

Program: RFEM 5, RSTAB 8
Category: Second-Order Analysis, Large Deformation Analysis, Member
Verification Example: 0051 – Pinned Beam Subjected to Bending

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Description

Beam pinned at the both ends is loaded with the force F at the middle. Neglecting its self-weight and shear stiffness, determine beam's maximum deflection, normal force and moment at the mid-span assuming the second and the third order theory.

Material	Steel	Modulus of Elasticity	E	210.000	GPa
		Shear Modulus	G	81.000	GPa
		Yield Stress	f_y	0.355	GPa
Geometry	Beam	Length	L	8.000	m
		Height	h	0.400	m
		Width	b	0.180	m
		Web Thickness	s	0.010	m
		Flange Thickness	t	0.014	m
Load		Force	F	215.000	kN

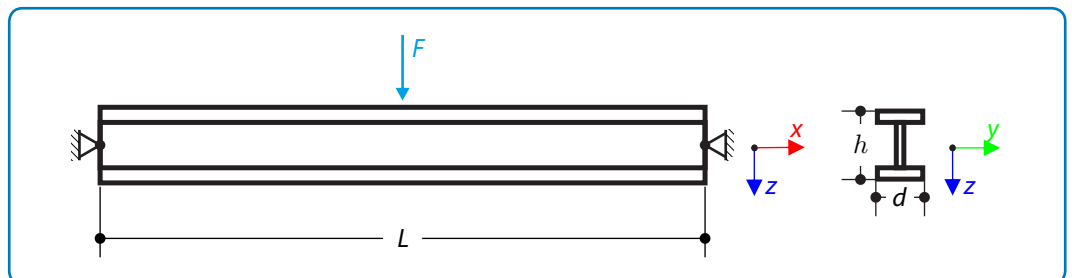


Figure 1: Problem sketch [1]

Analytical Solution

Analytical solution is not available for this example.

RFEM 5 and RSTAB 8 Settings

- Modeled in version RFEM 5.03.1142 and RSTAB 8.03.1142
- The element size is $l_{FE} = 0.800$ m
- The number of increments is 1
- The element type is member
- Isotropic linear elastic material model is used
- Shear stiffness of members is deactivated

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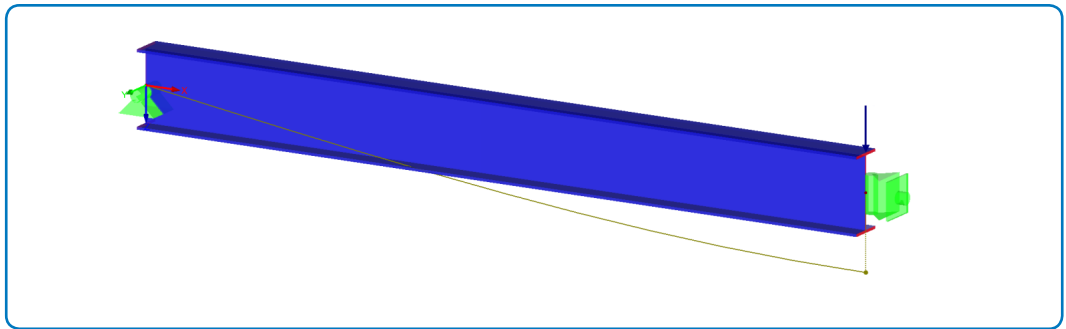


Figure 2: RFEM 5 model assuming the 2nd order theory

Results

Structure File	Program	Method of Analysis
0051.01	RFEM 5	Second-Order Analysis
0051.02	RFEM 5	Large Deformation Analysis
0051.03	RSTAB 8	Second-Order Analysis
0051.04	RSTAB 8	Large Deformation Analysis

As can be seen from the following comparisons, excellent agreement of the numerical outputs with the results given in [1] was achieved.

Analysis	S3D [2]	RFEM 5		RSTAB 8	
	$u_z(\frac{L}{2})$ [mm]	$u_z(\frac{L}{2})$ [mm]	Ratio [-]	$u_z(\frac{L}{2})$ [mm]	Ratio [-]
Second-Order Analysis	47.3	47.3	1.000	47.3	1.000
Large Deformation Analysis	46.4	46.4	1.000	46.4	1.000

Analysis	S3D [2]	RFEM 5		RSTAB 8	
	$M_y(\frac{L}{2})$ [kNm]	$M_y(\frac{L}{2})$ [kNm]	Ratio [-]	$M_y(\frac{L}{2})$ [kNm]	Ratio [-]
Second-Order Analysis	430	430	1.000	430	1.000
Large Deformation Analysis	423	423	1.000	423	1.000

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Analysis	S3D [2]	RFEM 5		RSTAB 8	
	$N(\frac{L}{2})$ [kN]	$N(\frac{L}{2})$ [kN]	Ratio [-]	$N(\frac{L}{2})$ [kN]	Ratio [-]
Second-Order Analysis	0	0	-	0	-
Large Deformation Analysis	147	147	1.000	147	1.000

References

- [1] LUMPE, G. and GENSICHEN, V. *Evaluierung der linearen und nichtlinearen Stabstatik in Theorie und Software: Prüfbeispiele, Fehlerursachen, genaue Theorie*. Ernst.
- [2] LUMPE, G. *S3D (Vers. 25.09.2011)*. Hochschule Biberach.