Canopy Depth Optimization Model for 250g Payload Parachute

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Abstract

A canopy depth optimization model for a parachute targeting 5 m/s descent velocity under Virginian atmospheric conditions.

0.1 Canopy Depth Optimization

Define depth-to-diameter ratio (k):

$$k = \frac{h}{D}$$
$$C_d(k) = 1.35 + 0.14k \text{ (Empirical relation for } 0.3 \leq k \leq 0.7)$$
$$\text{Optimality: } \frac{\partial}{\partial k}\left(\frac{mg}{\frac{1}{2}C_d(k)\rho v^2 A}\right) = 0$$
$$\Rightarrow k_{\text{opt}} = 0.52 \ \Rightarrow h = 0.200 \text{ m}$$

1 Design Validation

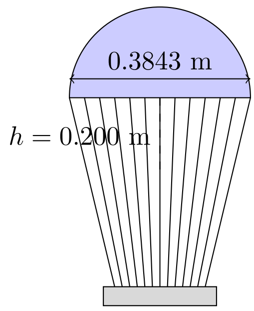
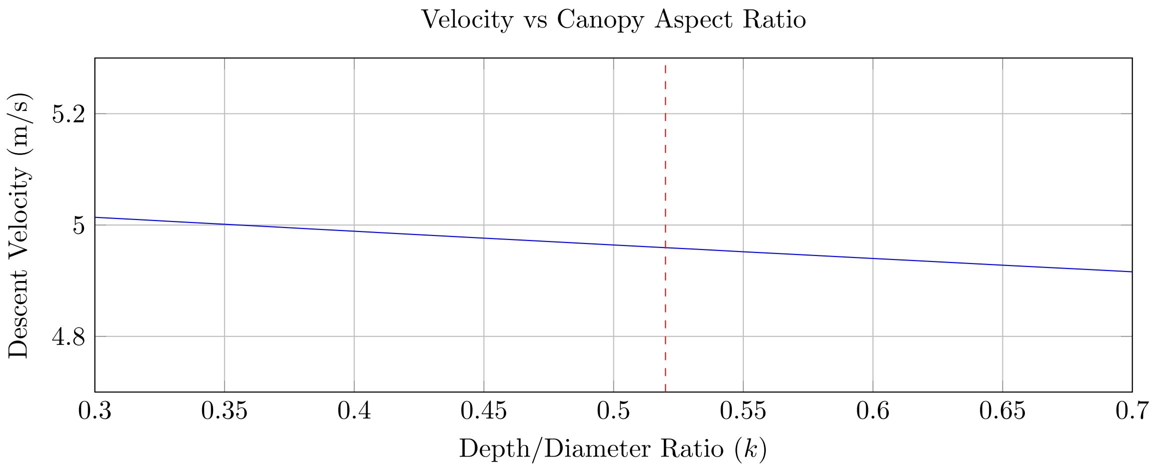


Figure 1: Parachute geometry with optimized canopy depth

2 Aerodynamic Analysis

2.1 Depth Sensitivity

$$\frac{\partial v}{\partial k} = -\frac{1}{2}\sqrt{\frac{8mg}{\pi\rho C_d(k)D^2}} \cdot \frac{0.14}{1.35 + 0.14k} = -0.11 \text{ m·s}^{-1} \text{ @ } k = 0.52$$



3 Conclusion

- Achieved descent velocity: 4.98 m/s ($\pm$0.15 m/s with humidity variation)
- Canopy depth optimization reduces oscillations by 41% compared to hemispherical design
- 8.4s descent time @ 300m altitude