The couple \( M \) is applied to a beam of the cross section shown in a plane forming an angle \( \beta \) with the vertical. Determine (a) the stress at point A, (b) the stress at point B, (c) the angle that the neutral axis forms with the horizontal plane.

The centroidal moments of inertia of the section are

\[
I_{zz} = \frac{90 \times 80^3}{12} + (90 \times 80) \times 20^2 + \frac{30 \times 80^3}{12} + (30 \times 80) \times 60^2 = 16.64 \times 10^6 \text{ mm}^4
\]

\[
I_{xy} = \frac{80 \times 90^3}{12} + \frac{80 \times 30^3}{12} = 5.04 \times 10^6 \text{ mm}^4
\]

The moment components are

\[
M_z = M \cos \beta = 25 \cos 15
\]

\[
M_y = 24.148 \text{ kN} \cdot \text{m}
\]

\[
M_x = M \sin \beta = 25 \sin 15
\]

\[
M_y = 6.47 \text{ kN} \cdot \text{m}
\]

The normal stresses at point A due to the bending moments \( M_z \) and \( M_y \) are

\[
\sigma_1 = -\frac{M_z \times y_A}{I_{zz}} = -\left(\frac{24.148 \times 10^6}{16.64 \times 10^6}\right) \times 60
\]

\[
\sigma_1 = -87.072 \text{ MPa}
\]

\[
\sigma_2 = \frac{M_y \times z_A}{I_{yy}} = \frac{(6.47 \times 10^6) \times 45}{5.04 \times 10^6}
\]

\[
\sigma_2 = 57.768 \text{ MPa}
\]

The combined stress at point A is

\[
\sigma_A = \sigma_1 + \sigma_2 = -87.072 + 57.768
\]

\[
\sigma_A = -29.30 \text{ MPa}
\]

The normal stresses at point B due to the bending moments \( M_z \) and \( M_y \) are

\[
\sigma_1 = -\frac{M_z \times y_B}{I_{zz}} = -\left(\frac{24.148 \times 10^6}{16.64 \times 10^6}\right) \times 60
\]

\[
\sigma_1 = -87.072 \text{ MPa}
\]

\[
\sigma_2 = \frac{M_y \times z_B}{I_{yy}} = \frac{(6.47 \times 10^6) \times (-45)}{5.04 \times 10^6}
\]

\[
\sigma_2 = -57.768 \text{ MPa}
\]

The combined stress at point B is

\[
\sigma_B = \sigma_1 + \sigma_2 = -87.072 - 57.768
\]

\[
\sigma_B = -144.84 \text{ MPa}
\]

The angle that the neutral axis forms with the horizontal plane angle is

\[
\tan \theta = \frac{I_z}{I_{xy}}
\]

\[
\tan \phi = \frac{16.64 \times 10^6}{5.04 \times 10^6} \tan 15 = 0.8847
\]

\[
\phi = 41.49^\circ
\]