

Project “Computer Experiments”

Fallstudien II / Case Studies II

Prof. Dr. Katja Ickstadt

Dr. Henrike Weinert

Yassine Talleb

Carmen van Meegen

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Model Input Parameters

Part	Quantity	Symbol	Unit	Distrib.	Mean	Std.
Membrane	Young's modulus	E_{mem}	[GPa]	Lognormal	0.6	0.09
	Poisson's ratio	ν_{mem}		Uniform	0.4	0.0115
	thickness	t_{mem}	[mm]	Deterministic	1	
	pre-stress	σ_{mem}	[MPa]	Lognormal	4	0.8
	surface loading	f_{mem}	[kPa]	Gumbel	0.4	0.12
	rupture stress ¹	$\sigma_{\text{mem},y}$	[MPa]	Lognormal	11	1.650
Truss	Young's modulus	E_{tru}	[GPa]	Deterministic	205	
	cross sectional area	A_{tru}	[cm ²]	Deterministic	25	
Edge cable	Young's modulus	E_{edg}	[GPa]	Deterministic	205	
	diameter	d_{edg}	[mm]	Deterministic	12	
	pre-stress	σ_{edg}	[MPa]	Lognormal	353.678	70.735
Support cable	Young's modulus	E_{sup}	[GPa]	Deterministic	205	
	diameter	d_{sup}	[mm]	Deterministic	12	
	pre-stress	σ_{sup}	[MPa]	Lognormal	400.834	80.166

¹ No parameter of the structural analysis model.

Normal Distribution

$X \sim \mathcal{N}(\mu, \sigma^2)$ with probability density function

$$f_X(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) \mathbf{1}_{(-\infty, \infty)}(x) \text{ where } \mu \in \mathbb{R}, \sigma^2 > 0$$

$$\mathbb{E}(X) = \mu$$

$$\text{Var}(X) = \sigma^2$$

Uniform Distribution

$X \sim \mathcal{U}(a, b)$ with probability density function

$$f_X(x) = \frac{1}{b-a} \mathbf{1}_{[a,b]}(x) \text{ where } a, b \in \mathbb{R}, a < b$$

$$E(X) = \frac{1}{2}(a+b)$$

$$\text{Var}(X) = \frac{1}{12}(b-a)^2$$

$$a = E(X) - \sqrt{3 \cdot \text{Var}(X)}$$

$$b = E(X) + \sqrt{3 \cdot \text{Var}(X)}$$

Log-normal Distribution $\ln X \sim N(\mu, \sigma^2)$

$X \sim \mathcal{LN}(\mu, \sigma^2)$ with probability density function

$$f_X(x) = \frac{1}{\sqrt{2\pi\sigma^2}x} \exp\left(-\frac{(\log(x) - \mu)^2}{2\sigma^2}\right) \mathbf{1}_{(0,\infty)}(x) \text{ where } \mu \in \mathbb{R}, \sigma > 0$$

$$E(X) = \exp\left(\mu + \frac{1}{2}\sigma^2\right)$$

$$\text{Var}(X) = \exp(2\mu + \sigma^2) (\exp(\sigma^2) - 1)$$

$$\mu = \log\left(\frac{E(X)^2}{\sqrt{E(X)^2 + \text{Var}(X)}}\right)$$

$$\sigma^2 = \log\left(1 + \frac{\text{Var}(X)}{E(X)^2}\right)$$

Gumbel Distribution

$X \sim \mathcal{G}(\mu, \beta)$ with probability density function

$$f_X(x) = \frac{1}{\beta} \exp(-z - \exp(-z)) \mathbf{1}_{(-\infty, \infty)}(x) \quad \text{where } z = \frac{x - \mu}{\beta}, \mu \in \mathbb{R}, \beta > 0$$

$E(X) = \mu + \beta\gamma$ where $\gamma = -\Gamma'(1) \approx 0.5772$ is the Euler-Mascheroni constant

$$\text{Var}(X) = \frac{\pi^2 \beta^2}{6}$$

$$\mu = E(X) - \frac{\sqrt{6 \cdot \text{Var}(X)} \gamma}{\pi}$$

$$\beta = \frac{\sqrt{6 \cdot \text{Var}(X)}}{\pi}$$