Verification Example

Program: RFEM 5, RF-GLASS

Category: Geometrically Linear Analysis, Isotropic Linear Elasticity, Glass, Solid

Verification Example: 0031 – Glass-Foil-Glass Plate

0031 – Glass-Foil-Glass Plate

Description

A composite plate, consisting of two glass layers and one foil layer in between, is subjected to the uniform pressure p. Neglecting plate's self-weight and assuming only the small deformation theory, determine the deflection u_z and stress $\sigma_{x,\max} = \sigma_{y,\max}$ in the middle of the bottom plane.

Consider following two types of boundary conditions:

- All sides are fully fixed
- Both glass layers are simply supported (z-direction is fixed only at the lowest glass plane)

Material	Glass	Modulus of Elasticity	$E_1 = E_3$	70000.000	MPa
		Poisson's Ratio	$\nu_1 = \nu_3$	0.230	–
	Foil	Modulus of Elasticity	E_2	0.030	MPa
		Poisson's Ratio	ν_2	0.499	–
Geometry	Plan	Length	L	1000.000	mm
		Width	L	1000.000	mm
	Layer 1	Thickness	t_1	4.000	mm
		Minimum z-coordinate	$z_{1,\min}$	−3.350	mm
		Maximum z-coordinate	$z_{1,\max}$	0.650	mm
	Layer 2	Thickness	t_2	0.700	mm
		Minimum z-coordinate	$z_{2,\min}$	0.650	mm
		Maximum z-coordinate	$z_{2,\max}$	1.350	mm
	Layer 3	Thickness	t_3	2.000	mm
		Minimum z-coordinate	$z_{3,\min}$	1.350	mm
		Maximum z-coordinate	$z_{3,\max}$	3.350	mm
Load		Constant Pressure	p	0.001	MPa

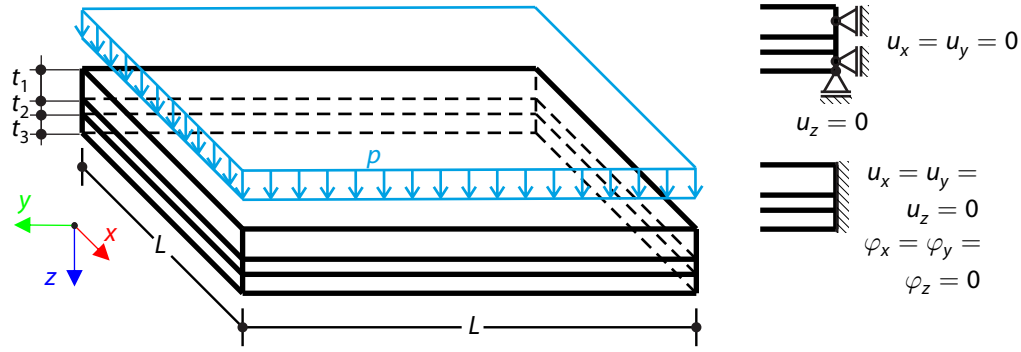

Figure 1: Problem sketch

RFEM 5 Settings

- Modeled in version RFEM 5.05.0018
- The element size is $l_{FE} = 0.020$ m
- Geometrically linear analysis is considered
- The number of increments is 1
- The element type is solid
- Isotropic linear elastic material model is used

Results

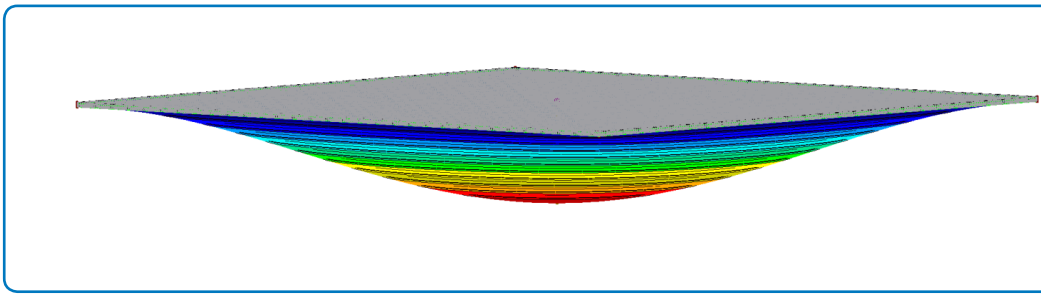

Figure 2: Deformation of composite plate with rotational degrees of freedom (simply supported plate)

Structure Files	Boundary Condition
0031.01	Fully Fixed
0031.02	Simply Supported

Because there is no analytical solution available, outputs from ANSYS are taken as a reference.

Boundary Conditions	ANSYS 15 (SOLID186)*	RFEM 5	
	$u_{z,max}$ [mm]	$u_{z,max}$ [mm]	Ratio [-]
Fully Fixed	2.828	2.764	0.977
Simply Supported	9.025	8.975	0.995

Boundary Conditions	ANSYS 15 (SOLID186)*	RFEM 5	
	$\sigma_{x,max} = \sigma_{y,max}$ [MPa]	$\sigma_{x,max} = \sigma_{y,max}$ [MPa]	Ratio [-]
Fully Fixed	7.165	7.002	0.977
Simply Supported	14.891	14.774	0.992

* Remark: Numerical solution in ANSYS 15 was carried out by the company Designtec s.r.o.