

Version January 2021

Add-on Module

RF-/ALUMINUM ADM

Ultimate and Serviceability Limit State Design According to ADM

Program Description

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1 Introduction

1.1 Add-on Module RF-/ALUMINUM ADM

The *Aluminum Design Manual* [1] provides design rules for aluminum structures in the United States of America. With the add-on modules RF-ALUMINUM ADM (for RFEM) and ALUMINUM ADM (for RSTAB), users obtain highly efficient and universal tools to design aluminum structures modeled with member elements according to this Specification.



This manual describes the add-on modules of both main programs conjointly under the designation **RF-/ALUMINUM ADM**.

RF-/ALUMINUM ADM carries out all typical ultimate limit state designs and stability analyses using either the allowable strength or load and resistance factor design method. They include the calculation of the allowable stresses for sections subject to tension, compression, flexure, shear, torsional or flexural-torsional buckling, as well as the design for combined forces.

For the stability analysis, you can specify for each member or set of members whether flexural buckling in the y- and/or z-direction is possible. You can also define additional lateral restraints in order to represent the model close to reality. From the boundary conditions, RF-/ALUMINUM ADM determines the slenderness ratios and the elastic critical buckling loads. The point of load application is considered as well, which has an effect on the torsional resistance.

For structures with slender cross-sections, the serviceability limit state represents an important design. The load cases, load or result combinations – defined with the relevant safety factors – can be adequately selected for the deflection analysis. If necessary, you can adjust the limit deformations to your specific demands.

The program allows you to optimize cross-sections and export the modified cross-sections to RFEM or RSTAB. Using the design cases, you can design separate structural components in complex structures or analyze variants.

Since RF-/ALUMINUM ADM is integrated in the main programs RFEM and RSTAB, the design relevant input data is already available when you open the module. After the calculation, you can evaluate the designs graphically in the RFEM or RSTAB work window.

Last but not least, it is possible to cover the analysis progress in the global printout report, from the determination of internal forces up to the results of the design.

We hope you enjoy working with RF-/ALUMINUM ADM.

Your DLUBAL team

1.2 Using the Manual

Topics like installation, graphical user interface, results evaluation, and printout are described in the manual of the main programs RFEM or RSTAB. The present manual focuses on typical features of the RF-/ALUMINUM ADM add-on module.

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The explanations in this manual follow the sequence of the input and result windows. In the text, the described **buttons** are given in square brackets, for example [View mode]. At the same time, they are pictured on the left. **Expressions** appearing in dialog boxes or windows are set in *italics*.

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



In RFEM/RSTAB, you have two options to start the add-on module RF-/ALUMINUM ADM.

Menu

To start the program from the RFEM or RSTAB menu bar, click

Add-on Modules \rightarrow Design - Aluminum \rightarrow RF-/ALUMINUM ADM.

Add	-on Modules Window	<u>H</u> e	lp	
4 0	Current Module			- 🔹 👂 🗶 🎬 😂 🚧 📾 📾 🗄 🎬 🥵 🤹 🏦 🎾 🗞 💠
	Design - Steel	Þ	Ŧ	💥 🔍 🔇 🗗 🕅 🛱 🎵 🛱 🛱 🛪 🔽 - 🎯 - 17 🖘 🚑 🗇 🧃
	Design - Concrete	►		
	Design - Timber	►		
	Design - Aluminum	•	EC9	RF-ALUMINUM Design of aluminum members according to Eurocode 9
	Dynamic	►	ADM	RF-ALUMINUM ADM Design of aluminum members according to ADM
	Connections	►		3
	Foundations	►		
	Stability	►		
	Towers	►		
	Piping	►		
	Others	×		
	External Modules	Þ		
	Stand-Alone Programs	Þ		

Figure 1.1: Menu Add-on Modules \rightarrow Design - Aluminum \rightarrow RF-ALUMINUM ADM

Navigator

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

Add-on Modules \rightarrow RF-/ALUMINUM ADM.

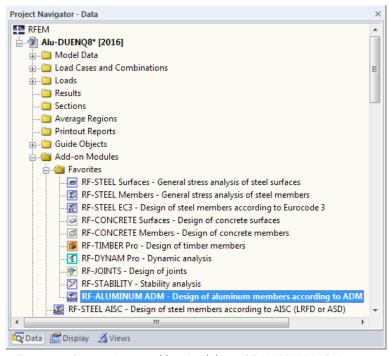


Figure 1.2: Data navigator Add-on Modules \rightarrow RF-ALUMINUM ADM

2 Input Data

When you start the add-on module RF-/ALUMINUM ADM, a new window appears. In this window, a navigator is displayed on the left, managing all available tables. The drop-down list above the navigator contains the design cases (see Chapter 7.1, page 54).

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

- Members and sets of members
- Load cases, load and result combinations
- Materials

6 3

Cancel

OK

- 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.

[OK] saves the results. Thus, you exit RF-/ALUMINUM ADM and return to the main program RFEM or RSTAB. To quit the add-on module without saving the new data, click [Cancel].

2.1 General Data

In the *1.1 General Data* Window, you can select the members, sets of members and actions you want to design. The two tabs manage the load cases, load and result combinations for the ULS and SLS analyses.

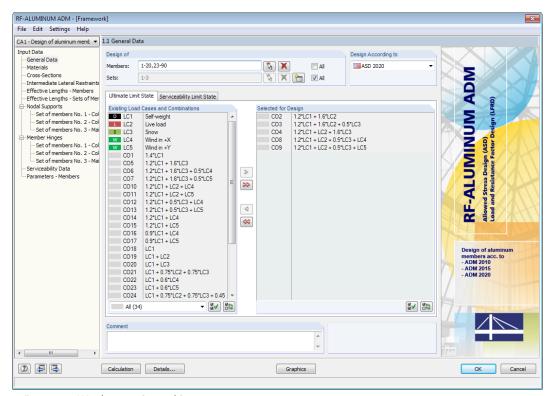


Figure 2.1: Window 1.1 General Data

Design of

Design of					
Members:	1,2,11,12,21,22,31,32,44,51,52,61-64,81-83,91-96,5	\$	×	All	
Sets:	1-8	13	\times	✓ All	

Figure 2.2: Design of members and sets of members

	×	
ĺ	\$	

The design can be carried out for *Members* and *Sets of Members*. If you want to design only selected objects, clear the *All* check box. Then you can access the text boxes and enter the numbers of the relevant members or sets of members. You can remove the list of numbers in the text boxes with the [Delete] button. Use the [Select] button to choose the objects graphically in the RFEM or RSTAB work window.

When you design a set of members, the program determines the extreme values of the analyses of all members contained in the set of members and takes into account the boundary conditions of connected members for the stability analysis. The results are shown in the 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 RFEM or RSTAB appears where you can define the parameters of the set of members.

Design According to

Design According to		
ASD 2020	~	
ASD 2020 Allowable Stro	ess Design	
LRFD 2020 Load and Res	istance Factor Design	
ASD 2015 Allowable Stre	ess Design	
ERFD 2015 Load and Res	istance Factor Design	
ASD 2010 Allowable Stre	ess Design	
ERFD 2010 Load and Res	istance Factor Design	

Figure 2.3: Design according to ASD or LRFD

In the drop-down list box in the upper-right corner of the window, you can select the design method for strength. The design for strength using the provisions for Allowable Strength Design *ASD 2020* is based on [1] Equation B.3-2:

$$R_a \le \frac{R_n}{\Omega} \tag{2.1}$$

The design for strength using the provisions for Load and Resistance Factor Design *LRFD 2020* is covered by [1] Equation B.3-1:

$$R_{u} \le \phi R_{n} \tag{2.2}$$

If a model has to be recalculated according to the revised Specifications ADM 2015 [2] or ADM 2010 [3], the respective items can be selected from the list.

Comment

Comment	
Design 2014-T6, T651	*
	~

Figure 2.4: User-defined comment

In this text box, you can enter user-defined notes, for example to describe the current design case.

2.1.1 Ultimate Limit State

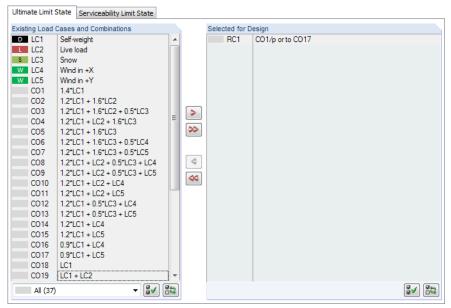


Figure 2.5: Window 1.1 General Data, tab Ultimate Limit State

Existing Load Cases and Combinations

Select all cases in the list

Invert selection of load cases

This column lists all load cases, load and result combinations that have been created in RFEM or RSTAB.

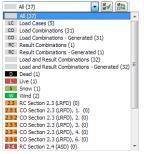
Use the > button to transfer the selected entries to the *Selected for Design* table on the right. Alternatively, you can double-click the entries. To transfer the entire list to the right, use the ≫ button.

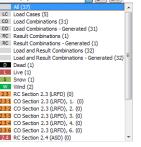
To transfer multiple entries of load cases, click the entries while pressing the [Ctrl] key, as common for Windows applications. Thus, you can transfer several load cases at the same time.

Load cases marked in red cannot be designed: This happens when the load cases are defined without any load data or contain only imperfections.

At the end of the list, several filter options are available. They will help you to assign the en-

tries sorted by load case, load combination, or action category. The buttons have the following









The column on the right lists the load cases as well as the load and result combinations selected for design. Use the 💽 button or double-click the entries to remove selected entries from the list. Use the < button to transfer the entire list to the left. 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 actions is difficult to discern. Second, for the determination of the elastic critical moment M_e for lateral-torsional buckling, the envelope of the moment distributions is analyzed, from which the most unfavorable distribution (max or min)



2 Input Data

is taken. However, this distribution only rarely reflects the moment distribution in the individual load combinations. Therefore, unfavorable values for M_e may be applied for result combinations.

Details...

In the dialog box *Details*, tab *General* you can specify how result combinations of the 'or' type are to be handled for the design (see Chapter 3.1.4, page 31).

Result combinations should be selected for design only in case of dynamic combinations. For "ordinary" combinations, load combinations are recommended, since there are the actual moment distributions taken for the determination of M_e.

2.1.2 Serviceability Limit State

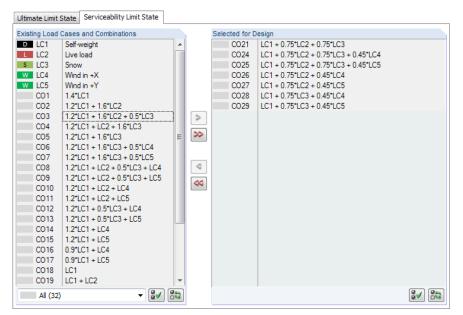


Figure 2.6: Window 1.1 General Data, tab Serviceability Limit State

Existing Load Cases and Combinations

This section lists all load cases, load and result combinations that have been created in RFEM or RSTAB.

Selected for Design



You can add or remove load cases, load combinations, and result combinations as described in Chapter 2.1.1.

Chapter L of the Aluminum Design Manual [2] provides recommendations concerning the deflections for serviceability. To adjust the preset values, click the [Details] button. The *Details* dialog box appears (see Figure 3.3, page 30) where you can change the limits in the *Serviceability* tab.

In the *1.9 Serviceability Data* Window, you can specify the reference lengths that are governing for the deformation analysis (see Chapter 2.9, page 25).

2.2 Materials

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

A			B			
laterial Material						
No. Description			Comment			
1 Aluminium Alclad 3003-H18 (Drawn Tube) ADM 201	5 🔳					
2 Steel A36 ANSI/AISC 360-05:2005-03						
3 Aluminium 5052-H32 (Sheet Plate, Rod Bar) ADM 2	015					
			X	3		
aterial Properties						
Main Properties	_					
Modulus of Elasticity	E	10095.100				
Shear Modulus	G	3785.670				
Poisson's Ratio	v	0.330				
Specific Weight	γ	171.89				
 Coefficient of Thermal Expansion 	α	1.2778E-05	1/°F			
 Partial Safety Factor 	γM	1.00		E	Material No. 1 use	d in
Additional Properties						
□ Thickness Range t ≤ 0.49 in					Cross-sections No	d
Tensile Ultimate Strength	Ftu	26.108			1,4,7	
Tensile Yield Strength	Fty	23.207				
 Compressive Yield Strength 	Fcy	20.306			Members No.:	
Shear Ultimate Strength	Fsu	15.230	ksi			
Shear Yield Strength	Fsy	13.924	ksi		3-15, 18-20, 23-2	7,30,35,40-53,55,58,
 Tensile Ultimate Strength of Weld-Affected Zones 	Ftuw	13.054	ksi			
 Tensile Yield Strength of Weld-Affected Zones 	Ftyw	4.351	ksi		Sets of members 1	No.:
 Compressive Yield Strength of Weld-Affected Zones 	Feyw	4.351	ksi		2,3	
 Shear Ultimate Strength of Weld-Affected Zones 	Fsuw	10.153	ksi		2,3	
Buckling Constant (Unwelded)	Bc	22.800	ksi			
Buckling Constant (Unwelded)	Do	0.133	ksi		Σ Lengths:	Σ Masses:
Buckling Constant (Unwelded)	Co	114.000			404.64 [ft]	0.18 [kip
Buckling Constant (Unwelded)	Bo	27.100	ksi			
Buckling Constant (Unwelded)	Dp	0.172				
 Buckling Constant (Unwelded) 	Cp	105.000				

Figure 2.7: 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 that are required to determine the internal forces are described in Chapter 4.3 of the RFEM manual and Chapter 4.2 of the RSTAB manual (*Main Properties*). The material properties required for design are stored in the global material library, too. Those values are preset (*Additional Properties*).

You can adjust the units and decimal places of the material properties and stresses using the menu **Settings** \rightarrow **Units and Decimal Places** (see Chapter 7.3, page 58).

Material Description

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

Aluminium Alclad 3003-H18 (Drawn Tube) ADM 2010	•	
Aluminium 3003-H18 (Drawn Tube)	ADM 2010	
Aluminium Alclad 3003-H12 (Sheet Plate)	ADM 2010	
Aluminium Alclad 3003-H14 (Sheet Plate)	ADM 2010	
Aluminium Alclad 3003-H16 (Sheet)	ADM 2010	
Aluminium Alclad 3003-H18 (Sheet)	ADM 2010	
Aluminium Alclad 3003-H14 (Drawn Tube)	ADM 2010	
Aluminium Alclad 3003-H18 (Drawn Tube)	ADM 2010	
Aluminium 3004-H32 (Sheet_Plate)	ADM 2010	
Aluminium 3004-H34 (Sheet Plate)	ADM 2010	
Aluminium 3004-H36 (Sheet)	ADM 2010	-

Figure 2.8: List of Materials

According to the design concept of the Specification [2], only materials of the *Aluminium* category are available in the list.

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, RF-/ALUMINUM ADM will import the material properties, too.

Generally, the material properties are not editable in the RF-/ALUMINUM ADM add-on module.

Material Library

Many materials are available in a library. To open the material library, click

$\mathbf{Edit} \to \mathbf{Material} \ \mathbf{Library}$

Naterial Library				
Filter	Material to Select			
Material category group:	Material Description	Standard		
	Aluminum 3003-H18-B209 (Sheet and Plate)	ADM 202		
Metal ~			-	
Material category:	Aluminum 3003-H18-B210 (Drawn Tube)	ADM 202	-	
	Aluminum Alclad 3003-H12-B209 (Sheet and Plate)	ADM 202	-	
Aluminum ~	Aluminum Alclad 3003-H14-B209 (Sheet and Plate)	ADM 202	0	
Standard group:	Aluminum Alclad 3003-H16-B209 (Sheet and Plate)	ADM 202	0	
	Aluminum Aldad 3003-H14-B210 (Drawn Tube)	ADM 202	0	
ASTM ~	🔲 Aluminum Aldad 3003-H18-B210 (Drawn Tube)	ADM 202	0	
Standard:	Aluminum 3004-H32-B209 (Sheet and Plate)	ADM 202	0	
	Aluminum 3004-H34-B209 (Sheet and Plate)	ADM 202	0	
ADM 2020 ~	Aluminum 3004-H36-B209 (Sheet and Plate)	ADM 202	-	
	—	ADM 202		
	Aluminum 3004-H38-B209 (Sheet and Plate)		-	
	Aluminum Alclad 3004-H32-B209 (Sheet and Plate)	ADM 202	-	
	Aluminum Alclad 3004-H34-B209 (Sheet and Plate)	ADM 202	0	
	Aluminum Alclad 3004-H36-B209 (Sheet and Plate)	ADM 202	0	
	Aluminum 3005-H25-B209 (Sheet and Plate)	ADM 202	0	
	Aluminum 3005-H28-B209 (Sheet and Plate)	ADM 202	0	
Include invalid 😽	Aluminum 3105-H25-B209 (Sheet and Plate)	ADM 202	0	
Favorites group:	Aluminum 5005-H12-B209 (Sheet and Plate)	ADM 202	-	
			0	
Beton - DIN 🛛 🗸 🎦 🐷	Search:		n	
	Search:			
Material Properties	Search:	ad 3003-H18-B21		e) ADM :
Material Properties	Search:		0 (Drawn Tub	
Material Properties	Search:	ad 3003-H18-B21		ksi
Material Properties	Search:	ad 3003-H18-B21	0 (Drawn Tub 10100.000	ksi
Material Properties Control Main Properties Modulus of Elasticity Shear Modulus	Search:	ad 3003-H18-B21	0 (Drawn Tub 10100.000 3800.000 0.330	ksi
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion	Search: Aluminum Alc	ad 3003-H18-B21	0 (Drawn Tub 10100.000 3800.000 0.330	ksi ksi Ibf/ft3
Material Properties ☐ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion ☐ Additional Properties	Search: Aluminum Alc	ad 3003-H18-B21 E G V Y	0 (Drawn Tub 10100.000 3800.000 0.330 176.21	ksi ksi Ibf/ft3
Material Properties ☐ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion ☐ Additional Properties ☐ Thickness Range t ≤ 0.50 in	Search: Aluminum Alc	ad 3003-H18-B21 E G V γ α	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05	ksi ksi Ibf/ft ³ 1/°F
Material Properties ☐ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion ☐ Additional Properties ☐ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength	Search: Aluminum Alc	E G V γ α F tu	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000	ksi ksi Ibf/ft ³ 1/°F ksi
Material Properties ■ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion ■ Additional Properties ■ Thickness Range t ≤ 0.50 in Tensile Utimate Strength ■ Tensile Vield Strength	Search: Aluminum Alc	E G V 7 α Ftu Fty	0 (Drawn Tub) 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000	ksi ksi Ibf/ft ³ 1/°F ksi ksi
Material Properties ☐ Main Properties Modulus of Easticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion ☐ Additional Properties ☐ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength Tensile Vield Strength Compressive Yield Strength	Search: Aluminum Alc	ad 3003-H18-B21 E G ν γ α	0 (Drawn Tube 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700	ksi ksi lbf/ft ³ 1/°F ksi ksi ksi
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion Additional Properties □ Thickness Range t ≤ 0.50 in Tensile Utimate Strength Compressive Yield Strength Shear Utimate Strength	Search: Aluminum Alc	ad 3003-H18-B21 E G ν γ α Ftu Fty Fey Fsu Fsu	0 (Drawn Tub) 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600	ksi ksi Ibf./ft ³ 1/°F ksi ksi ksi ksi
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion Additional Properties □ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength Compressive Yield Strength Shear Ultimate Strength Shear Yield Strength	Search:	E G V γ γ α Ftu Fty Fcy Fsu Fsu Fsu Fsu Fsu Fsu Fsu	0 (Drawn Tube 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800	ksi ksi lbf./ft ³ 1/°F ksi ksi ksi ksi ksi
Material Properties ■ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion ■ Additional Properties ■ Thickness Range t ≤ 0.50 in Tensile Utimate Strength Shear Utimate Strength Shear Utimate Strength Tensile Utimate Strength Tensile Utimate Strength Tensile Utimate Strength of V	Image: Search:	ad 3003-H18-B21 E G V γ α Ftu Fty Fsy Fsu Fsy Ftw Ftw	0 (Drawn Tube 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 13.000	ksi ksi bf/ft ³ 1/°F ksi ksi ksi ksi ksi ksi
Material Properties ☐ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Thermal Expansion ☐ Additional Properties ☐ Thickness Range t ≤ 0.50 in Tensile Vield Strength Shear Ultimate Strength Shear Vield Strength Tensile Ultimate Strength Shear Yield Strength Tensile Utimate Strength of Weile Tensile Utimate Strength of Weile	Yeld-Affected Zones d-Affected Zones	ad 3003-H18-B21 E G V γ α Ftu Fry Foy Fsu Fsy Ftw Ftw Ftw Fsy Ftw Ftw Ftw	0 (Drawn Tub) 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 4.500	ksi ksi bf./ft ³ 1/°F ksi ksi ksi ksi ksi ksi ksi ksi ksi
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion Additional Properties □ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength Shear Vield Strength Shear Yield Strength Shear Yield Strength of Weile Compressive Yield Strength of Weile	Yeld-Affected Zones J-Affected Zones f Weld-Affected Zones	ad 3003-H18-B21 E G V γ α Ftu Fty Fey Fsu Fsy Ftyw Foyw Foyw	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 13.800 4.500 4.500	ksi ksi lbf/ft ³ 1/°F ksi ksi ksi ksi ksi ksi ksi ksi ksi
Material Properties Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion Additional Properties □ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength Compressive Yield Strength Shear Ultimate Strength Shear Vield Strength Tensile Vield Strength of V Tensile Yield Strength of Weil Compressive Yield Strength of Weil Shear Ultimate Strength of Weil Compressive Yield Strength of Weil Shear Ultimate Strength of Weil Compressive Yield Strength of Weil Compressive Yield Strength of Weil Compressive Yield Strength of Weil	Yeld-Affected Zones d-Affected Zones eld-Affected Zones eld-Affected Zones eld-Affected Zones	E G V γ γ α Ftu Fty Fcy Fsu Fsu Fsu	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 13.800 4.500 7.800	ksi ksi lbf/ft ³ 1/*F ksi ksi ksi ksi ksi ksi ksi ksi ksi ksi
Material Properties ☐ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion ☐ Additional Properties ☐ Thickness Range t ≤ 0.50 in Tensile Ultimate Strength Shear Yield Strength Shear Yield Strength Shear Yield Strength Tensile Vitimate Strength of V Tensile Vitimate Strength of Vel Compressive Yield Strength of Vel	Yeld-Affected Zones d-Affected Zones d-Affected Zones d-Affected Zones d-Affected Zones d-Affected Zones Affected Zones	ad 3003-H18-B21 E G V γ α Ftu Fty Fey Fsu Fsy Ftyw Foyw Foyw	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 13.800 4.500 4.500	ksi ksi bf./ft 3 1/~F ksi ksi ksi ksi ksi ksi ksi ksi ksi ksi
Material Properties ■ Main Properties Modulus of Elasticity Shear Modulus Poisson's Ratio Specific Weight Coefficient of Themal Expansion Additional Properties Thickness Range t ≤ 0.50 in Tensile Utimate Strength Compressive Yield Strength Shear Wield Strength Shear Utimate Strength of Weid Compressive Yield Strength of Weid Compressive Yield Strength of Weid Compressive Yield Strength of Weid Shear Utimate Strength of Weid Shear Utimate Strength of Weid Shear Yield Strength of Weid	Yeld-Affected Zones d-Affected Zones d-Affected Zones eld-Affected Zones eld-Affected Zones Affected Zones Affected Zones Affected Zones Affected Zones Affected Zones Affected Zones J)	ad 3003-H18-B21 E G V γ α Ftu Fty Fcy Fsu Fsu Ftw Fuw Fuw Fuw Fuw Fsuw Fsuw	0 (Drawn Tub 10100.000 3800.000 0.330 176.21 1.3000E-05 26.000 23.000 20.700 15.600 13.800 13.800 13.800 0.3.000 4.500 4.500 2.700	ksi ksi bf/ft ³ 1/"F ksi ksi ksi ksi ksi ksi ksi ksi ksi ksi

Figure 2.9: Dialog box Material Library

2

In the *Filter* section, the current *Aluminium* material category is preset. Select the specific material in the *Material to Select* list. You can check the corresponding properties in the dialog section below.

Cancel

OK

OK

Click [OK] or use the [←] button to transfer the selected material to Window 1.2.

Chapter 4.3 of the RFEM manual and Chapter 4.2 of the RSTAB manual describe how materials can be filtered, added, or rearranged in the library.

2.3 Cross-Sections

This window lists the cross-sections used for design. In addition, you can specify optimization parameters here.

Coordinate System



The sectional coordinate system **yz** of RF-/ALUMINUM ADM corresponds to the one of RFEM or RSTAB (see image in Figure 2.10). The **y**-axis represents the major principal axis of the cross-section, the **z**-axis the minor axis. This coordinate system is used for both the input data and the results.

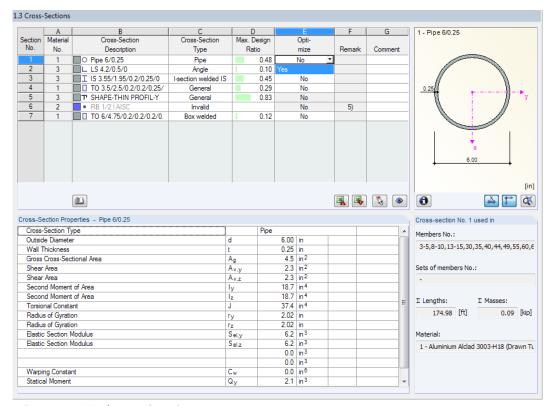


Figure 2.10: Window 1.3 Cross-Sections

Cross-Section Description

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

If you want to modify a cross-section, click the entry in column B. Then click [Cross-Section Library] or in the box, or press the function key [F7] to open the cross-section table of the current cross-section (see Figure 2.11).

3

1

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

Chapter 4.13 of the RFEM manual and Chapter 4.3 of the RSTAB manual describe how cross-sections can be selected from the library.

RF-/ALUMINUM ADM designs many types of cross-sections from the library or SHAPE-THIN sections. If the type of a section is *General* (see Figure 2.12), not all design options are available, however.

Figure 2.11: Parametric rectangular hollow section

RF-/ALUMINUM ADM performs all relevant designs for the following cross-section types:

- I-sections: rolled/welded, doubly symmetrical or mono-symmetric about the z-axis
- Hollow and box sections: rolled/welded, square-edged/rectangular, doubly-symmetrical
- Massive cross-sections: circular/rectangular
- Pipes
- Angles: rolled/welded simple sections with equal or unequal legs
- T-sections: rolled/welded, symmetrical about z-axis
- Channel-sections: rolled/welded, symmetrical about y-axis

Cross-Se	ction Lib	rary								
Rolled				Paramet	ric - Thin-	-Walled		Parametric - Massiv	'e	Parametric - Timber
I	Γ	$ \mathbf{T} $	L	I	Τ	Γ	Т	I T	T I	
0	0	0	۷	Т	L	L		T •	0	III III 0 00
l	1	\sim	•	L	I	Т	T	V H	I T	ттпп
				0	∇	Π	Π	TL	l s	ттт
Built-up				n	Ŭ	Π	Π	π	₩ ●	
II	I	T	٦Г	Ŧ	Ĭ	+	•	• •		II I V
Т	I	Ŧ	T	-	Ī	l	Г		T	
Ι	Ī	1	Ιē	Τ	C	۲,	亡			Standardized - Timber
••	T			Σ	0	∇	0			
								User-Defined		From Cross-Section Program
								۲		EJ
2	2 3									Cancel

Figure 2.12: Cross-sections of type General (highlighted)

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2 Input Data

You can directly enter the new cross-section description in column B. If the entry is listed in the database, RF-/ALUMINUM ADM imports the cross-section parameters.

A modified cross-section will be highlighted in blue.

If the cross-sections in RF-/ALUMINUM ADM are different from the ones used in RFEM or RSTAB, both cross-sections are displayed in the graphic on the right. The designs will be performed for the cross-section selected in RF-/ALUMINUM ADM, using the internal forces from RFEM or RSTAB.

Cross-Section Type

The program displays the cross-section type that will be used for the design. The nominal strengths and stability design depend on the type of cross-section. Cross-sections that are classified as *General* (see Figure 2.12) can only be designed for specific criteria.

Max. Design Ratio

This column is displayed after the calculation. It is useful to decide on the optimization of sections. The design ratios and colored relation scales show you which cross-sections have low utilizations and, thus, are oversized, or which ones are overloaded and undersized.

Optimize

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

To optimize a cross-section, open the corresponding drop-down list in column D or E and select *From current row*. Recommendations on the optimization can be found in Chapter 7.2 on page 56.

Remark

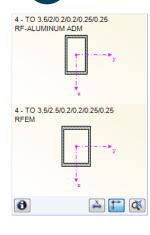
This column shows remarks in the form of footers that are explained below the cross-section list.

Member with Tapered Cross-Section

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

RF-/ALUMINUM ADM also designs tapered members, provided that the cross-section at the member start has the same number of stress points as the cross-section at the member end. The normal stresses, for example, are determined from the moments of inertia and the centroidal distances of the stress points. If the cross-section at the start and the end of a tapered member have a different number of stress points, the intermediate values cannot be interpolated.

The stress points including their numbering can also be checked graphically: Select the cross-section in Window 1.3 and click the [Info] button. The dialog box shown in Figure 2.13 appears.





Info About Cross-Section

0

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

oss-Section Property	Symbol	Value	Unit		IS 3.55/1.95/0.2/0.25/0
epth	d	3.55	in		
idth	ь	1.95	in		
eb thickness	s	0.20	in		1.05
ange thickness	t	0.25	in		1.95 K
let weld thickness	a	0.00	in		
oss-sectional area	Α	1.6	in ²		
near area	Ay	0.8	in ²	=	0.00
near area	Az	0.6	in ²	-	
near area according to EC 3	A _{v,y}	1.0	in ²		
near area according to EC 3	A _{v,z}	0.6	in ²		
astic shear area	A pl, y	1.0	in ²		3.55
astic shear area	A pl,z	0.7	in ²		
oment of inertia	Iγ	3.1	in ⁴		0.20
oment of inertia	Iz	0.3	in ⁴		
olar moment of inertia	Ip	3.4	in ⁴		0.00
overning radius of gyration	ry	1.41	in		
overning radius of gyration	rz	0.44	in		
olar radius of gyration	ro	1.47	in		+
adius of gyration of flange plus 1/5 of we	r zg	0.50	in		Z
eight	wt	1.86	lb/ft		
urface	Asurf	1.21	ft²/ft		
orsional constant	J	0.0	in ⁴		
arping constant referring to M	Cw	0.8	in ⁶		
ade factor	λ	0.110671	1/in		T I Stress points
astic section modulus	Sy	1.8	in ³		C/t-Parts
	c	0.0	: 3	*	

Figure 2.13: Dialog box Info About Cross-Section

The buttons below the cross-section graphic have the following functions:

Button	Function
Ŧ	Display or hide the stress points
	Display or hide the cross-section c/t-parts.
123	Display or hide the numbering of stress points or c/t -parts
	Display the details of stress points or c/t -parts (see Figure 2.14)
X	Display or hide the cross-section dimensions
;⇒	Display or hide the principal axes of the cross-section
X	Reset 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 (centroidal distances, statical moments of area, warping constants etc.) and c/t-parts (see Figure 2.14).

Q

Stress Poi	nts of IS 3.55/	/1.95/0.2/0.25	j/0					X
	A	B	C	D	E	F	G	IS 3.55/1.95/0.2/0.25/0
StressP	Coordi	nates	Statical Mom	ents of Area	Thickness	Wan	ping	
No.	y [in]	z [in]	Qy[in ³]	Q _z [in ³]	t [in]	W _{no} [in ²]	Qw [in 4]	
1	-0.97	-1.77	0.0	0.0	0.25	1.6	0.0	
2	-0.10	-1.77	-0.4	-0.1	0.25	0.2	-0.2	
3	0.00	-1.77	-0.4	-0.1	0.25	0.0	-0.2	
4	0.10	-1.77	-0.4	0.1	0.25	-0.2	0.2	1 23 5
5	0.97	-1.77	0.0	0.0	0.25	-1.6	0.0	
6	-0.97	1.77	0.0	0.0	0.25	-1.6	0.0	S
7	-0.10	1.77	-0.4	0.1	0.25	-0.2	-0.2	
8	0.00	1.77	-0.4	0.1	0.25	0.0	-0.2	
9	0.10	1.77	-0.4	-0.1	0.25	0.2	0.2	13 y
10	0.97	1.77	0.0	0.0	0.25	1.6	0.0	
11	0.00	-1.53	-0.8	0.0	0.20	0.0	0.0	
12	0.00	1.53	-0.8	0.0	0.20	0.0	0.0	
13	0.00	0.00	-1.0	0.0	0.20	0.0	0.0	6 7 <mark>8</mark> 10
								▼
								-
) 🔁 🔁
	สา							
	A							Close

Figure 2.14: Dialog box Stress Points of symmetric I-section

2.4 Intermediate Lateral Restraints

In Window 1.4, you can define lateral restraints along each member. In RF-/ALUMINUM ADM, this kind of support is always perpendicular to the minor z-axis of the cross-section (see Figure 2.13). Thus, you can manipulate the effective lengths which are important for the stability analyses.

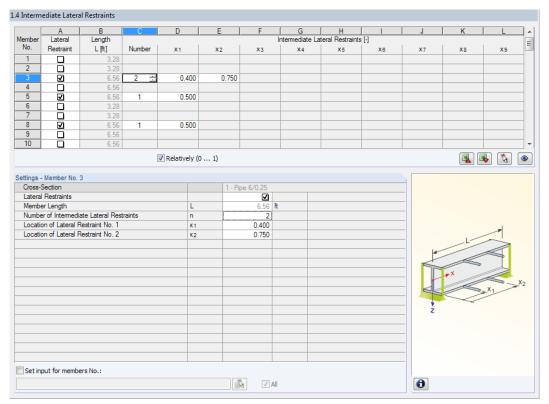


Figure 2.15: Window 1.4 Intermediate Lateral Restraints

In the upper table of the window, you can assign up to nine lateral restraints to every member. The *Settings* section shows the entry in a column overview for the member selected above.



1.5 Effective Lengths Manual

To define the lateral restraints of a member, select the *Lateral Restraints* check box in column A. To graphically select the member, click 3. If you select the check box, the other columns become accessible and you can enter the parameters.

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

🔽 Relatively (0 ... 1)

If you select the *Relatively (0... 1)* check box, you can define the support points by relative input. The positions of the intermediate restraints are determined by the member length and the relative distances of the member start. If you clear the *Relatively (0... 1)* check box, it is possible to define the distances manually in the upper table.

2.5 Effective Lengths - Members

The window is subdivided into two parts. The upper table includes summarized information about the length factors of buckling, lateral-torsional and flexural-torsional buckling as well as the equivalent lengths of the members. The lengths of the members are preset. In the *Settings* section, you can see additional information about the member selected in the upper table.

Click 🚯 to select a member graphically and show its row.

You can make any changes in the upper table as well as in the Settings tree.

	A	B	С	D	E	F	G	H		J	K	L	M	N	0	
	Buckling	Buckling				g About	Axis z/v	Later	ral-Torsio	nal and Flex	kural-Torsio	nal Buckling	Memi	per Type		
No.	Possible	Possible	Ky/u	Ky/uL [ft]	Possible	K _{z/v}	Kz/vL [ft]	Possible	K	Lw [ft]	LT [ft]	Me [kipft]	Туре у-у	Type z-z	Comment	
1	Ø	v	1.000	3.28	V	1.000	3.28	V	1.00	3.28	3.28	Eigenvalue	Beam	Beam		
2		V	1.000	3.28	V	1.000	3.28	V	1.00	3.28	3.28	Eigenvalue	Beam	Beam		
3	1	V	1.000	6.56	V	1.000						Eigenvalue				
4	V	V	1.000	6.56		1.000	6.56		1.00	6.56	6.56	Eigenvalue				
5	V	V	2.000	13.12	V	1.000	3.28		1.00	3.28	3.28	Eigenvalue				
6	V	2	1.000	3.28	V	1.000	3.28		1.00	3.28	3.28	Eigenvalue				
7	V	2	1.000	3.28	V	1.000	3.28		1.00	3.28	3.28	Eigenvalue				
8	V	2	1.000	6.56		1.000	3.28		1.00	3.28	3.28	Eigenvalue				
9	•	2	1.000	6.56		1.000	6.56		1.00	6.56	6.56	Eigenvalue				
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																ſ
														💌 强	😼 🚯	U
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	- Member Section	NO. 1					0	10.40/0	F (0				LS 4.2	/0.5/0		
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		e Maior Axis I	Dessibl	-		_			 ✓ ✓ 							
	ctive Len		u Fossibi	e		Ku			000							
	ctive Leng					KuL			.28 ft					+ + ^{1.2}	<u> </u>	
		Minor Axis	v Doosibl	-		NuL			20 1					++	2ª	
	ctive Len		V FUSSIDI	e		Kv			000					16 0.50	× 1	
	ctive Leng					KyL			.28 ft				4.20	52		
		Geometric 1	Avia Da	acibla		KVL			.20 n 					+−∭ ≼	•	٠
	ctive Len		y-Aus Fu	ISSIDIC		Ky			000				-	linni i		
	ctive Leng					KyL			28 ft				-		0.50	
		gin Geometric :	z-Avie De	eeible		RyL	-		.28 n 					4.3		
	ng About (2-7005 FC	ISSIDIE		Kz			000					+	• · •	
	ctive Leng					KzL			.28 ft					÷		
		juri Buckling I	Possible			NZL			.28 II 2				-	z		
	rusiolid	Ducking	Coolule						.00				-			
	3 Length					Lw			.00 .28 ft				-			
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	put for me	embers No.														
Set in																
Set in								E S	V All				0		👗 🔛	[



The effective lengths for buckling about the minor z-axis are aligned automatically with the entries of the *1.4 Intermediate Lateral Restraints* Window. If a member is divided into segments of different lengths, no values are displayed in the table columns G, J, and K of Window 1.5.

You can enter the effective lengths manually in the table and in the *Settings* tree, or define them graphically in the work window by clicking the ... button. The button is active when you place the cursor in the text box (see Figure 2.16).

2 Input Data

The Settings tree includes the following parameters:

- Cross-Section
- Length of the member
- Buckling Possible for the member (cf. column A)
- Buckling About Major Axis y Possible (cf. columns B to D)
- Buckling About Minor Axis z Possible (cf. columns E to G)
- Lateral-Torsional Buckling Possible (cf. columns H to L)
- Member Type (cf. columns M and N)

In the table, you can determine a buckling analysis or lateral-torsional and flexural-torsional analysis to be performed for the selected member. In addition, you can adjust the *Effective Length Factor* for the respective lengths. If you modify any factor, the equivalent member length is adjusted automatically, and vice versa.



You can also define the effective length of a member in a separate dialog box. To open it, click the button shown on the left (it is located below the upper table).

Select Effective Length Factor	
Type of K Value	
Theoretical	
 Recommended 	
Buckling About y-Axis	Buckling About z-Axis
© Ky = 0.65	© Kz = 0.65
© Ky = 0.8	
© Ky = 1.2	© К ₂ = 1.2
© K _Y = 1.0	© K _Z = 1.0
© K _Y = 2.0	© K _z = 2.0
© Ky = 2.0	© K _z = 2.0
	Uger-defined Kz = y
 Import from add-on module RF-STABILITY (Eigenvalue Analysis) 	 Import from add-on module RF-STABILITY (Eigenvalue Analysis)
RF-STABILITY-Case:	RF-STABILITY-Case:
	
Buckling mode No.: 0 🔄 🗞	Buckling mode No.:
Export effective length factor Ky: 0.800	Export effective length factor Kz: 0.800
	OK Cancel

Figure 2.17: Dialog box Select Effective Length Factor

In this dialog box, the *Theoretical* or *Recommended* values of the K factor can be defined that are to be assigned to the selected member. The theoretical and the recommended values are described in the *Commentary on the Specification for Structural Steel Buildings* [4] Table C-C2.2. Generally, it is possible to select predefined *K* factors or to enter *User-defined* values.

If an eigenvalue analysis has been performed in the RF-STABILITY or RSBUCK add-on module, you can import the respective *Buckling mode* in order to determine the factor.

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Buckling Possible

The stability analysis for buckling, lateral-torsional and flexural-torsional buckling requires the ability of members to absorb compressive forces. Members for which this is not possible due to their types (for example tension members, elastic foundations, rigid couplings) are excluded from the analysis a priori. The corresponding rows are dimmed and a note appears in the *Comment* column.

The *Buckling possible* check boxes in table row A and in the *Settings* tree enables you to control the stability design according to [2] Chapter C. They determine whether the analyses are to be performed for the members.

Buckling About Axis y / z

The *Possible* columns control if there is a buckling risk about the y-axis and/or z-axes. The y-axis represents the "major" principal member axis, the z-axis the "minor" axis. You can freely select the effective length factors K_v and K_z for buckling about the major and minor axes.

You can check the member axes in the cross-section graphic in the *1.3 Cross-Sections* Window (see Figure 2.10, page 11). To access the RFEM or RSTAB work window, click the [View Mode] button. There you can display the local member axes via the shortcut menu of a member or the *Display* navigator.

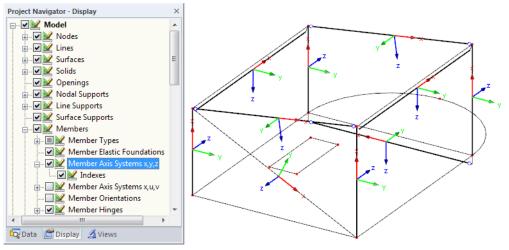


Figure 2.18: Selecting the member axis system in the Display navigator of RFEM

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

To specify the effective lengths in the work window graphically, click \square . You can click the button only if the cursor is placed in a K_vL or K_zL text box (see Figure 2.16).

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

Lateral-Torsional and Flexural-Torsional Buckling

Column H controls which members are included in the analysis of lateral-torsional and flexural-torsional buckling.

The effective lengths L_w and L_T can be defined in columns J and K. L_w represents the LTB unbraced length L_b as referred to in [2] Chapter F (Flexure), whereas L_T corresponds to the torsional and flexural-torsional unbraced length L_z of [2] Chapter E (Compression).

Me [kipft] Eigenvalue acc. to F Eigenvalue Manually If lateral restraints have been defined in Window 1.4 Intermediate Lateral Restraints, there is no possibility to apply any user-defined values.

To determine M_e by the *Eigenvalue* method, a member with four degrees of freedom at either side is created internally for the design. For *Beam* member types (see columns M and N), the lateral and torsional restraints are assumed to be fixed while the warping restraint is free. For *Cantilever* member types, however, lateral, torsional, and warping restraints are all assumed to be fixed while the free end is of course assumed to be free.

Alternatively, you can apply the values *according to* [2] *Chapter F* or define them *Manually* in the *Settings* table.

Member Type



For the design, the member lengths are considered variably for the brace points of a *Beam* or *Cantilever* with free ends. The relevant boundary settings can be selected in the list box for each member axis.

Comment

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

Set Input for Members No.

Below the *Settings* table, you find the *Set input for members No.* check box. When you select the check box, the <u>subsequent</u> settings will be applied to the selected members or *All* members (you can enter the member numbers manually or select them graphically using the \boxed{Im} button). This option is useful when you want to assign the same boundary conditions to several members (see also https://www.dlubal.com/en-US/support-and-learning/support/knowledge-base/000726).



2.6 Effective Lengths - Sets of Members

This window is available when you have selected one or more sets of members for design in the 1.1 General Data Window (see Figure 2.1, page 5).

			~		- (-									1 0
Set	A Buckling	B Buckling	C	D	E Buckling	F	G	H	l I Tamia	J	K	nal Buckling	M	mber Type	0
No.		Possible							ai-iorsio K				Type y		Comment
				Ky/uL [ft]				Possible	ĸ	L _w [ft]	LT [ft]	M _e [kipft]	Type y	y Type z-	2 Comment
1	Q	J	0.800		J	1.000	6.56				6.56	Eigenvalue			-
2	I	J	1.000	6.56	J	1.000	6.56				6.56	Eigenvalue			-
3	V	V	1.000	19.69		1.000	19.69				19.69	Eigenvalue			
														P	1 🗣 🚯 🛛
	- Set of Me	embers No	. 1										LS	4.2/0.5/0	
Set of	f Members							olumn 1					_		
	ss-Section						2	- LS 4.2/0.							
Lengt						L		6	56 ft						
	ling Possible						C		Ø						
	ling About I		u Possib	le					2					+	1.23
Effe	ective Leng	gth Factor				Ku		0.8	00					I	.∕∎u
	ective Leng					KuL		5	25 ft						1
Buckl	ling About I	Minor Axis	v Possib	e					v					2.97	<u>.50</u> × a
- Effe	ective Leng	gth Factor				Kv		1.0					=	4.2	1 1 .
	ective Leng					KyL			56 ft				=	-	
	ling About (y-Axis Po	ossible					v					+	0.50
	ective Leng					Ky		1.0							
	ective Leng					KyL		6	56 ft					+	4.20
	ling About (z-Axis Po	ossible					v						v
	ective Leng					Kz		1.0							•
	ective Leng					KzL			56 ft						-
	al-Torsional		Possible						v						
	rsional Leng	gth				LT		6	56 ft						
— Me								Eigenval	ue				-		
C-A-	nout for set	- NI													
_ set in	iput for set	ts No.:												2	
								E S	V All				6		🚔 🚰 (

Figure 2.19: Window 1.6 Effective Lengths - Sets of Members

The concept is similar to the previous 1.5 Effective Lengths - Members Window. Here you can enter the effective lengths for buckling about the two principal axes of the set of members, as described in Chapter 2.5.

2.7 Nodal Supports - Set of Members

Details...

This window appears when at least one set of members has been selected in the 1.1 General Data Window for design and when the option Do not use member-like input is set in the Details dialog box (see Figure 3.2, page 28).



The stability design of sets of members is carried out according to Chapter C of the Aluminum Design Manual [2]. According to Chapter E, you can design doubly symmetric, singly symmetric and unsymmetric cross-sections stressed by compression and/or bending in a plane. To obtain the critical moment M_a, a planar framework is created with four degrees of freedom whose parameters are to be defined in Window 1.7.

	А	B	С	D	E	F	G	Н	
Support	Node	Lat. Support		al Restraint	Warping	Support	Eccen		
No.	No.	uy:	ΦX	ØZ'	ω [kipft ³]	Rotation ß [°]	ex [in]	ez [in]	Comment
1	34	I	v	v	3.140	0.00	0.00	2.50	
2	31	0		V	3.140	0.00	0.00	2.50	
3	28	2	2			0.00	0.00	0.00	
4	25		2			0.00	0.00	0.00	
5									
6									
7									
8									
9									
10									
ottingen A	Nodal Support	No. 24				Q			
= Set of M		NO. 31							
					Column 1				
					Column 1				
Cross	-Section			No	2 - LS 4.2/0.5/0				
Cross- Node wit	-Section ith Support			No.	2 - LS 4.2/0.5/0 31				
Cross- Node wit Support	-Section ith Support			uγ	2 - LS 4.2/0.5/0 31				
Cross- Node wit Support Restrain	-Section th Support in Y'			uγ. φχ	2 - LS 4.2/0.5/0 31 2				
Cross- Node wit Support Restrain Restrain	-Section th Support in Y' ed about X'			uγ	2 - LS 4.2/0.5/0 31 2 2 31	kipft ³			APT -
Cross Node wit Support Restrain Restrain Warping	-Section th Support in Y' ed about X' ed about Z'			υγ' φχ φΖ'	2 - LS 4.2/0.5/0 31 2	kipft ³			e T
Cross Node wit Support Restrain Restrain Warping	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation			υγ" ΦΧ ΦΖ' ω	2 - LS 4.2/0.5/0 31 2 2 31 2 31 2 31 2 3.140	•			ez ez
Cross- Node wit Support Restrain Restrain Warping Support	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity			UΥ" ΦΧ ΦΖ' ω β	2 - LS 4.2/0.5/0 31 2 2 31 2 2 2 3 140 0.00	° in			ez
Cross- Node wit Support Restraine Warping Support Eccentrie	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			ez ez
Cross- Node wit Support Restraine Restraine Warping Support Eccentrie Eccentrie	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			ez ez
Cross- Node wit Support Restrain Warping Support Eccentric Eccentric	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			e ₂
Cross- Node wit Support Restrain Warping Support Eccentric Eccentric	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			ez
Cross- Node wit Support Restraine Restraine Warping Support Eccentrie Eccentrie	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			ez t
Cross- Node wit Support Restrain Restrain Warping Support Eccentric Eccentric	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			e ₂
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Cross- Node wil Support Restrain Restrain Warping Support Eccentric Eccentric	-Section th Support in Y' ed about X' ed about Z' Restraint Rotation icity icity			UΥ' ΦΧ ΦΖ' ω β εχ	2 - LS 4.2/0.5/0 31 2 31 2 31 2 31 3 1 40 0.00 0.00	° in			ez

Figure 2.20: Window 1.7 Nodal Supports - Set of Members



The current table manages the boundary conditions of the set of members selected in the navigator on the left!

The supports defined in RFEM or RSTAB, such as the supports in Z of a continuous beam, are not relevant in this window. The program imports the distributions of moments and shear forces automatically from RFEM/RSTAB. You can define several support conditions here that have an impact on stability failure (buckling, lateral-torsional buckling).

Supports on the start and end nodes of a set of members are preset. Any other supports, for example as a result of additional members, has to be added manually. You can select nodes graphically in RFEM/RSTAB work window using the start button.

2

The orientation of axes in a set of members is important for the definition of nodal supports. The program checks the position of nodes and internally defines the axes of nodal supports for Window 1.7, according to Figure 2.21 to Figure 2.24. The [Local Coordinate System] button below the model graphic can help you with the orientation. With it, you can display the set of members in a partial view where the axes are shown (see also Knowledge Base article https://www.dlubal.com/en-US/support-and-learning/support/knowledge-base/000961).



Figure 2.21: Auxiliary coordinate system of nodal supports - straight set of members

If all members of a set of members are on a straight line (see Figure 2.21), the local coordinate system of the first member in this set of members is applied for the entire set.

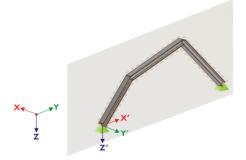


Figure 2.22: Auxiliary coordinate system of nodal supports - set of members in vertical plane

If the members of a set of members are not on a straight line, they still must be located in one plane. In Figure 2.22, the members are in a vertical plane. In this case, the X'-axis is horizontal and it is oriented in the direction of the plane. The Y'-axis is horizontal as well and defined as perpendicular to the X'-axis. The Z'-axis is oriented perpendicularly downwards.

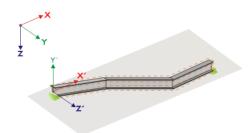


Figure 2.23: Auxiliary coordinate of nodal supports - set of members in horizontal plane

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

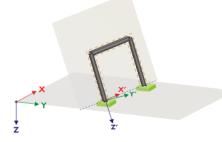


Figure 2.24: Auxiliary coordinate system of nodal supports - set of members in inclined plane

Figure 2.24 shows the general case of a non-straight set of members where the members are in an inclined plane. The definition of the X'-axis results from the intersection line between the inclined and horizontal planes. Thus, the Y'-axis is perpendicular to the X'-axis and directed perpendicularly to the inclined plane. The Z'-axis is defined perpendicular to the X'-axis and Y'-axis.

2 Input Data

The buttons below the graphic have the following functions:

Button	Function
	Display the model or the system sketch
4	Display the members as a 3D rendering or a wireframe model
Q	Display the current set of members or the entire model
	Display the irrelevant members of the model transparent or opaque
1	Display the set of members in the local coordinate system or the entire model
F x	Show the view in the direction of the X-axis
T-Y	Show the view against the Y-axis
TZ	Show the view in the direction of the Z-axis
	Display the isometric view

Table 2.3: Buttons of cross-section graphic

Click the 🔍 button to determine the constant of a warp spring at the supported nodes.

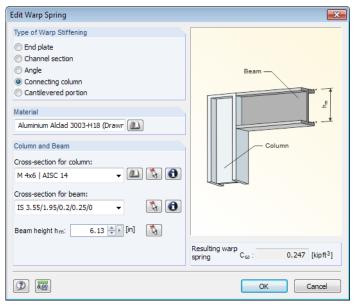


Figure 2.25: Dialog box Edit Warp Spring

In the Edit Warp Spring dialog box, you can select one of the following types of warp springs:

- End plate
- Channel section
- Angle
- Connecting column
- Cantilevered portion

You can select the materials and cross-sections using the lists and [Library] buttons. Click the solution for graphical selections in the RFEM or RSTAB model.

RF-/ALUMINUM ADM determines the *Resulting warp spring* C_{ω} from the parameters. By clicking [OK], you import the result in Window 1.7.

2.8 Member Hinges - Set of Members



This window appears when at least one set of members has been selected in the *1.1 General Data* Window and when the option *Do not use member-like input* is set in the *Details* dialog box (see Figure 3.2, page 28). In this window, you can define releases for members within sets of members that do not transfer specific internal forces for structural reasons. Make sure that no double hinges are created in interaction with Window 1.7.



The current table manages the parameters of the set of members selected in the navigator on the left.

.8 Memb	er Hinges ·	Set of Memb	ers No. 1 - Column	1			
	A	В	C	D	E	F	G
Hinge	Member	Member	Shear Release		Release	Warp Release	ŭ
No.	No.	Side	Vy	Мт	Mz [kipft/rad]	Μω	Comment
1	63	Start	Ó	V			
2	53	End			7.500		
3							E
4							
5							
6							
7							
8							
9							
10					<u> </u>		· · · · · · · · · · · · · · · · · · ·
							🖳 🖶 🐧 💿
	- Member No	o. 53					
⊡ Set of	Members ss-Section				Column 1 2 - LS 4.2/0	5.40	
		e at the End		No.	2 - LS 4.2/0	53	
	er with Hing. er Side	e al trie Erio		Side	L	End	
	Release in y	Direction		Vy			
	nal Release	Direction		MT			
	nt Release a	bout z-Axis		Mz	7	500 kipft/rad	
	ng Release			Mw			
Comme							×
				_			***
							M _T M ₀ Vy
							z
							Mz
Set in	put for relea	ase No.:					
						V All	0

Figure 2.26: Window 1.8 Member Hinges - Set of Members

The *Member No*. is to be entered in column A. Alternatively, use the button ... of the text box to select the member graphically in the work window.



In column B, you define the *Member Side* on which the hinge is located. You can also allocate the hinge to both member ends.

The table columns C to F control the hinges – or spring constants – of each release. By these hinges, you can adjust the set of members model to the real boundary conditions.

2.9 Serviceability Data

This window controls important settings of the serviceability limit state design. It is displayed when you have entered the corresponding data in the *Serviceability Limit State* tab of Window 1.1 (see Chapter 2.1.2, page 8).

	A	В	C	D	E	F	G	(Н
		Member		nce Length	Direc-	Precamber		
۱o.	Reference to	No.	Manually	L [ft]	tion	w _{o,z} [in]	Beam Type	Comment
1	Member			6.56	z	0.000	Beam	
2	Member	34		6.56	z	0.000	Beam	
3	Member	46	v	5.03	z	0.000	Beam	
4	Member	47	V	5.03	z	0.000	Beam	
5	Member	92		2.19	z	0.000	Cantilever End Free	
6	Set of Members	2		6.56	y, z	0.000	Beam	
7	Set of Members	3		19.69	y, z	0.000	Beam	
8								
9								
10								
11								
12								
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29								
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31								
32								

Figure 2.27: Window 1.9 Serviceability Data



In column A, you decide whether the analysis of the deflections refers to single members or sets of members.

Column B controls the numbers of members or sets of members that are to be designed. You can select the objects graphically in the RFEM or RSTAB work window using the ... button. The *Reference Length* is then shown in column D. This value represents the length of the member or set of members. If required, you can adjust it *Manually* when you have selected the check box in column C.



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

Table column F enables you to take into account a possible *Precamber* w_c. By default, the precamber refers to the major axes z and v. To change this, click the [Details] button. The *Details* dialog box appears (see Figure 3.3, page 30) where you can set the minor axes y and u in the *Serviceability* tab.



For the correct application of limit deformations, the *Beam Type* is essential. In column G, you can specify whether a beam or a cantilever is to be designed and which end is without support.

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



2.10 Parameters - Members

In the last window, you can define specific parameters for members subjected to axial tension.

A			В						
mber Cross-Sectional									
lo. Area	Comment								
1 🔲									
2									
3 🛛									
4									
5									
6									
7									
8									
9									
10									
				🕱 🗟 🍾					
tings - Member No. 3									
Cross-Section		4 - SHAPE-THIN	2XC260-150						
Cross-sectional area for tension design	_		2/02/00/100						
∃ Start (x=0 m)		4 - SHAPE-THIN	2XC260-150						
Cross-Sectional Area	Ag	2.41	in ²						
Net Cross-Sectional Area	An	2.15	in ²						
Effective Net Cross-Sectional Area	Ae	2.15							
Eccentricity of the Connection	x	0.00							
Eccentricity of the Connection	v	0.00	ft						
Length of the Connection in the Direction of Load	Lo	1.97							
∃ End (x=l)	-	4 - SHAPE-THIN							
Cross-Sectional Area	Ag	2.41							
Net Cross-Sectional Area	An	2.41							
Effective Net Cross-Sectional Area	Ae	2.41							
Eccentricity of the Connection	x	0.00							
 Eccentricity of the Connection 	y	0.00							
Length of the Connection in the Direction of Load	Lo	1.97		-Anet					
Comment				Anet					
Set input for members No.:									

Figure 2.28: Window 1.10 Parameters - Members

Cross-Sectional Area

When you select the check box of a member, the *Settings* table below becomes accessible where you can modify the cross-sectional area for tension design. By defining the net cross-sectional area A_n , you can control the effective net area of the section A_e to account for the effect of shear lag. Furthermore, eccentricities of the connection can be definied which refer to the local axes \overline{x} and \overline{y} of the member. Those have an influence on the effective net cross-sectional area, too.

The above-mentioned parameters can be specified for the Start and the End of each member.

Comment

In this column, you can enter user-defined comments for each member.

Below the *Settings* table, you find the *Set input for members No.* check box. When you select the check box, the <u>subsequent</u> settings will be applied to the selected members or *All* members (you can enter the member numbers manually or select them graphically using the setting).

3 Calculation

3.1 Detail Settings

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

The Details dialog box has the following tabs:

- Ultimate Limit State
- Stability

Details...

- Serviceability
- General

3.1.1 Ultimate Limit State

Details - ASD 2015	
Ultimate Limit State Stability Serviceability General	
Options	
Structure type	
 Building-type structure 	
Bridge-type structure	
Direct strength method acc. to B.5.4.6 and B.5.5.5	
Shear design of solid cross-sections	
Shear buckling design	
General elastic design of simple shear based on shear stress	
Limit Internal Forces for Interaction	
Allow design without influence of torsion if:	
f _{5.a} / (F _{sy} / Ω _T) ≤ 0.500 ▲	
Limit Values for Special Cases	
Cross-sections with shear and torsion	
Limit shear stress for designs acc. to H.3	
fs.a / (Fsy / Ωτ) ≤ 0.010 ▲	
	OK Cancel

Figure 3.1: Dialog box Details, tab Ultimate Limit State

The buttons in the *Details* dialog box have the following functions:

Button	Function
3	Reset default settings of the program
	Load user-defined default settings
	Save modified settings as default

Table 3.1: Buttons in *Details* dialog box

Options

Paramet	ric - Mass	sive	
	T	L	I
I			
	Ľ	I	
T	L	1	ſ
Π			
		T	

The *Structure type* options control whether the model is designed for the nominal loads and load combinations as appropriate for building-type structures (cf. [2] Section B.2.1) or for bridge-type structures (cf. [2] Section B.2.2). The Load and Resistance Factor Design (LRFD) is limited to building-type structures.

For flat elements in uniform compression or flexure, the *Direct strength method* can alternatively be applied according to [2] Sections B.5.4.6 and B.5.5.5.

By default, the *Shear design of solid cross-sections* is enabled. The figure to the left shows all types of solid cross-sections which can be defined by their parameters in RFEM or RSTAB.

The Shear buckling design of the members can be disabled if it is not revelant for the design case.

Optionally, a *General elastic design of simple shear based on shear stress* can be performed. In that case, the limit state stresses based on elastic parameters are applied for the elements.

Solid cross-sections Limit I

Limit Internal Forces for Interaction / Special Cases For the design of members for combined forces and torsion, it is possible to ignore the torsional

components of the stresses. If the shear ratios $\frac{f_s}{F_{sy}/\Omega_T}$ (no square) do not exceed the default of 50% for interaction, torsion is not considered in the design.

In the same way, you can ignore effects due to *shear and torsion* according to [2] Section H.3. If the shear ratios do not exceed the default of 1%, they are not considered.

These values are not part of the Specification [2]. They should be adjusted by the user to the respective situations.

3.1.2 Stability

Ultimate Limit State Stability Serviceability General Stability Analysis Intr Values for Special Cases Cross-section with compression and bending Laderaphorsional Buckling Condition of positive transverse loads: On or consider small moments and allow stability design acc. to Chapter E (intended axial compression) if: Bending Ma,y / (Mn,pl,y / Ωb) ≤ 0.010 ⊕ On ross-section edge directed from shear center (e.g. too frange, stabilizing effect) Do not consider small compression forces and allow stability design acc. to Chapter F (bending without compression) if: Or norsos-section edge directed from shear center (e.g. bottom flange, stabilizing effect) Do not consider small compression forces and allow stability design acc. to Chapter F (bending without compression) if: Sets of Members - Member-Like Input Use for all sets of members Use only for straight sets of members Use only for straight sets of members Use only for straight sets of members Use only for straight sets of members without intermediate restraints (simple beams or cantilevers)	Details - ASD 2015	
✓ Perform stability analysis Cross-sections with compression and bending Lateral-Torsional Buckling Do not consider small moments and allow stability design acc. to Chapter E (intended axial compression) if: Bending Ma,y / (Mn,pl,y / Ωb) ≤ 0.010 ⊕ Image: Section edge directed to shear center (e.g. top flange, destabilizing effect) Bending Ma,y / (Mn,pl,y / Ωb) ≤ 0.010 ⊕ Image: Image: Image: Association edge directed from shear center (e.g. bottom flange, stabilizing effect) Do not consider small compression forces and allow stability design acc. to Chapter F (bending without compression) if: Compression Pa / (Pn,pl / Ωc) ≤ 0.010 ⊕ Sets of Members - Members-Like Input Compression Pa / (Pn,pl / Ωc) ≤ 0.010 ⊕ Image: Use only for straight sets of members Use only for straight sets of members Use only for straight sets of members without intermediate	Ultimate Limit State Stability Serviceability General	
	Stability Analysis Image: Stability analysis Lateral-Torsional Buckling Load application of positive transverse loads: Image: On cross-section edge directed to shear center (e.g. top flange, destabilizing effect) Image: I	Cross-sections with compression and bending Do not consider small moments and allow stability design acc. to Chapter E (intended axial compression) if: Bending $M_{a,y} / (M_{n,pl,y} / \Omega_b) \leq 0.010 \frac{1}{\sqrt{2}}$ $M_{a,z} / (M_{n,pl,z} / \Omega_b) \leq 0.010 \frac{1}{\sqrt{2}}$ Do not consider small compression forces and allow stability design acc. to Chapter F (bending without compression) if:
	Use only for straight sets of members without intermediate restraints (simple beams or cantilevers)	OK Cancel

Figure 3.2: Dialog box Details, tab Stability

Stability Analysis

The *Perform stability analysis* check box controls whether to run a stability analysis in addition to the cross-section designs. If you clear the check box, the Windows 1.4 through 1.8 are not shown.

Lateral-Torsional Buckling

When there are *transverse loads*, the location must be specified at which those forces are acting: Depending on the load application point, the transverse loads can be stabilizing or destabilizing, which has an influence on the elastic critical moment.

Set of Members - Member-Like Input

By default, the *member-like input* is not applied for sets of members. That means that the boundary conditions have to be defined in Windows 1.7 Nodal Supports and 1.8 Member Hinges for each set of members.

Alternatively, it is possible to treat sets of members as "one long member". For that, you can define the factors K_z and K_w in Window 1.6 Effective Lengths - Sets of Members. Those factors are used to determine the support conditions β , u_y, φ_x , φ_z , and ω . In that case, the Windows 1.7 and 1.8 are not displayed.



If at all, it is recommended to use the member-like input method for straight sets of members only.

Limit Values for Special Cases

To design cross-sections with compression according to [2] Section E, it is possible to neglect *small moments* about the major and/or minor axes. The default values in the two text boxes are 1%, which represents the ratio of design moment and strength.

For the straight check of bending according to [2] Section F, you can similarly neglect *small compression forces* by a user-defined limit ratio.



These limit settings are <u>not</u> part of the Specification [2]. It is the responsibility of the user to apply or modify them.

3.1.3 Serviceability

Utimate Limit State Stability Serviceability General Peformation Relative to Shifted members ends / set of members ends Undeformed system Serviceability Limits (Deflections) Chapter L3 Cantilevers L / 300 C Le / 180 C Direction of Precamber Consider precamber in Y/u () y/u () mather in the system () for the s	etails - ASD 2015	
Deformation Relative to ④ Shifted members ends / set of members ends ● Undeformed system Serviceability Limits (Deflections) Chapter L.3 Cantilevers L / 560 ① Le / 180 ① Direction of Precamber Consider precamber in ④ z/v ④ Y/u ● Y/u	Ultimate Limit State Stability Serviceability General	
© Undeformed system Serviceability Limits (Deflections) Chapter L.3 L / 360 ⊕ Lov 180 ⊕ Direction of Precamber Consider precamber in		
Serviceability Limits (Deflections) Chapter L.3 Cantilevers L / 360 L c / 180 D Direction of Precamber Consider precamber in © 2/v © y/u	Shifted members ends / set of members ends	
Serviceability Limits (Deflections) Chapter L.3 Cantilevers L / 360 L c / 180 D Direction of Precamber Consider precamber in © 2/v © y/u		
L / 360 ⊕ L o / 180 ⊕ Drection of Precamber in	Undeformed system	
L / 360 L L / 180 D	Serviceability Limits (Deflections) Chapter L.3	
Direction of Precamber Consider precamber in		
Consider precamber in		
	Direction of Precamber	
© v/u	Consider precamber in	
	⊚ z/v	
	⊚ y/u	
	2 🔤 🕥 🖪 🕼	OK Cancel

Figure 3.3: Dialog box Details, tab Serviceability

Deformation Relative To

The two options specify whether the maximum deformations are to be referred to the shifted ends of the members / sets of members (i.e. line between first and last shifted nodes of deformed model) or to the undeformed initial system.

In most cases, the deformations are designed as relative to the displacements of the entire model.



The following Knowledge Base article illustrates how to refer deflections: https://www.dlubal.com/en-US/support-and-learning/support/knowledge-base/001081

Serviceability Limits (Deflections) Chapter L.3

In the two text boxes, you can check and, if necessary, adjust the limit deformations for beams and cantilevers.

Chapter L of the Aluminum Design Manual [2] provides recommendations concerning the deflections for serviceability. In RF-/ALUMINUM ADM, the existing deflections are compared to the limit values which refer to the lengths of the members or sets of members. Recommendations on the limit values can be found in the *Commentary on the Specification for Structural Steel Buildings* [4] Section L3, for example.

Direction of Precamber

By default, the precamber as specified in Window *1.9 Serviceability* (see Figure 2.27, page 25) refers to the major axes z and v. If appropriate, the minor axes y and u can be set.

3.1.4 General

Details - ASD 2015	
Ultimate Limit State Stability Serviceability General	
Calculation of Result Combinations with OR Type	Display Result Windows
 Analyze each load combination in result combination separately (precise solution, may be slower) Analyze result combination comprehensively (conservative solution, may be faster) 	 ✓ 2.1 Design by Load Case ✓ 2.2 Design by Cross-Section ✓ 2.3 Design by Set of Members ✓ 2.4 Design by Member
Cross-Section Optimization	 ✓ 2.5 Design by x-Location
Max allowable design ratio:	3.1 Governing Internal Forces by Member
Check of Member Slendernesses	3.2 Governing Internal Forces by Set of Members
Members with λ_{limit}	3.3 Member Slendernesses
- Tension only: 275 💼	4.1 Parts List by Member
- Compression / flexure: 185	4.2 Parts List by Set of Members
Denne Dentine Deleterer	Only for members / sets to be designed
Cross-Section Database	Of all members / sets of members
Allow design of shapes from the library of rolled steel cross-sections	
Settings of SHAPE-THIN Cross-Sections	
Consider cross-section as closed for J,Bredt /J more than:	
	OK Cancel

Figure 3.4: Dialog box Details, tab General

Calculation of Result Combinations with OR Type

When combinations are created automatically, often many load combinations (LCs) are produced. Usually, they are summarized in a result combination (RC) as alternatively effective ("OR combination") in order to determine the enveloping results: LC1/p or LC2/p or LC3/p or LC4/p etc. RF-/ALUMINUM ADM provides two options to design this result combination:

The components of each load combination can be analyzed *separately*. By this, the elastic critical moments are specifically determined for each load arrangement and then used for the design. This approach gives the exact results but implies a rather high demand of computing time as well.

Alternatively, the result combination can be analyzed *comprehensively*. The calculation is faster because only the extreme values with the corresponding internal forces are used for the design. The results, however, may be not be on the safe side if there is a RC with one combination in which several internal forces (e.g. N and M_y) are all slightly below the overall extremes.



By default, the optimization is targeted on the maximum allowable design ratio of 100%. You can set a lower (or higher) limit in the text box.

Check of Member Slendernesses

In the text boxes, you can specify the limit values λ_{limit} of the member slendernesses. It is possible to enter the specifications separately for members with tension forces only and for members with compression and flexure. The slenderness ratios are given in the tables of [2] Part VI.

The limit values are compared to the actual member slendernesses. These results are listed in the *3.3 Member Slendernesses* Window (see Chapter 4.8, page 41) when the corresponding check box has been selected in the *Display Result Windows* dialog box section (see below).

Cross-Section Database



In general, aluminum cross-sections are fabricated by extrusion molding. When the check box is selected, the design covers *rolled steel cross-sections* – possibly with aluminum material properties – of the library, too.

The figure to the left shows the rolled types of library cross-sections.

Rolled cross-sections

Settings of SHAPE-THIN Cross-Sections

For closed shapes of cross-sections, the nominal flexural strengths that are to be applied are different from those for open sections (see [2] Sections F.4.2.1 and F.4.2.3 for lateral-torsional buckling). Closed shapes resist lateral-torsional buckling primarily by torsional resistance.

RF-/ALUMINUM ADM classifies SHAPE-THIN sections as *closed* when the share of the Bredt torsional resistance J_{Bredt} of the overall torsional resistance J is greater than the value set in the text box.

Display Result Windows

In this dialog section, you can select the result windows, including parts list, that are to be displayed. The windows are described in Chapter 4 - Results.

The 3.3 Member Slendernesses Window is deactivated by default.

3.2 Start Calculation



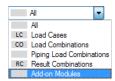
In all input windows of the RF-/ALUMINUM ADM module, you can start the calculation by clicking the [Calculation] button.

RF-/ALUMINUM ADM searches for the results of the relevant load cases, load and result combinations. If they are not available yet, the program starts the calculation in RFEM or RSTAB to determine the respective internal forces.

You can also start the calculation in the RFEM/RSTAB user interface: The *To Calculate* dialog box (menu **Calculate** \rightarrow **To Calculate**) includes the design cases of add-on modules, similar to load cases and load combinations.

Calculate						
oad Cases /	Combinations / Module Cases Result Tables					
Not Calculate	d			Selected for	Calculation	
No.	Description	<u>^</u>		No.	Description	-
D LC1	Self-weight			CA1	RF-ALUMINUM ADM - Design of aluminum members a	ccording
L LC2	Live load					
s LC3	Snow					
W LC4	Wind in +X					
W LC5	Wind in +Y					
2.3 CO1	1.4*LC1					
2.3 CO2	1.2*LC1 + 1.6*LC2					
2.3 CO3	1.2*LC1 + 1.6*LC2 + 0.5*LC3		>			
2.3 CO4	1.2*LC1 + LC2 + 1.6*LC3		>>			
2.3 CO5	1.2*LC1 + 1.6*LC3					
2.3 CO6	1.2*LC1 + 1.6*LC3 + 0.5*LC4					
2.3 CO7	1.2*LC1 + 1.6*LC3 + 0.5*LC5	=	4			:
2.3 CO8	1.2*LC1 + LC2 + 0.5*LC3 + LC4		4			
2.3 CO9	1.2*LC1 + LC2 + 0.5*LC3 + LC5					
.3 CO10	1.2*LC1 + LC2 + LC4					
.3 CO11	1.2*LC1 + LC2 + LC5					
.3 CO12	1.2*LC1 + 0.5*LC3 + LC4					
.3 CO13	1.2*LC1 + 0.5*LC3 + LC5					
.3 CO14	1.2*LC1 + LC4					
2.3 CO15	1.2*LC1 + LC5					
.3 CO16	0.9*LC1 + LC4					
2.3 CO17	0.9*LC1 + LC5					
2.3 RC1	CO1/p or to CO17	*				
All	· •					
					OK	Cancel

Figure 3.5: Dialog box To Calculate



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If the RF-/ALUMINUM ADM design cases are missing in the *Not Calculated* list, select *All* or *Add-on Modules* in the drop-down list below.

Select the RF-/ALUMINUM ADM case and transfer it to the list on the right with the Dutton. Then click [OK] to start the calculation.

To calculate a design case directly, use the list in the toolbar. Select the RF-/ALUMINUM ADM case in the toolbar list and click [Show Results].

Table Options	Add-on Modules <u>W</u> indow Help
🖆 🔲 🔲 💁	RF-ALUMINUM ADM CA1 - Design of a 🝸 < 🔌 😤 🎬 🕰 🙀 🚧 🗱 🗱
🔁 - 📬 - 🗊	🔐 + 🗊 + 🍕 🏨 🏨 🐴 📲 🍓 + ! 🕱 🔍 🍳 🖽 🔐 🕼 Show Results 🕅 + 🎽 + 🌚 +

Figure 3.6: Direct calculation of a RF-ALUMINUM ADM case in RFEM

You can then follow the design process in a separate dialog box.

4 Results

This chapter describes the result windows one by one. The evaluation of the results is described in Chapter 5.

4

RF-ALUMINUM ADM - [Frame ork] File Edit Settings Help CA1 - Design of aluminum memt - 2.1 Design by Load Case D Design Input Data G В E С General Data Load-ing Materials Descriptio No. × [ft] DS Ratio Design According to Formula Cross-Sections Uttimate Limit State Design 003 1.2*LC1 + 1.5*LC2 + 0.5*LC3 004 1.2*LC1 + 1.6*LC3 + 0.5*LC4 006 1.2*LC1 + 1.6*LC3 + 0.5*LC4 007 1.2*LC1 + 1.6*LC3 + 0.5*LC4 008 1.2*LC1 + LC2 + 0.5*LC3 + L 009 1.2*LC1 + LC2 + 0.5*LC3 + L Intermediate Lateral Restrair 348) Stability analysis - Biaxial bending and compression acc. to H. Intermediate Lateral Restraints Effective Lengths - Members Effective Lengths - Sets of Mer Nodal Supports Set of members No. 1 - Col Set of members No. 2 - Col Set of members No. 3 - Mai Member Hinger 3.28 3.28 3.28 3.28 6.56 6.56 0.75 ≤ 1 0.92 ≤ 1 ULS ULS ULS ULS ULS ULS 58 58 58 58 87 87 1.01 > 1 107) Cross-section check - Biaxial bending acc. to F 1ember Hinges --- Set of members No. 1 - Col --- Set of members No. 2 - Col ability Limit State Design Serviceabil CO19 LC1 + LC2 58 3.28 0.26 ≤ 1 401) Serviceability - Deflection in z-direction - Beam SLS 1.01 > 1 😌 🔄 > 1,0 🔹 🏹 💕 🛃 🏷 👁 9 Max: Set of members No. 3 - Mai Serviceability Data
 Details - Member 58 - x: 3.28 ft - C03

 El Material Properties - Auminum 5454-H112 (Extrusiona) I A

 Ercess-Section Properties - TO 6/4 75/0.2/0.2/0.2/0.2

 B Design Internal Forces

 Ercess-Section Local Buckling

 Design Internal Force

 B Design Analo

 B Adal Compression Force

 B Bending Moment

 - Maximum Bending Moment

 - Maximum Bending Moment

 - Tonalle Yield Strength

 - Compressive Yield Strength
 Parameters - Members 7 - TO 6/4.75/0.2/0.2/0.2/0.2 ns) | ADM 2010 Load Case Design by Cross-Section Design by Set of Members Design by Member 0.20 0.20 P. 1 219 kin Design by x-Locati 1.219 kip 2.263 kipft 2.904 kipft 0.075 kipft 0.238 kipft 12.329 ksi Ma,y Ma,y.segm Ma,z Ma,z,segm Governing Internal Forces by I Governing Internal Forces by S 3.00 Parts List by Member Parts List by Set of Members A.3 12.329 F_{ty} F_{oy} Ω_c P_{r.s} Compressive Yield Strength 13.054 ksi A.3 E.1 E.1 Safety Factor 1.650 / Factor Section Allowable Compressive Strength 32.754 kip Pr.» My.y Mn.s.y Yield Moment of Section Cross-Section Nominal Flexural Strength 0.20 7.479 kipf 7.919 kipft Cross-Section Nominal Hexural Strength Safety Factor Cross-Section Allowable Rexural Strength Design Component for M y Yield Moment of Section Cross-Section Nominal Rexural Strength Cross-Section Allowable Rexural Strength Ωb Mr.s.y 1.650 F.1 F.1 F.1 4.799 kipft 0.61 ≤1 η My My,z Mn.s.z Mr.s.z 6.564 kipft [in] 6.950 kipft 4.212 kipft F.1 0 🎽 🚰 🏹 III 2 4 3 Calculation Details... OK Cancel Graphics

After the calculation, the 2.1 Design by Load Case Window is displayed.

Figure 4.1: Result window with designs and details of results

The designs are presented in the result Windows 2.1 to 2.5. They are sorted by different criteria.

Windows 3.1 and 3.2 list the governing internal forces, Window 3.3 gives information on the member slendernesses. The last two Windows 4.1 and 4.2 show the parts lists for members and sets of members.

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

OK

[OK] saves the results. RF-/ALUMINUM ADM is closed and you return to the main program.





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The upper part of the window shows a summary of the governing designs. They are sorted by load case, load combination, and result combination. Furthermore, the table is divided in *Ultimate Limit State Design* and *Serviceability Limit State Design* results.

The lower part of the window contains the *Details* of the cross-section properties, internal forces, and design parameters for the load case that is selected in the upper table.

	A	B	C	D	E				F		G	ì
oad-		Member	Location	Design	1							1
ing	Description	No.	x [ft]	Ratio				De	sign According to F	omula	D	s
	Ultimate Limit State Design											
CO3	1.2*LC1 + 1.6*LC2 + 0.5*LC3	58	3.28	0.	75 ≤ 1	348) Stability	y analysis -	Biaxial b	ending and compre	ssion acc. to H.1	UL	S
CO4	1.2*LC1 + LC2 + 1.6*LC3	58	3.28	0.	92 ≤ 1	348) Stabilit	y analysis -	Biaxial b	ending and compre	ssion acc. to H.1	UL	S
CO6	1.2*LC1 + 1.6*LC3 + 0.5*LC4	58	3.28	0.	76 ≤ 1	348) Stabilit	y analysis -	- Biaxial b	ending and compre	ssion acc. to H.1	UL	S
C07	1.2*LC1 + 1.6*LC3 + 0.5*LC5	58	3.28	0.	86 ≤ 1	348) Stabilit	y analysis -	- Biaxial b	ending and compre	ssion acc. to H.1	UL	S
CO8	1.2*LC1 + LC2 + 0.5*LC3 + L	87	6.56	0.	86 ≤ 1	107) Cross-s	ection che	eck - Biax	ial bending acc. to	F	UL	S
CO9	1.2*LC1 + LC2 + 0.5*LC3 + L	87	6.56	1.	01 > 1	107) Cross-s	ection che	eck - Biax	ial bending acc. to	F	UL	.S
	Serviceability Limit State Design	_										_
2019	LC1 + LC2	58	3.28	0.	26 ≤ 1	401) Service	eability - De	eflection i	n z-direction - Beam		SL	S
			Max:	1	01 > 1	A			E	> 1,0 -	7 😂 🛐 🗞	0
			Piax.	1.	01 5	•			E			
	Member 87 - x: 6.56 ft - CO9									8 - SHAPE-TH	IN ALUTEC	
	-Section Local Buckling									▲		
	n Ratio						_					
	nding Moment			Ma,a		0.740						
	nding Moment			Ma,v		0.437						
	nsile Yield Strength			Fty		23.207			A.3			
	mpressive Yield Strength			Fcy		21.032			A.3	0		
	nsile Strength			F _{t,Ma}		30.169			F.8.1			
	mpressive Strength			Fc,Ma		21.032			F.8.2			
	astic Section Modulus			St,a			in ³					
	stic Section Modulus			S _{c,a}			in ³					-•
	oss-Section Nominal Flexural Stre	ngth		M _{n.s.a}		2.811			F		u u	
	nsile Strength			Ft,Mv		30.169			F.8.1			
	mpressive Strength			Fc,Mv		21.032			F.8.2	=	1	
— Co	stic Section Modulus			St,v			in ³					
Ela				S _{c,v}			in ³			-		
Ela Ela	stic Section Modulus			Mn.s.v		1.260	kipft		F		Ÿ	
Ela Ela Cro	oss-Section Nominal Flexural Stre	ngth		1.					F1		-	
Ela Ela Cro Sa	fety Factor	-		Ωb		1.650						
Ela Ela Cro Sa	oss-Section Nominal Flexural Stre	-				1.650 1.704	kipft		F.1		z	
Ela Ela Cro Sal Cro	fety Factor	rength		Ωb		1.704 0.764	kipft				z	
Ela Ela Cro Sa Cro Cro	fety Factor Ss-Section Nominal Flexural Stre fety Factor Ss-Section Allowable Flexural Str	rength		Ω _b M _{r.s.a}		1.704	kipft	≤1	F.1		z	
Ela Ela Cro Sal Cro Cro De	fety Factor Sss-Section Nominal Flexural Stre Sss-Section Allowable Flexural Str Sss-Section Allowable Flexural Str	rength		Ωb Mr.s.a Mr.s.v		1.704 0.764	kipft	≤1 ≤1	F.1	- 0	2	

Figure 4.2: Window 2.1 Design by Load Case

Description

In the first column, the descriptions of the load cases, load and result combinations used for the designs are displayed.

Member No.

This column contains the numbers of the members that have the highest design ratios of each designed load case or combination.

Location **x**

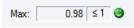
This column shows the x-locations of each member where the highest design ratios occur. For the table output, the program uses the following member x-locations:

- Start and end node
- Division points according to member division as defined in RFEM Table 1.16 or RSTAB Table 1.6
- Division of members according to specification for result diagrams (*Calculation Parameters* dialog box, *Global Calculation Parameters* tab in RFEM or RSTAB)
- Extreme values of internal forces



4 Results

Design Ratio



Columns D and E show the terms of design according to [2]. The lengths of the colored bars represent the respective design ratios.

Design According to Formula

This column lists the Sections of the Specification [2] by which the designs have been performed.

DS

The last column provides information on the design situations: *ULS* or *SLS* for the ultimate limit state or serviceability limit state design.

4.2 Design by Cross-Section

	A	B	С	D	E					F					
	Member	Location	Load-	Design											
No.	No.	x [ft]	ing	Ratio					Design Acc	cording to Formul	la				
2	LS 4.2/0.	5/0													
	1	1.54	C07	0.08	≤1	105) Cross-section	n check - Bend	ing about	u-axis acc.	to F					
	75	2.51	CO8			106) Cross-section				to F					
	89	3.28	CO4			107) Cross-section									
	74	1.64	CO4			135) Cross-section									
	17	1.74	CO4			174) Cross-section									
	17	1.64	CO9			178) Cross-section							n		
	17	2.12	CO3			184) Cross-section									
	75	2.51	CO8			188) Cross-section						d torsio	n		
	17	0.00	CO4	0.47	≤1	194) Cross-section	n check - Axial	force, biax	cial bending	and shear force					
			Max:	1.01	>1	8		۲	1 🎨			> 1,0	•	7 😂	3
Cross- Desigr	al Propertie Section Pr n Internal P	operties - LS Forces	5052-H32	(Sheet & Plate, F	Rod &	Bar) ADM 2010					•	2 - LS	4.2/0.5/	0	
Cross- Desigr	al Propertie Section Pro Internal F Section Lo	es - Aluminum operties - LS	5052-H32		Rod &	Bar) ADM 2010					• 	2 - LS	4.2/0.5/	1.23	
Cross- Desigr Cross- Leg	al Propertie Section Pro Internal F Section Lo	es - Aluminum operties - LS Forces ocal Buckling	5052-H32		Rod &	Bar) ADM 2010	-6.208	ksi	< 0	Compression		2 - LS	4.2/0.5/	1.23	1 2
Cross- Desigr Cross- Leg - Str	al Propertie Section Prin Internal F Section Lo A	es - Aluminum operties - LS Forces ocal Buckling	5052-H32		Rod &		-6.208 -1.252		< 0	Compression Compression		+	+	1.23	20
Cross- Desigr Cross- Leg - Str - Str - Str - Yie	al Propertie Section Pr In Internal F Section Lo A ress at Leg ress at Leg eld Strengt	es - Aluminum operties - LS Forces Iccal Buckling Start End	5052-H32		Rod &	Ga,A	-1.252 21.032	ksi ksi				ţ,	+	0 1.23 0.50	^u
Cross- Desigr Cross- Leg - Str - Str - Str - Yie	al Propertie Section Pro In Internal F Section Lo A ress at Leg ress at Leg	es - Aluminum operties - LS Forces Iccal Buckling Start End	5052-H32		Rod &	σ _{a,A} σ _{a,B}	-1.252 21.032 3.70	ksi ksi in		Compression		2 - LS	+	0 1.23 0.50	α
Cross- Desigr Cross- Leg - Str - Str - Str - Str - Cle - Th	al Propertie Section Pr In Internal F Section Lo A ress at Leg ress at Leg eld Strengt ear Width hickness	s - Aluminum operties - LS Forces ccal Buckling g Start g End h	5052-H32		Rod &	Ga,A Ga,B fy,a ba ta	-1.252 21.032 3.70 0.50	ksi ksi in		Compression		ţ,	+	0 1.23 0.50	a
Cross- Desigr Cross- Leg - Str - Str - Str - Cle - Th - Sle	al Propertie Section Pr In Internal F Section Lo A ress at Leg eld Strengt ear Width ickness endemess	es - Aluminum operties - LS Forces ccal Buckling g Start g End h Ratio	5052-H32 5 4.2/0.5/0		Rod &	σ _{a,A} σ _{a,B} f _{y,a} ba	-1.252 21.032 3.70	ksi ksi in		Compression		ţ,	+	0 <u>1.23</u> <u>0.50</u>	a a
Cross- Desigr Cross- Leg - Str - Str - Cle - Cle - Th - Sle - Le	al Propertie Section Pro- Internal F Section Lo A ress at Leg eld Strengt ear Width ickness endemess g A in unifi	es - Aluminum operties - LS Forces ocal Buckling g Start g End h Ratio com compress	5052-H32 5 4.2/0.5/0		Rod &	σ _a ,A σ _{a,B} f _{y,a} b _a t _a b _a /t _a	-1.252 21.032 3.70 0.50 7.400	ksi in in		Compression A.3.4		ţ,	+	0 <u>1.23</u> 0.50	a a 1050
Cross- Design Cross- Leg - Str - Str - Cle - Cle - Th - Sle - Le - Bu	al Propertie Section Pri Internal F Section Lo A ress at Leg eld Strengti aar Width iickness andemess g A in unifi ickling Cor	es - Aluminum operties - LS Forces occal Buckling) Start) End h Ratio om compress instant	5052-H32 5 4.2/0.5/0		Rod &	Ga,A Ga,B fy,a ba ta ba/ta Bp,a	-1.252 21.032 3.70 0.50 7.400 28.664	ksi in in ksi		Compression A.3.4 B.4		ţ,	+	1.23 0.50 4.20	α α 1050
Cross- Design Cross- Cross- Str - Str - Str - Cle - Str - St	al Propertie Section Pro- Internal F Section Lo A ress at Leg eld Strengt ear Width lickness g A in unifi- cickling Cor ickling Cor	es - Aluminum operties - LS orces ocal Buckling 3 Start 9 End h Ratio oom compress stant stant	5052-H32 5 4.2/0.5/0		Rod &	GaA GaB fy.a ba ta ba/ta Bp/ta Dp.a	-1.252 21.032 3.70 0.50 7.400 28.664 0.186	ksi in in ksi		Compression A.3.4 B.4 B.4		ţ,	+	1.23 0.50	α α 1950
Cross- Design Cross- Leg - Str - Str - Str - Cle - Cle - Cle - Cle - Cle - Cle - Bu - Bu - Bu - Bu - Bu	al Propertie Section Pro- Internal F Section Lo A ress at Leg eld Strengt ear Width ickness g A in unifi ickling Cor ickling Cor ickling Cor	es - Aluminum operties - LS orces ocal Buckling Start End h Ratio orm compress istant istant istant	5052-H32 5 4.2/0.5/0		Rod &	Ga,A Ga,B Fy,a ba ta ba/ta Ba/ta Dp.a Cp.a	-1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665	ksi in in ksi		Compression A.3.4 B.4 B.4 B.4		ţ,	+	1.23 0.50	α 000
Cross- Design Cross- Leg - Str - Str - Cle - Cle - Cle - Cle - Sle - Le - Bu - Bu - Bu - Bu - Bu - Bu - Bu	al Propertie Section Pro- Internal F Section Lo A ress at Leg eass at Leg east Leg e	es - Aluminum operties - LS orces ical Buckling Start End h Ratio orm compress stant estant stant g Constant	5052-H32 5 4.2/0.5/0		Rod &	σа,А σа,В fy,a ba ta ba/ta Bp,a Dp,a Cp,a Kt,a	1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665 0.500	ksi in in ksi		Compression A.3.4 B.4 B.4 B.4 B.4 Tab. B.4.3		ţ,	+	1.23 0.50	
Cross- Desigr Cross- Leg - Str - Str - Str - Cle - Th - Sle - Le - Bu - Bu - Bu - Bu - Po - Po	al Propertie Section Pro- Internal F Section Lo Ress at Leg eress at Leg eld Strengt aar Width ickness andemess g A in unif- ickling Cor ickling Cor ickling Cor ickling Cor ickling Cor ickling Cor ickling Cor ickling Cor	es - Aluminum operties - LS forces iccal Buckling Start End h N Ratio om compress stant stant stant stant g Constant g Constant	5052-H32 5 4.2/0.5/0		Rod &	σ _{a,A} σ _{a,8} f _{y,a} b _a t _a b _b A _a B _{p,a} D _{p,a} C _{p,a} K _{1,a} k _{2,a}	1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665 0.500 2.040	ksi in in ksi		Compression A.3.4 B.4 B.4 B.4 B.4 Tab. B.4.3 Tab. B.4.3		ţ,	+	1.23 0.50	a a 1990
Cross- Design Cross- Cross- Leg - Str - Str - Cle - Th - Sle - Le - Bu - Bu - Bu - Bu - Po - Sle - Sle	al Propertie Section Pro- Internal F Section Lor A ress at Leg ress at Leg res	s - Aluminum operties - LS orces scal Buckling Start End h Ratio orm compress stant stant stant stant g Constant g Constant g Constant Limit	5052-H32 5 4.2/0.5/0		Rod &	GaA GaB Fy.a ba ta ba/ta Bp.a Dp.a Cp.a K1.a K2.a S1.a.c	1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665 0.500 2.040 8.201	ksi in in ksi		Compression A.3.4 B.4 B.4 B.4 Tab. B.4.3 Tab. B.4.3 Tab. B.4.3 B.5.4		ţ,	+	1.23 0.50	
Cross- Design Cross- Cross- Stor Stor Stor Stor Clei Clei Clei Clei Clei Clei Clei Clei	al Propertie Section Pro- Internal F Section Lo A ress at Leg east Leg ald Strengt aar Width lickness andemess g A in unifi ickling Cor ickling Cor ic	es - Aluminum operties - LS Forces ccal Buckling g Start g End h h Ratio om compress stant estant stant g Constant g Constant Limit Limit	5052-H32 5 4.2/0.5/0		Rod &	σ _{a,A} σ _{a,B} f _{y,a} ba ta b _a /t _a B _{p,a} D _{p,a} C _{p,a} K _{1,a} k _{2,a} S _{1,a,c} S _{2,a,c}	1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665 0.500 2.040 8.201 20.533	ksi in in ksi	< 0	Compression A.3.4 B.4 B.4 B.4 B.4 Tab. B.4.3 Tab. B.4.3		ţ,	+	1.23 0.50	
Cross- Desigr Cross- Sross- Str Str Str Str Clei Clei Clei Clei Clei Clei Clei Clei	al Propertie Section Pro- Internal F Section Lo A ress at Leg east Leg eld Strengt ear Width lickness g A in unifu ckling Cor lockling	es - Aluminum operties - LS Forces ccal Buckling g Start g End h h Ratio om compress stant estant stant g Constant g Constant Limit Limit	5052-H32 5 4.2/0.5/0		Rod &	GaA GaB Fy.a ba ta ba/ta Bp.a Dp.a Cp.a K1.a K2.a S1.a.c	1.252 21.032 3.70 0.50 7.400 28.664 0.186 102.665 0.500 2.040 8.201	ksi in in ksi ksi		Compression A.3.4 B.4 B.4 B.4 Tab. B.4.3 Tab. B.4.3 Tab. B.4.3 B.5.4		ţ,	+	1.23 0.50	

Figure 4.3: Window 2.2 Design by Cross-Section

In the upper table, the highest ratios of all designed members and load cases or combinations are listed by cross-section. The results are sorted by cross-section design and stability analysis, as well as serviceability limit state design.

For a tapered member, the cross-sections of the member start and of the member end are listed separately.



4.3 Design by Set of Members

This result window is displayed when you have selected at least one set of members for design. The table lists the highest design ratios of each set of members.

	A	B	С	D	E					F				
et	Member	Location	Load-	Design										
lo.	No.	x [ft]	ing	Ratio					Design A	ccording to F	omula			
2	Column 2	(Member No	. 42,41)											
	42	1.93	C07	0.04	≤1	102) Cross-section	n check - Com	pression a	cc.to E					
	41	0.00	CO6	0.23	≤1	106) Cross-section	n check - Bend	ling about	z-axis acc	: to F				
	41	3.28	CO4			107) Cross-section								
	41	1.54	CO9	0.08	≤1	116) Cross-section	n check - Shea	ar force in	y-axis acc	to G				
	42	1.93	C07			117) Cross-section								
	42	0.00	CO3			126) Cross-section								
	42	0.00	CO3			128) Cross-section					ce in y-a	kis		
	41	0.39	CO6			133) Cross-section				n y-axis				
	41	0.19	CO8	0.01	≤1	135) Cross-section	n check - Torsi	on and sh	ear force					
			Max:	1.01	> 1	8		٩	1 🏝			> 1,0	• 7	2 🖪 🐧
ails -	Member 41	I - x: 3.28 ft	CO4									4 - TO 8/3	5/0.25/0.2	5/0.25/0.25
Cross-	Section La	cal Buckling												
Desigr	n Ratio													
Ben	iding Mom	ent				May	0.167	kipft						
Ben	iding Mom	ent				Maz	1.714	kipft			_		3.50	-+
Ten	sile Yield S	Strength				Fty	12.329	ksi		A.3		0	.25	0.25
- Con	npressive)	rield Strength	l			Fcy	13.054	ksi		A.3				
	isile Streng					F _{t,My}	16.027			F.8.1		0.25		
	npressive S					F _{o,My}	13.054			F.8.2		0		4.00
	stic Section					St,y	11.0							4.
	stic Section					S _{c.y}	11.0					8.00	2	
		Nominal Flex	ural Strengt	h		Mn.s.y	11.929			F		80		
	isile Streng					Ft,Mz	16.027			F.8.1	_			
	npressive S					F _{c,Mz}	13.054			F.8.2	E			
	stic Section	1110000100				St,z		in ³					_	
	stic Section					S _{c,z}		in ³				0.25		
Elas		Nominal Flex	ural Strengt	h		Mn.s.z	7.278			F		0		
Elas						0	1 650			F.1			1.75 ^Z	
Elas Cros Saf	ety Factor					Ωb								
Elas Cros Safe	ety Factor ss-Section	Allowable Fle				M _{r.s.y}	7.230			F.1				
Elas Cros Safe Cros	ety Factor ss-Section ss-Section	Allowable Fle Allowable Fle					7.230 4.411	kipft		F.1 F.1				
- Elas - Cro: - Safo - Cro: - Cro: - Des	ety Factor ss-Section ss-Section sign Compo	Allowable Fle				M _{r.s.y}	7.230	kipft	≤1					

Figure 4.4: Window 2.3 Design by Set of Members

The column *Member No.* shows the number of the member within the set that has the highest stress ratio for the respective design criteria.

The output by set of members presents the maximum design results of structural groups, such as frames or multi-part columns.

2.4 Design by Member

	A	B	С	D					E			
/lember	Location	Load-	Design									
No.	x [ft]	ing	Ratio					Desig	n Accord	ing to Formula		
1	Cross-section	n No. 2 - L										
	1.54	C07	0.08	≤1	105) Cross-s	ection check - I	Bending about	u-axis acc.	to F			
	1.64	CO8				ection check - I			to F			
	3.28	CO4				ection check - I						
	2.12	CO4				ection check -						
	1.54	C07								ear force and to		
	1.64	CO8								ear force and to	rsion	
	0.00	CO4	0.24	≤1	194) Cross-s	ection check - /	Axial force, biax	cial bending	and shea	ar force		
	3.28	CO4	0.45	≤1	198) Cross-s	ection check - /	Axial force, biax	cial bending	, shear fo	rce and torsion		
	1.54	C07	0.25	≤1	333) Stability	analysis - Bend	ling about u-ax	is and com	pression a	acc. to H.1		
		Max:	1.01	>1	8			9	2	2	E)	> 1,0 🔹 🖓 🔮 🛐 🏷 💿
)etails - I	Member 1 - x	1.54 ft - C	07									2 - LS 4.2/0.5/0
🗆 Design	n Internal Ford	es										
— Axia	I Force					Pa	-0.618	kip			1	
- She	ar Force					V _{a,a}	0.266	kip				
- She	ar Force					Va,v	0.529	kip				
- Tors	sional Momen	t				Ta	0.002	kipft				1.23
Ben	ding Moment					M _{a,a}	0.281	kipft				
Ben	ding Moment					Ma,v	-0.005	kipft			Ξ	
+ Cross-	Section Local	Buckling										α 2.50 0.50
🗄 Design	n Ratio											α 53 53 A
— Axia	I Compression	n Force				Pa	0.618	kip				¥
Ben	ding Moment					Ma,a	0.281	kipft				
- Max	imum Bendin	g Moment				Ma,a,segm	1.183	kipft				0.4
- Ten	sile Yield Stre	ngth				Fty	23.207	ksi		A.3	1	4.20
Corr	pressive Yiel	d Strength				Fey	21.032	ksi		A.3		v
- Cros	ss-Section No	minal Axial	Strength			Pn.s	-24652.800	kip		E.4		÷
Safe	ety Factor		-			Ωο	1.650			E.1		2
- Cros	ss-Section All	wable Cor	npressive Strengt	h		Pr.s	-14941.100	kip		E.1		
	d Moment of					M _{V.a}	6.086	kipft				
- Cros	ss-Section No	minal Flexu	ral Strength			Mn.s.a	6.086			F		
	etv Factor					Ωь	1.650			F.1		
		wable Flex	ural Strength			Mr.s.a	3.688	kipft		F.1		[in
	dulus of Elasti					E	10196,700				I	6

Figure 4.5: Window 2.4 Design by Member

In this window, the highest ratios of the cross-section checks, stability analyses, and serviceability designs are shown. The results are sorted by member number.

4.5 Design by x-Location

	A	B	С	D						E					
ember	Location	Load-	Design	-											
No.	x [ft]	ing	Ratio					Des	ign Accon	ding to Formu	ula				
	6.09	CO3					Biaxial bending								
	6.56	CO3					 Biaxial bending 								
	6.56	CO3					 Shear buckling 			force in z-ax	is				
	6.56	CO3	0.04	≤1	164) Cross-se	ection check	 Biaxial bending 	and shea	r force						
40			8/4/0.375/0.25												
	0.00	CO3					 Biaxial bending 								
	0.00	CO3					 Shear buckling 			force in z-ax	is				
	0.00	CO3					 Biaxial bending 								
	0.47	CO3	0.15	≤1	107) Cross-se	ection check	 Biaxial bending 	acc. to F							
		Max:	0.74	≤1	9			٩	12		•	> 1,0	• ? 4	>	
	Member 40 -		:03									3 - IS 8	8/4/0.375/0.25/0	1	
	Section Loca	l Buckling									^				
Desigr															
	iding Moment					Ma,y	1.701				_		4.00		- 1
	iding Moment					Ma,z	0.030								0.25
	sile Yield Stre					Fty	23.207			A.3	_	1 1			=
	npressive Yiel	d Strength				Fey	21.032			A.3	_			0.00	
	sile Strength					Ft,My	30.169			F.8.1	- 11				
	npressive Stre					F _{c,My}	21.032			F.8.2	_				
	stic Section M					St.y	10.8				_				
	stic Section N	io dalao				S _{c.y}	10.8				_	8.00	S		
	ss-Section No	minal Flexur	al Strength			Mn.s.y	18.939			F	- 11				
	sile Strength					F _{t,Mz}	30.169			F.8.1	=		0.38		
	npressive Stre					F _{c,Mz}	21.032			F.8.2	-			0.00	
_	stic Section M					S _{t,z}		in ³			_				
	stic Section M					S _{c,z}		in ³				∔	lin		
	ss-Section No	minal Flexur	al Strength			M _{n.s.z}	2.366	kipft		F			1 L		
	ety Factor					Ωb	1.650			F.1			z		
	ss-Section All					M _{r.s.y}	11.478			F.1					
	ss-Section All		ural Strength			M _{r.s.z}	1.434	kipft		F.1					
	ign Compone					ηMy	0.15		≤1						ſ
Dee	ign Compone	nt for Ma				ηMz	0.02		≤1						

Figure 4.6: Window 2.5 Design by x-Location

4

This window lists the maximum values of each member at every location x:

• Start and end node

3.1 Governing Internal Forces by Membe

- Division points according to member division as defined in RFEM Table 1.16 or RSTAB Table 1.6
- Division of members according to specification for result diagrams (*Calculation Parameters* dialog box, *Global Calculation Parameters* tab in RFEM or RSTAB)
- Extreme values of internal forces

4.6 Governing Internal Forces by Member

	A	B	C	D	E	F	G	Н	
1ember	Location	Load-		Forces [kip]		1	Ioments [kipft]		
No.	x [ft]	ing	N	Vy/Vu	Vz/Vv	Мт	My/Mu	M _z /M _v	Design According to Formula
1	Cross-section	No. 2 - LS	4.2/0.5/0						
	1.54	C07	-0.618	0.266	0.529	0.002	0.282	+0.005	105) Cross-section check - Bending about u-axis acc. to F
	1.64	CO8	-0.396	0.272	0.420	+0.008	0.000	0.117	106) Cross-section check - Bending about v-axis acc. to F
	3.28	CO4	-0.689	0.340	0.659	+0.002	1.342	-0.617	
	2.12	CO4	-0.694	0.342	0.660	+0.001	0.578	-0.223	135) Cross-section check - Torsion and shear force
	1.54	CO7	-0.618	0.266	0.529	0.002	0.282	+0.005	178) Cross-section check - Axial force, bending about u-axis, sh
	1.64	CO8	-0.396	0.272	0.420	+0.008	0.000	-0.117	188) Cross-section check - Axial force, bending about v-axis, sh
	0.00	CO4	-0.706	0.341	0.660	0.000	-0.823	0.503	194) Cross-section check - Axial force, biaxial bending and she
	3.28	CO4	-0.689	0.340	0.659	+0.002	1.342	-0.617	
	1.54	C07	-0.618	0.266	0.529	0.002	0.281		333) Stability analysis - Bending about u-axis and compression a
	1.54	C07	-0.618	0.266	0.529	0.002	0.282	+0.005	335) Stability analysis - Bending about u-axis, compression and
	1.64	CO8	-0.396	0.272	0.420	+0.008	0.000	-0.117	
	1.16	CO6	-0.568	0.276	0.447	+0.004	-0.011	0.062	
	3.28	CO4	-0.689	0.340	0.659	-0.002	1.342	-0.617	342) Stability analysis - Biaxial bending and compression acc. to
	3.28	CO4	-0.689	0.340	0.659	-0.002	1.342	-0.617	344) Stability analysis - Biaxial bending, compression and shear
2	Cross-section								
	2.12	CO6	-0.941	0.300	0.328	0.008	0.005	-0.105	106) Cross-section check - Bending about v-axis acc. to F
	0.00	CO4	-1.620	0.370	0.572	0.001	1.104	0.679	107) Cross-section check - Biaxial bending acc. to F
	0.39	CO9	-1.383	0.389	0.612	+0.008	-0.827	0.552	135) Cross-section check - Torsion and shear force
	1.93	CO4	-1.607	0.376	0.574	0.000	0.003	0.042	
	1.74	CO8	-1.131	0.316	0.330	0.015	-0.010	0.021	188) Cross-section check - Axial force, bending about v-axis, sh
	0.19	CO4	-1.619	0.371	0.573	0.001	-0.994	0.608	
	0.00	CO4	-1.620	0.370	0.572	0.001	-1.104	0.679	198) Cross-section check - Axial force, biaxial bending, shear for
	1.93	CO4	-1.607	0.376	0.574	0.000	0.003	0.042	339) Stability analysis - Bending about v-axis and compression a
	1.93	CO4	-1.607	0.376	0.574	0.000	0.003	0.042	
	3.28	CO4	-1.601	0.372	0.573	+0.001	0.779		342) Stability analysis - Biaxial bending and compression acc. to
	0.00	CO4	-1.620	0.370	0.572	0.001	-1.104	0.679	344) Stability analysis - Biaxial bending, compression and shear
3				375/0.375/0.3					
	6.09	CO3	-0.612	+0.009	-0.124	-0.040	-0.683		105) Cross-section check - Bending about y-axis acc. to F
	2.34	CO8	-0.505	0.315	-0.211	0.022	-0.005		106) Cross-section check - Bending about z-axis acc. to F
	0.00	CO8	-0.506	0.356	-0.277	0.022	0.572	1.019	
	0.00	CO3	-0.612	-0.009	-0.348	-0.040	0.833	0.043	126) Cross-section check - Shear buckling acc. to G.2 - Shear

Figure 4.7: Window 3.1 Governing Internal Forces by Member

For every member, this window displays the governing internal forces. Those are the internal forces that result in the maximum design ratios of each design.

Location **x**

This column informs you about the x-locations of each member where the highest ratios occur.

Loading

This column shows numbers of the load cases and combinations whose internal forces result in the maximum design ratios for each type of design.

Forces / Moments

For every member, this column displays the axial and shear forces as well as the torsional and bending moments that give the maximum ratios each design.



The last column shows the types of design and gives the Sections of the Specification [2] that were used for the analysis.

4.7 Governing Internal Forces by Set of Members

	A	В	C	D	E	F	G	Н	
et	Location	Load-		Forces [kip]		N	loments [kipft]		
ο.	x [ft]	ing	N	Vy/Vu	Vz/Vv	MT	My/Mu	M _z /M _v	Design According to Formula
1	Column 1 (Me	mber No. 1	7,16)						
	1.64	CO9	-0.989	-0.168	-0.190	0.013	0.222	0.002	105) Cross-section check - Bending about y-axis acc. to F
	0.77	CO8	-0.383	-0.323	-0.379	0.008	0.005	-0.292	106) Cross-section check - Bending about z-axis acc. to F
	3.28	CO4	-0.629	-0.507	-0.438	-0.001	-0.907	0.913	107) Cross-section check - Biaxial bending acc. to F
	2.32	CO4	-0.632	-0.509	-0.439	-0.001	-0.484	0.423	135) Cross-section check - Torsion and shear force
	1.74	CO4	-1.536	-0.442	-0.483	0.000	0.164	-0.001	174) Cross-section check - Axial force, bending about y-axis a
	1.64	CO9	-0.989	-0.168	-0.190	0.013	0.222	0.002	178) Cross-section check - Axial force, bending about y-axis, s
	2.12	CO3	-1.520	-0.421	-0.405	0.000	0.009	0.195	184) Cross-section check - Axial force, bending about z-axis a
	0.77	CO8	-0.383	-0.323	-0.379	0.008	0.005	-0.292	188) Cross-section check - Axial force, bending about z-axis, s
	0.00	CO4	-1.548	-0.437	-0.481	0.001	1.001	-0.766	194) Cross-section check - Axial force, biaxial bending and she
	3.28	CO4	-0.629	-0.507	-0.438	-0.001	-0.907	0.913	198) Cross-section check - Axial force, biaxial bending, shear
	1.74	CO4	-1.536	-0.442	-0.483	0.000	0.164	-0.001	333) Stability analysis - Bending about y-axis and compression
	1.74	CO4	-1.536	-0.442	-0.483	0.000	0.164	-0.001	335) Stability analysis - Bending about y-axis, compression and
	2.12	CO3	-1.520	-0.421	-0.405	0.000	0.009	0.195	339) Stability analysis - Bending about z-axis and compression
	2.12	CO3	-1.520	-0.421	-0.405	0.000	0.009	0.195	341) Stability analysis - Bending about z-axis, compression and
	3.28	CO4	-0.629	-0.507	-0.438	-0.001	-0.907	0.913	342) Stability analysis - Biaxial bending and compression acc.
	3.28	CO4	-0.629	-0.507	-0.438	-0.001	-0.907	0.913	344) Stability analysis - Biaxial bending, compression and shea
2	Column 2 (Me	mber No. 4	2,41)						
	1.93	C07	-1.935	-0.622	0.040	-0.003	0.002	-0.007	102) Cross-section check - Compression acc. to E
	0.00	CO6	-1.280	-0.754	-0.014	0.011	-0.003	-1.004	106) Cross-section check - Bending about z-axis acc. to F
	3.28	CO4	-1.375	-0.894	0.094	0.004	0.167	1.714	107) Cross-section check - Biaxial bending acc. to F
	1.54	CO9	-0.849	-0.606	0.030	-0.006	-0.008	0.007	116) Cross-section check - Shear force in y-axis acc. to G
	1.93	CO7	-1.935	-0.622	0.040	-0.003	0.002	-0.007	117) Cross-section check - Shear force acc. to G
	0.00	CO3	-2.568	-0.703	0.067	-0.003	-0.128	-1.307	126) Cross-section check - Shear buckling acc. to G.2 - Shea
	0.00	CO3	-2.568	-0.703	0.067	-0.003	-0.128	-1.307	128) Cross-section check - Shear buckling acc. to G.2 - Shea
	0.39	CO6	-1.277	-0.756	-0.014	0.011	-0.008	-0.712	133) Cross-section check - Torsion and shear force in y-axis
	0.19	CO8	-0.857	-0.656	-0.112	0.023	0.116	-0.764	135) Cross-section check - Torsion and shear force
	1.64	CO4	-2.829	-0.881	0.087	-0.002	-0.017	-0.194	181) Cross-section check - Axial force, bending about z-axis a
	0.00	CO4	-2.843	-0.854	0.085	-0.003	-0.158	-1.624	191) Cross-section check - Axial force, biaxial bending and sh
	1.93	C07	-1.935	-0.622	0.040	-0.003	0.002	-0.007	302) Stability analysis - Flexural buckling about y-axis acc. to E
	1.93	C07	-1.935	-0.622	0.040	-0.003	0.002	-0.007	306) Stability analysis - Flexural buckling about z-axis acc. to E
	1.64	CO4	-2.829	-0.881	0.087	-0.002	-0.017	-0.194	339) Stability analysis - Bending about z-axis and compression
	1.64	CO4	-2.829	-0.881	0.087	-0.002	-0.017	-0.194	340) Stability analysis - Bending about z-axis, compression and
_									E 😫 🖪 🗞

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

This result window is displayed when you have selected at least one set of members for design. The table lists the internal forces that result in the highest ratios for each set of members.



Details...

This window is shown when you have selected the respective check box in the *Details* dialog box, tab *General* (see Figure 3.4, page 31).

/lember		B	С	D	E	F	G	H	
		Length		Major Axis y/u			Minor Axis z/v		
No.	Under Stress	L [ft]	k y/u [-]	i y/u [in]	λy/u [-]	k _{z/v} [-]	i _{z/v} [in]	λ _{z/v} [-]	
1	Compression / Flexure	3.28	1.000	1.62	24.366	1.000	0.82	47.880	
2	Compression / Flexure	3.28	1.000	1.62	24.366	1.000	0.82	47.880	
3	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
4	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
5	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
6	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
7	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
8	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
9	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
10	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	_
11	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
12	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
13	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
14	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
15	Compression / Flexure	6.56	1.000	2.83	27.848	1.000	1.61	48.845	
16	Compression / Flexure	3.28	1.000	1.62	24.366	1.000	0.82	47.880	_
17	Compression / Flexure	3.28	1.000	1.62	24.366	1.000	0.82	47.880	
18	Compression / Flexure	8.75	1.000	2.83	37.130	1.000	1.61	65.126	
19	Compression / Flexure	8.75	1.000	3.00	35.031	1.000	0.75	140.174	
20	Compression / Flexure	8.75	1.000	2.83	37.130	1.000	1.61	65.126	
23	Compression / Flexure	8.75	1.000	2.83	37.130	1.000	1.61	65.126	
24	Compression / Flexure	8.75	1.000	3.00	35.031	1.000	0.75	140.174	
25	Compression / Flexure	8.75	1.000	2.83	37.130	1.000	1.61	65.126	
26	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
27	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
28	Compression / Flexure	6.56	1.000	3.00	26.273	1.000	0.75	105.131	
29	Compression / Flexure	6.56	1.000	3.00	26.273	1.000	0.75	105.131	
30	Compression / Flexure	6.56	1.000	3.00	26.273	1.000	0.75	105.131	_
31	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	
32	Compression / Flexure	3.28	1.000	2.82	13.941	1.000	1.46	26.984	

Figure 4.9: Window 3.3 Member slendernesses

Details...

The table lists the effective slendernesses of the designed members for both directions of the principal axes. They are determined in compliance with the load type. At the end of the list, there is a comparison with the limit values that have been defined in the *Details* dialog box, tab *General* (see Figure 3.4, page 31).

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

This window is displayed only for information. No stability analysis of the slendernesses is provided.

4.9 Parts List by Member

Finally, RF-/ALUMINUM ADM gives a summary of all designed cross-sections.

	A	B	C	D	E	F	G	Н (
art	Cross-Section	Number of	Length	Total Length	Surface Area	Volume	Unit Weight	Weight	Total Weight
lo.	Description	Members	[ft]	[ft]	[ft 2]	[ft 3]	[b/ft]	[b]	[kip]
1	2 - LS 4.2/0.5/0	8	3.28		36.75	0.72	4.62	15.17	
2	1 - TO 8/4/0.375/0.375/0.375/0.375	18	6.56	118.11	236.22	6.92	9.88	64.80	0.12
3	4 - TO 8/3.5/0.25/0.25/0.25/0.25		3.28		150.92	3.01	6.44	21.12	0.05
4	1 - TO 8/4/0.375/0.375/0.375/0.375	18	8.75		314.96	9.23	9.88	86.41	0.10
5	3 - IS 10/6/0.5/1/0	2	8.75		62.70	1.94	18.73	163.85	0.03
6	3 - IS 10/6/0.5/1/0	12	6.56	78.74	282.15	8.75	18.73	122.89	0.15
7	7 - TO 6/4.75/0.2/0.2/0.2/0.2	3	6.56	19.69	35.27	0.57	4.85	31.80	0.0
8	1 - TO 8/4/0.375/0.375/0.375/0.375	4	3.28	13.12	26.25	0.77	9.88	32.40	0.01
9	8 - SHAPE-THIN ALUTEC	1	6.56	6.56	12.52	0.08	2.00	13.10	0.00
0	5 - SHAPE-THIN PROFIL-Y	1	3.28	3.28	6.64	0.02	0.92	3.01	0.00
um		91		519.47	1164.37	32.00			0.5
									. 🐧 👁

Figure 4.10: Window 4.1 Parts List by Member

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

Part No.

Details...

The program automatically assigns item numbers to identical members.

Cross-Section Description

In this column, the numbers and descriptions of the cross-sections are listed.

Number of Members

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

Length

In column C, the lengths of the representative members are given.

Total Length

The values in this column represent the product of the previous two columns.

Surface Area



The area, which is related to the total length, is determined from the *Surface* of the cross-sections. It can be checked in Windows 1.3 and 2.1 through 2.5 in the *Info* dialog box (see Figure 2.13, page 14).



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

Unit Weight

The mass of a cross-section is related to the length of one meter. For tapered cross-sections, the program averages both section properties.

Weight

The values of this column represent the product of columns C and G.

Total Weight

The final column gives the total mass of each part.

Sum

At the bottom of the list, you find a summary of the values in columns B, D, E, F, and I. The last row of the *Total Weight* column shows the total amount of required aluminum.

4.10 Parts List by Set of Members

The last result window is displayed when you have selected at least one set of members for design. The table summarizes structural groups in a parts list, for example horizontal beams.

	A	B	C	D	E	F (G	н	
art	Set of Members	Number	Length	Total Length	Surface Area	Volume	Unit Weight	Weight	Total Weight
lo.	Description	of Sets	[ft]	[ft]	[ft ²]	[ft 3]	[b/ft]	[b]	[kip]
1	Column 1	1	6.56	6.56	9.19	0.18		30.34	0.0
2	Column 2	1	6.56	6.56	12.58	0.25	6.44	42.24	0.0
3	Main beam	1	19.69		35.27	0.57	4.85	95.39	0.0
um		3		32.81	57.03	1.00		[0.

Figure 4.11: Window 4.2 Parts List by Set of Members

Details on the columns can be found in Chapter 4.9. If different cross-sections are used in a set of members, the program averages the surface area, the volume, and the cross-section weight.

5 Results Evaluation

You can evaluate the results in many ways. For this, the buttons below the upper table are useful.

	A	В	С	D					E					
/lember	Location	Load-	Design											
No.	x [ft]	ing	Ratio	1				Design /	ccording	to Formula				
1	Cross-section	n No. 2 - L	S 4.2/0.5/0											
	1.54	C07	0.08	≤1	105) Cross-section	on check - Ben	ding about u-a	is acc. to	F					
	1.64	CO8	0.03	≤1	106) Cross-secti	on check - Ben	ding about v-a	is acc. to	F					
	3.28	CO4	0.53	≤1	107) Cross-secti	on check - Biaxi	ial bending acc	: to F						
	2.12	CO4	0.05	≤1	135) Cross-section	on check - Tors	ion and sheart	orce						
	1.54	C07	0.02	≤1	178) Cross-section	on check - Axia	force, bending	g about u-a	xis, shea	r force and torsior	ı			
	1.64	CO8			188) Cross-section						1 I			
	0.00	CO4			194) Cross-section									
	3.28	CO4			198) Cross-section									
	1.54	C07	0.26	≤1	333) Stability and	alysis - Bending	about u-axis a	nd compre	ssion acc	: to H.1				
		Max:	1.01	> 1	8			9	}	🔁 🛃	> 1,0	•	• • 📽 🖳 1	3
	Member 1 - x			& Pla	te Rod & Bar) I A	DM 2010		_			2 - LS	4.2/0	.5/0	
E Materi Cross- Desigr Cross-	al Properties Section Prope Internal Ford Section Loca	- Aluminum erties - LS ces	5052-H32 (Sheet	& Pla	ate, Rod & Bar) A	.DM 2010					2 - LS	4.2/0	.5/0	
	al Properties Section Prope In Internal Ford Section Loca In Ratio	-Aluminum erties - LS ces I Buckling	5052-H32 (Sheet	& Pla	ate, Rod & Bar) A		0.282	kinft			2 - LS	i 4.2/0.	.5/0	1
Materi Cross- Desigr Cross- Desigr Cross- Desigr Desigr Ber	al Properties Section Prope Internal Ford Section Loca Natio Iding Moment	- Aluminum erties - LS ces I Buckling	5052-H32 (Sheet	& Pla	ste, Rod & Bar) A	M _{a,a}	0.282			A 3	2 - LS	+ +	.5/0	1
Materi Cross- Desigr Cross- Cross- Desigr Desigr Ber Ber Ter	al Properties Section Prope Internal Ford Section Loca Ratio Inding Moment Isile Yield Stree	- Aluminum erties - LS ces I Buckling ength	5052-H32 (Sheet	& Pla	ste, Rod & Bar) A	M _{a,a} F _{ty}	23.207	ksi		A.3 A.3		t.t	5/0	1
Materi Cross- Desigr Oross- Cross- Desigr Desigr Ber Ter Con	al Properties Section Proper Internal Ford Section Loca In Ratio Iding Moment Isile Yield Stree Inpressive Yiel	- Aluminum erties - LS ces I Buckling ength d Strength	5052-H32 (Sheet	& Pla	ate, Rod & Bar) A	Ma,a Fty Fcy	23.207 21.032	ksi ksi		A.3	2 - LS	t.t	5/0	2
Materi Cross- Desigr Cross- Cross- Desigr Desigr Ber Ter Con Ter	al Properties - Section Properties - Internal Ford Section Loca In Ratio Iding Moment Isile Yield Stree Inpressive Yiel Isile Strength	- Aluminum erties - LS ces I Buckling ength d Strength	5052-H32 (Sheet	& Pla	ite, Rod & Bar) A	Ma,a Fty Fcy Ft,Ma	23.207 21.032 30.169	ksi ksi ksi				t.t	5/0	2
Materi Cross- Desigr Cross- Desigr Desigr Desigr Desigr Desigr Cross- Ter Con Ter Con	al Properties Section Proper Internal Ford Section Loca In Ratio Iding Moment Isile Yield Stree Inpressive Yiel	- Aluminum erties - LS ces I Buckling ength d Strength ength	5052-H32 (Sheet	& Pla	ate, Rod & Bar) A	Ma,a Fty Foy Ft,Ma Fc,Ma	23.207 21.032 30.169 27.341	ksi ksi ksi ksi		A.3 F.8.1		t.t	1.23 0 50 0	2 •
 Materi Cross- Desigr Cross- Desigr Ber Ter Con Ter Con Ter Con East 	al Properties Section Prop Internal Foro Section Loca Ratio ding Moment isile Yield Stre- pressive Yiel isile Strength pressive Stre	- Aluminum erties - LS ces I Buckling ength d Strength ength Iodulus	5052-H32 (Sheet	& Pla	ste, Rod & Bar) A	Ma.a Fty Fcy Ft.Ma Fc.Ma St.a	23.207 21.032 30.169 27.341 3.5	ksi ksi ksi in ³		A.3 F.8.1		t.t		
Materi	al Properties - Section Proper Internal Ford Section Loca In Ratio Inding Moment Isile Yield Stre- npressive Yiel Isile Strength Inpressive Stre- stic Section M stic Section M	- Aluminum erties - LS ces I Buckling ength d Strength lodulus lodulus	5052-H32 (Sheet 4.2/0.5/0	& Pla	tte, Rod & Bar) A	Ma,a Fty Fcy Ft,Ma Fc,Ma St,a Sc,a	23.207 21.032 30.169 27.341 3.5 3.5	ksi ksi ksi in ³ in ³		A.3 F.8.1		t.t	1.23 0 50 0	- - -
Materi Cross- Desigr Cross- Cross- Desigr Cross- Desigr Ber Ter Con Ter Con Eas Eas Cross- C	al Properties Section Properties Internal Force Section Loca In Ratio Inding Moment Isile Yield Stree Inpressive Yiel Isile Strength Inpressive Stree stic Section M	- Aluminum erties - LS ces I Buckling ength d Strength lodulus lodulus	5052-H32 (Sheet 4.2/0.5/0	& Pla	tte, Rod & Bar) A	Ma.a Fty Fcy Ft.Ma Fc.Ma St.a	23.207 21.032 30.169 27.341 3.5	ksi ksi ksi in ³ in ³		A.3 F.8.1 F.8.2		t.t		a • • • •
Materi ☐ Cross- ☐ Desigr ☐ Cross- ☐ Desigr ☐ Ber ☐ Cross- ☐ Desigr Ber Ter Con Ter Con Elas Cross- Cons Con Con Con Con Con Con Con Con	al Properties Section Proper Internal Ford Section Loca In Ratio ding Moment isile Yield Stre- npressive Yiel isile Strength npressive Stre- stic Section N stic Section No ety Factor	Aluminum erties - LS ces I Buckling ength Id Strength Iodulus Iodulus minal Flexu	5052-H32 (Sheet 4.2/0.5/0	& Pla	ite, Rod & Bar) A	Ma,a Fty Fcy Ft,Ma Fc,Ma St,a Sc,a Mn.s.a	23.207 21.032 30.169 27.341 3.5 3.5 6.086	ksi ksi ksi in ³ in ³ kipft		A.3 F.8.1 F.8.2		t.t		a 7
■ Materi ■ Cross ■ Design ■ Cross ■ Cross	al Properties Section Proper Internal Ford Section Loca In Ratio ding Moment isile Yield Stre- npressive Yiel isile Strength npressive Stre- stic Section N stic Section No ety Factor	Aluminum erties - LS ces I Buckling ength Id Strength Iodulus Iodulus minal Flexu	5052-H32 (Sheet 4.2/0.5/0 wal Strength	& Pla	te. Rod & Bar) A	Ma,a Fty Fcy Ft,Ma Fc.Ma St,a Sc,a Mn.s.a Qb Mr.s.a	23.207 21.032 30.169 27.341 3.5 3.5 6.086 1.650	ksi ksi ksi in ³ in ³ kipft		A.3 F.8.1 F.8.2 F. F. F.		t.t		2
Material ☐ Cross- ☐ Design ☐ Cross- ☐ Design ☐ Ber ☐ Cross- ☐ Design ☐ Cross- ☐ Cro	al Properties - Section Properties - Section Local Internal Ford Section Local International Content International Content International Content International Content Section Notes Section Allo Section Allo Section Allo	Aluminum erties - LS ces I Buckling ength Id Strength Iodulus Iodulus minal Flexu	5052-H32 (Sheet 4.2/0.5/0 wal Strength	& Pla	tte, Rod & Bar) A	Ma,a Fty Fcy Ft,Ma Fc,Ma St,a Sc,a Mn.s.a Ωb	23.207 21.032 30.169 27.341 3.5 3.5 6.086 1.650 3.688	ksi ksi ksi in ³ in ³ kipft	≤1	A.3 F.8.1 F.8.2 F F F.1		t.t		a V
Materi Aross Cross Desigr Cross Desigr Desigr Desigr Desigr Desigr Desigr Con Ter Con Ter Con Elas Cross Safr Cross	al Properties - Section Properties - Section Local Internal Ford Section Local International Content International Content International Content International Content Section Notes Section Allo Section Allo Section Allo	Aluminum erties - LS ces I Buckling ength Id Strength Iodulus Iodulus minal Flexu	5052-H32 (Sheet 4.2/0.5/0 wal Strength	& Pla	te, Rod & Bar) A	Ma,a Fty Fcy Ft,Ma Fc.Ma St,a Sc,a Mn.s.a Qb Mr.s.a	23.207 21.032 30.169 27.341 3.5 3.5 6.086 1.650 3.688	ksi ksi ksi in ³ in ³ kipft	<pre></pre>	A.3 F.8.1 F.8.2 F F F.1		t.t		- -

Figure 5.1: Buttons for results evaluation

The buttons have the following functions:

Button	Description	Function
`	Ultimate Limit State Designs	Display or hide the results of ULS design
2	Serviceability Limit State Designs	Display or hide the results of SLS design
	Result Combination	Create a new result combination from the governing load cases and load combinations
F	Color Bars	Display or hide the colored relation scales in the result tables
> 1,0 • > 1,0 • Max Define	Filter Parameters	Define the criterion to filter results in tables: ratios greater than 1, maximum, or user-defined limit
7	Apply Filter	Display only the rows with applied filter parameter (ratios greater than 1, maximum, user-defined limit)
2	Result Diagrams	Open the Result Diagram on Member Window \rightarrow Chapter 5.2, page 48
4	Excel Export	Export the table to MS Excel or OpenOffice \rightarrow Chapter 7.4.3, page 59
1	Member Selection	Select a member graphically to display its results in the table
۲	View Mode	Jump to the RFEM/RSTAB work window to change the view

Table 5.1: Buttons in the result windows 2.1 to 2.5



You can evaluate the results graphically in the RFEM or RSTAB work window.

RFEM/RSTAB background graphic and view mode

The RFEM or RSTAB work window in the background is useful when you want to find a specific member in the model: The member selected in the result window of RF-/ALUMINUM ADM is highlighted in the selection color in the background graphic. An arrow indicates the relevant x-location of the member that is selected in the table.

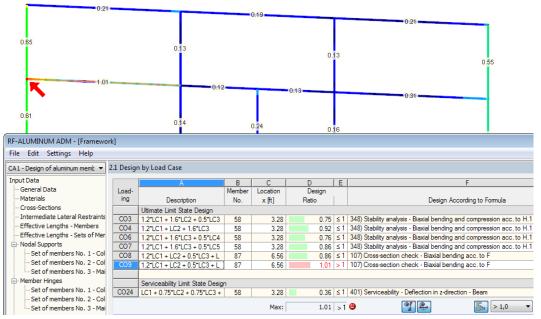


Figure 5.2: Indication of member and relevant *Location x* in the RFEM model



If you cannot improve the view by moving the RF-/ALUMINUM ADM window, click the solution to activate the *View mode*: The program hides the window so that you can modify the display in the RFEM/RSTAB user interface. The view mode provides the functions of the *View* menu, for example zooming, moving, or rotating the view. The pointer remains visible.

Click [Back] to return to the RF-/ALUMINUM ADM add-on module.

Project Navigator - Display

Title Info

• 💽 🔽 Two-Colored

RFEM/RSTAB work window

Graphics

You can graphically check the design ratios in the RFEM or RSTAB model: Click [Graphics] to exit the add-on module. Then the design ratios are displayed in the work window of RFEM or RSTAB – like internal forces of a load case.

In the *Results* navigator, you can specify which design ratios of the ultimate or serviceability limit state designs are to be displayed.

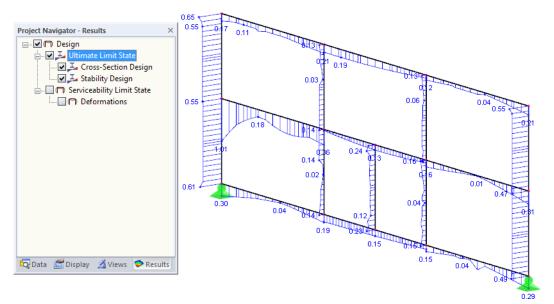


Figure 5.3: Results navigator for Ultimate Limit State and Serviceability Limit State designs

×

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To turn the display of results on or off, click the [Show Results] button (likewise to turning internal forces on or off). To display the result values, click the [Show Values] button to the right of it.

The RFEM/RSTAB tables are not relevant for the evaluation of the RF-/ALUMINUM ADM results.

RF-ALUMINUM ADM CA1 - Beams	J
LC1 - Self-weight LC2 - Live load	
CO1 - 1.4*LC1 + LC2	
RF-ALUMINUM ADM CA1 - Beams RF-ALUMINUM ADM CA2 - Columns	

You can set the design cases (see Chapter 7.1) by means of the list in the RFEM or 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.

07	Without Diagram		
07	Cross-Sections		
🗆 👩	Result Diagrams Filled		
🗹 🛜	Hatching		
🗆 👩	All Values		
🗆 👩	Extreme Values		
🗆 👩	Display Hidden Result Diagram		
🗆 👩	Reverse Results V-y and V-z		
🗆 👩	Results on Couplings	-	
🗟 Data 🖆 Dis	olay 🔏 Views 🗢 Results		
		*	

Figure 5.4: Display navigator: Results \rightarrow Members

When you have chosen one of the multicolor representations (options *With/Without Diagram*, *Cross-Sections*), the color panel is displayed, too. It provides common control functions which are described in the RFEM or RSTAB manual, Chapter 3.4.6.

5

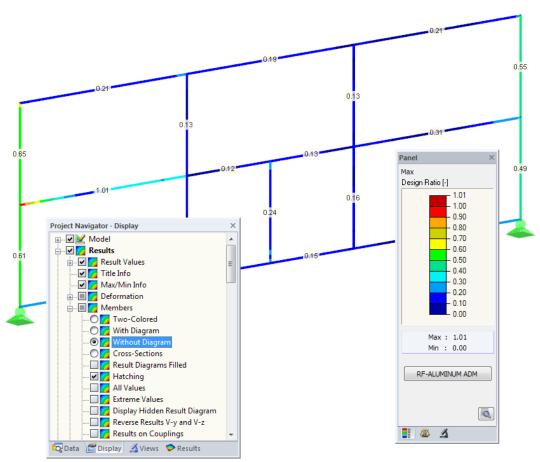


Figure 5.5: Design ratios with display option Without Diagram

You can transfer the graphics of design results to the printout report (see Chapter 6.2, page 52).

RF-ALUMINUM ADM

To return to the add-on module, click [RF-/ALUMINUM ADM] in the panel.

2

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5.2 Result Diagrams

You can also graphically evaluate the member results in the result diagrams.

Select the member (or set of members) in the RF-/ALUMINUM ADM result 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. This button is located below the upper result table (see Figure 5.1, page 44).

The result diagrams can also be accessed in the work window of RFEM or RSTAB via the menu

Results ightarrow Result Diagrams for Selected Members

or the corresponding button in the RFEM/RSTAB toolbar.

A new window appears. It shows the distribution of the design ratios along the selected member or set of members.

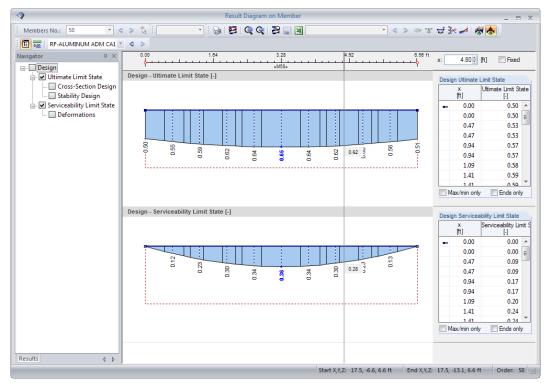
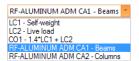


Figure 5.6: Dialog box Result Diagram on Member

You can set the results of the ultimate or serviceability limit state designs in the navigator.

Use the list in the toolbar above to select the relevant RF-/ALUMINUM ADM design case.

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







Basically, the RF-/ALUMINUM ADM result windows allow you to sort the results by various criteria. You can also use the filter options (see Figure 5.1, page 44) to reduce the tabular output with respect to design ratios. The function is described in this Knowledge Base article: https://www.dlubal.com/en-US/support-and-learning/support/knowledge-base/000733

Furthermore, you can use the filter options described in Chapter 9.9 of the RFEM manual to evaluate the results graphically.



For the RF-/ALUMINUM ADM graphics, you can also use the *Visibility* options to filter the members and evaluate them specifically (see RFEM manual, Chapter 9.9.1 or RSTAB manual, Chapter 9.7.1).

Filtering designs

Graphics

You can use the design ratios as filter criteria in the work window of RFEM or RSTAB (accessible by clicking [Graphics]). To apply this function, the panel must be displayed. If it is disabled, click the RFEM/RSTAB menu

$\textbf{View} \rightarrow \textbf{Control panel}$

or use the toolbar button shown on the left.

The panel is described in the RFEM or RSTAB manual, Chapter 3.4.6. The settings for filtering the ratios can be defined in the first tab (Color spectrum). As this tab is not available for the two-colored results, the options *Colored With/Without Diagram* or *Cross-Sections* have to be set in the *Display* navigator.

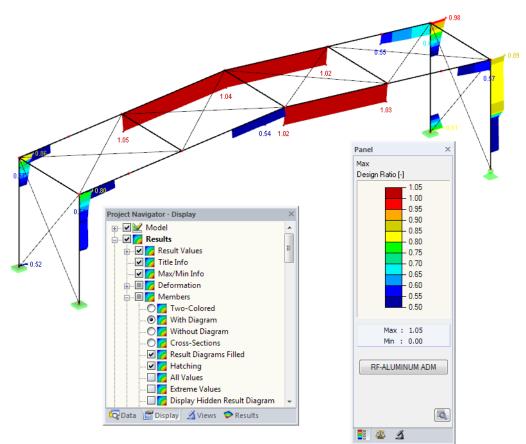


Figure 5.7: Filtering design ratios with adjusted color scale

Figure 5.7 presents a modified color spectrum: Only ratios greater than 0.50 are displayed in the color ranges between blue and red.

The function *Display hidden result diagram* in the *Display* navigator (**Results** \rightarrow **Members**) displays all ratios beyond the values of the color spectrum. Those diagrams are drawn as dotted lines.

5

Filtering members

1

In the *Filter* tab of the control panel, you can enter the numbers of members whose results you want to see exclusively. This function is described in Chapter 9.9.3 of the RFEM manual or Chapter 9.7.3 of the RSTAB manual.

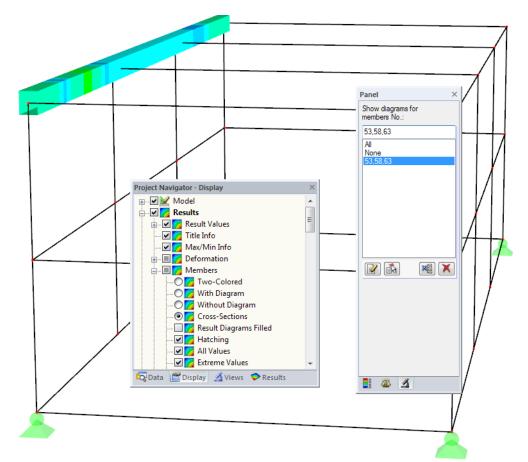


Figure 5.8: Member filter for the design ratios of a box girder

In contrast to the visibility mode, the entire model is displayed. Figure 5.8 shows the design ratios of one specific box girder. All other members of the model are displayed as well, but they have no design ratios.

6 Printout

6.1 Printout Report

In the same way as for RFEM or RSTAB, a printout report can be created for the RF-/ALUMINUM ADM data. You can illustrate the documentation by individual images and comments. The selection in the printout report controls which data of the add-on module is included in the final printout.



The printout report is described in the manuals of RFEM and RSTAB. In particular, Chapter 10.1.3.5 *Selecting Data of Add-on Modules* describes how the input and output data of add-on modules can be arranged.

<u>م</u>	Printout report - PR1: Input data a	nd reduced results* _ = = X
File View Edit Settings Insert Help		
😫 ka ka ka ka 🖸 🤣 🖬 🖆 🚰	🕹 🕰 🗧 💽 🛃 🖉 - 😓 条	ا کو کو
Printout Report Navigator	2.1 DESIGN BY LOAD	
Printout Report	CO/RC Load Case or RC CO/RC Description	n No. x [ft] Design Design Description
RF-ALUMINUM ADM	Ultimate Limit State Design CO3 1.2*LC1 + 1.6*LC2 + 0.5*LC3 CO4 1.2*LC1 + LC2 + 1.6*LC3	58 3.28 0.75 ≤1 348) ULS 58 3.28 0.92 ≤1 348) ULS
CA1 - Design of aluminum memb	ers ad CO8 1.2*LC1+1.6*LC3+0.5*LC4 CO7 1.2*LC1+1.6*LC3+0.5*LC5 CO8 1.2*LC1+LC2+0.5*LC5 CO8 1.2*LC1+LC2+0.5*LC3+LC4	58 2.38 0.75 ≤1 346) ULS 58 3.28 0.76 ≤1 346) ULS 68 3.28 0.76 ≤1 346) ULS 68 3.28 0.86 ≤1 346) ULS 68 3.28 0.86 ≤1 346) ULS 67 6.56 0.86 ≤1 346) ULS
1.2 Materials	CO9 1.2*LC1 + LC2 + 0.5*LC3 + LC5	87 0.50 0.80 51 107) ULS 87 6.58 1.01 >1 107) ULS
	rs CO19 LC1 + LC2	58 3.28 0.28 ≤ 1 401) SLS 58 3.28 0.33 ≤ 1 401) SLS
1.6 Effective Lengths - Sets of	Memi C020 LC1 + LC3 C024 LC1 + 0.75*LC2 + 0.75*LC3 + 0.45* C025 LC1 + 0.75*LC2 + 0.75*LC3 + 0.45*	58 3.28 0.33 ≤1 401 SLS LC4 58 3.28 0.38 ≤1 401 SLS LC5 58 3.28 0.38 ≤1 401 SLS
Results	2.2 DESIGN BY CROS Sect. Member Location LC/CO/	
2.1 Design by Load Case	No No 100	No.
2.3 Design by Set of Memb	ers 88 4.22 CO4	0.01 ≤ 1 102) Cross-section check - Compression acc. to E
Printout Report Selection - PR1		<u>ننا</u>
Program RFEM	Global Selection Input Data Results	
RF-ALUMINUM ADM	Display	Set
	2.1 Design by Load Case	No. Selection (e.g. 1-5,20)
	2.2 Design by Cross-Section	Cross-sections: All
	2.3 Design by Set of Members	Sets: All 🗸 💽 🗌
	2.4 Design by Member	Members:
	2.5 Design by x-Location	Members: All
	3.1 Governing Internal Forces	Select Intermediate Results
	3.2 Governing Internal Forces	Printout Report
	3.3 Member Slendernesses	With intermediate results Form: Short
	4.1 Parts List by Member	© Long
	4.1 Parts List by Member	Chapters to Display Image: Chapters to Display Image: Chapters to Display
	Filter settings	Cross-Section Properties
	> 1,0 -	Cross-Section Local Buckling
		Design Internal Forces
		V Design
Display		OK Cancel
Cover sheet		
Contents		
V Info pictures V Uppercase titles		
		OK Cancel

Figure 6.1: Selecting designs and intermediate results in the printout report

Click the [Details] button to specify if you want to include the intermediate results in the printout report as well. You can then select the *Chapters to Display* as seen in Figure 6.1. The detailed results can be recorded in a *Short* (compact compilation) or *Long* (list representation) form.

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 Graphic Printout

In RFEM or RSTAB, you can add every view of the work window to the printout report or send the image directly to your printer. In this way, you can prepare the design ratios displayed in the RFEM or RSTAB model for the printout.



The printing of graphics is described in the manuals of RFEM and RSTAB, Chapter 10.2.

Designs in RFEM/RSTAB model

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

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

			L	
١.			5	-
n	-			а
	Ŀ	-		3

or use the toolbar button shown on the left.

3							F	RFEM 5.0	7.0000 x64
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	Ta <u>b</u> le	<u>O</u> ptions
:	2	3 3	.		50	🔏 🍕	@ 🔁	216	1 🖸 🔁
1	- 9⁄	<i>%</i> 1	• 4 7 -	Print	Graphic 1	- <u>9×x</u> 🖭	t 🛍 ·	- 🗖 -	📬 - 🗊

Figure 6.2: Print Graphic button in RFEM toolbar

Result Diagrams



You can also [Print] the *Result Diagram on Member* to the report by using the corresponding button. It is also possible to print it directly.

(3)	
Members No.: 58 🔹 🗸	🕞 🍾 i 🔄 🚽 🖓 🖓
RF-ALUMINUM ADM CA1	⊲ > Print
Navigator 📮 🗙	

Figure 6.3: Print button in the dialog box Result Diagram on Member

The Graphic Printout dialog box appears.

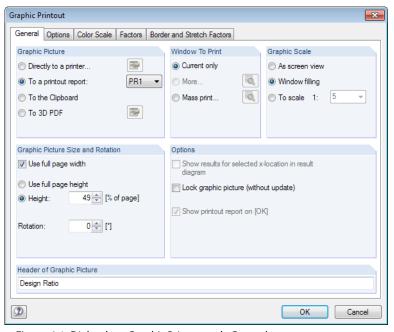


Figure 6.4: Dialog box Graphic Printout, tab General

6 Printout

This dialog box is described in detail in the manuals of RFEM and RSTAB, Chapter 10.2, inclusive of the other tabs of the dialog box.

•

When you have printed the image to the printout report, you can move it anywhere within the report by drag-and-drop.

To adjust an image subsequently in the printout report, right-click the relevant entry in the navi-Graphic Printout dialog

OK Cancel

ript Proportional	Symbols	ch Factors		
Proportional				
			Frame	
	Proportional		None	
Constant	Constant		Framed	
ctor: 1 🔺	Factor: 1		Title box	
nt Quality		Color		
Standard (max 1000 x 1000 pixels)		Grayscal	e	
Maximum (max 5000 x 5000 pixels)		 Texts an 	d lines in black	
User-defined		All colore	d	
Max number of pixels:	1000 <u>*</u>			

Figure 6.5: 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 elements or analyze members with particular design specifications (for example modified materials, strengths, restraints, etc.).

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

 RF-ALUMINUM ADM CA1 - Beams
 •

 LC1 - Self-weight
 •

 LC2 - Live load
 •

 CO1 - 1.4*LC1 + LC2
 •

 RF-ALUMINUM ADM CA1 - Beams
 •

 RF-ALUMINUM ADM CA2 - Columns
 •

To calculate a RF-/ALUMINUM ADM design case, you can also use the load case list in the toolbar of RFEM or RSTAB.

Create New Design Case

To create a new design case, use the RF-/ALUMINUM ADM menu and click

File ightarrow New Case.

The following dialog box appears:

New RF-Al	.UMINUM ADM Case
No.	Description
2	Design of aluminum members according to ADM -
	OK Cancel

In this dialog box, enter the (not yet used) *Number* of the new design case. The *Description* of the design case makes the selection in the load case list easier.

Click [OK] to open the 1.1 General Data Window of RF-/ALUMINUM ADM and enter the new data.

Rename Design Case

To change the description of a design case, use the RF-/ALUMINUM ADM menu and click

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

The following dialog box appears:

Rename R	F-ALUMINUM ADM Case
No. 2	Description Vew description
۲	OK Cancel

Figure 7.2: Dialog box Rename RF-ALUMINUM ADM Case

In this dialog box, you can specify a different *Description* as well as a different *Number* of the design case.

Figure 7.1: Dialog box New RF-ALUMINUM ADM Case

Copy Design Case

To copy the input data of the current design case, use the RF-/ALUMINUM ADM menu and click

File ightarrow Copy Case.

The following dialog box appears:

Copy RF	-ALUMINUM ADM Case
Copy fro	om Case
CA1 - D	Design of aluminum members according to ADM 👻
New Ca	se
No.:	Description:
3	Design according to LRFD -
٢	OK Cancel

Figure 7.3: Dialog box Copy RF-ALUMINUM ADM Case

Define the Number and, if necessary, a Description for the new case.

Delete Design Case

To delete design cases, use the RF-/ALUMINUM ADM menu and click

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

The following dialog box appears:

Delete Cases						
	le Cases					
No.	Description 🔺					
1	Design of aluminum members according to /					
2	New description					
3	Design according to LRFD					
	·					
	OK Cancel					

Figure 7.4: Dialog box Delete Case

You can select the design case in the list of Available Cases. To delete the selected case, click [OK].



7.2 Cross-Section Optimization

RF-/ALUMINUM ADM offers you the option to optimize overloaded or low-utilized cross-sections. To do this, open the drop-down list in column D or E in the *1.3 Cross-Sections* Window and select *Yes* (for parametric sections) or *From current row* (for rolled sections).

You can also start the optimization in the result windows by using the shortcut menu.

	Δ	В	C	D	E	E				
Section	Member	Location	Load-	Design		F				
No.	No.	x [ft]	ing	Ratio		Design According to Formula				
2	LS 4.2/0	5/0								
	1	1.54	C07	0.08	≤1	105) Cross-section check - Bending about u-axis acc. to F				
	75	ss-section check - Bending about v-axis acc. to F								
	89	Go to Cross-Section Doubleclick Section check - Biaxial bending acc. to F								
	74	Info About Cross-Section ss-section check - Torsion and shear force								
	17	Ontine	s-section check - Axial force, bending about u-axis and shear force							
	17	<u>Optimize Cross-Section</u> ss-section check - Axial force, bending about u-axis, shear force and torsion								
	17	Cross-	Section O	ptimization Para	imete	ers ss-section check - Axial force, bending about v-axis and shear force				
	75	2.51	CO8	0.08	≦1	188) Cross-section check - Axial force, bending about v-axis, shear force and torsion				
	17	0.00	CO4	0.47	≤1	194) Cross-section check - Axial force, biaxial bending and shear force				
			Max:	1.01	>1	;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;				

Figure 7.5: Shortcut menu in tables

During the optimization, RF-/ALUMINUM ADM determines the section that fulfills the <u>resistance</u> analysis requirements in the most "optimal" way, that is, comes as close as possible to the maximum allowable design ratio as specified in the *Details* dialog box (see Figure 3.4, page 31). The required cross-section properties are determined with the internal forces from RFEM or RSTAB. If a different section proves to be more favorable, that one is used for the design. Then, the graphic in Window 1.3 shows two cross-sections: the original section from RFEM/RSTAB and the optimized one (see Figure 7.7).

When you optimize a parametric cross-section, the following dialog box appears.

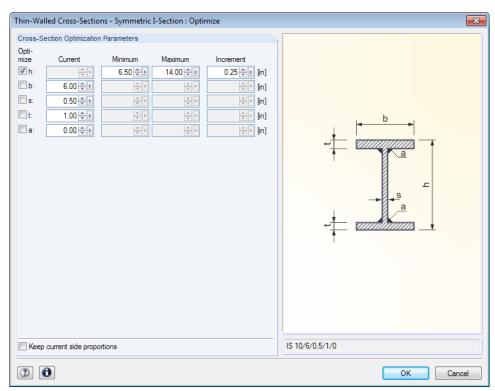


Figure 7.6: Dialog box Thin-Walled Cross-Sections - Symmetric I-Section: Optimize

By selecting the check boxes in the *Optimize* column, you decide which parameter(s) you want to modify. You can then specify the upper and lower limits of the parameter(s) in the *Minimum* and

Maximum columns. The *Increment* column controls the interval in which the size of the parameter varies during the optimization.

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



During the optimization, the internal forces are not automatically recalculated with the modified cross-sections: It is up to you to decide which sections are to be transferred to RFEM or RSTAB for a new calculation. Due to the optimized cross-sections and modified stiffnesses, the internal forces of the model may differ considerably. Therefore, we recommend recalculating the internal forces of the modified model after the first optimization. After that, you can optimize the cross-sections once again.

To export the modified cross-sections to RFEM or RSTAB, go to the *1.3 Cross-Sections* Window and click

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

1.3 Cross-Sections D Max. Design F G 2 - LS 3.75/0.5/0 Cross-Section Materia Cross-Section Opti Section RF-ALUMINUM ADM Comment No No. Description Ratio Remark Туре mize TO 8/4/0 375/0 375/0 37 Box welded No 1 1) 1) LS 3.75/0.5/0 Info About Cross-Section... IS 10/6/0.5/1/ TO 8/3.5/0.25/ 3 1) 1) Cross-Section Library... T SHAPE-THIN P Edit List 'Design of Members' in Window 1.1 5) 2 - LS 4.2/0.5/0 TO 6/4.75/0.2 **Optimize Cross-Section** SHAPE-THIN A RFEM Cross-Section Optimization Parameters 5) 9 Export Cross-Section to RFEM Export All Cross-Sections to RFEN Import Cross-Section from RFEM Import All Cross-Sections from RFEM 1) The cross-se RF-ALUMINUM ADM 📕 🗣 🐧 💌 🌥 🚰 🐼 0 Cross-Section Properties - LS 3.75/0.5/0 Cross-section No. 2 used in Cross-Section Type Angle Members No.: 3.75 in Leg Width Section Thickness 1,2,16,17,74,75,89,90 0.50 in Gross Cross-Sectional Area 3.5 in² 1.6 in² u} Sets of members No.: Shear Area Av.#{a . A_{v.v} Shear Area Second Moment of Area 1.5 in² 1 7.2 in 4 u} l#{a Second Moment of Area 19 in 4 Σ Lengths: Σ Masses Torsional Constant 0.3 in 4 26.25 [ft] 0.01 [kip] 1.43 in Radius of Gyration ٢u 0.73 in Radius of Gyration Sel,#{a Elastic Section Modulus 27 in 3 u} Material: Elastic Section Modulus -1.2 Sel.v in 3 - Aluminum 5052-H32 (Sheet & Plate, F Warping Constant Statical Moment 0.0 in⁶ 2.2 Qu in Statical Momen Q, 0.5 in³

Alternatively, you can use the shortcut menu in Window 1.3.

Figure 7.7: Shortcut menu in Window 1.3 Cross-Sections

Before the modified cross-sections are transferred to RFEM or RSTAB, the program asks you whether the results of RFEM/RSTAB should be deleted.

	RF-ALUMINUM ADM Information No. 65804
Do you If so, th	want to transfer the changed cross-sections to RFEM? e results of RFEM and RF-ALUMINUM ADM will be deleted.
	Yes No

Figure 7.8: Query when exporting sections

Calculation

When you confirm this query and start the [Calculation] in the RF-/ALUMINUM ADM module, the new internal forces and design ratios will be determined in a single calculation run.

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



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

7.3 Units and Decimal Places

The units and decimal places are managed in one dialog box for RFEM/RSTAB and for all add-on modules. In RF-/ALUMINUM ADM, you can use the menu to adjust the units by clicking

Settings \rightarrow Units and Decimal Places.

The *Units and Decimal Places* dialog box appears which you already know from RFEM or RSTAB. RF-/ALUMINUM ADM is preset in the *Program / Module* list.

Units and Decimal Places					×
Program / Module	RF-ALUMINUM ADM				
RF-DYNAM	Output Date		Dente Lint		
RF-DYNAM Pro	Output Data		Parts List		
RF-JOINTS		Unit Dec. places	3	Unit	Dec. places
RF-END-PLATE	Stresses:	ksi 🔻 3 ≑	Lengths:	ft 👻	· 2 🖨
RF-CONNECT					
···· RF-FRAME-JOINT Pro	Design ratios:	2	Total lengths:	ft 🔻	
RF-DSTV	Dimensionless:	- 👻 3 🖨	Surface areas:	ft^2 🔻	· 2 🖨
RF-DOWEL			Volumes:	[n00	
RF-HSS			volumes:	ft^3 🔻	· 2 ≑
RF-FOUNDATION			Weight per length:	lb/ft ▼	· 2 ≑
			Weight:		
			vveignt:	lb 🔻	
			Total weight:	kip 👻	2 🌩
- RF-MOVE					
- RF-IMP					
RF-TOWER Effective L					
RF-TOWER Design					
RF-LIMITS					
RF-PIPING Design					
RF-ALUMINUM ADM					
•					
P	ו			ОК	Cancel
				UK	Cancel

Figure 7.9: Dialog box Units and Decimal Places



You can save the settings as a user profile to apply them in other models. These functions are described in Chapter 11.1.3 of the manual of RFEM or RSTAB.

7.4 Data Transfer

7.4.1 Exporting Materials to RFEM/RFEM

When you have adjusted the materials in RF-/ALUMINUM ADM for design, you can export the modified materials to RFEM or RSTAB in a similar way as you export cross-sections: Open the *1.2 Materials* Window and then use the menu

Edit \rightarrow Export All Materials to RFEM/RSTAB.

You can also export the modified materials to RFEM/RSTAB using the shortcut menu in Window 1.2.



Figure 7.10: Shortcut menu in Window 1.2 Materials

Calculation

Before the materials are transferred to RFEM or RSTAB, the program asks you whether the results should be deleted. When you confirm the query and start the [Calculation] in RF-/ALUMINUM ADM, the new internal forces and design ratios will be determined in a single calculation run.

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

7.4.2 Exporting Effective Lengths to RFEM/RSTAB

When you have adjusted the effective lengths in RF-/ALUMINUM ADM for design, you can export the modified lengths to RFEM or RSTAB in a similar way as you export cross-sections: Go to the 1.5 *Effective Lengths - Members* Window and click

Edit \rightarrow Export All Effective Lengths to RFEM/RSTAB

or use the corresponding option in the shortcut menu of Window 1.5.

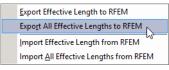


Figure 7.11: Shortcut menu in Window 1.5 Effective Lengths - Members

Before the effective lengths are transferred to RFEM or RSTAB, the program asks you whether the results should be deleted.

If the modified effective lengths have not been exported to RFEM/RSTAB yet, you can reimport the original lengths in Window *1.5 Effective Lengths - Members* via the options shown in Figure 7.11.

7.4.3 Exporting Results

The RF-/ALUMINUM ADM results can also be used by other programs.

Clipboard

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

Printout Report

You can print the data of RF-/ALUMINUM ADM into the global printout report (see Chapter 6.1, page 51) and export them subsequently by clicking

```
File \rightarrow Export to RTF.
```

The function is described in the manual of RFEM or RSTAB, Chapter 10.1.11.

Excel / OpenOffice

RF-/ALUMINUM ADM provides a function for directly exporting data to MS Excel, OpenOffice Calc, or the CSV file format. To open the corresponding dialog box, click

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

The following export dialog box appears:

Export of Tables	—
Table Parameters	Application
 With table header Only marked rows 	Microsoft Excel OpenOffice.org Calc CSV file format
Transfer Parameters	
Export table to active workbook Export table to active workshee Rewrite existing worksheet	
Selected Tables	
Active table All tables Input tables Result tables	Export hidden columns Export tables with details
	OK Cancel

Figure 7.12: Dialog box Export of Tables

When you have selected the relevant options, you can start the export by clicking [OK]. Excel or OpenOffice will be started automatically, i.e. you do not need to open the programs first.

x		5 - d	▶				Sheet1 - Excel 🔋 📧 🗕 🗖	×
F	ILE	HOME	INSERT	PAGE	LAYOUT	FORM	IULAS DATA REVIEW VIEW	
	ste v	Calib B	I <u>U</u> ≁	- 10 - 2 ont			$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	~
B	3	-	\sim	√ fx	IPE 300	Euro	norm 19-57	~
	Α	В	с	D	E	F	G	
1	Section	Member	Location	Load-	Design			
2	No.	No.	x [ft]	ing	Ratio		Design According to Formula	
3	1	TO 8/4/	0.375/0.37	5/0.375/0	.375]
4		86	4,22	CO4	0,01	≤1	102) Cross-section check - Compression acc. to E	
5		4	0,00	CO4	0,17	≤1	105) Cross-section check - Bending about y-axis acc. to F	
6		15	4,92	CO9	0,14	≤1	106) Cross-section check - Bending about z-axis acc. to F	
7		5	0,00	CO8	0,32	≤1	107) Cross-section check - Biaxial bending acc. to F	
8		47	5,47	CO3	0,00	≤1	115) Cross-section check - Shear force in z-axis acc. to G	
9		3	0,00	CO3	0,00	≤1	126) Cross-section check - Shear buckling acc. to G.2 - Shear force in z-axis	
10		3	0,00	CO6	0,00	≤1	128) Cross-section check - Shear buckling acc. to G.2 - Shear force in y-axis	
11		68	5,10	CO4	0,07	≤1	130) Cross-section check - Torsion acc. to H.2	
12		77	0,00	CO3	0,00	≤1	132) Cross-section check - Torsion and shear force in z-axis	
12		13	0,00	CO8	0,00	≤1	133) Cross-section check - Torsion and shear force in y-axis	
12								11-
		88	6,56	CO9	0,00	≤1	135) Cross-section check - Torsion and shear force	

Figure 7.13: Results in Excel



Literature

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