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1. Force Model

The bending problem of flexible canopy element is schematically defined in figure 1. With the assumption that PDMS remains linearly elastic, deflection of flexible canopy element is governed by numerical method proposed by Ang *et al.* (1993) on the form of Eq. 1.1 in Cartesian coordinates.

$$\frac{\frac{d^2x}{dy^2}}{\left[1+\left(\frac{dx}{dy}\right)^2\right]^{3/2}} = \frac{M_P(y)+M_B(x)}{EI} \tag{1.1}$$

where x and y are coordinates in which y is parallel to the original flexible canopy elements, $M_P(y)$ is the bending moment induced by equivalent concentrated load on the tip of canopy element (Eq. 1.2), $M_B(x)$ is the bending moment induced by body force distribution gravity force distribution, buoyancy force distribution. (Eq. 1.5)

$$M_P(y) = P(l-y) \tag{1.2}$$

For concentrated load P parallel to x axis is applid at the free end of a flexible canopy element, Chen (2010) rewrite the formulation of Ang *et al.* (1993).

$$\frac{dx}{dy} = \frac{\frac{P}{EI}\left(ly-\frac{y^2}{2}\right)}{\sqrt{1-\frac{P^2}{E^2I^2}\left(ly-\frac{y^2}{2}\right)^2}} \tag{1.3}$$

Once the appropriate l and δ are obtained from averaged bending positions(figure XXX), the equivalent load can be solved by standard Newton's method.

$$\frac{\delta}{L} = \int_0^{\delta} dx^* = \int_0^{l^*} dy^* \frac{K\left(l^*y^*-\frac{y^{*2}}{2}\right)}{\sqrt{1-K^2\left(l^*y^*-\frac{y^{*2}}{2}\right)^2}} \tag{1.4}$$

where $s^* = s/L$, $y^* = y/L$, $l^* = l/L$, $x^* = x/L$, and $K = PL^2/EI$. Based on PTV experiment, it is reasonable to approximate the bending curves of canopy elements are linear shape. Thus, the gravity force and buoyancy force are uniformly distributed along

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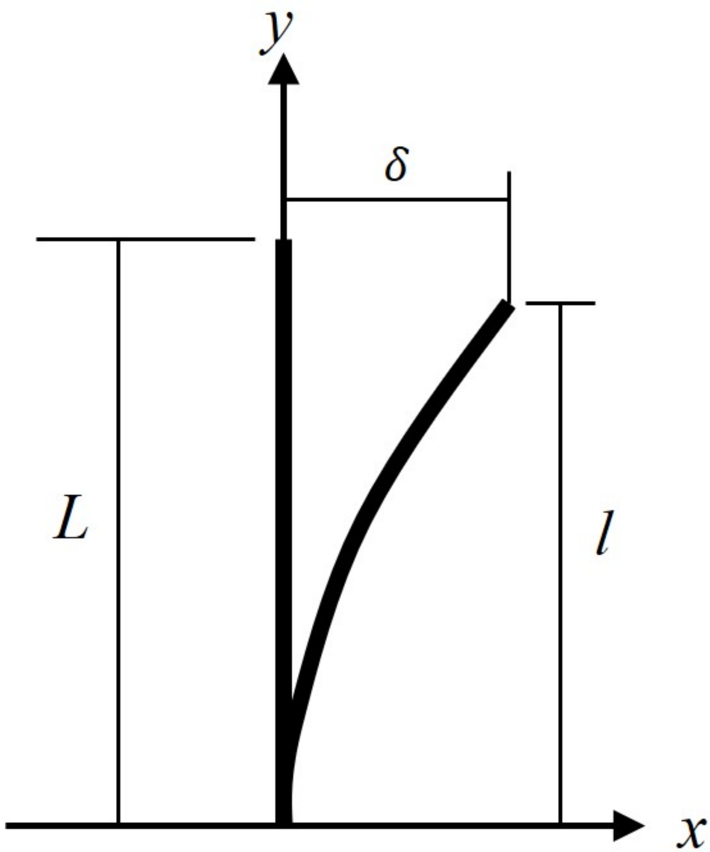

FIGURE 1. Bending of flexible canopy element.

x axis.

$$M_B(x) = \frac{\frac{F_G - F_B}{\delta}(\delta - x)^2}{2} \tag{1.5}$$

where F_G is the gravity force and F_B is the buoyancy force. Use similar numerical approach, equivalent force $P^{'}$ along x axis caused by gravity and buoyancy force can be calculated.

$$P_{equivalent} = P - P^{'} \tag{1.6}$$

REFERENCES

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