4 Diubal

Version September 2013

Add-on Module

STEEL NTC-DF

Ultimate Limit State, Serviceability and Stability Design According to NTC-RCDF 2004

Program **Description**

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I. Introduction

1.1 Add-on Module STEEL NTC-DF

The Mexican standard (NTC-DF) describes the design, analysis and construction of steel structures in Mexico. With the RSTAB add-on module STEEL NTC-DF, DLUBAL ENGINEERING SOFTWARE provides a powerful tool for designing steel framework models.

STEEL NTC-DF performs all typical ultimate limit state designs as well as stability and deformation analyses. The program is able to take into account various actions for the ultimate limit state design. Furthermore, you can choose between the interaction formulae mentioned in the code. In accordance with the code, STEEL NTC-DF divides the cross-sections to be designed into the cross-section slenderness types. In this way, you can check the limitation of the design capacity and of the rotational capacity due to local buckling for cross-section parts. Moreover, STEEL NTC-DF determines the c/t-ratios of the cross-section elements subjected to compression and classifies the cross-sections completely automatically.

The axial system of members in STEEL NTC-DF is different from the indices used in the Mexican standard: The index of the longitudinal member axis "z" is denoted as "x" in the program; "y" and "z" refer to the axes in the cross-section plane as seen in the image to the left.

For the stability analysis, you can specify for each member or set of members whether flexural buckling occurs in y- and/or z-direction. Furthermore, you can define additional lateral supports in order to represent the model close to reality. STEEL NTC-DF determines the slenderness and elastic critical buckling loads from the boundary conditions. The ideal critical moment for lateral torsional buckling required for the lateral torsional buckling design can be determined automatically. In addition to that, it is possible to take into account the load application point of transverse loads, which is affecting the torsional resistance considerably.

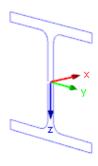
For models with extremely slender cross-sections, the serviceability limit state represents an important design. The limit deformations are preset by default settings and can be adjusted, if necessary. In addition, it is possible to specify reference lengths and precambers that are considered accordingly in the design.

If required, you can optimize cross-sections and export the modified cross-sections to RSTAB. The design cases enable you to design separate structural components in complex structures or analyze variants.

STEEL NTC-DF is an add-on module integrated in RSTAB. For this reason, the design relevant input data is already preset when you have started the module. Subsequent to the design, you can use the graphical RSTAB user interface to evaluate the results. Finally, the design process can be documented in the global printout report from the determination of internal forces to the design.

We hope you will enjoy working with STEEL NTC-DF.

Your DLUBAL Team



Axis system



1.2 STEEL NTC-DF - Team

The following people were involved in the development of STEEL NTC-DF:

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1.3 Using the Manual

Topics like installation, graphical user interface, results evaluation, and printout are described in detail in the manual of the main program RSTAB. The present manual focuses on typical features of the add-on module STEEL NTC-DF.

The descriptions in this manual follow the sequence and structure of the module's input and results windows. In the text, the described **buttons** are given in square brackets, for example [View mode]. At the same time, they are pictured on the left. **Expressions** appearing in dialog boxes, windows, and menus are set in *italics* to clarify the explanations.

At the end of the manual, you find the index. However, if you still cannot find what you are looking for, please check our website www.dlubal.com where you can go through our FAQ pages by selecting particular criteria.

1.4 Open the Add-on Module STEEL NTC-DF

RSTAB provides the following options to start the add-on module STEEL NTC-DF.

Menu

۲

To start the program in the RSTAB menu bar, click

 $\textbf{Add-on Modules} \rightarrow \textbf{Design} \textbf{-} \textbf{Steel} \rightarrow \textbf{STEEL NTC-DF}.$

Add-on Modules Window H	elp		
Current Module	>	🕐 🏄 🔗 💥 🕼	📾 🛤 🗄 📽 🤹 🏚 🥵 🕼 🔀 🕷
Design - Steel	r	STEEL	General stress analysis of steel members
Design - Concrete Design - Timber Design - Aluminium Dynamic Connections Foundations Stability	He Les He Les He He Ho	STEEL EC3 STEEL AISC I STEEL IS STEEL SIA STEEL BS STEEL GB STEEL CS	Design of steel members according to Eurocode 3 Design of steel members according to AISC (LRFD or ASD) Design of steel members according to IS Design of steel members according to SIA Design of steel members according to BS Design of steel members according to GB Design of steel members according to CS
Towers Others	LAS	STEEL AS	Design of steel members according to AS Design of steel members according to NTC-DF
Stand-Alone Programs	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Flexural buckling analysis Lateral-torsional and torsional-flexural buckling analysis torsional and torsional-flexural buckling analysis by FEM
		EL-PL C-TO-T PLATE-BUCKLING	Elastic-plastic design Analysis of limit slenderness ratios (c/t) Plate buckling analysis
	M	VERBAND (not installed	d) Design of wind bracings for roofs

Figure 1.1: Menu: Add-on Modules \rightarrow Design - Steel \rightarrow STEEL NTC-DF



Navigator

As an alternative, you can start the add-on module in the Data navigator by clicking

```
Add-on Modules \rightarrow STEEL NTC-DF.
```

Project Navigator - Data	×
⊨	•
🗄 🗤 🛅 Model Data	
🗄 🖞 🛅 Load Cases and Combinations	
🗄 🗤 🛅 Loads	
🗄 🖷 🛅 Results	
Printout Reports	
🛓 💼 Guide Objects	=
🖕 🚞 Add-on Modules	-
📄 🧰 Favorites	
STEEL - General stress analysis of steel members	
STEEL EC3 - Design of steel members according to Eurocode 3	
FE-LTB - Lateral-torsional buckling analysis by FEM	
TIMBER Pro - Design of timber members	
STEEL AISC - Design of steel members according to AISC (LRFD or ASD)	
STEEL SIA - Design of steel members according to SIA	
STEEL BS - Design of steel members according to BS	
STEEL GB - Design of steel members according to GB	
STEEL CS - Design of steel members according to CS	
STEEL AS - Design of steel members according to AS	
STEEL NTC-DF - Design of steel members according to NTC-DF	
ALUMINIUM - Design of aluminium members according to Eurocode 9	
KAPPA - Flexural buckling analysis	
LTB - Lateral-torsional buckling analysis	-
🔽 Data 🖀 Display 🔏 Views	

Figure 1.2: Data navigator: Add-on Modules → STEEL NTC-DF

Panel

If results from STEEL NTC-DF are already available in the RSTAB model, you can also open the design module in the panel:

Set the relevant STEEL NTC-DF design case in the load case list of the RSTAB toolbar. Then click the [Show Results] button to display the design criterion on the members graphically.

When the results display is activated, the panel is available, too. Click [STEEL NTC-DF] in the panel to open the module.

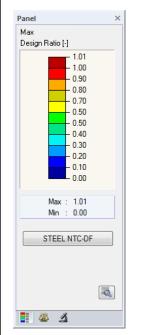
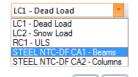


Figure 1.3: Panel button [STEEL NTC-DF]

STEEL NTC-DF



X.XX



2. Input Data

When you have started the add-on module, a new window opens. In this window, a Navigator is displayed on the left, managing the windows that can be currently selected. The drop-down list above the navigator contains the design cases (see chapter 7.1, page 51).

The design relevant data is defined in several input windows. When you open STEEL NTC-DF for the first time, the following parameters are imported automatically:

- Members and sets of members
- Load cases, load combinations, result combinations, and super combinations
- Materials
- Cross-sections
- Effective lengths
- Internal forces (in background, if calculated)

To select a window, click the corresponding entry in the navigator. To set the previous or next input window, use the buttons shown on the left. You can also use the function keys to select the next [F2] or previous [F3] window.

Click [OK] to save the results. Thus, you exit STEEL NTC-DF and return to the main program. To exit the module without saving the data, click [Cancel].

2.1 General Data

In the 1.1 *General Data* window, you select the members, sets of members, and actions that you want to design. The tabs are managing the load cases, load combinations, result combinations, and super combinations for the different designs.

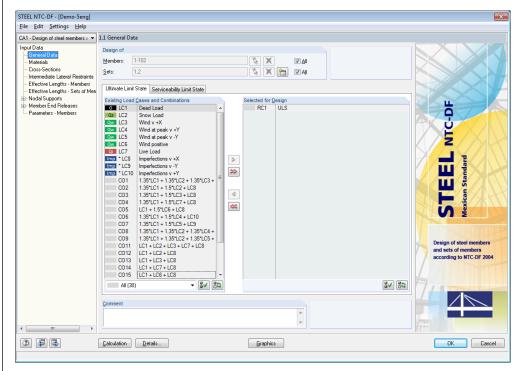


Figure 2.1: Window 1.1 General Data

Cancel

OK

Program STEEL NTC-DF © 2013 Dlubal Software GmbH



Design of

Design of			
Members:	1-8,11-18,21-28,31-46,51-64,66-69	X	🔲 All
Sets:	1,3,5-8	🗞 🗙 街	🔽 All

Figure 2.2: Design of members and sets of members



2

The design can be carried out for *Members* as well as for *Sets of Members*. If you want to design only selected objects, clear the *All* check box: Then you can access the input fields to enter the numbers of the relevant members or sets of members. The list of the numbers preset in the field can be selected by double-clicking and overwritten by entering the data manually. Alternatively, you can select the objects graphically in the RSTAB work window after clicking [[^]].

When you design a set of members, the program determines the extreme values of the analyses of all members contained in the set of members and takes into account the boundary conditions of connected members for the stability analysis. The results are shown in the results windows 2.3 *Design by Set of Members*, 3.2 *Governing Internal Forces by Set of Members*, and 4.2 *Parts List by Set of Members*.

Click [New] to create a new set of members. The dialog box that you already know from RSTAB appears where you can specify the parameters for a set of members.

2.1.1 Ultimate Limit State

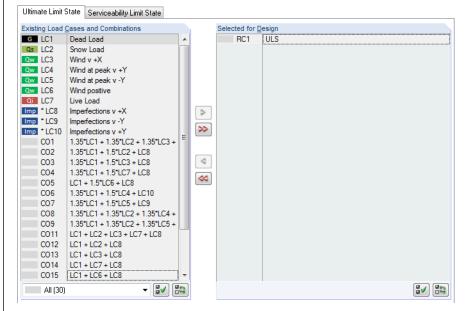


Figure 2.3: Window 1.1 General Data, tab Ultimate Limit State

Existing Load Cases and Combinations

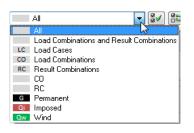
In this column, all load cases, load combinations, result combinations, and super combinations created in RSTAB are listed.



Click [▶] to transfer selected entries to the list *Selected for Design* on the right side. You can also double-click the items. To transfer the complete list to the right, click [▶▶].

To transfer multiple entries of load cases, select them while pressing the [Ctrl] key, as common for Windows applications. Then use the button [▶] to transfer them simultaneously.

Load cases marked by an asterisk (*), like load case 8 in Figure 2.3, cannot be designed: This happens when the load cases are defined without any load data or the load cases contain only imperfections. When you transfer the load cases, a corresponding warning appears.



At the end of the list, several filter options are available. They will help you assign the entries sorted by load case, load combination, or action category. The buttons have the following functions:

Selects all cases in the list
Inverts selection of load cases

Table 2.1: Buttons in the tab Ultimate Limit State

Selected for Design

The column on the right lists the load cases as well as the load and result combinations selected for design. To remove selected items from the list, click [4] or double-click the entries. To transfer the entire list to the left, click [4].

The analysis of an enveloping max/min result combination is performed faster than the analysis of all load cases and load combinations that have been globally set. However, when analyzing a result combination, the influence of the contained loads is difficult to discern.

2.1.2 Serviceability

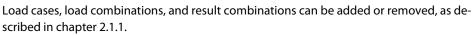
Wind positive Live Load Imperfections v +X	*		RC2	01.0
			1102	SLS
Imperfections v +X				
Imperfections v -Y				
Imperfections v +Y				
1.35*LC1 + 1.35*LC2 + 1.35*LC3 +				
1.35*LC1 + 1.5*LC2 + LC8				
1.35*LC1 + 1.5*LC3 + LC8				
1.35*LC1 + 1.5*LC7 + LC8				
LC1 + 1.5*LC6 + LC8		>>		
1.35*LC1 + 1.5*LC4 + LC10				
1.35*LC1 + 1.5*LC5 + LC9		_		
1.35*LC1 + 1.35*LC2 + 1.35*LC4 +		4		
1.35*LC1 + 1.35*LC2 + 1.35*LC5 +	=			
LC1 + LC2 + LC3 + LC7 + LC8	-	7		
LC1 + LC2 + LC8				
LC1 + LC3 + LC8				
LC1 + LC7 + LC8				
LC1 + LC6 + LC8				
LC1 + LC4 + LC10				
LC1 + LC5 + LC9				
LC1 + LC2 + LC4 + LC7 + LC10				
LC1 + LC2 + LC5 + LC7 + LC9				
ULS	Ŧ			
	$\begin{array}{l} 1.35^{+}LC1 + 1.5^{+}LC3 + LC8 \\ 1.35^{+}LC1 + 1.5^{+}LC7 + LC8 \\ LC1 + 1.5^{+}LC6 + LC8 \\ 1.35^{+}LC1 + 1.5^{+}LC4 + LC10 \\ 1.35^{+}LC1 + 1.5^{+}LC2 + L.35^{+}LC4 + \\ 1.35^{+}LC1 + 1.35^{+}LC2 + 1.35^{+}LC5 + \\ LC1 + LC2 + LC3 + LC7 + LC8 \\ LC1 + LC2 + LC8 \\ LC1 + LC3 + LC8 \\ LC1 + LC4 + LC8 \\ LC1 + LC6 + LC8 \\ LC1 + LC6 + LC8 \\ LC1 + LC4 + LC10 \\ LC1 + LC4 + LC10 \\ LC1 + LC5 + LC9 \\ LC1 + LC5 + LC9 \\ LC1 + LC2 + LC4 + LC7 + LC10 \\ LC1 + LC2 + LC4 + LC7 + LC10 \\ LC1 + LC2 + LC4 + LC7 + LC10 \\ LC1 + LC2 + LC4 + LC7 + LC10 \\ LC1 + LC2 + LC5 + LC7 + LC9 \\ ULS \end{array}$	$\begin{array}{c c} 1.35^{+}LC1 + 1.5^{+}LC3 + LC8 \\ 1.35^{+}LC1 + 1.5^{+}LC7 + LC8 \\ LC1 + 1.5^{+}LC6 + LC8 \\ 1.35^{+}LC1 + 1.5^{+}LC4 + LC10 \\ 1.35^{+}LC1 + 1.5^{+}LC5 + LC9 \\ 1.35^{+}LC1 + 1.35^{+}LC2 + 1.35^{+}LC4 + \\ 1.35^{+}LC1 + L.35^{+}LC2 + 1.35^{+}LC5 + \\ LC1 + LC2 + LC3 + LC7 + LC8 \\ LC1 + LC2 + LC8 \\ LC1 + LC4 + LC10 \\ LC1 + LC4 + LC10 \\ LC1 + LC4 + LC9 \\ LC1 + LC4 + LC7 \\ LC1 + LC4 + LC7 + LC10 \\ LC1 + LC4 + LC7 + LC9 \\ LC1 + LC2 + LC5 + LC7 + LC9 \\ ULS \\ \end{array}$	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $

Figure 2.4: Window 1.1 General Data, tab Serviceability Limit State

Existing Load Cases and Combinations

This section lists all load cases, load combinations, and result combinations created in RSTAB.

Selected for Design



You can assign different limit values for deflection to the individual load cases, load combinations, and result combinations. Those limit values of the deformations can be adjusted, if necessary: Click [Details] to open the dialog box *Details* (see Figure 3.3, page 30).

In the 1.9 *Serviceability Data* window, the reference lengths that are governing for the deformation check are managed (see chapter 2.9, page 25).







2.2 Materials

The window is subdivided into two parts. In the upper part, all materials created in RSTAB are listed. The *Material Properties* section shows the properties of the current material, that is, the table row currently selected in the upper section.

1.2 Materia	als				
	A		B		
Material	Material				
No.	Description		Comn	ient	
1	Steel B-254 (ASTM A36) NMX:2004-10				
2	Steel B-99 (ASTM A529) NMX:2004-10				
				R B X	
Material P					
🖂 Main Pi					
Mod	ulus of Elasticity	E	200000.000	MPa	
	ar Modulus	G	77200.000	MPa	
	son's Ratio	ν	0.295		
	cific Weight	γ		kN/m ³	
	ficient of Thermal Expansion	α	1.2000E-05	1/K	
	al Safety Factor	ΥM	1.00		Material No. 1 used in
	nal Properties	-			
	d Strength	Fy	250.000		Cross-sections No.:
Ultim	nate Strength	Fu	400.000	MPa	1,2,6,7,10,12,13,15,16
					Members No.:
					1-19,22-38,40,42-57,59,61-80,83-102
					1.2
					1,4
					Σ Lengths: Σ Masses:
					466.46 [m] 21.802 [t]

Figure 2.5: Window 1.2 Materials

Materials that will not be used in the design are dimmed. Materials that are not allowed are highlighted in red. Modified materials are displayed in blue.

The material properties required for the determination of internal forces are described in chapter 4.2 of the RSTAB manual (*Main Properties*). The material properties required for design are stored in the global material library. The values are preset (*Additional Properties*).

To adjust the units and decimal places of material properties and stresses, select from the module's menu **Settings** \rightarrow **Units and Decimal Places** (see chapter 7.3, page 55).

Material Description

The materials defined in RSTAB are already preset, but you can always modify them: To select the field, click the material in column A. Then click [▼] or press function key [F7] to open the material list.

Steel B-254 (ASTM A36) NMX:2004-10	-	-
Steel B-254 (ASTM A36)	NMX:2004-10	
Steel B-99 (ASTM A529)	NMX:2004-10	
Steel B-282 (ASTM A242) (Fy = 290 MPa)	NMX:2004-10	
Steel B-282 (ASTM A242) (Fy = 320 MPa)	NMX:2004-10	=
Steel B-282 (ASTM A242) (Fy = 345 MPa)	NMX:2004-10	
Steel B-284 (ASTM A572) (Fy = 290 MPa)	NMX:2004-10	
Steel B-284 (ASTM A572) (Fy = 345 MPa)	NMX:2004-10	-
Steel B-284 (ASTM A572) (Fy = 414 MPa)	NMX:2004-10	
Steel B-284 (ASTM A572) (Fy = 450 MPa)	NMX:2004-10	
Steel (ASTM A588)	NMX:2004-10	Ŧ

Figure 2.6: List of materials

According to the design concept of the standard [1], you can select only materials of the "Steel" category.



When you have imported a material, the design relevant Material Properties are updated.

If you change the material description manually and the entry is stored in the material library, STEEL NTC-DF will import the material properties, too.

Principally, it is not possible to edit the material properties in the add-on module STEEL NTC-DF.

Material Library

Numerous materials are already available in the library. To open the corresponding dialog box, click

Edit ightarrow Material Library

or use the button shown on the left.

		Material to Select			
Aterial category group:		Material Description	Standard		
Metal	-	Steel B-254 (ASTM A36)	NMX:	2004-10	
		Steel B-99 (ASTM A529)	III NMX:	2004-10	
faterial <u>c</u> ategory:		Steel B-282 (ASTM A242) (Fy = 290 MPa)	III NMX:	2004-10	
Steel	-	Steel B-282 (ASTM A242) (Fy = 320 MPa)	III NMX:	2004-10	
Standard group:		Steel B-282 (ASTM A242) (Fy = 345 MPa)	III NMX:	2004-10	
NMX		Steel B-284 (ASTM A572) (Fy = 290 MPa)	📲 NMX:	2004-10	
P NMA		Steel B-284 (ASTM A572) (Fy = 345 MPa)	III NMX:	2004-10	
tandard:		Steel B-284 (ASTM A572) (Fy = 414 MPa)	MX:	2004-10	
- NMX:2004-10	-	Steel B-284 (ASTM A572) (Fy = 450 MPa)	III NMX:	2004-10	
1007.2004 10		Steel (ASTM A588)	MX:	2004-10	
		Steel (ASTM A913)	MX:	2004-10	
		Steel (ASTM A992)	NMX:	2004-10	
		Steel B-177 (ASTM A53, B)	NMX:	2004-10	
Include invalid	2	Steel B-199 (ASTM A500)	NMX:	2004-10	
			I		
Eavorites only	*				7
laterial Properties			Steel B-2	254 (ASTM A36) N	MX:2004-
Main Properties			-		
 Modulus of Elasticity Shear Modulus 			E	200000.000 77200.000	
 Poisson's Ratio 			v	0.295	MEd
- Specific Weight			γ		kN/m ³
Coefficient of Thermal	Expansion		α	1.2000E-05	1/K
Additional Properties					
 Yield Strength 			Fy	250.000	MPa
 Ultimate Strength 					MPa

Figure 2.7: Dialog box *Material Library*

In the *Filter* section, *Steel* is preset as material category. Select the material quality that you want to use for the design in the *Material to Select* list. The corresponding properties can be checked in the dialog section below.

Click [OK] or [,-] to transfer the selected material to window 1.2 of the module STEEL NTC-DF.

Chapter 4.2 in the RSTAB manual describes in detail how materials can be filtered, added, or rearranged.

You can also select material categories like *Cast Iron* or *Stainless Steel*. Please check, however, whether these materials are allowed by the design concept of the standard [1].







2.3 Cross-sections

This window manages the cross-sections used for design. In addition, the module window allows you to specify optimization parameters.

	A	В	1 C	D	E	F	1 - IS 450/200/10/20/0
ection	Material	Cross-Section	Cross-Section Type	Opti-			
No.	No.	Description	for Classification	mize	Remark	Comment	
1	1	IS 450/200/10/20/0	I-section welded IS	No			200.0
2	1	T IS 400/200/10/18/0	I-section welded IS	No			
6	1	T IS 250/250/10/15/0	I-section welded IS	No			0.0
7	1	T IS 250/250/10/15/0	I-section welded IS	No			
9	2	IS 450/200/10/20/0	I-section welded IS	No			
10	1	IS 200/200/8/15/0	I-section welded IS	No			420.0
12	1	TO 80/80/5/5/5/5	Box welded	No			
13	1	Circle 24	Round bar	No			10.0
15	1	T IS 250/250/10/15/0	I-section welded IS	No			
16	1	T IS 360/150/8/12/0	I-section welded IS	No			
						B	
	ection Valu	ies - IS 450/200/10/20/0			X	i	Cross-section No. 1 used in
Cross	ection Valu Section Ty	ies - IS 450/200/10/20/0		I-section welded			 Image: A state of the state of
Cross Sectio	ection Valu Section Ty on Height	ies - IS 450/200/10/20/0	h	450.0 mm	-		Cross-section No. 1 used in
Cross Section Section	ection Valu Section Ty on Height on Width	ies - IS 450/200/10/20/0	b	450.0 mm 200.0 mm			Cross-section No. 1 used in Members No.:
Cross Section Section Web	ection Valu Section Ty on Height on Width Thickness	ies - IS 450/200/10/20/0	b tw	450.0 mm 200.0 mm 10.0 mm			Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102
Cross Section Section Web Flange	ection Valu Section Ty on Height on Width Thickness e Thickness	ies - IS 450/200/10/20/0	b tw tf	450.0 mm 200.0 mm 10.0 mm 20.0 mm			Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.:
Cross Section Section Web Flange	ection Valu Section Ty on Height on Width Thickness e Thickness Area	ies - IS 450/200/10/20/0	b tw tf At	450.0 mm 200.0 mm 10.0 mm 20.0 mm 12100.0 mm	2		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102
Cross Section Section Web Flange Gross Shear	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area	ies - IS 450/200/10/20/0	b tw tf At Ay	450.0 mm 200.0 mm 10.0 mm 20.0 mm	2 2		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.: 1,2
Cross Section Section Web Flange Gross Shear Shear	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area	es - IS 450/200/10/20/0 pe s	b t _w tf At Ay Az	450.0 mm 200.0 mm 10.0 mm 20.0 mm 12100.0 mm 8000.0 mm	2 2 2 2 2		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.: 1,2 Σ Lengths: Σ Masses:
Cross Section Section Web Flange Gross Shear Shear Shear Shear	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area Area	es - IS 450/200/10/20/0	b tw tf At Ay	450.0 mm 200.0 mm 10.0 mm 20.0 mm 12100.0 mm 8000.0 mm 4500.0 mm	2 2 2 2 4		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.: 1,2 Σ Lengths: Σ Masses:
Cross Section Section Web Flange Gross Shear Shear Shear Secor Secor	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area Area Area d Moment	es - IS 450/200/10/20/0 ppe s of Area of Area	b tw tf At Ay Az Iy	450.0 mm 200.0 mm 10.0 mm 20.0 mm 12100.0 mm 8000.0 mm 4500.0 mm 4.27501E+0 mm	2 2 2 4 4		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.: 1,2 Σ Lengths: Σ Masses:
Cross Section Web Flange Gross Shear Shear Shear Secor Torsion	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area Area Area and Moment	es - IS 450/200/10/20/0 ppe s of Area of Area nt	b tw lf At Ay Az ly lz J	450.0 mm 200.0 mm 10.0 mm 12100.0 mm 8000.0 mm 4500.0 mm 4.27501E+0 mm 26700800.0 mm	2 2 2 4 4 4		Cross-section No. 1 used in Members No.: 5,6,8,12,14,93,94,96,100,102 Sets of members No.: 1,2 Σ Lengths: Σ Masses:
Cross Section Web Flange Gross Shear Shear Shear Secor Secor Torsion Radiu	ection Valu Section Ty on Height on Width Thickness e Thickness Area Area Area and Moment nal Consta	s of Area of Area of Area of Area of Area	b tw tr At Ay Az ly lz	450.0 mm 200.0 mm 10.0 mm 12100.0 mm 8000.0 mm 4500.0 mm 4.27501E+0 mm 26700800.0 mm 1142810.0 mm	2 2 2 4 4 4 4		Cross-section No. 1 used in Members No.: 5.6.8,12,14,93,94,96,100,102 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 48.00 [m] 4.559 [Material:
Cross Section Section Web Flange Gross Shear Shar Shear Shar Shar Shar Shar Shar Shar Shar Sh	ection Value Section Ty in Height in Width Thickness e Thickness e Thickness Area Area d Moment inal Consta s of Gyratic	es - IS 450/200/10/20/0 ppe s of Area of Area of Area nt on	b lw lf At Ay Az ly iz J ry rz	450.0 mm 200.0 mm 20.0 mm 20.0 mm 12100.0 mm 4500.0 mm 4.27501E+0 mm 142810.0 mm 1142810.0 mm	2 2 2 2 4 4 4 4		Cross-section No. 1 used in Members No.: 5.6.8.12,14,93,94,96,100,102 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 48.00 [m] 4.559
Cross Section Section Web Flange Gross Shear Shar Shar Shar Shar Shar Shar Shar Sh	ection Value Section Ty in Height in Width Thickness e Thickness e Thickness Area Area d Moment ad Moment inal Consta s of Gyratic s of Gyratic	es - IS 450/200/10/20/0 ppe s of Area of Area of Area nt nt on loculus	b lw lf At Ay Az ly lz J ry	450.0 mm 200.0 mm 10.0 mm 220.0 mm 12100.0 mm 4500.0 mm 4.27501E+0 mm 142810.0 mm 1142810.0 mm 188.0 mm	2 2 2 4 4 4 3		Cross-section No. 1 used in Members No.: 5.6.8.12.14.93.94.96.100.102 Sets of members No.: 1.2 Σ Lengths: Σ 48.00 [m] 4.559 Material: 2
Cross Sectic Sectic Web Flange Gross Shear Shear Shear Secor Torsic Radiu Elastic Elastic	ection Valu Section Ty on Height on Width Thickness a Thickness a Thickness a Thickness a Thickness a Thickness a Thickness a Thickness a Thickness a Strate a Strate s of Gyratic s of Gyratic s of Gyratic s of Gyratic	es - IS 450/200/10/20/0 es - IS 450/200/10/20/0 s of Area of Area of Area of Area of Area on n Aodulus loculus loculus	b lw lf At Ay Az ly iz J fy fz Zy	450.0 mm 200.0 mm 20.0 mm 12100.0 mm 4500.0 mm 427501E+0 mm 26700800.0 mm 1142810.0 mm 1142810.0 mm 47.0 mm 47.0 mm	2 2 2 2 4 4 4 4 3 3		Cross-section No. 1 used in Members No.: 5.6.8,12,14,93,94,96,100,102 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 48.00 [m] 4.559 [Material:

Figure 2.8: Window 1.3 Cross-sections

Cross-Section Description

The cross-sections defined in RSTAB are preset together with the assigned material numbers.



To modify a cross-section, click the entry in column B selecting this field. Click [Cross-section Library] or [...] in the field or press function key [F7] to open the cross-section table of the current input field (see the following figure).

In this dialog box, you can select a different cross-section or a different cross-section table. To select a different cross-section category, click [Back to cross-section library] to access the general cross-section library.

Chapter 4.3 of the RSTAB manual describes how cross-sections can be selected from the library.

Welded Cross-Sections - I symmet	ric		
Cross-Section Type $\begin{array}{c c} I & I & I & T \\ \hline T & L & L & D \\ \hline C & I & T & T \\ \hline O & \nabla & I & I \\ \hline I & T & I \\ \hline I & I & T \\ \hline I & I \\ \hline I & L \\ \hline I \\ \end{array}$	360.0 m/m [mm] b: 170.0 m/m [mm] s: 8.0 m/m [mm] t: 14.0 m/m [mm] a: 0.0 m/m [mm]		
٩		IS 360/170/8/14/0	
			OK Cancel

Figure 2.9: IS cross-sections in the cross-section library

The new cross-section description can be entered in the input field directly. If the data base contains an entry, STEEL NTC-DF imports these cross-section parameters, too.

A modified cross-section will be highlighted in blue.

If cross-sections set in STEEL NTC-DF are different from the ones used in RSTAB, both crosssections are displayed in the graphic on the right. The designs will be performed with the internal forces from RSTAB for the cross-section selected in STEEL NTC-DF.

Cross-Section Type for Classification

The cross-section type used for the classification is displayed. The cross-sections listed in [1] Table 5.2 can be designed plastically or elastically depending on the Class. Cross-sections that are not covered by this table are classified as *General*.

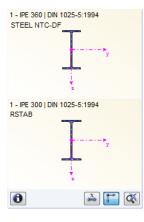
Max. Design Ratio

This table column is displayed only after the calculation. It is a decision support for the optimization. By means of the displayed design ratio and colored relation scales, you can see which cross-sections are little utilized and thus oversized, or overloaded and thus undersized.

Optimize

You can optimize every cross-section from the library: For the RSTAB internal forces, the program searches the cross-section that comes as close as possible to a user-defined maximum utilization ratio. You can define the maximum ratio in the *Other* tab of the *Details* dialog box, (see Figure 3.4, page 31).

To optimize a cross-section, open the drop-down list in column D or E and select the desired entry: *From Current Row* or, if available, *From favorites 'Description'*. Recommendations for the cross-section optimization can be found in chapter 7.2 on page 53.





Remark

This column shows remarks in the form of footers that are described in detail below the crosssection list.

A warning might appear before the calculation: *Incorrect type of cross-section!* This means that there is a cross-section that is not stored in the data base. This may be a user-defined cross-section or a SHAPE-THIN cross-section that has not been calculated yet. To select an appropriate cross-section for design, click [Library] (see description in Figure 2.8).

Member with tapered cross-section

For tapered members with different cross-sections at the member start and member end, the module displays both cross-section numbers in two tables, in accordance with the definition in RSTAB.

STEEL NTC-DF also designs tapered members, provided that the cross-section at the member's start has the same number of stress points as the cross-section at the member end. For example, the normal stresses, are determined from the moments of inertia and the centroidal distances of the stress points. If the cross-sections at the start and the end of a tapered member have a different number of stress points, the intermediate values cannot be interpolated. The calculation is possible neither in RSTAB nor in STEEL NTC-DF.

The cross-section's stress points including numbering can also be checked graphically: Select the cross-section in window 1.3 and click [Info]. The dialog box shown in Figure 2.10 appears.

Info About Cross-Section

In the dialog box *Info About Cross-Section*, you can view the cross-section properties, stress points, and c/t-parts.

Cross-Section Value Description	Symbol	Value	Unit	-	HE B 360 DIN 1025-2:1995
Depth	h	36.00	cm		
Width	Ь	30.00	cm		
Web thickness	tw	1.25	cm		
Flange Thickness	t r	2.25	cm		30.00
Root fillet radius	r	2.70	cm	Ξ	+
Cross-sectional area	A	181.00	cm ²	-	10
Shear area	Ay	112.63	cm ²		2.70
Shear area	Az	39.80	cm ²		
Shear area according to EC 3	Av.y	139.94	cm ²		
Shear area according to EC 3	A _{v,z}	60.96	cm ²		
√eb area	Aweb	39.40	cm ²		8
Plastic shear area	A _{pl,y}	135.00	cm ²		N N N N N N N N N N N N N N N N N N N
Plastic shear area	A _{pl,z}	42.19	cm ²		
Moment of inertia	ly	43190.00	cm ⁴		1.25
foment of inertia	Iz	10140.00	cm ⁴		
Governing radius of gyration	ſy	15.50	cm		
Governing radius of gyration	٢z	7.49	cm		
Polar radius of gyration	ro	17.21	cm		↓ · · · · · · · · · · · · · · · · · · ·
Radius of gyration of flange plus 1/5 of we	ſzg	8.03	cm		Z
/olume	V	18100.00	cm ³ /m		
√eight	wt	142.1	kg/m		
Surface	Asurf	1.850	m²/m		
Section factor	A _m /V	102.210	1/m		
Forsional constant	J	293.00	cm ⁴		🔲 🔝 Stress points 🛛 🖓 🚰
Warping constant	Cw	2.883E+06	cm ⁶		C/t-Parts
lastic section modulus	s.,	2400.00	cm ³	Ŧ	

Figure 2.10: Dialog box Info About Cross-Section

In the right part of the dialog box, the currently selected cross-section is displayed.







The buttons below the graphic are reserved for the following functions:

Button	Function
I	Displays or hides the stress points
	Displays or hides the c/t-parts
123	Displays or hides the numbering of stress points or c/t-parts
	Displays or hides the details of the stress points or c/t-parts (see Figure 2.11)
×	Displays or hides the dimensions of the cross-section
1	Displays or hides the principal axes of the cross-section
X	Resets the full view of the cross-section graphic

Table 2.2: Buttons of cross-section graphic

Click [Details] to call up detailed information on stress points (distance to center of gravity, statical moments of area, normalized warping constants etc.) and c/t-parts.

	A	B	С	D	E	F	G	HE B 260
StressP	Coordi	nates	Statical Mome	ents of Area	Thickness	Warp		
No.	y [cm]	z [cm]	Qy [cm ³]	Q _z [cm ³]	t [cm]	W _{no} [cm ²]	Sω [cm 4]	
1	-13.00	-13.00	0.00	0.00	1.75	157.63	0.00	
2	-2.90	-13.00	-213.95	-140.47	1.75	35.16	-1703.76	
3	0.00	-13.00	-280.04	-148.63	1.75	0.00	-1792.98	
4	2.90	-13.00	-213.95	140.47	1.75	-35.16	1703.76	
5	13.00	-13.00	0.00	0.00	1.75	-157.63	0.00	1 2 3 4 5
6	-13.00	13.00	0.00	0.00	1.75	-157.63	0.00	
7	-2.90	13.00	-214.31	140.52	1.75	-35.16	-1703.76	
8	0.00	13.00	-280.04	148.63	1.75	0.00	-1792.98	
9	2.90	13.00	-214.31	-140.52	1.75	35.16	1703.76	13 Y
10	13.00	13.00	0.00	0.00	1.75	157.63	0.00	
11	0.00	-8.85	-599.75	0.00	1.00	0.00	0.00	
12	0.00	8.85	-600.56	0.00	1.00	0.00	0.00	
13	0.00	0.00	-638.91	0.00	1.00	0.00	0.00	6 7 8 9 10
								z
2	-							Close

Figure 2.11: Dialog box Stress Points of HE B 260

Q



2.4 Intermediate Lateral Restraints

In window 1.4, you can define intermediate lateral restraints for members. STEEL NTC-DF always assumes this kind of support to be perpendicular to the cross-section's minor axis z (see Figure 2.10). Thus, it is possible to influence the members' effective lengths which are important for the stability analyses concerning flexural buckling and lateral-torsional buckling.

For the calculation, intermediate lateral restraints are considered as torsional supports.



1.4 Intern ediate Late В D Membe No. Lateral Number L [m] Restraint х3 X5 X1 X2 X4 X6 X9 19 20 0.500 ✓
 ✓ 0.500 24 🛐 😼 💊 🔽 Relatively (0 ... 1) Settings - Member No. 21 Cross-Section Lateral Restraints Member Length Number of Intermediate Lateral Restraints 0.500 Location of Lateral Restraint No. 1 X1 Set input for members No. V AI A

Figure 2.12: Window 1.4 Intermediate Lateral Restraints

can define the distances manually in the upper table.

In the upper part of the window, you can assign up to nine lateral restraints for each member. The *Settings* section shows the input as column overview for the member selected above.



To define the intermediate restraints of a member, select the *Lateral Restraint* check box in column A. To graphically select the member and to activate its row, click [^{\begin}]. By selecting the check box, the other columns become available for you to enter the parameters.

In column C, you specify the number of the intermediate restraints. Depending on the specification, one or more of the following *Intermediate Lateral Restraints* columns for the definition of the x-locations are available.

If the check box *Relatively* (0... 1) is selected, the support points can be defined by relative in-

put. The positions of the intermediate restraints are determined from the member length and the relative distances from the member start. If the *Relatively (0 ... 1)* check box is cleared, you

📝 Relatively (0 ... 1)

5

In case of cantilevers, avoid intermediate restraints because such supports divide the member into segments. For cantilevered beams, this would result in segments with lateral torsional restraints on one end each that are statically underdetermined.



2.5 Effective Lengths - Members

The window is subdivided into two parts. The table in the upper part contains summarized information about the factors for the lengths of buckling and lateral-torsional buckling as well as the equivalent member lengths of the members to be designed. The effective lengths defined in RSTAB are preset. In the *Settings* section, you can see further information on the member whose row is selected in the upper section.



....

Click the button [[^]] to select a member graphically and to show its row.

Changes can be made in the table as well as in the Settings tree.

	A	B	C	D	E	F	G	H		J	K	L
Member	Buckling	Buck	ing About A	xis y	Buck	ling About A	xis z	Lateral-	Torsional and	Torsional-Flex	ural Buckling	
No.	Possible	Possible	Ky	KyL [m]	Possible	Kz	KzL [m]	Possible	L _w [m]	LT [m]	Mu[kNm]	Comment
1	V	V	1.000	3.000	V	1.000	3.000	V	3.000	3.000	Eigenvalue	
2	V		1.000	3.000	√	1.000	3.000	V	3.000	3.000	Eigenvalue	
3		 ✓ 	1.000	5.000	 ✓ 	1.000	5.000		5.000	5.000	Eigenvalue	
4	√	 ✓ 	1.000	5.000	 ✓ 	1.000	5.000		5.000	5.000	Eigenvalue	
5	√	√	1.000	3.000	2	1.000	3.000	V	3.000	3.000	Eigenvalue	
6	√	 ✓ 	1.000	3.000	V	1.000	3.000	V	3.000	3.000	Eigenvalue	
7	V	2	1.000	5.000	V	1.000	5.000		5.000	5.000	Eigenvalue	
8	√	 ✓ 	1.000	6.000	V	1.000	6.000	V	6.000	6.000	Eigenvalue	
9	√	✓	1.000	5.000	✓	1.000	5.000		5.000	5.000	Eigenvalue	
10			1.000	7.810		1.000	7.810		7.810	7.810	Eigenvalue	This type of member is not a
	Member No	. 1									IS 250/	250/10/15/0
Cross-	Section					15 - IS 1	250/250/10	/15/0				
Length					L		3.000 m					
	ng Possible						S					
		jor Axis y Pos	sible				✓					
	ctive Length				Ky		1.000					+ 250.0 +
	ctive Length				KyL		3.000 <u></u> m					
		nor Axis z Pos	sible				√					0.0
	ctive Length				Kz		1.000					0.0
	ctive Length				KzL		3.000 m				- 9	
	Length	uckling Possil	bie		-						250.0	
	s Length sional Length				Lw LT	-	3.000 m 3.000 m					10.0
- Tors	sonai Lengtr				LI	D-	3.000 m jenvalue					
Comme	ant					Eig	envalue					annanna
Comme					_							1
					_							z
						_						
Set in	put for memb	ers No.:										

Figure 2.13: Window 1.5 Effective Lengths - Members

The effective lengths for buckling about the minor z-axis are aligned automatically with the entries of the 1.4 *Intermediate Lateral Restraints* window. If intermediate restraints divide the member into member segments of different lengths, the program displays no values in the table columns G, I, and J of window 1.5.

The effective lengths can be entered manually in the table and in the *Settings* tree, or defined graphically in the work window after clicking [...]. This button is enabled when you click in the input field (see figure above).

The Settings tree manages the following parameters:

- Cross-Section
- Member Length
- Buckling Possible for member (cf columns B and E)
- Buckling about Axis y Possible (cf columns C and D)
- Buckling about Axis z Possible (cf columns F and G)
- Lateral-Torsional Buckling Possible (cf columns I K)

In this table, you can specify for the currently selected member whether to carry out a buckling or a lateral-torsional buckling analysis. In addition to this, you can adjust the *Effective Length Factor* for the respective lengths. When a coefficient is modified, the equivalent member length is adjusted automatically, and vice versa.

2 Input Data



~

You can also define the buckling length of a member in a dialog box. To open it, click the button shown on the left. It is located on the right below the upper table of the window.

Select Effective Length Factor	×
Buckling About Axis y	Buckling About Axis z
© Ky = 2.0	© Kz = 2.0 Z++++
• K _y = 1.0	Kz = 1.0 Y Y Y
© Ky = 0.7	© K₂ = 0.7
© Ky = 0.5	© Kz = 0.5
© User-defined	User-defined Kz =
Import from add-on module RSBUCK (Eigenvalue Analysis)	 Import from add-on module RSBUCK (Eigenvalue Analysis)
RSBUCK-Case:	RSBUCK-Case:
CA1 - Stability analysis 🔹	CA1 - Stability analysis
Buckling shape No.:	Buckling shape No.:
Export effective length factor Ky: 1.000	Export effective length factor Kz : 1.000
D	OK Cancel

Figure 2.14: Dialog box Select Effective Length Factor

For each direction, the buckling length can be defined according to one of the Euler buckling modes or *User-defined*. If a RSBUCK case calculated according to the eigenvalue analysis is already available, you can also define a *Buckling Shape* to determine the factor.

Buckling Possible

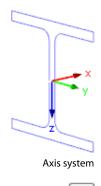
A stability analysis for flexural buckling requires the ability of members to absorb compressive forces. Therefore, members for which such absorption is not possible because of the member type (for example tension members, elastic foundations, rigid connections) are excluded from design in the first place. The corresponding rows appear dimmed and a note is displayed in the *Comment* column.

The *Buckling Possible* check boxes in table row A and in the *Settings* tree offer you a control option for the stability analyses: They determine whether the analysis should or should not be performed for a member.

Buckling about Axis y or Axis z

With the check boxes in the *Possible* table columns, you decide whether a member is susceptible to buckling about the y-axis and/or z-axis. These axes represent the local member axes, with axis y being the major and axis z the minor member axis. The buckling length coefficients K_y and K_z for buckling about the major or the minor axis can be selected freely.

You can check the position of the member axes in the cross-section graphic in the 1.3 *Cross-Sections* window (see Figure 2.8, page 13). To access the RSTAB work window, click [View mode]. In the work window, you can display the local member axes by using the member's context menu or the *Display* navigator (see figure below).



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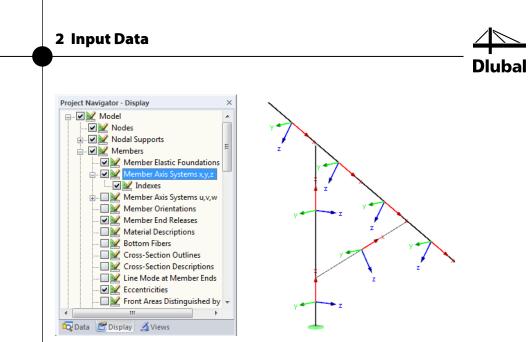


Figure 2.15: Selecting the member axis systems in the Display navigator of RSTAB

If buckling is possible about one or even both member axes, you can enter the effective length factors as well as the buckling lengths in the columns C and D or F and G. The same is possible in the *Settings* tree.

To specify the buckling lengths in the work window graphically, click [...]. This button becomes available when you click in a *KL*-input field (see Figure 2.13).

When you specify the effective length factor *K*, the program determines the effective length *KL* by multiplying the member length *L* by the effective length factor *K*. The input fields *K* and *KL* are interactive.

Lateral-Torsional and Torsional-Flexural Buckling Possible

Table column H shows you for which members the program performs an analysis of lateraltorsional and torsional-flexural buckling.

With the check box in the *Possible* columns, you decide whether a member is susceptible to torsional buckling. The LTB lengths L_w and the torsional lengths L_T in columns I and J can be edited by the user.

Elastic Buckling Moment Mu

The list in column K includes four options for the calculation of the nominal bending resistance moment M_u . It can be accessed by clicking the button [\checkmark] which appears after clicking in a cell of this table column.

• Eq. (3.24)

 M_u is calculated according to [1] clause 3.3.2.2.

$$M_{u} = \frac{\pi}{CL} \sqrt{E \cdot I_{z} \cdot G \cdot J + \left(\frac{\pi \cdot E}{L}\right)^{2} \cdot I_{z} \cdot C_{a}}$$

Use factor C_b

The modification factor C_b is calculated according to the AISC standard [2] equation F1-1.

$$C_{b} = \frac{12.5M_{max}}{2.5M_{max} + 3M_{A} + 4M_{B} + 3M_{C}}$$

where

M_{max}	absolute value of maximum bending moment in unbraced segment
M _A	absolute value of bending moment at quarter point of segment
MB	absolute value of bending moment at center of member or segment

M_c absolute value of bending moment at three-quarter point of segment

Mu [kNm] Eigenvalue ▼ Eq. (3.24) Use factor Cb Eigenvalue Manually

....



The nominal bending resistance moment is then calculated with this modification factor.

$$\mathsf{M}_{\mathsf{u}} = \mathsf{C}_{\mathsf{b}} \frac{\pi}{\mathsf{CL}} \sqrt{\mathsf{E} \cdot \mathsf{I}_{\mathsf{z}} \cdot \mathsf{G} \cdot \mathsf{J} + \left(\frac{\pi \cdot \mathsf{E}}{\mathsf{L}}\right)^2 \cdot \mathsf{I}_{\mathsf{z}} \cdot \mathsf{C}_{\mathsf{a}}}$$

• Eigenvalue

This option is set as default. It uses the general eigenvalue solver to determinate the elastic buckling moment.

• Manually

The value of M_u can be defined individually.

Comment

In the last table column, you can enter your own comments for each member to describe, for example, the selected effective member lengths.

2.6 Effective Lengths - Sets of Members

This window appears only if you have selected at least one set of members for design in the 1.1 *General Data* window (see Figure 3.2, page 28).

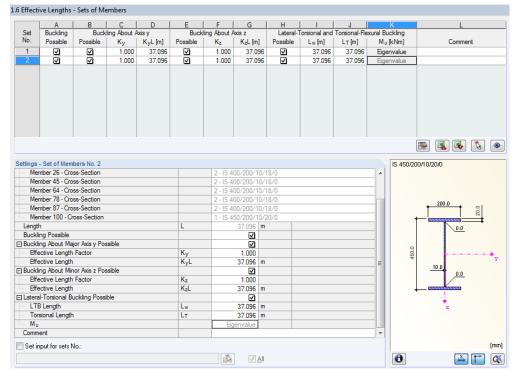


Figure 2.16: Window 1.6 Effective Lengths - Sets of Members

The concept of this window is similar to the one in the previous 1.5 *Effective Lengths - Members* window. In this window, you can enter the effective lengths for the buckling about the two principal axes of the set of members as described in chapter 2.5.





2.7 Nodal Supports - Sets of Members

This window is displayed only if you have selected at least one set of members for the design in the 1.1 *General Data* window.

If the *Member-Like Input* is selected for sets of members in the dialog box *Details* dialog box, tab *Stability* (see Figure 3.2, page 28), window 1.7 will not be displayed. In that case, you can define the intermediate lateral restraints by using division points in window 1.4.

	Α	B	С	D	E	F	G	H	
upport	Node	Support	Lat. Support	Rotational	Restraint	Warping	Eccer	tricity	
No.	No.	Rotation ß [°]	uy.	φ _X [kNm/rad]	φZ'	Restraint ω	ex [mm]	e z [mm]	Comment
1	13	0.00	2	2			0.0	0.0	
2	16	0.00	2	12.800 💌			0.0	-150.0	
3									
4									
5									
6									
7									
8									
9									
10									
ettings -	Node Sun	port No. 16							
	Members	port no. To							
	nber 13								
	tart				3 - IPE 400	DIN 1025-5:19	94		
E	nd					DIN 1025-5:19			
Men	nber 14 - C	ross-Section				DIN 1025-5:19			
Men	nber 15 - C	ross-Section				DIN 1025-5:19			
Node 1	with Suppo	nt		No.		16			
Suppo	rt Rotation			β		0.00 °			
Lateral	Support in	۱Y		UY.		2			
Restra	int About X	C.		φx.	12	800 kNm/rad			
Restra	int About Z			07					V V

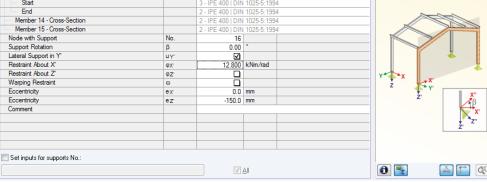


Figure 2.17: Window 1.7 Nodal Supports - Set of Members



Details.

To determine critical buckling factor of lateral-torsional buckling, a planar framework is created with four degrees of freedom for each node, which you have to define in window 1.7. This window refers to the <u>current</u> set of members (selected in the add-on module's navigator on the left).

The orientation of the axes in the set of members is important for the definition of nodal supports. The program checks the position of the nodes and internally defines, according to Figure 2.18 to Figure 2.21, the axes of the nodal supports for window 1.7.



Figure 2.18: Auxiliary coordinate system for nodal supports - straight set of members

If all members of a set of members lie in a straight line as shown in Figure 2.18, the local coordinate system of the first member in the set of members corresponds to the equivalent coordinate system of the entire set of members.



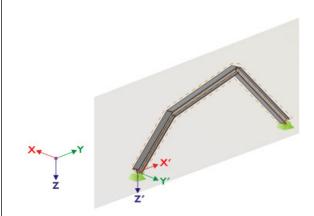


Figure 2.19: Auxiliary coordinate system for nodal supports - set of members in vertical plane

If members of a set of members are not lying in a straight line, they must at least lie in the same plane. In Figure 2.19, they are lying in a vertical plane. In this case, the axis X' is horizontal and aligned in direction of the plane. The axis Y' is horizontal as well and defined perpendicular to the axis X'. The axis Z' is directed perpendicularly downwards.

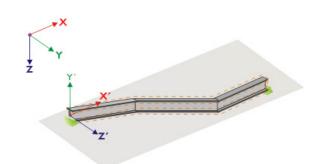


Figure 2.20: Auxiliary coordinate system for nodal supports - set of members in horizontal plane

If the members of a buckled set of members are lying in a horizontal plane, the X'-axis is defined parallel to the X-axis of the global coordinate system. Thus, the Y'-axis is oriented in the opposite direction to the global Z-axis and the axis Z' is directed parallel to the global Y-axis.

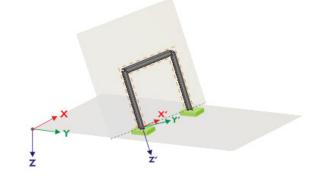


Figure 2.21: Auxiliary coordinate system for nodal supports - set of members in inclined plane

Figure 2.21 shows the general case of a buckled set of members: The members are not lying in one straight line but in an inclined plane. The definition of the X'-axis arises out of the intersection line of the inclined plane with the horizontal plane. Thus, the Y'-axis is defined perpendicular to the axis X' and directed perpendicular to the inclined plane. The Z'-axis is defined perpendicular to the X'- and Y'-axes.



2.8 Member End Releases - Sets of Members

This window is displayed only if you have selected at least one set of members for the design in the 1.1 *General Data* window. Here, you can define releases for members and sets of members that, due to structural reasons, do not transfer the locked degrees of freedom specified in window 1.7 as internal forces. This window refers to the <u>current</u> set of members (selected in the add-on module's navigator on the left).

Window 1.8 will not be displayed when in the Details dialog box (see Figure 3.2, page 28) the

Details...

.8 Member End R	eleases - Set of N	Members No. 2 - I	b			
A	В	C	D	E	F	G
Release Member		Shear Release	Moment		Warp Releas	
No. No.	Side	Vy	Мт	Mz [kNm/rad]		Comment
1 15	Start	Ó			Ő	
2 13	End	- H	— <u> </u>	15.000		
3				10.000		
4						
5						
6						
7						
8						
9						
10						
	-				•	
Settings - Member						
Set of Members				b		×
 Member 1 - C 	ross-Section			1 - HE A	100 Euronor	n 53-62
Member 3						
Start					450 DIN 1025	
End					360 DIN 1025	
- Member 4 - C					360 DIN 1025	
Member 5 - C					360 DIN 1025	
- Member 6 - C					360 DIN 1025	
 Member 7 - C 	ross-Section			2 - IPE 3	360 DIN 1025	5:1994
Member 8						
Start					360 DIN 1025	-3.1334
End					450 DIN 1025	
Member 2 - C				1 - HE A	100 Euronor	n 53-62
	elease at the End		No.		13	
Member Side			Side		End	
Shear Release			Vy			
Torsional Relea			MT			
Moment Releas			Mz		15.000 kNm	/rad
Warping Releas	e		Μω			▼
Set inputs for r	elease No.:				V All	🏹 📑 🏹 🕄

Figure 2.22: Window 1.8 Member Releases - Set of Members

Member-Like Input is selected for sets of members.

Member Side Start End Both

In table column B, you define the *Member Side* to which the release should be assigned. You can also connect the releases to both member sides.

In the columns C through F, you can define releases or spring constants to align the set of members model with the support conditions in window 1.7.



2.9 Serviceability Data

This input window controls several settings for the serviceability limit state design. It is only available if you have set the according entries in the *Serviceability Limit State* tab of window 1.1 (see chapter 2.1.2, page 10).

	A	B	C	D	E	F	G	Н
		Set of Members		nce Length	Direc-	Precamber		
No.	Reference to	No.	Manually	L [m]	tion	wc[mm]	Beam Type	Comment
1	Set of Members	2		37.096	y, z	0.0	Beam	
2	Set of Members	5		25.000	y, z	0.0	Beam	
3	Member	81		6.546	y, z	0.0	Beam	
4	Member	82	V	7.094	y, z	0.0	Cantilever End Free	
5	Member	83	V	6.546	y, z	0.0	Cantilever End Free	
6	Member	15		6.274	y. z	0.0	Beam	
7	Member	16		6.274	y, z	0.0	Beam	
8	Member	25		6.274	y, z	0.0	Beam	
9	Member	26		6.274	y, z	0.0	Beam	
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								



....



•

Details...

Figure 2.23: Window 1.9 Serviceability Data

In column A, you decide whether you want to apply the deformation to single members, lists of members, or sets of members.

In table column B, you enter the numbers of the members or sets of members that you want to design. You can also click [...] to select them graphically in the RSTAB work window. Then, the *Reference Length* appears in column D automatically. This column presets the lengths of the members, sets of members, or member lists. If required, you can adjust these values after selecting the *Manually* check box in column C.

In table column E, you define the governing *Direction* for the deformation analysis. You can select the directions of the local member axes y and z (or u and v for unsymmetrical cross-sections).

In column F, you can consider a precamber w_c.

The *Beam Type* is of vital importance for the correct application of limit deformations. In column G, you can specify whether there is a beam or a cantilever and which end should have no support.

The settings in the *Serviceability* tab of the *Details* dialog box decide whether the deformations are related to the undeformed initial model or to the shifted ends of members or sets of members (see Figure 3.3, page 30).



2.10 Parameters - Members

The last input window controls additional design parameters for members.

If the *Cross-Sectional Area* of a member is to be considered by specific parameters, set a check in relevant line of column A. You can then define the *Cross-sectional areas for tension design* in the *Settings* table below (net and effective areas, shear lag factor U).

			В						
Iember Cross-Sectional			0						
No. Area	Comment								
1 💟	Comment								
2									
3									
4									
5 2									
6 🗖									
7									
8 2									
9 0									
10									
				🛃 😼 🐧					
ttings - Member No. 8									
Cross-Section		1 - IS 450/200/1	10/20/0						
Cross-sectional area for tension design									
⊟ Start (x=0 m)		1 - IS 450/200/	10/20/0						
 Cross-Sectional Area 	At	12100.0							
 Net Cross-Sectional Area 	Anet	10000.0							
Effective Area	Ae	10000.0							
Shear Lag Factor U	U	1.000							
🖃 End (x=l)		1 - IS 450/200/							
 Cross-Sectional Area 	At	12100.0	mm ²						
 Net Cross-Sectional Area 	Anet	9000.0							
- Effective Area	Ae	7200.0							
Shear Lag Factor U	U	0.800							
Comment									
				-Anet					
Set input for members No.:									
				0					

Figure 2.24: Window 1.10 Parameters - Members

Those parameters are relevant for the design of member connections and of cross-sections with tension.



3. Calculation

3.1 Detail Settings

Calculation



Before you start the [Calculation], it is recommended to check the design details. You can open the corresponding dialog box in all windows of the add-on module by clicking [Details].

The dialog box *Details* contains the following tabs:

- Ultimate Limit State
- Stability
- Serviceability
- Other

3.1.1 Ultimate Limit State

tails		
Jltimate Limit State Stability Service	ability Other	
Options		
Plastic design acc. to 1.5		
Elastic design (also compact cross-	sections)	
Elastic design (based on Von Mises	stress)	
Shear design of solid cross-sections		
📝 Shear buckling design of webs		
General elastic design of shear bas	ed on shear stress	
Limit Internal Forces for Interaction		
Allow design without influence of torsio	n if:	
$\tau_t / F_R 0.6 F_y \le 0.500$		
Seismic design		
Factor of seismic behavior Q:	1.500 🚔	
2 🔤 🔿 📭 📭		OK Canc

Figure 3.1: Dialog box Details, tab Ultimate Limit State

Options

According to [1] clause 1.5, there is also a *Plastic design* possible for members. If the requirements given in clause 1.5(a) are satisfied, hot-formed doubly symmetric I-sections can be designed according to this option. Cross-sections that are assigned to type 1 or 2 ("compact") will be designed plastically in STEEL NTC-DF. If you do not want to perform a plastic design, you can activate the *Elastic design* for these cross-sections, too. Then all cross-sections will be considered as type 3 ("non-compact").



Alternatively, a conservative general elastic design based on stress analysis in stress points and VON MISES equivalent stresses can be applied. This option is useful for cross-sections with complex shapes or for members with torsional moments etc.

If the *Shear design* of solid flat or round bars or *Shear buckling design* of webs is not required in special cases, this design option can be deactivated.

The conservative *General elastic design of shear* based on the shear stress analysis in stress points can be activated additionally.

Limit Internal Forces for Interaction

The standard [1] offers no exact procedure how to design cross-sections under the torsion. Therefore, there is an option to ignore shear stress due to torsion for the cross-section design. You can enter the maximum ratio of torsional shear stress and shear strength so that the design is possible in spite of small torsional moments.

Seismic Design

The factor of seismic behavior Q can be edited, if necessary. This value is used to determine the cross-section type according to [1] Table 2.1.

3.1.2 Stability

Details	
Ultimate Limit State Stability Serviceability General	
Stability Analysis	Sets of Members - Member-Like Input
V Use	O not use member-like input
Second Order Effects Acc. to 1.5.1.1 and 3.4.3.3(b) Bending about major y-axis	 Use for all sets of members Use only for straight sets of members Use only for straight sets of members without intermediate restraints (simole beams or cantilevers)
increasing the bending moment Bending about minor z-axis Include effects from second order theory by increasing the bending moment	Welded L and H-Section Fabrication Determination of factor n acc. to 3.2.2.1
Determination of factor C (a) C = 1.00 (b) d. 1.5.1.1(a) and (b)	Rolled Fame-cut Limit Load for Special Cases
$\begin{array}{llllllllllllllllllllllllllllllllllll$	Cross-sections with compression and bending Do not consider small moments and allow stability design acc. to 3.2 (intended axial compression) if: Bending Muoy / FR Mp,y ≤ 0.010 (⇒)
Lateral-Torsional Buckling *	M _{uoz} / F _R M _{p,z} ≤ 0.010 (▲)
Load application of positive transverse loads: On cross-section edge directed to shear center (e.g. top flange, destabilizing effect)	Do not consider small compression forces and allow stability design acc. to 3.3 (bending without compression) f:
In shear center On cross-section edge directed from shear center (e.g. bottom flange, stabilizing effect)	Compression Pu / FR Rp ≤ 0.010 ⇒
*(set of members only)	Limit shear stress for stability designs: $\tau_t / F_R 0.6 F_y \le 0.010$
Determination of Design Bending Moment Resistance Mm Use approximate calculation acc. to Eq. (3.57) (only I-sections)	
	OK Cancel

Figure 3.2: Dialog box Details, tab Stability

Stability Analysis

The Use check box controls whether to run, in addition to the cross-section checks, a stability analysis. If you clear the check box, the input windows 1.4 through 1.8 will not be displayed.



Second Order Effects

If a load case is calculated according to a linear static analysis, you can consider the *effects from* 2nd order theory by increasing the bending moment about the major and/or minor axis, according to [1] clauses 1.5.1.1 and 3.4.3.3(b). When you design, for example, a frame whose governing buckling mode is represented by lateral displacement, you can determine the internal forces according to linear static analysis and increase them by the appropriate factors. If you increase the bending moment, it does not affect the flexural-buckling analysis according to [1] as it is performed by using the axial forces.

The Determination of factor C can be by default C = 1.00 or according to clause 1.5.1.1(a) and (b). The bending moments M_{ti} and M_{tp} are determined in very simple way – as constant ratio to the total bending moment value. This ratio is constant for all members. If second order effects are included, the factors B1 and B2 are used to calculate the final design values M_{uo} and M^*_{uo} according to [1] Eq. (1.1) and (1.2) for plastic design and also according to Eq. (3.59) to (3.62). The *Stability factor* I of the entire frame (model) according to clause 2.2.2 can be edited, if necessary.

Lateral-Torsional Buckling

If transverse loads are present, it is important to define where these forces are acting on the cross-section: Depending on the *Load application* point, transverse loads can be stabilizing or destabilizing, and thus can decisively influence the ideal critical moment. The determination of the buckling factor α_{cr} for set of members is based on those settings. Please note that the load application point is only taken into account for sets of members.

Determination of Bending Design Resistance M_m

The value of the bending design resistance M_m is required for cross-section types 1 or 2 according to [1] clause 3.4.3.2, Eq. (3.56). This value can be calculated according to clause 3.3.2 or, approximately, according to Eq. (3.57) for I-sections. When this option is checked, M_m is determined, the *approximate calculation* is applied according to the Eq. (3.57) for I-sections, and according to clause 3.3.2 for all other cross-sections.

Set of Members - Member-Like Input

It is recommended to apply the STEEL NTC-DF design only for straight sets of members. The stability data can be defined as member-like in window 1.6 (to treat a set of member like one single member) or as general in windows 1.7 and 1.8 (default). If the latter option *Do not use member-like input* is set, the support conditions have to be defined in window 1.7 for the sets of members.

With the option *Use for all sets of members*, you can define all stability data for sets of members in window 1.6 analogically to window 1.5 for single members. In this case, windows 1.7 and 1.8 are not displayed. The default simple girder values are used to determine the support conditions β , u_y , ϕ_x , ϕ_z and ω .

It is possible to use the member-like input *only for straight sets of members* with equal crosssection parameters. Windows 1.7 and 1.8 won't be displayed for straight sets. This option can be used e.g. for continuous beams.

The fourth option applies the member-like input only to *straight sets of members without intermediate restraints* modeled in RSTAB. Thus, only sets of members which have RSTAB supports/ restraints at their ends will be considered for the member-like input. This option can be used to design e.g. simple beams or cantilevers. The connection of transverse beams to the intermediate nodes of the set is not accounted for, however. Windows 1.7 and 1.8 won't be displayed for straight sets that have no intermediate restraints.

Welded I- and H-Section Fabrication

For I- and H-sections, *Rolled* or *Flame-cut* fabrication methods are possible. The member section constant *n* as specified in [1] clause 3.2.2.1(a) depends on this type of fabrication. The selected type is then applied to <u>all</u> I and H sections of the design case.





Limit Load for Special Cases

To design cross-sections for intended axial compression according to [1] clause 3.2, it is possible to neglect *small moments* about the major and the minor axes by settings defined in this dialog section.

In the same way, you can switch off small *compression forces* for the pure design of bending by defining a limit ratio for P_u to $F_R R_p$.

Intended *torsion* is not clearly specified in [1]. If a torsional stress is available that is not exceeding the shear stress ratio of 1 % preset by default, it is not considered in the stability design. In this case, the output shows results for flexural buckling and lateral-torsional buckling.



If one of the limits in this dialog section is exceeded, a note appears in the results window. No stability analysis is carried out. Nevertheless, the cross-section checks are run independently. These limit settings are <u>not</u> part of the Mexican standard. Changing the limits is in the responsibility of the program user.

3.1.3 Serviceability

tails		(
Ultimate Limit State Stability Servi	ceability Other	
Deformation Relative to		
Shifted members ends / set of me	mbers ends	
Undeformed system		
Serviceability Limits (Deflections) Ad		
Limit L / 24	Cantilevers	
L/ 24		

Figure 3.3: Dialog box Details, tab Serviceability

Deformation Relative to

The option fields control whether the maximum deformations are related to the shifted ends of members or sets of members (connection line between start and end nodes of the deformed system) or to the undeformed initial system. As a rule, the deformations have to be checked relative to the displacements in the entire structural system.

Serviceability Limits (Deflections)

Here you can check and, if necessary, adjust the limit deformations of beams and cantilevers.



3.1.4 Other

tails	
Itimate Limit State Stability Serviceability Other	
Cross-Section Optimization	Display Result Tables
Ma <u>x</u> allowable design	✓ 2.1 Design by Load Case
ratio: 1.000 牵	✓ 2.2 Design by Cross-Section
Check of Member Slendernesses	✓ 2.3 Design by Set of Members
Members with λlimit	2.4 Design by Member
Tension only: 300	✓ 2.5 Design by x-Location
Compression / flexure: 200	☑ 3.1 Governing Internal Forces by Member
	☑ 3.2 Governing Internal Forces by Set of Members
	3.3 Member Slendemesses
	4.1 Parts List by Member
	✓ 4.2 Parts List by Set of Members
	Only for members / sets to be designed
	○ Of all members / sets of members
) 🚾 🔿 📭 🕋	OK Cance

Figure 3.4: Dialog box Details, tab Other

Cross-Section Optimization

The optimization is targeted on the maximum stress ratio of 100 %. If necessary, you can specify a different limit value in this input field.

Check of Member Slendernesses

In the two input fields, you can specify the limit values λ_{limit} (the ratios K · L/r) in order to define member slendernesses. It is possible to enter specifications separately for members with pure tension forces and members with bending and compression. The default values are given in [1] clause 2.2.3.

The limit values are compared to the real member slendernesses in window 3.3. This window is available after the calculation (see chapter 4.8, page 40) if the corresponding check box is selected in the *Display Result Tables* dialog box section.

Display Result Tables

In this dialog section, you can select the results windows including parts list that you want to be displayed. Those windows are described in chapter 4 *Results*.

The 3.3 Member Slendernesses window is inactive by default.



3.2 Start Calculation

Calculation

To start the calculation, click the [Calculation] button that is available in all input windows of the STEEL NTC-DF add-on module.

STEEL NTC-DF searches for the results of the load cases, load combinations, and result combinations to be designed. If these cannot be found, the program starts the RSTAB calculation to determine the design relevant internal forces.

You can also start the calculation in the RSTAB user interface: The dialog box *To Calculate* (menu *Calculate* \rightarrow *To Calculate*) lists design cases of the add-on modules like load cases and load combinations are listed.

lot Calculated	d			Selected fr	or Calculation	
No.	Description		-	No.	Description	
AB LC2 QW LC4 QW LC4 QW LC5 QW LC6 Imp LC8 Imp LC10 C011 C012 C013 C014 C015 C016 C017 C018 C019 RC2	Snow Load Wind at peak v +Y Wind at peak v -Y Wind positive Imperfections v +X Imperfections v +Y LC1 + LC2 + LC3 + LC7 + LC8 LC1 + LC2 + LC3 + LC7 + LC8 LC1 + LC3 + LC8 LC1 + LC4 + LC8 LC1 + LC4 + LC8 LC1 + LC4 + LC7 LC1 + LC4 + LC7 + LC9 SLS	E	 		STEEL NTC-DF - Design of steel members according to NTC-DF	-
All	•	2				

Figure 3.5: Dialog box To Calculate

If the STEEL NTC-DF cases are missing in the *Not Calculated* section, select *All* or *Add-on Modules* in the drop-down list at the end of the list.

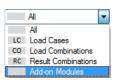
To transfer the selected STEEL NTC-DF cases to the list on the right, use the button [▶]. Click [OK] to start the calculation.

To calculate a design case directly, use the list in the toolbar. Select the STEEL NTC-DF case in the toolbar list, and then click [Show Results].

<u>Options</u>	Add-on Modules	<u>W</u> indow	Help
	STEEL NTC-DF CA1	- Desigr 👻	< > 🕑 🎬 🔗 💯 🚳 📾 📾 🦉 🏶 🥵 🏦
1	R () () ()	¥ 17 5	🗱 + 🛂 + 🚳 + Show Results] 🐂 🗸 🗸 🗤 🗤 🦏 🥁 🗍

Figure 3.6: Direct calculation of a STEEL NTC-DF design case in RSTAB

Subsequently, you can observe the design process in a separate dialog box.



>



4. Results

Window 2.1 *Design by Load Case* is displayed immediately after the calculation.

	Z.I Desigi	n by Load Case													
put Data		A	В	С	D	E				F					G
- General Data	Load-		Member	Location	Design										
- Materials	ing	Description	No.	x [m]	Ratio				Desi	gn According to	Formu	la			DS
- Cross-Sections		Ultimate Limit State Design													
Intermediate Lateral Restraints	LC1	Dead Load	12	1.000						ut y-axis and com					
Effective Lengths - Members	LC2	Snow Load	87	3.011						ut y-axis and com			3.3.2.2 an	id 3.4.3.2(a)	1
 Effective Lengths - Sets of Men 	LC3	Wind v +X	12	5.700						nal buckling acc	. to 3.	3.2.2			
- Nodal Supports	LC4	Wind at peak v +Y	99	0.000			101) Cross-secti								
 Set of members No. 1 	LC5	Wind at peak v -Y	98	0.000			101) Cross-secti								
- Set of members No. 2	LC6	Wind positive	17	0.000	0.08	≤1	321) Stability an	alysis - La	teral-torsio	nal buckling acc	. to 3.	3.2.2			
Member End Releases	LC7	Live Load	20	3.125	0.04	≤1	321) Stability an	alysis - La	teral-torsio	nal buckling acc	to 3.	3.2.2			
- Set of members No. 1	CO1		87	3.011	0.83	≤1	331) Stability an	alysis - Be	nding abo	ut y-axis and com	npress	ion acc. to	3.3.2.2 an	id 3.4.3.2(a)	1
- Set of members No. 2	CO2		87	3.011	0.76	≤1	331) Stability an	alysis - Be	nding abo	ut y-axis and com	npress	ion acc. to	3.3.2.2 an	d 3.4.3.2(a)	
Serviceability Data Parameters - Members				Max	0.83	≤1	•			? 8	•		7,1 😂		3
esults															
 Design by Load Case 		Member 12 - x: 1.000 m - LC1										1 - IS 450	0/200/10/20)/D	
- Design by Cross-Section		al Values - Steel B-254 (ASTM									^				
 Design by Set of Members 		Section Values - IS 450/200/	10/20/0												
- Design by Member		n Internal Forces													
- Design by x-Location		Section Type											. 200	.0.	
 Governing Internal Forces by M 	🖃 Desig														20.0
- Governing Internal Forces by Si		d Strength			F		250.000			1.3.1		1			-
- Member Slendernesses		npression Axial Force			P		25.499							0.0	
- Parts List by Member		tion Resistance			R		2722.500			3.2					
- Parts List by Set of Members		stic Buckling Stress			F		50.680								
		minal Critical Stress			F		42.298					150.0			-
		mber Resistance			R	c	460.628	kN		Eq. (3.3)		1	10.0		
		sign Component for N			η		0.06		≤1	3.4.3.2(a)			10.0	0.0	
		nding Moment				luoy	8.777								
		ximum Bending Moment			N	uoy.									
		sign Bending Resistance				Ry	481.556								
		dulus of Elasticity			E		200000.000							z	
		ar Modulus			G		77200.000								
		cond Moment of Area			12		26700800.0								
	Tor	sional Constant			J		1142810.0	mm ⁴							
	Wa	rping Constant			C	a	1.23267E+1	mm ⁶							ſπ
	- Seg	ment Length			L		6.000	m				_			
	- Sta	bility Factor			α	or	7.161				-	0		📥 🕽	
4 11															

Figure 4.1: Results window with designs and intermediate values

The designs are shown in the results windows 2.1 through 2.5, sorted by different criteria.

The windows 3.1 and 3.2 list the governing internal forces. Window 3.3 informs you about the member slendernesses. The last two results windows 4.1 and 4.2 show the parts lists sorted by member and set of members.

4

ОК

Every window can be selected by clicking the corresponding entry in the navigator. To set the previous or next input window, use the buttons shown on the left. You can also use the function keys to select the next [F2] or previous [F3] window.

Click [OK] to save the results. You exit STEEL NTC-DF and return to the main program.

Chapter 4 *Results* describes the different results windows one by one. Evaluating and checking results is described in chapter 5 *Results Evaluation*, page 43.

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4.1 Design by Load Case

The upper part of the window provides a summary, sorted by load cases, load combinations, and result combinations of the governing designs. Furthermore, the list is divided in ultimate limit state, serviceability and stability designs.

The lower part gives detailed information on the cross-section properties, analyzed internal forces, and design parameters for the load case selected above.

	A	B	C	D	E				F						G	٦
-bao		Member	Location	Design												
ing	Description	No.	x [m]	Ratio				Des	ign According to	Formu	ıla				DS	
	Ultimate Limit State Design															
LC1	Dead Load	12	1.000						ut y-axis and cor							
LC2	Snow Load	87	3.011						ut y-axis and cor			o 3.3.2	.2 and 3	.4.3.2(a)		
LC3	Wind v +X	12	5.700						nal buckling acc	. to 3.	3.2.2					
LC4	Wind at peak v +Y	99	0.000			01) Cross-secti										
LC5	Wind at peak v -Y	98	0.000	0.12	≤1 1(01) Cross-secti	on check	- Tension	acc. to 3.1							
LC6	Wind positive	17	0.000	0.08	≤1 3	21) Stability an	alysis - La	ateral-torsio	nal buckling acc	. to 3.	3.2.2					
LC7	Live Load	20	3.125						nal buckling acc							
CO1		87	3.011						ut y-axis and cor							
CO2		87	3.011	0.76	≤1 33	31) Stability an	alysis - Be	ending abo	ut y-axis and con	npress	ion acc. t	o 3.3.2	.2 and 3	.4.3.2(a)		
			Max	0.83	≤1 🙂)			91 2	-	L	751	2	3	8	ŕ
] Cross	n Internal Forces -Section Type												200.0			
Cross Desig				F کار ا		250.000 35.661			1.3.1	T T		 ►_	200.0		18.0	
Cross Desig Yie Co Se	-Section Type In Ratio Id Strength mpression Axial Force ction Resistance			P R	J 5	35.661 2439.000	kN kN		1.3.1			t ∎			18.0	
Cross Desig Yie Co Se Ela	-Section Type In Ratio Id Strength mpression Axial Force ction Resistance astic Buckling Stress			Pi R Fe	1 5	35.661 2439.000 40.102	kN kN MPa					+ •			18:0	
Cross Desig Yie Co Se Ela No	-Section Type gn Ratio Id Strength mpression Avial Force ction Resistance stic Buckling Stress minal Critical Stress			Pi R Fe Fr	1 5 2	35.661 2439.000 40.102 34.666	kN kN MPa MPa		3.2		0.001	t S			18.0	
Cross Desig Yie Co Se Ela No	-Section Type In Ratio Id Strength mpression Axial Force ction Resistance stic Buckling Stress minal Critical Stress miber Resistance			Pi R Fe	1 5 2	35.661 2439.000 40.102 34.666 338.206	kN kN MPa MPa		3.2 Eq. (3.3)		400.0				18.0	
Cross Desig Yie Co Se Ela No Me De	Section Type pn Ratio sld Strength mpression Avial Force ction Resistance stic Buckling Stress minal Critical Stress miber Resistance sign Component for N			Pr R Fr Fr R T	1 5 1 0 N	35.661 2439.000 40.102 34.666 338.206 0.11	kN kN MPa MPa kN	≤1	3.2		400.0				180	
Cross Desig Yie Co Se Ela No Me De Be	Section Type n Ratio d3 Strength mpression Axial Force ction Resistance setic Buckling Stress miber Resistance sign Component for N nding Moment			Pr R Fr Fr R M	J S S S S S N UOY	35.661 2439.000 40.102 34.666 338.206 0.11 207.633	kN kN MPa MPa kN kNm	≤1	3.2 Eq. (3.3)		400.0			0.0	181	
I Cross I Desig Co Co Se Ela No Me De Be Ma	Section Type n Ratio sld Strength mpression Axial Force ction Resistance satic Buckling Stress minal Critical Stress smber Resistance sign Component for N nding Moment soimum Bending Moment			Fr Fr M M M	s s c N uoy uoy,se	35.661 2439.000 40.102 34.666 338.206 0.11 207.633 207.633	kN kN MPa MPa kN kNm kNm	≤1	3.2 Eq. (3.3)		400.0			0.0	18.0	
Cross Desig Yie Co Se Ela No De Be Be Ma	Section Type pn Ratio d3 Strength mpression Axial Force ction Resistance satic Bucking Stress minal Critical Stress smber Resistance sign Component for N nding Moment sximum Bending Moment sximum Bending Resistance			Pi R; Fr R. M M M	J S S S S S N UOY	35.661 2439.000 40.102 34.666 338.206 0.11 207.633 207.633 383.949	kN kN MPa MPa kN kNm kNm kNm	≤1	3.2 Eq. (3.3)		400.0			0.0	18:0	
Cross Desig Yie Co Se Ela No De Be Ma De Ma	Section Type pn Ratio d3 Strength mpression Axial Force ction Resistance stic Bucking Stress minel critical Stress miber Resistance sign Component for N nding Moment sign Bending Moment sign Bending Moment sign Bending Resistance dulus of Basticity			Р	s s c N uoy uoy,se	35.661 2439.000 40.102 34.666 338.206 0.11 207.633 207.633 383.949 200000.000	kN kN MPa MPa kN kNm kNm kNm MPa	≤1	3.2 Eq. (3.3)		400.0			0.0	18:0	
Cross Desig Yie Co Se Ela No De Be Ma De Ma De Sh	Section Type n Ratio sld Strength mpression Axial Force ction Resistance sstic Buckling Stress minal Critical Stress smber Resistance sign Component for N nding Moment particular Stress somum Bending Resistance viduus of Elasticity ear Modulus			Р	s s c N uoy uoy,se	35.661 2439.000 40.102 34.666 338.206 0.11 207.633 383.949 200000.000 77200.000	kN kN MPa MPa kN kNm kNm kNm MPa MPa	≤1	3.2 Eq. (3.3)		400.h			0.0	18.0	
Cross Desig Yie Co See Ela No Me Be Be Be Be Ma De Sh Se	Section Type pn Ratio d3 Strength mpression Axial Force ction Resistance stic Bucking Stress minal Critical Stress minar Castion Stress sign Component for N nding Moment sign Bending Resistance sign Bending Resistance sign Bending Resistance odulus of Elasticity ear Modulus cond Moment of Area			Р	s s c N uoy uoy,se	35.661 2439.000 40.102 34.666 338.206 0.11 207.633 207.633 383.949 200000.000 77200.000 24030300.0	kN kN MPa MPa kN kNm kNm kNm MPa MPa mm ⁴	≤1 	3.2 Eq. (3.3)		400.0			0.0	180	
Cross Desig Yie Co Se Ela Na De Be Be Ma De Ma Sh Se To	Section Type pn Ratio d3 Strength mpression Axial Force ction Resistance stic Bucking Stress miber Resistance sign Component for N nding Moment sign Bending Noment sign Bending Moment sign Bending Moment sign Bending Moment cond Moment of Area rional Constant			Pr R Fr R M M M E G G Iz	s e n v v v v v v v y se	35.661 2439.000 40.102 33.666 0.11 207.633 207.633 383.949 20000.000 77200.000 24030300.0 860847.0	kN kN MPa MPa kN kNm kNm kNm MPa MPa mm ⁴ mm ⁴	≤1	3.2 Eq. (3.3)		400.0			0.0		
Cross Desig Yie Co Se Ela Na Me De Be Ma De Be Ma Sh Se To	Section Type In Ratio 43 Strength mpression Avial Force ction Resistance stic Bucking Stress minal Critical Stress mber Resistance sign Component for N nding Moment sign Bending Nement sign Bending Resistance dulus of Easticity ear Modulus cond Moment of Area rsional Constant aping Constant			Р	s e n v v v v v v v y se	35.661 2439.000 40.102 34.666 0.11 207.633 207.633 383.949 20000.000 77200.000 24030300.0 860847.0 8.75544E+1	kN kN MPa MPa kN kNm kNm kNm MPa MPa mm ⁴ mm ⁶	≤1	3.2 Eq. (3.3)		400.0			0.0	≠	
Cross Design Yié Co See Ela Noo See Be Be Be Ma De Ma Sh Se To Se Se Se Se Se Se Se Se Se Se Se Se Se	Section Type pn Ratio d3 Strength mpression Axial Force ction Resistance stic Bucking Stress miber Resistance sign Component for N nding Moment sign Bending Noment sign Bending Moment sign Bending Moment sign Bending Moment cond Moment of Area rional Constant			Pr R Fr R M M M E G G Iz	s e n v v v v v v v y se	35.661 2439.000 40.102 33.666 0.11 207.633 207.633 383.949 20000.000 77200.000 24030300.0 860847.0	kN kN MPa MPa kN kNm kNm kNm MPa MPa mm ⁴ mm ⁶	≤1	3.2 Eq. (3.3)		400.0			0.0	[r]	

Figure 4.2: Window 2.1 Design by Load Case

Description

This column shows the descriptions of the load cases, load combinations, and result combinations used for the designs.

Member No.

This column shows the number of the member that bears the maximum stress ratio of the designed loading.

Location x

This column shows the respective x-location where the member's maximum stress ratio occurs. For the table output, the program uses the following member locations *x*:

- Start and end node
- Division points according to possibly defined member division (see RSTAB table 1.6)
- Member division according to specification for member results (RSTAB dialog box *Calculation Parameters*, tab *Global Register Parameters*)
- Extreme values of internal forces

Design

Columns D and E display the design conditions according to [1].

The length of the colored scale represents the respective utilization ratio.



Design according to Formula

This column lists the code's equations by which the designs have been performed.

4.2 Design by Cross-Section

	A	B	С	D	E				F							
	Member	Location	Load	Design												
No.	No.	x [m]	Case	Ratio				Desig	n According to Formu	ıla						
1	IS 450/20	00/10/20/0														
	8	1.000	LC5			100) Negligible interna										
	5	0.900	LC6			101) Cross-section ch										
	94	0.000	CO1			102) Cross-section ch										
	8	5.700	LC3			105) Cross-section ch										
	14	3.000	LC4			106) Cross-section ch										
	93	0.750	CO1			115) Cross-section check - Shear force in z-axis acc. to 3.3.3										
	5	0.000	LC1		0.00 ≤ 1 126) Cross-section check - Shear buckling acc. to 3.3.3 - Shear force in z-axis 0.05 ≤ 1 141) Cross-section check - Bending about y-axis and shear force acc. to 3.3.4											
	93	3.000	CO5													
	93	3.000	C01	0.56	≤1	171) Cross-section ch	eck - Axial ford	e, bending ab	out y-axis and shear f	orce a	cc. to 3.3.4 a	and 3.4.3.1				
			Max	0.83	<1	3			9	2		جا 😫				
± Cross-	Section Va n Internal F	alues - IS 45 Forces	0/200/10/	20/0												
	n Internal F Section Ty n Ratio	orces	0/200/10/	20/0								200.0	† 31			
	n Internal F Section Ty n Ratio al Force	Forces /pe	0/200/10/	20/0		P*	-55.693				+	200.0	20.0			
E Cross- Design Cross- Design Axia Ber	n Internal F Section Ty n Ratio al Force nding Mome	Forces /pe	0/200/10/	20/0		Muoy	200.910	kNm			t					
	n Internal F Section Ty n Ratio al Force nding Mome ear Force	Forces /pe	0/200/10/	20/0		M _{uoy} V*z	200.910 88.308	kNm kN			t t		si <u></u>			
Cross- Design Cross- Design Axia Ber She We	n Internal F Section Ty n Ratio al Force nding Mome ear Force ab Depth	Forces /pe ent	0/200/10/	20/0		M _{uoy} V*z h	200.910 88.308 410.0	kNm kN mm	3.3.3		•		si <u></u>			
Cross- Design Cross- Design Cross- Design Axia Ber She We We	n Internal F Section Ty n Ratio al Force ading Mome ear Force b Depth b Thicknes	Forces /pe ent	0/200/10/	20/0		Muoy V*z h tw	200.910 88.308 410.0 10.0	kNm kN mm mm	3.3.3		450.0		si <u></u>			
Cross-	n Internal F Section Ty n Ratio al Force nding Mome ar Force b Depth b Thicknes ar Area	orces pe ent ss		20/0		Muoy V*z h t _w Az	200.910 88.308 410.0 10.0 4100.0	kNm kN mm mm mm ²			450.0		si <u></u>			
Cross- Design Cross- Design Axia Ber She We We She Nor	n Internal F Section Ty n Ratio al Force nding Mome ar Force b Depth b Thickness ar Area minal Shear	r Resistance		20/0		Muoy V*z h tw Az VN,z	200.910 88.308 410.0 10.0 4100.0 676.500	kNm kN mm mm mm ² kN	3.3.3		450.0	10.0	si <u></u>			
Cross Design Cross Design Axia Ber Axia Ber She We We She Nor Design Nor Design Cross Design Axia Ber She Nor Design Cross Cross Design Cross Cros	n Internal F Section Ty n Ratio al Force ding Mome ar Force b Depth b Thicknes ear Area minal Shear	orces pe ent ss		20/0		Muoy V*z h tw Az VN.z VR.z	200.910 88.308 410.0 10.0 4100.0 676.500 608.850	kNm kN mm mm mm ² kN kN			450.0	10.0	0 <u>0</u>			
Cross Design Cross- Design Axia Ber She We We She Nor Design She She She She She She She She	n Internal F Section Ty n Ratio al Force ding Mome ar Force b Depth b Thicknes ar Area minal Shear sign Shear ear Force	r Resistance		20/0		Muoy V*z h Łw Az VN.z VR.z V*y	200.910 88.308 410.0 10.0 4100.0 676.500 608.850 0.008	kNm kN mm mm mm ² kN kN kN	3.3.3		450.0	10.0	0 <u>0</u>			
Cross Design Cross Design Axia Ber She We We She Nor Des She She She	n Internal F Section Ty n Ratio al Force ding Mome aar Force b Depth b Thickness aar Area minal Shear sign Shear saar Force ear Area	orces pe ent ss r Resistance Resistance		20/0		Muoy V*z h Lw Az VN.z VR.z VR.z V [*] y Ay	200.910 88.308 410.0 10.0 676.500 608.850 0.008 8000.0	kNm kN mm mm mm ² kN kN kN kN kN mm ²	3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			
Cross Design Cross	n Internal F Section Ty n Ratio al Force ding Mome aar Force b Depth b Thicknew aar Area minal Shear sign Shear aar Area minal Shear aar Area	orces pe ent ss r Resistance Resistance		20/0		Muoy V*z h Az VN.z VR.z VR.z VR.z VR.y VN.y	200.910 88.308 410.0 10.0 4100.0 676.500 608.850 0.008 8000.0 1320.000	kNm kN mm mm ² kN kN kN kN kN kN	3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			
Cross Design Cross Design Cross Design Axia Ber She We We She Nor Des She	n Internal F Section Ty n Ratio al Force ding Mome aar Force b Depth b Thicknes ear Area minal Shear sar Area minal Shear sign Shear	Forces pe ent ss r Resistance Resistance r Resistance Resistance		20/0		Muoy V*z h kw Az VR.z VR.z VR.z VR.y VR.y VR.y	200.910 88.308 410.0 676.500 608.850 0.008 8000.0 1320.000 1188.000	kNm kN mm mm mm 2 kN	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			
Cross Design Cross Design Cross Design Axia Ber She We We She Nor Des She She Nor Des She	n Internal F Section Ty n Ratio al Force nding Mome ear Force b Depth b Thickner ear Area minal Shear sar Force ear Area minal Shear sar Force ear Area minal Shear sign Shear d Strength	Forces pe ent ss r Resistance r Resistance r Resistance		20/0		Muoy V*z h Az VN.z VR.z VR.z V*y Ay VN.y VR.y Fy	200.910 88.308 410.0 676.500 608.850 0.008 8000.0 1320.000 1188.000 250.000	kNm kNm kN mm mm mm² kN kN kN kN kN kN kN kN Mm² kN MM² MM² MPa MPa	3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			
Cross Design Cross Design Cross Design Axiz Ber She We We She Nor Des She	n Internal F Section Ty n Ratio al Force nding Mome aar Force b Depth b Thicknes aar Area minal Shea sigan Shear Area minal Shear sign Shear d Strength stic Section	Forces pe ent ss r Resistance Resistance r Resistance n Modulus		20/0		Muoy V*z h Az VN.z VR.z VR.z VR.y VN.y VR.y VN.y VR.y Z y	200.910 88.308 410.0 4100.0 676.500 608.850 0.008 8000.0 1320.000 1188.000 250.000	kNm kN mm mm ² kN kN kN kN kN kN kN mm ² kN kN mm ³	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			
Cross Cross Cross Cross Cross Design Axiz Ber She We We She Nor Des She	n Internal F Section Ty n Ratio al Force nding Mome ear Force b Depth b Thickner ear Area minal Shear sar Force ear Area minal Shear sar Force ear Area minal Shear sign Shear d Strength	Forces pe ent ss r Resistance r Resistance n Modulus n Modulus		20/0		Muoy V*z h Az VN.z VR.z VR.z V*y Ay VN.y VR.y Fy	200.910 88.308 410.0 676.500 608.850 0.008 8000.0 1320.000 1188.000 250.000	kNm kN mm mm ² kN kN kN kN kN kN kN mm ² kN kN mm ³	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		450.0	10.0	0 <u>0</u>			

Figure 4.3: Window 2.2 Design by Cross-Section

This window lists the maximum ratios of all members and actions selected for design, sorted by cross-section. The results are sorted by cross-section design, stability analysis and serviceability limit state design.

If there is a tapered member, both cross-section descriptions are displayed in the table row next to the section number.



4.3 Design by Set of Members

Set Member Location Load Design Design According to Formula 1 (Wember No. 14, 18,274,665,79,88,102)		B	B	C	D	E				F				
No. No. Plane Plane Plane 10 (Member No. 14,18,27,46,56,73,88,102) Image: state of the				Load										
65 1.046 LC3 0.00 ≤1 100, Negligible internal forces 102 0.000 CO2 0.02 ≤1 102, Cross-section check - Compression acc. to 3.2 46 5.647 LC2 0.04 ≤1 105, Cross-section check - Bending about y-axis acc. to 3.3.2.1 102 0.000 CO1 0.03 ≤1 116) Cross-section check - Shear force in z-axis acc. to 3.3.3 114 0.000 CO1 0.03 ≤1 115) Cross-section check - Shear force in z-axis acc. to 3.3.4 46 3.585 LC2 0.04 ≤1 120; Cross-section check - Shear force in z-axis 46 3.585 LC2 0.04 ≤1 117) Cross-section check - Shear force in z-axis and shear force acc. to 3.3.4 88 3.011 CO1 0.03 ≤1 107) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 0.73 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 0.77 1.087 CO1 <td< td=""><td>No.</td><td>x [m]</td><td>(m)</td><td>Case</td><td>Ratio</td><td></td><td></td><td></td><td>Desig</td><td>gn According to Formu</td><td>ila</td><td></td><td></td><td></td></td<>	No.	x [m]	(m)	Case	Ratio				Desig	gn According to Formu	ila			
102 0.000 CO2 0.02 ≤1 102/Coss-section check - Compression acc. to 3.2 46 5.647 LC2 0.04 ≤1 105/Cross-section check - Bending about z-axis acc. to 3.3.2.1 14 3.000 LC4 0.02 ≤1 105/Cross-section check - Shearf force in z-axis acc. to 3.3.2.1 102 0.000 CO1 0.03 ≤1 115/Cross-section check - Shear force in z-axis acc. to 3.3.3 14 0.000 LC1 0.00 ≤1 126/Cross-section check - Shear force in z-axis acc. to 3.3.4 46 3.585 LC2 0.04 ≤1 111/Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181/Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181/Cross-section check - Axial force, bending about z-axis and shear force acc. to 3.3.4 and 3.4.3.1 Max 0.83 ≤1 Stores-section check - Axial force, bending about z-axis and shear force acc. to 3.3.4 and 3.4.3.1 Uross-Section Values - LS A00/200/10/L8/O Store acc. to 3.3.4 and 3.4.3.1 Stores-Section Values - LS 400/200/10/L8/O	Member No	No. 14,18,27,	14,18,27,4	46,65,79,	88,102)									
46 5.647 LC2 0.04 ≤1 105) Cross-section check - Bending about y-axis acc. to 3.3.2.1 14 3.000 LC4 0.02 ≤1 106) Cross-section check - Bending about y-axis acc. to 3.3.2.1 102 0.000 CO1 0.03 ≤1 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 14 0.000 LC1 0.00 ≤1 126) Cross-section check - Shear buckling acc. to 3.3.3 - Shear force acc. to 3.3.4 46 3.585 LC2 0.04 ≤1 141) Cross-section check - Main force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Max: 0.83 ≤1 Statis Max: 0.83 ≤1 Statis Max: 0.83 ≤1 Statis Max: 0.83 ≤1 Statis Statis <t< td=""><td>65</td><td>1.046</td><td>1.046</td><td>LC3</td><td>0.00</td><td>≤1</td><td>100) Negligible interna</td><td>al forces</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	65	1.046	1.046	LC3	0.00	≤1	100) Negligible interna	al forces						
14 3.000 LC4 0.02 ≤1 106) Cross-section check - Bending about z-axis acc. to 3.3.2.1 102 0.000 CO1 0.03 ≤1 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 14 0.000 LC1 0.00 ≤1 115) Cross-section check - Shear force in z-axis 46 3.585 LC2 0.04 ≤1 117) Cross-section check - Bending about y-axis and shear force acc. to 3.3.4 88 3.011 CO1 0.03 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Max: 0.83 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Max: 0.83 ≤1 151) Cross-Section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 107:oss-Section Values - 15400/200/10/18/0 Interval force Interval force 2.1 \$400/200/10/18/0 10:oss-Section Values - 15400/200/10/18/0 Interval force Y 2.2 0.23 kN 2.1 \$400/200/10/18/0	102	0.000	0.000	CO2										
102 0.000 CO1 0.03 ≤1 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 14 0.000 LC1 0.00 ≤1 126) Cross-section check - Shear bucking about y-axis and shear force acc. to 3.3.4 46 3.555 LC2 0.04 ≤1 1110) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 88 3.011 CO1 0.03 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 180 Cross-section check - Axial force. Example 15 46 5 5 14 15 14 10.020 16 16 16 16 16 16 16 16 16 16 16 16 16	46													
14 0.000 LC1 0.00 ≤1 126) Cross-section check - Shear buckling acc. to 3.3.3 - Shear force in z-axis 46 3.585 LC2 0.04 ≤1 141) Cross-section check - Mail force, bending about y-axis and shear force acc. to 3.3.4 88 3.011 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Marc 0.83 ≤1 Statis - Member 88 - x: 3.011 m - CO1 Max 0.83 ≤1 Statis - Member 88 - x: 3.011 m - CO1 Statis - Member 88 - x: 3.011 m - CO1 Internal Values - Steel B-254 (ASTM A36) Cross-Section Type Cross-Section Type Cross-Section Type Design Internal Forces Cross-Section Type Cross-Section Type Cross-Section Type Cross-Section Type Design Internal Forces V*z 29.594 N 3.3.3 Cross-Section Type Design Internal Forces V*z 29.594 N 3.3.3 Cross-Section Type Design Internal Force V*z 29.594 N	14													
46 3.585 LC2 0.04 ≤1 141) Cross-section check - Bending about y-axis and shear force acc. to 3.3.4 88 3.011 CO1 0.03 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.4 and 3.4.3.1 Waterial Values - Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) 10 Cross-Section Values - 15 400/200/10/18/0 Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) 10 Design Ratio Image: Steel B-254 (KSTM A36) 10 Design Ratio Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) Image: Steel B-254 (KSTM A36) Image: Steel A-254 (KSTM A36) Image: Stee	102													
88 3.011 CO1 0.36 ≤1 171) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Mark 0.83 ≤1 21 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 Mark 0.83 ≤1 2 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 0.83 ≤1 2 181) Cross-section check - Axial force, bending about y-axis and shear force acc. to 3.3.4 and 3.4.3.1 0.83 ≤1 2 15 2 15 400/200/10/18/0 0.7005 Cross-Section Values - 15 54.00/200/10/18/0 2 -15 400/200/10/18/0 0.83 Jones force P* -20.233 kN 2 -15 400/200/10/18/0 0.84 If Ston Zov V* 2 29.594 kN 3.3.3 2 - 0.85 If Web Thickness If W 10.0 mm 3.3.3 - - - <	14													
27 1.087 CO1 0.03 ≤1 181) Cross-section check - Axial force, bending about z-axis and shear force acc. to 3.3.4 and 3.4.3.1 Mark 0.83 ≤1 Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Colspan="2">Colspan="2" Image: Colspan="2">Image: Colspan="2">Image: Colspan="2">Image: Colspan="2" Image: Colspan="2" <td></td>														
Max 0.83 ≤1 Image Imag														
stais - Member 88 - x: 3.011 m - C01 IMaterial Values - Steel B-254 (ASTM A36) Cross-Section Values - IS 400/200/10/18/0 Design Internal Forces Cross-Section Type Design Ratio Shear Area Nominal Shear Resistance Viry 0.001 kN Shear Area Ayy Tores Nominal Shear Resistance Viry 0.001 kN Shear Area Ayy Tores Nominal Shear Resistance Viry 10.00 mm² Shear Area Ayy 7200.00 mm² Shear Area Nominal Shear Resistance Viry 10.00 kN Shear Area Ayy 7200.00 mm² Shear Area <t< td=""><td>27</td><td>1.087</td><td>1.087</td><td>CO1</td><td>0.03</td><td> ≤1</td><td>181) Cross-section ch</td><td>neck - Axial ford</td><td>e, bending ab:</td><td>out z-axis and shear f</td><td>orce ad</td><td>cc. to 3.3.4</td><td>and 3.4.3.1</td><td></td></t<>	27	1.087	1.087	CO1	0.03	≤1	181) Cross-section ch	neck - Axial ford	e, bending ab:	out z-axis and shear f	orce ad	cc. to 3.3.4	and 3.4.3.1	
atalis - Member 88 - x: 3.011 m - C01 Material Values - Steel B-254 (ASTM A36) Coss-Section Values - 15 400/200/10/18/0 Design Internal Forces Oross-Section Values - 15 400/200/10/18/0 Design Internal Forces Oross-Section Values - 15 400/200/10/18/0 Design Ratio				Max	0.83	<1	8			9			🏹 😂 🖪	1 🚯
Bending Moment Mucy 117.477 kNm Fill Shear Force V*z 29.594 kN Shear Force Shear Area Az 33.3 Shear Area Shear Area Shear Force Shear Area Shear Ar	atio	pe					D.	20.202	LN				200.0	18.0
Shear Force V*z 29 594 kN F Web Depth h 364.0 mm 3.3.3 Web Thickness Lw 10.0 mm 3.3.3 Shear Area Az 3640.0 mm² 3.3.3 Nominal Shear Resistance VNz 600.600 kN 3.3.3 Design Shear Resistance VRz. 540.540 kN Eq. (3.38) Shear Area Ay 7200.0 mm² mm² Nominal Shear Resistance VNy 1188.000 kN 3.3.3		ant									-110	I †	_ innihuma	===‡
Web Depth h 364.0 mm 3.3.3 Web Thickness I.w 10.0 mm 3.3.3 Shear Area Az 3640.0 mm ² 3.3.3 Nominal Shear Resistance VN.z 600.600 kN 3.3.3 Design Shear Resistance VR.z 540.540 kN Eq. (3.38) Shear Area Ay 7200.0 mm ² 7200.0 mm ² Nominal Shear Resistance VN.y 1188.000 kN 3.3.3											- =		0.0	-
Web Thickness Iw 10.0 mm										3.3.3				
Shear Area Az 3640.0 mm² 10.0 Nominal Shear Resistance VN.z 600.600 kN 3.3.3 Design Shear Resistance VR.z 540.540 kN Eq. (3.38) Shear Area Ay 7200.0 mm² - Nominal Shear Resistance VN.y 1188.000 kN -		38					tw	10.0	mm			0.00		
Normal Shear Resistance V N.z b00.600 kN 3.3.3 Design Shear Resistance V R.z 5405.540 kN Eq. (3.3) Shear Force V * y 0.001 kN Eq. (3.3) Shear Area Ay 7200.0 mm²	•						Az	3640.0	mm ²			40		
Shear Force V*y 0.001 kN Shear Area Ay 7200.0 mm² Nominal Shear Resistance VN.y 1188.000 kN 3.3.3	Area	r Resistance	sistance				V _{N,z}	600.600	kN	3.3.3			10.0	
- Shear Area Ay 7200.0 mm ² - Nominal Shear Resistance VN.y 1188.000 kN 3.3.3		Resistance	istance				V _{R,z}			Eq. (3.38)				-
- Nominal Shear Resistance VN,y 1188.000 kN 3.3.3	al Shear R						V°y					↓		
The second s	al Shear R Shear Re						Ay						1	
Design Share Basistence V/a 1069 200 I-NI Ec. (2.20)	al Shear R Shear Re Force Area		sistance										z	
	al Shear R Shear Re Force Area al Shear R						V _{R,y}			Eq. (3.38)				
Yield Strength Fy 250.000 MPa 1.3.1	al Shear R Shear Re Force Area al Shear R Shear Re	Resistance	stance				E.,	250,000		1.3.1				
Elastic Section Modulus Zy 1515240.0 mm ³	al Shear R Shear Re Force Area al Shear Re Shear Re trength	Resistance												
	al Shear R Shear Re Force Area al Shear R Shear Re trength Section M	Resistance n Modulus	dulus				Zy							
Slendemess Limit λ _{s,1,My} 69.296 Slendemess Limit λ _{s,2,My} 104.935	al Shear R Shear Re Force Area al Shear Re trength Section M Section M	Resistance n Modulus n Modulus	dulus				Z _y S _y	1706440.0						ſ

Figure 4.4: Window 2.3 Design by Set of Members

This results window is displayed if you have selected at least one set of members for design. The window lists the maximum utilization ratios sorted by set of members.

The *Member No*. column shows the number of the one member within the set of members that bears the maximum ratio for the individual design criteria.

The output by set of members clearly presents the design for an entire structural group (for example a frame).



4.4 Design by Member

	A	B	С	D					E					
Member	Location	Load	Design											
No.	x [m]	Case	Ratio					Design Ac	cording to Formula					
1	Cross-section	n No. 15 -	IS 250/250/1	0/15	/0									
	2.100	LC4	0.00		100) Negligible interr									
	0.000	CO2	0.01		102) Cross-section cl									
	1.200	LC5			106) Cross-section cl									
	1.500	CO3			115) Cross-section cl									
	0.000	LC3	0.00	≤1	126) Cross-section cl	neck - Shea	ar buckling acc	. to 3.3.3 - Sh	ear force in z-axis					
	0.000	LC3			141) Cross-section cl									
	0.000	CO1	0.02		171) Cross-section cl									
	0.750	CO9	0.01		181) Cross-section cl					to 3.3.4	4 and 3.4	.3.1		
	0.000	CO2	0.01	≤1	302) Stability analysis	- Flexural b	ouckling about	y-axis acc. to	3.2.2					
		Max	0.83		۵				9		F	N 😂	I	
T Desig			/250/10/15/	0										
∃ Cross ⊒ Desig	n Internal Ford -Section Type n Ratio	ces	/250/10/15/	0								± 250.	<u>0</u> +	
E Cross E Desig Axia	n Internal Ford -Section Type n Ratio al Force	ces	/250/10/15/	0		P*	-17.198					1		
E Cross E Desig Axi Ber	n Internal Ford -Section Type n Ratio al Force nding Moment	ces	/250/10/15/	0		Muoy	2.123	kNm			+	250.	ļunnum	6
E Cross Desig Axia Ber She	n Internal Forc -Section Type n Ratio al Force nding Moment ear Force	ces	/250/10/15/	0		M _{uoy} V°z	2.123 1.523	kNm kN	222			1		6
E Cross Desig Axia Ber She We	n Internal Forc -Section Type n Ratio al Force nding Moment ear Force ab Depth	ces	/250/10/15/	0		M _{uoy} V*z h	2.123 1.523 220.0	kNm kN mm	3.3.3	- E	4	1	ļunnum	6
E Cross Desig Axis Ber She We We	n Internal Force -Section Type n Ratio al Force nding Moment ear Force ab Depth ab Thickness	ces	/250/10/15/	0		Muoy V*z h tw	2.123 1.523 220.0 10.0	kNm kN mm mm	3.3.3		250.0	1	ļunnum	
E Cross Desig Axia Ber She We We She	n Internal Forc -Section Type n Ratio al Force nding Moment ear Force ab Depth ab Thickness ear Area	Ces	/250/10/15/	0		Muoy V*z h t _w Az	2.123 1.523 220.0 10.0 2200.0	kNm kN mm mm mm ²			250.0	1	0.0	
E Cross Desig Axia Ber She We We She Nor	n Internal Forc -Section Type n Ratio al Force nding Moment ear Force eb Depth eb Thickness ear Area minal Shear Re	esistance	/250/10/15/	0		Muoy V*z h tw Az VN,z	2.123 1.523 220.0 10.0 2200.0 363.000	kNm kN mm mm mm ² kN	3.3.3		260.0		ļunnum	
Cross Cross Desig Axia Ber She We She No Oe	n Internal Forc -Section Type n Ratio al Force anding Moment ear Force ab Depth ab Depth ab Thickness ear Area minal Shear Re sign Shear Re	esistance	/250/10/15/			Muoy V*z h t _w Az V _{N,z} V _{R,z}	2.123 1.523 220.0 10.0 2200.0 363.000 326.700	kNm kN mm mm mm ² kN kN			250.0		0.0	2
Cross Cross Cross Desig Axia Ber She We She Nor Des She	n Internal Forc -Section Type n Ratio al Force anding Moment ear Force ab Depth ab Thickness ear Area minal Shear Re sign Shear Re ear Force	esistance	/250/10/15/			Muoy V*z h tw Az VN,z VR,z VR,z V*y	2.123 1.523 220.0 10.0 2200.0 363.000 326.700 0.002	kNm kN mm mm ² kN kN kN	3.3.3		250.0		0.0	2
Tross Cross Desig Axi Ber She We We She No Des She Sh	n Internal Forc -Section Type n Ratio al Force nding Moment aar Force ab Depth ab Thickness ear Area minal Shear Re sign Shear Re sar Force ear Area	esistance sistance	/250/10/15/			Muoy V*z h Lw Az VN,z VR,z VR,z V*y Ay	2.123 1.523 220.0 10.0 2200.0 363.000 326.700 0.002 7500.0	kNm kN mm mm ² kN kN kN kN mm ²	3.3.3 Eq. (3.38)		260.0		0.0	3
E Cross Desig Axia Ber She We She She She She She She She	n Internal Forc -Section Type n Ratio al Force nding Moment aar Force ab Depth ab Dhickness ear Area minal Shear Re ear Force ear Area minal Shear Re	esistance esistance	/250/10/15/			Muoy V*z h Lw Az VN,z VR,z VR,z VR,z V*y Ay VN,y	2.123 1.523 220.0 10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500	kNm kN mm mm mm ² kN kN kN kN kN kN	3.3.3 Eq. (3.38)		260.0		0.0	
Tross Cross Desig Axi Ber She We She No De: She She	n Internal Forc -Section Type n Ratio al Force ding Moment ear Force ab Depth ab Thickness ear Area minal Shear Re ear Force ear Area minal Shear Re ear Force minal Shear Re sign Shear Re	esistance esistance	/250/10/15/			Muoy V*z h Lw Az VN,z VR,z VR,z VR,z V*y Ay VN,y VR,y	2.123 1.523 220.0 363.000 366.700 0.002 7500.0 1237.500 1113.750	kNm kN mm mm mm ² kN kN kN	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		260.0		0.0	2
Tross Cross Coss Desig Axi Ber She We She No Des She She	n Internal Forc -Section Type n Ratio al Force nding Moment aar Force ab Depth ab Dhickness ear Area minal Shear Re ear Force ear Area minal Shear Re	esistance esistance esistance esistance	//250/10/15/			Muoy V*z h tw Az VN,z VR,z VR,z VR,z VR,y VR,y Fy	2.123 1.523 220.0 10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000	kNm kN mm mm mm ² kN kN kN kN kN kN kN kN kN Mm ² kN MM ² kN KN kN MPa MPa	3.3.3 Eq. (3.38)		250.0		0.0	
Cross Cross Desig Axi Ber She We She No Des She She	n Internal Force -Section Type n Ratio al Force nding Moment aar Force ab Depth ab Thickness ar Area minial Shear R aar Force aar Force aar Force aar Area minial Shear R aign Shear Re do Strength d Strength	esistance esistance esistance lodulus	//250/10/15/			Muoy V*z h tw Az VN,z VR,z VR,z VR,z VR,y Fy Zy	2.123 1.523 220.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000 900487.0	kNm kN mm mm mm2 kN kN kN kN kN kN MPa mm3 MPa	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		250.0		0.0	
	n Internal Forc -Section Type n Ratio al Force al Force ab Depth b Depth b Thickness ear Area minal Shear Re sar Force ear Area minal Shear Re sar Area minal Shear Re Id Strength	esistance esistance esistance sistance lodulus lodulus	//250/10/15/			Muoy V*z h tw Az VN,z VR,z VR,z VR,z VR,y VR,y Fy	2.123 1.523 220.0 10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000	kNm kN mm mm mm2 kN kN kN kN kN kN MPa mm3 MPa	3.3.3 Eq. (3.38) 3.3.3 Eq. (3.38)		250.0		0.0	[n

Figure 4.5: Window 2.4 Design by Member

This results window presents the maximum utilization ratios for the individual designs sorted by member number. The columns are described in detail in chapter 4.1 on page 34.

4.5 Design by x-Location

	A	B	С	D				E			
Member	Location	Load	Design								
No.	x [m]	Case	Ratio				Design Ac	cording to Formula			
	1.000	CO1	0.00	≤1	401) Serviceability - Deflection in	n z-direction (Be	eam)				
	1.000	CO7			406) Serviceability - Deflection in	n y-direction (Be	eam)				
	1.200	LC3	0.00		100) Negligible internal forces						
	1.200	CO2	0.01			ss-section check - Compression acc. to 3.2					
	1.200	LC5	0.01		106) Cross-section check - Bend						
	1.200	CO1	0.00		126) Cross-section check - Shea						
	1.200	CO1	0.01		171) Cross-section check - Axial						
	1.200	CO9			181) Cross-section check - Axial				o 3.3.4	4 and 3.4.3.1	
	1.200	CO2			302) Stability analysis - Flexural b						
	1.200	CO2	0.01	≤1	306) Stability analysis - Flexural b	ouckling about	z-axis acc. to	3.2.2			
		Max	0.83	≤1	9			?	•	E 🖌	😂 🖪 🚺
	n Internal Ford Section Type n Ratio										250.0
	al Force				P*	-12.563	kN				235.5
Ben	idina Moment				Muov	0.691	kNm				minnum
She	ar Force				V*z	0.871	kN		=		0.0
	b Depth				h	220.0	mm	3.3.3			
										9	5
We	b Thickness				tw	10.0	mm			2	
Wel Wel					t _w Az					250.0	
Wel Wel She	b Thickness	esistance				10.0	mm ²	3.3.3			<u>0.0</u>
Wel Wel She Non	b Thickness ar Area				Az	10.0 2200.0	mm ² kN	3.3.3 Eq. (3.38)			0.0
Wel Wel She Non Des	b Thickness ar Area ninal Shear R				Az V _{N,z}	10.0 2200.0 363.000 326.700 0.002	mm ² kN kN kN	0.010			0.0
Wel Wel She Non Des She She	b Thickness ar Area ninal Shear R sign Shear Re ar Force ar Area	esistance			Az VN,z VR,z	10.0 2200.0 363.000 326.700	mm ² kN kN kN	0.010			0.0
Wel Wel She Non Des She She Non	b Thickness ear Area ninal Shear R sign Shear Re ear Force ear Area ninal Shear R	esistance			Az V _{N,z} V _{R,z} V [*] y Ay V _{N,y}	10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500	mm ² kN kN kN mm ² kN	Eq. (3.38)			<u>0.0</u>
Wel Wel She Non Des She She Non Des	b Thickness ear Area ninal Shear R sign Shear Re ear Force ear Area ninal Shear R sign Shear Re	esistance			Az VN.z VR.z V [*] y Ay	10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750	mm ² kN kN kN mm ² kN kN	Eq. (3.38)			<u>0.0</u>
Wel Wel She Non Des She She Non Des	b Thickness ear Area ninal Shear R sign Shear Re ear Force ear Area ninal Shear R	esistance			Az VN.z VR.z V [*] y Ay VN.y VR.y Fy	10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000	mm ² kN kN kN mm ² kN kN Mm ² kN kN MPa	Eq. (3.38)			0.0 2
Wel Wel She Des She She She Des Yiel Elas	b Thickness aar Area ninal Shear Re agn Shear Re aar Force aar Area ninal Shear Re dign Shear Re d Strength stic Section N	esistance esistance esistance			Az VN,Z V*y Ay VN,Y VN,Y VR,Y	10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000 900487.0	mm ² kN kN kN mm ² kN kN MPa mm ³	3.3.3 Eq. (3.38)			<u>10.0</u> 2
Wel Wel She Des She She She Des Yiel Elas	b Thickness ear Area ninal Shear R sign Shear Re ear Force ear Area ninal Shear Re sign Shear Re d Strength	esistance esistance esistance			Az VN.z VR.z V [*] y Ay VN.y VR.y Fy	10.0 2200.0 363.000 326.700 7500.0 1237.500 1237.500 250.000 900487.0 1002250.0	mm ² kN kN kN mm ² kN kN MPa mm ³	3.3.3 Eq. (3.38)			
Wel Wel She Non Des She She Non Des Yîel Elas Plas	b Thickness aar Area ninal Shear Re agn Shear Re aar Force aar Area ninal Shear Re dign Shear Re d Strength stic Section N	lesistance esistance sistance lodulus lodulus			Åz VR.z. VR.z. V [*] y Ay VN.y. VR.y. Fy Zy	10.0 2200.0 363.000 326.700 0.002 7500.0 1237.500 1113.750 250.000 900487.0	mm ² kN kN kN mm ² kN kN MPa mm ³	3.3.3 Eq. (3.38)			

Figure 4.6: Window 2.5 Design by x-Location



This results window lists the maxima for each member at the locations **x** resulting from the division points in RSTAB:

- Start and end node
- Division points according to possibly defined member division (see RSTAB table 1.6)
- Member division according to specification for member results (RSTAB dialog box *Calculation Parameters*, tab *Global Register Parameters*)
- Extreme values of internal forces

4.6 Governing Internal Forces by Member

3.1 Governing Internal Forces by Memb

	A	В	C	D	E	F	G	H	
lember	Location	Load-		Forces [kN]			oments [kNm]		
No.	x [m]	ing	N	Vy	Vz	MT	My	Mz	Design According to Formula
1	Cross-section	No. 15 - IS	6 250/250/10/	15/0					
	2.100	LC4	0.000	0.149	0.000	0.000	0.000	0.211	100) Negligible internal forces
	0.000	CO2	-17.395	-0.004	0.137	0.000	0.409	-0.012	102) Cross-section check - Compression acc. to 3.2
	1.200	LC5	0.000	0.020	0.000	0.000	0.000 -0.607		106) Cross-section check - Bending about z-axis acc. to 3.3.2
	1.500	CO3	-9.413	0.000	0.741	0.000	0.436	0.000	115) Cross-section check - Shear force in z-axis acc. to 3.3.3
	0.000	LC3	-0.016	0.000	1.019	0.000	1.258	0.000	
	0.000	LC3	-0.016	0.000	1.019	0.000	1.258		141) Cross-section check - Bending about y-axis and shear for
	0.000	CO1	-17.198	-0.002	1.523	0.000	2.123		171) Cross-section check - Axial force, bending about y-axis a
	0.750	CO9	-14.287	0.315	+0.007	0.000	0.016		181) Cross-section check - Axial force, bending about z-axis a
	0.000	CO2	-17.395	-0.004	0.137	0.000	-0.409		302) Stability analysis - Flexural buckling about y-axis acc. to 3
	0.000	CO2	-17.395	-0.004	0.137	0.000	0.409	-0.012	
	0.000	CO2	17.395	-0.004	0.137	0.000	0.409		311) Stability analysis - Torsional buckling acc. to 3.2.2.2(a) -
	0.000	LC3	-0.016	0.000	1.019	0.000	1.258	0.000	321) Stability analysis - Lateral-torsional buckling acc. to 3.3.2
	0.000	LC1	0.000	0.000	0.000	0.000	0.000	0.000	400) Serviceability - Negligible deflections
	1.000	CO1	0.000	0.000	0.000	0.000	0.000	0.000	401) Serviceability - Deflection in z-direction (Beam)
	1.500	C07	0.000	0.000	0.000	0.000	0.000		406) Serviceability - Deflection in y-direction (Beam)
2				0.000					
2	Cross-section	No. 15 - 19	6 250/250/10/	0.000	0.000	0.000	0.000	0.000	406) Serviceability - Deflection in y-direction (Beam)
2	Cross-section 2.850	No. 15 - 19 LC5	6 250/250/10/ 0.000	0.000	0.000	0.000	0.000	0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces
2	Cross-section 2.850 1.800	No. 15 - 19 LC5 RC1	250/250/10/ 0.000 -43.099	0.000 15/0 0.551 0.195	0.000	0.000	0.000	0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligble internal forces 102) Cross-section check - Compression acc. to 3.2
2	Cross-section 2.850 1.800 0.000	No. 15 - IS LC5 RC1 LC5	250/250/10/ 0.000 -43.099 0.000	0.000 15/0 0.551 0.195 1.691	0.000	0.000	0.000	0.000 -0.213 0.137 2.981	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3
2	Cross-section 2.850 1.800 0.000 2.850	No. 15 - IS LC5 RC1 LC5 CO4	250/250/10/ 0.000 -43.099 0.000 -38.455	0.000 15/0 0.551 0.195 1.691 0.001	0.000	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.009 0.000 0.380	0.000 -0.213 0.137 2.981 0.001	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 115) Cross-section check - Shear force in z-axis acc. to 3.3.3
2	Cross-section 2.850 1.800 0.000 2.850 0.000	N₀. 15 - IS LC5 RC1 LC5 CO4 LC3	5 250/250/10/ 0.000 -43.099 0.000 -38.455 -0.016	0.000 15/0 0.551 0.195 1.691 0.001 0.000	0.000 0.000 0.010 0.000 0.822 2.620	0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.009 0.380 7.317	0.000 -0.213 0.137 2.981 0.001 0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Shearforce in z-axis acc. to 3.3.3 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 26) Cross-section check - Shear buckling acc. to 3.3.3
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3	5 250/250/10/ 0.000 -43.099 0.000 -38.455 -0.016 -0.016	0.000 15/0 0.551 0.195 1.691 0.001 0.000 0.000	0.000 0.010 0.000 0.822 2.620 2.620	0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.000 0.380 7.317 7.317	0.000 -0.213 0.137 2.981 0.001 0.000 0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Shear force in z-axis acc. to 3.3.3 116) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Shear force in z-axis acc. to 3.3.3 - Shr 141) Cross-section check - Shear buckling acc. to 3.3.3 - Shr 141) Cross-section check - Bending about y-axis and shear for
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1	250/250/10/ 0.000 -43.099 0.000 -38.455 -0.016 -0.016 -50.067	0.000 0.551 0.195 1.691 0.001 0.000 0.000 -0.010	0.000 0.000 0.010 0.000 0.822 2.620 2.620 4.454	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.009 0.000 0.380 17.317 17.317 -13.135	0.000 -0.213 0.137 2.981 0.001 0.000 0.000 -0.043	406) Serviceability - Deflection in y-direction (Beam) 100) Negligble internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 126) Cross-section check - Shear force in z-axis acc. to 3.3.3 - Shr 141) Cross-section check - Shear buckling acc. to 3.3.3 - Shr 141) Cross-section check - Shear buckling about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171) Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for 171 Cross-section check - Axial force, bending about y-axis and shear for about y-axis and shear for a y-axis about y-axis and shear for a y-axis about y-axis and shear for a y-axis about y-axis abo
2	Cross-section 2.850 1.800 2.850 0.000 0.000 0.000 0.000 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1 CO9	\$ 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.067 -50.053	0.000 0.551 0.195 1.691 0.001 0.000 0.000 0.000 0.000 2.014	0.000 0.010 0.000 0.822 2.620 2.620 4.454 0.010	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.009 0.380 17.317 17.317 13.135 0.010	0.000 -0.213 0.137 2.981 0.001 0.000 0.000 -0.043 3.391	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 115) Cross-section check - Shear buckling acc. to 3.3.3 - She 141) Cross-section check - Bending about y-axis and shear fo 171) Cross-section check - Axial force, bending about y-axis ar 181) Cross-section check - Axial force, bending about y-axis ar 181) Cross-section check - Axial force, bending about y-axis ar
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000 0.000 0.000 0.000 1.800	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1 CO9 RC1	6 250/250/10/ 0.000 -43.099 0.000 -38.455 -0.016 -0.016 -50.067 -50.053 -43.099	0.000 15/0 0.551 0.195 1.691 0.001 0.000 0.000 0.000 0.000 0.010 2.014 0.195	0.000 0.010 0.000 0.822 2.620 2.620 4.454 0.010 0.010	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.380 7.317 7.317 -13.135 -0.010 0.009	0.000 -0.213 0.137 2.981 0.001 0.000 0.000 -0.043 3.391 0.137	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.2 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Shear force in z-axis acc. to 3.3.3 - She 141) Cross-section check - Bending about z-axis and shear for 171) Cross-section check - Axial force, bending about z-axis a 181) Cross-section check - Axial force, bending about z-axis a 202) Stability analysis - Revarial buckling about z-axis acc.
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000 0.000 0.000 1.800 1.800	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1 CO9 RC1 RC1	\$ 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.067 -50.053 43.099 43.099	0.000 15/0 0.551 0.195 1.691 0.001 0.000 0.000 -0.010 2.014 0.195 0.195	0.000 0.010 0.010 0.822 2.620 2.620 4.454 0.010 0.010 0.010	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.380 17.317 17.317 -13.135 0.010 0.009 0.009	0.000 -0.213 0.137 2.981 0.001 0.000 0.000 0.000 0.0043 3.391 0.137 0.137	406) Serviceability - Deflection in y-direction (Beam) 100) Negligble internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 - Sh 141) Cross-section check - Shear buckling acc. to 3.3.3 - Sh 141) Cross-section check - Anal force, bending about y-axis at 181) Cross-section check - Axial force, bending about y-axis 1810; Cross-section check - Axial force, bending about y-axis acc. to 302) Stability analysis - Rexural buckling about y-axis acc. to 305) Stability anal
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000 0.000 1.800 1.800 1.800	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 CO1 CO9 RC1 RC1 RC1	\$ 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.057 -50.053 -43.099 -43.099 -43.099	15/0 0.551 0.195 1.691 0.000 0.000 0.000 0.000 2.014 0.195 0.195 0.195	0.000 0.000 0.010 0.000 0.822 2.620 4.454 0.010 0.010 0.010 0.010	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.380 7.317 7.317 -13.135 0.010 0.009 0.009	0.000 0.213 0.137 2.981 0.001 0.000 0.000 0.000 0.0043 3.391 0.137 0.137	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 105) Cross-section check - Shear force in z-axis acc. to 3.3.2 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Shear force in z-axis acc. to 3.3.3 127) Cross-section check - Axea force, bending about z-axis 131) Cross-section check - Axea force, bending about z-axis 132) Cross-section check - Axea force, bending about z-axis 132) Stability analysis - Flexural buckling about z-axis acc. to 3.2.2 306) Stability analysis - Flexural buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling about z-axis acc. to 3.2.2.2 131) Stability analysis - Trainal buckling acc. to 3.2.2 131) Stability analysis
2	Cross-section 2.850 0.000 2.850 0.000 0.000 0.000 1.800 1.800 1.800 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1 CO9 RC1 RC1 RC1 LC3	5 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.053 43.099 43.099 -43.099 -43.099 -0.016	0.000 15/0 0.551 0.195 1.691 0.001 0.000 0.000 0.000 0.010 2.014 0.195 0.195 0.195 0.195 0.195	0.000 0.010 0.022 2.620 2.620 4.454 0.010 0.010 0.010 0.010 0.010 2.620	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.380 17.317 17.317 13.135 0.010 0.009 0.009 0.009 17.317	0.000 0.137 0.137 0.001 0.000 0.000 0.000 0.043 3.391 0.137 0.137 0.137 0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.2 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Bending about y-axis and shear for 111) Cross-section check - Anal force, bending about y-axis 181) Cross-section check - Anal force, bending about y-axis and 181) Cross-section check - Avail force, bending about y-axis acc. 130) Stability analysis - Flexural buckling about y-axis acc. to 305 Stability analysis - Terrsional buckling acc. to 3.2.2 (2) 311) Stability analysis - Torsional buckling acc. to 3.2.2 (2) 313) Stability analysis - Torsional buckling acc. to 3.2.2 (2)
2	Cross-section 2.850 1.800 0.000 2.850 0.000 0.000 0.000 1.800 1.800 1.800 1.800 0.000 0.000 0.000 0.000 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 CO1 CO1 RC1 RC1 RC1 LC3 CO1	5 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.067 -50.053 -43.099 -43.099 -43.099 -0.016 -50.067	15/0 0.551 0.195 1.691 0.000 0.000 0.000 0.000 0.000 0.000 0.195 0.195 0.195 0.195 0.195 0.195	0.000 0.010 0.000 0.822 2.620 2.620 2.620 4.454 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.4454	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.009 0.000 0.380 17.317 17.317 13.135 0.010 0.009 0.009 0.009 0.009 17.317 -13.135	0.000 0.213 0.137 0.001 0.000 0.000 0.000 0.000 0.043 3.391 0.137 0.137 0.137 0.000 0.000 0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligble internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Shear buckling acc. to 3.3.3 - Sh 141) Cross-section check - Bending about z-axis ac 1810 Cross-section check - Axial force, bending about z-axis ac 1810 Cross-section check - Axial force, bending about z-axis ac 1810 Cross-section check - Valia force, bending about z-axis ac 1810 Cross-section check - Axial force, bending about z-axis ac 1810 Cross-section check - Axial force, bending about z-axis acc. to 305) Stability analysis - Texural buckling about z-axis acc. to 310) Stability analysis - Torsional buckling acc. to 3.2.2 (26) - 321) Stability analysis - Torsional buckling acc. to 3.3.2 331) Stability analysis - Bending about y-axis and compression
2	Cross-section 2.850 0.000 2.850 0.000 0.000 0.000 1.800 1.800 1.800 0.000	No. 15 - IS LC5 RC1 LC5 CO4 LC3 LC3 LC3 CO1 CO9 RC1 RC1 RC1 LC3	5 250/250/10/ 0.000 43.099 0.000 38.455 -0.016 -0.016 -50.053 43.099 43.099 -43.099 -43.099 -0.016	0.000 15/0 0.551 0.195 1.691 0.001 0.000 0.000 -0.010 2.014 0.195 0.195 0.195 0.195 0.195	0.000 0.010 0.022 2.620 2.620 4.454 0.010 0.010 0.010 0.010 0.010 2.620	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.009 0.000 0.380 17.317 17.317 13.135 0.010 0.009 0.009 0.009 17.317	0.000 0.137 0.137 0.001 0.000 0.000 0.000 0.043 3.391 0.137 0.137 0.137 0.000	406) Serviceability - Deflection in y-direction (Beam) 100) Negligible internal forces 102) Cross-section check - Compression acc. to 3.2 106) Cross-section check - Bending about z-axis acc. to 3.3.3 115) Cross-section check - Shear force in z-axis acc. to 3.3.3 126) Cross-section check - Shear buckling acc. to 3.3.3 - She 141) Cross-section check - Avial force, bending about y-axis and 171) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and 181) Cross-section check - Avial force, bending about y-axis and

Figure 4.7: Window 3.1 Governing Internal Forces by Member

For each member, this window displays the governing internal forces, that is, those internal forces that result in the maximum utilization in each design.

Location x

At this x location of the member, the respective maximum design ratio occurs.

Loading

This column displays the number of the load case, the load combination, or result combination whose internal forces result in the maximum design ratios.

Forces / Moments

For each member, this column displays the axial and shear forces as well as the torsional and bending moments producing maximum ratios in the respective cross-section designs, stability analyses, and serviceability limit state designs.

Design According to Formula

The final column informs you about the design types and the equations by which the designs according to [1] have been performed.



4.7 Governing Internal Forces by Set of Members

	A	В	C	D	E	F	G	Н	
Set	Location	Load-		Forces [kN]			loments [kNm]		
No.	x [m]	ing	N	Vy	Vz	MT	My	Mz	Design According to Formula
1			6,65,79,88,10						
	1.046	LC3	-0.197	0.000	-0.633	0.000	-0.766	0.000	
	0.000	CO2	-56.723	0.001	18.494	-0.002	0.000	0.000	
	5.647	LC2	-4.686	0.000	-0.034	0.000	15.680	0.000	
	3.000	LC4	0.000	0.001	0.000	0.005	0.000		106) Cross-section check - Bending about z-axis acc. to 3.3.2
	0.000	CO1	-56.325	0.000	21.304	-0.002	0.000		115) Cross-section check - Shear force in z-axis acc. to 3.3.3
	0.000	LC1	-32.222	0.000	-8.132	0.000	0.000	0.000	
	3.585			0.000	1.193	0.000	14.486	0.000	141) Cross-section check - Bending about y-axis and shear for
	3.011	CO1	-20.293	-0.001	-29.594	0.002	-117.477	-0.002	
	1.087	CO1	-18.905	-0.055	16.837	-0.002	-0.615		181) Cross-section check - Axial force, bending about z-axis a
	5.700	CO9	-31.776	-0.741	17.282	0.007	98.954		191) Cross-section check - Axial force, biaxial bending and she
	0.000	CO2	-56.723	0.001	18.494	-0.002	0.000		302) Stability analysis - Flexural buckling about y-axis acc. to 3
	0.000	CO2	-56.723	0.001	18.494	-0.002	0.000		306) Stability analysis - Flexural buckling about z-axis acc. to 3
	0.000	CO2	-56.723	0.001	18.494	-0.002	0.000		311) Stability analysis - Torsional buckling acc. to 3.2.2.2(a) - I
	5.647	LC2	-4.686	0.000	-0.034	0.000	15.680		321) Stability analysis - Lateral-torsional buckling acc. to 3.3.2
	1.000	CO1	-52.208	0.000	20.744	-0.002	20.991	0.000	331) Stability analysis - Bending about y-axis and compression
	1.000	RC1	-51.115	-1.122	17.409	-0.007	17.398	1.386	341) Stability analysis - Biaxial bending and compression acc.
	0.000	LC1	0.000	0.000	0.000	0.000	0.000	0.000	400) Serviceability - Negligible deflections
	3.137	CO1	0.000	0.000	0.000	0.000	0.000	0.000	401) Serviceability - Deflection in z-direction (Beam)
	3.000	CO6	0.000	0.000	0.000	0.000	0.000	0.000	406) Serviceability - Deflection in y-direction (Beam)
2	(Member No	12 17 26 4	5.64.78.87.10	0)					
	3.262	LC5	-0.943	0.027	0.883	0.007	0.364	-0.166	100) Negligible internal forces
	6.274	LC5	7.090	0.014	-0.885	-0.007	0.364		101) Cross-section check - Tension acc. to 3.1
	0.000	C09	-81.459	0.002	31.894	0.006	0.000		102) Cross-section check - Compression acc. to 3.2
	6.274	C07	-1.515	-0.021	0.850	0.009	50.785	-0.104	
	0.000	C01	-71.379	0.000	38.052	-0.002	0.000		115) Cross-section check - Shear force in z-axis acc. to 3.3.3
	0.000	LC1	-27.449	0.000	-8.777	0.000	0.000	0.000	
	0.314	C07	-1.560	0.020	-1.294	-0.009	50.449	-0.111	141) Cross-section check - Bending about y-axis and shear for
	3.137	C07	-1.904	-0.014	5.288	0.009	41.158		161) Cross-section check - Biaxial bending and shear force ac
	3.011	C01	-35.661	-0.001	-51.372	0.003	-207.633		171) Cross-section check - Axial force, bending about y-axis a
	1.468	C07	-14.314	-0.052	-13.030	-0.002	0.005		181) Cross-section check - Axial force, bending about z-axis a
	3.585	CO2	-33.100	0.051	10.878	-0.003	103.754	0.171	191) Cross-section check - Axial force, biaxial bending and she
	0.000	C02	-81.459	0.002	31.894	0.002	0.000		302) Stability analysis - Flexural buckling about v-axis acc. to 3

Figure 4.8: Window 3.2 Governing Internal Forces by Set of Members

This window shows the internal forces that result in the maximum ratios of the design for each set of members.



Member Slendernesses 4.8

	А	B	С	D	E	F	G	H	
/lember		Length		Major Axis y			Minor Axis z		
No.	Under Stress	L [m]	ky[-]	iy [mm]	λy[-]	k _z [-]	iz [mm]	λz [-]	
1	Compression / Flexure	3.000	1.000	107.7	27.849	1.000	63.5	47.263	
2	Compression / Flexure	3.000	1.000	107.7	27.849	1.000	63.5	47.263	
3	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
4	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
5	Compression / Flexure	3.000	1.000	188.0	15.960	1.000	47.0	63.863	
6	Compression / Flexure	3.000	1.000	188.0	15.960	1.000	47.0	63.863	
7	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
8	Compression / Flexure	6.000	1.000	188.0	31.921	1.000	47.0	127.727	
9	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
12	Compression / Flexure	6.000	1.000	188.0	31.921	1.000	47.0	127.727	
13	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
14	Compression / Flexure	6.000	1.000	188.0	31.921	1.000	47.0	127.727	
15	Compression / Flexure	3.011	1.000	167.2	18.010	1.000	47.1	63.958	
16	Compression / Flexure	3.011	1.000	167.2	18.010	1.000	47.1	63.958	
17	Compression / Flexure	3.011	1.000	167.2	18.010	1.000	47.1	63.958	
18	Compression / Flexure	3.011	1.000	167.2	18.010	1.000	47.1	63.958	
19	Compression / Flexure	6.274	1.000	107.7	58.240	1.000	63.5	98.840	
20	Compression / Flexure	6.250	1.000	188.0	33.251	1.000	47.0	133.049	
21	Compression / Flexure	6.250	1.000	188.0	33.251	1.000	47.0	133.049	
24	Compression / Flexure	3.262	1.000	167.2	19.512	1.000	47.1	69.292	
25	Compression / Flexure	3.262	1.000	167.2	19.512	1.000	47.1	69.292	
26	Compression / Flexure	3.262	1.000	167.2	19.512	1.000	47.1	69.292	
27	Compression / Flexure	3.262	1.000	167.2	19.512	1.000	47.1	69.292	
28	Compression / Flexure	3.546	1.000	107.7	32.918	1.000	63.5	55.865	
29	Compression / Flexure	3.000	1.000	107.7	27.849	1.000	63.5	47.263	
30	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
31	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
32	Compression / Flexure	3.546	1.000	86.2	41.123	1.000	52.1	68.012	
33	Compression / Flexure	3.000	1.000	86.2	34.791	1.000	52.1	57.540	
34	Compression / Flexure	5.000	1.000	30.7	162.938	1.000	30.7	162.938	
				More	bers with compr	reaction (flow wa			
				Max Kv/L			9		
				Max KyL Max K ₂ L			9		

Figure 4.9: Window 3.3 Member Slendernesses

Details...

Details...

This results window appears only if you select the respective check box in the Other tab of the Details dialog box (see Figure 3.4, page 31).

The table lists the effective slendernesses of the designed members for both directions of the principal axes. They were determined depending on the type of load. At the end of the list, you find a comparison with the limit values that have been defined in the Details dialog box, tab Other (see Figure 3.4, page 31).

Members of the member type "Tension" or "Cable" are not included in this window.

This window is displayed only for information. No stability design of slendernesses is intended.



4.9 Parts List by Member

Finally, STEEL NTC-DF provides a summary of all cross-sections included in the design case.

A	B	C	D	E	F	G	H	
Cross-Section	Number of	Length	Total Length	Surface Area	Volume	Unit Weight	Weight	Total Weight
Description	Members	[m]	[m]	[m ²]	[m ³]	[kg/m]	[kg]	[t]
15 - IS 250/250/10/15/0	4	3.00	12.00	17.76	0.12	76.15	228.44	0.914
12 - TO 80/80/5/5/5/5	25	5.00	125.00	40.00	0.19	11.77	58.88	1.472
1 - IS 450/200/10/20/0	4	3.00	12.00	20.16	0.15	94.98	284.95	1.140
1 - IS 450/200/10/20/0	6	6.00	36.00	60.48	0.44	94.98	569.91	3.41
13 - Circle 24	4	7.81	31.24	2.36	0.01	3.55	27.74	0.11
2 - IS 400/200/10/18/0	8	3.01	24.09	38.06	0.26	85.09	256.25	2.05
7 - IS 250/250/10/15/0	4	6.27	25.10	37.14	0.24	76.15	477.72	1.91
9 - IS 450/200/10/20/0	8	6.25	50.00	84.00	0.61	94.99	593.66	4.74
13 - Circle 24	8	8.02	64.18	4.84	0.03	3.55	28.49	0.22
2 - IS 400/200/10/18/0	8	3.26	26.10	41.24	0.28	85.09	277.62	2.22
6 - IS 250/250/10/15/0	2	3.55	7.09	10.50	0.07	76.15	270.01	0.54
6 - IS 250/250/10/15/0	3	3.00	9.00	13.32	0.09	76.15	228.44	0.68
10 - IS 200/200/8/15/0	2	3.55	7.09	8.40	0.05	57.78	204.87	0.410
10 - IS 200/200/8/15/0	3	3.00	9.00	10.66	0.07	57.78	173.33	0.52
16 - IS 360/150/8/12/0	1	6.55	6.55	8.54	0.04	49.36	323.12	0.32
2 - IS 400/200/10/18/0	8	6.27	50.19	79.30	0.54	85.09	533.88	4.27
6 - IS 250/250/10/15/0	1	4.09	4.09	6.06	0.04	76.15	311.74	0.31
10 - IS 200/200/8/15/0	1	4.09	4.09	4.85	0.03	57.78	236.53	0.23
6 - IS 250/250/10/15/0	1	7.09	7.09	10.50	0.07	76.14	540.17	0.54
6 - IS 250/250/10/15/0	1	6.55	6.55	9.69	0.06	76.15	498.45	0.49
	102		516.46	507.84	3.38			26.55
	15 - IS 250/250/10/15/0 12 - TO 80/80/5/5/5/5 13 - Grob 80/80/5/5/5/5 13 - Grobe 24 2 - IS 400/200/10/20/0 13 - Grobe 24 2 - IS 400/200/10/18/0 7 - IS 250/250/10/15/0 13 - Grobe 24 2 - IS 400/200/10/18/0 6 - IS 250/250/10/15/0 10 - IS 200/200/8/15/0 10 - IS 200/200/8/15/0 16 - IS 360/150/18/12/0 2 - IS 400/200/11/8/0 6 - IS 250/250/10/15/0 10 - IS 200/200/8/15/0 10 - IS 200/200/8/15/0 6 - IS 250/250/10/15/0 10 - IS 200/200/8/15/0 6 - IS 250/250/10/15/0	Description Members 15 - IS 250/250/10/15/0 2 12 - TO 80/800/55/5/5 25 1 - IS 450/200/10/20/0 4 1 - IS 450/200/10/20/0 4 1 - IS 450/200/10/20/0 6 13 - Cricle 24 4 2 - IS 400/200/10/20/0 8 9 - IS 450/200/10/20/0 8 13 - Cricle 24 8 13 - Storle 24 8 6 - IS 250/250/10/15/0 2 6 - IS 250/250/10/15/0 2 10 - IS 200/200/8/15/0 3 10 - IS 200/200/8/15/0 1 11 - IS 200/200/8/15/0 1 12 - IS 400/200/10/18/0 1 6 - IS 250/250/10/15/0 1 10 - IS 200/200/8/15/0 1 6 - IS 250/250/10/15/0 1 6 - IS 250/250/10/15/0 1 6 - IS 250/250/10/15/0 1	Description Members [m] 15 - IS 250/250/10/15/0 4 3.00 12 - TO 8/08/05/5/5/5 25 5.00 1 - IS 450/200/10/20/0 4 3.00 1 - IS 450/200/10/20/0 6 6.00 1 - IS 450/200/10/20/0 6 6.00 1 - IS 450/200/10/20/0 8 3.01 1 - Grebal 4 7.81 2 - IS 400/200/10/20/0 8 6.25 1 - Grebal 8 3.01 7 - IS 250/250/10/15/0 8 6.25 13 - Grebal 8 8.022 2 - IS 400/200/10/20/0 8 6.25 13 - Grebal 8 3.00 10 - IS 250/250/10/15/0 2 3.55 6 - IS 250/250/10/15/0 3 3.00 10 - IS 200/200/8/15/0 3 3.00 10 - IS 200/200/8/15/0 1 6.27 6 - IS 250/250/10/15/0 1 6.27 6 - IS 250/250/10/15/0 1 4.09 10 - IS 200/200/8/15/0 1 4.09	Description Members [m] [m] 15 - IS 250/250/10/15/0 4 3.00 12.00 12 - TO 80/80/55/5/5 25 5.00 125.00 1 - IS 450/200/10/20/0 4 3.00 12.00 1 - IS 450/200/10/20/0 6 6.00 36.00 1 - IS 450/200/10/20/0 6 6.00 36.00 1 - Screle 24 4 7.81 31.24 2 - IS 400/200/10/20/0 8 6.27 25.10 9 - IS 450/200/10/20/0 8 6.25 50.00 13 - Crele 24 8 8.02 641.8 2 - IS 400/200/10/20/0 8 6.25 50.00 13 - Crele 24 8 3.02 26.10 6 - IS 250/250/10/15/0 2 3.55 7.09 6 - IS 250/250/10/15/0 2 3.55 7.09 10 - IS 200/200/3/15/0 2 3.300 9.00 10 - IS 200/200/3/15/0 3 3.00 9.00 10 - IS 200/200/3/15/0 1 4.09 4.09	Description Members [m] [m] [m²] 15 - IS 250/250/10/75/0 4 3.00 12.00 17.76 12 - TO 80/800/575/5 25 5.00 125.00 40.00 1 - IS 450/200/10/20/0 4 3.00 12.00 20.16 1 - IS 450/200/10/20/0 6 6.00 36.00 60.48 1 - Greta 24 4 7.81 31.24 2.36 2 - IS 400/200/10/20/0 4 6.27 25.10 37.14 9 - IS 450/200/10/20/0 8 6.25 50.00 84.00 13 - Crela 24 8 8.02 64.18 4.84 2 - IS 400/200/10/20/0 8 6.25 50.00 84.00 13 - Crela 24 8 8.02 64.18 4.84 2 - IS 400/200/10/20/0 8 3.26 26.10 41.24 6 - IS 250/250/10/15/0 2 3.35 7.09 10.50 6 - IS 250/250/10/15/0 3 3.00 9.00 13.32 10 - IS 200/200/8/15	Description Members [m] [m] [m²] [m³] 15 - IS 250/250/10/15/0 4 3.00 12.00 17.07.6 0.12 12 - TO 80/800/55/5/5 25 5.00 125.00 40.00 0.19 1 - IS 450/200/10/20/0 6 6.00 36.00 60.48 0.44 1 - IS 450/200/10/20/0 6 6.00 36.00 60.48 0.41 1 - Screle 24 4 7.81 31.24 2.36 0.01 2 - IS 400/200/10/20/0 8 3.01 24.09 38.06 0.26 7 - IS 250/250/10/15/0 4 6.27 25.10 37.14 0.24 9 - IS 450/200/10/20/0 8 6.26 50.00 0.84.00 0.61 13 - Crele 24 8 8.02 64.18 4.84 0.03 2 - IS 400/200/10/20/0 8 3.26 26.10 4.124 0.28 6 - IS 250/250/10/15/0 2 3.35 7.09 10.00 0.07 6 - IS 250/250/10/15/0	Description Members [m] [m] [m2] [m3] [kg/m] 15 - IS 250/250/10/15/0 4 3.00 125.00 4.00.0 125.00 4.00.0 127.00 4.00.0 125.00 4.00.0 117.7 1 - IS 450/200/10/20/0 4 3.00 125.00 20.16 0.15 94.98 1 - IS 450/200/10/20/0 6 6.00 36.00 60.44 0.44 94.98 1 - IS 450/200/10/20/0 6 6.00 36.00 60.44 0.44 94.98 1 - Screle 24 4 7.81 31.24 2.36 0.01 35.5 2 - IS 400/200/10/18/0 8 3.01 2.409 38.06 0.26 85.09 7 - IS 250/250/10/15/0 4 6.27 25.10 37.14 0.24 78.15 1 - Sco/250/10/15/0 8 0.26 2.61.0 41.24 0.03 3.55 2 - IS 400/200/11/8/0 8 3.26 2.61.0 41.24 0.05 57.78 1 - S 250	Description Members [m] [m]

Figure 4.10: Window 4.1 Parts List by Member

By default, this list contains only the designed members. If you need a parts list for all members of the model, select the corresponding option in the *Details* dialog box, tab *Other* (see Figure 3.4, page 31).

Part No.

The program automatically assigns item numbers to similar members.

Cross-Section Description

This column lists the cross-section numbers and descriptions.

Number of Members

This column shows how many similar members are used for each part.

Length

This column displays the respective length of an individual member.

Total Length

This column shows the product determined from the two previous columns.

Surface Area



Details..

For each part, the program indicates the surface area related to the total length. The surface area is determined from the *Surface Area* of the cross-sections that can be seen in windows 1.3 and 2.1 through 2.5 in the cross-section information (see Figure 2.10, page 15).



Volume

The volume of a part is determined from the cross-sectional area and the total length.

Unit Weight

The *Unit Weight* of the cross-section is relative to the length of one meter. For tapered cross-sections, the program averages both cross-section masses.

Weight

The values of this column are determined from the respective product of the entries in column C and G.

Total Weight

The final column indicates the total mass of each part.

Sum

At the bottom of the list, you find a sum of the values in the columns B, D, E, F, and I. The last data field of the column *Total Weight* gives information about the total amount of steel required.

4.10 Parts List by Set of Members

	A	B	C	D	E	F	G	H	1
Part	Set of Members	Number	Length	Total Length	Surface Area	Volume	Unit Weight	Weight	Total Weight
No.	Description	of Sets	[m]	[m]	[m ²]	[m ³]	[kg/m]	[kg]	[t]
1		2	37.10			0.83		3275.30	6.55
Sum		2	57.10	74.19		0.83	00.23	3273.30	6.55
		-		71.10	110.02	0.00			0.00
								E 3] 🐧 🧕

Figure 4.11: Window 4.2 Parts List by Set of Members

The last results window is displayed if you have selected at least one set of members for design. The window summarizes an entire structural group (for example a horizontal beam) in a parts list.

Details on the various columns can be found in the previous chapter. If there are different cross-sections in a set of members, the program averages the surface area, the volume, and the cross-section weight.



5. **Results Evaluation**

You can evaluate the design results in different ways. The buttons below the first window part can help you to evaluate the results.

	A	B	С	D					E					
Member	Location	Load	Design											
No.	x [m]	Case	Ratio					Design Ac	cording to Formula					
1	Cross-section	n No. 15 - I	S 250/250/1											
	2.100	LC4			100) Negligible									
	0.000	CO2			102) Cross-sect									
	1.200	LC5			106) Cross-sect									
	1.500	CO3			115) Cross-sect									
0.000 LC3 0.00 ≤ 1 126) Cross-section check - Shear buckling acc. to 3.3.3 - Shear force in z-axis														
	0.000	LC3				ross-section check - Bending about y-axis and shear force acc. to 3.3.4								
	0.000	CO1							and shear force acc.					
	0.750	CO9							and shear force acc.	to 3.3.4	4 and 3.4	.3.1		
	0.000	CO2	0.01	≤1	302) Stability an	alysis - Flexural b	ouckling about	y-axis acc. to	3.2.2					
		Max:	0.83	≤1	۲				9	-	F	🏹 😂 🖪 🐧		
E Cross-	n Internal Ford Section Type													
Design										- 11		250.0		
	I Force					P*	-17.198			- 11	L +			
	iding Moment					Muoy	2.123			- =		0.0		
	ar Force					V*z	1.523			-11		0.0		
	b Depth h Thickness					h			3.3.3	-111	9			
	ar Area					t _w	10.0			-111	250.0	•••••••		
	ar Area ninal Shear B					Az VN z	2200.0 363.000		333	- 11		10.0		
	ion Shear R					V N,z V R z	363.000		3.3.3 Eq. (3.38)	- 11		<u></u>		
	agn Snear Re ar Force	sistance				VR,z V*v	0.002		EQ. (3.38)	_		annungunnun		
0.10	ar Force ar Area					Av	7500.0			-		1		
	ninal Shear R	opietopop				V _{N,V}	1237.500		3.3.3	-		z		
	ion Shear Re					VN.y VR.y	1237.500		Ea. (3.38)	-11				
	d Strenath	SISCONCE				F _V	250.000		1.3.1	- 1				
	tic Section N	lodulus				Zy	900487.0		1.3.1	-				
	tic Section N					Sv Sv	1002250.0			-				
										- 1				
- Plas	ndemess I imi					λs,1,My	69.296							

Figure 5.1: Buttons for results evaluation

The buttons have the following functions:

Button	Description	Function
Y	Ultimate Limit State Designs	Shows or hides the results of the ultimate limit state design
2	Serviceability Limit State Designs	Shows or hides the results of the serviceability limit state design
	Show Color Bars	Shows or hides the colored relation scales in the results windows
7 ,1	Show Rows with Ratio > 1	Displays only the rows where the ratio is greater than 1, and thus the design is failed
	Result Diagrams	Opens the window <i>Result Diagram on Member</i> → chapter 5.2, page 46
	Excel Export	Exports the table to MS Excel / OpenOffice → chapter 7.4.3, page 57
A	Member Selection	Allows you to graphically select a member to display its results in the table
۲	View Mode	Jumps to the RSTAB work window to change the view

Table 5.1: Buttons in results windows 2.1 to 2.5



5.1 Results in the RSTAB Model

To evaluate the design results, you can also use the RSTAB work window.

RSTAB background graphic and view mode

The RSTAB work window in the background is useful when you want to find the position of a particular member in the model: The member selected in the STEEL NTC-DF results window is highlighted in the selection color in the background graphic. Furthermore, an arrow indicates the member's x-location that is displayed in the selected table row.

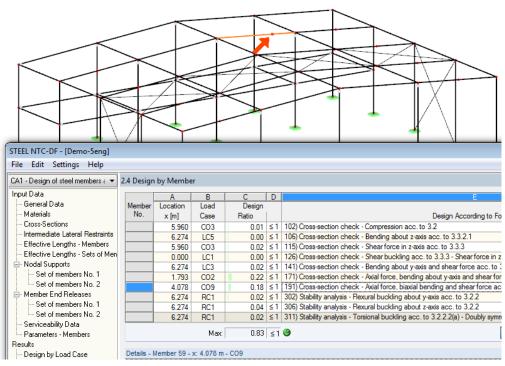


Figure 5.2: Indication of the member and the current Location x in the RSTAB model

If you cannot improve the display by moving the STEEL NTC-DF module window, click [Jump to Graphic] to activate the *View Mode*: The program hides the module window so that you can modify the display in the RSTAB user interface. The view mode provides the functions of the *View* menu, for example zooming, moving, or rotating the display. The pointer remains visible.

Click [Back] to return to the add-on module STEEL NTC-DF.

RSTAB work window

You can also graphically check the design ratios in the RSTAB model. Click [Graphics] to exit the design module. In the RSTAB work window, the design ratios are now displayed like the internal forces of a load case.

In the *Results* navigator, you can specify which design ratios of the service and ultimate limit state or fire resistance design you want to display graphically.

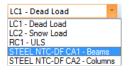
To turn the display of design results on or off, use the [Show Results] button known from the display of internal forces in RSTAB. To display the result values, click the [Show Values] toolbar button to the right.

The design cases can be set by means of the list in the RSTAB menu bar.

The RSTAB tables are of no relevance for the evaluation of design results









To adjust the graphical representation of the results, you can select $Results \rightarrow Members$ in the *Display* navigator. The display of the design ratios is *Two-Colored* by default.

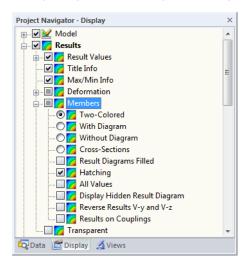


Figure 5.3: *Display* navigator: Results \rightarrow Members

When you select a multicolor representation (options *With/Without Diagram* or *Cross-Sections*), the color panel becomes available. It provides the common control functions described in detail in the RSTAB manual, chapter 3.4.6.

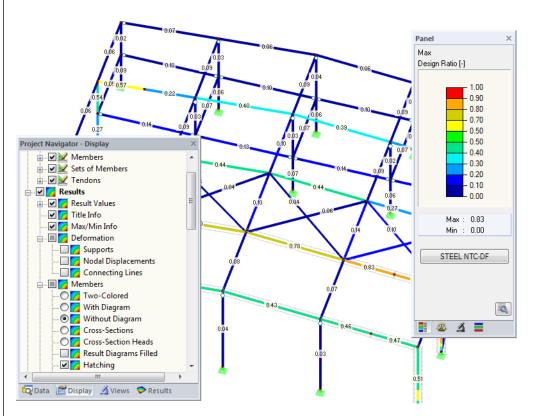


Figure 5.4: Design ratios with display option Without Diagram

The graphics of the design results can be transferred to the printout report (see chapter 6.2, page 49).

To return to the STEEL NTC-DF module, click [STEEL NTC-DF] in the panel.

STEEL NTC-DF



5.2 Result Diagrams

You can also graphically evaluate a member's result distributions in the result diagram.

To do this, select the member (or set of members) in the STEEL NTC-DF results window by clicking in the table row of the member. Then open the *Result Diagram on Member* dialog box by clicking the button shown on the left. The button is located below the upper results table (see Figure 5.1, page 43).

The result diagrams are also available in the RSTAB graphic. To display the diagrams, click

Results \rightarrow Result Diagrams for Selected Members

or use the button in the RSTAB toolbar shown on the left.

A window opens, graphically showing the distribution of the maximum design values on the member or set of members.

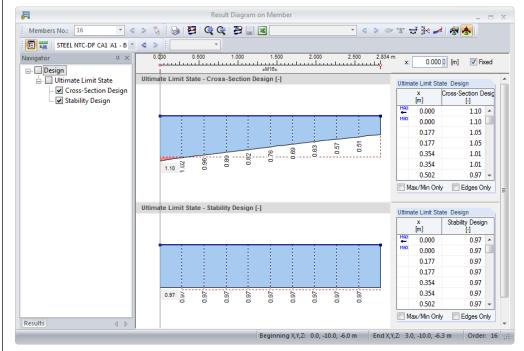
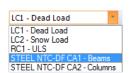


Figure 5.5: Dialog box Result Diagram on Member

Use the list in the toolbar above to choose the relevant STEEL NTC-DF design case.

The Result Diagram on Member dialog box is described in the RSTAB manual, chapter 9.5.





2

F



5.3 Filter for Results

The STEEL NTC-DF results windows allow you to sort the results by various criteria. In addition, you can use the filter options described in chapter 9.7 of the RSTAB manual to evaluate the design results graphically.

You can use the *Visibility* option also for STEEL NTC-DF (see RSTAB manual, chapter 9.7.1) to filter the members in order to evaluate them.

Filtering designs

The design ratios can easily be used as filter criteria in the RSTAB work window which you can access by clicking [Graphics]. To apply this filter function, the panel must be displayed. If it is not shown, click

View \rightarrow Control Panel (Color Scale, Factors, Filter)

or use the toolbar button shown on the left.

The panel is described in the RSTAB manual, chapter 3.4.6. The filter settings for the results must be defined in the first panel tab (Color spectrum). As this register is not available for the two-colored results display, you have to use the *Display* navigator and set the display options *Colored With/Without Diagram* or *Cross-Sections* first.

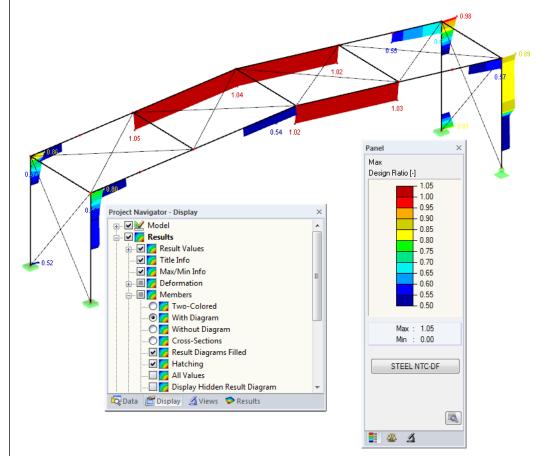


Figure 5.6: Filtering design ratios with adjusted color spectrum

As the figure above shows, the color spectrum can be set in such a way that only ratios higher than 0.50 are shown in a color range between blue and red.

If you select the *Display Hidden Result Diagram* option in the *Display* navigator (*Results* \rightarrow *Members*), you can display all design ratio diagrams that are not covered by the color spectrum. Those diagrams are represented by dotted lines.



× -





Filtering members

1

In the *Filter* tab of the control panel, you can specify the numbers of particular members to display their results exclusively, that is, filtered. This function is described in detail in the RSTAB manual, chapter 9.7.3.

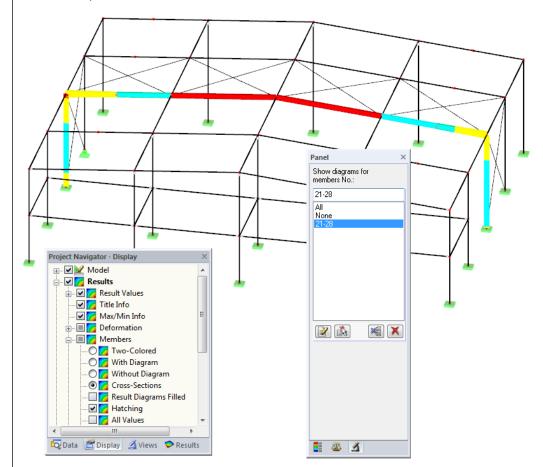


Figure 5.7: Member filter for the design ratios of a hall frame

Unlike the partial view function (*Visibilities*), the graphic displays the entire model. The figure above shows the design ratios of a hall frame. The remaining members are displayed in the model but are shown without design ratios.



6. Printout

6.1 Printout report

Similar to RSTAB, the program generates a printout report for the STEEL NTC-DF results, to which graphics and descriptions can be added. The selection in the printout report determines what data from the design module will be included in the printout.



The printout report is described in the RSTAB manual. In particular, chapter 10.1.3.5 *Selecting Data of Add-on Modules* describes how to select input and output data from add-on modules for the printout report.

For complex structural systems with many design cases, it is recommended to split the data into several printout reports, thus allowing for a clearly-arranged printout.

6.2 STEEL NTC-DF Graphic Printout

In RSTAB, you can add every picture that is displayed in the work window to the printout report or send it directly to a printer. In this way, you can prepare the design ratios displayed on the RSTAB model for the printout, too.



The printing of graphics is described in the RSTAB manual, chapter 10.2.

Designs on the RSTAB model

To print the currently displayed graphic of the design ratios, click

$\textbf{File} \rightarrow \textbf{Print Graphic}$

or use the toolbar button shown on the left.

ſ	🗐 R	STAB	8.00 (6	4bit) - [Hall*]			
	:4≥	<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	Insert	<u>C</u> alculate	<u>R</u> esults	<u>T</u> ools
	: 🗋	2	33) 🙀 🖻		🔏 🍕	Q 🔁
	9	- 2	í 💁 🤅	V. 🐒	왔 Print	Graphic	9 🎮 -	<u>9×x</u> ‡

Figure 6.1: Button Print Graphic in RSTAB toolbar

Result Diagrams



You can also transfer the *Result Diagram on Member* to the report or print it directly by using the [Print] button.

肩 Result Diagram on Membe	r	
Members No.: 18	- < > 🏷	i 🚱 😕 🔍 🔍 🗃 🔜
STEEL NTC-DF CA1	▼ < >	Print
Navigator $P \times$	0.000	0.500
🗹 Design Ratio	 	

Figure 6.2: Button Print Graphic in the dialog box Result Diagram on Member

The Graphic Printout dialog box appears (see the following page).



Graphic Picture	Window To Print Graphic Size
Oriectly to a printer PR1 To a printout report: PR1 To the Clipboard	Current only More Mass print Asscreen view Window filling To scale 1: 20
Graphic Picture Size and Rotation	Options
Use whole page height Height: 50 [¼ of page]	 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 STEEL NTC-DF - Design Ratio, CA1, Isometric	

Figure 6.3: Dialog box Graphic Printout, tab General

This dialog box is described in the RSTAB manual, chapter 10.2. The RSTAB manual also describes the *Options* and *Color Spectrum* tab.

You can move a graphic anywhere within the printout report by using the drag-and-drop function.

To adjust a graphic subsequently in the printout report, right-click the relevant entry in the navigator of the printout report. The *Properties* option in the context menu opens the *Graphic Printout* dialog box, offering various options for adjustment.

Graphic Printout				×
General Options Color Spectrum	Factors			
Script	Symbols		Frame	
Proportional	Proportional		© <u>N</u> one	
Onstant	Constant		Framed	
Eactor:	Factor: 1 🚔		Title box	
Print Quality		Color		
<u>Standard</u> (max 1000 x 1000 Pixels))	© <u>G</u> rayscale		
Maximum (max 5000 x 5000 Pixels))	Texts and lines in <u>black</u>		
Oser-defined		All colored		
Ma <u>x</u> number of pixels:	1000 🚔			
D			ОК	Cancel

Figure 6.4: Dialog box Graphic Printout, tab Options

Remove from Printout Repo	ort
Start with New Page	
Selection	
Properties	3
	2



7. General Functions

The final chapter describes useful menu functions as well as export options for the designs.

7.1 Design Cases

Design cases allow you to group members for the design: In this way, you can combine groups of structural components or analyze members with particular design specifications (for example changed materials, partial safety factors, optimization).

It is no problem to analyze the same member or set of members in different design cases.

To calculate a STEEL NTC-DF design case, you can also use the load case list in the RSTAB toolbar.

Create New Design Case

To create a new design case, use the STEEL NTC-DF menu and click

File ightarrow New Case.

The following dialog box appears:

New STE	EL NTC-DF Case
No.	Description
2	Design of steel members according to NTC-DF
1	OK Cancel

In this dialog box, enter a *No*. (one that is still available) for the new design case. The corresponding *Description* will make the selection in the load case list easier.

Click [OK] to open the STEEL NTC-DF window 1.1 *General Data* where you can enter the design data.

Rename Design Case

To change the description of a design case, use the STEEL NTC-DF menu and click

File \rightarrow Rename Case.

The following dialog box appears:

Rename S	TEEL NTC-DF Case	×
No. 2	Description New description	•
2		OK Cancel

Figure 7.2: Dialog box Rename STEEL NTC-DF Case

In this dialog box, you can define a different *Description* as well as a different *No*. for the design case.

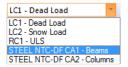


Figure 7.1: Dialog box New STEEL NTC-DF Case



Copy Design Case

To copy the input data of the current design case, select from the STEEL NTC-DF menu

```
File \rightarrow Copy Case.
```

The following dialog box appears:

	EL NTC-DF Case	
Copy fro	m Case	
CA1 - D	esign of steel members according to NTC-DF 🔹	
New Ca No.:	se Description:	
3	Second order theory design	
	OK Can	cel

Figure 7.3: Dialog box Copy STEEL NTC-DF Case

Define the No. and, if necessary, a Description for the new case.

Delete Design Case

To delete design cases, use the STEEL NTC-DF menu and click

```
\textbf{File} \rightarrow \textbf{Delete Case}.
```

The following dialog box appears:

Availal	ble Cases
No.	Description
1	Design of steel members according to NTC-
2	New description
	Second order theory design

Figure 7.4: Dialog box Delete Cases

The design case can be selected in the list *Available Cases*. To delete the selected case, click [OK].





7.2 Cross-Section Optimization

The design module offers you the option to optimize overloaded or little utilized cross-sections. To do this, select in column D or E of the relevant cross-sections in the 1.3 *Cross-Sections* window whether to determine the cross-section *From the current row* or the user-defined *Favorites* (see Figure 2.8, page 13). You can also start the cross-section optimization in the results windows by using the context menu.

	A	B	С	D	E	F
Section	Member	Location	Load	Design		
No.	No.	x [m]	Case	Ratio		Design According to Formula
1	IS 450/2	00/10/20/0				
	P	1 000	LCE	0.00	<1	100) Megligible internal forces
		Go to Cross-Section Doubleclick			uble	click oss-section check - Tension acc. to 3.1
	9	Info About Cross-Section				oss-section check - Compression acc. to 3.2
						oss-section check - Bending about y-axis acc. to 3.3.2.1
	1	Optimize C	ross-Secti	on		oss-section check - Bending about z-axis acc. to 3.3.2.1
	9	Cross-Secti	ion Optimi	zation <u>P</u> arar	neter	rs oss-section check - Shear force in z-axis acc. to 3.3.3
	5	0.000	LÚT -	0.00	21	rzuy cross-section check - Shear buckling acc. to 3.3.3 - Shear force in z-axis
	93	3.000	CO5	0.05	≤1	141) Cross-section check - Bending about y-axis and shear force acc. to 3.3.4
	93	3.000	CO1	0.56	≤1	171) Cross-section check - Axial force, bending about y-axis and shear force acc, to 3.3.4 and 3

Figure 7.5: Context menu for cross-section optimization

During the optimization process, the module determines the cross-section that fulfills the analysis requirements in the most optimal way, that is, comes as close as possible to the maximum allowable design ratio specified in the *Details* dialog box (see Figure 3.4, page 31). The required cross-section properties are determined with the internal forces from RSTAB. If another crosssection proves to be more favorable, this cross-section is used for the design. Then, the graphic in window 1.3 shows two cross-sections: the original cross-section from RSTAB and the optimized one (see Figure 7.7).

For a parameterized cross-section, the following dialog box appears when you select 'Yes' from the drop-down list.

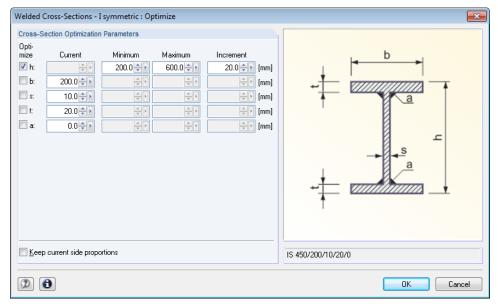


Figure 7.6: Dialog box Welded Cross-Sections - I symmetric : Optimize

By selecting the check boxes in the *Optimize* column, you decide which parameter(s) you want to modify. This enables the *Minimum* and *Maximum* columns, where you can specify the upper and lower limits of the parameter. The *Increment* column determines the interval in which the size of the parameter varies during the optimization process.

7 General Functions



If you want to *Keep current side proportions*, select the corresponding check box. In addition, you have to select at least two parameters for optimization.

Cross-sections based on combined rolled cross-sections cannot be optimized.

Please note that the internal forces are not automatically recalculated with the changed crosssections during the optimization: It is up to you to decide which cross-sections should be transferred to RSTAB for recalculation. As a result of optimized cross-sections, internal forces may vary significantly because of the changed stiffnesses in the structural system. Therefore, it is recommended to recalculate the internal forces of the modified cross-section data after the first optimization, and then to optimize the cross-sections once again.

You can export the modified cross-sections to RSTAB: Go to the 1.3 *Cross-Sections* window, and then click

$\textbf{Edit} \rightarrow \textbf{Export All Cross-Sections to RSTAB}.$

Alternatively, you can use the context menu in window 1.3 to export optimized cross-sections to RSTAB.

	A	В	С	D		E	F	G	2 - IS 400/200/10/15/0
	Material	Cross-Section	Cross-Section Type	Max. Desi	ign	Opti-			STEEL NTC-DF
No.	No.	Description	for Classification	Ratio		mize	Remark	Comment	
1	1	T IS 400/200/10/20/0	I-section welded IS).90	No	1)		
2	1	IS 400/200/10/15/0	Leasting molded IC		0.00	M-	1)		У
6	1	IS 250/250/10/15/0	Info About Cro	s-Section					
7	1	IS 250/250/10/15/0	Cross-Section L	ibrary					
9	2	IS 450/200/10/20/0	E PARTA DE LA						1
10	1	IS 200/200/8/15/0	E <u>d</u> it List 'Desigr	of Membe	rs' in Table	1.1 •			
12	1	TO 60/60/5/5/5/5	Optimize Cross	-Section			1)		2 - IS 400/200/10/18/0
13	1	Circle 24	Cross-Section (. D	_			RSTAB
15	1	IS 250/250/10/15/0	Cross-section (ptimization	n <u>P</u> aramete	rs			
16	1	T IS 360/150/8/12/0	Export Cross-Se	ction to RS1	ТАВ	_			•v
			Export <u>A</u> ll Cross	-Sections to	RSTAB				
			Import Cross-S	ection from	RSTAB				
		1) The cross-section in R	Import All Cros	s-Sections f	rom RSTA	2			
		- NITO DE	in poler in cros	, according to		-			
		NTC-DF.					🛃 😼	۲	ð 📑 à
							3	\$	
		ues - IS 400/200/10/15/0					R	\	Cross-section No. 2 used in
Cross	Section Ty	ues - IS 400/200/10/15/0			-section wel			 • 	
Cross- Sectio	Section Ty in Height	ues - IS 400/200/10/15/0		h	400.0	mm		 Image: A state of the state of	Cross-section No. 2 used in Members No.:
Cross- Section Section	Section Ty on Height on Width	ues - IS 400/200/10/15/0		h b	400.0 200.0	mm mm			Cross-section No. 2 used in Members No.:
Cross- Section Section Web	Section Ty in Height in Width Thickness	es - IS 400/200/10/15/0		h b t _w	400.0 200.0 10.0	mm mm mm			Cross-section No. 2 used in Members No.: 15-18,24-27,40,42,45,46,59,61,64,65,70
Cross- Section Section Web Flange	Section Ty on Height on Width Thickness e Thickness	es - IS 400/200/10/15/0		h b tw tf	400.0 200.0 10.0 15.0	mm mm mm			Cross-section No. 2 used in Members No.: 15-18,24-27,40,42,45,46,59,61,64,65,74 Sets of members No.:
Cross Section Section Web Flange Gross	Section Ty on Height on Width Thickness e Thickness Area	es - IS 400/200/10/15/0		h b t _w tf At	400.0 200.0 10.0 15.0 9700.0	mm mm mm mm ²			Cross-section No. 2 used in Members No.: 15-18,24-27,40,42,45,46,59,61,64,65,70
Cross- Section Section Web Flange Gross Shear	Section Ty in Height in Width Thickness a Thickness Area Area	es - IS 400/200/10/15/0		h b tw ff At Ay	400.0 200.0 10.0 15.0 9700.0 6000.0	mm mm mm mm ² mm ²			Cross-section No. 2 used in Members No.: 15-18,24-27,40,42,45,46,59,61,64,65,70 Sets of members No.:
Cross Section Section Web Flange Gross Shear Shear	Section Ty on Height on Width Thickness e Thickness Area Area Area	es - IS 400/200/10/15/0		h b tw tf At Ay Az	400.0 200.0 10.0 15.0 9700.0 6000.0 4000.0	mm mm mm mm ² mm ² mm ²			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.:
Cross Section Section Web Flange Gross Shear Shear Shear Shear	Section Ty in Height in Width Thickness e Thickness Area Area Area and Moment	Les - 15 400/200/10/15/0 ppe is of Area		h b tw tf At Az Iy 2	400.0 200.0 10.0 15.0 9700.0 6000.0 4000.0 2.64661E+0	mm mm mm mm ² mm ² mm ² mm ⁴			Cross-section No. 2 used in Members No.: 15-18,24-27,40,42,45,46,59,61,64,65,7 Sets of members No.: 1,2 Σ Lengths: Σ Masses:
Cross Section Section Web Flange Gross Shear Shear Shear Shear Secor Secor	Section Ty in Height in Width Thickness e Thickness e Thickness Area Area Area ad Moment ad Moment	Les - IS 400/200/10/15/0 Appe is of Area of Area		h b b tw tf At Ay Az Iy 2 Iz 2	400.0 200.0 10.0 15.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0	mm mm mm mm ² mm ² mm ² mm ⁴ mm ⁴			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42,45,46,59,61,64,65,7 Sets of members No.: 1,2
Cross Section Section Web Flange Gross Shear Shear Shear Shear Shear Shear Shear Shear Shear Shear	Section Ty on Height on Width Thickness a Thickness a Thickness Area Area Area a Area ad Moment and Moment and Consta	es - IS 400/200/10/15/0 ppe is of Area of Area nt		h b tw tf At Ay Az Iz Z J	400.0 200.0 10.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0 557072.0	mm mm mm mm ² mm ² mm ² mm ⁴ mm ⁴ mm ⁴			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 100.38 [m] 7.644 [t]
Cross Section Section Web Flange Gross Shear Shear Shear Shear Secor Torsion Radiu	Section Ty in Height in Width Thickness a Thickness a Thickness Area Area Area d Moment nal Consta s of Gyratii	Les - IS 400/200/10/15/0 ppe is of Area of Area of Area int on		h b tw tf At Ay Az Iz Z J Fy C Az C C C C C C C C C C C C C C C C C	400.0 200.0 10.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0 557072.0 165.2	mm mm mm mm ² mm ² mm ² mm ⁴ mm ⁴ mm ⁴ mm			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 100.38 (m) 7.644 [t] Material: 12
Cross Section Section Web Flange Gross Shear Shear Shear Shear Secor Torsion Radiu Radiu	Section Ty in Height in Width Thickness a Thickness a Thickness Area Area Area Area Moment nal Consta s of Gyratii s of Gyratii	es - IS 400/200/10/15/0 ype is of Area of Area int on on		h b tw tf At Ay Az Iz Z J ry rz V	400.0 200.0 10.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0 557072.0 165.2 45.4	mm mm mm mm ² mm ² mm ² mm ⁴ mm ⁴ mm ⁴ mm			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 100.38 [m] 7.644 [t]
Cross Section Section Web Flange Gross Shear Shear Shear Secor Torsion Radiu Radiu Elastion	Section Ty in Height in Width Thickness a Thickness a Thickness Area Area Area Area Area d Moment nal Consta s of Gyratii s of Gyratii c Section I	es - IS 400/200/10/15/0 ppe ss of Area of Area of Area nt on Modulus		h b tw tf At Ay Az Iz Zy Zy Zy	400.0 200.0 10.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0 557072.0 165.2 45.4	mm mm mm mm ² mm ² mm ⁴ mm ⁴ mm mm mm mm ³			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 100.38 (m) 7.644 (t) Material: 12
Cross Section Section Web Flange Gross Shear Shear Shear Secor Torsion Radiu Radiu Elastion Elastion	Section Ty in Height in Width Thickness a Thickness a Thickness Area Area Area Area Moment nal Consta s of Gyratii s of Gyratii	Les - IS 400/200/10/15/0 ppe is of Area of Area int on Aodulus Modulus		h b b b b b b b b b b b b b b b b b b b	400.0 200.0 10.0 9700.0 6000.0 4000.0 2.64661E+0 20030800.0 557072.0 165.2 45.4	mm mm mm mm ² mm ² mm ² mm ⁴ mm ⁴ mm mm mm mm mm mm ³			Cross-section No. 2 used in Members No.: 15-18.24-27.40.42.45.46.59.61.64.65.7 Sets of members No.: 1.2 Σ Lengths: Σ Masses: 100.38 (m) 7.644 [t] Material: 12

Figure 7.7: Context menu in window 1.3 Cross-Sections

Before the modified cross-sections are transferred to RSTAB, a security query appears as to whether the results of RSTAB should be deleted.

STEEL NTC-DF Information No. 26852
Do you want to transfer the changed cross-sections to RSTAB?
If so, the results of RSTAB and STEEL NTC-DF will be deleted.
Yes No

Figure 7.8: Query before transfer of modified cross-sections to RSTAB

Calculation

By confirming the query and then starting the [Calculation] in the STEEL NTC-DF module, the RSTAB internal forces as well as the designs will be determined in one single calculation run.

7 General Functions



If the modified cross-sections have not been exported to RSTAB yet, you can reimport the original cross-sections in the design module by using the options shown in Figure 7.7. Please note that this option is only available in window 1.3 *Cross-sections*.

5

If you optimize a tapered member, the program modifies the member start and end. Then it linearly interpolates the second moments of area for the intermediate locations. As these moments are considered with the fourth power, the designs may be inaccurate if the depths of the start and end cross-section differ considerably. In such a case, it is recommended to divide the taper into several members, thus modeling the taper layout manually.

7.3 Units and Decimal Places

Units and decimal places for RSTAB and the add-on modules are managed in one dialog box. To define the units in STEEL NTC-DF, use the menu and click

Settings \rightarrow Units and Decimal Places.

The program opens the dialog box that is familiar from RSTAB. STEEL NTC-DF is preset in the *Program / Module* list.

Units and Decimal Places					X
Program / Module	STEEL NTC-DF				
RSTAB	Output Data		Parts List		
STEEL	Output Data		Parts List	11.0	
STEEL EC3		Unit Dec. places		Unit	Dec. places
STEEL AISC	Stresses:	MPa 🔻 3 🜩	Lengths:	m 👻	2 🌲
STEEL IS	Design ratios:	2 🖨	Total lengths:	m 🔻	2 🌲
STEEL SIA	-		-		
STEEL BS	Dimensionless:	- 👻 3 🚔	Surface areas:	m^2 👻	2 🌲
- STEEL GB			Volumes:	[m^3 ▼]	2 🌲
STEEL CS STEEL AS					
STEEL NTC-DF			Weight per length:	kg/m 🔻	2 ≑
ALUMINIUM			Weight:	kg 🔻	2 🖨
KAPPA			-		
LTB			Total weight:	t 👻	3 🜩
FE-LTB					
EL-PL					
С-ТО-Т					
PLATE-BUCKLING					
CONCRETE					
CONCRETE Columns					
···· TIMBER Pro					
TIMBER					
···· DYNAM					
JOINTS					
···· END-PLATE					
CONNECT					
FRAME-JOINT Pro					
DSTV					
DOWEL					
	2				
				ОК	Cancel

Figure 7.9: Dialog box Units and Decimal Places

You can save the settings as user profile to reuse them in other models. These functions are described in the RSTAB manual, chapter 11.1.3.





7.4 Data Transfer

7.4.1 Export Material to RSTAB

If you have adjusted the materials in STEEL NTC-DF for design, you can export the modified materials to RSTAB in a similar manner as you can export cross-sections: Open the 1.2 *Materials* window, and then click

Edit \rightarrow Export All Materials to RSTAB.

You can also export the modified materials to RSTAB using the context menu of window 1.2.

Material Library
Export Material to RSTAB
Export <u>A</u> ll Materials to RSTAB
Import Material from RSTAB
Import All Materials from RSTAB

Figure 7.10: Context menu of window 1.2 Materials

Calculation

Before the modified materials are transferred to RSTAB, a security query appears as to whether the results of RSTAB should be deleted. When you have confirmed the query and then start the [Calculation] in STEEL NTC-DF, the RSTAB internal forces and designs are determined in one single calculation run.

If the modified materials have not been exported to RSTAB yet, you can transfer the original materials to the design module, using the options shown in Figure 7.10. Please note, however, that this option is only available in the 1.2 *Materials* window.

7.4.2 Export Effective Lengths to RSTAB

If you have adjusted the materials in STEEL NTC-DF for design, you can export the modified materials to RSTAB in a similar manner as you can export cross-sections: Open the window 1.5 *Effective Lengths - Members*, and then click

```
Edit \rightarrow Export All Effective Lengths to RSTAB.
```

or use the corresponding option on the context menu of window 1.5.

Export Effective Length to RSTAB
Export All Effective Lengths to RSTAB
Import Effective Length from RSTAB
Import <u>A</u> ll Effective Lengths from RSTAB

Figure 7.11: Context menu of window 1.5 Effective Lengths - Members

Before the modified materials are transferred to RSTAB, a security query appears as to whether the results of RSTAB should be deleted.

If the modified effective lengths have not been exported to RSTAB yet, you can reimport the original effective lengths to the design module, using the options shown in Figure 7.11. Please note, however, that this option is only available in the windows 1.5 *Effective Lengths - Members* and 1.6 *Effective Lengths - Sets of Members*.

7.4.3 Export Results

The STEEL NTC-DF results can also be used by other programs.

Clipboard

To copy cells selected in the results windows to the Clipboard, press the keys [Ctrl]+[C]. To insert the cells, for example in a word-processing program, press [Ctrl]+[V]. The headers of the table columns will not be transferred.



Printout report

You can print the data of the STEEL NTC-DF add-on module into the global printout report (see chapter 6.1, page 49) for export. Then, in the printout report, click

File \rightarrow Export to RTF.

The function is described in the RSTAB manual, chapter 10.1.11.

Excel / OpenOffice

STEEL NTC-DF provides a function for the direct data export to MS Excel, OpenOffice.org Calc or the file format CSV. To open the corresponding dialog box, click

```
\textbf{File} \rightarrow \textbf{Export Tables}.
```

The following export dialog box appears.

Export table to active workbook Export table to active worksheet Rewrite existing worksheet Selected Tables	Table Parameters	Application
CSV file format Transfer Parameters Export table to active workbook Export table to active worksheet Rewrite existing worksheet Selected Tables Active table All tables Input tables Input tables Input tables	📝 With table header	Microsoft Excel
Transfer Parameters Export table to active workbook Export table to active worksheet Rewrite existing worksheet Selected Tables Active table All tables Input tabl	🔲 Only marked rows	OpenOffice.org Calc
Export table to active worksheet Rewrite existing worksheet Selected Tables Active table All tables Input tables Input tables		CSV file format
Export table to active worksheet Rewrite existing worksheet Selected Tables Active table All tables Input tables Input tables	Transfer Parameters	
Rewrite existing worksheet Selected Tables Active table All tables Input tables	Export table to active workbook	
Rewrite existing worksheet Selected Tables Active table All tables Input tables		
Active table Active tables All tables Input tables	Export table to active worksheet	
Active table Active table Active tables Active tables Input tables		
All tables	Rewrite existing worksheet	
	Rewrite existing worksheet	
	Rewrite existing worksheet Selected Tables Active table	
	Rewrite existing worksheet Selected Tables Active table All tables	
	Rewrite existing worksheet Selected Tables Active table All tables Input tables	
OK Cancel	Rewrite existing worksheet Selected Tables Active table All tables Input tables	

Figure 7.12: Dialog box Export - MS Excel

When you have selected the relevant parameters, you can start the export by clicking [OK]. Excel or OpenOffice will be started automatically, that is, the programs do not have to be opened first.

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1	Section	Member	Location	Load	Design						
2	No.	No.	x [m]	Case	Ratio				D	esign According to Formula	
3	1	IS 450/20	0/10/20/0								
4	Ĩ	8	1,000	LC5	0,00	≤1	100) Negligible inter	nal force	s		
5		5	0,900	LC6	0,00	≤1	101) Cross-section	check - 1	Fension acc. to 3	.1	
6		94	0,000	CO1	0,03	≤1	102) Cross-section	check - (Compression acc	. to 3.2	
7		8	5,700	LC3	0,03	≤1	105) Cross-section	check - I	Bending about y-a	axis acc. to 3.3.2.1	
8		14	3,000	LC4	0,02	≤1	106) Cross-section	check - E	Bending about z-a	axis acc. to 3.3.2.1	
		93	0,750	CO1	0,15	≤1	115) Cross-section	check - S	Shear force in z-a	axis acc. to 3.3.3	
9		5	0,000	LC1	0,00	≤1	126) Cross-section	check - S	Shear buckling ac	cc. to 3.3.3 - Shear force in	z-axis
10		93	3,000	CO5	0,05	≤1	141) Cross-section	check - I	Bending about y-	axis and shear force acc. to	3.3.4
10 11		33									force
10 11 12		93	3,000	CO1	0,56		171) Cross-section				
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Figure 7.13: Result in Excel

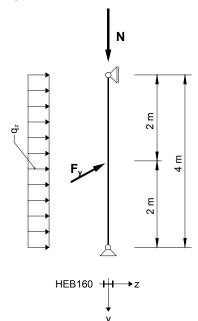


8. Example

In our example, we perform the stability analyses of flexural buckling and lateral-torsional buckling for a column with double-bending, taking into account the interaction conditions.

Design values

System and loads



Design values of the static loads

 $\begin{array}{ll} N_{d} & = 300 \; kN \\ q_{z,d} & = 5.0 \; kN/m \\ F_{y,d} & = 7.5 \; kN \end{array}$

Figure 8.1: System and design loads (γ times)

Internal forces according to linear static analysis

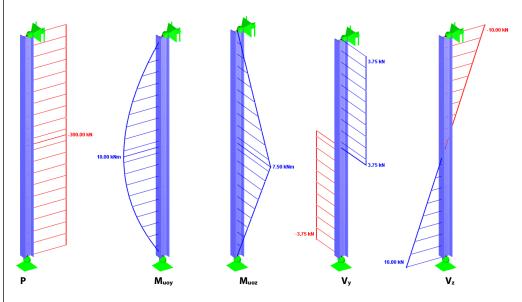


Figure 8.2: Internal forces



Design location (decisive x-location)

The design is performed for all x-locations (see chapter 4.5) of the equivalent member. The decisive location is x = 2.00 m. RSTAB determines the following internal forces:

 $P = -300.00 \ kN \qquad M_{uoy} = 10.00 \ kNm \qquad M_{uoz} = 7.50 \ kNm \qquad V_y = 3.75 \ kN \qquad V_z = 0.00 \ kN$

Cross-Section Properties HE-B 160, Steel B-254 (A36)

Property	Symbol	Value	Unit
Cross-section area	At	5425.00	mm ²
Moment of inertia	l _y	24920000.00	mm⁴
Moment of inertia	lz	8892000.00	mm⁴
Governing radius of gyration	r _y	67.80	mm
Governing radius of gyration	rz	40.50	mm
Polar radius of gyration	r₀	78.97	mm
Polar radius of gyration	r _{o,M}	419.00	mm
Cross-section mass	м	42.63	kg/m
Torsional constant	J	312400.00	mm⁴
Warping constant	Ca	4.794E+10	mm⁵
Elastic section modulus	Sy	311500.00	mm³
Elastic section modulus	Sz	111200.00	mm³
Plastic section modulus	Zy	354000.00	mm³
Plastic section modulus	Zz	169960.00	mm³

Flexural buckling about minor axis (\perp to z-z axis)

Flexural buckling critical stress

2

$$F_{E,z} = \frac{\pi^2 \cdot E}{(K_z \cdot L/r_z)^2} = \frac{\pi^2 \cdot 200000}{(1 \cdot 4000 / 40.50)^2} = 202.358 \text{MPa}$$

Flexural buckling critical load

$$P_{E,z} = A_t \frac{\pi^2 \cdot E}{(K_z \cdot L/r_z)^2} = 5425 \frac{\pi^2 \cdot 200000}{(1 \cdot 4000 / 40.50)^2} = 1097.79 \text{ kN}$$

Cross-section type acc. to [1] Table 2.1

"2 - compact":
$$A_e = A_t$$

Slenderness parameter

$$\lambda_{z} = \frac{K_{z} \cdot L}{r_{z}} \sqrt{\left(\frac{F_{y}}{\pi^{2} \cdot E}\right)} = \frac{1 \cdot 4000}{40.50} \sqrt{\left(\frac{250}{\pi^{2} \cdot 200000}\right)} = 1.112$$

Constant *n* acc. to [1] clause 3.2.2.1(1)

n = 2.00 for hot-rolled I-sections (F_y \leq 414 MPa, t_f \leq 50 mm)

. Dlubal

Design resistance in compression

$$R_{c,z} = \frac{F_y}{\left(1 + \lambda_z^{2n} - 0.15^{2n}\right)^{1/n}} A_t \cdot F_R = \frac{250}{\left(1 + 1.112^4 - 0.15^4\right)^{1/2}} 5425 \cdot 0.9 = 767.71 \text{ kN}$$

Design ratio

Result values from STEEL NTC-DF calculation

Pu	300.00	kN		
Rs	1220.63	kN		3.2
A _e /A _t	1.000			2.1.3
Fy	250.000	MPa		2.1
E	200000	MPa		
At	5425	mm²		
lz	8892000	mm⁴		
rz	40.486	mm		
Lz	4000	mm		
λz	1.112			3.2.2
F _{e,z}	202.213	MPa		Eq. (3.12)
n	2.000			3.2.2
F _{n,z}	157.236	MPa		
F _R	0.900			
R _{c,z}	767.71	kN		Eq. (3.3)
η	0.390		< 1	3.2.2
	R_{s} A_{e}/A_{t} F_{y} E A_{t} I_{z} r_{z} L_{z} λ_{z} $F_{e,z}$ n $F_{n,z}$ F_{R} $R_{c,z}$	Rs 1220.63 Ae/At 1.000 Fy 250.000 E 200000 At 5425 Iz 8892000 rz 40.486 Lz 4000 λz 1.112 Fe,z 202.213 n 2.000 Fn,z 157.236 FR 0.900 Rc,z 767.71	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $

Flexural buckling about major axis (\perp to y-y axis)

Flexural buckling critical stress

$$F_{E,y} = \frac{\pi^2 \cdot E}{\left(K_y \cdot L/r_y\right)^2} = \frac{\pi^2 \cdot 200000}{\left(1 \cdot 4000/67.80\right)^2} = 567.112 \text{MPa}$$

Flexural buckling critical load

$$P_{E,y} = A_t \frac{\pi^2 \cdot E}{(K_y \cdot L/r_y)^2} = 5425 \frac{\pi^2 \cdot 200000}{(1 \cdot 4000/67.80)^2} = 3076.585 \text{ kN}$$

Cross-section type acc. to Table 2.1

"2 - compact": $A_e = A_t$

Slenderness parameter

$$\lambda_{y} = \frac{K_{y} \cdot L}{r_{y}} \sqrt{\left(\frac{F_{y}}{\pi^{2} \cdot E}\right)} = \frac{1 \cdot 4000}{67.80} \sqrt{\left(\frac{250}{\pi^{2} \cdot 200000}\right)} = 0.664$$

Constant *n* acc. to clause 3.2.2.1(1)

n=2.00 for hot-rolled I-section (F_y ≤ 414 MPa, $t_f \leq 50$ mm)

Design resistance in compression

$$R_{c,y} = \frac{F_y}{\left(1 + \lambda_y^{2n} - 0.15^{2n}\right)^{1/n}} A_t \cdot F_R = \frac{250}{\left(1 + 0.664^4 - 0.15^4\right)^{1/2}} 5425 \cdot 0.9 = 1117.02 \text{ kN}$$

Design ratio

$$\frac{P}{R_{c,y}} = \frac{300}{1117.02} = \underbrace{0.27 \le 1}_{m_{c,y}}$$

Result values from STEEL NTC-DF calculation

Compression Axial Force	P_{u}	300.00	kN		
Section Resistance	Rs	1220.63	kN		3.2
Form Factor	A_e/A_t	1.000			2.1.3
Yield Strength	Fy	250.000	MPa		2.1
Modulus of Elasticity	E	200000	MPa		
Gross Area	At	5425.000	mm²		
Second Moment of Area	ly	24920000	mm⁴		
Radius of Gyration	Ry	67.776	mm		
Effective Length	Ly	4000.000	mm		
Slenderness	λ _y	0.664			3.2.2
Elastic Flexural Buckling Stress	$F_{e,y}$	566.706	MPa		Eq. (3.12)
Factor	n	2.000			3.2.2
Nominal Critical Stress	F _{n,y}	228.781	MPa		
Resistance Factor	F _R	0.900			
Member Resistance	R _{c,y}	1117.02	kN		Eq. (3.3)
Design Ratio	η	0.27		< 1	3.2.2



Lateral-torsional buckling

Nominal and design buckling moment resistance according to [1] clause 3.3.2.2

The **nominal buckling moment resistance** for lateral torsional buckling will be determined for this example according to Eq. (3.24), taking into account pinned supports free to warp.

$$M_{u} = \frac{\pi}{CL} \sqrt{E \cdot I_{z} \cdot G \cdot J + \left(\frac{\pi \cdot E}{L}\right)^{2} \cdot I_{z} \cdot C_{a}}$$

$$M_{u} = \frac{\pi}{4000} \sqrt{2.0e5 \cdot 8.892e6 \cdot 77200 \cdot 312400 + \left(\frac{\pi \cdot 2.0e5}{4000}\right)^{2} \cdot 8.892e6 \cdot 4.794e10} = 181.507 \text{ kNm}$$

Limits of unsupported length

$$X_{u} = 4.293C \frac{Z_{y}F_{y}}{GJ} \sqrt{\frac{C_{a}}{I_{z}}} = 4.293 \cdot 1 \frac{354000 \cdot 250}{77200 \cdot 312400} \sqrt{\frac{4.794e10}{8.892e6}} = 1.157$$

$$X_{r} = \frac{4}{3}C \frac{Z_{y}F_{y}}{GJ} \sqrt{\frac{C_{a}}{I_{z}}} = \frac{4}{3}1 \frac{354000 \cdot 250}{77200 \cdot 312400} \sqrt{\frac{4.794e10}{8.892e6}} = 0.359$$

$$L_{u} = \frac{\sqrt{2}\pi}{X_{u}} \sqrt{\frac{EC_{a}}{GJ}} \sqrt{1 + \sqrt{1 + X_{u}^{2}}} = \frac{\sqrt{2}\pi}{1.157} \sqrt{\frac{2.e5 \cdot 4.794e10}{77200 \cdot 312400}} \sqrt{1 + \sqrt{1 + 1.157^{2}}} = 3851 \text{ mm}$$

$$L_{r} = \frac{\sqrt{2}\pi}{X_{r}} \sqrt{\frac{EC_{a}}{GJ}} \sqrt{1 + \sqrt{1 + X_{r}^{2}}} = \frac{\sqrt{2}\pi}{0.359} \sqrt{\frac{2.e5 \cdot 4.794e10}{77200 \cdot 312400}} \sqrt{1 + \sqrt{1 + 0.359^{2}}} = 11198 \text{ mm}$$

The **nominal member moment plastic resistance** is determined according to clause 3.3.2.1. HEB-160: The cross-section type acc. to Table 2.1 is "2 - compact".

 $M_{p,y} = Z_y \cdot F_y = 354000 \cdot 250 = 88.50 \text{kNm}$

 $M_{p,z} = Z_z \cdot F_y = 170000 \cdot 250 = 42.50 \text{kNm}$

Design resistance acc. to 3.3.2.2(a) (L > L_u)

lf

$$M_{u} > \frac{2}{3}M_{py} \qquad \qquad M_{Ry} = 1.15 F_{R}M_{py} \left(1 - \frac{0.28M_{py}}{M_{u}}\right) \le F_{R}M_{py}$$

$$181.507 > \frac{2}{3} \cdot 88.5 = 59 \qquad \qquad M_{Ry} = \min\left\{1.15 \cdot 0.9 \cdot 88.50 \left(1 - \frac{0.2888.50}{181.507}\right), 0.9 \cdot 88.50\right\}$$

 $M_{Ry} = 79.092 \text{ kNm}$



Interaction of biaxial bending and compression

The design ratio is determined according to [1] clause 3.4.3.2(a). To calculate the final design ratio resistance acc. to Eq. (3.56), we need to determinate the value of M_m . This value can be calculated according to clause 3.3.2 or approximately according to Eq. (3.57) for I-sections. We use Eq. (3.57) in this example.

$$M_{m} = \min\left(F_{R}\left(1.07 - \frac{(L/r_{z})\sqrt{F_{y}/E}}{18.55}\right)M_{py};F_{R} \cdot M_{py}\right)$$
$$M_{m} = \min\left(0.9\left(1.07 - \frac{(4000/40.50)\sqrt{250/200000}}{18.55}\right)88.50;0.9 \cdot 88.50\right) = 70.232 \text{ kNm}$$

Interaction design ratio acc. to 3.4.3.2(a), Eq. (3.56)

The value of R_c is the minimum design resistance in compression.

$$\frac{P_{u}}{R_{c}} \! + \! \frac{M_{uoy}^{*}}{M_{m}} \! + \! \frac{M_{uoz}^{*}}{F_{R}M_{pz}} \! \leq \! 1$$

Result values from STEEL NTC-DF calculation

Yield Strength	Fy	250	MPa		1.3.1
Compression Axial Force	Pu	300.00	kN		
Section Resistance	Rs	1220.63	kN		3.2
Elastic Buckling Stress	F _e	202.213	MPa		
Nominal Critical Stress	Fn	157.236	MPa		
Member Resistance	R _c	767.71	kN		Eq. (3.3)
Design Component for N	η _N	0.39		< 1	3.4.3.2(a)
Bending Moment	M _{uoy}	3.60	kNm		
Maximum Bending Moment	M* _{uoy,segm}	10.00	kNm		
Nominal Section Resistance	M _{py}	88.50	kNm		
Design Bending Resistance	M _{Ry}	79.65	kNm		
Modulus of Elasticity	E	200000.000	MPa		
Shear Modulus	G	77200.000	MPa		
Second Moment of Area	lz	8892000.000	mm⁴		
Torsional Constant	J	312400.000	mm⁴		
Warping Constant	Ca	4.79400E+10	mm⁵		
Effective Length	L _w	4000	mm		3.3.2
Auxiliary Factor	X _r	0.359			Eq. (3.28)
Auxiliary Factor	Xu	1.157			Eq. (3.27)
Limit Unsupported Length	Lr	11198.700	mm		Eq. (3.26)
Limit Unsupported Length	Lu	3851.390	mm		Eq. (3.25)



				1	
Modification Factor	C _b	1.000			
Equivalent Moment Factor	С	1.000			3.3.2.2
Elastic Critical Moment	Mu	181.51	kNm		3.3.2.2
Design Bending Resistance	M _{my}	70.23	kNm		Eq. (3.57)
Design Component for My	η_{My}	0.142		< 1	3.4.3.2(a)
Bending Moment	M _{uoz}	1.50	kNm		
Maximum Bending Moment	M* _{uoz,segm}	7.50	kNm		
Nominal Section Resistance	M _{pz}	42.50	kNm		
Design Bending Resistance	M _{Rz}	37.53	kNm		
Design Component for Mz	η _{Mz}	0.196		< 1	3.4.3.2(a)
Resistance Factor	F _R	0.900			
Design Ratio	η	0.73		< 1	3.4.3.2(a)

A Literature

- [1] Normas Técnicas Complementarias para Diseño y Construcción de Estructuras Metálicas, Gaceta Oficial del Distrito Federal, Gobierno del Distrito Federal, México, La Ciudad de la Esperanza, 2004
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