Benchmark Example No. 16

Torsion due to Biaxial Bending

SOFiSTiK | 2018
VERIFICATION MANUAL
BE16: Torsion due to Biaxial Bending

VERIFICATION MANUAL, Version 2018-15.2
Software Version: SOFiSTIK 2018

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The user of the program is solely responsible for the applications. We strongly encourage the user to test the correctness of all calculations at least by random sampling.

Front Cover
1 Problem Description

The problem consists of a beam subjected to transverse load $P_z$ and a lateral load $P_y$, as shown in Fig. 1. The effect of torsion due to biaxial bending is examined.

![Figure 1: Problem Description](image)

2 Reference Solution

For an I-beam subjected to biaxial bending, without the action of a normal force, it follows directly from the beam theory that a torsional moment will inevitably appear, even if the cross-section is double symmetric, the load is centrically applied, and the beam is statically determined. In order to account for this effect, third order theory has to be utilised.

3 Model and Results

The properties of the model [1] are defined in Table 1. A standard steel material is used as well as a cross-section with a standard rolled steel shape. A safety factor $\gamma_M = 1.1$ is used, which according to DIN 18800-2 it is applied both to the yield strength and the stiffness. Furthermore, the self weight and the shear deformations are neglected. At the supports the warping is not constrained.

![Table 1: Model Properties](table)
The results are presented in Table 2. It has to be noted that the reference results are according to [1] and [4], where they are computed with another finite element software, and not with respect to an analytical solution.

<table>
<thead>
<tr>
<th></th>
<th>( C_M = 125900 \text{ [cm}^6\text{]} )</th>
<th>Ref. [1]</th>
<th>( C_M = 0 )</th>
<th>Ref. [1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \phi_x \text{ [rad]} )</td>
<td>0.0316</td>
<td>0.0315</td>
<td>0.0321</td>
<td>0.0321</td>
</tr>
<tr>
<td>( M_x \text{ [kN m]} )</td>
<td>0.183</td>
<td>0.185</td>
<td>0.185</td>
<td>0.189</td>
</tr>
<tr>
<td>( M_y \text{ [kN m]} )</td>
<td>24.88</td>
<td>24.9</td>
<td>24.85</td>
<td>24.9</td>
</tr>
<tr>
<td>( M_z \text{ [kN m]} )</td>
<td>5.57</td>
<td>5.6</td>
<td>5.71</td>
<td>5.7</td>
</tr>
</tbody>
</table>

### 4 Conclusion

This example presents a case where torsion is induced to the system because of biaxial bending. It has been shown that the behaviour of the beam is captured accurately.

### 5 Literature


