Verification Test Number

106

Scope

- Verify the calculation of wall forces for SAP2000 imported models
- Compare the wall forces for SAP2000 and ETABS imported models to the theoretical.

Files Used

Test Example 1 files

Example

The problem is a one-story, one-bay structure with one slab, one shear wall, three beams and two columns, shown in Figure 1.

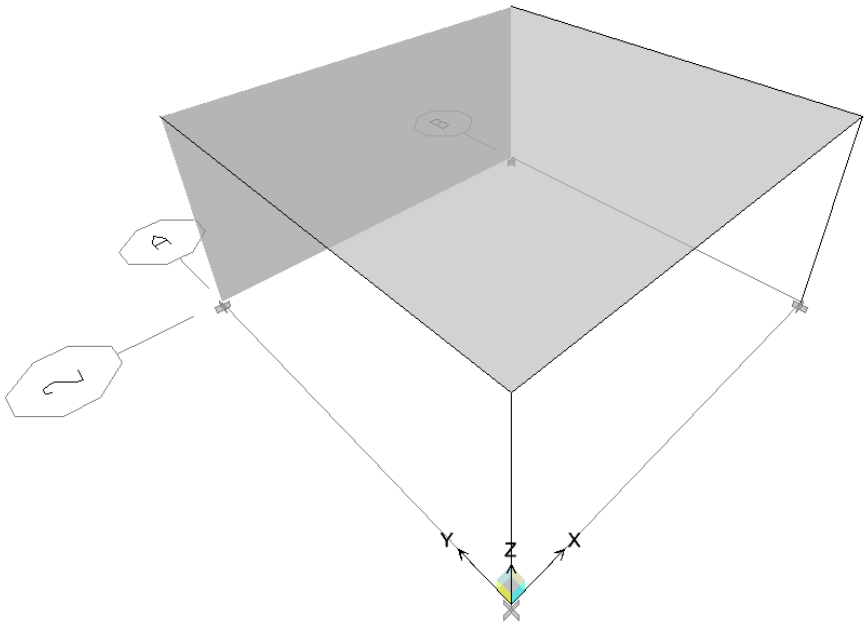

Figure 1. Example structure.

The story height is 3m and the bay lengths are 6m in both directions.

Three loadcases are applied:

- FX has two joint loads of 100 KN each in the direction of the X-axis, applied to the top corner joints.
- FY has two joint loads of 100 KN each in the direction of the Y-axis, applied to the top corner joints.
- FZ has two joint loads of 100 KN each in the direction of the Z-axis, applied to the top corner joints.

The wall element is discretized into a 2x2 mesh. The axial and shear degrees of freedom in both directions have been released at the top ends of the two columns.

Theoretical Solution

Axial Force N

The axial force N is equal to the sum of the forces in the Z-axis direction.

$$N = 200\ KN \text{ (compressive)}$$

Shear Force V_2

The shear force V_2 is the sum of the horizontal forces parallel to the face of the wall, that is, of loadcase FY.

$$V_2 = 200\ KN$$

Bending Moment M_2

The bending moment M_2 is found by multiplying the forces acting in the direction perpendicular to the wall by the height of the wall.

$$M_2 = 200\ KN \cdot 3\ m = 600\ KNm$$

Bending Moment M_3

The bending moment M_3 is found by multiplying the forces acting in the direction parallel to the wall by the height of the wall.

$$M_3 = 200\ KN \cdot 3\ m = 600\ KNm$$

Procedure

Model Imported from SAP2000

The calculations in this example are for the shear wall panel Test Example 1 – SAP2000 model.

Nodal Forces

Table 1 shows the nodal forces at the bottom section of the wall.

Area	Joint	Loadcase	F1	F2	F3	M1	M2
2	4	FX	-100.000	0.001	-99.571	0.006	-1.282
2	~118	FX	0.000	0.009	-22.621	-0.001	0.000
2	4	FY	-1.228	-100.000	0.000	293.541	-0.651
2	~118	FY	-0.443	0.000	0.000	0.000	0.118
2	4	FZ	18.961	0.000	100.000	-0.004	-3.969
2	~118	FZ	1.423	0.000	0.000	0.000	-1.896
2	~118	FX	0.000	-0.009	22.621	0.001	0.000
2	13	FX	-100.000	-0.001	99.571	-0.006	-1.282
2	~118	FY	0.443	0.000	0.000	0.000	-0.118
2	13	FY	1.228	-100.000	0.000	293.541	0.651
2	~118	FZ	-1.423	0.000	0.000	0.000	1.896
2	13	FZ	-18.961	0.000	100.000	-0.004	3.969

Table 1. Nodal forces at bottom section of the wall.

Axial Force N

The axial force N is found by summing up the vertical forces F3 of loadcase FZ at the bottom section of the wall.

$$N = \sum_{bottom} F_3 = 200\ KN \text{ (compressive)}$$

Shear Force V_2

The shear force V_2 is found by summing up the horizontal nodal forces F1 and F2 of loadcase FZ at the bottom section of the wall, taking into account the angle of the wall to axis X, which is 0.

$$V_2 = \sum_{bottom} \left(F_1 \cdot Cos(\vartheta) + F_2 \cdot Sin(\vartheta) \right) = 200\ KN$$

Bending Moment M_2

The bending moment M_2 is found by summing up the banding moments M1 and M2 of loadcase FY, at the bottom section of the wall, taking into account the angle of the wall to axis X which is 0.

$$M_2 = \sum_{bottom} \left(M_1 \cdot Cos(\vartheta) + M_2 \cdot Sin(\vartheta) \right) = 587\ KN$$

Bending Moment M_3

The bending moment M_3 is found by summing up the moment of the vertical forces F3 of loadcase FX about the centroid of the wall, at the bottom section of the wall.

$$M_3 = \sum_{bottom} \left(F_3 \cdot \Delta x \right) = \left(-99.5\ KN \right) \cdot \left(-3.0\ m \right) + 99.5\ KN \cdot 3.0\ m = 597\ KNm$$

Model Imported from ETABS

The shear wall forces are calculated by ETABS and appear in Table 2.

Results Comparison

The results of the theoretical calculations are compared to the results of the models created with SAP2000 and with ETABS.

Test Example 1	Theoretical	SAP2000	ETABS
N	-200 KN	-200 KN	-200 KN
V_2	200 KN	200 KN	200 KN
M_2	600 KNm	587 KNm	522 KNm
M_3	600 KNm	597 KNm	597 KNm

Table 2. Comparison of SAP2000 and ETABS model results.