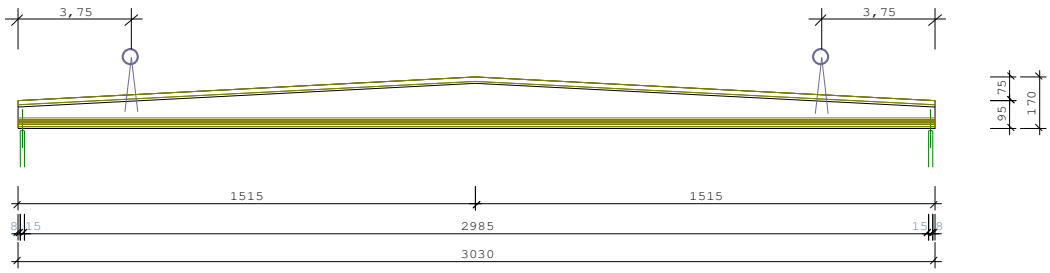
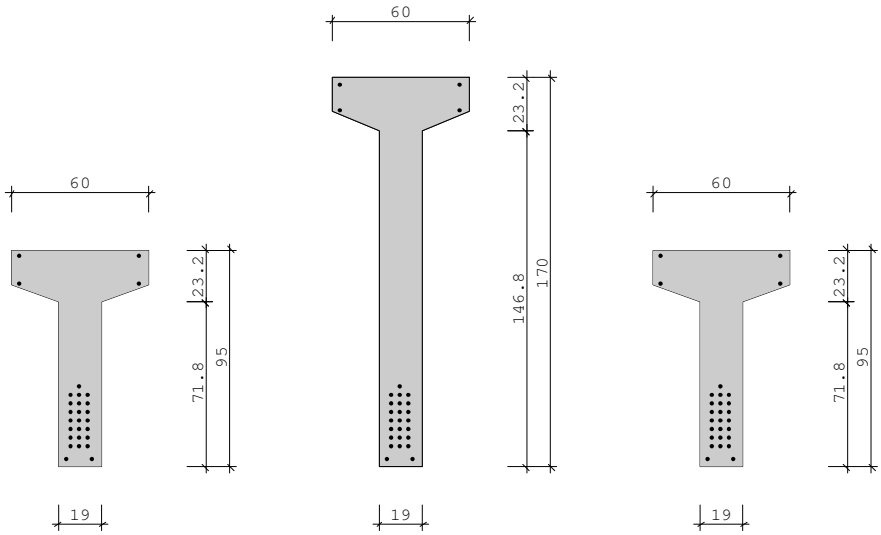
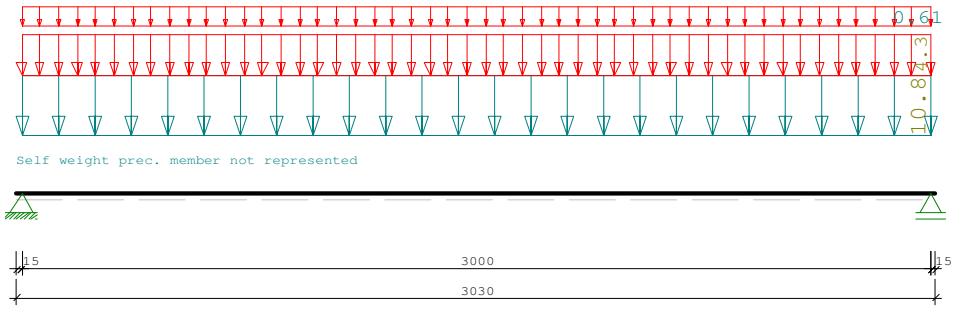
Position: FDB-Hd-2

Prestressed Concrete Girder B8 01/2017 (Frilo finalrelease)







System:

Double-pitch roof

Basics:
Load combinatorics: NA to BS EN 1990/A1:2009-06 + EN 1990:2002/AC:2010
ULS: Structural safety checks(STR)
permanent/variable design situation with equation 6.10 a,b

Design code: NA to BS EN 1992-1-1/A2:2015-07 + EN 1992-1-1:2004 /AC:2010
Prestressing for pretensioning

System Geometry:

Total	L	=	30.30	m	Effective	L1	=	30.00 m
Outstand left	L0	=	0.15	m	right	L2	=	0.15 m
Distance Ridge	L3	=	15.15	m				
Height beam :								
left	H1	=	95.0	cm	Ridge	H2	=	170.0 cm
right	H3	=	95.0	cm				

Relation eff.span to height of beam:
L1/H2 = 17.65

Attachment, distance from the beginning resp. end of beam:

Hook	L8	=	3.75	m	right	L9	=	3.75 m

Cross-section Precast :

Layer of cross-section from top to bottom

Nr	width [cm]	Distance [cm]	Remarks
1	60.0	0.0	
2	60.0	15.0	
3	19.0	23.2	web begin
4	19.0	170.0	web end

Web height over beam length constant

Material:

Prestressing steel

Make
Y1770S7 Strand 7 wires

	d_d	=	4.1	mm	d_p	=	12.3	mm
	E_p	=	195000	N/mm²	A_p	=	0.930	cm²
	$f_{p0.1k}$	=	1520	N/mm²	f_{pk}	=	1770	N/mm²
	ε_{uk}	=	35.0	‰	ε_{ud}	=	31.5	‰

Partial safety factor :
γ_s = 1.15

Coeff. prestress:

charact. value	r_{sup}	=	1.00		r_{inf}	=	1.00
Design value	$\gamma_{p,max}$	=	1.10		$\gamma_{p,min}$	=	0.90

Proof of crack width

Equ. diameter	d_{pV}	=	7.20	mm	ξ	=	0.60	(Tab. 6.2)

Relation class 2 (strands, wires, low relaxation)

σ_{p0}/f_{pk}	10 h	200 h	1000 h	500000h
0.60	0.1	0.2	0.4	2.5
0.70	0.3	0.7	1.0	3.9
0.80	1.2	1.9	2.4	6.1

- Losses in % by 3.3.2 (6), example process

Permitted stresses:

in formwork	σ_p	<=	1368.0	N/mm²	(0.90* $f_{p0.1k}$)
after anchor. release	σ_p	<=	1292.0	N/mm²	(0.85* $f_{p0.1k}$)
rare Lc	σ_p	<=	1327.5	N/mm²	(0.75* $f_{p0.1k}$)

Transmission length

	η_{p1}	=	3.20		η_1	=	1.00	
	α_1	=	1.00		α_2	=	0.19	
	σ_{pm0}	=	882	N/mm²				
PT:	f_{ctdt}	=	0.81	N/mm²	f_{bpt}	=	2.58	N/mm²
	l_{pt}	=	0.80	m				

Dispersion_length:
d = 0.95 m
l_{disp} = 1.24 m

Reinforcing steel:

Longitudinal				Stirrup $d_{s,b}$= 8 mm			
	B 500B				B 500B		
E_s	= 200000	N/mm²		E_s	= 200000	N/mm²	
f_{yk}	= 500	N/mm²		f_{yk}	= 500	N/mm²	
f_{tk}	= 540	N/mm²		f_{tk}	= 540	N/mm²	
ε_{uk}	= 50.0	‰		ε_{uk}	= 50.0	‰	
ε_{ud}	= 45.0	‰		ε_{ud}	= 45.0	‰	

Partial safety factor :

γ_s	= 1.15			γ_s	= 1.15		

permitted stresses in SLS :

σ_s	<= 400	N/mm²		σ_s	<= 400	N/mm²	(0.80 * f_{yk})

Durability:

	top				bottom		
attack on concrete	X0				X0		
attack on reinforc.	XC1				XC1		
min. concrete class	C 20/25				C 20/25		
stirrup	ϕ,l = 8	mm					
long. reinforcement	ϕ,m = 20	mm		ϕ,m = 16	mm		
prestressed steel	d_p = 12.3	mm	strand , s >=2.5* dp				
allowance in design	Δc_{dev} = 5	mm	*2	Δc_{dev} = 5	mm	*2	
stirrup	$c_{min,l}$ = 15	mm		$c_{min,l}$ = 15	mm		
concrete coverage	$c_{nom,l}$ = 20	mm		$c_{nom,l}$ = 20	mm		
longitudinal bars	$c_{min,m}$ = 20	mm	*5	$c_{min,m}$ = 16	mm	*5	
concrete coverage	$c_{nom,m}$ = 28	mm	*1	$c_{nom,m}$ = 28	mm	*1	
prestressing steel :	$c_{min,p}$ = 19	mm	*5	$c_{min,p}$ = 19	mm	*5	
concrete coverage	$c_{nom,p}$ = 28	mm	*1	$c_{nom,p}$ = 28	mm	*1	
laying dist. link	$c_{,l}$ = 20	mm		$c_{,l}$ = 20	mm		
all. crack width	w_{max} = 0.20	mm		w_{max} = 0.20	mm		
decompression	not req.			not req.			

*1:with cmin,l
*2: QA
*5: bond decisive

Concrete:

Precast

	C 50/60		
f_{ck}	= 50.00	N/mm²	
α_{cc}	= 0.85		
$f_{ctk0.05}$	= 2.85	N/mm²	
α_{ct}	= 1.00		
γ	= 25.00	kN/m³	unit
E_{cm}	= 37000	N/mm²	
α_E	= 1.00		Coefficient E-modulus
G_{cm}	= 14800	N/mm²	

Partial safety factor :

γ_c	= 1.35		

permitted stresses in SLS :

rare Lc	σ_c	>= -30.00	N/mm²		
q.perm.Lc	σ_c	>= -22.50	N/mm²		
Removal the anchor t= t0T(sto)= 5.1 d					
	$f_{cm(t)}$	= 44.43	N/mm²		
	$f_{ck(t)}$	= 36.43	N/mm²		
linear creep	σ_c	>= -16.39	N/mm²	(k2=0.45)	
maximum	σ_c	>= -25.50	N/mm²	(k6=0.70)	

Creep coeff. & shrinkage strain

Heat treatment in stressing mould
Tt0= 60 °C (until releasing the anchor)
teq= 4533 h (equivalent time difference for relaxation)
t0T= 5.1 d (according to temperature adjusted concrete age)
CementStrenght class 42,5R;52,5
ρ= 0.5 (Aging coefficient)
Reference point for t0 is the start of the concreting of the precast

Creep	t0 Days	LC %	tT1 Days	T1 °C	tT2 Days	T2 °C	tT3 Days	T3 °C
Storage	1	50						
Use precast	21	50						

L.	Segment	TQS	t0	t	α	$t_{0,eff}$ B.9	β_{t0} B.5	β_H B.8	$\beta_{c(t,t0)}$ B.7	ϕ_{RH} B.3	β_{fcm} B.4	$\phi(t,t0)$ B.1
1	Storage	PcC	1.0	21.0	1	10.2	0.59	463.7	0.38	1.47	2.21	0.74
2	Use precast	PcC	21.0	26000.0	1	10.2	0.59	463.7	0.61	1.47	2.21	1.17

L.	A [cm²]	U [cm]	h0 [cm]	$\beta_{ds}(t0,ts)$	$\beta_{ds}(t,ts)$ 3.10	β_{RH} B.12	$\varepsilon_{cd,0}$ B.11	β_{as} 3.13	ε_{ca}/10e6 3.12	$\varepsilon_{cs}(t,t0)$ [‰]
1	4013.10	446.8	179.7	0.000	0.172	1.36	536.0	0.60	100.00	0.141
2	4013.10	446.8	179.7	0.172	0.996	1.36	536.0	1.00	100.00	0.430

Loads:

Self weight

Beam left g11 = 6.47 kN/m
Ridge g12 = 10.03 kN/m
Beam right g13 = 6.47 kN/m

Total G = 250.1 kN
Volume V = 10.00 m³
Surf. A = 95.00 m²

Loads during usage

Units: concentrated load[kN] concentrated moment[kNm] line load[kN/m]

span	type	gle	qle	Dist. a [m]	gri	qri	Length [m]	Fact	Ew.	Sim.	Pos.
1	1	10.80	4.30					1.00	10	0	
1	1	0.00	0.61					1.00	9	0	

Load types: 1 = uniformly distr., 2 = single load at a, 3 = single moment at a
4 = trapezoidal load from a, 5 = triangle load over L

Actions:

Ew.	γ_Q	ψ_0	ψ_1	ψ_2	Dep.	Cat.	Description
9	1.50	0.50	0.20	0.00	0	W	Wind loads
10	1.50	0.50	0.20	0.00	0	S	Snow loads <1000m

Tendons:

Dist(BO) > 3.5 cm axis horizontal > 4.3 cm vertical > 3.7 cm

lay. No.	num-ber	area Ap [cm²]	Dist. bott. Yp [cm]	Prestressing $\sigma_p^{(0)}$ [N/mm²]	Count	<--- Isolations ---> to x1 [m]	from x2 [m]	Type ||
1	3	2.79	8.5	1000	0			UK
2	3	2.79	12.3	1000	0			UK
3	3	2.79	16.1	1000	0			UK
4	3	2.79	19.9	1000	0			UK
5	3	2.79	23.7	1000	0			UK
6	3	2.79	27.5	1000	0			UK
7	3	2.79	31.3	1000	0			UK

lay. No.	number	area Ap [cm²]	Dist. bott. Yp [cm]	Prestressing $\sigma_p^{(0)}$ [N/mm²]	Count	<--- Isolations ---> to x1 [m]	from x2 [m]	Type ||
8	1	0.93	35.1	1000	0			UK

x1 and x2 with respect to the left beginning from joint
The calculation of the losses due to creep, shrinkage and relaxation following the method from Abelein

Untensioned reinforcement:

Layer No.	number	diam. Φs,l [mm]	area As [cm²]	Dist. bott. Ys [cm]	effective range from xA [m]	to xE [m]	Type ||
1	2	16	4.02	3.5	0.00	30.30	UK
2	2	20	6.28	166.5	0.00	30.30	OK
3	2	20	6.28	155.0	0.00	30.30	OK

xA and xE with respect to the left beginning from joint

Surface reinforcement acc.to Tab. NA.J.41 (B0 < D0) :

Web (Z1/S3) AsS = 1.24 cm²/m (UwkS <= XC4) (per side)
Top flange (Z3/S1) AsO = 0.00 cm²/m (UwkS <= XC4)

Settings for shear resistance check

Bearing width, distance bearing edge, effective height of the bearing line
left bAl = 0.15 m al = 0.07 m dAl = 0.92 m
right bAr = 0.15 m ar = 0.07 m dAR = 0.92 m
For shear reinforcement not decisive ranges over support A and B:
xaRe=0.99 m direct bearing (width of bearing/2 + eff. depth)
xbLi=0.99 m direct bearing (width of bearing/2 + eff. depth)

Deflection check:

Total deflection	fGes <= L/ 250		Increase deflection	fZuw <= L/ 500	
Cantilever left	f <= 0.1	cm		f <= 0.1	cm
Span	f <= 12.0	cm		f <= 6.0	cm
Cantilever right	f <= 0.1	cm		f <= 0.1	cm

quasi- permanent combination and eff. char. prestress
Deflection due to shrinkage considered
Tension stiffening: Member rigidity, rare combination

RESULTS (summary)

Reaction forces (t = infinitely):
(kN, G:perm., Q:variable. ,V: Sum)

	<------char. value-----> G	min Q	max Q	<--ULS(PT)----> min V	max V
A (left)	287.01	0.00	73.65	287.01	462.02
B (right)	287.01	0.00	73.65	287.01	462.02

Reactions by components, char. values

	LC	left [kN]	right [kN]	grp.	act.
G1	Sto->IF	0.98	-0.00	1	-
G1	Sto->IF	124.04	124.04	2	-
G1	Sto->IF	-0.00	0.98	3	-
G1M	Ere	28.01	-2.09	4	-
G1M	Ere	99.11	99.10	5	-
G1M	Ere	-2.09	28.01	6	-
G2	Use->IF	162.00	162.00	7	-
Q	Use->IF	64.50	64.50	0	10
Q	Use->IF	9.15	9.15	0	9

max. bending moment in erection state(char. value):
MF = 2763.72 kNm at x = 15.15 m

Checks are not complied with:			
Crack MinAs+AsDuc bottom	AsMin = 6.70 cm2	Util=	1.67
Increase-deflection(serv)	|df| = 6.49 cm	Util=	1.08
Prc.: Compression t0(sto)	σc =- 27.29 N/mm2	Util=	1.07
σc < -0.70*fck(t)= 25.50 N/mm2			

Measures:
sufficient stirrup in the pressure zone(7.2 (2))
or increasing the initial strength
(tensioning later, concrete class, cement selection,
specify in particular technological measures fcm(t0) predef.)

Warning:
Prc.: Compression t0(sto) σc =- 23.83 N/mm2
σc < 0.45*fck(t)=- 16.39 N/mm2
_disproport. creep by increased creep considered(fk= 1.36)

Required shear reinforcement:
Column A: asw= 4.96 cm2/m
Column B: asw= 4.96 cm2/m

Bursting reinforcementleft	Laying length= 0.93 m
ab x= 0.00 m As = 5.30 cm2	

Bursting reinforcementright	Laying length= 0.93 m
from x= 30.30 m As = 5.30 cm2	

Check of anchorage
left : Resisting tens force in anchorage range Util= 0.98
right : Resisting tens force in anchorage range Util= 0.98

Overview crit. sections

Selected basic grid: Ns = 10

Checkvalue	Extrem	Utilisatio	n	x[m]
Flexural capacity bottom	η = 1.19	0.84		11.49
Flexural capacity top	η = 7.35	0.14		3.75
Resisting tens force bot	η = 1.02	0.98		0.15
Resisting tens force top	η = 7.35	0.14		3.75
Prc.: Compression t0(sto)	σc =- 27.29 N/mm2	1.07		3.75
Prc.: Compression rare Lc	σc = -22.10 N/mm2	0.74		3.75
Tens. str. prestr. steel	σp,Sk = 1069 N/mm2	0.81		11.11
Stress in reinforcement	σs = 143.6 N/mm2	0.36		10.81
Crack MinAs+AsDuc bottom	AsMin = 6.70 cm2	1.67		15.15 !!!
Crack MinAs+AsDuc top	AsMin = entf.	-----		0.00
Crack width bottom	wk = 0.08 mm	0.42		11.15
Crack width top	wk = 0.15 mm	0.75		3.75
Deflection top	ft = -2.55 cm	0.21		16.83
Deflection bottom	fb = 7.75 cm	0.65		13.47
Increase-deflection(serv)	|df| = 6.49 cm	1.08		13.47 !!!
Prc.: Shear reinf (web)	asw = 4.96 cm2/m	1.00		1.14
Concrete strut capacity	η = 1.79	0.56		0.22
Linear creep limit, informative:				
Prc.: Compression t0(sto)	σc =- 23.83 N/mm2	1.45		29.64
Prc.: Compression q-pe Lc	σc = -18.67 N/mm2	0.83		29.38
Tensile stress state I, informative:				
Prc.: Tens. str (Is)	σc = 9.68 N/mm2	Zu.II		10.14
Prc.: Tens. str (Sc)	σc = 3.24 N/mm2	Zu.II		29.64

---- Check not required
**** Check not fulfilled

Overview crit. sections

Selected basic grid: Ns = 10

Checkvalue	Extrem	Utilisatio	n	x[m]

Prc.: Precast component Add.: in-situ supplement
Is : Installed state Sc : State of construction
AsDuk:Ductility reinforcement

Internal forces [kN,kNm]

	<-----extern loads PT---- ->				<----prestress unstressed state-->				
x	Min	Max	Min	Max	Storage ,tB		Use ,tE		Pre
[m]	My	My	Qz	Qz	Nv	Mv	Nv	Mv	Grd
0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
0.15	-0.1	-0.1	-1.3	-1.0	-394.7	-148.9	41.3	-32.3	2.51
0.15	-0.1	0.4	-1.3	460.8	-401.7	-151.6	38.0	-33.6	2.47
0.22	-0.2	32.1	-1.9	458.8	-621.2	-235.6	-72.7	-76.9	1.91
1.14	-5.8	442.1	-10.2	432.4	-1956.7	-791.8	-1176.5	-561.0	2.62
1.24	-6.8	485.2	-11.1	429.5	-1956.7	-797.2	-1183.1	-569.9	2.43
3.37	-51.7	1334.2	-31.3	367.5	-1956.7	-911.3	-1287.6	-742.6	1.13
3.75	-64.3	1471.7	98.4	356.2	-1956.7	-931.5	-1298.6	-769.8	1.06
6.73	197.4	2400.7	75.4	266.8	-1956.7	-1088.6	-1359.4	-966.5	0.81
10.10	406.7	3125.0	46.9	162.5	-1956.7	-1264.0	-1390.7	-1155.8	0.74
11.15	451.9	3278.3	37.5	129.3	-1956.7	-1318.2	-1395.1	-1208.1	0.74
13.47	515.6	3492.3	15.8	54.9	-1956.7	-1437.4	-1398.1	-1313.1	0.75
15.15	529.6	3538.5	-0.7	0.7	-1956.7	-1523.3	-1395.9	-1380.5	0.78
16.83	515.6	3492.3	-54.9	-15.8	-1956.7	-1437.4	-1398.1	-1313.1	0.75
20.20	406.7	3125.0	-162.5	-46.9	-1956.7	-1264.0	-1390.7	-1155.8	0.74
23.57	197.4	2400.7	-266.8	-75.4	-1956.7	-1088.6	-1359.4	-966.5	0.81
26.55	-64.3	1471.7	-356.2	35.0	-1956.7	-931.5	-1298.6	-769.8	1.06
26.93	-51.7	1334.2	-367.5	31.3	-1956.7	-911.3	-1287.6	-742.6	1.13
29.06	-6.8	485.2	-429.5	11.1	-1956.7	-797.2	-1183.1	-569.9	2.43
29.38	-3.7	346.3	-438.8	8.2	-1956.7	-780.0	-1111.1	-517.8	2.82
29.64	-1.9	231.2	-446.2	5.8	-1956.7	-765.9	-782.4	-354.7	1.85
30.15	-0.1	0.4	-460.8	1.3	-401.7	-151.6	38.0	-33.6	2.47
30.15	-0.1	-0.1	1.0	1.3	-394.7	-148.9	41.3	-32.3	2.51
30.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

	<- rare Lc->		<- freq. Lc->		<q.- perm. Lc>	
x	Min	Max	Min	Max	Min	Max
[m]	My	My	My	My	My	My
0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.15	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
0.15	-0.1	0.3	-0.1	0.3	-0.1	0.2
0.22	-0.2	24.7	-0.2	20.8	-0.2	19.9
1.14	-4.3	340.7	-4.3	286.9	-4.3	274.6
1.24	-5.1	373.9	-5.1	314.9	-5.1	301.4
3.37	-38.3	1028.5	-38.3	867.0	-38.3	829.9
3.75	-47.6	1134.5	-47.6	956.6	-47.6	915.7
6.73	214.0	1851.1	214.0	1562.5	214.0	1496.3
10.10	423.4	2410.1	423.4	2036.5	423.4	1950.7
11.15	468.5	2528.4	468.5	2137.1	468.5	2047.2
13.47	532.3	2693.7	532.3	2277.7	532.3	2182.1
15.15	546.3	2729.4	546.3	2308.1	546.3	2211.3
16.83	532.3	2693.7	532.3	2277.7	532.3	2182.1
20.20	423.4	2410.1	423.4	2036.5	423.4	1950.7
23.57	214.0	1851.1	214.0	1562.5	214.0	1496.3
26.55	-47.6	1134.5	-47.6	956.6	-47.6	915.7
26.93	-38.3	1028.5	-38.3	867.0	-38.3	829.9
29.06	-5.1	373.9	-5.1	314.9	-5.1	301.4
29.38	-2.8	266.9	-2.8	224.7	-2.8	215.0
29.64	-1.4	178.2	-1.4	150.0	-1.4	143.6
30.15	-0.1	0.3	-0.1	0.3	-0.1	0.2
30.15	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
30.30	0.0	0.0	0.0	0.0	0.0	0.0

	<Flex. capacity->				<-----resisting tensile force--------->				
						Offset	al = Cot(Θ) * z/2		
x[m]	η un	η to	η bo	σl/σR	al	η to	σl/σR	a	l [m]
0.08	----	----	----	0.00#	---	+422.8	0.00#	43	
0.15	----	----	----	0.00#	---	+322.2	0.00#	43	
0.15	----	----	+1.02	0.00#	104	+320.2	0.00#	43	
0.22	+64.4	----	+1.28	0.00#	104	+244.7	0.00#	43	
0.31	+28.5	----	+1.60	0.00#	105	+180.6	0.00#	44	
0.32	+26.8	----	+1.63	0.00#	105	+176.8	0.00#	44	
0.45	+15.5	+537.2	+2.01	0.00#	105	+109.7	2.87*!	44	
0.61	+10.3	+246.9	+2.39	0.00#	106	+79.1	3.95*!	44	
0.92	+6.33	+104.2	+2.89	0.00#	108	+47.3	4.21*!	45	
1.22	+4.72	+61.3	+2.59	1.60#	110	+32.3	4.26*!	46	
1.24	+4.65	+59.3	+2.57	1.59#	110	+31.5	4.26*!	46	
1.53	+3.80	+39.3	+2.33	1.16#	111	+22.3	4.32*!	47	
1.84	+3.18	+27.4	+2.13	1.04#	113	+16.5	4.39*!	47	
3.37	+1.96	+8.90	+1.59	6.19*!	122	+8.40	4.83*!	51	
3.75	+1.81	+7.35	+1.54	7.76*!	165	+7.35	4.96*!	94	
6.73	+1.32	----	+1.27	15.33*!	89	----	0.02#	---	
10.10	+1.19	----	+1.19	17.34*!	71	----	0.00#	---	
13.47	+1.23	----	+1.22	15.56*!	79	----	0.00#	---	
16.83	+1.23	----	+1.23	15.56*!	79	----	0.00#	---	
20.20	+1.19	----	+1.19	17.34*!	71	----	0.00#	---	
23.57	+1.32	----	+1.27	15.33*!	89	----	0.02#	---	
26.55	+1.81	+7.35	+1.54	7.76*!	165	+7.35	4.96*!	52	
26.93	+1.96	+8.90	+1.59	6.19*!	122	+8.41	4.83*!	51	
28.46	+3.18	+27.4	+2.13	1.04#	113	+16.5	4.39*!	47	
28.77	+3.80	+39.3	+2.33	1.16#	111	+22.3	4.32*!	47	
29.06	+4.65	+59.4	+2.57	1.59#	110	+31.5	4.26*!	46	
29.08	+4.72	+61.3	+2.59	1.60#	110	+32.3	4.26*!	46	
29.38	+6.33	+104.3	+2.89	0.00#	108	+47.3	4.21*!	45	
29.69	+10.3	+247.2	+2.39	0.00#	106	+79.2	3.95*!	44	
29.85	+15.5	+538.0	+2.01	0.00#	105	+109.9	2.87*!	44	
29.98	+26.8	----	+1.63	0.00#	105	+177.0	0.00#	44	
29.99	+28.5	----	+1.60	0.00#	105	+180.8	0.00#	44	
30.08	+64.4	----	+1.28	0.00#	104	+245.0	0.00#	43	
30.15	----	----	+1.02	0.00#	104	+320.6	0.00#	43	
30.15	----	----	----	0.00#	---	+322.6	0.00#	43	
30.22	----	----	----	0.00#	---	+423.4	0.00#	43	

---- Check not required
**** Check not fulfilled
#:Main tens.stress σl #!: σl > fctk0.05
*:Edge tens. str. σR *!: σR > fctk0.05

Concrete stress precast [N/mm2]

x[m]	σc,1 Sto.	σc,2 Sto/Ere	σc Rc	σc Qc	σt Is	σt Sc
0.08	-2.20	-2.20	-1.29	-1.29	+1.12	+0.44
0.15	-4.95	-4.95	-3.82	-3.82	+1.07	+0.86
0.15	-5.03	-5.04	-3.90	-3.89	+1.07	+0.87
0.49	-17.41	-20.12	-15.24	-15.24	+1.51	+2.51
0.62	-23.11	-25.65	-15.26	-15.26	+1.69	+3.16
0.66	-23.83	-26.57	-15.55	-15.55	+1.65	+3.24
0.92	-21.94	-26.54	-18.91	-18.67	+0.67	+2.83
1.00	-21.70	-26.54	-19.84	-18.41	+0.38	+2.71
1.24	-20.98	-26.53	-20.07	-17.87	------	+2.36
3.37	-15.99	-27.09	-21.88	-13.85	+0.82	+4.68
3.75	-15.31	-27.29	-22.10	-13.25	+2.02	+4.78
6.73	-11.51	-17.59	-15.99	-9.92	+7.91	+2.28
10.10	-9.48	-14.30	-15.66	-10.65	+9.68	+1.03
13.47	-8.85	-12.78	-14.36	-9.68	+8.58	+0.81
15.15	-8.88	-12.46	-12.92	-8.72	+7.39	+0.96
16.83	-8.85	-12.78	-14.36	-9.68	+8.58	+0.81
20.20	-9.48	-14.30	-15.66	-10.65	+9.68	+1.03
23.57	-11.51	-17.59	-15.99	-9.92	+7.91	+2.28
26.55	-15.31	-27.29	-22.10	-13.25	+2.02	+4.78

Concrete stress precast [N/mm2]

x[m]	σc,1 Sto.	σc,2 Sto/Ere	σc Rc	σc Qc	σt Is	σt Sc
26.93	-15.99	-27.09	-21.88	-13.85	+0.82	+4.68
29.06	-20.98	-26.53	-20.07	-17.87	------	+2.36
29.30	-21.70	-26.54	-19.84	-18.41	+0.38	+2.71
29.38	-21.94	-26.54	-18.91	-18.67	+0.67	+2.83
29.64	-23.83	-26.57	-15.55	-15.55	+1.65	+3.24
29.68	-23.11	-25.65	-15.26	-15.26	+1.69	+3.16
29.81	-17.41	-20.12	-15.24	-15.24	+1.51	+2.51
30.15	-5.03	-5.04	-3.90	-3.89	+1.07	+0.87
30.15	-4.95	-4.95	-3.82	-3.82	+1.07	+0.86
30.22	-2.20	-2.20	-1.29	-1.29	+1.12	+0.44

---- Check not required
**** Check not fulfilled
σc,1 : Disproportional creeping check with early strength (supp.)
σc,2 : Compressive stress check with early strength (bear./erect.)
σc,SK: Compression check rare load combination
σc,QK: Disproportional creep check quasi-perm. load case
σt,EZ: Tensile stresses,Installed state,Rare load combination (informative)
σt,BZ: Tensile stresses,Stage of construction, Rare load combination (informative)

Tensile stresses steel [N/mm2]

x[m]	σp,Sk	σs,Sk
0.08	+79.0	+1.5
0.15	+178.0	+3.3
0.15	+181.2	+3.4
0.83	+901.4	+53.8
1.24	+900.1	+57.4
3.37	+899.3	+82.1
3.75	+900.1	+87.8
6.73	+985.8	+47.3
10.10	+1065.5	+140.7
11.15	+1068.7	+143.4
13.47	+1047.8	+116.1
16.83	+1047.8	+116.1
20.20	+1065.5	+140.7
23.57	+985.8	+47.3
26.55	+900.1	+87.8
26.93	+899.3	+82.1
29.06	+900.1	+57.4
29.47	+901.4	+53.8
30.15	+181.2	+3.4
30.15	+178.0	+3.3
30.22	+79.0	+1.5

---- Check not required
**** Check not fulfilled
Limit tens check rare load combination

Crack check width

x[m]	<As(Min,Duc)[cm2]> botto	m top	res.	<Crack width[mm]-> botto	m top	res.	<Dec.: σDc[N/mm2]> botto	m top	res.
0.15	+3.71	----		----	----				
0.15	+3.71	----		----	----				
0.45	+3.77	----		----	+0.04				
1.24	+3.93	----		----	+0.07				
3.37	+4.35	----		----	+0.13				
3.75	+4.43	----		----	+0.15				
6.73	+5.02	----		+0.05	----				
10.10	+5.69	----		+0.08	----				
11.15	+5.90	----		+0.08	----				
13.47	+6.36	----		+0.07	----				
15.15	+6.70	----		+0.06	----				

Crack check width

x[m]	<As(Min,Duc)[cm2]> botto	m top	res.	<Crack width[mm]-> botto	m top	res.	<Dec.: σDc[N/mm2]> botto	m top	res.
16.83	+6.36	----		+0.07	----				
20.20	+5.69	----		+0.08	----				
23.57	+5.02	----		+0.05	----				
26.55	+4.43	----		----	+0.15				
26.93	+4.35	----		----	+0.13				
29.06	+3.93	----		----	+0.07				
29.85	+3.77	----		----	+0.04				
30.15	+3.71	----		----	----				
30.15	+3.71	----		----	----				

---- Check not required
**** Check not fulfilled
Min: Min reinforce width crack
Duk: Ductility reinforce acc. to 9.2.1.1
Decompression:
bttm.: not required
top : not required
Crack width:
bttm.: wmax= 0.20 mm Frequent load combination
top : wmax= 0.20 mm Frequent load combination

Deflection

Deflection check:

permiss.:	per ftot = L/ 250	per fincr= L/ 500
Cantilever left	0.1 cm	0.1cm
Span	12.0 cm	6.0cm
Cantilever right	0.1 cm	0.1cm

quasi- permanent combination and eff. char. prestress
Deflection due to shrinkage considered
Tension stiffening: Member rigidity, rare combination

x[m]	Storage f(tB)	Storage f(tE)	Use f(tB)	Use f(tE)	df	[cm]
0.00	+0.0	+0.1	+0.0	-0.1	-0.1	
3.37	-0.9	-1.3	+0.2	+2.5	+2.3	
6.73	-1.4	-2.0	+0.7	+5.1	+4.4	
10.10	-1.7	-2.4	+1.1	+6.9	+5.8	
13.47	-1.8	-2.5	+1.3	+7.8	+6.5	
16.83	-1.8	-2.5	+1.3	+7.8	+6.5	
20.20	-1.7	-2.4	+1.1	+6.9	+5.8	
23.57	-1.4	-2.0	+0.7	+5.1	+4.4	
26.93	-0.9	-1.3	+0.2	+2.5	+2.3	
30.30	+0.0	+0.1	+0.0	-0.1	-0.1	

x [m]	h [cm]	Ii [m4]	yui [cm]
0.00	0.0	0.000000	0.0
3.37	111.7	0.038227	67.2
6.73	128.3	0.056496	76.2
10.10	145.0	0.079505	85.2
13.47	161.7	0.107653	94.1
16.83	161.7	0.107653	94.1
20.20	145.0	0.079505	85.2
23.57	128.3	0.056496	76.2
26.93	111.7	0.038227	67.2
30.30	0.0	0.000000	0.0

Creep period		Storage	t=tB , εcs(t0,t)= 0.0000 o/oo								
x [m]	ϕ t,t0	kϕ	NEd [kN]	MEd,Qk [kNm]	Sx1 [cm3]	ε1 o/oo	ε2s o/oo	X02 [cm]	Sx2 [cm3]	MEd,Sk [kNm]	ε2s [o/oo]
0.00	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00
3.37	0.00	1.00	-1957	-547.0	0	0.00	0.00	0.0	0	-547.0	0.00
6.73	0.00	1.00	-1957	-424.5	0	0.00	0.00	0.0	0	-424.5	0.00
10.10	0.00	1.00	-1957	-390.5	0	0.00	0.00	0.0	0	-390.5	0.00
13.47	0.00	1.00	-1957	-455.1	0	0.00	0.00	0.0	0	-455.1	0.00
16.83	0.00	1.00	-1957	-455.1	0	0.00	0.00	0.0	0	-455.1	0.00
20.20	0.00	1.00	-1957	-390.5	0	0.00	0.00	0.0	0	-390.5	0.00
23.57	0.00	1.00	-1957	-424.5	0	0.00	0.00	0.0	0	-424.5	0.00
26.93	0.00	1.00	-1957	-547.0	0	0.00	0.00	0.0	0	-547.0	0.00
30.30	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00

x [m]	Mcr [kNm]	σs [MPa]	σsr [MPa]	ζ	ρM1 [1/km]	ρM2 [1/km]	ρM [1/km]	ρS1 [1/km]	ρS2 [1/km]	ρS [1/km]
0.00	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000
3.37	-897.7	0	0	0.00	-0.387	0.000	-0.387	0.000	0.000	0.000
6.73	-1069.2	0	0	0.00	-0.203	0.000	-0.203	0.000	0.000	0.000
10.10	-1244.5	0	0	0.00	-0.133	0.000	-0.133	0.000	0.000	0.000
13.47	-1423.7	0	0	0.00	-0.114	0.000	-0.114	0.000	0.000	0.000
16.83	-1423.7	0	0	0.00	-0.114	0.000	-0.114	0.000	0.000	0.000
20.20	-1244.5	0	0	0.00	-0.133	0.000	-0.133	0.000	0.000	0.000
23.57	-1069.2	0	0	0.00	-0.203	0.000	-0.203	0.000	0.000	0.000
26.93	-897.7	0	0	0.00	-0.387	0.000	-0.387	0.000	0.000	0.000
30.30	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000

Creep period		Storage	t=tE , εcs(t0,t)= -0.1412 o/oo								
x [m]	ϕ t,t0	kϕ	NEd [kN]	MEd,Qk [kNm]	Sx1 [cm3]	ε1 o/oo	ε2s o/oo	X02 [cm]	Sx2 [cm3]	MEd,Sk [kNm]	ε2s [o/oo]
0.00	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00
3.37	0.74	1.80	-1727	-467.7	766	0.00	0.00	0.0	0	-467.7	0.00
6.73	0.74	1.81	-1750	-351.8	892	0.00	0.00	0.0	0	-351.8	0.00
10.10	0.74	1.82	-1763	-317.6	1015	0.00	0.00	0.0	0	-317.6	0.00
13.47	0.74	1.81	-1769	-375.4	1133	0.00	0.00	0.0	0	-375.4	0.00
16.83	0.74	1.81	-1769	-375.4	1133	0.00	0.00	0.0	0	-375.4	0.00
20.20	0.74	1.82	-1763	-317.6	1015	0.00	0.00	0.0	0	-317.6	0.00
23.57	0.74	1.81	-1750	-351.8	892	0.00	0.00	0.0	0	-351.8	0.00
26.93	0.74	1.80	-1727	-467.7	766	0.00	0.00	0.0	0	-467.7	0.00
30.30	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00

x [m]	Mcr [kNm]	σs [MPa]	σsr [MPa]	ζ	ρM1 [1/km]	ρM2 [1/km]	ρM [1/km]	ρS1 [1/km]	ρS2 [1/km]	ρS [1/km]
0.00	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000
3.37	-833.4	0	0	0.00	-0.594	0.000	-0.594	0.027	0.000	0.027
6.73	-1003.0	0	0	0.00	-0.305	0.000	-0.305	0.021	0.000	0.021
10.10	-1174.8	0	0	0.00	-0.196	0.000	-0.196	0.017	0.000	0.017
13.47	-1349.4	0	0	0.00	-0.171	0.000	-0.171	0.014	0.000	0.014
16.83	-1349.4	0	0	0.00	-0.171	0.000	-0.171	0.014	0.000	0.014
20.20	-1174.8	0	0	0.00	-0.196	0.000	-0.196	0.017	0.000	0.017
23.57	-1003.0	0	0	0.00	-0.305	0.000	-0.305	0.021	0.000	0.021
26.93	-833.4	0	0	0.00	-0.594	0.000	-0.594	0.027	0.000	0.027
30.30	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000

Creep period Use precast t=tB , εcs(t0,t)= -0.1412 o/oo

x [m]	ϕ t,t0	kϕ	NEd [kN]	MEd,Qk [kNm]	Sx1 [cm3]	ε1 o/oo	ε2s o/oo	X02 [cm]	Sx2 [cm3]	MEd,Sk [kNm]	ε2s [o/oo]
0.00	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00
3.37	0.74	182.18	-1727	-2.1	766	0.00	0.00	0.0	0	-2.1	0.00
6.73	0.74	0.41	-1750	480.4	892	0.00	0.00	0.0	0	480.4	0.00
10.10	0.74	0.66	-1763	759.7	1015	-0.50	0.23	96.5	0	759.7	0.23
13.47	0.74	0.63	-1769	824.4	1133	0.00	0.00	0.0	0	824.4	0.00
16.83	0.74	0.63	-1769	824.4	1133	0.00	0.00	0.0	0	824.4	0.00
20.20	0.74	0.66	-1763	759.7	1015	-0.50	0.23	96.5	0	759.7	0.23
23.57	0.74	0.41	-1750	480.4	892	0.00	0.00	0.0	0	480.4	0.00
26.93	0.74	182.18	-1727	-2.1	766	0.00	0.00	0.0	0	-2.1	0.00
30.30	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00

x [m]	Mcr [kNm]	σs [MPa]	σsr [MPa]	ζ	ρM1 [1/km]	ρM2 [1/km]	ρM [1/km]	ρS1 [1/km]	ρS2 [1/km]	ρS [1/km]
0.00	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000
3.37	-833.4	0	0	0.00	-0.265	0.000	-0.265	0.027	0.000	0.027
6.73	685.4	0	0	0.00	0.093	0.000	0.093	0.021	0.000	0.021
10.10	824.9	47	62	0.00	0.170	0.518	0.170	0.017	0.000	0.017
13.47	970.4	0	0	0.00	0.130	0.000	0.130	0.014	0.000	0.014
16.83	970.4	0	0	0.00	0.130	0.000	0.130	0.014	0.000	0.014
20.20	824.9	47	62	0.00	0.170	0.518	0.170	0.017	0.000	0.017
23.57	685.4	0	0	0.00	0.093	0.000	0.093	0.021	0.000	0.021
26.93	-833.4	0	0	0.00	-0.265	0.000	-0.265	0.027	0.000	0.027
30.30	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000

Creep period Use precast t=tE , εcs(t0,t)= -0.5711 o/oo

x [m]	ϕ t,t0	kϕ	NEd [kN]	MEd,Qk [kNm]	Sx1 [cm3]	ε1 o/oo	ε2s o/oo	X02 [cm]	Sx2 [cm3]	MEd,Sk [kNm]	ε2s [o/oo]
0.00	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00
3.37	1.90	-2.70	-1288	87.3	766	0.00	0.00	0.0	0	285.8	0.00
6.73	1.90	1.57	-1359	529.7	892	-0.66	0.28	87.6	-425	884.6	0.96
10.10	1.90	1.81	-1391	794.9	1015	-0.75	0.53	83.0	155	1254.3	1.33
13.47	1.90	1.79	-1398	869.0	1133	-0.69	0.46	95.2	114	1380.6	1.21
16.83	1.90	1.79	-1398	869.0	1133	-0.69	0.46	95.2	114	1380.6	1.21
20.20	1.90	1.81	-1391	794.9	1015	-0.75	0.53	83.0	155	1254.3	1.33
23.57	1.90	1.57	-1359	529.7	892	-0.66	0.28	87.6	-425	884.6	0.96
26.93	1.90	-2.70	-1288	87.3	766	0.00	0.00	0.0	0	285.8	0.00
30.30	0.00	1.00	0	0.0	0	0.00	0.00	0.0	0	0.0	0.00

x [m]	Mcr [kNm]	σs [MPa]	σsr [MPa]	ζ	ρM1 [1/km]	ρM2 [1/km]	ρM [1/km]	ρS1 [1/km]	ρS2 [1/km]	ρS [1/km]
0.00	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000
3.37	470.8	0	0	0.00	-0.167	0.000	-0.167	0.179	0.000	0.179
6.73	599.7	191	81	0.92	0.399	0.757	0.729	0.142	-0.069	-0.053
10.10	730.9	266	85	0.94	0.490	0.903	0.878	0.114	0.020	0.026
13.47	864.6	243	90	0.93	0.390	0.724	0.700	0.094	0.011	0.017
16.83	864.6	243	90	0.93	0.390	0.724	0.700	0.094	0.011	0.017
20.20	730.9	266	85	0.94	0.490	0.903	0.878	0.114	0.020	0.026
23.57	599.7	191	81	0.92	0.399	0.757	0.729	0.142	-0.069	-0.053
26.93	470.8	0	0	0.00	-0.167	0.000	-0.167	0.179	0.000	0.179
30.30	0.0	0	0	0.00	0.000	0.000	0.000	0.000	0.000	0.000

Shear reinforc [cm2/m],			η compr. strut			
x[m]	VEd [kN]	VEd,red [kN]	Cot Θ	z [cm]	web asw	η Vrdmax
0.08	0.70	----	1.00	58.12	+2.15	----
0.22	456.52	----	2.50*	69.54	+4.96	+1.79
0.23	455.91	----	2.50*	69.59	+4.96	+1.79
1.14	403.19	403.19	2.50	74.86	+4.96	+2.39
1.24	397.65	397.65	2.50	75.32	+4.86	+2.44
3.37	290.34	290.34	2.50	85.66	+3.12	+2.92
3.75	273.12	273.12	3.33	87.66	+2.15	+3.30
6.73	150.53	150.53	1.58	102.22	+2.15	+11.4
10.10	41.14	41.14	1.00	119.12	+2.15	+45.1
13.47	72.72	72.72	1.00	135.48	+2.15	+34.2
15.15	121.97	121.97	1.00	143.62	+2.15	+21.6
16.83	72.72	72.72	1.00	135.48	+2.15	+34.2
20.20	41.13	41.13	1.00	119.12	+2.15	+45.1
23.57	150.53	150.53	1.58	102.22	+2.15	+11.4
26.55	273.12	273.12	3.33	87.66	+2.15	+3.30
26.93	290.34	290.34	2.50	85.66	+3.12	+2.92
29.06	397.65	397.65	2.50	75.32	+4.86	+2.44
29.16	403.19	403.19	2.50	74.86	+4.96	+2.39
30.08	456.52	----	2.50*	69.54	+4.96	+1.79
30.22	0.70	----	1.00	58.12	+2.15	----

---- Check not required
**** Check not fulfilled
*: Take over from last construction phase

Sect. max. bending mom. x = 15.15 m f.beam beg

INTERNAL FORCES FROM EXTERNAL LOADING:

maximum moment : [kNm]
LAc: dominant variable action (leading action)

Creep period	ULS(PT)	rare	freq.	q.-perm.
		---------- Combination----------		
Storage	1345.09	996.34	996.34	996.34
Storag./Erect.	754.10	546.26	546.26	546.26
Utilisation	3538.52	2729.40	2308.09	2211.34
LAc	10	10	10	-

Minimum moment : [kNm]

Creep period	ULS(PT)	rare	freq.	q.-perm.
		---------- Combination----------		
Storage	996.31	996.34	996.34	996.34
Storag./Erect.	529.62	546.26	546.26	546.26
Utilisation	2211.31	2211.34	2211.34	2211.34
LAc	-	-	-	-

maximum shear force:[kN]

Creep period	ULS(PT)

Storage	-0.00
Storag./Erect.	0.73
Utilisation	-0.00
LAc	-

Internal forces per load, characteristic value

L.	LC		<----- Myk ----> G	Q	<----- Qzk ----> G	Q	Grp.	Ac.
0	G1	Sto->IF	-0.04	0.00	0.00	0.00	1	-
1	G1	Sto->IF	996.41	0.00	-0.00	0.00	2	-
2	G1	Sto->IF	-0.04	0.00	-0.00	0.00	3	-
3	G1	M Ere	-23.78	0.00	2.09	0.00	4	-
4	G1	M Ere	593.83	0.00	0.00	0.00	5	-
5	G1	M Ere	-23.78	0.00	-2.09	0.00	6	-
6	G2	Use->IF	1215.00	0.00	-0.00	0.00	7	-
7	Q	Use->IF	0.00	483.75	0.00	-0.00	0	10
8	Q	Use->IF	0.00	68.62	0.00	-0.00	0	9

PT : permanent + transient design situation (fundam. combination)
Rc : rare combination
Fc : frequent combination
Qc : quasi-permanent combination

Components from maximum moment t=utilisation, design values

	PT	Rc	Fc	Qc
G1	1244.20	996.34	996.34	996.34
G2	1517.23	1215.00	1215.00	1215.00
Q	777.09	518.06	96.75	0.00

Components from minimum moment t=utilisation, design values

	PT	Rc	Fc	Qc
G1	996.31	996.34	996.34	996.34
G2	1215.00	1215.00	1215.00	1215.00
Q	0.00	0.00	0.00	0.00

Components from maximum shear force t=utilisation, design values

	PT	Rc	Fc	Qc
G1	-0.00			
G2	-0.00			
Q	-0.00			

EFFECTIVE TENDONS(prestressed concrete condition for t = t0 (sto))

Δσ(Tt0)= -39 N/mm2 due to heat treatment

Layer No.	No.	Area Ap [cm2]	Distanc f.BO [cm]	e max [N/mm2]	Prestress min [N/mm2]	tens.force max [kN]	tens.force min [kN]	shortt Relax. [N/mm2]
1	3	2.79	8.5	956	956	267	267	-5
2	3	2.79	12.3	956	956	267	267	-5
3	3	2.79	16.1	956	956	267	267	-5
4	3	2.79	19.9	956	956	267	267	-5
5	3	2.79	23.7	956	956	267	267	-5
6	3	2.79	27.5	956	956	267	267	-5
7	3	2.79	31.3	956	956	267	267	-5
8	1	0.93	35.1	956	956	89	89	-5

UNTENSIONED REINFORCEMENT:

Layer No.	Number	Diameter [mm]	Area [cm2]	Distance f.BO [cm]
1	2	16.00	4.02	3.5
2	2	20.00	6.28	155.0
3	2	20.00	6.28	166.5

CROSS SECTION VALUES

No.	W [cm]	H [cm]	(layers from top to bottom)
1	60.0	0.0	
2	60.0	15.0	
3	19.0	23.2	
4	19.0	170.0	

		Beam cross-section Brutto	effect.
Area	in m2	0.4013	0.4174
Moment of inertia	in m4	0.113790	0.123744
Centroid from bottom	in m	0.9969	0.9844

Relaxation

Lay. No.	Storag. Δσpr,1 [N/mm2]	Use Δσpr,2 [N/mm2]
1	-0.11	-12.45
2	-0.11	-12.42
3	-0.11	-12.40
4	-0.11	-12.37
5	-0.11	-12.34
6	-0.11	-12.32

Relaxation

Lay. No.	Storag. Δσpr,1 [N/mm2]	Use Δσpr,2 [N/mm2]
7	-0.11	-12.29
8	-0.11	-12.26

PRESTR. STEEL, LOSSES DUE TO CREEPING, SHRINKING AND RELAXATION:

(unstressed state, aver. value at end of creep section)

Lay. No.	Storag. σp,csr1 [N/mm2]	Use σp,csr2 [N/mm2]
1	-58.56	-81.27
2	-57.98	-82.77
3	-57.40	-84.26
4	-56.83	-85.76
5	-56.25	-87.25
6	-55.68	-88.74
7	-55.10	-90.24
8	-54.52	-91.73

STRESS IN REINFORC. d.t. CREEPING, SHRINKING and RELAXATION:

(unstressed state, aver. value at end of creep section)

Lay. No.	Storag. σs,csr1 [N/mm2]	Use σs,csr2 [N/mm2]
1	-60.75	-71.10
2	-37.18	-133.04
3	-35.39	-137.74

INTERNAL FORCES FROM PRESTRESS (tB=Beg.,tE=End creep period)

Creep period	<----Npm0,t-----> tB [kN]	tE [kN]	<-----Mpm0,t-----> tB [kNm]	tE [kNm]
Storag.	-1956.74	-1770.66	-1523.30	-1437.91
Use	-1770.66	-1395.91	-1437.91	-1380.45

BENDING with NORMAL FORCE ULS

L.	Creep period tB:Beg. tE:End	eff. Cross sect.	layer Tens zone	. Lever arm(cm)	MRd (kNm)	MEd (kNm)	η (>1.0)
1	tB Storage	P	top	140.5	783.4	MEd < 0	n/a #1
2	tE Storage	P	bttm.	143.9	4595.8	1345.1	3.42
3	tB Storag./Erect.	P	top	140.5	783.4	MEd < 0	n/a #1
4	tE Storag./Erect.	P	bttm.	143.9	4595.8	754.1	6.09
5	tE Utilisation	P	top	146.2	923.3	MEd < 0	n/a
6	tE Utilisation	P	bttm.	143.6	4612.3	3538.5	1.30

#1: fck(t)= 0.73 * fck

Interim results :

L.	<--- ε---> Co	St (o/oo)	comp.-zone (cm)	<steel ten.> Ap (cm2)	As (cm2)	<-tension--> PrSt (kN)	Bst (kN)	<-compress.force-> Bn (kN)	PrSt (kN)	Rei (kN)
1	3.50	7.50	52.98	0.00	12.57	0	551	1869	-1467	166
2	3.50	27.50	18.80	20.46	4.02	3046	182	2852	0	357
3	3.50	7.50	52.98	0.00	12.57	0	551	1869	-1467	166
4	3.50	27.50	18.80	20.46	4.02	3046	182	2852	0	357
5	3.50	12.70	35.97	0.00	12.57	0	555	1742	-1339	163
6	3.50	28.30	18.33	20.46	4.02	3051	182	2788	0	441

Zl.		σR [N/mm2]	σI [N/mm2]	z [cm]	σx [N/mm2]	τ [N/mm2]
1	F	0.00	0.01	62.20	-4.55	0.20
2	F	0.00	0.01	66.20	-4.20	0.20
3	F	1.06	0.00	23.20	-1.65	0.09
4	F	0.00	0.01	23.20	-1.54	0.09
5	F	0.00	0.00	0.00	0.00	0.00
6	F	13.82	ZONE B			

SHEAR RESISTANCE

Design value shear force

L.	Creep period tB:Beg. tE:End	Com-bin.	VEd0 [kN]	MEd [kNm]	dV [kN]	dV fro
1	tB Storage	PT MMax	-0.0	1345.1	46.3	Vccd
2	tE Storage	PT MMax	-0.0	1345.1	46.3	Vccd
3	tB Storag./Erect.	PT QMax	0.7	745.8	25.7	Vccd
4	tE Storag./Erect.	PT QMax	0.7	745.8	25.7	Vccd
5	tB Utilisation	PT MMax	-0.0	3538.5	122.0	Vccd
6	tE Utilisation	PT MMax	-0.0	3538.5	122.0	Vccd

Effective cross-section

L.	eff. CS+TZ	bw [cm]	d [cm]	zII [cm]	Ac [cm2]	Asl [cm2]	σcp [N/mm2]	VRdc [kN]
1	P u	19.0	166.5	143.9	4013.1	24.48	4.39	381.10
2	P u	19.0	166.5	143.9	4013.1	24.48	3.97	380.54
3	P u	19.0	166.5	143.9	4013.1	24.48	4.39	381.10
4	P u	19.0	166.5	143.9	4013.1	24.48	3.97	380.54
5	P u	19.0	166.5	143.6	4013.1	24.48	3.97	380.54
6	P u	19.0	166.5	143.6	4013.1	24.48	3.13	340.66

Shear design v1= 0.480

L.	VEd [kN]	VEd,red [kN]	αcw [kN]	Cot.-Θ	asw [cm2/m]	com ment	- al [cm]	VRdmax [kN]	
1	46.28	46.28	1.163	1.000	1.83	Min	83.3	2197.9	#1
2	46.28	46.28	1.107	1.000	2.15	Min	83.3	2690.4	
3	26.39	26.39	1.163	1.000	1.83	Min	83.3	2197.9	#1
4	26.39	26.39	1.107	1.000	2.15	Min	83.3	2690.4	
5	121.97	121.97	1.107	1.000	2.15	Min	83.3	2685.6	
6	121.97	121.97	1.085	1.000	2.15	Min	83.3	2630.5	

#1: fck(t)= 0.73 * fck

CRACK CONTROL

bttm.: perm. cracking: wk < 0.20 mm, Frequent load combination
top : perm. cracking: wk < 0.20 mm, Frequent load combination

L.	Tab1 creep period tB:Beg/tE:End	eff. Cross sect.	lay. Ten. zone	rsup rinf	max. σs [N/mm2]	max sr [mm]	εsm-εcm o/oo	wk [mm]
1	tB Storage	P	top	1.00 no tens. in TZ				
2	tE Storage	P	bttm.	1.00 no tens. in TZ				
3	tB Storag./Erect.	P	top	1.00no cracks				
4	tE Storag./Erect.	P	bttm.	1.00 no tens. in TZ				
5	tE Utilisation	P	top	1.00 no tens. in TZ				
6	tE Utilisation	P	bttm.	1.00	91.6	203.49	0.275	0.056

Intern. forces and elongation (cond. II)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕ_{eff}	εc [o/oo]	X0II [cm]
1	-1956.7	-527.0	-1.6	208.5			
2	-1770.7	-441.6	-7.8	217.3			
3	-1956.7	-977.0	1.0	157.8			
4	-1770.7	-891.6	-11.3	157.3			
5	-1395.9	830.9	-8.1	121.4			
6	-1395.9	927.6	4.0	116.2	1.90	-0.67	99.13

L.	heff [cm]	Aceff [cm2]	ξ1	Ap [cm2]	As [cm2]	effρ o/o	ρ,tot o/o	k1	k2	k3	c [cm]	k4
6	23.6	448.8	1.15	11.16	4.02	4.212	3.382	1.4	0.50	3.4	2.7	0.425

L.	<Crack int. f.> Nges [kN]	Mges [kNm]	<---Cond.I----> max σ [N/mm2]	X0I [cm]	<------Cond.II------> ϕ_{eff}	εc [o/oo]	X0II [cm]
6	-1395.9	932.3	4.1	116.0			

Minimum reinforcement for crack control:

L.	Creep period tB:Beg/tE:End	eff. Cross sect.	layer Ten. zone	rsup rinf	rare.Lc σct [N/mm2]	req.As [cm2]	ex.As [cm2]
1	tB Storage	P	top	1.00	-1.20 < 4.1	not req.	
2	tE Storage	P	bttm.	1.00	-7.76 < 4.1	not req.	
3	tB Storag./Erect.	P	top	1.00	1.41 < 4.1	not req.	
4	tE Storag./Erect.	P	bttm.	1.00	-11.34 < 4.1	not req.	
5	tB Utilisation	P	top	1.00	-7.82 < 4.1	not req.	
6	tE Utilisation	P	bttm.	1.00	7.39	<= 0 cm2	

L.	D [mm]	x0IZ [cm]	v.Ap [cm2]	ξ1	<------- web --------> k	kc	Act [cm2]	As [cm2]	<-------flange-------> k	kc	Act [cm2]	As [cm2]
6	16	54.0	5.6	1.15	0.65	0.31	1027	2.54	--no flange--			

Ductility reinforcement in pre-compr. tensile zone:

bt = 19.0 cm fctm = 4.07 N/mm2
d = 166.5 cm
req. As = 6.70 cm2 exis.As = 4.02 cm2

STRESS CHECKS for GZG:

Concrete stresses due to prestress, creep, shrinkage a. relax.

L.	Stress P (condition I) due to	recast top N/mm2	bottom N/mm2
1	Pst rel. anch.	4.12	-16.81
2	ksr storage	-0.05	1.13
3	ksr use	0.57	1.35

Concrete stresses due to loads, by compoments

L.	Stress (condition I) due to	M[kNm]	Precast top N/mm2	bottom N/mm2
1	G1	996.34	-5.76	7.93
2	G2	1215.00	-7.03	9.67
3	Q(Qc)	0.00	0.00	0.00
4	Q(Rc)	518.06	-3.00	4.12

Tab. Compr stresses of concrete (Rc= rare Lc, Qc= q.-permanent Lc)

L.	Creep sector tB:Beg/tE:End	eff. Cross sect.	MEd :Precast Max=+ Min=-	Rc N/mm2	Qc N/mm2
1	tB Storage	F	--	-8.88	-8.88
2	tE Storage	F	--	-7.76	-7.76
3	tB Storag./Erect.	F	--	-12.46	
4	tE Storag./Erect.	F	--	-11.34	
5	tB Utilisation	F	+-	-12.92	-8.72
6	tE Utilisation	F	+-	-11.97	-7.93

Tab. Steel- a. tension str. concr

L.	Creep sector tB:Beg/tE:End	eff. Cross sect.	MEd : Max=+ Min=-	Sk,Pm max. σp [N/mm2]	Sk max. σs [N/mm2]	Sk Fbt. σt [N/mm2]
1	tB Storage	F	-+-	+917.4	+0.0	+0.00
2	tE Storage	F	-+-	+867.6	+0.0	+0.00
3	tB Storag./Erect.	F	---	+905.3	+3.7	+0.96
4	tE Storag./Erect.	F	-+-	+855.4	+0.0	+0.91
5	tB Utilisation	F	++-	+1014.4	+66.2	+1.91
6	tE Utilisation	F	++-	+1005.9	+73.3	+0.00

<---rare Lc.--><---Cond.I----><------Cond.II------> (P= Pk)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕ_{eff}	εc [o/oo]	X0II [cm]
1	-1956.7	527.0	-1.6	208.5			
2	-1770.7	441.6	-1.7	217.3			
3	-1956.7	977.0	1.0	157.8			
4	-1770.7	891.6	0.9	157.3			
5	-1770.7	1291.5	6.0	112.2	0.74	-0.61	81.31
6	-1395.9	1349.0	7.4	102.2	1.45	-0.79	72.66

<-q.-perm.Lc.-><---cond.I----><------cond.II------> (P= Pk)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕ_{eff}	εc [o/oo]	X0II [cm]
1	-1956.7	527.0	-1.6	208.5			
2	-1770.7	441.6	-1.7	217.3			
3	0.0	0.0	0.0	0.0			
4	0.0	0.0	0.0	0.0			
5	-1770.7	773.4	1.9	139.4			
6	-1395.9	830.9	3.3	121.4	1.90	-0.62	107.83

<---rare Lc.--><---Cond.I----><------Cond.II------> (P= Pm)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕ_{eff}	εc [o/oo]	X0II [cm]
1	-1956.7	527.0	-1.6	208.5			
2	-1770.7	441.6	-1.7	217.3			
3	-1956.7	977.0	1.0	157.8			
4	-1770.7	891.6	0.9	157.3			
5	-1770.7	1291.5	6.0	112.2	0.74	-0.61	81.31
6	-1395.9	1349.0	7.4	102.2	1.45	-0.79	72.66

Selected section x = 1.04 m f.le.bear.

INTERNAL FORCES FROM EXTERNAL LOADING:

maximum moment : [kNm]
LAc: dominant variable action (leading action)

Creep period	ULS(PT)	rare	freq.	q.-perm.
		---------- Combination----------		
Storage	169.27	125.36	125.36	125.36
Storag./Erect.	-4.66	-4.66	-4.66	-4.66
Utilisation	463.68	357.35	300.95	288.00
LAc	10	10	10	-

Minimum moment : [kNm]

Creep period	ULS(PT)	rare	freq.	q.-perm.
		---------- Combination----------		
Storage	125.34	125.36	125.36	125.36
Storag./Erect.	-6.29	-4.66	-4.66	-4.66
Utilisation	287.98	288.00	288.00	288.00
LAc	-	-	-	-

maximum shear force:[kN]

Creep period	ULS(PT)

Storage	158.15
Storag./Erect.	-10.64
Utilisation	430.98
LAc	10

Internal forces per load, characteristic value

L.	LC		<----- Myk ----> G	Q	<----- Qzk ----> G	Q	Grp.	Ac.
0	G1	Sto->IF	-0.07	0.00	0.00	0.00	1	-
1	G1	Sto->IF	125.44	0.00	117.14	0.00	2	-
2	G1	Sto->IF	-0.00	0.00	-0.00	0.00	3	-
3	G1	M Ere	-4.65	0.00	-7.87	0.00	4	-
4	G1	M Ere	-0.01	0.00	-0.01	0.00	5	-
5	G1	M Ere	0.00	0.00	0.00	0.00	6	-
6	G2	Use->IF	162.64	0.00	150.77	0.00	7	-
7	Q	Use->IF	0.00	64.75	0.00	60.03	0	10
8	Q	Use->IF	0.00	9.19	0.00	8.52	0	9

PT : permanent + transient design situation (fundam. combination)
Rc : rare combination
Fc : frequent combination
Qc : quasi-permanent combination

Components from maximum moment t=utilisation, design values

	PT	Rc	Fc	Qc
G1	156.57	125.36	125.36	125.36
G2	203.10	162.64	162.64	162.64
Q	104.02	69.35	12.95	0.00

Components from minimum moment t=utilisation, design values

	PT	Rc	Fc	Qc
G1	125.34	125.36	125.36	125.36
G2	162.64	162.64	162.64	162.64
Q	0.00	0.00	0.00	0.00

Components from maximum shear force t=utilisation, design values

	PT	Rc	Fc	Qc
G1	146.28			
G2	188.27			
Q	96.43			

EFFECTIVE TENDONS(prestressed concrete condition for t = t0 (sto))

Δσ(Tt0)= -39 N/mm2 due to heat treatment

Layer No.	No.	Area Ap [cm2]	Distanc f.BO [cm]	e max [N/mm2]	Prestress min [N/mm2]	tens.force max [kN]	tens.force min [kN]	shortt Relax. [N/mm2]
1	3	2.79	8.5	956	956	267	267	-5
2	3	2.79	12.3	956	956	267	267	-5
3	3	2.79	16.1	956	956	267	267	-5
4	3	2.79	19.9	956	956	267	267	-5
5	3	2.79	23.7	956	956	267	267	-5
6	3	2.79	27.5	956	956	267	267	-5
7	3	2.79	31.3	956	956	267	267	-5
8	1	0.93	35.1	956	956	89	89	-5

UNTENSIONED REINFORCEMENT:

Layer No.	Number	Diameter [mm]	Area [cm2]	Distance f.BO [cm]
1	2	16.00	4.02	3.5
2	2	20.00	6.28	85.9
3	2	20.00	6.28	97.4

CROSS SECTION VALUES

No.	W [cm]	H [cm]	(layers from top to bottom)
1	60.0	0.0	
2	60.0	15.0	
3	19.0	23.2	
4	19.0	100.9	

		Beam cross-section Brutto	effect.
Area	in m2	0.2700	0.2860
Moment of inertia	in m4	0.025752	0.028658
Centroid from bottom	in m	0.6226	0.6120

Relaxation

Lay. No.	Storag. Δσpr,1 [N/mm2]	Use Δσpr,2 [N/mm2]
1	-0.08	-8.09
2	-0.08	-8.28
3	-0.09	-8.47
4	-0.09	-8.67
5	-0.09	-8.87
6	-0.09	-9.07

Relaxation

Lay. No.	Storag. Δσpr,1 [N/mm2]	Use Δσpr,2 [N/mm2]
7	-0.09	-9.28
8	-0.09	-9.49

PRESTR. STEEL, LOSSES DUE TO CREEPING, SHRINKING AND RELAXATION:

(unstressed state, aver. value at end of creep section)

Lay. No.	Storag. σp,csr1 [N/mm2]	Use σp,csr2 [N/mm2]
1	-111.05	-159.58
2	-107.19	-156.95
3	-103.33	-154.32
4	-99.47	-151.70
5	-95.60	-149.07
6	-91.74	-146.45
7	-87.88	-143.83
8	-84.02	-141.22

STRESS IN REINFORC. d.t. CREEPING, SHRINKING and RELAXATION:

(unstressed state, aver. value at end of creep section)

Lay. No.	Storag. σs,csr1 [N/mm2]	Use σs,csr2 [N/mm2]
1	-119.05	-160.80
2	-33.13	-98.88
3	-21.13	-90.24

INTERNAL FORCES FROM PRESTRESS (tB=Beg.,tE=End creep period)

Creep period	<----Npm0,t-----> tB [kN]	tE [kN]	<-----Mpm0,t-----> tB [kNm]	tE [kNm]	<-- ϕfac --> -> σc (qpmLC) Prc	Cpc
Storag.	-1956.74	-1672.70	-794.53	-693.45	1.22	
Use	-1672.70	-1179.81	-693.45	-565.46	1.00	

BENDING with NORMAL FORCE ULS

L.	Creep period tB:Beg. tE:End	eff. Cross sect.	layer Tens zone	. Lever arm(cm)	MRd (kNm)	MEd (kNm)	η (>1.0)	
1	tB Storage	P	top	71.8	404.7	MEd < 0	n/a	#1
2	tE Storage	P	bttm.	75.3	2259.7	169.3	13.35	
3	tB Storag./Erect.	P	top	71.8	404.7	6.3	64.35	#1
4	tE Storag./Erect.	P	bttm.	75.3	2259.7	MEd < 0	n/a	
5	tB Utilisation	P	top	76.7	528.8	MEd < 0	n/a	
6	tE Utilisation	P	bttm.	75.1	2244.6	463.7	4.84	

#1: fck(t)= 0.73 * fck

Interim results :

L.	<--- ε---> Co	St (o/oo)	comp.-zone (cm)	<steel ten.> Ap (cm2)	As (cm2)	<-tension--> PrSt (kN)	Bst (kN)	<-compress.force-> Bn (kN)	PrSt (kN)	Rei (kN)
1	3.50	3.10	51.65	0.00	12.57	0	547	1822	-1475	166
2	3.50	15.50	17.94	20.46	4.02	2852	179	2734	0	339
3	3.50	3.10	51.65	0.00	12.57	0	547	1822	-1475	166
4	3.50	15.50	17.94	20.46	4.02	2852	179	2734	0	339
5	3.50	5.70	37.05	0.00	12.57	0	549	1794	-1419	163
6	3.50	16.30	17.22	20.46	4.02	2851	179	2630	0	394

Zl.		σR [N/mm2]	σI [N/mm2]	z [cm]	σx [N/mm2]	τ [N/mm2]
1	F	2.43	1.60	1.00	1.60	0.02
2	F	0.00	1.23	1.00	1.23	0.02
3	F	4.25	ZONE B			
4	F	0.00	0.00	0.00	0.00	0.00
5	F	0.00	1.37	26.20	-4.77	2.89
6	F	0.00	1.62	32.20	-3.86	2.98

SHEAR RESISTANCE

Design value shear force

L.	Creep period tB:Beg. tE:End	Com-bin.	VEd0 [kN]	MEd [kNm]	dV [kN]	dV fro
1	tB Storage	PT QMax	158.1	169.2	-11.1	Vccd
2	tE Storage	PT QMax	158.1	169.2	-11.1	Vccd
3	tB Storag./Erect.	PT QMax	-10.6	-6.3	0.0	-------
4	tE Storag./Erect.	PT QMax	-10.6	-6.3	0.0	-------
5	tB Utilisation	PT QMax	431.0	463.7	-30.6	Vccd
6	tE Utilisation	PT QMax	431.0	463.7	-30.6	Vccd

Effective cross-section

L.	eff. CS+TZ	bw [cm]	d [cm]	zII [cm]	Ac [cm2]	Asl [cm2]	σcp [N/mm2]	VRdc [kN]
1	P u	19.0	97.4	75.3	2700.0	24.48	5.40	280.27
2	P u	19.0	97.4	75.3	2700.0	24.48	5.58	299.76
3	P o	19.0	91.6	71.8	2700.0	12.57	5.40	242.23
4	P o	19.0	91.6	71.8	2700.0	12.57	5.58	258.18
5	P u	19.0	97.4	75.1	2700.0	24.48	5.58	299.76
6	P u	19.0	97.4	75.1	2700.0	24.48	3.93	254.16

Shear design v1= 0.480

L.	VEd [kN]	VEd,red [kN]	αcw [kN]	Cot.-Θ	asw [cm2/m]	com ment	- al [cm]	VRdmax [kN]	
1	147.02	147.02	1.242	2.447	1.83	Min	92.1	860.4	#1
2	147.02	147.02	1.151	2.089	2.15	Min	78.7	1139.8	
3	10.64	10.64	1.242	1.000	1.83	Min	45.8	1171.2	#1
4	10.64	10.64	1.151	1.000	2.15	Min	45.8	1394.8	
5	400.42	400.42	1.151	2.500	4.91	Var	93.9	1006.3	
6	400.42	400.42	1.106	2.500	4.91	Var	93.9	967.5	

#1: fck(t)= 0.73 * fck

CRACK CONTROL

bttm.: perm. cracking: wk < 0.20 mm, Frequent load combination
top : perm. cracking: wk < 0.20 mm, Frequent load combination

L.	Tab1 creep period tB:Beg/tE:End	eff. Cross sect.	lay. Ten. zone	rsup rinf	max. σs [N/mm2]	max sr [mm]	εsm-εcm o/oo	wk [mm]
1	tB Storage	P	top	1.00	no cracks			
2	tE Storage	P	bttm.	1.00	no tens. in TZ			
3	tB Storag./Erect.	P	top	1.00	56.9	422.44	0.171	0.072
4	tE Storag./Erect.	P	bttm.	1.00	no tens. in TZ			
5	tB Utilisation	P	top	1.00	no tens. in TZ			
6	tE Utilisation	P	bttm.	1.00	no tens. in TZ			

Intern. forces and elongation (cond. II)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕeff	εc [o/oo]	X0II [cm]
1	-1956.7	-669.2	2.4	90.5			
2	-1672.7	-568.1	-18.0	90.7			
3	-1956.7	-799.2	4.2	85.7	0.00	-0.72	69.71
4	-1672.7	-698.1	-20.8	85.2			
5	-1672.7	-405.5	-0.2	102.5			
6	-1179.8	-264.5	-9.8	105.9			

L.	heff [cm]	Aceff [cm2]	ξ1	Ap [cm2]	As [cm2]	effρ o/o	ρ,tot o/o	k1	k2	k3	c [cm]	k4
3	10.4	623.6	1.29	0.00	6.28	1.008	1.008	0.8	0.50	3.4	2.5	0.425

L.	<Crack int. f.> Nges [kN]	Mges [kNm]	<---Cond.I----> max σ [N/mm2]	X0I [cm]	<------Cond.II------> ϕeff	εc [o/oo]	X0II [cm]
3	-1956.7	-787.8	4.1	86.1			

Minimum reinforcement for crack control:

L.	Creep period tB:Beg/tE:End	eff. Cross sect.	layer Ten. zone	rsup rinf	rare.Lc σct [N/mm2]	req.As [cm2]	ex.As [cm2]
1	tB Storage	P	top	1.00	3.42 <	4.1	not req.
2	tE Storage	P	bttm.	1.00	-17.98 <	4.1	not req.
3	tB Storag./Erect.	P	top	1.00	5.22	<= 0 cm2	
4	tE Storag./Erect.	P	bttm.	1.00	-20.76 <	4.1	not req.
5	tB Utilisation	P	top	1.00	1.49 <	4.1	not req.
6	tE Utilisation	P	bttm.	1.00	-8.57 <	4.1	not req.

L.	D [mm]	x0IZ [cm]	v.Ap [cm2]	ξ1	<------- web --------> k	kc	Act [cm2]	As [cm2]	<-------flange-------> k	kc	Act [cm2]	As [cm2]
3	20	14.8	0.0	0.00	0.65	0.00	281	-1.#J	0.97	0.53	500	4.65

Ductility reinforcement in pre-compr. tensile zone:

bt = 19.0 cm fctm = 4.07 N/mm2
d = 97.4 cm
req. As = 3.92 cm2 exis.As = 4.02 cm2

STRESS CHECKS for GZG:

Concrete stresses due to prestress, creep, shrinkage a. relax.

L.	Stress (condition I) due to	P recast top N/mm2	bottom N/mm2
1	Pst rel. anch.	4.16	-23.81
2	ksr storage	-0.41	3.15
3	ksr use	-0.05	4.46

Concrete stresses due to loads, by compoments

L.	Stress (condition I) due to	M[kNm]	Precast top N/mm2	bottom N/mm2
1	G1	125.36	-1.74	2.68
2	G2	162.64	-2.25	3.47
3	Q(Qc)	0.00	0.00	0.00
4	Q(Rc)	69.35	-0.96	1.48

Tab. Compr stresses of concrete (Rc= rare Lc, Qc= q.-permanent Lc)

L.	Creep sector tB:Beg/tE:End	eff. Cross sect.	MEd :Precast Max=+ Min=-	Rc N/mm2	Qc N/mm2	
1	tB Storage	F	--	-21.13	-21.13	#1
2	tE Storage	F	--	-17.98	-17.98	
3	tB Storag./Erect.	F	--	-26.53*		
4	tE Storag./Erect.	F	--	-20.03		
5	tB Utilisation	F	--	-14.51	-14.51	
6	tE Utilisation	F	--	-10.05	-10.05	

#1: because σc > 0.45* fck(t) increased ceep modulus

Tab. Steel- a. tension str. concr

L.	Creep sector tB:Beg/tE:End	eff. Cross sect.	MEd : Max=+ Min=-	Sk,Pm max. σp [N/mm2]	Sk max. σs [N/mm2]	Sk Fbt. σt [N/mm2]
1	tB Storage	F	---	+888.2	+8.7	+2.43
2	tE Storage	F	-+-	+814.3	+0.0	+2.02
3	tB Storag./Erect.	F	---	+900.1	+56.9	+0.00
4	tE Storag./Erect.	F	---	+789.2	+50.7	+0.00
5	tB Utilisation	F	++-	+825.4	+0.0	+0.00
6	tE Utilisation	F	++-	+699.4	+0.0	+0.00

<---rare Lc.--><---Cond.I----><------Cond.II------> (P= Pk)

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	ϕ_{eff}	εc [o/oo]	X0II [cm]
1	-1956.7	669.2	2.4	90.5			
2	-1672.7	568.1	2.0	90.7			
3	-1956.7	799.2	4.2	85.7	0.00	-0.72	69.71
4	-1672.7	698.1	3.8	85.2	0.89	-1.02	72.12
5	-1672.7	405.5	-0.2	102.5			
6	-1179.8	277.5	-0.3	103.8			

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]		<-q.-perm.Lc.-><---cond.I----><------cond.II------> (P= Pk) ϕeff	εc [o/oo]	X0II [cm]
1	-1956.7	669.2	2.4	90.5				
2	-1672.7	568.1	2.0	90.7				
3	0.0	0.0	0.0	0.0				
4	0.0	0.0	0.0	0.0				
5	-1672.7	405.5	-0.2	102.5				
6	-1179.8	277.5	-0.3	103.8				

L.	Nges [kN]	Mges [kNm]	max σ [N/mm2]	X0I [cm]	<---rare Lc.--><---Cond.I----><------Cond.II------> (P= Pm) ϕeff	εc [o/oo]	X0II [cm]
1	-1956.7	669.2	2.4	90.5			
2	-1672.7	568.1	2.0	90.7			
3	-1956.7	799.2	4.2	85.7	0.00	-0.72	69.71
4	-1672.7	698.1	3.8	85.2	0.89	-1.02	72.12
5	-1672.7	405.5	-0.2	102.5			
6	-1179.8	277.5	-0.3	103.8			

Lateral buckling (STIGLAT)

Safety for service state η = 1.69 < 2.00
Design overturning moment: 4657.51 KNm
existing moment : 2763.72 kNm without prestress
Combination of characteristic values

Interim values acc. to 'Beton- und Stahlbetonbau' 1985, H. 9,10,11

Eb	=	37000.0	N/mm2	Gb	=	14800.0	N/mm2	It, Iy aver-			
It	=	2.1e-003	m4	Iy	=	3.9e-003	m4	aged n. Rafla			
Ix	=	1.1e-001	m4	Ak	=	4664.5	MN2m4	(It 60% as C.II)			
hc	=	1.584	m	β1	=	0.000		β2	=	0.003	
k1	=	3.540		k2	=	1.000		k3	=	0.920	
Mk	=	7415.5	kNm	Wxo	=	0.1239	m3	at x	=	10.10	m
σB	=	52.9	N/mm2	σT	=	33.2	N/mm2	λV	=	83.1	

(σT acc. eq.62 calculated !)

CHECK LATERAL BUCKLING IN ERECTING STATE (acc. to Stiglat)

Height of left attachment point about l.e. beam Hml: 114.0 cm
Height of right attachment point about l.e. beam Hmr: 114.0 cm

Erection with spreader

Lat. buckling safety η = 4.29 > 2.50

Design overturning moment: 2343.70 kNm
existing moment : 546.26 kNm without prestress

Interim values acc. to 'Beton- und Stahlbetonbau' 1985, H. 9,10,11

β4	=	0.000		δ	=	0.000		γ	=	1.000	
f	=	0.331	m	Ak	=	4664.5	MN2m4	p	=	0.752	
j(α)	=	0.095		α	=	1.478		qk1	=	47.8	kN/m
Wxo	=	0.1488	m3	Mk	=	2700.1	kNm	at x	=	16.83	m
σB	=	18.1	N/mm2	σT	=	15.8	N/mm2	λV	=	141.8	

ANCHORAGE BY BOND (over the left bearing)

lpt2= 0.96 m lr= 3.37 m Distance first bending crack
fctd(t)= 0.81 N/mm2 t= release anchorage
fbpt= 2.58 N/mm2
ηP2= 1.20 fbpd= 2.28 N/mm2

x [m]	Zp [kN]	Zs [kN]	Td [kN]	η= (Zp+Zs)/T
0.15	494.12	178.55	657.86	1.02
0.31	1013.74	178.49	745.75	1.60
0.61	1994.78	178.36	910.04	2.39
0.92	2846.39	178.58	1047.17	2.89
1.22	2851.12	178.60	1172.00	2.59
1.53	2852.69	178.62	1300.99	2.33
1.84	2864.65	178.87	1429.98	2.13

La No.	dist.BO [cm]	XA [m]	σp [N/mm2]	to Gl.	lbpd [m]	xk [m]	ΣZp [kN]	ΣZs [kN]	Tsd [kN]	add.As [cm2]
1	8.5	0.00	597	a	1.93	Anchorage range uncracked(PT)				
2	12.3	0.00	608	a	1.92	Anchorage range uncracked(PT)				
3	16.1	0.00	619	a	1.91	Anchorage range uncracked(PT)				
4	19.9	0.00	631	a	1.90	Anchorage range uncracked(PT)				
5	23.7	0.00	642	a	1.89	Anchorage range uncracked(PT)				
6	27.5	0.00	653	a	1.87	Anchorage range uncracked(PT)				
7	31.3	0.00	664	a	2.01	Anchorage range uncracked(PT)				
8	35.1	0.00	675	a	2.00	Anchorage range uncracked(PT)				

ANCHORAGE BY BOND (over theright bearing)

lpt2= 0.96 m lr= 3.37 m Distance first bending crack
fctd(t)= 0.81 N/mm2 t= release anchorage
fbpt= 2.58 N/mm2
ηP2= 1.20 fbpd= 2.28 N/mm2

x [m]	Zp [kN]	Zs [kN]	Td [kN]	η= (Zp+Zs)/T
28.46	2864.65	178.87	1429.98	2.13
28.77	2852.69	178.62	1300.99	2.33
29.08	2851.12	178.60	1172.00	2.59
29.38	2846.39	178.58	1047.17	2.89
29.69	1994.78	178.36	910.04	2.39
29.99	1013.74	178.49	745.75	1.60
30.15	494.12	178.55	657.86	1.02

La No.	dist.BO [cm]	XA [m]	σp [N/mm2]	to Gl.	lbpd [m]	xk [m]	ΣZp [kN]	ΣZs [kN]	Tsd [kN]	add.As [cm2]
1	8.5	0.00	597	a	1.93	Anchorage range uncracked(PT)				
2	12.3	0.00	608	a	1.92	Anchorage range uncracked(PT)				
3	16.1	0.00	619	a	1.91	Anchorage range uncracked(PT)				
4	19.9	0.00	631	a	1.90	Anchorage range uncracked(PT)				
5	23.7	0.00	642	a	1.89	Anchorage range uncracked(PT)				
6	27.5	0.00	653	a	1.87	Anchorage range uncracked(PT)				
7	31.3	0.00	664	a	2.01	Anchorage range uncracked(PT)				
8	35.1	0.00	675	a	2.00	Anchorage range uncracked(PT)				

BURSTING REINFORCEMENT at beginning of beam

γp,unfav=1.20

No.	< Transfer zone > from (fr. out. edge) [m]	to [m]	dist. BOBe. [cm]	<-- Section about last effective layer --> Increase conc. [MN]	prestr [MN]	shear force [MN]	factor (inter-pol.)	req.As [cm2]
1	0.00	1.24	36.10	-1.29	1.76	0.47	0.41	5.30

red. dispersion length indented wire w.o. strand 3/4*e= 0.93 m

The bursting reinforcement must be arranged in zone of reduced dispersion length.

BURSTING REINFORCEMENT at end of beam

γp,unfav=1.20

No.	< Transfer zone > from (fr. out. edge) [m]	to [m]	dist. BOBe. [cm]	<-- Section about last effective layer --> Increase conc. [MN]	prestr [MN]	shear force [MN]	factor (inter-pol.)	req.As [cm2]
1	30.30	29.06	36.10	-1.29	1.76	0.47	0.41	5.30

red. dispersion length indented wire w.o. strand 3/4*e= 0.93 m

The bursting reinforcement must be arranged in zone of reduced dispersion length.