1 Level:

- Name : Story 1
- Reference level : 35,200 (m)
- Concrete creep coefficient : φ_p = 2,232301
- cement class : N
- Environment class : XC2
- Structure class : S3
- Quality assurance system (4.4.1.3(3); A.2.1(1))

2 Column: Column2 Number: 1

2.1 Material properties:

- Concrete : C30/37 f_{ck} = 30,00 (MPa)
  Unit weight : 2501,364 (kG/m3)
  Aggregate size : 20,000 (mm)
- Longitudinal reinforcement: : B500B f_{yk} = 500,00 (MPa)
  Ductility class : B
- Transversal reinforcement: : B500B f_{yk} = 500,00 (MPa)

2.2 Geometry:

2.2.1	Rectangular	0,250 x 0,400 (m)
2.2.2	Height: L	= 5,300 (m)
2.2.3	Slab thickness	= 0,000 (m)
2.2.4	Beam height	= 0,400 (m)
2.2.5	Cover	= 0,030 (m)

2.3 Calculation options:

- Calculations according to : EN 1992-1-1:2004 AC:2008
- Seismic dispositions : No requirements
- Precast column : no
- Pre-design : no
- Slenderness taken into account : yes
- Compression : with bending
- Ties : to slab
- More than 50 % loads applied: after 90 day
- Fire resistance class : No requirements

2.4 Loads:

Case	Nature	Group	γ_f	N (kN)	My(s) (kN*m)	My(i) (kN*m)	Mz(s) (kN*m)	Mz(i) (kN*m)
ULS/1=1*1.35 + 2*1.35 + 3*1.50 + 4*1.50 + 5*1.50 + 6*0.90	design(Structural)	2	1,000000	1029,57	**0,40**	0,00	**-12,57**	0,00
ULS/2=1*1.35 + 2*1.35 + 3*1.50 + 4*1.50 + 5*1.50	design(Structural)	2	1,000000	1038,83	0,41	0,00	-9,13	0,00
ULS/3=1*1.35 + 2*1.35	design(Structural)	2	1,000000	801,56	0,35	0,00	-7,29	0,00
ULS/4=1*1.00 + 2*1.00 + 3*1.50 + 4*1.50 + 5*1.50 + 6*0.90	design(Structural)	2	1,000000	821,76	0,31	0,00	-10,68	0,00
ULS/5=1*1.00 + 2*1.00 + 3*1.50 + 4*1.50 + 5*1.50	design(Structural)	2	1,000000	831,02	0,32	0,00	-7,24	0,00
ULS/6=1*1.00 + 2*1.00	design(Structural)	2	1,000000	593,75	0,26	0,00	-5,40	0,00
ULS/7=1*1.35 + 2*1.35 + 3*1.05 + 4*1.05 + 5*1.05 + 6*0.90	design(Structural)	2	1,000000	958,39	0,38	0,00	-12,02	0,00
ULS/8=1*1.35 + 2*1.35 + 3*1.05 + 4*1.05 + 5*1.05	design(Structural)	2	1,000000	967,65	0,40	0,00	-8,58	0,00
ULS/9=1*1.00 + 2*1.00 + 3*1.05 + 4*1.05 + 5*1.05 + 6*0.90	design(Structural)	2	1,000000	750,58	0,29	0,00	-10,13	0,00
ULS/10=1*1.00 + 2*1.00 + 3*1.05 + 4*1.05 + 5*1.05	design(Structural)	2	1,000000	759,84	0,30	0,00	-6,69	0,00
ULS/11=1*1.35 + 2*1.35 + 3*1.05 + 4*1.05 + 5*1.05 + 6*1.50	design(Structural)	2	1,000000	952,22	0,37	0,00	-14,31	0,00
ULS/12=1*1.35 + 2*1.35 + 6*1.50	design(Structural)	2	1,000000	786,12	0,33	0,00	-13,03	0,00
ULS/13=1*1.00 + 2*1.00 + 3*1.05 + 4*1.05 + 5*1.05 + 6*1.50	design(Structural)	2	1,000000	744,41	0,28	0,00	-12,42	0,00
ULS/14=1*1.00 + 2*1.00 + 6*1.50	design(Structural)	2	1,000000	578,31	0,23	0,00	-11,14	0,00
SLS:CHR/1=1*1.00 + 2*1.00 + 3*1.00 + 4*1.00 + 5*1.00 + 6*0.60	Design SLS(permanente)	2	1,000000	745,76	0,29	0,00	-8,92	0,00
SLS:CHR/2=1*1.00 + 2*1.00 + 3*1.00 + 4*1.00 + 5*1.00	Design SLS(permanente)	2	1,000000	751,93	0,30	0,00	-6,62	0,00
SLS:CHR/3=1*1.00 + 2*1.00	Design SLS(permanente)	2	1,000000	593,75	0,26	0,00	-5,40	0,00
SLS:CHR/4=1*1.00 + 2*1.00 + 3*0.70 + 4*0.70 + 5*0.70 + 6*0.60	Design SLS(permanente)	2	1,000000	698,30	0,28	0,00	-8,55	0,00
SLS:CHR/5=1*1.00 + 2*1.00 + 3*0.70 + 4*0.70 + 5*0.70	Design SLS(permanente)	2	1,000000	704,48	0,29	0,00	-6,26	0,00
SLS:CHR/6=1*1.00 + 2*1.00 + 3*0.70 + 4*0.70 + 5*0.70 + 6*1.00	Design SLS(permanente)	2	1,000000	694,19	0,27	0,00	-10,08	0,00
SLS:CHR/7=1*1.00 + 2*1.00 + 6*1.00	Design SLS(permanente)	2	1,000000	583,46	0,24	0,00	-9,23	0,00
SLS:FRE/8=1*1.00 + 2*1.00 + 3*0.50 + 4*0.50 + 5*0.50	Design SLS(permanente)	2	1,000000	672,84	0,28	0,00	-6,01	0,00
SLS:FRE/9=1*1.00 + 2*1.00	Design SLS(permanente)	2	1,000000	593,75	0,26	0,00	-5,40	0,00
SLS:FRE/10=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30	Design SLS(permanente)	2	1,000000	641,20	0,27	0,00	-5,77	0,00
SLS:FRE/11=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30 + 6*0.20	Design SLS(permanente)	2	1,000000	639,14	0,27	0,00	-6,53	0,00
SLS:FRE/12=1*1.00 + 2*1.00 + 6*0.20	Design SLS(permanente)	2	1,000000	591,69	0,26	0,00	-6,17	0,00
SLS:QPR/13=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30	Design SLS(permanente)	2	1,000000	641,20	**0,27**	0,00	**-5,77**	0,00
SLS:QPR/14=1*1.00 + 2*1.00	Design SLS(permanente)	2	1,000000	593,75	**0,26**	0,00	**-5,40**	0,00
ACC:SEI/1=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30 + 11*1.00	design ACC(permanente)	2	1,000000	666,31	0,58	-0,01	-14,51	-0,10
ACC:SEI/2=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30 + 15*1.00	design ACC(permanente)	2	1,000000	668,41	0,66	-0,01	-9,04	-0,10
ACC:SEI/3=1*1.00 + 2*1.00	design ACC(permanente)	2	1,000000	593,75	0,26	0,00	-5,40	0,00
ACC:SEI/4=1*1.00 + 2*1.00 + 11*1.00	design ACC(permanente)	2	1,000000	618,86	0,57	-0,01	-14,14	-0,10
ACC:SEI/5=1*1.00 + 2*1.00 + 15*1.00	design ACC(permanente)	2	1,000000	620,95	0,64	-0,01	-8,67	-0,10
ACC:SEI/6=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30 + 11*-1.00	design ACC(permanente)	2	1,000000	616,09	-0,04	0,01	2,97	0,10
ACC:SEI/7=1*1.00 + 2*1.00 + 3*0.30 + 4*0.30 + 5*0.30 + 15*-1.00	design ACC(permanente)	2	1,000000	614,00	-0,11	0,01	-2,50	0,10
ACC:SEI/8=1*1.00 + 2*1.00 + 11*-1.00	design ACC(permanente)	2	1,000000	568,64	-0,05	0,01	3,34	0,10
ACC:SEI/9=1*1.00 + 2*1.00 + 15*-1.00	design ACC(permanente)	2	1,000000	566,54	-0,12	0,01	-2,13	0,10

γf - load factor

2.5 Calculation results:

Safety factors Rd/Ed = 1,039063 > 1.0

2.5.1 ULS Analysis

Design combination: ULS/1=1*1.35 + 2*1.35 + 3*1.50 + 4*1.50 + 5*1.50 + 6*0.90 (C)
Internal forces:
Nsd = 1029,57 (kN) Msdy = 0,24 (kN*m) Msdz = -7,54 (kN*m)
Design forces:
Cross-section in the middle of the column
N = 1029,57 (kN) N*etotz = 51,38 (kN*m) N*etoty= -84,47 (kN*m)

Eccentricity:		ez (My/N)	ey (Mz/N)
Static	eEd:	0,000 (m)	-0,007 (m)
Imperfection	ei:	0,000 (m)	0,011 (m)
II order	e2:	0,050 (m)	0,063 (m)
Minimal	emin:	0,020 (m)	0,020 (m)
Total	etot:	0,050 (m)	-0,082 (m)

2.5.1.1. Detailed analysis-Direction Y:

2.5.1.1.1 Slenderness analysis

Non-sway structure

L (m)	Lo (m)	λ	λlim	
5,100	5,100	44,167296	17,289299	Slender column

2.5.1.1.2 Buckling analysis

M2 = 0,40 (kN*m) M1 = 0,00 (kN*m) Mmid = 0,24 (kN*m)
Case: Cross-section in the middle of the column, Slenderness taken into account
M0 = M0e = 0.6*M02+0.4*M01 = 0,24 (kN*m)
M0emin = 0.4*M02
ea = 0,000 (m)
Method based on nominal curvature
M2 = N * e2 = 51,14 (kN*m)
e2 = lo^2 / c * (1/r) = 0,050 (m)
c = 10,000000
(1/r) = Kr*Kϕ*(1/r0) = 0,019096
Kr = 0,907141
Kϕ = 1 + β*φef = 1,458853
β = 0.35+fck/200-λ/150 = 0,205551
φef = 2,232301
1/r0 =(fyd/Es)/(0.45*d) = 0,014430
d = 0,350 (m) (5.35)
Es = 200000,00 (MPa)
fyd = 454,55 (MPa)
MEdmin = 20,59 (kN*m)
MEd = max(MEdmin,M0Ed + M2) = 51,38 (kN*m)

2.5.1.2. Detailed analysis-Direction Z:

2.5.1.2.1 Slenderness analysis

Non-sway structure

L (m)	Lo (m)	λ	λlim	
5,100	5,100	70,667673	17,289299	Slender column

2.5.1.2.2 Buckling analysis

M2 = 0,00 (kN*m) M1 = -12,57 (kN*m) Mmid = -7,54 (kN*m)
Case: Cross-section in the middle of the column, Slenderness taken into account
M0 = M0e = 0.6*M02+0.4*M01 = -7,54 (kN*m)
M0emin = 0.4*M02
ea = θi*lo/2 = 0,011 (m)

θ1 = θo ∗ αh * αm = 0,004428
θo = 0,005000
αh = 0,885615
αm = (0,5(1+1/m))^0.5 = 1,000000
m = 1,000000

Method based on nominal curvature

M2 = N * e2 = 65,30 (kN*m)
e2 = lo^2 / c * (1/r) = 0,063 (m)
c = 10,000000
(1/r) = Kr*Kϕ*(1/r0) = 0,024385
Kr = 0,907141
Kϕ = 1 + β*φef = 1,064474
β = 0.35+fck/200-λ/150 = 0,028882
φef = 2,232301
1/r0 =(fyd/Es)/(0.45*d) = 0,025253
d = 0,200 (m) (5.35)
Es = 200000,00 (MPa)
fyd = 454,55 (MPa)

MEdmin = 20,59 (kN*m)
MEd = max(MEdmin,M0Ed + M2) = -84,47 (kN*m)

2.5.2 SLS analysis

- **Cracking**

Design combination: SLS:CHR/1=1*1.00 + 2*1.00 + 3*1.00 + 4*1.00 + 5*1.00 + 6*0.60 (A)
Internal forces:
N = 745,76 (kN) My = 0,29 (kN*m) Mz = -8,92 (kN*m)

$\sigma(N,My,Mz) < \sigma_{cr}(N,My,Mz, A_s = 0)$
Wkmax = 0,300 (mm)
Wk = 0,000 (mm)

Stresses in steel

Design combination: SLS:CHR/1=1*1.00 + 2*1.00 + 3*1.00 + 4*1.00 + 5*1.00 + 6*0.60 (A)
Internal forces:
N = 745,76 (kN) My = 0,29 (kN*m) Mz = -8,92 (kN*m)

$\sigma(N,My,Mz) < \sigma_{cr}(N,My,Mz, A_s = 0)$

σs_{lim} = 400,00 (MPa)

α_{axis} = 0,65172 (Deg)

ξ_{axis} = 0,442 (m)

σs_{max} = 140,98 (MPa)
y = 0,050 (m)
z = 0,050 (m)

σs_{min} = 99,33 (MPa)
y = 0,200 (m)
z = 0,350 (m)

$\sigma s_{lim}/\sigma s$ = 2,837229

Stress in concrete

Design combination: SLS:CHR/1=1*1.00 + 2*1.00 + 3*1.00 + 4*1.00 + 5*1.00 + 6*0.60 (A)
Internal forces:
N = 745,76 (kN) My = 0,29 (kN*m) Mz = -8,92 (kN*m)

$\sigma(N,My,Mz) < \sigma_{cr}(N,My,Mz, A_s = 0)$

σc_{lim} = 13,50 (MPa)

α_{axis} = 0,65172 (Deg)

ξ_{axis} = 0,442 (m)

σc_{max} = 7,66 (MPa)

σc_{min} = 0,00 (MPa)

$\sigma c_{lim}/\sigma c_{max}$ = 1,762773

2.5.3 Reinforcement:

Real (provided) area	Asr = 12,566 (cm2)
Ratio:	ρ = 1,256637 %

2.6 Reinforcement:

Main bars (B500B):

- 4 ϕ20 l = 5,270 (m)

Transversal reinforcement: (B500B):

stirrups:	24 ϕ8	l = 1,156 (m)
pins	24 ϕ8	l = 1,156 (m)

3 Material survey:

- Concrete volume = 0,490 (m3)
- Formwork = 6,370 (m2)

- Steel B500B
  - Total weight = 62,960 (kG)
  - Density = 128,490 (kG/m3)
  - Average diameter = 13,180 (mm)
  - Reinforcement survey:

Diameter	Length (m)	Weight (kG)	Number (No.)	Total weight (kG)
8	1,156	0,456	24	10,956
20	5,270	13,001	4	52,004