بسمه تعالی

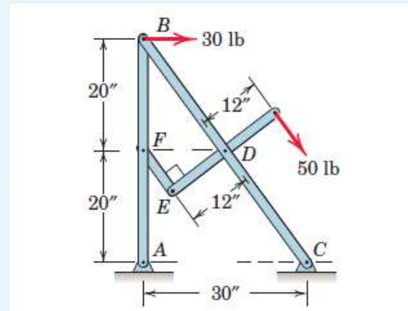
مبحث قابها و ماشینها

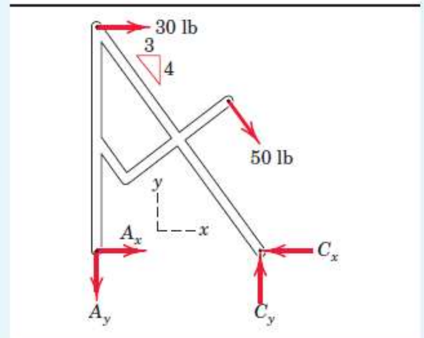
This "jaws-of-life" machine is used by rescuers to pry apart wreckage.

مثالهای تکمیلی:

SAMPLE PROBLEM 4/7

Neglect the weight of the frame and compute the forces acting on all of its members.





Solution. We note first that the frame is not a rigid unit when removed from (1) its supports since $BDEF$ is a movable quadrilateral and not a rigid triangle. Consequently the external reactions cannot be completely determined until the individual members are analyzed. However, we can determine the vertical components of the reactions at A and C from the free-body diagram of the frame (2) as a whole. Thus,

$[\Sigma M_C = 0]$ $\quad 50(12) + 30(40) - 30A_y = 0 \quad A_y = 60$ lb *Ans.*

$[\Sigma F_y = 0]$ $\quad C_y - 50(4/5) - 60 = 0 \quad C_y = 100$ lb *Ans.*

Next we dismember the frame and draw the free-body diagram of each part. Since EF is a two-force member, the direction of the force at E on ED and at F on AB is known. We assume that the 30-lb force is applied to the pin as a part of (3) member BC. There should be no difficulty in assigning the correct directions for forces E, F, D, and B_x. The direction of B_y, however, may not be assigned by inspection and therefore is arbitrarily shown as downward on AB and upward on BC.

Member ED. The two unknowns are easily obtained by

$[\Sigma M_D = 0]$ $\quad 50(12) - 12E = 0 \quad E = 50$ lb *Ans.*

$[\Sigma F = 0]$ $\quad D - 50 - 50 = 0 \quad D = 100$ lb *Ans.*

Member EF. Clearly F is equal and opposite to E with the magnitude of 50 lb.

Member AB. Since F is now known, we solve for B_x, A_x, and B_y from

$[\Sigma M_A = 0]$ $\quad 50(3/5)(20) - B_x(40) = 0 \quad B_x = 15$ lb *Ans.*

$[\Sigma F_x = 0]$ $\quad A_x + 15 - 50(3/5) = 0 \quad A_x = 15$ lb *Ans.*

$[\Sigma F_y = 0]$ $\quad 50(4/5) - 60 - B_y = 0 \quad B_y = -20$ lb *Ans.*

The minus sign shows that we assigned B_y in the wrong direction.

Member BC. The results for B_x, B_y, and D are now transferred to BC, and the (4) remaining unknown C_x is found from

$[\Sigma F_x = 0]$ $\quad 30 + 100(3/5) - 15 - C_x = 0 \quad C_x = 75$ lb *Ans.*

We may apply the remaining two equilibrium equations as a check. Thus,

$[\Sigma F_y = 0]$ $\quad 100 + (-20) - 100(4/5) = 0$

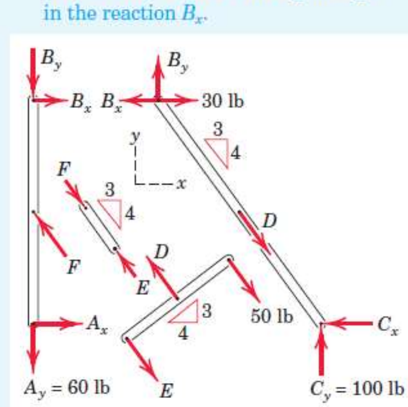
$[\Sigma M_C = 0]$ $\quad (30 - 15)(40) + (-20)(30) = 0$

Helpful Hints

(1) We see that this frame corresponds to the category illustrated in Fig. 4/14*b*.

(2) The directions of A_x and C_x are not obvious initially and can be assigned arbitrarily, to be corrected later if necessary.

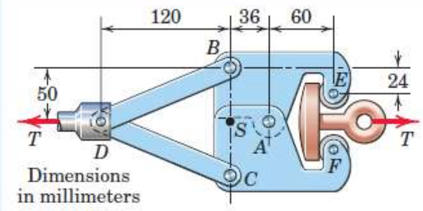
(3) Alternatively the 30-lb force could be applied to the pin considered a part of BA, with a resulting change in the reaction B_x.

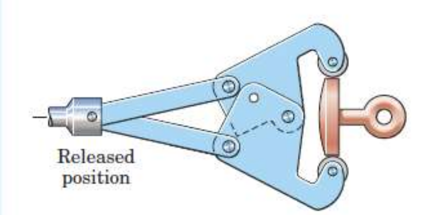


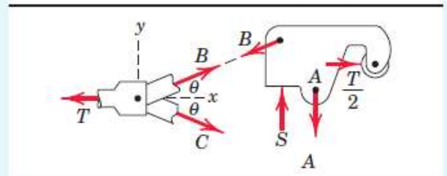
(4) Alternatively we could have returned to the free-body diagram of the frame as a whole and found C_x.

SAMPLE PROBLEM 4/8

The machine shown is designed as an overload protection device which releases the load when it exceeds a predetermined value T. A soft metal shear pin S is inserted in a hole in the lower half and is acted on by the upper half. When the total force on the pin exceeds its strength, it will break. The two halves then rotate about A under the action of the tensions in BD and CD, as shown in the second sketch, and rollers E and F release the eye bolt. Determine the maximum allowable tension T if the pin S will shear when the total force on it is 800 N. Also compute the corresponding force on the hinge pin A.







Solution. Because of symmetry we analyze only one of the two hinged members. The upper part is chosen, and its free-body diagram along with that for the connection at D is drawn. Because of symmetry the forces at S and A have no ① x-components. The two-force members BD and CD exert forces of equal magnitude $B = C$ on the connection at D. Equilibrium of the connection gives

$[\Sigma F_x = 0]$ $\qquad B\cos\theta + C\cos\theta - T = 0 \qquad 2B\cos\theta = T$

$$B = T/(2\cos\theta)$$

From the free-body diagram of the upper part we express the equilibrium of moments about point A. Substituting $S = 800$ N and the expression for B gives

② $[\Sigma M_A = 0]$ $\qquad \dfrac{T}{2\cos\theta}(\cos\theta)(50) + \dfrac{T}{2\cos\theta}(\sin\theta)(36) - 36(800) - \dfrac{T}{2}(26) = 0$

Substituting $\sin\theta/\cos\theta = \tan\theta = 5/12$ and solving for T give

$$T\left(25 + \frac{5(36)}{2(12)} - 13\right) = 28\,800$$

$$T = 1477\text{ N} \qquad \text{or} \qquad T = 1.477\text{ kN} \qquad \textit{Ans.}$$

Finally, equilibrium in the y-direction gives us

$[\Sigma F_y = 0]$ $\qquad S - B\sin\theta - A = 0$

$$800 - \frac{1477}{2(12/13)}\frac{5}{13} - A = 0 \qquad A = 492\text{ N} \qquad \textit{Ans.}$$

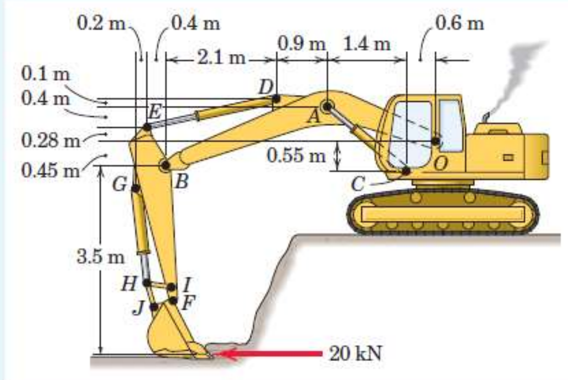
Helpful Hints

① It is always useful to recognize symmetry. Here it tells us that the forces acting on the two parts behave as mirror images of each other with respect to the x-axis. Thus, we cannot have an action on one member in the plus x-direction and its reaction on the other member in the negative x-direction. Consequently the forces at S and A have no x-components.

② Be careful not to forget the moment of the y-component of B. Note that our units here are newton-millimeters.

SAMPLE PROBLEM 4/9

In the particular position shown, the excavator applies a 20-kN force parallel to the ground. There are two hydraulic cylinders AC to control the arm OAB and a single cylinder DE to control arm $EBIF$. (a) Determine the force in the hydraulic cylinders AC and the pressure p_{AC} against their pistons, which have an effective diameter of 95 mm. (b) Also determine the force in hydraulic cylinder DE and the pressure p_{DE} against its 105-mm-diameter piston. Neglect the weights of the members compared with the effects of the 20-kN force.



Solution. (a) We begin by constructing a free-body diagram of the entire arm assembly. Note that we include only the dimensions necessary for this portion of the problem—details of the cylinders DE and GH are unnecessary at this time.

$[\Sigma M_O = 0]$ $\quad -20\,000(3.95) - 2F_{AC} \cos 41.3°(0.68) + 2F_{AC} \sin 41.3°(2) = 0$

$$F_{AC} = 48\,800 \text{ N or } 48.8 \text{ kN} \qquad \textit{Ans.}$$

From $F_{AC} = p_{AC}A_{AC}$, $p_{AC} = \dfrac{F_{AC}}{A_{AC}} = \dfrac{48\,800}{\left(\pi \dfrac{0.095^2}{4}\right)} = 6.89(10^6)$ Pa or 6.89 MPa $\quad$ *Ans.*

Helpful Hint

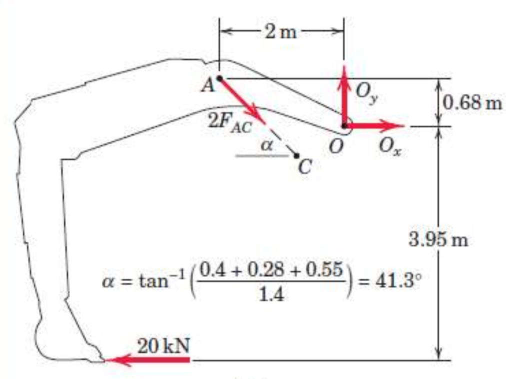
1 Recall that force = (pressure)(area).

(b) For cylinder DF, we "cut" the assembly at a location which makes the desired cylinder force external to our free-body diagram. This means isolating the vertical arm $EBIF$ along with the bucket and its applied force.

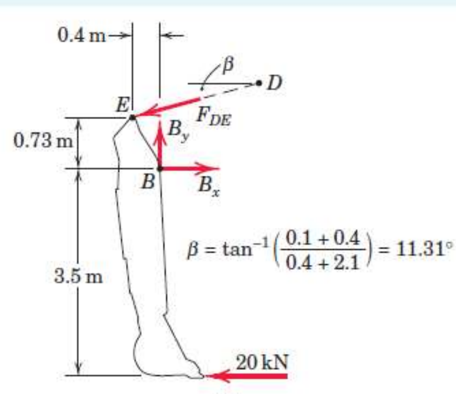
$[\Sigma M_B = 0]$ $\quad -20\,000(3.5) + F_{DE} \cos 11.31°(0.73) + F_{DE} \sin 11.31°(0.4) = 0$

$$F_{DE} = 88\,100 \text{ N or } 88.1 \text{ kN} \qquad \textit{Ans.}$$

$$p_{DE} = \frac{F_{DE}}{A_{DE}} = \frac{88\,100}{\left(\pi \dfrac{0.105^2}{4}\right)} = 10.18(10^6) \text{ Pa or } 10.18 \text{ MPa} \qquad \textit{Ans.}$$

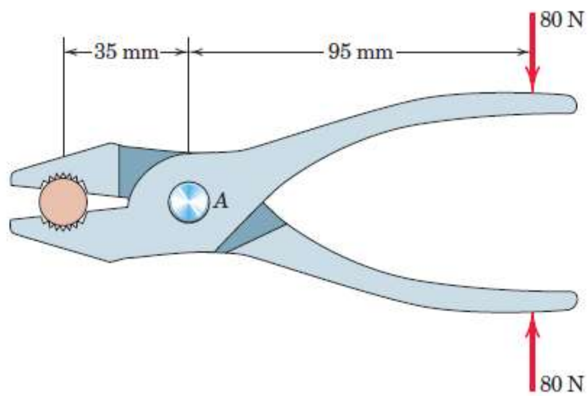


(a)

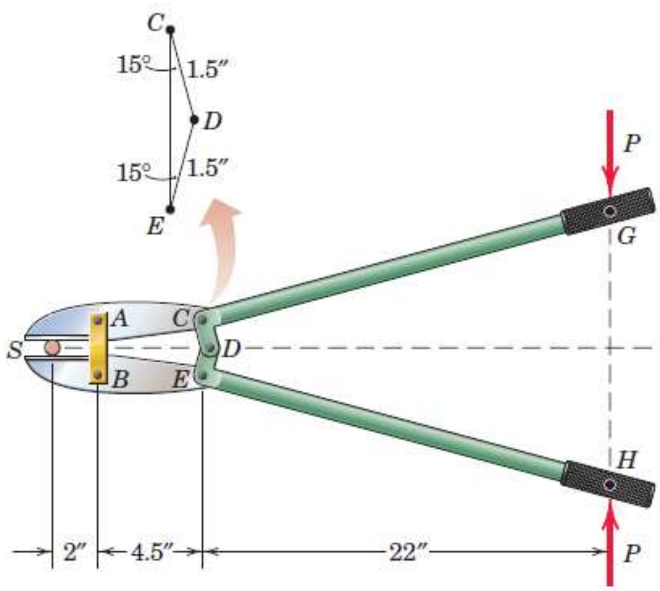


(b)

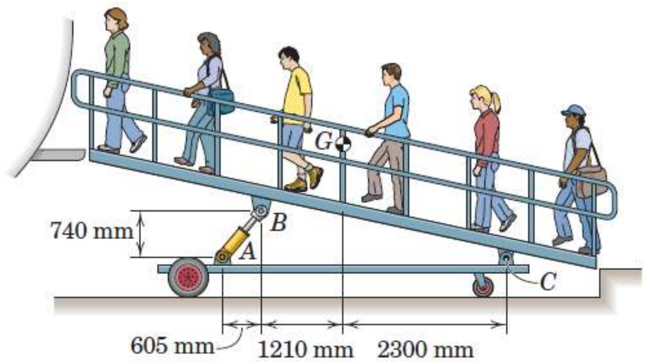
تمرین۱: به کمک یک انبردست و با نیروی ۸۰ نیوتن یک میلگرد فشرده میشود. نیروی اعمالی به میلگرد و همچنین نیروی وارد شده به پین A را بیابید.



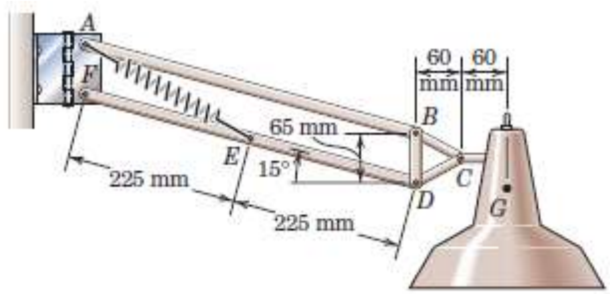
اگر همین نیر به قیچی شکل زیر اعمال شود نیروی اعمالی به میلگرد چه خواهد بود؟



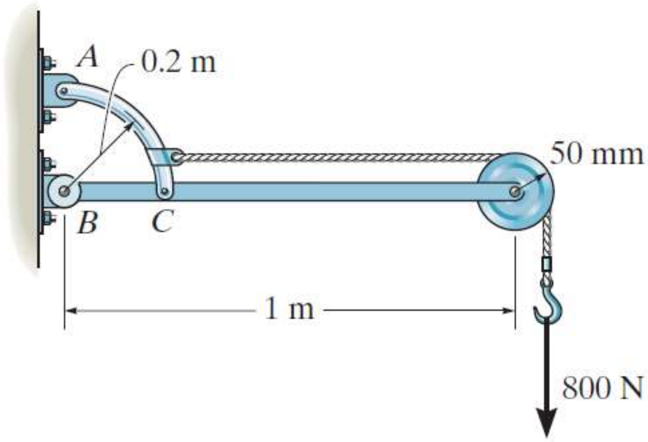
تمرین۲: در سطح شیبدار نشان داده شده وزن قطعات و مسافرین در مجموع یک تن است. نیروی جک AB و نیروهای عکس العمل در پین C را بیابید.



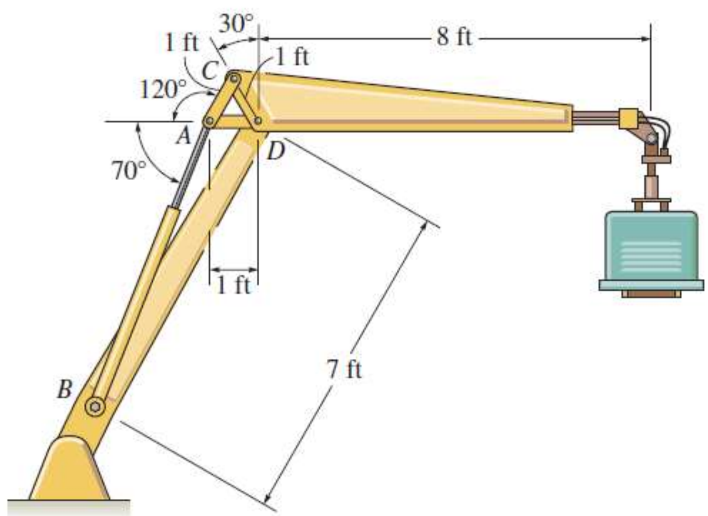
تمرین۳: در چراغ مطالعه نشان داده شده نیروی فنر برای نگه داشتن چراغ در وضعیت تعادل نشان داده شده را بیابید. (پین C دارای اصطکاک بوده و مانع از چرخیدن چراغ حول C میشود.)



تمرین۴: در قاب نشان داده شده در شکل، نیروهای تکیه گاهی در پینهای A,B و C را بیابید.



تمرین۵: در جرثقیل هیدرولیکی نشان داده شده نیروی جک AB و اعضای AC و AD را بیابید. وزن بار ۱۴۰۰ پوند است.



موفق باشید.