0210 – Eccentric Transverse Force

Description

A console made of round bar of diameter d is loaded by means of eccentric transverse force F_y according to **Figure 1**. Determine the maximal deflection $u_{y,max}$ and maximal twist $\varphi_{x,max}$ of the console using geometrically linear analysis. The problem is described by the following set of parameters.

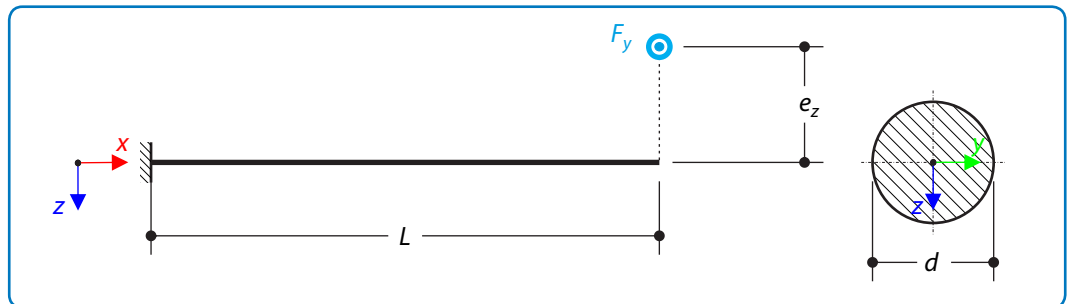| Material	Steel	Modulus of Elasticity	E	210000.000	MPa
		Poisson's Ratio	ν	0.300	—
Geometry		Length	L	1.000	m
		Diameter	d	20.000	mm
		Eccentricity	e_z	0.250	m
Load		Transverse Force	F_y	0.100	kN

Figure 1: Problem sketch

Analytical Solution

Considering geometrically linear analysis, the deflection of the console tip is defined by the following simple formula

$$u_{z,max} = \frac{F_y L^3}{3EI_y} \approx 20.210 \text{ mm,} \qquad (210 - 1)$$

where I_y is the moment of inertia of the circular cross-section. Transverse eccentric force F_y causes furthermore torque

$$M_x = F_y e_z. \qquad (210 - 2)$$

The twist of the console tip $\varphi_{x,max}$ is defined by means of the following formula

$$\varphi_{x,max} = \frac{M_x L}{GJ} \approx 0.0197 \text{ rad,} \qquad (210-3)$$

where G is the shear modulus and J is the torsional constant of the cross-section.

RFEM 5 and RSTAB 8 Settings

- Modeled in RFEM 5.19.01 and RSTAB 8.19.01
- The element size is $l_{FE} = 0.100$ m
- Isotropic linear elastic material model is used

Results

Structure Files	Program	Details
0210.01	RFEM 5	Eccentric Member Load
0210.02	RFEM 5	Rigid Member
0210.03	RSTAB 8	Rigid Member

Model	Analytical Solution	RFEM 5 / RSTAB 8	
	$u_{y,max}$ [mm]	$u_{y,max}$ [mm]	Ratio [-]
RFEM 5, Eccentric Member Load		20.210	1.000
RFEM5, Rigid Member	20.210	20.210	1.000
RSTAB 8, Rigid Member		20.210	1.000

Model	Analytical Solution	RFEM 5 / RSTAB 8	
	$\varphi_{x,max}$ [rad]	$\varphi_{x,max}$ [rad]	Ratio [-]
RFEM 5, Eccentric Member Load		0.0197	1.000
RFEM5, Rigid Member	0.0197	0.0197	1.000
RSTAB 8, Rigid Member		0.0197	1.000