

Version November 2017

Program

SHAPE-THIN

Cross-section properties and designs of thin-walled cross-sections

Introductory Example

All rights, including those of translations, are reserved. No portion of this book may be reproduced – mechanically, electronically, or by any other means, including photocopying – without written permission of DLUBAL SOFTWARE GMBH.



© Dlubal Software GmbH 2017 Am Zellweg 2 93464 Tiefenbach Germany

Tel.: +49 9673 9203-0 Fax: +49 9673 9203-51 E-mail: info@dlubal.com Web: www.dlubal.com Dlub



Contents

Contents

Page

1.	Introduction 2
2.	Cross-Section and Loads
2.1	Cross-section
2.2	Internal Forces
3.	Creating the Cross-Section4
3.1	Starting SHAPE-THIN
3.2	Creating the Cross-section4
4.	Cross-Section Data
4.1	Checking Default Settings
4.2	Changing Material
4.3	Defining Elements
4.3.1	Placing Elements
4.3.2	Editing Elements
4.4	Defining Angle
4.4.1	Placing Section
4.4.2	Rotating Section
4.5	Defining Welds
4.5.1	Deleting Point Elements
4.5.2	Placing Welds
4.6	Checking Cross-Section Parts
5.	Loads
5. 5.1	Loads19Load Case 1: Tension and Bending19
5. 5.1 5.2	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21
5. 5.1 5.2 5.3	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22
5. 5.1 5.2 5.3 6.	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23
 5.1 5.2 5.3 6. 6.1 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23
 5.1 5.2 5.3 6.1 6.2 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24
 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24
5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24
5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24
5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7.	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25
5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results29
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 7.3 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25Results Tables29Multiple Windows View32
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 7.3 8. 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25Results Tables29Multiple Windows View32Documentation33
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 7.3 8. 8.1 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25Results Tables29Multiple Windows View32Documentation33Creating Printout Report33
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 7.3 8. 8.1 8.2 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25Results Tables29Multiple Windows View32Documentation33Creating Printout Report33Adjusting Printout Report34
 5. 5.1 5.2 5.3 6. 6.1 6.2 6.2.1 6.2.2 6.3 7. 7.1 7.2 7.3 8. 8.1 8.2 8.3 	Loads19Load Case 1: Tension and Bending19Load Case 2: Compression and Bending21Checking Load Cases22Calculation23Adjusting Calculation Parameters23Checking Input Data24Plausibility Check24Checking Interconnecting Elements24Calculating the Cross-Section24Results25Graphical Results25Results Tables29Multiple Windows View32Documentation33Creating Printout Report33Adjusting Printout Report34Printing Graphics in Printout Report35

1 Introduction

With this introductory example we want to show you the most important functions of the program SHAPE-THIN. Like in any other software there are many ways to reach a goal in SHAPE-THIN. Depending on the situation and your personal preferences, it may be useful to proceed in one way or another.

The example describes a steel angle to which an unequal angle section is welded. We will determine the cross-section values, the stresses and the effective widths of the angle. Furthermore, this simple cross-section should encourage you to discover the possibilities of SHAPE-THIN on your own.



Once the 90 day testing phase has expired, you can still enter and calculate the angle as the restrictions for the demo version of a maximum of four elements are met.

The described buttons are given in square brackets; for example, [Apply]. In addition, they are pictured on the left. Expressions appearing in dialog boxes, tables, and menus are set in *italics*. This way you can better follow the explanations. Required input is written in **bold**.

To find a description of the program functions, read the manual of SHAPE-THIN that you can download on our website.

The file **Section.du8** including cross-section properties is also stored in the *Examples* project that was created during the installation. However, for the first steps with SHAPE-THIN we recommend entering the section manually.

2 Cross-Section and Loads

2.1 Cross-section

The example is a welded steel angle consisting of steel plates with a thickness of 12 mm and 10 mm to which an angle section L 200x150x12 is welded.



Figure 2.1: Sketch of cross-section

The section is made of steel S 355.

2.2 Internal Forces

Load case 1: Tension and bending



In the first load case, a tensile force is applied together with biaxial bending. The internal forces are acting in the direction of the member axes x, y and z.

- N = 35 kN
- $V_v = 15 \text{ kN}$
- $V_z = -25 \text{ kN}$
- $M_v = 60 \text{ kNm}$
- $M_z = 15 \text{ kNm}$

Load case 2: Compression and bending

In the second load case, we will analyze a compressive force together with bending moments.

- $\mathrm{N}=-80~\mathrm{kN}$
- $V_y = -10 \text{ kN}$
- $\rm V_z = -20 \ kN$
- $M_y = 40 \text{ kNm}$
- ${\rm M_z}=-5~{\rm kNm}$

3 Creating the Cross-Section



3.1 Starting SHAPE-THIN

We start SHAPE-THIN with the icon **Dlubal SHAPE-THIN 8.xx** on the desktop.

You can also start the program on the taskbar

 $\textbf{Start} \rightarrow \textbf{All Programs} \rightarrow \textbf{Dlubal} \rightarrow \textbf{Dlubal SHAPE-THIN 8.xx}.$

3.2 Creating the Cross-section

The SHAPE-THIN work window opens and we can see a dialog box. We are asked to define the general data of a new cross-section.

If a section is already displayed in the window, we close it by using the menu **File** \rightarrow **Close**. Then, we open the *General Data* dialog box with the menu **File** \rightarrow **New**.

New Model - General Data	×
General History	
Cross-Section Name Description	
Section Manual exa	mple
Project Name Description	
Examples Example m	odels
Folder:	8
C:\Users\Public\Documents\Dlubal\Projects\Exam	ples
loading conditions)	
c/t parts and effective cross-section properties	
Plastic capacity design (with combined loading conditions)	
Positive Orientation of Y-Axis	Template
○ To the left	Open template cross-section:
● To the right	
ž	
Comment	
	~ 🕞
	· · · · · · · · · · · · · · · · · · ·
2 📝 🚾 🐴 🖏 🛤	OK Cancel

Figure 3.1: Dialog box New Model - General Data

In the *Cross-Section Name* text box we enter **Section**, and in the *Description* box we enter **Manual example**. A model name must always be defined because it determines the name of the SHAPE-THIN file. A description, however, does not necessarily need to be used.

Then, we select the **Examples** project from the list in the field *Project Name* if it is not preset. The *Description* of the project and the *Folder* are shown automatically.

In the dialog section *Calculate Additionally*, we select the checkbox for **c/t parts and effective cross-section properties** because we want to perform a classification.

We don't change the Positive Orientation of Y-Axis, and we keep the default To the right.

Finally, we have defined the general data of the model. We close the dialog box with [OK].

The empty work window of SHAPE-THIN is displayed.

4 Cross-Section Data

4.1 Checking Default Settings

Work window





To change the position of the axes, we click the button [Move, Zoom, Rotate] in the toolbar above. The mouse pointer turns into a hand. While holding down the left mouse button we can now place the work space in any position. For entering data we recommend moving the axes of coordinates to the left in the direction of the navigator.

 \odot

The hand also allows zooming in and out: Hold down the shift key and the left mouse button and move the pointer up and down.

To close the function, you have different possibilities:

- Click the toolbar button again
- Press the [Esc] key
- Right-click into the work space

Units

For our example, we set the metric units. The units and decimal places can be changed anytime during the input and evaluation. The values will be converted and adjusted automatically.

We open the dialog box Units and Decimal Places by clicking on the menu

 $\textbf{Edit} \rightarrow \textbf{Units and Decimal Places}.$



Figure 4.1: Dialog box Units and Decimal Places

We click the [Load Saved Profile] button. In the Load Profile dialog box, we select the Metric profile.

When clicking [OK], the modified units are set for the *Input*, *Results* and *Dimensions*. We save our changes by [OK], thus closing the *Units and Decimal Places* dialog box.

Grid

-

The grid forms the background of the work space. The spacing of grid points can be adjusted with the button *Settings of Work Plane, Grid/Snap, Object Snap, Guide Lines* shown on the left.

Work Plane, Grid/Snap, Object Snap and Guidelines		×
Origin of Work Plane		
Node No.: 🗸 🍾		
Coordinates Y: 0.0 + [mm] Z: 0.0 + [mm]		
Grid/Snap Object Snap Guidelines Background Laye	rs Line Grids	
Show Type	Number of Grid Points	5
Grid Cartesian	Dynamically according to size of model	
	(+) (-)	
Distance: 10 - [px]	Direction 1: 30 - 30 -	
	2: 30 - 30 -	
71.6	Grid Point Spacing	
	Space b: 20.0 - [mm]	
tet to be	h : 20.0 ≑▶ [mm]	
A A A A A A A A A A A A A A A A A A A	Rotation β: 0.00 + [*]	
z z	Grid Line Spacing	5
	Number n1: 10 🜩	
	n2: 10 🜩	
	OK Cancel	

Figure 4.2: Dialog box Work Plane, Grid/Snap, Object Snap and Guidelines

For our example, we adjust the grid point spacing to **20 mm**. We close the dialog box with [OK].

SNAP GRID

For entering data later it is important that the control fields *SNAP* und *GRID* in the status bar are set active. This way the grid becomes visible in the work space and the points will be snapped on the grid when clicking.

Mouse functions

The mouse functions follow the general standards for Windows applications. To select an object for further editing, we click it once with the **left** mouse button. To open its Edit dialog box, we double-click the object.

When we click an object with the **right** mouse button, its shortcut menu appears showing us object-related commands and functions.



By scrolling the **wheel button** we can maximize or minimize the current model representation. The position of the mouse pointer is always taken as the center of the zoom area.



By holding down the wheel button we can move the model directly without previously activating the button [Move, Zoom, Rotate]. The pointer symbols show the selected function.

4.2 Changing Material

Steel A992 is preset as material. As our section consists of steel S355, we have to change the material.

In the navigator, we click on the \pm symbol to open the **materials**. Then, we click on the entry *1: Steel A992* with the right mouse button.

In the shortcut menu, we select the **Edit** option.



Figure 4.3: Edit materials in shortcut menu of navigator

The dialog box Edit Material appears.



Figure 4.4: Dialog box Edit Material with access to library

1



Material Library			
Filter	Material to Select		
Matorial catogony groups	Material Description	Standard	
		EN 1002-1-1:20	05-05
Metal ~	Steel 5 235	EN 1993-1-1:20	105-05
	Steel S 275	EN 1993-1-1:20	005-05
Material category:	Steel S 355	🔯 EN 1993-1-1:20	005-05
Steel ~	Steel S 450	EN 1993-1-1:20	05-05
	Steel S 275 N	EN 1993-1-1:20	05-05
Standard group:	Steel S 275 NL	EN 1993-1-1:20	05-05
EN 🗸	Steel S 355 N	EN 1993-1-1-20	05-05
		EN 1002 1 1/20	05 05
Standard:	Steel S 355 NL	EN 1993-1-1:20	105-05
EN 1993-1-1:2005-05	Steel S 420 N	EN 1993-1-1:20	005-05
	Steel S 420 NL	EN 1993-1-1:20	05-05
	Steel S 460 N	EN 1993-1-1:20	05-05
	Steel S 460 NL	EN 1993-1-1:20	05-05
	Steel S 275 M	EN 1993-1-1:20	05-05
	Steel S 275 MI	EN 1993-1-1:20	05-05
	Steel S 255 M	EN 1002 1 1/20	05 05
	Steel S 355 M	EN 1993-1-1:20	105-05
	Steel S 355 ML	EN 1993-1-1:20	005-05
🗌 Include invalid 🛛 🔤	Steel S 420 M	EN 1993-1-1:20	05-05
Eavorites group:	Steel S 420 ML	EN 1993-1-1:20	05-05
r avonceo groupi			
	Search:		7
Material Properties	Search:		N 1993-1-1:2005-0
Material Properties	Search:	Steel S 355 EN	N 1993-1-1:2005-0
Material Properties	Search:	Steel S 355 EN	1993-1-1:2005-0 0000.0 N/mm ²
Material Properties Main Properties Modulus of Elasticity Shear Modulus	Search:	Steel S 355 EN	V 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ²
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio	Search:	E 21 G 8 V	1 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight	Search:	E 21 G 8 V 7	1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³
Material Properties Main Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans	Search:	E 21 G 8 ν 7 α 1.200	1 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties District 20 operties	Search:	E 21 G 8 γ 7 α 1.200	11993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t ≤ 40.0 mm	sion	E 21 G 8 γ 7 α 1.200	11993-1-1:2005-0 0000.0 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C
☐ Brokers group ☐ Main Properties ☐ Main Properties ☐ Main Properties ☐ Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans ☐ Additional Properties ☐ Thickness Range t ≤ 40.0 mm Yield Strength	Search:	E 21 G 8 γ 7 α 1.200	1 1993-1-1:2005-0 0000.0 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C
Image: Statute	Search:	E 21 G 8 γ 1.200 fy fu	V 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C 355.0 N/mm ² 490.0 N/mm ²
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t > 40.0 mm Yield Strength Utimate Strength Thickness Range t > 40.0 mm	Search: Search: sion	E 21 G 8 γ 1.200 fy fu fy fu	1 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C 355.0 N/mm ² 490.0 N/mm ² 335.0 N/mm ²
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t \$ 40.0 mm Yield Strength Thickness Range t \$ 40.0 mm Yield Strength	Search:	E 21 G 8 γ 1 α 1.200 fy fu fy fu	1 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/'C 355.0 N/mm ² 490.0 N/mm ² 335.0 N/mm ²
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t ≤ 40.0 mm Yield Strength Ultimate Strength	Search:	E 21 G 8 γ 1200 fy 1200 fy 1400 fu 1200	1993-1-1:2005-0 0000.0 N/mm2 0769.2 N/mm2 0.300 78.50 KN/m3 00E-05 355.0 N/mm2 490.0 N/mm2 335.0 N/mm2 470.0 N/mm2
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t ≤ 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 80.0 mm Yield Strength Thickness Range t > 80.0 mm Yield Strength	Search:	E 21 G 8 v 7 α 1.200 fy 1 fy 1 fy 1 fy 1	1 1993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C 355.0 N/mm ² 490.0 N/mm ² 335.0 N/mm ² 470.0 N/mm ²
■ Material Properties ■ Main Properties ■ Modulus of Elasticity Shear Modulus ■ Poisson's Ratio Specific Weight Coefficient of Thermal Expans ■ Additional Properties ■ Thickness Range t ≤ 40.0 mm Yield Strength ■ Thickness Range t > 40.0 mm Yield Strength ■ Thickness Range t > 80.0 mm Yield Strength ■ Thickness Range t > 80.0 mm Yield Strength ■ Utimate Strength	Image: Search:	E 21 G 8 v 7 α 1.200 fy fu fy fu fy fu fy fu fy fu	11993-1-1:2005-0 0000.0 N/mm ² 0769.2 N/mm ² 0.300 78.50 kN/m ³ 00E-05 1/°C 355.0 N/mm ² 490.0 N/mm ² 470.0 N/mm ² 315.0 N/mm ² 470.0 N/mm ²
→ Brokes group Material Properties ■ Main Properties ■ Modulus of Elasticity > Shear Modulus ■ Poisson's Ratio > Specific Weight ⊂ Coefficient of Thermal Expans ■ Additional Properties ■ Thickness Range t ≤ 40.0 mm Yield Strength ■ Thickness Range t > 40.0 mm Yield Strength ■ Thickness Range t > 80.0 mm Yield Strength ■ Thickness Range t > 80.0 mm Yield Strength ■ Thickness Range t > 80.0 mm ■ Yield Strength ■ Thickness Range t > 80.0 mm ■ Yield Strength ■ Thickness Range t > 80.0 mm	Image: Search:	E 21 G 8 ν 7 α 1.200 fy fu fy fu fy fu fy fu	11993-1-1:2005-0 0000.0 N/mm² 0769.2 N/mm² 0.300 78.50 KN/m³ 00E-05 355.0 N/mm² 490.0 N/mm² 335.0 N/mm² 335.0 N/mm² 335.0 N/mm² 315.0 N/mm² 470.0 N/mm²
Image: Second System Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t ≤ 40.0 mm Yield Strength Ultimate Strength	Image: Search:	E 21 G 8 ν 7 α 1.200 fy 1 fy fu fy fu fy fu fy fu fy fu fy fu	11993-1-1:2005-0 0000.0 N/mm2 0769.2 N/mm2 0.300 78.50 KN/m3 00E-05 355.0 N/mm2 490.0 N/mm2 335.0 N/mm2 335.0 N/mm2 315.0 N/mm2 295.0 N/mm2
Interview of the second se	Image: Search:	E 21 G 8 γ 7 α 1.200 fy 1	11993-1-1:2005-0 0000.0 N/mm2 0769.2 N/mm2 0.300 78.50 KN/m3 78.50 300E-05 1/°C 335.0 N/mm2 335.0 N/mm2 335.0 N/mm2 315.0 N/mm2 315.0 N/mm2 315.0 N/mm2 315.0 N/mm2 315.0 N/mm2 470.0 N/mm2 295.0 N/mm2 295.0 N/mm2
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t > 40.0 mm Yield Strength Utimate Strength Thickness Range t > 40.0 mm Yield Strength Utimate Strength Thickness Range t > 40.0 mm Yield Strength Utimate Strength Thickness Range t > 100.0 mm Yield Strength Utimate Strength Thickness Range t > 100.0 mm Yield Strength Utimate Strength Thickness Range t > 100.0 mm Yield Strength Thickness Range t > 100.0 mm Yield Strength Thickness Range t > 100.0 mm Yield Strength Thickness Range t > 100.0 mm Tield Strength Thickness Range t > 150.0 mm Thic	Image: Search:	E 21 G 8 ν 7 α 1.200 fy fu	11993-1-1:2005-0 0000.0 N/mm2 0769.2 N/mm2 0.300 78.50 78.50 kN/m3 300E-05 1/°C 335.0 N/mm2 470.0 N/mm2 315.0 N/mm2 295.0 N/mm2 450.0 N/mm2
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expans Additional Properties Thickness Range t ≤ 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 40.0 mm Yield Strength Ultimate Strength Thickness Range t > 100.0 mr Yield Strength Ultimate Strength Thickness Range t > 100.0 mr Yield Strength Thickness Range t > 150.0 mr	Image: Search:	E 21 G 8 γ 7 α 1.200 fy 6 fy 6	1993-1-1:2005-0 0000.0 N/mm2 0769.2 N/mm2 0.300 78.50 78.50 kN/m3 00E-05 1/°C 335.0 N/mm2 490.0 N/mm2 335.0 N/mm2 470.0 N/mm2 315.0 N/mm2 295.0 N/mm2 285.0 N/mm2

Figure 4.5: Selecting Steel S 355 in the library

The dialog section *Filter* offers several categories so that we can restrict the materials according to certain criteria. We set the filters as shown in the figure above. We can see that the list *Material to Select* becomes clearer.

We click on the material **Steel S 355**. In the dialog section below, we can check the *Material Properties* including the different ranges of element thicknesses.

We use the [OK] button in both dialog boxes to import the changed material properties.

Now we can start to enter the cross-section geometry.

4.3 Defining Elements

It is possible to first define the nodes graphically or in tables, and to later connect them with elements. For our example, however, it is better to use the direct graphical input of elements where nodes are created automatically.

4.3.1 Placing Elements

We open the dialog box for placing an element graphically on the menu

Insert ightarrow Model Data ightarrow 1.4 Elements ightarrow Polyline ightarrow Graphically ightarrow Continuous



or use the corresponding button in the toolbar, which is faster.

The dialog box New Element (Polyline) appears.

														New Element (Polyline) X
					÷									Element No. Node No.
														1 2
														Reference Coordinates
														Ocurrent CS Y: 200.0 € [mm]
										9. 200				Grid origin Z: 0.0 [mm]
			444	444	111	444	444		44	Z: 0	.0 1	n.m.	_	Clastnode
										5				Length
	2								-					L: 2000 🖨 [mm]
														Step
														Thickness
														t: 10.0 ∨ 🗭 ► [mm]
					•									Effective thickness for shear the image is t
						•	·	•						Rand
		-				•								
•			-			•	•				•		•	Bendradius r:
•						•	•							
					•						•			Material
•	1		•			•	•	•				•		1 Steel S 355 EN 1993-1-1:2005-05 V
					•			•			•		·	
	· · ·				·		•	•		· ·	•		•	Арріу
•	· ·	·	·			÷	•			· ·	÷		•	

Figure 4.6: Dialog box New Element (Polyline)

The *Element No.* **1** and the *Thickness* of **10 mm** are preset. The *Material* is **Steel S 355**. We accept these settings because we will adjust the flange thickness subsequently.

When we move the mouse across the work space, we see the coordinates of the pointer displayed in the window. The reticle snaps at the points of the 20 mm grid.

With a click on the left mouse button we place node **1** as the initial point in the zero point (Y/Z-coordinates **0.0/0.0**).

With another mouse click we define node **2** in the grid point **200.0/0.000** as the element's end point.

As we have chosen the *Continuous* option, node 2 represents the initial node of our next element no. **2**. Thus, we can go on with placing node **3** in the grid point **200.0/400.0**.

We close the function with a right mouse click into the empty work window or with [Esc].

Changing the view

For the full screen view we select on the menu

View ightarrow Show All.

Q

We can also use the corresponding toolbar button or the function key [F8].

Displaying numbers

Before we enter more data, it is recommended to activate the numbering of the nodes and elements. The quickest way is to right-click into an empty area of the work window.

A shortcut menu with useful functions appears. We click the entry Show Numbering.



Figure 4.7: Activating the numbering in the shortcut menu

4.3.2 Editing Elements

When we go to element 1 and hover the pointer over it briefly, the quick info shows us, among other information, the element thickness *t* of 10 mm.



As our flange has a thickness of 12 mm, we need to correct it. We double-click element 1 to open the *Edit Element* dialog box.



Please make sure to double-click the element on its edge to avoid "catching" the blue c-t zone!

We correct the *Thickness t* to **12 mm**.

E dia Finanzai	\sim
Lait Liement	~
General	
Element No	
List of Nodes Element Type 'Polyline'	-
1.2 🎝 🦻	
Material	
1 Sharl S 255 EN 1002 1 1/2005 05	
Thickness	
Thickness t: 12.0 V (mm)	
Effective thickness for shear transfer	
t*: 10.0 ∨ ♠ ▶ [mm]	
Comment	
⑦ ☑ OK Cancel	

Figure 4.9: Dialog box Edit Element

After [OK] the model represented in the work window is refreshed.

4.4 Defining Angle

Now, we connect an unequal angle 200x150x12 to the horizontal element.

4.4.1 Placing Section



We open the cross-section library with the button shown on the left.

Cross-See	ction Li	brary													×
Rolled				Parame	etric - Th	nin-Walle	d	Parame	etric - Ma	assive		Parame	tric - Tir	nber	
I	Γ	\mathbf{T}^{i}	L	I	Τ	Τ	Т		T	Т	Ξ		\bigcirc		
0	0	0	<u>د</u> ۸	ngles	L	L		T	\bigcirc	0		000		Ф	0
l	±	~	•	L	I	Т	T	∇	Ш	Л		T	T		FI
				0	Δ	Π	Π	T	Ъ	1	r	T	T	Ξ	II
Built-up				n	Ŭ	Π	Π	π	m	VV	•				
II	I	T		Ţ	Ť	+	•			D	23			I	∇
Т	I	I	T	-	İ	l	Γ			25					
I	İ	I	I	Τ	Ľ	Ľ,	Ľ					Standa	rdized -	Timber	
	1			Σ	0	∇	0						ID		
Leq., Lu	ineq., KL	. eq., KL	uneq., LS,					User-De	efined			From C	ross-Se	ction Pro	ogram
									Ľ			Ē			
D 9	24													С	ancel

Figure 4.10: Cross-Section Library

In the dialog section Rolled, we click the button [Angles].

4

In the dialog box *Rolled Cross-Sections - Angles*, we select the cross-section **L 200x150x12** in the *Table* **LU**.

Δ

Rolled Cross-Sections - Angles				×
Cross-Section Type	To Select		To Select	L 200x150x12 EN 10056-1:1998
	Table	Manufacturer/Standard	Cross-Section ^	
	L L	EN 10056-1:1998	L 100x65x7	
	LLU	EN 10056-1:1998	L 100x65x8	
	LL	Euronorm 56-77	L 100x65x10	
	LLU	Euronorm 57-78	L 100x75x8	
L +			L 100x75x10	
			L 100x75x12	12.0
			L 120x80x8	0.0
			L 120x80x10	a a a a a a a a a a a a a a a a a a a
Þ			L 120x80x12	
Filter			L 125x75x8	
			L 125x75x10	°
Manufacturer/Standard group:			L 125x75x12	++
EN ~			L 135x65x8	36.1
Manufacturer/Standard:			L 135x65x10	150.0
			L 150x75x9	
All			L 150x75x10	z
Cross-section shape:			L 150x75x12	
All			L 150x75x15	
			L 150x90x10	
Cross-section note:			L 150x90x12	[mm]
All ~			L 150x90x15	
			L 150x100x10	
			L 150x100x12	Material
			L 200x100x10	1 - Steel S 355 EN 1993-1-1:2005-05
			L 200x100x12	
Include invalid			L 200x100x15	
Favorites group:			L 200x150x12	
			L 200x150x15 V	L 200x150x12 EN 10056-1:1998
٢ الله الله الله الله الله الله الله				OK Cancel

Figure 4.11: Selecting angles in the library

We can check the properties of the angle with the [Info] button.

Furthermore, Steel S 355 is preset as Material. We confirm the dialog box with [OK].

The dialog box Set Section appears.

0

Set Section		X
Section No. 1 Section L 200x150x12 EN 10056-1:1990 Material 1 Steel S 355 EN 1993-1-1 Offset Point Location y: -139.2 2: 30.1 0: [mm] pic Cross-Section Location	8 :2005-0! ~ te: lect offset point in the section ture. Section Rotation	offset point
● Y : 44.3	Parallel to the element	✓ Nodes ✓ Auxiliary points
C Edge of element	Rotation	Options
No.: 0 Distance s:	β: -90.00 🜩 [°]	Connect section with null element Reduce section into individual elements Snap
Ø		Apply

Figure 4.12: Dialog box Set Section

We specify a Section Rotation β of **-90**° to put the section in a more favorable position.

In addition, we tick the check box **Reduce section into individual elements**.

When we move the angle with the mouse across the screen, we see that the current "auxiliary point" (offset point) for placing the section lies in its centroid. In the angle's section sketch, the auxiliary point is shown in red.

Because we want to connect the section with its long leg, we change the offset point. In the sketch, we click the red node at the left section end so that it is shown in light red.

Now, to place the section, we go to node **2** in the work window. As soon as the node is displayed with its coordinates in the status bar, we press the left mouse button.



Figure 4.13: Placing angle at node 2

A message appears documenting the result of the section reduction to elements and point elements.



Strictly speaking, it would be correct to connect the angle to the element's edge. But then another element of the thickness zero would be created ensuring the shear stiff connection. The demo restrictions of a maximum of four elements would be exceeded for our example.

We close the function with a right mouse click into the empty work window or with [Esc].

4.4.2 Rotating Section

We adjust the position of the angle with the *Mirror* function.

Selecting objects

Before we can use the editing functions (copy, rotate, mirror), the relevant objects must be determined or "selected".

We draw a window across the section that has just been set – from the left to the right. It is necessary that the window completely includes the elements 3 and 4.







How to select objects:

- If you pull up the window from the left to the right, the selection contains only objects that are completely within this window. If you pull up the window from the right to the left, the selection additionally contains those objects that are cut by the window.
- The selection is acting "alternatively": When you click an object (node, element, point element), the selection of an already selected object will be canceled. Only the new object is selected. To add the object to an existing selection, hold down the [Shift] key when clicking.

Mirroring objects

17

We open the Mirror function with the button shown on the left.



Figure 4.15: Dialog box Mirror

It is important that the check box for *Create copy* is <u>not</u> ticked in the *Mirror* dialog box. Now, we mirror the angle around the origin (0.0/0.0) and the *parallel axis* **Y**. After [OK] we see that SHAPE-THIN has put the angle into the correct position.

	1										2-			3-									
	1//	44	44	Hit	44		44	46	<u>+++</u>	44	XX	////	44	111	477	///	477	///	11	244	 •	•	-
											11									\$7/			
	÷ .				•	•	•	•	•	·	\mathbb{Z}		•	•		•	•	•	•	· ¥//			•
	ł										$\boldsymbol{\Sigma}$												
	Γ.				•		•	•	•	•	12	•				•				4	•		
											\mathcal{N}									-122			
					•		•	•	•	•	12						•	•					
																				. 1//			
																				. [/]			
									•		1												
											\mathbb{Z}									V.			
					•	•	•	•	·	•	[2]					•			•	3			
											\mathcal{A}												
								•			\mathcal{A}												1
											\mathcal{N}												
											\mathcal{A}												
											14												
					•			•	•		1							•	•				
•					•	•	•	•	•	•	12	•			•	•			•				
											12												
					•		•	•	•	•	12												
											\mathcal{A}												
											\mathbb{Z}												
											$\langle \lambda \rangle$												
											VA.												
											14												
											1												
								•	·		1			•					•				
1				•				•	·		1	1					•	•					
											23												
									•														-

Figure 4.16: Mirrored angle

Δ

4.5 Defining Welds

Now, we adjust the connection zone between the elements. Then, we model the weld connections.

4.5.1 Deleting Point Elements



We zoom in the zone of the connection between the elements and the angle. For zooming in we can use the wheel button or the button [Zoom with Window].

We see an opening in the connection zone which has been caused by the mirrored angle. We eliminate it by right-clicking the point element **4** and selecting the option **Delete Point Element** in the shortcut menu.



Figure 4.17: Deleting Point Elements

4.5.2 Placing Welds

We define a double fillet weld of 6 mm between the web and the flange.



With the button shown on the left or selecting on the menu

Insert ightarrow Model Data ightarrow Welds ightarrow Graphically,

we open the dialog box Set Weld.



Figure 4.18: Dialog box Set Weld

We change the *Thickness* to **6 mm**. To set the weld, we go to the point with the coordinates (**205.0/6.0**) in the work window. As soon as the reticle is snapped in the corner (red square on the pointer), we press the left mouse button.

For setting the second weld we change the *Rotation* α to **90.0**°. Then, we place the weld at the point with the coordinates (**195.0/6.0**).





We close the function with a right mouse click into the empty work window or with [Esc]. Finally, we have entered all geometry data.



Checking data in navigator and tables

All entered objects can be found in the directory tree of the *Data* navigator and in the tabs of the table. The entries in the navigator can be opened with a click on the \pm sign. To switch between the tables, we click on the table tabs.



We can hide and display the navigator as well as the tables by selecting **View** \rightarrow **Navigator** or **Table** on the menu. We can also use the corresponding toolbar buttons.

In the tables, the objects are organized in various tabs. The *Cross-Section* L 200x150x12 is missing as we have selected the option *Reduce section into individual elements* in the settings.

Checking c/t parts

SHAPE-THIN automatically creates cross-section parts that are required to determine the c/t ratios according to Eurocode 3. At the same time, the support conditions (outstand flanges or internal compression parts) and the reduced lengths due to point elements and welds are identified.

In the graphic, the *c/t-Parts* represented in the center lines of the elements are shown in light blue. In table 1.7, the data is listed numerically.

Graphics and tables are interactive: For example, to find a c/t part in the table, we go to table *1.7 Cross-Section Parts for Classification According to EN 1993-1*. When we click a c/t part in the work window, its corresponding table row is highlighted in color.



Figure 4.20: c/t parts in graphic, navigator and table

Saving data

Now, we have finally entered all model data. We save our cross-section by clicking on the menu

```
File 
ightarrow Save
```

or we use the corresponding button in the toolbar.



5 Loads

Load Cases and Combinations
 Load Cases
 Load Combinations

The Data navigator lists two entries in the folder Load Cases and Combinations:

- Load cases
- Load combinations

In load cases, it is possible to define the internal forces, for example, due to self-weight, snow or wind load. In load combinations, we can organize the internal forces of load cases that are superimposed with partial safety factors according to particular combination expressions.

Now, we define the internal forces in two separate load cases as specified in Chapter 2.2.

5.1 Load Case 1: Tension and Bending

Creating a load case

We use the button 🥶 to create a new load case.

:4	<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	<u>I</u> nsert	<u>C</u> alculate	<u>R</u> esults	Tools	Ta <u>b</u> le	<u>O</u> ptions	<u>W</u> indow	<u>H</u> elp						
:	2	3	1 🗂	6	50	🖪 🍕	Q 👎			23			4	>	🔎 🏳	ŭ	1 📾
•	Y	¶.	t t	1 ל	1 × 2××		5 R	۹ 🔊	8 - I	New Lo	oad Case	σχ	τ σγ	%	G _{K.pl}	1	\Leftrightarrow

Figure 5.1: Button New Load Case

The dialog box Edit Load Cases and Combinations appears.

Edit Load Cases and Combinations					×
Load Cases Load Combinations					
Existing Load Cases LC1 Tension and bending	LC No.	Load Case Description Tension and bending	~	Use	~
	General				
	Action Category Dead		~		
<>	Comment				
			10		
D				ОК	Cancel

Figure 5.2: Dialog box Edit Load Cases and Combinations, tab Load Cases

Load case number 1 is preset with the action category *Dead*. We enter the *Load Case Description* **Tension and bending**.

Then, we confirm the input with [OK] and close the dialog box.

Defining internal forces

In the tables toolbar, we click the button 🚺 .

	a 🖪 🤁 📾 📾	36	\$	\$ 3	X
	Table 3 Loads		B	С	D
c/t-Part	lable bi Loudb		c/t-Part	Restr	aints
No.	Elements		Туре	Start	End

Figure 5.3: Button *Table 3. Loads*

The table 3.1 Internal Forces is displayed.

We enter the forces and moments as follows.

3.1 Inte	rnal Ford	es										×
	• 🖪 🖂	-	36	\$	\$	🕺 達 🔤	📴 📃 📰		<u>۰</u> 🔁	LC1 - Tensior	n and 👻	4
	А	B	С	D	E	F	G	Н		J	K	
Location	Member	Location	Axial Force	Shear	Forces	Torsional	Moments	Bending	Moments	Bimoment		-
No.	No.	x [mm]	N [kN]	Vu [kN]	Vv [kN]	M _{xp} [kNm]	M _{xs} [kNm]	M _u [kNm]	Mv [kNm]	M _∞ [kNm ²]	Comment	
1	1	0.0	35.00	15.00	-25.00	0.00	0.00	60.00	15.00	0.00		
2												
3												
4												\sim
Internal	Forces											
Internal	roices											
Please e	enter the	member	number.									

1

Figure 5.4: Table 3.1 Internal Forces

13

The analysis requires the definition of a *Member* number and a *Location x*. For our example, however, this data is not relevant. The allocation of members and member design locations is especially important for the import of internal forces from RSTAB/RFEM.

The algebraic signs of forces and moments are determined in SHAPE-THIN by the following rules:



Figure 5.5: Definition of internal forces

The bending moment M_y is positive if tensile stresses occur on the positive member side (in the direction of the z-axis). M_z is positive if compressive stresses occur on the positive member side (in the direction of the y-axis). The sign definition for torsional moments, axial forces and shear forces conforms to the usual conventions: These internal forces are positive if they act on the positive section in a positive direction.

13

As we can see in the column titles of the shear forces and the moments in table 3.1, the internal forces are not related to the global axes *y* and *z* as specified in Chapter 2.2 but to the principal axes **u** and **v**. We will adjust it later (see Chapter 6.1, page 23). The entered values won't be converted; only the column titles will be changed.

3

5.2 Load Case 2: Compression and Bending

We create a new load case for the second constellation of internal forces. We can use the menu

Insert ightarrow Loads ightarrow New Load Case

or the button in the table toolbar (to the left of the load case list).

Edit Load Case	s and Combinations					×
Load Cases Loa	ad Combinations					
Existing Load	Cases	LC No.	Load Case Description		Use	
D LC1	Tension and bending	2	Compression and bending	~		
D LC2	Compression and bending					_
		Action Category				

Figure 5.6: Dialog box Edit Load Cases and Combinations

We enter the Load Case Description Compression and bending.

Then, we change the Action Category and select **Dead** loads in the list.

This time, we enter the internal forces in a dialog box that we open on the menu

Insert \rightarrow Loads \rightarrow 3.1 Internal Forces \rightarrow Dialog Box.

The forces and moments are as follows as described in Chapter 2.2:

New X-Site		×
No. Member No.		
Location		
Location	x : 0.0 + [mm]	
Internal Forces		
Axial force	N : -80.00 🗭 [kN]	×
Shear forces	Vu: -10.00 € ► [kN]	
	V _V : -20.00 ♀ ▶ [kN]	Y X N N
Torsional moments	Mxp: 0.00 + [kNm]	Z Wy Mx
	M _{xs} : 0.00 + [kNm]	wz vz
Bending moments	Mu: 40.00 + [kNm]	* Mz
	M _V : -5.00 ♣ ▶ [kNm]	
Bimoment	M _∞ : 0.00 ← [kNm ²]	
Comment		
	~	
۵۵		OK Cancel

Figure 5.7: Dialog box New X-Site

We confirm the dialog box with [OK]. Then, we check the result in the table 3.1 Internal Forces.



5.3 Checking Load Cases

Now, both load cases are defined. In the table, we can use the buttons <a> and <> to switch between the load cases.

3.1 Inte	rnal For	es										×
	🖾 🖼 🔁 🛤 🖶 🍽 🕲 🐼 😥 🐼 👔 🐹 🔺 🖶 💾 🗮 🔛 🗳 🚳 LC2 - Compressio 🔪 🔍 📑 🔅											
	A	В	С	D	E	F	G	H		J	K	
Location	Member	Location	Axial Force	Shear	Forces	Torsional	Moments	Bending	Moments	Bimoment		
No.	No.	x [mm]	N [kN]	Vu [kN]	Vv [kN]	M _{xp} [kNm]	M _{xs} [kNm]	Mu[kNm]	Mv [kNm]	M _ω [kNm ²]	Comment	
1	1	0.0	-80.00	-10.00	-20.00	0.00	0.00	40.00	-5.00	0.00		
2												
3												
4												
5												
6												~
Internal	Forces											

Figure 5.8: Switching between load cases

Again, the data entered for the internal forces is reflected in the tree of the Data navigator.



Figure 5.9: Load cases and internal forces in Data navigator

We don't define any internal forces for Load Combinations.

It is recommended to [Save] the entered data again.



6 Calculation

Before we start the calculation, we check the calculation parameters and the input data.

6.1 Adjusting Calculation Parameters

We access the calculation parameters by selecting on the menu

Calculate ightarrow Calculation Parameters

	-
10	
	100
	~

or by using the corresponding button in the toolbar.

The dialog box Calculation Parameters opens.

Calculation Parameters		X
Global Calculation Parameters c/t-Parts and Effective Cros	s-Section	
Settings Internal divisions for calculation: Elements: 20 ÷ Curved elements: 15 ÷ Point elements: 50 ÷	Stresses Determine stresses for: Most unfavorable element edges Element center lines only Shear stresses on null elements: Redistribute shear stresses from null elements to normal elements 	Options Automatic calculation after every change Consider overlapping elements only once in calculation Principal axis inclination α. Transform principal axes such that I _u (major axis) is always greater than I _v (minor axis)
Plastic Analysis Simplex method settings Maximum total number of simplex subelements: Subelements: Number of simplex subelements: across thickness of elements: Lateral Restraint Point D Activate Location Y0,D Z0,D (mm)	Calculate and display shear stresses on null elements without redistribution Calculation of equivalent stresses σeqv :	Internal forces relative to: Principal axes u, v Axes y, z Calculation of torsional constant J: Analytic Correction factor η : 1.00 \clubsuit Finite element method
D		OK Cancel

Figure 6.1: Dialog box Calculation Parameters, tab Global Calculation Parameters

In the first tab, we change the relation of the internal forces to the **Axes y**, **z**. The entered forces and moments won't be converted.

In the second tab, we check if the Code EN 1993-1-1 and EN 1993-1-5 is set.

Code c/t-Parts According to Standard: Geometr (Parts) Geometr (Parts)	s ical criterion to determine end restraints of	Effective Cross-Section Determine ψ for cross-section classification according to Table 5.2:
According to Standard: Geometr © EN 1993-1-1 and EN 1993-1-5 CN 1994-1-1:2007 Restrain	ical criterion to determine end restraints of	Determine ψ for cross-section classification according to Table 5.2:
DIN 18800 (Elastic Elastic method) 45 Applicable only for rectangular hollow sections, doubly or singly symmetric 1-sections, Ur, Cr, Z-sections, top-hat sections, trapezoidal hollow ribs 45	t is to be created for c/t-part if an element ; at an angle greater than: :00 ♀ [°] /t-parts manually	 Eixed on, increase on to reach fyd Increase on and on uniformly Increase limiting c/t for Class 3 by modified material factor e according to EN 1993-1-1, 5.5.2(9)
Assign buckling curves Element greater t Axis y/u : c 90 Axis z/v : c 90 Default correlation factor βw: 90 1.00 ‡ [-] Partial safety factor γM2:	is "significant" if the length is than: [% of the diameter] is "straight" if the length is greater [% length of connecting line]	□ Effective widths according to Annex E EN1993-1-5 □ Fire resistance (e = 0.85) Maximum number of iterations: 10 ÷ Maximum difference: 0.05 ÷ [-]

Figure 6.2: Dialog box Calculation Parameters, tab c/t-Parts and Effective Cross-Section

We confirm the changes with [OK].

6.2 Checking Input Data

SHAPE-THIN offers several possibilities to check data.

6.2.1 Plausibility Check

We select on the menu

```
Tools \rightarrow Plausibility Check
```



and define the following settings in the dialog box Plausibility Check.

Plausibility Check	×
Check Check	Type of Check O Normal With warnings None, only statistic
Ø	OK Cancel

Figure 6.3: Dialog box Plausibility Check

If the program does not detect any inconsistencies after clicking [OK], a message appears showing a summary of the cross-section and load case data.

6.2.2 Checking Interconnecting Elements

Now, we check if there is an interconnecting cross-section. We can access this checking option by selecting on the menu

Tools \rightarrow Model Check \rightarrow Check for Interconnecting Elements.

SHAPE-THIN displays the following result.

SHAPE-THIN Information No. 35639					
The cross-section is interconnecting.					
	OK				

Figure 6.4: Result of model check



If this was not the case, SHAPE-THIN will calculate the cross-section according to the theory of stiffening shear wall systems without considering the parallel axis theorem (Steiner).

6.3 Calculating the Cross-Section

We start the calculation on the menu

 $\textbf{Calculate} \rightarrow \textbf{Calculate} \, \textbf{All}$



or by using the corresponding button in the toolbar.

The results are displayed immediately after the calculation.



7.1 Graphical Results

The statical moments Q_u are represented as isobands on the cross-section. These gradients are related to the cross-section's principal axis *u* that is also represented in the graphic. Table *4.1 Gross Section Properties* lists the cross-section parameters.



Figure 7.1: Cross-section with gradient of statical moments and principal axes (gross section)

Now, we hide the numbering of nodes and elements again: With a right-click in an empty space of the work window we open the general shortcut menu (see Figure 4.7, page 10) where we deactivate the entry *Show Numbering*.

Displaying effective cross-section

With the button [Effective Parts] we can switch between the result values of the gross cross-section (button "off") and of the effective section (button "on"). To evaluate the effective cross-section, we switch this function **on**.



Figure 7.2: Button [Effective Parts]

Load case LC2 *Compression and bending* was last set. SHAPE-THIN displays the cross-section values taking into account the failing parts available in this constellation of internal forces. In the left flange, we can see the reduced width of the cross-section part subjected to compression (see Figure 7.3). The statical moments change accordingly.

Repeat - Save Model	Enter
User-Defined View	Þ
Show Numbering	
Show Results	
Show Dimensions	
Show Comments	
	Repeat - Save Model User-Defined View Show Numbering Show Results Show Dimensions Show Comments

С.



Figure 7.3: Statical moments Q_u for LC2 on effective cross-section

Selecting load cases

0

We can switch between the results of the load cases with the buttons < and > in the toolbar (to the right of the load case list) as we already know from the input. It is also possible to use the list.

Selecting results in navigator

A new navigator, the fourth in its series, manages the result categories for the graphical display. We have access to the *Results* navigator only when the results display is active. The results can be displayed and hidden in the *Display* navigator. We can also use the [Show Results] button.

Project Navigator - Results	\times
🖃 🗐 🕅 SHAPE-THIN	
🖨 🗐 🗇 Ordinates	
On y	
OM z	
Om u	
0 m v	
O 🗊 Qy	
O 🗊 Qz	
•• 🖓 🖓 Qu	
O Coordinates M	
O	
Ο ጦ σ _x	
Ο Π τ	
OM Geqv	
OM Utilization Ratio	
Shear Forces	
🗔 Data 🖆 Display 🔏 Views 🗢 Results	

Figure 7.4: Results navigator

With the control fields we can set the cross-section properties and stresses available in both load cases for the graphical display.



7 Results

Normal stresses



In the *Results* navigator, we select the results category **Stresses** σ_x . We can also use the button shown on the left.

LC1 - Tension and be 💌

In the toolbar, we set load case LC1.



Max sigma-x: 136.4, Min sigma-x: -53.6 N/mm^2

Figure 7.5: Normal stresses σ_x with smooth color transition

When we click the button an in the panel, another dialog box opens where we can activate **Smooth color transition** for the stress graphic.

In the cross-section of LC1, which is subjected to tension, all cross-section parts are effective.

© DLUBAL SOFTWARE 2017

28

Shear stresses

We set the results category **Stresses** τ in the *Results* navigator. We can also use the button shown on the left.

Then, we click the list button [Results As Isobands] to switch Off the surface representation. Now,





Figure 7.6: Shear stresses au with scaled up diagrams

In the panel tab *Factors*, we can use the spin buttons 🖻 to scale the *Element diagrams*.

Toolbar

The Results toolbar offers more functions for evaluating results.

Results		×
🔂 🖏 🐻 ర్జ్ ర్హార్ట్ 😴 🤣 🐨 👼 🔹 🔣 🔶 🎦 🚺 👻 Member: 1	▼ < > Location: 0.0	- 0 0
Figure 7.7: Toolbar <i>Results</i>		

The buttons next to the symbols of the section diagrams and stresses have the following meanings:

Button	Function
137	Shows the element thicknesses or only the center lines
¢	Displays and hides the inertia ellipse
	Displays and hides the control panel
C	Shows the cross-section with or without effective widths
	List button: shows the diagrams as isobands or two-colored lines
	List button. Shows the diagrams as isobands of two-colored lines

Table 7.1: Buttons in Results toolbar



Isobands

X Off τ



C

7.2 Results Tables

The results are also numerically available and listed in tables.

We set Table *5.4.Effective Section Properties* to check on the section properties of the effective cross-section. They depend on the load case because the effective widths are taken into account.

1 👪 🛃 💶 🛯 🖼 🔛 🛛	26 1			LC1 - Tension and
А	B	C	D	E
Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	104.32	cm ²	
	Ageom	104.32	cm ²	geometric cross-sectional area (not ideal)
Shear areas	Av	34.90	cm ²	
	A ₇	31.61	cm ²	
	Au	39.10	cm ²	
	Av	29.84	cm ²	
Centroid position	VCO	23.14	cm	relative to zero point
	ZC 0	8.85	cm	
Moments of inertia	lv.	14347.38	cm ⁴	about centroidal axes v. z
	17	11728.50	cm ⁴	
	lvz.	-515.05	cm ⁴	
Inclination of principal axes	α.	10.74	•	clockwise
Principal moments of inertia		14445.04	cm ⁴	about principal axes u. v in C
	ly ly	11630.84	cm ⁴	
Polar moments of inertia	ln.	26075.88	cm ⁴	
r oldriftomorite or lifetud	In M	42208.93	cm ⁴	about shear center M
Radii of ovration	iy.	11 72	cm	relative to centroid C
Radii or gyration	i-	10.60	cm	
	1Z	2 22	om	
Drive size of an article	in	11 77	om	about principal axes us v in C
Frincipal radii or gyration	10	10.56	om	about principal axes u, v in c
Delever dii of everytic e	1	10.00	om	
Polar radii of gyration	1p	20.11	om	about about contor M
W	TP,M	20.11	cm	
Tamianal associate	I W,M	42.40	om 4	and subted applitically
Considerational constant	J	43.70	om 4	
Secondary torsional constant	JS	2400.74	cm.	alative to see a sist
Location of the shear center	9 M,0	20.30	cm	relative to zero point
	2 M,U	-3.20	om	relative to control C
	ум	-2.04	cm	
147	2 M	-12.13	cm 8	adative to contacid C
vvarping constants	1 _{0.} C	214/3/0.30	CIII 9	
A strange from the former and the s	100.M	233007.04	CIIIS	
Auxiliary value for warp rotation	Γω,Μ C	-0.403	3	
Section moduli	Su,max	401.00	om 3	in distance 124.2 mm
	Su,min	-1103.05	om ³	in distance 124.2 mm
	Sv.max	474 70	om ³	in distance v.v fillit
	S	-4/4./8	om ³	in distance -240.0 mm
	Sy,max	400.02	om ³	in distance 311.3 mm
	Sec.	-1013.01	om ³	in distance 194.0 mm
	Samia	-506.70	om ³	in distance (00.0 mm
Warning agentian marketi	Sz,min	-300.78	om4	in piscance -231.4 mm
warping section moduli	S M, max	1202.47	om 4	in node 4
Temienal eastion and the	S. S.	-1232.47	om ³	
Consideral section modulus	Jt.	0.48	om	
Stability parameters	10	3./6	om	
	TV	-0.4/	om	
	r M,u	3.49	om	
Deduction factor	FM, V	32.55	cm 1/eer	
Reduction factor	AM M	0.01	1/CM	
wax, plastic bending moments	Mpl,y,d	323.494	KINM Ishlar	
	IVI pl,z,d	289.767	KINM	

Figure 7.8: Table 4.1 Section Properties

We can go to the other results tables by clicking the table tabs.

Statical moments, warping statical moments and stresses are displayed numerically each on the start and end nodes as well as in element centers.

7

Filtering stresses

We navigate to Table 5.7 Stresses on Effective Section. With the table button [Result Filter] we can adjust the results rows in a separate dialog box.

Table Filter		×
Select Values $\checkmark \heartsuit \heartsuit \sigma_{X,N}$ $\neg \diamondsuit \heartsuit \sigma_{X,Mv}$ $\neg \And \heartsuit \sigma_{X,Mv}$ $\neg \And \heartsuit \sigma_{X,Mv}$ $\neg \And \heartsuit \sigma_{X,Mz}$ $\neg \And \heartsuit \sigma_{X,N+M}$ $\neg \And \heartsuit \sigma_{X}$ $\neg \And \heartsuit \sigma_{X}$ $\neg \And \heartsuit \tau_{Vu}$ $\neg \And \heartsuit \tau_{Vy}$ $\neg \And \heartsuit \tau_{Vz}$ $\neg \checkmark \heartsuit \tau_{Vz}$	*	Select Locations Start value Select Locations Center value Max. Value Min. Value MAX. Value
		OK Cancel

Figure 7.9: Dialog box Table Filter

We can remove all check marks by clicking the button \boxed{M} . Then, we select some relevant stress types (see Figure 7.9). Furthermore, we want to display only the **MAX** and **MIN** values of the entire section.

After clicking [OK], Table 5.7 Stresses on Effective Section shows only the extreme values of the selected stresses.

5.7 Stre	7 Stresses on Effective Section ×								
	🖾 📴 🗓 🚍 🐑 😝 🤭 😨 💷 🖓 👘 🔛 📓 📾 LC1 - Tension and 🔹 < > Member: 1 🔹 < >								
	A	B	С	D	E	F			
Element	Node	Distance		Stresses	[N/mm ²]				
No.	No.	s [mm]	Symbol	Value	Limit	Ratio			
	Max/Min in Whole	e Cross-Section							
1	1	0.0	$MAX \sigma_{x,N}$	3.4	355.0	0.01			
1			MIN σ _{x,N}	3.4	355.0	0.01			
2	3	400.0	MAX $\sigma_{x,My}$	129.8	355.0	0.37			
1			MIN σ _{x,My}	-43.8	355.0	0.12			
1	1	0.0	MAX $\sigma_{x,Mz}$	30.1	355.0	0.08			
4			MIN σ _{x,Mz}	-21.7	355.0	0.06			
2	3	400.0	MAX $\sigma_{\rm X}$	136.4	355.0	0.38			
3			MIN σ _x	-53.6	355.0	0.15			
3		38.8	MAX τ _{Vy}	4.7	205.0	0.01			
2			MIN τ _{Vy}	-1.4	205.0	0.00			
3	2	0.0	MAX τ _{Vz}	3.2	205.0	0.01			
2			MIN τ _{Vz}	-8.4	205.0	0.02			
Effectiv	And And And And And And And And And And								

Figure 7.10: Table 5.7 Stresses on Effective Section with filtered results

As in the graphics, we can use the buttons \triangleleft and \triangleright to switch between the two load cases.

Checking classification

The details of the classification are listed in Table 5.2 Classification of the Cross-Section According to EN 1993-1.

5.2 Classification of the Cross-Section According to EN 1993-1											
4	a 🗓 🗷 🔼 😸 S	2 3 5		4 🖓	E	× 🖬	LC1 - Tension and 👻 🔍	> Mer	mber: 1	*	< >
	A	B	C	D	E	F	G	H	1	J	-
c/t-Part		Restraint	Subtr. Ler	ngth [mm]	Width	Thickness					
No.	Elements	Туре	∆start	Δ end	c [mm]	t [mm]	Description	Symbol	Value	Unit	
1	1	One side	0.0	13.5	186.5	12.0	Normal stress	σ _{x,start}	-10.4	N/mm ²	
							Normal stress	σ _{x,end}	-30.8	N/mm ²	
							Boundary stress relative to fy,d	σ 1	355.0	N/mm ²	
							Boundary stress relative to fy,d	σ2	119.5	N/mm ²	
							Stress ratio	Ψ	0.337		
							Material factor dependent on fy	ε	0.814		
							Compression zone factor	α.	0.591		
							c/t-ratio	c/t	15.543		
							Limiting proportions	λ1	7.323		
								λ2	8.136	-	
								λ3	11.391	-	
							Class of the c/t-part		4		
2	2	One side	14.5	0.0	385.5	10.0	Normal stress	σ _{x,start}	-24.4	N/mm ²	
							Normal stress	σ _{x,end}	136.4	N/mm ²	
							Boundary stress relative to fy,d	σ 1	355.0	N/mm ²	
							Boundary stress relative to fy,d	σ2	-1985.8	N/mm ²	
							Stress ratio	Ψ	-5.594		
							Material factor dependent on fy	8	0.814		
							Compression zone factor	α	1.000		
							c/t-ratio	c/t	38.551		
							Limiting proportions	λ1	7.323		
								λ2	8.136	-	
								λ3	223.166	-	
							Class of the c/t-part		3		~
Classific	ation of the Cross-Section	According to E	EN 1993-	1 Effecti	ive Width	s Accordir	na to EN 1993-1 Effective Sec	tion Properti	es	II	< + F

Figure 7.11: Table 5.2 Classification of the Cross-Section According to EN 1993-1 for LC1

In Table 5.3 Effective widths according to EN 1993-1, we can check the details which are relevant to determine the effective widths.

1	a 🗊 🔚 🔚 📾 🛛	3 5		2 🖓		×	LC2 - Compressio 👻 🔇	> Me	mber: 1	-	4
	A	В	C	D	E	F	G	H	1	J	
Part		Restraint	Subtr. Ler	ngth (mm)	Width	Thickness					
0.	Elements	Туре	Δ_{start}	Δ end	c [mm]	t [mm]	Description	Symbol	Value	Unit	
1	1	One side	0.0	13.5	186.5	12.0	Normal stress	σ _{x,start}	-57.9	N/mm ²	
							Normal stress	σ _{x,end}	-42.7	N/mm ²	
							Boundary stress relative to fy,d	σ 1	57.9	N/mm ²	
							Boundary stress relative to fy,d	σ2	42.7	N/mm ²	
							Stress ratio	Ψ	0.737	-	
							Buckling factor	kσ	0.453	-	
							Euler relative stress	σe	785.7	N/mm ²	
							Max. compressive stress	σ	57.9	N/mm ²	
							Plate slenderness	λp.σ	0.999	-	
							Reduction factor	ρ	0.813	-	
							Effective width	beff	151.5	mm	
	2	One side	14.5	0.0	385.5	10.0	Normal stress	σ _{x,start}	-35.7	N/mm ²	
							Normal stress	σ _{x,end}	80.0	N/mm ²	
							Boundary stress relative to fy,d	σ 1	35.7	N/mm ²	
							Boundary stress relative to fy,d	σ <u>2</u>	-80.0	N/mm ²	
							Stress ratio	Ψ	-2.240	-	
							Buckling factor	kσ	98.736	-	
							Euler relative stress	σe	127.7	N/mm ²	
							Max. compressive stress	σ	35.7	N/mm ²	
							Plate slenderness	λp.σ	0.168	-	
							Reduction factor	ρ	1.000	-	

Figure 7.12: Table 5.3 Effective widths according to EN 1993-1 for LC2

7.3 Multiple Windows View

The cross-section diagrams and stresses can be displayed side by side in different windows. To access this function, we click on the menu

 $\textbf{Results} \rightarrow \textbf{Arrange Result Windows}.$

Show Results in Multiple Windows	×
Select Results	Option Update view and results
	OK Cancel

Figure 7.13: Dialog box Show Results in Multiple Windows

In the dialog box *Show Results in Multiple Windows*, we tick the check boxes selecting only the statical moments Q_u and Q_v .

After [OK] we see both cross-section diagrams displayed next to each other in windows.



Figure 7.14: Statical moments Q_u and Q_v of gross cross-section

8 Documentation

8.1 Creating Printout Report

SHAPE-THIN offers a print preview for the documentation, which is called *printout report*. There, we can define the input data and results appearing in the report. Moreover, it is possible to add graphics, descriptions and scans.



We start the printout report with the button [Current Printout Report]. We find it in the toolbar to the right of the printer button.

A dialog box opens where we can choose a *Template* for the new printout report.

New Printou	t Report X					
No.	Description					
	1 Input data and reduced results					
Printout Re 1 - Input dat	ta and reduced results					
Ð	OK Cancel					

Figure 8.1: Dialog box New Printout Report

We accept the template 1 - Input data and reduced results and create the print preview with [OK].

Printout report - PR1: Input data and reduced results*		- п ×
File View Edit Settings Insert Help		
	TN R B D D 2 2 2 2 0	
Printout Report Navigator ×		/
	Bavaria Construction Joseph Street 10, 98765 Rainbow Valley	Pager 1/9 Sheet: 1 MODEL
1.2 Materials	Project Examples Model: Section Example models Manual example	Date: 07.11.2018
II.2.1 Materials - Limit Stress II.4 Elements II.5 Point Elements II.5 Velds I.6 Welds I.7 Cross-Section Parts for Classification		[mm] Comment -439 -411 -1173 -1173
 ⊕- boads ⊕- Results - Load Cases, Load Combinations ↓- ↓ 4.1 Gross Section Properties ↓ 4.2 Gross Statical Moments ↓ 4.3 Gross Warping Statical Moments 	• Lamesan - 2940 1 1440 1 100a 1 • 1.2 MATERIALS Material Modulus of Elastici Shear Modulus No. 1 Shear S 355 (EV 1991-1-2005-05 21000.0 80795.2	24.2 Specific Weight Safety Factor γ [kNm ³] γμ [-] 76.50 1.00
4.5 Stresses on Gross Section 4.6 Welds on Gross Section 5.2 Classification of the Cross-Section A 5.3 Effective widths according to EN 19 5.4 Effective Section Properties 5.5 Effective Statical Moments	I.2.1 MATERIALS - LIMIT STRESS Material Element Thiomese [mm] Yield Stress No Description From To fts [NmmP] 1 Steel \$ 350 BN 1993-1-12005-00 00 600 935 000 0000 1000 335 9300 1000 335 1000 1000 2000 <t< td=""><td>Limit Stress [Nimm²] 94 T Part 0 335.0 205.0 356.0 0 335.0 193.4 356.0 0 316.0 193.4 356.0 0 266.0 170.3 266.0 0 267.0 165.8 227.0</td></t<>	Limit Stress [Nimm ²] 94 T Part 0 335.0 205.0 356.0 0 335.0 193.4 356.0 0 316.0 193.4 356.0 0 266.0 170.3 266.0 0 267.0 165.8 227.0
J.6 Effective Warping Statical Moments J.7 Stresses on Effective Section J.8 Welds on Effective Section	1.4 ELEMENTS Normal Material Thidmess Length No Type Nodes No. No. [mm] [mm] 1 Polytice 1.2 1 12.0 200.0 2 Polytice 2.3 1 10.0 400.0 3 Polytice 2.0 1 12.0 140.0 4 Polytice 2.0 1 12.0 144.0	Comment
	I.5 POINT ELEMENTS Material Position Space No. Y[mm] Z[mm] rigmm] rigmm] 1 Inert Rectople 1 397.0 3.0 0.0 2 Inert Rectople 1 388.0 6.0 15.0 3 Remove Rounding 388.0 144.0 7.5	ng Rotation Area b [mm] \$(1) A [mm ²] 60 90.00 48.3 -90.00 12.1
	How ELDS Thidness Position Rotation Span Angle No Type a (mm) Y (mm) Z (mm) a (1) ac (1) 1 File 00 2000 60 000 5000 2 File 500 195.0 60 90.00 90.00	Comment
< > <		>
	MODEL LOADS	Pages: 9 Page: 1

Figure 8.2: Print preview in printout report

8.2 Adjusting Printout Report

On the left, we see the navigator listing the selected chapters. When we click a navigator entry, the content of the corresponding chapter is displayed on the right.

The contents set by default can be adjusted individually. For our example we change the output of cross-section values: We right-click the chapter *Results - Load Cases, Load Combinations* and select *Selection* on the shortcut menu.

Printout Report Navigator	×
🖃 🚞 Printout Report	
🖨 🖮 SHAPE-THIN	
🖶 🗀 Model	
🖨 🚞 Loads	
2.1 Load Cases	
3.1 Forces and Moments	
🖨 🖮 Results - Load Cases, Load Combination	าร
	Remove from Printout Report
- 4.2 Statical Moments	Start with New Page
- 4.3 Warping Statical Moments	Selection
4.5 Stresses	Brapartias
	Properties
6.2 Classification of the Cross-Section	n According to EN 1993-1
6.3 Effective widths according to EN	1993-1

Figure 8.3: Shortcut menu Results - Load Cases, Load Combinations

In the dialog box *Printout Report Selection*, tab *LC/CO Results*, we remove the check marks of Tables **5.5 Effective Statical Moments** and **5.6 Effective Warping Statical Moments**.

PE-THIN	Global S	election Model Data Loads LC/CO Results					
	Tables to Display						
	Display	Table	Al	Number Selection (e.g. '1-4,8')			
	V	4.1 Gross Section Properties	•	All			
	V	4.2 Gross Statical Moments	2	All			
	V	4.3 Gross Warping Statical Moments	☑	All			
	V	4.4 Gross Cell Areas	\checkmark	All			
	☑	4.5 Stresses on Gross Section	☑	All			
		4.6 Welds on Gross Section	☑	All			
	1	4.7 Shear Wall Section Properties	1	All			
	Image: A state of the state	4.8 Shear Wall Section Forces	2	All			
		4.9 Plasticity	2	All			
	V	5.1 Check of the c/t-Parts According to DIN 18800	1	All			
	<u> </u>	5.2 Classification of the Cross-Section According to EN 1993-1	<u> </u>	Al			
		5.3 Effective widths according to EN 1993-1	<u> </u>	Al			
		5.4 Effective Section Properties	<u></u>	All			
-		5.5 Effective Statical Moments	<u></u>	All			
		5.6 Effective Warping Statical Moments		All			
		5.7 Stresses on Effective Section	<u> </u>	All			
y							
ver sheet ntents o pictures		×					
percase titles	- 40	50 St.					

Figure 8.4: Deactivating statical and warping statical moments by using the Printout Report Selection

After we have confirmed the dialog box, the print preview is adjusted accordingly.

It is possible to move chapters in the navigator to another position by using the drag-and-drop mouse function. To delete a chapter, we can use the shortcut menu (see Figure 8.3) or the [Delete] key.

8.3 Printing Graphics in Printout Report

Often, graphics are integrated in the printout illustrating the documentation.

Printing statical moments

We close the printout report with eta.

Then, we answer the query for saving the changes with [Yes] and return to the SHAPE-THIN work window.

The result diagrams of the statical moments Q_u and Q_v were set last (see Figure 7.13, page 32). We print these two graphics in the printout report by selecting on the menu

File ightarrow Print Graphic

or by using the corresponding button in the toolbar.

In the dialog box *Graphic Printout*, we set the print specifications as shown in Figure 8.5. In addition, we enter **Statical moments** as the *Header of Graphic Picture*.

When printing several windows we can adjust the *Window Arrangement* with the button . We set option **3**) to print the two graphics one below the other.

Graphic Printout			×			
General Options Border and Stretch						
Graphic Picture		Window To Print Graphic Size				
O Directly to a printer	2	Current only	v			
To a printout report: PR	1: 1 ~ (More More				
⊖ To the Clipboard		○ Mass print ○ To scale 1:	100 ~			
Graphic Picture Size and Rotation		Options				
Use full page width		Show results for selected x-location in result diagram				
Use full page height		Lock graphic picture (without update)				
		Show printout report on [OK]				
Rotation: 0 🔶 [°]	Window	/ Arrangement		×		
	Arrang	ement of Graphics on Page				
Header of Graphic Picture						
Statical moments	Statical moments OPage Filling					
	01)	1	2	1 2		
	_ 4)	1 5) 1 1	1 1	1 1 1 1 1 1		
	Ø		ОК	Cancel		

Figure 8.5: Dialog boxes Graphic Printout and Window Arrangement



B

© DLUBAL SOFTWARE 2017

We don't change the default settings of the other tabs.

Finally, we print both statical moment diagrams in the printout with [OK]. The graphics are placed at the end of chapter *Results - Load Cases, Load Combinations*.





Figure 8.6: Statical moments in printout report

We move the graphic up to the entry *Section Properties* by using the drag-and-drop function (hold down left mouse button).

Printing equivalent stresses

We close the printout report and save the modifications.

We maximize the remaining window with 💷.

Then, we set the window filling view and show the whole model with the button 🤇 or the function key [F8].



Now we display the **equivalent stresses** σ_{eqv} of load case **LC2**. Furthermore, we switch the display of the *Effective Parts* on.

Then, we select the [Isobands] again for a colored representation of the stresses.

We click the button is to open the dialog box *Graphic Printout* again (see Figure 8.7).

Now, for the printing we set the *Height* of the graphic picture to **50 %**. Thus, the graphic will use exactly a half page in the printout report. We want *To Scale* the graphic with **1:5**.

8

s sigma-eqv [N/mm^2] mpression and bending	M
••••••••••••••••••••••••••••••••••••••	
Graphic Printout	×
General Options Color Scale Border and St	tretch Factors
Graphic Picture ○ Directly to a printer ● To a printout report: ● To the Clipboard	Window To Print Graphic Size © Current only As screen view More Window filling Mass print To scale 1: 5 ×
Graphic Picture Size and Rotation ✓ Use full page width O Use full page height ● Height: 50 ♀ [% of page]	Options Show results for selected x-location in result diagram Lock graphic picture (without update)
Rotation: 0 🗘 [°]	Show printout report on [OK]
Header of Graphic Picture	
<sigma>_{eqv}</sigma>	
Ø	OK Cancel



Figure 8.7: Printing the equivalent stresses

We click [OK]. The graphic is printed in the printout report where it is placed again at the end of the chapter *Results - Load Cases, Load Combinations*. We move it to the entry *Stresses*.



Figure 8.8: Graphic of equivalent stresses in printout report

Printing the printout report

Now, we can send the printout report to the printer by using the [Print] button.

The integrated PDF printer enables printing data of the printout report in a PDF file. We use this function and select on the printout report's menu

8

$\textbf{File} \rightarrow \textbf{Export to PDF}.$

The Windows dialog box Save As opens where we specify the storage location and the file name.

We click [Save], and then a PDF file is created with bookmarks making the navigation in the digital document easier.





Save

B

9 Outlook

Now, we are at the end of our example. We hope that this introduction helps you to easily find access to SHAPE-THIN and makes you curious about unknown functions. Find a detailed program description in the user manual of SHAPE-THIN that you can download on our website.

You can access the program's online help on the **Help** menu or with [F1] and search for certain expressions as seen in the manual. The online help is based on the SHAPE-THIN manual.

You can also contact our hotline team and ask any question by e-mail. Or have a look at the FAQ and the Knowledge Base pages on our website.



It is possible to import the cross-section of our example to an RSTAB or RFEM model. You can also use it for designs in the add-on modules RF-/STEEL or RF-/STEEL EC3.

New Cross-Section			\times
No. Color	Cross-Section Description [mm]	Image: International and the state of the state	
Cross-Section Pr	mport Cross-Section from SHAPE-THIN	×	
Cross-Section P			
Moments of inert	SHAPE-THIN Cross-Sections	SHAPE-THIN SECTION	
Torsion	SECTION		
Bending			
Cross-sectional a		Trener La y	
Axial		/ u	
Shear			
Inclination of prin		/8	
Angle		4 + V z	
Overall dimension			
Vviatn	😴 🕅 🕅	a	
Depth			
Comment	Description of SHAPE-THIN Cross-Section		
	Manual example		
	(D) (D)		
2 0.00		OK Cancel	Cancel

Figure 9.1: Importing SHAPE-THIN section to RSTAB/RFEM



Figure 9.2: Deformations in RSTAB/RFEM model