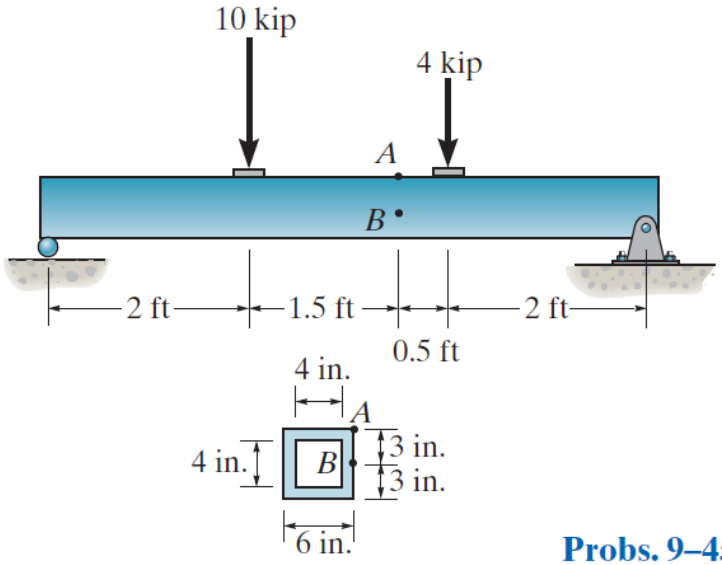
problem 9-46

9–46. Determine the principal stress in the box beam at point B. 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

```
yc = [3/2; 2/2; -2/2; -3/2]*u.in;
Ac = [6*3; -4*2; -4*2; 6*3]*u.in^2;
Ic = [6*3^3; -4*2^3; -4*2^3; 6*3^3]*u.in^4/12;

[yn Qn In] = beam.neutral_axis(yc, Ac, Ic); %#ok
b.I = rewrite(sum(In), 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
```

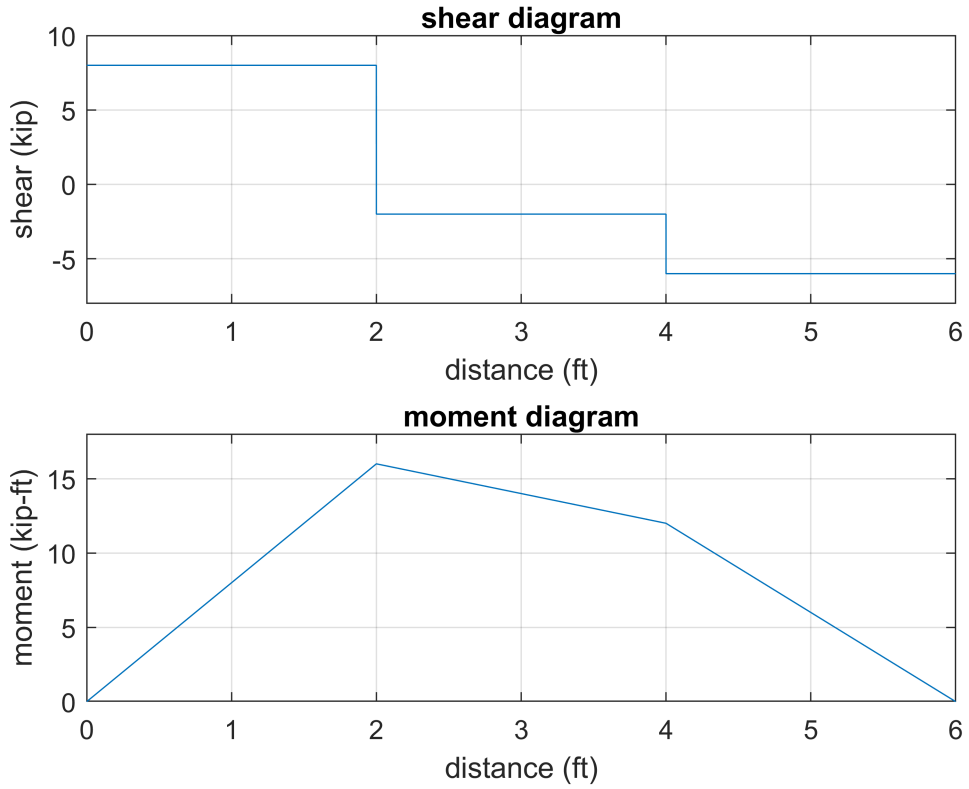
R1 = 8 kip

```
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 B

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

M_B = 13 ft kip

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

V_B = −2 kip

stresses at point B

```
b.I = rewrite(b.I, u.in);
sigma_B = sym(0)
```

sigma_B = 0

```
Q_B = sum(Qn(1:2));
t_B = 2*u.in;
tau_val = rewrite(-V_B*Q_B/(b.I*t_B), u.psi);
tau_B = vpa(tau_val, 5) %#ok
```

tau_B = 219.23 psi

```
tau_B = tau_val;
```

mohr stresses at point B

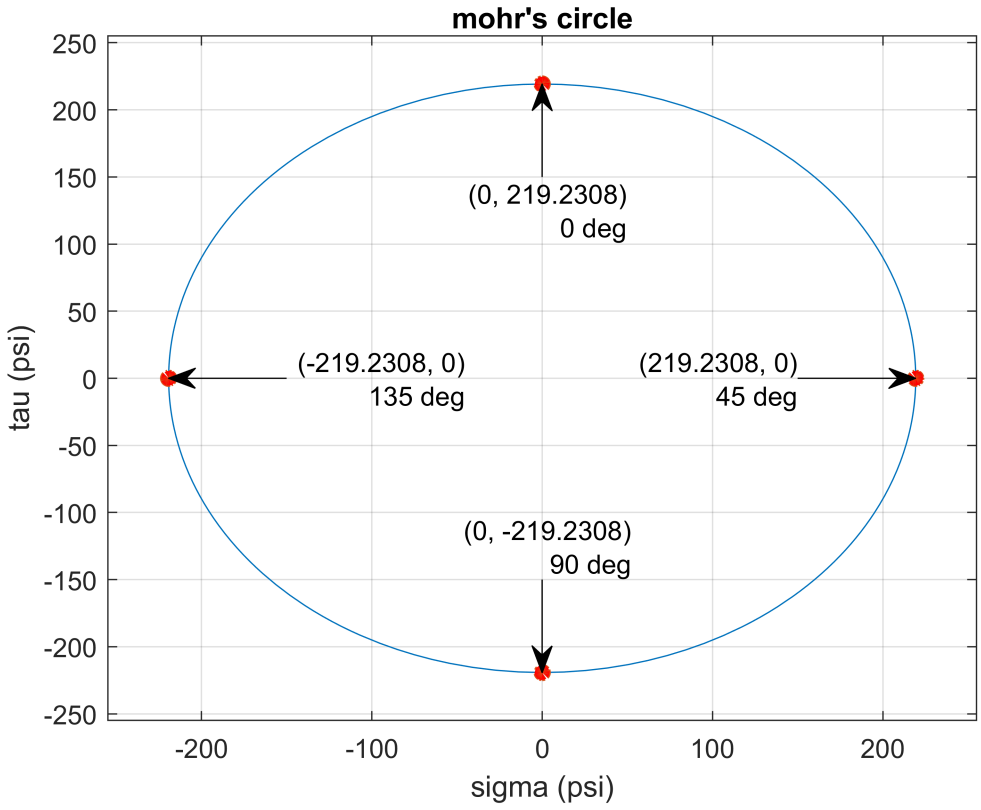
```
sigmax = sym(0);
sigmay = sym(0);
tauxy = tau_B;

[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, {'psi'});
axis([-255 255 -255 255])
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 = 150;
      y1 = 0;
    case 2
      x1 = -150;
      y1 = 0;
    case 3
      x1 = xvals(3);
      y1 = 150;
```

```
    case 4
      x1 = xvals(4);
      y1 = -150;
  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 tau_val;
clear xvals yvals thetavals k x1 y1 x2 y2 text_str;
```