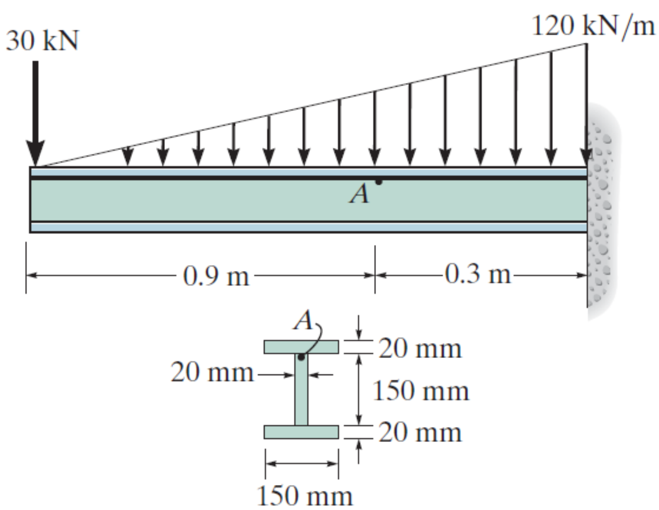
problem 9-29

•9–29. The wide-flange beam is subjected to the loading shown. Determine the principal stress in the beam at point A, which is located at the top of the web. Although it is not very accurate, use the shear formula to determine the shear stress. Show the result on an element located at this point.



Prob. 9–29

beam

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

old_assum = assumptions;
clearassum;
args = {'mode' 'factor'};
wf = findpoly(1, 'thru', [0 0], [1.2*u.m -120*u.kN/u.m], args{:});

b = beam;
b = b.add('reaction', 'force', 'R', 1.2*u.m);
b = b.add('reaction', 'moment', 'M', 1.2*u.m);
b = b.add('applied', 'force', -30*u.kN, 0);
b = b.add('distributed', 'force', wf, [0 1.2]*u.m);
b.L = 1.2*u.m;
```

section properties

```
yc = [150/2+20/2; 0; -150/2-20/2]*u.mm;
Ac = [150*20; 20*150; 150*20]*u.mm^2;
Ic = [150*20^3; 20*150^3; 150*20^3]*u.mm^4/12;

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

elastic curve

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

y(x, E) =

$$-\frac{32000\ (5\,x-6\,\mathrm{m})^2\ (125\,x^3+300\,x^2\,\mathrm{m}+1290\,x\,\mathrm{m}^2+2664\,\mathrm{m}^3)}{5901\ \mathrm{E}}\ \frac{\mathrm{kN}}{\mathrm{m}^6}$$

```
dy
```

dy(x, E) =

$$-\frac{800000\ (25\,x^2+126\,\mathrm{m}^2)\ (5\,x-6\,\mathrm{m})\ (5\,x+6\,\mathrm{m})}{5901\ \mathrm{E}}\ \frac{\mathrm{kN}}{\mathrm{m}^6}$$

```
m
```

m(x) =

$$-\frac{10\,x\ (5\,x^2+9\,\mathrm{m}^2)}{3}\ \frac{\mathrm{kN}}{\mathrm{m}^2}$$

```
v
```

v(x) =

$$-10\ (5\,x^2+3\,\mathrm{m}^2)\ \frac{\mathrm{kN}}{\mathrm{m}^2}$$

```
w
```

w(x) =

$$-100\,x\ \frac{\mathrm{kN}}{\mathrm{m}^2}$$

reactions

```
R = r.R %#ok
```

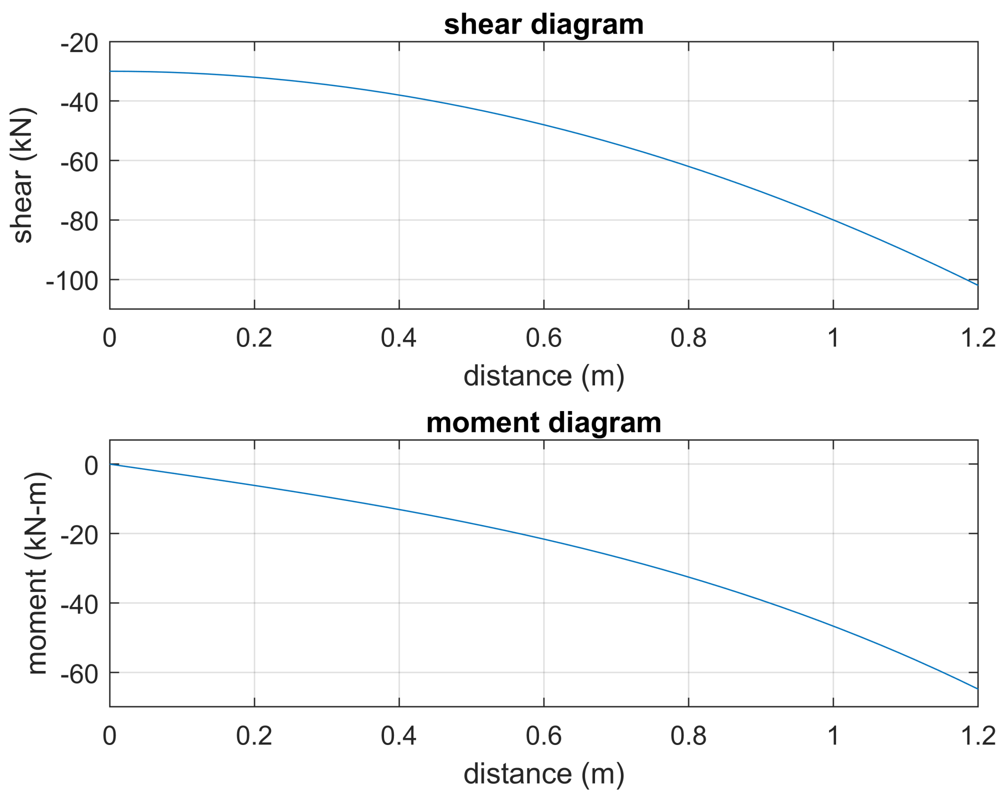
R = $102\ \mathrm{kN}$

```
M = vpa(r.M) %#ok
```

M = $-64.8\ \mathrm{kN\ m}$

shear and moment diagrams

```
beam.shear_moment(m, v, [0 1.2], {'kN' 'm'});
subplot(2,1,1);
axis([0 1.2 -110 -20]);
subplot(2,1,2);
axis([0 1.2 -70 7]);
```



loads at point A

```
M_val = m(0.9*u.m);
M_A = vpa(M_val) %#ok
```

M_A = $-39.15\ \mathrm{kN\ m}$

```
V_val = v(0.9*u.m);
V_A = vpa(V_val) %#ok
```

V_A = -70.5 kN

```
M_A = M_val;
V_A = V_val;
```

stresses at point A

```
y_A = 150*u.mm/2;
b.I = rewrite(b.I, u.mm);
sigma_val = rewrite(-M_A*y_A/b.I, u.MPa);
sigma_A = vpa(sigma_val, 4) %#ok
```

sigma_A = 59.71 MPa

```
Q_A = Qn(1);
t_A = 20*u.mm;
tau_val = rewrite(-V_A*Q_A/(b.I*t_A), u.MPa);
tau_A = vpa(tau_val, 4) %#ok
```

tau_A = 18.28 MPa

```
sigma_A = sigma_val;
tau_A = tau_val;
```

mohr stresses at point A

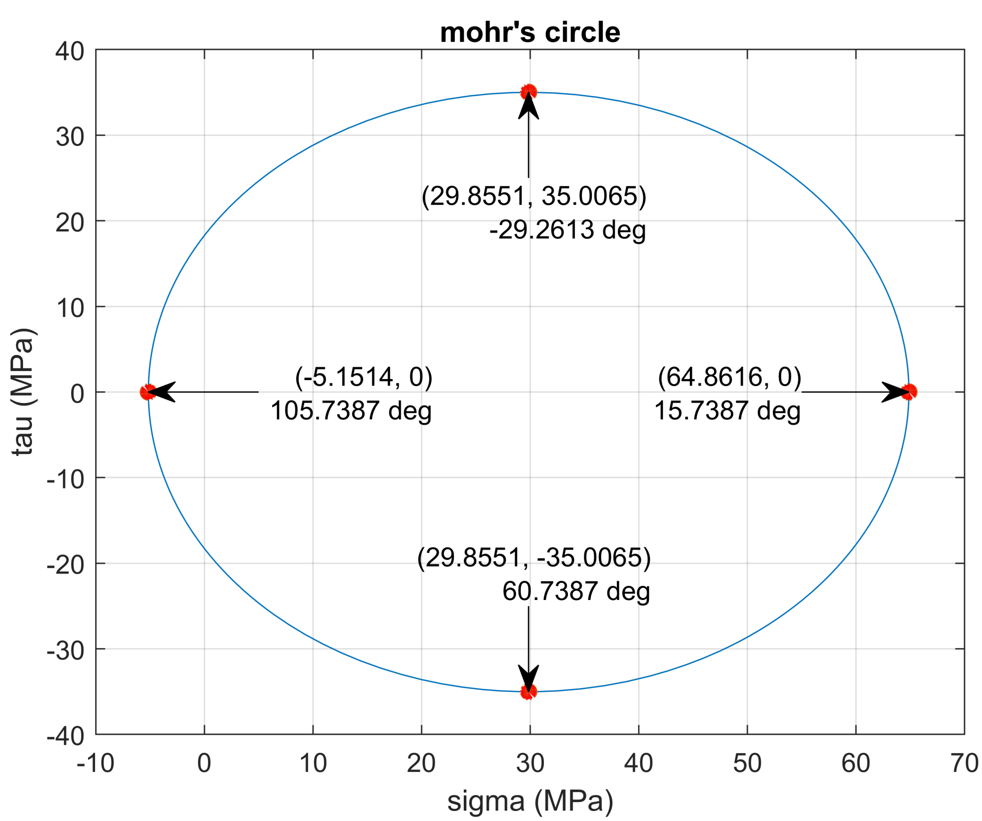
```
sigmax = sigma_A;
sigmay = sym(0);
tauxy = tau_A;

[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, {'MPa'});
axis([-10 70 -40 40]);
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 = 55;
      y1 = 0;
    case 2
      x1 = 5;
      y1 = 0;
    case 3
      x1 = xvals(3);
      y1 = 25;
    case 4
      x1 = xvals(4);
      y1 = -25;
  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 args old_assum R M M_val V_val sigma_val tau_val;
clear xvals yvals thetavals k x1 y1 x2 y2 text_str;
```