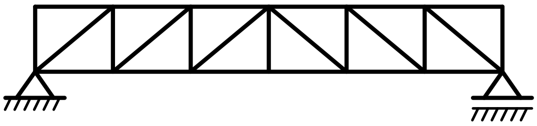
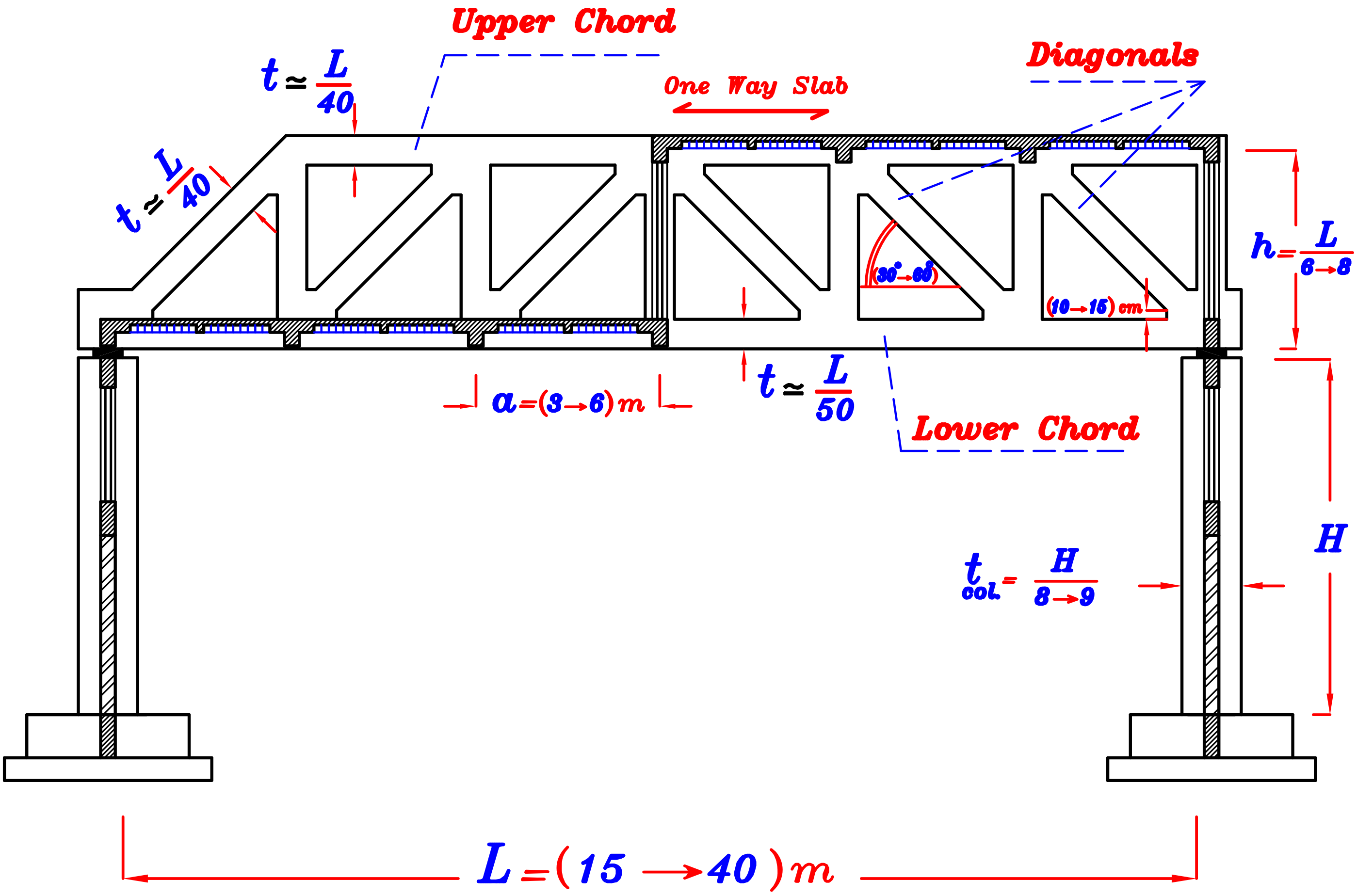
Truss & Vierendeel.

نسألكم الدعاء

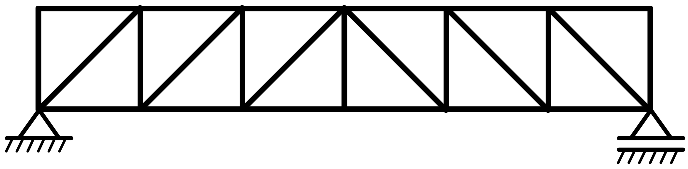
Truss & Vierendeel. Table of Contents.

Trusses





* Span $(L) = (15 \rightarrow 40)\ m$
* Height $(h) = \dfrac{L}{6 \rightarrow 8}$
* t (Compression members) $\simeq \dfrac{L}{40}$
* t (Tension members) $\simeq \dfrac{L}{50}$
* $b =$ $0.30\ m$, $\dfrac{\text{Spacing}}{20}$ } الأكبر
* $t_{col.} = \dfrac{H}{8 \rightarrow 9}$



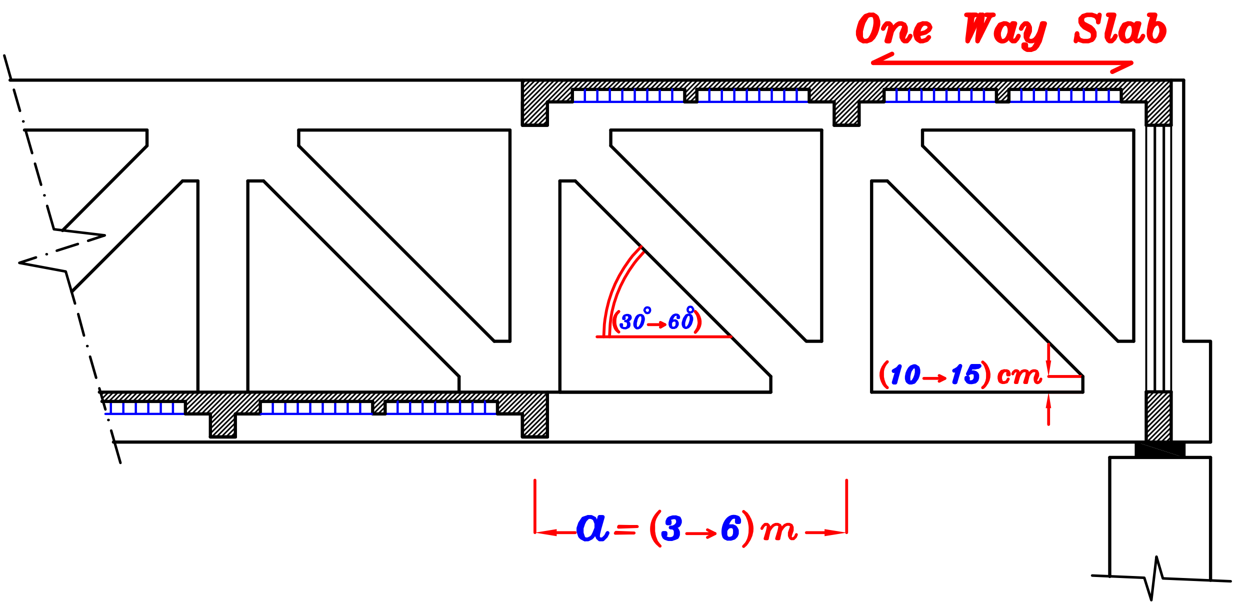
Statical System

يجب أن تكون كل الاحمال مركزه عند ال *Joints* فقط و لكى نتحكم فى ذلك يجب أن :

١ـ نضع كل الكمرات المحموله على ال *Truss* عند ال *Joints* فقط .

٢ـ نأخذ كل البلاطات *One Way Slabs* فى إتجاه الكمرات بحيث لا ترمى أى أحمال على ال *Truss* (عاده تؤخذ *One Way H.B. slab*) .

٣ـ نفرض أن ال *O.W.* لل *Truss* يؤثر كأنه *Concentrated Load* عند ال *Joints*.



لتحديد نوع القوى (شد أو ضغط) فى ال *members* يكون حسب شكل ال *B.M.* و شكل ال *Truss*.

*** Upper & Lower Chord**

إذا كان ال *member* فى نفس إتجاه ال *B.M.* يكون عليه شد.

إذا كان ال *member* عكس إتجاه ال *B.M.* يكون عليه ضغط.

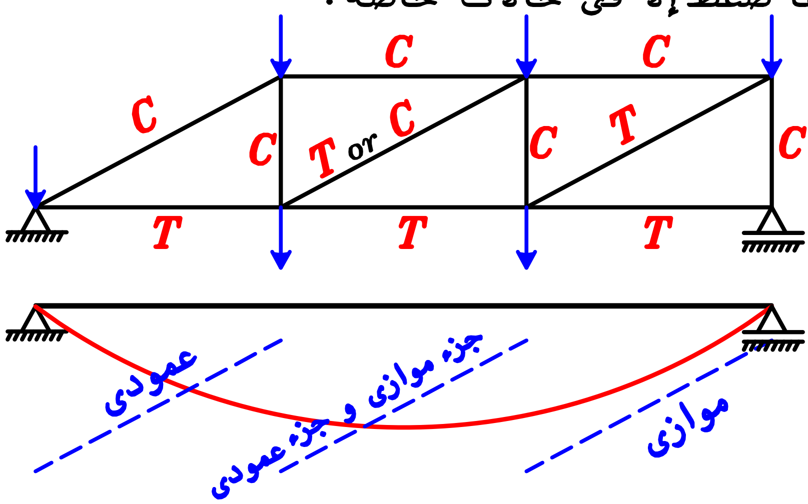
*** Diagonal members**

إذا كان ال *member* موازى لل *moment* يكون عليه شد.

إذا كان ال *member* عمودى على ال *moment* يكون عليه ضغط.

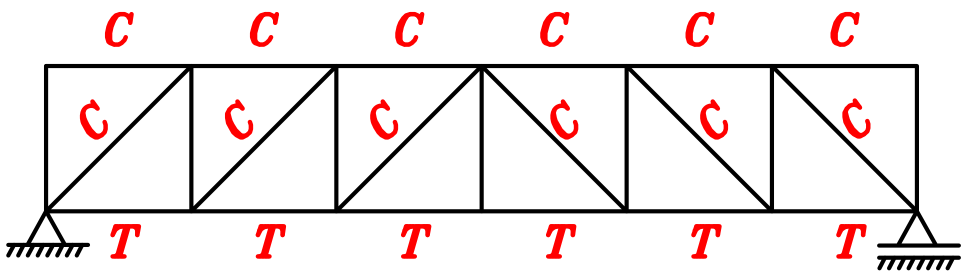
*** Vertical members**

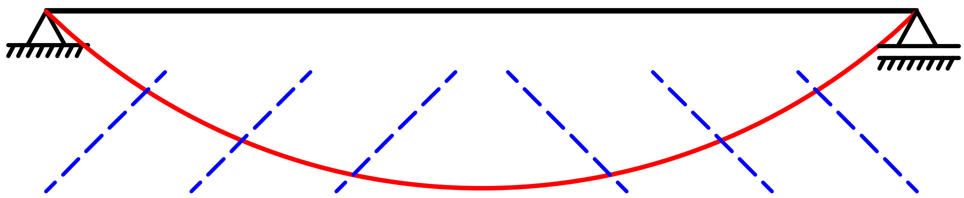
عاده يكون عليها ضغط إلا فى حالات خاصه .

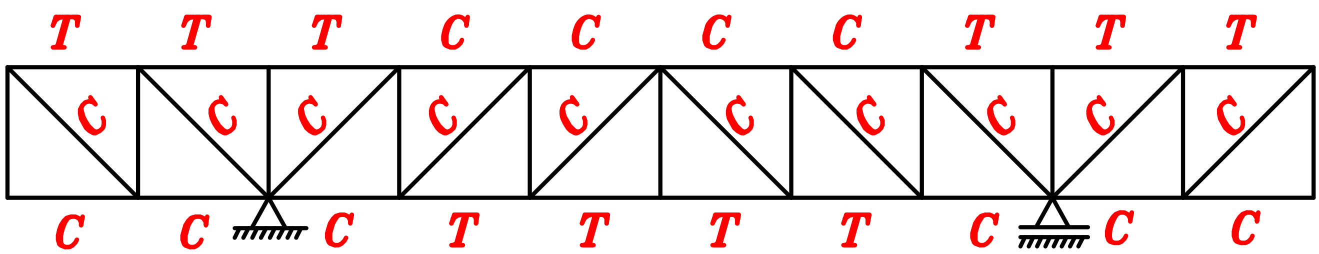


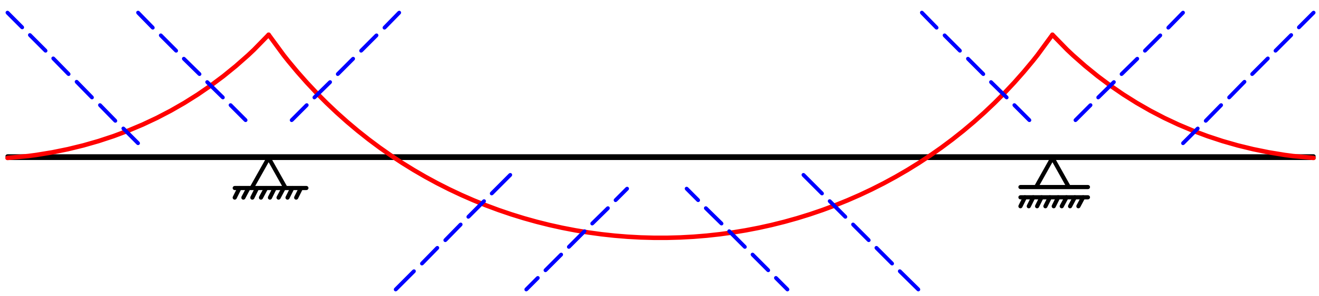
حيث أن الخرسانه أفضل فى الضغط من الشد (عكس ال *Steel*)

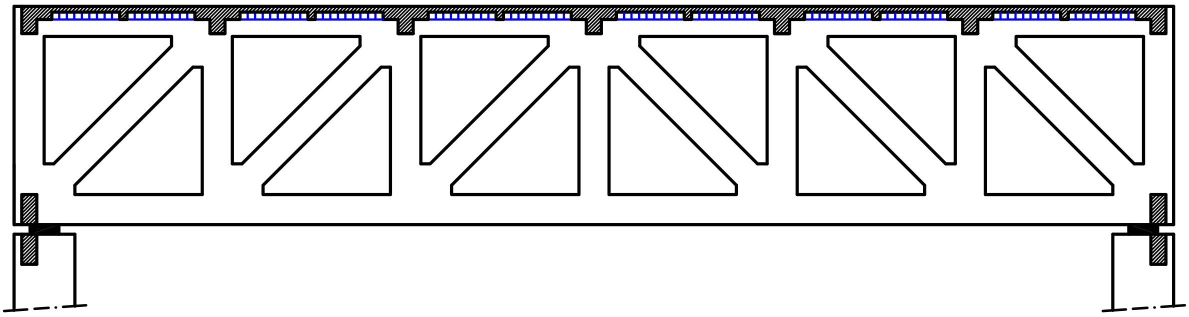
∴ فمن المفضل وضع ال *Diagonal members* عمودية على شكل ال *B.M.* لكى تكون معرضه للضغط .

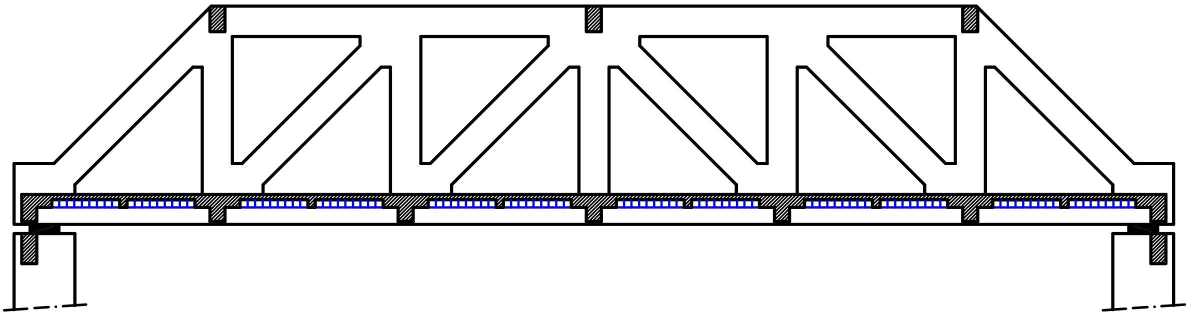


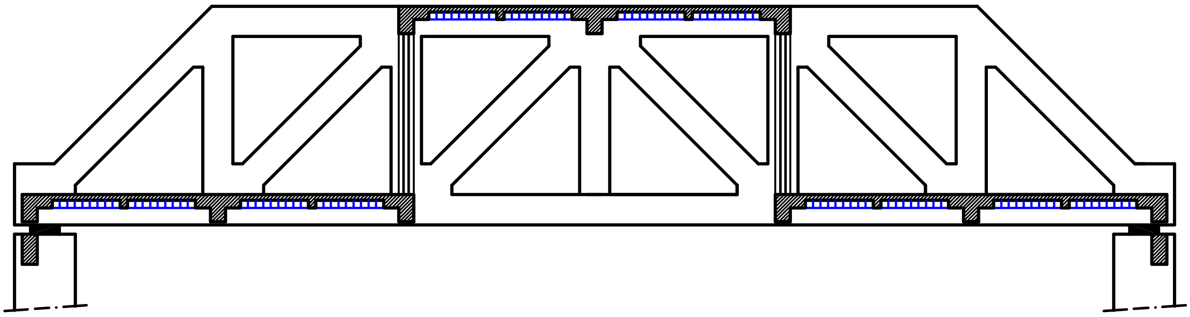


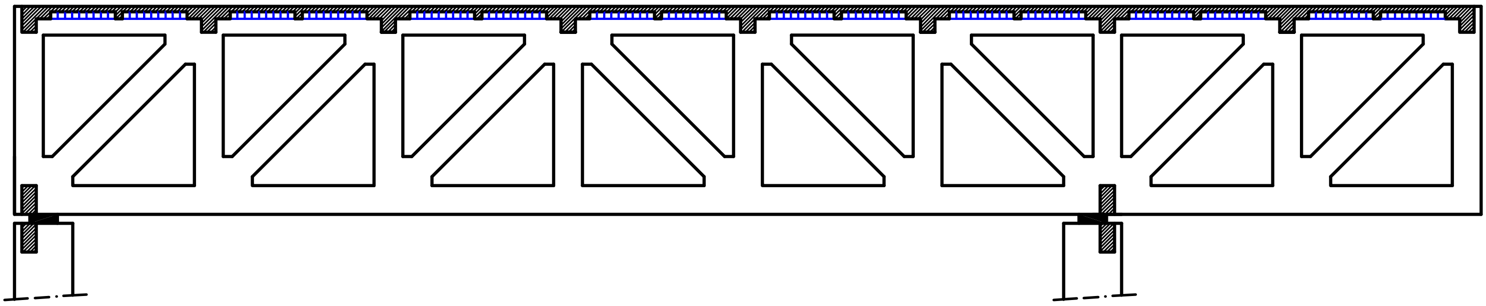


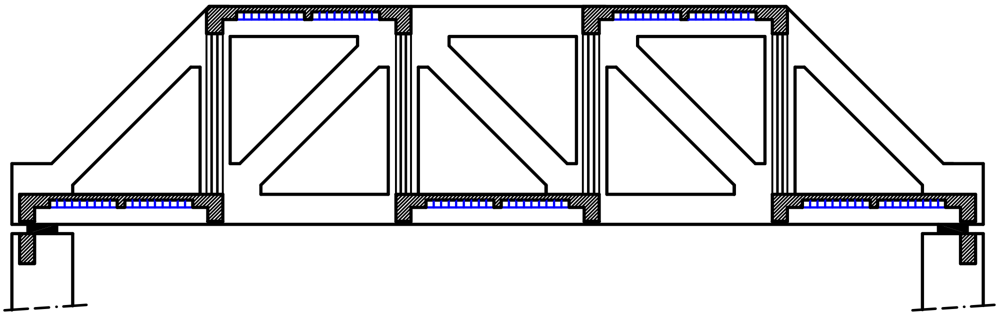


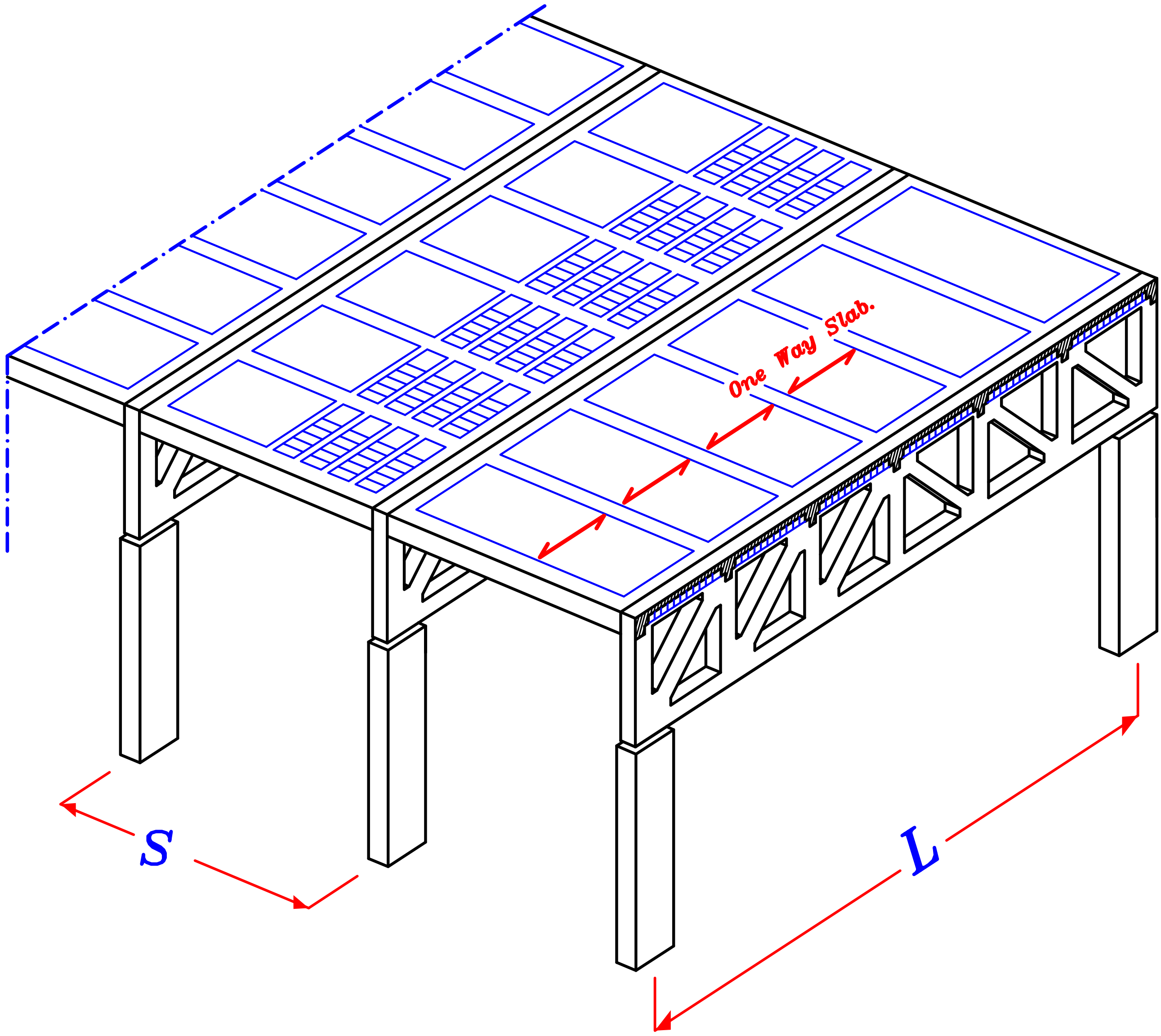


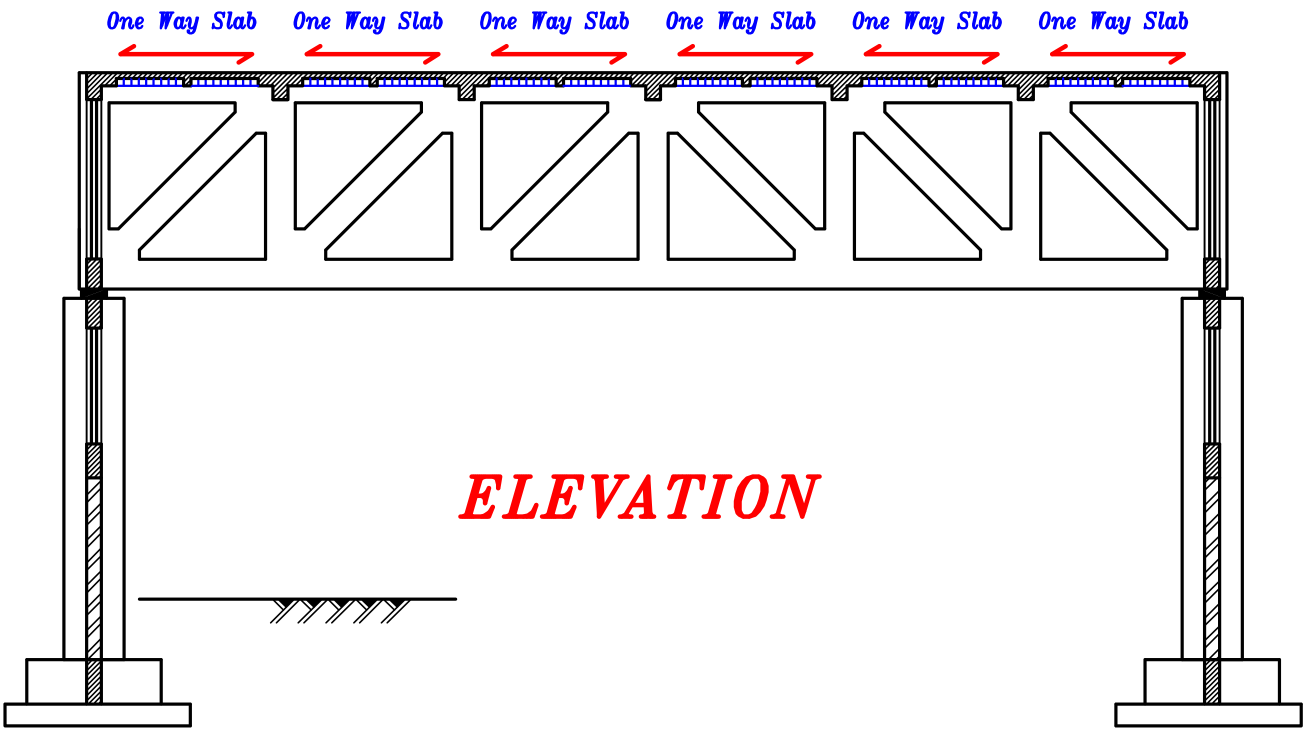




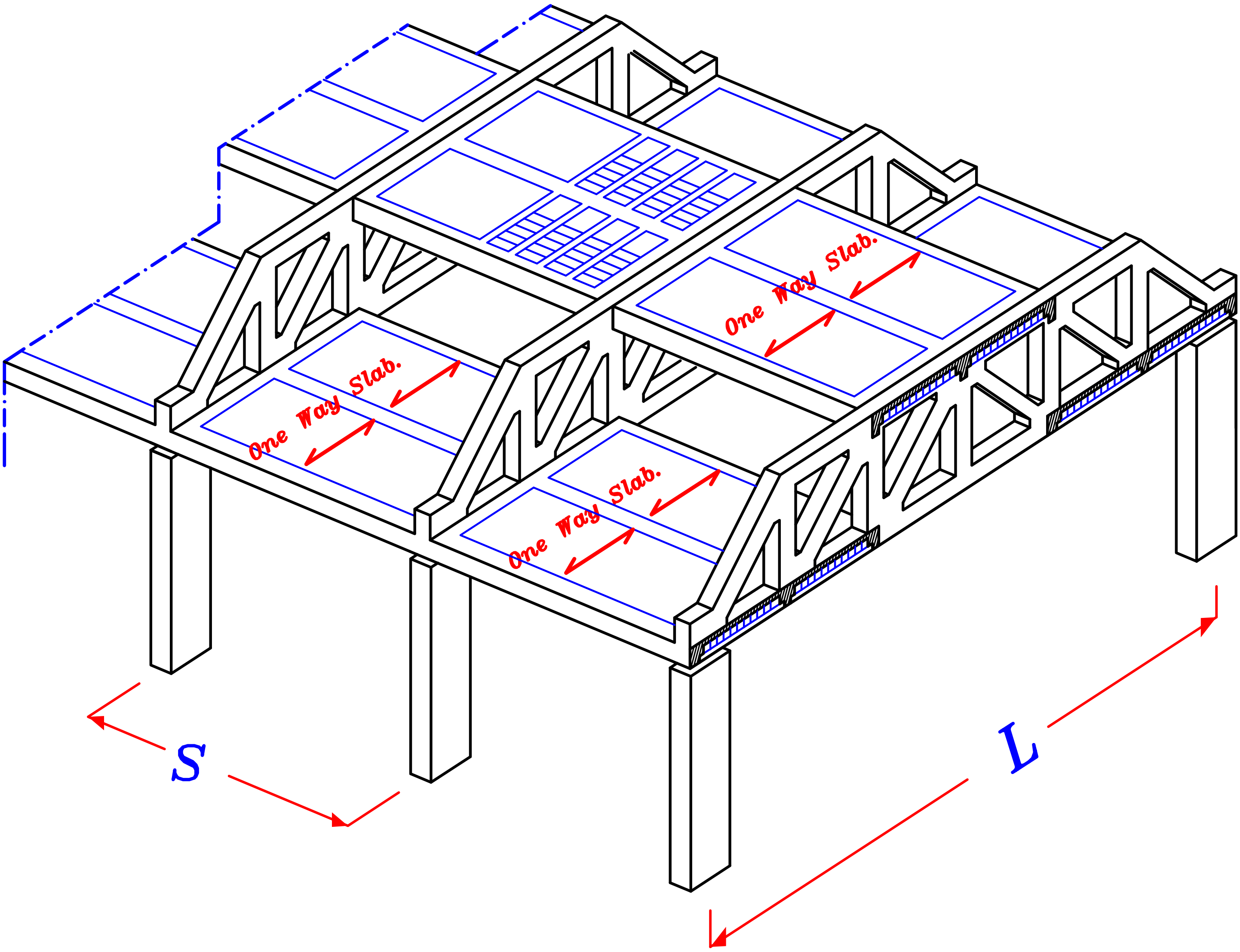


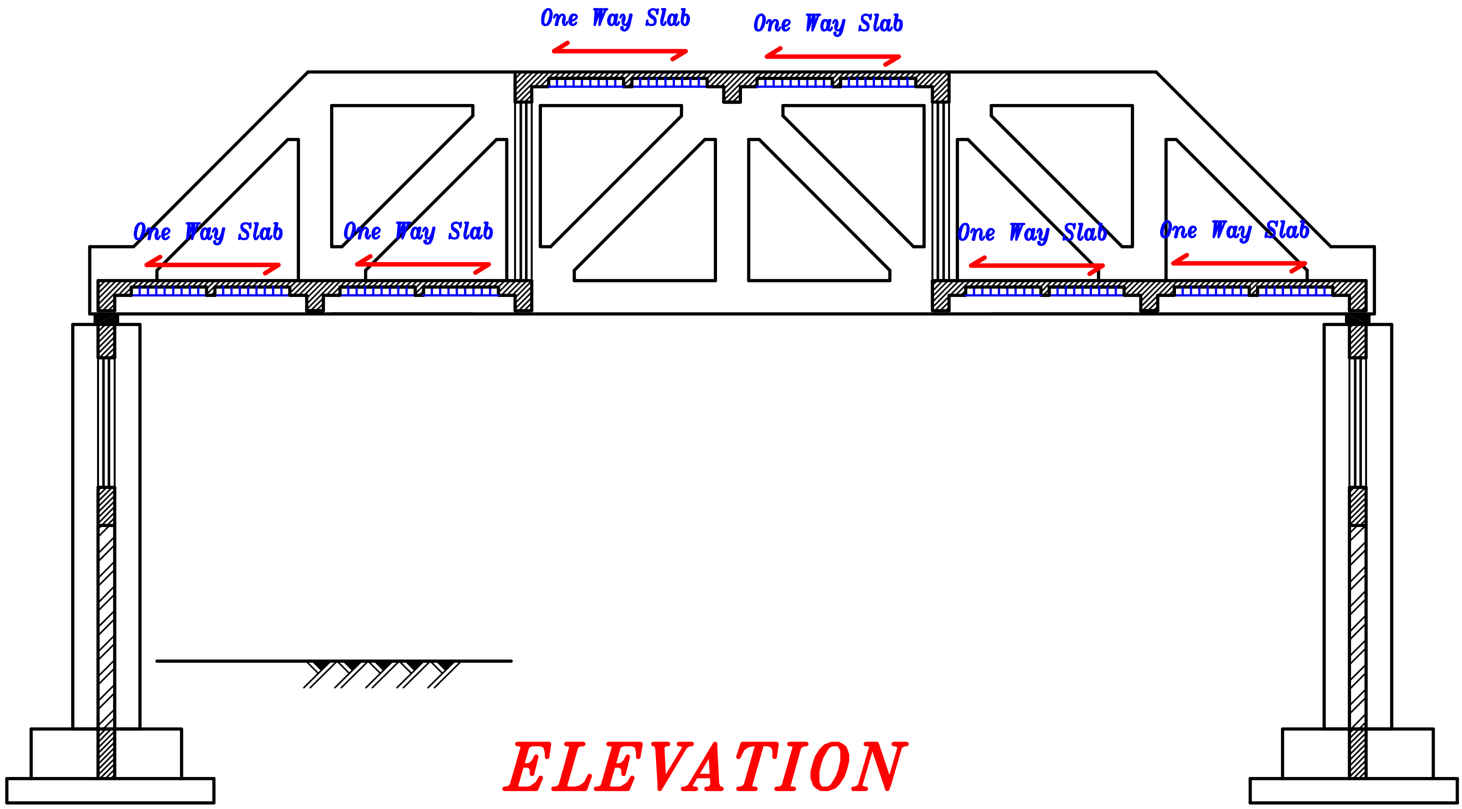



One Way Slab.
S
L


One Way Slab
One Way Slab
One Way Slab
One Way Slab
One Way Slab
One Way Slab

ELEVATION


One Way Slab.
One Way Slab.
One Way Slab.
S
L


One Way Slab
One Way Slab
One Way Slab
One Way Slab
One Way Slab
One Way Slab

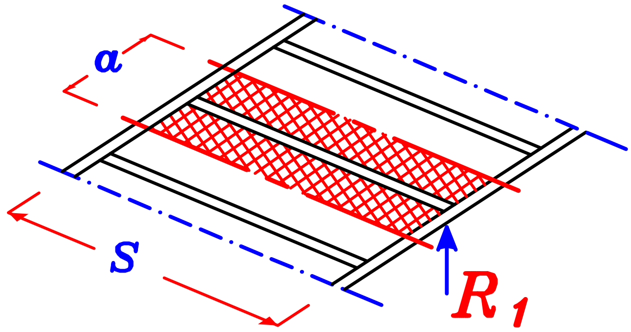
ELEVATION

Loads on Truss.

① Get Loads on Beam B_1

$$w_1 = O.W._{(beam)} + \left(\frac{w_{rib}}{S}\right) * a$$

$$R_1 = w_1 * S$$



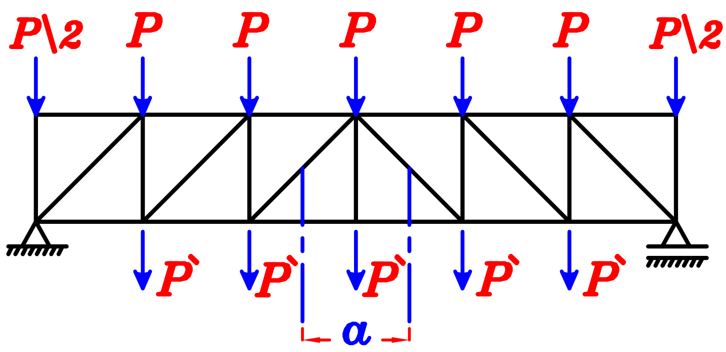
② Take

O.W. (Truss)

$\simeq$ 17.5 kN\m\` (U.L.)

$$P` = \frac{o.w. * a}{2} = \checkmark \; kN$$

$$P = P` + R_1 = \checkmark \; kN$$



③ Solve the Truss, By using.

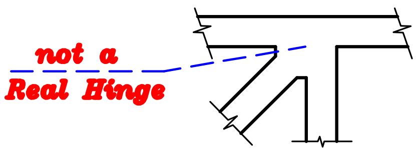
Computer or method of sections or Joints equilibrium.

Then get N.F. on all members.

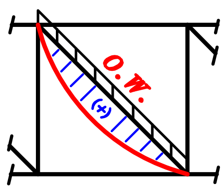
④ Design the Members.

توجد عزوم على ال members المختلفه نتيجه

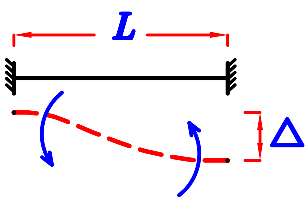
ⓐ The joints are not a Real Hinges.



ⓑ Due to O.W. of the member.



ⓒ Relative Displacement of joints.



$$M = \frac{6 E_c I}{L^2} \Delta$$

لذلك عند تصميم ال members المختلفه نأخذ قيمه moment صغيره

Take $M = \checkmark$ kN.m $\xrightarrow{From}$ $\frac{e}{t} \simeq 0.1 \longrightarrow 0.2$ ✓✓

ⓐ Design of Compression members.

Designed on N, M

N From calculation of Truss
M From $\frac{e}{t} \simeq 0.1 \longrightarrow 0.2$ ✓✓
} Use I.D.

$\frac{N}{F_{cu}\, b\, t}$, $\frac{e}{t} \simeq 0.1$ } Get ρ

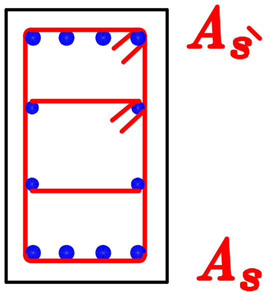
$\mu = \rho * F_{cu} * 10^{-4}$

$A_s = A_{s}` = \mu\, b\, t$

IF $\rho < 1.0 \xrightarrow{Take} \rho = 1.0$

2Ø12\25 cm

2Ø12\25 cm



– Check $A_{s_{min.}}$

Calculate $A_{s_{Total}} = A_s + A_{s}`$

Calculate $A_{s_{min.}} = \frac{0.6}{100} * b * t$

IF $A_{s_{Total}} \geqslant A_{s_{min.}}$ $\therefore$ o.k.

IF $A_{s_{Total}} < A_{s_{min.}} \xrightarrow{take} A_s = A_{s}` = \frac{A_{s_{min.}}}{2}$

ⓑ Design of Tension members.

Designed on T, M

T From calculation of Truss

M From $\frac{e}{t} \simeq 0.1 \longrightarrow 0.2$ ✓✓

ملحوظه

إتجاه الـ moment غير معلوم لذا نصمم على
على أى إتجاه و نضع الحديد الأكبر فى الإتجاهين .

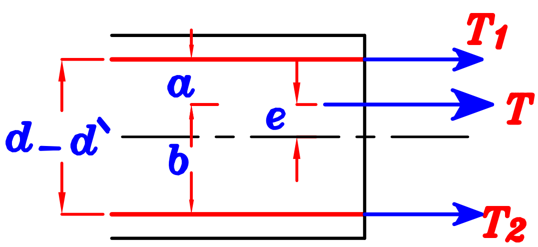
$e \simeq 0.1\, t$

$a = \frac{t}{2} - c - e$

$b = \frac{t}{2} + c + e$

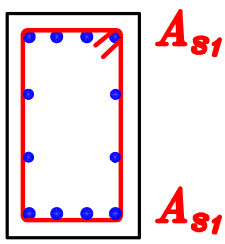
$T_1 = \frac{b}{a+b} * T$

$A_{s1} = \frac{T_1}{F_y \backslash \delta_s}$

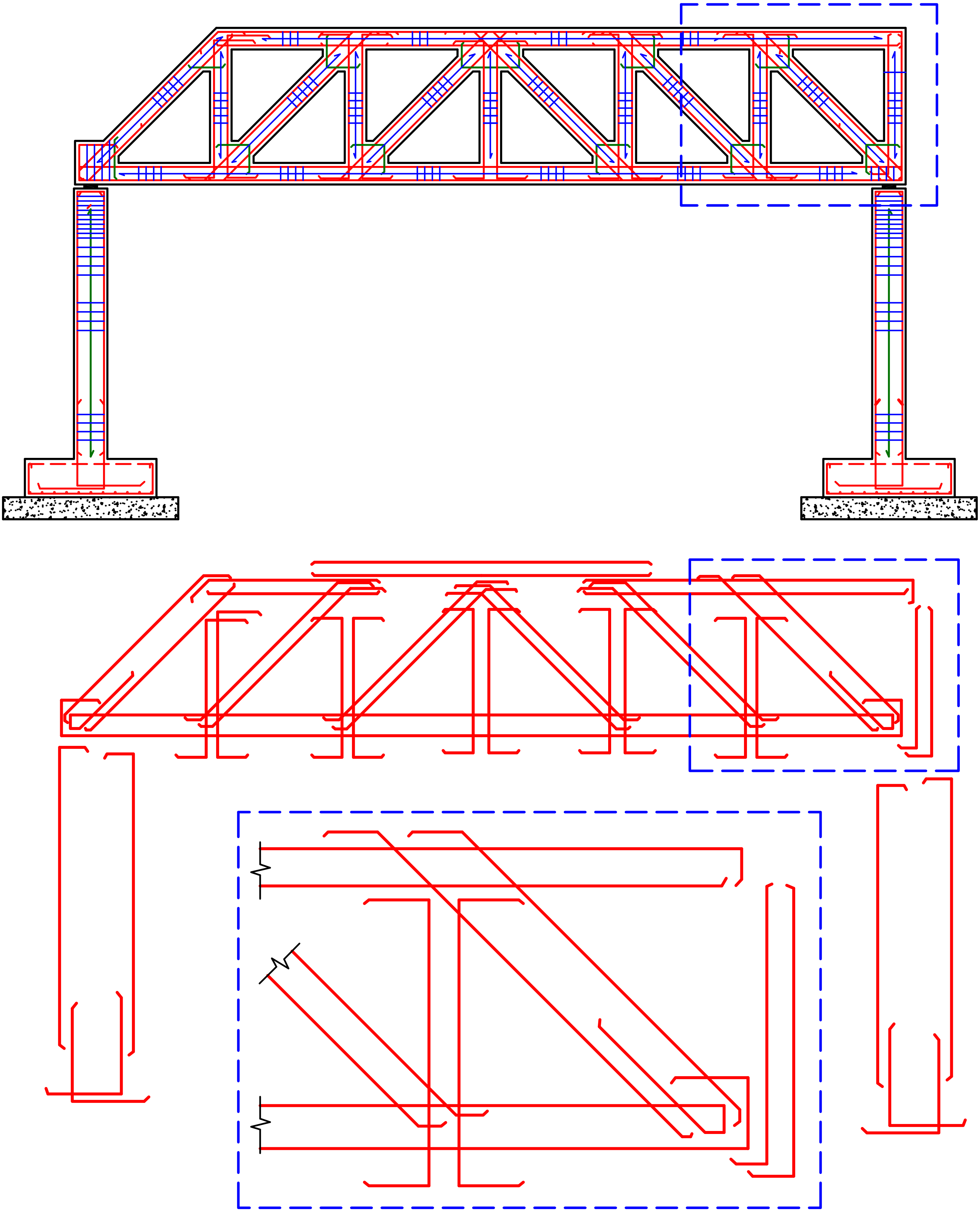


2Ø10\30 cm

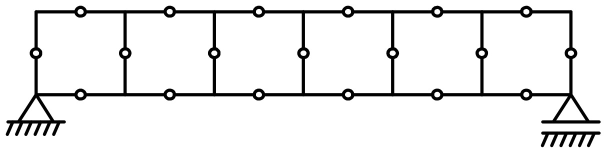
2Ø10\30 cm

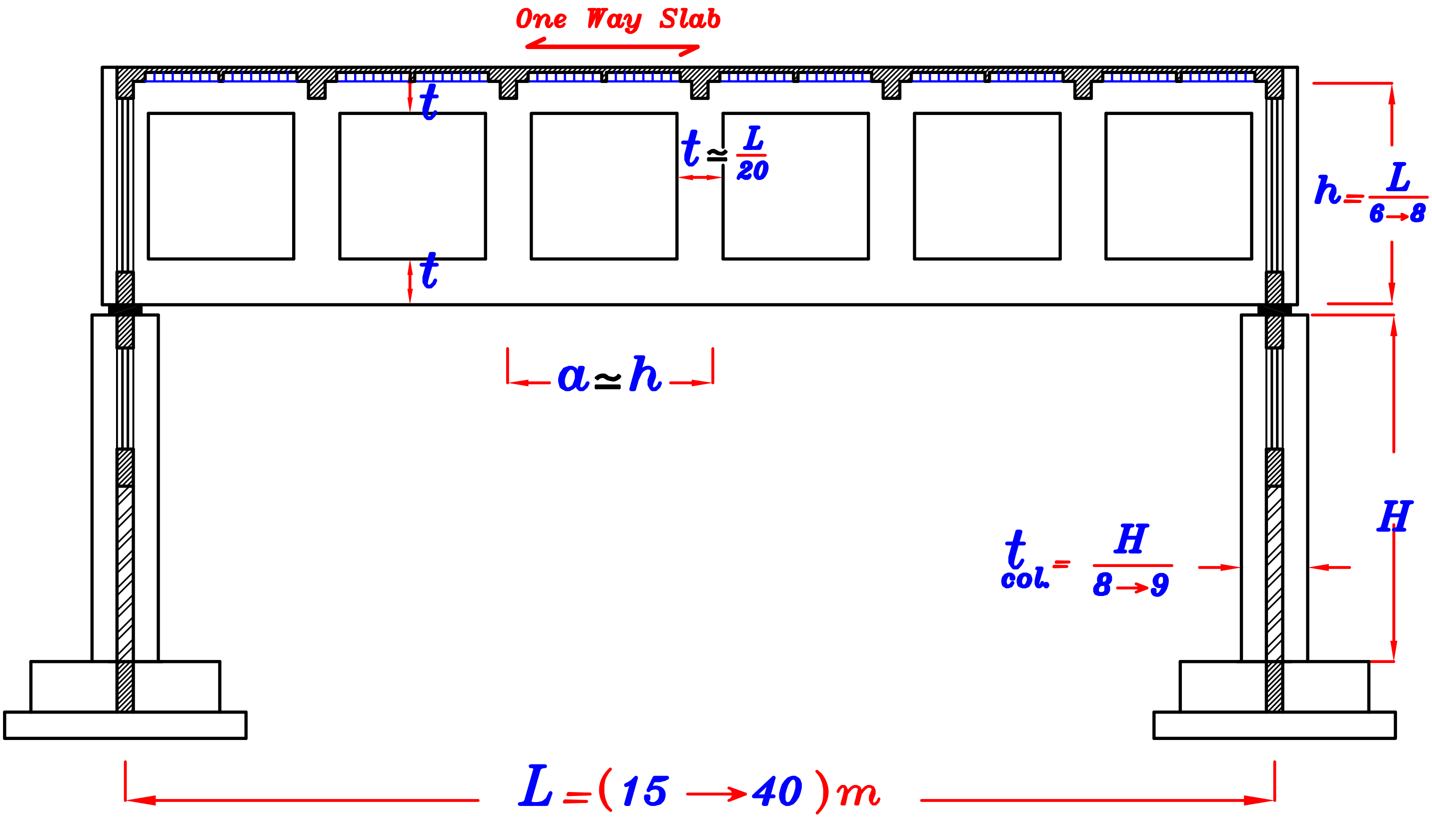


RFT. of Truss.



Vierendeel





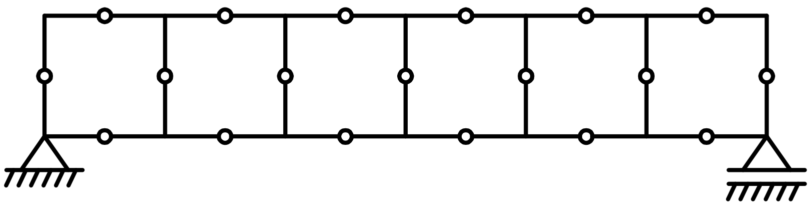
* Span $(L) = (15 \to 40)\ m$

* Height $(h) = \frac{L}{6 \to 8}$

* t (Vierendeels) $\simeq \frac{L}{20}$

* $b = 0.30\ m$, $\frac{Spacing}{20}$ } الأكبر

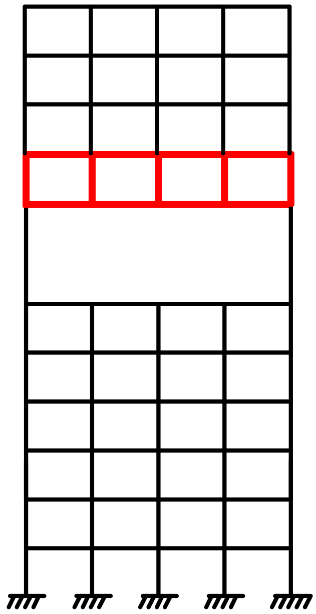
* $t_{col.} = \frac{H}{8 \to 9}$



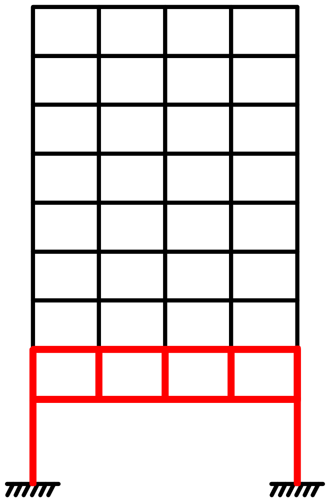
Statical System

أهم إستخدامات ال Vierendeels

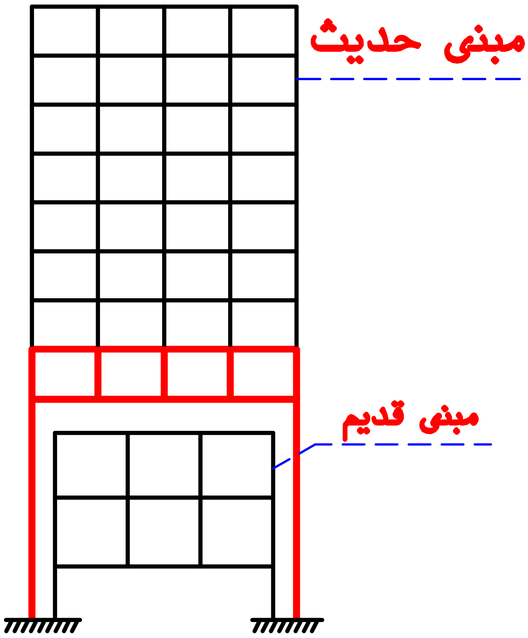
يتميز ال **Vierendeels** أنه يستطيع أن يحمل عدد من أدوار المبنى فوقه دون وضع أعمده فى المنتصف .



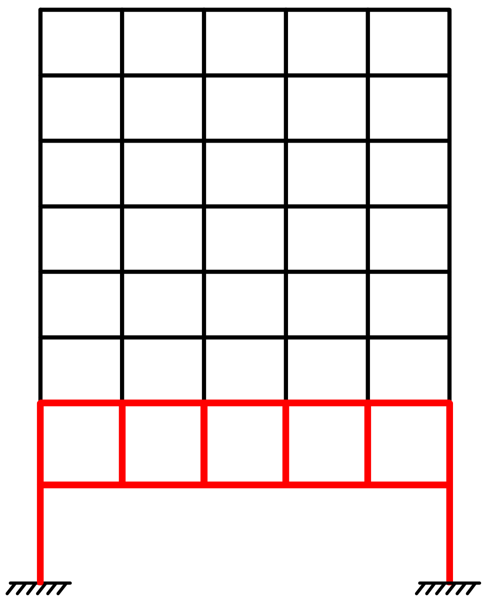
توجد قاعه بدون أعمده داخليه فى الدور السادس و الادوار العلويه محموله على *Vierendeels* فى الدور السابع و ال *Vierendeels* محموله على أعمده خارجيه

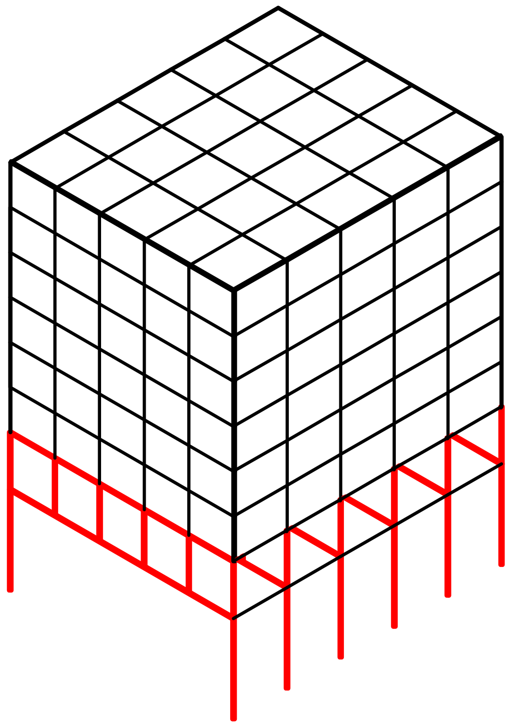


لا توجد أعمدة فى الدور الارضى لان كل الادوار العلويه محموله على *Vierendeels* و ال *Vierendeels* محموله على أعمدة خارجيه



المبنى الحديث محمول على *Vierendeels* و ال *Vierendeels* محموله على أعمدة خارجيه دون أن يحمل على المبنى القديم





Analysis of Vierendeel.

We have Two method to solve the Vierendeel.

① Exact Method.

Using Computer

فى هذه الطريقه ممكن أخذ البلاطات

One way OR Two way

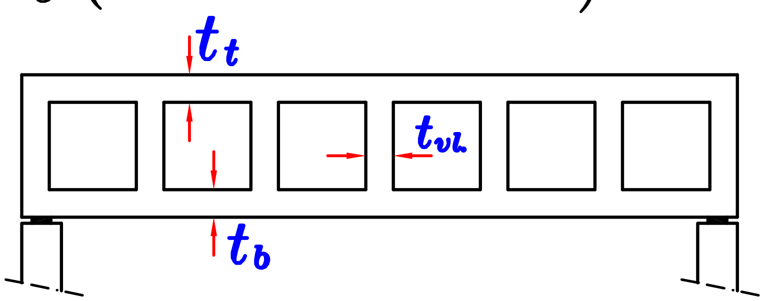
② Approximate Method.

To solve by this method we have to take

1_ Take the slabs one way (at beam direction)

2_ $t_t = t_b$

3_ $t_{vl.}$ is Constant.

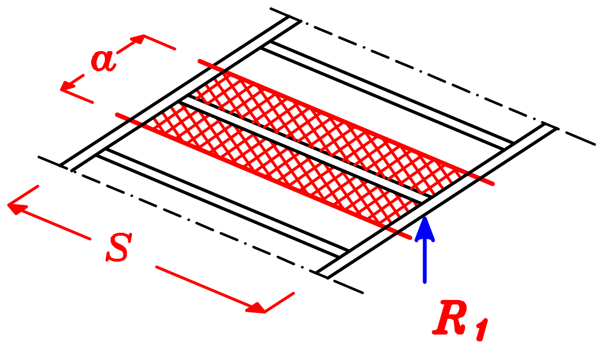


Steps of Design.

① Get Loads on Beam B_1

$w_1 = O.W._{(beam)} + w_s * a$

$R_1 = w_1 * S$



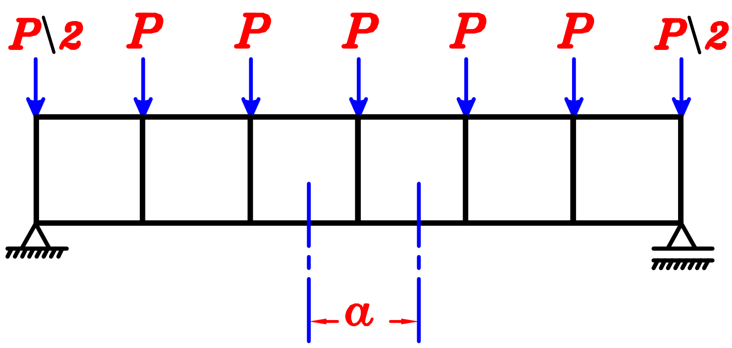
② Take

$w` = O.W.$ (Vierendeel)

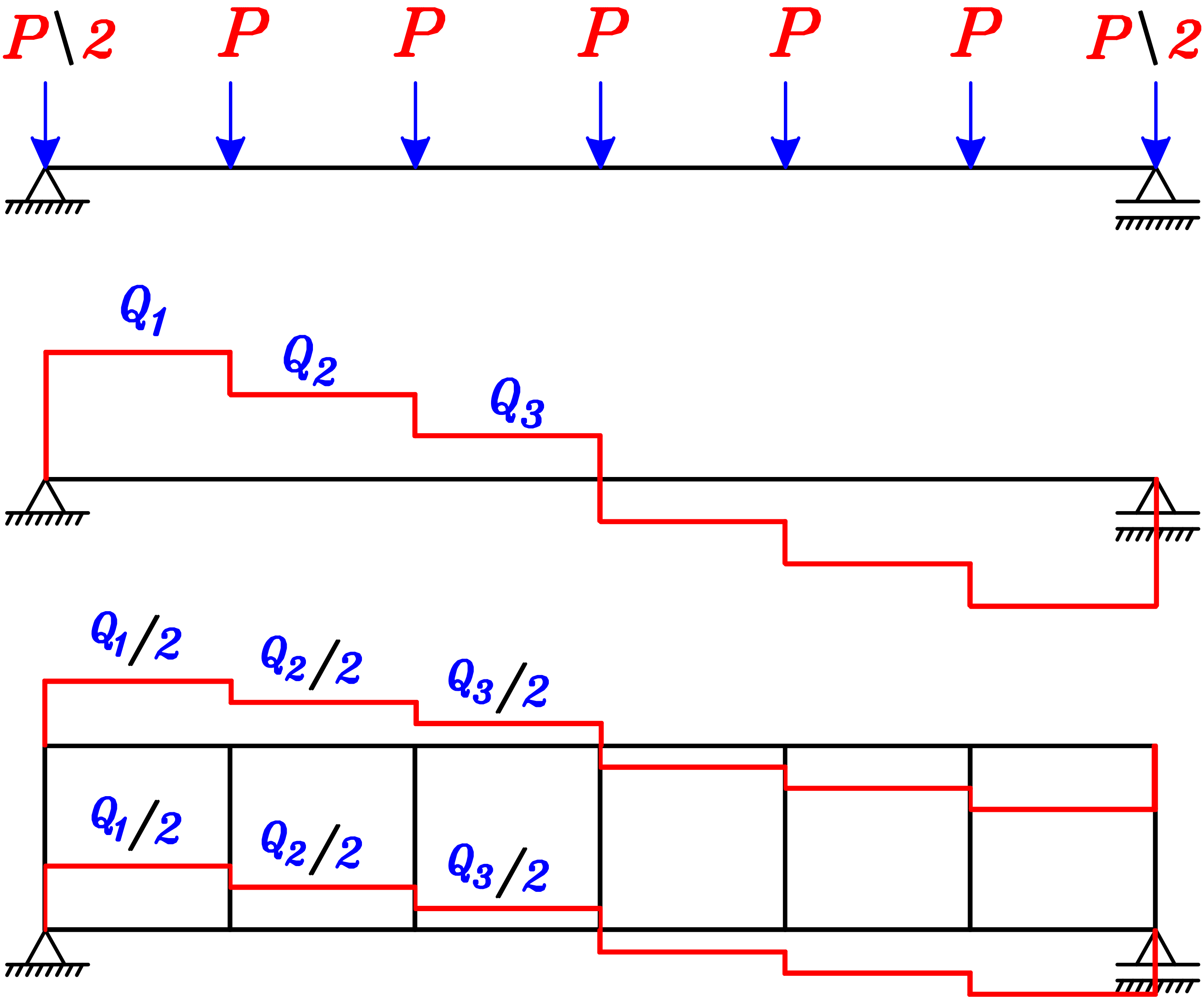
$\simeq$ 25.0 kN\m` (U.L.)

$P` = w` * a = ✓$ kN

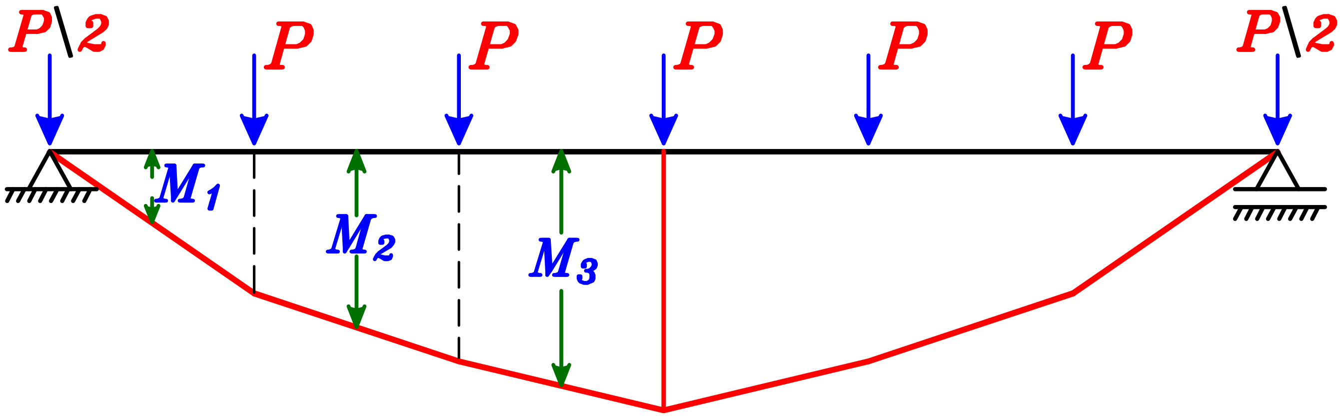
$P = P` + R_1 = ✓$ kN

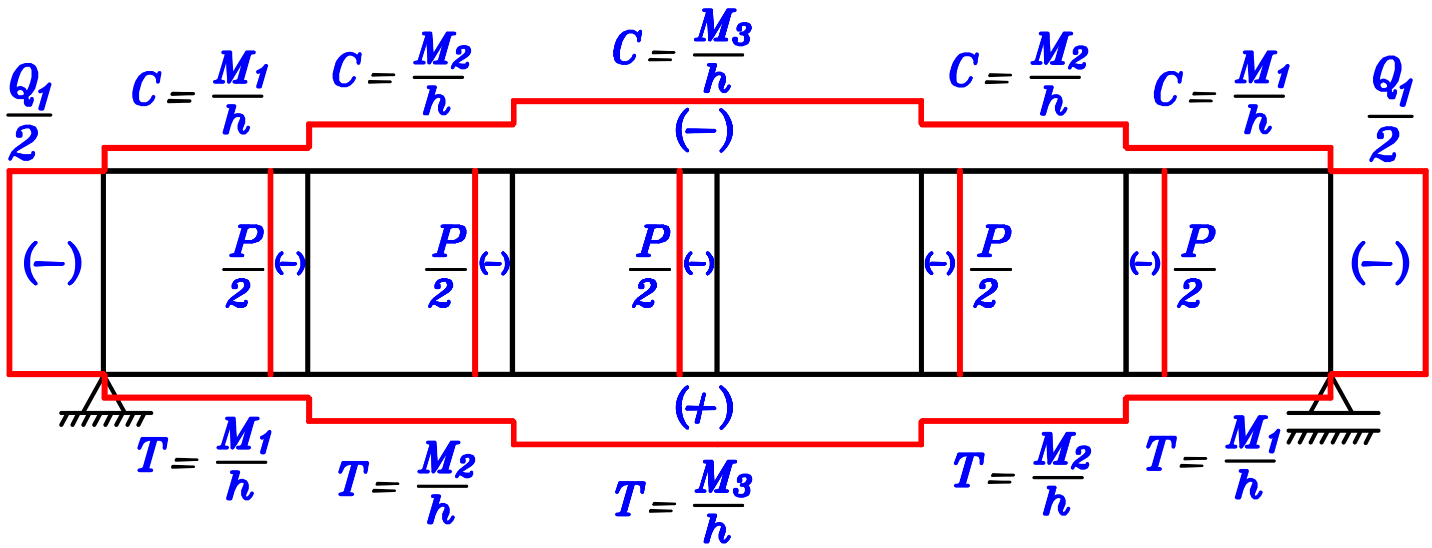


N.F.D. on Vierendeels.

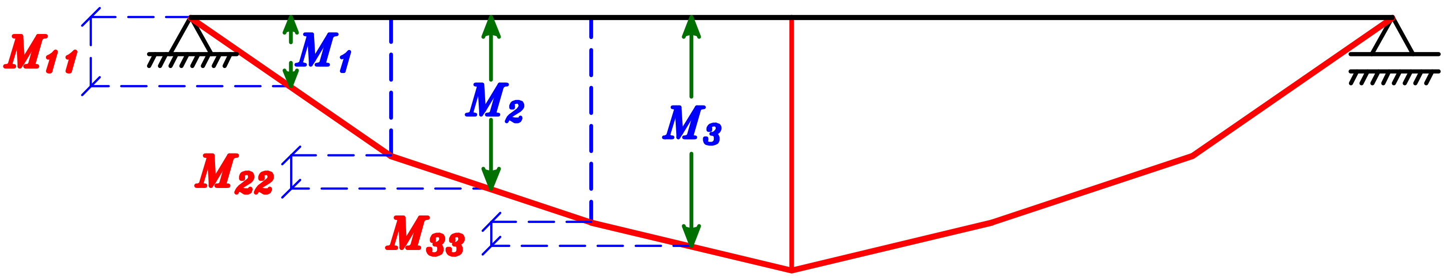


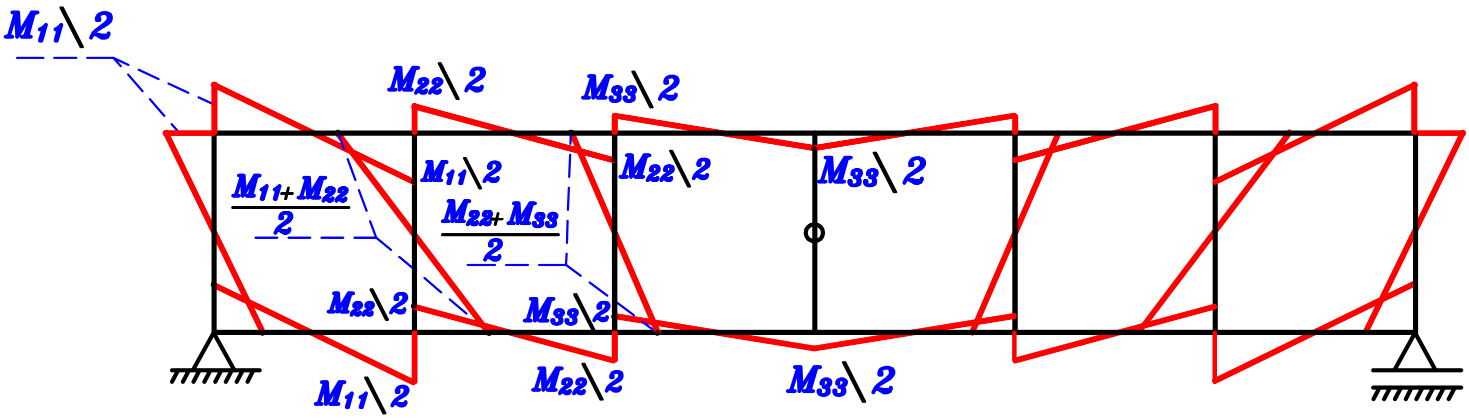
N.F.D. on Vierendeels.

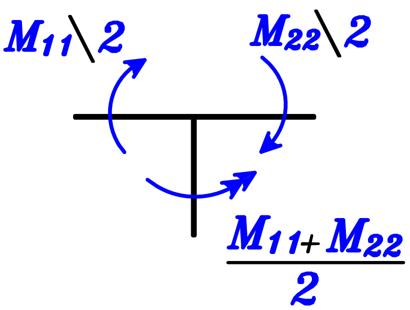




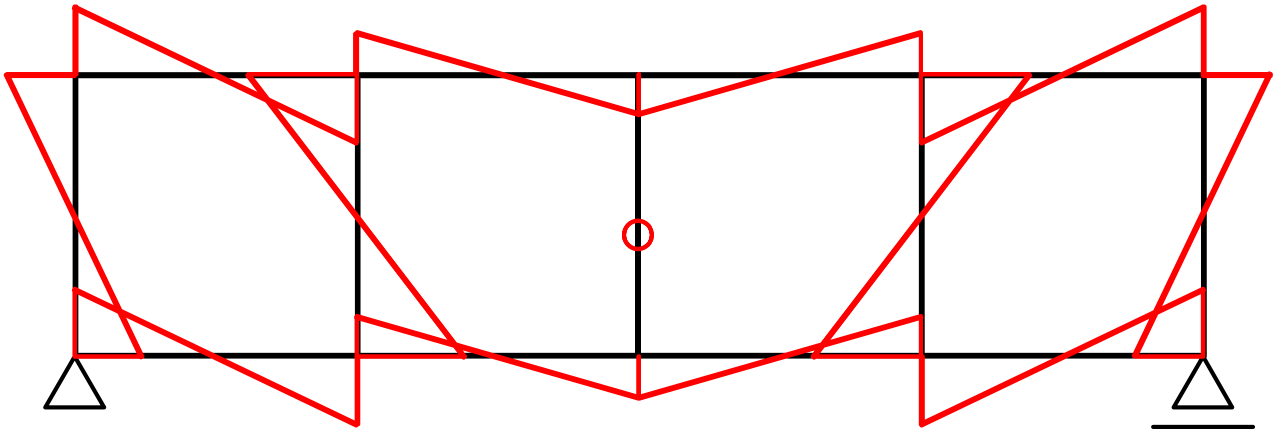
B.M.D. on Vierendeels.

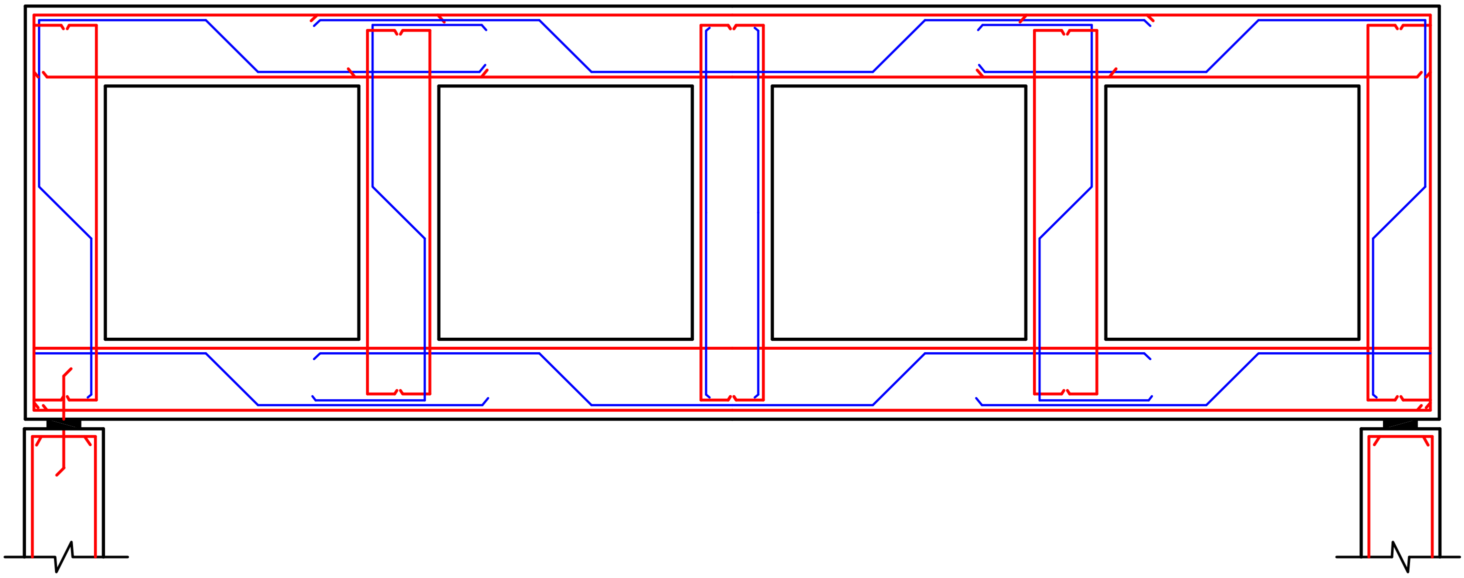


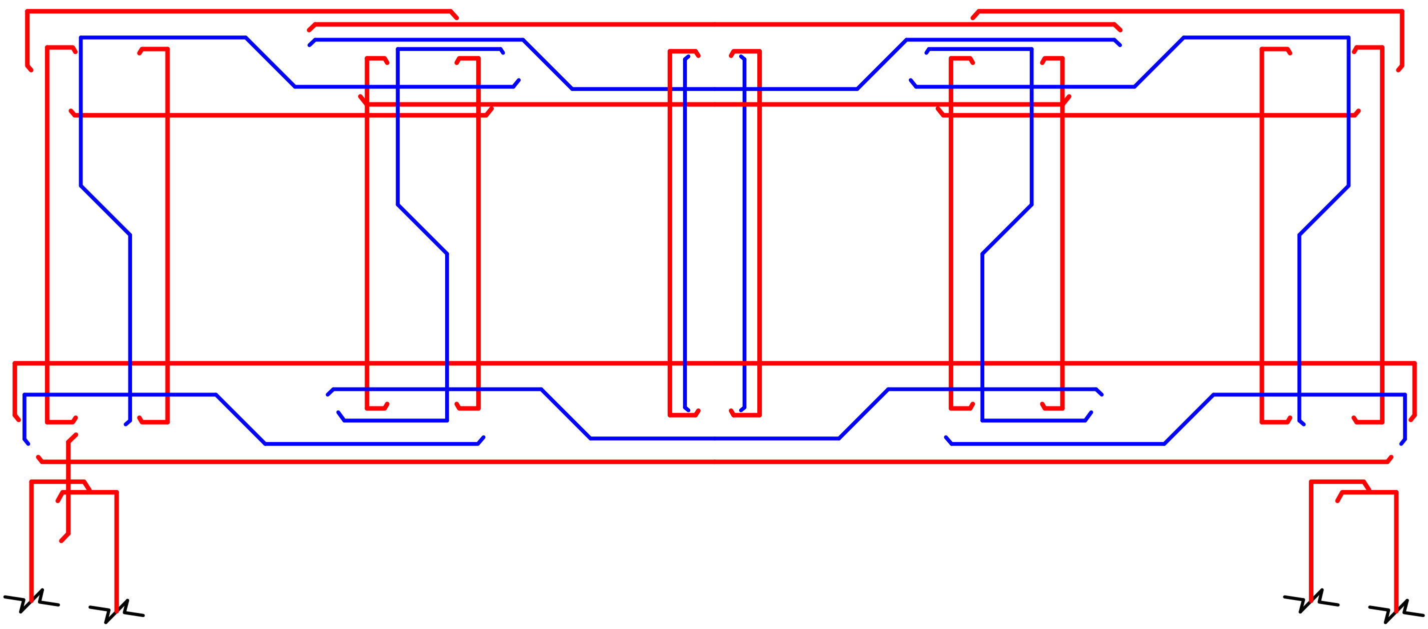




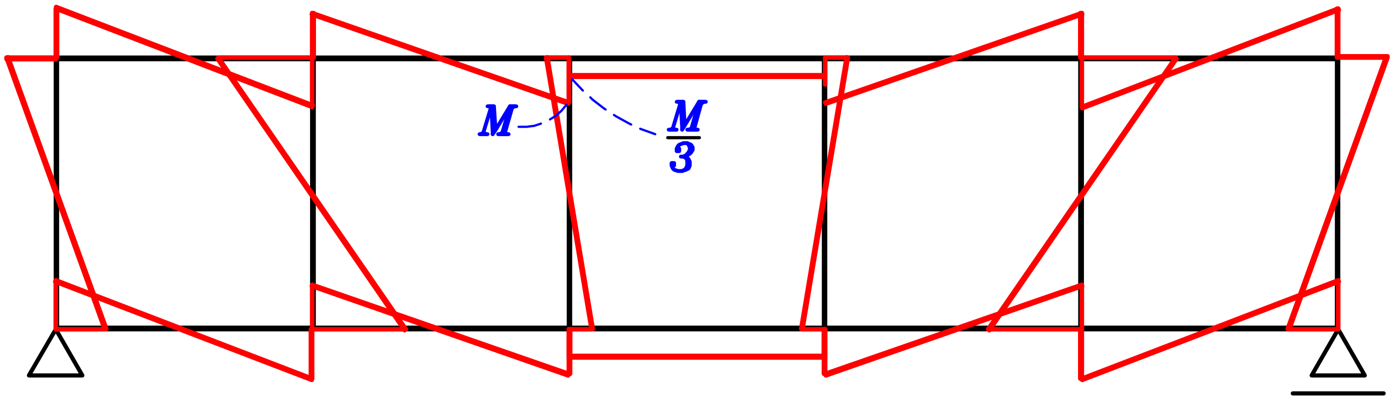
RFT. of Vierendeel. 4 Segments

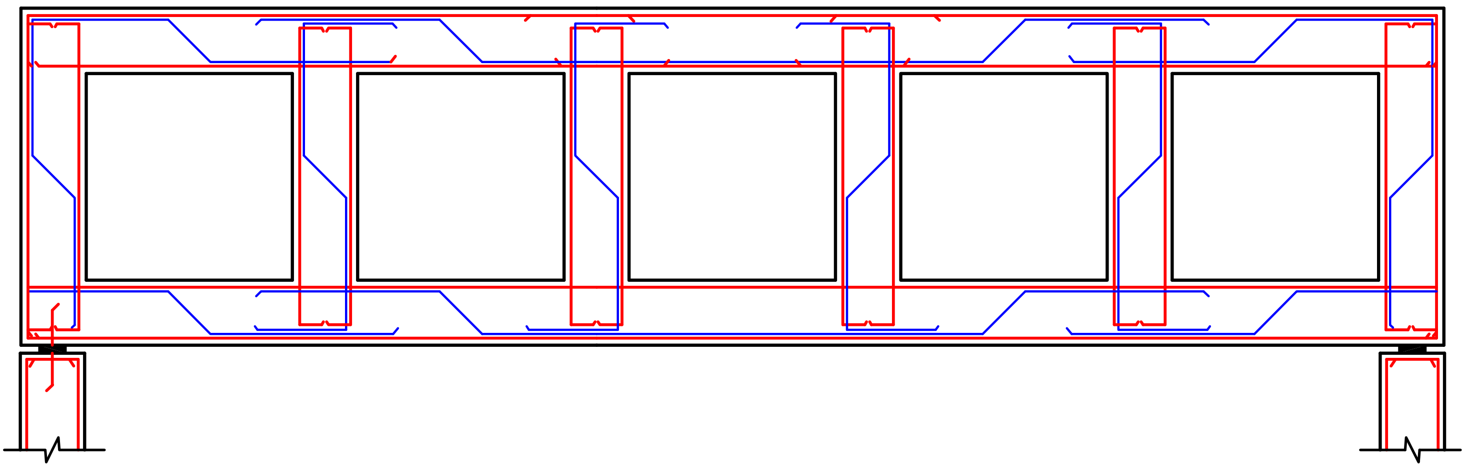


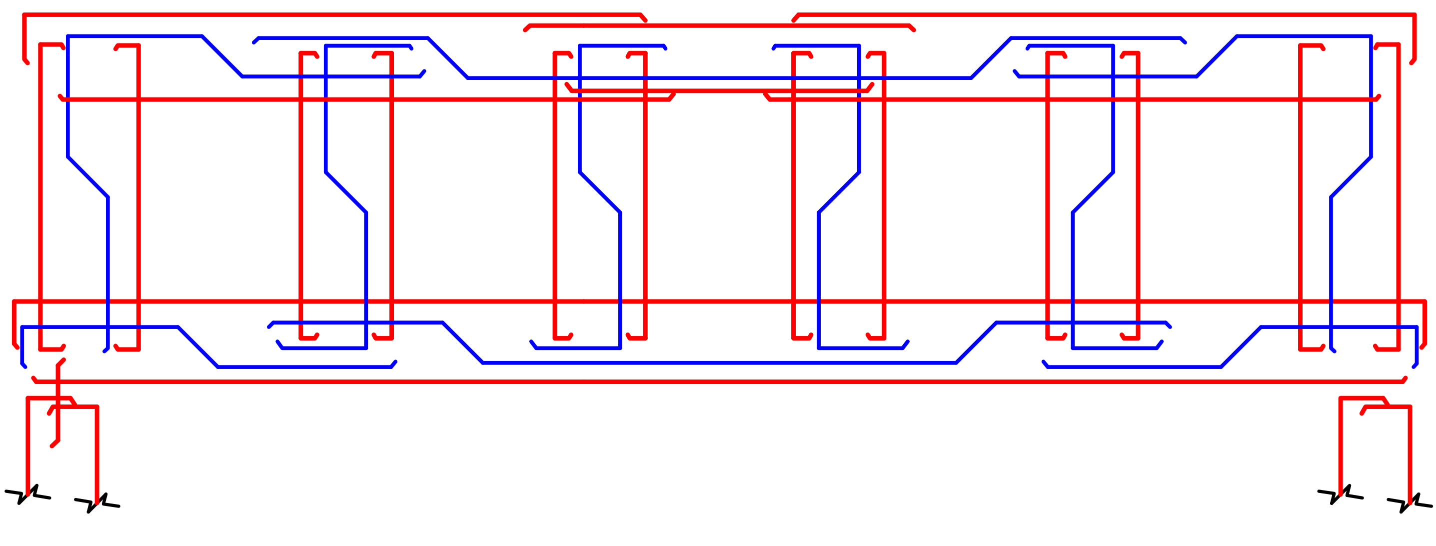




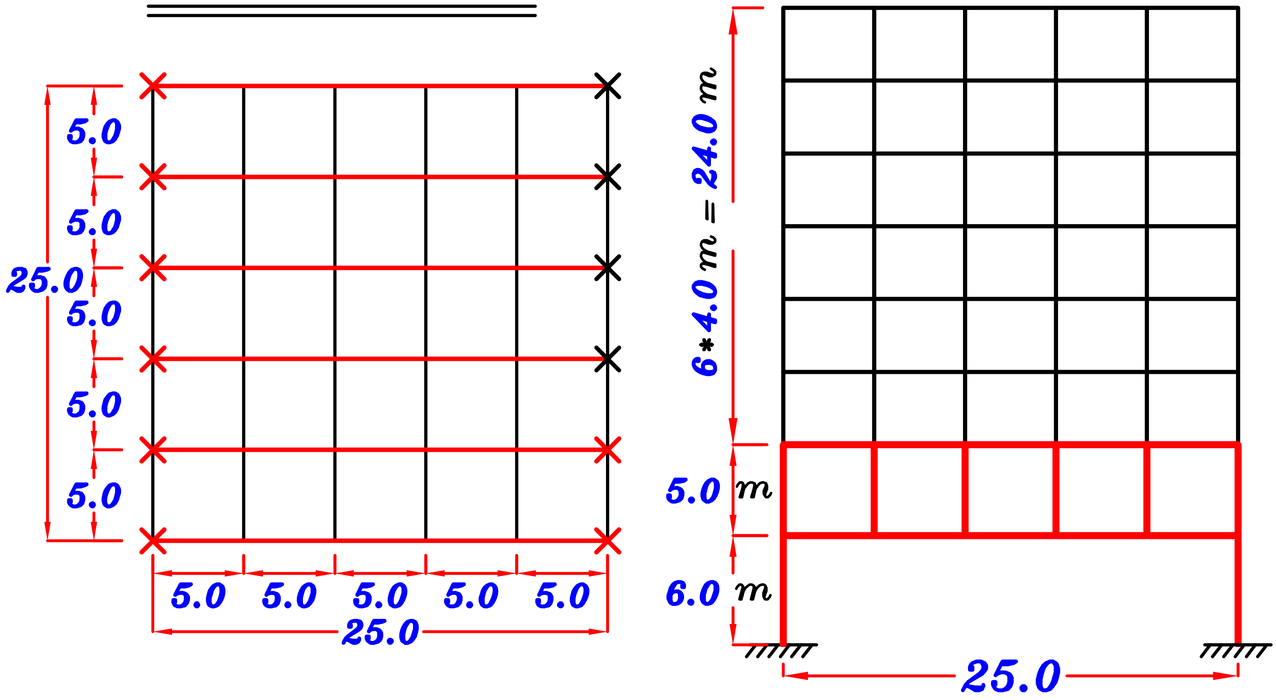
RFT. of Vierendeel. 5 Segments







Example.



For the given Figure shows a layout of a building of an area **25.0 * 25.0** m^2
The building consists of ground Floor and Seven typical Floor.
The interior columns are removed at the ground Floor.
The total equivalant working loads is **10.0** kN/m^2

$F_{cu} = 30 \; N \backslash mm^2$, $F_y = 360 \; N \backslash mm^2$

It is required to:

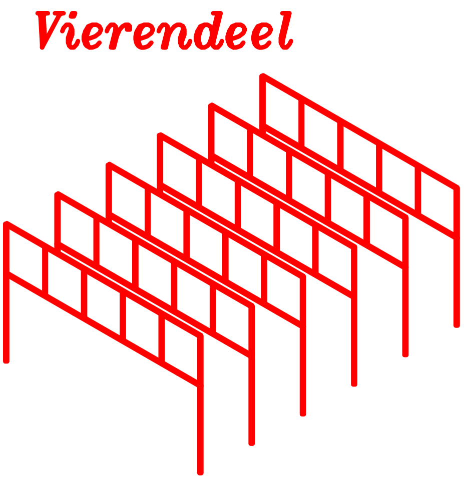
1 – *Choose a reasonable structural system For the ground Floor and draw its Concrete dimensions in plan and elevation to scale* **1:50**

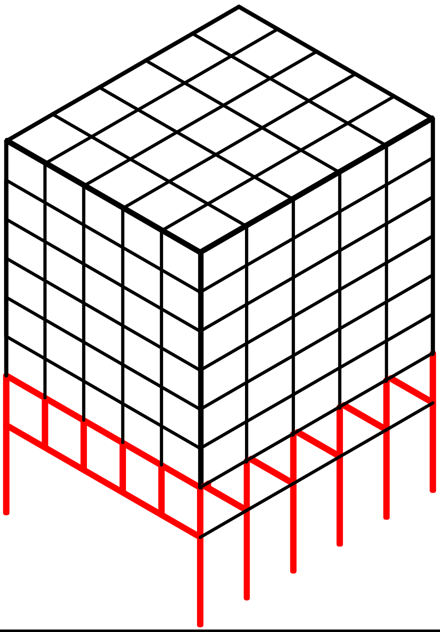
2 – *Calculate the Loads on the main supporting element.*

3 – *Draw Internal Forces Diagrams For the main supporting element.*

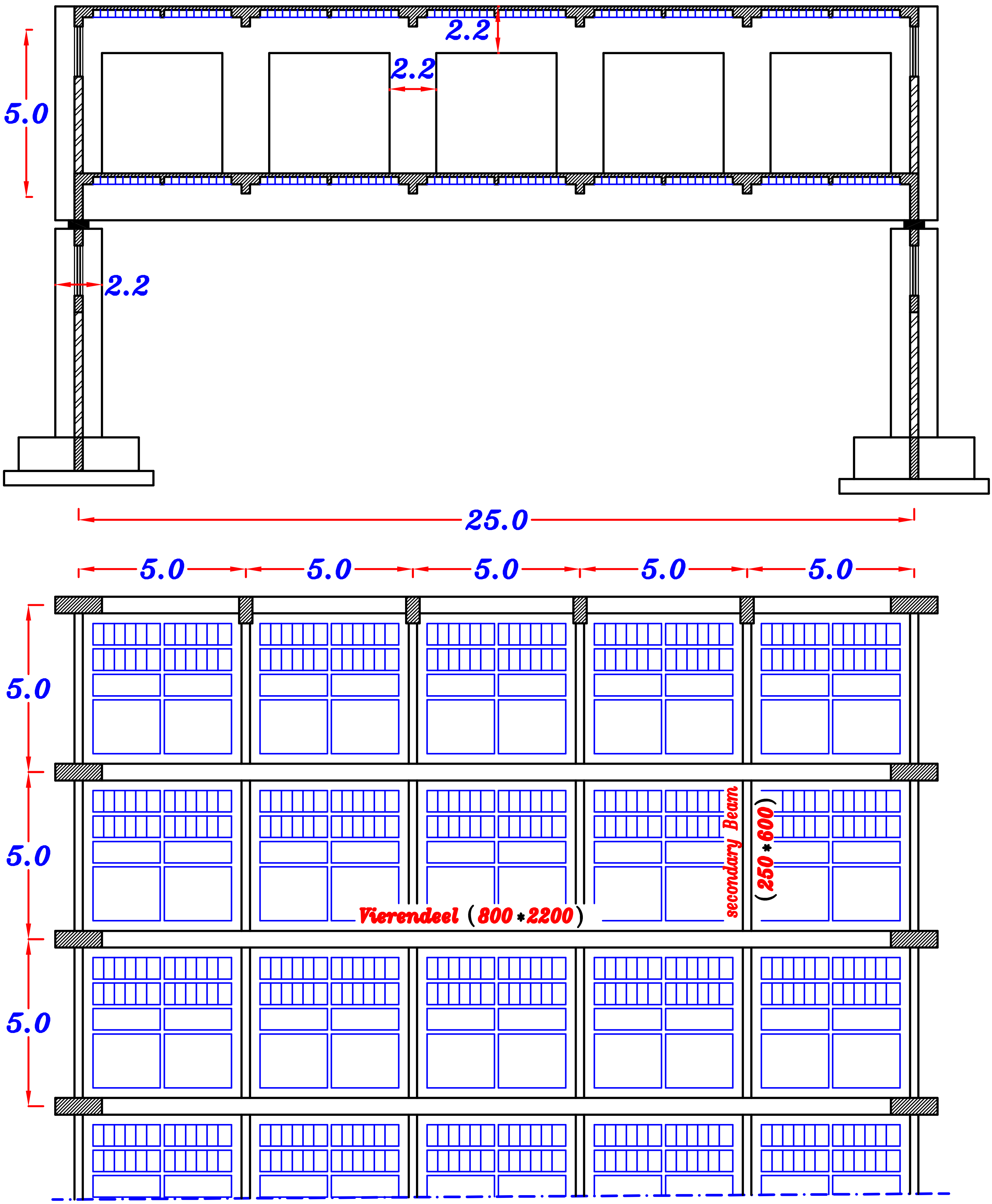
4 – *Design the main supporting element.*

5 – *Draw details of RFT. of the main supporting element in elevation and cross sections to scale 1:25*





1 – Take the main supporting element Vierendeel (800 * 2200)



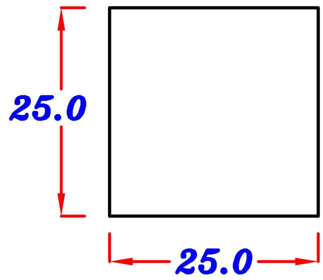
2 – Calculate the Loads on the main supporting element.

The total equivalant working loads is 10.0 kN/m^2

– $W_{av\,(U.L.)} = 10.0 * 1.5 = 15.0\ kN/m^2$

– Total Load For one Floor = W_{av} * Floor area

$= 15.0 * 25.0 * 25.0 = 9375\ kN$

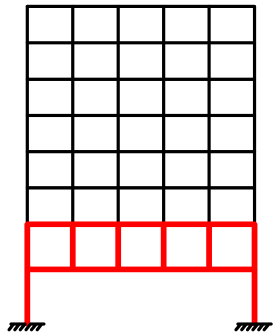


– Total Load For the building

يتم زياده وزن سقف الدور الارضى .

= Load of one Floor * No. of Floors.

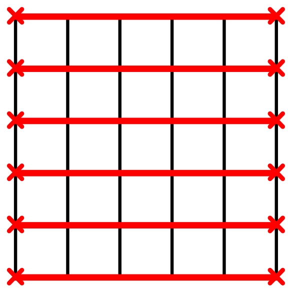
$= 9375 * 8.0 = 75000\ kN$



– Total Load on One Vierendeel.

يتم توزيع الحمل الكلى على عدد ال Vierendeels

مع فرض أن أول و أخر system سيحمل نصف الحمل فقط.



Total Load on One Vierendeel.

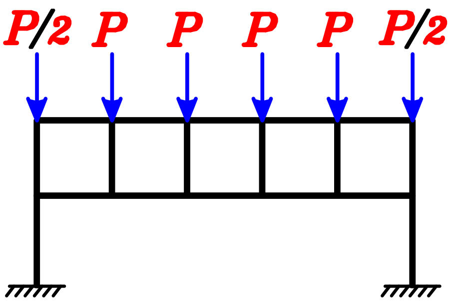
$= \frac{75000\ kN}{5.0} = 15000\ kN$

– Load on one joint of the Vierendeel.

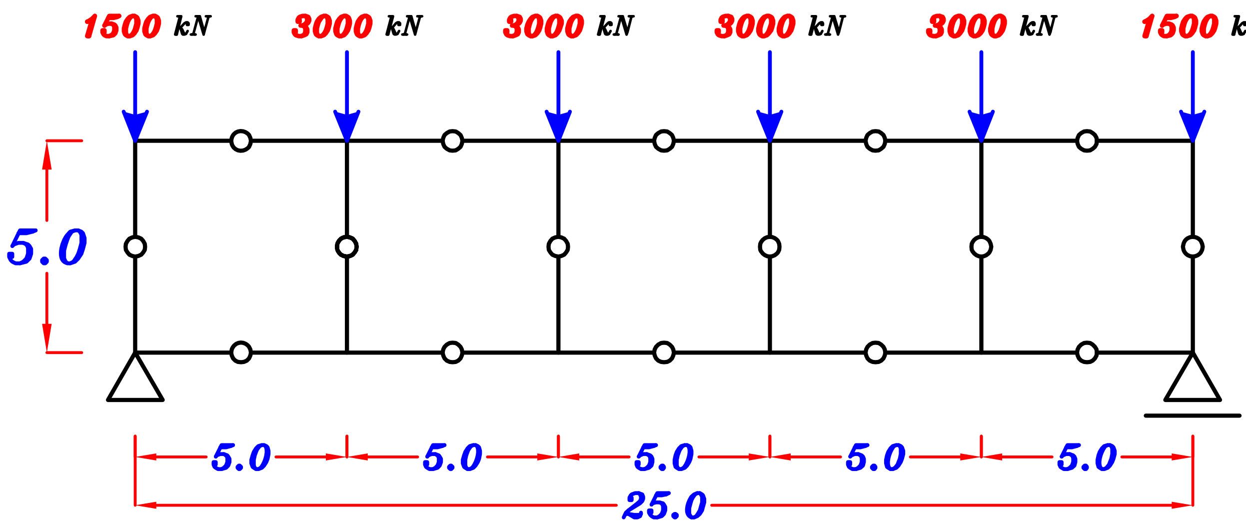
يتم توزيع الحمل الكلى لل Vierendeels على عدد ال joints

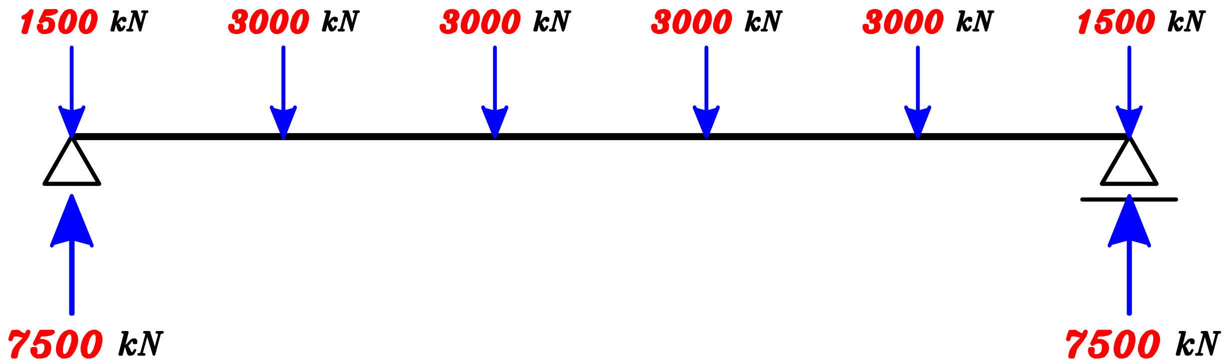
مع فرض أن أول و أخر joint ستحمل نصف الحمل فقط

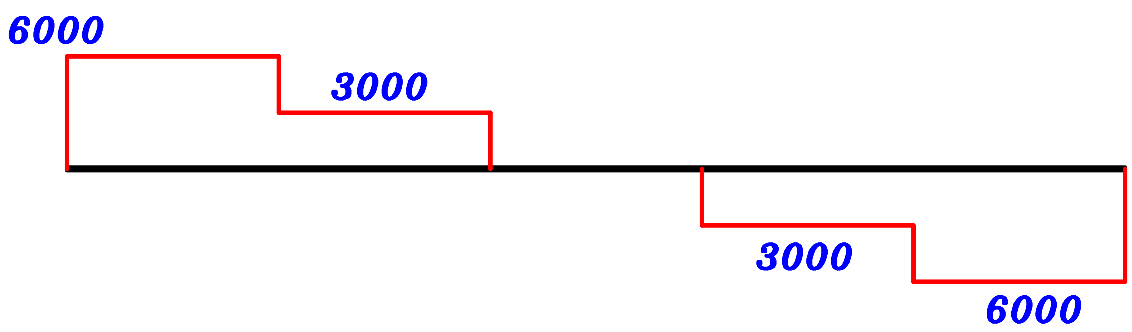
$P = \frac{15000\ kN}{5.0} = 3000\ kN\ (U.L.)$

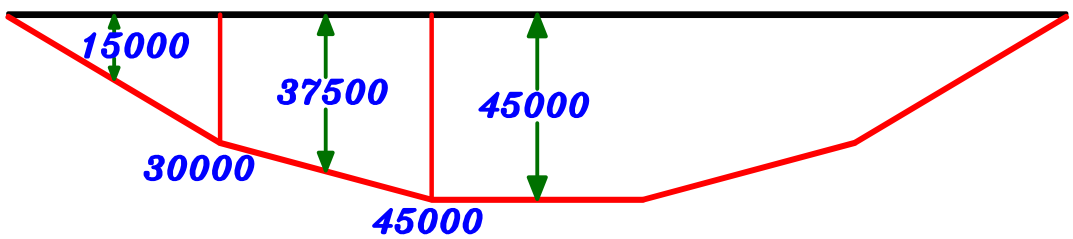


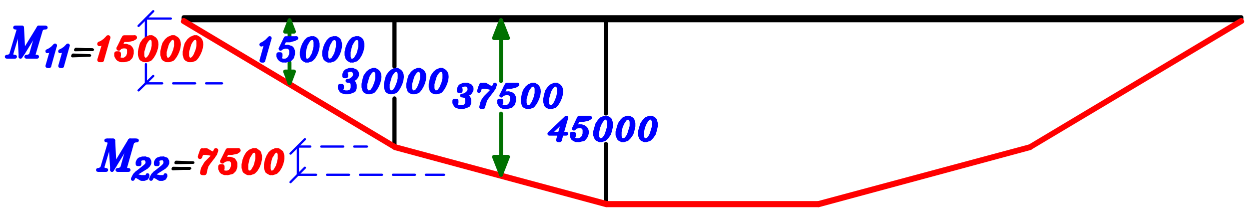
3 – Draw Internal Forces Diagrams For the main supporting element.



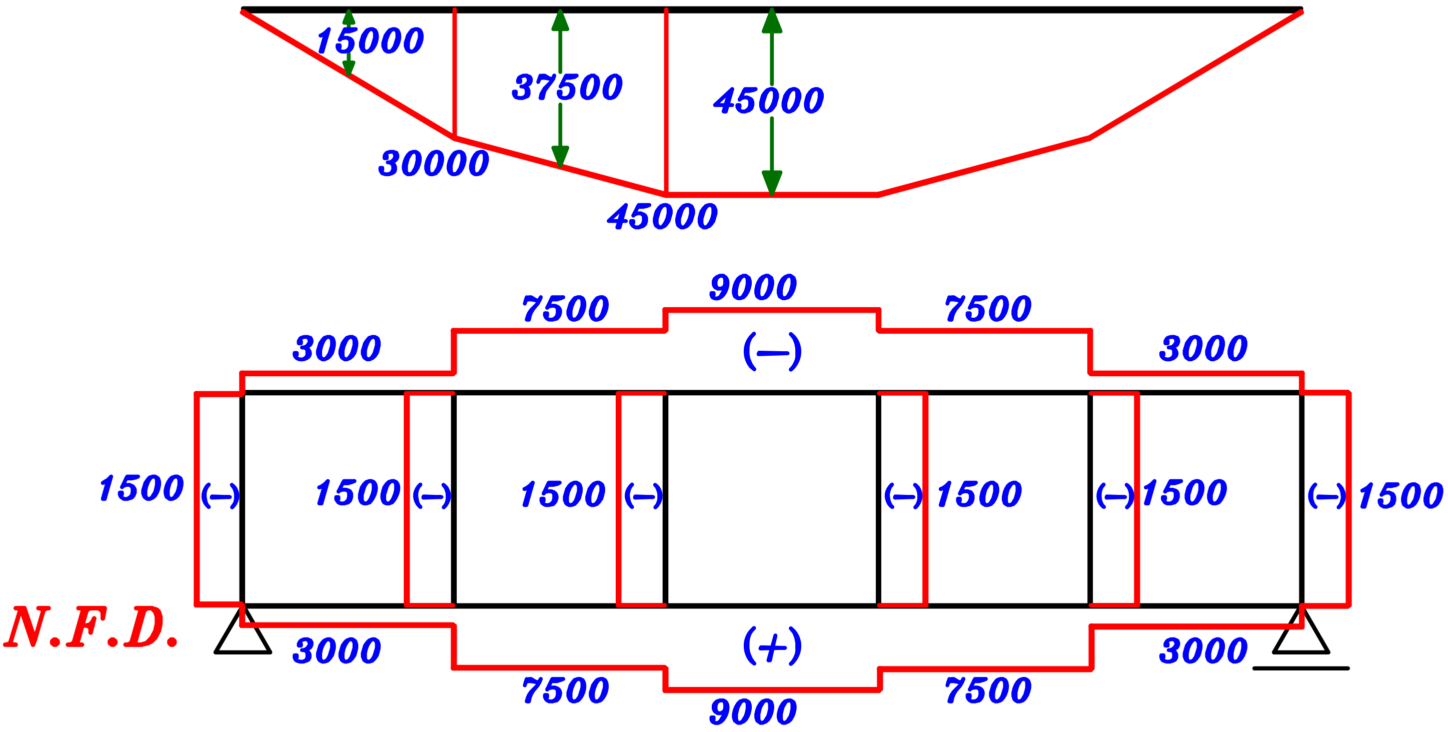




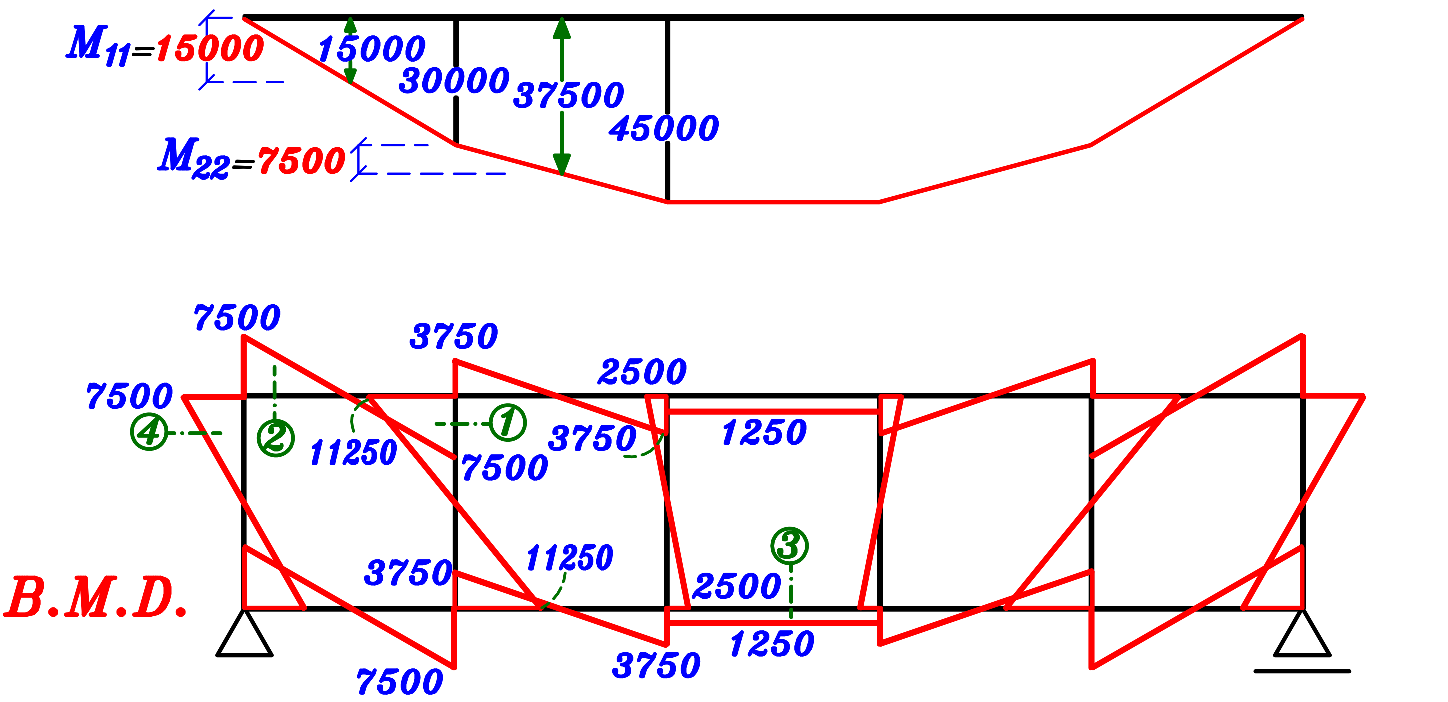




N.F.D. on Vierendeel.



B.M.D. on Vierendeel.



Design of sections.

Sec. ① R–Sec.

$M = 11250$ kN.m , $N = 1500$ kN , $b = 800$ mm , $t = 2200$ mm

Check $\frac{N}{F_{cu}\, b\, t} = \frac{1500 * 10^3}{30 * 800 * 2200} = 0.028 < 0.04$ (Neglect N)

$$2100 = C_1 \sqrt{\frac{11250 * 10^6}{30 * 800}} \longrightarrow C_1 = 3.06 \longrightarrow J = 0.747$$

$$A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{11250 * 10^6}{0.747 * 360 * 2100} = 19920\ mm^2$$

26 ϕ 32

$$n = \frac{b - 25}{\phi + 25} = \frac{800 - 25}{32 + 25} = 13.6 = 13.0$$

Sec. ② R–Sec.

$M = 7500$ kN.m , $N = 3000$ kN , $b = 800$ mm , $t = 2200$ mm

Check $\frac{N}{F_{cu}\, b\, t} = \frac{3000 * 10^3}{30 * 800 * 2200} = 0.056 > 0.04$ (Don't Neglect N)

$e = \frac{M}{N} = \frac{7500}{3000} = 2.50\ m \quad \therefore \frac{e}{t} = \frac{2.50}{2.2} = 1.13\ m > 0.5 \xrightarrow{use} e_s$

$$e_s = e + \frac{t}{2} - c = 2.50 + \frac{2.2}{2} - 0.1 = 3.50\ m$$

$$M_s = N * e_s = 3000 * 3.50 = 10500\ kN.m$$

$$2100 = C_1 \sqrt{\frac{10500 * 10^6}{30 * 800}} \longrightarrow C_1 = 3.17 \longrightarrow J = 0.757$$

$$A_s = \frac{M_s}{J\, F_y\, d} - \frac{N_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{10500 * 10^6}{0.757 * 360 * 2100} - \frac{3000 * 10^3}{(360 \backslash 1.15)}$$

$$= 8764\ mm^2$$

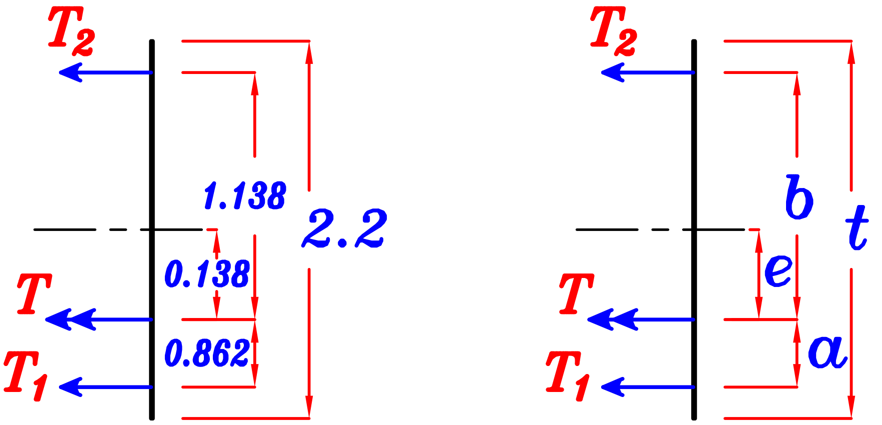
12 ϕ 32

Sec. ③ R–Sec.

$M = 1250$ kN.m , $T = 9000$ kN , $b = 800$ mm , $t = 2200$ mm

$$e = \frac{M}{T} = \frac{1250}{9000} = 0.138 \text{ m}$$

$$\therefore \frac{e}{t} = \frac{0.138}{2.20} = 0.062 < 0.5 \longrightarrow$$ **Small Eccentricity.**



$$a = \frac{t}{2} - c - e = \frac{2.20}{2} - 0.10 - 0.138 = 0.862 \text{ m}$$

$$b = \frac{t}{2} - c + e = \frac{2.20}{2} - 0.10 + 0.138 = 1.138 \text{ m}$$

$$T_1 = T_{U.L.}\left(\frac{b}{a+b}\right) = 9000\left(\frac{1.138}{0.862 + 1.138}\right) = 5121 \text{ kN}$$

$$A_{s1} = \frac{T_1}{(F_y/\gamma_s)} = \frac{5121 * 10^3}{(360 \backslash 1.15)} = 16358 \text{ mm}^2$$

22 ∅ 32

Sec. ④ R–Sec.

$M = 7500$ kN.m , $N = 1500$ kN , $b = 800$ mm , $t = 2200$ mm

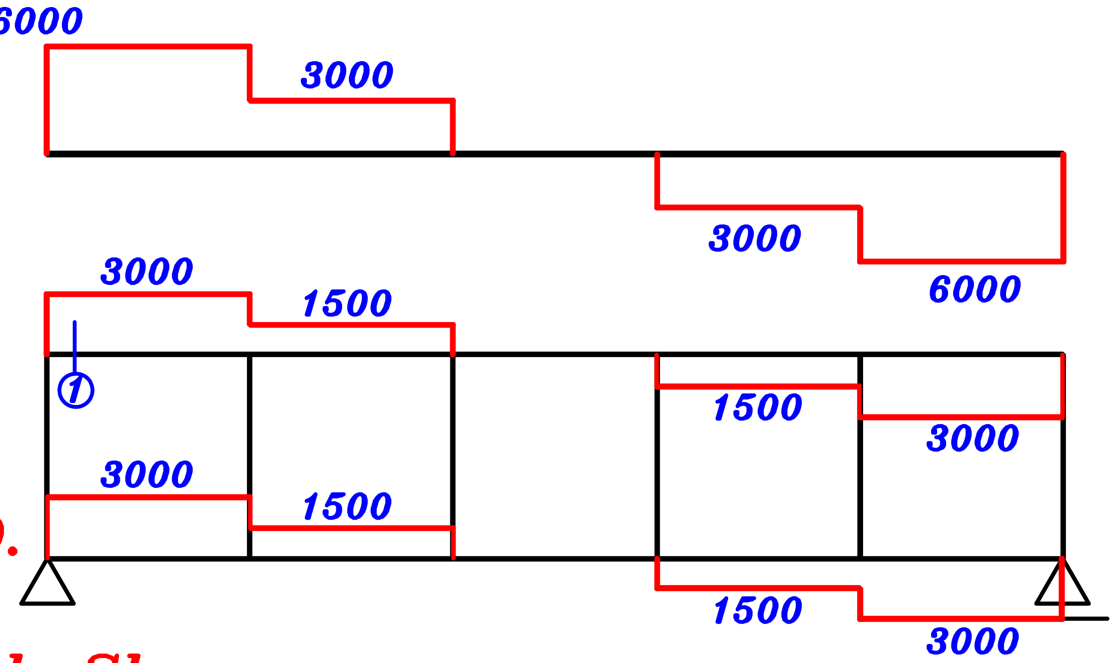
$$\text{Check} \quad \frac{N}{F_{cu}\, b\, t} = \frac{1500 * 10^3}{30 * 800 * 2200} = 0.028 < 0.04 \quad (\text{Neglect } N)$$

$$2100 = C_1 \sqrt{\frac{7500 * 10^6}{30 * 800}} \longrightarrow C_1 = 3.75 \longrightarrow J = 0.793$$

$$A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{7500 * 10^6}{0.793 * 360 * 2100} = 12510 \text{ mm}^2$$

16 ∅ 32

S.F.D. on Vierendeels.



S.F.D.

Check Shear.

– Allowable shear stress.

$$q_{cu} = 0.24\sqrt{\frac{F_{cu}}{\gamma_c}} = 0.24\sqrt{\frac{30}{1.5}} = 1.07 \quad N\backslash mm^2$$

$$q_{max.} = 0.7\sqrt{\frac{F_{cu}}{\gamma_c}} = 0.7\sqrt{\frac{30}{1.5}} = 3.0 \quad N\backslash mm^2$$

Actual shear stress.

$$q_U = \frac{Q}{b\,d} = \frac{3000 * 10^3}{800 * 2100} = 1.78 \; N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\therefore$ We need Stirrups more Than 5 ϕ8 \ m`

Use Stirrups ϕ 12 steel 360/520

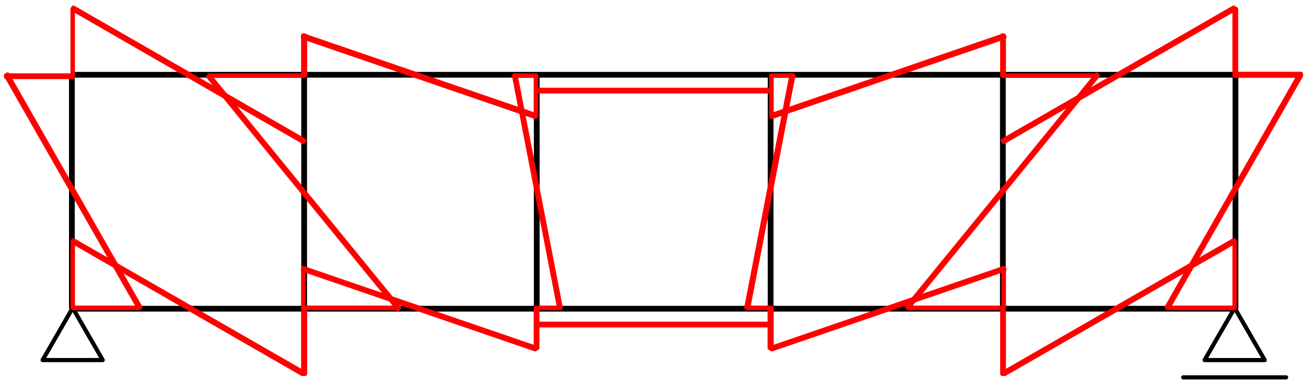
$$\therefore \text{ Use } \quad q_s = q_u - \frac{q_{cu}}{2} = \frac{n\,A_s(F_y\backslash\gamma_s)}{b\;S}$$

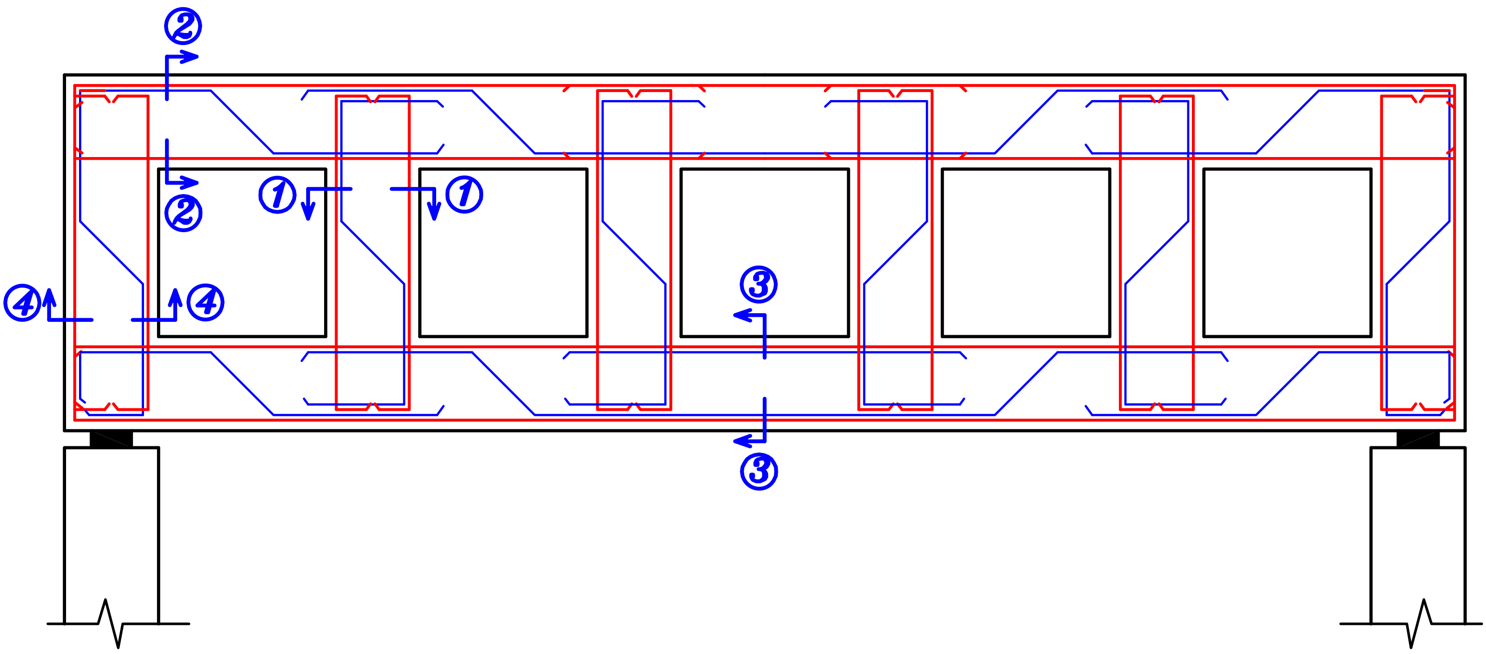
* Take $n = 4$, $\phi 12 \longrightarrow A_s = 113\ mm^2$

$$1.78 - \frac{1.07}{2} = \frac{4 * 113\ (360\backslash 1.15)}{800 * S} \longrightarrow S = 142.0\ mm > 100\ mm$$

$$\therefore \text{No. of stirrups}\backslash m` = \frac{1000}{S} = \frac{1000}{142.0} = 7.0\ \backslash m`$$

Use Stirrups **7 ϕ12 \ m`** 4 branches





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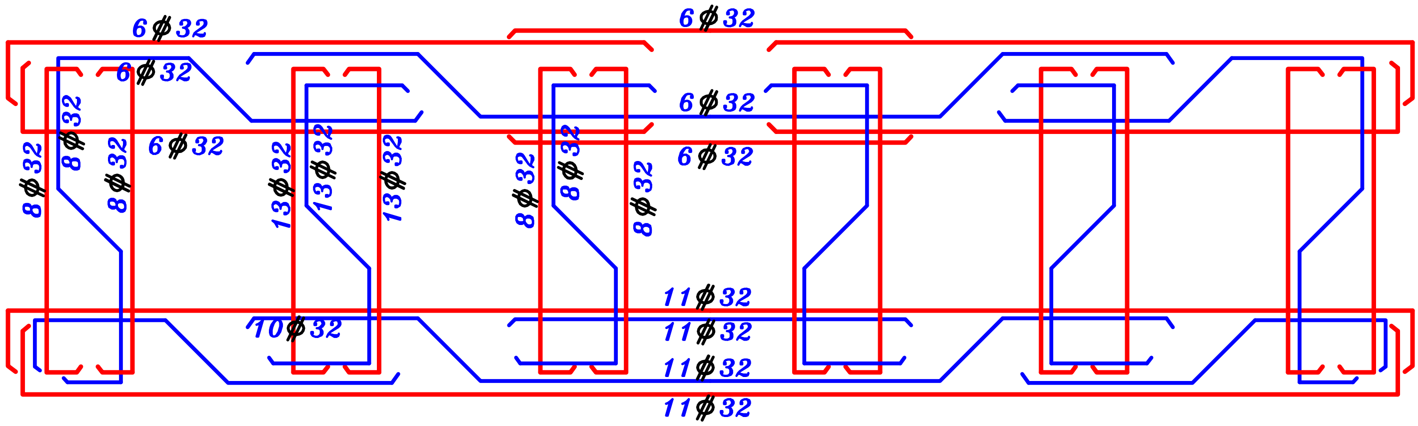

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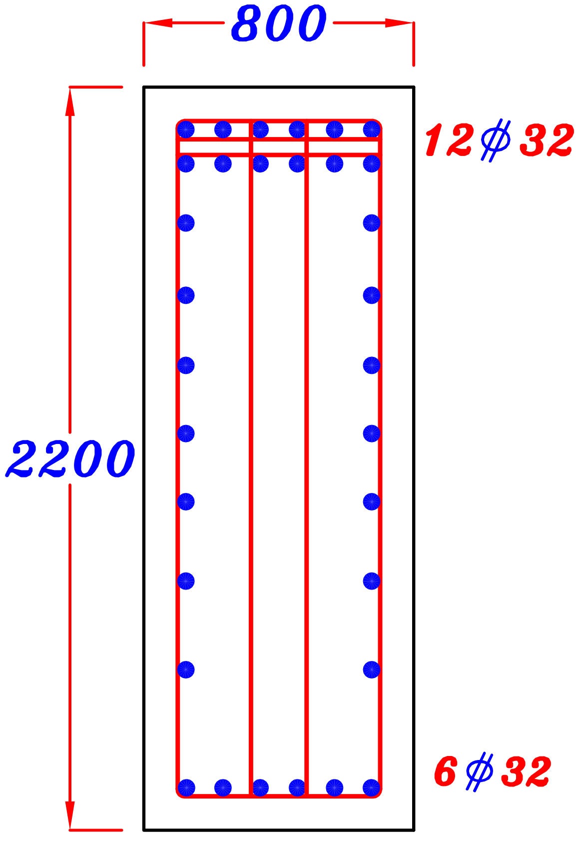
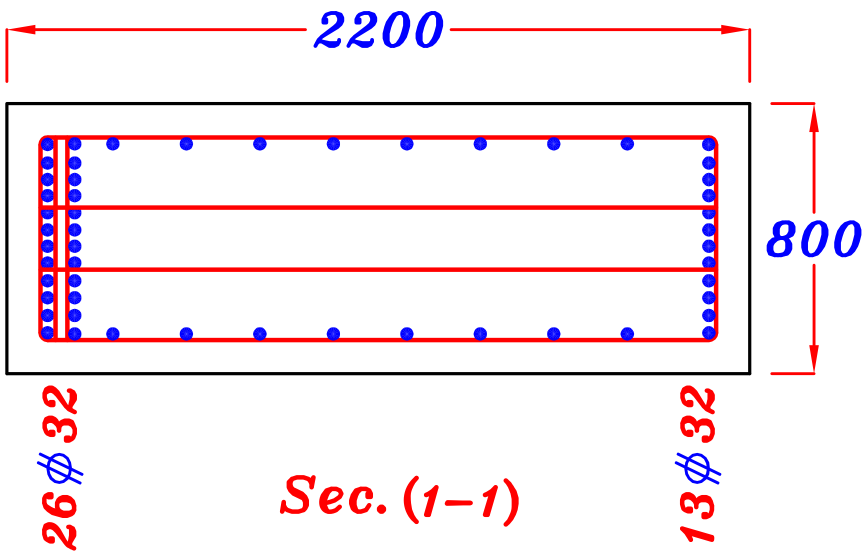
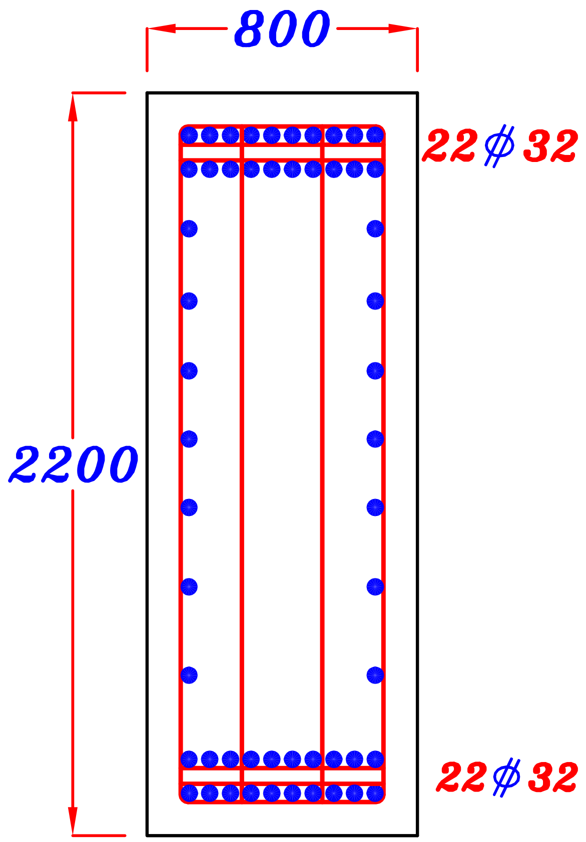


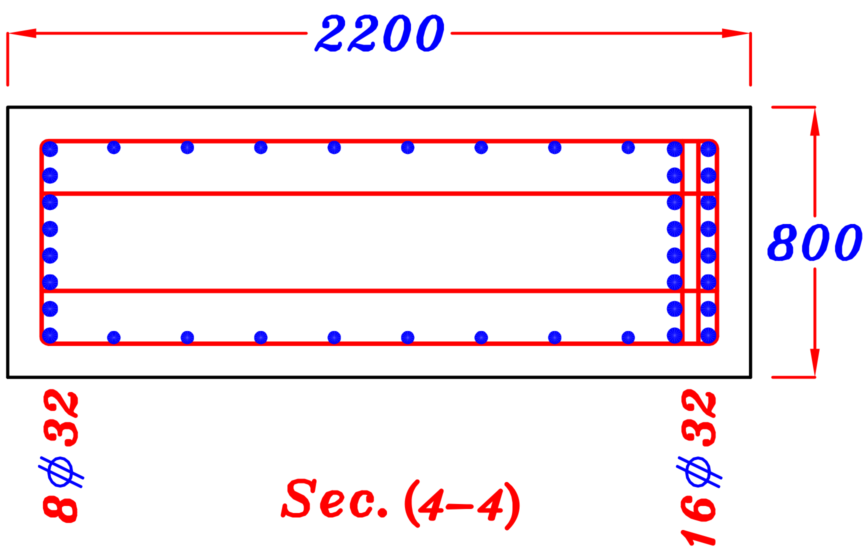
Sec. (2-2)



Sec. (1-1)



Sec. (3-3)



Sec. (4-4)