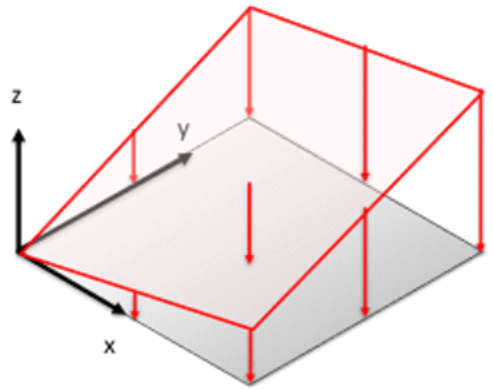
Problem 6

A surface pressure is acting over a 5-meter square area. The magnitude of the pressure, in kPa, is described by the function below. Find the overall magnitude of the force exerted and the location of the equivalent point load.



$$F(x,y) = 5x + 10y$$

$$F_{eq} = \int_0^5 \left(\int_0^5 (5x + 10y)\,dx \right) dy$$

$$F_{eq} = \int_0^5 \left(\left|_0^5 \frac{5}{2}x^2 + 10yx \right. \right)$$

$$\frac{5}{2}(25) + 10y(5) - 0 - 0 \rightarrow \frac{125}{2} + 50y$$

$$F_{eq} = \int_0^5 \left(\frac{125}{2} + 50y \right) dy = \left|_0^5 \frac{125}{2}y + 25y^2 \right.$$

312.5 625

$$F_{eq} = 937.5 \text{ kN}$$

$$x_{cg} = \frac{\int_0^5 \left(\int_0^5 \left(5x^2 + 10xy \right) dx \right) dy}{937.5}$$

$$\int_0^5 5x^2 + 10xy \; dx = \left|_0^5 \frac{5}{3}x^3 + 5yx^2 \right.$$

$$= \frac{625}{3} + 125y$$

$$\int_0^5 \frac{625}{3} + 125y \; dy = \left|_0^5 \frac{625}{3}y + \frac{125}{2}y^2 \right.$$

$$x_{cg} = \frac{\frac{3125}{3} + \frac{3125}{2}}{937.5} = \underline{2.78ft}$$

$$y_{cg} = \frac{\int_0^5 \left(\int_0^5 \left(5xy + 10y^2 \right) dx \right) dy}{937.5}$$

$$\int_0^5 5xy + 10y^2 = \left|_0^5 \frac{5}{2}yx^2 + 10y^2x \right.$$

$$= \frac{125}{2}y + 50y^2$$

$$\int_0^5 \left(\frac{125}{2}y + 50y^2\right) dy = \left|_0^5 \frac{125}{4}y^2 + \frac{50}{3}y^3\right.$$

$$y_q = \frac{\frac{3125}{4} + \frac{6250}{3}}{937.5} = \underline{3.06\,m}$$

Solution

$F_{eq} = 937.5\ kN$ downwards at $[2.78, 3.06]\,m$