NEMETSCHEK Scia

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Manual

Bridge Combinations EN 1990

Scia Engineer

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Version Information

Welcome to the Bridge combinations EN 1990 manual.

This document provides introduction and information on the use of the Bridge combinations defined by EN 1990 and EN 1991-2, in the way how are implemented within Scia Engineer.

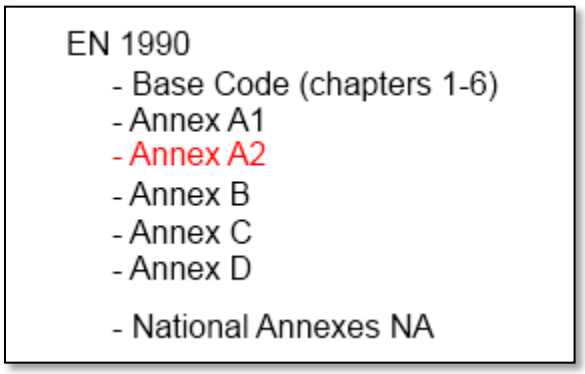
Version info

Document Title	Bridge combinations EN 1990
Release	2013
Revision	08/2012

Introduction

The purpose of this document is to introduce and explain, how the combinations for bridges, described in EN 1990 and EN 1991-2, are implemented within Scia Engineer. This document also contains a small tutorial example, which details how the user can define bridge combinations correctly together with the standard building combinations.

Special rules for bridge combinations are defined by EN 1990 Amendment A1, which brings Annex A2.



In this Annex A2, three main types of bridge combinations are defined. Combinations for Road bridges, Footbridges and Rail bridges. Special types of loading for each particular type are also defined together with its ψ and γ values. For each structure type a list of rules on how to combine these types of loading in the combination itself is also provided.

The basic idea of new combinations is, that in addition user defines in his combination so called Structure parameter, which will be the main parameter, for distinguishing which types of loads, ψ and γ values and finally rules, are to be applied. Afterwards user can insert all suitable load cases to his combination. When generating envelope combinations, a sub level of combination, called Decomposed EN combinations, is introduced. These decomposed EN combinations are generated with respect to the activated rules.

The bridge functionality is protected by a new protection code, therefore a new item is implemented in the Functionality folder in the Project data dialog.

In general, the user may proceed in several steps, when defining new bridge (or even building) combination. Do not take this as an exact order in combination definition. User may also start with adjusting parameters in NA Setup dialog and then proceed differently. Take this as a proposal, which will be used as an example in this document.

Step 1: Activate Protection

Step 2: Create Load groups

Step 3: Assign Load cases to the Load groups

Step 4: Create a Code Combination

step 5: Decomposed EN combinations

Step 6: Adjust (if needed) ψ values, γ values and combination rules in NA Setup dialog

The user should have a good understanding of Eurocodes in general, especially the application of the EN 1990 and EN 1991-2.

Accompanying this document, the reader will find two files for the example.

Footbridge example_initial.esa (only structure)

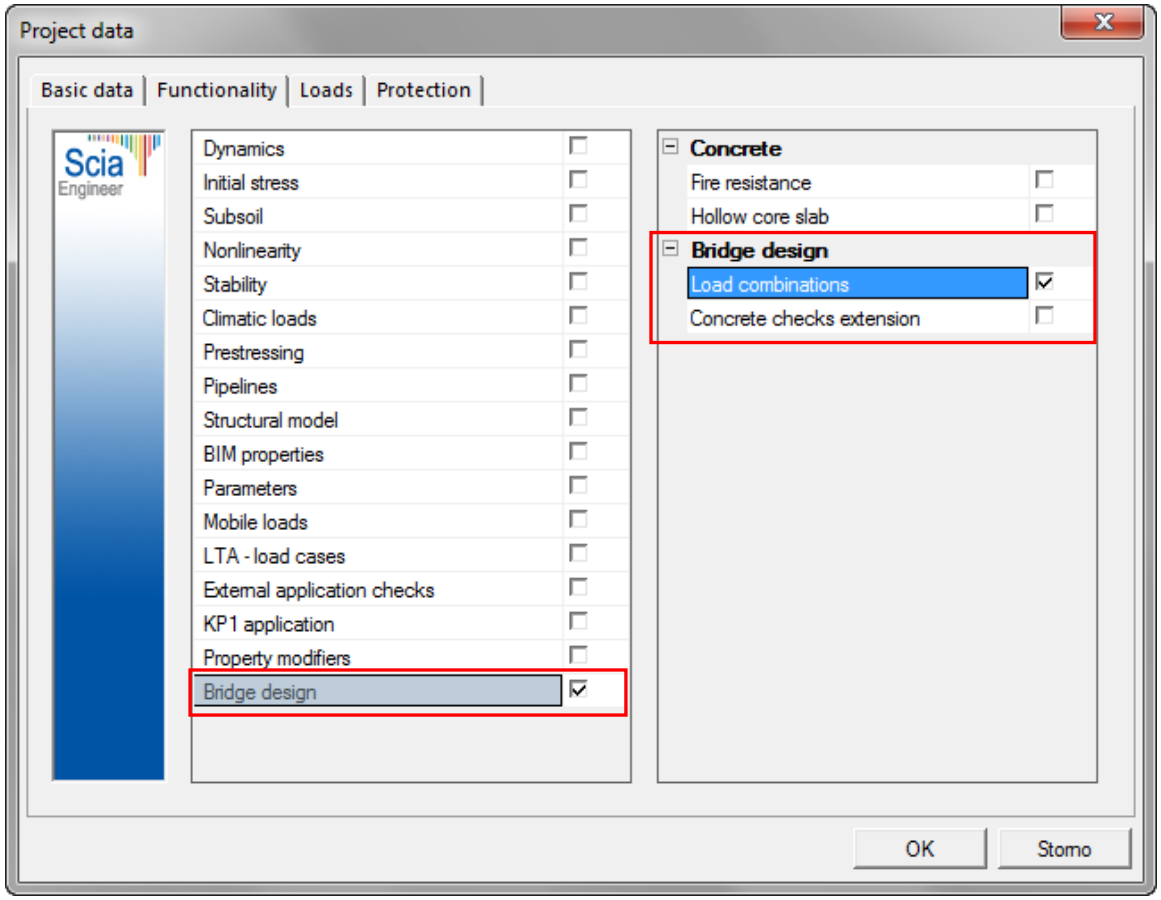
Footbridge example_final.esa (structure with loading and combinations)

Bridge combinations

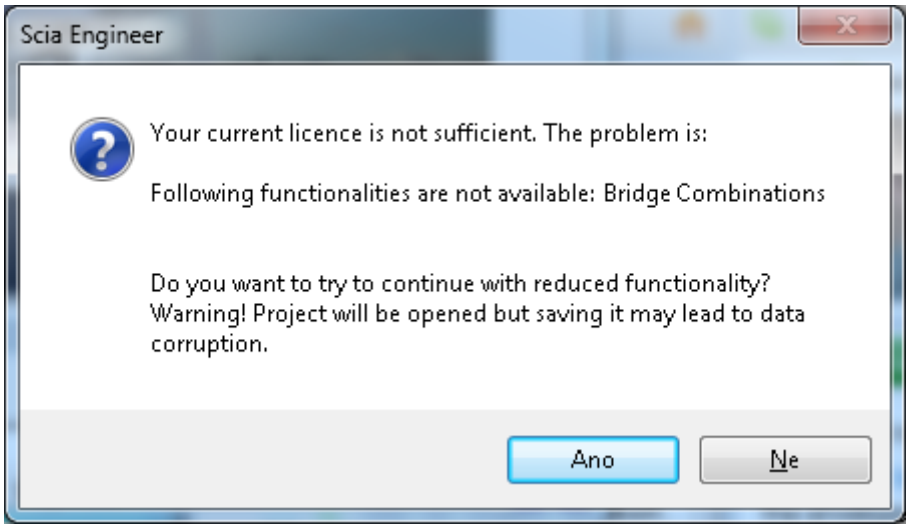
Step 1: Activate protection

The bridge combinations functionality is protected by a new commercial module and appropriate technical module, therefore new item **Bridge design** is added in the Functionality folder in the Project data dialog. If checked, then the user may check also two new items in the right window. By activating the **Load combinations** check box in the project, a new parameter called Structure, will be expanded with other items for bridges. It can be set for Load groups, Combination and also in the Construction stages Setup dialog.

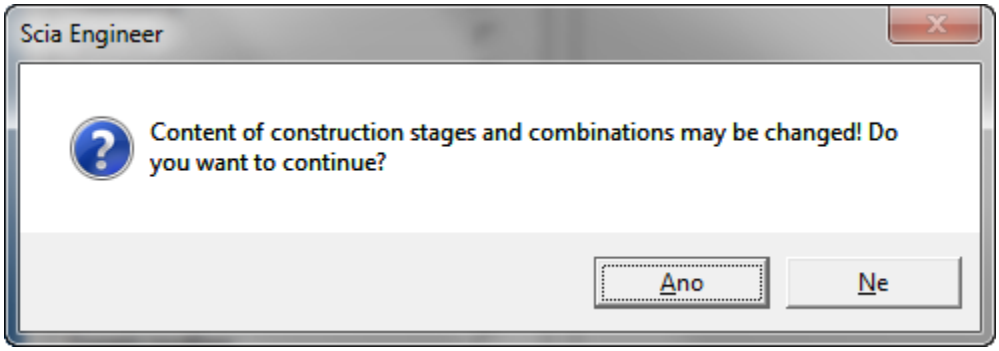
If the functionality is off, the Structure setting will automatically be set to Building and all bridge items will not be visible to the user. If the functionality is off, no bridge combinations can be defined.



It may happen, that the user tries to open project, which is already containing some load groups or combinations or even construction stages which have the Structure parameter set to any bridge type, with Scia Engineer without proper license. In this case warning dialog below will be displayed.



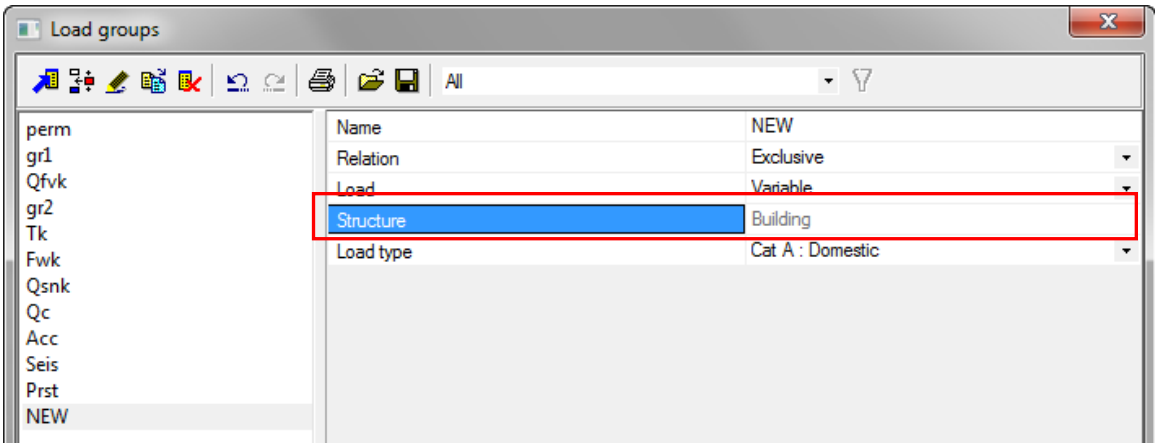
Similar use case may happen, when the user deactivates the check Load combinations in the Functionality folder in the Project data dialog.



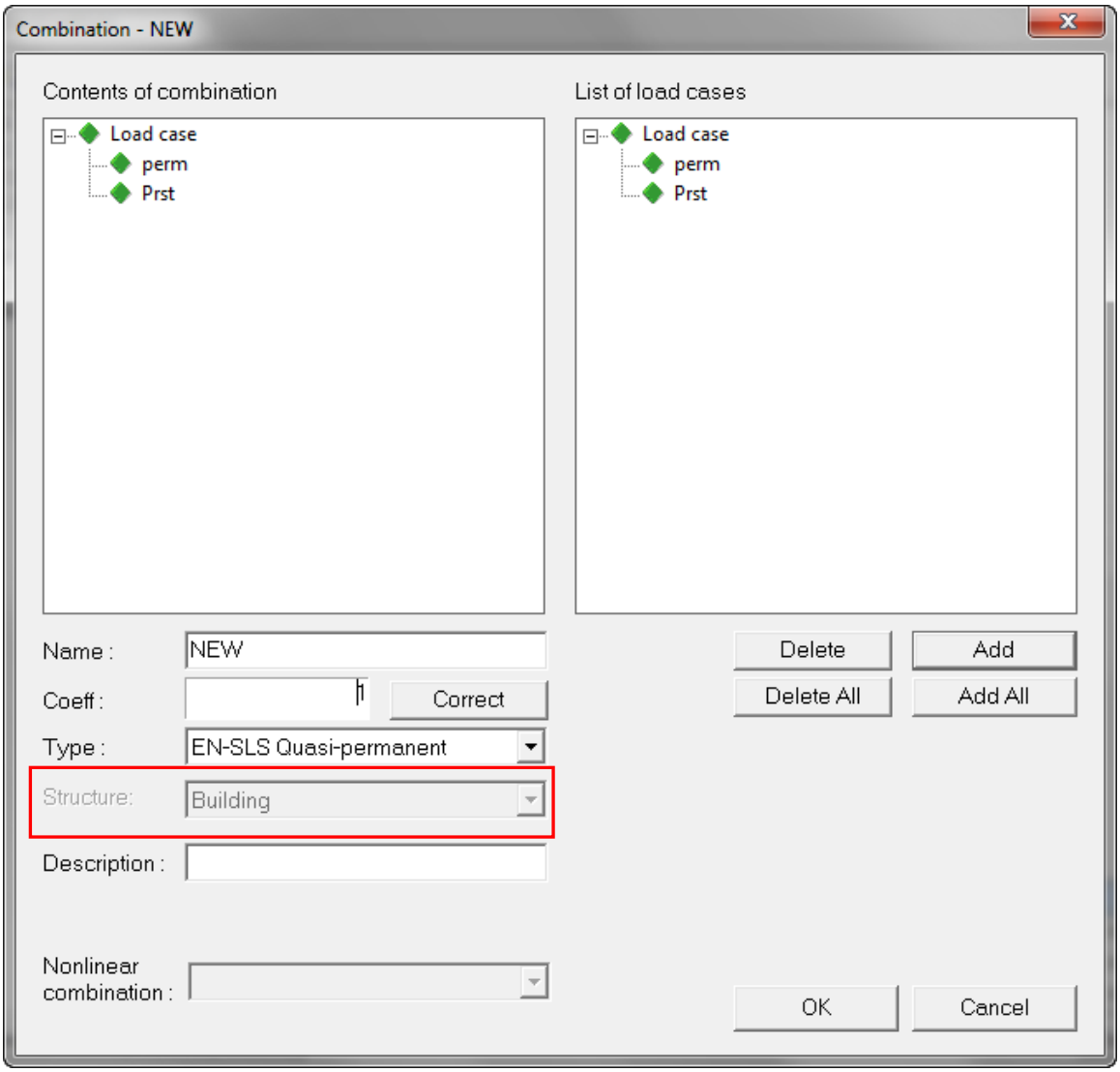
If the user confirms one of the two dialogs above, then a few things should be kept in mind:

New projects:

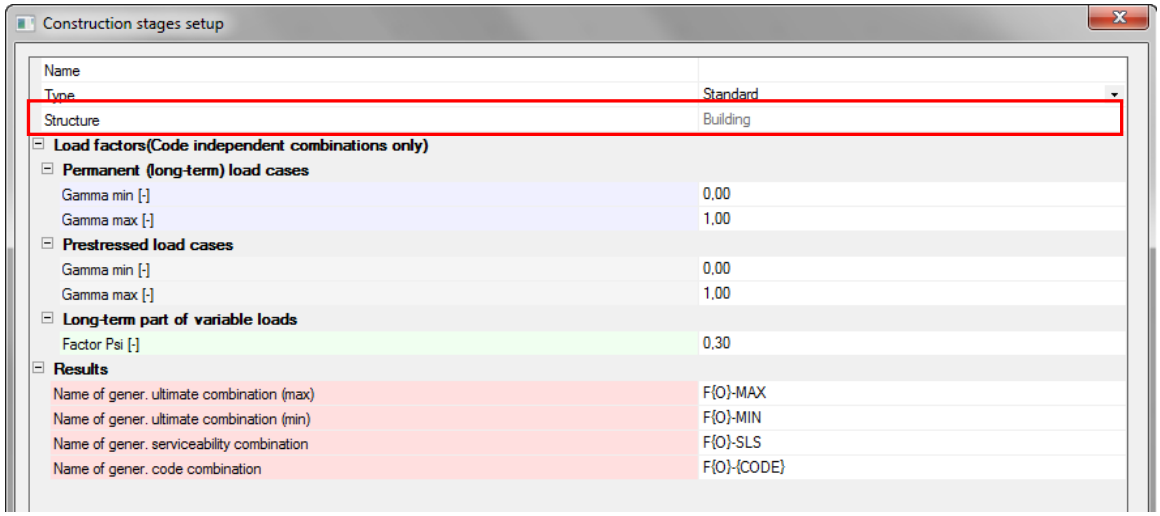
Content of a the **Structure** combo box in the Load group dialog will be reduced only to **Building** and will be always disabled (no new load groups with bridge structure are allowed to be created).



Content of a the **Structure** combo box in Combinations dialogs will be reduced only to **Building** and will be always disabled (no new combinations with bridge Structure are allowed to be created).



Content of a the Structure combo box in the Construction stages dialog (also in the variable loads imputing dialog), will be reduced only to **Building** and will be always disabled.



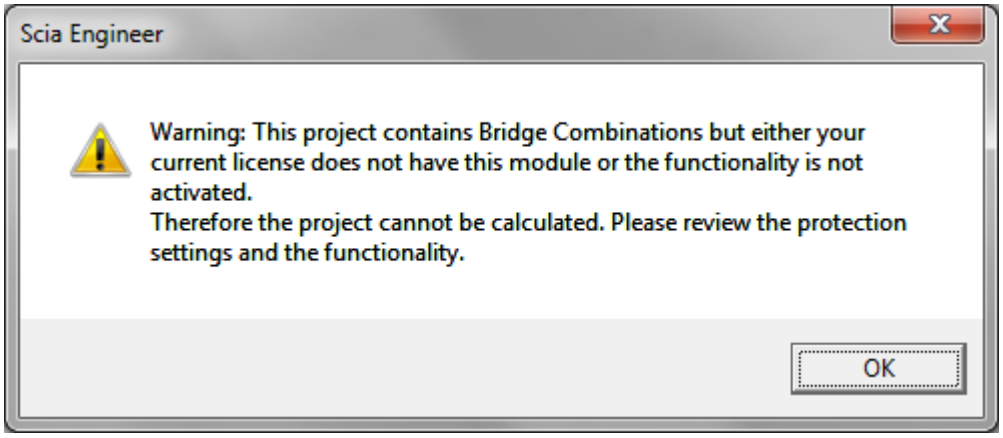
Older projects:

Any previously created **Load groups**, which were set to some bridge Structure type, will remain untouched, until they are edited. If edited, the Structure parameter will be automatically set to Building and parameter Load type to Category A (first item in the combo).

Any previously created **Combinations**, which were set to some bridge Structure type, will remain untouched, until they are edited. If edited, the Structure parameter will be automatically set to Building. All non-suitable variable load cases will be removed from the combination.

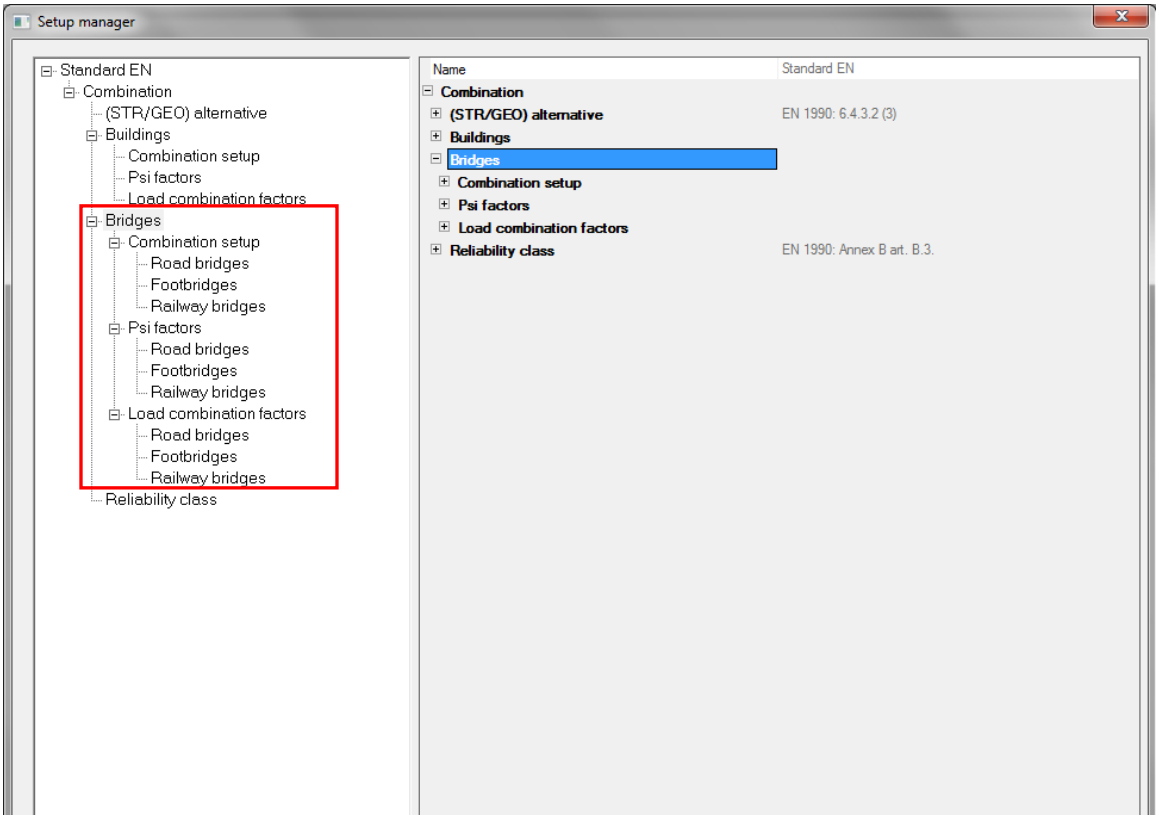
The Structure parameter in the Construction stages Setup dialog will be directly changed to Building and all variable load cases in previously created **Construction stages** will be removed from these stages.

The user will also not be able to calculate projects with these bridge combinations without a proper license. If the license will not be found, a warning will be displayed when calculation is started. After confirmation of this warning dialog the calculation will be terminated. It will also not be possible to explode such combinations into envelopes or linear combinations.



On the other hand, all parameters connected to the bridges will still be visible in The NA Setup dialog, both for new and old projects:

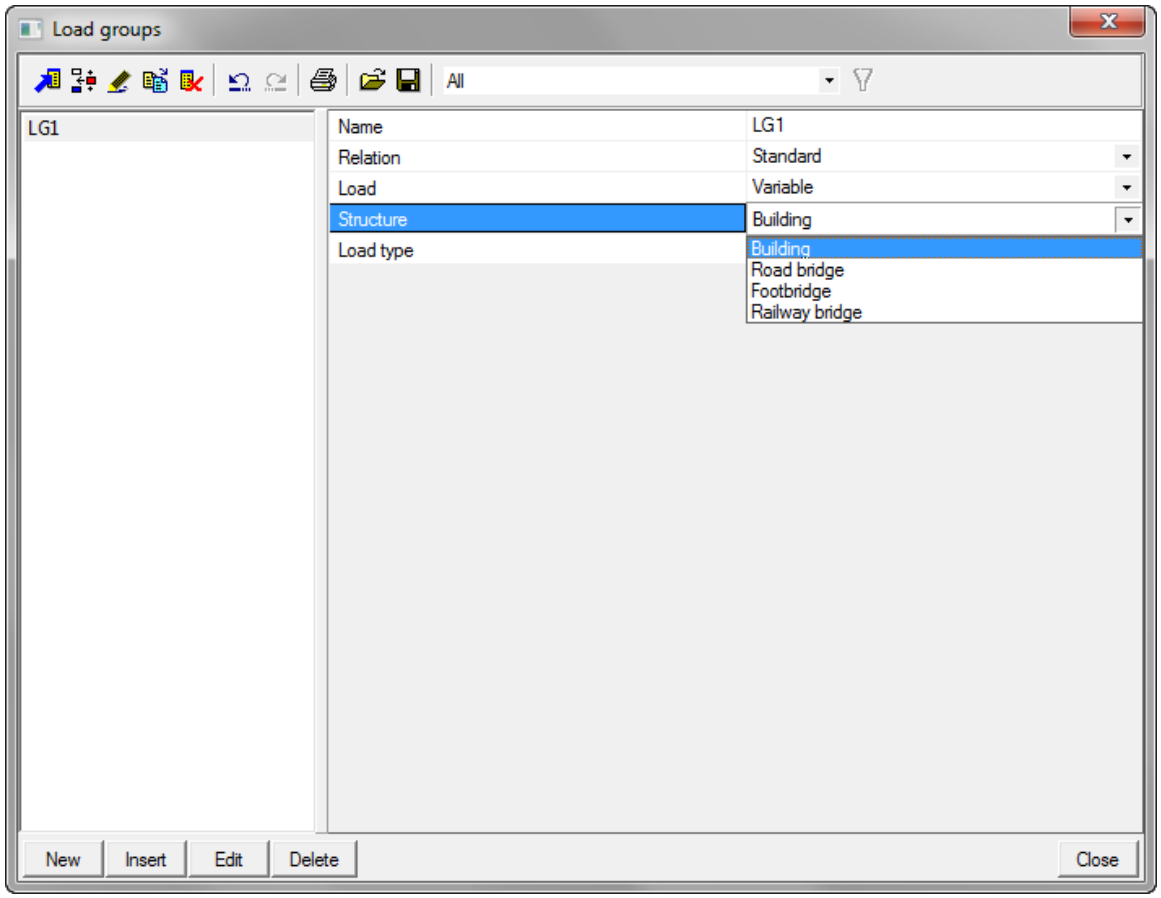
- NA Setup manager – Combination setup
- NA Setup manager - Psi factors ψ
- NA Setup manager - Load combination factors γ



Step 2: Create Load groups

For further generation of bridge combinations it is neccessary to distinguish variable load groups containing loads for buildings from variable load groups containing loads for bridges. When a Load group is set to **Variable**, new parameter **Structure** will be displayed. In the combo box it is possible to select from four options:

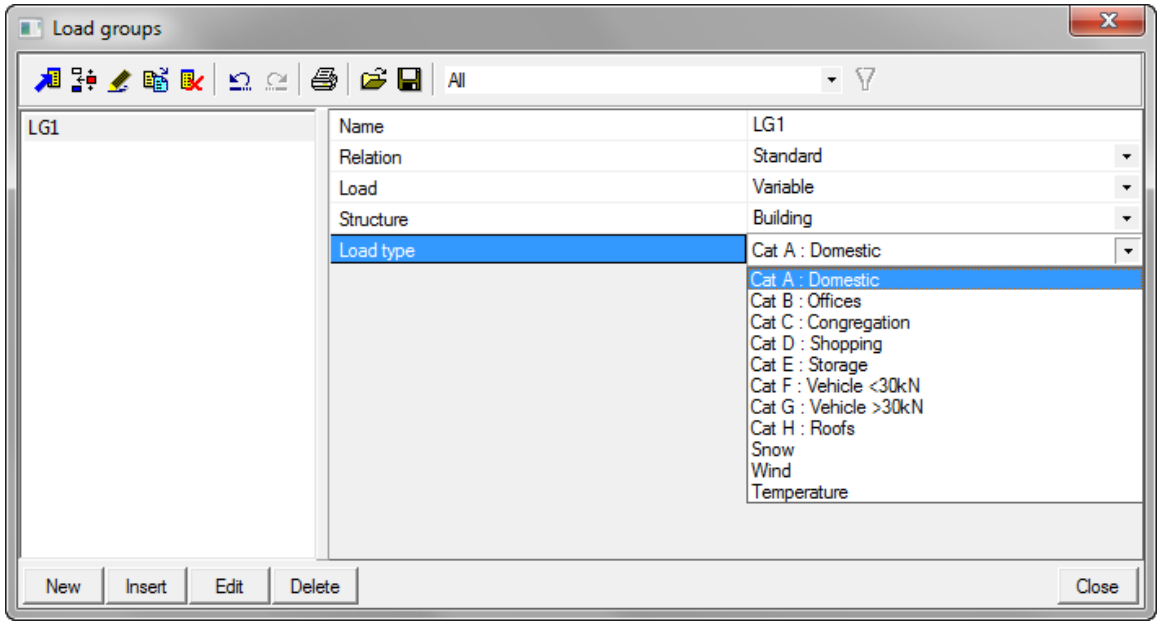
- Building (default standard, as it is implemented now)
- Road bridge (for list of actions see EN 1990;2002 Annex A2, table A2.1)
- Footbridge (for list of actions see EN 1990;2002 Annex A2, table A2.2)
- Railway bridge (for list of actions see EN 1990;2002 Annex A2, table A2.3)



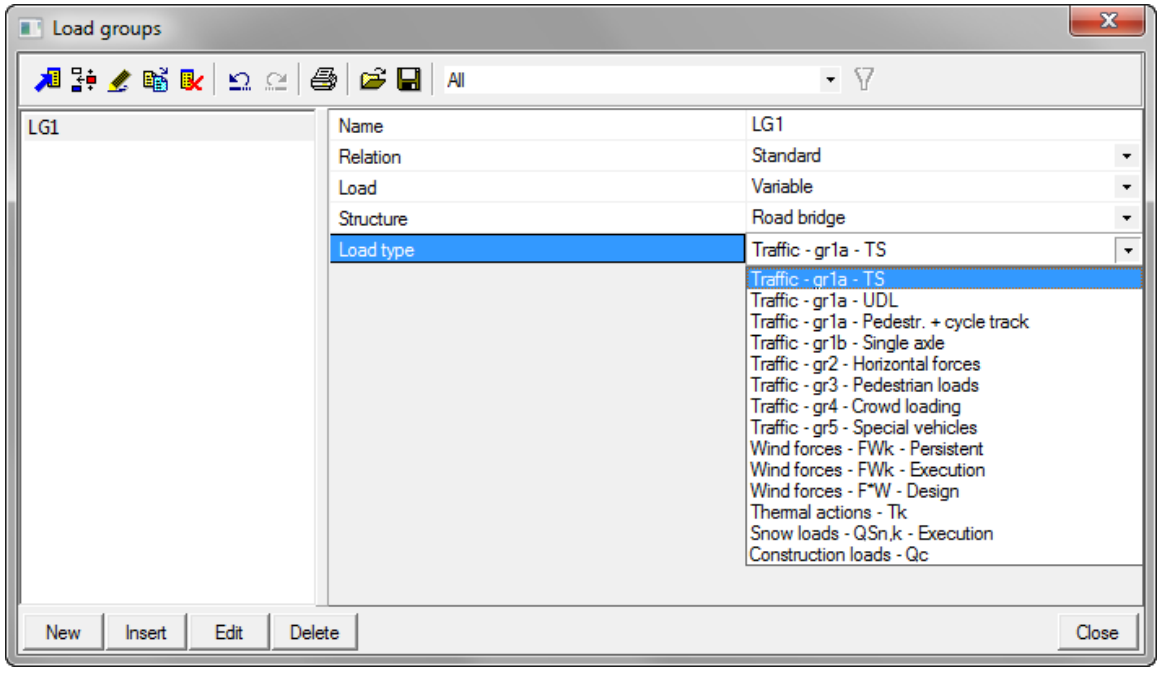
The Structure parameter will be disabled, when the functionality Bridge combinations is not activated in the Project data dialog. It is set to Building by default.

According to the selection in this combo box, the content of Load type combo box is adjusted.

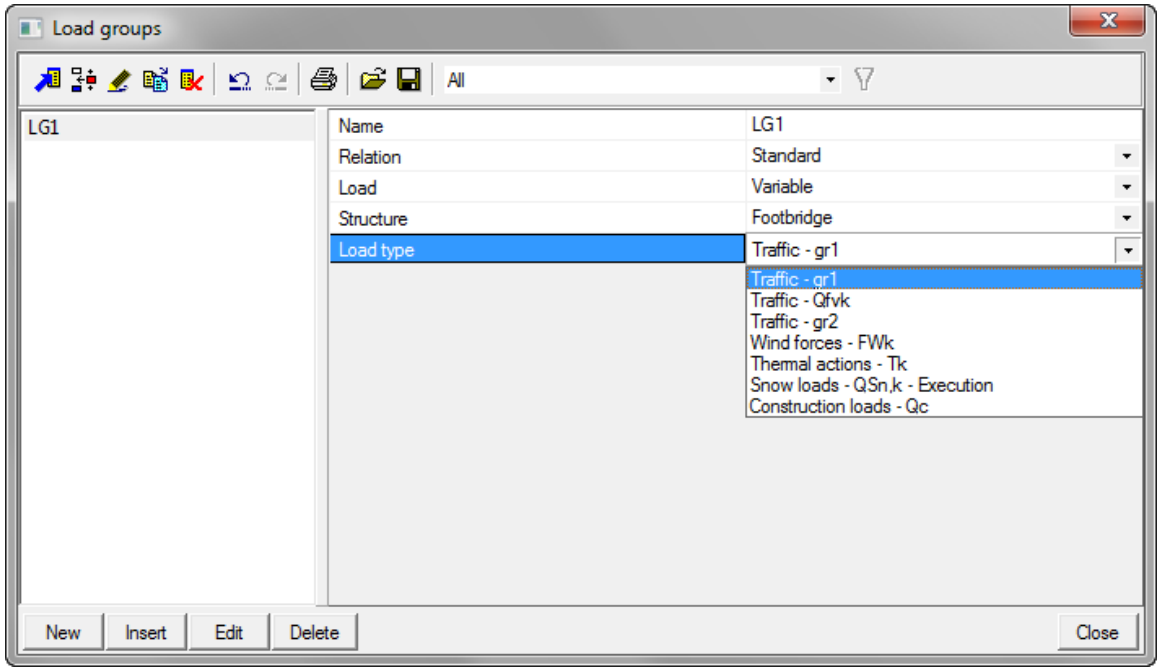
Content of a Load type combo box with the Structure parameter set to **Buildings**:



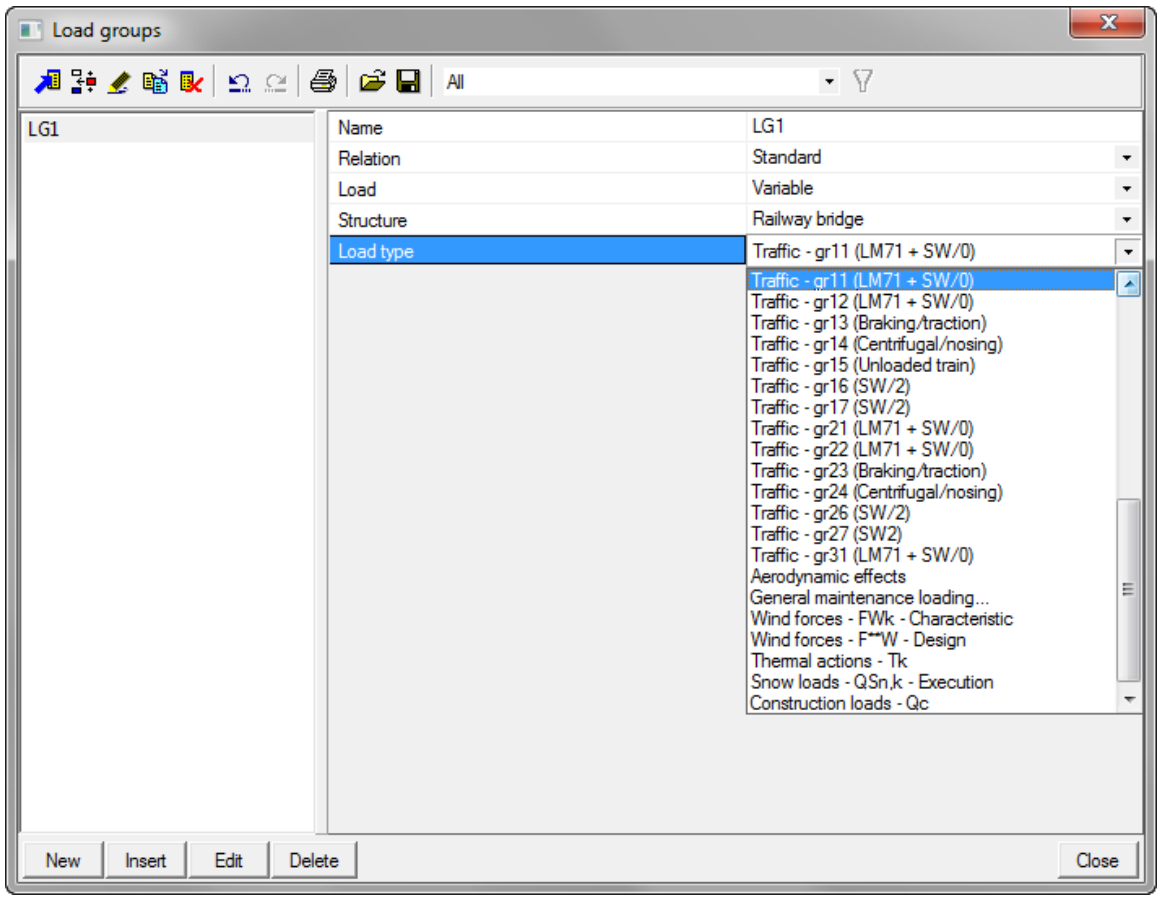
Content of a Load type combo box with the Structure parameter set to **Road Bridges**:



Content of a Load type combo box with the Structure parameter set to **Footbridges**:



Content of a Load type combo box with the Structure parameter set to **Railway bridges**:

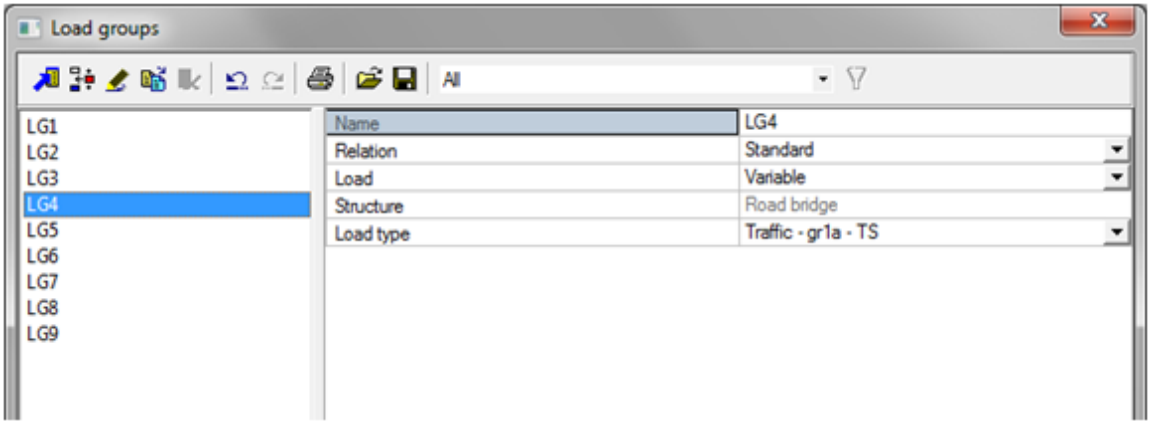


There is no mapping table between the items from this combo box. If for example the Structure parameter is set to Building and the Load type is set to Cat H and afterwards the Structure parameter is changed, the first value of the selected option will be selected in the Load type combo.

Whenever a certain load case will be assigned to a certain combination, aditional restrictions are implemented both for load group and load case in the Load group and the Load case dialogs. Let's imagine that we have a LC4 assigned to a LG4, which Structure is set to Road bridges. A combination CO1 for Road bridges is already created and LC4 is assigned in the combination.

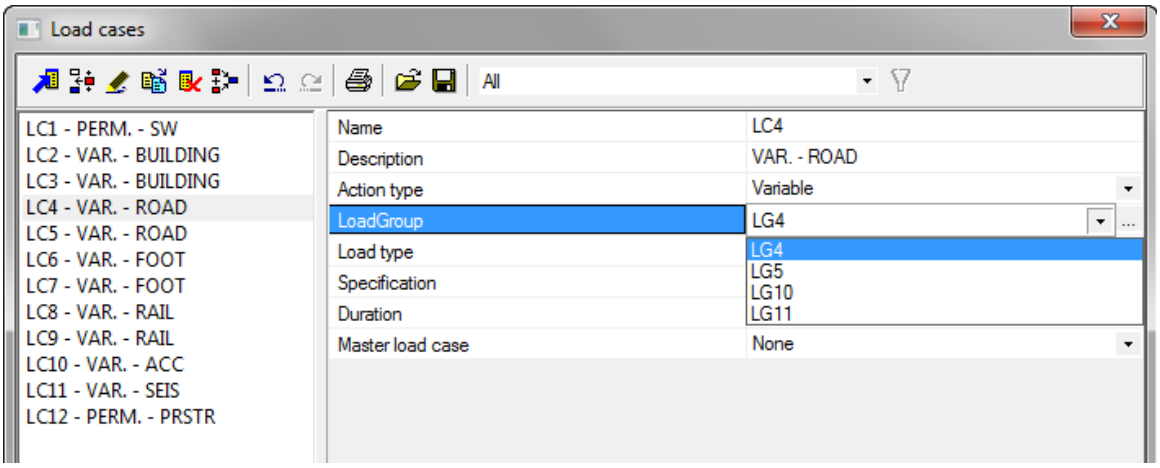
Load group:

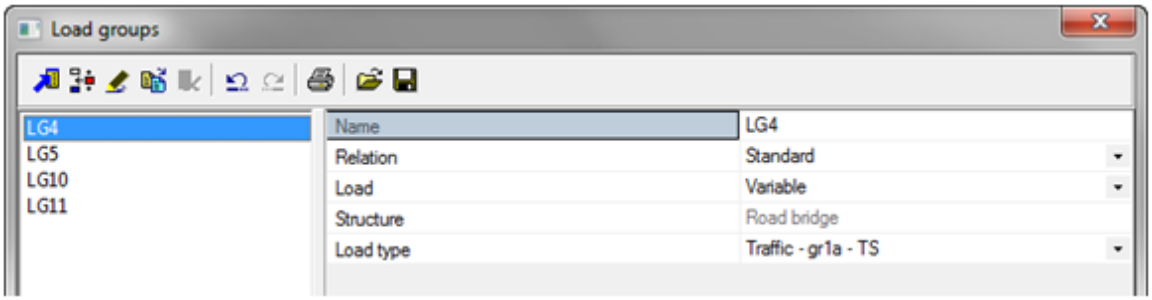
The Structure parameter for LG4 will became disabled and will not be possible to change. On the other hand, Load type will still be possible to change.



Load case:

For LC4 it will still be possible to change the Load group parameter to something else, but the user may select only load groups with the same Structure parameter or independent variable load groups for accidental and seismic loads. By pressing the three dots edit button, the Load group dialog will be displayed, but with filtered content.



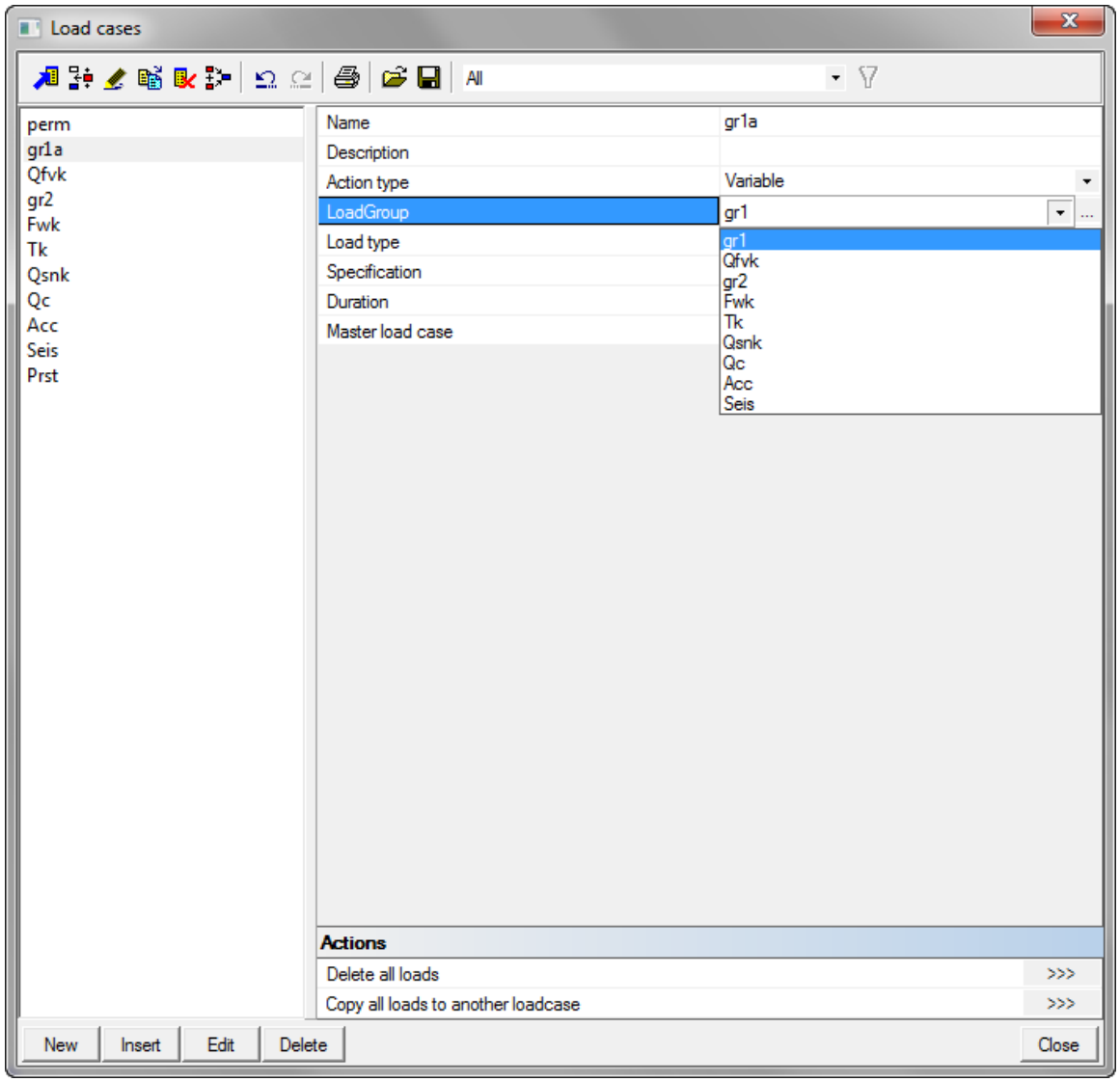


These restrictions become active right after assigning a certain load case into the combination. If the load case is not assigned yet, the user may freely change the load group.

Step 3: Assign Load cases to the Load groups

In this step, the user assigns his load cases in the load groups, which were defined in previous step. The only change, in comparison to the use of older versions of Scia Engineer, is the restriction with load group change, after assigning a load case into the combination. This has been described also in the previous step.

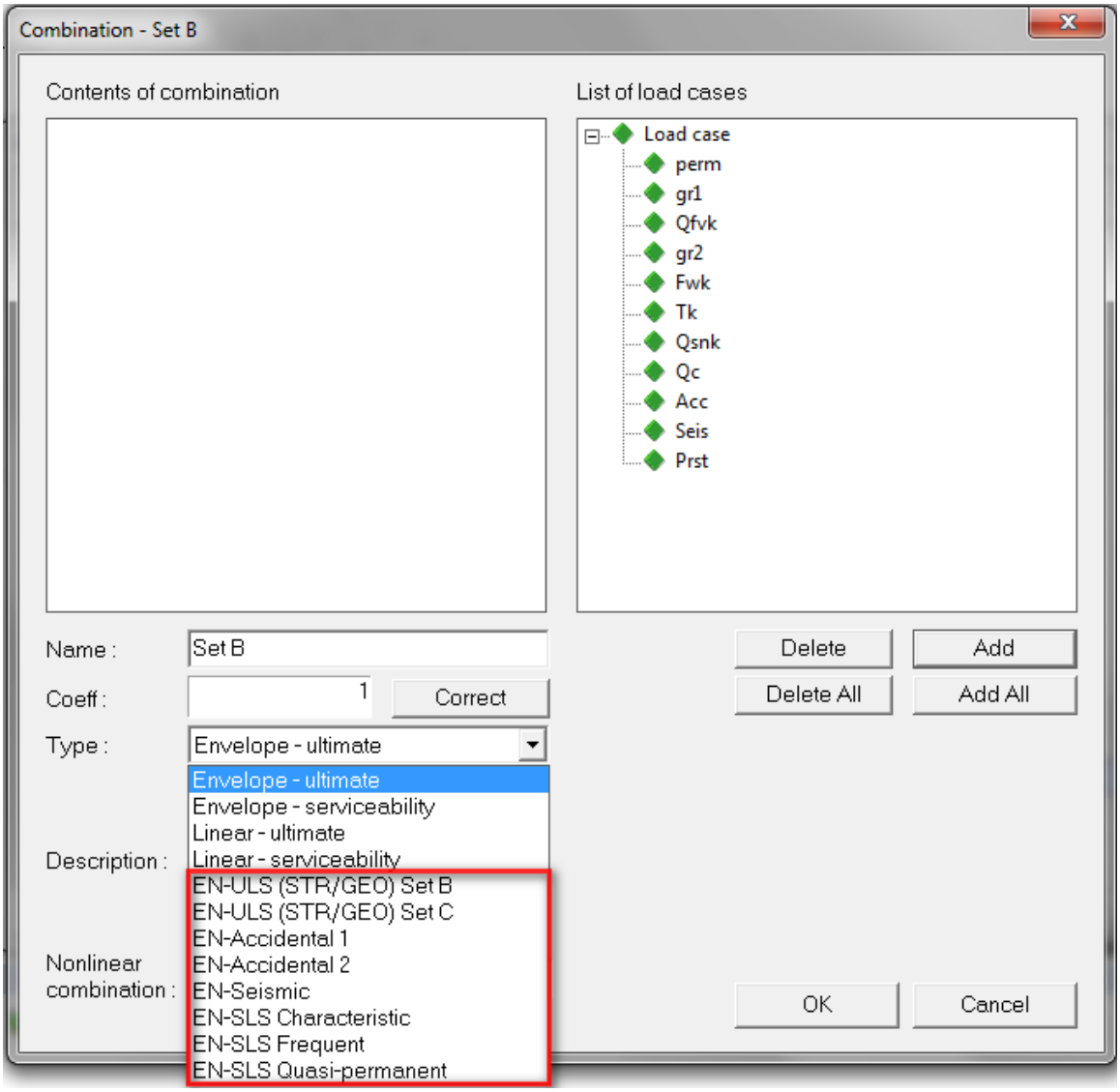
The user opens the Load cases dialog and from the combo box Load group chooses an appropriate load group.

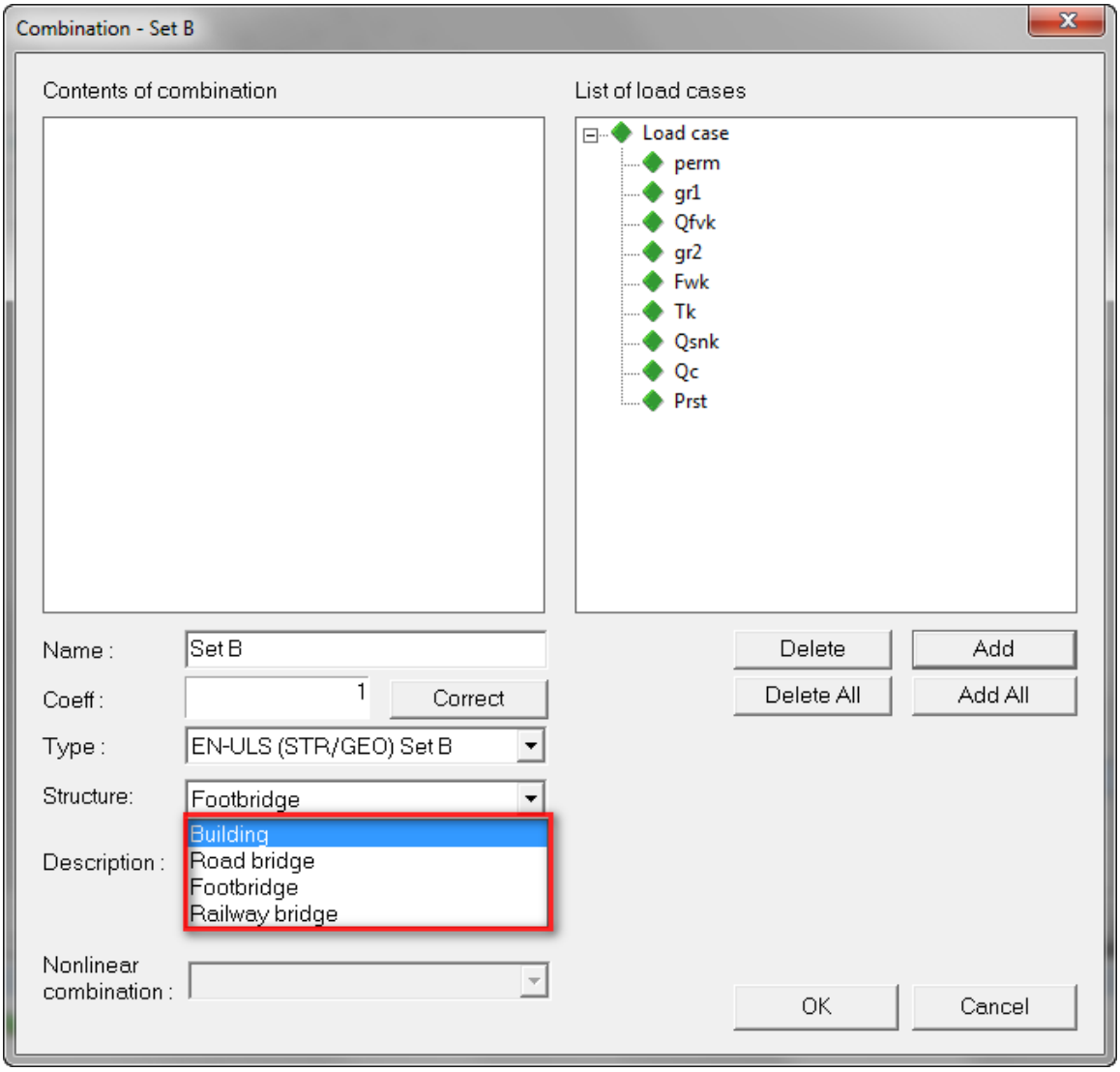


Step 4: Create a Code Combination

Combinations for buildings are distinguished from combinations for bridges too. The reason for this is the usage of correct γ and Ψ factors, which are different and will be defined in another system requirement. There is also a new combo box named **Structure**, where user may choose from four possibilities: Buildings, Road bridges, Footbridges, and Railway bridges.

This combo is visible only for marked types of combinations, shown on picture below. Else it is hidden.



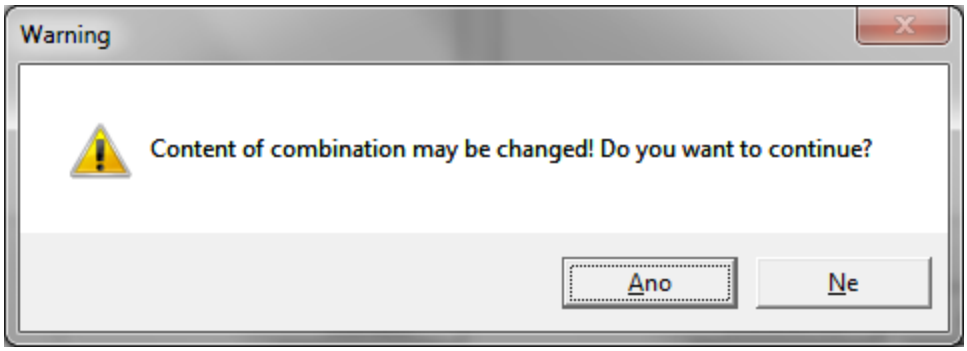


The right window with list of load cases is filtered according to the Structure selected in the combo. This window shows :

- Permanent load cases
- Permanent prestress load cases
- Load cases connected to Accidental and Seismic load groups (only for Accidental or Seismic combinations)
- Load cases, which are assigned to a certain variable load group, with the same Structure type defined

If a Building combination for example is created, and then it is switched for example to Footbridge combination, the content of the right window is refreshed and also the content of the combination is checked. If any non-compatible variable load is found, it is automatically removed from the content of the combination.

During this switch a warning message is displayed together with the changed content on the background. the user may accept the change or cancel it.



The same warning is displayed when switching to/from Accidental and Seismic combinations. Load cases which are assigned to Accidental load groups, are possible to input into the **code** combination only when **type of the combination** is set to Accidental1 or Accidental 2 combination. Practically the same way behaves load cases assigned to Seismic load groups, which are possible to input only into **Seismic code** combination. In all other cases, accidental and seismic load cases are not displayed in the List of load cases window. Also when such load cases are already inputed in the content of combination and after that the type is changed, they are removed from the combination.

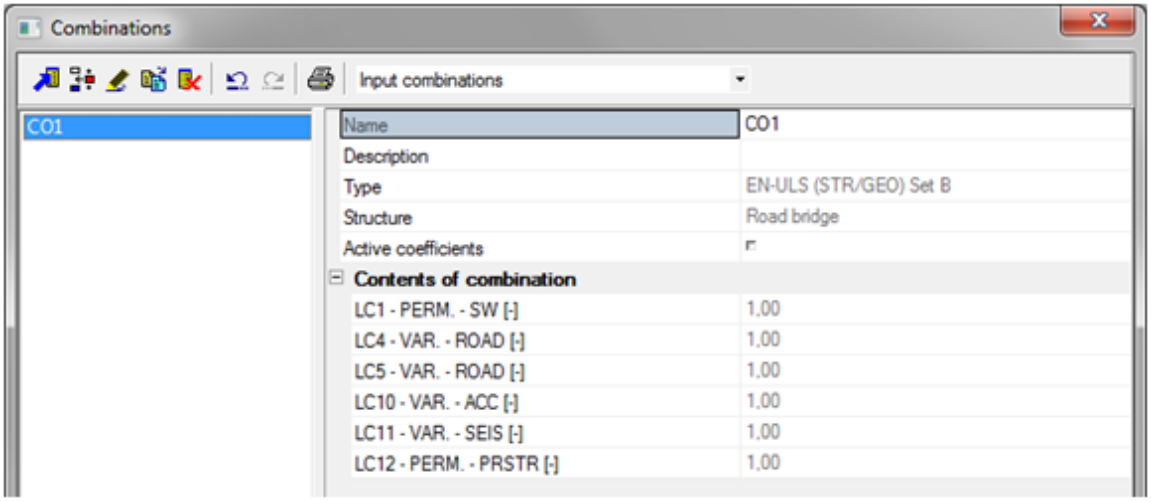
Example:

Type of the combination	List of load cases
Envelope, Linear	All
EN-Code non-Accidental 1,2 and non-Seismic	All except Accidental and Seismic
EN-Code Accidental 1,2	All except Seismic
EN-Code Seismic	All except Accidental

The previous warning dialog is also displayed when switching combination type from non-code to a code combination. The Structure parameter is set to Building as the default option.

The Structure parameter is also visible in the main Combinations dialog, where it has only informative character. Here it is disabled and **is not possible** to change it. Therefore the list of the load cases is always valid. The Structure parameter is visible again only for the Code combinations here. Else it is hidden.

Parameter Type is also always disabled and it is **not possible** to change it.

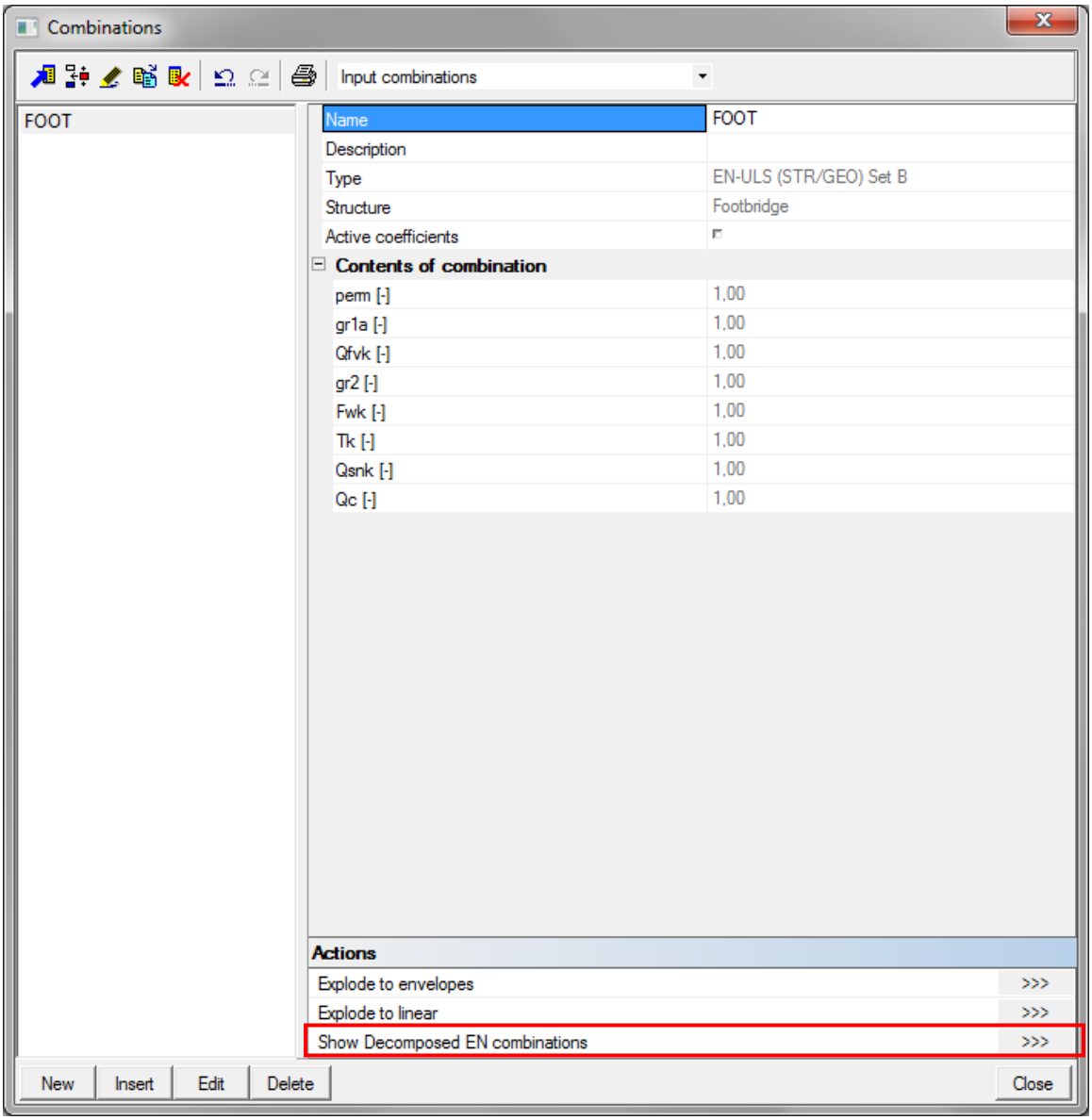


This restrictions are implemented to ensure the correct input for the combinations.

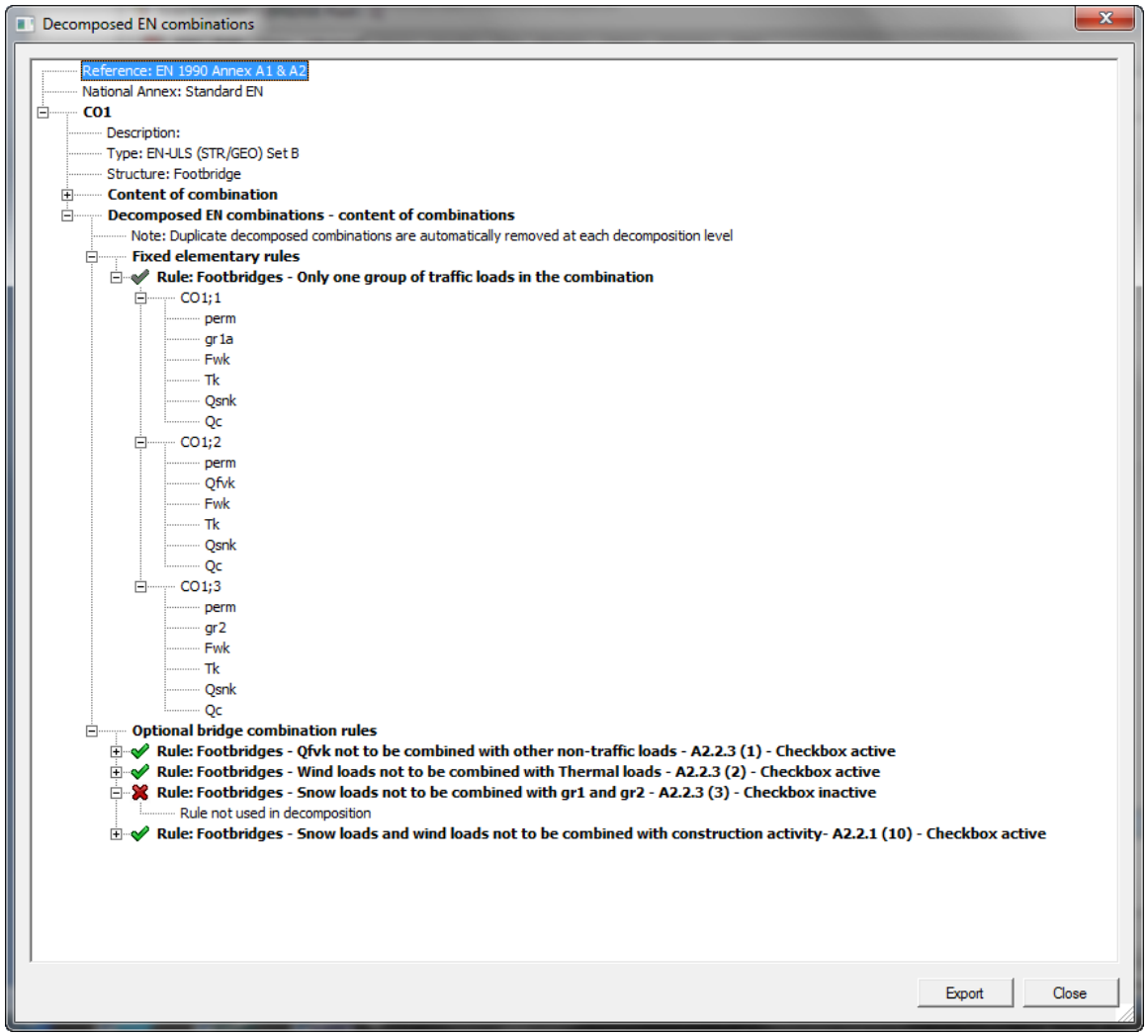
Step 5: Decomposed EN combinations

For further generation of envelope combinations it is necessary to extract so-called **Decomposed EN combinations** from the user defined "mother" Code combination. These new combinations are the result combinations after applying both fixed elementary rules and optional combination setup rules, on a original combination. These Decomposed EN combinations will be then used for generating envelope combinations.

There is Decomposed EN combination action button shown for all buildings, road bridge, footbridge and railway bridge Code combinations in the main Combinations dialog. It is hidden for all other combinations. By pressing red marked three dots edit button the user may access a dialog, where these combinations are stored together with the documented decomposition process itself.



By pressing mentioned edit button a new dialog is displayed. Here the precise process of decomposed EN combinations can be viewed and checked. Final combinations can be found on the bottom of the dialog, as in each step rule is applied on the combinations from the previous step. By default, all check are active and need to be taken into the consideration. If the user deactivates the check itself in the setup, it means, that the rule should be skipped. This will be recognized in the dialog by showing the warning message under such rule.



There is also a button for exporting all the data into the txt file. If used, the user is asked for a path and a file name. By default, the path to the user folder will be set. After confirmation, txt file is saved and directly opened in a notepad.

In general, there are three levels of filtering redundant combinations.

- First filtering is applied on the level of decomposed combinations, where all duplicated combinations are removed at each decomposition level.
- Second level is done during generating envelope combinations
- Final level is executed on the level of linear explosion.

Decomposed EN combinations takes into account special rules given by EN 1990 Annex A2 and EN 1991-2. Not every variable load should be combined with all others. For each Structure, a set of appropriate rules is defined to enable proper generation of envelope combinations.

Generation rules for Building

Code EN 1990 A1 table A1.1 specifies these possible variable loads:

Action	ψ_0	ψ_1	ψ_2
Imposed loads in buildings, category (see EN 1991-1-1)			
Category A : domestic, residential areas	0,7	0,5	0,3
Category B : office areas	0,7	0,5	0,3
Category C : congregation areas	0,7	0,7	0,6
Category D : shopping areas	0,7	0,7	0,6
Category E : storage areas	1,0	0,9	0,8
Category F : traffic area, vehicle weight ≤ 30kN	0,7	0,7	0,6
Category G : traffic area, 30kN < vehicle weight ≤ 160kN	0,7	0,5	0,3
Category H : roofs	0	0	0
Snow loads on buildings (see EN 1991-1-3)*			
Finland, Iceland, Norway, Sweden	0,70	0,50	0,20
Remainder of CEN Member States, for sites located at altitude H > 1000 m a.s.l.	0,70	0,50	0,20
Remainder of CEN Member States, for sites located at altitude H ≤ 1000 m a.s.l.	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,6	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
NOTE The ψ values may be set by the National annex. * For countries not mentioned below, see relevant local conditions.			

According to the code EN1991-1-1, it is not necessary to combine every variable load with the rest. Exact rules are given separately also for buildings. By default, all these rules **are enabled, to follow standard EC-EN**. However user is able to override these rules in national annex setup by certain checkboxes. If the certain rule will be unchecked, than the combinations will ignore the recommendation from EC-EN and will skip this rule.

In fact, there is only one rule to be applied for buildings:

> **EN 1991-1-1:2002 (E)**
>
> **3.3.2 Additional provisions for buildings**
>
> (1) On roofs, imposed loads, and snow loads or wind actions should not be applied together simultaneously.

This can be interpreted in different words like:

Category H loading should not be combined with snow or wind.

Here is the table, which shows, how to combine variable loads:

	Cat A	Cat B	Cat C	Cat D	Cat E	Cat F	Cat G	Cat H	Snow	Wind	Temp.
Cat A											
Cat B											
Cat C											
Cat D											
Cat E											
Cat F											
Cat G											
Cat H											
Snow											
Wind											
Temp.											

Rule 1 active - Category H loading not to be combined with snow or wind - EN 1991-1-1: 3.3.2 (1) -

As you can see for example, Cat H should be combined with everything but Snow and Wind.

Note:

Table above shows only Standard EN load groups. Also other additional NA load groups are correctly taken into account in the combination rules.

Generation rules for Road bridges

Code EN 1990 A2 table A2.1 specifies these possible variable loads:

Action	Symbol		Ψ_0	Ψ_1	Ψ_2
Traffic loads	gr1a (LM1 + pedestrian or cycle-track loads)	TS	0,75	0,75	0
		UDL	0,4	0,4	0
		Pedestrian + cycle track loads	0,4	0,4	0
	gr1b (Single axle)		0	0,75	0
	gr2 (Horizontal forces)		0	0	0
	gr3 (Pedestrian loads)		0	0,4	0
	gr4 (LM4 - Crowd loading)		0	-	0
	gr5 (LM3 - Special vehicles)		0	-	0
Wind forces	F_{wk}	Persistent design situations	0,6	0,2	0
		Execution	0,8	-	0
	F^*_w		1	-	-
Thermal actions	T_k		0,6	0,6	0,5
Snow loads	$Q_{sn,k}$ (during execution)		0,8	-	-
Construction loads	Q_c		1	-	1

Traffic loads (Load models) for road bridges should be, according to the code EN 1991-2, sorted to several so called Group of loads. These groups of loads should be combined with other variable loads but not with other group of loads from traffic. They are **mutually exclusive**.

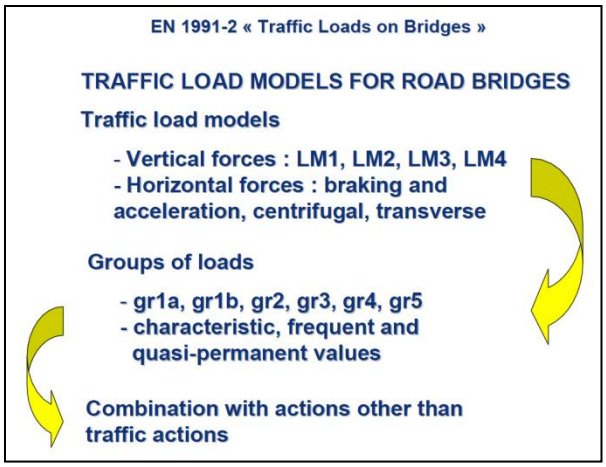
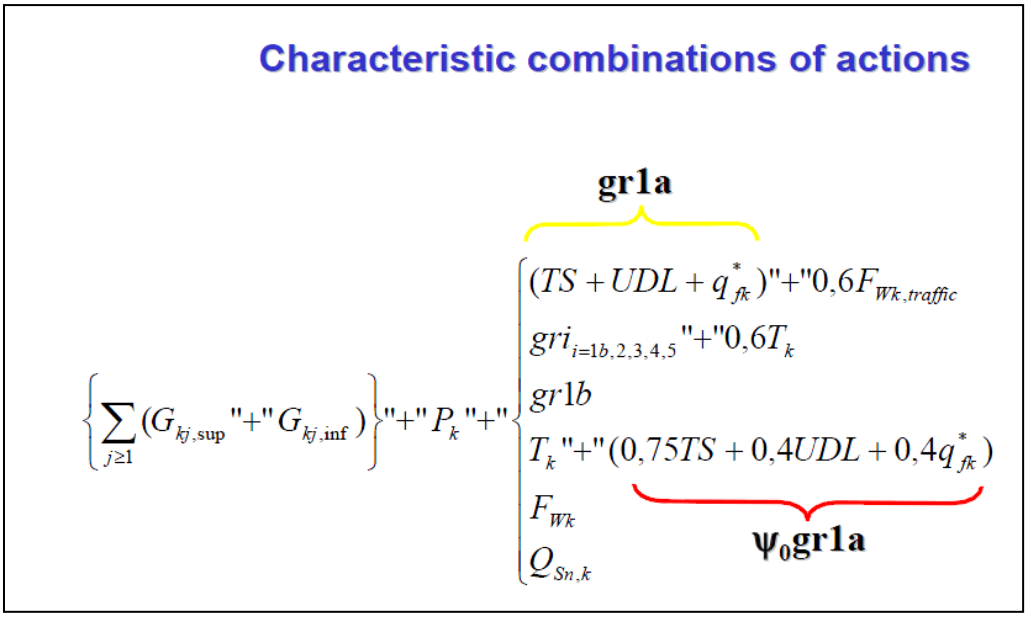


Table 4.4a - Assessment of groups of traffic loads (characteristic values of the multi-component action)

Load type		CARRIAGEWAY						FOOTWAYS AND CYCLE TRACKS
		Vertical forces				Horizontal forces		Vertical forces only
Reference		4.3.2	4.3.3	4.3.4	4.3.5	4.4.1	4.4.2	5.3.2-(1)
Load system		LM1 (TS and UDL systems)	LM2 (Single axle)	LM3 (Special vehicles)	LM4 (Crowd loading)	Braking and acceleration forces	Centrifugal and transverse forces	Uniformly Distributed load
Groups of Loads	gr1a	Characteristic values				[a]	[a]	Combination value [b]
	gr1b		Characteristic value					
	gr2	Frequent values [b]				Characteristic value	Characteristic value	
	gr3 [d]							Characteristic value [c]
	Gr4				Characteristic value			Characteristic value [b]
	Gr5	See annex A		Characteristic value				
	Dominant component action (designated as component associated with the group)							

[a] May be defined in the National Annex.
[b] May be defined in the National Annex. The recommended value is 3 kN/m^2.
[c] See 5.3.2.1-(2). One footway only should be considered to be loaded if the effect is more unfavourable than the effect of two loaded footways.
[d] This group is irrelevant if gr4 is considered.

Problematic group of loads gr1a – see example, how it may be used in the combination



If the user will create **multiple load groups with TS, UDL or Pedestrian loads for gr1a**, it will **always be considered together** in the combination!! This means that all load cases from these load groups together will be considered either leading or accompanying.

Here is the list of Road bridges rules and a table, which shows, how to combine variable loads:

Only one wind action in the combination	-
Only one group of traffic loads in the combination	-
Rule 1 active - gr1b not to be combined with other non-traffic loads - A2.2.2 (2)	-
Rule 2 active - Snow or wind load not to be combined with gr2 - A2.2.2 (3)a	NA/other
Rule 3 active - Snow or wind load not to be combined with gr3 - A2.2.2 (3)b	NA/other
Rule 4 active - Snow or wind load not to be combined with gr4 - A2.2.2 (3)c	NA/other
Rule 5 active - Snow not to be combined with gr1a and gr1b - A2.2.2 (4)	NA/other
Rule 6 active - Wind loads not to be combined with Thermal loads - A2.2.2 (6)	NA/other
Rule 7 active - Snow loads and wind loads not to be combined with construction activity- A2.2.1 (10)	other

	gr1a-TS	gr1a-UDL	gr1a-Ped	gr1b	gr2	gr3	gr4	gr5	$F_{wk}P$	$F_{wk}E$	F^*_w	T_k	$Q_{sn,k}$	Q_c
gr1a-TS														
gr1a-UDL														
gr1a-Ped														
gr1b													+Rule 5	
gr2														
gr3														
gr4														
gr5														
$F_{wk}P$														
$F_{wk}E$														
F^*_w														
T_k														
$Q_{sn,k}$				+Rule 5										
Q_c														

As you can see for example, group of loads gr1a should be combined with Wind, Thermal forces T_k and Construction loads Q_c only.

Concentrated load Q_{fvk} is also mentioned in the EN 1990, but for road bridges no exact group of loads is defined for this load. It is up to the user, where he puts it. Probably load group gr3-pedestrian is the most suitable one.

Generation rules for Footbridges

Code EN 1990 A2 table A2.2 specifies these possible variable loads:

Action	Symbol	Ψ_0	Ψ_1	Ψ_2
Traffic load	gr1	0,4	0,4	0
	Q_{fwk}	0	0	0
	gr2	0	0	0
Wind forces	F_{wk}	0,3	0,2	0
Thermal actions	T_k	0,6	0,6	0,5
Snow loads	$Q_{s,k}$ (during execution)	0,8	-	0
Construction loads	Q_c	1	-	1

(2) Three models, mutually exclusive, should be taken into account, as relevant. They consist of :

– a uniformly distributed load, q_{fk}

– a concentrated load Q_{fwk} , and

– loads representing service vehicles, Q_{serv} .

In fact gr1 equals to q_{fk}

In fact gr2 equals Q_{serv}

Table 5.1 - Definition of groups of loads (characteristic values)

Load type		Vertical forces		Horizontal forces
Load system		Uniformly distributed load	Service vehicle	
Groups of loads	gr1	q_{fk}	0	Q_{flk}
	gr2	0	Q_{serv}	Q_{flk}

+ the Q_{fwk}, where horizontal forces should not be considered

Here is the list of rules for Footbridges and a table, which shows, how to combine variable loads:

Only one group of traffic loads in the combination	-
Rule 1 active - Q_{fvk} not to be combined with other non-traffic loads - A2.2.3 (1)	-
Rule 2 active - Wind loads not to be combined with Thermal loads - A2.2.3 (2)	NA/other
Rule 3 active - Snow loads not to be combined with gr1 and gr2 - A2.2.3 (3)	NA/other
Rule 4 active - Snow loads and wind loads not to be combined with construction activity- A2.2.1 (10)	other

	gr1	Q_{tvk}	gr2	F_{wk}	T_k	$Q_{sn,k}$	Q_c
gr1							
Q_{tvk}							
gr2							
F_{wk}							
T_k							
$Q_{sn,k}$							
Q_c							

As you can see for example, the Group of loads gr1 should be combined with wind forces F_{wk}, Thermal actions T_k and Construction loads Q_c only.

Generation rules for Railway bridges

The EN 1990 specifies two different types of traffic actions which can be used. Individual Components of traffic Actions and **Main traffic actions (group of loads)**. Since the majority of combinations are done through group of loads, **only** this option is supported.

Code EN 1990 A2 table A2.3 specifies these possible variable loads:

Action		Symbol	Ψ_0	Ψ_1	Ψ_2
Individual components of traffic actions to be skiped in Stage 1					
Main traffic actions (Group of loads)	Traffic load	gr11 (LM71 + SW/0)	0,8	0,8	0
		gr12 (LM71 + SW/0)			
		gr13 (Braking/traction)			
		gr14 (Centrifugal/nosing)			
		gr15 (Unloaded train)			
		gr16 (SW/2)			
		gr17 (SW/2)			
		gr21 (LM71 + SW/0)	0,8	0,7	0
		gr22 (LM71 + SW/0)			
		gr23 (Braking/traction)			
		gr24 (Centrifugal/nosing)			
		gr26 (SW/2)			
		gr27 (SW2)			
		gr31 (LM71 + SW/0)	0,8	0,6	0
	Other operating actions	Aerodynamic effects	0,8	0,5	0
		General maintenance loading for non public footpaths	0,8	0,5	0
	Wind forces	F_{wk}	0,75	0,5	0
		F**w	1	0	0
	Thermal actions	T_k	0,6	0,6	0,5
	Snow loads	$Q_{sn,k}$ (during execution)	0,8	-	0
	Construction loads	Q_c	1	-	1

Table 6.11 - Assessment of Groups of Loads for rail traffic (characteristic values of the multicomponent actions)

number of tracks on structure			Groups of loads Reference EN 1991-2			Vertical forces 6.3.2/6.3.3	6.3.3	6.3.4	Horizontal forces 6.5.3	6.5.1	6.5.2	Comment
1	2	≥ 3	number of tracks loaded	Load Group[8]	Loaded track	LM 71[1] SW/0 [1], [2] HSLM[6][7]	SW/2 [1],[3]	Unloaded train	Traction, Braking [1]	Centrifugal force [1]	Nosing force [1]	
			1	gr11	T_1	1			1 [5]	0,5 [5]	0,5 [5]	Max. vertical 1 with max. longitudinal
			1	gr 12	T_1	1			0,5 [5]	1 [5]	1 [5]	Max. vertical 2 with max. transverse
			1	gr 13	T_1	1 [4]			1	0,5 [5]	0,5 [5]	Max. longitudinal
			1	gr 14	T_1	1 [4]			0,5 [5]	1	1	Max. lateral
			1	gr 15	T_1			1		1 [5]	1 [5]	Lateral stability with "unloaded train"
			1	gr 16	T_1		1		1 [5]	0,5 [5]	0,5 [5]	SW/2 with max. longitudinal
			1	gr 17	T_1		1		0,5 [5]	1 [5]	1 [5]	SW/2 with max. transverse
			2	gr 21	T_1 T_2	1 1			1 [5] 1 [5]	0,5 [5] 0,5 [5]	0,5 [5] 0,5 [5]	Max. vertical 1 with max longitudinal
			2	gr 22	T_1 T_2	1 1			0,5 [5] 0,5 [5]	1 [5] 1 [5]	1 [5] 1 [5]	Max. vertical 2 with max. transverse
			2	gr 23	T_1 T_2	1 [4] 1 [4]			1 1	0,5 [5] 0,5 [5]	0,5 [5] 0,5 [5]	Max. longitudinal
			2	gr 24	T_1 T_2	1 [4] 1 [4]			0,5 [5] 0,5 [5]	1 1	1 1	Max. lateral
			2	gr 26	T_1 T_2	1	1		1 [5] 1 [5]	0,5 [5] 0,5 [5]	0,5 [5] 0,5 [5]	SW/2 with max. longitudinal
			2	gr 27	T_1 T_2	1	1		0,5 [5] 0,5 [5]	1 [5] 1 [5]	1 [5] 1 [5]	SW/2 with max. transverse
			≥3	gr 31	T_i	0.75			0.75 [5]	0.75 [5]	0.75 [5]	Additional load case

Here is the list of rules for Railway bridges and a table, which shows, how to combine variable loads:

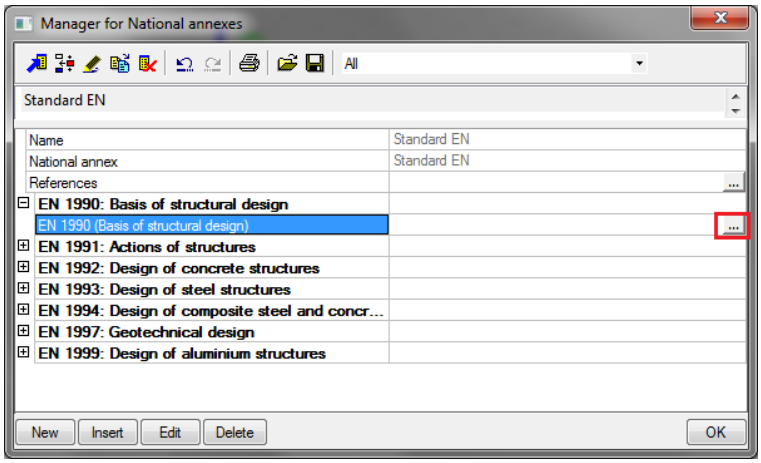
Only one wind action in the combination	-
Only one group of traffic loads in the combination	-
Rule 1 active -Snow loads not to be taken into account - A2.2.4 (1)	NA
Rule 2 active -Wind action not to be combined with gr13 or gr23- A2.2.4 (3)a	-
Rule 3 active -Wind action not to be combined with gr16, gr17, gr26, gr27- A2.2.4 (3)b	-
Rule 4 active - Snow loads and wind loads not to be combined with construction activity- A2.2.1 (10)	other

	gr11	gr12	gr13	gr14	gr15	gr16	gr17	gr21	gr22	gr23	gr24	gr26	gr27	gr31	Ae	Gml	F_{wk}	F^{**}_w	T_k	$Q_{ex,k}$	Q_c
gr11																					
gr12																					
gr13																					
gr14																					
gr15																					
gr16																					
gr17																					
gr21																					
gr22																					
gr23																					
gr24																					
gr26																					
gr27																					
gr31																					
Ae																					
Gml																					
F_{wk}																					
F^{**}_w																					
T_k																					
$Q_{ex,k}$																					+Rule 4
Q_c																				+Rule 4	

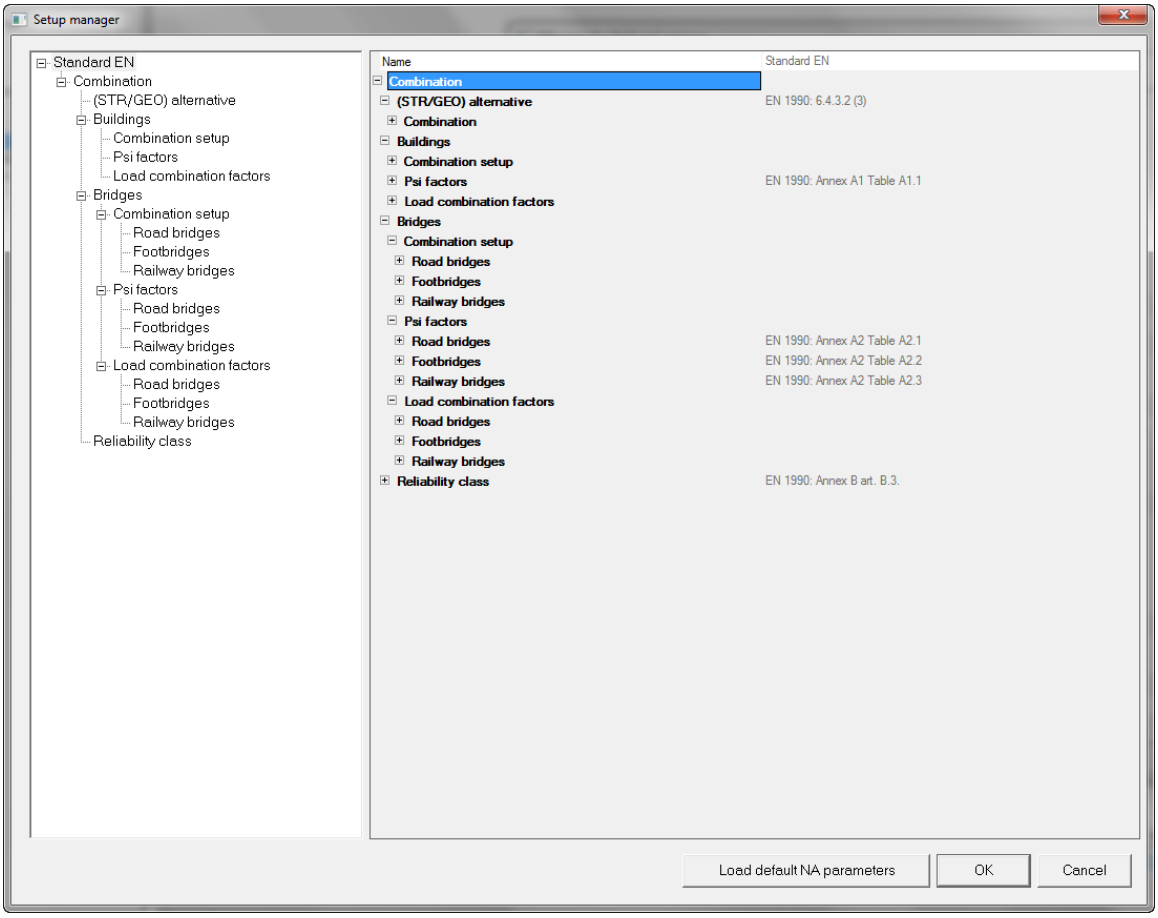
As you can see for example, group of loads gr13 should be combined with Aerodynamics, Gml, Thermal actions T_k and Construction loads Q_c only.

Step 6: NA Setup dialog

All combination rules together with ψ values and γ values may be accessed in the NA Setup dialog. They are different for buildings and for all three types of bridges. The user may access them by pressing edit button for EN 1990 in the manager of National annexes dialog.



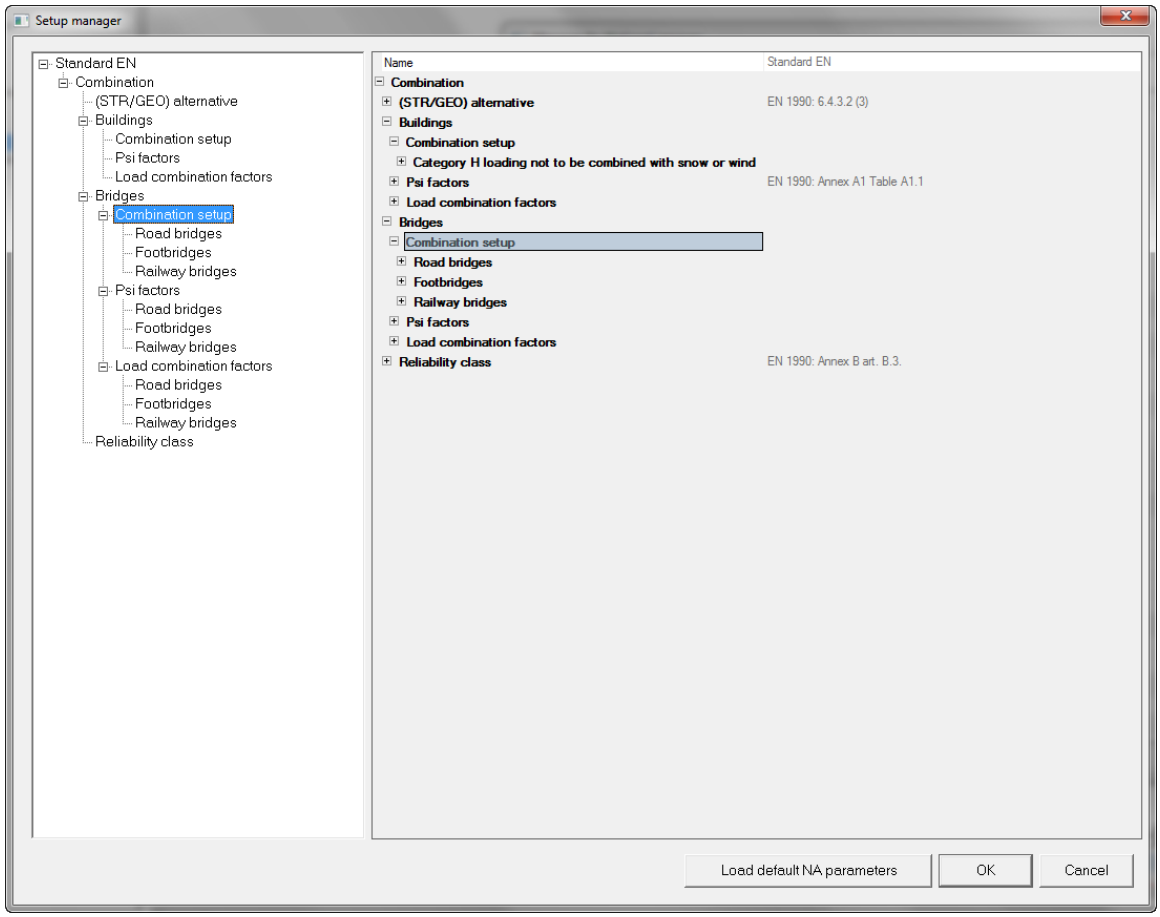
By pressing this button the Setup dialog is opened and from the very first look it is obvious, that the whole structure has been changed.



Combination setup

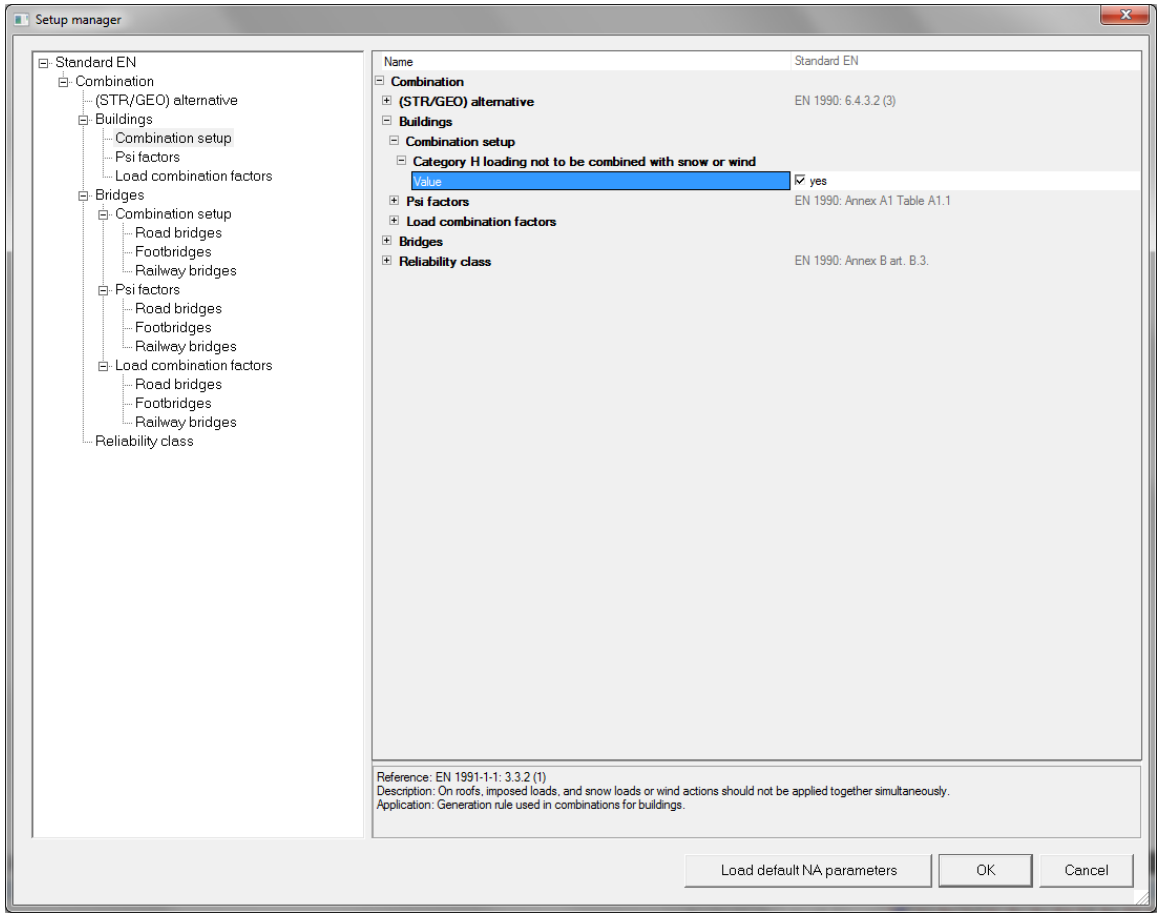
According to the codes EN 1990 Annex2 and EN 1991-2, it is not necessary to combine every variable load with the rest. Exact rules are given separately for all kinds of bridges and also for buildings. By default, all these rules **are enabled, to follow standard EC-EN**. However user will be able to use the rules in national annex setup by certain checkboxes. If the certain rule will be unchecked, than the combinations will ignore the recommendation from EC-EN and will not consider this rule.

Combination setup rules both for bridges and for buildings are listed here.



By setting focus on a certain rule, the description field will be displayed in the dialog to provide more detailed info on a selected value. In this field, three strings (Reference, Description and Application) are displayed.

Combination rules for Buildings:

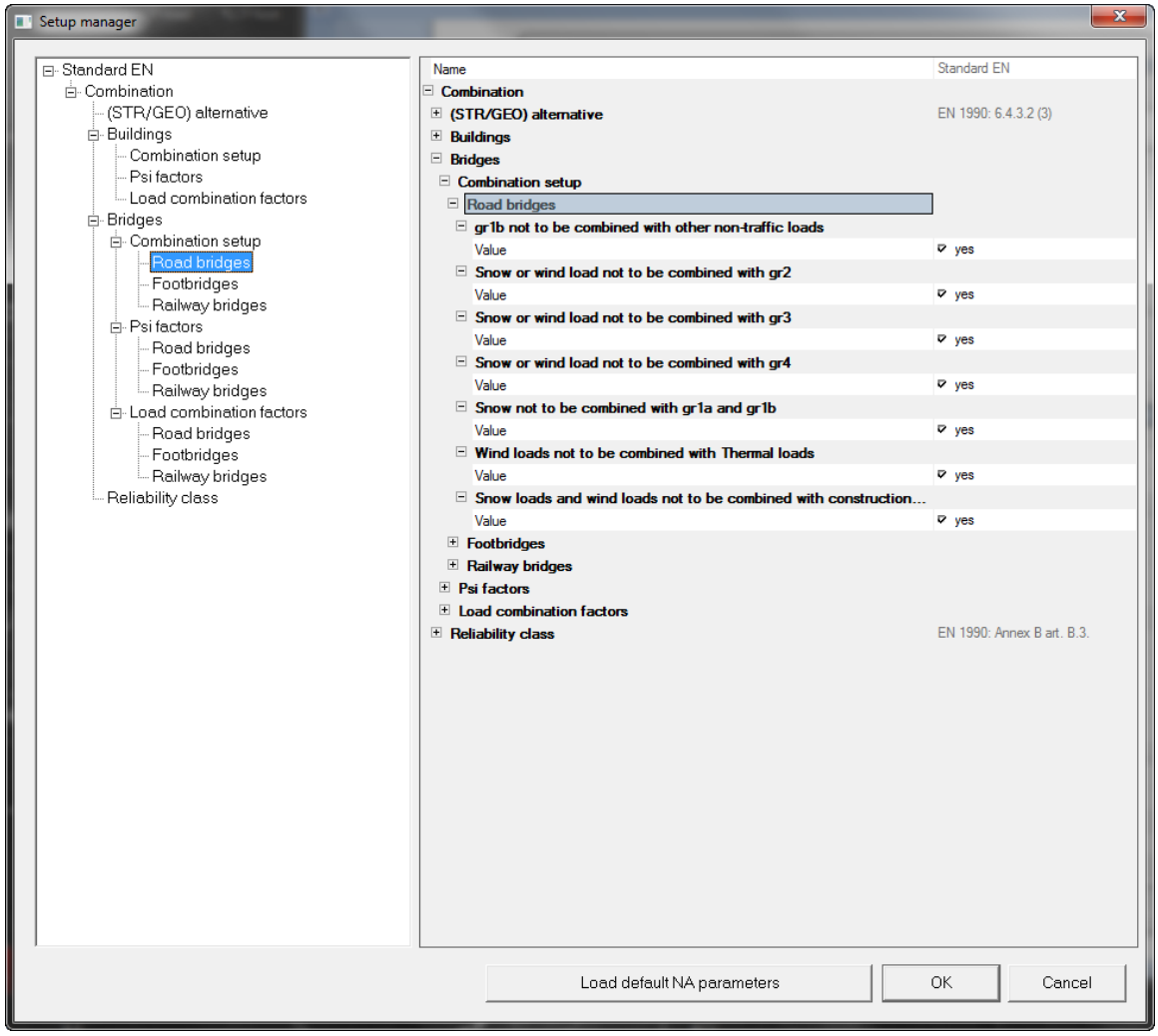


The following rules for Combination setup for Buildings are given:

Category H loading not to be combined with snow or wind

- Reference: EN 1991-1-1: 3.3.2 (1)
- Description: On roofs, imposed loads, and snow loads or wind actions should not be applied together simultaneously.
- Application: Generation rule used in combinations for buildings.

Combination rules for Road bridges:



The following rules for Combination setup for Road bridges are given:

gr1b not to be combined with other non-traffic loads

- Reference: EN 1990: Annex A2 A2.2.2 (2)
- Description: Load Model 2 (or associated group of loads gr1b) and the concentrated load Qfwk (see 5.3.2.2 in EN 1991-2) on footways need not be combined with any other variable non traffic action.
- Application: Generation rule used in combinations for road bridges.

Snow or wind load not to be combined with gr2

- Reference: EN 1990: Annex A2 A2.2.2 (3)

- Description: Neither snow loads nor wind actions need be combined with braking and acceleration forces or the centrifugal forces or the associated group of loads gr2.
- Application: Generation rule used in combinations for road bridges.

Snow or wind load not to be combined with gr3

- Reference: EN 1990: Annex A2 A2.2.2 (3)
- Description: Neither snow loads nor wind actions need be combined with loads on footways and cycle tracks or with the associated group of loads gr3
- Application: Generation rule used in combinations for road bridges.

Snow or wind load not to be combined with gr4

- Reference: EN 1990: Annex A2 A2.2.2 (3)
- Description: Neither snow loads nor wind actions need be combined with crowd loading (Load Model 4) or the associated group of loads gr4.
- Application: Generation rule used in combinations for road bridges.

Snow not to be combined with gr1a and gr1b

- Reference: EN 1990: Annex A2 A2.2.2 (4)
- Description: Snow loads need not be combined with Load Models 1 and 2 or with the associated groups of loads gr1a and gr1b unless otherwise specified for particular geographical areas.
- Application: Generation rule used in combinations for road bridges.

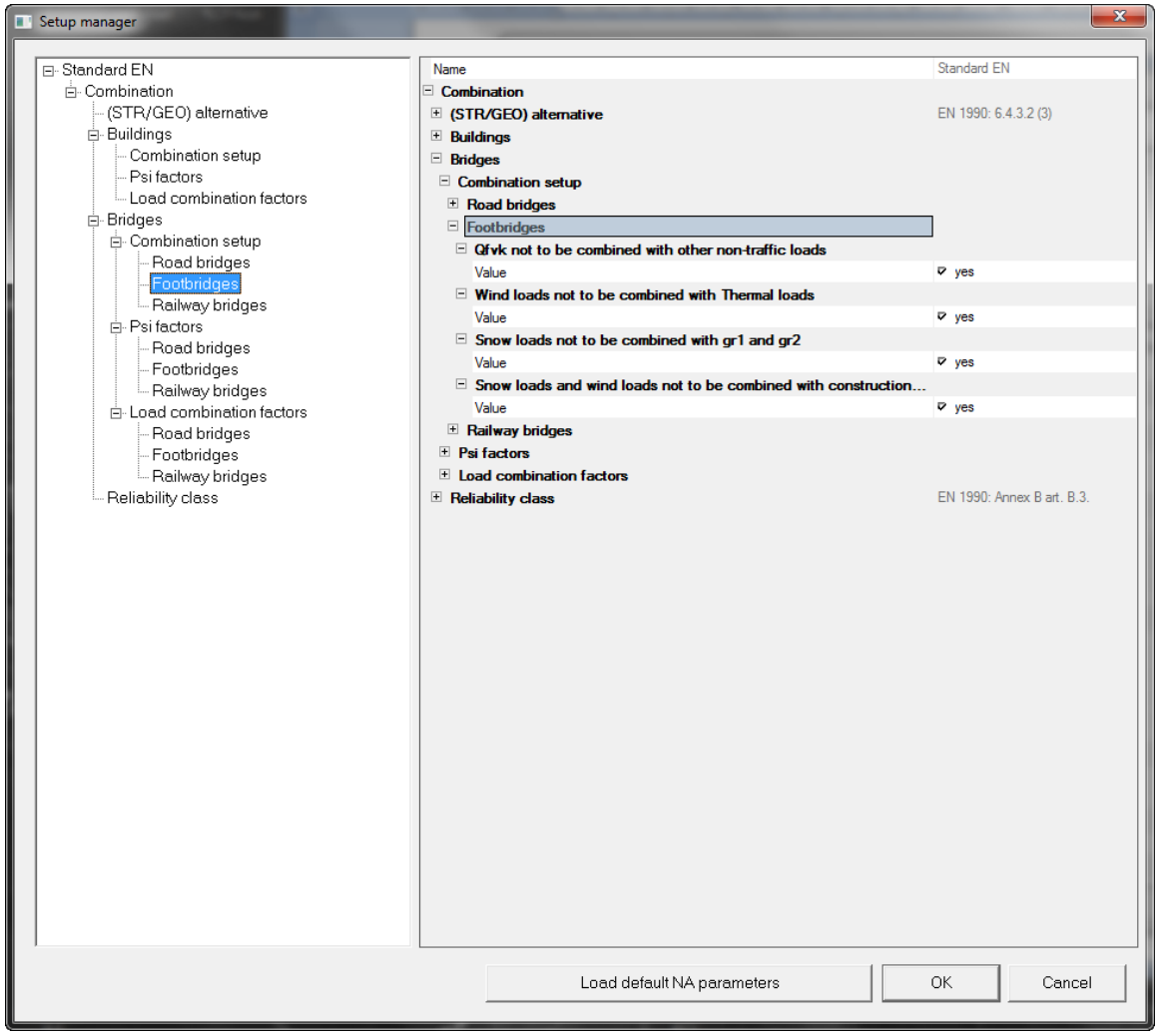
Wind loads not to be combined with Thermal loads

- Reference: EN 1990: Annex A2 A2.2.2 (6)
- Description: Wind actions and thermal actions need not be taken into account simultaneously unless otherwise specified for local climatic conditions.
- Application: Generation rule used in combinations for road bridges.

Snow loads and wind loads not to be combined with constr. activity

- Reference: EN 1990: Annex A2 A2.2.1 (10)
- Description: Snow loads and wind actions need not be considered simultaneously with loads arising from construction activity Qca (i.e. loads due to working personnel).
- Application: Generation rule used in combinations for road bridges.

Combination rules for Footbridges:



The following rules for Combination setup for Footbridges are given:

Qfvk not to be combined with other non-traffic loads

- Reference: EN 1990: Annex A2 A2.2.3 (1)
- Description: The concentrated load Qfwk need not be combined with any other variable actions that are not due to traffic.
- Application: Generation rule used in combinations for footbridges.

Wind loads not to be combined with Thermal loads

- Reference: EN 1990: Annex A2 A2.2.3 (2)

- Description: Wind actions and thermal actions need not be taken into account simultaneously unless otherwise specified for local climatic conditions.
- Application: Generation rule used in combinations for footbridges.

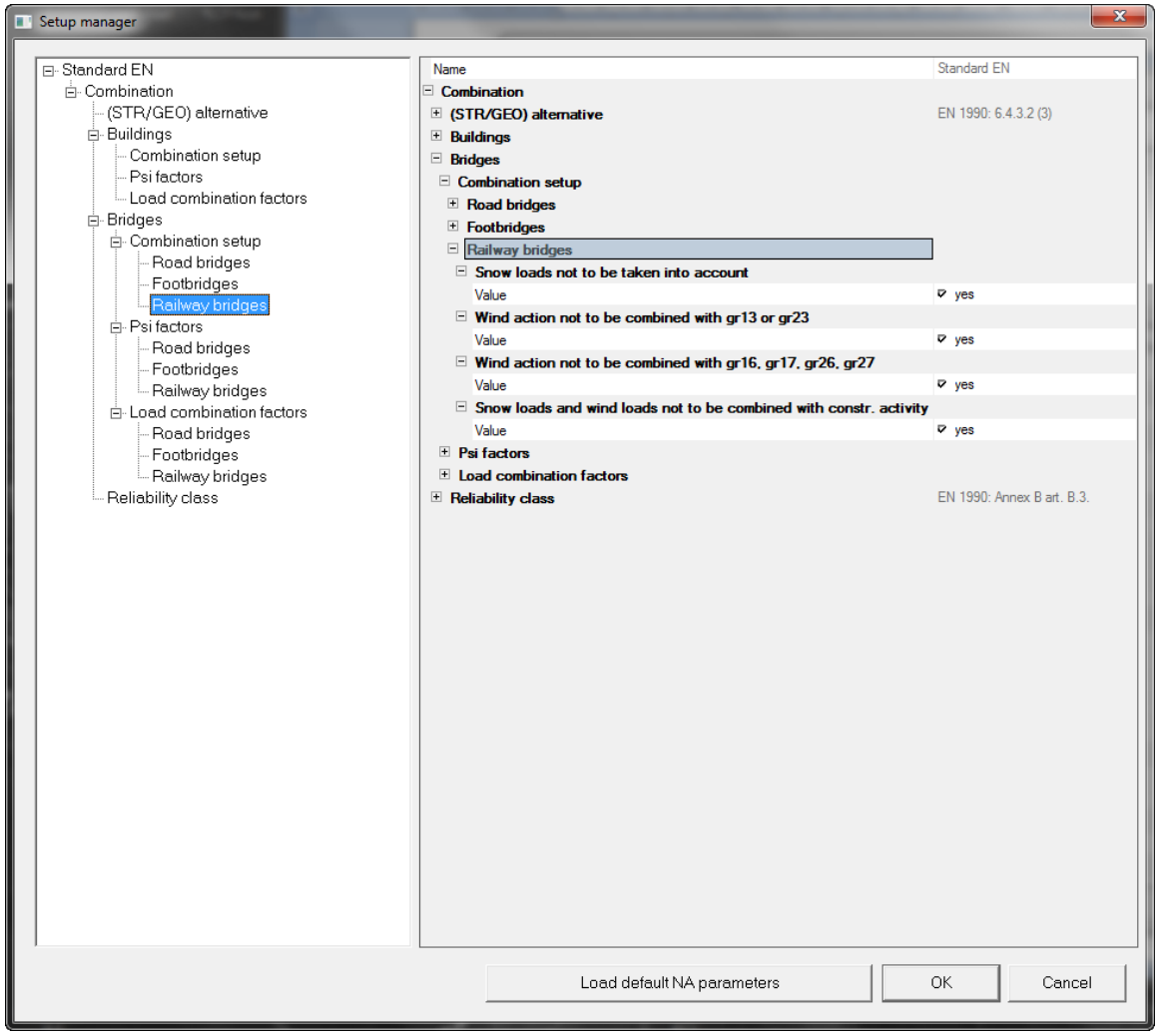
Snow loads not to be combined with gr1 and gr2

- Reference: EN 1990: Annex A2 A2.2.3 (3)
- Description: Snow loads need not be combined with groups of loads gr1 and gr2 for footbridges unless otherwise specified for particular geographical areas and certain types of footbridges.
- Application: Generation rule used in combinations for footbridges.

Snow loads and wind loads not to be combined with constr. activity

- Reference: EN 1990: Annex A2 A2.2.1 (10
- Description: Snow loads and wind actions need not be considered simultaneously with loads arising from construction activity Qca (i.e. loads due to working personnel).
- Application: Generation rule used in combinations for footbridges.

Combination rules for Railway bridges:



The following rules for Combination setup for Railway bridges are given:

Snow loads not to be taken into account

- Reference: EN 1990: Annex A2 A2.2.4 (1)
- Description: Snow loads need not be taken into account in any combination for persistent design situations nor for any transient design situation after the completion of the bridge unless otherwise specified for particular geographical areas and certain types of railway bridges.
- Application: Generation rule used in combinations for railway bridges.

Wind action not to be combined with gr13 or gr23

- Reference: EN 1990: Annex A2 A2.2.4 (3)

- Description: Wind action need not be combined with groups of loads gr 13 or gr 23.
- Application: Generation rule used in combinations for railway bridges.

Wind action not to be combined with gr16, gr17, gr26, gr27

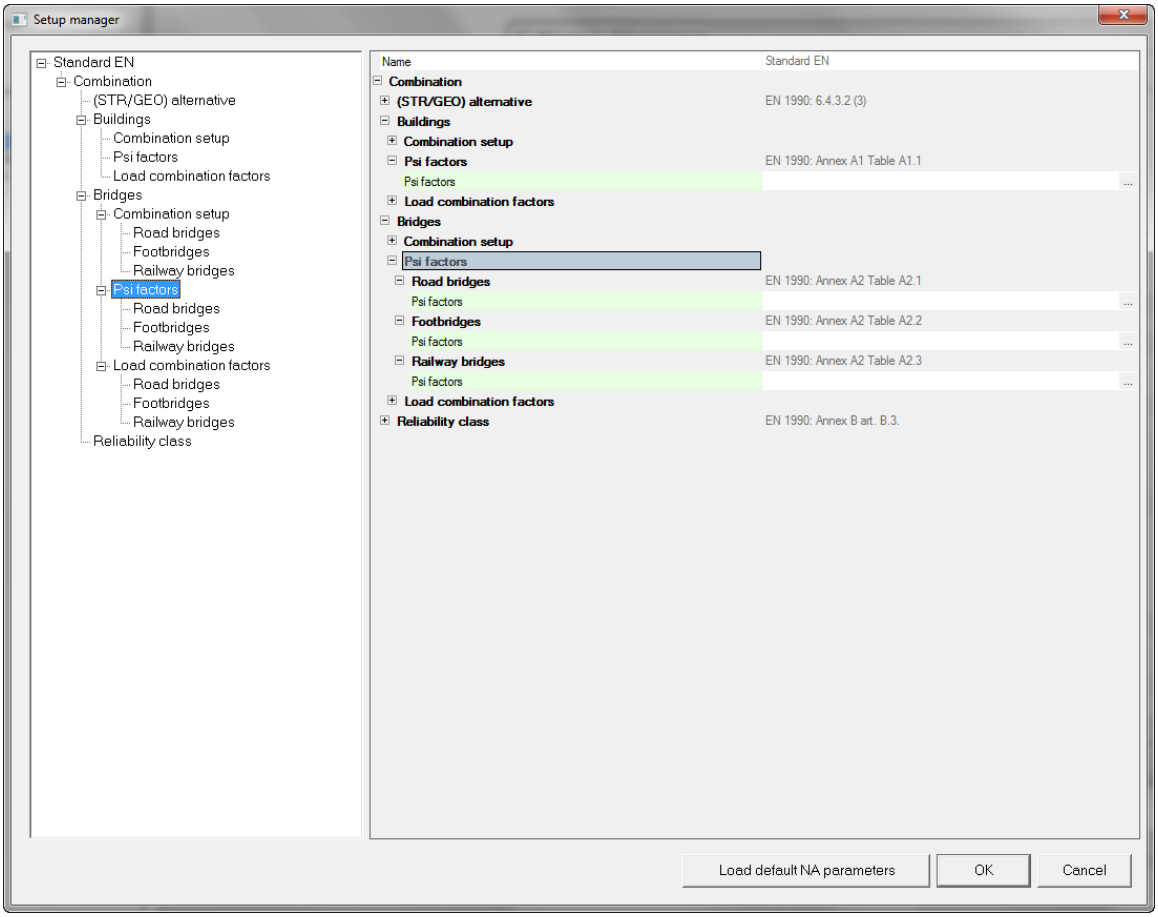
- Reference: EN 1990: Annex A2 A2.2.4 (3)
- Description: Wind action need not be combined with groups of loads gr 16, gr 17, gr 26, gr 27.
- Application: Generation rule used in combinations for railway bridges.

Snow loads and wind loads not to be combined with constr. activity

- Reference: EN 1990: Annex A2 A2.2.1 (10)
- Description: Snow loads and wind actions need not be considered simultaneously with loads arising from construction activity Qca (i.e. loads due to working personnel).
- Application: Generation rule used in combinations for railway bridges.

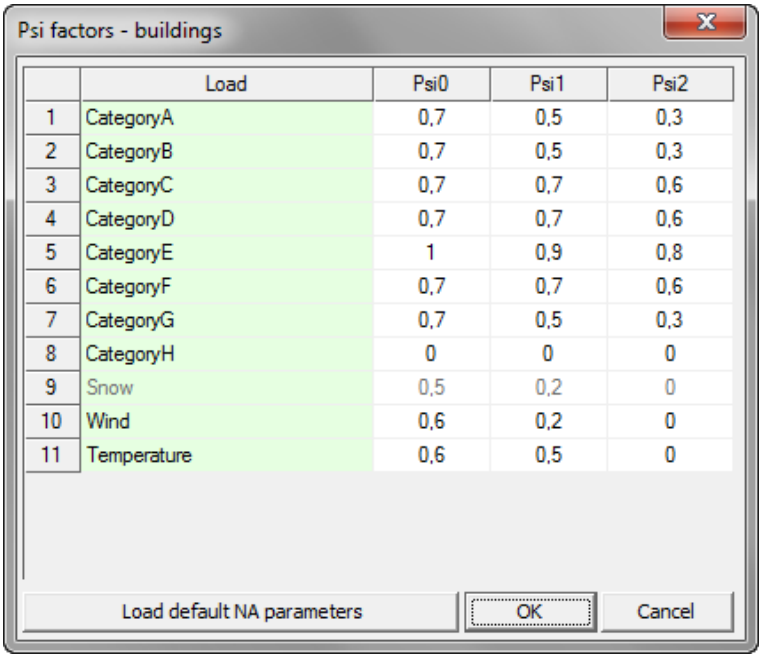
Psi factors

Groups for Psi factors Ψ both for bridges and buildings are implemented here.



Psi factors are code recommended values and user may edit them by using the appropriate edit button. By pressing it, new dialog appears and here the user may adjust the values. The dialog name corresponds to the appropriate type used. (for example Psi factors for buildings)

Psi factors Ψ_0, Ψ_1 and, Ψ_2 for buildings are given by EN1990 A1, Table A1.1.

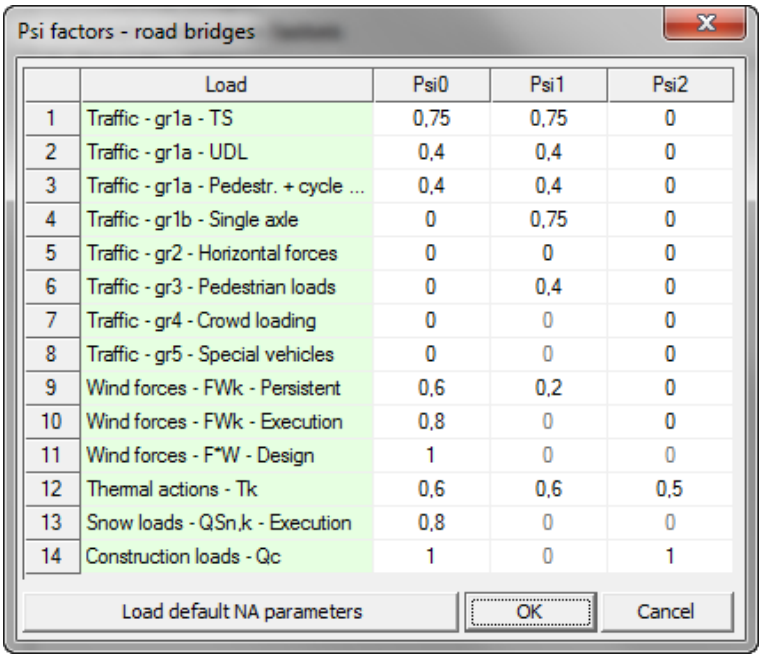


	Load	Psi0	Psi1	Psi2
1	CategoryA	0,7	0,5	0,3
2	CategoryB	0,7	0,5	0,3
3	CategoryC	0,7	0,7	0,6
4	CategoryD	0,7	0,7	0,6
5	CategoryE	1	0,9	0,8
6	CategoryF	0,7	0,7	0,6
7	CategoryG	0,7	0,5	0,3
8	CategoryH	0	0	0
9	Snow	0,5	0,2	0
10	Wind	0,6	0,2	0
11	Temperature	0,6	0,5	0

Note:

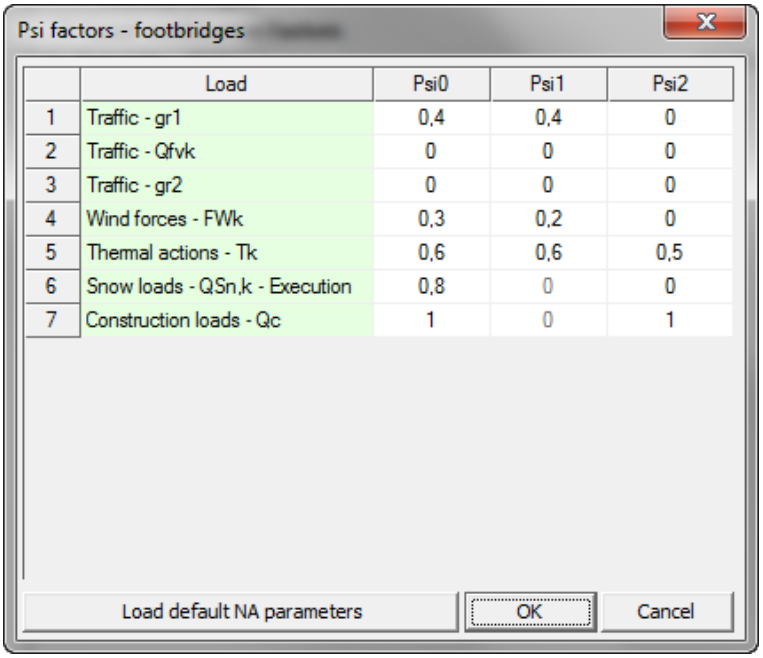
Table above shows only Standard EN load groups. Also other additional NA load groups are correctly shown in appropriate national annexes.

Psi factors Ψ_0, Ψ_1 and, Ψ_2 for road bridges are given by EN1990 A2, Table A2.1.



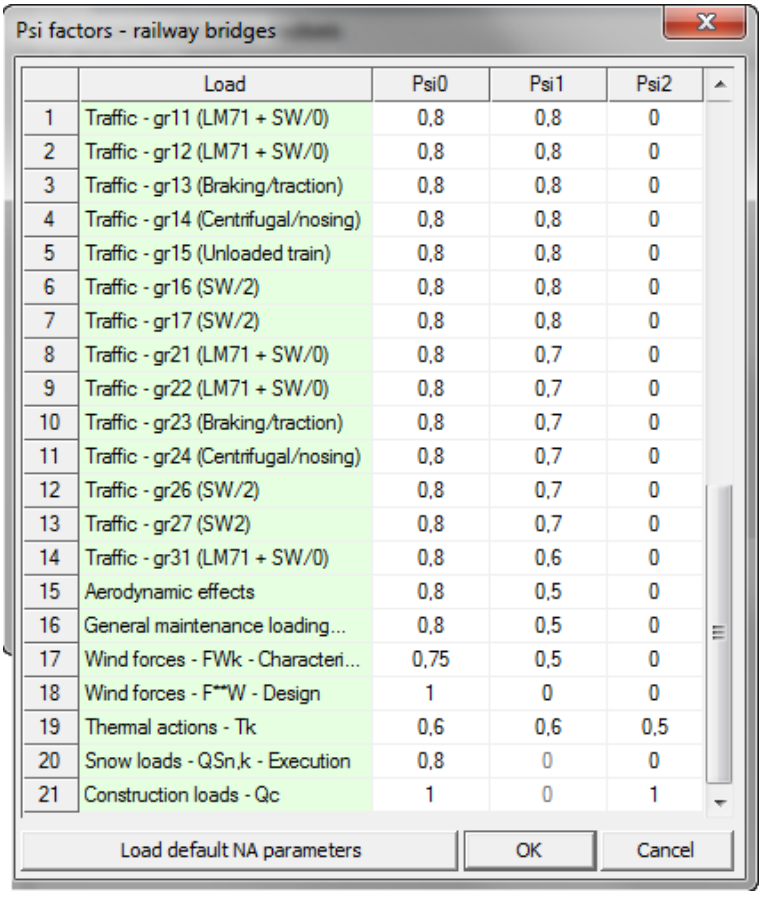
	Load	Psi0	Psi1	Psi2
1	Traffic - gr1a - TS	0,75	0,75	0
2	Traffic - gr1a - UDL	0,4	0,4	0
3	Traffic - gr1a - Pedestr. + cycle ...	0,4	0,4	0
4	Traffic - gr1b - Single axle	0	0,75	0
5	Traffic - gr2 - Horizontal forces	0	0	0
6	Traffic - gr3 - Pedestrian loads	0	0,4	0
7	Traffic - gr4 - Crowd loading	0	0	0
8	Traffic - gr5 - Special vehicles	0	0	0
9	Wind forces - FWk - Persistent	0,6	0,2	0
10	Wind forces - FWk - Execution	0,8	0	0
11	Wind forces - F*W - Design	1	0	0
12	Thermal actions - Tk	0,6	0,6	0,5
13	Snow loads - QSn,k - Execution	0,8	0	0
14	Construction loads - Qc	1	0	1

Psi factors Ψ_0, Ψ_1 and, Ψ_2 for footbridges are given by EN1990 A2, Table A2.2.



	Load	Psi0	Psi1	Psi2
1	Traffic - gr1	0,4	0,4	0
2	Traffic - Qfvk	0	0	0
3	Traffic - gr2	0	0	0
4	Wind forces - FWk	0,3	0,2	0
5	Thermal actions - Tk	0,6	0,6	0,5
6	Snow loads - QSn,k - Execution	0,8	0	0
7	Construction loads - Qc	1	0	1

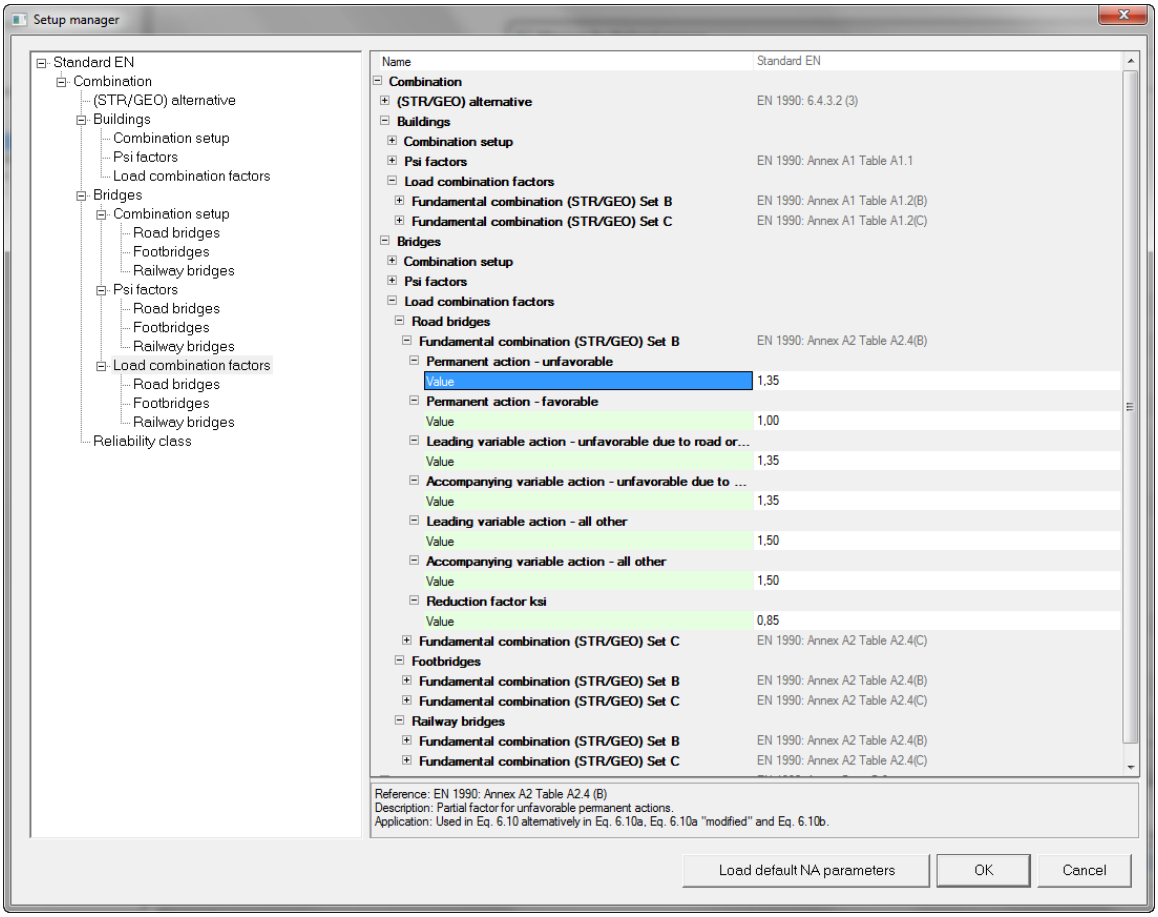
Psi factors Ψ_0, Ψ_1 and, Ψ_2 for railway bridges are given by EN1990 A2, Table A2.3.



	Load	Psi0	Psi1	Psi2
1	Traffic - gr11 (LM71 + SW/0)	0,8	0,8	0
2	Traffic - gr12 (LM71 + SW/0)	0,8	0,8	0
3	Traffic - gr13 (Braking/traction)	0,8	0,8	0
4	Traffic - gr14 (Centrifugal/nosing)	0,8	0,8	0
5	Traffic - gr15 (Unloaded train)	0,8	0,8	0
6	Traffic - gr16 (SW/2)	0,8	0,8	0
7	Traffic - gr17 (SW/2)	0,8	0,8	0
8	Traffic - gr21 (LM71 + SW/0)	0,8	0,7	0
9	Traffic - gr22 (LM71 + SW/0)	0,8	0,7	0
10	Traffic - gr23 (Braking/traction)	0,8	0,7	0
11	Traffic - gr24 (Centrifugal/nosing)	0,8	0,7	0
12	Traffic - gr26 (SW/2)	0,8	0,7	0
13	Traffic - gr27 (SW2)	0,8	0,7	0
14	Traffic - gr31 (LM71 + SW/0)	0,8	0,6	0
15	Aerodynamic effects	0,8	0,5	0
16	General maintenance loading...	0,8	0,5	0
17	Wind forces - FWk - Characteri...	0,75	0,5	0
18	Wind forces - F**W - Design	1	0	0
19	Thermal actions - Tk	0,6	0,6	0,5
20	Snow loads - QSn,k - Execution	0,8	0	0
21	Construction loads - Qc	1	0	1

Load combination factors

Groups for Load combination factors γ both for bridges and buildings are implemented here.



Load combination factors γ values will be editable directly in the setup.

As you can see from the picture above, by setting focus on an item, the description field is displayed at the bottom of the dialog to provide more detailed info on a selected value. In this field, three strings are displayed:

- Reference - provides reference to the EN Code
- Description - provides explanation on the value
- Application - provides place, where the value is used

Load combination factors for buildings from EN 1990 A1, Tables A1.2 (B,C)

Load combination factors for buildings	
Fundamental combination (STR/GEO) Set B	EN 1990: Annex A1...
Permanent action - unfavorable	
Value [-]	1,35
Permanent action - favorable	
Value [-]	1,00
Leading variable action	
Value [-]	1,50
Accompanying variable action	
Value [-]	1,50
Reduction factor ksi	
Value [-]	0,85
Fundamental combination (STR/GEO) Set C	EN 1990: Annex A1...
Permanent action - unfavorable	
Value [-]	1,00
Permanent action - favorable	
Value [-]	1,00
Leading variable action	
Value [-]	1,30
Accompanying variable action	
Value [-]	1,30

Load combination factors for Road bridges from EN 1990 A2, Tables A2.4 (B,C)

Load combination factors for road bridges	
Fundamental combination (STR/GEO) Set B	EN 1990: Annex A2...
Permanent action - unfavorable	
Value [-]	1,35
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to road or pedestrian	
Value [-]	1,35
Accompanying variable action - unfavorable due to road or pedestrian	
Value [-]	1,35
Leading variable action - all other	
Value [-]	1,50
Accompanying variable action - all other	
Value [-]	1,50
Reduction factor ksi	
Value [-]	0,85
Fundamental combination (STR/GEO) Set C	EN 1990: Annex A2....
Permanent action - unfavorable	
Value [-]	1,00
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to road or pedestrian	
Value [-]	1,15
Accompanying variable action - unfavorable due to road or pedestrian	
Value [-]	1,15
Leading variable action - variable part of ...	
Value [-]	1,30
Accompanying variable action - variable part of ...	
Value [-]	1,30
Leading variable action - all other	
Value [-]	1,30
Accompanying variable action - all other	
Value [-]	1,30

Load combination factors for Footbridges from EN 1990 A2, Tables A2.4 (B,C)

Load combination factors for footbridges	
Fundamental combination (STR/GEO) Set B	EN 1990: Annex A2...
Permanent action - unfavorable	
Value [-]	1,35
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to road or pedestrian	
Value [-]	1,35
Accompanying variable action - unfavorable due to road or pedestrian	
Value [-]	1,35
Leading variable action - all other	
Value [-]	1,50
Accompanying variable action - all other	
Value [-]	1,50
Reduction factor ksi	
Value [-]	0,85
Fundamental combination (STR/GEO) Set C	EN 1990: Annex A2....
Permanent action - unfavorable	
Value [-]	1,00
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to road or pedestrian	
Value [-]	1,15
Accompanying variable action - unfavorable due to road or pedestrian	
Value [-]	1,15
Leading variable action - variable part of ...	
Value [-]	1,30
Accompanying variable action - variable part of ...	
Value [-]	1,30
Leading variable action - all other	
Value [-]	1,30
Accompanying variable action - all other	
Value [-]	1,30

Load combination factors for Railway bridges from EN 1990 A2, Tables A2.4 (B,C)

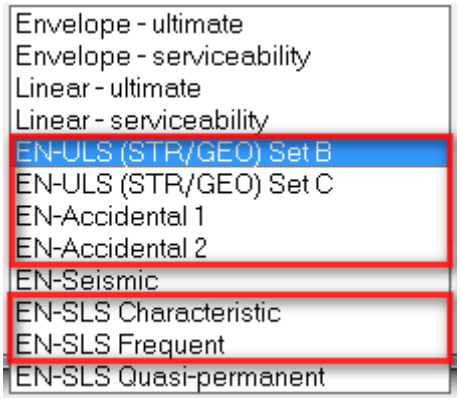
Load combination factors for railway bridges	
Fundamental combination (STR/GEO) Set B	EN 1990: Annex A2...
Permanent action - unfavorable	
Value [-]	1,35
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to railway	
Value [-]	1,45
Accompanying variable action - unfavorable due to railway	
Value [-]	1,45
Leading variable action - unfavorable due to railway gr 16-17	
Value [-]	1, 20
Accompanying variable action - unfavorable due to railway gr 16-17	
Value [-]	1, 20
Leading variable action - unfavorable due to railway gr 26-27	
Value [-]	1, 20
Accompanying variable action - unfavorable due to railway gr 26-27	
Value [-]	1, 20
Leading variable action - all other	
Value [-]	1,50
Accompanying variable action - all other	
Value [-]	1,50
Reduction factor ksi	
Value [-]	0,85
Fundamental combination (STR/GEO) Set C	EN 1990: Annex A2....
Permanent action - unfavorable	
Value [-]	1,00
Permanent action - favorable	
Value [-]	1,00
Leading variable action - unfavorable due to railway	
Value [-]	1,25
Accompanying variable action - unfavorable due to railway	
Value [-]	1,25
Leading variable action - variable part of ...	
Value [-]	1,30
Accompanying variable action - variable part of ...	
Value [-]	1,30
Leading variable action - all other	
Value [-]	1,30
Accompanying variable action - all other	
Value [-]	1,30

Other features

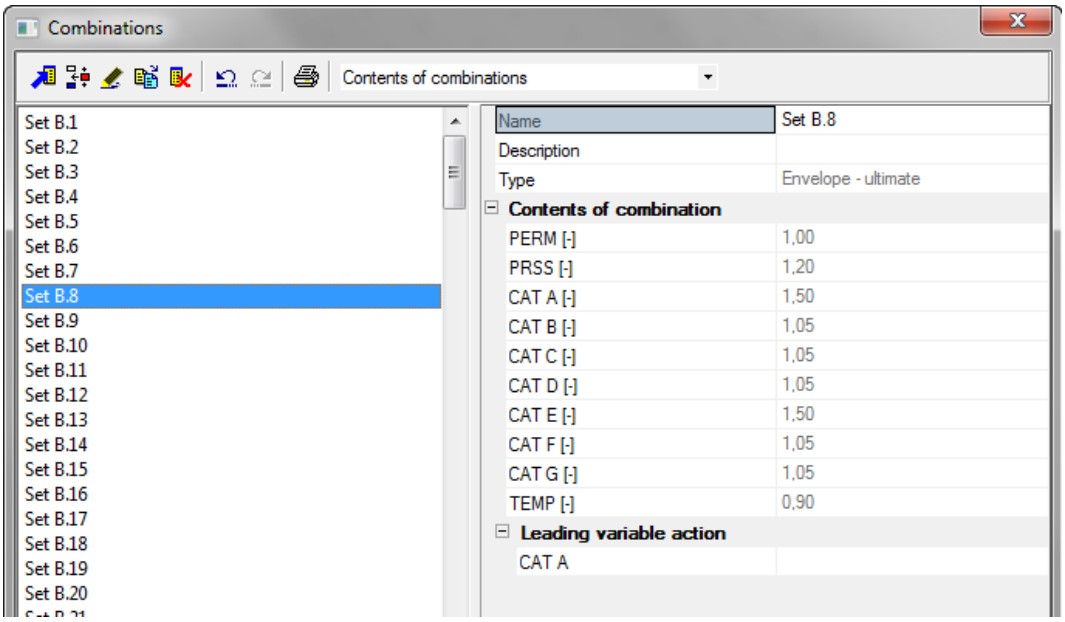
Leading variable action

There is a sub-group, which shows which variable load case is leading for each generated envelope combination. This info is visible in the combination dialog, when the **Content of combination** filter is active.

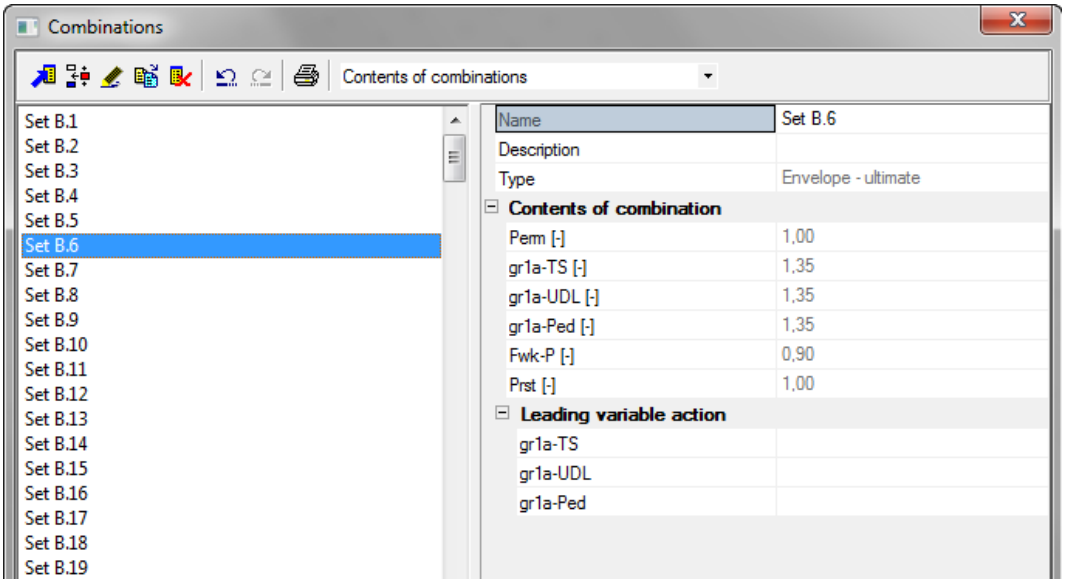
This change will be noticeable in Content of combination only for such EN Code combinations, which define a leading variable action. These are in fact the red marked combinations on the following picture.



The sub-group **Leading variable action** is displayed together with the appropriate leading variable load case only for such generated envelope combinations, which really contain some leading variable action. The load case is displayed without any coefficient **in this sub-group**. If there is no leading variable action in the generated envelope combination, no sub group is shown.



In case of Road bridges, when all sub-groups of Group of loads gr1a are defined, there may be also more than one leading variable action.



(STR/GEO) alternative

The EN 1990 code specifies three possibilities how to define Combinations of actions for persistent or transient design situations:

Equation 6.10:

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

Equation 6.10a & 6.10b

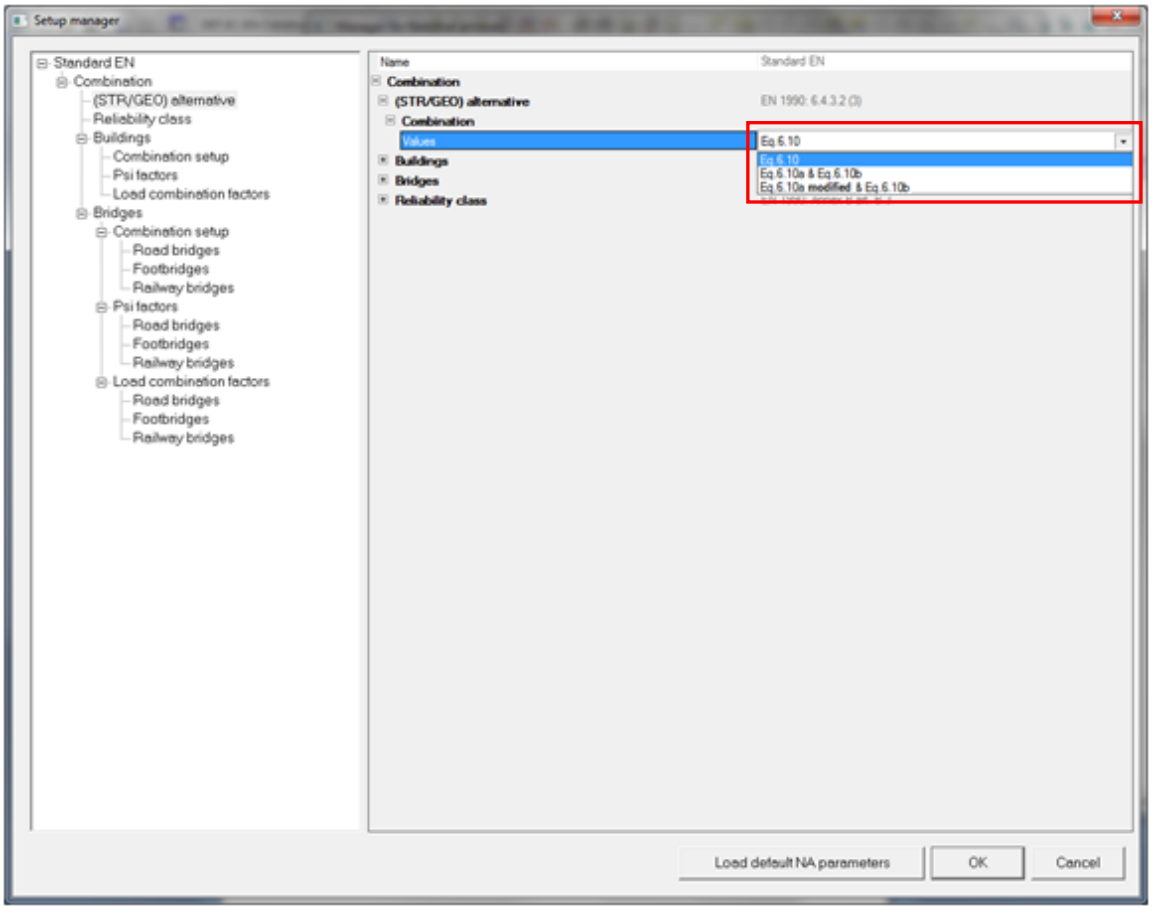
$$\begin{cases} \sum_{j\geq 1} \gamma_{G,j} G_{k,j} "+" \gamma_P P "+" \gamma_{Q,1} \psi_{0,1} Q_{k,1} "+" \sum_{i>1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \\ \sum_{j\geq 1} \xi_j \gamma_{G,j} G_{k,j} "+" \gamma_P P "+" \gamma_{Q,1} Q_{k,1} "+" \sum_{i>1} \gamma_{Q,i} \psi_{0,i} Q_{k,i} \end{cases}$$

Equation 6.10a "modified" & 6.10b

Note 1 of Table A1.2(B) specifies, that the choice between 6.10, or 6.10a and 6.10b will be in the National annex. In case of 6.10a and 6.10b, the National annex may in addition modify 6.10a to include permanent actions only. If applied, then the formula would look like this:

$$\sum_{j\geq 1} \gamma_{Gj,sup} G_{kj,sup} "+" \sum_{i>1} \gamma_{Gj,inf} G_{kj,inf}$$

The user can now select this **6.10a "modified"& 6.10b** equation in the same combo box, next to already implemented equations 6.10 and equation 6.10a & 6.10b in NA setup dialog. See the picture below.



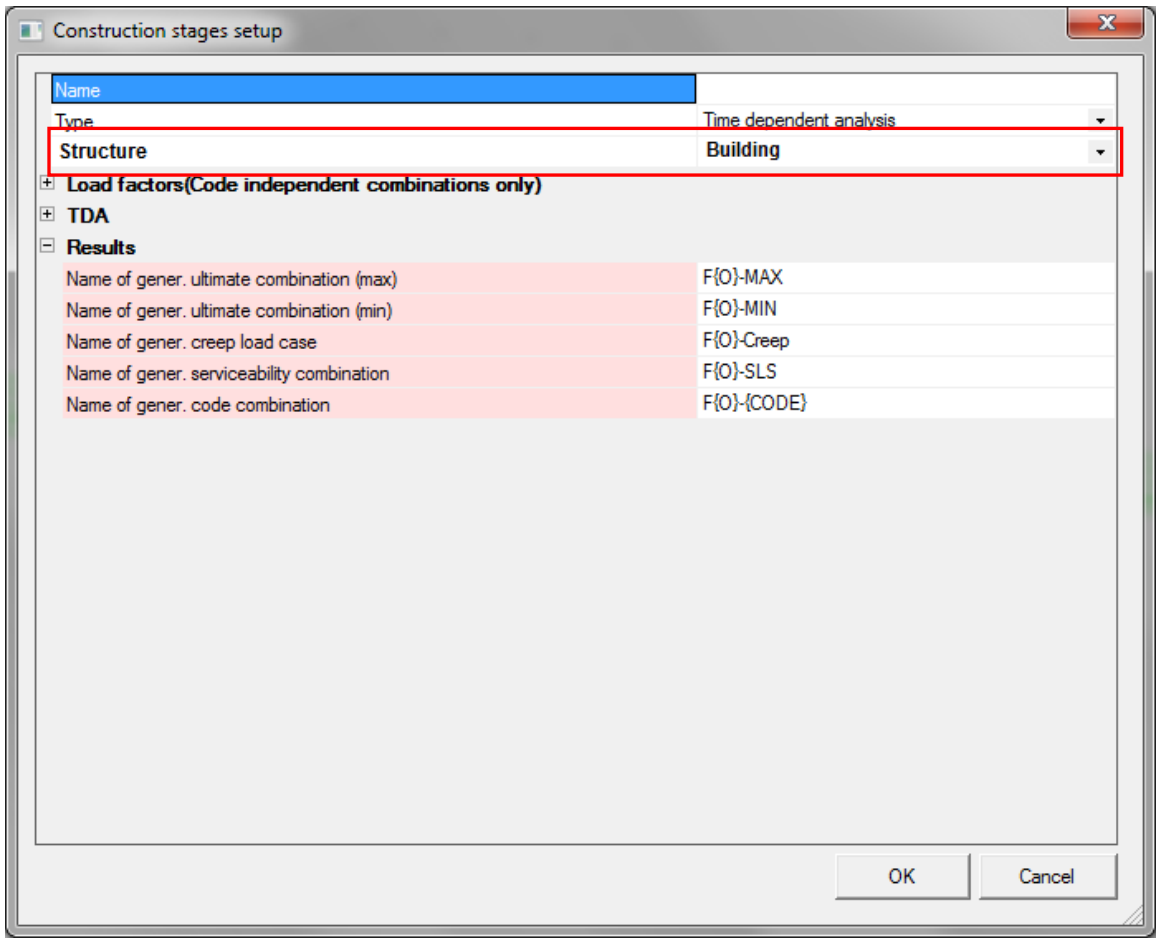
By choosing this Equation, envelope combinations generated from a Code combination 6.10a "modified" will contain **only permanent unfavorable and permanent favorable load cases**. No variable, accidental, seismic or prestress load cases are taken into account with this 6.10a "modified" part of equation. Envelope combinations coming from 6.10b will be the same as for previous option from the combo box.

Construction stages

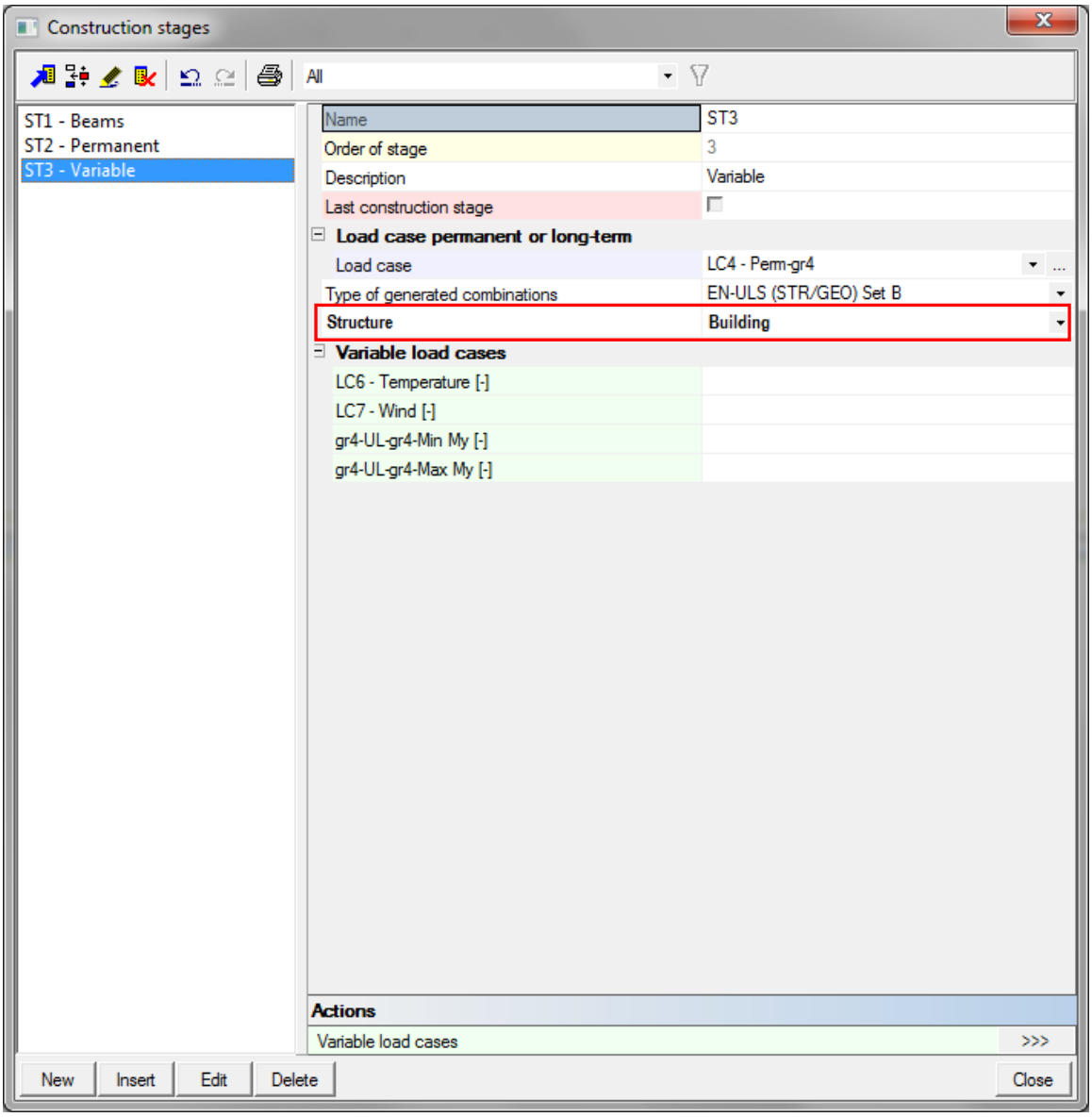
Automatically generated Code combinations from the Construction stages are created with respect to the latest bridge combination development and also envelope combinations should respect rules and appropriate settings.

Adjusted implementation of a Structure parameter together with the filter for variable load cases in construction stages environment should do the trick.

There is one major switch in the Construction stages setup, where the user decides which Structure parameter will be used for all Construction stages. Building will be set as a default value, but the user may still choose also one of the three bridge items.

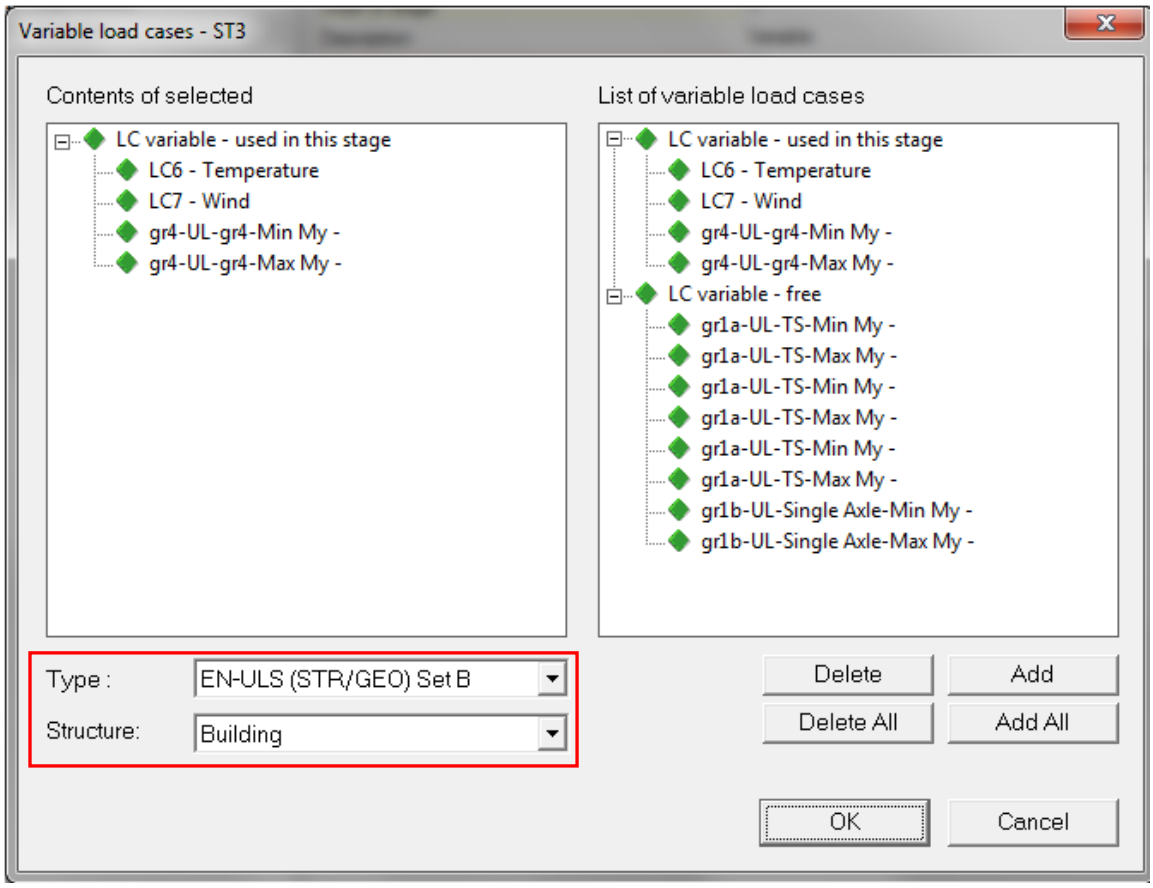


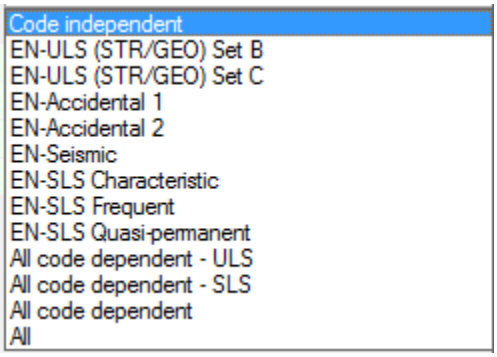
When the user creates some construction stages, there will also be parameter Structure displayed right below the Type parameter. It will not be possible to change it. Also the Type of generated combinations is disabled if any load group in the project has its Structure parameter different than Buildings.


Construction stages
All
ST1 - Beams
ST2 - Permanent
ST3 - Variable
Name
ST3
Order of stage
3
Description
Variable
Last construction stage
Load case permanent or long-term
Load case
LC4 - Perm-gr4
Type of generated combinations
EN-ULS (STR/GEO) Set B
Structure
Building
Variable load cases
LC6 - Temperature [-]
LC7 - Wind [-]
gr4-UL-gr4-Min My [-]
gr4-UL-gr4-Max My [-]
Actions
Variable load cases
>>>
New
Insert
Edit
Delete
Close

Two combo boxes are implemented in the dialog below. Combo box Structure is read from the setup and is always disabled. Combo box Type is enabled. The Structure combo box is not shown for Type set to **Code independent**.

List of variable load cases, in right window, is always filtered out according to the Structure parameter set in the setup.





If the user selects possibility "All", then all generated code combinations will have the Structure parameter set according to the setup. Generated code independent combinations will not have the Structure parameter.

Example

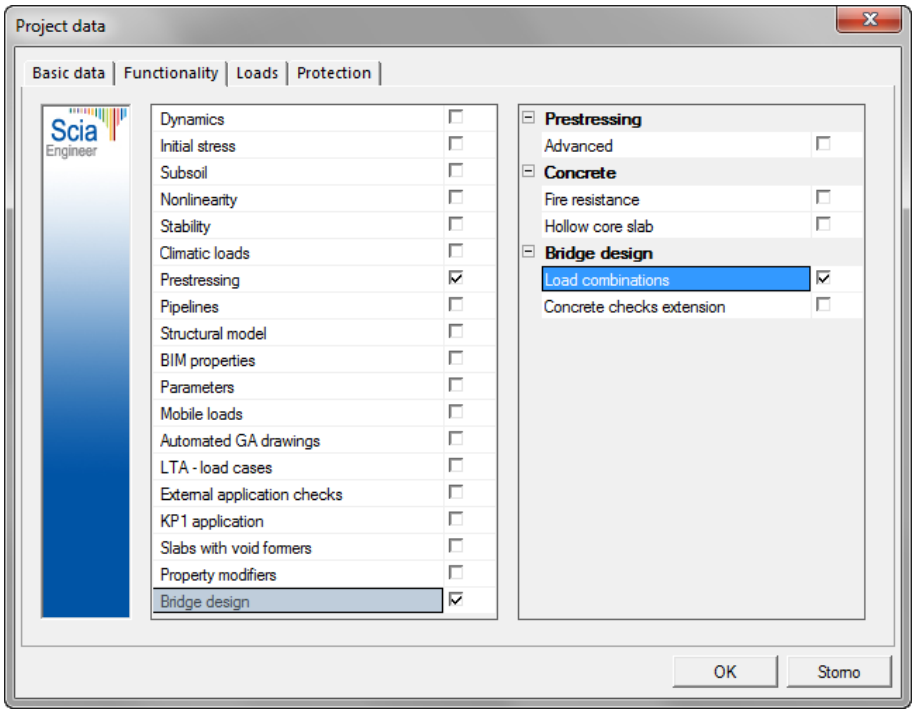
In this simple example the way how to define and adjust a combination for a Footbridge is illustrated. The functionality is demonstrated on a simple beam structure, where in each load case only point force loading will be defined. It shows how to define load groups, combinations and also how to handle rules in the NA Setup dialog.

In this example the same steps, as in the previous chapters, are used.

To follow this example, please open the project **Footbridge example_initial.esa**, which contains a predefined one beam structure and supports.

Step 1: Activate Protection

In the very first step, the user needs to activate functionality for bridge combinations. This can be done through the folder Functionality in the Project data dialog, by checking the Bridge design item in the left window and then also checking the item Load combinations in the right window.



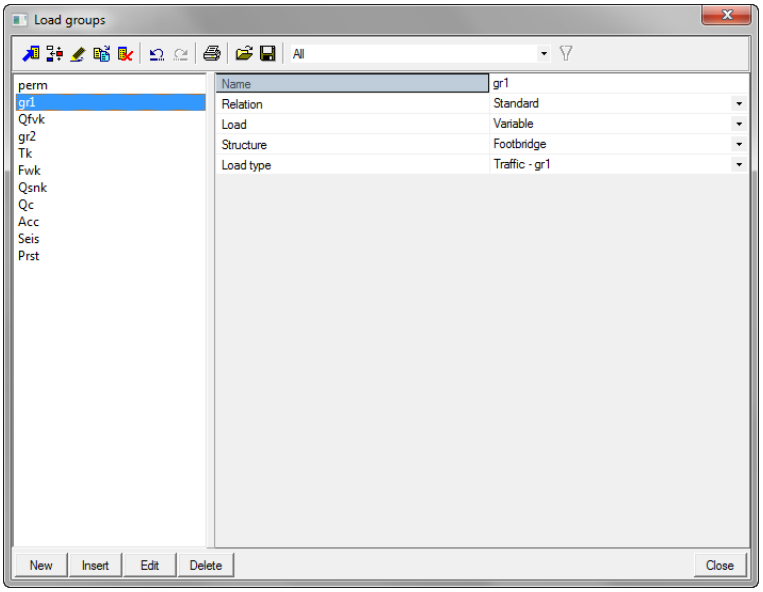
Please note, that also functionality for Prestressing is activated, to enable input of load cases used for prestress loading.

Note:

The ruling check box for the bridge combinations functionality is the one which is called Load combinations. If only the Bridge design item in the left window is checked, it will still not be possible to change the Structure parameter to one of the bridge types.

Step 2: Create Load groups

In this step load groups are created for the Footbridge Structure. Load groups can be added using the Load group dialog. The following load groups for permanent, variable, accidental, seismic and prestress loading will be defined:



Name	Load	Structure	Load type
perm	Permanent	-	-
gr1	Variable	Footbridge	gr1
Qfvk	Variable	Footbridge	Qfvk
gr2	Variable	Footbridge	gr2
Tk	Variable	Footbridge	Tk
Fwk	Variable	Footbridge	Fwk
Qsnk	Variable	Footbridge	Qsnk
Qc	Variable	Footbridge	Qc
Acc	Accidental	-	-

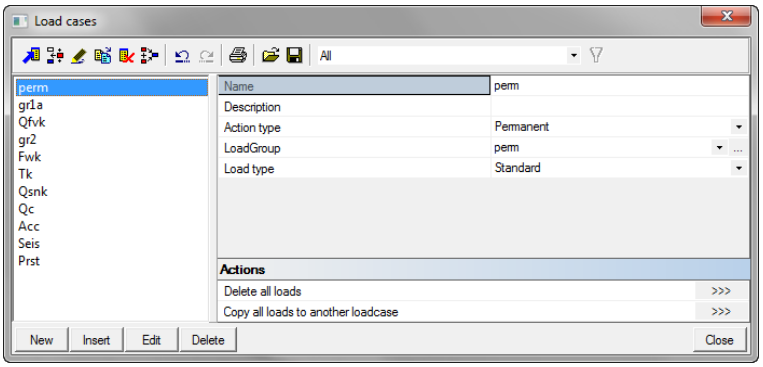
Seis	Seismic	-	-
Prst	Permanent	-	-

Note:

Whenever a certain load case is assigned to a certain combination, aditional restrictions are implemented for load group in Load groups dialog. The Structure parameter will became disabled and it will not be possible to change it. On the other hand, the Load type will still be possible to be changed. If the load case is not assigned yet, the user may freely change load group.

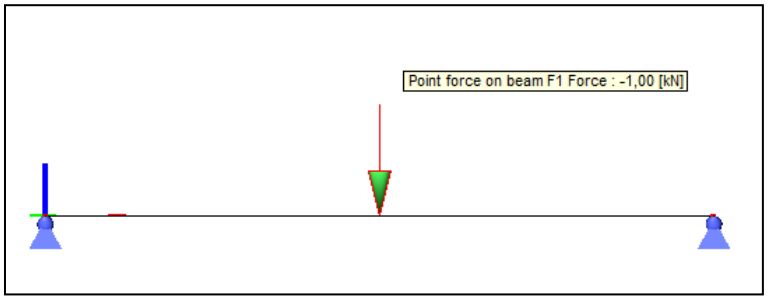
Step 3: Assign Load cases to the Load groups

In this step load cases are created for each load group. This can be done in a standard way in the Load cases dialog.

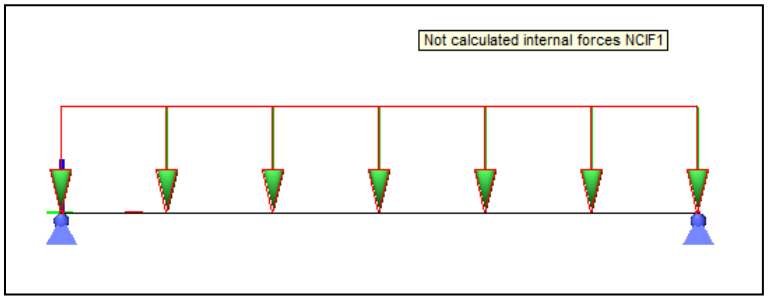


Name	Action type	Load group	Load type
perm	Permanent	perm	Standard
gr1	Variable	gr1	Static
Qfvk	Variable	Qfvk	Static
gr2	Variable	gr2	Static
Tk	Variable	Tk	Static
Fwk	Variable	Fwk	Static
Qsnk	Variable	Qsnk	Static
Qc	Variable	Qc	Static
Acc	Accidental	Acc	Static
Seis	Seismic	Seis	Static
Prst	Permanent	Prst	Prestress

After definition of all load cases, loading is defined. In this example, as we already mentioned at the very beginning, we will define only 1KN point load in the middle of the beam, for every load case.



The only difference is prestressing load case Prst, where we will define line load, shown on the picture below, with the intensity of -0,2Kn/m.

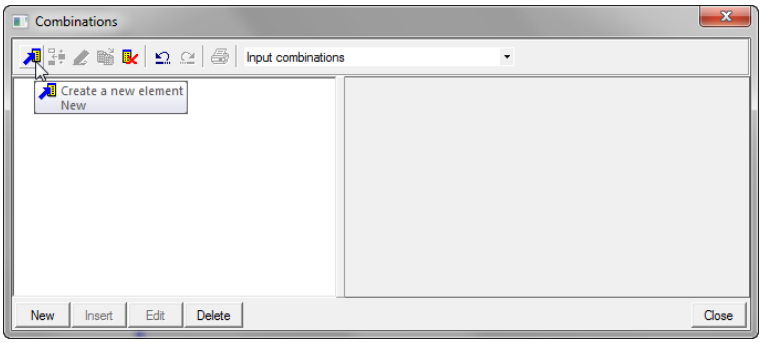


Note:

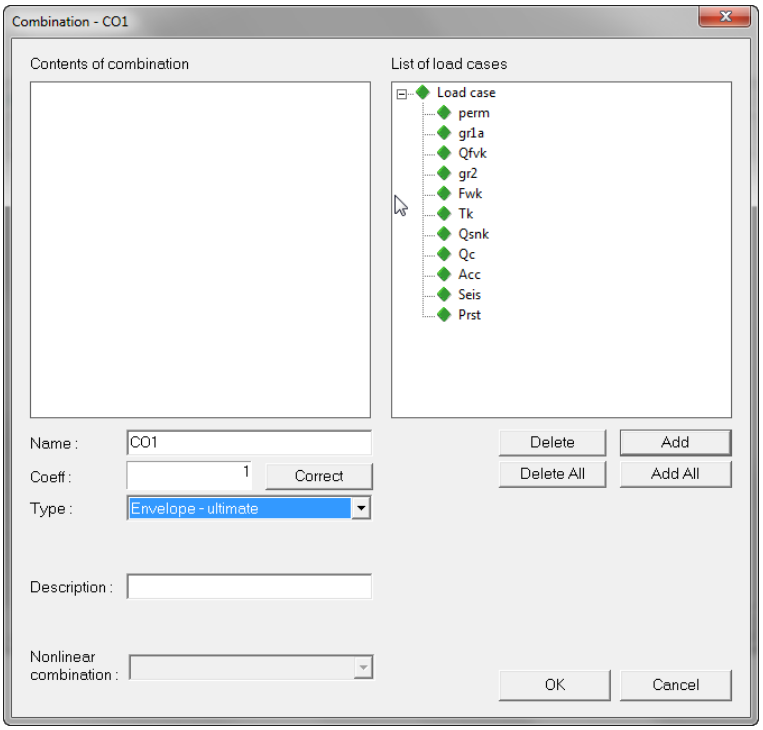
Whenever a certain load case is assigned to a certain combination, aditional restrictions are implemented for load case in Load cases dialog. It will still be possible to change the Load group parameter to something else, but the user may select only load groups with the same Structure parameter or independent variable load groups for accidental and seismic loads. By pressing the three dots edit button, the Load groups dialog is displayed, but with filtered content. If a load case is not assigned yet, the user may freely change load group.

Step 4: Create a Code Combination

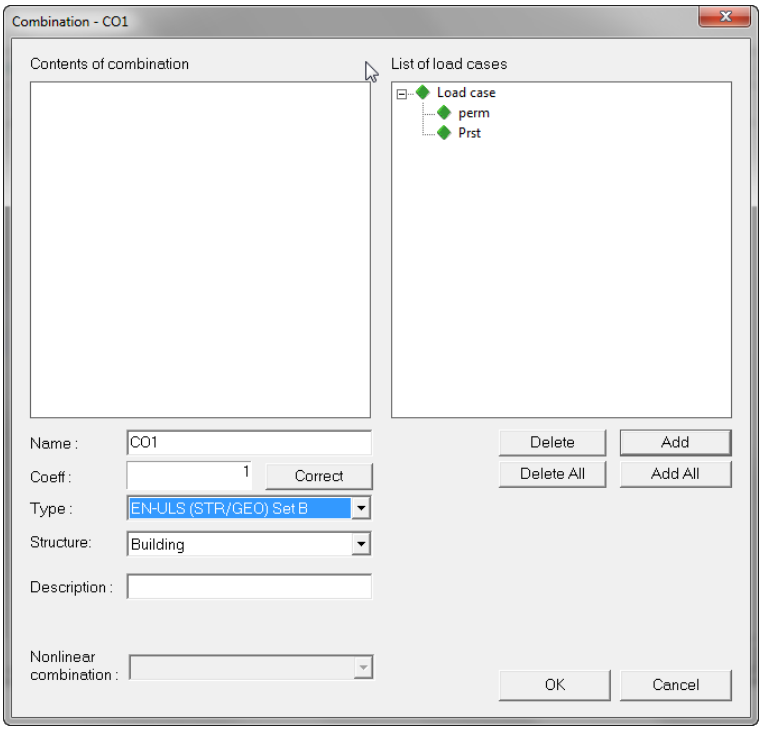
After definition of all load cases combination can be created. This can be done through standard Combinations dialog. User presses button New in main Combinations dialog:



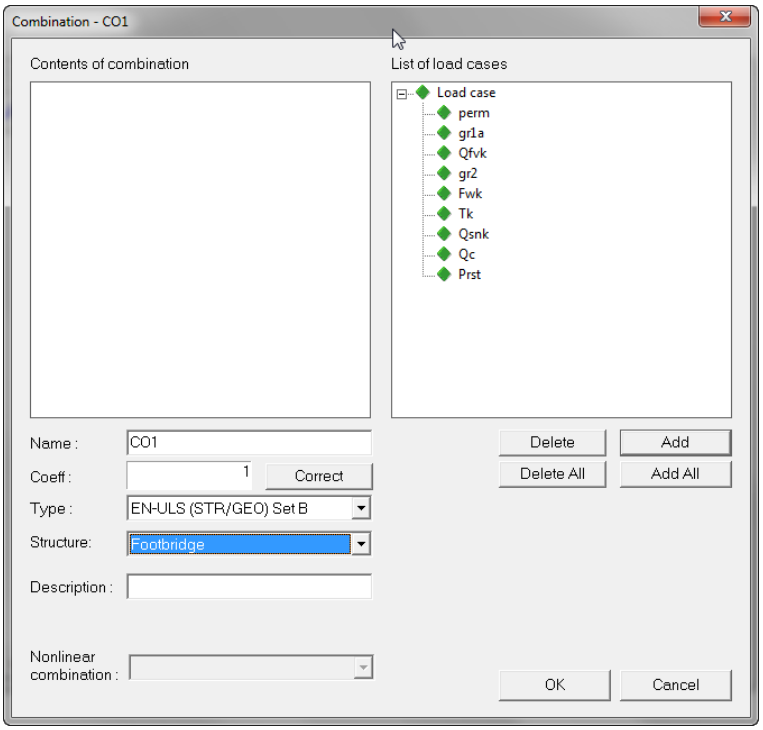
The edit dialog is opened and by default the Type of the combination is set to Envelope - ultimate. The structure parameter is not displayed and therefore all load cases are visible in the right window.



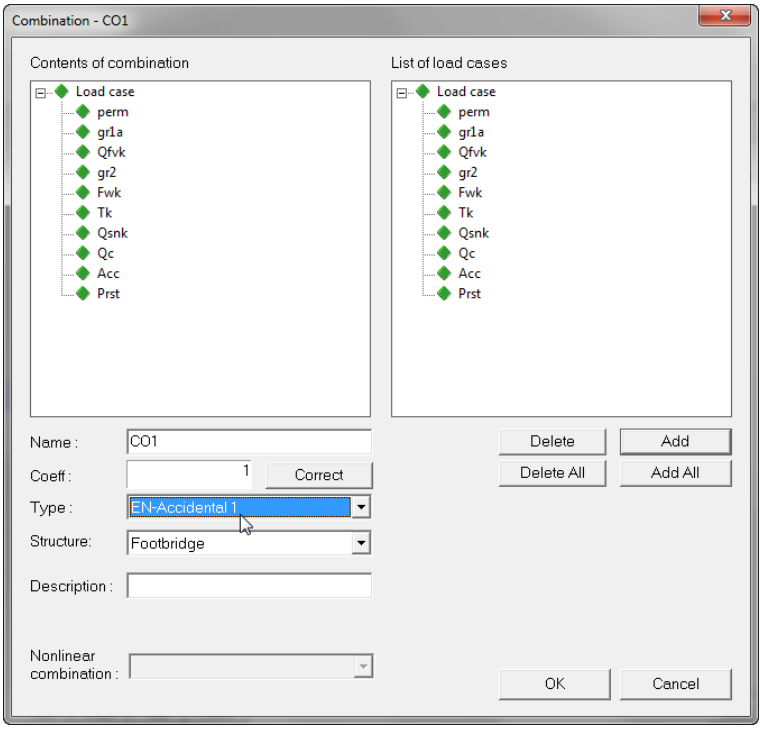
Set the type of the combination to EN-ULS (STR/GEO) Set B. The Structure parameter is displayed and by default it is set to Building. Due to this, only permanent load cases are displayed in the right window.



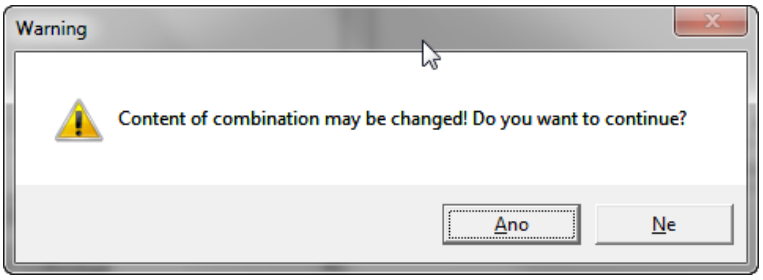
If the Structure parameter is changed to Footbridge, almost all the predefined load cases appear in the right window. Only the load cases from Accidental and Seismic load groups are missing. The reason is that those may be inputted only in Accidental 1,2 or Seismic types of combinations.



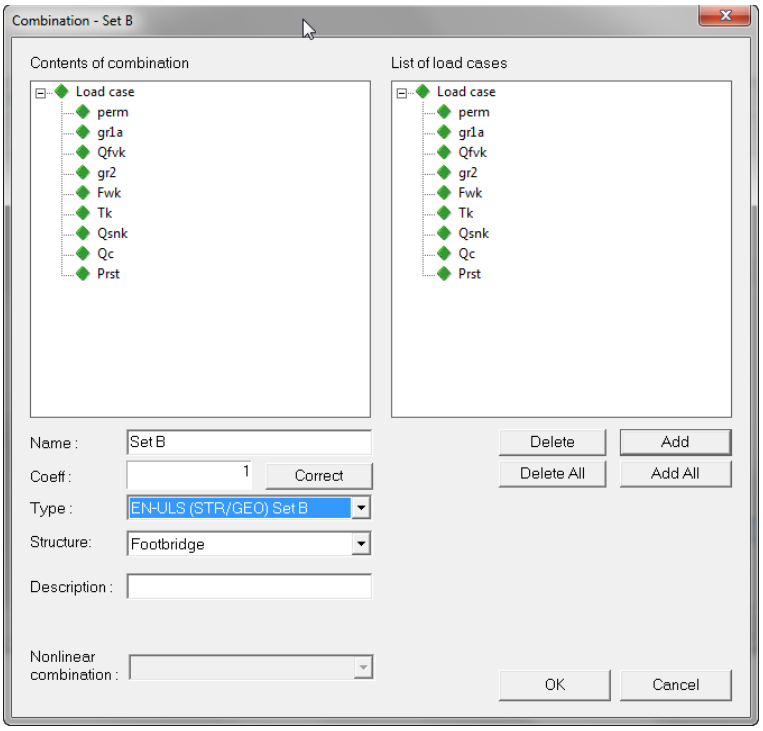
Change the Type of the combination to EN-Accidental 1. Notice that now also load case Acc is displayed in the window for possible input. Add all load cases in the combination.



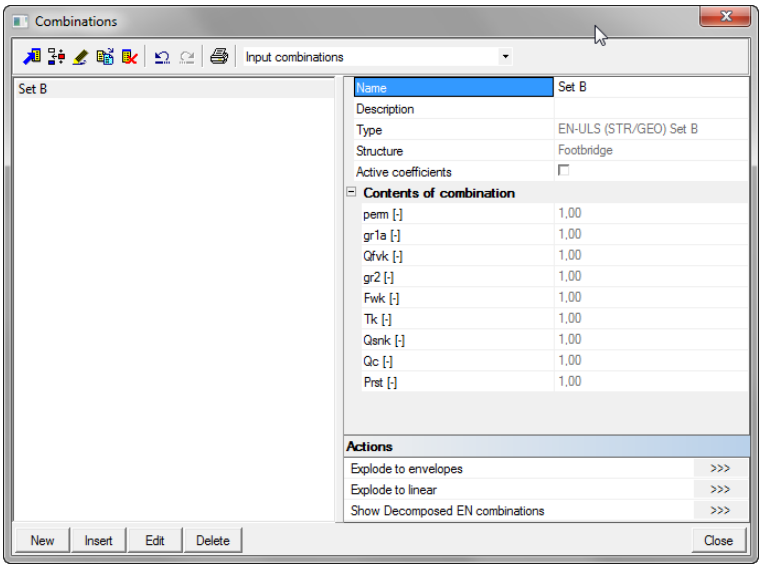
Change the type back to EN-ULS (STR/GEO) Set B. A warning that content may be changed is displayed. This is due to the fact that accidental load cases may be included in the combination, which is not correct. Confirm the warning dialog.



If we take a look at the content of the combination we can find out, that load case Acc for accidental loading was removed from both left and right windows. Rename the combination and confirm the dialog.



After the confirmation, we have Set B combination created in the main Combinations dialog.

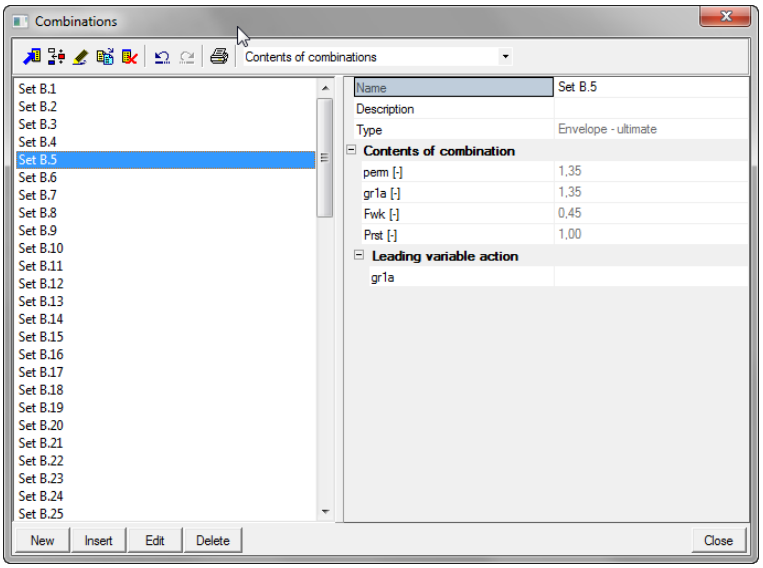


Note:

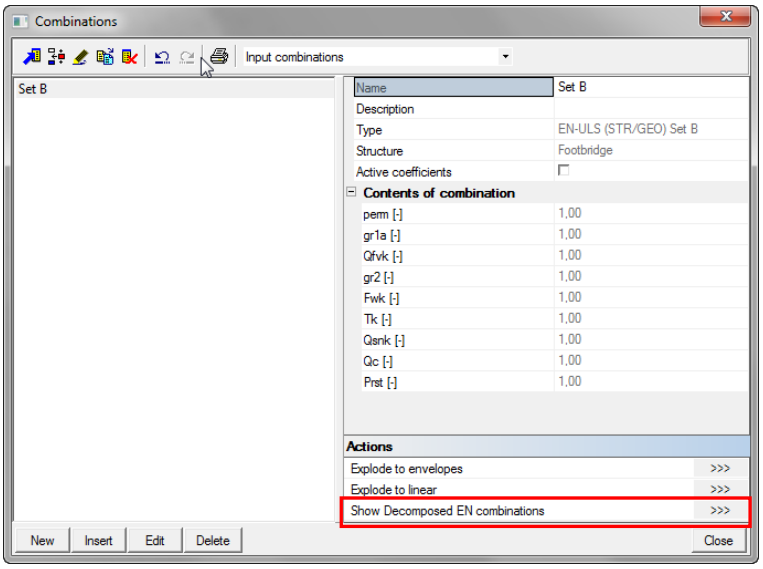
Both the Type and the Structure combo boxes are disabled in this dialog. This is to avoid an incorrect input for the combination. Both can be changed by editing the combination.

Step 5: Decomposed EN combinations

At this step, in fact, everything is done and envelope combinations are generated from our Code combination. The user may see all generated envelope combinations in the main Combinations dialog, by changing filter to "Contents of combination". In our example there are 80 generated envelope combinations.



A complete info on the decomposed combinations may be found in Decomposed EN combinations dialog, which can be opened by pressing red marked action button. Here the user may further investigate what happened to the original "mother" code combinations and how the rules were applied in the process.



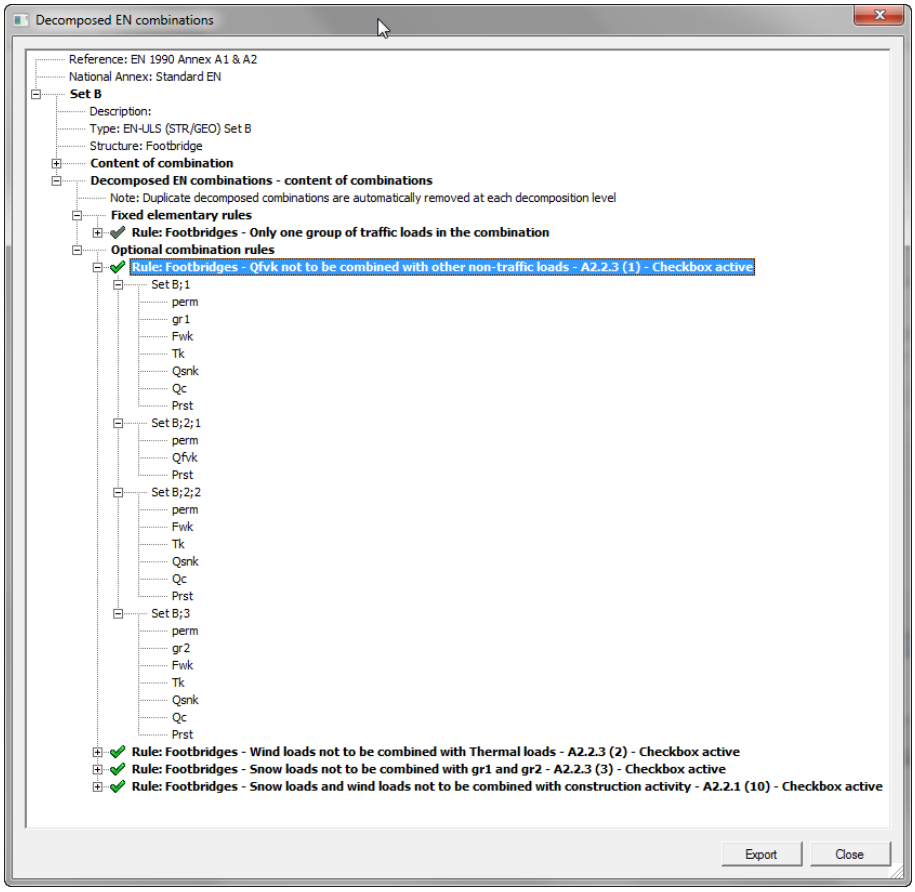
By pressing this action button, the dialog Decomposed EN combinations is opened:

Here the user besides reference and national annex is able to see other info on the selected combination, such as name , description, type, structure and original content before the rules were applied. The most important thing in this dialog is, that all applicable rules are also displayed. Rules are split into two main groups:

- **Fixed elementary rules** - these are the rules, which are always applied and cannot be changed.
- **Optional combination rules** - these are rules, which may be adjusted in NA setup by checking/unchecking appropriate item. There is always a reference to a EN Code article and also status of the check box in the NA setup. If the rule is used, it has a sign of green check. If the rules is not used, than it has a red cross sign.

Under each rule, there may be a split of original so-called "mother" combination to several decomposed combinations. Let's take a look at the first fixed rule, which specifies, that only one group of traffic loads should be in combination. Since load cases gr1, Qfwk and gr2 are connected to the load groups, with the same name and the same type of loads, which are given by EN as traffic groups, they should not be combined together. In this step the original combination is split into three decomposed combinations called Set B;1, Set B;2 and Set B;3. Each of these combinations contains only load cases from one traffic load group.

Next examine another rule, which is the first from the group of Optional combination rules. It specifies that Qfwk should not be combined with other non-traffic loading. Since this is the second rule which is used, the decomposed combinations, obtained in the previous step (Set B;1, Set B;2 and Set B;3) are used.



It can be seen that decomposed combinations Set B;1 and Set B;3 did not change. It may be seen also in the name of these combinations. They are exactly the same as in the previous step. On the other hand the combination Set B;2 was split into Set B;2;1 and Set B;2;1.

The same procedure can be followed for the other rules. The combinations used for generation of envelope combinations are always shown in the very last step of the decomposition process (under the last applied rule).

In addition, the Export button can be used to save all information from this Decomposed EN combinations dialog in a txt file.

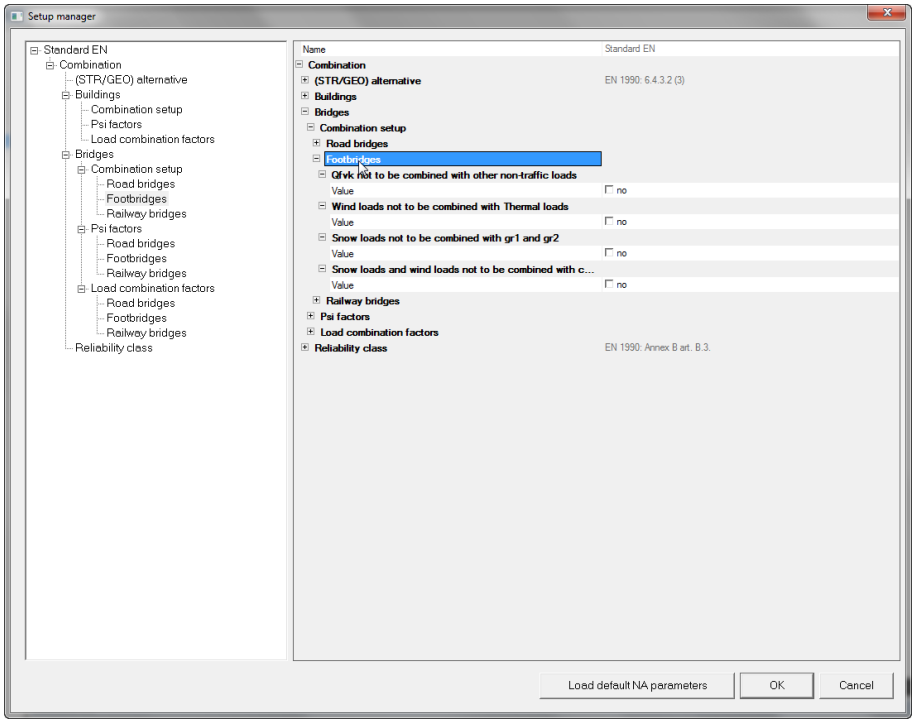
Note:

Each Structure (Building, Road bridge, Footbridge, Railway bridge) has its own set of rules which can be applied. This is based on EN 1990 A1 & A2.

The first rule applied on the original combination is applied on its original content. Any other rule is applied on the decomposed EN combinations, which were generated in previous step. Combinations used for generation of envelope combinations are always shown in the last step of decomposition process (under last applied rule).

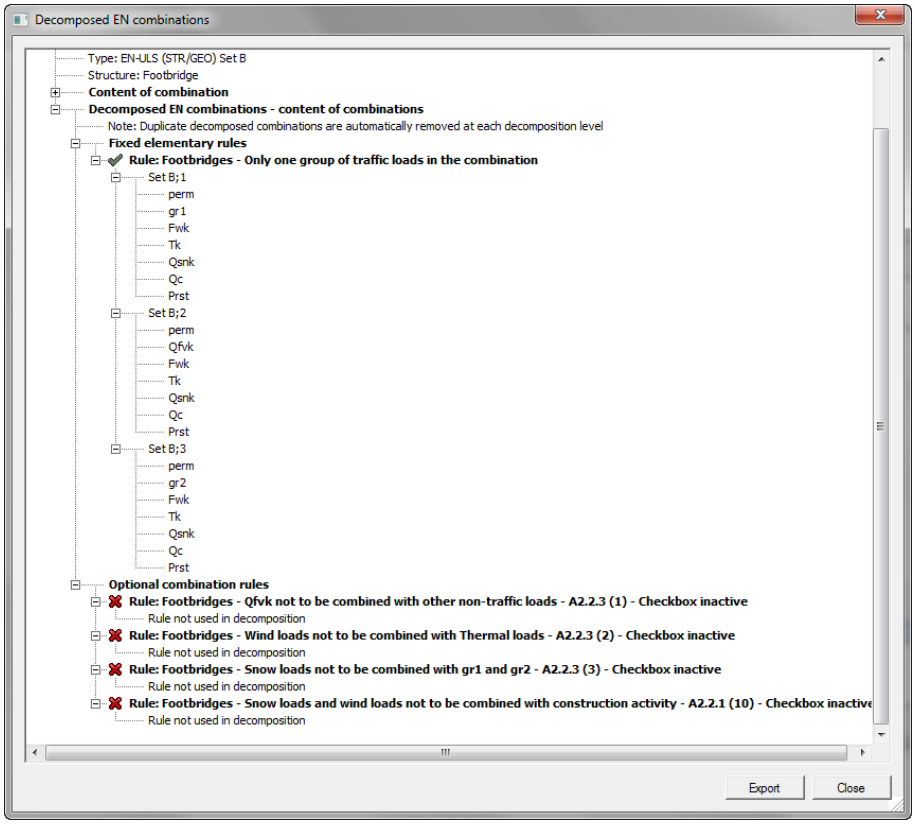
Step 6: NA Setup dialog

In this step we will show only the change in decomposed EN combinations which concerns deactivating some rules. In the NA Setup dialog we will deactivate all rules for footbridges(see picture below). Changes in Psi and Gamma values will cause only different coefficients, which will be used by load cases in the generated envelope combinations and if not zero, it does not influence the number of generated envelope combinations.



If take a look at the generated envelope combinations in main combinations dialog, by changing filter to "Contents of combination" we can see, that 80 generated envelope combinations were reduced to 48 envelope combinations.

In Decomposed EN combinations dialog we can see, that only one fixed rule is being applied. These three combinations coming from this rule, are used for generating envelope combinations instead of the original Code combination. There is a note under each rule with the red cross, that this rule is not used in decomposition.


Decomposed EN combinations
Type: EN-ULS (STR/GEO) Set B
Structure: Footbridge
Content of combination
Decomposed EN combinations - content of combinations
Note: Duplicate decomposed combinations are automatically removed at each decomposition level
Fixed elementary rules
Rule: Footbridges - Only one group of traffic loads in the combination
Set B;1
perm
gr1
Fwk
Tk
Qsnk
Qc
Prst
Set B;2
perm
Qfvk
Fwk
Tk
Qsnk
Qc
Prst
Set B;3
perm
gr2
Fwk
Tk
Qsnk
Qc
Prst
Optional combination rules
Rule: Footbridges - Qfvk not to be combined with other non-traffic loads - A2.2.3 (1) - Checkbox inactive
Rule not used in decomposition
Rule: Footbridges - Wind loads not to be combined with Thermal loads - A2.2.3 (2) - Checkbox inactive
Rule not used in decomposition
Rule: Footbridges - Snow loads not to be combined with gr1 and gr2 - A2.2.3 (3) - Checkbox inactive
Rule not used in decomposition
Rule: Footbridges - Snow loads and wind loads not to be combined with construction activity - A2.2.1 (10) - Checkbox inactive
Rule not used in decomposition
Export
Close