

Version November 2009

Add-on Module

RSCOMBI

Generation of Load Groups and Load Combinations

Program Description

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Contents

	Contents	Page		Contents F	'age
1	Introduction	4	222	Load Combination According to EN	
1. 1 1	Add on Module RECOMPL	4	5.5.5	1990	26
1.1		4	3.3.3.1	General Data	26
1.2	RSCOMBITEAM	5	3.3.3.2	Actions	27
1.3	Note to Manual	5	3.3.3.3	Action Categories	27
1.4	Installation	5	3.3.3.4	Imperfections	28
2.	Theoretical Principles	6	3.3.3.5	Coefficients	28
2.1	General	6	3.4	Results Masks	30
2.2	Standards	6	J. 1	Conception of Load Crouns	20
2.2.1	DIN 1055-100	6	5.4.1		20
2.2.2	DIN 18800	8	3.4.1.1	Load Groups by Actions	30
2.2.3	EN 1990	9	3.4.1.2	Load Groups	32
2.3	Reducing Load Groups	10	3.4.2	Generation of Load Combinations	34
3.	Using RSCOMBI	11	3.4.2.1	Load Combinations by Actions	34
3.1	Starting RSCOMBI	11	3.4.2.2	Load Combinations	35
3.2	Masks	11	3.5	Main Menus	36
33	Innut Masks	13	3.5.1	File	36
2.21	Load Combinations According to DIN	15	3.5.2	Settings	37
5.5.1	1055-100	13	3.5.3	Help	37
3.3.1.1	General Data	13	4.	Printing	38
3.3.1.2	Actions	14	5.	Examples	39
3.3.1.3	Action Categories	16	5.1	Single-Span Girder (DIN 1055-100)	39
3.3.1.4	Imperfections	17	5.2	Girder with Cantilever (DIN 1055-100)	44
3.3.1.5	Coefficients	19	5.3	Skeleton Structure (DIN 1055-100)	49
3.3.2	Load Combination According to DIN 18800	21	5.4	Skeleton Structure with Imperfections (DIN 1055-100)	54
3.3.2.1	General Data	21	5.5	Frame (DIN 18800)	58
3.3.2.2	Actions	22	5.6	Girder Grillage (EN 1990)	62
3.3.2.3	Action Categories	23	5.7	Column (ASCE 7)	66
3.3.2.4	Imperfections	23	5.8	Framework Structure (CAN/CSA)	70
3.3.2.5	Coefficients	24	A:	Literature	73



. Introduction

1.1 Add-on Module RSCOMBI

Dear users of the add-on module RSCOMBI,

a new generation of standards requires checking various combinations of load cases. If you are working with more extensive spatial structures, the manual creation of all combinations can be very time-consuming and error-prone. With the add-on module RSCOMBI from the RSTAB program family, you can automate this creation process. During the development of the RSCOMBI module, we concentrated mainly on quality and user-friendliness.

RSCOMBI creates load groups and load combinations according to European standards and other country codes. The following standards are supported:

- EN 1990 [1], including relevant National Annexes (Eurocode)
- EN 1995 (Eurocode 5) [2]
- ASCE 7 (United States) [3]
- ACI 318-08 (United States) [4]
- CAN / CSA (Canada) [5]
- IS 800 (India) [6]
- DIN 1055-100 (Germany) [7]
- DIN 18800 (Germany) [8]
- DIN 1052 (Germany) [9]

RSCOMBI takes over load cases created in the main program RSTAB, assigns them corresponding actions in compliance with standards, and creates all possible load groups or load combinations according to the selected standard. Consequently, these groups and combinations are again transferred to RSTAB, where you can calculate them in the familiar way.

Often it is not necessary to transfer all generated load groups or combinations to RSTAB. You can reduce their number before the export automatically or manually. Thus, the calculation time is shortened.

RSCOMBI also offers the following functions:

- generation of load groups from RSTAB load cases for the non-linear analysis (including imperfections)
- generation of load combinations from RSTAB load cases for the linear analysis
- load cases can be defined as "alternative" (that is mutually exclusive)
- possibility to define dependence of load cases including imperfections on normal load cases
- besides default coefficients according to standards, you can define your coefficients and save them
- results are displayed in two ways:
 - results by actions correspond to a definition in relevant standards and make the check easier
 - results by load cases correspond to load groups and load combinations in the Data navigator of RSTAB
- a synoptic summary of results, including applied coefficients and information about actions and load cases
- reduction of a number of generated load groups by using the default analysis of extreme values for linear analysis results

We welcome any improvement suggestions by our users coming out from practice and wish you much success and delight when working with our module RSCOMBI.

Your DLUBAL ENGINEERING SOFTWARE team.



1.2 RSCOMBI Team

The following people participated in the development of the RSCOMBI module:

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1.3 Note to Manual

This manual is divided into several chapters, where the module is described from various important viewpoints. We assume that you know theoretical principles of structural loading according to relevant standards and all the appropriate problems. Nevertheless, this manual contains some theoretical information that facilitates better understanding of our module.

Here you can find a brief overview of chapters and annexes of this manual:

• Chapter 1: Introduction

We briefly describe a functional range and usage options of the RSCOMBI module.

• Chapter 2: Theoretical Principles

We shortly explain the theoretical principles of the RSCOMBI module. We mention rules and excerpts from the standards EN 1990, DIN 1055-100, and DIN 18800, because the module generates load groups and load combinations according to these norms. In this chapter, we also deal with a possibility to reduce generated results by using the default analysis of extreme values for linear calculation results.

• Chapter 3: Using RSCOMBI Module

We describe work with RSCOMBI in detail. We explain selection of design cases, takeover of load cases from the main program RSTAB, allocation of load cases to actions and classification of actions to given categories. In addition, we describe how to define and save your own partial coefficients and combination coefficients. In this chapter, we also introduce view options for results and clarify export of generated load groups and load combinations to RSTAB.

- Chapter 4: Examples
- We give some examples in this chapter.

1.4 Installation

RSCOMBI is not a stand-alone program; it represents the add-on module integrated to the main program RSTAB. Therefore you have to start the installation of the RSTAB program to install RSCOMBI. During the installation, you must use a new authorization file that you got when purchasing the module. The installation process is described in the RSTAB manual.



2. Theoretical Principles

2.1 General

If you proceed according to new standards, often it can be very laborious to consider all possible load cases and to select the decisive ones.

The task for RSCOMBI is to compose automatically all potential load groups or load combinations according to the relevant standard.

The RSCOMBI module is integrated to the RSTAB program and it uses load cases that have been defined in the main program. RSCOMBI distinguishes between two categories during the transfer of load cases: The first category consists of normal load cases, the second one of load cases with imperfections. For working with load cases in RSCOMBI, it is not important whether the load cases from the first category are described in RSTAB as 'permanent', 'variable' or 'accidental', as 'prestress' or 'favorable'.

The standards set the rules that describe the combinations for independent actions in corresponding design situations. According to [9], an independent action occurs when characteristic values of a force or deformation have a unique origin (for example dead load, live load, snow or ice load, wind load or temperature actions). The actions are independent when they arise from different sources and a mutual relation can be neglected regarding structural safety.

In the RSCOMBI module, you can define the actions and then assign RSTAB load cases to those actions. Finally, the actions are classified into action categories according to the corresponding standards.

2.2 Standards

2.2.1 DIN 1055-100

The standard DIN 1055-100 [7] requires the ultimate limit state design and the serviceability limit state design.

The ultimate limit states include the

- loss of a static equilibrium of a structure or its part,
- failure of a structure or its part, for example by breakage, excessive deformation, transition to a kinematic chain, stability loss or shear,
- failure of a structure or its part due to material fatigue or other time-dependent actions.

The **ultimate limit states** should be analyzed in four design situations. Combination rules are set for these design situations:

- Permanent situations that correspond to regular conditions of structure operation
- Temporary situations that are related to time limited structural states, for example during construction or reparation

The load combination for permanent and temporary situations (the basic combination) is:

$$\sum_{j\geq 1} \gamma_{G,j} \cdot G_{k,j} + \gamma_{P} \cdot P_{k} + \gamma_{Q,1} \cdot Q_{k,1} + \sum_{i>1} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{k,i}$$

Formula 2.1



Accidental situations that are related to accidental loads of a structure or its surroundings, for example fire, explosion or shock

The load combination for accidental design situations is:

$$\sum_{j\geq 1} \gamma_{\text{GA},j} \cdot \textbf{G}_{k,j} + \gamma_{\text{PA}} \cdot \textbf{P}_k + \textbf{A}_d + \psi_{1,1} \cdot \textbf{Q}_{k,1} + \sum_{i>1} \ \psi_{2,i} \cdot \textbf{Q}_{k,i}$$

Formula 2.2

• Seismic design situations

The load combination for seismic design situations is:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_k + \boldsymbol{\gamma}_1 \cdot \boldsymbol{A}_{\text{Ed}} + \sum_{i\geq 1} \boldsymbol{\psi}_{2,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.3

Symbols in formulas:

- + "in combination with"
- Σ "combination of independent loads from"
- G_{k,j} independent permanent load that takes one or several characteristic constant values of force or deformation
- P_k independent load from prestress (characteristic prestress value)
- $Q_{k,1}$ main independent variable load that takes one or several characteristic variable values of force or deformation
- Q_{k,i} secondary independent variable load that takes one or several characteristic variable values of force or deformation
- A_d design value of accidental load
- A_{Ed} design value of seismic load
- $\gamma_{G,j}$ partial coefficient of permanent independent load $G_{k,j}$
- $\gamma_{GA,j}$ like $\gamma_{G,j}$, but for accidental design situations
- γ_P partial coefficient of independent load from prestress
- γ_{PA} like γ_{P} , but for accidental design situations
- $\gamma_{Q,1}$ partial coefficient of main independent variable load $Q_{k,1}$
- $\gamma_{Q,i}$ partial coefficient of secondary independent variable load $Q_{k,i}$
- γ₁ weight coefficient for seismic loads
- $\Psi \qquad \mbox{corresponding combination coefficient to determine representative values of variable loads}$

The **serviceability limit states** should be analyzed in three design situations. The following load combinations are set for these design situations:

• Characteristic situations with irreversible effects on a structure

The load combination for characteristic situations is:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_k + \boldsymbol{Q}_{k,1} + \sum_{i>1} \boldsymbol{\psi}_{0,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.4

• Frequent situations with reversible effects on a structure The load combination for frequent situations is:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_{\!k} + \boldsymbol{\psi}_{1\!,1} \cdot \boldsymbol{Q}_{k,1} + \sum_{i>1} \boldsymbol{\psi}_{2,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.5



Quasi-permanent situations with long-term effects on a structure

The load combination for quasi-permanent situations is:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_k + \sum_{i\geq 1} \boldsymbol{\psi}_{2,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.6

The symbols are described on the previous page.

2.2.2 **DIN 18800**

The standard DIN 18800 [8] requires the ultimate limit state design and the serviceability limit state design.

The ultimate limit states are considered in two design situations. It is necessary to create basic combinations and accidental combinations.

Basic combinations:

Permanent loads G and all unfavorable variable loads Q

The load combination is:

$$\sum_{i\geq 1} \gamma_{\mathsf{G},j} \cdot \mathsf{G}_{\mathsf{k},j} + \sum_{i>1} \gamma_{\mathsf{Q},i} \cdot \psi \cdot \mathsf{Q}_{\mathsf{k},i}$$

Formula 2.7

Permanent loads G and always one unfavorable variable load Q_i The load combination is:

$$\sum_{j\geq 1} \gamma_{G,j} \cdot \boldsymbol{G}_{k,j} + \gamma_{Q,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.8

Accidental combinations:

Permanent loads G, all unfavorable variable loads Q_i and one accidental load A The load combination is:

$$\sum_{j\geq 1} \gamma_{\text{GA},j} \cdot \textbf{G}_{k,j} + \sum_{i>1} \gamma_{\text{QA},i} \cdot \psi \cdot \textbf{Q}_{k,i} + \gamma_{\text{A},i} \cdot \textbf{A}_{k,i}$$

Formula 2.9

Symbols in formulas:

.

- "in combination with" +
- Σ "combination of independent loads from"
- independent permanent load that takes one or several characteristic constant val-G_{k,i} ues of force or deformation
- independent variable load that takes one or several characteristic variable values of Q_{k,i} force or deformation
- $A_{k,i}$ independent accidental load that takes one or several characteristic variable values of force or deformation
- partial coefficient of permanent independent load Gki $\gamma_{G,j}$
- partial coefficient of independent variable load Q_{k.1} γ_{Q,j}
- partial coefficient of independent accidental load Aki ŶΑ,i
- like $\gamma_{G,i}$, but for accidental design situations γ_{GA,j}
- Ψ relevant combination coefficient to determine representative values of variable loads



2.2.3 EN 1990

The standard EN 1990 [1] requires the ultimate limit state design and the serviceability limit state design.

The ultimate limit states include:

- EQU: Loss of a static equilibrium of a structure or its part, where
 - even smaller variations in a load value or spatial distribution of load of the same origin are important
 - strength of structural materials or of foundation soil is usually not decisive.
- STR: An inner failure or excessive deformation of a structure or supporting elements including foundation footings, piles, underground walls and so on, where the strength of structural materials is decisive.
- **GEO**: A failure or excessive deformation of foundation soil, where the strength of soil or rock subsoil are important for the ultimate limit state.
- FAT: A fatigue failure of a structure or supporting elements.

The **ultimate limit states** should be analyzed in four design situations. Combination rules are stated for these design situations:

- Permanent situations that correspond to conditions of regular structure operation
- Temporary situations that are related to time-limited states of a structure, for example during construction or reparation

The load combination for permanent and temporary situations (the basic combination) is either according to the formula

$$\sum_{j\geq 1} \gamma_{G,j} \cdot G_{k,j} + \gamma_P \cdot P_k + \gamma_{Q,1} \cdot Q_{k,1} + \sum_{i>1} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{k,i}$$

Formula 2.10

or, alternatively for STR and GEO limit state, as a less favorable combination from formulas 2.11 and 2.12:

$$\sum_{j\geq 1} \gamma_{\mathsf{G},j} \cdot \mathsf{G}_{\mathsf{k},j} + \gamma_{\mathsf{P}} \cdot \mathsf{P}_{\mathsf{k}} + \gamma_{\mathsf{Q},1} \cdot \psi_{0,1} \cdot \mathsf{Q}_{\mathsf{k},1} + \sum_{i>1} \gamma_{\mathsf{Q},i} \cdot \psi_{0,i} \cdot \mathsf{Q}_{\mathsf{k},i}$$

Formula 2.11

$$\sum_{j\geq 1} \xi_j \cdot \gamma_{G,j} \cdot G_{k,j} + \gamma_P \cdot P_k + \gamma_{Q,1} \cdot Q_{k,1} + \sum_{i>1} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{k,i}$$

Formula 2.12

• Accidental situations that are related to accidental loads of a structure or its surroundings, for example fire, explosion or shock

The load combination for accidental design situations:

$$\sum_{j \ge 1} G_{k,j} + P + A_d + (\psi_{1,1} oder \psi_{2,1}) \cdot Q_{k,1} + \sum_{i > 1} \psi_{2,i} \cdot Q_{k,i}$$

Formula 2.13

Seismic design situations

The load combination for seismic design situations is:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_k + \boldsymbol{A}_{Ed} + \sum_{i\geq 1} \boldsymbol{\psi}_{2,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.14



Formula 2.12 contains the reduction coefficient for unfavorable permanent loads ξ_i . The other symbols have their common meanings (see page 7).

The **serviceability limit states** should be analyzed in three design situations that are the same like in the standard DIN 1055-100. For these design situations, the following load combinations are set:

Characteristic situations with irreversible effects on a structure

The load combination for characteristic situations:

$$\sum_{k \geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_{k} + \boldsymbol{Q}_{k,1} + \sum_{i > 1} \boldsymbol{\psi}_{0,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.15

Frequent situations with reversible effects on a structure

The load combination for frequent situations:

$$\sum_{j\geq 1} \boldsymbol{G}_{k,j} + \boldsymbol{P}_{k} + \boldsymbol{\psi}_{1,1} \cdot \boldsymbol{Q}_{k,1} + \sum_{i>1} \boldsymbol{\psi}_{2,i} \cdot \boldsymbol{Q}_{k,i}$$

Formula 2.16

 Quasi-permanent situations with long-term effects on a structure The load combination for quasi-permanent situations:

$$\sum_{i\geq 1} G_{k,j} + P_k + \sum_{i\geq 1} \psi_{2,i} \cdot Q_{k,i}$$

Formula 2.17

In the European standard EN 1990, the combination rules have been fixed. However, each state can alter the values of used coefficients. In RSCOMBI where you select the standard EN 1990 CEN, the coefficients set by European commission CEN will be applied.

2.3 Reducing Load Groups

The complexity of the structure and the number of loads and load cases influence the number of generated load groups or load combinations considerably. If you apply the standards DIN 1055-100 or EN 1990 in particular, you get often a very high number of load groups.

The RSCOMBI module offers the option to reduce the number of possible load groups effectively and to generate only decisive groups of load cases.

For this, one or more load combinations are generated automatically. Those are then calculated in the main program RSTAB. The number of load combinations depends on the selected design situation.

For every x-location, it is checked if the load case induces any maximum or minimum value. Only those load cases are used in RSCOMBI to form load groups or load combinations.

The reduction by using automatically generated combinations guarantees that the results in RSCOMBI will contain all decisive groups of load cases. Instead of automatically generated combinations, you can also create your own load combinations in RSTAB for this reduction and use them in RSCOMBI. A reduction of this kind does not differ functionally from an automated reduction by generated load combinations.

The reducing option is only possible for creating load groups, not for load combinations.



3. Using RSCOMBI

3.1 Starting RSCOMBI

The RSCOMBI module can be started by using the command from the main menu Additional Modules \rightarrow Others \rightarrow RSCOMBI 2006 or from the *Data* navigator by clicking the item Additional Modules \rightarrow RSCOMBI 2006.



Figure 3.1: Starting the RSCOMBI module from the Data navigator and from the main menu Additional Modules

3.2 Masks

Masks are used to enter input data and to define cases in RSCOMBI and also later to display numeric results on a screen.

After RSCOMBI has been started, you can see the navigator on the left side that contains all currently available masks. Above the navigator, there is the list of previously defined cases.

You can open the masks either by clicking the relevant navigator item in RSCOMBI or you can browse them by using the keys [F2] and [F3] or the buttons [\Leftarrow] and [\Rightarrow].

By using the [Calculation] button, you run the generation procedure after having defined of all input data.

By the [OK] button, you save both input data and results before you exit the module, while by the button [Cancel] you exit the module without data saving.

By the [?] button or the functional key [F1], you start the Help function.

By the [Coefficients...], you open the dialog box, where you can define partial safety coefficients or combination coefficients.

By the [Check] button, you can run the plausibility check.

The buttons [Calculation], [Coefficients...], and [Check] are available only in input masks.



If any results mask is opened after a successful calculation, the [Export...] button is available in that mask. By using this button, you can export the generated load groups or load combinations to the main program RSTAB.

RSCOMBI 2006 - [Example_1]															x
<u>File</u> <u>Settings</u> <u>H</u> elp															
CA1 👻	2.2 Load	Groups													
Input Data General Data Actions Action Categories Results Load Groups by Actions Load Groups - Reduced	LG LG1 LG2 LG3 LG4 LG5	A Apply X X X	B Design Situation UB UB UB UB	C LC1 1.35 1.35 1.35 1.35 1.35	D LC2 1.50 1.50 1.05	E LC3 - 1.05 1.50 1.50	F LC4 ·	G LC5 - - -							
	Load C LC LC1 LC2 LC3	ases in G L Dead Live lo	enerated Loa oad Case De oad ad load	ad Group escription	n LG3	Actio AC1 AC2 AC3	n C	ategory 1. 3.C 3.F	Ultimate Prevailing	e limit state γ 1.35 1.50 1.50	- Basic Co	7 · Ψ 1.35 1.50 1.05			
	Domina	nt					Export						ЭК	Cancel	

Figure 3.2: Basic layout of results masks



3.3 Input Masks

In the input masks, all data and parameters necessary for the generation are entered.

3.3.1 Load Combinations According to DIN 1055-1003.3.1.1 General Data

After having started RSCOMBI, the mask 1.1 General Data appears in the module window.

A1	 1.1 General Data 			
nput Data	Generate for RSTAB of	F	Supplementary Examination	
- General Data - Actions	Load Groups		<u>Reduce Possible Load Groups by</u>	
Action Categories	Coad Combinations	∙ ⊻ariable Superposition	Examining RSTAB Results	
	Content Combinations	Permanent Superposition	From Automatically Defined	a 🔤 🙂
	Combination Rules acc	ording to Code	Combinations	
	DIN 1055-100	-	Prom Load Combinations:	
	1033-100	·		
	Generating for Design	Situations		
	Static Equilibrium:	Basic Combination EB		
		Accidental EA		
		Seismic Es		S
	Ultimate Limit State:	Basic Lombination UB Accidental LIA		
		Seismic US		
	Serviceability Limit	Characteristic SC		
	State:	Frequent SF		Load Groups or
		Quasi-permanent SQ		Load Combinations
	🔄 <u>G</u> enerate Suppleme	ntary Combinations		
	from Favorable Perr	nanent Actions		
	Comment		Numbering	
			Start Number of Generated	
			- Load Group: 1 👔	

Figure 3.3: Mask 1.1 General Data

In the section *Generate for RSTAB*, you can decide if *Load groups* or *Load combinations* from variable or permanent load cases are to be generated. The difference between load groups and load combinations is described in detail in the RSTAB manual. If you select the option *Load combinations – permanent superposition*, all load cases with the attribute "permanent" are considered. In this case, a considerably greater number of load combinations will be generated than with the variable superposition.

In the section *Combination Rules According to Code*, you choose the standard and, thus, also the rules how to generate load groups or load combinations. The following standards are available: EN 1990, EN 1995, ASCE 7, ACI 318-08, CAN/CSA, IS 800, DIN 1055-100, DIN 18800, and also DIN 1052. The following description in this chapter is related to the standard DIN 1055-100.

The standard DIN 1055-100 requires the ultimate limit state design and the serviceability limit state design. For the ultimate limit state, it is distinguished whether loss of a static equilibrium or failure by breakage are considered. With the module, you can generate load combinations for the following *Design Situations*:

- Static equilibrium (ultimate limit state, partial coefficients for the analysis of static loss of equilibrium)
 - Basic combination see formula 2.1
 - Accidental see formula 2.2
 - Seismic see formula 2.3



- Load capacity (ultimate limit state, partial coefficients for the analysis of a structure failure by breakage)
 - Basic combination see formula 2.1
 - Accidental see formula 2.2
 - Seismic see formula 2.3
- Analysis of serviceability (serviceability limit state)
 - Characteristic see formula 2.4
 - Frequent see formula 2.5
 - Quasi-permanent see formula 2.6

If you tick the option Generate supplementary combinations from favorable permanent actions, the favorable and unfavorable actions will be considered separately. They enter the analysis with different partial coefficients. However, this is related only to the design situation 'Ultimate limit state'. In case of the design situation 'Static equilibrium', these actions are always distinguished, while the design situation 'Serviceability' does not recognize favorable and unfavorable actions.

In the section *Supplementary Examination*, you can select *Reduce possible load groups by examining RSTAB results...* Then you have to decide if automatically generated combinations will be calculated in RSTAB or other combinations will be selected for calculation. These combinations must be predefined in RSTAB, though. The principle of this reduction is described in chapter 2.3.

In the section *Numbering*, you can enter the first number of the generated load group or load combination which is created in RSTAB after the export. If you click the button next to the input box, the first free number is set for the generated load group or combination.

3.3.1.2 Actions

In mask 1.2 Actions, actions are created and load cases that have been defined in RSTAB are assigned to them. This mask is divided into the sections Actions, Existing Load Cases, and Load Cases in Action AC#.





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3 Using RSCOMBI

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In the section *Actions*, the list of all already created actions is displayed. The actions can be specified by *Action description* or by *Action comment*.

A new action is created by using the button in the section *Actions*, in the bottom left corner.

By the second button, you create a number of new actions that is equal to the number of load cases. Consequently, exactly one load case is allocated to every action.

By the next button, you delete a selected action.

With the last button, you can delete all actions created so far.

In the section *Existing Load Cases*, you can see the list of all load cases taken over from RSTAB which have not yet been allocated to any action. The list does not contain the RSTAB load cases defined as 'Imperfections'.

If you select the button in the bottom left corner in the section *Existing Load Cases*, all load cases that have not been allocated yet are displayed in the list. If this button is not selected, all load cases are displayed.

The second button in this section is used to edit the General Data of a selected load case.

The list of load cases that are allocated to a currently selected action is shown in the section *Load Cases in Action AC#*. You can assign either only one selected load case or all existing load cases together. Each load case can be allocated to one action only. With the button in the bottom right corner of the section *Load Cases in Action AC#*, you can edit the General Data of the selected load case.

Two or even more load cases can be defined as mutually exclusive ones. It means that these cases never occur in a load group or load combination simultaneously. This can be achieved by entering the same description for these load cases in the *Alternative* column.



Figure 3.5: Alternative relation between LC6 and LC7



žΞ

2



3.3.1.3 Action Categories

In the mask 1.3 Action Categories, the actions are allocated to the relevant categories.

-	 I.3 Actions in Action Categories according 	ng to DIN 1055-100	
put Data General Data	Action Categories	Actions	
Actions Action Categories	1. Permanent Actions	G _{k.j} : AC1	3
2	<u>2</u> . Prestress	Pk:	N
	3.A Imposed Loads - Category A - Domes	tic, Residential Q _{k,i} :	👔 🔲 Live Loads and
	3. <u>B</u> · Category B · Offices	Q _{k,i} :	Subsumed as o
	3.C · Category C · Congre	gation Areas Q _{k,i} : AC2	Independent Ac
	3.D · Category D · Shoppi	ng Q _{k,i} :	3
	3.E · Category E · Storage	e Q _{k,i} :	N
	3. <u>F</u> Traffic Loads · Category F - Vehicle	e Weight ≤ 30 kN Q _{k,i} : AC3	
	3. <u>G</u> · Category G - Vehicle	e Weight ≤160 kN. Q _{k,i} :	3
	3. <u>H</u> · Category H · Roofs	Q _{k,i} :	3
	4.A Snow and Ice Loads - Sites at Attitud	le H ≤ 1 000 m Q _{k,i} :	🛛 🗖 Do Not Combin
	4.B - <u>S</u> ites at Altitud	e H > 1 000 m Q _{k,i} :	Selected Load Cases with Othe
	<u>5</u> . Wind Loads	Qkj:	Load Cases
	6. Temperature (non Fire)	Qk,j:	
	Z. Foundation Subsidence	Q _{k,i} :	Simultaneously
	8. Other Actions	Q _{k,i} :	Acting Load Cases
	9. Accidental Actions	Ad: AC4	
	- 1 <u>0</u> . Seismic Actions		

Figure 3.6: Mask 1.3 Action Categories

\$

To allocate actions to specific categories, the Actions are to be selected in the relevant entry fields. You can also use the button [Select action(s) from a list] which opens the dialog box Select Actions. There, a list of all actions that have not been allocated yet is shown.

tions 💌
or Selection
Permanent actions
Live load - halls, meeting rooms
Traffic loads - F
Accidental loads
Seismic loads
-
Multiple selection possible via [Ctrl]
OK Cancel

In mask 1.3, you can use the option Live loads and traffic loads to be subsumed as one independent action. The possibility to merge live and traffic loads that exist within one building is explained for example in [9], annex A, page 37. This option influences the generation of load groups or load combinations according to formulas 2.1, 2.2, 2.4, and 2.5 (see chapter 2.2.1) which contain the main variable load $Q_{k,1}$. If you select this option, either all live and traffic loads will be considered as the main loads or none of them will be classified as main load. Thus, all live and traffic loads will be always multiplied by the same combination coefficient ψ .

Figure 3.7: Dialog box Select Actions



3.3.1.4 Imperfections

The mask 1.4 *Imperfections* is only displayed if load groups are to be generated. Only load groups can be calculated according to a second order or large deformation analysis.

This mask contains the sections *Existing Load Cases - Type 'Imperfection'*, *Imperfection-Type Load Cases in Combinations*, and *Options*.

RSCOMBI 2006 - [Example 4]		
File Settings Help		
CA1 •	1.4 Imperfection-Type Load Cases	
Input Data General Data Actions Action Categories Imperfections	Existing Load Cases - Type "Imperfection"	Derection-Type Load Cases in Combinatorics LC Load Case Description Alternative Only with LC Never with LC Image: Comparison of the second se
	Calculation Coefficients Check	OK Cancel

Figure 3.8: Mask 1.4 Imperfections

In the section *Existing Load Cases - Type 'Imperfection'*, all imperfections created in RSTAB which have not yet been put into groups for generation are displayed. The buttons in the sections have the same functions as in mask 1.2.

RSCOMBI takes into account only imperfections selected in the section *Imperfection-Type Load Cases in Combinations*.

If you have selected at least one imperfection-type load case, every possible load group will be created with and without those imperfections. If you want to generate only load cases with imperfections, it is necessary to tick the box *Allocation of imperfection-type load cases to each load group* in the section *Options*.

In Figure 3.9, the load cases LC9 and LC10 are to be used for the generation of load groups. At first, load groups without any imperfections will be generated, then with LC9, then with LC10, and finally with LC9 and LC10 simultaneously.



RSCOMBI 2006 - [Example_4]	le la constante de la constante
<u>File</u> <u>Settings</u> <u>H</u> elp	
CA1	1.4 Imperfection-Type Load Cases
Input Data General Data Actions Action Categories Imperfections	Existing Load Cases - Type Imperfection* Imperfection-Type Load Cases in Combinatorics Imperfection Imperfection-Type Load Cases in Combinatorics Imperfection Atemative Only with LC Imperfection +X Imperfection +X Imperfection +X Imperfection +Y Imperfection +Y Imperfection +Y Imperfection +Y Imperfection +Y Imperfection +Y
	Options ■ Allocation of Imperfection-Type Load Cases to Each Load Group ■ Include Imperfection-Type Load Cases in the Combinations Subject to Defined Load Cases
	Calculation Coefficients Check OK Cancel

Figure 3.9: Mask 1.4 Imperfections, section Imperfection-Type Load Cases in Combinations

You can define the imperfection-type load cases as *Alternative*, similarly to ordinary load cases. Hence, only one imperfection-type load case is put into each load group.

In the columns *Only with LC* and *Never with LC*, you can further reduce the number of generated load groups. For this, select the option *Include imperfection-type load cases in the combinations subject to defined load cases* in the section *Options* below. In this way, you can determine the relation between the relevant imperfection and a specific load case.

RSCOMBI 2006 - [Example_4]			×
<u>File</u> <u>Settings</u> <u>H</u> elp			
CA1 👻	1.4 Imperfection-Type Load Cases		
CA1 ▼ Input Data General Data Actions Action Categories Imperfections	I.4 Imperfection-Type Load Cases Existing Load Cases - Type 'Imperfection'	Imperfection-Type Load Cases LC Load Case Descripti LC9 Imperfection +X Imperfection +Y	in Combinatorics on Alternative Only with LC Never with LC Imp LC6 Imp LC7 Participation of Imperfection-Type Load Cases to Each Load Group Imperfection-Type Load Cases in the Combinations Subject to Defined Load Cases
	Calculation Coefficients) Check		OK Cancel

Figure 3.10: Mask 1.4 Imperfections, section Options



3.3.1.5 Coefficients

You open the dialog box *Coefficients* by clicking the button [Coefficients...]. This dialog box has two tabs.

In these tabs, the *Partial Safety Coefficients* and *Combination Coefficients* which will be used to generate load groups or combinations are set by default according to the standard DIN 1055-100.

In the tab *Partial Safety Coefficients*, the design situations for both the static equilibrium and ultimate limit state are defined. They only differ in the respective safety coefficients.

DIM	V 10	55-100 - Coefficient	is					×
F	artia	al Safety Coefficients	Combination Coeffic	ients				
b	Parti	al Safety Coefficients	s for Position Stability					
					De	esign Situation		
	Actio	on Category			Combination	Accidental	Earthquake	
	1.	Permanent Actions	unfavorable	γG,sup:	1.10 🜩	1.00 ≑	1.00 ≑	
			favorable	γG,inf:	0.90 🌩	0.95 🚔	1.00 🚔	
	2.	Prestress	unfavorable	γP,sup:	1.10 🚔	1.00 🚔	1.00 🚔	
			favorable	γP,inf:	0.90 🜩	1.00 🚔	1.00 🚔	
	3 8.	Variable Actions	unfavorable	γο:	1.50 🌩	1.00	1.00 🜩	
	9.	Accidental Actions		γA:		1.00		
	10.	Earthquake Actions		γ 1:			1.00 🜩	
	Parti	al Safety Coefficients	s for Ultimate Limit Sta	ate				
					De	esign Situation		
	Actio	on Category			Basic Combination	Accidental	Earthquake	
	1.	Permanent Actions	unfavorable	γG,sup:	1.35 🜩	1.00 🜩	1.00 🚔	
			favorable	γG,inf:	1.00 🛬	1.00 🚔	1.00 🚔	
	2.	Prestress		γP:	1.00 🜩	1.00 🚔	1.00 🜩	
	3 8.	Variable Actions	unfavorable	γο:	1.50 ≑	1.00 ≑	1.00 🚔	
	9.	Accidental Actions		γA:		1.00		
	10.	Earthquake Actions		γı:			1.00 🚖	
S	2	D 😭 📭					JK Ca	incel

Figure 3.11: Dialog box Coefficients, default partial safety coefficients according to DIN 1055-100



The Combination Coefficients differ according to the action categories.

DIN 1055-100 - Coefficients			×					
Partial Safety Coefficients Combination Coefficients								
Combination Coefficients of Variable Actions								
Action Category	ΨΟ	₩ 1	Ψ2					
3.A Imposed Loads - Category \underline{A} - Domestic, Residential $$	0.70 🚔	0.50 🌩	0.30 🚔					
3.B - Category <u>B</u> - Offices	0.70 🚔	0.50 🌩	0.30 ≑					
3.C - Category <u>C</u> - Congregation Areas	0.70 🚔	0.70 🚔	0.60 🚔					
3.D - Category <u>D</u> - Shopping	0.70 🚖	0.70 🚖	0.60 ≑					
3.E - Category <u>E</u> - Storage	1.00 🚖	0.90 ≑	0.80 🌩					
3.F Traffic Loads - Category <u>F</u> - Vehicle Weight \leq 30 kN	0.70 ≑	0.70 🜲	0.60 ≑					
3.G - Category G - Vehicle Weight ≤ 160 kN.	0.70 ≑	0.50 ≑	0.30 ≑					
3.H - Category <u>H</u> - Roofs	0.00 🚔	0.00	0.00 🌲					
<u>4</u> .A Snow and Ice Loads - Sites at Attitude H \leq 1 000 m	0.50 ≑	0.20 🌩	0.00 ≑					
4.B - <u>S</u> ites at Altitude H > 1 000 m	0.70 🚔	0.50 ≑	0.20 🌲					
<u>5</u> . Wind Loads	0.60 🚔	0.50 🜩	0.00 🜩					
6. Temperature (non Fire)	0.60 ≑	0.50 ≑	0.00 ≑					
7. Foundation Subsidence	1.00 ≑	1.00 🜩	1.00 ≑					
8. Other Actions	0.80 🚔	0.70 🌩	0.50 ≑					
		OK	Cancel					

Figure 3.12: Dialog box Coefficients, default combination coefficients according to DIN 1055-100

Apart from the coefficients that are set by default according to corresponding standards, you can also create and save your own sets of coefficients. Click the button [Save Factors As 'Set of Coefficients'] to open a dialog box where you can enter a name of a new set.

Save Co	efficients		×
Save Co	pefficients as		
<u>N</u> ame:	New set		
Set a	as Default		
		ОК С.	ancel

Figure 3.13: Dialog box Save Coefficients

You can set the new coefficients as default.

The button [Load Set of Coefficients] opens a dialog box where previously defined sets of coefficients can be loaded (see Figure 3.14 on the following page).





Figure 3.14: Dialog box Load Coefficients

The set of coefficients *Default*, corresponding to the standard, represents the first item in this list. You cannot edit or delete this set.

By using the check box next to the set name, you can also define a different set as default.

3.3.2 Load Combination According to DIN 18800

3.3.2.1 General Data

After having started RSCOMBI, the mask 1.1 General Data appears in the module window.

41	 1.1 General Data 		
nput Data	Generate for RSTAB of	Supplementary Examination	
- General Data Actions	Load <u>G</u> roups	Reduce Possible Load Groups by	
- Action Categories	○ Load Combinations - Variable Superposition	Examining RSTAB Results	
Data ieneral Data actions votion Categories mperfections	O Load Combinations - Permanent Superposition	From Automatically Defined Combinations	
	Combination Rules according to Code	From Load Combinations:	
	DIN 18800		
	Generating for Design Situations		
	Static Equilibrium: Basic Combination EB		
	Accidental EA		
	✓ Ultimate Limit State: ✓ Basic Combination UB Accidental UA		S
	Serviceability Limit State S		E
			Generating Load Groups or Load Combinations
	Generate Supplementary Combinations from Favorable Permanent Actions		
	Comment	Numbering	
		Start Number of Generated	
		- Load Group: 1	

Figure 3.15: Mask 1.1 General Data

In this mask, only the section *Generation for Design Situations* is different from the mask described in chapter 3.3.1.1 on page 13.



The standard DIN 18800 requires the ultimate limit state design and the serviceability limit state design. For the ultimate limit state, it should be distinguished whether the loss of the static equilibrium or the failure due to breakage are considered. RSCOMBI enables you to generate load combinations for the following *Design Situations*:

- Static equilibrium (ultimate limit state, partial coefficients for criterion loss of static equilibrium)
 - Basic combination see formula 2.7 and formula 2.8
 - Accidental see formula 2.9
- Load capacity (ultimate limit state, partial coefficients for criterion failure of structure due to breakage)
 - Basic combination see formula 2.7 and formula 2.8
 - Accidental see formula 2.9
- Serviceability (serviceability limit state) see formula 2.7

3.3.2.2 Actions

In this mask, actions are created and load cases that have been defined in RSTAB are assigned to them.



Figure 3.16: Mask 1.2 Actions

The functionality of this mask does not depend on the standard. All functions are described in chapter 3.3.1.2 on page 14.



3.3.2.3 Action Categories

In this mask, the actions are allocated to the relevant categories.

File Settings Help CA1 Input Data General Data Action Categories Action Categories Actions Imperfections 2 Vaiable Actions Qk/ AC2 3 Accidental Actions Action Categories Actions 1 Permanent Actions 2 Vaiable Actions 3 Accidental Actions Accidental Actions Additions Accidental Actions Additions Accidental Actions Additions Accidental Actions Additions Benetic Model Benetic Model	RSCOMBI 2006 - [Example_4]			
CA1 I 3 Actions in Action Categories according to DIN 18800 Input Data Action Categories General Data Action Categories Action Categories I. Permanent Actions Q: Variable Actions Q: Variable Actions 3: Accidental Actions Action Categories 3: Accidental Actions Action Categories 0: Do Not Combine Selected Load Cases with Other Cases with Other 0: Simultaneously Acting Load Cases Simultaneously	<u>File</u> Settings <u>H</u> elp			
Input Data Action Categories Actions Action Categories 1. Permanent Actions Gkgi AC1 Imperfections 2. Variable Actions Gkgi AC2 Imperfections I	CA1 👻	1.3 Actions in Action Categories according to DIN 18800		
	CA1	Actions in Action Categories according to DIN 18800 Action Categories Permanent Actions	Actions AC1 AC2 AC3, AC4	Do Not Combine Selected Load Cases with Other Load Cases
	0.88	Calculation Coefficients Check		

Figure 3.17: Mask 1.3 Action Categories

For DIN 18800, the assignment of actions to individual categories is the same like for the standard DIN 1055-100. It is described in chapter 3.3.1.3 on page 16.

3.3.2.4 Imperfections

The mask 1.4 Imperfections is only displayed if load groups are to be generated.

ne <u>s</u> ettings <u>n</u> eip	I							
A1	▼ 1.4 Imperfe	ction-Type Load Cases	;					
General Data Action Categories Imperfections	Existing Lo LC9 LC10	ad Cases - Type 'Imperfe Imperfection +X Imperfection +Y	ection'	Imperfec LC	tion-Type Load Cases in Co Load Case Description	mbinatorics Alternative	Only with LC	Never with I
			-	<u>الا</u>	or V	tions	mperfection-Typ	De Load Case
						Include Imper in the Combin Cases	fection-Type Lo ations Subject t	ad Cases o Defined Lo
0 5 5	Calculation	Coefficients	Check			6	ОК	Cancel

Figure 3.18: Mask 1.4 Imperfections



This mask contains the sections *Existing Load Cases - Type 'Imperfection'*, *Imperfection-Type Load Cases in Combinations*, and *Options*.

The functionality of this mask is independent of the selected standard. It is described in chapter 3.3.1.4 on page 17.

3.3.2.5 Coefficients

You open the dialog box *Coefficients* by clicking the button [Coefficients...]. The dialog box has two tabs.

In these tabs, the *Partial Safety Coefficients* and *Combination Coefficients* which will be used to generate load groups or combinations are set by default according to the standard DIN 18800.

In the tab *Partial Safety Coefficients*, the design situations for both the static equilibrium and ultimate limit state are defined. They only differ in the respective safety coefficients.

DIN 18800 - Coefficients	5			٢.
Partial Safety Coefficient	ts Combination Coefficients	3		_
Partial Safety Coefficie	nts for Position Stability			
		Design	Situation	
Action Category		Combination	Accidental	
1. <u>P</u> ermanent Action	s unfavorable γ _{G.}	sup: 1.10 🚔	1.00 🚔	
	favorable γ _G	inf: 0.90 ≑	1.00	
2. Variable Actions	unfavorable γρ:	1.50 🜩	1.00	
2 Assidental Astion			1.00	
5. Accidental Action	s ya		1.00	
Partial Safety Coefficie	nts for Ultimate Limit State			
		Design Basic	Situation	
Action Category		Combination	Accidental	
1. Permanent Action	s unfavorable γ _{G.}	sup: 1.35 🚔	1.00	
	favorable γ _G	inf: 1.00 🚔	1.00	
2. Variable Actions	unfavorable γg:	1.50 🚔	1.00	
3. Accidental Action	s γa:		1.00	
Partial Safety Coefficier	nts for Serviceability Limit Sta	ite		
		Design Situation	n	
Action Category		Combination		
1. Permanent Action	s yg:	1.00		
2. Varjable Actions	unfavorable γα:	1.00		
			OK Cancel	

Figure 3.19: Dialog box Coefficients, default partial safety coefficients according to DIN 18800



The Combination Coefficients differ according to the design situations.

DIN 18800 - Coefficients		×
Partial Safety Coefficients Combination Coefficients		
Combination Coefficients of Variable Actions		
Design Situation yi		
Structure Equilibrium:		
Ultimate Limit State: 0.90 x		
Serviceability Limit State: 1.00		
	ОК	Cancel

Apart from the coefficients that are set by default according to corresponding standards, you can also create and save your own sets of coefficients (see chapter 3.3.1.5 on page 19).

Figure 3.20: Dialog box Coefficients, default combination coefficients according to DIN 18800



3.3.3 Load Combination According to EN 1990

3.3.3.1 General Data

After having started RSCOMBI, the mask 1.1 General Data appears in the module window.

A1 ·	 I.1 General Data 	
put Data	Generate for RSTAB of	Supplementary Examination
General Data Actions	Load Groups	Reduce Possible Load Groups by
Action Categories	Load Combinations - Variable Superposition	Examining RSTAB Results
-	Load Combinations - Permanent Superposition	From Automatically Defined
		Combinations
	Combination Rules according to Code	From Load Combinations:
	EN 1990 -	
	Generating for Design Situations	Settings for Combinatorics acc. to EN 1990
	Statio Equilibrium: Racio Combination	Paris Ultrack Link Clark Carthington
		Apply Combination
	Seismic	S Rule:
	V Illtimate Limit State: V Basic Combination	and 6.10b
		A Accidental Combination according
	Seismic U	S to Equations 6.11a and 6.11b
	Serviceability Limit 🔲 Characteristic S	C Coefficient
	State: Frequent S	F Generating
	🕅 Quasi-permanent 🛛 S	Q Load Combination
	Generate Supplementary Combinations from Favorable Permanent Actions	
	Comment	Numbering
		Start Number of Generated
		- Load Group: 1 💦

Figure 3.21: Mask 1.1 General Data

In this mask, only the section *Generation for Design Situations* is different from the mask described in chapter 3.3.1.1 on page 13.

The following description refers to the standard EN 1990. EN 1990 CEN or EN 1990 CZ only differ in the coefficients that are set by default.

The standard EN 1990 requires the ultimate limit state design and the serviceability limit state design. For the ultimate limit state, it should be distinguished whether the loss of the static equilibrium or the failure due to breakage are considered. RSCOMBI enables you to generate load combinations for the following *Design Situations*:

- Static equilibrium (ultimate limit state, partial coefficients for criterion loss of static equilibrium)
 - Basic combination see formula 2.10, formula 2.11 or formula 2.12
 - Accidental see formula 2.13
 - Seismic see formula 2.14
- Load capacity (the ultimate limit state, partial coefficients for the analysis of a structure failure by breakage)
 - Basic combination see formula 2.10, formula 2.11 or formula 2.12
 - Accidental see formula 2.13
 - Seismic see formula 2.14
- Serviceability (the serviceability limit state)
 - Characteristic see formula 2.15
 - Frequent see formula 2.16
 - Quasi-permanent see formula 2.17



3.3.3.2 Actions

In this mask, actions are created and load cases that have been defined in RSTAB are assigned to them.

RSCOMBI 2006 - [Example_2]				×
<u>File</u> Settings <u>H</u> elp				
CA1 •	.2 Load Cases in Actions			
Input Data — General Data — Actions — Action Categories	Actions AC1 Permanent actions AC2 Wind loads AC3 Live loads AC4 Traffic loads		Action Description: Permanent actions Action Comment:	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories''.
	Existing Load Cases LC3 Live load - span LC4 Live load - cantilev LC5 Traffic load - span LC6 Traffic load - cantile	er ever E Q Q	Load Cases in Action Ac1 No. Load Case Description LC1 Dead load - span LC2 Dead load - cantilever	Atemative
	Calculation Coefficients	Check		OK Cancel

Figure 3.22: Mask 1.2 Actions

The functionality of this mask does not depend on the standard. All functions are described in chapter 3.3.1.2 on page 14.

3.3.3.3 Action Categories

In mask 1.3, the actions are allocated to the relevant categories.

41	 I.3 Actions in Action Categories according 	ording to EN 1990 CEN	
put Data General Data	Action Categories	Actions	
Actions Action Categories	1. Permanent Actions	G _{k.j} : AC1	<i>3</i>
Hotor Catagolics	<u>2</u> . Prestress	Pk:	<u></u>
	3.A Imposed Loads - Category A - Do	mestic, Residential Qk,i:	Live Loads and
	3. <u>B</u> · Category B · Off	ices Qk,i:	I raffic Loads to Subsumed as or
	3.C · Category C · Co	ngregation Areas Qk,j: AC3	Independent Ac
	3.D · Category D · Sh	opping Qkj:	N
	3. <u>E</u> · Category E · Sto	prage Q _{k,i} :	N
	3. <u>F</u> Traffic Loads · Category F - Ve	hicle Weight ≤ 30 kN Qk,i: AC4	\$
	3.G · Category G - Ve	hicle Weight ≤160 kN. Qk,j:	A state
	3. <u>H</u> - Category H - Ro	ofs Qk,i:	<u></u>
	4.A Snow and Ice Loads · Finl., Islan	d, Norway, Sweden Qk,i:	Do Not Combine
	4.B · Other CEN Countries · Sites at Al	ltitude H > 1 000 m Qk,j:	Cases with Othe
	4.C - Sites at A	ltitude H ≤1 000 m Q _{k,i} :	Load Cases
	5. Wind Loads	Q _{k,i} : AC2	
	6. Temperature (non Fire)	Q _{k,i} :	<i>3</i>
	Z. Accidental Actions	Ad:	3
	8. Seismic Actions	A _{Ed} : AC5	3

Figure 3.23: Mask 1.3 Action Categories



For EN 1990, the assignment of actions to individual categories is the same like for the standard DIN 1055-100 and is described in chapter 3.3.1.3 on page 16.

3.3.3.4 Imperfections

The mask 1.4 *Imperfections* is only displayed only if load groups are to be generated. Only load groups can be calculated according to the second order or large deformation analysis.

RSCOMBI 2006 - [Example_4]								×
<u>File</u> <u>Settings</u> <u>H</u> elp								
CA1 👻	1.4 Imperfe	ction-Type Load Cases						
Input Data — General Data — Actions — Action Categories — Imperfections	Existing Lo LC9 LC10	ad Cases - Type Imperfec Imperfection +X Imperfection +Y		Imperfect LC	tion-Type Load Cases in Co Load Case Description	Alternative	Only with LC	Never with LC
						j≜lication of I to Each Load] Include Impe in the Combin Cases	mperfection-Type Group fection-Type Lo alions Subject t	be Load Cases ad Cases a Defined Load
	Calculation	Coefficients	Check				OK	Cancel

Figure 3.24: Mask 1.4 Imperfections

This mask contains the sections *Existing Load Cases - Type 'Imperfection'*, *Imperfection-Type Load Cases in Combinations*, and Options.

The functionality of this mask is independent of the selected standard. It is described in chapter 3.3.1.4 on page 17.

3.3.3.5 Coefficients

You open the dialog box *Coefficients* by clicking the button [Coefficients...]. The dialog box has two tabs.

In these tabs, the *Partial Safety Coefficients* and *Combination Coefficients* which will be used to generate load groups or combinations are set by default according to the standard EN 1990.

In the tab *Partial Safety Coefficients*, the design situation for both the static equilibrium and ultimate limit state are defined. They only differ in the respective partial safety coefficients.



'art	ial Safety Coefficients Co	mbination Coefficients				
Par	tial Safety Coefficients for	Position Stability				
			D	esign Situation		
Act	ion Category		Basic Combination	Accidental	Earthquake	
1.	Permanent Actions	unfavorable YG.sup;	1.10 🚔	1.00 🜩	1.00 🜩	
	_	favorable vision	0.90	1.00 🚖	1.00	
		idvorabio yo,iii.	0.00	1.00	1.00	
2.	Prestress	unfavorable γρ _{,sup} :	1.10 ≑	1.00 ≑	1.00 ≑	
		favorable yp,inf:	0.90 🌲	1.00 ≑	1.00 ≑	
3						
6.	Variable Actions	unfavorable γα:	1.50 🚔	1.00 ≑	1.00 🚔	
7	Accidental Actions	× 0.		1.00		
1.	Accidental Actions	78		1.00		
8.	Earthquake Actions	y1:			1.00 🜩	
Par	tial Safety Coefficients for	Ultraneta Ultrate Otata				
		Uitimate Limit State				
		Uitimate Limit State	D	esign Situation		
Act	ion Category	Unimate Limit State	De Basic Combination	esign Situation Accidental	Earthquake	
Act	ion Category Permanent Actions	unfavorable y _{G,sup} ;	De Basic Combination	Accidental	Earthquake	
Act 1.	ion Category Permanent Actions	unfavorable γ _{G,sup} : favorable γ _{G,sup} :	De Basic Combination	Accidental	Earthquake	
Act 1.	ion Category Per <u>m</u> anent Actions	unfavorable γG,sup: favorable γG,sup:	Dasic Combination	Accidental	Earthquake	
Act 1. 2.	ion Category Pem_anent Actions Pregtress	unfavorable yG,sup: favorable yG,inf: yp:	Dasic Combination 1.35 - 1.00 - 1.00 -	Accidental	Eathquake	
Act 1. 2.	ion Category Permanent Actions Prestress	unfavorable γ _{G,sup} ; favorable γ _{G,inf} ; γp;	D Basic Combination 1.35 - 1.00 - 1.00 -	Accidental	Earthquake	
Act 1. 2. 3 6.	ion Category Permanent Actions Pregtress Variable Actions	unfavorable γ _{G,sup} : favorable γ _{G,inf} : γp: unfavorable γ _Q :	Di Basic Combination 1.35 1.00 1.00 1.00 1.50	esign Situation <u>Accidental</u> 1.00 + 1.00 + 1.00 + 1.00 + 1.00 +	Earthquake	
Act 1. 2. 3 6. 7.	ion Category Permanent Actions Prestress Variable Actions Agcidental Actions	unfavorable γ _{θ,s} up: favorable γ _{θ,i} nf: γp: unfavorable γο: γA:	Di Basic Combination 1.35 ☆ 1.00 ☆ 1.00 ☆ 1.50 ☆	Accidental 1.00 ÷ 1.00 ÷ 1.00 ÷ 1.00 ÷ 1.00 ÷ 1.00 ÷	Earthquake	
Act 1. 2. 3 6. 7. 8.	ion Category Permanent Actions Prestress Variable Actions Agcidental Actions Earthquake Actions	unfavorable γ _{G,sup} ; favorable γ _{G,inf} ; γp; unfavorable γ _Q ; γA; γ1;	D Basic Combination 1.35 1.00 1.00 1.00 1.50	esign Situation Accidental 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$	Earthquake 1.00 + 1.00	
Act 1. 2. 3 6. 7. 8.	ion Category Permanent Actions Prestress Variable Actions Agcidental Actions Earthquake Actions	unfavorable γ _{G,sup} ; favorable γ _{G,inf} ; γp; unfavorable γο; γA; γ1;	D Basic Combination 1.35 🐨 1.00 🕎 1.00 🛫	esign Situation Accidental 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$ 1.00 $\frac{1}{\sqrt{2}}$	Earthquake 1.00 🕎 1.00 🕎 1.00 🕎 1.00 🕎 1.00 🛬	

Figure 3.25: Dialog box Coefficients, default partial safety coefficients according to EN 1990 CZ

The Combination Coefficients differ according to the action categories.

C1 - Coefficients				-
Partial Safety Coeff	icients Combination Coefficients			
Combination Coeff	ficients of Variable Actions			
Antine Colonna				
Action Category		ψο	ψ1	Ψ2
3.A Imposed Loa	ds - Category <u>A</u> - Domestic, Residential	0.70 ≑	0.50 ≑	0.30 🚔
3.B	- Category <u>B</u> - Offices	0.70 ≑	0.50 ≑	0.30 ≑
3.C	- Category <u>C</u> - Congregation Areas	0.70 ≑	0.70 ≑	0.60 ≑
3.D	- Category <u>D</u> - Shopping	0.70 ≑	0.70 ≑	0.60 🚖
3.E	- Category <u>E</u> - Storage	1.00 ≑	0.90 ≑	0.80 ≑
3.F Traffic Loads	- Category <u>F</u> · Vehicle Weight ≤ 30 kN .	0.70 ≑	0.70 🌲	0.60 ≑
3.G	-Category <u>G</u> ·Vehicle Weight ≤ 160 kN.	0.70 ≑	0.50 ≑	0.30 ≑
3.H	- Category <u>H</u> - Roofs	0.00 ≑	0.00 ≑	0.00 ≑
4.A Snow and Ice	e Loads - Finl., Island, Norway, Sweden	0.70 ≑	0.50 ≑	0.20 ≑
4.B - Other CEN (Countries - Sites at Altitude H > 1 000 m	0.70 🜲	0.50 ≑	0.20 ≑
4.C	- Sites at Altitude H ≤ 1 000 m	0.50 ≑	0.20 ≑	0.00 ≑
5. Wind Loads		0.60 ≑	0.20 🚔	0.00
6. Temperature	(non Fire)	0.60	0.50 🌩	0.00
Combination Rule	according to Equations 6.10a and 6.10b			
<u>R</u> eduction Coeffici for Combination Ri	ient of Permanent Unfavorable Actions ule according to Equation 6.10b	ξ 0.85		
2 🍋 📳			ОК	Cancel

Figure 3.26: Dialog box Coefficients, default combination coefficients according to EN 1990 CZ



Apart from the coefficients that are set by default according to corresponding standards, you can also create and save your own sets of coefficients. This possibility is described in chapter 3.3.1.5 on page 19.

If the standard EN 1990 is applied, it is also necessary to enter the coefficient ξ , together with partial and combination coefficients. The coefficient ξ is used in formula 2.12 (it corresponds to formula 6.10b in EN 1990).

In the pictures, you can see default coefficients according to EN 1990 CZ. If you select the standard EN 1990 CEN, some coefficients will be different.

3.4 Results Masks

There are two results masks available in the RSCOMBI module. In the first mask, the generated results are listed by actions. This table corresponds to the definition of actions in a standard. In the second mask, the generated load groups or load combinations are listed individually, together with the included load cases.

3.4.1 Generation of Load Groups

3.4.1.1 Load Groups by Actions

The mask 2.1 *Load Groups by Actions* consists of two parts. In the upper table, the generated load groups by actions are shown in a general way. In the lower part, detailed information is given on the line which is selected in the upper table.

A F-All design situations	 2.1 Load 	Groups	by Actions										
put Data — General Data — Actions — Action Categories esults — Load Groups by Actions — Load Groups y Actions — Load Groups - Reduced	No. 1 2 3 4 5	A Apply X X X X	B Generated Load Groups LG1 LG24 LG510 LG1112 LG1318	C Design Situation UB UB UB UB UB	D AC1 1.35 1.35 1.35 1.35 1.35	E AC2 - 1.50 1.50 - 1.05	F AC3 - 1.05 1.50 1.50						
	Actions AC AC1	in Gene	rated Load Group Action Descript nent actions	: LG5 10 ion	Category 1.	U	ltimate lin inant	nit state - γ 1.35	Basic Cor ¥	mbination γ.ψ 1.35	Load Ca No.	ases in Action Loar	AC2 I Cases
	AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F		3	1.50 1.50	0.70	1.50 1.05	2 3	LC3 + LC4 LC4	

Figure 3.27: Mask 2.1 Load Groups by Actions

The upper table contains several columns. In the first column *No.*, the individual entries are listed by numbers. In the column *Apply*, you can activate check boxes and, thus, decide which load groups are to be exported to RSTAB.

In the column *Generated Load Groups*, you see which load groups belong to an entry. In the column *Design Situation*, you find a description of the design situation for which corresponding load groups were generated. The descriptions from mask 1.1 are applied here. In the remaining columns, the actions are displayed with the relevant coefficients.



If you click any item in the upper table, more data is shown in the lower table. In the section Actions in Generated Load Groups, the list of all considered actions is displayed, including their Description and Action Categories (see mask 1.3).

In the column *Dominant*, the main action is marked. The action is considered dominant if it acts as $Q_{k,1}$ in formulas 2.1, 2.2, 2.4, 2.5, 2.10, 2.11, 2.13 or 2.14 (see chapter 2.2). The applied coefficients γ , ψ and ξ of every action are determined according to the design situation and action category. The action coefficient in an entry represents the product of these factors.

If you click any action in the section Actions in Generated Load Groups, the corresponding load cases shown in the section Load Cases in Action AC#. Additionally, all possibilities how to consider these load cases in a given action can be read. These possibilities depend on the action category and on the possible 'Alternative' relation of the actions. It is assumed that in case of the action categories 'Permanent' or 'Prestress', all allocated load cases are considered simultaneously, unless an alternative relation was defined among them. In case of the action categories 'Variable', 'Accidental', and 'Seismic', the allocated load cases can be superimpose in all possible combinations.

In Figure 3.27, an example is shown in which 18 load groups in total were generated for the design situation 'Ultimate limit state – basic combination'. For all five entries, you can see how the relevant actions were applied in the formula of this design situation. The third entry is 1.35 AC1 + 1.50 AC2 + 1.05 AC3. By considering these actions, six load groups are generated that are described as $LG5 \dots 10$.

The first action AC1 is named *Permanent actions*. It was allocated to category 1 (*Permanent actions*) in mask 1.3 and is used with the coefficient $\gamma = 1.35$ in the generated load groups.

The second action AC2 is named *Imposed loads*. It was allocated to category 3.C (*Imposed loads, category C - congregation areas*) in mask 1.3 and is used with the coefficient $\gamma = 1.50$ in the generated load groups. It is the dominant load that can appear as *LC3* or *LC3 + LC4* or *LC4*.

The third action AC3 is named *Traffic loads*. It was allocated to category 3.F (*Traffic loads, category F - vehicle weight < 30 kN*) in mask 1.3 and is multiplied with the coefficient $\gamma * \psi = 1.50 * 0.70 = 1.05$ in the generated load groups.



3.4.1.2 Load Groups

The mask 2.2 *Load Groups* consists of two parts, too. In the upper part, all generated load groups are listed. In the lower part, detailed information is given on the line which is selected in the upper table.



Figure 3.28: Mask 2.1 Load Groups

The upper table contains several columns. In the first column *LG*, the numbers of all generated load groups are displayed. In the column *Apply*, you can activate check boxes and, thus, decide which load groups are to be exported to RSTAB. This column is synchronized with the same column in mask 2.1. In the column *Design Situation*, you find a description of the design situation for which corresponding load groups were generated. In the remaining columns, the load cases are displayed that are contained in each load group.

If you click any item in the upper table, details of the selected load group are shown in the lower table. In the column *LC* in the lower table, all load cases are shown that are included in this load group. Their *Description* appears in the next column. In the column *Action*, the actions which have been allocated to each load case in mask 1.2 is displayed. In the column *Category*, the relevant action category is shown and in the column *Prevailing*, the main action in a given load group is marked. The coefficients γ , ψ , and ξ for every action, which are applied in the load group, are determined on the basis of the design situation and action category. The action coefficients represent the products of these factors.

In Figure 3.28, you can see the first 12 load groups from the total number of 18 generated load groups. LG5 consists of 1.35LC1 + 1.35LC2 + 1.5LC3 + 1.05LC5. The load cases LC1 and LC2 belong to action AC1. Action AC1 was allocated to category 1 (*Permanent actions*) in mask 1.3. It is multiplied by the coefficient $\gamma = 1.35$ in this load group LG5. Load case LC3 belongs to action AC2. Action AC2 was allocated to category 3.C (*Imposed loads, category C - congregation areas*). It is the prevailing load case in LG5 and, therefore, is multiplied by the coefficient $\gamma = 1.50$. Load case LC5 belongs to action AC3. Action AC3 was allocated to category 3.F (*Traffic loads, category F - vehicle weight < 30 kN*) in mask 1.3. It is multiplied by the coefficient $\gamma^* \psi = 1.50^* 0.70 = 1.05$ in LG5.



If you compare Figure 3.27 and Figure 3.28, you find out that the third entry of the generated load groups in Figure 3.27 (*1.35AC1+1.50AC2+1.05AC3*) corresponds to load groups LG5 .. 10.

The load groups LG5 to LG10 are described in Figure 3.28 as follows:

LG5: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.05LC5
LG6: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.05LC6
LG7: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.50LC4 + 1.05LC5
LG8: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.50LC4 + 1.05LC6
LG9: 1.35LC1 + 1.35LC2 + 1.50LC4 + 1.05LC5
LG10: 1.35LC1 + 1.35LC2 + 1.50LC4 + 1.05LC6

Action AC1 includes the load cases LC1 and LC2. Regarding the fact that it is a permanent action, both load cases can occur only simultaneously. Action AC2 includes the load cases LC3 and LC4. As it is a variable action, three combinations are possible: *LC3* or *LC3* + *LC4* or *LC4*. Action AC3 includes the load cases LC5 and LC6. It is a variable action, too. Because an 'Alternative' relation was defined between LC5 and LC6, the combinations *LC5* or *LC6* originate. If the actions are replaced by load cases, the entry 1.35AC1 + 1.50AC2 + 1.05AC3 represents in total 1*3*2 = 6 load groups which are specified as LG5 ... 10 in Figure 3.27.

In this way, you can retrace the load groups in mask 2.2 that are contained in every table row in mask 2.1. All possible combinations are created, unless you have ticked the option *Reduce possible load groups by examining RSTAB results* in mask 1.1. In this case, only the decisive load groups are generated. You can also retrace the load groups of mask 2.1 in mask 2.2, but be aware that many generated load groups have not been considered here.



3.4.2 Generation of Load Combinations

3.4.2.1 Load Combinations by Actions

The mask 2.1 *Load Combinations by Actions* consists of two parts. In the upper table, the generated load combinations by actions are shown in a general way. In the lower part, detailed information is given on the line which is selected in the upper table.



Figure 3.29: Mask 2.1 Load Combinations by Actions

The mask layout is similar to the mask described in chapter 3.4.1.1 on page 30. Hence, it is not described here again.

In Figure 3.29, you can see the results of the same example as in Figure 3.27. The difference is that loads with the combination criterion 'variable' enter combinations as possible ones, i.e. only if their internal forces increase the internal forces of the combined results.

In Figure 3.29, you can see that the two load combinations CO5 and CO6 were generated for the design situation 'Ultimate limit state - basic combination'. This means that four internal load combinations must have been created in individual actions. For example, see load combination CO5 1.35AC1/p + 1.50AC2/p + 1.05AC3. Actions with the symbol "/p" are considered as 'permanent' in a combination, actions without the symbol as 'variable'. The first action AC1 this combination was classified as Permanent action. It was allocated to category 1 (*Permanent actions*) in mask 1.3 and is multiplied by the coefficient $\gamma = 1.35$ in the generated load combination. The second action AC2 was described as Imposed load and allocated to category 3.C (Imposed loads, category C - congregation areas) in mask 1.3. It is multiplied by the coefficient $\gamma = 1.50$ in the generated load combination. It represents the prevailing load. Action AC2 includes the load cases LC3 and LC4. The respective internal combination CO2 is LC3 + LC4 (see Figure 3.30) and includes all options how to combine the load cases LC3 and LC4 in action AC2. The third action AC3 represents a Traffic load and was allocated to category 3.F (Traffic loads, category F - vehicle weight < 30 kN) in mask 1.3. It is multiplied by the coefficient $\gamma^* \psi = 1.50^* 0.70 = 1.05$ in the generated load combination.



3.4.2.2 Load Combinations

The mask 2.2 *Load Combinations* consists of two parts. In the upper part, all generated load combinations are listed. In the lower part, detailed information is shown about a load combination that is currently selected in the upper table.



Figure 3.30: Mask 2.2 Load Combinations

The layout of this mask is similar to the mask described in chapter 3.4.1.2 on page 32. Hence, it is not described here again.

In Figure 3.30, you can see that two load combinations CO5 and CO6 were generated for the design situation 'Ultimate limit state - basic combination'. Combination CO5 is defined as 1.35CO1/p + 1.50CO2/p + 1.05CO3 or 1.05CO4. The first internal load combination CO1 belongs to action AC1 which was described as "permanent" and allocated to category 1 (*Permanent actions*). Both AC1 and CO1 are multiplied by the coefficient $\gamma = 1.35$ in the load combination CO5. The load combination CO1 consists of LC1/p + LC2/p. The second internal load combination CO2 belongs to action AC2 which was described as *Imposed load* and was allocated to category 3.C (*Imposed loads, category C - congregation areas*). It represents the prevailing action. In the load combination CO2 consists of *LC3* + *LC4*. The third and fourth load combinations CO3 and CO4 belong to action AC3, type *Traffic load*. It was allocated to category 3.F (*Traffic loads, category F - vehicle weight < 30 kN*). Both AC3 and CO3 and CO4 are multiplied by the coefficient $\gamma = 1.5 \times 0.70 = 1.05$ in load combination CO3 includes LC5, and the combination CO4 includes LC6.



3.5 Main Menus

The main menus contain all necessary commands for processing cases in RSCOMBI. You open the main menu by clicking its name or by pressing the [Alt] key together with the key whose letter is underlined in the menu name. For the main menu *File*, you press [Alt+F]. The commands contained in the main menus are also called up by pressing their underlined letter on the keyboard.

3.5.1 File

New Case

This command is used to create a new case of generation data.

New RSC	OMBI 2006-Case
<u>N</u> o. 2	Description Case 2
٢	OK Cancel

Figure 3.31: Dialog box New RSCOMBI 2006-Case

In the dialog box, it is necessary to enter the *No.* and *Description* of a new case. If you click the button $[\mathbf{v}]$, the list of all already used cases is shown.

In the new case, you can save another independent set of input and output data.

Rename Case

This command changes the *Description* of the current case in RSCOMBI and optionally also assigns a different number to this case.

Rename	RSCOMBI 2006-Case
<u>N</u> o. 2	Description New description
2	OK Cancel

Figure 3.32: Dialog box Rename RSCOMBI 2006-Case

Copy Case

This command copies data of the current case to a new case. You can change the *No.* and enter the *Description* of the new case.

Copy RSCOMBI 2006-Case				
Copy from Case				
CA1	•			
New Ca	ase	5		
<u>N</u> o.:	Description:			
2	Load capacity - basic combination 👻			
	OK Cancel			

Figure 3.33: Dialog box Copy RSCOMBI 2006-Case


Delete Case

Delete	Cases	×
Availat	ole Cases	
No.	Description	
1	All design situations	
2	Case 2	
3	Load capacity - basic combination	•
٢	OK Cance	əl

Figure 3.34: Dialog box Delete Cases

When you click this command, the list of all cases created in RSCOMBI is shown. Click the case you wish to delete. After closing the dialog box by the [OK] button, the selected case is deleted. If you want to select more cases by the mouse, you must hold down the [Ctrl] key.

3.5.2 Settings

Reduction by Selecting Dominant Actions

luctic	on by selecting the Dominant Actions			l
	A	B	C	D
AC	Action Description	Туре	Load Cases in AC	Dominant
2	Live loads - offices	3.B	LC2, LC3	×
3	Live loads - comidors, halls	3.D	LC4, LC5	×
4	Wind loads	5.	LC6, LC7	
5	Snow and ice loads	4.A	LC8	
2				Cancel

Figure 3.35: Dialog box Reduction by Selecting Dominant Actions

It is possible to previously select the dominant actions by using the check box in column D *Dominant*. Thus, the number of generated load groups or combinations can be reduced considerably.

3.5.3 Help

This main menu calls up the *Help* function that is derived from this manual, but it may be more up-to-date than the printed version.



4. Printing

If you want to print the input and output data of RSCOMBI, you have to return to the main program RSTAB. Then call up the command [Current Printout Report].

The functions how to edit and change the layout of the printout report are described chapter 10.1 of the RSTAB manual.

In the dialog box *Printout Report Selection*, more tabs become available when you click the item **RSCOMBI 2006** in the list *Program / Modules* on the left.

Printout Report Selection D	1		×
Program / Modules	Global Selection General Data Res	ults	
RSTAB RSCOMBI 2006	Display Display Data of Module 1. Input Data 2. Results Cases to Display Did to 110		
	Display <u>all Lases</u>	Course Dischar	
	CA2 Case 2	CA1 All design situations	•
Display Cover Sheet Contents Info Pictures			
٢		ОК	Cancel

Figure 4.1: Dialog box Printout Report Selection: RSCOMBI 2006 and its tabs with detailed data



5. Examples

5.1 Single-Span Girder (DIN 1055-100)

Structure and loads

A single-span girder is loaded by five load cases. Every load case represents an individual action. The load cases and girder have already been defined in RSTAB.

Load case	Action	Action category
LC1	AC1	permanent
LC2	AC2	imposed loads, 3.C - congregation areas $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$
LC3	AC3	traffic loads, 3.F – vehicle weight < 30 kN $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$
LC4	AC4	accidental
LC5	AC5	seismic

Table 5.1: Load cases and actions

In RSCOMBI, load groups are to be generated for the design situation 'Ultimate limit state - basic combination' according to DIN 1055-100, and consequently also for all other design situations. These are then to be exported to RSTAB.

Input data

In the mask 1.1 *General Data*, you choose that **load groups** are to be generated according to **DIN 1055-100** for the design situation **Ultimate limit state – basic combination**.

CA1	▼ 1.1 General Data			
Input Data General Data Actions Action Categories	Generate for RSTAB of © Load <u>Groups</u> Coad Combinations - Combination Rules acco DIN 1055-100	Variable Superposition Permanent Superposition rding to Code	Supplementary Examination Reduce Possible Load Groups by Examining RSTAB Results From Automatically Defined Combinations From Load Combinations:	
	Generating for Design S	ituations Basic Combination EB Accidental EA Seismic ES Basic Combination UB		SCOL
	Serviceability Limit State:	Accidental UA Seismic US Characteristic SC Frequent SF Quasi-permanent SQ		Generating Load Groups or Load Combinations
	Generate Supplemer from Favorable Perm	tary Combinations anent Actions	_	
	Comment		Numbering Start Number of Generated - Load Group: 1	
2 5 5	Calculation Coefficie	nts		OK Cancel

Figure 5.1: Mask 1.1 General Data



When you open mask 1.2, action AC1 is created automatically and load case LC1 is allocated to it. Other load cases defined in RSTAB are displayed in the list *Existing Load Cases*.

RSCOMBI 2006 - [Example_1]				×
<u>File</u> <u>Settings</u> <u>H</u> elp				
CA1 -	1.2 Load Cases in Actions			
Input Data — General Data — Actions — Action Categories	Actions AC1 Permanent actio		Action Description: Permanent actions Action Comment:	Note: Button 'Create New Action' can be used to define 'Actions'. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories'.
	Existing Load Cases LC2 Live load LC3 Traffic load LC4 Shock LC5 Seismic load		Load Cases in Action AC1 No. Load Case Description LC1 Dead load	Atemative
	Calculation Coefficients	. Check		OK Cancel

ωñ

Regarding the fact that every load case represents one action, you can quickly create corresponding actions by using the second button in the section *Actions*. See this button here on the left. The individual load cases are then automatically allocated to actions. You can also add action descriptions.

RSCOMBI 2006 - [Example_1]				
<u>File</u> <u>Settings</u> <u>H</u> elp				
CA1 -	1.2 Load Cases in Actions			
Input Data General Data Actions Action Categories	Actions AC1 Permanent actions AC2 Imposed load 3.C AC3 Traffic load 3.F AC4 Accidental action AC5 Seismic load Existing Load Cases		n Description: mic load	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories''.
	Calculation Coefficients	Check		OK Cancel

Figure 5.3: Actions with allocated load cases

Figure 5.2: Mask 1.2 Actions



3

The actions are then allocated to specific categories in mask 1.3 Action Categories.

1	 1.3 Actions in Action Categories accordir 	ng to DIN 1055-100		
put Data	Action Categories	Actions		
General Data Actions	1 Permanent Actions	Gue: AC1		
 Action Categories 	<u>.</u>			
	<u>2</u> . Prestress	Pk:	3	
	3.A Imposed Loads - Category A - Domes	tic, Residential Qk,i:	Traffia	ads and
	3. <u>B</u> · Category B · Offices	Qk,i:	Subsur	ned as o
	3.C · Category C · Congre	gation Areas Q _{k,i} : AC2	Indepe	ndent Ac
	3.D - Category D - Shoppi	ng Q _{k,i} :	1	
	3.E - Category E - Storage	e Q _{k,i} :	1	
	3.F Traffic Loads - Category F - Vehicle	eWeight ≤ 30 kN Qk.,i: AC3		
	3.G Category G - Vehicle	e Weight ≤160 kN. Qk,i:		
	3. <u>H</u> · Category H · Roofs	Qk,i:	1	
	A Snow and Ice Loads Step at Attitud	le H ≤ 1.000 m	🔨 🗖 Do Not	Combine
	4.R Sites at Altitude	eH \ 1.000 m	Selecte	d Load
	4.0 . <u>J</u> ites at Attitud		Load C	ases
	<u>5</u> . Wind Loads	Qk,i:	3	
	6. Temperature (non Fire)	Qk,i:	N	
	Z. Foundation Subsidence	Qk,i:	🛐 🔲 Simulta	neously
	8. Other Actions	Qk,i:	Cases	
	9 Accidental Actions	6a: 004		
	10 Seismic Actions	Acr: AC5		

Figure 5.4: Mask 3.1 Action Categories

No imperfection-type load cases were defined in RSTAB for this example. Thus, the input is complete.

Results for design situation 'ULS - basic combination'

For the design situation 'Ultimate limit state - basic combination', five load groups are created according to formula 2.1 (see page 6).



Figure 5.5: Mask 2.1 Load Groups by Actions



In mask 2.2, you can find the detailed results. These are sorted by *load cases* instead of *actions*.

RSCOMBI 2006 - [Example_1]															x
<u>File</u> <u>Settings</u> <u>H</u> elp															
CA1 👻	2.2 Load	Groups	;												
Input Data General Data		A	B Design	С	D	E	F	G							
Actions	LG LG1	Apply	Situation	LC1	LC2	LC3	LC4	LC5							
Action Lategories	LG2		UB	1.35	1.50										
- Load Groups by Actions	LG3	×	UB	1.35	1.50	1.05	-	•							
Load Groups	LG4		UB	1.35	-	1.50	-	•							
Load Groups - Reduced	LG5	×	UB	1.35	1.05	1.50	-	•							
	Load C	ases in G	ienerated Loa	d Group	LG3				Ultimate	e limit state	- Basic Ci	ombination			
	LC		.oad Case De	scriptio	n	Actio	n C	ategory	Prevailing	γ	Ψ	γ.Ψ			
	LC1	Dead	load			AC	1	1.		1.35	-	1.35			
	LC2	Live lo	ad			AC2	2	3.C	×	1.50	-	1.50			
	LC3	Traffic	: load			AC	3	3.F		1.50	0.70	1.05			
	Domina	ant					Export						ОК	Cance	əl

Figure 5.6: Mask 2.2 Load Groups

Results for all design situations

If you select <u>all</u> design situations in mask 1.1 (see Figure 5.1), the following load groups will be created:

- 10 load groups for the situation 'Static equilibrium basic combination' (EB, LG1 .. 10, see formula 2.1)
- 10 load groups for the situation 'Static equilibrium accidental' (EA, LG11 .. 20, see formula 2.2)
- 4 load groups for the situation 'Static equilibrium seismic' (ES, LG21 .. 24, see formula 2.3)
- **5** load groups for the situation 'Ultimate limit state basic combination' (UB, LG25 .. 29, see formula 2.1)
- **5** load groups for the situation 'Ultimate limit state accidental' (UA, LG30 .. 34, see formula 2.2)
- 4 load groups for the situation 'Ultimate limit state seismic' (US, LG35 .. 38, see formula 2.3)
- 5 load groups for the situation 'Serviceability limit state characteristic' (SC, LG39 .. 43, see formula 2.4)
- 5 load groups for the situation 'Serviceability limit state frequent' (SF, LG44 .. 48, see formula 2.5)
- 4 load groups for the situation 'Serviceability limit state quasi-permanent' (SQ, LG49 .. 52, see formula 2.6)



2.2 Load	Groups						
	A	В	C	D	E	F	G
LG	Apply	Design Situation	LC1	LC2	LC3	LC4	LC5
IG1		FR	1 10		-		
LG2		FR	1 10	1.50	-		
163		EB	1 10	1.50	1.05	-	-
164		ED	1.10	1.50	1.00		
165		ED	1.10	1.05	1.50		-
LGG		ED	0.00	1.05	1.00	•	-
167		ED	0.50	1 50	-	-	-
1.69		ED	0.00	1.50	1.05	-	-
1.69			0.50	1.50	1.00	-	-
1610		EB	0.90	1.05	1.50	-	-
LG11		EB	1.00	CU.I	UC.I	1.00	-
LG12		EA	1.00	-	-	1.00	-
LG12	쓰	EA	1.00	0.70	-	1.00	-
LG13	<u> </u>	EA	1.00	0.70	0.60	1.00	-
LG14		EA	1.00		0.70	1.00	-
LG15		EA	1.00	0.60	0.70	1.00	-
LG16	<u> </u>	EA	0.95	-	-	1.00	-
LG1/	×	EA	0.95	0.70	-	1.00	-
LG18	×	EA	0.95	0.70	0.60	1.00	-
LG19	×	EA	0.95	-	0.70	1.00	-
LG20		EA	0.95	0.60	0.70	1.00	-
LG21	×	ES	1.00	-	-	-	1.00
LG22	×	ES	1.00	0.60	-	-	1.00
LG23	×	ES	1.00	0.60	0.60	-	1.00
LG24	×	ES	1.00	-	0.60	-	1.00
LG25	×	UB	1.35	-	-	-	-
LG26	×	UB	1.35	1.50	-	-	-
LG27	×	UB	1.35	1.50	1.05	-	-
LG28	×	UB	1.35	-	1.50	-	-
LG29	×	UB	1.35	1.05	1.50	-	-
LG30		UA	1.00	-	-	1.00	-
LG31		UA	1.00	0.70	-	1.00	-
LG32		UA	1.00	0.70	0.60	1.00	-
LG33		UA	1.00	-	0.70	1.00	-
LG34		UA	1.00	0.60	0.70	1.00	-
LG35		US	1.00	-	-	-	1.00
LG36		US	1.00	0.60	-	-	1.00
LG37		US	1.00	0.60	0.60	-	1.00
LG38		US	1.00		0.60	-	1.00
LG39	×	SC	1.00	-	-	-	-
LG40	×	SC	1.00	1.00	-	-	-
LG41		SC	1.00	1.00	0.70	-	-
LG42		SC	1.00	-	1.00	-	-
LG43		SC	1.00	0.70	1.00	-	-
LG44		SF	1.00			-	-
LG45		SF	1.00	0.70	-		-
LG46		SF	1.00	0.70	0.60	-	-
LG47		SE	1.00	-	0.70	-	-
LG48		SE	1.00	0.60	0.70	-	-
LG49		SQ	1.00				-
1650		SQ	1.00	0.60			
1651		50	1.00	0.00	0.60		
1652		50	1.00	0.00	0.00		
LUDZ	<u> </u>	26	1.00	-	0.00	-	-

Figure 5.7: Mask 2.2 Load Groups, all design situations (overall view)

When you export the 52 generated load groups to RSTAB, there is a possibility to export three 'Either-or' combinations additionally. For this, simply select this option in the section *Either/or Load Combination* in the *Export* dialog box (see Figure 5.8).



Figure 5.8: Dialog box Export

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Three load combinations are created:

- CO1: LG1/p or LG2/p or LG3/p or ... or LG24/p
- CO2: LG25/p or LG26/p or LG27/p or LG28/p or LG29/p
- CO3: LG39/p or LG40/p or LG41/p or ... or LG52/p

CO1 determines the extreme values for the design situation 'Static equilibrium', CO2 the extreme values for the design situation 'Ultimate limit state', and CO3 the extreme values for the design situation 'Serviceability limit state'.

5.2 Girder with Cantilever (DIN 1055-100)

Structure and loads

A single-span girder with a cantilever beam is, similar to the previous example, loaded by permanent loads, live loads and traffic loads. The imposed loads are divided into two load cases: one part acts on the span, the other part on the cantilever.

Load case	Action	Action category
LC1, LC2	AC1	permanent
LC3, LC4	AC2	imposed loads, 3.C – congregation areas $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$
LC5 or LC6	AC3	traffic loads, 3.F – vehicle weight < 30 kN $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$

Table 5.2: Load cases and actions

Load groups are to be generated for the design situation 'Ultimate limit state - basic combination' according to DIN 1055-100.

Input data

In the mask 1.1 *General Data*, you choose that **load groups** are to be generated according to **DIN 1055-100** for the design situation **Ultimate limit state - basic combination**.

To distinguish favorable and unfavorable actions of permanent loads, you select the option *Generate supplementary combinations from favorable permanent actions*.



41	 1.1 General Data 			
put Data	Generate for RSTAB of		Supplementary Examination	
General Data Actions	O Load Groups		<u>Reduce Possible Load Groups by</u>	
- Action Categories	Coad Combinations	⊻ariable Superposition	Examining RSTAB Results	
	Contractions - Combinations - Contractions - Con	Permanent Superposition	From Automatically Defined	a 💶 o 🚺
	Combination Pulse acco	rding to Code	Combinations	
	DIN 1055 100		From Load Combinations:	
	001-0001 MIC	•		
	Generating for Design S	lituations		
	🔝 <u>S</u> tatic Equilibrium:	Basic Combination EB		
		Accidental EA		
		Seismic ES		S
	Ultimate Limit State:	Basic Combination UB		
		Seismic US		
	Serviceability Limit	Characteristic SC		
	State:	Frequent SF		Generating Load Groups or
		Quasi-permanent SQ		Load Combinations
	Generate Suppleme	ntary Combinations	-	
		Iditerit Actions		
	Comment		Numbering	
			Start Number of Generated	
			- Load Group: 1 👔	The second second

Figure 5.9: Mask 1.1 General Data

When you open mask 1.2, the action **AC1** is created automatically and load case **LC1** is allocated to it. This mask looks like the one of example 1 in Figure 5.2. However, it is necessary to allocate LC2 to AC1 as well, which you do by using the button displayed here on the left.

AC2 and AC3 are created by clicking the button [Create New Action] in the section Actions.

When allocating LC5 and LC6 to AC3, you must pay attention to their mutual exclusivity. Hence, you enter the same description in the *Alternative* column.

RSCOMBI 2006 - [Example_2]				×
<u>File</u> <u>Settings</u> <u>H</u> elp				
CA1 -	1.2 Load Cases in Actions			
Input Data Ceneral Data Actions Action Categories	Actions AC1 Permanent actions AC2 Imposed loads AC3 Traffic loads		xction <u>D</u> escription: Traffic loads xction <u>C</u> omment:	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories''.
	Existing Load Cases		oad Cases in Action AC3 No. Load Case Description LC5 Traffic load - span LC6 Traffic load - cantilever	Alternative Load Postio Load Postio
o FB		Check		OK Cancel
		ensur		

Figure 5.10: Mask 1.2 Actions

to alloc

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You carry out the allocation of actions AC1, AC2, and AC3 to corresponding categories like in example 1. There have no imperfections been defined in the second example, too.

Results

For the design situation 'Ultimate limit state - basic combination', 36 load groups are generated according to formula 2.1 (see page 6). These load groups are listed as 10 items in mask 2.1.

ile Settings Help												
X1	 2.1 Load 	Groups	by Actions									
nnut Data		A	В	С	D	Е	F	1				
- General Data			Generated	Design								
Actions	No.	Apply	Load Groups	Situation	AC1	AC2	AC3					
Action Categories	1	×	LG1	UB	1.35	-	-					
lesults	2	×	LG2 4	UB	1.35	1.50	-					
- Load Groups by Actions	3	×	LG5 10	UB	1.35	1.50	1.05					
- Load Groups	4	×	LG11 12	UB	1.35		1.50					
Load Groups - Reduced	5	×	LG13 18	UB	1.35	1.05	1.50					
•	6	×	LG19	UB	1.00	-	-					
	7	×	LG20 22	UB	1.00	1.50	-					
	8	×	LG23 28	UB	1.00	1.50	1.05					
	9	×	LG29 30	UB	1.00		1.50					
	10	×	LG31 36	UB	1.00	1.05	1.50					
	Actions	: in Gener	ated Load Group:	LG5 10		U	timate lin	nit state -	Basic Co	mbination	Load C	ases in Action AC2
	AC	_	Action Descript	ion	Category	Domi	nant	γ	Ψ	γ.Ψ	No.	Load Cases
		Perma	nent actions		1.			1.35	-	1.35	1	LC3
	AC1										-	
	AC1 AC2	Impos	ed loads		3.C	2	3	1.50	-	1.50	2	LC3 + LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F			1.50 1.50	- 0.70	1.50 1.05	2	LC3 + LC4 LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F		<u>]</u>	1.50	0.70	1.50 1.05	3	LC3 + LC4 LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F		<u>]</u>	1.50	0.70	1.50 1.05	3	LC3+LC4 LC4
	AC1 AC2 AC3	Impose Traffic	ed loads loads		3.C 3.F		<u>]</u>	1.50	0.70	1.50 1.05	3	LC3+LC4 LC4
	AC1 AC2 AC3	Impose Traffic	ed loads loads		3.C 3.F			1.50	0.70	1.50 1.05	3	LC3 + LC4 LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F]	1.50	0.70	1.50 1.05	3	LC3 + LC4 LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F		<u>]</u>	1.50	0.70	1.50 1.05	3	LC3+LC4 LC4
	AC1 AC2 AC3	Impos Traffic	ed loads loads		3.C 3.F			1.50	0.70	1.50	3	LC3 + LC4 LC4
	AC1 AC2 AC3	Traffic	ed loads loads		3.C 3.F			1.50	0.70	1.50	3	LC3 + LC4 LC4
	AC1 AC2 AC3	Impose Traffic	ed loads loads		3.C 3.F			1.50	0.70	1.50 1.05	3	LC3+LC4 LC4

Figure 5.11: Mask 2.1 Load Cases by Actions

All generated load groups are individually shown in mask 2.2 Load Groups.



	A	В	C	D	E	F	G	H
		Design						
LG	Apply	Situation	LC1	LC2	LC3	LC4	LC5	LC
LG1		UB	1.35	1.35	-	-	-	-
LG2	×	UB	1.35	1.35	1.50	-	-	-
LG3	×	UB	1.35	1.35	1.50	1.50	-	-
LG4	×	UB	1.35	1.35	-	1.50	-	-
LG5	×	UB	1.35	1.35	1.50	-	1.05	-
LG6	×	UB	1.35	1.35	1.50	-	-	1.0
LG7	×	UB	1.35	1.35	1.50	1.50	1.05	-
LG8	×	UB	1.35	1.35	1.50	1.50	-	1.0
LG9	×	UB	1.35	1.35	-	1.50	1.05	-
LG10	×	UB	1.35	1.35	-	1.50	-	1.0
LG11	×	UB	1.35	1.35	-	-	1.50	-
LG12	×	UB	1.35	1.35	-	-	-	1.5
LG13	×	UB	1.35	1.35	1.05	-	1.50	-
LG14	×	UB	1.35	1.35	1.05	-	-	1.
LG15	×	UB	1.35	1.35	1.05	1.05	1.50	-
LG16	×	UB	1.35	1.35	1.05	1.05	-	1.
LG17	×	UB	1.35	1.35	-	1.05	1.50	-
LG18	×	UB	1.35	1.35	-	1.05	-	1.5
LG19	×	UB	1.00	1.00	-	-	-	-
LG20	×	UB	1.00	1.00	1.50	-	-	-
LG21	×	UB	1.00	1.00	1.50	1.50	-	-
LG22	×	UB	1.00	1.00	-	1.50	-	-
LG23	×	UB	1.00	1.00	1.50	-	1.05	-
LG24	×	UB	1.00	1.00	1.50	-	-	1.0
LG25	×	UB	1.00	1.00	1.50	1.50	1.05	-
LG26	×	UB	1.00	1.00	1.50	1.50	-	1.0
LG27	×	UB	1.00	1.00	-	1.50	1.05	-
LG28	×	UB	1.00	1.00	-	1.50	-	1.0
LG29	×	UB	1.00	1.00	-	-	1.50	-
LG30	×	UB	1.00	1.00	-	-	-	1.5
LG31	×	UB	1.00	1.00	1.05	-	1.50	-
LG32	×	UB	1.00	1.00	1.05	-	-	1.5
LG33	×	UB	1.00	1.00	1.05	1.05	1.50	-
LG34	×	UB	1.00	1.00	1.05	1.05	-	1.5
LG35	×	UB	1.00	1.00	-	1.05	1.50	-
LG36		UB	1.00	1.00	-	1.05	-	1.5

Figure 5.12: Mask 2.2 Load Groups (overall view)

When you compare masks 2.1 (Figure 5.11) and 2.2 (Figure 5.12), you can see that a total of six load groups in mask 2.2 correspond to the third table row in mask 2.1: 1.35AC1 + 1.50 AC2 + 1.05 AC3:

- LG5: 1.35LC1 + 1.35LC2 + 1.50LC3 +1.05LC5
- LG6: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.05LC6
- LG7: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.50LC4 + 1.05LC5
- LG8: 1.35LC1 + 1.35LC2 + 1.50LC3 + 1.50LC4 + 1.05LC6
- LG9: 1.35LC1 + 1.35LC2 + 1.50LC4 +1.05LC5
- LG10: 1.35LC1 + 1.35LC2 + 1.50LC4 +1.05LC6

These load groups can be retraced by substituting all possible load combinations by actions successively:

- AC1: LC1 + LC2
- AC2: LC3
 - LC3 + LC4 LC4
- AC3: LC5 LC6



Note

The permanent loads LC1 of the span and LC2 of the cantilever were allocated to the action AC1. Therefore, the same partial coefficients (1.35 or 1.00) are always assigned to both load cases in the load groups. If LC1 and LC2 act independently, you must allocate these load cases to different actions:

Load case	Action	Action category
LC1	AC1	permanent
LC2	AC2	permanent
LC3, LC4	AC3	imposed loads, 3.C - congregation areas $\psi_0 = 0,70, \psi_1 = 0,70, \psi_2 = 0,60, \psi_2 = 0,60$
LC5 or LC6	AC4	traffic loads, 3.F - vehicle weight < 30 kN $\psi_0 = 0,70, \psi_1 = 0,70, \psi_2 = 0,60$

Table 5.3: LC1 and LC2 in different actions

In this case, the load cases LC1 and LC2 are multiplied by different partial coefficients. Then a total of 72 load groups will be generated.

2.1 Load	d Groups	by Actions					
	A	В	С	D	E	F	G
		Generated	Design				
No.	Apply	Load Groups	Situation	AC1	AC2	AC3	AC4
1		LG1	UB	1.35	1.35	-	-
2	×	LG2 4	UB	1.35	1.35	1.50	-
3	×	LG5 10	UB	1.35	1.35	1.50	1.05
4	×	LG11 12	UB	1.35	1.35	-	1.50
5	×	LG13 18	UB	1.35	1.35	1.05	1.50
6	×	LG19	UB	1.00	1.35	-	-
7	×	LG20 22	UB	1.00	1.35	1.50	-
8	×	LG23 28	UB	1.00	1.35	1.50	1.05
9	×	LG29 30	UB	1.00	1.35	-	1.50
10	×	LG31 36	UB	1.00	1.35	1.05	1.50
11	×	LG37	UB	1.00	1.00	-	-
12	×	LG38 40	UB	1.00	1.00	1.50	-
13	×	LG41 46	UB	1.00	1.00	1.50	1.05
14	×	LG47 48	UB	1.00	1.00	-	1.50
15	×	LG49 54	UB	1.00	1.00	1.05	1.50
16	×	LG55	UB	1.35	1.00	-	-
17	×	LG56 58	UB	1.35	1.00	1.50	-
18	×	LG59 64	UB	1.35	1.00	1.50	1.05
19	×	LG65 66	UB	1.35	1.00	-	1.50
20	×	LG67 72	UB	1.35	1.00	1.05	1.50

Figure 5.13: Mask 2.1 Load Groups by Actions (LC1 and LC2 in different actions)



5.3 Skeleton Structure (DIN 1055-100)

Structure and loads

A skeleton structure is loaded by permanent load, live load of office areas, live load of shopping areas, wind and snow.

Load case	Action	Action category	
LC1	AC1	permanent	
LC2, LC3	AC2	mposed loads, 3.B - offices $\psi_0 = 0.70, \psi_1 = 0.50, \psi_2 = 0.30$	
LC4, LC5	AC3	imposed loads, 3.D - shopping $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$	
LC6 or LC7	AC4	5 wind loads $\psi_0 = 0.60, \psi_1 = 0.50, \psi_2 = 0$	
LC8	AC5	4.A - snow and ice loads - sites at altitude < 1000 m $\psi_0 = 0.50, \psi_1 = 0.20, \psi_2 = 0$	

Table 5.4: Load cases and actions

There are load groups and load combinations to be generated for the design situation 'Ultimate limit state - basic combination' according to DIN 1055-100.

Input data for generation of load groups

In mask 1.1 *General Data*, you choose that **load groups** are to be generated according to **DIN 1055-100** for the design situation **Ultimate limit state - basic combination**.

When you open mask 1.2, the action **AC1** is created automatically and load case **LC1** is allocated to it. This mask looks like the one of example 1 in Figure 5.2.

2

The actions AC2 to AC5 are created by using the button [Create New Action] in the section *Actions*. When allocating LC6 and LC7 to AC4, you must pay attention to their mutual exclusivity. Hence, you enter the same description in the *Alternative* column.



RSCOMBI 2006 - [Example_3]		×
<u>File</u> <u>Settings</u> <u>H</u> elp		
CA1 👻	1.2 Load Cases in Actions	
Input Data – General Data – Actions – Action Categories	Actions AC1 Permanent actions AC2 Imposed loads - offices AC3 Imposed loads - shopping AC4 V/nd loads AC5 Snow and ice loads	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories''.
		
	Calculation Coefficients Check	OK Cancel

Figure 5.14: Mask 1.2 Actions

The actions are then allocated to specific categories in mask 1.3. For the two live loads, it is necessary to create two actions AC2 and AC3 because different combination coefficients ψ apply for offices (LC2 and LC3, AC2) and for shopping areas (LC4 and LC5, AC3). However, according to [9], annex A, page 37, imposed and traffic loads within one building are usually can be joined to one independent action. All imposed and traffic loads are considered as one action in the combination according to formula 2.1 (see page 6) for the design situation 'Ultimate limit state - basic combination' if you activate the option *Live loads and traffic loads to be subsumed as one independent action*.

	 1.3 Actions in Action Categories accordi 	ng to DIN 1055-100	
out Data - General Data	Action Categories	Actions	
- Actions - Action Categories	1. Permanent Actions	G _{k,j} : AC1	3
	<u>2</u> . Prestress	Pk:	₹ 3
	3.A Imposed Loads - Category A - Dome:	stic, Residential Q _{k,i} :	🔨 🔽 Live Loads a
	3. <u>B</u> · Category B · Office:	s Q _{k,i} : AC2	Subsumed as
	3. <u>C</u> · Category C · Congr	egation Areas Q _{k,i} :	Independent
	3.D · Category D · Shopp	ing Q _{k,i} : AC3	1
	3.E · Category E · Storag	je Q _{k,i} :	5
	3.E Traffic Loads · Category F - Vehicl	le Weight ≤ 30 kN Q _{k.i} :	1
	3. <u>G</u> · Category G - Vehicl	le Weight ≤ 160 kN. Q _{k,i} :	1
	3. <u>H</u> · Category H · Roofs	Q _{k,i} :	3
	4.A Snow and Ice Loads - Sites at Attitu	de H≤1 000 m Qkri: AC5	💦 📃 Do Not Comb
	- 4.B - Sites at Altitud	de H > 1 000 m Q _{k,i} :	Selected Loa
		0	Load Cases
	5. Wind Loads		3
	6. Temperature (non Fire)	Qk,i:	<u></u>
	Z. Foundation Subsidence	Qk,i:	Acting Load
	8. Other Actions	Qk,i:	Cases
	9. Accidental Actions	Ad:	3
	1 <u>0</u> . Seismic Actions	A _{Ed} :	1

Figure 5.15: Mask 1.3 Action Categories



There have no imperfections been defined in this example.

Results

203 load groups are generated for the design situation 'Ultimate limit state - basic combination' according to formula 2.1 (see page 6). In mask 2.1, these are shown as follows:

2.1 Load	Groups	by Actions						
	A	B	С	D	E	F	G	Н
		Generated	Design					
No.	Apply	Load Groups	Situation	AC1	AC2	AC3	AC4	AC5
1	×	LG1	UB	1.35	-	-	-	-
2	×	LG2 4	UB	1.35	1.50	-	-	-
3	×	LG5 13	UB	1.35	1.50	1.50	-	-
4	×	LG14 31	UB	1.35	1.50	1.50	0.90	-
5	×	LG32 49	UB	1.35	1.50	1.50	0.90	0.75
6	×	LG50 58	UB	1.35	1.50	1.50	-	0.75
7	×	LG59 64	UB	1.35	1.50	-	0.90	-
8	×	LG65 70	UB	1.35	1.50	-	0.90	0.75
9	×	LG71 73	UB	1.35	1.50	-	-	0.75
10	×	LG74 76	UB	1.35	-	1.50	-	-
11	×	LG77 82	UB	1.35	-	1.50	0.90	-
12	×	LG83 88	UB	1.35	-	1.50	0.90	0.75
13	×	LG89 91	UB	1.35	-	1.50	-	0.75
14	×	LG92 93	UB	1.35	-	-	1.50	-
15	×	LG94 99	UB	1.35	1.05	-	1.50	-
16	×	LG100 117	UB	1.35	1.05	1.05	1.50	-
17	×	LG118 135	UB	1.35	1.05	1.05	1.50	0.75
18	×	LG136 141	UB	1.35	1.05	-	1.50	0.75
19	×	LG142 147	UB	1.35	-	1.05	1.50	-
20	×	LG148 153	UB	1.35	-	1.05	1.50	0.75
21	×	LG154 155	UB	1.35	-	-	1.50	0.75
22	×	LG156	UB	1.35	-	-	-	1.50
23	×	LG157 159	UB	1.35	1.05	-	-	1.50
24	×	LG160 168	UB	1.35	1.05	1.05	-	1.50
25	×	LG169 186	UB	1.35	1.05	1.05	0.90	1.50
26	×	LG187 192	UB	1.35	1.05	-	0.90	1.50
27	×	LG193 195	UB	1.35	-	1.05	-	1.50
28	×	LG196 201	UB	1.35	-	1.05	0.90	1.50
29	×	LG202 203	UB	1.35	-	-	0.90	1.50

Figure 5.16: Mask 2.1 Load Groups by Actions (overall view)

The fact that actions AC2 and AC3 are considered as one action can be seen in the results: These two actions are taken into account together either as dominant load $Q_{k,1}$ (coefficient 1.5) or as secondary load $Q_{k,i}$ (coefficient 1.05).

Thus, both AC2 and AC3 are considered as Dominant actions in load groups LG14 to LG31.

l Groups	by Actions							
A	В	С	D	E	F	G	H	
	Generated	Design						
Apply	Load Groups	Situation	AC1	AC2	AC3	AC4	AC5	
×	LG1	UB	1.35	-	-	-	-	
×	LG2 4	UB	1.35	1.50	-	-	-	
×	LG5 13	UB	1.35	1.50	1.50	-	-	
×	LG14 31	UB	1.35	1.50	1.50	0.90	-	
×	LG32 49	UB	1.35	1.50	1.50	0.90	0.75	
×	LG50 58	UB	1.35	1.50	1.50	-	0.75	
×	LG59 64	UB	1.35	1.50	-	0.90	-	
×	LG65 70	UB	1.35	1.50	-	0.90	0.75	
×	LG71 73	UB	1.35	1.50	-	-	0.75	
×	LG74 76	UB	1.35	-	1.50	-	-	
×	LG77 82	UB	1.35	-	1.50	0.90	-	
×	LG83 88	UB	1.35	-	1.50	0.90	0.75	
	Groups Apply X X X X X X X X X X X X X X X X X X X	A B A B Generated Load Groups A LG1 X LG24 X LG513 X LG1431 X LG5058 X LG5058 X LG5058 X LG5170 X LG57173 X LG7173 X LG7782 X LG8388	A B C Apply Generated Design Apply Load Groups Situation X LG1 UB X LG24 UB X LG513 UB X LG3249 UB X LG5058 UB X LG5964 UB X LG5570 UB X LG7173 UB X LG7476 UB <td>A B C D Generated Design A A B C D Apply Load Groups Situation AC1 B 1.35 A B 1.35 A B 1.35 A A B 1.35 A A B 1.35 A A B 1.35 A A A A B 1.35 A</td> <td>A B C D E Generated Design AC2 AC2 AC2 Apply Load Groups Situation AC1 AC2 K LG1 UB 1.35 - K LG24 UB 1.35 1.50 K LG513 UB 1.35 1.50 K LG3249 UB 1.35 1.50 K LG5058 UB 1.35 1.50 K LG5964 UB 1.35 1.50 K LG6570 UB 1.35 1.50 K LG7173 UB 1.35 1.50 K LG7476 UB 1.35 - K LG7782 UB 1.35 -</td> <td>Groups by Actions A B C D E F Generated Apply Design Load Groups Situation AC1 AC2 AC3 K LG1 UB 1.35 - - - K LG2 4 UB 1.35 1.50 - K LG3 UB 1.35 1.50 - - K LG5 13 UB 1.35 1.50 1.50 K LG32 .49 UB 1.35 1.50 1.50 K LG32 .49 UB 1.35 1.50 1.50 K LG35 .50 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K</td> <td>Groups by Actions A B C D E F G Generated Apply Design Load Groups Situation AC1 AC2 AC3 AC4 K LG1 UB 1.35 - - - K LG2 4 UB 1.35 1.50 - - K LG513 UB 1.35 1.50 1.50 - - K LG513 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 - 0.90 K LG5558 UB 1.35 1.50 - 0.90 K LG5570 UB 1.35 1.50 - 0.90 K LG7476 UB 1.35 - 1.50 - K<</td> <td>Groups by Actions A B C D E F G H Generated Apply Design Load Groups C D E F G H Generated LG1 Design UB AC1 AC2 AC3 AC4 AC5 K LG1 UB 1.35 - - - - K LG24 UB 1.35 1.50 - - - K LG513 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 0.90 - K LG3249 UB 1.35 1.50 1.50 0.90 - K LG3558 UB 1.35 1.50 - 0.75 K LG5570 UB 1.35 1.50 - 0.75 K LG7476 UB 1.35 - 1.50</td>	A B C D Generated Design A A B C D Apply Load Groups Situation AC1 B 1.35 A B 1.35 A B 1.35 A A B 1.35 A A B 1.35 A A B 1.35 A A A A B 1.35 A	A B C D E Generated Design AC2 AC2 AC2 Apply Load Groups Situation AC1 AC2 K LG1 UB 1.35 - K LG24 UB 1.35 1.50 K LG513 UB 1.35 1.50 K LG3249 UB 1.35 1.50 K LG5058 UB 1.35 1.50 K LG5964 UB 1.35 1.50 K LG6570 UB 1.35 1.50 K LG7173 UB 1.35 1.50 K LG7476 UB 1.35 - K LG7782 UB 1.35 -	Groups by Actions A B C D E F Generated Apply Design Load Groups Situation AC1 AC2 AC3 K LG1 UB 1.35 - - - K LG2 4 UB 1.35 1.50 - K LG3 UB 1.35 1.50 - - K LG5 13 UB 1.35 1.50 1.50 K LG32 .49 UB 1.35 1.50 1.50 K LG32 .49 UB 1.35 1.50 1.50 K LG35 .50 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K LG65 .70 UB 1.35 1.50 - K	Groups by Actions A B C D E F G Generated Apply Design Load Groups Situation AC1 AC2 AC3 AC4 K LG1 UB 1.35 - - - K LG2 4 UB 1.35 1.50 - - K LG513 UB 1.35 1.50 1.50 - - K LG513 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 - 0.90 K LG5558 UB 1.35 1.50 - 0.90 K LG5570 UB 1.35 1.50 - 0.90 K LG7476 UB 1.35 - 1.50 - K<	Groups by Actions A B C D E F G H Generated Apply Design Load Groups C D E F G H Generated LG1 Design UB AC1 AC2 AC3 AC4 AC5 K LG1 UB 1.35 - - - - K LG24 UB 1.35 1.50 - - - K LG513 UB 1.35 1.50 1.50 - - K LG3249 UB 1.35 1.50 1.50 0.90 - K LG3249 UB 1.35 1.50 1.50 0.90 - K LG3558 UB 1.35 1.50 - 0.75 K LG5570 UB 1.35 1.50 - 0.75 K LG7476 UB 1.35 - 1.50

Acti	ions ir	n Generated Load Group: LG1431		Ultimate I	imit state -	Basic Cor	nbination
ŀ	٩C	Action Description	Category	Dominant	γ	Ψ	γ.Ψ
A	C1	Permanent actions	1.		1.35	-	1.35
A	C2	Imposed loads - offices	3.B	×	1.50	-	1.50
A	C3	Imposed loads - shopping	3.D	×	1.50	-	1.50
A	C4	Wind loads	5.		1.50	0.60	0.90

Figure 5.17: Actions in generated load groups LG14 .. 31



Input data for generation of load combinations

The input data differs from the previous entry in one thing only: in mask 1.1, you select the option **Load combinations - variable superposition** in section *Generate for RSTAB*.

A1 •	1.1 General Data			
nput Data	Generate for RSTAB of		Supplementary Examination	
- Lieneral Data	Coad Groups	[Reduce Possible Load Combinations by	
Action Categories	Load Combinations -	⊻ariable Superposition	Examining RSTAB Results	
	Contractions - Combinations - Contractions - Con	Permanent Superposition	From Automatically Defined	
			Combinations	
	Combination Rules acco	rding to Code	From Load Combinations:	
	DIN 1055-100	-		
	Generating for Design S	ituations		
	Static Equilibrium:	Basic Combination	в	
		Accidental 8	A	U
		Seismic B	S	
	☑ Ultimate Limit State:	V Basic Combination	IB	
		Accidental I	A	
		Seismic I	IS	
	Serviceability Limit	Characteristic	C	Concepting
	State:	Frequent	F	Load Groups or
		Quasi-permanent	Q	Load Combination
	Generate Suppleme	ntary Combinations		
	from Pavorable Pern	ianent Actions		
	<u>C</u> omment		Numbering	
			Start Number of Generated	
			- Load Combination: 1	

Figure 5.18: Mask 1.1 General Data: Generation of load combinations

Results of generation of load combinations

For the design situation 'Ultimate limit state - basic combination', three load combinations CO7 to CO9 are generated which are to be analyzed. These combinations are created according to formula 2.1 (see page 6).

	F													
CA1 👻	2.1 Load	Combi	nations by A	ctions										
Input Data		A	B	C	D	E	F	G						
General Data	00		Design		400			105						
- Actions		Apply	Situation	AC1	AC2	AC3	AC4	AC5						
Action Categories	/	×	UB	1.35/p	1.50/p	1.50/p	0.90	0.75						
Results	<u>8</u>		UB	1.35/p	1.05	1.05	1.50/p	0.75						
 Load Combinations by Actions 	3	×	UB	1.35/p	1.05	1.05	0.90	1.50/p						
- Load Combinations														
Load Combinations - Heduced														
	Actions	in Gener	rated Load Co	ombination	: CO7		UI	ltimate lin	nit state -	Basic Cor	mbination	Load Co	ombinations in AC	2
	Actions AC	in Gener	ated Load Co Action Des	ombination	: CO7	Category	UI Domin	ltimate lin	nit state - 7	Basic Cor	nbination γ.ψ	Load Co No.	ombinations in AC	2 ases
	Actions AC AC1	in Gener	rated Load Co Action Des nent actions	ombination	: CO7	Category 1.	UI Domin	ltimate lin nant	nit state - 7 1.35	Basic Cor ¥	mbination γ.Ψ 1.35	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2	in Gener Perma	rated Load Co Action Deso nent actions ed loads - offic	ombination cription ces	: CO7	Category 1. 3.B	UI Domin	ltimate lir nant	nit state - γ 1.35 1.50	Basic Cor ¥ -	nbination γ.ψ 1.35 1.50	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3	in Gener Perma Impose	rated Load Co Action Des nent actions ed loads - offic ed loads - sho	ombination cription ces pping	: CO7	Category 1. 3.B 3.D	UI Domin	timate lin nant	nit state - 7 1.35 1.50 1.50	Basic Cor V -	mbination γ.Ψ 1.35 1.50 1.50	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC3 AC4	in Gener Perma Impose Wind I	rated Load Co Action Desinent actions ed loads - offic ed loads - sho loads	ombination cription ces pping	: CO7	Category 1. 3.B 3.D 5.		timate lir nant	nit state - γ 1.35 1.50 1.50 1.50	Basic Cor	nbination 7 · Ψ 1.35 1.50 1.50 0.90	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ises
	Actions AC AC1 AC2 AC3 AC4 AC5	in Gener Perma Impose Wind I Snow	ated Load Cc Action Des nent actions ed loads - offic ed loads - sho oads and ice loads	ombination cription ces opping	: CO7	Category 1. 3.B 3.D 5. 4.A		Itimate lin nant	nit state - γ 1.35 1.50 1.50 1.50 1.50 1.50	Basic Cor - - 0.60 0.50	mbination 7 · Ψ 1.35 1.50 1.50 0.90 0.75	Load Co No. 1	ombinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	in Gener Perma Impose Wind I Snow	rated Load Cc Action Des nent actions ed loads - offic ed loads - sho loads and ice loads	ombination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A	UI Domir	timate lir nant 0 0 1	mit state - γ 1.35 1.50 1.50 1.50 1.50 1.50	Basic Cor - - 0.60 0.50	nbination	Load Co No. 1	ombinations in AC Load Cz LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	Perma Impose Wind I Snow	rated Load Cc Action Desi nent actions ed loads - offic ed loads - sho loads and ice loads	ombination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A	UI Domin	timate lir nant G G J	nit state - γ 1.35 1.50 1.50 1.50 1.50	Basic Cor	nbination 7 · Ψ 1.35 1.50 1.50 0.90 0.75	Load Co No. 1	mbinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	in Gener Perma Impose Impose Wind I Snow	rated Load Cc Action Dese nent actions ed loads - offic ed loads - sho oads and ice loads	ombination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A	UI Domin	ltimate lin nant C C C C C C C C C C C C C C C C C C C	nit state - γ 1.35 1.50 1.50 1.50 1.50	Basic Cor 	γ · ψ 1.35 1.50 1.50 0.90 0.75	Load Co No. 1	ombinations in AC Load Ca LC2 + LC3	2 3585
	Actions AC AC1 AC2 AC3 AC4 AC5	in Gener Perma Impose Impose Wind I Snow	Action Des Action Des nent actions ed loads - offic ed loads - sho loads and ice loads	probination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A		ltimate lin	nit state - γ 1.35 1.50 1.50 1.50 1.50 1.50	Basic Cor	nbination γ · Ψ 1.35 1.50 0.90 0.75	Load Co No. 1	unbinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	Perma Impose Wind I Snow	rated Load Cc Action Desi nent actions ed loads - offic ed loads - sho oads and ice loads	ombination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A		timate lir nant 0 0 1	nit state - γ 1.35 1.50 1.50 1.50 1.50	Basic Cor	γ · ψ 1.35 1.50 1.50 0.90 0.75	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	Perma Impose Wind I Snow	Action Des Action Des nent actions ed loads - offic ed loads - offic ed loads - sho loads and ice loads	probination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A	UI Domin	timate lir nant 0 0 1	nit state - γ 1.35 1.50 1.50 1.50 1.50	Basic Cor - - 0.60 0.50	nbination 7 · ¥ 1.35 1.50 1.50 0.90 0.75	Load Co No.	umbinations in AC Load Ca LC2 + LC3	2 ases
	Actions AC AC1 AC2 AC3 AC4 AC5	Perma Impose Impose Wind I Snow	rated Load Cr Action Des nent actions de loads - sho ioads and ice loads	probination cription ces pping	: CO7	Category 1. 3.B 3.D 5. 4.A	UI Domii X	timate lir nant	nit state - γ 1.35 1.50 1.50 1.50 1.50	Basic Cor	nbination γ · ψ 1.35 1.50 1.50 0.90 0.75	Load Co No.	ombinations in AC Load Ca LC2 + LC3	2 ases

Figure 5.19: Mask 2.1 Load Combinations by Actions



The combinations CO1 to CO6 represent all possible combinations of load cases within the respective actions. In the lower part of mask 2.1 in Figure 5.19, you can see that the only possible internal load combination in action AC2 is the combination CO2 LC2 + LC3. If you click some different action, the internal combination for this action becomes visible.

Mask 2.2 differs from mask 2.1 mainly in the upper part, where actions are replaced by inner load combinations. If any inner load combinations are in brackets, then these inner combinations are in the relation *Alternative*.

RSCOMBI 2006 - [Example-3A]														
<u>F</u> ile <u>S</u> ettings <u>H</u> elp														
CA1 👻	2.2 Load	Combir	nations											
Input Data		A	В	C	D	E	F	G		H [
General Data	со	Apply	Design Situation	C01	CO2	CO3	CO4	COS	; ,	CO6				
Action Categories	C07	×	UB	1.35/p	1.50/p	1.50/p	(0.90)	(0.90)	0.75				
Results	CO8	×	UB	1.35/p	1.05	1.05	(1.50/p)	(1.50/	p)	0.75				
- Load Combinations by Actions	CO9	×	UB	1.35/p	1.05	1.05	(0.90)	(0.90) 1	50/p				
Coad Combinations - Reduced											liking	F 3		
	Load C	ases in Li	enerated Lo	ad Combinat	ion CU7		Provoil	0	officien	to	Ultimate	e limit state	- Basic Li	ombinati
	со	Apply	No.	Descrip	otion	Category	ing	y	V	ι ς γ.ψ	LC1/p	LC2	LC3	LC4
	C01		AC1	Permanent ac	ctions	1.	ń	1.35	-	1.35	1.0	-		
	CO2		AC2	mposed load	s - offices	3.B	×	1.50	-	1.50	-	1.0	1.0	-
	CO3	×	AC3	mposed load	s - shoppi	3.D	×	1.50	-	1.50	-	-	-	1.0
	CO4	×	AC4	Wind loads		5.		1.50	0.60	0.90	-	-		
	CO5	×	AC4	Wind loads		5.		1.50	0.60	0.90	-	-	-	-
	06	×	AC5	Snow and ice	loads	4.A		1.50	0.50	0.75		-	-	-
	∢					III								
	Domina	nt				Export						OK		Cancel

Figure 5.20: Mask 2.2 Load Combinations

The list of internal load combinations is displayed in the lower part of mask 2.2.

For example, the load combination CO7 is expressed as follows in mask 2.1 (Figure 5.19):

1.35AC1/p + 1.50AC2/p + 1.50AC3 + 0.90AC4 + 0.75AC5

If you replace AC1 by combination CO1, AC2 by CO2, AC3 by CO3, AC4 by CO4 or CO5, and AC5 by CO6, you get:

CO7: 1.35CO1/p + 1.50CO2/p + 1.50CO3/p + 0.90CO4 or 0.90CO5 + 0.75CO6



5.4 Skeleton Structure with Imperfections (DIN 1055-100)

Structure and loads

The skeleton structure from example 3 is again loaded by permanent loads, live loads of offices and shopping areas, wind and snow. Additionally, imperfections are included.

Load case	Action	Action category
LC1	AC1	permanent
LC2, LC3	AC2	imposed loads, 3.B - offices $\psi_0 = 0.70, \psi_1 = 0.50, \psi_2 = 0.30$
LC4, LC5	AC3	imposed loads, 3.D - shopping $\psi_0 = 0.70, \psi_1 = 0.70, \psi_2 = 0.60$
LC6 or LC7	AC4	5 wind loads $\psi_0 = 0.60, \psi_1 = 0.50, \psi_2 = 0$
LC8	AC5	4.A - snow and ice loads - sites at altitude < 1000 m $\psi_0 = 0.50, \psi_1 = 0.20, \psi_2 = 0$
LC9, LC10		imperfections

Table 5.5: Load cases and actions

Load groups are to be generated for the design situation 'Ultimate limit state - basic combination' according to DIN 1055-100.

Input data

In masks 1.1, 1.2, and 1.3, you enter the same input data as in example 3.

When you open mask 1.4, the two imperfection-type load cases LC9 and LC10 are shown.

RSCOMBI 2006 - [Example 4]							X
<u>File</u> <u>Settings</u> <u>H</u> elp							
CA1 👻	1.4 Imperfe	ction-Type Load Cases					
Input Data General Data Actions Categories Imperfections	Existing Lo LC3 LC10	ad Cases - Type Imperfection Imperfection +X Imperfection +Y		tion-Type Load Cases in Co Load Case Description	mbinatorics Alternative	Only with LC	Never with LC
	Calculation	Coefficients Chec	ж		(OK	Cancel

Figure 5.21: Mask 1.4 Imperfections

•



In order to consider the load cases LC9 and LC10 for the generated load groups, transfer them to the list *Imperfection-Type Load Cases in Combinations* by using the arrow. The imperfections LC9 and LC10 can never act simultaneously, hence the same description has to be applied in the column *Alternative*.

Load groups are calculated according to the second order theory. Therefore, every load group should contain one imperfection. For this reason, select the option *Allocation of imperfection-type load cases to each load group*.



Figure 5.22: Mask 1.4 Imperfections, LC9 and LC10 in a combination





Results

For the design situation 'Ultimate limit state - basic combination', 406 load groups are generated according to formula 2.1 (see page 6). These are listed in mask 2.1 as follows.

111	1.0	Los Autores						
2.1 LOa	a Groups	by Actions						
	A	B	C	D	E	F	G	H
Ne		Generated	Design					
INO.	Apply	Load Groups	Situation	AC1	AC2	AC3	AC4	AC5
1	X	LG12	UB	1.35	-	-	-	-
2	×	LG3 8	UB	1.35	1.50	-	-	-
3		LG9 26	UB	1.35	1.50	1.50	-	-
4		LG27 62	UB	1.35	1.50	1.50	0.90	-
5	×	LG63 98	UB	1.35	1.50	1.50	0.90	0.75
6	×	LG99 116	UB	1.35	1.50	1.50	-	0.75
7	×	LG117 128	UB	1.35	1.50	-	0.90	-
8	×	LG129 140	UB	1.35	1.50	-	0.90	0.75
9	×	LG141 146	UB	1.35	1.50	-	-	0.75
10	×	LG147 152	UB	1.35	-	1.50	-	-
11	×	LG153 164	UB	1.35	-	1.50	0.90	-
12	×	LG165 176	UB	1.35	-	1.50	0.90	0.75
13	×	LG177 182	UB	1.35	-	1.50	-	0.75
14	×	LG183 186	UB	1.35	-	-	1.50	-
15	×	LG187 198	UB	1.35	1.05	-	1.50	-
16	×	LG199 234	UB	1.35	1.05	1.05	1.50	-
17	×	LG235 270	UB	1.35	1.05	1.05	1.50	0.75
18	×	LG271 282	UB	1.35	1.05	-	1.50	0.75
19	×	LG283 294	UB	1.35	-	1.05	1.50	-
20	×	LG295 306	UB	1.35	-	1.05	1.50	0.75
21	×	LG307310	UB	1.35	-	-	1.50	0.75
22	×	LG311 312	UB	1.35	-	-	-	1.50
23	×	LG313 318	UB	1.35	1.05	-	-	1.50
24	×	LG319 336	UB	1.35	1.05	1.05	-	1.50
25	×	LG337 372	UB	1.35	1.05	1.05	0.90	1.50
26	×	LG373 384	UB	1.35	1.05	-	0.90	1.50
27	×	LG385 390	UB	1.35	-	1.05	-	1.50
28	×	LG391 402	UB	1.35	-	1.05	0.90	1.50
29		LG403_406	UB	1 35	-	-	0.90	1 50

Figure 5.23: Mask 2.1 Load Groups by Actions (overall view)

If you compare these results with those of the previous example 3 (Figure 5.16), you will notice that the number of generated load groups was duplicated. This is due to the fact that an imperfection was allocated to every load group, once as LC9 and once as LC10.

<u>File Settings H</u> elp																
CA1 🔻	2.2 Load	Groups														
Input Data		A	B	C	D	E	F	G	H		J	K	L			
- General Data	16		Design	1.01	1.00	1.00	1.04	1.05	1.00	107	1.00	1.00	1.010			
- Actions	Lu	Apply	Situation	LUT	LCZ	LC3	LC4	LCS	LCB	LC/	LC8	LC9	LC IU			
 Action Categories 	LGT	<u> </u>	UB	1.35		•		-				1.00	-			
Imperfections	LGZ		UB	1.35	-	•		-		•		-	1.00			
Results	LG3	<u> </u>	UB	1.35	1.50	•	•	-	•	•		1.00	-			
 Load Groups by Actions 	LG4		UB	1.35	1.50	1.50	•	-	•	•	•	1.00	1.00			
- Load Groups	LGS		UB	1.30	1.50	1.50	•	-	•	•	-	1.00	1.00			
Load Groups - Reduced	167		UB	1.30	1.50	1.00		-				1.00	1.00			
	169		UB	1.30	•	1.50	•	-	•	•		1.00	1.00			
	169		UB LID	1.00	1.50	1.00	1.50	-			-	1.00	1.00			
	1G10		LIB	1.30	1.50	•	1.50	•		•		1.00	1.00			
	LG11		LIR	1.35	1.50		1.50	1.50				1.00	1.00			
	1G12		LIB	1.35	1.50		1.50	1.50				1.00	1.00			
	Load C	ases in G	enerated Loa .oad Case De	id Group escriptio	LG1	Actio	n C	ategory	Prev	Ultimati vailing	e limit st γ	ate - Ba	isic Com ¥	nbination γ.ψ		
	LC1	Dead	oad			AC1		1.	[1.35	j 🛛	-	1.35		
	LC9	Imperf	ection +X					Imp	erfectio	n-Type	Load C	ase				
	Domina	nt					Export								ж	Cance

Figure 5.24: Mask 2.2 Load Groups



Note

Sometimes you know in advance that imperfections belong to certain load cases and it is pointless to connect them with other load cases. In this example, load case LC6 includes wind in direction +X and LC7 wind in direction +Y. The imperfection in LC9 is defined as inclination in direction +X and the imperfection in LC10 as inclination in direction +Y. Therefore it is not suitable to combine LC6 and LC10 or LC7 and LC9 in load groups. These groups will not be decisive.

In RSCOMBI, you can use this fact to reduce the number of generated load groups: Select the check box *Include imperfection-type load cases in combinations subject to defined load cases* in mask 1.4.



Figure 5.25: Mask 1.4 Imperfections, check boxes in the Options section

If you run the generation of load groups again now, only 250 load groups will be created instead of 406.



5.5 Frame (DIN 18800)

Structure and loads

The frame is loaded by permanent load, two variable loads and two accidental loads.

Load case	Action	Action category
LC1	AC1	permanent
LC2, LC3, LC4	AC2	variable (imposed loads)
LC5	AC3	variable (traffic loads)
LC6	AC4	accidental
LC7	AC5	accidental

Table 5.6: Load cases and actions

Load groups are to be generated for all design situations according to DIN 18800.

Input data

In the mask 1.1 *General Data*, you select that **load groups** are to be generated according to **DIN 18800**. Tick **all design situations**.

A1	 1.1 General Data 		
nput Data General Data	Generate for RSTAB of	Supplementary Examination	
- Actions	Load <u>Groups Load Combinations</u> - Variable Superposition	Reduce Possible Load Groups by Examining RSTAB Results	
Actor categores	Load Combinations - Permanent Superposition	From Automatically Defined	a 💻 o 🚺
	Combination Rules according to Code	Combinations Combinations:	
	DIN 18800		
	Generating for Design Situations		ō
	♥ Static Equilibrium: ♥ Basic Combination EB ♥ Accidental EA		U
	✓ Ultimate Limit State: ✓ Basic Combination UB ✓ Accidental UA		S
			~
			Generating
			Load Groups or Load Combinations
	Generate Supplementary Combinations from Favorable Permanent Actions		
	Comment	Numbering	
		Start Number of Generated - Load Group: 1	
	Colordation Coofficients Choole		

Figure 5.26: Mask 1.1 General Data

When you open mask 1.2, action AC1 is created automatically and load case LC1 is allocated to it. Other load cases defined in RSTAB are displayed in the list *Existing Load Cases*.



RSCOMBI 2006 - [Example_5]		•
<u>F</u> ile <u>S</u> ettings <u>H</u> elp		
CA1 ·	1.2 Load Cases in Actions	
Input Data General Data Actions Action Categories	Actions AC1 Self-weight Action Description: Self-weight Action Comment:	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to
	Existing Load Cases LC2 Live load 1 LC3 Live load 3 LC4 Live load 3 LC5 Traffic LC6 Shock LC7 Fire	Alternative
9 5 6	Calculation Coefficients Check	OK Cancel

Figure 5.27: Mask 1.2 Actions

2

The actions AC2 to AC5 are created by using the button [Create New Action]. Then, the corresponding load cases are allocated.

A1	↓ 1.2 Load Case	es in Actions					
nut Data							
- General Data	Actions	C -Ki-h	•			Note:	
- Actions	ALT	Seir-weight	-	Action D	escription:	Button 'Lreate New Ac be used to define "Acti	tion' ci ons''
- Action Categories	AL2	Live loads		Live loa	ds	 Those are independent 	ofea
	AL3	i rarric loads				other.	
	AL4	Accidental load I				By means of the tables	belov
	ALS .	Accidental load 2		Action <u>C</u>	omment:	allocated to each Actio	n.
						In the following table 1	3 the
			•			Actions are then alloca	ted to
	P					the corresponding "Aci Categories"	ion
						Calogones .	
	Existing Loa	d Cases		Load Ca	ases in Action AC2		
			*	No.	Load Case Description	Alternative	
				LC2	Live load 1		
					Live load 2		
			2				
			E				
			4				
			-				
			*			2	
			Plant 1				

Figure 5.28: Actions with allocated load cases



The actions are then allocated to individual categories in mask 1.3 Action Categories.

RSCOMBI 2006 - [Example_5]			- X
<u>File</u> <u>Settings</u> <u>H</u> elp			
CA1	 1.3 Actions in Action Categories according 	g to DIN 18800	
CA1 Input Data General Data Actions Action Categories	I.3 Actions in Action Categories according Action Categories I. Permanent Actions Variable Actions Accidental Actions	g to DIN 18800 Actions	
			Do Not Combine Selected Load Cases with Other Load Cases
5 4 Q	Calculation Coefficients Check		OK Cancel

Figure 5.29: Mask 1.3 Action Categories

As there haven't been defined any imperfections for this example in RSTAB, the input is complete.



Results

In mask 2.1, 128 load groups are listed as follows:

- 16 load groups for the situation 'Ultimate limit state basic combination' (UB, LG1 LG16, see formula 2.7 and formula 2.8)
- 32 load groups for the situation 'Ultimate limit state accidental' (UA, LG17 LG48, see formula 2.9)
- 32 load groups for the situation 'Static equilibrium basic combination' (EB, LG49 LG80, see formula 2.7 and formula 2.8)
- 32 load groups for the situation 'Static equilibrium accidental' (EA, LG81 - LG112, see formula 2.9)
- 16 load groups for the situation 'Serviceability limit state' (S, LG113 - LG128, see formula 2.7)

.1 Load	Groups	by Actions						
	A	B	<u> </u>	D	E	F	G	Н
No		Generated	Design					
INO.	Apply	Load Groups	Situation	AC1	AC2	AC3	AC4	AC5
1		LG1	UB	1.35	-	-	-	-
2	×	LG2 8	UB	1.35	1.50	-	-	-
3	×	LG9 15	UB	1.35	1.35	1.35	-	-
4	×	LG16	UB	1.35	-	1.50	-	-
5	×	LG17	UA	1.00	-	-	1.00	
6	×	LG18	UA	1.00	-	-	-	1.00
7	×	LG19 25	UA	1.00	0.90	-	1.00	
8	×	LG26 32	UA	1.00	0.90	0.90	1.00	-
9	×	LG33	UA	1.00	-	0.90	1.00	-
10	×	LG34 40	UA	1.00	0.90	-	-	1.00
11	×	LG41 47	UA	1.00	0.90	0.90	-	1.00
12	×	LG48	UA	1.00	-	0.90	-	1.00
13	×	LG49	EB	1.10	-	-	-	-
14	×	LG50 56	EB	1.10	1.50	-	-	-
15	×	LG5763	EB	1.10	1.35	1.35	-	-
16	×	LG64	EB	1.10	-	1.50	-	-
17	×	LG65	EB	0.90	-	-	-	-
18	×	LG66 72	EB	0.90	1.50	-	-	-
19	×	LG73 79	EB	0.90	1.35	1.35	-	-
20	×	LG80	EB	0.90	-	1.50	-	-
21		LG81	EA	1.00	-	-	1.00	-
22		LG82	EA	1.00	-	-	-	1.00
23		LG83 89	EA	1.00	0.90	-	1.00	-
24		LG90 96	EA	1.00	0.90	0.90	1.00	-
25		LG97	EA	1.00	-	0.90	1.00	-
26		LG98 104	EA	1.00	0.90	-	-	1.00
27		LG105 111	EA	1.00	0.90	0.90	-	1.00
28		LG112	EA	1.00	-	0.90	-	1.00
29	×	LG113	S	1.00	-	-	-	-
30	X	LG114 120	S	1.00	1.00	-	-	-
31	×	LG121 127	S	1.00	1.00	1.00	-	-
			-					

Figure 5.30: Mask 2.1 Load Groups by Actions (an overall view)



5.6 Girder Grillage (EN 1990)

Structure and loads

The girder grillage is loaded by permanent load, live load, traffic load, and snow and wind loads.

Load case	Action	Action category
LC1	AC1	permanent
LC2, LC3, LC4	AC2	imposed load, 3.D - shopping
LC5	AC3	traffic load, 3.F - vehicle weight < 30 kN
LC6	AC4	snow and ice loads - other CEN members - sites at alti- tude over 1000 m
LC7 or LC8	AC5	wind loads

Table 5.7: Load cases and actions

Load groups are to be generated for the design situation 'Ultimate limit state - basic combination' according to EN 1990 CEN.

Input data

In the mask 1.1 *General Data*, select that **load groups** are to be generated according to **EN 1990** for the design situation **Ultimate limit state - basic combination**. To economize on material, the combination rule according to **formulas 6.10 and 6.10b** is to be applied. Formulas 6.10 and 6.10b in EN 1990 correspond to Formula 2.11 and Formula 2.12 in this manual (see page 9).



Figure 5.31: Mask 1.1 General Data



When you open mask 1.2, the action **AC1** is created automatically and load case **LC1** is allocated to it. The remaining load cases that have been defined in RSTAB are displayed in the section *Existing Load Cases*.

RSCOMBI 2006 - [Example_6]			×
<u>File</u> <u>Settings</u> <u>H</u> elp			
CA1 👻	1.2 Load Cases in Actions		
Input Data — General Data — Actions — Action Categories	AC1 Permanent actions	Action Description: Permanent actions	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding "Action Categories'.
	Existing Load Cases LC2 Span 1 LC3 Span 2 LC4 Span 3 LC5 Traffic LC6 Snow LC7 Wind in +X LC8 Wind in +Y	Load Cases in Action AC1 No. Load Case Description LC1 Dead load	Alternative
	Calculation Coefficients Check		OK Cancel

Figure 5.32: Mask 1.2 Actions

2

The actions AC2 to AC5 can now be created by using the button [Create New Action].

When allocating LC7 and LC8 to action AC5, you must pay attention to the mutual exclusivity of these two load cases. Thus, enter the same description in the *Alternative* column.

RSCOMBI 2006 - [Example_6]				×
<u>File</u> <u>Settings</u> <u>H</u> elp				
CA1 🗸	1.2 Load Cases in Actions			
Input Data General Data Actions Action Categories	Actions AC1 Permanent actions Live loads AC3 Trafic loads AC4 Snow and ice loads AC5 Wind loads Existing Load Cases		Action Description: wind loads Action Comment:	Note: Button 'Create New Action' can be used to define 'Actions''. Those are independent of each other. By means of the tables below, Load Cases can then be allocated to each Action. In the following table 1.3, the Actions are then allocated to the corresponding 'Action Categories''. Attemative Wind Wind Execution
	Calculation Coefficients	Check		OK Cancel

Figure 5.33: Actions with allocated load cases



The actions can then be allocated to corresponding categories in mask 1.3.

41	 1.3 Actions in Action Categories according to EN 19 	90 CEN		
iput Data General Data	Action Categories	Actions		
- Actions - Action Categories	1. Permanent Actions	G _{kj} : AC1	3	
	2. Prestress	Pk:	\$	
	3.A Imposed Loads - Category A - Domestic, Resident	ial Q _{k,i} :	🐴 🔳 Live Lo	ads and
	3.B · Category B · Offices	Q _{k,i} :	Subsur	Loads to ned as or
	3.C · Category C · Congregation Areas	s Q _{k,i} :		ndent Ac
	3.D · Category D · Shopping	Q _{k,i} : AC2		
	3.E · Category E · Storage	Q _{k,i} :	1	
	3.F Traffic Loads → Category F → Vehicle Weight ≤ 3	0 kn Q.k.i: AC3	5	
	3.G · Category G - Vehicle Weight ≤1	60 kN. Q.k.j:		
	3.H · Category H · Roofs	Q _{k,i} :	1	
	4.4. Snow and Ice Loads - Fint Island Norway Swe	den Qua:	Do Nol	Combine
	4.B - Other CEN Countries - Sites at Altitude H > 1 000	m Qkg: AC4	Selecter	ed Load with Othe
	4.C - Sites at Attitude H ≤ 1 000	m Qkj:	Load C	ases
	E Month and	0 ACE	(¥)	
	5. Wind Loads	Uk,i: AU5	N	
	6. Temperature (non Fire)	Qk,::	Simulta Acting	ineously Load
	Z. Accidental Actions	Ad:	Cases.	
	8. Seismic Actions	Aed:	3	

Figure 5.34: Mask 1.3 Action Categories

As there aren't any imperfections to be considered, the input is complete.



Results in RSCOMBI

In mask 2.1, 341 load groups are displayed.

The load groups LG1 to LG96 were generated according to formula 2.11, the load groups LG97 to LG341 according to formula 2.12 (see page 9).

	A	B	C	D	F	F	G	н
		Generated	Design	0			u	- 11
No.	Apply	Load Groups	Situation	AC1	AC2	AC3	AC4	ACS
1	, the last	LC1	LID	1.25	7102	7100	7104	7100
2				1.00	1.05			-
2		1020		1.00	1.05	1.05	-	-
3		10315		1.00	1.00	1.00	1.05	-
5		LG1022		1.30	1.05	1.05	1.05	
6	믬	LG2330		1.00	1.05	1.05	1.00	0.5
7		LG3750		1.00	1.05	1.00	1.05	0.5
2		1.659 71		1.00	1.05		1.05	0.0
9	믬	1672 05		1.00	1.05		1.00	0.3
10		1,000		1.00	1.00	1.05		0.3
11		1000		1.00	-	1.05	1.05	-
12				1.50	-	1.05	1.05	
12		LG00 03		1.30	-	1.05	1.00	0.9
14		1692		1.30	-	1.00	1.05	0.9
15		1092	UB	1.30	-		1.05	
16		1.095 90	UB	1.30	-		1.05	0.9
17		103536	UB	1.30	-	-	-	0.9
12		1000 104	UB	1.10	1.50			-
10		LG98 104	UB	1.10	1.50	1.05	-	-
20		LG105111	UB	1.15	1.50	1.05	1.05	-
20		LG112118	UB	1.15	1.50	1.05	1.05	-
21		10119132	UB	1.15	1.50	1.05	1.05	0.9
22		LG133146	UB	1.15	1.50	1.05	1.05	0.9
23		LG14/153	UB	1.15	1.50		1.05	-
24		LG 154 167	UB	1.10	1.50	-	1.05	0.9
20		LG 168 181	UB	1.10	1.50	1 50	-	0.9
20		LG 182	UB	1.15	- 1.05	1.50	-	-
2/		LG 183 189	UB	1.10	1.05	1.50	1.05	-
20		LG 190 196	UB	1.10	1.05	1.50	1.05	-
29		LG 197 210	UB	1.10	1.05	1.50	1.05	0.9
30		LG211224	UB	1.15	1.05	1.50	- 1.05	0.9
22		LG225	UB	1.15	-	1.50	1.05	-
32		LG22622/	UB	1.15	-	1.50	1.05	0.9
33		10228229	UB	1.15	-	1.50	1.50	0.9
25		LG230	UB	1.15	1.05	-	1.50	-
30		1023123/	UB	1.15	1.05	1.05	1.50	-
30	<u> </u>	LGZ38 244	UB	1.15	1.05	1.05	1.50	-
27		1/22/15 250					1.00	0.9
37		LG245 258	UB	1.10	1.00	1.00	1 50	0.0
37 38		LG245 258 LG259 272	UB	1.15	1.05	- 1.05	1.50	0.9
37 38 39	X	LG245 258 LG259 272 LG273	UBUB	1.15	1.05	- 1.05	1.50 1.50	0.9
37 38 39 40	X	LG245 258 LG259 272 LG273 LG274 275	UB UB UB	1.15 1.15 1.15 1.15	1.05 - -	- 1.05 1.05	1.50 1.50 1.50	0.9
37 38 39 40 41	X	LG245 258 LG259 272 LG273 LG274 275 LG276 277	UB UB UB UB	1.15 1.15 1.15 1.15 1.15	1.05 - - -	- 1.05 1.05 -	1.50 1.50 1.50 1.50	0.9
37 38 39 40 41 42 42	X	LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279	UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - - -	- 1.05 1.05 - -	1.50 1.50 1.50 1.50 -	0.9 0.9 0.9 1.5
37 38 39 40 41 42 43 44	X X X X X	LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279 LG280 293	UB UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - - 1.05 1.05	1.05 1.05 1.05 -	1.50 1.50 1.50 1.50 -	0.9 0.9 0.9 1.5 1.5
37 38 39 40 41 42 43 44 44	X X X X X X X	LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279 LG280 293 LG294 307	UB UB UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - 1.05 1.05 1.05	1.05 1.05 1.05 - - - 1.05 1.05	1.50 1.50 1.50 1.50 - - -	0.9 0.9 0.9 1.5 1.5 1.5
37 38 39 40 41 42 43 44 45 46		LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279 LG280 293 LG294 307 LG308 321	UB UB UB UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - 1.05 1.05 1.05 1.05	1.05 - 1.05 1.05 - - - - 1.05 1.05	1.50 1.50 1.50 1.50 - - - 1.05	0.9 0.9 0.9 1.5 1.5 1.5 1.5
37 38 39 40 41 42 43 44 45 46 47		LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279 LG280 293 LG294 307 LG308 321 LG308 321 LG322 335	UB UB UB UB UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - 1.05 1.05 1.05 1.05	1.05 1.05 1.05 - - 1.05 1.05 - - 1.05	1.50 1.50 1.50 - - - 1.05 1.05	0.9 0.9 0.9 1.5 1.5 1.5 1.5 1.5 1.5 1.5
37 38 39 40 41 42 43 44 45 46 47 49	X X X X X X X X	LG245 258 LG259 272 LG273 LG274 275 LG276 277 LG278 279 LG280 293 LG294 307 LG308 321 LG322 335 LG336 337	UB UB UB UB UB UB UB UB UB UB UB	1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15	1.05 1.05 - - 1.05 1.05 1.05 1.05	1.05 1.05 1.05 - - 1.05 1.05 - 1.05 - 1.05	1.50 1.50 1.50 1.50 - - 1.05 1.05 - - - 1.05	0.90 0.90 0.90 1.50 1

Figure 5.35: Mask 2.1 Load Groups by Actions (overall view)



5.7 Column (ASCE 7)

Structure and loads

A concrete column is loaded by five load cases. Every load case represents an individual action. The load cases and column have already been defined in RSTAB.

Load case	Action	Action category
LC1	D	dead load
LC2	L	live load
LC3	W	wind load
LC4	Fa	flood load
LC5	E	earthquake load

Table 5.8: Load cases and actions as specified in ASCE 7

In RSCOMBI, load groups are to be generated according to ASCE 7-02, section 2.3 (LRFD), that is *Combining factored loads using strength design*, and consequently also according to section 2.4 (ASD), that is *Combining factored loads using allowable stress design*. Then all results are to be exported to RSTAB.

Input data

In the mask 1.1 *General Data*, you choose that **load groups** are to be generated according to **ASCE 7**, Section 2.3 (LRFD). Due to the fact that flood load is to be considered, select the option *Load combinations including flood load according to 2.3.3 or 2.4.2.*



Figure 5.36: Mask 1.1 General Data



For the American ASCE 7 standard, the mask 1.3 *Action Categories* does not exist. All action categories are listed in the mask 1.2 *Load Cases in Actions*. In the lower tables of this mask, you assign existing load cases to available actions.

<u>File</u> <u>Settings</u> <u>H</u> elp								
CA1		ses in Actions						
Input Data General Data Actions	Actions D Di E F Fa H L	Pead Load Weight of Ice Earthquake Load Load due to Fluids with Well- Flood Load Load due to Lateral Earth Pre Live Load	de T	Action D Dead Lo Action D	escription: oad		Note: All action catego listed here. Load then be assigne through the lowe	pries will be I cases will d to the actions r tables.
	Existing LC LC1 LC2 LC3 LC4 LC5	ad Cases Dead load Live load Wind load Shock Seismic load		Load Ca No. LC1	eses in Action D	Load Case Descripti	on	Alternative
	Calculation	Coefficients Che	ck				OK	Cancel

Figure 5.37: Mask 1.2 Load Cases in Actions with all specified actions according to ASCE 7 in section Actions

Every load case represents one action. You can also insert action descriptions in the box *Action comment.* The input is now complete.

Results for the strength design (LRFD)

By combining factored loads using the strength design, seven load groups are generated.

RSCOMBI 2006 - [Example 1]											×
File Settings Help											
CA1	2.1 Loa	d Groups	by Actions								
Input Data		A	В	C C	D	E	F	G	1		
- General Data			Generated	Design							
Actions	No.	Apply	Load Groups	Situation	D	Fa	L	W			
Results	1	×	LG1	2.3 (5)	1.20	-	-	-			
- Load Groups by Actions	2	×	LG2	2.3 (5)	1.20	-	1.00	-			
- Load Groups	3	×	LG3	2.3 (6)	0.90	-	-	-			
Load Groups - Reduced	4	×	LG4	2.3 (6)	0.90	1.00	-	-			
	5	×	LG5	2.3 (6)	0.90	1.00	-	0.80			
	6	쓰	LG6	2.3 (6)	0.90		-	0.80			
		<u> </u>	LG7	2.3 (/)	0.90	-	-	-			
	A 12			105					o	1 10	1 A 2 - E
	Action	s in Genei	rated Load Group:	Lub Antine Desert	at an				Section 2.3 (b)	Load La	ses in Action Fa
	AC	0.1		Action Desch	puon				Factor	110.	Lodu Cases
	5	Dead	Load					_	0.90		104
	I I I I I I I I I I I I I I I I I I I	Flood	Load					_	0.90		
	**	wind	Load					_	0.00		
					Ex	port					OK Cancel
-											

Figure 5.38: Mask 2.1 Load Groups by Actions - results for strength design (LRFD)



In mask 2.2, you can find the detailed results. These are sorted by *load cases* instead of *actions*.

RSCOMBI 2006 - [Example_1]											×
<u>File</u> <u>Settings</u> <u>H</u> elp											
CA1 👻	2.2 Load	Groups									
Input Data		A	В	С	D	E	F				
- General Data	16		Design								
Actions	LG	Apply	Situation	LC1	LC2	LC3	LC4				
Results	162		2.3 (5)	1.20	- 1.00	•	•				
Load Groups by Actions	LG2		2.3 (5)	0.90	1.00						
Load Groups - Reduced	LG4		2.3 (6)	0.90			1.00				
Ebad croups - rreduced	LG5		2.3 (6)	0.90		0.80	1.00				
	LG6	×	2.3 (6)	0.90	•	0.80	•				
	LG7		2.3 (7)	0.90	•	-	•				
	Load C	ases in G	enerated Loa	d Group	LG5					Section 2.3 (6)	
	LC		Load Case	Descript	ion		Action	Factor of Action	Exceptional 1	Factor	
	LC1	Dead	load				D	0.90	-	0.90	
	LC3	Wind	oad				W	0.80	-	0.80	
	LC4	Shock	:				Fa	1.00	-	1.00	
l											
							Export				OK Cancel

Results for the allowable stress design (ASD)

By combining factored loads using the allowable stress design, five load groups are generated.

RSCOMBI 2006 - [Example_1]												X
<u>File</u> <u>Settings</u> <u>H</u> elp												
CA1 VI 2.1 Load Groups by Actions												
Input Data	1	A	В	С	D	E	F	G				
- General Data	Ne		Generated	Design		_						
Actions	INO.	Apply	Load Groups	Situation	D	Fa	L	W				
Results			LG1	2.4 (1)	1.00	•	•	-				_
- Load Groups by Actions	2		LG2	2.4 (7)	0.60	. 0.75	-	-				-
- Load Groups	4		164	2.4(7)	0.00	0.75		1.00				
- Load Groups - Heduceo	5		LG5	2.4(7)	0.60	-	-	1.00				
	Actions	s in Gene	rated Load Group	: LG4					Section 2.4 (7)	Load C	ases in Action D	
	AC			Action Descri	ption				Factor	No.	Load Cases	
	D	Dead	Load				0.60 1 LC1					
	Fa	Flood	Load			0.75						
	W	Wind	Load						1.00			
					Exp	port					OK Can	icel

Figure 5.40: Mask 2.1 Load Groups by Actions - results for allowable stress design (ASD)

Figure 5.39: Mask 2.2 Load Groups



In case of the strength design, you can export seven load groups and also one 'Either-or' combination to RSTAB. For the latter, you have to select this option in the section *Either/or Load Combination* in the *Export* dialog box.

Statistics	Export Type
Generated Load Groups to be Exported in RSTAB Number of - Load Groups: 7 - Load Combinations: 1	Generated load groups are to be exported as LG1 - LG7. There already exist in RSTAB LG1 LG52!
Either/Or Load Combination Image: Additionally summarize all generated Load Groups im an 'Either-Or' Load Combination	 Type of Numbering: Use the first free position and renumber newly generated LG Delete original LG with identical numbers Delete original LG with identical and higher numbers

Figure 5.41: Dialog box Export – strength design (LRFD)

In case of the allowable stress design, five load groups and one load combination can be exported to RSTAB.

Export	
Statistics	Export Type
Generated Load Groups to be Exported in RSTAB	Generated load groups are to be exported as LG1 - LG5.
Number of	
- Load Groups: 5	
- Load Combinations: 1	There already exist in RSTAB LG1 LG52!
Either/Or Load Combination	Type of Numbering:
Additionally summarize all generated	 Use the first free position and renumber newly generated LG
in an 'Either-Or' Load Combination	O Delete original LG with identical numbers
	Delete original LG with identical and higher numbers
٦	OK Cancel

Figure 5.42: Dialog box *Export* – allowable stress design (ASD)



5.8 Framework Structure (CAN/CSA)

Structure and loads

A framework structure is loaded by dead load, live loads of offices and of shopping areas, and wind loads.

Load case	Action	Action category
LC1	D	Dead load
LC2, LC3, LC4, LC5	L	Live load
LC6, LC7	w	Wind load

Table 5.9: Load cases and actions

There are load groups and load combinations to be generated according to the Canadian standard CAN/CSA, clause 7.2.2 (without earthquake).

Input data for generation of load groups

In the mask 1.1 *General Data*, you decide that **load groups** are to be generated according to **CAN/CSA S16.1-94**, *Clause 7.2.2 (without earthquake)*.

In mask 1.2 *Load Cases in Actions*, all action categories are to be specified. You assign load cases to actions in the lower tables.

When allocating LC6 and LC7 to W, you must pay attention to the mutual exclusivity of these two load cases. Thus, enter the same description in the *Alternative* column



Figure 5.43: Mask 1.2 Load Cases in Actions



Results

48 load groups are generated for clause 7.2.2 of the CAN/CSA standard. In mask 2.1, they are listed as follows.

RSCOMBI 2006 - [Example_3]													
File Settings Help	- 110	d Groups	hy Actions										
CAT	• K.1 LUat	loloups	by Actions	C .			- (
Input Data		A	Generated	Design	U	E	r						_
- General Data	No.	Apply	Load Groupe	Situation	D		w						
- Actions	1	7 ppiy	LG1	722	1.25	-							
Hesults	2		162 16	7.2.2	1.25	1.50							_
Load Groups by Actions	2		1617 /6	722	1.25	1.00	1.05						_
Load Groups	4		LG47_48	722	1.25	1.00	1.50						
Load croups - rieduced													
	Action	s in Gene	rated Load Group:	LG1746					Cla	use 7.2.2	Load Ca	ases in Action L	
	AC		Actio	n Description			α	Ψ	γ	Factor	No.	Load Cases	
	D	Dead	Load				1.25			1.25	1	LC2	
	L	Live L	oad (Use and Oco	cupanncy of st	tructures,	moveab	1.50	0.70	1.00	1.05	2	LC2 + LC3	
	W	Wind	oad				1.50	0.70	1.00	1.05	3	LC2 + LC3 + LC4	
											4	LC2 + LC3 + LC4 + L	Ξ
											5	LC2 + LC3 + LC5	
											6	LC2 + LC4	
											7	LC2 + LC4 + LC5	
											8	LC2 + LC5	
											9	LC3	
											10	LC3 + LC4	
											11	LC3 + LC4 + LC5	
											_		_
					E ve	nort						OK Cance	al

Figure 5.44: Mask 2.1 Load Groups by Actions

Input data for generation of load combinations

The input data differs from the previous entry in one thing only: in mask 1.1, you select the option **Load combinations - variable superposition** in section *Generate for RSTAB*.

	1.1 General Data		
ut Data General Data Actions	Generate for RSTAB of Load Groups Coad Combinations - Variable Superposition Load Combinations - Permanent Superposition	Supplementary Examination Reduce Possible Load Combinations by Examining RSTAB Results From Automatically Defined	
	Combination Rules according to Code CAN / CSA	Combinations From Load Combinations:	
	Generating for Combinations acc. to CAN / CSA Clause 7.2.2 (without Earthquake) Clause 7.2.§ (with Earthquake) Generate Supplementary Combinations from Favorable Pernament Actions		RSCO
	General	Numbering	Generating Load Groups or Load Combination
		Start Number of Generated - Load Combination: 1	

Figure 5.45: Mask 1.1 General Data: Generation of load combinations



Results of generation of load combinations

For the design situation according to clause 7.2.2 of the Canadian standard CAN/CSA, the three load combinations CO5 to CO7 are generated which are to be analyzed.

RSCOMBI 2006 - [Example_3]													
<u>File Settings H</u> elp													
CA1 👻	2.1 Load	l Combir	nations by A	ctions									
Input Data		A	В	C	D	E							
- General Data			Design										
Actions	00	Apply	Situation	D	L	W							
Results	5		7.2.2	1.25/p	1.50	-							
- Load Combinations by Actions	6	×	7.2.2	1.25/p	1.05	1.05							
Load Combinations	7	×	7.2.2	1.25/p	-	1.50							
Load Combinations - Reduced													
	Actions	: in Gener	ated Load Co	ombination Action Des	: CO5			a	W	Cla	use 7.2.2	Load Co No	ombinations in D
		Dead	, beal	00011 200	onption			1 25	¥	1	1 25	1	101/2
		Live	Lodu	Occupan	nov of et	nuctures n	novesh	1.20	1.00	1.00	1.20		LCI/p
						Expo	ort						OK Cancel

Figure 5.46: Mask 2.1 Load Combinations by Actions

The combinations CO1 to CO4 represent all possible combinations of load cases within the respective actions. In the lower part of mask 2.1 in Figure 5.46, you can see that there are two possible internal load combinations within combination CO5: LC1/p and LC1/p + LC3. If you click some different combination, the internal combinations become visible.


A: Literature

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