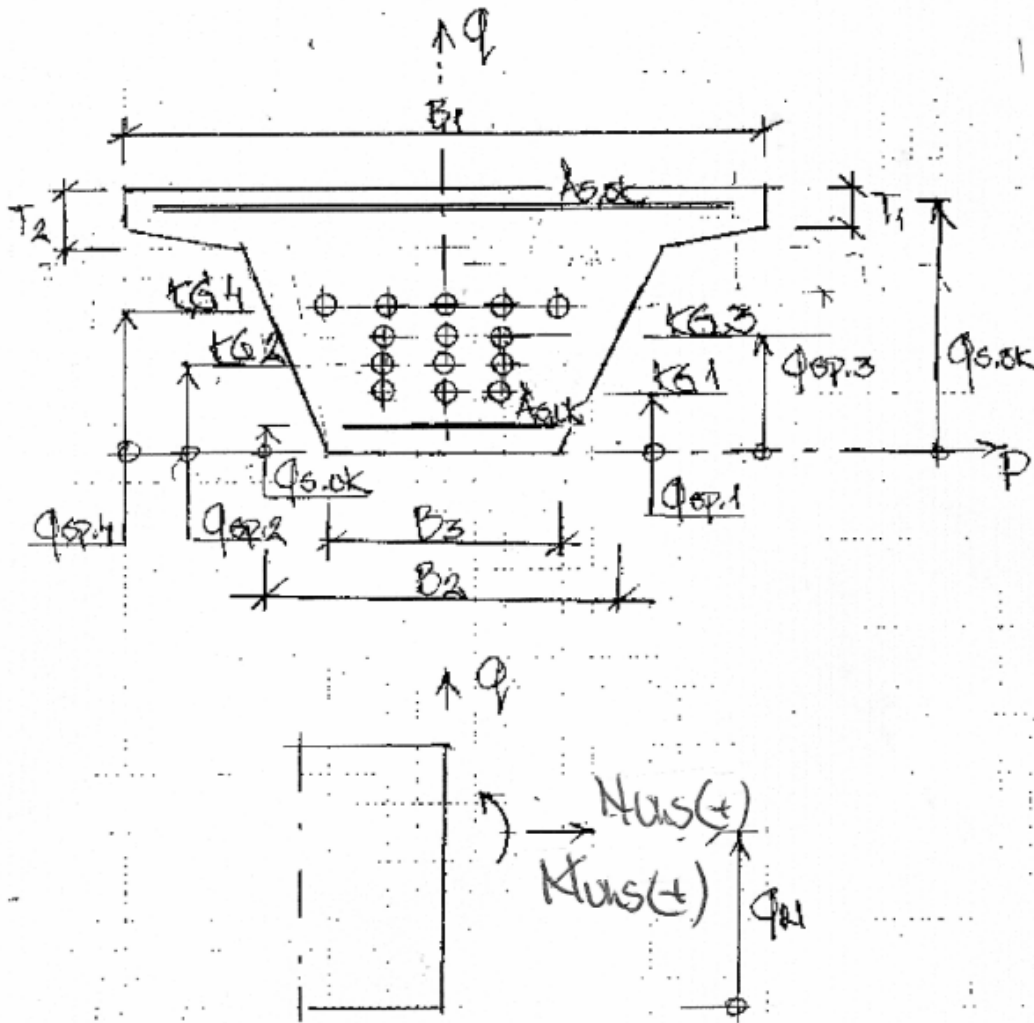


Object: Main girder - max/min moment

**PRINCIPLE SKETCH**



**INPUT****Concrete**

Resistance class (1:C30/37, 2:C35/45, 3:C40/50, 4:C45/55 or 5:C50/60):

$BTG := 2$

Material coefficient:

$\gamma_c := 1.50$  : ultimate state (ULS) see EC2-1-1 table 2.1N

Correction factors:

$\alpha_{cc} := 1.00$

$\alpha_{ct} := 1.00$

**Reinforcement**

Resistance class (1:Ks40, 2:B500B or 3:Ks60):

$TYP := 2$

Dimension (1: $\phi 10$ , 2:  $\phi 12$ , 3: $\phi 16$ , 4: $\phi 20$ , 5: $\phi 25$  or 6: $\phi 32$ ):

$DIM := 3$

Material coefficient :

$\gamma_s := 1.15$  : ultimate state (ULS) see EC2-1-1 table 3.1

**Prestress**

System:

1:BBRV 22 $\phi 6$ , 2:BBRV 32 $\phi 6$ , 3:BBRV 44 $\phi 6$ , 4:FREY 6  $\phi 13$ , 5:FREY 12 $\phi 13$ , 6:FREY 12 $\phi 16$ ,  
7:VSL 7 $\phi 13$ , 8:VSL 12 $\phi 13$ , 9:VSL 6-15, 10:Cona Multi 12 $\phi 13$ . 11:Cona Multi 12 $\phi 16$  or 12:CCL 13 $\phi 16$ .

$SYSTEM := 9$

Material coefficient :

$\gamma_{s,p} := 1.15$  : ultimate state (ULS) see EC2-1-1 table 3.1

**Factors stress-elongation for cross section design**

$\lambda := 0.80$  : see SS-EN 1992-1-1 eq. 3.19

$\eta := 1.00$  : see SS-EN 1992-1-1 eq. 3.20

**Input receipt****Concrete :**

$f_{ck} = 35.0 \text{ MPa}$      $f_{ctk_{0.05}} = 2.2 \text{ MPa}$      $f_{ctk_{0.95}} = 4.2 \text{ MPa}$      $\varepsilon_{cu} = 0.0035$      $E_{cm} = 34.1 \text{ GPa}$

**Reinforcement :**

$\phi = 16 \text{ mm}$      $f_{yk} = 500 \text{ MPa}$      $E_{sk} = 200 \text{ GPa}$

**Prestress :**

$f_{p0.1k} = 1640 \text{ MPa}$

$f_{pk} = 1860 \text{ MPa}$

$\varepsilon_{puk} := 3.5\%$

$E_p := 195 \cdot \text{GPa}$

$A_{sp} = 2250 \text{ mm}^2$

**Geometry**

s	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	H	T <sub>1</sub>	T <sub>2</sub>
0,5	7000	3000	2000	1500	250	300
0,5	7000	3000	2000	1500	250	300
3,8	7000	3000	2000	1500	250	300
7,0	7000	3000	2000	1500	250	300
10,3	7000	3000	2000	1500	250	300
13,5	7000	3000	2000	1500	250	300
16,8	7000	3000	2000	1500	250	300
20,0	7000	3000	2000	1500	250	300
20,0	7000	3000	2000	1500	250	300
23,3	7000	3000	2000	1500	250	300
26,5	7000	3000	2000	1500	250	300
m	mm	mm	mm	mm	mm	mm

Number of section:

$$Antal \equiv 11 \cdot st$$

**Reinforcement**

s	A <sub>s, uk</sub>	q <sub>s, uk</sub>	A <sub>s, ök</sub>	q <sub>s, ök</sub>
0,5	2011	76	7037	1424
0,5	2011	76	7037	1424
3,8	2011	76	7037	1424
7,0	2001	76	7037	1424
10,3	2011	76	7037	1424
13,5	2011	76	7037	1424
16,8	2011	76	7037	1424
20,0	2011	76	7037	1424
20,0	2011	76	7037	1424
23,3	2011	76	7037	1424
26,5	2011	76	7037	1424
m	mm <sup>2</sup>	mm	mm <sup>2</sup>	mm

$$A_{s, \text{ök}} := \frac{7000 \cdot \text{mm}}{200 \cdot \text{mm}} \cdot \pi \cdot \left( \frac{16 \cdot \text{mm}}{2} \right)^2 = 7037 \text{ mm}^2$$

$$A_{s, \text{UK}} := \frac{2000 \cdot \text{mm}}{200 \cdot \text{mm}} \cdot \pi \cdot \left( \frac{16 \cdot \text{mm}}{2} \right)^2 = 2011 \text{ mm}^2$$

**Pretension - zero elongation for each cable group**

s	$\epsilon_{p0,1}$	$\epsilon_{p0,2}$	$\epsilon_{p0,3}$	$\epsilon_{p0,4}$
0,5	1,00	1,00	0	0
0,5	1,00	1,00	0	0
3,8	1,00	1,00	0	0
7,0	1,00	1,00	0	0
10,3	1,00	1,00	0	0
13,5	1,00	1,00	0	0
16,8	1,00	1,00	0	0
20,0	1,00	1,00	0	0
20,0	1,00	1,00	0	0
23,3	1,00	1,00	0	0
26,5	1,00	1,00	0	0
m	%	%	%	%

**Pretension - number of cables in each cable group**

s	n <sub>1</sub>	n <sub>2</sub>	n <sub>3</sub>	n <sub>4</sub>
0,5	6	2	0	0
0,5	6	2	0	0
3,8	6	2	0	0
7,0	6	2	0	0
10,3	6	2	0	0
13,5	6	2	0	0
16,8	6	2	0	0
20,0	6	2	0	0
20,0	6	2	0	0
23,3	6	2	0	0
26,5	6	2	0	0
m	st	st	st	st

**Pretension - location of each cable group**

s	q <sub>sp.1</sub>	q <sub>sp.2</sub>	q <sub>sp.3</sub>	q <sub>sp.4</sub>
0,5	1200	780	0	0
0,5	1200	780	0	0
3,8	929	929	0	0
7,0	476	476	0	0
10,3	176	176	0	0
13,5	178	178	0	0
16,8	412	412	0	0
20,0	790	790	0	0
20,0	790	790	0	0
23,3	1182	1182	0	0
26,5	1350	1350	0	0
m	mm	mm	mm	mm

**Design forces ULS excluding parasite forces**

(N > 0 kN indicates "tension", see principle sketch. Distance to position of normal forces is denoted q<sub>N</sub>.)

s	M <sub>ULS.0</sub>	N <sub>ULS.0</sub>	q <sub>N</sub>
0,5	1550	-935	700
0,5	-1139	344	850
3,8	9271	556	930
7,0	15101	573	930
10,3	17780	202	930
13,5	17185	57	930
16,8	13688	950	930
20,0	7422	-1396	930
20,0	-5444	1559	930
23,3	-13345	1284	930
26,5	-24612	639	930
m	kNm	kN	mm

**Forces load case prestress including parasite forces**

(N &gt; 0 kN indicates "tension", see see principle sketch.)

s	M <sub>FÖRSP</sub>	N <sub>FÖRSP</sub>	$\psi\gamma$	Anm.
0,5	14728	-25084	1,35	PT-t0
0,5	12372	-21071	1,00	PT-t2
3,8	-1009	-18885	1,00	PT-t2
7,0	-6311	-19768	1,00	PT-t2
10,3	-12331	-19286	1,00	PT-t2
13,5	-14562	-23969	1,35	PT-t0
16,8	-7398	-19650	1,00	PT-t2
20,0	2912	-23204	1,35	PT-t0
20,0	2446	-19491	1,00	PT-t2
23,3	9490	-19492	1,00	PT-t2
26,5	14075	-19743	1,00	PT-t2
m	kNm	kN	-	-

**Forces in each cable group**

s	N <sub>sp.1</sub>	N <sub>sp.2</sub>	N <sub>sp.3</sub>	N <sub>sp.4</sub>
0,5	-18813	-6271	0	0
0,5	-15803	-5268	0	0
3,8	-14164	-4721	0	0
7,0	-14826	-4942	0	0
10,3	-14465	-4822	0	0
13,5	-17977	-5992	0	0
16,8	-14738	-4913	0	0
20,0	-17403	-5801	0	0
20,0	-14618	-4873	0	0
23,3	-14619	-4873	0	0
26,5	-14807	-4936	0	0
m	kN	kN	kN	kN

**Parasite forces**

(N &gt; 0 kN indicates "tension", see see principle sketch.)

$$N_{TV} = (N_{FÖRSP} - N_{sp,1} - N_{sp,2} - N_{sp,3} - N_{sp,4})$$

$$M_{TV} = M_{FÖRSP} - N_{sp,1} \cdot (Q_N - q_{sp,1}) - N_{sp,2} \cdot (Q_N - q_{sp,2}) - N_{sp,3} \cdot (Q_N - q_{sp,3}) - N_{sp,4} \cdot (Q_N - q_{sp,4})$$

s	M <sub>TV</sub>	N <sub>TV</sub>
0,5	4820	0
0,5	7209	0
3,8	-990	0
7,0	2664	0
10,3	2210	0
13,5	3463	0
16,8	2781	0
20,0	6161	0
20,0	5175	0
23,3	4578	0
26,5	5783	0
m	kNm	kN

**Design forces ULS including parasite forces**

$$N_{ULS} = N_{ULS,0} + \psi_T \cdot N_{TV}$$

$$M_{ULS} = M_{ULS,0} + \psi_T \cdot M_{TV}$$

s	M <sub>ULS</sub>	N <sub>ULS</sub>
0,5	8057	-935
0,5	6070	344
3,8	8281	556
7,0	17765	573
10,3	19990	202
13,5	21860	57
16,8	16469	950
20,0	15739	-1396
20,0	-269	1559
23,3	-8767	1284
26,5	-18829	639
m	kNm	kN

**CALCULATION**

Calculation according to SS-EN 1992-1-1 section 6.1.

**Design values concrete****Ultimate state ULS**

$$f_{cd} := \alpha_{cc} \cdot \frac{f_{ck}}{\gamma_c} = 23.3 \text{ MPa}$$

: see EC2-1-1 eq. 3.15

$$f_{ctd} := \alpha_{ct} \cdot \frac{f_{ctk_{0.05}}}{\gamma_c} = 1.5 \text{ MPa}$$

: see EC2-1-1 eq. 3.16

**Design values reinforcement****Ultimate state ULS**

$$f_{yd} := \frac{f_{yk}}{\gamma_s} = 435 \text{ MPa}$$

$$E_s := E_{sk} = 200 \text{ GPa}$$

**Design values pretension cables****Ultimate state ULS**

$$f_{pd} := \frac{f_{p0.1k}}{\gamma_s} = 1426 \text{ MPa}$$

$$f_{pud} := \frac{f_{pk}}{\gamma_{s,p}} = 1617 \text{ MPa}$$

$$\varepsilon_{pud} := 0.9 \cdot \varepsilon_{puk} = 0.032$$

$$\varepsilon_{py} := \frac{f_{pd}}{E_p} = 7.313 \cdot 10^{-3}$$

**RESULTS****Neutral axis, inner forces and lever arms**

s	x	q <sub>cc</sub>	d <sub>sc</sub>	d <sub>st</sub>	d <sub>sp.1</sub>	d <sub>sp.2</sub>	d <sub>sp.3</sub>	d <sub>sp.4</sub>	A <sub>c</sub>
0,5	181	1428	76	1424	300	720	1500	1500	1,013
0,5	190	1424	76	1424	300	720	1500	1500	1,061
3,8	194	1423	76	1424	571	571	1500	1500	1,084
7,0	200	1420	76	1424	1024	1024	1500	1500	1,122
10,3	202	1419	76	1424	1324	1324	1500	1500	1,133
13,5	201	1419	76	1424	1322	1322	1500	1500	1,127
16,8	204	1418	76	1424	1088	1088	1500	1500	1,142
20,0	183	1427	76	1424	710	710	1500	1500	1,023
20,0	713	295	76	1424	790	790	0	0	1,277
23,3	712	295	76	1424	1182	1182	0	0	1,275
26,5	701	290	76	1424	1350	1350	0	0	1,253
m	mm	mm	mm	mm	mm	mm	mm	mm	m <sup>2</sup>

**Inner forces**

s	F <sub>oc</sub>	F <sub>sc</sub>	F <sub>st</sub>	F <sub>sp.1</sub>	F <sub>sp.2</sub>	F <sub>sp.3</sub>	F <sub>sp.4</sub>
0,5	-23627	2856	874	19718	6825	0	0
0,5	-24767	2951	874	19693	6805	0	0
3,8	-25291	2992	874	20139	6713	0	0
7,0	-26179	3057	870	20845	6948	0	0
10,3	-26434	3060	874	21313	7104	0	0
13,5	-26299	3060	874	21321	7107	0	0
16,8	-26655	3060	874	20918	6973	0	0
20,0	-23863	2876	874	20446	6815	0	0
20,0	-29795	874	3060	19538	6513	0	0
23,3	-29760	874	3060	19718	6573	0	0
26,5	-29231	874	3060	19805	6602	0	0
m	kN	kN	kN	kN	kN	kN	kN

**Ultimate moment & moment capacity**

s	M <sub>u</sub>	M <sub>Rd</sub>		M <sub>ULS</sub>	η
0,5	10081	10762	>	8057	75%
0,5	9977	9779	>	6070	62%
3,8	14435	14162	>	8281	58%
7,0	27415	27134	>	17765	65%
10,3	36514	36416	>	19990	55%
13,5	36481	36453	>	21860	60%
16,8	29260	28796	>	16469	57%
20,0	18536	19230	>	15739	<b>82%</b>
20,0	16146	15156	>	269	2%
23,3	26580	25765	>	8767	34%
26,5	31268	30859	>	18829	61%
m	kNm	kNm		kNm	-