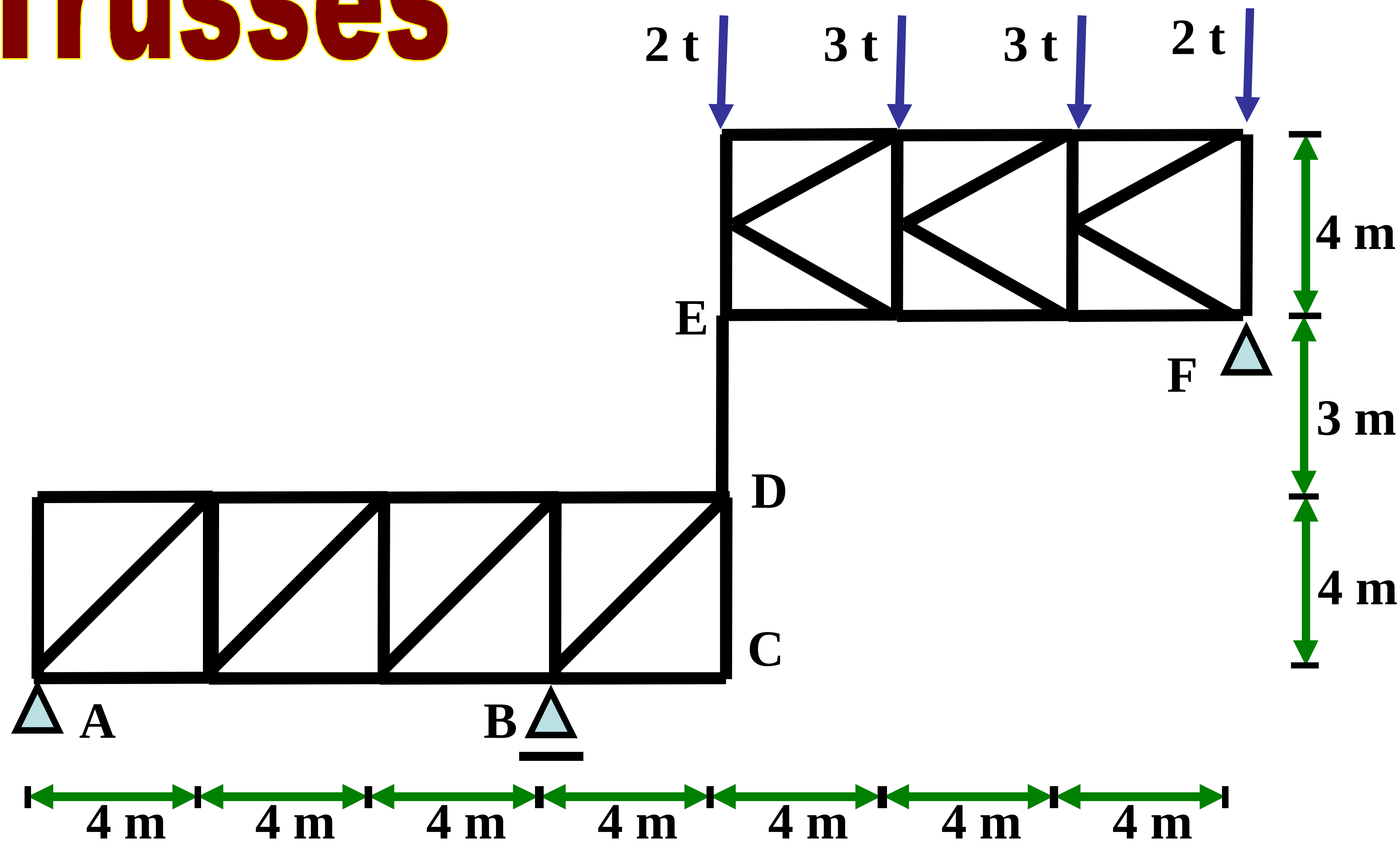
الحالات التى تصبح فيها الكمرة غير متزنه.

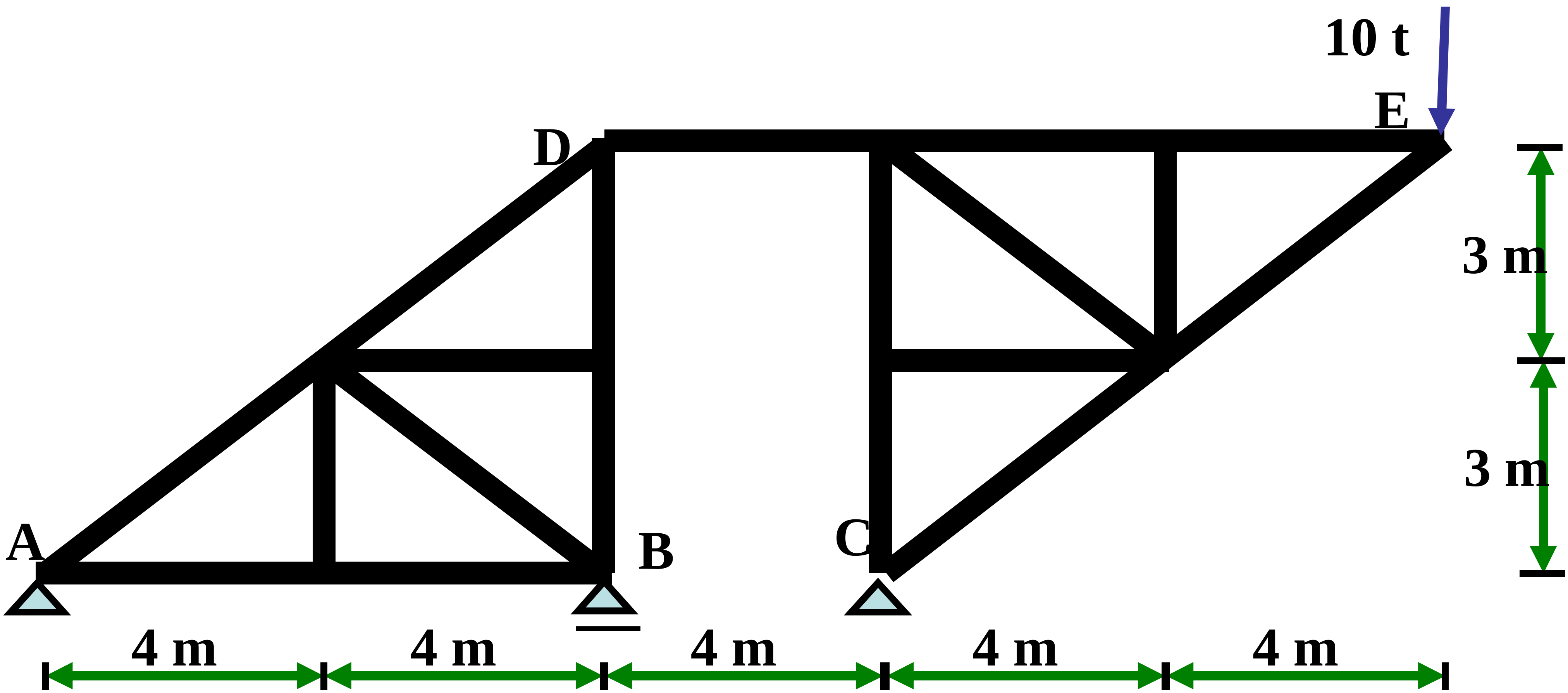
Unstable structure.





Trusses

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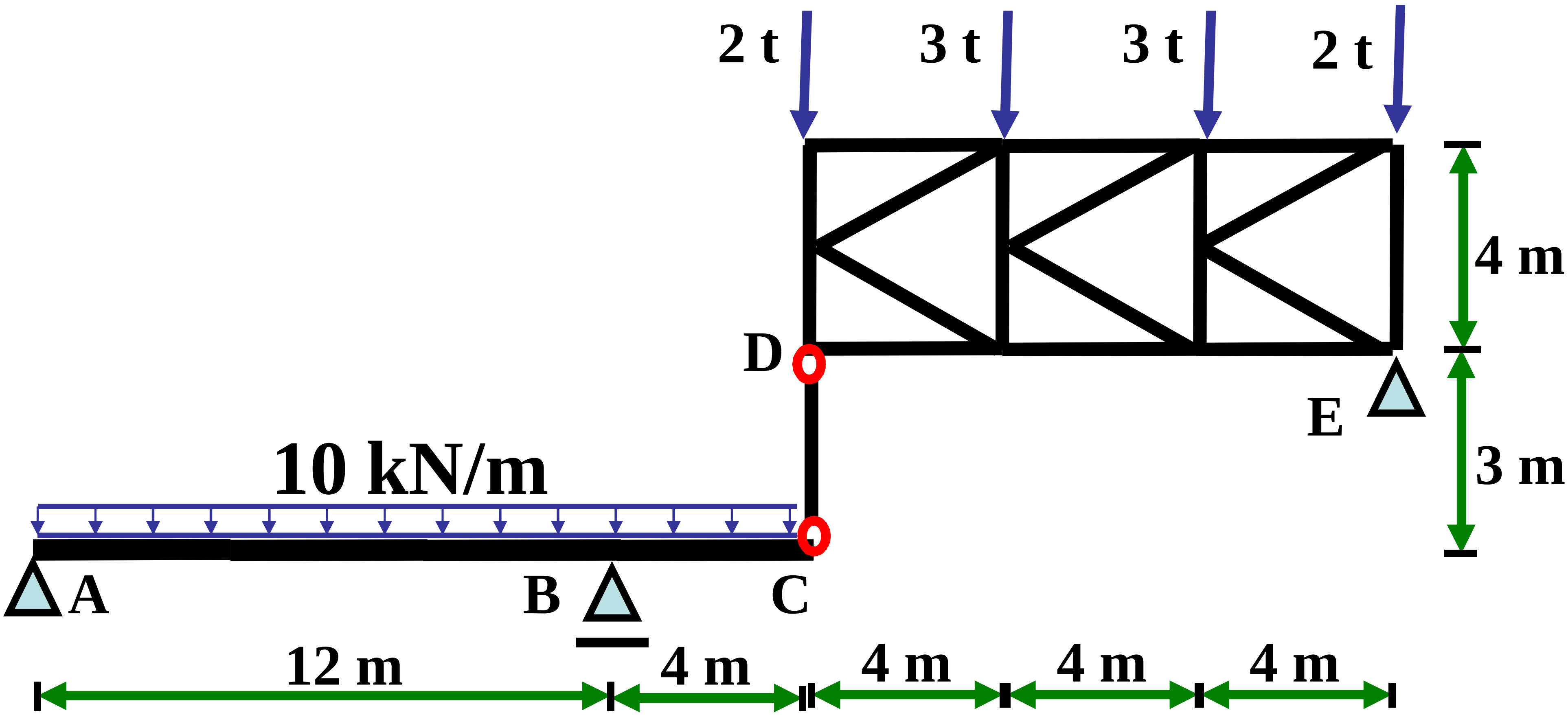
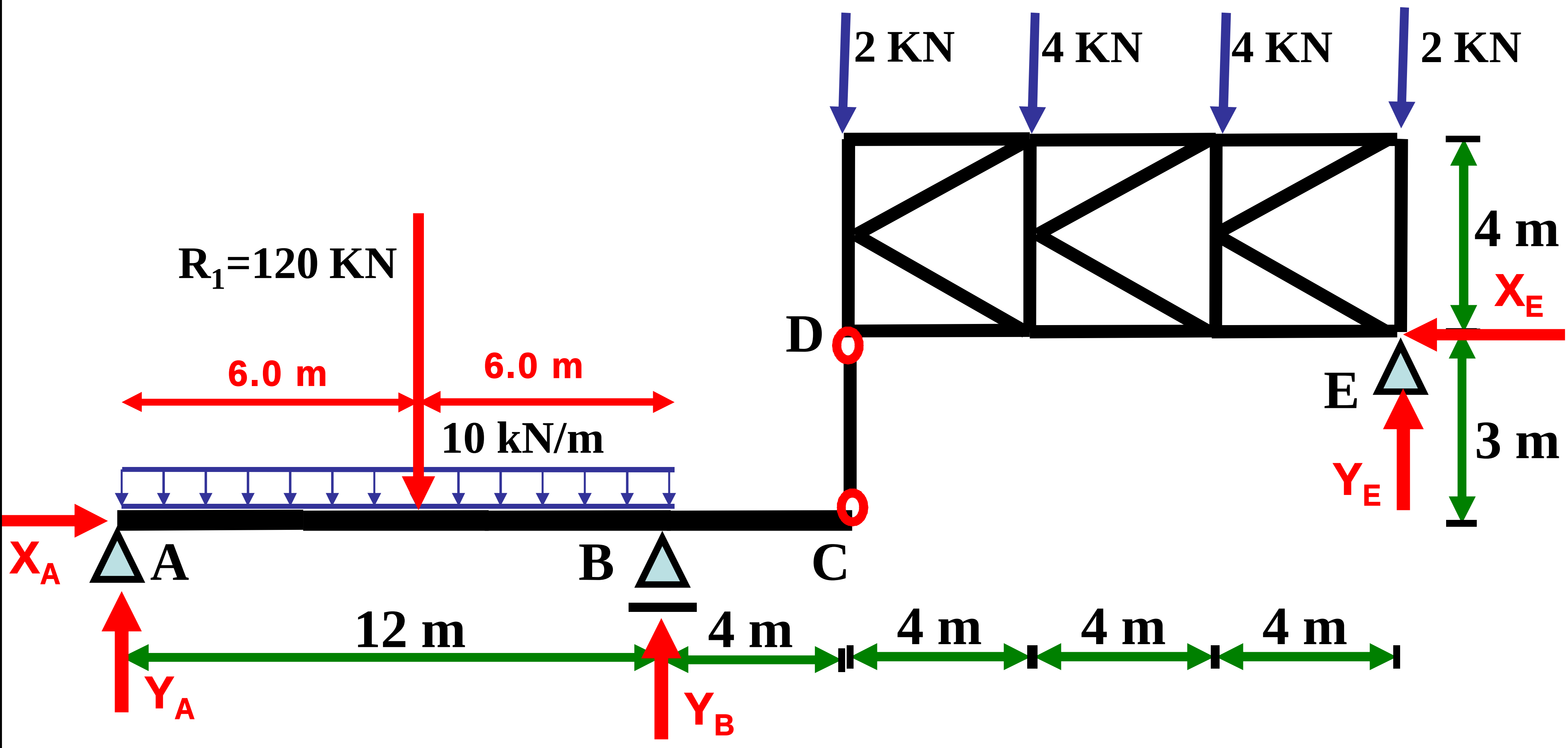
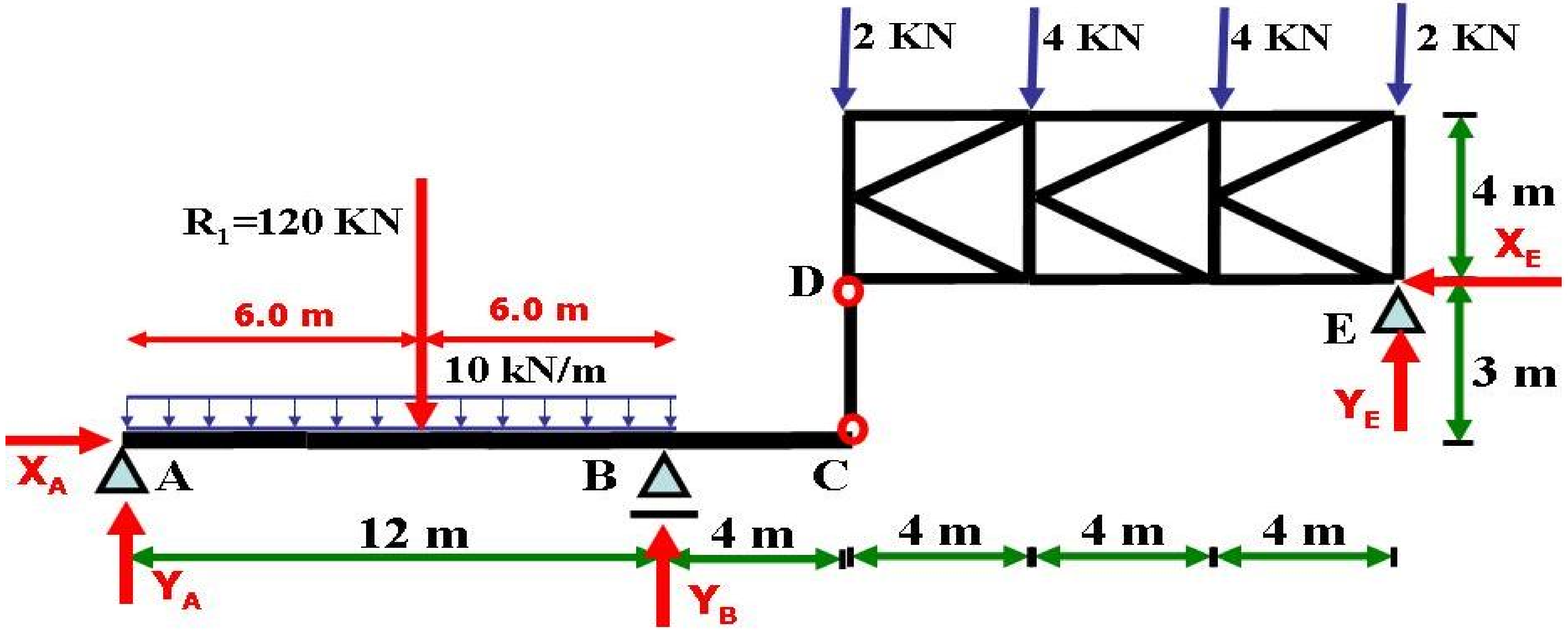


Determine the reaction for the following truss

first method





$\Sigma M_{DR} = 0.0$

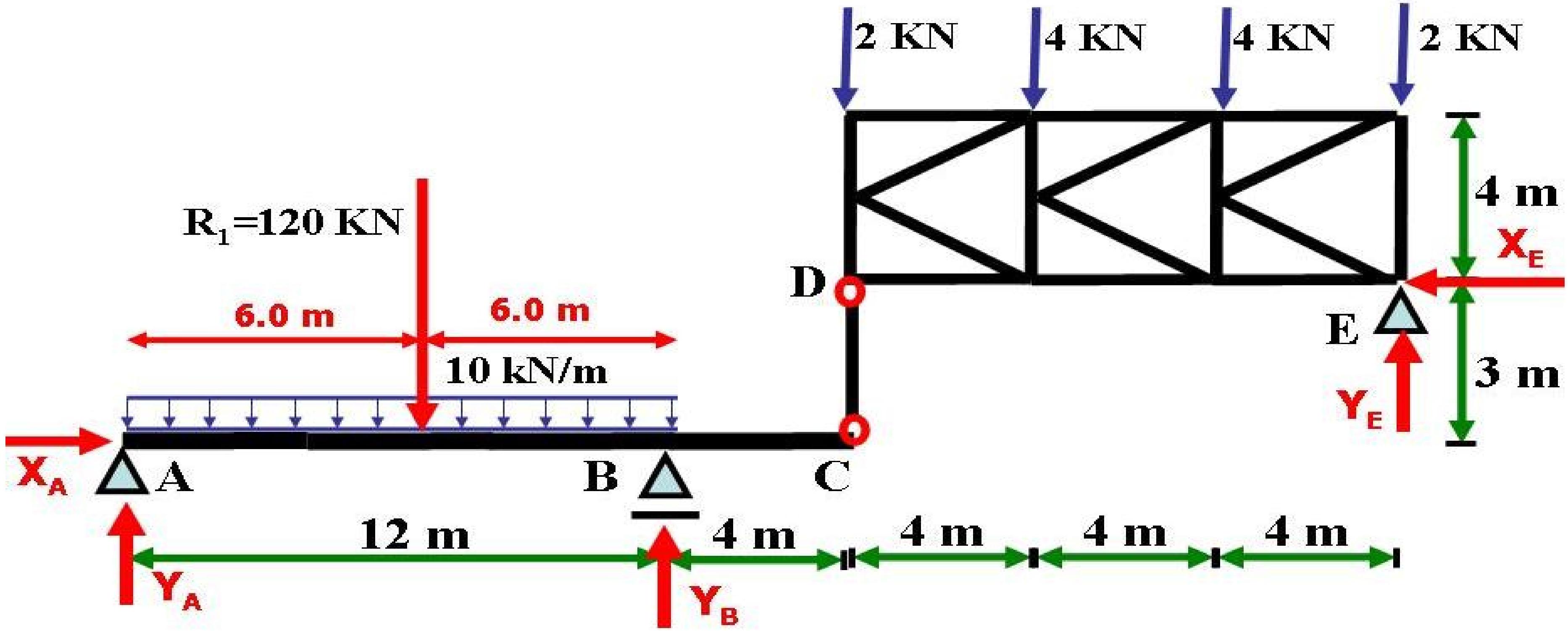
$$Y_E * 12.0 = 4 * 4.0 + 4 * 8.0 + 2 * 12.0$$

$$Y_E = 6.0 \text{ KN}$$

$\Sigma M_{CR} = 0.0$

$$6.0 * 12.0 + X_E * 3 = 4 * 4.0 + 4 * 8.0 + 2 * 12.0$$

$$X_E = 0.0$$



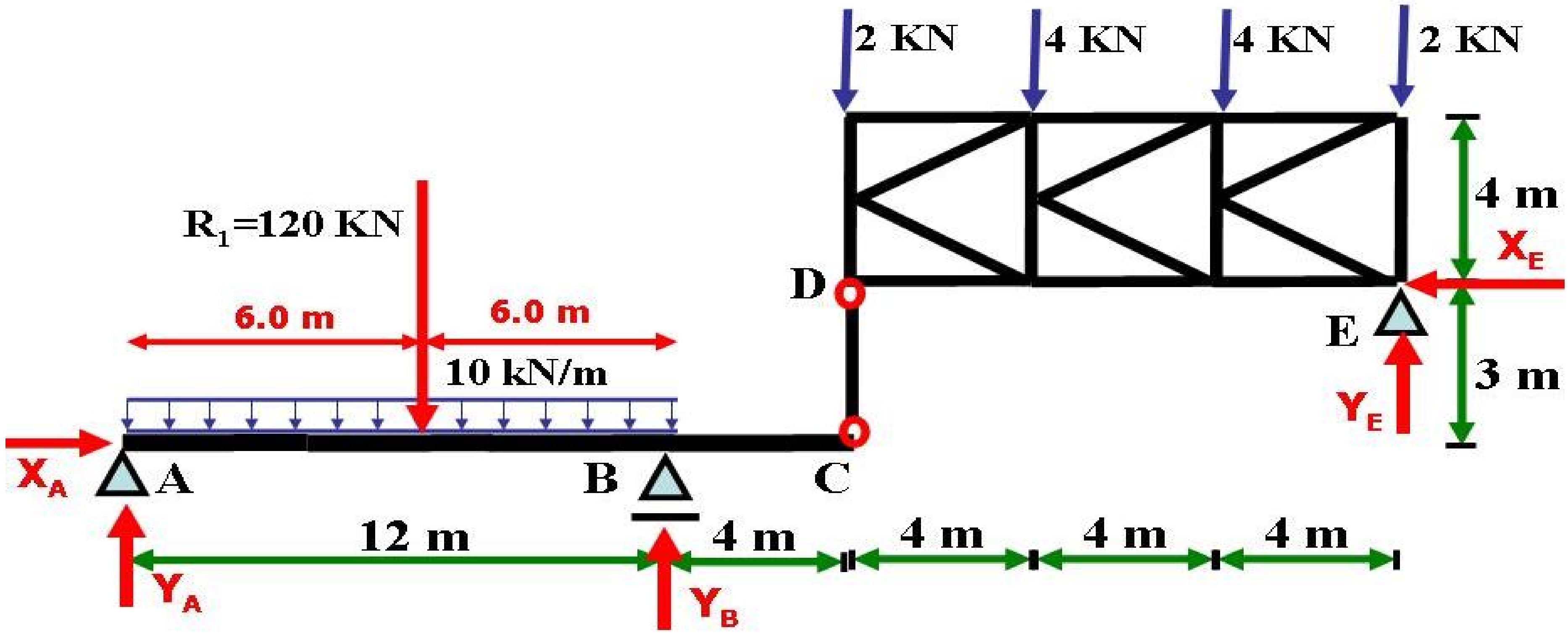
$$\sum F_X = 0.0$$

$$X_A = 0.0$$

$$\sum M_A = 0.0$$

$$Y_B*12.0 + 6*28 = 120*6+2*16+4*20.0+4*24.0+2*28.0$$

$$Y_B = 68.0 \text{ KN}$$

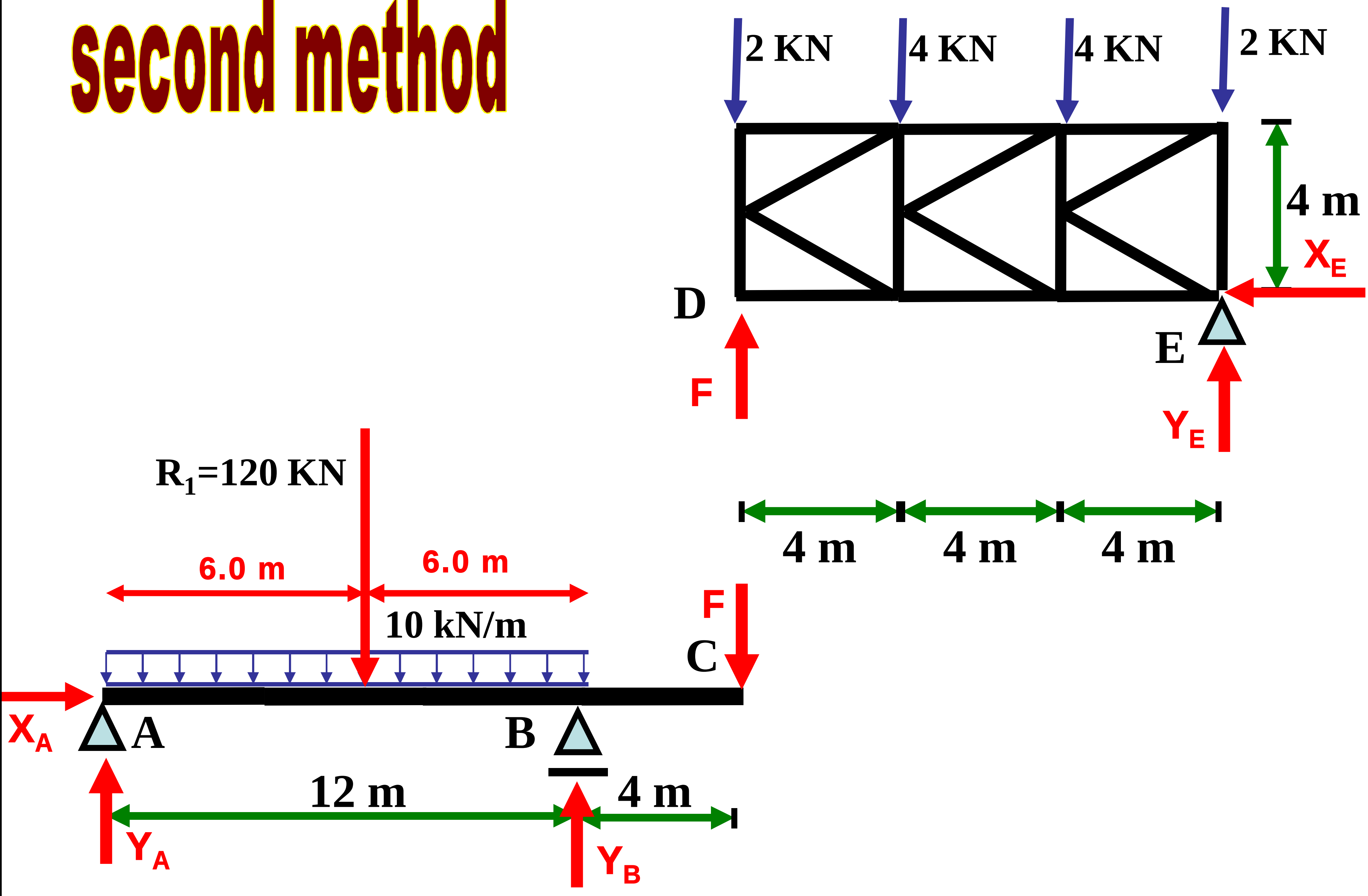


$$\sum F_Y = 0.0$$

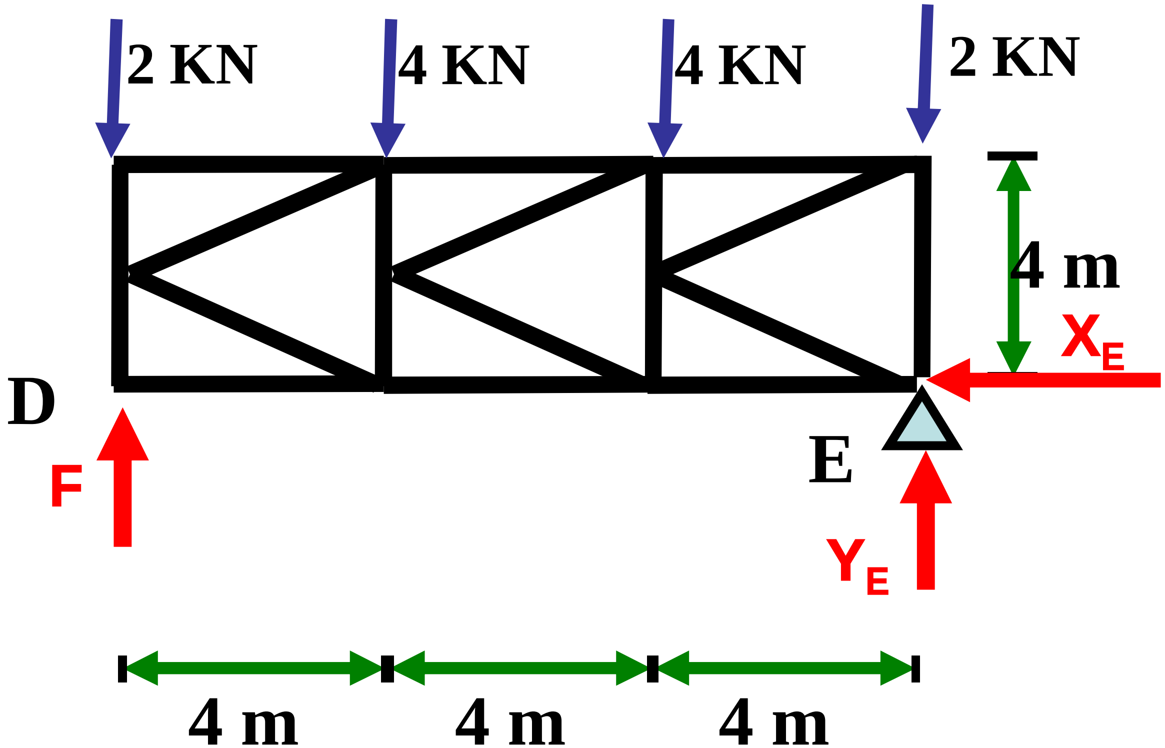
$$Y_A + 68 + 6 = 120 + 2 + 4 + 4 + 2$$

$$Y_A = 58 \text{ KN}$$

second method



Part DE



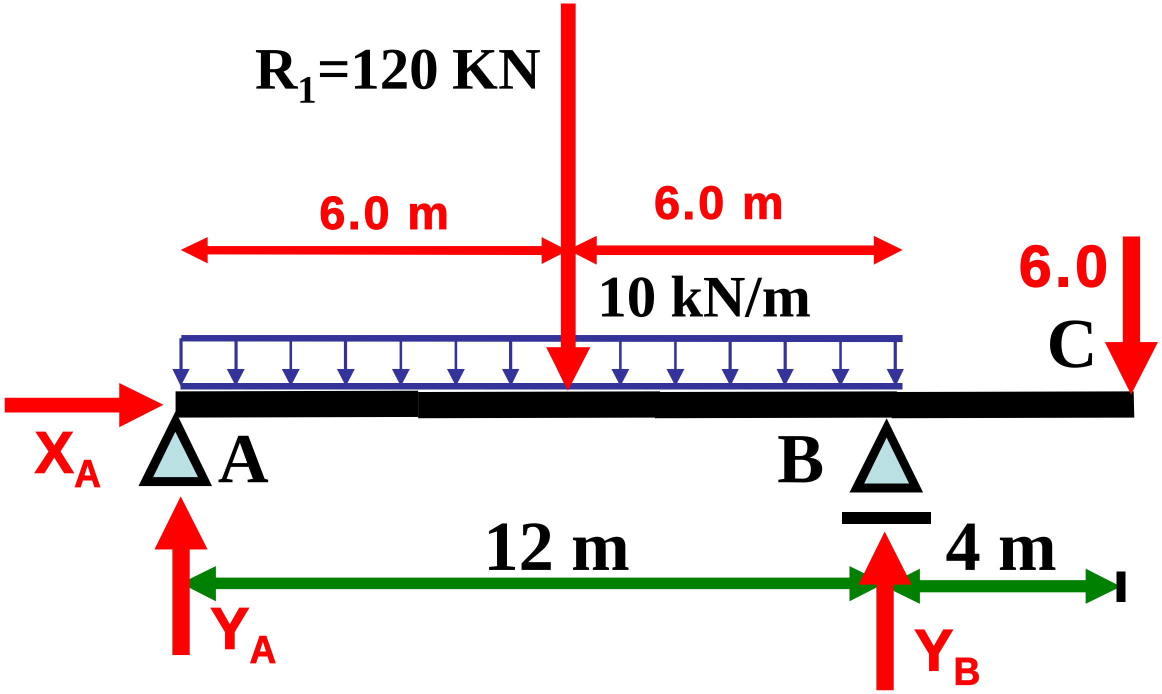
$$\sum F_X = 0.0$$

$$X_E = 0.0$$

$$\sum F_Y = 0.0$$

$$F = Y_E = (2+4+4+2)/2 = 6.0$$ From symmetry

Part AD



$\sum F_X = 0.0$

$X_A = 0.0$

$\sum M_A = 0.0$

$Y_B * 12 = 120 * 6 + 6 * 16$

$Y_B = 68$ KN

$\sum F_Y = 0.0$

$Y_A = 120 + 6 - 68 = 58$ KN

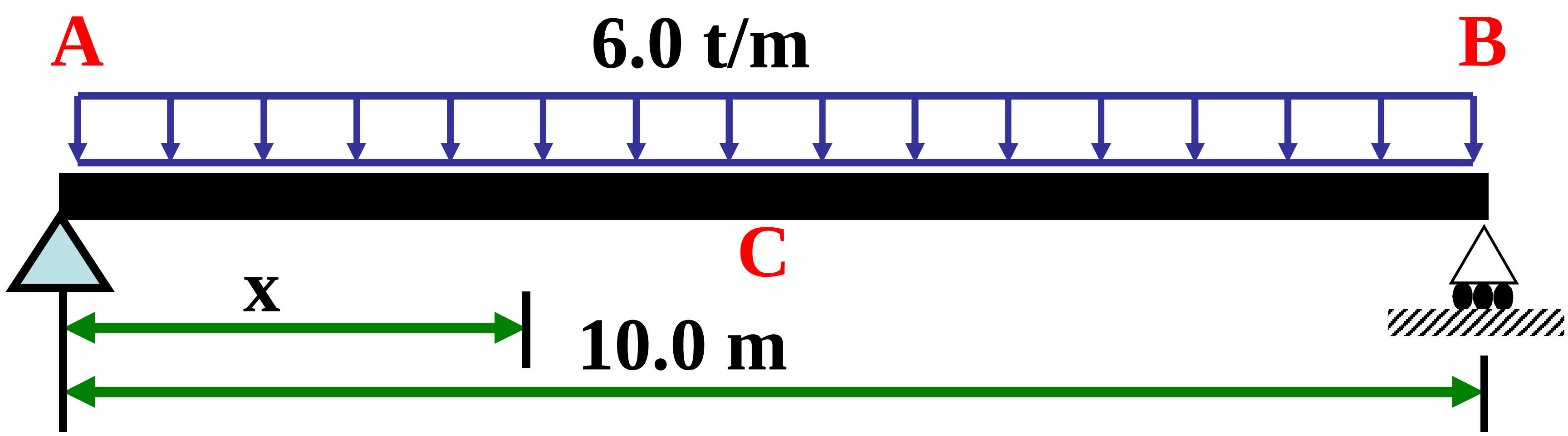
بســـــم اللــــــــه الرحمـــــن الرحيـــم

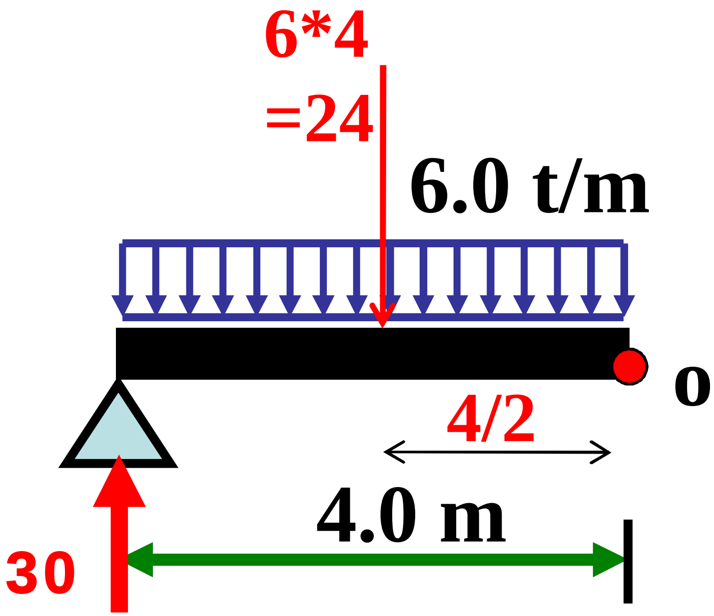
Double Integration

Eng : Ayman abdo

خطوات الحل:

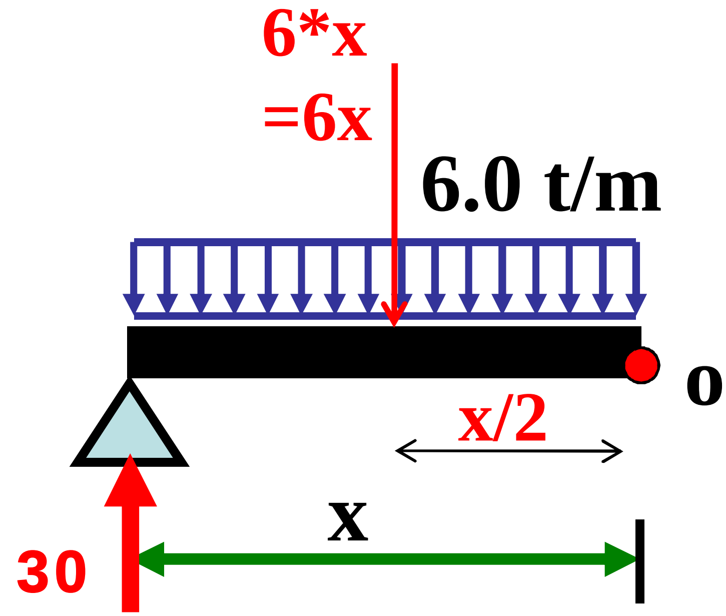
1- يتم عمل معادلة للعزم بدلالة (x) حتى يتم استخدامها فى التكاملات ويفضل ان يتم عمل المعادلة من الاتجاه الاسهل للكمرة.





$$M_o = 30 * 4 - 6 * 4 * 4/2$$
$$= 72 \ t.m$$

للتوضيح فقط



$$Mo = 30 * x - 6 * x * x/2$$
$$= 30x - 3x2 \quad t.m$$

هذه الطريقة افضل فى الحسابات لاننا
نستطيع من خلالها حساب العزم فى اى مكان
بالتعويض بقيمة x للمكان

2- يتم التعويض بمعادلة العزم فى معادلة الـ double integration.

$$y'' = -\frac{1}{EI}(M)$$

$$y'' = -\frac{1}{EI}(30x - 3x^2)$$

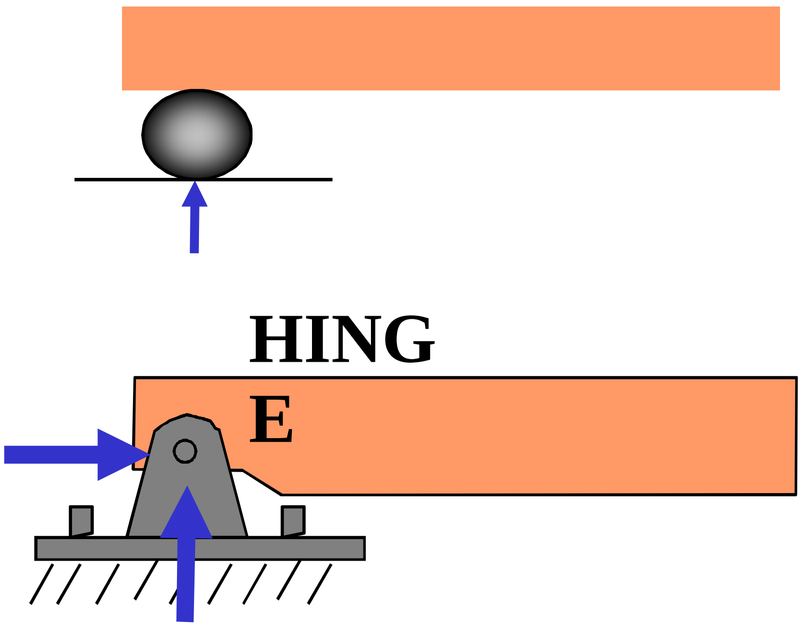
$$y' = \theta = -\frac{1}{EI}(30x^2/2 - 3x^3/3 + c_1) = -\frac{1}{EI}(15x^2 - x^3 + c_1)$$

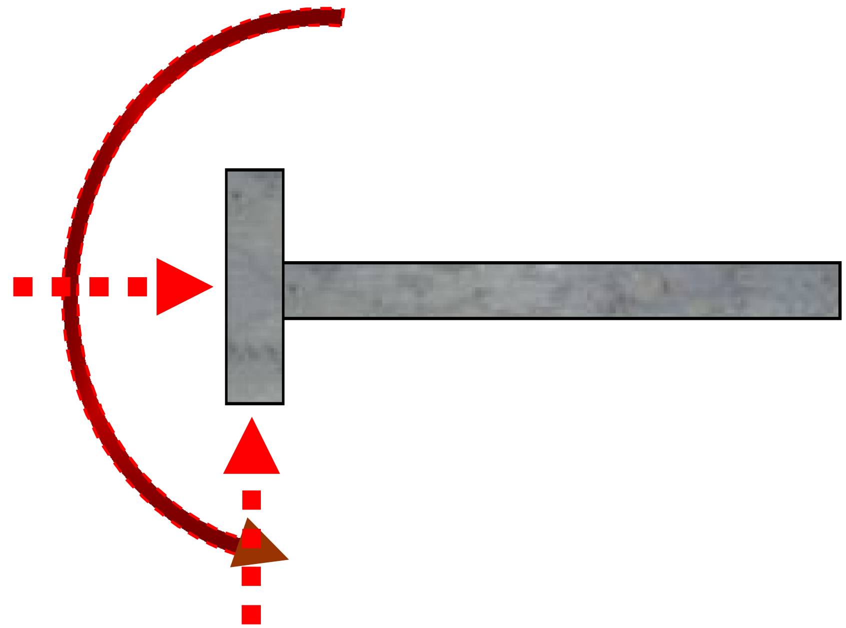
$$y = -\frac{1}{EI}(5x^3 - x^4/4 + c_1 x + c_2)$$

لاحظ اننا حصلنا على المعادلات المطلوبة
ولكن فقط بعد الحصول على الثوابت

Boundary Conditions

ROLLER





y = 0.0 at roller and hinged support

y = 0.0 and θ = 0.0 at fixed support

3- يتم التعويض بـ boundary condition فى معادلة الهبوط والدوران السابقة.

At x = 0.0 >>>> y = 0.0 عند النقطه A الهبوط يساوى صفر

$$y = -\frac{1}{EI}(5x^3 - x^4/4 + c_1 x + c_2) = 0.0$$

$$5*(0)^3 - (0)^4/4 + c_1*(0) + c_2 = 0.0$$

$$c_2 = 0.0$$

At x = 10.0 >>>> y = 0.0 عند النقطه B الهبوط يساوى صفر

$$y = -\frac{1}{EI}(5x^3 - x^4/4 + c_1 x + c_2) = 0.0$$

$$5*(10)^3 - (10)^4/4 + c_1*(10) + 0.0 = 0.0$$

$$c_1 = -250.0$$

>>>>> $\theta = -\frac{1}{EI}(15x^2 - x^3 - 250)$

$$y = -\frac{1}{EI}(5x^3 - x^4/4 - 250x)$$

$at\ x = 0.0$ >>>>

$$\theta = -\frac{1}{EI}(15*0^2 - 0^3 - 250) = \frac{250}{EI}$$

$$y = -\frac{1}{EI}(5*0^3 - 0^4/4 - 250*0) = 0$$

1- عند خط التماثل للكمرة

Θc = 0.0

2- بسبب التماثل

ΘA = - ΘB

$at\ x = 5.0$ >>>>

$$\theta = -\frac{1}{EI}(15*5^2 - 5^3 - 250) = \frac{0}{EI} = 0.0$$

$$y = -\frac{1}{EI}(5*5^3 - 5^4/4 - 250*5) = -\frac{781.25}{EI}$$

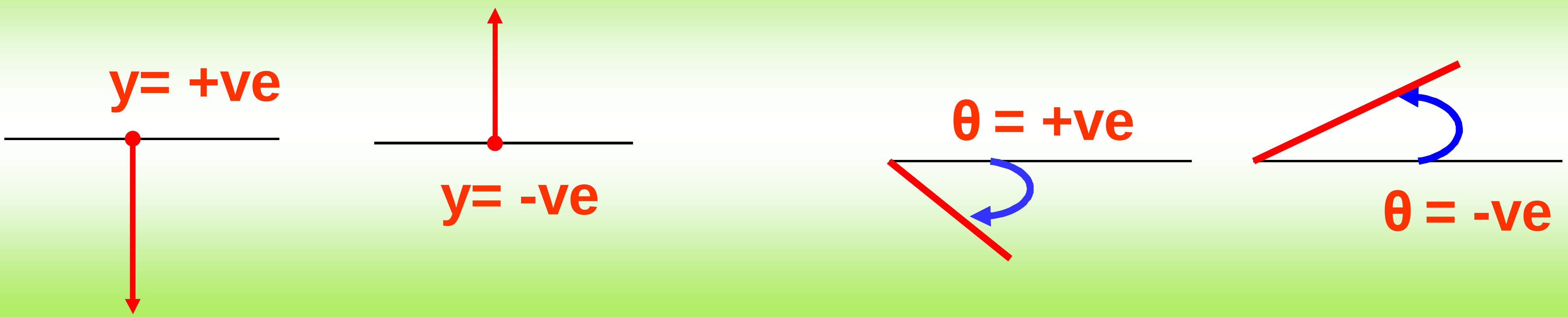
Position of max deflection = position of zero rotation

Ymax @ θ = 0.0

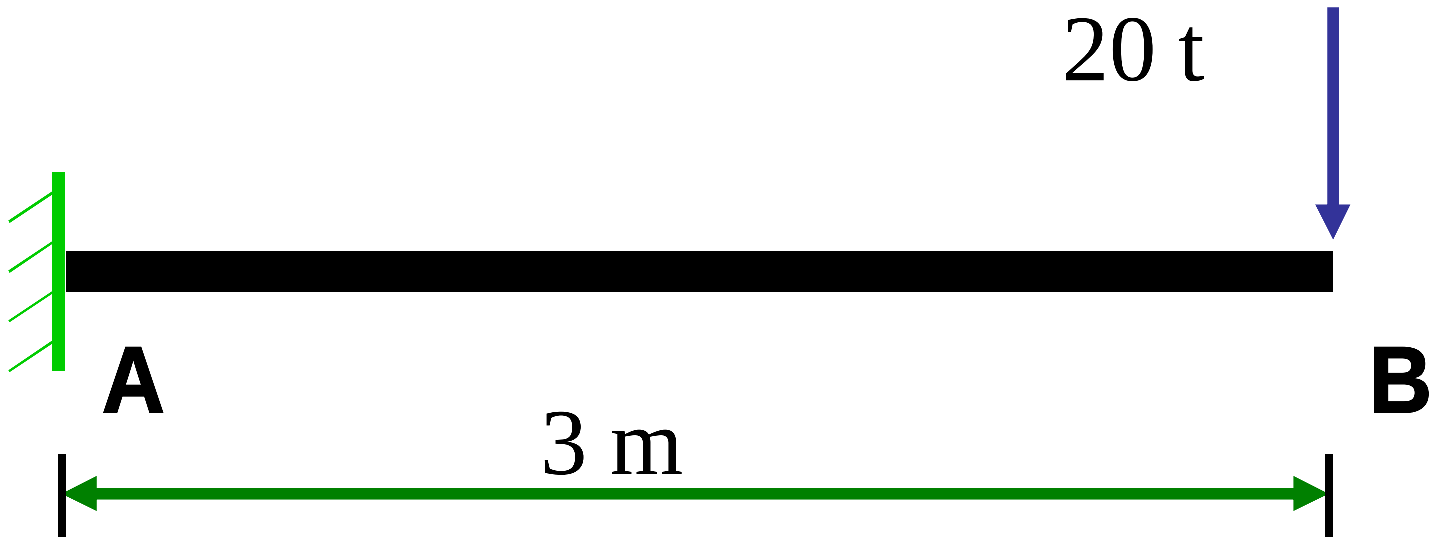
$$\theta = -\frac{1}{EI}(15 * x^2 - x^3 - 250) = 0.0$$

$$15 * x^2 - x^3 - 250 = 0.0 \quad by\ using\ calculator \quad x = 5.0$$

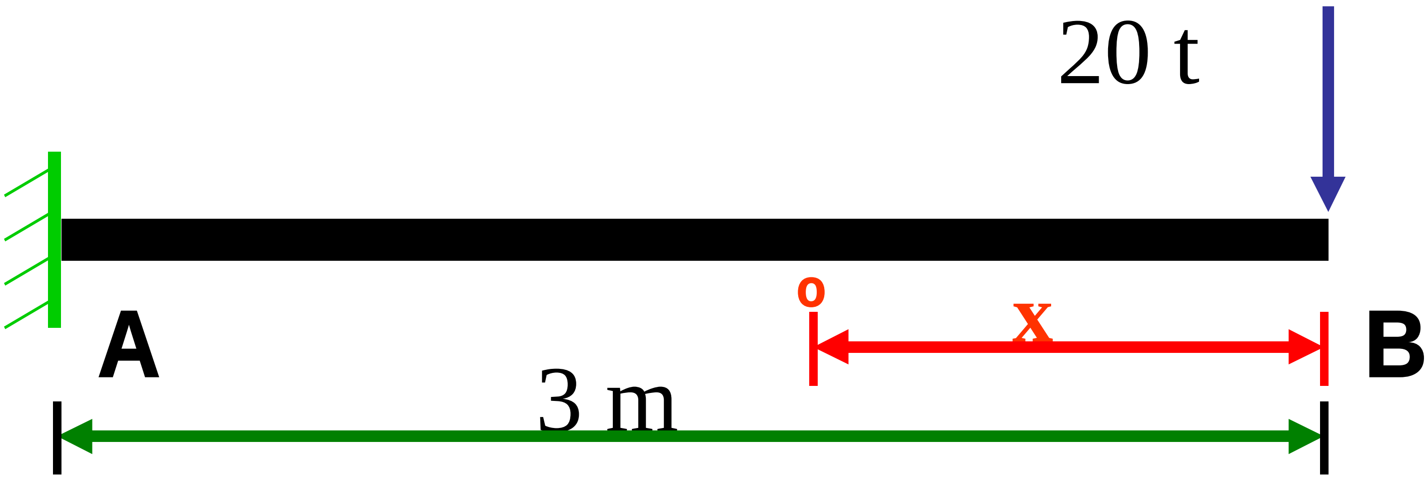
$$y_{\max} = -\frac{1}{EI}(5 * 5^3 - 5^4 / 4 - 250 * 5) = -\frac{781.25}{EI}$$



Example No. 2



Required the deflection and rotation at point b



بداية الـ x من B افضل حتى لو كان هناك خطأ فى ال reaction عند A لن يؤثر

Mo = - 20 x   t.m

$$y'' = -\frac{1}{EI}(M)$$

$$y'' = -\frac{1}{EI}(-20x)$$

$$y' = \theta = -\frac{1}{EI}(-10x^2 + c_1)$$

$$y = -\frac{1}{EI}(-10x^3/3 + c_1 x + c_2)$$

At x = 3.0 >>>> θ = 0.0 **عند النقطه A الدوران يساوى صفر**

$$y' = \theta = -\frac{1}{EI}(-10*3^2 + c_1) = 0.0$$

$$-10*3^2 + c_1 = 0.0$$

$$\boxed{c_1 = 90.0}$$

At x = 3.0 >>>> y = 0.0 **عند النقطه A الهبوط يساوى صفر**

$$y = -\frac{1}{EI}(-10*3^3/3 + 90*3 + c_2) = 0.0$$

$$-10*3^3/3 + 90*3 + c_2 = 0.0$$

$$\boxed{c_2 = -180}$$

Final equations

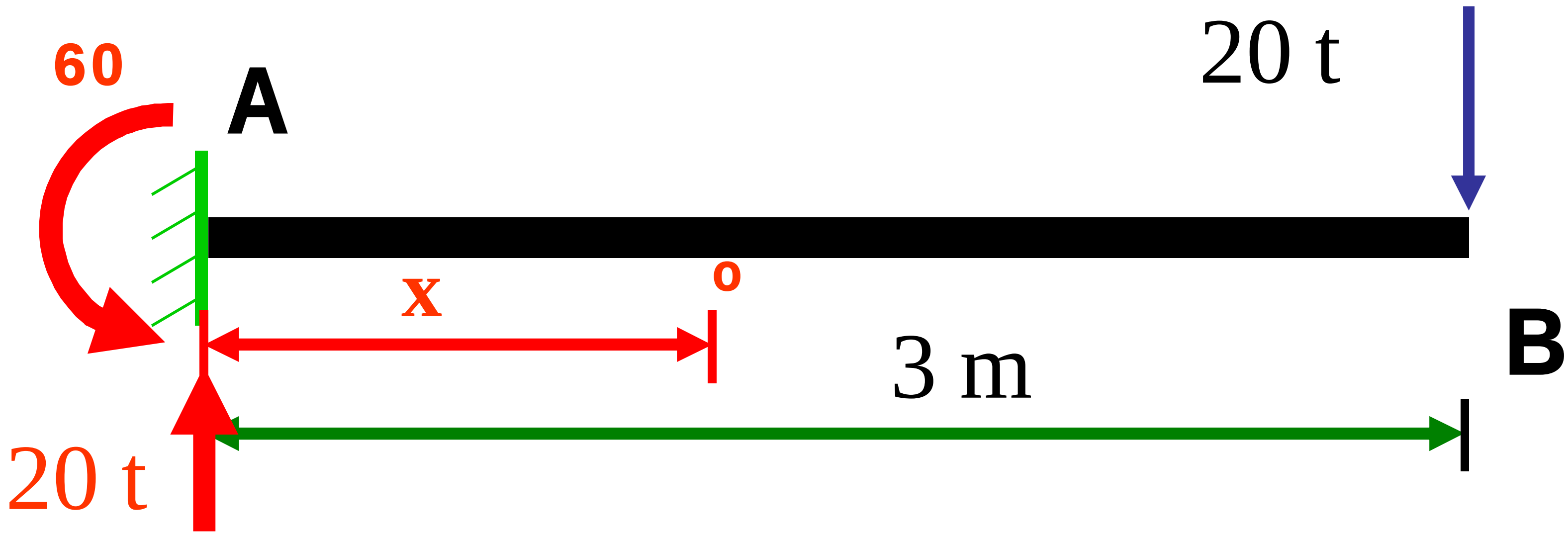
$$\theta = -\frac{1}{EI}(-10x^2 + 90)$$

$$y = -\frac{1}{EI}(-10x^3/3 + 90x - 180)$$

$$at\ x = 0.0 \quad >>>>$$

$$\theta = -\frac{1}{EI}(-10 * 0^2 + 90) = -\frac{90}{EI}$$

$$y = -\frac{1}{EI}(-10 * 0^3/3 + 90 * 0 - 180) = \frac{180}{EI}$$



حل اخر

Mo = 20 x – 60 t.m

$$y'' = -\frac{1}{EI}(M)$$

$$y'' = -\frac{1}{EI}(20x - 60)$$

$$y' = \theta = -\frac{1}{EI}(10x^2 - 60x + c_1)$$

$$y = -\frac{1}{EI}(10x^3/3 - 30x^2 + c_1 x + c_2)$$

At x = 0.0 >>>> θ = 0.0 **عند النقطه A الدوران يساوى صفر**

$$y' = \theta = -\frac{1}{EI}(10*0^2 - 60*0 + c_1) = 0.0$$

$$10*0^2 - 60*0 + c_1 = 0.0$$

$$c_1 = 0.0$$

At x = 0.0 >>>> y = 0.0 **عند النقطه A الهبوط يساوى صفر**

$$y = -\frac{1}{EI}(10*0^3/3 - 30*0^2 + 0*0 + c_2) = 0.0$$

$$10*0^3/3 - 30*0^2 + 0*0 + c_2 = 0.0$$

$$c_2 = 0.0$$

Final equations

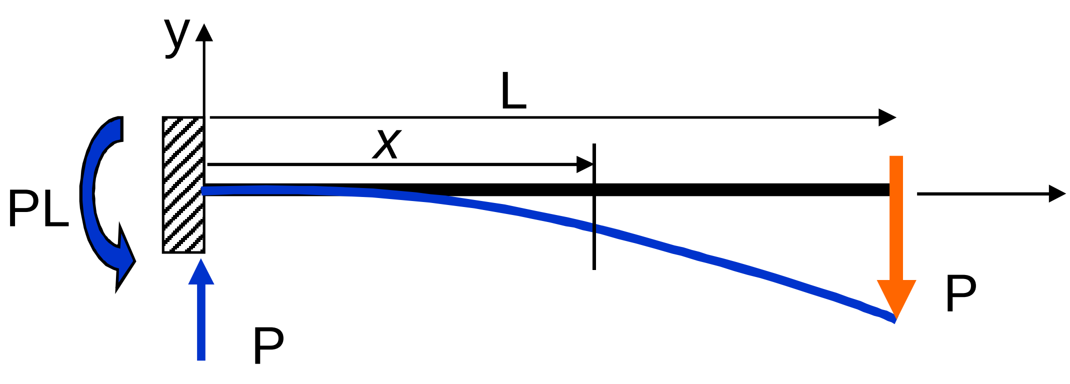
$$\theta = -\frac{1}{EI}(10x^2 - 60x)$$

$$y = -\frac{1}{EI}(10x^3/3 - 30x^2)$$

$at\ x = 3.0 \quad >>>>$

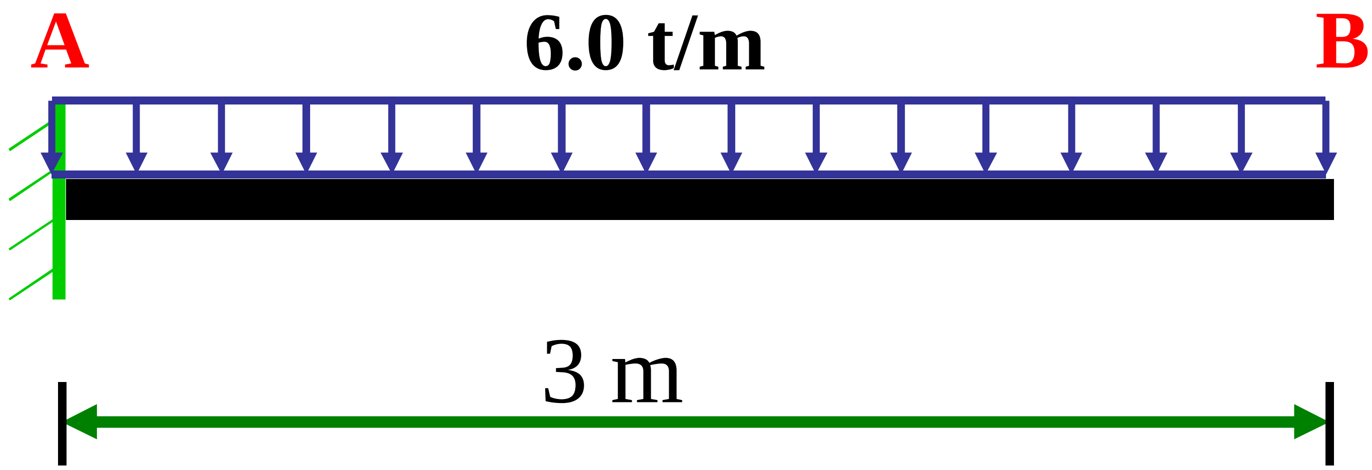
$$\theta = -\frac{1}{EI}(10*3^2 - 60*3) = -\frac{90}{EI}$$

$$y = -\frac{1}{EI}(10*3^3/3 - 30*3^2) = \frac{180}{EI}$$

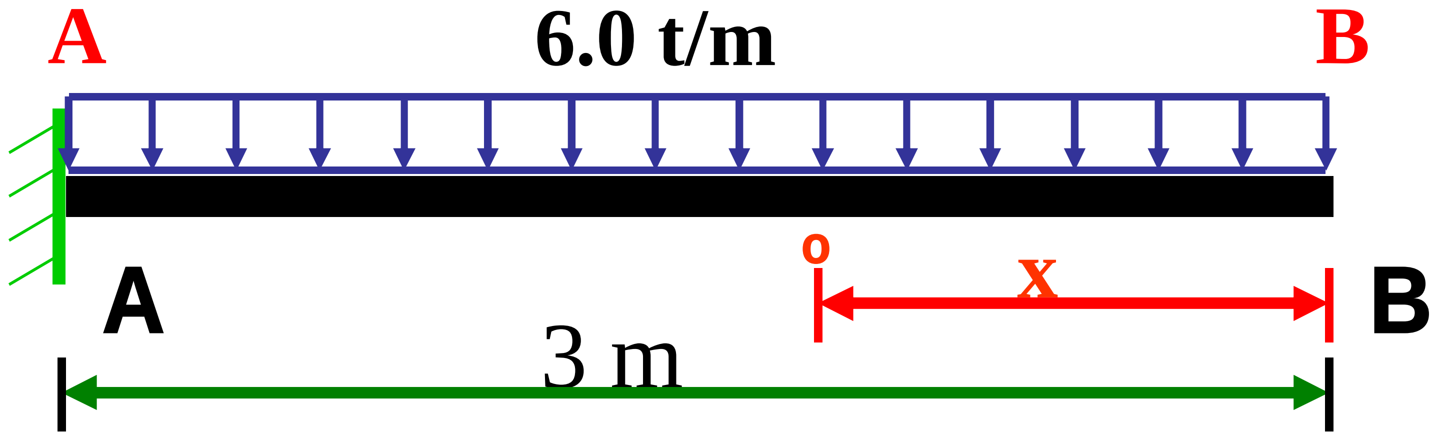


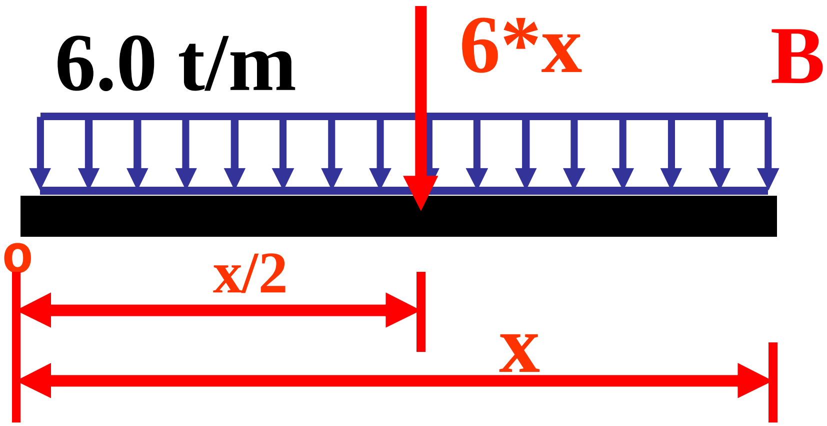
نفس الحل الاول وبالتالى
كان من الافضل اختيار
المعادلة الاولى فى الحل

Problem 1



Required the deflection and rotation at point B





$M_o = - 6*x*x/2= -3x^2$

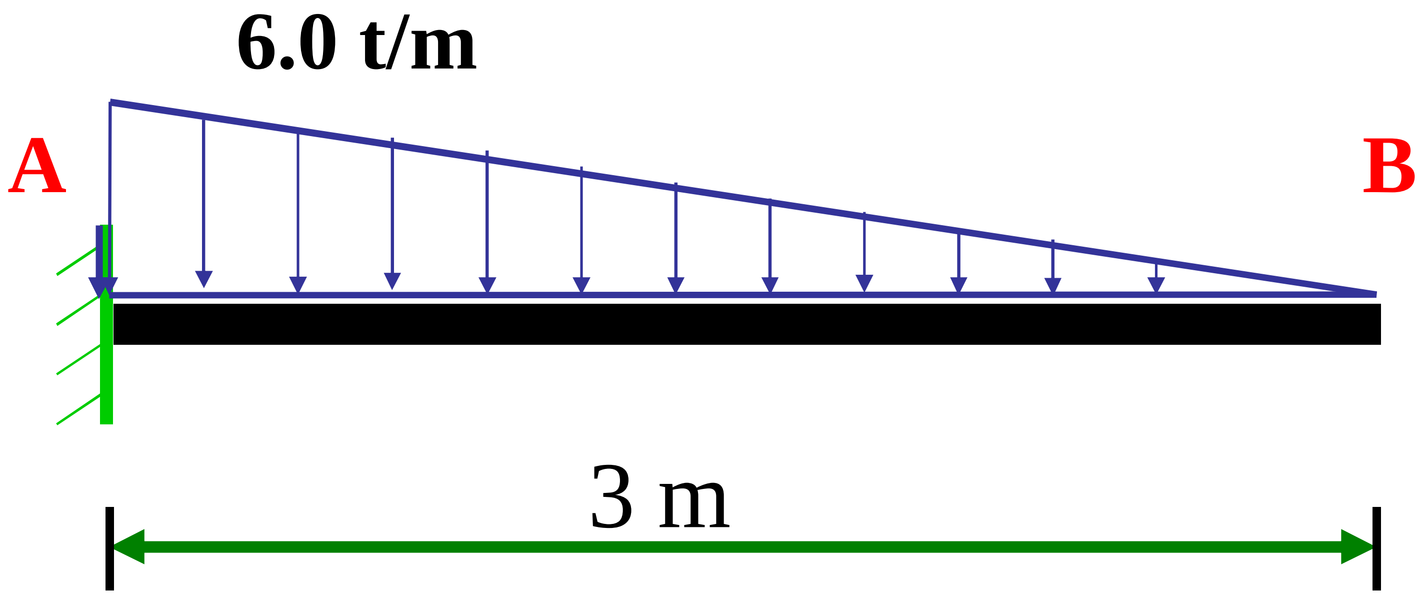
Boundary Condition **fixed support**

at A>>> x=3.0 >>>> θ=0.0

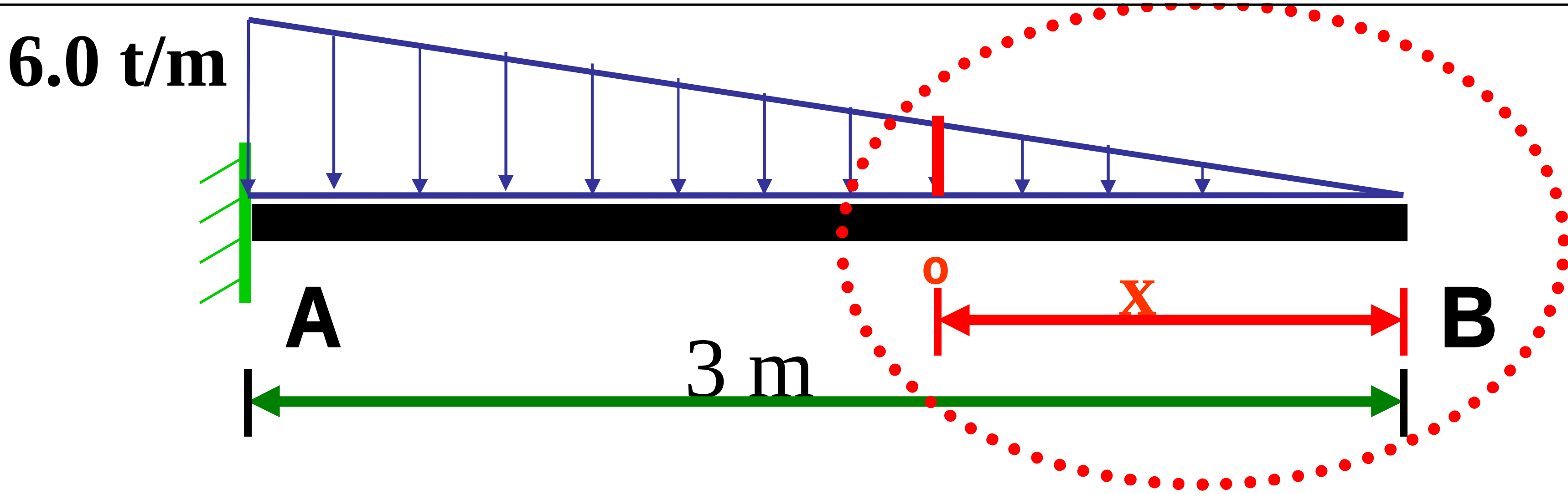
at A>>> x=3.0 >>>> y=0.0

باقى الحل بسيط ....

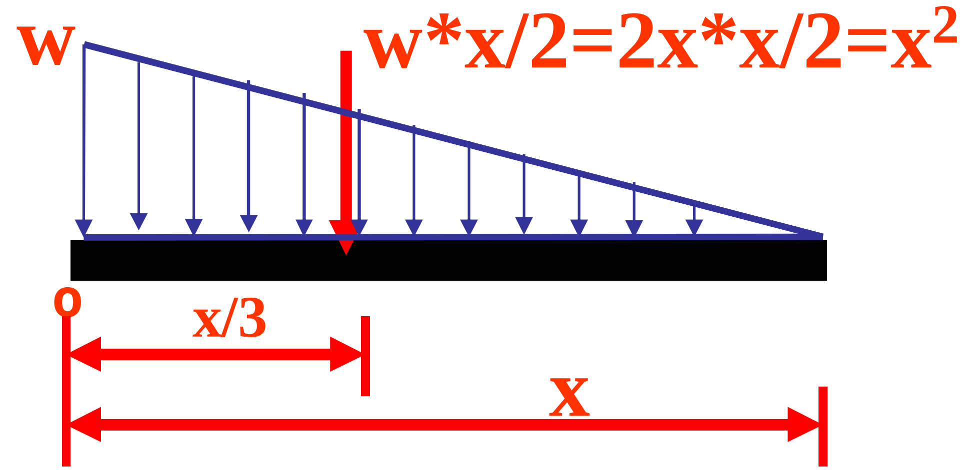
Problem 2



Required the deflection and rotation at point B



w/x=6/3 >> w= 2x



Mo = - x2*x/3 = -x3/3

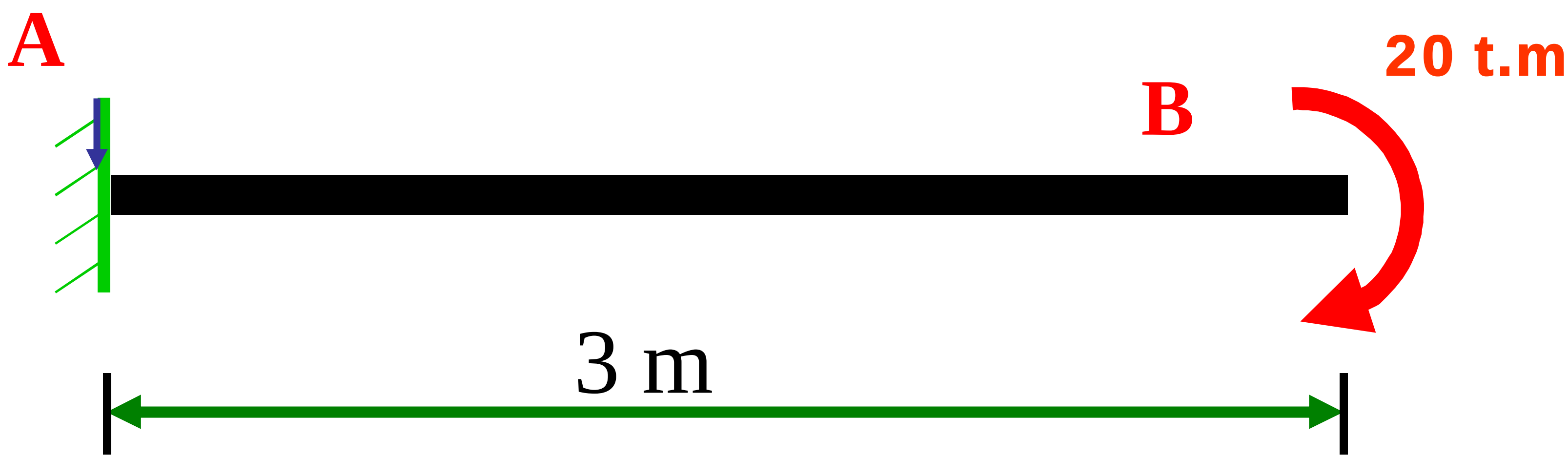
Boundary Condition fixed support

at A>>> x=3.0 >>>> θ=0.0

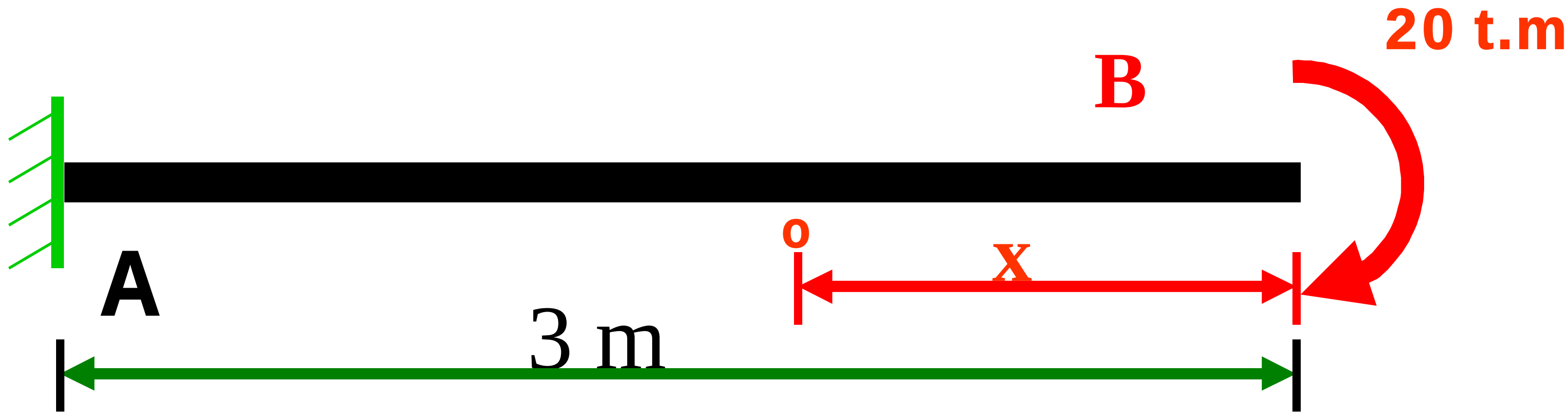
at A>>> x=3.0 >>>> y=0.0

باقى الحل بسيط ....

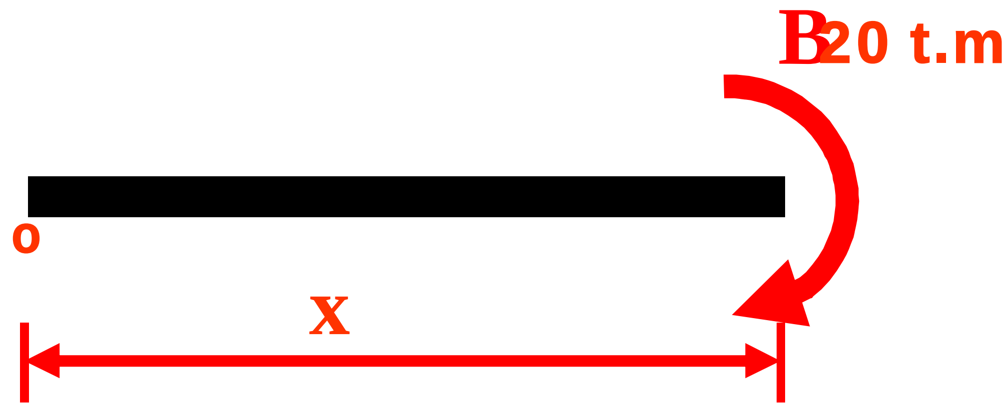
Problem 3



Required the deflection and rotation at point B



$M_o = -20$



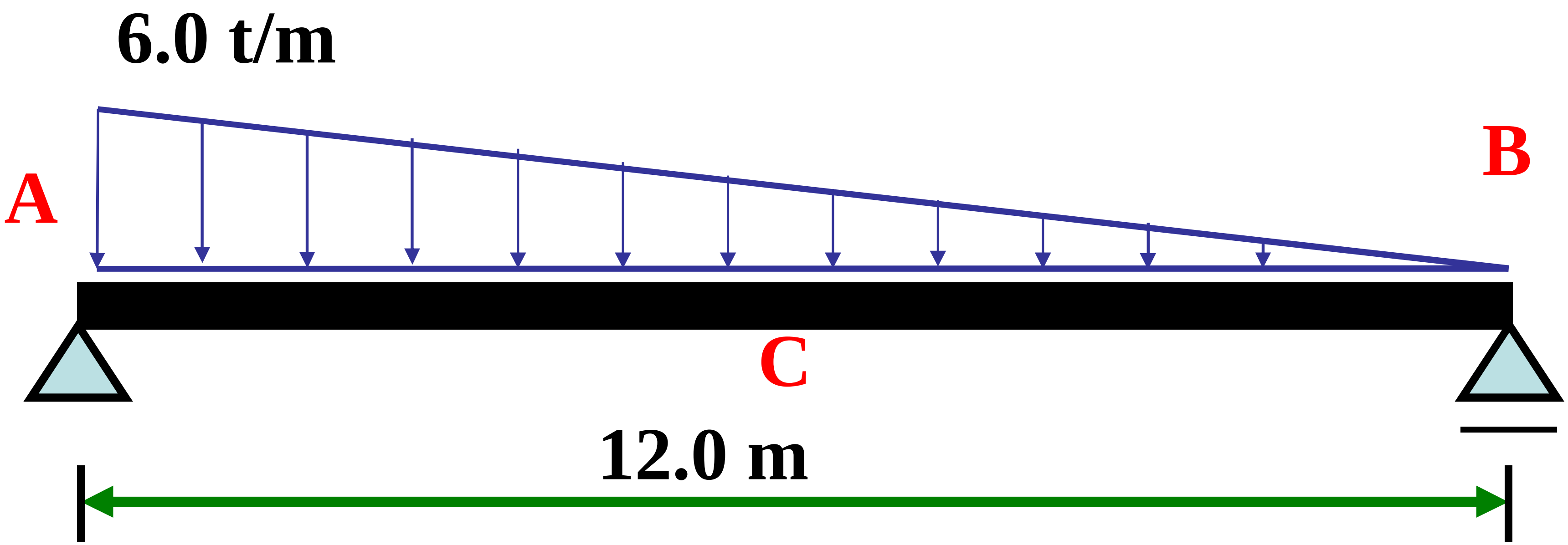
Boundary Condition **fixed support**

at A>>> $x=3.0$ >>>> $\theta=0.0$

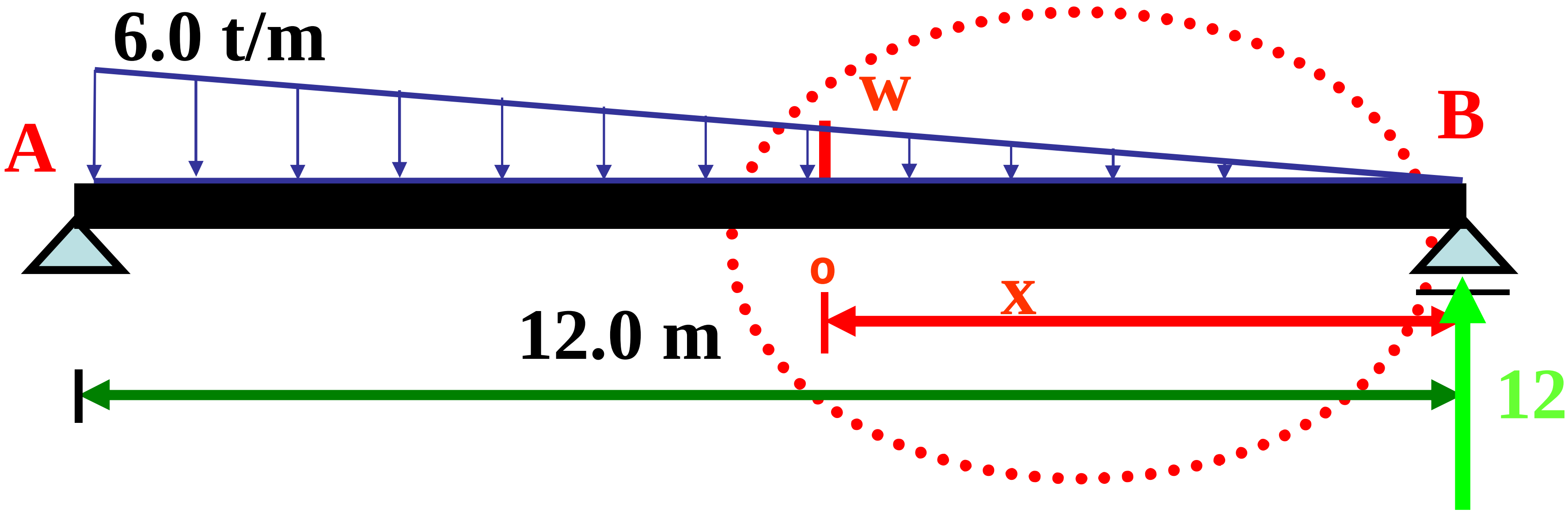
at A>>> $x=3.0$ >>>> $y=0.0$

باقى الحل بسيط ....

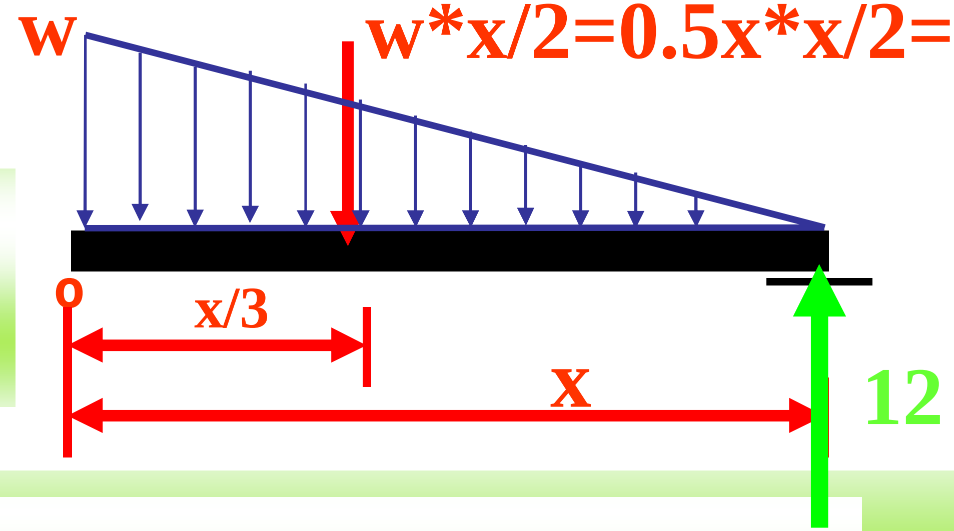
Problem 4



Required the deflection and rotation at point A, B and C



$w/x=6/12$ >> $w= 0.5x$ **$w*x/2=0.5x*x/2=x^2/4$**



$$M_o = 12x - x^2/4 * x/3$$
$$= 12x - x^3/12$$

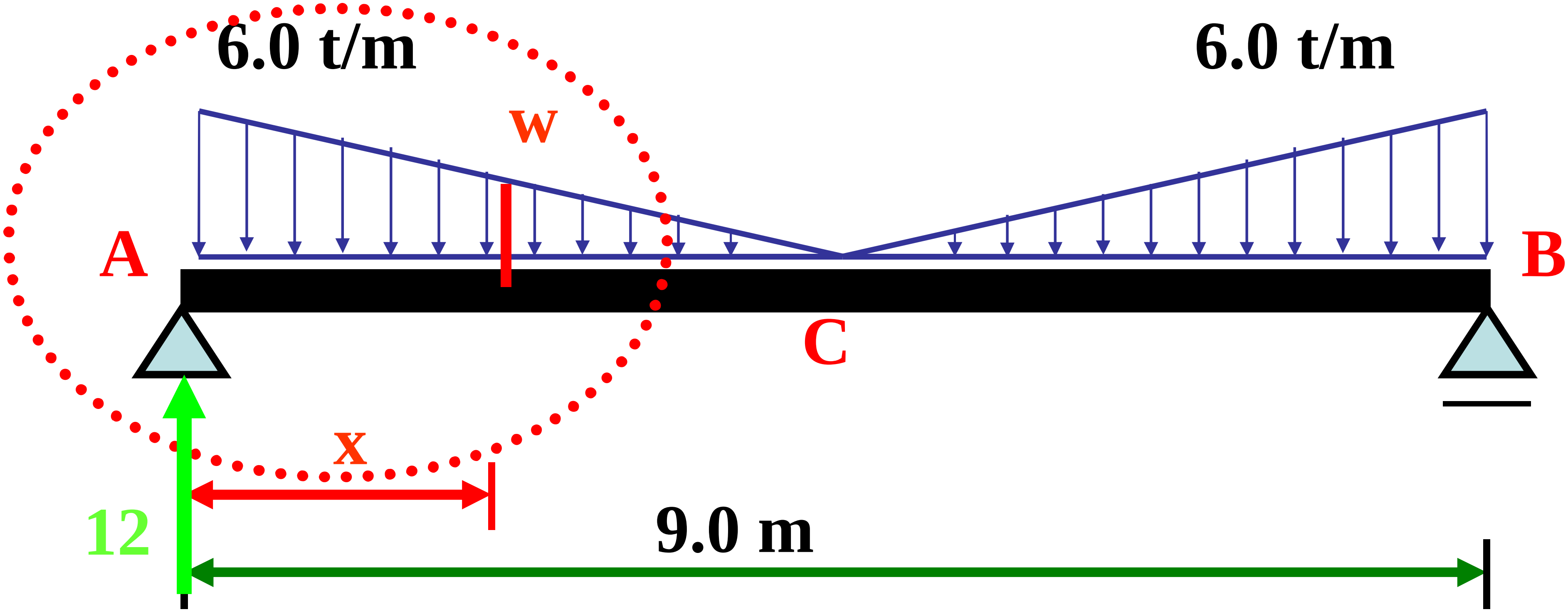
Boundary Condition **hinged support**

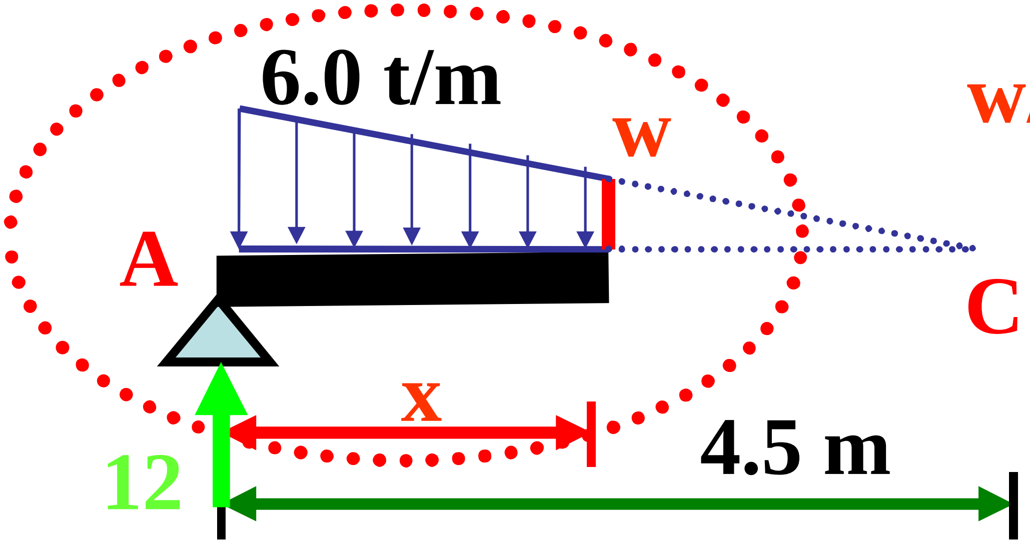
at B >>> x=0.0 >>>> y=0.0

at A >>> x=12. >>>> y=0.0

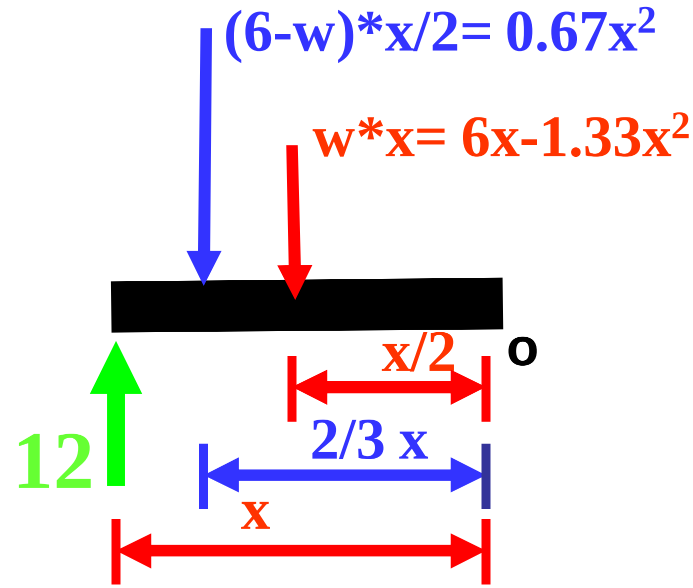
باقى الحل بسيط ....

Problem 5





$w/(4.5-x)=6/4.5 \gg w= 6-1.33x$



$M_o = 12x- 0.67x^2*2/3x-(6x-1.33x^2)*1/2\ x$

$=12x -3x^2+ 0.22\ x^3$

Boundary Condition **hinged support**

at A >>> x=0.0 >>>> y=0.0

at C >>> x=4.5 >>>> θ=0.0 **from symmetry**

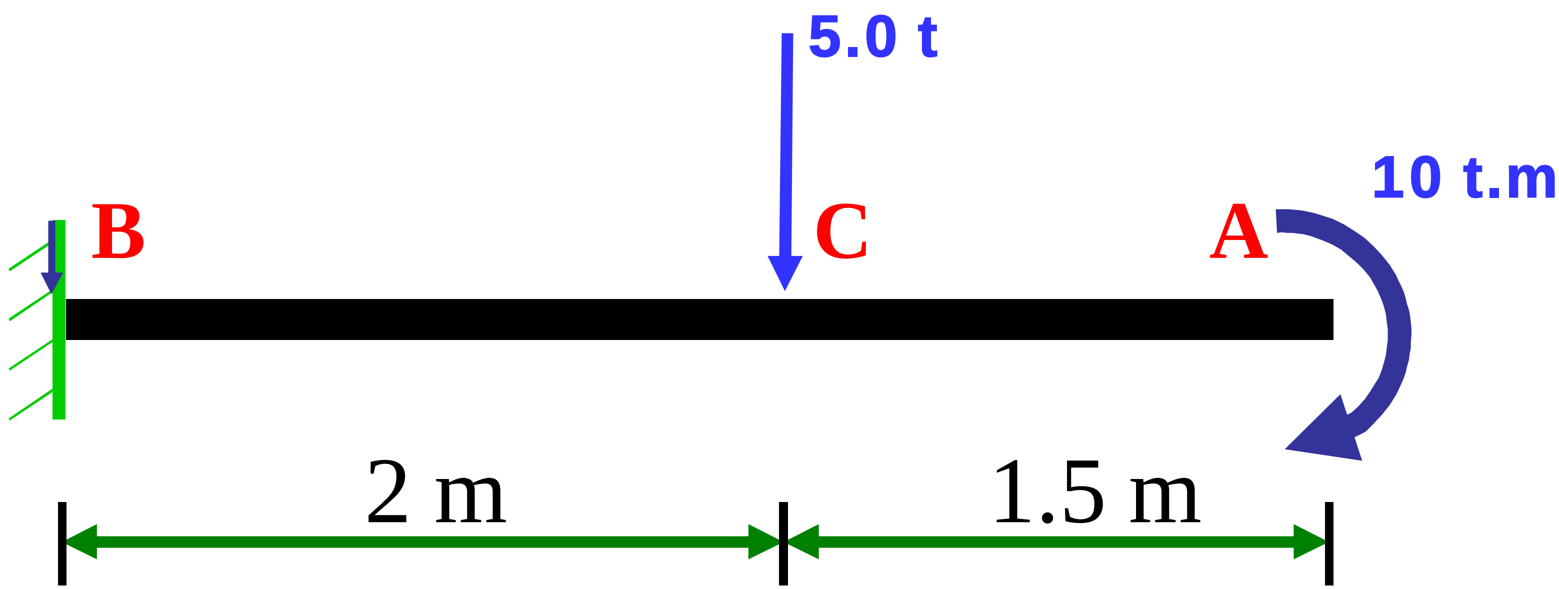
.... باقى الحل بسيط

بسم الله الرحمن الرحيم

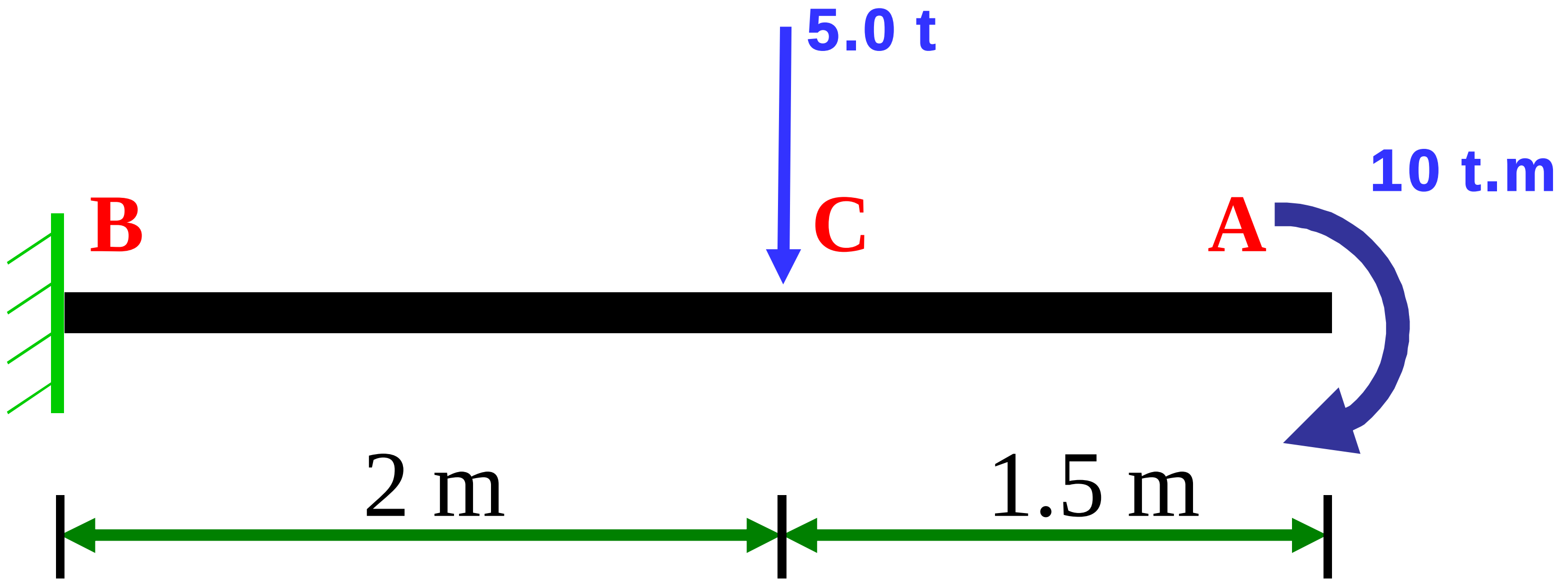
Double Integration With Variable Interval

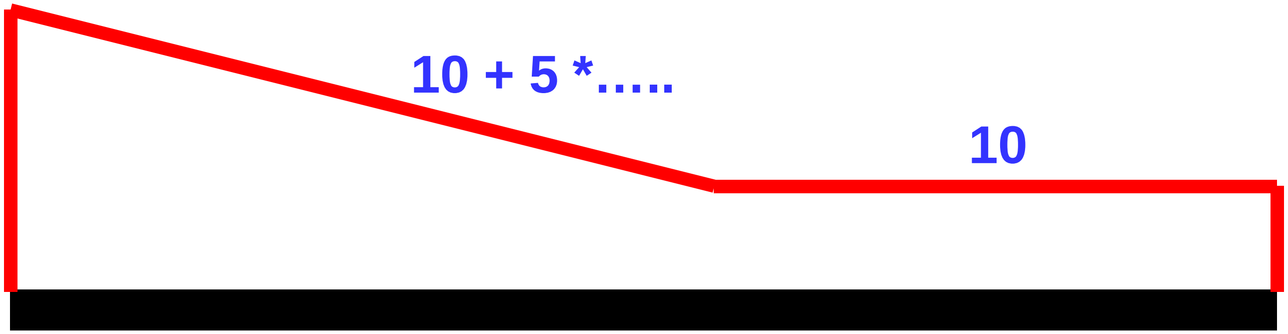
Eng : Ayman abdo

Problem 1

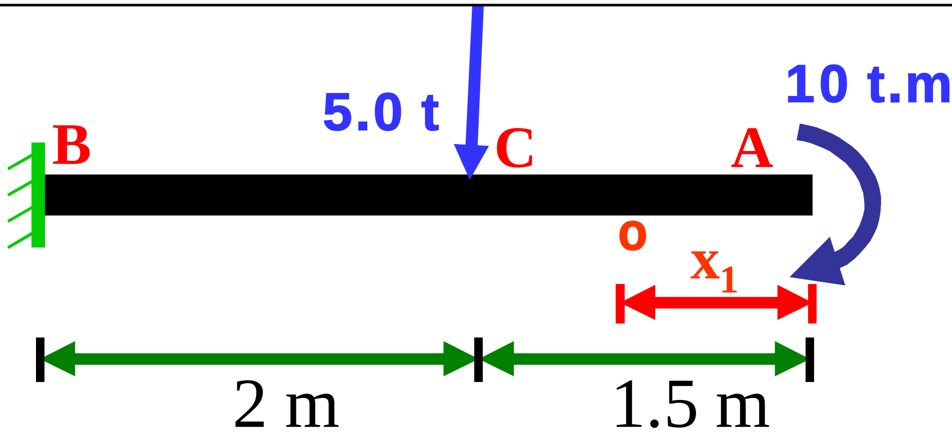


Required the deflection and rotation at point A and C





لو نظرنا الى العزم نجد انه مقسم الى جزئين كل جزء له معادله مختلفة وبالتالى عند التعويض فى معادلة **double integration** بالتالى يتم التعويض مرتين مما سيتسبب فى وجود **4 boundary conditions**



Part A >> C

x1= 0 >> x1= 1.5

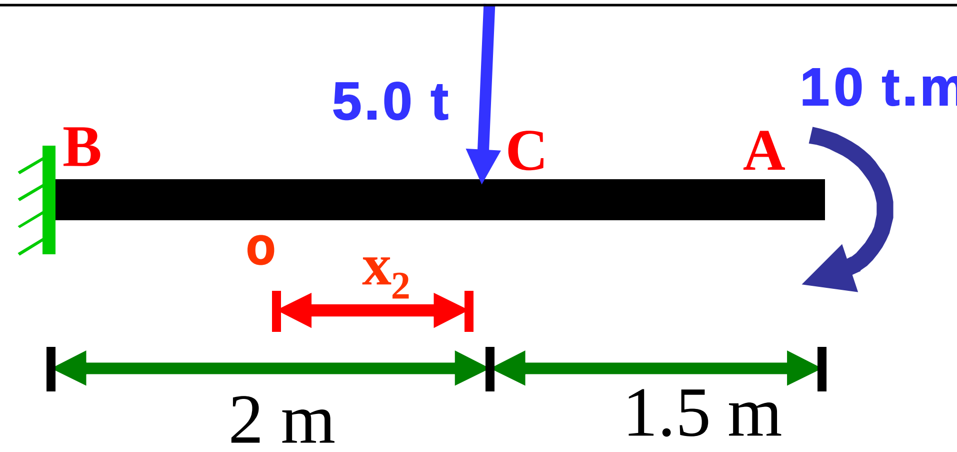
Mo = -10

$$y_1'' = -\frac{1}{EI}(M)$$

$$y_1'' = -\frac{1}{EI}(-10)$$

$$y_1' = \theta_1 = -\frac{1}{EI}(-10x_1 + c_1)$$

$$y_1 = -\frac{1}{EI}(-5x_1^2 + c_1x_1 + c_2)$$



Part C >> B

x2= 0 >> x2= 2

Mo = -10 -5x2

$$y_2'' = -\frac{1}{EI}(M)$$

$$y_2'' = -\frac{1}{EI}(-10-5x_2)$$

$$y_2' = \theta_2 = -\frac{1}{EI}(-10x_2 - 2.5x_2^2 + c_3)$$

$$y_2 = -\frac{1}{EI}(-5x_2^2 - 0.83x_2^3 + c_3x_1 + c_4)$$

At $x_2 = 2.0$ >>>> $\theta_2 = 0.0$ **عند النقطه B الدوران يساوى θ_2 = صفر**

$$y_2' = \theta_2 = -\frac{1}{EI}(-10x_2 - 2.5x_2^2 + c_3) = 0$$

$$-10*2 - 2.5*2^2 + c_3 = 0$$

$$c_3 = 30$$

At $x_2 = 2.0$ >>>> $y_2 = 0.0$ **عند النقطه B الهبوط يساوى y_2 = صفر**

$$y_2 = -\frac{1}{EI}(-5x_2^2 - 0.83x_2^3 + c_3x_1 + c_4) = 0.0$$

$$-5*2^2 - 0.83*2^3 + 30*2 + c_4 = 0.0$$

$$c_4 = -33.33$$

At $x_1 = 1.5$ & $x_2 = 0.0$ >> $\theta_1 = \theta_2$ **عند النقطة C الدوران يساوى $\theta_1 = \theta_2$**

$$\theta_1(x_1 = 1.5) = -\frac{1}{EI}(-10x_1 + c_1) = -\frac{1}{EI}(-10*1.5 + c_1) \qquad >> 1$$

$$\theta_2(x_2 = 0) = -\frac{1}{EI}(-10x_2 - 2.5x_2^2 + 30) = -\frac{1}{EI}(+30) \qquad >> 2$$

From 1 & 2

$$-\frac{1}{EI}(-10*1.5 + c_1) = -\frac{1}{EI}(+30) \qquad >>>> \qquad \boxed{c_1 = 45}$$

At $x_1 = 1.5$ & $x_2 = 0.0$ >> $y_1 = y_2$ **عند النقطة C الدوران يساوى $y_1 = y_2$**

$$y_1(x_1 = 1.5) = -\frac{1}{EI}(-5x_1^2 + c_1x_1 + c_2) = -\frac{1}{EI}(-5*1.5^2 + 45*1.5 + c_2) \quad >>> 1$$

$$y_2(x_2 = 0) = -\frac{1}{EI}(-5x_2^2 - 0.83x_2^3 + c_3x_2 + c_4) = -\frac{1}{EI}(-33.33) >>> 2$$

From 1 & 2

$$-\frac{1}{EI}(-5*1.5^2 + 45*1.5 + c_2) = -\frac{1}{EI}(-33.33) \quad >>>> \qquad \boxed{c_2 = -89.6}$$

Final equations

Part A >> C

x1= 0 >> x1= 1.5

$$y_1' = \theta_1 = -\frac{1}{EI}(-10x_1 + 45)$$

$$y_1 = -\frac{1}{EI}(-5x_1^2 + 45x_1 - 89.6)$$

Part C >> B

x2= 0 >> x2= 2

$$y_2' = \theta_2 = -\frac{1}{EI}(-10x_2 - 2.5x_2^2 + 30)$$

$$y_2 = -\frac{1}{EI}(-5x_2^2 - 0.83x_2^3 + 30x_1 - 33.3)$$

$$at \quad A \;>>\; x_1 = 0.0$$

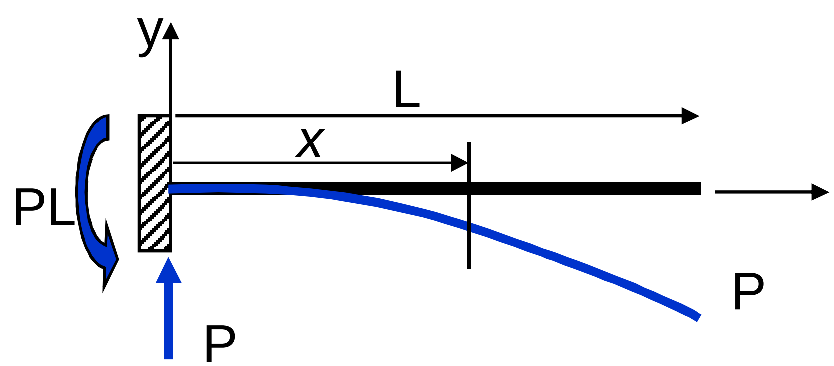
$$\theta_A = -\frac{1}{EI}(-10*0 + 45) = -\frac{45}{EI}$$

$$y_A = -\frac{1}{EI}(-5*0 + 45*0 - 89.6) = \frac{89.6}{EI}$$

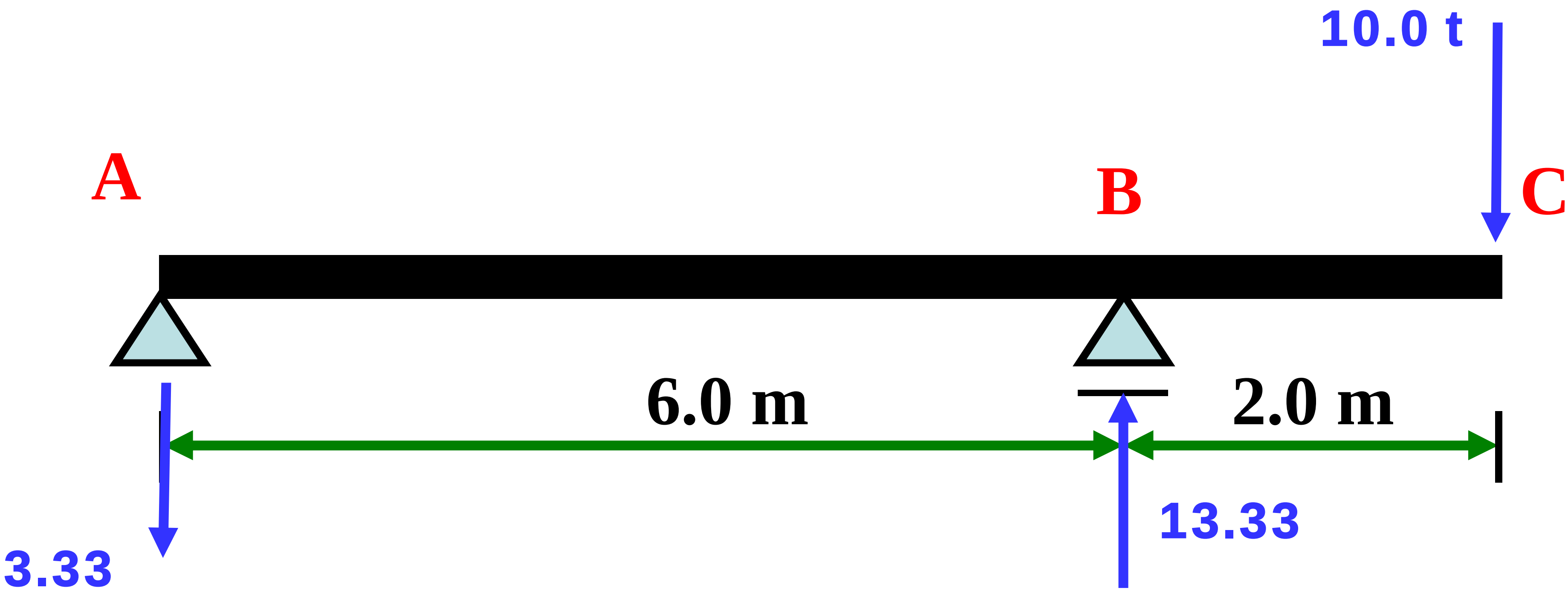
$$at \quad C \;>>\; x_1 = 1.5$$

$$\theta_c = -\frac{1}{EI}(-10*1.5 + 45) = -\frac{30}{EI}$$

$$y_c = -\frac{1}{EI}(-5*1.5^2 + 45*1.5 - 89.6) = \frac{33.3}{EI}$$



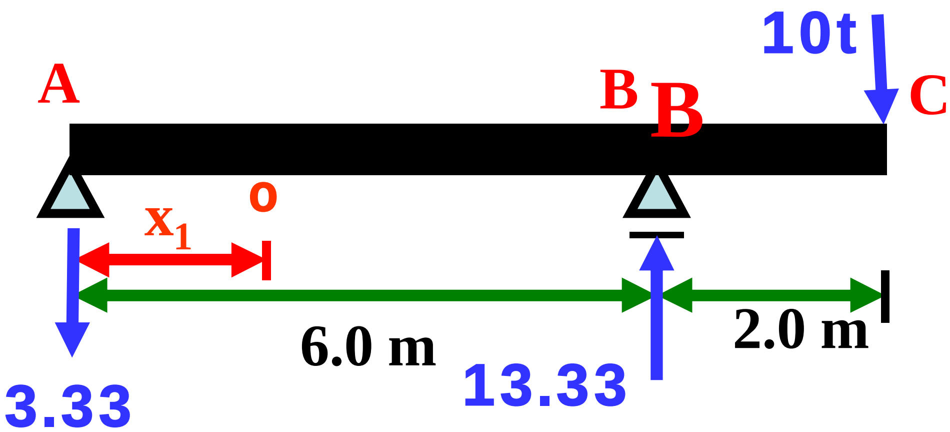
Problem 2



$$\sum M_A = 0.0 \quad >> \quad Y_B * 6 = 10 * 8$$

$$Y_B = 13.33 \uparrow$$

$$\sum Y = 0.0 \quad >> \quad Y_A = 3.33 \downarrow$$



Part A >> B

x1= 0 >> x1= 6.0

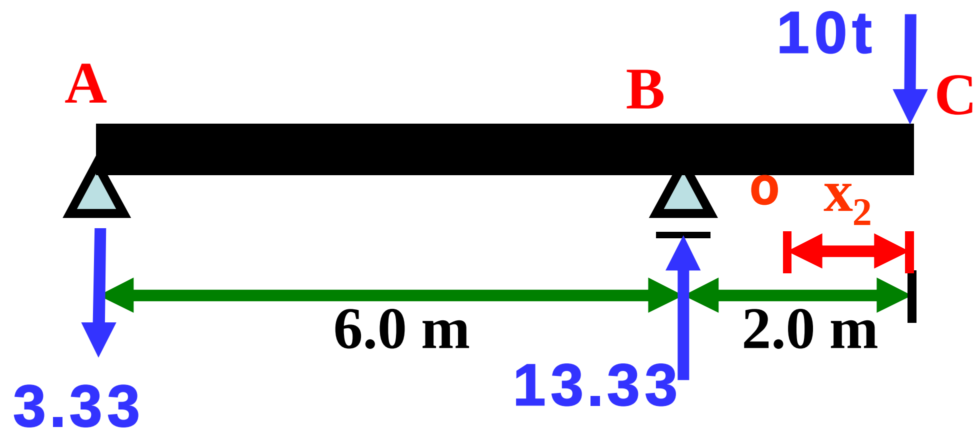
Mo = -3.3 x1

$$y_1'' = -\frac{1}{EI}(M)$$

$$y_1'' = -\frac{1}{EI}(-3.33x_1)$$

$$y_1' = \theta_1 = -\frac{1}{EI}(-1.67x_1^2 + c_1)$$

$$y_1 = -\frac{1}{EI}(-0.55x_1^3 + c_1x_1 + c_2)$$



Part C >> B

x2= 0 >> x2= 2

Mo = -10 x2

$$y_2'' = -\frac{1}{EI}(M)$$

$$y_2'' = -\frac{1}{EI}(-10x_2)$$

$$y_2' = \theta_2 = -\frac{1}{EI}(-5x_2^2 + c_3)$$

$$y_2 = -\frac{1}{EI}(1.67x_2^3 + c_3x_2 + c_4)$$

At $x_1 = 0.0$ >>>> $y_1 = 0.0$ **عند النقطه A الهبوط يساوى y_1 = صفر**

$$y_1 = -\frac{1}{EI}(0+0+c_2) = 0 \quad >>>> \quad \boxed{c_2 = 0}$$

At $x_1 = 6$ & $x_2 = 2$ >>>> $y_1 = y_2 = 0.0$

>>>> $\theta_1 = \theta_2$

At $x_1 = 6$ >>>> $y_1 = 0.0$

$$y_1 = -\frac{1}{EI}(-0.55x_1^3 + c_1 x_1 + c_2) = 0$$

$$-0.55 * 6^3 + c_1 * 6 + 0 = 0 \quad >>>> \quad \boxed{c_1 = 20}$$

At $x_2 = 2$ >>>> $y_2 = 0.0$

$$y_2 = -\frac{1}{EI}(1.67x_2^3 + c_3 x_2 + c_4) = 0$$

$$1.67 * 2^3 + c_3 * 2 + c_4 = 0 \quad >>> \quad \boxed{2c_3 + c_4 = 13.33 \quad >> 1}$$

At $x_1 = 6$ & $x_2 = 2$ >>>> $\theta_1 = \theta_2$

$$-\frac{1}{EI}(-1.67 * 6_1^2 + 20) = -\frac{1}{EI}(-5 * 2_1^2 + C_3) \quad >> \quad \boxed{C_3 = -20 \quad >> C_4 = 53.33}$$

Final equations

Part A >> B
x1= 0 >> x1= 6.0

$$y_1' = \theta_1 = -\frac{1}{EI}(-1.67x_1^2 + 20)$$

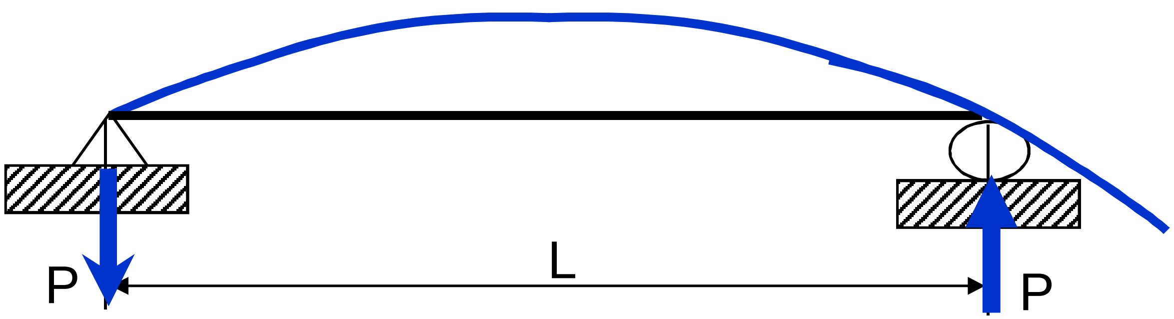
$$y_1 = -\frac{1}{EI}(-0.56x_1^3 + 20x_1)$$

Part C >> B
x2= 0 >> x2= 2

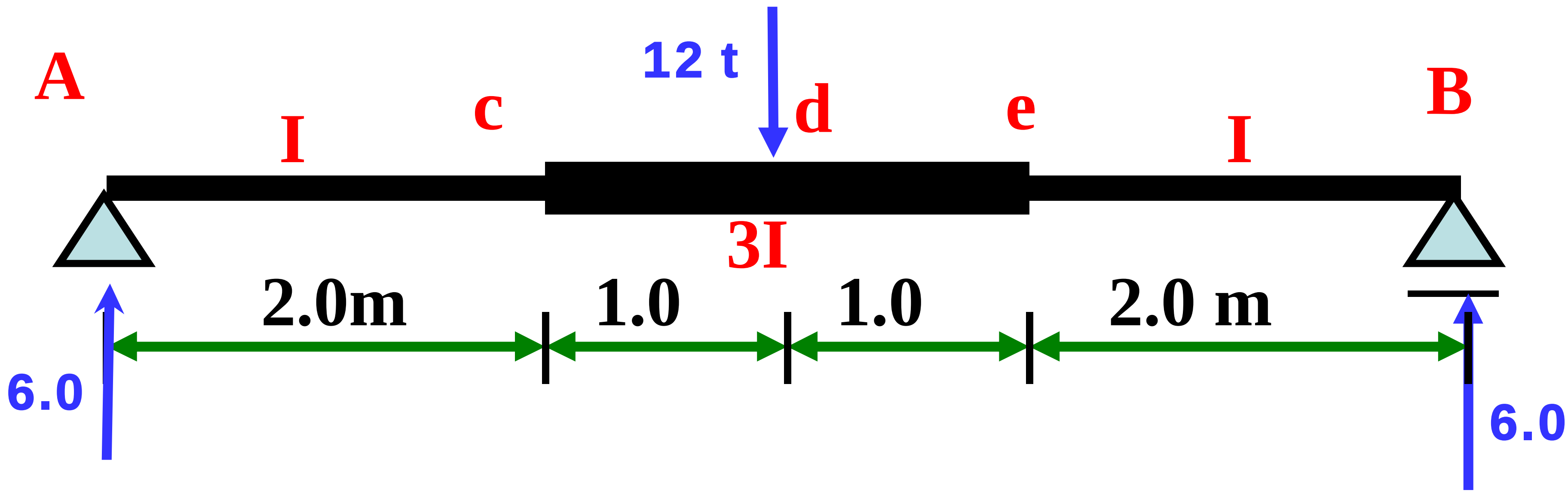
$$y_2' = \theta_2 = -\frac{1}{EI}(-5x_2^2 - 20)$$

$$y_2 = -\frac{1}{EI}(-1.67x_2^3 - 20x_2 + 53.33)$$

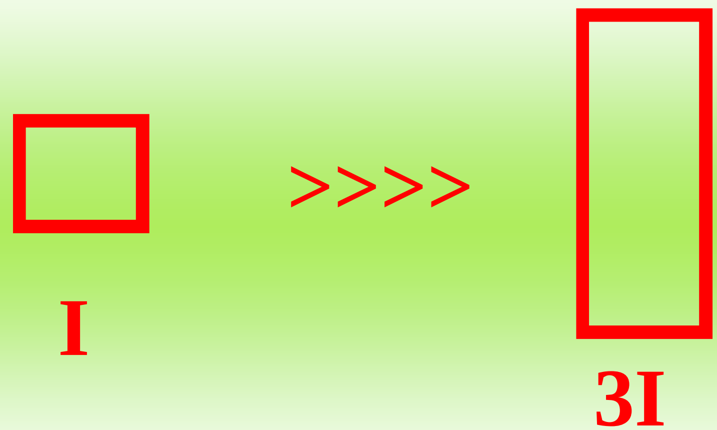
بالتعويض باحداثى اى نقطه يمكن
الحصول على الهبوط والدوران عندها

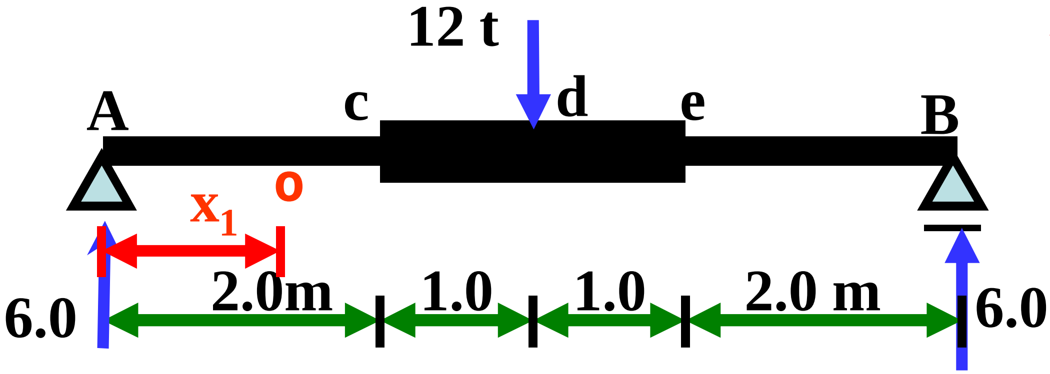


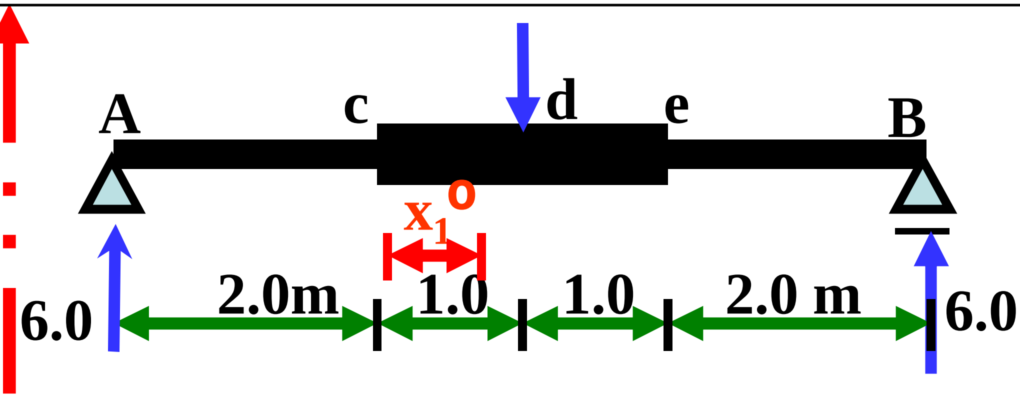
Problem 3



معنى ان القطاع 3I يعنى الـ inertia بتتضاعف ثلاث مرات







Part A >> C

x1= 0 >> x1= 2.0

Mo = 6 x1

$$y_1'' = -\frac{1}{EI}(M)$$

$$y_1'' = -\frac{1}{EI}(6x_1)$$

$$y_1' = \theta_1 = -\frac{1}{EI}(3x_1^2 + c_1)$$

$$y_1 = -\frac{1}{EI}(x_1^3 + c_1 x_1 + c_2)$$

Part C >> d

x2= 0 >> x2= 1

Mo = 6*(2+ x2) = 12+6x2

$$y_2'' = -\frac{1}{3EI}(M)$$

$$y_2'' = -\frac{1}{3EI}(6x_2 + 12)$$

$$y_2' = \theta_2 = -\frac{1}{3EI}(12x_2 + 3x_2^2 + c_3)$$

$$y_2 = -\frac{1}{3EI}(6x_2^2 + x_2^3 + c_3 x_2 + c_4)$$

At $x_1 = 0.0$ >>>> $y_1 = 0.0$ **عند النقطه A الهبوط يساوى y_1 = صفر**

$$y_1 = -\frac{1}{EI}(x_1^3 + c_1 x_1 + c_2) = 0.0 \quad >>> \quad 0 + c_1 * 0 + c_2 = 0.0 \quad >> \quad \boxed{c_2 = 0.0}$$

At $x_2 = 1.0$ >>>> $\theta_2 = 0.0$ **عند النقطه d الدوران يساوى θ_2 = صفر**
بسبب وجود تماثل عند هذه النقطة

$$y_2' = \theta_2 = -\frac{1}{3EI}(12x_2 + 3x_2^2 + c_3) = 0 \quad >>> \quad 12*1 + 3*1^2 + c_3 = 0.0 \quad >> \quad \boxed{c_3 = -15}$$

At $x_1 = 2$ & $x_2 = 0.0$ >> $\theta_1 = \theta_2$ عند النقطه C الدوران يساوى $\theta_1 = \theta_2$

$$\theta_1(x_1 = 2) = -\frac{1}{EI}(3*2^2 + c_1) = -\frac{1}{EI}(12 + c_1) \quad >> 1$$

$$\theta_2(x_2 = 0) = -\frac{1}{3EI}(12*0 + 3*0 - 15) = -\frac{1}{3EI}(-15) \quad >> 2$$

From 1 & 2

$$-\frac{1}{EI}(12 + c_1) = -\frac{1}{3EI}(-15) \quad >>>> \quad \boxed{c_1 = -17}$$

At $x_1 = 1.5$ & $x_2 = 0.0$ >> $y_1 = y_2$ عند النقطه C الدوران يساوى $y_1 = y_2$

$$y_1(x_1 = 2) = -\frac{1}{EI}(2^3 - 17*2 + 0) = -\frac{1}{EI}(-26) \quad >>> 1$$

$$y_2(x_2 = 0) = -\frac{1}{3EI}(0 + 0 + 0 + c_4) = -\frac{1}{3EI}(c_4) >>> 2$$

From 1 & 2

$$c_4 = 3* -26 = \boxed{-78}$$

Final equations

Part A >> c
x1= 0 >> x1= 2.0

$$\theta_1 = -\frac{1}{EI}(3x_1^2 - 17)$$

$$y_1 = -\frac{1}{EI}(x_1^3 - 17x_1)$$

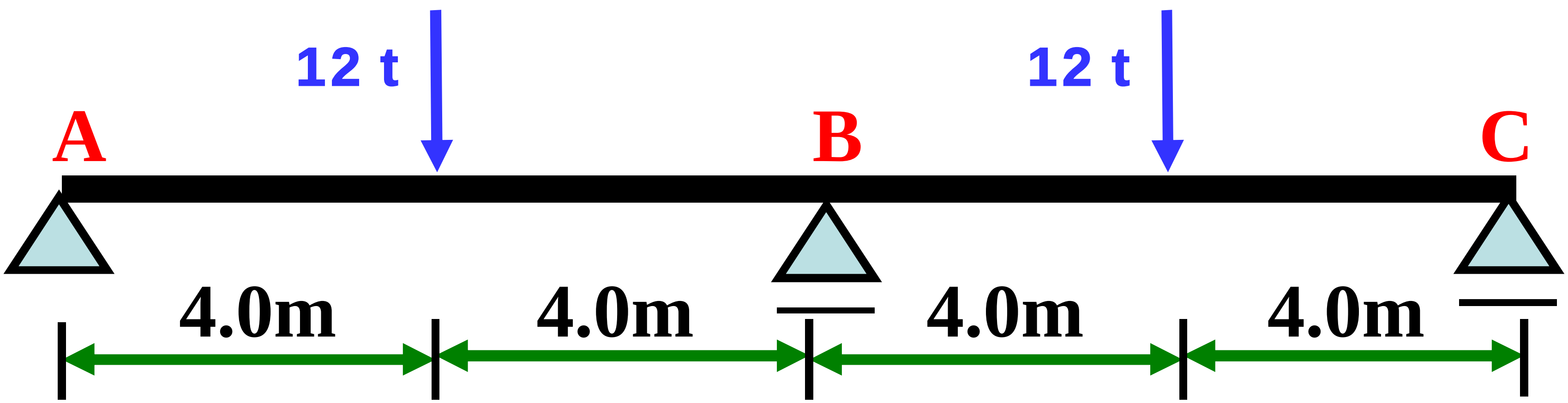
Part c >> d
x2= 0 >> x2= 1

$$\theta_2 = -\frac{1}{3EI}(12x_2 + 3x_2^2 - 15)$$

$$y_2 = -\frac{1}{3EI}(6x_2^2 + x_2^3 - 15x_2 - 78)$$

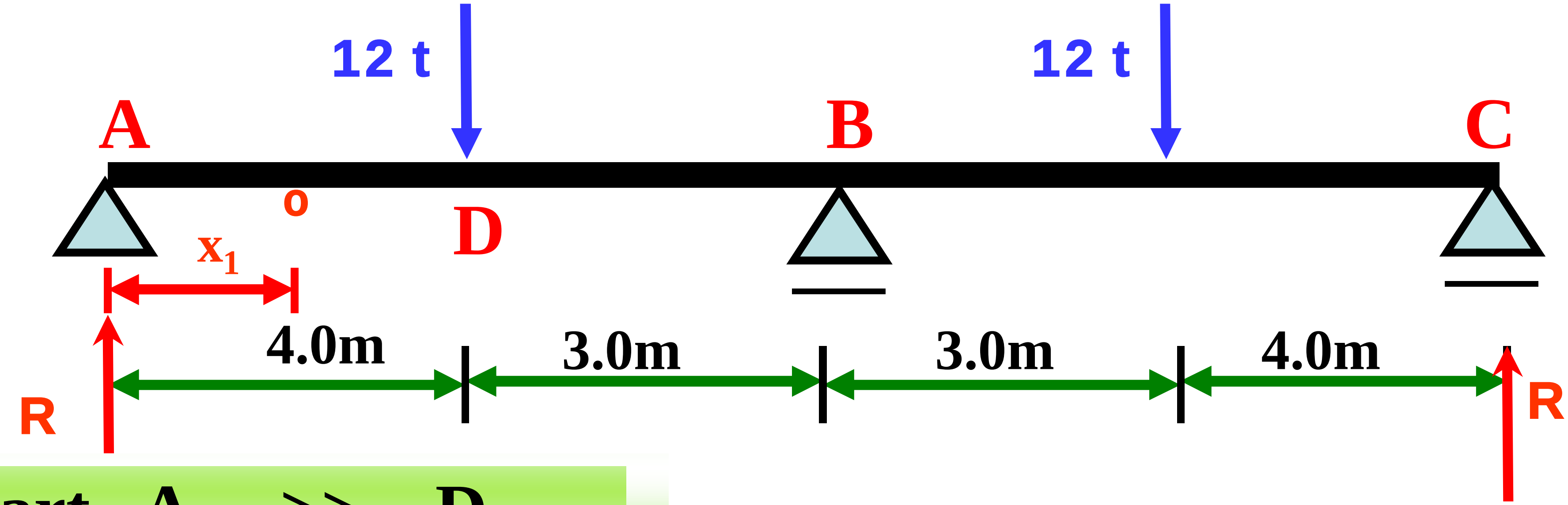
بالتعويض باحداثى اى نقطه يمكن
الحصول على الهبوط والدوران عندها

Problem 3



المطلوب رسم العزم لهذه الكمرة الغير محدده استاتيكيا

مع العلم ان الهبوط عند النقطه B يساوى صفر



Part A >> D

x1= 0 >> x1= 4.0

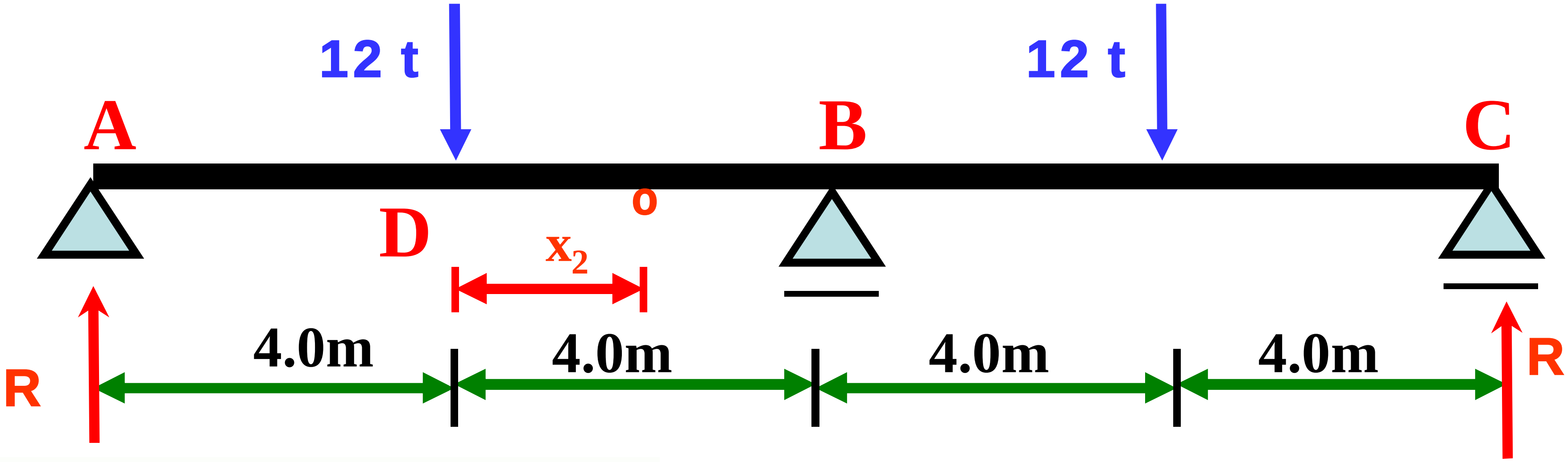
Mo = R x1

$$y_1'' = -\frac{1}{EI}(M)$$

$$y_1'' = -\frac{1}{EI}(Rx_1)$$

$$y_1' = \theta_1 = -\frac{1}{EI}(0.5Rx_1^2 + c_1)$$

$$y_1 = -\frac{1}{EI}(0.167Rx_1^3 + c_1x_1 + c_2)$$



Part D >> B

x2= 0 >> x2= 3

Mo = R*(4+ x2) + 12* x2 = 4R+Rx2+12x2

$$y_2'' = -\frac{1}{EI}(M)$$

$$y_2'' = -\frac{1}{EI}(4R + Rx_2 + 12x_2)$$

$$y_2' = \theta_2 = -\frac{1}{EI}(4Rx_2 + 0.5Rx_2^2 + 6x_2^2 + c_3)$$

$$y_2 = -\frac{1}{EI}(2Rx_2^2 + 0.167Rx_2^3 + 2x_2^3 + c_3x_2 + c_4)$$

At $x_1 = 0.0$ >>>> $y_1 = 0.0$ 	عند النقطه A الهبوط يساوى y1 = صفر

$$y_1 = -\frac{1}{EI}(0.167R*0+c_1*0+c_2)=0 \quad >> \quad \boxed{c_2 = 0}$$

At $x_1 = 1.0$ 	عند النقطه D الدوران يساوى $\theta_1 = \theta_2$

>>>> $\theta_1 = \theta_2$ 	بسبب وجود تماثل عند هذه النقطة

At $x_2 = 1.0$

$$\theta_1[(x_1=4)] = -\frac{1}{EI}(0.5R*4^2+c_1) = \theta_2[x_2=0] = -\frac{1}{EI}(4R*0+0.5R*0+6*0+c_3)$$

$$\boxed{8R+c_1 = c_3 \qquad >> \quad 1}$$

At $x_1 = 1.0$ 	عند النقطه D الدوران يساوى $y_1 = y_2$

>>>> $y_1 = y_2$ 	بسبب وجود تماثل عند هذه النقطة

At $x_2 = 1.0$

$$y_1 = -\frac{1}{EI}(0.167R*4^3+c_1*4+0) = y_2 = -\frac{1}{EI}(2R*0+0.167R*0+2*0+c_3*0+c_4) = -\frac{1}{EI}(c_4)$$

$$\boxed{10.67R+4c_1 = c_4 \qquad >> \quad 2}$$

At $x_2 = 4.0$ >>>> $\theta_2 = 0.0$ عند النقطه B الهبوط يساوى θ_2 = صفر

$$\theta_2 = -\frac{1}{3EI}(4R*4+0.5R*16+6*16+c_3)=0$$

$$4R*4+0.5R*16+6*16+c_3=0$$

$$c_3=-24R+96 \quad >>> \quad 3$$

At $x_2 = 4.0$ >>>> $y_2 = 0.0$ عند النقطه B الهبوط يساوى y_2 = صفر

$$y_2 = -\frac{1}{EI}(2R*16+0.167R*64+2*64+c_3*4+c_4)=0$$

$$2R*16+0.167R*64+2*64+c_3*4+c_4=0$$

$$42.66R+128+c_3*4+c_4=0 \qquad >>> \quad 4$$

$$8R + c_1 = c_3 \quad >> \quad 1$$

$$10.67R + 4c_1 = c_4 \quad >> \quad 2$$

$$c_3 = -24R + 96 \quad >>> \quad 3$$

$$42.66R + 128 + c_3 * 4 + c_4 = 0 \quad >>> \quad 4$$

From 3 in 1

$8R+c_1=-24R+96$

$>>>c_1=-32R+96$ >> 5

From 5 in 2

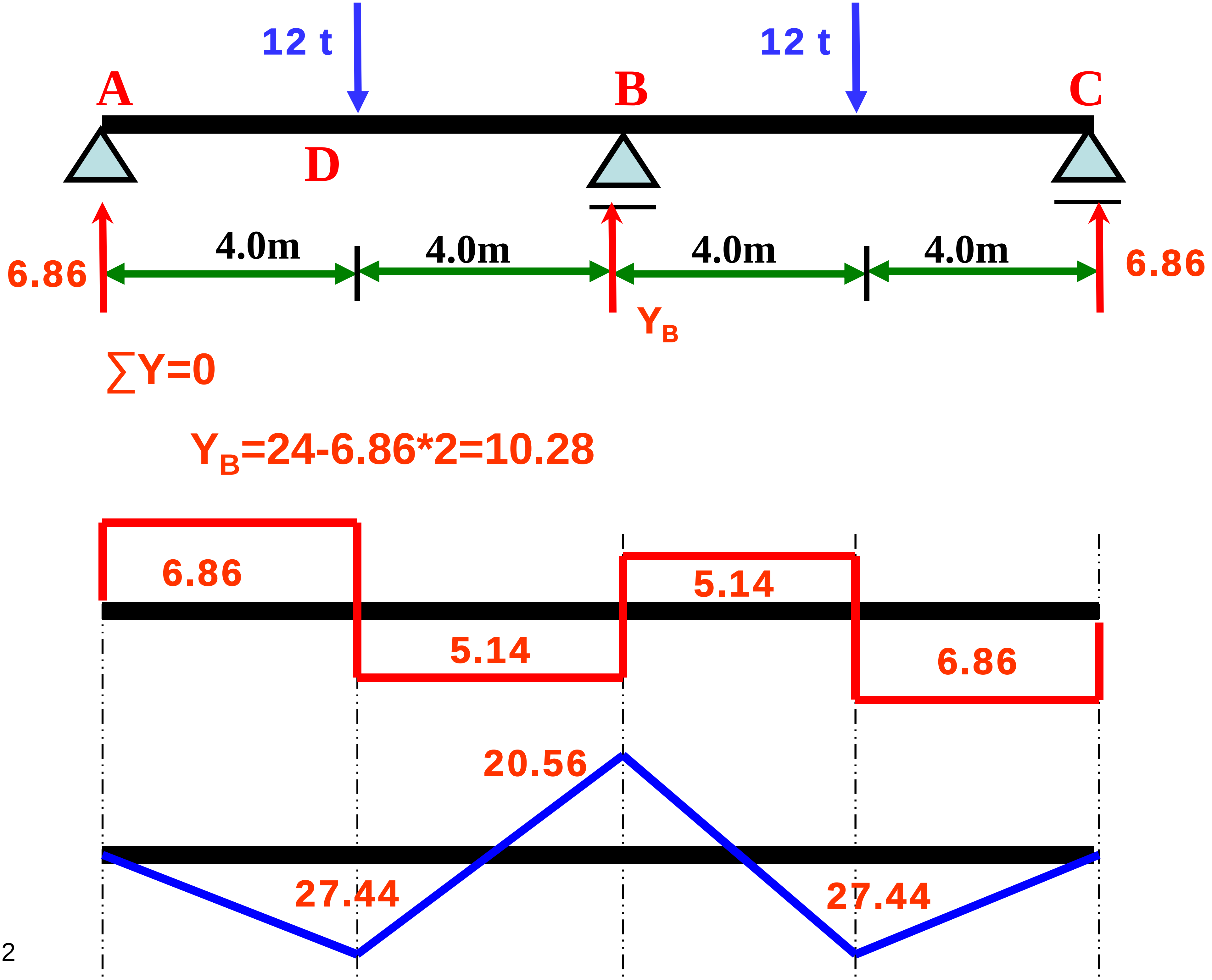
$10.67R+4(-32R+96)=c_4$

$>>>c_4=-117.33R+384$ >>6

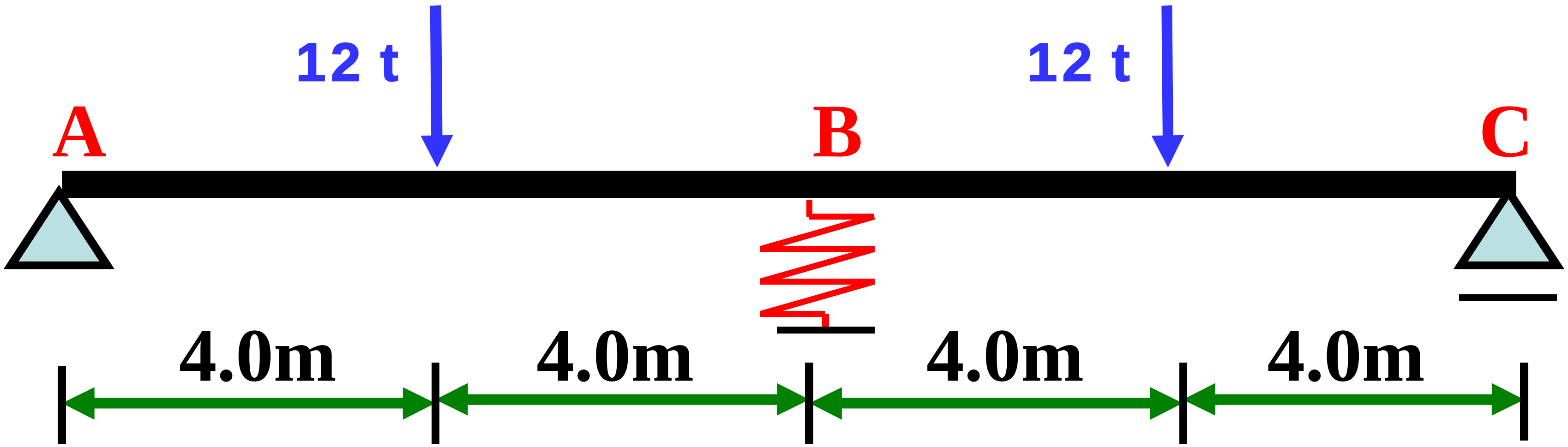
From 5, 6 in 4

$42.67R+128+4(-14R+96)-117.33R+384 =0$

>>> R= 6.86 ton


12 t
12 t
A
B
C
D
6.86
4.0m
4.0m
4.0m
4.0m
6.86
Y_B
$\sum Y=0$
$Y_B=24-6.86*2=10.28$
6.86
5.14
5.14
6.86
20.56
27.44
27.44

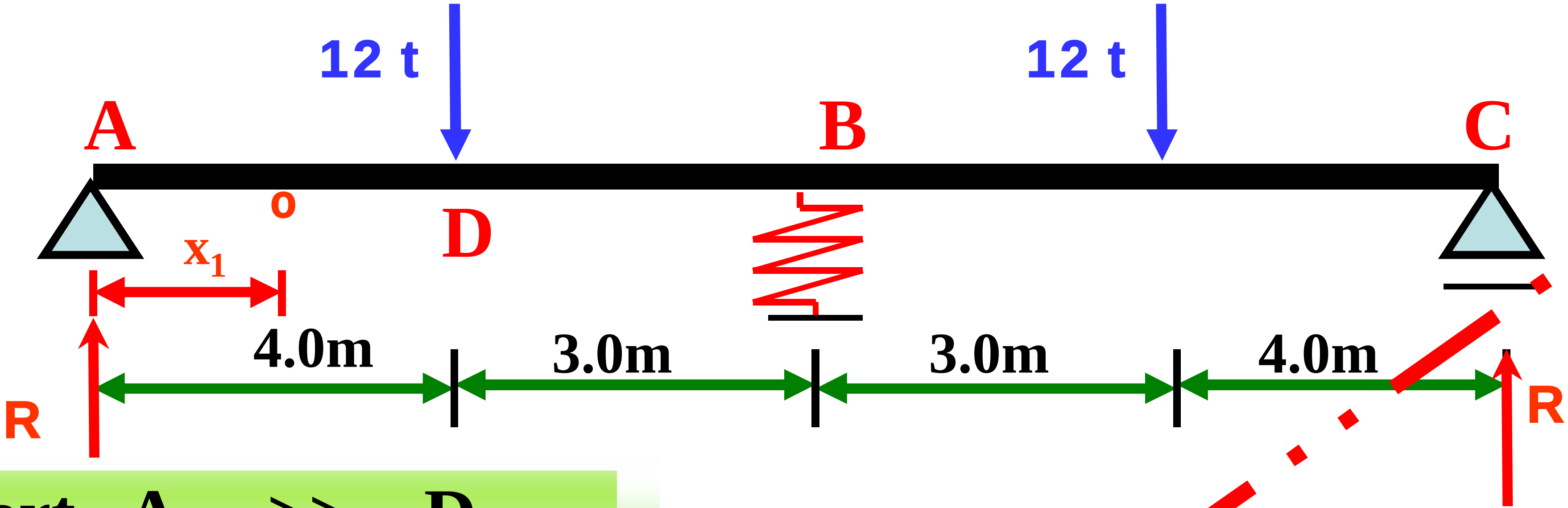
Problem 3



المطلوب رسم العزم لهذه الكمرة الغير محدده استاتيكيا

مع العلم ان الهبوط عند النقطه B يساوى 2cm

$EI=4000\ t/m^2$



Part A >> D

x1= 0 >> x1= 4.0

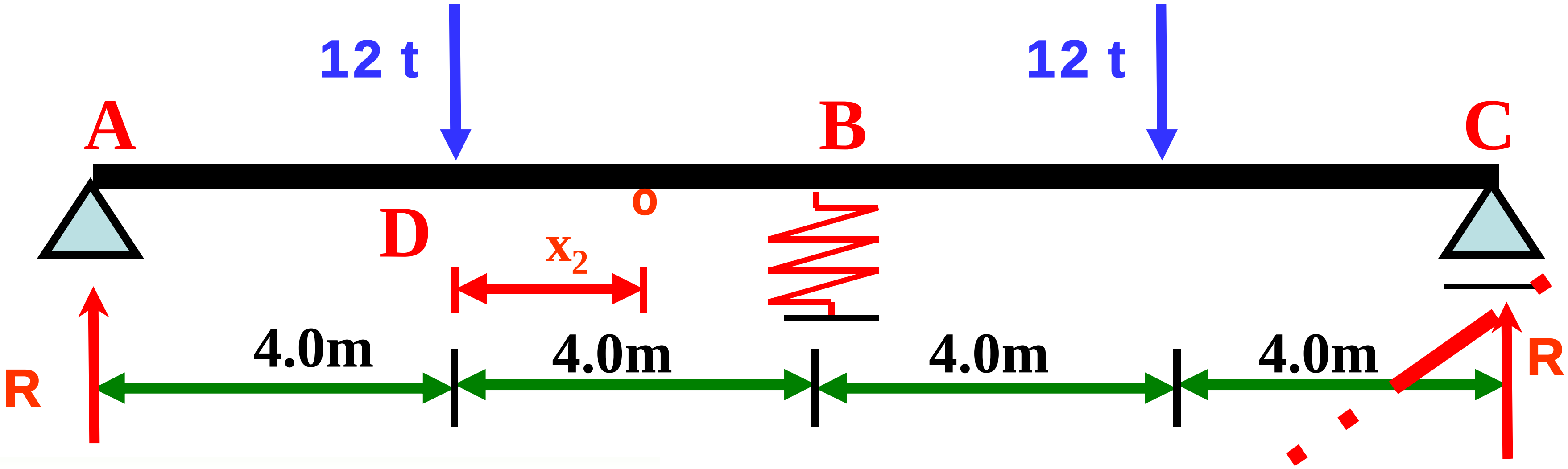
Mo = R x1

$$y_1'' = -\frac{1}{EI}(M)$$

$$y_1'' = -\frac{1}{EI}(Rx_1)$$

$$y_1' = \theta_1 = -\frac{1}{EI}(0.5Rx_1^2 + c_1)$$

$$y_1 = -\frac{1}{EI}(0.167Rx_1^3 + c_1x_1 + c_2)$$



Part D >> B

x2= 0 >> x2= 3

Mo = R*(4+ x2) + 12* x2 = 4R+Rx2+12x2

$$y_2'' = -\frac{1}{EI}(M)$$

$$y_2'' = -\frac{1}{EI}(4R + Rx_2 + 12x_2)$$

$$y_2' = \theta_2 = -\frac{1}{EI}(4Rx_2 + 0.5Rx_2^2 + 6x_2^2 + c_3)$$

$$y_2 = -\frac{1}{EI}(2Rx_2^2 + 0.167Rx_2^3 + 2x_2^3 + c_3x_2 + c_4)$$

At $x_1 = 0.0$ >>>> $y_1 = 0.0$

عند النقطة A الهبوط يساوى y1 = صفر

$$y_1 = -\frac{1}{EI}(0.167R*0+c_1*0+c_2)=0 \quad >> \quad \boxed{c_2 = 0}$$

At $x_1 = 1.0$

>>>> $\theta_1 = \theta_2$

At $x_2 = 1.0$

عند النقطة D الدوران يساوى $\theta_1 = \theta_2$
بسبب وجود تماثل عند هذه النقطة

$$\theta_1[(x_1=4)] = -\frac{1}{EI}(0.5R*4^2+c_1) = \theta_2[x_2=0] = -\frac{1}{EI}(4R*0+0.5R*0+6*0+c_3)$$

$$\boxed{8R+c_1 = c_3 \quad >> \quad 1}$$

At $x_1 = 1.0$

>>>> $y_1 = y_2$

At $x_2 = 1.0$

عند النقطة D الدوران يساوى $y_1 = y_2$
بسبب وجود تماثل عند هذه النقطة

$$y_1 = -\frac{1}{EI}(0.167R*4^3+c_1*4+0) = y_2 = -\frac{1}{EI}(2R*0+0.167R*0+2*0+c_3*0+c_4) = -\frac{1}{EI}(c_4)$$

$$\boxed{10.67R+4c_1 = c_4 \quad >> \quad 2}$$

At $x_2 = 4.0$ >>>> $\theta_2 = 0.0$

عند النقطه B الهبوط يساوى θ_2 = صفر

$$\theta_2 = -\frac{1}{3EI}(4R*4+0.5R*16+6*16+c_3)=0$$

$$4R*4+0.5R*16+6*16+c_3=0$$

$$c_3 = -24R + 96 \quad >>> \quad 3$$

At $x_2 = 4.0$ >>>> $y_2 = 0.02$

عند النقطه B الهبوط يساوى y_2 = 0.02

$$y_2 = -\frac{1}{4000}(2R*16+0.167R*64+2*64+c_3*4+c_4)=0.02$$

$$2R*16+0.167R*64+2*64+c_3*4+c_4=80$$

$$42.66R + c_3*4 + c_4 = 48 \quad >>> \quad 4$$

$$8R + c_1 = c_3 \quad >> \quad 1$$

$$10.67R + 4c_1 = c_4 \quad >> \quad 2$$

$$c_3 = -24R + 96 \quad >>> \quad 3$$

$$42.66R + c_3 * 4 + c_4 = 48 \quad >>> \quad 4$$

From 3 in 1

8R+c1=-24R+96

>>>c1=-32R+96 >> 5

From 5 in 2

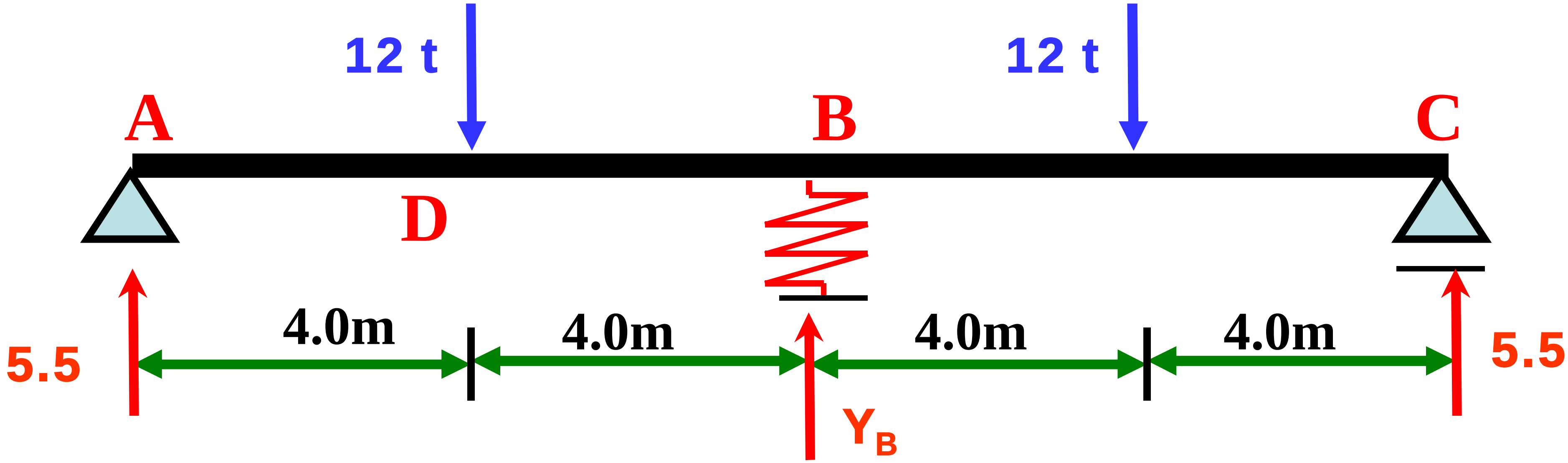
10.67R+4(-32R+96)=c4

>>>c4=-117.33R+384 >>6

From 5, 6 in 4

42.67R+4(-14R+96)-117.33R+384 =48

>>> R= 5.5 ton



$\sum Y=0$

$Y_B=24-5.5*2=13$

بالتالى يمكن الرسم

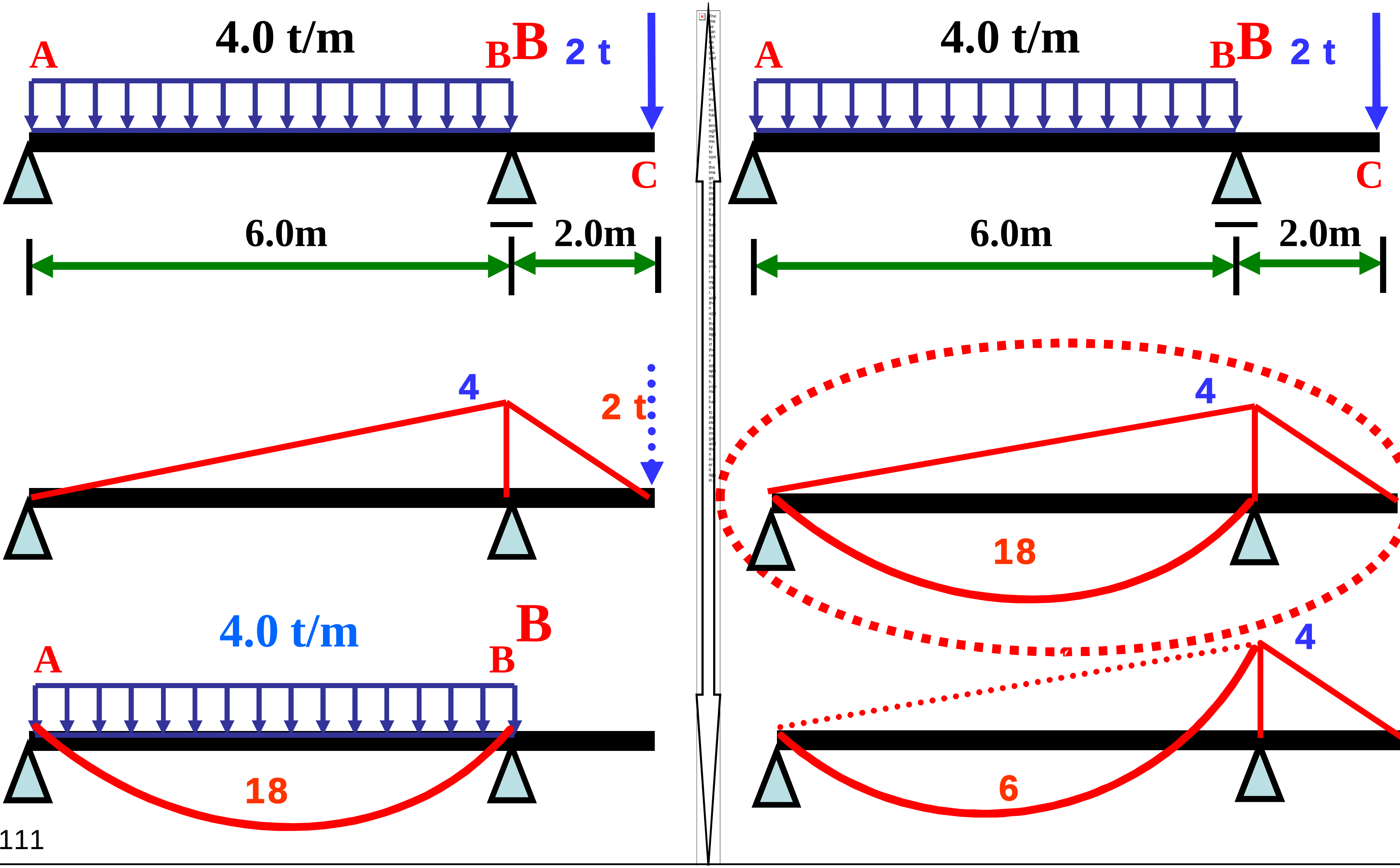
بسم الله الرحمن الرحيم

CONJEGATE BEAM METHOD

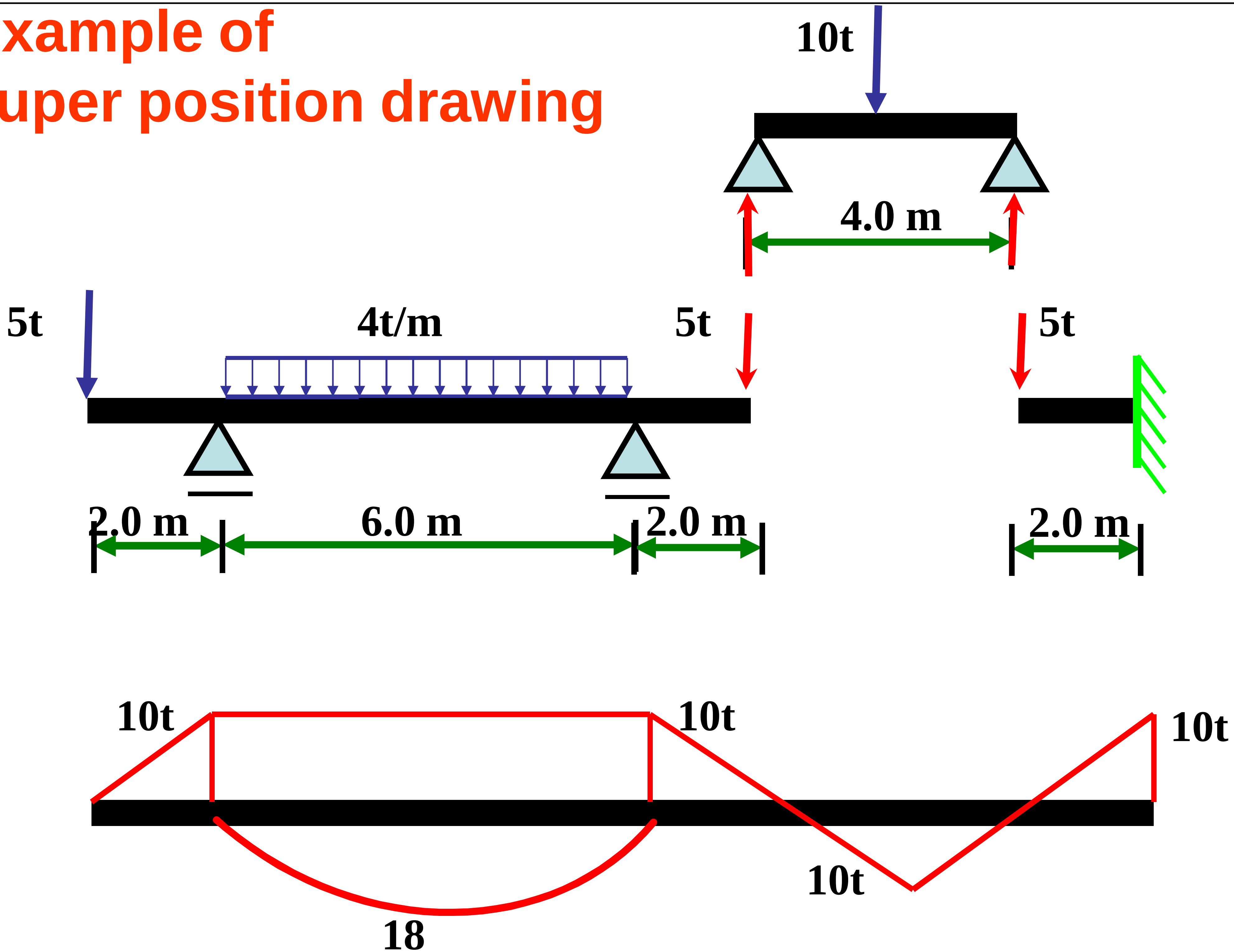
Eng : Ayman abdo

خطوات الحل:

1- يتم رسم العزم على الكمرة المعطاه ويفضل بطريقة الـ super position.

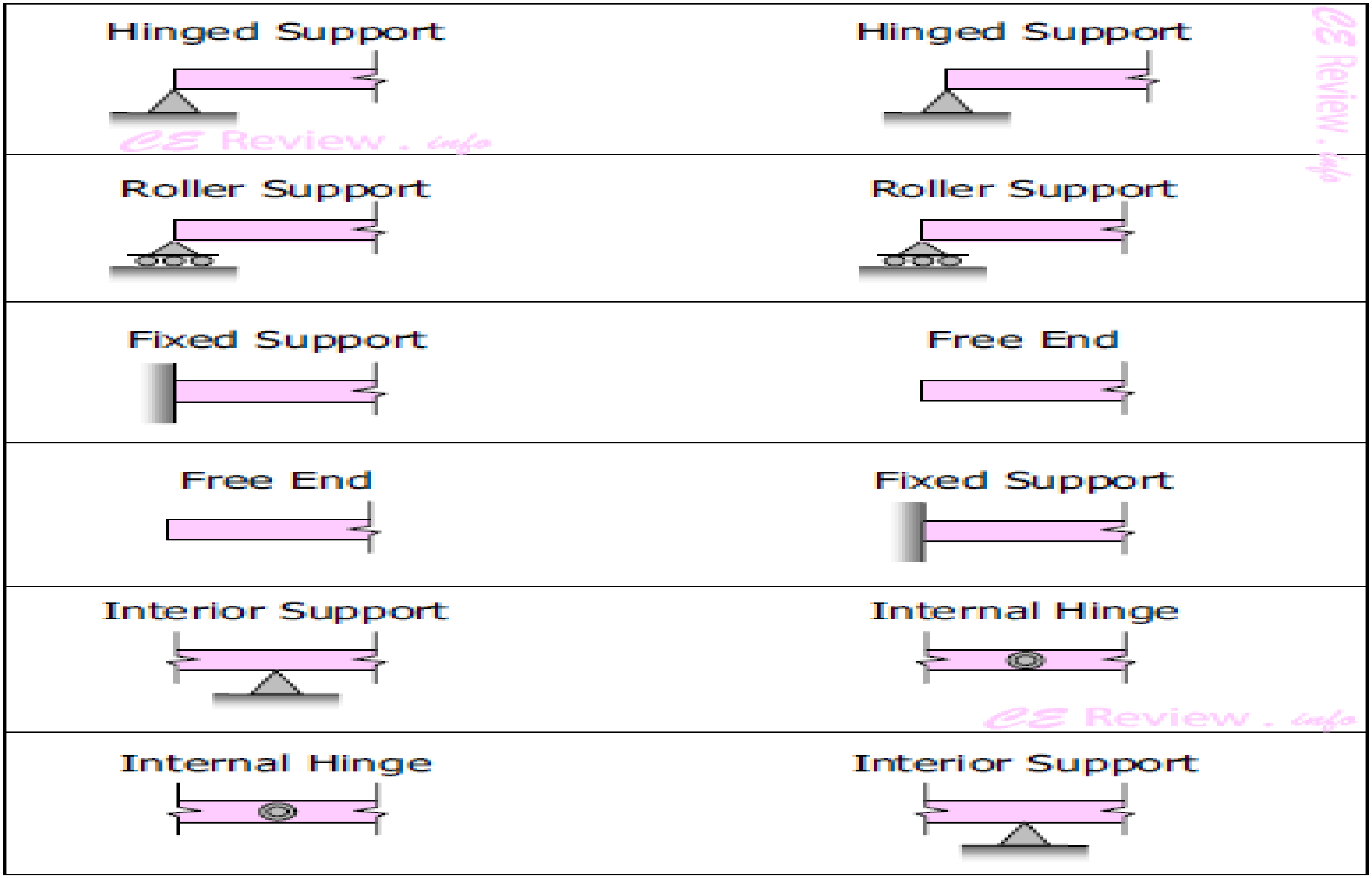


Example of super position drawing

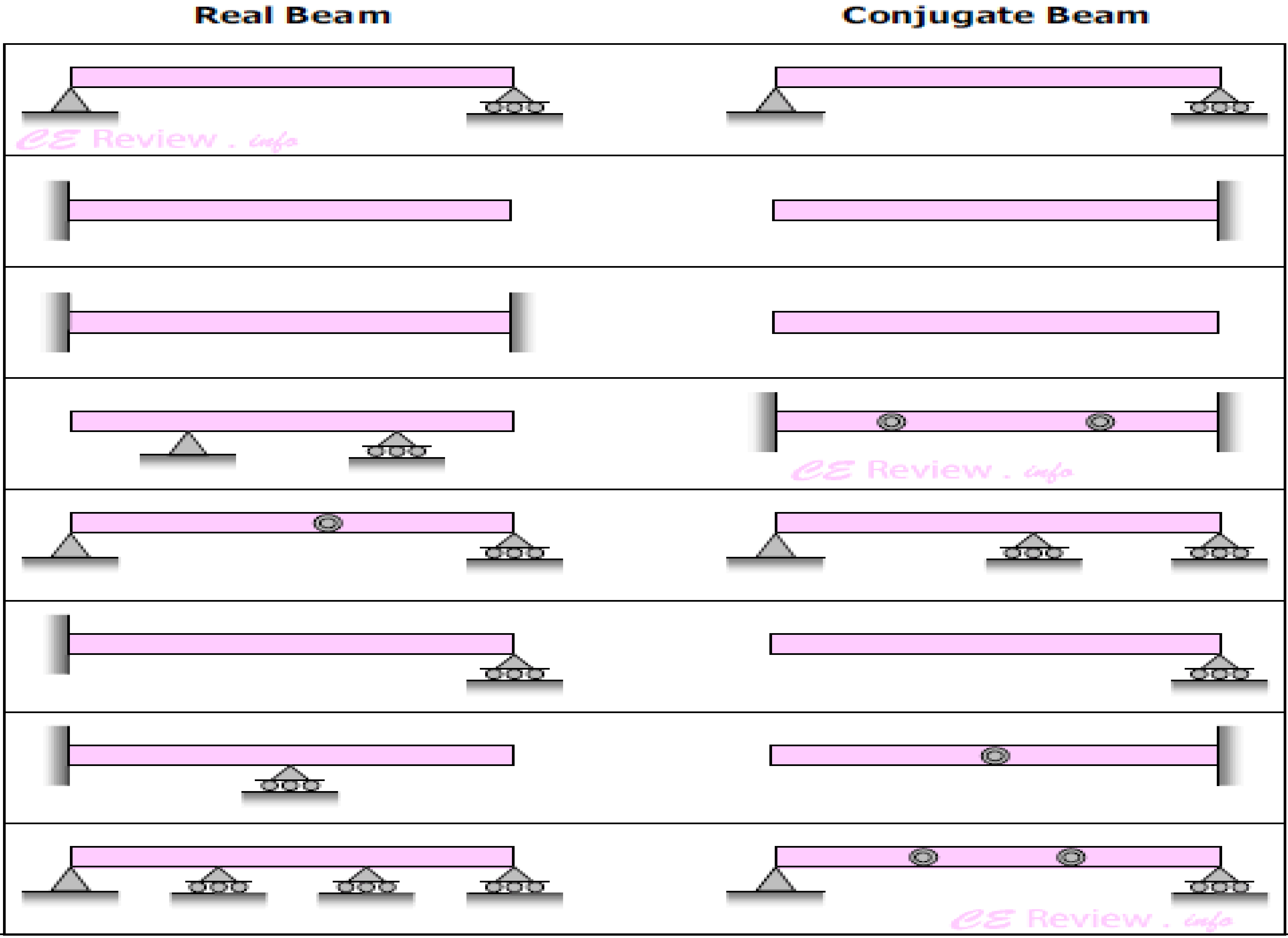


2- يتم تحويل الكمرة الى conjugate beam.

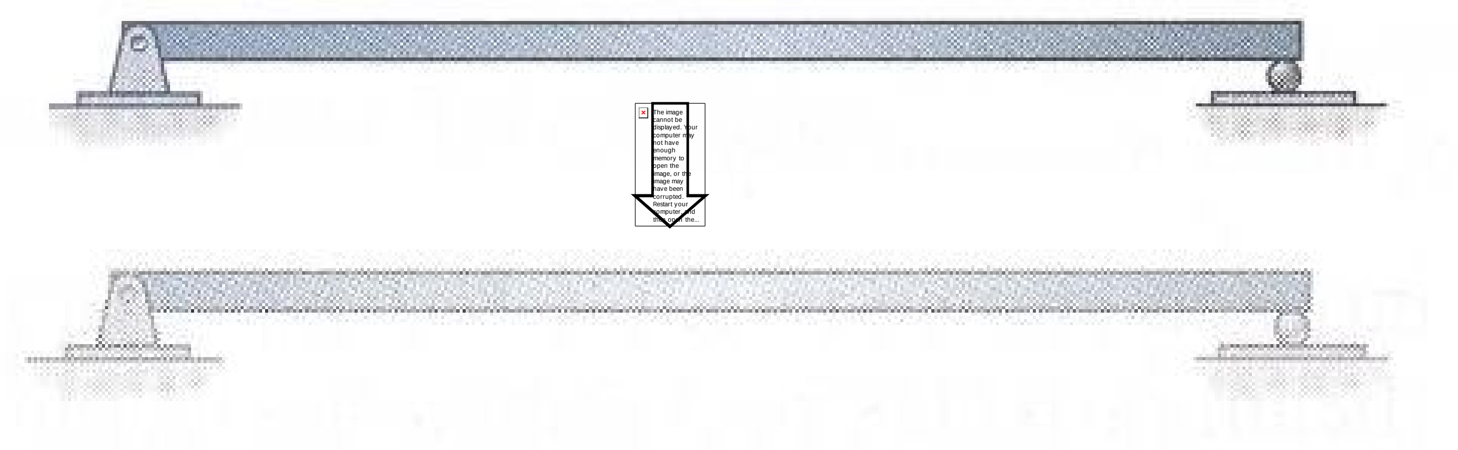
Real Beam Support | **Conjugate Beam Support**

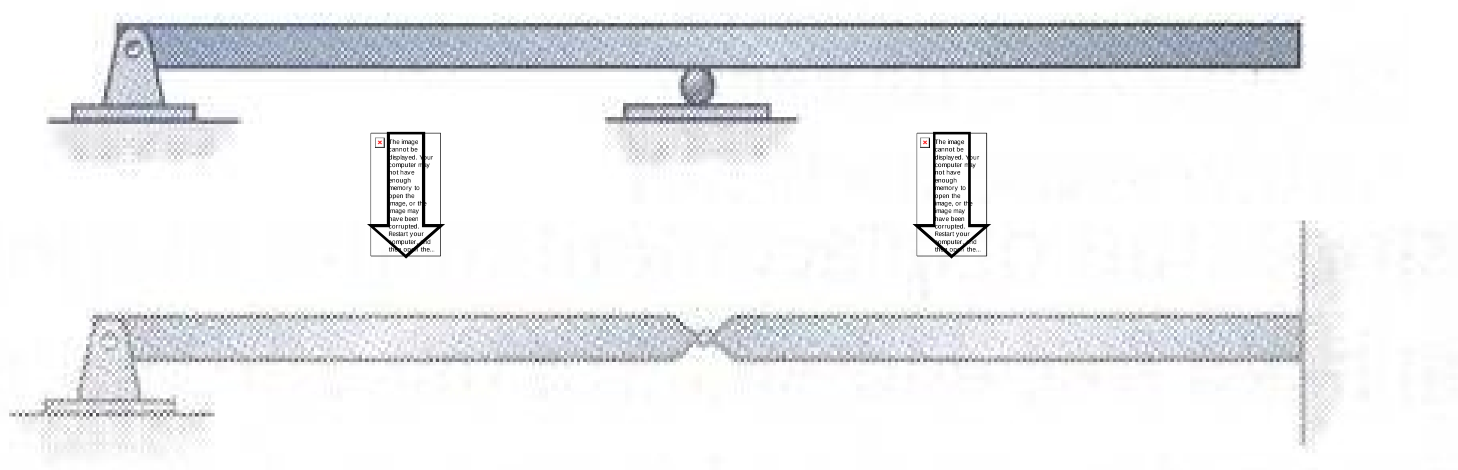


Examples of Conjugate Beam Supports



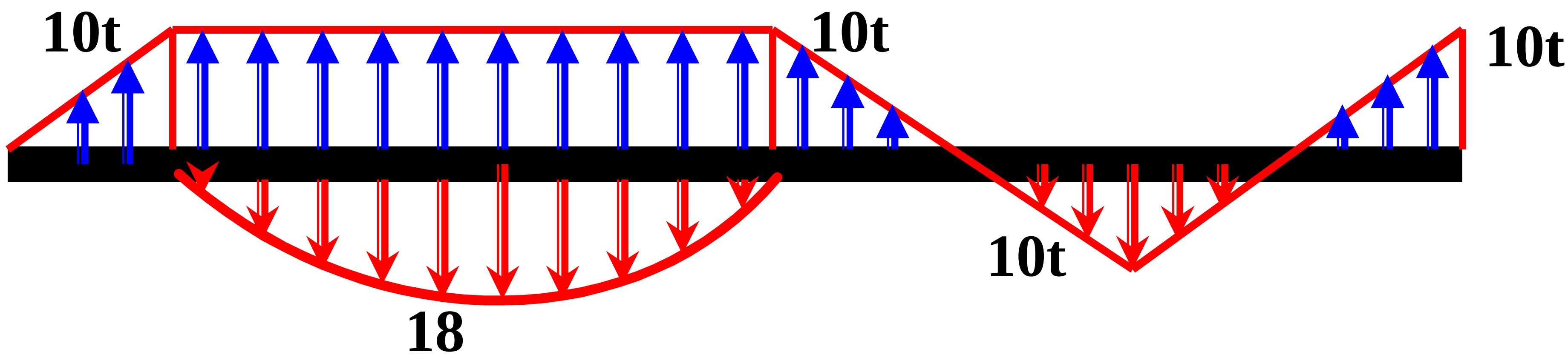
Examples of Conjugate Beam Supports





3- يتم وضع رسمة العزم الموجوده بالخطوه (1) على الكمرة الـ conjugate على انها احمل بنفس شكلها ويكون اتجاه اسهم الاحمال مرتبط بوجوده على الكمره.

مثلا لو كان الحمل اعلى الكمرة يتم توجيهه لاعلى والعكس.



4- من الكمرة الجديده يتم حساب قيمة

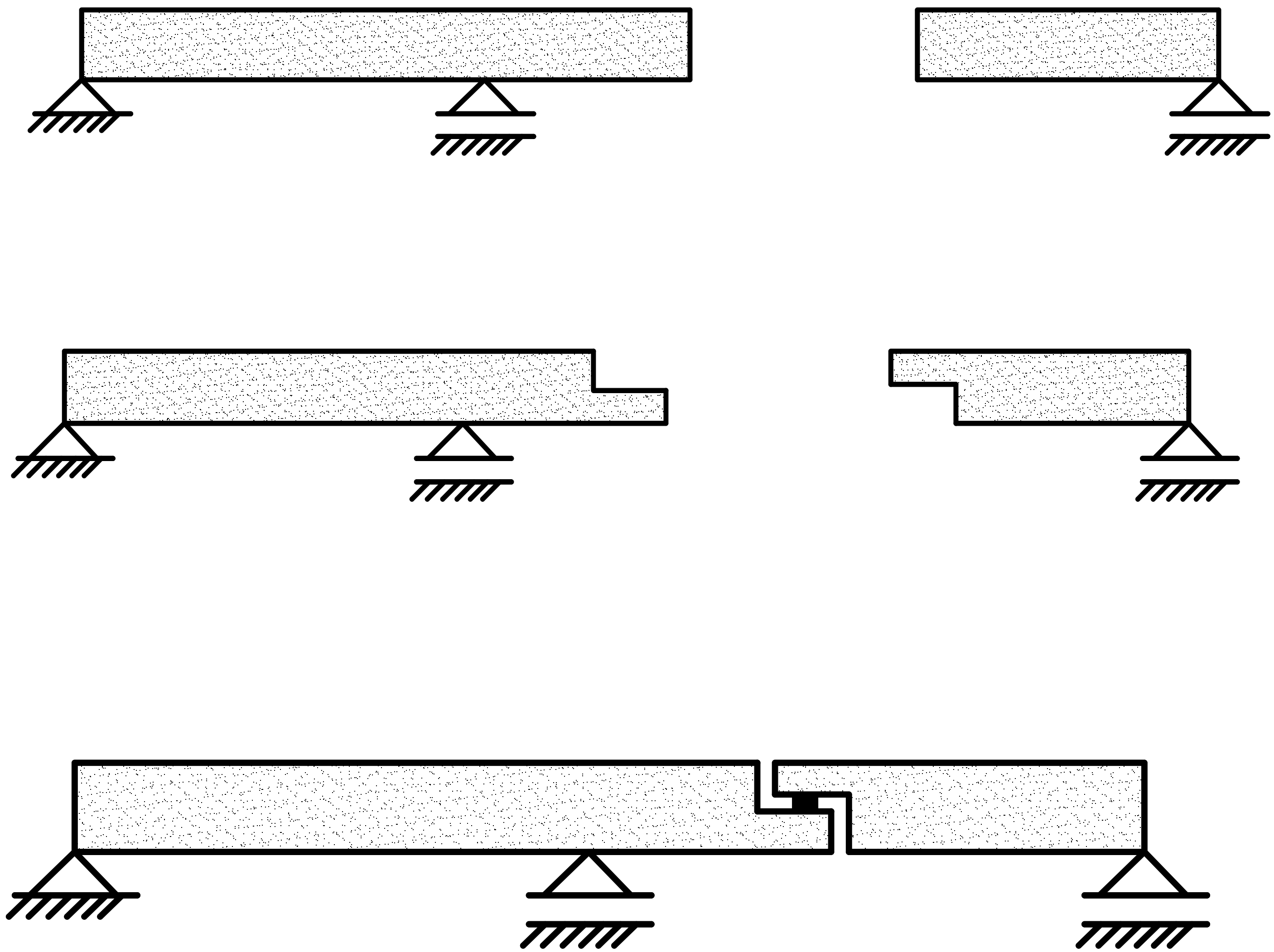
الـ moment عند النقط المطلوب عندها الـ deflection

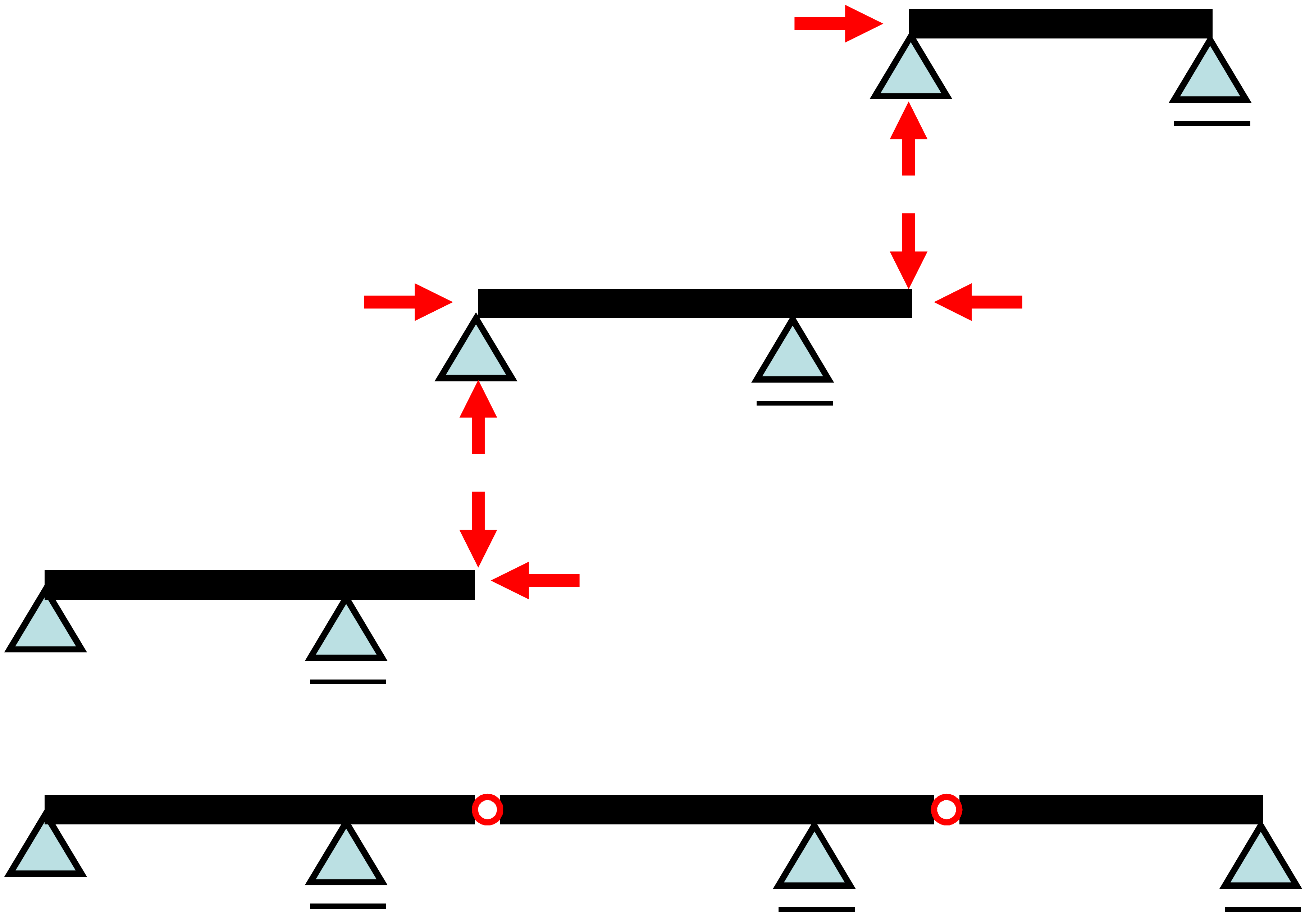
وايضا حساب الـ shear عند النقط المطلوب عندها الـ rotation.

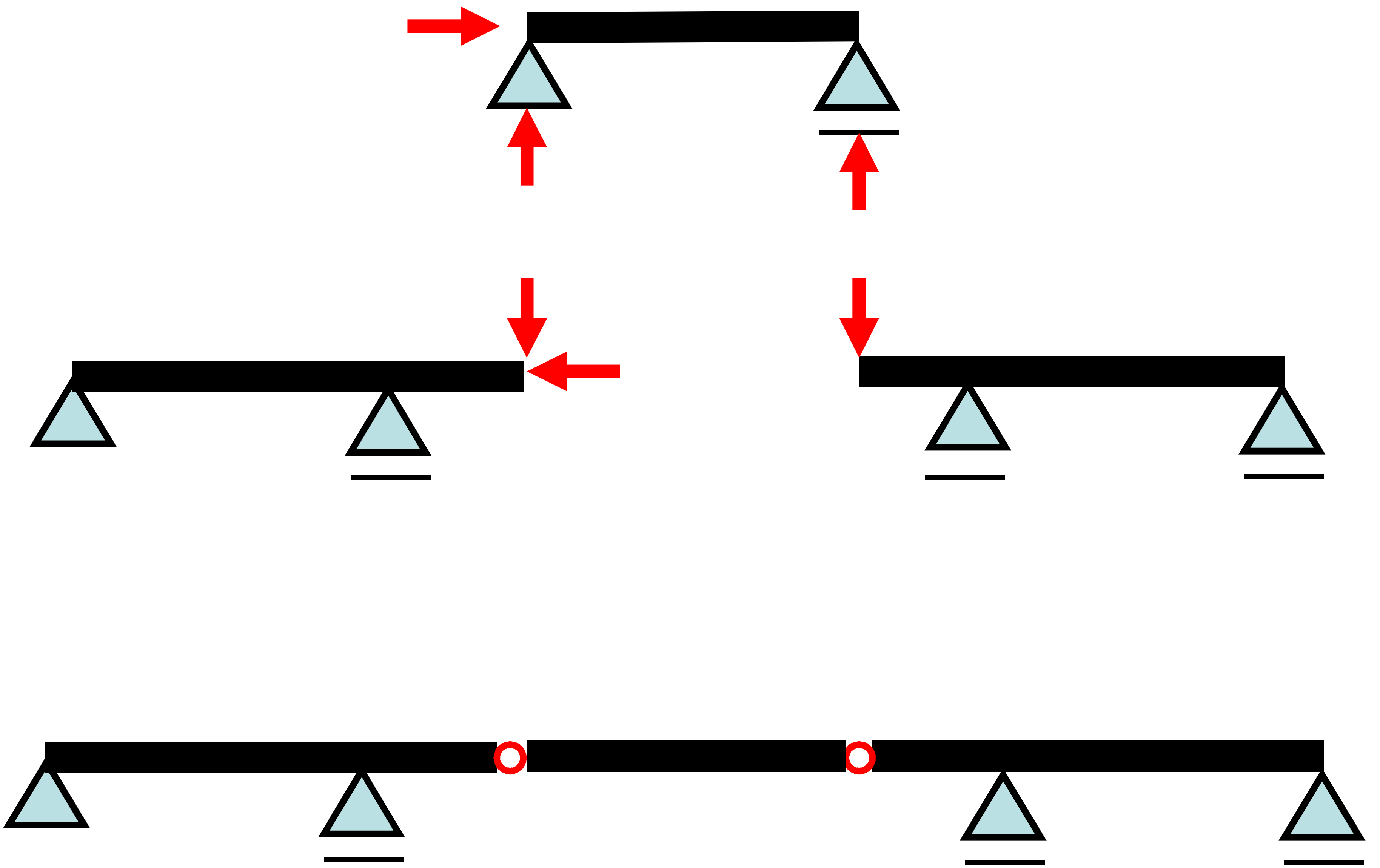
$$\theta = \frac{(shear)}{EI} \qquad from \ the \ new \ beam$$

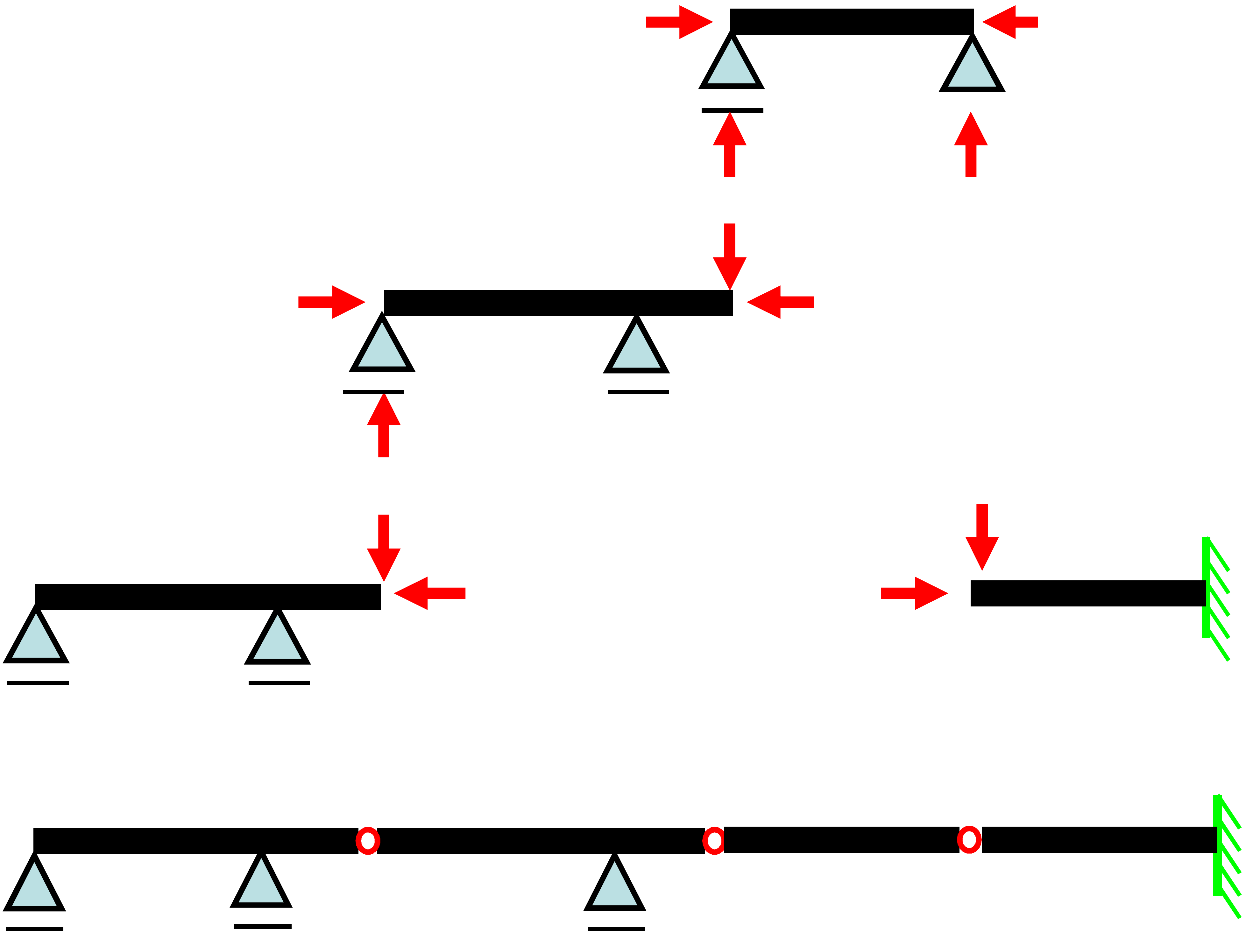
$$y = \frac{(moment)}{EI} \qquad from \ the \ new \ beam$$

بعض انواع الفصل





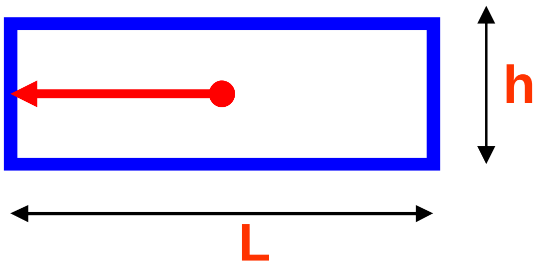




بعض المساحات المطلوب
معرفة قيمتها واماكن تركيزها

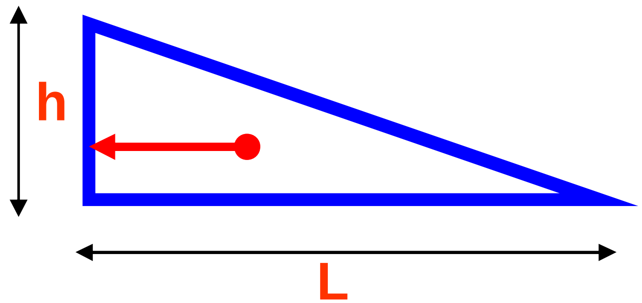
A=L.h

Ç @ L/2



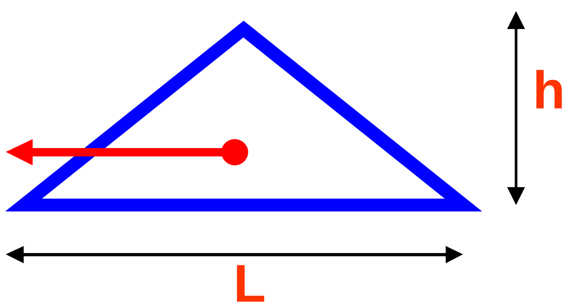
A=L.h/2

Ç @ L/3



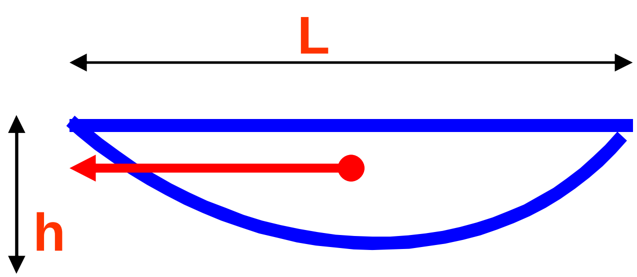
A=L.h/2

Ç @ L/2



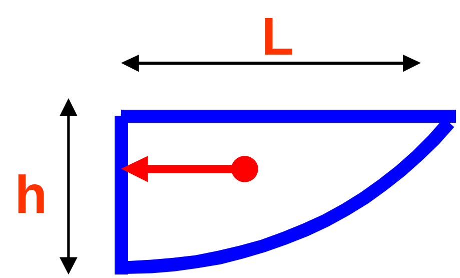
A=2/3L.h

Ç @ L/2



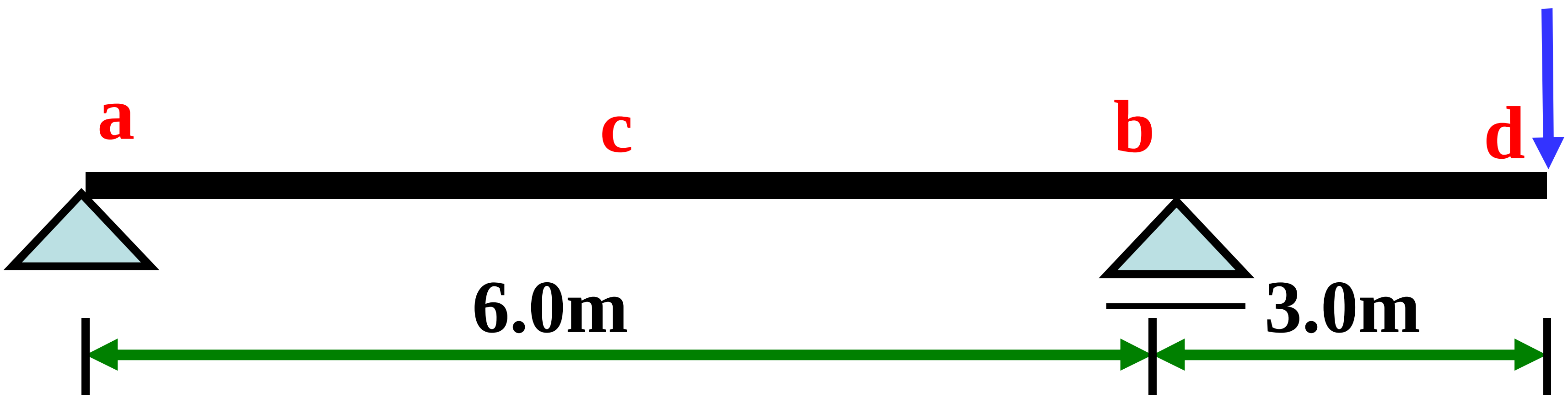
A=2/3L.h

Ç @ 3/8L



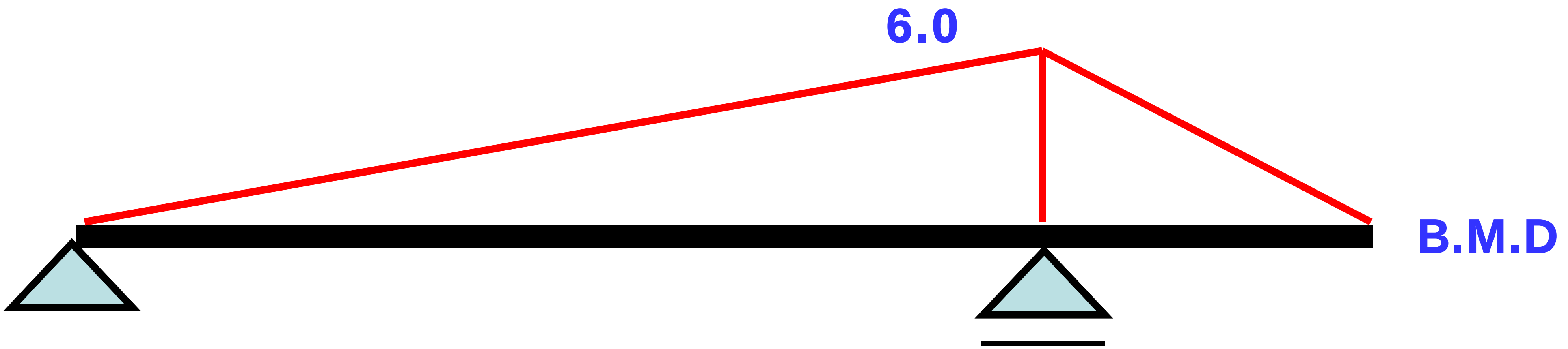
Problem 1

اذكر الله



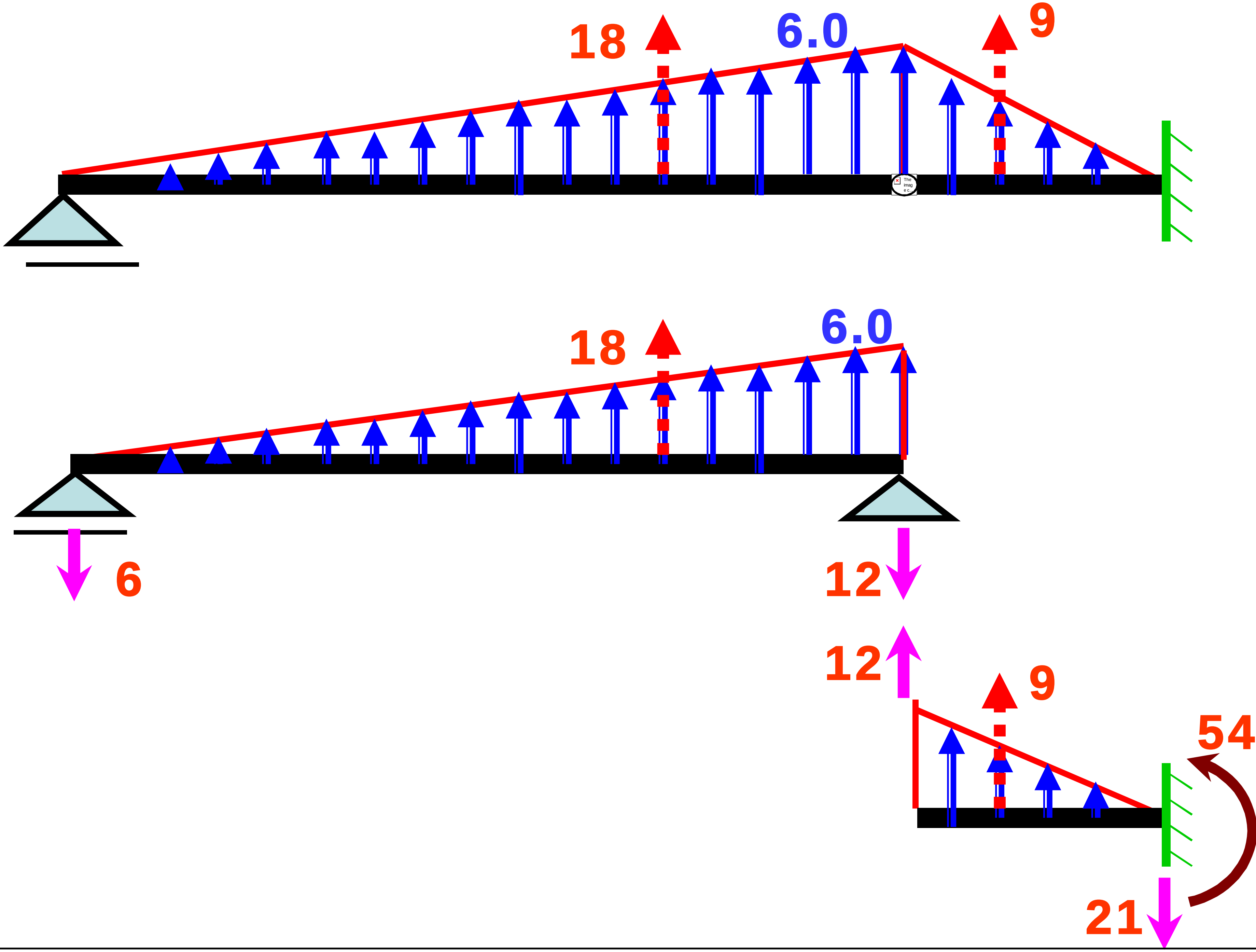
Required the deflection and rotation at point a, b, c and d.
And also draw elastic curve

1-Draw B.M.d

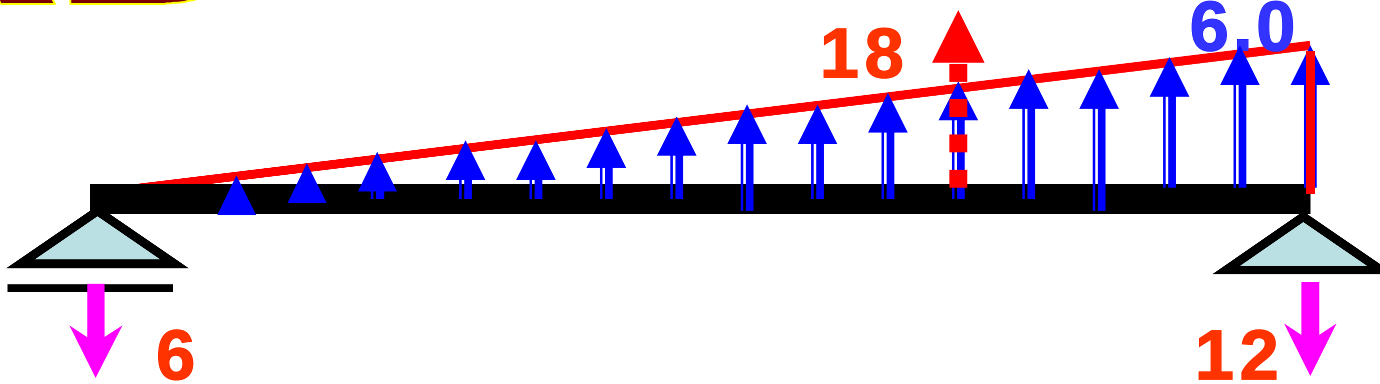


2- convert to conjugate

3-Final Beam



Part AB



$$sh_a = -6 \quad >>>> \quad \theta_a = \frac{(-6)}{EI}$$

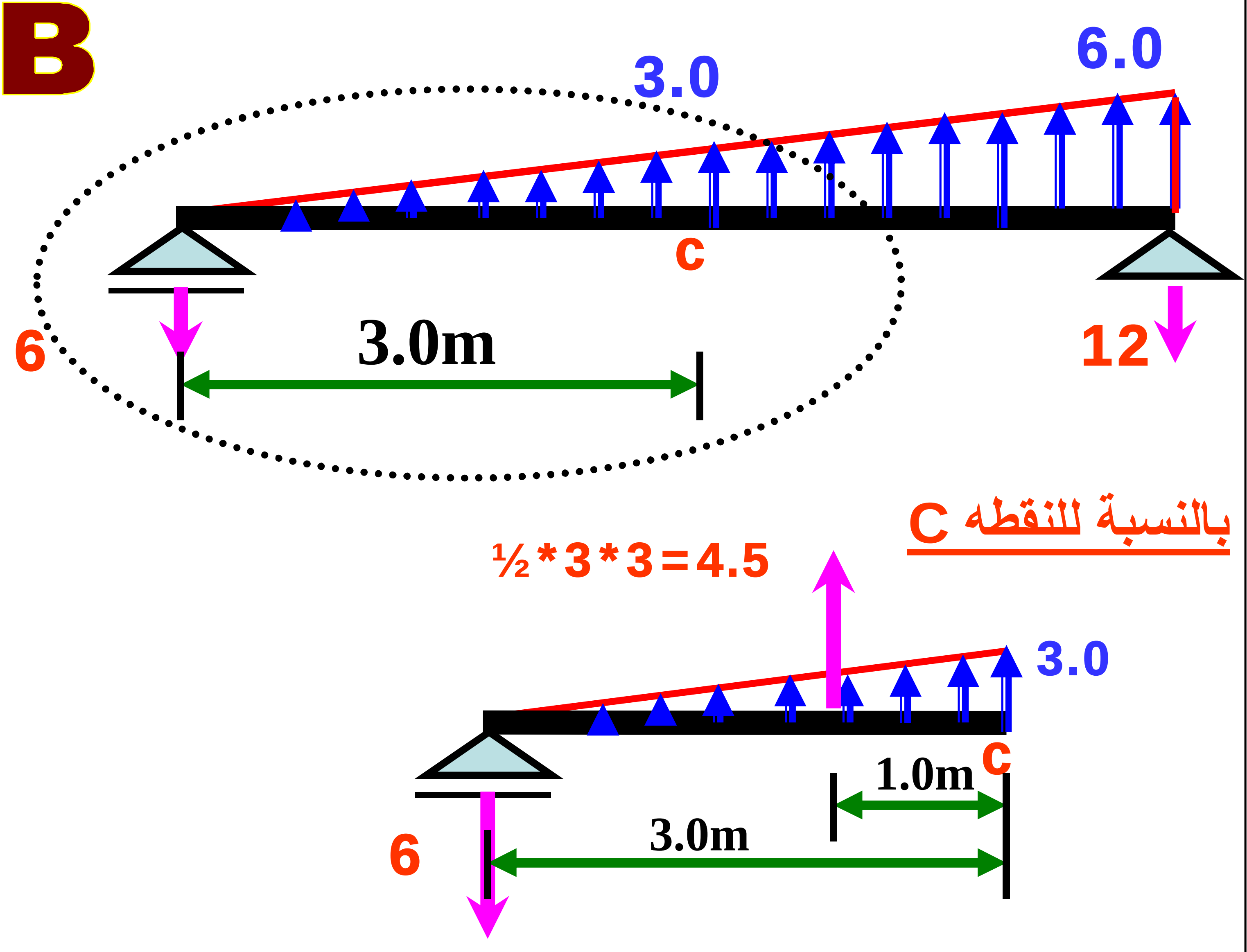
$$M_a = 0.0 \quad >>>> \quad y_a = \frac{(0.0)}{EI} = 0$$

الـ shear من الشمال وطالع موجب ومن
اليمن ونازل برضه موجب والعكس

$$sh_b = +12 \quad >>>> \quad \theta_b = \frac{(+12)}{EI}$$

$$M_b = 0.0 \quad >>>> \quad y_b = \frac{(0.0)}{EI} = 0$$

Part AB



$$sh_c = -6 + 4.5 = -1.5 \quad >>>> \quad \theta_a = \frac{(-1.5)}{EI}$$

$$M_c = -6 * 3 + 4.5 * 1 = -13.5 \quad >>>> \quad y_a = \frac{(-13.5)}{EI}$$

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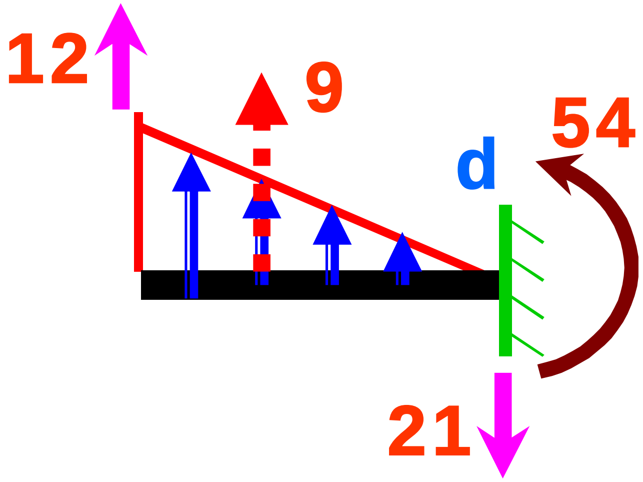
Part BD

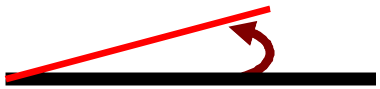


$$sh_a = +21 \quad >>>> \quad \theta_a = \frac{(+21)}{EI}$$

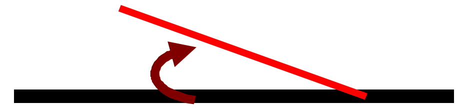
$$M_a = -54 \quad >>>> \quad y_a = \frac{(+54)}{EI}$$

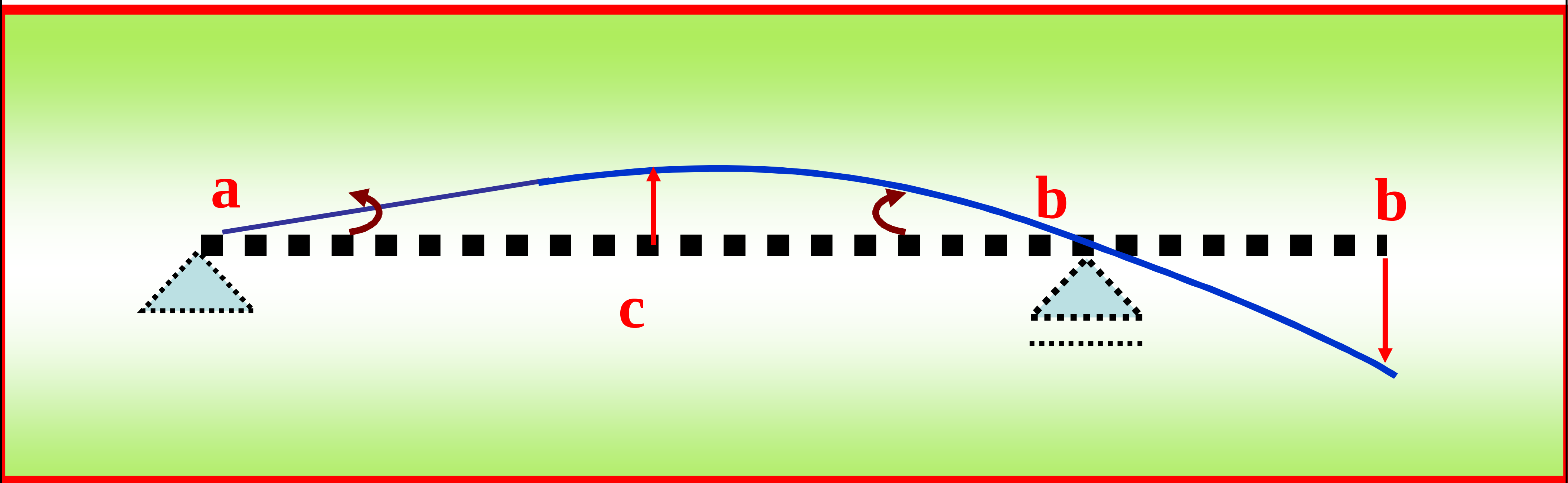
Draw Elastic Curve

θ_a = -ve

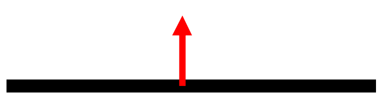


θ_b = +ve

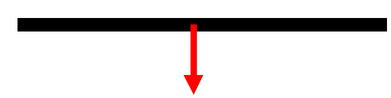




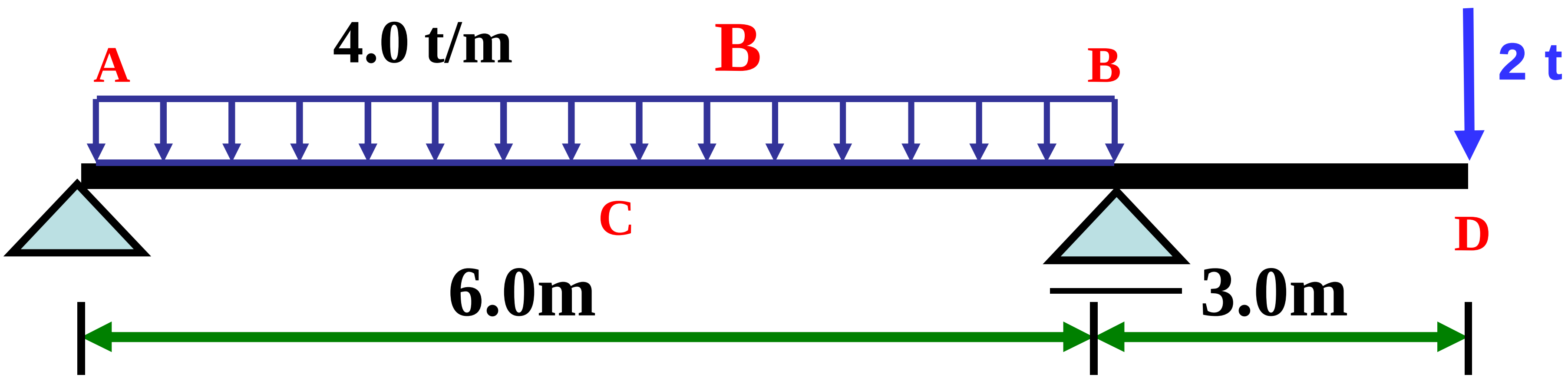
y_c = -ve



y_d = +ve



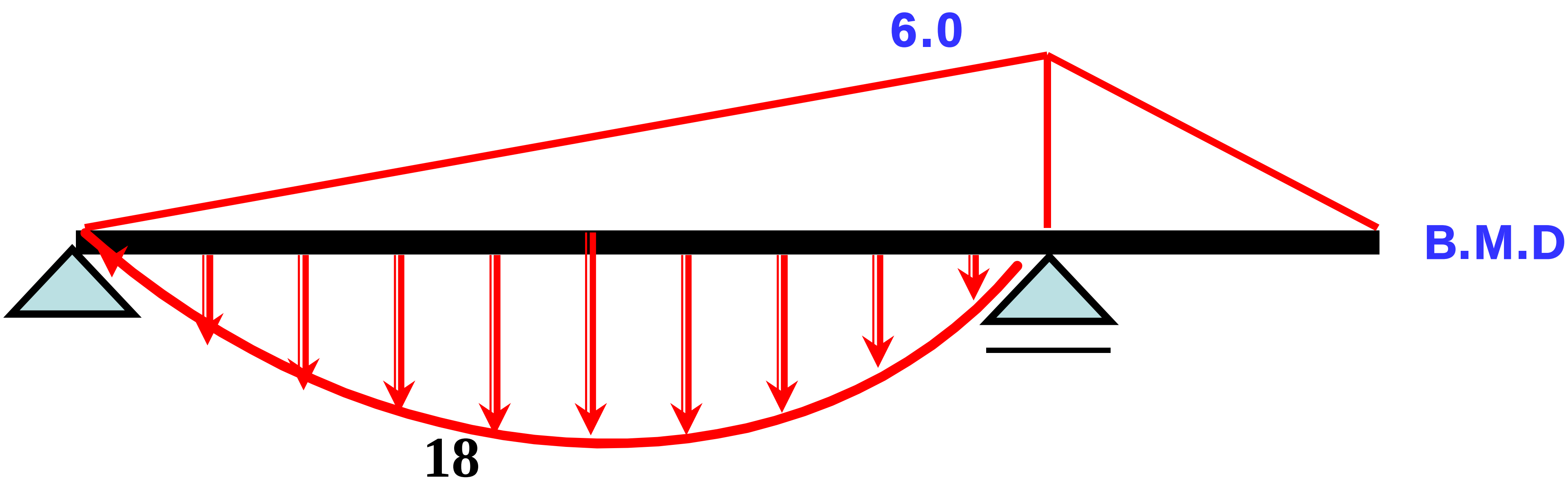
Problem 2



Required the deflection and rotation at point a, b, c and d.

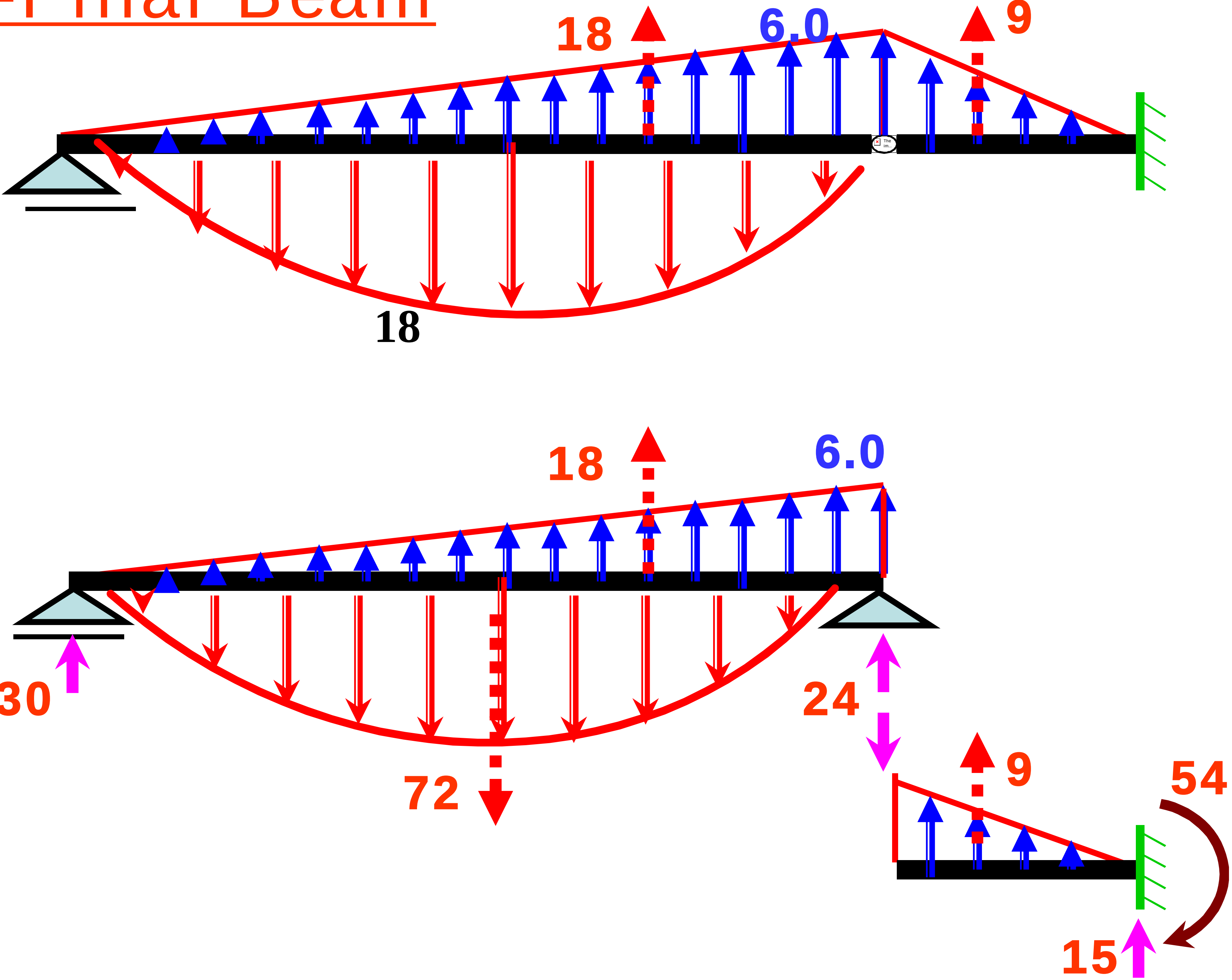
And also draw elastic curve

1-Draw B.M.d

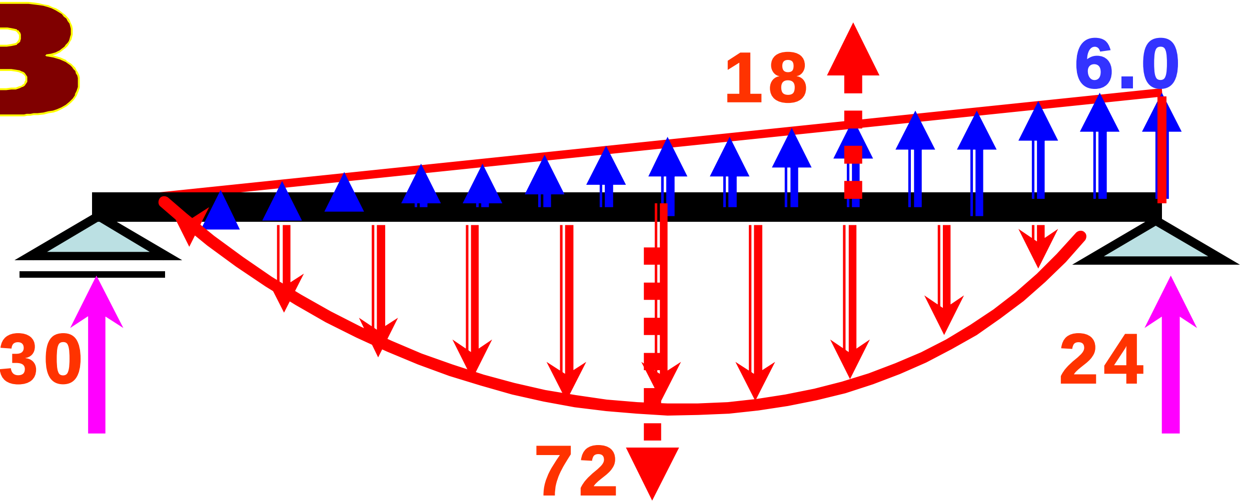


2- convert to conjugate

3-Final Beam



Part AB



$$sh_a = +30 \quad >>>> \quad \theta_a = \frac{(+30)}{EI}$$

$$M_a = 0.0 \quad >>>> \quad y_a = \frac{(0.0)}{EI} = 0$$

$$sh_b = -24 \quad >>>> \quad \theta_b = \frac{(-24)}{EI}$$

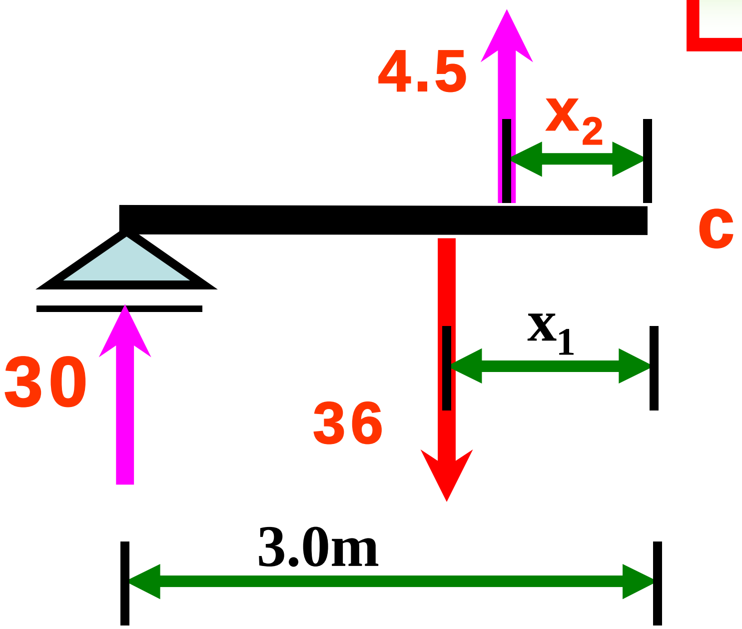
$$M_b = 0.0 \quad >>>> \quad y_b = \frac{(0.0)}{EI} = 0$$

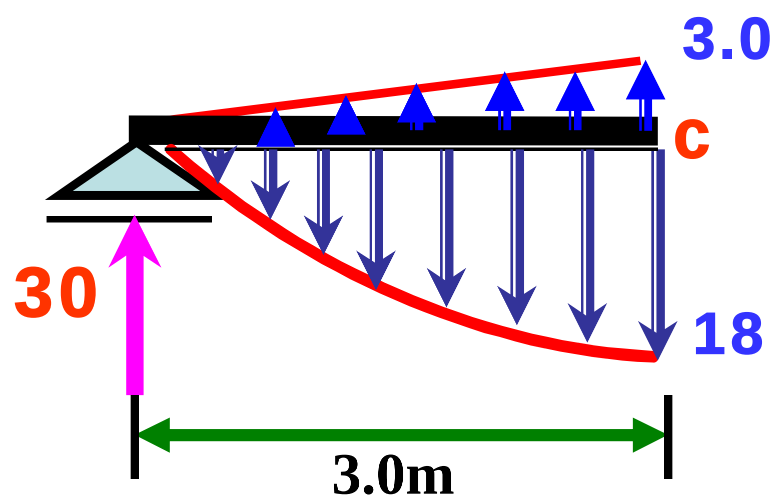
الـ shear من الشمال وطالع موجب ومن
اليمن ونازل برضه موجب والعكس

Part AB

بالنسبة للنقطه C

$R_1=2/3*3*18=36$ $X_1=3/8*3=1.125$	$R_2=1/2*3*3=4.5$ $X_2=1/3*3=1$

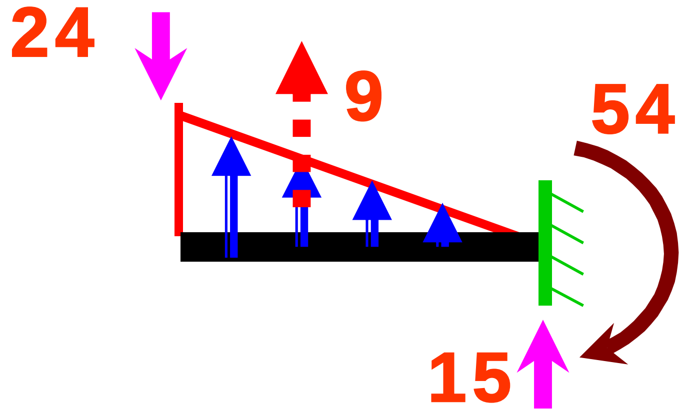




$$sh_a = 30 - 36 + 4.5 = -1.5 \quad >>>> \quad \theta_a = \frac{(-1.5)}{EI}$$

$$M_a = 30 * 3 + 4.5 * 1 - 36 * 1.125 = 54 \quad >>>> \quad y_a = \frac{(54)}{EI}$$

Part BD



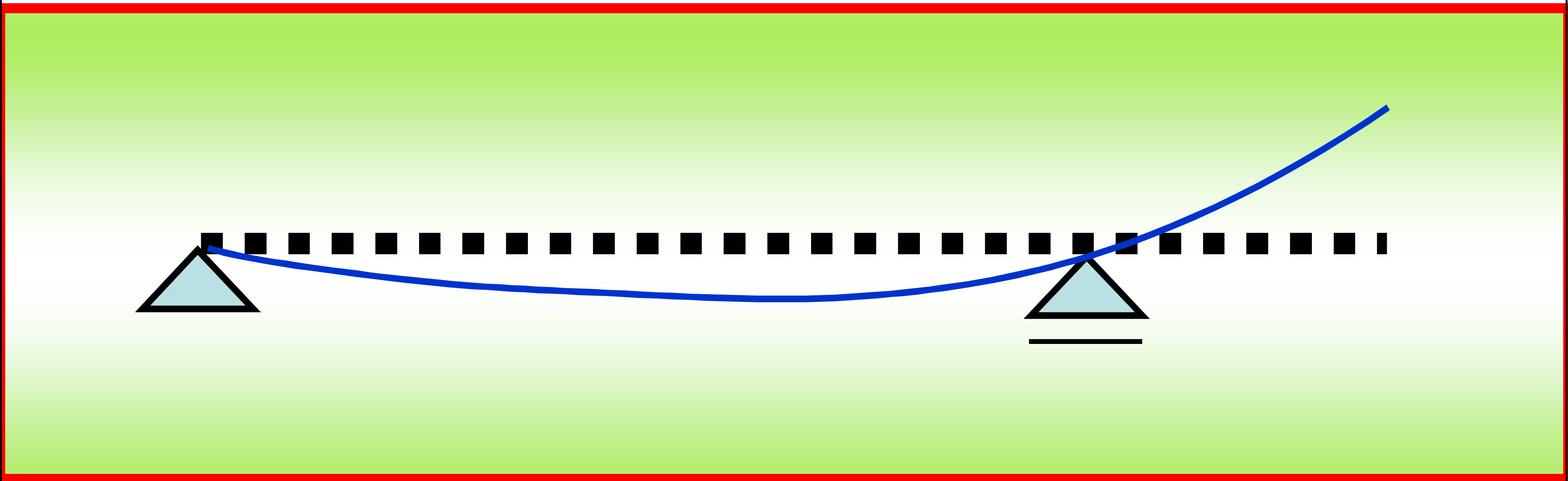
$$sh_a = 15 \quad >>>> \quad \theta_a = \frac{(-15)}{EI}$$

$$M_a = -54 \quad >>>> \quad y_a = \frac{(-54)}{EI}$$

Draw Elastic Curve

θ_a = -ve

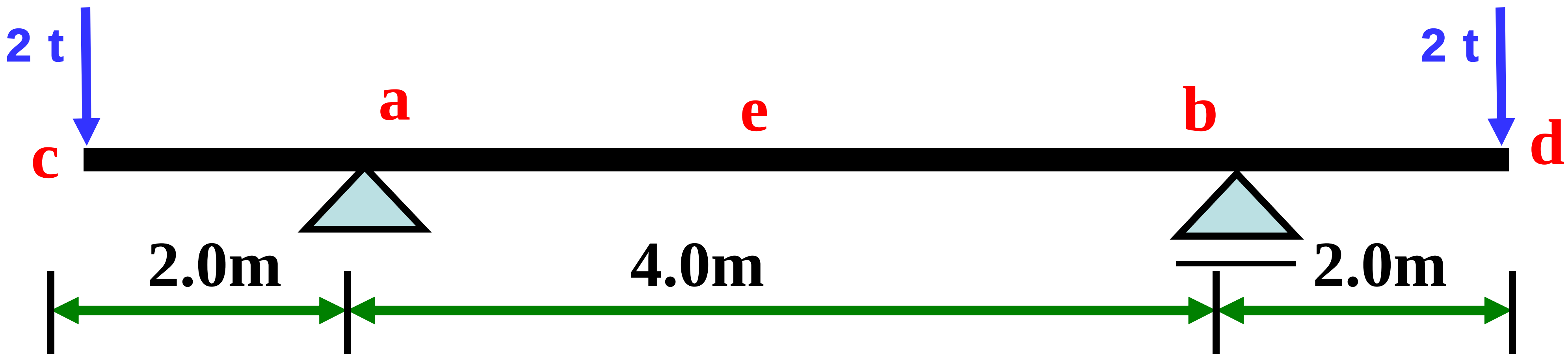
θ_b = +ve



y_c = +ve

y_d = - ve

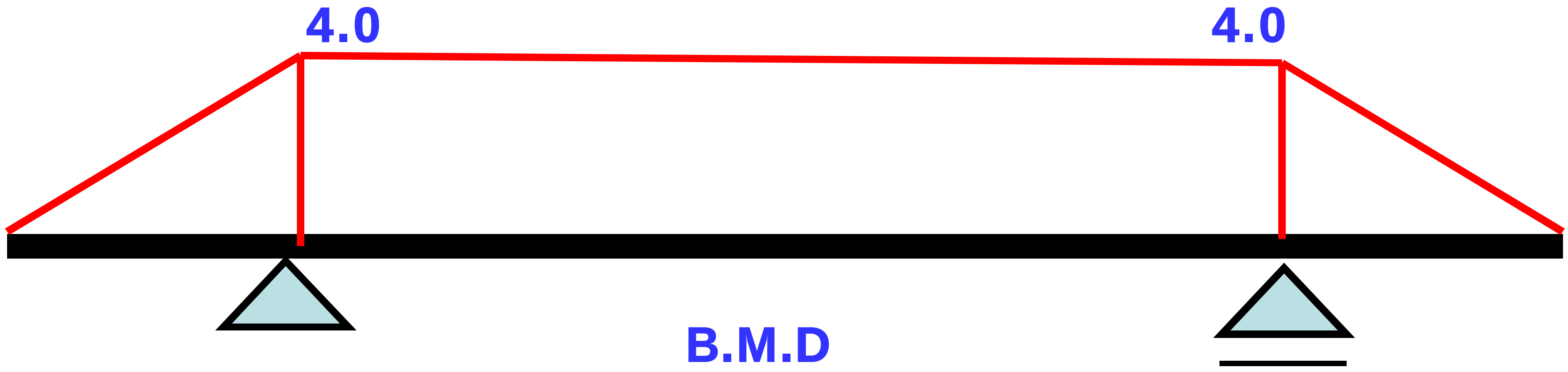
Problem 3



Required the deflection and rotation at point a, b, c, d and e.

And also draw elastic curve

1-Draw B.M.d

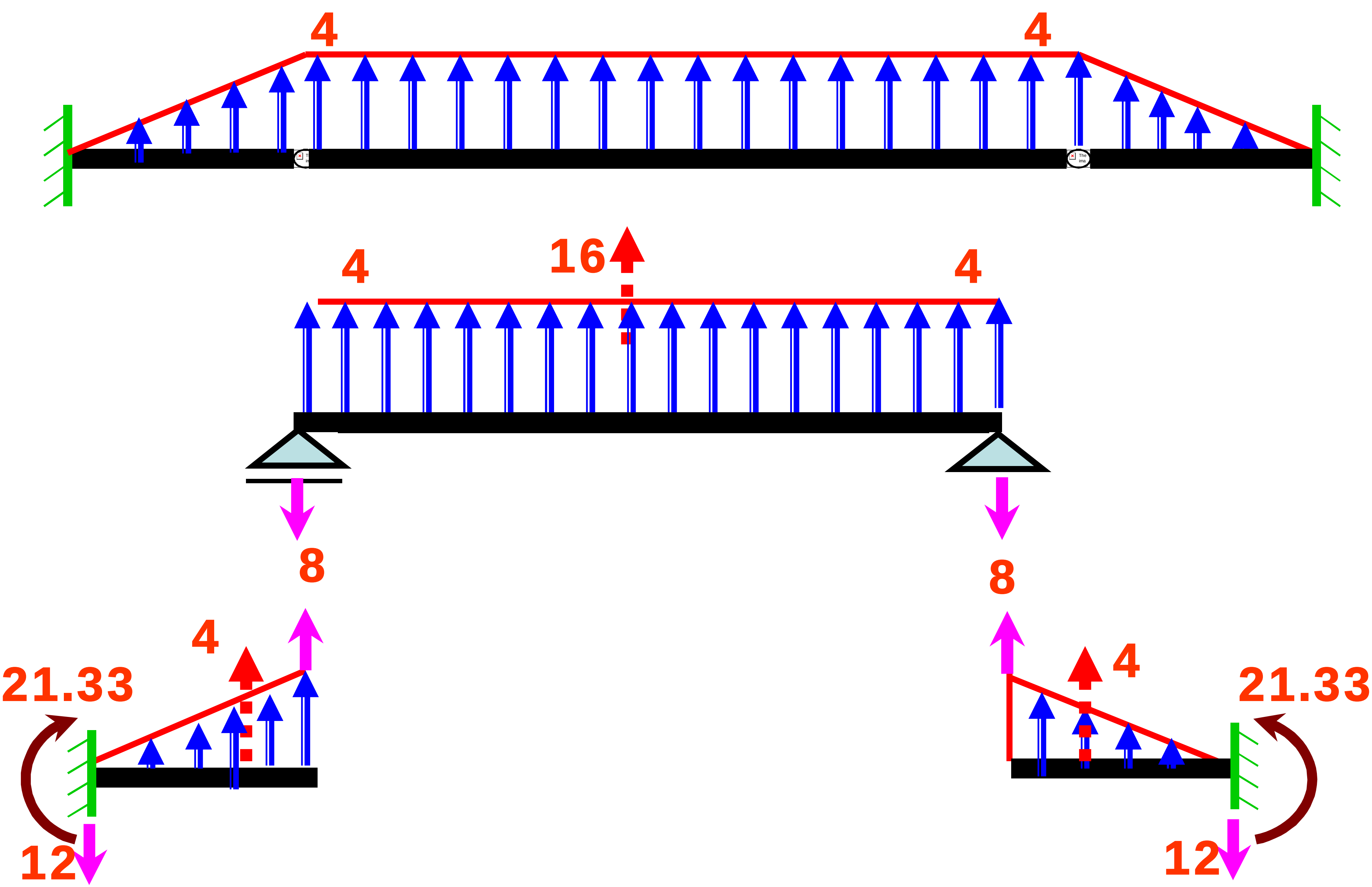


B.M.D

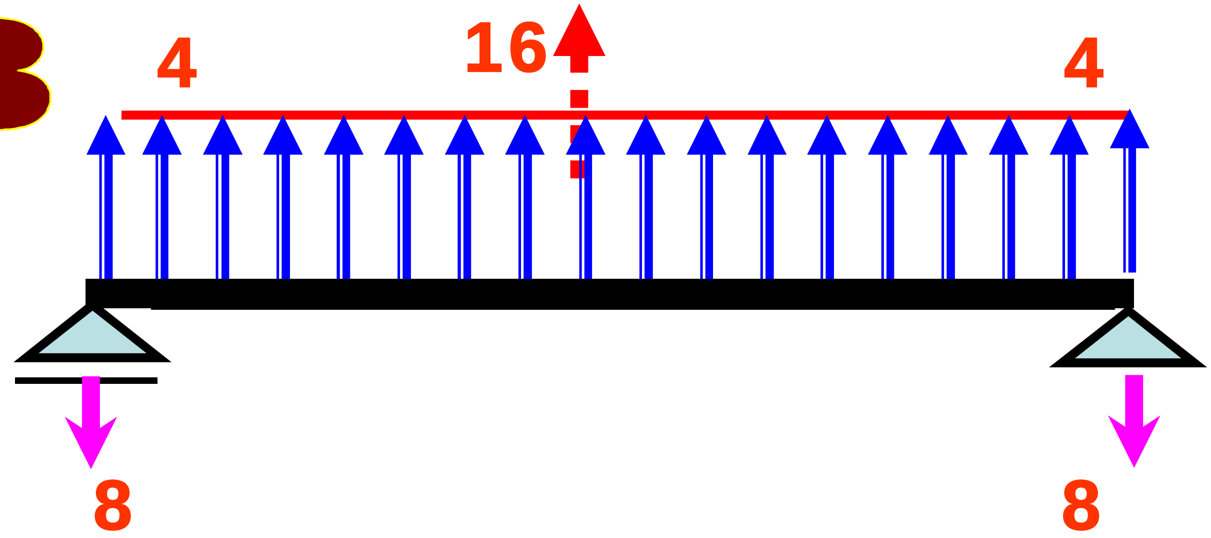
2- convert to conjugate

Conjugate beam

3-Final Beam



Part AB



$$sh_a = -8 \quad >>>> \quad \theta_a = \frac{(-8)}{EI}$$

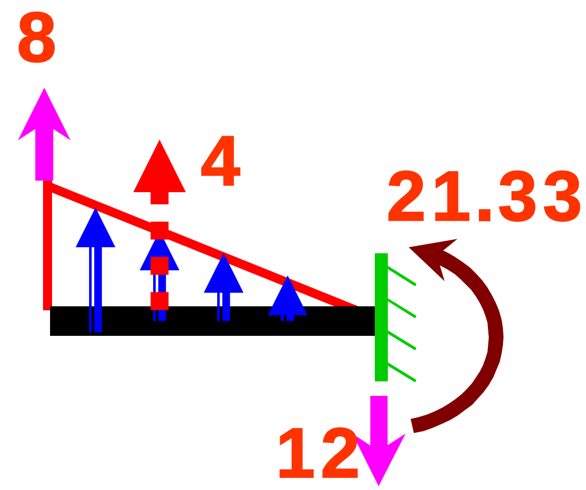
$$M_a = 0.0 \quad >>>> \quad y_a = \frac{(0.0)}{EI} = 0$$

$$sh_b = +8 \quad >>>> \quad \theta_b = \frac{(+8)}{EI}$$

$$M_b = 0.0 \quad >>>> \quad y_b = \frac{(0.0)}{EI} = 0$$

الـ shear من الشمال وطالع موجب ومن
اليمن ونازل برضه موجب والعكس

Part BD

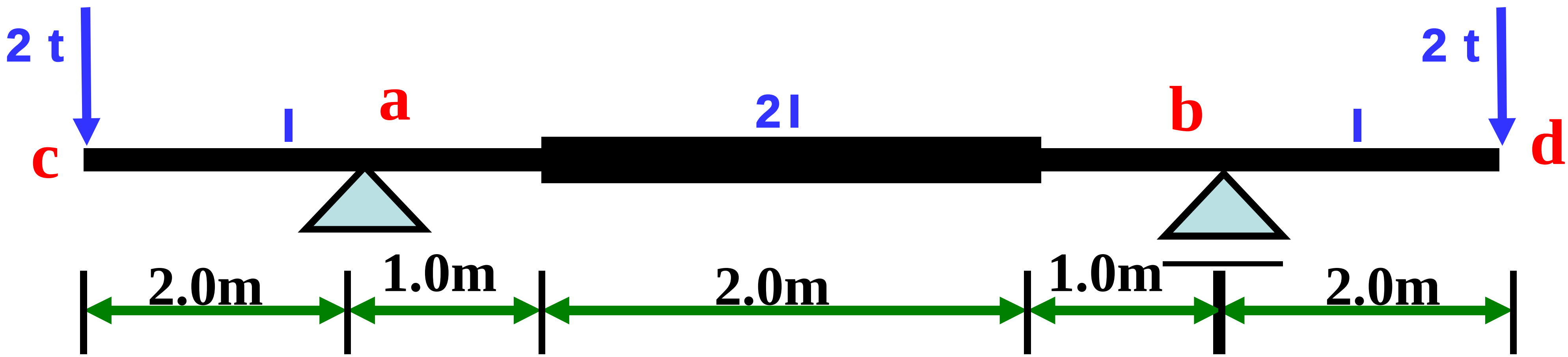


$$sh_d = +12 \quad >>>> \quad \theta_d = \frac{(+12)}{EI}$$

$$M_d = +21.33 \quad >>>> \quad y_d = \frac{(+21.33)}{EI}$$

بعض الأفكار المهمه جدا

1- حالة وجود تغير فى الـ inertia

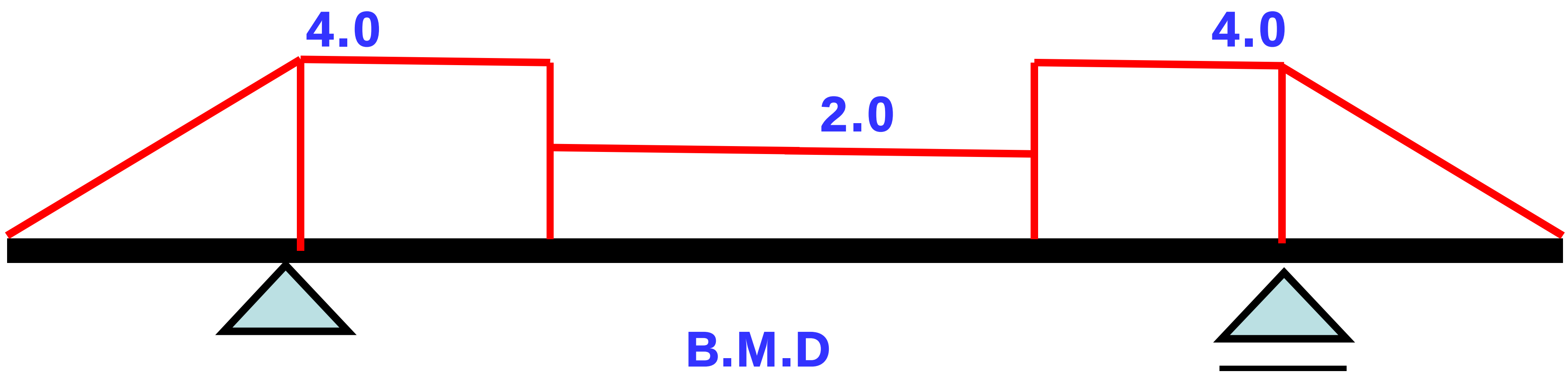


Required the deflection and rotation at point a, b, c and d.

And also draw elastic curve

1-Draw B.M.d

يتم قسمة المساحة على المعامل
الموجود بجوار كل inertia

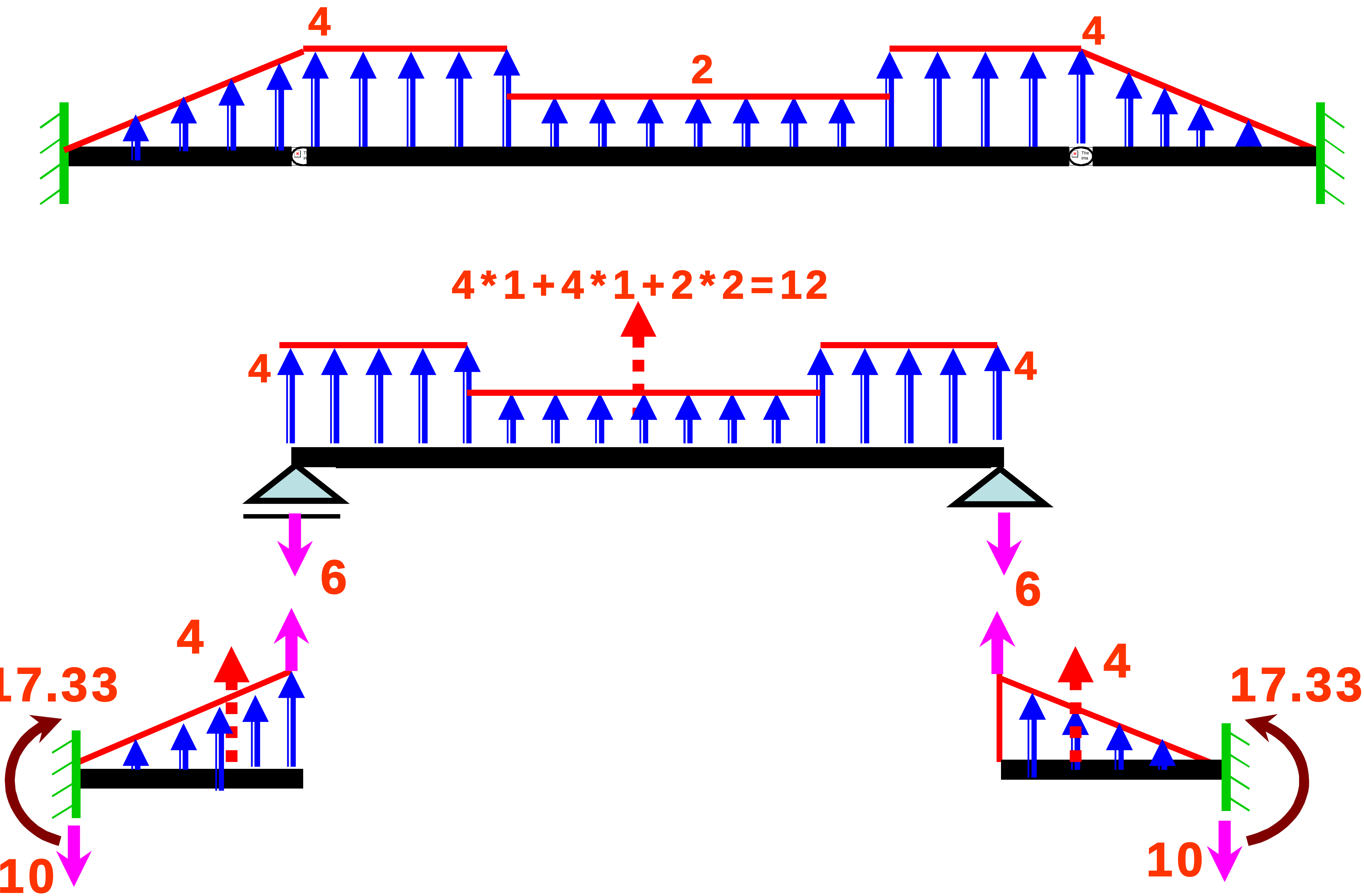


B.M.D

2- convert to conjugate

Conjugate beam

3-Final Beam



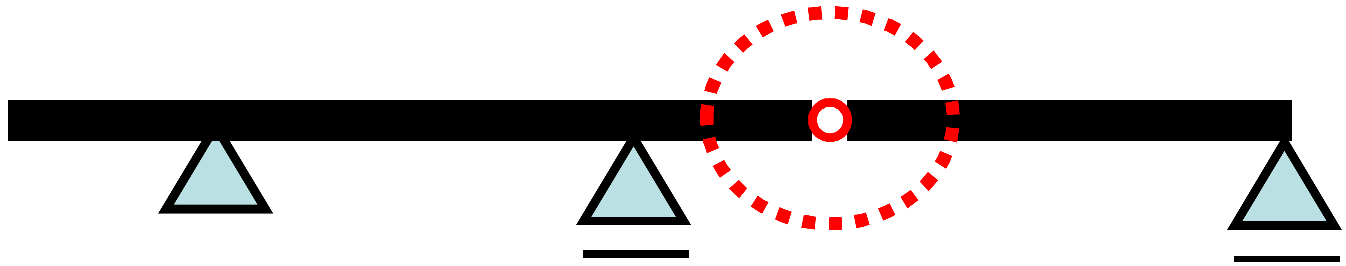
كمل الحل عادى

$$\theta = \frac{(shear)}{EI}$$

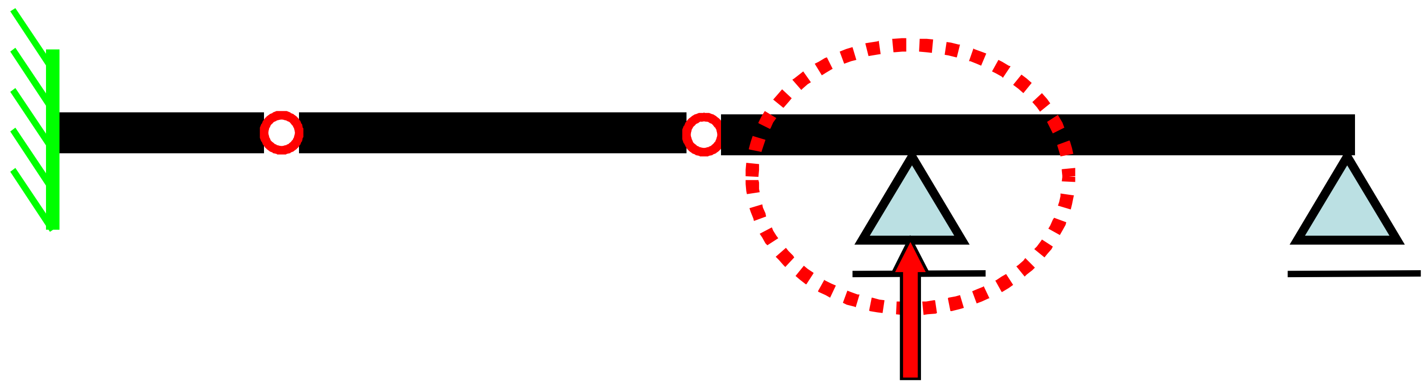
$$y = \frac{(moment)}{EI}$$

1- حالة وجود intermediate hinge فى الكمرة الرئيسية

Real beam

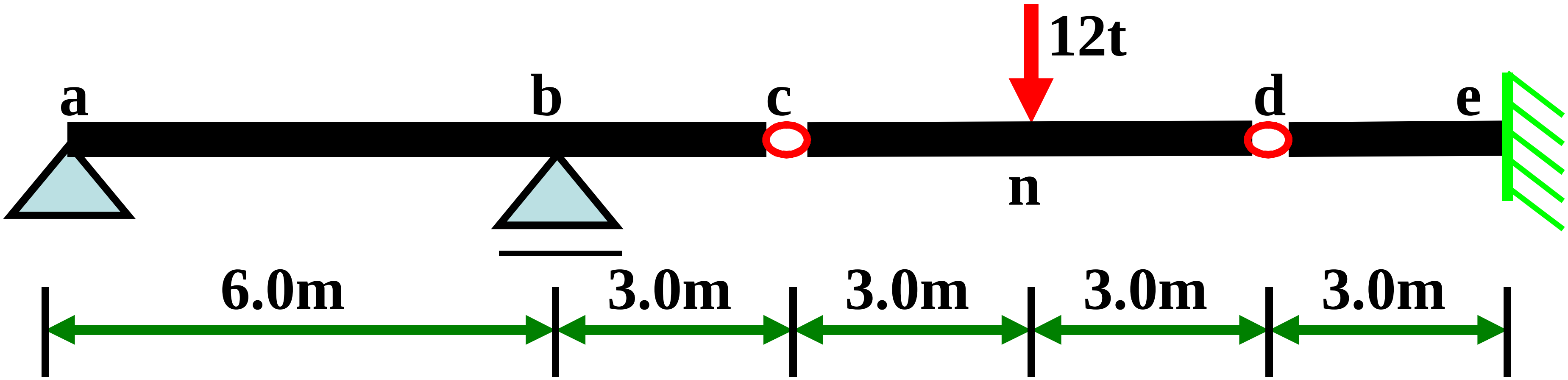


conjugate beam



نلاحظ عند تغيير intrmediate hinge ال hinge وسطى يكون هناك reactionعند هذه النقطه وبالتالى يكون هناك قيمتين للـ shear عند هذه النقطه وبالتالى وجود قيمتين للدوران يتم طلبهم فى المسأله بالدوران يمين وشمال النقطه θ_R and θ_L

final 2006

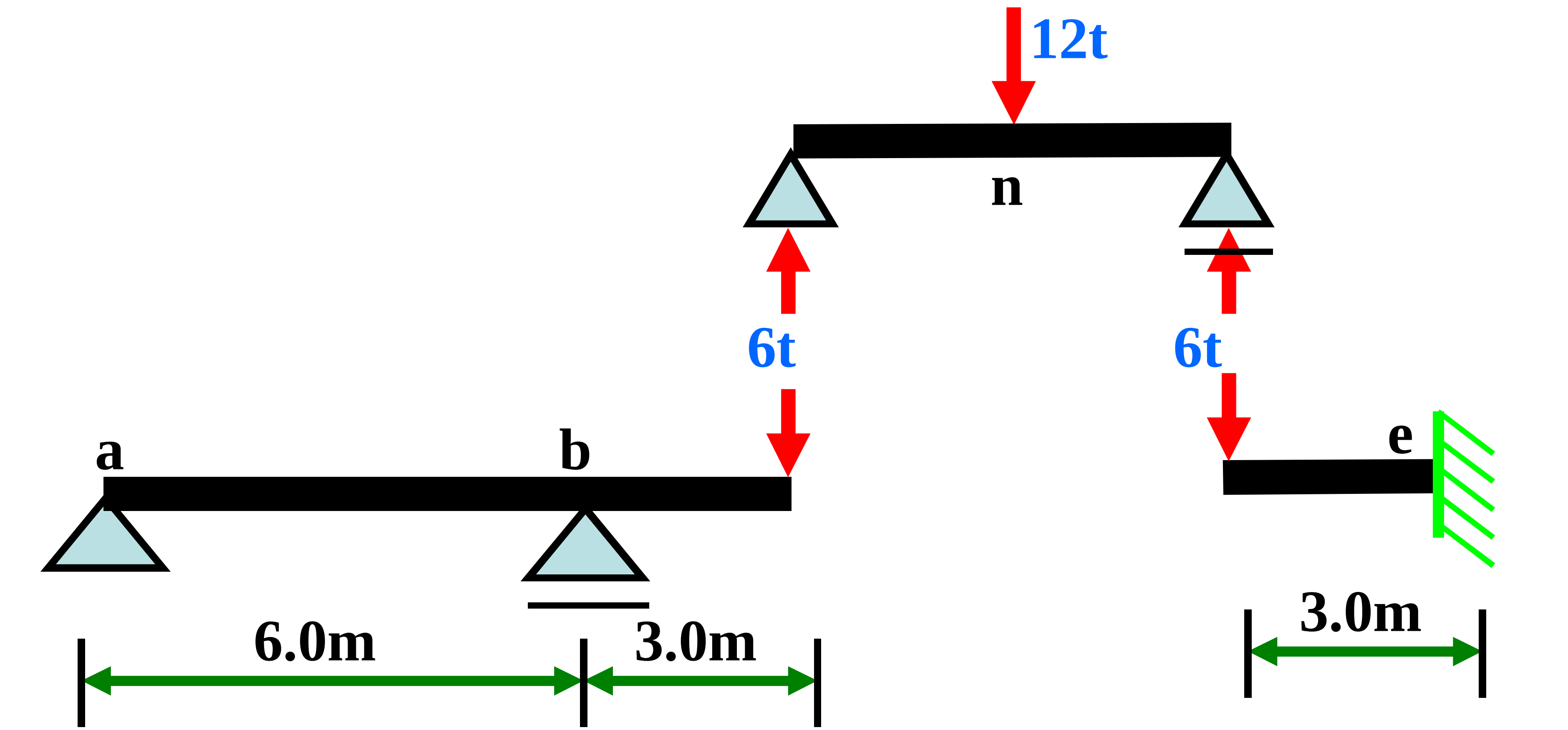


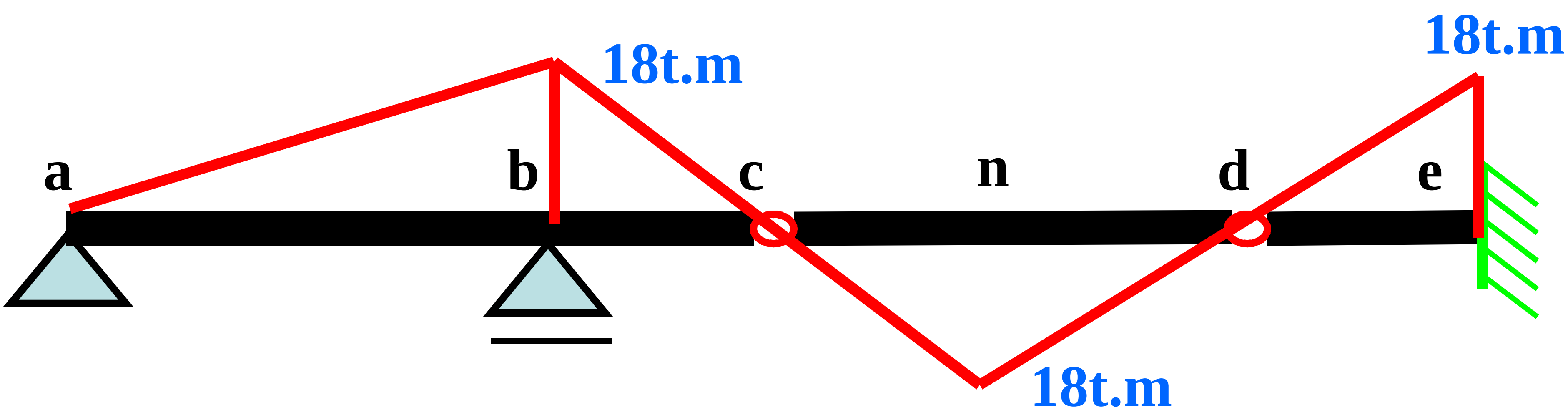
Required the deflection at c, d, n and slope at point n, b.

And draw elastic curve

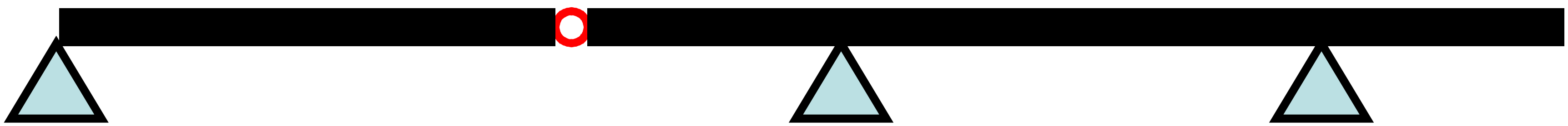
EI=5400 $t.m^2$

draw B.M.D

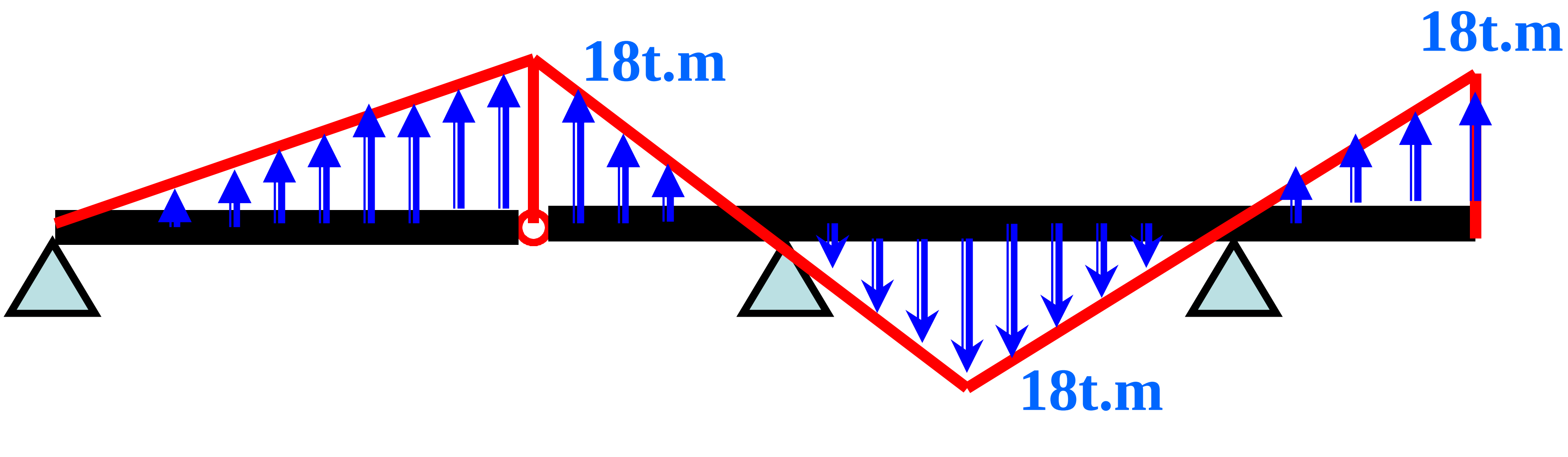


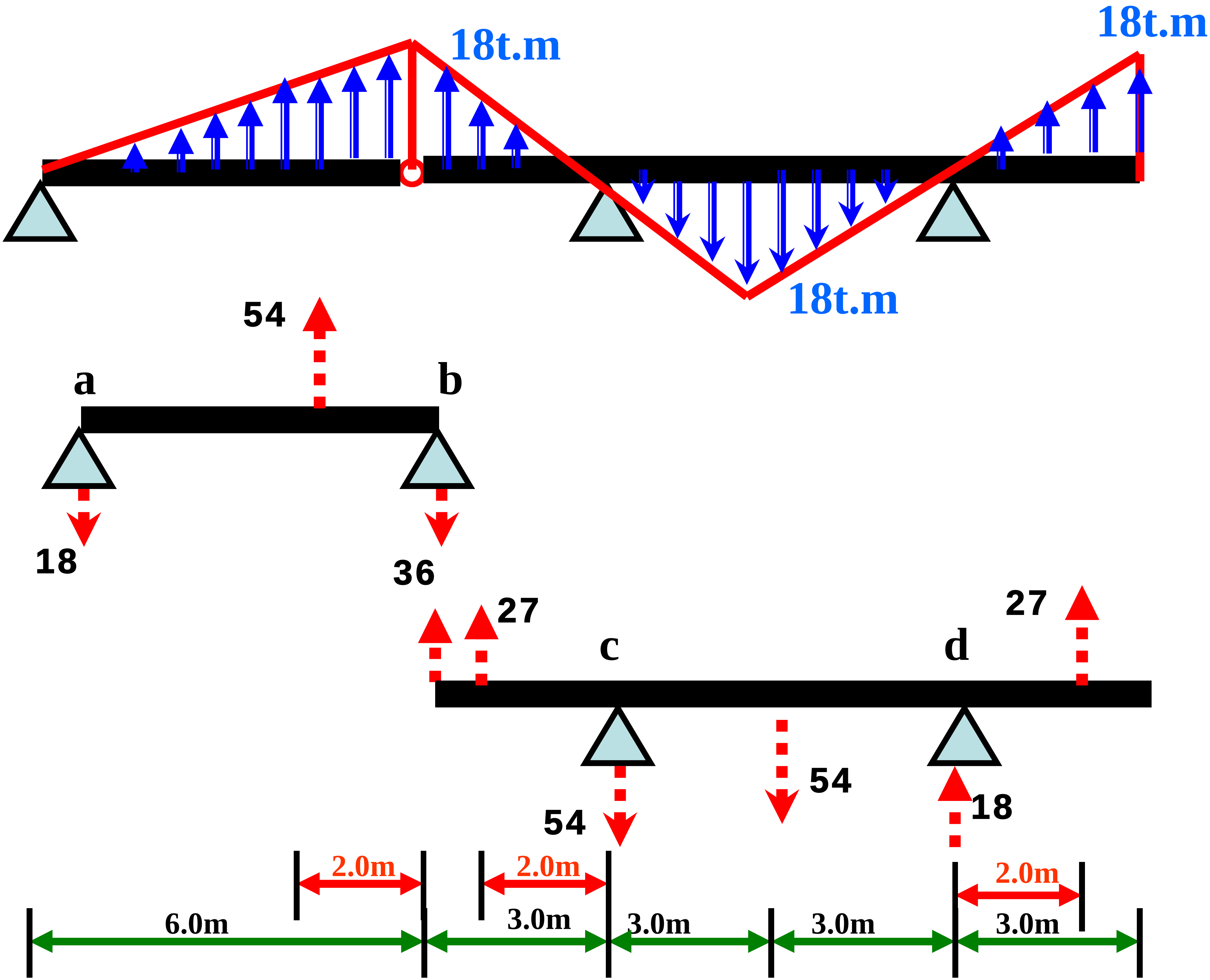


convert to conjugate beam



the final beam with the new load

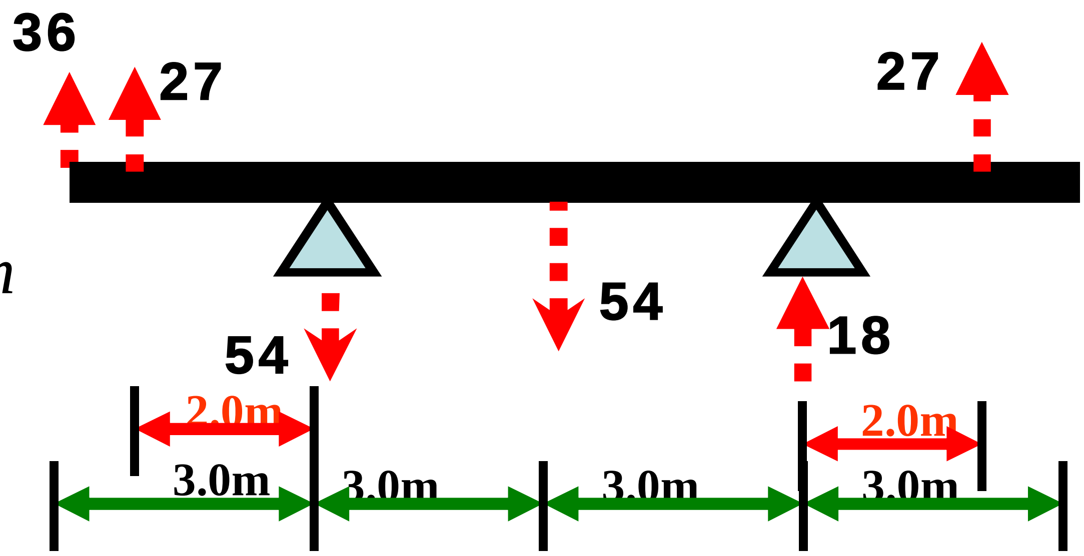



18t.m
18t.m
18t.m
54
a
b
18
36
27
c
d
27
54
54
18
2.0m
2.0m
2.0m
6.0m
3.0m
3.0m
3.0m
3.0m

Part B-D

$$y_c = \frac{(36 * 3 + 27 * 2)}{5400} = 0.03\,m$$

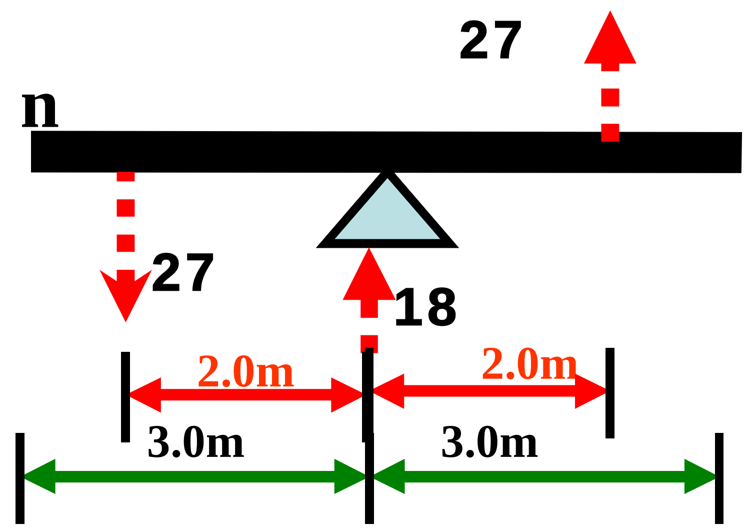
$$y_d = \frac{(27 * 2)}{5400} = 0.01\,m$$



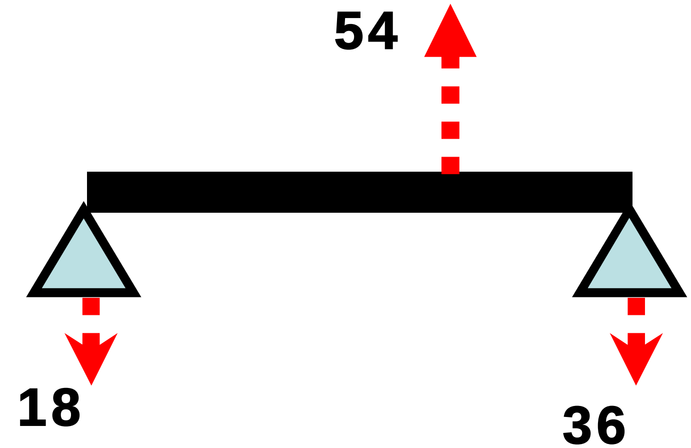
point n

$$\theta_n = \frac{-27 - 18 + 18}{5400} = -0.0033$$

$$y_d = \frac{(-27 * 1 + 18 * 3 + 27 * 5)}{5400} = 0.03\,m$$

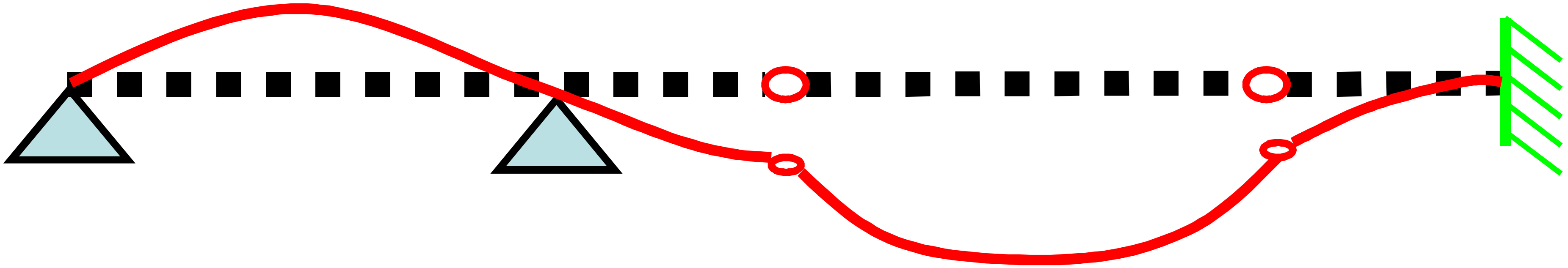


Part A-B



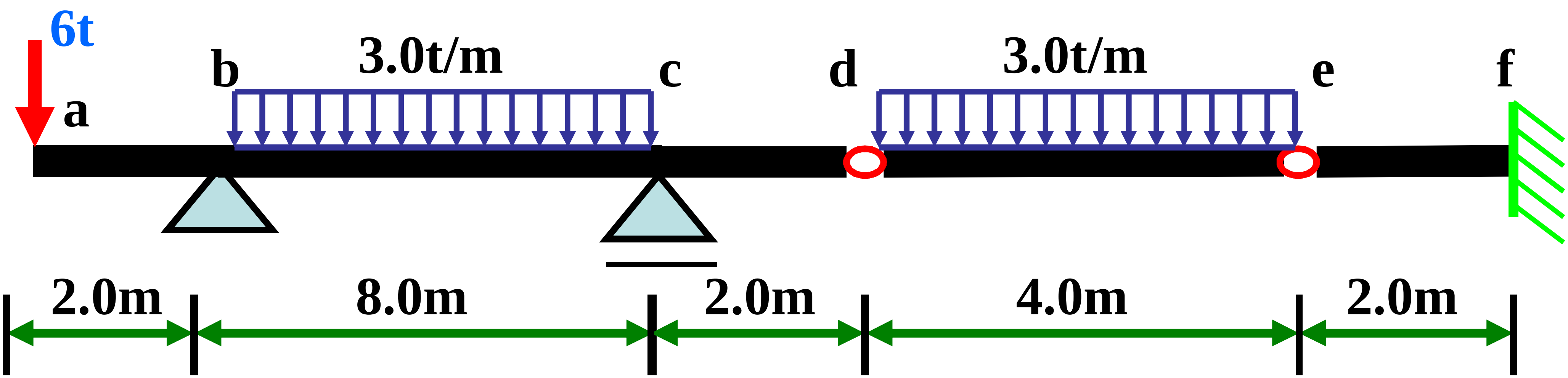
$$\theta_b = \frac{(36)}{5400} = 0.0066 \ rad$$

Elastic Curve



final 2004

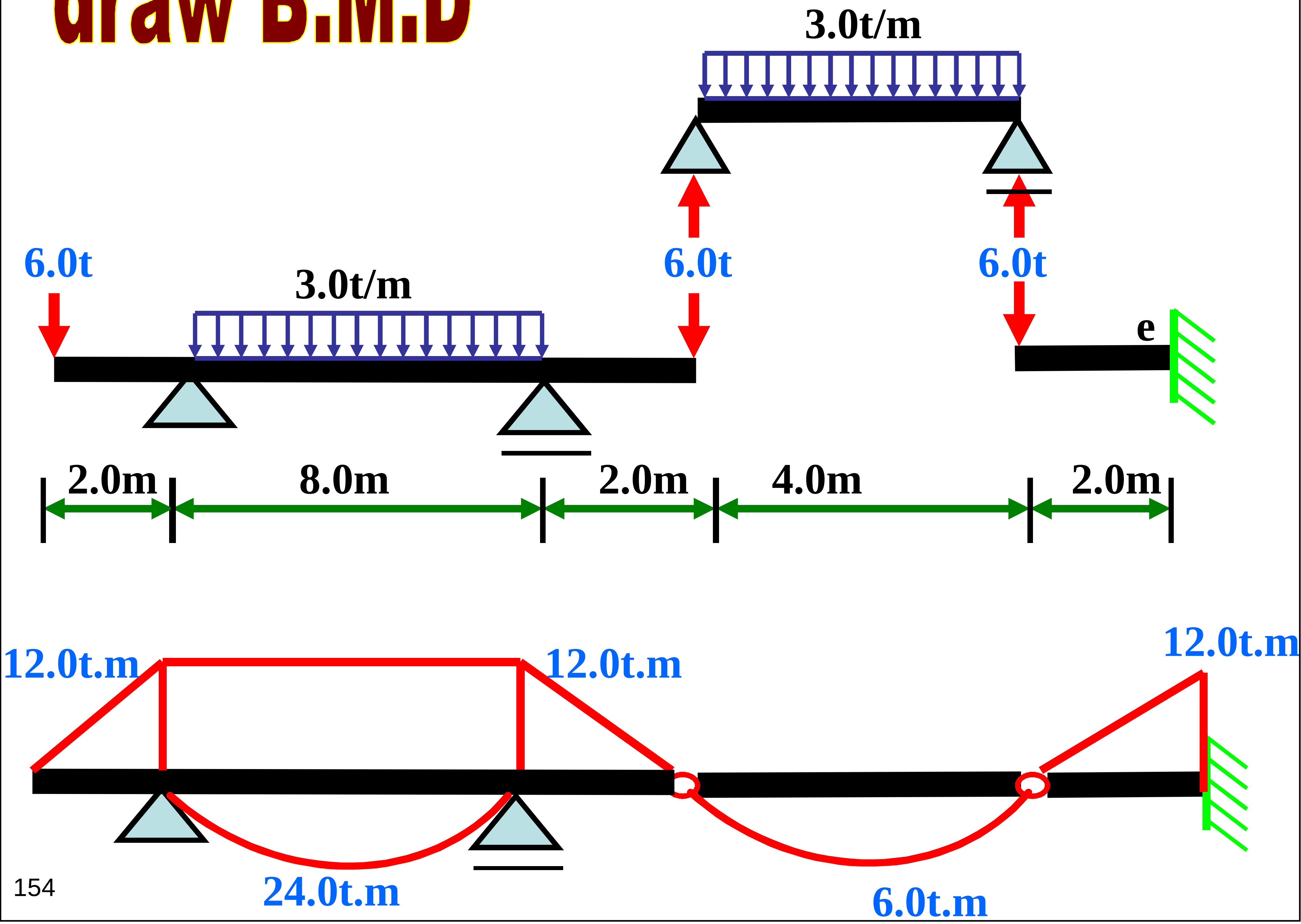
اذكر الله



Required the deflection at a, d, e and slope at point b and **($\theta_{d\ R}$) and ($\theta_{d\ L}$) and ($\theta_{e\ rel}$).** And draw elastic curve.

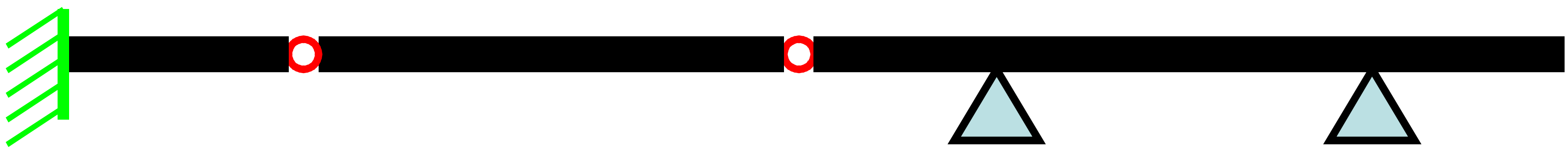
EI=8000 t.m^2

draw B.M.D

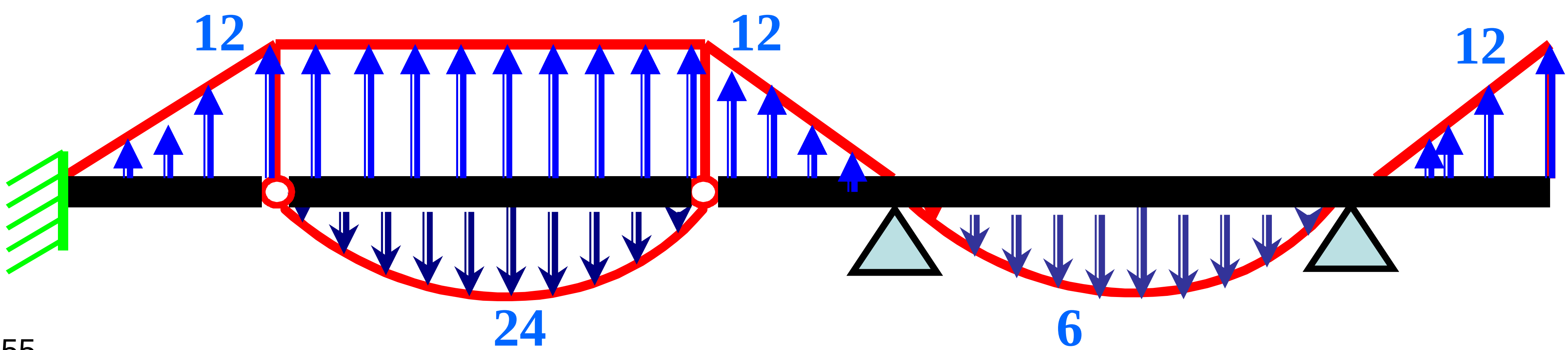


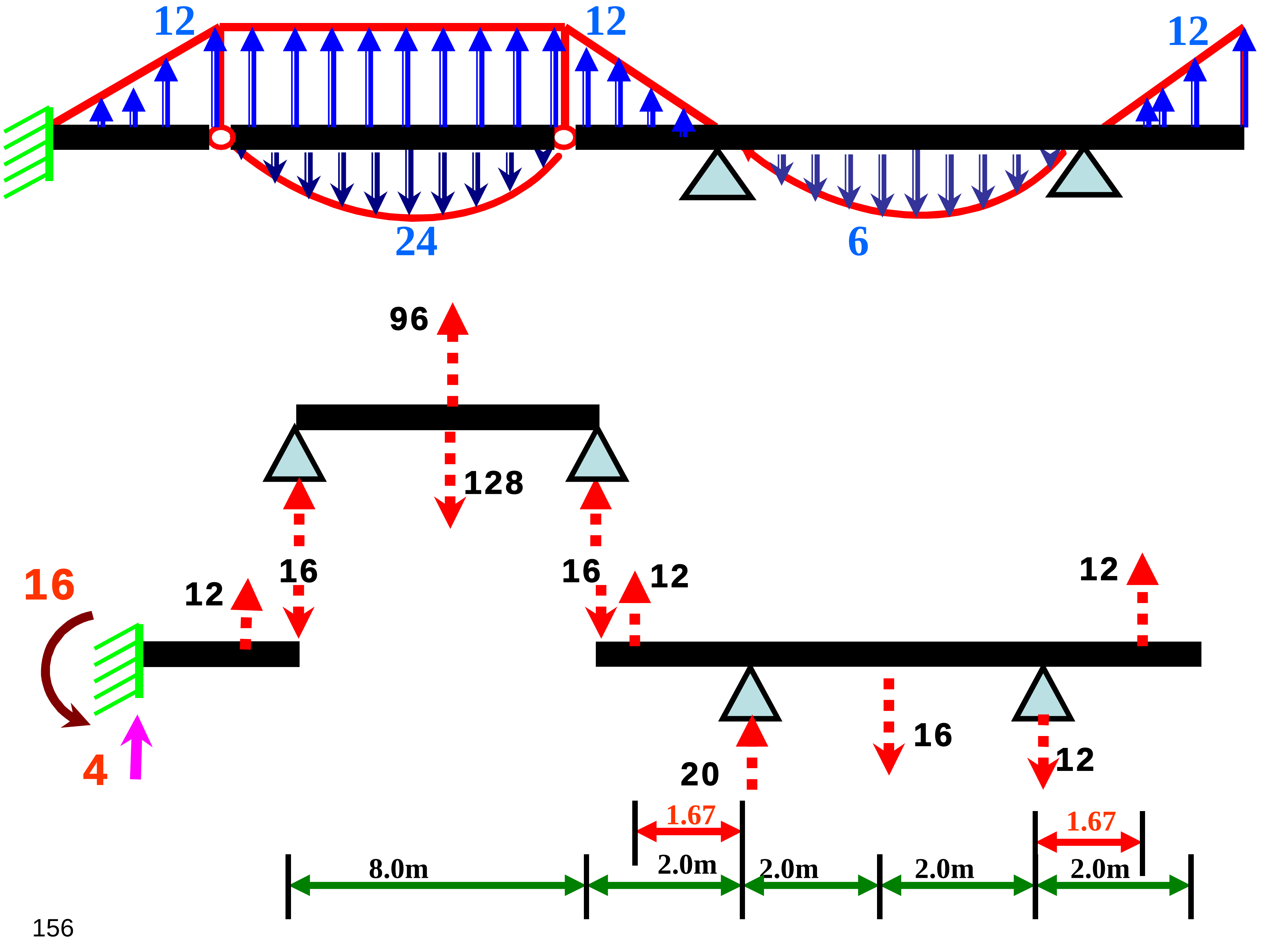
3.0t/m
6.0t
3.0t/m
6.0t
6.0t
e
2.0m
8.0m
2.0m
4.0m
2.0m
12.0t.m
12.0t.m
12.0t.m
24.0t.m
6.0t.m

convert to conjugate beam



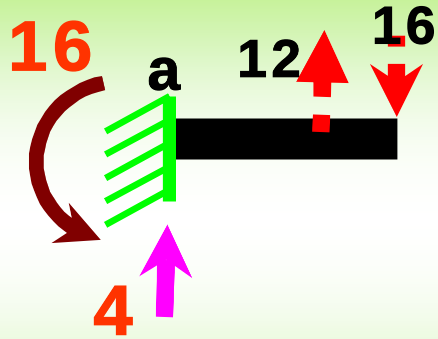
the final beam with the new load





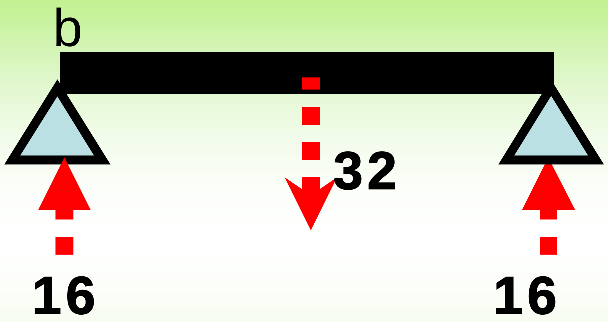
12
12
12
24
6
96
128
16
16
12
12
12
16
4
16
20
12
1.67
1.67
8.0m
2.0m
2.0m
2.0m
2.0m

Part A-B



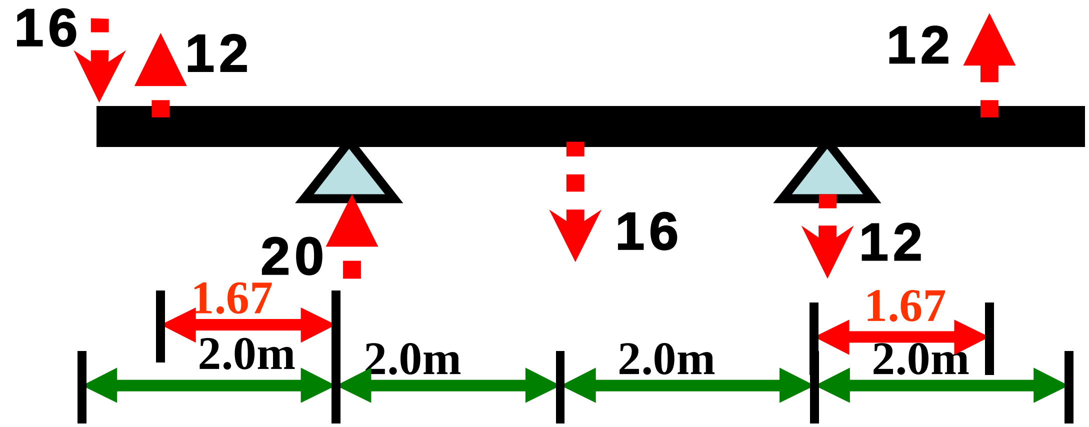
$$y_a = \frac{(-16)}{8000} = -0.002\ m$$

Part B-C



$$y_b = \frac{(+16)}{8000} = 0.002\ rad$$

Part C-F



$$y_d = \frac{(-16 * 2 + 12 * 1.67)}{8000} = -0.002\ m$$

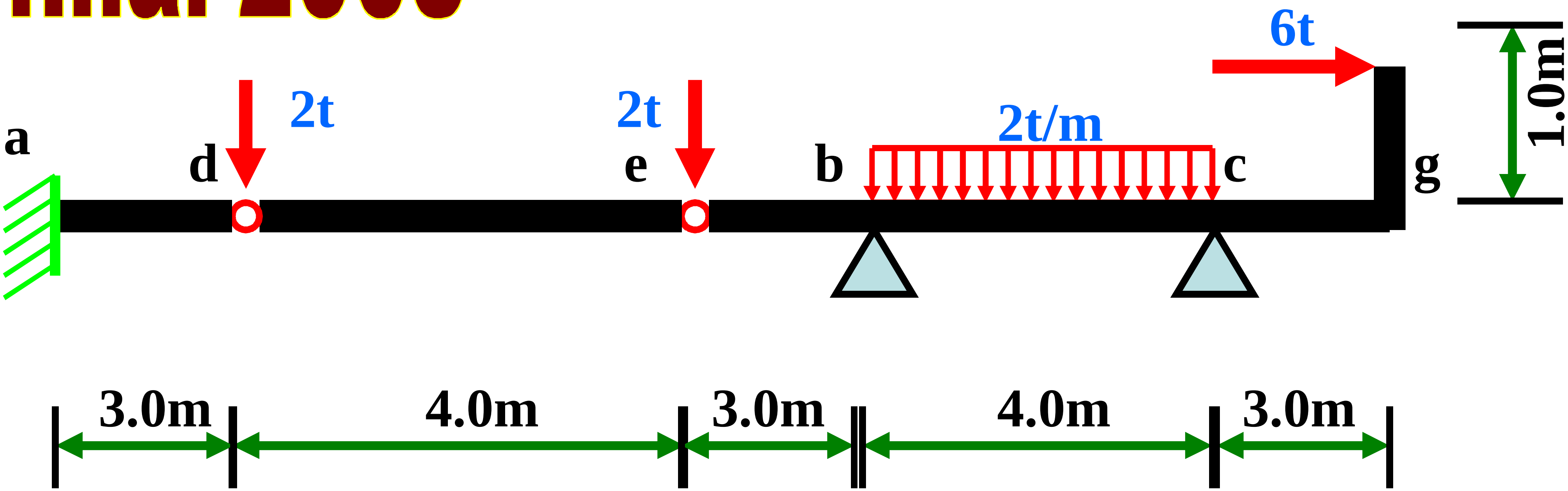
$$y_e = \frac{(12 * 1.67)}{8000} = 0.002\ m$$

$$\theta_{d\ rel} = \frac{(reaction\ \ @\ d)}{8000} = \frac{(20)}{8000} 0.0025\ rad$$

$$\theta_{d\ L} = \frac{(shear\ \ @\ d\ \ left)}{8000} = \frac{(-16 + 12)}{8000} = -0.0005\ rad$$

$$\theta_{d\ R} = \frac{(shear\ \ @\ d\ \ right)}{8000} = \frac{(-16 + 12 + 20)}{8000} = 0.002\ rad$$

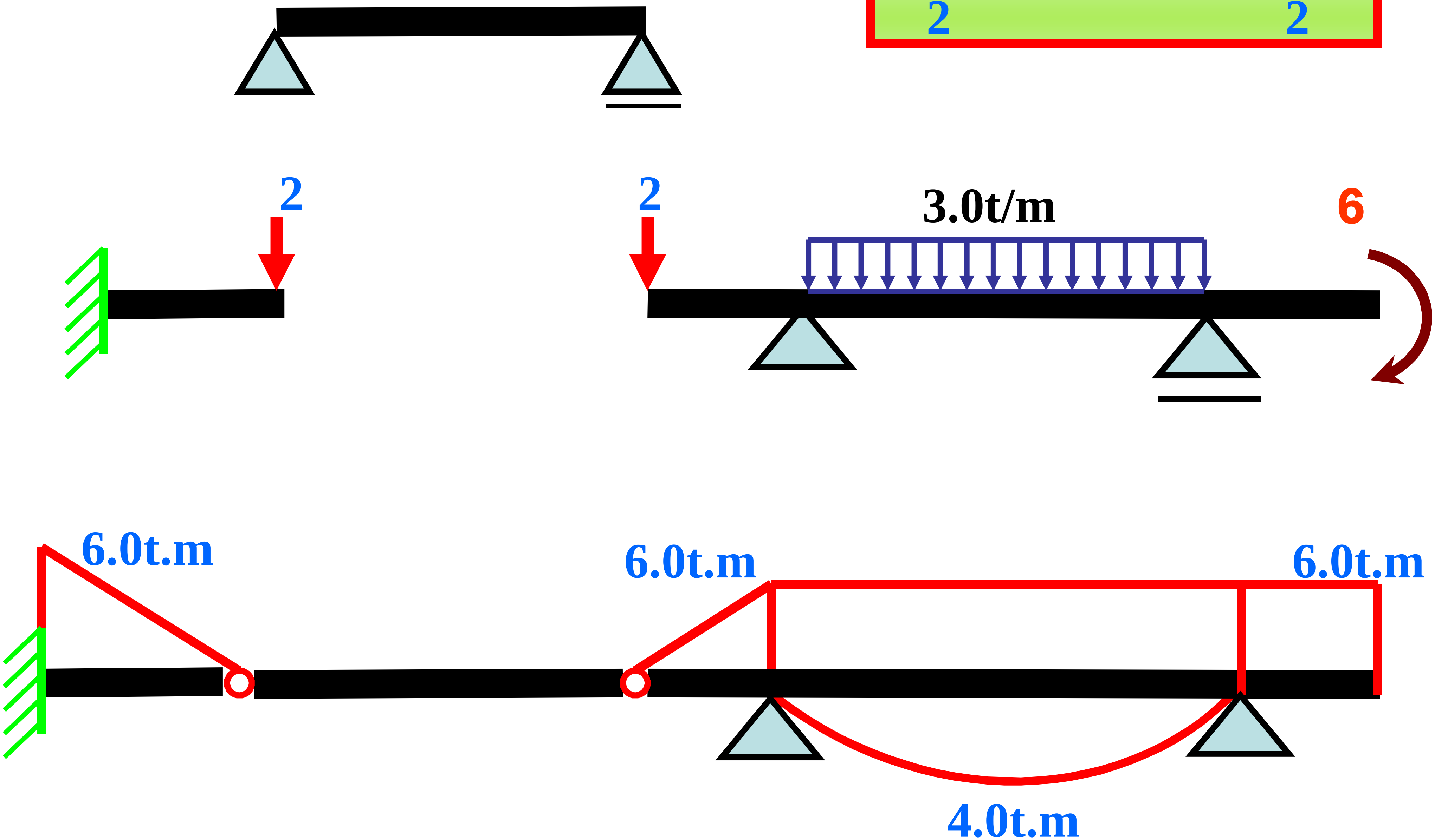
final 2008



Required the deflection at g, d, e and slope at point b and ($\theta_{d\ R}$) and ($\theta_{e\ rel}$).

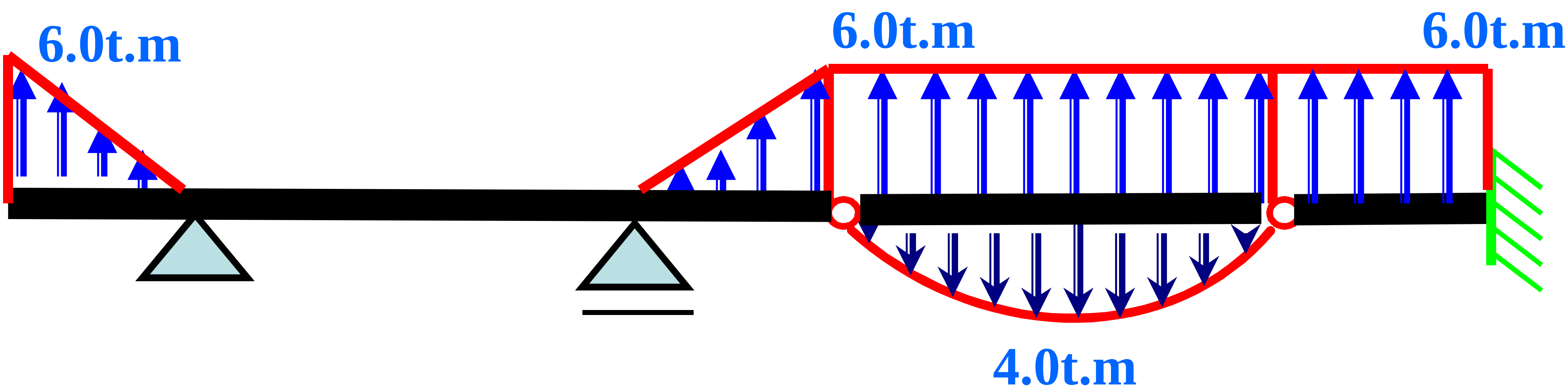
EI=8000 t.m^2

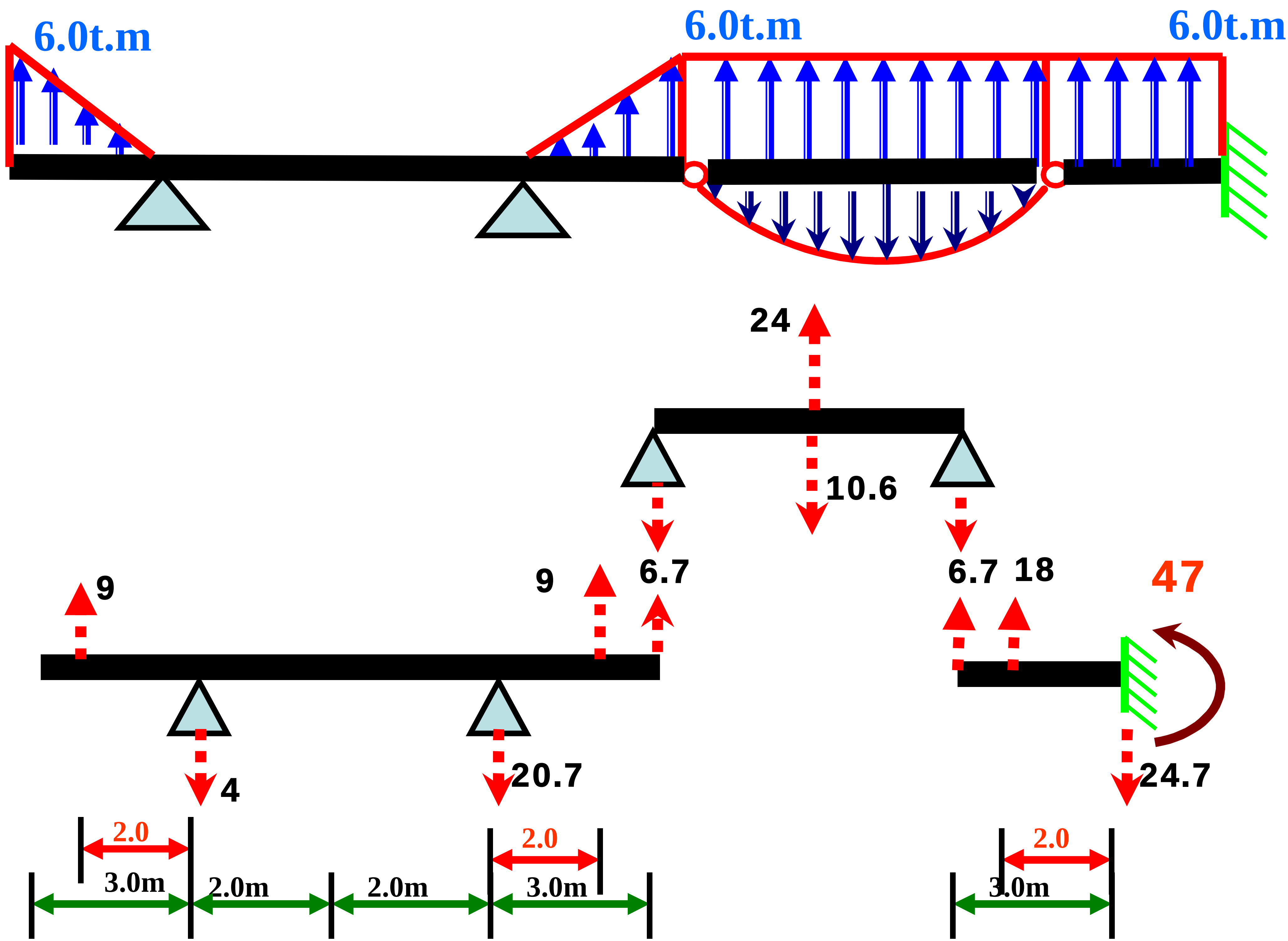
draw B.M.D



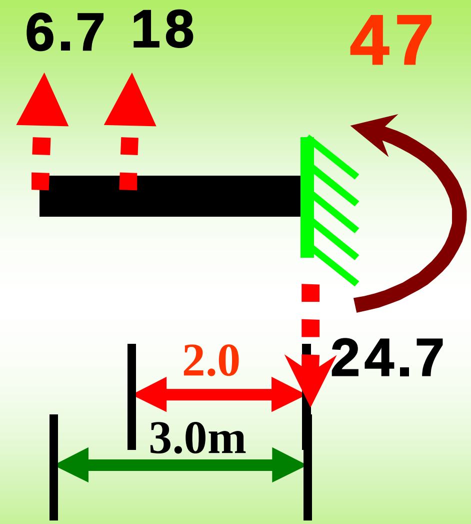
convert to conjugate beam

the final beam with the new load



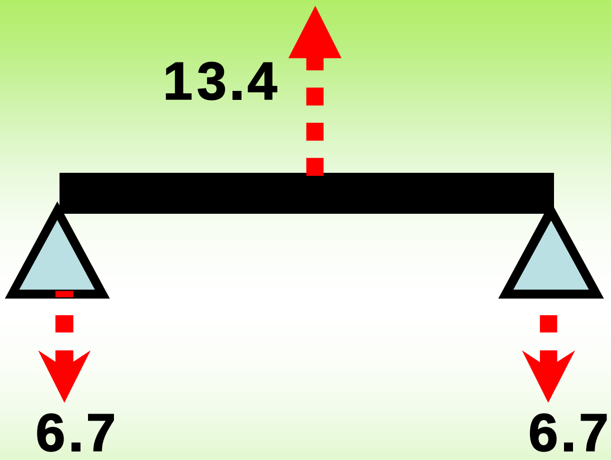

6.0t.m
6.0t.m
6.0t.m
24
10.6
6.7
6.7
18
9
9
47
4
20.7
24.7
2.0
2.0
2.0
3.0m
2.0m
2.0m
3.0m
3.0m

Part A-B



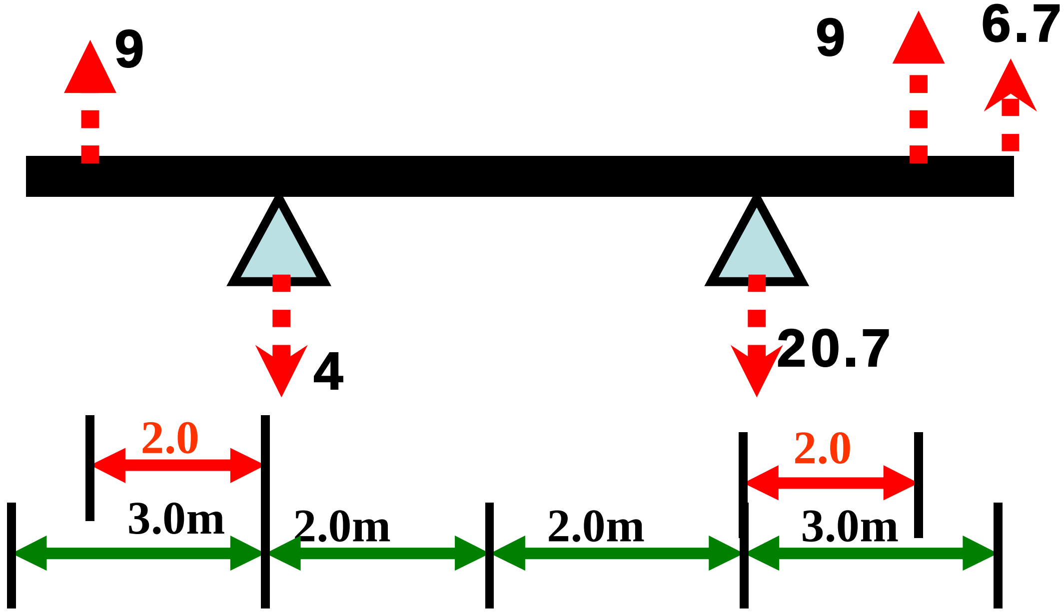
$$y_g = \frac{(47)}{8000} = 0.005875 \ m$$

Part B-C



$$\theta_b = \frac{(-6.7)}{8000} = -0.0083 \ rad$$

Part C-F



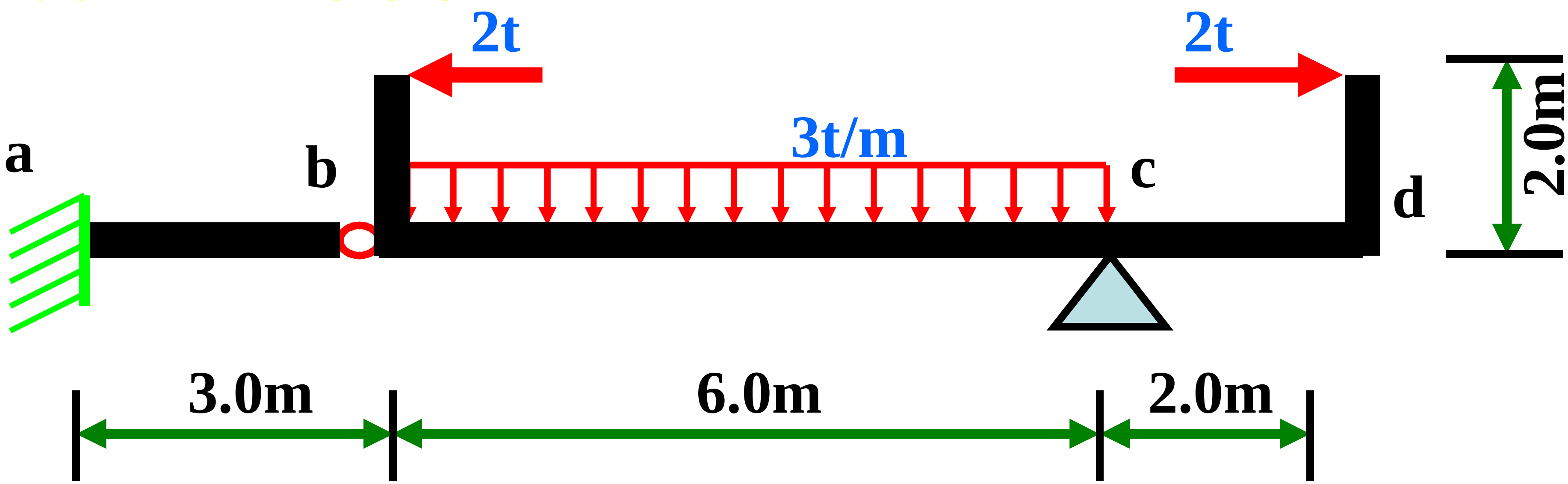
$$y_d = \frac{(9 * 2)}{8000} = 0.00225 \ m$$

$$y_e = \frac{(9 * 2 + 6.7 * 3)}{8000} = 0.00475 \ m$$

$$\theta_{e \ rel} = \frac{(reaction \ @ \ e)}{8000} = \frac{(-20.7)}{8000} = -0.00257 \ rad$$

$$\theta_{d \ R} = \frac{(shear \ @ \ d \ right)}{8000} = \frac{(9 - 4)}{8000} = 0.000625 \ rad$$

Mid term 2008



Required:

1- the left rotation at b.

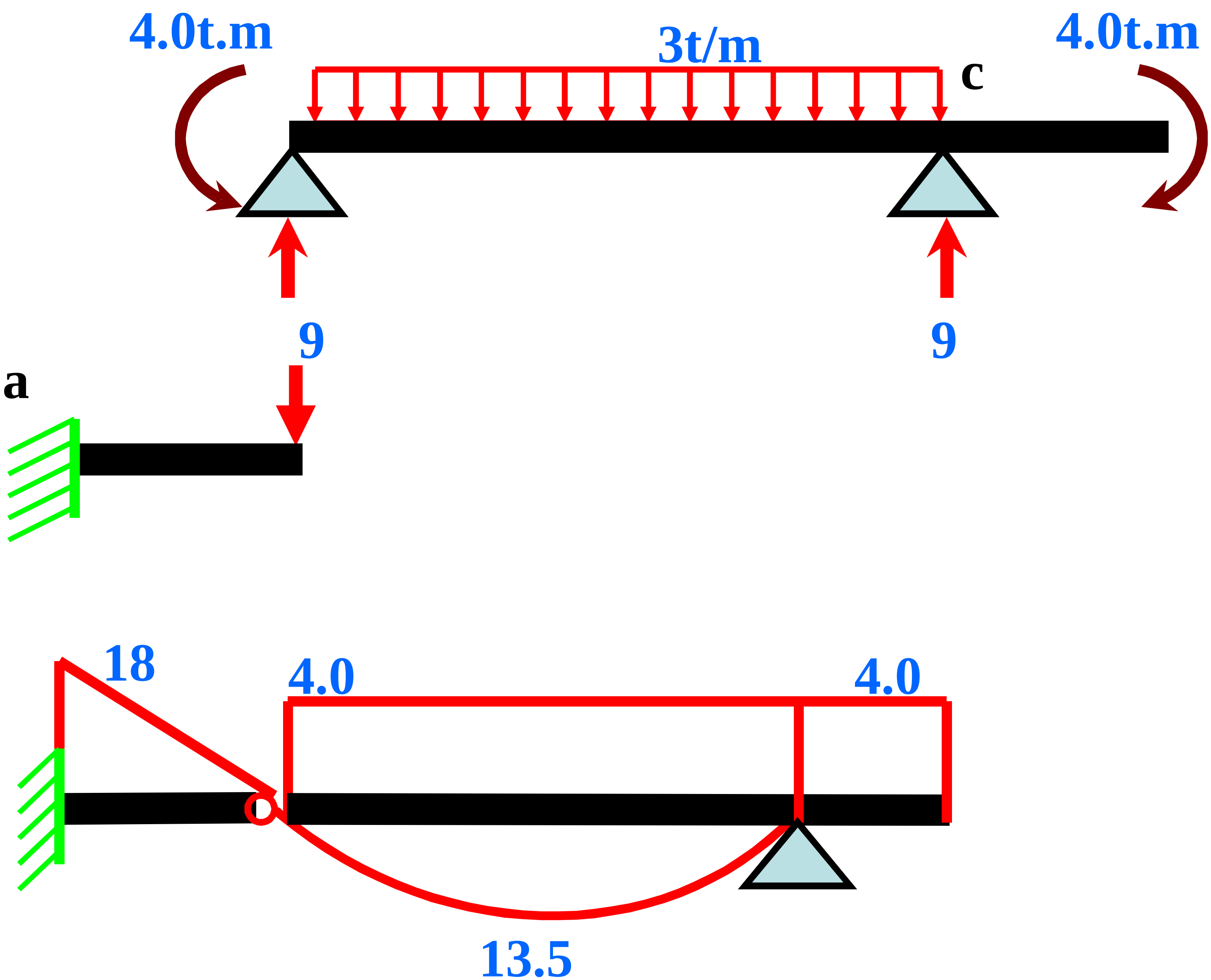
2- slope at d.

3- deflection at b and d.

4- draw elastic curve.

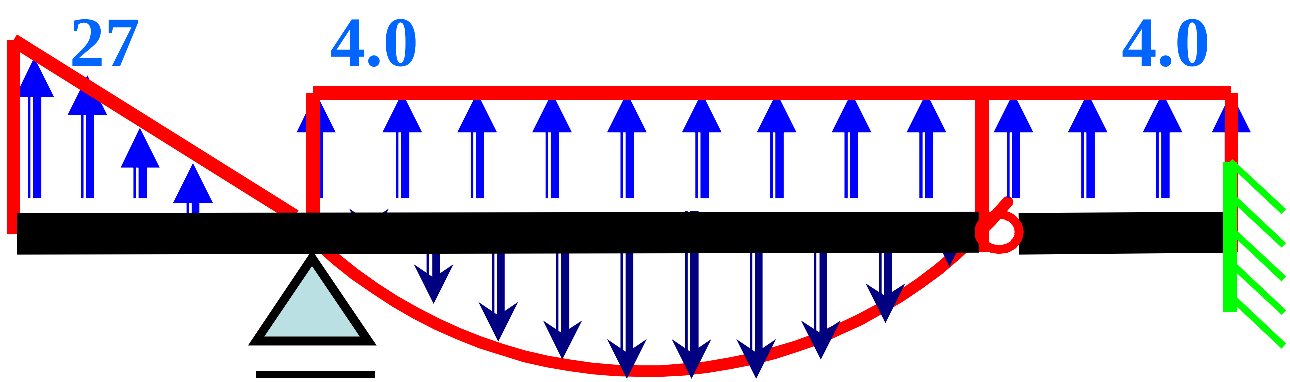
$EI=8000\ t.m^2$

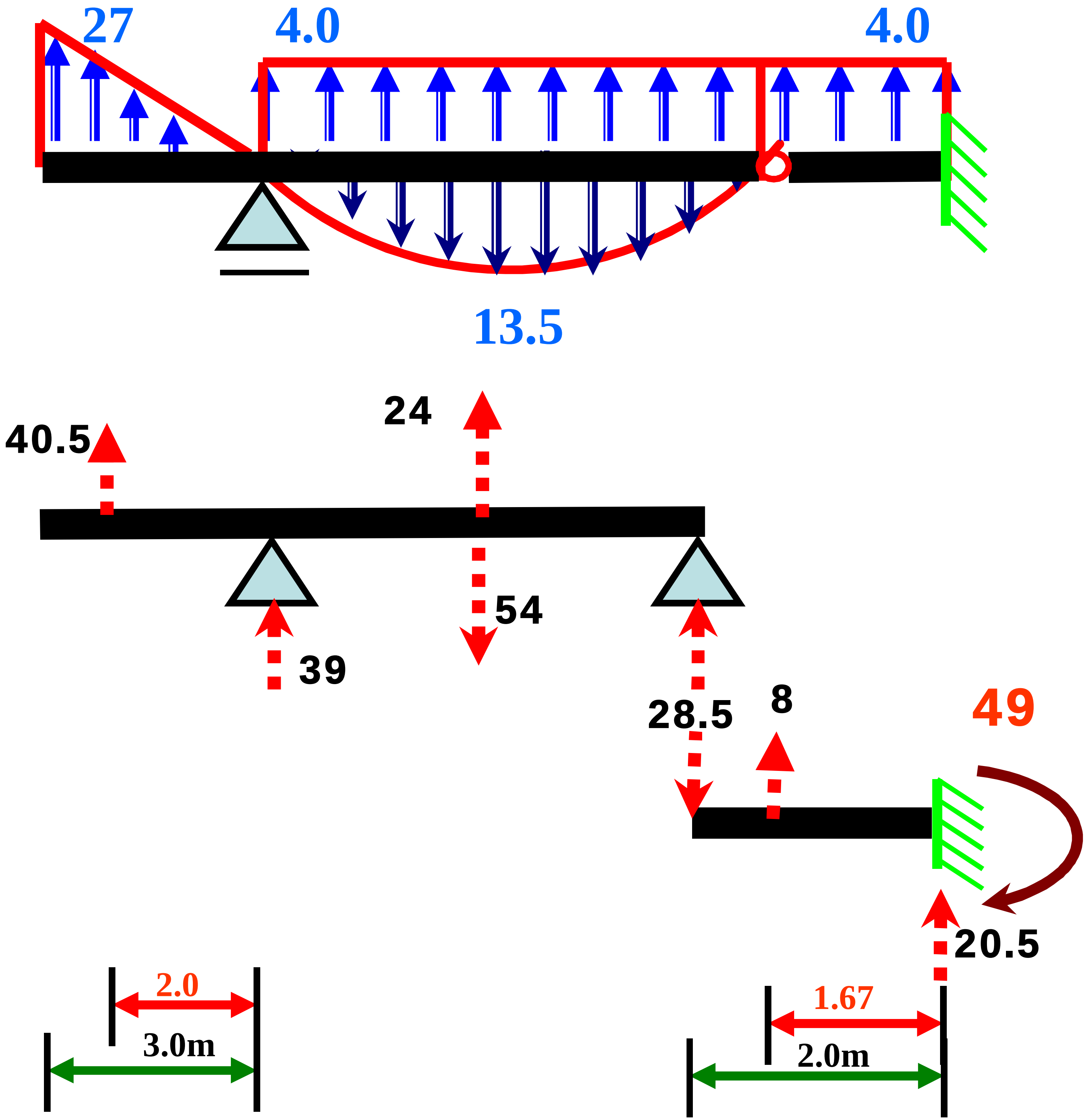
draw B.M.D



convert to conjugate beam

the final beam with the new load





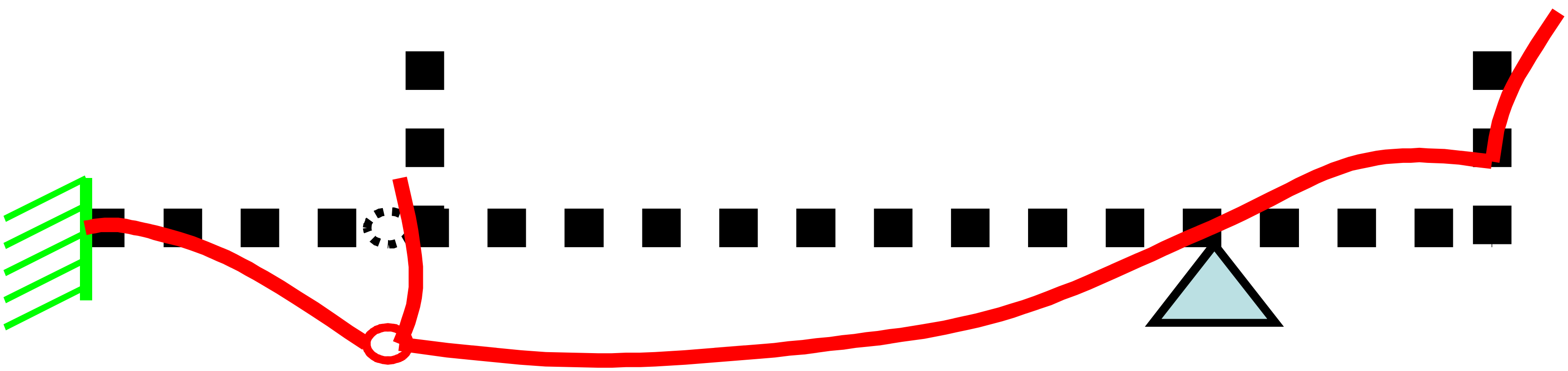
27
4.0
4.0
13.5
24
40.5
54
39
28.5
8
49
20.5
2.0
3.0m
1.67
2.0m

$$\theta_{b\ left} = \frac{(40.5)}{8000} = 0.005\ rad$$

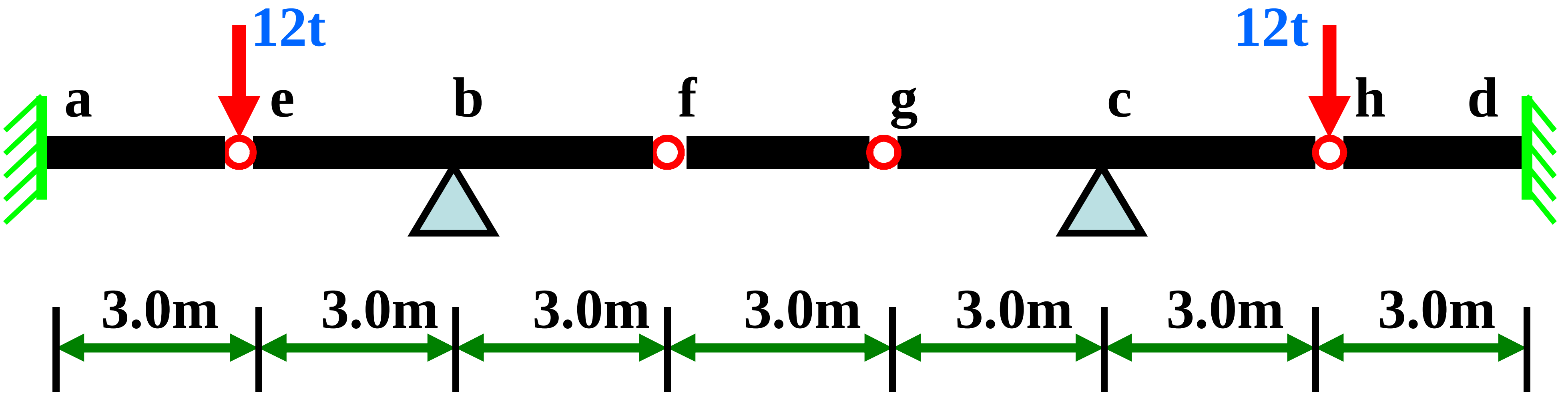
$$\theta_{d} = \frac{(-20.5)}{8000} = -0.0025\ rad$$

$$y_{b} = \frac{(40.5 * 2)}{8000} = 0.01\ m$$

$$y_{d} = \frac{(-49)}{8000} = -0.006\ m$$



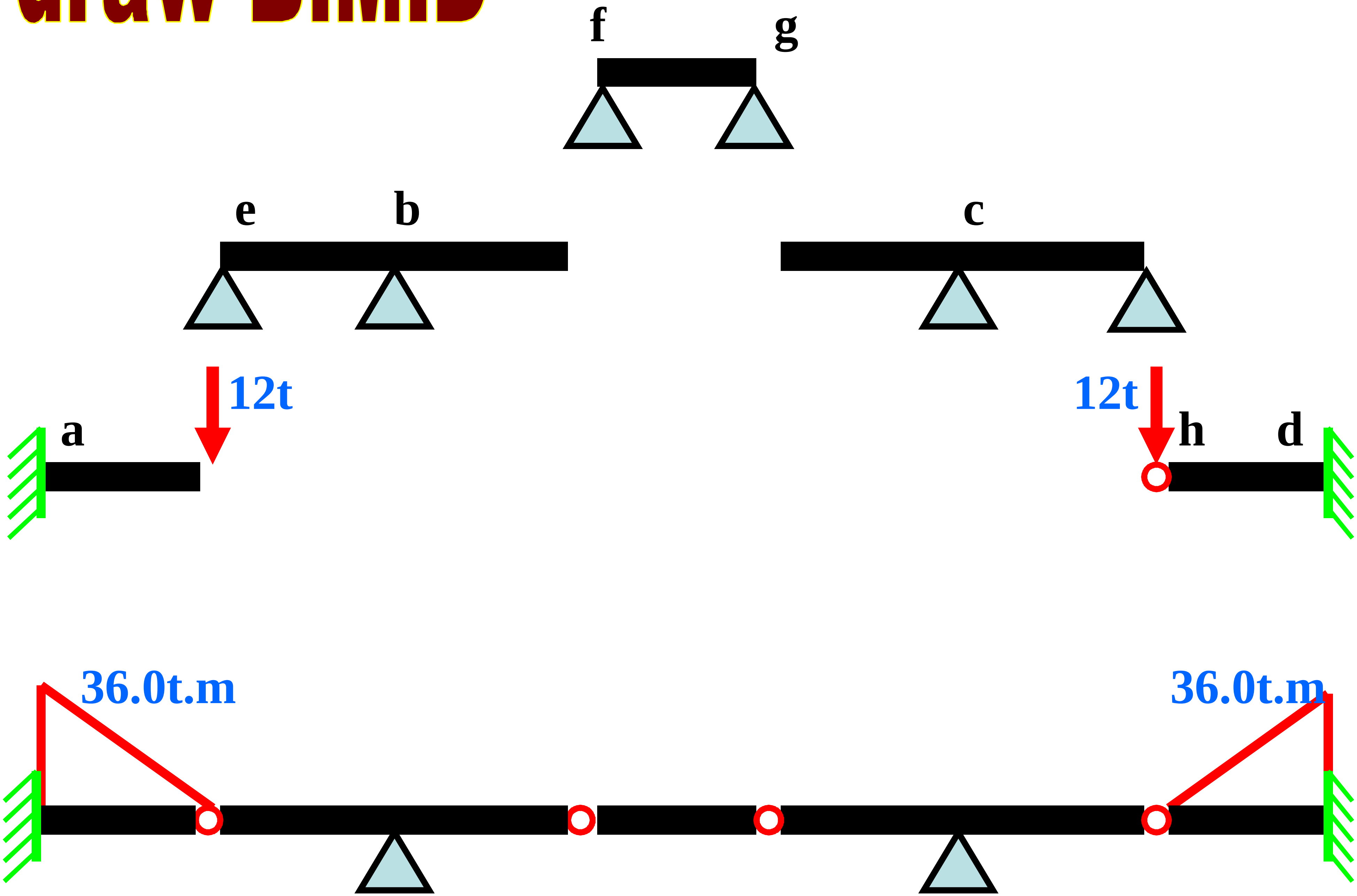
final 2009



Required slope and deflection at point b, e, f and g.

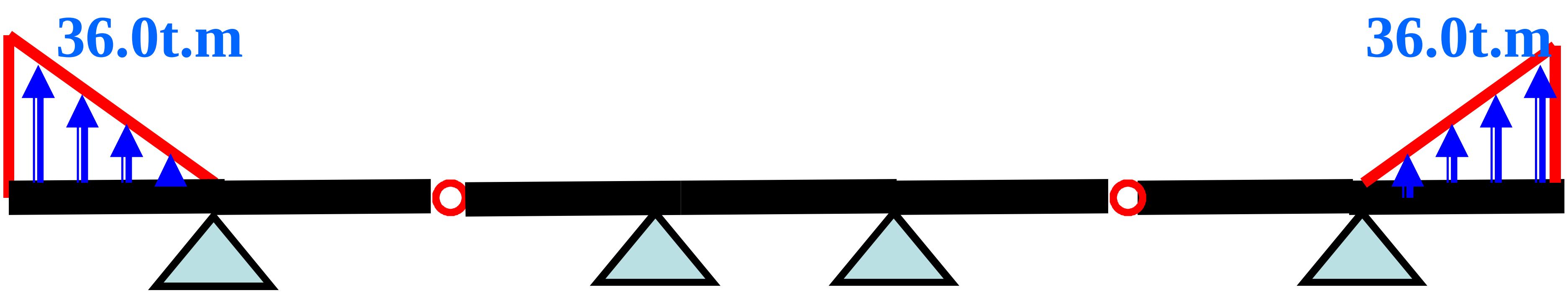
EI=3600 t.m^2

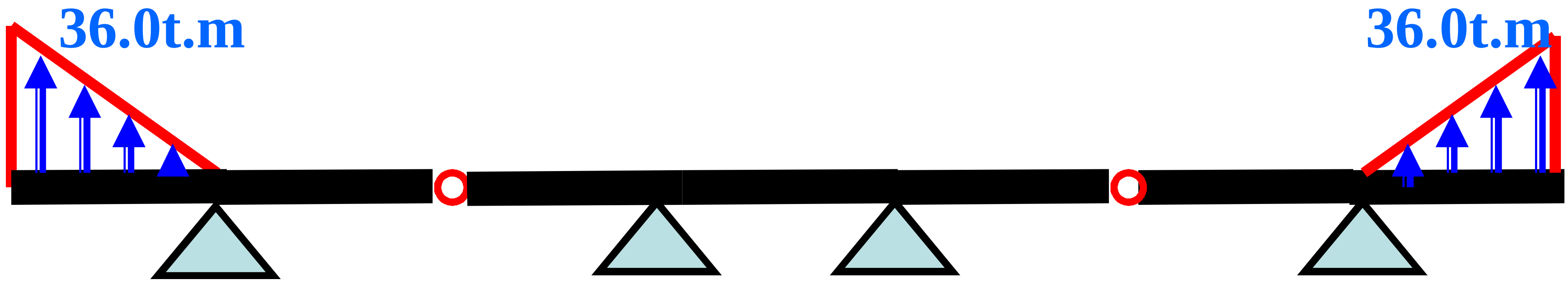
draw B.M.D



convert to conjugate beam

the final beam with the new load





try your self

بسم الله الرحمن الرحيم

VERTUAL WORK

Eng : Ayman abdo

The principle of work and energy is:

$$U_e = U_i$$

Work of External Forces & Moments → U_e

Strain Energy Internal Forces → U_i

$$\omega_{\text{internal}} = \int \frac{M_0 . M_1}{EI} . dl + \int \frac{Q_0 . Q_1}{GA_r} . dl + \int \frac{N_0 . N_1}{EA} . dl$$

M >>> Moment.

Q >>> Shear.

N >>> Normal.

$$\omega_{\text{internal}} = \int \frac{M_0 . M_1}{EI} . dl$$

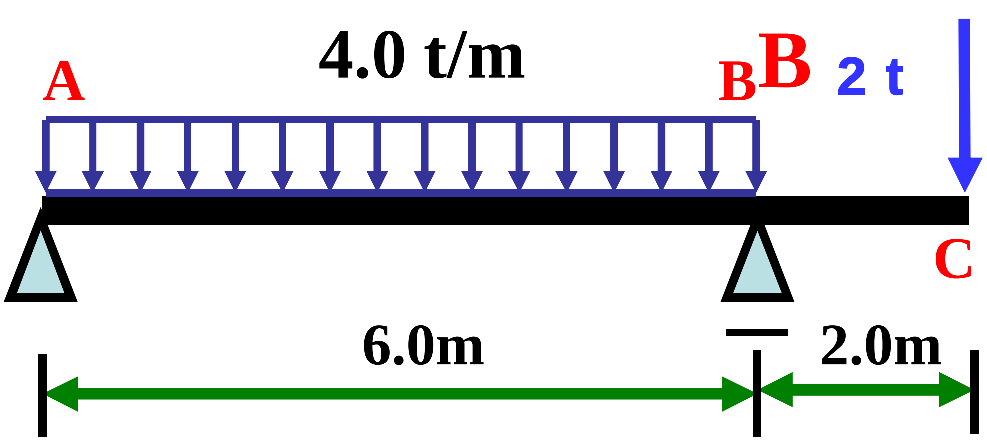
For Beams

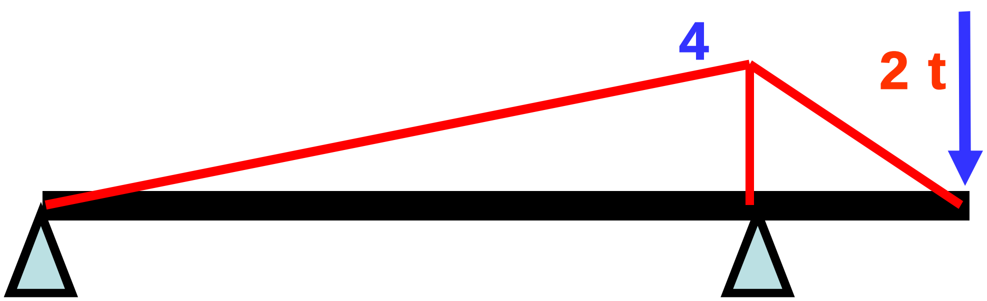
$$\omega_{\text{internal}} = \int \frac{N_0 . N_1}{EA} . dl$$

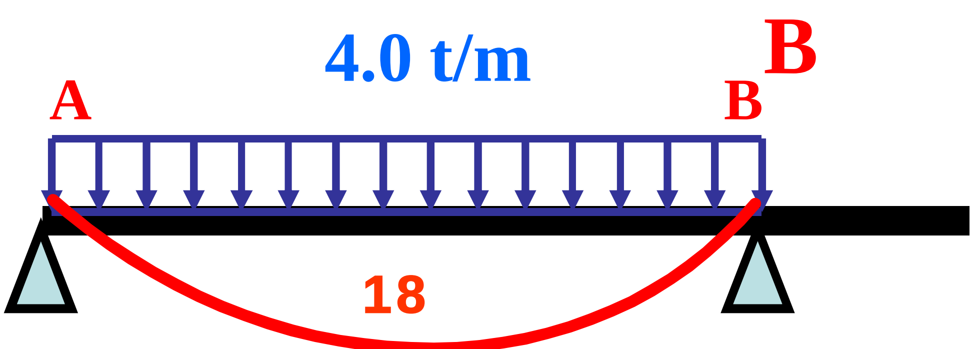
For truss

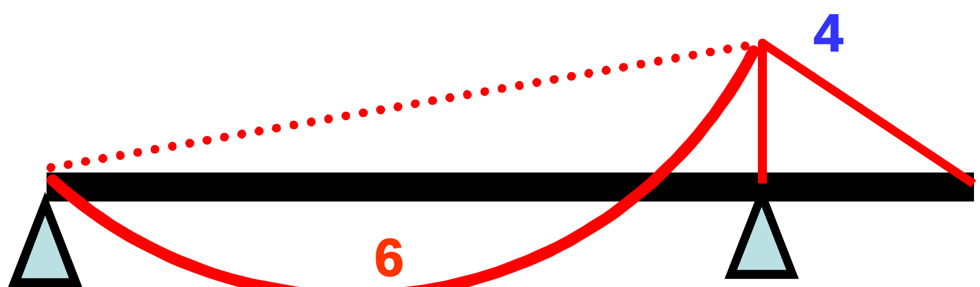
خطوات الحل:

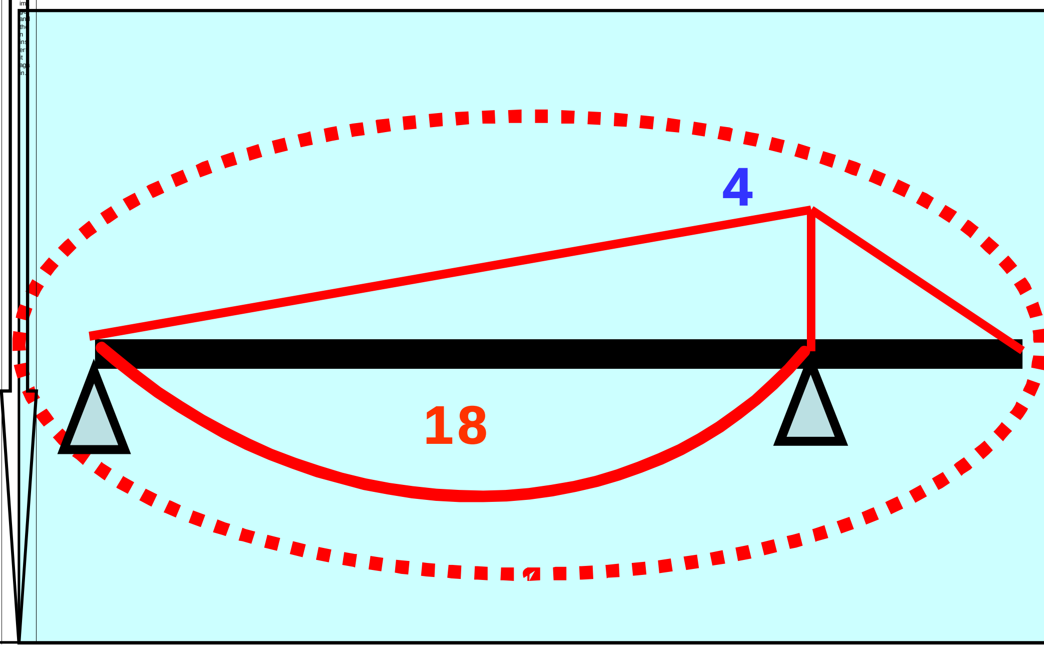
1- يتم رسم العزم على الكمرة المعطاه بطريقة الـ super position.



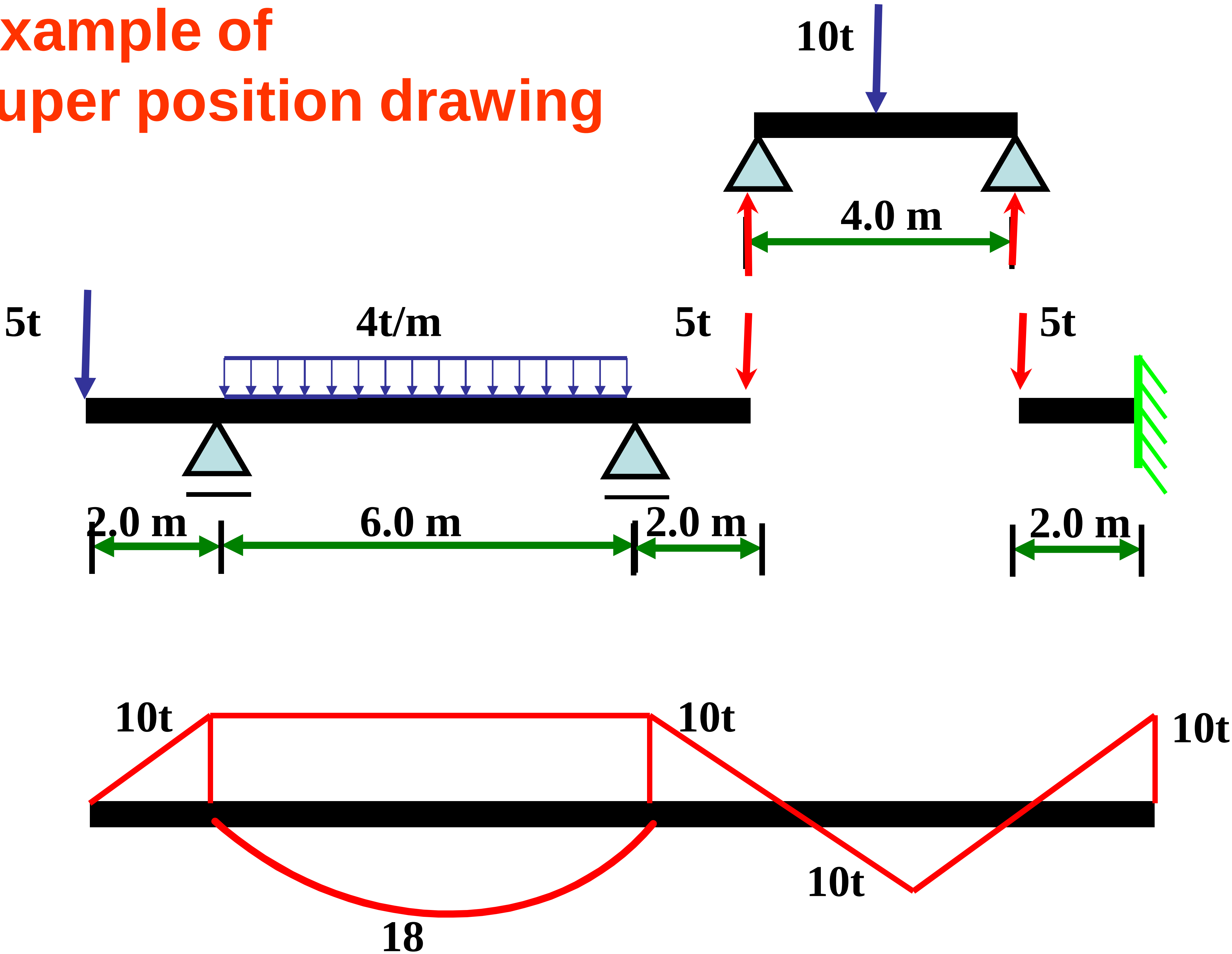




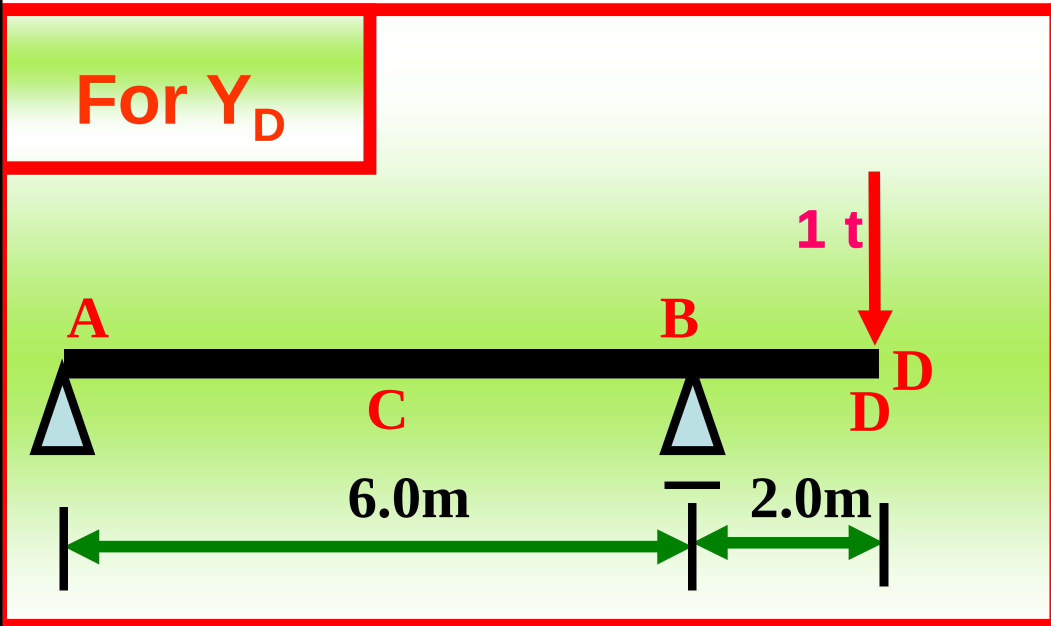


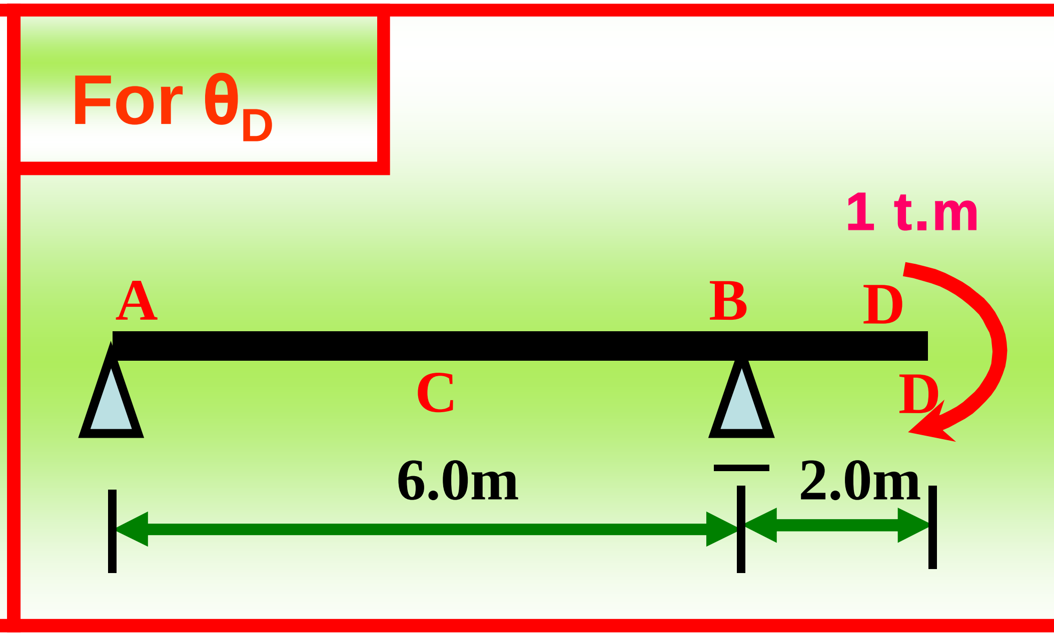


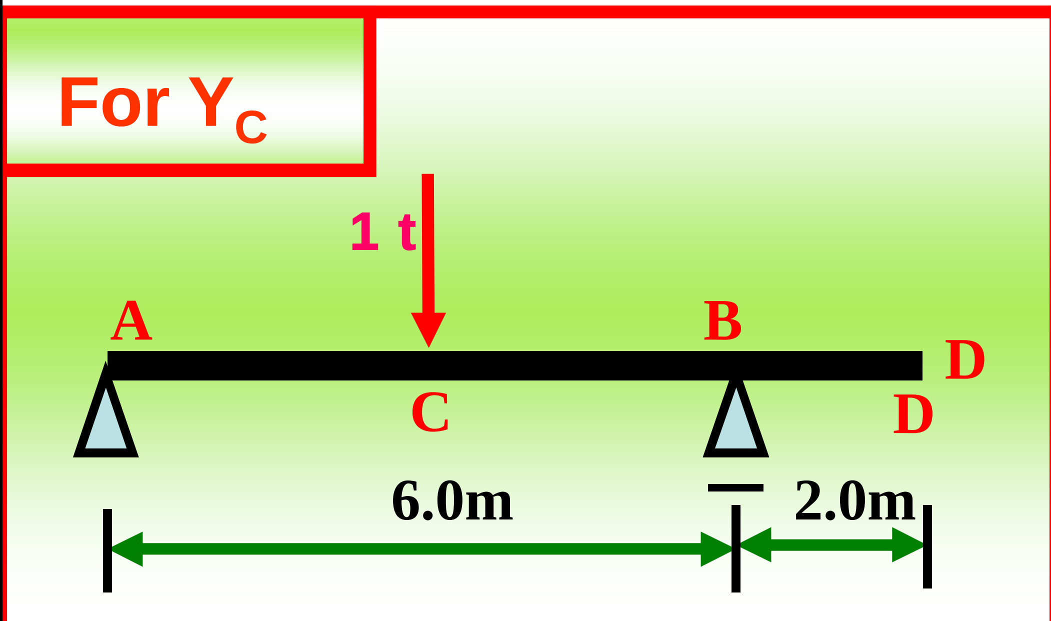
Example of super position drawing

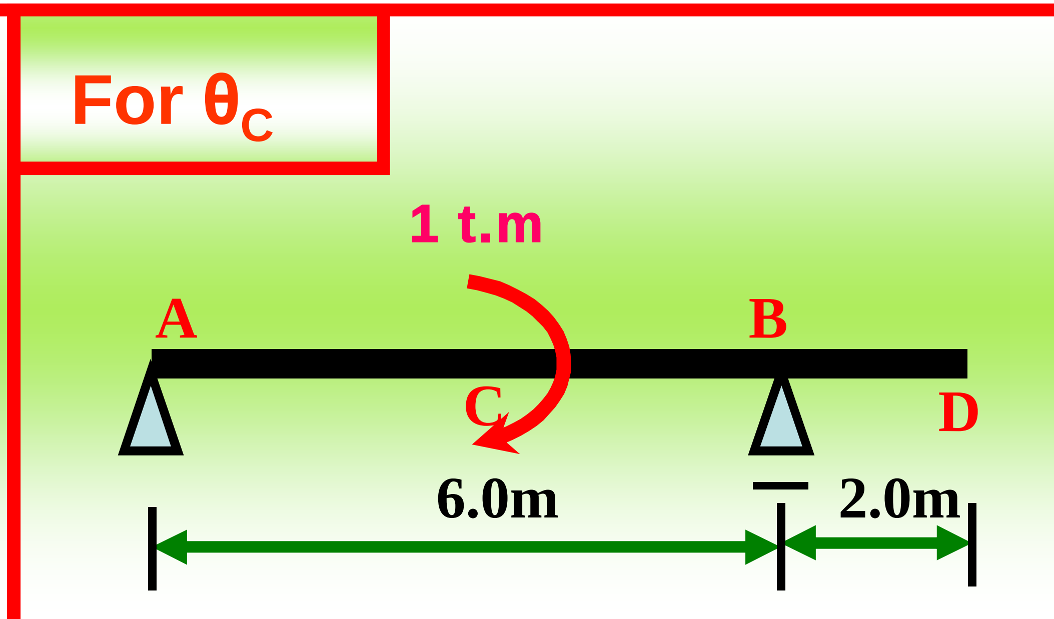


2- يتم ازالة الاحمال كلها من على الكمرة ووضع 1 ton عند النقطه المطلوب حساب الهبوط عندها فى اتجاه الحركة او 1t.m عند طلب الدوران عند نقطه، ورسم العزم عليها.







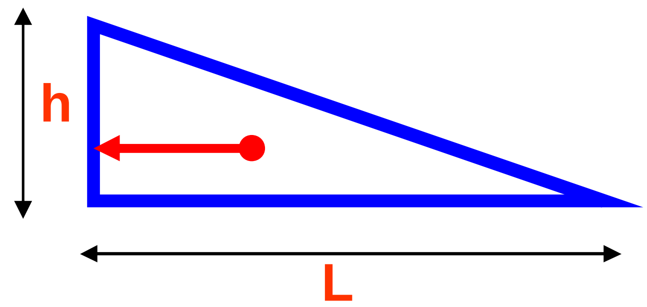


3- يتم تكامل الشكل الاساسى بالخطوه 1 والشكل المرسوم للمطلوب الاول بالخطوه 2 والتكامل هنا سيكون تكامل مساحات:

بعض المساحات المطلوب معرفة قيمتها واماكن تركيزها

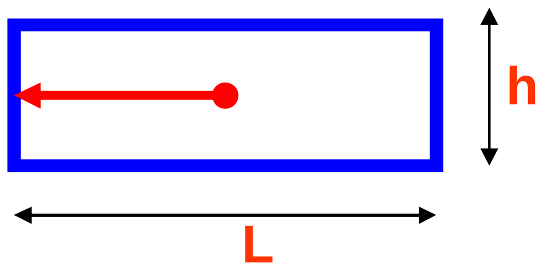
$A = L.h/2$

Ç @ L/3



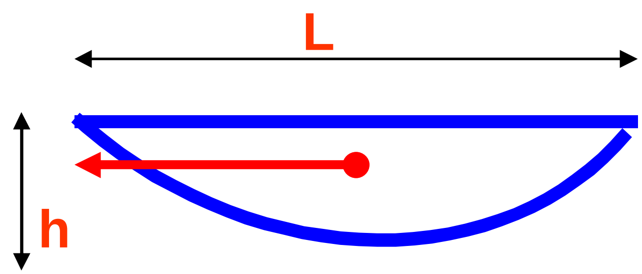
$A = L.h$

Ç @ L/2



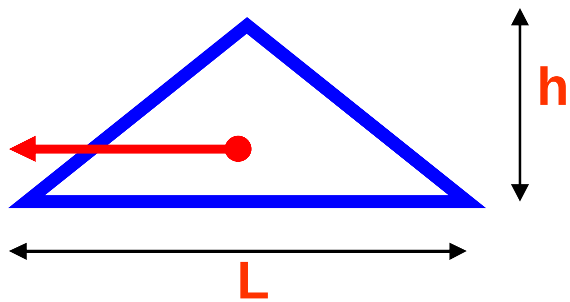
$A = 2/3 L.h$

Ç @ L/2



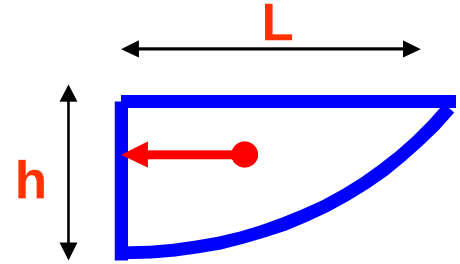
$A = L.h/2$

Ç @ L/2



$A = 2/3 L.h$

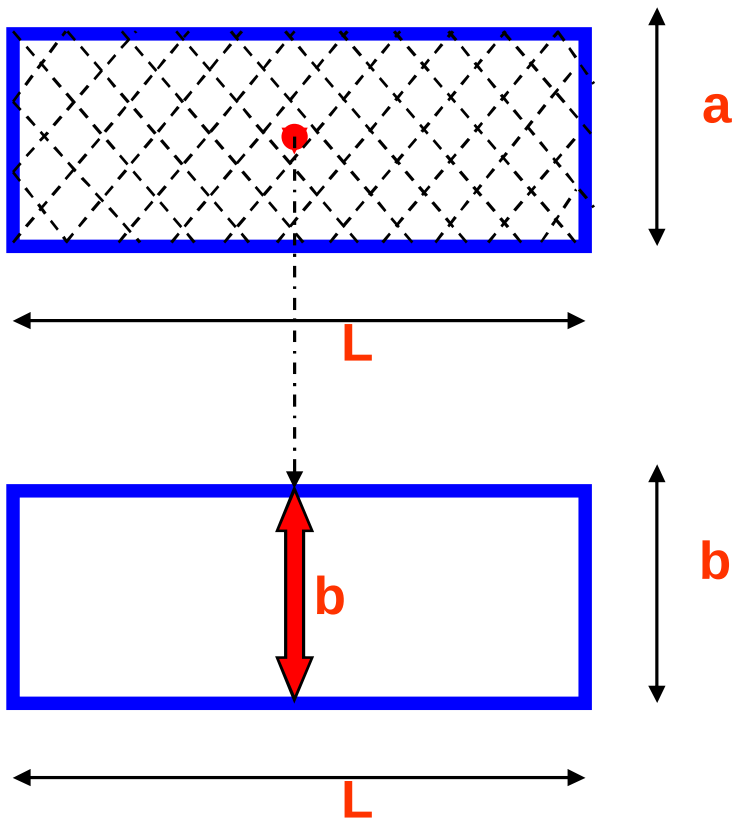
Ç @ 3/8L



تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

A=a.L

ç @ L/2

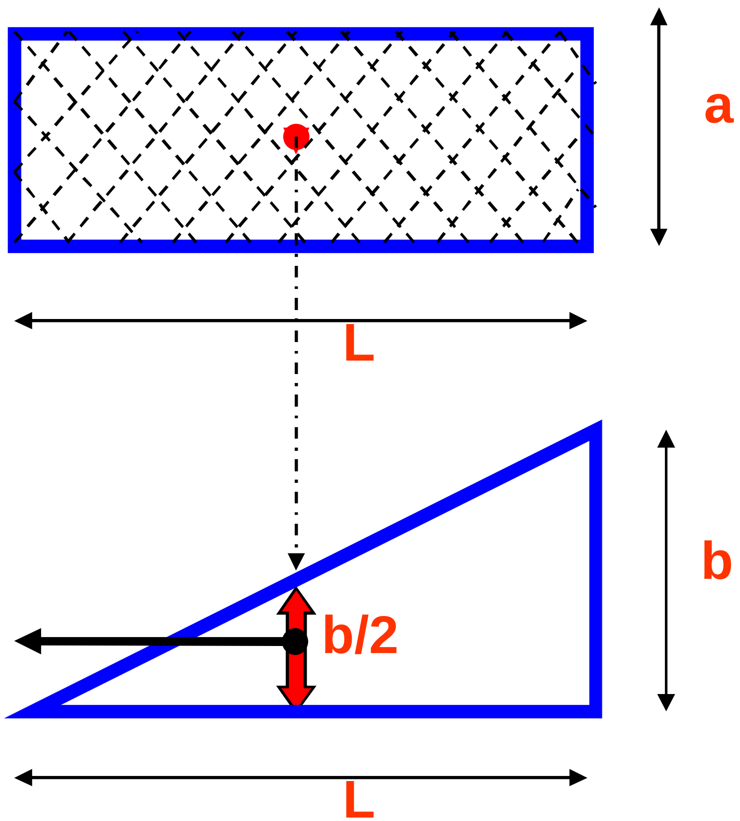


$$\int \frac{M_0 . M_1}{EI} . dl = (a.L) * b = a.b.L$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

A=a.L

ç @ L/2

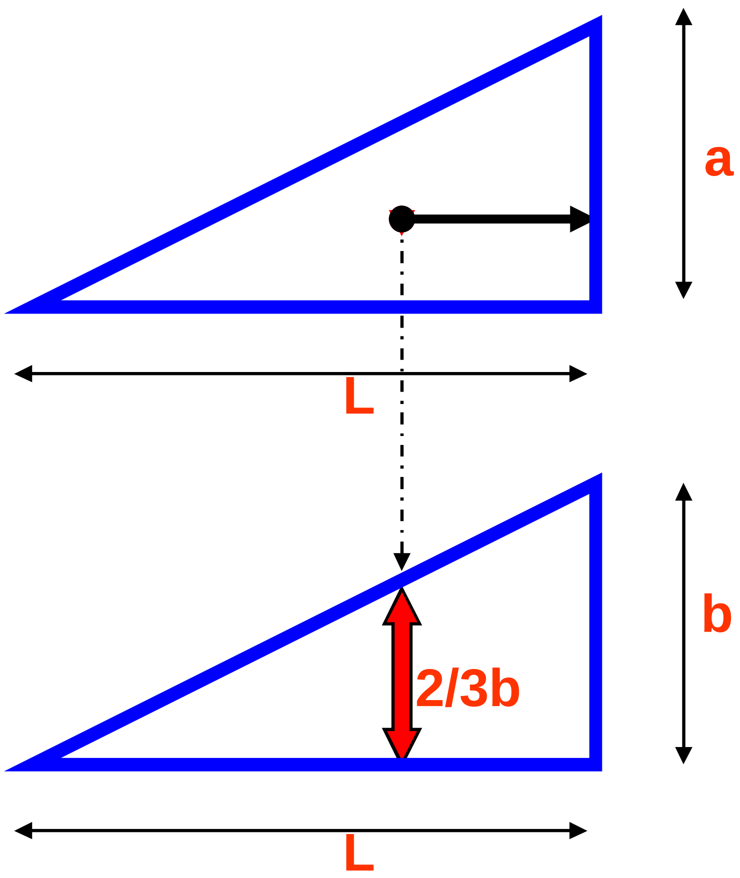


$$\int \frac{M_0 . M_1}{EI} . dl = (a.L) * b/2 = a.b.L/2$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

A=a.L/2

ç @ L/3

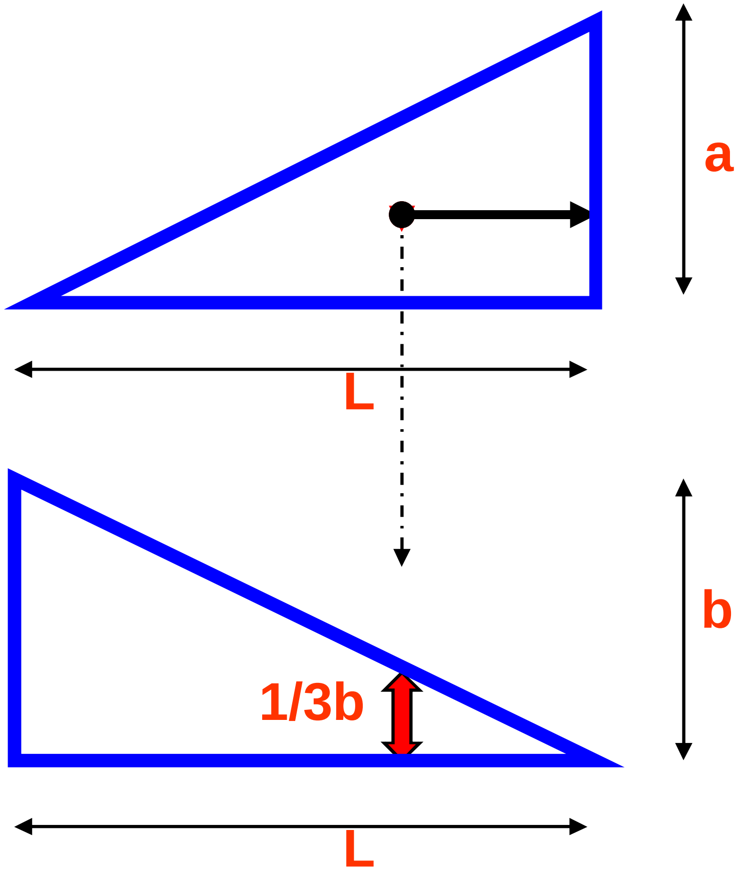


$$\int \frac{M_0 . M_1}{EI} . dl = (a.L/2) * 2/3b = a.b.L/3$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

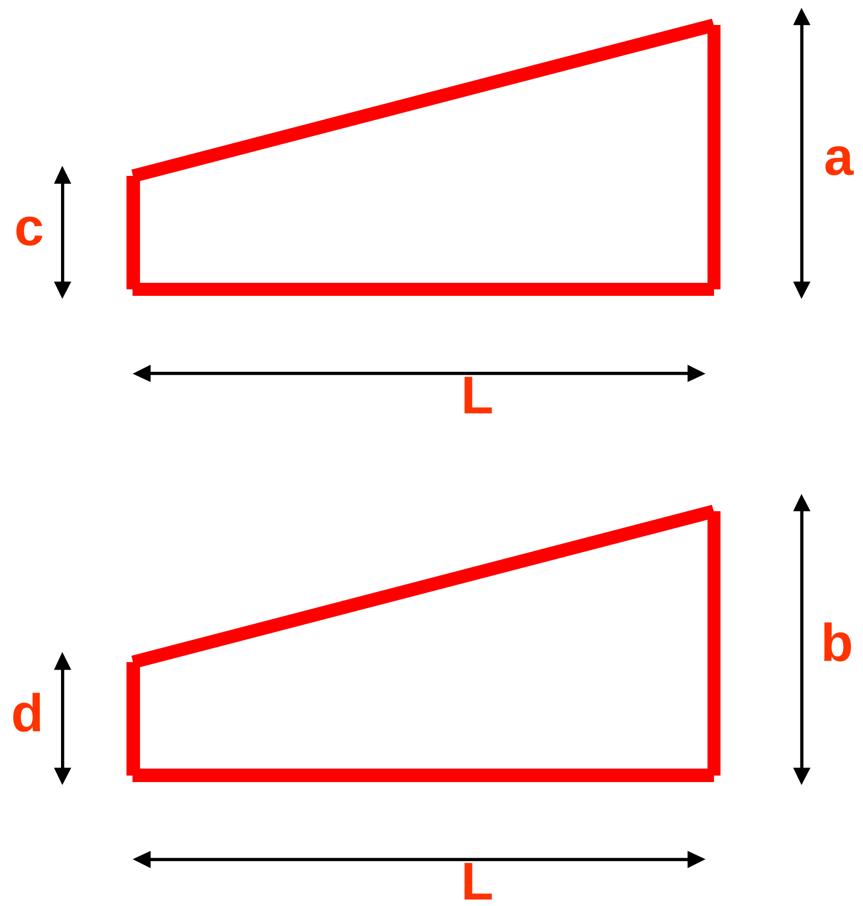
A=a.L/2

ç @ L/3



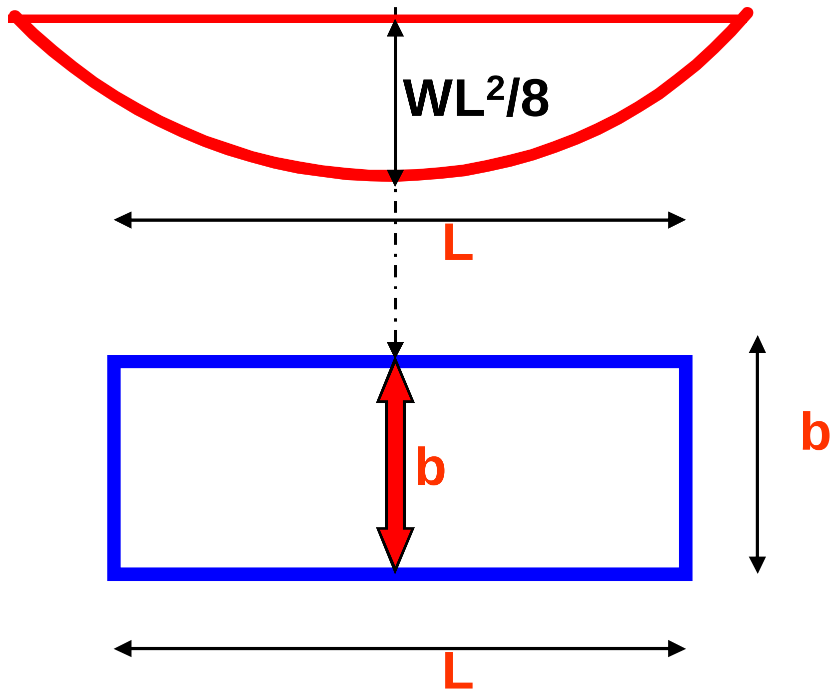
$$\int \frac{M_0 . M_1}{EI} . dl = (a.L/2) * 1/3b = a.b.L/6$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى



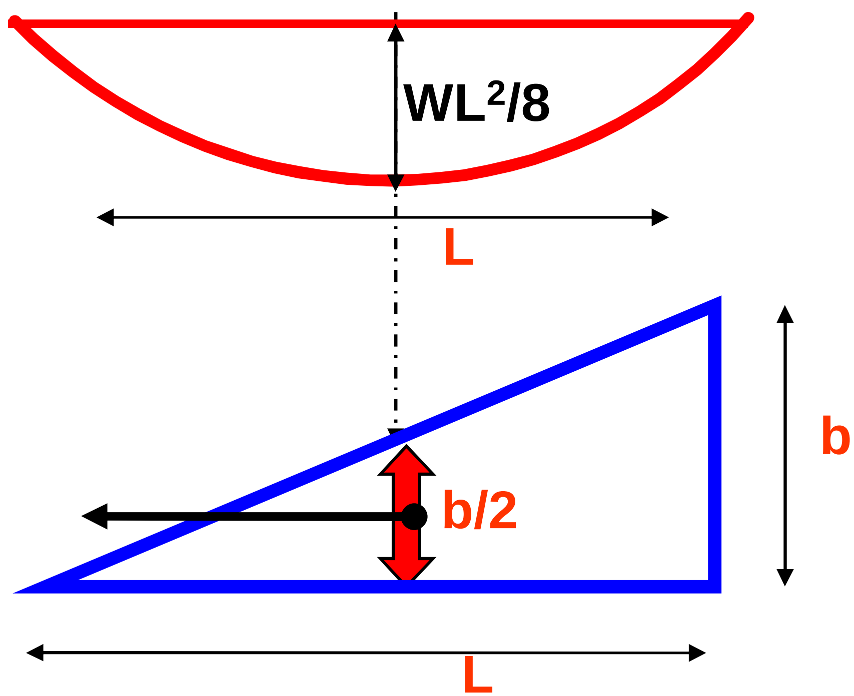
$$\int \frac{M_0 . M_1}{EI} . dl = (L/3)[ab+dc+0.5*(ad+bc)]$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى



$$\int \frac{M_0 . M_1}{EI} . dl = 2/3*wL^2*L/8*b = wL^3/12*b$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

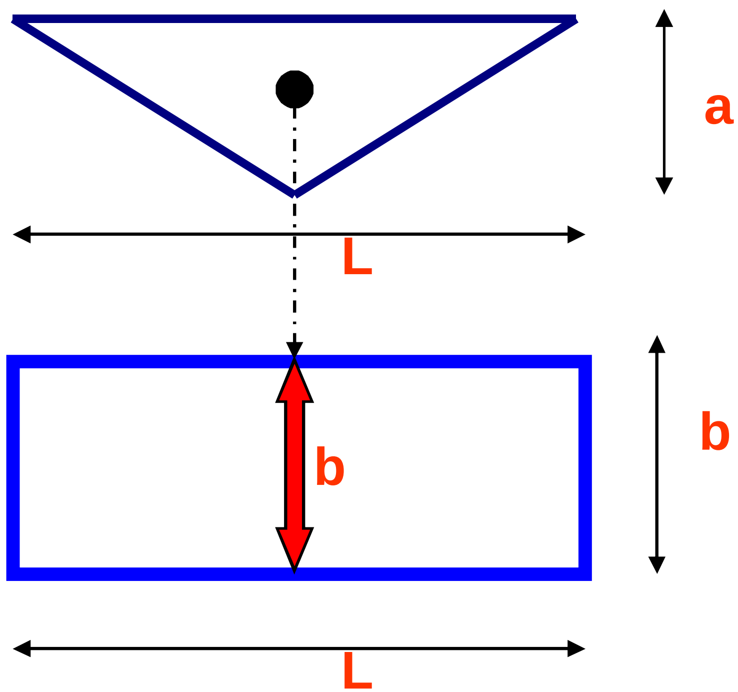


$$\int \frac{M_0 . M_1}{EI} . dl = 2/3*wL^2*L/8*b/2 = wL^3/24*b$$

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى

A=a.L/2

ç @ L/2

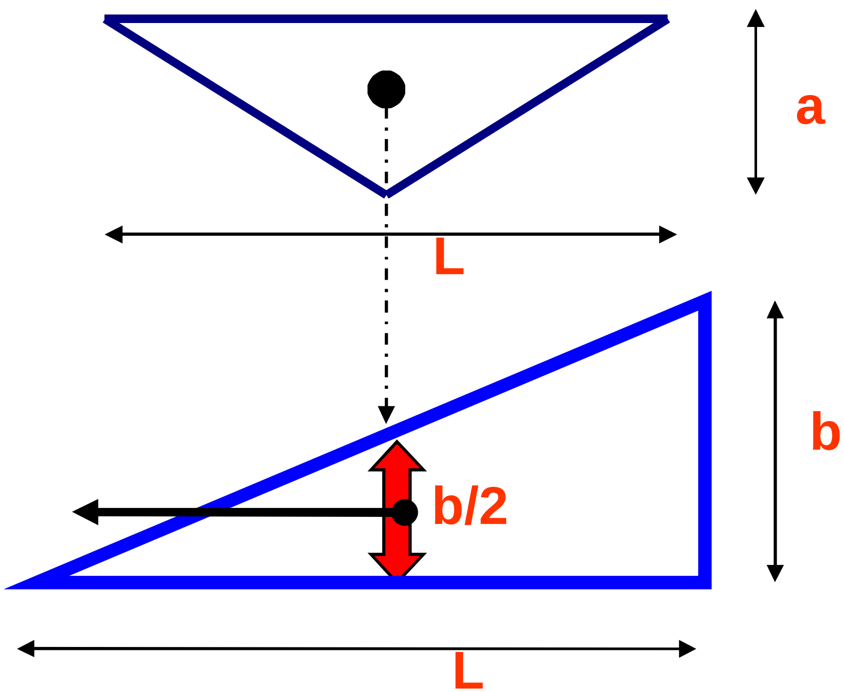


$$\int \frac{M_0 . M_1}{EI} . dl =$$ **(a.L/2)* b =a.b.L/2**

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع
المقابل لمركز هذه المساحه على الشكل الثانى

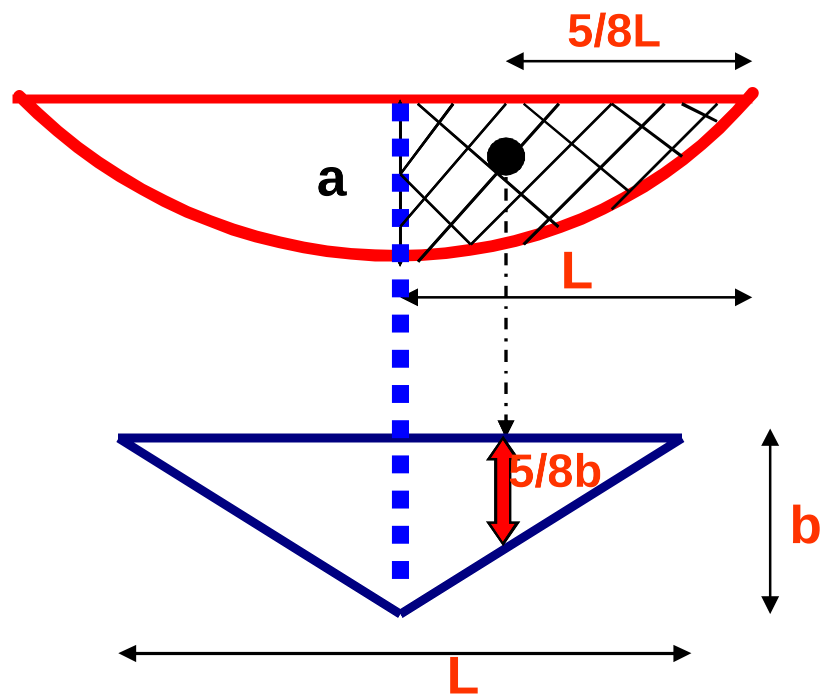
A=a.L/2

ç @ L/2



$$\int \frac{M_0 . M_1}{EI} . dl =$$ **(a.L/2)*b/2 =a.b.L/4**

تكامل المساحتين هو عباره عن مساحة احدهم * الارتفاع المقابل لمركز هذه المساحه على الشكل الثانى



A=2/3.a.L

Ç @ 5/8L

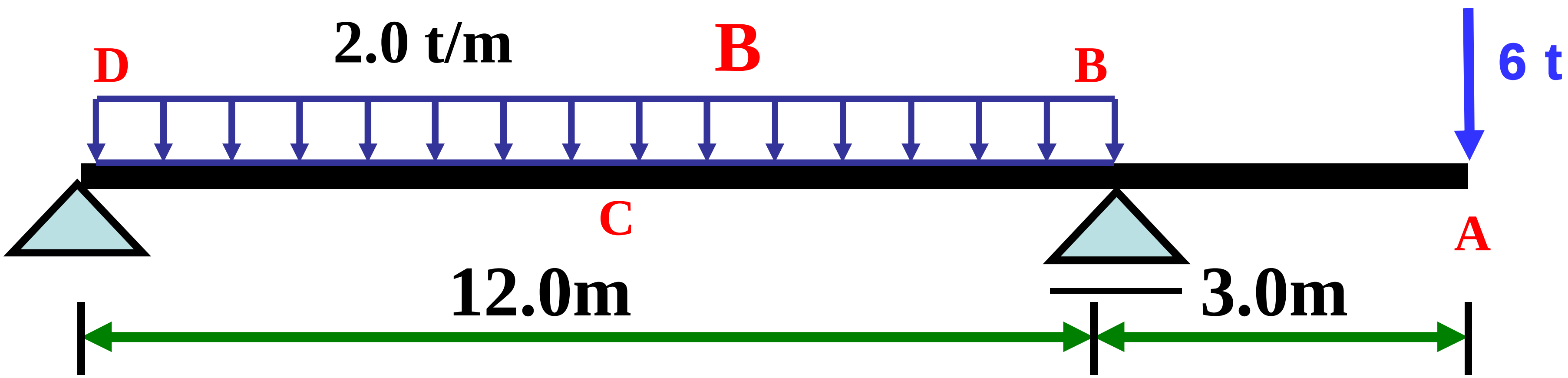
$$\int \frac{M_0 . M_1}{EI} . dl = 2*[(2/3.a.L)*5/8b]$$

بســـــم اللـــــــه الرحمـــن الرحيـــم

VERTUAL WORK FOR BEAMS

Eng : Ayman abdo

Problem 1



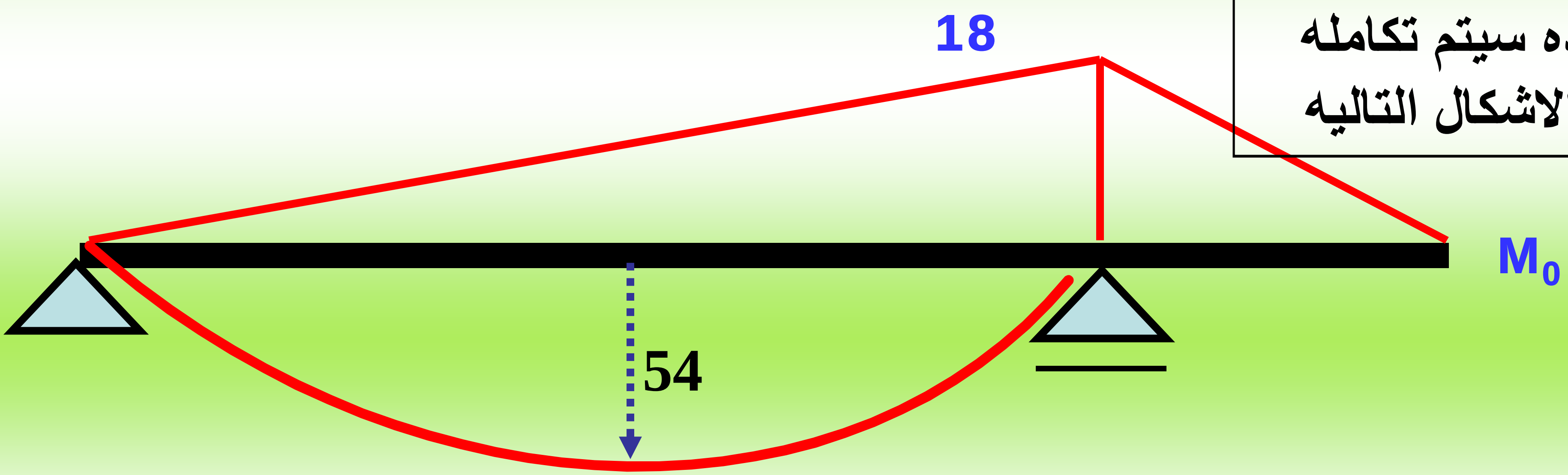
Required (1) the deflection at a, c.

(2) The rotation at point a, b, c, d.

And also draw elastic curve

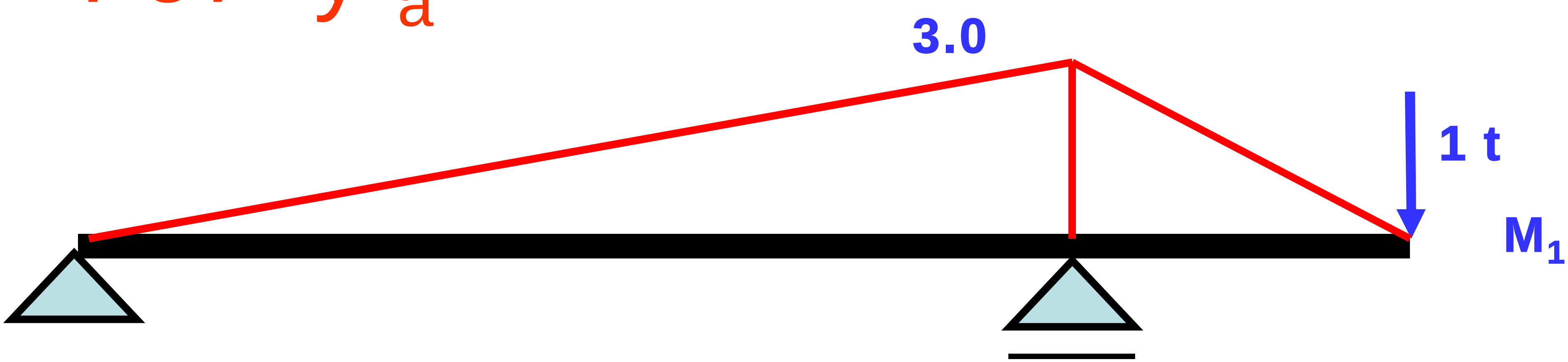
$EI = 8000\ t.m^2$

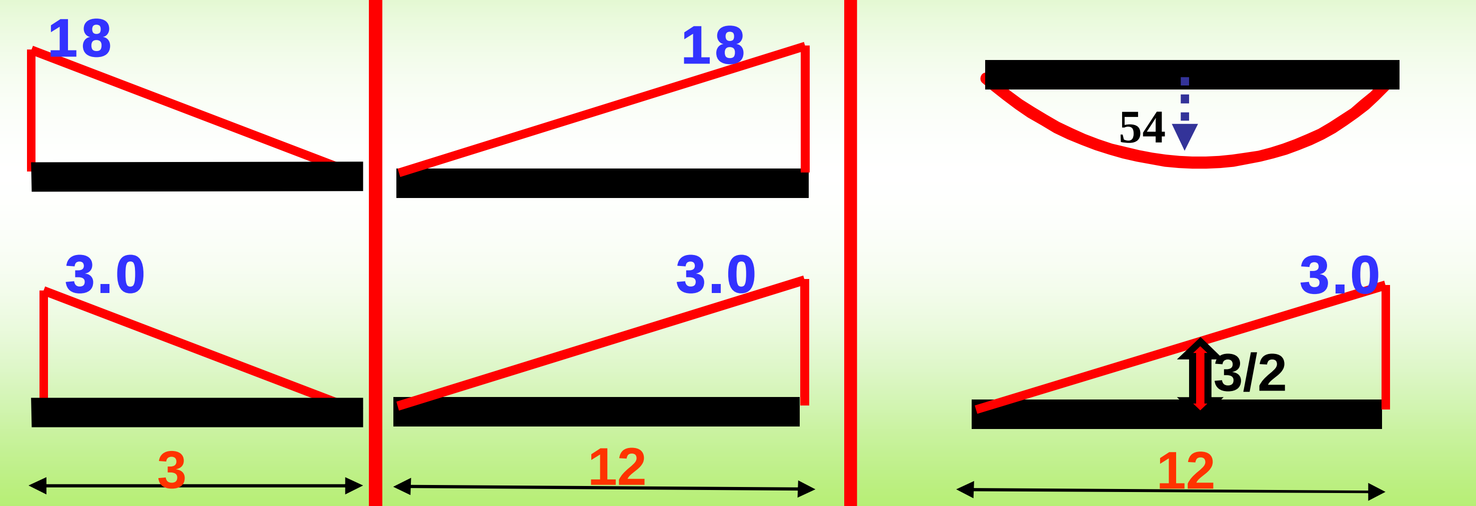
1-Draw B.M.d



الشكل ده سيتم تكامله
مع كل الاشكال التاليه

2- For y_a



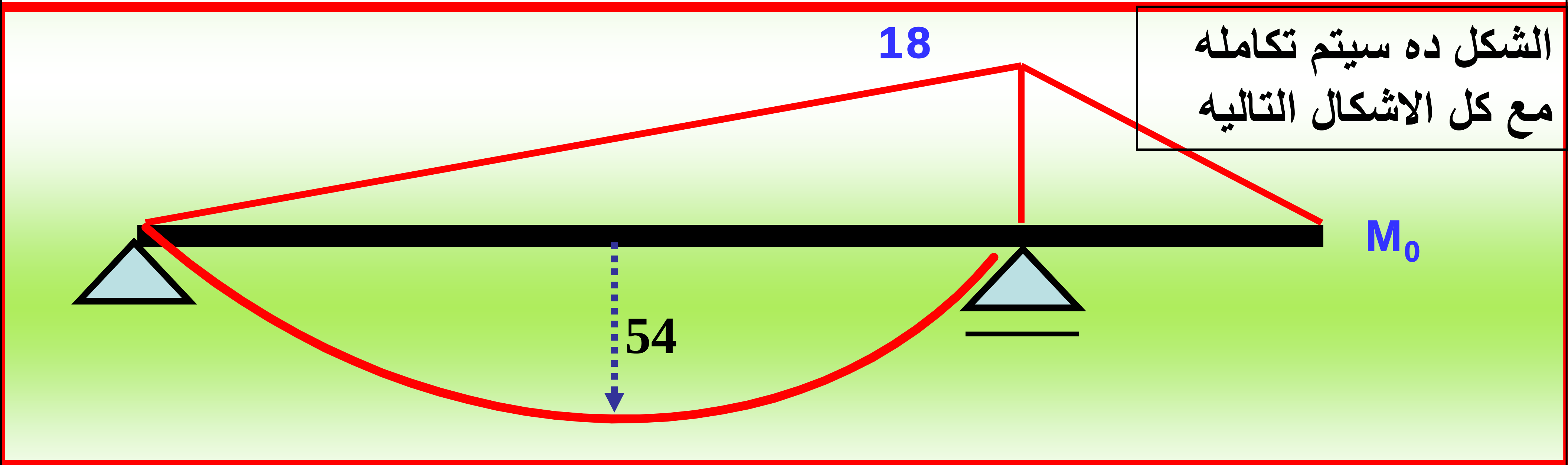


$$y_a = \int \frac{M_0 . M_1}{EI} . dl = \frac{1}{8000}\left[\frac{18*3*3}{3} + \frac{18*3*12}{3} - \left(\frac{2}{3}*54*12*1/2*3\right)\right]$$

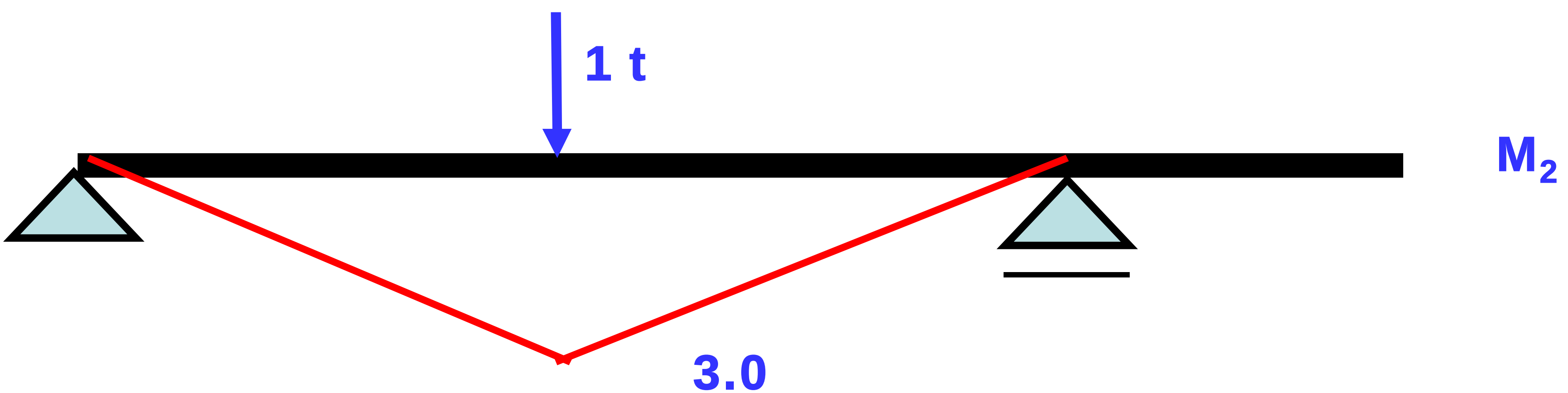
$$= -0.04725\ m$$

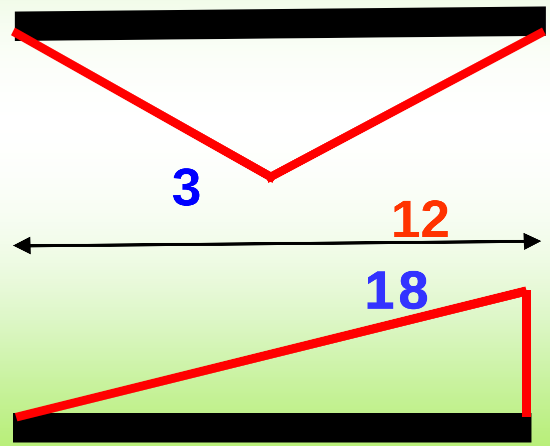
عندما فرضنا الـ (y_a) فرضناها لاسفل ومن الحسابات
سالبه معناها ان الحركه عكس الاتجاه.

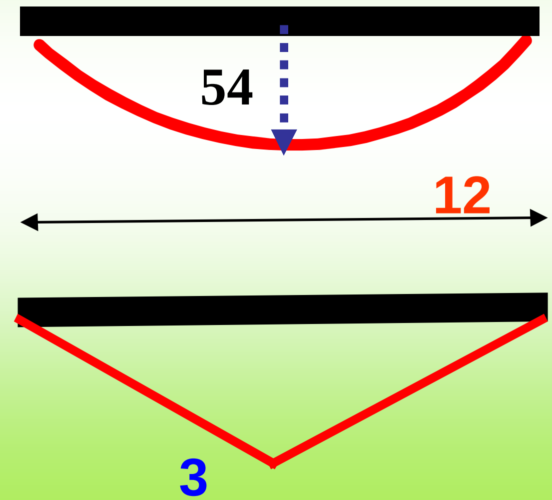
1-Draw B.M.d



2- For y_c



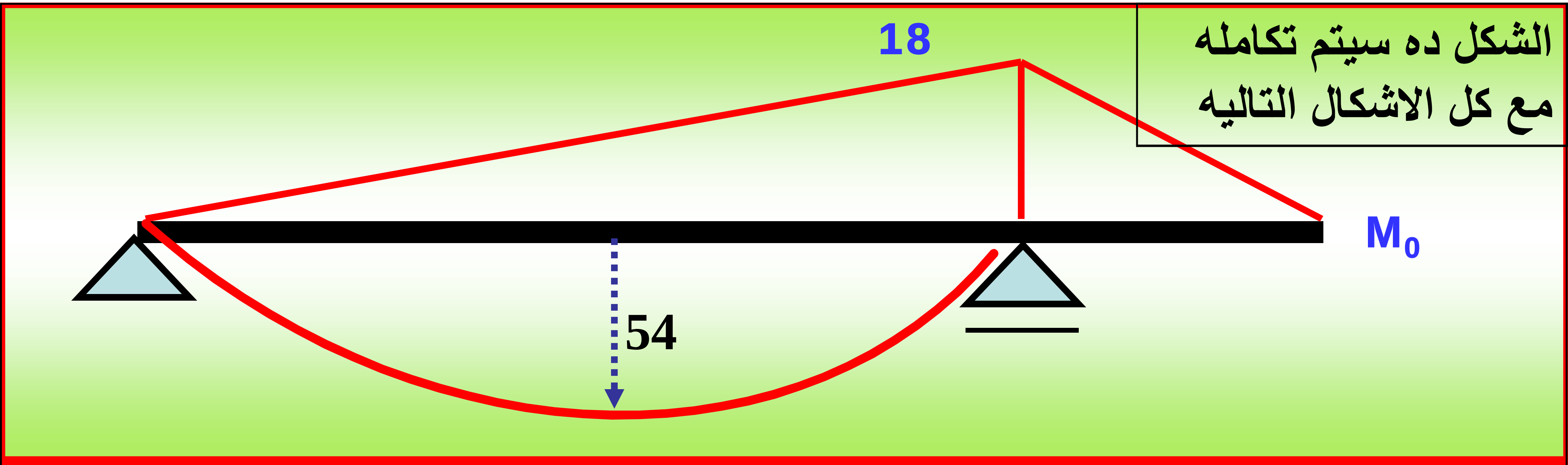




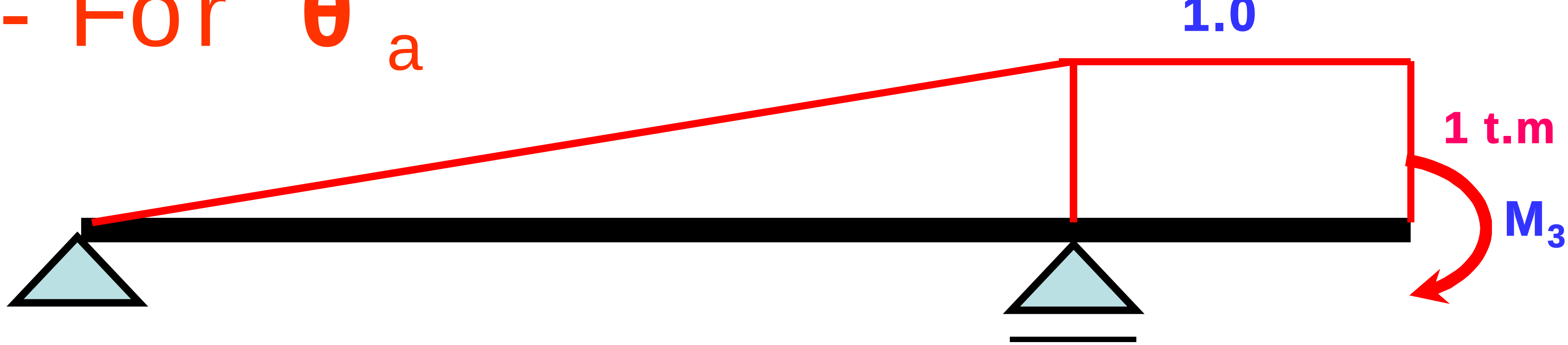
$$y_c = \int \frac{M_0 . M_1}{EI} . dl = \frac{1}{8000}\left[-1/2*3*12*9 + 2*\left(\frac{2}{3}*54*6*5/8*3\right)\right]$$

$$= 0.081\, m$$

عندما فرضنا الـ (y_c) فرضناها لاسفل ومن الحسابات
موجبه معناها ان الحركه بنفس الاتجاه.

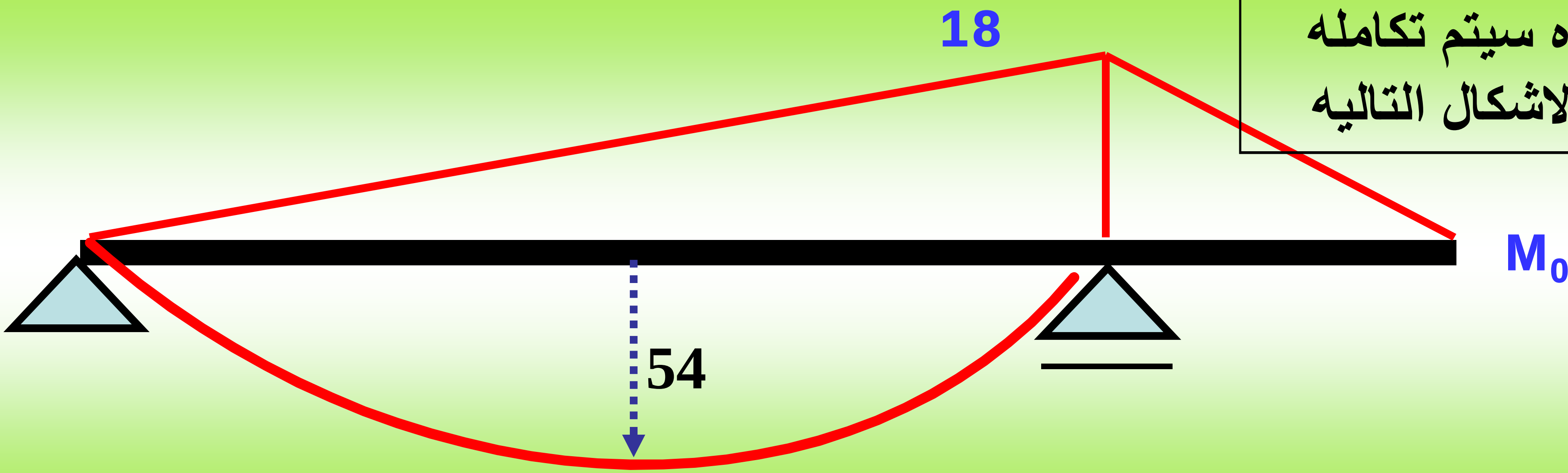


2- For θ a



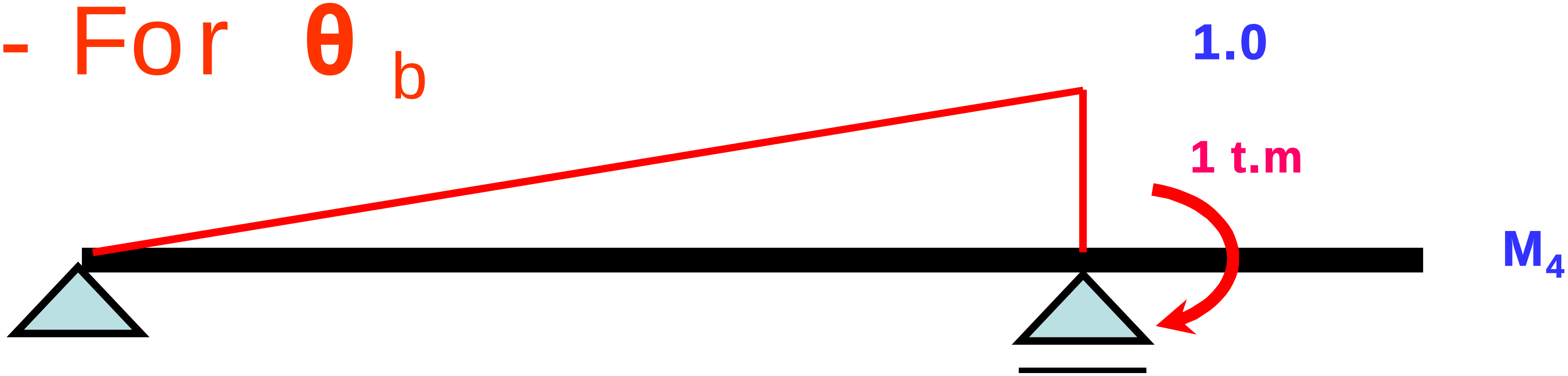
$$\theta_a = \int \frac{M_0 . M_1}{EI} . dl = \frac{1}{8000}\left[\frac{1*3*18}{2} + \frac{1*18*12}{3} - \frac{2}{3}*54*12*0.5\right]$$

$$= -0.0146\ rad$$



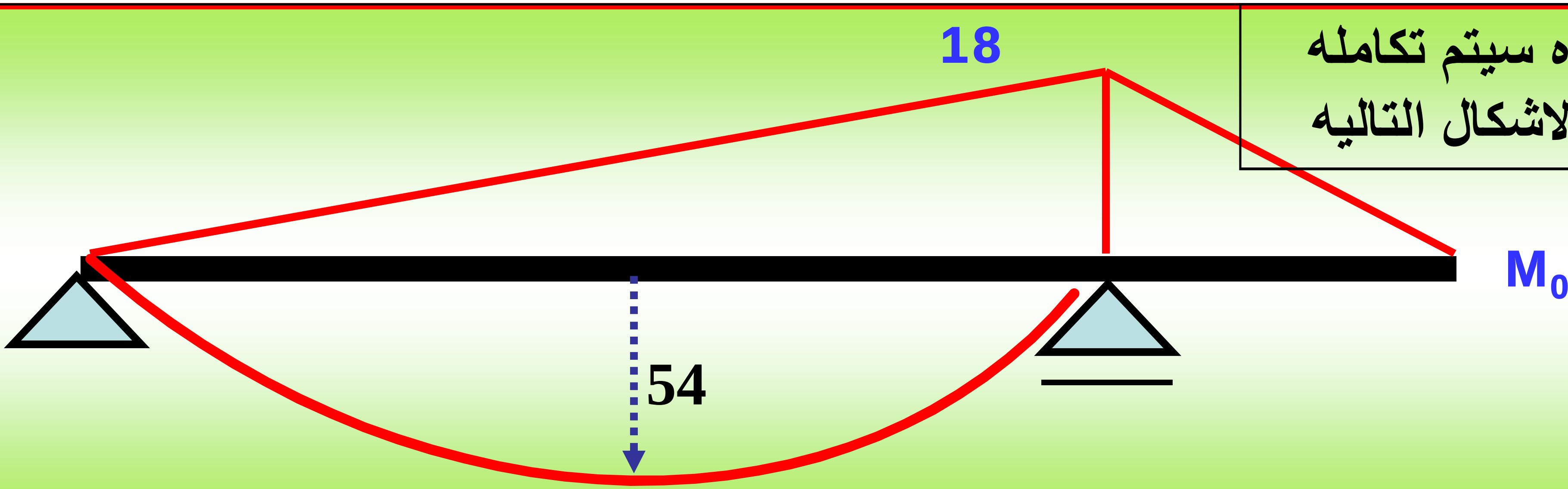
الشكل ده سيتم تكامله
مع كل الاشكال التاليه

2- For θ b

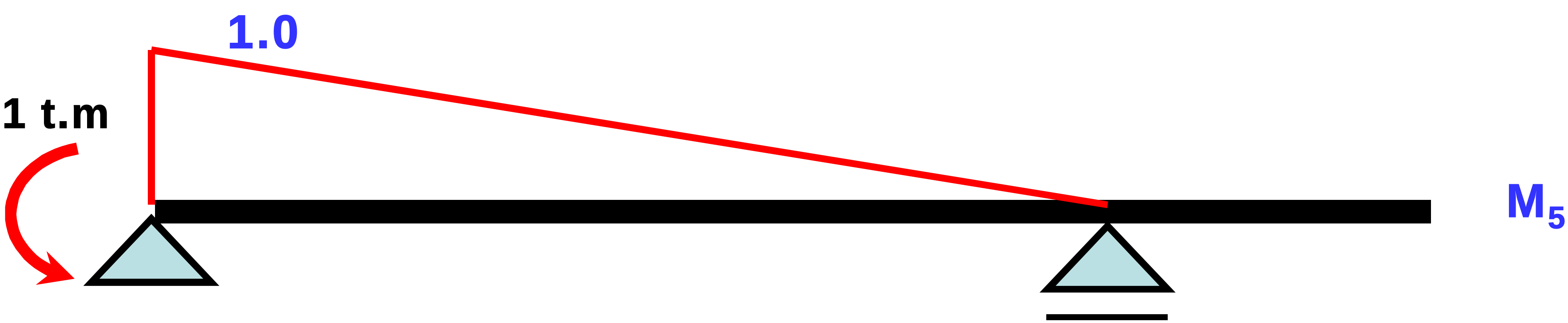


$$\theta_a = \int \frac{M_0 . M_1}{EI} . dl = \frac{1}{8000}\left[\frac{1*18*12}{3} - \frac{2}{3}*54*12*0.5 \right]$$

$$= -0.018\ rad$$

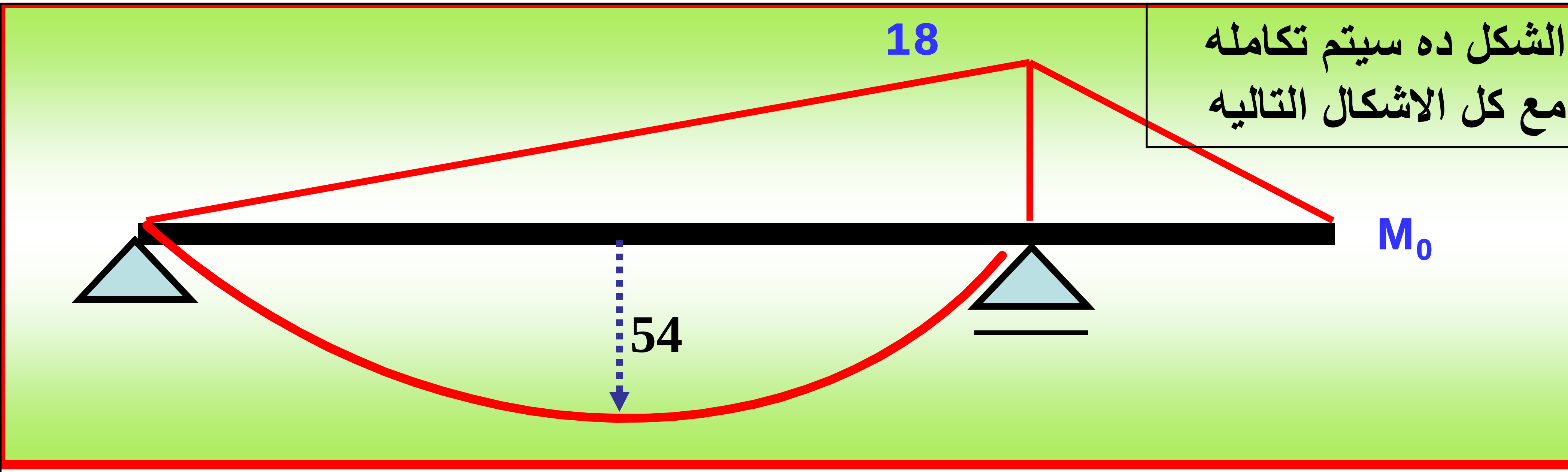


2- For θ_d

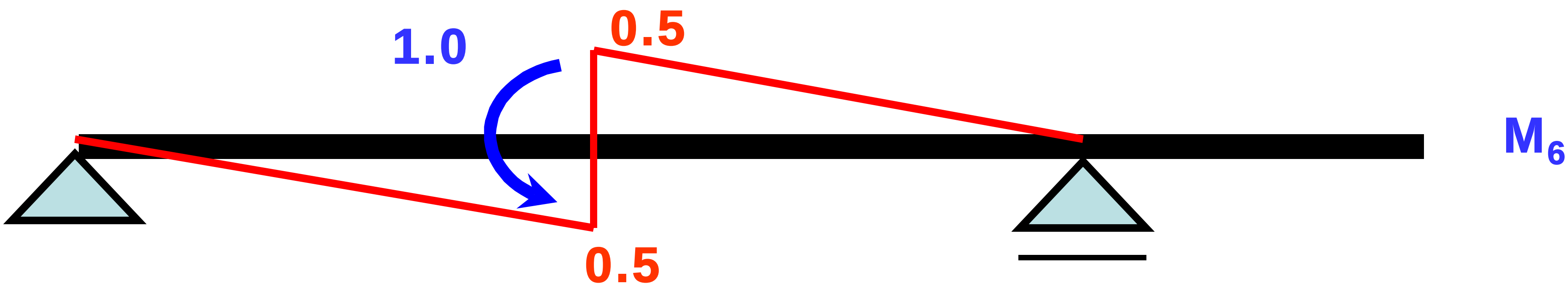


$$\theta_a = \int \frac{M_0 . M_1}{EI} . dl = \frac{1}{8000}\left[\frac{1*18*12}{6} - \frac{2}{3}*54*12*0.5\right]$$

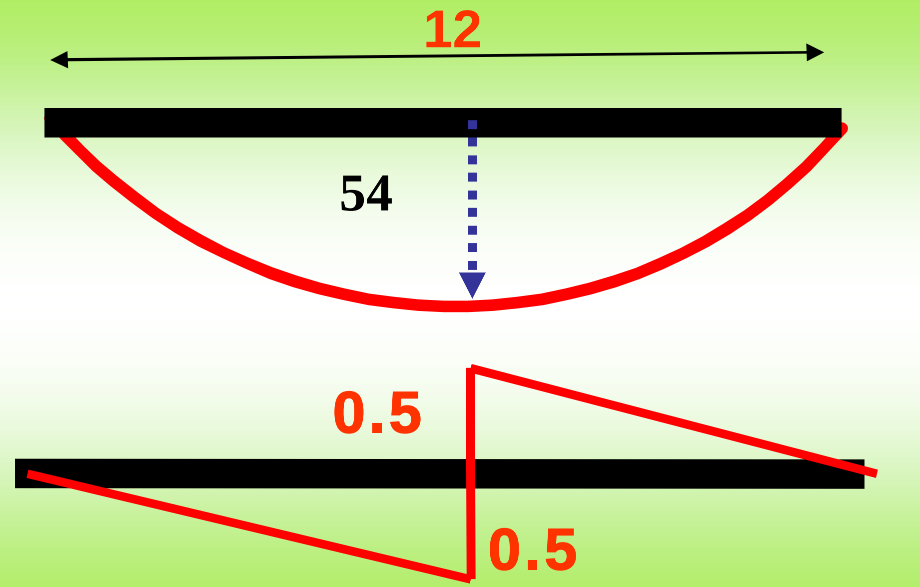
$$= -0.0225\ rad$$

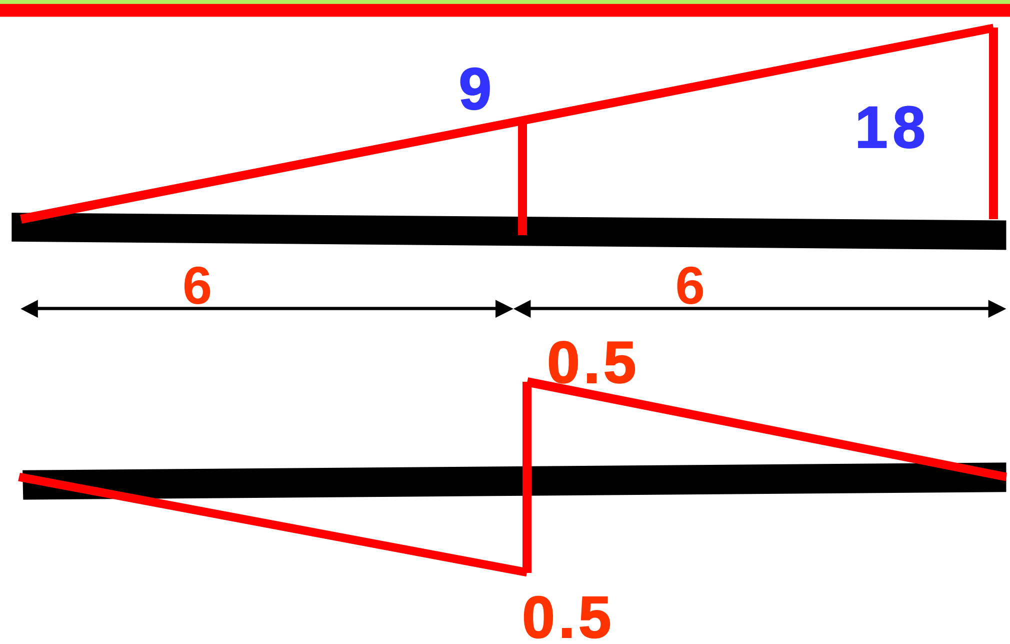


2- For θ c



تكامل الشكلين يعطى صفر لان النصف الشمال
يعطى اشاره موجب والجزء اليمين يعطى اشاره
سالب بنفس القيمه وبالتالى المحصله صفر

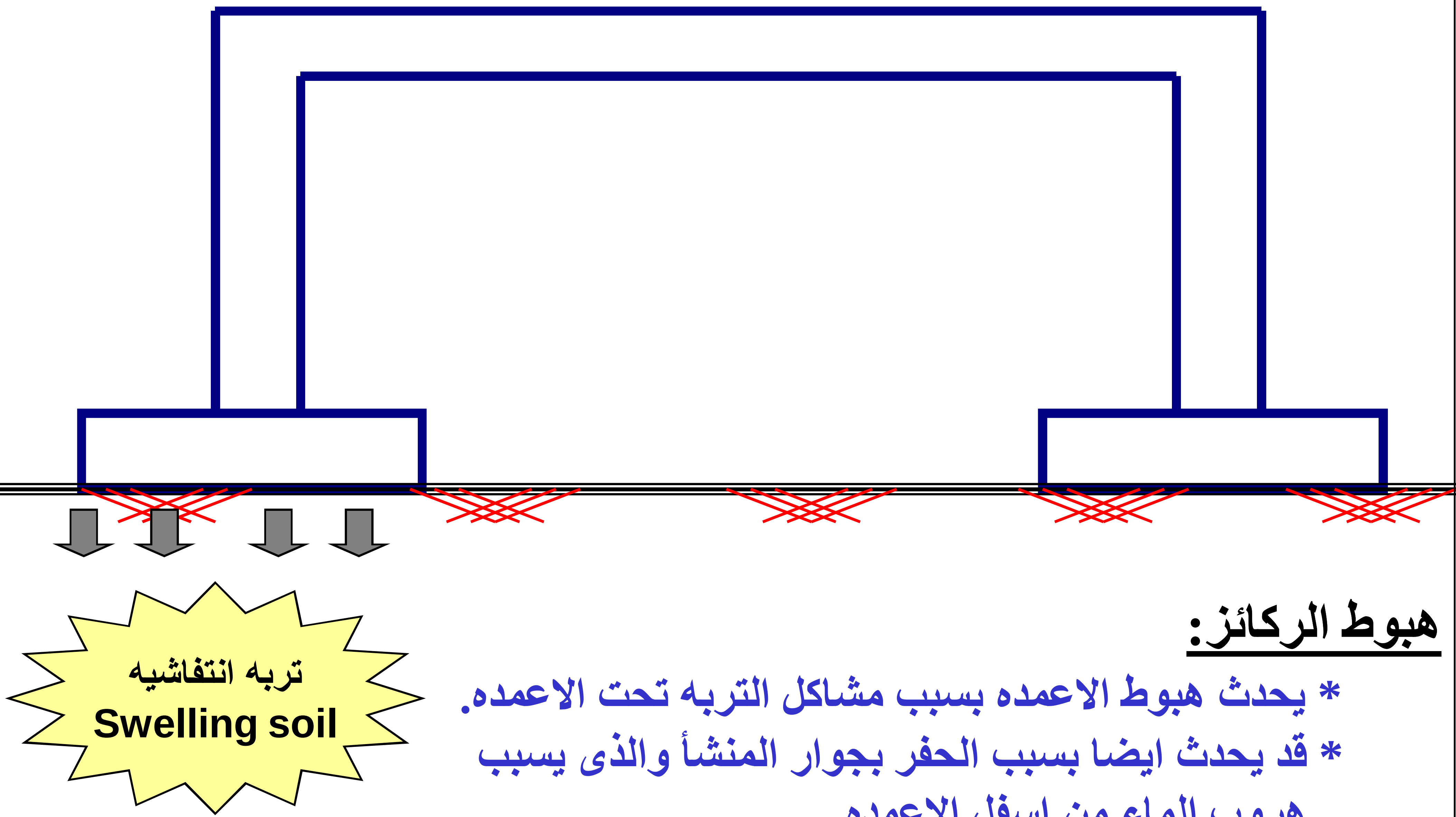




$$\theta_c = \frac{1}{8000}\left[\frac{0.5*9*6}{3} - \frac{6}{3}*\left(0.5*9+0+0.5*(0.5*18)\right)\right]$$

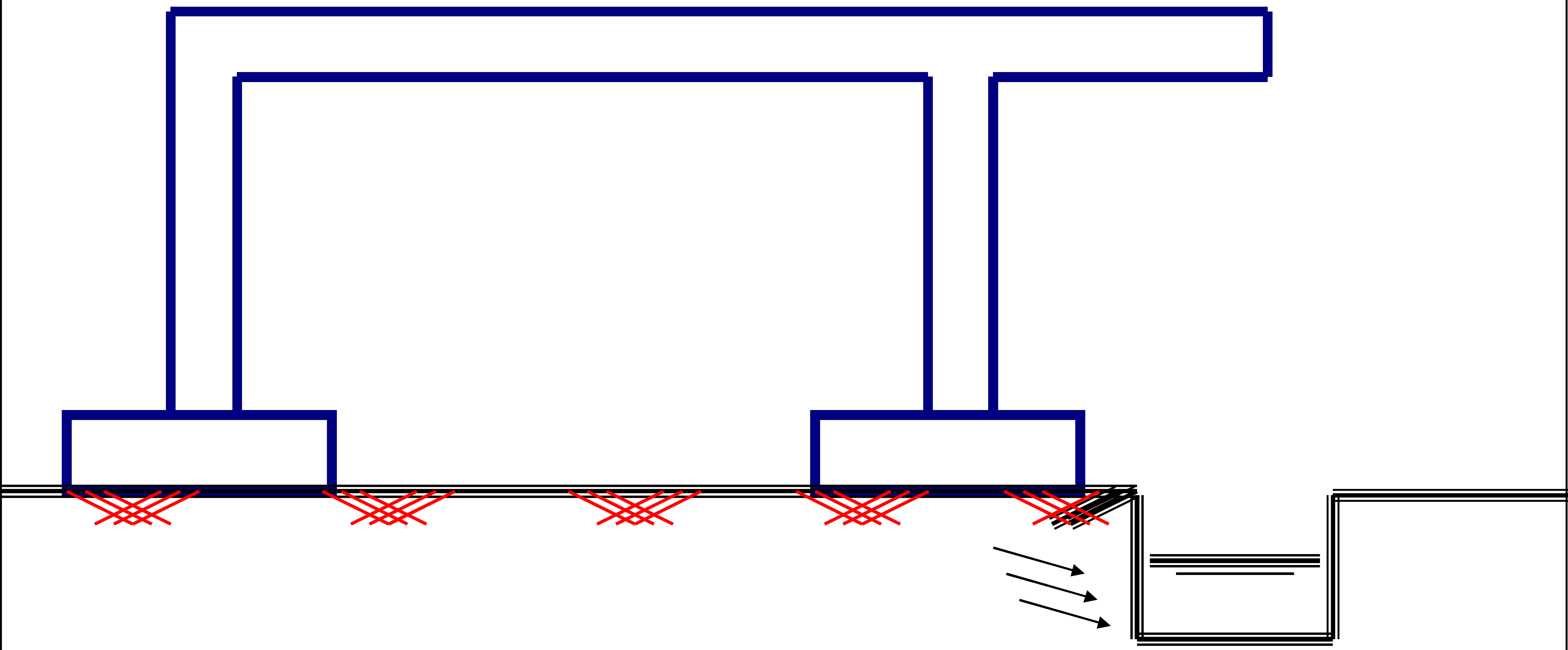
$$= -0.001125\ rad$$

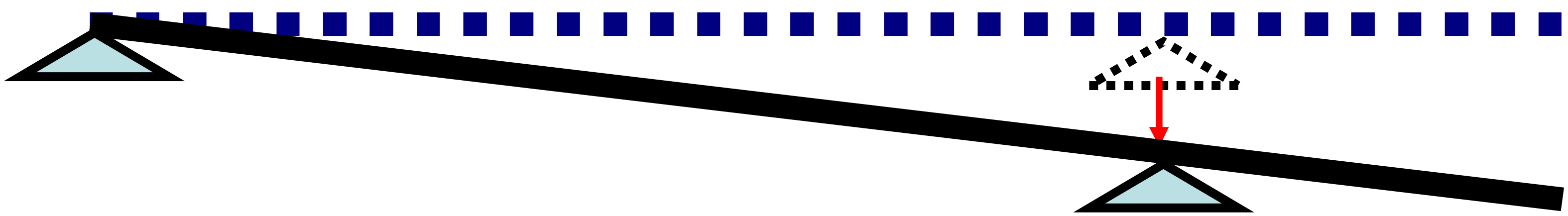
CASE OF SETTELMENT الـهبـوط



هبوط الركائز:

* يحدث هبوط الاعمده بسبب مشاكل التربه تحت الاعمده.
* قد يحدث ايضا بسبب الحفر بجوار المنشأ والذى يسبب هروب الماء من اسفل الاعمده.



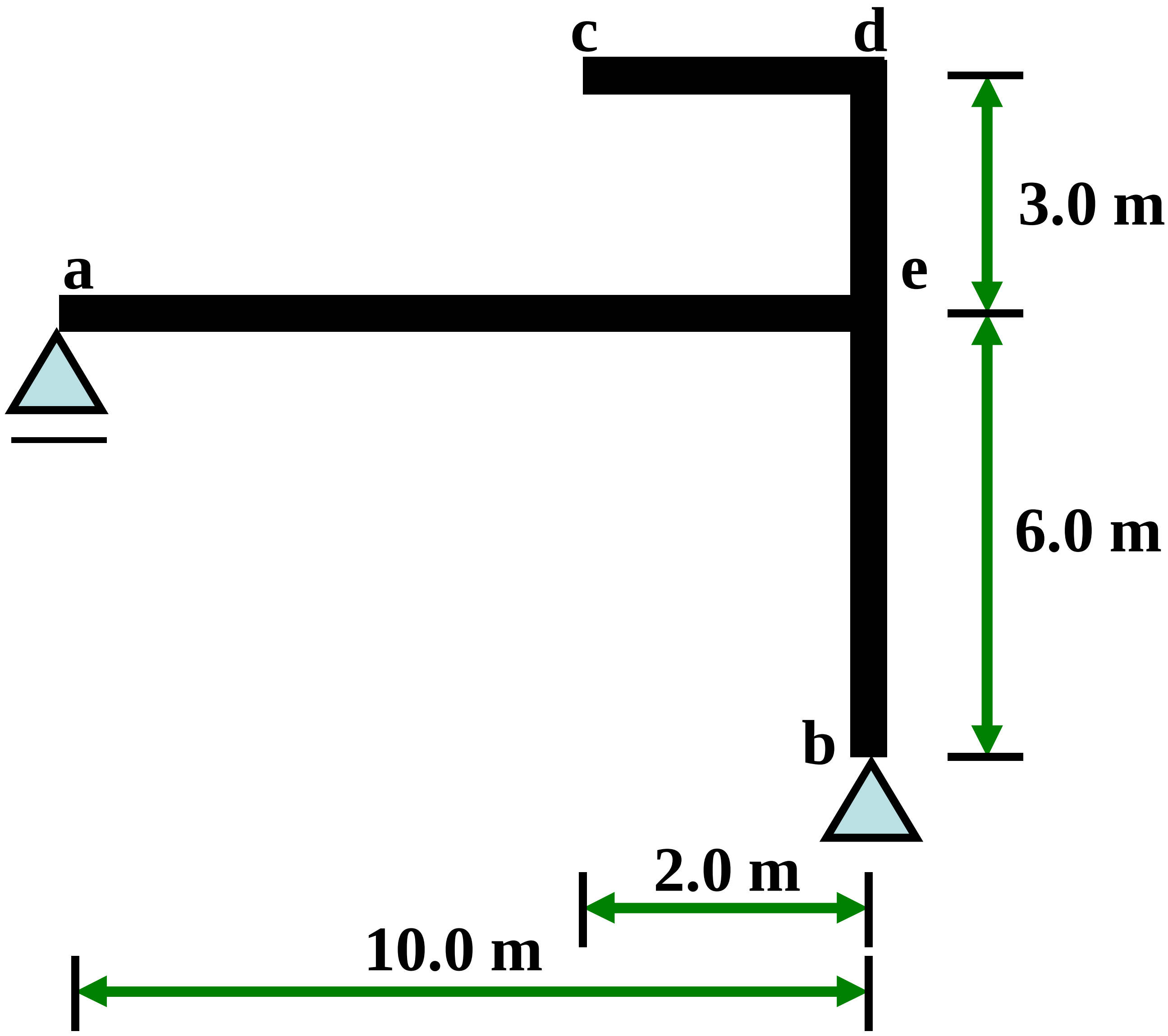


طريقة الحل

1- يتم ازالة كل الاحمال من الكمرة.
2- يتم وضع 1ton عند النقطة المطلوب حساب الهبوط عندها.
3- يتم حساب الـ reaction الناتج عن الـ 1ton.

$$\sum (F * y + M * \theta) = 0.0$$

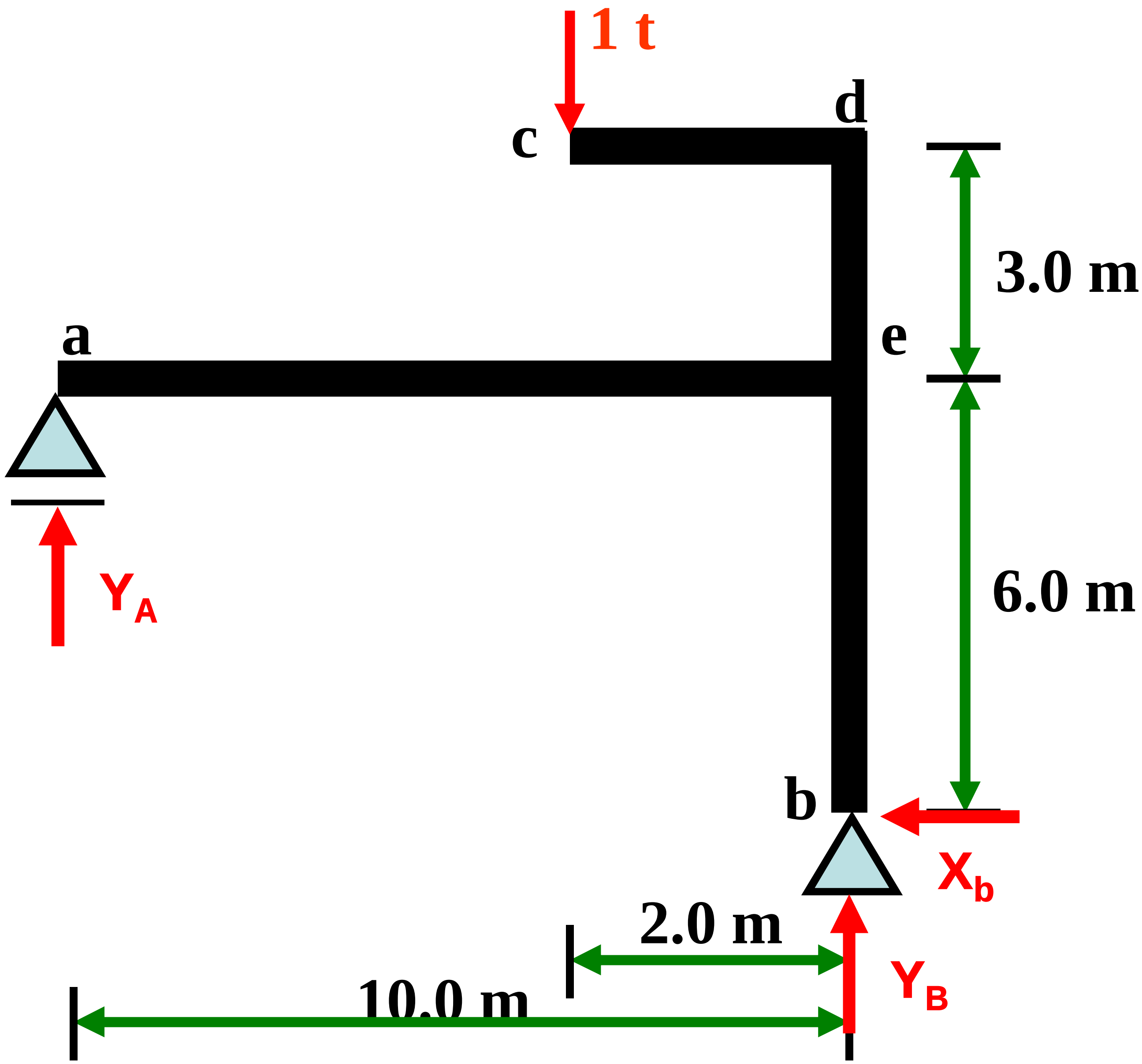
Example two



Required : Δ_{vc} and Δ_{hd} and θ_a **due to settlement at b = 2cm.**

For Δ_{vc}

المطلوب هو الازاحة
الرأسيه عند النقطه c



$\sum F_X = 0.0$

$X_b = 0.0$

$\sum M_A = 0.0$

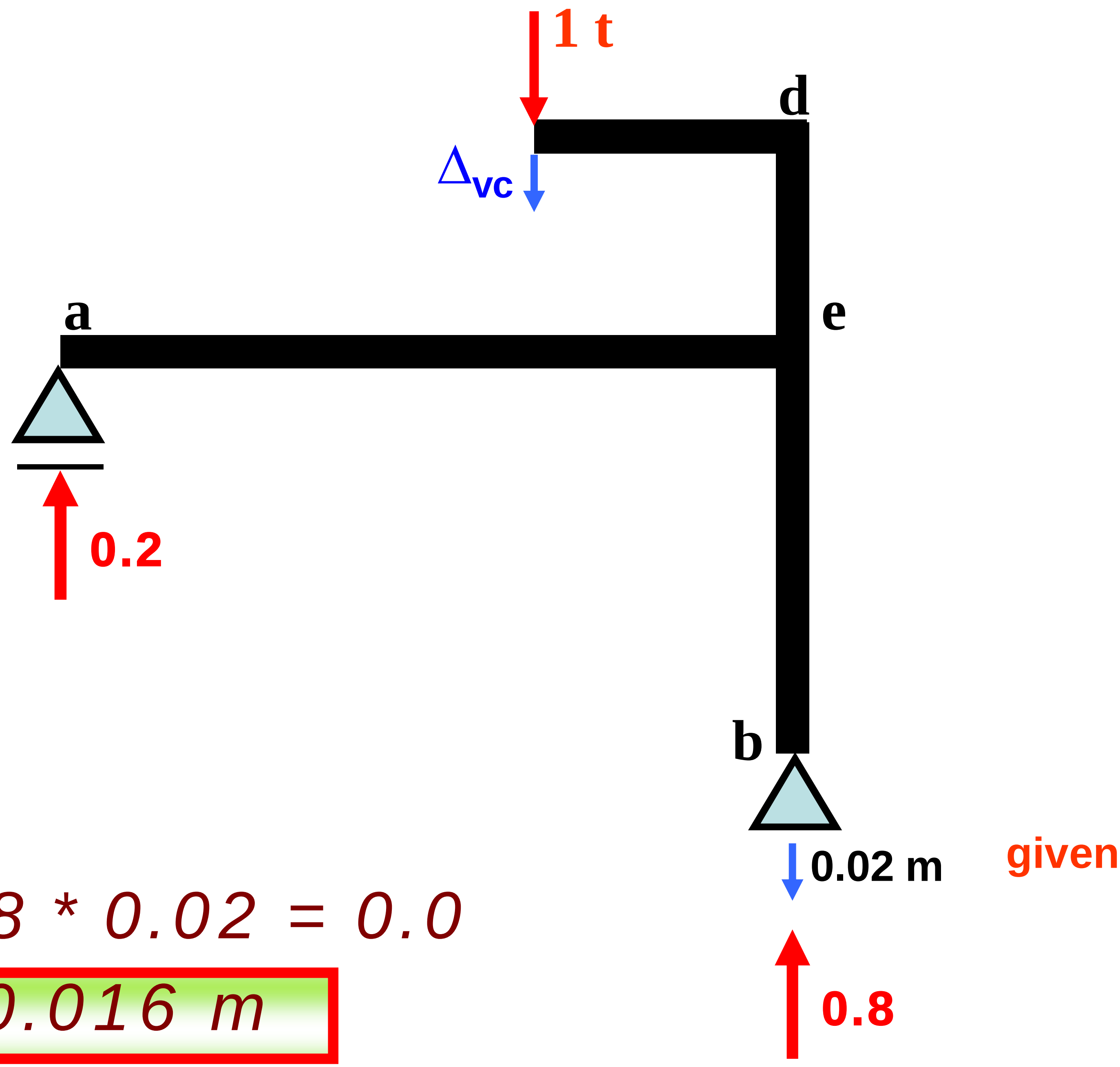
$Y_B * 10 = 1 * 8$

$Y_B = 0.8$

$\sum F_Y = 0.0$

$Y_A + 0.8 = 1$

$Y_A = 0.2$



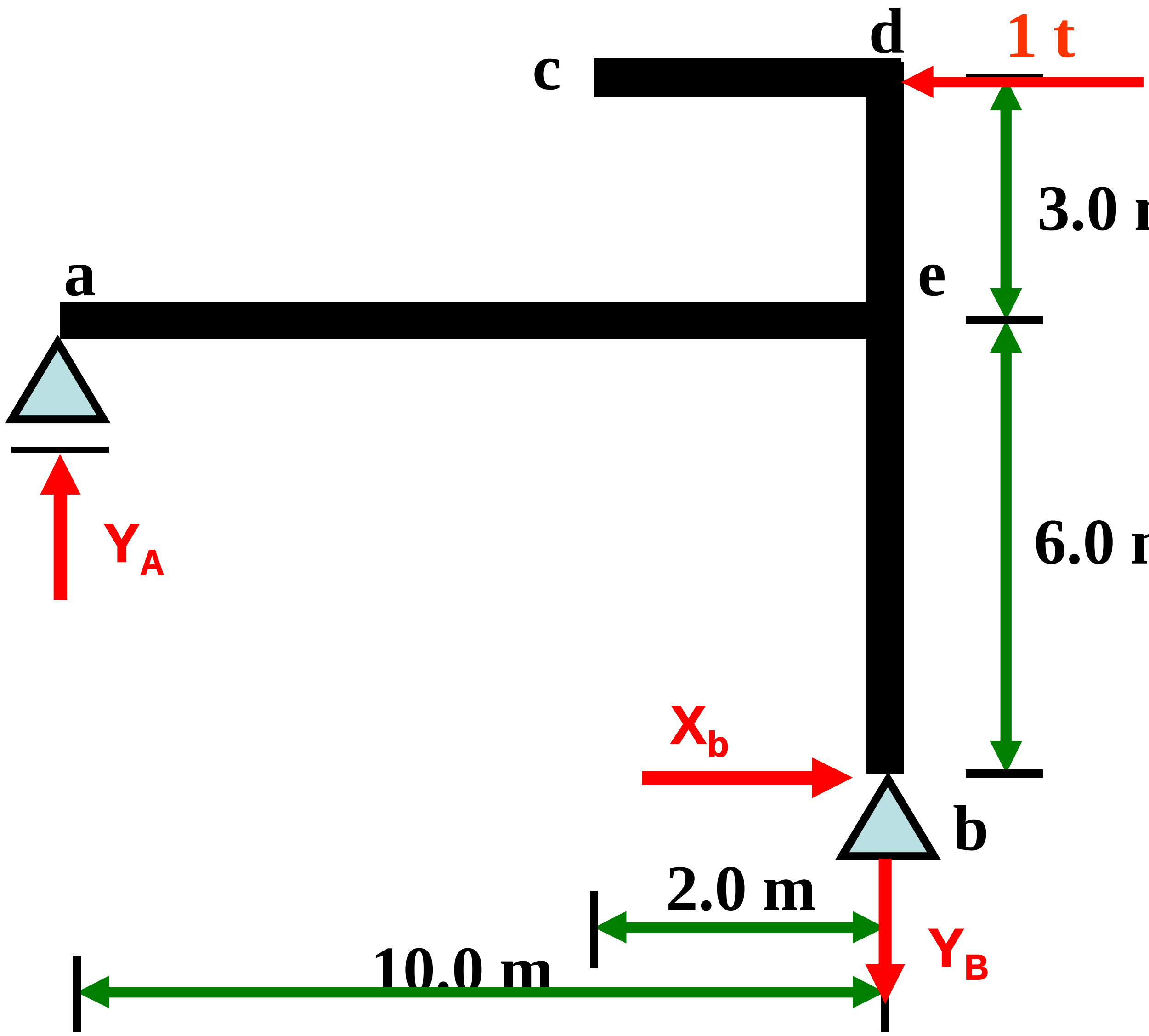
القوه عكس الازاحه

$$1 * \Delta vc - 0.8 * 0.02 = 0.0$$

$$>> \Delta vc = 0.016\ m$$

For Δ_{hd}

المطلوب هو الازاحة
الافقيه عند النقطه d



$\sum \mathbf{F}_X = 0.0$

$X_b = 1.0$

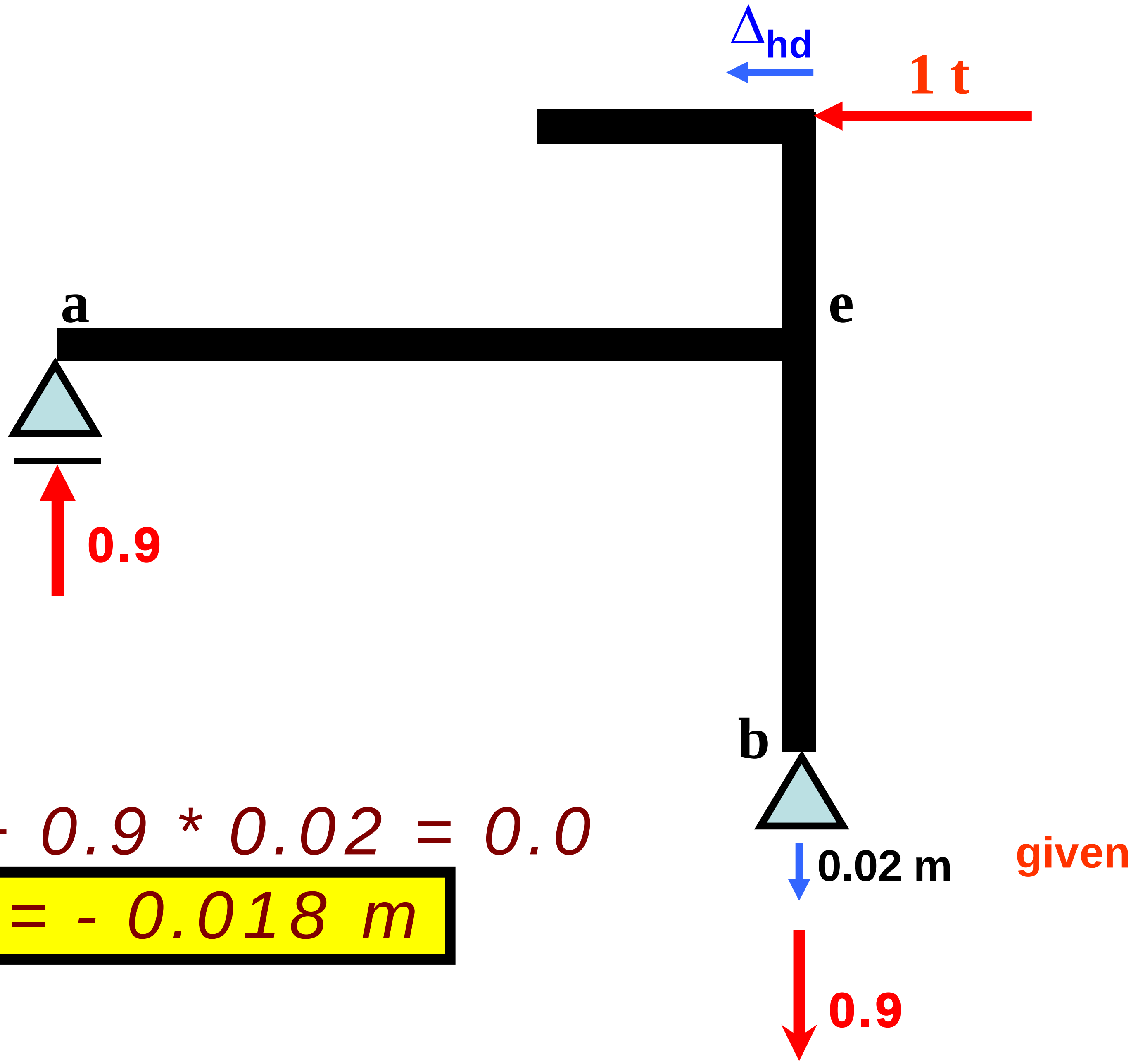
$\sum \mathbf{M}_A = 0.0$

$Y_B * 10 = 1 * 3 + 1 * 6$

$Y_B = 0.9$

$\sum \mathbf{F}_Y = 0.0$

$Y_A = 0.9$

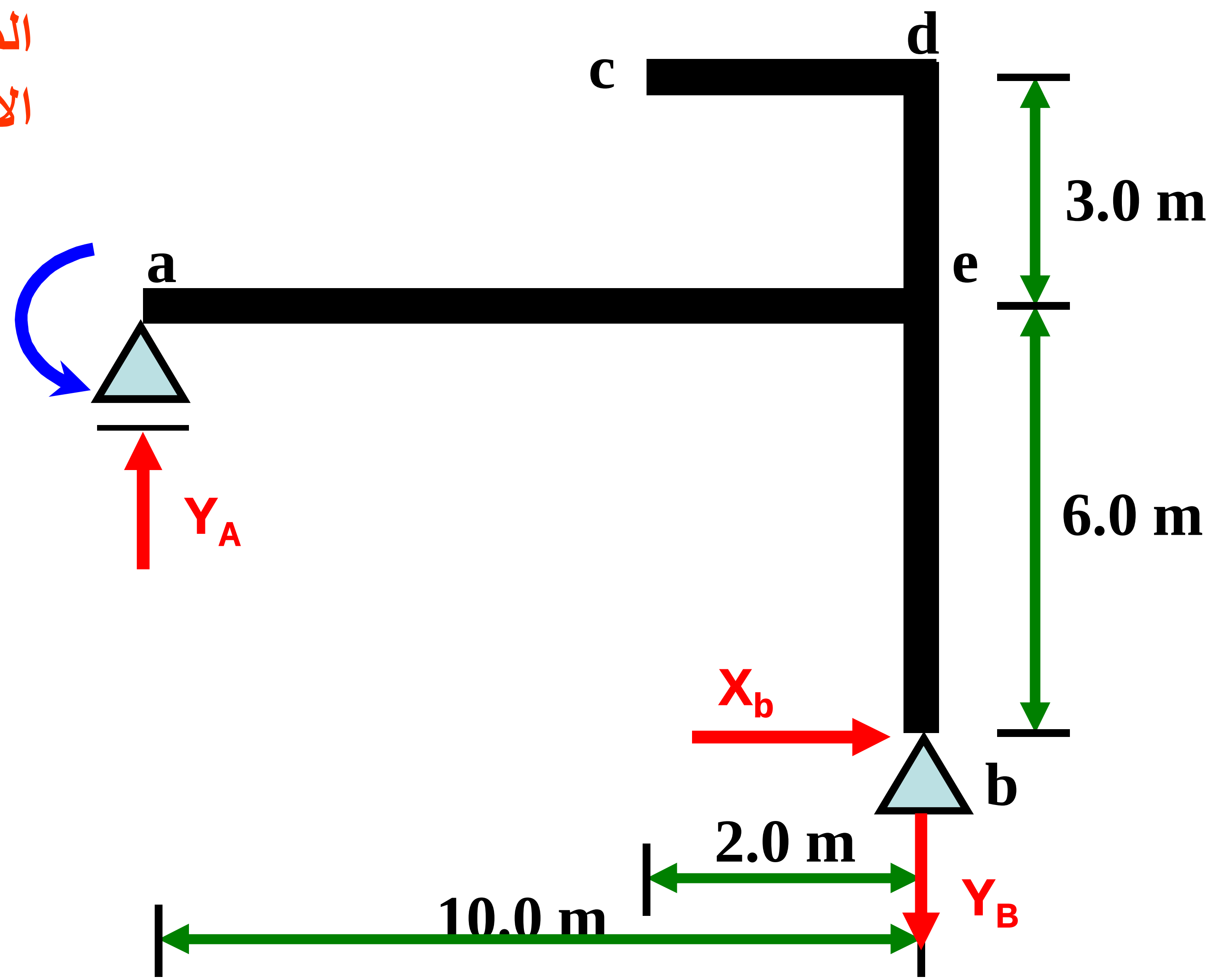


$$1 * \Delta hd + 0.9 * 0.02 = 0.0$$

>> $\Delta hd = -0.018$ m

For θ_a

المطلوب هو الازاحة
الافقيه عند النقطه d



$$\sum \mathbf{F}_X = 0.0$$

$$X_b = 0.0$$

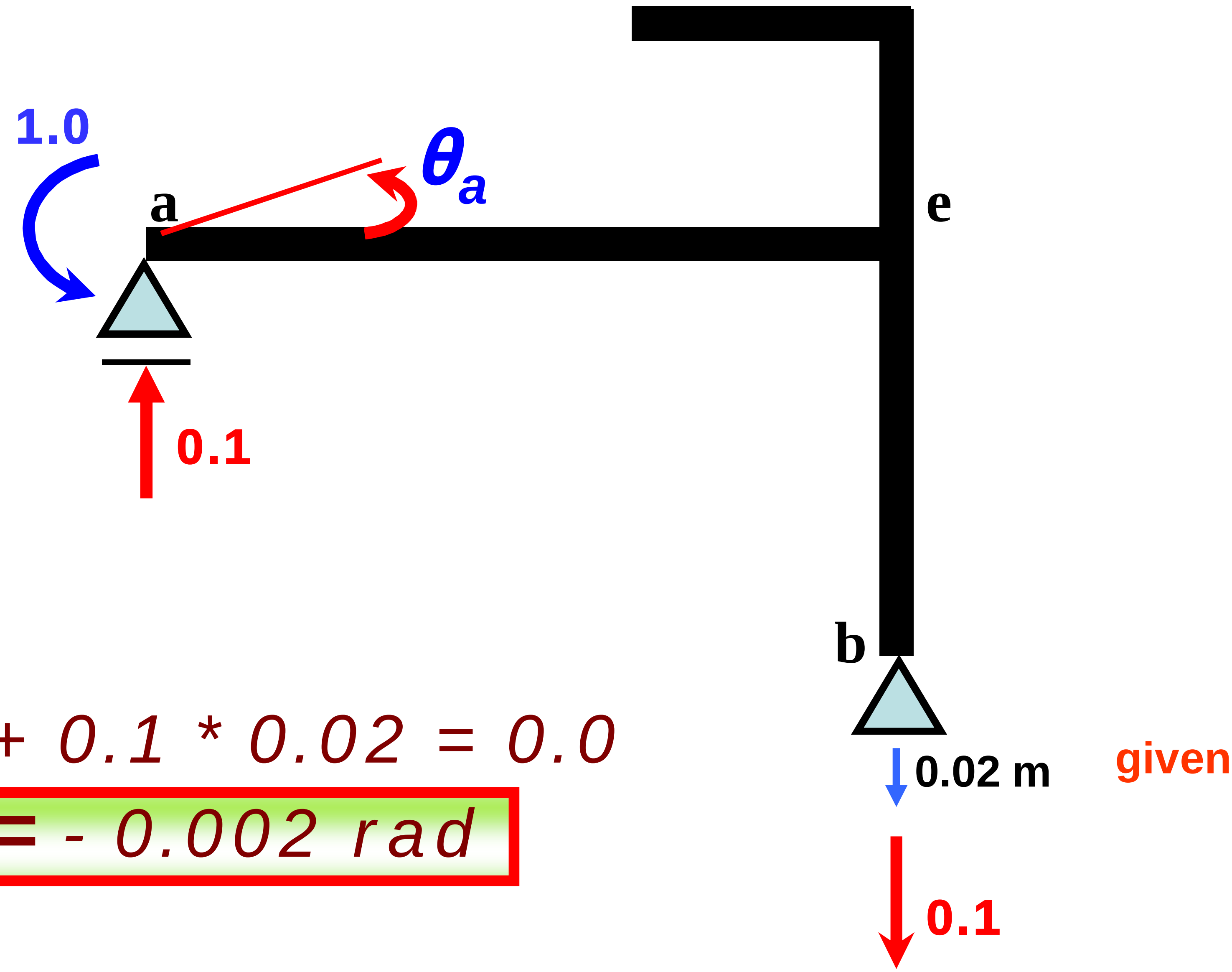
$$\sum \mathbf{M}_A = 0.0$$

$$Y_B * 10 = 1$$

$$Y_B = 0.1$$

$$\sum \mathbf{F}_Y = 0.0$$

$$Y_A = 0.1$$



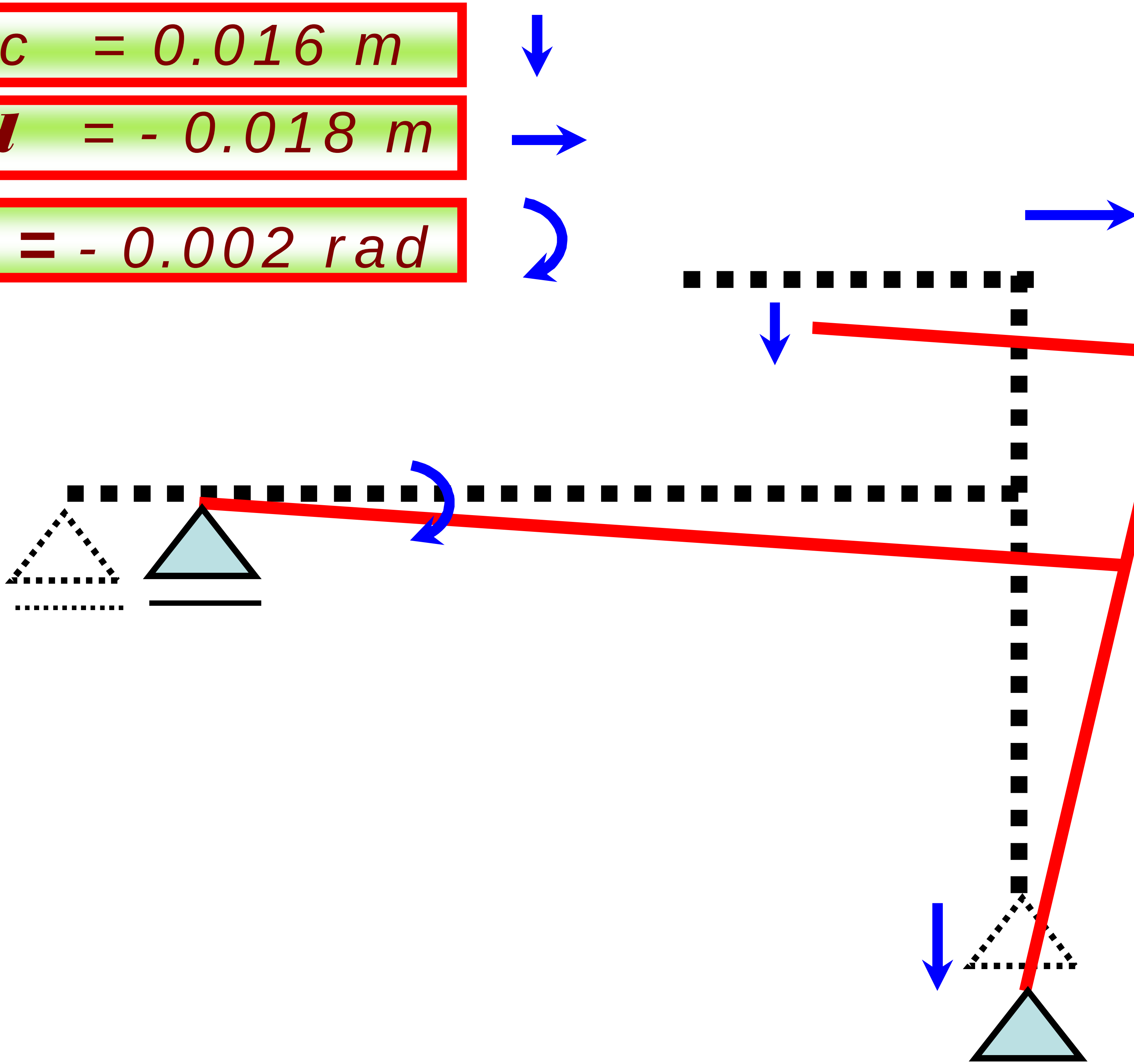
$$1 * \theta_a + 0.1 * 0.02 = 0.0$$

>> θa = - 0.002 rad

>> Δvc = 0.016 m

>> Δhd = - 0.018 m

>> θa = - 0.002 rad



CASE OF TEMPRATURE تأثير الحرارة

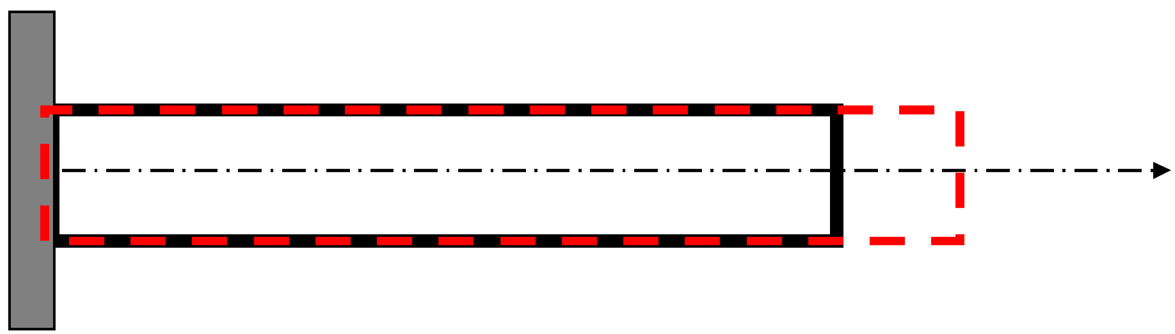
Case of uniform temprature.

طريقة الحل

1- يتم ازالة كل الاحمال من الكمرة.

2- يتم وضع 1ton عند النقطة المطلوب حساب الهبوط عندها.

3- يتم رسم الـ normal الناتج عن الـ 1ton.

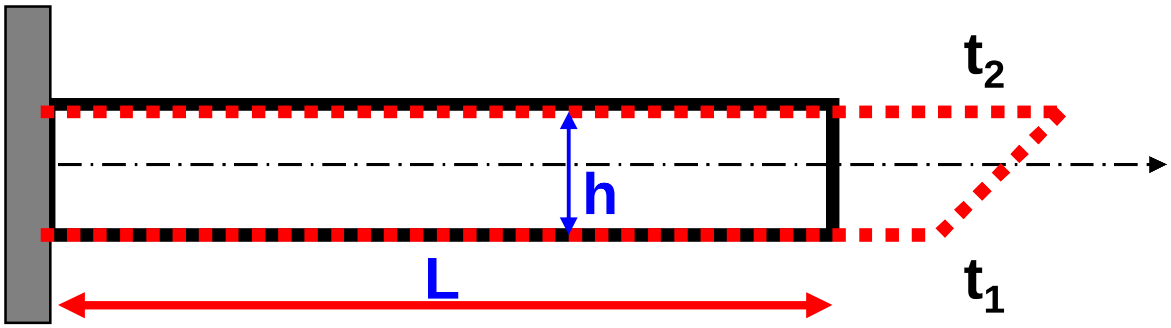


y or θ = α * dt * (Area of normal)

Case of non uniform temprature.

طريقة الحل

1- يتم ازالة كل الاحمال من الكمرة.
2- يتم وضع 1ton عند النقطة المطلوب حساب الهبوط عندها.
3- يتم رسم الـ normal الناتج عن الـ 1ton.



$$y \;\; or \;\; \theta = \alpha.\left(\frac{t_2 + t_1}{2}\right).\sum Area\,Normal + \alpha.\left(\frac{t_2 - t_1}{h}\right).\sum Area\;of\;Moment$$

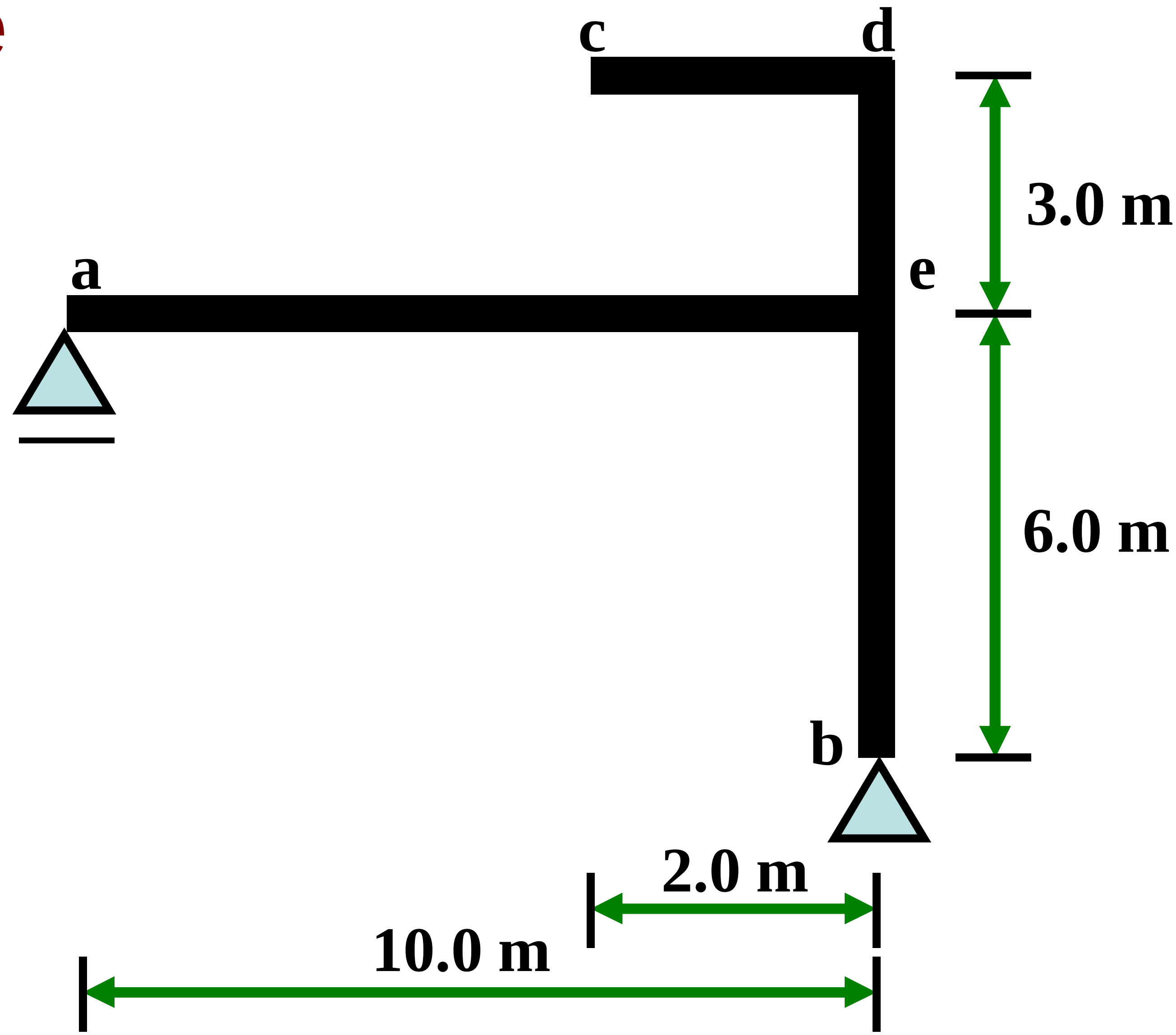
t_2 >>>> *external temrature.*

t_1 >>>> *internal temrature.*

h >>>> *beam depth.*

α >>>> *thermal coeffiecnt.*

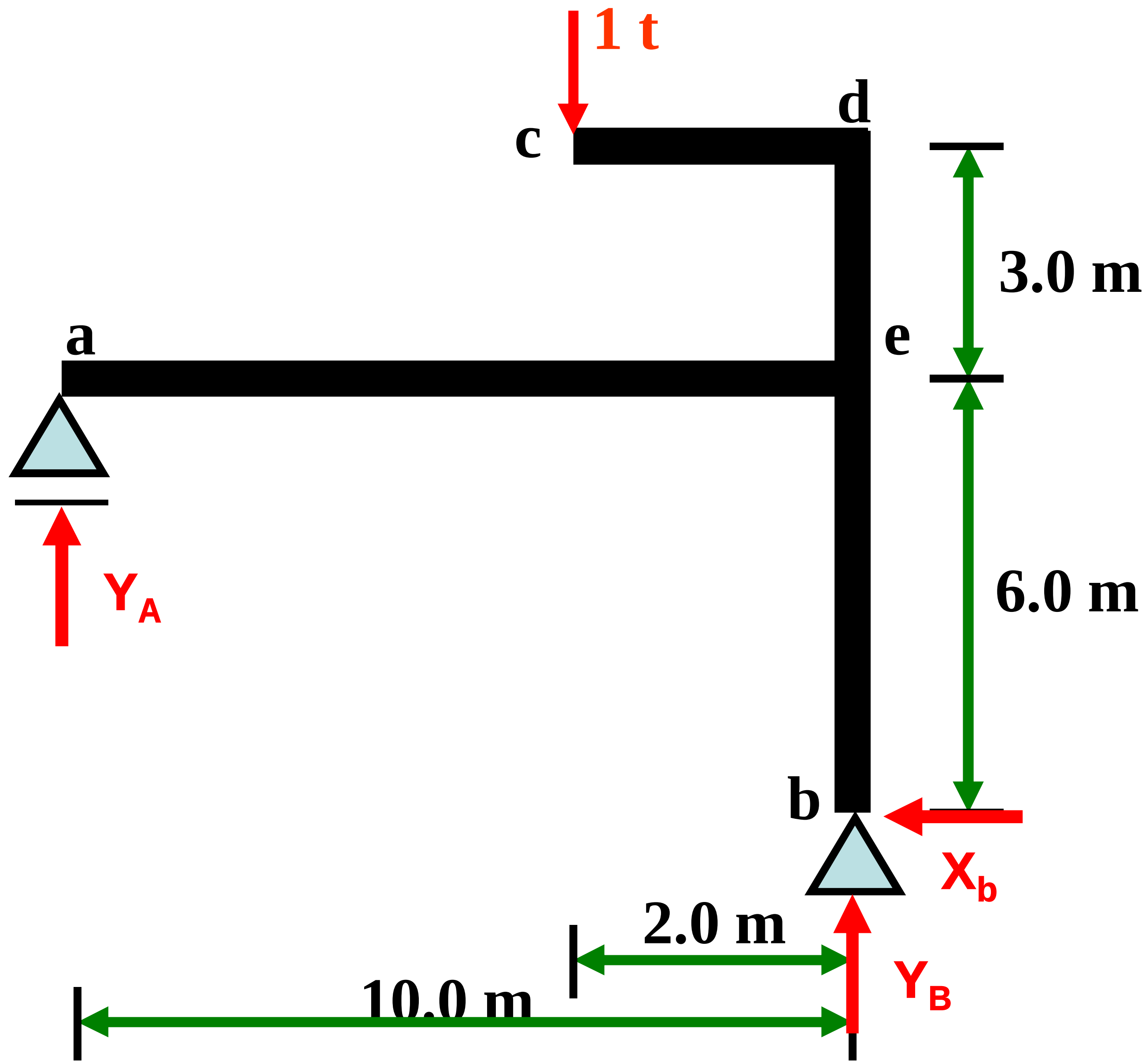
Example three



Required : Δ_{vc} **and** Δ_{hd} **and** θ_a **due to uniform increase in temperature equal 20°.** $\alpha = 10^{-5}$

For Δ_{vc}

المطلوب هو الازاحة
الرأسيه عند النقطه c



$$\sum \mathbf{F}_X = 0.0$$

$$X_b = 0.0$$

$$\sum \mathbf{M}_A = 0.0$$

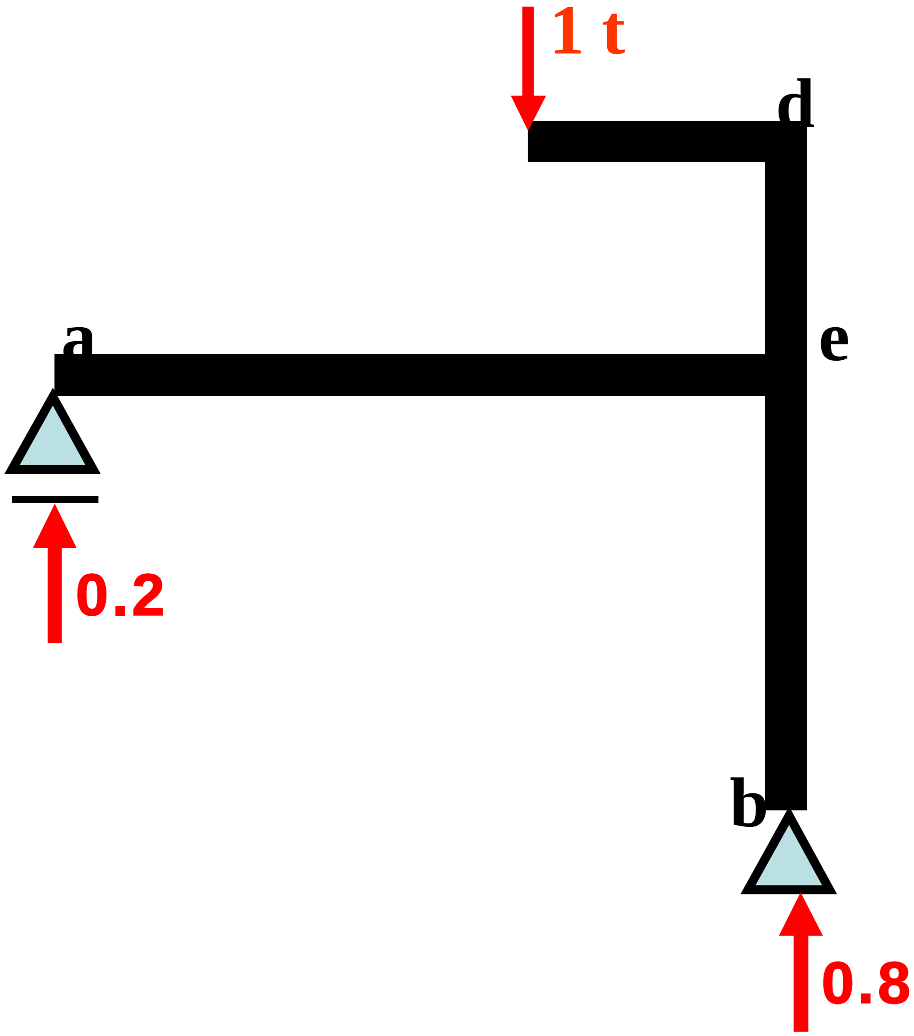
$$Y_B * 10 = 1 * 8$$

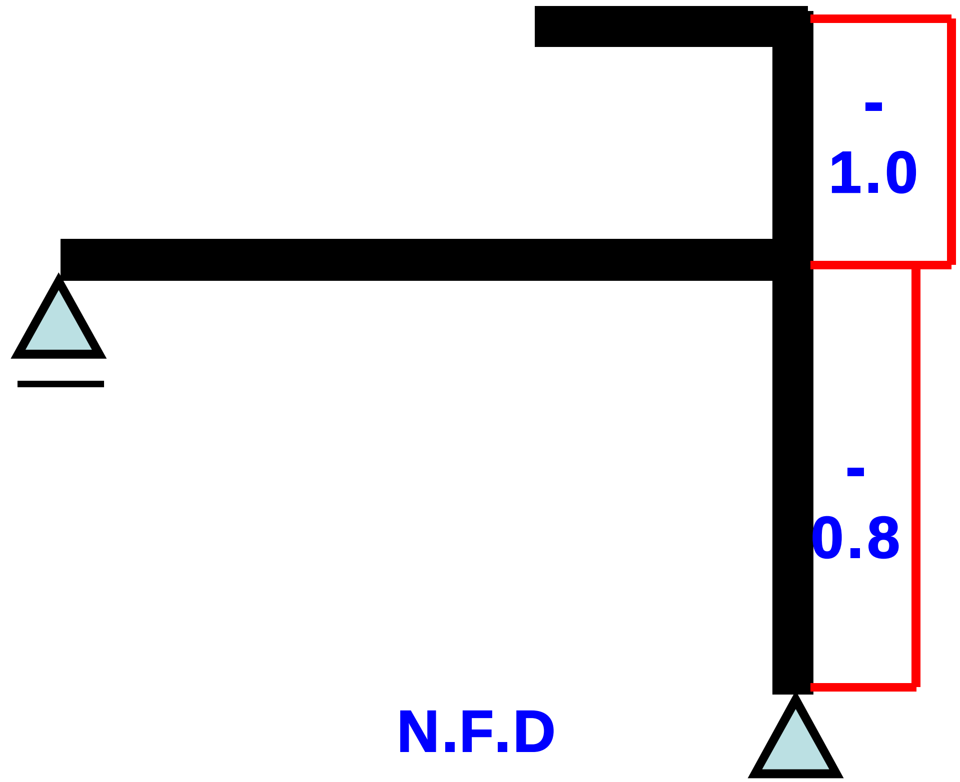
$$Y_B = 0.8$$

$$\sum \mathbf{F}_Y = 0.0$$

$$Y_A + 0.8 = 1$$

$$Y_A = 0.2$$



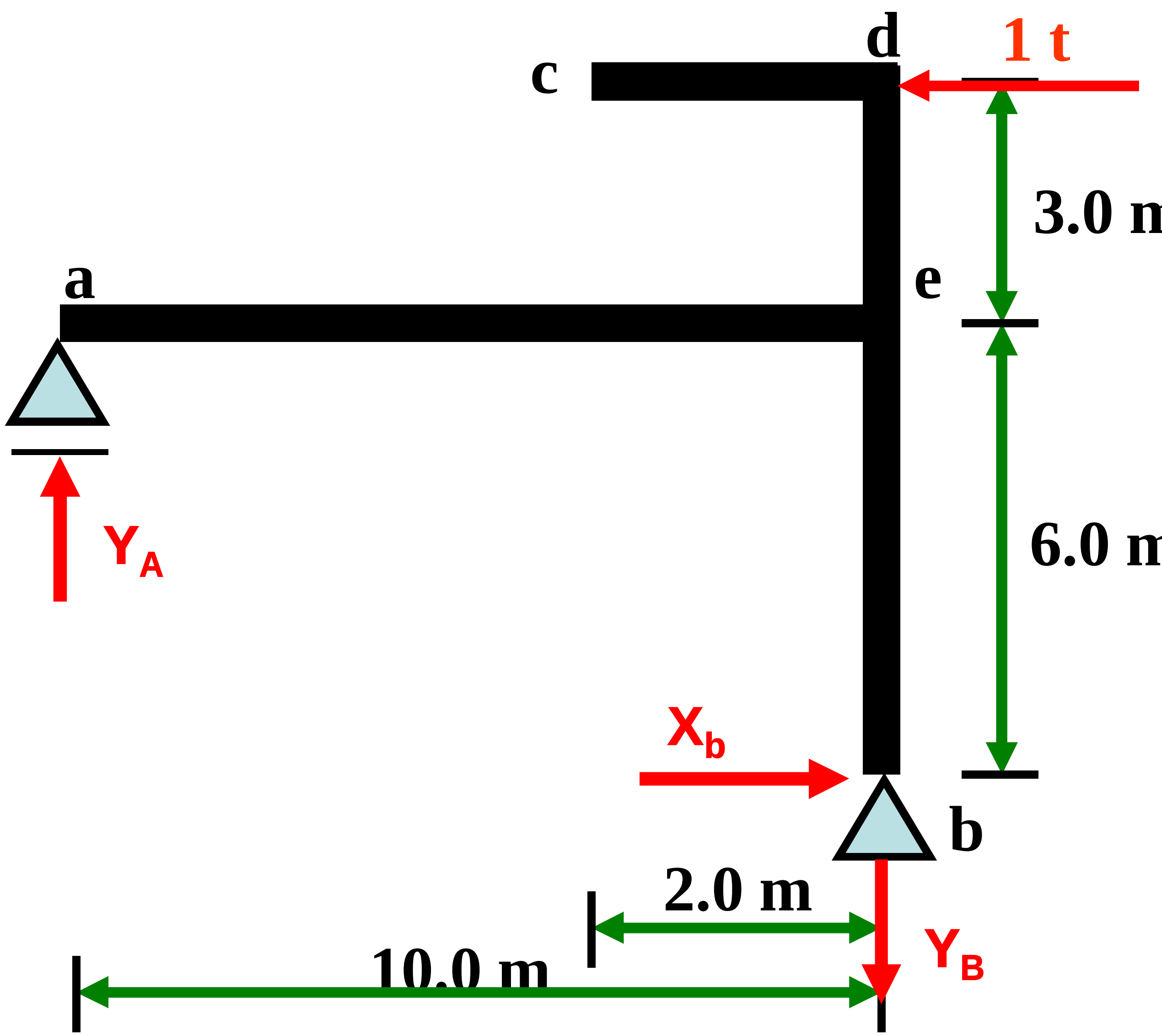


$$\Delta_{vc} = 10^{-5} * 20 * (-1*3-0.8*6) = -0.00156 \text{ m}$$

For Δ_{hd}

المطلوب هو الازاحة

الافقيه عند النقطه d



$\sum F_X = 0.0$

$X_b = 1.0$

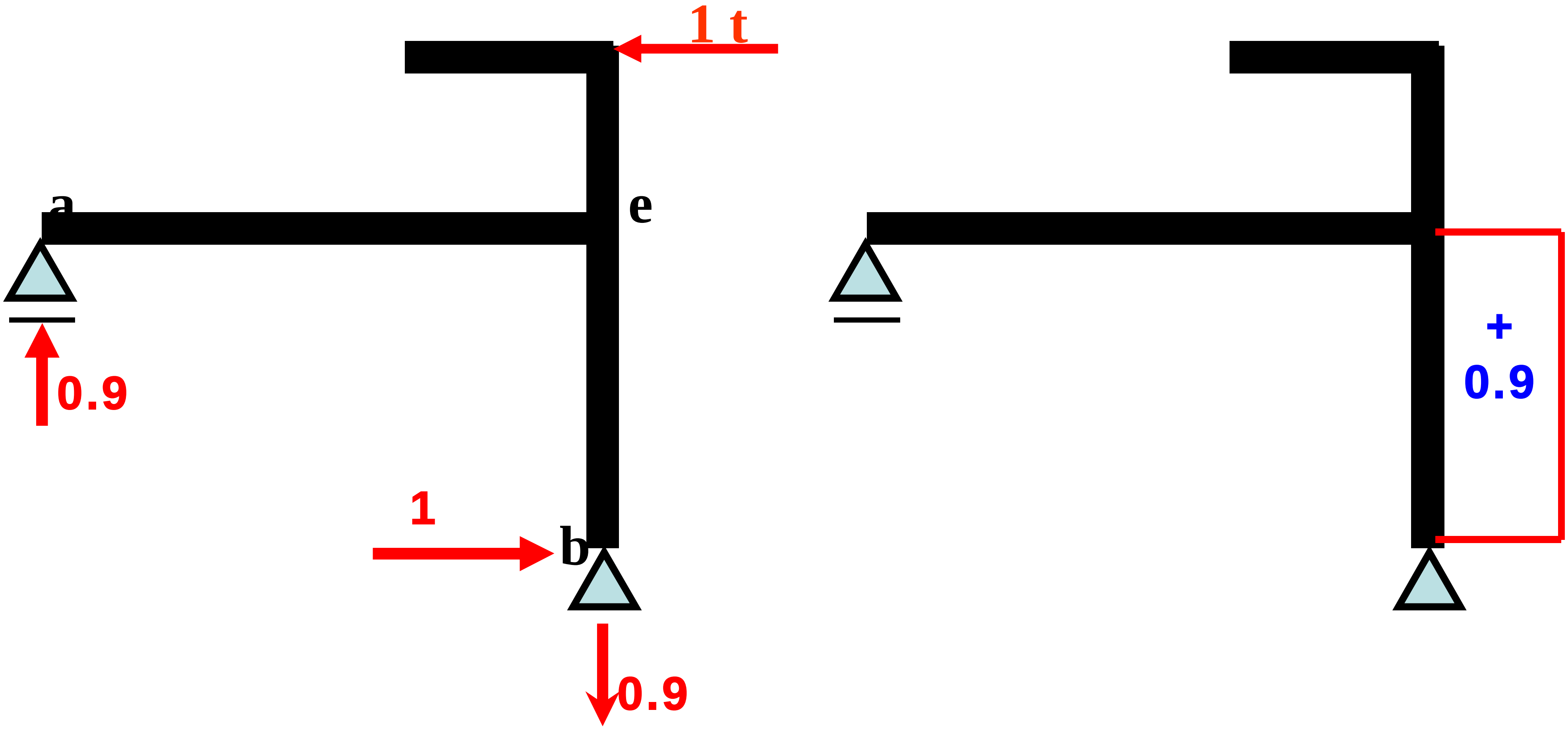
$\sum M_A = 0.0$

$Y_B * 10 = 1 * 3 + 1 * 6$

$Y_B = 0.9$

$\sum F_Y = 0.0$

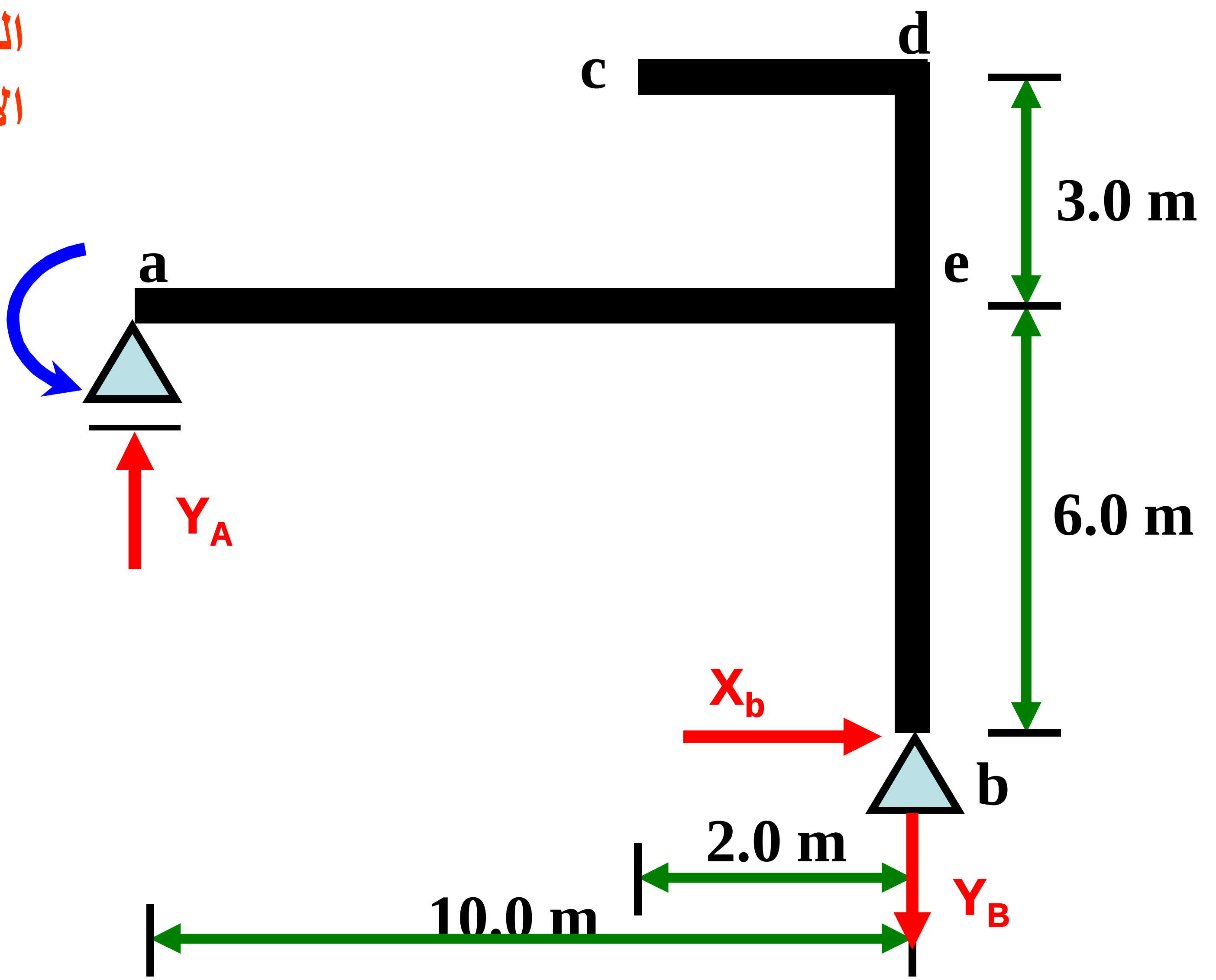
$Y_A = 0.9$



$$\Delta_{hd} = 10^{-5} * 20 * (+0.9*6) = 0.00108 \text{ m}$$

For θ_a

المطلوب هو الازاحة
الافقيه عند النقطه d



$\sum \mathbf{F}_X = 0.0$

$X_b = 0.0$

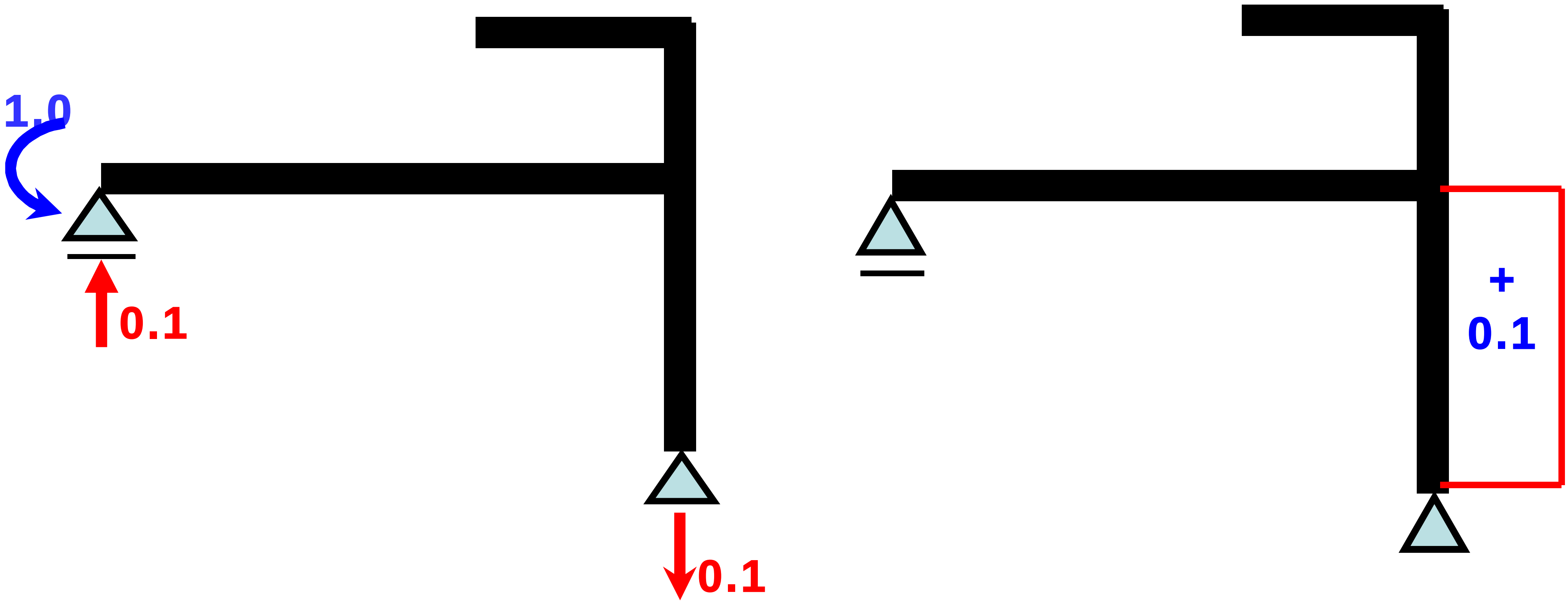
$\sum \mathbf{M}_A = 0.0$

$Y_B * 10 = 1$

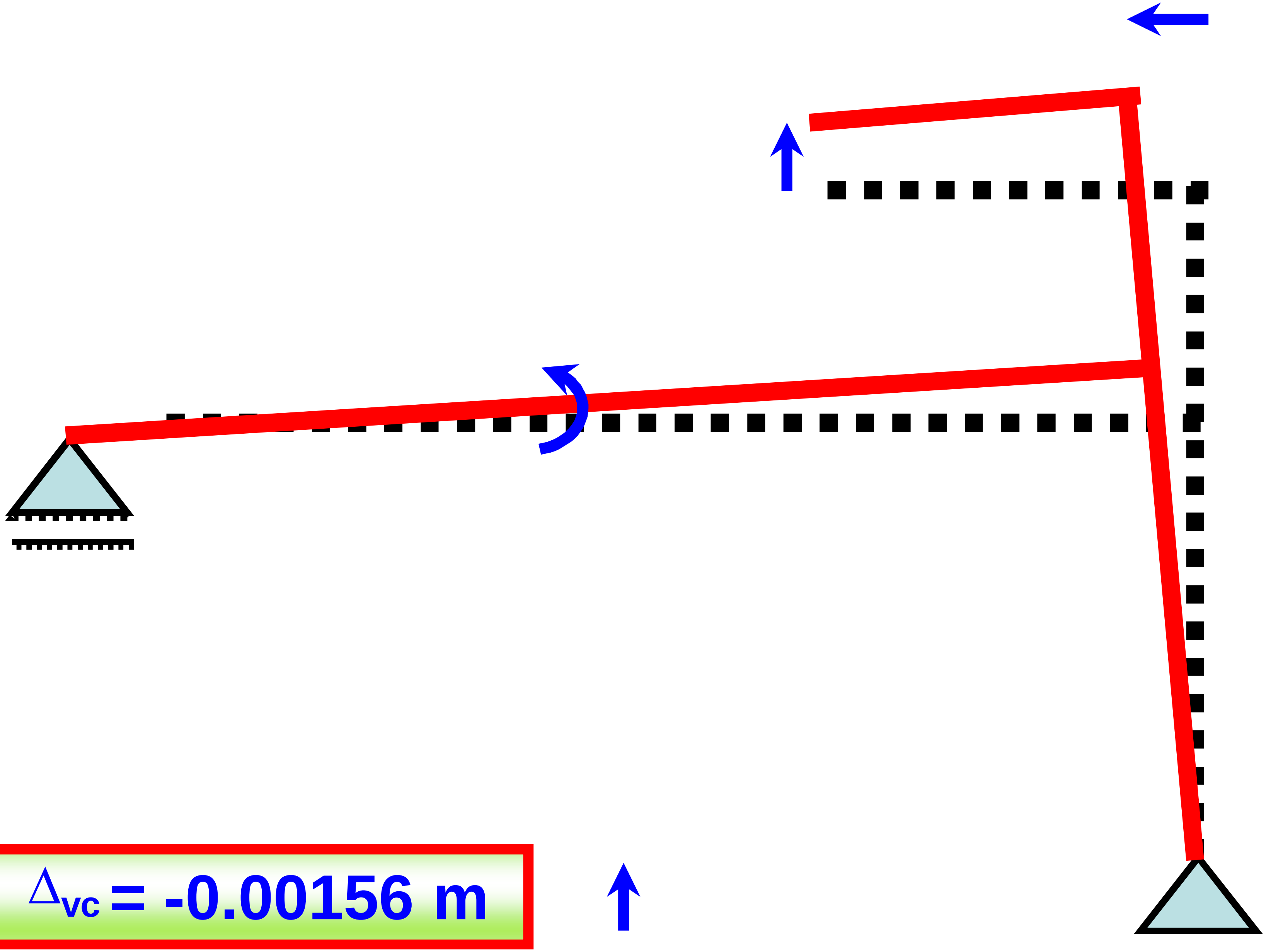
$Y_B = 0.1$

$\sum \mathbf{F}_Y = 0.0$

$Y_A = 0.1$



$\theta_a = 10^{-5} * 20 * (+0.1*6) = 0.00012$ rad



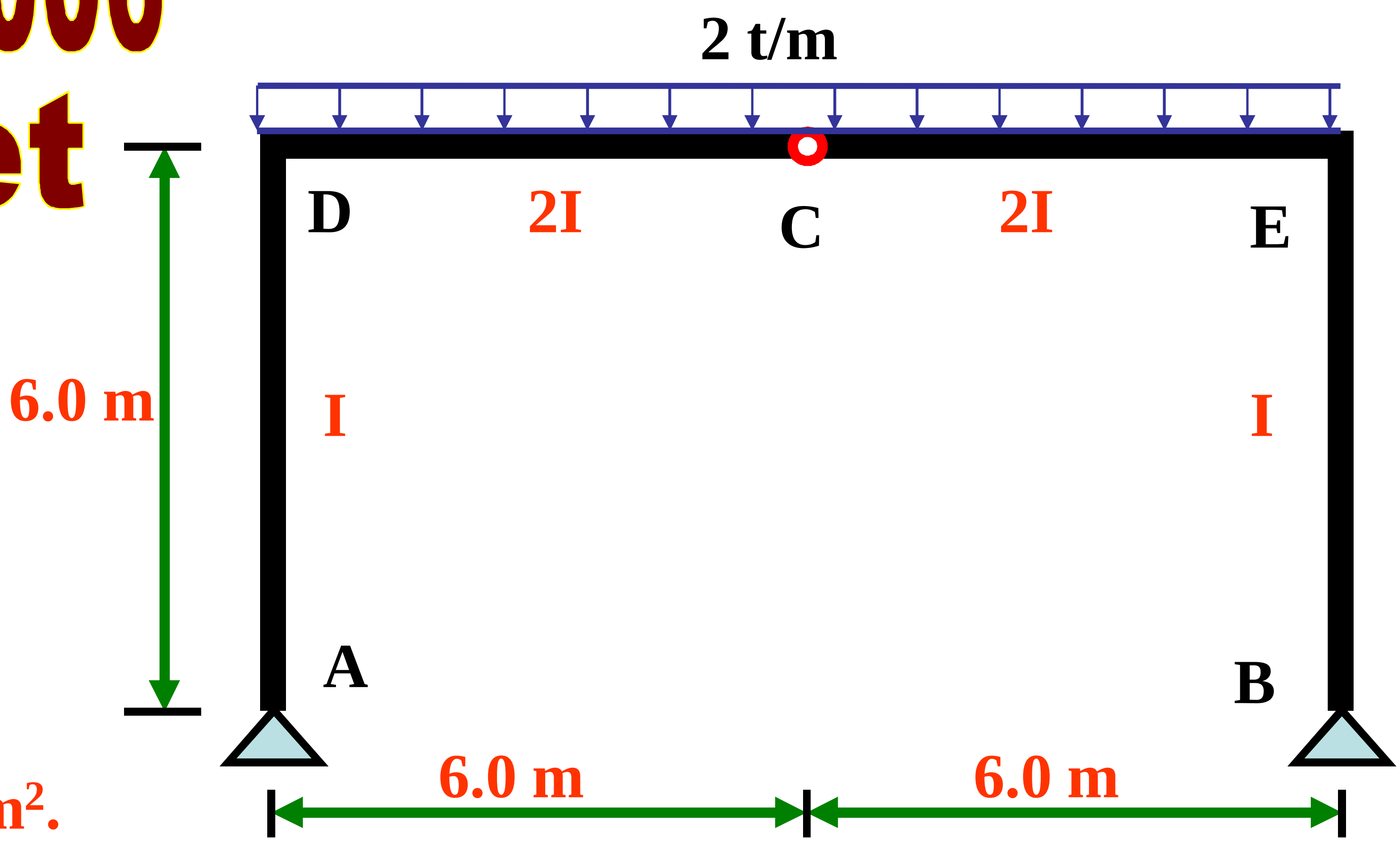
Δ_{vc} = -0.00156 m

Δ_{hd} = 0.00108 m

θ_a = 0.00012 rad

Exams problems

final 2006 sheet

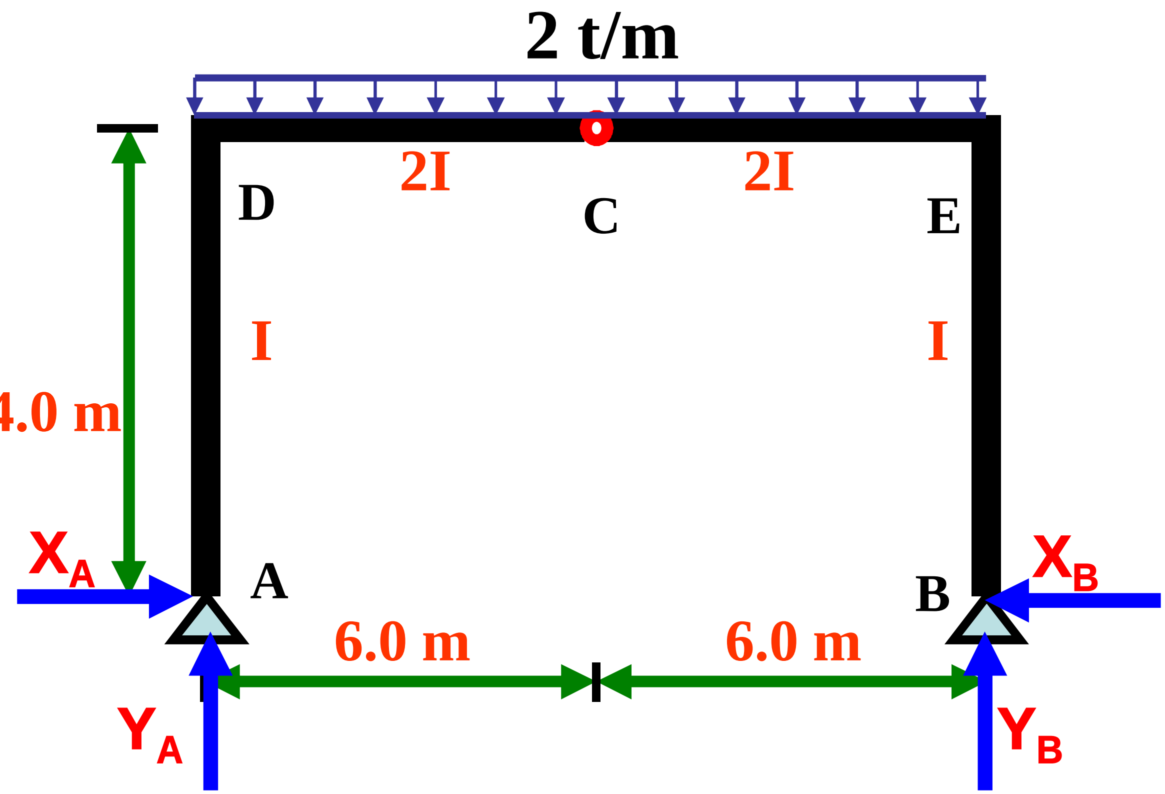


EI = 9000 t.m^2.
α = 10^{-5}.

For the Shown Frame, Calculate the Vertical Deflection at C, Horizontal Deflection at D and Draw the Elastic Curve due to:

1- Given Loads.
2- Horizontal Movement at B =2cm to the Right.
3- Uniform Rise in Temperature 40^0.

Reactions



$\sum F_Y = 0.0$

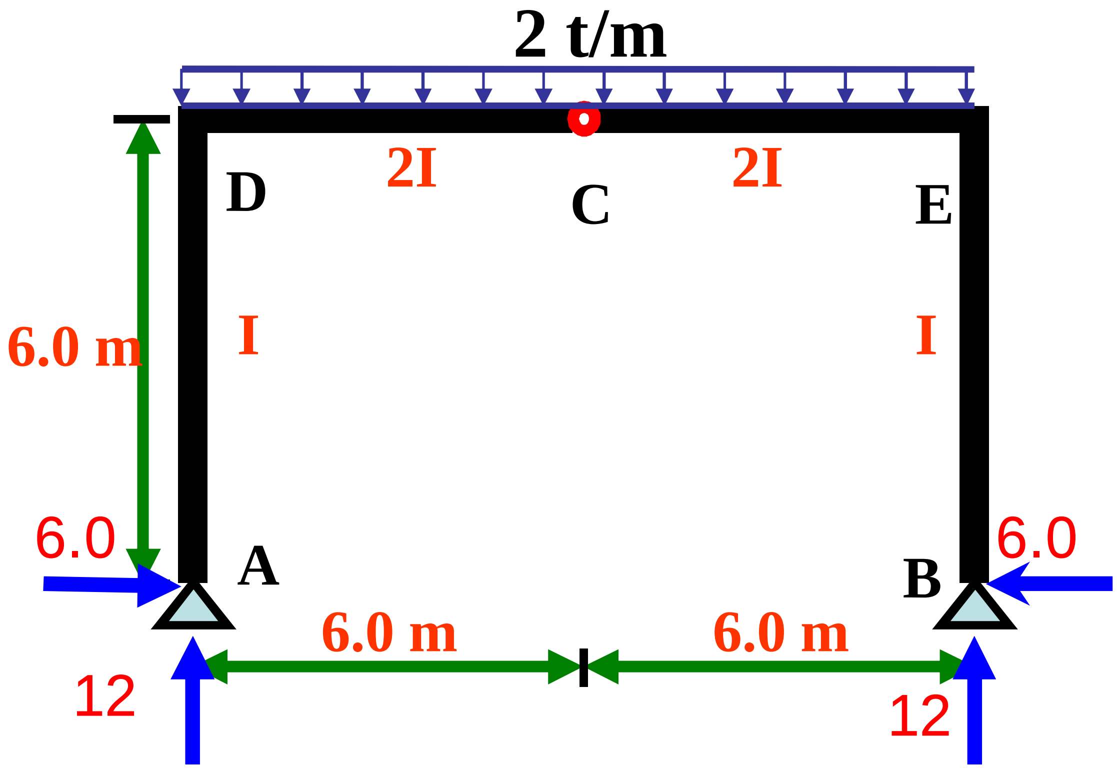
$Y_A = Y_B = 24/2=12$

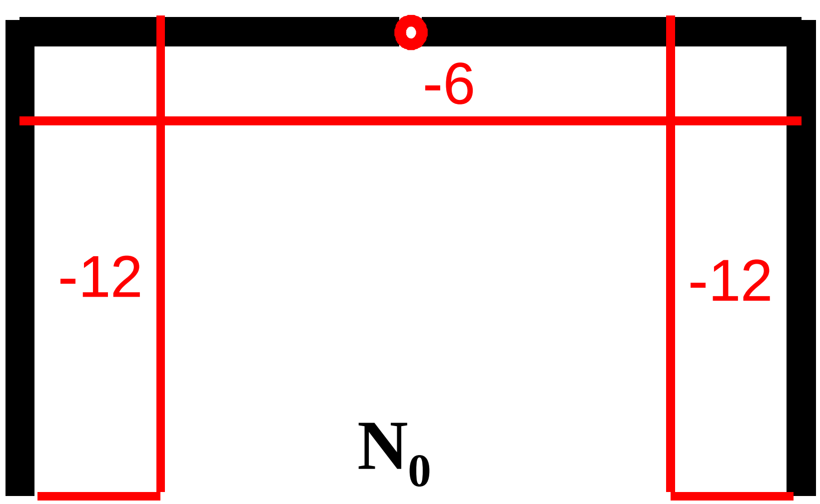
$\sum M_{cr} = 0.0$

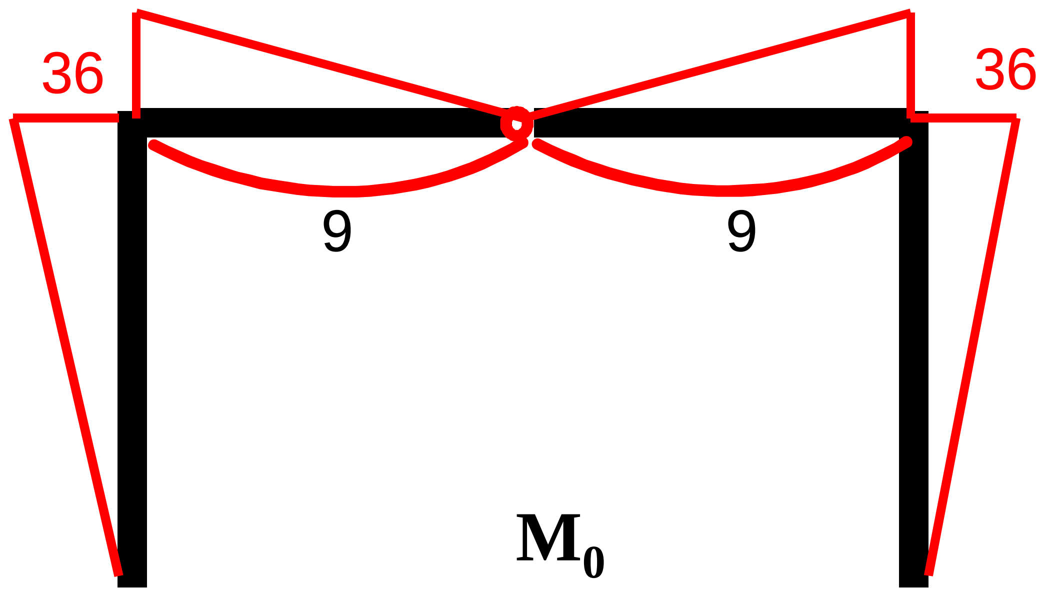
$X_B*6.0 + 12*3 = Y_B*6$ >>>> $X_B = 6$ t

$\sum F_X = 0.0$

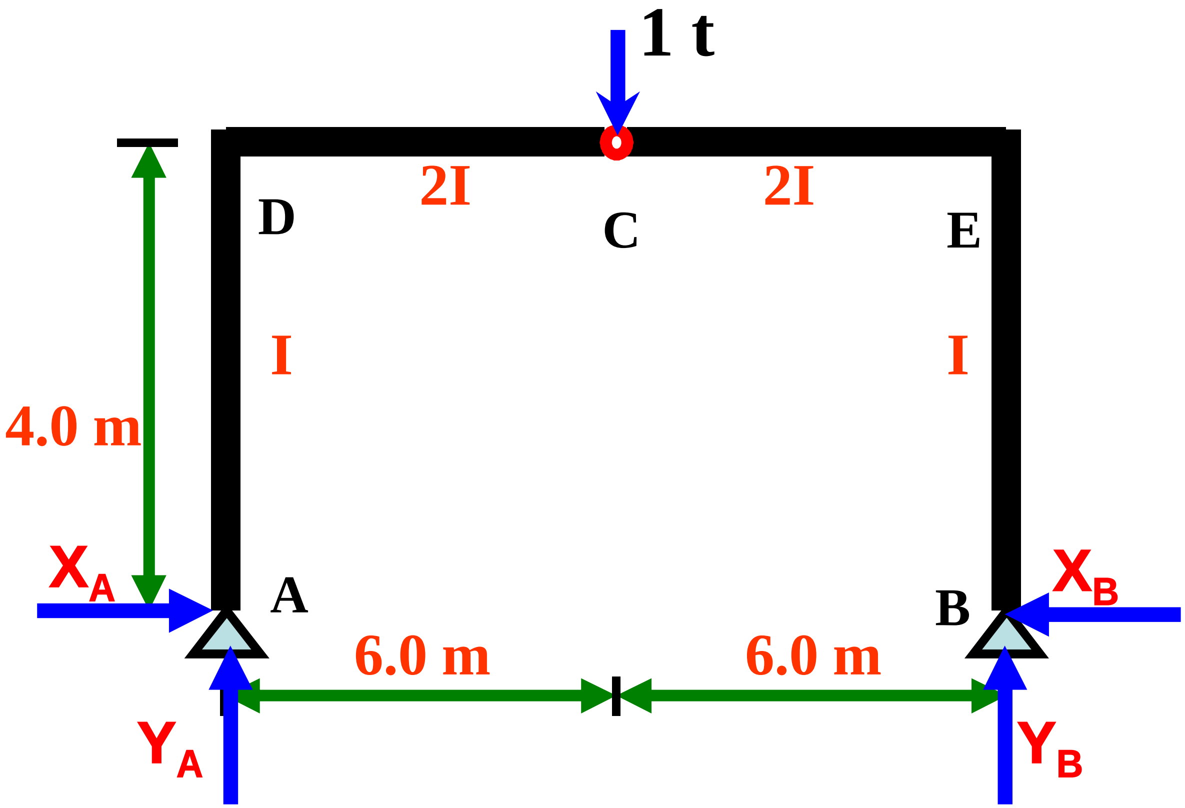
$X_A = 6.0$


2 t/m
D
2I
C
2I
E
6.0 m
I
I
6.0
A
B
6.0
6.0 m
6.0 m
12
12


-6
-12
-12
N_0


36
36
9
9
M_0

For yc



$\sum F_Y = 0.0$

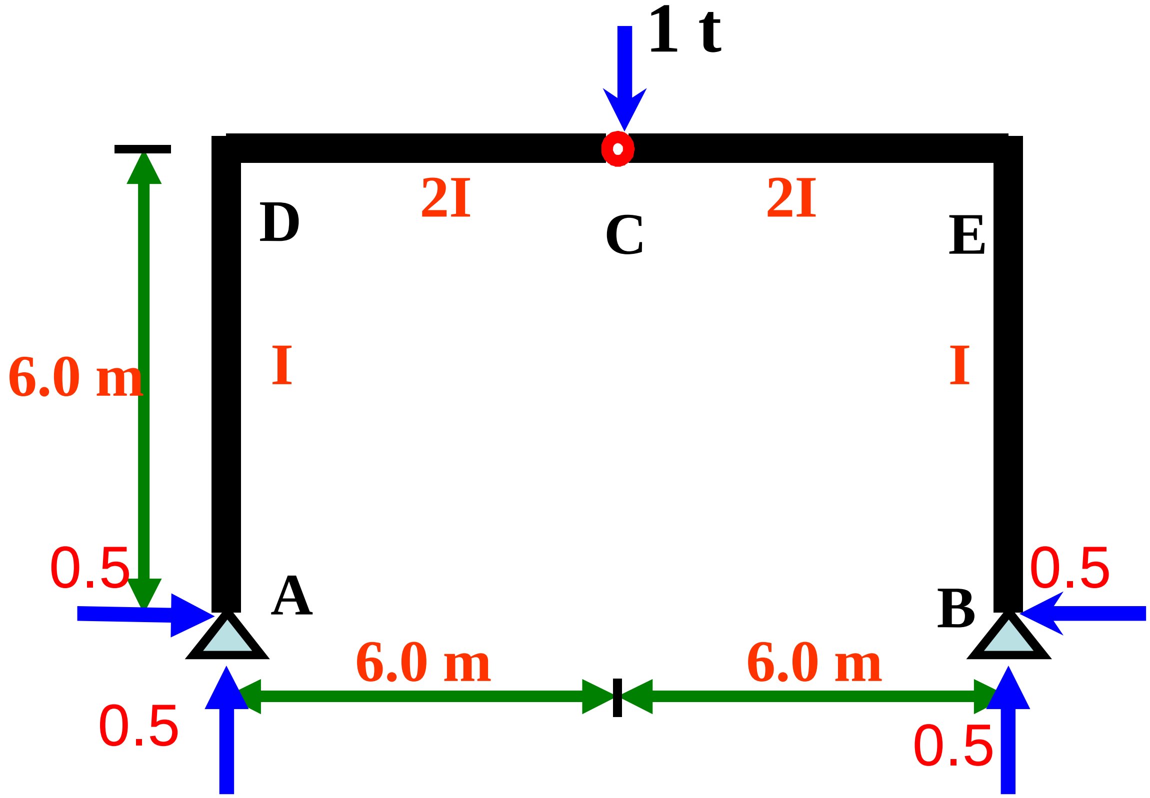
$Y_A = Y_B = 1/2$

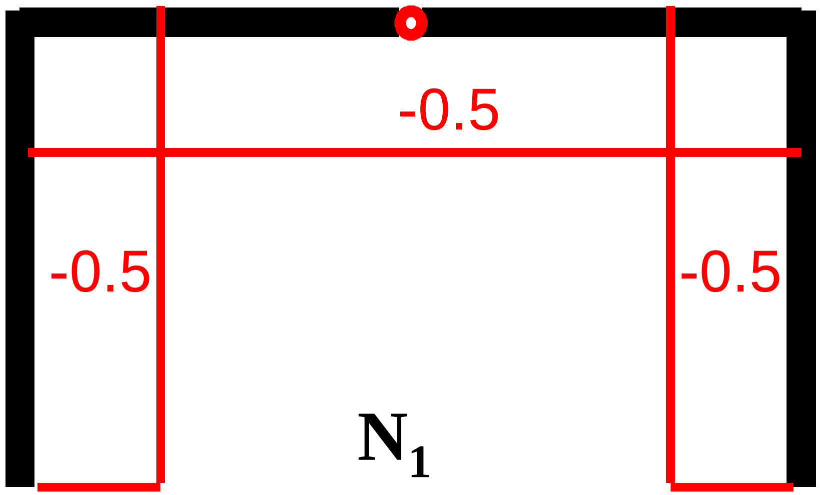
$\sum M_{cr} = 0.0$

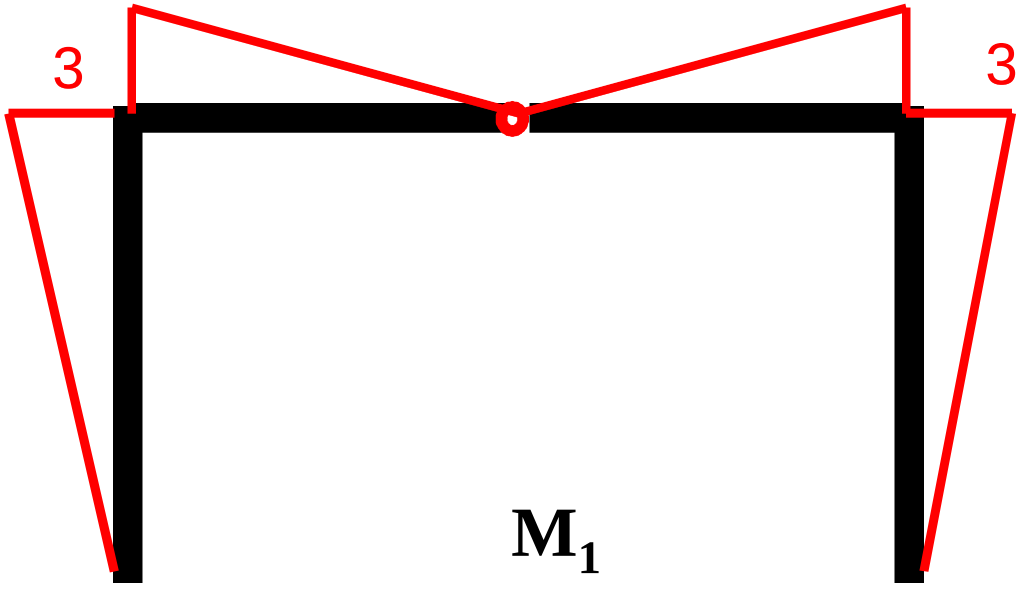
$X_B*6.0 = Y_B*6$ >>>> $X_B = 0.5$ t

$\sum F_X = 0.0$

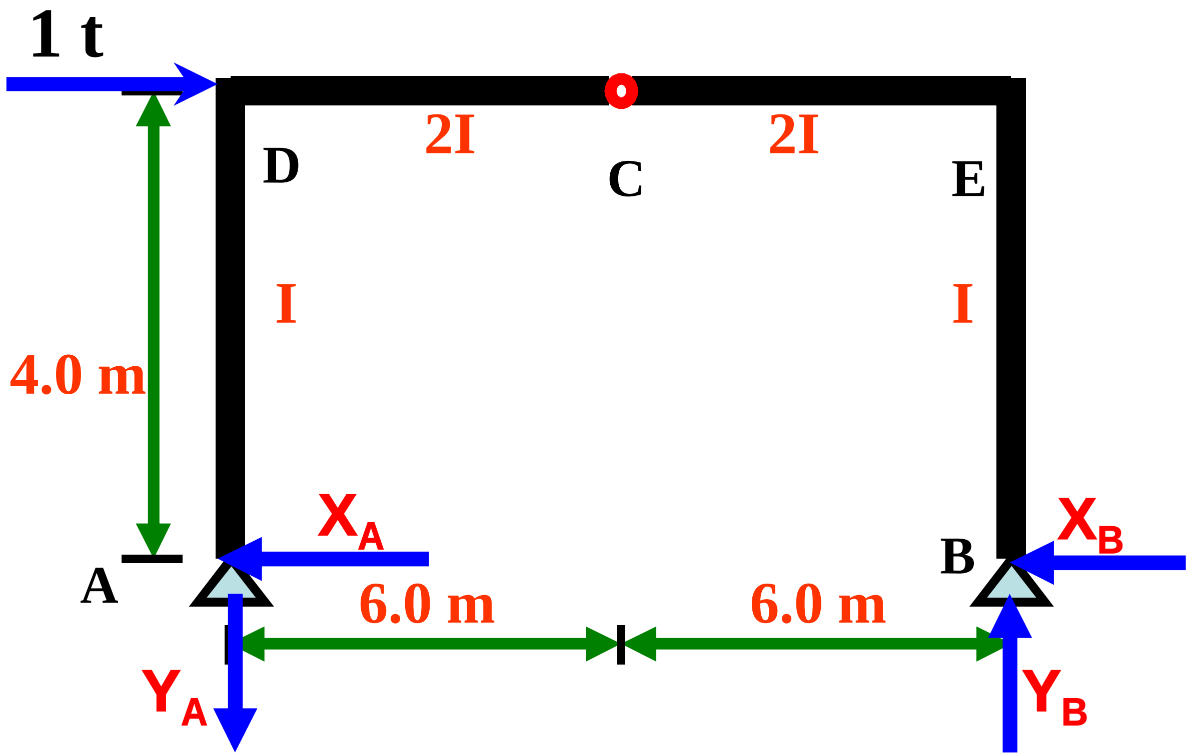
$X_A = 0.5$


1 t
D
2I
C
2I
E
6.0 m
I
I
0.5
A
0.5
B
6.0 m
6.0 m
0.5
0.5


-0.5
-0.5
-0.5
N1


3
3
M1

For hd



$\sum M_a = 0.0$ (counterclockwise)

$1*6.0 = Y_B*12$ >>>> $Y_B = 0.5$ t

$\sum M_{cr} = 0.0$ (counterclockwise)

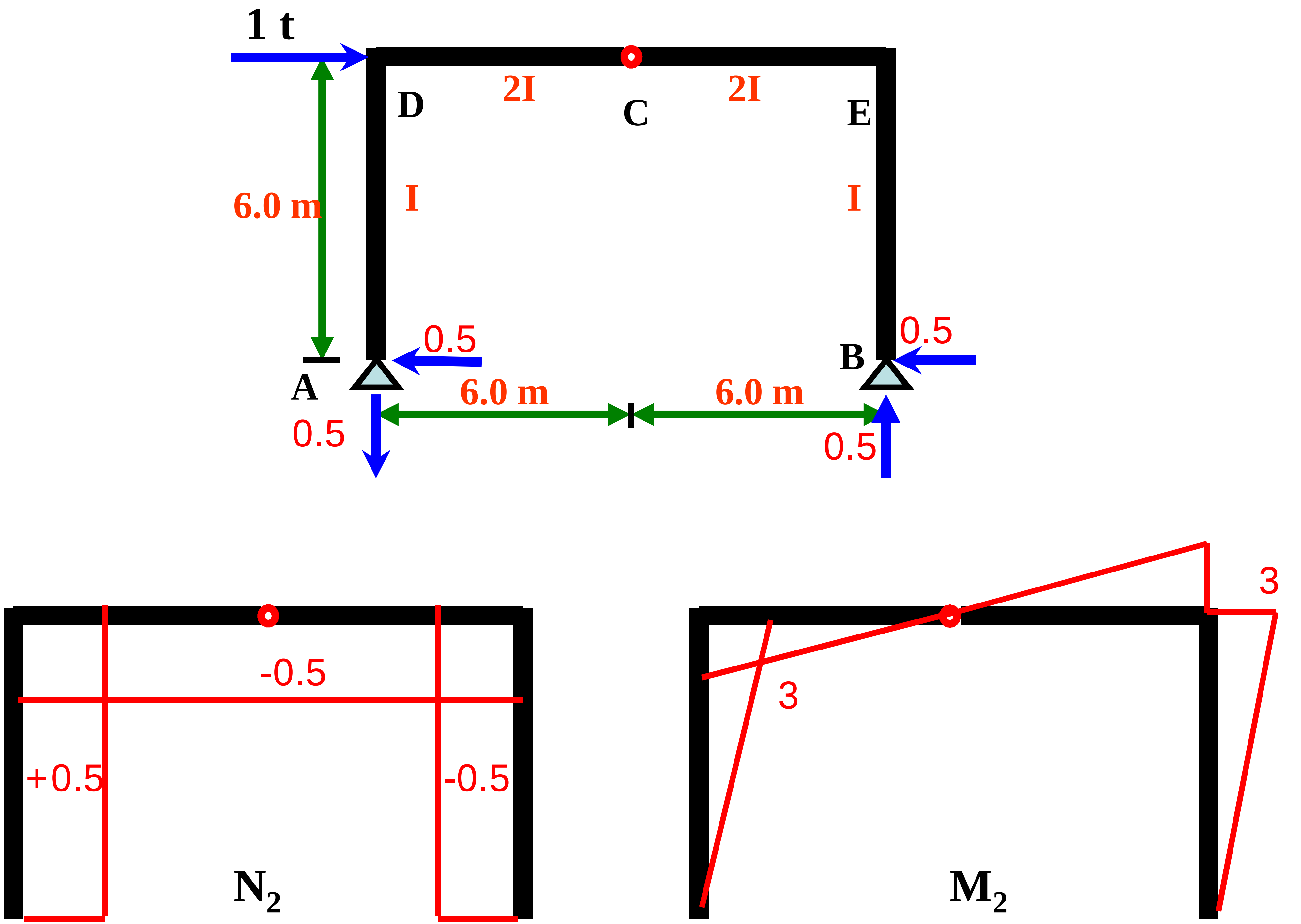
$X_B*6.0 = Y_B*6$ >>>> $X_B = 0.5$ t

$\sum F_X = 0.0$

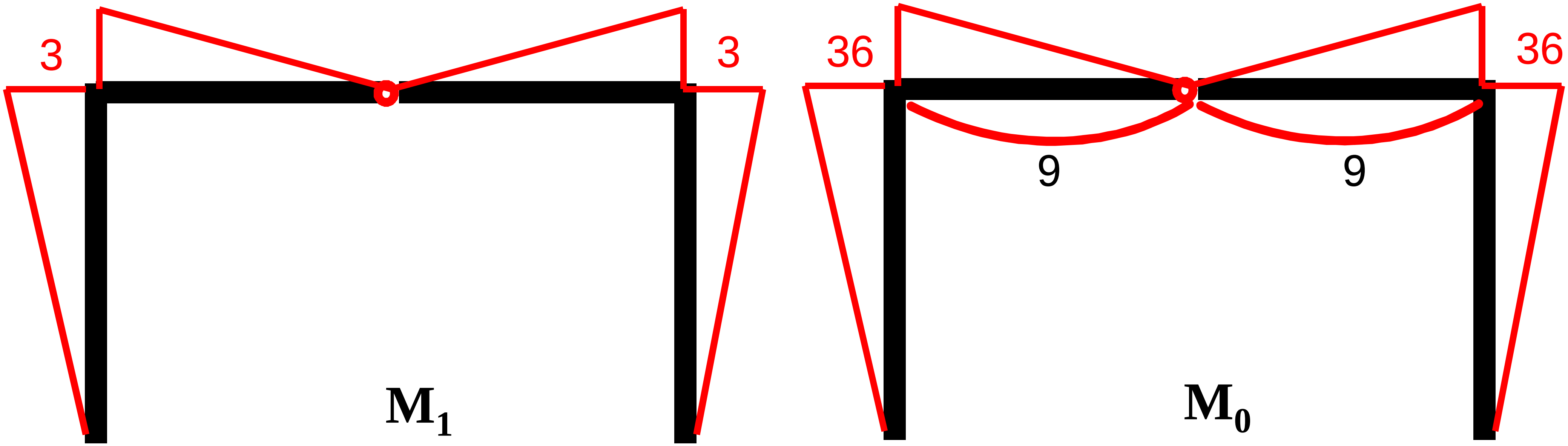
$X_A = 1 - 0.5 = 0.5$

$\sum F_Y = 0.0$

$Y_A = Y_B = 0.5$


1 t
2I
2I
D
C
E
6.0 m
I
I
0.5
0.5
B
A
6.0 m
6.0 m
0.5
0.5
-0.5
+0.5
-0.5
N2
3
3
M2

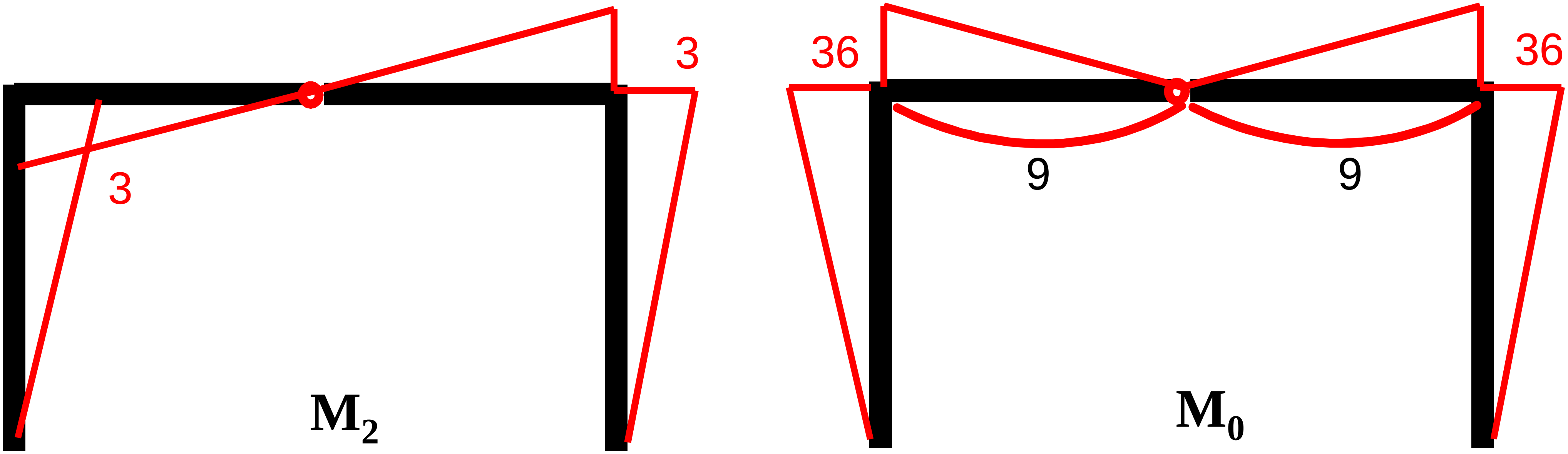
given loads



$$yc = 2*\left[\frac{1}{EI}\left[\frac{36*3*6}{3}\right]+\frac{1}{2EI}\left[\frac{36*3*6}{3}-\frac{2}{3}*9*6*1.5\right]\right]$$

$$= \frac{594}{EI} = 0.066m$$

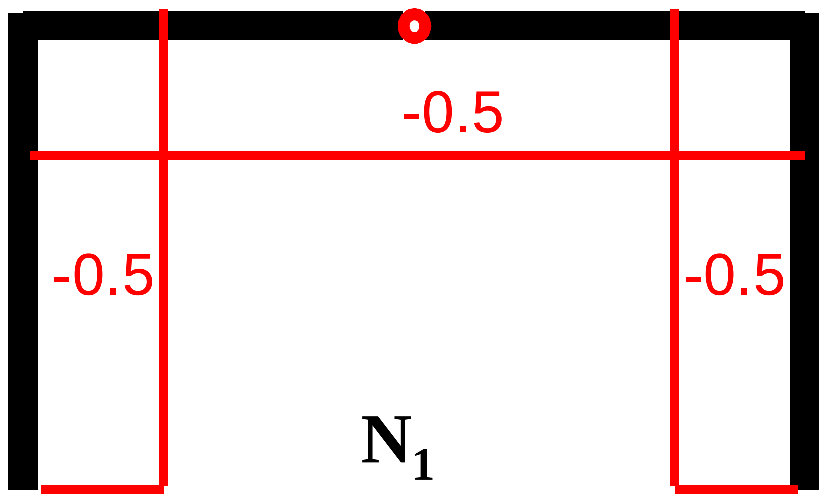
given loads



$$hd = 0.0$$

تكامل شكل متماثل مع شكل متماثل عكسى يساوى صفر

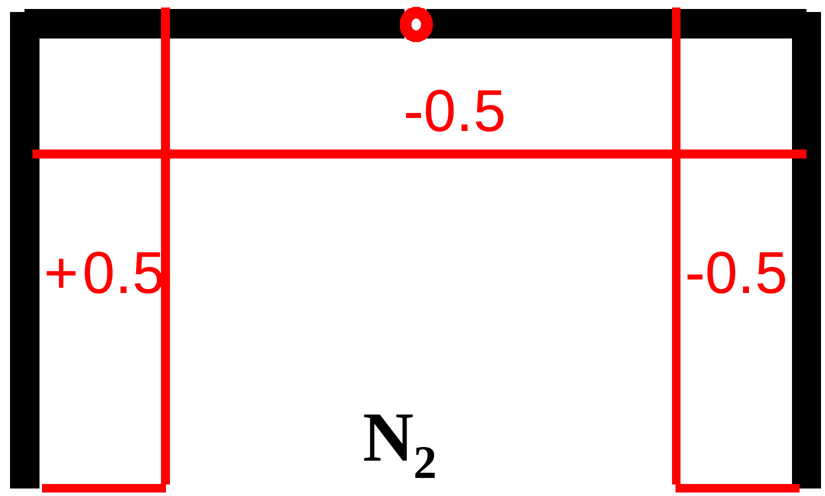
Uniform temperature=40



$$Area\ of\ \ Normal = -0.5*6 - 0.5*12 - 0.5*6 = -12$$

$$yc = \alpha * dt * Area\ of\ \ Normal = 10^{-5} * 40 * -12 = -0.0048m$$

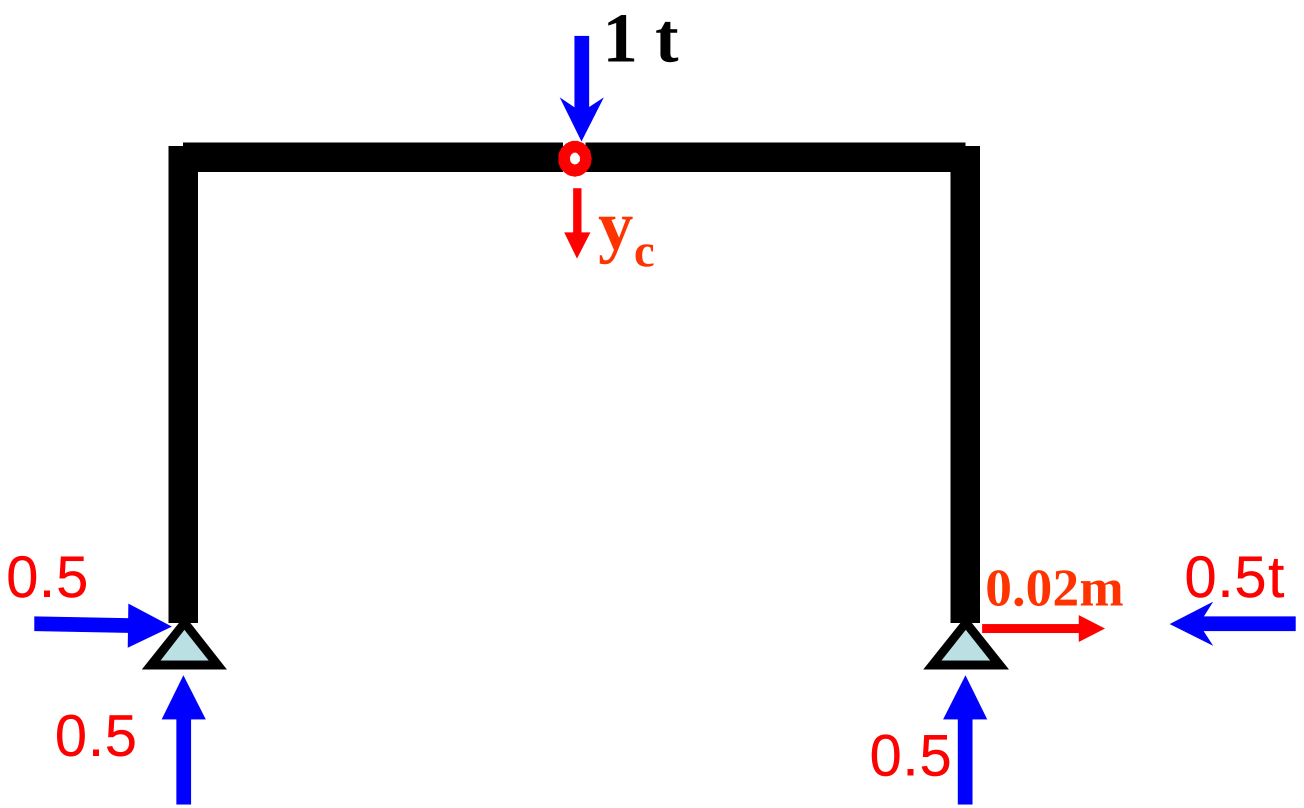
Uniform temprature=40



$$Area\ of\ \ Normal = +0.5*6 - 0.5*12 - 0.5*6 = -6$$

$$hd = \alpha * dt * Area\ of\ \ Normal = 10^{-5} * 40 * -6 = -0.0024m$$

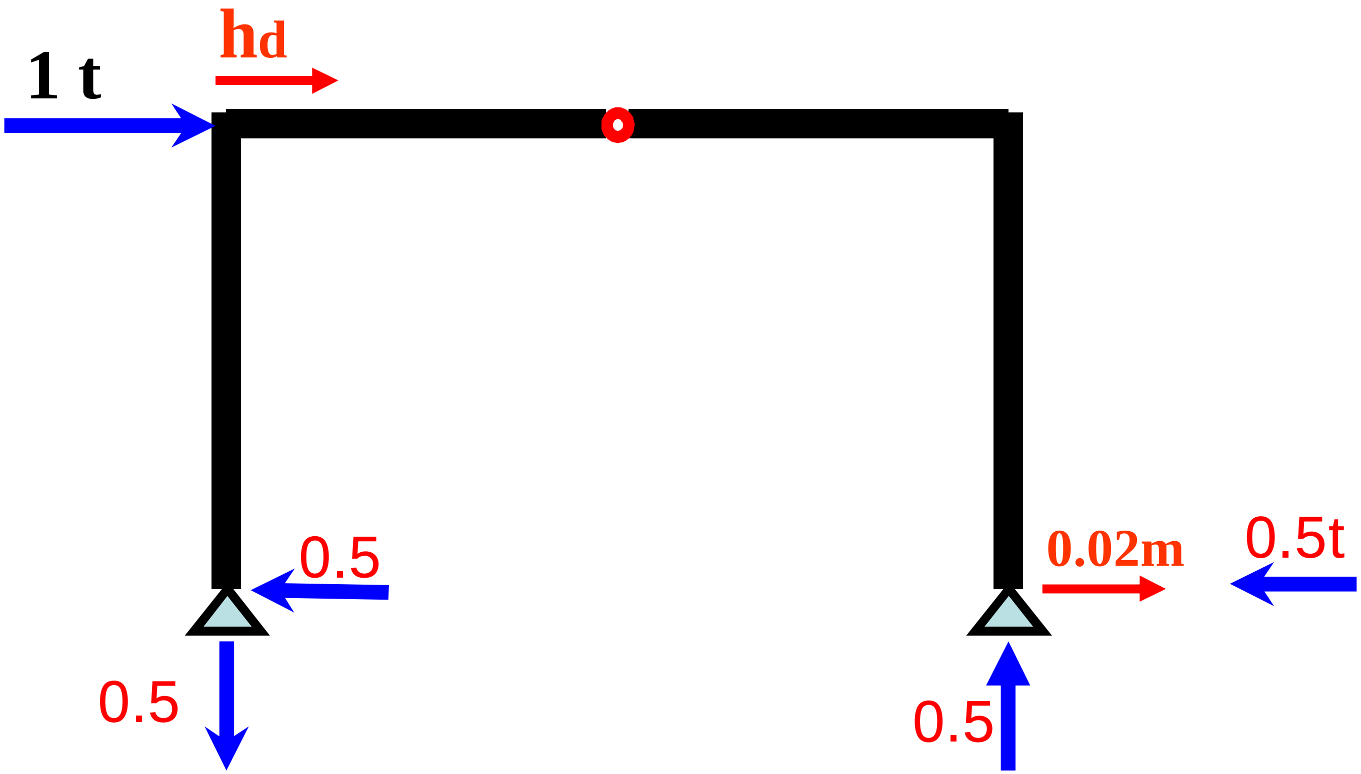
movement at b to the right =0.02 m



$$1 * yc - 0.5 * 0.02 = 0.0$$

$$yc = 0.01m$$

movement at b to the right =0.02 m



$$1 * hd - 0.5 * 0.02 = 0.0$$

$$hd = 0.01m$$

Zagazig University – Faculty of Engineering

Dept. of Structural Engineering

Structural Analysis II

Exercise No. 4 (Deflections)
Virtual Work Method

For the shown Structures, determine the Slope angle and deflection values as mentioned using the Virtual Work Method due to given load

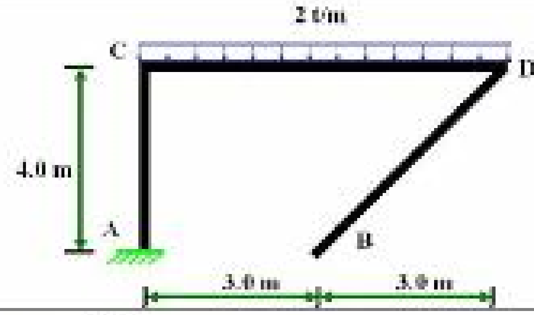
4.1.

- Rotation at Point B
- Vertical Deflection at d
- Relative rotation at d
- Draw Elastic Curve

4.2.

- Rotation at Point C
- Horizontal Deflection at B
- Vertical Deflection at D
- Relative Movement Between B and C

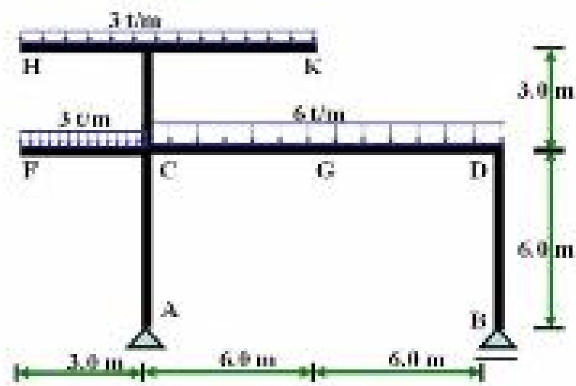
EI = 10000 t.m^2.



4.3.

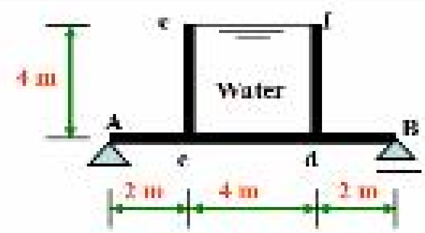
- Rotation at D
- Horizontal Displacement at B
- Vertical Deflection at G

EI = 12000 t.m^2



4.4.

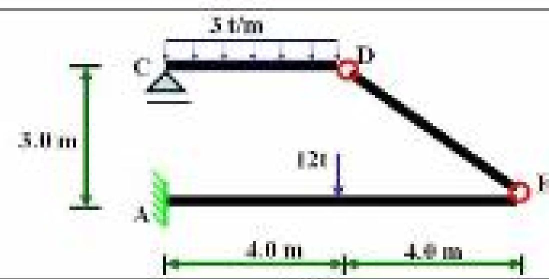
- Rotation at Point D
- Vertical Deflection at E



4.5.

- Horizontal Displacement at D
- Vertical Displacement at E
- Rotation at point C

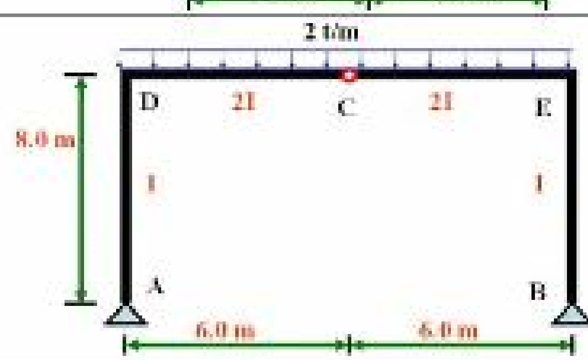
EI = 10000 t.m^2.



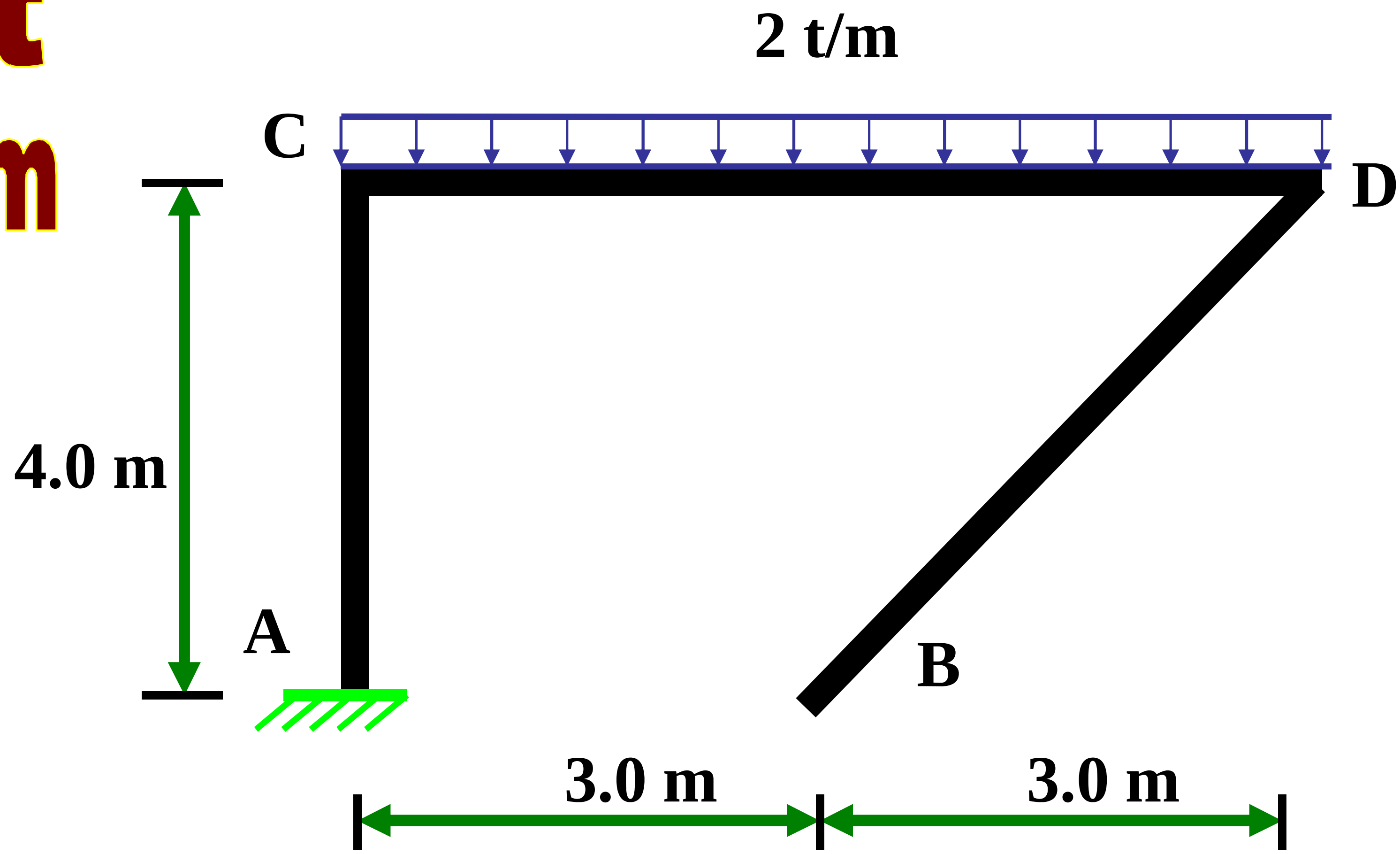
4.5.

- Vertical Deflection at C
- Horizontal Deflection at D
- Draw the Elastic Curve

EI = 9000 t.m^2.



sheet
mid term



For the Shown Frame, Calculate the Rotation at Point D due to:

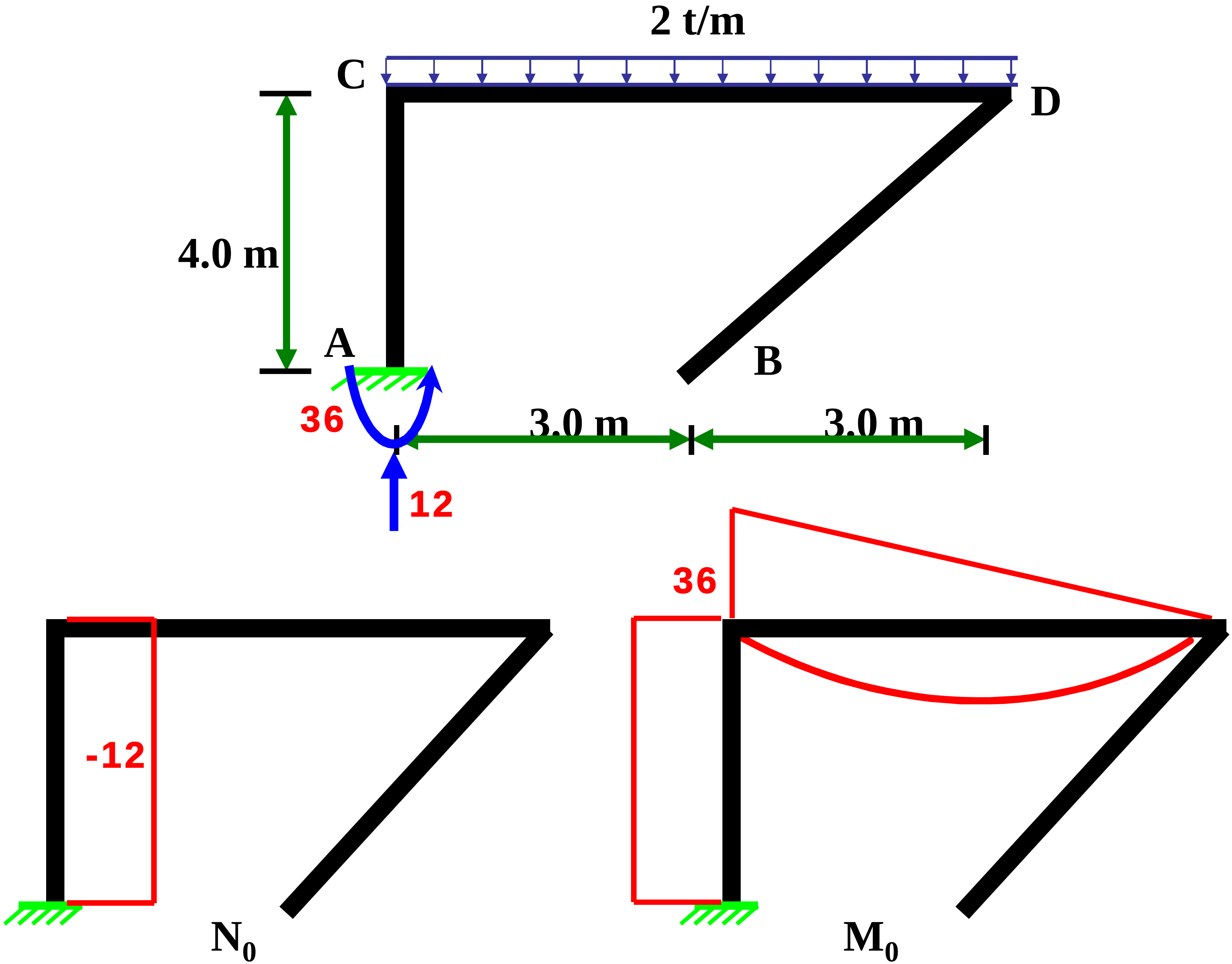
1- Given Loads.

2- Rotational Settlement at A = 1 rad.

3- Rise in Temperature 30^0 in All Members.

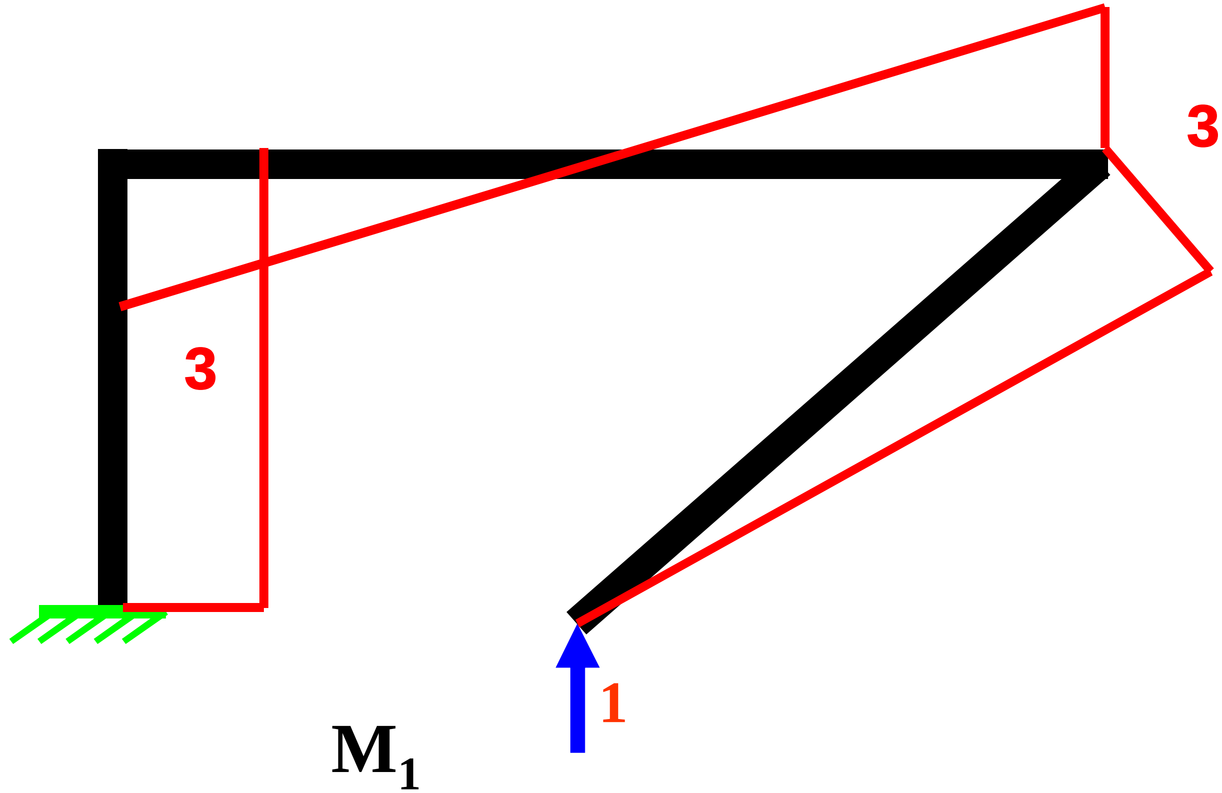
EI = 10000 $t.m^2$.

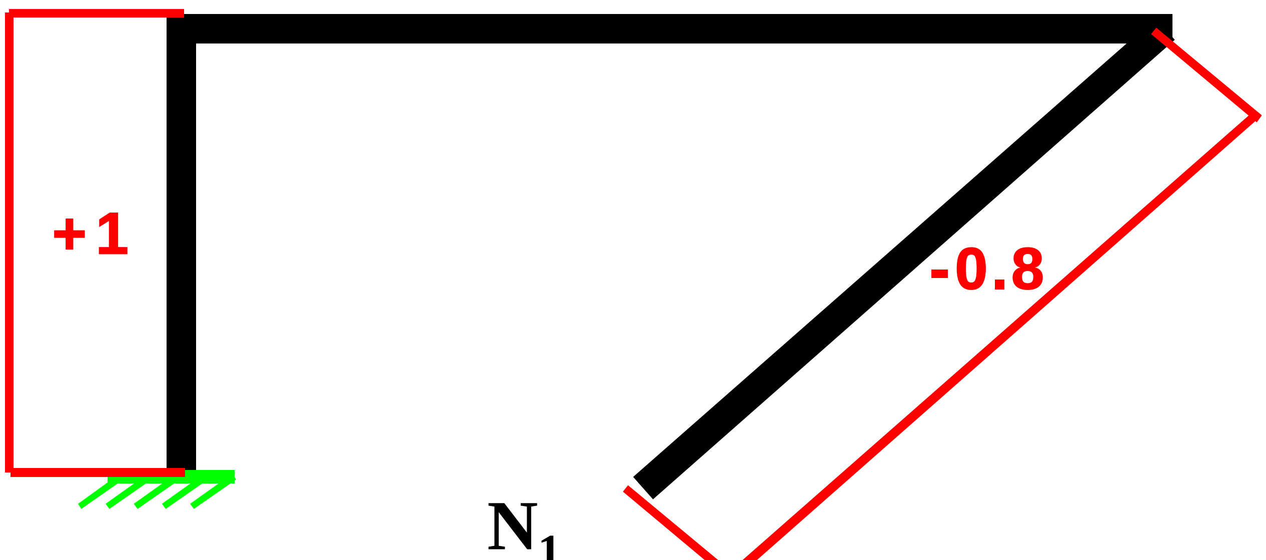
α = 10^{-5}.



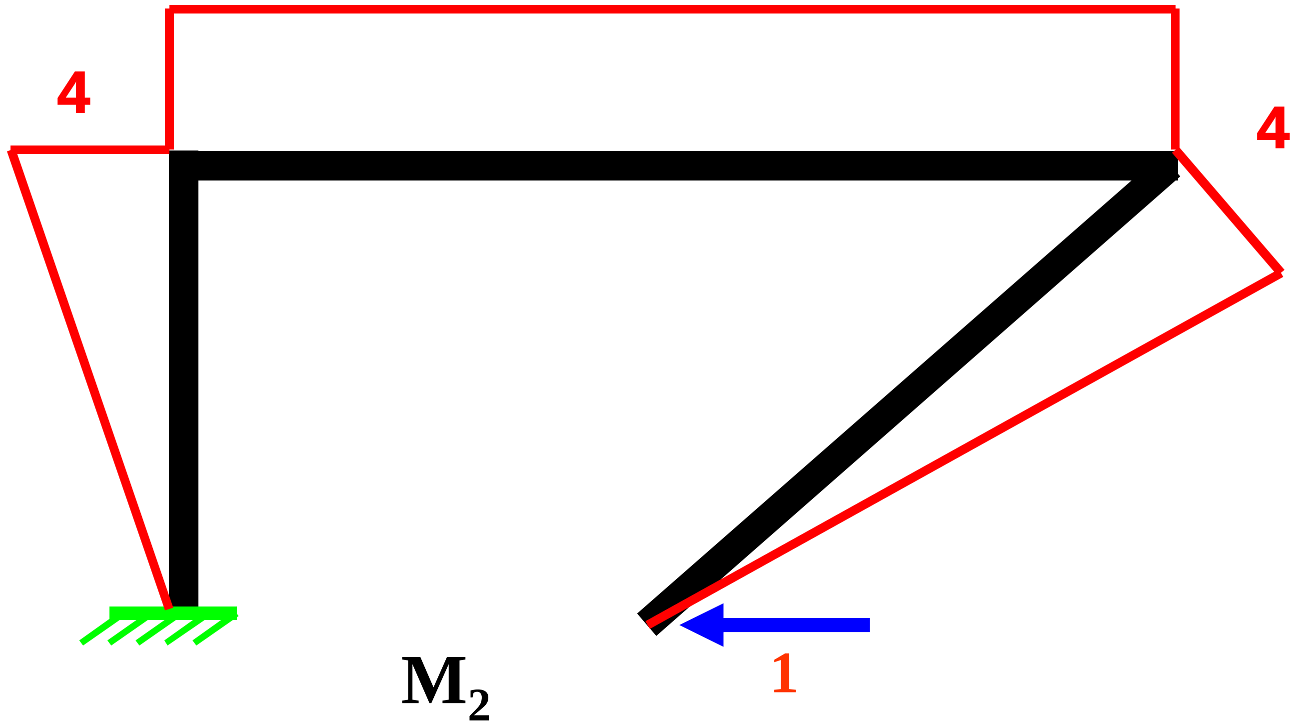
2 t/m
C
D
4.0 m
A
B
36
3.0 m
3.0 m
12
36
-12
N0
M0

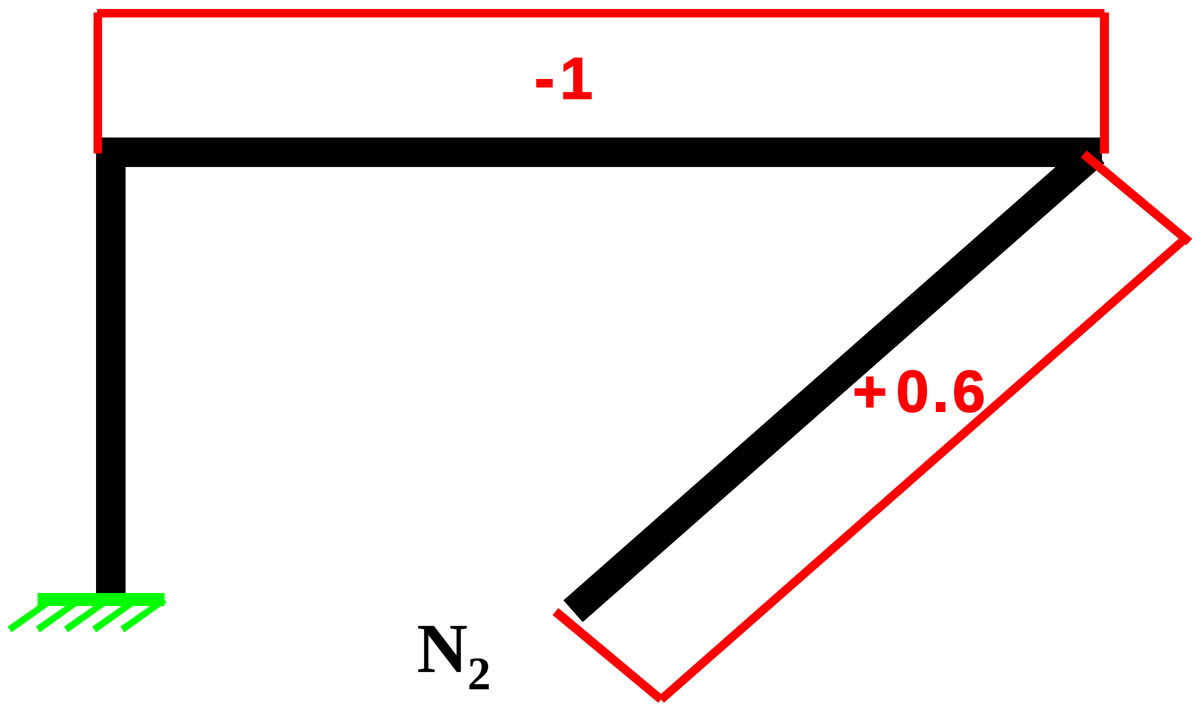
For yb



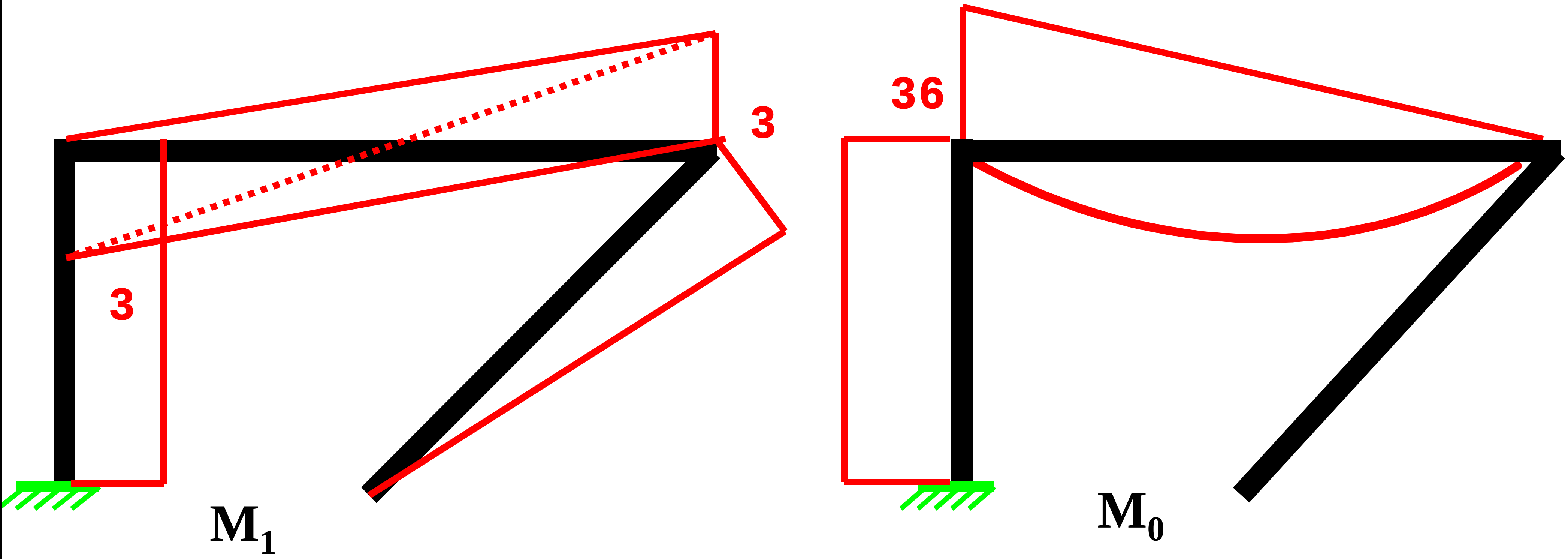


For xb



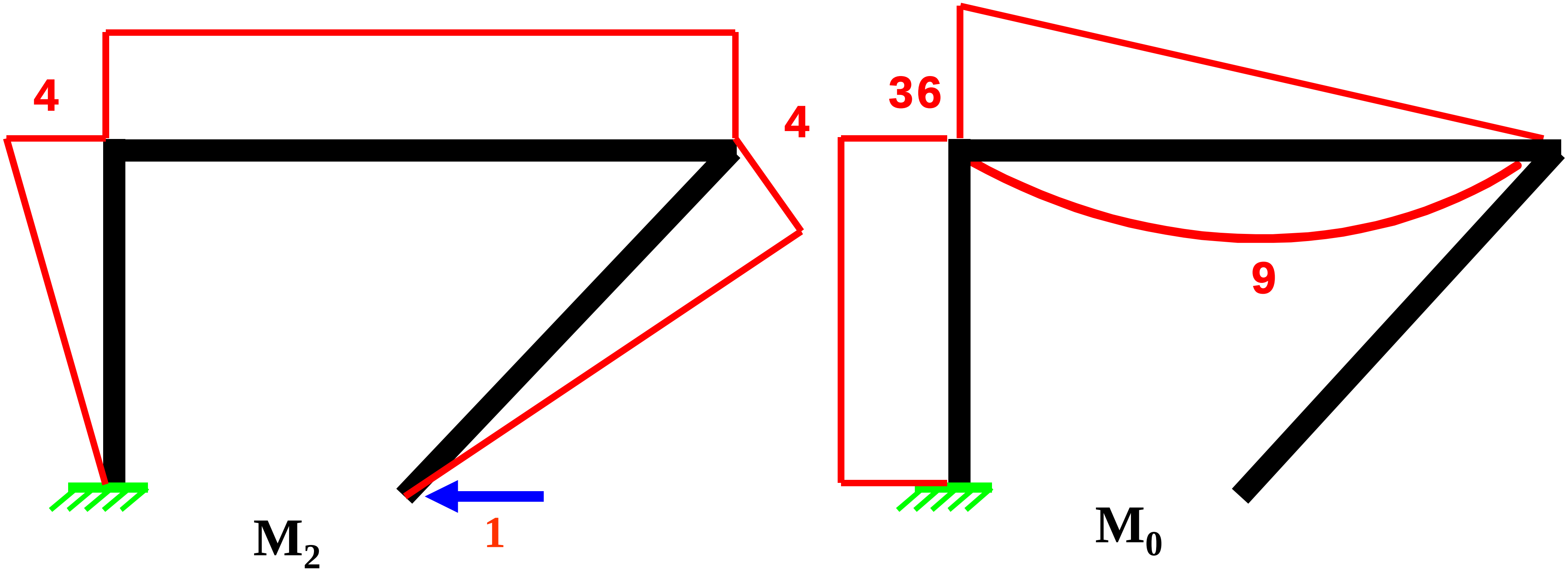


given loads



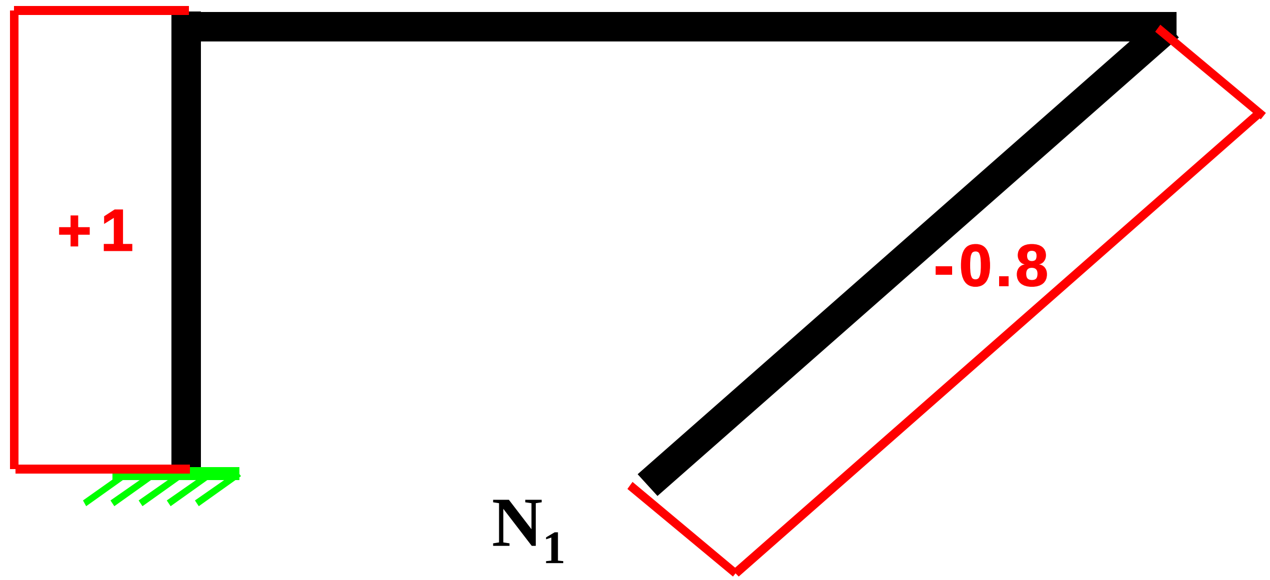
$$yc = \frac{1}{EI}\left[\frac{36*3*6}{6} - \frac{36*3*6}{3} - 36*3*4\right]$$

given loads



$$yc = \frac{1}{EI}\left[\frac{36*4*6}{2} - 2/3*9*6*4 + \frac{36*4*4}{2}\right]$$

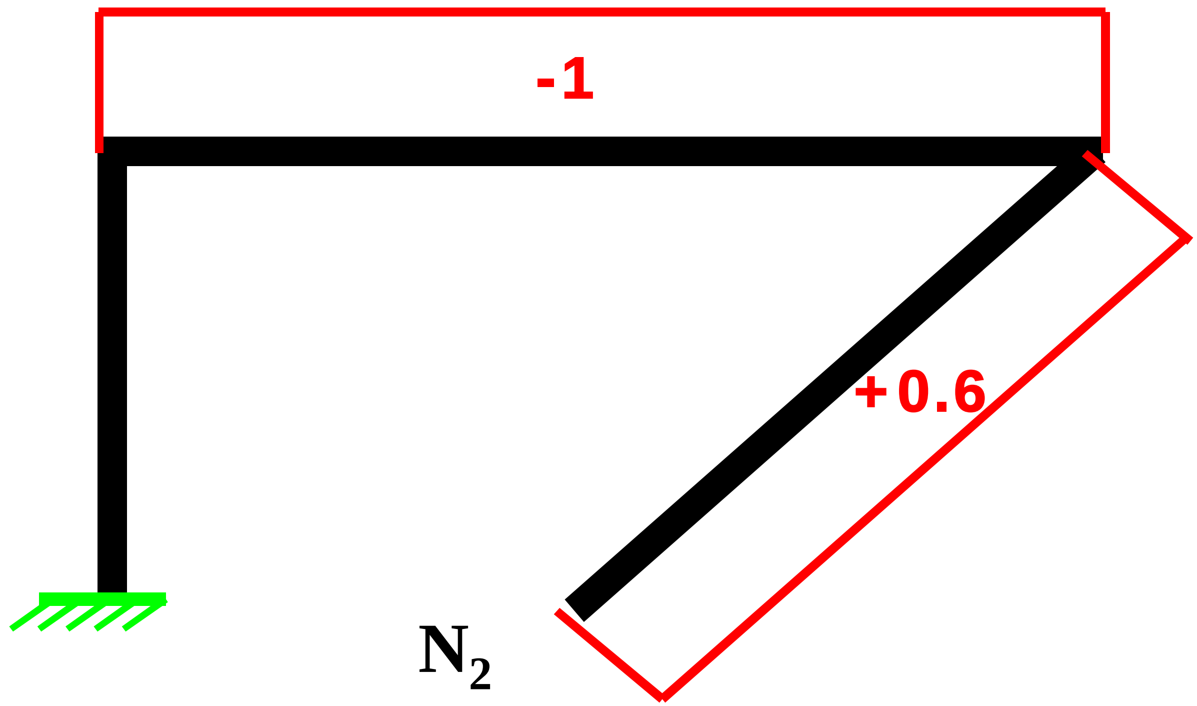
Uniform temperature=30



$$Area\ of\ \ Normal = -0.8 * 5 + 1 * 4 = 0.0$$

$$yc = \alpha * dt * Area\ of\ \ Normal = 10^{-5} * 30 * 0 = 0$$

Uniform temperature=30

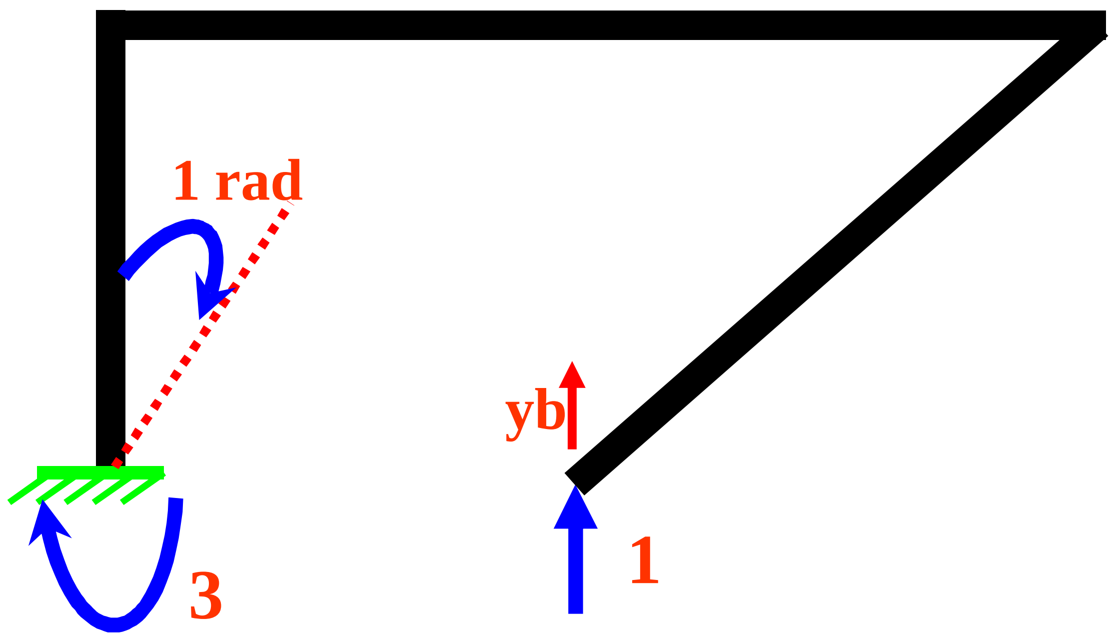


$$Area\ of\ \ Normal = -0.6*5 - 1*6 = -3$$

$$hd = \alpha * dt * Area\ of\ \ Normal = 10^{-5} * 30 * -3 =$$

rotation at b = 1 rad

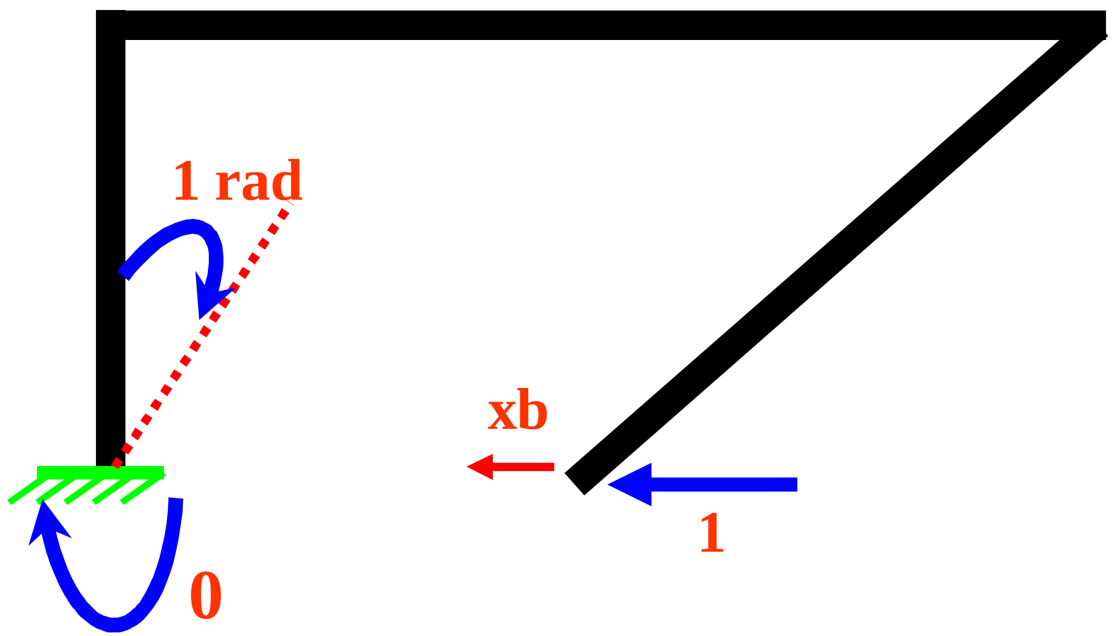
موجب يعنى مع عقارب الساعه



$$1 * yb + 3 * 1 = 0.0$$

$$yb = -3cm$$

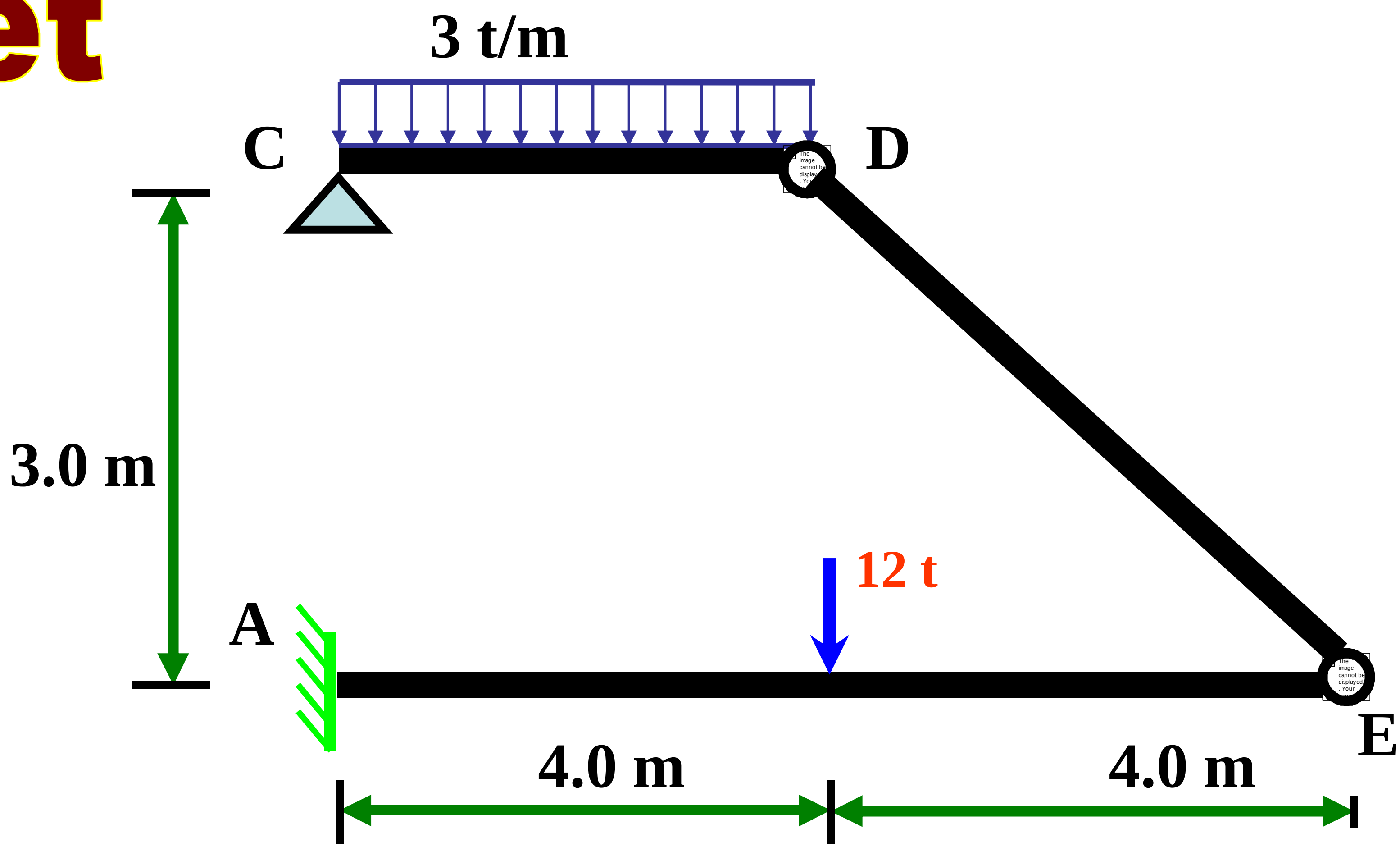
rotation at b = 1 rad



$$1 * xb - 0 * 1 = 0.0$$

$$xb = 0$$

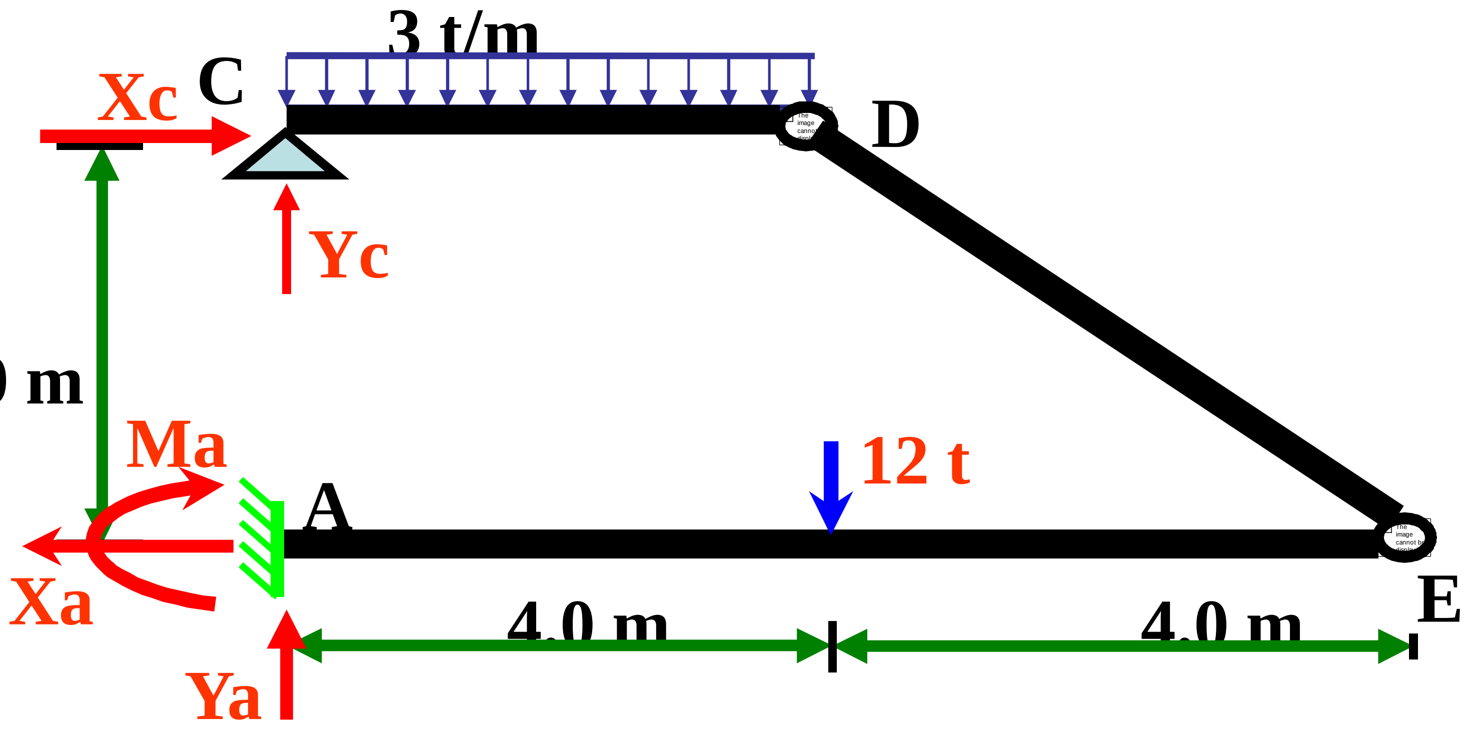
sheet



For the Shown Frame, Calculate:

1- horizontal displacement at D.
2- vertical displacement at E.
3- rotation at C.

$EI = 10000\ t.m^2$.



$\sum M_{DR} = 0.0$

$Y_c * 4 = 12*2$ >> Yc = 6.0

$\sum M_{E\,up} = 0.0$

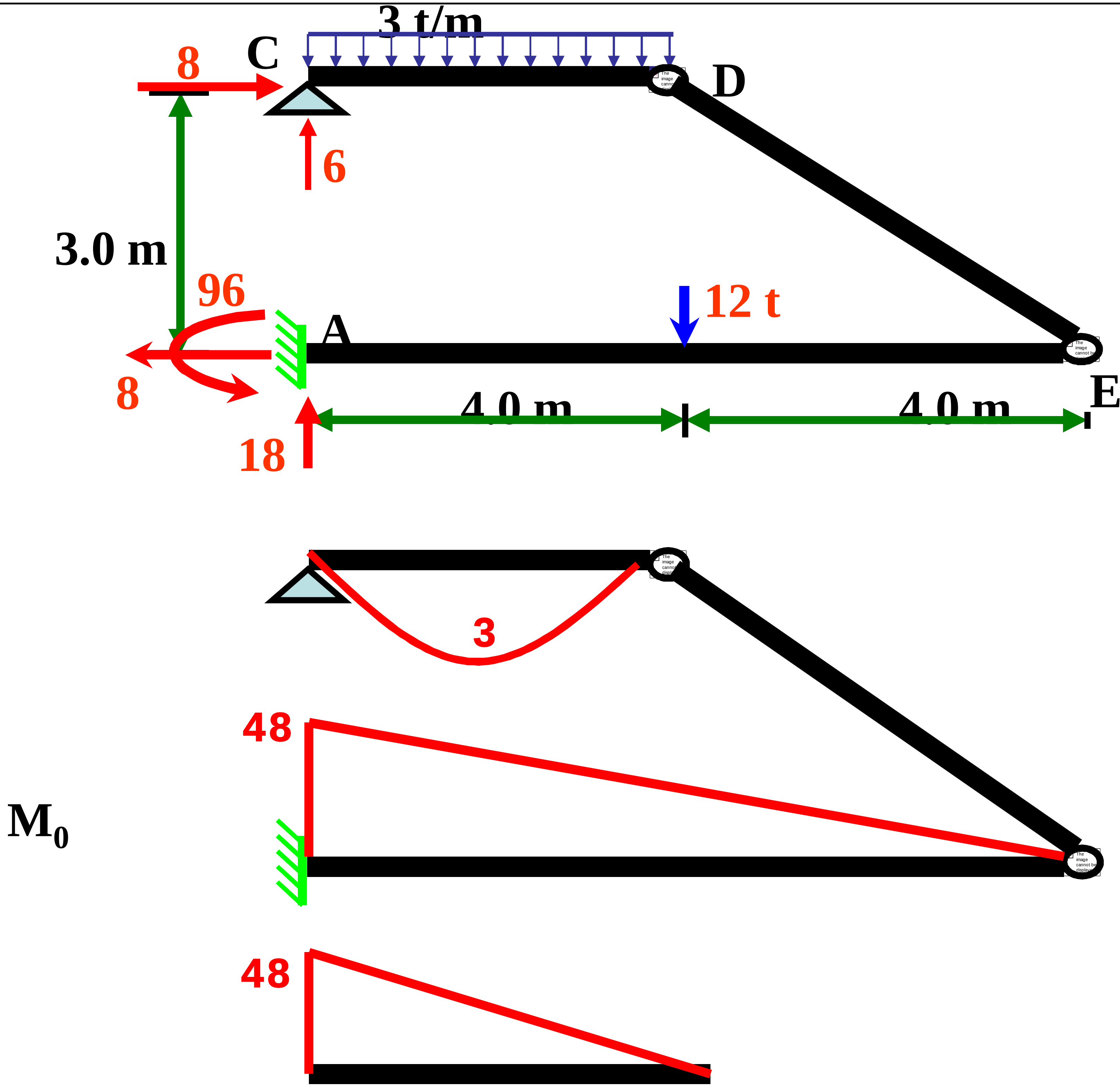
6*8+Xc*3-12*6=0 >>> Xc = 8.0

$\sum F_X = 0.0$

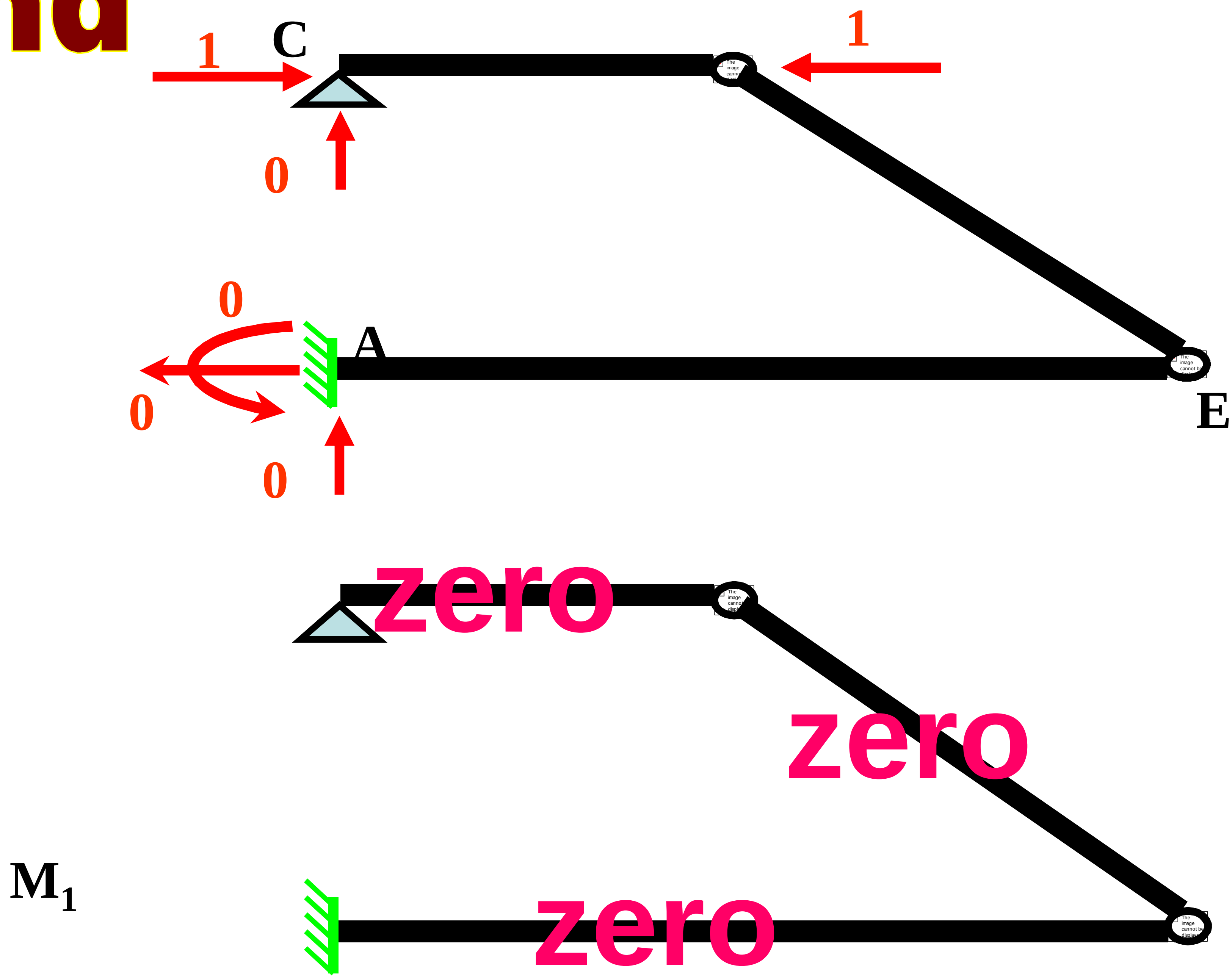
$X_a = 8.0$

$\sum M_A = 0.0$

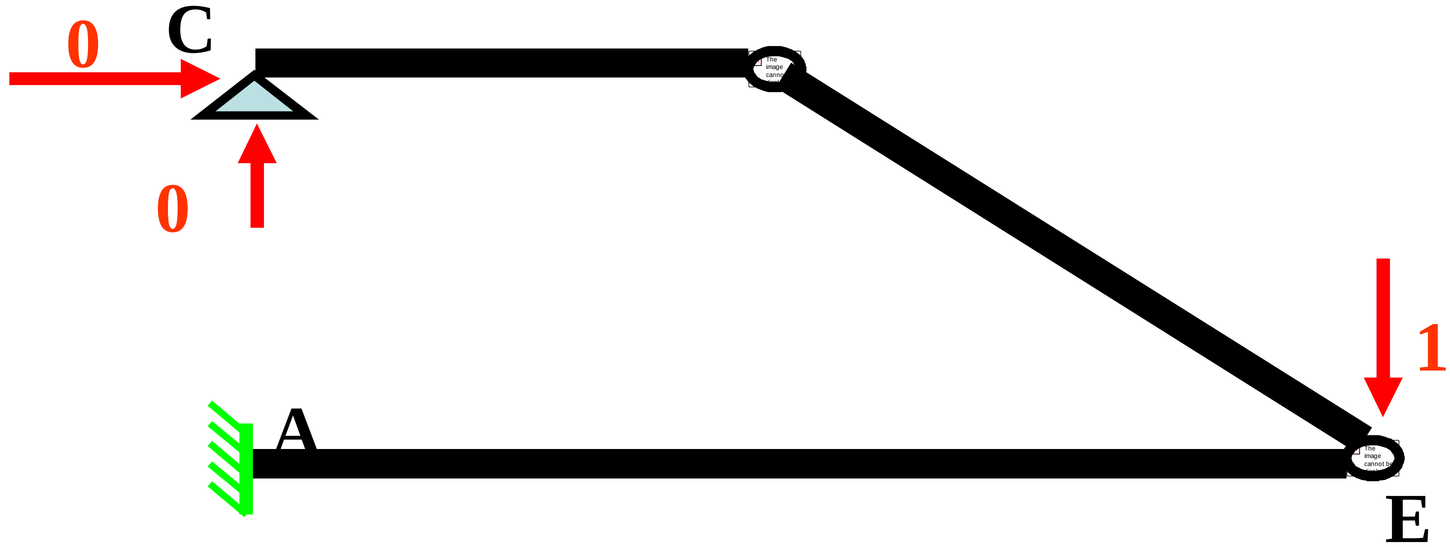
Ma – 8*3 – 12*2 – 12*4 = 0.0 >> Ma = 96

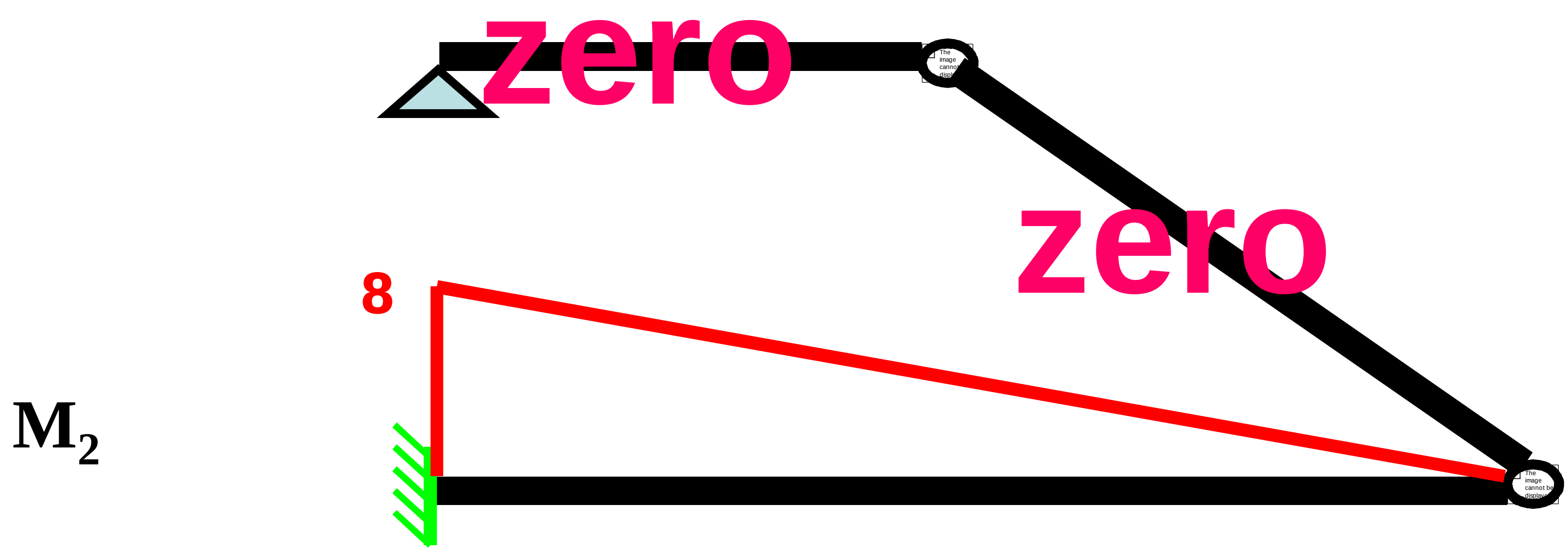

3 t/m
8
C
D
6
3.0 m
96
12 t
A
8
E
4.0 m
4.0 m
18
3
48
M0
48

For hd

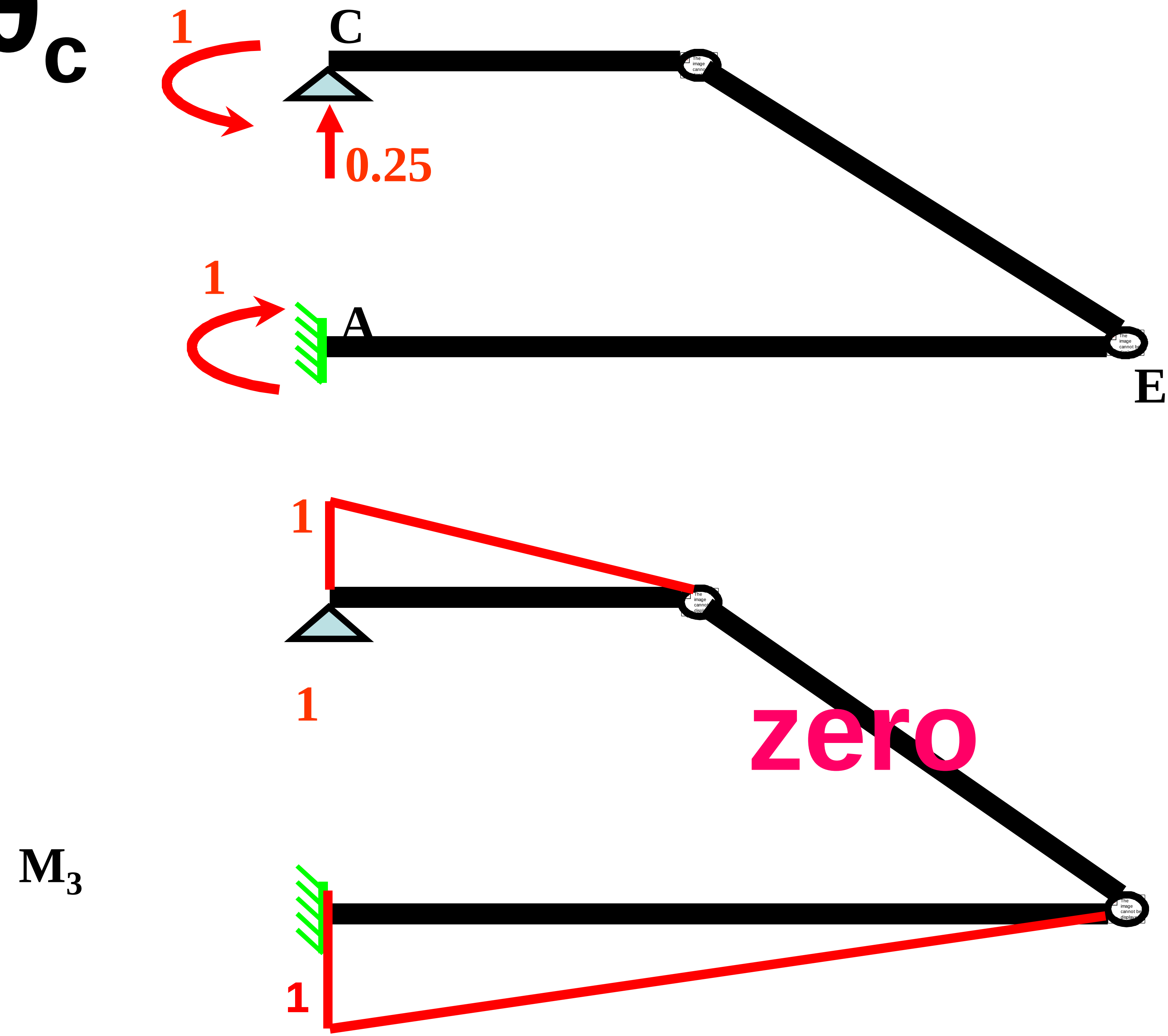


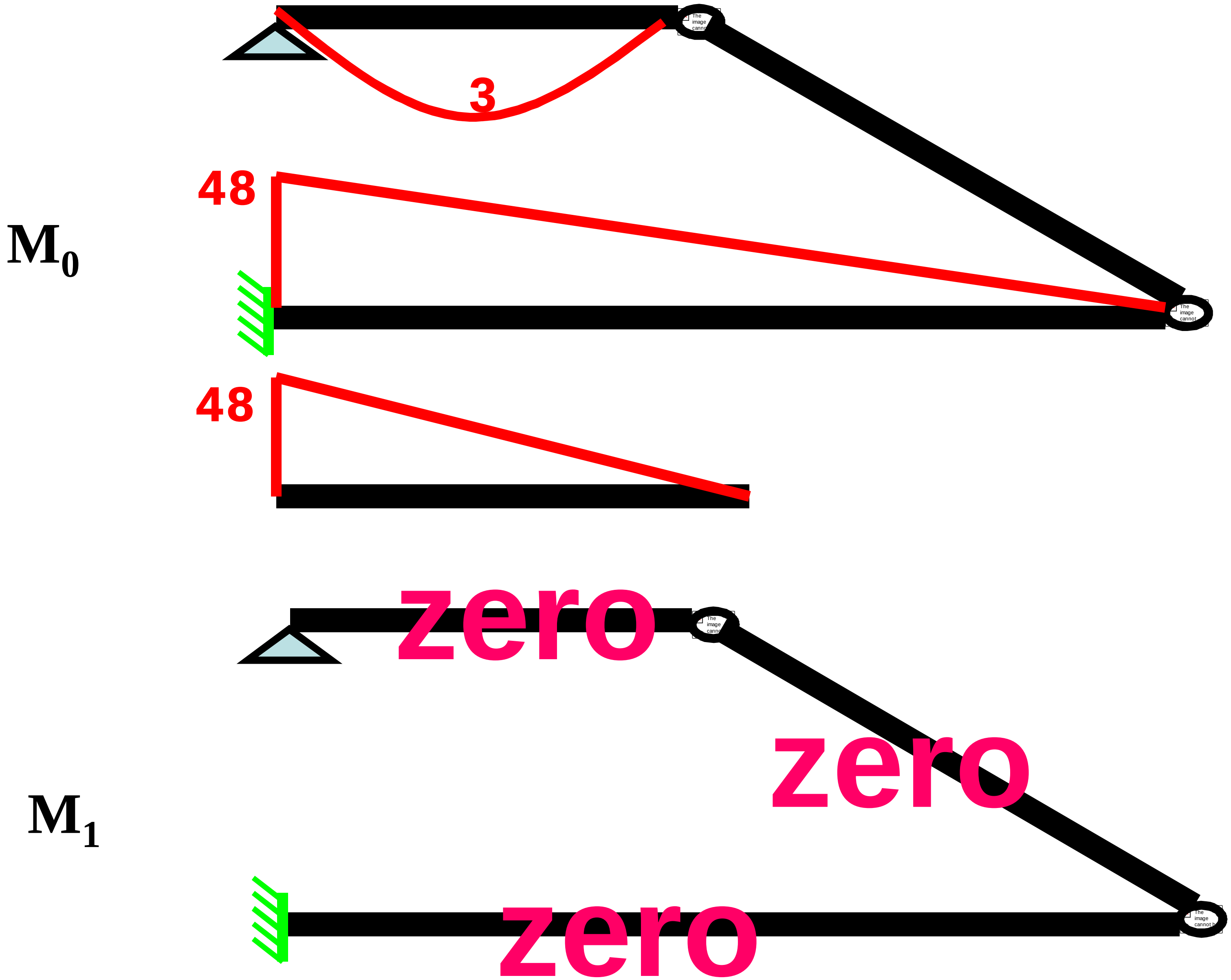
For ye



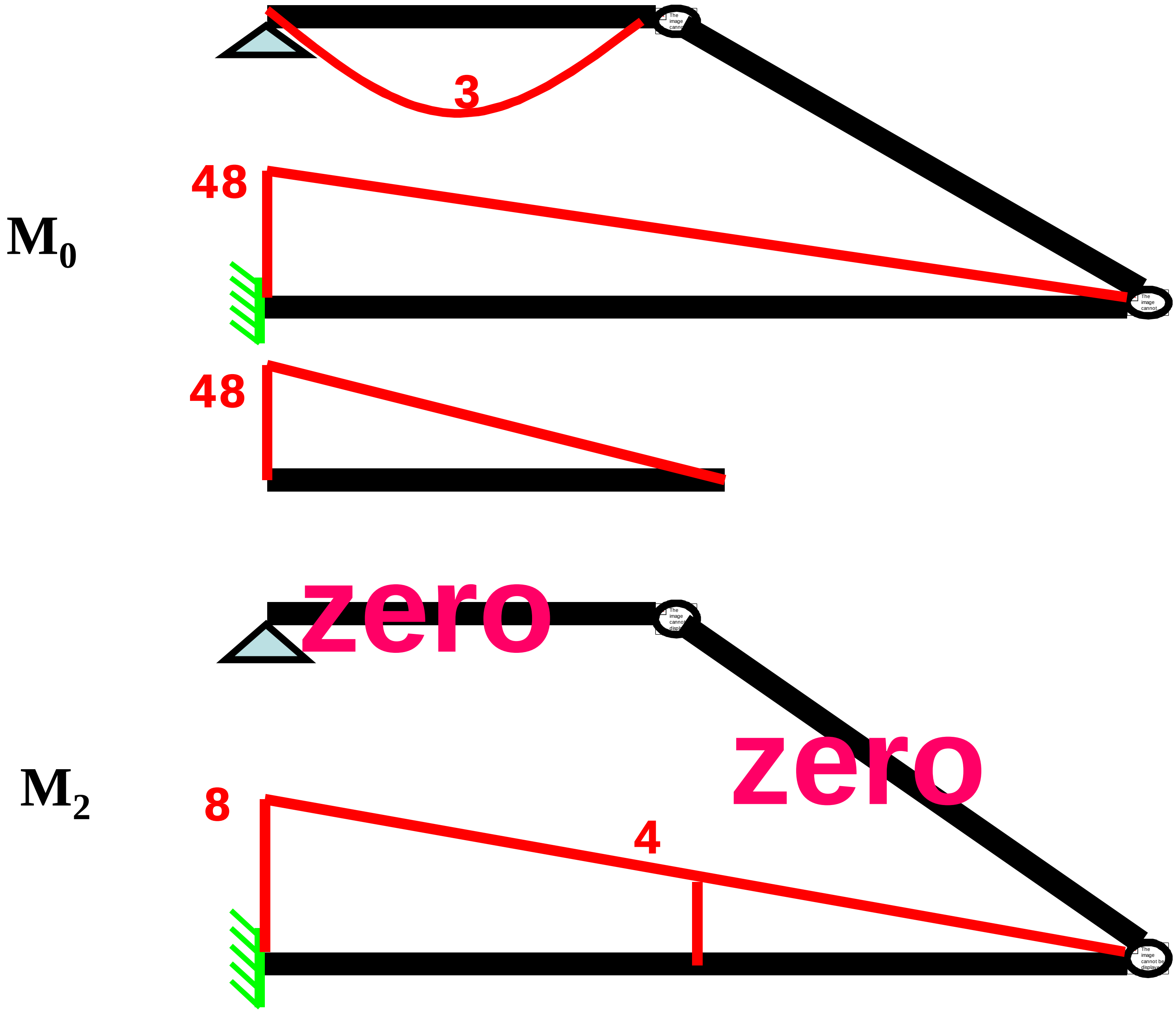


For θ_c

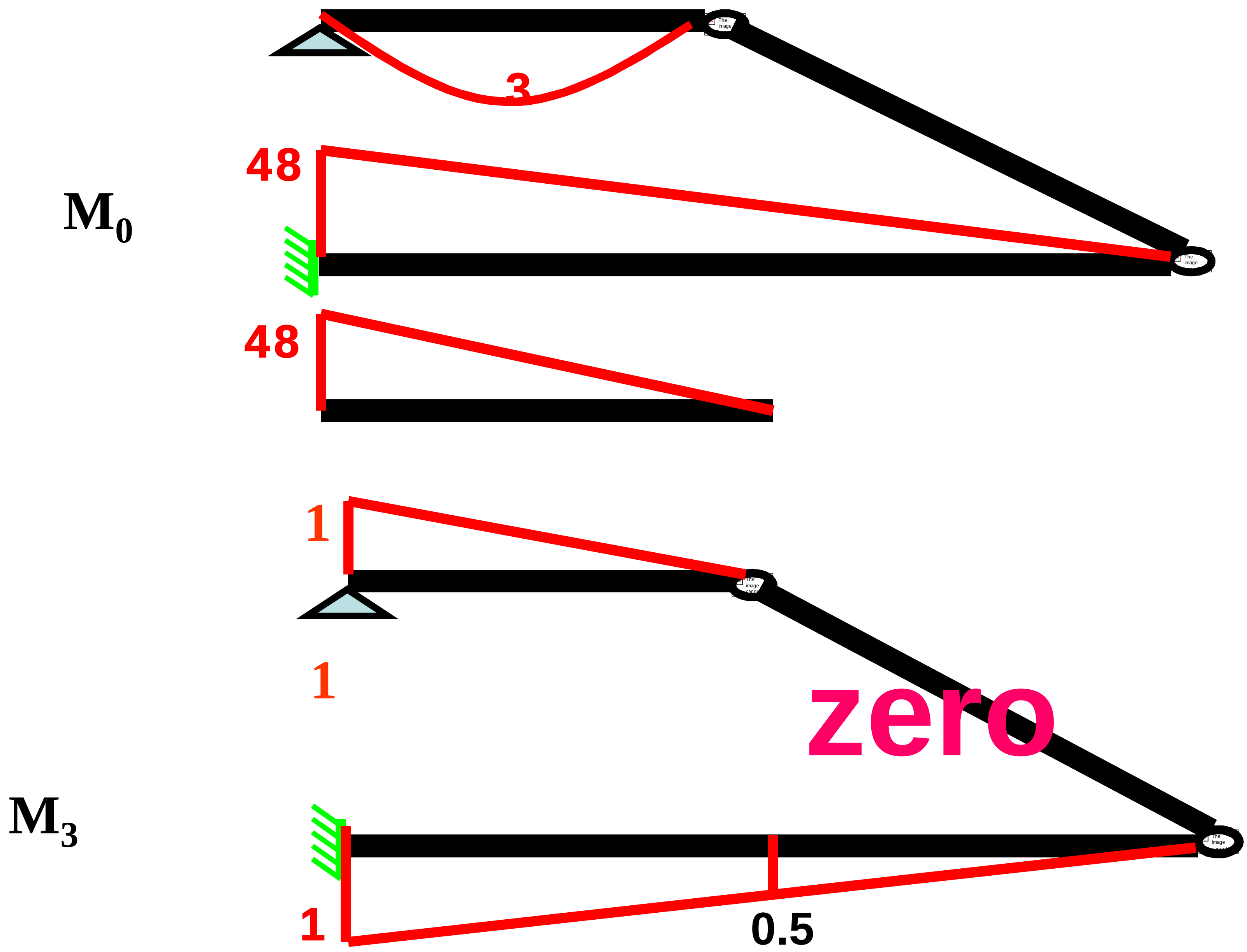




$$hd = 0.0$$



$$ye = \frac{1}{EI}\left[\frac{48*8*8}{3} + \frac{4}{3}\left(48*8 + 0.5(48*4)\right)\right] =$$



$$\theta c = \frac{1}{EI}\left[\frac{-48*1*8}{3} - \frac{4}{3}\left(48*1+0.5(48*0.5)\right) - 2/3*3*4*0.5 \right] =$$

VERTUAL WORK

TRUSSES

خطوات الحل:

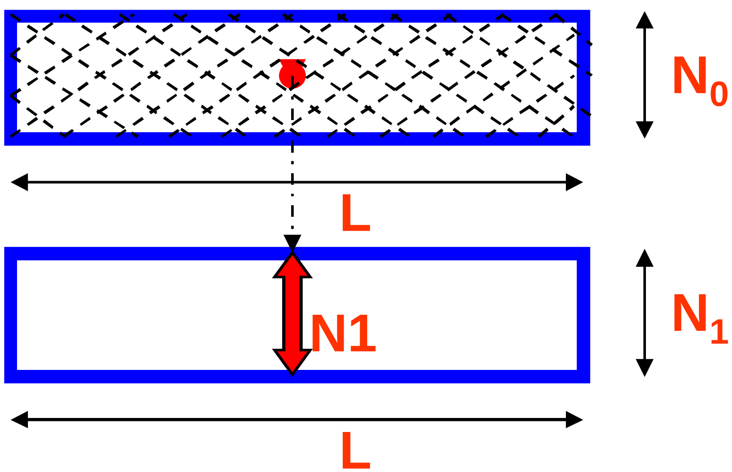
1- يتم رسم الـ normal على الـ truss المعطى.

Find N_0

2- يتم ازالة الاحمال وضع حمل 1ton ورسم الـ normal على الـtruss.

Find N_d

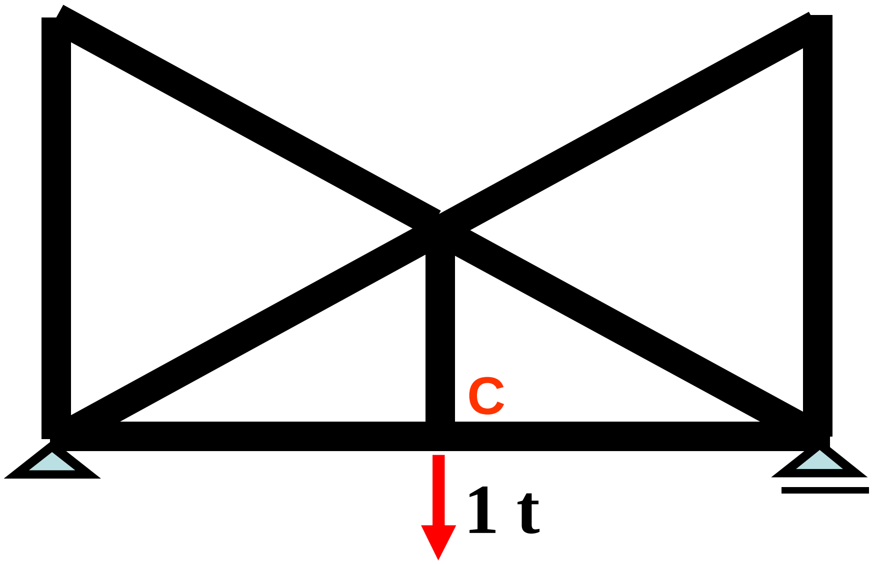
3- يتم تكامل الشكل الاساسي بالخطوه 1 والشكل المرسوم للمطلوب الاول بالخطوه 2 والتكامل هنا سيكون تكامل مساحات:



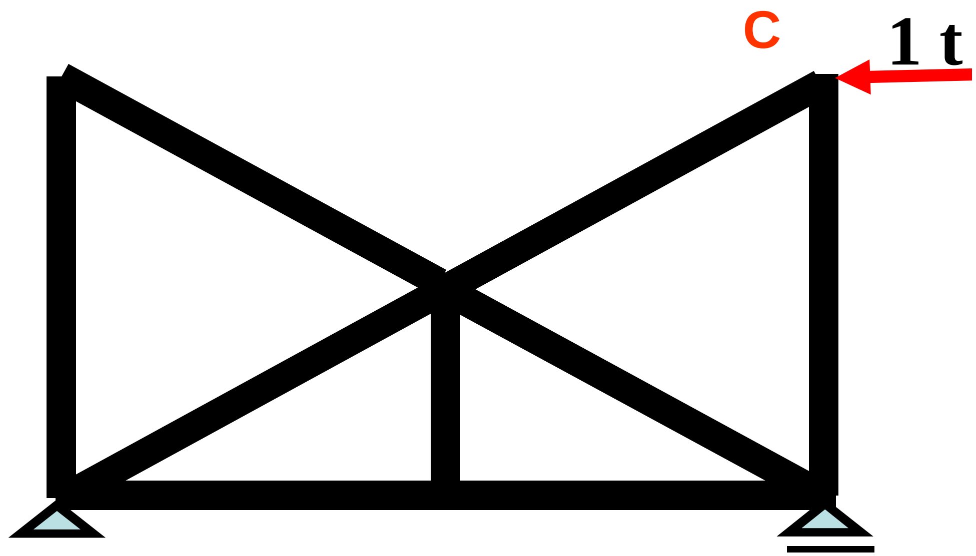
كل رسومات الـ normal فى الـ truss تكون عبارة عن مستطيلات

$$\omega_{internal} = \int \frac{N_0 . N_1}{EA} . dl = \frac{\sum (N_0 . N_1 . L)}{EA}$$

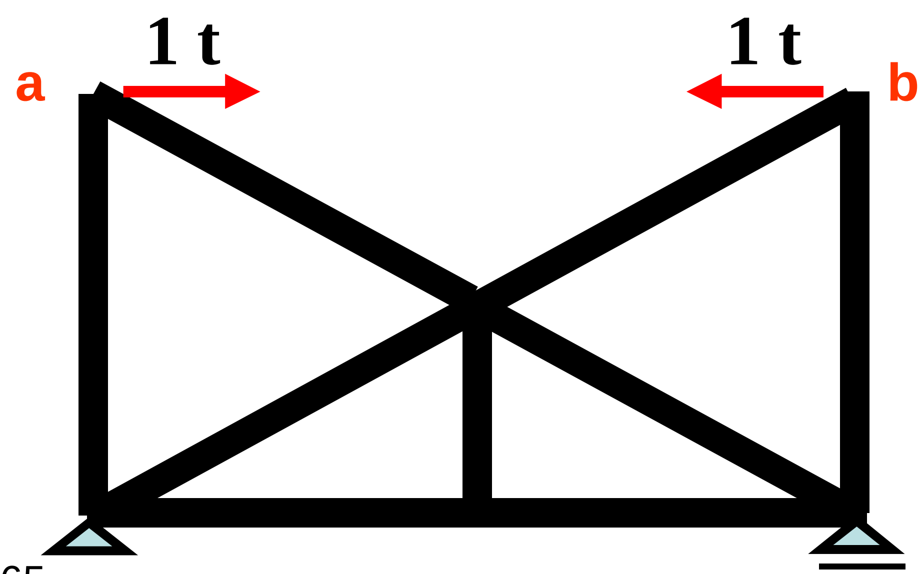
for δvc



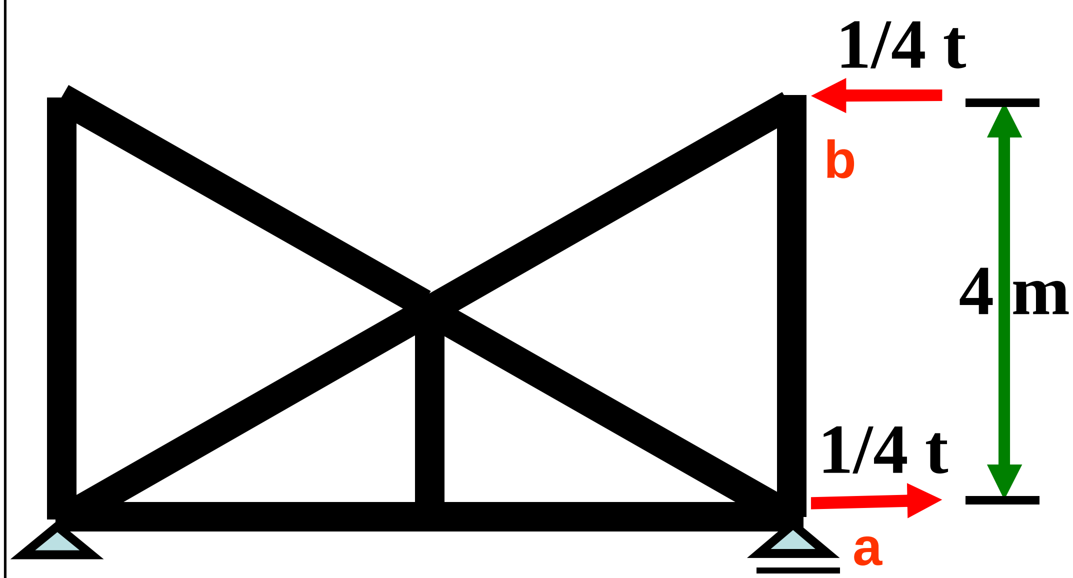
for δhc



for $rel(ab)$



for θab



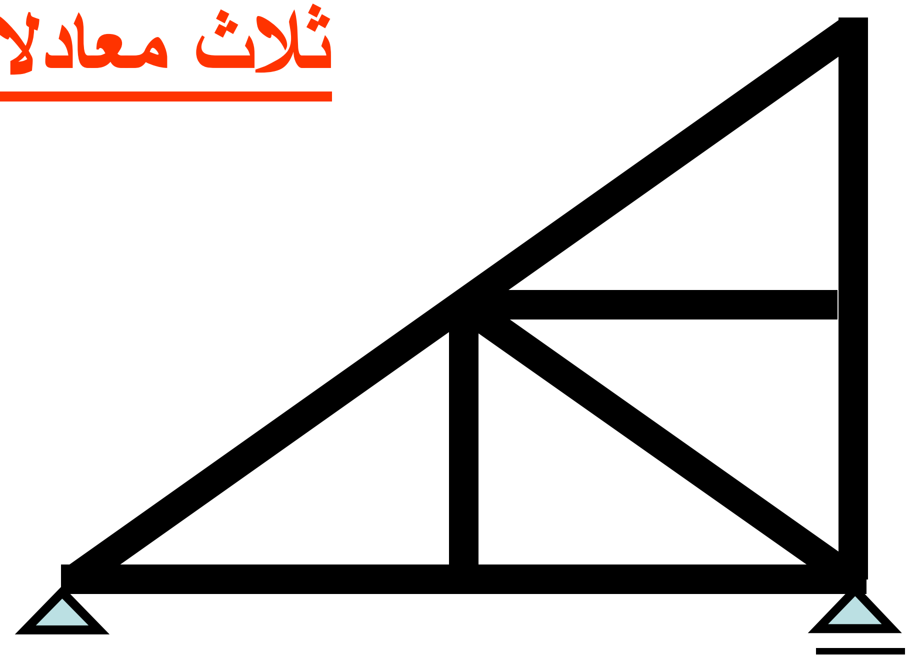
مراجعـــــــــــة سريعــــــــــــه على بعض المصطلحــــــــات مــن المعلومــــات السابقـــة

ثلاث معادلات وثلاث مجاهيل

$$\sum F_X = 0.0$$

$$\sum F_Y = 0.0$$

$$\sum M_A = 0.0$$



خمس معادلات وخمس مجاهيل

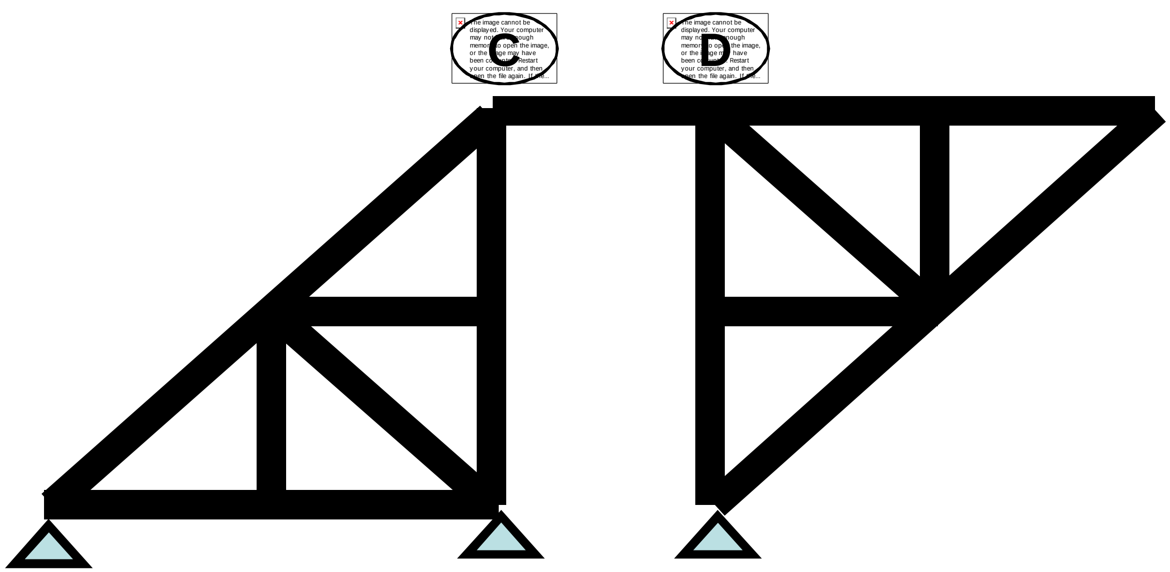
$$\sum F_X = 0.0$$

$$\sum F_Y = 0.0$$

$$\sum M_A = 0.0$$

$$\sum M_{CR} = 0.0$$

$$\sum M_{DR} = 0.0$$



خمس معادلات وخمس مجاهيل

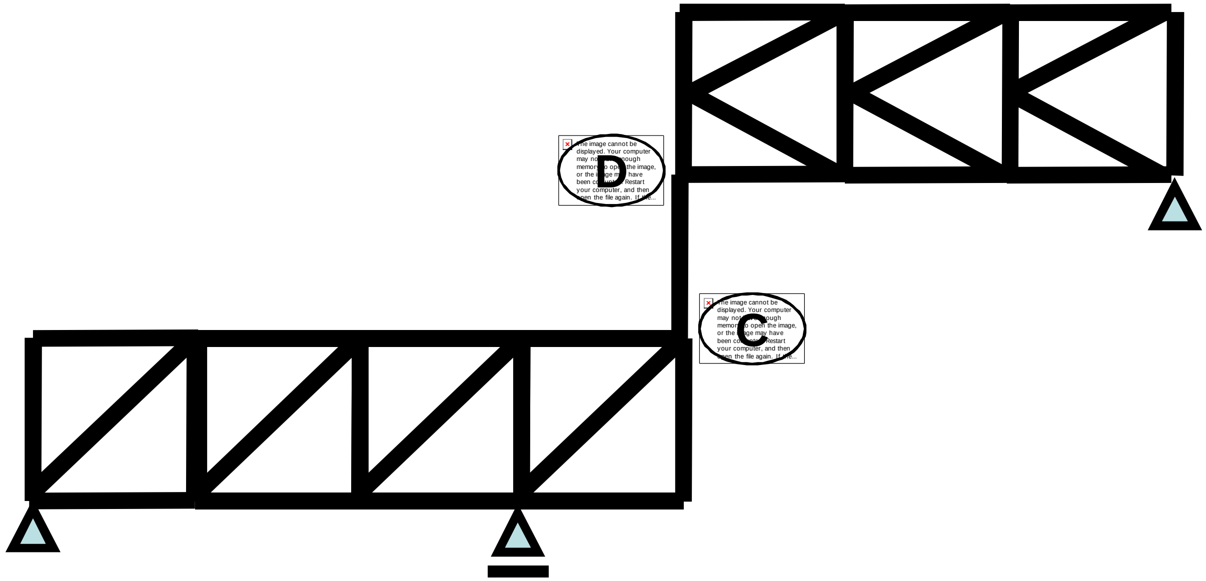
$$\sum F_X = 0.0$$

$$\sum F_Y = 0.0$$

$$\sum M_A = 0.0$$

$$\sum M_{CR} = 0.0$$

$$\sum M_{DR} = 0.0$$



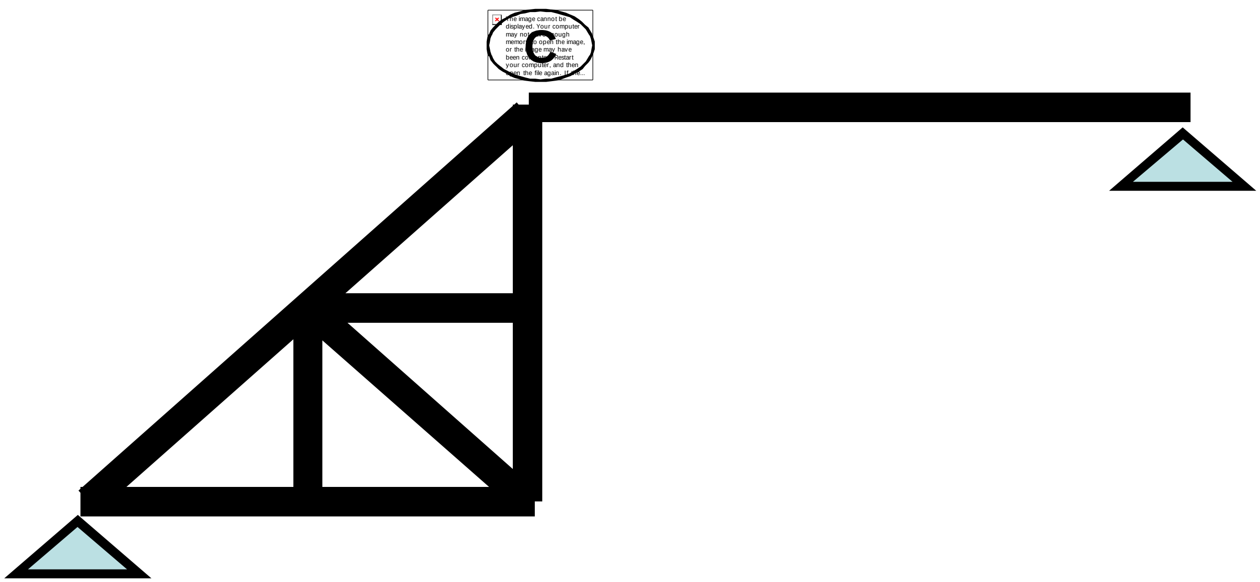
اربع معادلات واربع مجاهيل

$$\sum F_X = 0.0$$

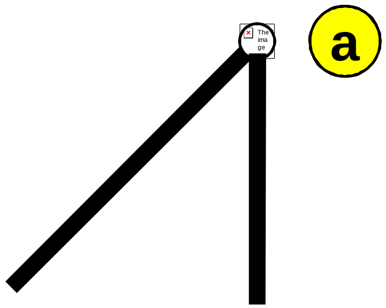
$$\sum F_Y = 0.0$$

$$\sum M_A = 0.0$$

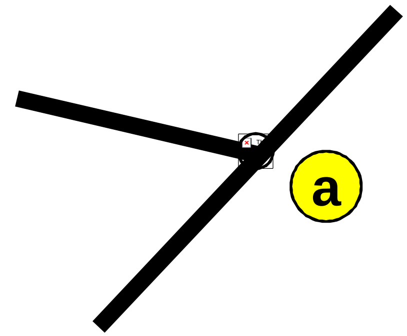
$$\sum M_{CR} = 0.0$$



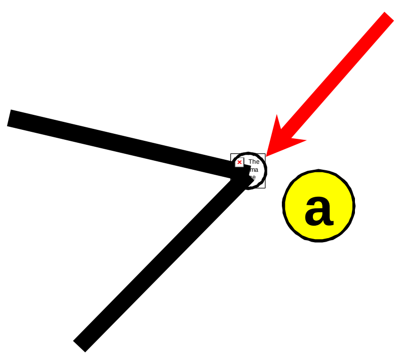
Zero members



- Joint
  - No loads
  - Only two members
  - The two members are zeros

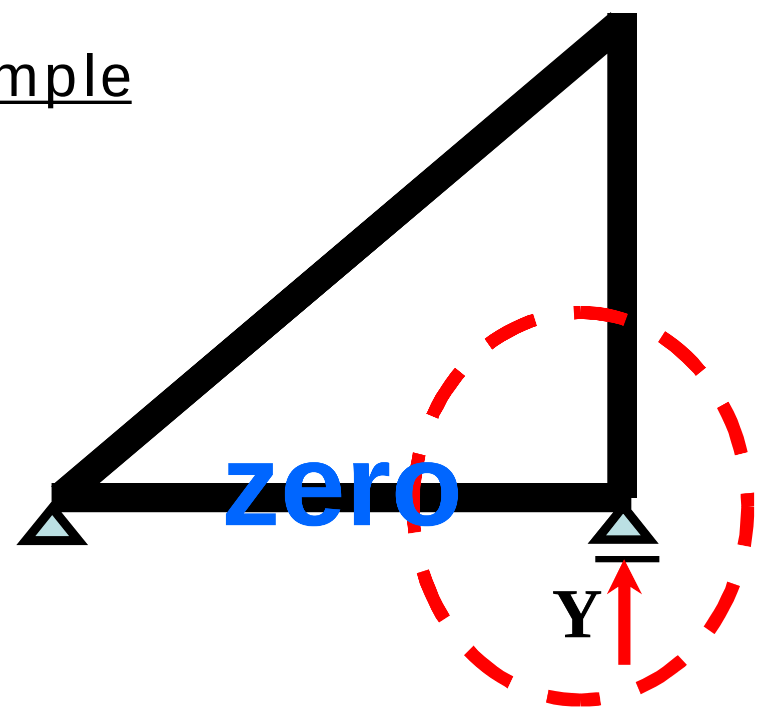


- Joint
  - No loads
  - عنصرين فى اتجاه واحد والثالث مخالف
  - 0.0 = العنصر الثالث



- Joint
  - قوة باستقامة عنصر والثالث مخالف
  - 0.0 = العنصر الثالث

- Example

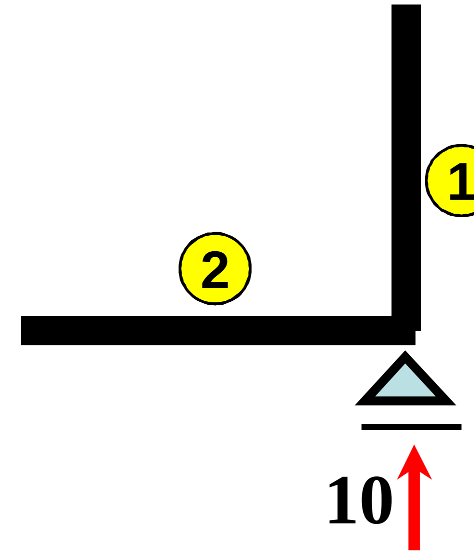


Some famous joints

Joint one

F1 =10 ↓

F2 =0.0



Joint two

$\sum F_y = 0$

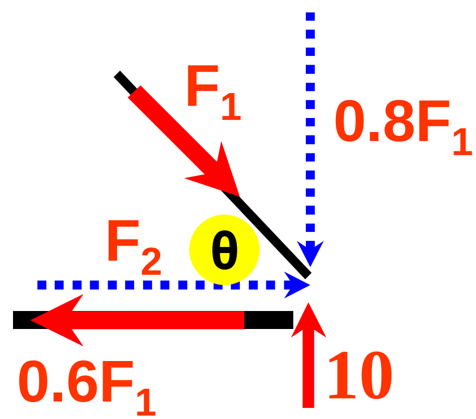
$0.8F_1 - 10 = 0$

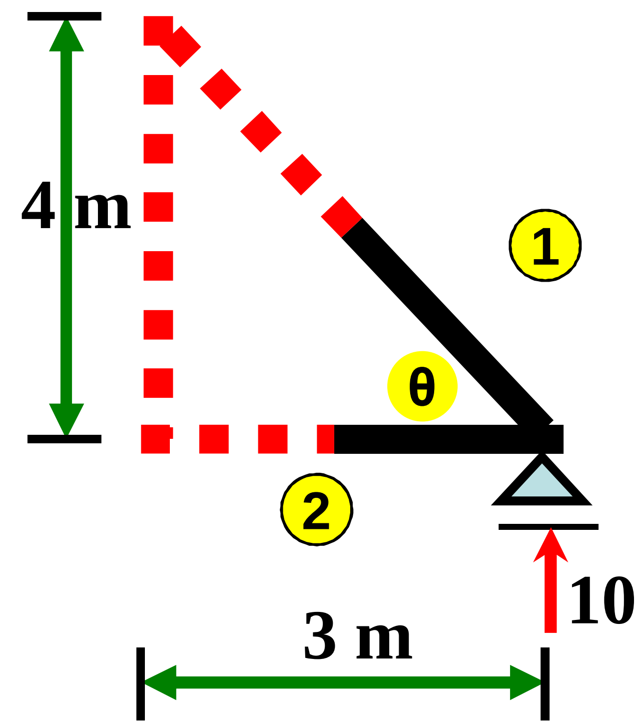
$F_1 = 12.5$

$\sum F_x = 0$

$12.5 * 0.6 - F_2 = 0$

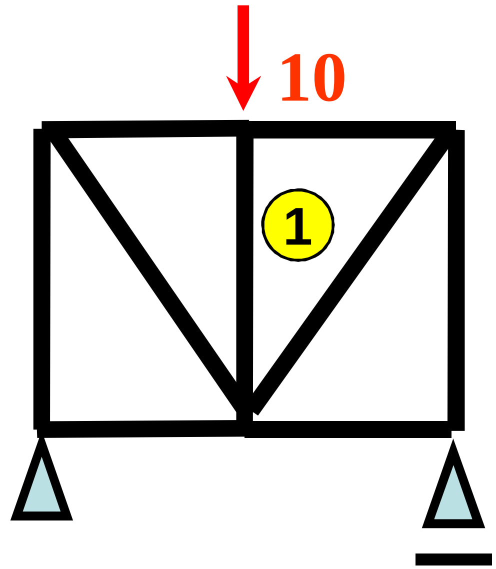
$F_1 = 7.5$





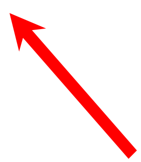
Joint three

F1 =15

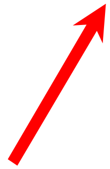


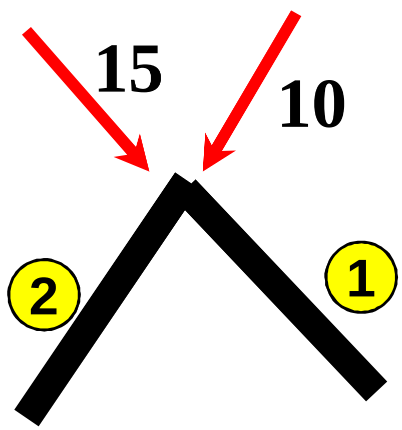
Joint four

F1 =15

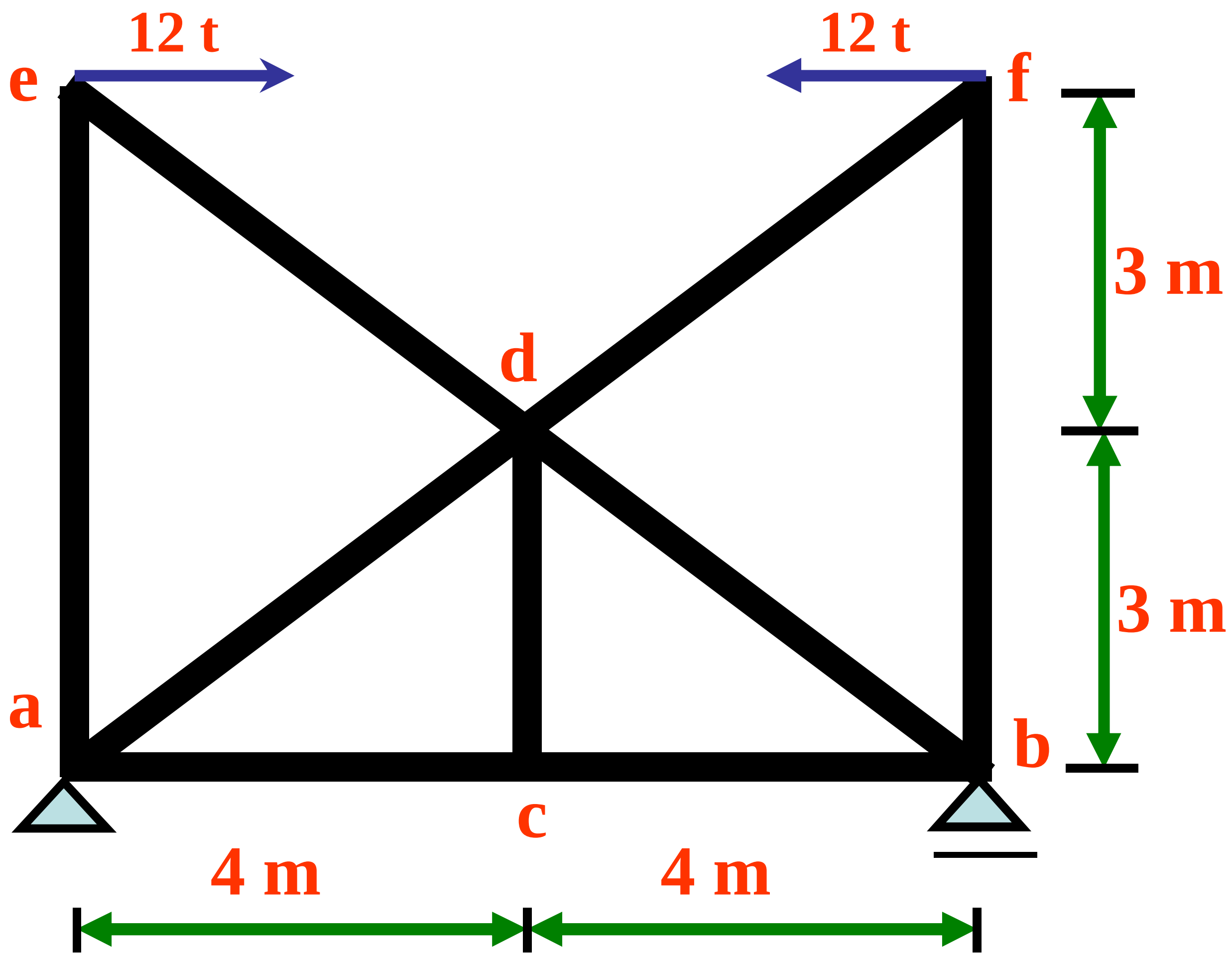


F2 =10





Example One

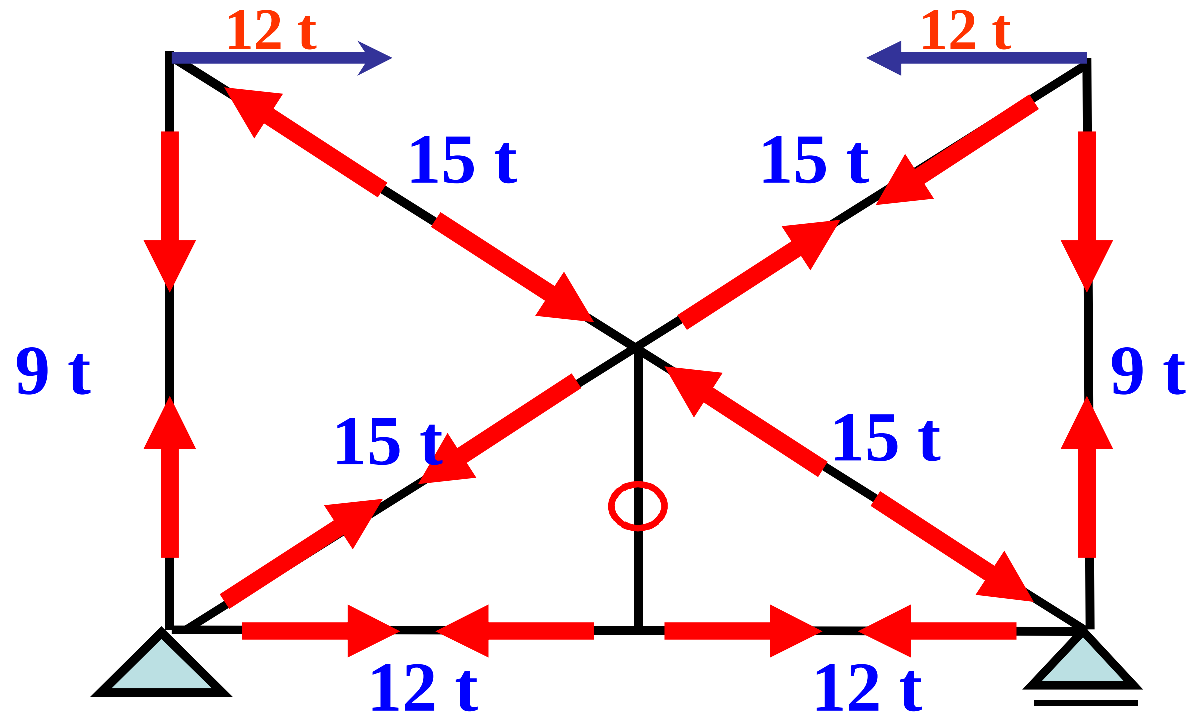


EA=10000 t

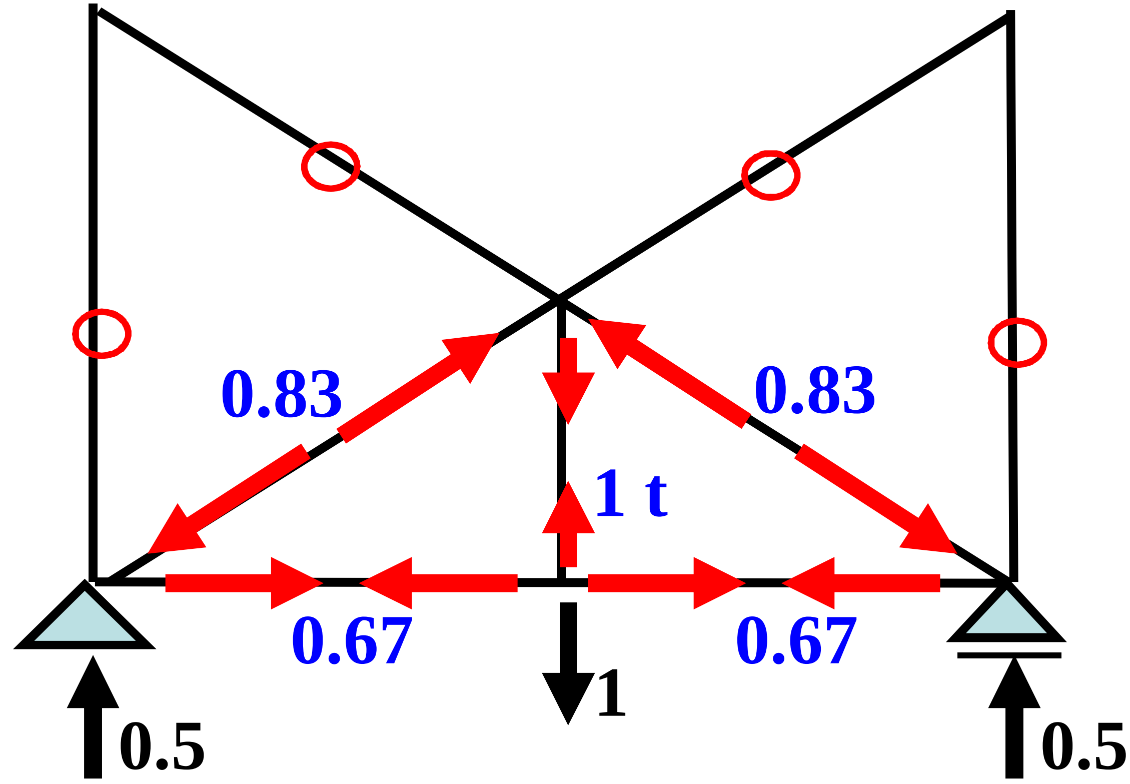
Required

$$\delta vc,\ \delta rel(fe),\ and\ \theta(fb)$$

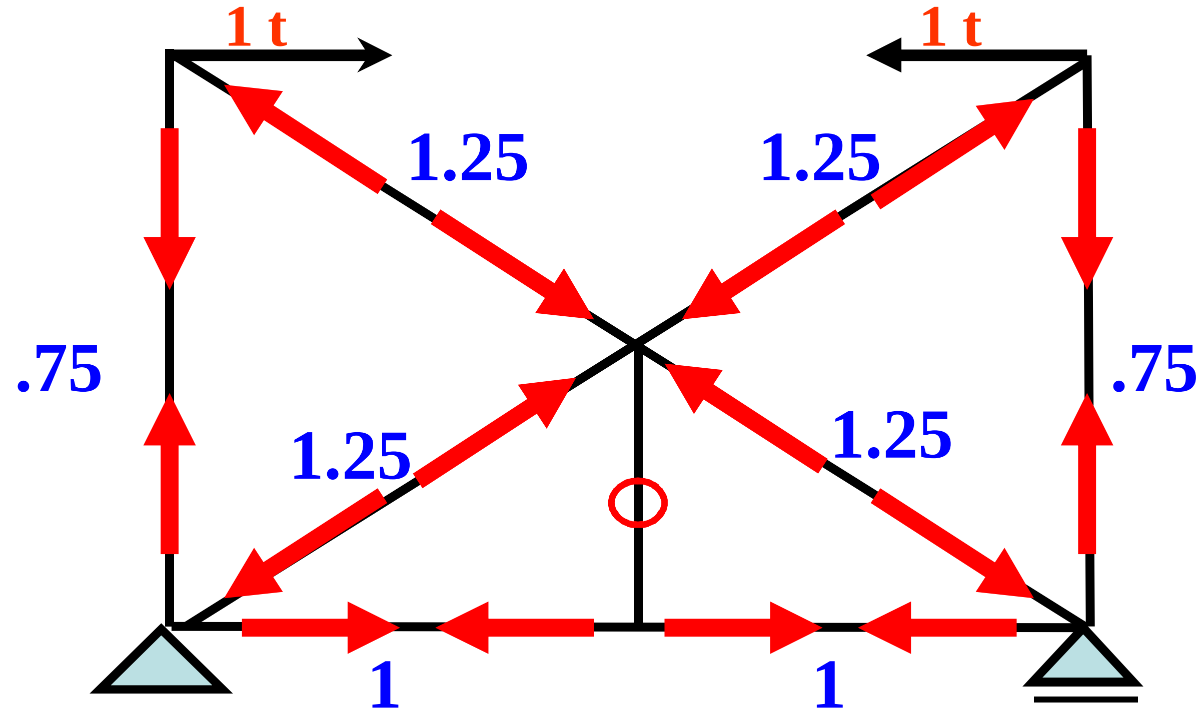
N_0



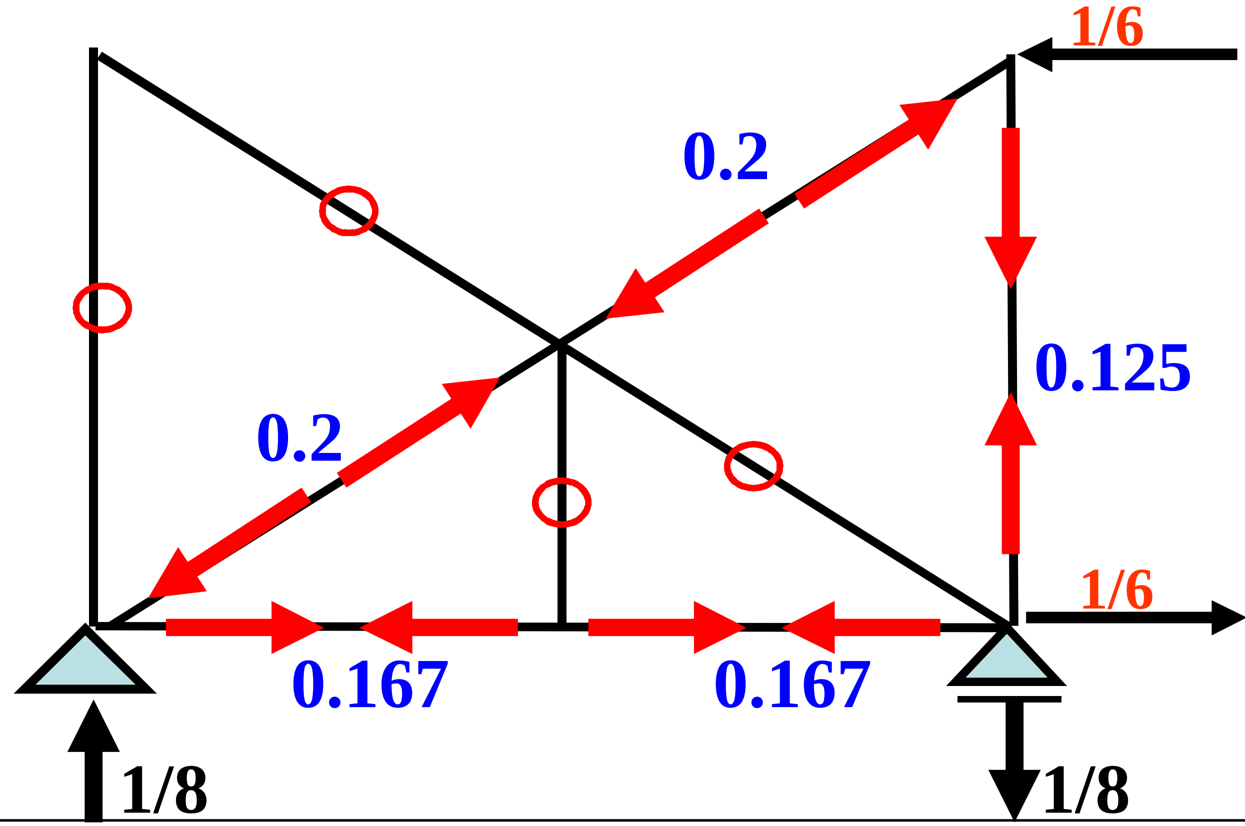
N_1



N_2



N_3



member	L	N_0	N_1	N_2	N_3	$N_0 N_1 L$	$N_0 N_2 L$	$N_0 N_3 L$
Ac	4	12	0.67	1	0.167	32	48	8
Cb	4	12	0.67	1	0.167	32	48	8
Ae	6	9	0	0.75	0	0	40.5	0
Cd	3	0	1	0	0	0	0	0
Bf	6	9	0	0.75	0.125	0	40.5	6.75
Ad	5	-15	-0.83	-1.25	-0.2	62.5	93.75	15.625
Df	5	-15	0	-1.25	-0.2	0	93.75	15.625
Bd	5	-15	-0.83	-1.25	0	62.5	93.75	0
De	5	-15	0	-1.25	0	0	93.75	0
∑						189	552	54

$$\delta vc = \frac{\sum N_0 N_1 L}{EA} = \frac{189}{EA}$$

$$\delta rel(fe) = \frac{\sum N_0 N_2 L}{EA} = \frac{552}{EA}$$

$$\theta(fb) = \frac{\sum N_0 N_3 L}{EA} = \frac{54}{EA}$$

CASE OF SETTELMENT الـهبوط

1- يتم ازالة كل الاحمال من الكمرة.

2- يتم وضع واحد طن عند النقطه المطلوب عندها الهبوط.

3- يتم حساب الـــ reactionالناتج عن الواحد طن.

$$\sum (F * y + M * \theta) = 0.0$$

للمثال السابق

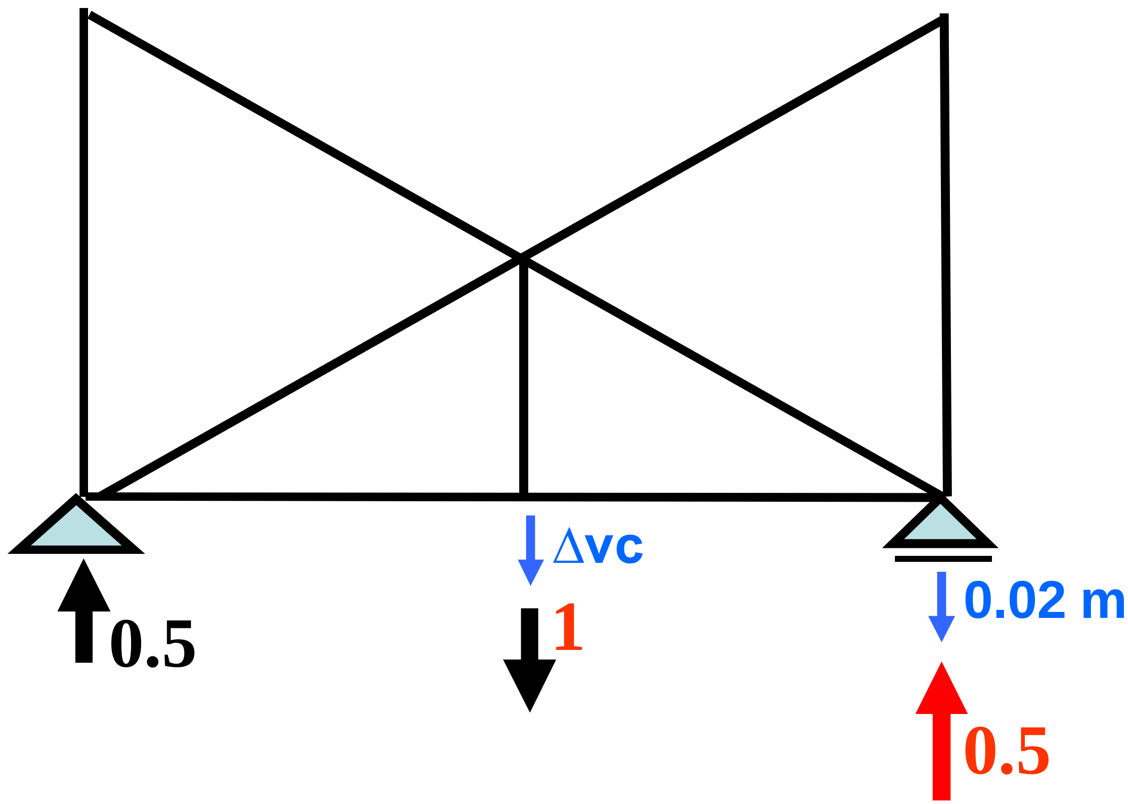
اذا كان المطلوب الثانى هو

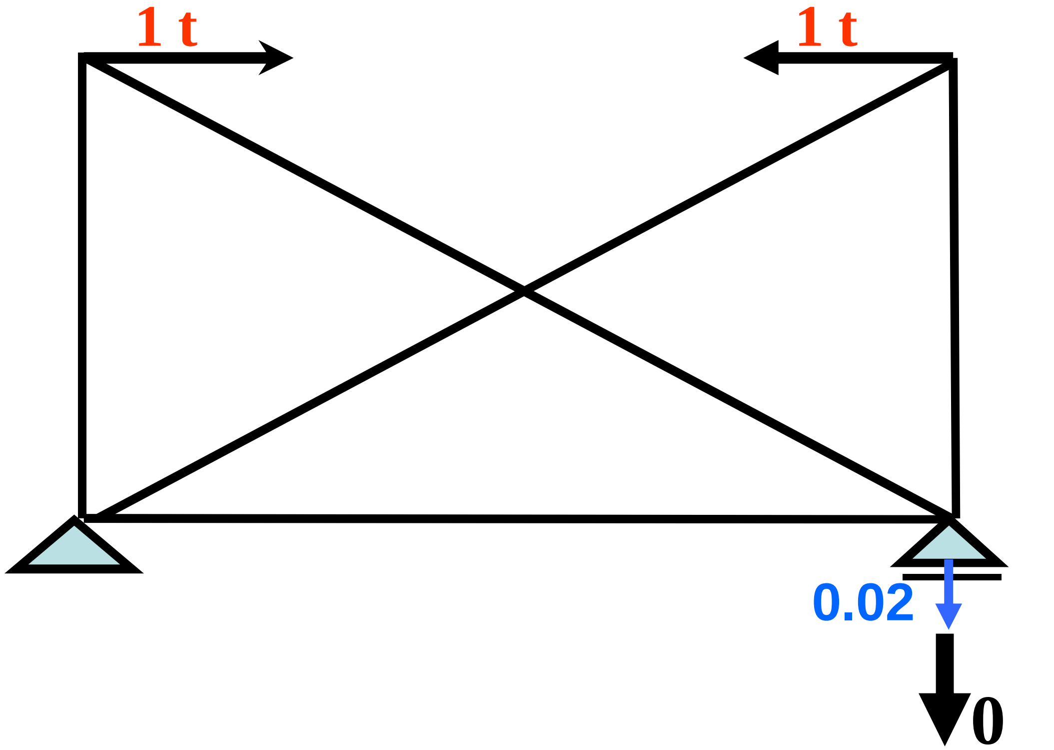
$$\text{Required}$$

$$\delta vc,\ \delta rel(fe),\ and\ \ \theta(fb) \qquad due\,to\,settelment\,at\,B = 2cm$$

$$1 * \Delta vc - 0.5 * 0.02 = 0.0$$

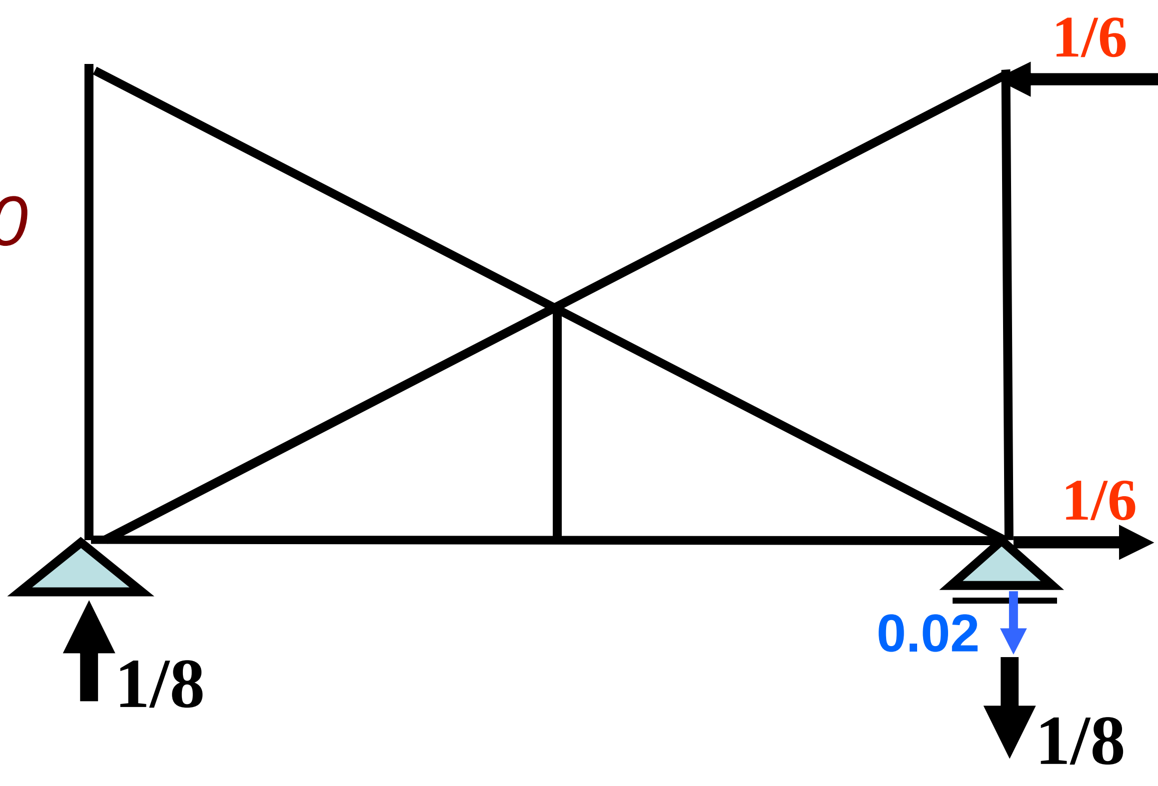
$$>> \Delta vc = 0.01\ m$$





$1 * \Delta rel(ef) - 0 * 0.02 = 0.0$

$>> \Delta rel(ef) = 0.0$



$1 * \theta fb + 1/8 * 0.02 = 0.0$

$>> \theta fb = 0.0025\ rad$

CASE OF TEMPRATURE تأثير الحرارة

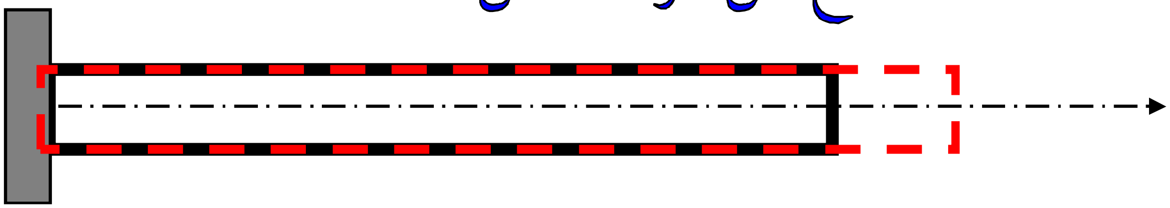
Case of uniform temprature.

طريقة الحل

1- يتم ازالة كل الاحمال من الكمرة.

2- يتم وضع واحد طن عند النقطه المطلوب عندها الهبوط.

3- يتم رسم normal الناتج عن الواحد طن.



y or θ = α * dt * (Area of normal) = α * dt *∑ (N*L)

للمثال السابق

اذا كان المطلوب الثالث هو

Required

$\delta vc,\ \delta rel(fe),\ and\ \ \theta(fb)\quad due\,to\,uniform\ rise\ in\ temp\ in\ all\ members$

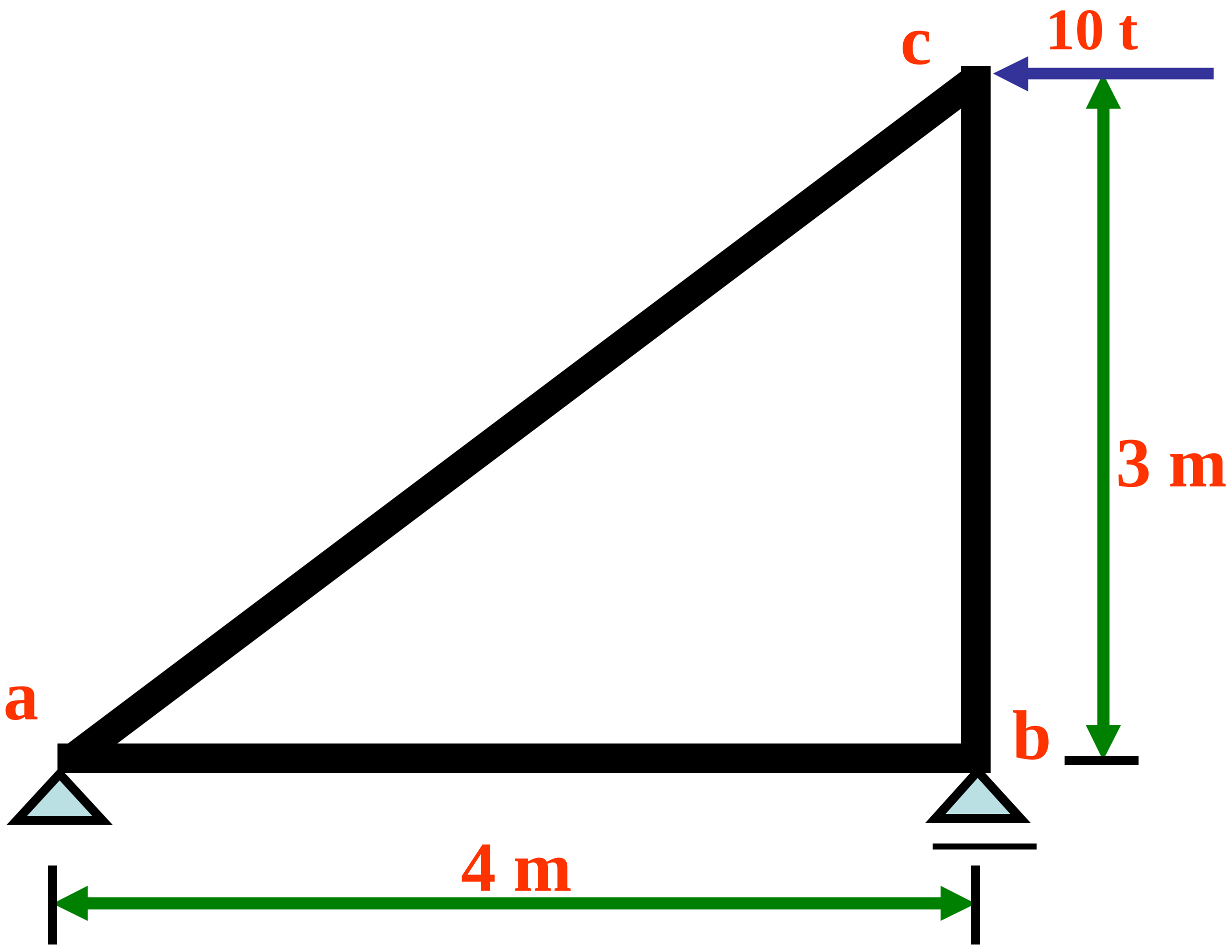
member	L	N_0	N_1	N_2	N_3	N_1L	N_2L	N_3L
Ac	4	12	0.67	1	0.167	2.68	4	0.67
Cb	4	12	0.67	1	0.167	2.68	4	0.67
Ae	6	9	0	0.75	0	0	4.5	0
Cd	3	0	1	0	0	3	0	0
Bf	6	9	0	0.75	0.125	0	4.5	0.75
Ad	5	-15	-0.83	-1.25	-0.2	-4.15	-6.25	-1
Df	5	-15	0	-1.25	-0.2	0	-6.25	-1
Bd	5	-15	-0.83	-1.25	0	-4.15	-6.25	0
De	5	-15	0	-1.25	0	0	-6.25	0
∑						0.0	-12.5	0.083

$$\delta vc = \alpha.\Delta t.\sum(N_1 L) = 10^{-5} * 40 * 0 = 0$$

$$\delta rel(fe) = \alpha.\Delta t.\sum(N_2 L) = 10^{-5} * 40 * -12.5$$

$$\theta(fb) = \alpha.\Delta t.\sum(N_3 L) = 10^{-5} * 40 * 0.83$$

Example Two



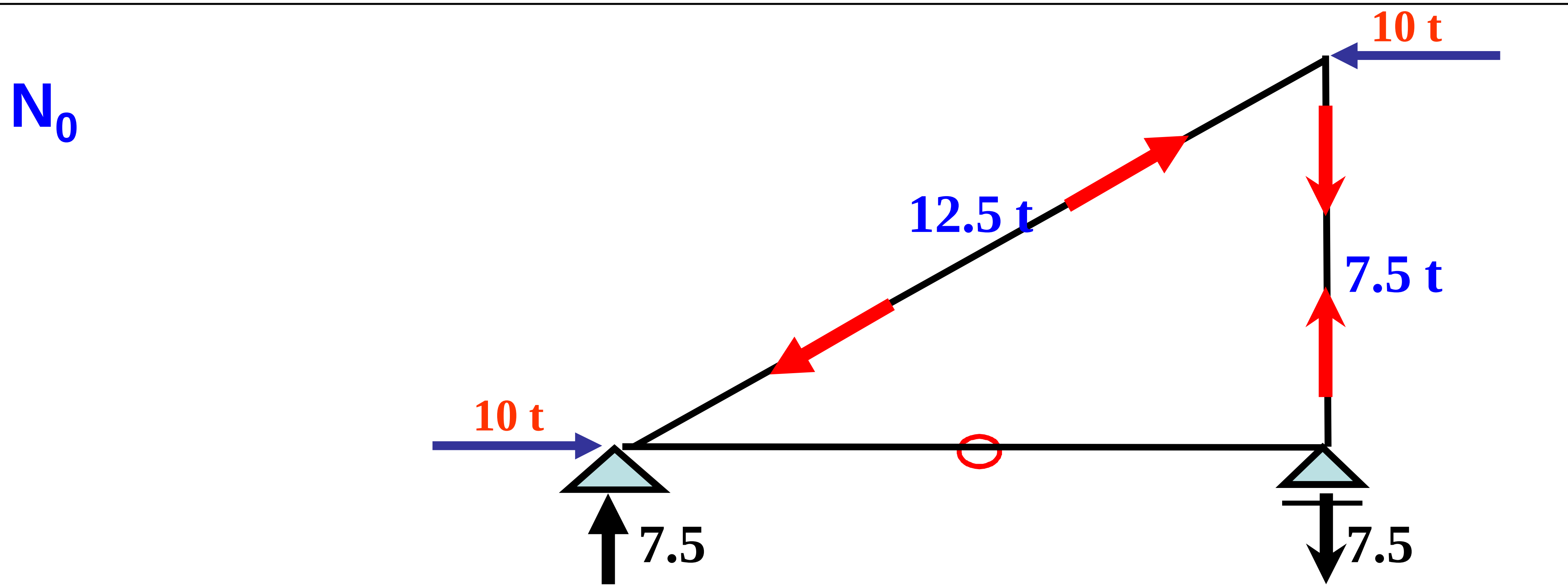
$\text{Required} \quad \delta hc$

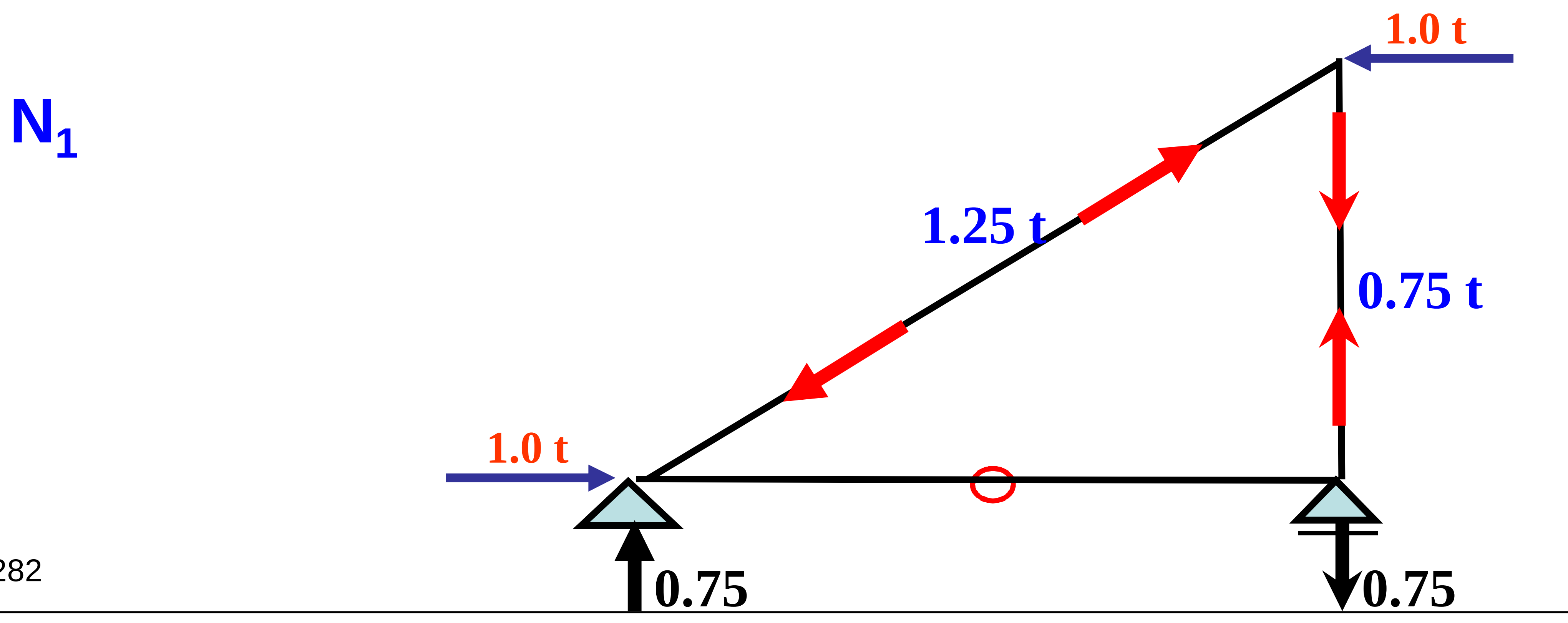
$1-\text{given loads}$

EA=10000 t

$2-\text{settelment at } b=2cm$

$3-\text{uniform rise in temprature } 20^{0} \text{ in member } ac$


N0
10 t
12.5 t
7.5 t
10 t
7.5
7.5


N1
1.0 t
1.25 t
0.75 t
1.0 t
0.75
0.75

member	L	N_0	N_1	$N_0 N_1 L$	$N_1 L$
AB	4	0	0	0	
BC	4	7.5	0.75	22.5	
CA	6	-12.5	-1.25	93.75	-7.5
∑				116.25	-7.5

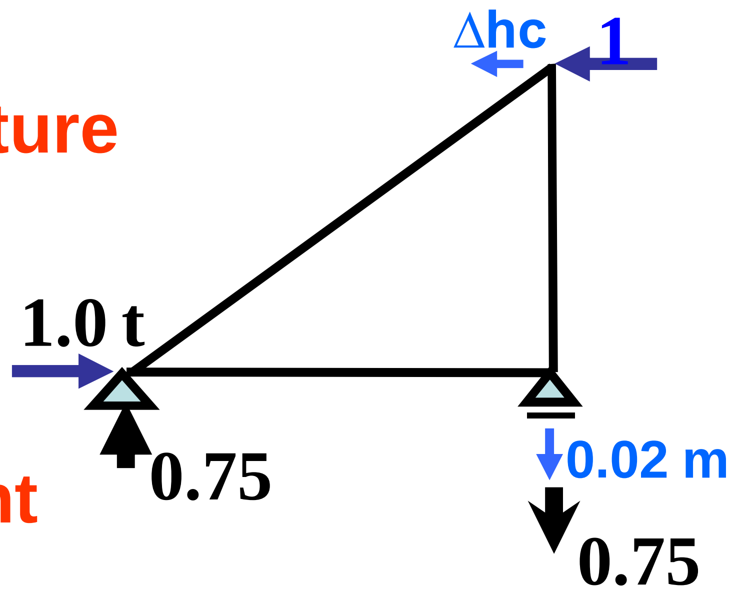
لم يتم حساب القيم هنا لان هذه العناصر
لم يحدث فيها تاثر بالحراره

$$\delta hc = \frac{\sum N_0 N_1 L}{EA} = \frac{116.25}{EA}$$ **Given loads**

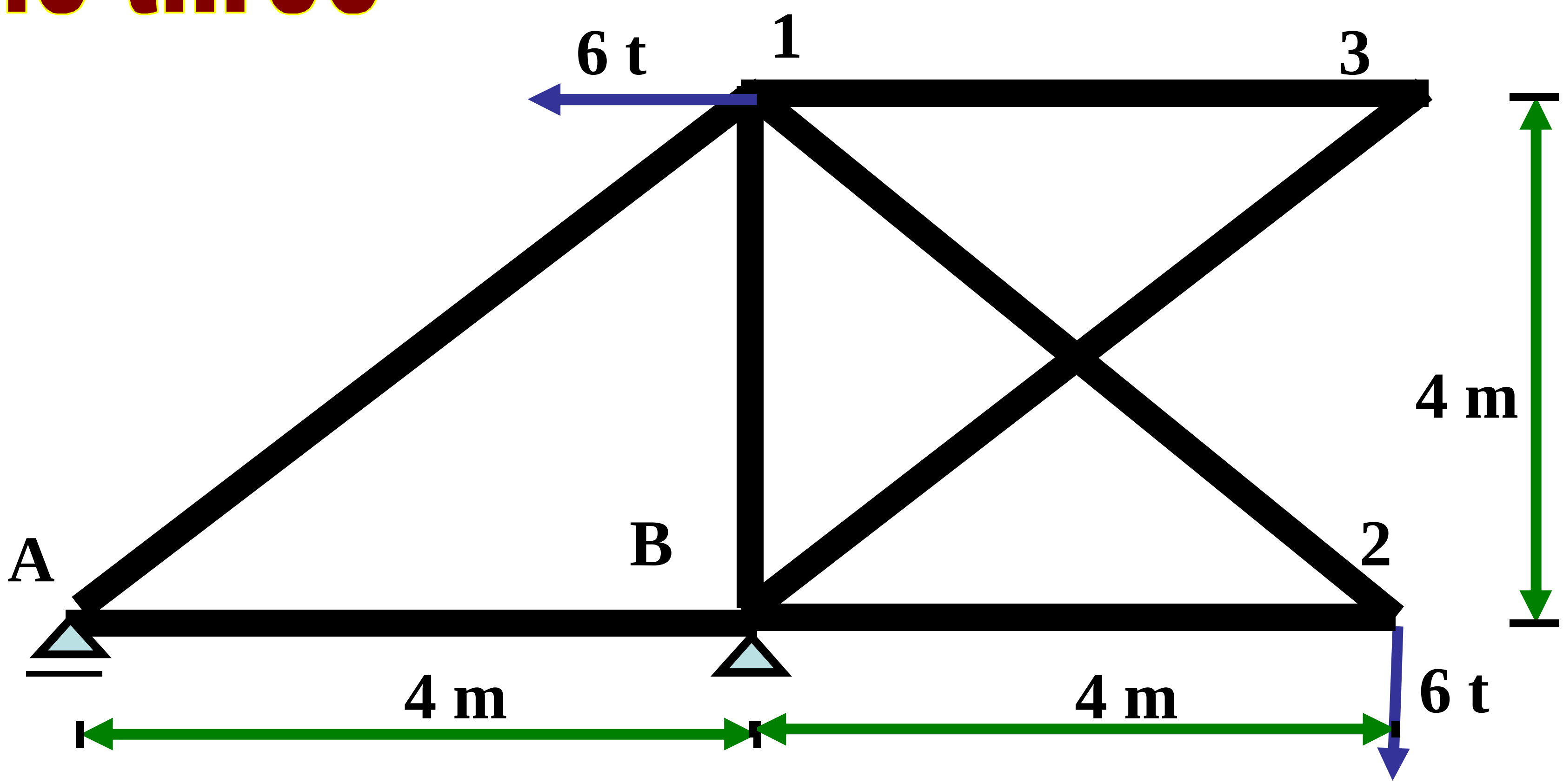
$$\delta hc = \alpha . \Delta t . (\sum N_1 L) = 10^{-5} * 20 * -7.5$$ **temperature**

*1 * Δhc + 0.75 * 0.02 = 0.0*

>> Δhc = - 0.015 m **settlement**



Example three



For the shown truss determine the horizontal displacement at point 1 and relative displacement between 2 and 3 due to:

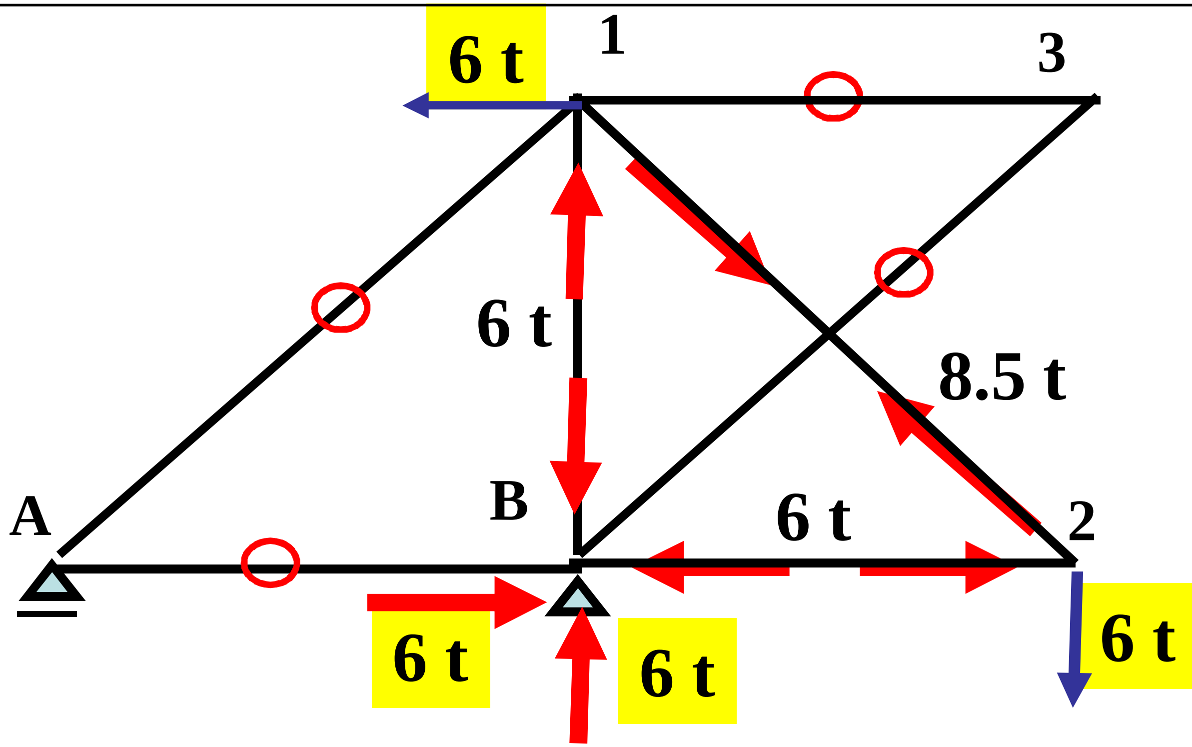
1- Given Load.

2- Settlement at B=1.5 cm.

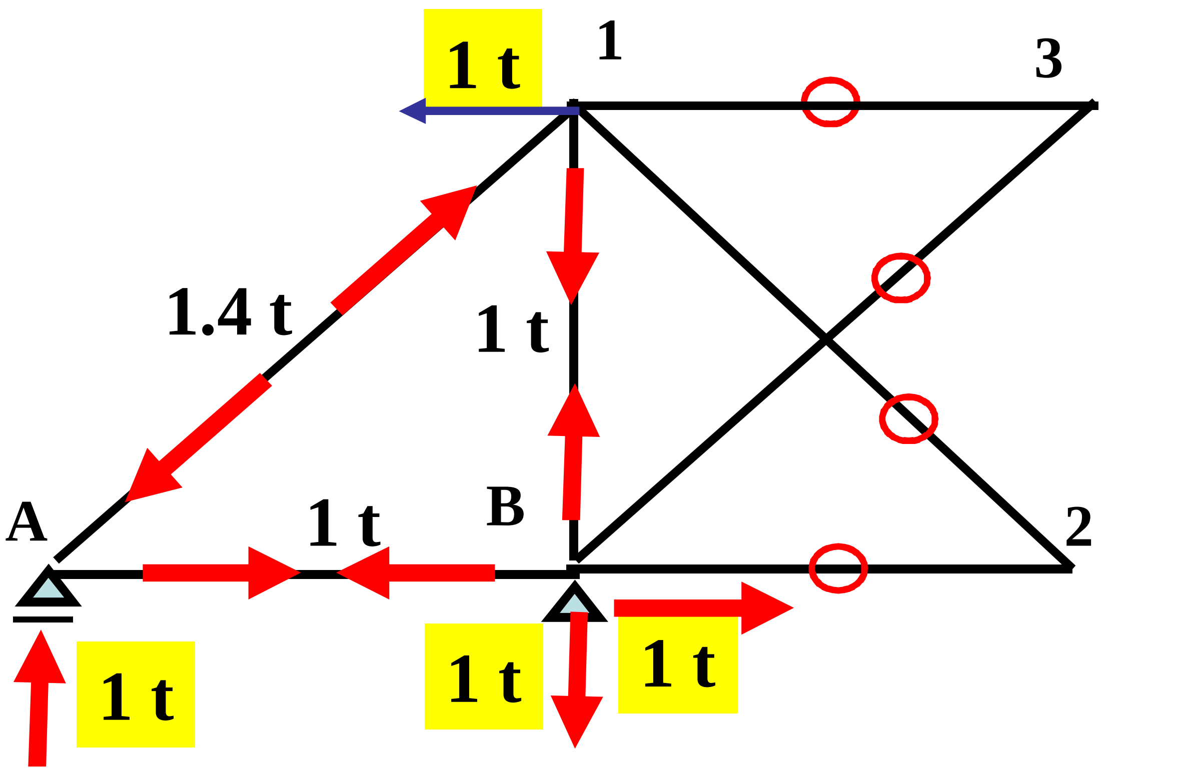
3- Rise In Temperature 30^0 In Chord AB2.

EA=10000 ton $\alpha = 10^{-5}$

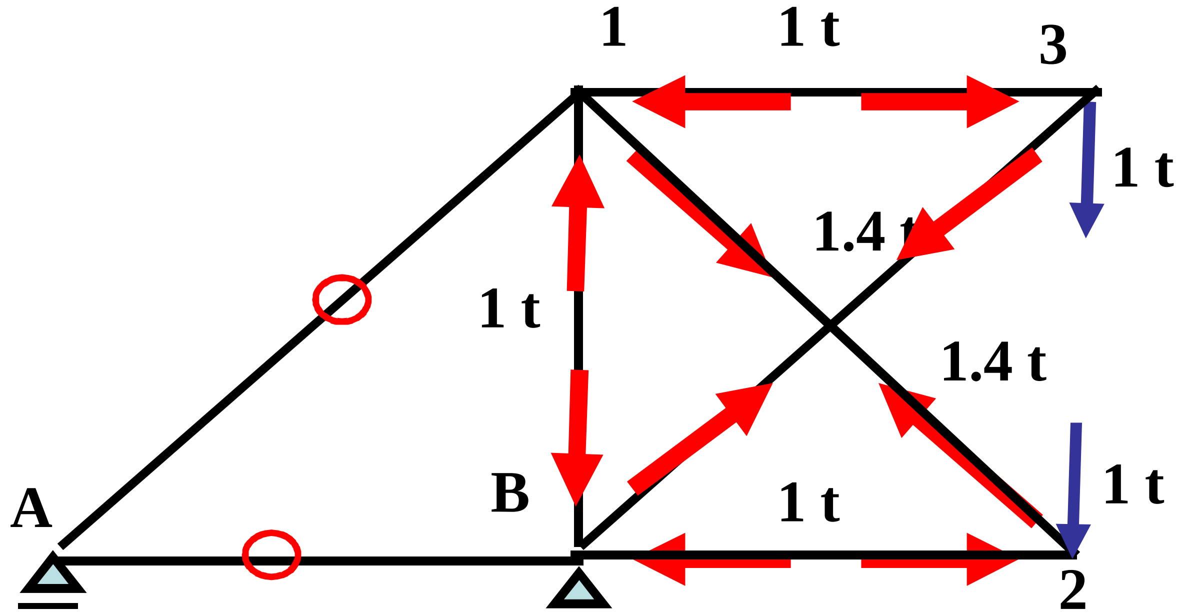
N_0



N_1



N_2



member	L	N_0	N_1	N_2	$N_0 N_1 L$	$N_0 N_2 L$	$N_1 L$	$N_2 L$
AB	4	0	1	0	0	0	4	0
B2	4	-6	0	-1	0	24	0	-4
13	4	0	0	-1	0	0		
B1	4	-6	1	-1	-24	24		
A1	7	0	-1.4	0	0	0		
B3	7	0	0	1.4	0	0		
12	7	8.5	0	1.4	0	84		
∑					-24	132	4	-4

$$\delta h1 = \frac{\sum N_0 N_1 L}{EA} = \frac{-24}{10000}$$

$$\delta 23 = \frac{\sum N_0 N_2 L}{EA} = \frac{132}{10000}$$

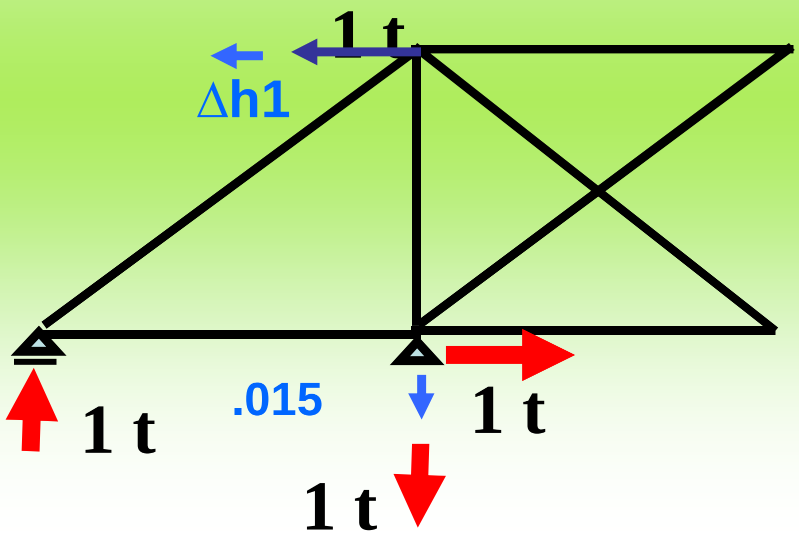
Given loads

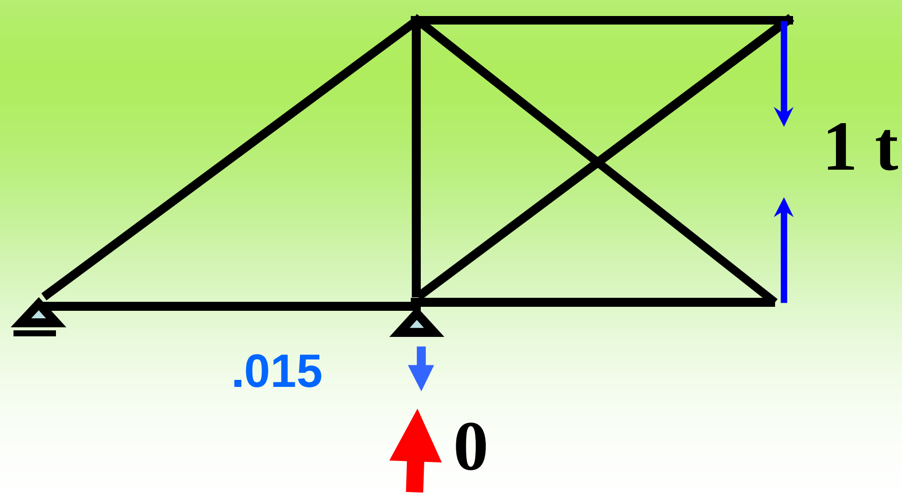
$$\delta h1 = \alpha.\Delta t.(\sum N_1 L) = 10^{-5} * 30 * 4$$

temperature

$$\delta 23 = \alpha.\Delta t.(\sum N_1 L) = 10^{-5} * 30 * -4$$

settlement





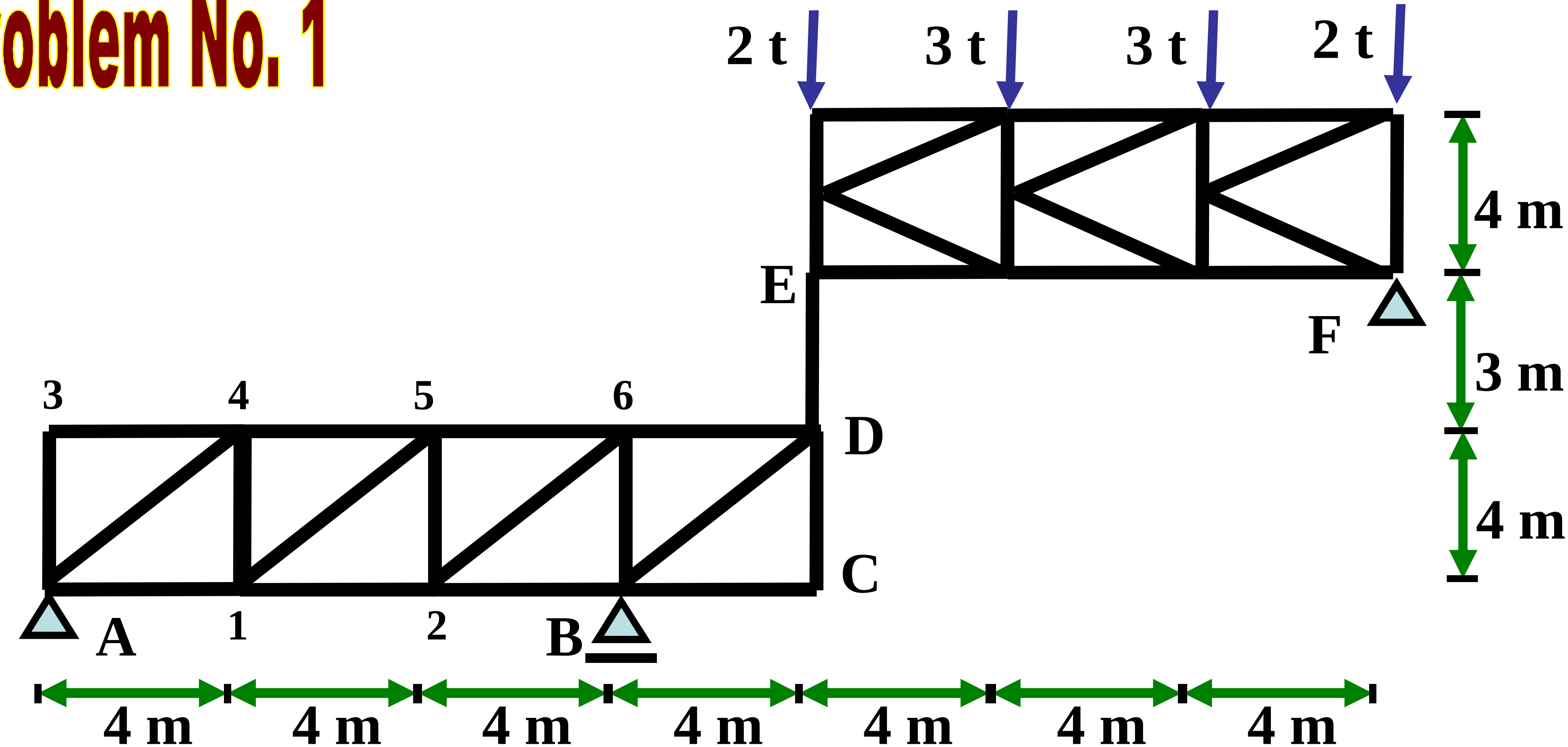
*1 * Δh1 + 1 * 0.015 = 0.0*

>> Δh1 = - 0.015 m

*1 * Δ23 + 0 * 0.015 = 0.0*

>> Δh23 = 0.0

Problem No. 1

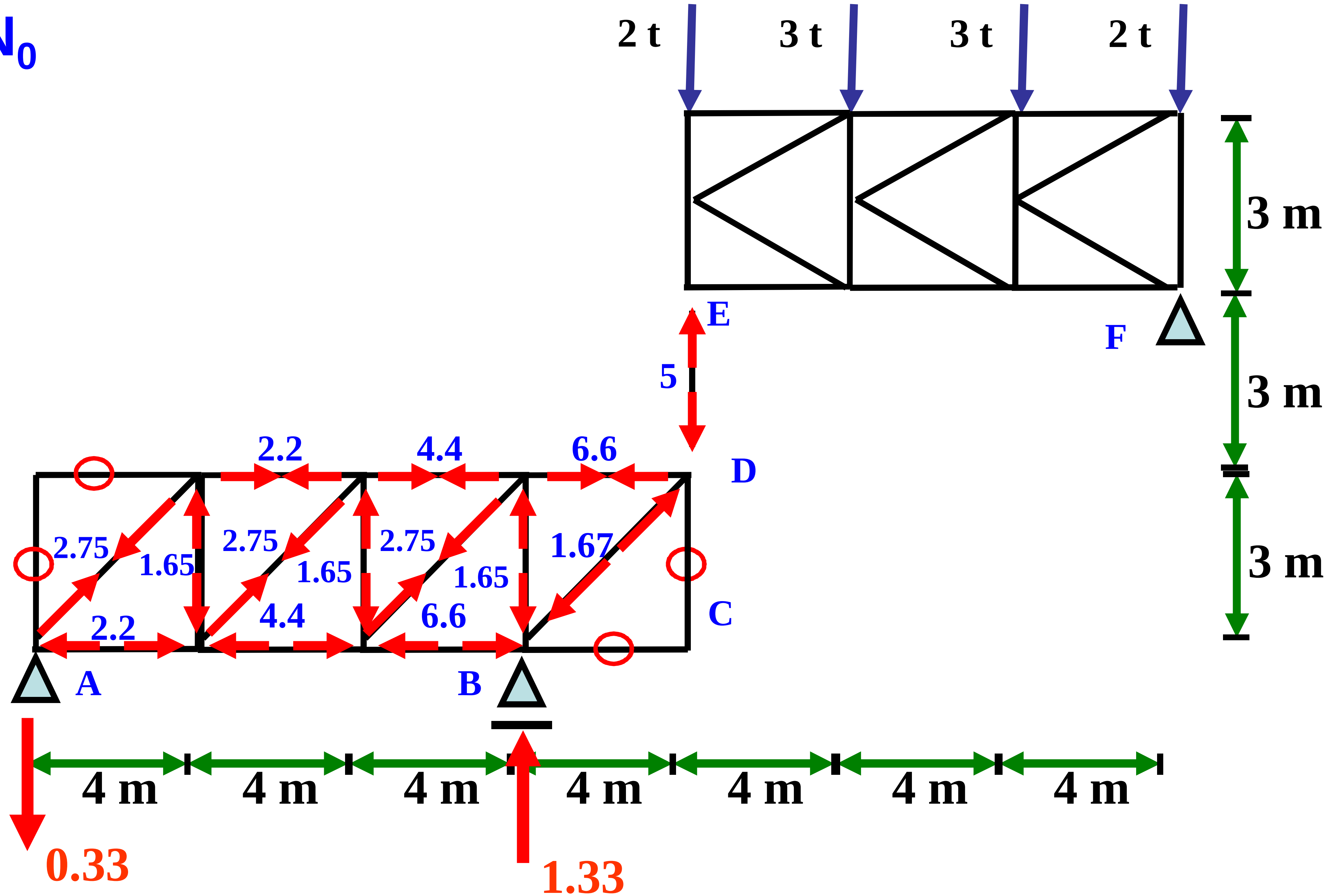


For the shown truss determine the vertical deflection E and the rotation of member CD due to:

1- Given Load.

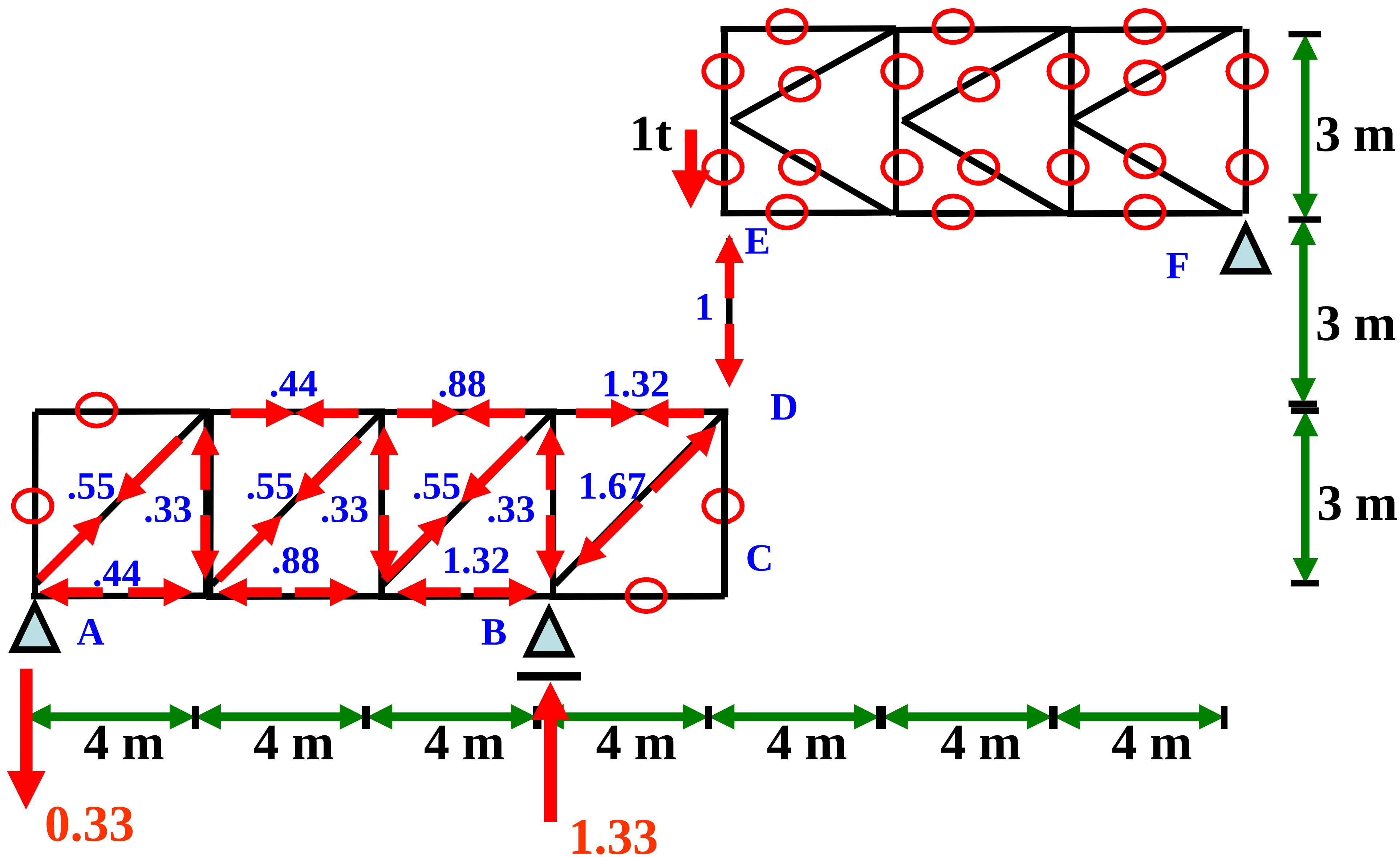
2- Vertical and horizontal movement at A =2cm downward and 3cm to the left. L/EA=.003 cm/t.

N_0



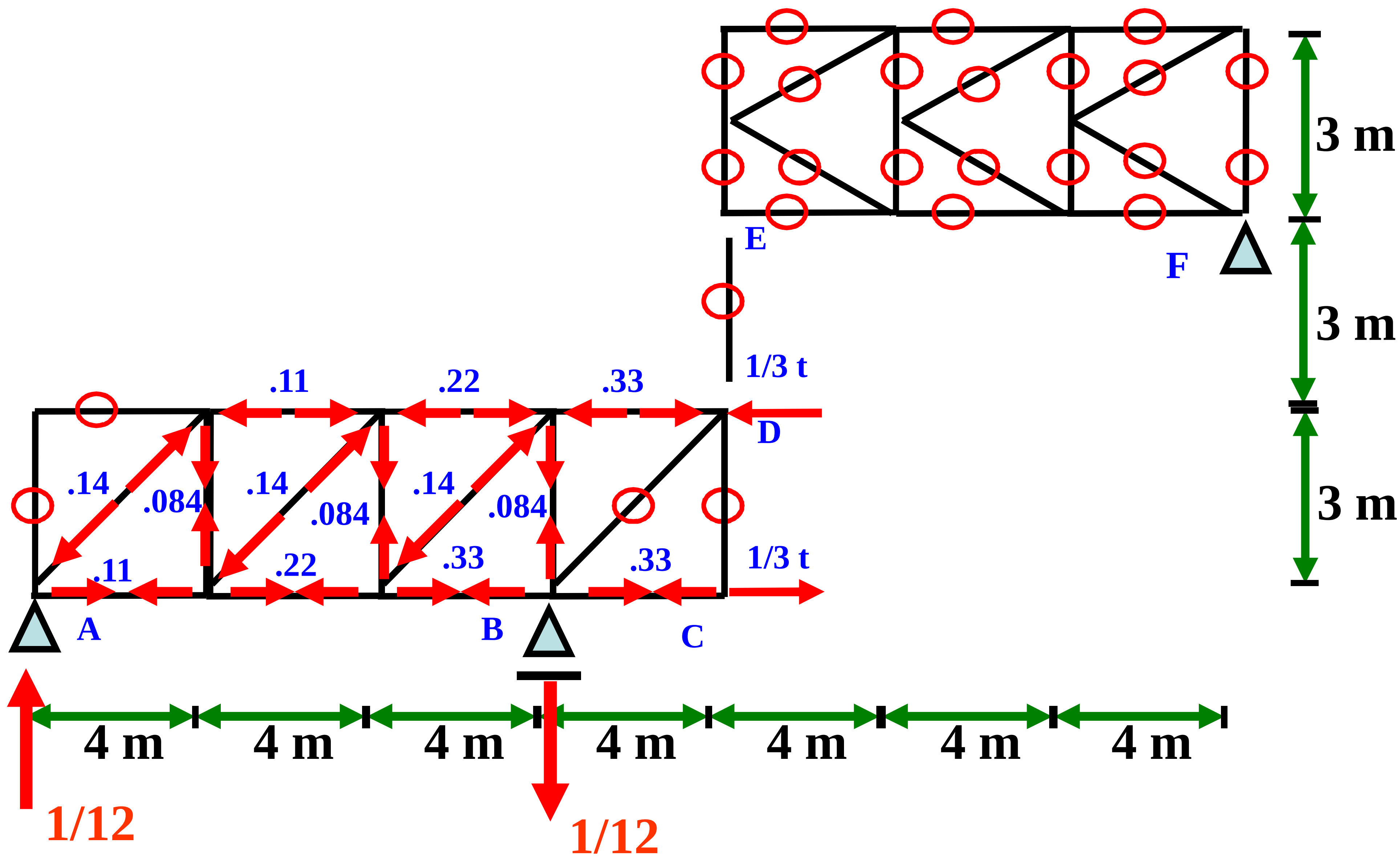
2 t
3 t
3 t
2 t
3 m
3 m
3 m
E
F
5
D
C
A
B
2.2
4.4
6.6
2.75
1.65
2.75
1.65
2.75
1.65
1.67
2.2
4.4
6.6
4 m
4 m
4 m
4 m
4 m
4 m
4 m
0.33
1.33

N_1



1t
E
F
1
D
C
A
B
3 m
3 m
3 m
.44
.88
1.32
.55
.33
.55
.33
.55
.33
1.67
.44
.88
1.32
4 m
4 m
4 m
4 m
4 m
4 m
4 m
0.33
1.33

N_2

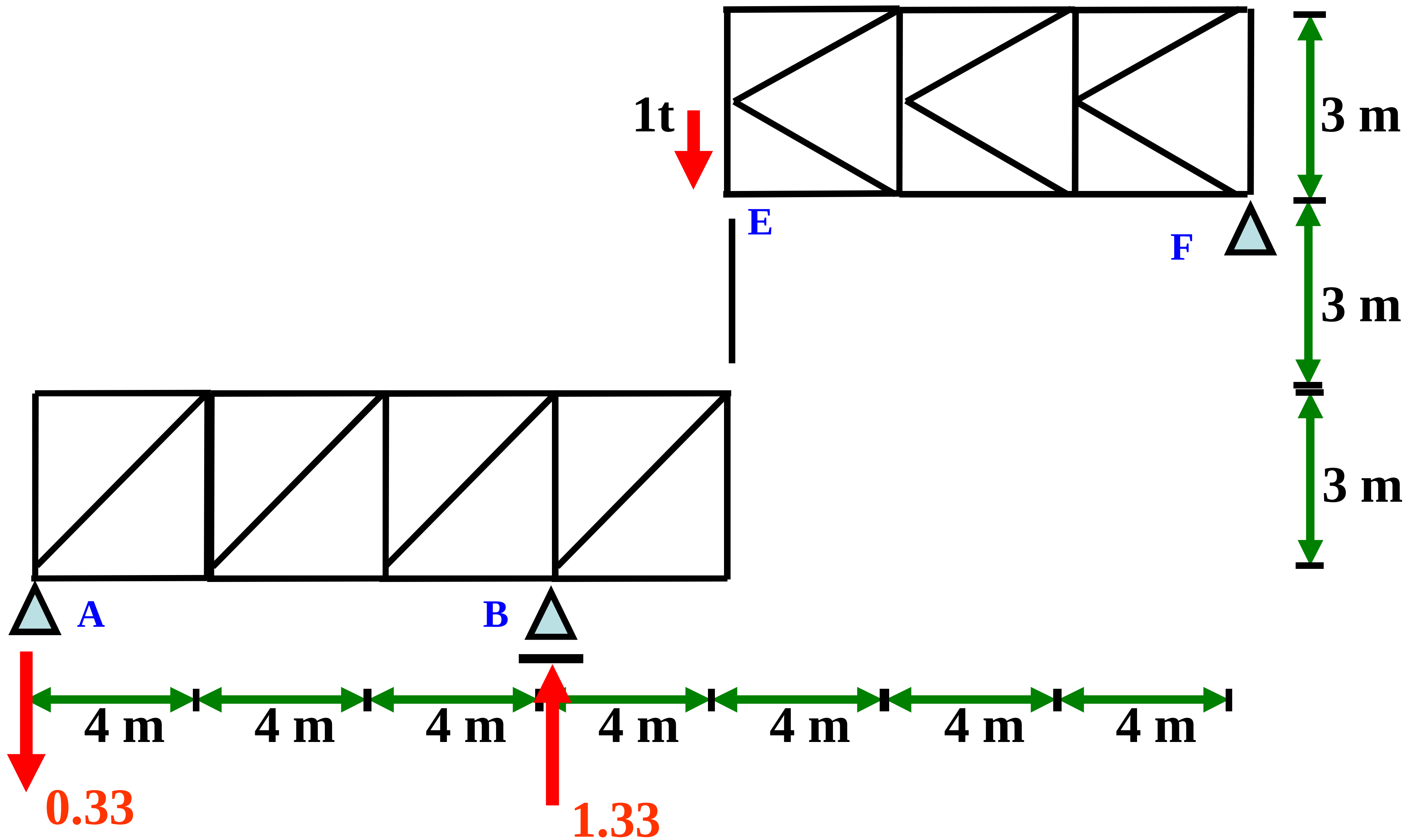


3 m
3 m
3 m
E
F
1/3 t
.11
.22
.33
D
.14
.084
.14
.084
.14
.084
.11
.22
.33
.33
1/3 t
A
B
C
4 m
4 m
4 m
4 m
4 m
4 m
4 m
1/12
1/12

member	N_0	N_1	N_2	$N_0 N_1$	$N_0 N_2$
A1	-2.2	-0.44	0.11	0.968	-0.242
12	-4.4	-0.88	0.22	3.872	-0.968
2b	-6.6	-1.32	0.33	8.712	-2.178
bc	0.0	0.0	0.33	0	0
34	0.0	0.0	0.0	0	0
45	2.2	0.44	0.11	0.968	0.242
56	4.4	0.88	0.22	3.872	0.968
6d	6.6	1.32	0.33	8.712	2.178
A3	0.0	0.0	0	0	0
14	-1.65	-0.33	0.084	0.55	-0.1386
25	-1.65	-0.33	0.084	0.55	-0.1386
B6	-1.65	-0.33	0.084	0.55	-0.1386
Cd	0.0	0.0	0	0	0
A4	2.75	0.55	0.14	1.5	1.51
15	2.75	0.55	0.14	1.5	1.51
26	2.75	0.55	0.14	1.5	1.51
bd	-1.67	-1.67	0	2.78	0
dE	-5.0	-1.0	0	5	0
∑				36.2	4.11

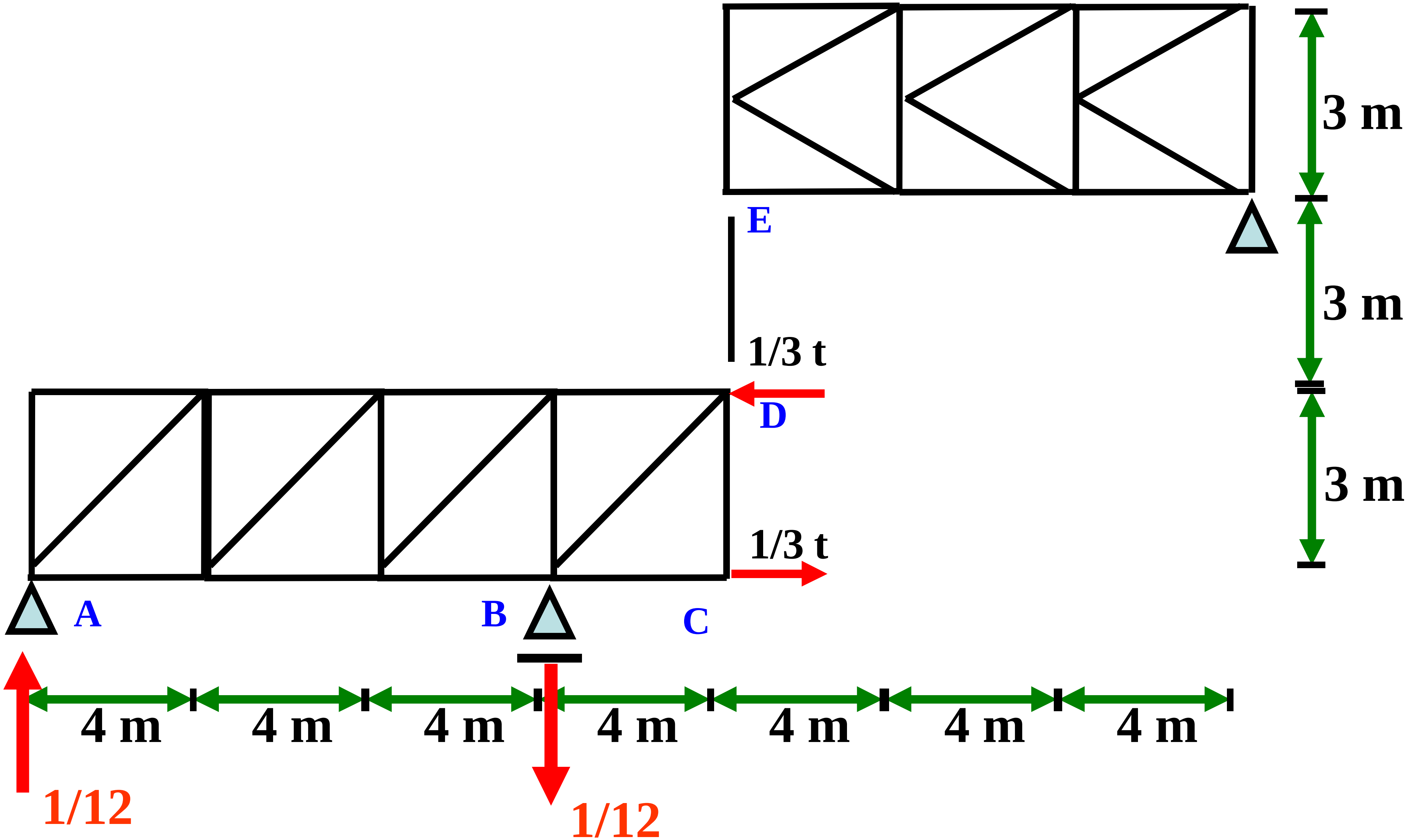
$$\delta ve = \frac{L}{EA} * \sum N_0 N_1 = 0.003 * 36.2$$

$$\theta(fb) = \frac{L}{EA} * \sum N_0 N_2 = 0.003 * 4.11$$



$$1 * \Delta vE + 0.33 * 0.02 + 0 * .03 = 0.0$$

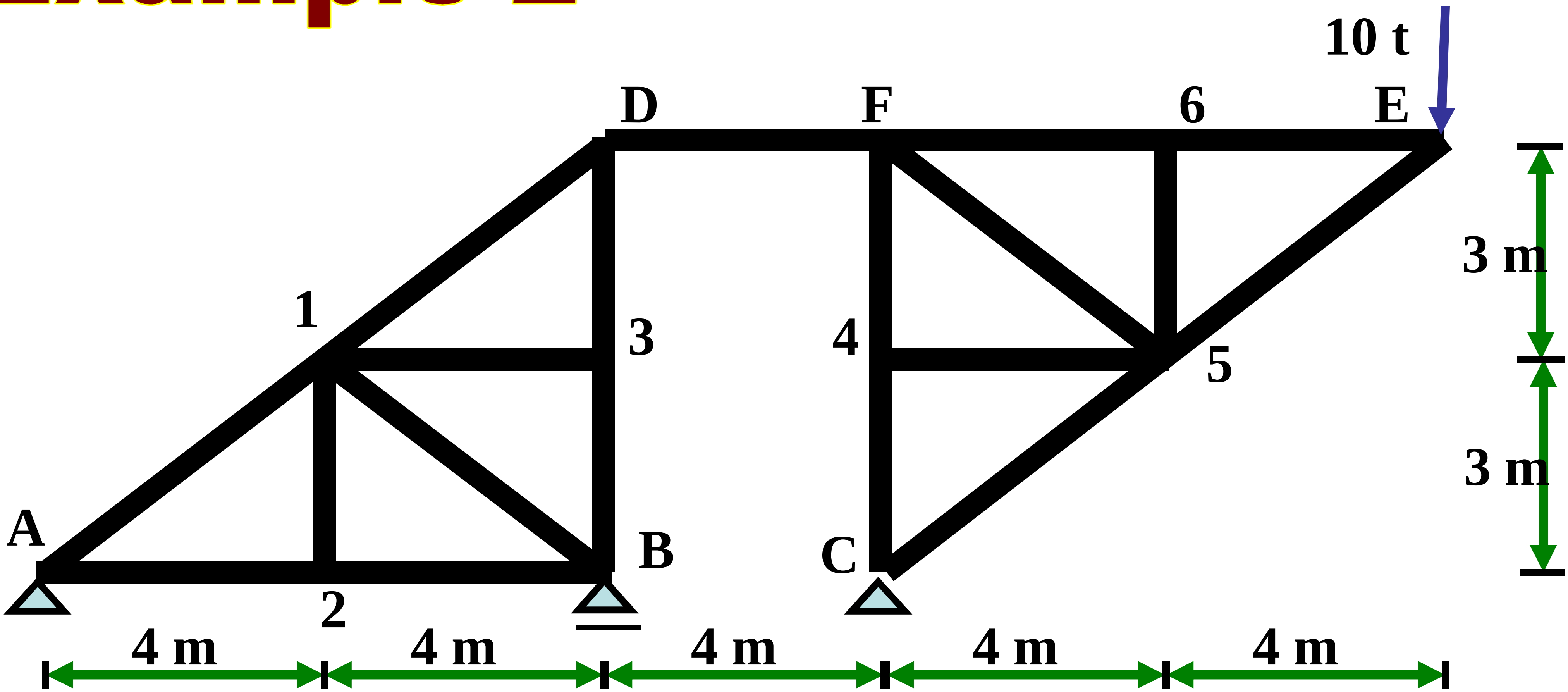
$$>> \Delta vE = -0.0066 \ m$$



$$1 * \theta DC - 1/12 * 0.02 + 0 * .03 = 0.0$$

$$>> \theta DC = 0.0016\ m$$

Example 2

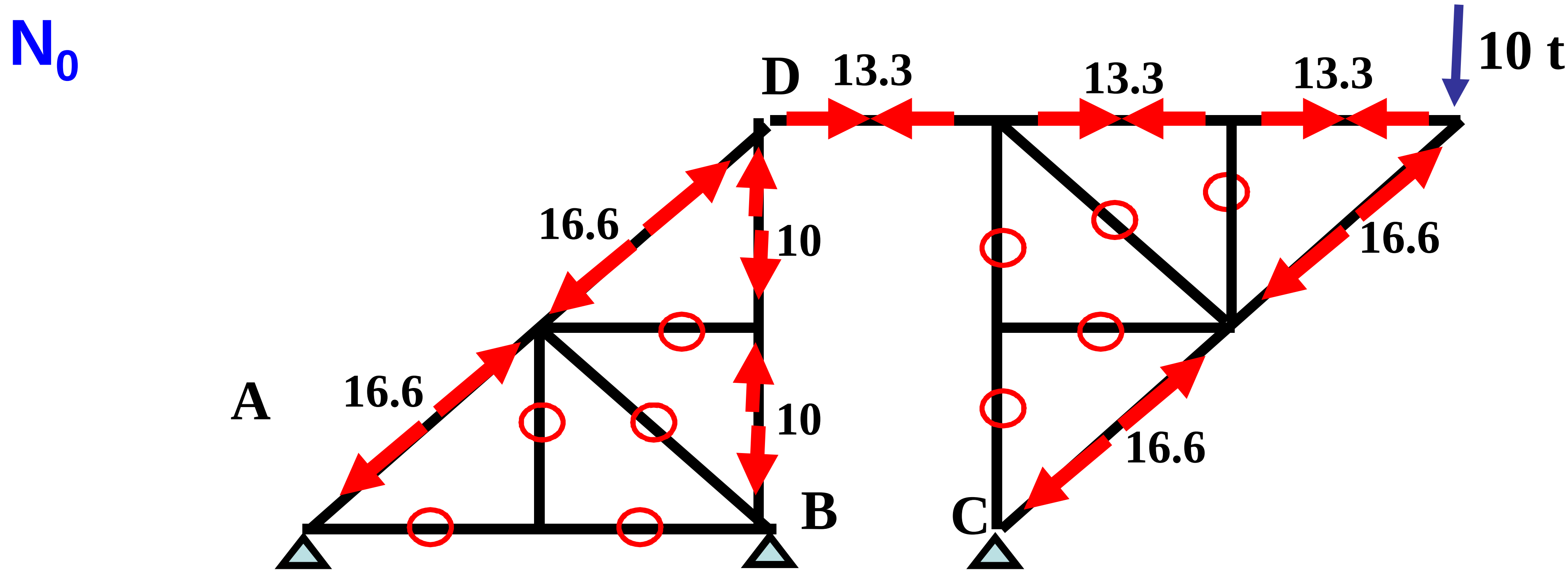


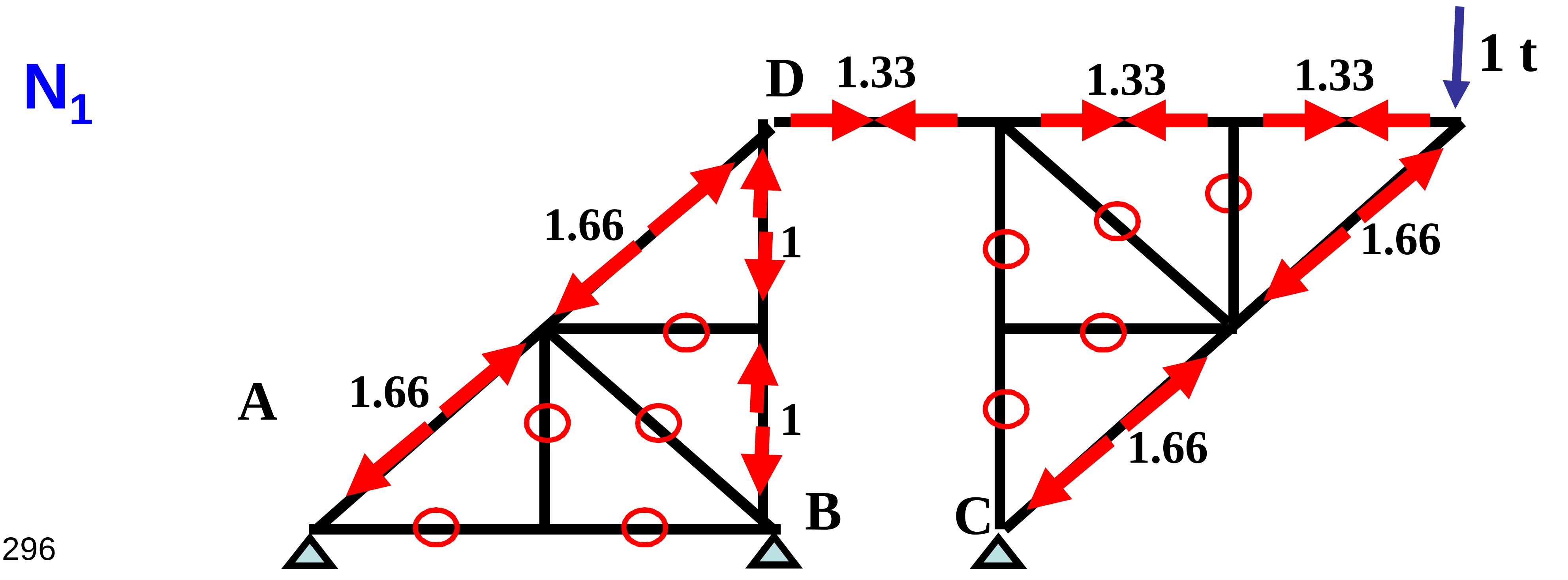
For the shown truss determine the vertical deflection E and horizontal displacement at D due to:

1- Given Load.

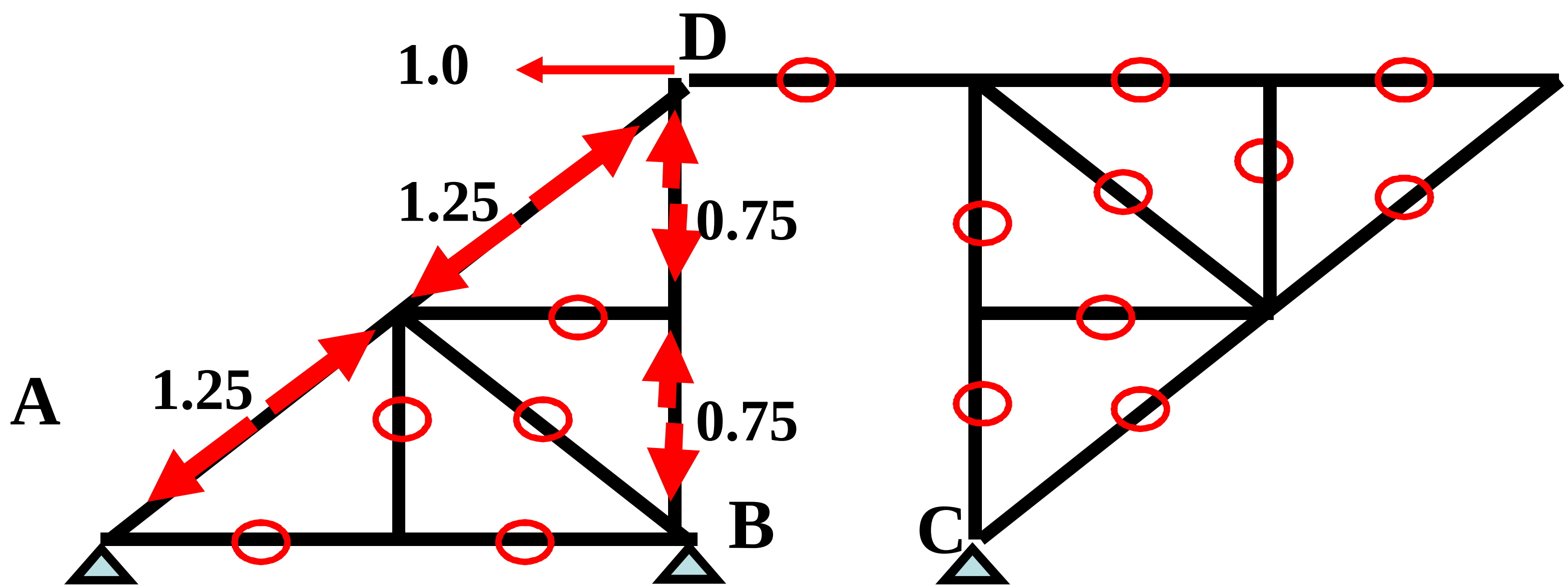
2- Settlement Of Support A=2cm And Horizontal Displacement At Support C=3cm To The Right.

3- Rise In Temperature 30^0 In All Members EA=10000 ton $\alpha = 10^{-5}$


N0
D
13.3
13.3
13.3
10 t
16.6
10
16.6
A
16.6
10
16.6
B
C


N1
D
1.33
1.33
1.33
1 t
1.66
1
1.66
A
1.66
1
1.66
B
C

N_2



member	L	N_0	N_1	N_2	$N_0 N_1 L$	$N_0 N_2 L$	$N_1 L$	$N_2 L$
A2	4	0	0	0	0	0	0	0
2b	4	0	0	0	0	0	0	0
13	4	0	0	0	0	0	0	0
45	4	0	0	0	0	0	0	0
Df	4	13.3	1.33	0	71.11	0	5.33	0
F6	4	13.3	1.33	0	71.11	0	5.33	0
6e	4	13.3	1.33	0	71.11	0	5.33	0
21	3	0	0	0	0	0	0	0
B3	3	-10	-1.0	-0.75	30	22.5	-3	-2.25
3d	3	-10	-1.0	-0.75	30	22.5	-3	-2.25
C4	3	0	0	0	0	0	0	0
4f	3	0	0	0	0	0	0	0
56	3	0	0	0	0	0	0	0
B1	5	0	0	0	0	0	0	0
5f	5	0	0	0	0	0	0	0
A1	5	16.67	1.667	1.25	138.9	104	8.33	6.25
1d	5	16.67	1.667	1.25	138.9	104	8.33	6.25
C5	5	-16.67	-1.667	0	138.9	0	-8.33	0
5e	5	-16.67	-1.667	0	138.9	0	-8.33	0
$\sum$					768.8	253	10	8

$$\delta ve = \frac{\sum N_0 N_1 L}{EA} = \frac{768.8}{10000}$$

Given loads

$$\delta hd = \frac{\sum N_0 N_2 L}{EA} = \frac{253}{10000}$$

$$\delta ve = \alpha.\Delta t.(\sum N_1 L) = 10^{-5} * 30 * 10$$

temperature

$$\delta hd = \alpha.\Delta t.(\sum N_1 L) = 10^{-5} * 30 * 8$$

settlement

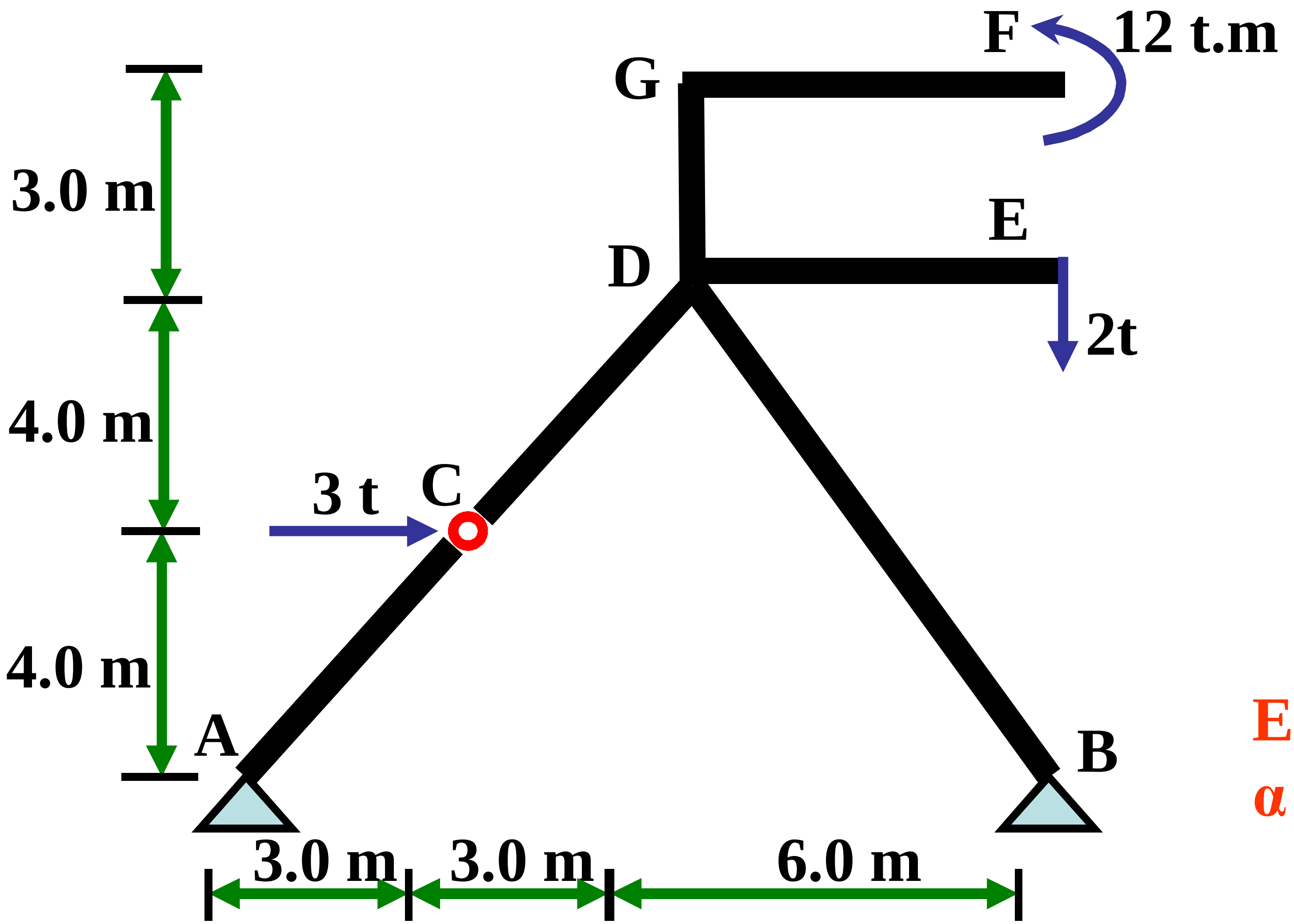
*1 * Δ**ve** + 3 * 1.33 -1*2 = 0.0*

*>> Δ**ve** = - 2 cm*

*1 * Δ**hd** + 0.75 * 2 + 3*0= 0.0*

*>> Δ**hd** = -1.5 cm*

Problem No. 3



EI = 10000 t.m^2.

α = 10^{-5}.

For the Shown Frame, Calculate the Rotation at Point D due to:

1- Given Loads.

2- Settlement at A =2cm.

3- Rise in Temperature 30^0 in All Members.

$\sum M_A = 0.0$

$3*4+2*12-12-Y_B*12=0 \quad >> \quad Y_B = 2.0\ t$

$\sum F_Y = 0.0$

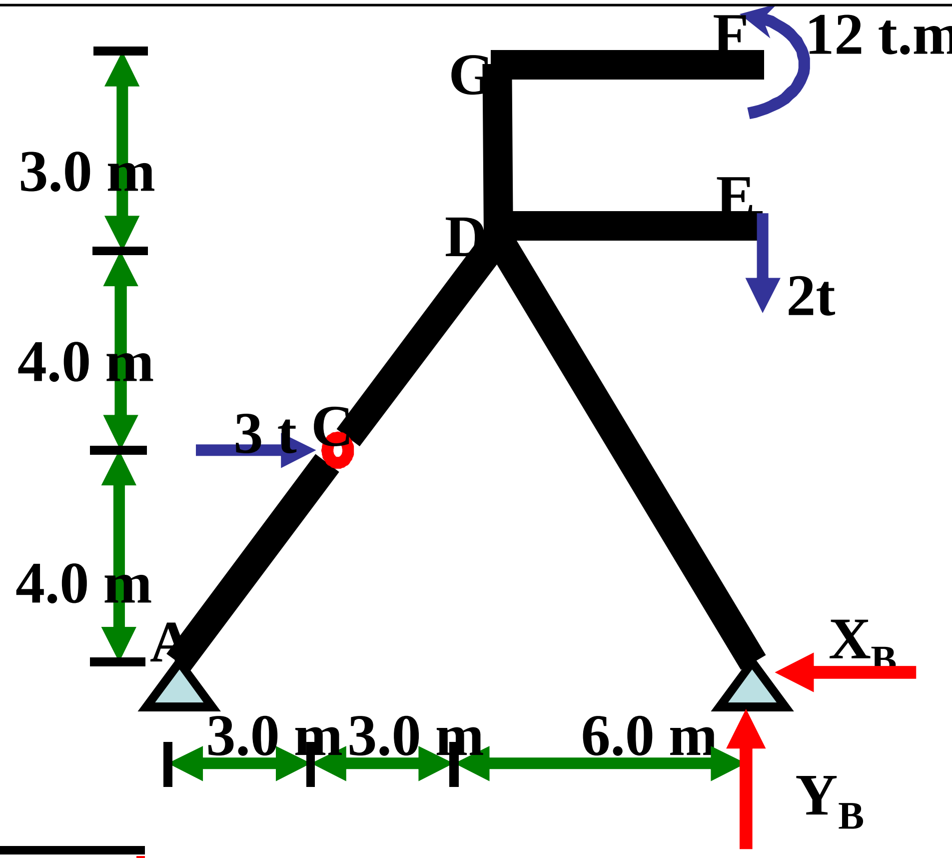
$Y_A = 2-2 = 0.0$

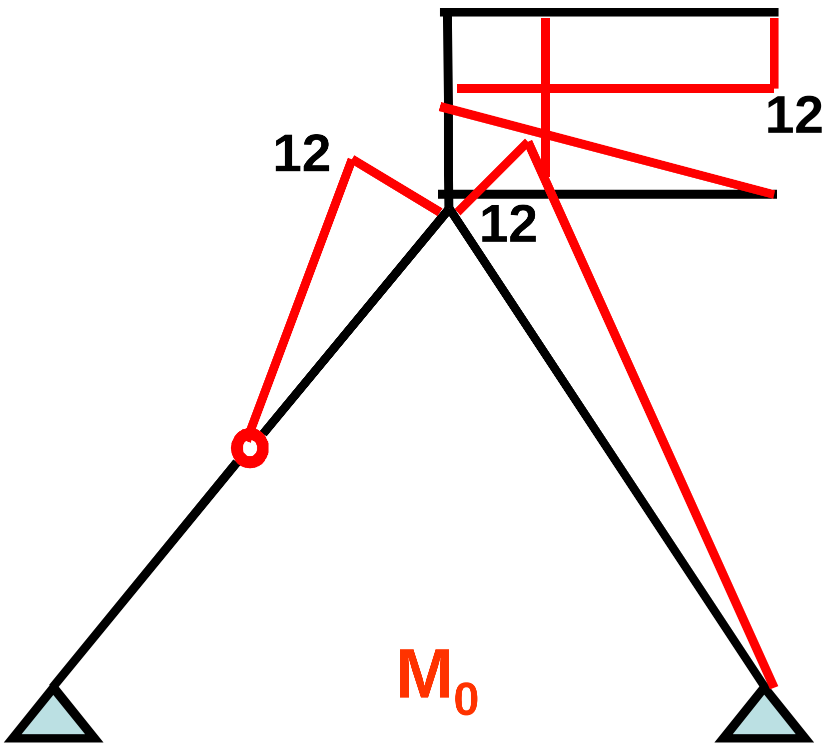
$\sum M_{CL} = 0.0$

$0*3 - X_A*4 = 0.0 \quad >> \quad X_A = 0.0$

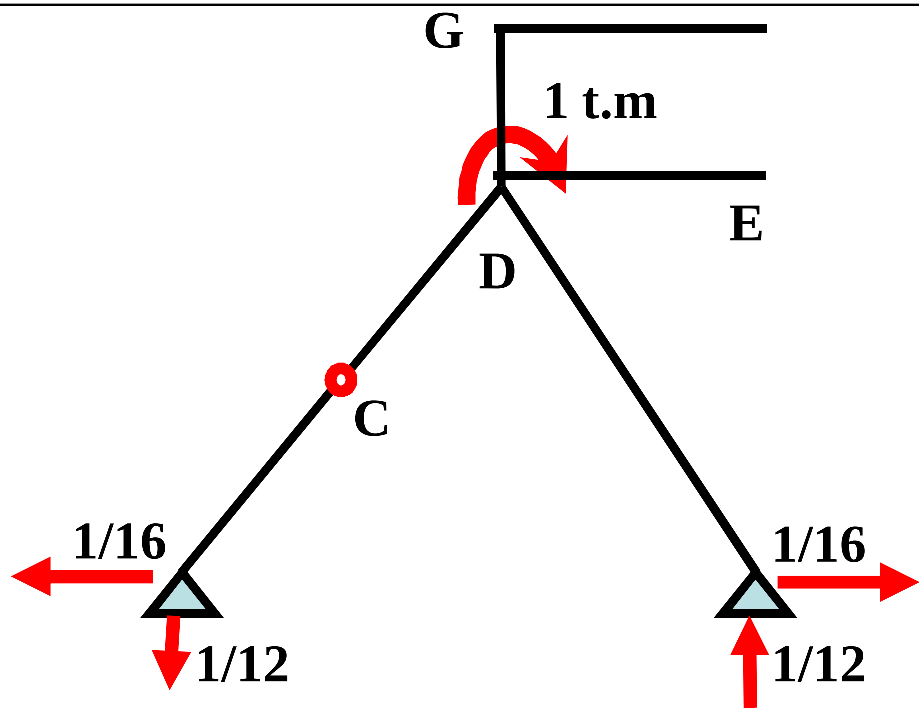
$\sum F_X = 0.0$

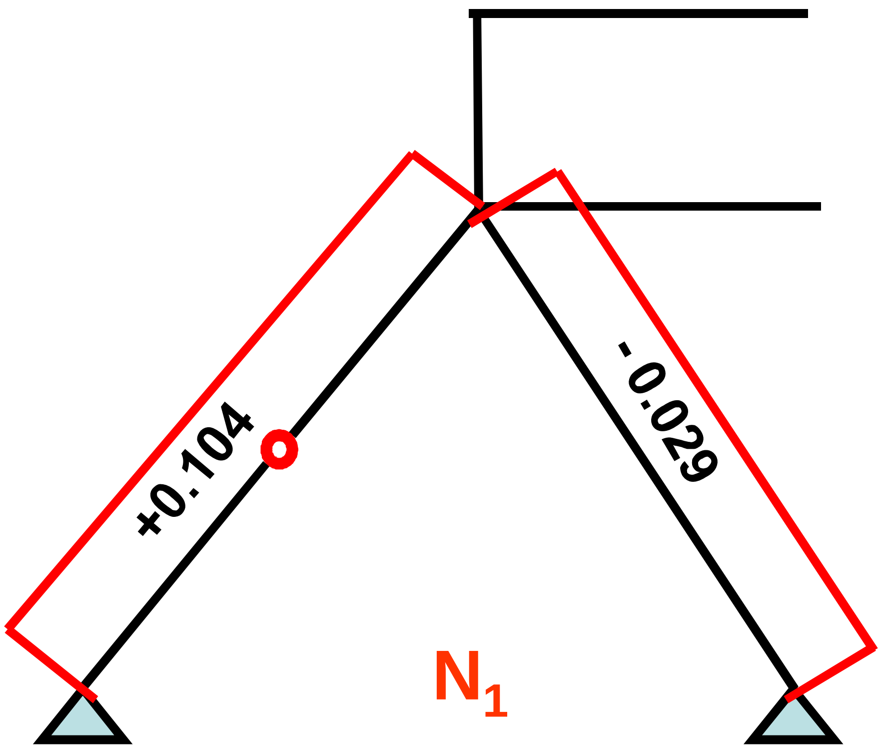
$X_B = 3.0$



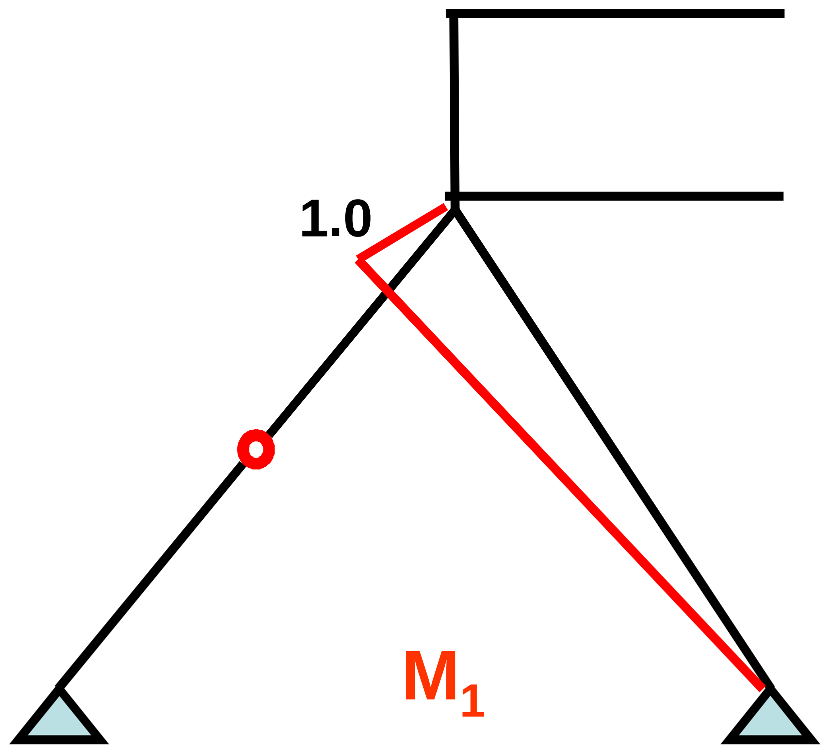


For θ_d



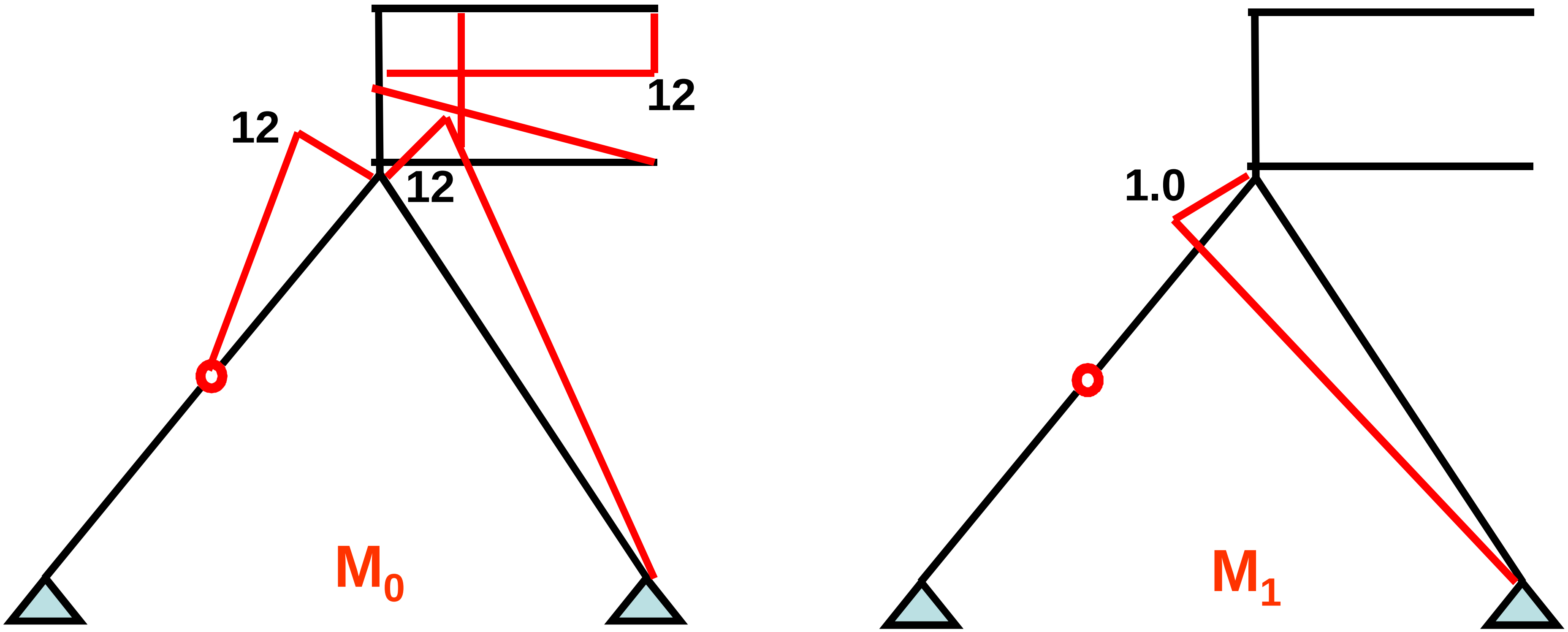


N_1



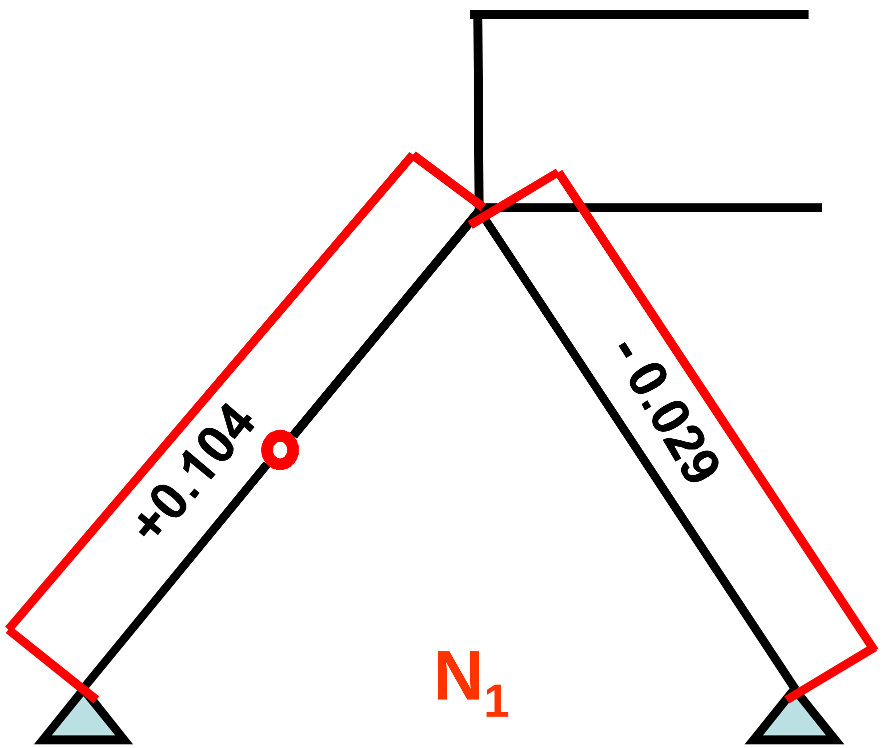
M_1

given loads



$$\theta d = \frac{1}{EI}\left[\frac{-1*12*10}{3}\right] = -4*10^{-4}\,rad$$

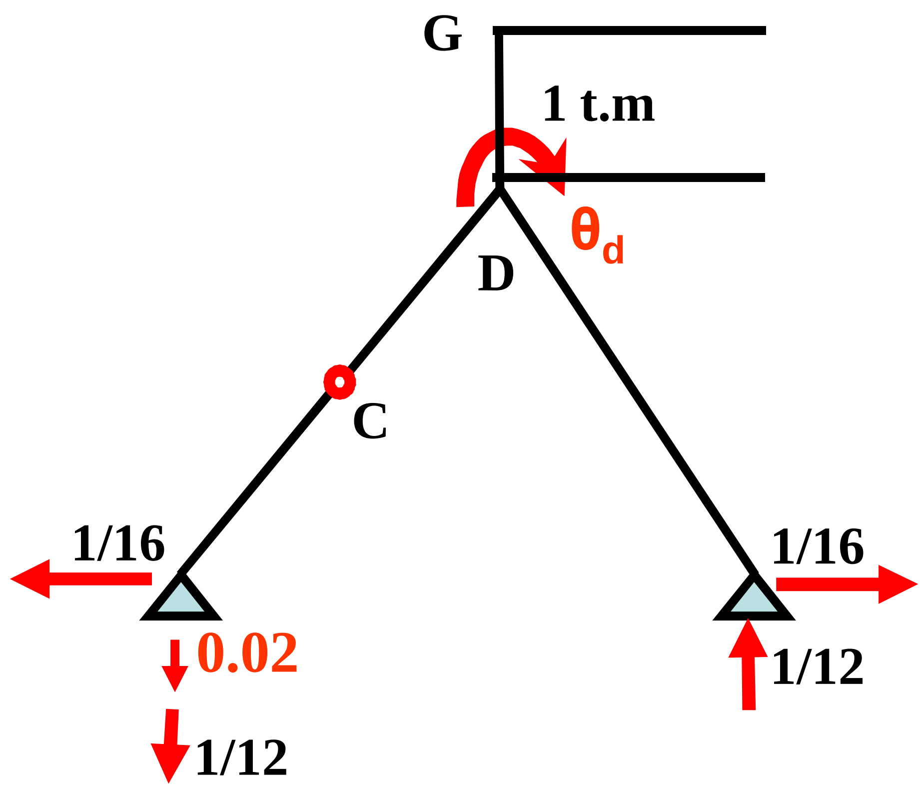
Uniform temperature=30



$$Area\ of\ \ Normal = -0.209*10 + 0.104*10 = -1.05$$

$$\theta_d = \alpha * dt * Area\ of\ \ Normal = 10^{-5} * 30 * -1.05 = 0$$

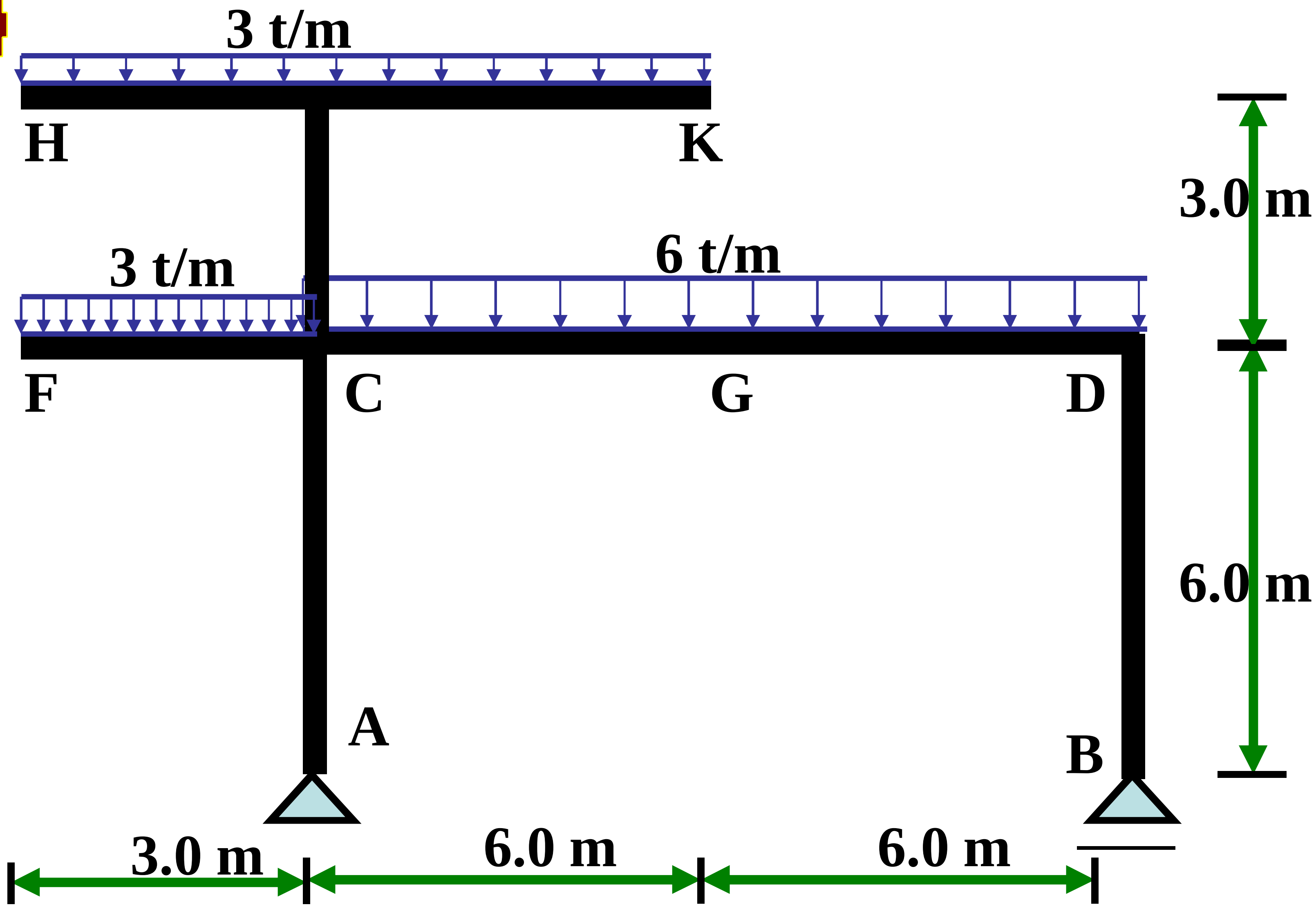
due settelment at A = 2 cm



$$1*\theta_d + 1/12*0.02 = 0.0$$

$$\theta_d = -0.0167\ rad$$

Problem No. 4

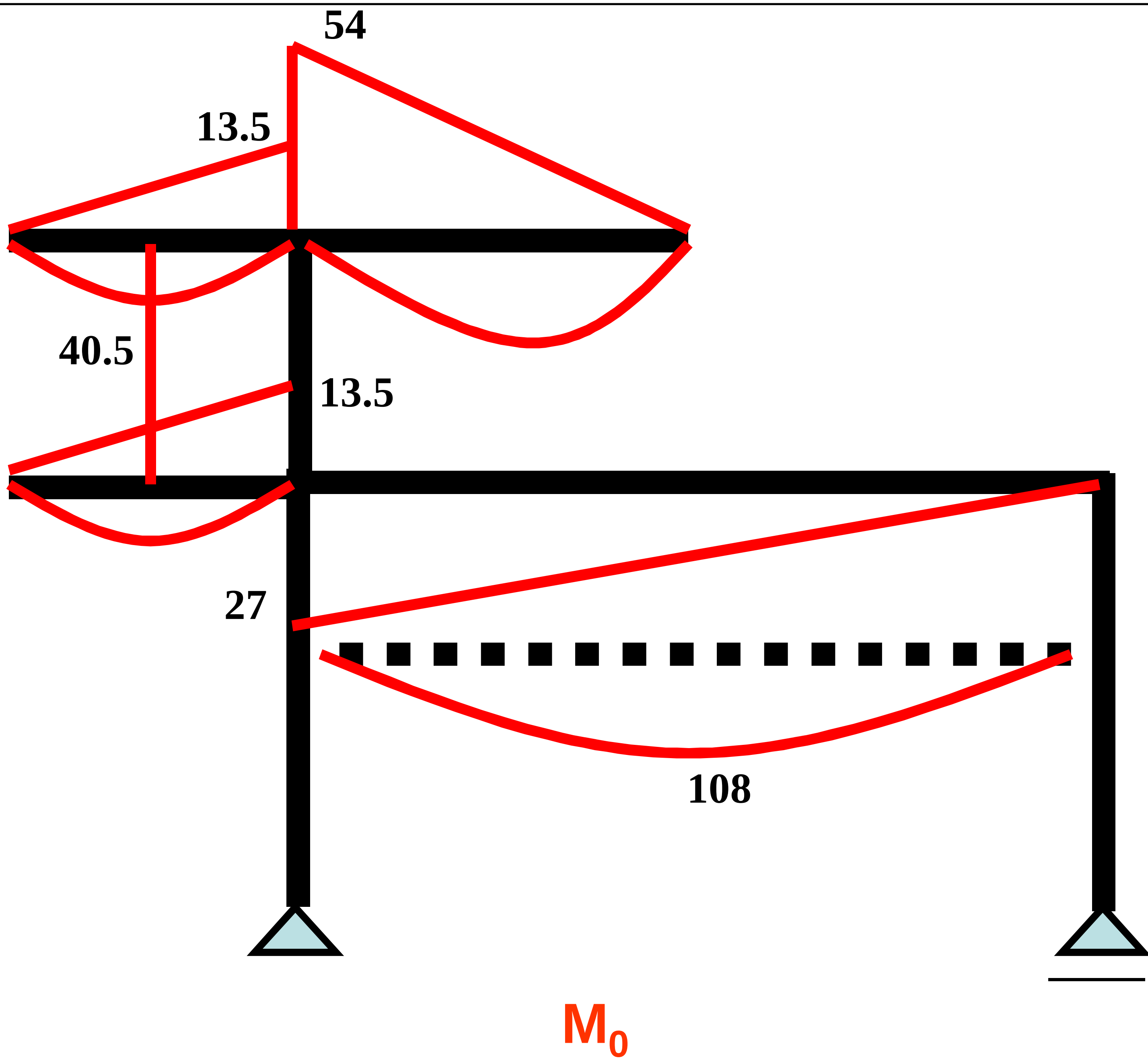


For the Shown Frame, Calculate the Rotation at D, Horizontal Displacement at B and Vertical Deflection at G due to:

1- Given Loads.

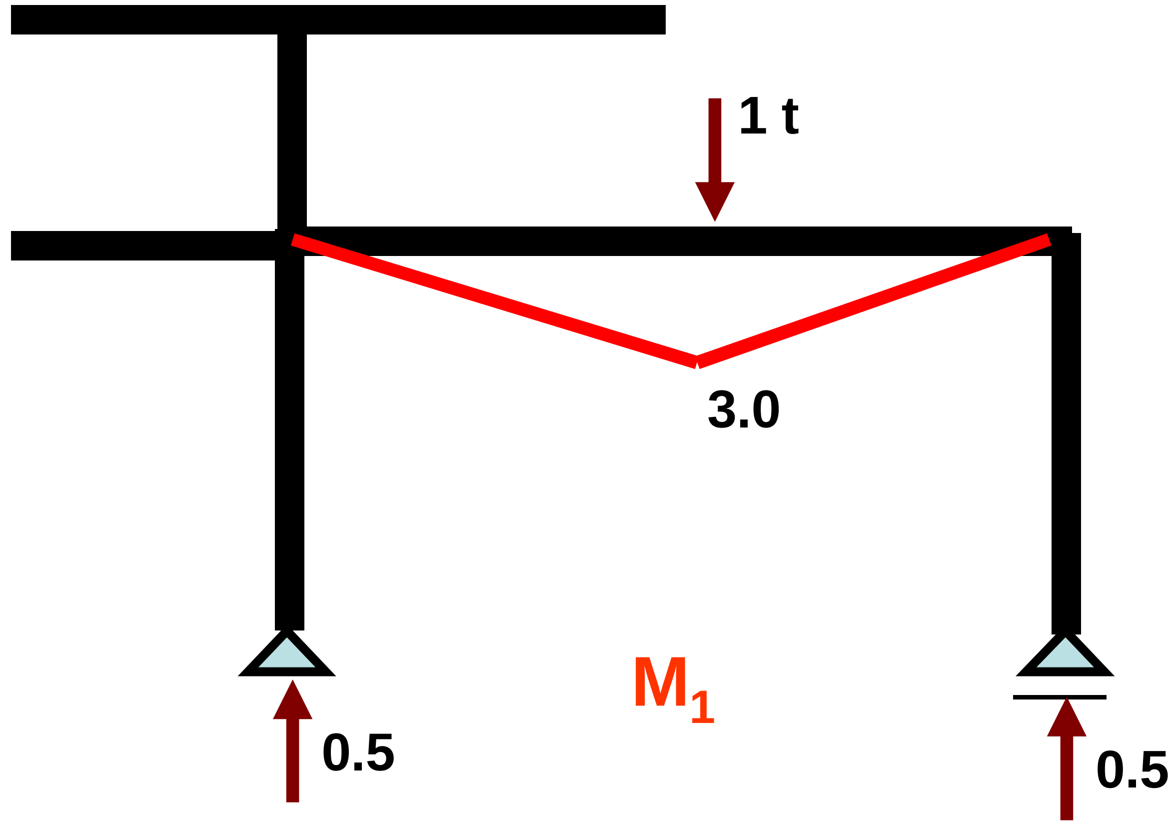
2- Downward Settlement at A = 2cm.

EI = 12000 t.m^2


54
13.5
40.5
13.5
27
108
M_0

For Δ_{vg}

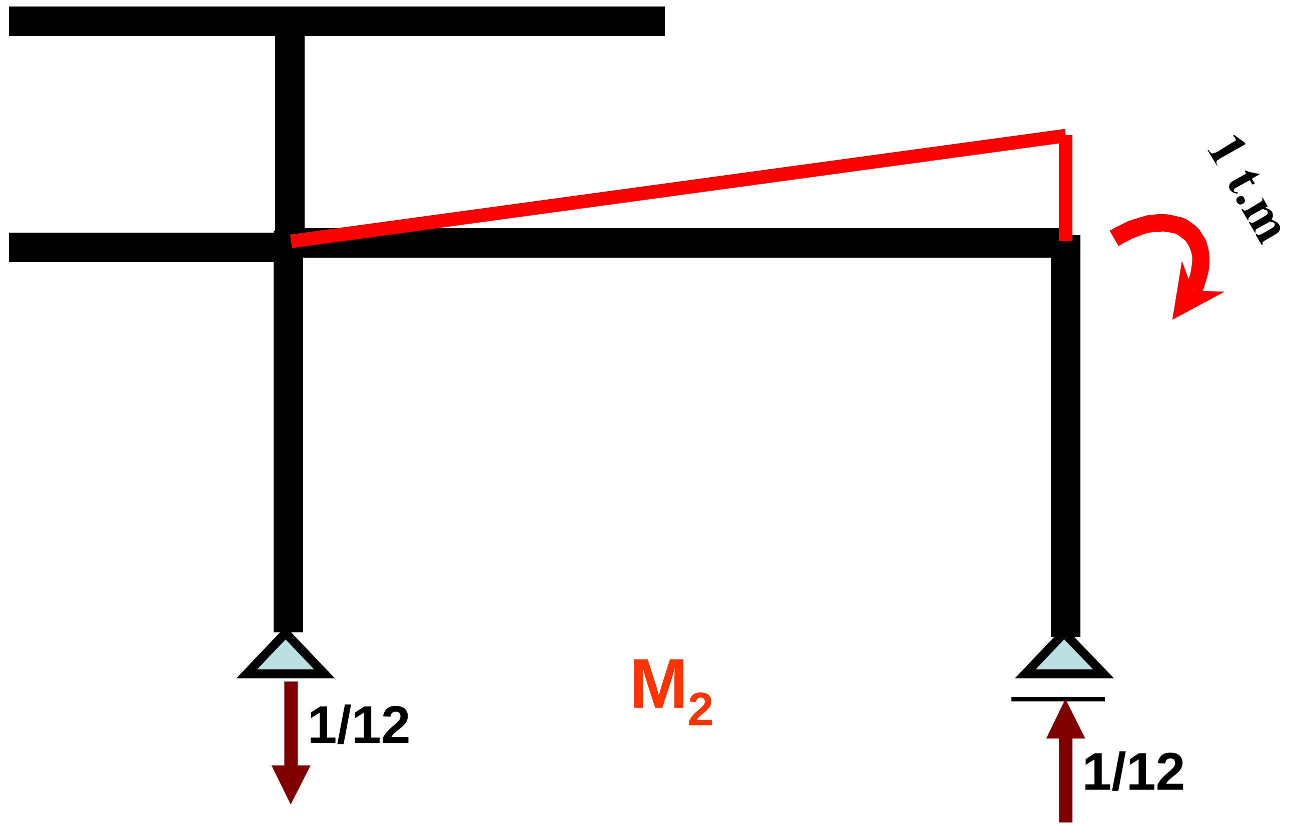
given loads



$$\Delta vg = \frac{1}{EI}\left[-\frac{1}{2}*3*12*13.5+2\left(\frac{2}{3}*108*6*5/8*3\right)\right] = 0.155$$

For θ_d

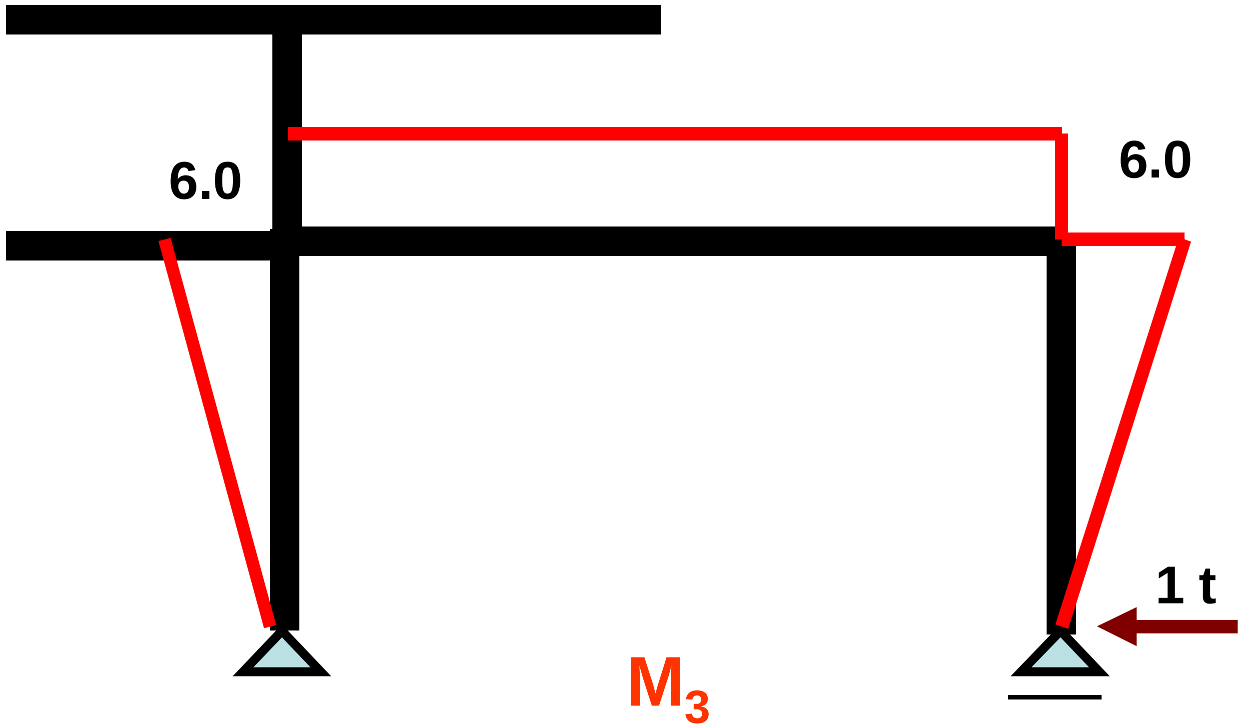
given loads



$$\theta d=\frac{1}{EI}\left[-\frac{1*27*12}{6}-\left(\frac{2}{3}*108*12*0.5\right)\right]=-0.004 rad$$

For Δ_{hb}

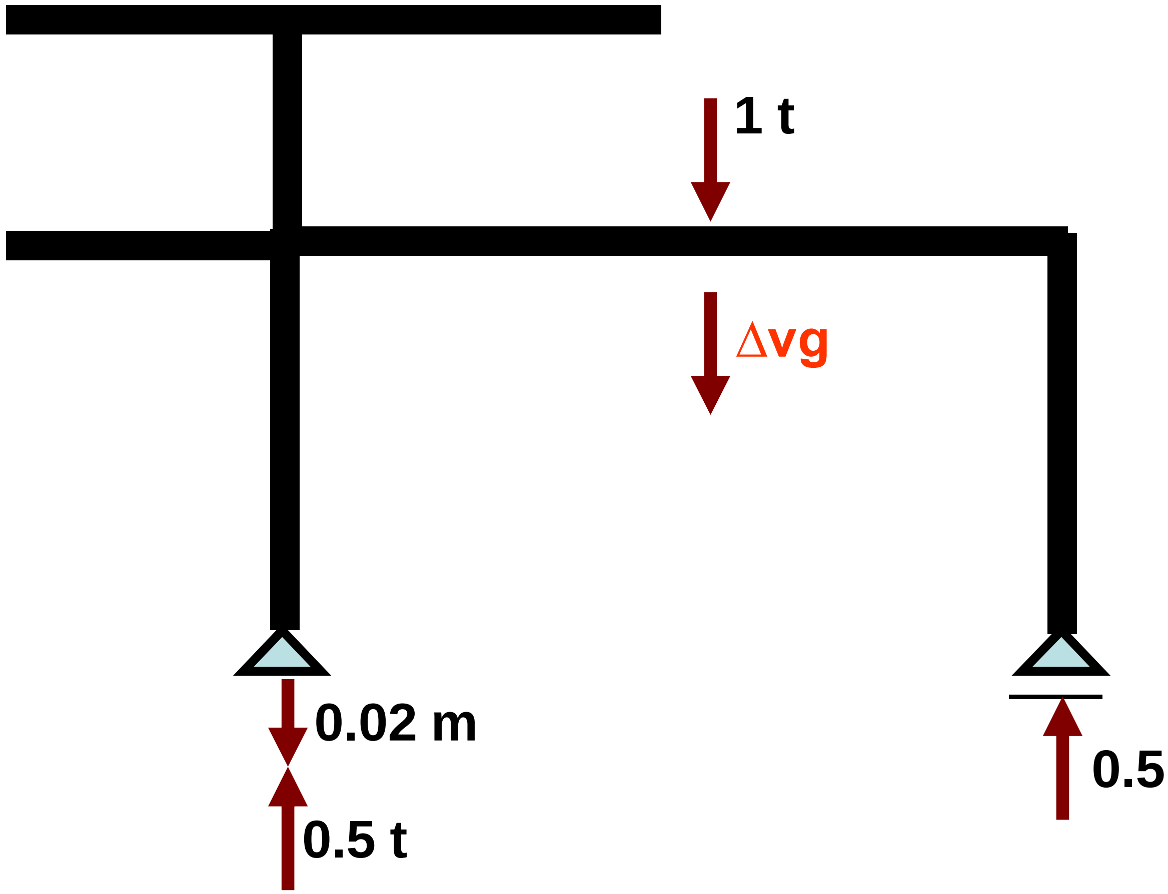
given loads



$$\Delta hb = \frac{1}{EI}\left[-\frac{27*6*12}{2} - \frac{2}{3}*108*12*6\right] = -0.513m$$

Downward Settlement at A = 2cm

For Δ_{vg}

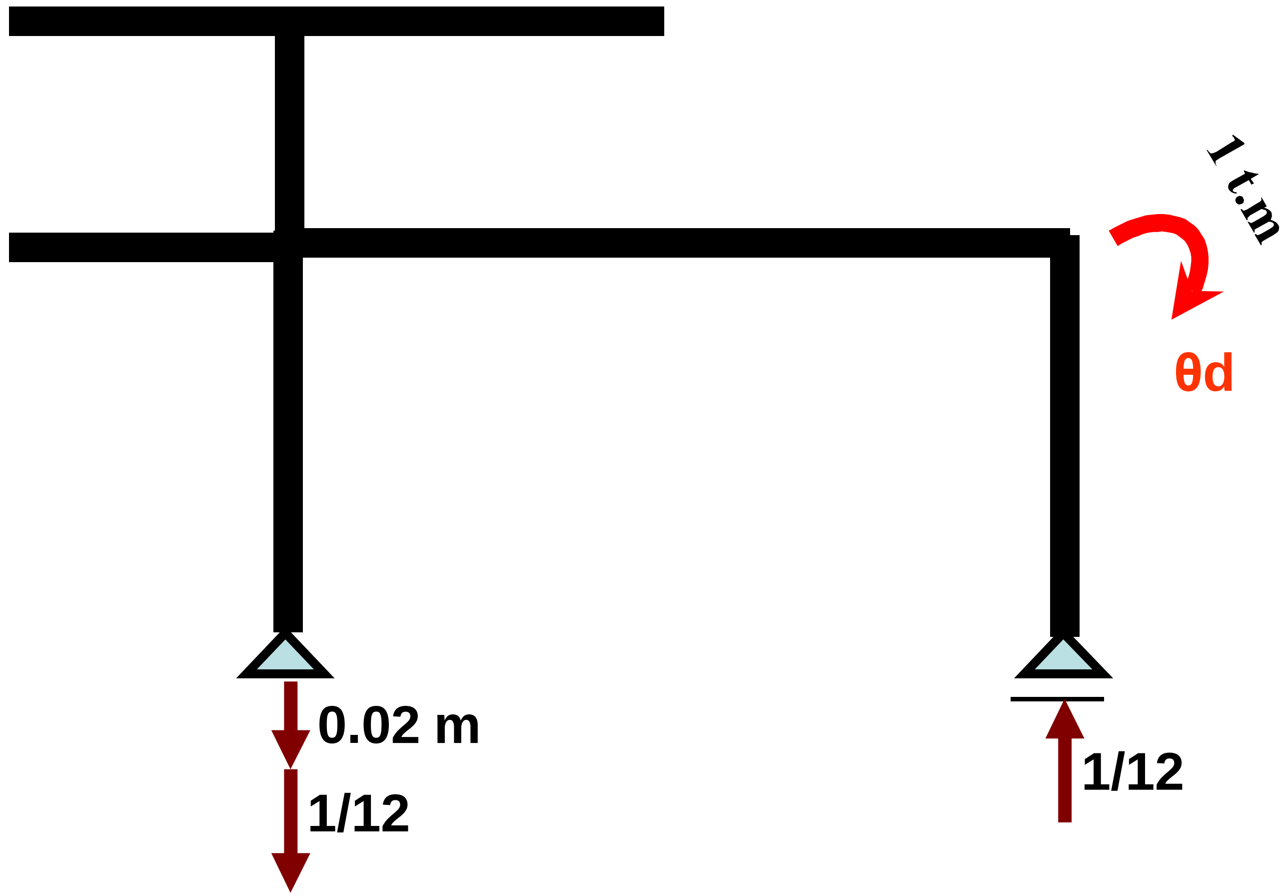


$$1 * \Delta vg - 0.5 * 0.02 = 0.0$$

$$\Delta vg = 0.01\, m$$

Downward Settlement at A = 2cm

For θ_d

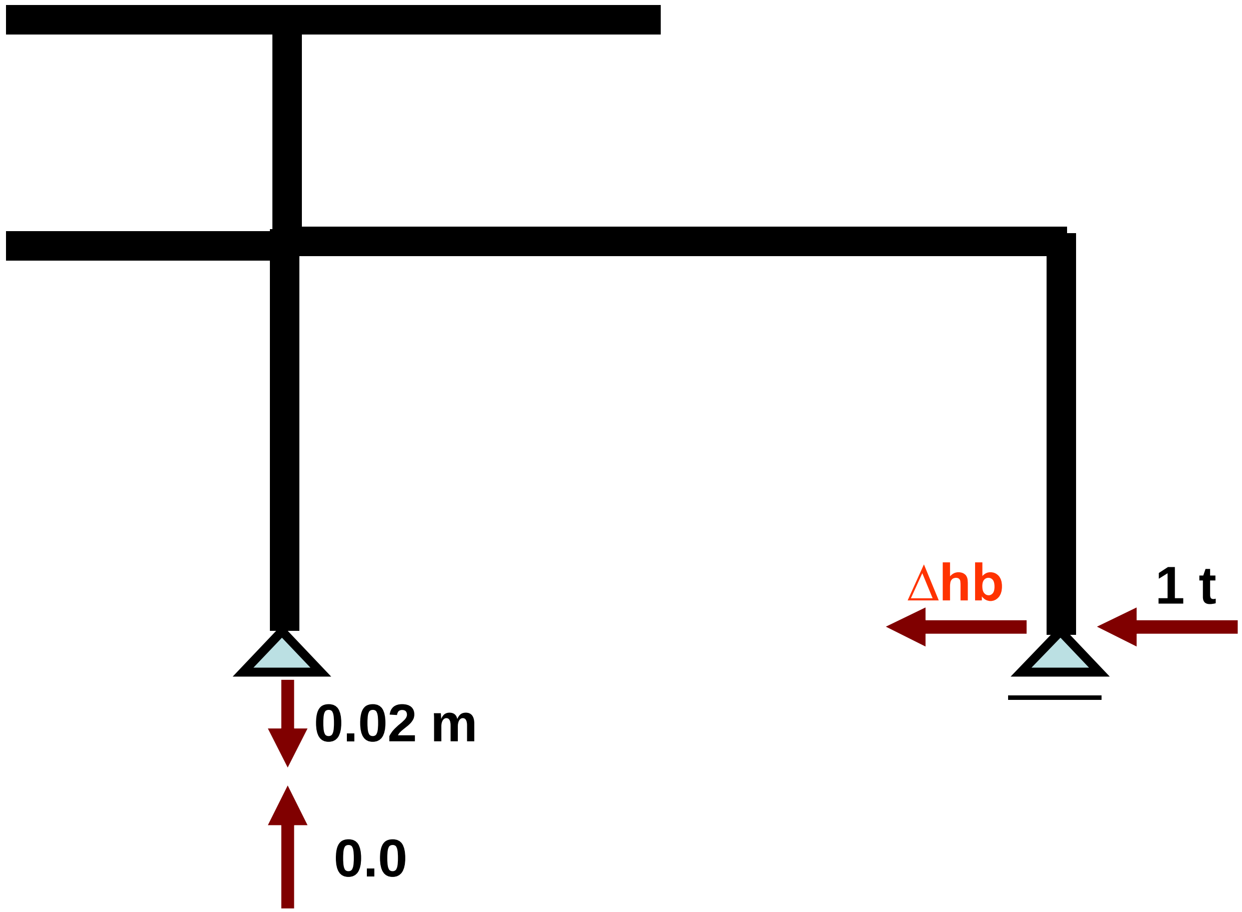


$$1 * \theta_d + 1/12 * 0.02 = 0.0$$

$$\theta_d = -0.0167\ rad$$

Downward Settlement at A = 2cm

For Δ_{hb}



$$1 * \Delta hb + 0.0 * 0.02 = 0.0$$

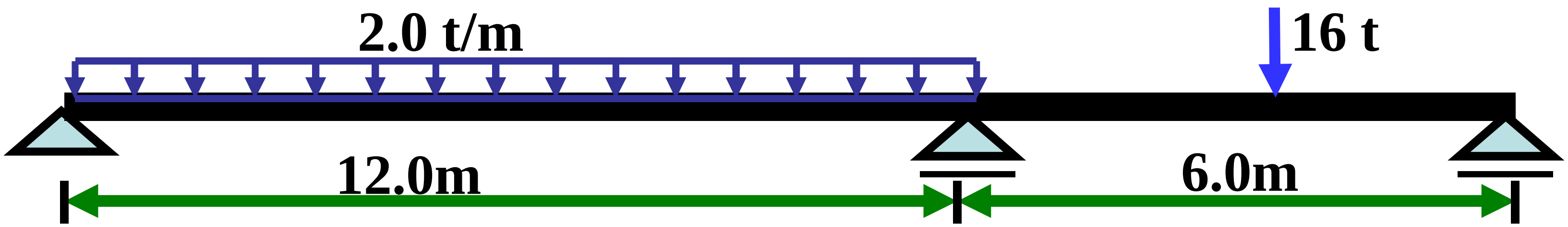
$$\Delta hb = 0.0$$

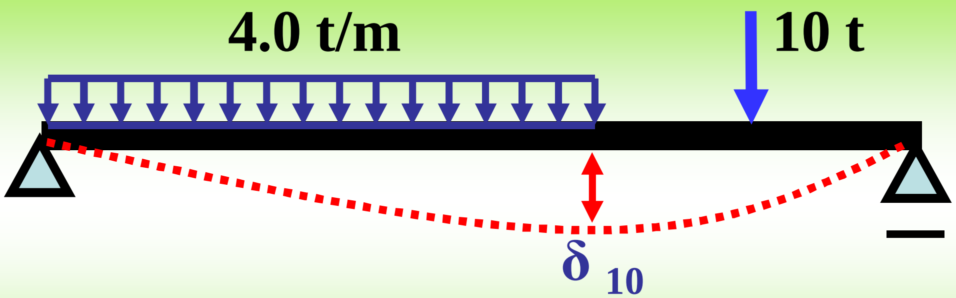
بســــم اللـــــه الرحمـــــن الرحيـــم

Consistant Deformation

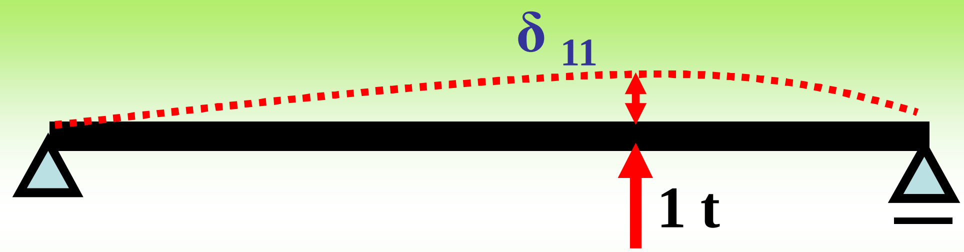
Eng : Ayman abdo

الهدف من دراسة المنشآت (indeterminate structures) بعد دراسة الهبوط هى ان اى support يضاف للكمرة سيتسبب فى زيادة معادلة للهبوط عند هذه النقطه وبالتالى يمكن استخدامها لحساب المجاهيل الزياده



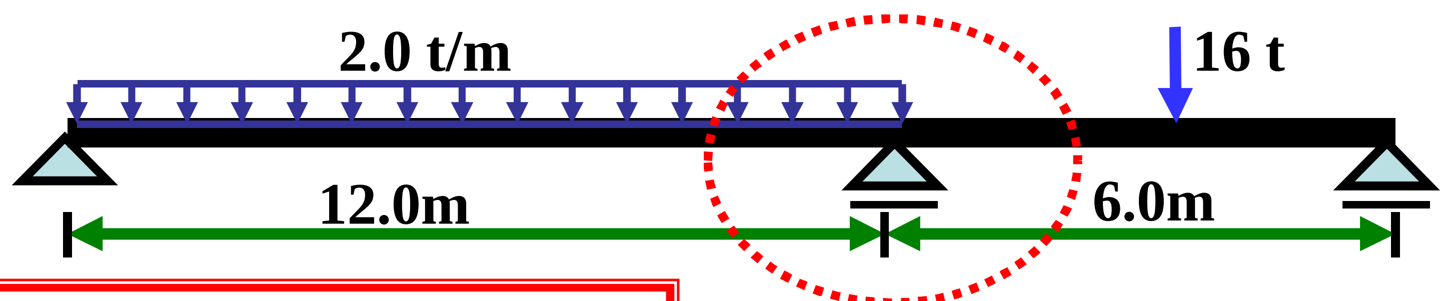


δ_{10} = support الهبوط حالة عدم وجود



δ_{11} = الـ deformation حالة وجود 1t لاعلى

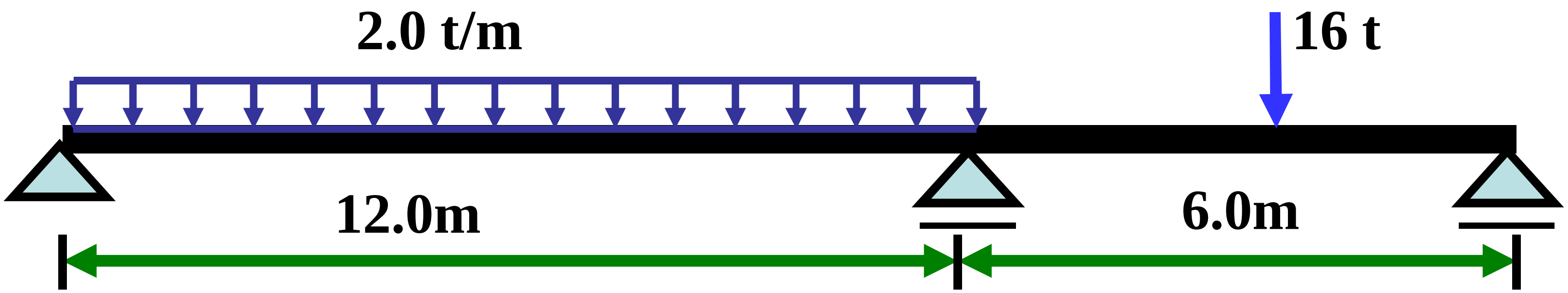
R*δ 11 = الـ deformation حالة وجود reaction كامل لاعلى



الهبوط النهائى عند هذا الـ support = 0.0

>>> $\delta_{10} + R * \delta_{11} = 0.0$

Example 1



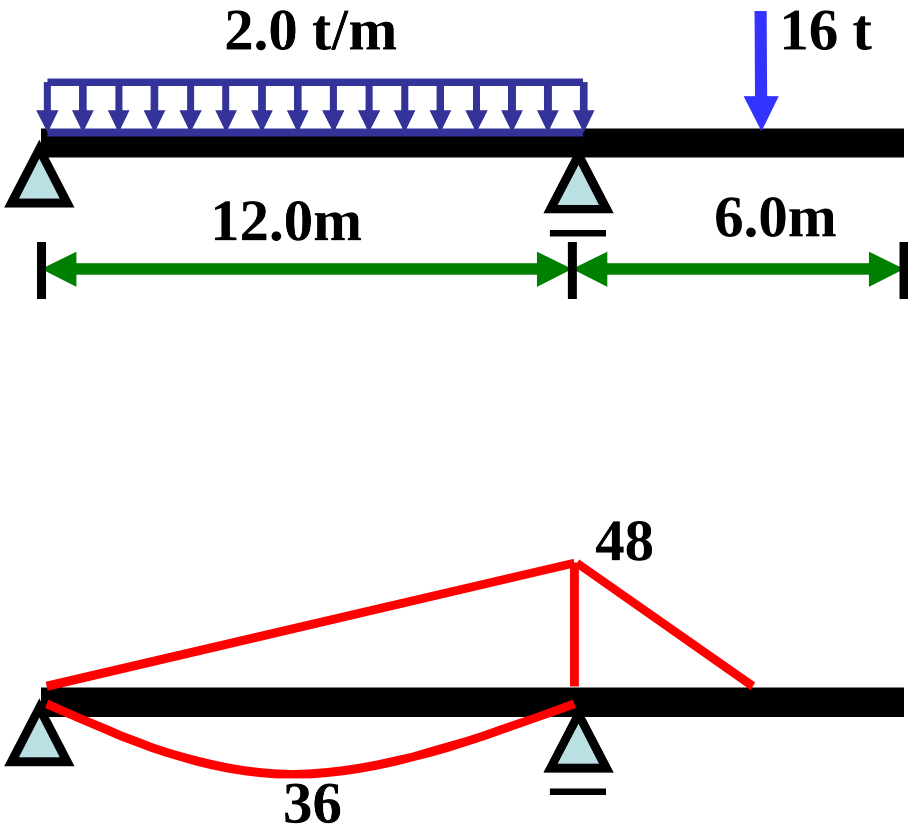
Draw B.M.D , S.F.D, and N.F.D EI = 10000

خطوات الحل:

1- يتم عمل main system وذلك بازالة الـ reaction الزياده على الكمرة المعطاه بشرط انها تبقى متزنه.

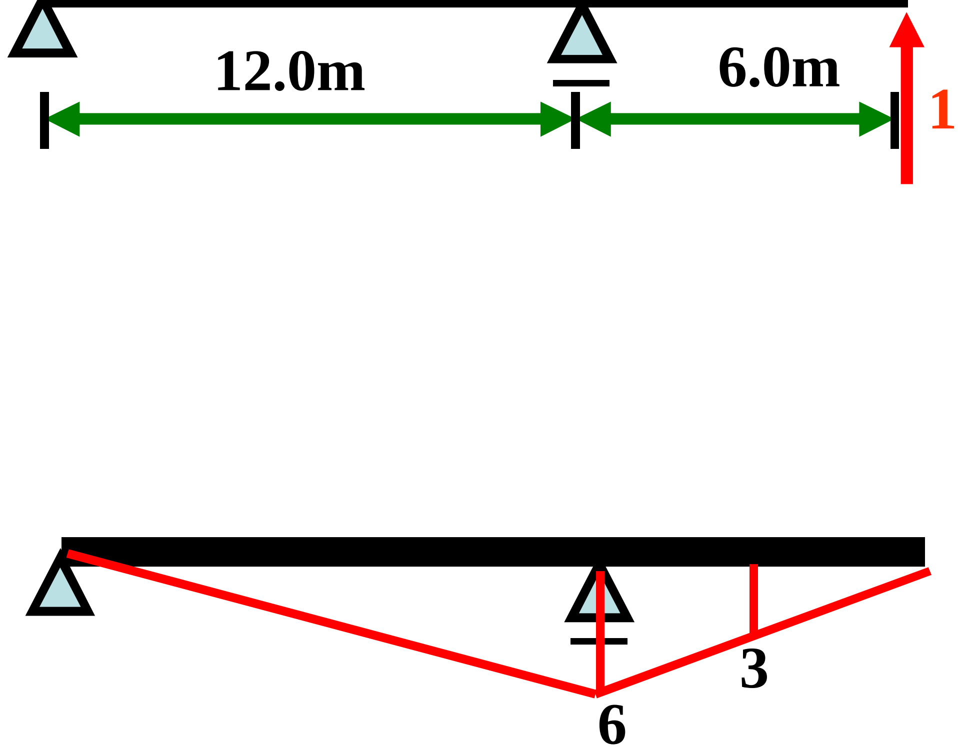
main system

2- draw (M_0) [loads + X=0]



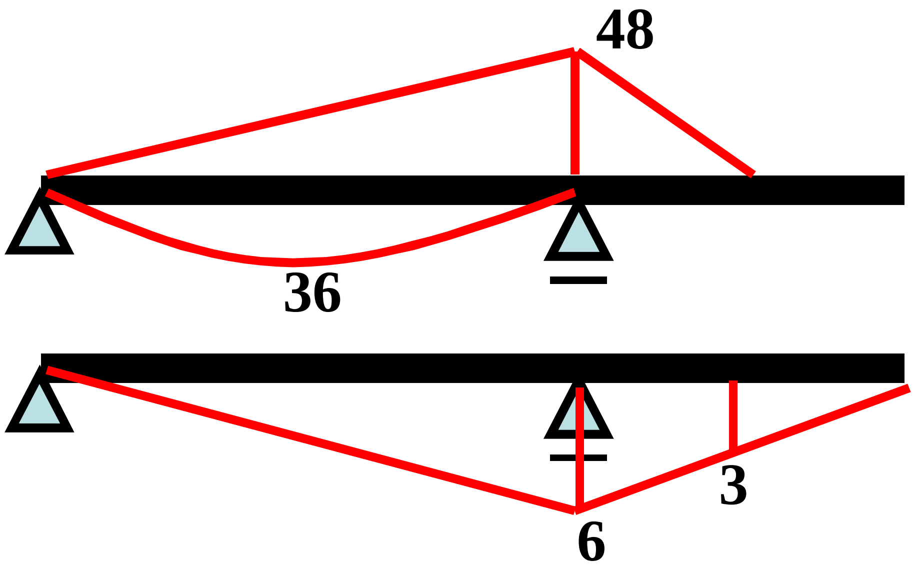
M_0

3- draw (M_1) [no loads + X=1]



M_1

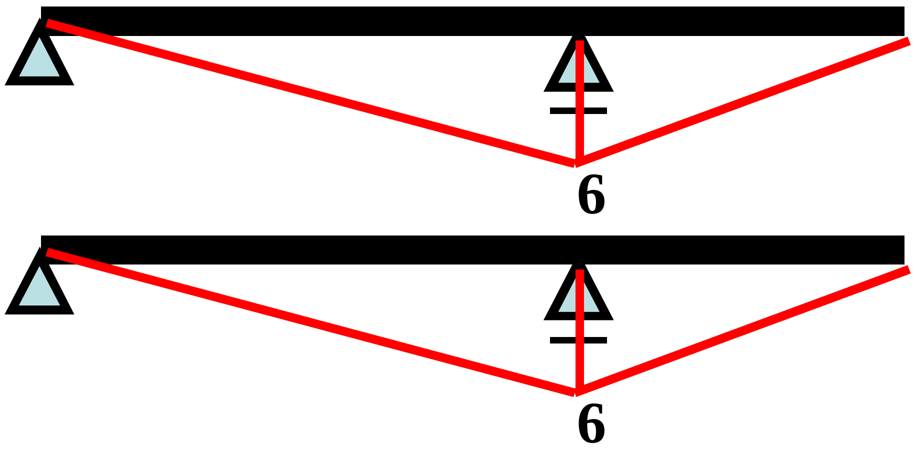
δ_{10} = M_1 مع M_0 تكامل



$$\delta_{10} = \frac{1}{10000}\left[-\frac{48*6*12}{3}+\left(\frac{2}{3}*36*12*1/2*6\right)-\frac{3}{3}*(6*48+0.5*(3*48))\right]$$

$$= -\frac{648}{10000}\,m$$

δ_{11} = M_1 مع M_1 تكامل

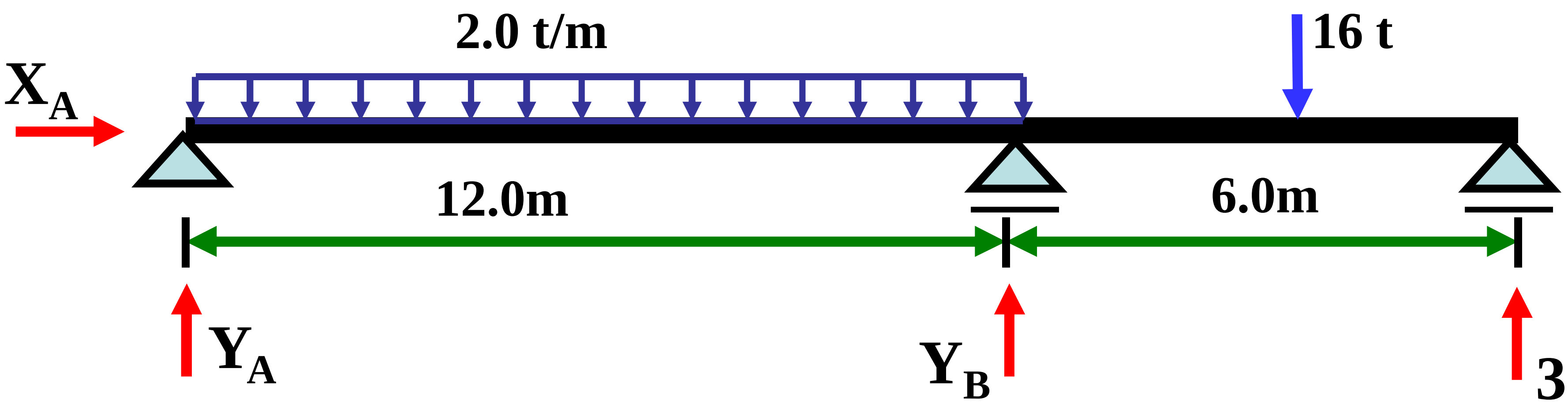


$$\delta_{11} = \frac{1}{10000}\left[\frac{6*6*12}{3}+\frac{6*6*6}{3}\right]$$

$$= \frac{216}{10000}\,m$$

$$\delta_{10} + X \cdot \delta_{11} = 0.0$$

$$-\frac{648}{10000} + X * \frac{216}{10000} = 0.0 \quad >> \quad X = 3\, ton$$



$\sum M_A = 0.0$

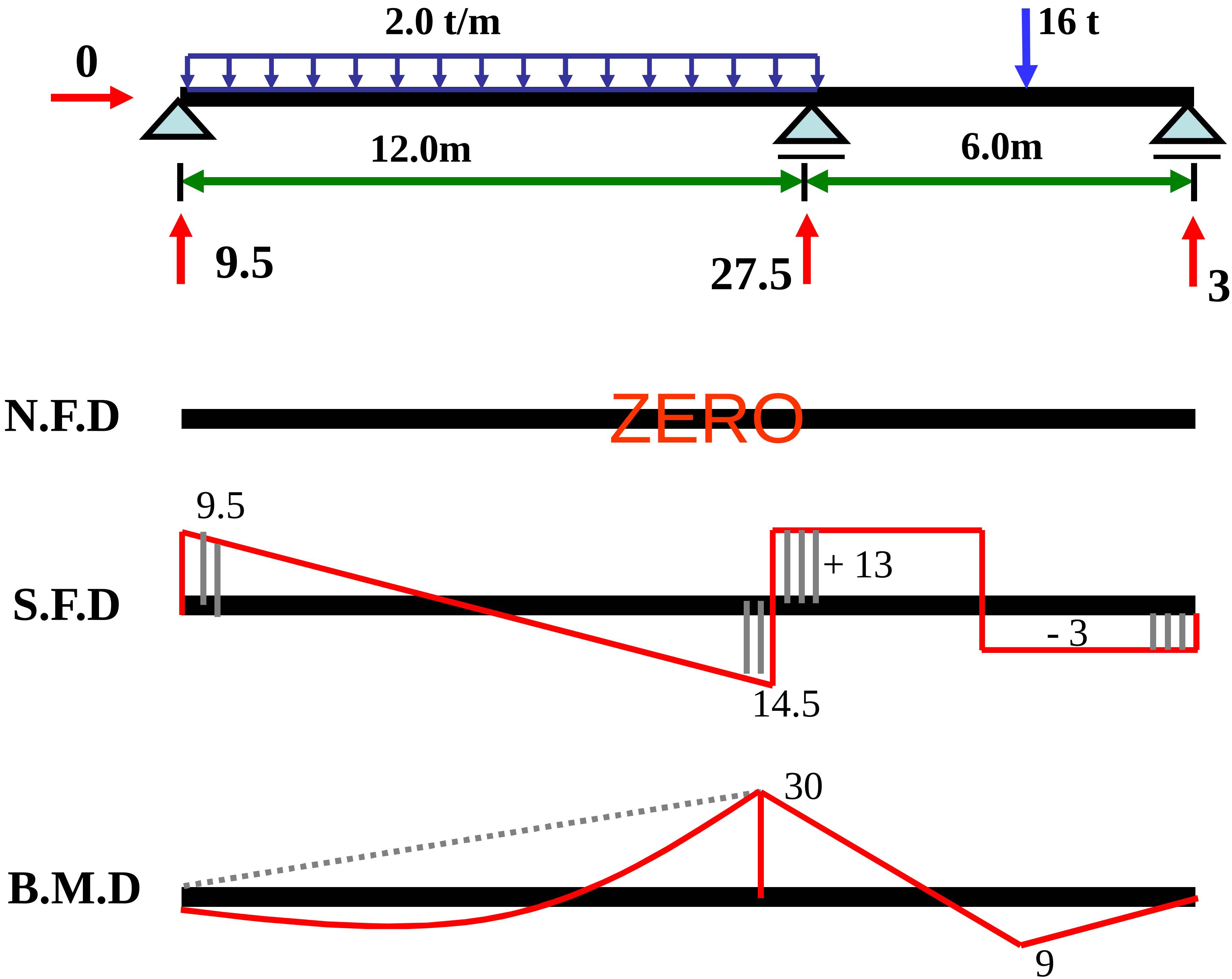
$24 * 6 + 16 * 15 – Y_B *12 – 3 * 18 = 0 \quad >> \quad Y_B = 27.5$ t

$\sum F_Y = 0.0$

$Y_A = 24 + 16 - 27.5 - 3 = 9.5$

$\sum F_X = 0.0$

$X_A = 0.0$

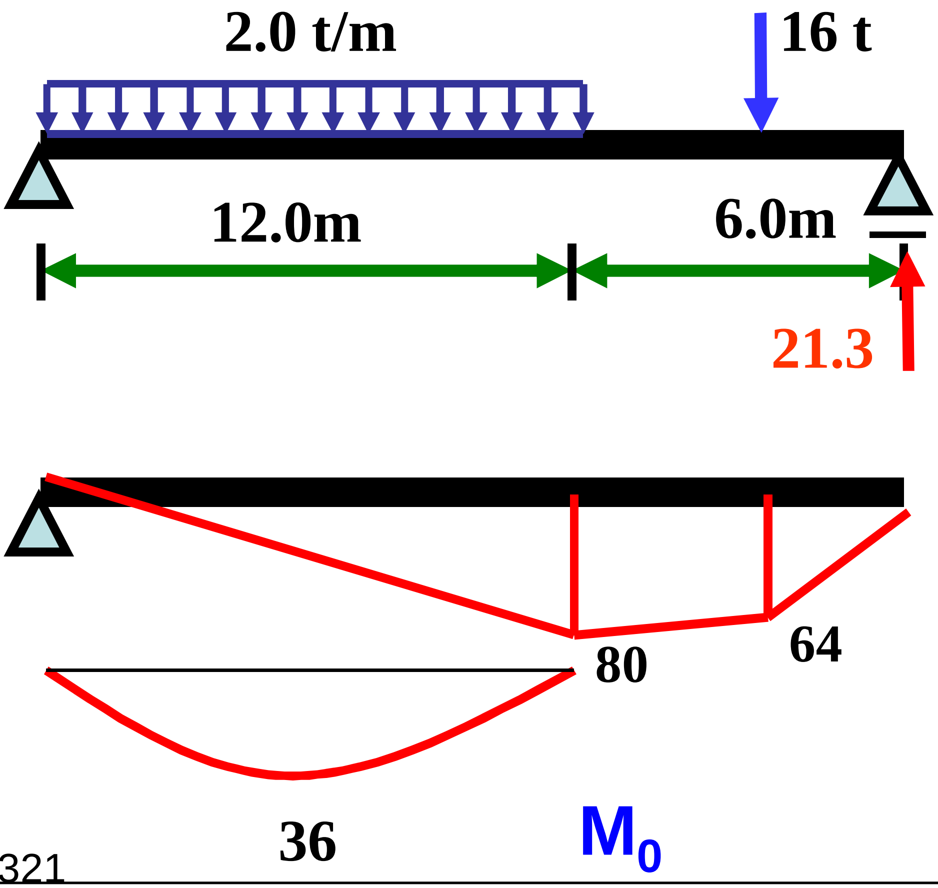


2.0 t/m
16 t
0
12.0m
6.0m
9.5
27.5
3
N.F.D
ZERO
S.F.D
9.5
+ 13
- 3
14.5
B.M.D
30
9

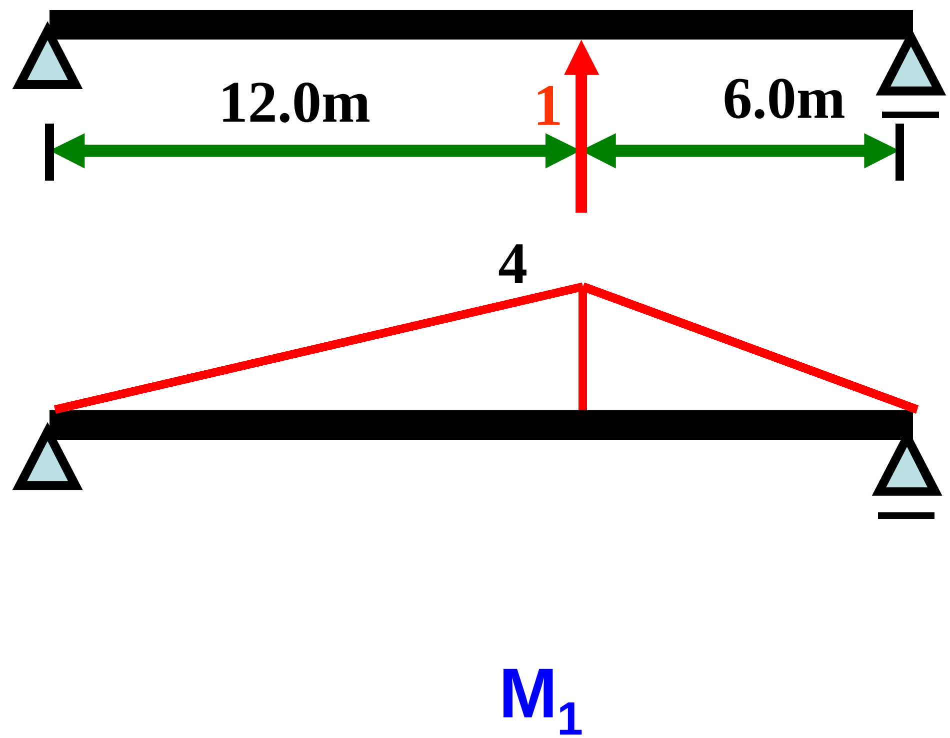
حل اخر:

main system

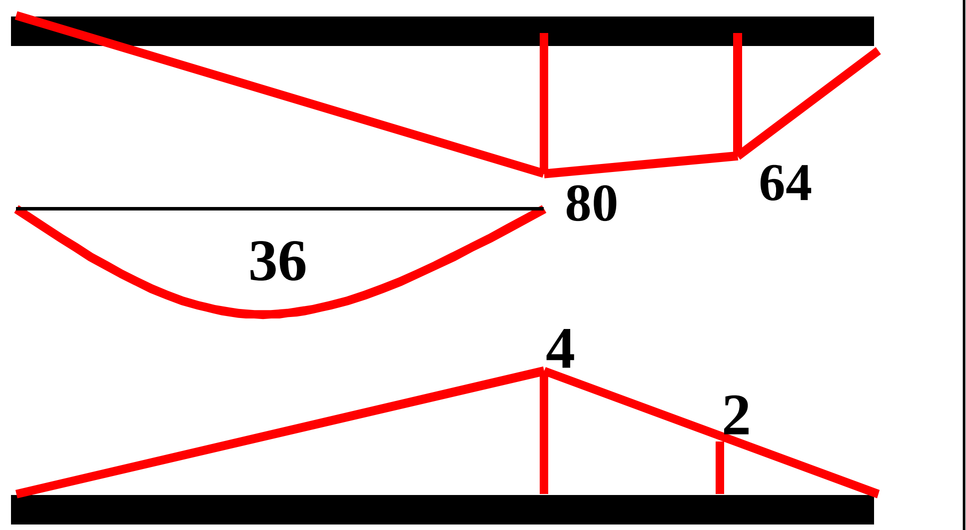
2- draw (M_0) [loads + X=0]



3- draw (M_1) [no loads + X=1]



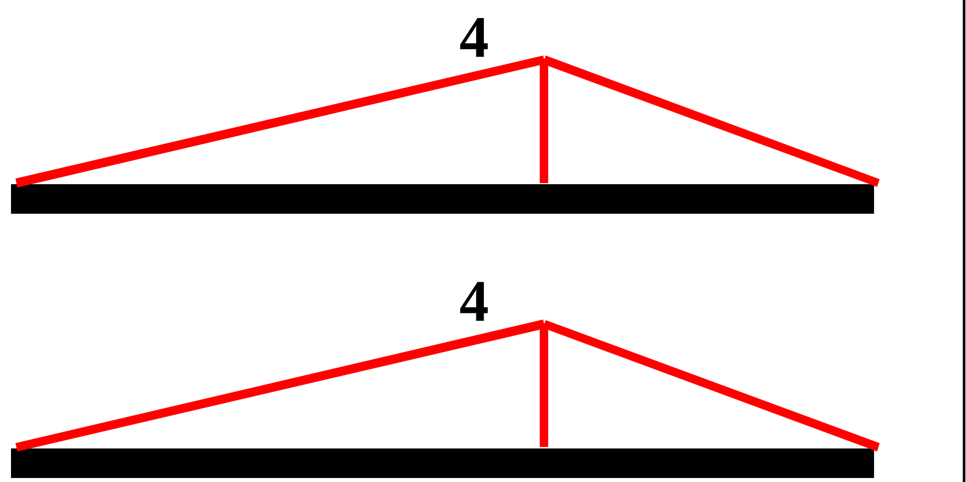
$\delta_{10} = M_1$ مع M_0 تكامل



$$\delta_{10} = \frac{1}{10000}\left[-\frac{80*4*12}{3} - \left(\frac{2}{3}*36*12*2\right) - \frac{3}{3}*(4*80+64*2+0.5*(4*64+2*80)) - 2*64*3/3\right]$$

$$= -\frac{2640}{10000}\,m$$

$\delta_{11} = M_1$ مع M_1 تكامل

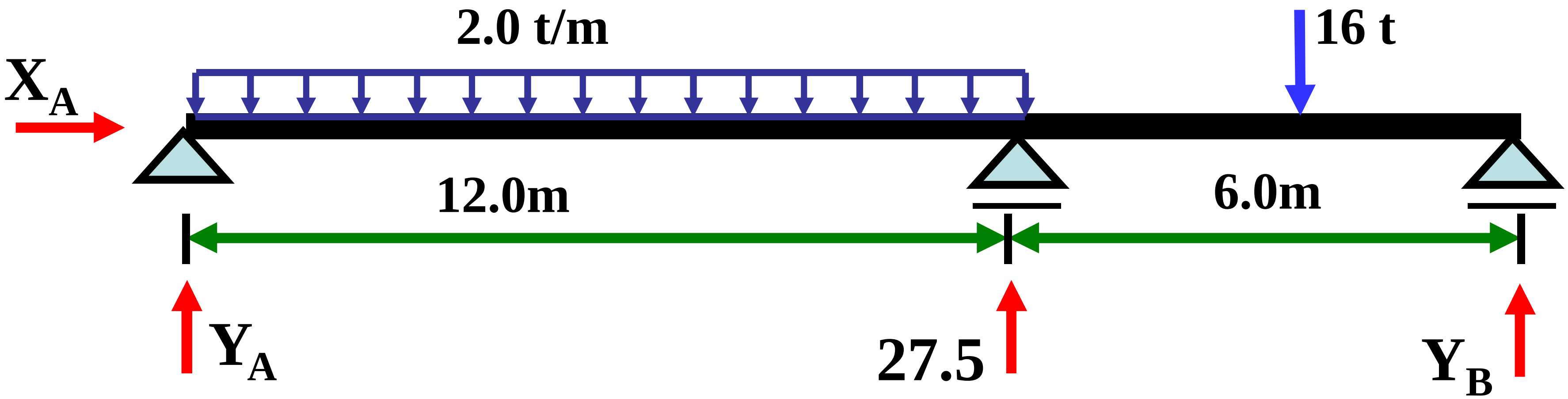


$$\delta_{11} = \frac{1}{10000}\left[\frac{4*4*12}{3} + \frac{4*4*6}{3}\right]$$

$$= \frac{96}{10000}\,m$$

$$\delta_{10} + X \, . \, \delta_{11} = 0.0$$

$$-\frac{2640}{10000} + X * \frac{96}{10000} = 0.0 \quad >> \quad X \quad = 27.5\ ton$$



$$\sum M_A = 0.0$$

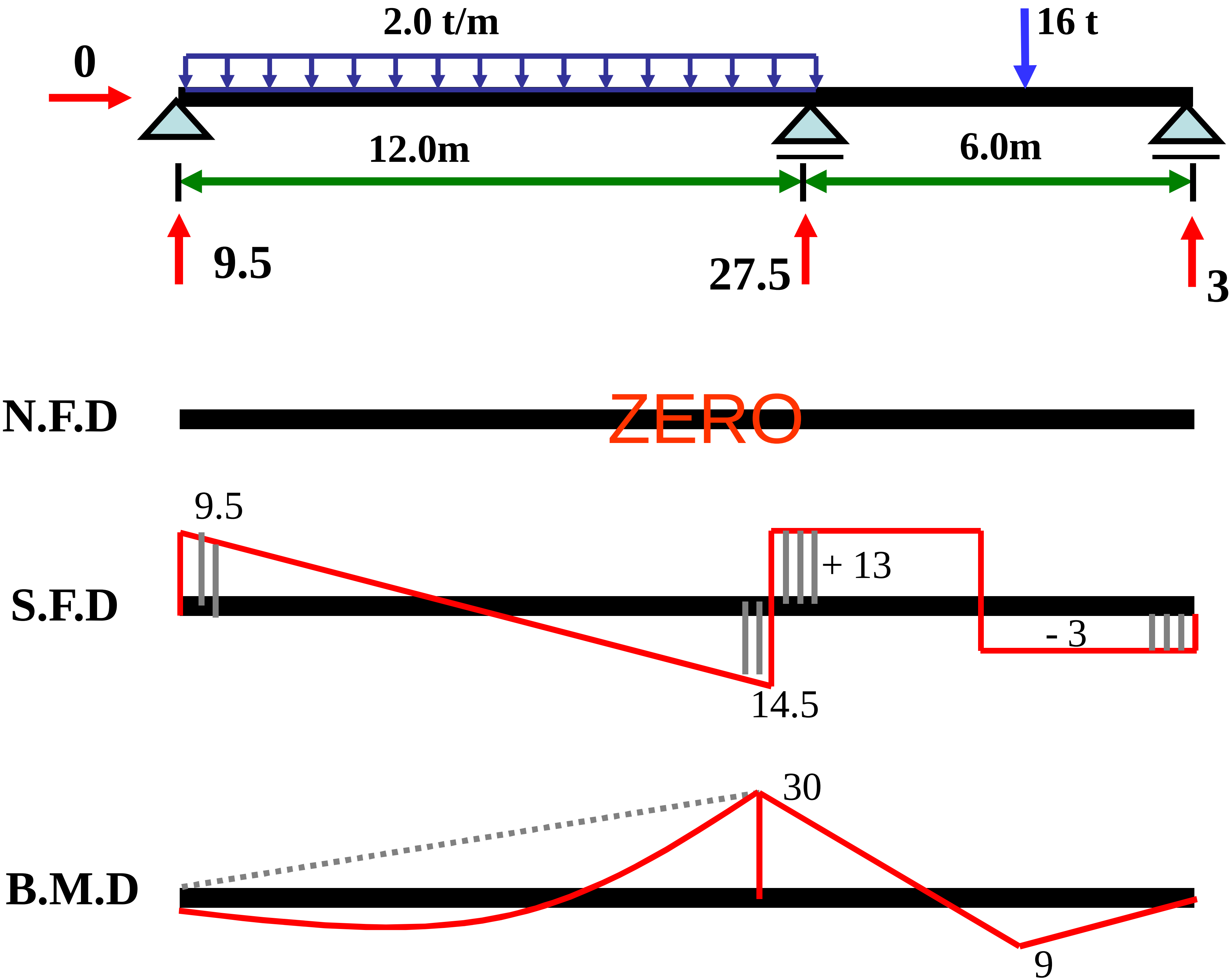
$$24 * 6 + 16 * 15 - Y_c * 18 - 27.5 * 12 = 0 \quad >> \quad Y_c = 3.0\ t$$

$$\sum F_Y = 0.0$$

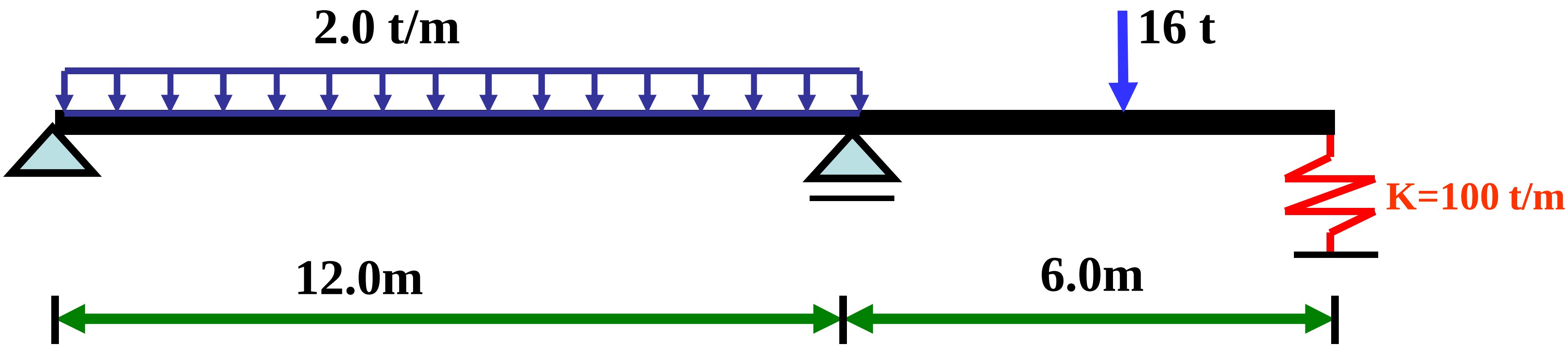
$$Y_A = 24 + 16 - 27.5 - 3 = 9.5$$

$$\sum F_X = 0.0$$

$$X_A = 0.0$$


2.0 t/m
16 t
0
12.0m
6.0m
9.5
27.5
3
N.F.D
ZERO
S.F.D
9.5
+ 13
- 3
14.5
B.M.D
30
9

Example 2



Draw B.M.D , S.F.D, and N.F.D   EI = 10000

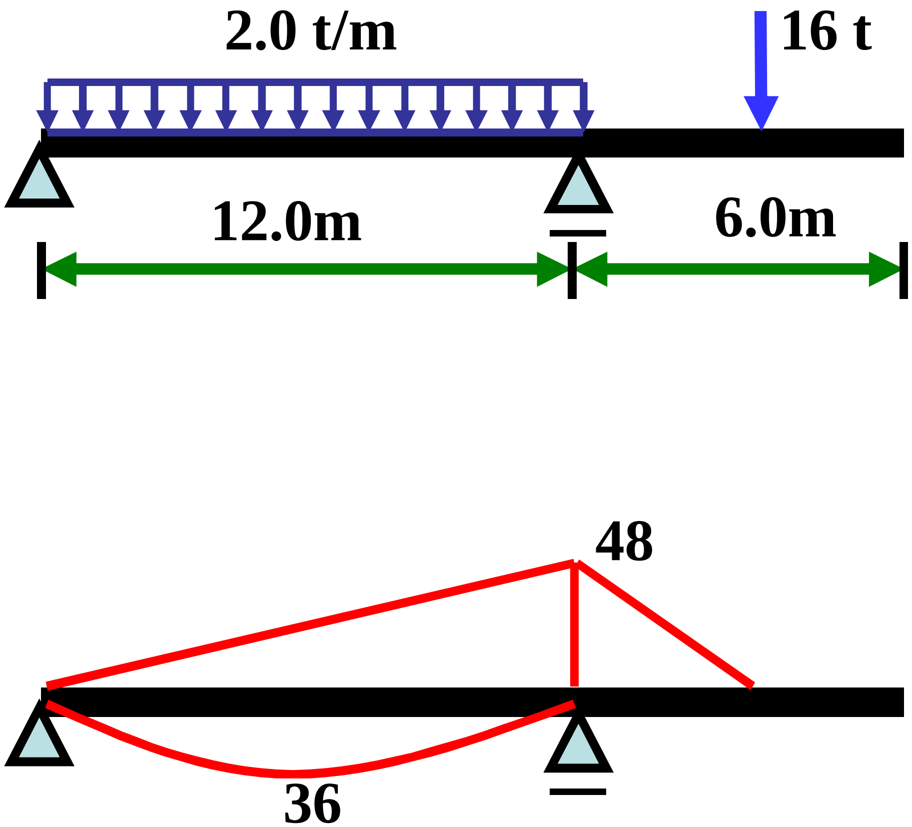
R / k = Δ = spring الهبوط النهائى عند هذا الـ

>>> $\delta_{10} + R * \delta_{11} = - R / K$

>>> $\delta_{10} + R * (\delta_{11} + 1/k) = 0$

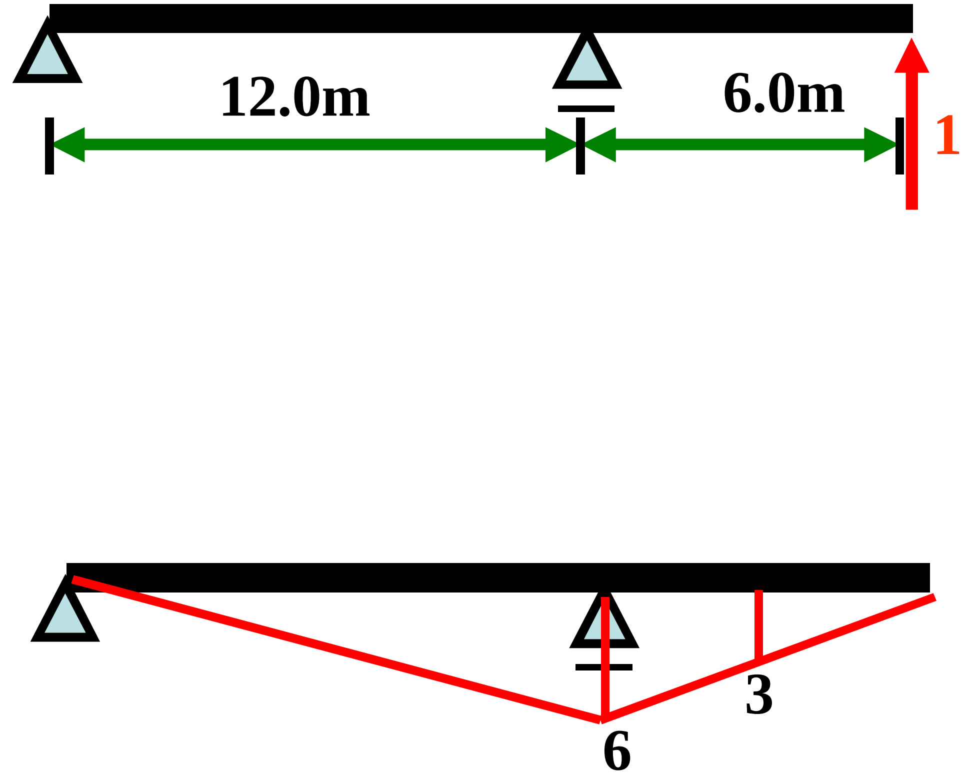
main system

2- draw (M_0) [loads + X=0]



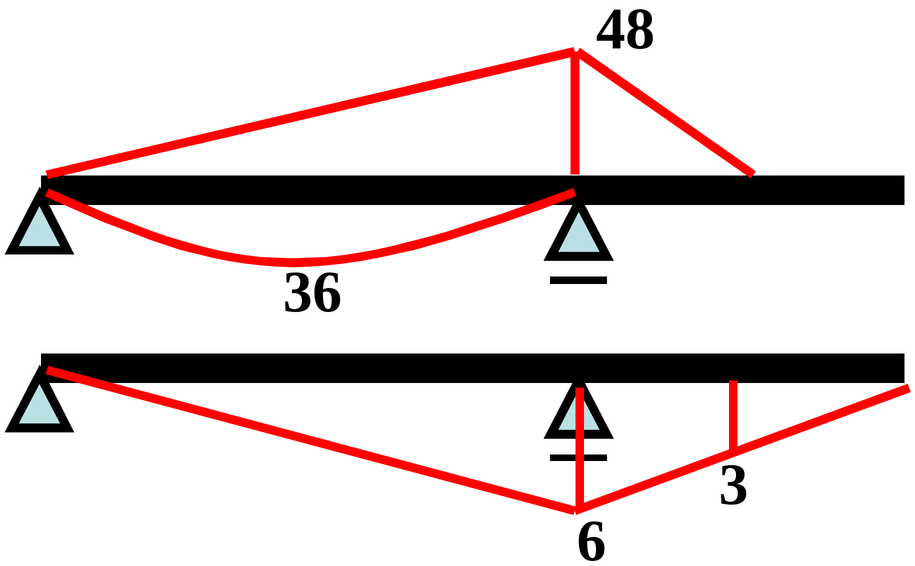
M_0

3- draw (M_1) [no loads + X=1]



M_1

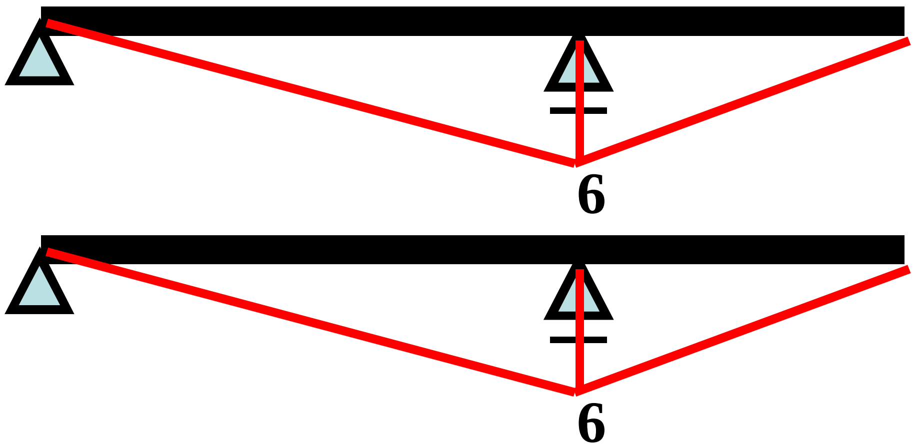
$\delta_{10} = M_1$ مع M_0 تكامل



$$\delta_{10} = \frac{1}{10000}\left[-\frac{48*6*12}{3} + \left(\frac{2}{3}*36*12*1/2*6\right) - \frac{3}{3}*(6*48+0.5*(3*48)) \right]$$

$$= -\frac{648}{10000}\,m$$

$\delta_{11} = M_1$ مع M_1 تكامل

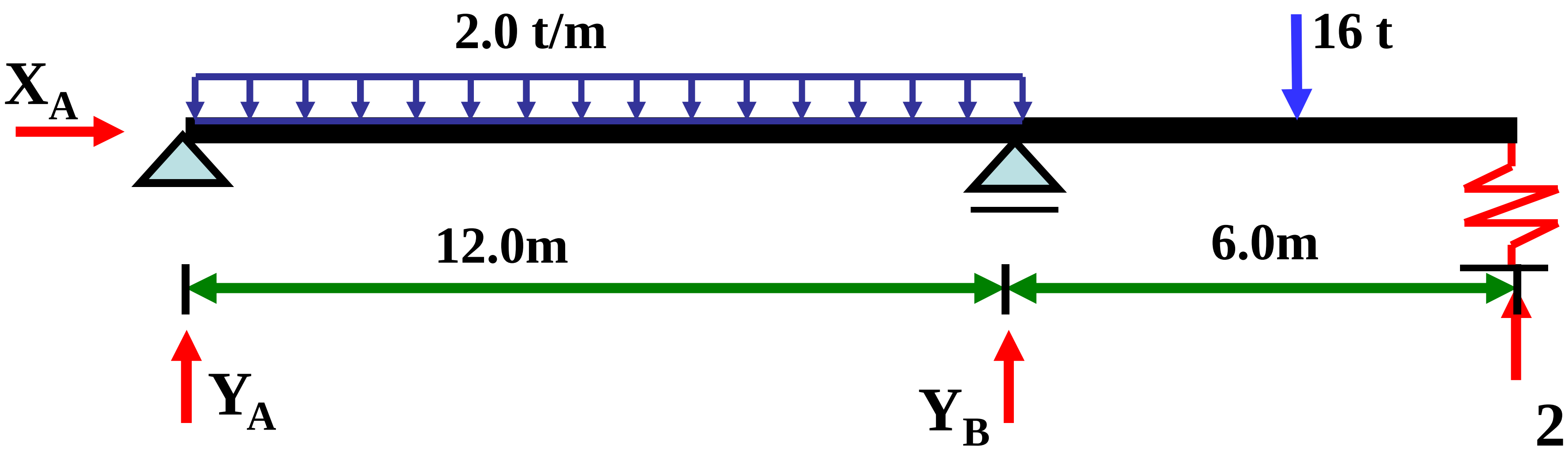


$$\delta_{11} = \frac{1}{10000}\left[\frac{6*6*12}{3} + \frac{6*6*6}{3} \right]$$

$$= \frac{216}{10000}\,m$$

$$\delta_{10} + X\,.\,(\,\delta_{11} + 1/k\,) = 0.0$$

$$-\frac{648}{10000} + X * (\frac{216}{10000} + \frac{1}{100}) = 0.0 \quad >> \quad X \quad = 2\ ton$$



$\sum M_A = 0.0$

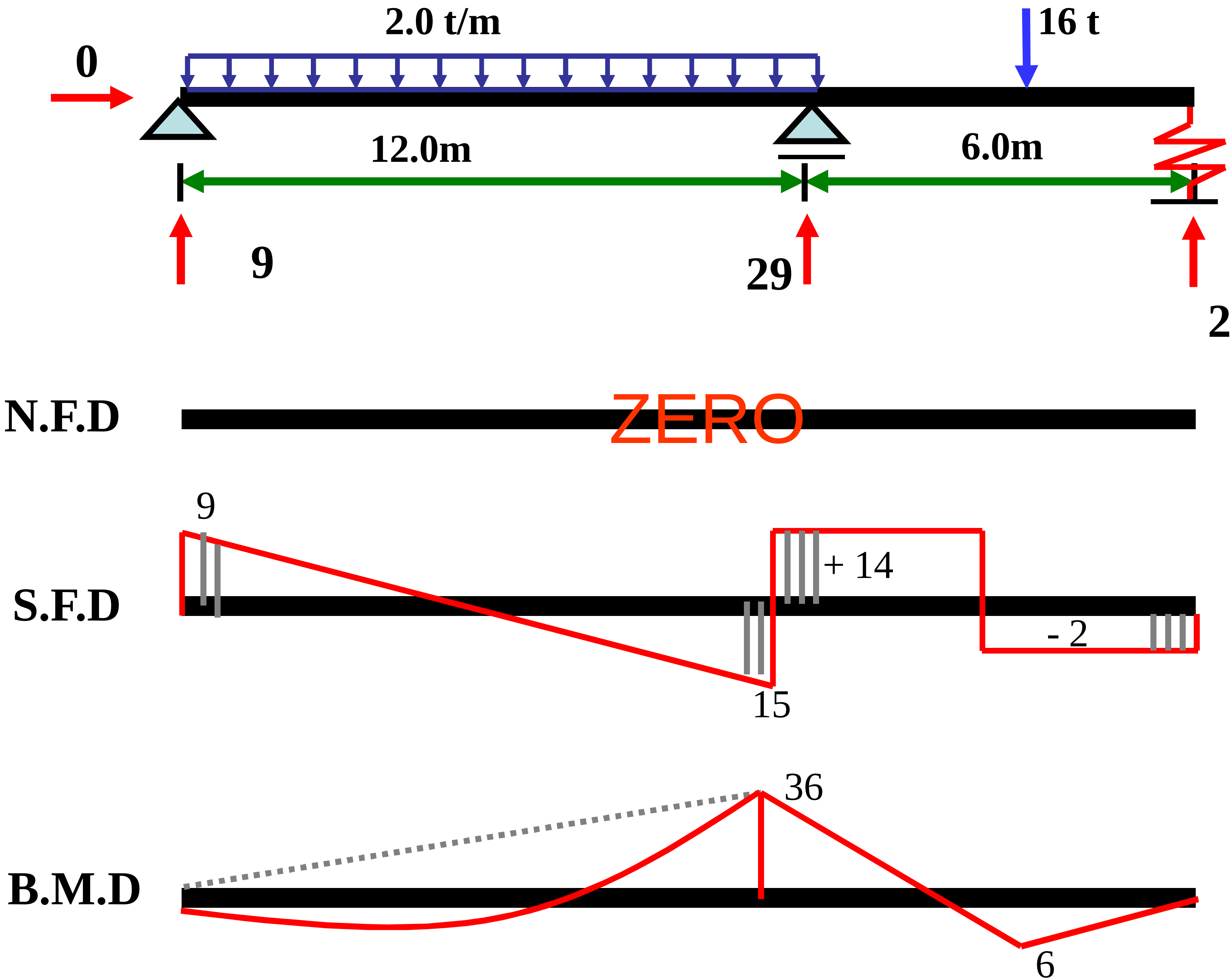
24 * 6 + 16 * 15 – Y_B *12 – 2 * 18 =0 >> Y_B = 29 t

$\sum F_Y = 0.0$

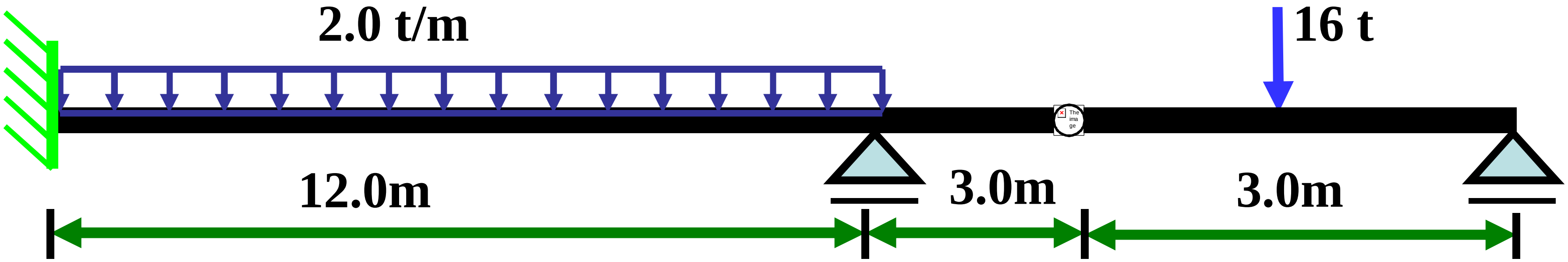
Y_A = 24 + 16 - 29 - 2 = 9

$\sum F_X = 0.0$

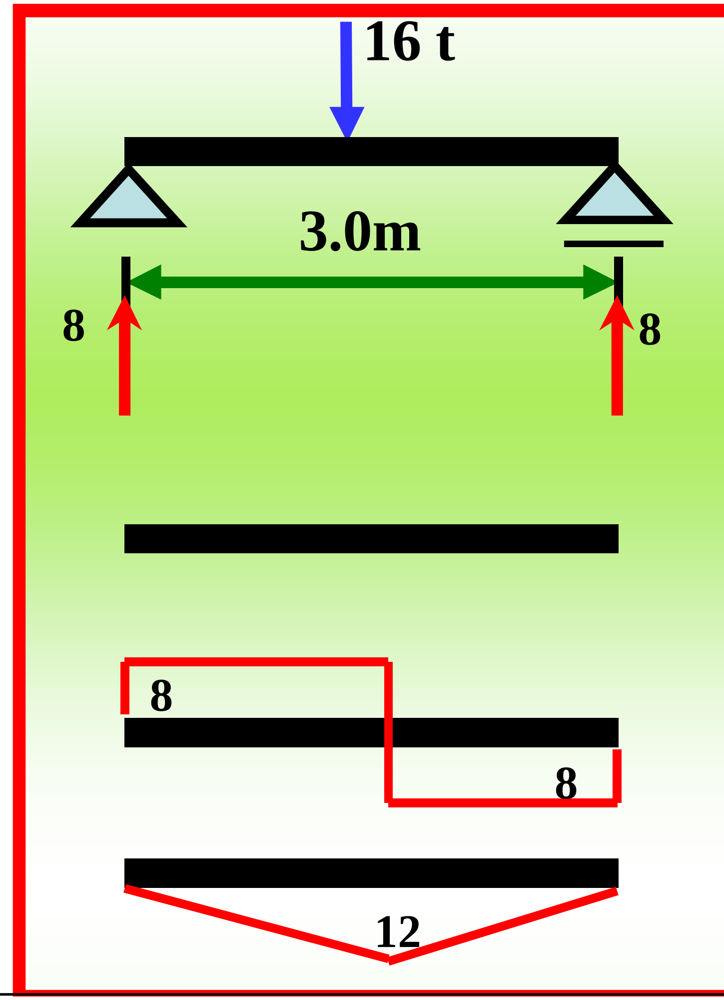
X_A = 0.0


2.0 t/m
16 t
0
12.0m
6.0m
9
29
2
N.F.D
ZERO
9
S.F.D
+ 14
- 2
15
36
B.M.D
6

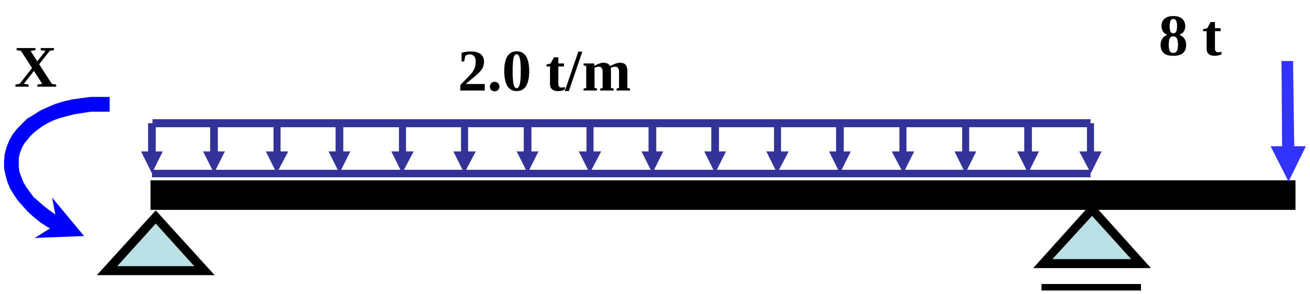
Example 3



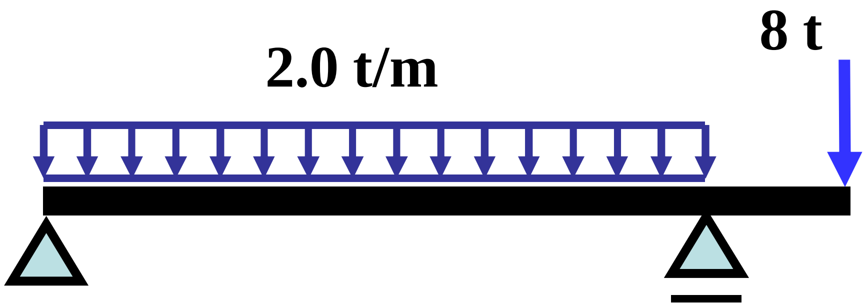
Draw B.M.D , S.F.D, and N.F.D   EI = 10000

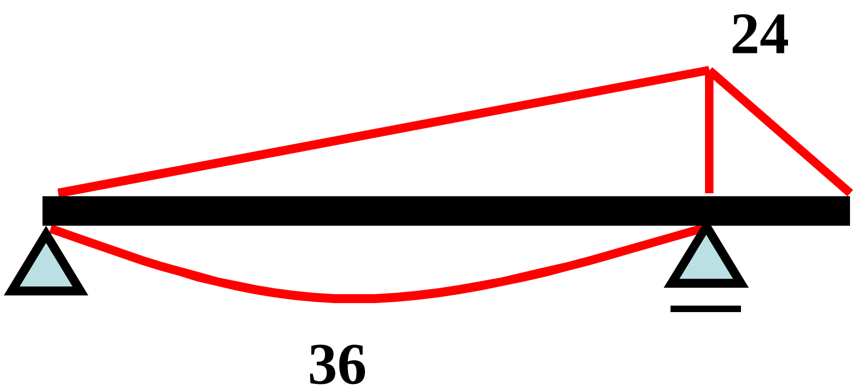


main system



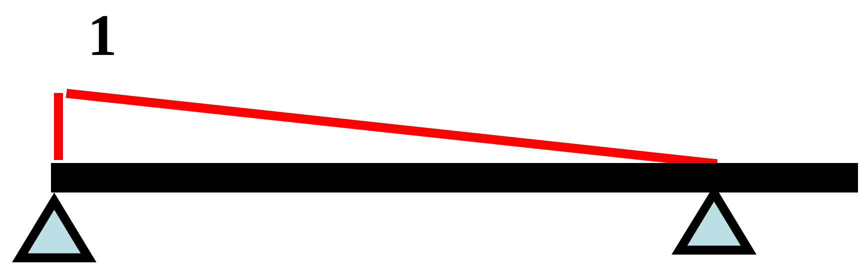
2- draw (M_0) [loads + X=0]





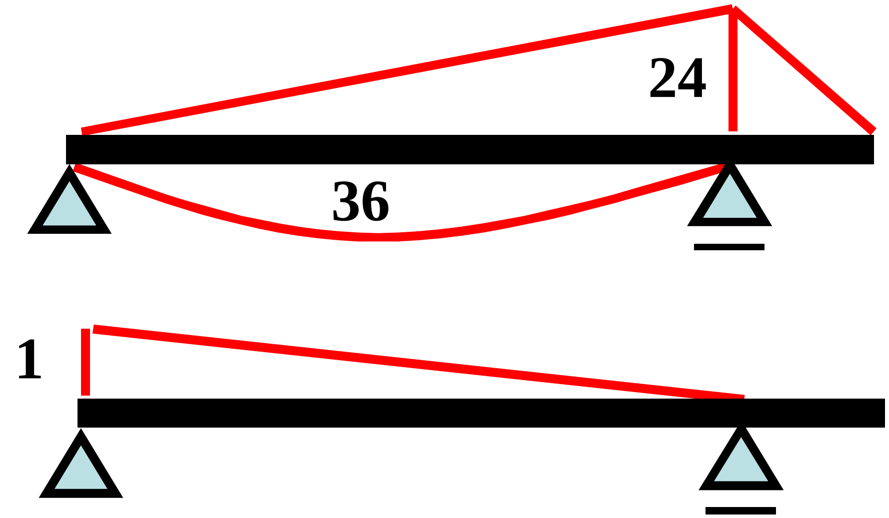
M_0

3- draw (M_1) [no loads + X=1]



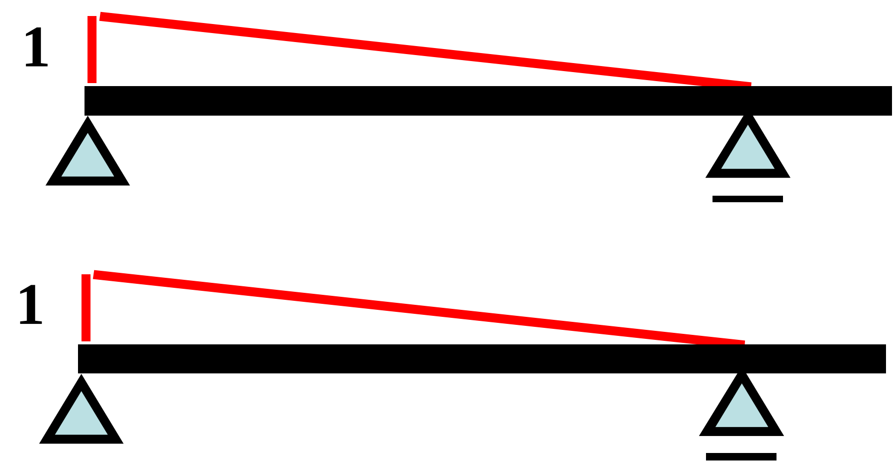
M_1

$\delta_{10} = M_1$ مع M_0 تكامل



$$\delta_{10} = \frac{1}{10000}\left[\frac{24*1*12}{6} - \left(\frac{2}{3}*36*12*0.5\right)\right] = -\frac{96}{10000}\,m$$

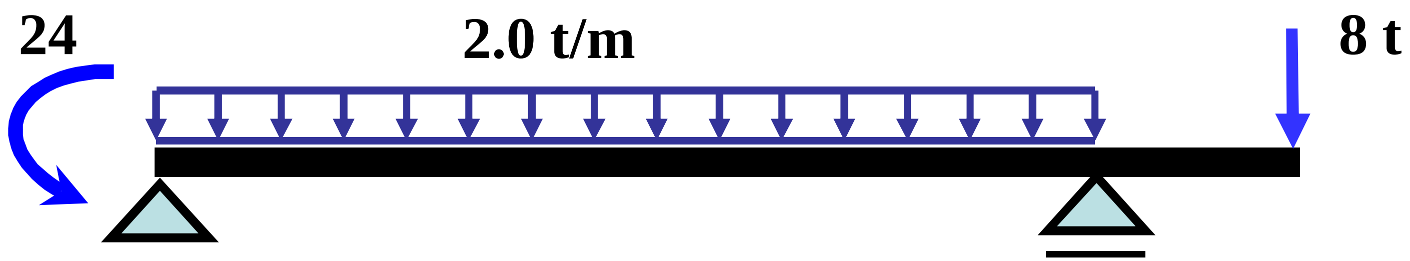
$\delta_{11} = M_1$ مع M_1 تكامل



$$\delta_{11} = \frac{1}{10000}\left[\frac{1*1*12}{3}\right] = \frac{4}{10000}\,m$$

$$\delta_{10} + X \, . \, \delta_{11} = 0.0$$

$$-\frac{96}{10000} + X * \frac{4}{10000} = 0.0 \quad >> \quad X = 24 \;\; t.m$$



$\sum M_A$ = 0.0

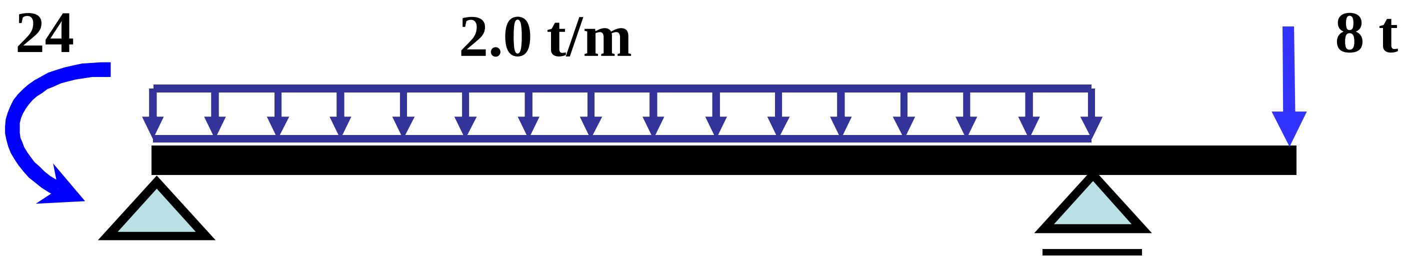
16 * 6 – Y_B *12 + 8 * 15 - 24 = 0.0 >> Y_B = 16 t

$\sum F_Y$ = 0.0

Y_A = 24 + 8 - 16 = 16

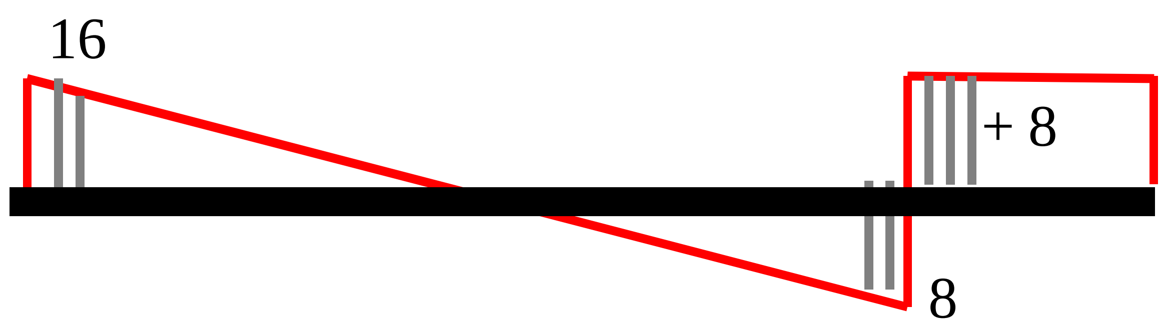
$\sum F_X$ = 0.0

X_A = 0.0

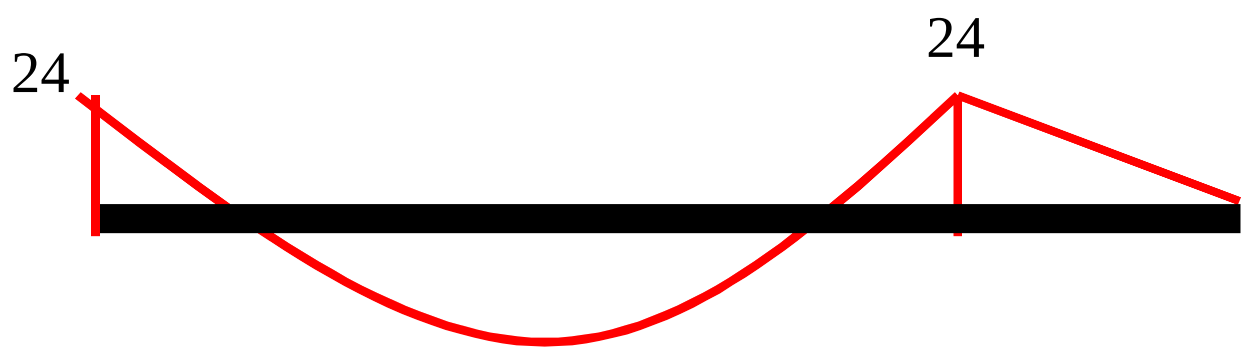


N.F.D

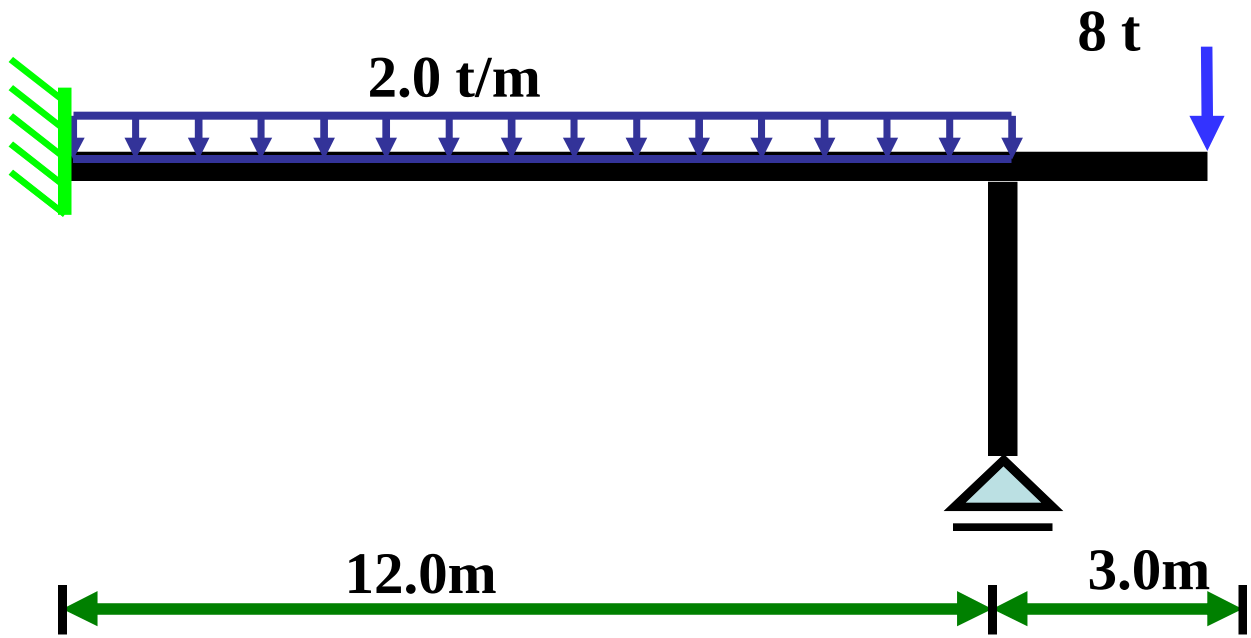
S.F.D



B.M.D

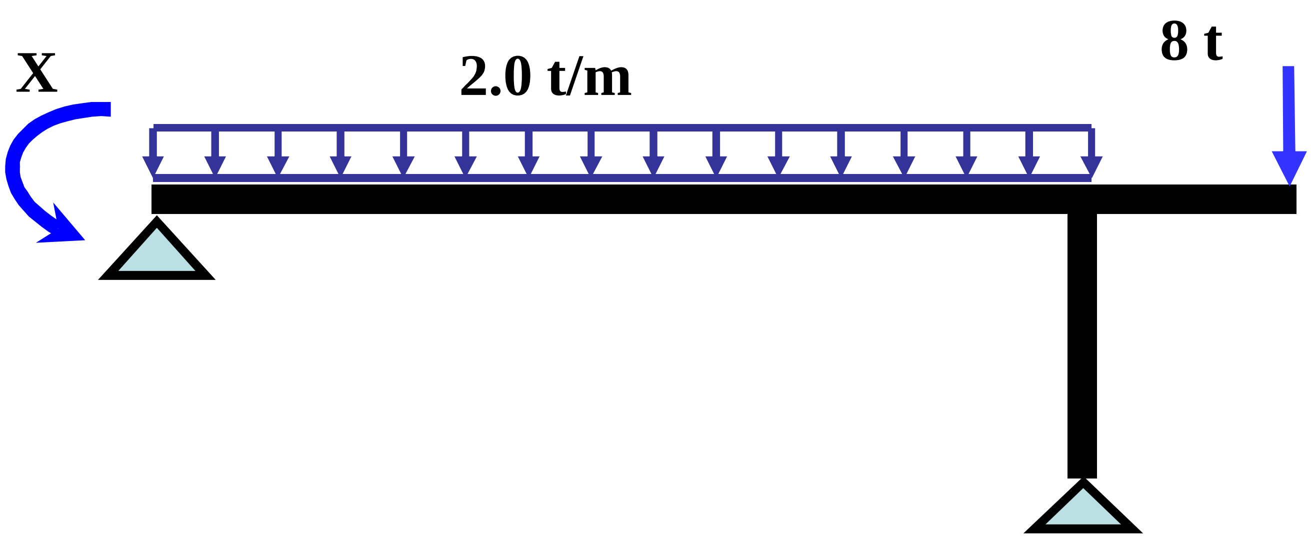


Example 4

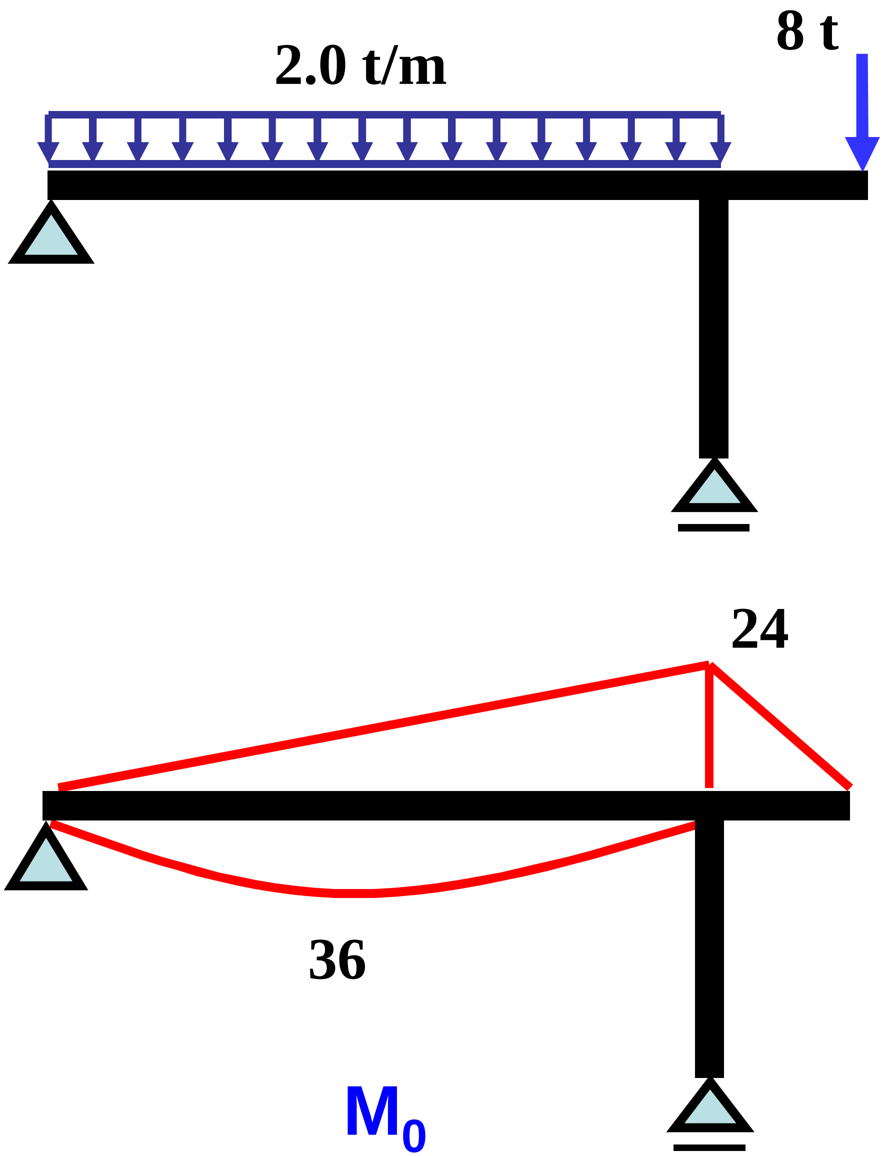


Draw B.M.D , S.F.D, and N.F.D   EI = 10000

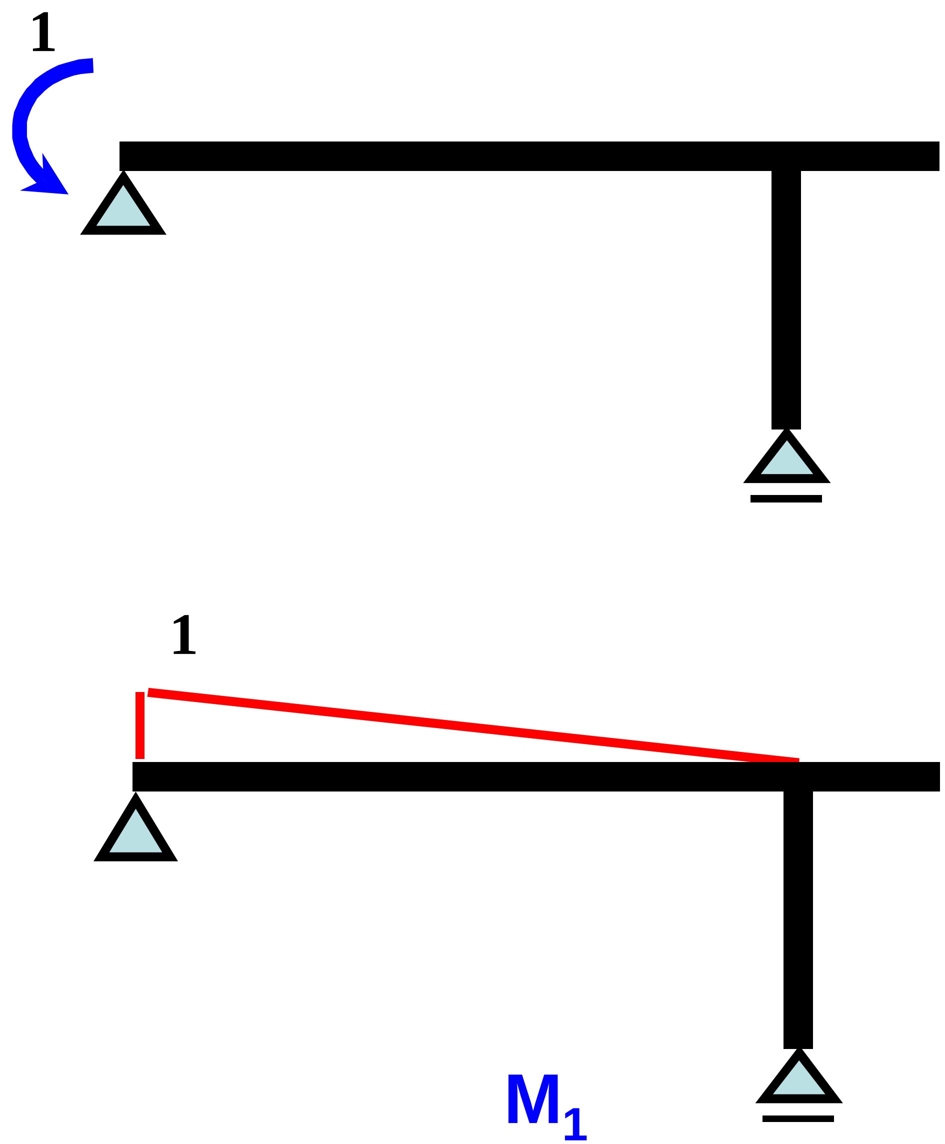
main system



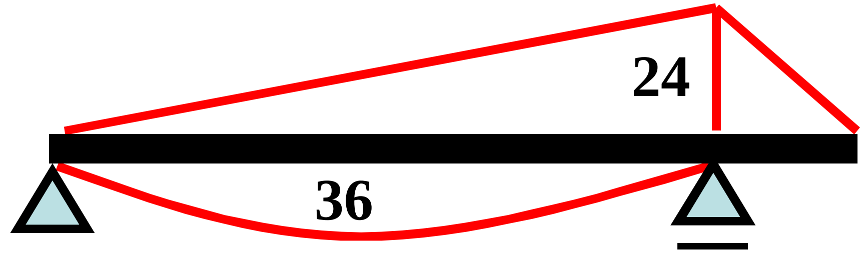
2- draw (M_0) [loads + X=0]

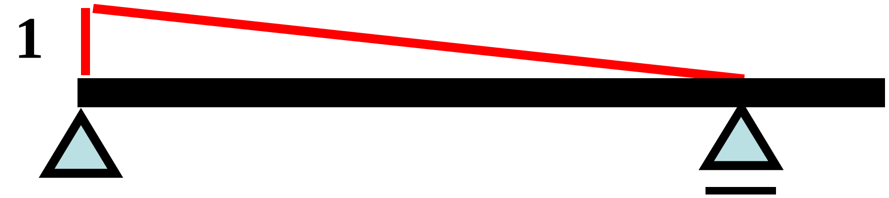


3- draw (M_1) [no loads + X=1]



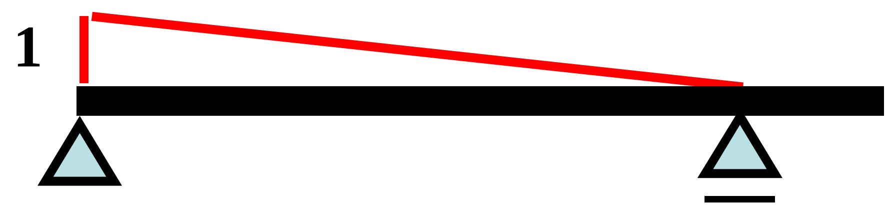
$\delta_{10} = $ تكامل M_0 مع M_1



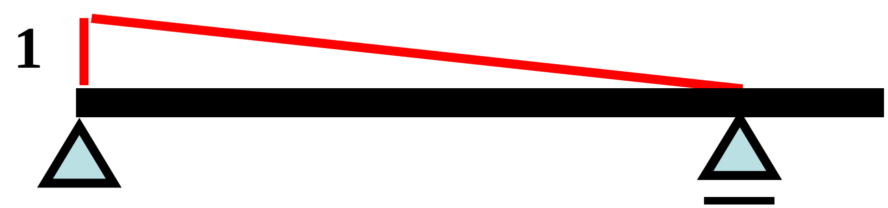


$$\delta_{10} = \frac{1}{10000}\left[\frac{24*1*12}{6} - \left(\frac{2}{3}*36*12*0.5\right)\right] = -\frac{96}{10000}\,m$$

$\delta_{11} = $ تكامل M_1 مع M_1

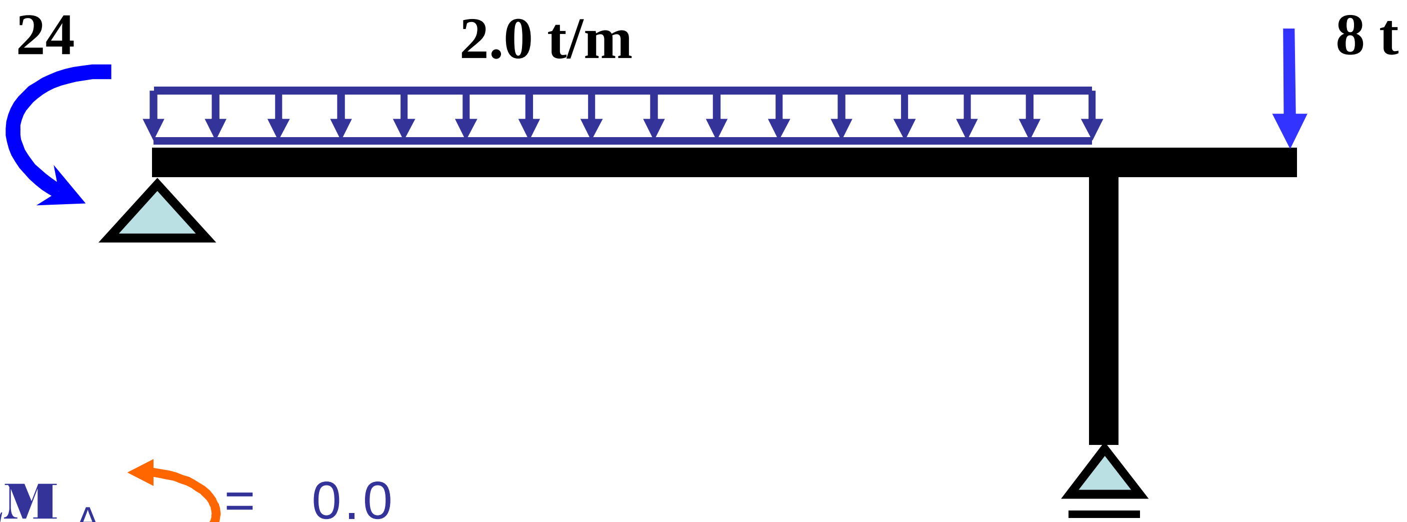


$$\delta_{11} = \frac{1}{10000}\left[\frac{1*1*12}{3}\right] = \frac{4}{10000}\,m$$



$$\delta_{10} + X \cdot \delta_{11} = 0.0$$

$$-\frac{96}{10000} + X * \frac{4}{10000} = 0.0 \quad >> \quad X = 24 \;\; t.m$$



$\sum M_A$ = 0.0

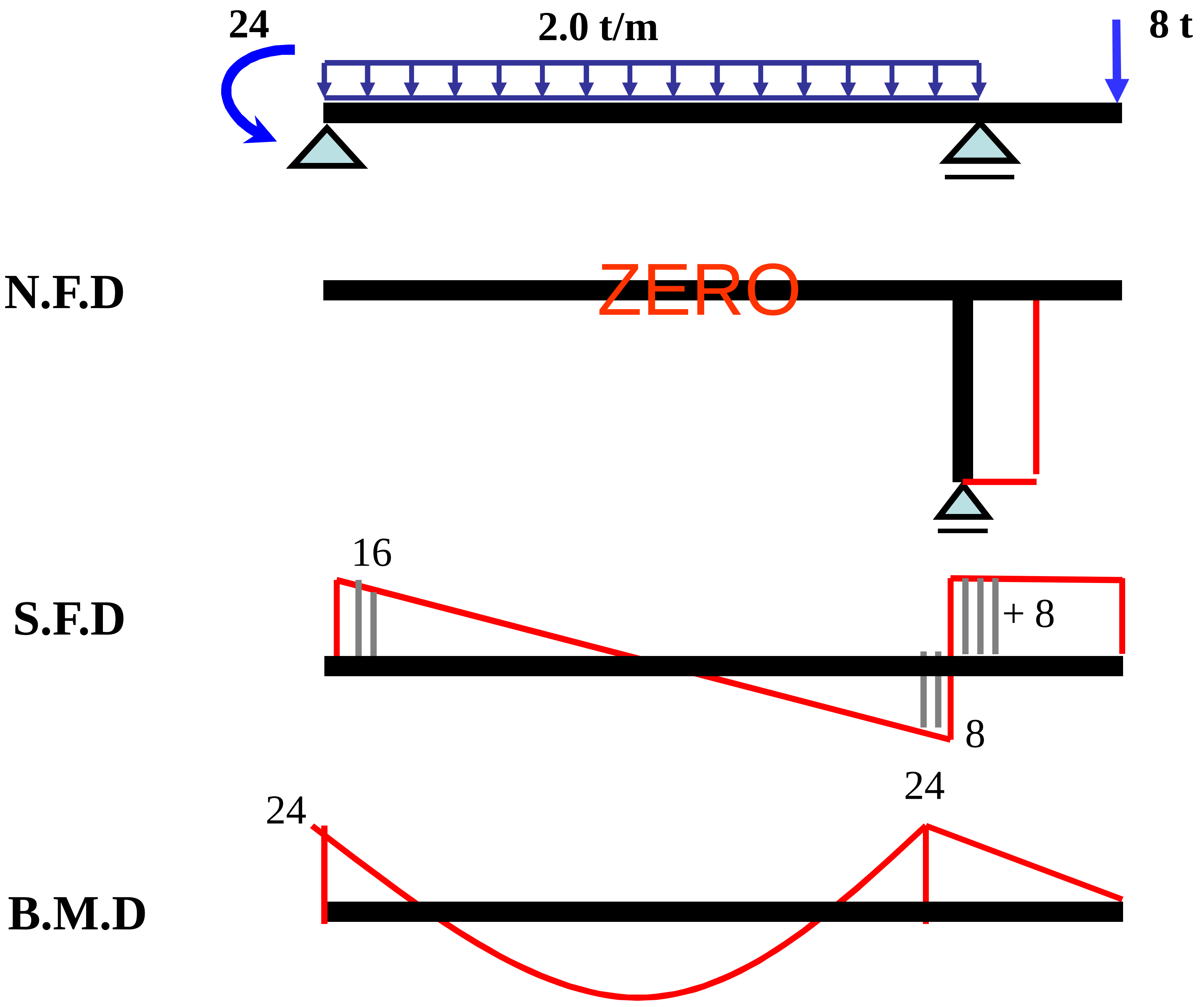
16 * 6 – Y_B *12 + 8 * 15 - 24 = 0.0 >> Y_B = 16 t

$\sum F_Y$ = 0.0

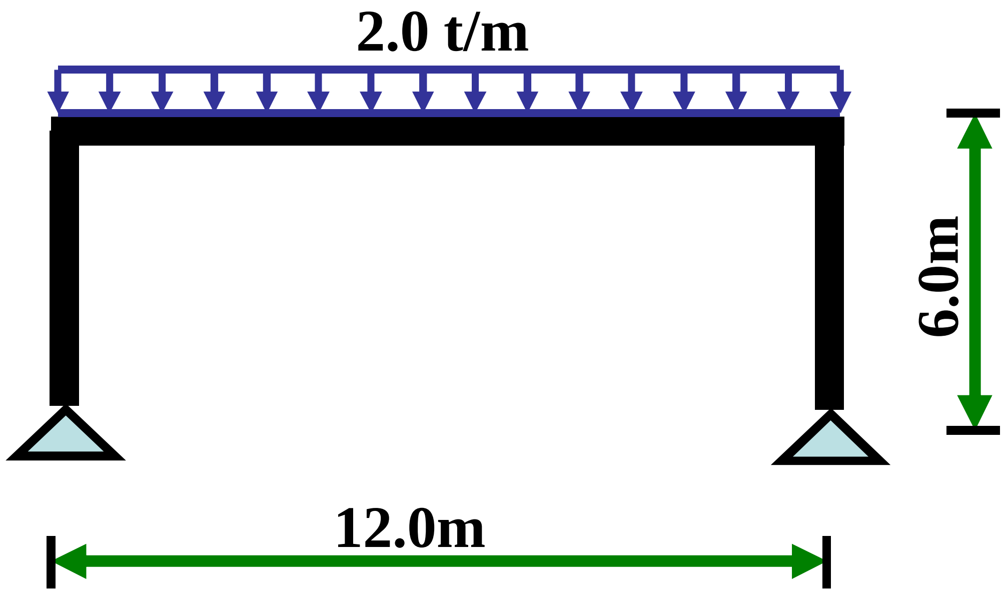
Y_A = 24 + 8 - 16 = 16

$\sum F_X$ = 0.0

X_A = 0.0

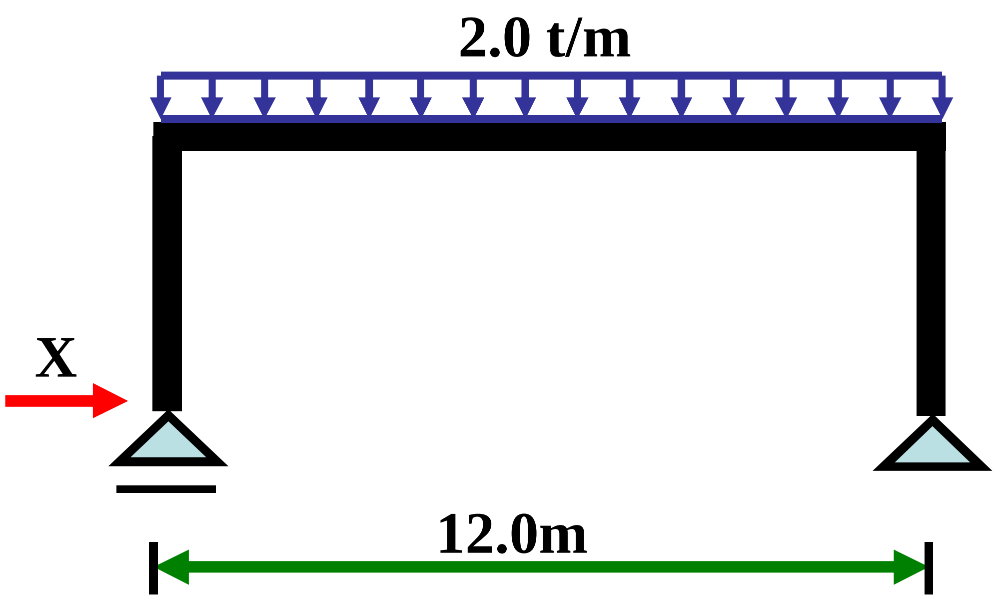

24
2.0 t/m
8 t
N.F.D
ZERO
S.F.D
16
+ 8
8
B.M.D
24
24

Example 5

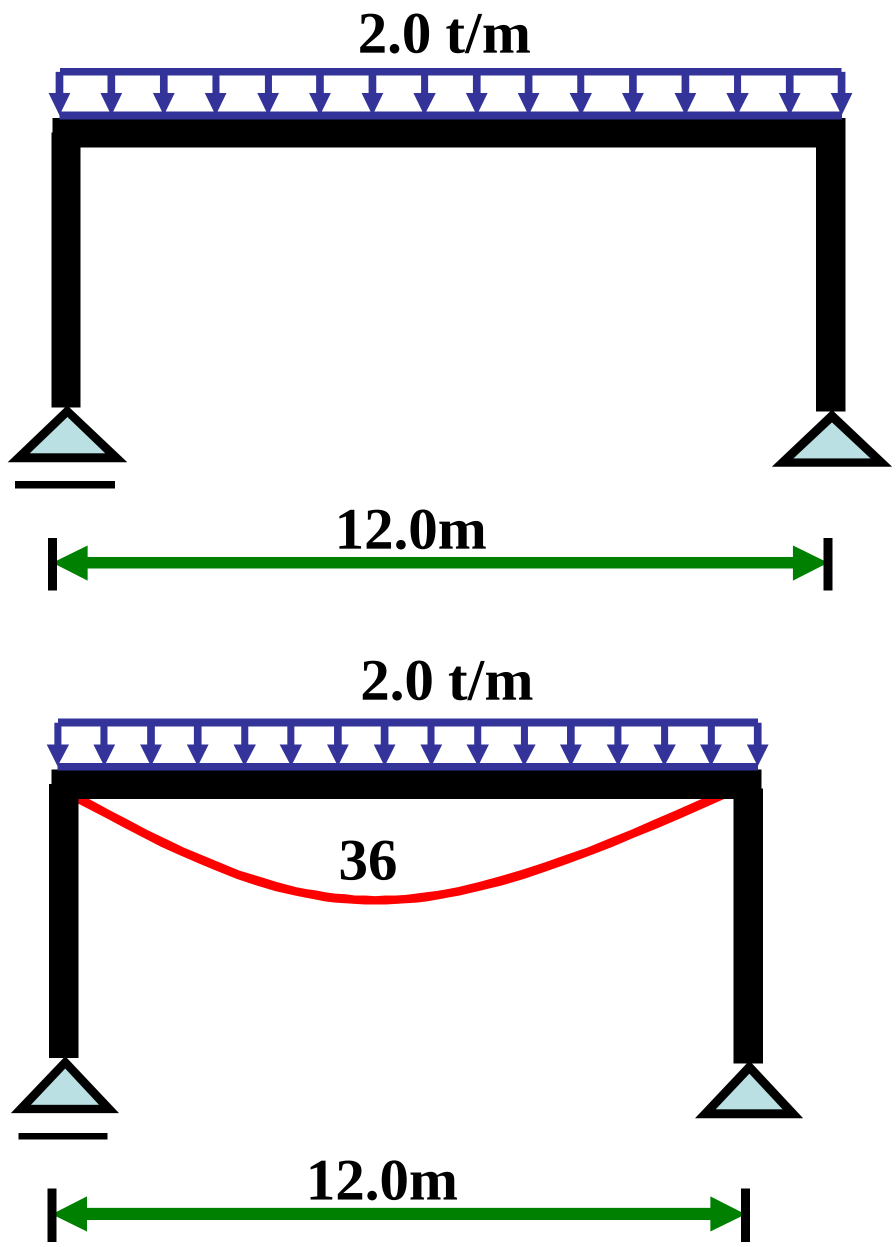


Draw B.M.D , S.F.D, and N.F.D   EI = 10000

main system

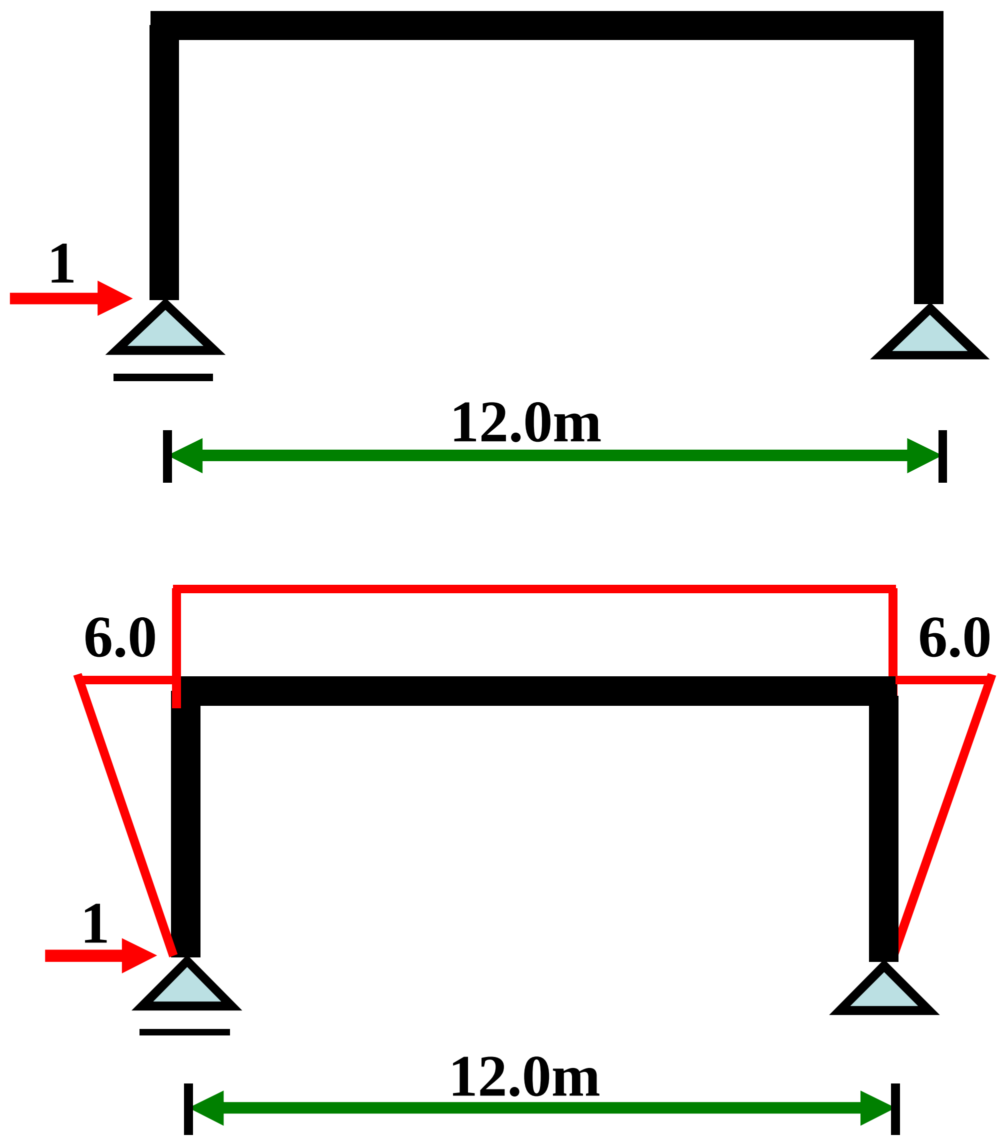


2- draw (M_0) [loads + X=0]



M_0

3- draw (M_1) [no loads + X=1]



M_1

δ 10 = M1 مع M0 تكامل

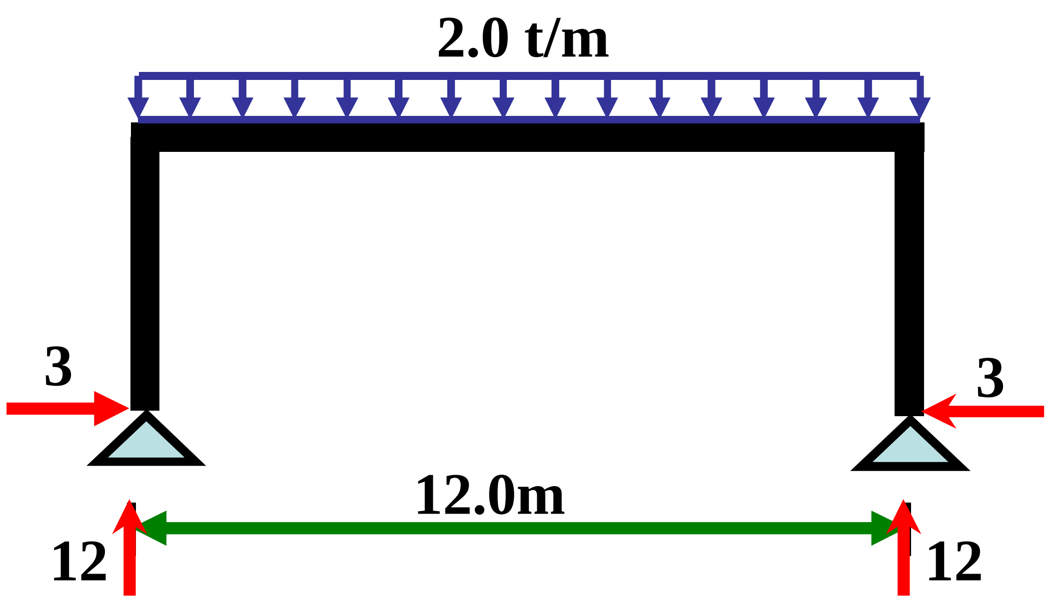
$$\delta_{10} = \frac{1}{10000}\left[-\left(\frac{2}{3} * 36 * 12 * 6\right)\right] = -\frac{1728}{10000}\ m$$

δ 11 = M1 مع M1 تكامل

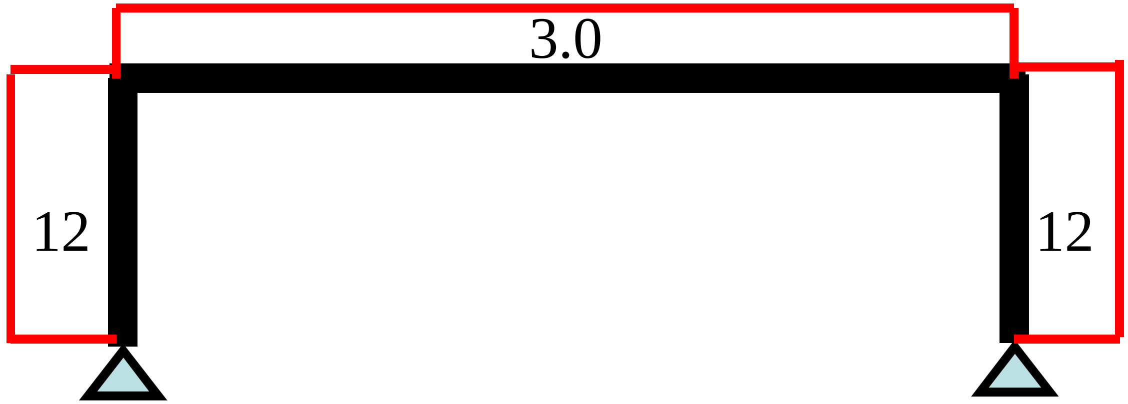
$$\delta_{11} = \frac{1}{10000}\left[\frac{6*6*6}{3} + \frac{6*6*6}{3} + 6*6*12 \right] = \frac{576}{10000}\ m$$

$$\delta_{10} + X\,.\,\delta_{11} = 0.0$$

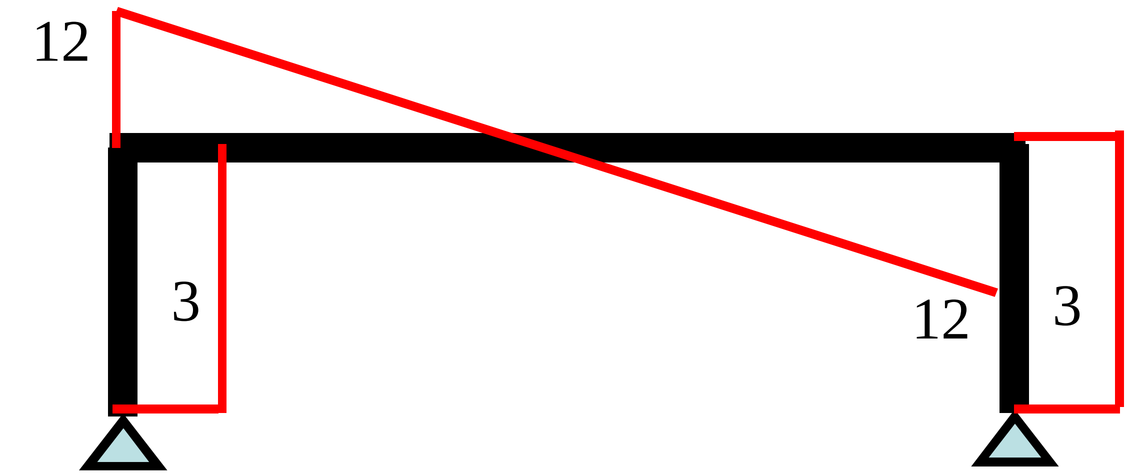
$$-\frac{1728}{10000} + X * \frac{576}{10000} = 0.0 \;\; >> \;\; X = 3.0 \;\; t.m$$



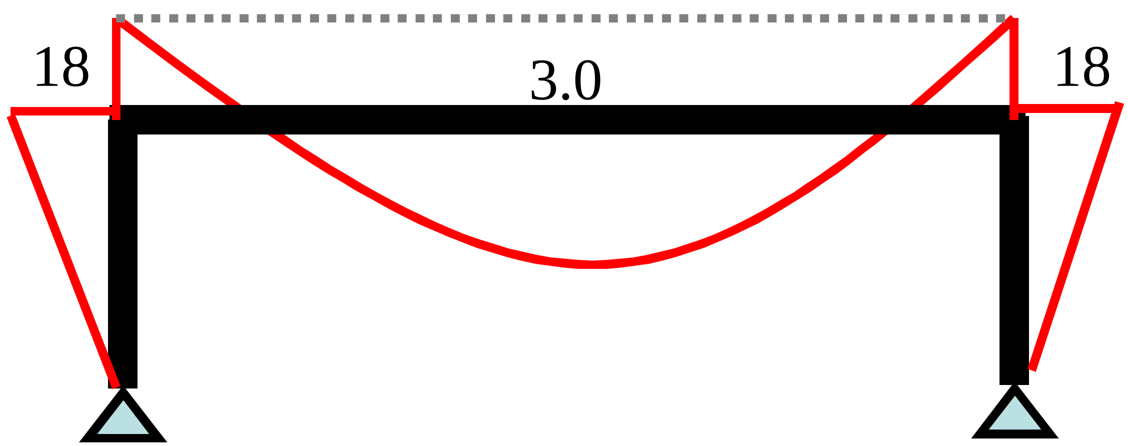
N.F.D



S.F.D



B.M.D



Consistant Deformation for n degree of indeterminate

$$\delta_{10} + X_1 . \delta_{11} = 0.0$$

Indeterminate 1 degree

$$\delta_{10} + X_1 . \delta_{11} + X_2 . \delta_{12} = 0.0$$

$$\delta_{20} + X_1 . \delta_{21} + X_2 . \delta_{22} = 0.0$$

Indeterminate 2 degree

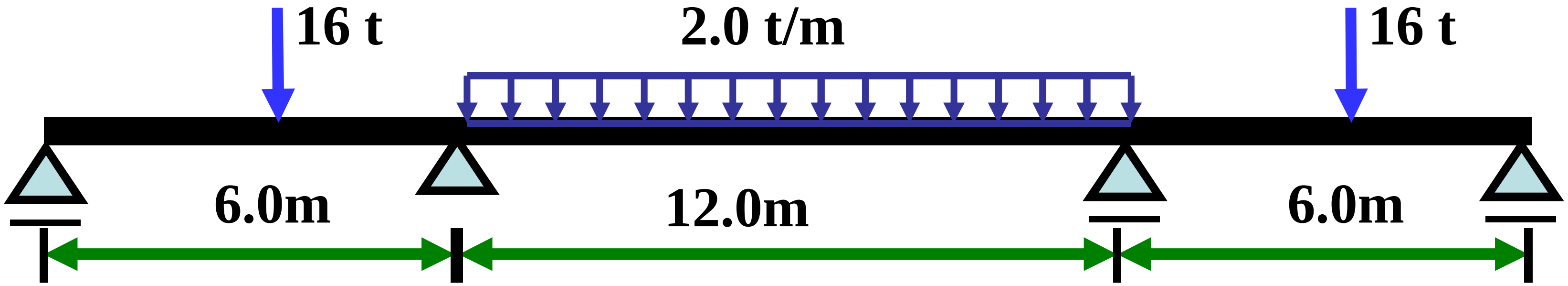
$$\delta_{10} + X_1 . \delta_{11} + X_2 . \delta_{12} + X_3 . \delta_{13} = 0.0$$

$$\delta_{20} + X_1 . \delta_{21} + X_2 . \delta_{22} + X_3 . \delta_{23} = 0.0$$

$$\delta_{30} + X_1 . \delta_{31} + X_2 . \delta_{32} + X_3 . \delta_{33} = 0.0$$

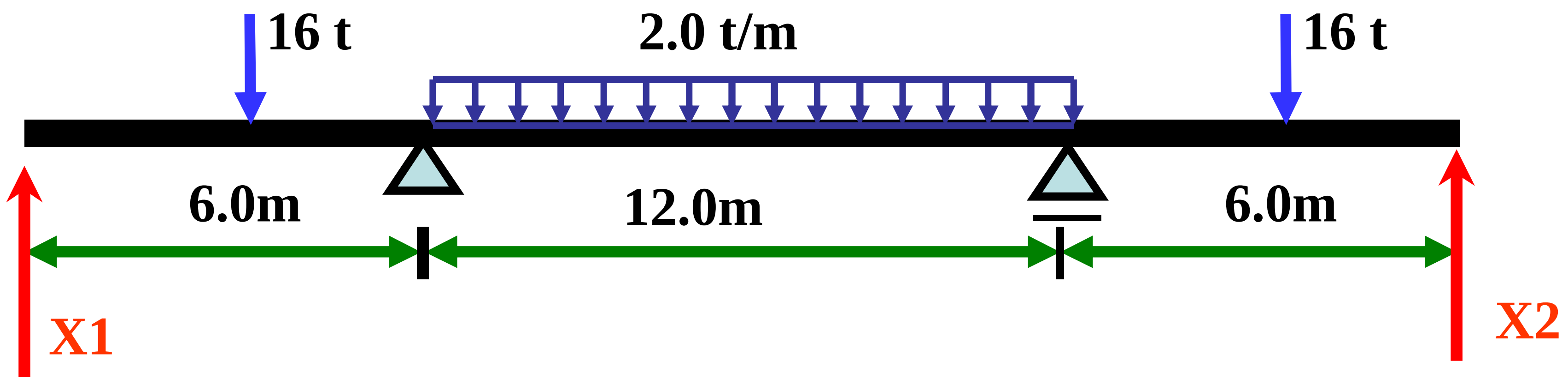
Indeterminate 3 degree

Example 1

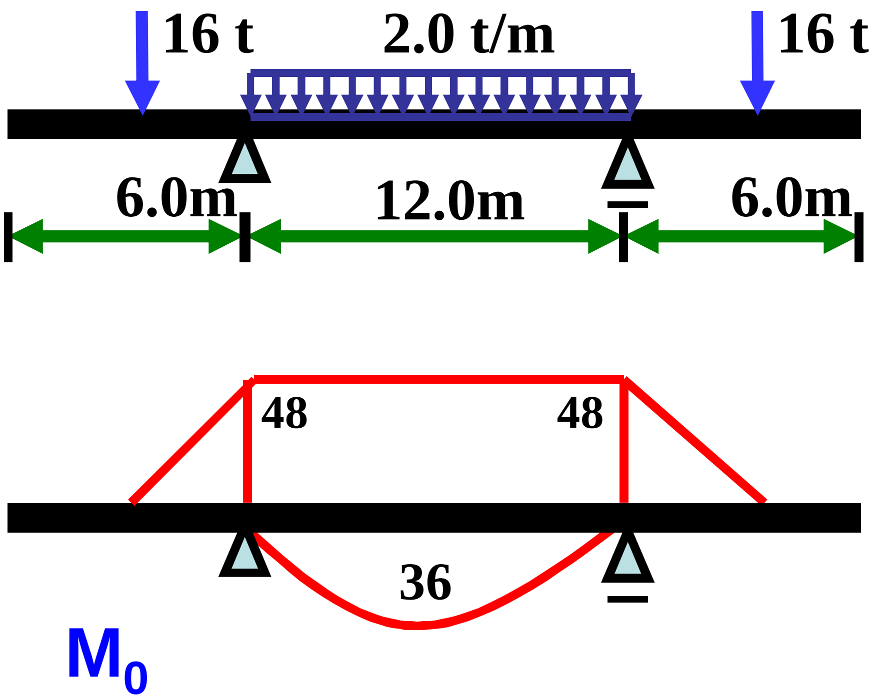


Draw B.M.D , S.F.D, and N.F.D   EI = 10000

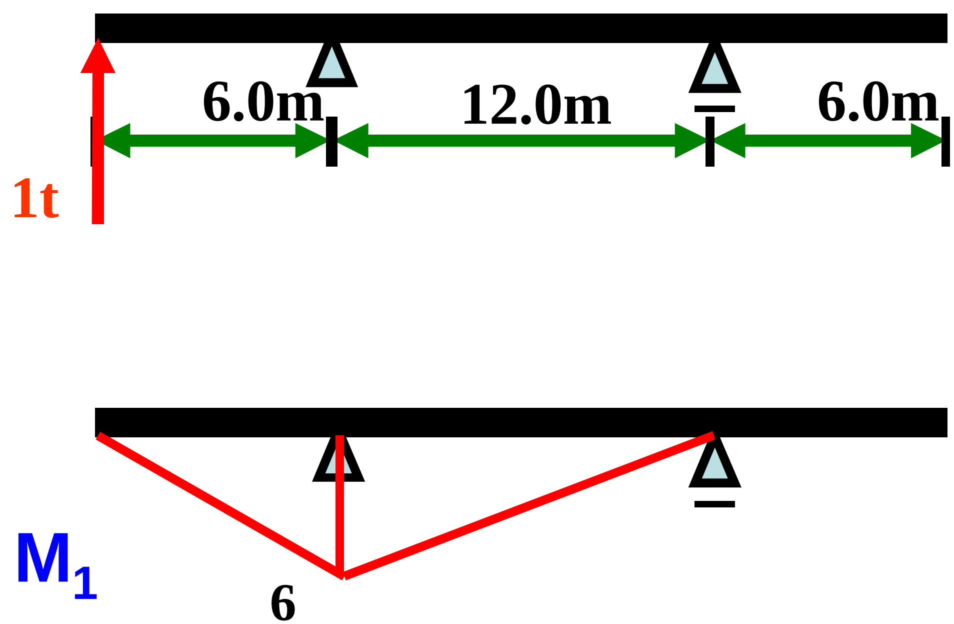
main system



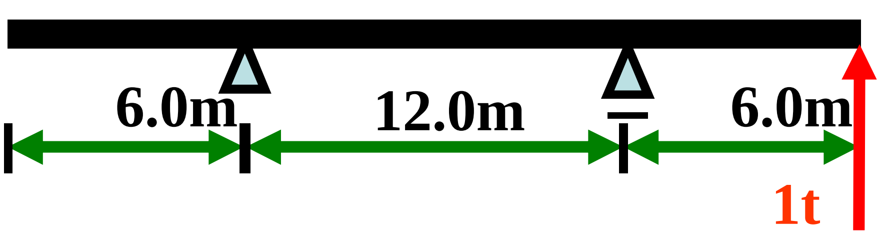
2- draw (M_0)
[loads + X_1=0 & x_2=0]

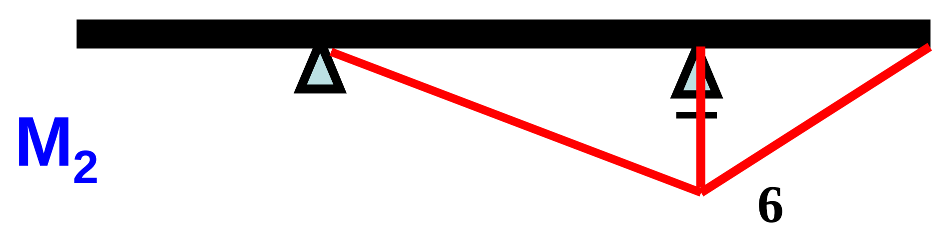


3- draw (M_1)
[no loads + X_1=1 + X_2=0]



2- draw (M_2)
[no loads + X_1=0 & x_2=1]





$$\delta_{10} = \frac{1}{10000}\left[-\frac{48*6*12}{2}+\left(\frac{2}{3}*36*12*1/2*6\right)-\frac{3}{3}*(6*48+0.5*(3*48))\right] = -\frac{1224}{10000}\,m$$

$$\delta_{20} = \frac{1}{10000}\left[-\frac{48*6*12}{2}+\left(\frac{2}{3}*36*12*1/2*6\right)-\frac{3}{3}*(6*48+0.5*(3*48))\right] = -\frac{1224}{10000}\,m$$

$$\delta_{11} = \frac{1}{10000}\left[\frac{6*6*12}{3}+\frac{6*6*6}{3}\right]=\frac{216}{10000}\,m$$

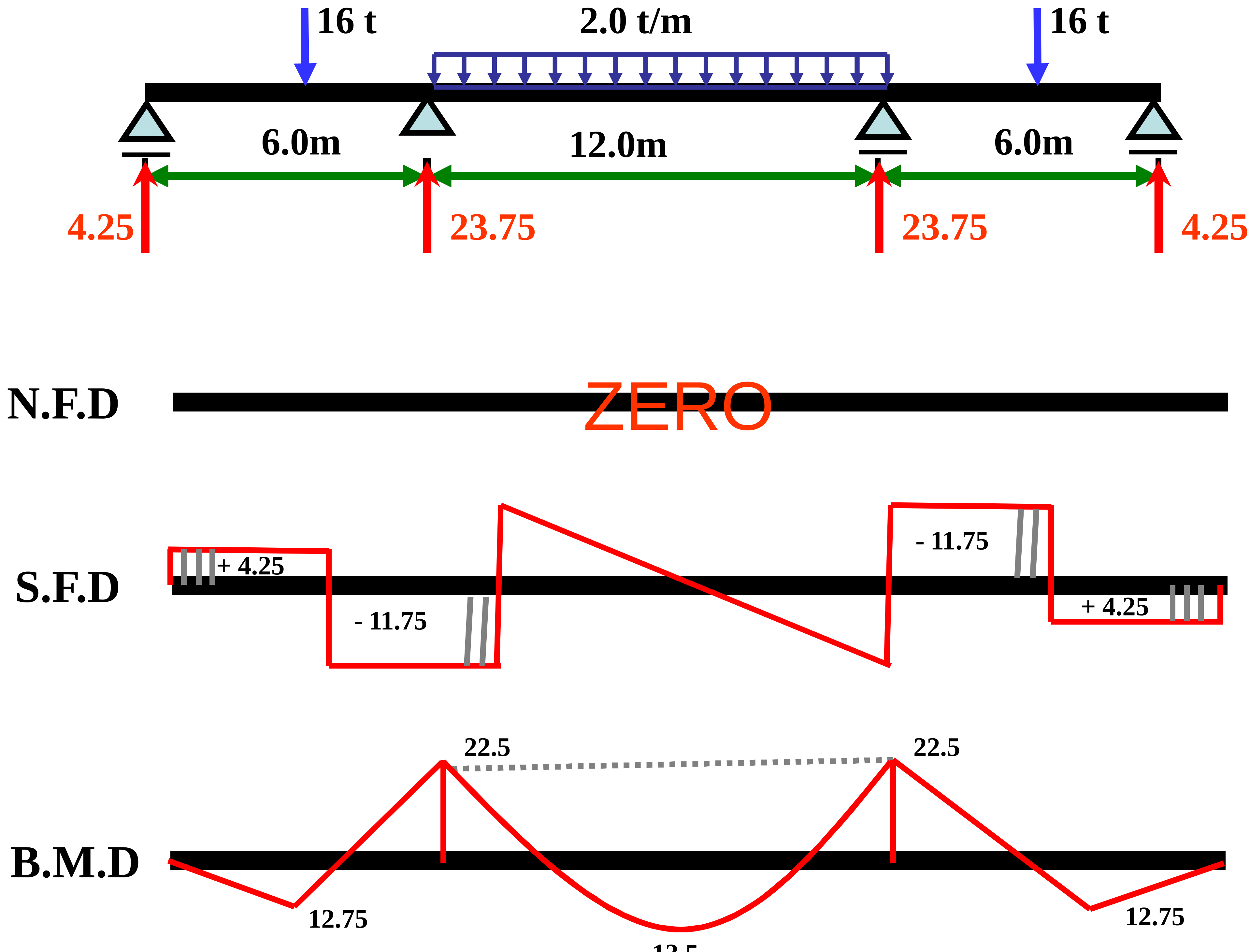
$$\delta_{22} = \frac{1}{10000}\left[\frac{6*6*12}{3}+\frac{6*6*6}{3}\right]=\frac{216}{10000}\,m$$

$$\delta_{21} = \delta_{12} = \frac{1}{10000}\left[\frac{6*6*12}{6}\right]=\frac{72}{10000}\,m$$

$$-\frac{1224}{10000}+X_1.\frac{216}{10000}+X_2.\frac{72}{10000}=0.0$$

$$-\frac{1224}{10000}+X_1.\frac{72}{10000}+X_2.\frac{216}{10000}=0.0$$

X1= 4.25 ton and X2= 4.25 ton

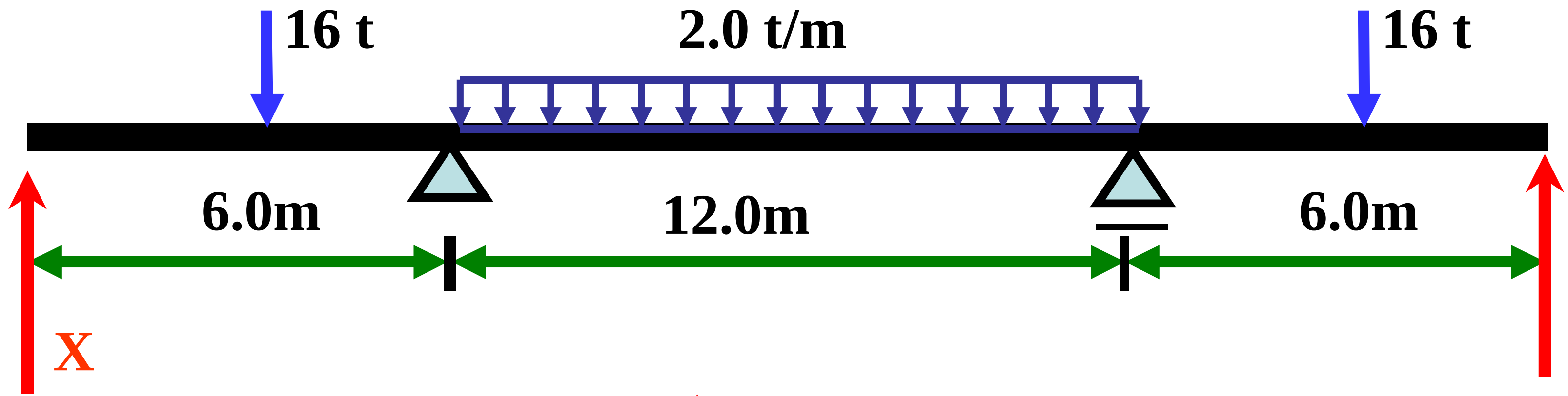


16 t
2.0 t/m
16 t
6.0m
12.0m
6.0m
4.25
23.75
23.75
4.25
N.F.D
ZERO
S.F.D
+ 4.25
- 11.75
- 11.75
+ 4.25
B.M.D
22.5
22.5
12.75
13.5
12.75

main system

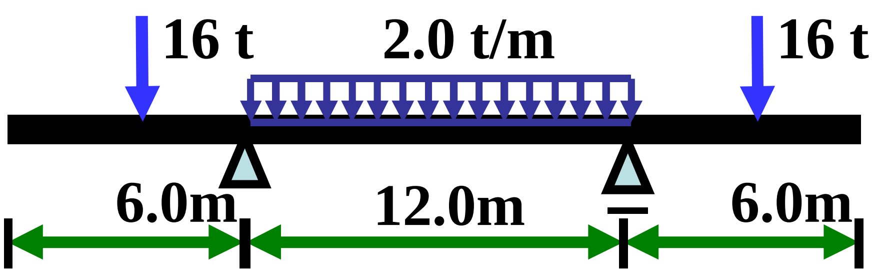
استخدام التماثل

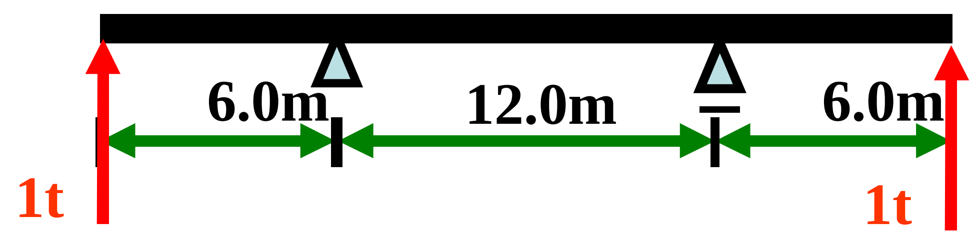
حل اخر:

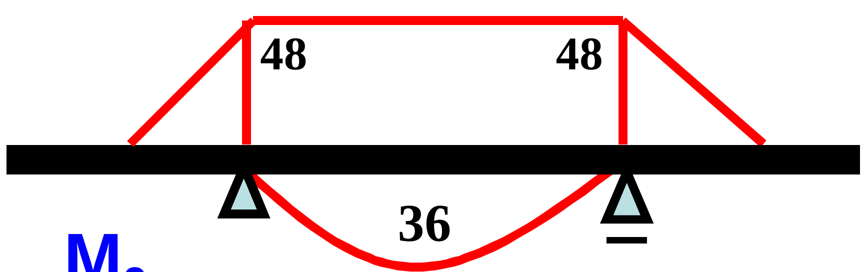


2- draw (M_0)
[loads + X=0]

3- draw (M_1)
[no loads + X=1]







M_0

M_1

$$\delta_{10} = \frac{1}{10000}\left[-48*6*12+\left(\frac{2}{3}*36*12*6\right)-2*(\frac{3}{3}*(6*48+0.5*(3*48)))\right] = -\frac{2448}{10000}\,m$$

$$\delta_{11} = \frac{1}{10000}\left[6*6*12+\frac{6*6*6}{3}*2\right]=\frac{576}{10000}\,m$$

$$-\frac{2448}{10000}+X.\frac{576}{10000}=0.0 \quad >> \quad X=4.25t$$

الباقى كما تم فى السابق

بسم الله الرحمن الرحيم

Settelment and Temprature

Eng : Ayman abdo

Case of Settelment

$$\delta_{10} = zero$$

δ 10 + R * **δ 11 = settlement**

$$\delta_{11} = the\ same\ in\ given\ loads$$

Case of Uniform Teprature

$$\delta_{10} = \alpha\ .\ \Delta t\ .\ \sum A_N$$

δ 10 + R * **δ 11 = 0.0**

$$\delta_{11} = the\ \ same\ \ in\ \ given\ \ loads$$

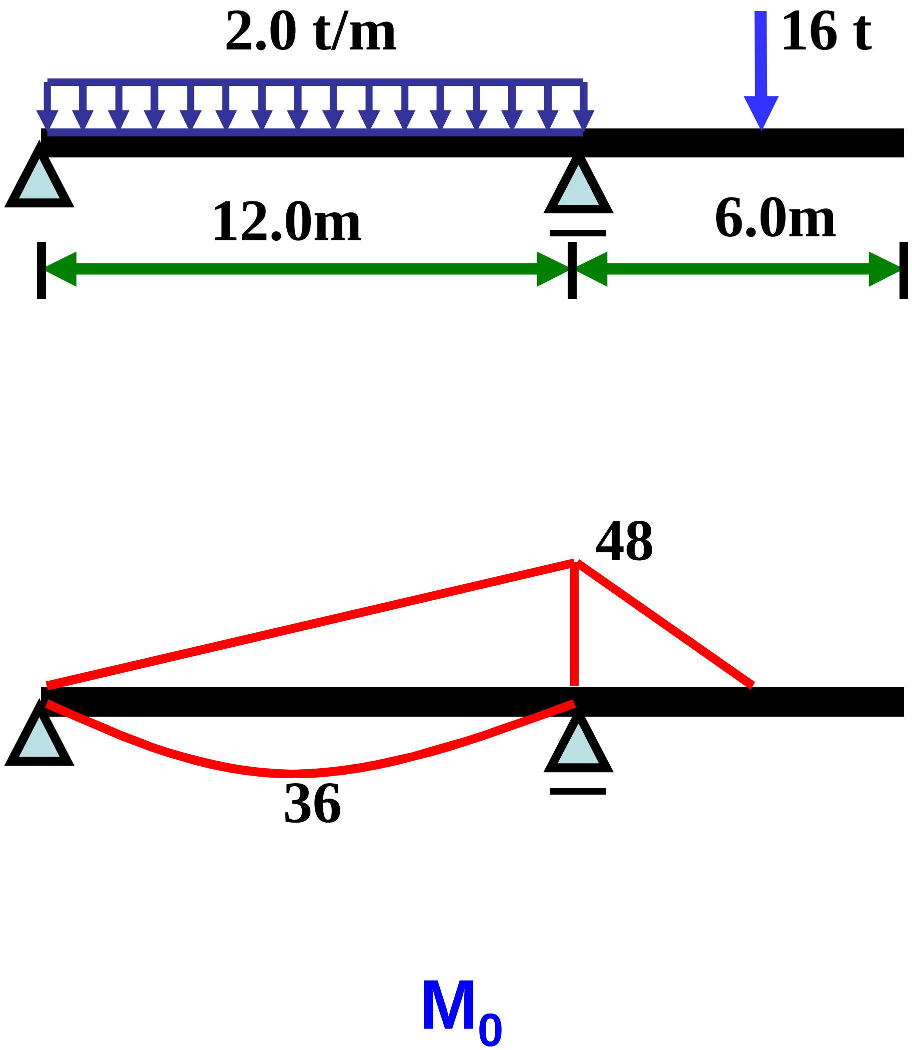
Case of Non Uniform Teprature

$$\delta_{10} = \alpha\ .\ (\frac{t_1 + t_2}{2})\ .\ \sum A_N + \alpha\ .\ (\frac{t_2 - t_1}{h})\ .\ \sum A_M$$

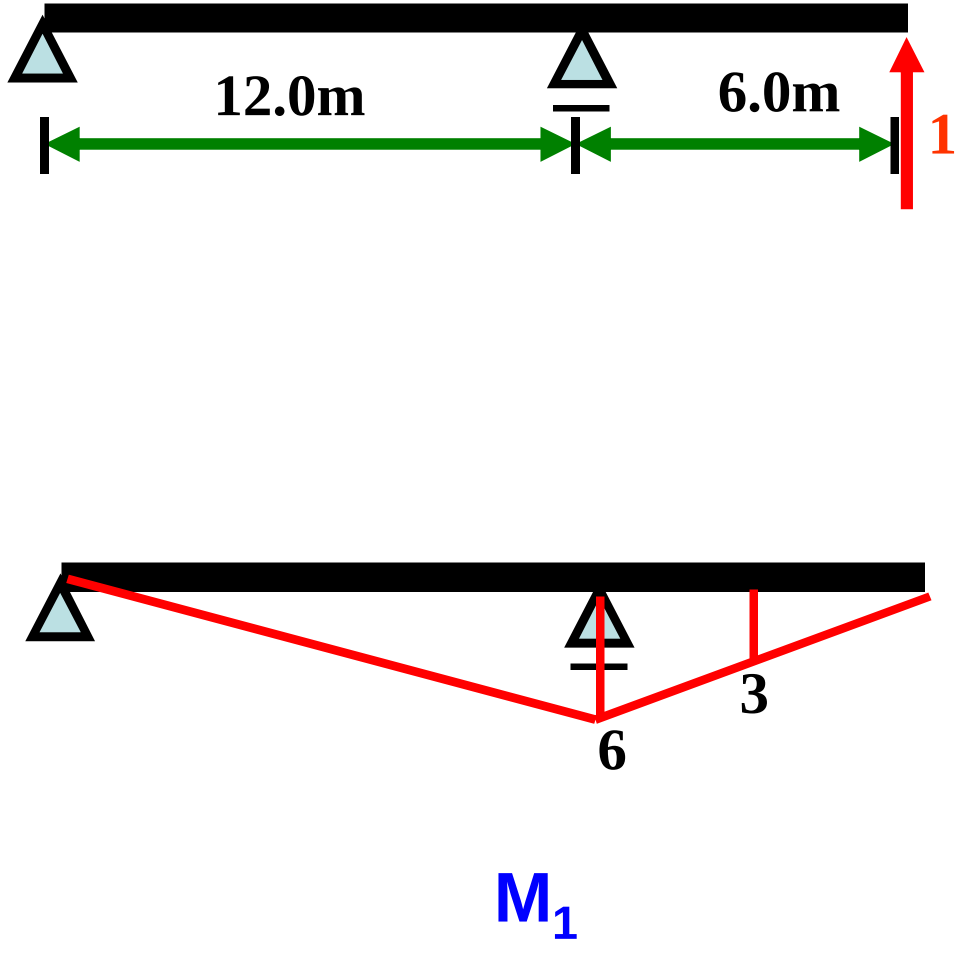
$$\delta_{11} = the\ \ same\ \ in\ \ given\ \ loads$$

δ 10 + R * **δ 11 = 0.0**

2- draw (M_0) [loads + X=0]



3- draw (M_1) [no loads + X=1]



Case of given loads

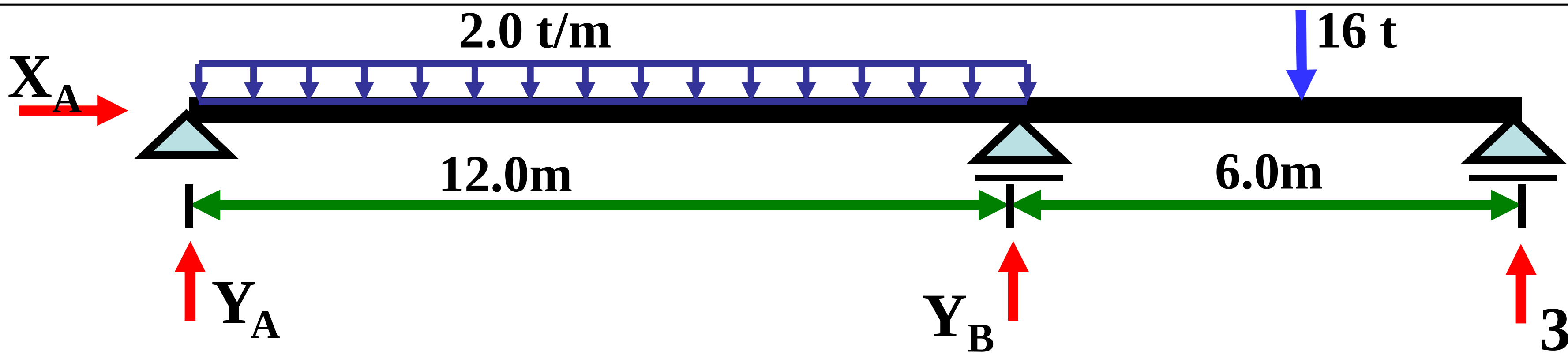
$$\delta_{10} = \frac{1}{30000}\left[-\frac{48*6*12}{3}+\left(\frac{2}{3}*36*12*1/2*6\right)-\frac{3}{3}*(6*48+0.5*(3*48))\right]$$

$$= -\frac{648}{30000}\,m$$

$$\delta_{11} = \frac{1}{30000}\left[\frac{6*6*12}{3}+\frac{6*6*6}{3}\right] = \frac{216}{30000}\,m$$

$$\delta_{10} + X\,.\,\delta_{11} = 0.0$$

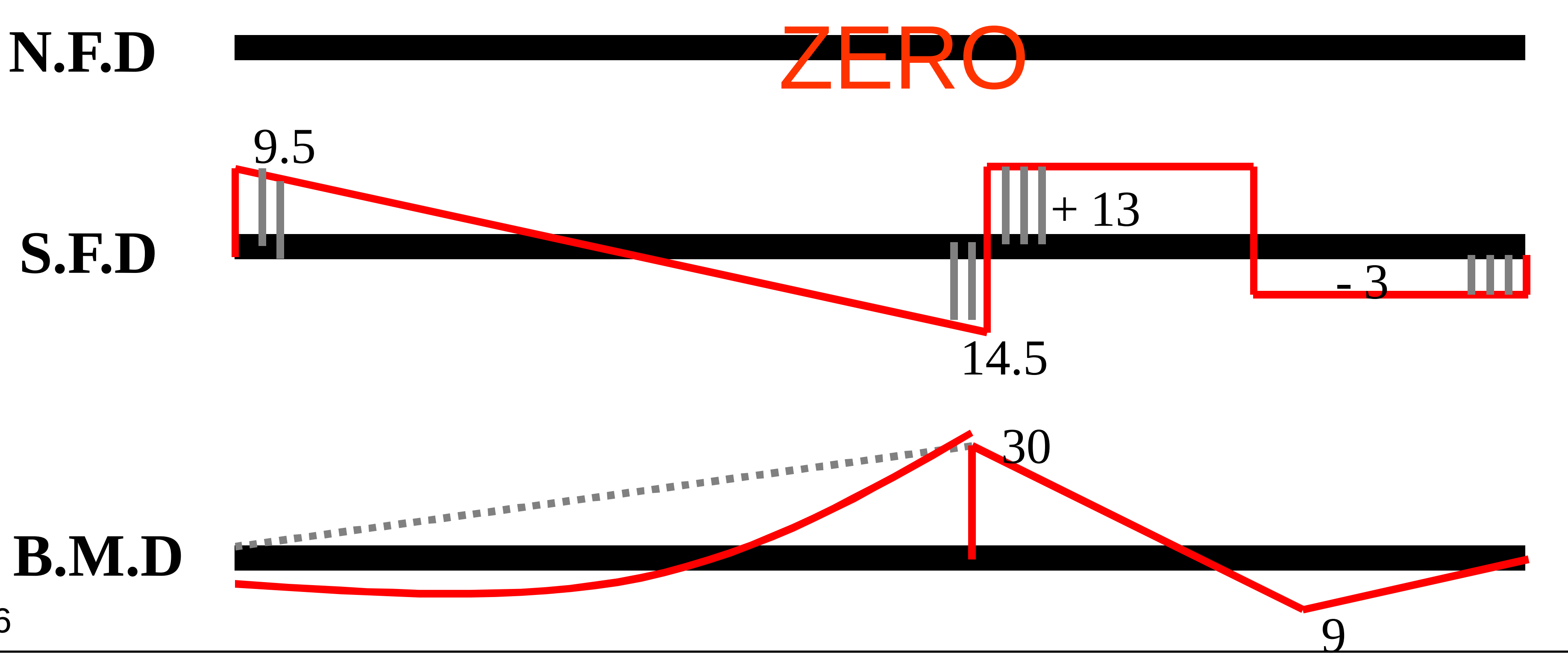
$$-\frac{648}{30000} + X * \frac{216}{30000} = 0.0 \;\;>>\;\; X \;\; = 3\,ton$$



$\sum M_A$ (↺) $= 0.0$ $\quad$ $24 * 6 + 16 * 15 - Y_B * 12 - 3 * 18 = 0 \quad >> \quad Y_B = 27.5$ t

$\sum F_Y = 0.0$ $\quad$ $Y_A = 24 + 16 - 27.5 - 3 = 9.5$

$\sum F_X = 0.0$ $\quad$ $X_A = 0.0$



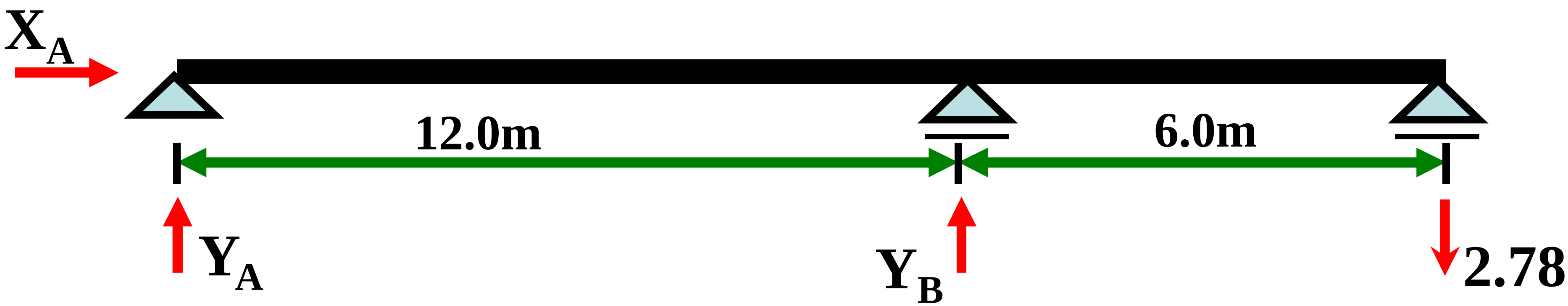
Case of Settelment

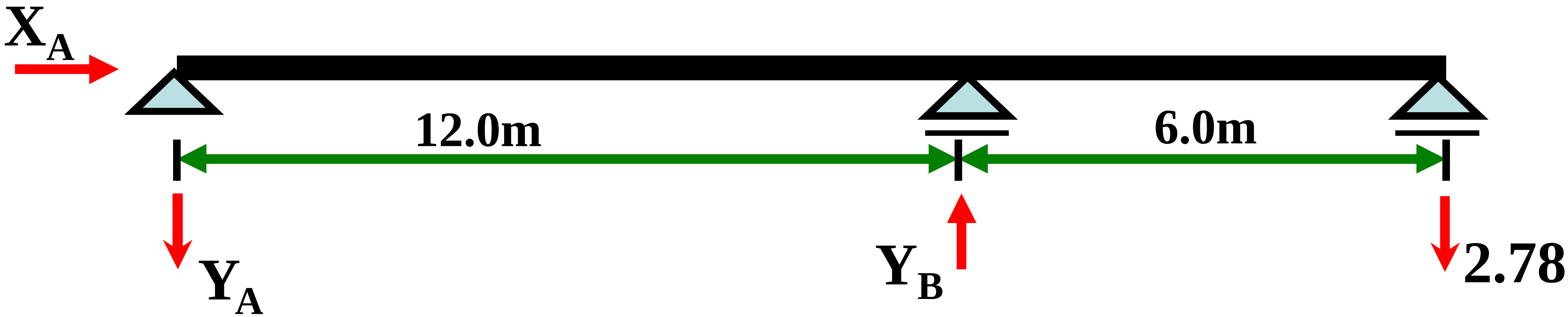
$$\delta_{10} = zero$$

$$\delta_{11} = \frac{216}{10000}\, m$$

$$\delta_{10} + X \,.\, \delta_{11} = -0.02$$

$$0.0 + X * \frac{216}{30000} = -0.02 \quad >> \quad X \quad = -2.78\, ton$$





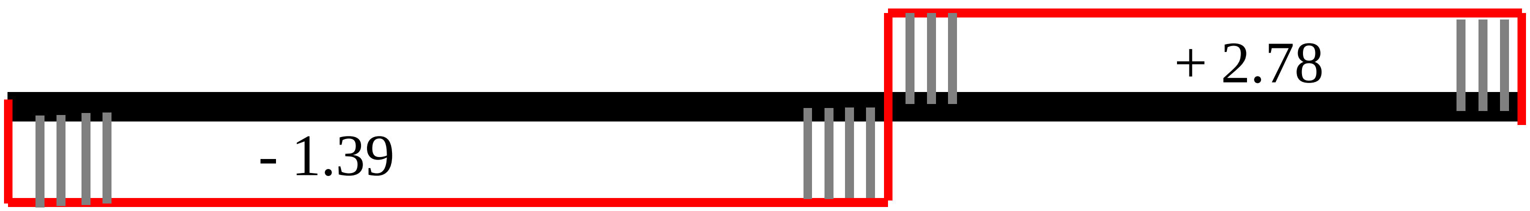
ΣM_A = 0.0 $\qquad Y_B*12 - 2.78*18 = 0 \quad >> \quad Y_B = 4.17$ t

ΣF_Y = 0.0 $\qquad Y_A = 4.17 - 2.78 = 1.39$

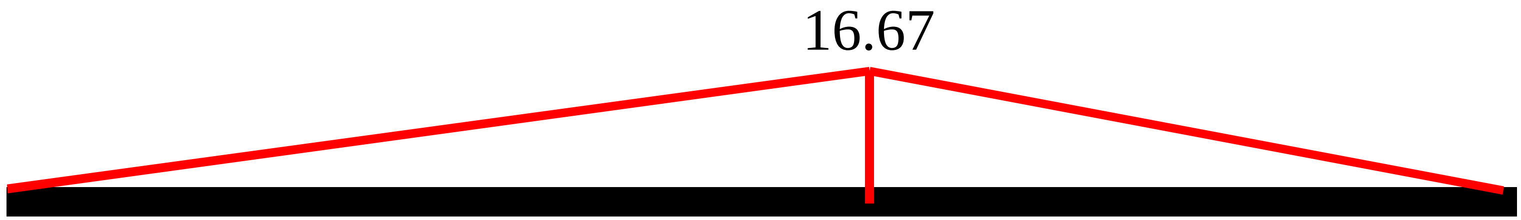
ΣF_X = 0.0 $\qquad X_A = 0.0$

N.F.D

S.F.D



B.M.D



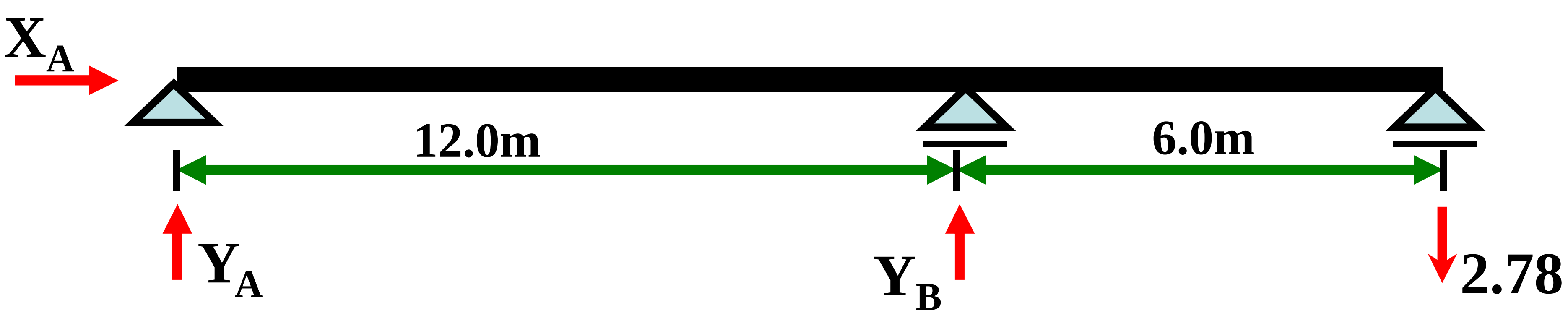
Case of uniform temprature

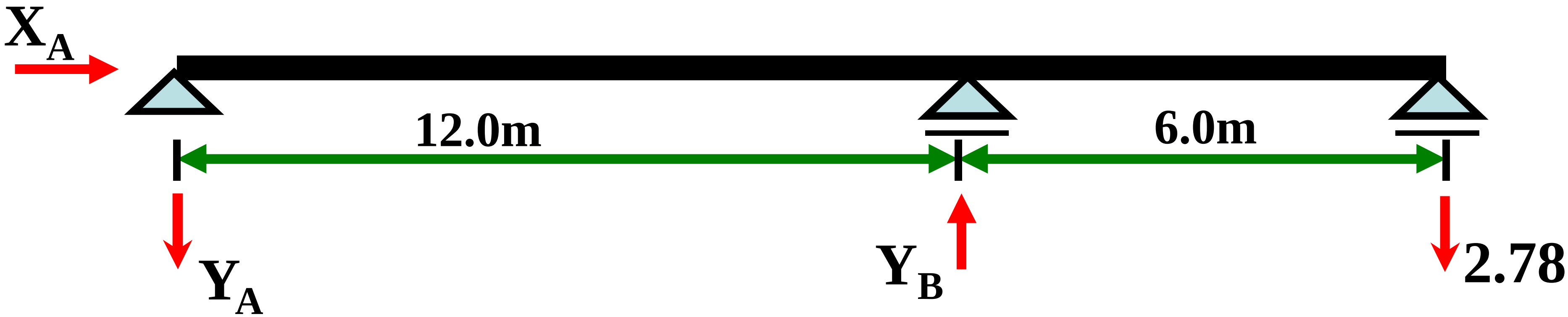
$$\delta_{10} = zero$$

$$\delta_{11} = \frac{216}{10000} m$$

$$\delta_{10} + X \,.\, \delta_{11} = -0.02$$

$$0.0 + X * \frac{216}{30000} = -0.02 \quad >> \quad X = -2.78\, ton$$





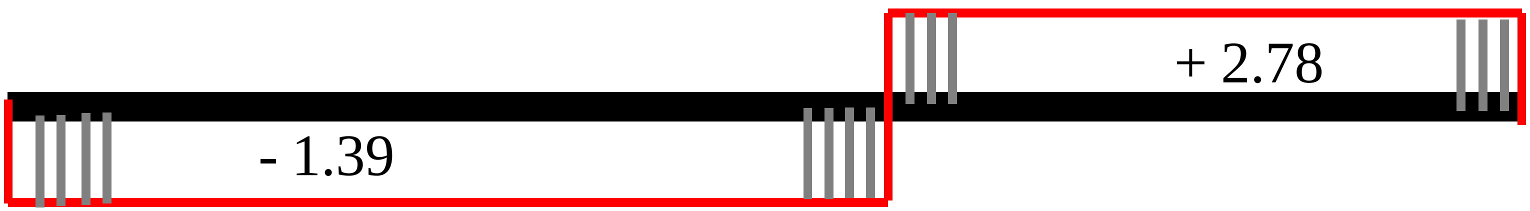
$\Sigma M_A = 0.0$ $\qquad Y_B * 12 - 2.78 * 18 = 0 \quad >> \quad Y_B = 4.17$ t

$\Sigma F_Y = 0.0$ $\qquad Y_A = 4.17 - 2.78 = 1.39$

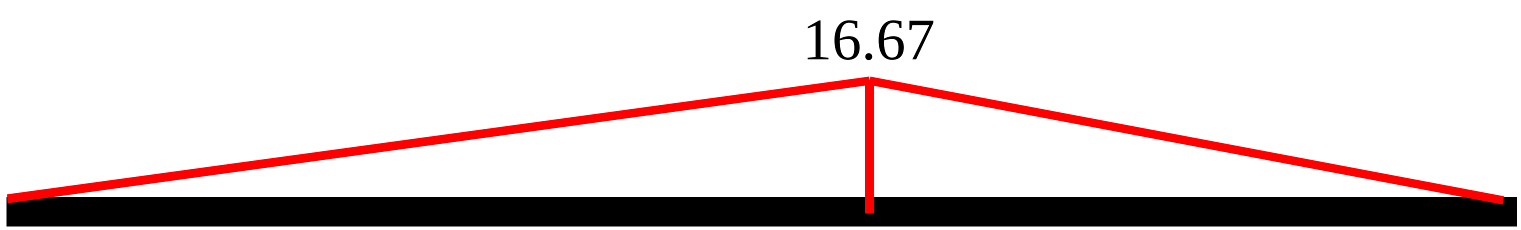
$\Sigma F_X = 0.0$ $\qquad X_A = 0.0$

N.F.D

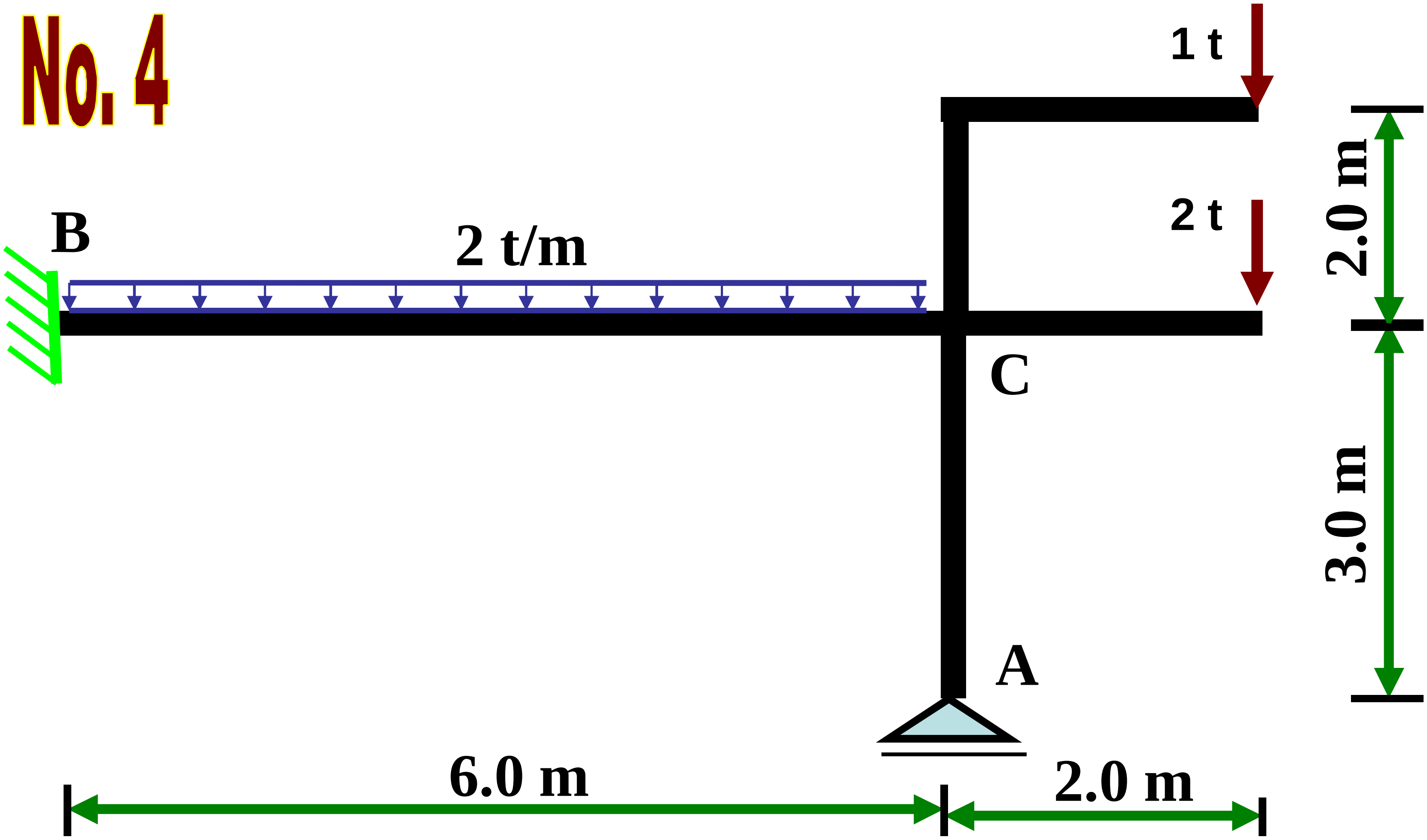
S.F.D



B.M.D



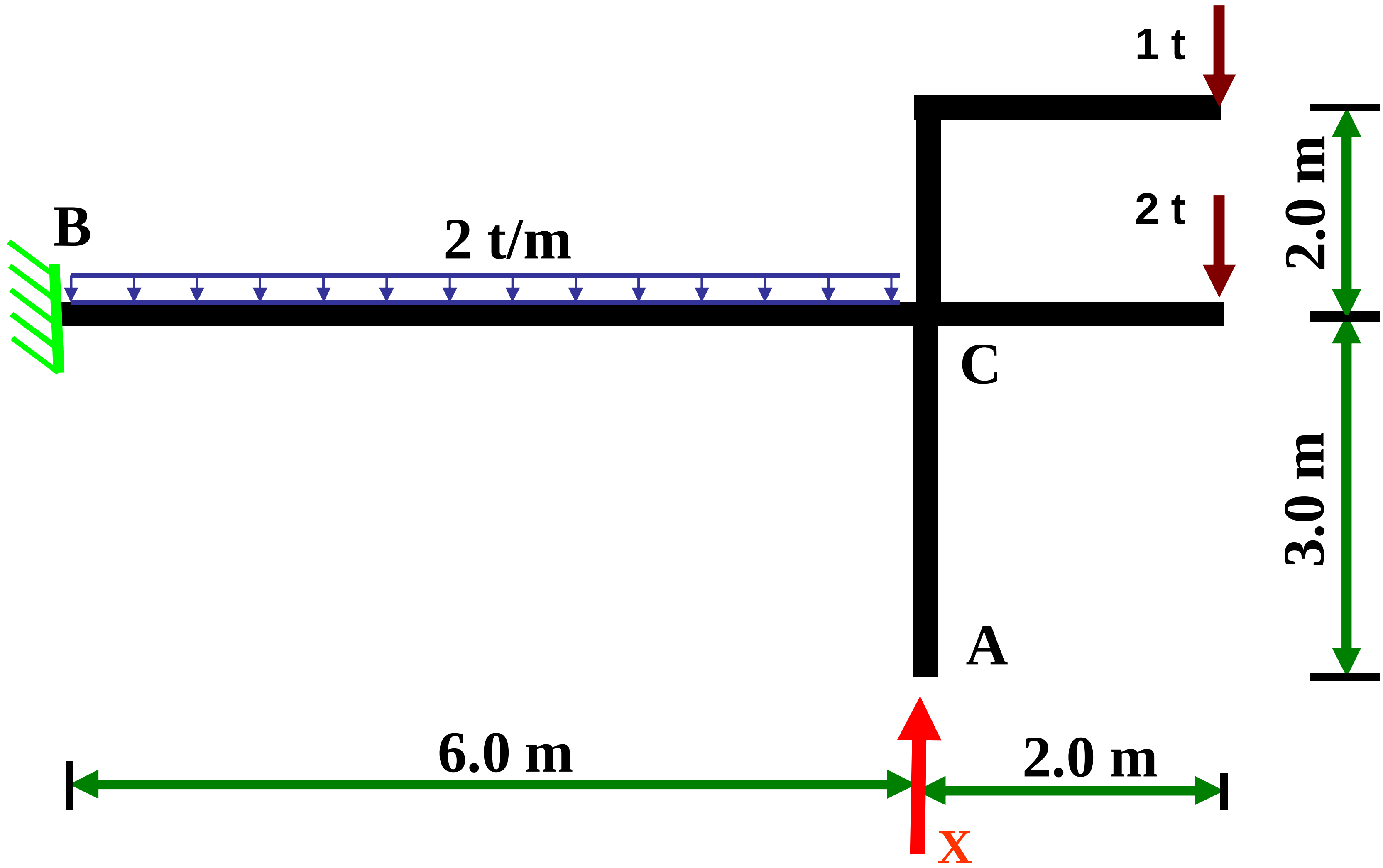
Problem No. 4



Draw B.M.D , S.F.D, and N.F.D   EI = 6000 t.m2 $\alpha = 10^{-5}$

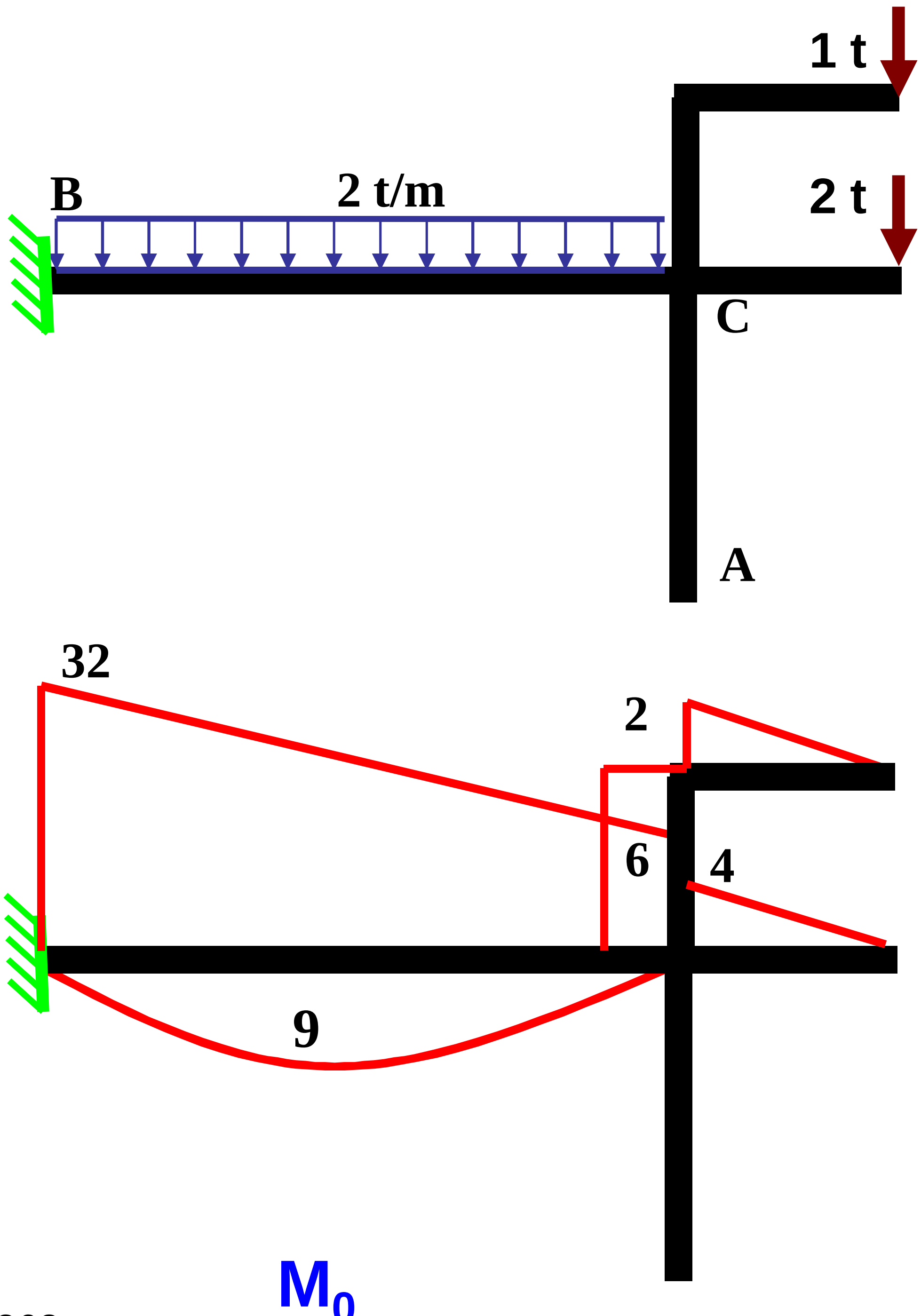
Due to (1) given loads.
(2) settlement at A = 2cm.
(3) uniform rise in temperature equals 20^0
(4) t1=20 , t2=40 and h = 0.6m

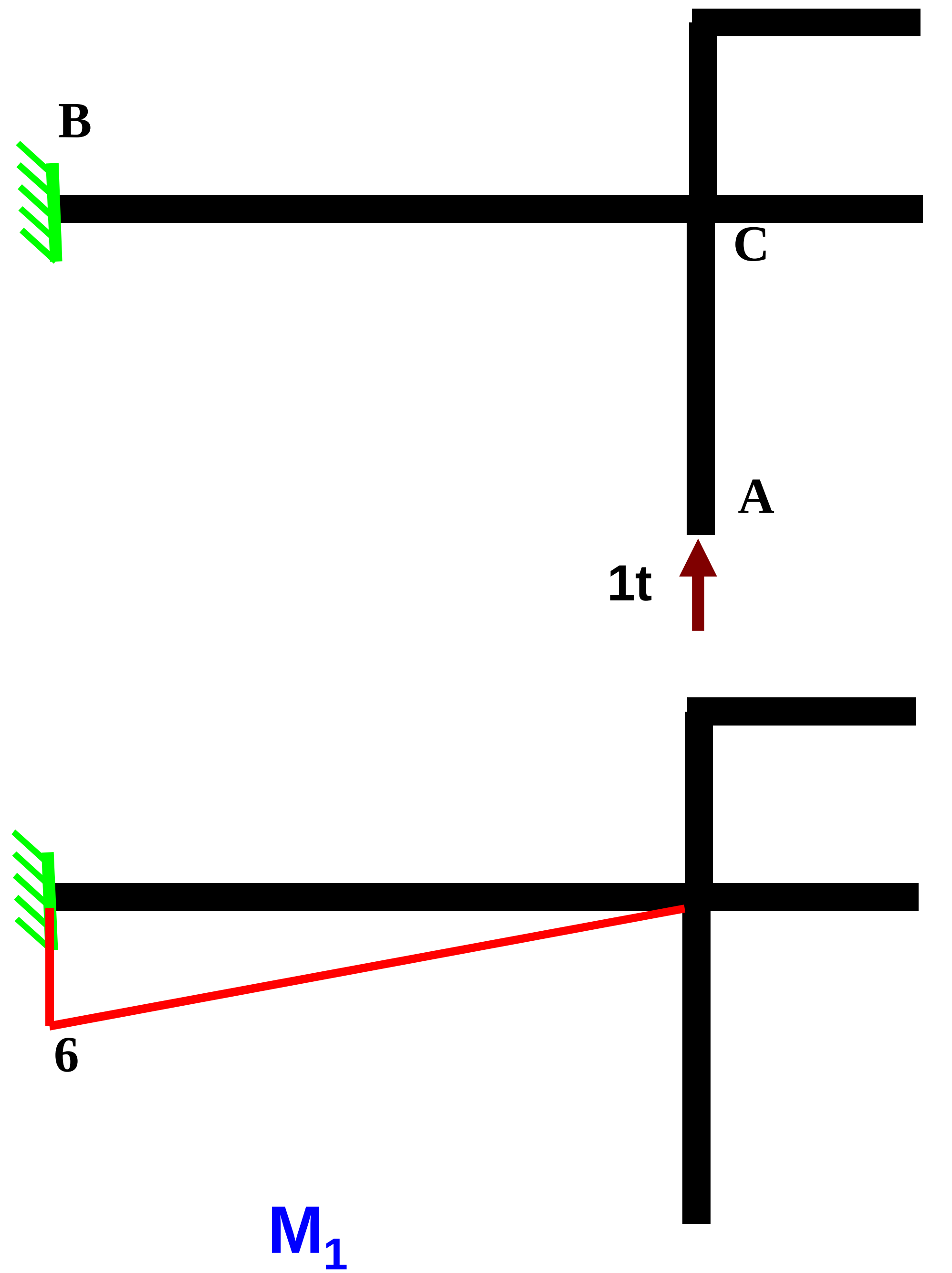
Main System



2- draw (M_0) [loads + X=0]

3- draw (M_1) [no loads + X=1]





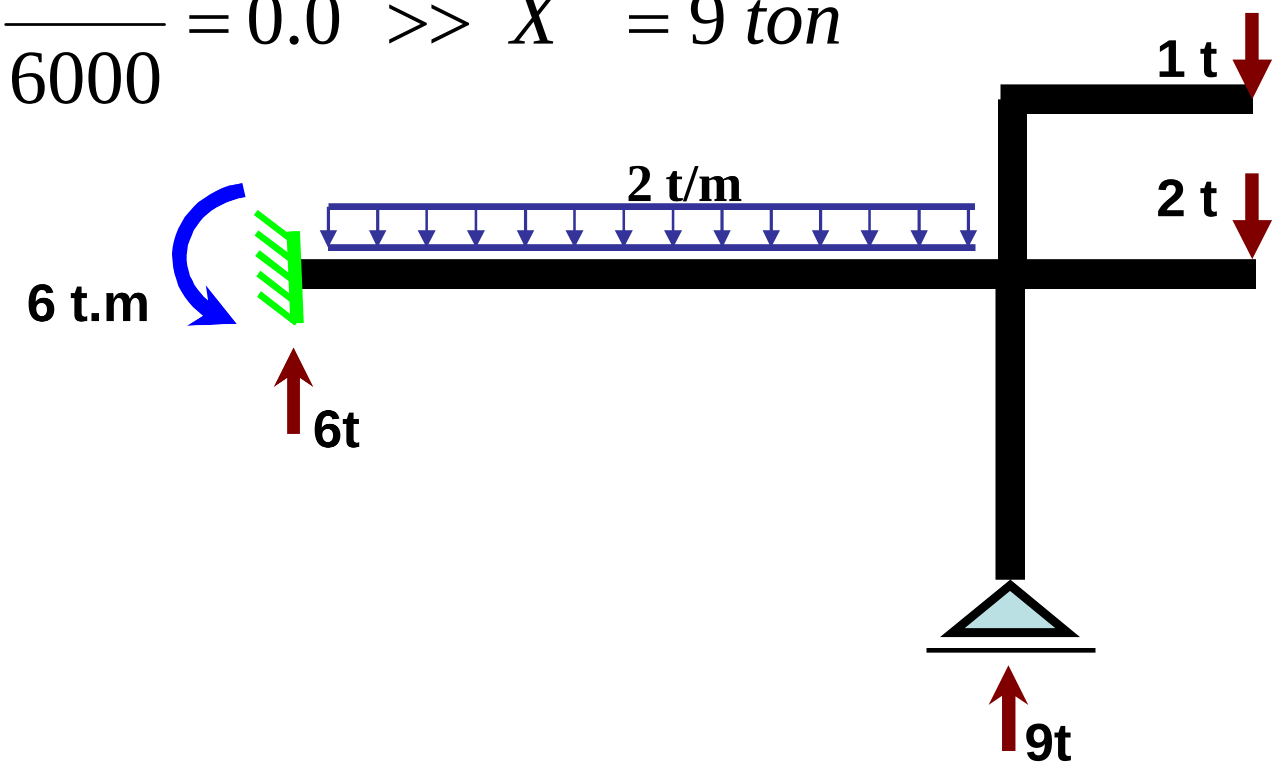
Case of given loads

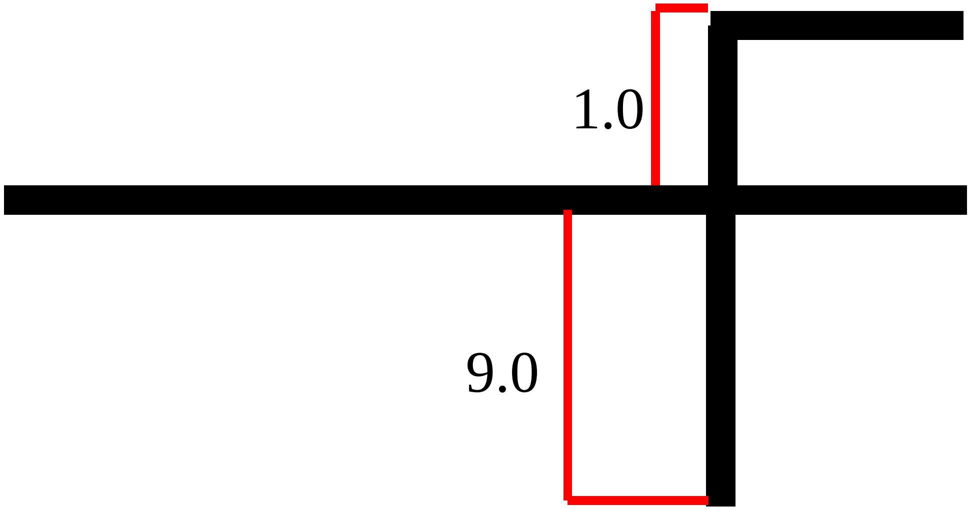
$$\delta_{10} = \frac{1}{6000}\left[-\frac{6}{3} * (6*60 + 0.5*(6*6)) + 2/3*9*6*3 \right] = -\frac{648}{6000}$$

$$\delta_{11} = \frac{1}{6000}\left[\frac{6*6*6}{3} \right] = \frac{72}{6000}\, m$$

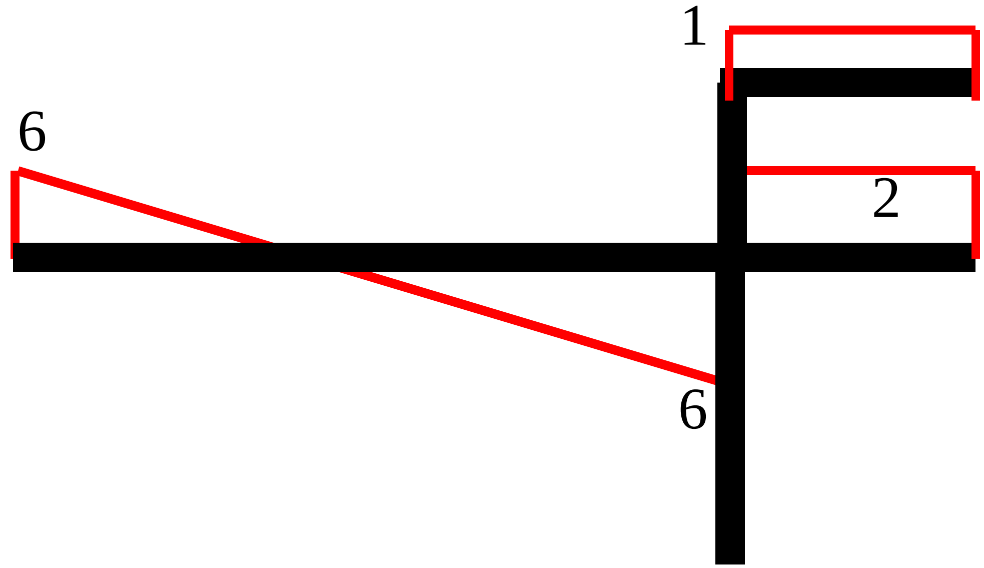
$$\delta_{10} + X \,.\, \delta_{11} = 0.0$$

$$-\frac{648}{6000} + X * \frac{72}{6000} = 0.0 \;\; >> \;\; X = 9\ ton$$

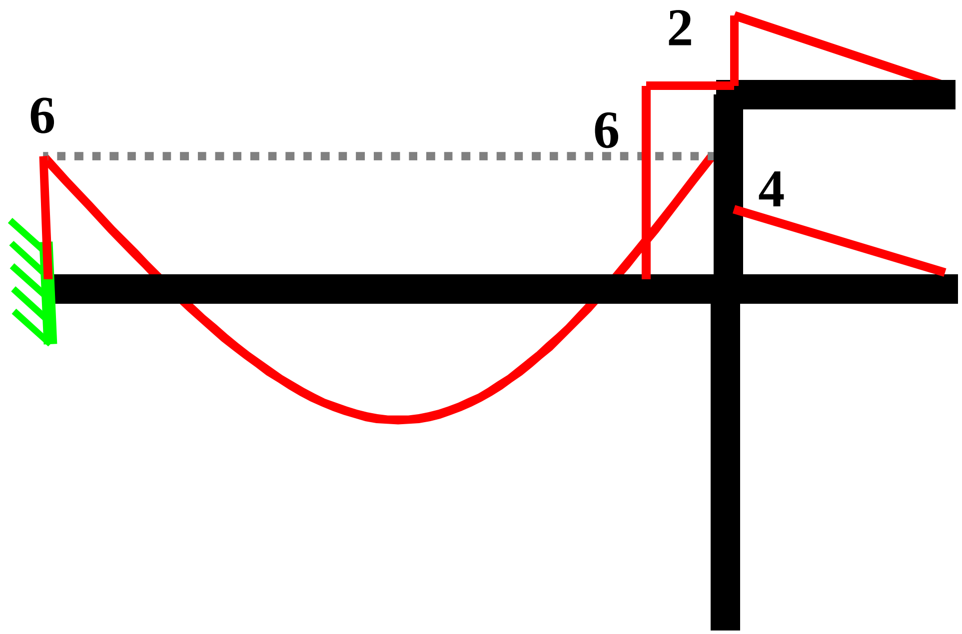




N.F.D



S.F.D

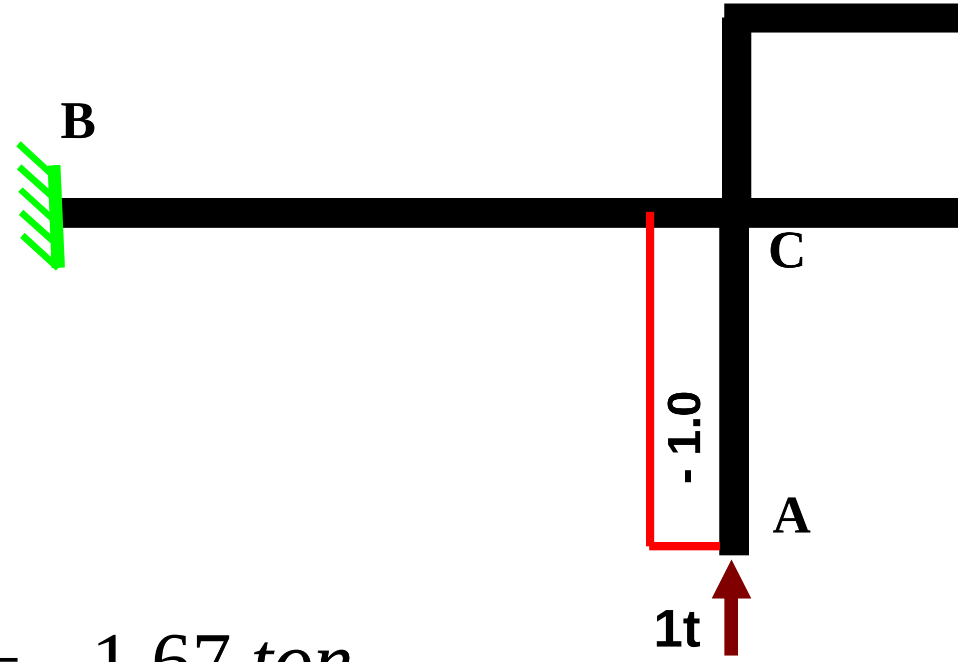


B.M.D

Case of Settelment

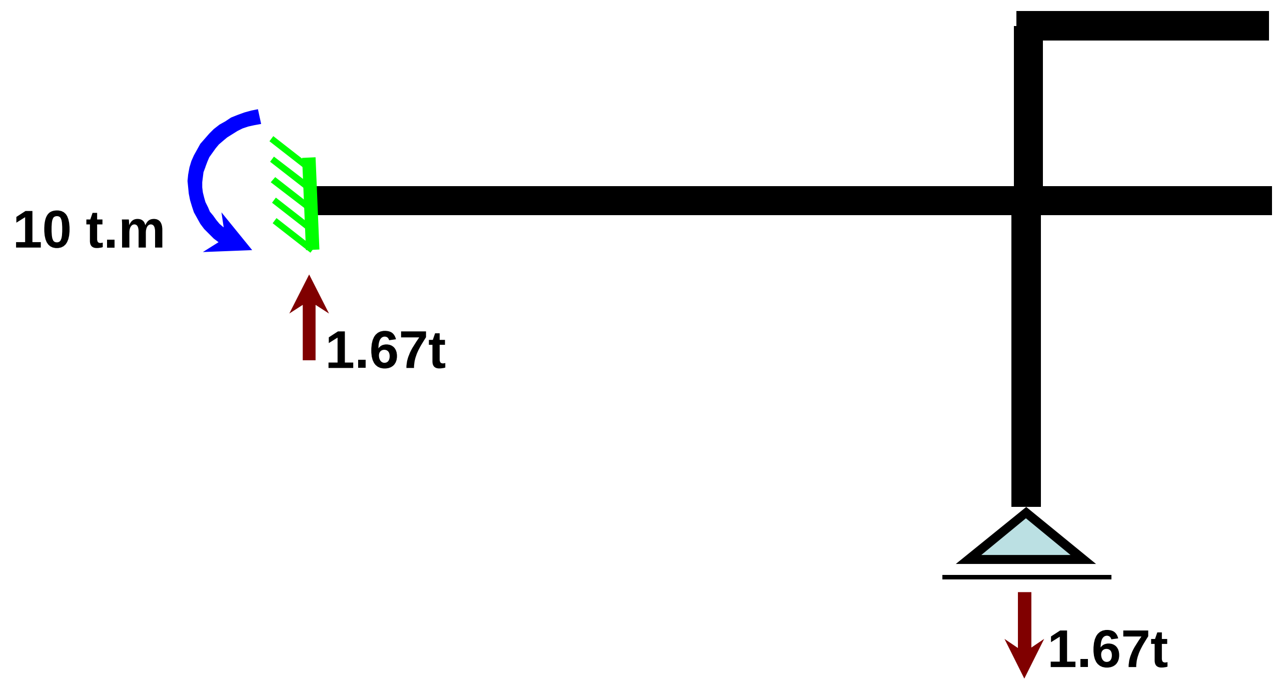
$$\delta_{10} = 0.0$$

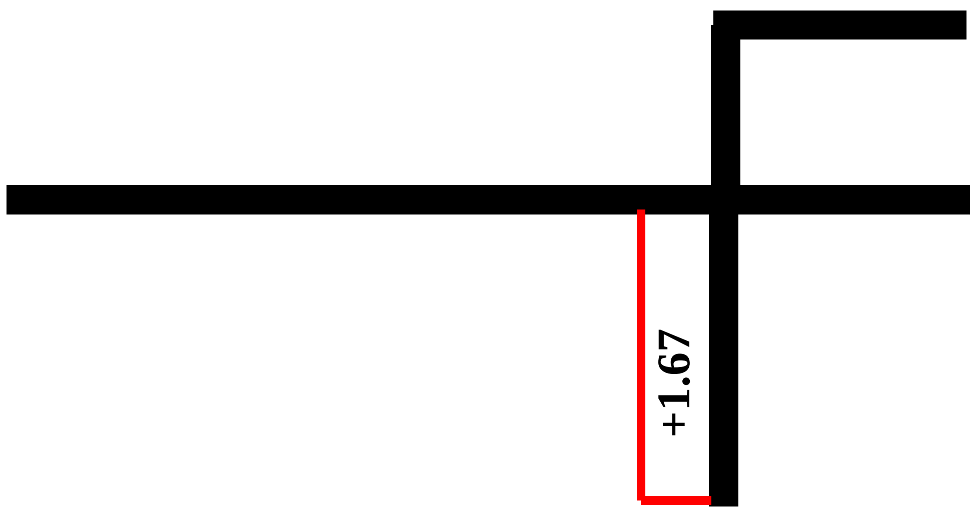
$$\delta_{11} = \frac{72}{6000}\, m$$



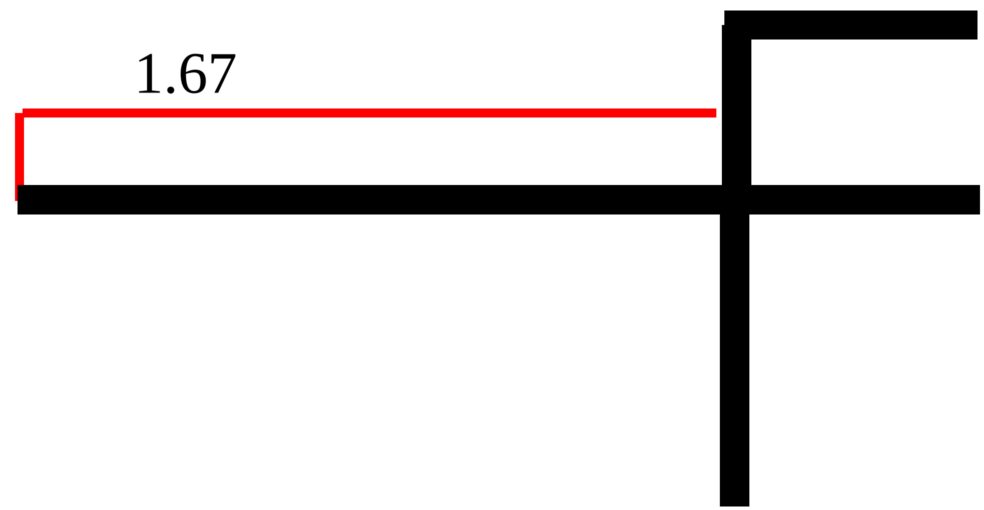
$$\delta_{10} + X\,.\,\delta_{11} = -0.02$$

$$0.0 + X * \frac{72}{6000} = -0.02 \quad >> \quad X \quad = -1.67\ ton$$

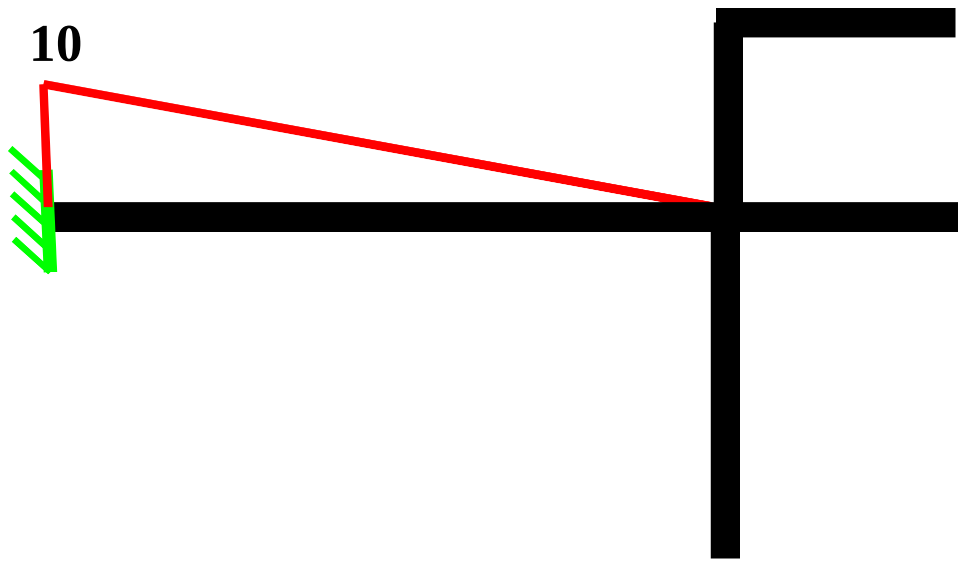




N.F.D



S.F.D

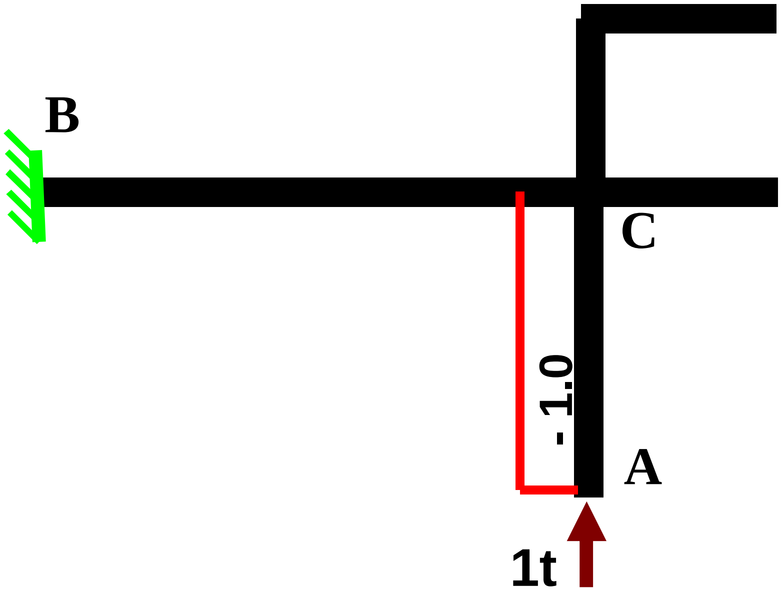


B.M.D

Case of uniform temprature

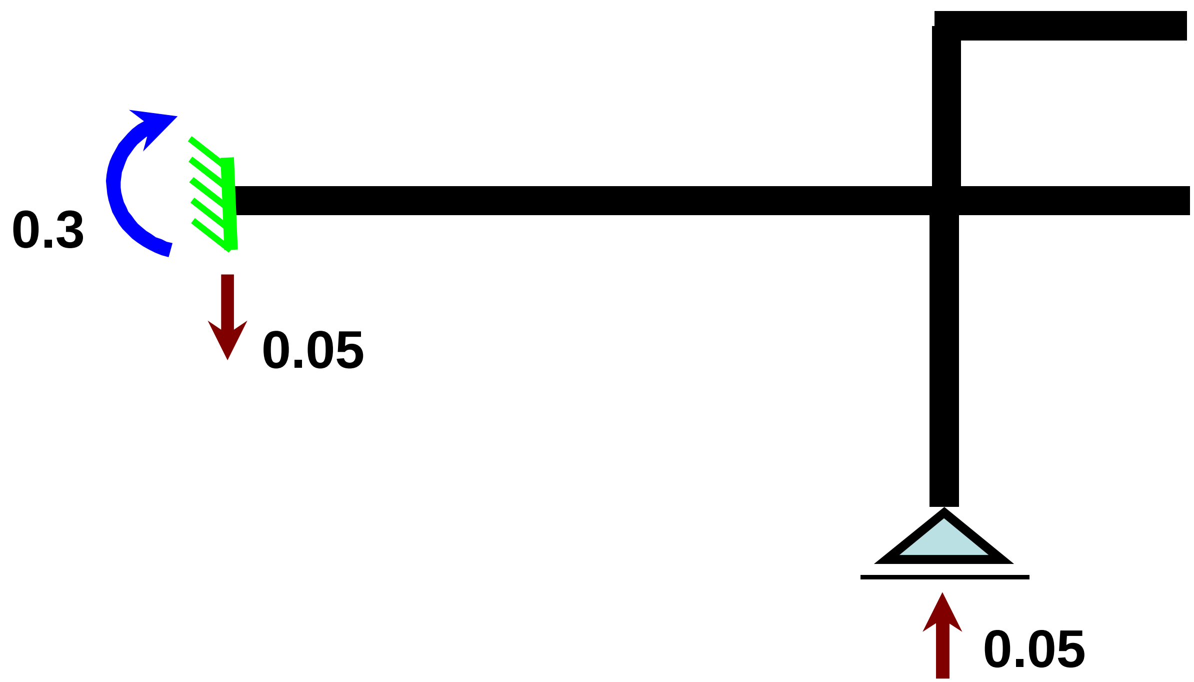
$$\delta_{10} = 10^{-5} * 20 * (-1 * 3) = -60 * 10^{-5}$$

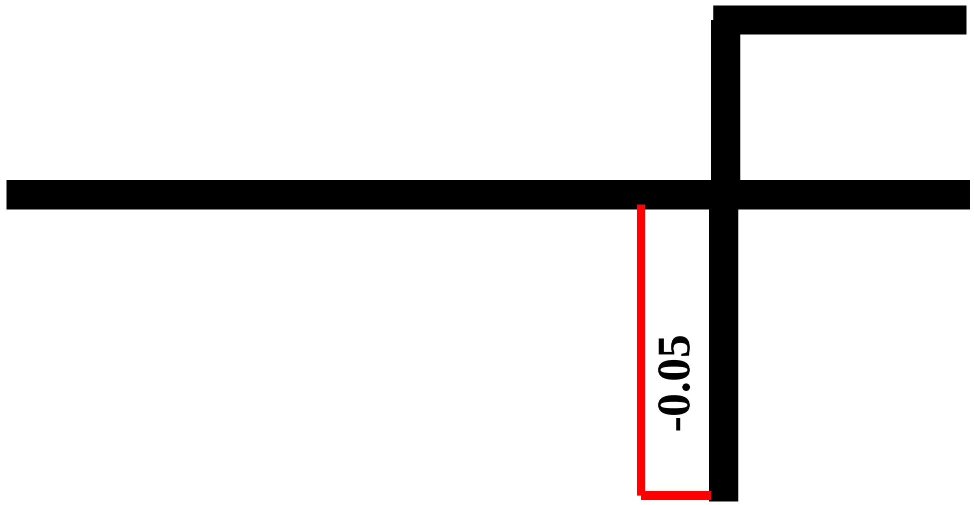
$$\delta_{11} = \frac{72}{6000} m$$



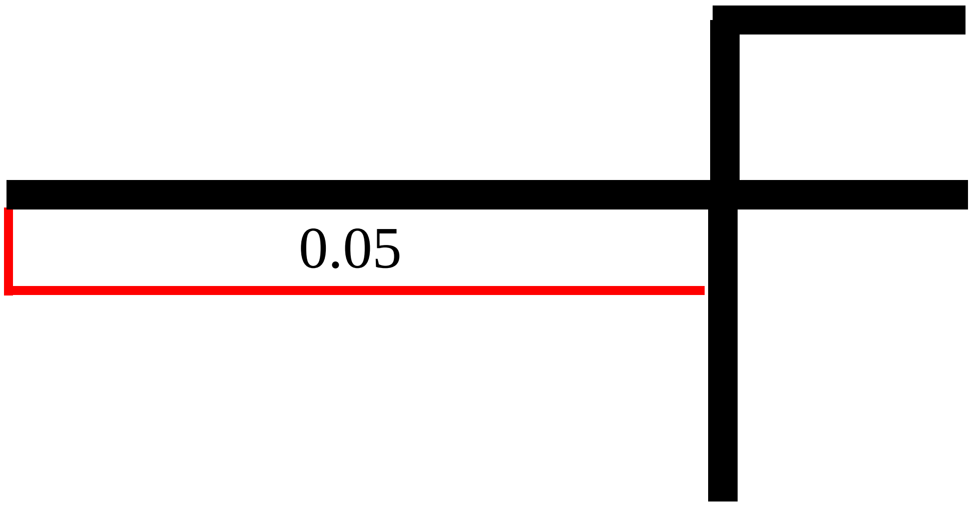
$$\delta_{10} + X . \delta_{11} = 0.0$$

$$-60 * 10^{-5} + X * \frac{72}{6000} = 0.0 \quad >> \quad X = 0.05\, ton$$





N.F.D



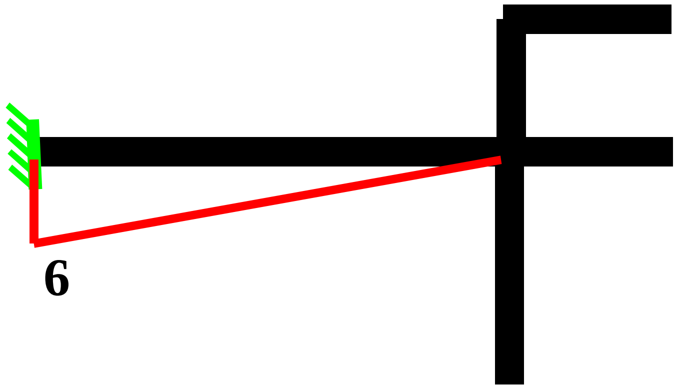
S.F.D

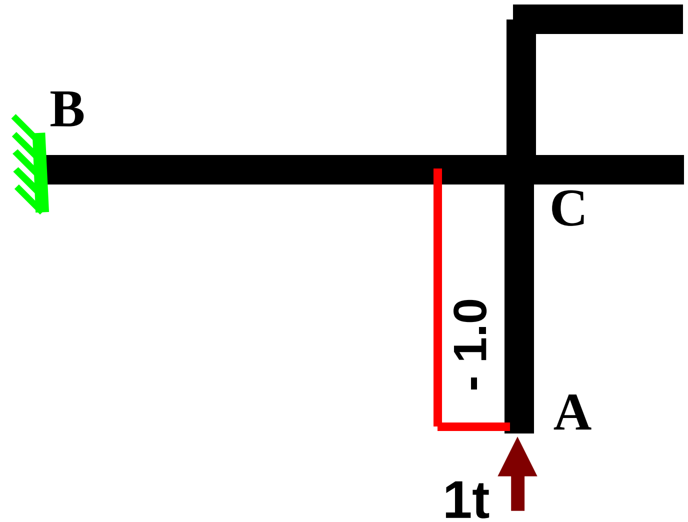
B.M.D

Case of non uniform temprature

$$\delta_{10} = 10^{-5} * (\frac{20+40}{2} * (-1*3) + 10^{-5} * (\frac{40-20}{0.6} * (0.5*6*6) = 5.1*10^{-3}$$

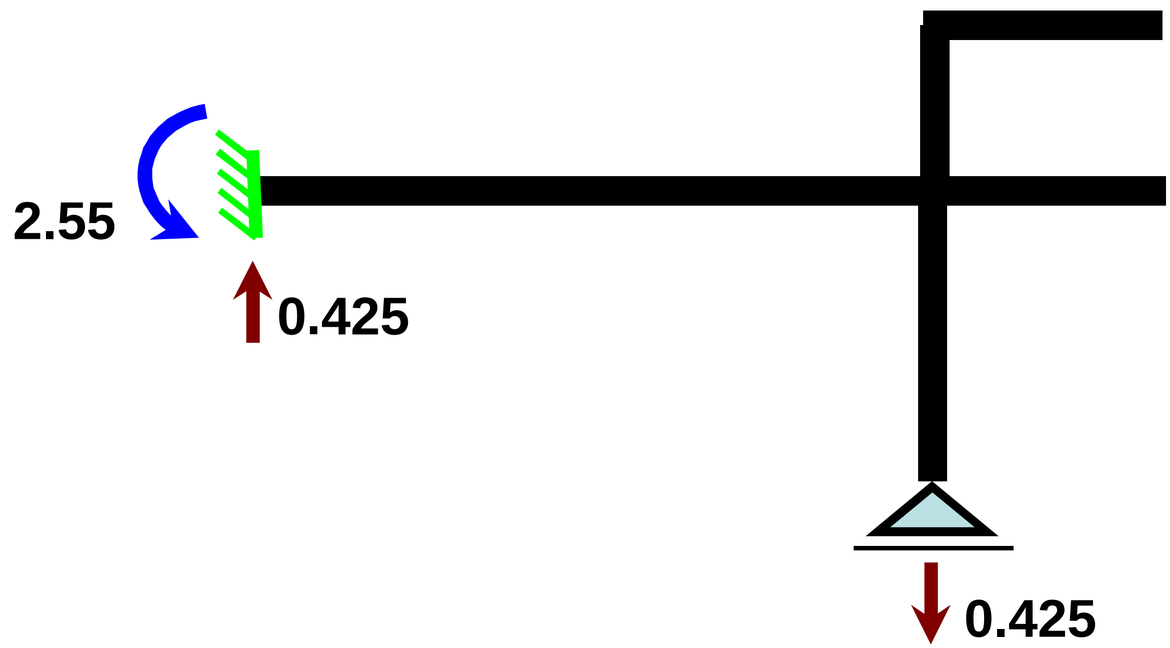
$$\delta_{11} = \frac{72}{6000} m$$

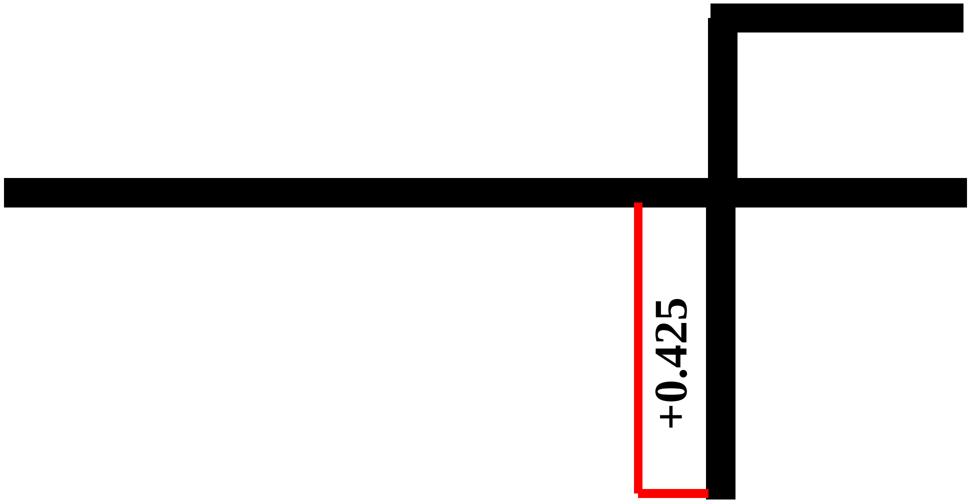




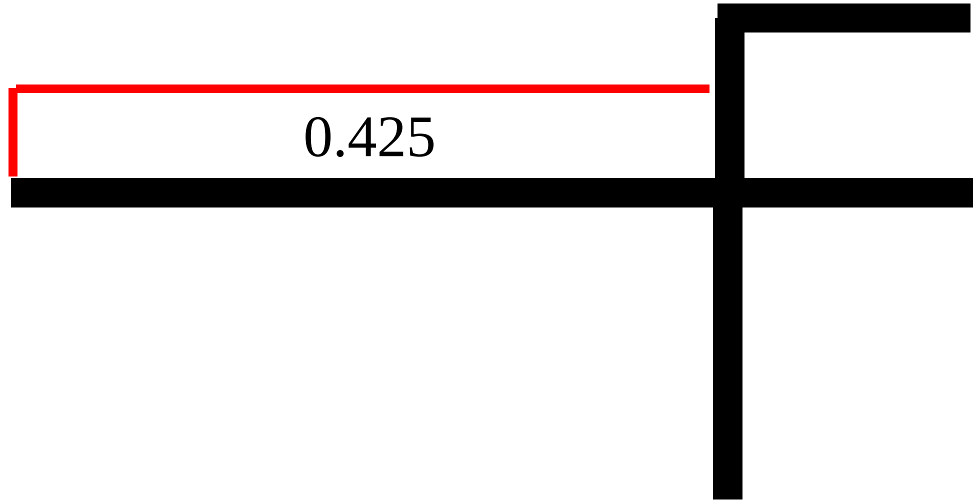
$$\delta_{10} + X \, . \, \delta_{11} = 0.0$$

$$5.1*10^{-3} + X * \frac{72}{6000} = 0.0 \quad >> \quad X = -0.425 \, ton$$

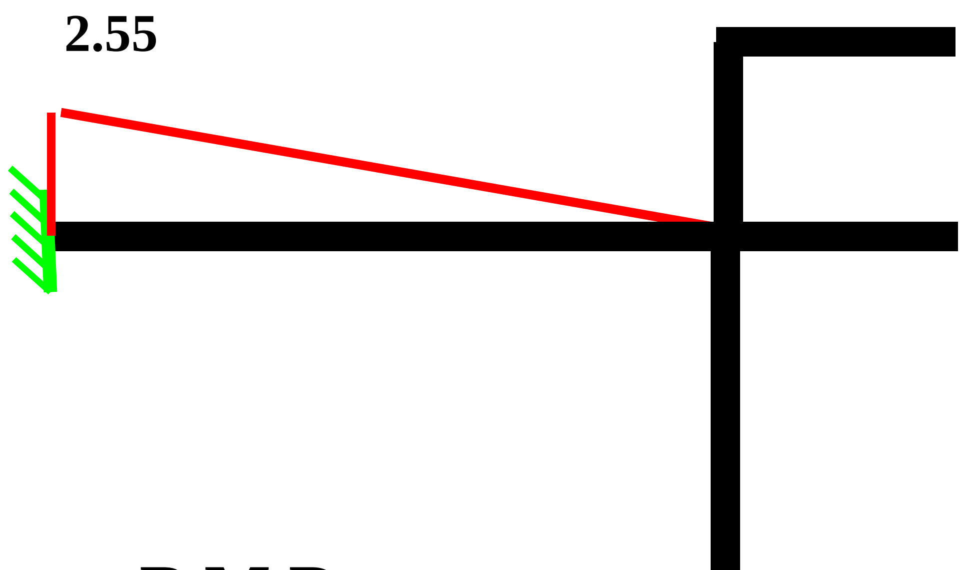




N.F.D



S.F.D



B.M.D

Closed Frame

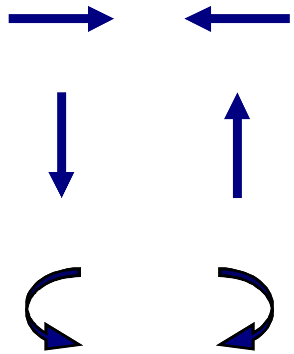
حالة وجود closed frame

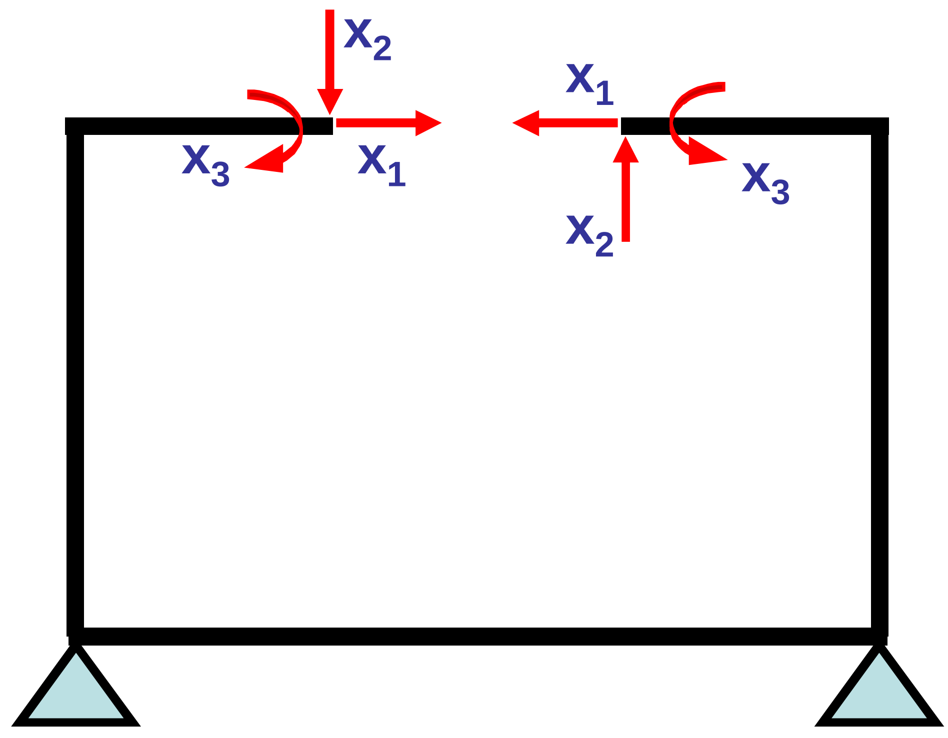
يكون هناك ثلاثة مجاهيل اضافيه وهى

Normal

Shear

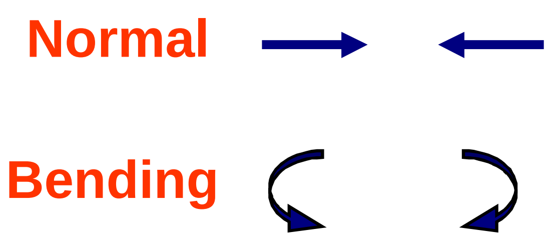
Bending

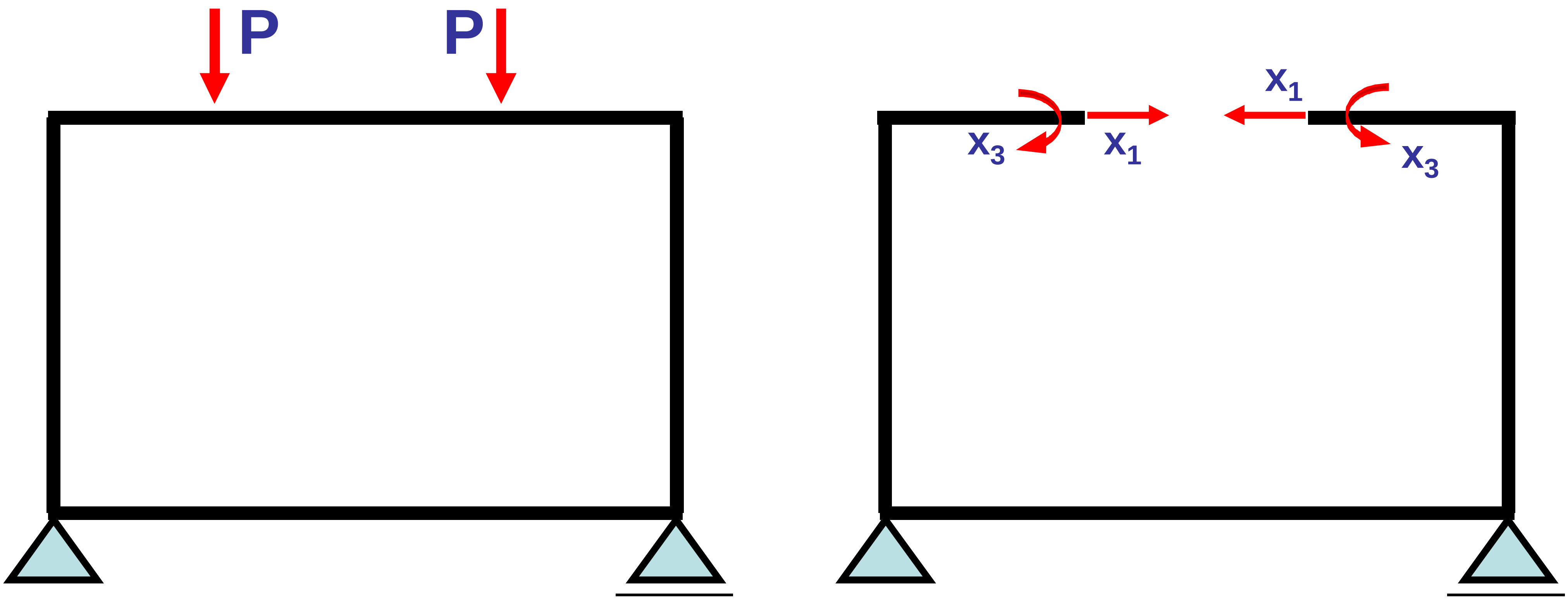




حـــالة وجـــود تمـــاثل

عند خط التماثل يكون الـ (shear = zero)

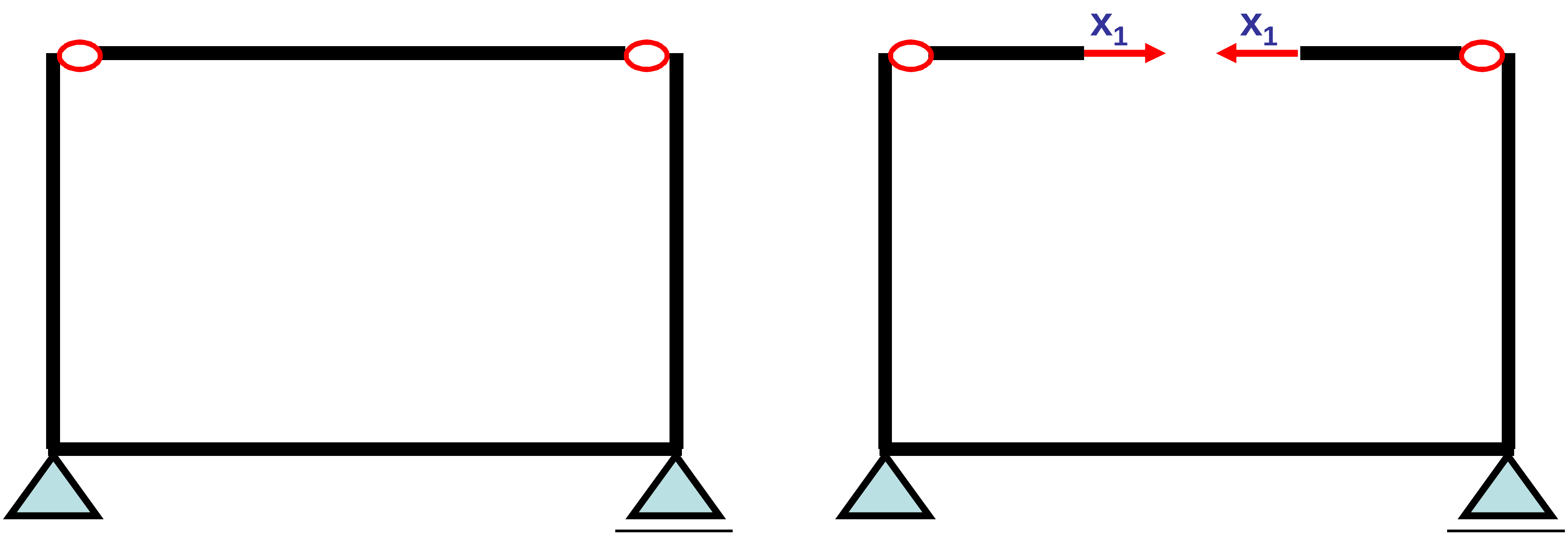




حـــالة وجـــود link member

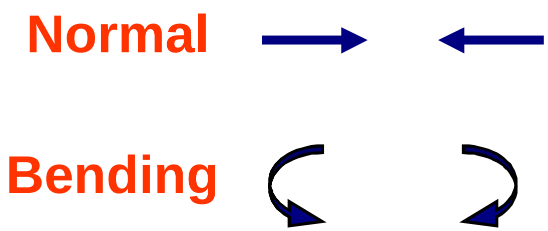
يكون المجهول الوحيد بها هى الـ (normal force)

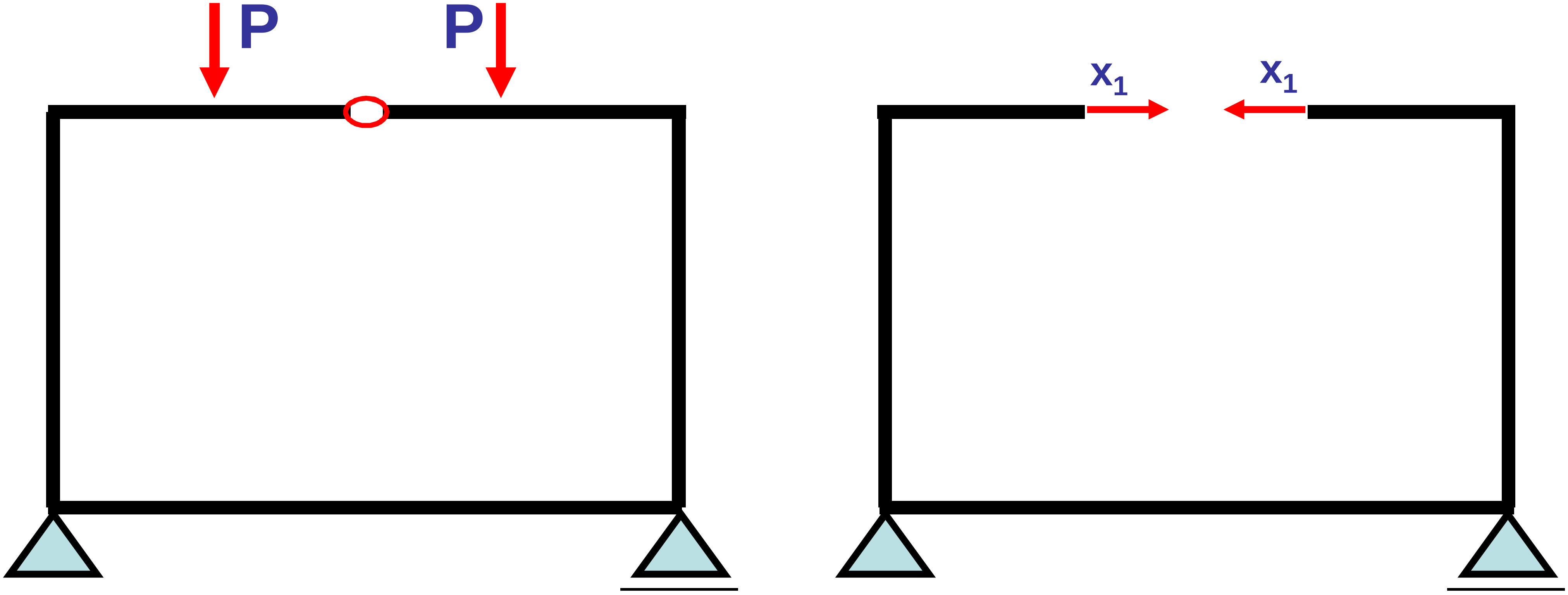
Normal 



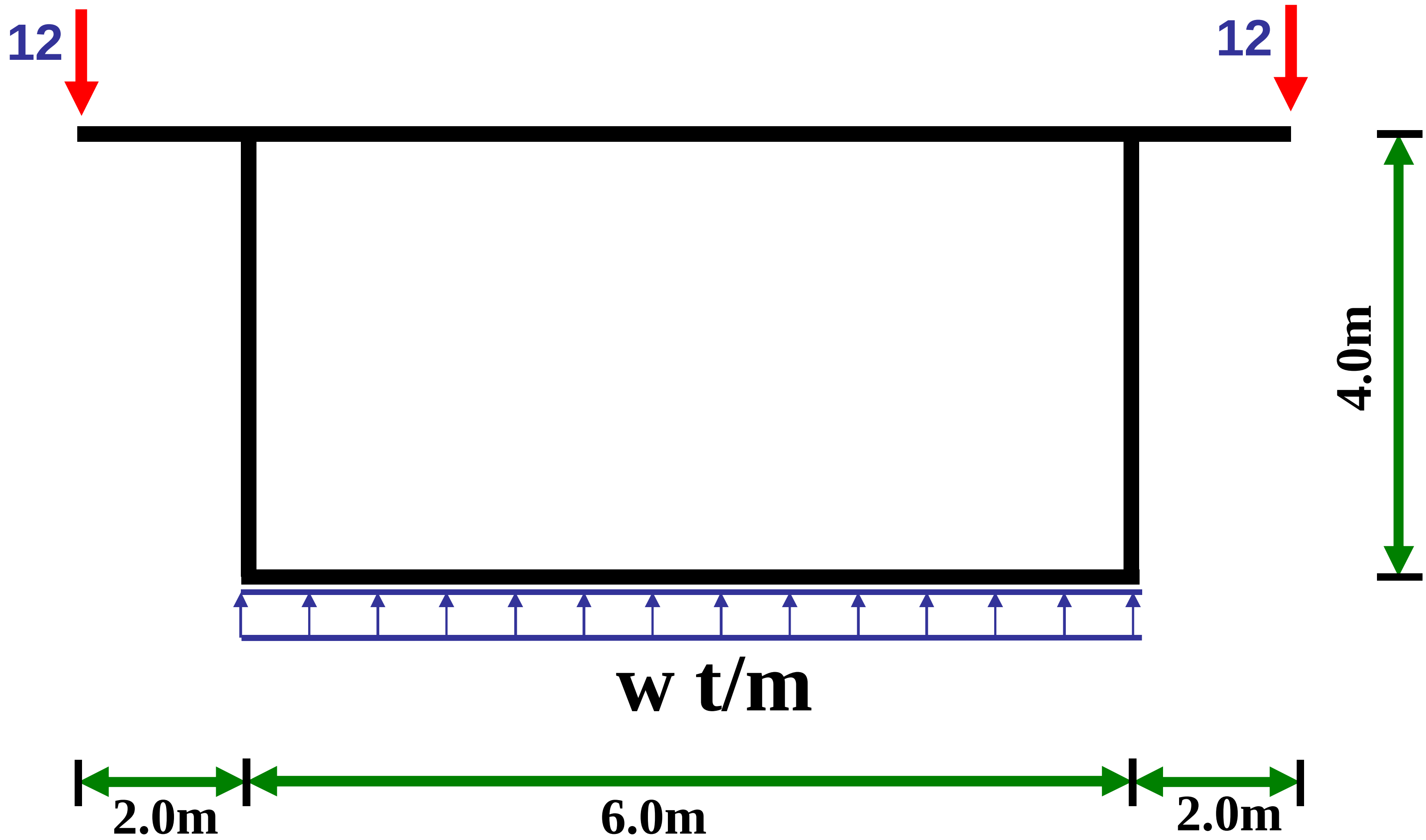
حــالة وجـــود تمـــاثل

عند خط التماثل يكون الـ (shear = zero)



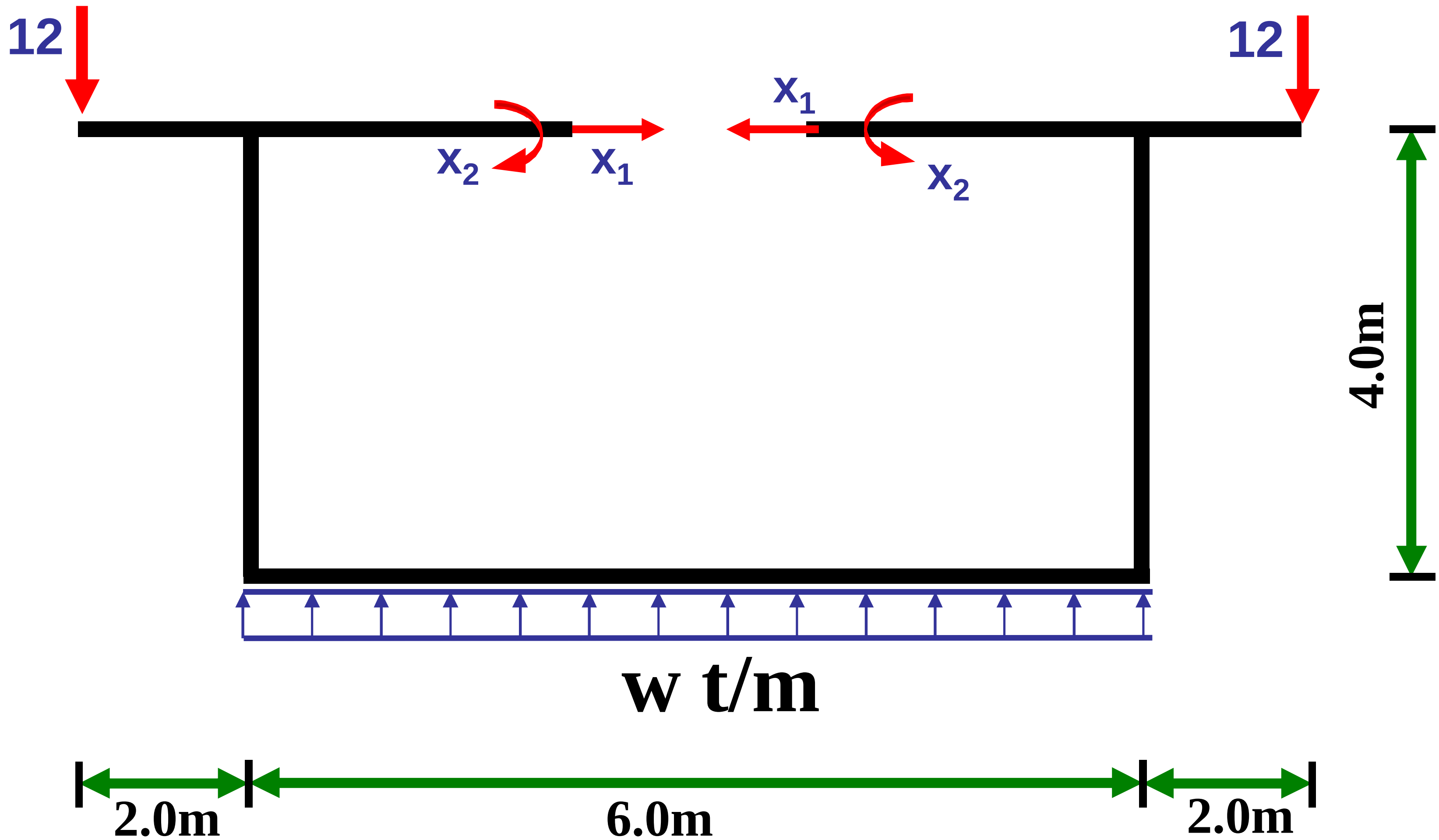


المثـــــال الاول



Draw B.M.D , S.F.D, and N.F.D EI = 6000 t.m2
Due to (1) given loads

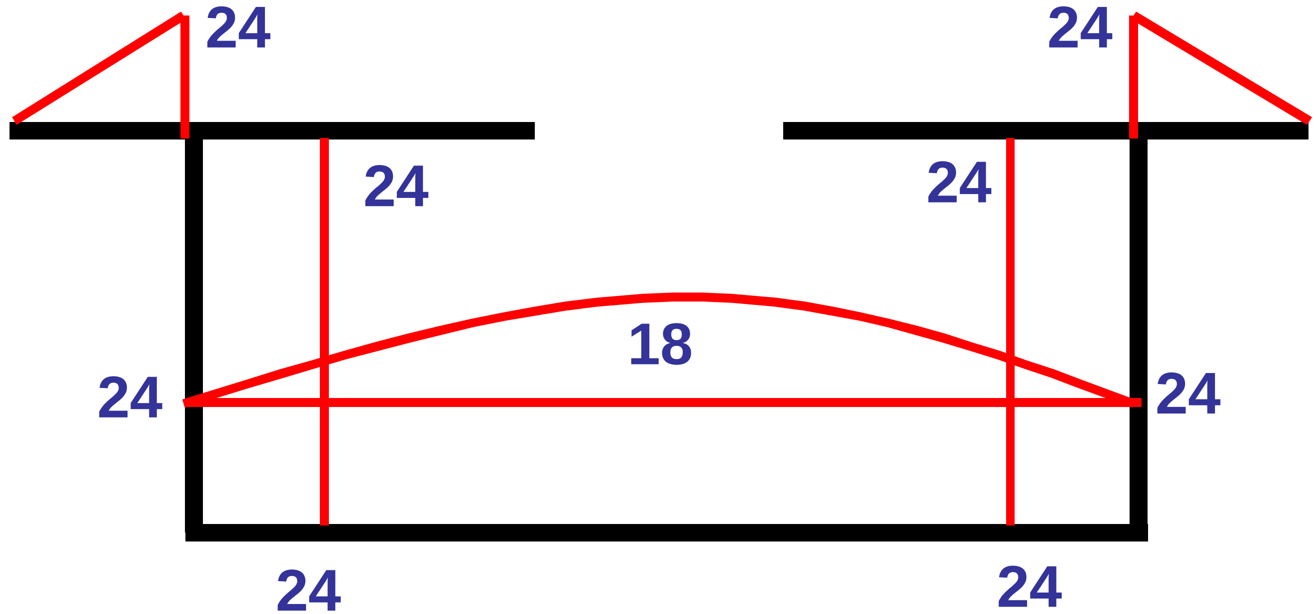
Main System



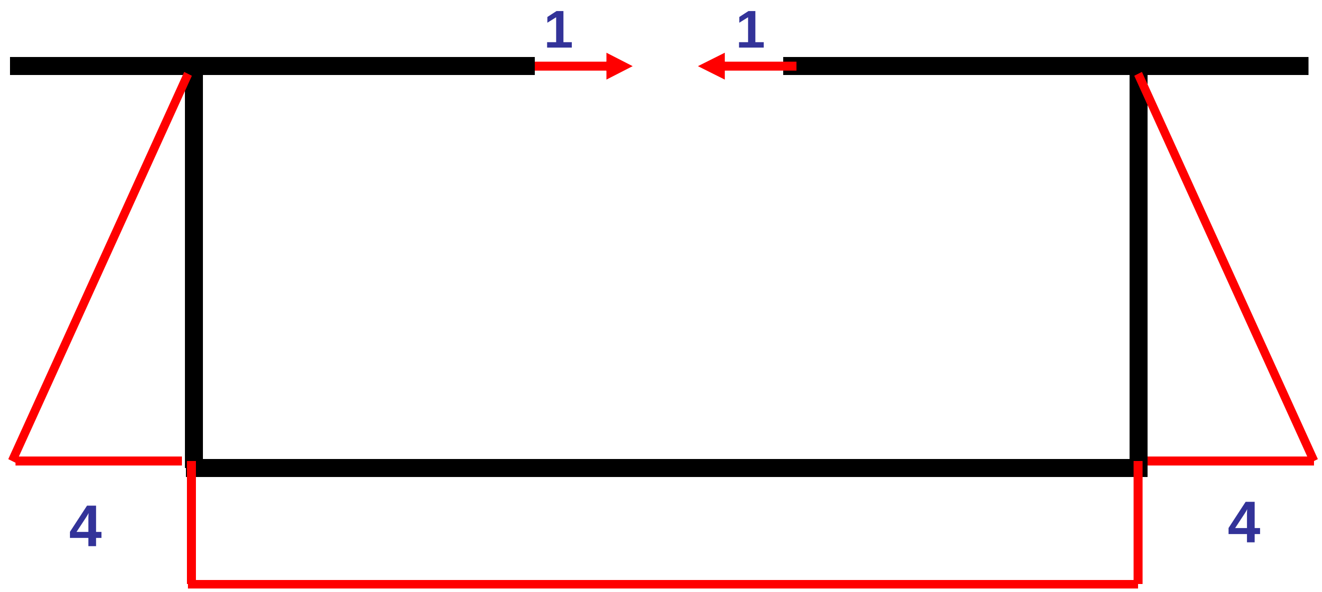
$6\,W = 24$

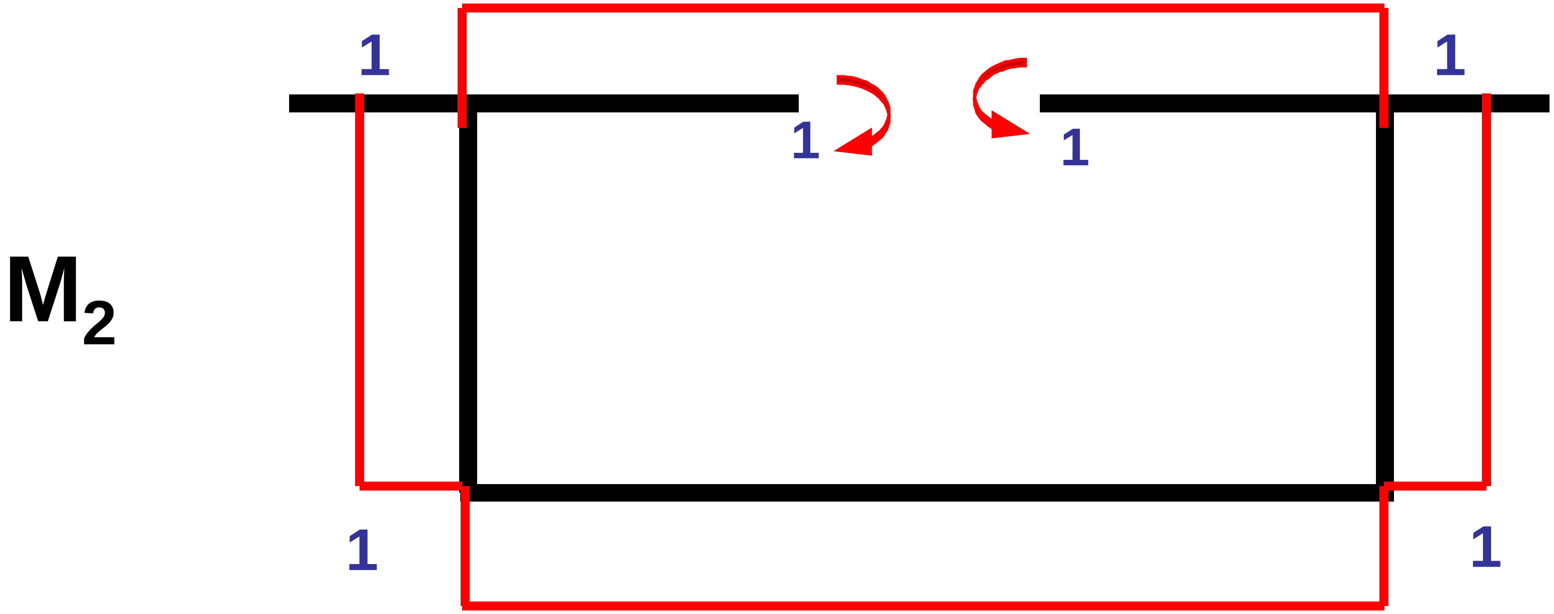
$W = 4$ t/m

M_0



M_1





$$\delta_{10} = \frac{1}{10000}\left[-2*\frac{24*4*4}{2} - 24*4*6 - \frac{2}{3}*18*6*4\right] = -\frac{1248}{10000}\ m$$

$$\delta_{20} = \frac{1}{10000}\left[-2*24*1*4 - 24*1*6 - \frac{2}{3}*18*6*1\right] = -\frac{408}{10000}\ m$$

$$\delta_{11} = \frac{1}{10000}\left[\frac{4*4*4}{3} + 4*4*6\right] = \frac{117.33}{10000}\ m$$

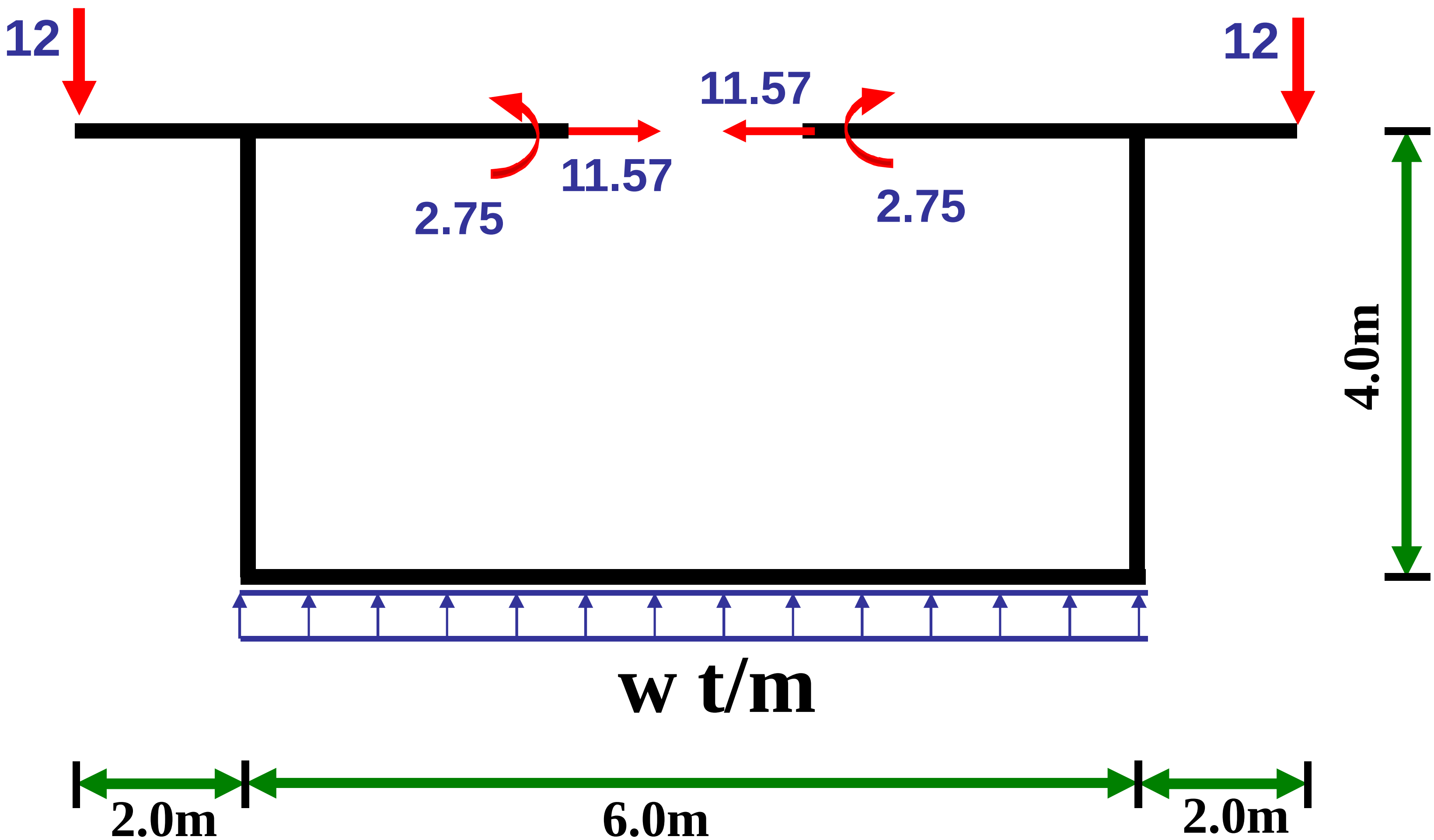
$$\delta_{22} = \frac{1}{10000}\left[1*1*6*2 + 1*1*4*2\right] = \frac{20}{10000}\ m$$

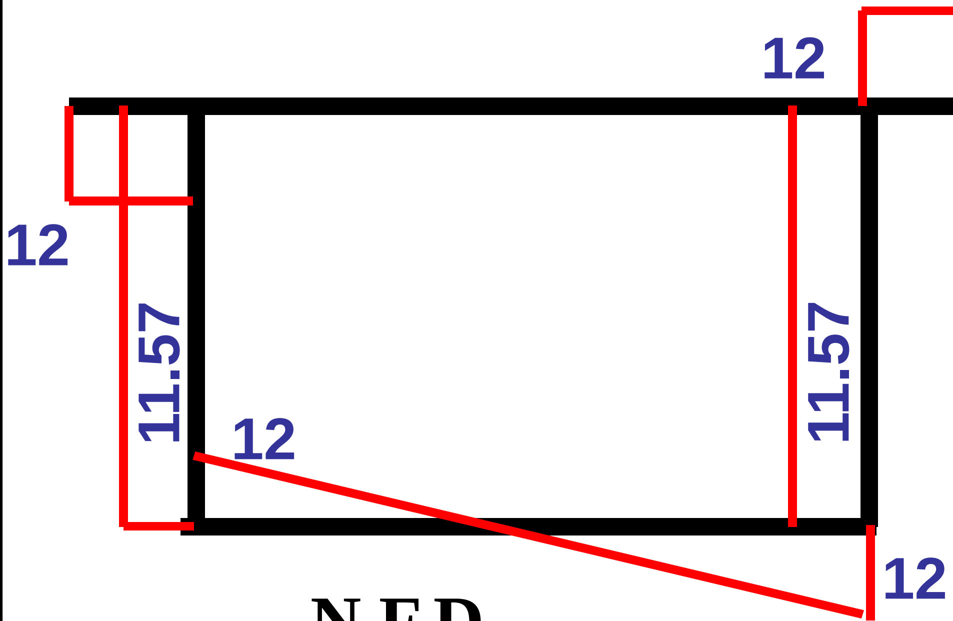
$$\delta_{21} = \delta_{12} = \frac{1}{10000}\left[\frac{1*4*4}{2}*2 + 1*4*6\right] = \frac{40}{10000}\ m$$

$$-\frac{1248}{10000}+X_1.\frac{117.33}{10000}+X_2.\frac{40}{10000}=0.0$$

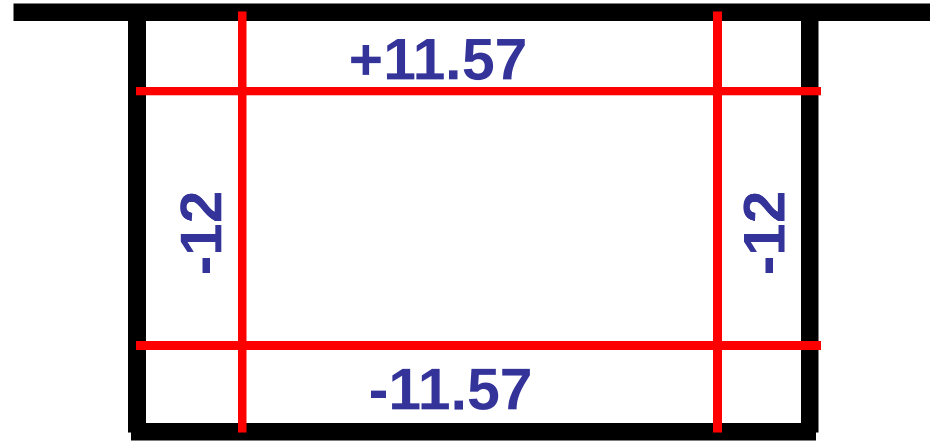
$$-\frac{408}{10000}+X_1.\frac{40}{10000}+X_2.\frac{20}{10000}=0.0$$

X1= 11.57 ton and X2= -2.75 ton

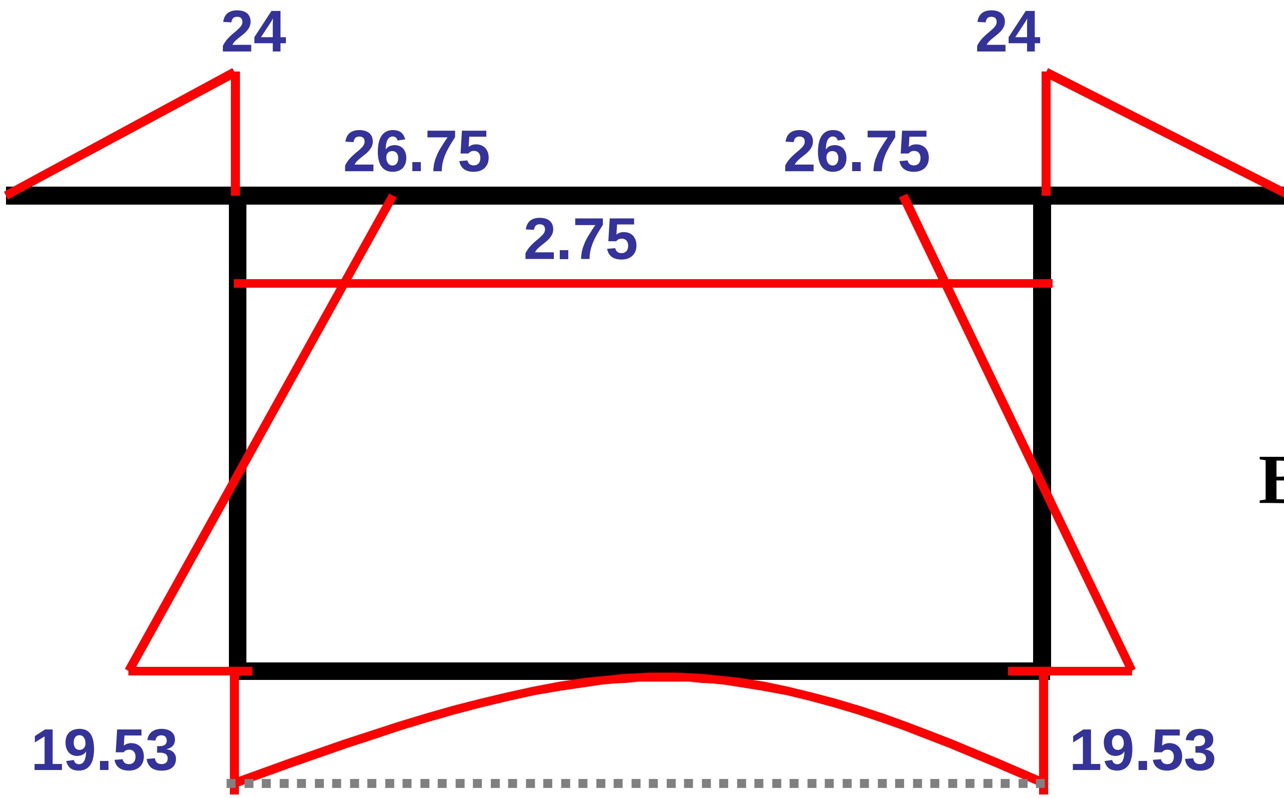



12
12
11.57
12
11.57
12

N.F.D

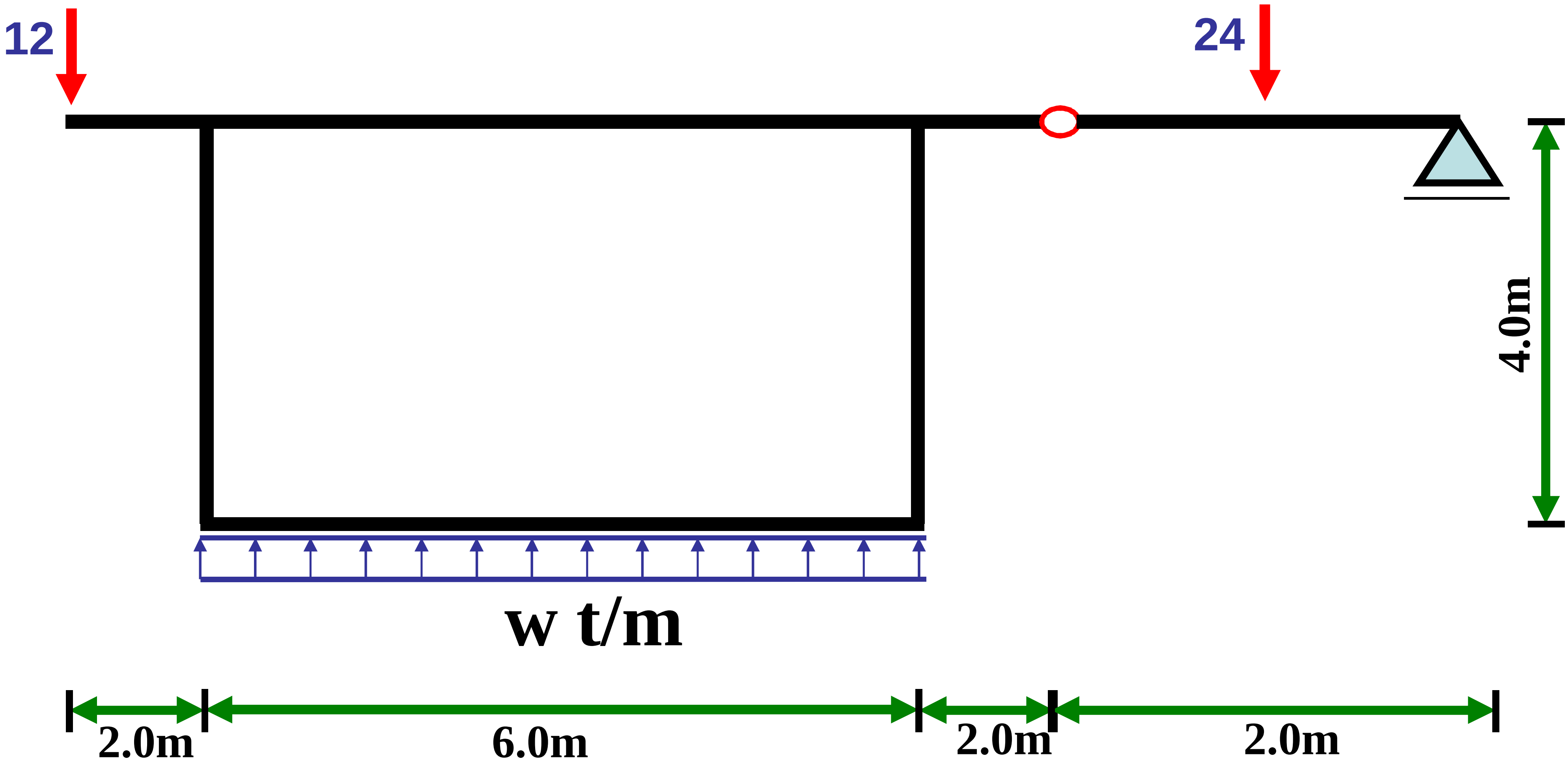

+11.57
-12
-12
-11.57

S.F.D

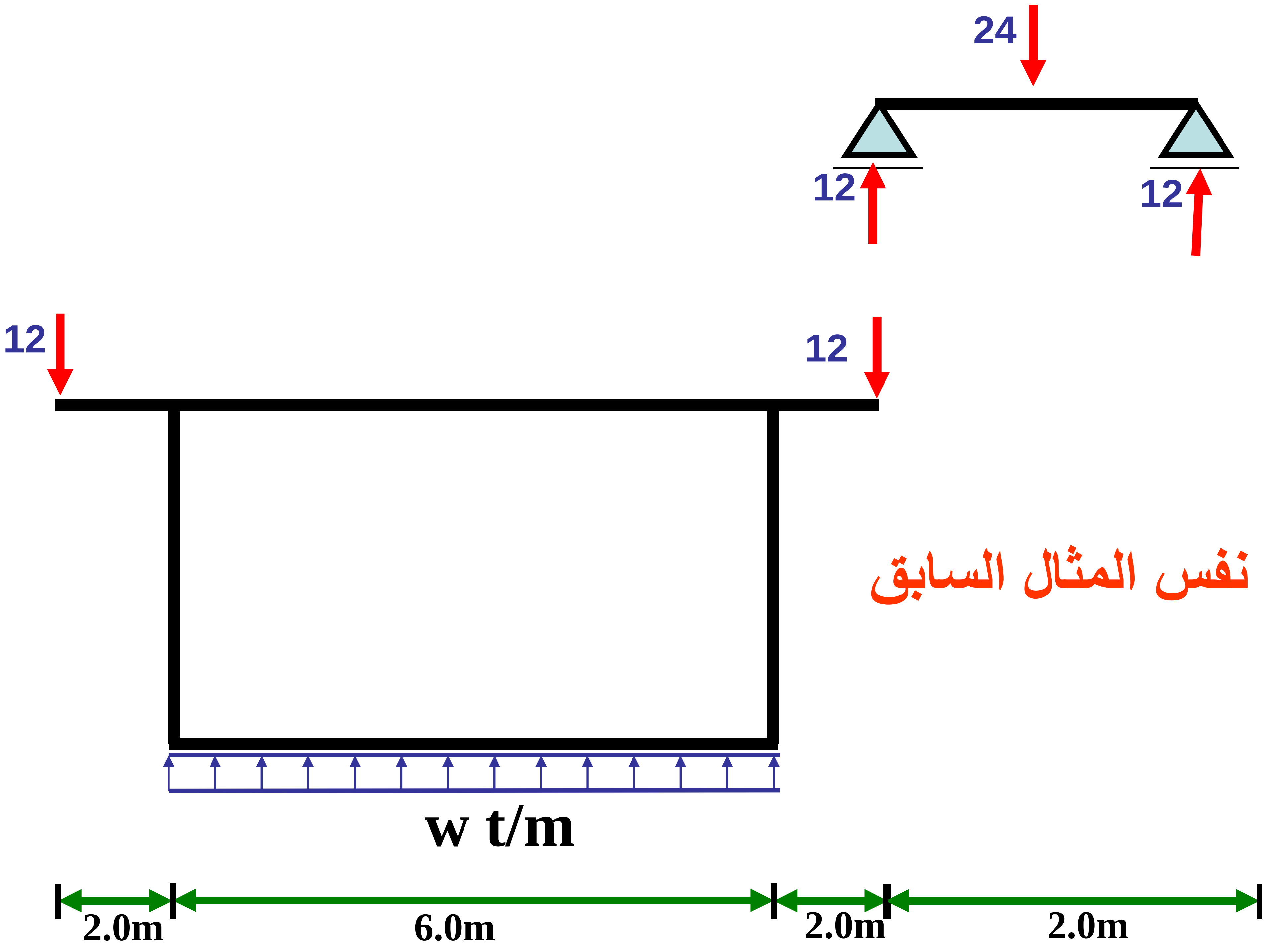

24
24
26.75
26.75
2.75
19.53
19.53

B.M.D

المثـــــال الثانى



Draw B.M.D , S.F.D, and N.F.D EI = 6000 t.m2
Due to (1) given loads

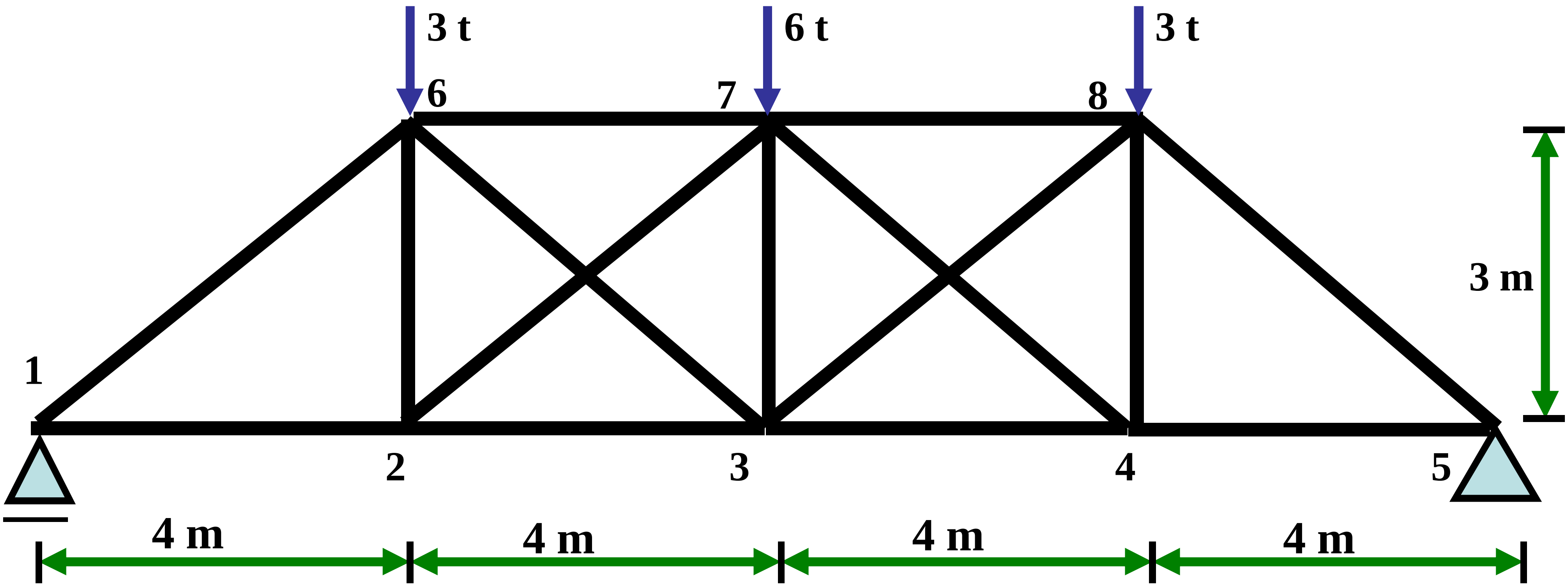


كمل نفس المثال السابق

Consistant Deformation

Truss

Example one



For the shown truss determine find the forces in all members due to:

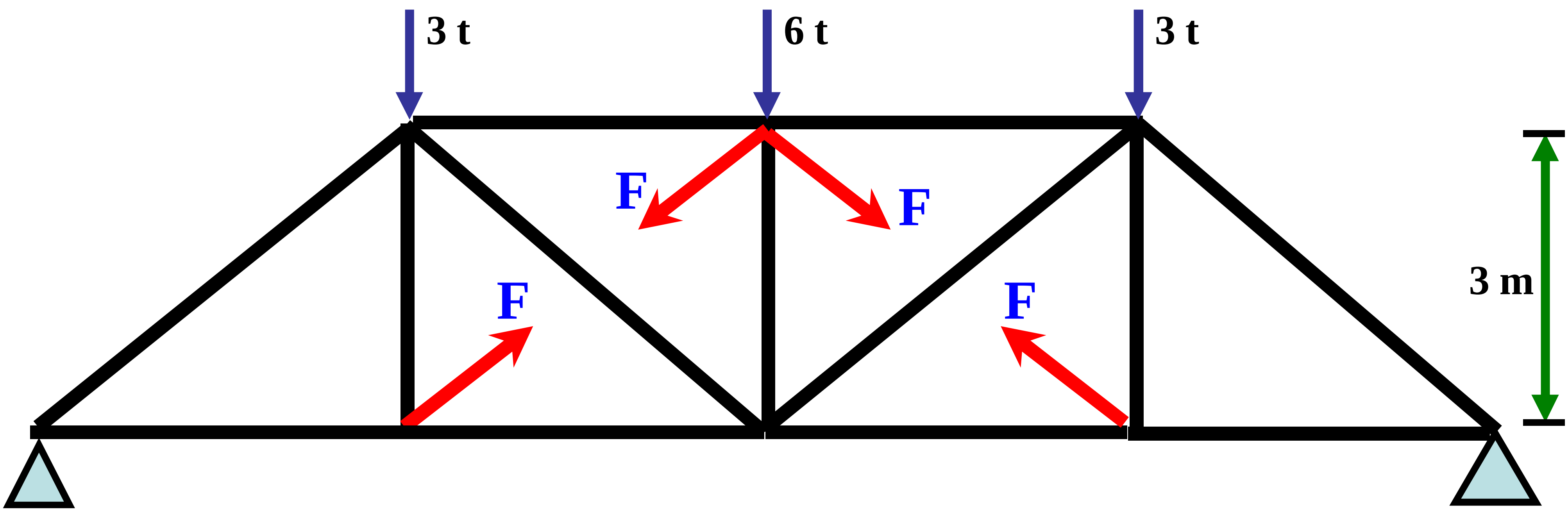
1- Given Load.

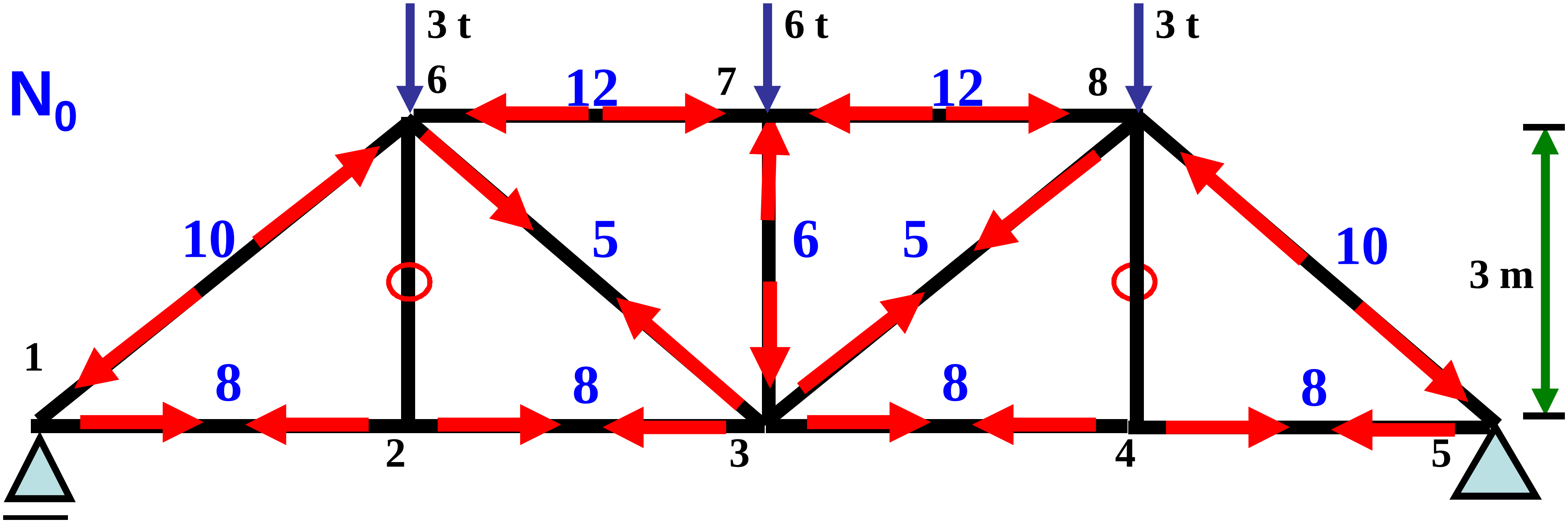
2- Settlement at (point5)=1.5 cm.

3- drop In Temperature 30^0.

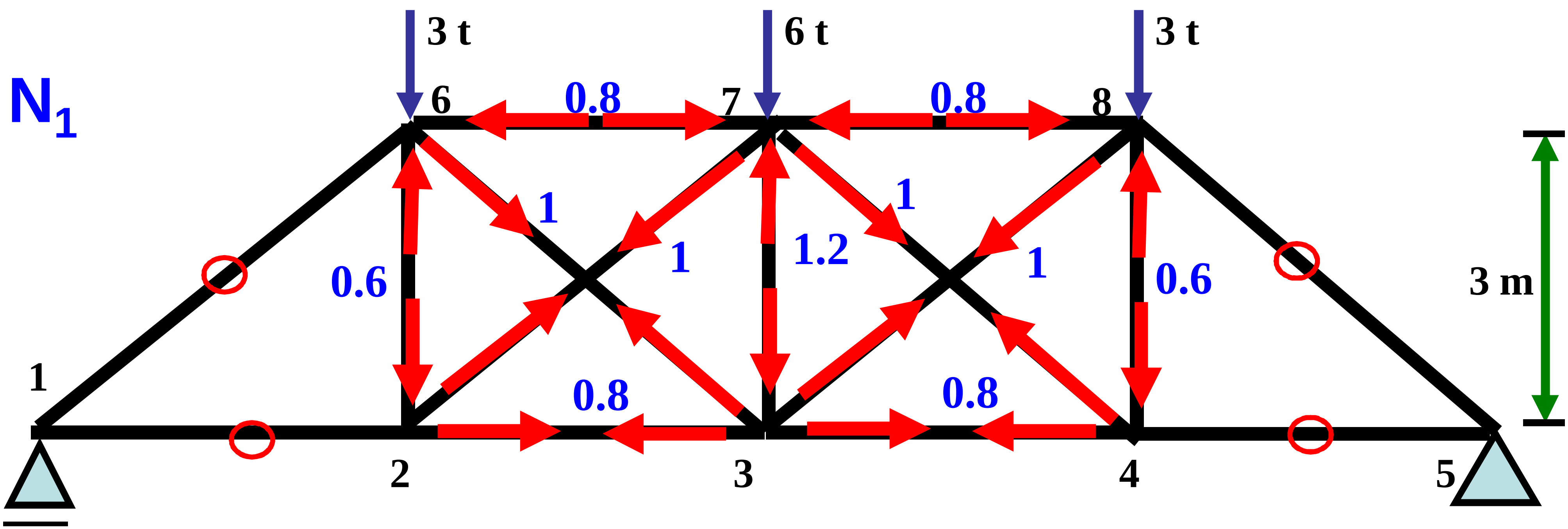
EA=40000 ton $\alpha = 10^{-5}$

main system





N_0
3 t
6 t
3 t
6
7
8
12
12
10
5
6
5
10
3 m
1
8
8
8
8
2
3
4
5



N_1
3 t
6 t
3 t
6
7
8
0.8
0.8
1
1
1.2
1
1
0.6
0.6
3 m
1
0.8
0.8
2
3
4
5

temprature

settelment

Given loads

member	L	N_0	N_1		$N_0 N_1 L$	$N_1 N_1 L$	$N_1 L$		N_F	N_F	N_F
2-6	3	0	-0.6		0	1.08	-1.8				
3-7	3	-6	-1.2		21.6	4.32	-3.6				
4-8	3	0	-0.6		0	1.08	-1.8				
1-2	4	8	0		0	0	0				
2-3	4	8	-0.8		-25.6	2.56	-3.2				
3-4	4	8	-0.8		-25.6	2.56	-3.2				
4-5	4	8	0		0	0	0				
6-7	4	-12	-0.8		38.4	2.56	-3.2				
7-8	4	-12	-0.8		38.4	2.56	-3.2				
1-6	5	-10	0		0	0	0				
2-7	5	0	1		0	5	5				
3-8	5	5	1		25	5	5				
3-6	5	5	1		25	5	5				
4-7	5	0	1		0	5	5				
5-8	5	-10	0		0	0	0				
$\sum$					97.2	36.72	0.0				

Case of given loads

$$\delta_{10} = \frac{\sum N_0 N_1 L}{EA} = \frac{97.2}{40000}$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{36.72}{40000}$$

$$\delta_{10} + X \, . \, \delta_{11} = 0.0$$

$$\frac{97.2}{40000} + F * \frac{36.72}{40000} = 0.0 \quad >> \quad F = -2.65 \, ton$$

Given loads

$$N_F = N_0 + F * N_1 = N_0 - 2.65 N_1$$

يتم عمل الحسابات فى الجدول فقط

Case of Temprature

$$\delta_{10} = \alpha.\Delta t.\sum(N1.L) = 0.0$$

$$\delta_{11} = given \;\; load = \frac{36.72}{40000}$$

$$\delta_{10} + X \,.\, \delta_{11} = 0.0$$

$$0 + F * \frac{36.72}{40000} = 0.0 \;\; >> \;\; F \;\; = 0$$

Temprature

$$N_F = F * N_1 = 0$$

يتم عمل الحسابات فى الجدول فقط

Case of settelment

$$\delta_{10} = 0.0$$

$$\delta_{11} = given \ \ load = \frac{36.72}{40000}$$

$$\delta_{10} + X \,.\, \delta_{11} = 0.0$$

$$0 + F * \frac{36.72}{40000} = 0.0 \quad >> \quad F = 0$$

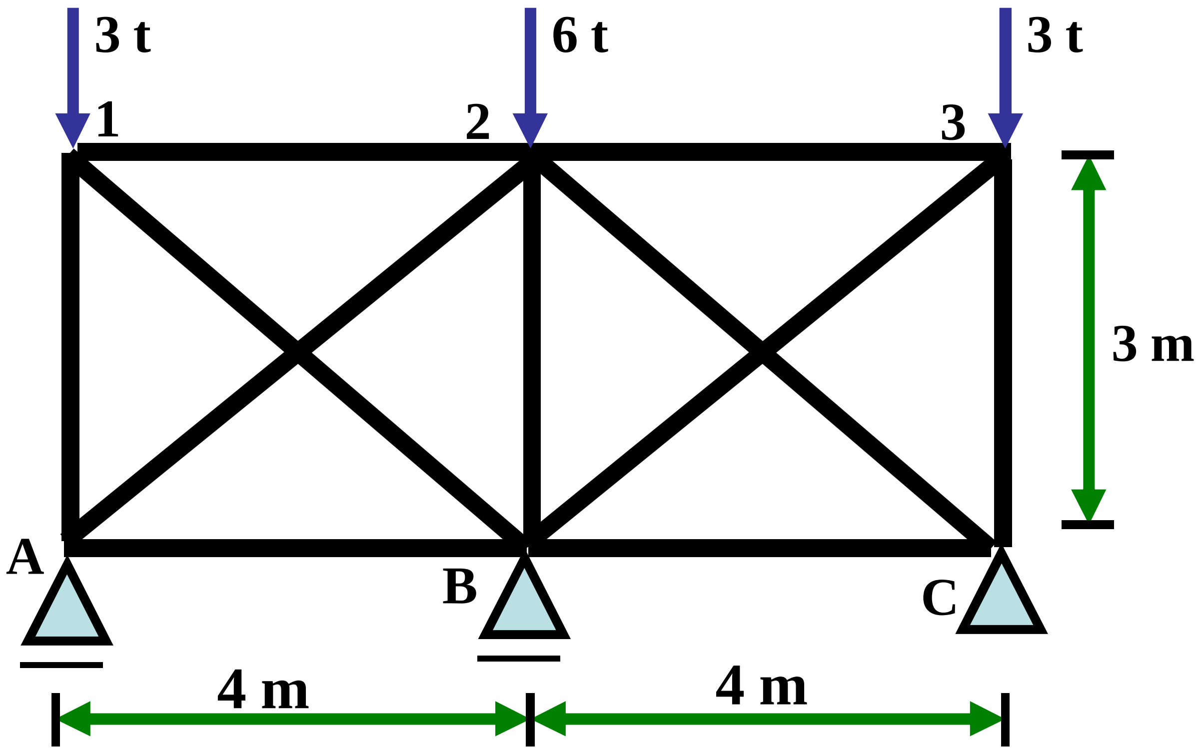
Temprature

$$N_F = F * N_1 = 0$$

يتم عمل الحسابات فى الجدول فقط

لاحظ انه عندما يكون المنشأ خارجى determinate فانه لا يتأثر بالحرارة ولا الـ settlement

Example Two



For the shown truss determine find the forces in all members due to:

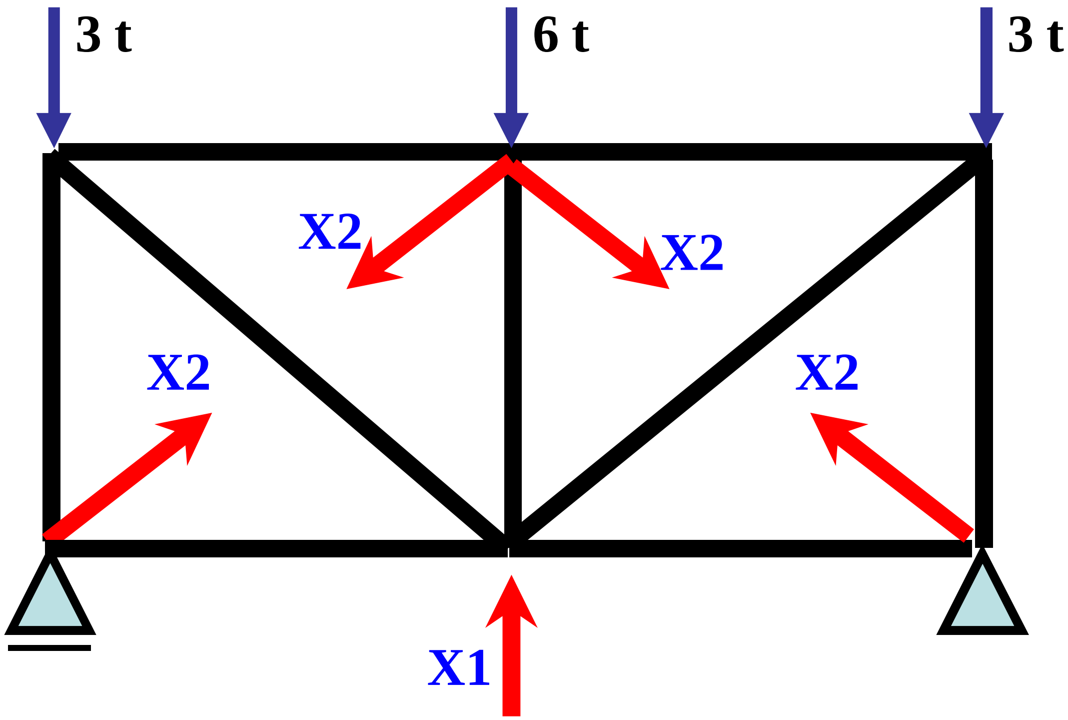
1- Given Load.

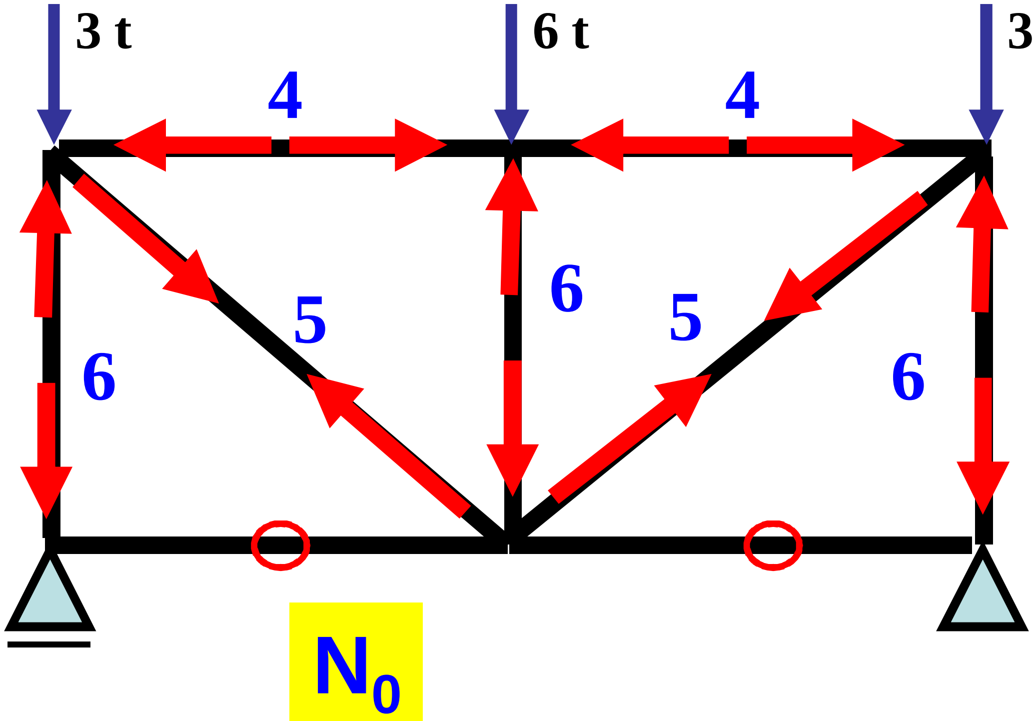
2- Settlement at B=1.5 cm.

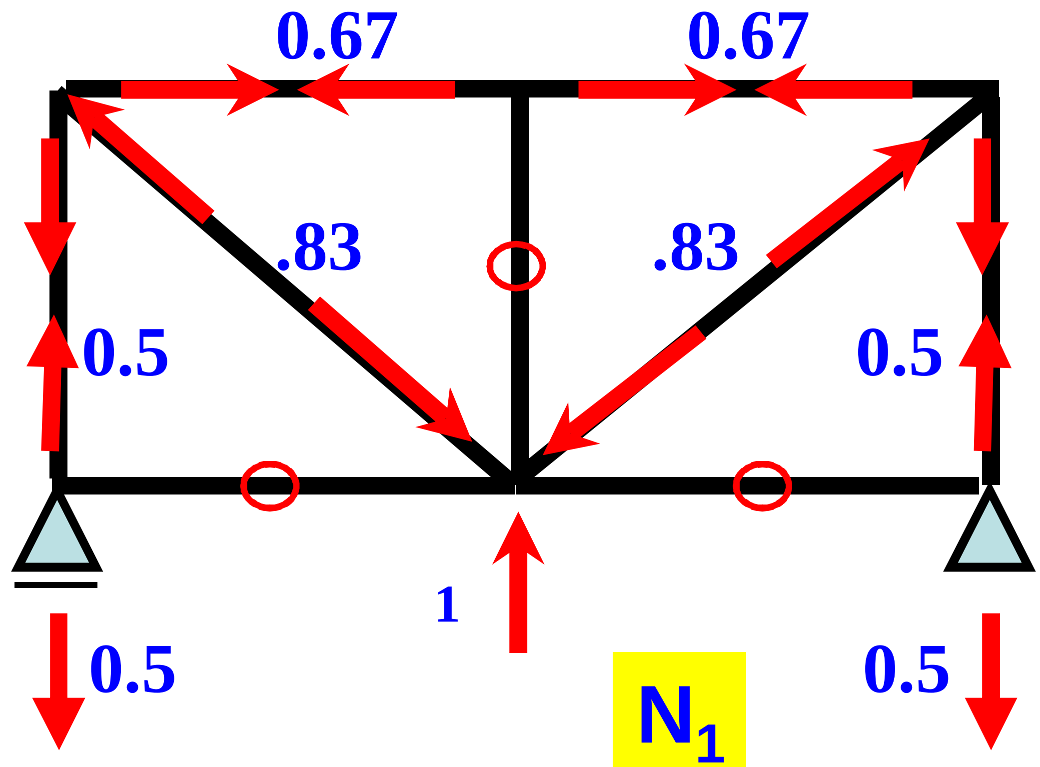
3- drop In Temperature 30^0 In Chord AB2.

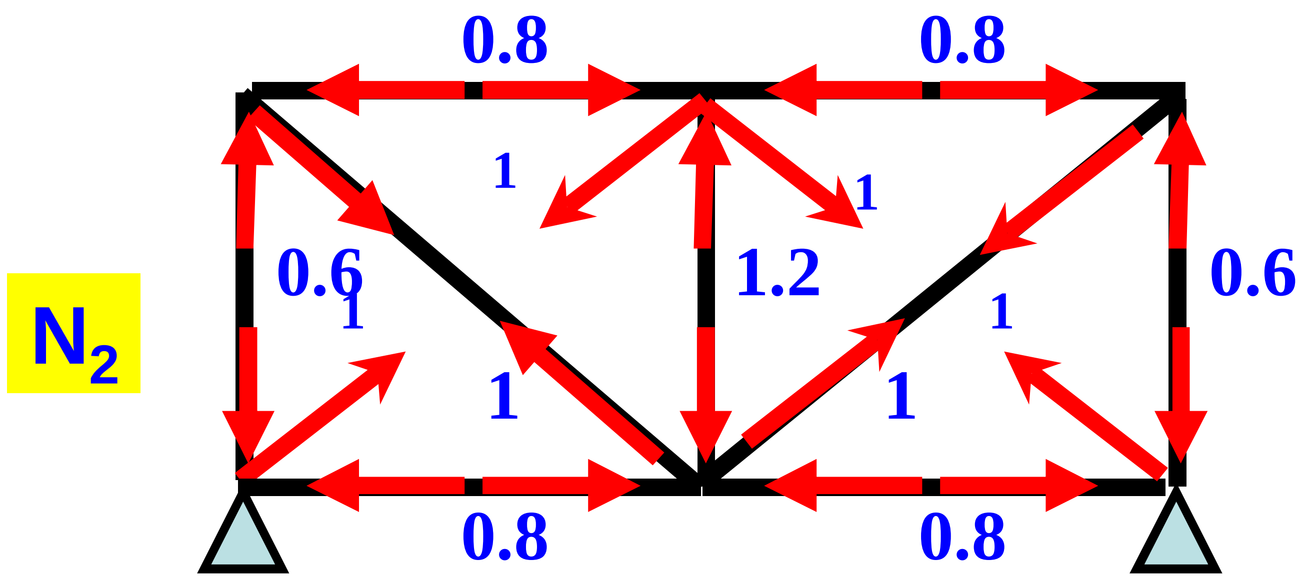
EA=10000 ton $\alpha = 10^{-5}$

main system




3 t
6 t
3 t
4
4
5
5
6
6
6
N0


0.67
0.67
.83
.83
0.5
0.5
1
0.5
0.5
N1


0.8
0.8
1
1
0.6
1
1.2
0.6
1
1
1
1
0.8
0.8
N2

temprature

settelment

Given loads

member	L	N_0	N_1	N_2	$N_0 N_1 L$	$N_0 N_2 L$	$N_1 N_1 L$	$N_2 N_2 L$	$N_2 N_1 L$	$N_1 L$	$N_2 L$	N_F	N_F	N_F
AB	4	0	0	-0.8	0	0	0	2.56	0	0	-3.2			
BC	4	0	0	-0.8	0	0	0	2.56	0	0	-3.2			
1-2	4	-4	0.67	-0.8	-10.67	12.8	1.77	2.56	-2.13	2.67	-3.2			
2-3	4	-4	0.67	-0.8	-10.67	12.8	1.77	2.56	-2.13	2.67	-3.2			
A-1	3	-6	0.5	-0.6	-15	10.8	0.75	1.08	-0.9	1.5	-1.8			
B-2	3	-6	0	-1.2	-15	21.6	0	4.32	0	0	-3.6			
C-3	3	-6	0.5	-0.6	-15	10.8	0.75	1.08	-0.9	1.5	-1.8			
A-2	5	0	0	1	0	0	0	5	0	0	5			
B-3	5	5	-.83	1	-20.83	25	3.47	5	-4.166	-4.15	5			
B-1	5	5	-.83	1	-20.83	25	3.47	5	-4.166	-4.15	5			
C-2	5	0	0	1	0	0	0	5	0	0	5			
$\sum$					-108	118.8	12	36.75	-14.4	0	0			

Case of given loads

$$\delta_{10} = \frac{\sum N_0 N_1 L}{EA} = -\frac{108}{10000} \qquad \delta_{20} = \frac{\sum N_0 N_2 L}{EA} = \frac{118.8}{10000}$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{12}{10000} \qquad \delta_{22} = \frac{\sum N_2 N_2 L}{EA} = \frac{36.75}{10000}$$

$$\delta_{12} = \frac{\sum N_1 N_2 L}{EA} = -\frac{14.4}{10000}$$

$$\delta_{10} + X_1 . \delta_{11} + X_2 . \delta_{12} = 0.0$$

$$\delta_{20} + X_1 . \delta_{21} + X_2 . \delta_{22} = 0.0$$

>> x1=9.66 & x2=0.55

Given loads

$$N_F = N_0 + 9.66 N_1 + 0.55 N_2$$

يتم عمل الحسابات فى الجدول فقط

Case of Temprature

$$\delta_{10} = 10^{-5} * -30 * 0 = 0 \qquad \delta_{20} = 10^{-5} * -30 * 0 = 0$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{12}{10000} \qquad \delta_{22} = \frac{\sum N_2 N_2 L}{EA} = \frac{36.75}{10000}$$

$$\delta_{12} = \frac{\sum N_1 N_2 L}{EA} = -\frac{14.4}{10000}$$

$$\delta_{10} + X_1 . \delta_{11} + X_2 . \delta_{12} = 0.0$$

$$\delta_{20} + X_1 . \delta_{21} + X_2 . \delta_{22} = 0.0$$

>> x1=0 & x2=0

Temprature

$$N_F = 0$$

يتم عمل الحسابات فى الجدول فقط

Case of settelment

$$\delta_{10} = 0.0 \qquad \delta_{20} = 0.0$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{12}{10000} \qquad \delta_{22} = \frac{\sum N_2 N_2 L}{EA} = \frac{36.75}{10000}$$

$$\delta_{12} = \frac{\sum N_1 N_2 L}{EA} = -\frac{14.4}{10000}$$

$$\delta_{10} + X_1 . \delta_{11} + X_2 . \delta_{12} = -0.015$$

$$\delta_{20} + X_1 . \delta_{21} + X_2 . \delta_{22} = 0.0$$

>> x1=-23.6 & x2=-9.25

Temprature

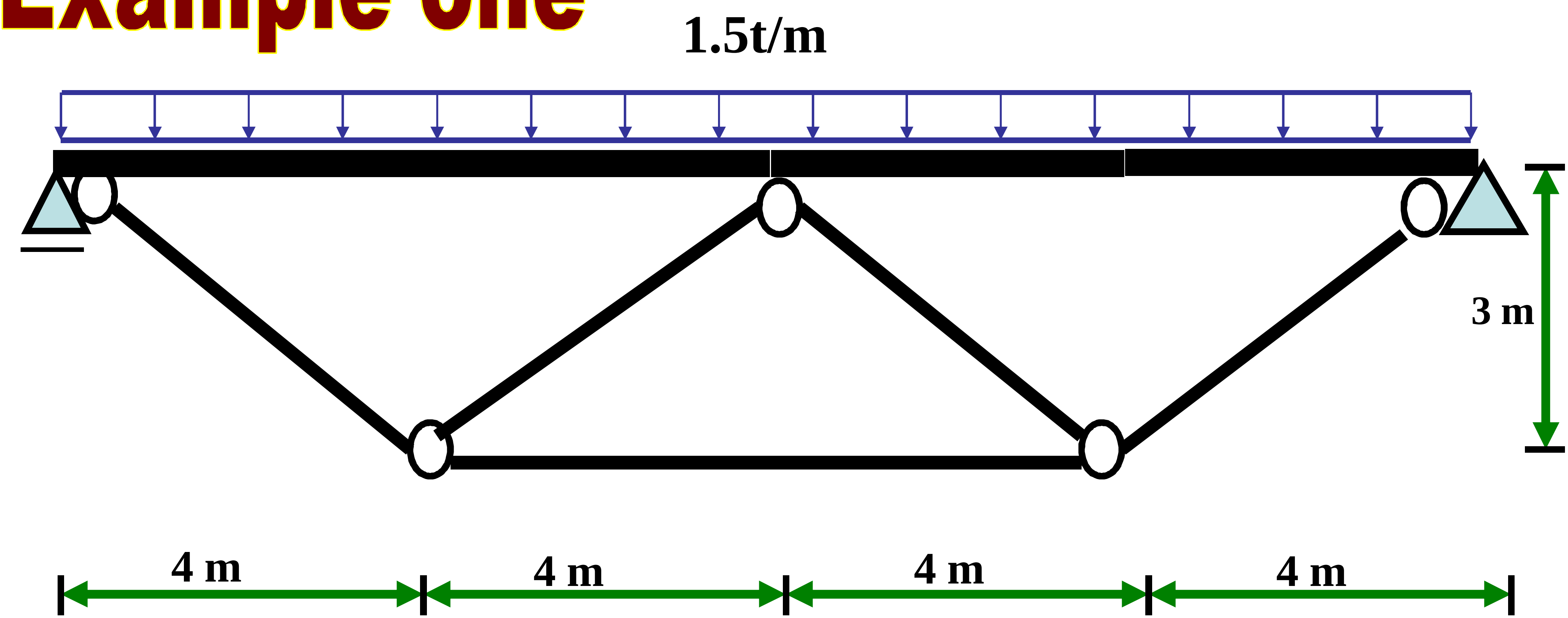
$$N_F = N_0 - 23.6 N_1 - 9.25 N_2$$

يتم عمل الحسابات فى الجدول فقط

Consistant Deformation

Trussed beam

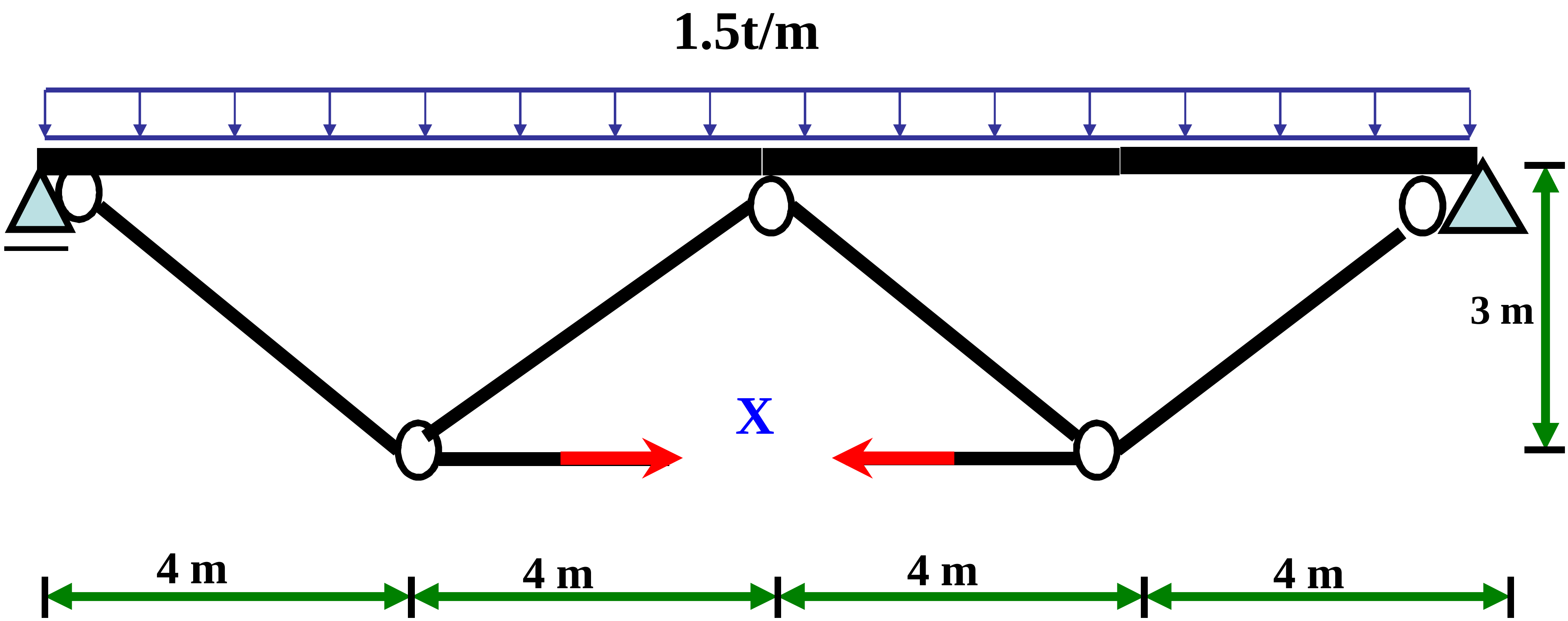
Example one

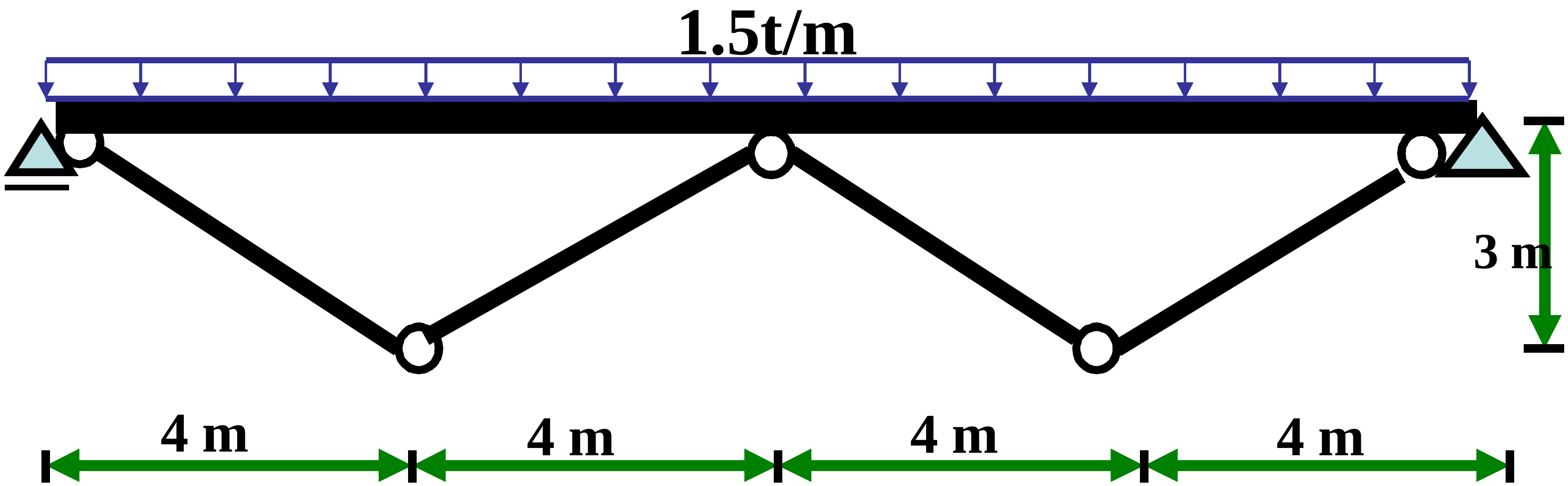


For the shown truss determine find the forces in all members due to:

EI_{beam}=6000 ton EA_{beam}=2400 ton EA_{link}=4000 ton

main system

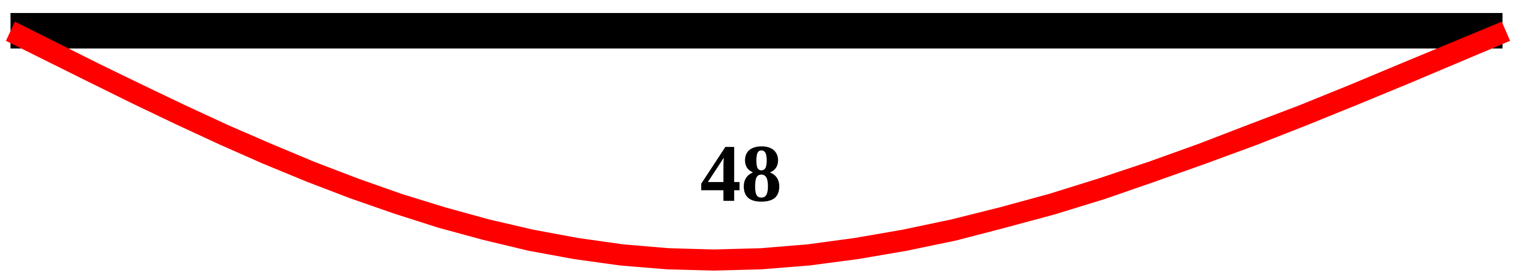


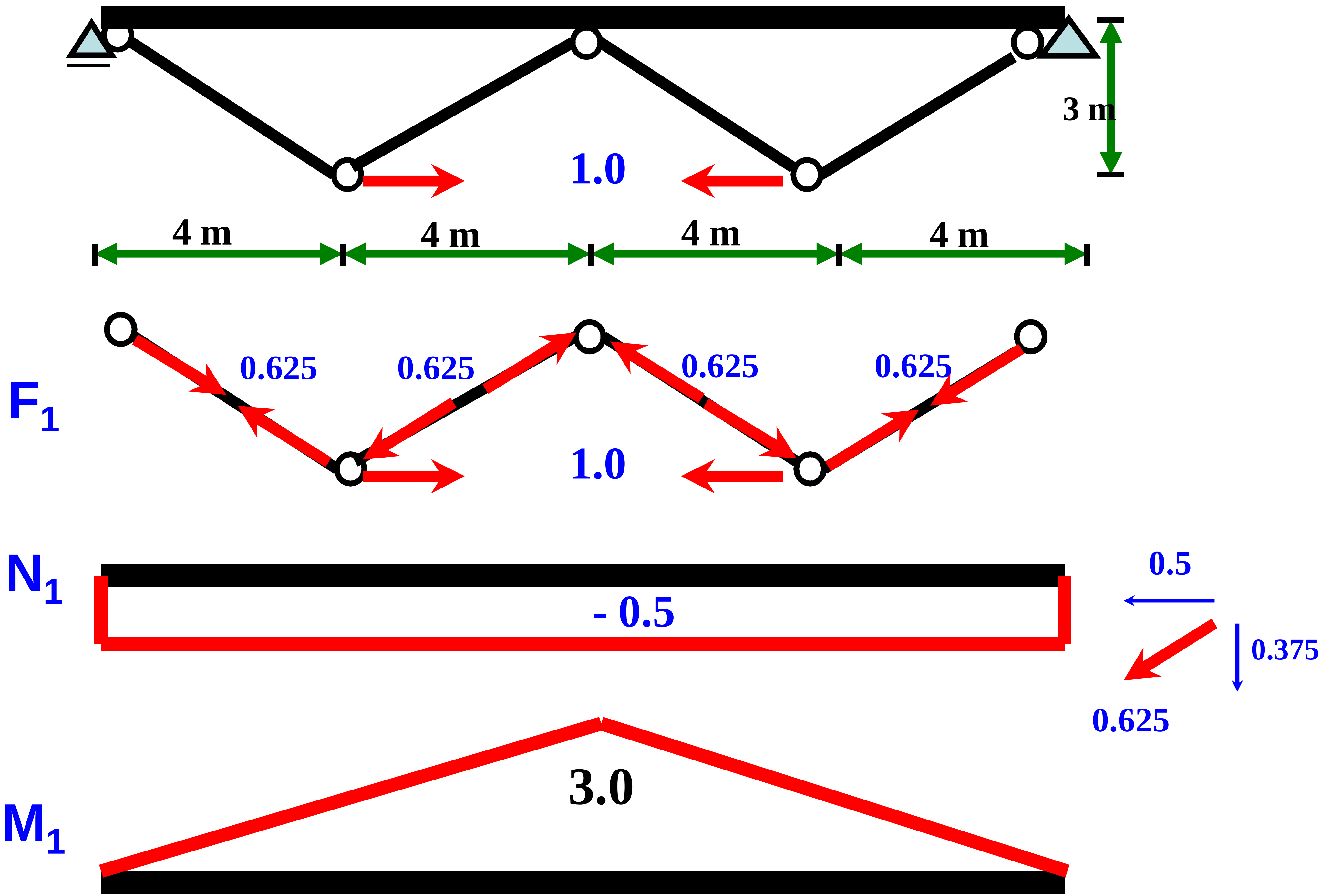


F_0

N_0

M_0





3 m
1.0
4 m
4 m
4 m
4 m
F_1
0.625
0.625
0.625
0.625
1.0
N_1
0.5
- 0.5
0.375
0.625
M_1
3.0

Case of given loads

$$\delta_{10} = \int \frac{M0M1}{EI} + \frac{\sum N_0 N_1 L}{EA} + \frac{\sum F_0 F_1 L}{EA}$$

$$= \frac{1}{6000}\left[-\frac{2}{3} * 48 * 8 * 5/8 * 3 * 2\right] + 0.0 + 0.0 = -0.16$$

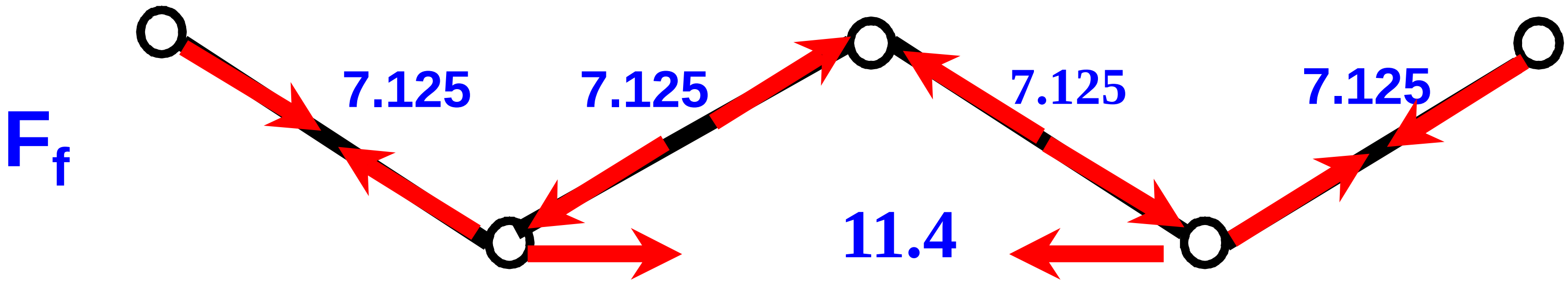
$$\delta_{11} = \int \frac{M_1 M_1}{EI} + \frac{\sum N_1 N_1 L}{EA} + \frac{\sum F_1 F_1 L}{EA}$$

$$= \frac{1}{6000}\left[\frac{3*3*8}{3} * 2\right] + \frac{1}{2400}\left[0.5 * 0.5 * 16\right] + \frac{1}{4000}\left[0.625^2 * 5 * 4 + 1 * 8\right] = 0.0136$$

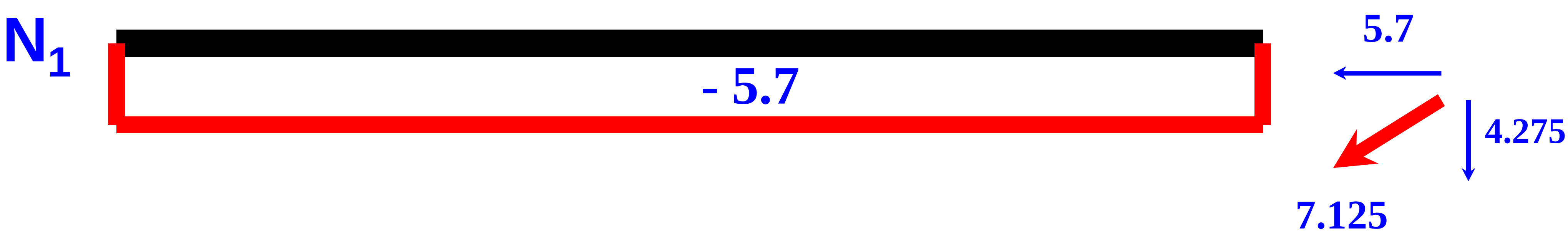
$$\delta_{10} + X \, . \, \delta_{11} = 0.0$$

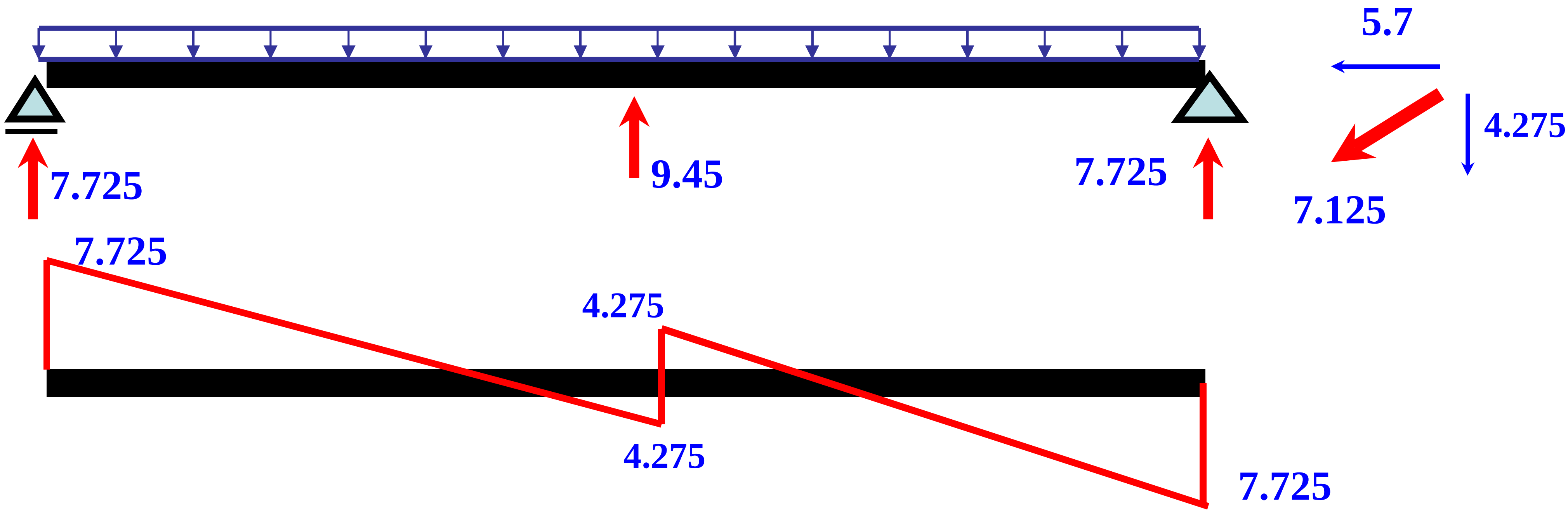
$$-0.16 + X * 0.0136 = 0.0 \quad >> \quad X \quad = 11.74 \; ton$$

$$F_F = F_0 + 11.4F_1 = 0 + 11.4F_1 = 11.4F_1$$

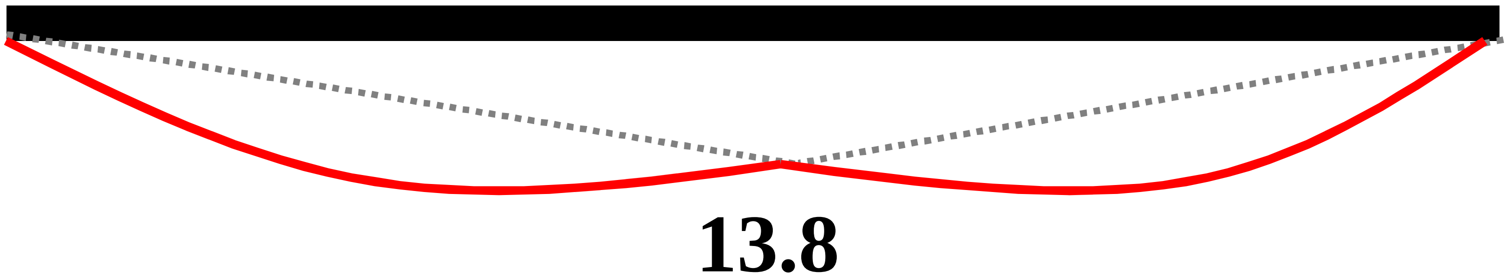


$$N_F = N_0 + 11.4N_1 = 0 + 11.4N_1 = 11.4N_1$$





$$M_F = M_0 + 11.4M_1$$

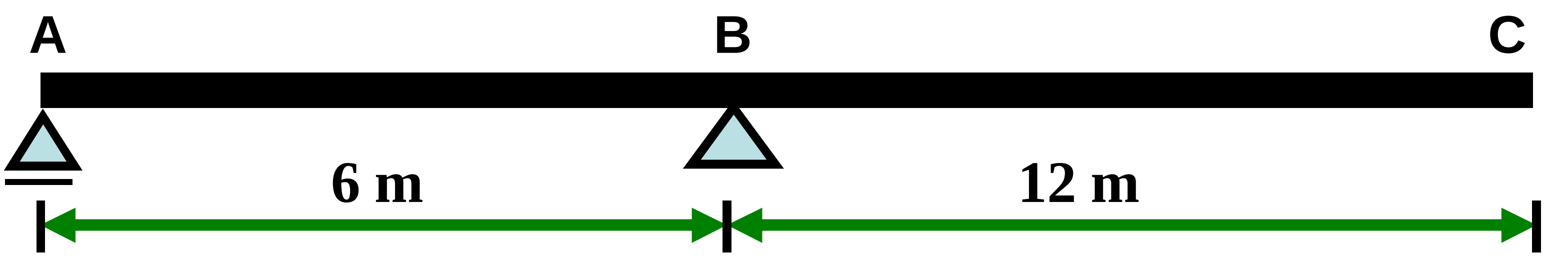


Consistant Deformation

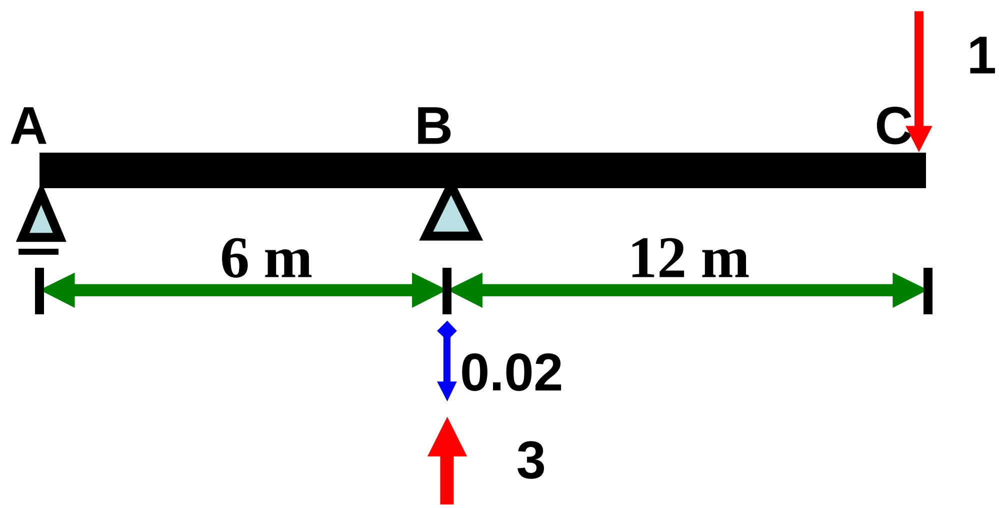
Forced deformation

Forced deformation

virtual work بطريقة الـ main system هى تحويل الهبوط المعطى الى المكان المأخوذ فى الـ



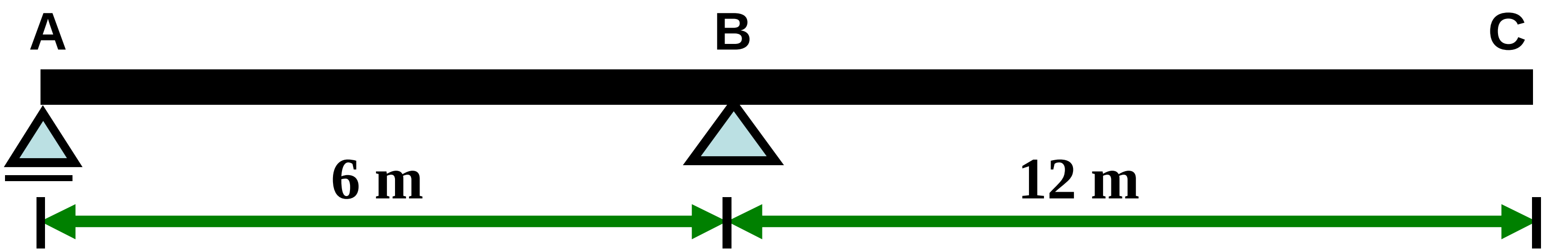
Given settlement at b =2cm



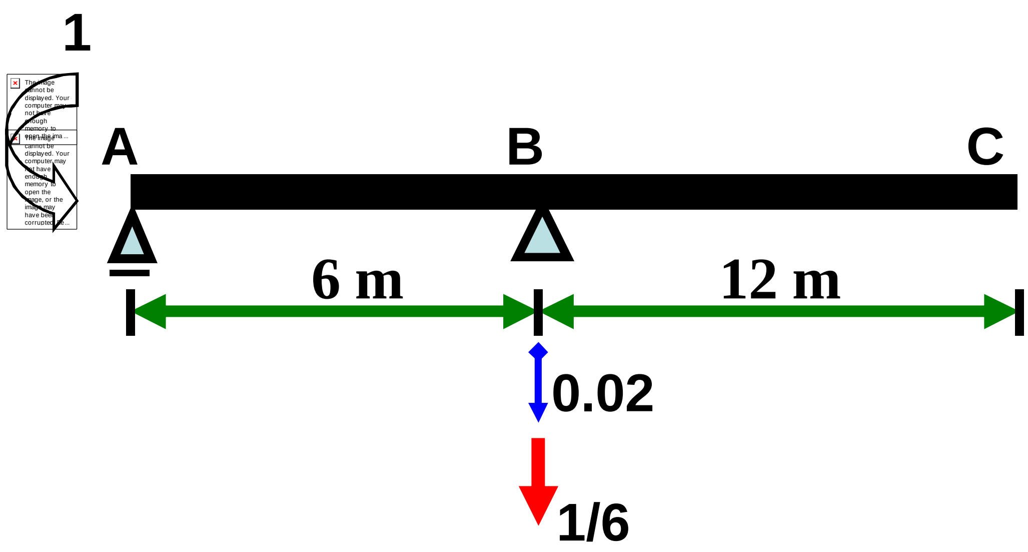
Required deflection at C

$$\Delta c * 1 - 3 * 0.02 = 0.0$$

$$\Delta c = 0.06$$



Given settlement at b =2cm

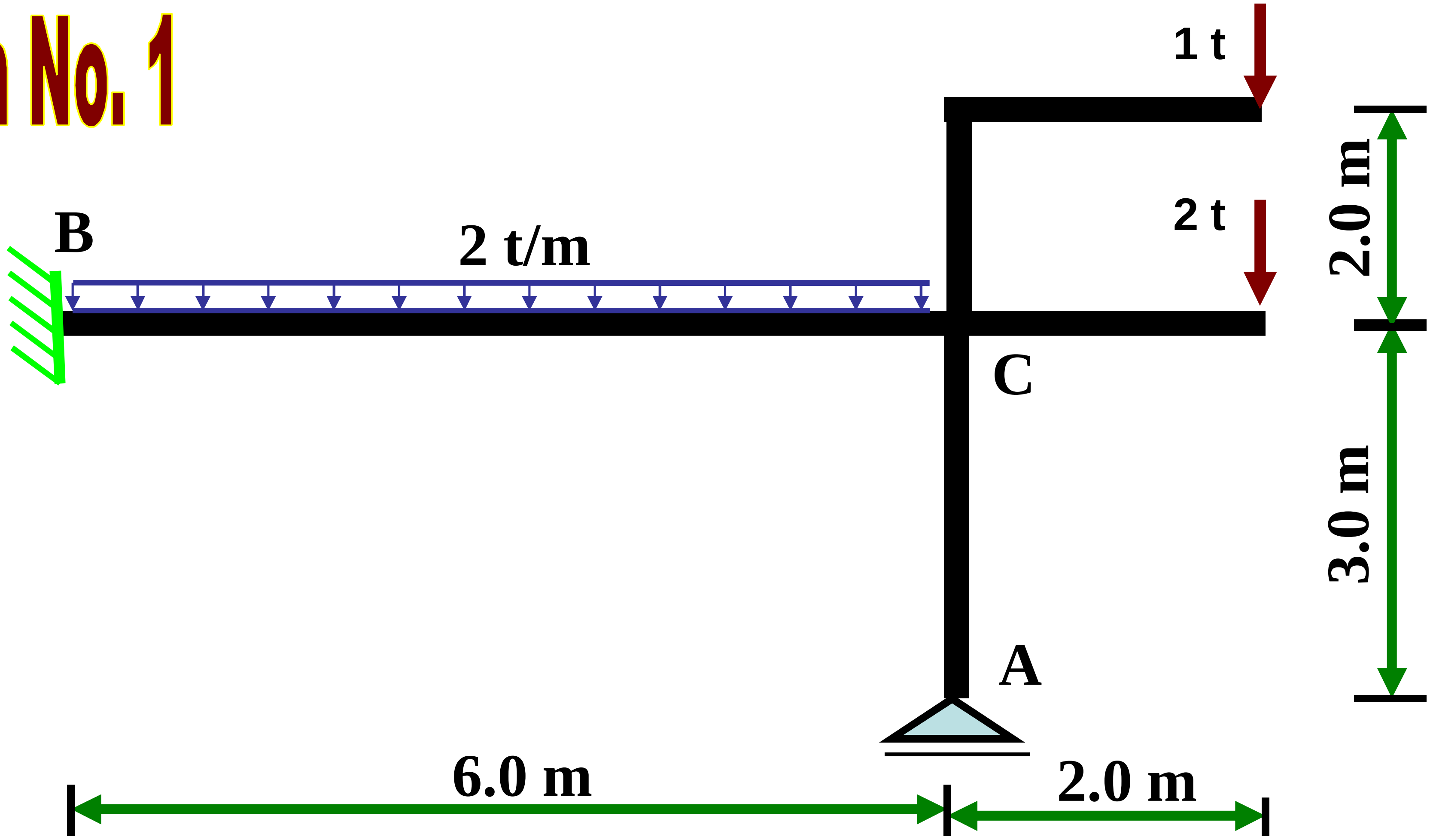


Required slope at A

$$\theta_A * 1 - 1/6 * 0.02 = 0.0$$

$$\theta_A = 0.0033$$

Problem No. 1

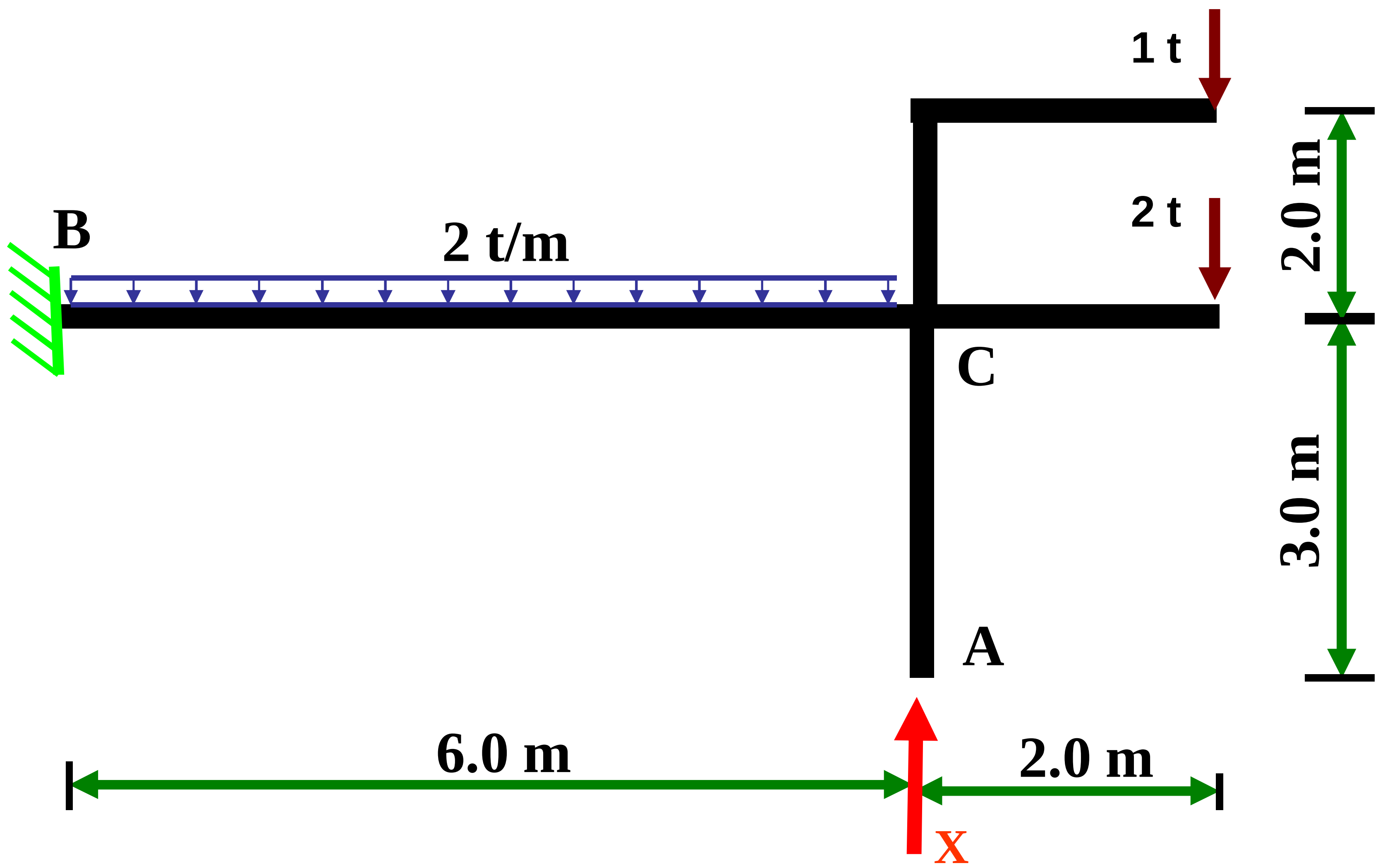


Draw B.M.D , S.F.D, and N.F.D   EI = 6000 t.m2

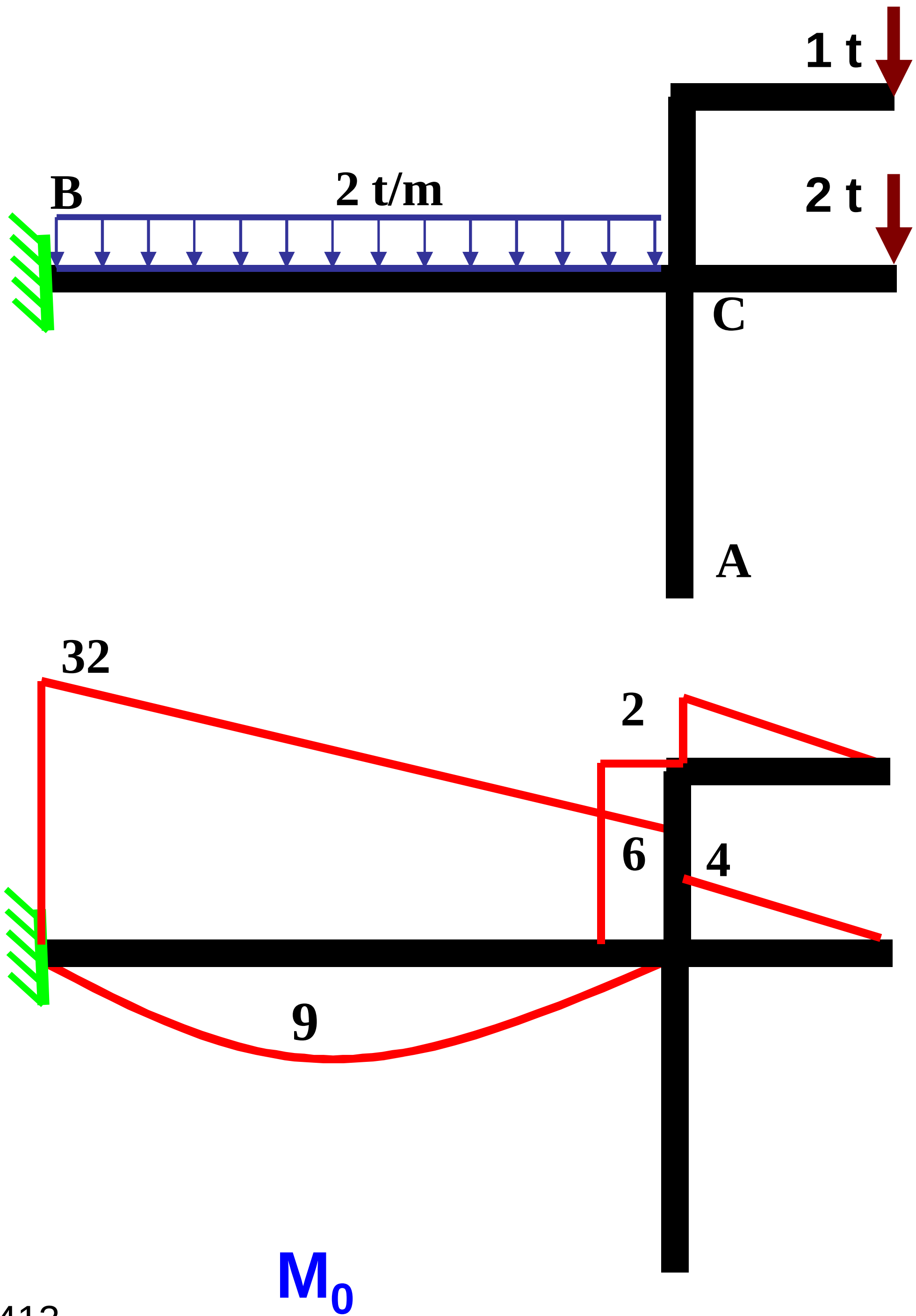
Due to   (1) given loads.

(2) rotation at B = 0.003 rad clockwise.

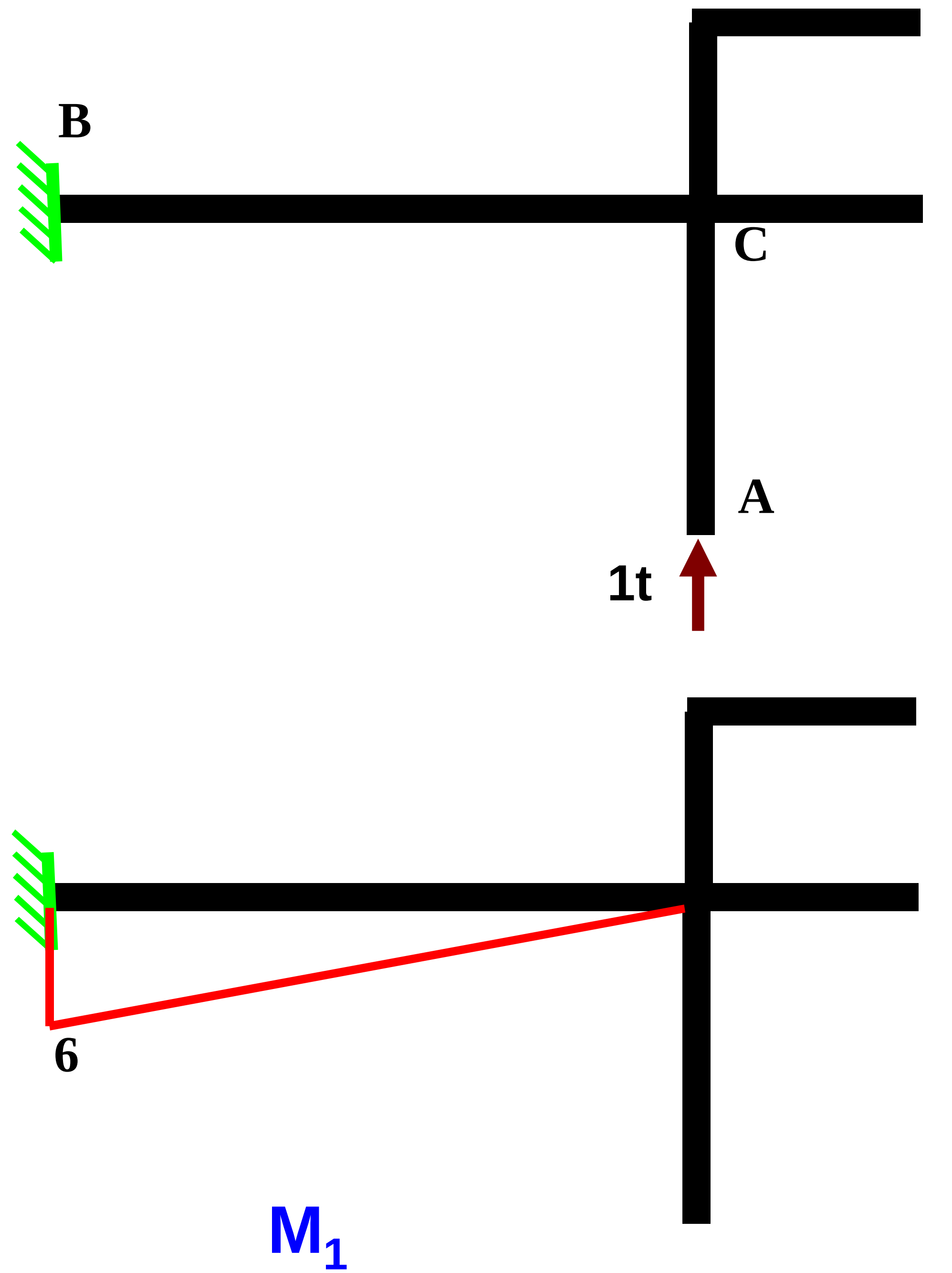
Main System



2- draw (M0) [loads + X=0]



3- draw (M1) [no loads + X=1]



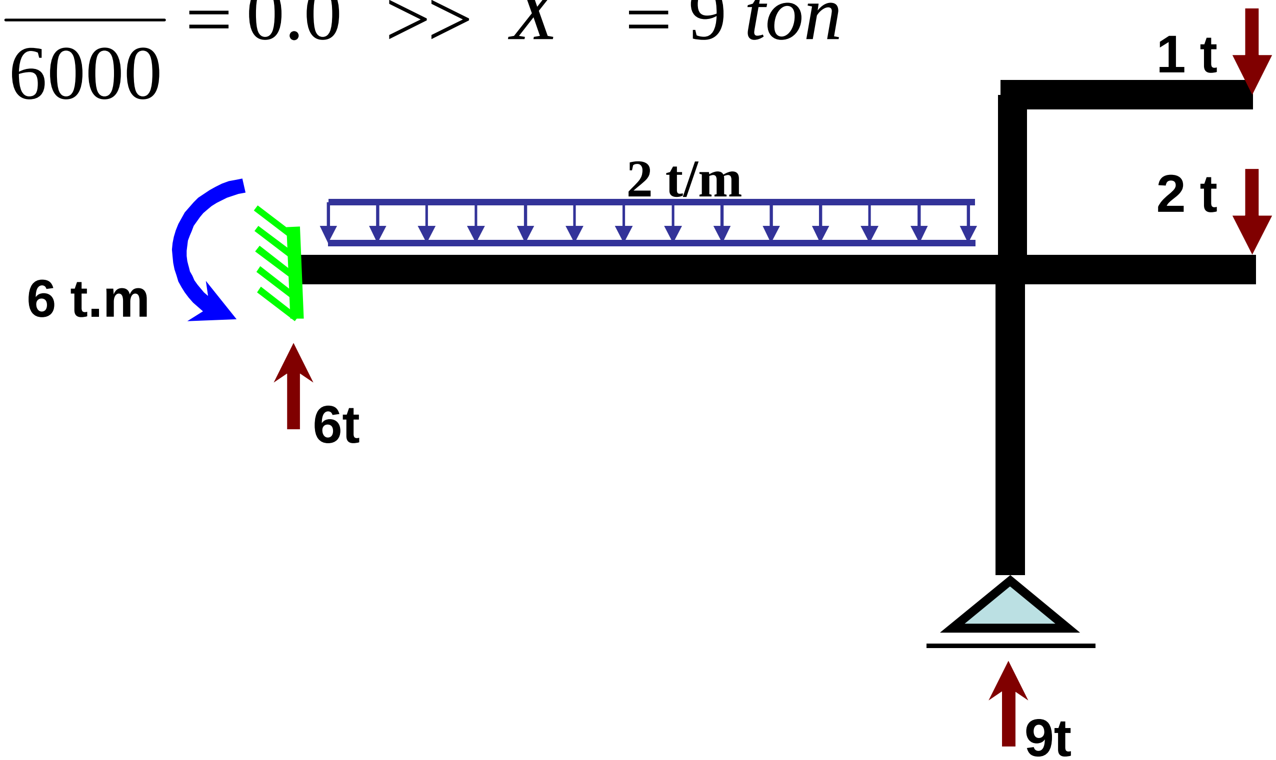
Case of given loads

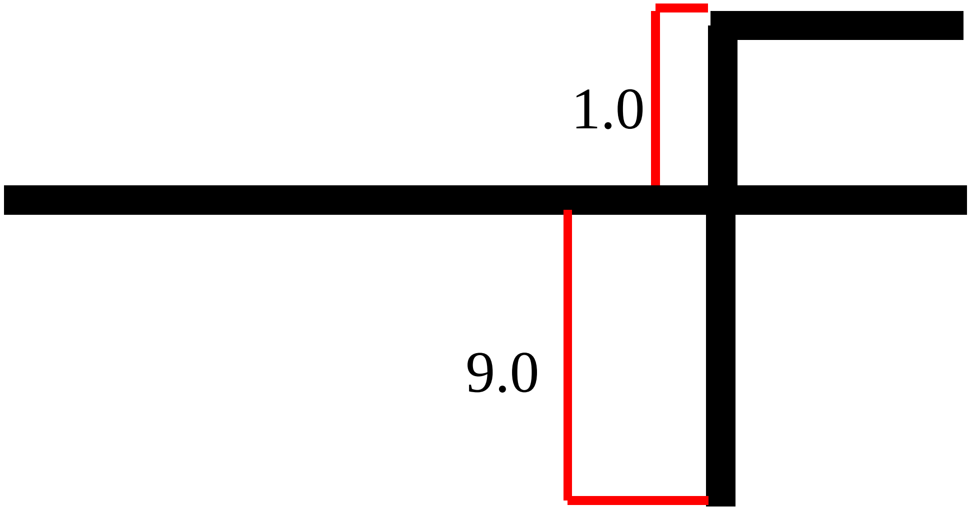
$$\delta_{10} = \frac{1}{6000}\left[-\frac{6}{3}*(6*60+0.5*(6*6))+2/3*9*6*3 \right] = -\frac{648}{6000}$$

$$\delta_{11} = \frac{1}{6000}\left[\frac{6*6*6}{3} \right] = \frac{72}{6000}\, m$$

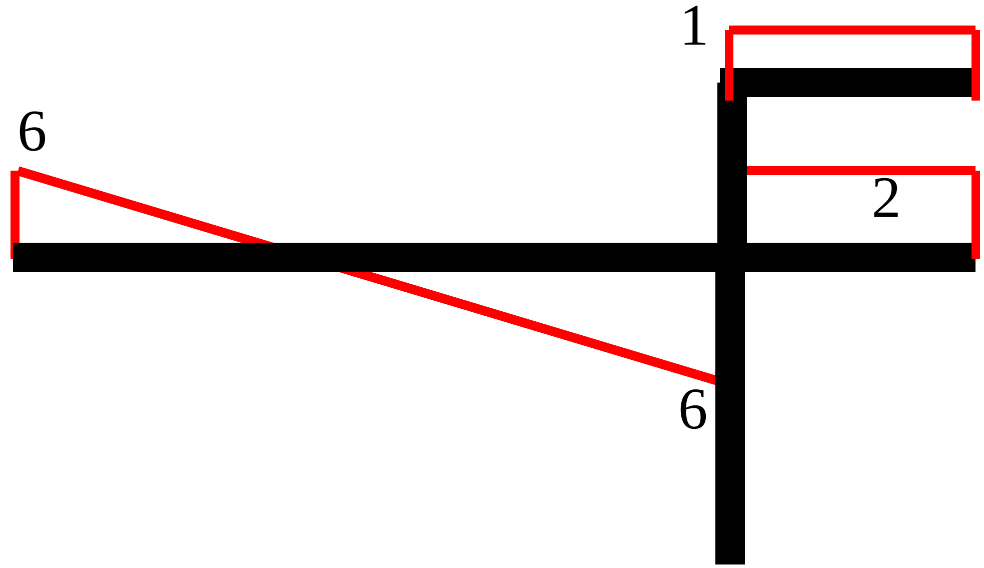
$$\delta_{10} + X\,.\,\delta_{11} = 0.0$$

$$-\frac{648}{6000} + X * \frac{72}{6000} = 0.0 \;\; >> \;\; X \;\; = 9\ ton$$

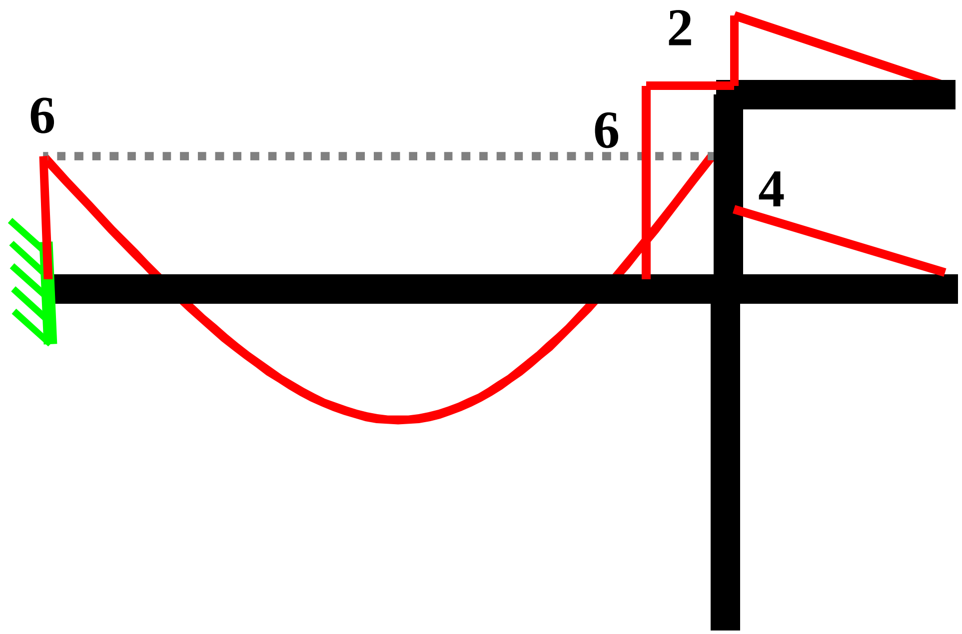




N.F.D

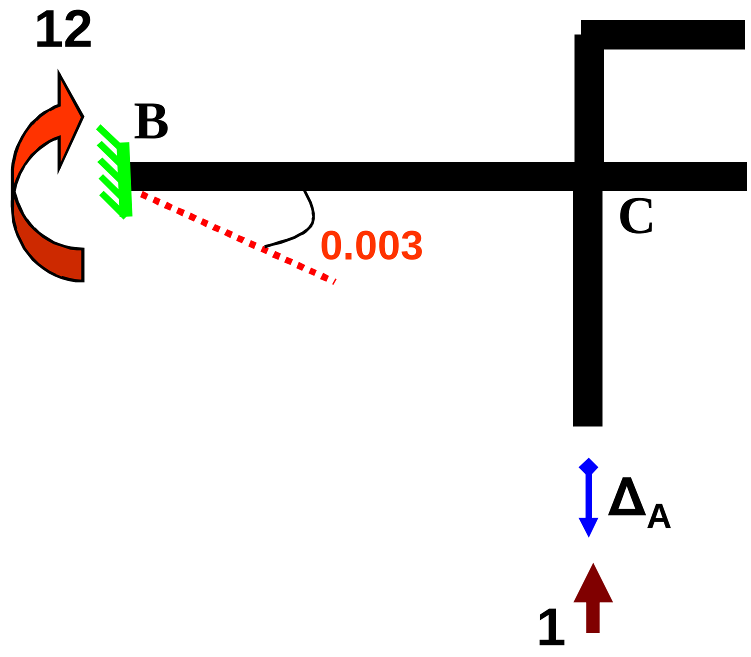


S.F.D



B.M.D

Case of Settelment



$$\delta_{10} = 0.0$$

$$\delta_{11} = \frac{72}{6000}\, m$$

$$\delta_{10} + X \,.\, \delta_{11} = \Delta_A$$

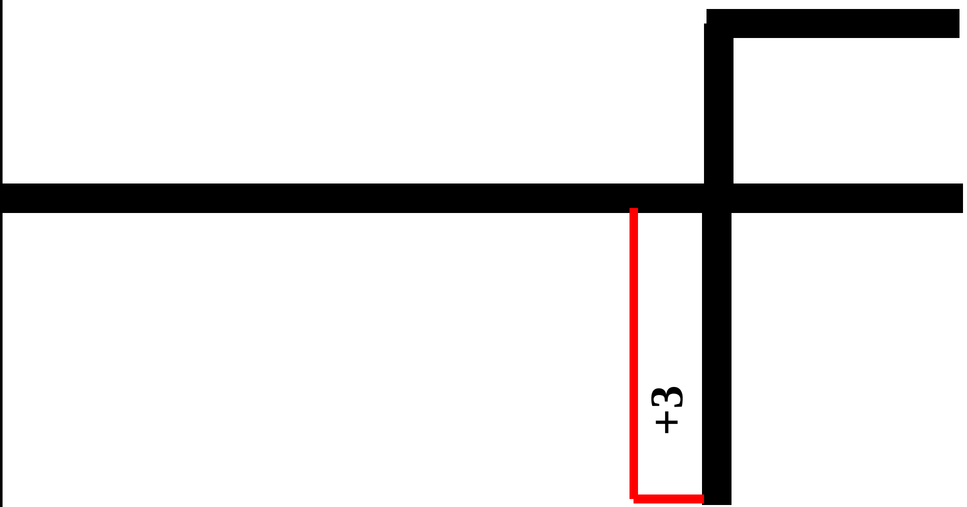
لاحظ ان المعطى هو θB والموجود فى المعادلة ΔA
فيتم نقل الدوران عند B الى هبوط عند ِ Aبطريقة الـvirtual work

$0.003 * 12 + 1 * \Delta_A = 0.0$

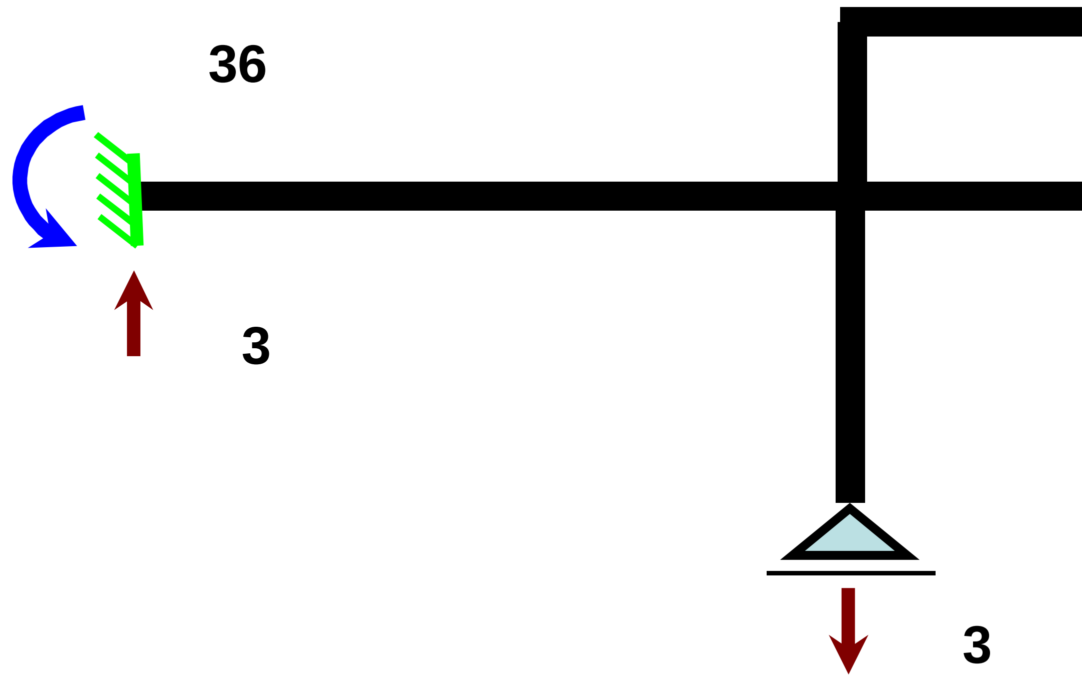
$\Delta_A = -0.036$

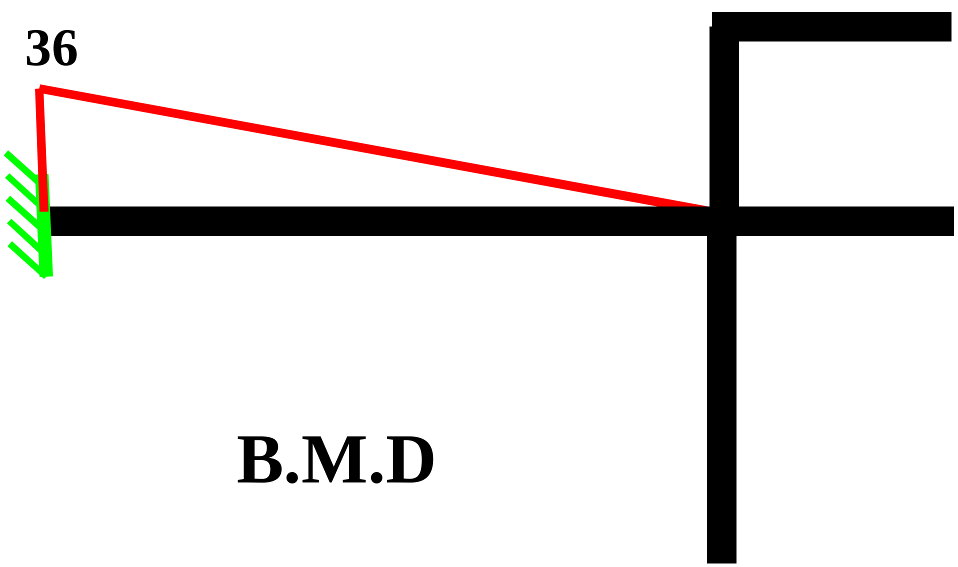
$$0.0 + X \,.\, \frac{72}{6000} = -0.036$$

$$X \,.\, \frac{72}{6000} = -3 \;\; ton$$

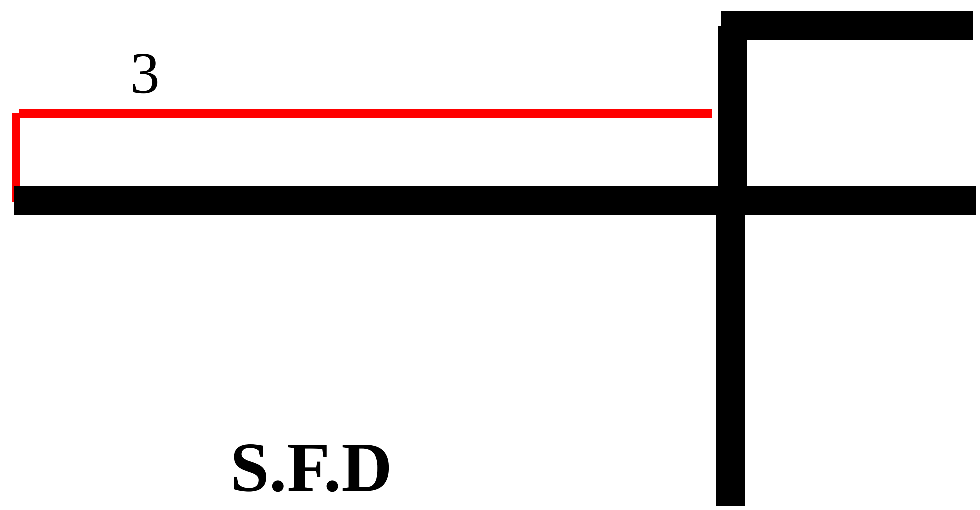


N.F.D



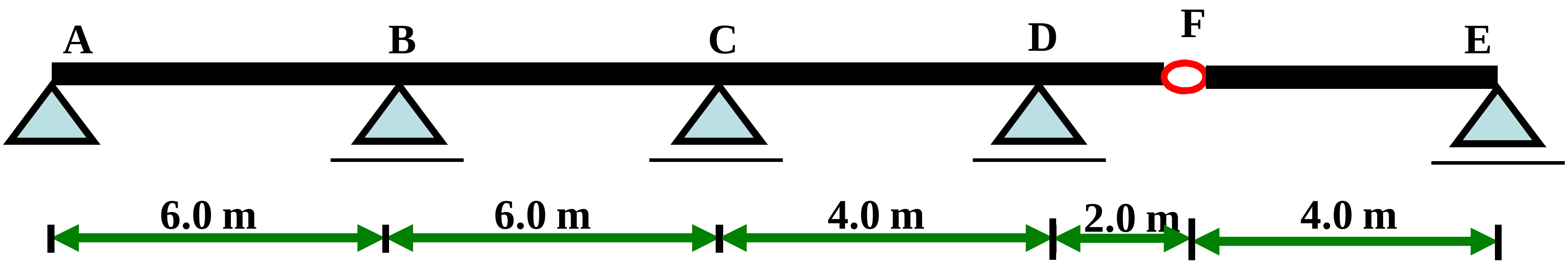


B.M.D



S.F.D

Problem No. 1



Draw B.M.D , S.F.D, and N.F.D   EI = 5000 t.m^2

Due to (1) settlement at A 2.5 cm .
(2) settlement at B 1.0 cm .
(3) settlement at C 1.5 cm .
(4) settlement at E 3.0 cm .

Main System

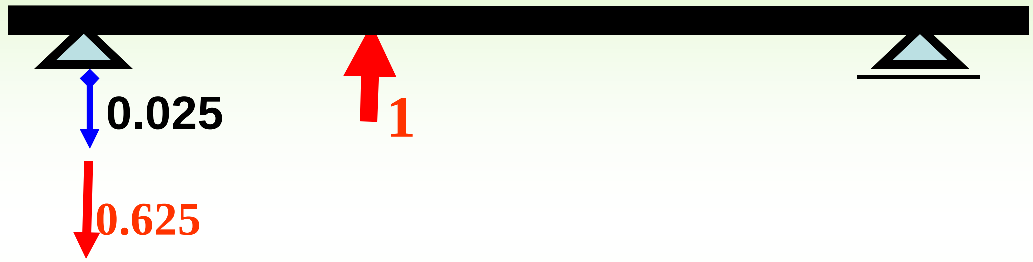
الجزء الـ determinate لا يتأثر
بالهبوط وبالتالى يتم حذف الهبوط عند E

Direct settelment

$\Delta B= - 1.0$ cm
$\Delta C= - 1.5$ cm

Forced deformation settelment

نقل الهبوط عند A الى B, C



$0.625*0.025+1* \Delta B=0$

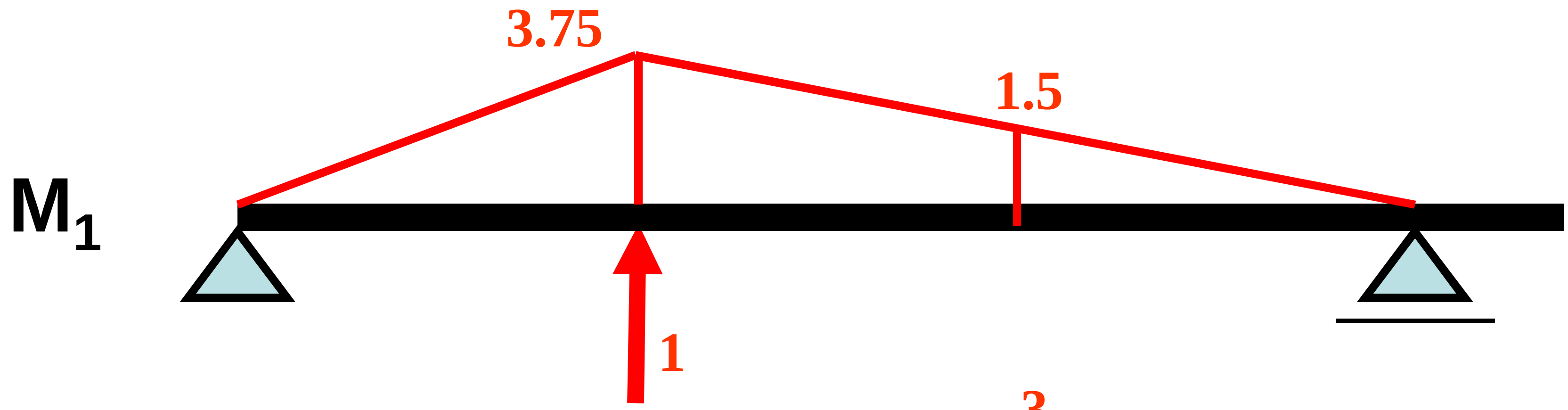
$\Delta B= - 0.0156$

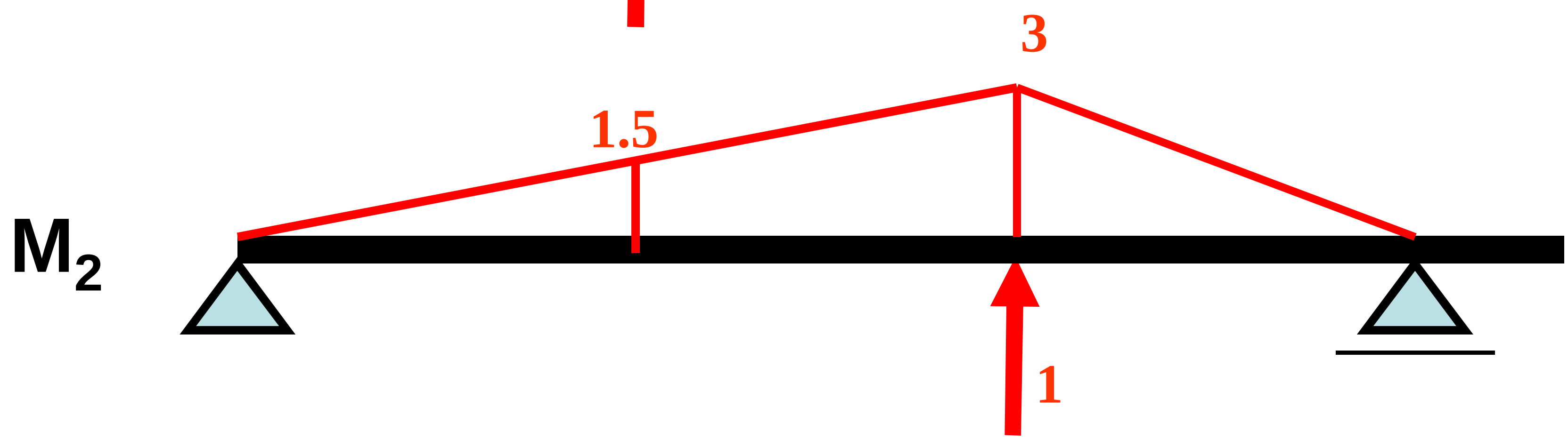
$0.25*0.025+1* \Delta C=0$

$\Delta C= - 0.00625$

$$\Delta B = -0.01 - 0.0156 = - 0.0256 \text{ m}$$

$$\Delta C = -0.015 - 0.00625 = - 0.02125 \text{ m}$$





$$\delta_{12} = \frac{1}{5000}\left[\frac{3.75*1.5*6}{3}+\frac{3.0*1.5*4}{3}+\frac{6}{3}[1.5*3.75+3*1.5+0.5*[1.5*1.5+3*3.75]]\right]$$

$$= 0.0102 \quad m$$

$$\delta_{11} = \frac{1}{5000}[3.75*3.75*6/3+3.75*3.75*10/3]= 0.015 \ m$$

$$\delta_{22} = \frac{1}{5000}\left[\frac{3*3*12}{3}+\frac{3*3*4}{3}\right]= 0.0096 \quad m$$

$$\delta_{10} + X_1 . \delta_{11} + + X_2 . \delta_{12} = \Delta_B$$

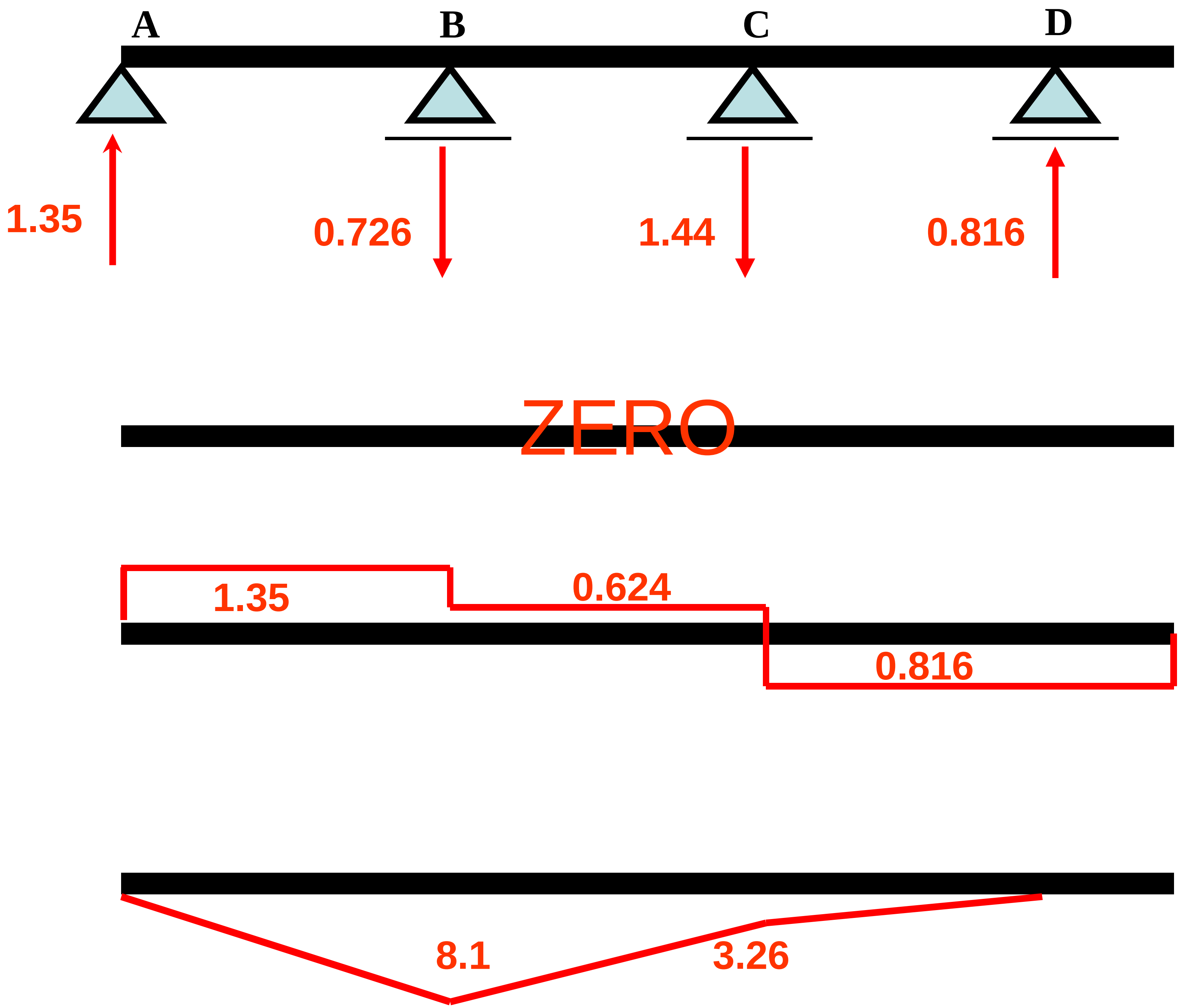
$$\delta_{20} + X_1 . \delta_{21} + + X_2 . \delta_{22} = \Delta_C$$

$$0.0 + X_1 * 0.015 + X_2 . 0.0102 = -0.0256$$

$$0.0 + X_1 . 0.0102 + X_2 . 0.0096 = -0.02125$$

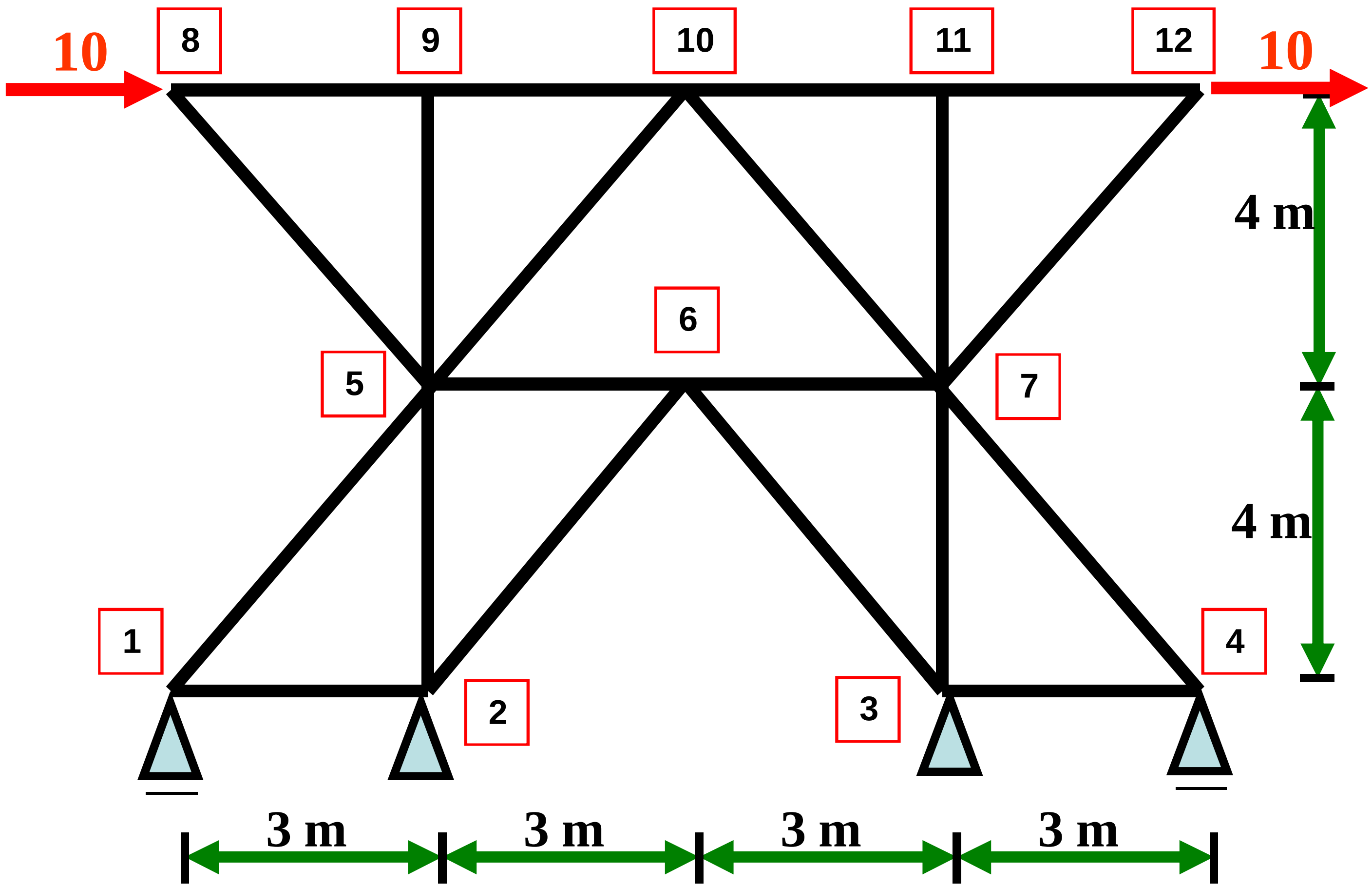
X1 = -0.726

X2 = -1.44


A
B
C
D
1.35
0.726
1.44
0.816
ZERO
1.35
0.624
0.816
8.1
3.26

Examples

Examples one



For the shown truss determine find the forces in all members due to:

1- Given Load.

3- drop In Temperature 30^0 in member 8 — 12 .

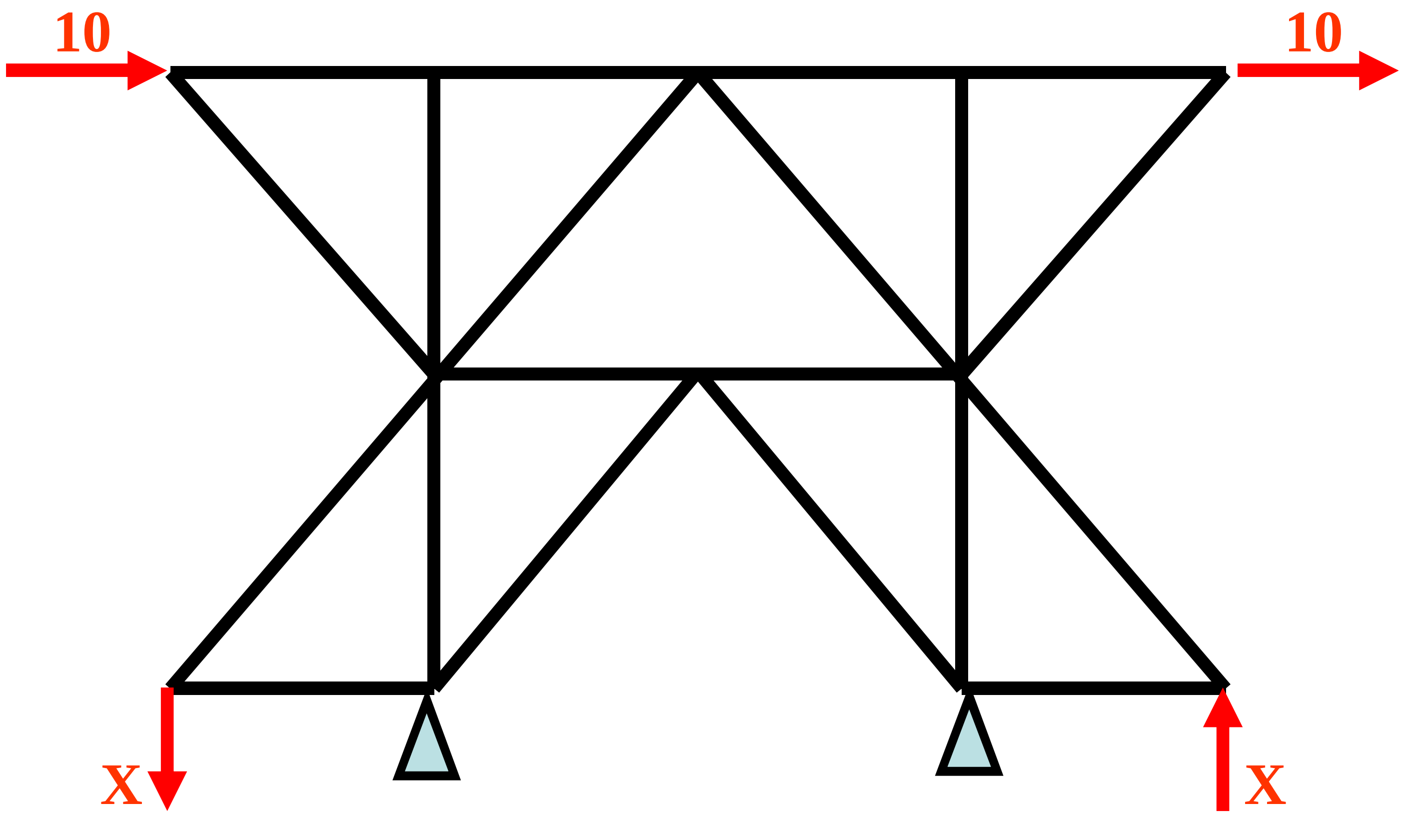
EA=10000 ton $\alpha = 10^{-5}$

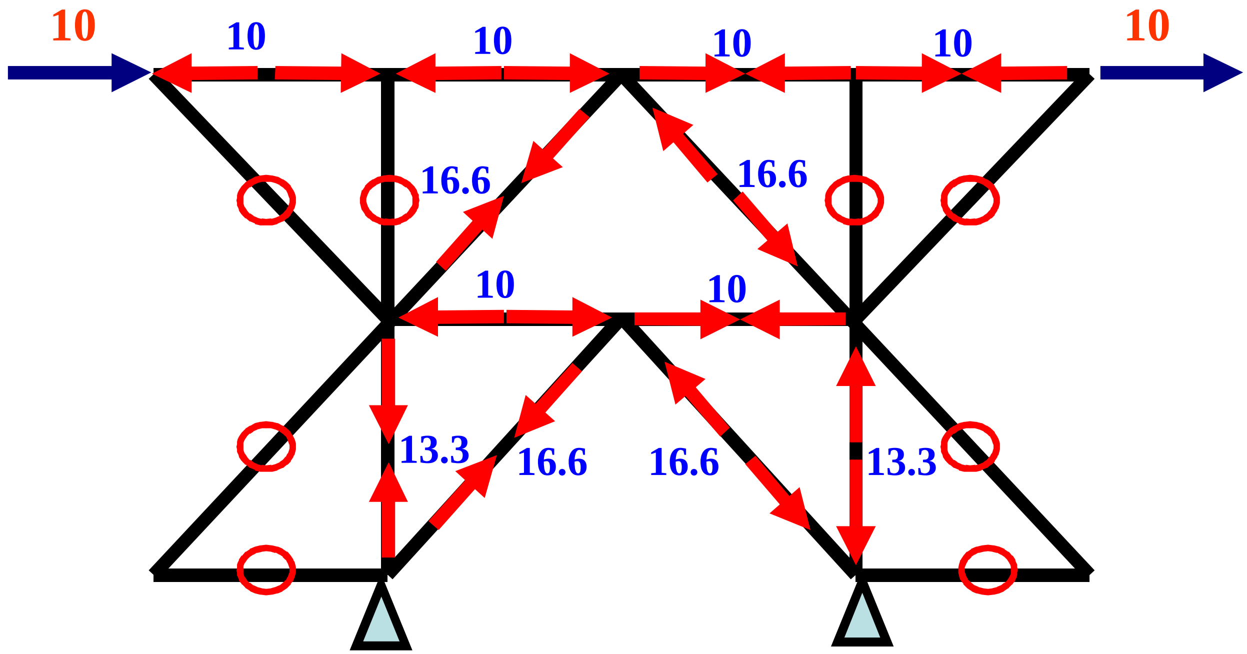
b= 20 , J= 12 , r = 6

b + r = 26 unknowns

2 j = 24 equations

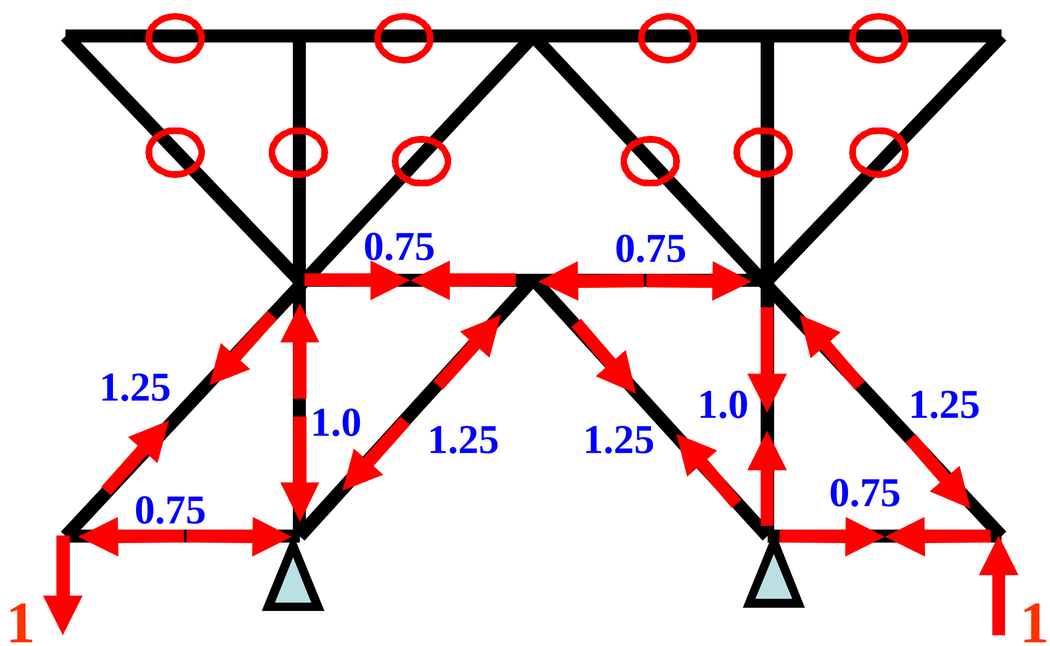
عدد المجاهيل الزياده 2 وبسبب التماثل العكسى يتم فرضه مجهول واحد





10
10
10
10
10
10
16.6
16.6
10
10
13.3
16.6
16.6
13.3

N_0



0.75
0.75
1.25
1.0
1.25
1.25
1.0
1.25
0.75
0.75
1
1

N_1

temperature

Given loads

member	L	N_0	N_1		$N_0 N_1 L$	$N_1 N_1 L$	$N_1 L$	N_F	N_F
1-2	3	0	-0.75		0	1.6875	-2.25		0
3-4	3	0	0.75		0	1.6875	2.25		0
5-6	3	-10	0.75		-22.5	1.6875	2.25		0
6-7	3	10	- 0.75		-22.5	1.6875	- 2.25		0
8-9	3	-10	0		0	0	0		0
9-10	3	-10	0		0	0	0		0
10-11	3	10	0		0	0	0		0
11-12	3	10	0		0	0	0		0
2-5	4	13.3	-1		-53.2	4	-4		0
5-9	4	0	0		0	0	0		0
3-7	4	-13.3	1		-53.2	4	4		0
7-11	4	0	0		0	0	0		0
1-5	5	0	1.25		0	7.8125	6.25		0
2-6	5	16.6	-1.25		-104.16	7.8125	-6.25		0
3-6	5	-16.6	1.25		-104.16	7.8125	6.25		0
4-7	5	0	-1.25		0	7.8125	-6.25		0
5-8	5	0	0		0	0	0		0
5-10	5	16.6	0		0	0	0		0
7-10	5	-16.6	0		0	0	0		0
7-12	5	0	0		0	0	0		0
428 ∑					-359.72	46	0		

Case of given loads

$$\delta_{10} = \frac{\sum N_0 N_1 L}{EA} = -\frac{359.72}{10000}$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{49}{10000}$$

$$\delta_{10} + X \,.\, \delta_{11} = 0.0$$

$$-\frac{359.72}{10000} + X * \frac{49}{10000} = 0.0 \quad >> \quad X = 7.35\, ton$$

Given loads

$$N_F = N_0 + 7.35 * N_1$$

يتم عمل الحسابات فى الجدول فقط

Case of Temprature

$$\delta_{10} = \alpha.\Delta t.\sum(N1.L) = 0.0$$

$$\delta_{11} = \frac{\sum N_1 N_1 L}{EA} = \frac{49}{10000}$$

$$\delta_{10} + X.\delta_{11} = 0.0$$

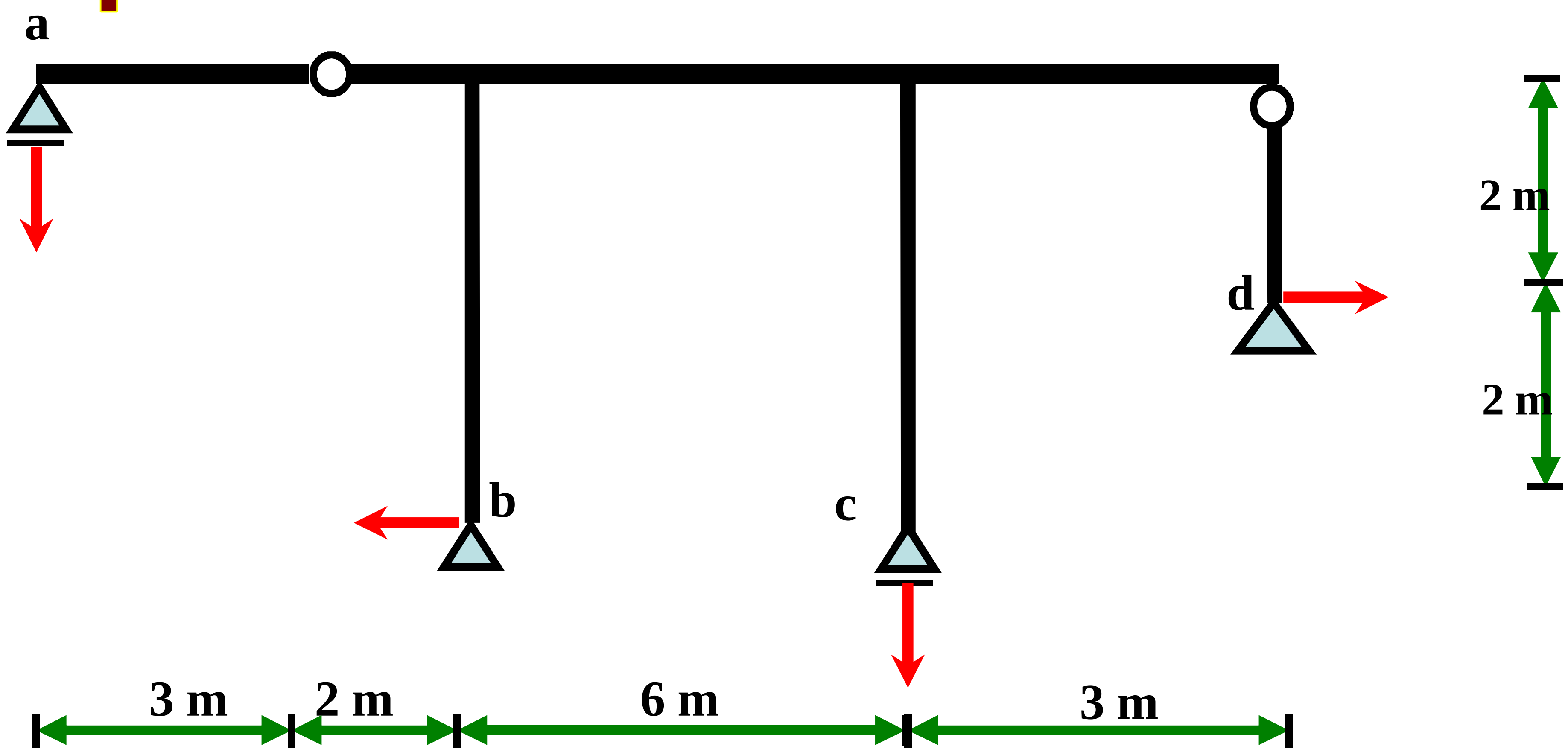
$$0 + F * \frac{36.72}{40000} = 0.0 \quad >> \quad F = 0$$

Temprature

$$N_F = F * N_1 = 0$$

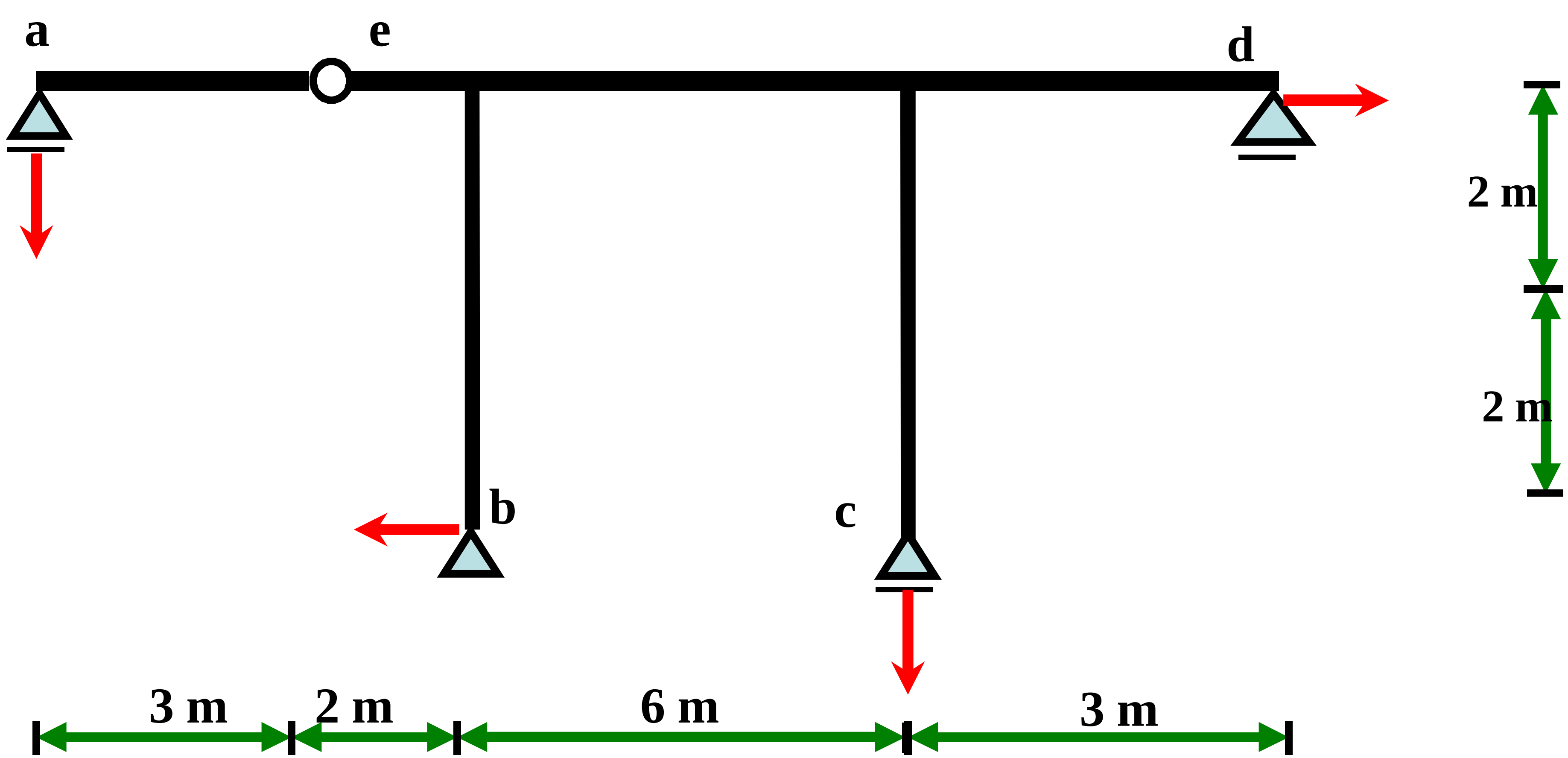
يتم عمل الحسابات فى الجدول فقط

Examples two



Draw B.M.D , S.F.D, and N.F.D EI = 6000 t.m2

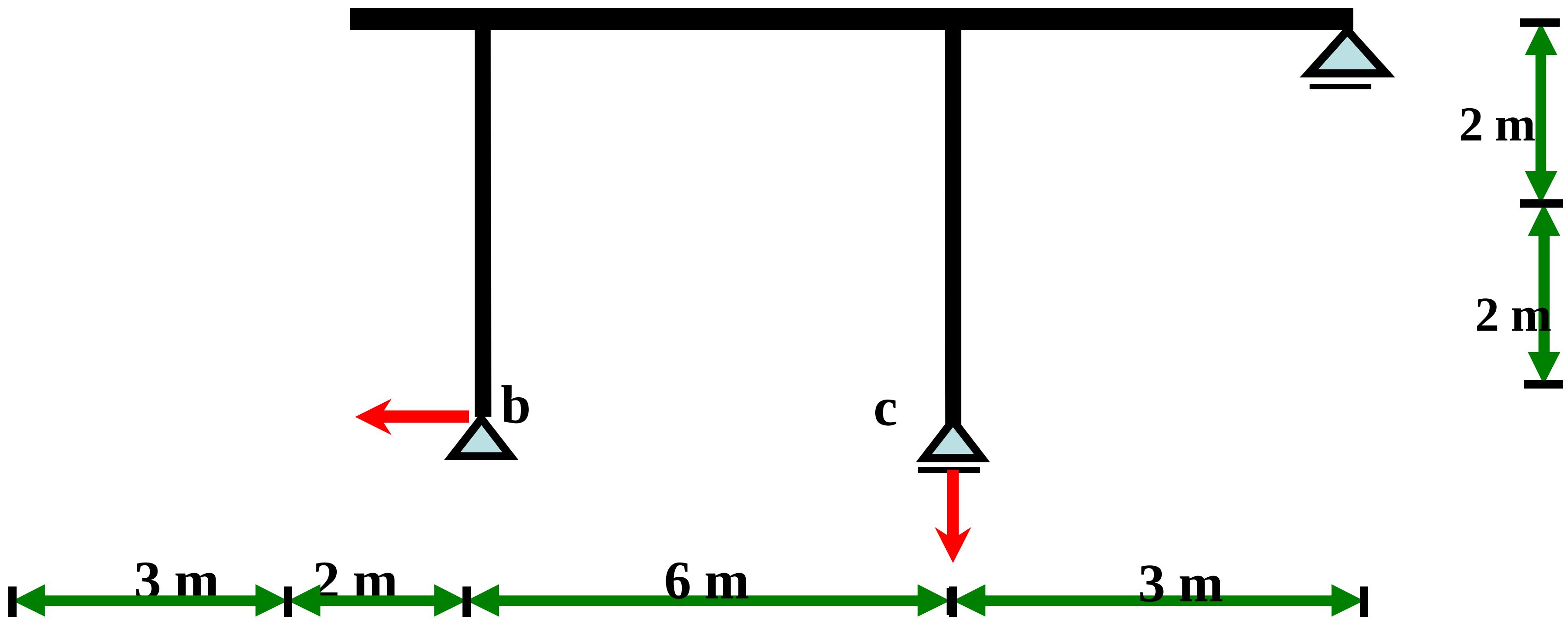
Due to (1) settlement at A = 1cm.
and left movement at B = 2cm.
and settlement at C = 3cm.
and right movement at D = 2cm.



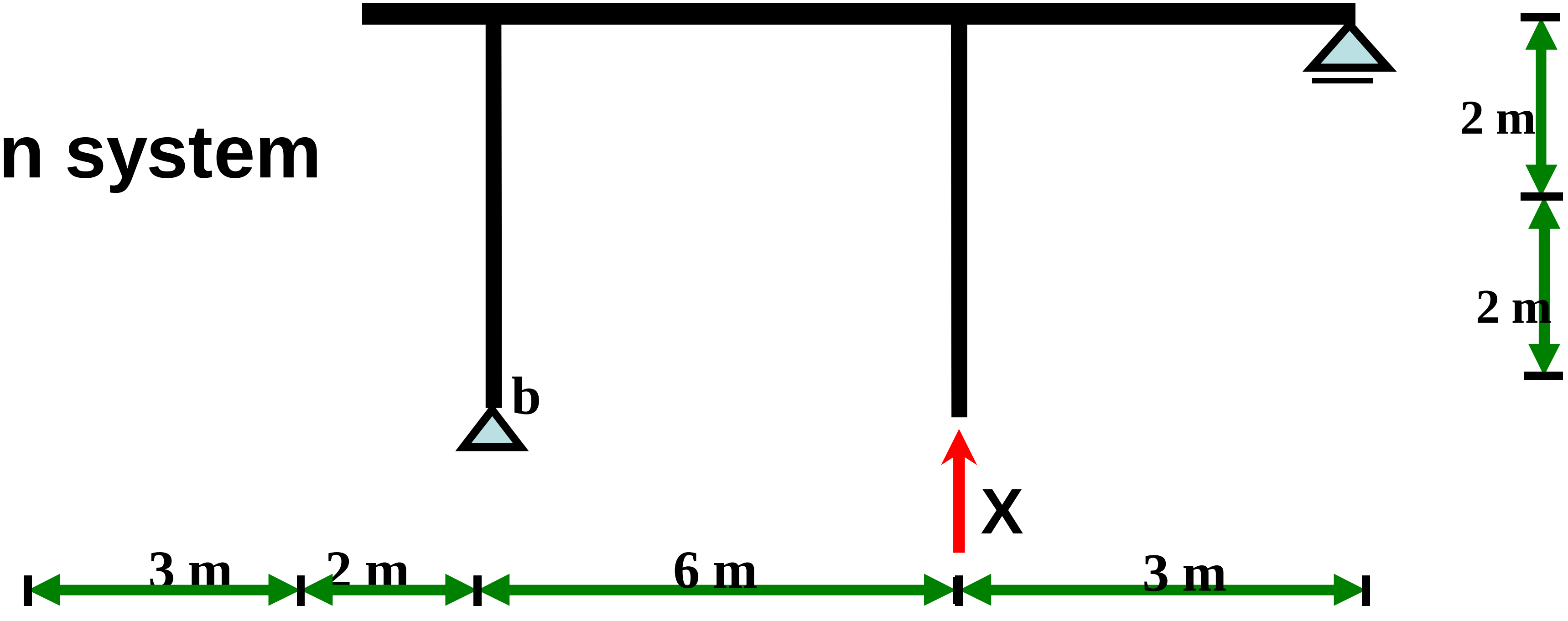
Part (a e) >> determinate

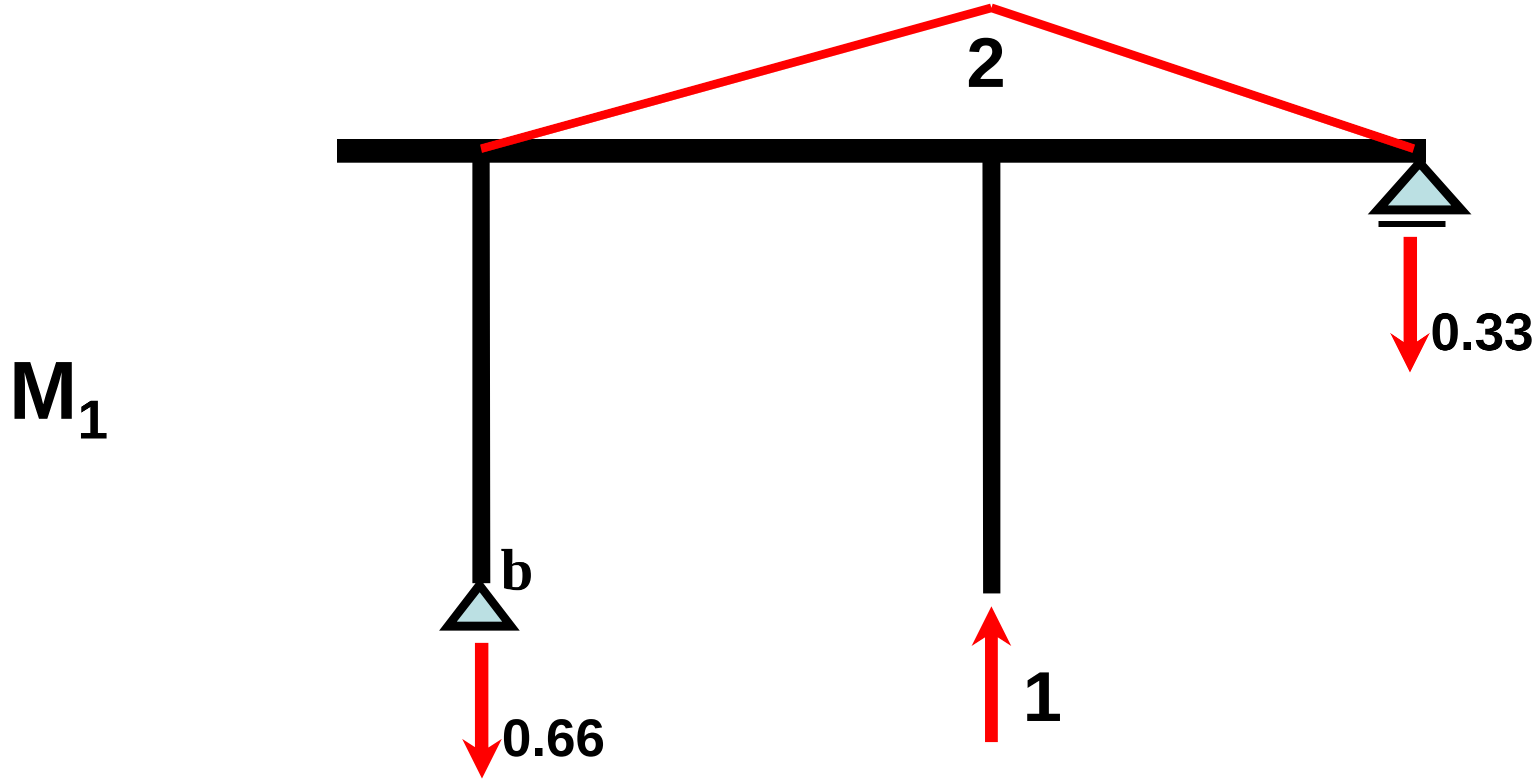
الهبوط لا يؤثر فى الـ determinate structure

الحركة عند d افقية وهى الحركة الاساسيه للـ roller وبالتالى لا تؤثر



Main system





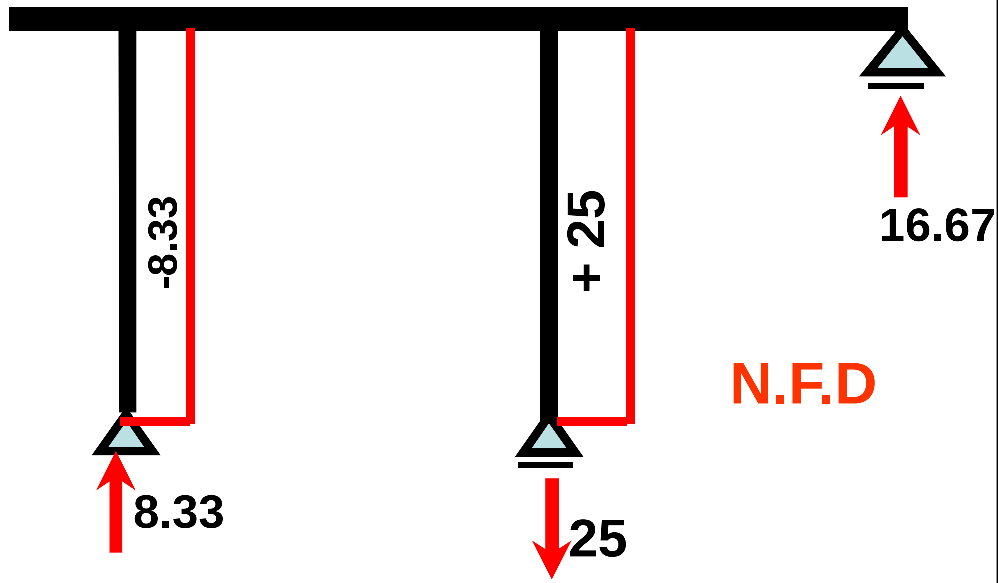
$$\delta_{11} = \frac{1}{10000}\left[\frac{2*2*3}{3} + \frac{2*2*6}{3} \right] = 12*10^{-4}$$

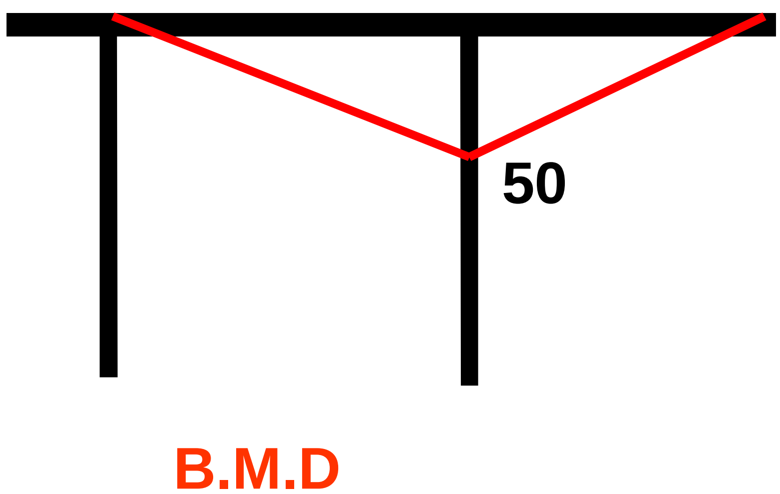
$$\delta_{10} = 0.0$$

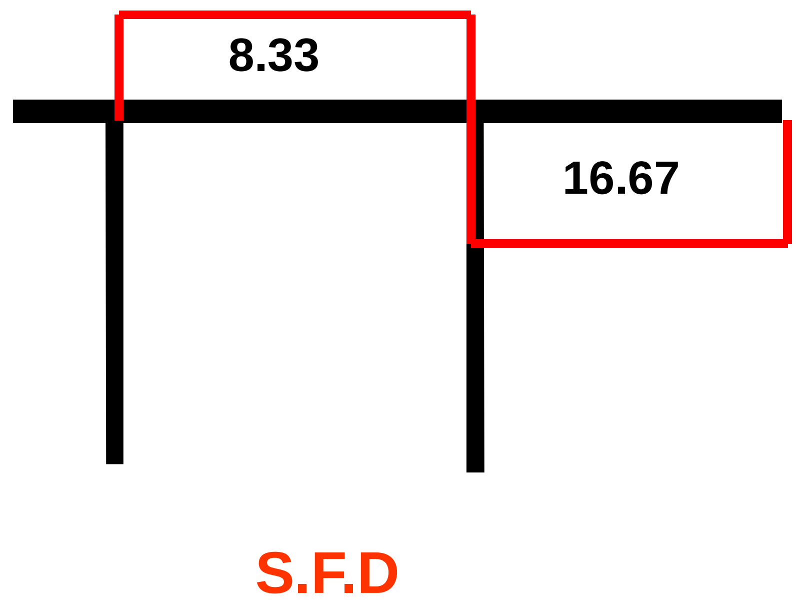
$$\delta_{11} = 12*10^{-4}$$

$$\delta_{10} + X \, . \, \delta_{11} = \Delta_c$$

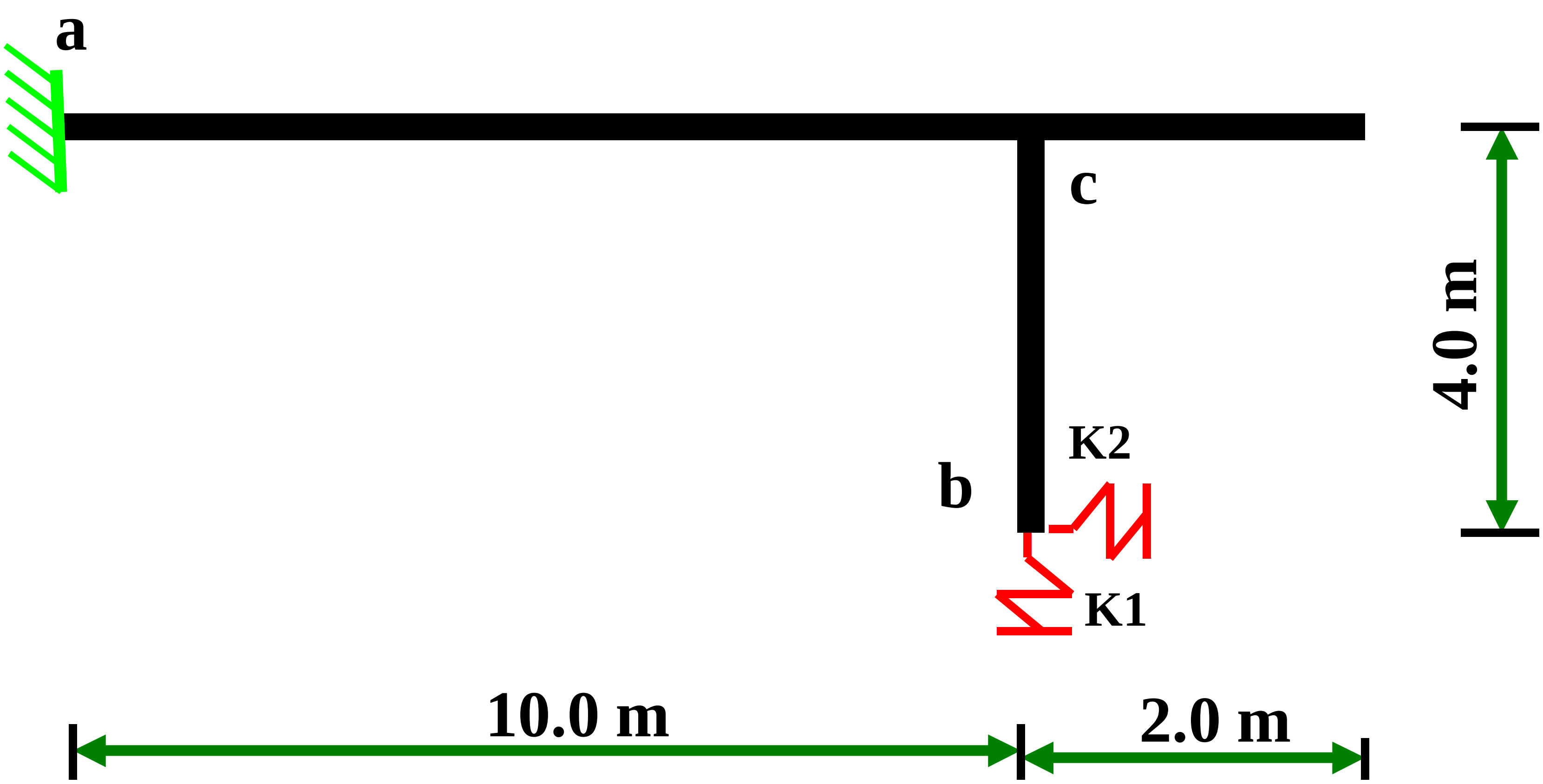
$$0 + X * 12*10^{-4} = 0.03 \quad >> \quad X = -25\,t$$







Examples three



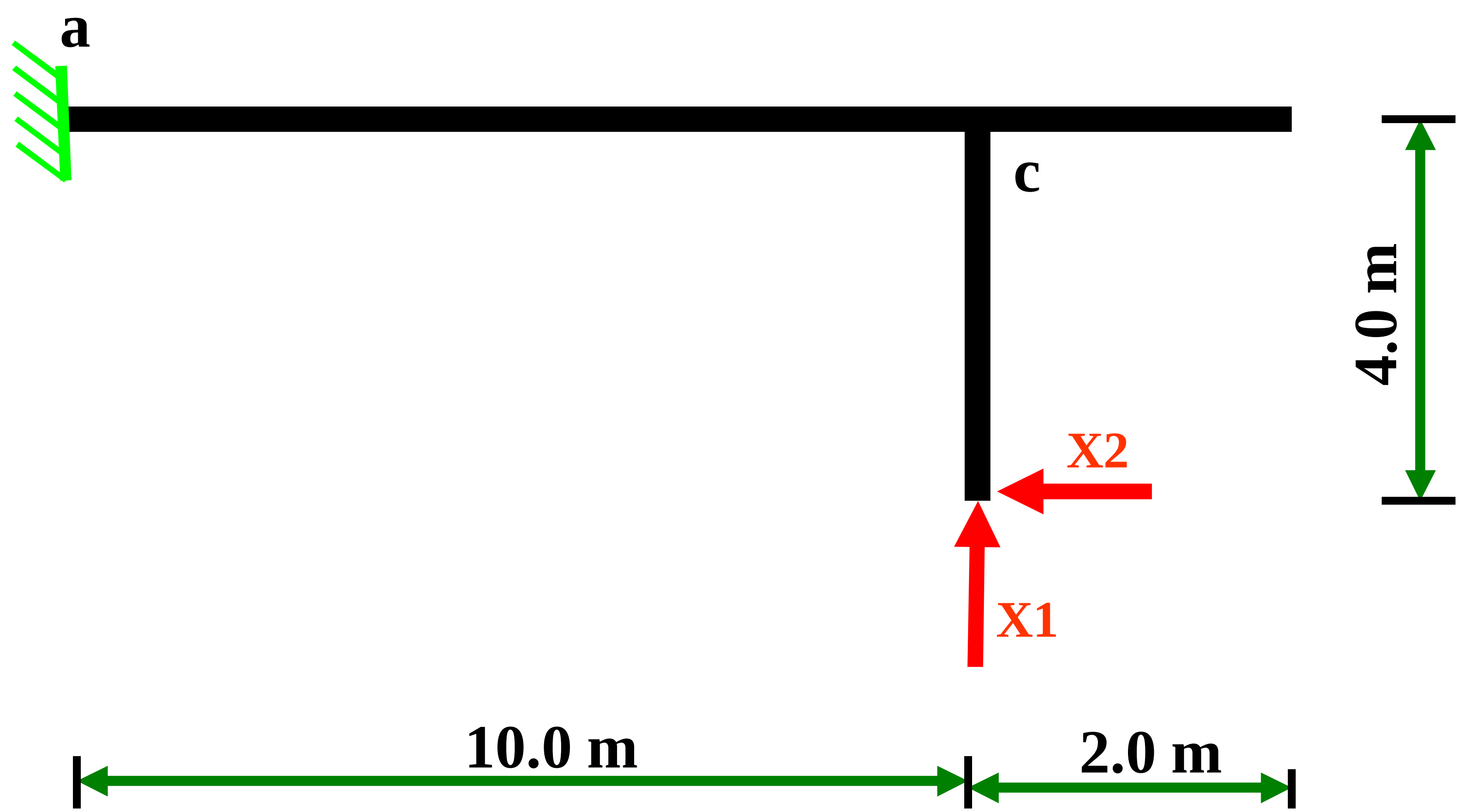
Draw B.M.D , S.F.D, and N.F.D EI = 10000 t.m2

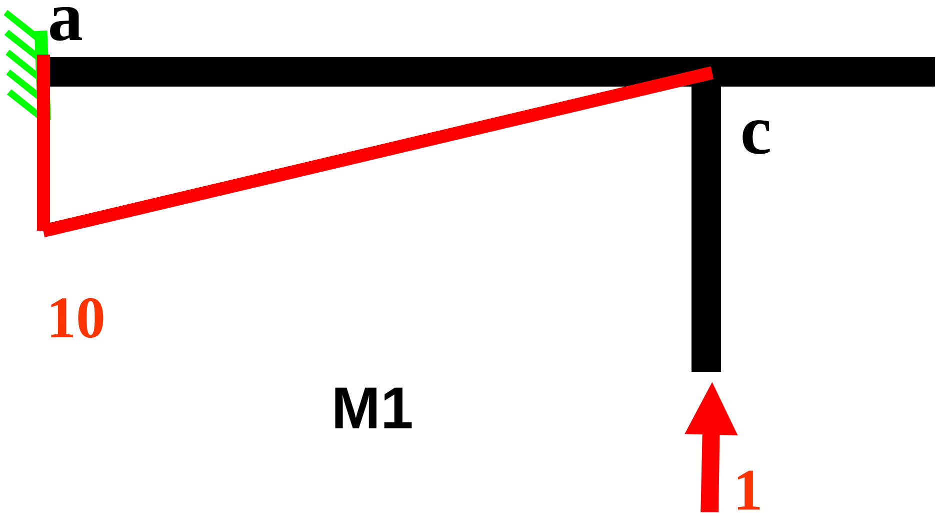
Due to

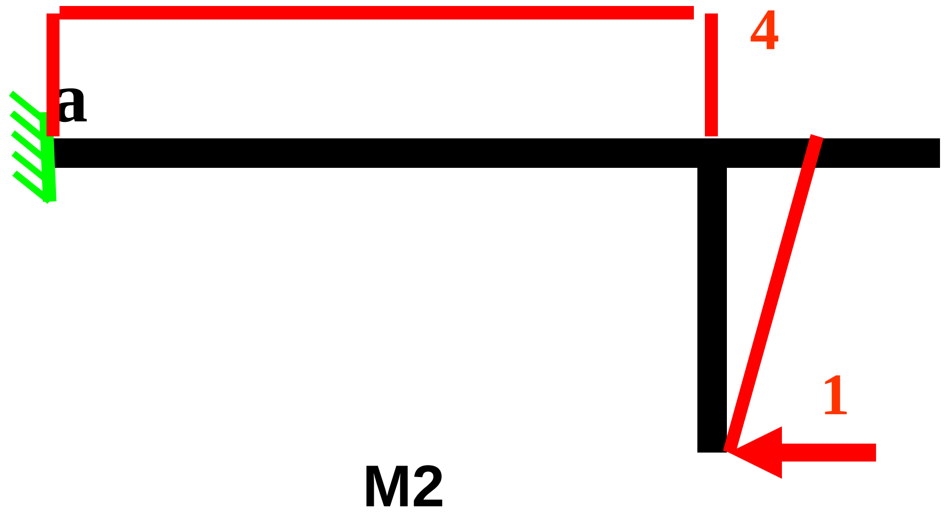
Anti Clockwise Rotation at A = 0.001 rad.

K1= 400t/m K2=200t/m

Main System



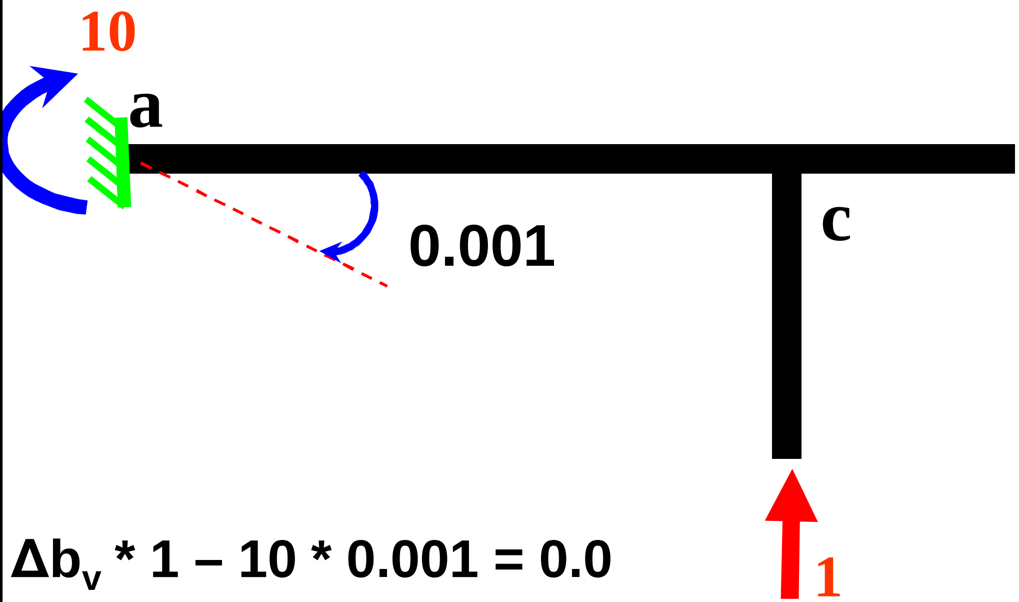




$$\delta_{11} = \frac{1}{10000}\left[\frac{10*10*10}{3} \right] = 0.033$$

$$\delta_{22} = \frac{1}{10000}\left[\frac{4*4*4}{3} + 4*4*10 \right] = 0.018$$

$$\delta_{12} = \frac{1}{10000}\left[\frac{10*4*10}{2} \right] = 0.02$$



$\Delta b_v * 1 - 10 * 0.001 = 0.0$

$\Delta b_v = 0.01$

$\Delta b_h * 1 - 4 * 0.001 = 0.0$

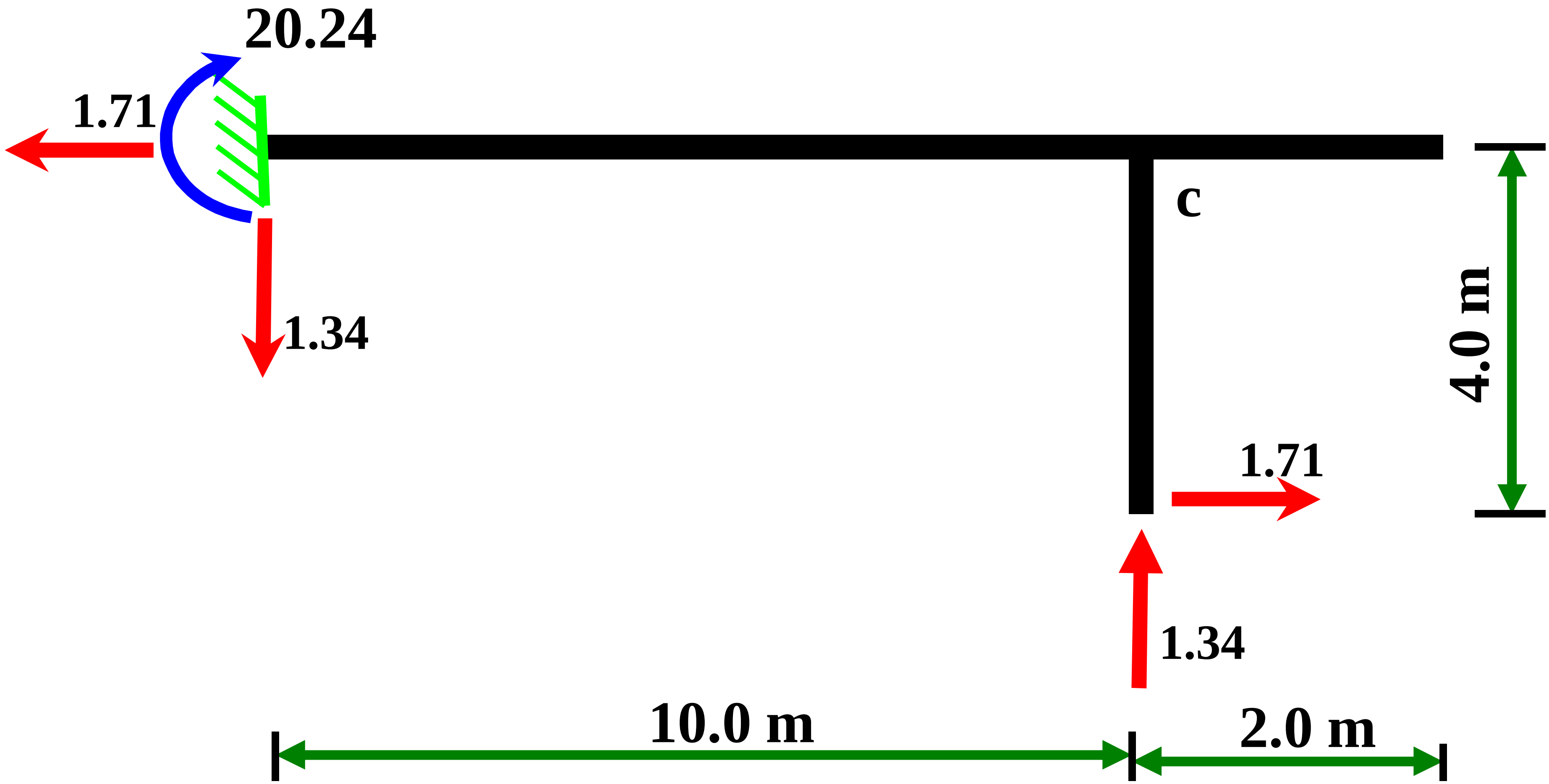
$\Delta b_h = -\ 0.004$

$$0.0 + X_1 * (0.033 + \frac{1}{400}) + X_2 * 0.02 = 0.0$$

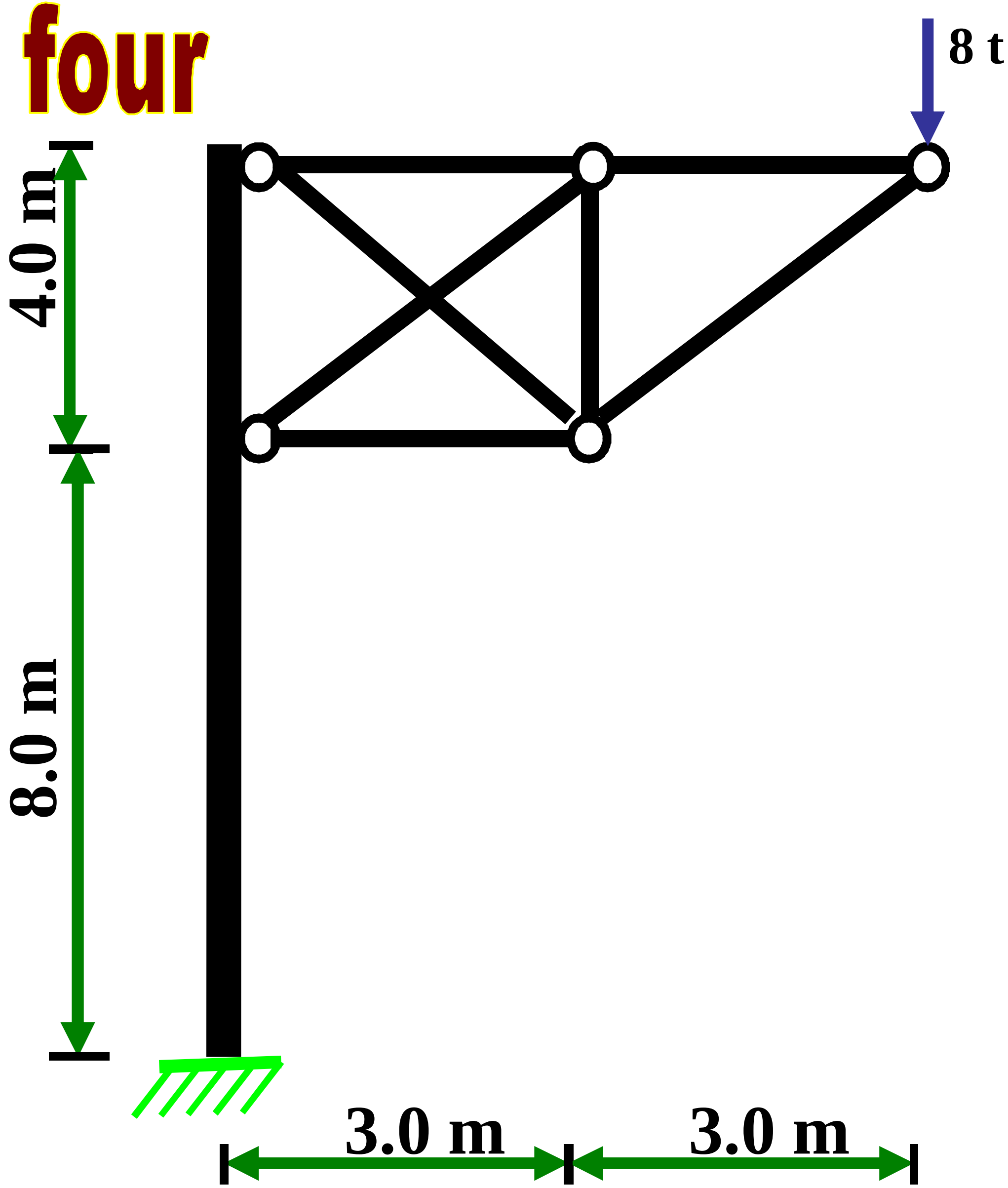
$$0.0 + X_1 * 0.02 + X_2 * (0.018 + \frac{1}{200}) = 0.0$$

X1=1.34

X2=-1.71

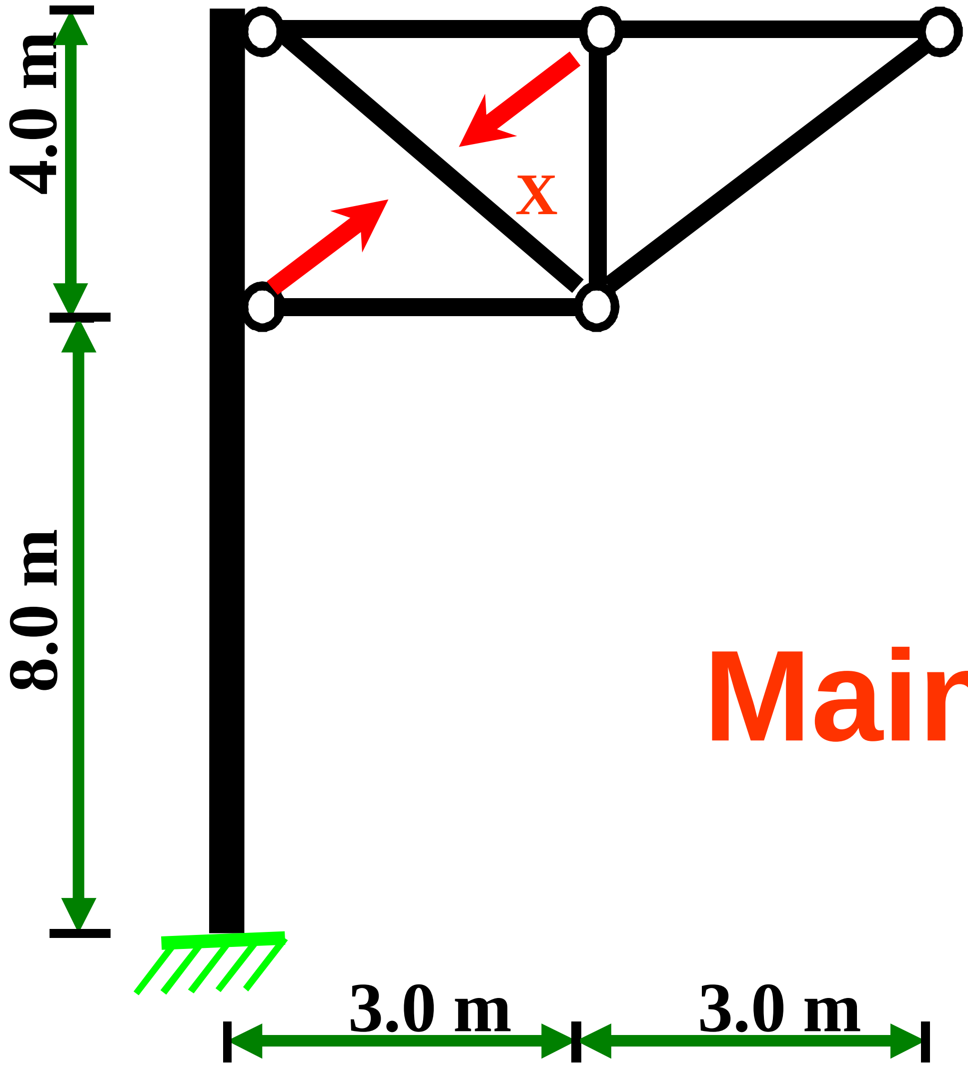

20.24
1.71
1.34
c
1.71
1.34
4.0 m
10.0 m
2.0 m

Examples four



For the shown truss determine find the forces in all members due to:

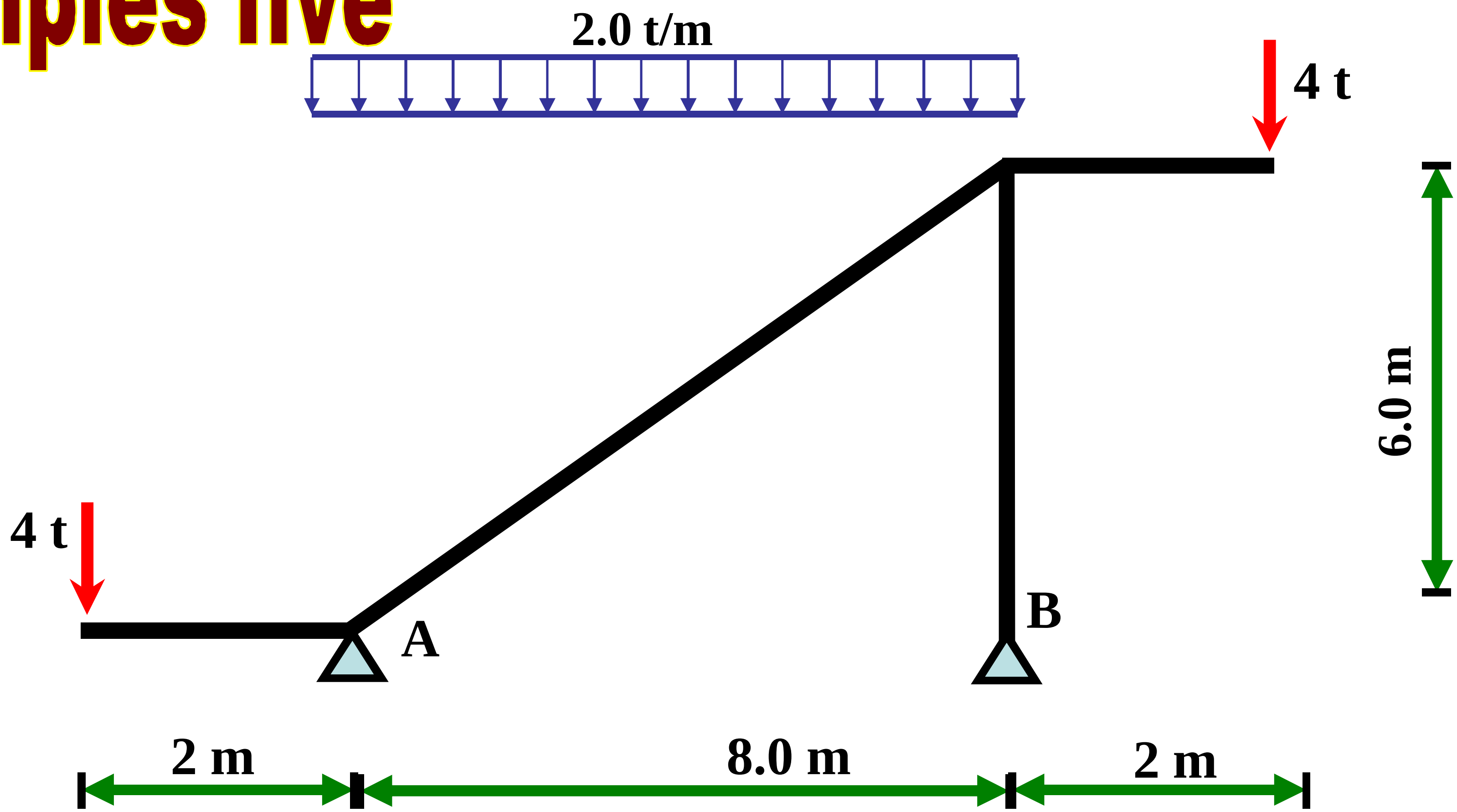
EI_{column}=6000 ton EA_{link}=4000 ton



Main system

continue

Examples five

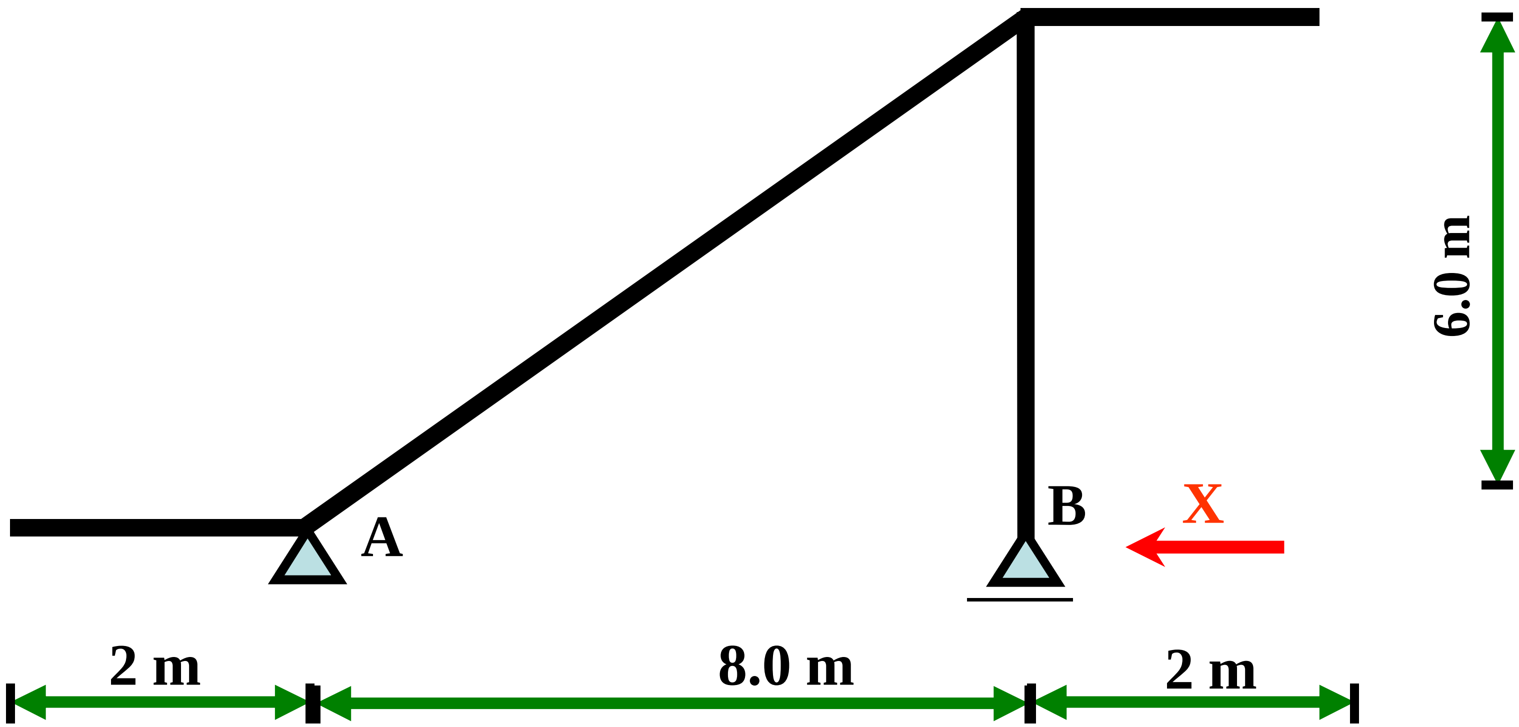


Draw B.M.D , S.F.D, and N.F.D   EI = 8000 t.m2 & EA = 20000 t.m2

Due to (1) given loads

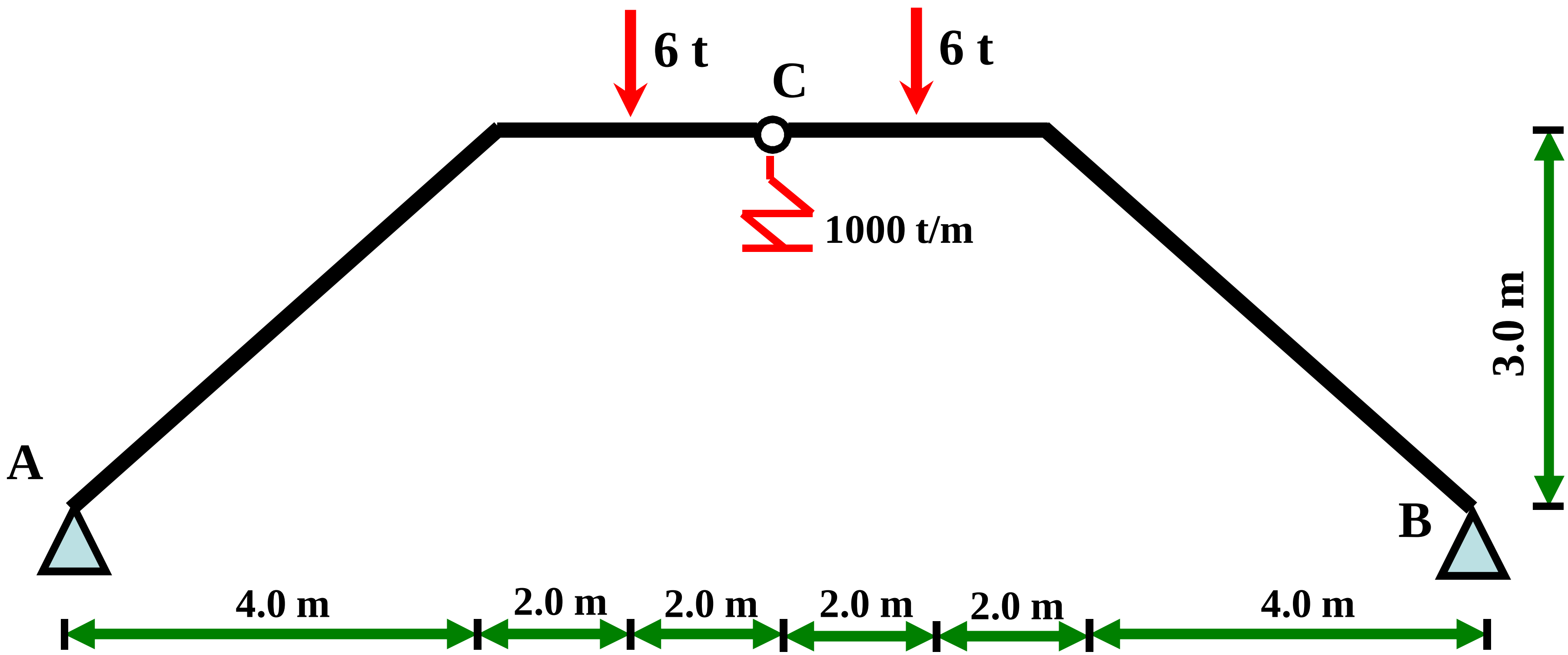
(2) uniform rise in temperature in member AD 50^0

Main system



continue

Examples six

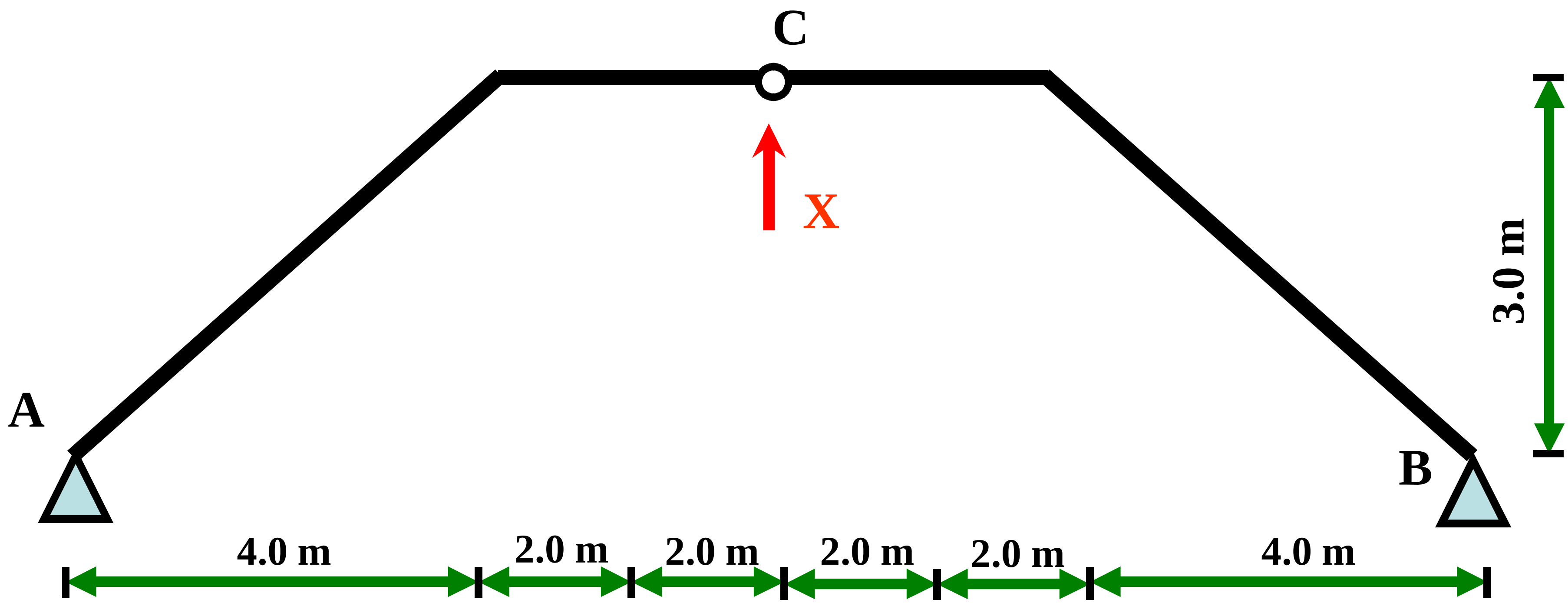


Draw B.M.D , S.F.D, and N.F.D   EI = 10000 t.m2

Due to (1) given loads

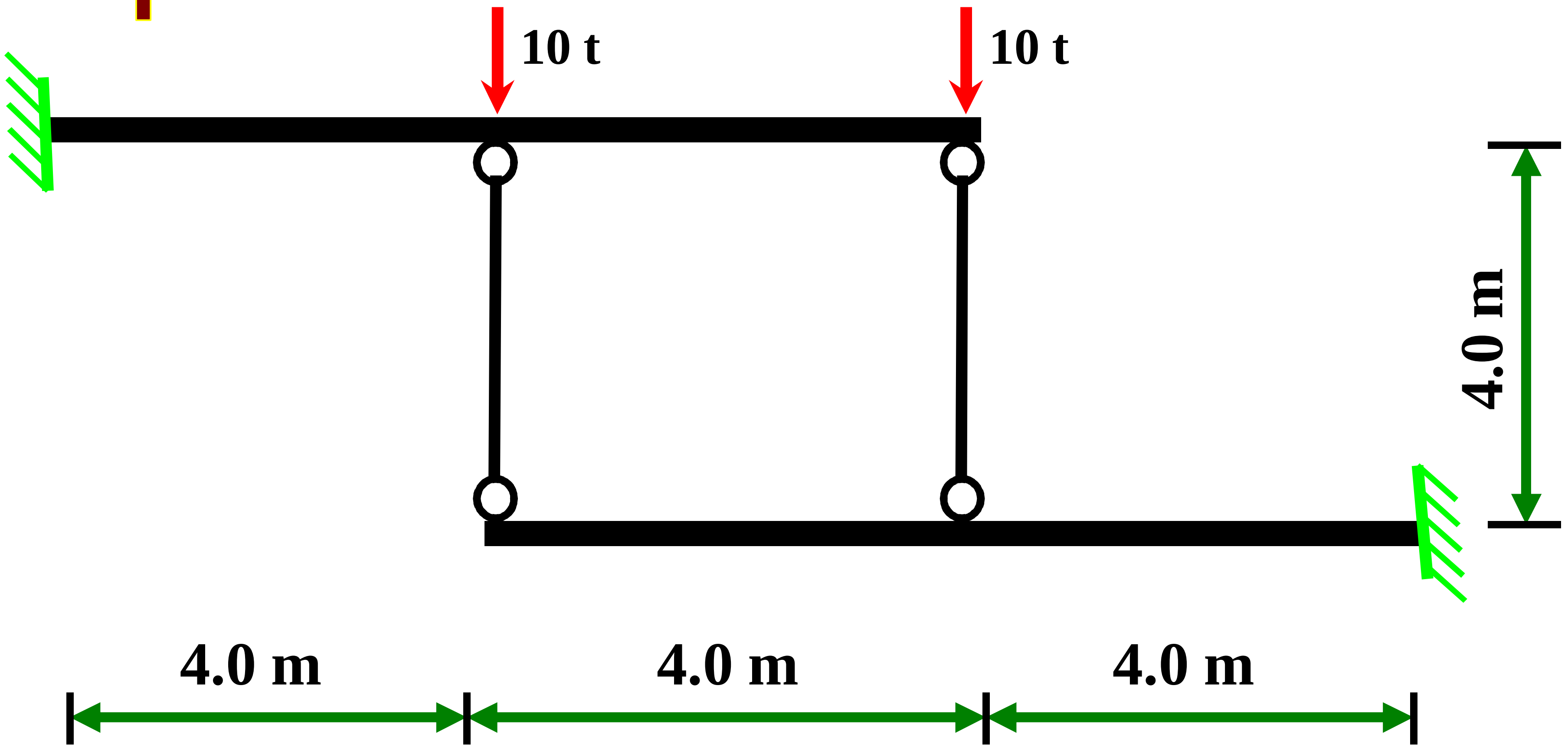
(2) uniform rise in temperature 30^0

Main system



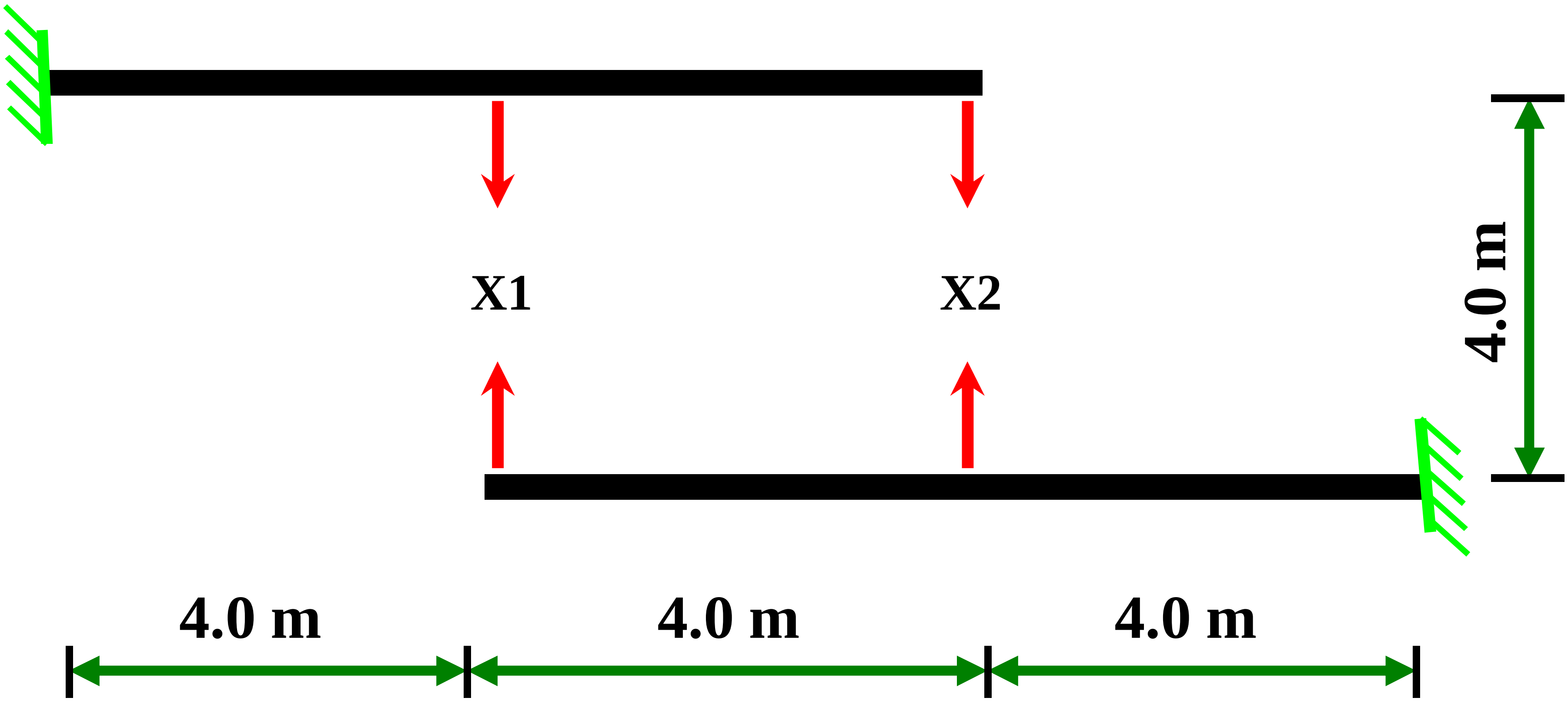
continue

Examples seven



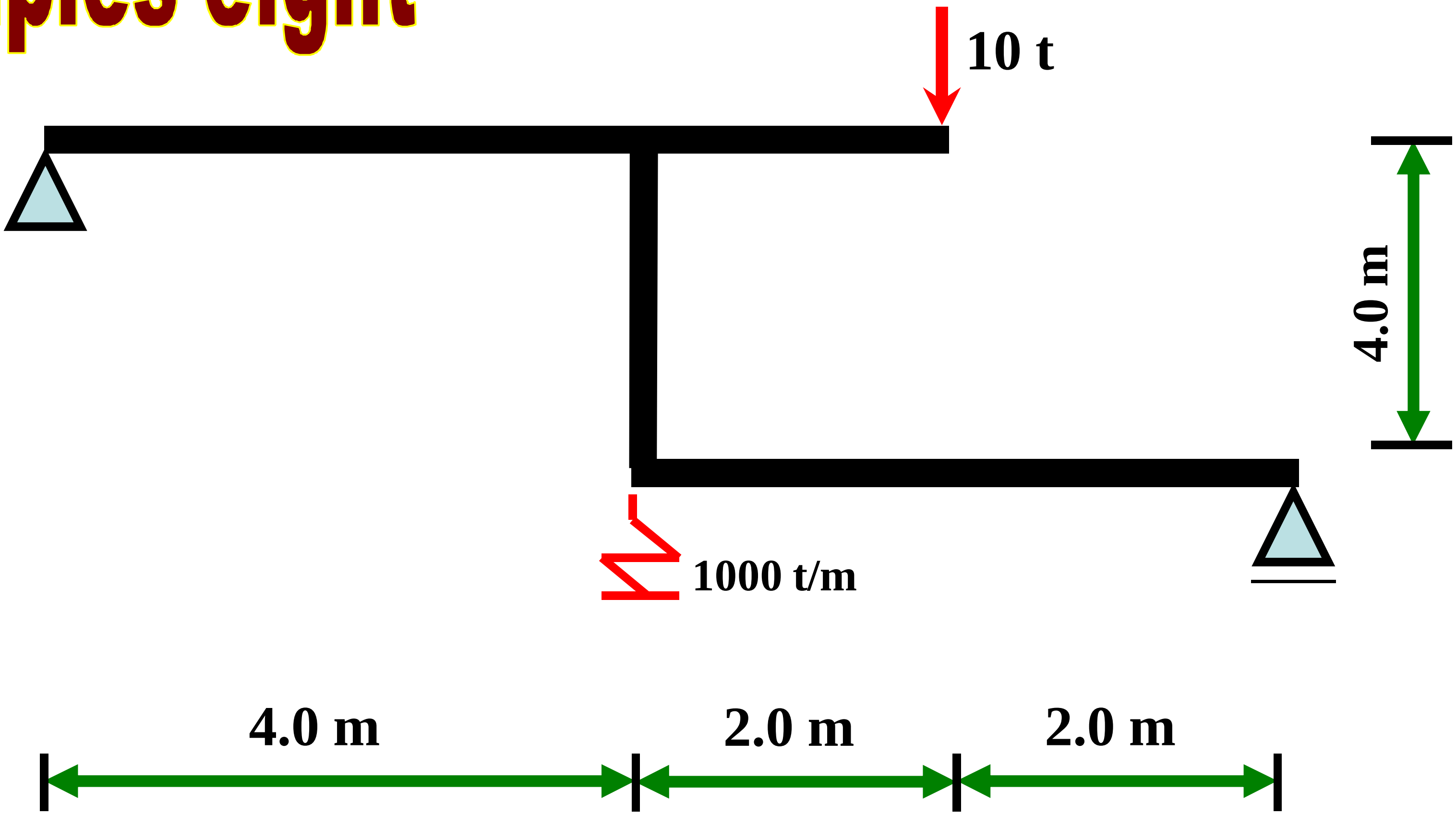
Draw B.M.D , S.F.D, and N.F.D EI = 10000 t.m2

Main system



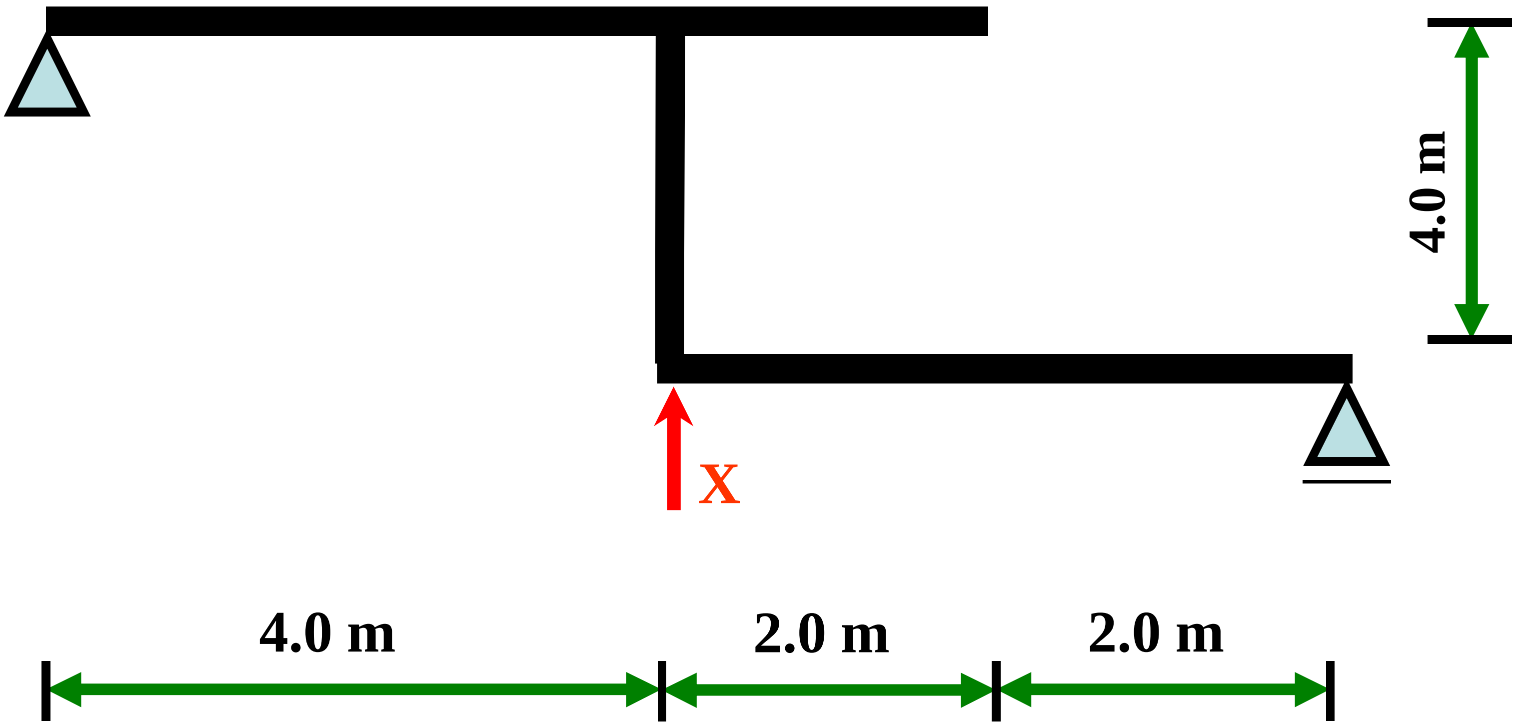
continue

Examples eight



Draw B.M.D , S.F.D, and N.F.D EI = 10000 t.m2

Main system



continue

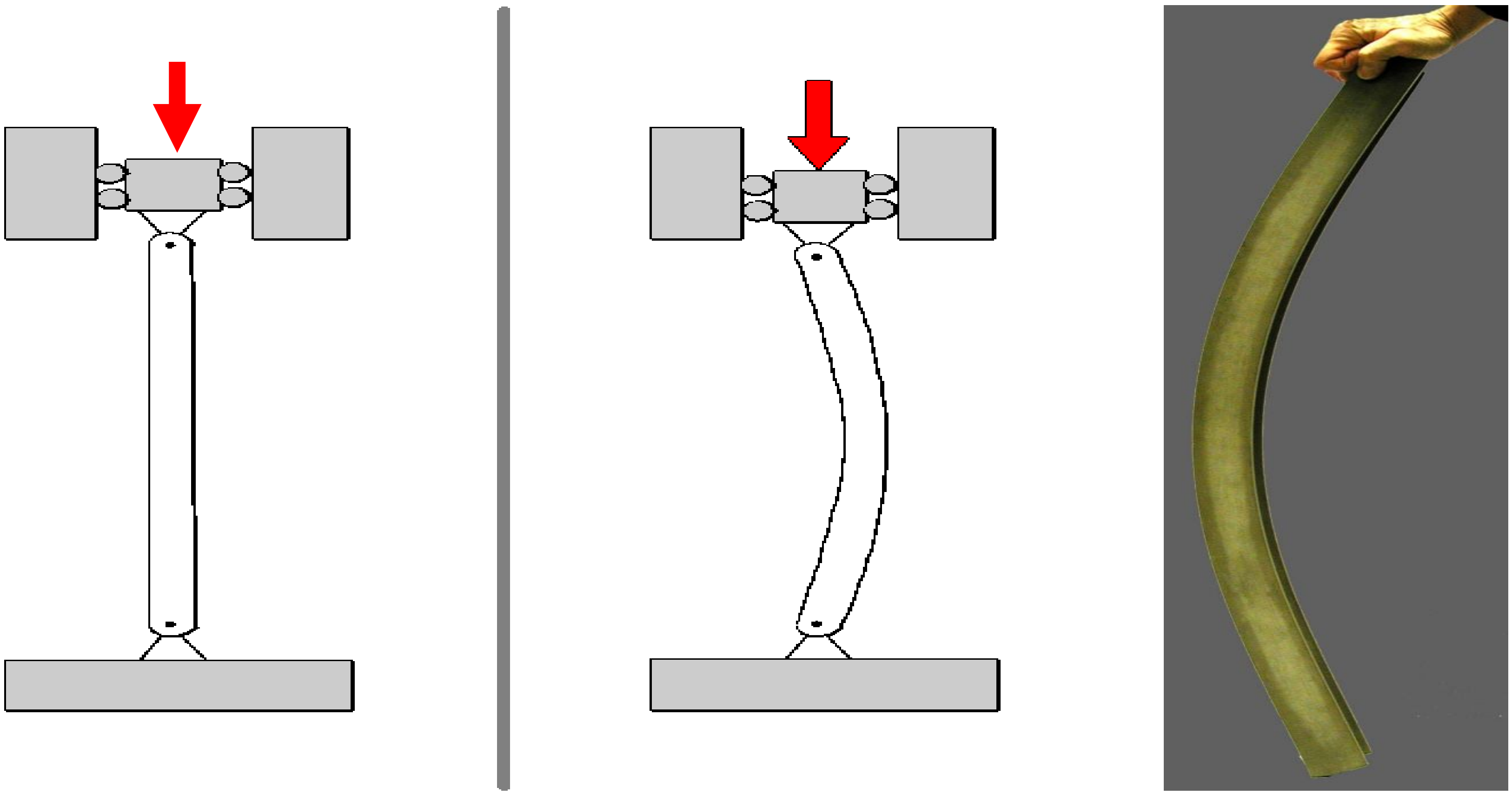
بسم الله الرحمن الرحيم

Buckling in Columns

Supjected to Normal only

Eng : Ayman abdo

• عندما يكون ابعاد العمود صغيرة بالنيبة لإرتفاعة فإن تعرض العمود لاحمال ضغط كبيره تسبب حدوث إنبعاج (تقوس) فى العمود.



• لاحظ أن الحمل فى البداية ماشى مع الـ **axis** للعمود وبالتالى يتولد **normal** فقط أما فى الحالة الثانية بعد حدوث التقوس يكون هناك ترحيل بمسافة (y) تسبب وجود عزوم

$$M = P.\ y$$

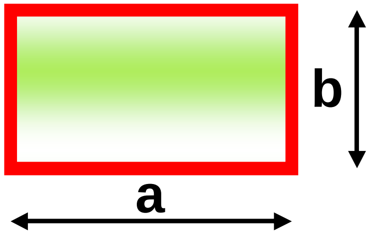

بعض المصطلحات المهمة جدا فى الحسابات

1- INERTIA

1- تكون معطاه فى بعض المسائل.

$$Ix \quad and \quad Iy$$

2- يتم حسابها فى بعض المسائل ويكون للأشكال السهله.



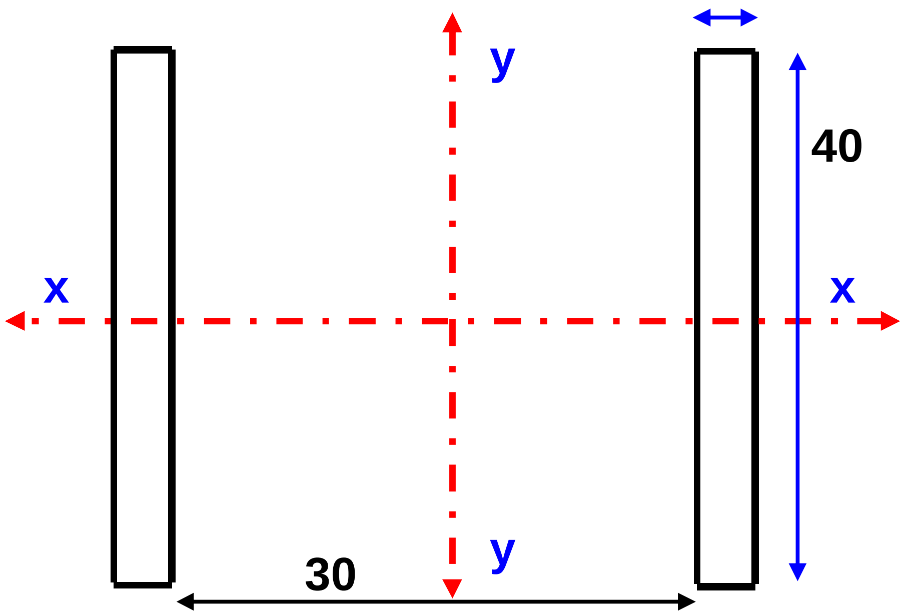
$$Ix = Iy = \frac{\pi}{64} D^4$$

$$Ix = \frac{a * b^3}{12} \qquad Iy = \frac{b * a^3}{12}$$

3- فى بعض المسائل يتم اعطاء الـ inertia لجزء من القطاع ويتم تركيب جزء اخر عليه ليتم اضافتة فى الحسابات.

تجميع شكلين معا

2 plates 2*40 cm



$$A = 2 * (2 * 40) = 160 \quad cm^2$$

$$Ix = 2 * \left(\frac{2 * (40)^3}{12} \right)$$

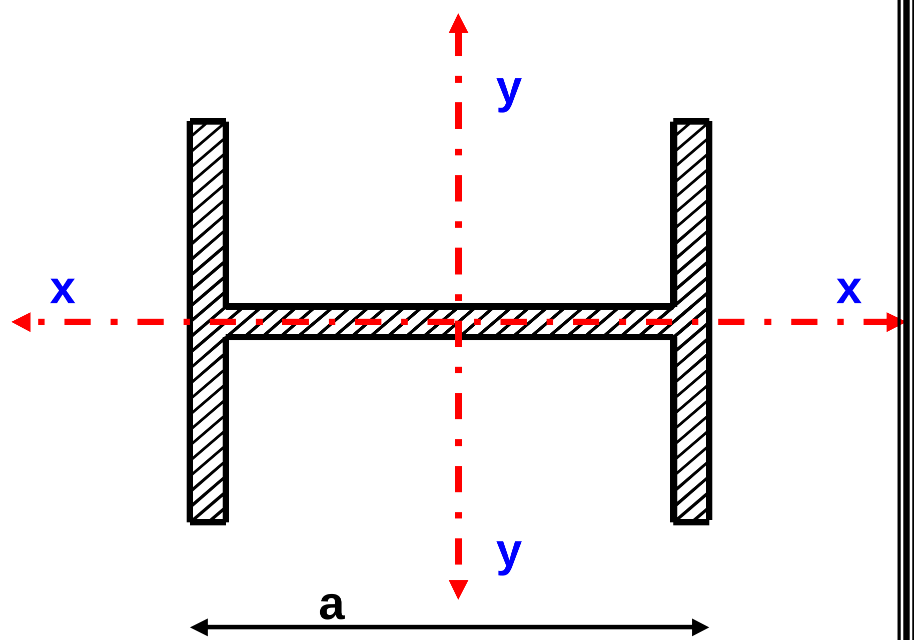
$$Iy = 2 * \left(\frac{40 * (2)^3}{12} + 80 * (16)^2 \right)$$

$$for \quad BFIB \quad No \quad 30$$

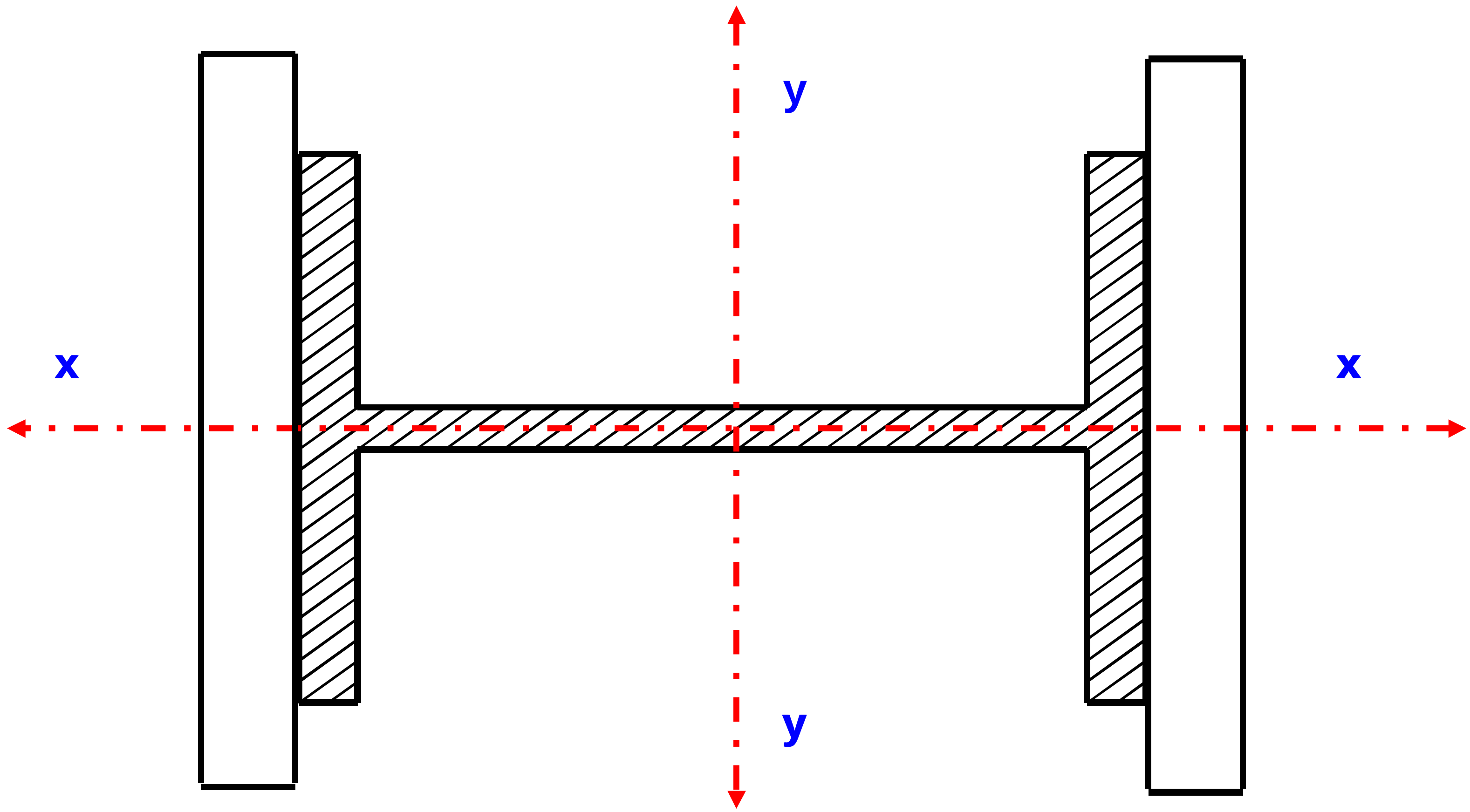
$$A = 100 \quad cm^2$$

$$Ix = 50000 \quad cm^4$$

$$Iy = 100000 \quad cm^4$$



معنى No 30 ان المسافة a=30 عادة لا توضع على الرسم يتم معرفتها من اسم الـ I beam



$$A = 100 + 160 = 260 \quad cm^2$$

$$Ix = 50000 + 2 * \left(\frac{2 * (40)^3}{12} \right)$$

$$Iy = 100000 + 2 * \left(\frac{40 * (2)^3}{12} + 80 * (16)^2 \right)$$

تجميع شكلين معا

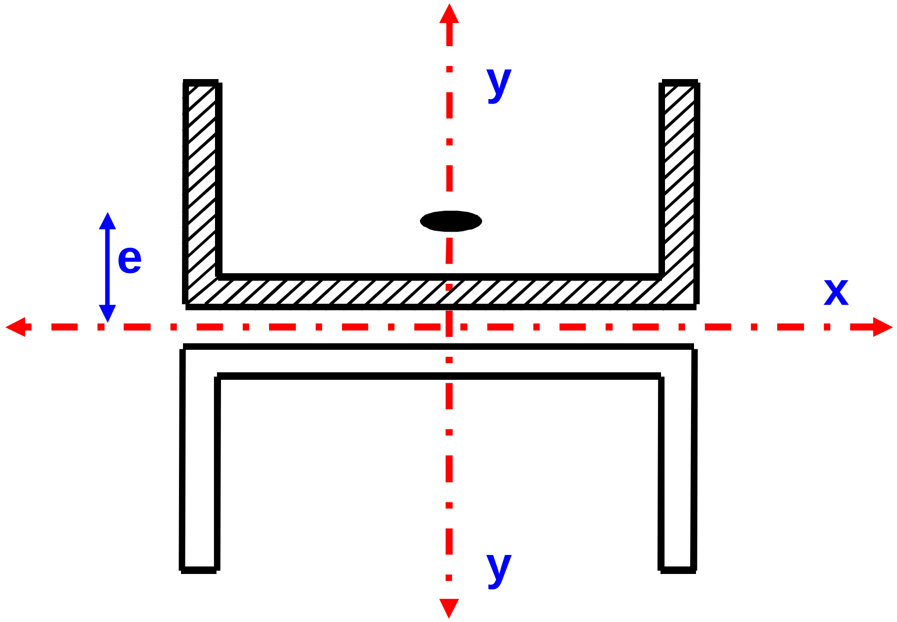
$for \quad CH \quad No \quad 10$

$A = 13.5$

$Ix = 206 \quad cm^4$

$Iy = 29.3 \quad cm^4$

$e = 1.55$



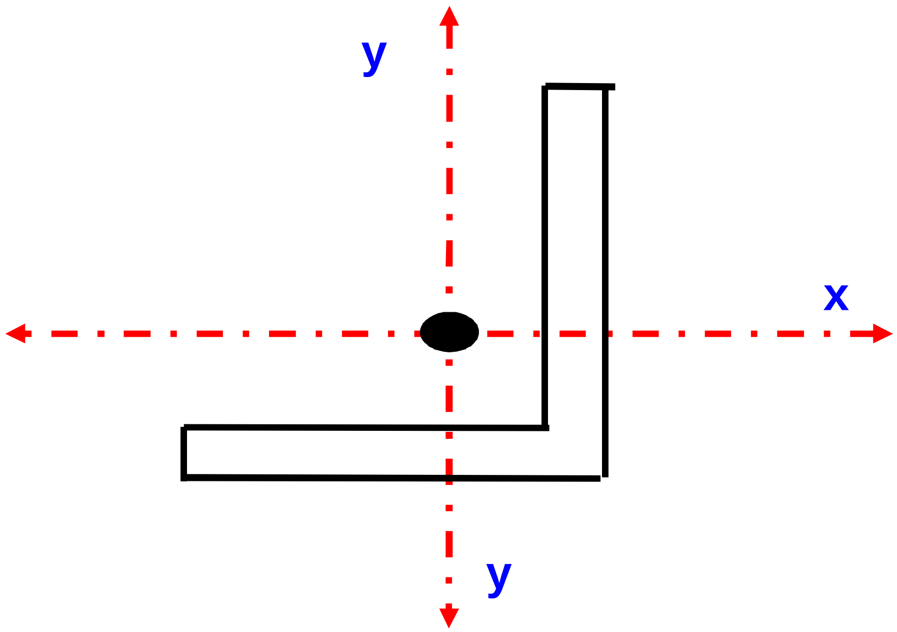
$$A = 13.5 * 2 = 27 \ cm^2$$

$$Ix = 2 * \left(206 + 13.5 * (1.55)^2\right) = 477$$

$$Iy = 2 * \left(29 \quad\right) = 58 \quad cm4$$

Minimum Inertia

$$for \quad L \quad \sec \quad No \quad 10$$



$$Ix = Iy = 472 \quad cm^4$$

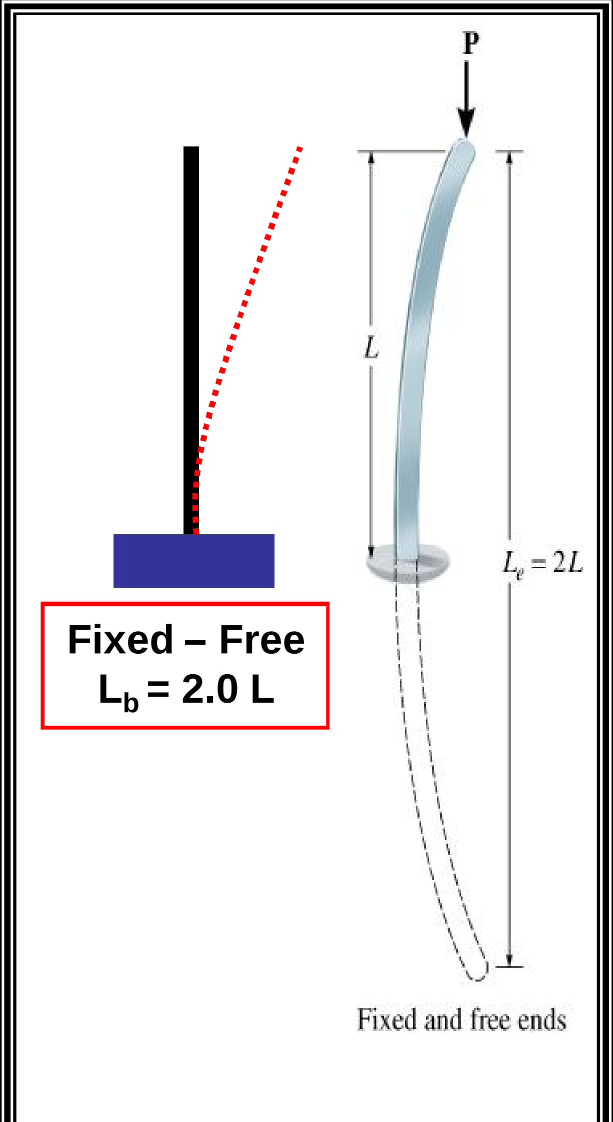
$$Ixy = 312 \quad cm^4$$

$$I_{(\min)} = \left(\frac{Ix + Iy}{2}\right) - \sqrt{\left(\frac{Ix - Iy}{2}\right)^2 + Ixy^2}$$

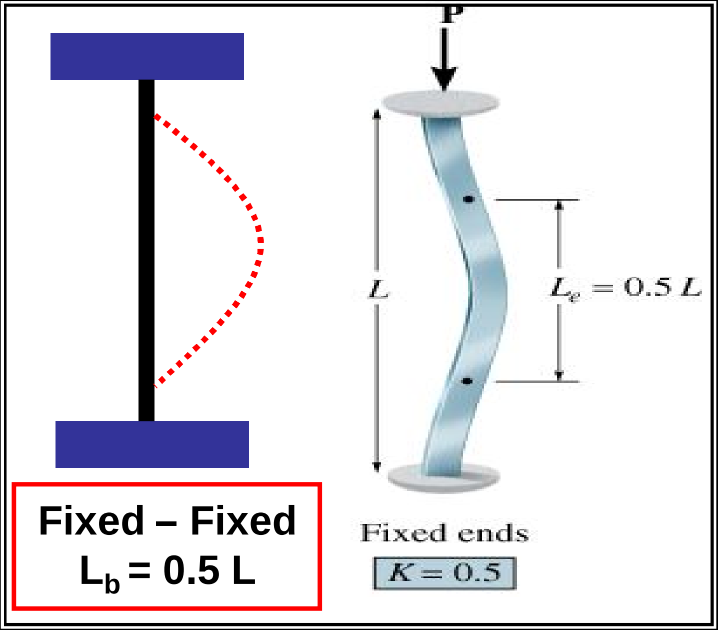
$$I_{(\min)} = \left(\frac{472 + 472}{2}\right) - \sqrt{\left(\frac{472 - 472}{2}\right)^2 + (312)^2} = 160 \ cm^2$$

2- Buckling Length

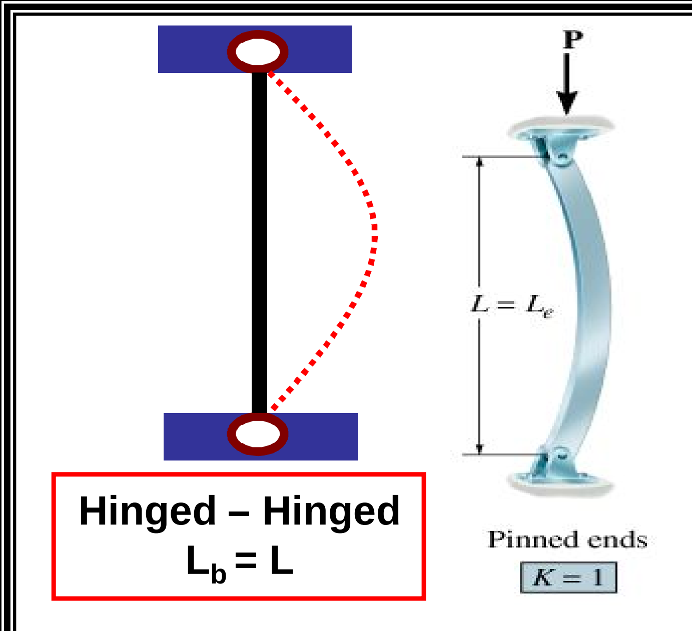
<u>الحالة الاولى</u> عندما يكون العمود غير مقيد من البدايه للنهاية نجد ان الـ buckling length متساوى حول المحورين



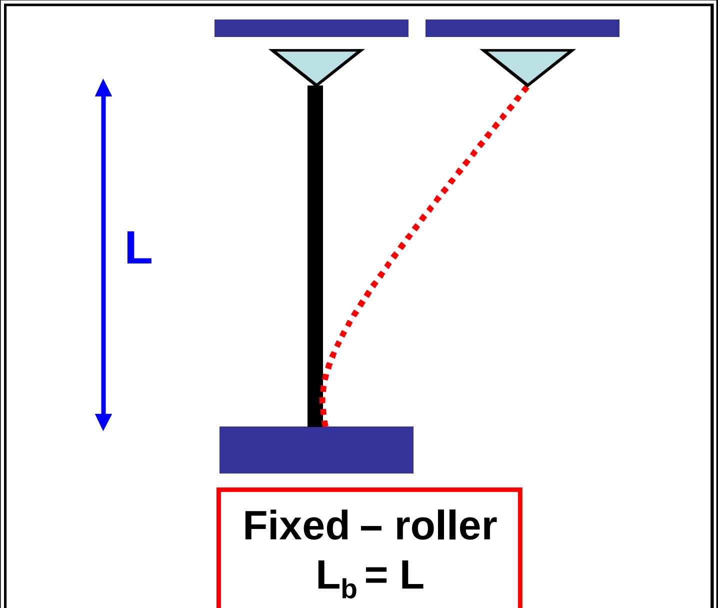
Fixed – Free
$L_b = 2.0\ L$



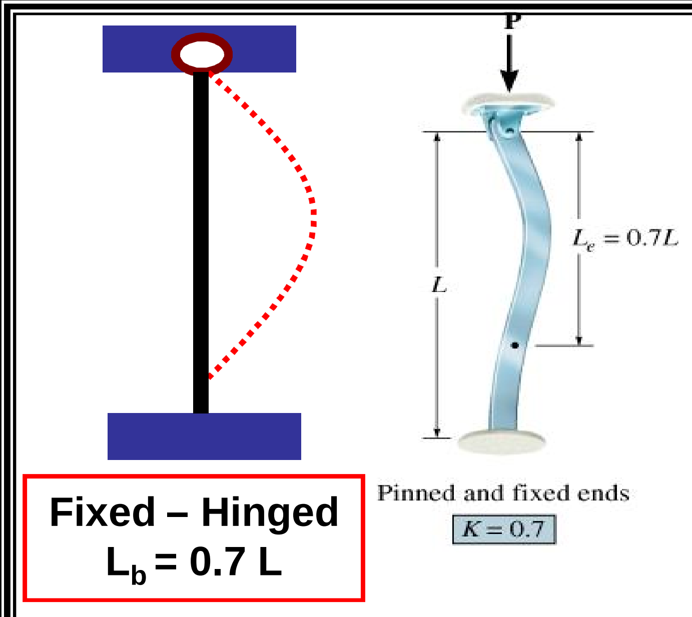
Fixed – Fixed
$L_b = 0.5\ L$



Hinged – Hinged
$L_b = L$

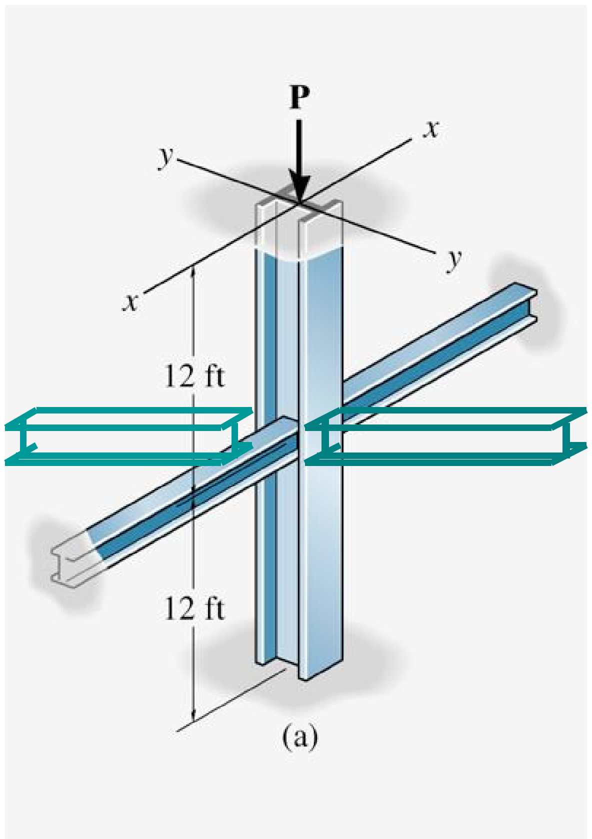


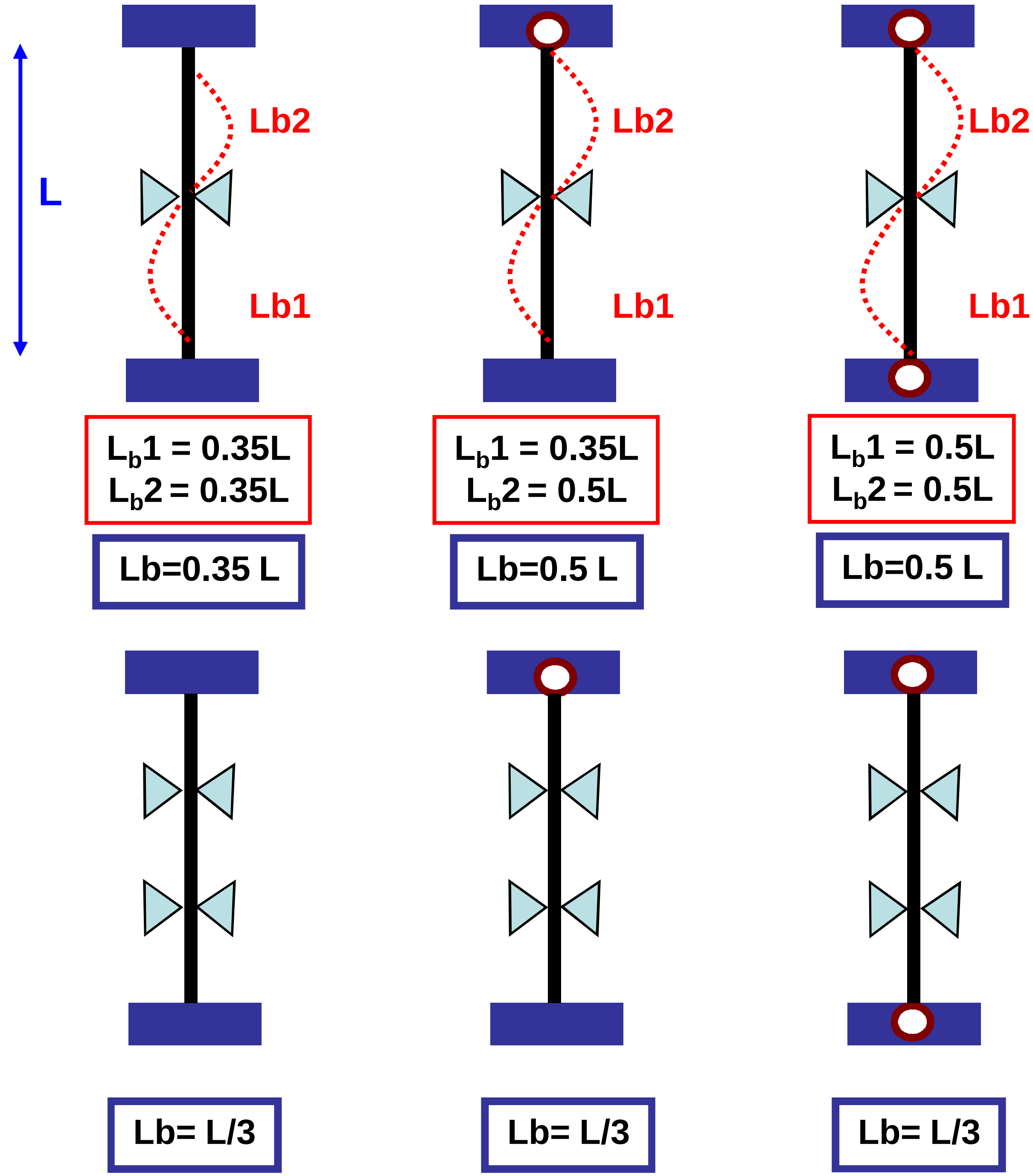
Fixed – roller
$L_b = L$



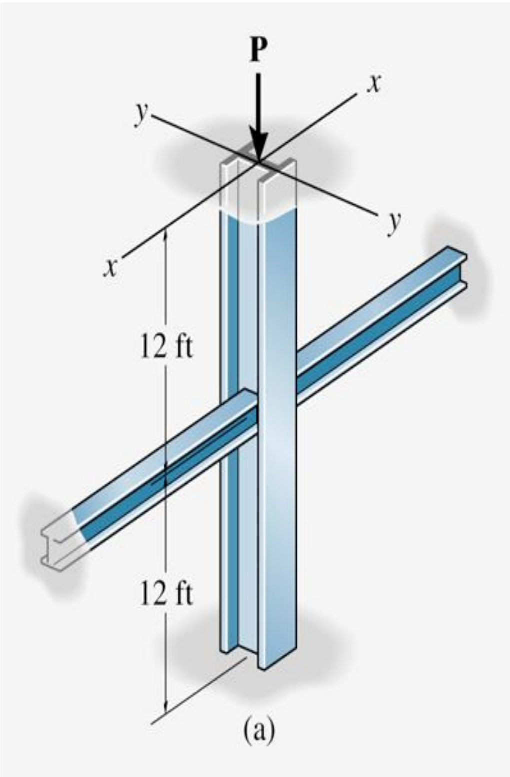
Fixed – Hinged
$L_b = 0.7\ L$

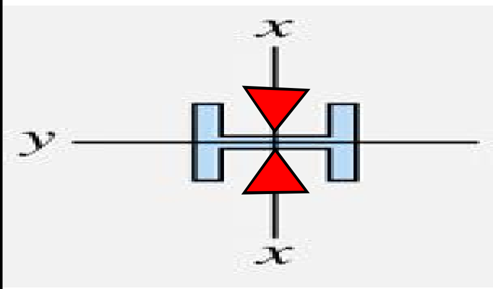
الحالة الثانية عندما يكون العمود مقيد فى الاتجاهين نجد ان الـ buckling length متساوى أيضا حول المحورين





الحالة الثالثة عندما يكون العمود مقيد فى اتجاه واحد نجد ان الـ buckling length مختلف حول المحورين



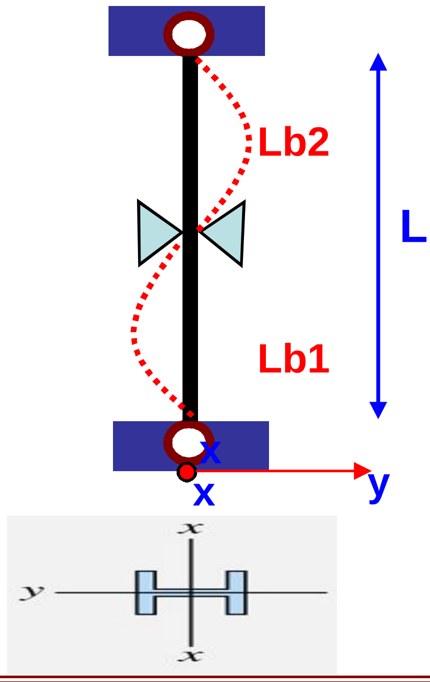


مع المحور الذى يظهر نقطه
على العمود (X)

$L_b x = 0.5 L$

مع المحور الاخر
على العمود (y)

$L_b y = L$

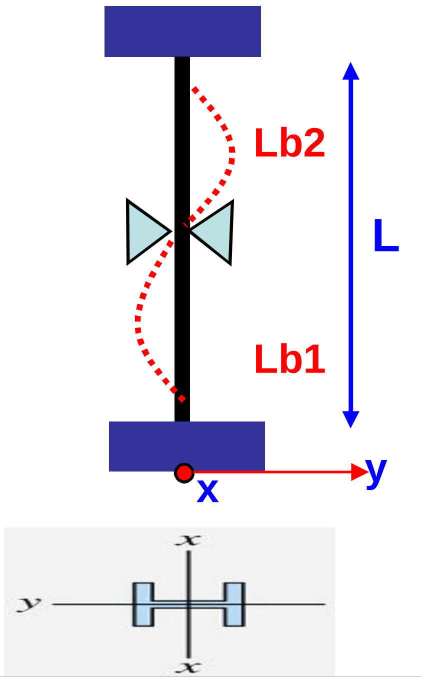


مع المحور الذى يظهر نقطه
على العمود (X)

$L_b x = 0.7 * 0.5 L = 0.35 L$

مع المحور الاخر
على العمود (y)

$L_b y = 0.5 L$



Critical Buckling Load of Column

$$first \quad step \quad (Radius \quad of \quad gyration \quad)$$

$$i_{\min} = \sqrt{\frac{\operatorname{Im} \ in}{A}}$$

$$\sec \ ond \quad step \quad (\ sylinderne \quad ss \quad ratio \ )$$

$$\lambda = \frac{L_b}{i_{\min}}$$

The critical buckling load (p_{cr}) known as euler buckling load as:

$$P_{cr} = \frac{\pi^2 E I_{\min}}{L_b^2}$$

where: **E = Young Modulus of Elasticity.**

I = Minimum moment of Inertia.

L = Buckling length of column.

Permissible Buckling Load of Column

For steel 37

$$if \quad \lambda \geq 104 \quad ---- \quad \sigma_{pb} = \frac{6000}{\lambda^2} \qquad (t/cm^2)$$

$$if \quad \lambda \leq 104 \quad ---- \quad \sigma_{pb} = 1.1 - 0.00005\,\lambda^2 \qquad (t/cm^2)$$

$P_{pb} = \sigma_{pb} * A$

For steel 44

$$if \quad \lambda \geq 96 \quad ---- \quad \sigma_{pb} = \frac{6000}{\lambda^2} \qquad (t/cm^2)$$

$$if \quad \lambda \leq 96 \quad ---- \quad \sigma_{pb} = 1.3 - 0.00007\,\lambda^2 \qquad (t/cm^2)$$

$P_{pb} = \sigma_{pb} * A$

For steel 52

$$if \quad \lambda \geq 104 \quad ---- \quad \sigma_{pb} = \frac{7500}{\lambda^2} \qquad (t/cm^2)$$

$$if \quad \lambda \leq 104 \quad ---- \quad \sigma_{pb} = 1.4 - 0.000065\,\lambda^2 \qquad (t/cm^2)$$

$P_{pb} = \sigma_{pb} * A$

طريقـــــة الحــــل

$First \quad step$

$(Calculate \quad Buckling \quad Length)$

$Second \quad step$

$(Calculate \quad Minimum \quad Inertia)$

$Third \quad step \quad (Radius \quad of \quad gyration)$

$$i_{\min} = \sqrt{\frac{\mathrm{Im}\, in}{A}}$$

$Fourth \quad step \quad (Sylinderne \quad ss \quad ratio)$

$$\lambda = \frac{L_b}{i_{\min}}$$

$Fifth \quad step \quad (Critical \quad Load)$

$$P_{cr} = \frac{\pi^2 E I_{\min}}{L_b^2}$$

$six \quad step \quad (Permissibl \quad e\ Load)\ by\ (st\ \&\ \lambda)$

$$P_{pb} = \sigma_{pb} * A$$

$seven \quad step \quad (Factor \quad of \quad safety)$

$$n = \frac{P_{cr}}{P_{pb}}$$

Example one

given

for *IBE* 30

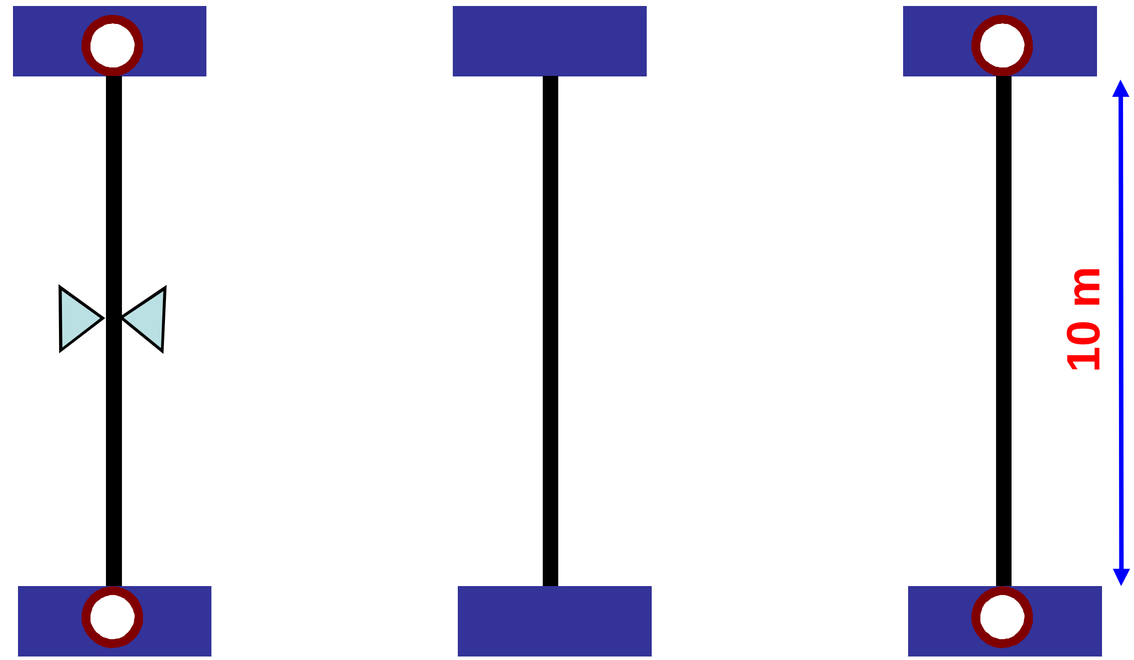
$$Ix = 25700$$

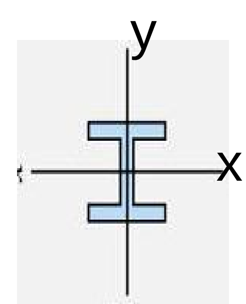
$$Iy = 9010$$

$$E = 2100$$

$$A = 154$$

st 52





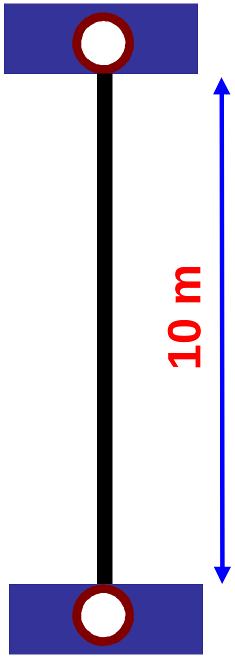
Required Pcr Ppb and n in the three cases

(a) Hinged – Hinged case.

(b) Fixed -- Fixed case.

(c) Hinged – Hinged and restricted in x direction only

Case (a)



First step

$$(Lb = 1000 \ cm)$$

Second step

$$(\mathrm{Im}in = 9010)$$

Third step (Radius of gyration)

$$i_{\min} = \sqrt{\frac{\mathrm{Im}in}{A}} = \sqrt{\frac{9010}{154}} = 7.65cm$$

Fourth step (Sylinderness ratio)

$$\lambda = \frac{L_b}{i_{\min}} = \frac{1000}{7.65} = 130.7$$

Fifth step (Critical Load)

$$P_{cr} = \frac{\pi^2 \ E \ I_{\min}}{L_b^{\ 2}} = \frac{\pi^2 * 2100 * 9010}{(1000)^2} = 186.75t$$

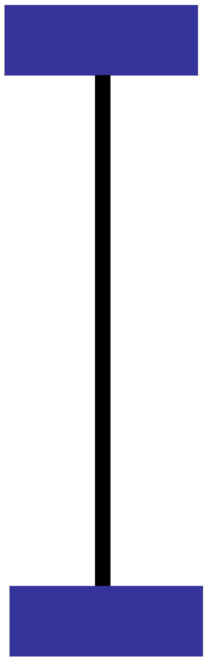
six step (Permissible Load) by $(st52 \ \& \ \lambda = 130)$

$$\sigma_{pb} = \frac{7500}{\lambda^2} = \frac{7500}{(130.7)^2} = 0.438t/cm2 \quad --- \quad P_{pb} = \sigma_{pb} * A = 0.438 * 154 = 67.45t$$

seven step (Factor of safety)

$$n = \frac{P_{cr}}{P_{pb}} = \frac{186.75}{67.45} = 2.77$$

Case (b)



First step

$$(Lb = 500 \ cm)$$

Second step

$$(\mathrm{Im}in = 9010)$$

Third step (Radius of gyration)

$$i_{\min} = \sqrt{\frac{\mathrm{Im}in}{A}} = \sqrt{\frac{9010}{154}} = 7.65cm$$

Fourth step (Sylinderness ratio)

$$\lambda = \frac{L_b}{i_{\min}} = \frac{500}{7.65} = 65.35$$

Fifth step (Critical Load)

$$P_{cr} = \frac{\pi^2 \ E \ I_{\min}}{L_b{}^2} = \frac{\pi^2 * 2100 * 9010}{(500)^2} = 747 \ t$$

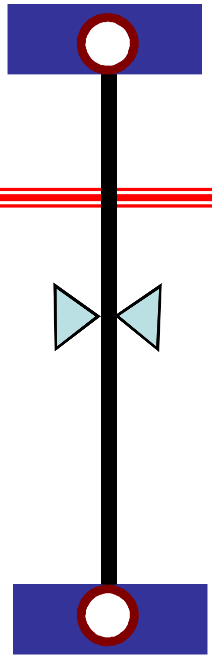
six step (Permissible Load) by (st52 & $\lambda = 65$)

$$\sigma_{pb} = 1.4 - 0.000065\lambda^2 = 1.122t / cm2 \quad --- \quad P_{pb} = 1.122 * 154 = 172.85t$$

seven step (Factor of safety)

$$n = \frac{P_{cr}}{P_{pb}} = \frac{747}{172.85} = 4.32$$

Case (c)



$$(\ Lbx = 1000\ \ cm)$$

$$(\ Ix = 25760)$$

$$ix = \sqrt{\frac{Ix}{A}} = \sqrt{\frac{25760}{154}} = 12.93cm$$

$$\lambda x = \frac{L_{bx}}{i_x} = \frac{1000}{12.93} = 77.32$$

$$P_{cr}x = \frac{\pi^2\ E\ I_x}{L_b x^2} = \frac{\pi^2 * 2100 * 25760}{(1000)^2} = 534\ t$$

$$(st52\ \&\ \ \lambda = 77)$$

$$\sigma_{pb} = 1.0114t / cm2 \qquad -> P_{pb} = 1.0114 * 154 = 155.75t$$

$$n = \frac{P_{cr}}{P_{pb}} = \frac{534}{155.75} = 3.428$$

$$(\ Lby = 500\ \ cm)$$

$$(\ Iy = 9010)$$

$$iy = \sqrt{\frac{Iy}{A}} = \sqrt{\frac{9010}{154}} = 7.65cm$$

$$\lambda y = \frac{L_{by}}{iy} = \frac{500}{7.65} = 65.36$$

$$P_{cr}x = \frac{\pi^2\ E\ I_y}{L_b y^2} = \frac{\pi^2 * 2100 * 9010}{(500)^2} = 747\ t$$

$$(st52\ \&\ \ \lambda = 65.36)$$

$$\sigma_{pb} = 1.1224t / cm2 \qquad -> P_{pb} = 1.1224 * 154 = 172.85t$$

$$n = \frac{P_{cr}}{P_{pb}} = \frac{747}{172.85} = 4.32$$

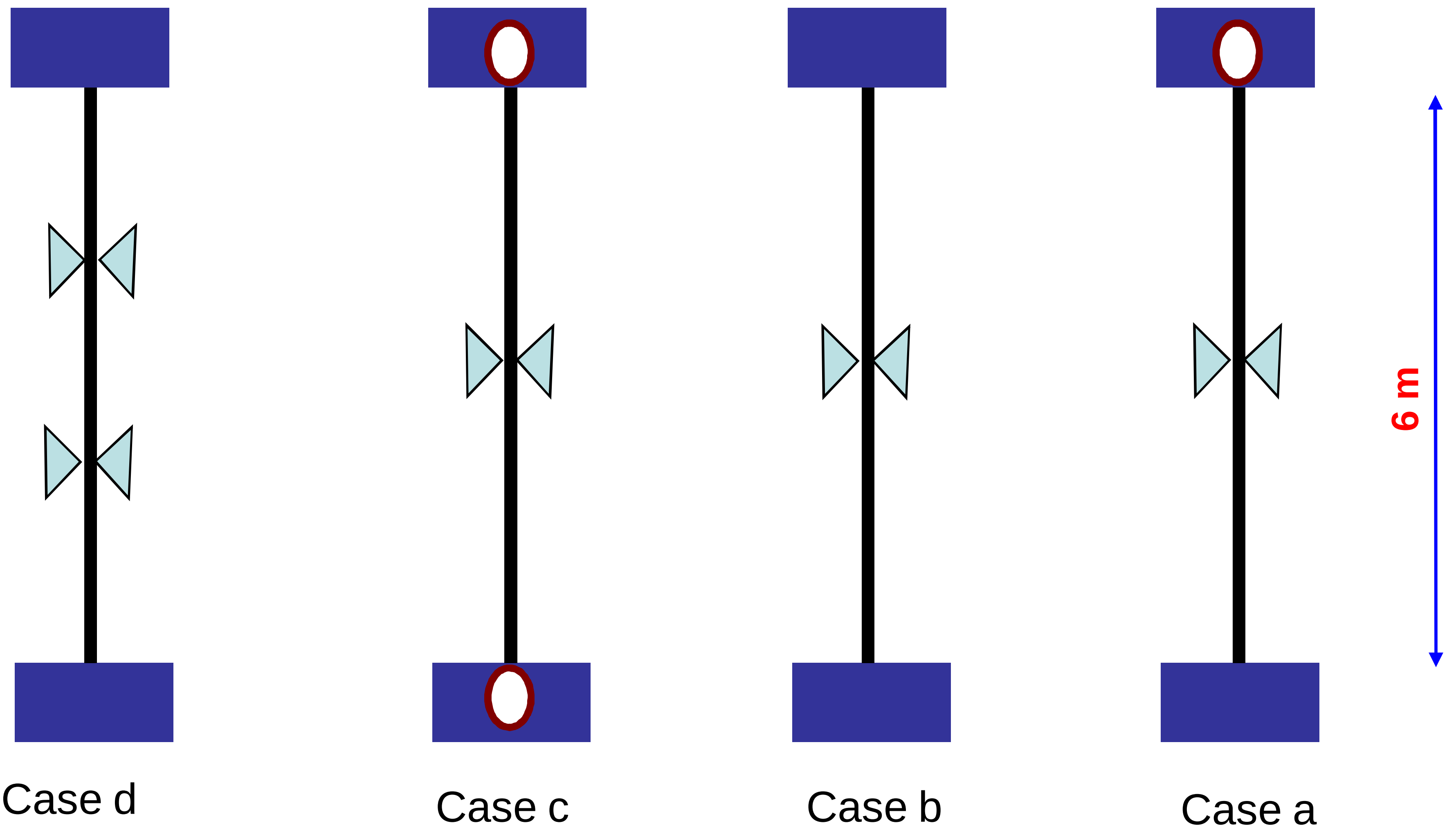
>> Pcr =534

>> Ppb= 155

Example two

Using Euler formula find the critical buckling load for each case of the following member and draw the deformed shape.

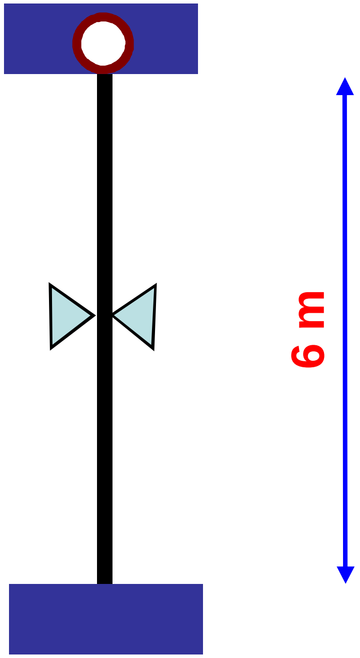
I = 300 cm4   and L = 600cm



Case a

$$(Lb = 300 \ \ cm)$$

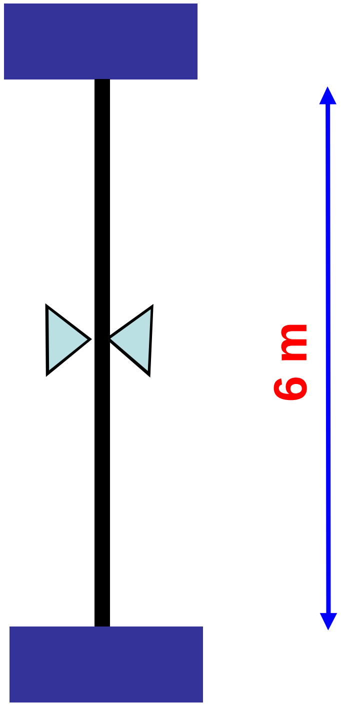
$$P_{cr}x = \frac{\pi^2 \ E \ I_{\min}}{L_b^{\ 2}} = \frac{\pi^2 * 2000 * 300}{(300)^2} = 65.8 \ ton$$



Case b

$$(Lb = 0.7 * 300 = 210 \ \ cm)$$

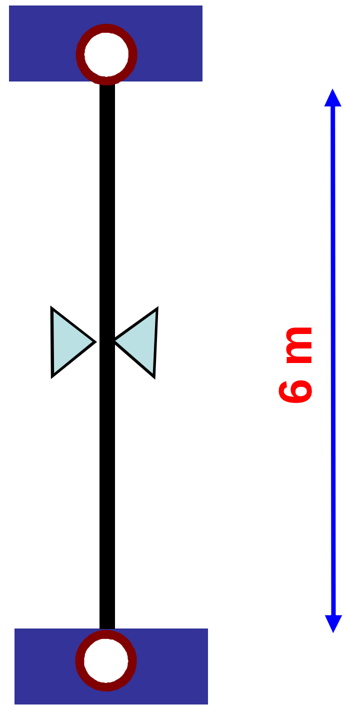
$$P_{cr}x = \frac{\pi^2 \ E \ I_{\min}}{L_b^{\ 2}} = \frac{\pi^2 * 2000 * 300}{(210)^2} = 134 ton$$



Case c

$$(Lb = 300 \ cm)$$

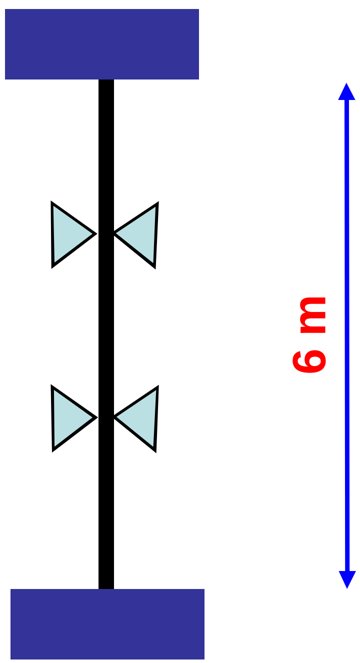
$$P_{cr}x = \frac{\pi^2 \ E \ I_{\min}}{L_b^{\ 2}} = \frac{\pi^2 * 2000 * 300}{(300)^2} = 65.8 \ ton$$



Case d

$$(Lb = 200 \ cm)$$

$$P_{cr}x = \frac{\pi^2 \ E \ I_{\min}}{L_b^{\ 2}} = \frac{\pi^2 * 2000 * 300}{(200)^2} = 148 \, ton$$



Example three

$given$

$for \quad IBE30$

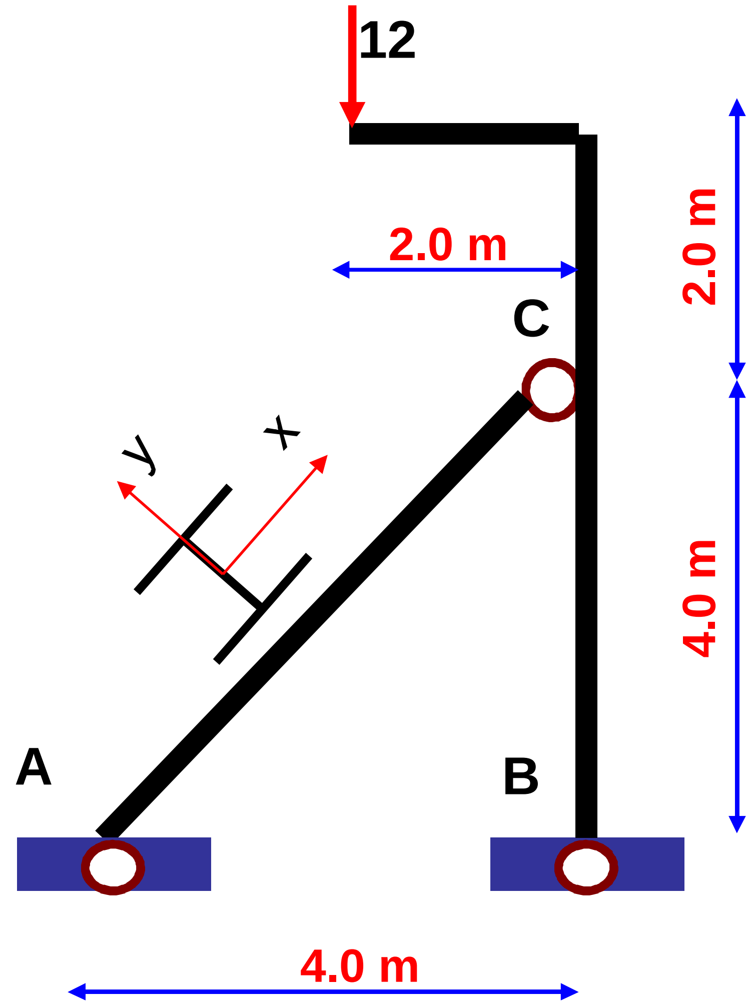
$$Ix = 5740$$

$$Iy = 988$$

$$E = 2100$$

$$A = 53.4$$

$st \;\; 37$



(a) Required Ppb in member AC

(b) Actual F. O. S

(c) Increase the permissible load to the twice without increase dimension of section

$\Sigma M_B = 0.0$

F cos 45 *4 = 12 * 2

F=8.5 ton

$(Lb = 565 \ cm)$

$(I_{min} = 988)$

$$i = \sqrt{\frac{I}{A}} = \sqrt{\frac{988}{53.4}} = 4.3 \, cm$$

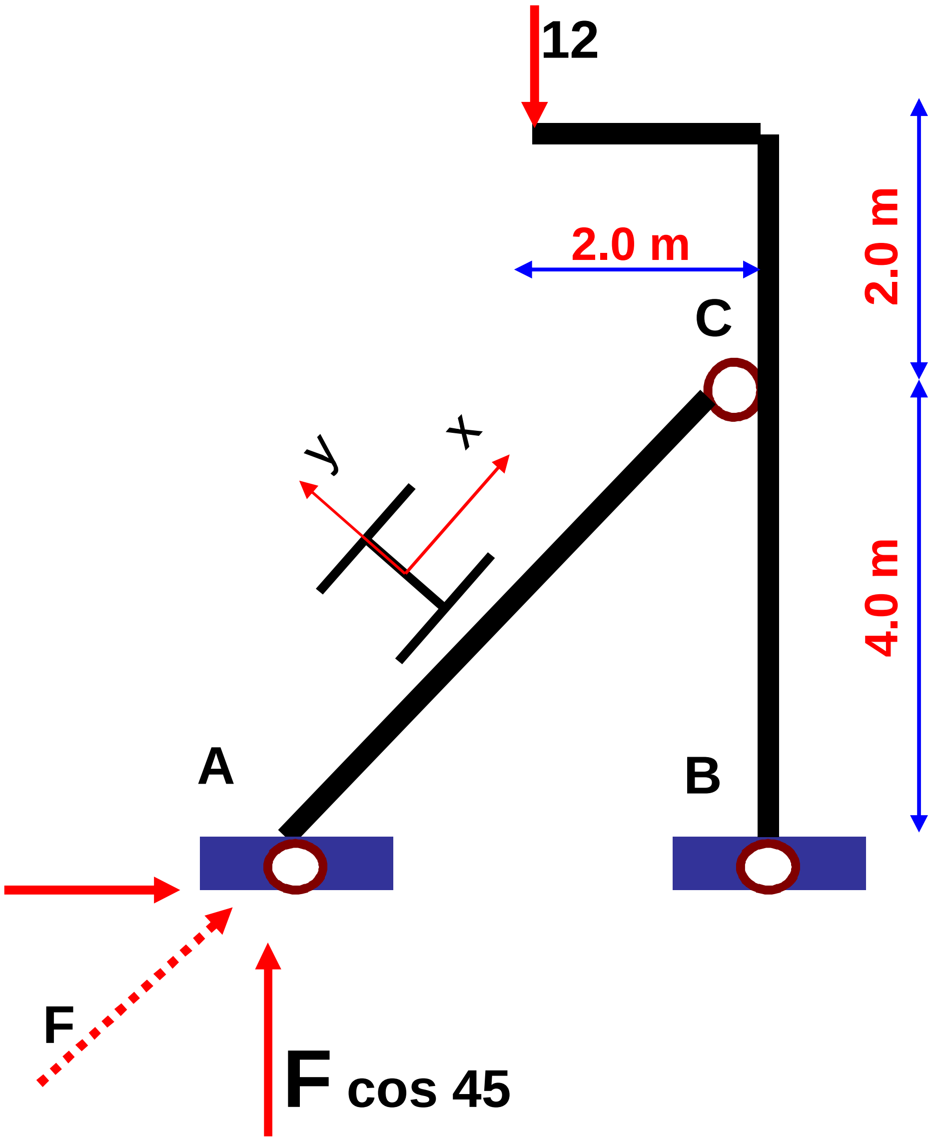
$$\lambda = \frac{L_b}{i_x} = \frac{565}{4.3} = 131 > 104$$

$$P_{cr} = \frac{\pi^2 \ E \ I}{L_b^2} = \frac{\pi^2 * 2100 * 988}{(565)^2} = 20.37 \ ton$$

$(st37 \ \& \ \lambda = 131)$

$$\sigma_{pb} = \frac{6000}{131^2} t / cm2 \quad -> P_{pb} = 0.3496 * 53.4 = 18.67 \ t$$

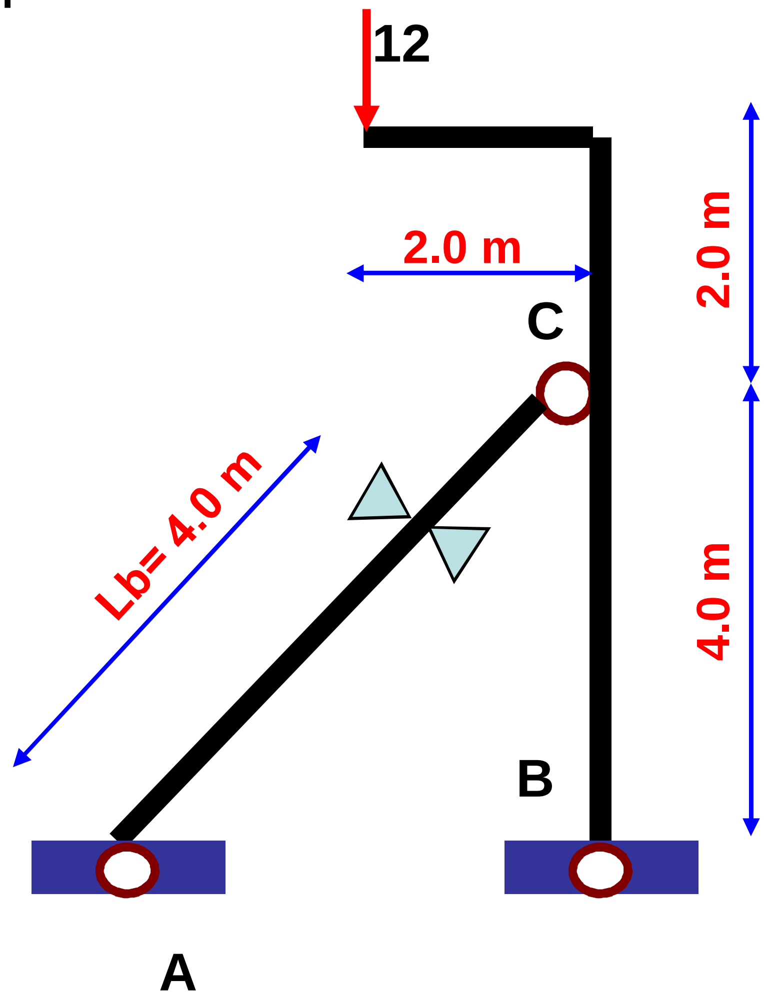
$$n_{actual} = \frac{20.37}{8.5} = 2.4$$



$$P_{pb} = 2*18.67 = 37.35 \quad >> \qquad \sigma_{pb} = \frac{37.35}{53.4} = 0.7$$

$$\sigma_{pb} = \frac{6000}{\lambda^2} = 0.7 \quad -> \quad \lambda = 92.6$$

$$\lambda = \frac{L_b}{4.3} = 92.6 \quad ---> L_b = 400cm$$



يتم ترك خواص القطاع كما هى

ويتم مضاعفة الـ Ppb وبالراجع يتم حساب Lb

بســــم اللــــــه الرحمـــن الرحيـــم

Buckling in Columns

Normal and Moment

Eng : Ayman abdo

حالة ان يكون العمود معرض لـ normal and moment

$$\sigma_{\max} = \frac{P}{A} * \frac{\sigma_{pc}}{\sigma_{pb}} + \frac{M_x}{I_x} * y + \frac{M_y}{I_y} * x \leq \sigma_{pc}$$

σ_{pc} (permissible compression)

for st37---- σpc = 1.1 t/cm2

for st44---- σpc = 1.3 t/cm2

for st52---- σpc = 1.4 t/cm2

σ_{pb} (permissible buckling)

Lb = ……

imin=…….

λ = ……..

Σpb=……

خــواص القطـــاع

A, Ix, Iy

given

خــواص القطـــاع

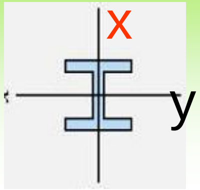
x, y

معطاة على القطاع

فى المسائل لا يوجد الا عزم واحد فقط من العزمين Mx, My

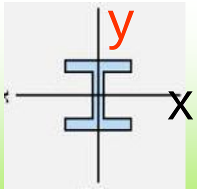
P {normal force in the column}

Mx {normal force in the column}



عندما يكون المحور x هو العمودى

My {normal force in the column}



عندما يكون المحور y هو العمودى

افكار المسائل

النوعية الأولى

معطى كـــــل الاحمـــال علـــى المنشـــــأ
والمطلـــــوب عمل (check)

1- calculate --------- P, (Mx or My)

2- σ_{max} = from the equation=------

3- if $\sigma_{max} \leq \sigma_{pc}$ safe

4- if $\sigma_{max} > \sigma_{pc}$ unsafe

النوعية الثانية

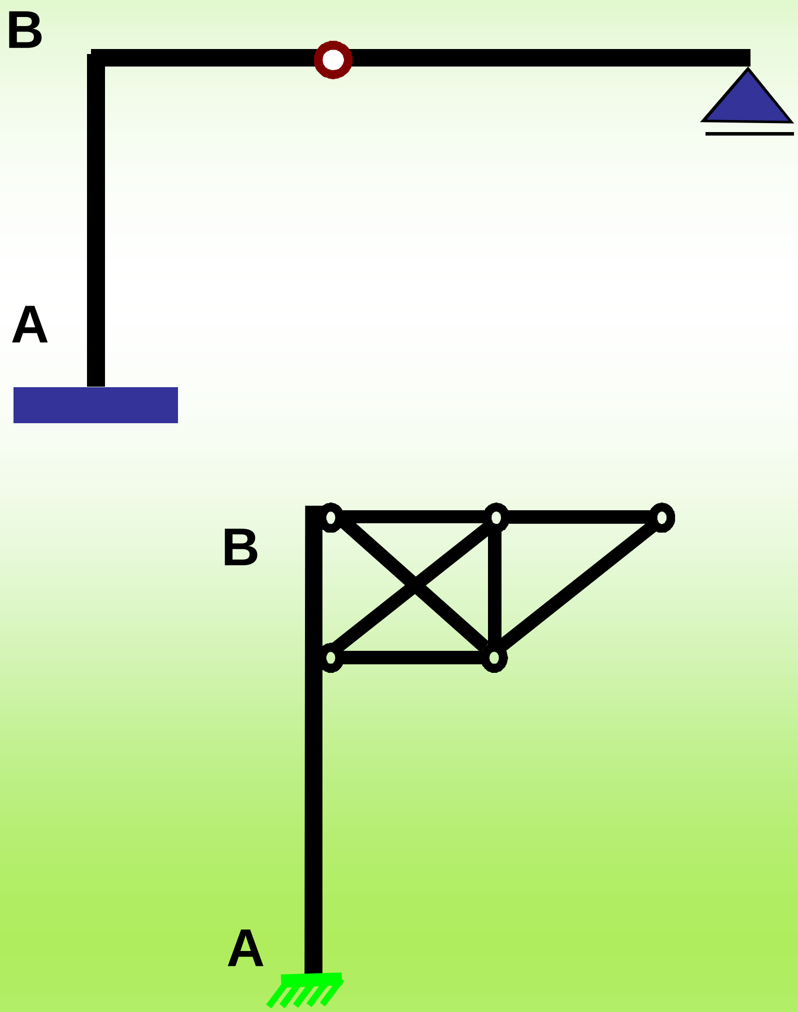
معطى حمـــل مجهول علـــى المنشـــــأ
والمطلـــــوب عمل (max load)

1- calculate - P, (Mx or My)
بدلالة المجهول

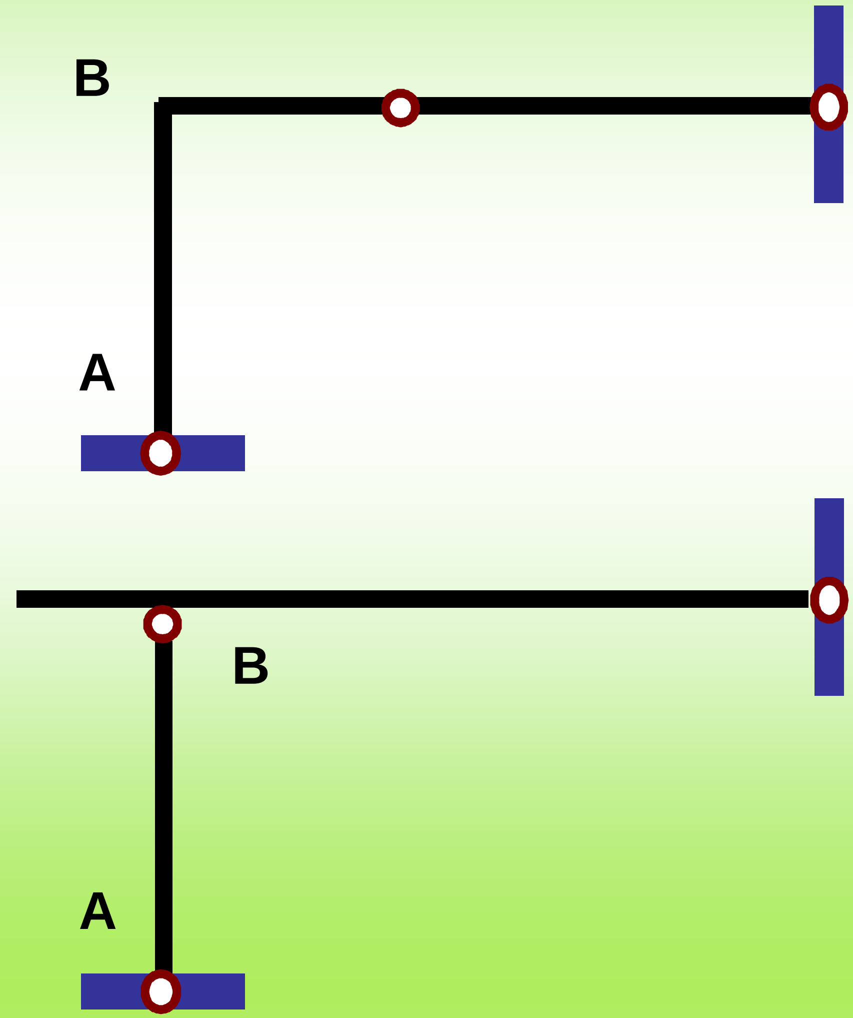
2- σ_{max} = as a function of P
بدلالة المجهول

3- $\sigma_{max} = \sigma_{pc}$
>>>> P=----

Buckling length



فى المســائل اذا كان العمــود مثبــت على الارض
بـ fixed فيتم اخذه (fixed – free)



فى المســائل اذا كان العمــود مثبــت على الارض
بـ hinge فيتم اخذه (hinged – hinged)

Example one

$$given$$

$$for \quad IBE32$$

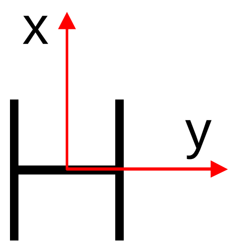
$$Ix = 45000$$

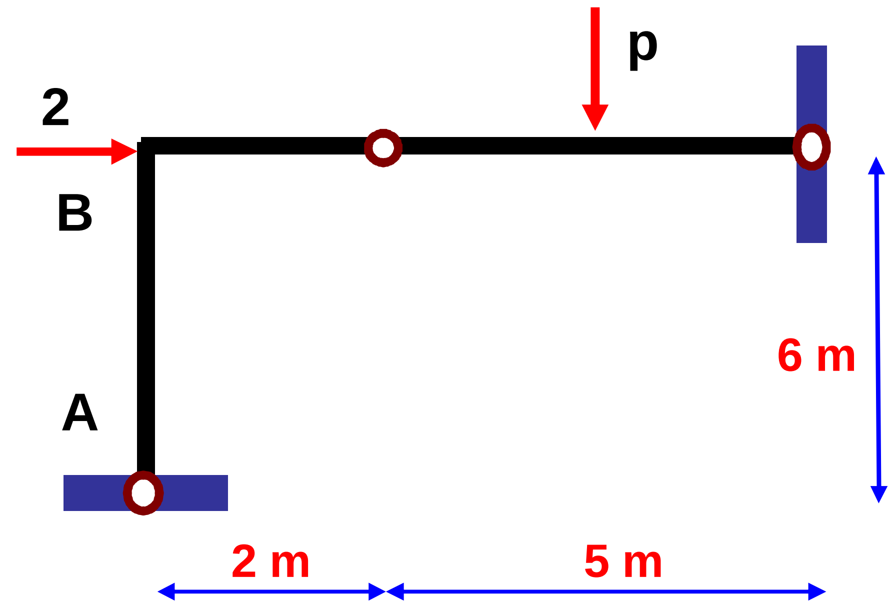
$$Iy = 10800$$

$$E = 2000$$

$$A = 190$$

$$st \quad 44$$

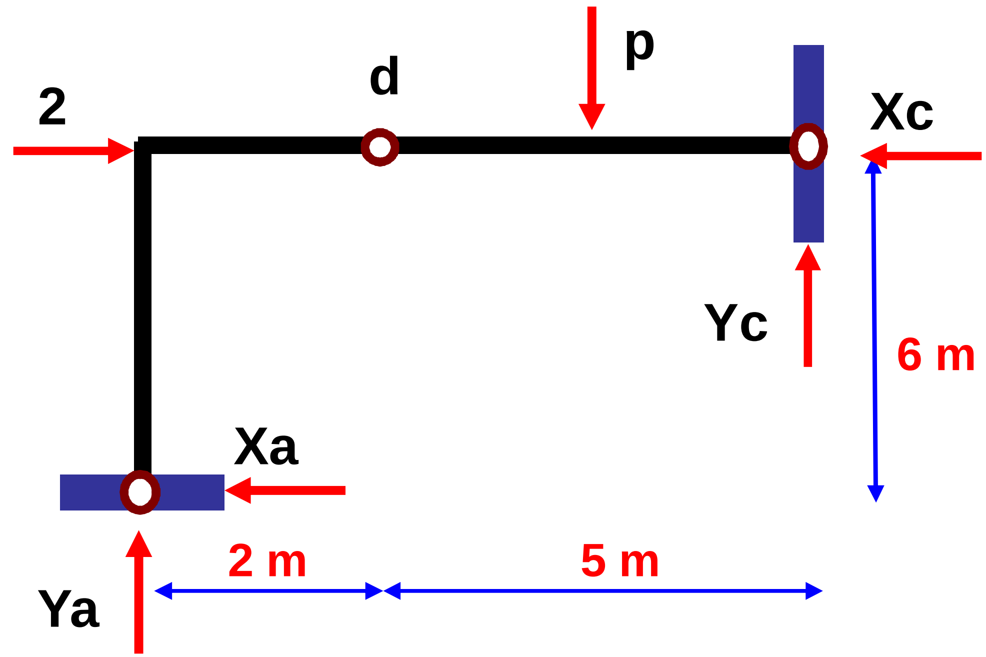




Required for column AB :

(1) max safe load P.

(2) critical load Pcr.



$\sum M_{dr}$ ↻ = 0.0

P * 2.5 – Yc*5 = 0.0 >> Y_c = 0.5 P

$\sum F_Y$ = 0.0

Y_A = 0.5 P

$\sum M_A$ ↻ = 0.0

P * 4.5 – 0.5 P * 7 – Xc *6= 0.0 >> X_c = 2 + P/6

$\sum F_X$ = 0.0

X_A = 2.0

الـ normal فى العمود A-B (N = 0.5 P t)

محور x لاعلى -- Mx هى اللى شغالة – (Mx = 2*600 = 1200 t.cm)

العمود A-B مثبت بـ hinge على الارض (hinged – hinged) ---- L_b = 600cm

$$\sigma_{max} = \frac{P}{A} * \frac{\sigma_{pc}}{\sigma_{pb}} + \frac{M_x}{I_x} * y$$

$(Lb = 600 \ cm)$

$$i = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{10800}{190}} = 7.54 \ cm$$

$$\lambda = \frac{L_b}{i_x} = \frac{600}{7.54} = 79.6 < 96$$

$$P_{cr} = \frac{\pi^2 \ E \ I}{L_b^2} = \frac{\pi^2 \ * 2000 * 10800}{(600)^2} = 592 \ ton$$

$$\sigma_{pb} = 1.3 - 0.00007 \lambda^2 = 0.856 \quad t/cm2$$

for st44---- σpc = 1.3 t/cm2

خــواص القطـــاع
A=190
Ix=45000
y = 16

(Mx = 1200 t.cm)

(N = 0.5 P t)

$$\sigma \max = \frac{0.5P}{190} * \frac{1.3}{0.856} + \frac{1200}{45000} * 16 = 1.3$$

$$>>>> \quad P \max = 32.87 \ ton$$

Example two

$given$

$for \quad IBE32$

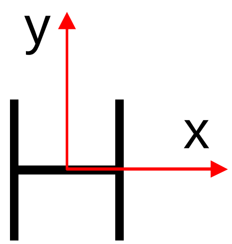
$Ix = 4670$

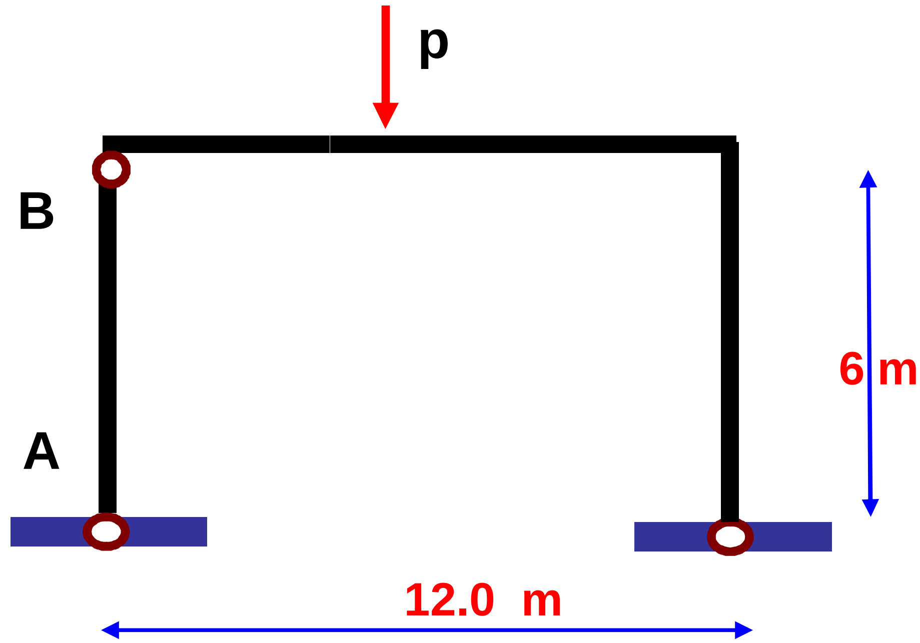
$Iy = 13900$

$E = 2000$

$A = 254$

$st \quad 44$





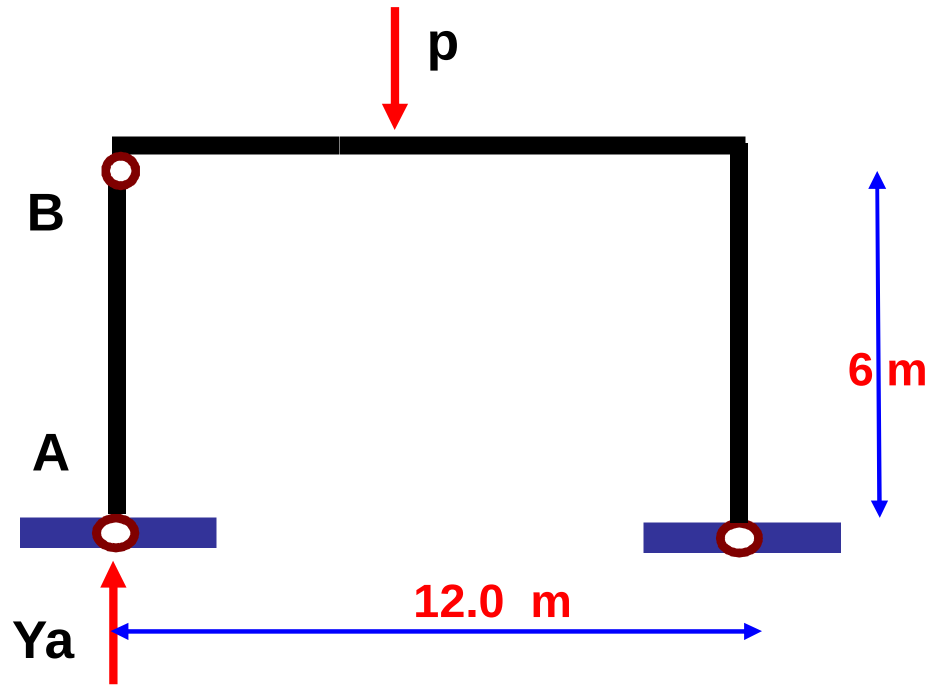
Required in column AB:

(1) max safe load P.

(2) critical load Pcr.

$\sum F_Y = 0.0$

$Y_A = 0.5\ P$



(N = 0.5 P t)

(My = 0.0 for link member)

for st44---- σpc = 1.3 t/cm2

Lb = 600cm ---- (hinged – hinged) على الارض hinge العمود A-B مثبت بـ

خــواص القطـــاع
A=254
Iy=13900
x = 16

$$\sigma \max = \frac{P}{A} * \frac{\sigma pc}{\sigma pb} + \frac{My}{Iy} * x = \sigma pc$$

$$(Lb = 600 \quad cm)$$

$$i = \sqrt{\frac{\operatorname{Im} in}{A}} = \sqrt{\frac{4670}{254}} = 4.28 \quad cm$$

$$\lambda = \frac{Lb}{i} = \frac{600}{4.28} = 140 < 96$$

$$Pcr = \frac{\pi^2 E I}{Lb^2} = \frac{\pi^2 * 2000 * 4670}{(600)^2} = 256 \quad ton$$

$$\sigma pb = \frac{6000}{140^2} = 0.306 \quad t / cm \ 2$$

$$\sigma \max = \frac{0.5P}{254} * \frac{1.3}{0.306} = 1.3$$

>>>> $P \max = 77 \ ton$

Example three

$$for \quad BFIB \quad No \quad 30$$

$$A = 100 \quad cm^2$$

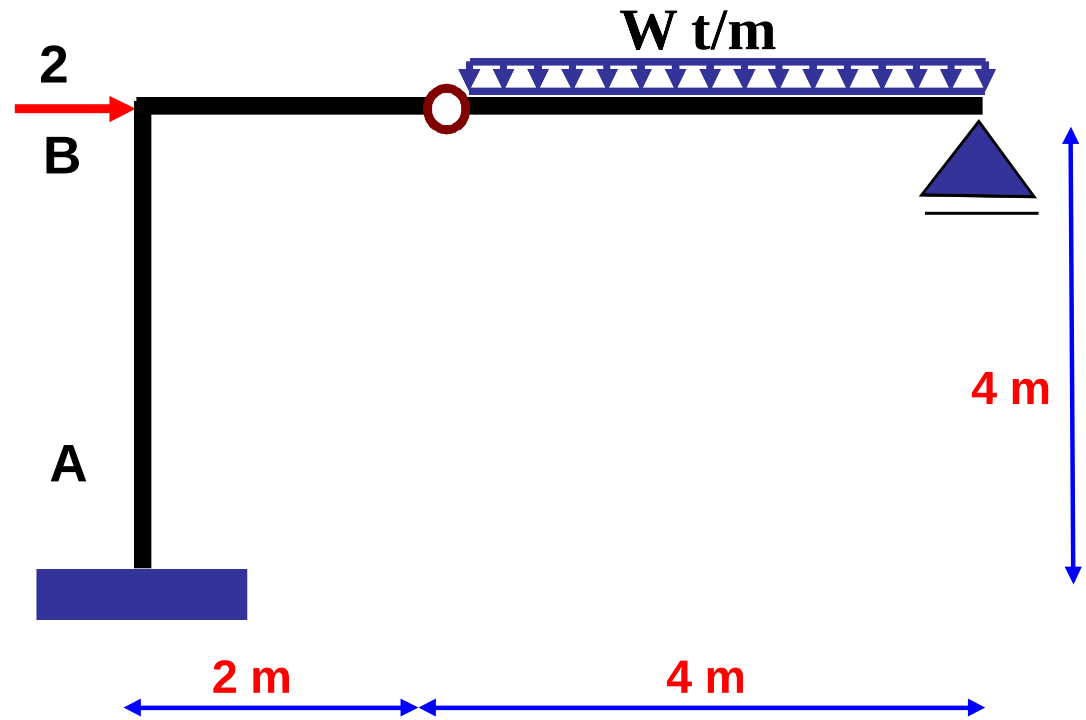
$$Ix = 5000 \quad cm^4$$

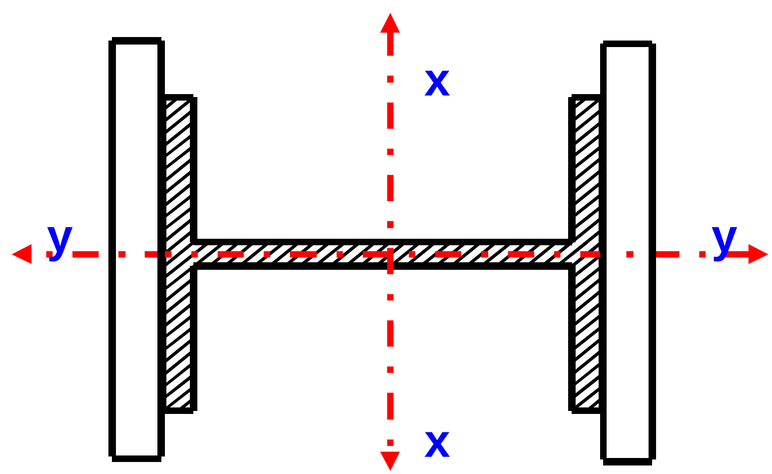
$$Iy = 10000 \quad cm^4$$

2 plates 2*40 cm

$$E = 2000$$

$$st \ 52$$





Required for column AB :

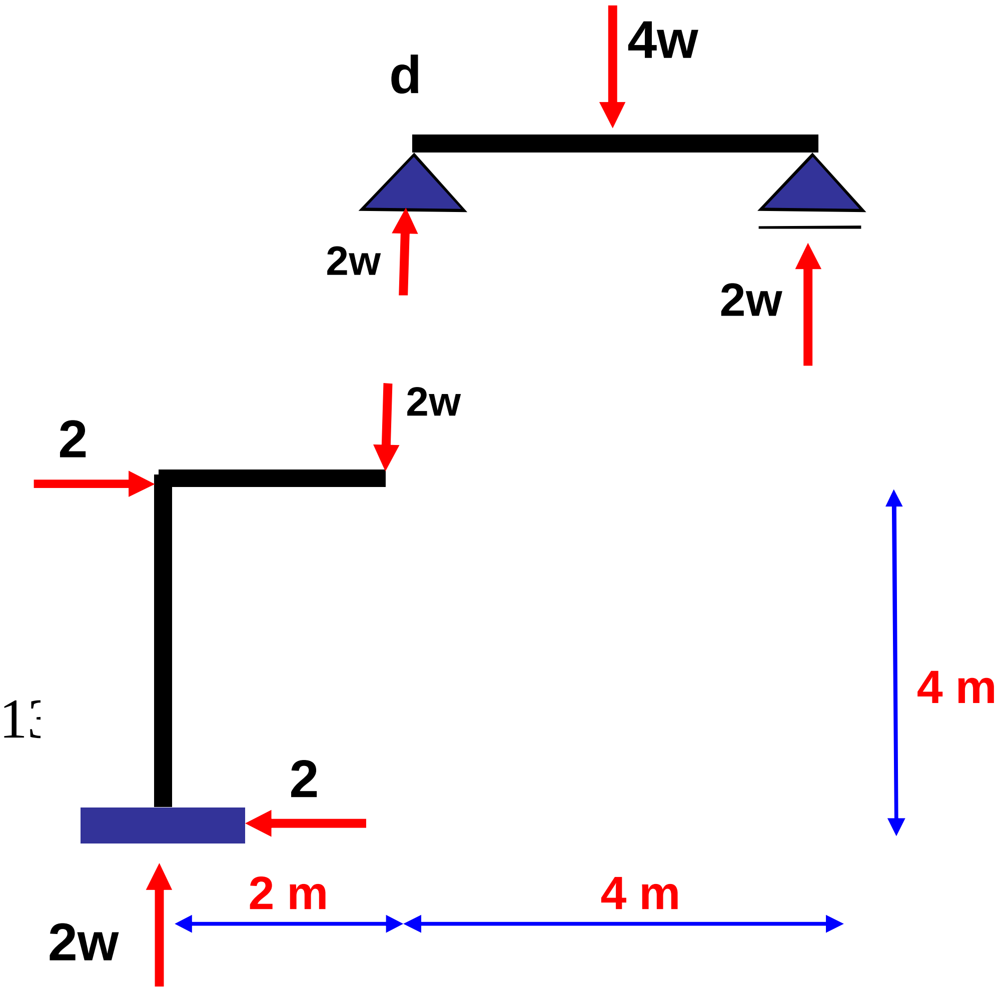
(1) W max.

(2) critical load Pcr.

$$A = 100 + 160 = 260\ cm^2$$

$$Ix = 5000 + 2 * \left(\frac{2*(40)^3}{12} \right) = 27333$$

$$Iy = 10000 + 2 * \left(\frac{40*(2)^3}{12} + 80*(16)^2 \right) = 51013$$



(N = 2w t) A-B الـ normal فى العمود

(Mx = 2*400 + 2w * 200 = 800+400w) – محور x لاعلى -- Mx هى اللى شغالة

L_b = 2*400 = 800 cm ---- (fixed – free) العمود A-B مثبت بـ fixed على الارض

$$\sigma \max = \frac{P}{A} * \frac{\sigma pc}{\sigma pb} + \frac{Mx}{Ix} * y$$

$$(\, Lb = 800 \;\; cm \,)$$

$$i = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{27333}{260}} = 32.42 \; cm$$

$$\lambda = \frac{L_b}{i_x} = \frac{800}{32.42} = 24.7 \; < 85$$

$$P_{cr} = \frac{\pi^2 \; E \; I}{L_b^2} = \frac{\pi^2 \; * 2000 * 27333}{(800)^2} = 843 \; ton$$

$$\sigma_{pb} = 1.4 - 0.000065 \lambda^2 = 1.36 \;\; t / cm2$$

for st52---- σpc = 1.4 t/cm2

خـــواص القطـــاع
A=260
Ix=27333
y = 15+2=17

(Mx = 800+400w)

(N = 2w t)

$$\sigma \max = \frac{2w}{260} * \frac{1.4}{1.36} + \frac{(800 + 400w)}{27333} * 17 = 1.4$$

$$>>>> \qquad w\max = 3.5 \; t / m$$

Example four

given

for $IBE30$

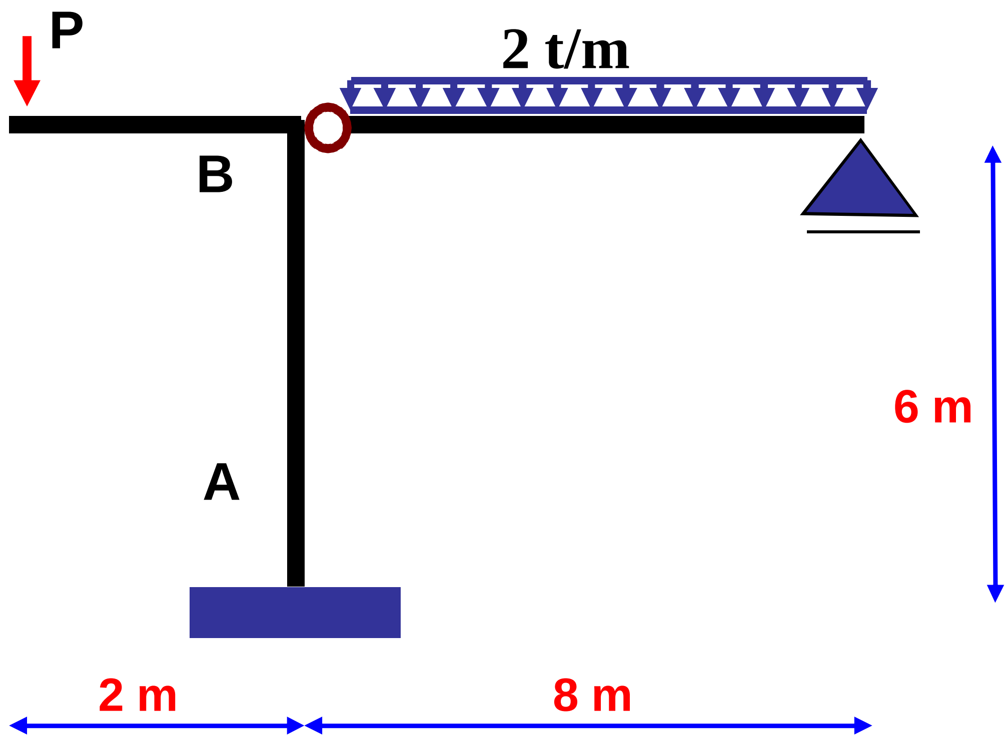
$$Ix = 80000$$

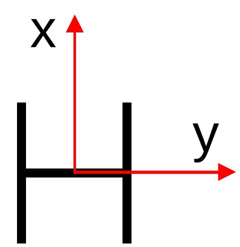
$$Iy = 120000$$

$$E = 2100$$

$$A = 300$$

$st\ 37$

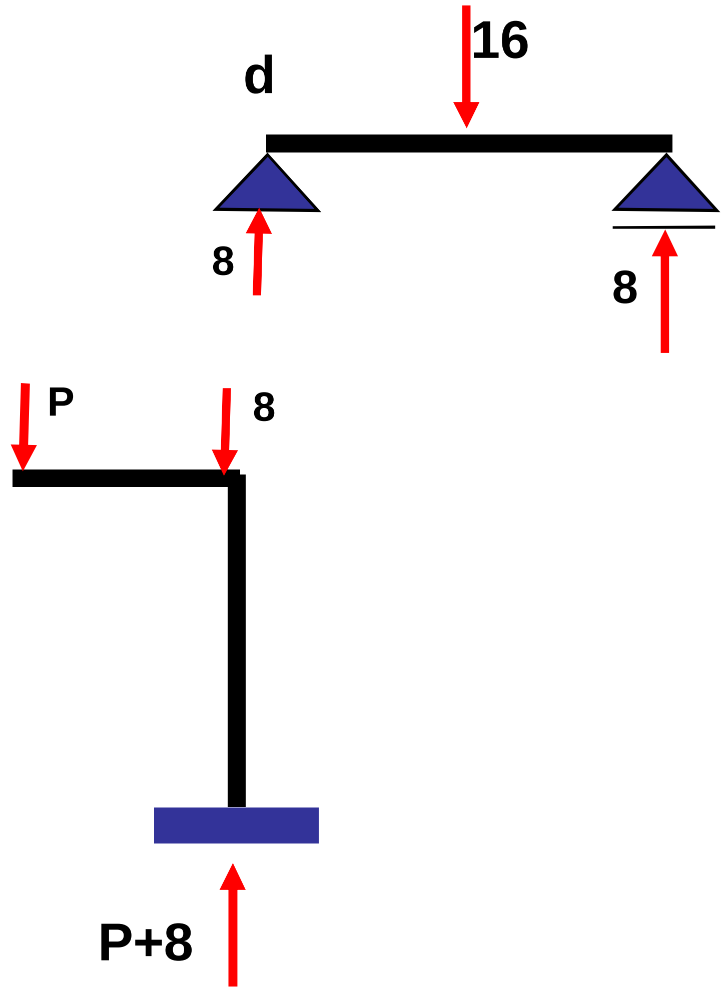




Required for column AB :

(1) P max.

(2) critical load Pcr.



الـ normal فى العمود A-B (N = (P+8))

محور x لاعلى -- Mx هى اللى شغالة – (Mx = 200*P=200P)

العمود A-B مثبت بـ fixed على الارض (fixed – free) ---- $L_b = 2*600 = 1200$ cm

$$\sigma \max = \frac{P}{A} * \frac{\sigma pc}{\sigma pb} + \frac{Mx}{Ix} * y$$

$$(Lb = 1200 \ \ cm)$$

$$i = \sqrt{\frac{I_{\min}}{A}} = \sqrt{\frac{80000}{300}} = 16.33 \ cm$$

$$\lambda = \frac{L_b}{i_x} = \frac{1200}{16.33} = 73.44 < 104$$

$$P_{cr} = \frac{\pi^2 \ E \ I}{L_b^2} = \frac{\pi^2 * 2100 * 80000}{(1200)^2} = 115 \ ton$$

$$\sigma_{pb} = 1.1 - 0.00005\lambda^2 = 0.83 \ \ t/cm2$$

for st37---- σpc = 1.1 t/cm2

خــواص القطـــاع
A=300
Ix=80000
y = 15

(Mx = 200P)

(N = 8+P)

$$\sigma \max = \frac{(8+P)}{300} * \frac{1.1}{0.83} + \frac{200P}{120000} * 15 = 1.1$$

$$>>>> \quad P\max = 52 \ t/m$$

Example five
Final 2009

given

for IBE32

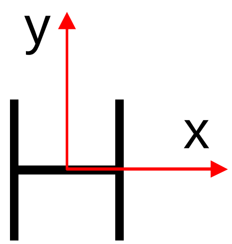
$$Ix = 4670$$

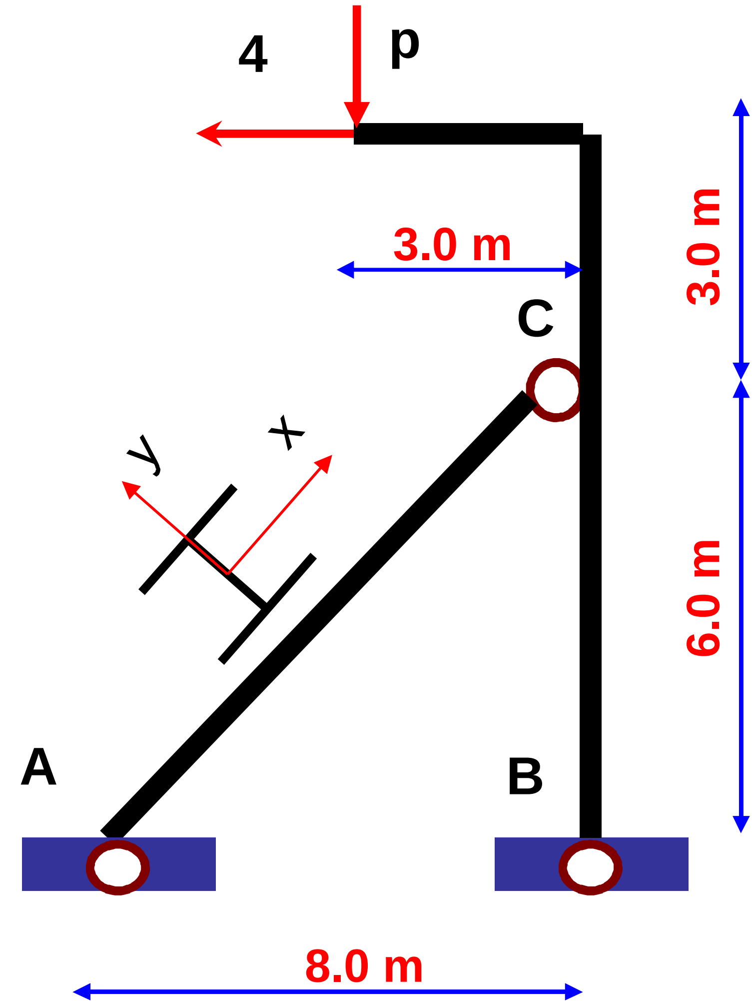
$$Iy = 13900$$

$$E = 2000$$

$$A = 254$$

st 44





Required in column AB:

(1) max safe load P.

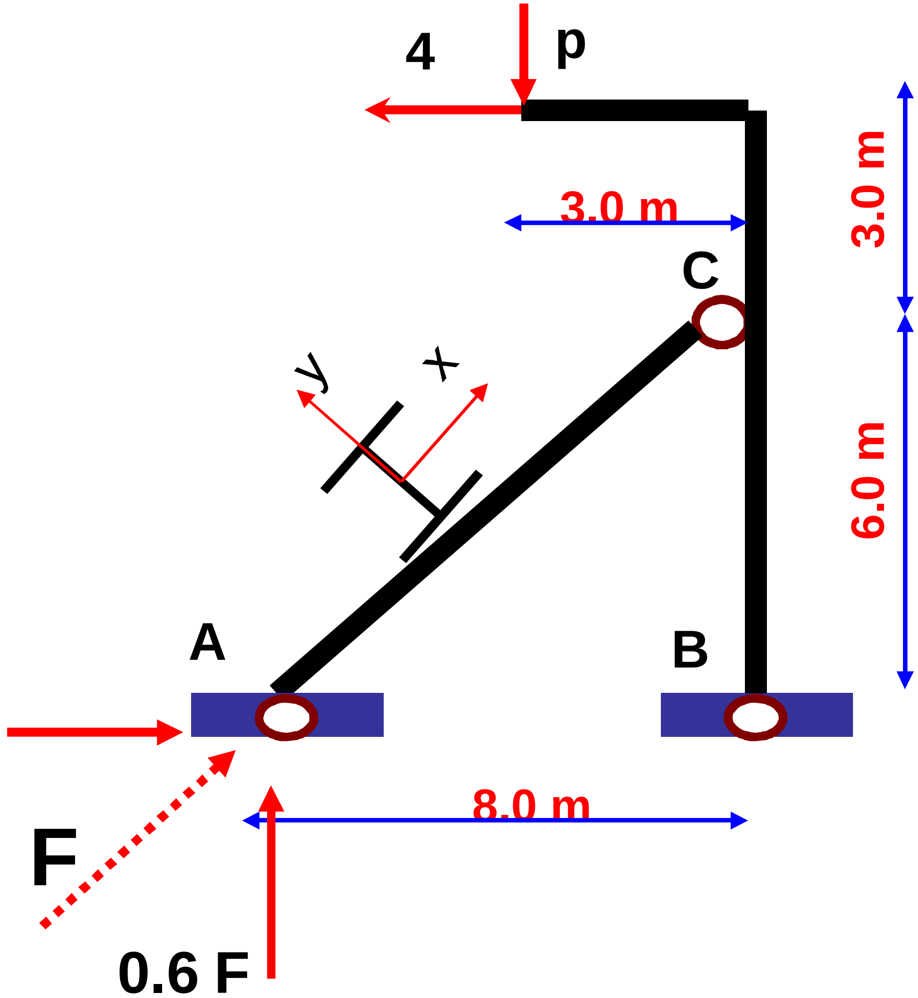
(2) critical load P_{cr} and factor of safety.

(3) derive the formula of Buckling length

$$\Sigma M_B = 0.0$$

$$0.6\ F * 8 = 4*9+3P$$

$$F = 0.625P+7.5$$



(N = 0.625 P +7.5)

For st44 ---- σpc = 1.3 t/cm2

L_b = 1000cm ---- (hinged – hinged) على الارض hinge العمود A-C مثبت بـ

خـــواص القطـــاع
A=254
Iy=13900
x = 16

$$\sigma \max = \frac{P}{A} * \frac{\sigma pc}{\sigma pb} = \sigma pc$$

$$(Lb = 1000 \ cm)$$

$$i = \sqrt{\frac{\text{Im } in}{A}} = \sqrt{\frac{4670}{254}} = 4.28 \ cm$$

$$\lambda = \frac{Lb}{i} = \frac{1000}{4.28} = 233 < 96$$

$$Pcr = \frac{\pi^2 EI}{Lb^2} = \frac{\pi^2 * 2000 * 4670}{(1000)^2} = 92 \ ton$$

$$\sigma pb = \frac{6000}{233^2} = 0.11 \ t/cm2$$

$$\sigma \max = \frac{7.5 + 0.625P}{254} * \frac{1.3}{0.11} = 1.3$$

$$>>>> \quad P\max = 32 \ ton$$

$$FoS = \frac{92}{32} = 2.81$$

Example six
Final 2008

given

for $IBE32$

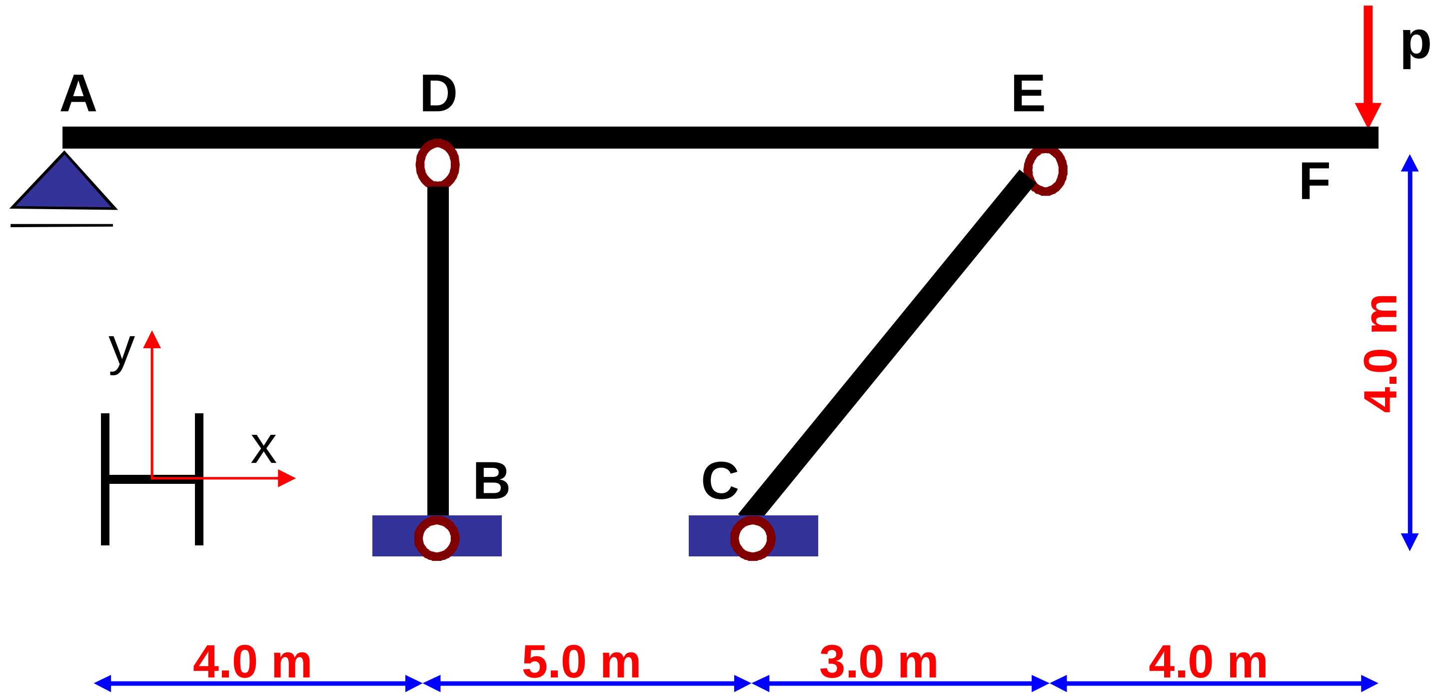
$Ix = 4670$

$Iy = 13900$

$E = 2000$

$A = 254$

$st\ 44$



Required in column BD:

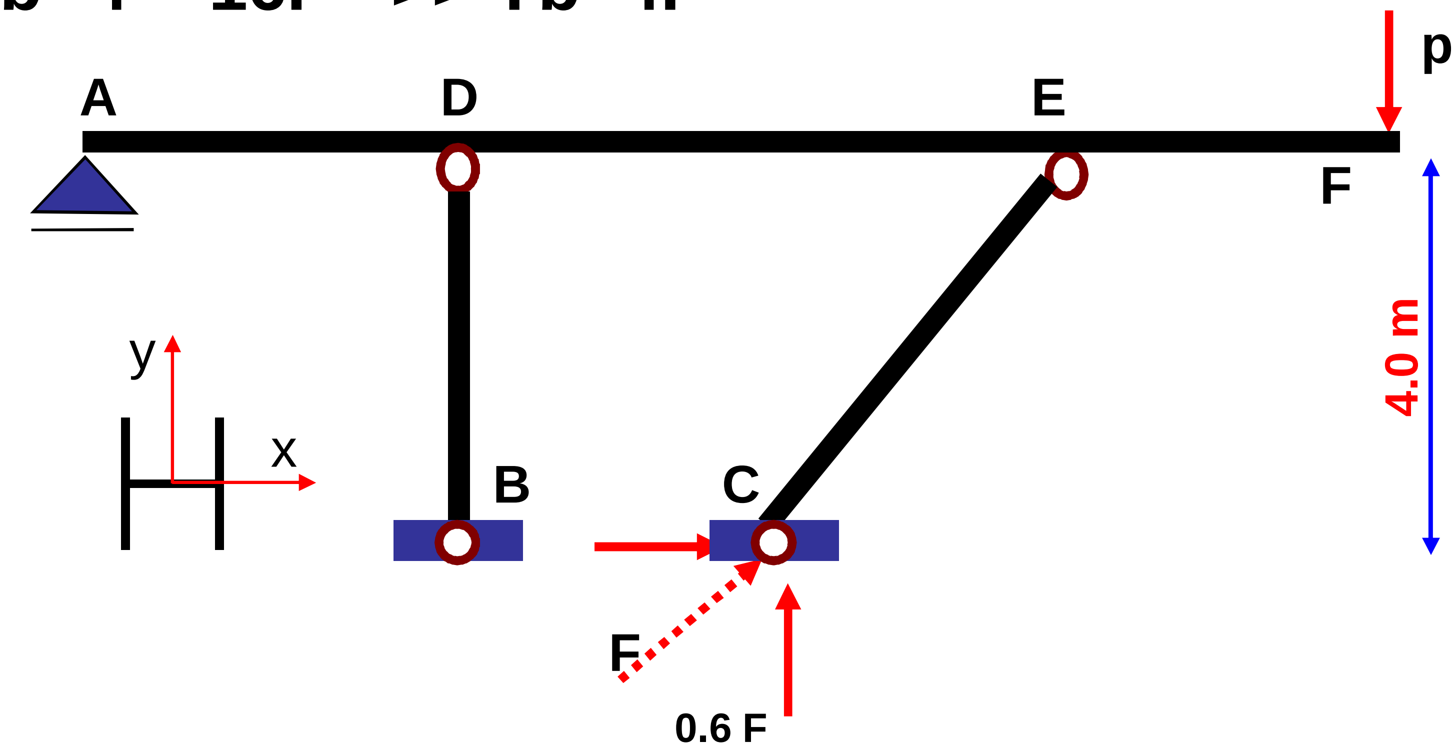
(1) max safe load P.

(2) critical load P_{cr} and factor of safety.

(3) derive the formula of Buckling length

Force in member CE is zero

$\Sigma M_A = 0.0$ Yb *4 = 16P >> Yb=4P



L_b = 400cm ---- (hinged – hinged) على الارض hinge مثبت بـ B-D العمود

خـــواص القطـــاع

A=254, Iy=13900, x = 16

(N = 4P)

For st44 ---- σpc = 1.3 t/cm2

$$\sigma \max = \frac{P}{A} * \frac{\sigma pc}{\sigma pb} = \sigma pc$$

$$(Lb = 400 \quad cm)$$

$$i = \sqrt{\frac{\operatorname{Im} in}{A}} = \sqrt{\frac{4670}{254}} = 4.28 \quad cm$$

$$\lambda = \frac{Lb}{i} = \frac{400}{4.28} = 93.4 < 96$$

$$Pcr = \frac{\pi^2 E I}{Lb^2} = \frac{\pi^2 * 2000 * 4670}{(400)^2} = 576 \quad ton$$

$$\sigma pb = 1.3 - 0.00007 * 93^2 = 0.6945 \quad t / cm \ 2$$

$$\sigma \max = \frac{4P}{254} * \frac{1.3}{0.6945} = 1.3$$

$$>>>> \quad P \max = 44 \ ton$$

$$FoS = \frac{576}{44} = 13$$

Example seven

$$E = 2000$$

$$st\ 52$$

$for \quad BFIB \quad No \quad 32$

$A = 171 \quad cm^{2}$

$Ix = 32250 \quad cm^{4}$

$Iy = 9910 \quad cm^{4}$

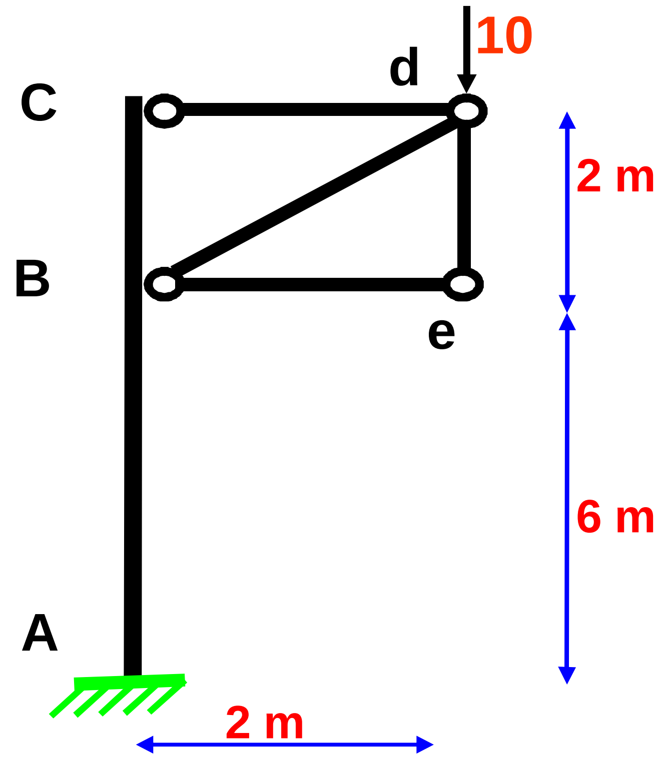
$for \quad CH \quad No \quad 10$

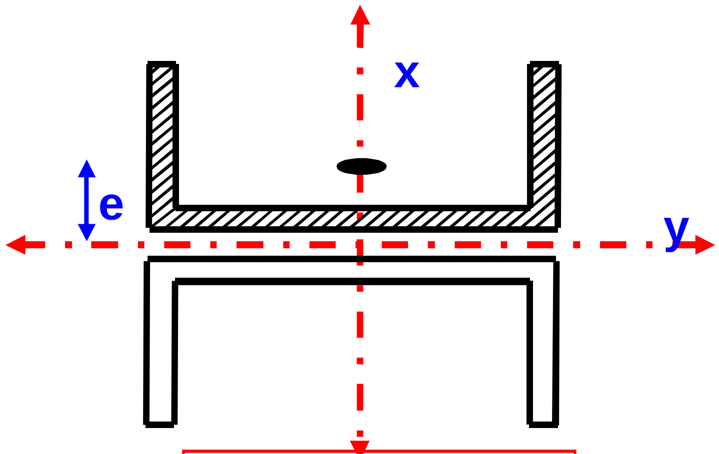
$A = 13.5 \quad cm^{2}$

$Ix = 206 \quad cm^{4}$

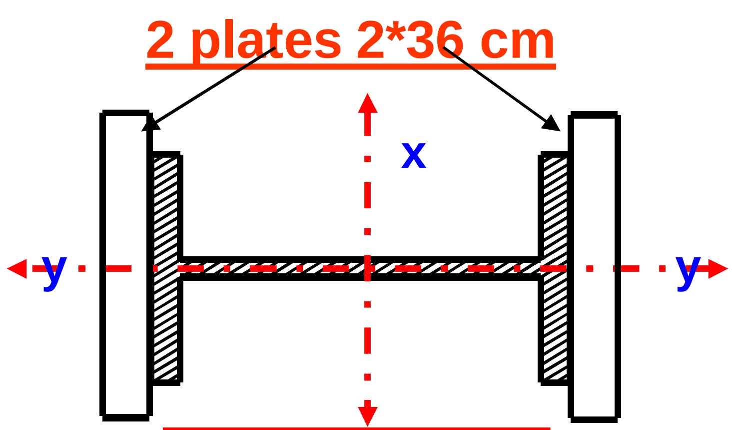
$Iy = 29.3 \quad cm^{4}$

$e = 1.55 \ cm$





For all links



For column

Required check all members

Column section

A=171+2*(36*2)= 315

$Ix=32250+2*(36*2^3/12+36*2*17^2)$
$= 73914$ cm4

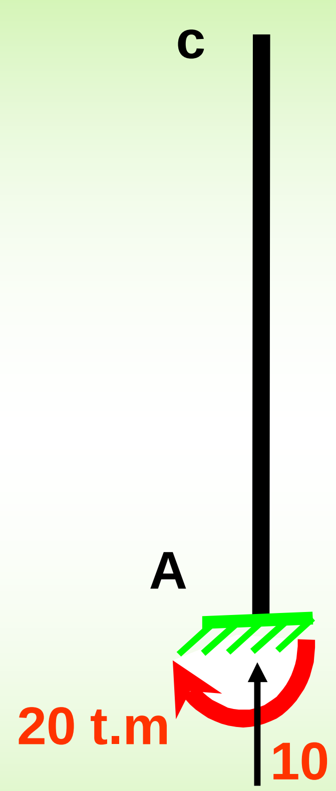
$Iy=9910+2*(2*36^3/12)$
$= 25462$ cm4

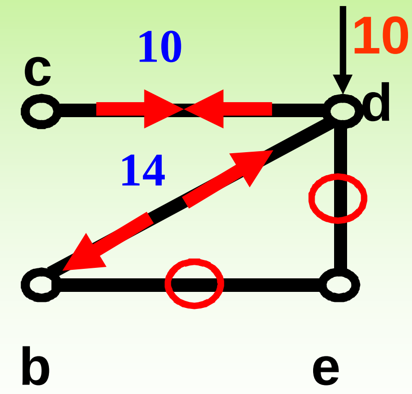
Link section

A= 2 * 13.5 =27

Ix = 2 * 206 = 412 cm4

$Iy = 2*(29.3 + 13.5 * 1.55^2) = 123.5$ cm4





Member (be and ed) --- zero member

Member (cd) --- tension member

Member bd

$$Lb = 283cm$$

$$i\min = \sqrt{\frac{123.5}{27}} = 2.138$$

$$\lambda = \frac{283}{2.138} = 132 \; > 104$$

$$\sigma pb = \frac{6000}{132^2} = 0.343$$

$$\sigma \max \; = \; \frac{14.14}{27} * \frac{1.1}{0.343} = 1.67 > 1.1 \quad unsafe$$

column ac

$$Lb = 1600 \ cm$$

$$i\min = \sqrt{\frac{25462}{315}} = 9$$

$$\lambda = \frac{1600}{9} = 178 \ > 104$$

$$\sigma pb = \frac{6000}{178^2} = 0.1916$$

$$\sigma\max \ = \ \frac{10}{315} * \frac{1.1}{0.1916} + \frac{2000}{73914} * 18 = 0.669 \ < \ 1.1 \quad safe$$

Effect of Temprature

$$\Delta L = \frac{P.L}{E.A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$\Delta L = \alpha.\Delta t.L \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$\frac{P.L}{E.A} = \alpha.\Delta t.L$$

$$>> P = \alpha.\Delta t.E.A$$

$$P \leq Pcr$$

$$\Delta t \leq \frac{\pi^2.\mathrm{Im}in}{\alpha.A.L_b^2}$$

Example one

given

$$for \quad IBE32$$

$$Ix = 12510$$

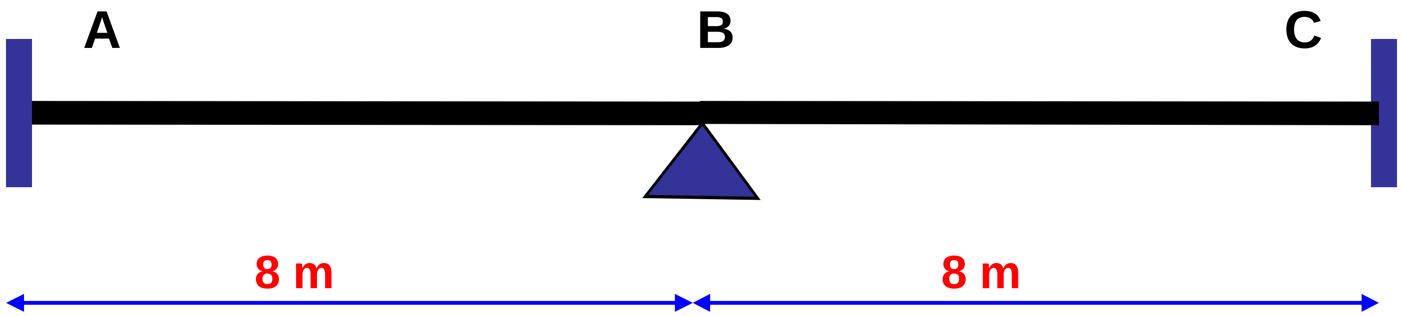
$$Iy = 782$$

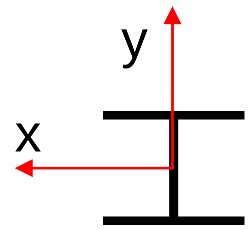
$$E = 2100$$

$$A = 77.8$$

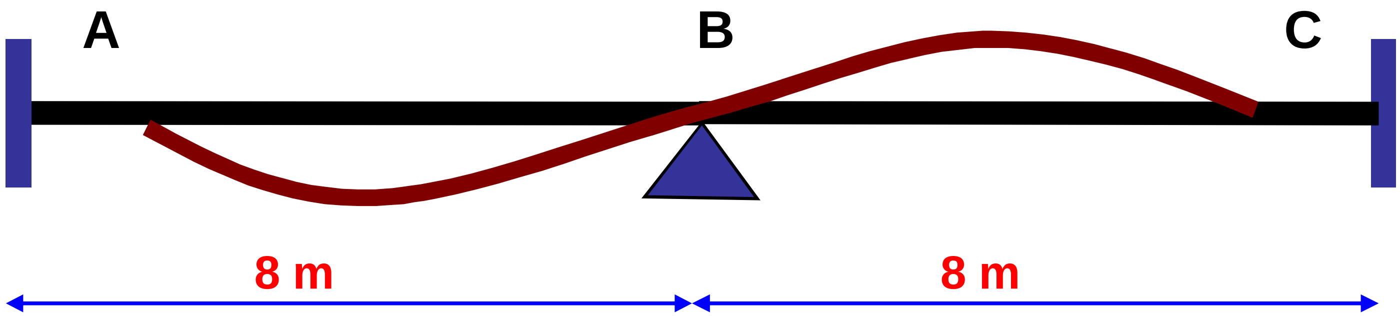
$$st \ 52$$

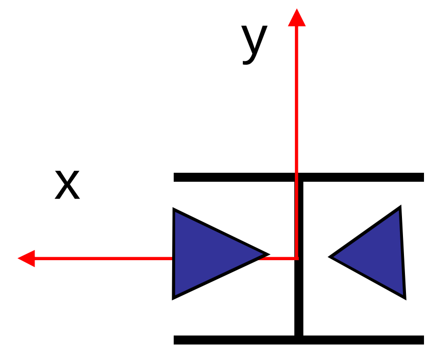
$$\alpha = 1.2 * 10 \wedge (-5)$$





Required Δt_{max}





$$Lb = 0.7 * 800 = 560 cm$$

$$\Delta t \le \frac{\pi^2 .* 782}{1.2 * 10^{-5} * 77.8 * 560^2} = 26.36$$

Example two

given

for $IBE32$

$Ix = 12510$

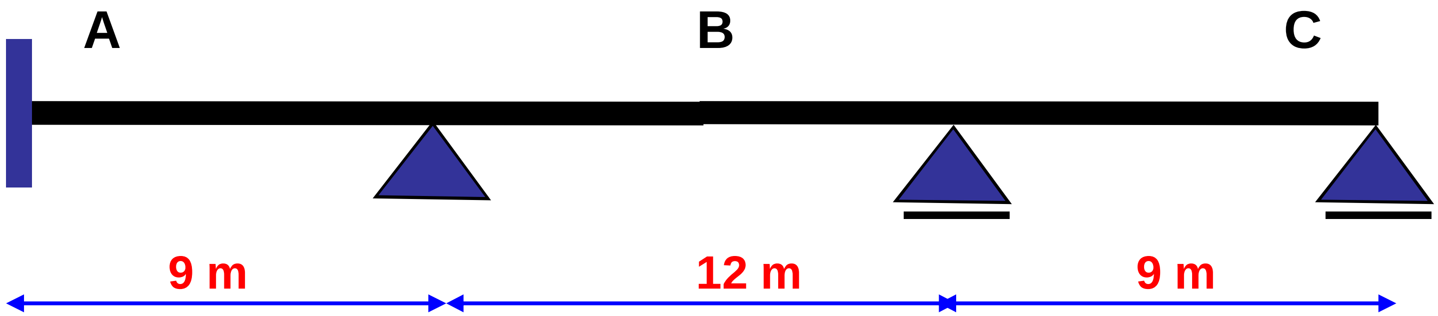
$Iy = 782$

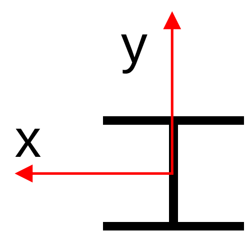
$E = 2100$

$A = 77.8$

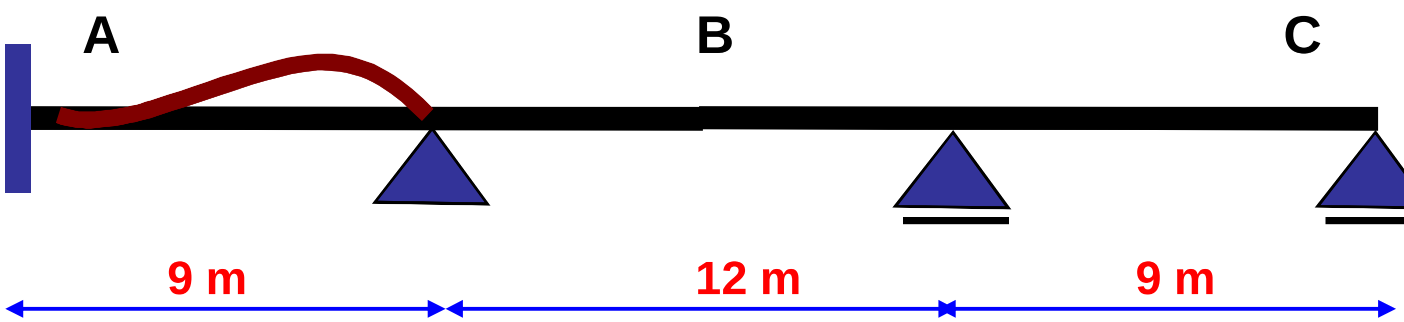
$st\ 52$

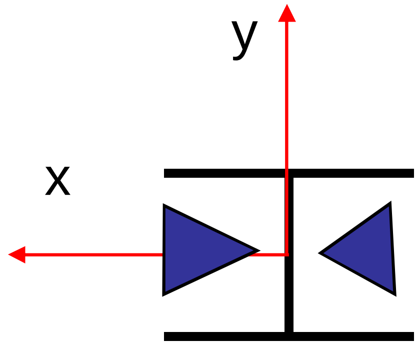
$\alpha = 1.2*10^\wedge(-5)$





Required Δt_{max}





$$Lb = 0.7 * 900 = 630 cm$$

$$\Delta t \leq \frac{\pi^2 . * 782}{1.2 * 10^{-5} * 77.8 * 630^2} = 14.8$$

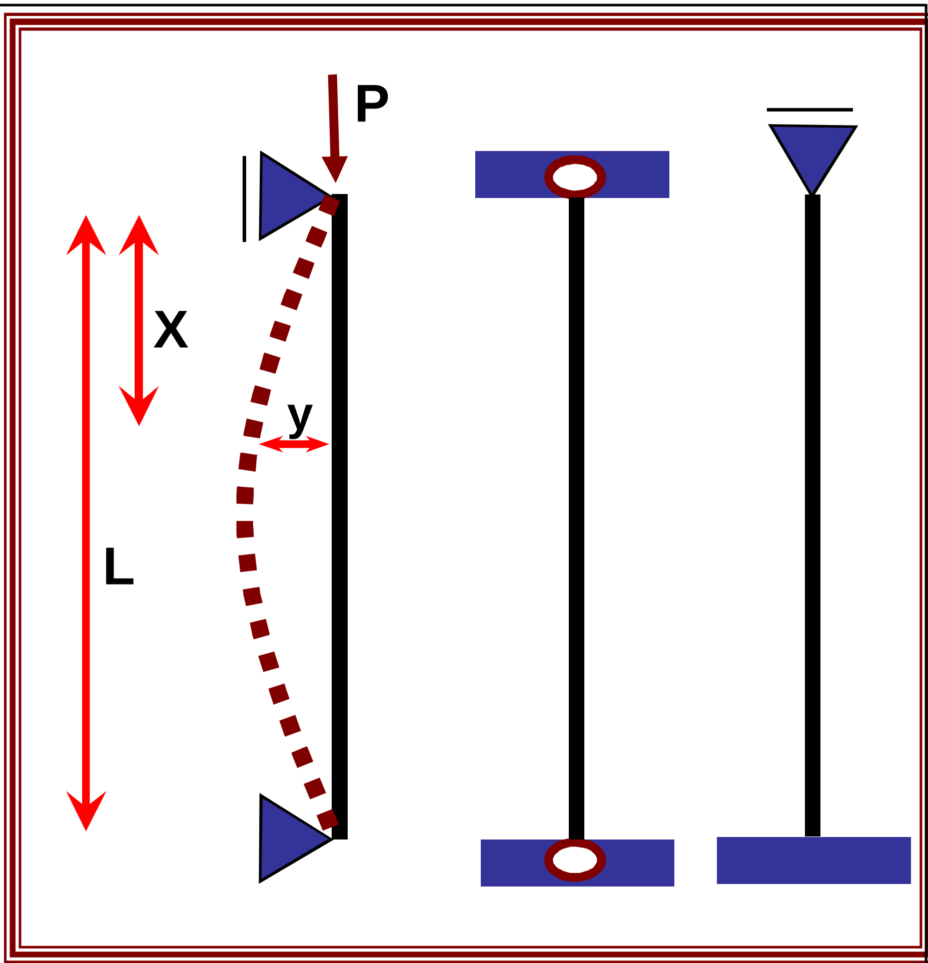
الإثباتات

$$M = P.y$$

$$y'' = -\frac{Py}{EI} \qquad C^2 = \frac{P}{EI}$$

$$y'' + C^2.y = 0.0$$

$$y = c1 \,.\, \cos cx + c2 \,.\, \sin cx$$



$$at \quad x = 0 \; > y = 0 \quad > c1 = 0.0$$

$$at \quad x = L \; > y = 0 > c2.\sin cl = 0.0$$

$$c2.\sin cL = 0.0 \quad >> \quad \sin cL = 0.0$$

$$>> \; cL = n * \pi \quad >> \quad c^2 L^2 = n^2 * \pi^2$$

$$\frac{PL^2}{EI} = n^2 * \pi^2 \quad >> \quad Pcr = n^2 \frac{\pi^2 EI}{L^2}$$

$$Pcr = n^2 \frac{\pi^2 EI}{L^2} = n^2 \frac{\pi^2 EI}{Lb^2}$$

$$Lb = L$$

$$M = -P.(\Delta - y)$$

$$C^2 = \frac{P}{EI}$$

$$y'' = -\frac{-P.(\Delta - y)}{EI} = \frac{P}{EI}\Delta - \frac{P}{EI}y$$

$$y'' + C^2.y - C^2.\Delta = 0.0$$

$$y = c1 . \cos cx + c2 . \sin cx + \Delta$$

$$at \quad x = 0 \; > y = 0 \qquad > c1 \; = \; -\Delta$$

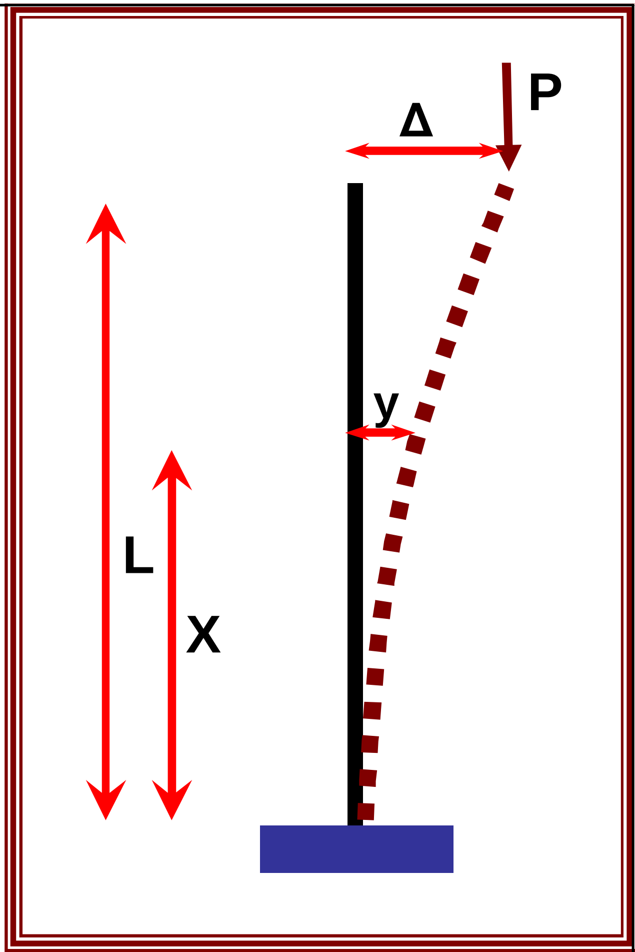
$$at \quad x = 0 \; > y' = 0 \qquad > c2 \; = \; 0.0$$

$$at \quad x = L \; > y = \Delta$$

$$> \; y = -\Delta \cos cL + \Delta = \Delta \qquad > \; \cos cL = 0.0$$

$$> \; cL = n * \pi / 2 \qquad >> \; c^2 L^2 = \frac{n^2 * \pi^2}{4}$$

$$\frac{PL^2}{EI} = n^2 * \pi^2 \quad >> \quad Pcr = n^2 \frac{\pi^2 EI}{(2L)^2} = n^2 \frac{\pi^2 EI}{(Lb)^2}$$



Lb=2L

بسم الله الرحمن الرحيم

Determency and without calculation

Eng : Ayman abdo

Determinacy

For Beams and Frames

b >>>> No. members
r >>>> No. of Reaction
J >>>> No. of joints
c >>>> each of intermediate hinge (intermediate hinge -1) عدد العناصر التى يفصلها

3b + r >>>> مجاهيل

3j + c >>>> معادلات

معادلات > مجاهيل Unstable

معادلات = مجاهيل Stable & determinate

معادلات < مجاهيل Stable & indeterminate

b= 15 , J= 12

c= 0 , r= 9

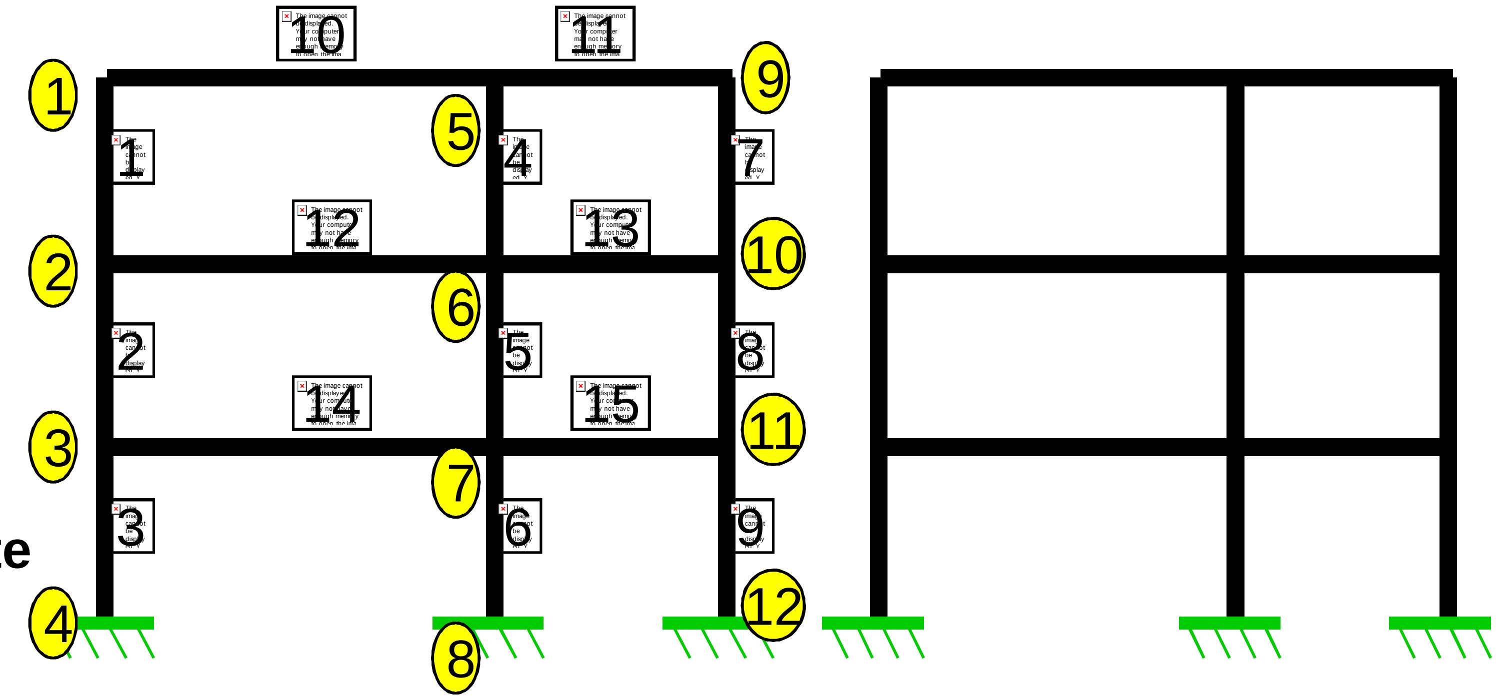
3b + r = 54 unknowns

3j + c = 36 equations

Unknowns > equations

> stable & Indeterminate

> (54-36= 18 degree)



b= 15 , J= 12

c= 6 , r= 5

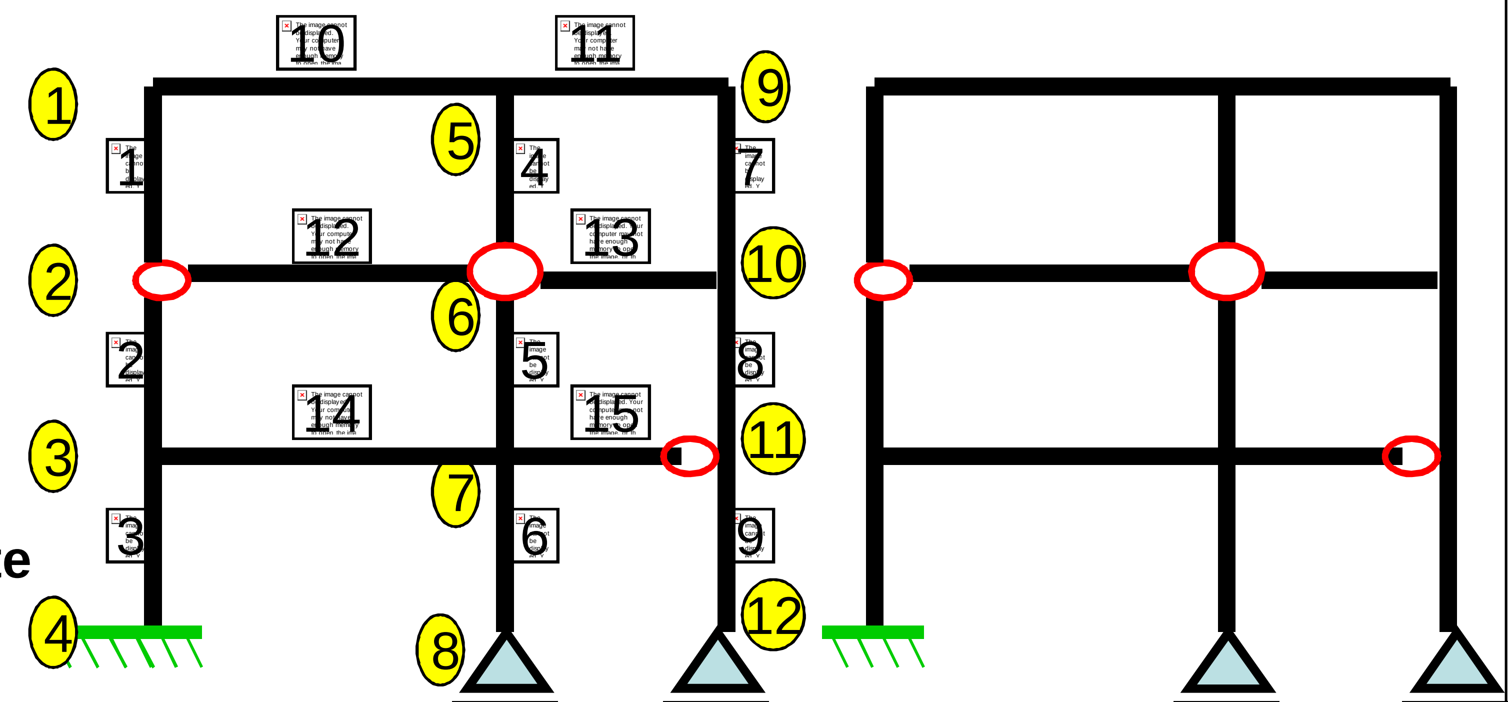
3b + r = 50 unknowns

3j + c = 42 equations

Unknowns > equations

> stable & Indeterminate

> (50- 42= 8 degree)



first

b= 16 , J= 13

c= 6 , r= 5

3b + r = 53 unknowns

3j + c = 45 equations

> stable & Indeterminate

> (53- 45= 8 degree)

second

b= 15 , J= 12

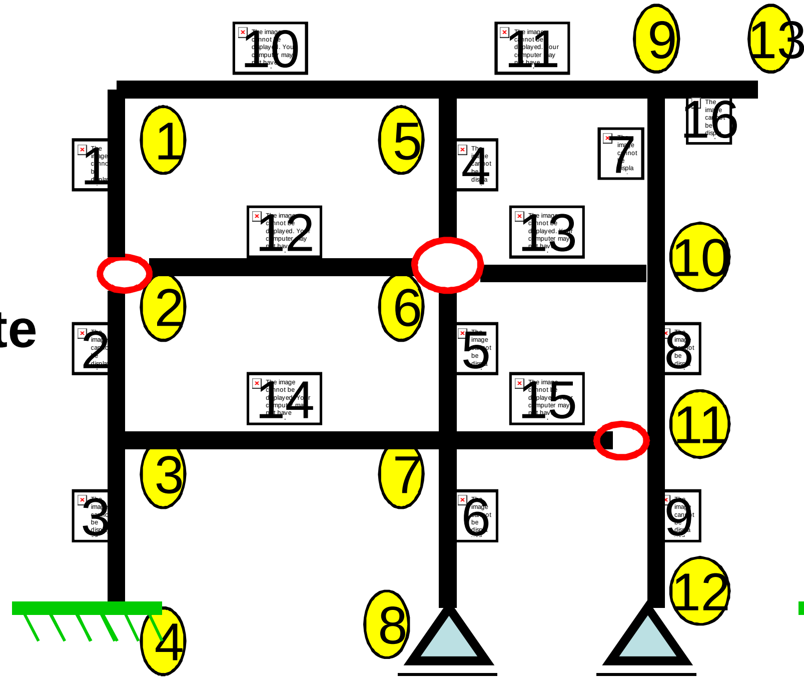
c= 6 , r= 5

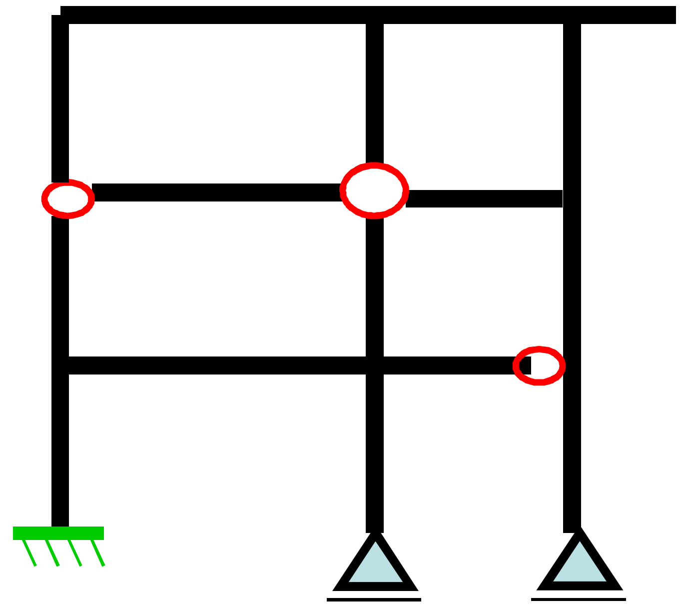
3b + r = 50 unknowns

3j + c = 42 equations

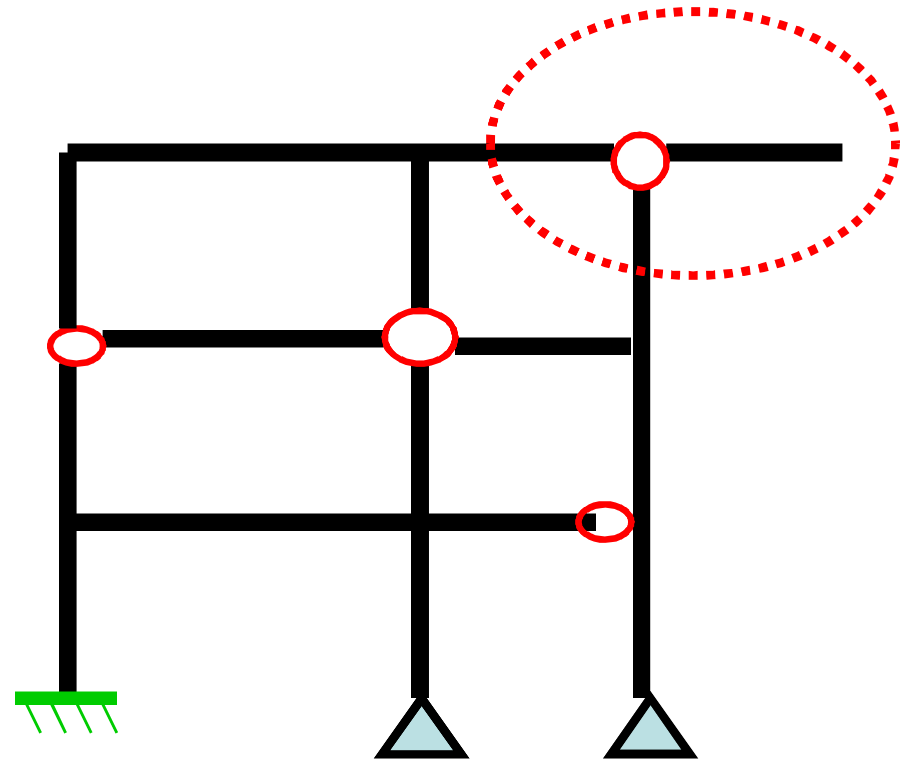
> stable & Indeterminate

> (50- 42= 8 degree)





Unstable



Determinacy

For Trusses

b >>>> No. members
r >>>> No. of Reaction
J >>>> No. of joints

b + r >>>> مجاهيل

2j >>>> معادلات

مجاهيل < معادلات Unstable

مجاهيل = معادلات Stable & determinate

مجاهيل > معادلات Stable & indeterminate

b= 37 , J= 21

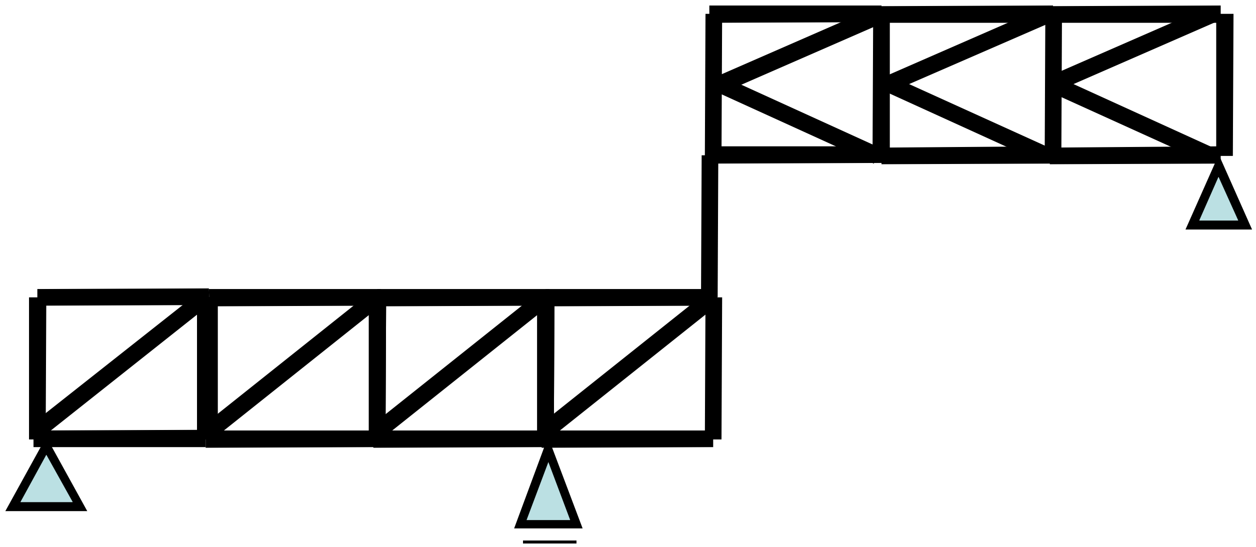
, r = 5

b + r = 42 unknowns

2 j = 42 equations

Unknowns = equations

> stable & determinate



b= 19 , J= 10

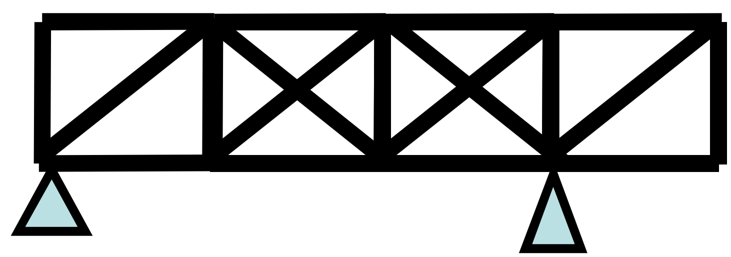
, r = 4

b + r = 23 unknowns

2 j = 20 equations

> stable & Indeterminate

> (23- 20= 3 degree)

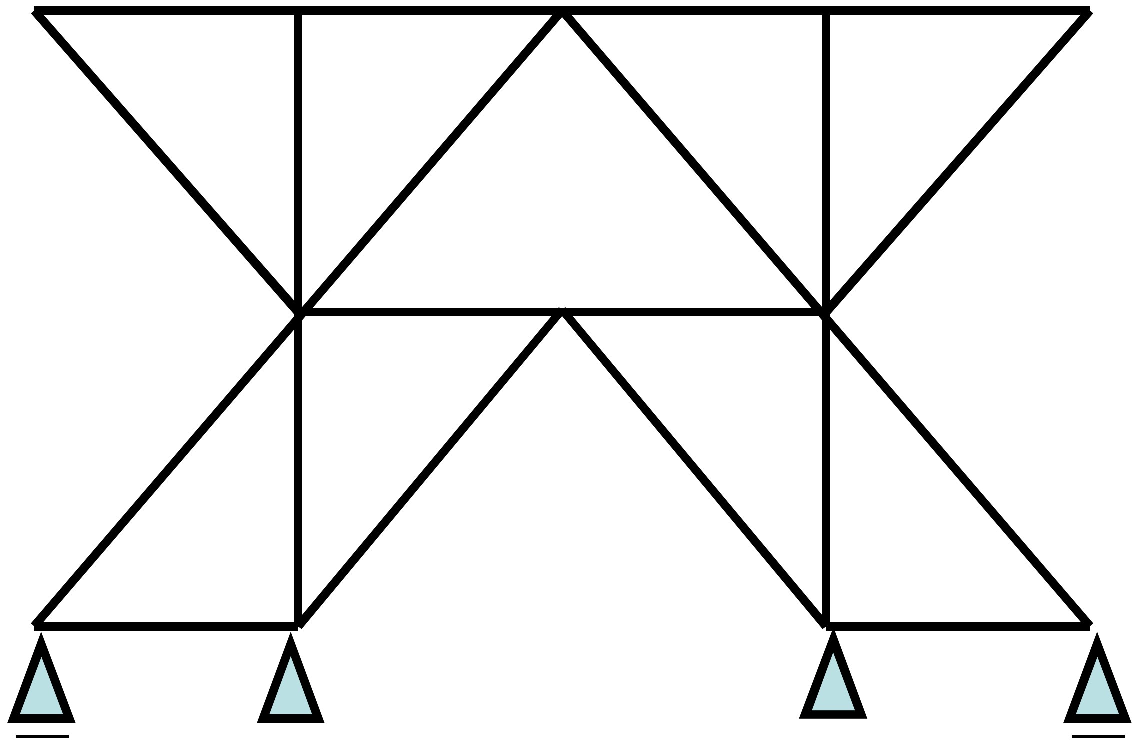


b= 20 , J= 12
, r = 6

b + r = 26 unknowns

2 j = 24 equations

> stable & Indeterminate
> (26- 24= 2 degree)

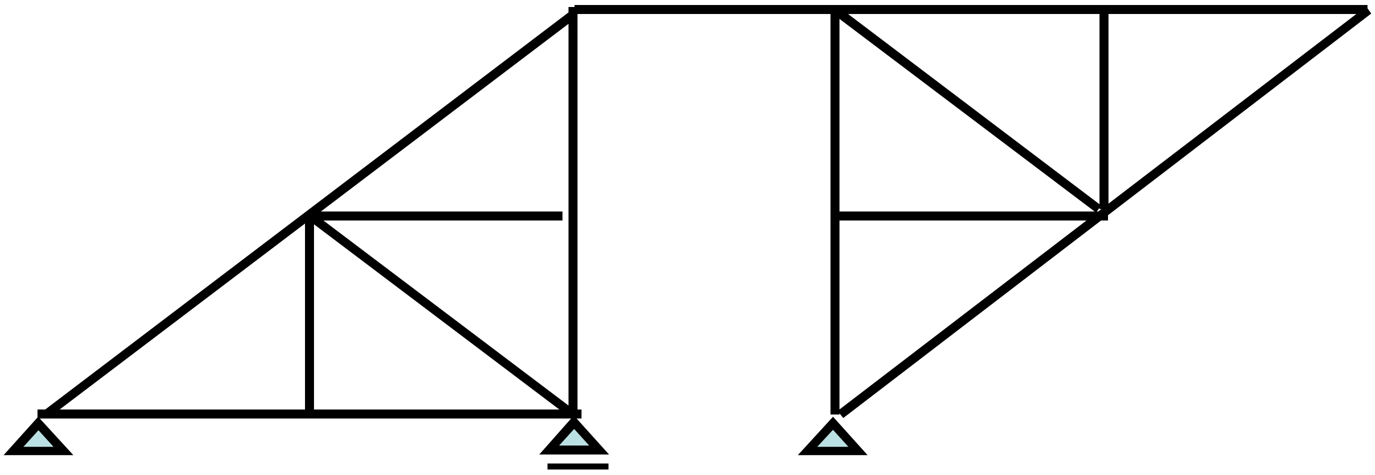


b= 19 , J= 12
, r = 5

b + r = 24 unknowns

2 j = 24 equations

> stable & determinate



بســــم اللـــــه الرحمـــن الرحيـــم

Without Calculation

determinate and Indeterminate structure

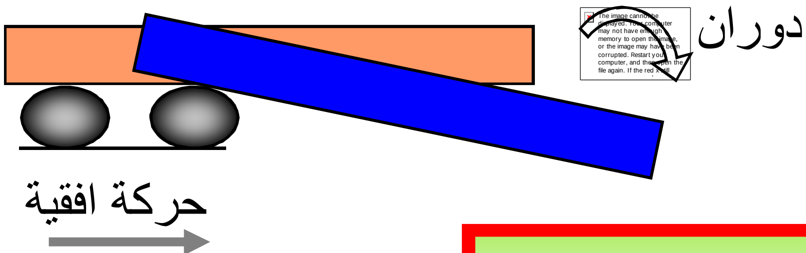
Eng : Ayman abdo

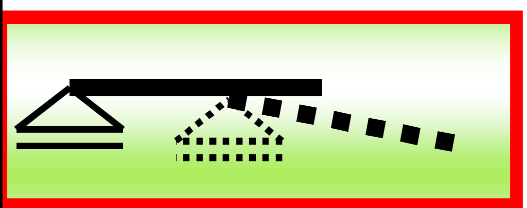
بعض الاساسيات الهامه

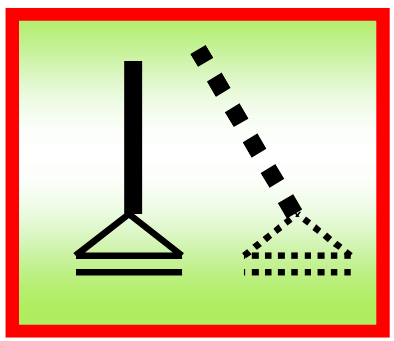
1- SUPPORTS

ROLLER SUPPORT

تسمح بالحركة الافقية والدوران

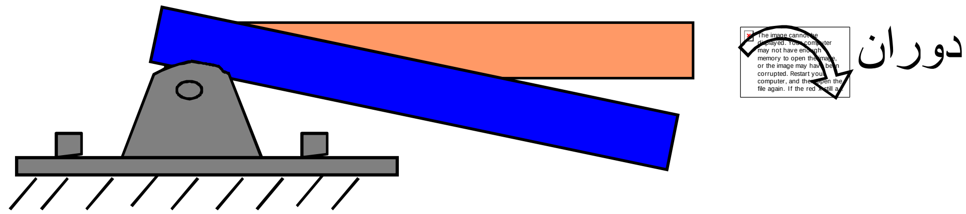


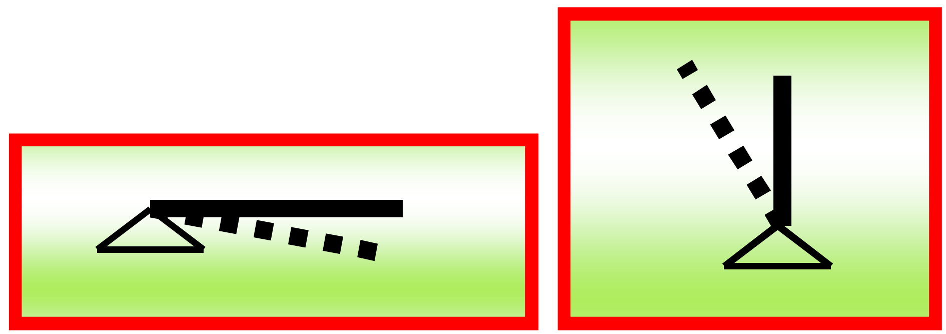




HINGED SUPPORT

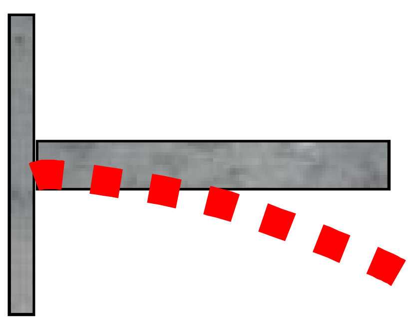
تسمح بالدوران فقط

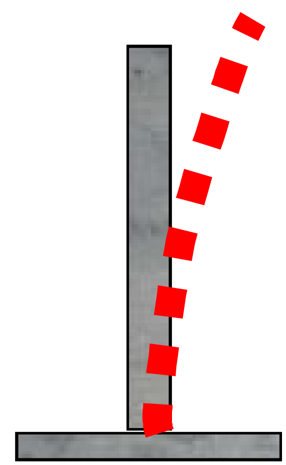




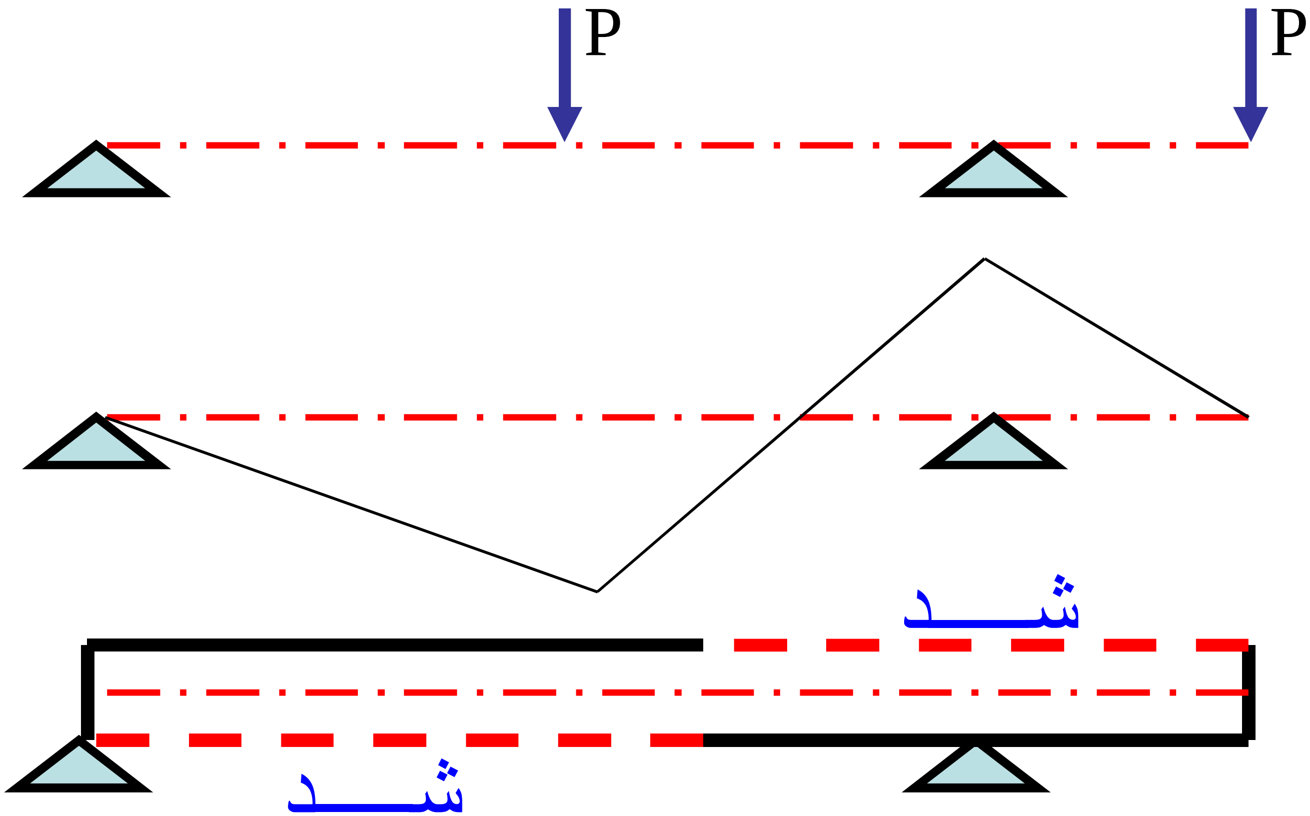
FIXED SUPPORT

لا تسمح بأى حركة



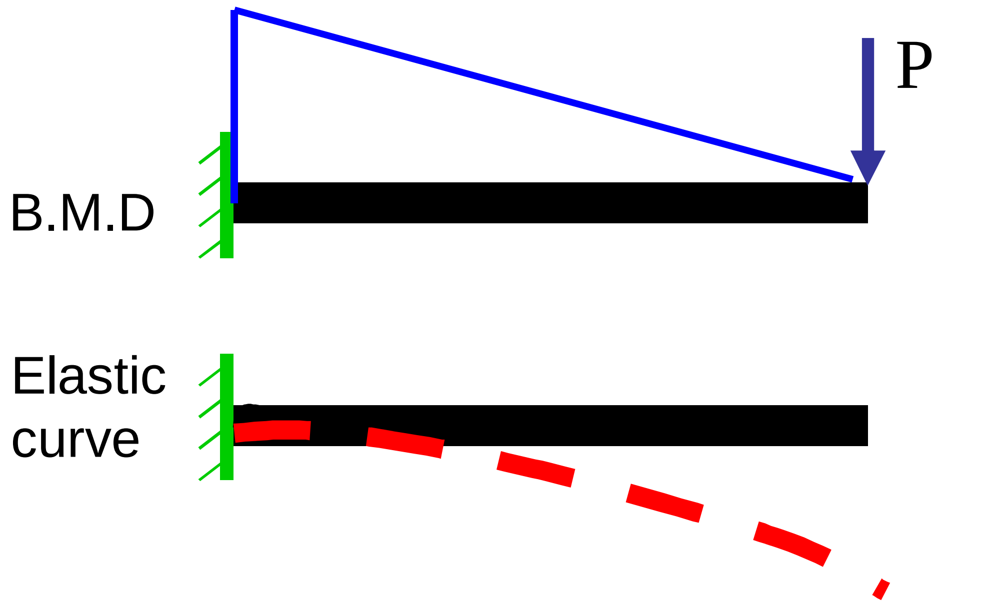


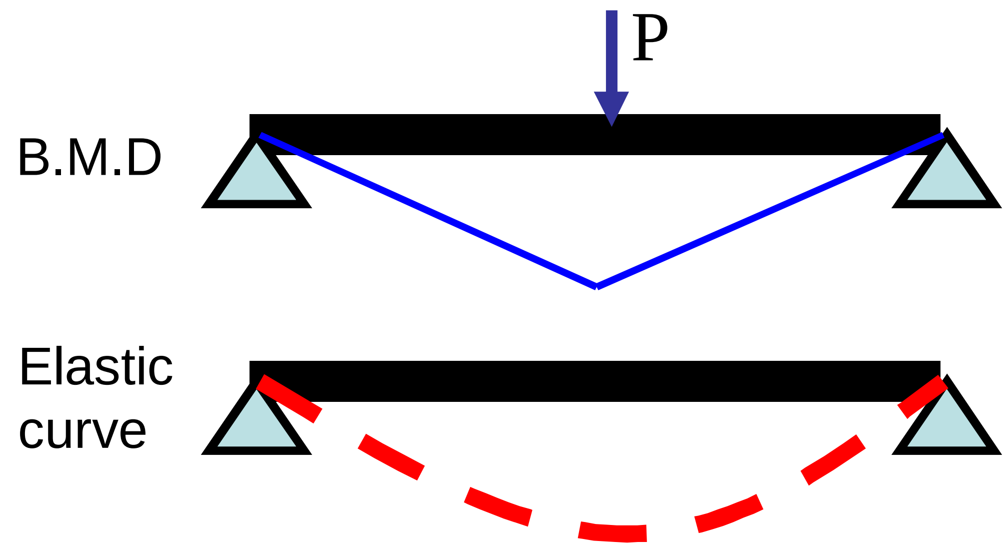
1- يكون العزم فى اتجاه الشد

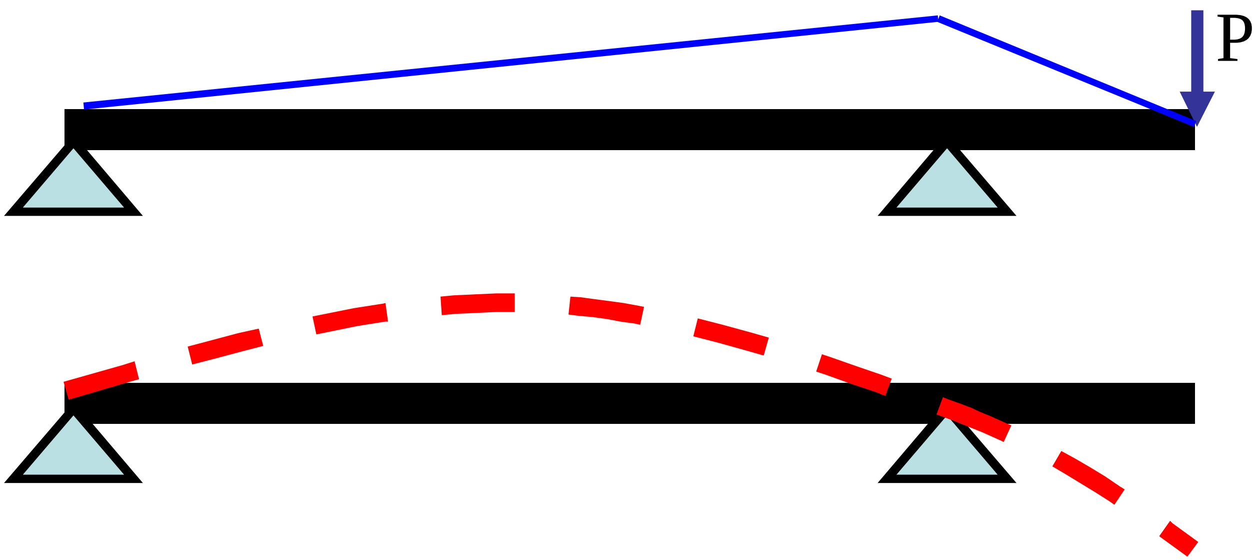


2- يجب ان تكون الزاويه ثابته قبل وبعد التشكل

3- يكون الانحناء محدب ناحية العزم

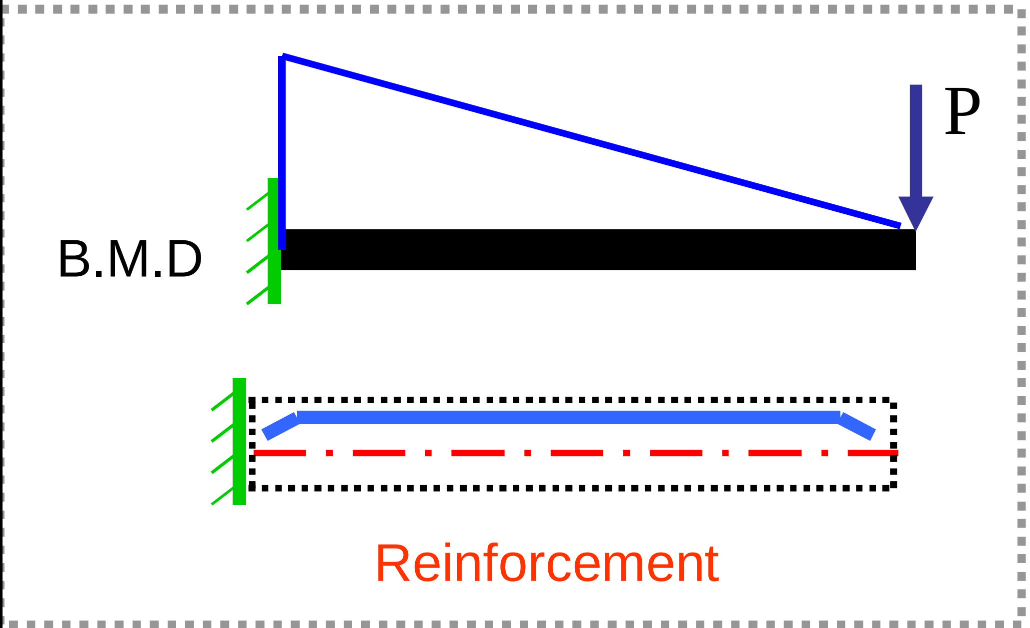


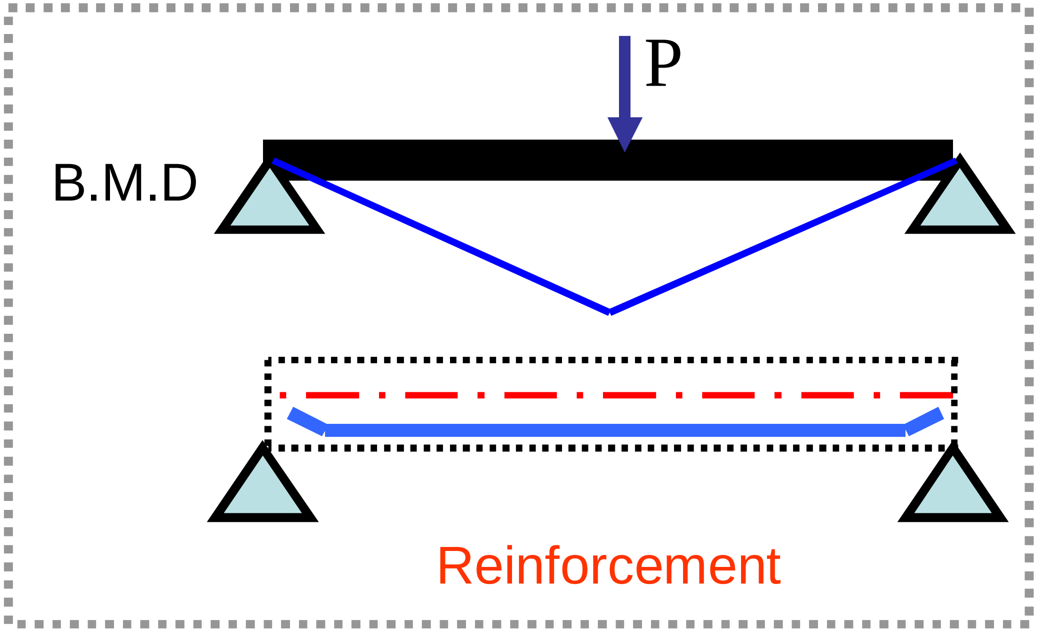


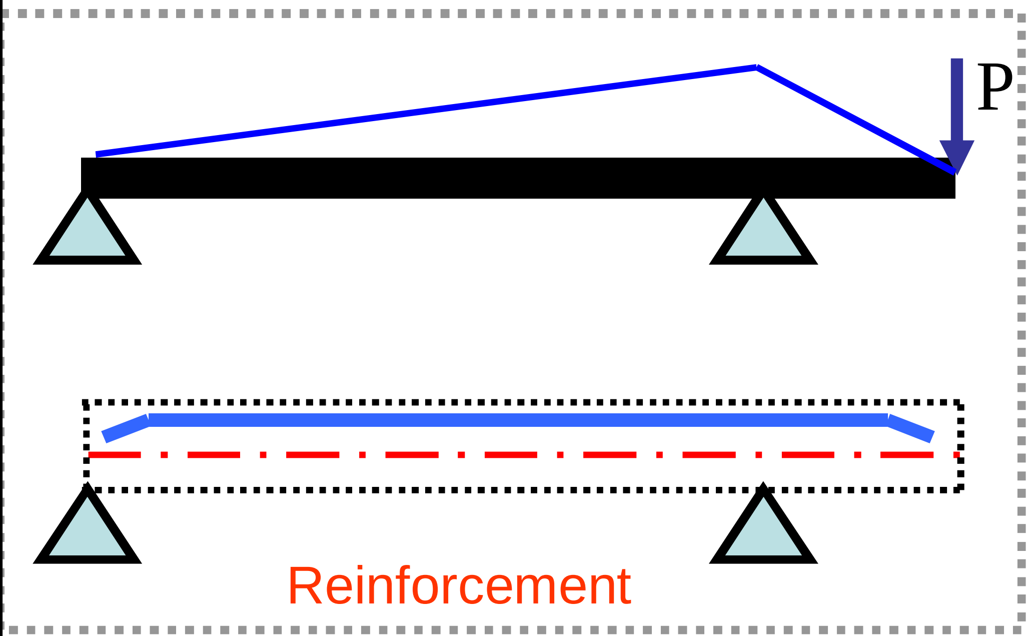


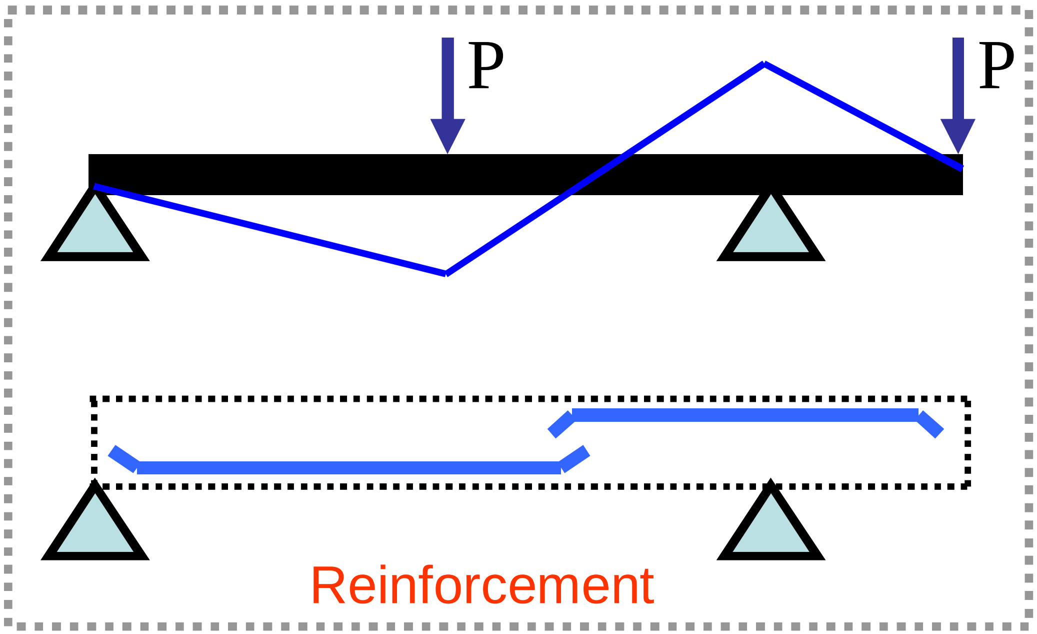
الاجزاء التى لا يوجد عليها عزوم
ترسم فى الـ elastic curve
خط مستقيم

4- يكون التسليح ناحية العزم







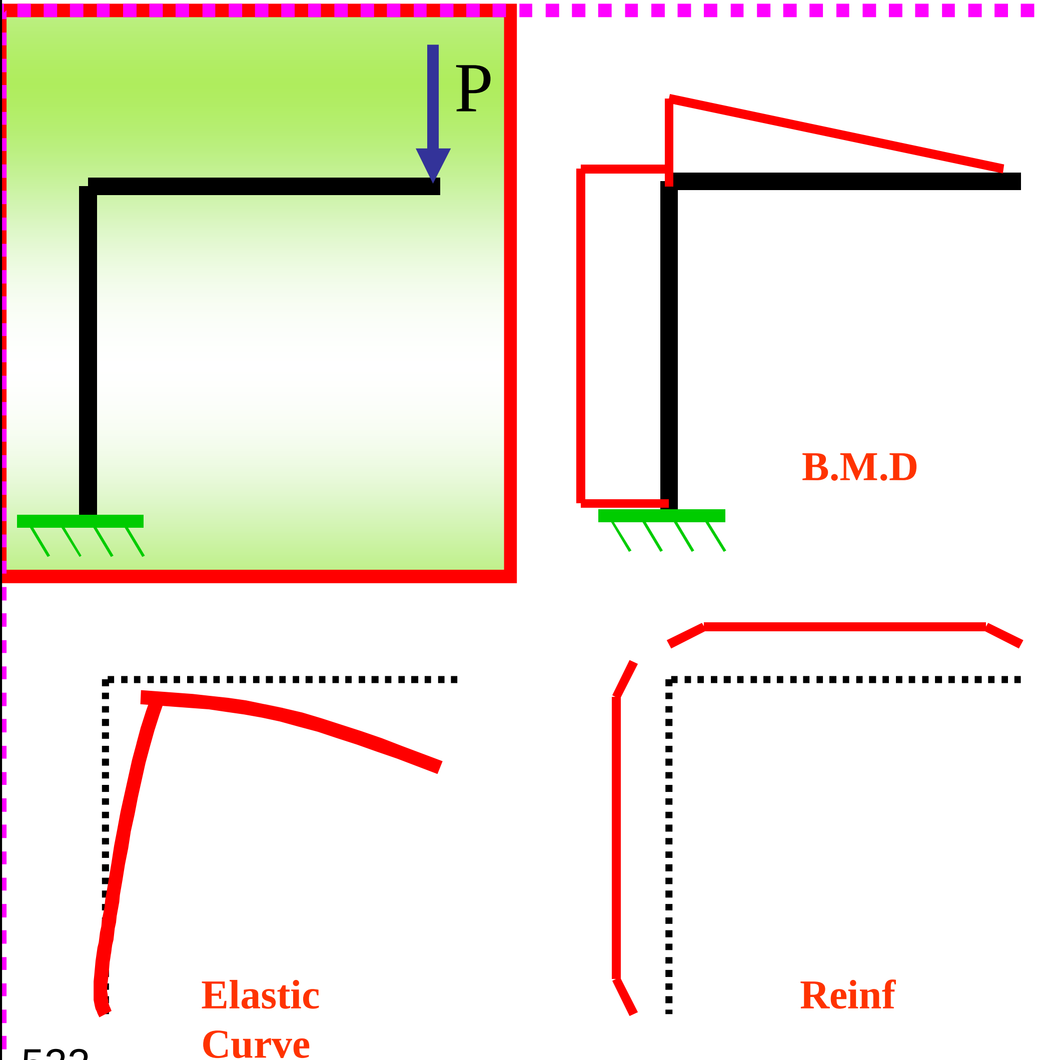


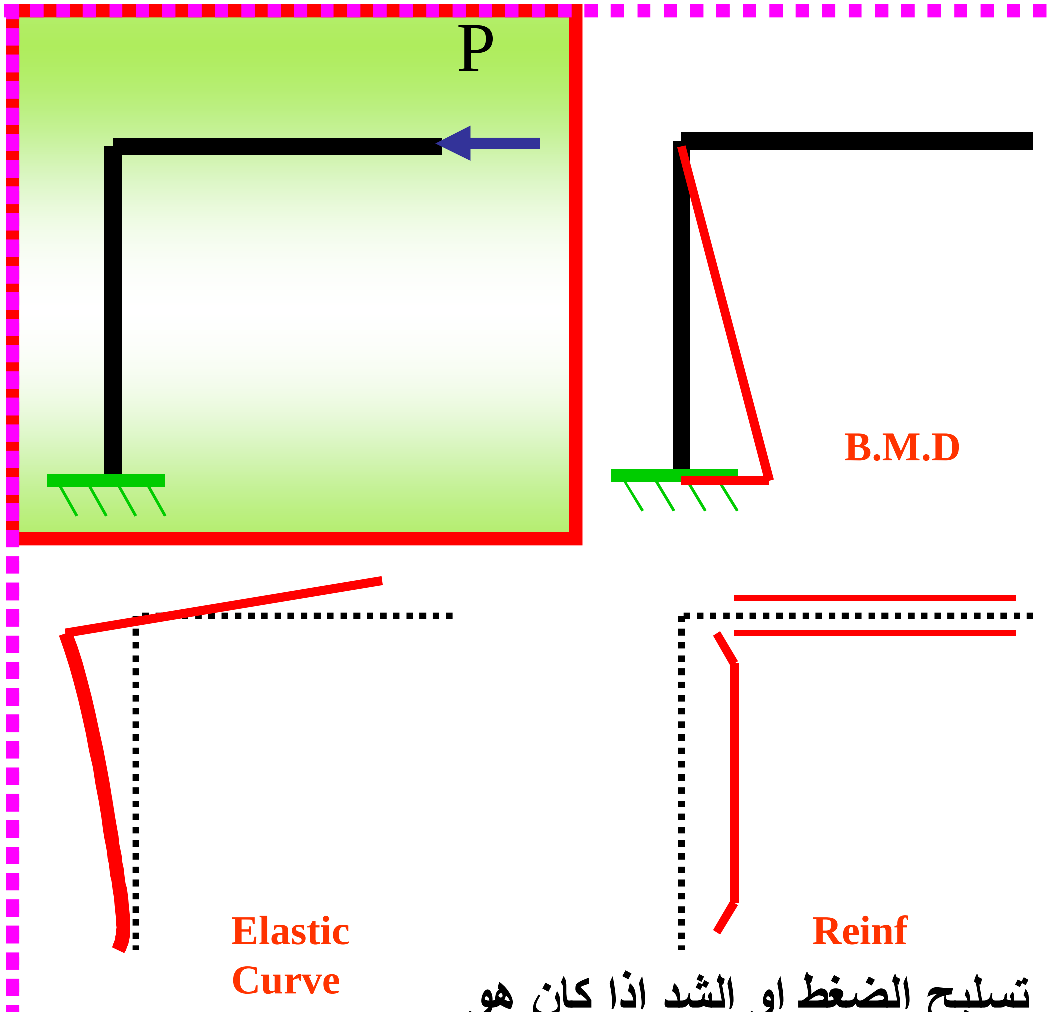
Determinate Structures

فى هذه المنشآت سيكون من السهل توقع اتجاهات الـ reactions

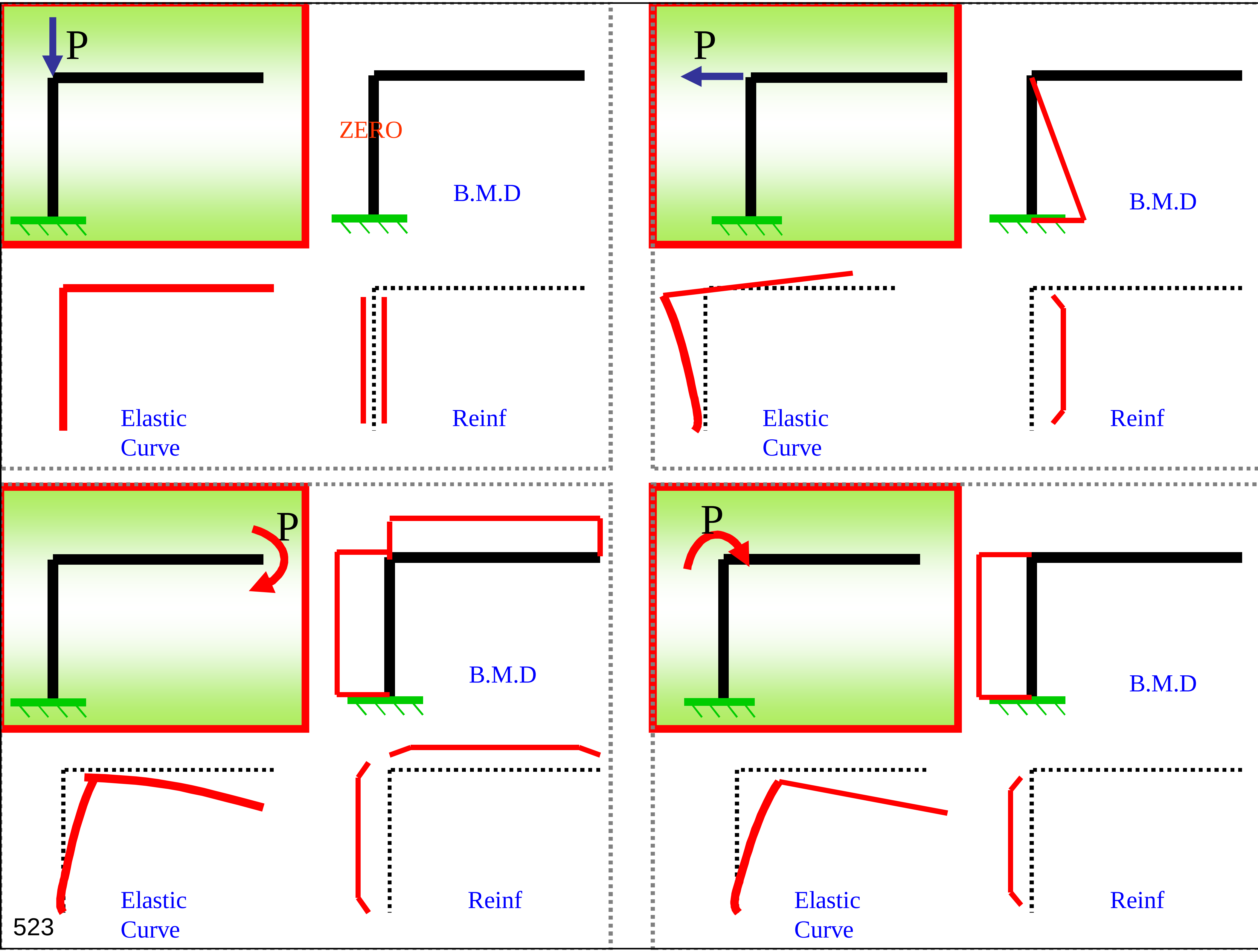
1- رسم العزوم

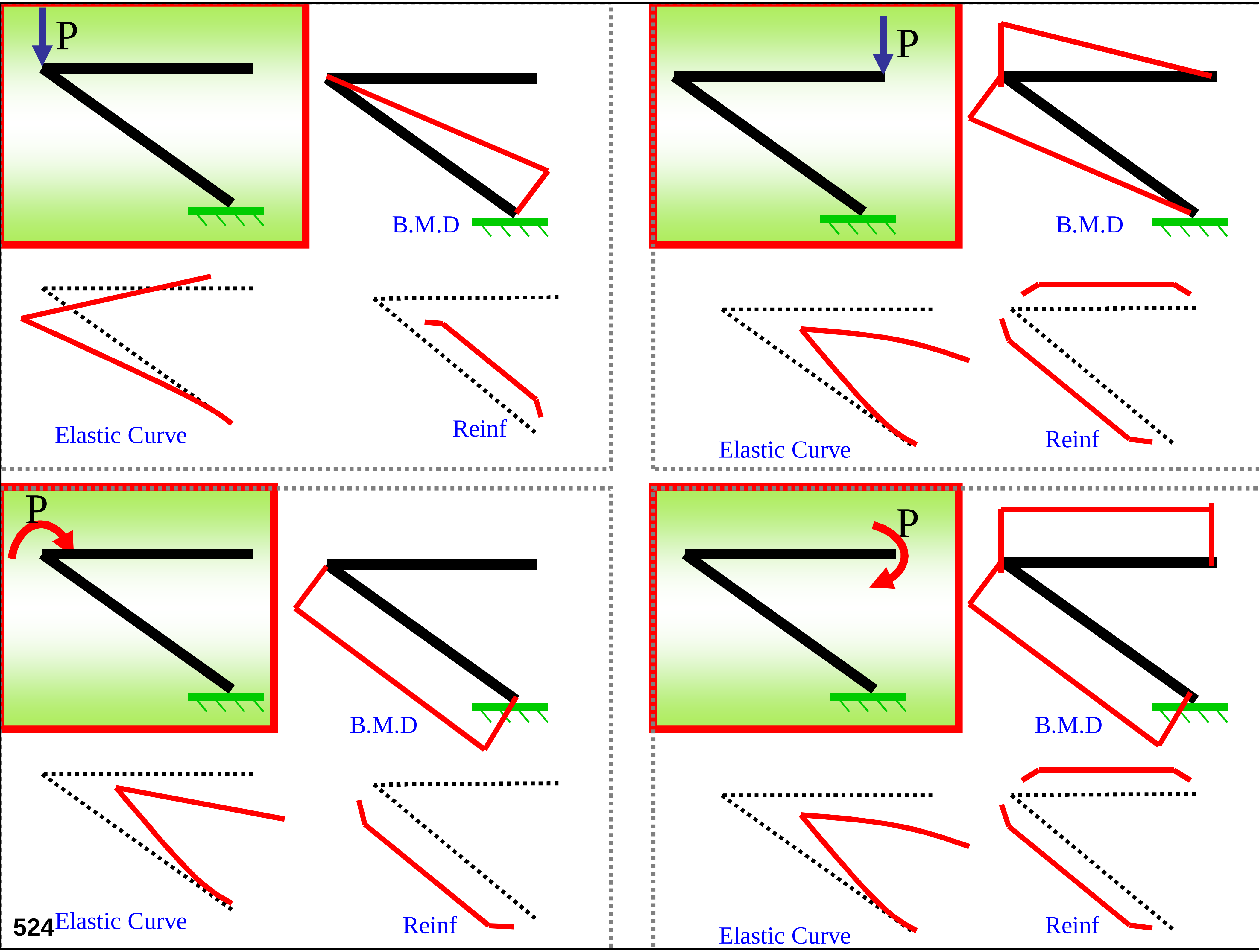
2- يتم تحديد اتجاه التحديب حسب شكل العزم واماكن التسليح

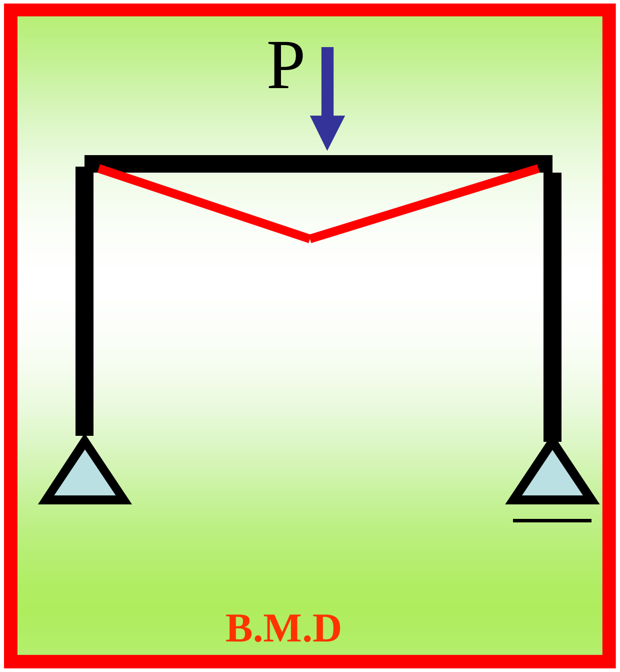


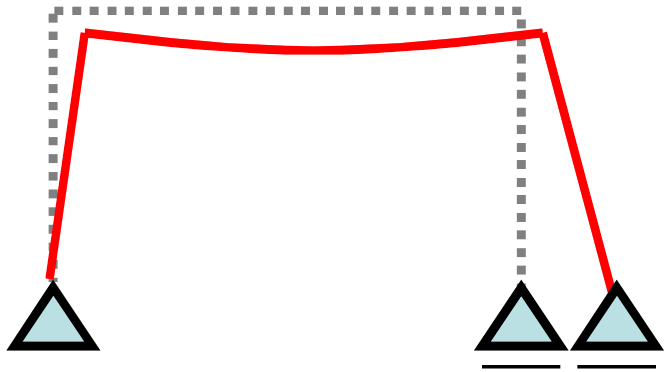


تسليح الضغط او الشد اذا كان هو الموجود فقط يكون فى الاتجاهين

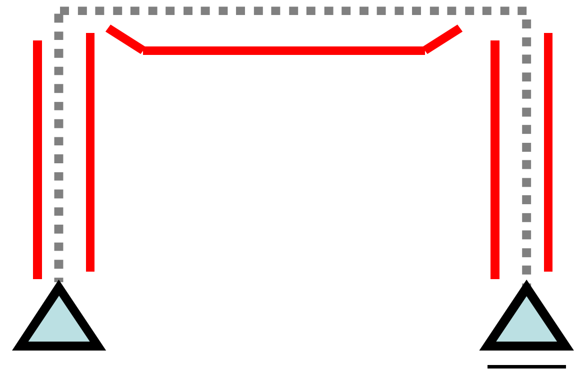

P
ZERO
B.M.D
Elastic
Curve
Reinf
P
B.M.D
Elastic
Curve
Reinf
P
B.M.D
Elastic
Curve
Reinf
P
B.M.D
Elastic
Curve
Reinf


P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf
P
B.M.D
Elastic Curve
Reinf

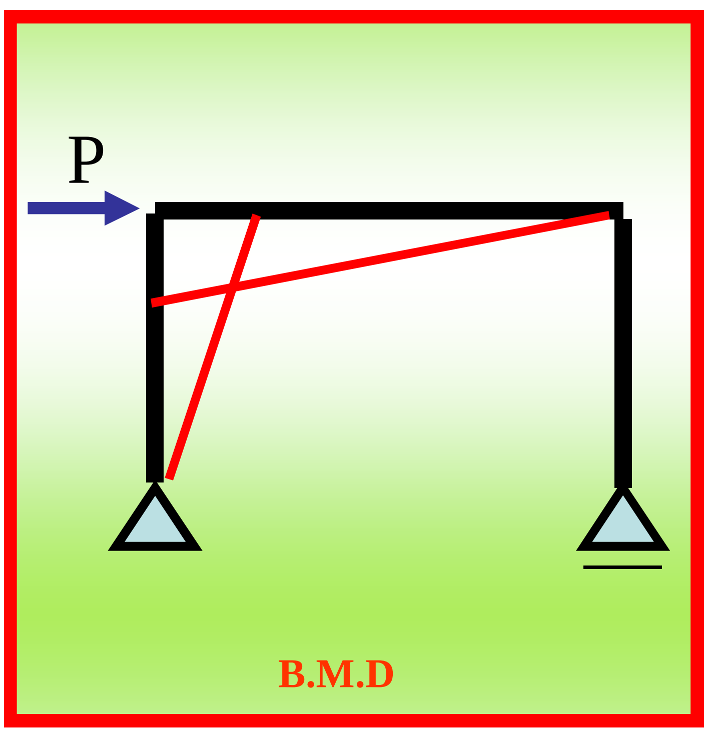


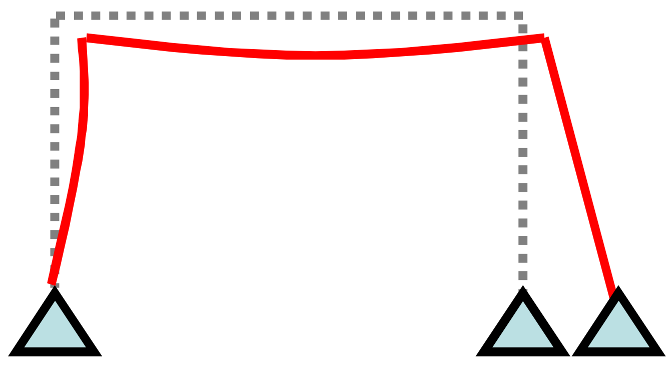


Elastic Curve

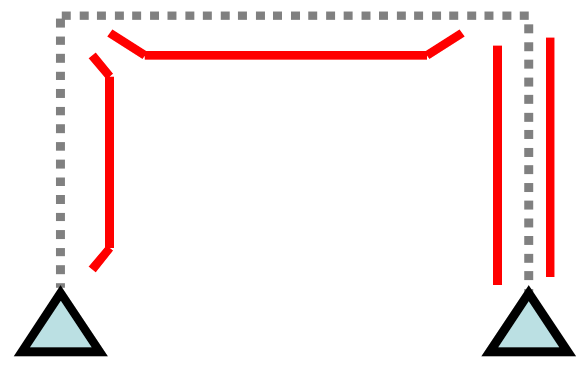


Reinforcement

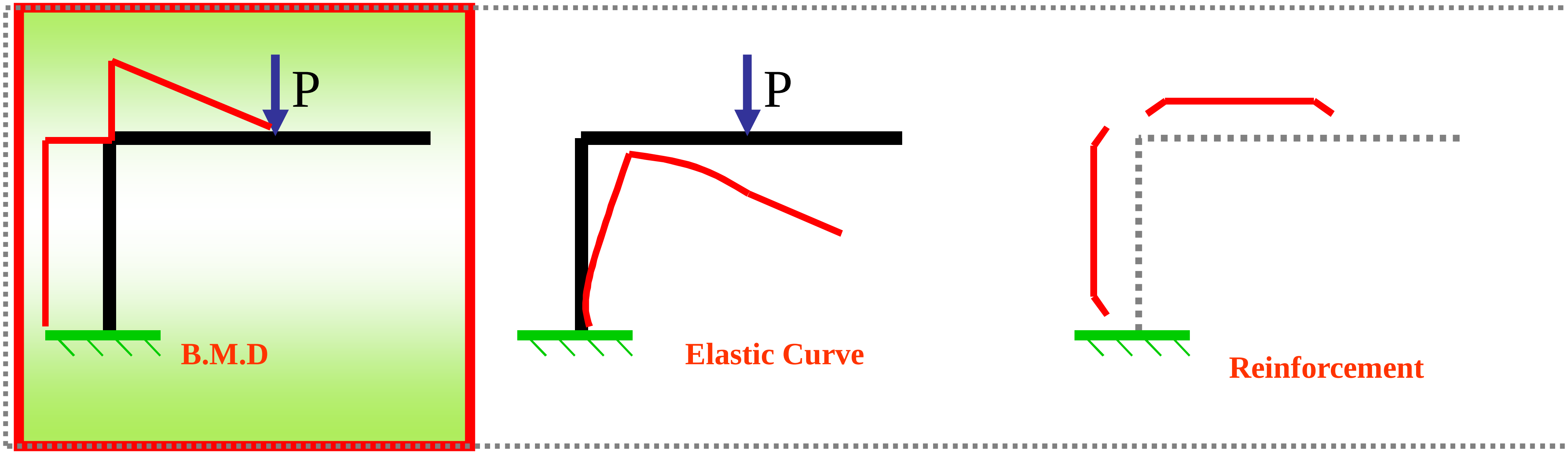


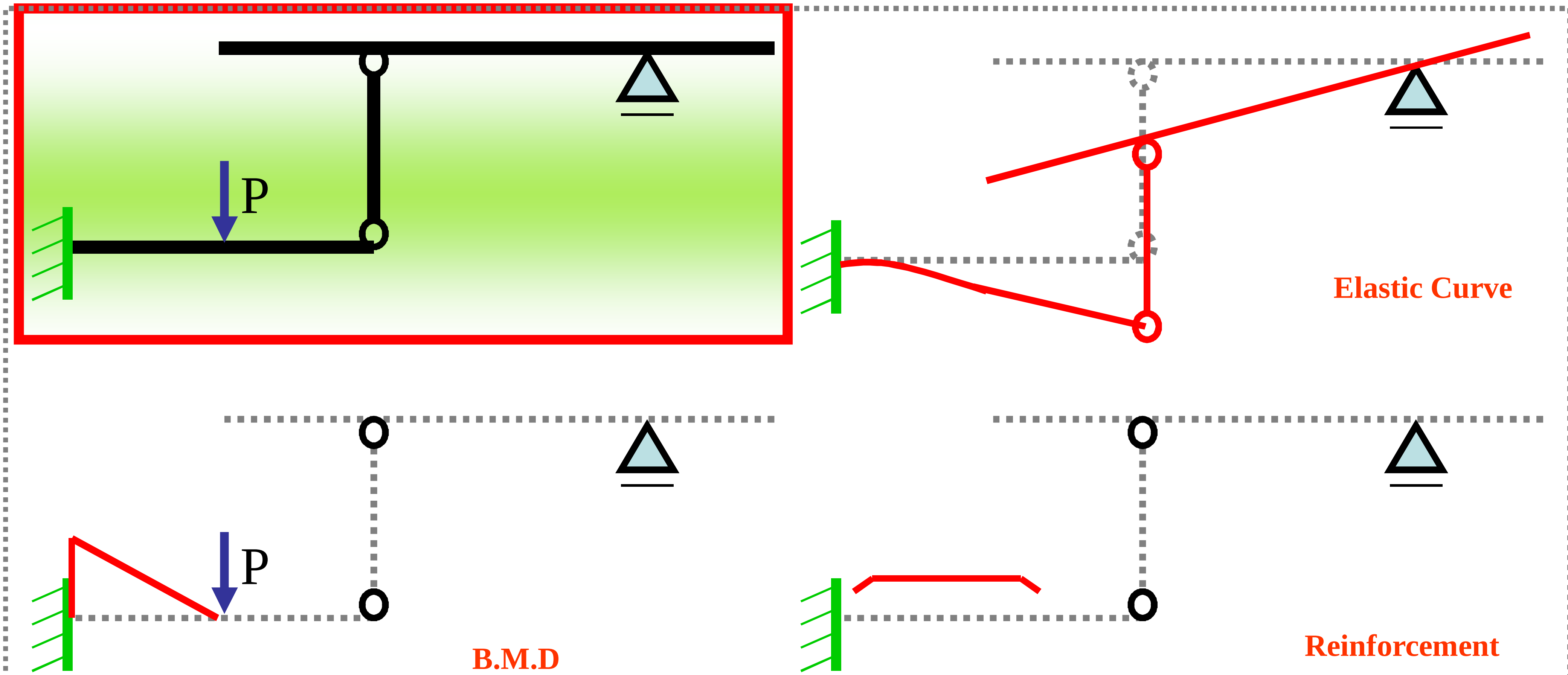


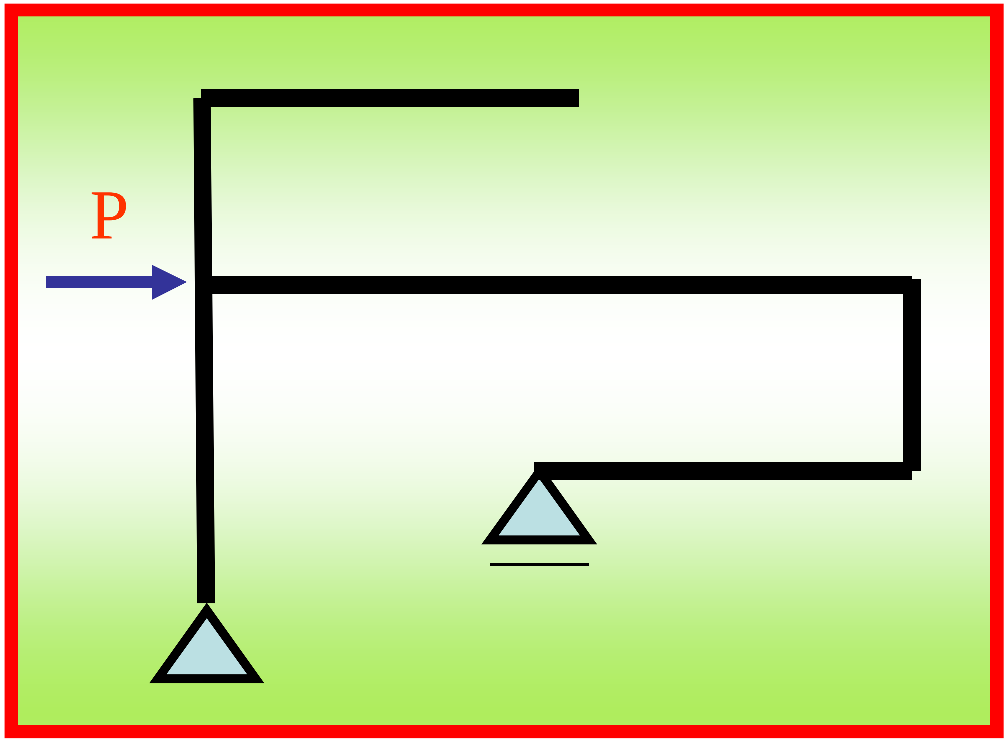
Elastic Curve

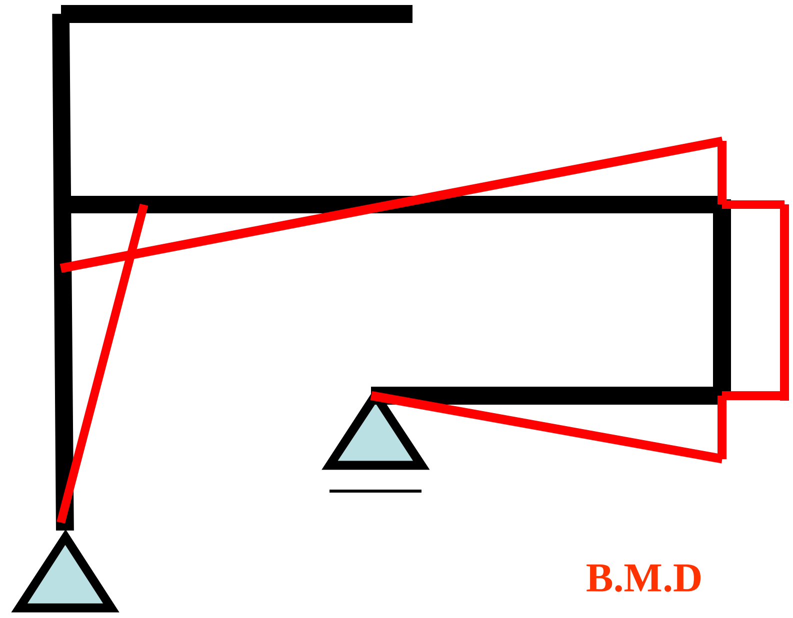


Reinforcement

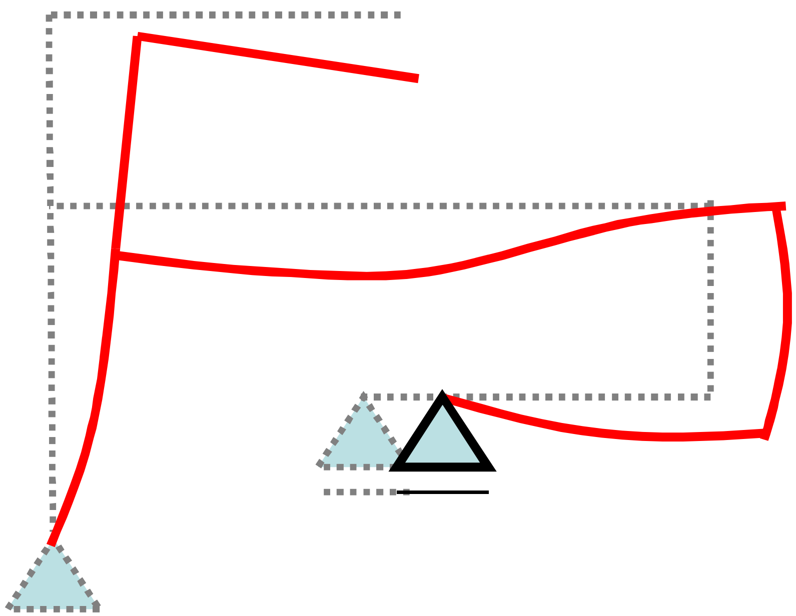

P
B.M.D
P
Elastic Curve
Reinforcement


P
Elastic Curve
P
B.M.D
Reinforcement

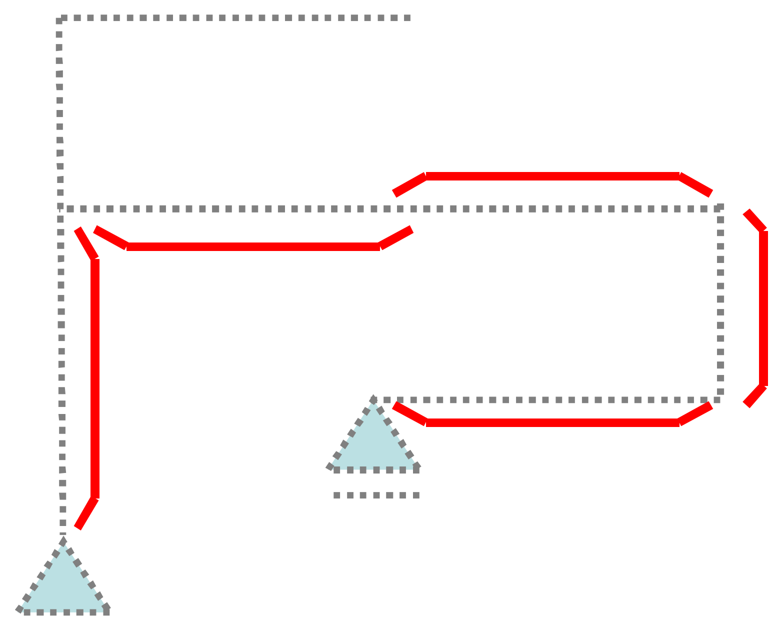




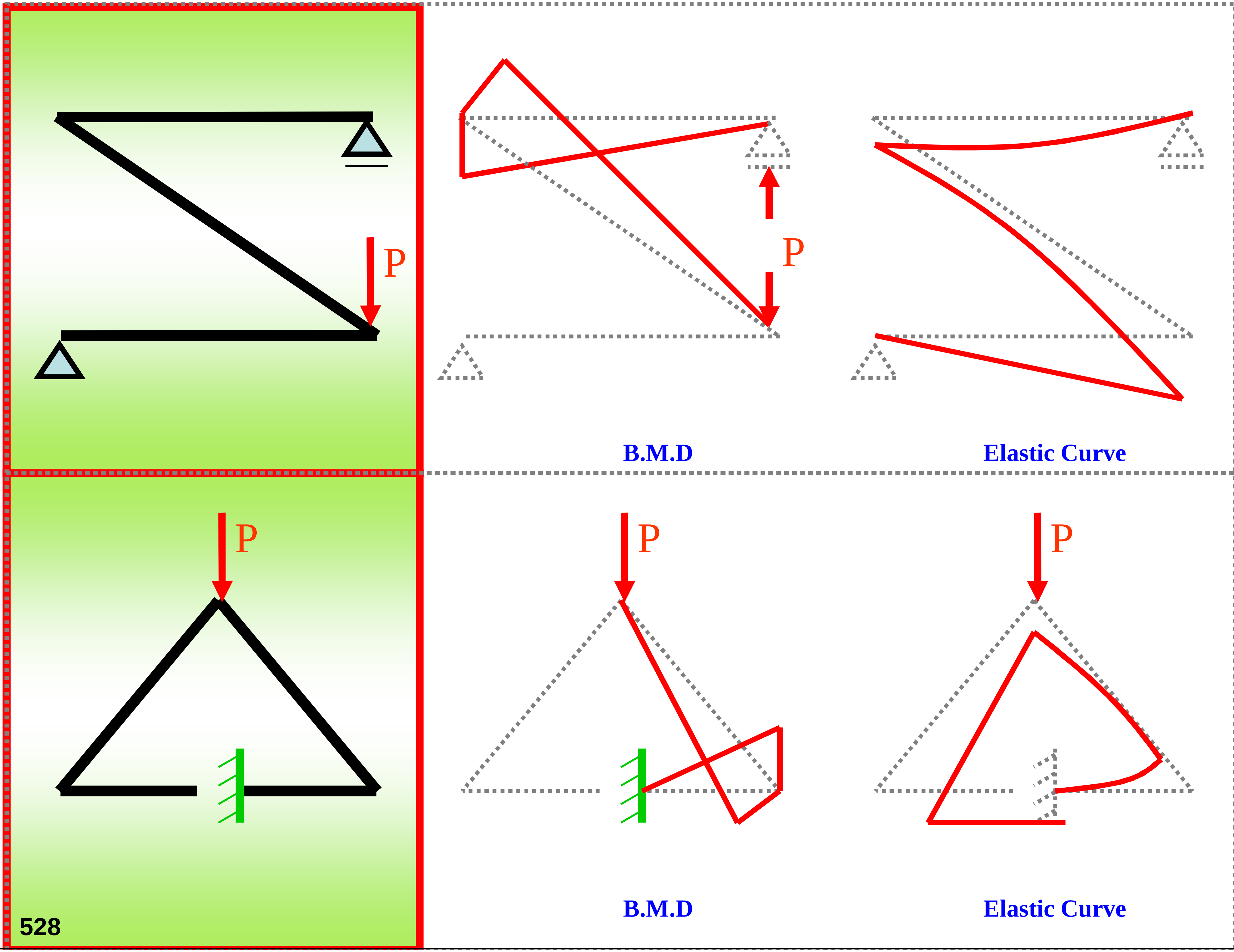
B.M.D

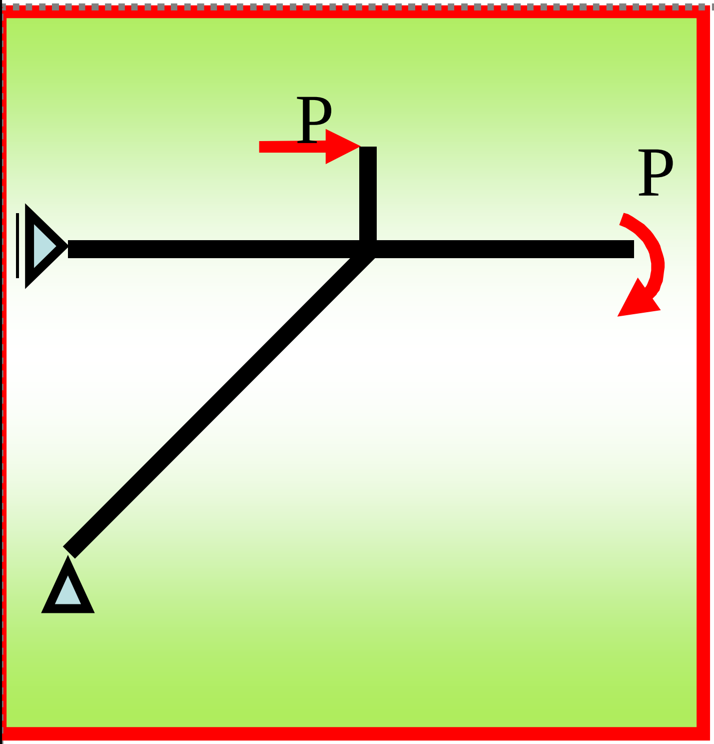


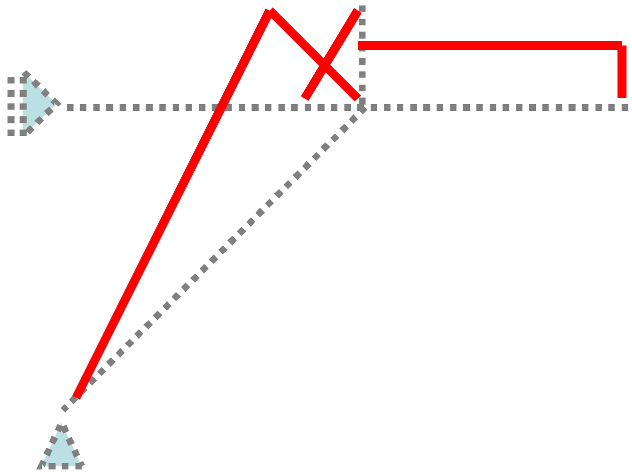
Elastic Curve



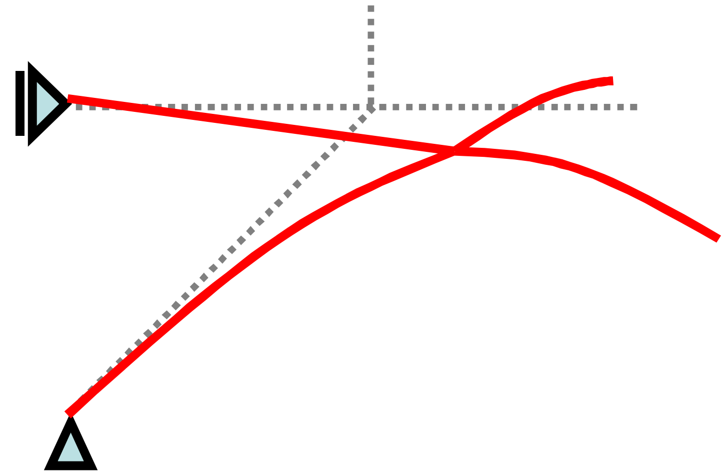
Reinforcement


P
P
B.M.D
Elastic Curve
P
P
P
B.M.D
Elastic Curve

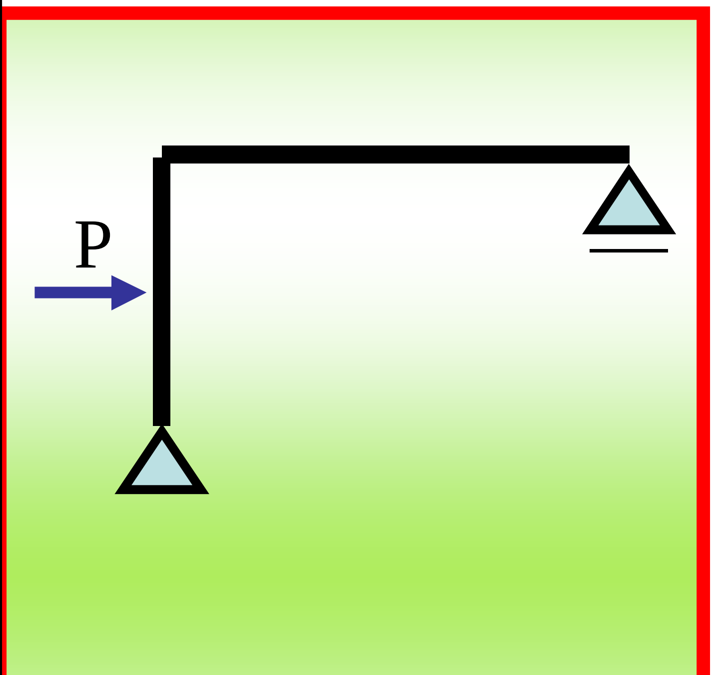


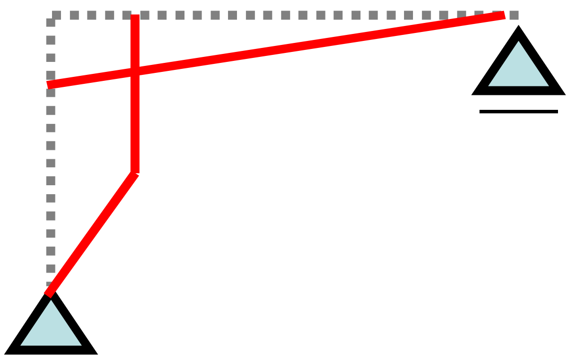


B.M.D



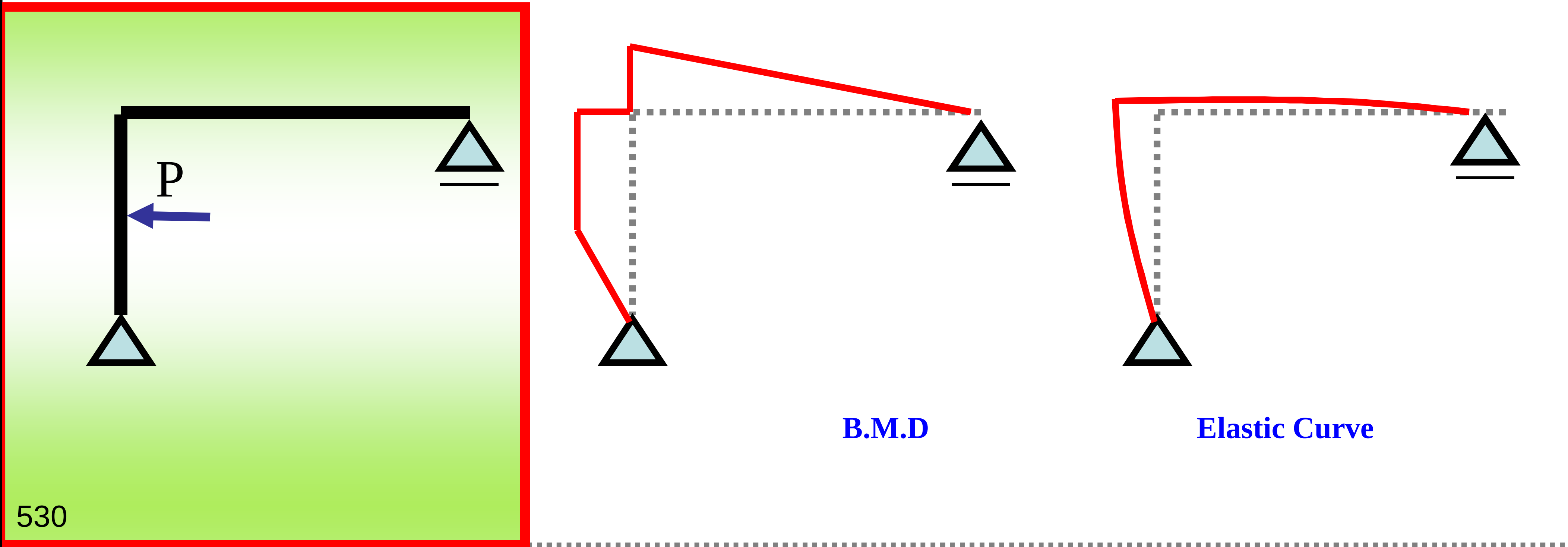
Elastic Curve

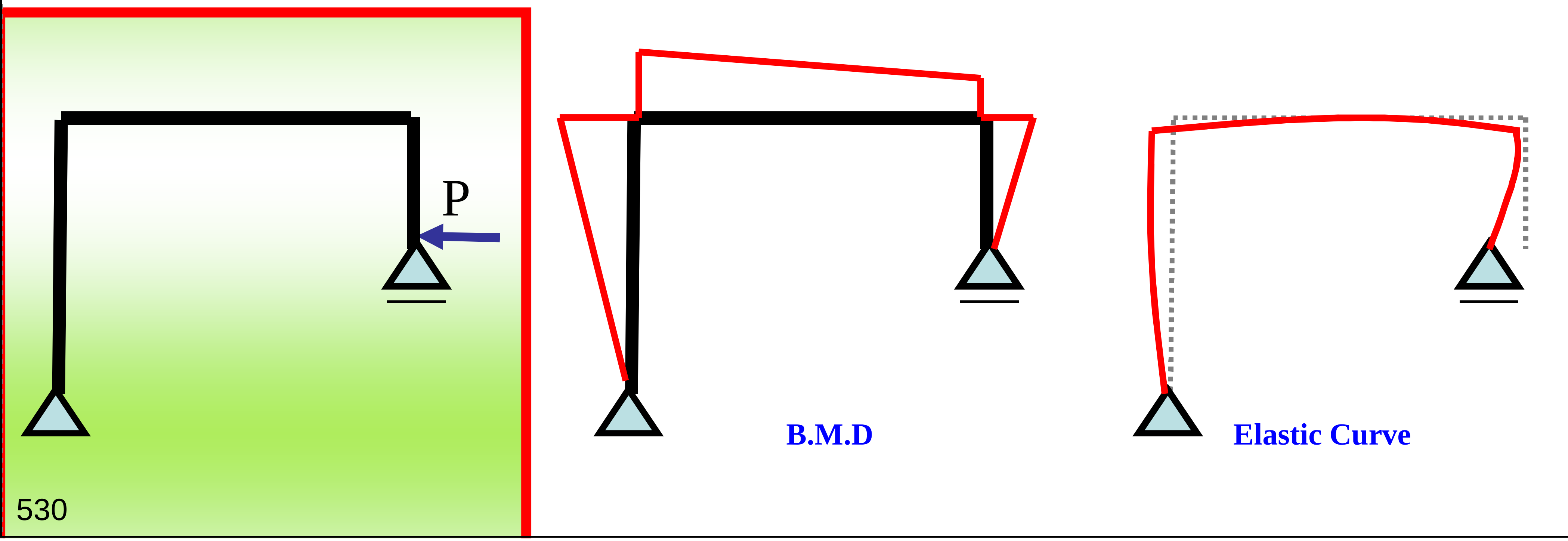


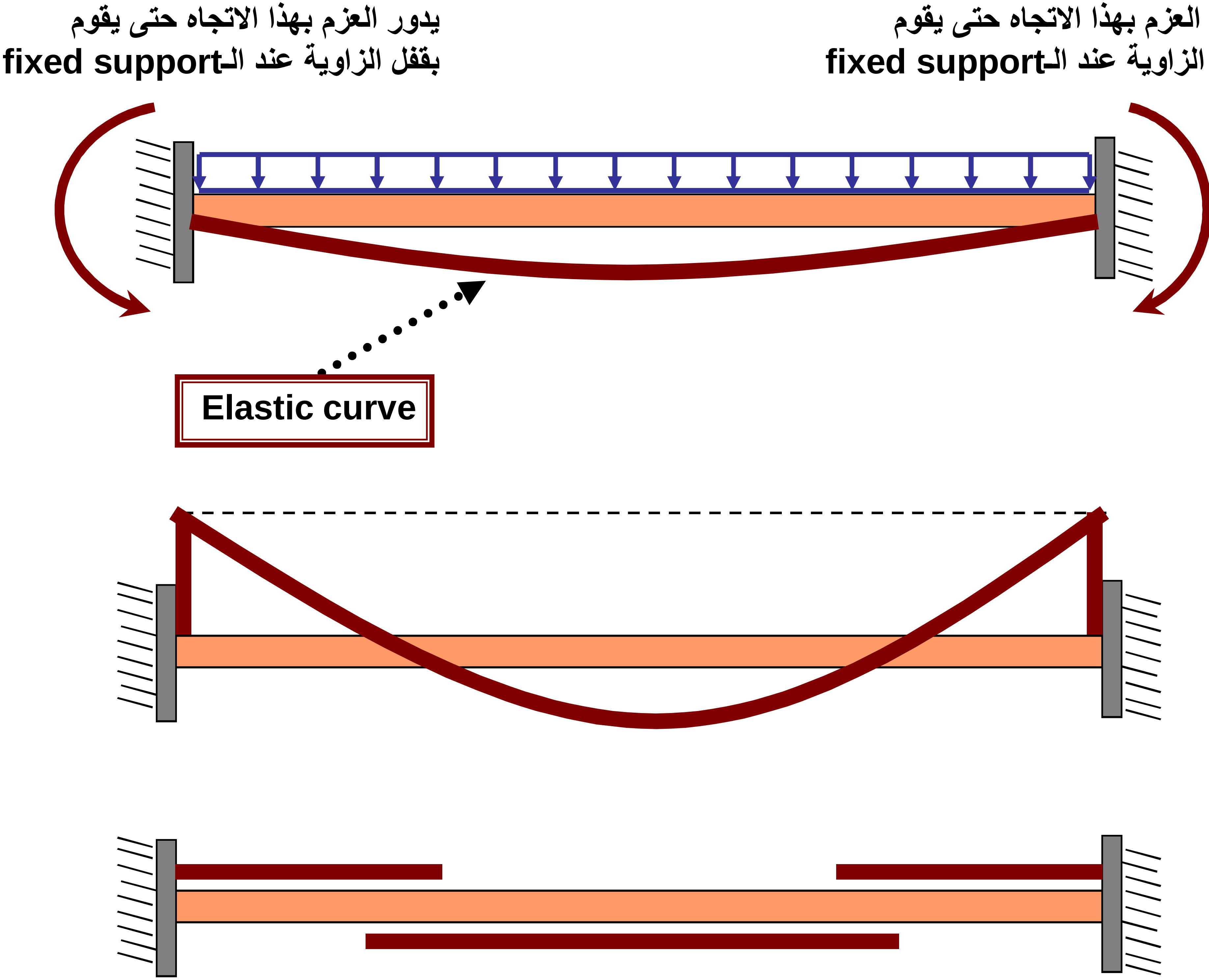


B.M.D

Elastic Curve

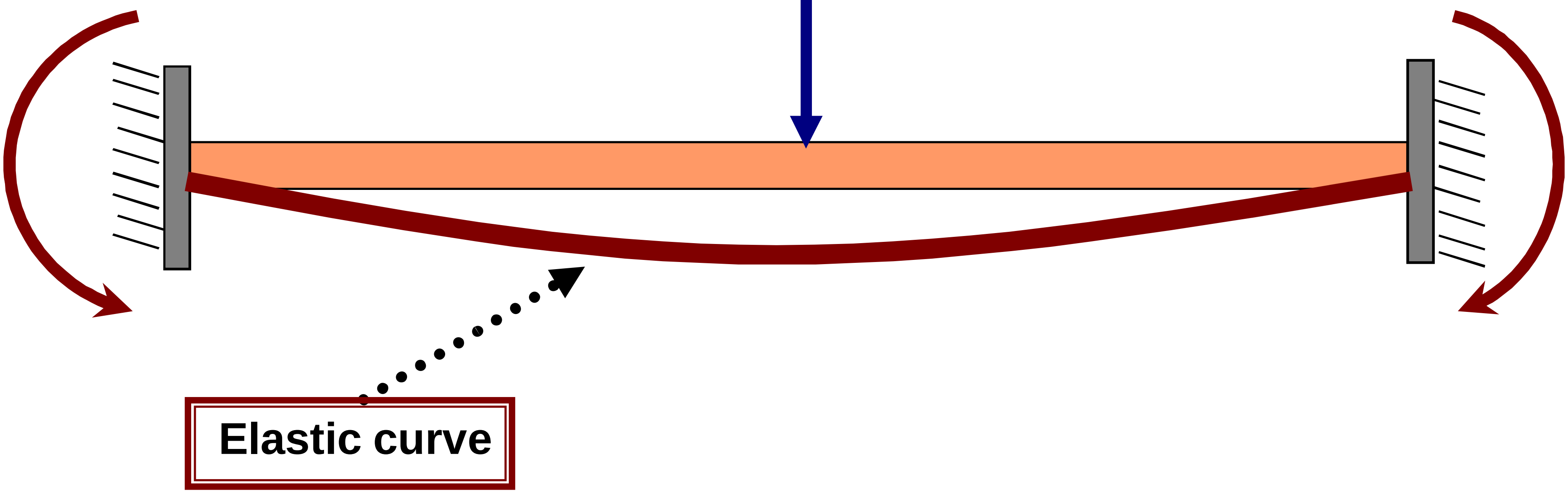

P
B.M.D
Elastic Curve
530

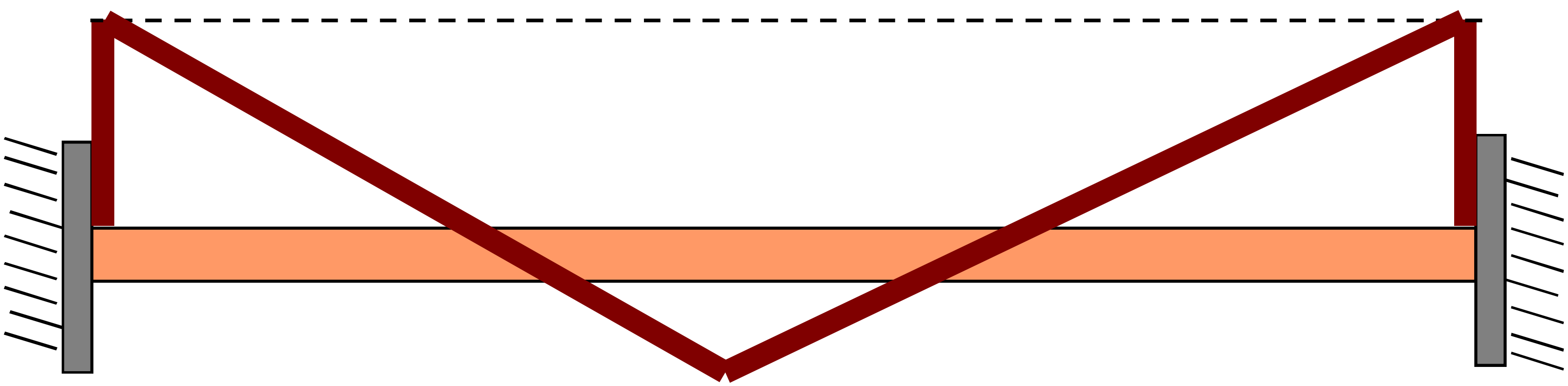

P
B.M.D
Elastic Curve
530


يدور العزم بهذا الاتجاه حتى يقوم
بقفل الزاوية عند الـfixed support
يدور العزم بهذا الاتجاه حتى يقوم
بقفل الزاوية عند الـfixed support
Elastic curve

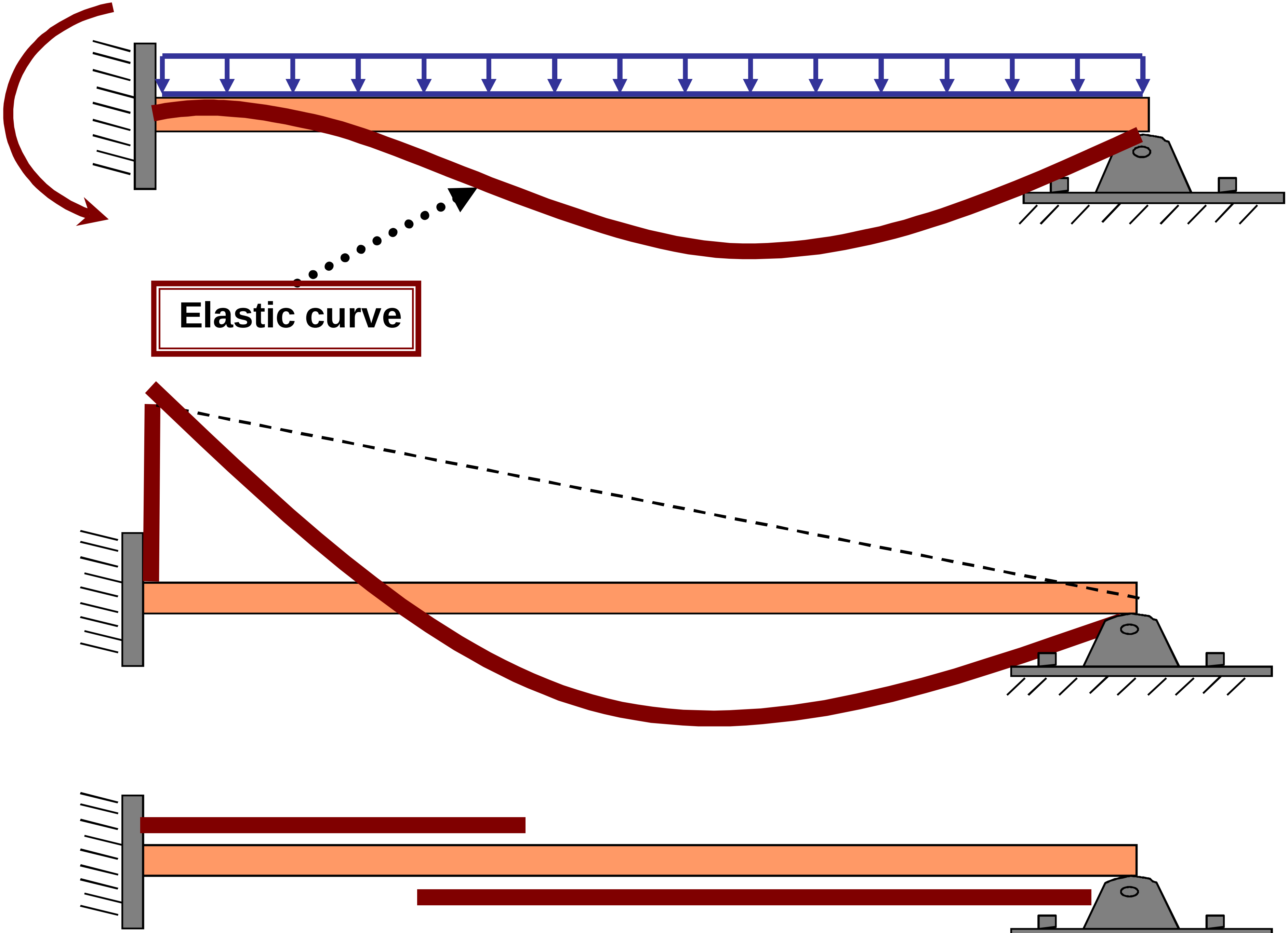
يدور العزم بهذا الاتجاه حتى يقوم بقفل الزاوية عند الـfixed support

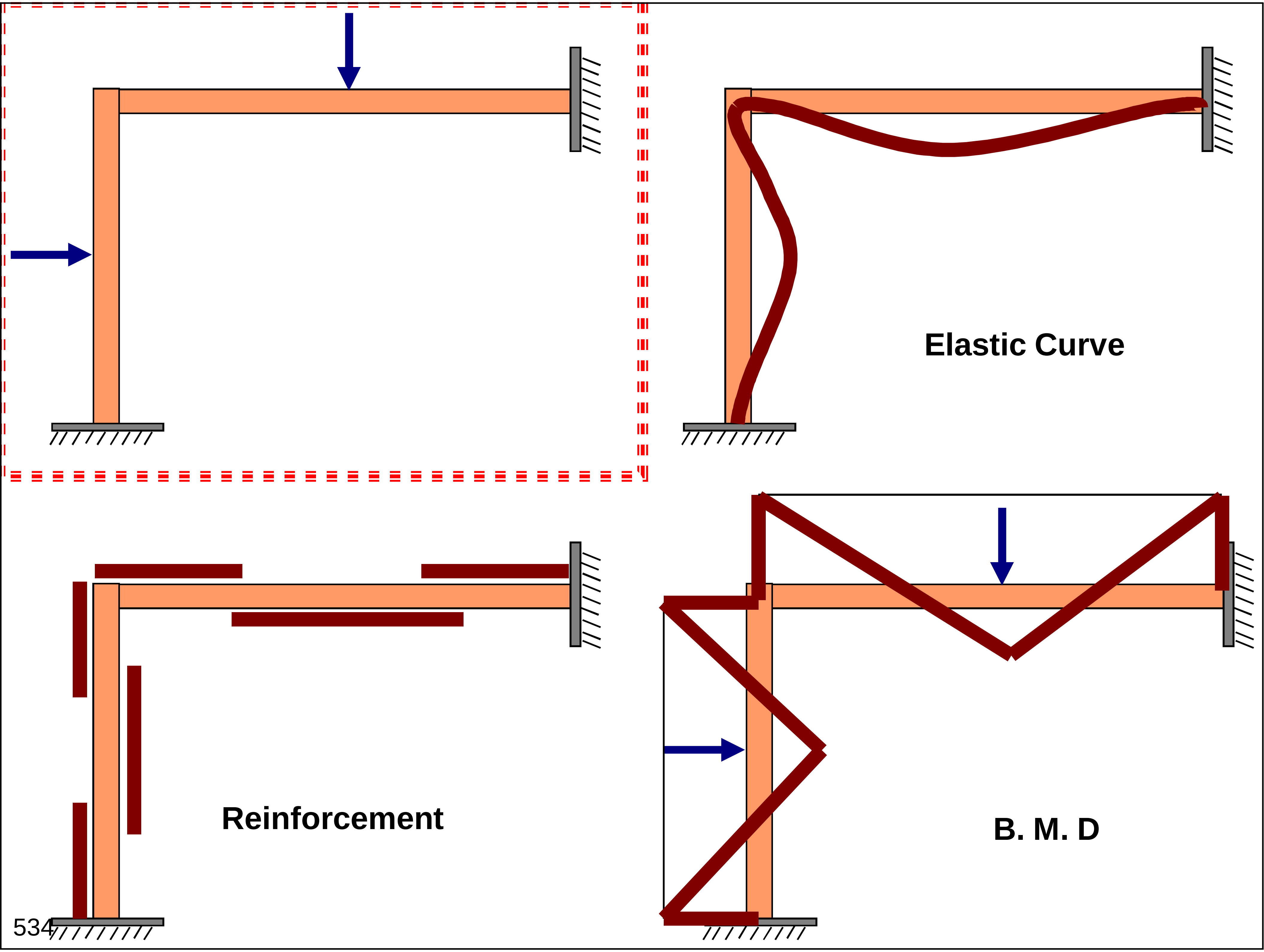
يدور العزم بهذا الاتجاه حتى يقوم بقفل الزاوية عند الـfixed support

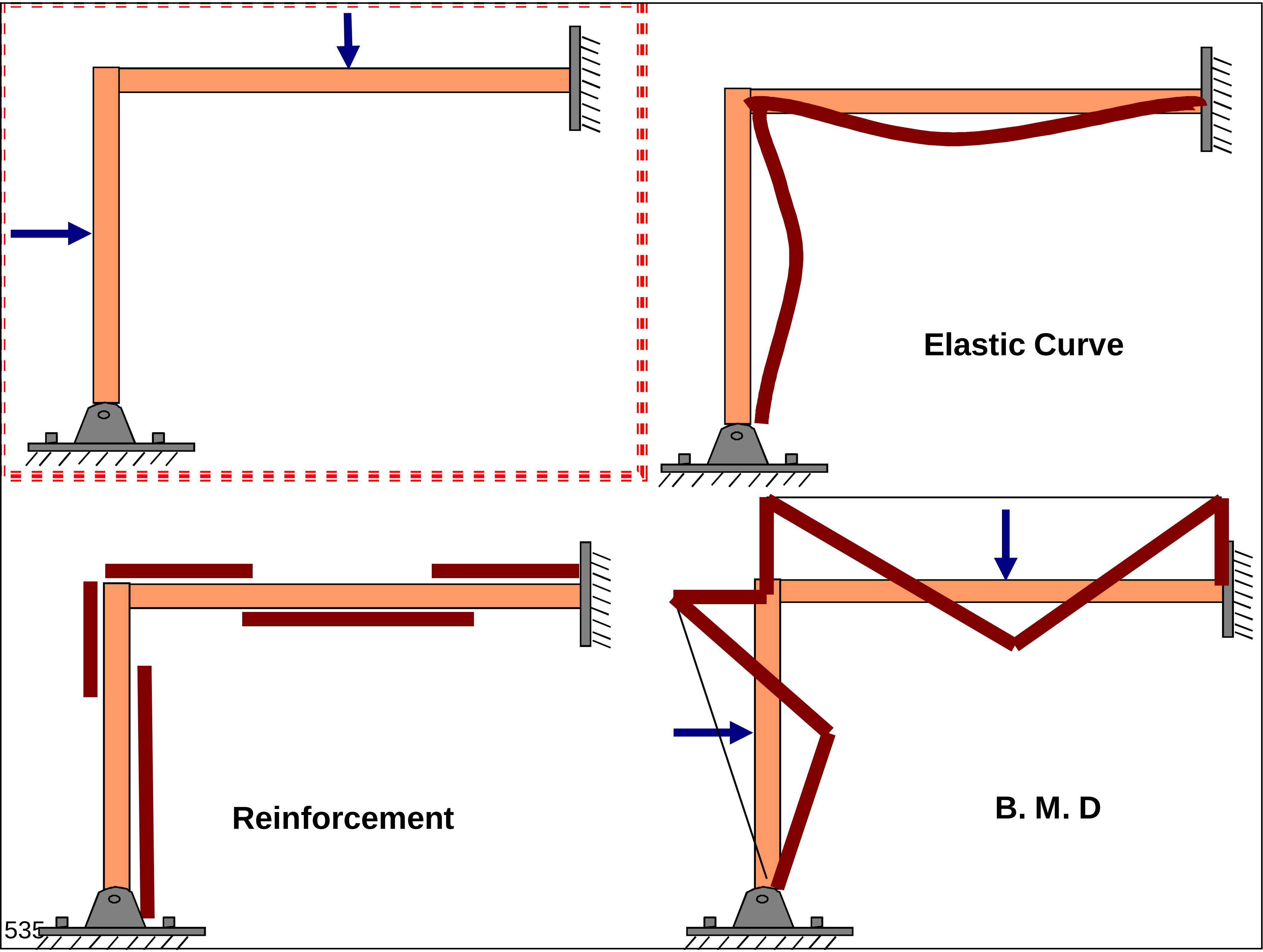


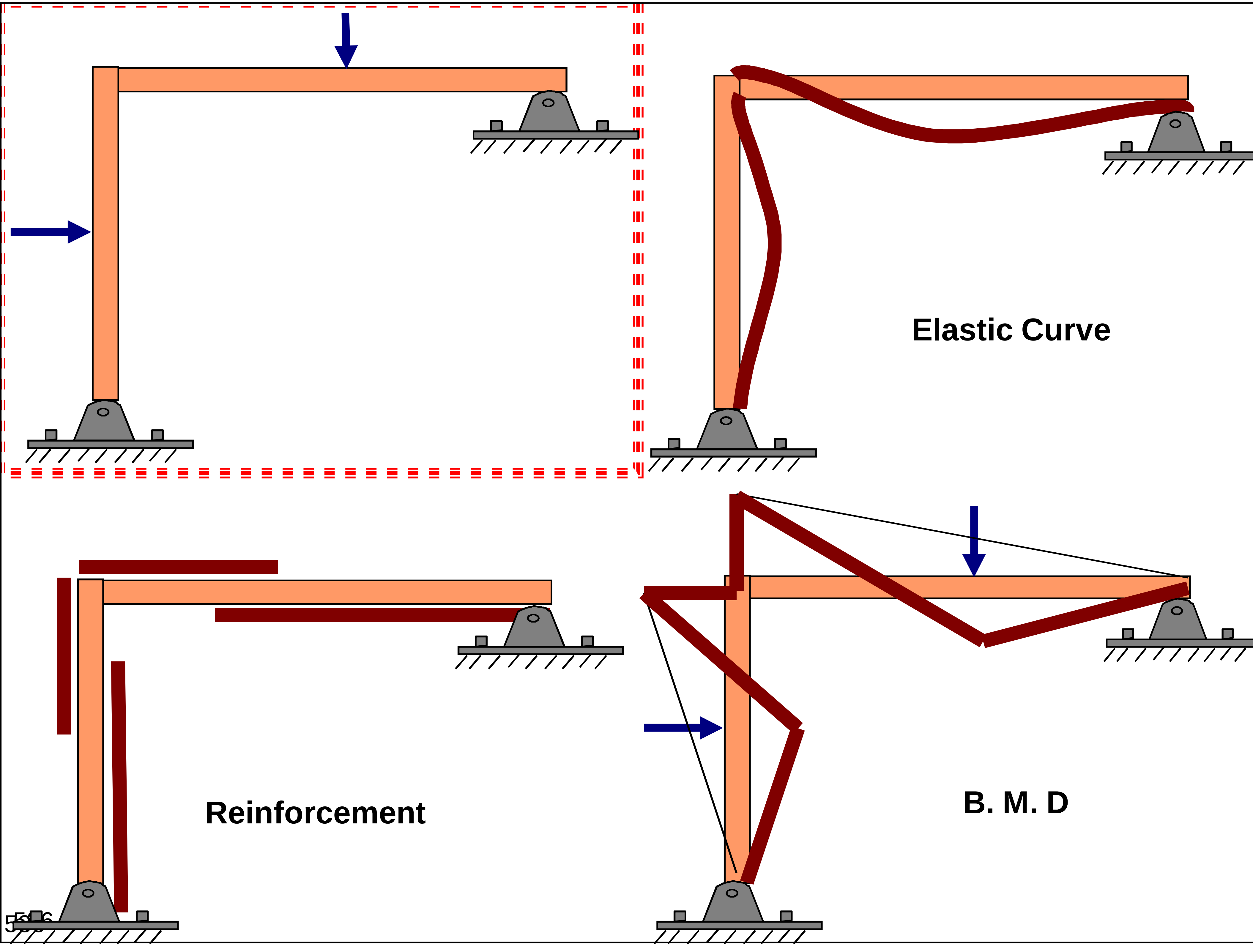


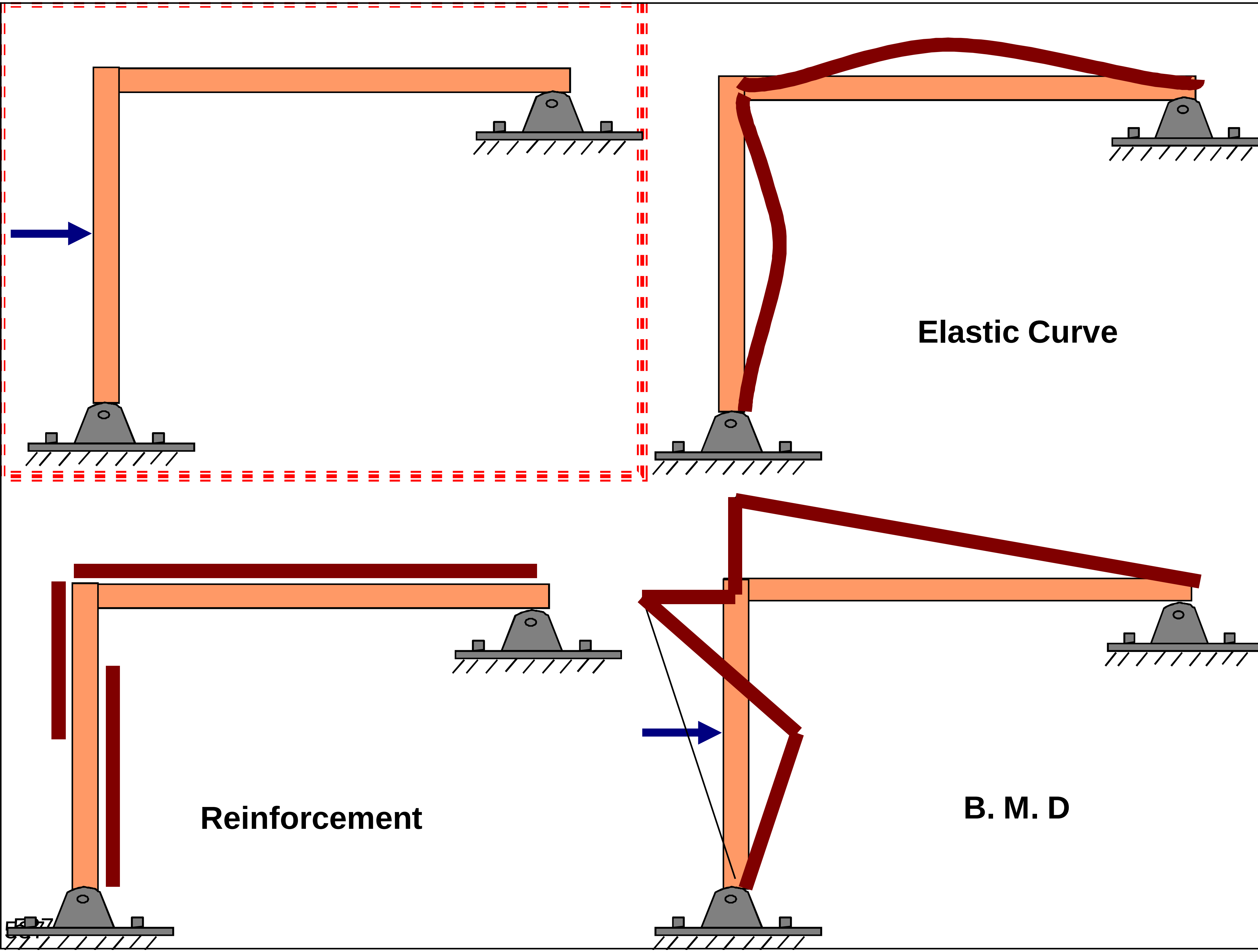
يدور العزم بهذا الاتجاه حتى يقوم
بقفل الزاوية عند الـfixed support

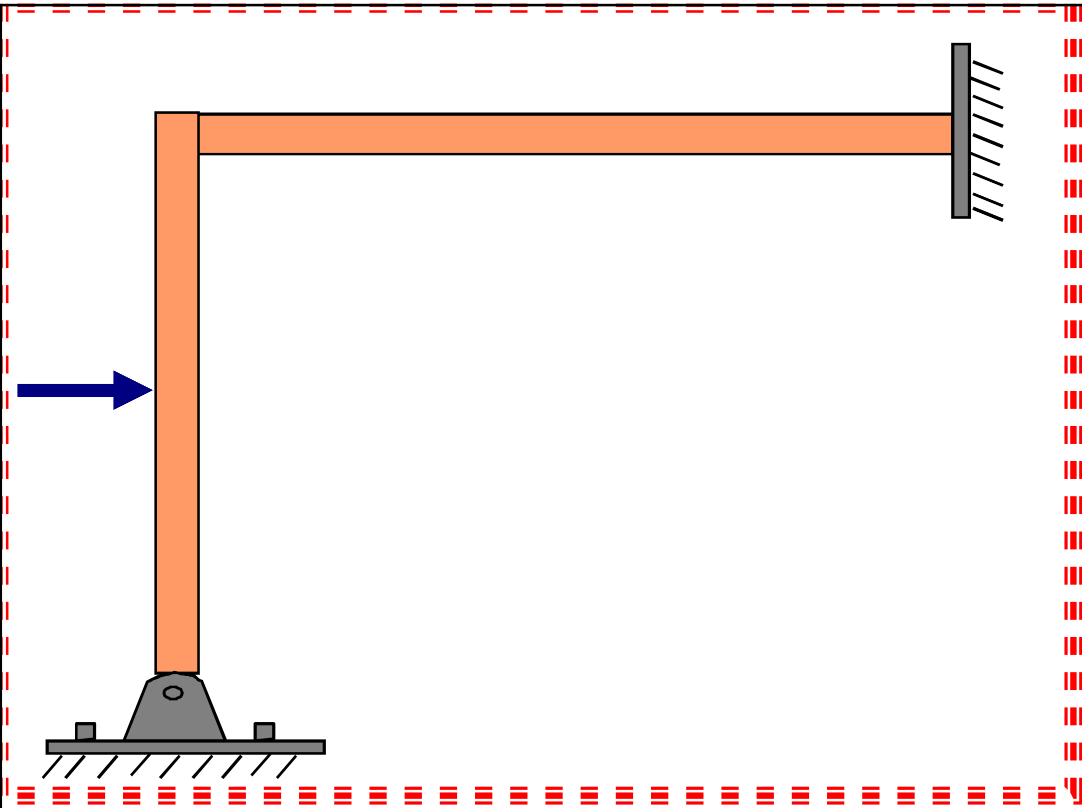


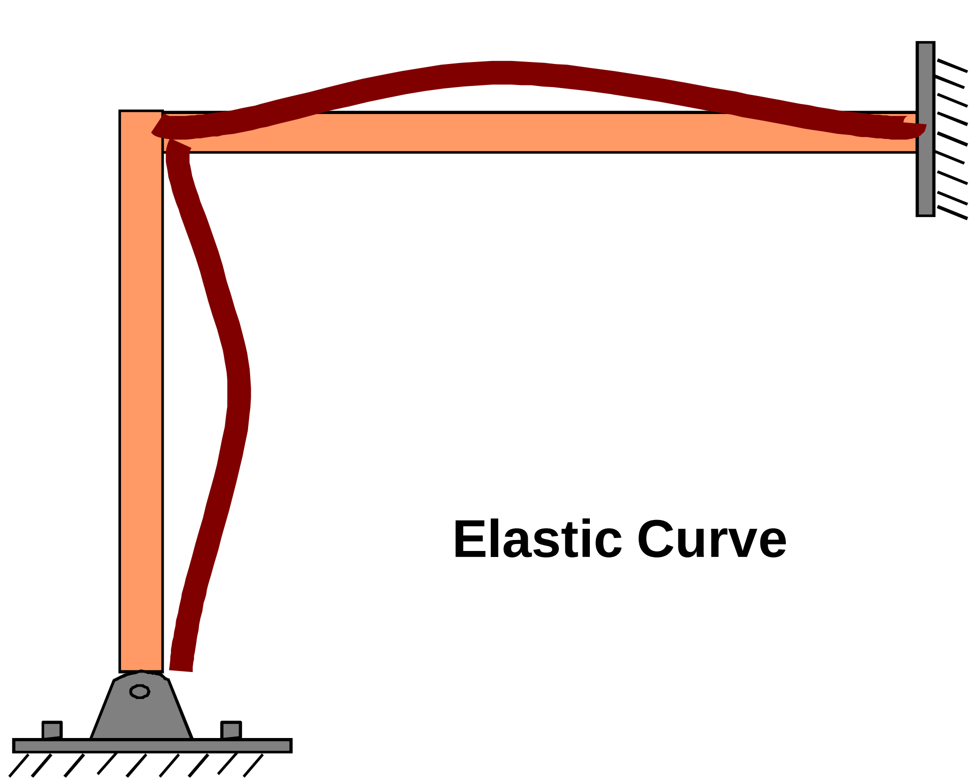

Elastic Curve
Reinforcement
B. M. D


Elastic Curve
Reinforcement
B. M. D

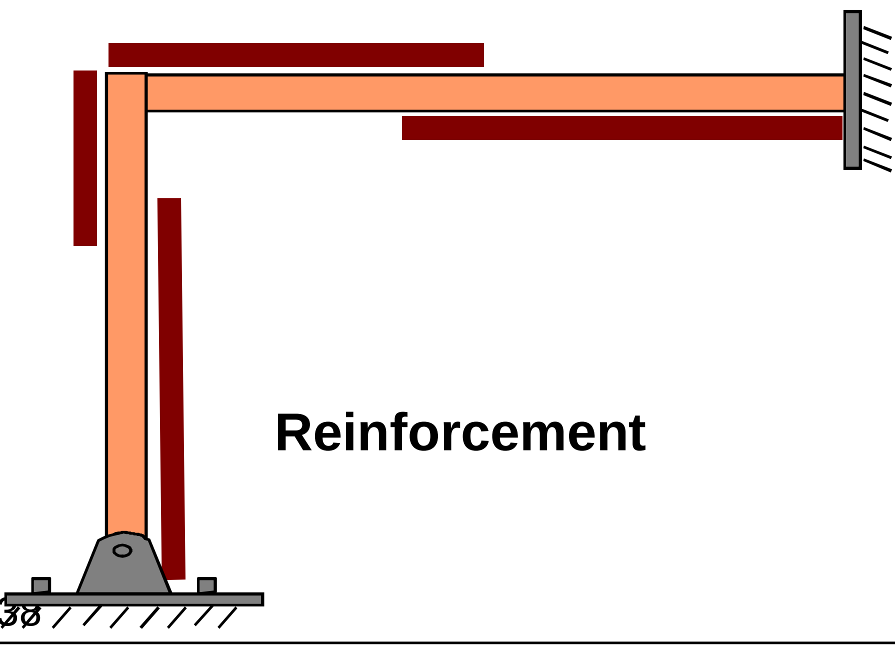

Elastic Curve
Reinforcement
B. M. D

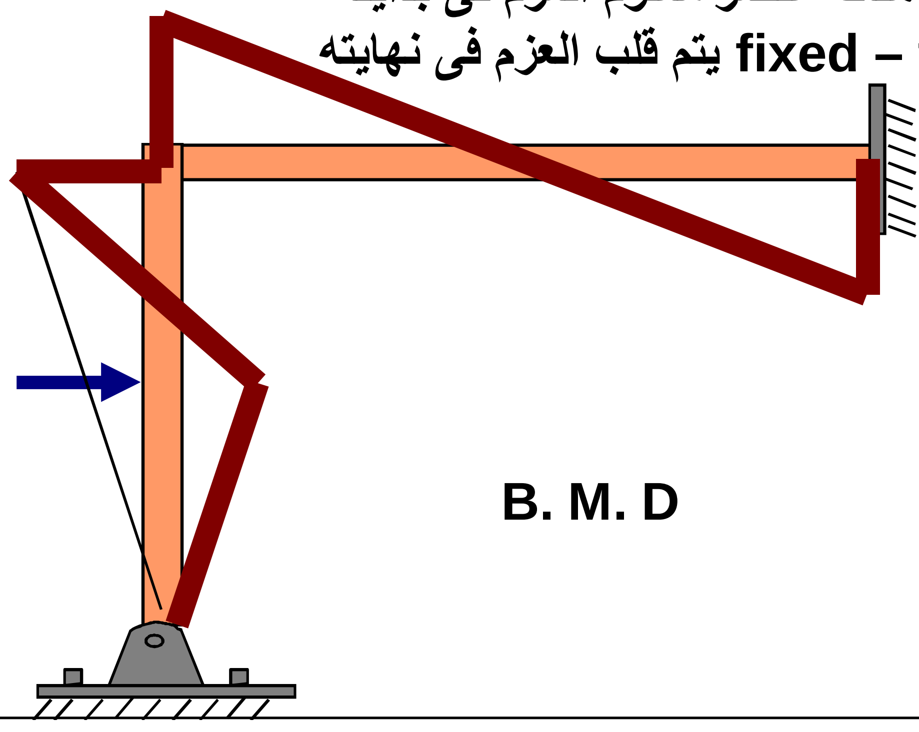

Elastic Curve
Reinforcement
B. M. D

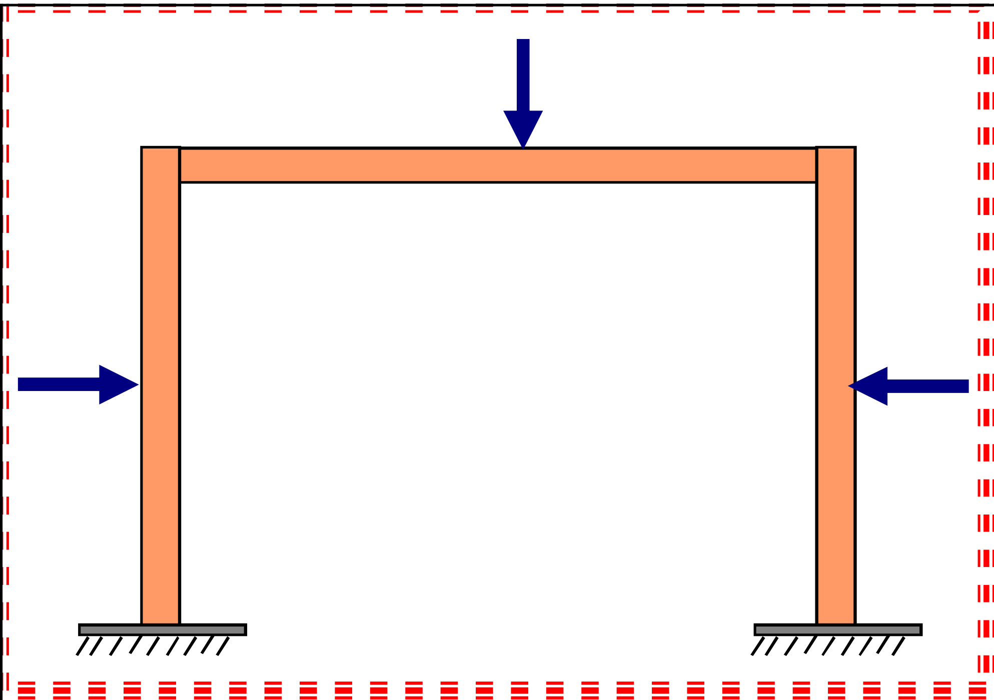


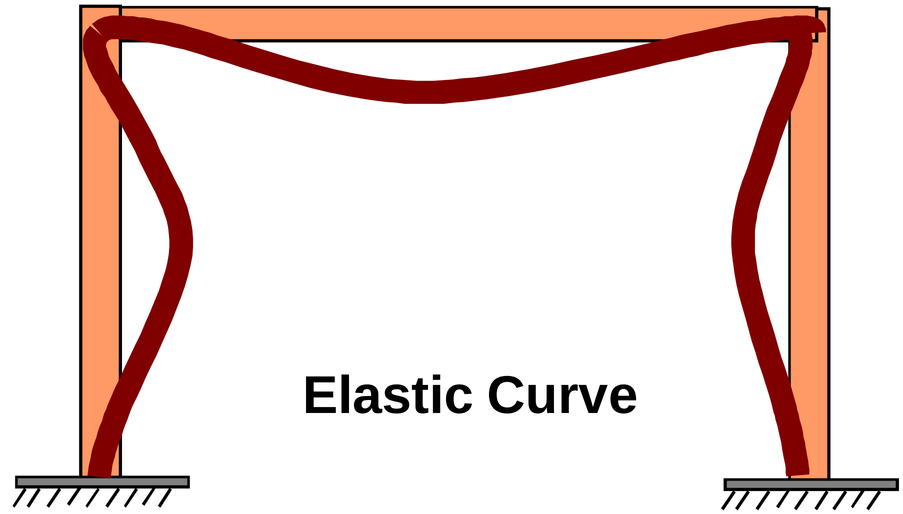


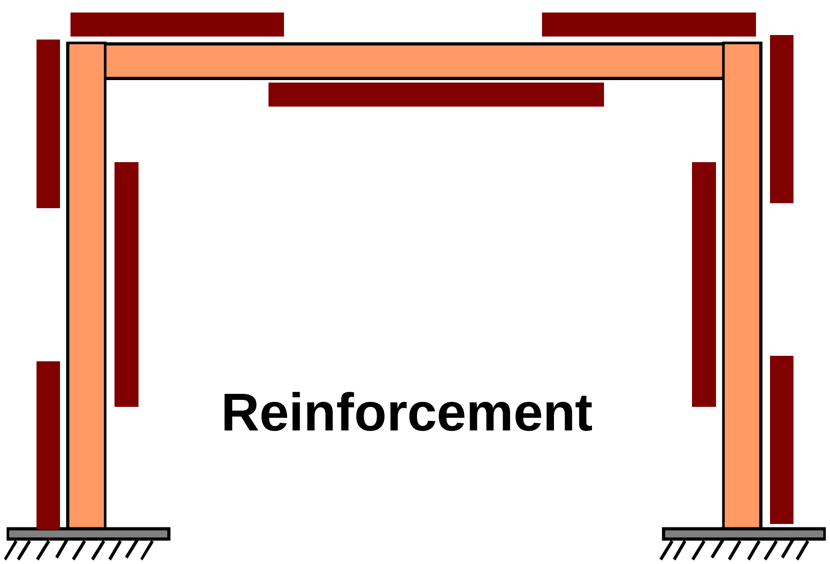
عندما يكون هناك عنصر معلوم العزم فى بدايته
وهو fixed – fixed يتم قلب العزم فى نهايته

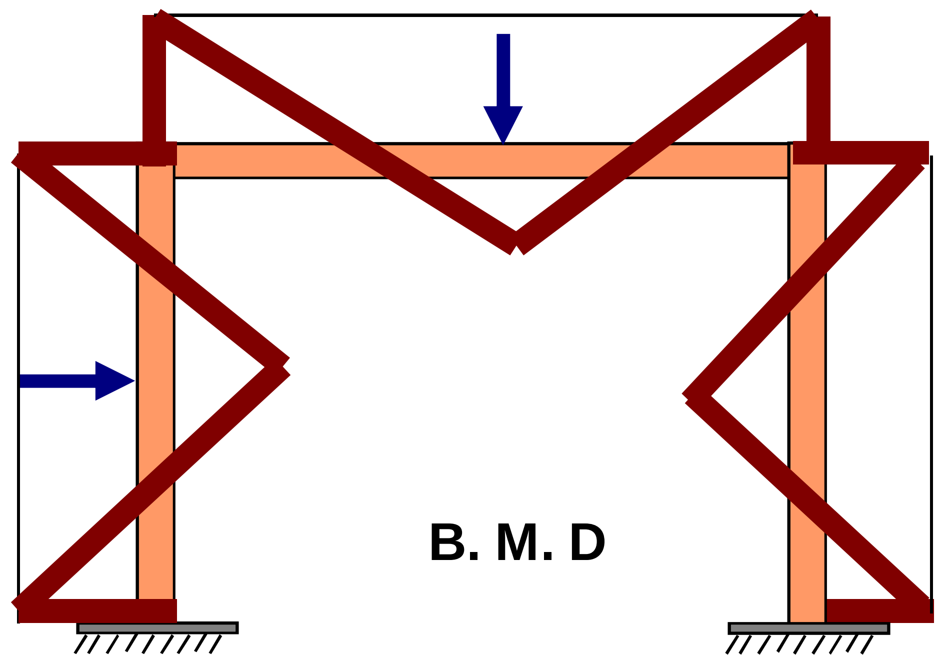


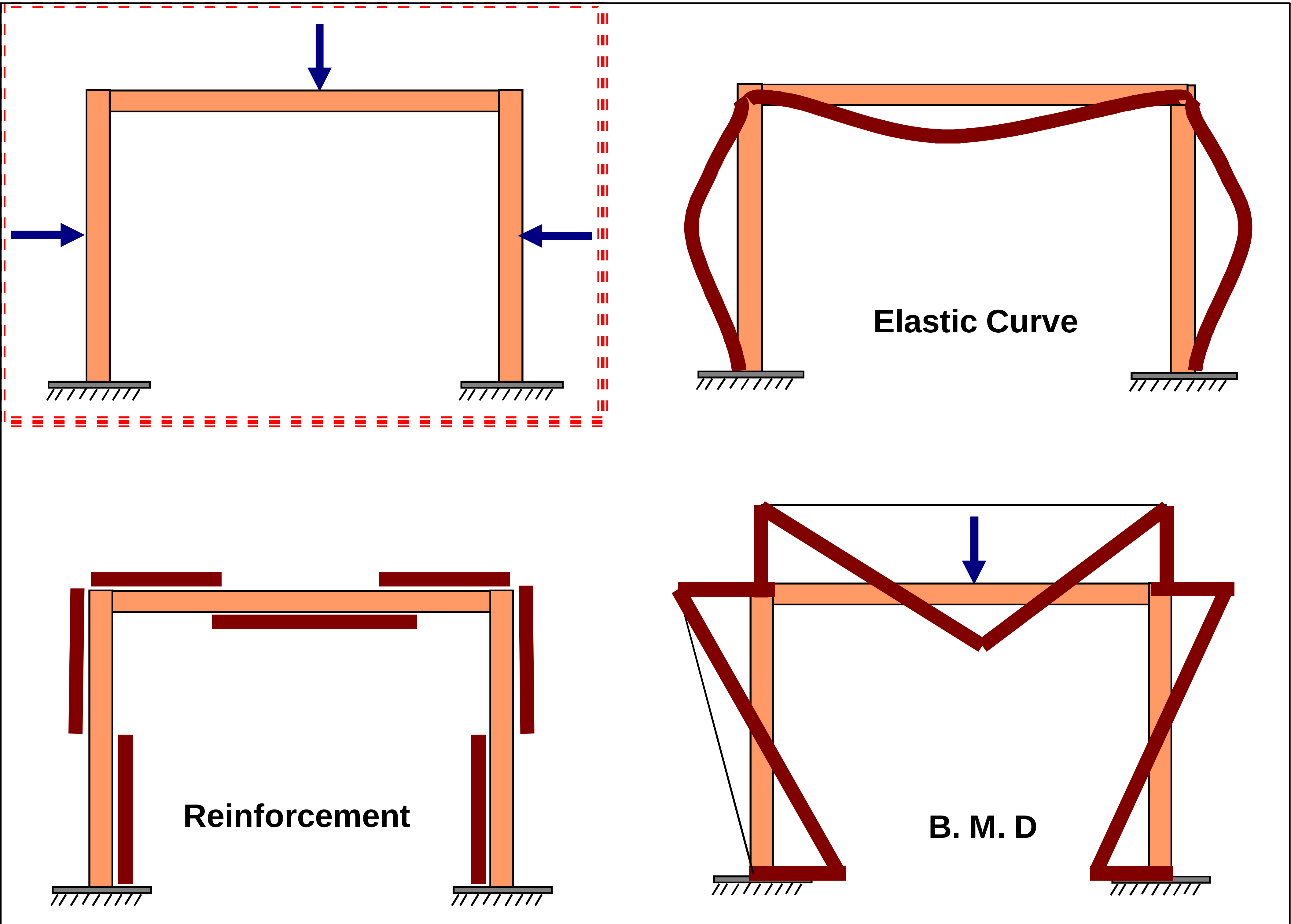


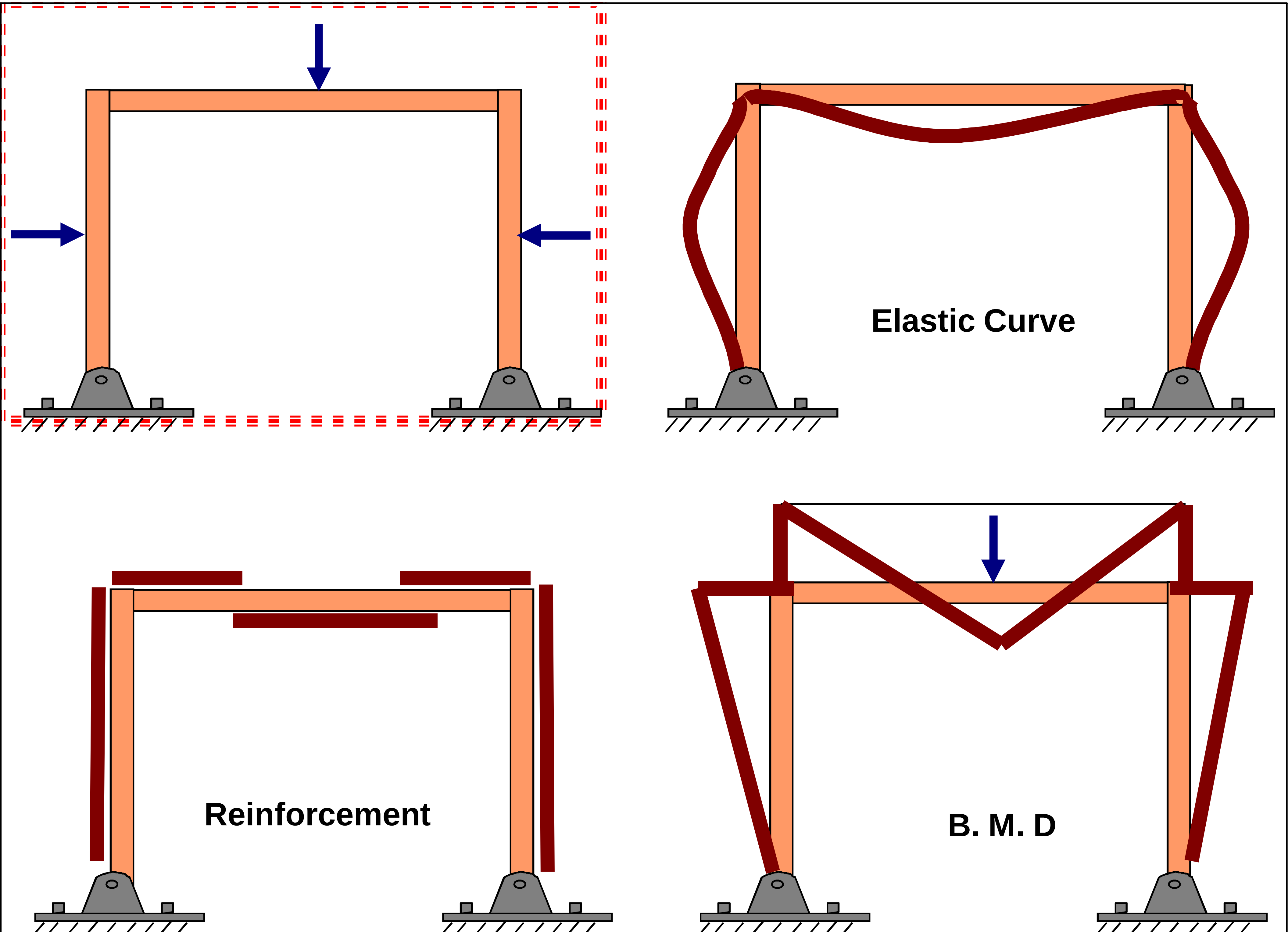


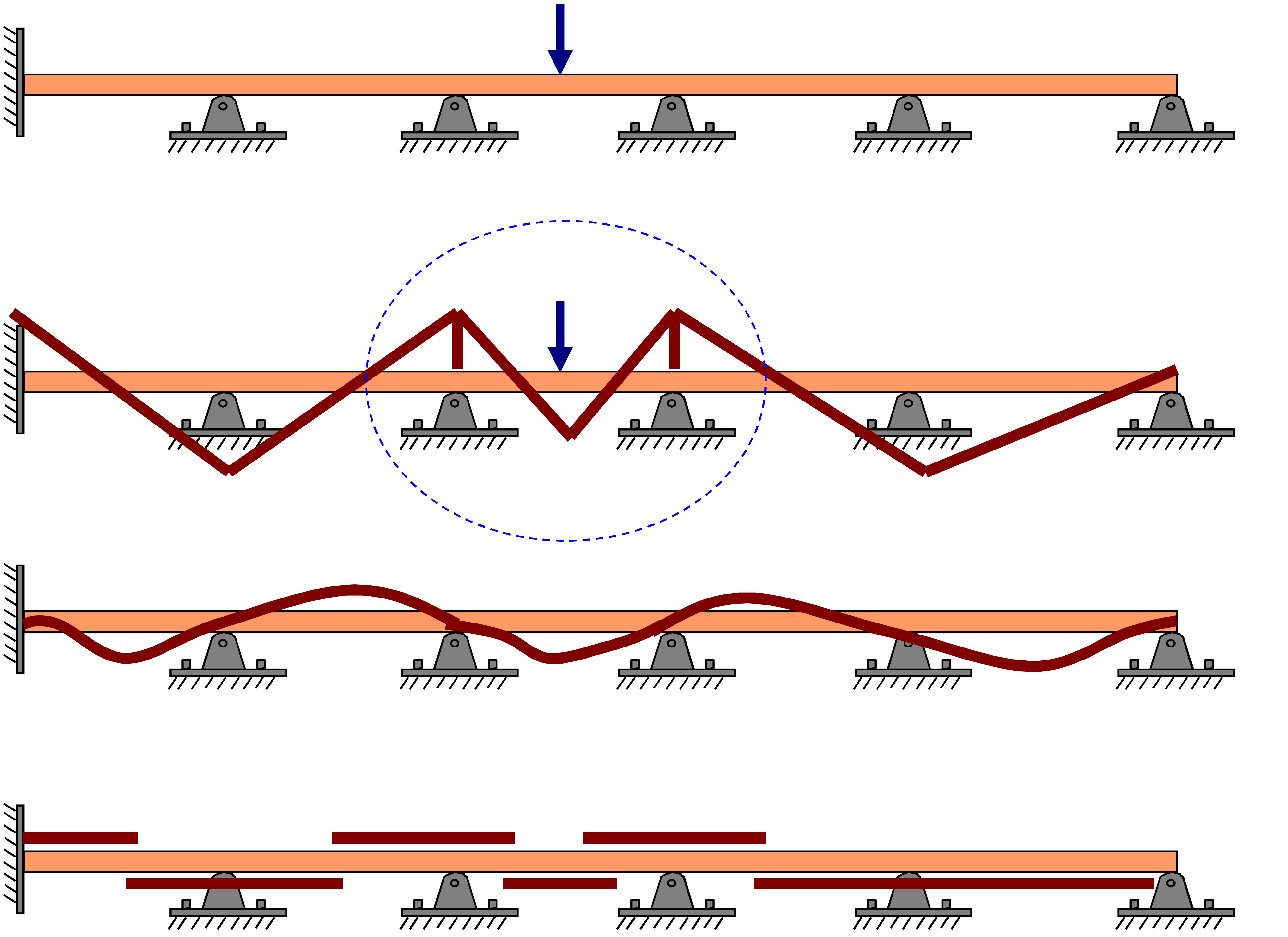

Elastic Curve


Reinforcement

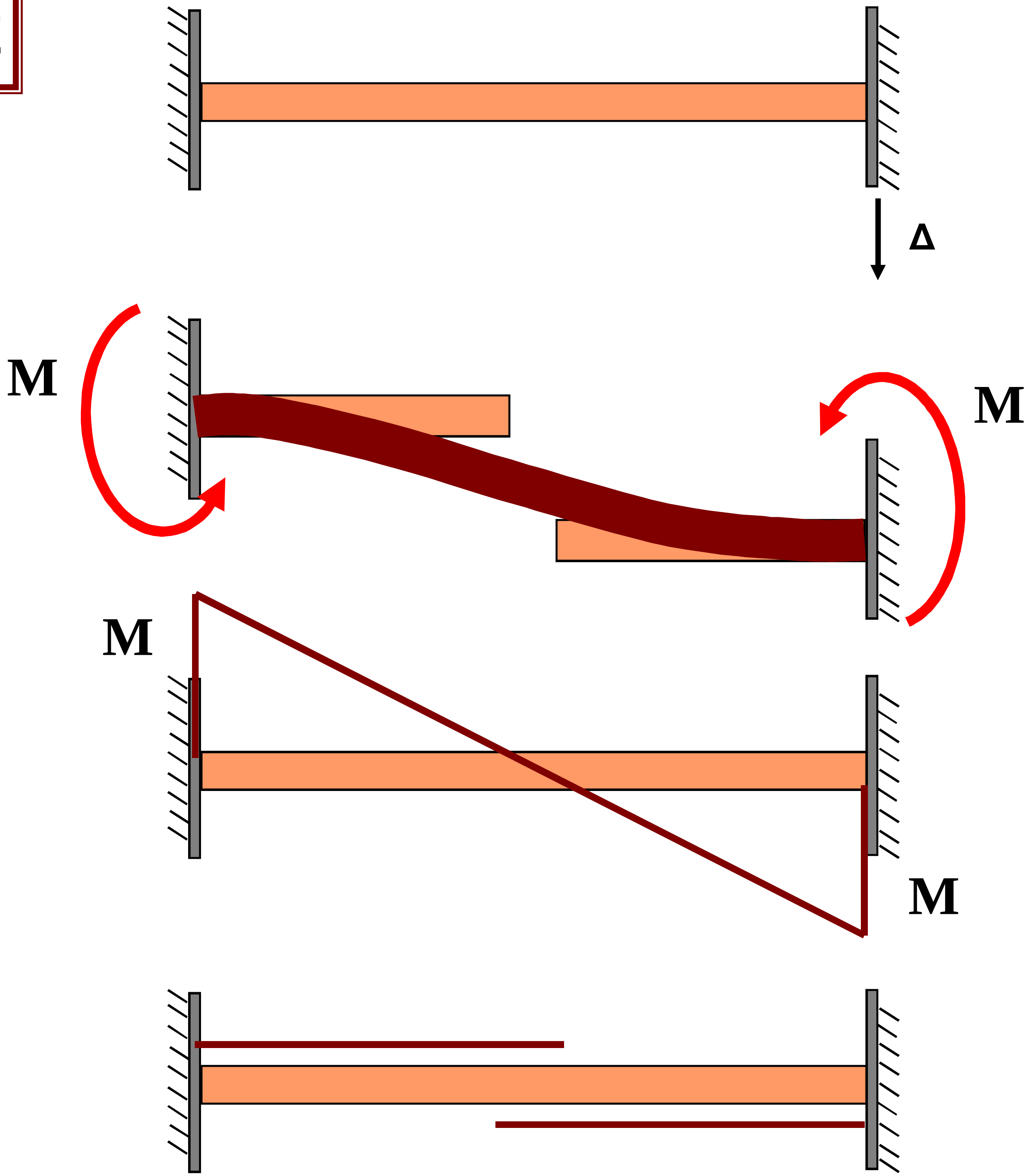

B. M. D

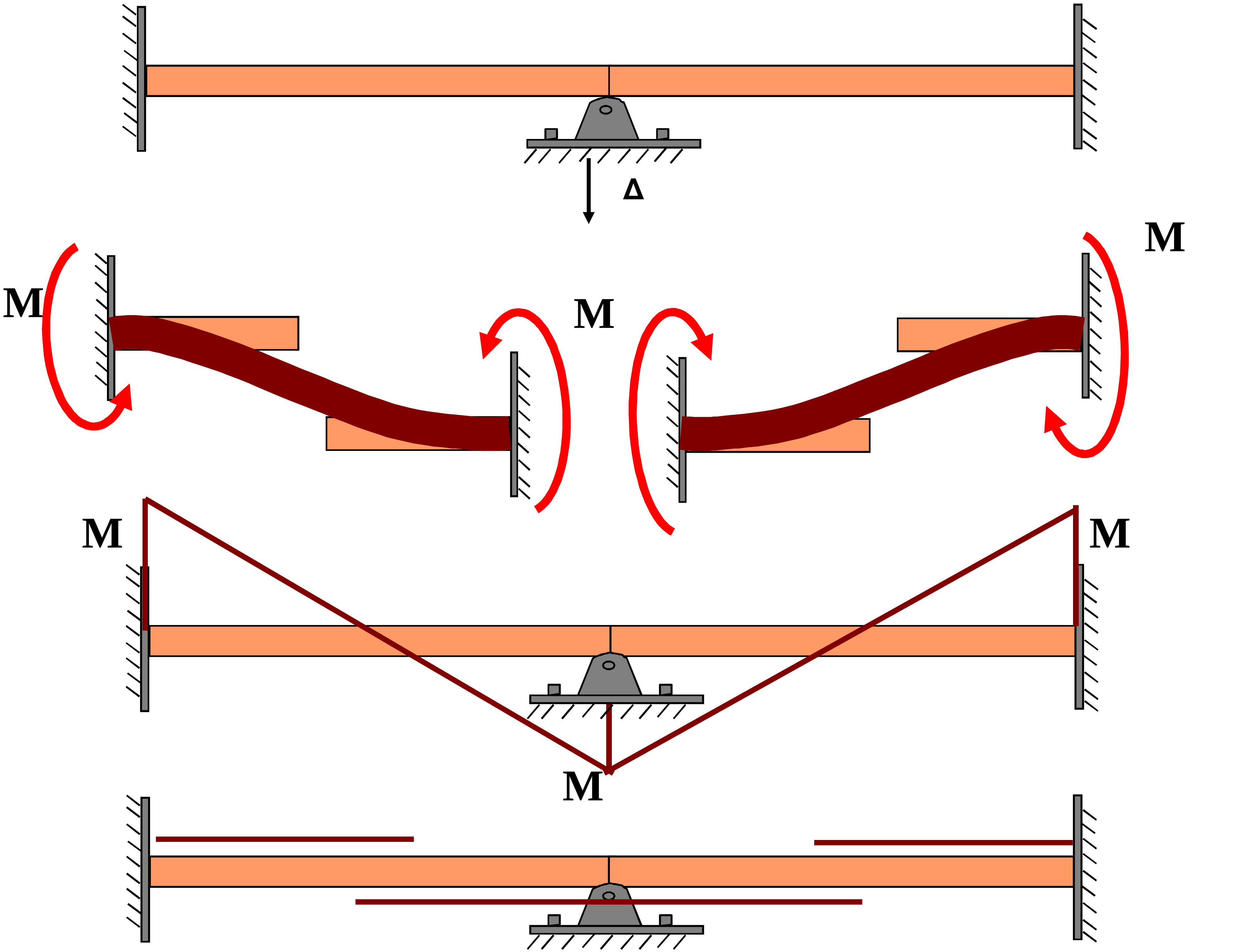

Elastic Curve
Reinforcement
B. M. D

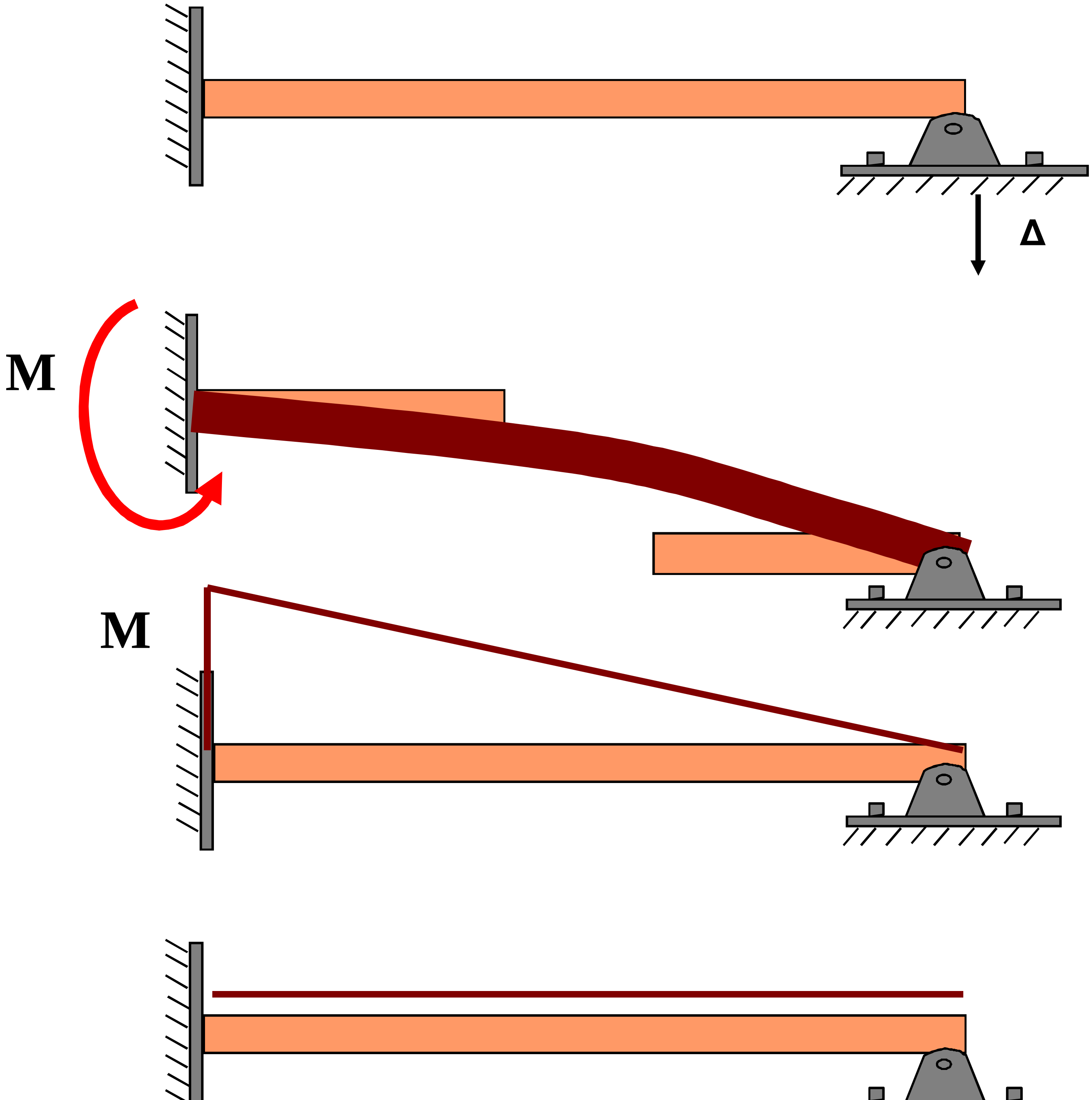

Elastic Curve
Reinforcement
B. M. D

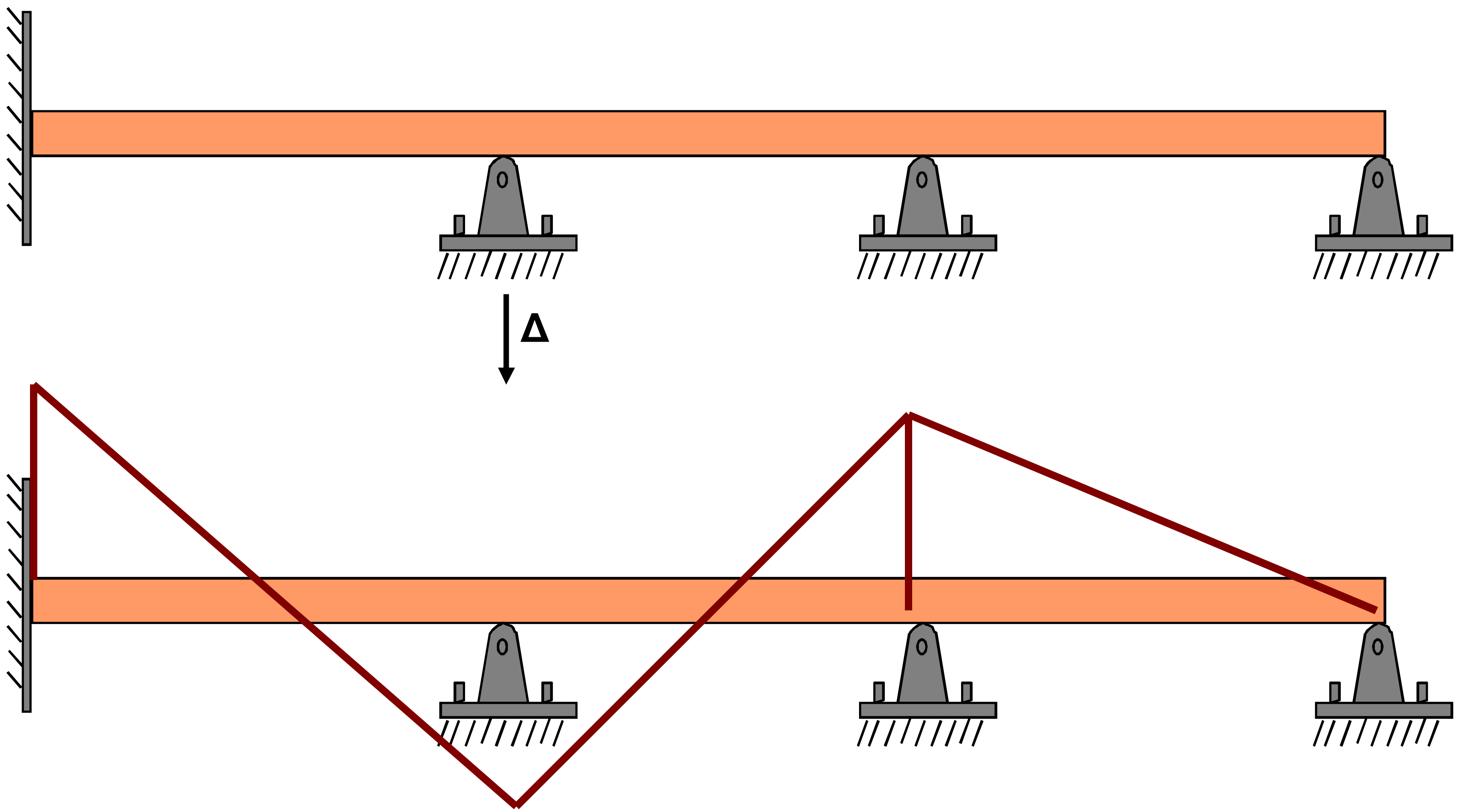


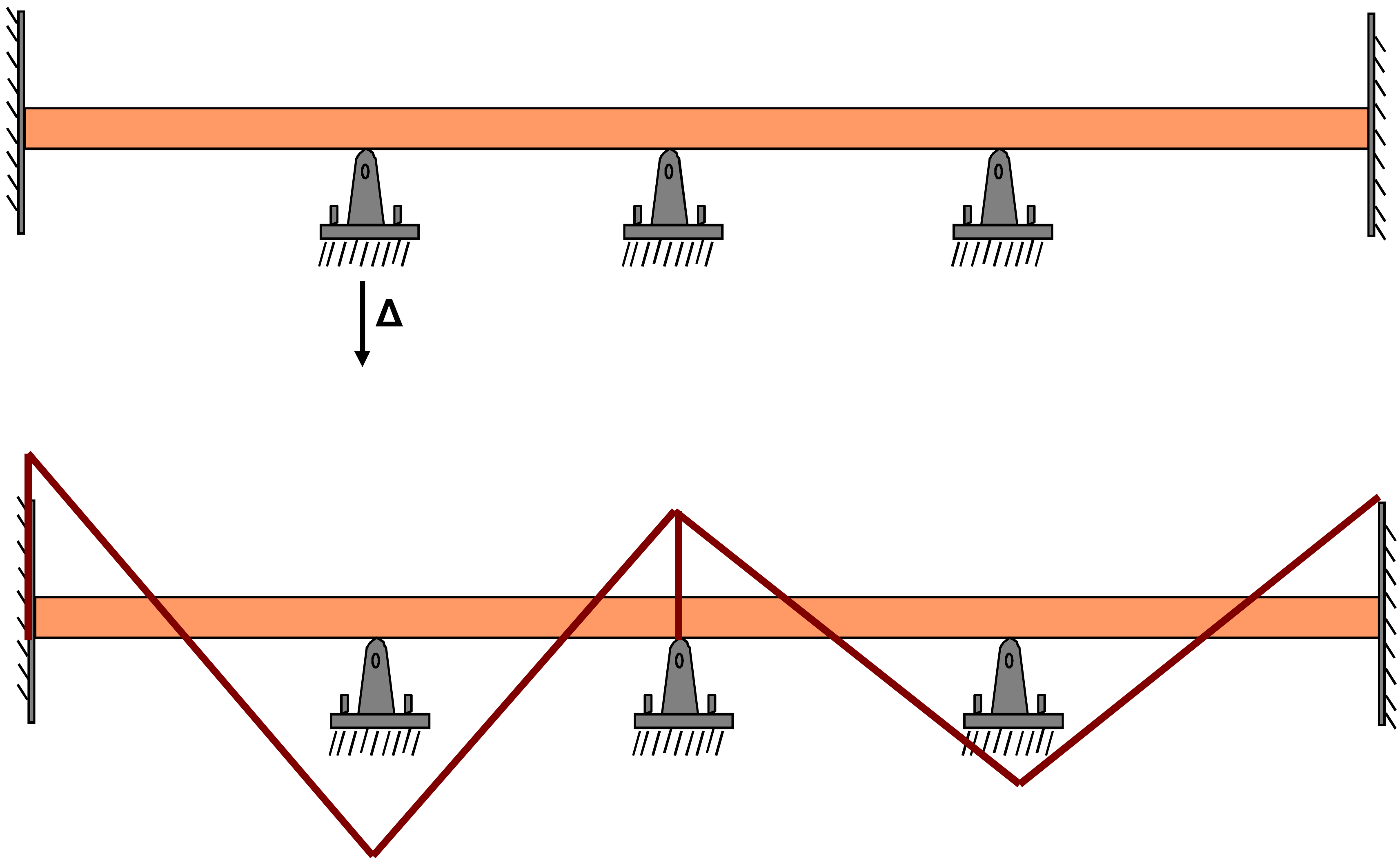
Settlement




Δ
M
M
M
M
M
M
M
M


Δ
M
M


Δ


Δ

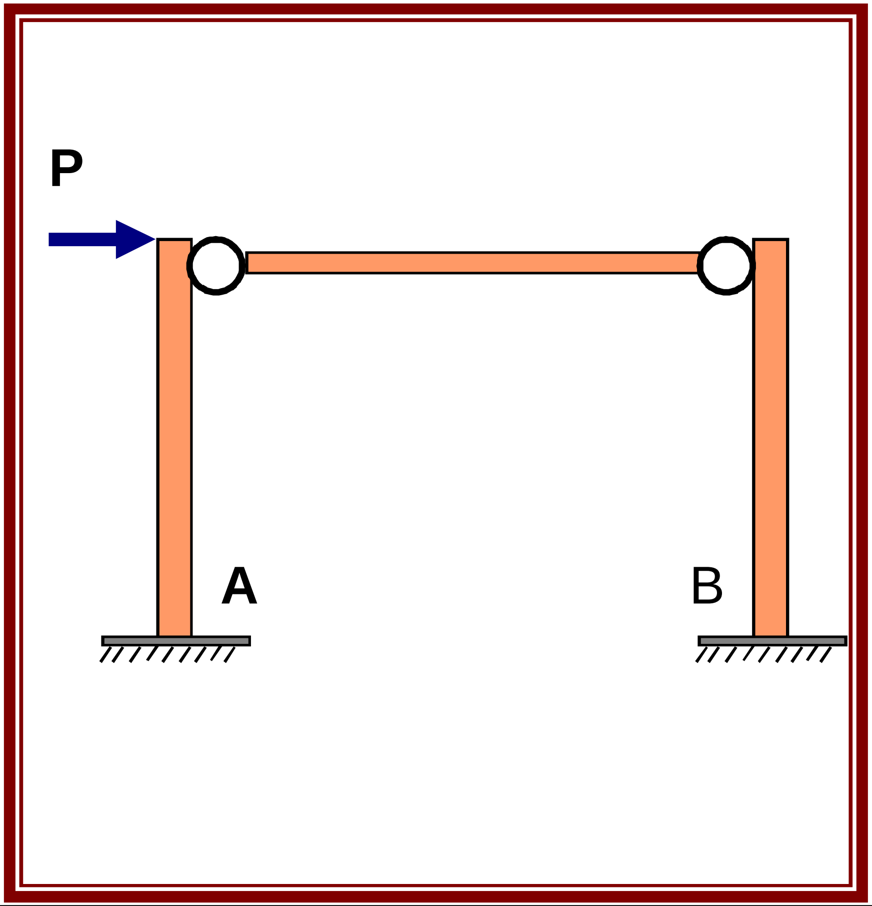
Final 2009

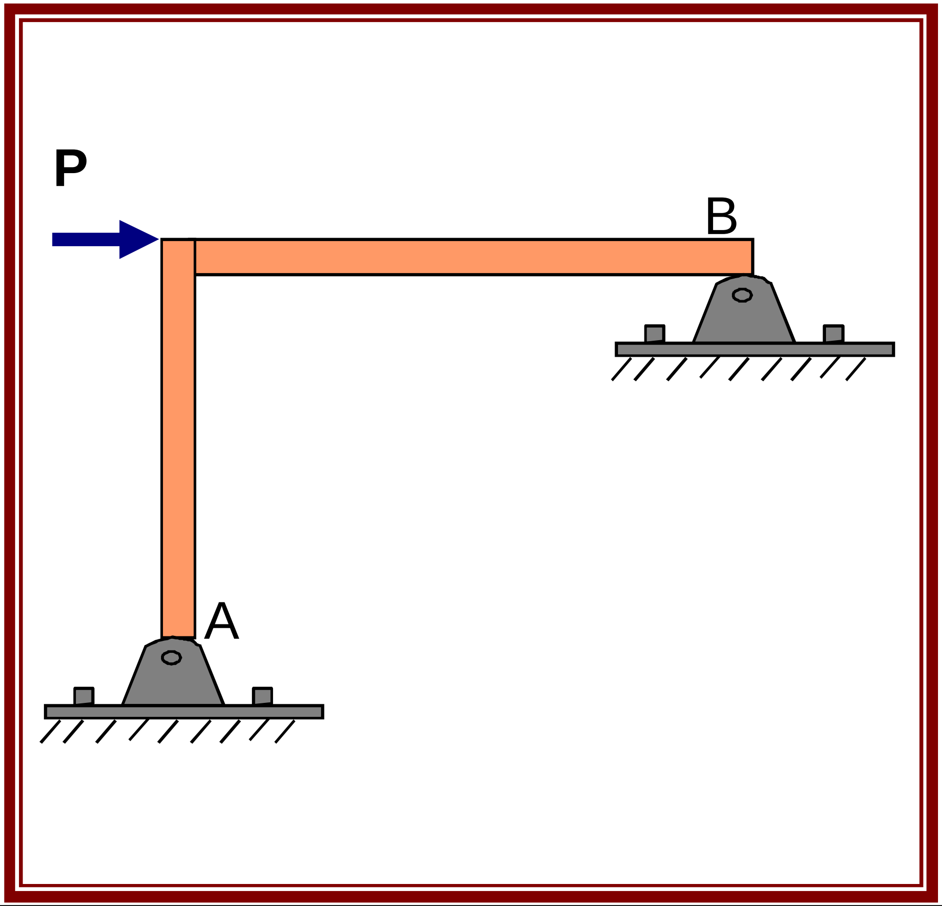
For the following two shapes draw B.M.D, reinforcement and elastic curve due to:

(a) given loads.

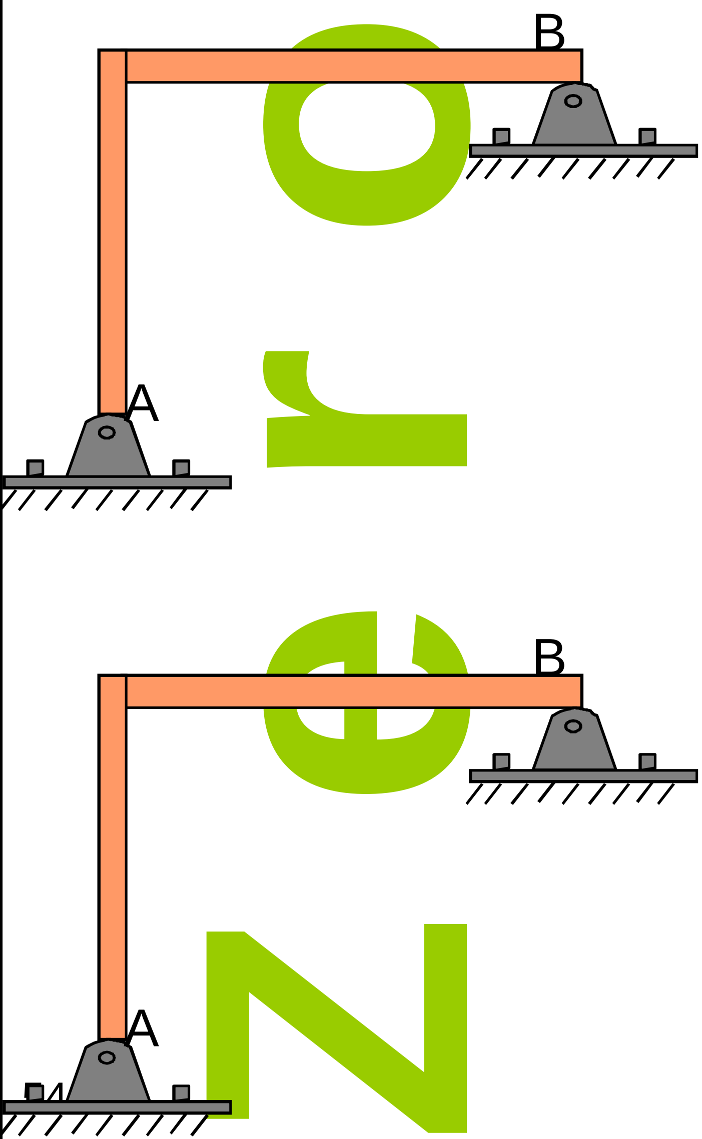
(b) settlement at A.

(c) uniform rise in temperature.

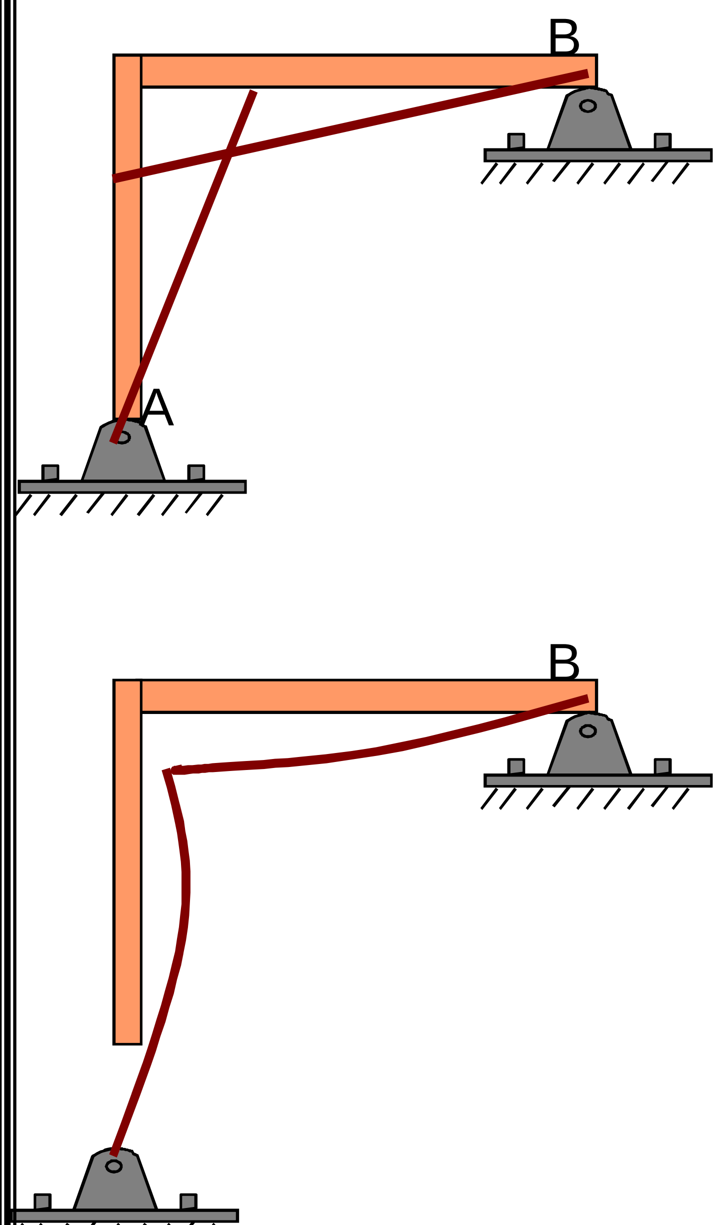




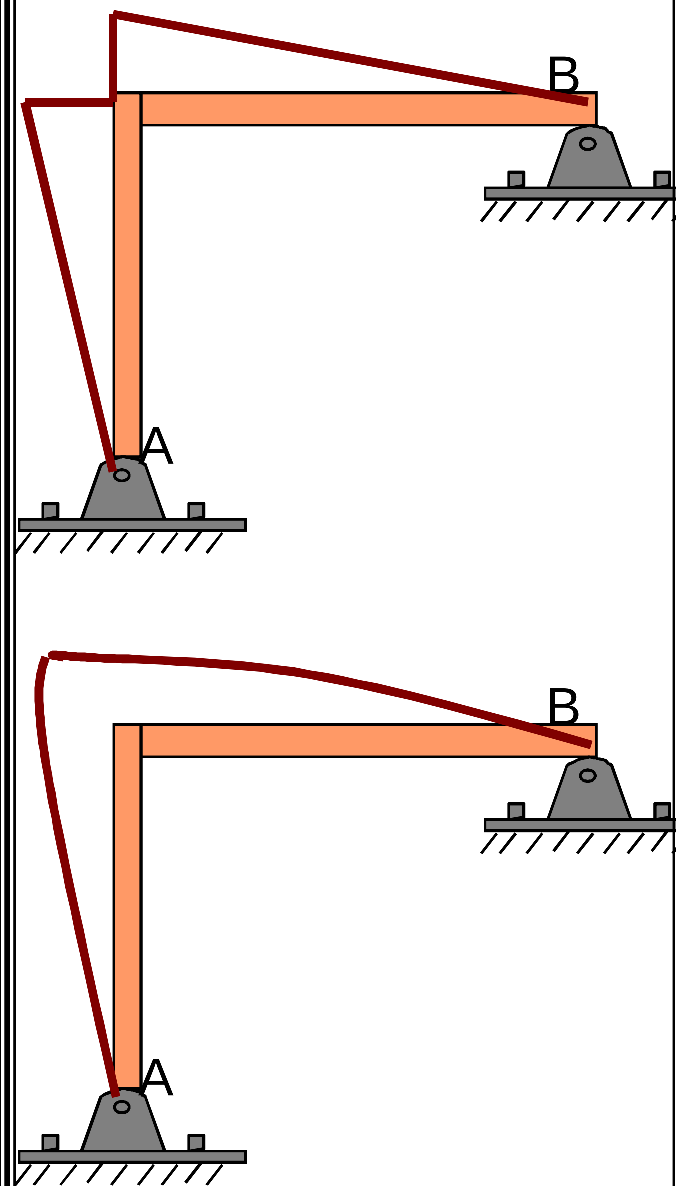
Given loads



Settlement at A

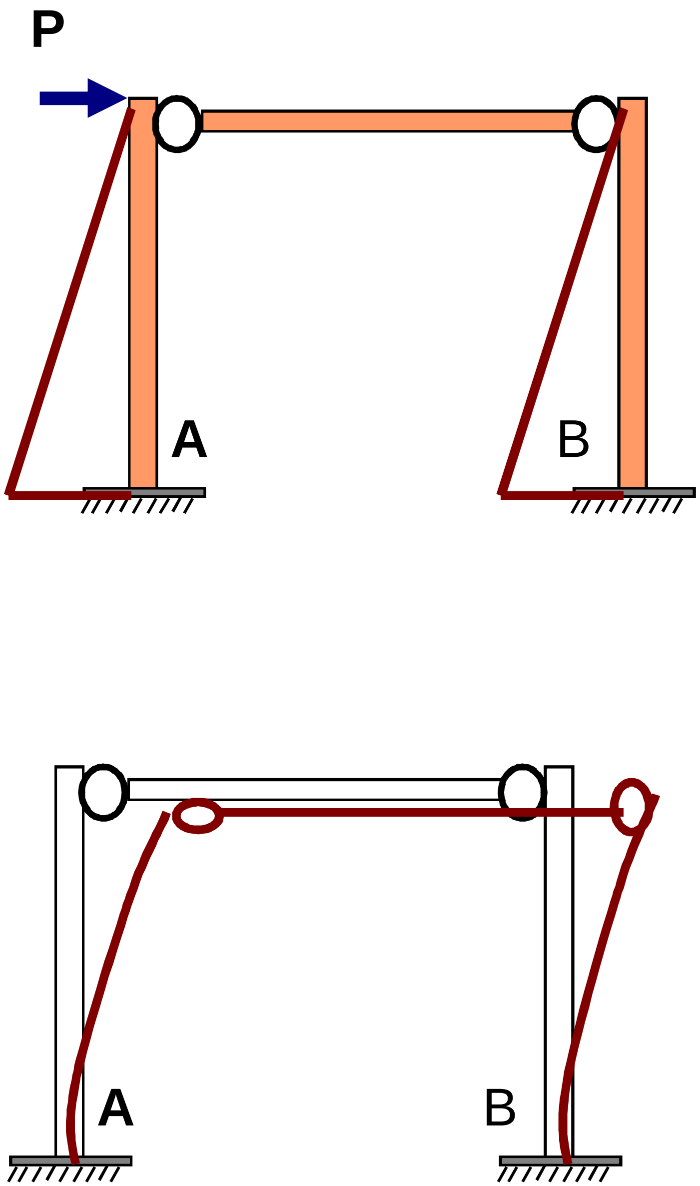


Uniform temperature

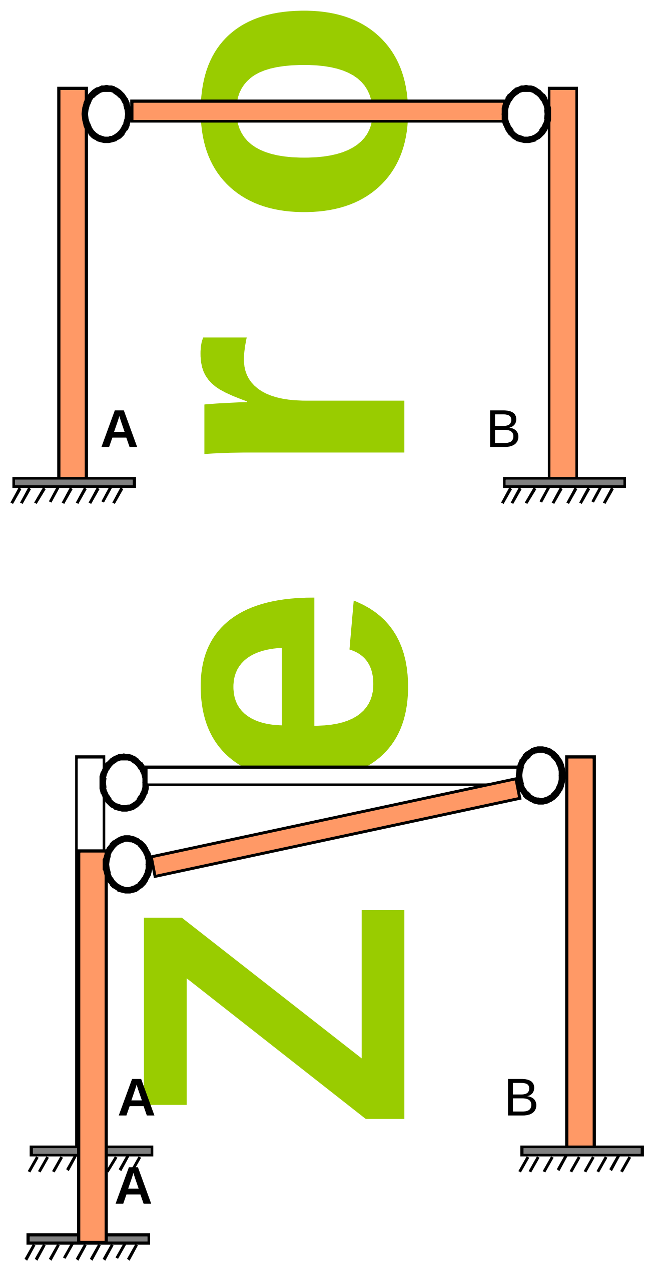


التسليــــــــح فى اتجـــــاه العـــزم

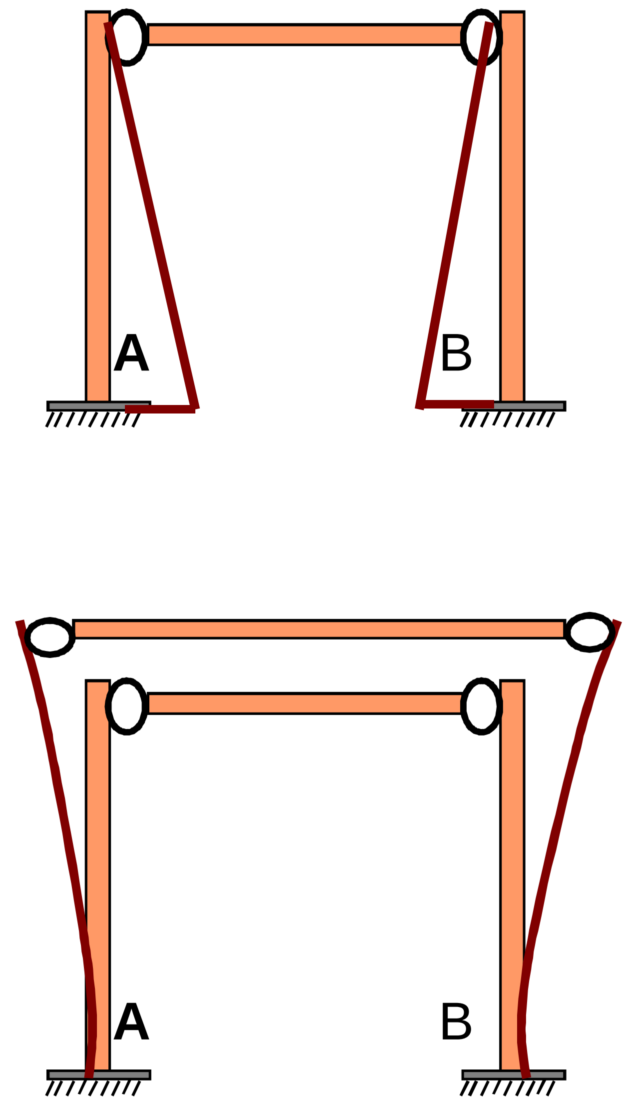
Given loads



Settlement at A



Uniform temperature



الحمـــــــــد لله الذى هدانـــــا للاســـلام
ولـــولا اللـــــــــــــه لمـــا إهتدينـــــــا

الحمـــــــــد لله الذى وفقتـــــا لهذا العمل
واتمنى من الله ان ينفعنا به بعد الممـــــات

واتمنى من الله ان يوفق كل المهندسين لما يحبه الله ويرضاه

للطباعة يمكن الطباعة كل اربعة شرائح في صفحة واحده