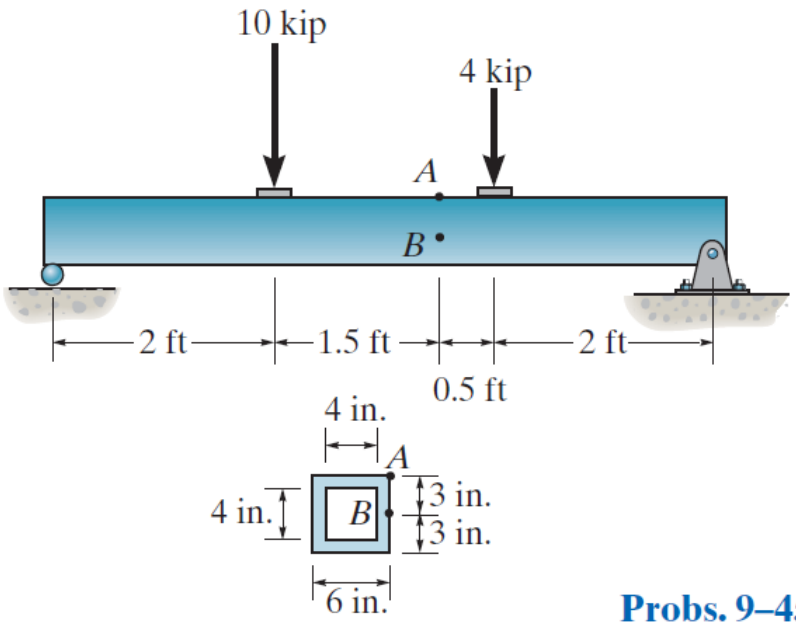
problem 9-45

•9–45. Determine the maximum in-plane shear stress in the box beam at point *A*. Show the results on an element located at this point.



Probs. 9–45/46

beam

```
u = symunit;
x = sym('x');
E = sym('E');

old_assum = assumptions;
clearassum;

b = beam; %(kip,ft)
b = b.add('reaction', 'force', 'R1', 0);
b = b.add('reaction', 'force', 'R2', 6*u.ft);
b = b.add('applied', 'force', -10*u.kip, 2*u.ft);
b = b.add('applied', 'force', -4*u.kip, 4*u.ft);
b.L = 6*u.ft;
```

section properties

```
Bo = 6*u.in;
Bi = 4*u.in;
```

```
b.I = rewrite((Bo^4-Bi^4)/12, u.ft);
```

elastic curve

```
[y(x,E) dy(x,E) m v w r] = b.elastic_curve(x, 'factor'); %#ok
y
```

y(x, E) =

$$\begin{cases} -\dfrac{20736\,x\,(22\,\mathrm{ft}^2 - x^2)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } x \le 2\,\mathrm{ft} \\ -\dfrac{5184\,(x^3 - 30\,x^2\,\mathrm{ft} + 148\,x\,\mathrm{ft}^2 - 40\,\mathrm{ft}^3)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } x \in (2\,\mathrm{ft}, 4\,\mathrm{ft}] \\ -\dfrac{5184\,(x - 6\,\mathrm{ft})\,(3\,x^2 - 36\,x\,\mathrm{ft} + 28\,\mathrm{ft}^2)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } 4\,\mathrm{ft} < x \end{cases}$$

```
dy
```

dy(x, E) =

$$\begin{cases} -\dfrac{20736\,(22\,\mathrm{ft}^2 - 3\,x^2)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } x \le 2\,\mathrm{ft} \\ -\dfrac{5184\,(3\,x^2 - 60\,x\,\mathrm{ft} + 148\,\mathrm{ft}^2)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } x \in (2\,\mathrm{ft}, 4\,\mathrm{ft}] \\ -\dfrac{5184\,(9\,x^2 - 108\,x\,\mathrm{ft} + 244\,\mathrm{ft}^2)}{65\,\mathrm{E}}\ \dfrac{\mathrm{kip}}{\mathrm{ft}^4} & \text{if } 4\,\mathrm{ft} < x \end{cases}$$

```
m
```

m(x) =

$$\begin{cases} 8\,x\,\mathrm{kip} & \text{if } x \le 2\,\mathrm{ft} \\ -2\,(x - 10\,\mathrm{ft})\,\mathrm{kip} & \text{if } x \in (2\,\mathrm{ft}, 4\,\mathrm{ft}] \\ -6\,(x - 6\,\mathrm{ft})\,\mathrm{kip} & \text{if } 4\,\mathrm{ft} < x \end{cases}$$

```
v
```

v(x) =

$$\begin{cases} 8\,\mathrm{kip} & \text{if } x \le 2\,\mathrm{ft} \\ -2\,\mathrm{kip} & \text{if } x \in (2\,\mathrm{ft}, 4\,\mathrm{ft}] \\ -6\,\mathrm{kip} & \text{if } 4\,\mathrm{ft} < x \end{cases}$$

```
w
```

w(x) = 0

reactions

```
R1 = r.R1 %#ok
```

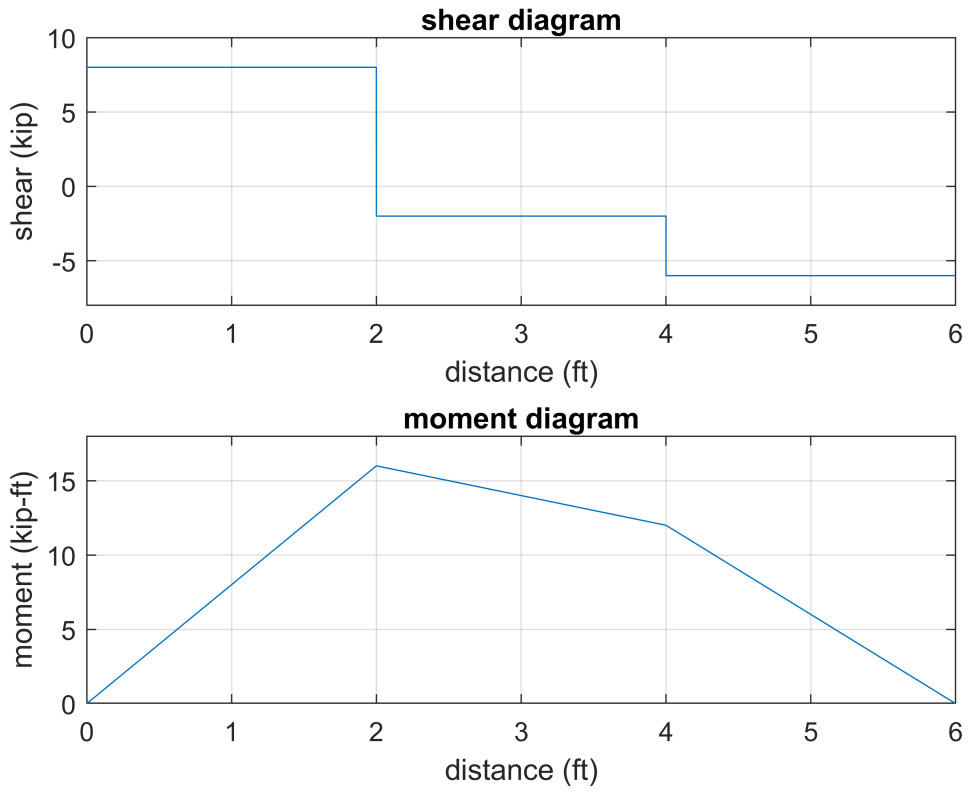
R1 = 8 kip

```
R2 = r.R2 %#ok
```

R2 = 6 kip

shear and moment diagrams

```
beam.shear_moment(m, v, [0 6], {'kip' 'ft'});
subplot(2,1,1);
axis([0 6 -8 10]);
subplot(2,1,2);
axis([0 6 0 18]);
```



loads at point A

```
M_A = m(3.5*u.ft)
```

M_A = 13 ft kip

```
V_A = v(3.5*u.ft)
```

V_A = −2 kip

stresses at point A

```
y_A = 3*u.in;
b.I = rewrite(b.I, u.in);
sigma_val = rewrite(-M_A*y_A/b.I, u.ksi);
sigma_A = vpa(sigma_val) %#ok
```

sigma_A = −5.4 ksi

```
tau_A = sym(0)
```

tau_A = 0

```
sigma_A = sigma_val;
```

mohr stresses at point A

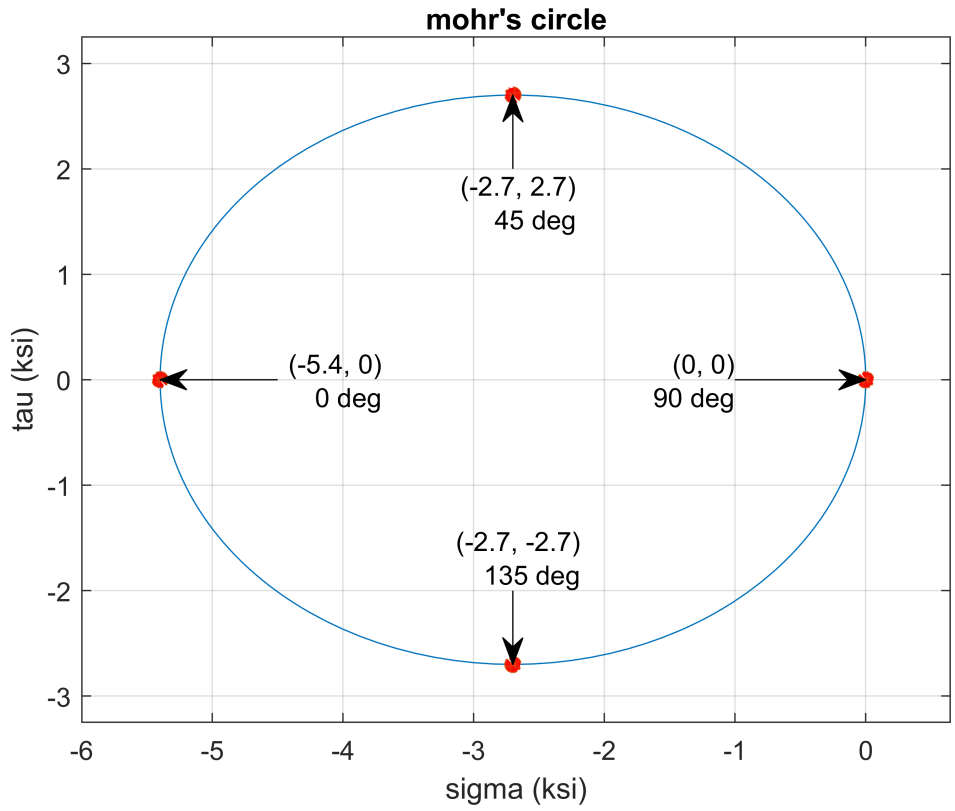
```
sigmax = sigma_A;
sigmay = sym(0);
tauxy = tau_A;

[sigmaxp sigmayp tauxyp thetap] = beam.principal(sigmax, sigmay, tauxy); %#ok
[sigmaxs sigmays tauxys thetas] = beam.max_shear(sigmax, sigmay, tauxy); %#ok
```

mohr's circle

```
beam.mohr_plot(sigmax, sigmay, tauxy, {'ksi'});
axis([-6 0.65 -3.25 3.25]);
xvals = double(separateUnits([sigmaxp sigmaxs]));
yvals = double(separateUnits([tauxyp tauxys]));
thetavals = double(separateUnits([thetap thetas]));
hold on;
plot(xvals, yvals, 'o', 'MarkerFaceColor', 'r');
for k = 1:4
  switch k
    case 1
      x1 = -4.5;
      y1 = 0;
    case 2
      x1 = -1;
      y1 = 0;
```

```
    case 3
      x1 = xvals(3);
      y1 = 2;
    case 4
      x1 = xvals(4);
      y1 = -2;
  end
  [x1 y1] = ds2nfu(x1, y1); %#ok
  [x2 y2] = ds2nfu(xvals(k), yvals(k)); %#ok
  text_str = {['(' num2str(xvals(k)) ', ' num2str(yvals(k)) ')']
              [num2str(thetavals(k)) ' deg']};
  annotation('textarrow', [x1 x2], [y1 y2], 'String', text_str);
end
```



clean up

```
setassum(old_assum);
clear old_assum R1 R2 sigma_val;
clear xvals yvals thetavals k x1 y1 x2 y2 text_str;
```