

Program: RFEM 5, RF-FORM-FINDING

Category: Large Deformation Analysis, Isotropic Linear Elasticity, Member

Verification Example: 0205 – Cable Equilibrium Force

0205 – Cable Equilibrium Force

Description

A cable is loaded by means of the uniform load p according to **Figure 1**. This causes the deformed shape in the form of the circular segment with radius r . Determine the equilibrium force of the cable N to obtain the given sag of the cable h . The add-on module RF-FORM-FINDING is used for this purpose. Elastic deformations are neglected both in RF-FORM-FINDING and in analytical solution, also self-weight is neglected in this example. The problem is described by the following set of parameters.

Material	Steel Cable	Modulus of Elasticity	E	210000.000	MPa
		Poisson's Ratio	ν	0.300	–
Geometry		Supports Distance	L	1.000	m
		Cable Sag	s	0.010	m
Load		Member Uniform Load	p	1.000	kN/m

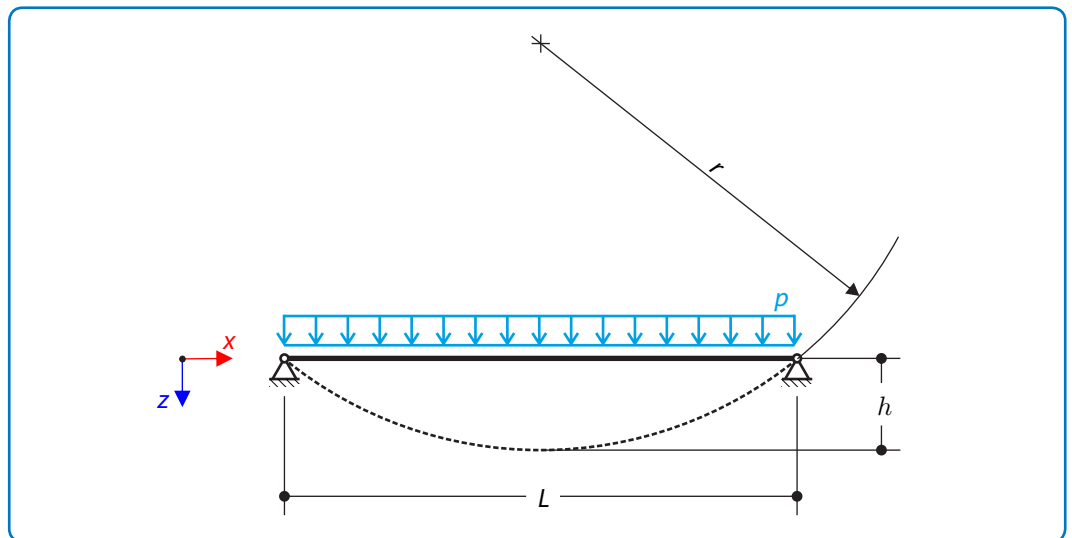


Figure 1: Problem sketch

Analytical Solution

The stress state of the membrane can generally be expressed by means of Laplace equation

$$\frac{\sigma_1}{r_1} + \frac{\sigma_2}{r_2} = \frac{p}{t}, \quad (205 - 1)$$

where σ_1, σ_2 are stresses in meridian and parallel direction respectively, r_1, r_2 are the radii in the corresponding directions and t is the thickness of the membrane. In case of the cable the second

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principal stress is equal to $\sigma_2 = 0$. The internal equilibrium force in the cable with the circular segment shape can be then derived using (205 – 1)

$$N = pr. \quad (205 - 2)$$

In this case, there is given sag of the cable h and the supports distance L . The radius r can be calculated by means of the following equation

$$r = \frac{L^2}{8h} + \frac{h}{2}. \quad (205 - 3)$$

The result internal equilibrium force N is then equal to

$$N = p \left(\frac{L^2}{8h} + \frac{h}{2} \right) \approx 12.505 \text{ kN}. \quad (205 - 4)$$

RFEM 5 Settings

- Modeled in RFEM 5.15.01
- The number of elements is 10
- Isotropic linear elastic material model is used

Results

Structure Files	Program	Modul
0205.01	RFEM 5	RF-FORM-FINDING

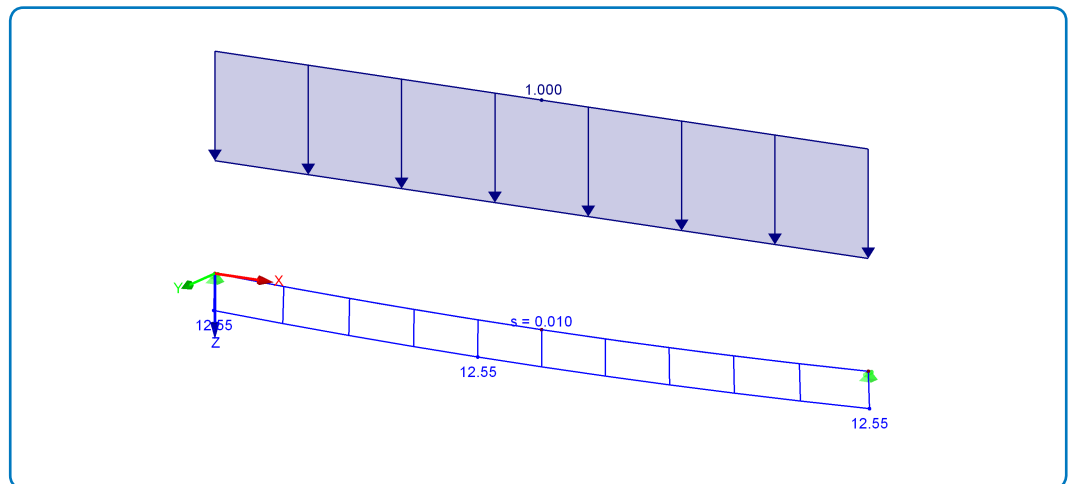


Figure 2: Result internal force in RFEM 5

Analytical Solution	RFEM 5 – RF-FORM-FINDING	
N [kN]	N [kN]	Ratio [-]
12.505	12.550	1.004