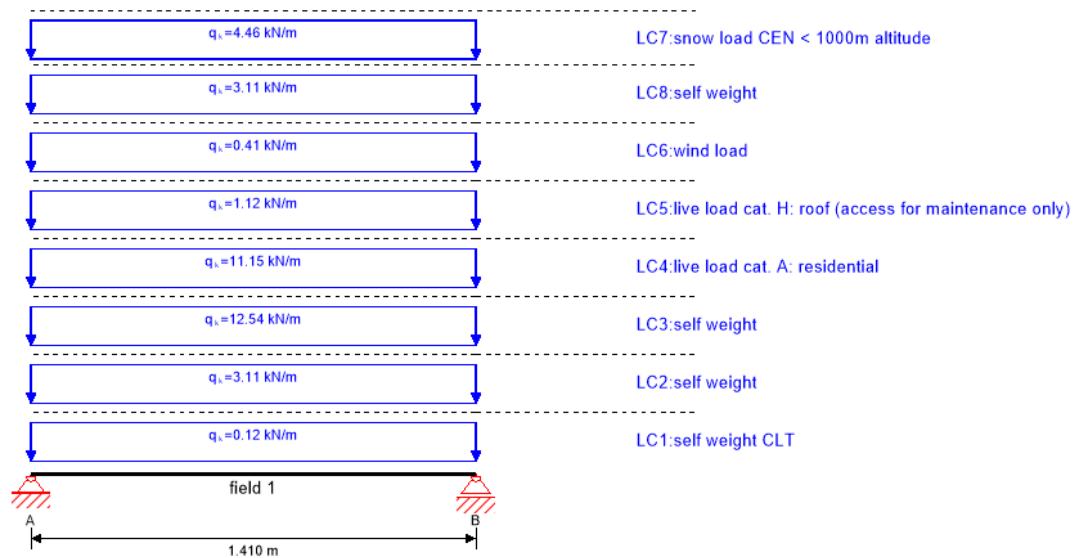


## system



## global utilization ratio


80 %

|     |      |          |      |     |      |               |     |         |      |      |      |
|-----|------|----------|------|-----|------|---------------|-----|---------|------|------|------|
| ULS | 80 % | ULS fire | 37 % | SLS | 30 % | SLS vibration | 0 % | support | 68 % | void | -1 % |
|-----|------|----------|------|-----|------|---------------|-----|---------|------|------|------|

## section: wooden beam 12/20.5

|  |               |                |                    |                    |                    |
|--|---------------|----------------|--------------------|--------------------|--------------------|
|  | section width | section height | area               | $I_y$              | $I_z$              |
|  | [cm]          | [cm]           | [mm <sup>2</sup> ] | [mm <sup>4</sup> ] | [mm <sup>4</sup> ] |
|  | 12            | 20.5           | 24,600             | 86,151,250         | 29,520,000         |

## section fire: wooden beam 12/20.5

|                                                                                     |               |                |                    |                    |                    |
|-------------------------------------------------------------------------------------|---------------|----------------|--------------------|--------------------|--------------------|
|  | section width | section height | area               | $I_y$              | $I_z$              |
|                                                                                     | [cm]          | [cm]           | [mm <sup>2</sup> ] | [mm <sup>4</sup> ] | [mm <sup>4</sup> ] |
|                                                                                     | 7.6           | 20.5           | 15,507             | 54,305,130         | 7,393,569          |
|                                                                                     |               |                |                    |                    |                    |

|                                                                                        |            |           |           |            |       |       |                |            |
|----------------------------------------------------------------------------------------|------------|-----------|-----------|------------|-------|-------|----------------|------------|
| fire resistance class:R 90                                                             | time       |           | 90 min    |            |       |       |                |            |
| fire protection layering : 2 x 12.5 mm gypsum plasterboard Type F                      | $t_{ch,h}$ | $t_{f,h}$ | $t_{a,h}$ | $d_{ta,h}$ | $k_0$ | $d_0$ | $d_{char,0,h}$ | $d_{ef,h}$ |
| gypsum plasterboard Type A (acc. to EN 520)gypsum plasterboard Type F (acc. to EN 520) | [min]      | [min]     | [min]     | [mm]       | [-]   | [mm]  | [mm]           | [mm]       |
|                                                                                        | 38         | 38        | 57        | 25         | 1     | 7     | 0.0            | 0.0        |

## material values

| material | $f_{m,k}$            | $f_{t,0,k}$          | $f_{t,90,k}$         | $f_{c,0,k}$          | $f_{c,90,k}$         | $f_{v,k}$            | $f_{r,k \text{ min}}$ | $E_{0,mean}$         | $G_{mean}$           | $E_{0,5}$            |
|----------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|----------------------|
|          | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ]  | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] |
| GL 30h   | 30.00                | 24.00                | 0.50                 | 30.00                | 2.50                 | 2.50                 | 1.20                  | 13,600.00            | 650.00               | 11,300.00            |
| GL 30h   |                      |                      |                      |                      |                      |                      |                       |                      |                      |                      |

## load

## load case groups

|     | load case category | Typ | duration  | Kmod | $\gamma_{inf}$ | $\gamma_{sup}$ | $\Psi_0$ | $\Psi_1$ | $\Psi_2$ |
|-----|--------------------|-----|-----------|------|----------------|----------------|----------|----------|----------|
| LC1 | self weight CLT    | G   | permanent | 0.6  | 1              | 1.35           | 1        | 1        | 1        |
| LC1 | self weight CLT    | G   | permanent |      |                |                |          |          |          |
| LC2 | self weight        | G   | permanent | 0.6  | 1              | 1.35           | 1        | 1        | 1        |
| LC2 | self weight        | G   | permanent |      |                |                |          |          |          |
| LC3 | self weight        | G   | permanent | 0.6  | 1              | 1.35           | 1        | 1        | 1        |
| LC3 | self weight        | G   | permanent |      |                |                |          |          |          |

| load case groups |                                                                                                              |        |                                  |      |                |                |          |          |          |
|------------------|--------------------------------------------------------------------------------------------------------------|--------|----------------------------------|------|----------------|----------------|----------|----------|----------|
|                  | load case category                                                                                           | Typ    | duration                         | Kmod | $\gamma_{inf}$ | $\gamma_{sup}$ | $\psi_0$ | $\psi_1$ | $\psi_2$ |
| LC4<br>LC4       | live load cat. A: residential<br>live load cat. A: residential                                               | Q<br>Q | medium<br>term<br>medium<br>term | 0.8  | 0              | 1.5            | 0.7      | 0.5      | 0.3      |
| LC5<br>LC5       | live load cat. H: roof (access for maintenance only)<br>live load cat. H: roof (access for maintenance only) | Q<br>Q | short<br>term<br>short<br>term   | 0.9  | 0              | 1.5            | 0        | 0        | 0        |
| LC6<br>LC6       | wind load<br>wind load                                                                                       | Q<br>Q | short<br>term<br>short<br>term   | 0.9  | 0              | 1.5            | 0.6      | 0.2      | 0        |
| LC7<br>LC7       | snow load CEN < 1000m altitude<br>snow load CEN < 1000m altitude                                             | Q<br>Q | short<br>term<br>short<br>term   | 0.9  | 0              | 1.5            | 0.5      | 0.2      | 0        |
| LC8<br>LC8       | self weight<br>self weight                                                                                   | G<br>G | permanent<br>permanent           | 0.6  | 1              | 1.35           | 1        | 1        | 1        |

#### LC1:self weight CLT

| continuous load |               |
|-----------------|---------------|
| field           | load at start |
|                 | [kN/m]        |
| 1               | 0.12          |
| 1               |               |

#### LC2:self weight

| continuous load |               |
|-----------------|---------------|
| field           | load at start |
|                 | [kN/m]        |
| 1               | 3.11          |
| 1               |               |

#### LC3:self weight

| continuous load |               |
|-----------------|---------------|
| field           | load at start |
|                 | [kN/m]        |
| 1               | 12.54         |
| 1               |               |

#### LC4:live load cat. A: residential

| continuous load |               |
|-----------------|---------------|
| field           | load at start |
|                 | [kN/m]        |
| 1               | 11.15         |
| 1               |               |

#### LC5:live load cat. H: roof (access for maintenance only)

| continuous load |               |
|-----------------|---------------|
| field           | load at start |
|                 | [kN/m]        |
| 1               | 1.12          |
| 1               |               |

**LC6:wind load**
**continuous load**

| field | load at start |
|-------|---------------|
|       | [kN/m]        |
| 1     | 0.41          |
| 1     |               |

**LC7:snow load CEN < 1000m altitude**
**continuous load**

| field | load at start |
|-------|---------------|
|       | [kN/m]        |
| 1     | 4.46          |
| 1     |               |

**LC8:self weight**
**continuous load**

| field | load at start |
|-------|---------------|
|       | [kN/m]        |
| 1     | 3.11          |
| 1     |               |

**ULS combinations**

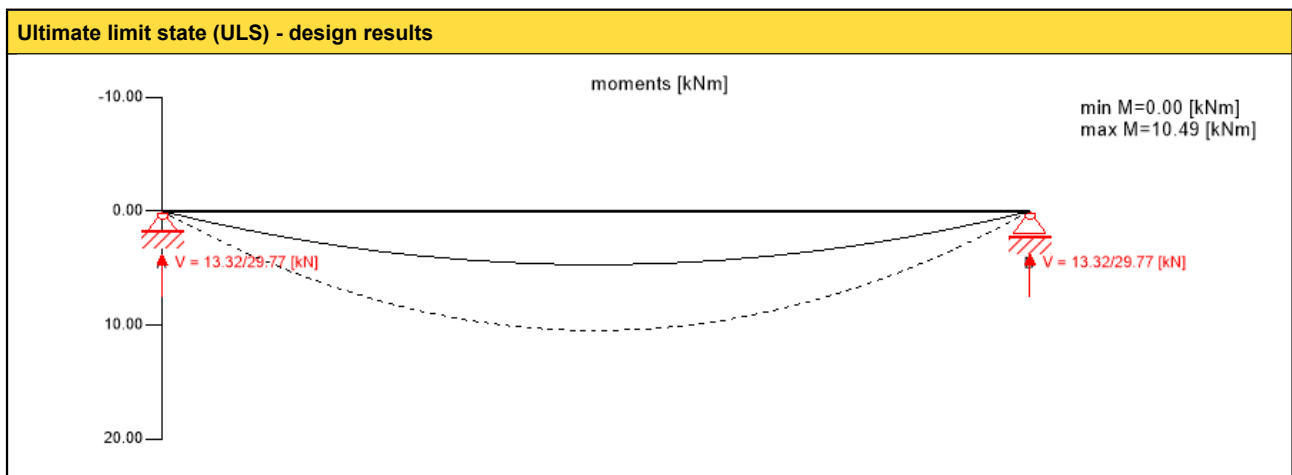
|       | combination rule                                                                                                                                                     |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LCO1  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8$                                                                                              |
| LCO1  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8$                                                                                              |
| LCO2  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4$                                                                            |
| LCO2  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4$                                                                            |
| LCO3  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5$                                                   |
| LCO3  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5$                                                   |
| LCO4  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6$                          |
| LCO4  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6$                          |
| LCO5  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6 + 1.50/0.00 * 0.50 * LC7$ |
| LCO5  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6 + 1.50/0.00 * 0.50 * LC7$ |
| LCO6  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5$                                                                            |
| LCO6  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5$                                                                            |
| LCO7  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4$                                                   |
| LCO7  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4$                                                   |
| LCO8  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.60 * LC6$                          |
| LCO8  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.60 * LC6$                          |
| LCO9  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.60 * LC6 + 1.50/0.00 * 0.50 * LC7$ |
| LCO9  | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.60 * LC6 + 1.50/0.00 * 0.50 * LC7$ |
| LCO10 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6$                                                                            |
| LCO10 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6$                                                                            |
| LCO11 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4$                                                   |
| LCO11 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4$                                                   |
| LCO12 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5$                          |
| LCO12 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5$                          |
| LCO13 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.50 * LC7$ |
| LCO13 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC6 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.50 * LC7$ |
| LCO14 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7$                                                                            |
| LCO14 | $1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7$                                                                            |

| ULS combinations |                                                                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | combination rule                                                                                                                                                   |
| LCO15            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4                                                   |
| LCO15            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4                                                   |
| LCO16            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5                          |
| LCO16            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5                          |
| LCO17            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6 |
| LCO17            | 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.35/1.00 * LC3 + 1.35/1.00 * LC8 + 1.50/0.00 * LC7 + 1.50/0.00 * 0.70 * LC4 + 1.50/0.00 * 0.00 * LC5 + 1.50/0.00 * 0.60 * LC6 |

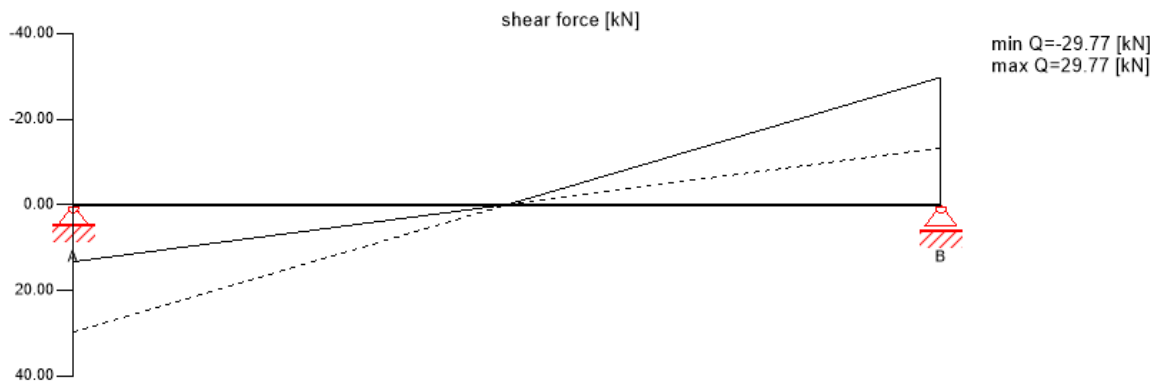
[illegible]

| SLS characteristic combination |                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                | combination rule                                                                                                                                                                                                                                                                                                                             |
| LCO35<br>LCO35                 | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8$                                                                                                                                                                                           |
| LCO36<br>LCO36                 | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.60 * LC6 + 1.00/0.00 * 0.50 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.60 * LC6 + 1.00/0.00 * 0.50 * LC7$ |
| LCO37<br>LCO37                 | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.60 * LC6 + 1.00/0.00 * 0.50 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.60 * LC6 + 1.00/0.00 * 0.50 * LC7$ |
| LCO38<br>LCO38                 | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC6 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.50 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC6 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.50 * LC7$ |
| LCO39<br>LCO39                 | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC7 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.60 * LC6$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * LC7 + 1.00/0.00 * 0.70 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.60 * LC6$ |

| SLS quasi-permanent combination |                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | combination rule                                                                                                                                                                                                                                                                                                                                           |
| LCO40<br>LCO40                  | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8$                                                                                                                                                                                                         |
| LCO41<br>LCO41                  | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.00 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.00 * LC7$ |
| LCO42<br>LCO42                  | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.00 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.00 * LC7$ |
| LCO43<br>LCO43                  | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC7$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC6 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC7$ |
| LCO44<br>LCO44                  | $1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC7 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC6$<br>$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/1.00 * LC3 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC7 + 1.00/0.00 * 0.30 * LC4 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC6$ |



### Ultimate limit state (ULS) - design results



### ULS flexural design

| field | dist. | $f_{m,k}$            | $\gamma_m$ | $k_{mod}$ | $k_{sys,z}$ | $k_{hm}$ | $f_{m,y,d}$          | $M_{y,d}$ | $\sigma_{m,y,d}$     | ratio |              |
|-------|-------|----------------------|------------|-----------|-------------|----------|----------------------|-----------|----------------------|-------|--------------|
|       | [m]   | [N/mm <sup>2</sup> ] | [-]        | [-]       | [-]         | [-]      | [N/mm <sup>2</sup> ] | [kNm]     | [N/mm <sup>2</sup> ] |       |              |
| 1     | 0.71  | 30.00                | 1.25       | 0.80      | 1.00        | 1.10     | 21.12                | 10.49     | 12.48                | 59 %  | LCO2<br>LCO2 |

### ULS shear analysis

| field | dist. | $f_{v,k}$            | $\gamma_m$ | $k_{mod}$ | $f_{v,d}$            | $V_d$ | $T_{v,d}$            | ratio |              |
|-------|-------|----------------------|------------|-----------|----------------------|-------|----------------------|-------|--------------|
|       | [m]   | [N/mm <sup>2</sup> ] | [-]        | [-]       | [N/mm <sup>2</sup> ] | [kN]  | [N/mm <sup>2</sup> ] |       |              |
| 1     | 0.21  | 2.50                 | 1.25       | 0.80      | 1.60                 | 21.11 | 1.29                 | 80 %  | LCO2<br>LCO2 |

### ULS lateral torsional buckling design

| field | $M_{y,d}$ | $N_{c,d}$ | $\sigma_{m,y,d}$     | $\sigma_{c,d}$       | ratio |              |
|-------|-----------|-----------|----------------------|----------------------|-------|--------------|
|       | [kNm]     | [kN]      | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] |       |              |
| 1     | 10.49     | 0.00      | 12.48                | 0.00                 | 59 %  | LCO2<br>LCO2 |

### flexural stress analysis

|                    |       |                   |               |       |                   |   |
|--------------------|-------|-------------------|---------------|-------|-------------------|---|
| $M_{y,d} =$        | 10.49 | kNm               | $f_{m,k} =$   | 30.00 | N/mm <sup>2</sup> |   |
| $N_{t,d} =$        | 0.00  | kN                | $\gamma_m =$  | 1.25  | -                 |   |
|                    |       |                   | $k_{mod} =$   | 0.80  | -                 |   |
|                    |       |                   | $k_{sys,y} =$ | 1.00  | -                 |   |
|                    |       |                   | $k_{hm} =$    | 1.10  | -                 |   |
|                    |       |                   | $k_l =$       | 1.00  | -                 |   |
| $\sigma_{t,d} =$   | 0.00  | N/mm <sup>2</sup> | $f_{t,d} =$   | 16.90 | N/mm <sup>2</sup> |   |
| $\sigma_{m,y,d} =$ | 12.48 | N/mm <sup>2</sup> | $f_{m,y,d} =$ | 21.12 | N/mm <sup>2</sup> | ✓ |
| utilization ratio  |       |                   |               |       | 59 %              |   |

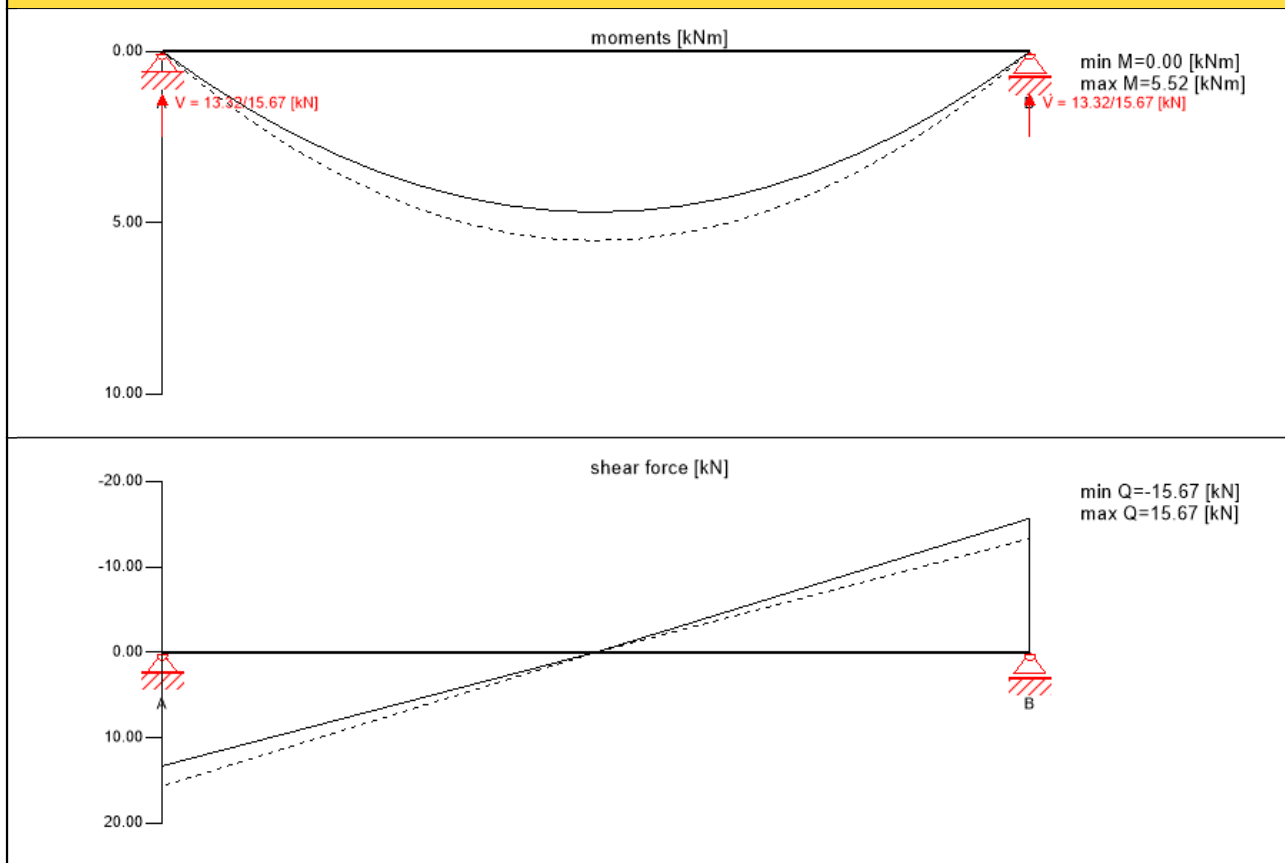
### shear stress analysis

|                   |       |                   |              |      |                   |   |
|-------------------|-------|-------------------|--------------|------|-------------------|---|
| $V_d =$           | 21.11 | kN                | $f_{v,k} =$  | 2.50 | N/mm <sup>2</sup> |   |
|                   |       |                   | $\gamma_m =$ | 1.25 | -                 |   |
|                   |       |                   | $k_{mod} =$  | 0.80 | -                 |   |
| $T_{v,d} =$       | 1.29  | N/mm <sup>2</sup> | $f_{v,d} =$  | 1.60 | N/mm <sup>2</sup> | ✓ |
| utilization ratio |       |                   |              |      | 80 %              |   |

### lateral torsional buckling analysis

|                    |       |                   |               |       |                   |   |
|--------------------|-------|-------------------|---------------|-------|-------------------|---|
| $M_{y,d} =$        | 10.49 | kNm               | $f_{m,k} =$   | 30.00 | N/mm <sup>2</sup> |   |
| $N_{c,d} =$        | 0.00  | kN                | $\gamma_m =$  | 1.25  | -                 |   |
|                    |       |                   | $k_{mod} =$   | 0.80  | -                 |   |
|                    |       |                   | $k_{sys,y} =$ | 1.00  | -                 |   |
|                    |       |                   | $k_{hm} =$    | 1.10  | -                 |   |
|                    |       |                   | $k_l =$       | 1.00  | -                 |   |
| $\sigma_{m,y,d} =$ | 12.48 | N/mm <sup>2</sup> | $f_{m,y,d} =$ | 21.12 | N/mm <sup>2</sup> | ✓ |
| utilization ratio  |       |                   |               |       | 59 %              |   |

### Ultimate limit state (ULS) fire design - results



### ULS fire flexural design

| field | dist. | $f_{m,k}$            | $\gamma_m$ | $k_{mod}$ | $k_{sys,z}$ | $k_{fi}$ | $f_{m,y,d}$          | $M_{y,d}$ | $\sigma_{m,y,d}$     | ratio |                |
|-------|-------|----------------------|------------|-----------|-------------|----------|----------------------|-----------|----------------------|-------|----------------|
|       | [m]   | [N/mm <sup>2</sup> ] | [-]        | [-]       | [-]         | [-]      | [N/mm <sup>2</sup> ] | [kNm]     | [N/mm <sup>2</sup> ] |       |                |
| 1     | 0.71  | 30.00                | 1.00       | 1.00      | 1.00        | 1.15     | 37.95                | 5.52      | 10.43                | 27 %  | LCO19<br>LCO19 |

### ULS fire shear analysis

| field | dist. | $f_{v,k}$            | $\gamma_m$ | $k_{mod}$ | $k_{fi}$ | $f_{v,d}$            | $V_d$ | $\tau_{v,d}$         | ratio |                |
|-------|-------|----------------------|------------|-----------|----------|----------------------|-------|----------------------|-------|----------------|
|       | [m]   | [N/mm <sup>2</sup> ] | [-]        | [-]       | [-]      | [N/mm <sup>2</sup> ] | [kN]  | [N/mm <sup>2</sup> ] |       |                |
| 1     | 0.21  | 2.50                 | 1.00       | 1.00      | 1.15     | 2.88                 | 11.12 | 1.08                 | 37 %  | LCO19<br>LCO19 |

### ULS fire lateral torsional buckling design

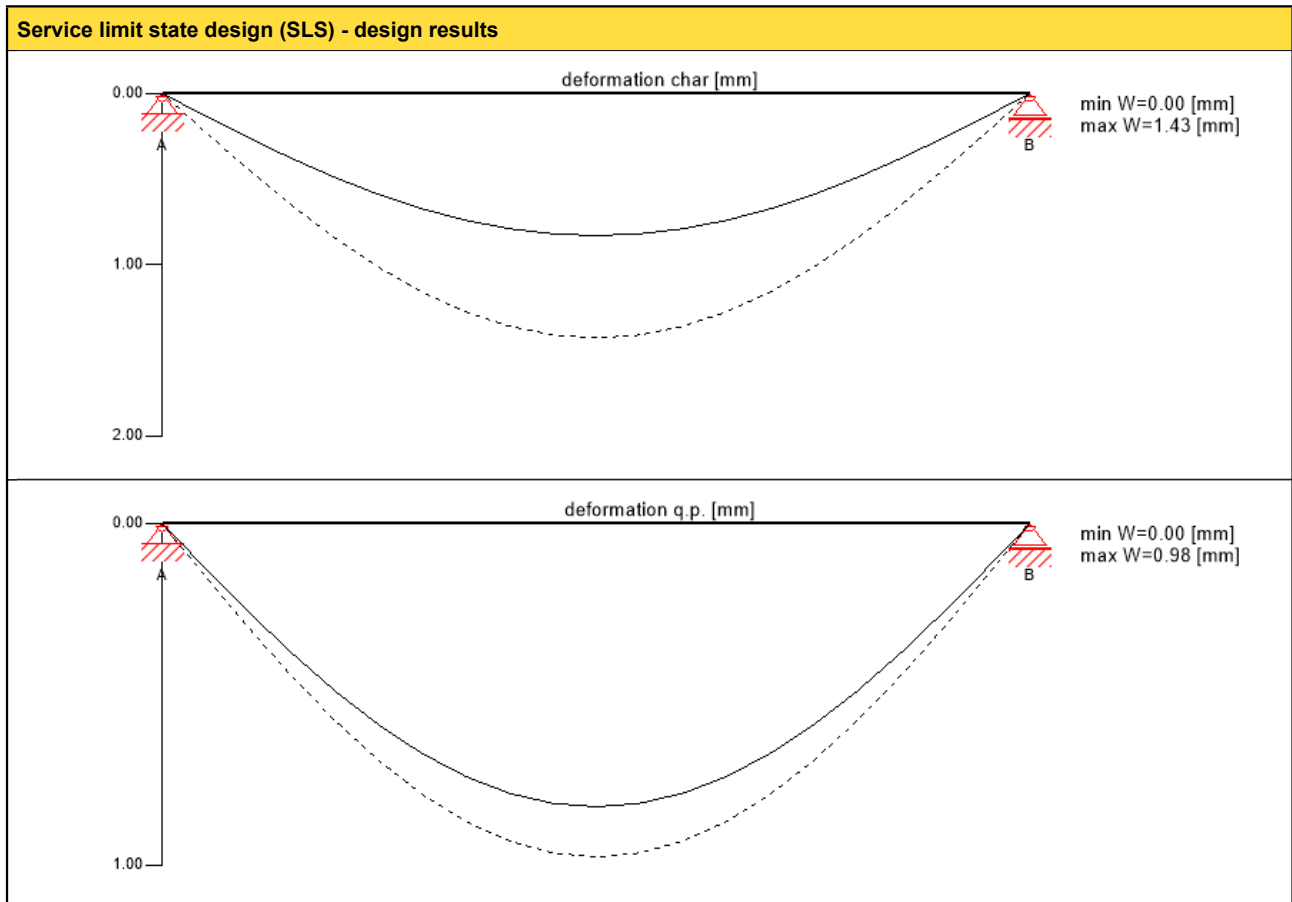
| field | $M_{y,d}$ | $N_{c,d}$ | $\sigma_{m,y,d}$     | $\sigma_{c,d}$       | ratio |                |
|-------|-----------|-----------|----------------------|----------------------|-------|----------------|
|       | [kNm]     | [kN]      | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] |       |                |
| 1     | 5.52      | 0.00      | 10.43                | 0.00                 | 27 %  | LCO19<br>LCO19 |

### flexural stress analysis fire

|                          |       |                   |               |       |                   |             |
|--------------------------|-------|-------------------|---------------|-------|-------------------|-------------|
| $M_{y,d} =$              | 5.52  | kNm               | $f_{m,k} =$   | 30.00 | N/mm <sup>2</sup> |             |
| $N_{t,d} =$              | 0.00  | kN                | $\gamma_m =$  | 1.00  | -                 |             |
|                          |       |                   | $k_{mod} =$   | 1.00  | -                 |             |
|                          |       |                   | $k_{sys,y} =$ | 1.00  | -                 |             |
|                          |       |                   | $k_{hm} =$    | 1.10  | -                 |             |
|                          |       |                   | $k_l =$       | 1.00  | -                 |             |
|                          |       |                   | $k_{fi} =$    | 1.15  | -                 |             |
| $\sigma_{t,d} =$         | 0.00  | N/mm <sup>2</sup> | $f_{t,d} =$   | 30.36 | N/mm <sup>2</sup> |             |
| $\sigma_{m,y,d} =$       | 10.43 | N/mm <sup>2</sup> | $f_{m,y,d} =$ | 37.95 | N/mm <sup>2</sup> | ✓           |
| <b>utilization ratio</b> |       |                   |               |       |                   | <b>27 %</b> |

| shear stress analysis fire |       |                   |              |      |                     |
|----------------------------|-------|-------------------|--------------|------|---------------------|
| $V_d =$                    | 11.12 | kN                | $f_{v,k} =$  | 2.50 | N/mm <sup>2</sup>   |
|                            |       |                   | $\gamma_m =$ | 1.00 | -                   |
|                            |       |                   | $k_{mod} =$  | 1.00 | -                   |
|                            |       |                   | $k_{fi} =$   | 1.15 | -                   |
| $T_{v,d} =$                | 1.08  | N/mm <sup>2</sup> | $f_{v,d} =$  | 2.88 | N/mm <sup>2</sup> ✓ |
| utilization ratio          |       |                   |              | 37 % |                     |

| lateral torsional buckling analysis fire |       |                   |               |       |                     |
|------------------------------------------|-------|-------------------|---------------|-------|---------------------|
| $M_{y,d} =$                              | 5.52  | kNm               | $f_{m,k} =$   | 30.00 | N/mm <sup>2</sup>   |
| $N_{c,d} =$                              | 0.00  | kN                | $\gamma_m =$  | 1.00  | -                   |
|                                          |       |                   | $k_{mod} =$   | 1.00  | -                   |
|                                          |       |                   | $k_{sys,y} =$ | 1.00  | -                   |
|                                          |       |                   | $k_{hm} =$    | 1.10  | -                   |
|                                          |       |                   | $k_i =$       | 1.00  | -                   |
|                                          |       |                   | $k_{fi} =$    | 1.15  | -                   |
| $\sigma_{m,y,d} =$                       | 10.43 | N/mm <sup>2</sup> | $f_{m,y,d} =$ | 37.95 | N/mm <sup>2</sup> ✓ |
| utilization ratio                        |       |                   |               | 27 %  |                     |



| $w_{inst} = w[char]$ |           |       |             |             |       |
|----------------------|-----------|-------|-------------|-------------|-------|
| field                | $K_{def}$ | limit | $w_{limit}$ | $w_{calc.}$ | ratio |
|                      |           | [-]   | [mm]        | [mm]        |       |
| 1                    | 0.6       | L/300 | 4.7         | 1.4         | 30 %  |

| $w_{fin} = w[char] + w[q.p.]*k_{def}$ |           |       |             |             |       |
|---------------------------------------|-----------|-------|-------------|-------------|-------|
| field                                 | $K_{def}$ | limit | $w_{limit}$ | $w_{calc.}$ | ratio |
|                                       |           | [-]   | [mm]        | [mm]        |       |
| 1                                     | 0.6       | L/150 | 9.4         | 2.0         | 21 %  |

| $w_{net,fin} = w[q.p.] + w[q.p.]*k_{def}$ |           |                |             |             |       |
|-------------------------------------------|-----------|----------------|-------------|-------------|-------|
| field                                     | $K_{def}$ | limit          | $W_{limit}$ | $W_{calc.}$ | ratio |
|                                           |           | [-]            | [mm]        | [mm]        |       |
| 1                                         | 0.6       | L/250<br>L/250 | 5.6         | 1.6         | 28 %  |

vibration analysis

| general                          |  |          |  |        |  |  |  |
|----------------------------------|--|----------|--|--------|--|--|--|
| total mass                       |  | Infinity |  | [t]    |  |  |  |
| tributary width                  |  | 0.0      |  | [m]    |  |  |  |
| stiffness longitudinal direction |  | Infinity |  | [kNm²] |  |  |  |
| stiffness cross direction        |  | 0.0      |  | [kNm²] |  |  |  |
| modal damping                    |  | 1.0      |  | [%]    |  |  |  |
| α                                |  | 0.0      |  | [-]    |  |  |  |
| man weight                       |  | 0.0      |  | [N]    |  |  |  |
| modal mass                       |  | NaN      |  | [kg]   |  |  |  |

| analysis                |            |             |            |         |          |       |        |
|-------------------------|------------|-------------|------------|---------|----------|-------|--------|
| criterion               | calc.      | class I     | class II   | class I | class II | cl. I | cl. II |
| frequency criterion min | -1.0 [Hz]  | 4.5 [Hz]    | 4.5 [Hz]   | 0 %     | 0 %      | ✓     | ✓      |
| frequency criterion     | -1.0 [Hz]  | 8.0 [Hz]    | 6.0 [Hz]   | 0 %     | 0 %      | ✓     | ✓      |
| acceleration criterion  | 0.0 [m/s²] | 0.05 [m/s²] | 0.1 [m/s²] | 0 %     | 0 %      | ✓     | ✓      |
| stiffness criterion     | 0.0 [mm]   | 0.25 [mm]   | 0.5 [mm]   | 0 %     | 0 %      | ✓     | ✓      |

| support design |             |       |                    |           |            |              |                      |                      |           |           |                      |      |       |
|----------------|-------------|-------|--------------------|-----------|------------|--------------|----------------------|----------------------|-----------|-----------|----------------------|------|-------|
| nr.            | type        | width | area               | $k_{mod}$ | $\gamma_m$ | $k_{c,90,k}$ | $f_{c,k}$            | $f_{c,d}$            | $V_{max}$ | $V_{min}$ | $\sigma_{c,d}$       |      | ratio |
|                |             | [mm]  | [cm <sup>2</sup> ] | [-]       | [-]        | [-]          | [N/mm <sup>2</sup> ] | [N/mm <sup>2</sup> ] | [kN]      | [kN]      | [N/mm <sup>2</sup> ] |      |       |
| A              | rigid plate | 120   | 156.00             | 0.80      | 1.25       | 1.75         | 2.50                 | 2.80                 | 29.77     | 0.00      | 1.91                 | LCO2 | 68 %  |
| A              | rigid plate |       |                    |           |            |              |                      |                      |           |           |                      | LCO2 |       |
| B              | rigid plate | 120   | 156.00             | 0.80      | 1.25       | 1.75         | 2.50                 | 2.80                 | 29.77     | 0.00      | 1.91                 | LCO2 | 68 %  |
| B              | rigid plate |       |                    |           |            |              |                      |                      |           |           |                      | LCO2 |       |

| support reaction                                     |           |       |       |
|------------------------------------------------------|-----------|-------|-------|
| load case category                                   | $k_{mod}$ | $A_v$ | $B_v$ |
|                                                      |           | [kN]  |       |
| self weight CLT                                      | 0.6       | 0.09  | 0.09  |
|                                                      |           | 0.09  | 0.09  |
| self weight                                          | 0.6       | 2.19  | 2.19  |
|                                                      |           | 2.19  | 2.19  |
| self weight                                          | 0.6       | 8.84  | 8.84  |
|                                                      |           | 8.84  | 8.84  |
| live load cat. A: residential                        | 0.8       | 7.86  | 7.86  |
|                                                      |           | 0.00  | 0.00  |
| live load cat. H: roof (access for maintenance only) | 0.9       | 0.79  | 0.79  |
|                                                      |           | 0.00  | 0.00  |
| wind load                                            | 0.9       | 0.29  | 0.29  |
|                                                      |           | 0.00  | 0.00  |
| snow load CEN < 1000m altitude                       | 0.9       | 3.14  | 3.14  |
|                                                      |           | 0.00  | 0.00  |
| self weight                                          | 0.6       | 2.19  | 2.19  |
|                                                      |           | 2.19  | 2.19  |

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