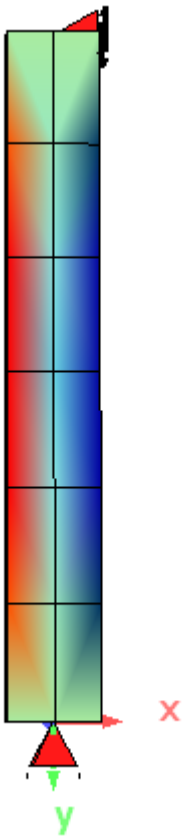
Design Code Example

Superposition acc. to DS EN 1990 / DS EN1992-2004



1 Introduction

The following example of a concrete column according to EN 1992-1-1 DK NA:2007 shows the superposition according to EN 1990 DK NA:2007. Here only the defaults of the INI file (ds_en1992-2004.ini) are used for the selected actions.

The input is done exclusively on numeric basis with the CADINP input language in the TEDDY.

2 Definition of the Design Code and the System

2.1 Input of the Design Code

For each design code there is an INI file which includes information about materials, actions, combinations and design values. This information is activated about the input for record NORM in program AQUA.

Special feature in this example:

For the superposition with design values according to equation (6.10b) of EN 1990 DK NA:2007 the additional factor K_{FI} is necessary.

Table A1.2(B) - Design values of actions (STR/GEO) (Set B)

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions
	Unfavourable	Favourable		
(Eq. 6.10a)	$K_{FI}\,\gamma_{Gj,sup}\,G_{kj,sup}$	$\gamma_{Gj,inf}\,G_{kj,inf}$		
(Eq. 6.10b)	$\xi\,K_{FI}\,\gamma_{Gj,sup}\,G_{kj,sup}$	$\gamma_{Gj,inf}\,G_{kj,inf}$	$K_{FI}\,\gamma_{Q,1}\,Q_{k,1}$	$K_{FI}\,\gamma_{Q,i}\,\psi_{0,i}\,Q_{k,i}$

The additional factor K_{FI} depends on the selected category at record NORM of the program AQUA.

It is therefore necessary here to select the safety class (consequences class). In the code EN 1990 DK NA:2007 Annex B three consequences classes are described. The additional superposition factor K_{FI} which is defined in Table A1.2(B) EN 1990 DK NA:2007 depends on the consequences class:

K_{FI} depends on the consequences class defined in Annex B Table B3 as follows:

- consequences class CC3: K_{FI} = 1,1
- consequences class CC2: K_{FI} = 1,0
- consequences class CC1: K_{FI} = 0,9

The inspection level according to EN 1992-1-1 DK NA:2007 which is necessary for the design is chosen in record NORM at CAT simultaneously with the safety class (consequence class). The possible selection of both is fully described in the AQUA manual record NORM.

In this example CAT HN is defined in record NORM:

HN => H for high safety (consequences class CC3)
N for normal control (inspection level normal)

The reduction factor ξ is preset firmly in the INI file and in the database. The reduction factor ξ is given here with 1.0

NOTE 2 – The following values of γ and ξ shall be used:
ξ=1,0

2.2 System

Here a concrete column with constant cross section and a height of 3 m is considered as a plane system with the dead load direction in negative Y direction. Following cross section is defined for this purpose:

Cross section:	rectangle	h/b= 40/20cm
	concrete:	C 25/30
	reinforcement:	S 500B

CADINP input for AQUA and SOFiMSHA

```
PROG AQUA urs:1
HEAD Example DS EN1992-2004
HEAD Design code, material and cross section
NORM DS EN1992-2004  CAT HN
CONC 1 C 25
STEE 2 S 500B
SREC 1 H 0.4 B 0.2 MNC 1
END

PROG SOFIMSHA URS:2
HEAD Example DS EN1992-2004
HEAD System
SYST WFRA GDIR NEGY
NODE 1 FIX PP ; 2 0.0 3.0 FIX PX
BEAM 1 1 2 DIV 6
END
```

3 Action and Loading

The actions and loadings are defined with the program SOFiLOAD. For the definition of the action it suffices to input the action only with its action code in record ACT, e.g. ACT G for the permanent action dead load. The corresponding information about the safety factors and combination coefficients as well as the definition, how the actions is considered during superposition, are defined with the INI file and do not have to be input explicitly.

Following actions and loadings are planned:

Dead load G:	dead load for load case 1
	Dead load of the column and single load at column head of 15 kN
Variable action Q_B:	imposed loads in buildings office areas category B for load case 2
	single load at column head in dead load direction of 25 kN
Snow SD:	snow for load case 3
	single load at column head in dead load direction of 10 kN
Wind W:	wind for load case 4
	constant line load acting on beam 1 in global X direction of 1.0 kN/m

Impact A: accidental action impact for load case 5
single load acting on beam 1 in global X direction 1.0 m above column base

3.1 CADINP Input for SOFiLOAD

```
PROG SOFILOAD urs:3
HEAD Example DS EN1992-2004
HEAD Action and loads
ACT G
  LC 1 DLY -1.0
  POIN TYPE PG  P 15.0 X 0.0 Y 3.0
ACT Q_B
  LC 2
  POIN TYPE PG  P 25.0 X 0.0 Y 3.0
ACT SD
  LC 3
  POIN TYPE PG  P 10.0 X 0.0 Y 3.0
ACT W
  LC 4
  LINE TYPE PXX P1 1.0 X1 0.0 Y1 3.0 X2 0.0 Y2 0.0
ACT A
  LC 5
  POIN TYPE PXX P 10.0 X 0.0 Y 1.0
END
```

3.2 Printout of the Actions

For the later superposition the table of the actions is interesting in the SOFiLOAD printout. In this table all input actions are printed with their safety factors and combination coefficients as well as the information about how the action is considered during superposition:

Actions

type	T	sup	Title		γ-u	γ-f	γ-a	ψ-0	ψ-1	ψ-2	ψ-1'
G	G	perm	dead load		1.20	1.00	1.00	1.00	1.00	1.00	1.00
Q_B	Q	cond	Pay load offices	cat. B	1.50	0.00	1.00	0.60	0.40	0.20	1.00
SD	Q	cond	snow loading		1.50	0.00	1.00	0.30	0.20	0.00	1.00
W	Q	excl	wind loading		1.50	0.00	1.00	0.30	0.20	0.00	1.00
A	A	excl	impact loading		1.00	0.00	1.00	1.00	1.00	1.00	1.00

The information about the actions should be checked by the user. The modification of single values is possible with an explicit input of the value which should be changed in record ACT.

4 Calculation of the Single Load Cases

The calculation of the single load cases is done with the program ASE according to first order theory without consideration of imperfections.

5 Combinations and Superposition

5.1 Defaults

The combinations with the corresponding superposition are preset in the INI file. These defaults are shown in the Superposition Manager (SSD tasks ‘Define Combinations‘ and ’Superpositioning’) and can be modified there. With the following MAXIMA input in TEDDY it is possible the calculate the defaults from the INI file. The input of the records CTRL and ECHO is not urgently necessary here.

5.1.1 CADINP Input

```
PROG MAXIMA urs:8
HEAD Example DS EN1992-2004
HEAD Default from INI
CTRL INIT             $ Combinations and superposition rules are not deleted in the cdb
ECHO CHCK             $ Control of the printout, here output of the relevant values
END
```

5.1.2 Printout

At first the single combinations are printed with their corresponding check list of the actions and load cases:

```
Combination rule Number 100
Crack width
Superposition according to manual MAXIMA formula 7
Resulting loadcases type Service: Permanent combination

Loadcase selection and Actions
Act type   γ-u   γ-f   γ-a   ψ-0   ψ-1   ψ-2   ψ-1'
     LC factor Type of loadcase                          Title
G     G   1.00  1.00  1.00  1.00  1.00  1.00  1.00 dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   1.00  0.00  1.00  0.60  0.40  0.20  1.00 Pay load offices      cat. B
      2   1.00 Conditional LC                Pay load offices      ca
SD    Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 snow loading
      3   1.00 Conditional LC                snow loading
W     Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 wind loading
      4   1.00 Exclusive LC   A10            wind loading
```

```
Combination rule Number 101
Crack width
Superposition according to manual MAXIMA formula 5
Resulting loadcases type Service: Frequent combination

Loadcase selection and Actions
Act type   γ-u   γ-f   γ-a   ψ-0   ψ-1   ψ-2   ψ-1'
     LC factor Type of loadcase                          Title
G     G   1.00  1.00  1.00  1.00  1.00  1.00  1.00 dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   1.00  0.00  1.00  0.60  0.40  0.20  1.00 Pay load offices      cat. B
      2   1.00 Conditional LC              Pay load offices      ca
SD    Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 snow loading
      3   1.00 Conditional LC              snow loading
W     Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 wind loading
      4   1.00 Exclusive LC   A10          wind loading

Combination rule Number 102
Decompression
Superposition according to manual MAXIMA formula 7
Resulting loadcases type Service: Permanent combination

Loadcase selection and Actions
Act type   γ-u   γ-f   γ-a   ψ-0   ψ-1   ψ-2   ψ-1'
     LC factor Type of loadcase                          Title
G     G   1.00  1.00  1.00  1.00  1.00  1.00  1.00 dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   1.00  0.00  1.00  0.60  0.40  0.20  1.00 Pay load offices      cat. B
      2   1.00 Conditional LC              Pay load offices      ca
SD    Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 snow loading
      3   1.00 Conditional LC              snow loading
W     Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 wind loading
      4   1.00 Exclusive LC   A10          wind loading

Combination rule Number 103
Deflections
Superposition according to manual MAXIMA formula 7
Resulting loadcases type Service: Permanent combination

Loadcase selection and Actions
Act type   γ-u   γ-f   γ-a   ψ-0   ψ-1   ψ-2   ψ-1'
     LC factor Type of loadcase                          Title
G     G   1.00  1.00  1.00  1.00  1.00  1.00  1.00 dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   1.00  0.00  1.00  0.60  0.40  0.20  1.00 Pay load offices      cat. B
      2   1.00 Conditional LC              Pay load offices      ca
SD    Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 snow loading
      3   1.00 Conditional LC              snow loading
W     Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 wind loading
      4   1.00 Exclusive LC   A10          wind loading

Combination rule Number 105
charact. support reactions
Superposition according to manual MAXIMA formula 4
Resulting loadcases type Service: Rare combination

Loadcase selection and Actions
Act type   γ-u   γ-f   γ-a   ψ-0   ψ-1   ψ-2   ψ-1'
     LC factor Type of loadcase                          Title
G     G   1.00  1.00  1.00  1.00  1.00  1.00  1.00 dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   1.00  0.00  1.00  0.60  0.40  0.20  1.00 Pay load offices      cat. B
      2   1.00 Conditional LC              Pay load offices      ca
W     Q   1.00  0.00  1.00  0.30  0.20  0.00  1.00 wind loading
      4   1.00 Exclusive LC   A10          wind loading
```

```
Combination rule Number 106
equ.6.10a Table A1.2(B)
Superposition according to explicitly defined formula
KFI·γ*{G}+γ*{P}
Resulting loadcases type Ultimate Design combination

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
G     G   1.32  1.00  dead load
      1   1.00 permanent load grouped in actions            dead load


Combination rule Number 107
equ.6.10b Table A1.2(B)
Superposition according to explicitly defined formula
(ξ·KFI/0.90)*G+γ*{P}+KFI·γ*{Q1}+KFI·γ·ψ-0*{QI}
Resulting loadcases type Ultimate Design combination

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
G    EX   1.10  0.90  dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   0.99  0.00  1.65  0.00  Pay load offices      cat. B
      2   1.00 Conditional LC             Pay load offices      ca
SD    Q   0.50  0.00  1.65  0.00  snow loading
      3   1.00 Conditional LC             snow loading
W     Q   0.50  0.00  1.65  0.00  wind loading
      4   1.00 Exclusive LC   A10         wind loading

Combination rule Number 109
Accidental Table A1.3
Superposition according to explicitly defined formula
(1.00/0.00)*A+1.00*{G}+1.00*{P}+(ψ-2/0.00)*{QI}
Resulting loadcases type Ultimate accidental combin.

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
A    EX   1.00  0.00  impact loading
      5   1.00 Exclusive LC   A15         impact loading
G     G   1.00  1.00  dead load
      1   1.00 permanent load grouped in actions            dead load
Q_B   Q   0.20  0.00  Pay load offices      cat. B
      2   1.00 Conditional LC             Pay load offices      ca
SD    Q   0.00  0.00  snow loading
      3   1.00 Conditional LC             snow loading
W     Q   0.00  0.00  wind loading
      4   1.00 Exclusive LC   A10         wind loading
```

The table of the generated load cases follows:

Generated Loadcases

Number	Comb	Title
1121	100	MAXP-N BEAM Forces and moments
1122	100	MINP-N BEAM Forces and moments
1125	100	MAXP-VZ BEAM Forces and moments
1126	100	MINP-VZ BEAM Forces and moments
1129	100	MAXP-MY BEAM Forces and moments
1130	100	MINP-MY BEAM Forces and moments
1221	101	MAXF-N BEAM Forces and moments
1222	101	MINF-N BEAM Forces and moments
1225	101	MAXF-VZ BEAM Forces and moments
1226	101	MINF-VZ BEAM Forces and moments
1229	101	MAXF-MY BEAM Forces and moments
1230	101	MINF-MY BEAM Forces and moments
1321	102	MAXP-N BEAM Forces and moments
1322	102	MINP-N BEAM Forces and moments
1325	102	MAXP-VZ BEAM Forces and moments
1326	102	MINP-VZ BEAM Forces and moments
1329	102	MAXP-MY BEAM Forces and moments
1330	102	MINP-MY BEAM Forces and moments
1471	103	MAXP-UX NODE Displacements
1472	103	MINP-UX NODE Displacements
1473	103	MAXP-UY NODE Displacements
1474	103	MINP-UY NODE Displacements
1481	103	MAXPPHIZ NODE Displacements
1482	103	MINPPHIZ NODE Displacements
1951	105	MAXR-PX NODE Support reactions
1952	105	MINR-PX NODE Support reactions
1953	105	MAXR-PY NODE Support reactions
1954	105	MINR-PY NODE Support reactions
1961	105	MAXR-MZ NODE Support reactions
1962	105	MINR-MZ NODE Support reactions
2151	106	MAX-PX NODE Support reactions
2152	106	MIN-PX NODE Support reactions
2153	106	MAX-PY NODE Support reactions
2154	106	MIN-PY NODE Support reactions
2161	106	MAX-MZ NODE Support reactions
2162	106	MIN-MZ NODE Support reactions
2121	106	MAX-N BEAM Forces and moments
2122	106	MIN-N BEAM Forces and moments
2125	106	MAX-VZ BEAM Forces and moments
2126	106	MIN-VZ BEAM Forces and moments
2129	106	MAX-MY BEAM Forces and moments
2130	106	MIN-MY BEAM Forces and moments
2251	107	MAX-PX NODE Support reactions
2252	107	MIN-PX NODE Support reactions
2253	107	MAX-PY NODE Support reactions
2254	107	MIN-PY NODE Support reactions
2261	107	MAX-MZ NODE Support reactions
2262	107	MIN-MZ NODE Support reactions
2221	107	MAX-N BEAM Forces and moments
2222	107	MIN-N BEAM Forces and moments
2225	107	MAX-VZ BEAM Forces and moments
2226	107	MIN-VZ BEAM Forces and moments
2229	107	MAX-MY BEAM Forces and moments
2230	107	MIN-MY BEAM Forces and moments
2451	109	MAXA-PX NODE Support reactions
2452	109	MINA-PX NODE Support reactions
2453	109	MAXA-PY NODE Support reactions
2454	109	MINA-PY NODE Support reactions
2461	109	MAXA-MZ NODE Support reactions
2462	109	MINA-MZ NODE Support reactions
2421	109	MAXA-N BEAM Forces and moments
2422	109	MINA-N BEAM Forces and moments
2425	109	MAXA-VZ BEAM Forces and moments
2426	109	MINA-VZ BEAM Forces and moments
2429	109	MAXA-MY BEAM Forces and moments
2430	109	MINA-MY BEAM Forces and moments

The printout of the relevant values of the single superposition is requested with the input ECHO CHCK. All factors which are necessary for the superposition as well as the initial values of the single load cases are printed in the tables. A further description of the output is done in chapter 5.2.2.

The user should check the superposition by investigating random samples! For this the printout of the relevant values with ECHO CHCK is recommended.

5.2 Combinations for Ultimate Limit State

In the INI file two combinations are defined for the ultimate limit state:

- Combination 106 according to equation (6.10a) EN 1990 DK NA:2007
- Combination 107 according to equation (6.10b) EN 1990 DK NA:2007

Table A1.2(B) - Design values of actions (STR/GEO) (Set B)

Persistent and transient design situations	Permanent actions		Leading variable action (*)	Accompanying variable actions
	Unfavourable	Favourable		
(Eq. 6.10a)	$K_{FI}\,\gamma_{Gj,sup}\,G_{kj,sup}$	$\gamma_{Gj,inf}\,G_{kj,inf}$		
(Eq. 6.10b)	$\xi\,K_{FI}\,\gamma_{Gj,sup}\,G_{kj,sup}$	$\gamma_{Gj,inf}\,G_{kj,inf}$	$K_{FI}\,\gamma_{Q,1}\,Q_{k,1}$	$K_{FI}\,\gamma_{Q,i}\,\psi_{0,i}\,Q_{k,i}$

The explicit MAXIMA input for these combinations should be explained now.

5.2.1 CADINP Input

For the combinations according to equation (6.10a) and (6.10b) EN 1990 DK NA:2007 it is necessary to defined an explicit defined combination with COMB EXTR EXPL in MAXIMA. The type of the result load cases is DESI – ultimate design combination. The basis load case numbers of the result load cases are defined with BASE 3100 and BASE 3200.

In combination 11 (acc. to equation 6.10a) only the permanent actions should be considered with the indicated factors K_{FI} = 1.1 and the safety factor $\gamma_{Gj,sup}$ = 1.2. In record ADD for the permanent actions the literal KFG is defined for the unfavourable

factor FACU. KFG is the product of K_{FI} * $\gamma_{Gj,sup}$. In the favourable case the favourable safety factor $\gamma_{Gj,inf}$ is used automatically. So the action G is considered in this combination with 1.2 * 1.1 = 1.35 in unfavourable case and with 1.0 in favourable case. The maximum and minimum values of the internal beam forces as well as the support reactions at the column base are defined for the superposition in the SUPP records. The MAXIMA input reads for combination 11:

```
+PROG MAXIMA urs:5
HEAD Example DS EN1992-2004
HEAD Superposition for ultimate limite state
HEAD EN 1990 DK NA:2007 table A1.2(B) equation (6.10a)
CTRL INIT
ECHO CHCK
$explicit defined combination with action groups
COMB 11 EXTR EXPL TYPE DESI  BASE 3100
 ADD {G}  FACU KFG                    $ permanent actions with unfavourable KFI*GAMU, favourable with GAMF
SUPP 11 MAMI ETYP BEAM TYPE N,VZ,MY
SUPP 11 MAMI ETYP NODE TYPE PX,PY
END
```

Because a dominant action Qk,1 has to be determined in equation (6.10b), the combination 12 is generated with actions groups for the variable actions in the records ADD. The dominant action is input with {Q1} and the following variable actions with {QI}. The superposition factors FACU and FACF are input as literals or as numerical value. E.g. in combination 12 with ADD {QI} FACU KFG0 the following actions are used in the unfavourable case with KFG0 = KFI*γu*ψ0 and in the favourable case with 0.0.

The input for the dominant action is ADD {Q1} FACU KFG. The respective dominant action is determined automatically by the program MAXIMA and is considered in unfavourable case with K_{FI} * γu.

The permanent action is input here with G and not as action group, because several favourable safety factors are given the code EN 1990 DK NA:2007 Table A1.2(B) (self weight of structural members = dead load = γf =0.9 and self weight of ground = γf =1.0). The unfavourable factor FACU is considered about the input XKFI = ξ * K_{FI}. The safety factor γu for G is given here with 1.0. Because γu is saved in the database with 1.2, it should not input here.

The favourable factor FACF has to be input here as 0.9 and not with the literal GAMF, because it is different from the value in the database and the favourable factor which is used in combination 11.

The possible literals for the factors FACU and FACF are described in the MAXIMA manual at record ADD.

As in the input for combination 11 the maximum and minimum values of the internal beam forces as well as the support reactions at the column base are defined for the superposition in the SUPP records.

```
+PROG MAXIMA urs:9
HEAD Example DS EN1992-2004
HEAD Superposition for ultimate limite state
HEAD EN 1990 DK NA:2007 table A1.2(B) equation (6.10b)
CTRL INIT
ECHC CHCK
$explicit defined combination with action groups
COMB 12 EXTR EXPL TYPE DESI  BASE 3200
 ADD  G   FACU XKFI FACF 0.9             $ dead load action with unfavourable KFI*XSI and favourable 0.9
 ADD {Q1} FACU KFG                       $ dominant variable action KFI*GAMU
 ADD {QI} FACU KFG0                      $ other variable actions KFG0 = KFI*GAMU*PSI0
SUPP 12 MAMI ETYP BEAM TYPE N,VZ,MY
SUPP 12 MAMI ETYP NODE TYPE PX,PY
END
```

If other superposition factors should be used than given in Table A1.2(B), you can input these factors manually in record ADD at FACU and/or FACF.

5.2.2 Printout of the Superposition Results

As already described the printout of MAXIMA begins with the combination and their corresponding check list of the actions and load cases. Then follow the table of the resultant load cases:

- for combination 11

```
Combination rule Number  11
Superposition according to explicitly defined formula
KFI·γ*{G}
Resulting loadcases type Ultimate Design combination

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
G     G   1.32  1.00  dead load
      1   1.00 permanent load grouped in actions           dead load

Generated Loadcases
Number Comb Title
  3121   11 MAX-N BEAM
  3122   11 MIN-N BEAM
  3125   11 MAX-VZ BEAM
  3126   11 MIN-VZ BEAM
  3129   11 MAX-MY BEAM
  3130   11 MIN-MY BEAM
  3151   11 MAX-PX NODE
  3152   11 MIN-PX NODE
  3153   11 MAX-PY NODE
  3154   11 MIN-PY NODE
```

- for combination 12

```
Combination rule Number  12
Superposition according to explicitly defined formula
(ξ·KFI/0.90)*G+KFI·γ*{Q1}+KFI·γ·ψ-0*{QI}
Resulting loadcases type Ultimate Design combination

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
G    EX   1.10  0.90  dead load
      1   1.00 permanent load grouped in actions           dead load
Q_B   Q   0.99  0.00  1.65  0.00  Pay load offices      cat. B
      2   1.00 Conditional LC             Pay load offices      ca
SD    Q   0.50  0.00  1.65  0.00  snow loading
      3   1.00 Conditional LC             snow loading
W     Q   0.50  0.00  1.65  0.00  wind loading
      4   1.00 Exclusive LC   A10         wind loading

Generated Loadcases
Number Comb Title
  3221   12 MAX-N BEAM
  3222   12 MIN-N BEAM
  3225   12 MAX-VZ BEAM
  3226   12 MIN-VZ BEAM
  3229   12 MAX-MY BEAM
  3230   12 MIN-MY BEAM
  3251   12 MAX-PX NODE
  3252   12 MIN-PX NODE
  3253   12 MAX-PY NODE
  3254   12 MIN-PY NODE
```

The output of the relevant superposition values is recommended with the input ECHO CHCK. This extended output should be explained here for the minimum normal force min-N LC 3222 of the combination 12. The most minimum normal force is determined in the beam at section x= 0.0 mm = column base. The internal forces and moments of the single load case are printed at first:

```
Relevant Forces in Beam-Elements
Grp   Beam     x   LC Title          N      Vz      My
 No    No.   [m]  No.             [kN]    [kN]   [kNm]
  0      1 0.000    1            -21.0    0.00    0.00
  0      1 0.000    2            -25.0    0.00    0.00
  0      1 0.000    3            -10.0    0.00    0.00
  0      1 0.000    4              0.0    1.50    0.00
   ------------------------------------------------------------------------
```

The determination of the used superposition factors follows for each load case in dependence on the action:

```
Acti       G:   sumGU=  -27.7200*;   sumGF=  -18.9000;
   LC       1
facGU    1.10 -> unfavourable factor = XSI*KFI=1.1 (gamu=1.0) for LC 1
facGF    0.90 -> favourable factor gamf=0.9 for LC 1
   ------------------------------------------------------------
Acti     Q_B:   sumL1=  -41.2500*;   sumQ=  -24.7500
sumL1 = sum of the loads dominant action = -25.0*1.65 = -41.25 kN,
   * means that Q_B is determined as dominant action
   sumQ  = sum of the loads following action = -25.0*0.99 = -24.75 kN
   sumL1 - sumQ = (-41.25)-(-24.75) = -16.5 kN
   LC       2
facL1    1.65 -> factor for unfavourable case of the dominant action
facQ     0.99 -> factor for unfavourable case of the following action
   ------------------------------------------------------------
Acti      SD:   sumL1=  -16.5000;   sumQ=   -4.9500*
   sumL1 = sum of the loads dominant action = -10.0*1.65 = -16.5 kN,
   sumQ  = sum of the loads following action = -10.0*0.495 = -4.95 kN
   * means that SD is determined as following action
   sumL1 - sumQ = (-16.5)-(-4.95) = -11.55 kN
   LC       3
facL1    1.65 -> factor for unfavourable case of the dominant action
facQ     0.50 (0.495)->factor for unfavourable case of the following
action
   ------------------------------------------------------------
Acti       W:   sumL1=    0.0000;   sumQ=    0.0000*
   sumL1 = sum of the loads dominant action = 0.0
   sumQ  = sum of the loads following action = 0.0
   W does not supply any contribution, because N = 0.0 for LC 4
   LC       4
facL1    0.00
facQ     0.00
   ------------------------------------------------------------
```

The dominant action is that variable action which has the biggest difference between sumL1 and sumQ!

The determined factor and the superimposed minimum normal force for the beam at x=0.0 is printed in three lines at the end:

```
  LC       1       2       3       4
fact    1.10    1.65    0.50    0.00
  ------------------------------------------------------------------------
  0      1 0.000 3222 MIN-N BE   -69.3    0.00    0.00
```

Min-N = 1.1*(-21.0) + 1.65*(-25.0) + 0.5*(-10.0) = -69.3 kN

The designation MAX or MIN at the superposition refers exclusively to the sign of the superposition values:
positive sign -> MAX
negative sign -> MIN

5.3 Accidental Combinations

In the INI file there are preset two accidental combinations:

- Combination 108 according to equation (6.11a/b) EN 1990 DK NA:2007 Appendix 1: 15-12-2008 Table A1.3 for an accidental load (2nd line)

Tabel A1.3 Regningsmæssige lastværdier til brug ved lastkombinationer ved ulykkesdimensioneringstilfælde og seismiske dimensioneringstilfælde

Tabellen erstattes af

Dimensioneringstilfælde	Permanente laster		Dominerende ulykkeslast eller seismisk last	Ikke-dominerende variable laster*	
	Ugunstige	Gunstige		Eventuel primær	Andre
Brand (~~Formel 6.11a/b~~)	$G_{kj,sup}$	$G_{kj,inf}$	A_d	$\psi_{1,1}\ Q_{k,1}$	$\psi_{2,i}\ Q_{k,i}$
Ulykke i øvrigt (Formel 6.11a/b)	$G_{kj,sup}$	$G_{kj,inf}$	A_d	$\psi_{2,1}\ Q_{k,1}$	$\psi_{2,i}\ Q_{k,i}$
Seismisk (Formel 6.12a/b)	$G_{kj,sup}$	$G_{kj,inf}$	A_d		$\psi_{2,i}\ Q_{k,i}$

The explicit MAXIMA input for these combinations should be explained now.

5.3.1 CADINP Input

For this combination 13 **without dominant action = ψ2*Qk,1** it is necessary to define an explicit defined combination with COMB EXTR EXPL in MAXIMA. The type of the result is ACCI – ultimate accidental combination. The basis load case number of the result load cases is defined with BASE 3300. In the MAXIMA input actions groups for the permanent and variable actions are defined using the record ADD. MAXIMA uses all permanent and variable actions from the database. The action A is input as single action because another possible accidental action may be available in the database (e.g. fire -> action AB). The permanent and accidental actions do not have any factors here. So the unfavourable factors FACU are 1.0. The favourable factor FACF is for {G} also 1.0 and for A however 0.0. All variable actions should be considered in the unfavourable case with their respective combination coefficients ψ2. MAXIMA uses the coefficient ψ2 for each available variable action from the database with the input of the literal PSI2 at FACU.
For the superposition the maximum and minimum values of the internal beam forces as well as the support reactions at the column base are defined in the SUPP records.

```
+PROG MAXIMA urs:10
HEAD Example DS EN1992-2004
HEAD Accidental superposition without dominant action
HEAD EN 1990 DK NA:2007 table A1.3 equation (6.11a/b) Accidental
CTRL INIT
ECHO CHCK
$explicit defined combination because no dominant action for the variable actions
COMB 13 EXTR EXPL TYPE ACCI  BASE 3300
 $ first variant - universal
 ADD  A   FACU 1.0  FACF 0.0      $ accidental action
 ADD {G}  FACU 1.0  FACF 1.0      $ permanent actions with gama
 ADD {QI} FACU PSI2 FACF 0.0      $ all variable actions for unfavourable case with psi2
SUPP 13 MAMI ETYP BEAM TYPE N,VZ,MY
SUPP 13 MAMI ETYP NODE TYPE PX,PY
END
```

5.3.2 Printout of the Superposition Results

As already described the printout of MAXIMA begins with the combination and their corresponding check list of the actions and load cases. Then follow the table of the resultant load cases:

```
Combination rule Number  13
Superposition according to explicitly defined formula
(1.00/0.00)*A+1.00*{G}+(ψ-2 /0.00)*{QI}
Resulting loadcases type Ultimate accidental combin.

Loadcase selection and Actions
Act type fac-u fac-f facu1 facf1 facu2 facf2 facu3 facf3
     LC factor Type of loadcase                          Title
A    EX   1.00  0.00  impact loading
      5   1.00 Exclusive LC   A15          impact loading
G     G   1.00  1.00  total dead load
      1   1.00 permanent load grouped in actions            total dead load
Q_B   Q   0.20  0.00  Pay load offices      cat. B
      2   1.00 Conditional LC              Pay load offices      ca
SD    Q   0.00  0.00  snow loading
      3   1.00 Conditional LC              snow loading
W     Q   0.00  0.00  wind loading
      4   1.00 Exclusive LC   A10          wind loading

Generated Loadcases
Number Comb Title
  3321   13 MAXA-N BEAM
  3322   13 MINA-N BEAM
  3325   13 MAXA-VZ BEAM
  3326   13 MINA-VZ BEAM
  3329   13 MAXA-MY BEAM
  3330   13 MINA-MY BEAM
  3351   13 MAXA-PX NODE
  3352   13 MINA-PX NODE
  3353   13 MAXA-PY NODE
  3354   13 MINA-PY NODE
```