Device cart on swivel castors, 15 kg at 1.07 m

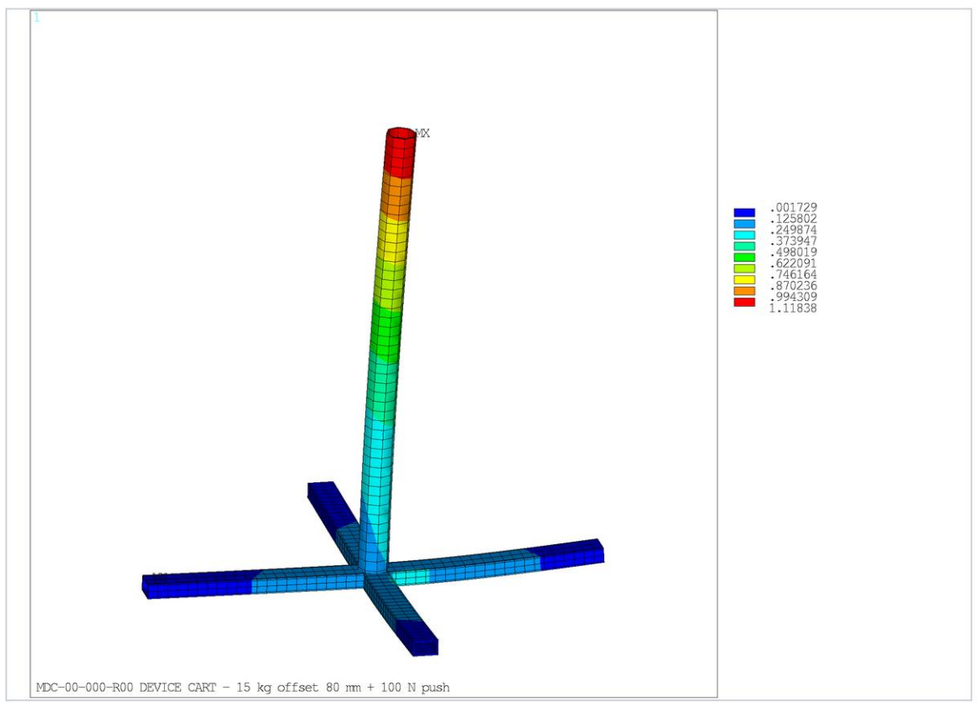
Concept design · parametric 3D CAD · tipping stability by hand in MATLAB · beam FEA and modal





Design data

Device	up to 15 kg, offset up to 80 mm
Shelf	400 x 350 mm at 1.07 m
Base	cross, RHS 50 x 30 x 3
Castors	4 x D100 on a 640 mm square
Ballast	plate 360 x 360 x 10, 10 kg
Column	tube D60 x 3
Handle	at 950 mm
Cart mass	27.8 kg, 0 interferences
Total mass	42.8 kg, CoG at 669 mm



Results

	FEA	Hand (MATLAB)
Tipping angle, worst direction		20.6 deg (target 10)
Push that tips, braked castors		111 N (target 100)
Castor loads, 100 N push	29 / 173 N	29 / 173 N
Column stress	13 MPa	13 MPa
Shelf deflection, 100 N push	1.08 mm	0.57 mm (column only)
First natural frequency	10.4 Hz	

Method

Stability comes first: tipping angle and the horizontal push that tips the cart with braked castors, with the device offset and the swivel castors turned the unfavourable way. The first layout (560 mm castor square, no ballast) tipped at 70 N, so the base was widened and a 10 kg ballast plate added. A beam model (142 elements) then gives castor loads, stresses, shelf deflection and natural frequencies; castor loads match the hand statics exactly.