

Version August 2017

Add-on Module

# **RF-/STEEL NBR**

Desing of Steel Members According to ABNT NBR 8800

## **Program Description**

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## 1 Introduction

#### 1.1 Add-on Module RF-/STEEL NBR

The Standard ABNT NBR 8800 *Design of steel and composite structures for buildings* [1] describes the design of steel buildings in the Federative Republic of Brazil. With the add-on modules RF-STEEL NBR (for RFEM) and STEEL NBR (for RSTAB), DLUBAL provides powerful tools for the design of steel beam models according to this Standard.



In the following, the add-on modules of both main programs are described in one manual and are referred to as **RF-/STEEL NBR**.

RF-/STEEL NBR performs all typical ultimate limit state designs as well as stability and deformation analyses. The program takes into account various actions for the ultimate limit state design. The allocation of designed cross-sections into three types (compact, noncompact and slender) makes an important part of the design according to the Brazilian Standard. The purpose of this classification is to determine the range in which the local buckling in cross-section parts limits the load capacity so that the rotational capacity of cross-sections can be verified. RF-/STEEL NBR determines the limiting width-to-thickness ratios of compressed parts and carries out the classification automatically.

For the stability analyis, you can determine for every single member or set of members whether buckling and flexural buckling is possible. Lateral restraints can be added for a realistic representation of the structural model.

For models with slender cross-sections, the serviceability limit state has become an essential aspect of the design. The limit deformations are preset according to the Standard, but can be adjusted. In addition, you can specify the reference lengths and precambers, if necessary.

The program allows you to optimize cross-sections and to export them to RFEM or RSTAB. Using the design cases, it is possible to design separate structural components of complex structures or analyze alternatives with different sections or materials.

Since RF-/STEEL NBR is integrated in the main program, the design relevant input data is preset when the module is called up. After the analysis, the design results can be evaluated graphically in the work window of RFEM or RSTAB. Last but not least, it is possible to keep records of the analysis in the global printout report which includes the internal forces and the design results.

We hope you will enjoy working with RF-/STEEL NBR.

Your DLUBAL team

#### 1.2 Using the Manual

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

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

At the end of the manual, you can find the index. If you cannot find what you are looking for, go to the Knowledge Base where you can search for the solution of the problem. Or consult the FAQs on our website.



RFEM and RSTAB provide the following options to open the RF-/STEEL NBR add-on module.

#### Menu

To start the program from the menu bar, select

```
Add-on Modules \rightarrow Design - Steel \rightarrow RF-/STEEL NBR.
```

| Add         | i-on Modules   | <u>W</u> indow | He | elp         |                   |             |            |                                  |                   |
|-------------|----------------|----------------|----|-------------|-------------------|-------------|------------|----------------------------------|-------------------|
| <b>4</b> 00 | Current Modul  | e              |    |             | * <               | > <u>P</u>  | <b>*</b> 🛸 | 🎽 🚳 📾 🔛 🎆 🖗                      | 42 🥵 🏦 🎜          |
|             | Design - Steel |                | •  | <i>.</i>    | RF-STEEL Surfaces |             |            | General stress analysis o        | of steel surfaces |
|             | Design - Concr | ete            | ۲  | Ľ           | RF-STEEL Member   | s           |            | General stress analysis of       | f steel members   |
|             | Design - Timbe | r              |    | Fe          | RF-STEEL EC3      |             | Des        | ign of steel members according   | g to Eurocode 3   |
|             | Design - Alumi | nium           |    | Also        | RF-STEEL AISC     | De          | sign of s  | steel members according to AIS   | C (LRFD or ASD)   |
|             | Dynamic        |                |    | LIS         | RF-STEEL IS       |             |            | Design of steel members          | according to IS   |
|             | Connections    |                | 1  | SIA         | RF-STEEL SIA      |             |            | Design of steel members a        | ccording to SIA   |
|             | Foundations    |                |    | BS          | RF-STEEL BS       |             |            | Design of steel members a        | according to BS   |
|             | Stability      |                |    | 1G8         | RF-STEEL GB       |             |            | Design of steel members a        | according to GB   |
|             | Towers         |                |    | CSA         | RF-STEEL CSA      |             |            | Design of steel members ac       | cording to CSA    |
|             | Others         |                | 4  | LAS         | RF-STEEL AS       |             |            | Design of steel members a        | according to AS   |
|             | External Modul | les            | ×  | NIC         | RF-STEEL NTC-DF   |             |            | Design of steel members accor    | ding to NTC-DF    |
|             | Stand-Alone Pr | ograms         | ▶  | Isp         | RF-STEEL SP       |             |            | Design of steel members          | according to SP   |
|             |                |                |    | PIPM        | RF-STEEL Plastic  |             |            | Design of steel members acc      | cording to PIFM   |
|             |                |                |    | SANS        | RF-STEEL SANS     |             |            | Design of steel members acc      | ording to SANS    |
|             |                |                |    | NBR         | RF-STEEL NBR      |             | N          | Design of steel members ac       | cording to NBR    |
|             |                |                |    | <b>J</b> FD | RF-STEEL Fatigue  | Members     | 5          | Fatigue design of                | f steel members   |
|             |                |                |    | 1           | RF-KAPPA          |             |            | Flexural b                       | uckling analysis  |
|             |                |                |    | Ð           | RF-LTB            | La          | teral-tor  | rsional and torsional-flexural b | uckling analysis  |
|             |                |                |    | €.<br>FE    | RF-FE-LTB         | Lateral-tor | rsional a  | nd torsional-flexural buckling   | analysis by FEM   |

Figure 1.1: Menu Add-on Modules  $\rightarrow$  Design - Steel  $\rightarrow$  RF-STEEL NBR

#### **Navigator**

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

```
\textbf{Add-on Modules} \rightarrow \textbf{RF-/STEEL NBR}.
```



Figure 1.2: Data navigator Add-on Modules  $\rightarrow$  RF-STEEL NBR

## 2 Input Data

When you have started the add-on module, a new window appears. In this window, a *Navigator* is displayed on the left. It manages the different window that can be currently selected. The drop-down list above the navigator contains the design cases (see Chapter 7.1, page 39).

The design-relevant data is to be defined in several input windows. When you open RF-/STEEL NBR for the first time, the following parameters are imported automatically:

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

5 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 quit RF-/STEEL NBR and return to RFEM or RSTAB. To exit the add-on module without saving any changes, click [Cancel].

#### 2.1 General Data

In the 1.1 General Data Window, you can select the members, sets of members and actions for the design. The two tabs manage the load cases, load and result combinations for the different types of design.



Figure 2.1: Window 1.1 General Data

| Design of |                        |       |       |
|-----------|------------------------|-------|-------|
| Members:  | 1,2,4-6,8,81-83,99-102 | 🚯 🗙   | 🔲 Ali |
| Sets:     | 1-5                    | 🖏 🗙 🎦 | V AI  |

Figure 2.2: Design of members and sets of members

```
X
```

2

The design can be carried out for *Members* as well as for *Sets of Members*. If you want to design only selected objects, clear the *All* check box. Then you can access the text boxes to enter the numbers of the relevant members or sets of members. The [Delete] button clears the list of preset numbers. The [Select] button enables you to define the objects graphically in the work window of RFEM or RSTAB.

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 Windows 2.3 Designs 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. There you can specify the parameters of the set of members.

#### 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

| Ultimate Limit | State Serviceability Limit State |    |    |                |                                 |  |
|----------------|----------------------------------|----|----|----------------|---------------------------------|--|
| Existing Load  | Cases and Combinations           |    |    | Selected for D | lesign                          |  |
| LC1            | Self-weight                      |    |    | CO3            | 1.35*LC1 + LC8 + LC9 + LC10     |  |
| Q.Ge LC2       | Snow                             |    |    | CO9            | 1.35*LC1 + 1.5*LC2 + LC8 + LC9  |  |
| Qw LC3         | Wind in +X                       | Ξ  |    | CO13           | 1.35*LC1 + 1.5*LC2 + LC9 + LC10 |  |
| Qw LC4         | Wind in +Y                       |    |    |                |                                 |  |
| Qw LC5         | Wind in -Y                       |    |    |                |                                 |  |
| Q Ge LC7       | Live load                        |    |    |                |                                 |  |
| CO1            | 1.35*LC1 + LC8                   |    |    |                |                                 |  |
| CO2            | 1.35*LC1 + LC8 + LC9             |    |    |                |                                 |  |
| CO4            | 1.35*LC1 + LC8 + LC10            |    |    |                |                                 |  |
| CO5            | 1.35*LC1 + LC9                   |    | >> |                |                                 |  |
| CO6            | 1.35*LC1 + LC9 + LC10            |    |    |                |                                 |  |
| C07            | 1.35*LC1 + LC10                  |    | _  |                |                                 |  |
| CO8            | 1.35*LC1 + 1.5*LC2 + LC8         |    |    |                |                                 |  |
| CO10           | 1.35*LC1 + 1.5*LC2 + LC8 + LC9 + |    |    |                |                                 |  |
| CO11           | 1.35*LC1 + 1.5*LC2 + LC8 + LC10  |    | ~  |                |                                 |  |
| CO12           | 1.35*LC1 + 1.5*LC2 + LC9         |    |    |                |                                 |  |
| CO14           | 1.35*LC1 + 1.5*LC2 + LC10        |    |    |                |                                 |  |
| CO15           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO16           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO17           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO18           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO19           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO20           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L |    |    |                |                                 |  |
| CO21           | 1.35*LC1 + 1.5*LC2 + 1.5*LC7 + L | Ŧ  |    |                |                                 |  |
| All (195       |                                  | 33 |    |                |                                 |  |

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

#### **Existing Load Cases and Combinations**

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

To transfer selected items to the *Selected for Design* list on the right, click  $\geq$ . Alternatively, you can double-click the items. To transfer the complete list to the right, click  $\geq$ .

To select several items at once, click them while pressing the [Ctrl] key – as common for Windows applications.



#### 2 Input Data

|      | All (195)                                      |
|------|--|
|      | All (195)                                      |
| LC   | Load Cases (9)                                 |
| CO   | Load Combinations (184)                        |
| CO   | Load Combinations - Generated (184)            |
| RC   | Result Combinations (2)                        |
| RC   | Result Combinations - Generated (2)            |
|      | Load and Result Combinations (186)             |
|      | Load and Result Combinations - Generated (186) |
| QGe  | General variable actions (2)                   |
| Qw   | Wind (3)                                       |
| S Qp | CO SLS - Quasi-permanent (12)                  |
| S Qp | RC SLS - Quasi-permanent (1)                   |
| Imp  | Imperfection (3)                               |
| G Si | Self-weight of structures built on site (0)    |
| Norm | CO ULS - Normal (0)                            |
| Norm | RC ULS - Normal (0)                            |
|      |  |

If a load case is highlighted in red, it cannot be designed. This happens when a load case has no loads or contains only imperfections.

At the end of the list, some filter options are available. They help you to assign the items by load case, load combination, or action category. The buttons next to the box have the following functions:

| Selects all load cases in the list  |
|-------------------------------------|
| Inverts the selection of load cases |
|                                     |

Table 2.1: Buttons in the Ultimate Limit State tab

#### **Selected for Design**

The column on the right lists the load cases, load and result combinations selected for design. To remove an item from the list, click <a> or double-click the item. To transfer the entire list to the left, click <<>>.</a>

Result combination

The design of an enveloping max/min result combination *RC* is faster than the design of all contained load cases and load combinations. However, the influence of the contained actions is difficult to check afterwards.

#### 2.1.2 Serviceability Limit State

| disting Load C | ases and Combinations            |          |    | Selected for D | Design                |  |
|----------------|----------------------------------|----------|----|----------------|-----------------------|--|
| CO165          | 1.35*LC1 + 1.4*LC4 + 1.2*LC7 + L | <b>^</b> |    | S Qp RC2       | SLS - Quasi-permanent |  |
| CO166          | 1.35*LC1 + 1.4*LC4 + 1.2*LC7 + L |          |    |                |                       |  |
| CO167          | 1.35*LC1 + 1.4*LC4 + 1.2*LC7 + L |          |    |                |                       |  |
| CO168          | 1.35*LC1 + 1.4*LC4 + 1.2*LC7 + L |          |    |                |                       |  |
| CO169          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| CO170          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| C0171          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| CO172          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| CO173          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| CO174          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          | >> |                |                       |  |
| CO175          | 1.35*LC1 + 1.4*LC5 + 1.2*LC7 + L |          |    |                |                       |  |
| Qp CO176       | LC1 + LC8                        |          |    |                |                       |  |
| Qp CO177       | LC1 + LC9                        |          |    |                |                       |  |
| Op CO178       | LC1 + LC10                       |          |    |                |                       |  |
| Qp CO179       | LC1 + 0.6*LC2 + LC8              |          | ~  |                |                       |  |
| Op CO180       | LC1 + 0.6*LC2 + LC9              |          |    |                |                       |  |
| Qp CO181       | LC1 + 0.6*LC2 + LC10             |          |    |                |                       |  |
| Op CO182       | LC1 + 0.6*LC2 + 0.6*LC7 + LC8    |          |    |                |                       |  |
| Op CO183       | LC1 + 0.6*LC2 + 0.6*LC7 + LC9    |          |    |                |                       |  |
| Qp CO184       | LC1 + 0.6*LC2 + 0.6*LC7 + LC10   |          |    |                |                       |  |
| Qp CO185       | LC1 + 0.6*LC7 + LC8              |          |    |                |                       |  |
| Op CO186       | LC1 + 0.6*LC7 + LC9              | Ξ        |    |                |                       |  |
| Op CO187       | LC1 + 0.6*LC7 + LC10             |          |    |                |                       |  |
| RC1            | ULS – Normal                     | -        |    |                |                       |  |

Figure 2.4: 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 and result combinations as described in Chapter 2.1.1.

The limit values of the deflections are preset in the *Details* dialog box (see Figure 3.1, page 19). To adjust those values, click the [Details] button.

In the *1.8 Serviceability Data* Window, you can specify the reference lengths of the deformation analysis (see Chapter 2.8, page 18).

#### **2.2 Materials**

This window consists of two parts: The upper table lists all materials created in RFEM or RSTAB. The *Material Properties* section below shows the characteristics of the current material, i.e. the table row which is selected above.

| 2 Mater    | als                                  |     |            |                   |  |
|------------|--------------------------------------|-----|------------|-------------------|--|
|            | A                                    |     | В          |                   |  |
| Material   | Material                             |     |            |                   |  |
| No.        | Description                          |     | Comm       | nent              |  |
| 1          | Steel CG-26   ABNT NBR 8800:2008     |     |            |                   |  |
| 2          | Steel G-30   ABNT NBR 8800:2008      |     |            |                   | -  |
| 3          | Concrete f'c = 4000 psi   ACI 318-11 |     |            |                   |  |
|            |                                      |     |            |                   |  |
|            |                                      |     |            | 🖹 ĕ 🐧 💿           |  |
| Material F | Properties                           |     |            |                   | -  |
|            | ropenies                             | E   | 200000 0   | N/mm?             | J  |
| She        | and the story                        | 6   | 200000.0   | N/mm <sup>2</sup> | -  |
| Poie       | eon's Ratio                          |     | 77000.0    | 10/100-           | -  |
| Sne        | cific Weight                         | ~ ~ | 79.50      | kN/m3             | -  |
| Coe        | fficient of Thermal Expansion        | 0   | 1 2000E-05 | 1/K               | -  |
| Pad        | ial Safety Factor                    | 744 | 1.20002-03 |                   | -  |
| - Additio  | nal Properties                       | 1   | 1.00       |                   | Material No. 1 used in                   |
| Yiel       | d Strength                           | fv  | 255.00     | MPa               | Cross-sections No.:                      |
| Ultir      | nate Strength                        | fu  | 410.00     | MPa               | 1 2 6 7 10 12 12 15                      |
|            |                                      |     |            |                   | . 1-3,6,7,10,12,13,13                    |
|            |                                      |     |            |                   | Members No.:                             |
|            |                                      |     |            |                   | 1-8,11,13-18,21-28,31-46,51-64,81-83,91- |
|            |                                      |     |            |                   | Sets of members No.:                     |
|            |                                      |     |            |                   | 15                                       |
|            |                                      |     |            |                   | 1-0                                      |
|            |                                      |     |            |                   | Σ Lengths: Σ Masses:                     |
|            |                                      |     |            |                   | 460.46 [m] 15.920 [t]                    |
|            |                                      |     |            |                   |  |

Figure 2.5: Window 1.2 Materials

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

The material properties required to determine the internal forces (*Main Properties*) are described in Chapter 4.3 of the RFEM manual and Chapter 4.2 of the RFEM manual. The material properties required for design (*Additional Properties*) are stored in the global material library. These values are preset.

To adjust the units and decimal places of the material properties and stresses, select **Settings**  $\rightarrow$  **Units and Decimal Places** from the menu bar of the module (see Chapter 7.3, page 43).

#### **Material Description**

The materials defined in RFEM or RSTAB are preset, but you can always modify them: Click the material in column A, and then click the subtron or press the function key [F7] to open the material list.

| A                                |                    |   |
|----------------------------------|--------------------|---|
| Material                         |                    |   |
| Description                      |                    |   |
| Steel CG-26   ABNT NBR 8800:2008 |                    |   |
| Steel MR 250                     | ABNT NBR 8800:2008 | A |
| Steel AR 350                     | ABNT NBR 8800:2008 |   |
| Steel AR 350 COR                 | ABNT NBR 8800:2008 | Ξ |
| Steel AR 415                     | ABNT NBR 8800:2008 |   |
| Steel CG-26                      | ABNT NBR 8800:2008 |   |
| Steel CG-28                      | ABNT NBR 8800:2008 |   |
| Steel CF-26 (Cold Rolled)        | ABNT NBR 8800:2008 |   |
| Steel CF-26 (Hot Rolled)         | ABNT NBR 8800:2008 |   |
| Steel CF-28 (Cold Rolled)        | ABNT NBR 8800:2008 |   |
| Steel CF-28 (Hot Rolled)         | ABNT NBR 8800:2008 | Ŧ |

Figure 2.6: List of materials

According to the design concept of the Standard [1], only materials of the Brazilian *Steel* category are available in the list.

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

As a matter of principle, the material properties cannot be edited in the RF-/STEEL NBR module.

#### **Material Library**

Alternatively, you can use the material library to change a material. To open the library, select

Edit  $\rightarrow$  Material Library

|  | × |  |  |
|--|---|--|--|
|  |   |  |  |
|  |   |  |  |
|  |   |  |  |
|  |   |  |  |

| Material to Select         Material category group:       Material Description       S         Material category:       Steel MR 250       S         Material category:       Steel AR 350       S         Steel       Steel AR 350 COR       S         Steel are stop of the stop of  | Standard<br>ABNT<br>SABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                | I<br>NBR 8800:2008<br>NBR 8800:2008  |                   |
|--|--|--|-------------------|
| Material category group: Material Description S   Metal Steel MR 250 S   Material category: Steel AR 350 COR S   Steel Steel AR 350 COR S   Steel or Use of the second se  | Standard<br>Standard<br>Standard<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT | NBR 8800:2008<br>NBR 8800:2008   |                   |
| Metal   Material category:   Steel   Steel   Steel   Standard group:   Standard:   Standard:   Standard:   Steel CF-26 (Cold Rolled)   Steel CF-26 (Cold Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-30 (Hot Rolled)   Steel G-30   Steel G-35   Steel G-42   Steel G-42   Steel G-45   Steel G-46   Steel G-47   Steel G-48   Steel G-40   Steel G-41   Steel G-42   Steel G-45   Steel G-45   Steel G-46   Steel G-47   Steel G-48   Material Properties   Main Properties   Main Properties   Main Properties  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008 NBR 8800:208 NBR 8800:208 NBR 8800:208 NBR 8800:208 NBR 8800:208 NBR 8800 NBR 8 |                   |
| Material category:   Steel AR 350   Steel AR 350 COR   Steel CG-26   Steel CG-26   Steel CF-26 (Cold Rolled)   Steel CF-26 (Cold Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-30 (Hot Rolled)   Steel G-30   Steel G-31   Steel G-35   Steel G-35   Steel G-35   Steel G-35   Steel G-35   Steel G-35   Steel G-36   Steel G-37   Steel G-37   Steel G-38   Steel G-30   Steel G-35   Steel G-35   Steel G-35   Steel G-36   Steel G-37   Steel G-37   Steel G-38   Steel G-38   Steel G-38   Steel G-39   Steel G-35   Steel G-35   Steel G-35   Steel G-35   Steel G-36   Steel G-37   Steel G-38   Steel G-38 <td< td=""><td>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT</td><td>NBR \$800:2008<br/>NBR \$800:2008</td><td></td></td<>  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR \$800:2008<br>NBR \$800:2008   |                   |
| Material category: Steel AR 350 COR Steel AR 415 Standard group: Steel CG-26 Steel CG-26 Steel CG-26 Steel CG-26 Steel CG-26 (Cold Rolled) Steel CF-26 (Cold Rolled) Steel CF-26 (Cold Rolled) Steel CF-28 (Cold Rolled) Steel CF-   | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008  |                   |
| Steel   Steel and ard group:   Standard group:   Standard:   Standard:   Standard:   Steel CF-26 (Cold Rolled)   Steel CF-26 (Hot Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-28 (Hot Rolled)   Steel CF-28 (Hot Rolled)   Steel CF-30 (Hot Rolled)   Steel G-35   Steel G-35   Steel G-35   Steel G-42   Steel G-45   Steel G-45   Steel G-45   Steel G-45   Steel G-45   Steel G-45   Steel G-46   Steel G-47   Steel G-47   Steel G-48   Steel G-4  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008<br>NBR 8800:2008   |                   |
| Standard group:   Standard group:   Steel CG-26   Steel CG-28   Standard:   Standard:   Standard:   Standard:   Steel CF-26 (Cold Rolled)   Steel CF-28 (Hot Rolled)   Steel CF-30 (Hot Rolled)   Steel G-35   Steel G-35   Steel G-35   Steel G-42   Steel G-42   Steel G-45   Steel G-45   Steel G-46   Steel O-40     Main Properties     Main Properties     Main Modulus of Elasticity     E     Shear Modulus  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR. 8800:2008  |                   |
| standard group:   Steel CG-28   Steel CG-28   Steel CF-26 (Cold Rolled)   Steel CF-26 (Hot Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-28 (Cold Rolled)   Steel CF-28 (Hot Rolled)   Steel CF-30 (Hot Rolled)   Steel CF-30 (Hot Rolled)   Steel CF-30 (Steel G-35   Steel G-35   Steel G-42   Steel G-42   Steel G-45   Steel G-45   Steel G-45   Steel G-45   Steel G-45   Steel G-46   Steel G-47   Steel G-48   Steel G-45   Steel G-46   Steel G-47   Steel G-48   Steel G-48  <  | Abri<br>Abri<br>Abri<br>Abri<br>Abri<br>Abri<br>Abri<br>Abri                                     | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| Index       Steel CF-26 (Cold Rolled)         Standard:       Steel CF-26 (Hot Rolled)         ABINT NBR 8800:2008       Steel CF-26 (Hot Rolled)         Steel CF-28 (Cold Rolled)       Steel CF-28 (Hot Rolled)         Steel CF-28 (Hot Rolled)       Steel CF-28 (Hot Rolled)         Steel CF-28 (Hot Rolled)       Steel CF-30 (Hot Rolled)         Steel G-35       Steel G-35         Steel G-42       Steel G-42         Steel G-45       Steel G-45         Steel G-45       Steel G-45         Steel G-42       Steel G-42         Steel G-45       Steel G-42         Steel G-45       Steel G-45         Steel G-46       Steel G-46         Main Properties       Steel G-40         Main Properties       Steel Modulus       G  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR \$800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| Standard:   Stael CF-28 (bot Rolled)   Steel CF-28 (cold Rolled)   Steel CF-28 (bot Rolled)   Steel CF-28 (bot Rolled)   Steel CF-28 (bot Rolled)   Steel CF-28 (bot Rolled)   Steel CF-30 (bot Rolled)   Steel CF-30 (bot Rolled)   Steel CF-30 (bot Rolled)   Steel G-35   Steel G-42   Steel G-42   Steel G-42   Steel G-45   Steel G-45   Steel F-32/Q-32   Steel CF-30 (bot Rolled)     Steel G-41     Steel G-42   Steel G-45   Steel G-45   Steel G-45   Steel G-46     Steel G-47     Steel G-48     Steel G-41     Steel G-42   Steel G-45     Steel G-45     Steel G-46     Steel G-47     Steel G-48     Steel G-49     Steel G-41     Steel G-42     Steel G-43     Steel G-44     Steel G-45     Steel G-47     Steel G-48     Steel G-41     Steel G-42     Steel G-42     Steel G-42     Steel G-41     Steel G-42     Steel G-42     Steel G-42     Steel G-42     Steel G-42   <  | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008  |                   |
| Steel G-28 (cold Rolled)   Steel G-30   Steel G-35   Steel G-42   Steel G-42   Steel G-42   Steel G-45   Steel G-45 </td <td>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT<br/>ABNT</td> <td>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008<br/>NBR 8800:2008</td> <td></td>   | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| ABNT NBR 8800:2008   | ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT                                     | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| Steel GF-20 (Hot Rolled)         Steel GF-30 (Hot Rolled)         Steel GF-35         Steel GF-42         Steel GF-42         Steel F-32/Q-32         Steel F-35/Q-35         Steel OF-40         Steel OF-40         Steel Reserver         Main Properties         Main Properties         Main Vodulus       G  | ABNT   | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008  |                   |
| Steel G-30       Steel G-35       Steel G-35       Steel G-45       Steel G-45       Steel F-32/Q-32       Steel F-35/Q-35       Favorites group:       Indudu sof Elasticity       Main Properties       Main Properties       Shear Modulus       G  | ADATI<br>ABNT<br>ABNT<br>ABNT<br>ABNT<br>ABNT  | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| Include invalid     Steel G-35       Include invalid     Steel G-42       Steel F-32/Q-32     Steel F-35/Q-35       Favorites group:     Steel G-40       Image: Steel Steel G-40     Steel G-45       Steel F-35/Q-35     Steel G-40       Induiting Steel G-40     Steel G-41       Image: Steel G-42     Steel G-42       Steel G-45     Steel G-45       Steel F-35/Q-35     Steel G-40       Image: Steel G-40     Steel G-40  | ABNT   | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008   |                   |
| Steel G-35<br>Steel G-32<br>Steel G-42<br>Steel G-45<br>Steel F-32/Q-32<br>Steel F-35/Q-35<br>Favorites group:<br>Steel G-45<br>Steel F-32/Q-32<br>Steel F-35/Q-35<br>Steel G-40<br>Steel G-40<br>Steel G-40<br>Steel G-40<br>Steel G-40<br>Steel G-45<br>Steel G-40<br>Steel G-40<br>Stee | ABNT   | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008  |                   |
| Steel G-45 Steel G-45 Steel G-45 Steel F-32/Q-32 Steel F-35/Q-35 Favorites group: Steel G-45 Steel F-32/Q-32 Steel F-35/Q-35 Steel G-40 Steel Modulus Steel G-40 Steel Modulus G   | ABNT<br>ABNT<br>ABNT<br>ABNT   | NBR 8800:2008<br>NBR 8800:2008<br>NBR 8800:2008  |                   |
| Steel G-45 Steel G-45 Steel F-32/Q-32 Steel F  | ABNT   | NBR 8800:2008  |                   |
| Steel F-32/Q-32 Steel F-32/Q-32 Steel F-35/Q-35 Steel C-40 Steel   |  | NBR 8800:2008  |                   |
| Steel F-35/Q-35     Steel F-35/Q-35       Favorites group:     Steel O-40       Image: Steel Properties     Search:       Main Properties     Search:       Main Properties     Search:       Shear Modulus of Elesticity     E  |  | NBR 8800:2008  |                   |
| Image: Steel 0.40     Image: Steel 0.40  | I 🖾 ABNT   |  |                   |
| Iaterial Properties  Main Properties  Modulus of Elasticity  Shear Modulus  G  |  | NBR 8800:2008  |                   |
| Iaterial Properties  Main Properties  Modulus of Elasticity  Shear Modulus  G  |  |  |                   |
| ∃Main Properties Modulus of Elasticity E Shear Modulus G   | Stee   | el CG-26   ABNT I  | NBR 8800:         |
| Modulus of Elasticity E<br>Shear Modulus G   |  |  |                   |
| - Shear Wodulus  | E  | 200000.0   | N/mm <sup>2</sup> |
| Poisson's Batio  | u v  | //000.0  | N/mm~             |
| Specific Weight  | v<br>7   | 78.50  | kN/m <sup>3</sup> |
| Coefficient of Themal Expansion a  | α  | 1.2000E-05   | 1/K               |
| Additional Properties  |  |  |                   |
| - Yield Strength fy  | fy   | 255.0  | N/mm <sup>2</sup> |
| Ultimate Strength fu   | fu   | 410.0  | N/mm <sup>2</sup> |

Figure 2.7: Dialog box Material Library

In the *Filter* section, *ABNT NBR 8800:2008* is the default Standard. Select the material quality that you want to use for the design in the *Material to Select* list. You can check the corresponding properties in the dialog section below.

OK

Click [OK] or press [-] to transfer the selected material to Window 1.2 of RF-/STEEL NBR.

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

In the library, you can also select materials of categories *Cast Iron* and *Stainless Steel*. Please check, however, whether those materials are covered by the design concept of the Standard [1].

#### 2.3 Cross-Sections

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

|   | ٨  | n n   | 1  |  |  | E (    | F        |  | 0.10.000.000   |   |
|---|--|---|--|--|--|--------|----------|--|--|---|
|   | A  | Creas Section   | Carea Seatia   | n Onti   | _  | E      | F        |  | 2 - VS 300x46   N  | BR 5884   |
| No  | Material   | Cross-Section   | Cross-Secul  | n Opu-   |  | Demade | Comment  |  |  |   |
| 4   | INO.   |   | Type   | mize   |  | Nemark | Comment  |  | . 1  | 80.0  |
| 1   | 1  | VS 300x46   NBR 5884  | I-section rolle  | d No   | -  |        |          |  |  |   |
| 2   | 1  | VS 300x46   NBR 5884  | I-section rolle  | d No   | <u> </u>   |        |          |  | +  |   |
| 3   | 1  | VS 400x34   NBR 5884  | I-section rolle  | d No   |  |        |          |  | 12.1   |   |
| 6   | 1  | CS 200 x 41   NBR 5884  | I-section rolle  | d From current   | row  |        |          |  |  |   |
| /   | 1  | CS 400 x 165   NBR 5884   | I-section rolle  | d No   | _  |        |          |  | 0  |   |
| 9   | 2  | VS 350x33   NBR 5884  | I-section rolle  | d No   |  |        |          |  | 300  |   |
| 10  | 1  | CS 250 x 49   NBR 5884  | I-section rolle  | d No   |  |        |          |  |  |   |
| 12  | 1  | TO 80/80/4.5/4.5/4.5/4.5  | Box welded   | No   |  |        |          |  |  | 4.8   |
| 13  | 1  | • RD 24   | Round bar  | No   |  |        |          |  |  |   |
| 15  | 1  | CS 300 x 92   NBR 5884  | I-section rolle  | d No   |  |        |          |  |  |   |
| 16  | 3  | Circle 300  | Invalid  | No   |  | 6)     |          |  |  | 1   |
|   |  |   |  |  |  |        |          |  |  | z   |
|   |  |   |  |  |  |        |          |  |  |   |
|   |  |   |  |  |  |        |          |  |  | 1   |
|   |  |   |  |  |  |        |          |  |  |   |
|   |  |   |  |  |  |        |          | _  |  |   |
|   |  |   |  |  |  | 3      | 😼 🐧      | ۲  | 0  | 🍝 😭   |
|   |  |   |  |  |  |        | 🔹 🚯 (    | ۲  | 0  | ĭ.  |
| ss-Si   | ection Prop  | perties - VS 300x46   NBR 5884  |  |  |  | ×      | <b>I</b> | ۲  | Cross-section No.  | 2 used in   |
| ss-Si<br>ìross-   | ection Prop<br>Section Ty  | vs 300x46   NBR 5884  |  | I-section roll   | ed   |        |          | •  | Cross-section No.  | 2 used in   |
| ss-Sectio   | ection Prop<br>Section Ty<br>n Height  | VS 300x46   NBR 5884  ype   |  | I-section roll<br>300.0  | ed<br>mm   |        |          | •  | Cross-section No.<br>Members No.:  | 2 used in   |
| ss-Si<br>Cross-<br>Sectio   | ection Prop<br>Section Ty<br>n Height<br>n Width   | Perties - VS 300x46   NBR 5884<br>ype   | h<br>b   | I-section roll<br>300.0<br>180.0   | ed<br>mm<br>mm   |        |          | •  | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4   | 2 used in   |
| ss-Sectio<br>Sectio<br>Veb  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness  | perties - VS 300x46   NBR 5884<br>ype   | h<br>b<br>t <sub>w</sub>   | I-section roll<br>300.0<br>180.0<br>4.8  | ed<br>mm<br>mm   |        |          | •  | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4   | 2 used in   |
| ss-So<br>cross-<br>Sectio<br>Sectio<br>Veb  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>Thickness   | VS 300x46   NBR 5884      ype  ss   | h<br>b<br>tw<br>tf   | I-section roll<br>300.0<br>180.0<br>4.8<br>12.5  | ed<br>mm<br>mm<br>mm   |        |          |  | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4<br>Sets of members N  | 2 used in<br>1-46   |
| ss-Sectio<br>Sectio<br>Sectio<br>Root I   | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>Thickness<br>Radius   | VS 300x46   NBR 5884           ype           88   | h<br>b<br>t <sub>w</sub><br>tf   | I-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0   | ed<br>mm<br>mm<br>mm<br>i mm   |        |          |  | Cross-section No.:<br>Members No.:<br>3-8,13-18,23-28,4<br>Sets of members N<br>2.3  | 2 used in<br>1-46   |
| ss-Sectio<br>Sectio<br>Sectio<br>Root I<br>Gross  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>Thickness<br>Radius<br>Area of M  | perties - VS 300x46   NBR 5884<br>ype<br>ss<br>ember  | h<br>b<br>tw<br>tf<br>r<br>Ag  | I-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10  | ed<br>mm<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup>  |        |          |  | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4<br>Sets of members N<br>2,3   | 2 used in<br>1-46   |
| ss-So<br>Cross<br>Sectio<br>Sectio<br>Root I<br>Gross<br>Shear  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness   | Perties - VS 300x46   NBR 5884<br>spe   | h<br>b<br>tw<br>tr<br>r<br>Ag<br>Aw  | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>45.00   | ed<br>mm<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup>   |        |          | <ul> <li>Image: Constraint of the second second</li></ul> | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4<br>Sets of members N<br>2,3   | 2 used in<br>1-46   |
| ss-Si<br>Cross<br>Sectio<br>Sectio<br>Veb<br>Flange<br>Root I<br>Gross<br>Shear<br>Shear  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>Thickness<br>Radius<br>Area of M<br>Area<br>Area  | Perties - VS 300x46   NBR 5884  ype  s8 ember   | h<br>b<br>tw<br>tr<br>r<br>Ag<br>Aw:   | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7<br>45.00<br>14.25   | ed<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup>  |        |          | <ul> <li>Image: A marked black</li> <li>Ima</li></ul>   | Cross-section No.<br>Members No.:<br>3-8,13-18,23-28,4<br>Sets of members N<br>2,3<br>Σ Lengths:   | 2 used in<br>1-46<br>Ιο.:<br>Σ Masses:  |
| Section<br>Section<br>Section<br>Section<br>Section<br>Section<br>Section<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>adius<br>Area of M<br>Area<br>d Moment  | perties - VS 300x46   NBR 5884<br>ype<br>ss<br>ember<br>t of Area   | h<br>b<br>tw<br>tr<br>r<br>Ag<br>Aw;<br>lv   | l-section roll<br>300.0<br>188.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7<br>45.00<br>142.5<br>10128.00   | ed mm<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup>  |        |          | <ul> <li>Image: Constraint of the second second</li></ul> | Cross-section No.           Members No.:         3-8,13-18,23-28,4           Sets of members N         2,3           Σ         Lengths:           100.38 [m]         100.38 [m]                                | 2 used in<br>1-46<br>Ιο.:<br>Σ Masses:<br>4.443   |
| ss-Si<br>Cross<br>Sectio<br>Sectio<br>Sectio<br>Root I<br>Flange<br>Root I<br>Gross<br>Shear<br>Shear<br>Shear<br>Secor<br>Secor  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>adius<br>Area of M<br>Area<br>d Moment<br>d Moment  | Perties - VS 300x46   NBR 5884  ppe ss ember t of Area t of Area t of Area                                  | h<br>b<br>tw<br>tr<br>r<br>Ag<br>Aw;<br>Aw;<br>Iy<br>Iz                                  | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>, 45.00<br>14.25<br>10128.00<br>1215.00   | ed mm<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup>   |        |          | <ul> <li>Image: A marked bit is a marked b</li></ul> | Cross-section No.           Members No.:           3-8,13-18,23-28,4           Sets of members N           2.3           Σ           Lengths:           100.38           [m]                                   | 2 used in<br>1-46<br>lo.:<br>Σ Masses:<br>4.443   |
| ss-Si<br>Cross<br>Sectio<br>Sectio<br>Veb<br>Root I<br>Root I<br>Gross<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear   | ection Proj<br>Section Tr<br>n Height<br>n Width<br>Thickness<br>Radius<br>Area of M<br>Area<br>d Moment<br>d Moment<br>nal Consta   | Perties - VS 300x46   NBR 5884  ype  ss ember  t of Area ant  | h<br>b<br>tw<br>tr<br>Ag<br>Aw,<br>ly<br>ly<br>lz  | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7 45.00<br>7 45.00<br>14.25<br>10128.00<br>1215.00<br>24.42                                       | ed<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup>  |        |          |  | Cross-section No.           Members No.:         3-8,13-18,23-28,4           Sets of members N         2,3           Σ         Lengths:           100.38 [m]           Material:                               | 2 used in<br>1.46<br>lo.:<br>Σ Masses:<br>4.443   |
| ss-Si<br>Cross<br>Sectio<br>Sectio<br>Sectio<br>Root I<br>Gross<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shear<br>Shar<br>Shar<br>Shar<br>Shar<br>Shar<br>Shar<br>Shar<br>Sh | ection Proj<br>Section Tr<br>n Height<br>n Width<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickness<br>Thickn | Perties - VS 300x46   NBR 5884  ype  ss ember  t of Area t of Area ant on                                   | h<br>b<br>tw<br>tr<br>r<br>Ag<br>Aw,<br>J<br>ly<br>lz<br>J<br>J                          | I-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7 45.00<br>14.25<br>10128.00<br>1215.00<br>1215.00<br>24.42<br>132.1                              | ed mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup>  |        |          |  | Cross-section No.           Members No.:         3-8,13-18,23-28,4           Sets of members N         2,3           Σ         Lengths:           100.38 [m]         Material:           1         Set OC 2011 | 2 used in<br>1-46<br>lo.:<br>Σ Masses:<br>4.443   |
| ss-Si<br>Gectio<br>Sectio<br>Sectio<br>Sectio<br>Root I<br>Gross<br>Shear<br>Shear<br>Secor<br>Torsio<br>Radiu<br>Radiu   | ection Prop<br>Section To<br>n Height<br>n Width<br>Thickness<br>a Thickness<br>a Thickness<br>a Thickness<br>a Thickness<br>a Thickness<br>a Area<br>Area<br>Area<br>Area<br>Area<br>d Moment<br>nal Consta<br>s of Gyratii<br>s of Gyratii   | Perties - VS 300x46   NBR 5884  ppe ss ember t of Area t of Area ant on | h<br>b<br>tw<br>tr<br>r<br>Aw,<br>Aw,<br>Iy<br>Iz<br>J<br>J<br>r<br>y<br>r               | I-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7 45.00<br>14.25<br>10128.00<br>1215.00<br>24.42<br>132.1<br>45.7                                 | ed mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>mm   |        |          |  | Cross-section No.           Members No.:         3-8,13-18,23-28.4           Sets of members N         2.3           Σ         Lengths:           100.38 [m]           Material:           1 - Steel CG-26 [ A | 2 used in<br>1-46<br>Io.:<br>Σ Masses:<br>4.443<br>KBNT NBR 8800-20   |
| SS-SI<br>Cross-<br>Sectio<br>Sectio<br>Sectio<br>Tange<br>Root I<br>Gross<br>Shear<br>Shear<br>Secor<br>Torsio<br>Radiu<br>Radiu<br>Radiu<br>Elastic  | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>a Thickness<br>a Thickness<br>a Thickness<br>a Satist<br>Area<br>Area<br>Area<br>d Moment<br>d Moment<br>nal Consta<br>s of Gyrati<br>s of Gyrati<br>s of Gyrati  | VS 300x46   NBR 5884      ype  ss ember  t of Area on on Mord Mis   | h<br>b<br>tw<br>tr<br>Aw<br>Aw<br>Iy<br>ly<br>lz<br>J<br>fy<br>rz<br>ry<br>rz            | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7 45.00<br>14.25<br>10128.00<br>1215.00<br>24.42<br>132.1<br>45.7<br>675.00                       | ed<br>mm<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>3</sup> |        |          |  | Cross-section No.           Members No.:         3-8,13-18,23-28,4           Sets of members N         2,3           Σ         Lengths:           100.38 [m]           Material:           1 - Steel CG-26 [ A | 2 used in 146 1.46 1.46 1.46 1.46 1.44 1.44 1.44  |
| Cross<br>Section<br>Section<br>Web<br>Plange<br>Root I<br>Gross<br>Shear<br>Shear<br>Shear<br>Secor<br>Torsio<br>Radiu<br>Radiu<br>Elastion<br>Elastion   | ection Prop<br>Section Ty<br>n Height<br>n Width<br>Thickness<br>a Thickness<br>a Th  | Perties - VS 300x46   NBR 5884  ype  ss ember  t of Area t of Area ant on on Modulus Modulus                | h<br>b<br>tw<br>tr<br>Ag<br>Aw,<br>J<br>ly<br>lz<br>J<br>J<br>ry<br>ry<br>rz<br>Wy<br>Wy | l-section roll<br>300.0<br>180.0<br>4.8<br>12.5<br>0.0<br>58.10<br>7 45.00<br>14.25<br>10128.00<br>1215.00<br>1215.00<br>24.42<br>132.1<br>45.7<br>675.00<br>1125.00 | ed<br>mm<br>mm<br>mm<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>4</sup><br>cm <sup>3</sup>   |        |          |  | Cross-section No.           Members No.:         3-8,13-18,23-28,4           Sets of members N         2,3           Σ         Lengths:           100.38 [m]           Material:           1 - Steel CG-26 [ A | Σ         Image: Constraint of the second seco |

Figure 2.8: Window 1.3 Cross-Sections

#### **Cross-Section Description**

The cross-sections defined in RFEM or RSTAB are preset with their material numbers.

If you want to modify a cross-section, select the entry in column B. Click the *button* or *in* in the box, or press the function key [F7] to open the cross-section table of the current cross-section type (see Figure 2.9).

3

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

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

You can directly enter the new cross-section description in the text box. If the entry is listed in the database, RF-/STEEL NBR imports the cross-section parameters.

A modified cross-section will be highlighted in blue.

If the cross-section in RF-/STEEL NBR is different from the one of RFEM or RSTAB, both sections are displayed in the graphic area. The designs will then be performed with the internal forces of RFEM/RSTAB for the section defined in RF-/STEEL NBR.



| Thin-Walled Cross-Sections - Sym   | metric I-Section   | X                  |
|--|--|--------------------|
| Cross-Section Type<br>$\begin{bmatrix} I & I & I & T \\ T & L & U \\ C & I & T & T \\ \hline U & T & T \\ \hline U & T & T \\ \hline U & T & T \\ \hline I & T & T \\ \hline I & I & T \\ \hline I & L & J \\ \hline I & C & C \\ \hline \Sigma & 0 & \nabla & O \\ \hline \hline$ | Parameters         h:       250.0 ⊕/b [mm]         b:       250.0 ⊕/b [mm]         s:       12.0 ⊕/b [mm]         t:       20.0 ⊕/b [mm]         a:       0.0 ⊕/b [mm] |                    |
|  |  | IS 250/250/12/20/0 |
| 2 🔤 🖹  |  | OK Cancel          |

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

#### **Cross-Section Type**

The program displays the type of cross-section that will be used for the classification according to [1] Clause 5.1.2.1.

#### Max. Design Ratio

This column is shown only after the calculation. It is useful for the optimization: By means of the design ratios and colored relation scales, you can see which cross-sections are little utilized and thereby oversized, and overloaded and for this reason undersized.

#### Optimize

Details...

It is possible to optimize every cross-section from the library. The program searches the cross-section that comes as close as possible to a user-defined maximum utilization ratio. You can specify this maximum ratio in the *Details* dialog box (see Figure 3.1, page 19).

To optimize a cross-section, open the drop-down list in column D (resp. E) and select *From current row*. Recommendations on the optimization can be found in Chapter 7.2 on page 41.

#### Remark

This column shows remarks as footers. They 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 ends, the module displays both section numbers in two rows, according to the definition in RFEM or RSTAB.

RF-/STEEL NBR also designs tapered members, provided that the section at the member start has the same number of stress points as the cross-section at the member end. If the two cross-sections have different numbers of stress points, the intermediate values cannot be interpolated. In this case, the calculation is neither possible in RFEM/RSTAB nor in RF-/STEEL NBR.

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

#### **Info About Cross-Section**

| Ð |
|---|
|---|

0

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

| Info About Cross-Section VS 300x46          | NBR 5884         |           |                    |   | ×                       |
|---|------------------|-----------|--------------------|---|-------------------------|
| Cross-Section Property                      | Symbol           | Value     | Unit               |   | VS 300x46   NBR 5884    |
| Depth                                       | d                | 300.0     | mm                 |   |                         |
| Width                                       | b                | 180.0     | mm                 |   |                         |
| Web thickness                               | tw               | 4.8       | mm                 |   |                         |
| Flange thickness                            | tf               | 12.5      | mm                 |   | + 180.0                 |
| Cross-sectional area                        | A                | 58.10     | cm <sup>2</sup>    |   | +                       |
| Shear area                                  | Ay               | 37.52     | cm <sup>2</sup>    |   | <u>si</u>               |
| Shear area                                  | Az               | 13.17     | cm <sup>2</sup>    | Ξ | ÷                       |
| Shear area according to EC 3                | A <sub>V,Y</sub> | 45.04     | cm <sup>2</sup>    |   |                         |
| Shear area according to EC 3                | A <sub>v,z</sub> | 13.06     | cm <sup>2</sup>    |   |                         |
| Plastic shear area                          | A pl,y           | 45.00     | cm <sup>2</sup>    |   |                         |
| Plastic shear area                          | A pl,z           | 13.66     | cm <sup>2</sup>    |   | 00                      |
| Moment of inertia                           | Iy               | 10128.00  | cm <sup>4</sup>    |   | сл <u>У</u>             |
| Moment of inertia                           | Iz               | 1215.00   | cm <sup>4</sup>    |   |                         |
| Governing radius of gyration                | ry               | 132.1     | mm                 |   | 4.8                     |
| Governing radius of gyration                | rz               | 45.7      | mm                 |   |                         |
| Polar radius of gyration                    | ro               | 139.8     | mm                 |   |                         |
| Radius of gyration of flange plus 1/5 of we | rzg              | 49.2      | mm                 |   |                         |
| Volume                                      | V                | 5810.00   | cm <sup>3</sup> /m |   | +                       |
| Weight                                      | wt               | 45.6      | kg/m               |   | Z                       |
| Surface                                     | Asurf            | 1.311     | m²/m               |   |                         |
| Section factor                              | Am/V             | 225.559   | 1/m                |   |                         |
| Torsional constant                          | J                | 24.42     | cm <sup>4</sup>    |   | Imal                    |
| Warping constant                            | Cw               | 251068.00 | cm <sup>6</sup>    |   |                         |
| Elastic section modulus                     | Sy               | 675.00    | cm <sup>3</sup>    |   | III III 🔊 Stress points |
| Elastic section modulus                     | Sz               | 135.00    | cm <sup>3</sup>    |   | C III C/t-Parts         |
| 147   | IM .             | 1040 63   | 4                  | Ŧ |                         |
|   |                  |           |                    |   | Close                   |

Figure 2.10: Dialog box Info About Cross-Section

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

Click the solutions find detailed information on the *Stress points* (centroidal distances, statical moments of area, warping constants etc.) or *c/t-Parts*, respectively.

| Stres | s Poir | nts of VS 300 | x46   NBR 58 | 84                    |                                   |           |                                    |           | ×                     |
|-------|--------|---------------|--------------|-----------------------|-----------------------------------|-----------|------------------------------------|-----------|-----------------------|
|       |        | A             | В            | С                     | D                                 | E         | F                                  | G         | VS 300x46             |
| Stre  | essP   | Coord         | nates        | Statical Mom          | ents of Area                      | Thickness | Wan                                | bing      |                       |
| N     | ۱o.    | y [mm]        | z [mm]       | Qy [cm <sup>3</sup> ] | Q <sub>z</sub> [cm <sup>3</sup> ] | t [mm]    | W <sub>no</sub> [cm <sup>2</sup> ] | Qw [cm 4] |                       |
|       | 1      | -90.0         | -150.0       | 0.00                  | 0.00                              | 12.5      | 129.38                             | 0.00      |                       |
|       | 2      | -2.4          | -150.0       | -156.68               | -50.48                            | 12.5      | 3.41                               | -727.23   |                       |
|       | 3      | 0.0           | -150.0       | -160.68               | -50.62                            | 12.5      | 0.00                               | -727.73   |                       |
|       | 4      | 2.4           | -150.0       | -156.68               | 50.48                             | 12.5      | -3.41                              | 727.23    | 1 23 5                |
|       | 5      | 90.0          | -150.0       | 0.00                  | 0.00                              | 12.5      | -129.38                            | 0.00      |                       |
|       | 6      | -90.0         | 150.0        | 0.00                  | 0.00                              | 12.5      | -129.38                            | 0.00      |                       |
|       | 7      | -2.4          | 150.0        | -156.68               | 50.48                             | 12.5      | -3.41                              | -727.23   |                       |
|       | 8      | 0.0           | 150.0        | -160.68               | 50.62                             | 12.5      | 0.00                               | -727.73   |                       |
|       | 9      | 2.4           | 150.0        | -156.68               | -50.48                            | 12.5      | 3.41                               | 727.23    | 13 y                  |
|       | 10     | 90.0          | 150.0        | 0.00                  | 0.00                              | 12.5      | 129.38                             | 0.00      |                       |
|       | 11     | 0.0           | -137.5       | -324.11               | 0.00                              | 4.8       | 0.00                               | 0.00      |                       |
|       | 12     | 0.0           | 137.5        | -324.11               | 0.00                              | 4.8       | 0.00                               | 0.00      |                       |
|       | 13     | 0.0           | 0.0          | -368.34               | 0.00                              | 4.8       | 0.00                               | 0.00      | 6 7 <mark>8 10</mark> |
|       |        |               |              |                       |                                   |           |                                    |           | z                     |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
|       |        |               |              |                       |                                   |           |                                    |           |                       |
| 2     |        | 1             |              |                       |                                   |           |                                    |           | Close                 |

Figure 2.11: Dialog box Stress Points of VS 300x46

#### 2.4 Intermediate Lateral Restraints

In Window 1.4, you can define lateral restraints for members. In RF-/STEEL NBR, this kind of support acts perpendicular to the z-axis of the cross-section (the minor axis, see Figure 2.10). Thus, you can manipulate the effective lengths of the members for the stability design concerning flexural buckling and lateral-torsional buckling.



Figure 2.12: Window 1.4 Intermediate Lateral Restraints

In the upper table, you can assign up to nine lateral restraints to each member. The *Settings* section below shows a column overview for the member selected above.

To define the restraints of a specific member, select the *Lateral Restraints* check box in column A. Then the other columns will be accessible where you can enter the parameters. To graphically select the member, click 3.

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

☑ Relatively (0...1) When the *Relatively (0...1)* check box is activated, you can define the support points by their relative spacings. The positions of the intermediate restraints result from the member length and the relative distances from the member start. When you clear the *Relatively (0...1)* check box, you can define the absolute distances.

#### 2.5 Design Parameters

This window controls specific parameters that are relevant for the design according to [1].

| L.5 Design | Parameters            |                       |               |                                   |        |                 |          |                      |
|------------|-----------------------|-----------------------|---------------|-----------------------------------|--------|-----------------|----------|----------------------|
|            | А                     | B                     | С             | D                                 |        |                 | E        |                      |
| Member     | Gross Area            | Net Area              | Reduction     | Effective Area                    |        |                 |          |                      |
| No.        | Ag [cm <sup>2</sup> ] | An [cm <sup>2</sup> ] | Factor Ct [-] | A <sub>e</sub> [cm <sup>2</sup> ] |        |                 | Comments |                      |
| 1          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 2          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 3          | 43.80                 | 43.80                 | 1.000         | 43.80                             |        |                 |          |                      |
| 4          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 5          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 6          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 7          | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 8          | 43.80                 | 43.80                 | 1.000         | 43.80                             |        |                 |          |                      |
| 11         | 58.10                 | 58.10                 | 1.000         | 58.10                             |        |                 |          |                      |
| 12         | 706.86                | 706.86                | 1.000         | 706.86                            |        |                 |          | -                    |
|            |                       |                       |               |                                   |        |                 |          | 💐 😽 🔇 🔍              |
| Settings - | Member No. 1          |                       |               |                                   |        |                 |          | VS 300x46   NBR 5884 |
| Cross-     | Section               |                       |               | 1 - VS                            | 300x46 | VBR 5884        |          |                      |
| Gross      | Area                  |                       | 1             | Ag 🛛                              | 58.10  | cm <sup>2</sup> |          |                      |
| Net An     | ea                    |                       | 1             | An                                | 58.10  | cm <sup>2</sup> |          |                      |
| Reduc      | tion Factor           |                       | 0             | Ct                                | 1.000  |                 |          | 190.0                |
| Effectiv   | ve Area               |                       | ŀ             | Ae                                | 58.10  | cm <sup>2</sup> |          | 100.0                |
| Comme      | ent                   |                       |               |                                   |        |                 |          | +                    |
|            |                       |                       |               |                                   |        |                 |          | 12.5                 |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          | g                    |
|            |                       |                       |               |                                   |        |                 |          | Y Y                  |
|            |                       |                       |               |                                   |        |                 |          | 4.8                  |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          | z                    |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          |                      |
|            |                       |                       |               |                                   |        |                 |          |                      |
| C Set ing  | put for members N     | 0.:                   |               |                                   |        |                 |          | [mm]                 |
|            |                       |                       |               |                                   | 3      | All             |          | 1                    |

Figure 2.13: Window 1.5 Design Parameters

For each member, the *Gross Area* of the section is listed. The values can be modified in the *Net Area* column, e.g. when there are holes in the section. The net area  $A_n$  is required for the design of members for tension according [1] Clause 5.2.

The *Reduction Factor*  $C_t$  is related to the plastic behavior of the section. It can be specified according to [1] Clause 5.2.5.

In the last column, the *Effective Area*  $A_e$  of the cross-section is shown for each member. The values are determined from the data of the two previous columns.



The window consists of two parts. The upper table presents a summary of all length factors of buckling, torsional buckling and lateral-torsional buckling as well as the respective member lengths. The effective lengths defined in RFEM or RSTAB are preset. In the *Settings* section, additional information about the member selected in the upper table is given.

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

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

|            | А                   | B            | С            | D        | E                   | F            | G            | Ι H      |            | J                                 | K        | L      | М                | N          | _   |
|------------|---------------------|--------------|--------------|----------|---------------------|--------------|--------------|----------|------------|-----------------------------------|----------|--------|------------------|------------|-----|
| /lember    | Buckling            | Bu           | ckling About | Axis y   | Bu                  | ckling About | Axis z       | Tor      | sional Buc | kling                             | L.T      | .В.    | Modification     |            |     |
| No.        | Possible            | Possible     | Ky           | KyLy [m] | Possible            | Kz           | KzLz [m]     | Possible | Kx         | K <sub>x</sub> L <sub>x</sub> [m] | Possible | Lь [m] | Factor C b [-]   | Comment    |     |
| 1          | √                   | •            | 1.000        | 6.000    | 2                   | 1.000        |              | <b>V</b> | 1.000      |                                   | <b>v</b> |        | 1.000            |            | -   |
| 2          | 2                   | V            | 1.000        | 6.000    | 2                   | 1.000        | 6.00         |          | 1.000      | 6.000                             | <b>v</b> | 6.000  | 1.000            |            |     |
| 3          | 2                   | V            | 1.000        | 3.011    | V                   | 1.000        | 3.01         | <b>V</b> | 1.000      | 3.011                             | <b>V</b> | 3.011  | 1.000            |            |     |
| 4          |                     | •            | 1.000        | 3.262    | 2                   | 1.000        | 3.26         | 2 🗹      | 1.000      | 3.262                             | 2        | 3.262  | 1.000            |            | _   |
| 5          |                     | <b>V</b>     | 1.000        | 6.274    | V                   | 1.000        | 3.13         | 7 🗹      | 1.000      | 3.137                             | 2        | 3.137  | 1.000            |            |     |
| 6          |                     | <b>V</b>     | 1.000        | 6.274    | <                   | 1.000        | 6.274        | <b>I</b> | 1.000      | 6.274                             | <b>V</b> | 6.274  | 1.000            |            |     |
| 7          | V                   | V            | 1.000        | 3.262    | ☑                   | 1.000        | 3.26         | 2 🗹      | 1.000      | 3.262                             |          | 3.262  | 1.000            |            |     |
| 8          | V                   | V            | 1.000        | 3.011    | $\checkmark$        | 1.000        | 3.01         |          | 1.000      | 3.011                             | V        | 3.011  | 1.000            |            |     |
| 11         | <ul><li>✓</li></ul> | <b>v</b>     | 1.000        | 6.000    | <ul><li>✓</li></ul> | 1.000        | 6.00         |          | 1.000      | 6.000                             | <b>V</b> | 6.000  | 1.000            |            |     |
| 12         | <ul><li>✓</li></ul> | <b>V</b>     | 1.000        | 6.000    | <ul><li>✓</li></ul> | 1.000        | 6.00         |          | 1.000      | 6.000                             | <b>V</b> | 6.000  | 1.000            |            |     |
| Settings - | Member No.          | 1            |              |          |                     | 1.151        |              | 5004     |            |                                   |          | VS 3   | 300x46   NBR 588 | 34         |     |
| Cross-     | Section             |              |              |          |                     | 1 - VS 3     | 300x46   NBI | R 5884   |            |                                   |          | _      |                  |            |     |
| Length     | 1                   |              |              |          | L                   |              | 6.000 m      |          |            |                                   |          | _      |                  |            |     |
| Bucklin    | ng Possible         | A : D        | 4.1          |          |                     |              | <u> </u>     |          |            |                                   |          | _      |                  |            |     |
| - Bucklir  | ng About Maj        | or Axis y Po | ossible      |          | V                   |              |              |          |            |                                   |          | _      | 180.0            |            |     |
| Effe       | ctive Length        | Factor       |              |          | Ky I                |              | 000 m        |          |            |                                   |          | _      |                  | I          |     |
| E Bucklin  | on About Min        | or Avie z Po | reeible      |          | KyLy                |              | 0.000 j III  |          |            |                                   |          |        | ÷.               |            |     |
| Effe       | ctive Length        | Factor       | Jaalule      |          | K-                  |              | 1 000        |          |            |                                   |          |        | 12               |            |     |
| El Torsior | hal Buckling F      | Possible     |              |          | 112                 |              | 1.000        |          |            |                                   |          | -      |                  |            |     |
| Effe       | ctive Length        | Factor (for  | Torsional Bu | cklina)  | Kx                  |              | 1 000        |          |            |                                   |          | _      | 0.0              |            |     |
| - Lateral  | -Torsional Bu       | ckling Pos   | sible        |          |                     |              |              |          |            |                                   |          | _      | ж<br>Ж           |            | 1   |
| Modific    | ation Factor        |              |              |          | Сь                  |              | 1.000 -      |          |            |                                   |          | _      | 4.               | 8          |     |
| Comme      | ent                 |              |              |          |                     |              |              |          |            |                                   |          | _      |                  |            |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        |                  | ~~~~       |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        |                  |            |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        | z                |            |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        |                  |            |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        |                  |            |     |
|            |                     |              |              |          |                     |              |              |          |            |                                   |          |        |                  |            |     |
| Set in     | put for membe       | ers No.:     |              |          |                     |              |              |          |            |                                   |          |        |                  |            | [r  |
|            |                     |              |              |          |                     | <b></b>      |              |          |            |                                   |          |        | l                |            | ſ   |
|            |                     |              |              |          |                     | 3            | V AI         |          |            |                                   |          |        |                  | 3 <b>1</b> | - H |

Figure 2.14: Window 1.6 Effective lengths - Members

The effective lengths for buckling about the minor z-axis and torsional as well as lateral-torsional buckling are aligned automatically with the settings of Window *1.4 Intermediate Lateral Restraints* (see Chapter 2.4). If intermediate lateral restraints divide the member into segments of different lengths, no values are displayed in the table columns G, J, and L.

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 2.14).

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)
- Torsional Buckling Possible (cf. columns H to J)
- Lateral-Torsional Buckling Possible (cf. columns K and L)
- Modification Factor (cf. column M)

The table controls for which members an analyis of buckling, torsional or lateral-torsional buckling is to be performed. In addition, the *Effective Length Factor* and the *Modification Factor* can be adjusted for the respective designs. If you modify the 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 separate below the upper table.

| Select Effective Length Factor  |  |
|---|--|
| Buckling About Axis y   | Buckling About Axis z  |
| $\mathbb{R}$ Rigid - free $k_{r,y} = 2.0$ $\mathbb{B}$ Hinged - hinged $k_{r,y} = 1.0$ $\mathbb{R}$ Rigid - hinged $k_{r,y} = 0.2$ $\mathbb{R}$ Rigid - rigid $k_{r,y} = 0.5$ $\mathbb{D}$ User-defined $k_{r,y} =$ | Bigid - free         K <sub>cr,z</sub> = 2.0         Hinged - hinged         K <sub>cr,z</sub> = 1.0         Rigid - hinged         K <sub>cr,z</sub> = 0.7         Rigid - rigid         K <sub>cr,z</sub> = 0.5         Uger-defined         K <sub>cr,z</sub> = |
| Import from add-on module RF-STABILITY     (Eigenvalue Analysis)     RF-STABILITY-Case:     CA1 - Stability analysis     The stability analysis   | Import from add-on module RF-STABILITY<br>(Eigenvalue Analysis)      RF-STABILITY-Case:      CA1 - Stability analysis  |
| Buckling mode No.:  | Buckling mode No.:   |
| Export effective length factor kor,y : 1.000 📩 [-]  | Export effective length factor $k_{cr,z}$ : 1.000 $rac{}{\sim}$ [-]  |
| ٦   | OK Cancel  |

Figure 2.15: Dialog box Select Effective Length Factor

For each direction, you can select one of the four Euler buckling modes or apply a *User-defined* effective length factor  $k_{cr}$ . If an eigenvalue analysis has been performed in the RF-STABILITY or RSBUCK add-on module, you can import the *Buckling mode* in order to determine the factor.

#### **Buckling Possible**

The stability analysis for flexural and lateral-torsional buckling requires compressive forces to be included. Members for which this is not possible due to their member types (tension members, elastic foundations, rigid couplings) are disabled by default. 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 allow you to control the stability analyses: They determine whether the analyses for a member are to be performed or not.

#### Buckling About Axis y / Buckling about Axis z

The *Possible* columns control whether there is a buckling risk about the y-axis and/or z-axis. Those axes represent the local member axes, where the y-axis is the "major" and the z-axis is the "minor" member axis. You can freely define the effective length factors K<sub>y</sub> and K<sub>z</sub> for buckling about the major or the minor axis.

٩

You can check the position of the member axes in the cross-section graphic in the *1.3 Cross-Sections* Window (see Figure 2.8, page 9). To access the RFEM or RSTAB work window, click the [View Mode] button. There you can display the local member axes by using the shortcut menu of the member or the *Display* navigator (see Figure 2.16).



Figure 2.16: Displaying member axes in Display navigator of RFEM

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

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

#### **Torsional Buckling**

Column H controls whether a torsional buckling design is to be performed. The effective length factors,  $K_x$ , and the torsional buckling lengths,  $K_x L_x$ , can be defined in columns I and J. The *x*-axis represents the center line of a member.



Figure 2.17: Member axes

#### L.T.B.

Column K controls whether a lateral-torsional buckling analysis is to be carried out. The lateral-torsional buckling lengths  $L_b$  can be defined in column L.

#### **Modification Factor**

In column M, the modification factor  $C_b$  for bending according to [1] Clauses 5.4.2.3 or 5.4.2.4 can be defined for each member.

#### Comment

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

#### Set Input for Members No.

Below the *Settings* table, you find the *Set input for members No.* check box. If you select this 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 with the button). This option is useful when you want to assign identical boundary conditions to several members (see https://www.dlubal.com/en/support-and-learning/support/knowledge-base/000726).



With this function, you cannot change the settings you have already made.

#### 2.7 Effective Lengths - Sets of Members

This window controls the effective lengths for sets of members. It is only displayed when you have selected one or more sets of members for design in the *1.1 General Data* Window (see Figure 2.2, page 5).

|            |                | г в г        |              |          |                               | - I                      |              | H        |           |                                   | K        |          | м                | I N      |    |
|------------|----------------|--------------|--------------|----------|-------------------------------|--------------------------|--------------|----------|-----------|-----------------------------------|----------|----------|------------------|----------|----|
| Set        | Buckling       | Buc          | ckling About | Axis y   | Buc                           | kling About              | Axis z       | Tors     | ional Bud | kling                             | L.T      | .B.      | Modification     |          | _  |
| No.        | Possible       | Possible     | Ky           | KyLy [m] | Possible                      | Kz                       | KzLz [m]     | Possible | Kx        | K <sub>x</sub> L <sub>x</sub> [m] | Possible | Lь [m]   | Factor C b [-]   | Commer   | nt |
| 1          | √)             | •            | 1.000        | 6.000    | <b>v</b>                      | 1.000                    | 6.00         |          | 1.000     | 6.000                             | <b>V</b> | 6.000    | 1.000            |          | _  |
| 2          | 2              |              | 0.500        | 6.274    | 2                             | 0.500                    | 6.274        |          | 1.000     | 12.548                            | 2        | 12.548   | 1.000            |          |    |
| 3          | 2              | -<br>-       | 1.000        | 12.548   | 2                             | 0.500                    | 6.274        |          | 1.000     | 12.548                            | -<br>-   | 12.548   | 1.000            |          |    |
| 4          | -              | -<br>-       | 1.000        | 6.546    | 2                             | 1.000                    | 6.54         |          | 1.000     | 6.546                             | -        | 6.546    | 1.000            |          |    |
| 5          |                | -<br>-       | 1.000        | 7.094    | 2                             | 1.000                    | 7.094        |          | 1.000     | 7.094                             | -<br>-   | 7.094    | 1.000            |          | _  |
|            |                |              |              |          |                               |                          |              |          |           |                                   |          |          |                  |          | -  |
|            |                |              |              |          |                               |                          |              |          |           |                                   |          |          |                  | <b>B</b> |    |
| ettings -  | - Set of Memb  | ers No. 3    |              |          |                               |                          |              |          |           |                                   |          | VS 4     | 400x34   NBR 588 | 34       |    |
| Set of     | Members        |              |              |          |                               |                          |              |          |           |                                   |          | <b>^</b> |                  |          |    |
| 🗆 Men      | nber 41        |              |              |          |                               |                          |              |          |           |                                   |          |          |                  |          |    |
| S          | tart           |              |              |          |                               | 3 - VS 4                 | 400x34   NBI | R 5884   |           |                                   |          |          |                  |          |    |
| - E        | nd             |              |              |          |                               | 2 - VS :                 | 300x46   NBI | R 5884   |           |                                   |          |          | , 160.0          |          |    |
| Men        | nber 42 - Cros | s-Section    |              |          | _                             | 2 - VS 3                 | 300x46   NBI | R 5884   |           |                                   |          |          |                  | 1        |    |
| Men        | nber 43 - Cros | s-Section    |              |          |                               | 2 - VS 300x46   NBR 5884 |              |          |           |                                   |          |          | t <del>sta</del> |          |    |
| Length     | 1              |              |              |          | L                             |                          | 12.548 m     |          |           |                                   |          |          | εċ               |          |    |
| Bucklin    | ng Possible    |              |              |          |                               |                          | <u> </u>     |          |           |                                   |          |          |                  |          |    |
| - Bucklin  | ng About Maje  | or Axis y Po | ssible       |          |                               | _                        | <b>U</b>     |          |           |                                   |          | =        | 9                |          |    |
| Effe       | ctive Length   | Factor       |              |          | Ky                            |                          | 1.000        |          |           |                                   |          |          | 400              |          | •  |
| Effe       | ctive Length   |              |              |          | KyLy                          |                          | 12.548 m     |          |           |                                   |          |          |                  | •        |    |
| Bucklin    | ng About Mine  | or Axis z Po | ssible       |          |                               |                          | <b>U</b>     |          |           |                                   |          |          |                  | <u> </u> |    |
| Effe       | ctive Length   | Factor       |              |          | Kz                            |                          | 0.500        |          |           |                                   |          |          |                  |          |    |
| Effe       | ctive Length   |              |              |          | KzLz                          |                          | 6.274 j m    |          |           |                                   |          |          | +                |          |    |
| - I orsion | nal Buckling F | ossible      |              | 1.6      | 14                            |                          | <b>U</b>     |          |           |                                   |          |          | ÷                |          |    |
| Effe       | ctive Length   | Factor (for  | Torsional Bu | ckling)  | Kx                            |                          | 1.000        |          |           |                                   |          |          | z                |          |    |
| Effe       | ctive Length   | (for Torsion | al Buckling) |          | K <sub>x</sub> L <sub>x</sub> |                          | 12.548 m     |          |           |                                   |          |          |                  |          |    |
| _ Latera   | I-Torsional Bu | ckling Poss  | sible        |          |                               |                          | <b>V</b>     |          |           |                                   |          |          |                  |          |    |
| LTB        | Length         |              |              |          | Lb                            |                          | 12.548 m     |          |           |                                   |          | -        |                  |          |    |
| Set in     | put for sets N | 0.:          |              |          |                               |                          |              |          |           |                                   |          |          |                  |          | [m |
| _          |                |              |              |          |                               |                          |              |          |           |                                   |          |          | -                |          | -  |

Figure 2.18: Window 1.7 Effective Lengths - Sets of Members

The concept of the window is similar to the previous *1.6 Effective Lengths - Members* Window. Here you can define the effective lengths for buckling, torsional buckling and lateral-torsional buckling for sets of members, as described in Chapter 2.6.

#### 2.8 Serviceability Data

The last input window controls the settings for the serviceability limit state design of specific objects. It is available when you have selected one or more load cases or combinations in the Serviceability Limit State tab of Window 1.1 (see Chapter 2.1.2, page 6).

| 8 Servic | eability Data  |        |          |            |          |                        |                     |          |
|----------|----------------|--------|----------|------------|----------|------------------------|---------------------|----------|
|          | A              | В      | C        | D          | E        | F                      | G                   | Н        |
|          |                | Member | Referer  | nce Length | Direc-   | Precamber              |                     |          |
| No.      | Reference to   | No.    | Manually | L [m]      | tion     | w <sub>o, v</sub> [mm] | Beam Type           | Comment  |
| 1        | Set of Members | 2      |          | 12.548     | y, z     | 0.0                    | Beam                |          |
| 2        | Set of Members | 5      |          | 7.094      | y, z     | 0.0                    | Beam                |          |
| 3        | Member         | 82     |          | 7.094      | y, z     | 0.0                    | Beam                |          |
| 4        | Member         | 81     | <b>V</b> | 4.546      | y, z     | 0.0                    | Cantilever End Free |          |
| 5        | Member         | 83     | <b>V</b> | 4.546      | y, z     | 0.0                    | Cantilever End Free |          |
| 6        | Member         | 15     |          | 6.274      | y, z     | 0.0                    | Beam                |          |
| 7        | Member         | 16     |          | 6.274      | y/u, z/v | 0.0                    | Beam                |          |
| 8        | Member         | 25     |          | 6.274      | y/u, z/v | 0.0                    | Beam                |          |
| 9        | Member         | 26     |          | 6.274      | y/u, z/v | 0.0                    | Beam                |          |
| 10       |                |        |          |            |          |                        |                     |          |
| 11       |                |        |          |            |          |                        |                     |          |
| 12       |                |        |          |            |          |                        |                     |          |
| 13       |                |        |          |            |          |                        |                     |          |
| 14       |                |        |          |            |          |                        |                     |          |
| 15       |                |        |          |            |          |                        |                     |          |
| 16       |                |        |          |            |          |                        |                     |          |
| 17       |                |        |          |            |          |                        |                     |          |
| 18       |                |        |          |            |          |                        |                     |          |
| 19       |                |        |          |            |          |                        |                     |          |
| 20       |                |        |          |            |          |                        |                     |          |
| 21       |                |        |          |            |          |                        |                     |          |
| 22       |                |        |          |            |          |                        |                     |          |
| 23       |                |        |          |            |          |                        |                     |          |
| 24       |                |        |          |            |          |                        |                     |          |
| 25       |                |        |          |            |          |                        |                     |          |
| 26       |                |        |          |            |          |                        |                     |          |
| 27       |                |        |          |            |          |                        |                     |          |
| 28       |                |        |          |            |          |                        |                     |          |
| 29       |                |        |          |            |          |                        |                     |          |
| 30       |                |        |          |            |          |                        |                     |          |
| 31       |                |        |          |            |          |                        |                     |          |
| 32       |                |        |          |            |          |                        |                     |          |
|          |                |        |          |            |          |                        |                     |          |
|          |                |        |          |            |          |                        |                     |          |
|          |                |        |          |            |          |                        |                     | <b>(</b> |

Figure 2.19: Window 1.8 Serviceability Data



In Column A, you define whether the deformation refers to single members, lists of members, or sets of members.

For a list or set of members, the orientation and rotation of all contained members must be identical. This will guarantee that the components of the deformation are taken into account correctly.

In column B, you can specify the numbers of the members or sets of members that are to be analyzed. The 🔜 button enables you to select the objects graphically in the work window. In column D, the Reference Length of each object is shown. The geometrical lengths of the members, lists or sets of members are set by default. If necessary, you can adjust those values after having selected the Manually check box in column C.



Column E controls the governing Direction for the deformation analysis. You can select the directions of the local member axes y and z (or u and v for unsymmetrical cross-sections). You can consider a *Precamber* w<sub>c</sub> in column F, if applicable. The reference to the axes is controlled



Beam Type Beam Cantilever Start Free Cantilever End Free Details...

by the specification in the *Details* dialog box (see Figure 3.1, page 19). The Beam Type is important for the correct reference to the limit deformations. In column G, you

can specify whether a beam or a cantilever is to be analyzed. For the latter, you can define which end has no support.

The Details dialog box controls whether the deformations are related to the undeformed system or the shifted ends of the members or sets of members (see Figure 3.1, page 19).

## **3** Calculation

#### 3.1 Detail Settings

Details...

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 [Details].

| Details  |   | ×   |
|--|---|---|
| Coefficients of Resistance, Tab. 3             | Limit Values for Special Cases                          | Display Result Windows                            |
| Yielding, buckling and instability ya1 1.100   | Do not consider small moments if:                       | 2.1 Design by Load Case                           |
| Rupture ya2 1.350 🚔                            | Bending M <sub>y,Sd</sub> / M <sub>y,Rd</sub> ≤ 0.010 🚔 | 2.2 Design by Cross-Section                       |
|  | Mz,Sd / Mz,Rd ≤ 0.010 🚔                                 | 2.3 Design by Set of Members                      |
|  |   | 2.4 Design by Member                              |
| Check of Maximum Effective Slenderness Ratio   | Do not consider small axial forces if:                  | 2.5 Design by x-Location                          |
| Members with KL / r                            | Tension $N_{t,Sd} / N_{t,Rd} \le 0.010$                 | ☑ 3.1 Governing Internal Forces by Member         |
| - Tension: 300 👻                               | Compression Nc,Sd / Nc,Rd ≤ 0.010 🚔                     | ✓ 3.2 Governing Internal Forces by Set of Members |
| - Compression / flexure: 200 🚔                 |   | 3.3 Member Slendernesses                          |
| Display slenderness check for all member types | Do not consider small shear forces if:                  |   |
|  | Shear V <sub>y,Sd</sub> / V <sub>y,Rd</sub> ≤ 0.010 🚔   | ✓ 4.1 Parts List by Member                        |
| Serviceability (Deflections)                   | V <sub>z,Sd</sub> / V <sub>z,Rd</sub> ≤ 0.010 🚔         | ✓ 4.2 Parts List by Set of Members                |
| Limiting deflection: L / 360 🚔 Lc / 180 🚔      | Contractions for some southers with                     | Only for members / sets to be designed            |
|  | Limit shear stress for cross-sections with:             | Of all members / sets of members                  |
| Deformation relative to:                       | Torsion tSd/tRd ≤ 0.010 ₩                               |   |
| Shifted member ends / set of members ends      | Crean Continuation                                      |   |
| Undeformed system                              |   |   |
|  | Max allowable design ratio: 1.000 👻                     |   |
|  |   |   |
|  | Direction of Broosmber                                  |   |
|  | Consider another in suit                                |   |
|  | Consider precamber in axis                              |   |
|  | © Z/V   |   |
|  | © y/u   |   |
|  |   |   |
|  |   |   |
|  |   |   |
|  |   | OK Cancel   |

Figure 3.1: Dialog box Details

#### **Coefficients of Resistance**

The factors of the material resistance are preset according to [1] Table 3 regarding yielding, buckling, instability ( $\gamma_{a1}$ ) and rupture ( $\gamma_{a2}$ ). If required, those coefficients can be adjusted.

#### **Check of Maximum Effective Slenderness Ratio**

According to [1] Clause 5.2.8, the slenderness ratio *KL* / *r* preferably should not exceed 300 for tension members. For members with compression or flexure, the slenderness ratio should not exceed 200 (cf. [1] Clause 5.3.4). If required, the limit ratios can be adjusted.

By default, the slenderness ratios are not checked for specific member types, such as "Tension" and "Cable" members. It is possible, however, to activate the check for all member types.

The limit ratios are compared to the real member slendernesses in Window 3.3. That window is available after the calculation (see Chapter 4.8, page 28) when the corresponding option has been checked in the *Display Result Windows* section of the *Details* dialog box.

#### Serviceability (Deflections)

For the SLS design, the limiting deflections can be separately defined for beams (default: L/360) and cantilevers (default: L/180). Annex C of the Standard [1] gives recommendations on the maximum values for deflections.

The options below specify whether the deformations are related to the shifted member ends or set of members ends (line between start and end nodes of deformed model) or to the undeformed original system. The difference is illustrated by an example in the *Knowledge Base* at our Web site: https://www.dlubal.com/en/support-and-learning/support/knowledge-base/001081

#### **Limit Values for Special Cases**

For a simplified design, it is possible to neglect small bending moments, axial or shear forces as well as shear stresses due to torsion. The limit ratios of the moments, forces or stresses can be entered in this section of the dialog box.



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

#### **Cross-Section Optimization**

By default, the optimization is targeted on the maximum design ratio of 100 %. If required, you can change the limit value in this text box.

#### **Direction of Precamber**

When you specify two directions in column E of the 1.8 *Serviceability Data* Window and apply a precamber in column F, you can determine for which direction the precamber is to be considered.

#### **Display Result Windows**

In this dialog section, you can select which result windows including parts list are to be displayed in the output. Those windows are described in Chapter 4.

Window 3.3 Member Slendernesses is deactivated by default.

#### 3.2 Starting Calculation

Calculation

In all input windows of RF-/STEEL NBR, you can start the design via the [Calculation] button.

The add-on module searches for the results of the load cases, load and result combinations that are to be designed. If they are not available yet, RF-/STEEL NBR starts the calculation in RFEM or RSTAB to determine the relevant internal forces.

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

## **4 Results**

Window 2.1 Design by Load Case appears immediately after the calculation.

| RE-STEEL NBR - [Hall]               |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           | X      |
|-------------------------------------|------------|-----------------------------------|------------|----------|---------|---------|------------------|------------|----------------|----------------|-----------------------|-------------|-----------|--------|
| File Edit Settings Help             |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| The care bearings help              |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| CA1 - Design of steel members 👻     | 2.1 Desigi | n by Load Case                    |            |          |         |         |                  |            |                |                |                       |             |           |        |
| Input Data                          |            | A                                 | В          | С        | D       | E       |                  |            |                | F              |                       |             |           | G      |
| General Data                        | Load-      |                                   | Member     | Location | Design  |         |                  |            |                |                |                       |             |           |        |
| Materials                           | ing        | Description                       | No.        | x [m]    | Ratio   |         |                  |            | Desig          | n According to | Formula               |             |           | DS     |
| Cross-Sections                      |            | Ultimate Limit State Design       |            |          |         |         |                  |            |                |                |                       |             |           |        |
| Design Deservations                 | CO3        | 1.35*LC1 + LC8 + LC9 + LC1        | 68         | 3.125    | 0.91    | ≤1      | 341) Combined    | forces ac  | c. to 5.5.1    |                |                       |             |           |        |
| Effective Lengths Members           | CO9        | 1.35*LC1 + 1.5*LC2 + LC8 +        | 22         | 6.000    | 1.00    | ) ≤1    | 112) Bending at  | oout y-axi | s, LTB, sem    | i compact type |                       |             |           |        |
| Effective Lengths - Nembers         | C013       | 1.35*LC1 + 1.5*LC2 + LC9 +        | 22         | 6.000    | 1.00    | 1 2 1   | 112) Bending at  | oout y-axi | s, LIB, sem    | i compact type |                       |             |           |        |
| Serviceability Data                 |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| Results                             | DCD        | Serviceability Limit State Desig  | n          | 0.500    |         | 21      | (01) Dealers fee |            |                | Arren C. Defle | a stille a la se dise | ation (Dama | <b>`</b>  |        |
| Design by Load Case                 | RC2        | SLS - Quasi-permanent             | 99         | 2.500    | 0.84    | 1 2 1   | 401) Design for  | serviceat  | plinty acc. to | Annex C - Den  | ection in z-dire      | ction (beam | )         |        |
| Design by Cross-Section             |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| Design by Set of Members            |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| Design by Member                    |            |                                   |            |          |         |         |                  |            | -              | -              |                       |             |           |        |
| ···· Design by x-Location           |            |                                   |            | Max:     | 1.00    | ≤1      | ۲                | 9          | ₽.             | 5              | > 1,0                 | - 7         | 2 🍕 🕅     | 3 🔍    |
| Governing Internal Forces by №      |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
| ···· Governing Internal Forces by S | Details -  | Member 68 - x: 3.125 m - CO3      |            |          |         |         |                  |            |                |                | 9 - VS 40             | 0x37   NBR  | 5884      |        |
| Member Slendernesses                |            | ial Properties - Steel G-30   ABN | T NBR 88   | 00:2008  |         |         |                  |            |                |                |                       |             |           |        |
| Parts List by Member                | Cross-     | -Section Properties - VS 400x3    | 7   NBR 58 | 84       |         |         |                  |            |                |                |                       |             |           |        |
| · Parts List by Set of Members      | E Desig    | n Internal Forces                 |            |          | N       |         | 70.50            | 1.51       |                |                |                       |             |           |        |
|                                     | - Ax02     | al Force                          |            |          | IN Sd   |         | /9.59            | KIN        |                |                | - 1                   | 180.0       | <u>,</u>  |        |
|                                     | She        | sar Force                         |            |          | Vy<br>V |         | 0.01             | KIN<br>IzN |                |                |                       | Ι.          | T         |        |
|                                     | Tor        | sional Moment                     |            |          | Ter     |         | 0.00             | kNm        | _              |                | - 1                   | 2           | 1 N N N N |        |
|                                     | Flee       | rural Moment                      |            |          | Mu      |         | 72.52            | k Nm       |                |                | -                     | ~           |           |        |
|                                     | Flex       | kural Moment                      |            |          | Mz      |         | 0.00             | kNm        |                |                | -                     |             |           |        |
|                                     | FT Cross   | Section Type                      |            |          |         |         |                  |            |                |                | - 9                   |             |           |        |
|                                     | Design     | n Ratio                           |            |          |         |         |                  |            |                |                | - 4                   |             |           | Y      |
|                                     | - Axia     | al Force                          |            |          | NSd     |         | 79.59            | kN         |                |                |                       | 4           | .8        |        |
|                                     | - Axia     | al Resistance                     |            |          | NRd     |         | 1281.82          | kN         |                |                |                       |             |           |        |
|                                     | Rat        | tioNsd / NRd                      |            |          | n       |         | 0.062            |            | ≤ 0.2          |                |                       |             |           |        |
|                                     | - Mor      | ment                              |            |          | My,s    | d       | 72.52            | kNm        |                |                |                       |             |           |        |
|                                     | - Mor      | ment Resistance                   |            |          | My,F    | td 🛛    | 82.37            | kNm        |                | Annex G        |                       | 2           |           |        |
|                                     | Rat        | tio My,sd / My,Rd                 |            |          | my      |         | 0.880            |            |                |                | _                     |             |           |        |
|                                     | Des        | sign Ratio                        |            |          | η       |         | 0.91             |            | ≤1             | 5.5.1.2 b)     | _                     |             |           |        |
|                                     |            |                                   |            |          |         |         |                  |            | _              |                | -                     |             |           |        |
|                                     |            |                                   |            |          |         |         |                  |            | _              |                | -                     |             |           | [mm]   |
|                                     |            |                                   |            |          |         |         |                  |            |                |                |                       |             | X         | - M    |
| <                                   |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |
|                                     | Calculat   | ion Details                       |            |          |         | nobice  |                  |            |                |                |                       | OK          |           | ancel  |
|                                     | Calculat   | Detalls                           |            |          | G       | apriles | ,                |            |                |                |                       |             |           | pricer |
| Design Internal Forces              |            |                                   |            |          |         |         |                  |            |                |                |                       |             |           |        |

Figure 4.1: Result window with design results and details

The designs results are shown in Windows 2.1 to 2.5, 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 by member and set of members.



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



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

Chapter 4 describes the different result windows one by one. The evaluation and checking of the results is described in Chapter 5 starting on page 31.





The upper part provides a summary of the results, sorted by load case, load and result combinations of the governing designs. Furthermore, the list is split into *Ultimate Limit State Design* and *Serviceability Limit State Design* results.

Δ

The *Details* section below includes specific information on the cross-section properties, internal forces, and design parameters for the load case or combination selected in the upper table.



Figure 4.2: Window 2.1 Design by Load Case

#### Description

This column shows the descriptions of each designed load case, load or result combination.

#### Member No.

In this column, the number of each member is given that has the maximum design ratio of the respective loading.

#### Location **x**

The column shows the x-location of each member where the maximum design ratio occurs. For the tabular output, the program uses the following member locations *x*:

- Start and end nodes
- Division points according to optionally defined member divisions (see RFEM Table 1.16 or RSTAB Table 1.6)
- Member divisions according to specification for member results (see RFEM/RSTAB dialog box *Calculation Parameters*, tab *Global Calculation Parameters*)
- Extreme values of internal forces

#### **Design Ratio**

Max: 0.98 ≤1 🥹

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

The lengths of colored bars represent the respective design ratios.

#### **Design According to Formula**

This column lists the references of the Standard [1] according to which the different types of design have been performed.

#### DS

The last column provides information on the respective design situations.

## 4.2 Design by Cross-Section

| 2.2 Design                       | by Cross   | -Section       |              |                   |    |                      |                   |                 |           |                 |       |           |      |
|----------------------------------|--|----------------|--------------|-------------------|----|----------------------|-------------------|-----------------|-----------|-----------------|-------|-----------|------|
|                                  | A  | В              | С            | D                 | F  |                      |                   |                 |           | F               |       |           |      |
| Section                          | Member   | Location       | Load-        | Design            |    |                      |                   |                 |           |                 |       |           |      |
| No.                              | No.  | x [m]          | ing          | Ratio             |    |                      |                   | Des             | ign Accor | ding to Formula |       |           |      |
| 1                                | VS 550x8   | 8 I NBR 588    | 4            | 1                 |    |                      |                   |                 | -         | -               |       |           |      |
|                                  | 31   | 0.000          | CO13         | 0.07              | ≤1 | 102) Compression w   | ithout buckling a | acc. to 5.3.    | 2         |                 |       |           |      |
|                                  | 22   | 6.000          | CO9          | 0.74              | ≤1 | 110) Bending about   | y-axis acc. to 5. | 4.2.2           |           |                 |       |           |      |
|                                  | 22   | 6.000          | CO9          | 0.93              | ≤1 | 112) Bending about   | y-axis, LTB, sen  | ni compact      | type      |                 |       |           |      |
|                                  | 22   | 6.000          | CO9          | 0.74              | ≤1 | 114) Bending about   | y-axis, LFB, con  | pact type       |           |                 |       |           |      |
|                                  | 22   | 6.000          | CO9          | 0.74              | ≤1 | 117) Bending about   | y-axis, LWB, co   | mpact type      |           |                 |       |           |      |
|                                  | 22   | 6.000          | CO13         | 0.01              | ≤1 | 130) Bending about   | z-axis acc. to 5  | 4.2.2           |           |                 |       |           |      |
|                                  | 22   | 6.000          | CO13         | 0.01              | ≤1 | 134) Bending about   | z-axis, LFB, con  | npact type      |           |                 |       |           |      |
|                                  | 32   | 0.750          | CO13         | 0.43              | ≤1 | 171) Shear in z-axis | acc. to 5.4.3     |                 |           |                 |       |           |      |
|                                  | 22   | 6.000          | CO9          | 0.05              | ≤1 | 201) Torsion - Open  | ed cross-section  | s               |           |                 |       |           | -    |
|                                  |  |                | Max:         | 0.99              | ≤1 | ۲                    |                   | 9               | 2         | 🗈 🗐             | > 1,0 | - 🤊 💕 🛐 🕻 | 3    |
| Details - I<br>Materia<br>Cross- | Image: |                |              |                   |    |                      |                   |                 |           |                 |       |           |      |
| - Axia                           | I Force  |                |              |                   |    | Nsd                  | -131.73           | kN              |           |                 |       |           |      |
| She                              | ar Force   |                |              |                   |    | Vy                   | 0.25              | kN              |           |                 |       | 200.0     |      |
| - She                            | ar Force   |                |              |                   |    | Vz                   | 129.57            | kN              |           |                 |       | -         |      |
| Tors                             | sional Morr  | nent           |              |                   |    | Tsd                  | -0.32             | kNm             |           |                 |       | 16.0      |      |
| Flex                             | ural Mome  | nt             |              |                   |    | My                   | 439.48            | kNm             |           |                 |       |           |      |
| - Flex                           | ural Mome  | nt             |              |                   |    | Mz                   | -1.15             | kNm             |           |                 |       |           |      |
| Eross-                           | Section Ty   | pe             |              |                   |    |                      |                   |                 |           |                 | 20.0  |           | ·•   |
| Design                           | n Ratio  |                |              |                   |    |                      |                   |                 |           |                 |       |           | Y    |
| - Mor                            | nent   |                |              |                   |    | My,Sd                | 439.48            | kNm             |           |                 |       | 6.3       |      |
| Yiel                             | d Stress   |                |              |                   |    | fy                   | 255.00            | MPa             |           |                 |       |           |      |
| Res                              | idual Com  | pression in Fl | anges        |                   |    | σr                   | 76.50             | MPa             |           | Tab. G1 5)      |       |           |      |
| Elas                             | tic Section  | n Modulus      |              |                   |    | Wy                   | 2340.00           | cm <sup>3</sup> |           |                 |       | ÷         |      |
| Ben                              | ding Mom   | ent Correspo   | nding to the | Start of Yielding |    | M <sub>y,r</sub>     | 417.69            | kNm             |           | Tab. G1         |       | z         |      |
| - Moo                            | dification F   | actor          |              |                   |    | Сь                   | 1.000             |                 |           | 5.4.2.3         |       |           |      |
| - Plas                           | tic Bendin   | g Moment       |              |                   |    | M <sub>pl,y</sub>    | 652.45            | kNm             |           |                 |       |           |      |
| - Coe                            | fficient of  | Resistance     |              |                   |    | γa1                  | 1.100             |                 |           | Tab. 3          |       |           |      |
| - Mor                            | nent Resis   | tance          |              |                   |    | M <sub>y,Rd</sub>    | 470.45            | kNm             |           | Annex G         |       |           | [mm] |
| Des                              | ign Ratio  |                |              |                   |    | ηιтв                 | 0.93              |                 | ≤1        | 5.4.1.3         | 0     | s i       |      |
| <u> </u>                         |  |                |              |                   |    |                      | -                 |                 | -         |                 |       |           |      |

Figure 4.3: Window 2.2 Design by Cross-Section

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

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

## 4.3 Design by Set of Members

| Desigr   | n by Set of  | Members      |             |                       |    |                    |                  |            |             |                |     |          |          |           |          |   |
|----------|--|--------------|-------------|-----------------------|----|--------------------|------------------|------------|-------------|----------------|-----|----------|----------|-----------|----------|---|
|          | A  | B            | С           | D                     | E  |                    |                  |            |             | F              |     |          |          |           |          |   |
| Set      | Member   | Location     | Load-       | Design                |    |                    |                  |            |             |                |     |          |          |           |          |   |
| No.      | No.  | x [m]        | ing         | Ratio                 |    |                    |                  |            | Design Acc  | ording to Form | ula |          |          |           |          |   |
| 2        | Set 2 (Me  | mber No. 13  | -15)        |                       |    |                    |                  |            |             |                |     |          |          |           |          |   |
|          | 14   | 0.000        | CO13        | 0.05                  | ≤1 | 102) Compression   | without buckli   | ng acc. to | 5.3.2       |                |     |          |          |           |          |   |
|          | 15   | 6.274        | CO13        | 0.73                  | ≤1 | 110) Bending abou  | ut y-axis acc. t | o 5.4.2.2  |             |                |     |          |          |           |          | Ξ |
|          | 13   | 0.000        | CO13        | 0.99                  | ≤1 | 112) Bending about | ut y-axis, LTB,  | semi com   | pact type   |                |     |          |          |           |          |   |
|          | 13   | 0.000        | CO13        | 0.73                  | ≤1 | 114) Bending abou  | ut y-axis, LFB,  | compact    | type        |                |     |          |          |           |          |   |
|          | 15   | 6.274        | CO13        | 0.70                  | ≤1 | 115) Bending abou  | ut y-axis, LFB,  | semi com   | pact type   |                |     |          |          |           |          |   |
|          | 13   | 0.000        | CO13        | 0.73                  | ≤1 | 117) Bending abou  | ut y-axis, LWB   | , compact  | t type      |                |     |          |          |           |          |   |
|          | 15   | 0.000        | CO9         | 0.06                  | ≤1 | 130) Bending abou  | ut z-axis acc. t | o 5.4.2.2  |             |                |     |          |          |           |          |   |
|          | 13   | 2.008        | CO9         | 0.02                  | ≤1 | 134) Bending abou  | ut z-axis, LFB,  | compact    | type        |                |     |          |          |           |          |   |
|          | 15   | 0.000        | CO9         | 0.04                  | ≤1 | 135) Bending abou  | ut z-axis, LFB,  | semi com   | pact type   |                |     |          |          |           |          | - |
|          |  |              | Max:        | 0.99                  | ≤1 | ۹                  |                  | ٩          | 1 🔍         | <b>3</b>       | F)  | > 1,0    | •        | 7 😂       | <b>B</b> | > |
| etails - | Member 15  | - x: 6 274 n | - 0013      |                       |    |                    |                  |            |             |                |     | 2 . VS 6 | 00v61    | I NBR 588 | 84       | _ |
| - Tr     | ickness  |              |             |                       |    | tw                 | 63               | mm         |             |                |     | 2-000    | 000001   | THDIA DOG | -        |   |
| Lir      | nith/t   |              |             |                       |    | (b/t)lim           | 41 728           |            |             | Tab E1         |     |          |          |           |          |   |
| b/       | t ratio  |              |             |                       |    | (b/t)              | 76.349           |            | > (b/t) lin |                |     |          |          |           |          |   |
| Par      | ameters of   | Table G 1    |             |                       |    | (0.14)             |                  |            | a (ar chin  |                |     |          |          |           |          |   |
| — Ulti   | mate Limit S   | State LTB    |             |                       |    |                    |                  |            |             |                |     |          | +        | 250.0     | +        |   |
| La       | teral torsion  | nal buckling | enath       |                       |    | Lb                 | 6.274            | m          |             |                |     |          | <u> </u> |           |          |   |
| Ra       | adius of Gvi   | ration       |             |                       |    | [7                 | 56.4             | mm         |             |                |     |          | 9.5      |           | -        |   |
| - SI     | endemess i   | parameter co | rresponding | a to plastification l | ТВ | λο                 | 49,290           |            |             | Tab. G.1       |     |          |          | ' I -     |          |   |
| - SI     | endemess   | parameter co | rresponding | a to vielding LTB     |    | λr                 | 131.376          |            |             | Tab. G.1       |     |          |          |           |          |   |
| - SI     | endemess   | parameter LT | в           |                       |    | λ                  | 111.233          |            | ≤λr         |                |     | 0.0      |          |           |          |   |
| — Ültii  | mate Limit   | State LFB    |             |                       |    |                    |                  |            |             |                |     | -        |          |           | 7        | 1 |
| — - Ha   | alf of Full Fl   | ange Width   |             |                       |    | b                  | 125.0            | mm         |             |                | E   |          |          | 6.3       |          |   |
| Tr       | nickness   | -            |             |                       |    | tr                 | 9.5              | mm         |             |                |     |          |          |           |          |   |
| - SI     | endemess   | parameter co | rresponding | g to plastification l | FB | λρ                 | 10.642           |            |             | Tab. G.1       |     |          | ––       |           | -        |   |
| - SI     | endemess   | parameter co | rresponding | g to yielding LFB     |    | λr                 | 27.783           |            |             | Tab. G.1       |     |          |          | 1         |          |   |
| - SI     | endemess   | parameter LF | B           |                       |    | λ                  | 13.158           |            | ≤λr         |                |     |          |          | z         |          |   |
| — Ulti   | mate Limit S   | State LWB    |             |                       |    |                    |                  |            |             |                |     |          |          |           |          |   |
| — - He   | eight of We  | b            |             |                       |    | h                  | 481.0            | mm         |             |                |     |          |          |           |          |   |
| Tr       | ickness  |              |             |                       |    | tw                 | 6.3              | mm         |             |                |     |          |          |           |          |   |
| SI       | - Slendemess parameter corresponding to plastification LWB |              |             |                       | λρ | 105.301            |                  |            | Tab. G.1    |                |     |          |          | Im        |          |   |
| SI       | - Slendemess parameter corresponding to yielding LWB       |              |             |                       | λr | 159.632            |                  |            | Tab. G.1    |                |     |          |          | [m        | mi       |   |
| - 9      | Slendemess parameter LWB                                   |              |             |                       |    | λ                  | 76.349           |            | ≤λp         |                | +   | 0        |          |           | 🔺 🚰 🖸    | X |

Figure 4.4: Window 2.3 Design by Set of Members

This result window is displayed when you have selected at least one set of members for the design. It lists the maximum design ratios sorted by set of members.

The *Member No.* column shows the number of the member within the set which has the maximum ratio with respect to the specific design criterion.

The output by set of members clearly presents the design for an entire structural group, e.g. a frame.

| .4 Desigr   | n by Membe  | r                                      |   |                 |                 |                     |                                |                 |            |            |         |                       |      |
|-------------|---|--|---|-----------------|-----------------|---------------------|--------------------------------|-----------------|------------|------------|---------|-----------------------|------|
|             | A   | В                                      | С   | D               | [               |                     |                                |                 | E          |            |         |                       |      |
| Member      | Location  | Load-                                  | Design                                      |                 |                 |                     |                                |                 |            |            |         |                       |      |
| No.         | x [m]   | ing                                    | Ratio                                       |                 |                 |                     |                                | Design <i>i</i> | According  | to Formula |         |                       |      |
| 99          | Cross-section   | n No. 12 -                             | TO 80/80/4.5/4                              | .5/4.5          | /4.5            |                     |                                |                 |            |            |         |                       |      |
|             | 5.000   | CO9                                    | 0.02  | 2 ≤1            | 102) Compress   | sion without buck   | ling acc. to 5.3               | .2              |            |            |         |                       |      |
|             | 5.000   | CO13                                   | 0.72  | ! ≤1            | 110) Bending a  | about y-axis acc.   | to 5.4.2.2                     |                 |            |            |         |                       |      |
|             | 5.000   | CO13                                   | 0.72  | 2 ≤1            | 112) Bending a  | about y-axis, LTB   | , semi compact                 | type            |            |            |         |                       |      |
|             | 5.000   | CO13                                   | 0.72  | ! ≤1            | 114) Bending a  | about y-axis, LFB   | compact type                   |                 |            |            |         |                       |      |
|             | 5.000   | CO13                                   | 0.72  | 2 ≤ 1           | 117) Bending a  | about y-axis, LWE   | <ol><li>compact type</li></ol> | в               |            |            |         |                       |      |
|             | 5.000   | CO9                                    | 0.2   | 5 ≤1            | 130) Bending a  | about z-axis acc.   | to 5.4.2.2                     |                 |            |            |         |                       |      |
|             | 5.000   | CO9                                    | 0.25  | 5 ≤1            | 134) Bending a  | about z-axis, LFB   | compact type                   |                 |            |            |         |                       |      |
|             | 5.000   | CO9                                    | 0.25  | 5 ≤1            | 137) Bending    | about z-axis, LWE   | 8, compact type                | e               |            |            |         |                       |      |
|             | 0.000   | CO9                                    | 0.03  | 8 ≤1            | 1/1) Shear in : | z-axis acc. to 5.4. | 3                              |                 |            |            |         |                       | ~    |
|             |   | Max:                                   | 0.99  | ≤1              | ۲               |                     |                                | <b>%</b>        | <b>e</b> - | <b>:</b>   | > 1,0   | - 7 😂 💐               | 3    |
| Details - I | Member 99 - :<br>al Properties -<br>Section Properties -<br>Internal Ford | x: 5.000 m<br>Steel CG-<br>erties - TC | - CO13<br>26   ABNT NBR<br>2 80/80/4.5/4.5/ | 8800:2<br>4.5/4 | 2008<br>5       |                     |                                |                 |            |            | 12 - TO | 80/80/4.5/4.5/4.5/4.5 |      |
| Axia        | Force   |  |   |                 |                 | Nsa                 | -5.22                          | kN              |            |            |         |                       |      |
| She         | ar Force  |  |   |                 |                 | Vv                  | 0.84                           | kN              |            |            |         | 80.0                  | +    |
| She         | ar Force  |  |   |                 |                 | Vz                  | 1.11                           | kN              |            |            |         | 4.5                   | 4.5  |
| - Tors      | sional Momen  | t                                      |   |                 |                 | Tsd                 | 0.15                           | kNm             |            |            |         | II I                  | [ .  |
| - Flex      | ural Moment   |  |   |                 |                 | My                  | 6.43                           | kNm             |            |            | - int   |                       |      |
| - Flex      | ural Moment   |  |   |                 |                 | Mz                  | -2.24                          | kNm             |            |            | 4       |                       | 40.0 |
| Cross-      | Section Type  |  |   |                 |                 |                     |                                |                 |            |            | 9       |                       |      |
| Design      | n Ratio   |  |   |                 |                 |                     |                                |                 |            |            | 8       |                       | Y    |
| - Mor       | nent  |  |   |                 |                 | M <sub>y,Sd</sub>   | 6.43                           | kNm             |            |            |         |                       |      |
| - Sec       | tion Modulus  |  |   |                 |                 | Wy                  | 38.52                          | cm <sup>3</sup> |            |            |         |                       |      |
| Yiel        | d Stress  |  |   |                 |                 | fy                  | 255.00                         | MPa             |            |            | 4.5     |                       |      |
| Coe         | fficient of Re  | sistance                               |   |                 |                 | 7a1                 | 1.100                          |                 |            | Tab. 3     | I '     | 40.0                  |      |
| - Mor       | nent Resistar   | ice                                    |   |                 |                 | My,Rd               | 8.93                           | kNm             |            | 5.4.2.2    |         | 40.0                  |      |
| - Des       | ign Ratio   |  |   |                 |                 | η                   | 0.72                           |                 | ≤1         | 5.4.1.3    |         |                       |      |
|             |   |  |   |                 |                 |                     |                                |                 |            |            |         |                       | [mm] |
|             |   |  |   |                 |                 |                     |                                |                 |            |            | 0       | X                     | F 🕅  |

Figure 4.5: Window 2.4 Design by Member

This result window lists the maximum ratios of the individual designs for each member. The columns are described Chapter 4.1 on page 22.

## 4.5 Design by x-Location

| 2.5 Design  | .5 Design by x-Location |                  |                     |          |               |                   |                 |          |               |               |   |                          |             |
|-------------|-------------------------|------------------|---------------------|----------|---------------|-------------------|-----------------|----------|---------------|---------------|---|--------------------------|-------------|
|             | A                       | В                | C                   | D        | (             |                   |                 |          | F             |               |   |                          |             |
| Member      | Location                | Load-            | Design              |          |               |                   |                 |          |               |               |   |                          |             |
| No.         | x [m]                   | ing              | Ratio               |          |               |                   |                 | De       | sign Accordin | ng to Formula |   |                          |             |
|             | 3.429                   | CO9              | 0.09                | ≤1       | 321) Torsiona | al buckling acc.  | to 5.3.2        |          |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.05                | ≤1       | 102) Compre   | ssion without bu  | ickling acc. to | 5.3.2    |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.36                | ≤1       | 110) Bending  | about y-axis ac   | c. to 5.4.2.2   |          |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.45                | ≤1       | 112) Bending  | about y-axis, L   | TB, semi comp   | act type | )             |               |   |                          |             |
|             | 4.286                   | CO9              | 0.36                | ≤1       | 114) Bending  | ) about y-axis, L | FB, compact t   | ype      |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.36                | ≤1       | 117) Bending  | ) about y-axis, L | WB, compact     | type     |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.01                | ≤1       | 130) Bending  | about z-axis ac   | c. to 5.4.2.2   |          |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.01                | ≤1       | 134) Bending  | ) about z-axis, L | FB, compact t   | ype      |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.33                | ≤1       | 171) Shear in | z-axis acc. to 5  | 5.4.3           |          |               |               |   |                          |             |
|             | 4.286                   | CO9              | 0.04                | ≤1       | 201) Torsion  | - Opened cross    | sections        |          |               |               |   |                          | -           |
|             |                         | Max:             | 0.99                | ≤1       | ۲             |                   |                 | [        | Y 🏝           | <b>3</b>      | 1 | > 1,0 🔹 🦞 🛃 👌            | \$ <b>@</b> |
| Detella 1   |                         |                  |                     |          |               |                   |                 |          |               |               |   |                          |             |
| Details - I | Member 22 - 3           | C 4.286 M        | - 009               |          |               | -                 | <b>CO O</b>     |          |               |               |   | 1 - VS 550x88   NBR 5884 |             |
| - Na        | idius or Gyrati         | on<br>amotor oor | manandina ta ala    | ntifican | tion I TP     | Tz 1              | 10 200          | mm       |               | Tab. G 1      |   |                          |             |
| - Sie       | andemess par            | ameter co        | responding to pia:  | dina l   |               | Ap                | 125.099         |          |               | Tab. G.1      |   |                          |             |
| - Sle       | endemess par            | ameter I T       | R                   | ungi     |               | 2                 | 98.618          |          | < 2 .         | 1ab. G. 1     |   |                          |             |
| Ultin       | nate Limit Sta          | te I FB          | 0                   |          |               | ~                 | 00.010          |          |               |               |   | 250.0                    |             |
| - Ha        | of Full Fland           | e Width          |                     |          |               | b                 | 125.0           | mm       |               |               |   | +                        |             |
| - Th        | ickness                 |                  |                     |          |               | tr                | 16.0            | mm       |               |               |   | 99                       |             |
| Sle         | endemess par            | ameter co        | responding to pla:  | stifica  | tion LFB      | λρ                | 10.642          |          |               | Tab. G.1      |   | -                        |             |
| Sle         | endemess par            | ameter co        | responding to yiel  | ding l   | LFB           | λr                | 27.783          |          |               | Tab. G.1      |   |                          |             |
| Sle         | enderness par           | ameter LFI       | В                   |          |               | λ                 | 7.812           |          | ≤λp           |               | 1 | 200                      |             |
| Ultin       | nate Limit Sta          | te LWB           |                     |          |               |                   |                 |          |               |               |   | 6                        | У           |
| He          | ight of Web             |                  |                     |          |               | h                 | 518.0           | mm       |               |               |   | 6.3                      |             |
| - • Th      | ickness                 |                  |                     |          |               | tw                | 6.3             | mm       |               |               |   |                          |             |
| Sle         | endemess par            | ameter co        | rresponding to pla  | stifica  | tion LWB      | λρ                | 105.301         |          |               | Tab. G.1      |   |                          |             |
| Sle         | endemess par            | ameter co        | rresponding to yiel | ding l   | LWB           | λr                | 159.632         |          |               | Tab. G.1      |   |                          |             |
| Sle         | enderness par           | ameter LV        | /B                  |          |               | λ                 | 82.222          |          | ≤λp           |               | = | Z                        |             |
| Design      | n Ratio                 |                  |                     |          | ata :=        |                   |                 | 1        |               |               |   |                          |             |
| Mon         | nent                    |                  |                     |          |               | My,Sd             | 213.17          | kNm      |               |               |   |                          |             |
| - Plas      | tic Bending N           | Ioment           |                     |          |               | Mpl,y             | 652.45          | ĸNm      |               | <b>T</b> 1 0  |   |                          |             |
| - Coe       | fricient of Res         | sistance         |                     |          |               | Ya1               | 1.100           | 1.81     |               | Tab. 3        |   |                          | [mm]        |
| Mon         | nent Hesistan           | се               |                     |          |               | My,Rd             | 593.13          | ĸNm      |               | Annex G       |   |                          | <b>→</b>    |
| - Des       | ign Katio               |                  |                     |          |               | ηlwb              | 0.36            |          | 51            | 5.4.1.3       |   |                          |             |

Figure 4.6: Window 2.5 Design by x-Location

4



- Start and end nodes
- Division points according to optionally defined member division (see RFEM Table 1.16 or RSTAB Table 1.6)
- Member divisions according to specification for member results (see RFEM/RSTAB dialog box Calculation Parameters, tab Global Calculation Parameters)
- Extreme values of internal forces

#### 4.6 Governing Internal Forces by Member

|       | A             | B          | C            | D           | E      | F     | G            | Н     |   |
|-------|---------------|------------|--------------|-------------|--------|-------|--------------|-------|---|
| ember | Location      | Load-      |              | Forces [kN] |        | M     | oments [kNm] |       |   |
| No.   | x [m]         | ing        | N            | Vy          | Vz     | MT    | My           | Mz    | Design According to Formula                       |
| 1     | Cross-section | No. 1 - VS | 550x88   NBR | 5884        |        |       |              |       |   |
|       | 0.000         | CO13       | -126.61      | 0.14        | -56.11 | 0.00  | 134.02       | 0.48  | 102) Compression without buckling acc. to 5.3.2   |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 110) Bending about y-axis acc. to 5.4.2.2         |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 112) Bending about y-axis, LTB, semi compact type |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 114) Bending about y-axis, LFB, compact type      |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 117) Bending about y-axis, LWB, compact type      |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 130) Bending about z-axis acc. to 5.4.2.2         |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 134) Bending about z-axis, LFB, compact type      |
|       | 1.714         | CO13       | -106.40      | 0.17        | -56.88 | 0.00  | 37.27        | 0.21  | 171) Shear in z-axis acc. to 5.4.3                |
|       | 6.000         | CO9        | -57.76       | 0.58        | -55.17 | 0.03  | -202.88      | -0.46 | 201) Torsion - Opened cross-sections              |
|       | 0.000         | CO13       | -126.61      | 0.14        | -56.11 | 0.00  | 134.02       | 0.48  | 302) Flexural buckling about z-axis acc. to 5.3.2 |
|       | 0.000         | CO13       | -126.61      | 0.14        | -56.11 | 0.00  | 134.02       | 0.48  | 321) Torsional buckling acc. to 5.3.2             |
|       | 6.000         | CO13       | -57.90       | 0.15        | -55.50 | -0.01 | -204.33      | -0.51 | 341) Combined forces acc. to 5.5.1                |
|       |               |            |              |             |        |       |              |       |   |
| 2     | Cross-section | No. 1 - VS | 550x88   NBR | 5884        |        |       |              |       |   |
|       | 0.000         | CO9        | -127.76      | -0.08       | 60.82  | -0.01 | -153.48      | -0.77 | 102) Compression without buckling acc. to 5.3.2   |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 110) Bending about y-axis acc. to 5.4.2.2         |
|       | 6.000         | CO9        | -59.00       | -0.33       | 60.29  | -0.21 | 213.99       | 0.77  | 112) Bending about y-axis, LTB, semi compact type |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 114) Bending about y-axis, LFB, compact type      |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 117) Bending about y-axis, LWB, compact type      |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 130) Bending about z-axis acc. to 5.4.2.2         |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 134) Bending about z-axis, LFB, compact type      |
|       | 2.571         | CO9        | -97.47       | -0.23       | 61.75  | -0.10 | 4.29         | -0.18 | 171) Shear in z-axis acc. to 5.4.3                |
|       | 6.000         | CO9        | -59.00       | 0.14        | 59.82  | -0.21 | 213.99       | 0.77  | 201) Torsion - Opened cross-sections              |
|       | 0.000         | CO9        | -127.76      | -0.08       | 60.82  | -0.01 | -153.48      | -0.77 | 301) Flexural buckling about y-axis acc. to 5.3.2 |
|       | 0.000         | CO9        | -127.76      | -0.08       | 60.82  | -0.01 | -153.48      | -0.77 | 302) Flexural buckling about z-axis acc. to 5.3.2 |
|       | 0.000         | CO9        | -127.76      | -0.08       | 60.82  | -0.01 | -153.48      | -0.77 | 321) Torsional buckling acc. to 5.3.2             |
|       | 0.000         | CO3        | -91.09       | 0.02        | 22.26  | 0.00  | -56.28       | -0.09 | 341) Combined forces acc. to 5.5.1                |
|       |               |            |              |             |        |       |              |       |   |
| 11    | Cross-section | No. 1 - VS | 550x88   NBR | 5884        |        |       |              |       |   |
|       | 0.000         | CO13       | -152.64      | 0.06        | -91.91 | 0.00  | 194.72       | 0.33  | 102) Compression without buckling acc. to 5.3.2   |
|       | 6.000         | CO13       | -92.86       | 0.16        | -89.66 | -0.07 | -357.78      | -0.52 | 110) Bending about y-axis acc. to 5.4.2.2         |
|       | 6.000         | CO13       | -92.86       | 0.16        | -89.66 | -0.07 | -357.78      | -0.52 | 112) Bending about y-axis, LTB, semi compact type |
|       | 6.000         | CO13       | -92.86       | 0.16        | -89.66 | -0.07 | -357.78      | -0.52 | 114) Bending about y-axis, LFB, compact type      |

Figure 4.7: Window 3.1 Governing Internal Forces by Member

For all designed members, the internal forces are listed that effectuate the maximum ratios of each type of design.

#### Location **x**

This column shows the x-locations where the maximum design ratios occur.

#### Loading

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

#### **Forces / Moments**

For each member, these columns present the axial and shear forces as well as the torsional and bending moments which give the maximum ratios in the respective cross-section designs, stability analyses, and serviceability limit state designs.

#### **Design According to Formula**

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

## 4.7 Governing Internal Forces by Set of Members

|     | A            | В           | C       | D           | E     | F     | G           | Н     |  |
|-----|--------------|-------------|---------|-------------|-------|-------|-------------|-------|--|
| Set | Location     | Load-       |         | Forces [kN] |       | Ň     | oments [kNm | ]     |  |
| No. | x [m]        | ing         | N       | Vy          | Vz    | MT    | My          | Mz    | Design According to Formula  |
| 1   | Set 1 (Membe | er No. 51,5 | 2)      |             |       |       |             |       |  |
|     | 0.000        | CO13        | -136.26 | -0.04       | 0.27  | -0.02 | -0.45       | 1.06  | 102) Compression without buckling acc. to 5.3.2                    |
|     | 0.000        | CO9         | -136.25 | -0.70       | 2.19  | -0.02 | -8.36       | -0.71 | 110) Bending about y-axis acc. to 5.4.2.2                          |
|     | 0.000        | CO9         | -136.25 | -0.70       | 2.19  | -0.02 | -8.36       | -0.71 | 112) Bending about y-axis, LTB, semi compact type                  |
|     | 0.000        | CO9         | -136.25 | -0.70       | 2.19  | -0.02 | -8.36       | -0.71 | 114) Bending about y-axis, LFB, compact type                       |
|     | 0.000        | CO9         | -136.25 | -0.70       | 2.19  | -0.02 | -8.36       | -0.71 | 117) Bending about y-axis, LWB, compact type                       |
|     | 3.000        | CO9         | -99.71  | -0.10       | 1.63  | -0.02 | -1.73       | 1.39  | 130) Bending about z-axis acc. to 5.4.2.2                          |
|     | 3.000        | CO9         | -99.71  | -0.10       | 1.63  | -0.02 | -1.73       | 1.39  | 134) Bending about z-axis, LFB, compact type                       |
|     | 3.000        | CO9         | -99.71  | -0.69       | 2.22  | -0.02 | -1.73       | 1.39  | 171) Shear in z-axis acc. to 5.4.3                                 |
|     | 0.000        | CO9         | -52.10  | -0.10       | 0.60  | -0.11 | -1.95       | 1.08  | 201) Torsion - Opened cross-sections                               |
|     | 0.000        | CO13        | -136.26 | -0.04       | 0.27  | -0.02 | -0.45       | 1.06  | 301) Flexural buckling about y-axis acc. to 5.3.2                  |
|     | 0.000        | CO13        | -136.26 | -0.04       | 0.27  | -0.02 | -0.45       | 1.06  | 302) Flexural buckling about z-axis acc. to 5.3.2                  |
|     | 0.000        | CO13        | -136.26 | -0.04       | 0.27  | -0.02 | -0.45       | 1.06  | 321) Torsional buckling acc. to 5.3.2                              |
|     | 0.000        | CO3         | -129.34 | -0.14       | 1.90  | -0.01 | -6.93       | 0.07  | 341) Combined forces acc. to 5.5.1                                 |
|     |              |             |         |             |       |       |             |       |  |
| 2   | Set 2 (Membe | er No. 13-1 | 5)      |             |       |       |             |       |  |
|     | 0.000        | CO13        | -93.87  | -0.95       | 68.85 | -0.13 | -134.68     | -1.07 | 102) Compression without buckling acc. to 5.3.2                    |
|     | 6.274        | CO13        | -86.75  | 0.64        | -1.96 | -0.45 | 234.50      | 1.71  | 110) Bending about y-axis acc. to 5.4.2.2                          |
|     | 0.000        | CO13        | -96.86  | -0.25       | 78.87 | -0.37 | -358.16     | -0.45 | 112) Bending about y-axis, LTB, semi compact type                  |
|     | 0.000        | CO13        | -96.86  | -0.25       | 78.87 | -0.37 | -358.16     | -0.45 | 114) Bending about y-axis, LFB, compact type                       |
|     | 6.274        | CO13        | -86.75  | 0.64        | -1.96 | -0.45 | 234.50      | 1.71  | 115) Bending about y-axis, LFB, semi compact type                  |
|     | 0.000        | CO13        | -96.86  | -0.25       | 78.87 | -0.37 | -358.16     | -0.45 | 117) Bending about y-axis, LWB, compact type                       |
|     | 0.000        | CO9         | -88.67  | 0.05        | 54.47 | 0.20  | 67.90       | 2.64  | 130) Bending about z-axis acc. to 5.4.2.2                          |
|     | 2.008        | CO9         | -94.27  | -0.87       | 72.46 | -0.16 | -204.52     | -1.65 | 134) Bending about z-axis, LFB, compact type                       |
|     | 0.000        | CO9         | -88.67  | 0.05        | 54.47 | 0.20  | 67.90       | 2.64  | 135) Bending about z-axis, LFB, semi compact type                  |
|     | 0.000        | CO13        | -96.86  | -0.25       | 78.87 | -0.37 | -358.16     | -0.45 | 171) Shear in z-axis acc. to 5.4.3                                 |
|     | 3.262        | CO9         | -92.91  | -1.03       | 54.72 | 0.17  | 69.10       | 2.41  | 181) Shear in y-axis acc. to 5.4.3                                 |
|     | 6.274        | CO9         | -87.39  | 0.64        | -2.12 | -0.45 | 234.43      | 1.74  | 201) Torsion - Opened cross-sections                               |
|     | 0.000        | CO13        | -93.87  | -0.95       | 68.85 | -0.13 | -134.68     | -1.07 | 301) Flexural buckling about y-axis acc. to 5.3.2                  |
|     | 0.000        | CO13        | -93.87  | -0.95       | 68.85 | -0.13 | -134.68     | -1.07 | 302) Flexural buckling about z-axis acc. to 5.3.2                  |
|     | 0.000        | CO13        | -93.87  | -0.95       | 68.85 | -0.13 | -134.68     | -1.07 | 321) Torsional buckling acc. to 5.3.2                              |
|     | 0.000        | RC2         | 0.00    | 0.00        | 0.00  | 0.00  | 0.00        | 0.00  | 400) Design for serviceability - Negligible deflections            |
|     | 3.137        | RC2         | 0.00    | 0.00        | 0.00  | 0.00  | 0.00        | 0.00  | 401) Design for serviceability acc. to Annex C - Deflection in z-c |
|     |              |             |         |             |       |       |             |       |  |
|     |              |             |         |             |       |       |             |       |  |

#### 3.2 Governing Internal Forces by Set of Members

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

For each set of members, this window shows the internal forces that result in the maximum design ratios. The respective equations according to [1] are referred to in the last column.





Window 3.3 is shown when you have selected the respective check box in the *Details* dialog box (see Figure 3.1, page 19).

| .3 Memb | er Slendernesses      |        |       |                                       |                 |                            |              |         |       |
|---------|-----------------------|--------|-------|---------------------------------------|-----------------|----------------------------|--------------|---------|-------|
|         | А                     | В      | C     | D                                     | E               | F                          | G            | H       |       |
| Member  |                       | Length |       | Major Axis y                          |                 |                            | Minor Axis z |         |       |
| No.     | Under Stress          | L [m]  | ky[-] | iy [mm]                               | λy[-]           | k <sub>z</sub> [-]         | iz [mm]      | λz [-]  |       |
| 1       | Compression / Flexure | 6.000  | 1.000 | 239.0                                 | 25.099          | 1.000                      | 60.8         | 98.618  |       |
| 2       | Compression / Flexure | 6.000  | 1.000 | 239.0                                 | 25.099          | 1.000                      | 60.8         | 98.618  |       |
| 11      | Compression / Flexure | 6.000  | 1.000 | 239.0                                 | 25.099          | 1.000                      | 60.8         | 98.618  |       |
| 16      | Compression / Flexure | 6.274  | 1.000 | 210.3                                 | 29.830          | 1.000                      | 56.4         | 111.236 |       |
| 17      | Compression / Flexure | 3.262  | 1.000 | 210.3                                 | 15.512          | 1.000                      | 56.4         | 57.843  |       |
| 18      | Compression / Flexure | 3.011  | 1.000 | 210.3                                 | 14.318          | 1.000                      | 56.4         | 53.390  |       |
| 21      | Compression / Flexure | 6.000  | 1.000 | 239.0                                 | 25.099          | 1.000                      | 60.8         | 98.618  |       |
| 22      | Compression / Flexure | 6.000  | 1.000 | 239.0                                 | 25.099          | 1.000                      | 60.8         | 98.618  |       |
| 31      | Compression / Flexure | 3.000  | 1.000 | 239.0                                 | 12.550          | 1.000                      | 60.8         | 49.309  |       |
| 32      | Compression / Flexure | 3.000  | 1.000 | 239.0                                 | 12.550          | 1.000                      | 60.8         | 49.309  |       |
| 39      | Compression / Flexure | 3.000  | 1.000 | 239.0                                 | 12.550          | 1.000                      | 60.8         | 49.309  |       |
| 66      | Compression / Flexure | 6.250  | 1.000 | 168.3                                 | 37.144          | 1.000                      | 40.7         | 153.617 |       |
| 67      | Compression / Flexure | 6.250  | 1.000 | 168.3                                 | 37.144          | 1.000                      | 40.7         | 153.617 |       |
| 68      | Compression / Flexure | 6.250  | 1.000 | 168.3                                 | 37.144          | 1.000                      | 40.7         | 153.617 |       |
| 69      | Compression / Flexure | 6.250  | 1.000 | 168.3                                 | 37.144          | 1.000                      | 40.7         | 153.617 |       |
| 81      | Compression / Flexure | 6.546  | 1.000 | 85.6                                  | 76.481          | 1.000                      | 49.1         | 133.250 |       |
| 82      | Compression / Flexure | 7.094  | 1.000 | 85.6                                  | 82.883          | 1.000                      | 49.1         | 144.405 |       |
| 83      | Compression / Flexure | 6.546  | 1.000 | 85.6                                  | 76.481          | 1.000                      | 49.1         | 133.250 |       |
| 99      | Compression / Flexure | 5.000  | 1.000 | 30.9                                  | 161.930         | 1.000                      | 30.9         | 161.930 |       |
| 100     | Compression / Flexure | 5.000  | 1.000 | 30.9                                  | 161.930         | 1.000                      | 30.9         | 161.930 |       |
|         |                       |        |       |                                       |                 |                            |              |         |       |
|         |                       |        |       | Membe<br>Max KyL / ry                 | rs with compres | sion / flexure:<br>≤ 200 🔮 |              |         |       |
|         |                       |        |       | Max K <sub>z</sub> L / r <sub>z</sub> | : 161.930       | ≤ 200 🕲                    |              | E)      | 🛐 🐧 💌 |

Figure 4.9: Window 3.3 Member Slendernesses

The table lists the effective slenderness ratios of the designed members for both directions of the principal axes. They are determined in compliance with the load type.

Details...

Below the list, you find a comparison of the most unfavorable values with the limit values that have been defined in the *Details* dialog box (see Figure 3.1, page 19).

Members of the types 'tension' or 'cable' are not included in this table.



This window is only informative. It does not provide any stability analysis of slendernesses.

#### 4.9 Parts List by Member

Finally, RF-/STEEL NBR provides a summary of all cross-sections contained in the design case.

|     | A                                      | B         | C      | D            | E                 | F                 | G           | H      |              |
|-----|--|-----------|--------|--------------|-------------------|-------------------|-------------|--------|--------------|
| art | Cross-Section                          | Number of | Length | Total Length | Surface Area      | Volume            | Unit Weight | Weight | Total Weight |
| D.  | Description                            | Members   | [m]    | [m]          | [m <sup>2</sup> ] | [m <sup>3</sup> ] | [kg/m]      | [kg]   | [t]          |
|     | 1 - VS 550x88   NBR 5884               | 5         | 6.00   | 30.00        | 62.62             | 0.34              | 88.39       | 530.35 | 2.65         |
|     | 2 - VS 500x61   NBR 5884               | 1         | 6.27   | 6.27         | 12.47             | 0.05              | 61.07       | 383.17 | 0.3          |
|     | 2 - VS 500x61   NBR 5884               | 1         | 3.26   | 3.26         | 6.48              | 0.03              | 61.07       | 199.25 | 0.19         |
|     | 2 - VS 500x61   NBR 5884 3 - VS 550x75 | 1         | 3.01   | 3.01         | 6.14              | 0.03              | 68.06       | 204.95 | 0.2          |
|     | 1 - VS 550x88   NBR 5884               | 3         | 3.00   | 9.00         | 18.79             | 0.10              | 88.39       | 265.17 | 0.7          |
|     | 9 - VS 400x37   NBR 5884               | 4         | 6.25   | 25.00        | 37.76             | 0.12              | 36.90       | 230.59 | 0.9          |
|     | 6 - CS 200 x 41   NBR 5884             | 2         | 6.55   | 13.09        | 15.50             | 0.07              | 41.21       | 269.78 | 0.5          |
|     | 6 - CS 200 x 41   NBR 5884             | 1         | 7.09   | 7.09         | 8.40              | 0.04              | 41.21       | 292.36 | 0.2          |
|     | 12 - TO 80/80/4.5/4.5/4.5/4.5          | 2         | 5.00   | 10.00        | 3.20              | 0.01              | 10.67       | 53.34  | 0.1          |
| )   | 13 - RD 24                             | 2         | 7.81   | 15.62        | 1.18              | 0.01              | 3.55        | 27.71  | 0.0          |
| m   |  | 22        |        | 122.35       | 172.54            | 0.78              |             |        | 6.1          |
|     |  |           |        |              |                   |                   |             |        |              |
|     |  |           |        |              |                   |                   |             |        |              |

Figure 4.10: Window 4.1 Parts List by Member

By default, this list contains only the designed members. If you need a parts list for all members of the model, select the corresponding option in the Details dialog box (see Figure 3.1, page 19).

#### Part No.

Details...

The program automatically assigns item numbers to members with identical features.

#### **Cross-Section Description**

This column lists the cross-section numbers and descriptions.

#### Number of Members

Column B shows how many similar members are used for each part.

#### Length

This column shows the respective length of an individual member.

#### **Total Length**

In this column, the product determined from the two previous columns is given.

#### Surface Area



For each item, the program gives the surface area relative to the total length. This area is determined from the Surface Area of the cross-sections. It can be checked in Windows 1.3 and 2.1 to 2.5 in the cross-section properties (see Figure 2.10, page 11).



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

#### **Unit Weight**

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

#### Weight

The values of this column represent the products of the entries in columns C and G.

#### **Total Weight**

The final column gives the total mass of each sectional part.

#### Sum

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

#### 4.10 Parts List by Set of Members

|   | A              | B       | C      | D            | E                 | F                 | G           | H      |             |
|---|----------------|---------|--------|--------------|-------------------|-------------------|-------------|--------|-------------|
|   | Set of Members | Number  | Length | Total Length | Surface Area      | Volume            | Unit Weight | Weight | Total Weigh |
|   | Description    | of Sets | [m]    | [m]          | [m <sup>2</sup> ] | [m <sup>3</sup> ] | [kg/m]      | [kg]   | [t]         |
|   | Set 1          | 1       | 6.00   | 6.00         | 10.70             | 0.07              | 92.16       | 552.95 | 0.5         |
|   | Set 2          | 1       | 12.55  | 12.55        | 25.09             | 0.10              | 62.75       | 787.37 | 0.7         |
|   | Set 3          | 1       | 12.55  | 12.55        | 25.09             | 0.10              | 62.75       | 787.37 | 0.          |
| 1 |                | 3       |        | 31.10        | 60.88             | 0.27              |             |        | 2.1         |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |
|   |                |         |        |              |                   |                   |             |        |             |

Figure 4.11: Window 4.2 Parts List by Set of Members

The last result window is displayed when you have selected at least one set of members for design. It represents the parts list of structural groups (for example horizontal beams).

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

## **5 Results Evaluation**

You can evaluate the design results in different ways. For this, the buttons below the tables are very useful.

| 5 A | Desig | Inc | <br>ma la ca |
|-----|-------|-----|--------------|

|             | A              | B            | С                | D     |                              |                      |                 | E        |            |            |                 |   |
|-------------|----------------|--------------|------------------|-------|------------------------------|----------------------|-----------------|----------|------------|------------|-----------------|---|
| Member      | Location       | Load-        | Design           |       |                              |                      |                 |          |            |            | _               |   |
| No.         | x [m]          | ing          | Ratio            |       |                              |                      | Design A        | ccording | to Formula |            |                 | 4 |
|             |                |              |                  |       |                              |                      |                 |          |            |            |                 |   |
| 2           | Cross-sectio   | n No. 1 - V  | S 550x88   NBR ! | 5884  |                              |                      |                 |          |            |            |                 |   |
|             | 0.000          | CO9          | 0.04             | ≤1    | 102) Compression without a   | buckling acc. to 5.3 | 2               |          |            |            |                 |   |
|             | 6.000          | CO9          | 0.36             | ≤1    | 110) Bending about y-axis    | acc. to 5.4.2.2      |                 |          |            |            |                 |   |
|             | 6.000          | CO9          | 0.45             | ≤1    | 112) Bending about y-axis,   | LTB, semi compact    | type            |          |            |            |                 | Т |
|             | 6.000          | CO9          | 0.36             | ≤1    | 114) Bending about y-axis,   | LFB, compact type    |                 |          |            |            |                 | Т |
|             | 6.000          | CO9          | 0.36             | ≤1    | 117) Bending about y-axis,   | LWB, compact type    | •               |          |            |            |                 | Т |
|             | 6.000          | CO9          | 0.01             | ≤1    | 130) Bending about z-axis    | acc. to 5.4.2.2      |                 |          |            |            |                 |   |
|             | 6.000          | CO9          | 0.01             | ≤1    | 134) Bending about z-axis,   | LFB, compact type    |                 |          |            |            |                 |   |
|             | 2.571          | CO9          | 0.15             | ≤1    | 171) Shear in z-axis acc. to | 5.4.3                |                 |          |            |            |                 | 4 |
|             |                | Max:         | 1.06             | >1    | 8                            |                      | 9               | 2.       |            | > 1,0      | - 7 🐸 🖪 🗞 💿     | 1 |
|             |                |              |                  |       | -                            |                      |                 | ¥        |            | · ·        |                 | 1 |
| Details - I | Member 2 - x   | : 0.000 m -  | CO9              |       |                              |                      |                 |          |            | 1 - VS 550 | 0x88   NBR 5884 | Т |
|             | al Properties  | - Steel CG-2 | 26   ABNT NBR 8  | 800:2 | 008                          |                      |                 |          |            |            |                 |   |
|             | Section Prop   | erties - VS  | 550x88   NBR 58  | 84    |                              |                      |                 |          |            |            |                 |   |
| Design      | n Internal For | ces          |                  |       |                              |                      |                 |          |            |            |                 |   |
| — Axia      | al Force       |              |                  |       | Nsd                          | -127.76              | kN              |          |            |            | + 250.0         |   |
| - She       | ar Force       |              |                  |       | Vy                           | -0.08                | kN              |          |            | L .        |                 |   |
| - She       | ar Force       |              |                  |       | Vz                           | 60.82                | kN              |          |            | I          | 9.9             |   |
| - Tors      | sional Momer   | nt           |                  |       | Tsd                          | -0.01                | kNm             |          |            |            | ÷               |   |
| - Flex      | ural Moment    |              |                  |       | My                           | -153.48              | kNm             |          |            |            |                 |   |
| - Flex      | tural Moment   |              |                  |       | Mz                           | -0.77                | kNm             |          |            | 0.0        |                 |   |
| (           | Section Type   | •            |                  |       |                              |                      |                 |          |            | 33         | Y               |   |
| Design      | n Ratio        |              |                  |       |                              |                      |                 |          |            |            | 6.3             |   |
| — Axia      | al Force       |              |                  |       | N <sub>c,Sd</sub>            | 127.76               | kN              |          |            |            |                 |   |
| - Gro       | ss Area of M   | ember        |                  |       | Ag                           | 112.60               | cm <sup>2</sup> |          |            |            |                 |   |
| - Yiel      | d Stress       |              |                  |       | fy                           | 255.00               | MPa             |          |            | · •        |                 |   |
| - Coe       | fficient of Re | sistance     |                  |       | 7a1                          | 1.100                |                 |          | Tab. 3     |            | *               |   |
| Axia        | al Force Resi  | stance       |                  |       | N <sub>c,Rd</sub>            | 2871.30              | kN              |          | 5.3.2      |            | -               |   |
| - Des       | ign Ratio      |              |                  |       | η                            | 0.04                 |                 | ≤1       |            |            | [mm]            |   |
| L           |                |              |                  |       |                              |                      |                 |          |            |            |                 |   |
|             |                |              |                  |       |                              |                      |                 |          |            | 0          | 🍝 📬 🏹           |   |
|             |                |              |                  |       |                              |                      |                 |          |            |            |                 | - |

Figure 5.1: Buttons for results evaluation

The buttons have the following functions:

| Button                            | Description                          | Function   |
|-----------------------------------|--------------------------------------|--|
| <b>Y</b>                          | Ultimate Limit<br>State Design       | Shows or hides the results of the ULS design   |
| <b>e</b>                          | Serviceability Limit<br>State Design | Shows or hides the results of the SLS design   |
|                                   | Result Combination                   | Creates a new result combination from the governing load cases and load combinations   |
| E.                                | Color Bars                           | Shows or hides the colored relation scales in the tables   |
| > 1,0 •<br>> 1,0<br>Max<br>Define | Filter Parameters                    | Describes the filter criterion for the output in the tables:<br>Design ratios greater than 1, maximum value or user-defined<br>limit |
| 7                                 | Apply Filter                         | Displays only rows where the filter parameters are valid<br>(ratio > 1, maximum, user-defined limit)                                 |
| 2                                 | Result Diagrams                      | Opens the Result Diagram on Member Window $\rightarrow$ Chapter 5.2, page 35   |
|                                   | Excel Export                         | Exports the table to MS Excel $\rightarrow$ Chapter 7.4.3, page 44   |
| <b>N</b>                          | Member Selection                     | Option to select a member graphically for tabular results  |
| ۲                                 | View Mode                            | Jumps to the RFEM/RSTAB work window to change the view   |

Table 5.1: Buttons in Windows 2.1 to 2.5



You can also evaluate the design results in the work window of RFEM or RSTAB.

#### Background graphic and view mode

The work window of RFEM or RSTAB in the background is useful for you to find the location of a particular member in the model: There, the member selected in the RF-/STEEL NBR result window is highlighted. Furthermore, an arrow indicates the relevant location x on this member.



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



If you cannot improve the display by moving the RF-/STEEL NBR module window, click the solution to activate the *view mode*. Thus, you hide the module window so that you can change the view in the user interface of RFEM or RSTAB. In the view mode, you can use the functions of the *View* menu, e.g. zoom, move, or rotate the view. The arrow will remain visible when doing so.

Click [Back] to return to the RF-/STEEL NBR module.

#### **RFEM/RSTAB** work window

Graphics

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

In the *Results* navigator, you can select whether the ratios of the ULS and/or SLS designs are to be displayed.



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



To turn the display of the design ratios on or off, use the [Show Results] button which is familiar from the display of internal forces. To switch the result values on or off, click the [Show Values] button next to it.

The tables of RFEM or RSTAB are of no relevance for the steel design results. You can set the relevant RF-/STEEL NBR design case in the list of the toolbar.

| RF-STEEL NBR CA1 - Beams   | Ţ, |
|----------------------------|----|
| LC1 - Self-weight          | 2  |
| LC2 - Imposed loads        |    |
| RC1 - 1.35*LC1/p + 1.5*LC2 |    |
| RF-STEEL NBR CA1 - Beams   |    |
| RESTEEL NBB CA2 - Columns  |    |

The graphical representation of the design results can be controlled in the *Display* navigator, item **Results**  $\rightarrow$  **Members**. The ratios are shown *Two-Colored* by default.



Figure 5.4: Display navigator: Results  $\rightarrow$  Members

When you have selected a multicolor display (options *With/Without Diagram* or *Cross-Sections*), the color panel is available. It provides the common control functions which are described in detail in the RFEM/RSTAB manual, Chapter 3.4.6.

5



Figure 5.5: Design ratios with display option Without Diagram

The graphics of the design results can be transferred to the printout report (see Chapter 6.2, page 38).

RF-STEEL NBR

To return to the add-on module, use the [RF-/STEEL NBR] button in the panel.

#### 5.2 Result Diagram

You can graphically evaluate the design ratios in a result diagram, without using the work window of RFEM or RSTAB.

Select the member (or set of members) in the RF-/STEEL NBR result window by clicking in the relevant table row. Then click the get button to open the *Result Diagram on Member* dialog box. This button is located below the upper table (see Figure 5.1, page 31).

In the work window of RFEM or RSTAB, the result diagram can be accessed from the menu

#### Results ightarrow Result Diagrams for Selected Members

I

or via the toolbar button shown on the left.

A new window opens. It presents the distribution of the maximum design values on the member or set of members.



Figure 5.6: Dialog box Result Diagram on Member

You can switch the ULS and SLS results on or off in the Results navigator.

Use the list in the toolbar to select the relevant RF-/STEEL NBR design case.

RF-STEEL NBR CA1 - Beams LC1 - Self-weight LC2 - Imposed loads RC1 - 1.35°LC1/p + 1.5°LC2 RF-STEEL NBR CA1 - Beams RF-STEEL NBR CA2 - Columns

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





The RF-/STEEL NBR result windows allow you to sort the results by various criteria. In addition, you can use the filter options for the tables (see Figure 5.1, page 31) to reduce the numerical output according to specific ratios. This function is described in the *Knowledge Base* at our Web site: https://www.dlubal.com/en/support-and-learning/support/knowledge-base/000733

Furthermore, you can apply the filter options described in Chapter 9.9 of the RFEM manual or Chapter 9.7 of the RSTAB manual to evaluate the results graphically.



You can also use the *Visibility* options for RF-/STEEL NBR to filter the members and evaluate them (see RFEM manual, Chapter 9.9.1 or RSTAB manual, Chapter 9.7.1).

#### **Filtering design ratios**



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

#### View ightarrow Control Panel (Color scale, Factors, Filter)



or use the toolbar button shown on the left.

The panel is described in the RFEM/RSTAB manual, Chapter 3.4.6. The filter settings for the results can be defined in the first tab (Color scale). As this tab is not available for the two-colored results display, you have to set the display option *Colored With/Without Diagram* or *Cross-Sections* in the *Display* navigator (see Figure 5.4, page 33).

As seen in the figure to the left, the color spectrum can be set in such a way that only ratios greater than 0.50 are shown in the color ranges between blue and red.

#### **Filtering members**

In the *Filter* tab of the control panel, you can specify the numbers of particular members to display their results exclusively, i.e. filtered. This function is described in the RFEM manual, Chapter 9.9.3 or RSTAB manual, Chapter 9.7.3.



Figure 5.7: Filtering design ratios of one frame

Unlike the *Visibility* function, the entire model is displayed. Figure 5.7 shows the design ratios of one frame only. All other members are displayed in the model, but they have no design results.

## **6** Printout

#### 6.1 Printout Report

Similarly to RFEM or RSTAB, the program generates a printout report for the RF-/STEEL NBR results which can be supplemented by graphics and descriptions. The selection in the printout report controls which data of the design module are included in the final printout.



The printout report is described in the RFEM or RSTAB manual. 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 selected.

| A Printout report - PR1: Inpu | it data and reduced results*    |  |                                   |  | _ 0 %              |  |  |  |  |
|-------------------------------|---------------------------------|--|-----------------------------------|--|--------------------|--|--|--|--|
| Eile View Edit Setting        | r Jasart Hala                   |  |                                   |  |                    |  |  |  |  |
| D D D D M                     | insert Heip                     |  | 9.0                               |  |                    |  |  |  |  |
| Printeut Papart Navigator     |                                 |  | 🥪 🚾                               |  |                    |  |  |  |  |
| Printout Report               |                                 |  |                                   | In according to NER 8800               |                    |  |  |  |  |
| 💮 💼 RFEM                      |                                 | 2.4 DESIGN BT IVE                            |                                   |  |                    |  |  |  |  |
| RF-STEEL NBR                  |                                 | No. x [m] RC                                 | Formula                           |  |                    |  |  |  |  |
| E-S CA1 - Beams               | Data                            | 1 Cross-section No. 1 - VS 550<br>0.000 CO13 | x88   NBR 5884<br>0.04 ≤ 1 102) ( | Compression without buckling acc. to 5 | .3.2               |  |  |  |  |
| 1.1 General                   |                                 | 6.000 CO13                                   | 0.34 ≤1 110) I<br>0.42 ≤1 112) I  | Bending about y-axis acc. to 5.4.2.2   |                    |  |  |  |  |
|                               | Printout Report Selection - PR1 |  |                                   |  |                    |  |  |  |  |
| 1.5 Design                    | Program                         | Global Selection Input Data Results          |                                   |  |                    |  |  |  |  |
| 🛅 1.7 Effectiv                | RF-STEEL NBR                    | Display                                      |                                   |  |                    |  |  |  |  |
| 1.8 Service                   | RF-STABILITY                    |  |                                   |  | Set                |  |  |  |  |
|                               |                                 | 2.1 Design by Load Case                      |                                   | No. Selection (e.g. 1-5,20)            |                    |  |  |  |  |
| 1.4 Des                       |                                 | 2.2 Design by Cross-Section                  | Cross-sections:                   | All                                    |                    |  |  |  |  |
| E CA2 - Column                |                                 | 2.3 Design by Set of Members                 | Sets:                             | All                                    | - 🖏 🔍 🗆            |  |  |  |  |
|                               |                                 | 2.4 Design by Member                         | Members:                          | All                                    | - 🖏 💽 🗆            |  |  |  |  |
|                               |                                 | 2.5 Design by x-Location                     | Members:                          | All                                    |                    |  |  |  |  |
|                               |                                 | 3.1 Governing Internal Forces                | Select Intermediate Results       |  | ~ %                |  |  |  |  |
|                               |                                 | 3.2 Governing Internal Forces                | Distant Dennet                    |  | - <b></b>          |  |  |  |  |
|                               |                                 | 3.3 Member Slendernesses                     | With intermediate marks           | Form: @ Chard                          | - 1                |  |  |  |  |
|                               |                                 |  | Vitri intermediate results        | Form: Short                            |                    |  |  |  |  |
|                               |                                 | 🔲 4. 1 Parts List by Member                  |                                   |  |                    |  |  |  |  |
|                               |                                 | 🔲 4.2 Parts List by Set of Members           | Chapters to Display               |  | T                  |  |  |  |  |
|                               |                                 | Filter settings                              | Cross-Section Properties          |  |                    |  |  |  |  |
|                               |                                 |  | Cross-Section Type                |  |                    |  |  |  |  |
|                               |                                 | × 1,0  | Design Internal Forces            |  |                    |  |  |  |  |
|                               |                                 |  | Design                            |  |                    |  |  |  |  |
|                               |                                 |  |                                   |  |                    |  |  |  |  |
|                               |                                 |  |                                   |  |                    |  |  |  |  |
|                               |                                 |  |                                   |  |                    |  |  |  |  |
|                               |                                 |  |                                   |  |                    |  |  |  |  |
|                               | Diselari                        |  |                                   | OK Cancel                              |                    |  |  |  |  |
|                               | Cover sheet                     |  |                                   |  |                    |  |  |  |  |
|                               | Contents                        |  |                                   |  |                    |  |  |  |  |
|                               | Info pictures                   |  |                                   |  |                    |  |  |  |  |
|                               | Uppercase titles                |  |                                   |  |                    |  |  |  |  |
|                               |                                 |  |                                   |  |                    |  |  |  |  |
|                               | 2                               |  |                                   |  | OK Cancel          |  |  |  |  |
|                               |                                 | 0.000 CO13                                   | 0.08 ≤1 171)                      | Shear in z-axis acc. to 5.4.3          |                    |  |  |  |  |
|                               | •                               |  | _                                 |  | 4                  |  |  |  |  |
|                               |                                 | RF-STEEL NB                                  | K                                 |  | Pages: 65 Page: 47 |  |  |  |  |

Figure 6.1: Selecting designs and intermediate results in printout report



Click the [Details] button when you want to include all or specific intermediate results in the printout report. They can be documented in a *Short* (compact list) or *Long* (descriptive list) form.



If you work on complex models featuring many design cases, you can split the data into several printout reports, thus allowing for a clearly arranged documentation.

#### 6.2 Graphic Printout

In RFEM or RSTAB, you can add any picture of the work window to the printout report or send it directly to the printer. In this way, the design ratios shown on the RFEM/RSTAB model can be used for the documentation.



The printing of graphics is described in the RFEM or RSTAB manual, Chapter 10.2.

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

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

| <br>- | -        |
|-------|----------|
| Δ.    | <u>b</u> |
| 104   | - 14     |
| 0     | 0        |

or use the toolbar button shown on the left.

| 4⊳ | <u>F</u> ile | <u>E</u> dit | <u>V</u> iew | Insert | <u>C</u> alculate | <u>R</u> esults | Tools | Ta <u>b</u> le | <u>O</u> ptions |
|----|--------------|--------------|--------------|--------|-------------------|-----------------|-------|----------------|-----------------|
|    | 2            | 33           | <b>.</b> 8   |        | 50                | ₿ 🍕             | Q 🔁   |                | <u>•</u> 3      |
| 9  | - 9⁄         | × -          | ¶7+          | Print  | Graphic           | - <u>9^xx</u> 🖭 | 1 🛍 - | -              | 📬 - 🗊           |

Figure 6.2: [Print Graphic] button in RFEM toolbar

The Graphic Printout dialog box appears.

| Graphic Printout   |   | ×                   |  |  |  |  |  |  |  |
|--|---|---------------------|--|--|--|--|--|--|--|
| General Options Color Scale Factors Border and Stretch Factors |   |                     |  |  |  |  |  |  |  |
| Graphic Picture  | Window To Print   | Graphic Scale       |  |  |  |  |  |  |  |
| O Directly to a printer  | Current only  | As screen view      |  |  |  |  |  |  |  |
| To a printout report:  | O More  | Window filling      |  |  |  |  |  |  |  |
| To the Clipboard   | Mass print  | ◎ To scale 1: 100 - |  |  |  |  |  |  |  |
| © To 3D PDF  |   |                     |  |  |  |  |  |  |  |
| -  |   |                     |  |  |  |  |  |  |  |
|  |   |                     |  |  |  |  |  |  |  |
| Graphic Picture Size and Rotation                              | Options   |                     |  |  |  |  |  |  |  |
| Vse full page width  | Show results for selected x-location in result<br>diagram |                     |  |  |  |  |  |  |  |
| Use full page height   | Lock graphic picture (without update)                     |                     |  |  |  |  |  |  |  |
| ● Height: 40 → [% of page]                                     |   | ,                   |  |  |  |  |  |  |  |
|  | Show printout report on [OK]                              |                     |  |  |  |  |  |  |  |
| Rotation: 0 🚔 [*]  |   |                     |  |  |  |  |  |  |  |
|  |   |                     |  |  |  |  |  |  |  |
|  |   |                     |  |  |  |  |  |  |  |
| Header of Graphic Picture                                      |   |                     |  |  |  |  |  |  |  |
| Design Ratio   |   |                     |  |  |  |  |  |  |  |
|  |   | OK Cancel           |  |  |  |  |  |  |  |
|  |   |                     |  |  |  |  |  |  |  |

Figure 6.3: Dialog box Graphic Printout, tab General

The dialog box is described in the RFEM or RSTAB manual, Chapter 10.2. This chapter also describes the other tabs of the dialog box.

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

| Remove from Printout Report |  |  |  |  |  |  |
|-----------------------------|--|--|--|--|--|--|
| Start with New Page         |  |  |  |  |  |  |
| Selection                   |  |  |  |  |  |  |
| Properties >                |  |  |  |  |  |  |
| Properties                  |  |  |  |  |  |  |

If you want to modify an image in the printout report, right-click the relevant entry in the navigator of the printout report. The *Properties* option in the shortcut menu opens the *Graphic Printout* dialog box again. It offers you several options to adjust the image.

## **7 General Functions**

This chapter describes the menu functions and export options for the design results.

#### 7.1 Design Cases

Design cases allow you to arrange members for specific analyses. In this way, you can combine groups of structural components or analyze members with particular design specifications, e.g. modified materials, coefficients, cross-sections.

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



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

#### Create design case

To create a new design case, use the RF-/STEEL NBR menu and select

File ightarrow New Case.

The following dialog box appears.

| New RF-ST | EEL NBR Case   |
|-----------|--|
| No.       | Description Design of steel members according to NBR |
| D         | OK Cancel  |

Figure 7.1: Dialog box New RF-STEEL NBR Case

Enter a *No.* (one that is still available) for the new design case and an optional *Description*. It facilitates the selection in the load case list.

Then click [OK] to open the *1.1 General Data* Window of RF-/STEEL NBR where you can enter the data of the new design case.

#### Rename design case

To change the description of a design case, use the RF-/STEEL NBR menu and select

#### $\mathbf{File} \rightarrow \mathbf{Rename} \ \mathbf{Case}.$

The following dialog box appears.

| Rename RI | F-STEEL NBR Case | ×         |
|-----------|------------------|-----------|
| No.       | Description      |           |
|           | New description  |           |
|           |                  | OK Cancel |

Figure 7.2: Dialog box Rename RF-STEEL NBR Case

You can specify a different Description as well as a different No. for the design case.

#### Copy design case

To copy the input data of the current design case, use the RF-/STEEL NBR menu and select

File ightarrow Copy Case.

The following dialog box appears.

| Copy RF-S | TEEL NBR Case                               |
|-----------|---|
| Copy from | n Case                                      |
| CA1 - De  | esign of steel members according to NBR 🔹 🔻 |
| New Cas   | e   |
| No.:      | Description:                                |
| 3         | Reduced material strength 👻                 |
| D         | OK Cancel                                   |

Figure 7.3: Dialog box Copy RF-STEEL NBR Case

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

#### **Delete design case**

To delete a design case, use the RF-/STEEL NBR menu and select

```
File 
ightarrow Delete Case.
```

The following dialog box appears.

| C | Delete C | ases                                     |
|---|----------|--|
|   | Availab  | le Cases                                 |
|   | No.      | Description                              |
|   | 1        | Design of steel members according to NBR |
|   | 2        | New description                          |
|   | 3        | Reduced material strength                |
|   |          |  |
|   |          |  |
|   |          |  |
|   |          |  |
|   |          |  |
|   | ٢        | OK Cancel                                |

Figure 7.4: Dialog box Delete Case

Select the design case in the list of Available Cases. To delete this case, click [OK].



| Opti-            |   |
|------------------|---|
| mize             |   |
| No               | • |
| No               |   |
| From current row |   |

The design module offers you the option to optimize overstressed or little utilized cross-sections. Open the drop-down list in column D resp. E in Window *1.3 Cross-Sections* (see Figure 2.8, page 9) and select the optimization option *From current row*.

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

| .4 Design | by Membe                                   | r                                      |                   |          |                                |                                |  |  |  |  |
|-----------|--|--|-------------------|----------|--------------------------------|--------------------------------|--|--|--|--|
|           | A  | В                                      | С                 | D        |                                | E                              |  |  |  |  |
| Member    | Location                                   | Load-                                  | Design            |          |                                |                                |  |  |  |  |
| No.       | x [m]                                      | ing                                    | Ratio             |          |                                | Design According to Formula    |  |  |  |  |
| 1         | Cross-section No. 1 - VS 550x88   NBR 5884 |  |                   |          |                                |                                |  |  |  |  |
|           | 0.000                                      | 0.000 CO13 0.04 ≤ 1 102) Compression v |                   |          | without buckling acc. to 5.3.2 |                                |  |  |  |  |
|           | 6.000                                      | CO13                                   | 0.34              | ≤1       | 110) Bending abou              | t y-axis acc. to 5.4.2.2       |  |  |  |  |
|           | 6.00                                       |  |                   |          |                                | y-axis, LTB, semi compact type |  |  |  |  |
|           | 6.00                                       | <u>G</u> o to 0                        | pross-Section     |          | Doubleclick                    | y-axis, LFB, compact type      |  |  |  |  |
|           | 6.00                                       | Info Al                                | out Cross-Secti   | on       |                                | y-axis, LWB, compact type      |  |  |  |  |
|           | 6.00                                       | 0.0                                    |                   |          |                                | z-axis acc. to 5.4.2.2         |  |  |  |  |
|           | 6.00                                       | Optim                                  | ize Cross-Section |          | 2                              | z-axis, LFB, compact type      |  |  |  |  |
|           | 1.71                                       | Cross-                                 | Section Optimiz   | ation    | Parameters                     | acc. to 5.4.3                  |  |  |  |  |
|           | 6 000 1                                    | CO3                                    | 0.00              | $\leq 1$ | 201) Lorsion - Oper            | ned cross-sections             |  |  |  |  |

Figure 7.5: Shortcut menu to Optimize Cross-Section

During the optimization, the module determines the section that fulfills the analysis requirements in the "optimal" way, i.e. comes as close as possible to the maximum allowable design ratio specified in the *Details* dialog box (see Figure 3.1, page 19). The required cross-sectional properties are calculated with the internal forces of RFEM or RSTAB. If a different cross-section proves to be more favorable, it will be used for the design. In this case, the graphic in Window 1.3 shows two cross-sections – the original section from RFEM or RSTAB and the optimized one (see Figure 7.7).

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

| Thin-Wall     | ed Cross-Section:   | s - Symmetric I- | Section : Optin | nize      |      |                  | x |
|---------------|---------------------|------------------|-----------------|-----------|------|------------------|---|
| Cross-Se      | ection Optimization | Parameters       |                 |           |      |                  |   |
| Opti-<br>mize | Current             | Minimum          | Maximum         | Increment |      |                  |   |
| ✓ h:          |                     | 200.0 🜩 🕨        | 500.0 🜩 🕨       | 10.0 🜩 🕨  | [mm] |                  |   |
| <b>b</b> :    | 140.0 🜩 🕨           |                  |                 |           | [mm] |                  |   |
| <b>s</b> :    | 5.0 🜩 🕨             | * >              | * >             |           | [mm] |                  |   |
| 🗖 t:          | 8.0 🜩 🕨             |                  | * +             | A V       | [mm] | , b ,            |   |
| 🗖 a:          | 0.0                 |                  |                 |           | [mm] |                  |   |
|               |                     |                  |                 |           |      |                  |   |
| Кеер          | current side propor | tions            |                 |           |      | IS 250/140/5/8/0 |   |
| <b>D</b>      | 9                   |                  |                 |           |      | OK Cancel        |   |

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

By selecting the check box(es) in the *Optimize* column, you decide which parameter(s) you want to modify. They activate the *Minimum* and *Maximum* columns where you can specify the upper and lower limits of each parameter. The *Increment* column controls the interval in which the value of the parameter varies during the optimization.

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

Cross-sections composed of combined rolled cross-sections cannot be optimized.



Please note that the optimization does <u>not</u> recalculate the internal forces with the modified cross-sections: It is up to you to decide which sections should be transferred to RFEM or RSTAB for a new analysis. As a result of optimized cross-sections, the internal forces may vary considerably because of the changed stiffnesses of the model. Therefore, it is recommended to recalculate the internal forces resulting from the modified cross-sections after the first optimization, and then to optimize the sections once again.

To export the modified cross-section(s) to RFEM or RSTAB, go to Window 1.3 Cross-Sections and select

#### Edit $\rightarrow$ Export All Cross-Sections to RFEM.

You can also use the shortcut menu in Window 1.3 to export one or all optimized cross-sections to RFEM or RSTAB.



Figure 7.7: Shortcut menu in Window 1.3 Cross-Sections

Before the modified cross-sections are transferred to RFEM or RSTAB, a confirmation is required as to whether the RFEM/RSTAB results should be deleted.

|                     | RF-STEEL NBR<br>Information No. 53426   |
|---------------------|---|
| Do you<br>If so, th | want to transfer the changed cross-sections to RFEM?<br>e results of RFEM and RF-STEEL NBR will be deleted. |
|                     | Yes No  |

Figure 7.8: Confirmation when exporting cross-sections

Calculation

By approving the confirmation and starting the [Calculation] in the RF-/STEEL NBR module, the internal forces of RFEM or RSTAB as well as the design ratios will be determined in one 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 last two menu options shown in Figure 7.7. Please note that this shortcut menu is only available in Window 1.3 Cross-sections.



When optimizing a tapered member, the program modifies the cross-sections of the member start and member end. For the intermediate locations, the second moments of area are linearly interpolated. Since those values are considered with the fourth power, the designs may be inaccurate if the depths of the start and end cross-sections differ considerably. It is then recommended to divide the taper into several members, thus modeling the taper layout manually.

### 7.3 Units and Decimal Places

The units and decimal places of RFEM or RSTAB and of all add-on modules are managed in one dialog box. To define the units for RF-/STEEL NBR, select

Settings  $\rightarrow$  Units and Decimal Places.

The dialog box which is familiar from RFEM or RSTAB appears. RF-/STEEL NBR is preset in the *Program / Module* list.

| Inits and Decimal Places                 |                |                  |                    |          | <b>— X</b>  |
|--|----------------|------------------|--------------------|----------|-------------|
| Program / Module                         | RF-STEEL NBR   |                  |                    |          |             |
| RFEM 🔺                                   | Output Data    |                  | Darta Liat         |          |             |
| ···· RF-STEEL Surfaces                   | Output Data    |                  | Parts List         |          |             |
| ···· RF-STEEL Members                    |                | Unit Dec. places |                    | Unit     | Dec. places |
| ···· RF-STEEL EC3                        | Stresses:      | MPa 🔻 2 ≑        | Lengths:           | m 🔻      | 2 🌲         |
| ···· RF-STEEL AISC                       | Desire estina. |                  | Tatal lanathay     |          | 2           |
| RF-STEEL IS                              | Design ratios. |                  | rotai lengtris.    | • •      | 2 💌         |
| - RF-STEEL SIA                           | Dimensionless: | - 🚽 3 🚔          | Surface areas:     | m^2 ▼    | 2 🌩         |
| - RF-STEEL BS                            |                |                  | Volumos            |          | 2           |
| RF-STEEL GB                              |                |                  | voidilles.         | <u> </u> | 4           |
| RF-STEEL CSA                             |                |                  | Weight per length: | kg/m 🔫   | 2 🌩         |
|  |                |                  | Weight:            |          | 2           |
| RF-STEEL NIC-DF                          |                |                  | weight.            | Kg 🔹     | 2           |
| RF-STEEL SP                              |                |                  | Total weight:      | t 🔻      | 3 ≑         |
| RF-STEEL Plastic                         |                |                  |                    |          |             |
| DE STEEL SANS                            |                |                  |                    |          |             |
| DE STEEL NDD                             |                |                  |                    |          |             |
| DE ALLIMINIU IM                          |                |                  |                    |          |             |
|  |                |                  |                    |          |             |
|  |                |                  |                    |          |             |
|  |                |                  |                    |          |             |
| DE-EL-DI                                 |                |                  |                    |          |             |
| BE-C-TO-T                                |                |                  |                    |          |             |
| PLATE-BUCKLING                           |                |                  |                    |          |             |
|  |                |                  |                    |          |             |
| BE-CONCRETE Membr                        |                |                  |                    |          |             |
| BE-CONCRETE Colum                        |                |                  |                    |          |             |
| RF-PUNCH                                 |                |                  |                    |          |             |
| RF-PUNCH Pro                             |                |                  |                    |          |             |
|  |                |                  |                    |          |             |
| ) () () () () () () () () () () () () () | 1              |                  |                    | OK       | Canaci      |
|  | J              |                  |                    | UK       | Cancel      |

Figure 7.9: Dialog box Units and Decimal Places

🖹 (ک

You can save the settings as a user-defined profile to reuse them in other models. Those functions are described in the RFEM or RSTAB manual, Chapter 11.1.3.

#### 7.4 Data Transfer

#### 7.4.1 Exporting Materials to RFEM/RSTAB

If you have modified the materials in RF-/STEEL NBR for the design, you can export those materials to RFEM or RSTAB in a similar way as you export cross-sections: Open the *1.2 Materials* Window and then select

```
Edit \rightarrow Export All Materials to RFEM/RSTAB.
```

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



Figure 7.10: Shortcut menu of Window 1.2 Materials

#### Calculation

Before the modified materials are transferred to RFEM or RSTAB, a confirmation is required as to whether the results of the main program should be deleted. When you approve this confirmation and then start the [Calculation] in RF-/STEEL NBR, the new internal forces and design ratios will be determined in one single calculation run.

If the modified materials have not been exported to RFEM or RSTAB yet, you can transfer the original materials to the design module via the last two menu options shown in Figure 7.10. Please note that this shortcut menu is only available in Window *1.2 Materials*.

#### 7.4.2 Exporting Effective Lengths to RFEM/RSTAB

If you have adjusted the effective lengths in RF-/STEEL NBR for the design, you can export the modified values to RFEM or RSTAB in a similar way as you export cross-sections: Go to Window *1.5 Effective Lengths - Members* and then select

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

You can also use the corresponding option on the shortcut menu of Window 1.5.

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

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

Before the modified effective lengths are transferred to RFEM or RSTAB, a confirmation has to be approved as to whether the results of the main program should be deleted.

#### 7.4.3 Exporting Results

The RF-/STEEL NBR results can also be used by other programs.

#### Clipboard

To copy cells selected in the result windows 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-/STEEL NBR to the printout report (see Chapter 6.1, page 37). To export the tables and graphics, then select the printout report menu

```
\textbf{File} \rightarrow \textbf{Export to RTF}.
```

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

#### Excel

RF-/STEEL NBR provides a function for the direct data export to MS Excel or the CSV file format. To open the corresponding dialog box, select

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

| Table Parameters       App         Image: Second   | cation<br>icrosoft Excel<br>SV file format |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|
| Viith table header       Image: Comparison of the comparison o                                       | icrosoft Excel<br>SV file format           |  |  |  |  |  |  |  |
| Only marked rows  Transfer Parameters  Export table to active workbook Export table to active worksheet  Rewrite existing worksheet  Selected Tables  All tables  Input tables  Input tables   | SV file format                             |  |  |  |  |  |  |  |
| Transfer Parameters         Export table to active workbook         Export table to active worksheet         Rewrite existing worksheet         Rewrite existing worksheet         All tables         Input tables   |  |  |  |  |  |  |  |  |
| Transfer Parameters         Export table to active workbook         Export table to active worksheet         Rewrite existing worksheet         Selected Tables         All tables         Input tables  |  |  |  |  |  |  |  |  |
| Export table to active workbook  Export table to active worksheet  Rewrite existing worksheet  Selected Tables  All tables  Input tables  In |  |  |  |  |  |  |  |  |
| Export table to active worksheet     Ø Rewrite existing worksheet  Selected Tables      Active table     All tables     Jinput tables  |  |  |  |  |  |  |  |  |
|  | Export table to active worksheet           |  |  |  |  |  |  |  |
| Selected Tables  Active table  All tables  Input tables  |  |  |  |  |  |  |  |  |
| Active table     All tables     Input tables   |  |  |  |  |  |  |  |  |
| All tables Input tables  | xport hidden columns                       |  |  |  |  |  |  |  |
| ✓ Input tables   | xport tables with details                  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| Result tables  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Figure 7.12: Dialog box Export of Tables

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

|     | 🚽 🤊 <del>-</del> (e | ×   <del>-</del>                                   |              | Tak         | ole1 - | Micros                                       | oft Excel                          |          |             |               |          |  | 2     | 2     |
|-----|---------------------|--|--------------|-------------|--------|--|------------------------------------|----------|-------------|---------------|----------|--|-------|-------|
| F   | ile Hor             | ne Insert  | Page Layou   | ut Formula  | as     | Data   | Review                             | View     | Add-l       | ins           | ∞ 🧉      |  | ē     | 23    |
|     | B3                  | B3 - fx Cross-section No. 1 - VS 550x88   NBR 5884 |              |             |        |  |                                    |          |             |               |          |  |       | ٧     |
|     | А                   | В  | С            | D           | Е      |  |                                    |          | F           |               |          |  |       | F     |
| 1   | Member              | Location   | Load-        | Design      |        |  |                                    |          |             |               |          |  |       |       |
| 2   | No.                 | x [m]  | ing          | Ratio       |        |  | D                                  | esign A  | According   | to Formul     | a        |  |       |       |
| 3   | 1                   | Cross-sectio                                       | n No. 1 - VS | 550x88 NB   | SR 58  | 84   |                                    |          |             |               |          |  |       | ]     |
| 4   |                     | 0,000  | CO13         | 0,04        | ≤1     | 102) C                                       | ompressio                          | on witho | out buckli  | ing acc. to ! | 5.3.2    |  |       |       |
| 5   |                     | 6,000  | CO13         | 0,34        | ≤1     | 110) E                                       | ending abo                         | out y-ax | kis acc. to | 5.4.2.2       |          |  |       |       |
| 6   |                     | 6,000  | CO13         | 0,43        | ≤1     | 112) B                                       | ending abo                         | out y-ax | kis, LTB, s | emi compa     | act type |  |       |       |
| 7   |                     | 6,000  | CO13         | 0,34        | ≤1     | 114) B                                       | ending abo                         | out y-ax | kis, LFB, o | ompact typ    | be       |  |       |       |
| 8   |                     | 6,000  | CO13         | 0,34        | ≤1     | 117) E                                       | ending abo                         | out y-ax | kis, LWB,   | compact ty    | /pe      |  |       |       |
| 9   |                     | 6,000  | CO13         | 0,00        | ≤1     | 130) E                                       | ending abo                         |          |             |               |          |  |       |       |
| 10  |                     | 6,000  | CO13         | 0,00        | ≤1     | 134) Bending about z-axis, LFB, compact type |                                    |          |             |               |          |  |       |       |
| 11  |                     | 1,714  | CO13         | 0,14        | ≤1     | 171) S                                       | 171) Shear in z-axis acc. to 5.4.3 |          |             |               |          |  |       |       |
| 12  |                     | 6,000  | CO9          | 0,00        | ≤1     | 201) T                                       | orsion - Op                        | oened c  | ross-sect   | ions          |          |  |       |       |
| 13  |                     | 0,000  | CO13         | 0,09        | ≤1     | 302) F                                       | lexural buo                        | ckling a | bout z-ax   | is acc. to 5  | .3.2     |  |       |       |
| 14  |                     | 0,000  | CO13         | 0,07        | ≤1     | 321) T                                       | orsional bu                        | uckling  | acc. to 5.3 | 3.2           |          |  |       |       |
| 15  |                     | 6,000  | CO13         | 0,46        | ≤1     | 341) 0                                       | ombined f                          | orces a  | cc. to 5.5. | 1             |          |  |       |       |
| 16  |                     |  |              |             |        |  |                                    |          |             |               |          |  |       |       |
| 17  | 2                   | Cross-sectio                                       | n No. 1 - VS | 550x88   NB | 8R 58  | 84   |                                    |          |             |               |          |  |       |       |
| 18  |                     | 0,000  | CO9          | 0,04        | ≤1     | 102) 0                                       | ompressio                          | n with   | out buckli  | ing acc. to ! | 5.3.2    |  |       |       |
| 19  |                     | 6,000  | CO9          | 0,36        | ≤1     | 110) E                                       | ending abo                         | out y-ax | kis acc. to | 5.4.2.2       |          |  |       |       |
| 20  |                     | 6,000  | CO9          | 0,45        | ≤1     | 112) E                                       | ending abo                         | out y-ax | kis, LTB, s | emi compa     | act type |  |       |       |
| 21  |                     | 6,000  | CO9          | 0,36        | ≤1     | 114) E                                       | ending abo                         | out y-ax | kis, LFB, o | ompact typ    | be       |  |       |       |
| 22  |                     | 6,000  | CO9          | 0,36        | ≤1     | 117) E                                       | ending abo                         | out y-ax | kis, LWB,   | compact ty    | pe       |  |       | -     |
| H 4 | ▶ ₩ 2.4             | Design by M  | ember 🧷 🔁    | /           |        |  | 14                                 |          |             |               |          |  | - ▶ [ | ī     |
| Rea | dy                  |  |              |             |        |  |                                    |          |             | 00 % 🗩        |          |  | ÷     | ) .:: |

Figure 7.13: Results in Excel





[1] *NBR 8800:2008: Design of steel and composite structures for buildings*. Associação Brasileira de Normas Técnicas, 2008.

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## 

|--|

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B

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