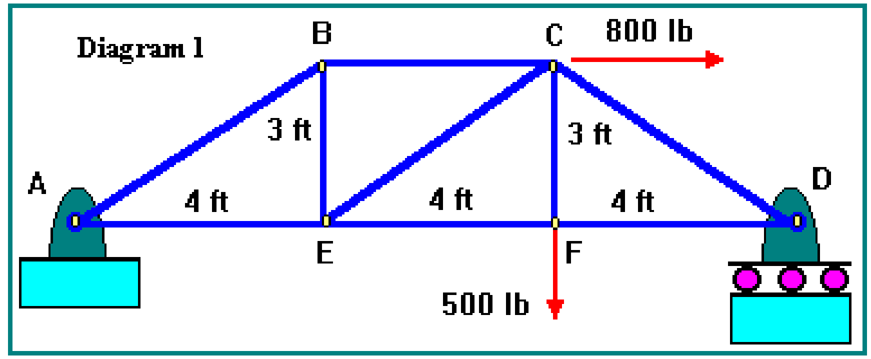
Method of Joints & Unit Load Method

Method of Joints

- The Method of Joints a technique for finding the internal forces acting within a truss.
- It works under the assumption that all the members are pin-connected, making them two force members.
- Equations of static equilibrium can then be written for each pinned joint, and the set of equations can be solved simultaneously to find the forces acting in the members.
- The biggest problem with the method of joints is the amount of work that goes into computing each member's force.

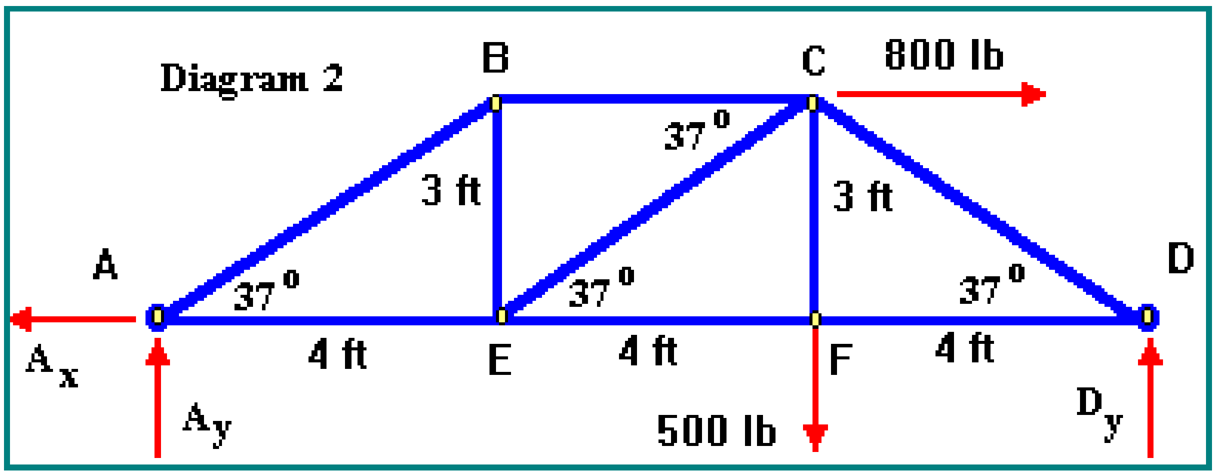
Example



- A truss supported by a pinned joint at Point A and supported by a roller at point D.
- A vertical load of 500 lb. acts at point F, and a horizontal load of 800 lb. acts at Point C.
- For this structure we wish to determine the values of the support reactions, and the force (tension/compression) in members BE, BC, and EF.

Solution

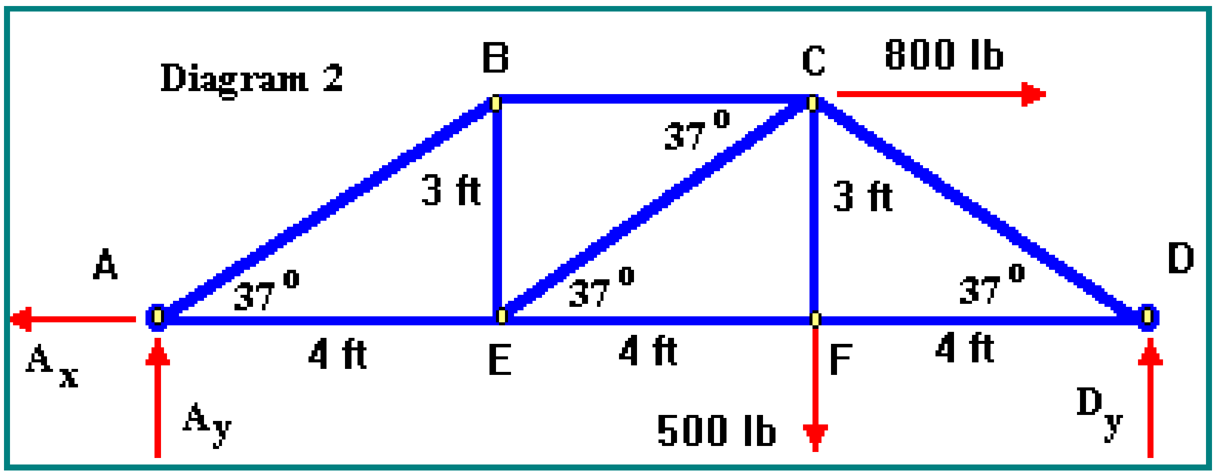
- Draw a Free Body Diagram of the entire structure showing and labeling all external load forces and support forces, include any needed dimensions and angles.



Solution Continued

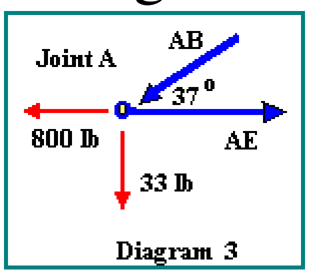
- Apply the Equilibrium Equations

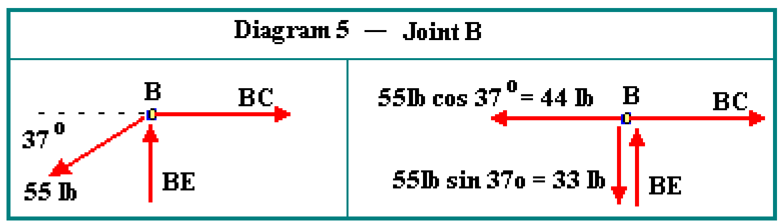
A_x = 800 lb, A_y = -33 lb, D_y = 533 lb

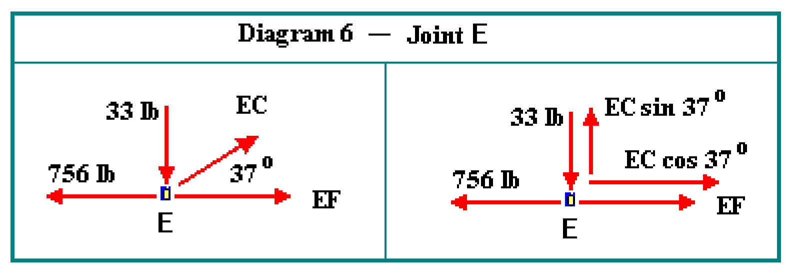


Solution Continued

- In Method of Joints, we examine the joint (pin or hinge) where members come together.
- To solve completely for the forces acting on a joints we must have a joint which has, at most, two unknown forces acting.







Unit Load Method

- The method of virtual work (unit-load method), is one of the several techniques available that can be used to solve for displacements and rotations at any point on a structure.
- The virtual work method can be used to determine the deflection of trusses. We know from the principle of virtual work for trusses that the deflection can be calculated by the equation

$$1(\Delta) = \sum n(\delta)$$

Unit Load Method Continued

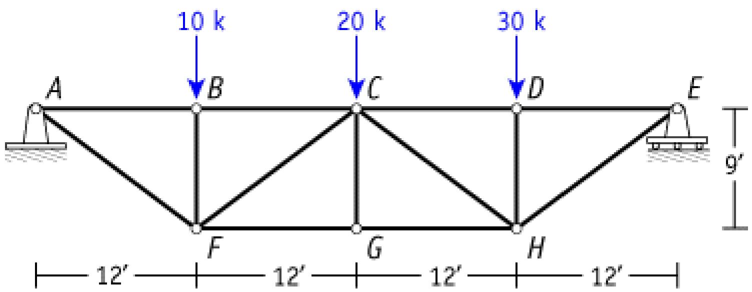
- This change in length can be caused by the applied loads acting on each member, temperature changes, and by fabrication errors.

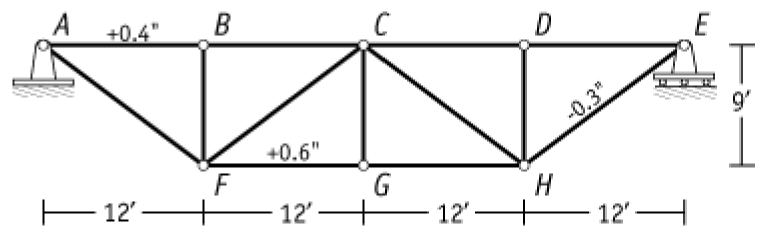
- Axial Deformation: $\delta = \dfrac{NL}{AE} \rightarrow 1(\Delta) = \sum_{i=1}^{i=m} \dfrac{n_i N_i L_i}{A_i E_i}$

- Temperature Changes: $\delta = \alpha(\Delta T)L \rightarrow 1(\Delta) = \sum_{i=1}^{i=j} n_i \alpha_i (\Delta T_i) L_i$

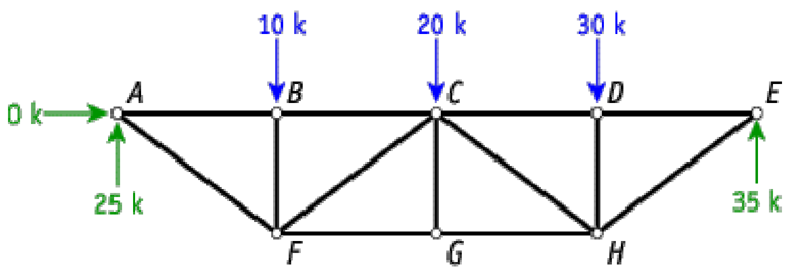
- Fabrication Errors: $1(\Delta) = \sum_{i=1}^{i=k} n_i (\delta_i)$

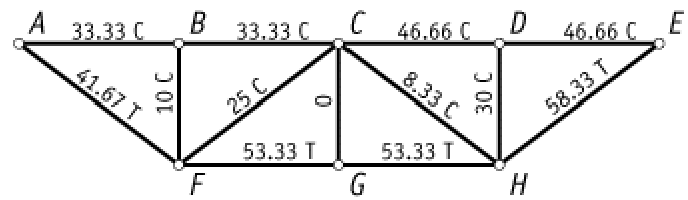
Example



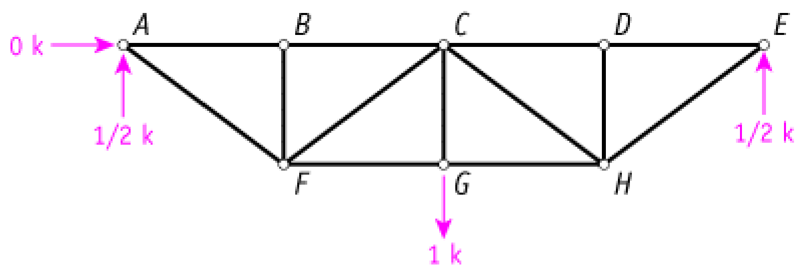


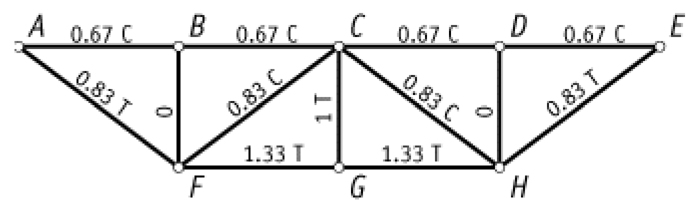
fabrication errors are present





Example Continued





Member	n(k)	Change in Length (δ) (in)	n(δ)(k-in)
AB	-0.67	+ 0.4	-0.268
FG	1.33	+ 0.6	0.798
HE	0.83	- 0.3	-0.249
		Sum	0.281

Member	n(k)	N(k)	L(in)	AE (in^2-ksi)	nNL/AE (in-k)
AB	-0.67	-33.33	48	58000	0.0184
BC	-0.67	-33.33	48	58000	0.0184
CD	-0.67	-46.66	48	58000	0.0257
DE	-0.67	-46.66	48	58000	0.0257
AF	0.83	41.67	60	58000	0.0359
BF	0	-10	36	58000	0
CF	-0.83	-25	60	58000	0.0216
FG	1.33	53.33	48	58000	0.0589
CG	1	0	36	58000	0
CH	-0.83	-8.33	60	58000	0.0072
GH	1.33	53.33	48	58000	0.0589
DH	0	-30	36	58000	0
HE	0.83	58.33	60	58000	0.0503
				Total	0.3209

Finite Element Method

The finite element method (FEM) is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as of integral equations. The solution approach is based either on eliminating the differential equation completely (steady state problems), or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically integrated using standard techniques such as Euler's method, Runge-Kutta, etc.