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# Relationship between vascular bundles and flexural rigidity of bamboo

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## ABSTRACT

This study explored the optimal spatial distribution of vascular bundles such that the flexural rigidity from transverse bending($D_{\perp}$) is maximized. A model of the section is shown in Fig.1 and its expression of volume fraction is compared with a verified equation (Sato et al., 2017). Halpin-Tsai equation is used to calculate transverse Young's modulus and flexural rigidity (Eq.1). As a result, the optimal distribution is parabolic gradation with increasing mean volume fraction.

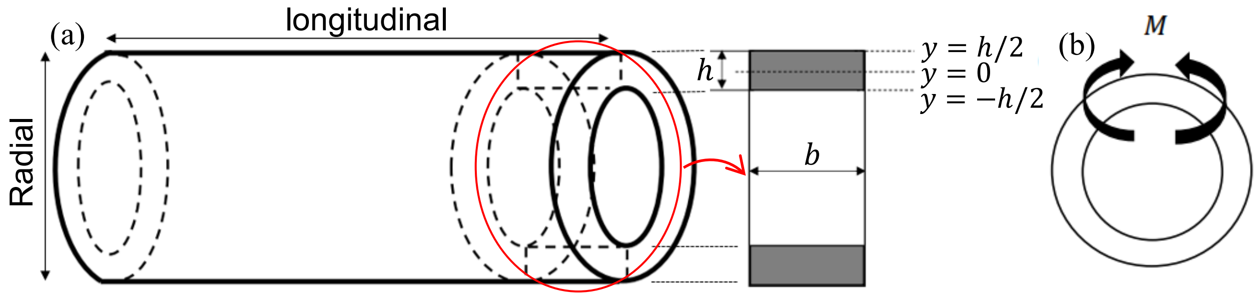


Fig. 1 Model of (a) hollow cylinder's longitudinal section (b)Transverse bending

$$D_{\perp} = E_m \cdot \int_{-\frac{h}{2}}^{\frac{h}{2}} \frac{1 + \xi\eta(k_0 + k_1 y + k_2 y^2)}{1 - \eta(k_0 + k_1 y + k_2 y^2)} y^2 dy,\ \eta = \left(\frac{E_f}{E_m} - 1\right) / \left(\frac{E_f}{E_m} + \xi\right) \quad (1)$$

$E_f$-Fiber modulus, $E_m$-Matrix modulus, $\xi$-geometry parameter, $k_0, k_1, k_2$-Coefficient

## REFERENCES

Sato, M., Inoue, A. and Shima, H. (2017) "Bamboo-inspired optimal design for functionally graded hollow cylinders," *PLoS ONE*, 12(5).

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