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ACCIS — ADVANCED COMPOSITES COLLABORATION FOR INNOVATION & SCIENCE

UKRI Engineering and Physical Sciences Research Council

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Imperfection-Insensitive Continuous Tow-Sheared Cylinders

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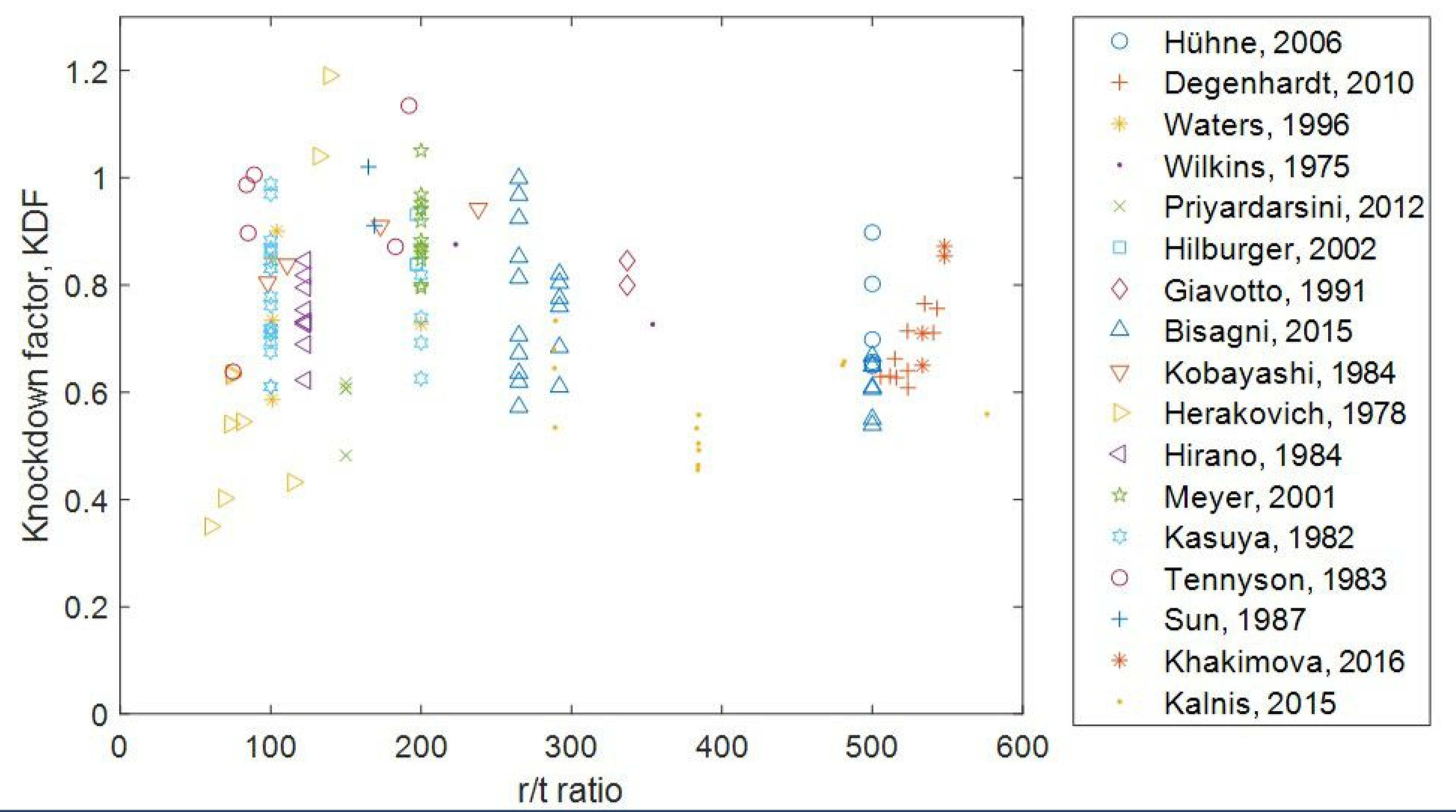
Problem

$$\text{KDF} = \left(\frac{P^*_{\text{ex}}}{P^*_{\text{cr}}}\right)$$

$$P^*_{\text{cr}} = \frac{2\pi E t^2}{\sqrt{3(1-\nu^2)}}$$

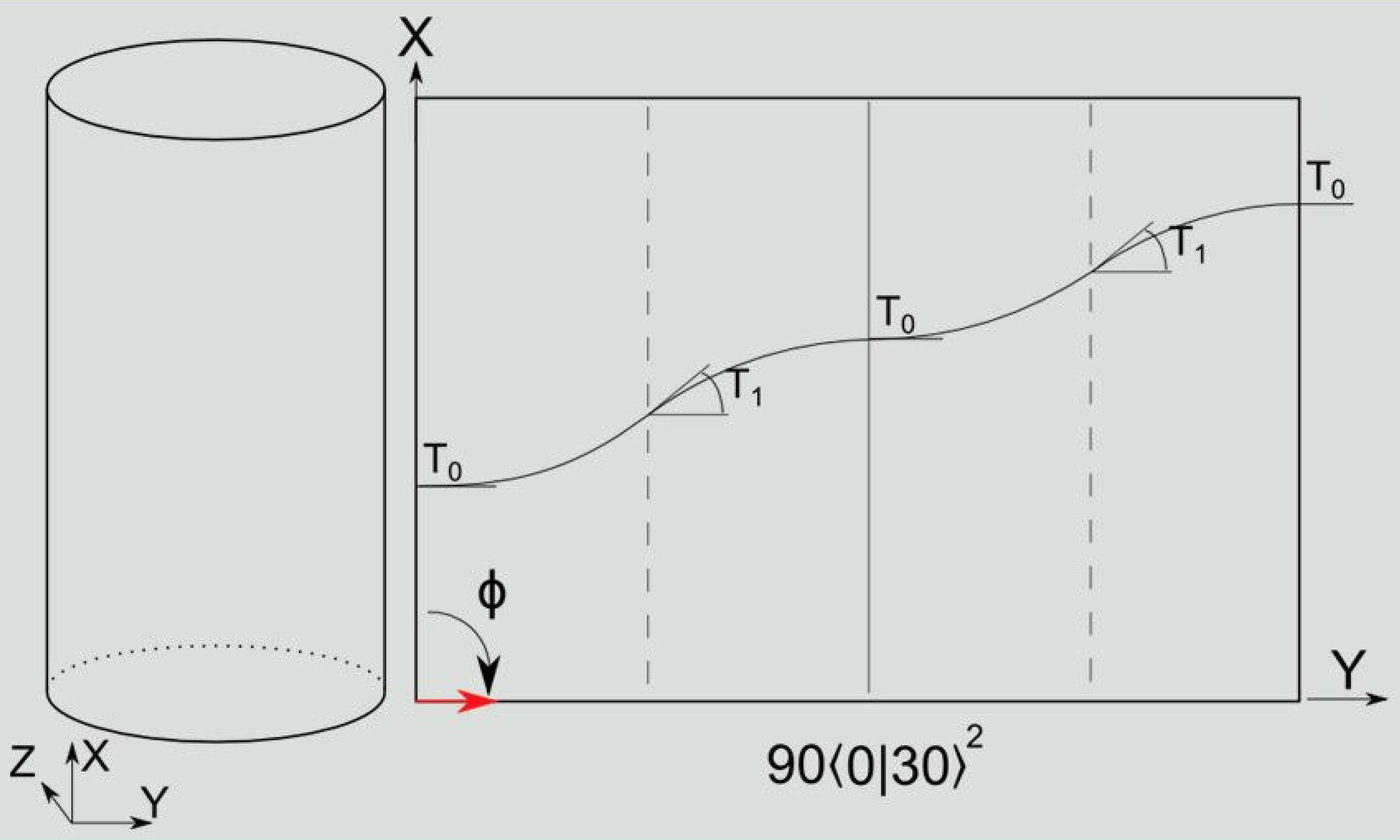
- Discrepancy between theory and experimental results due to imperfection sensitivity
- Conservative design philosophy leading to inefficient, heavy structures



Nomenclature

$$\phi\langle T_0|T_1\rangle^n$$

- ϕ: angle from X-axis to define cross-head direction
- T_0: angle from ϕ that defines initial shearing angle
- T_1: angle from T_0 that defines final shearing angle
- n: periodicity, *i.e.* how many the cycle $T_0 \rightarrow T_1 \rightarrow T_0$ happens

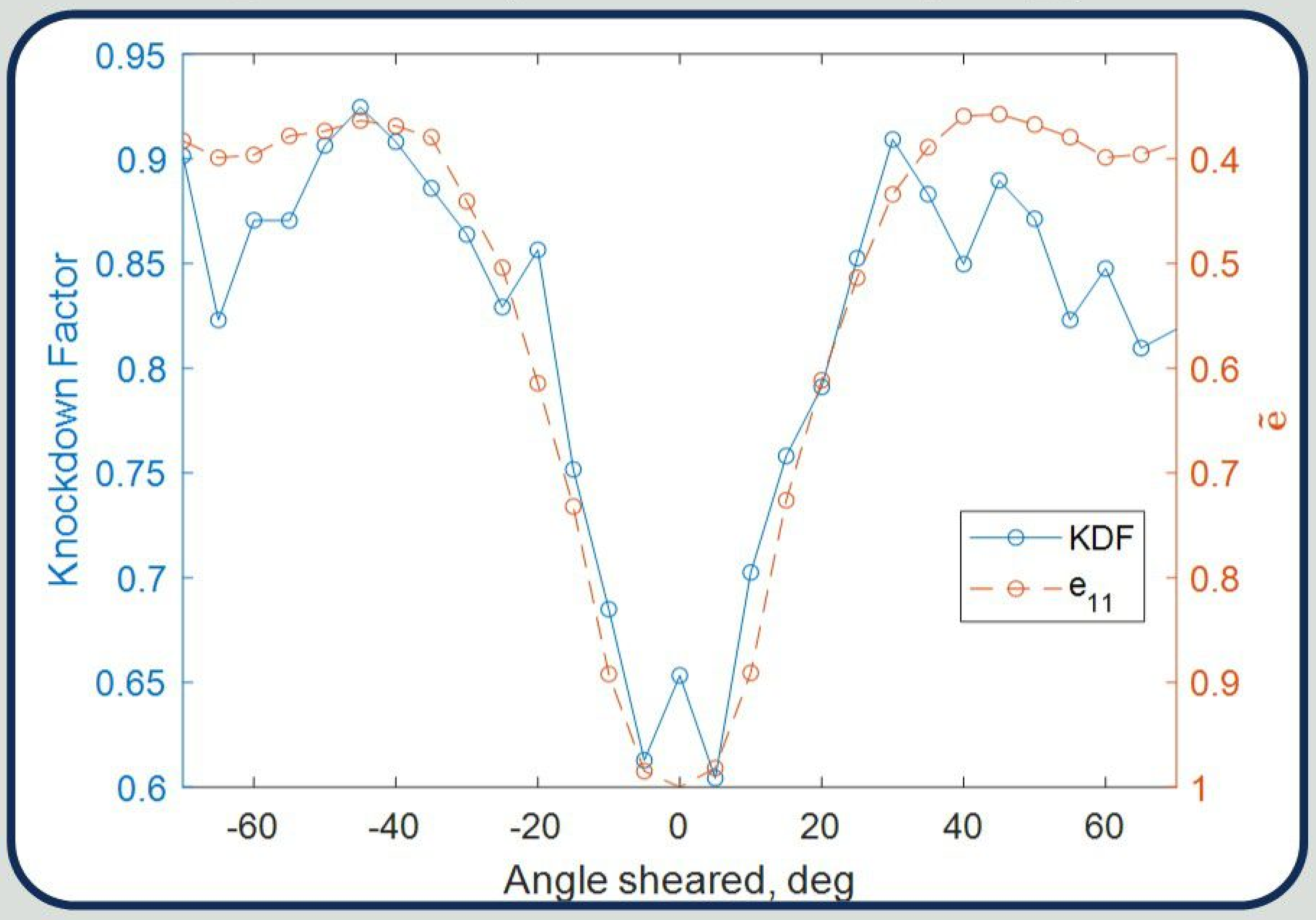


Results

$$[0\pm\langle 30|T_1\rangle^8, 90\pm\langle 30|T_1\rangle^{12}]_s$$

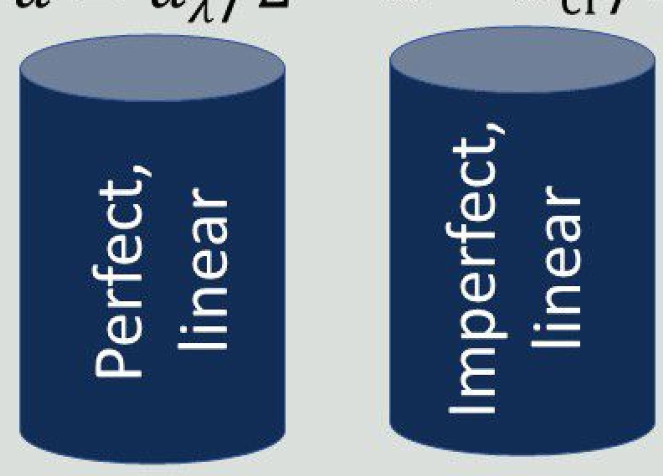
$$\text{KDF} = \left(\frac{P_\lambda}{P_{\text{cr}}}\right)$$

$P = P_\lambda$, $u = u_\lambda$ — $P = P_{\text{cr}}$, $u = u_{\text{cr}}$



$$\tilde{e} = \text{rms}\left(\bar{e}^{\text{perf}}_{11} - \bar{e}^{\text{imp}}_{11}\right)$$

$P = P_\lambda/2$, $u = u_\lambda/2$ — $P = P_{\text{cr}}/2$, $u = u_{\text{cr}}/2$



Cylinder	P^μ [kN]	σ [kN]	Var [N]
$[0\pm\langle 20\|25\rangle^2, 90\pm\langle 35\|25\rangle^9]_s$	193.4	4.16	84.7
$[\pm 45, 0, 90]_s$	170.6	5.72	178
Δ%	+13%	- 32%	- 71%

- Optimisation to maximise imperfect buckling load across a range of imperfections
- **Increased** average imperfect buckling load
- **Decreased** standard deviation and variance

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