Version December 2013

Add-on Module



Ultimate Limit State and Serviceability Limit State Design According to SP 16.13330.2011 – Updated Edition of SNiP II-23-81*

Program **Description**

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Contents

	Contents	Page		Contents	Page
					5
1.	Introduction	4	4.6	Governing Internal Forces by Member	33
1.1	Additional Module STEEL SP	4	4.7	Governing Internal Forces by Set of	24
1.2	STEEL SP Team	5	1 9	Member Slandernesses	25
1.3	Using the Manual	5	4.0	Parts List by Member	36
1.4	Starting STEEL SP	6	4.9	Parts List by Set of Members	20
2.	Input Data	8	4.10 E		37
2.1	General Data	8	5.	Results Evaluation	38
211	Ultimate Limit State	9	5.1	Results in the RSTAB Model	39
2.1.1	Sonvicessbility Limit State	11	5.2	Result Diagrams	41
2.1.2		10	5.3	Filter for Results	42
2.2	Materials	12	6.	Printout	44
2.3	Cross-Sections	14	6.1	Printout Report	44
2.4	Intermediate Lateral Restraints	18	62	STEEL SP Graphic Printout	44
2.5	Effective Lengths - Members	19	7	Concerting	
2.6	Effective Lengths - Sets of Members	22	7.	General Functions	40
2.7	Serviceability Data	23	7.1	Design Cases	46
2.8	Parameters - Members	24	7.2	Cross-Section Optimization	48
3.	Calculation	25	7.3	Units and Decimal Places	50
3.1	Details	25	7.4	Data Transfer	51
3.2	Start Calculation	27	7.4.1	Export Material to RSTAB	51
Л	Posults	79	7.4.2	Export Effective Lengths to RSTAB	51
		20	7.4.3	Export Results	51
4.1	Design by Load Case	29	8.	Example	53
4.2	Design by Cross-Section	30	Δ.	Litoratura	EO
4.3	Design by Set of Members	31	A		20
4.4	Design by Member	32	В	Index	59
4.5	Design by x-Location	32			



I. Introduction

1.1 Additional Module STEEL SP

The Russian Standard *SP 16.13330.2011* determines rules for the design, analysis and construction of steel buildings in the Russian Federation. With the add-on module STEEL SP from the DLUBAL SOFTWARE GMBH company all users obtain a highly efficient and universal tool to design steel structures according to this standard.

All typical designs of load capacity, stability and deformation are carried out in the module STEEL SP. Different actions are taken into account during the load capacity design. STEEL SP automatically calculates the limiting width-to-thickness ratios of compressed parts and carries out the slenderness check of cross-section automatically.

The sectional coordinate system in STEEL SP is different from the indices used in the Russian code. It corresponds to the one used in RSTAB: The indices "y" and "z" refer to the axes in the cross-section plane as seen in the image to the left.

For the stability design, you can determine for every single member or set of members whether buckling is possible in the direction of y-axis and/or z-axis. Lateral supports can be added for a realistic representation of the structural model. The specific ratios of slendernesses and critical stresses are automatically determined by STEEL SP on the basis of the boundary conditions. The location where the loads are applied, which influences the lateral torsional design, can be defined in the detailed settings.

The serviceability limit state has become important for the static calculation of modern civil engineering as more and more slender cross-sections are being used. In STEEL SP, load cases, load combinations and result combinations can be arranged individually to cover the various design situations.

If required, you can use the add-on module to optimize cross-sections and export the modified cross-sections to RSTAB. Using the design cases, you can design separate structural components in complex structures or analyze variants.

STEEL SP 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 determination of internal forces to design.

We hope you will enjoy working with STEEL SP.

Your DLUBAL Team



Axis system



1.2 STEEL SP Team

The following people participated in the development of the STEEL SP module:

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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 SP.

The descriptions in this manual follow the sequence and structure of the module's input and results windows. The text of the manual shows the described **buttons** 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 don't find what you are looking for, please check our website **www.dlubal.com** where you can go through our comprehensive *FAQ* pages by selecting particular criteria.





1.4 Starting STEEL SP

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

Menu

To start the program in the RSTAB menu bar, click

```
\textbf{Add-on Modules} \rightarrow \textbf{Design} \textbf{-} \textbf{Steel} \rightarrow \textbf{STEEL SP}.
```

Add-on Modules Window	<u>H</u> elp		
Current Module	2	××× 🐼 🔛 🛤	a : 🞬 🗱 🤹 🛊 🥵 📇 😕 🔌 🍌 🗙 🚱 🧐
Design - Steel	1	STEEL	General stress analysis of steel members
Design - Concrete	1	STEEL EC3	Design of steel members according to Eurocode 3
Design - Timber	Aise	STEEL AISC	Design of steel members according to AISC (LRFD or ASD)
Design - Aluminium	Is	STEEL IS	Design of steel members according to IS
Connections	SIA	STEEL SIA	Design of steel members according to SIA
Eoundations	18S	STEEL BS	Design of steel members according to BS
Stability	168	STEEL GB	Design of steel members according to GB
Toward	Is	STEEL CS	Design of steel members according to CS
Others	IAS	STEEL AS	Design of steel members according to AS
Otners	NIC	STEEL NTC-DF	Design of steel members according to NTC-DF
Stand-Alone Programs	Þ 🎵	STEEL SP	Design of steel members according to SP

Figure 1.1: Main Menu: Additional Modules \rightarrow Design - Steel \rightarrow STEEL SP

Navigator

You can also start the add-on module in the Data navigator by clicking

Add-on Modules \rightarrow STEEL SP.

Project Navigator - Data	×
🛅 Results	*
Printout Reports	
🗊 💼 Guide Objects	
🖨 📹 Add-on Modules	
🔝 STEEL EC3 - Design of steel members according to Eurocode 3	
- 🐷 STEEL AISC - Design of steel members according to AISC (LRFD or ASD)	-
Image: STEEL IS - Design of steel members according to IS	-
	_
- 😹 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	
STEEL SP - Design of steel members according to SP	
STEEL Plastic Members - Design of steel members according to Partial In	
Image: STEEL NBR - Design of steel members according to NBR	
	Ŧ
🛱 Data 📓 Display 🔏 Views	

Figure 1.2: Data Navigator: Add-on Modules \rightarrow STEEL SP

1 Introduction



Panel





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

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

When the results display is activated, the panel is available, too. Now you can click the button [STEEL SP] in the panel to open the module.



STEEL SP

Figure 1.3: Panel button [STEEL SP]



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 46).

The design relevant data is defined in several input windows. When you open STEEL SP 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 SP and return to the main program. If you click [Cancel], you exit the module but without saving the data.

2.1 General Data

In window 1.1 *General Data*, 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.

- Design of steel members a 💌	1.1 General Data							
ut Data	Design of							
General Data	Members: 1-9	11-18 21-28 31-46 51-64 66-69 71-74	R1-83 91				1 K	
Materials Creas Sections	Monbola.	,	01.00,01				19	
Intermediate Lateral Restraints	Sets: 2			B X	AI 🛛			
Effective Lengths - Members								
Effective Lengths - Sets of Merr	Ultimate Limit St	ate Serviceability Limit State						
Serviceability Data	Existing Load Ca	ases and Combinations		Selected for I	Design			
Parameters - Members	Imp IC8	Imperfections v +X		G IC1	Dead Load			
	Imp LC9	Imperfections v -Y		Qs LC2	Snow Load			
	Imp LC10	Imperfections v +Y		Qw LC3	Wind v +X		AR C	0
	CO1	1.35*LC1 + 1.35*LC2 + 1.35*LC3 + 1.		Qw LC4	Wind at peak v +Y		1	
	CO2	1.35*LC1 + 1.5*LC2 + LC8		Qw LC5	Wind at peak v -Y		17	S o
	CO3	1.35*LC1 + 1.5*LC3 + LC8		Qw LC6	Wind positive		1	
	CO4	1.35*LC1 + 1.5*LC7 + LC8		Qi LC7	Live Load		N	-
	CO5	LC1 + 1.5*LC6 + LC8					11	
	CO6	1.35*LC1 + 1.5*LC4 + LC10						
	C07	1.35*LC1 + 1.5*LC5 + LC9	>>					
	C08	1.35*LC1 + 1.35*LC2 + 1.35*LC4 + 1.						
	CO9	1.35°LC1 + 1.35°LC2 + 1.35°LC5 + 1.						./
	C011	LC1 + LC2 + LC3 + LC7 + LC8	4					
	C012	LC1 + LC2 + LC8	44					
	013	LC1 + LC3 + LC8						
	C014							
	015							Sector Sector 1
	017						Des	sign of steel members
	CO18	101+102+104+107+1010					acc	. 10
	CO19	101+102+105+107+109					Re	vised version of SNIP II.
	BC1	Ext 1						
	RC2	Extrémní charakteristické hodnotv					1/	
							1	
	AL (22)	- 0.1 05				8_ (85		
	/w (23)						11	Translation in the later
	Comment							
					*		7	
					-		1788	
4 111							1711	

Figure 2.1: Window 1.1 General Data

Cancel

OK



Design of

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

Figure 2.2: Design of members and sets of members



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 designs 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 result 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, Ultimate Limit State tab

Existing Load Cases and Combinations

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



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 at once, select them while pressing the [Ctrl] key, as common for Windows applications.

Load cases marked by an asterisk (*), like load cases 8 to 10 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:

Select all cases in the list.
Invert selection of load cases.

Table 2.1: Buttons in tab Ultimate Limit State

Selected for Design

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

The design of an enveloping max/min result combination is performed faster than the design of all contained load cases and load combinations. However, the analysis of a result combination has also disadvantages: First, the influence of the contained loads is difficult to discern.

Second, for the determination of the elastic critical moment for lateral-torsional buckling, the envelope of the moment distributions is analyzed, from which the most unfavorable distribution (max or min) is taken. However, this distribution only rarely reflects the moment distribution in the individual load combinations. Thus, in the case of a RC design, more unfavorable values for the elastic critical moment are to be expected, leading to higher ratios.

Result combinations should be selected for design only for dynamic combinations. For "usual" combinations, load combinations are recommended.



combination



2.1.2 Serviceability Limit State



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

Existing Load Cases and Combinations

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

Selected for Design

Load cases, load combinations, and result combinations can be added or removed, as described in chapter 2.1.1.

The limit values of the deformations are controlled by the settings in the *Details* dialog box (see Figure 3.1, page 25) which you can call up by clicking the [Details] button.

In the window 1.7 *Serviceability Data*, the reference lengths decisive for the deformation check are managed (see chapter 2.7, page 23).





2.2 Materials

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

L2 Materi	als				
	A		В		
Material	Material				
No.	Description		Comn	nent	
1	Steel C 255 (Profiles) GOST 27772-88:1989-0 -				
2	Steel C 345 K (Profiles) GOST 27772-88:1989-				
				a a	
Material P	roperties				
E Main F	meties				
Mod	lulus of Elasticity	E	210000.000	MPa	
She	ar Modulus	G	80769.200	MPa	
Pois	son's Ratio	v	0.300		
Spe	cific Weight	Y	78.50	kN/m ³	
Coe	fficient of Thermal Expansion	α	1.2000E-05	1/K	
Part	ial Safety Factor	ΥM	1.10		
🖃 Additio	nal Properties				Material No. 1 used in
🗆 Thio	kness Range t ≤ 1.00 cm				Cross-sections No.:
- Y	ield Strength	fy	25.50	kN/cm ²	1-3.6.7.9.10.12.13.15.16
- U	ltimate Strength	fu	38.00	kN/cm ²	10,0,7,0,10,12,10,10,10
🗆 Thio	kness Range t > 1.00 cm and t ≤ 2.00 cm				
— Y	ield Strength	fy	24.50	kN/cm ²	Members No.:
- U	ltimate Strength	fu	37.00	kN/cm ²	1-8,11-18,21-28,31-46,51-64,66-69,71-74,
🗆 Thio	kness Range t > 2.00 cm and t ≤ 4.00 cm				
— Y	ield Strength	fy	23.50	kN/cm ²	Sets of members No.:
- U	Itimate Strength	fu	37.00	kN/cm ²	2
					Σ Lengths: Σ Masses: 516.46 [m] 18.940 [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 in the module's menu **Settings** → **Units and Decimal Places** (see chapter 7.3, page 50).

Material Description

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

Material		
Description		
Steel C 255 (Profiles) GOST 27	7772-88:1989-0	
Steel C 235 (Profiles)	GOST 27772-88:1989-01	
Steel C 245 (Profiles)	GOST 27772-88:1989-01	
Steel C 255 (Profiles)	GOST 27772-88:1989-01	-
Steel C 275 (Profiles)	GOST 27772-88:1989-01	=
Steel C 285 (Profiles)	GOST 27772-88:1989-01	
Steel C 345 (Profiles)	GOST 27772-88:1989-01	
Steel C 345 K (Profiles)	GOST 27772-88:1989-01	
Steel C 375 (Profiles)	GOST 27772-88:1989-01	
Steel C 235 (Sheets, Bands)	GOST 27772-88:1989-01	
Steel C 245 (Sheets, Bands)	GOST 27772-88:1989-01	Ŧ

Figure 2.6: List of materials



According to the design concept of SP 16.13330.2011 [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 SP will import the material properties, too.

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

Material Library

1

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 category group:	material to obloct			
Metal	Material Description	Standard		
- Motor	 Steel C 235 (Profiles) 	GOST	27772-88:1989-01	
	Steel C 245 (Profiles)	GOST	27772-88:1989-01	
Material category:	Steel C 255 (Profiles)	GOST	27772-88:1989-01	
Steel	 Steel C 275 (Profiles) 	GOST	27772-88-1989-01	
	Steel C 285 (Profiles)		27772-88-1989-01	
Standard group:	Steel C 245 (Profiles)		27772.00.1000.01	
GOST	Steel C 345 (Fromes)		27772-00.1000.01	
	Steel C 345 K (Profiles)	GUST	27772-88:1989-01	
Standard:	Steel C 3/5 (Profiles)	GOST	2///2-88:1989-01	
GOST 27772-88:1989-01	 Steel C 235 (Sheets, Bands) 	GOST	2///2-88:1989-01	
	Steel C 245 (Sheets, Bands)	GOST	27772-88:1989-01	
	Steel C 255 (Sheets, Bands)	🚾 GOST	27772-88:1989-01	
	Steel C 275 (Sheets, Bands)	🧰 GOST	27772-88:1989-01	
	Steel C 285 (Sheets, Bands)	🚾 GOST	27772-88:1989-01	
🗌 Include invalid	Steel C 345 (Sheets, Bands)	🚃 GOST	27772-88:1989-01	
Favorites only				7
laterial Properties		Steel C 235 (Profi	es) GOST 27772	-88:1989-
Main Properties				
Modulus of Elasticity		E	210000.000	MPa
- Shear Modulus		G	80769.200	MPa
Poisson's Ratio		v	0.300	1 11 / 2
Specific Weight Coefficient of Thermal Evenes	aian	γ	/8.50	KN/m ³
Partial Safety Factor	SIGH	24	1.2000E-05	17 K
- Additional Properties		TM	1.10	
☐ Thickness Range t ≤ 2.00 cm	n			
 Yield Strength 		fy	235.000	MPa
		fu	360.000	MPa
 Ultimate Strength 	n and t ≤ 4.00 cm			
Ultimate Strength			005 000	MD-
Ultimate Strength Thickness Range t > 2.00 cm Yield Strength		ty	225.000	мга

In the *Filter* section, *Steel* is preset as material category. Select the steel grade that you want to use for the design in the list *Material to Select*. 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 SP.

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 covered by the design concept of the Code [1].

OK

Figure 2.7: Dialog box *Material Library*



2.3 Cross-Sections

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

Coordinate System

The sectional coordinate system in STEEL SP is different from the indices used in the Russian standard. It corresponds to the one used in RSTAB (see image in Figure 2.8): The **y**-axis is the <u>major</u> principal axis of the cross-section, the **z**-axis the <u>minor</u> axis. This coordinate system is used for both the input data and the results.

	A	B	C	D		E	F	G		1 - IP-B 55 B1 GO	ST, 1994
ection	Material	Cross-Section	Cross-Section Type	Max. De	esign	Opti-					
INO.	No.	Description	for Classification	Rati	io	mize	Remark	c Comme	nt	220	0.0
1	1	I IP-B 55 B1 GOST, 1994	I-section rolled		0.64	No <u>*</u>					
2	1	T IP-B 40 B1 GOST, 1994	I-section rolled		1.11 No					+	
3	1	I IP 40 B1 GOST 26020-83	I-section rolled		1.11 From	current row				13.5	24.0
6	1	T IP-K 20 K2 GOST, 1994	I-section rolled		0.15	No				· · ·	
7	1	T IP-K 20 K2 GOST, 1994	I-section rolled		0.09	No					
9	1	T IP-B 35 B2 GOST, 1994	I-section rolled		0.70	No				43.	
10	1	HP 200x54 CAN/CSA-S1	I-section rolled		0.06	No				-un	
12	1	QRO 70x5 GOST 30245-	Box rolled		0.08	No					9.5
13	1	Circle 24	General		0.04	No					
15	1	T IP-K 25 K2 GOST, 1994	I-section rolled		0.05	No					
16	1	I IP-B 25 B1 GOST, 1994	I-section rolled		0.71	No					
17	1	L 160x100x12 GOST 851	Angle			No	5)				z
18	1	TU 250/50/100/10/6/0	General			No	5)				
oss-Si	ection Valu	les - IP-B 55 B1 GOST, 1994			I continue as	11- J			-	Cross-section No. 1	used in
Cross	Section Ty	pe			I-section ro	lled			-	Members No .:	
Sectio	n Height		ł	1	543.	0 mm			-11	1 2 11 12 21 22 31	32 39 40
Sectio	n Width		E)	220.	0 mm			-11	1,2,11,12,21,22,01,	52,55,45
Web	hickness		t	w	9.	5 mm			-11	0. () N	
Hange	hicknes	s	1	f	13.	5 mm			-111	Sets of members ivo	
HOOT	Kadius		r		24.	U mm			-111	2	
Area o	r Cross-Se	ction	/	۹ ^	11336.	0 mm -		0.4.1.1	E		
Shear	Area			۹vy	5940.	0 mm²		8.4.1.1	-11	Σ Lengths:	Σ Masses:
Shear	Area		/	₹w,z	5158.	5 mm -		(54)	-111	48.00 [m]	4 271
Mome	nt of Inertia	3		У	0.56820E+	u mm *			-	40.00 [m]	7.2/1
Tome	nt or inertia	3		z	24045000.	0 mm *			-	Material	
I OISIO	nai Consta	nt	1	t	508324.	u mm "			-	Matenal:	
Radiu	s of Gyratic	201	r	У	221.	1 mm				1 - Steel C 235 (Pro	files)
Radiu	s of Gyratic	NTI Anado do un	r	Z .	46.	1 mm 0 mm 3			-		
Clastic	Section N	loculus Andulus	\	V yn,mîn	2000900.	u inm s D mm 3			-		
clastic	Section N	noulus Andria	1	v zn,min	218600.	u inm			-		
- 1 A ST 10	- Jection IV	ICCULIUS		- mu					1.1		

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.



5



$\begin{array}{c c} \text{Cross-Section Type} & \text{Par} \\ \hline I & I & I & T \\ \hline I & I & T & T \\ \hline & & I & I \\ \hline & & I & I \\ \hline & & I & T & T \\ \hline & & & I \\ \hline & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline & & & &$	arameters 360.0 *** [mm] 170.0 *** [mm] 8.0 *** [mm] 14.0 ** [mm] 0.0 *** [mm]	t t	
- 1 1 J I 2 I		*	
	<u>à</u> ()	IS 360/170/8/14/0	

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 SP imports these cross-section parameters, too.

A modified cross-section will be highlighted in blue.

If cross-sections set in STEEL SP are different from the ones used in RSTAB, both cross-sections are displayed in the graphic in the right part of the window. The designs will be performed with the internal forces from RSTAB for the cross-section selected in STEEL SP.

Cross-Section Type for Classification

The cross-section type used for the classification is displayed, e.g. I-shape rolled, welded, box, round bar, etc. Cross-sections that are not covered by the standard 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 in the same table that comes as close as possible to a userdefined maximum ratio. The maximum ratio can be defined in the *Details* dialog box (see Figure 3.1, page 25).

If you want 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 48.





Remark

0

0

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 registered 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 after 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 rows, in accordance with the definition in RSTAB.

STEEL SP 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 start and the end cross-section of a tapered member have not the same number of stress points, the intermediate values cannot be interpolated. The calculation is possible neither in RSTAB nor in STEEL SP.

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.

Info About Cross-Section IP-B 55 B1	GOST, 1994	4				x
Cross-Section Property	Symbol	Value	Unit	•	IP-B 55 B1 GOST, 1994	_
Depth	d	543.0	mm			
Width	b	220.0	mm			
Web thickness	tw	9.5	mm			
Flange thickness	tf	13.5	mm		220.0	
Root fillet radius	r	24.0	mm		+ +	
Cross-sectional area	Α	11336.0	mm 2			
Shear area	Ay	4958.4	mm 2	E	- 24.0	
Shear area	Az	4891.3	mm 2			
Shear area according to EC 3	A _{v,y}	6258.3	mm 2			
Shear area according to EC 3	A _{v,z}	6172.3	mm 2			
Plastic shear area	A _{pl,y}	5940.0	mm 2		43.0	
Plastic shear area	A _{pl,z}	5030.3	mm 2		w A	
Moment of inertia	ly	5.568E+08	mm 4			
Moment of inertia	l _z	2.405E+07	mm 4		9.5	
Governing radius of gyration	г _у	221.6	mm			
Governing radius of gyration	٢z	46.1	mm			
Polar radius of gyration	ro	226.3	mm			
Radius of gyration of flange plus 1/5 of wel	rzg	53.5	mm		t i i i i i i i i i i i i i i i i i i i	
Volume	V	1.134E+07	mm³/m		Z	
Weight	wt	89.0	kg/m			
Surface	A _{surf}	1.906	m²/m			
Section factor	A _m /V	168.119	1/m		land the second s	
Torsional constant	J	508324.0	mm 4			щ
Warping constant	Cw	1.679E+12	mm 6		T III Stress points	K
Elastic section modulus	Sy	2050900.0	mm 3		C/t-Parts	2
T I	le	210000.0	9	*		_
					Close	

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 have the following functions:

Button

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iu iu	
	Dlubal
Function	
Displays or hides the stress points	
Displays or hides the c/t-parts	

∕ | ∕∽

	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)
X	Displays or hides the dimensions of the cross-section
	Displays or hides the principal axes of the cross-section
N	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	C	D	E	F	G	IP-B 55 B1	
tressP	Coordir	nates	Statical Mom	ents of Area	Thickness Warping				
No.	y [mm]	z [mm]	Q _y [mm ³]	Q _z [mm ³]	t [mm]	W _{no} [mm ²]	Sw [mm 4]		
1	-110.0	-271.5	0.0	0.0	13.5	29122.5	0.0		
2	-28.8	-271.5	-290180.0	-76080.0	13.5	7611.6	-20146300.0		
3	0.0	-271.5	-403184.0	-82400.5	13.5	0.0	-21623500.0		
4	28.8	-271.5	-290180.0	76080.0	13.5	-7611.6	20146300.0		1 2 34 5
5	110.0	-271.5	0.0	0.0	13.5	-29122.5	0.0		the state of the s
6	-110.0	271.5	0.0	0.0	13.5	-29122.5	0.0		
7	-28.8	271.5	-290398.0	76095.7	13.5	-7611.6	-20146300.0		
8	0.0	271.5	-403184.0	82400.5	13.5	0.0	-21623500.0		
9	28.8	271.5	-290398.0	-76095.7	13.5	7611.6	20146300.0		13 v
10	110.0	271.5	0.0	0.0	13.5	29122.5	0.0		
11	0.0	-234.0	-901745.0	0.0	9.5	0.0	0.0		
12	0.0	234.0	-903270.0	0.0	9.5	0.0	0.0		
13	0.0	0.0	-1.16E+06	0.0	9.5	0.0	0.0		6 7 89 10
									z
									ă (*)

Figure 2.11: Dialog box Stress Points of IP-B 55 B1

Q



2.4 Intermediate Lateral Restraints

In window 1.4, you can define intermediate lateral restraints for members. STEEL SP always assumes this kind of support to be perpendicular to the cross-section's minor axis z (see Figure 2.8). Thus, it is possible to influence the members' effective lengths which are important for the design of column buckling and lateral torsional buckling.



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

A B C D E F G H I J K L Intermediate Lateral Restraints Number x1 x2 x3 x4 x5 x6 x7 x8 x9 1 Q 6.000 1 0.500 x4 x5 x6 x7 x8 x9 2 0 6.000 1 0.500 x4 x5 x6 x7 x8 x9 3 Q 3.011 2 0.333 0.667 x8 x8 x7 x8 x9 4 Q 3.262 x8	4 Interm	ediate Latera	I Restraints										
Internet berger Lateral Lateral Lateral Restricts 1 Intermediate Lateral Restricts 1 No. Restrict L(m) Number x1 x2 x3 x4 x5 x6 x7 x8 x9 1 Q 6.000 1 0.500 -	[A	В	С	D	E	F	G	Н		J	K	L
No. Restraint L [m] Number x1 x2 x3 x4 x5 x6 x7 x8 x9 1 0 6.000 1 0.000 -	Member	Lateral	Length					ntermediate Late	eral Restrain	ts[-]			
1 0 6.000 1 0.500 -	No.	Restraint	L [m]	Number	X1	X2	X3	X4	×5	×e	×7	X8	X9
2 0 0.00 0	1		6.000	1	0.500								
3 Ø 3.011 2 0.333 0.667 Image: Control of C	2		6.000										
4 3.262 0 0 0.600 0.800 0	3		3.011	2	0.333	0.667							
5 Ø 6.274 4 0.200 0.400 0.600 0.300 6 0 6.274 0	4		3.262										
6 0 6.274 0 <td>5</td> <td>✓</td> <td>6.274</td> <td>4</td> <td>0.200</td> <td>0.400</td> <td>0.600</td> <td>0.800</td> <td></td> <td></td> <td></td> <td></td> <td></td>	5	✓	6.274	4	0.200	0.400	0.600	0.800					
1 3.262	6		6.274										
0 3.011 0 <td>/</td> <td><u> </u></td> <td>3.262</td> <td></td>	/	<u> </u>	3.262										
11 0 0.000 12 6.000 Image: Contract of the second se	11	<u> </u>	3.011										
Relatively (0 1) Cross-Section Lateral Restraints Member Length L Coston of Lateral Restraints Location of Lateral Restraint No. 1 Location of Lateral Restraint No. 1 Location of Lateral Restraint No. 3 Location of Lateral Restraint No. 4 Location of Lateral Restraint No. 3 Kall Set input for members No.:	12		6.000										
Image: New Yey (V 1) The darvey (V 1) Cross-Section 2 - IP-B 40 B1 I GOST, 1994 Lateral Restraints Member Length L 6.274 m Number of Intermediate Lateral Restraints n 4 Location of Lateral Restraint No. 1 x1 0.200 Location of Lateral Restraint No. 3 x3 0.600 Location of Lateral Restraint No. 3 x3 0.600 Location of Lateral Restraint No. 4 4 0 0 Location of Lateral Restraint No. 3 x3 0.600 0 Location of Lateral Restraint No. 4 4 0 0 Location of Lateral Restraint No. 4 4 0 0 Location of Lateral Restraint No. 4 4 0 0 Location of Lateral Restraint No. 4 4 0 0 0 Set input for members No:: XI XI 0 0 0	12		0.000		7 Deletively (0	1)							
stings - Member No. 5 Cross-Section 2 - IP-8 40 B1 IGOST, 1994 Lateral Restraints 0 Member Length L 6.274 m Number of Intermediate Lateral Restraints n 4 Location of Lateral Restraint No. 1 x1 0.200 Location of Lateral Restraint No. 2 x2 0.400 Location of Lateral Restraint No. 3 x3 0.600 Location of Lateral Restraint No. 4 x4 0.800 Set input for members No.: Image: All Set input for members No.: Image: All Set input for members No.:				2	Relatively (U	1)							V
Cross-Section 2 - IP-B 40 B11 GOST, 1994 Lateral Restraints Image: Cost of Cost o	ettings -	Member No.	5										
Lateral Restraints O O Member Length L 6.274 m m Number of Intermediate Lateral Restraint No. 1 x1 0.200 Intermediate Lateral Restraint No. 2 x2 0.400 Intermediate Lateral Restraint No. 2 x3 0.600 Intermediate Lateral Restraint No. 3 x3 0.600 Intermediate Lateral Restraint No. 4 x4 0.800 Intermediate Lateral Restraint No. 4	Cross-S	Section				2 - IP	-B 40 B1 GO	ST, 1994					
Member Length L 6.274 m Number of Internal Restraints n 4 Location of Lateral Restraint No. 1 x1 0.200 Location of Lateral Restraint No. 2 x2 0.400 Location of Lateral Restraint No. 3 x3 0.600 Location of Lateral Restraint No. 4 x4 0.800 Location of Lateral Restraint No. 4 x4 0.800 <	Lateral	Restraints									_		
Number of Intermediate Lateral Restraints n 4 Location of Lateral Restraint No. 1 x1 0.200 Location of Lateral Restraint No. 2 x2 0.400 Location of Lateral Restraint No. 3 x3 0.600 Location of Lateral Restraint No. 4 x4 0.800 Location of Lateral Restraint No. 4 X	Membe	er Length			L		6.274 m				_		
Location of Lateral Restraint No. 1 K1 0.200 Location of Lateral Restraint No. 2 K2 0.400 Location of Lateral Restraint No. 3 K3 0.600 Location of Lateral Restraint No. 4 K4 0.800 Location of Lateral Restraint No. 4 K4 0.800 Set input for members No.:	Numbe	er of Intermedia	ate Lateral Res	traints	n		4				_		
Location of Lateral Restraint No. 2 K2 0.400 Location of Lateral Restraint No. 3 K3 0.600 Location of Lateral Restraint No. 4 K4 0.800	Locatio	on of Lateral H	lestraint No. 1		×1		0.200				_		-
Location of Lateral Restraint No. 3 X3 U.600 Location of Lateral Restraint No. 4 X4 0.800	Locatio	on of Lateral H	estraint No. 2		×2		0.400				_		~
Declarifier resultant into, 4 X4 0,800	Locatio	on of Lateral P	Vestraint No. 3		×3		0.600				- 14-	//	
Set input for members No.:	LUCALIC		estraint No. 4				0.000						
Set input for members No.:													
Set input for members No.:												*	< x
Set input for members No.:													_×1
Set input for members No.:												\sim	
Set input for members No.:											z		
Set input for members No.:													
Set input for members No.:													
Set input for members No.:											_		
Set input for members No.:													
Set input for members No.:											_		
	Set inp	put for membe	rs No.:										
						6	A VAI				0		

Figure 2.12: Window 1.4 Intermediate Lateral Restraints

In the upper part of the window, you can assign up to nine lateral supports 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-

input. The positions of the intermediate supports are determined from the member length and the relative distances from the member start. When the check box *Relatively (0 ... 1)* is

🔽 Relatively (0 ... 1)



cleared, you can define the distances manually in the upper table. In case of cantilevers, avoid intermediate restraints because such supports divide the member into segments. For cantilevered beams, this would results in segments with torsional restraints

on one end each that are statically underdetermined.



2.5 Effective Lengths - Members

Window 1.5 consists of two parts. In table in the upper part provides summarized information on the effective length coefficients μ_y and μ_z , the effective lengths μ_y and μ_z , the effective lengths l_{ef} for lateral-torsional buckling and the beam type of the members to be designed. The effective lengths defined in RSTAB are preset. In the *Settings* section, further information is shown about 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	С	D	E	F	G	H		J		K	
Member	Buckling	Bucklin	g About Majo	or Axis (y)	Bucklin	g About Mina	or Axis (z)	Late	eral-Torsional Buck	kling			
No.	Possible	Possible	μy	μl _У [m]	Possible	μΖ	μl z [m]	Possible	Beam Type	lef [m]		Comment	
1	V		1.000	6.000	V	1.000	3.000	2	Beam	3.000			
2	✓	✓	1.000	6.000	 ✓ 	1.000	6.000	1	Beam	6.000			
3	✓	 ✓ 	1.000	3.011	V	1.000	1.004	1	Beam	1.004			
4	✓	✓	1.000	3.262	✓	1.000	3.262	V	Beam	3.262			
5	✓	✓	1.000	6.274	✓	1.000	1.255		Beam	1.255			
6	✓	✓	1.000	6.274	V	1.000	6.274	1	Beam	6.274			
7	✓	✓	1.000	3.262	V	1.000	3.262	V	Beam	3.262			
8	√	✓	1.000	3.011	V	1.000	3.011	V	Beam	3.011			
11	√	V	1.000	6.000	V	1.000	6.000	V	Beam	6.000			
12		✓	1.000	6.000	V	1.000	6.000	1	Beam	6.000			
ettinas -	Member No.	1									IP-B 45 B1	IGOST 1994	
Cross-S	Section					1 - IP-B 45	B1IGOST.	1994				10001,1001	
Length	1				1	(6.000 m						
Bucklin	ng Possible						J						
🗆 Bucklir	ng About Axis	y Possible					2					199.0	
Effe	ctive Length (Coefficient			μγ		1.000					100.0	
Effe	ctive Length				μly	(6.000 m				+		
Bucklir B	ng About Axis	z Possible					V					P 18.0	
Effe	ctive Length	Coefficient			μz		1.000						
- Effe	ctive Length				μlz		3.000 m				0		
Lateral	-Torsional Bu	ckling Possil	ble				✓				446.		
Bea	m type						Beam				-		
LTB	Length				lef		3.000 m					0.0	
Comme	ent					_							
											+		
												÷	
												z	
Set inp	out for membe	ers No.:											[r

Figure 2.13: Window 1.5 Effective Lengths - Members

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

The Settings tree manages the following parameters:

- Cross-section
- *Length* (actual length of the member)
- Buckling Possible (cf column A)
- Buckling About Major Axis y Possible (buckling lengths, cf columns B D)
- Buckling About Minor Axis z Possible (buckling lengths, cf columns E G)
- Lateral-Torsional Buckling Possible (cf column H)
- Beam Type (cf column I)
- Lateral-Torsional Buckling Length (cf column J)

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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.

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 Coefficient	x
Buckling About Axis y	Buckling About Axis z
$ Rigid - free \mu_V = 2.0 $	© <u>Rigi</u> d - free µ _z = 2.0 z + → ↓
• Hinged - hinged z z z	Minged - hinged μ _z = 1.0
Rigid - hinged $\mu_y = 0.7$	© Rigid - hinged μ _z = 0.7
$ Rigid - rigid \mu_V = 0.5 $	Pigid - rigid µz = 0.5
© User-defined µy =	Uger-defined μz =
[mport from add-on module RSBUCK (Eigenvalue Analysis)	 Import from add-on module RSBUCK (Eigenvalue Analysis)
RSBUCK-Case:	RSBUCK-Case:
Buckling mode No.:	Buckling mode No.:
Export effective length coefficient μ_{y} : 1.000 $\stackrel{\land}{\searrow}$	Export effective length coefficient μ_z : 1.000
	OK Cancel

Figure 2.14: Dialog box Select Effective Length Coefficient

In this dialog box, the values of the coefficient μ can be defined that are to be assigned to the selected member(s). The μ coefficients are described in detail in [1], clause 10.3 – Effective lengths of columns (page 240). Generally, it is possible to select predefined coefficients or to enter *User-defined* values.

If a RSBUCK case calculated according to the eigenvalue analysis is already available, you can also select a *Buckling mode* to determine the factor.

Buckling Possible

A stability analysis for buckling and lateral 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 indicated in the *Comment* column.

The *Buckling Possible* check boxes in table row A enable and in the *Settings* tree enable you to classify specific members as compression members or, alternatively, to exclude them from the design according to [1].



2 Input Data



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 effective length coefficients μ_y and μ_z for buckling about the major or the minor axes can be selected freely.

You can check the position of the member axes in the cross-section graphic in window 1.3 *Cross-Sections* (see Figure 2.8, page 14). 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.



Figure 2.15: Displaying the member axes in the Display navigator of RSTAB

If buckling is possible about one or even both member axes, you can enter the buckling length coefficients as well as the buckling lengths in the columns C and D respectively 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 μ l input field.

When you define the effective length coefficient μ , the program determines the effective length μ by multiplying the member length *l* by this buckling length coefficient.

Lateral-Torsional Buckling

Table column H controls whether a lateral torsional buckling design is to be carried out.

Column I provides two options to allocate the *Beam Type* according to [1] Annex G, Tables G.1 and G.2.

The lateral-torsional buckling lengths *l*_{ef} depend on the settings of window 1.4 *Intermediate Lateral Restraints*. There is also a possibility to insert a user-defined value into the column J.

Comment

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

Below the *Settings* table, you find the *Set input for members No.* check box. If selected, the settings entered <u>afterwards</u> will be applied to the selected or to *All* members. Members can be selected by typing the member number or by selecting them graphically using the [\S] button. This option is useful when you want to assign the same boundary conditions to several members. Please note that already defined settings cannot be changed subsequently with this function.



....





2.6 Effective Lengths - Sets of Members

The input window 1.6 controls the effective lengths for sets of members. It is only available if one or more sets of members have been selected in window 1.1 *General Data*.

1.6 Effectiv	ve Lengths -	Sets of Me	embers										
	А	B	C	D	E	F	G	Н		J	[К	
Set	Buckling	Bucklin	ng About Maji	or Axis (y)	Bucklin	ng About Mine	or Axis (z)	Late	ral-Torsional Buck	ding			
No.	Possible	Possible	μγ	μly[m]	Possible	μz	μl _z [m]	Possible	Beam Type	lef [m]		Comment	
2	V	V	1.000	6.000	V	1.000	3.000	2	Beam	3.000			
											*	i	%
Settings -	Set of Memb	ers No. 2									IP-B 45 B1 0	3OST, 1994	
Set of	Members					Set No.2							
Cros	s-Section					1 - IP-B 45	B1 GOST,	1994					
Length	1 I				1		6.000 m						
Bucklin	ng Possible						J					199.0	
🖃 Bucklin	ng About Axis	y Possible					✓				1	100.0	
Effe	ctive Length (Coefficient			μγ		1.000						
Effe	ctive Length				μμ		6.000 m					2 18.0	
🖃 Bucklin	ng About Axis	z Possible					V						
Effe	ctive Length (Coefficient			μz	_	1.000				q		
Effe	ctive Length				μlz		3.000 m				446.		
Lateral	-Torsional Bu	ckling Possi	ble				V						¥
Bear	m type						Beam					a.0	
LTB	Length				lef		3.000 m						
Comme	ent										+	! * 2	
Set inp	put for sets No	D.:											[mm]
						ā.	V All				0	X	F

Figure 2.16: Window 1.6 Effective Lengths - Set 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 of the set of members for buckling and lateral-torsional buckling as described in chapter 2.5.



2.7 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 *General Data* (see Figure 2.4, page 11).

	A	В	C	DÍ	E	F	G	I H
		Members	Referen	ce Length	Direc-	Precamber		
).	Reference to	No.	Manually	L [m]	tion	w _c [mm]	Beam Type	Comment
	Member	4		3.262	y, z	0.0	Beam	
2	Member	13		3.011	y, z	0.0	Beam	
3	Member	14		3.262	y, z	0.0	Beam	
1	Member	23		3.011	y, z	0.0	Beam	
5	List of Members	3-5		12.548	y, z	0.0	Beam	
5	Set of Members	2		6.000	y, z	0.0	Beam	
7								
3								
)								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								
1								
2								







Details...

Figure 2.17: Window 1.7 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.

Table column E defines 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).

A precamber w_c can be taken into account by using entries specified in column F.

The *Beam Type* is of vital importance for the correct application of limit deformations. In table column G, you can select the girder to be a beam or a cantilever and decide which end should have no support.

The settings of the *Details* dialog box determine whether the deformations are related to the undeformed initial model or to the shifted ends of members or sets of members (see Figure 3.1, page 25).

2.8 Parameters - Members

The last input window controls additional design parameters for members.

	Α	В			С	
lember	Service factor	Cross-Sectional				
No.	γc	Area			Comment	t
1	0.900					
2	0.900					
3	0.900					
4	0.900					
5	0.900					
6	0.900					
7	0.900					
8	0.900					
11	0.900					
12	0.900					
ettings - Cross-	- Member No. 1 Section			1 - IP-B 45 B1 (GOST, 1994	
Cruss-	e factor			1 - IF-D 43 D1 (0	3051, 1334	
	sectional area for ten	sion design	10	J		
E Star	t (x=0 m)	alon dough		1 - IP-B 45 B1 I (SOST 1994	
0	ross-Sectional Area		A	8430.0	mm ²	
- N	let Cross-Sectional A	ea	An	8430.0	mm ²	
E End	(x=l)			1 - IP-B 45 B1 I (GOST, 1994	
C	ross-Sectional Area		A	8430.0	mm ²	
N	let Cross-Sectional A	ea	An	8430.0	mm ²	
	ent					
Comme						
Comme						
Comme						
Comme						
Comme						
Comme						
Comme						Anet
Comme						Anet
Comme						Anet

Figure 2.18: Window 1.8 Parameters - Members

Service Factor

In column A, there is the possibility to set a value of service factor according to [1] Table 1. The value is set as 0.9 by default. However, it is <u>important</u> to check the structural member and to correct this value if appropriate.

Cross-Sectional Area

Column B provides an option to reduce the cross-sectional area of the selected member. The values of reduced net cross-sectional areas are related to the start and end of the members.



3. Calculation

3.1 Details



Details...

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].

etails		
Check of Maximum Effective Slenderness Ratio	Partial Safety Factors	Display Result Tables
Members with KL / r - Tension: 300 - Compression / flexure: 180	Factor acc. to Table 3 γ_m : 1.025	 ✓ 2.1 Design by Load Case ✓ 2.2 Design by Cross-Section ✓ 2.3 Design by Set of Members
Serviceability (Deflections) Maximum deflection: L / 300 * Deformation relative to: • • Shifted members ends / set of members ends • • Undeformed system • Stability Analysis • • Check stability • Load aplication of possitive transverse loads • Load aplication of possitive transverse load acc. to tables • • On cross-section edge directed to shear center • • On cross-section edge directed from shear center • • On cross-section edge directed from shear center • • On cross-section edge directed from shear center • • Q. On cross-section edge directed from shear center • • Q. and G.4: • • On cross-section edge directed from shear center • • Q. and G.4: • • On cross-section edge directed from shear center • • Q. and G.4: • • On cross-section edge directed from shear center • • As allowable design ratio: 1.000 *	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	 ✓ 2.4 Design by Member ✓ 2.5 Design by x-Location ✓ 3.1 Governing Internal Forces by Member ✓ 3.2 Governing Internal Forces by Set of Members ○ 3.3 Member Stendernesses ✓ 4.1 Parts List by Member ✓ 4.2 Parts List by Set of Members ④ Only for members / sets to be designed ● Of all members / sets of members
	J	OK Cancel

Figure 3.1: Dialog box Details

Check of Maximum Effective Slenderness Ratio

In the two input fields, you can specify the limit values $K \cdot L/r$ of the slenderness ratios. It is possible to enter specifications separately for members with pure tension forces and members with bending and compression.

The real member slendernesses are compared to the limit values in window 3.3. This window is available after the calculation (see chapter 4.8, page 35) if the corresponding check box is selected in the dialog section *Display Result Tables*.

This check does not apply to the member types "Tension" and "Cable" because they are excluded from this check.

Serviceability (Deflections)

In this section, it is possible to change set the allowable deflection for the serviceability limit state design if the default value L/300 is not appropriate.

The two option fields below control whether the *Deformation* is to be 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.



Stability Analysis

When ticking the check box in this dialog section, you decide if you want to perform a *Stability Analysis* generally. If you clear the check box, the input windows 1.4 to 1.7 won't be displayed.

Load application of positive transverse loads

Usually, loads act on members (transverse loads). 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 in this way they can decisively influence the lateral torsional buckling design.

Cross-Section Optimization

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

Partial Safety Factors

In this section, you can change partial safety factor γ_m according to [1] Table 3. The most common value is set as default for this factor.

Limit Values for Special Cases

It is possible to neglect small stresses due to *Bending*, *Tension*, *Compression* or *Torsion* and, thus, allow a simplified design which eliminates negligible internal forces. In this dialog section, the limits of the different types of stresses can be defined. Those are the ratios between the existing stresses and the corresponding resistances of each cross-section.



These limit settings are <u>not</u> part of the code [1]. Changing the limits is in the responsibility of the program user.

Options

All cross-sections are automatically classified as Class 1 so that there is an elastic design. Alternatively, you can activate the *Plastic Design* for all cross-sections.

Display Result Tables

In this dialog section, you can select the results windows including parts list that you want to be displayed. The 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 SP add-on module.

STEEL SP searches for the results of the load cases, load 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: In the dialog box *To Calculate* (menu *Calculate* \rightarrow *To Calculate*), design cases of the add-on modules like load cases and load combinations are listed.

Not Calculate	d			Selected for	Calculation	
No.	Description	*		No.	Description	
Imp LC8 Imp LC9 Imp LC10 C01 C02 C03 C04 C05 C06 C07 C08 C09 C011 C012 C013 C014 C015 C016 C017 C018 C019 RC1 RC2	$\label{eq:second} \begin{array}{ llllllllllllllllllllllllllllllllllll$	E	× ×	CA1	STEEL SP - Design of steel members according to SP	
All	<u>1</u> ▼	a			1	



Figure 3.2: To Calculate Dialog box

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

To transfer the selected STEEL SP cases to the list on the right, use the button $[\blacktriangleright]$. Click [OK] to start the calculation.

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

STEEL SP	CA1 - De	sign o	of s	- 4	>	<u>@</u>	x_xx	× xx	જ 🛤
X 🗊	🗗 🕅	Y.	Īz	- X	Z	+	B-	Show	Results

Figure 3.3: Direct calculation of a STEEL SP design case in RSTAB

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



Results 4.

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

.1 - Design of steel members a 💌	2.1 Desigr	n by Load Case												
out Data		A	В	C	D	E				F				G
- General Data	Load-		Member	Location	Design									
- Materials	ing	Description	No.	x [m]	Ratio				Design	According to Fo	omula			DS
Cross-Sections		Ultimate Limit State Design												
Intermediate Lateral Restraints	LC1	Dead Load	81	0.000	0.7	1 ≤1	313) Stability an	alysis - Flex	ural-torsio	nal buckling acc	c. to 7.1.5	ذ		UL
Effective Lengths - Members	LC2	Snow Load	23	0.000	1.0	5 > 1	326) Stability an	alysis - Ben	iding abou	it y-axis and axia	al force - O	Out-of plane	stability check	< UI
Effective Lengths - Sets of Merr	LC3	Wind v +X	13	0.000	0.1	8 ≤1	322) Stability an	alysis - Late	eral torsion	nal buckling acci	ording to	8.4.1		UL
Serviceability Data	LC4	Wind at peak v +Y	81	3.273	0.7	2 ≤1	322) Stability an	alysis - Late	eral torsion	nal buckling acci	ording to	8.4.1		UL
Parameters - Members	LC5	Wind at peak v -Y	81	3.273	0.4	5 ≤1	322) Stability an	alysis - Late	eral torsion	nal buckling acci	ording to	8.4.1		U
ults	LC6	Wind positive	23	0.000	0.4	0 ≤1	322) Stability an	alysis - Late	eral torsion	nal buckling acci	ording to	8.4.1		UL
Design by Load Case	LC7	Live Load	66	3.125	0.7	7 ≤1	322) Stability an	alysis - Late	eral torsion	nal buckling acci	ording to	8.4.1		U
Design by Cross-Section														
Design by Set of Members		Serviceability Limit State Desig	n											
Design by Member					1.0		•	67			0		a 🖬 🕯	*
Design by x-Location				Max:	1.0	9 > 1	•		-	E 2.	.0	<u> </u>	2 🗳 🛛	3
Governing Internal Forces by M	Details	Marthan 04									10.0			_
Governing Internal Forces by Se	Details -	Member 61 - X: 0.000 m - EC1	\ \								16 - 1	2-8 25 81	GOST, 1994	
Parts List by Member	11 Mater	al values - Steel C 255 (Profiles) COCT 100	,										
Parts List by Set of Members	E Cross	- Jeterrel Correct	3031, 133	4										
	E Desig	minitemai Forces	727								-			
	Deeig	erriess crieck acc. to 7.3.1 and	7.3.7									+	124.0	
	Design	al Forme					60 592	ĿN						
	Gen	an Area				^	2269.0	mm2				9	- Warmen	
	Mo	dulus of Electicity				-	21000.00	kN/om2				~	12.0	
	Yiel	Id Point				-	21000.00	kN/cm2		-				
	Saf	atv Factor				vyn (m	1 025	KIN GIT-		Table 3		8.0		
	Der	eign Resistance				2	24.89	kN/om2		Table 2		24		
	Fffe	active Length					6 546	m		10010 2			5.0	
	Sou	cific Slendemess Ratio					8.069			713			T	
	Fac	tor				•2 •	1 000			(F 1)				
	Coe	ficient				> max	0.117			(11)		+		
	Fac	tor				10	0.117	-	-	715	-		*	
	Ser	vice Factor				10 (n	0.900		-	Table 1			•	
	Der	sign Ratio				n	0.000	-	<10	715	-			
							0.71		20					
							-	-	-	-	-			
							-		-		-			
							-				A		X	P
							_		-	1				

Figure 4.1: Results window with designs and intermediate values

The designs are shown in the results windows 2.1 to 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.

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. Thus you exit STEEL SP 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 38.



OK

🎱 🚑



4.1 Design by Load Case

The upper part of this window provides a summery, sorted by load cases, load combinations, and result combinations of the governing designs. Furthermore, the list is divided in *Ultimate Limit State Design* and *Serviceability Limit State Design* results.

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

I and	A	В	C	D	E				F				G
10au-		Member	Location	Design									
ing	Description	No.	x [m]	Ratio				Desi	ign According to Fo	omula			D
	Ultimate Limit State Design												
LC1	Dead Load	21	2.000	0.71	≤1[3	326) Stability an	alysis - Ben	iding abo	ut y-axis and axial f	force - Out-	of plane st	ability check ad	× UL
LC2	Snow Load	23	0.000	1.11	>13	326) Stability an	alysis - Ben	iding abo	ut y-axis and axial f	force - Out-	of plane st	ability check ad	×UL
LC3	Wind v +X	11	5.400	0.20) ≤1 3	322) Stability an	alysis - Late	eral torsio	nal buckling accor	ding to 8.4.	.1		UL
LC4	Wind at peak v +Y	81	3.273	0.72	! ≤1 3	322) Stability an	alysis - Late	eral torsio	nal buckling accor	ding to 8.4.	.1		UL
LC5	Wind at peak v -Y	81	3.273	0.45	i ≤1 3	322) Stability an	alysis - Late	eral torsio	nal buckling accor	ding to 8.4.	.1		UL
	Serviceability Limit State Desi	an											
LC1	Dead Load	23	1.506	0.20) ≤1 4	401) Serviceabi	lity - Deflect	tion in z-d	direction for beam				
			Max:	1.11	>1	9	9	2	 > 1,0	•	31 😂	🖪 🖏	
etaile .	Member 21 - v: 2 000 m - I C1									1 10 8/	E B1 L CO	ST 1004	
7 Mater	ial Values - Steel C 235 (Profiles	2)								1-16-04	501160	31, 1334	
El Cross	-Section Values - IP-B 45 B1 I	" GOST 199	4										
FI Desid	in Internal Forces	0001,100											
E Slend	emers check acc to 731 and	727											
		11.3.1											
Desid	in Ratio	17.3.7									195	9.0	
] Desig Axi	in Ratio al Force	17.3.7		N		63.016	kN				199	9.0	
] Desig Axi Be	n Ratio al Force nding Moment	17.3.7		N	l 1 _V	63.016 33.729	kN kNm			-		18.0	
Desig Axi Be Ne	in Ratio ial Force nding Moment t Cross-Sectional Area	11.3.1		N A	l Ny	63.016 33.729 8430.0	kN kNm mm ²				195 0-71	9.0 18.0	
Desig Axi Be Ne Yie	n Ratio nal Force nding Moment t Cross-Sectional Area Id Point	11.3.7		N A F	l Ay Na	63.016 33.729 8430.0 23.50	kN kNm mm ² kN/cm ²				13:0	9.0 18.0	
Desig Axi Be Ne Yie Sa	n Ratio nal Force nding Moment t Cross-Sectional Area Id Point fely Factor			A F	l Ay Syn m	63.016 33.729 8430.0 23.50 1.025	kN kNm mm ² kN/cm ²		Table 3	46.0	15.0	9.0 18.0	
Desig Axi Be Ne Yie Sa De	n Ratio nal Force nding Moment t Cross-Sectional Area Id Point fety Factor sign Resistance			N A F 7 F	l Nn Ryn m Ry	63.016 33.729 8430.0 23.50 1.025 22.93	kN kNm mm ² kN/cm ² kN/cm ²		Table 3 Table 2	446.0	13:	9.0 18.0	• • y
Desig Axi Be Ne Yie Sa De Ela	In Ratio al Force nding Moment t Cross-Sectional Area Id Point fely Factor sign Resistance sistic Section Modulus			N A F 7 F V	I Ay Ayn M Ayn Ay Vyn,min	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0	kN kNm mm ² kN/cm ² kN/cm ² mm ³		Table 3 Table 2	446.0	0721	8.0 18.0 8.0	• • y
Desig Axi Be Ne Yie Sa De Ela Fa	n Ratio n Ratio al Force t Cross-Sectional Area di Point fety Factor sign Resistance stic Section Modulus ctor			N A F 7 7 F V V	I In Syn M Sy Vyn,min Iz	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368	kN mm ² kN/cm ² kN/cm ² mm ³		Table 3 Table 2 7.1.3	446.0	13:0	9.0 18.0 8.0	* y
Desig Axi Be Ne Yie Sa De Ela Fa	n Ratio n Ratio al Force nding Moment (Cross-Sectional Area Id Point fety Factor sign Resistance sito Section Modulus ctor efficient			N A F 7 7 F V V ¢ ¢	I In Iyn M Yyn Yyn,min Iz	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621	kN kNm mm ² kN/cm ² kN/cm ² mm ³		Table 3 Table 2 7.1.3 (G.1) or (G.2)	446.0	0.21	8.0 18.0 8.0	• y
Desig Axi Be Ne Yie Sa De Ela Fa Co	n Ratio n Ratio al Force nding Moment (Cross-Sectional Area 3d Point fety Factor sign Resistance stic Section Modulus ctor efficient centroty Ratio			N A F 7 F V ¢ ¢	I Ay Ryn M Ry Vyn,min Iz Vb Ny	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621 10.519	kN kNm mm ² kN/cm ² kN/cm ² mm ³		Table 3 Table 2 7.1.3 (G.1) or (G.2) 9.2.5	446.0	130	<u>8.0</u>	••y
Desig Axi Be Ne Yie Sa De Ela Fa Co Ec Fa	n Ratio n Ratio al Force nding Moment t Cross-Sectional Area id Point fety Factor sign Resistance sito Section Modulus ctor efficient corticol ctor ctor ctor			N A F F V ¢ ¢ ¢	I Nn Ryn M Ry Vyn,min Iz Ib Ny	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621 10.519 0.138	kN kNm kN/cm ² kN/cm ² mm ³		Table 3 Table 2 7.1.3 (G. 1) or (G. 2) 9.2.5 (112) or (113)	446.0	12.0	9.0 18.0 8.0	•у
Desig Axi Be Ne Yie Sa De Ea Fa Co Ec Fa Se	n Ratio n Ratio al Force nding Moment (Cross-Sectional Area dd Point fety Factor sign Resistance sistic Section Modulus ctor efficient centricity Ratio ctor vice Factor			N A F 7 F V ¢ ¢ ¢ ¢ 7 7	I Nn Ryn M Ry Vyn,min Iz Ib D Yy C	63.016 33.729 8430.0 23.50 1.025 22.93 128700.0 0.368 0.621 10.519 0.138 0.900	kN kNm mm ² kN/cm ² kN/cm ² mm ³		Table 3 Table 2 7.1.3 (G.1) or (G.2) 9.2.5 (112) or (113) Table 1 Table 1	446.0	190	8.0 18.0 8.0	*y
Desig Axi Be Ne Yie Sa De Ela Fa Co Ec Fa Se De	n Ratio n Ratio al Force nding Moment (Cross-Sectional Area Id Point (Cross-Sectional Area Id Point (Cross-Section Modulus tor sign Resistance stor Section Modulus tor entricity Ratio tor vice Factor sign Ratio			N A F 7 F V Q Q Q 0 7 7 7 7 7	I Ay My M M M M M M M M M M M M M M M M M	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621 10.519 0.138 0.900 0.71	kN kNm mm ² kN/cm ² mm ³	≤1	Table 3 Table 2 7.1.3 (G.1) or (G.2) 9.2.5 (112) or (113) Table 1 9.2.4 (111)	446.0	130	8.0 18.0 8.0	у
Desig Axi Be Ne Yie Sa De Ela Fa Co Ec Fa Se De	n Ratio n Ratio al Force nding Moment (Cross-Sectional Area kid Point fety Factor sign Resistance stor Section Modulus ctor efficient centroity Ratio ctor vice Factor sign Ratio			N A F 7 7 F V V ¢ ¢ ¢ ¢ ¢ ¢ 7 7 7	I Ay Ma Syn M Sy Vyn,min z b b I Yy c I	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621 10.519 0.138 0.900 0.71	kN kNm mm ² kN/cm ² mm ³	≤1	Table 3 Table 2 7.1.3 (G.1) or (G.2) 9.2.5 (112) or (113) Table 1 9.2.4 (111)	446.0	180	8.0	*•y
Desig Axi Be Ne Sa De Ea Fa Co Ec Fa Se De	n Ratio n Ratio n Ratio al Force nding Moment t Cross-Sectional Area id Point fety Factor sign Resistance sito Section Modulus tor efficient ctor efficient ctor tor tor vice Factor sign Ratio			N N A F 7 7 7 7 7 8 8 8 7 7 7 7	I Ay Nn Syn M Sy Vyn,min iz C C C	63.016 33.729 8430.0 23.50 1.025 22.93 1287000.0 0.368 0.621 10.519 0.138 0.900 0.71	kN kNm mm ² kN/cm ² mm ³	≤1	Table 3 Table 2 7.1.3 (G.1) or (G.2) 9.2.5 (112) or (113) Table 1 9.2.4 (111)	446.0	180		*y

Figure 4.2: Window 2.1 Design by Load Case

Description

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

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 Calculation Parameters)
- Extreme values of internal forces

Design Ratio

0.92 ≤ 1

Max:

۲

Columns D and E display the design conditions according to SP 16.13330.2011 [1].

The lengths of the colored bars represent the respective utilizations.



Design according to Formula

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

DS

The final column provides information on the respective design-relevant design situation (DS): ULS (Ultimate Limit State) or SLS (Serviceability Limit State).

4.2 Design by Cross-Section

	A	B	С	D	E						F				
Section	Member	Location	Load	Design											
No.	No.	x [m]	Case	Ratio	1				Desi	ign Acco	ording to Formula				-
1	IP-B 45 B	1 GOST, 19	94												
	39	3.000	LC4	0.01	≤1	100) N	egligible interna	l forces							
	31	0.000	LC1	0.06	≤1	102) C	oss-section ch	eck - Compres	sion acc. to	7.1.1					
	2	6.000	LC4	0.01	≤1	106) Ci	oss-section ch	eck - Shearfo	rce in y-axis	acc. to	8.2.3				
	32	0.000	LC2	0.21	≤1	108) C	oss-section ch	eck - Shearfo	rce in z-axis	acc. to	8.2.3				
	21	6.000	LC2	0.64	≤1	111) G	oss-section ch	eck - Bending	about y-axi	s acc. to	8.2.1 - Class 1				
	1	3.000	LC4	0.17	≤1	116) C	oss-section ch	eck - Bending	about z-axi	s acc. to	8.2.1 - Class 1				_
	21	6.000	LC2	0.56	≤1	139) C	oss-section ch	eck - Bending	about y- an	nd/or z-a:	xis acc. to 8.2.1				
	21	6.000	LC2	0.59	≤1	181) C	oss-section ch	eck - Biaxial b	ending abou	uty-axis,	shear and axial for	ce acc. to 9	.1.1		
	31	0.000	LC1	0.06	≤1	301) S	ability analysis	 Flexural buck 	ling about y	y-axis ac	c.to 7.1.3				
			Max:	1.11	>1	8			9	2	 > 1.0	•	⅔1) 💿
Materi Cross- Design Slende	al Values - Section Va Internal F emess che	Steel C 235 lues - IP-B orces ck acc. to 7.	(Profiles) 45 B1 GO 3.1 and 7.3	ST, 1994 3.7									199.0	0	
Design	n Hatio							0.750							
She	ar Force	-					Qy C	3./52	KIN 3			†	- - •		
Sta	ical Mome	nt 					Sz	59401.5 15707000.0	mm ³				12	18.0	
Thi	nent of the	rua Jongo					1z	10/5/000.0	mm "						
Yiel	d Point	lange					But	23.50	kN/cm2			0.9			
Saf	atv Factor						1 Ver	1 025	KIN/ GIT		Table 3	44	- T		Y
Der	ion Resista	ance					Be	13.30	kN/cm ²		Table 2		8	.0	
Ser	vice Factor	r					Vo.	0.900			Table 1		T		
Des	ion Ratio						n 10	0.01		<1	8 2 1 (42)				
													+		
															Ima

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 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

	A	B	C	D	E						F		
Set	Member	Location	Load	Design									
No.	No.	x [m]	Case	Ratio					Desi	ign Acco	rding to Formula		
2	Set No.2	(Member No.	1)										
	1	0.000	LC1	0.04	≤1	102) Cross	s-section che	ck - Compres	sion acc. to	7.1.1			
	1	6.000	LC4	0.01	≤1	106) Cross	s-section che	ck - Shearfor	rce in y-axis	acc. to	8.2.3		
	1	0.000	LC2	0.04	≤1	108) Cross	s-section che	ck - Shearfor	rce in z-axis	acc. to	8.2.3		
	1	6.000	LC2	0.32	≤1	111) Cross	s-section che	eck - Bending	about y-axi	s acc. to	8.2.1 - Class 1		
	1	3.000	LC4	0.17	≤1	116) Cross	s-section che	eck - Bending	about z-axi	s acc. to	8.2.1 - Class 1		
	1	6.000	LC2	0.28	≤1	139) Cross	s-section che	eck - Bending	about y- an	id/or z-ax	is acc. to 8.2.1		
	1	6.000	LC2	0.29	≤1	181) Cross	s-section che	eck - Biaxial be	ending abou	ut y-axis,	shear and axial for	rce acc. to	o 9.1.1
	1	0.000	LC1	0.04	≤1	301) Stabi	lity analysis -	Flexural buck	ling about y	/-axis acc	c. to 7.1.3		
	1	0.000	LC1	0.05	≤1	311) Stabi	lity analysis -	Flexural buck	ling about :	z-axis aco	c. to 7.1.3		
			Max	1 11	<u>\</u> 1	0			9	2	E >1.0	•	🔨 😂 🖪 🛝
Cross Desig Slend	-Section Va n Internal F erness che	alues - IP-B Forces ck.acc.to 7.2	45 B1 GOS 3.1 and 7.3	ST, 1994 .7									199.0
Desig	n Ratio												
- Axia	al Force						N	-23.438	KN 2				
- Net	t Cross-Sec	tional Area					An	8430.0	mm ²				₽ <u>18.0</u>
- Tie	Id Point						Ryn	23.50	kN/cm ²				
- Sat	ety Factor						γm	1.025	1.817 2		Table 3	9	3
								00.00			T 11 0		
De	sign Resist	ance					Ry	22.93	KIN/Cm-		Table 2	244	4
De: Ber	nding Mom	ent					Ry My	22.93 85.338	kNm		Table 2	200	8.0
Ber Coe	sign Resist nding Mom efficient	ent Madulus					Ry My cy	22.93 85.338 1.099	kNm		Table 2 Table F.1	244	8 <u>.0</u>
- De: Ber - Coe Ela	sign Resist nding Mom efficient stic Section	n Modulus					Ry My Cy Wyn,min	22.93 85.338 1.099 1287000.0	kNm mm ³		Table 2 Table F.1	944	8.0_
- Der Ber - Cor Ela Ser	sign Resist nding Mom efficient stic Section vice Facto	n Modulus r					Ry My Cy Wyn,min Yo	22.93 85.338 1.099 1287000.0 0.900	kNm mm ³		Table 2 Table F.1 Table 1		\$ <u>8.0</u>
- Des Ber - Coe - Ela Ser - Fac	sign Resist nding Mom efficient stic Section vice Facto ctor	n Modulus r					Ry My Cy Wyn,min Yc rn	22.93 85.338 1.099 1287000.0 0.900 1.500	kN/cm² kNm mm ³		Table 2 Table F.1 Table 1 Table F.1		8.0
Ber Coe Ela Ser Fac	sign Resist ading Mom efficient stic Section vice Facto vice Facto sign Ratio	n Modulus r					Ry My cy Wyn,min γο rn ηN	22.93 85.338 1.099 1287000.0 0.900 1.500 0.01	kN/cm ² kNm mm ³		Table 2 Table F.1 Table 1 Table F.1		8.0 2.
Des Ber Coe Ela Ser Fac Des Des	sign Resist ading Mom efficient stic Section vice Facto tor sign Ratio sign Ratio	n Modulus r					Ry My Cy Wyn,min γo rn ηN ηM,y	22.93 85.338 1.099 1287000.0 0.900 1.500 0.01 0.29 0.29	kNn/cm² kNm mm ³		Table 2 Table F.1 Table 1 Table F.1		
- Des Ber - Coe - Ela - Ser - Fac - Des - Des - Des	sign Resist anding Mom efficient stic Section vice Facto ctor sign Ratio sign Ratio sign Ratio	n Modulus r					Ry My cy Wyn,min γo rn ηN ηM.y	22.93 85.338 1.099 1287000.0 0.900 1.500 0.01 0.29 0.29	kNm mm ³	≤1	Table 2 Table F.1 Table 1 Table F.1 9.1.1.(105)		8.0 8.0 2
Der Ber Coe Ela Ser Fac Der Der	sign Resist nding Mom- efficient stic Sectior vice Facto vice Facto stor sign Ratio sign Ratio	n Modulus r					Ry My cy Wyn,min γo rn ηN ηM,y	22.93 85.338 1.099 1287000.0 0.900 1.500 0.01 0.29 0.29	kNm mm ³	≤1	Table 2 Table F.1 Table 1 Table F.1 9.1.1.(105)		2 2 2 2

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 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	В	C	D					E						
lember	Location	Load	Design												
No.	x [m]	Case	Ratio					Design A	ccording	to Formula					
1	Cross-section	n No. 1 - If	P-B 45 B1 GOST	, 199	4										
	0.000	LC1	0.04	≤1	102) Cross-section	check - Comp	pression acc. t	o 7.1.1							
	6.000	LC4	0.01	≤1	106) Cross-section	check - Shea	r force in y-axi	is acc. to 8	.2.3						
	0.000	LC2	0.04	≤1	108) Cross-section	check - Shea	r force in z-axi	is acc. to 8	.2.3						
	6.000	LC2	0.32	≤1	111) Cross-section	check - Bend	ing about y-a	dis acc. to 8	3.2.1 - Cla	ss 1					
	3.000	LC4	0.17	≤1	116) Cross-section	check - Bend	ing about z-ax	is acc. to 8	3.2.1 - Cla	ss 1					
	6.000	LC2	0.28	≤1	139) Cross-section	check - Bend	ing about y- a	nd/or z-axis	s acc. to	8.2.1					
	6.000	LC2	0.29	≤1	181) Cross-section	check - Biaxia	al bending abo	out y-axis, s	hear and	axial force acc. to	9.1.1				
	0.000	LC1	0.04	≤1	301) Stability analy	sis - Flexural b	uckling about	y-axis acc.	to 7.1.3						
	0.000	LC1	0.05	≤1	311) Stability analy	sis - Flexural b	uckling about	z-axis acc.	to 7.1.3						
		Max:	1.11	>1	0			9	2	 > 1.0	-	7.1	2	🖪 🐧	1
] Cross-] Desigr	Section Value n Internal Ford	es - IP-B4 ces	5 B1 GOST, 199)4											
Cross- Desigr Slende Desigr	Section Value n Internal Forc emess check n Ratio	es - IP-B 4 ces acc.to 7.3	5 B1 (GOST, 199)4								t	199.0	_	
Cross- Desigr Slende Desigr Axia	Section Value n Internal Force emess check n Ratio al Force	es - IP-B 4 ces acc. to 7.3	5 B1 GOST, 199	94		N	-23.438	kN				,	199.0		
Cross- Desigr Slende Desigr Axia Net	Section Value In Internal Force emess check In Ratio al Force Cross-Section	es - IP-B 4 ces acc. to 7.3 nal Area	5 B1 GOST, 199)4		N An	-23.438 8430.0	kN mm ²				<u></u> t	199.0	18.0	
] Cross-] Desigr] Slende] Desigr Axia Net Yiel	Section Value In Internal Force In Ratio In Ratio In Force Cross-Section Id Point	es - IP-B 4 ces acc. to 7.3 nal Area	5 B1 GOST, 199	94		N An Ryn	-23.438 8430.0 23.50	kN mm ² kN/cm ²				<u></u> t	199.0	18.0	
Cross- Desigr Slende Desigr Axia Net Yiel Safe	Section Value n Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor	es - IP-B 4 bes acc. to 7.3 nal Area	5 B1 GOST, 199)4		N An Ryn Ym	-23.438 8430.0 23.50 1.025	kN mm ² kN/cm ²		Table 3			199.0	18.0	
Cross- Desigr Slende Desigr Axia Net Yiel Safe Des	Section Value n Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor sign Resistance	es - IP-B 4 acc. to 7.3 nal Area	5 B1 GOST, 199)4		N An Ryn Ym Ry	-23.438 8430.0 23.50 1.025 22.93	kN mm ² kN/cm ² kN/cm ²		Table 3 Table 2		446.0	199.0	18.0	
Cross- Desigr Slende Desigr Axia Net Yiel Safe Des Ben	Section Value n Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor sign Resistance ding Moment	es - IP-B 4 ces acc. to 7.3 nal Area	5 B1 GOST, 199)4		N An Ryn 7m Ry My	-23.438 8430.0 23.50 1.025 22.93 85.338	kN mm ² kN/cm ² kN/cm ² kNm		Table 3 Table 2		446.0	199.0	18.0	
Cross- Desigr Slende Desigr Axia Net Yiel Safe Des Ben Cross	Section Value n Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor sign Resistance ding Moment efficient	es - IP-B 4 bes acc. to 7.3 nal Area	5 B1 GOST, 199)4		N An Ryn Ym Ry My cy	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099	kN mm ² kN/cm ² kN/cm ² kNm		Table 3 Table 2 Table F.1		446.D	199.0 0721 8.	<u>18.0</u>	
Cross- Desigr Slende Desigr Axia Net Yiel Safe Des Ben Coe	Section Value In Internal Force emess check In Ratio al Force Cross-Section d Point ety Factor sign Resistance ding Moment afficient stic Section M	es - IP-B 4 bes acc. to 7.3 nal Area be	5 B1 GOST, 199)4		N An Ryn Ym Ry My Cy Wyn,min	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099 1287000.0	kN mm ² kN/cm ² kN/cm ² kNm mm ³		Table 3 Table 2 Table F.1		446.0	199.0 0.21 8.	<u>18.0</u>	
Cross- Desigr Slende Desigr Axia Net Yiel Safr Des Ber Coe Elas	Section Value n Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor sign Resistance ding Moment efficient stic Section M vice Factor	es - IP-B 4 bes acc. to 7.3 nal Area be lodulus	5 B1 GOST, 199)4		N An Ryn Ry My cy Wyn,min ?o	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099 1287000.0 0.900	kN mm ² kN/cm ² kN/cm ² kNm mm ³		Table 3 Table 2 Table F.1 Table 1		446.0	199.0	<u>18.0</u>	
Cross- Desigr Slende Desigr Axia Net Yiel Safr Des Ber Coe Elas Ser Fac	Section Value In Internal Force emess check In Ratio al Force Cross-Section d Point ety Factor sign Resistance ding Moment stic Section M vice Factor tor tor	es - IP-B 4 bes acc. to 7.3 nal Area be lodulus	5 B1 GOST, 199			N An Ryn Ym Ry Cy Cy Wyn,min Yc	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099 1287000.0 0.900 1.500	kN mm ² kN/cm ² kNm mm ³		Table 3 Table 2 Table F.1 Table 1 Table F.1		446.0	199.0	<u>18.0</u>	
Cross- Design Slende Design Axia Net Yiel Safe Des Ben Coe Elas Sen Fac	Section Value In Internal Force emess check In Ratio al Force Cross-Section d Point ety Factor sign Resistance ading Moment afficient stic Section M vice Factor tor sign Ratio ice Patie	es - IP-B 4 bes acc. to 7.3 nal Area be lodulus	5 B11 GOST, 199			N An Ryn γm Ry My cy Wyn,min γο Γη ηΝ	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099 1287000.0 0.900 1.500 0.01	kN mm ² kN/cm ² kNm mm ³		Table 3 Table 2 Table F.1 Table 1 Table F.1		446.0	199.0	18.0 0	
Cross- Design Slende Design Axia Yiel Safe Des Ben Coe Elas Sen Fac Des	Section Value In Internal Force mesaic check and Force Cross-Section d Point of Poin	es - IP-B 4 bes acc. to 7.3 mal Area be lodulus	5 B1 GOST, 199			N An Ryn γm Ry Cy Wyn,min γc rn ηΝ γη Νy	-23 438 8430.0 23 50 1.025 22 93 85 338 1.099 1287000.0 0.900 0.500 0.011 0.29	kN mm² kN/cm² kN/cm² kNm mm³		Table 3 Table 2 Table F.1 Table 1 Table F.1		446.0	199.0	<u>18.0</u>	
Cross- Design Slende Design Axia Net Yiel Safi Des Ben Coe Elas Sen Fac Des Des	Section Value Internal Force emess check n Ratio al Force Cross-Section d Point ety Factor sign Resistant ding Moment fificient stic Section M vice Factor tor sign Ratio sign Ratio sign Ratio	es - IP-B 4 bes acc. to 7.3 nal Area be	5 B1 GOST, 199	<u>.</u>		N An Ryn Ym Ry My Cy Wyn,min γο rn ηΝ ηΜ,y η	-23.438 8430.0 23.50 22.93 85.338 1.099 1287000.0 0.900 1.500 0.011 0.29 0.29	kN mm² kN/cm² kN/cm² kNm mm³	≤1	Table 3 Table 2 Table 7.1 Table 1 Table 7.1 9.1.1.(105)		446.0	199.0 0 0 1 1 9 2	<u>18.0</u>	
Cross- Cross- Slende Desigr Axia Net Yiel Safi Des Ben Coe Elas Ser Fac Des Des Des	Section Value Internal Force emess check n Ratio al Force Cross-Section ding Arone ty Factor sign Resistant ding Moment fficient stic Section M vice Factor tor sign Ratio sign Ratio	es - IP-B 4 res acc. to 7.3 nal Area	5 B11 GOST, 199			N An Ryn Ym Ry My Cy Wyn,min Yo rn ηN y N,y η	-23.438 8430.0 23.50 1.025 22.93 85.338 1.099 1287000.0 0.900 1.500 0.01 1 0.29 0.29	kN mm ² kN/cm ² kN/cm ² kNm mm ³	≤1	Table 3 Table 2 Table F.1 Table 1 Table F.1 9.1.1.(105)		446.0	199.0 071 8.	<u>18.0</u>	

Figure 4.5: Window 2.4 Design by Member

This results window presents the maximum ratios for the individual designs sorted by member number. The columns are described in detail in chapter 4.1 on page 29.

4.5 Design by x-Location

2.5 Design	n by x-Locat	ion												
	A	В	C	D					E					
Member	Location	Load	Design											Г
No.	x [m]	Case	Ratio					Design A	ccording t	o Formula				
1	Cross-sectio	n No. 1-I	P-B 45 B1 GOST	, 199	4									
	0.000	LC1	0.04	≤1	102) Cross-section	check - Com	pression acc. t	o 7.1.1						
	0.000	LC4	0.01	≤1	106) Cross-section	check - Shea	ar force in y-axi	is acc. to 8.	2.3					
	0.000	LC2	0.04	≤1	108) Cross-section	check - Shea	ar force in z-axi	is acc. to 8.	2.3					
	0.000	LC1	0.04	≤1	301) Stability analys	sis - Flexural b	ouckling about	y-axis acc.	to 7.1.3					
	0.000	LC1	0.05	≤1	311) Stability analys	sis - Flexural b	ouckling about	z-axis acc.	to 7.1.3					
	0.000	LC1	0.04	≤1	313) Stability analys	sis - Flexural-t	orsional buckli	ng acc. to 🛛	7.1.5					
	0.000	LC1	0.00	≤1	400) Serviceability	 Negligible d 	eformations							
	1.000	LC1	0.04	≤1	102) Cross-section	check - Com	pression acc. t	o 7.1.1						
	1.000	LC4	0.01	≤1	106) Cross-section	check - Shea	ar force in y-axi	is acc. to 8.	2.3					-
		Max:	1.11	> 1	8			9	2	 > 1,0	•	🍾 💕	3	۵
Details -	Member 1 - v	0.000 m -	1.01								1 10 8 4	15 B1 LCOST 199	4	_
FI Materi	al Values - St	eel C 235 (Profiles)								1	10 D1 0001, 100	· .	
ET Cross-	Section Value	es · IP-B 4	5 B1 GOST 199	4										
E Desig	n Internal For	ces												
FI Slende	emess check	acc. to 7.3	3.1 and 7.3.7											
FI Desig	n Ratio											+ 199.0		
Axia	al Force					N	70.935	kN						
Gro	ss Area					A	8430.0	mm ²				18.0		
Mod	dulus of Elast	icity				E	21000.00	kN/cm ²						
- Yiel	d Point					Ryn	23.50	kN/cm ²						
- Saf	ety Factor					γm	1.025			Table 3	46.0			
Des	ign Resistan	ce				Ry	22.93	kN/cm ²		Table 2	4		1	I
Effe	ctive Length					μlz	3.000	m				8.0		
Rac	dius of Gyratic	n				٢z	43.3	mm						
Sler	nderness Rat	io				λz	69.302							
Spe	cific Slender	ness Ratio				λz	2.290			7.1.3				
Fac	tor					α	0.040			Table 7		z		
- Fac	tor					β	0.090			Table 7				
- Fac	tor					δz	16.753			(9)				
- Fac	tor					φz	0.779			7.1.3				
Ser	vice Factor					Yo	0.900			Table 1			Im	
- Des	ign Ratio					η	0.05		≤ 1.0	7.1.3		_	Įm	m
											0	×		X

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 defined 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 Calculation Parameters*)
- Extreme values of internal forces

4.6 Governing Internal Forces by Member

3.1 Governing Internal Forces by Member

	A	B	C	D	E	F	G	H	
ember	Location	Load-		Forces [kN]		N	Ioments [kNm]	
No.	x [m]	ing	N	Vy	Vz	Mx	My	Mz	Design According to Formula
1	Cross-section	No. 1 - IP-	B 45 B1 GOS	T, 1994					
	0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1
	6.000	LC4	0.000	3.752	0.000	0.010	0.000	-0.011	106) Cross-section check - Shear force in y-axis acc. to 8.2.3
	0.000	LC2	-23.438	0.000	-14.223	0.000	0.000	0.000	108) Cross-section check - Shear force in z-axis acc. to 8.2.3
	6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	111) Cross-section check - Bending about y-axis acc. to 8.2.1
	3.000	LC4	0.000	0.002	0.000	0.010	0.000	5.620	116) Cross-section check - Bending about z-axis acc. to 8.2.1
	6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	139) Cross-section check - Bending about y- and/or z-axis ac
	6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	181) Cross-section check - Biaxial bending about y-axis, shea
	0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	301) Stability analysis - Flexural buckling about y-axis acc. to
	0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	311) Stability analysis - Flexural buckling about z-axis acc. to
	6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	313) Stability analysis - Flexural-torsional buckling acc. to 7.1.
	6.000	LC1	-16.996	0.000	-10.283	0.001	-61.698	0.000	322) Stability analysis - Lateral torsional buckling according to
	6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	324) Stability analysis - Bending about y-axis and axial force -
	4.000	LC2	-23.438	0.000	-14.223	0.000	-56.892	0.000	326) Stability analysis - Bending about y-axis and axial force -
	0.000	LC1	0.000	0.000	0.000	0.000	0.000	0.000	400) Serviceability - Negligible deformations
	2 000	1.01	0.000	0.000	0.000	10.000			401) Constant little Definition in a disarting for basis
	3.000	LUT	0.000	0.000	0.000	0.000	0.000	0.000	401) Serviceability - Deflection in z-direction for beam
2	Cross-section 0.000	No. 1 - IP-	B 45 B1 GOS -70.935	T, 1994	10.283	0.000	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1
2	Cross-section 0.000 6.000	No. 1 - IP- LC1 LC4	0.000 B 45 B1 GOS -70.935 0.000	0.000 T, 1994 0.000 3.752	10.283	0.000	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3
2	Cross-section 0.000 6.000 0.000	No. 1 - IP- LC1 LC4 LC2	8 45 B1 GOS -70.935 0.000 -23.438	0.000 T, 1994 0.000 3.752 0.000	10.283 0.000 14,223	0.000	0.000	0.000	401) Serviceability - Deriection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 108) Cross-section check - Shear force in z-axis acc. to 8.2.2
2	Cross-section 0.000 6.000 0.000 6.000	No. 1 - IP- LC1 LC4 LC2 LC2	0.000 B 45 B1 GOS -70.935 0.000 -23.438 -23.438	0.000 T, 1994 0.000 3.752 0.000 0.000	10.283 0.000 14.223 14.223	0.000	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3 108) Cross-section check - Shear force in z-axis acc. to 8.2.1 108) Cross-section check - Shear force in z-axis acc. to 8.2.1 111) Cross-section check - Shear force in z-axis acc. to 8.2.1
2	Cross-section 0.000 6.000 0.000 6.000 3.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC2	8 45 B1 GOS -70.935 0.000 -23.438 -23.438 0.000	T, 1994 0.000 3.752 0.000 0.000 0.000	10.283 0.000 14.223 14.223 0.000	0.000	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 109) Cross-section check - Shear force in y-axis acc. to 8.2.1 110) Cross-section check - Shear force in y-axis acc. to 8.2.1 111) Cross-section check - Bending about y-axis acc. to 8.2.1 116) Cross-section check - Bending about y-axis acc. to 8.2.1
2	Cross-section 0.000 6.000 0.000 6.000 3.000 6.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC2 LC2	8 45 B1 GOS -70.935 0.000 -23.438 -23.438 0.000 -23.438	T. 1994 0.000 3.752 0.000 0.000 0.000 0.002 0.000	10.283 0.000 14.223 14.223 0.000 14.223	0.000 0.000 0.000 0.000 0.000 -0.010 0.000	0.000 0.000 0.000 0.000 85.338 0.000 85.338	0.000 0.000 0.000 0.000 0.000 5.620 0.000	401) Serviceability - Denection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 110) Cross-section check - Bending about y-axis acc. to 8.2. 116) Cross-section check - Bending about y-axis acc. to 8.2. 130) Cross-section check - Bending about y-axis acc. to 8.2. 130) Cross-section check - Bending about y-axis acc. to 8.2. 130) Cross-section check - Bending about y-axis acc. to 8.2.
2	Cross-section 0.000 6.000 6.000 6.000 3.000 6.000 6.000	No. 1 - IP- LC1 LC2 LC2 LC2 LC2 LC4 LC2 LC2	8 45 B1 GOS -70.935 0.000 -23.438 -23.438 0.000 -23.438 -23.438 -23.438	T, 1994 0.000 3.752 0.000 0.000 0.000 0.002 0.000 0.000	10.283 0.000 14.223 14.223 0.000 14.223 14.223 14.223	0.000	0.000 0.000 0.000 85.338 0.000 85.338 85.338	0.000 0.000 0.001 0.000 0.000 5.620 0.000 0.000	401) Serviceability - Deriection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.2 108) Cross-section check - Shear force in z-axis acc. to 8.2.2 111) Cross-section check - Bending about y-axis acc. to 8.2. 139) Cross-section check - Bending about y-axis acc 130) Cross-section check - Banding about y-axis, sacc 131) Cross-section check - Baxial bending about y-axis, sacc 131) Cross-section check - Baxial bending about y-axis, sacc
2	Cross-section 0.000 6.000 6.000 3.000 6.000 6.000 6.000 0.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC4 LC2 LC2 LC2	0.000 B 45 B1 GOS 0.000 -23.438 0.000 -23.438 0.000 -23.438 -23.4	T, 1994 0.000 3.752 0.000 0.000 0.000 0.000 0.000 0.000 0.000	10.283 0.000 14.223 14.223 14.223 0.000 14.223 14.223 10.283	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000 0.000 0.000 85.338 0.000 85.338 85.338 85.338	0.000 0.000 0.001 0.000 0.000 0.000 0.000 0.000 0.000	401) Serviceability - Denection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3 110) Cross-section check - Shearforce in z-axis acc. to 8.2.3 111) Cross-section check - Bending about y-axis acc. to 8.2. 139) Cross-section check - Bending about y-axis acc. to 8.2. 139) Cross-section check - Bending about y-axis acc. to 8.2. 131) Cross-section check - Bending about y-axis acc. to 8.2. 131) Cross-section check - Bending about y-axis acc. to 8.2. 131) Cross-section check - Bending about y-axis acc. to 8.2. 131) Cross-section check - Bending about y-axis acc. to 8.2. 131) Stability analysis - Recurring buckling about y-axis acc. to 8.2.
2	Cross-section 0.000 6.000 0.000 6.000 6.000 6.000 0.000 0.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC4 LC2 LC4 LC2 LC2 LC1 LC1	0.000 8 45 B1 GOS -70.935 0.000 -23.438 -23.438 0.000 -23.438 -23.438 -23.438 -70.935 -70.935	T, 1994 0.000 3.752 0.000 0.000 0.002 0.000 0.000 0.000 0.000 0.000 0.000	10.283 10.283 0.000 14.223 14.223 14.223 14.223 14.223 10.283 10.283	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 85.338 0.000 85.338 85.338 85.338 0.000 0.000 0.000	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	401) Serviceability - Denection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 108) Cross-section check - Shear force in z-axis acc. to 8.2.1 110) Cross-section check - Bending about y-axis acc. to 8.2.1 116) Cross-section check - Bending about y-axis acc. to 8.2.1 130) Cross-section check - Bending about y-axis acc. to 8.2.1 130) Cross-section check - Bending about y-axis acc. to 8.2.1 131) Stability analysis - Rexural buckling about y-axis acc. to 131) Stability analysis - Rexural buckling about y-axis acc. to
2	Cross-section 0.000 6.000 0.000 6.000 6.000 6.000 0.000 0.000 0.000 6.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC4 LC2 LC1 LC1 LC1 LC1	0.000 B 45 B1 GOS -70,935 0.000 -23,438 -23,438 -23,438 -23,438 -23,438 -23,438 -70,935 -70,935 -23,438	T, 1994 0.000 3.752 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	10.283 0.000 14.223 14.223 0.000 14.223 14.223 10.283 10.283 14.223	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 85.338 0.000 85.338 85.338 0.000 0.000 0.000 85.338	0.000 -0.011 0.000 5.620 0.000 0.000 0.000 0.000 0.000 0.000	102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 108) Cross-section check - Shear force in y-axis acc. to 8.2.1 110) Cross-section check - Shear force in z-axis acc. to 8.2.1 111) Cross-section check - Bending about y-axis acc. to 8.2.1 113) Cross-section check - Bending about y-axis acc. to 8.2.1 139; Cross-section check - Bending about y-axis acc. to 8.2.1 131) Cross-section check - Bending about y-axis, acc. to 8.2.1 131) Cross-section check - Bending about y-axis, acc. to 3.1 131) Cross-section check - Bending about y-axis, acc. to 3.13 331) Stability analysis - Rexural buckling about y-axis acc. to 3.13 331) Stability analysis - Rexural buckling about y-axis acc. to 3.13
2	Cross-section 0.000 6.000 0.000 6.000 6.000 6.000 0.000 0.000 6.000 6.000 6.000	No. 1 - IP- LC1 LC2 LC2 LC2 LC2 LC2 LC2 LC2 LC1 LC1 LC1 LC2 LC1	0.000 8 45 B1 GOS -70.935 0.000 -23.438 -23.438 -23.438 -23.438 -70.935 -70.935 -70.935 -23.438 -16.996	T. 1994 0.000 3.752 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	10.283 0.000 14.223 14.223 14.223 14.223 10.283 10.283 14.223 10.283	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 85.338 0.000 85.338 85.338 0.000 0.000 85.338 61.698	0.000 -0.011 0.000 5.620 0.000 0.000 0.000 0.000 0.000 0.000	401) Serviceability - Denection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3 110) Cross-section check - Bending about y-axis acc. to 8.2.3 111) Cross-section check - Bending about y-axis acc. to 8.2.3 130) Cross-section check - Bending about y-axis acc. to 8.2.3 131) Cross-section check - Bending about y-axis acc. to 8.2.3 132) Cross-section check - Bending about y-axis acc. to 8.2.3 133) Cross-section check - Bending about y-axis acc. to 8.3 131) Cross-section check - Bending about y-axis acc. to 3.3 131) Stability analysis - Rexural buckling about y-axis acc. to 7.1 232) Stability analysis - Rexural torsional buckling according to 232) Stability analysis - Lateral torsional buckling according to
2	Cross-section 0.000 6.000 0.000 6.000 6.000 0.000 0.000 0.000 6.000 6.000 6.000 6.000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC4 LC2 LC2 LC1 LC1 LC2 LC1 LC2 LC1 LC2	0.000 B 45 B1 GOS -70.935 0.000 -23.438 -23.438 -23.438 -23.438 -23.438 -70.935 -70.935 -23.438 -16.996 -23.438	T, 1994 0.000 3.752 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	10.283 0.000 14.223 14.223 14.223 14.223 14.223 10.283 10.283 14.223 10.283 14.223 14.223	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	0.000 0.000 0.000 85.338 0.000 85.338 85.338 0.000 0.000 85.338 0.000 85.338 0.000 85.338 85.338	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	401) Serviceability - Deflection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3 108) Cross-section check - Shearforce in z-axis acc. to 8.2.3 110) Cross-section check - Bending about y-axis acc. to 8.2. 139) Cross-section check - Bending about y-axis acc. to 8.2. 139) Cross-section check - Bending about y-axis acc. to 8.2. 130) Cross-section check - Bending about y-axis acc. to 8.2. 131) Sability analysis - Rexural buckling about y-axis acc. to 7.1 132) Stability analysis - Rexural buckling about z-axis acc. to 7.1 232) Stability analysis - Rexural buckling accort to 7.1 232) Stability analysis - Lateral torsional buckling according to 234) Stability analysis - Lateral torsional buckling according to 234) Stability analysis - Rexural buckling according to 235 Stability analysis - Rexural buckling according to 235 Stability analysis - Rexural buckling according to 236 Stability analysis - Rexural buckling according to 237 Stability analysis - Rexural buckling according to 237 Stability analysis - Rexural buckling according to 237 Stability analysis - Rexural buckl
2	Cross-section 0.000 6.000 0.000 6.000 0.000 0.000 0.000 0.000 0.000 6.000 0.000 6.000 0.000 0.000 0.000 0.000 0.000 0.000	№. 1 - IP- LC1 LC4 LC2 LC4 LC2 LC4 LC2 LC4 LC2 LC4 LC2 LC4 LC2 LC1 LC2 LC1 LC2 LC1 LC2 LC1 LC2 LC1 LC2 LC1 LC2 LC1	0.000 B 45 B1 GOS -70.935 0.000 -23.438 -23.438 -23.438 -23.438 -70.935 -70.935 -70.935 -70.935 -23.438 -16.996 -23.438 -23.438	0.000 T. 1994 0.000 3.752 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 0.000 0.000	10.283 10.283 10.000 14.223 14.223 14.223 10.283 10.283 10.283 10.283 10.283 10.283 10.283 14.223 10.283 14.223 14.223 14.223	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	0.000 0.000 0.000 85.338 0.000 85.338 0.000 0.000 0.000 85.338 61.698 85.338 14.223	0.000 -0.011 0.000 0.000 5.620 0.000 0.000 0.000 0.000 0.000 0.000 0.000	401) Serviceability - Deflection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.1 108) Cross-section check - Shear force in y-axis acc. to 8.2.1 110) Cross-section check - Bending about y-axis acc. to 8.2.1 110) Cross-section check - Bending about y-axis acc. to 8.2.1 111) Cross-section check - Bending about y-axis acc. to 8.2.1 112) Cross-section check - Bending about y-axis acc. to 8.2.1 113) Cross-section check - Bending about y-axis acc. to 8.2.1 111) Cross-section check - Bending about y-axis acc. to 8.2.1 112) Cross-section check - Bending about y-axis acc. to 8.2.1 113) Sability analysis - Rexural buckling about y-axis acc. to 7.1 113) Sability analysis - Rexural buckling about y-axis acc. to 7.1 122) Stability analysis - Lateral torsional buckling according to 2349 Sability analysis - Bending about y-axis and axial force- 126) Stability analysis - Bending about y-axis and axial force 127) Sability analysis - Bending about y-axis and axial force
2	Cross section 0.000 6.000 0.000 6.000 6.000 0.000 0.000 0.000 6.000 6.000 0.000 6.000 0.0000 0.0000 0.000 0.0000 0.000000	No. 1 - IP- LC1 LC4 LC2 LC2 LC2 LC4 LC2 LC1 LC1 LC2 LC1 LC2 LC1 LC2 LC2 LC1 LC2 LC2 LC2 LC2 LC2	0.000 8 45 B1 GOS 0.000 -23.438 -23.438 -23.438 -23.438 -23.438 -70.935 -70.935 -23.438 -16.996 -23.438 -16.996 -23.438 -23.438 -4.934 -23.438 -2	T, 1994 0.000 3.752 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000 0.00000000	0.000 10.283 0.000 14.223 14.223 14.223 10.283 10.283 14.223 10.283 14.223	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 0.000	0.000 0.000 0.000 85.338 0.000 85.338 0.000 0.000 0.000 0.000 85.338 0.000 0.000 0.000 85.338 1.000	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 0.000	401) Serviceability - Denection in 2-direction for beam 102) Cross-section check - Compression acc. to 7.1.1 106) Cross-section check - Shear force in y-axis acc. to 8.2.3 108) Cross-section check - Shearforce in z-axis acc. to 8.2.3 111) Cross-section check - Bending about y-axis acc. to 8.2.3 113) Cross-section check - Bending about y-axis acc. to 8.2.3 113) Cross-section check - Bending about y-axis acc. to 8.2.3 113) Cross-section check - Bending about y-axis acc. to 8.2.3 113) Cross-section check - Bending about y-axis acc. to 8.2.3 113) Sability analysis - Rexural buckling about y-axis acc. to 113) Sability analysis - Rexural buckling about y-axis acc. to 113) Sability analysis - Rexural buckling about y-axis acc. to 7.1 222) Sability analysis - Lateral torsional buckling according to 2349 Sability analysis - Bending about y-axis and axial force - 326) Sability analysis - Bending about y-axis and axial force -

Figure 4.7: Window 3.1 Governing Internal Forces by Member

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

Location x

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

Load Case

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 design ratios in the respective ultimate limit state and serviceability limit state designs.

Design According to Formula

The final column provides information on the types of design and the equations by which the designs according to [1] have been performed.



4.7 Governing Internal Forces by Set of Members

A	B	C	D	E	F	G	Н	
et Location	Load-		Forces [kN]		Ň	loments [kNm]		
lo. x [m]	ing	N	Vy	Vz	Mx	My	Mz	Design According to Formula
2 Set No.2 (M	ember No. 1)						
0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	102) Cross-section check - Compression acc. to 7.1.1
6.000	LC4	0.000	3.752	0.000	0.010	0.000	-0.011	106) Cross-section check - Shear force in y-axis acc. to 8.2.3
0.000	LC2	-23.438	0.000	-14.223	0.000	0.000	0.000	108) Cross-section check - Shear force in z-axis acc. to 8.2.3
6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	111) Cross-section check - Bending about y-axis acc. to 8.2.1 -
3.000	LC4	0.000	0.002	0.000	0.010	0.000	5.620	116) Cross-section check - Bending about z-axis acc. to 8.2.1 -
6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	139) Cross-section check - Bending about y- and/or z-axis acc.
6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	181) Cross-section check - Biaxial bending about y-axis, shear a
0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	301) Stability analysis - Flexural buckling about y-axis acc. to 7.
0.000	LC1	-70.935	0.000	-10.283	0.001	0.000	0.000	311) Stability analysis - Flexural buckling about z-axis acc. to 7.7
6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	313) Stability analysis - Flexural-torsional buckling acc. to 7.1.5
6.000	LC1	-16.996	0.000	-10.283	0.001	-61.698	0.000	322) Stability analysis - Lateral torsional buckling according to 8
6.000	LC2	-23.438	0.000	-14.223	0.000	-85.338	0.000	324) Stability analysis - Bending about y-axis and axial force - In
4.000	LC2	-23.438	0.000	-14.223	0.000	-56.892	0.000	326) Stability analysis - Bending about y-axis and axial force - O
0.000	LC1	0.000	0.000	0.000	0.000	0.000	0.000	400) Serviceability - Negligible deformations
3.000	LC1	0.000	0.000	0.000	0.000	0.000	0.000	401) Serviceability - Deflection in z-direction for beam

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.



4.8 Member Slendernesses

	A	B	С	D	E	F	G	H	
Member		Length		Major Axis y			Minor Axis z		
No.	Under Stress	L [m]	ky[-]	iy [mm]	λy[-]	k _z [-]	iz [mm]	λz [-]	
1	Compression / Flexure	6.000	1.000	184.5	32.519	0.500	43.3	69.302	
2	Compression / Flexure	6.000	1.000	184.5	32.519	1.000	43.3	138.605	
3	Compression / Flexure	3.011	1.000	160.4	18.779	0.333	34.2	29.381	
4	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
5	Compression / Flexure	6.274	1.000	166.6	37.667	0.200	44.8	28.022	
6	Compression / Flexure	6.274	1.000	166.6	37.667	1.000	44.8	140.111	
7	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
8	Compression / Flexure	3.011	1.000	160.4	18.779	1.000	34.2	88.143	
11	Compression / Flexure	6.000	1.000	184.5	32.519	1.000	43.3	138.605	
12	Compression / Flexure	6.000	1.000	184.5	32.519	1.000	43.3	138.605	
13	Compression / Flexure	3.011	1.000	160.4	18.779	1.000	34.2	88.143	
14	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
15	Compression / Flexure	6.274	1.000	166.6	37.667	1.000	44.8	140.111	
16	Compression / Flexure	6.274	1.000	166.6	37.667	1.000	44.8	140.111	
17	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
18	Compression / Flexure	3.011	1.000	160.4	18.779	1.000	34.2	88.143	
21	Compression / Flexure	6.000	1.000	184.5	32.519	1.000	43.3	138.605	
22	Compression / Flexure	6.000	1.000	184.5	32.519	1.000	43.3	138.605	
23	Compression / Flexure	3.011	1.000	160.4	18.779	1.000	34.2	88.143	
24	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
25	Compression / Flexure	6.274	1.000	166.6	37.667	1.000	44.8	140.111	
26	Compression / Flexure	6.274	1.000	166.6	37.667	1.000	44.8	140.111	
27	Compression / Flexure	3.262	1.000	166.6	19.587	1.000	44.8	72.858	
28	Compression / Flexure	3.011	1.000	160.4	18.779	1.000	34.2	88.143	
31	Compression / Flexure	3.000	1.000	184.5	16.259	1.000	43.3	69.302	
32	Compression / Flexure	3.000	1.000	184.5	16.259	1.000	43.3	69.302	
33	Compression / Flexure	3.000	1.000	85.5	35.107	1.000	49.5	60.625	
34	Compression / Flexure	3.546	1.000	85.5	41.497	1.000	49.5	71.659	
35	Compression / Flexure	3.000	1.000	85.5	35.107	1.000	49.5	60.625	
	Compression / Flow re-	4 094	1 000	85.5	47 910	1 000	49.5	82.734	

Figure 4.8: Window 3.3 Member Slendernesses

This results window is shown only when you have selected the respective check box in the *Details* dialog box (see Figure 3.1, page 25).

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 (see Figure 3.1, page 25).

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

This window is displayed only for information. No design of the slendernesses is carried out.



_	
D-4-	-11-
Deta	1115



4.9 Parts List by Member

Finally, STEEL SP provides a summary of all cross-sections that are included in the design case.

		B	С	D	E	F	G	H	
Part	Cross-Section	Number of	Length	Total Length	Surface Area	Volume	Unit Weight	Weight	Total Weight
No.	Description	Members	[m]	[m]	[m ²]	[m ³]	[kg/m]	[kg]	[t]
1	1 - IP-B 45 B1 GOST, 1994	6	6.00	36.00	59.08	0.30	66.18	397.05	2.38
2	2 - IP-B 40 B1 GOST, 1994 3 - IP 40 B1	8	3.01	24.09	35.42	0.16	52.36	157.68	1.26
3	2 - IP-B 40 B1 GOST, 1994	8	3.26	26.10	40.36	0.19	56.65	184.80	1.47
4	2 - IP-B 40 B1 GOST, 1994	8	6.27	50.19	77.62	0.36	56.65	355.39	2.84
5	1 - IP-B 45 B1 GOST, 1994	4	3.00	12.00	19.69	0.10	66.18	198.53	0.79
6	10 - HP 200x54 CAN/CSA-S16-01	3	3.00	9.00	10.89	0.06	53.54	160.61	0.48
7	10 - HP 200x54 CAN/CSA-S16-01	2	3.55	7.09	8.58	0.05	53.54	189.84	0.38
8	10 - HP 200x54 CAN/CSA-S16-01	1	4.09	4.09	4.95	0.03	53.54	219.18	0.21
9	15 - IP-K 25 K2 GOST, 1994	4	3.00	12.00	17.45	0.11	72.36	217.08	0.86
10	6 - IP-K 20 K2 GOST, 1994	3	3.00	9.00	10.46	0.06	49.87	149.61	0.44
11	6 - IP-K 20 K2 GOST, 1994	2	3.55	7.09	8.24	0.05	49.87	176.84	0.35
12	6 - IP-K 20 K2 GOST, 1994	1	4.09	4.09	4.76	0.03	49.87	204.17	0.20
13	7 - IP-K 20 K2 GOST, 1994	4	6.27	25.10	29.15	0.16	49.87	312.88	1.2
14	9 - IP-B 35 B2 GOST, 1994	8	6.25	50.00	68.10	0.32	49.56	309.78	2.4
15	16 - IP-B 25 B1 GOST, 1994	1	6.55	6.55	6.29	0.02	25.65	167.93	0.10
16	6 - IP-K 20 K2 GOST, 1994	1	7.09	7.09	8.24	0.05	49.87	353.79	0.35
17	6 - IP-K 20 K2 GOST, 1994	1	6.55	6.55	7.60	0.04	49.87	326.46	0.32
18	12 - QRO 70x5 GOST 30245-03	25	5.00	125.00	32.85	0.15	9.70	48.51	1.2
19	13 - Circle 24	4	7.81	31.24	2.36	0.01	3.55	27.74	0.1
20	13 - Circle 24	8	8.02	64.18	4.84	0.03	3.55	28.49	0.22
Sum		102		516.46	456.95	2.27			17.84

Figure 4.9: 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 (see Figure 3.1, page 25).

Part No.

Details..

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

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 to 2.5 in the cross-section information (see Figure 2.10, page 16).

Volume

0

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

4.2 Parts List by Set of Members Set of Memb Part No. engt [m ³] of Sets Description [m] [m] [m²] [kg/m] [kg] [t] 6.00 6.00 9.85 0.05 66.18 397.05 0.397 Sum 6.00 9.85 0.05 0.397 🔄 强 💊 📀

Figure 4.10: 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 table 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 different cross-sections are used in the set of members, the program averages the surface area, the volume, and the cross-section weight.



5. **Results Evaluation**

The design results can be evaluated in different ways. For this, the buttons in the results windows are very useful which are located below the upper tables.



Figure 5.1: Buttons for results evaluation

These buttons have the following functions:

Button	Description	Function
?	Ultimate Limit State Designs	Turns on and off the results of the ultimate limit state design
2	Serviceability Limit State Designs	Turns on and off the results of the serviceability limit state design
	Show Color Bars	Turns on and off the colored reference 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 41
	Excel Export	Exports the table to MS Excel / OpenOffice → chapter 7.4.3, page 51
\$	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 through 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 SP 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 SP 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 SP.

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 or ultimate limit state 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, use the toolbar button [Show Values] to the right.

As the RSTAB tables are of no relevance for the evaluation of design results, you can hide them.

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











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

This graphics of the design results can be transferred to the printout report (see chapter 6.2, page 44).

To return to the STEEL SP module, click [STEEL SP] in the panel.

STEEL SP



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 SP 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 38).

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

$\textbf{Results} \rightarrow \textbf{Result Diagrams for Selected Members}$

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 SP design case.

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





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5.3 Filter for Results

The STEEL SP 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* options also for STEEL SP (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 stress ratio diagrams that are not covered by the color spectrum. Those diagrams are represented by dotted lines.





× -



Filtering members

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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 stress 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 SP 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 10.1.3.4 *Selecting Data of Add-on Modules* describes how to select input and output data of add-on modules for the printout.

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 SP 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 in 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.

1	🗐 R	STAB	8.00 (6	4bit) - [Hall*]			
	84≥	<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	i) 🙀 🖻	50	🛛 🖓	@ 🛃
	1	- 2	4 🗈 i	V1 落	왔 Prin	t Graphic	🕅 🕅 🎽	<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 by using the [Print] button. It is also possible to print it directly.

肩 Result Diagram	m on Membe	r	
Members No.:	181	- < > 🏷 🛛	
Navigator	τ×	0.000	0.500 Print
Ultima	ate Limit Sta	Design [-]	

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

The dialog box Graphic Printout opens (see figure on next page).







Graphic Printout		×
General Options		
Graphic Picture	Window To Print	Graphic Size
O Directly to a printer	Ourrent only	As screen view
To a printout report:	🔘 More	Window filling
To the Clipboard	🔘 Mass print	○ To scale 1: 100 ▼
Graphic Picture Size and Rotation	Options	
Use whole page width	Show results for selected a diagram	clocation in result
Use whole page height	Cock graphic picture (with	out update)
● Height: 100 → [% of page]		
	Show printout report on [0	K]
Rotation: 0 🚔 [*]		
Header of Cranhia Distura		
Result diagrams in Member - M181		
		OK Cancel

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 option *Properties* in the context menu opens the dialog box *Graphic Printout*, offering various options for adjustment.

Graphic Printout				×
General Options				
Script	Symbols		Frame	
Proportional	Proportional		None	
Onstant	Constant		Framed	
Factor: 1	Factor: 1		Title box	
Print Quality		Color		
Standard (max 1000 x 1000 Pixels))	Grayscale	e	
Maximum (max 5000 x 5000 Pixels)	Texts and	d lines in black	
O User-defined		All colore	d	
Max number of pixels:	1000 🛨			
٢			ОК	Cancel

Figure 6.4: Dialog box Graphic Printout, tab Options

Remove from Printout Report Start with New Page Selection... Properties...



7. General Functions

This 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 SP 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 SP menu and click

File ightarrow New Case.

The following dialog box appears:

New STE	EL SP Case
No.	Description
2	Design of steel members according to SP
٢	OK Cancel

Figure 7.1: Dialog box New STEEL SP Case

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 SP window 1.1 General Data where you can enter the design data.

Rename a Design Case

To change the description of a design case, use the STEEL SP menu and click

$\textbf{File} \rightarrow \textbf{Rename Case}.$

The following dialog box appears:

Rename	STEEL SP Case	X
No. 1	Description New Description	
٢		OK Cancel

Figure 7.2: Dialog box Rename STEEL SP Case

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





Copy a Design Case

To copy the input data of the current design case, use the STEEL SP menu and click

File \rightarrow Copy Case.

The following dialog box appears:

opy STE	EL SP Case
Copy fro	m Case
CA1 - D	esign of steel members according to SP 🔹
New Cas	se
No.:	Description:
2	Design of Bottom Flange

Figure 7.3: Dialog box Copy STEEL SP Case

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

Delete a Design Case

To delete design cases, use the STEEL SP menu and click

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

The following dialog box appears:

Delete	e Cases
Avai	able Cases
No.	Description
1	Design of steel members according to SP
2	Design of Bottom Flange
3	Design of Upper Flange
<u> </u>	· · · · · · · · · · · · · · · · · · ·
()	
9	OK Cancel

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 14). 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
	153	0.000	LC11		0.53	≤1	108) (Cross-section check - Shear force in z-axis acc. to 8.2.3
	153	0.000	LC11		0.92	≤1	111)(Cross-section check - Bending about y-axis acc. to 8.2.1 - Class 1
	153	0.000	1011		0.01	11	1201 (Gross-section check - Bending about y- and/or z-axis acc. to 8.2.1
	153	<u>G</u> o to Cr	oss-Sectio	n	Dou	ublec	lick	ross-section check - Biaxial bending about y-axis, shear and axial force acc. to 9.1.1
	171	Info Abo	ut Cross-	Sectio	on			tability analysis - Flexural buckling about y-axis acc. to 7.1.3
	171							tability analysis - Flexural buckling about z-axis acc. to 7.1.3
	147	<u>O</u> ptimize	e Cross-Se	ction	1			tability analysis - Flexural-torsional buckling acc. to 7.1.5
	138	Cross-Se	ction Opt	imiza	tion <u>P</u> aram	eter	s	tability analysis - Lateral torsional buckling according to 8.4.1
	153	0.000	LUT .		0.92	51	324) .	stability analysis - Bending about y-axis and axial force - In plane stability check acc. to
	153	0.000	LC11		0.67	≤1	326) 3	Stability analysis - Bending about y-axis and axial force - Out-of plane stability check ac

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 3.1, page 25). 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	C	D		E Í	F		9 - IP-B 25 B2 I GO	ST 1994
ction	Material	Cross-Section	Cross-Section Type	Opti-					STEEL SP	
o.	No.	Description	for Classification	mize	R	emark	Commen	t		_
1	1	I IP-B 55 B1 GOST, 1994	I-section rolled	No						
2	1	I IP-B 40 B1 GOST, 1994	I-section rolled	No						y
3	1	I IP 40 B1 GOST 26020-83	I-section rolled	No						
6	1	T IP-K 20 K2 GOST, 1994	I-section rolled	No						
7	1	T IP-K 20 K2 GOST, 1994	I-section rolled	No						-
9	1	I IP-B 25 B2 GOST, 1994	Leaction rolled	No		1)				
10 1 HP 200x54 CAN/CSA-S16-01			Info About Cros	s-Section					9 - IP-B 35 B2 GO	ST, 1994
12	1	🔜 💷 QRO 70x5 GOST 30245-03	Cross-Section Li	brarv					RSTAB	
13	1	Circle 24								
15	1	T IP-K 25 K2 GOST, 1994	E <u>d</u> it List 'Design	of Members	in Table 1	.1 •				
16	1	I IP-B 25 B1 GOST, 1994	Optimize Cross-	Section						У
17	1	L 160x100x12 GOST 8510-86								
18	1	TU 250/50/100/10/6/0	Cross-Section Optimization Parameters							
		1) The entry continuity DCTAD is d	Export Cross-See					=		
		I) The cross-section in KSTAB is a	Evenent All Crean	Continue to I	OCT A D					
			Export An Cross-		🗳 🔇					
			Import Cross-Se	ction from R	STAB					
ISS-Se	ection Valu	es - IP-B 25 B2 GOS1, 1994	Import All Cross	-Sections fro	m RSTAB			_	Cross-section No. 9	used in
cross-	Section Ty	pe	····•					-	Members No .:	
Sectio	n Height		h	250.0	mm				66.69 71.74	
Sectio	n Width		b	125.0	mm			- 11	00.00,71-74	
Webl	hickness		tw	6.0	mm			- 11	0. / J N	
Hange	hicknes	5	tr	9.0	mm			_	Sets of members No.	:
Hoot H	Radius		r	12.0	mm			_	•	
Area o	f Cross-Se	ction	A	3/66.0	mm 4			- E		
Shear	Area		Avy	2250.0	mm ²		8.4.1.1	_	Σ Lengths:	Σ Masses:
Shear	Area		Aw,z	1500.0	mm 4		(54)	-11	50.00 [m]	1.478
Moment of Inertia		ly	40520000.0	mm "			-11	30.00 [m]	1.470	
Moment of Inertia Torsional Constant			Iz	2938000.0	mm *			-11		
			It	//454.0	mm "			-11	Matenai:	
Radius of Gyration				103.7	mm			_	1 - Steel C 255 (Prof	iles)
Radius	s or Gyratic	n Later	Γz	27.9	mm			_		
Elastic	Section N	loquius	VV yn,min	324200.0	mm -			_		
Elastic	Section N	loaulus	VV zn,min	4/000.0	mm v			_		
riastic	Section N	louulus	∠ py	0.000000	i inim Y			-		

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 SP Information No. 20050
Do you	want to transfer the changed cross-sections to RSTAB?
lf so, th	e results of RSTAB and STEEL SP will be deleted.
	Yes <u>N</u> o

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 SP 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 import 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 manually modeling the taper layout.

7.3 Units and Decimal Places

Units and decimal places for RSTAB and the add-on modules are managed in one dialog box. In STEEL SP, you can use the menu to define the units. To open the corresponding dialog box, click

Settings \rightarrow Units and Decimal Places.

The program opens the following dialog box that you already know from RSTAB. STEEL SP will be preset in the list *Program / Module*.

Program / Module STEEL SP Barta List Output Data STEEL AISC Stresses: STEEL IS Stresses: STEEL SIA Design ratios: STEEL CS Stresses: STEEL SIA Dimensionless: STEEL SIS Stresses: STEEL SS Stresses: STEEL SS Stresses: STEEL SS Dimensionless: STEEL SSI Stresses: STEEL SSI Stresses: STEEL SSI Stresses: STEEL NTC-OF Stresses: STEEL SSI Stresses: STEEL SSI Stresses: STEEL NBR Stresses: STEEL SSI Stresses: STEEL SSI Stresses: STEEL SANS Stresses: ALUMINIUM KAPPA LTB EL-PL CONCRETE Columns TIMBER Pro TIMBER Row TIMBER Row TIMBER SANC TIMBER CSA T TIMBER CSA T COMPOSITE-BEAM T	Units and Decimal Places							X
RSTAB Output Data Parts List STEEL EC3 Stesses: Unit Dec. places STEEL IS Stesses: RN/Amage 2 and a an	Program / Module		STEEL SP					
STEEL STEEL C3 STEEL AISC STEEL IS STEEL SIA STEEL SIA STEEL SIA STEEL GB STEEL C3 STEEL SIA STEEL SIA STEEL SIA STEEL SIA STEEL SIA STEEL AS STEEL ND STEEL NDCOF STEEL NDR STEEL NBR STEEL SPACE CONCRETE CONCRETE CONCRETE Columns TIMBER CSA TIMBER CSA STEEL NB	···· RSTAB							
Unit Dec. places STEEL AISC STEEL AISC STEEL SIA STEEL SIA STEEL SIA STEEL SIA STEEL SIA STEEL CS STEEL CS STEEL AS STEEL AS STEEL AS STEEL SP STEEL Plastic Member STEEL SANS ALUMINIUM KAPPA - LTB - FE-LTB - EL-PL C-TO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL		Output Data			Parts List		
STEEL AISC Stresses: kN/cm^2 v 2 * STEEL IS Design ratios: 2 * Total lengths: m v 2 * STEEL BS Stresses: • • • 3 * 2 * Surface areas: m 2 * 2 * STEEL AS Stresses: • • • 3 * 3 * 2 * Volumes: m * 2 * STEEL AS Stresses: • • • 3 * 3 * 2 * Volumes: m * 2 * STEEL NTC-DF STEEL NTC-DF STEEL NTC-DF * * * * 2 * STEEL NTC-DF STEEL SANS - - * 4 * 2 * * * * 2 * STEEL NBR STEEL SANS - </td <td> STEEL EC3</td> <td></td> <td></td> <td>Unit</td> <td>Dec. places</td> <td></td> <td>Unit</td> <td>Dec. places</td>	STEEL EC3			Unit	Dec. places		Unit	Dec. places
STEEL IS Design ratios: 2 STEEL SIA Dimensionless: 3 STEEL AS Suface areas: m ² 2 STEEL AS Weight per length: kg/m 2 STEEL SIA Weight per length: kg/m 2 STEEL SANS ALUMINIUM kg/m 2 STEEL SANS ALUMINIUM kg/m 2 Height: kg 2 Total weight: Total weight: kg 2 Total weight: Total weight: kg 2 Total weight: STEEL NBR STEEL SANS Steel SANS ALUMINIUM KAPPA Total weight: total weight: FE-LTB EL-PL Total weight: total weight: FE-LTB EL-PL Total weight: total weight: TIMBER AWC TIMBER CSA TMBER Total weight: TIMBER CSA TIMBER Total weight Total weight: TIMBER CSA TIMBER Total weight: Total weight: TIMBER CSA Total weight: Total weight: Total weight: Total weight: Total weight: Total weight: Total weight: <	STEEL AISC		Stresses:	kN/cm^2 ▼	2 🚔	Lengths:	m 🔻	2 🚔
→ STEEL SIA → STEEL BS → STEEL GB → STEEL GB → STEEL GB → STEEL AS → STEEL NTC-DF → STEEL SIP → STEEL SIP → STEEL SANS → ALUMINIUM → KAPPA − LTB → FFL TB → FEL TB → TIMBER AWC → TI	STEEL IS		_					
STEEL BS - STEEL CS - STEEL CS - STEEL AS - STEEL NTC-DF - STEEL NTC-DF - STEEL Plastic Member - STEEL Plastic Member - STEEL Plastic Member - STEEL SANS - ALUMINIUM - KAPPA - LTB - FE-LTB - EL-PL - CTO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL SIA		Design ratios:		2 🤤	Total lengths:	m 🔻	2
STEEL GB STEEL CS STEEL AS STEEL AS STEEL NTC-DF STEEL SP STEEL Plastic Member STEEL SANS ALUMINIUM KAPPA LTB FFE-LTB EL-PL C-TO-T PLATE-BUCKLING CONCRETE Columns TIMBER Pro TIMBER CSA TIMBER	- STEEL BS		Dimensionless:		3 🜩	Surface areas:	m^2 ▼	2 🚔
STEEL CS STEEL AS STEEL NTC-DF STEEL SP STEEL SP STEEL SANS ALUMINIUM KAPPA LTB FE-LTB EL-PL C-CTO-T PLATE-BUCKLING CONCRETE Columns TIMBER PRO TIMBER CSA TIMBER CSA TI	STEEL GB							
- STEEL AS - STEEL NC-DF - STEEL SP - STEEL Plastic Member - STEEL NBR - STEEL AS - STEEL SANS - ALUMINIUM - KAPPA - LTB - FE-LTB - EL-PL - CTO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER AWC - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL CS	E				Volumes:	m~3 ▼	2
STEEL NTC-DF STEEL SP STEEL SP STEEL SANS -ALUMINIUM - KAPPA - LTB - FE-LTB - EL-PL - C-TO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER AWC - TIMBER AWC - TIMBER CSA - TIMBER AWC - TIMBER AWC - TIMBER CSA	STEEL AS					Weight per length:	kg/m 👻	2 ≑
STEELSP - STEEL Plastic Member - STEEL NBR - STEEL NBR - STEEL SANS - ALUMINIUM - KAPPA - LTB - FE-LTB - EL-PL - CTO-T - PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER CSA - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL NTC-DF							
STEEL Plastic Member STEEL NBR STEEL SANS ALUMINIUM - KAPPA - LTB - FE-LTB - EL-PL - CTO-T - PLATE-BUCKLING - CONCRETE - CONCRETE - CONCRETE - TIMBER Pro - TIMBER CSA - TIMBER CSA - TIMBER CSA	STEEL SP					Weight:	kg 🔻	2 🖵
 STEEL NBR STEEL SANS ALUMINUM KAPPA LTB FE-LTB EL-PL C-CTO-T PLATE-BUCKLING CONCRETE Columns TIMBER Pro TIMBER AWC TIMBER CSA TIMBER COMPOSITE-BEAM 	- STEEL Plastic Member					Total weight:	t 🔻	3 🌩
- STEEL SANS - ALUMINIUM - KAPPA - LTB - FE-TB - EL-PL - C-TO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL NBR							
- ALDMINIUM - KAPPA - LTB - FE-LTB - EL-PL - C-TO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER Pro - TIMBER RWC - TIMBER AWC - TIMBER CSA - TIMBER CSA - TIMBER - COMPOSITE-BEAM	STEEL SANS							
- KAPPA - LTB - FE-LTB - EL-PL - CTO-T - PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	ALUMINIUM							
- LTB - FE-LTB - EL-PL - C-TO-T - PLATE-BUCKLING - CONCRETE Columns - TIMBER AWC - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	КАРРА	_						
- FELTB - EL-PL - C-TO-T - PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	LTB							
- ELPL - CTO-T - PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	FE-LTB							
- CTO-T - PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	···· EL-PL							
- PLATE-BUCKLING - CONCRETE - CONCRETE Columns - TIMBER AWC - TIMBER AWC - TIMBER - COMPOSITE-BEAM								
- CONCRETE - CONCRETE Columns - TIMBER Pro - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM *	PLATE-BUCKLING							
- CONCRETE Columns - TIMBER AWC - TIMBER AWC - TIMBER CSA - TIMBER - COMPOSITE-BEAM	CONCRETE							
	CONCRETE Columns							
	TIMBER Pro							
	- TIMBER AWC							
	TIMBER CSA							
	TIMBER							
	COMPOSITE-BEAM	-						
		n B)					OK	Cancel
		ME)					UK	Cancer



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 SP for design, you can export the modified materials to RSTAB in a similar manner as you export members and cross-sections: Open window 1.2 *Materials*, and then click

Edit \rightarrow Export All Materials to RSTAB.

You can also export the modified materials to RSTAB by 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 7.9: 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 SP, 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 7.9. Please note, however, that this option is only available in window 1.2 *Materials*.

7.4.2 Export Effective Lengths to RSTAB

If you have adjusted the materials in STEEL SP for design, you can export the modified materials to RSTAB in a similar manner as you export cross-sections: Open 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.



Figure 7.10: 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 retransfer the original effective lengths to the design module, using the options shown in Figure 7.10. Please note, however, that this option is only available in window 1.5 *Effective Lengths - Members* and 1.6 *Effective Lengths - Sets of Members*.

7.4.3 Export Results

The STEEL SP 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 SP add-on module into the global printout report (see chapter 6.1, page 44) for export. Then, in the printout report, click

File \rightarrow Export to RTF.

The function is described in the RSTAB manual, 10.1.11.

Excel / OpenOffice

STEEL SP 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

📝 With table header	Microsoft Excel
Only marked rows	OpenOffice.org Calc
	CSV file format
Transfer Parameters	
Export table to active workbook	
Export table to active worksheet	
Rewrite existing worksheet	
Selected Tables	_
Active table	Export tables with details
🔘 All tables	
🗸 Input tables	
Result tables	

Figure 7.11: 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.

	Α	B	С	D	E	F	G
1	Section	Member	Location	Load	Design		
2	No.	No.	x [m]	Case	Ratio		Design According to Formula
3	1	IP-B 55 B	I GOST, 199	14			
4		39	3,000	LC4	0,00	≤1	100) Negligible internal forces
5		21	0,000	LC2	0,02	≤1	102) Cross-section check - Compression acc. to 7.1.1
6		2	6,000	LC4	0,01	≤1	106) Cross-section check - Shear force in y-axis acc. to 8.2.3
7		32	0,000	LC2	0,14	≤1	108) Cross-section check - Shear force in z-axis acc. to 8.2.3
8		21	6,000	LC2	0,39	≤1	111) Cross-section check - Bending about y-axis acc. to 8.2.1 - Class 1
9		1	3,000	LC4	0,12	≤1	116) Cross-section check - Bending about z-axis acc. to 8.2.1 - Class 1
10		21	6,000	LC2	0,34	≤1	139) Cross-section check - Bending about y- and/or z-axis acc. to 8.2.1
11		21	6,000	LC2	0,35	≤1	181) Cross-section check - Biaxial bending about y-axis, shear and axial force acc. to 9.1.1
12		21	0,000	LC2	0,02	≤1	301) Stability analysis - Flexural buckling about y-axis acc. to 7.1.3
13		21	0,000	LC2	0,05	≤1	311) Stability analysis - Flexural buckling about z-axis acc. to 7.1.3
14		21	6,000	LC2	0,45	≤1	313) Stability analysis - Flexural-torsional buckling acc. to 7.1.5
15		1	6,000	LC2	0,30	≤1	322) Stability analysis - Lateral torsional buckling according to 8.4.1
16		21	6,000	LC2	0,39	≤1	324) Stability analysis - Bending about y-axis and axial force - In plane stability check acc. to 9.2.2
17		21	1,000	LC2	0,64	≤1	326) Stability analysis - Bending about y-axis and axial force - Out-of plane stability check acc. to 9.2.4
18						_	
19	2	IP-B 40 B	GOST, 199	14		-	
20		45	0,000	LC4	0,01	≤1	100) Negligible internal forces
21		26	0,000	LC4	0,01	≤1	101) Cross-section check - Tension acc. to 7.1.1
22		41	0,000	LC2	0,06	≤1	102) Cross-section check - Compression acc. to 7.1.1
23		23	0,000	LC2	0,15	≤1	108) Cross-section check - Shear force in z-axis acc. to 8.2.3
24		23	0,000	LC2	0,99	≤1	111) Cross-section check - Bending about y-axis acc. to 8.2.1 - Class 1
25		23	0,000	LC2	0,86	≤1	139) Cross-section check - Bending about y- and/or z-axis acc. to 8.2.1
26		23	0,000	LC2	0,89	≤1	181) Cross-section check - Biaxial bending about y-axis, shear and axial force acc. to 9.1.1

Figure 7.12: Results in Excel



8. Example

Column with Biaxial Bending

In this example, the stability design of buckling and lateral buckling is carried out by analyzing the relevant interaction conditions according to [1].

Design values



Figure 8.1: System and design loads (y-fold)

Internal forces according to linear static analysis





Design location (decisive location x)

The design is performed for all locations x (see chapter 4.5) of the member. The following internal forces act in the decisive location at x = 2.00 m:

 $N = -300.00 \text{ kN} \qquad M_y = 10.00 \text{ kNm} \qquad M_z = 7.50 \text{ kNm} \qquad Q_y = 3.75 \text{ kN} \qquad Q_z = 0.00 \text{ kN}$

Cross-section properties IP 30 S1

Property	Symbol	Value	Unit
Area of cross-section	Ag	68.31	cm ²
Moment of inertia	ly	10400.00	cm⁴
Moment of inertia	lz	1040.00	cm⁴
Radius of inertia	r _y	12.34	cm
Radius of inertia	rz	4.64	cm
Cross-section weight	G	53.60	kg/m
Moment of torsional rigidity	J	22.34	cm ⁴
Warping moment of inertia	C _w	287500.00	cm⁵
Elastic cross-section modulus	$W_{\text{yn,min}}$	715.00	cm³
Elastic cross-section modulus	W _{nz,min}	147.00	cm³

Material properties C 275

Property	Symbol	Value	Unit
Characteristic strength	R _{yn}	27.50	kN/cm ²
Partial safety factor	γm	1.025	-
Design strength	Ry	26.83	kN/cm ²
Modulus of elasticity	E	21000.00	kN/cm ²

Slenderness check of cross-section – Tables 9 and 10

Compression according to 7.3

Flange – Table 10

<u>Slenderness</u>

 $\lambda_{f} = (b_{ef} / t_{f}) \sqrt{R_{y} / E}$ $R_{y} = 26.83 \text{ kN/cm}^{2}$

 $E = 21000 \text{ kN/cm}^2$

 $b_{ef}/t_f = 7.8/1.1 = 7.091$

$$\lambda_{f} = (b_{ef} / t_{f}) \sqrt{R_{y} / E} = 7.091 \sqrt{26.83 / 210000} = 0.253$$

Limit slenderness ratio

$$\begin{split} \overline{\lambda}_{uf} &= 0.36 + 0.10\overline{\lambda} \\ \overline{\lambda} &= \lambda \sqrt{R_y / E} \\ \lambda &= \max(\lambda_y, \lambda_z) \\ \lambda &= \max(I_{ef,y} / i_y, I_{ef,z} / i_z) = \max(400 / 12.34, 400 / 4.64) = \max(32.42, 86.22) = 86.22 \end{split}$$

 $R_v = 26.83 \text{ kN/cm}^2$ $E = 21000 \text{ kN/cm}^2$ $\overline{\lambda} = 86.22\sqrt{26.83/210000} = 3.082$ $\overline{\lambda}_{uf} = 0.36 + 0.10\overline{\lambda} = 0.36 + 0.1 \cdot 3.082 = 0.668$ $\lambda_f < \overline{\lambda}_{uf}$ - Stiffeners are not necessary Web – Table 9 <u>Slenderness</u> $\lambda_{w} = (h_{ef} / t_{w}) \sqrt{R_{y} / E}$ $R_y = 26.83 \text{ kN/cm}^2$ $E = 21000 \text{ kN/cm}^2$ $h_{ef}/t_{w} = 23.3/0.8 = 29.12$ $\lambda_w = (h_{ef} / t_w) \sqrt{R_y / E} = 29.12 \sqrt{26.83 / 210000} = 1.041$ Limit slenderness ratio $\overline{\lambda} = 86.22\sqrt{26.83/210000} = 3.082$ for $\overline{\lambda} > 2.0$ $\overline{\lambda}_{UW} = 1.20 + 0.35\overline{\lambda}$ $\overline{\lambda}_{W} = 1.20 + 0.35\overline{\lambda} = 1.20 + 0.35 \cdot 3.082 = 2.60$ $\lambda_w < \overline{\lambda}_{uw}$ - Reduction of cross-section area is not necessary

Cross section check

Shear and bending according to 8.2

Design Formula (44):

$$\frac{0.87}{\mathsf{R}_y\gamma_c}\sqrt{\sigma_y^2-\sigma_y\sigma_z+\sigma_z^2+3\tau_{yz}^2} \le 1.0$$

This formula is applied to the stresses due to bending and shear that exist at the most exposed stress point no. 1 of the cross-section (see figure to the left).

$$\frac{0.87}{26.83 \cdot 0.95} \sqrt{1.4^2 - 1.4 \cdot 5.1 + 5.1^2 + 0} \le 1.0$$
$$\frac{0.87}{26.83 \cdot 0.95} \cdot 5.92 \le 1.0$$
$$0.20 \le 1.0$$

- OK

Design Formula (44):

$$\frac{r_{yz}}{R_s \gamma_c} \le 1.0$$

_

This part of the formula is applied to the shear stresses that exist at stress point no. 3.

$$\frac{0.13}{15.56 \cdot 0.95} \le 1.0$$
$$0.01 \le 1.0$$

- OK





Biaxial bending and compressive force according to 9.1.1

Design Formula (105):

$$\left(\frac{N}{A_{n}R_{y}\gamma_{c}}\right)^{n} + \left(\frac{M_{y}}{c_{y}W_{yn,min}R_{y}\gamma_{c}}\right) + \left(\frac{M_{z}}{c_{z}W_{zn,min}R_{y}\gamma_{c}}\right) \le 1.0$$

$$A_f / A_w = 20 \cdot 1.1 / 26.9 \cdot 8 = 1.02$$

We linearly interpolate the values in Table F.1 to determine these coefficients:

$$c_y = 1.069, \ c_z = 1.47, \ n = 1.5$$

Service factor for columns: $\gamma_c = 0.95$

$$\left(\frac{300}{68.31 \cdot 26.83 \cdot 0.95}\right)^{1.5} + \left(\frac{1000}{1.069 \cdot 715 \cdot 26.83 \cdot 0.95}\right) + \left(\frac{750}{1.47 \cdot 147 \cdot 26.83 \cdot 0.95}\right) \le 1.0$$

 $(0.17)^{1.5} + 0.05 + 0.14 \le 1.0$

 $0.26 \leq\! 1.0$

- OK

Stability check

Biaxial bending and compressive force according to 9.2

Design Formula (116):

 $N/(\varphi_{eyz}AR_y\gamma_c) \le 1.0$

Design Formula (117):

 $\varphi_{\text{evz}} = \varphi_{\text{ez}} \left(0.6 \sqrt[3]{\text{c}} + 0.4 \sqrt[4]{\text{c}} \right)$

For the linear interpolation of ϕ_{ez} according to Table E.3, the values of the relative eccentricity $m_{ef,z}$ and of the flexibility $\overline{\lambda}_z$ are required.

 $\overline{\lambda}_z = \lambda_z \sqrt{R_y / E}$

 $\overline{\lambda}_z = 86.22\sqrt{26.83/210000} = 3.082$

 $m_{ef,z} = \eta m_z$

where m_z eccentricity ratio η coefficient of cross

coefficient of cross-section shape acc. to Table E.2

 $m_z = e_z A / W_{c,z}$

W_{c,z} is the sectional modulus computed for the most compressed fiber.

 $e_z = M_z / N$

 $e_z = 750/300 = 2.5 \text{ cm}$

 $m_{z} = 2.5 \cdot 68.31/147 = 1.16$

For $\overline{\lambda}_z$ = 3.082 , m_z = 1.16 and A_f / A_w = 1.022 , the shape coefficient η according to Table E.2 can be determined as follows:

$$\eta = (1.90 - 0.1 \cdot m_z) - 0.02(6 - m_z) \cdot \overline{\lambda}_z$$
$$\eta = (1.90 - 0.1 \cdot 1.16) - 0.02(6 - 1.16) \cdot 3.082 = 1.485$$

$$m_{ef,z} = 1.485 \cdot 1.16 = 1.723$$

8 Example



For $m_{ef,z}$ = 1.723 and $\overline{\lambda}_z$ = 3.082, the value of ϕ_{ez} can be linearly interpolated according to Table E.3:

```
\phi_{ez}=0.337
```

The coefficient c is to be calculated according to Formulas (112), (113) or (114).

$$m_y = e_y A / W_{c,y}$$

 $e_y = M_y / N$

 $e_{y} = 1000/300$

 $e_y = 3.33 cm$

 $m_y = 3.33 \cdot 68.31/715 = 0.318$

For the eccentricity ratio $m_{\gamma}<5$, Formula (112) is to be applied to determine the coefficient c.

$$c = \beta / (1 + \alpha m_y) \le 1.0$$

The coefficients $\alpha \,$ and $\,\beta \,$ are taken from Table 21.

$$c = 1.0/(1+0.7\cdot0.318) \le 1.0$$

c = 0.818

We can now apply the coefficient c in Formula (117):

$$\varphi_{evz} = \varphi_{ez} \left(0.6 \sqrt[3]{c} + 0.4 \sqrt[4]{c} \right)$$

 $\phi_{eyz} = 0.337 \Big(0.6 \sqrt[3]{0.818} + 0.4 \sqrt[4]{0.818} \Big) = 0.318$

Finally we get from Formula (118):

```
N/(\phi_{eyz}AR_y\gamma_c) \le 1.0
```

 $300/(0.318 \cdot 68.31 \cdot 26.83 \cdot 0.95) \le 1.0$

 $0.542 \le 1.0$

- OK

A Literature

- Code of Rules for Steel Structures SP 16.13330.2011, Revised version SNIP II-23-81*, Moscow 2011
- [2] Rules for Member Stability in EN 1993-1-1, ECCS Technical Committee 8 Stability



B Index

В

Background graphic
Beam type23
Buckling20
Buckling about axis21
Buttons
c
Calculation25
Cantilever
Clipboard51
Color spectrum
Colored design
Column buckling
Control panel42
Coordinate system14
Cross-section
Cross-section class
Cross-section design
Cross-section library14
Cross-section optimization
Cross-section type15
Cross-sectional area24
D
D Decimal places
D Decimal places 12, 50 Deflection
D Decimal places
D Decimal places
D Decimal places
D Decimal places
D Decimal places
D Decimal places
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E 25
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E Effective length
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E Effective length 19, 22, 51 Effective slenderness 25
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52 Exit STEEL SP 8
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52 Exit STEEL SP 8 Export 51
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52 Exit STEEL SP 8 Export 51 Export cross-section 49
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 52 Excel 52 Exit STEEL SP 8 Export 51 Export cross-section 49 Export effective length 51
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52 Exit STEEL SP 8 Export 51 Export effective length 51
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 52 Excel 52 Exit STEEL SP 8 Export 51 Export effective length 51 Export effective length 51 Export effective length 51
D Decimal places 12, 50 Deflection 25 Deformation analysis 23 Design 9, 15, 28, 29, 30 Design case 39, 46, 47 Design situation 30 Details 25 Display navigator 40, 42 E E Effective length 19, 22, 51 Effective slenderness 25 Excel 52 Exit STEEL SP 8 Export 51 Export cross-section 49 Export material 51 Export material 51 Favorites 48

Filter
Filtering members
G
General Data8
Graphic
Graphic printout
н
Hidden result diagram
1
Info about cross-section
Installation5
Intermediate Lateral Restraints
Intermediate restraints18
Internal forces
к
K factor
1
Lateral restraint
Lateral torsional buckling 18.21
Length 19.36
List of members
Load application
Load case
Load combination
Location x
м
Material 51
Material description 12
Material library
Material properties
Materials
Members
N
Navigator
0
OpenOffice 52
Optimization 15 26 48 49
P
Panel 7.40.43
Parameterized cross-section
Parameters 24
- arameter J

Part
Partial safety factors26
Parts list
Plastic design26
Precamber23
Print
Printout report
R
Reference length11
Reference scales
Relatively18
Remark16
Rendering42
Result combination9, 10
Result diagram41, 44
Results evaluation
Results representation40
Results values
Results window28
RSBUCK20
RSTAB graphic44
RSTAB work window39
S
Selecting windows8
Service factor24
Serviceability25
Serviceability limit state 11, 23, 25, 38

Set of members......9, 22, 23, 31, 34, 37 Shifted member ends......25



Slenderness
Spacial cases
Stability analysis
Stainless steel13
Start calculation
Start program6
Start STEEL SP6
Stress point 17
Sum
Surface area
т
Tapered member16, 30, 50
Torsional support18
Transverse load 26
U
Ultimate limit state9, 38
Undeformed system25
Units 12, 50
User profile