Influence Lines of Trusses

خطوط التأثير للـ Trusses

نسألكم الدعاء

Table of Contents

* Influence Lines of Trusses ———— Page 2
* Drawing I.L. Diagram using sections method ——— Page 3
* Drawing I.L. Diagram using Joint method ——— Page 4
* Zero Members ———————————— Page 5
* Examples ———————————————— Page 6

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INFLUENCE LINES OF TRUSSES

هو عبارة عن رسم *Diagram* يعبر عن قيمة الـ *Reactions* عند الـ *Supports*

أو تغير قيمة الـ *Force in members* نتيجة تغير مكان الحمل على

الـ *Truss* و الحمل المتحرك دائما هو ١ طن رأسى و مكان وجوده فوق

الـ *Joints* فقط

و لرسم الـ *I.L.(Force at any member in truss)* يتم أولا حساب

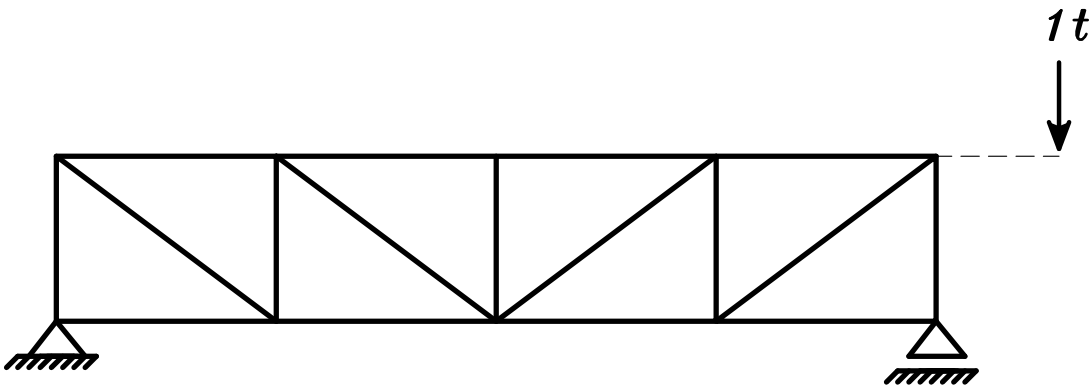
ورسم الـ *I.L. Reactions* و ذلك كما فى حالة الكمرات

×× فى حالة وجود *2 Reactions in X*(X_a, X_b) يتم فرض اتجاههم عكس

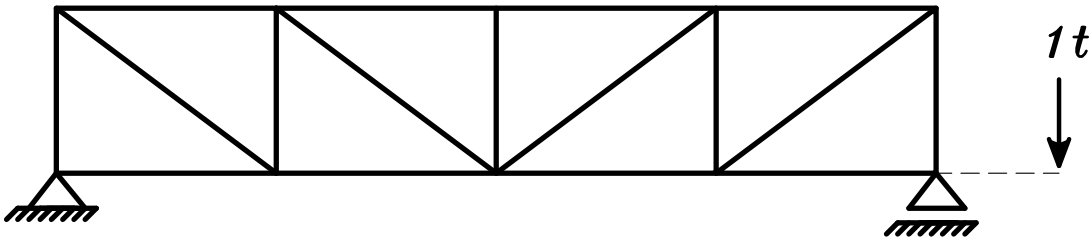
بعض و باستخدام معادلة $\Sigma X = 0$ يكون $X_a = X_b = 0$

و بالتالى يتم رسم *Diagram* واحد لهما معا

×× يجب تحديد المستوى الذى يتحرك عليه الحمل فى المسألة



الحمل يتحرك على المستوى العلوى من الـ *Truss*



الحمل يتحرك على المستوى السفلى من الـ *Truss*

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لحساب و رسم الـ I.L. Diagrams

يتم الحل كما فى الـTrusses العادية و ذلك بأخذ قطاع يمر بالـmember المراد حساب القوى به بحيث يمر القطاع بثلاثة مجاهيل فقط من ضمنهم الـ member المطلوب

هذا القطاع يقسم الـ Truss الى جزئين و يتم أخذ أى جزء منهم و دراسته و يتم اخفاء الـmember المراد ايجاد القوة به

اذا كا الـ members 2 الاخرين يتلاقيان فى نقطة يتم أخذ العزوم عندها و ايجاد القوى فى الـ member

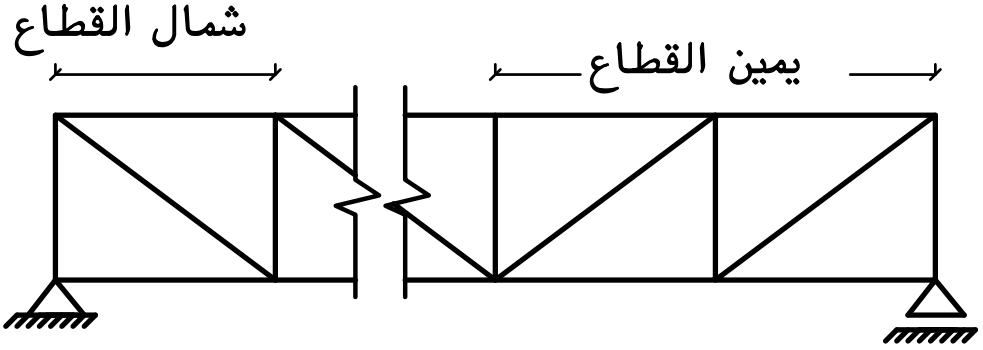
اذا كا الـ members 2 الاخرين متوازيان يتم أخذ مجموع القوى فى الاتجاه العمودى عليهم = صفر و ايجاد القوى فى الـ member المطلوب

و الفارق فى حالة الـ I.L

أننا نكتب لكل member معادلتين

×× اذا كان الحمل يتحرك يمين القطاع ندرس الجزء ناحية الشمال

×× اذا كان الحمل يتحرك شمال القطاع ندرس الجزء ناحية اليمين



مع العلم أن الاحمال التى تدخل فى معادلات الحساب هى الـReactions و القوى داخل الـmembers التى يتم القطع فيها

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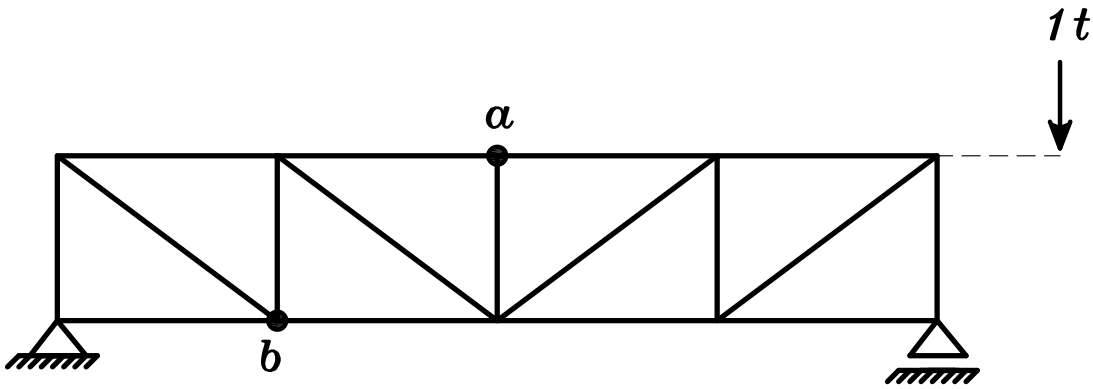
لحساب و رسم الـ I.L. Diagrams

و تعتمد هذه الطريقة على انه كل Joint يجب ان تكون متزنة على حدة لكى يكون المنشأ كله متزن أى أنه يمكن تطبيق معادلات الاتزان عند كل Joint وهى

$$\Sigma X = 0 \ , \ \Sigma Y = 0$$



الفارق الوحيد فى حالة الـ I.L.

اذا كان الحمل لا يمكن أن يقف عند الـ Joint التى ندرسها مثل Joint (b) يتم كتابة معادلة الاتزان مرة واحدة

اذا كان الحمل يمكن أن يقف عند الـ Joint التى ندرسها مثل Joint (a) يتم كتابة معادلة الاتزان مرتين

١- مرة عندما يكون الحمل فوق الـ Joint ويتم أخذه فى الحسابات

٢- مرة عندما يكون الحمل بعيدا عن الـ Joint ولا يتم أخذه فى الحسابات

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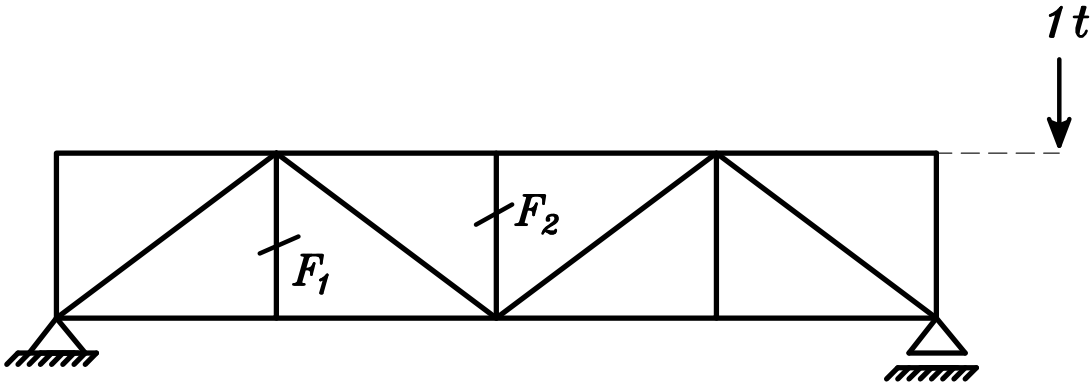
Zero members

يوجد بعض الـ members تكون القوى بها صفر و يمكن معرفتها بمجرد النظر بدون حل و يطلق ليها الـ Zero members و يتم معرفتها كالتالى

١- اذا وجد Joint يخرج منها 2 members و لا يوجد على هذه الـ Joint أى أحمال تكون القوى فى الـ 2 members تساوى صفر

٢- اذا وجد Joint يخرج منها 2 members و لا يوجد على هذه الـ Joint الا حمل واحد فى اتجاه ا حد الـ 2 members تكون القوى فى الـ member الاخر تساوى صفر

٣- اذا وجد Joint يخرج منها 3 members و لا يوجد على هذه الـ Joint أى أحمال و كان يوجد 2 members على خط واحد تكون القوى فى الـ member الثالث تساوى صفر



الفارق الوحيد فى حالة الـ I.L.

اذا كان الحمل لا يمكن أن يقف عند الـ Joint التى من دراسنها عرفنا الـ Zero member يكون الـ member دائما Zero member مثل F_1

اذا كان الحمل يمكن أن يقف عند الـ Joint التى من دراستها عرفنا الـ Zero member يتم كتابة معادلة الاتزان مرتين مثل F_2

١- مرة عندما يكون الحمل فوق الـ Joint $F_2 = \checkmark$

٢- مرة عندما يكون الحمل بعيدا عن الـ Joint $F_2 = 0$

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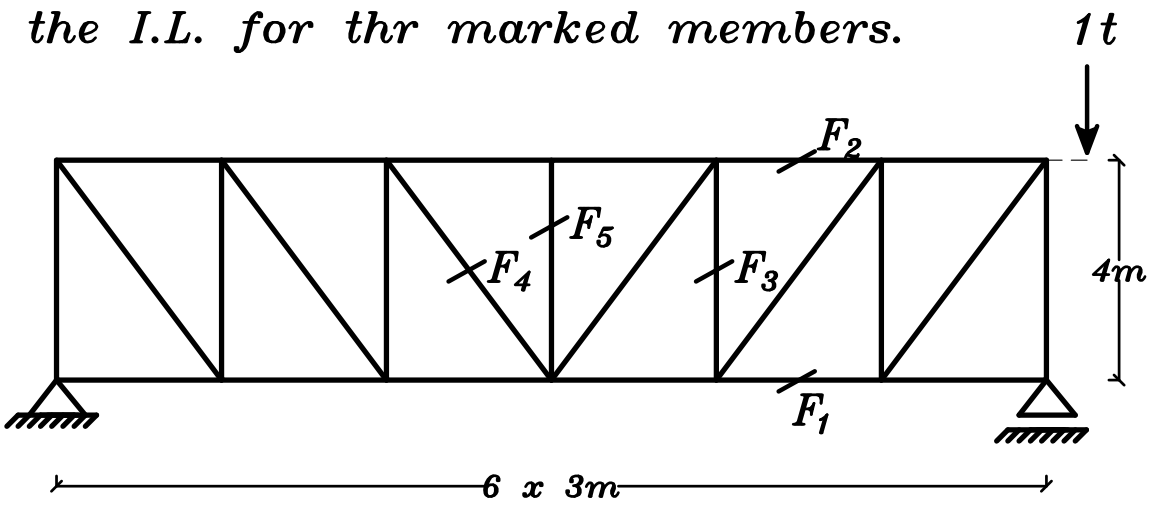
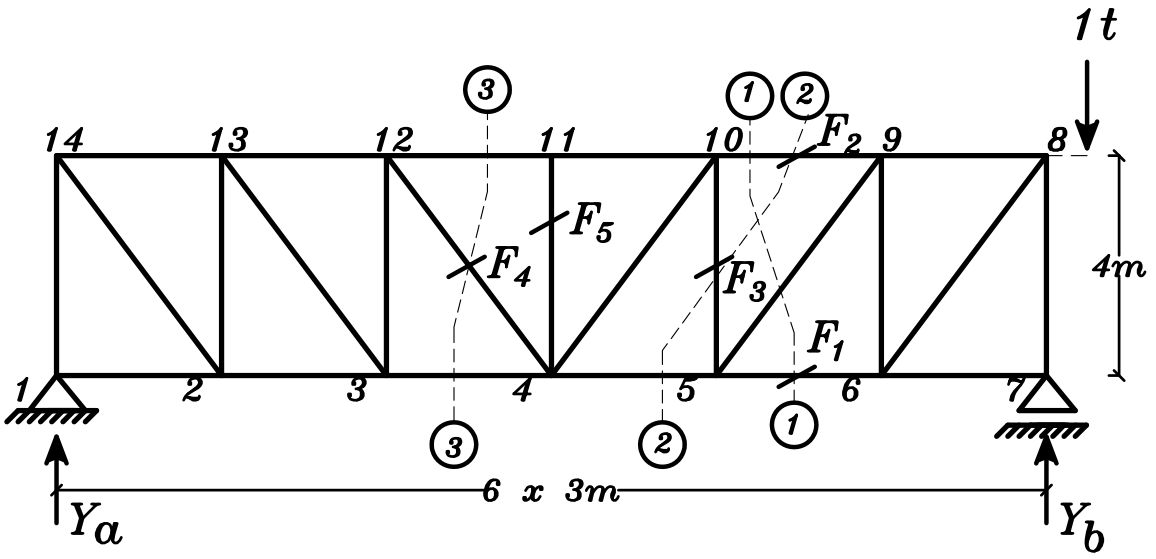
Example

Draw the I.L. for thr marked members.





For F_5 Equilibrium of joint (11)

1ton at joint (11)

$F_5 = -1$

1ton at anywhere else

$F_5 = 0$

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For F_1 Sec 1-1 ($\Sigma M_9 = 0$)

1ton from (10-14)

$\Sigma M_{9\ right} = 0$

$3Y_b - 4F_1 = 0$

$F_1 = 0.75Y_b$

1ton from (8-9)

$\Sigma M_{9\ left} = 0$

$15Y_a - 4F_1 = 0$

$F_1 = 3.75Y_a$

For F_2 Sec 1-1 ($\Sigma M_5 = 0$)

1ton from (10-14)

$\Sigma M_{5\ right} = 0$

$6Y_b + 4F_2 = 0$

$F_2 = -1.50Y_b$

1ton from (8-9)

$\Sigma M_{5\ left} = 0$

$12Y_a + 4F_2 = 0$

$F_2 = -3.0Y_a$

For F_3 Sec 2-2 ($\Sigma Y = 0$)

1ton from (10-14)

$\Sigma Y_{right} = 0$

$Y_b + F_3 = 0$

$F_3 = -Y_b$

1ton from (8-9)

$\Sigma Y_{left} = 0$

$Y_a - F_3 = 0$

$F_3 = Y_a$

For F_4 Sec 3-3 ($\Sigma Y = 0$)

1ton from (12-14)

$\Sigma Y_{right} = 0$

$Y_b + 0.8F_4 = 0$

$F_4 = -1.25Y_b$

1ton from (8-11)

$\Sigma Y_{left} = 0$

$Y_a - 0.8F_4 = 0$

$F_4 = 1.25Y_a$

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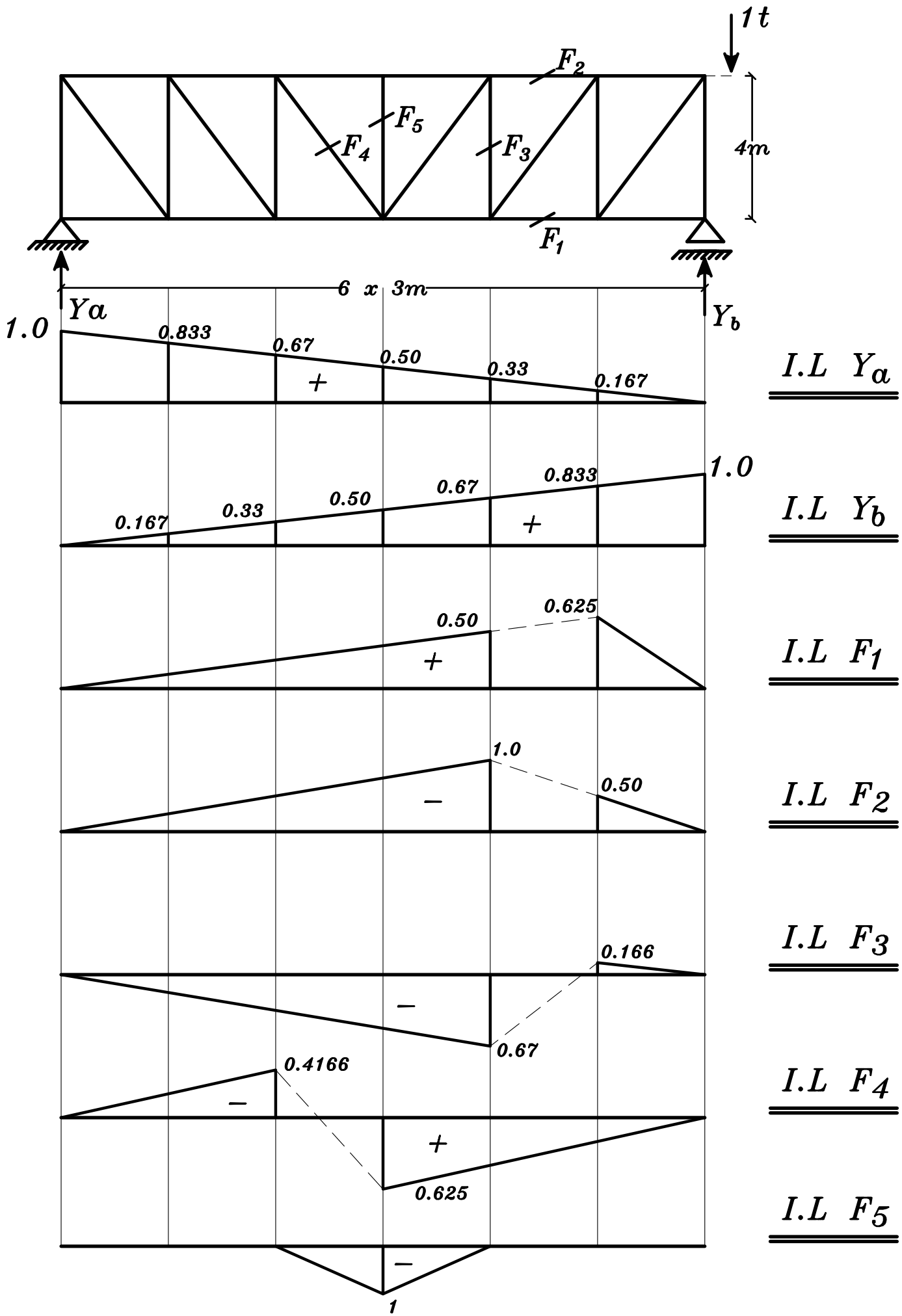

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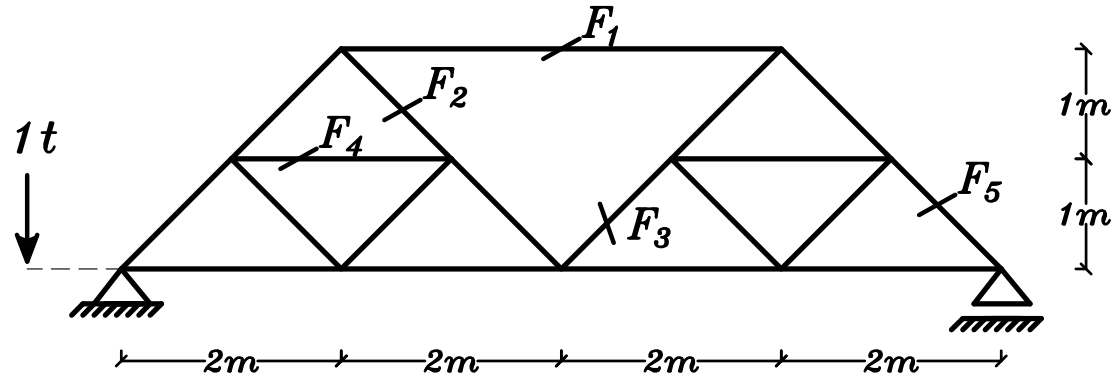
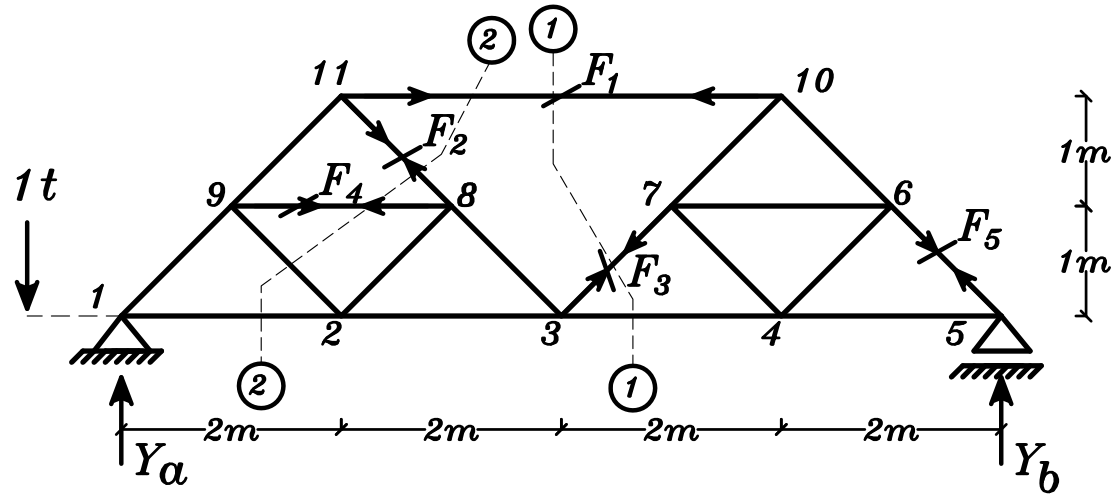
Example

Draw the I.L. for thr marked members.





For F_5 Equilibrium of joint (5) $\Sigma y = 0$

1ton at joint (5)

$$\Sigma Y = 0$$

$$Y_b + 0.707F_5 - 1 = 0$$

$$F_5 = 1.414 (1 - Y_b)$$

1ton at anywhere else

$$\Sigma Y = 0$$

$$Y_b + 0.707F_5 = 0$$

$$F_5 = -1.414\ Y_b$$

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For F_1 Sec 1-1 ($\Sigma M_3 = 0$)

1ton from (1-3)

$\Sigma M_{3\ right} = 0$

$4Y_b + 2F_1 = 0$

$F_1 = -2\ Y_b$

1ton from (4-5)

$\Sigma M_{3\ left} = 0$

$4Y_a + 2F_1 = 0$

$F_1 = -2Y_a$

For F_2 Equilibrium of joint (11)

$\Sigma Y = 0$ --- $F_2 Cos\alpha + F_{9-11} Cos\alpha$ ---- $F_2 = -F_{9-11}$

$\Sigma X = 0$ --- $F_1 + F_2 Sin\alpha - F_{9-11} Sin\alpha = 0$

$F_2 = -0.707\ F_1$

For F_3 Sec 1-1 ($\Sigma Y = 0$)

1ton from (1-3)

$\Sigma Y_{right} = 0$

$Y_b - 0.707F_3 = 0$

$F_3 = 1.414Y_b$

1ton from (4-5)

$\Sigma Y_{left} = 0$

$Y_a + 0.707F_3 = 0$

$F_3 = -1.414Y_a$

For F_4 Sec 2-2 ($\Sigma M_2 = 0$)

1ton from (2-5)

$\Sigma M_{2\ right} = 0$

$2Y_a + F_4 + 2(0.707F_2) + 2F_1 = 0$

$F_4 = -(2\ Y_a + F_1)$

1ton at (1)

$\Sigma M_{2\ left} = 0$

$6Y_b + F_4 + 2(0.707F_2) + 2F_1 = 0$

$F_4 = -(6\ Y_b + F_1)$

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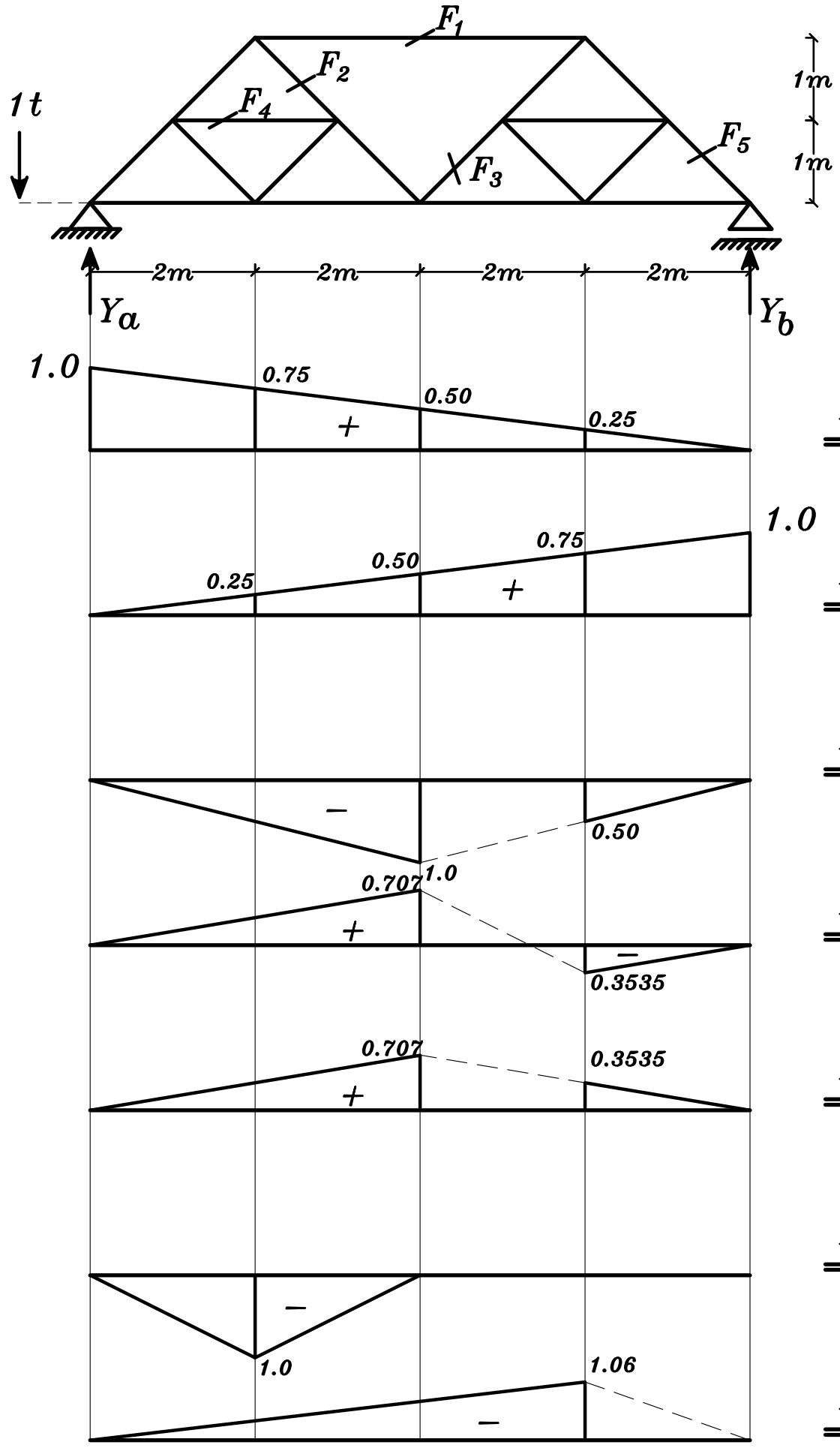

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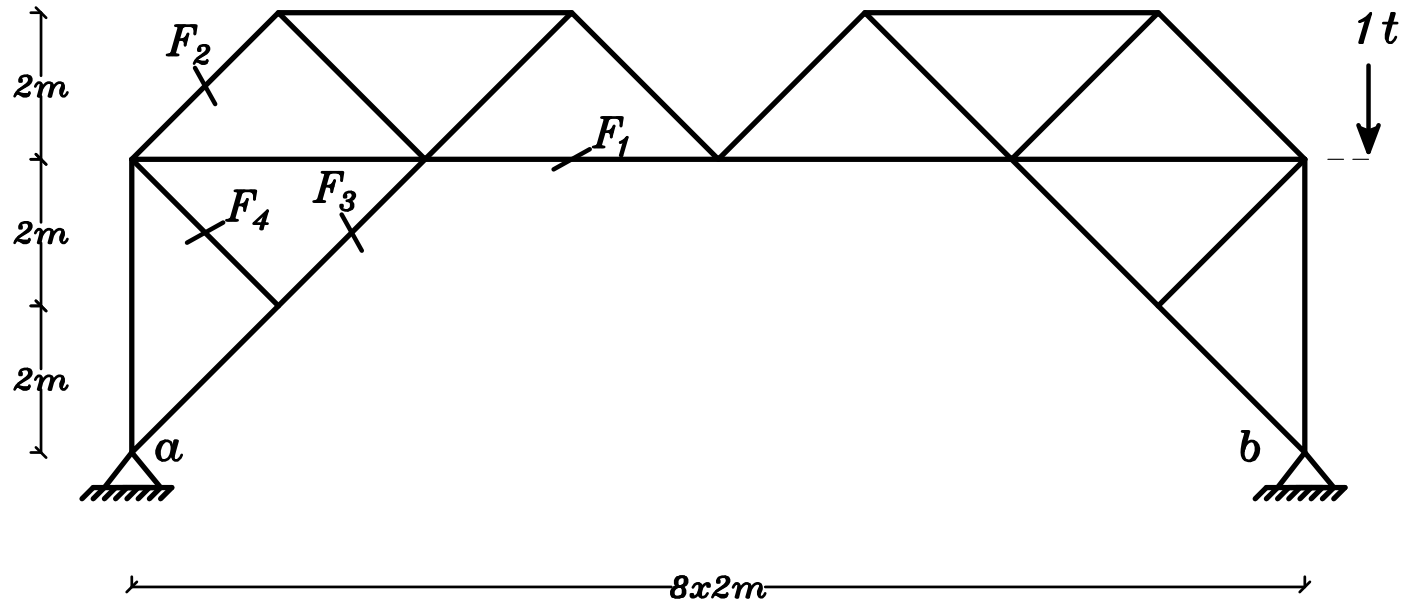
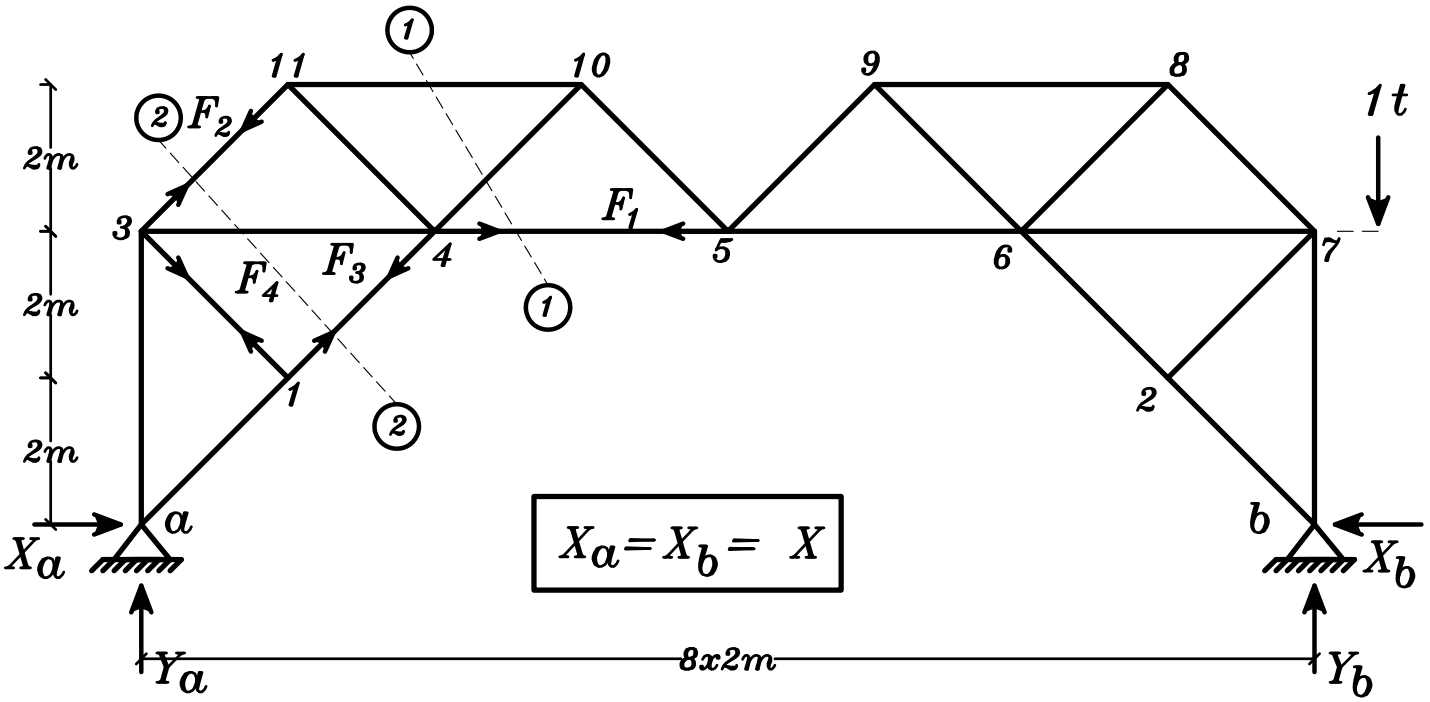
Example

Draw the I.L. for thr marked members.





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For X $(\Sigma M_5 = 0)$

1ton from (3–5)

$\Sigma M_{5\ right} = 0$

$8Y_b - 4X = 0$

$X = 2\ Y_b$

1ton from (5–7)

$\Sigma M_{5\ left} = 0$

$8Y_a - 4X = 0$

$X = 2Y_a$

For F_1 **Sec 1–1** $(\Sigma M_{10} = 0)$

1ton from (3–4)

$\Sigma M_{10\ right} = 0$

$2F_1 + 6X - 10Y_b = 0$

$F_1 = 5Y_b - 3X$

1ton from (5–7)

$\Sigma M_{10\ left} = 0$

$2F_1 + 6X - 6Y_a = 0$

$F_1 = 3.0Y_a - 3X$

For F_2 **Sec 2–2** $(\Sigma M_4 = 0)$

1ton from (4–7)

$\Sigma M_{4\ left} = 0$

$4Y_a - 4X + (0.707F_2)(4) = 0$

$F2 = 1.414\ (X - Y_a)$

1ton at joint (3)

$\Sigma M_{4\ right} = 0$

$12Y_b - 4X + (0.707F_2)(4) = 0$

$F2 = 1.414(X - 3Y_b)$

For F_4 **Equilibrium of joint (1)**

F_4 is a zero member if 1t at any joint

For F_3 **Equilibrium of joint (A)**

$\Sigma X = 0$ --- $X + 0.707\ F_3 = 0$

$F_3 = -1.414\ X$ if 1 ton at any joint

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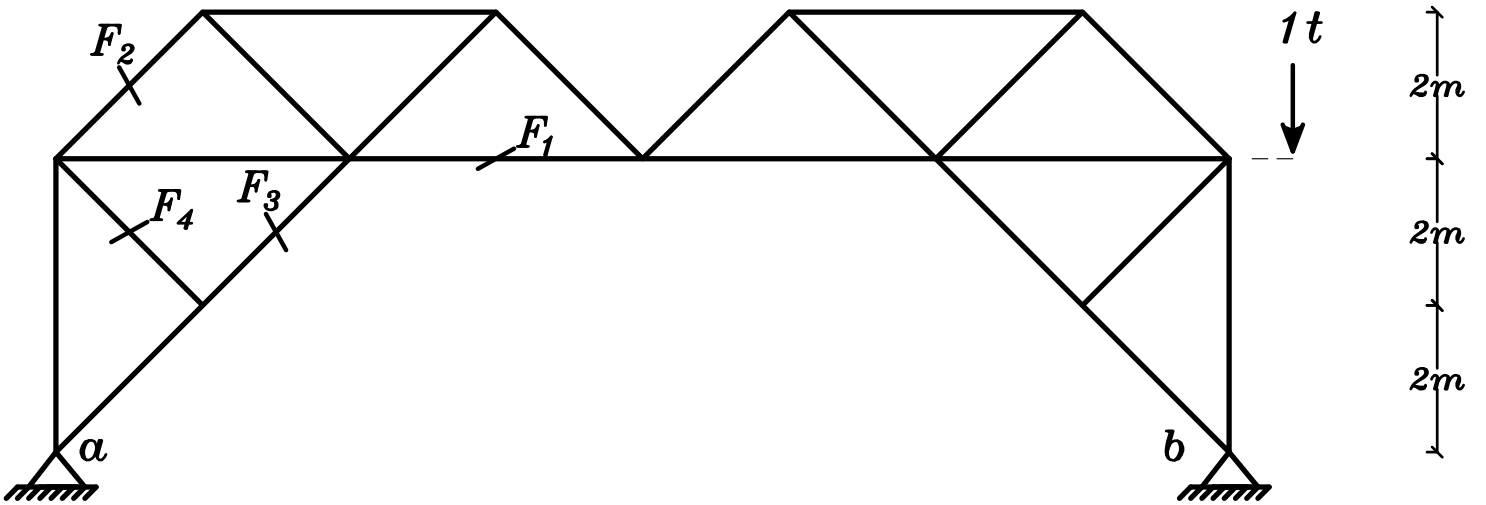

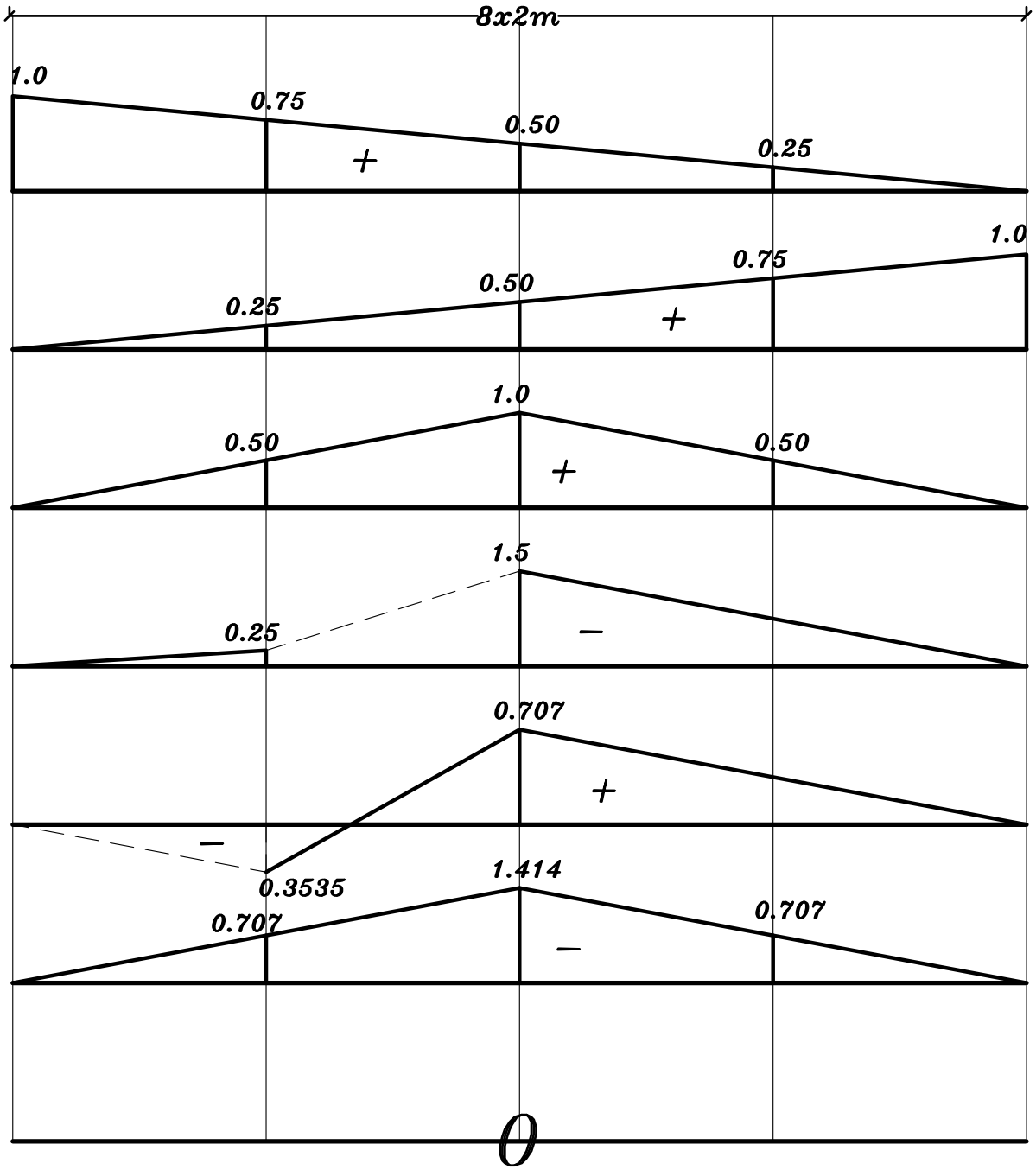

I.L Y_a

I.L Y_b

I.L X

I.L F_1

I.L F_2

I.L F_3

I.L F_4

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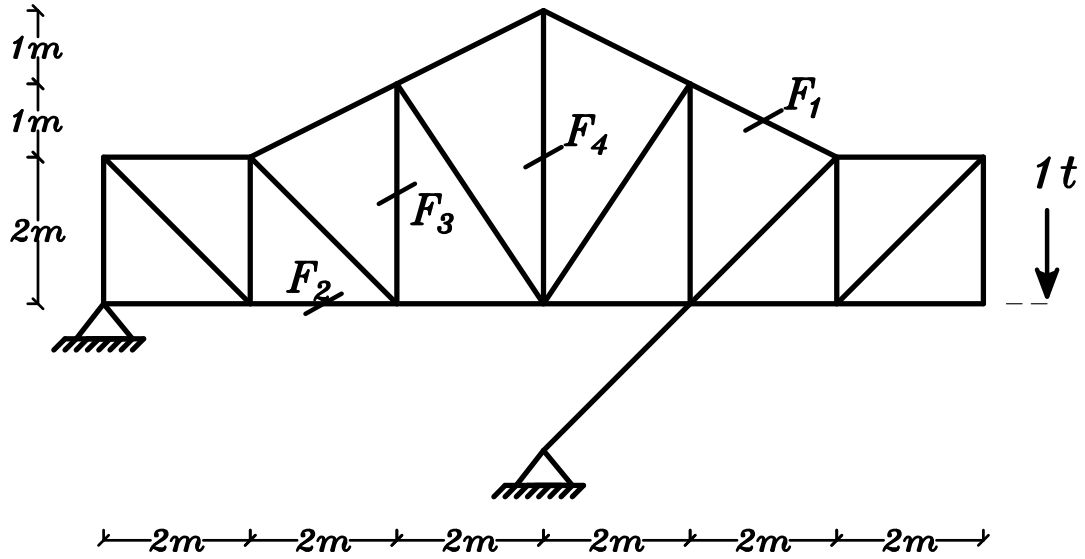
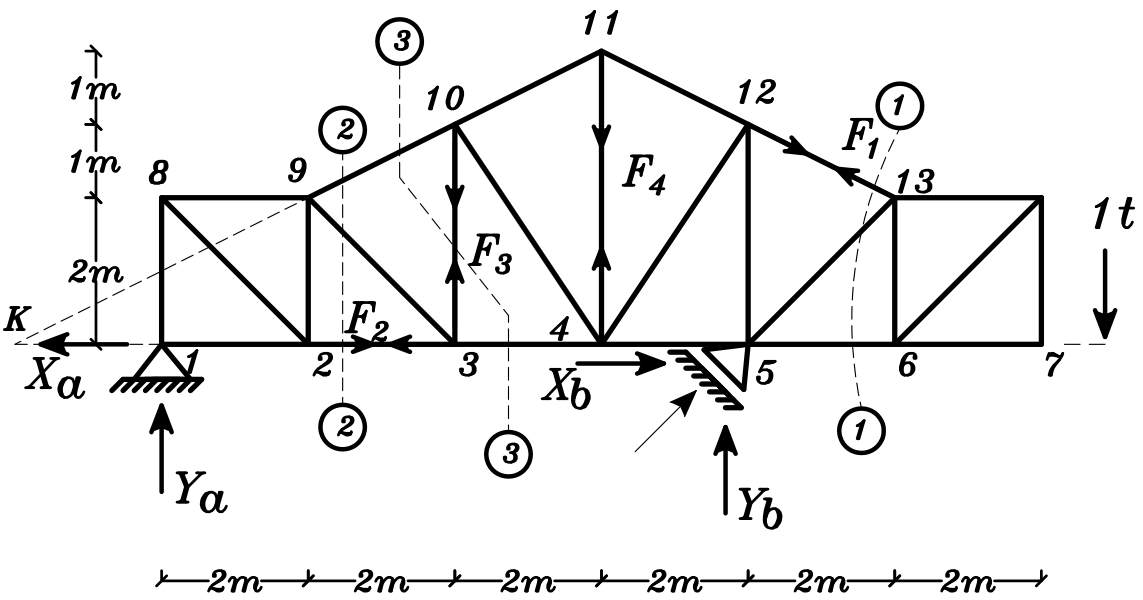
Example

Draw the I.L. for thr marked members.





$$Y_b = X_b$$

$$X_a = X_b$$

$$\boxed{X_a = X_b = Y_b = X}$$

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For F_1 Sec 1-1 ($\Sigma M_5 = 0$)

1ton from (1-5)

$\Sigma M_{5\ right} = 0$

$F_1 \cos\alpha \times 2 - F_1 \sin\alpha \times 2 = 0$

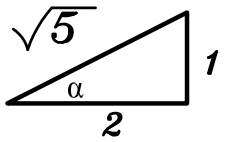
$F_1 = 0$

1ton from (6-7)

$\Sigma M_{5\ left} = 0$

$8Y_a + F_1 \cos\alpha \times 3 = 0$

$F_1 = -2.98Y_a$



For F_2 Sec 2-2 ($\Sigma M_9 = 0$)

1ton from (1-2)

$\Sigma M_{9\ right} = 0$

$2X_b + 6Y_b - 2F_2 = 0$

$2X + 6X - 2F_2 = 0$

$F_2 = 4X$

1ton from (3-7)

$\Sigma M_{9\ left} = 0$

$2Y_a + 2X_b - 2F_2 = 0$

$2Y_a + 2X - 2F_2 = 0$

$F_2 = Y_a + X$

For F_3 Sec 3-3 ($\Sigma M_K = 0$)

1ton from (1-3)

$\Sigma M_{K\ right} = 0$

$10Y_b - 6F_3 = 0$

$F_3 = 1.66\ Y_b$

1ton from (4-7)

$\Sigma M_{K\ left} = 0$

$2Y_a + 6F_3 = 0$

$F_3 = -0.33Y_a$

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For F_4, we have to get F_{11-12} first

For F_{11-12} Sec 2-2 ($\Sigma M_2 = 0$)

1ton from (1-4)

$\Sigma M_{4\ right} = 0$

$F_{11-12} Cos\alpha \ x3 + F_{11-12} Sin\alpha \ x2 + 2Y_b = 0$

$F_{11-12} = -0.559 Y_b$

1ton from (5-7)

$\Sigma M_{4\ left} = 0$

$F_{11-12} Cos\alpha \ x4 + 6Y_a = 0$

$F_{11-12} = -1.667 Y_a$

For F_4 Equilibrium of joint (11)

$\Sigma X = 0$ --- $F_{11-12} = F_{10-11}$

$\Sigma Y = 0$ --- $F_{11-12} Sin\alpha \ x2 + F_4 = 0$

$F_4 = -0.8944 \ F_{11-12}$

1ton from (1-4)

$F_4 = 0.50 \ Y_b$

1ton from (5-7)

$F_4 = 1.50 \ Y_a$

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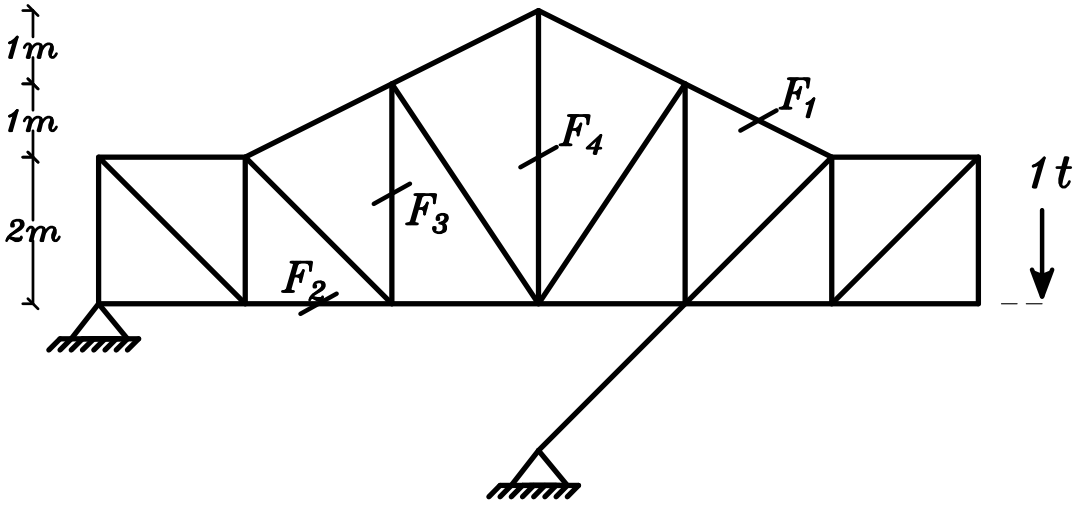
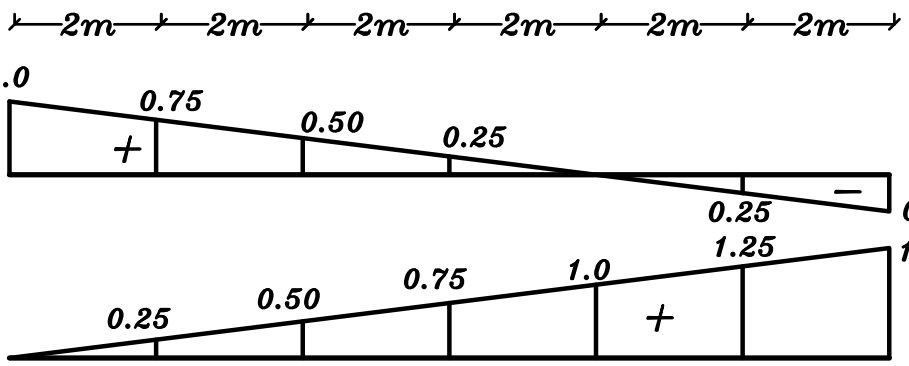
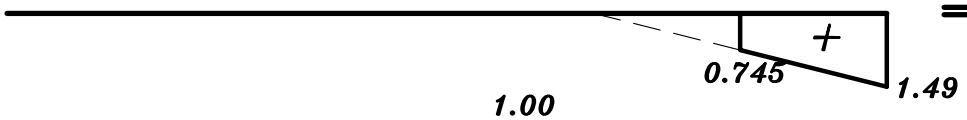


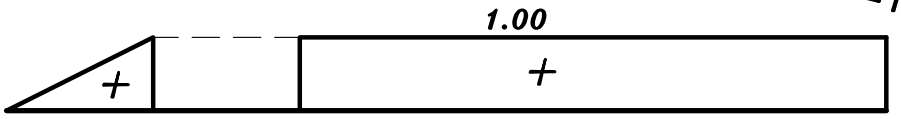


I.L Y_a

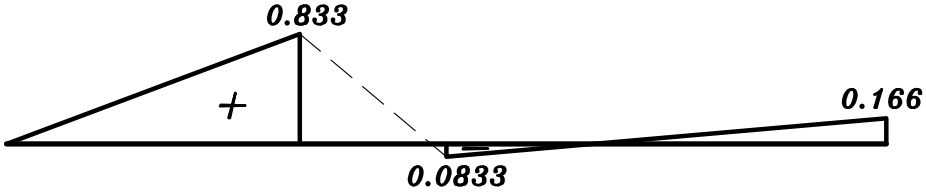
I.L X



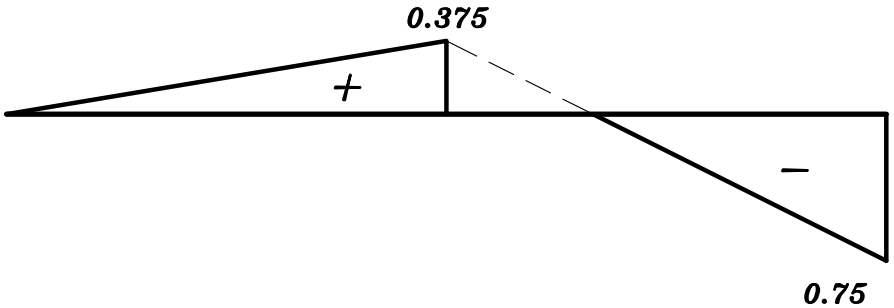
I.L F_1



I.L F_2



I.L F_3



I.L F_4

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Example

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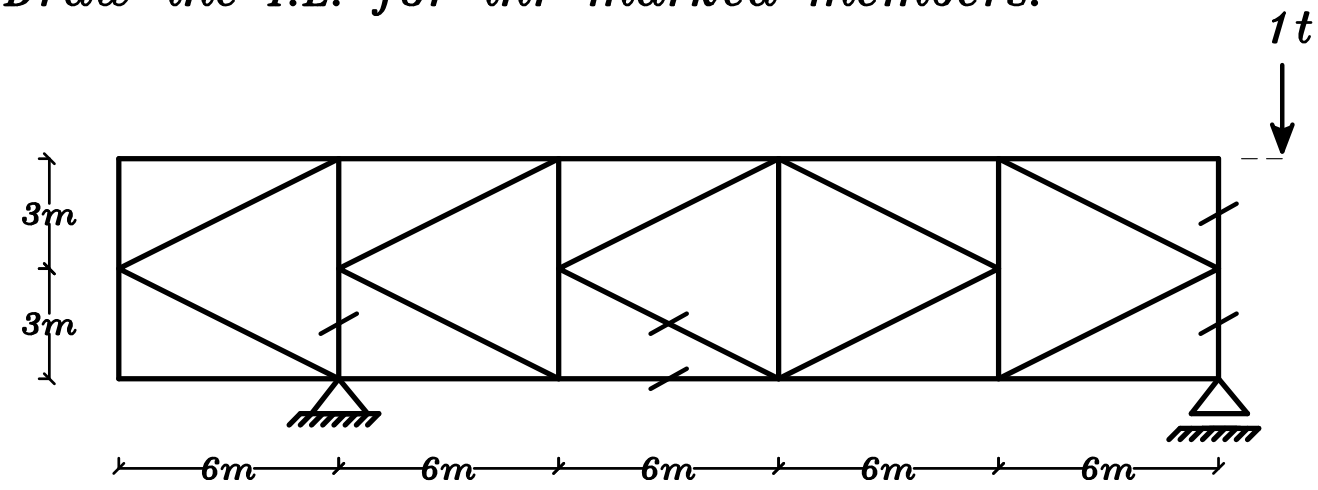

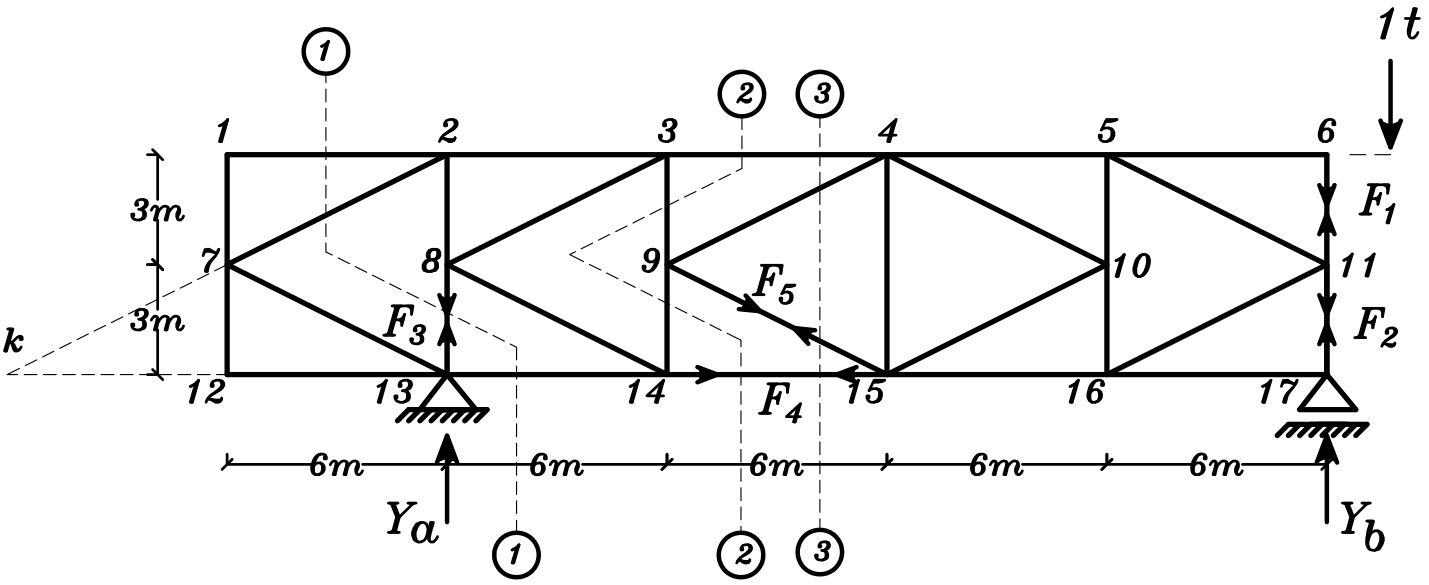

For F_1 Equilibrium of joint (6)

1ton at joint (6)

$$\Sigma Y = 0$$
$$F_1 = -1$$

1ton at anywhere else

$$\Sigma Y = 0$$
$$F_1 = 0$$

For F_2 Equilibrium of joint (17)

$$\Sigma Y = 0$$
$$F_2 + Y_b = 0$$
$$F_2 = -Y_b$$

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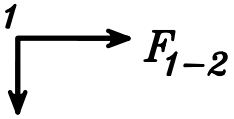
For F_3 Sec 1–1 ($\Sigma M_k = 0$)

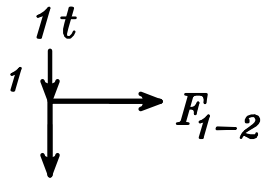
From equilibrium of joint (1)

$\Sigma X = 0$

$F_{1-2} = 0$



OR



1ton from (2–6)

$\Sigma M_{k\ left} = 0$

$12Y_a + 12F_3 = 0$

$F_3 = -Y_a$

1ton at joint (1)

$\Sigma M_{k\ right} = 0$

$36Y_b - 12F_3 = 0$

$F_3 = 3Y_b$

For F_4 Sec 2–2 ($\Sigma M_3 = 0$)

1ton from (1–3)

$\Sigma M_{3\ right} = 0$

$18Y_b - 6F_4 = 0$

$F_4 = 3Y_b$

1ton from (4–6)

$\Sigma M_{3\ left} = 0$

$6Y_a - 6F_4 = 0$

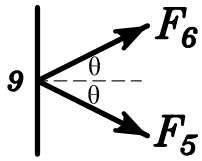
$F_4 = Y_a$

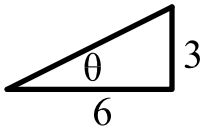
For F_5 Sec 3–3 ($\Sigma Y = 0$)

From equilibrium of joint (9)

$\Sigma X = 0$

$F_5 \cos\theta + F_4 \cos\theta = 0$





$F6 = -F_5$

1ton from (1–3)

$\Sigma\ Y_{right} = 0$

$Y_b + F_5 \sin\theta - F_6 \sin\theta = 0$

$Y_b + 2F_5 \sin\theta = 0$

$F_5 = -1.118\ Y_b$

1ton from (4–6)

$\Sigma\ Y_{left} = 0$

$Y_a - F_5 \sin\theta + F_6 \sin\theta = 0$

$Y_a - 2F_5 \sin\theta = 0$

$F_5 = +1.118\ Y_a$

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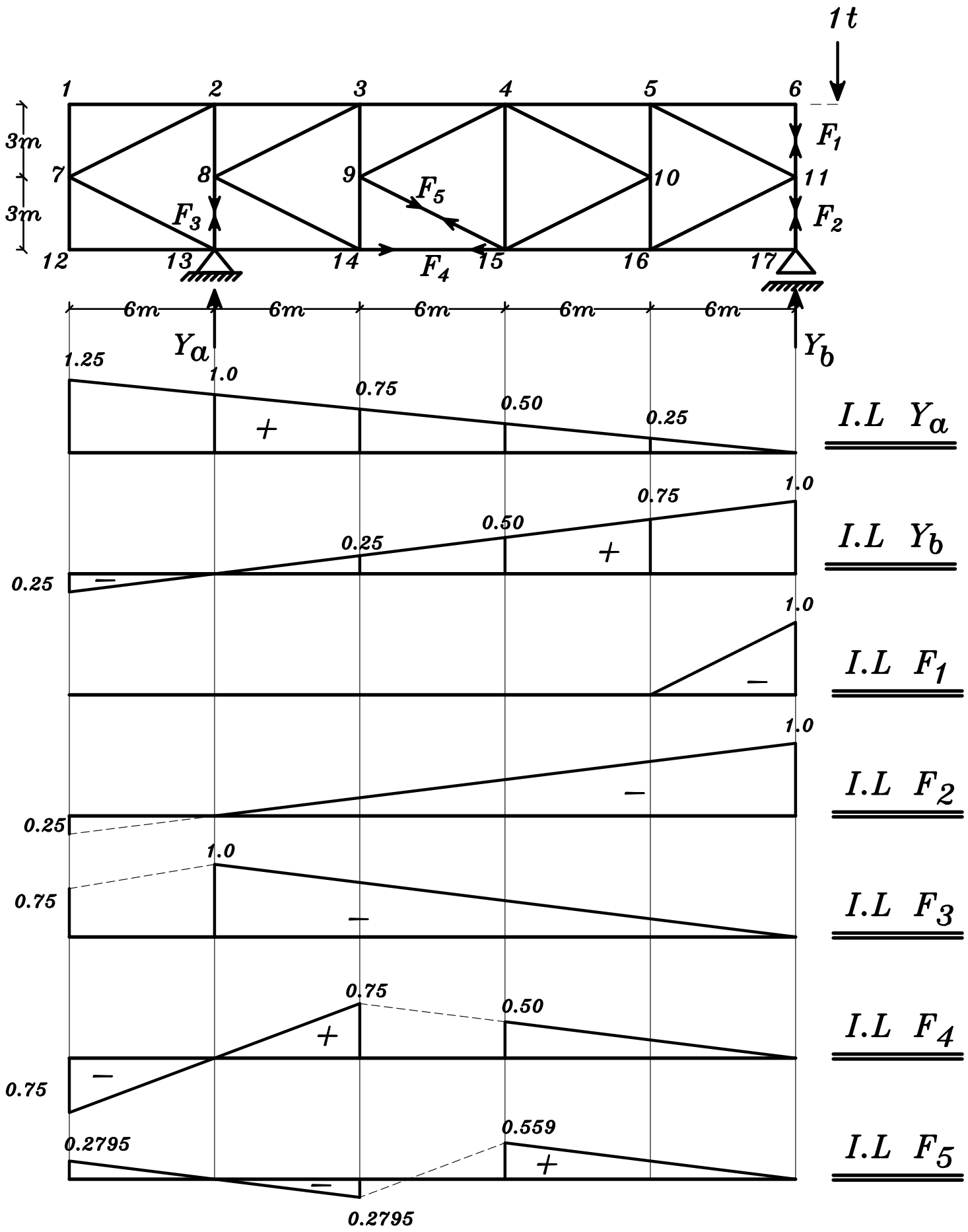

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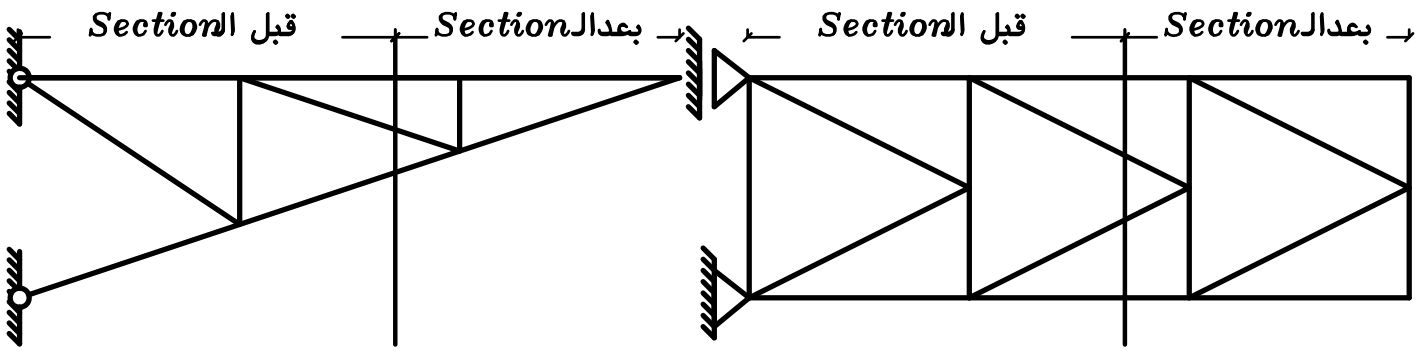
CANTLIVER TRUSSES



يتم الحل كما سبق و ذلك بأخذSection و يتم تقسيم المسألة جزئين

عندما يتحرك الحمل بعيدا عن الطرف الحر (قبل الـ Section)

يتم الحساب من ناحية الطرف الحر و تكون القوى دائما تساوى صفر و ذلك لانه فى هذه الحالة لا يوجدReactions و لا أحمال و بالتالى القوى سوف تساوى صفر

عندما يتحرك الحمل ناحية الطرف الحر (بعد الـ Section)

يتم الحساب أيضا من ناحية الطرف الحر و حيث أن الـ I.L عبارة عن خط مستقيم يتم حساب أى قيمتين من هذه الناحية و التوصيل بينهما

١- يتم وضع الـ ١ طن عند أول Joint بعد الـSection

و حساب قيمة القوى من ناحية الطرف الحر نتيجة الـ ١طن على أساس أنها مسألة عادية كما فى الترم الاول

٢- يتم وضع الـ ١طن عند أخر Joint فى الطرف الحر

و حساب قيمة القوى من ناحية الطرف الحر نتيجة الـ ١طن على أساس أنها مسألة عادية كما فى الترم الاول

٣- يتم التوصيل بين القيمتين بخط مستقيم و قبل القطاع تكون القوى تساوى صفر

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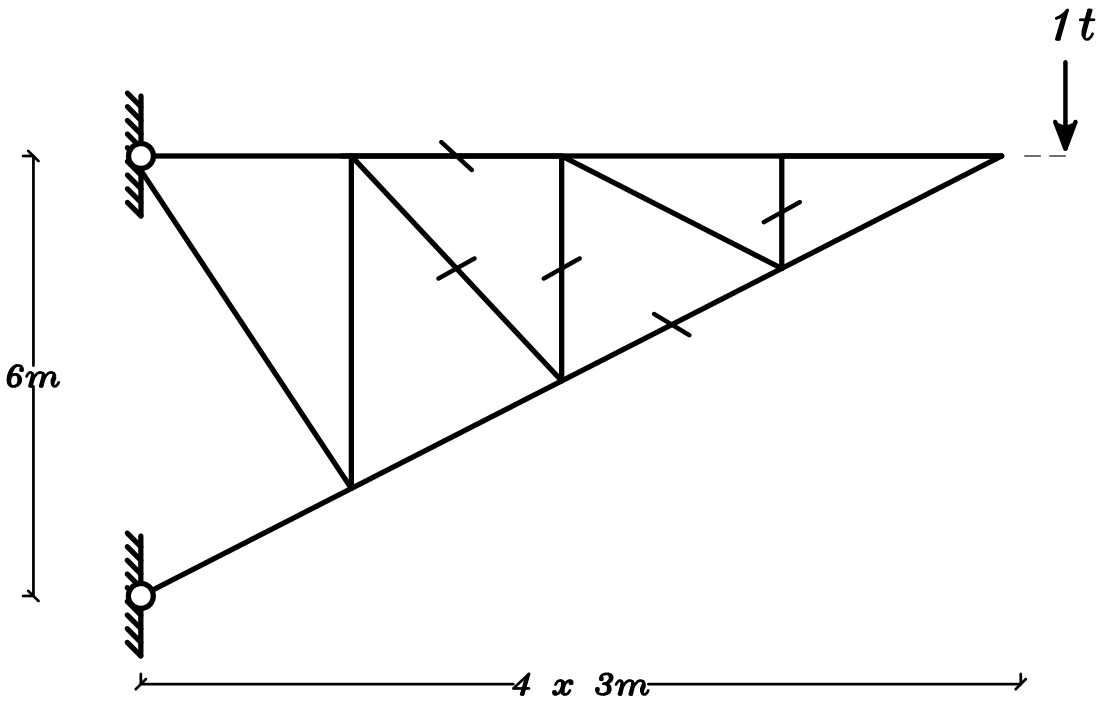
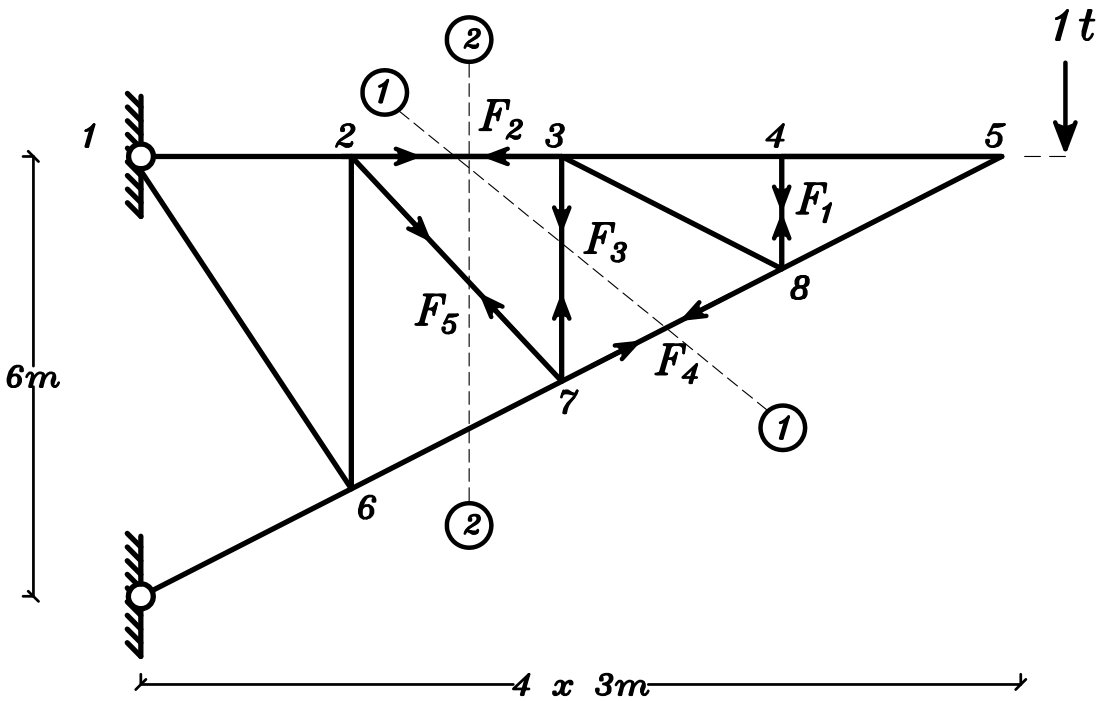


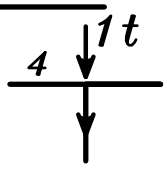


For F_1 Equilibrium of joint (4)

1ton at joint (4)

$\Sigma Y = 0$

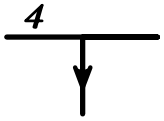
$F_1 = -1$



1ton at anywhere else

$\Sigma Y = 0$

$F_1 = 0$



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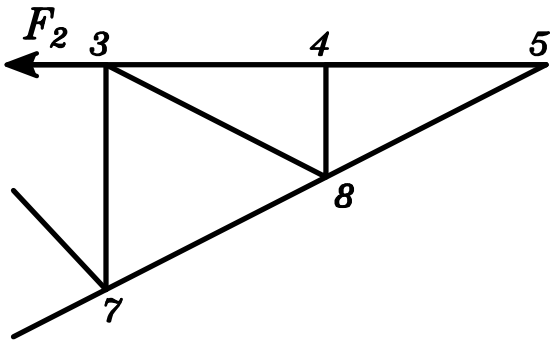
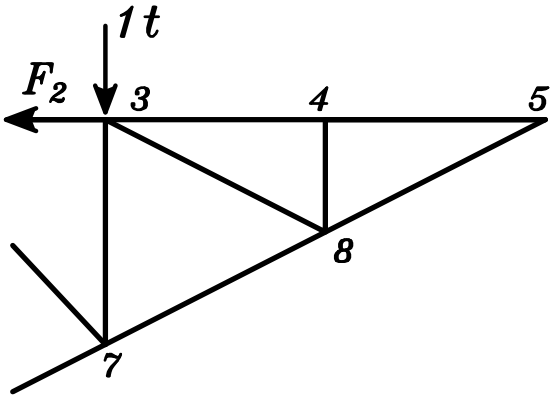
For F_2 Sec 1-1 ($\Sigma M_7 = 0$)



1ton at joint (3)

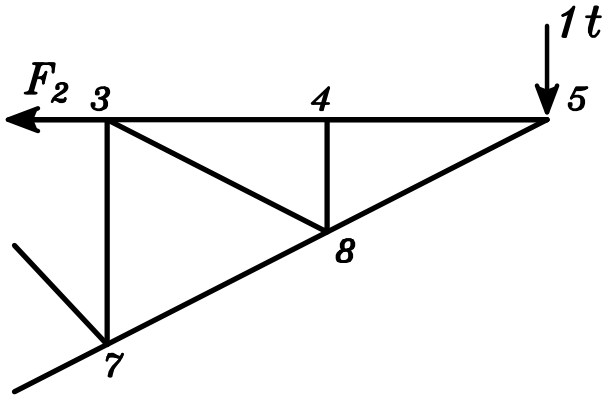


$\Sigma M_7 = 0$

$3F_2 = 0$

$F_2 = 0$

1ton at joint (5)



$\Sigma M_7 = 0$

$1x6 - 3F_2 = 0$

$F_2 = 2t$

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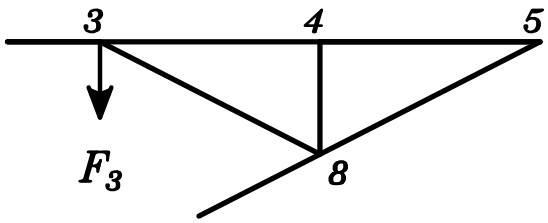
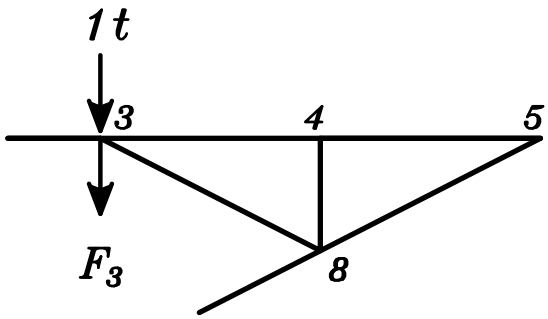
For F_3 Sec 1-1 ($\Sigma M_5 = 0$)



1ton at joint (3)

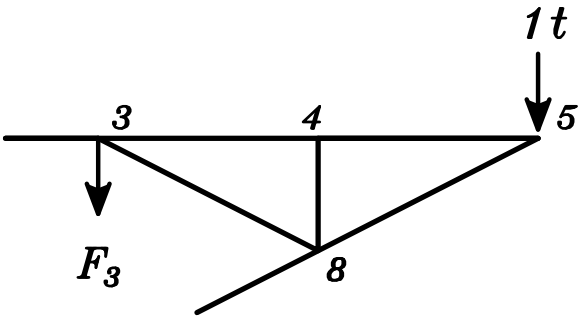


$\Sigma M_5 = 0$

$6F_3 + 1x6 = 0$

$F_3 = -1\ t$

1ton at joint (5)

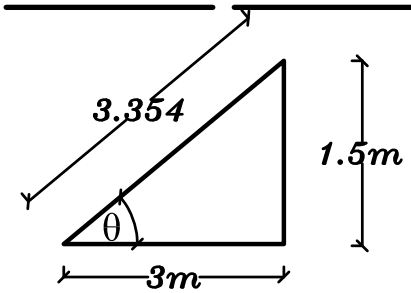


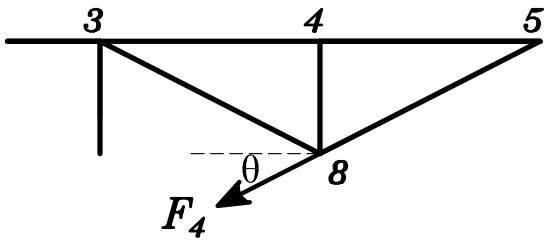
$\Sigma M_5 = 0$

$3F_3 = 0$

$F_3 = 0$

For F_4 Sec 1-1 ($\Sigma M_3 = 0$)





1ton at joint (3)

$\Sigma M_3 = 0$

$1.5xF_4\ Cos\theta + 3F_4\ Sin\theta = 0$

$F_4 = 0$

1ton at joint (5)

$\Sigma M_3 = 0$

$1.5xF_4\ Cos\theta + 3F_4\ Sin\theta + 1x6 = 0$

$F_4 = -2.236\ t$

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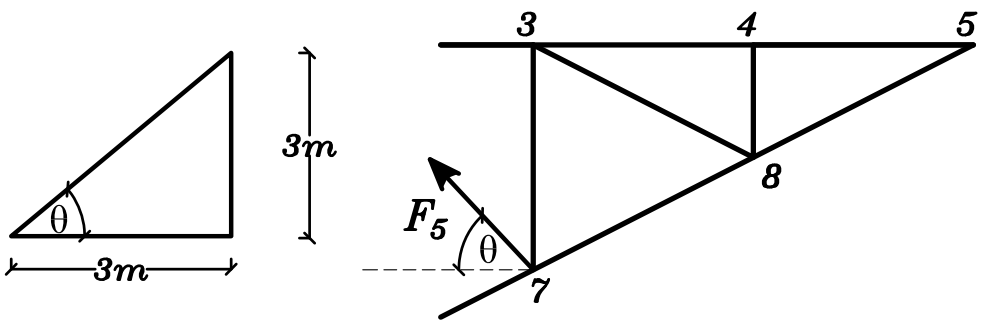
For F_5 Sec 2-2 ($\Sigma M_5 = 0$)



1ton at joint (3)

$\Sigma M_5 = 0$

$3xF_5 Cos\theta + 6F_5 Sin\theta - 1x6 = 0$

$F_5 = 0.942\ t$

1ton at joint (5)

$\Sigma M_5 = 0$

$3xF_5 Cos\theta + 6F_5 Sin\theta = 0$

$F_5 = -2.236\ t$

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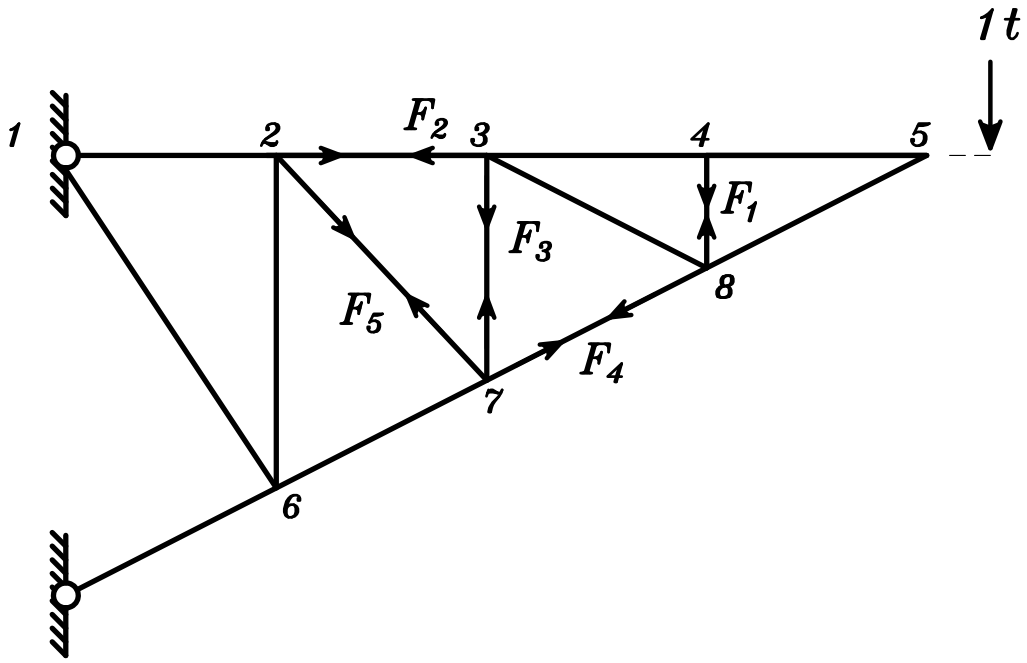

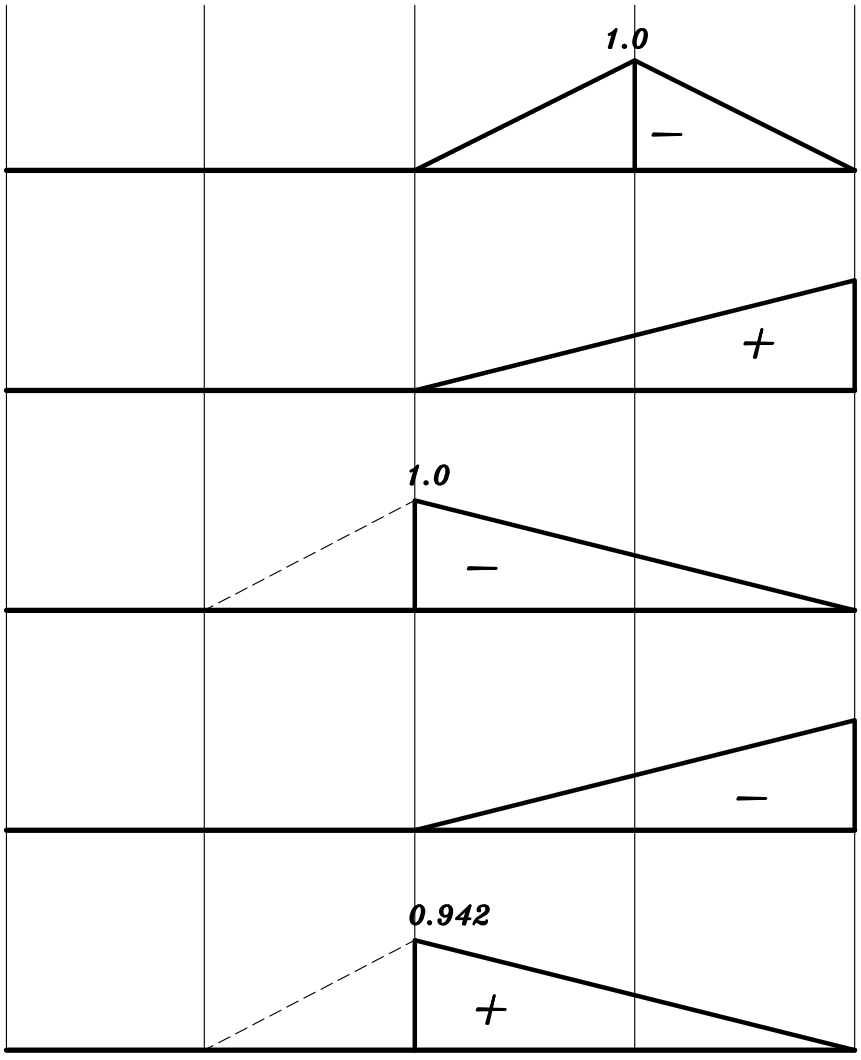

$I.L\ F_1$

$I.L\ F_2$

$I.L\ F_3$

$I.L\ F_4$

$I.L\ F_5$

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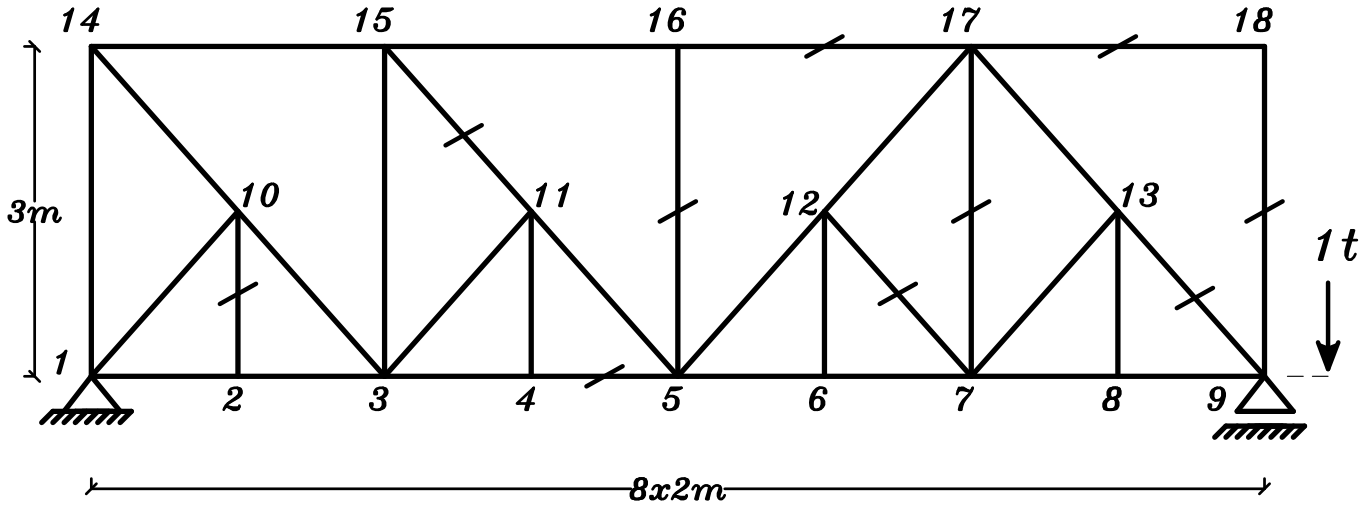

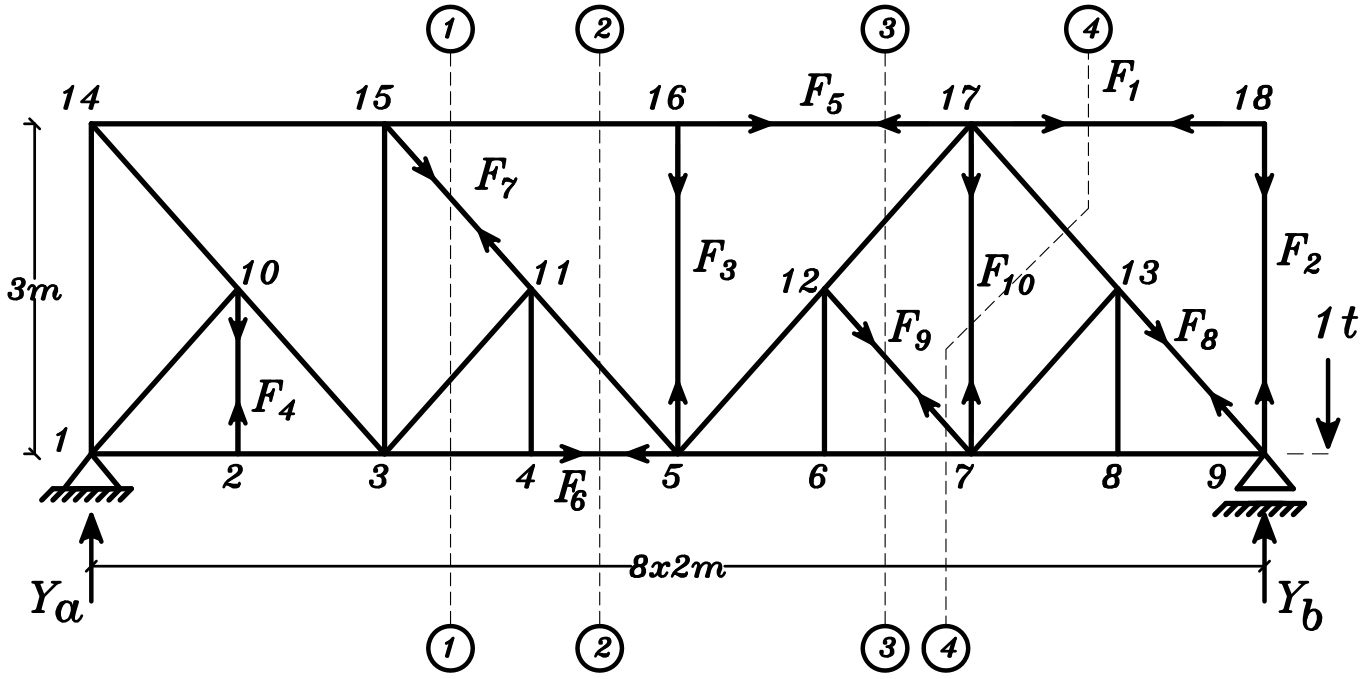

For F_1 ,F_2,F_3

Zero members if 1 ton at anywhere.

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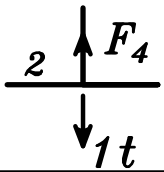
For F_4 Equilibrium of joint (2)

1ton at joint (2)

$\Sigma Y = 0$

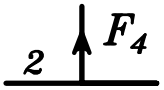
$F_4 = +1$



1ton at anywhere else

$\Sigma Y = 0$

$F_4 = 0$



For F_5 Sec 1-1 ($\Sigma M_5 = 0$)

1ton from (1-4)

$\Sigma M_{5\ right} = 0$

$8Y_b + 3F_5 = 0$

$F_5 = -2.66\ Y_b$

1ton from (5-9)

$\Sigma M_{5\ left} = 0$

$8Y_a + 3F_5 = 0$

$F_5 = -2.66Y_a$

For F_6 Sec 1-1 ($\Sigma M_{15} = 0$)

1ton from (1-4)

$\Sigma M_{15\ right} = 0$

$12Y_b - 3F_6 = 0$

$F_6 = 4\ Y_b$

1ton from (5-9)

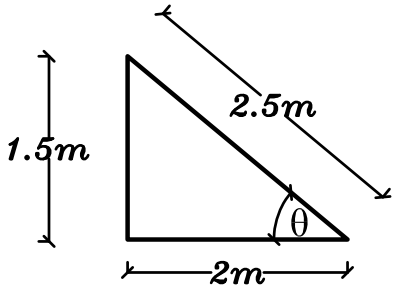
$\Sigma M_{15\ left} = 0$

$4Y_a - 3F_6 = 0$

$F_6 = 1.33Y_a$

For F_7 Sec 2-2 ($\Sigma M_3 = 0$)

$Cos\theta = 0.8$, $Sin\theta = 0.6$



1ton from (1-3)

$\Sigma M_{3\ right} = 0$

$12Y_b + 1.5x0.8F_7 + 2x0.6F_7 + 3F_5 = 0$

$F_7 = -5\ Y_b - 1.25F_5$

1ton from (4-9)

$\Sigma M_{3\ left} = 0$

$4Y_a + 3x0.8F_7 + 3F_5 = 0$

$F_7 = -1.66Y_a - 1.25F_5$

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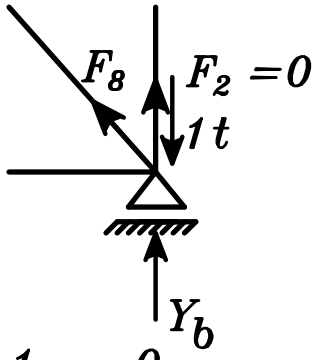
For F_8 Equilibrium of joint (9) ($\Sigma Y = 0$)

1ton at joint (9)

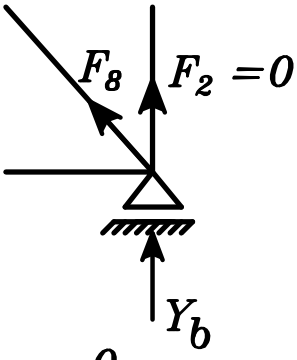


$\Sigma Y = 0$

$Y_b + 0.6F_8 - 1 = 0$

$F_8 = 1.66 (1 - Y_b)$

1ton at anywhere else



$\Sigma Y = 0$

$-Y_b + 0.6F_8 = 0$

$F_8 = -1.66Y_b$

For F_9 Sec 3-3 ($\Sigma M_5 = 0$)

1ton from (1-6)

$\Sigma M_{5\ right} = 0$

$8Y_b + 4x0.6F_9 + 3F_5 = 0$

$F_9 = -1.25\ F_5 - 3.33Y_b$

1ton from (7-9)

$\Sigma M_{5\ left} = 0$

$8Y_a + 2x0.6F_9 + 1.5x0.8F_9$

$+ 3F_5 = 0$

$F_9 = -1.25F_5 - 3.33Y_a$

For F_{10} Sec 4-4 ($\Sigma M_9 = 0$)

1ton from (1-6)

$\Sigma M_{9\ right} = 0$

$4x0.6F_9 + 4F_{10} = 0$

$F_{10} = -0.6\ F_9$

1ton from (7-9)

$\Sigma M_{9\ left} = 0$

$16Y_a - 6x0.6F_9 + 1.5x0.8F_9$

$- 4F_{10} = 0$

$F_{10} = 4Y_a - 0.6F_9$

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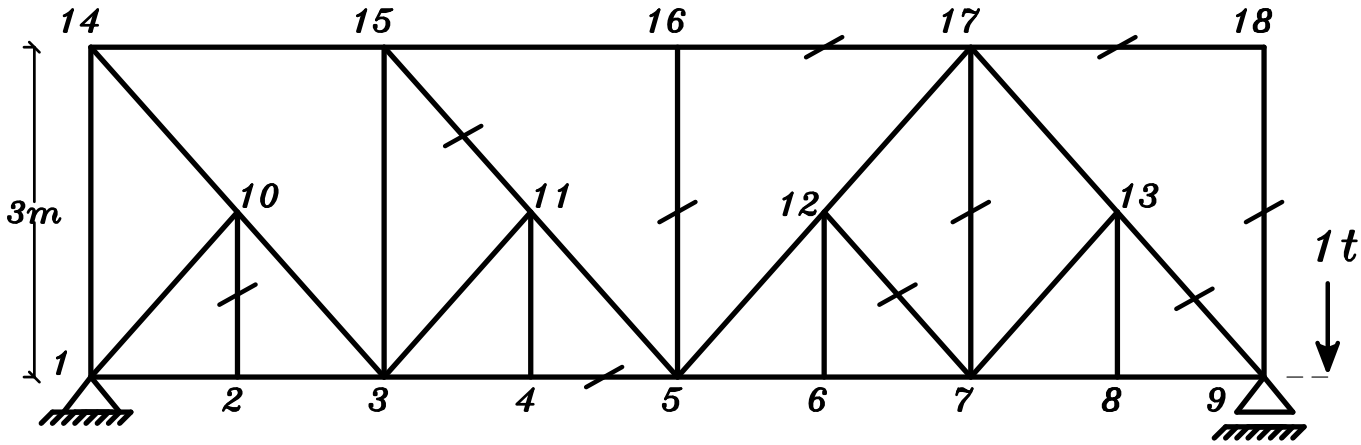

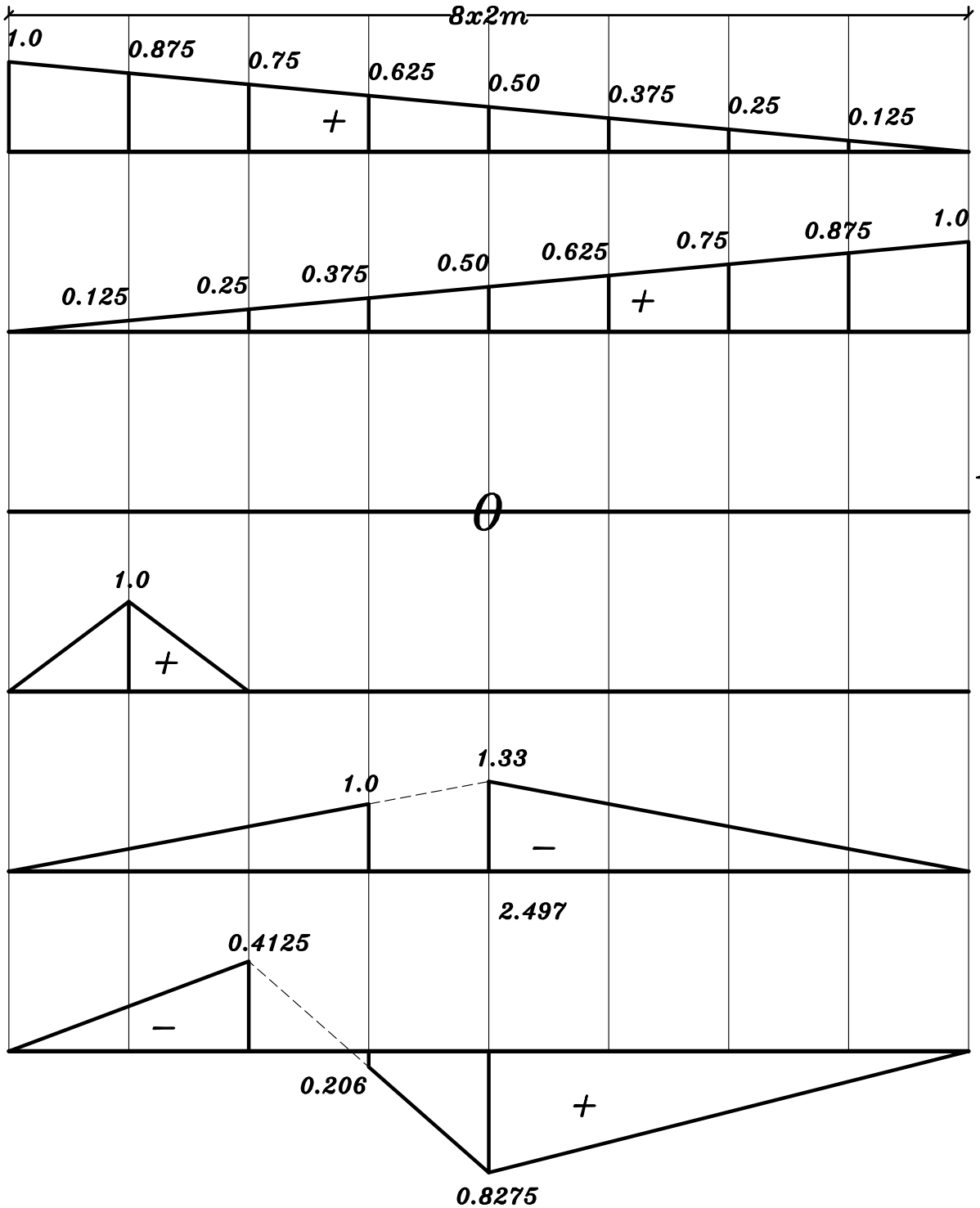

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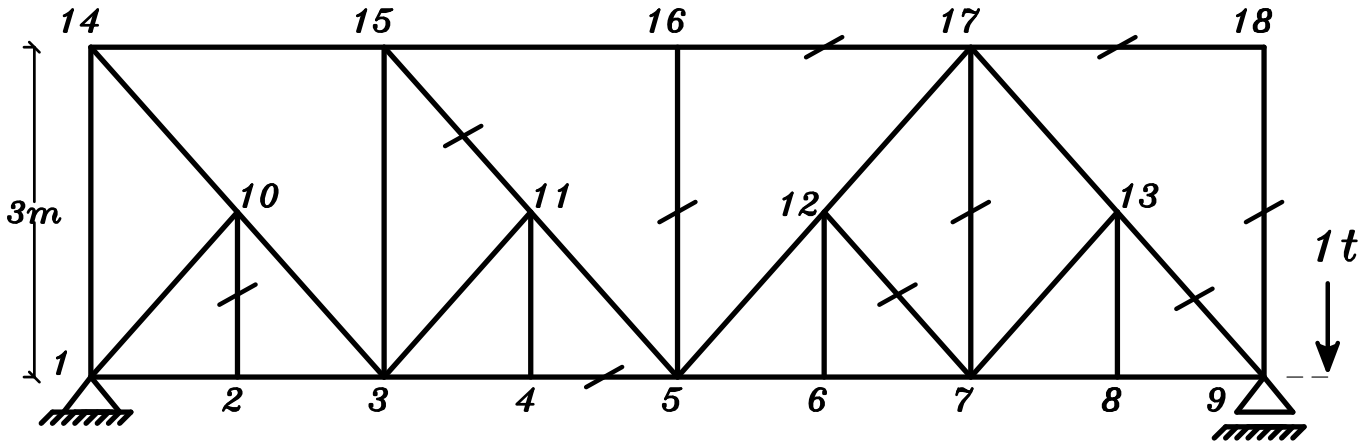

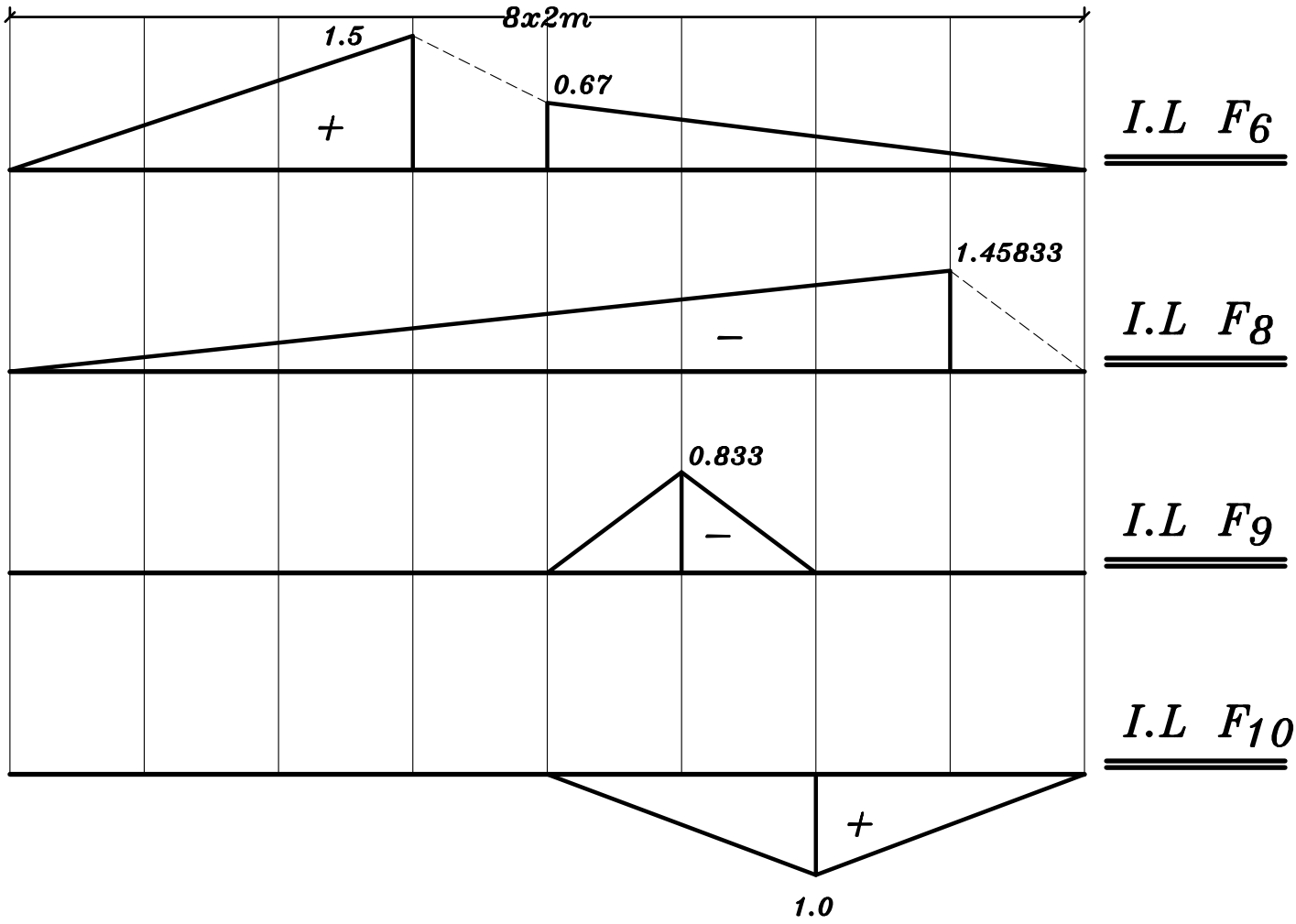

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