1.5 Derive the relations given by (1.4) and (1.5).

Remark: $(1.4): V_x = \tau \cdot t \cdot a$
$(1.5): V_y = \tau \cdot t \cdot b$

Solution:

(1) Consider a very small section within the curved panel with thickness t and length δL. τ is the constant shear stress, so we have the shear force $\Delta V = \tau \cdot (\delta L \cdot t)$ acting on the cross section.

(2) It is possible to take apart the shear force into x and y direction shown in the figure, where

$$\Delta V_x = \Delta V \cdot \cos\theta = \tau \cdot \delta L \cdot t \cdot \cos\theta = \tau \cdot t \cdot (\delta L \cdot \cos\theta)$$
$$= \tau \cdot t \cdot \Delta x$$

similarly, $\Delta V_y = \tau \cdot t \cdot \delta y$

(3) Now consider the length to be extremely small, therefore $\Delta V_x \to dV_x$ as well as $\Delta V_y \to dV_y$. The horizontal component and the vertical component of the shear force V_x, V_y can be verified as following:

$$V_x = \int dV_x = \int_0^a \tau \cdot t \cdot dx = \tau \cdot t \cdot a$$

$$V_y = \int dV_y = \int_0^b \tau \cdot t \cdot dy = \tau \cdot t \cdot b$$