Introduction to Statics

.PDF Edition – Version 0.95

Unit 19
Trusses: Method of Sections

Helen Margaret Lester Plants
Late Professor Emerita
Wallace Starr Venable
Emeritus Associate Professor
West Virginia University, Morgantown, West Virginia

Unit 19
Trusses: Method of Sections

Frame 19-1

***Introduction**

In the preceding unit you learned some general facts about trusses as well as a method of solution called the "Method of Joints." In this unit, you will again use some of the facts and learn a second method of solution, the "Method of Sections." Either method can be used alone to analyze any statically determinate truss, but for real efficiency you need to be able to handle both methods alone or in combination.

Go to the next frame.

*This topic is sometimes excluded from a short statics course. Check your schedule to see if your instructor requires you to study it at this time.

Correct response to preceding frame

No response

Frame 19-2

Review

The force in any truss member acts _____ .

In any free body diagram which includes a joint, all forces acting toward the joint are

_____ .

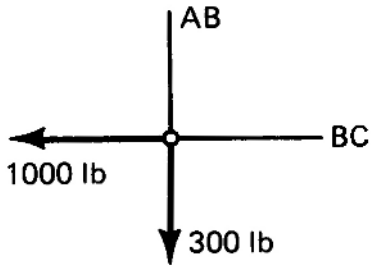
Correct response to preceding frame

along the member
compressive, compression

Frame 19-3

Review

What is the force in each of the members shown below?



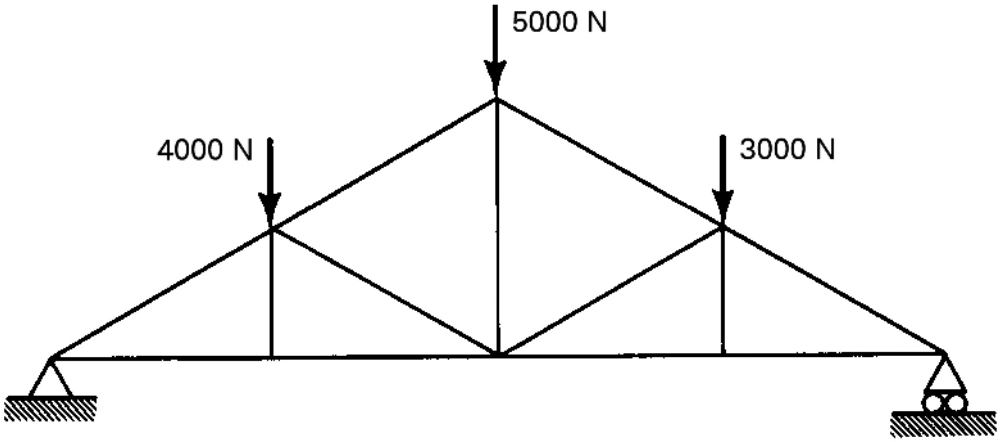
Correct response to preceding frame

```
AB = 300 lb T
BC = 1000 lb T
```

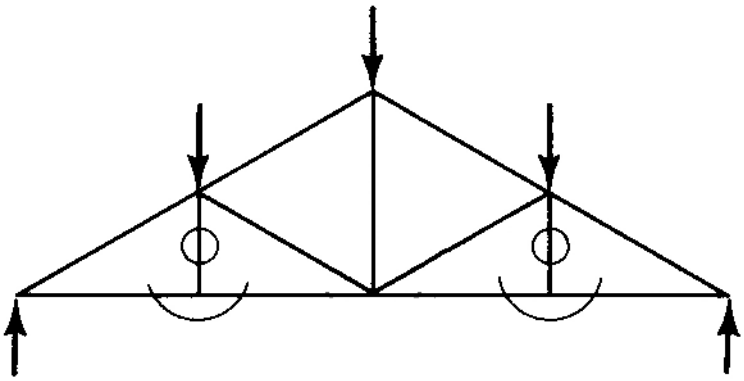
Frame 19-4

Review

In the truss below, write 0 on any unloaded members. Draw a line connecting any pairs which we know are equally loaded by the method of joints.



Correct response to preceding frame



Frame 19-5

Method of Sections

The method of sections is most effectively employed when one wishes to know the loads in only a few members of a truss. (If you want them in all members you may as well use the method of joints and considerable patience.) It hinges on dividing the truss into two parts and then considering a free body diagram of one part or the other, often employing $\sum \overline{M}_0 = 0$ to solve.

Go to the next frame.

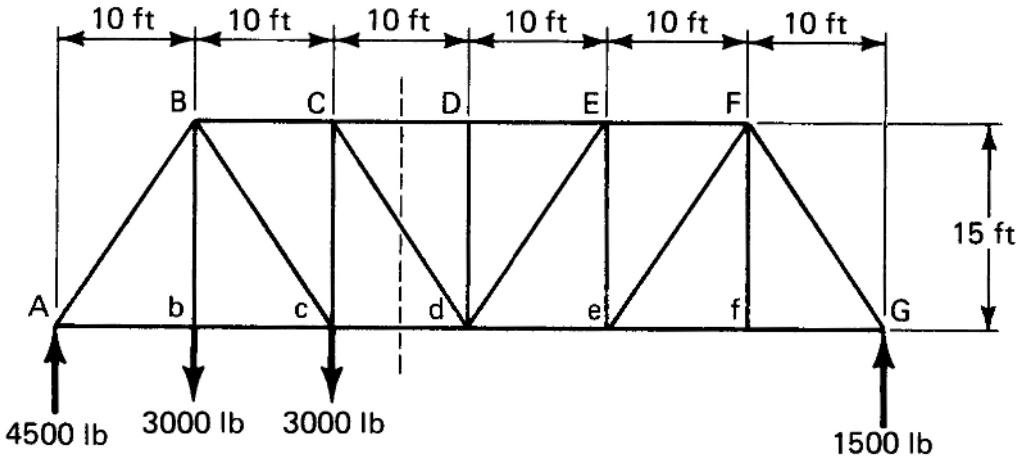
Correct response to preceding frame

No response

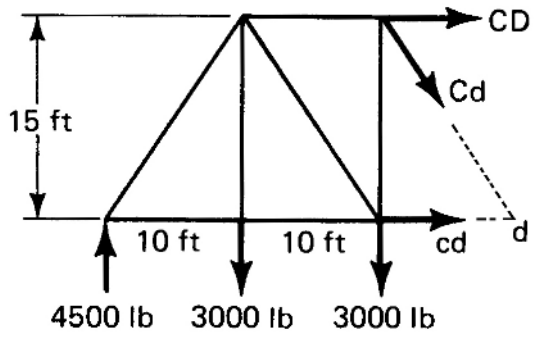
Frame 19-6

Procedure

To find the forces in members CD, Cd and cd follow the procedure below.



First draw a line, such as the dashed line above, through as many as possible of the members in question. Then draw a free body of everything on one side or the other, replacing the cut members by the forces acting in them. Guess a sense for any force whose sense is unknown. Then solve by taking the sum of the moments about a convenient point or by summing forces.



To find CD

$\sum \overline{M}_d = 0$ gives
CD = – 3000 (wrong guess about sense, but that's OK)
CD = 3000 lb C

Now write $\sum \overline{M}_c = 0$ and find cd .

Note: About the sense of forces... I always choose to draw an unknown force as tension. Then if it comes out minus I know it is compression. This is common practice but not the eleventh commandment.

Correct response to preceding frame

cd = 4000 lb T

Solution:

$(-15\bar{j} \times cd\bar{i}) + (-20\bar{i} \times 4500\bar{j}) + (-10\bar{i} \times -3000\bar{j}) = 0$

$(15cd - 90000 + 30000)\,\bar{k} = 0$

cd = 6000 - 2000

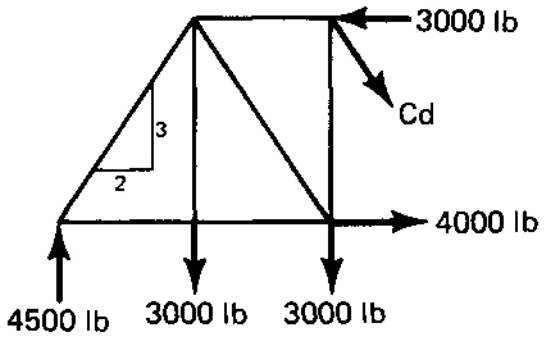
cd = 4000 as assumed

cd = 4000 lb T

Frame 19-7

Completion of Section

The findings from the preceding frame are shown below. Use $\Sigma\bar{F} = 0$ to find Cd.



Correct response to preceding frame

$Cd = 500\sqrt{13} = 1800$ lb C

Solution:

$$Cd\,\frac{(2i - 3j)}{\sqrt{13}} + 1000\bar{i} - 1500\bar{j} = 0$$

$\bar{i}$ equation

$$\frac{2Cd}{\sqrt{13}} = -1000 \text{ (wrong guess)}$$

$$Cd = 500\sqrt{13} = 1803 \text{ lb C}$$

or

$\bar{j}$ equation

$$\frac{-3Cd}{\sqrt{13}} = 1500$$

$$Cd = 500\sqrt{13} \text{ C as before}$$

Frame 19-8

Transition

That's how the method works. Clever, what?

To make it work for you, the first step is to learn to draw a correct FBD and to select a convenient moment center. To these aims the next several frames are directed.

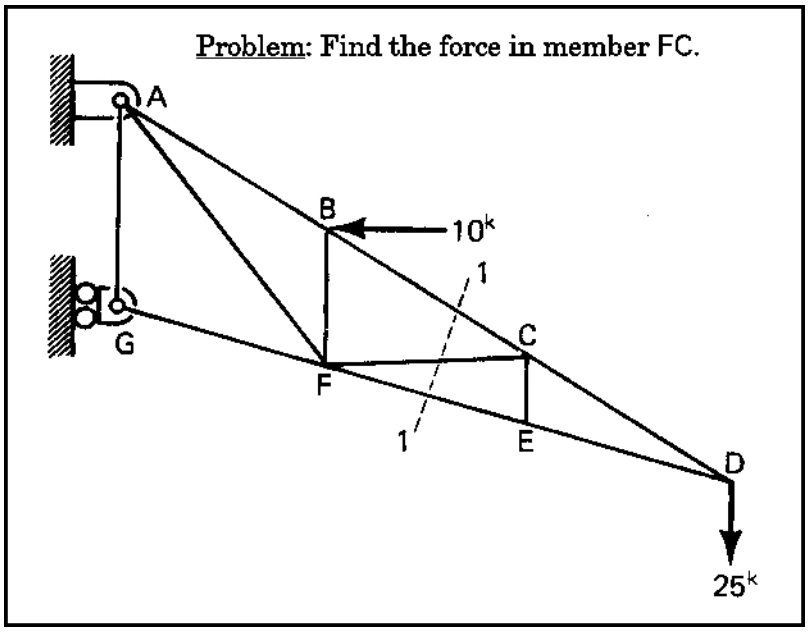
Go to the next frame.

Correct response to preceding frame

No response

Frame 19-9

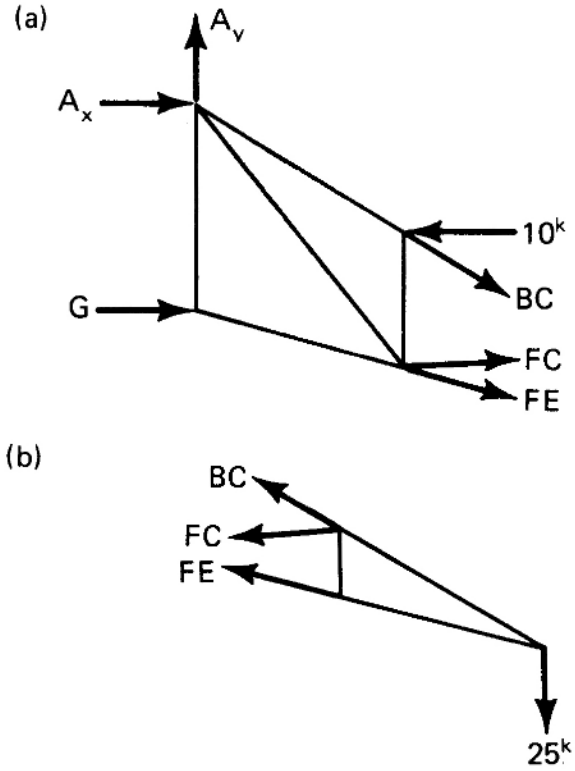
Free Body Diagrams



To solve this problem by the method of sections, you pass a section (indicated by a line) through three members of the truss, one of which is the desired member.

The next step is to draw a free body of one part or the other indicating all known and unknown forces.

Here are the free bodies resulting from section 1-1 above.



Which is easier to solve for FC ?

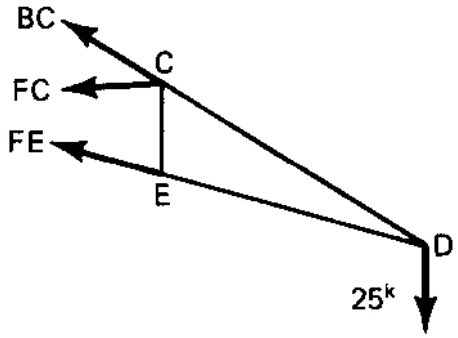
☐ (a) ☐ (b)

Correct response to preceding frame

(b) is easier
(To solve (a) it would first be necessary to find A_x, A_y, and G .)

Frame 19-10

Moment Center



1. In the free body above, one can find the force in FC directly by taking moments about point _____ .

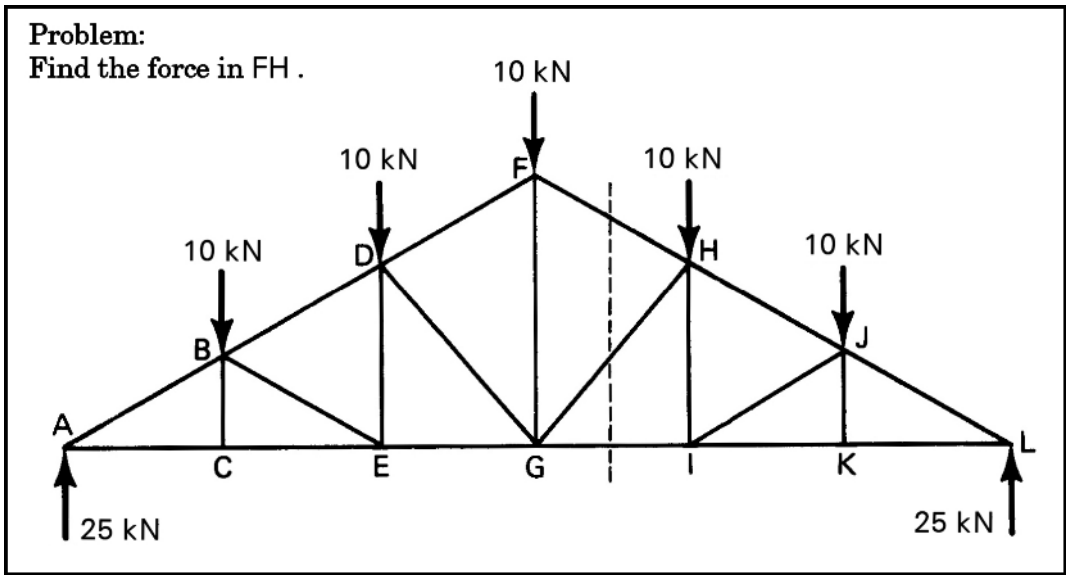
2. Find FC .

Correct response to preceding frame

point D
FC = 0

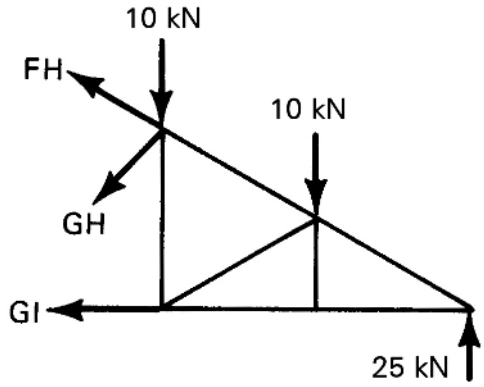
Frame 19-11

Free Body Diagrams



The section that should be used is indicated on the truss. Decide which side of the section will give the easier solution and draw a free body of it. Then say where you would take moments to find FH .

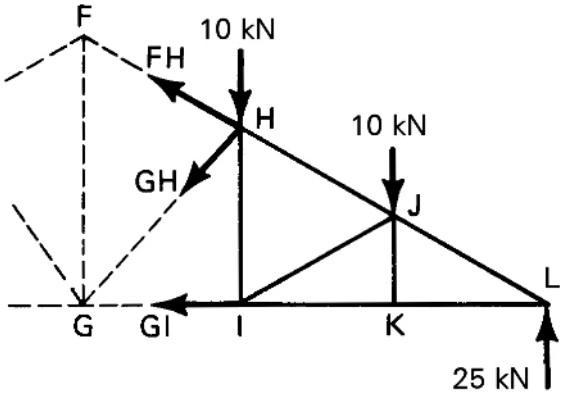
Correct response to preceding frame



(Senses of unknown forces were chosen arbitrarily as tension.)
Take $\sum \overline{M}_G = 0$ to find FH .

Frame 19-12

Moment Centers



About what point would you take moments to find GI? _____

To find GH ? _____

Suppose you knew GI . How could you find FH and GH without taking moments?

_____

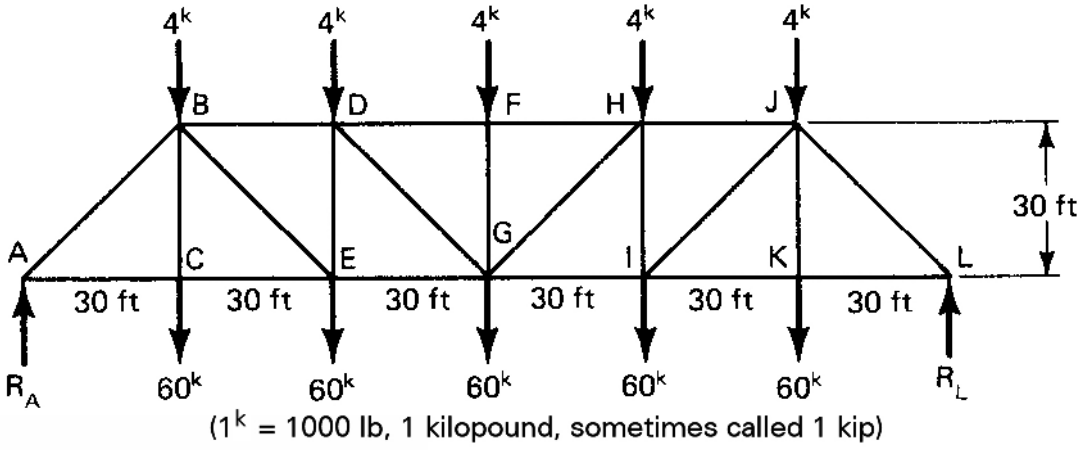
_____

Correct response to preceding frame

To find GI $\Sigma \overline{M}_F = 0$
To find GH $\Sigma \overline{M}_L = 0$
$\Sigma \overline{F} = 0$ will give the solution if only two forces are unknown.

Frame 19-13

Free Body Diagram

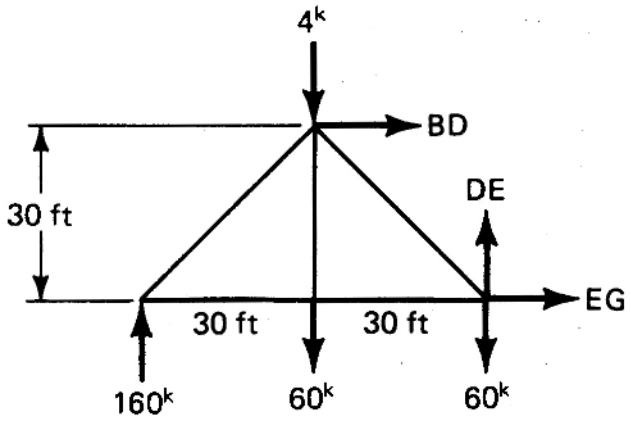


(1k = 1000 lb, 1 kilopound, sometimes called 1 kip)

Find the reactions on the truss shown, by using a free body of the whole truss. Select a section and draw a FBD to find the force in member DE. (There is no rule that says the section selected must be vertical, or even straight, but to be useful it must usually cut no more than three unknown members.)

Correct response to preceding frame

$R_A = R_L = 160^k$



Frame 19-14

Solution

1. Using the free body above, find DE .

2. Select a moment center and find BD .

3. Now find EG .

Correct response to preceding frame

$DE = 36^{k}_{C}$

$BD = 256^{k}_{C}$

$EG = 256^{k}_{T}$

Solution:

1. $\Sigma\overline{F} = 0$

$$160\overline{j} - 2(60)\overline{j} - 4\overline{j} + DE\overline{j} + BD\overline{i} + EG\overline{i} = 0$$

$$160 - 120 - 4 + DE = 0$$

$$DE = -36 \text{ (wrong guess)}$$

$$DE = 36^{k}_{C}$$

2. $\Sigma\overline{M}_{E} = 0$

$$-160(60)\overline{k} + 64(30)\overline{k} - 30\ BD\overline{k} = 0$$

$$BD = -256$$

$$BD = 256^{k}_{C}$$

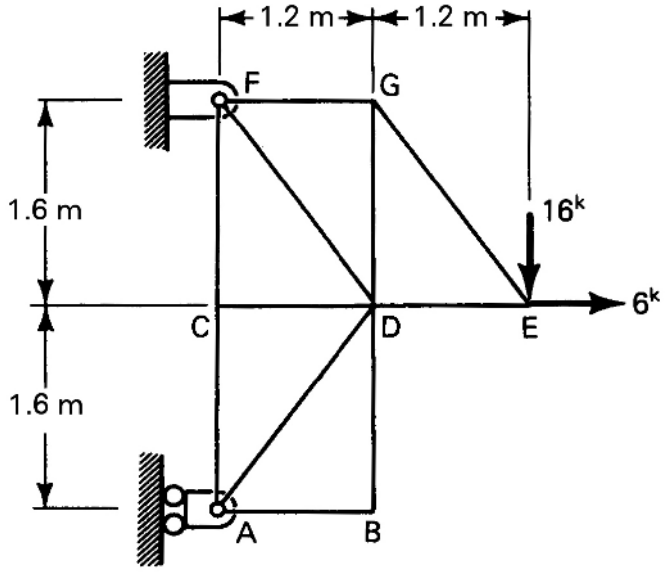
3. From $\Sigma\overline{F} = 0$

$$EG = -BD$$

$$EG = 256^{k}_{T}$$

Frame 19-15

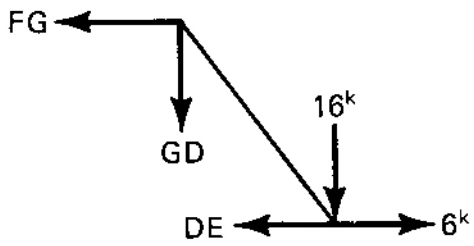
Method of Sections



Using the method of sections, find the force in FG .

Correct response to preceding frame

$FG = 12^{k}T$ **Solution:**



$$\bar{M}_D = 0$$

$$1.6\bar{j} \times -FG\bar{i} + 1.2\bar{i} \times -16\bar{j} = 0$$

$$0 = 1.6FG\bar{k} - 1.2(16)\bar{k}$$

$$FG = 12 \text{ (right guess)}$$

$$FG = 12^{k}T$$

Frame 19-16

Transition

Okay, that covers the ground. You have learned how to draw the free bodies and write the equations involved in solving trusses by the method of sections.

The only thing that remains is a little practice in problems involving numbers. In the problems that follow your solution may vary in details from mine. (It may, in fact, be cleverer.) However the end results should be the same.

Go to the next frame.

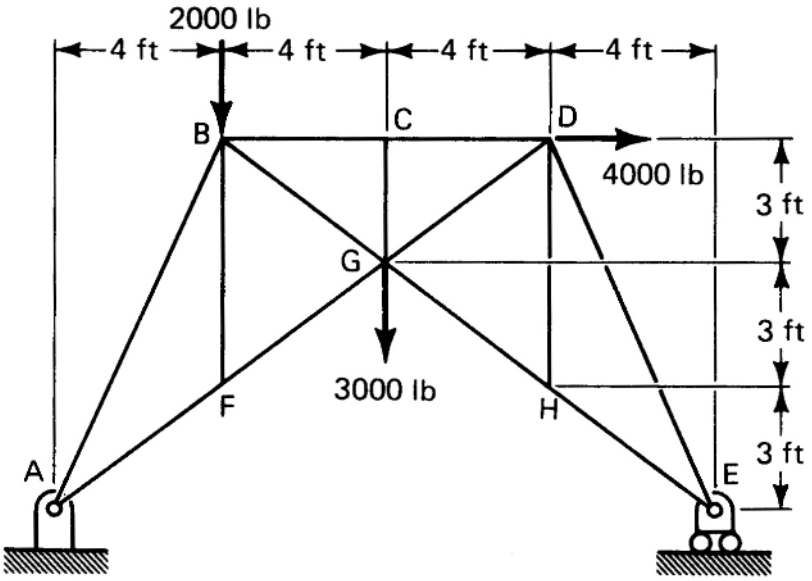
Correct response to preceding frame

No response

Frame 19-17

Truss Analysis

Be alert to the possibility of using both the method of joints and the method of sections in this problem.



Find the reactions at A and E . Find the forces in BC , BF , and FG .

Correct response to preceding frame

$\bar{A}_x = -4000\bar{i}$

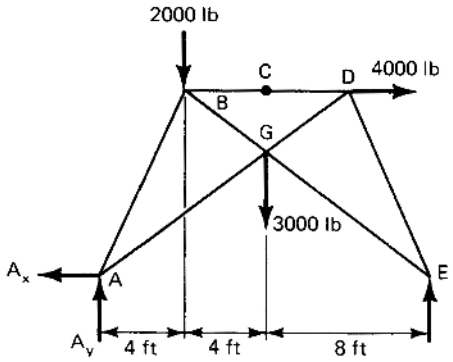
$\bar{A}_y = 750\bar{j}$

BC = 7333 lb C

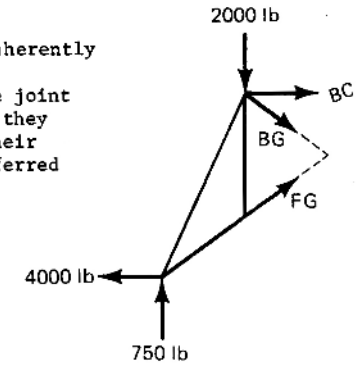
BF = 0

FG = 8125 lb T

Solution:



Note:
Reactions are neither inherently tension or compression since the details of the joint are unknown. Therefore they must be identified by their vector directions as referred to the FBD of the truss.



By inspection of joint F, BF = 0

$\Sigma\bar{M}_A = 0$

$16E - 9(4000) - 4(2000) - 8(3000) = 0$

$\bar{E} = 4250\bar{j}$

$\Sigma\bar{F} = 0$

$\bar{A}_x = -4000\bar{i}$

$\bar{A}_y = 750\bar{j}$

$\Sigma\bar{M}_G = 0$ gives BC = 7333 lb C

$\Sigma\bar{M}_B = 0$

$$-6\bar{j} \times FG\left(\frac{4}{5}\bar{i} + \frac{3}{5}\bar{j}\right) + \left(-9\bar{j} \times -4000\bar{i}\right) + \left(-4\bar{i} \times 750\bar{j}\right) = 0$$

FG = 8125 lb T

Frame 19-18

Notebook

Complete page 19-1 of your notebook.

Correct response to preceding frame
There are no zero force members in this truss.
AB = 8^k C
BD = 8^k C
DE = 9^k T
CE = 15^k T

Frame 19-19

Summary

That completes the study of trusses. Nothing really new, you see, but nice applications of earlier work.

You have studied the method of joints, which is well suited to finding the forces in many members, particularly if they occur sequentially. With patience it will yield all forces in the truss. In addition you have learned to use the method of sections, which is best suited to solving single members or groups of members near the center of the truss.

Historically, practicing Civil Engineers used a third method - graphical analysis - which is probably easier than either of the others when one wishes to find all the forces in all the members. Most people prefer it to the method of joints for such problems.

Unfortunately, it is beyond the objectives of these units. However, cheer up: If you do much work with trusses, someone will insist on teaching it to you. If you don't do much work with trusses, you'll never need it.

Today a practicing structural engineer would probably have a package of computer programs which would handle truss programs, but if you only have one or two problems to solve the cost of the programs, and the time needed to purchase and learn them,

With what you have learned in these units you should be able to analyze any truss you need to, and do so with fair efficiency. That should be enough to please us both.