PROBLEM 3-20 SCP THE STATE OF STRESS AT A POINT IS

$\sigma_x = -6$ ksi $\qquad \tau_{xy} = 9$ ksi

$\sigma_y = 18$ ksi $\qquad \tau_{yz} = 6$ ksi

$\sigma_z = -12$ ksi $\qquad \tau_{zx} = -15$ ksi

GIVEN THAT THE MATERIAL IS BRASS ($E = 15.4$ Msi, $\nu = 0.324$), DETERMINE THE STATE OF STRAIN IN THE MATERIAL

GIVEN:

1. THE STATE OF STRESS $[\sigma] = \begin{bmatrix} -6 & 9 & -15 \\ 9 & 18 & 6 \\ -15 & 6 & -12 \end{bmatrix}$ ksi
2. THE MATERIAL IS BRASS (FROM THE TEXT)
   - $E = 15.4$ msi
   - $\nu = 0.324$

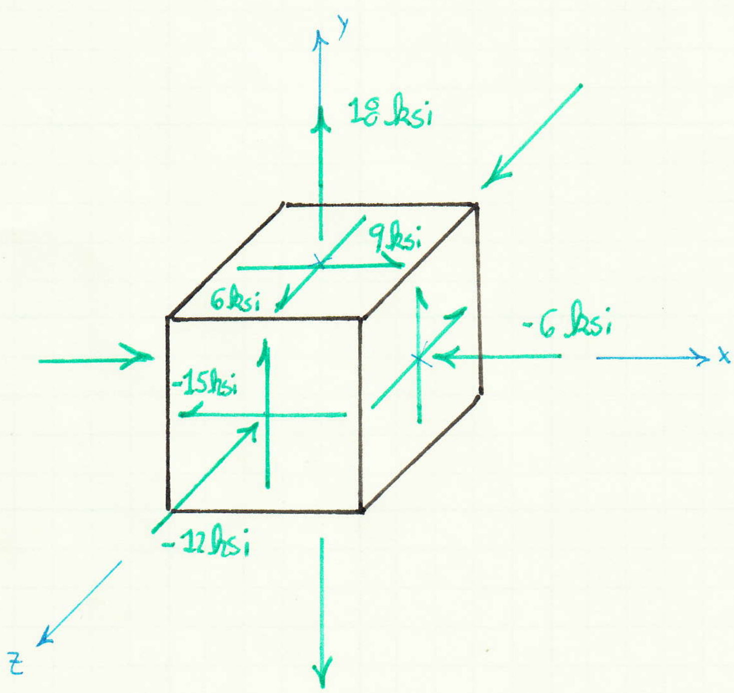
ASSUMPTIONS

1. THE MATERIAL IS RESPONDING IN A LINEAR-ELASTIC MANNER
2. SMALL DEFORMATIONS

FIND:

1. THE COMPLETE STATE OF STRAIN IN THE MATERIAL

FIGURE:



SOLUTION:

KNOWING THAT THE RELATIONSHIP BETWEEN STRESS AND STRAIN IN A LINEAR - ISOTROPIC - HOMOGENEOUS MATERIAL IS

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{yz} \\ \gamma_{xz} \\ \gamma_{xy} \end{Bmatrix} = \begin{bmatrix} 1/E & -\nu/E & -\nu/E & 0 & 0 & 0 \\ -\nu/E & 1/E & -\nu/E & 0 & 0 & 0 \\ -\nu/E & -\nu/E & 1/E & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{2(1+\nu)}{E} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{2(1+\nu)}{E} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{2(1+\nu)}{E} \end{bmatrix} \begin{Bmatrix} \sigma_x \\ \sigma_y \\ \sigma_z \\ \tau_{yz} \\ \tau_{xz} \\ \tau_{xy} \end{Bmatrix} \quad (1)$$

FOR BRASS, $E = 15.4(10^6)$ PSI AND $\nu = 0.324$

$$1/E = \frac{1}{15.4(10^6)} \frac{in^2}{lb} = 64.94(10^{-9}) \frac{in^2}{lb} \quad (2)$$

$$\frac{\nu}{E} = \frac{0.324}{15.4(10^6)} \frac{in^2}{lb} = 21.04(10^{-9}) \frac{in^2}{lb} \quad (3)$$

$$\frac{2\cdot(1+\nu)}{E} = \frac{2\cdot(1+0.324)}{15.4(10^6)} \frac{in^2}{lb} = 172.0(10^{-9}) \frac{in^2}{lb} \quad (4)$$

THEREFORE

$$\begin{Bmatrix} \epsilon_x \\ \epsilon_y \\ \epsilon_z \\ \gamma_{yz} \\ \gamma_{xz} \\ \gamma_{xy} \end{Bmatrix} = \begin{bmatrix} 64.94 & -21.04 & -21.04 & 0 & 0 & 0 \\ -21.04 & 64.94 & -21.04 & 0 & 0 & 0 \\ -21.04 & -21.04 & 64.94 & 0 & 0 & 0 \\ 0 & 0 & 0 & 172.0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 172.0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 172.0 \end{bmatrix} \times (10^{-9}) \frac{in^2}{lb} \begin{Bmatrix} -6\,ksi \\ 18\,ksi \\ -12\,ksi \\ 6\,ksi \\ -15\,ksi \\ 9\,ksi \end{Bmatrix} = \begin{Bmatrix} -500 \\ 1500 \\ -100 \\ 100 \\ -260 \\ -1500 \end{Bmatrix} \times (10^{-6})$$

SUMMARY:

THE CALCULATION MADE ABOVE IS IN TERMS OF ENGINEERING STRAIN. THE CALCULATIONS WERE PERFORMED USING MATLAB AND ARE SHOWN ON THE NEXT PAGE.

HOMEWORK SOLUTION
MER311: ADVANCED STRENGTH

PROB 3-70 SUP (σ-ε BASIS) PG 3 of 3
SHIGLEY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>> S=[-6.0e3 18.0e3 -12.0e3 6.0e3 -15.0e3 9.0e3]'

S =

   -6000
   18000
  -12000
    6000
  -15000
    9000

>> C=[64.94 -21.04 -21.04 0 0 0;
-21.04 64.94 -21.04 0 0 0;
-21.04 -21.04 64.94 0 0 0;
0 0 0 172.0 0 0;
0 0 0 0 172.0 0;
0 0 0 0 0 172.0]*1e-9

C =

   1.0e-06 *

    0.0649   -0.0210   -0.0210         0         0         0
   -0.0210    0.0649   -0.0210         0         0         0
   -0.0210   -0.0210    0.0649         0         0         0
         0         0         0    0.1720         0         0
         0         0         0         0    0.1720         0
         0         0         0         0         0    0.1720

>> e=C*S

e =

   -0.0005 = εx
    0.0015 = εy
   -0.0010 = εz
    0.0010 = γyz
   -0.0026 = γxz
    0.0015 = γxy

>>
```