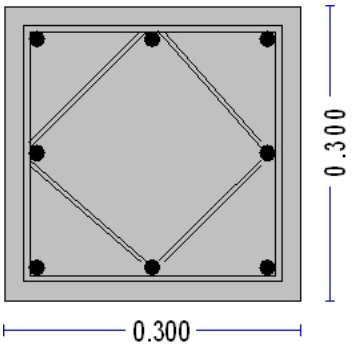
Example Columns

1. COLUMN-001



Column cross section in biaxial bending
(EC2 EN1992-1-1:2004, EC0 EN1990-1-1:2002)

b =0.300 m, h =0.300 m, Nsd =200.00 kN
Msd xx = 50.00 kNm, Msd yy = 50.00 kNm

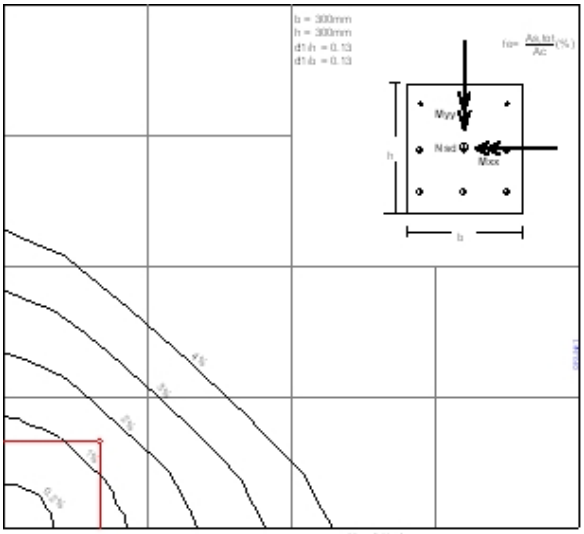
Concrete-Steel class: C25/30-S500 (EC2 §3)
Concrete cover : Cnom=20 mm (EC2 §4.4.1)
γc=1.50, γs=1.15 (EC2 Table 2.1N)

1.1. Dimensions and loads

Column of rectangular cross section b=0.300 m, h=0.300 m
Loads, axial Nsd=200.00 kN (compression), moments Msdxx=50.00 kNm, Msdyy=50.00 kNm
Effective depth of cross section d=h-d1, d1=d2=Cnomc+Øs+Ø/2=20+8+20/2=38mm, dx=262mm, dy=262mm

1.2. Design for compression with small eccentricity (EC2 §6.1, §9.2.1)

Approximate design from Tables (d1/h=0.10)
Kordina K, Bemessungshilfsmittel zu EC 2 Teil 1
Planung von Stahlbeton ..., Berlin, Beuth, 1992
Mx/(bh²fcd)=0.11, My/(hb²fcd)=0.11, N/(bh·fcd)=-0.13
As·fyk/(bh·fck)=0.39, As= 1345mm², As/Ac=1.49%



Design using numerical integration
Design chart for double bending and axial force
obtained from numerical integration using a
grid of 10x10=100 cross-section subdivisions
Nsd=200.00kN (compression),
Msdxx=50.00kNm, Msdyy=50.00kNm
C25/30-S500
b=300mm, h=300mm
dx=262mm, dy=262mm, d1=d2=38mm
d1/h=0.127, d2/b=0.127
ey=Msdxx/Nsd= 50.00/200.00=0.250m=250mm
ex=Msdyy/Nsd= 50.00/200.00=0.250m=250mm
zsy=h/2-d1=300/2-38=112mm, e=250mm>szy=112mm
zsx=b/2-d1=300/2-38=112mm, e=250mm>szx=112mm
As,tot=1350mm², As,tot/Ac=1.50%

As,tot=13.50cm²

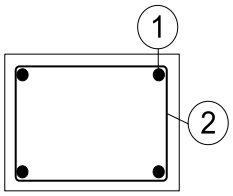
Minimum longitudinal reinforcement, As>=0.0020Ac, Øs>=8, As,min=4Ø8(2.01cm²) (EC2 §9.5.2.2)
Maximum longitudinal reinforcement, As<=0.04Ac, (As,max=36.00cm²) (EC2 §9.5.2.3)
Transverse reinforcement, links with minimum Øs at maximum spacing Scl,t (EC2 §9.5.3)
at column heights from 0.30m to H-0.30m: Links Øs>=6, Scl,t<=300mm
at regions 0 to 0.30m and H-0.30m to H : Links Øs>=6, Scl,t<=180mm
Basic required anchorage length Lbd=390mm =0.390m (EC2 Eq.8.3)

Longitudinal reinforcement: 8Ø16 (16.08cm²)

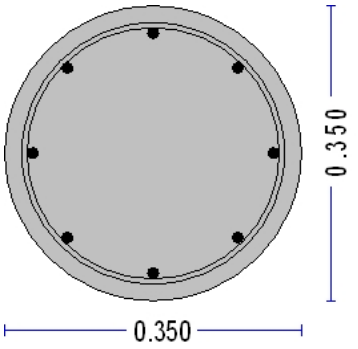
Tranverse reinforcement: Links 2Ø8/30.0 [h:0.30m~H-0.30m], **2Ø8/18.0** [h:0~0.30m, H-0.30m~H]

1.3. Reinforcing bar schedule

Num	type	reinforcing bar [mm]	items	∅	g/m [kg/m]	length [m]	weight [kg]
1	1	3000	8	16	1.580	3.000	37.92
2	2	80 250 80 250 250 250	13	8	0.395	1.160	5.96
3	2	80 180 80 180 180 180	13	8	0.395	0.880	4.52
		Total weight [kg]					**48.40**



2. COLUMN-002



Column cross section in biaxial bending
(EC2 EN1992-1-1:2004, EC0 EN1990-1-1:2002)

D =0.350 m, Nsd =250.00 kN
Msd xx = 62.50 kNm, Msd yy = 37.50 kNm
Concrete-Steel class: C25/30-S500 (EC2 §3)
Concrete cover : Cnom=20 mm (EC2 §4.4.1)
γc=1.50, γs=1.15 (EC2 Table 2.1N)

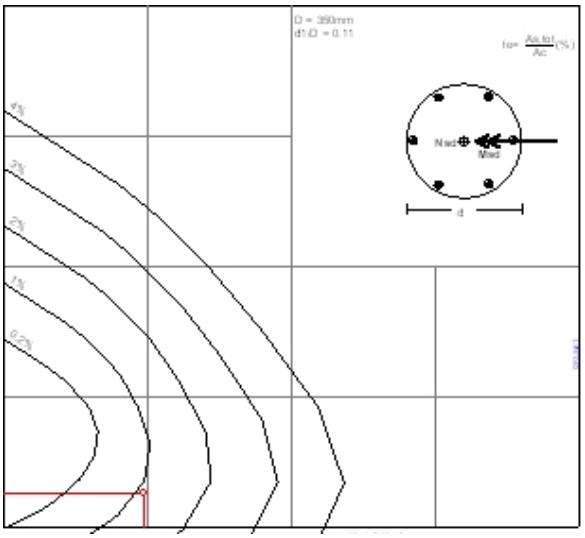
2.1. Dimensions and loads

Circular column with diameter D=0.350 m
Loads, axial Nsd=250.00 kN (compression), moments Msdxx=62.50 kNm, Msdyy=37.50 kNm
Effective depth of cross section d=h-d1, d1=d2=Cnomc+Øs+Ø/2=20+8+20/2=38mm, d=312mm

2.2. Design for compression with small eccentricity

(EC2 §6.1, §9.2.1)

Kordina K, Bemessungshilfsmittel zu EC 2 Teil 1
Planung von Stahlbeton ..., Berlin, Beuth, 1992
Msd/(2x3.14r³fcd)=0.13, Nd/(3.14r²fcd)=-0.16
As·fyk/(bh·fck)=0.27, As= 995mm², As/Ac=1.03%



Design using numerical integration
Design chart for single bending and axial force
obtained from numerical integration of the
concrete and steel forces over the cross-section
Msd=(62.50²+37.50²)½ =72.89kNm
Nsd=250.00kN (compression), Msd=72.89kNm
C25/30-S500
D=350mm
d=312mm, d1= 38mm, d2= 38mm, d1/D=0.109
e=Msd/Nsd=72.89/250.00=0.292m=292mm
zs=h/2-d1=350/2-38=137mm, e=292mm>sz=137mm
As1=As2=601mm², (As1+As2)/Ac=1.25%
ec2/es1=-3.50/-3.81

As,tot=12.03cm²

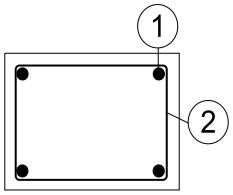
Minimum longitudinal reinforcement, As>=0.0020Ac, Øs>=8, As,min=6Ø8(3.02cm²) (EC2 §9.5.2.2)
Maximum longitudinal reinforcement, As<=0.04Ac, (As,max=38.48cm²) (EC2 §9.5.2.3)
Transverse reinforcement, links with minimum Øs at maximum spacing Scl,t (EC2 §9.5.3)
at column heights from 0.35m to H-0.35m: Links Øs>=6, Scl,t<=20x14=280m
at regions 0 to 0.35m and H-0.35m to H : Links Øs>=6, Scl,t<=12x14=168m
Basic required anchorage length Lbd=350mm =0.350m (EC2 Eq.8.3)

Longitudinal reinforcement: 8Ø14 (12.32cm²)

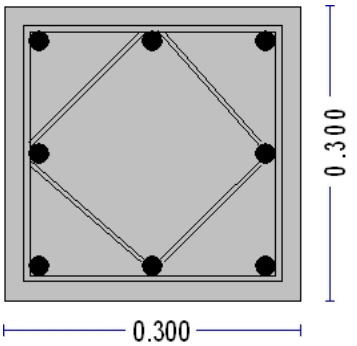
Tranverse reinforcement: Links Ø8/28.0 [h:0.35m~H-0.35m] , **Ø8/17.0** [h:0~0.35m, H-0.35m~H]

2.3. Reinforcing bar schedule

Num	type	reinforcing bar [mm]	items	∅	g/m [kg/m]	length [m]	weight [kg]
4	1	3000	8	14	1.210	3.000	29.04
5	2	80 290 80 290 290 290	13	8	0.395	1.320	6.78
		Total weight [kg]					**35.82**



3. COLUMN-003



Strength of column (double eccentricity)
(EC2 EN1992-1-1:2004, EC0 EN1990-1-1:2002)

b =0.300 m, h =0.300 m
As=4Ø20+4Ø16 (20.60cm²)
Concrete-Steel class: C25/30-S500 (EC2 §3)
Concrete cover : Cnom=20 mm (EC2 §4.4.1)
γc=1.50, γs=1.15 (EC2 Table 2.1N)

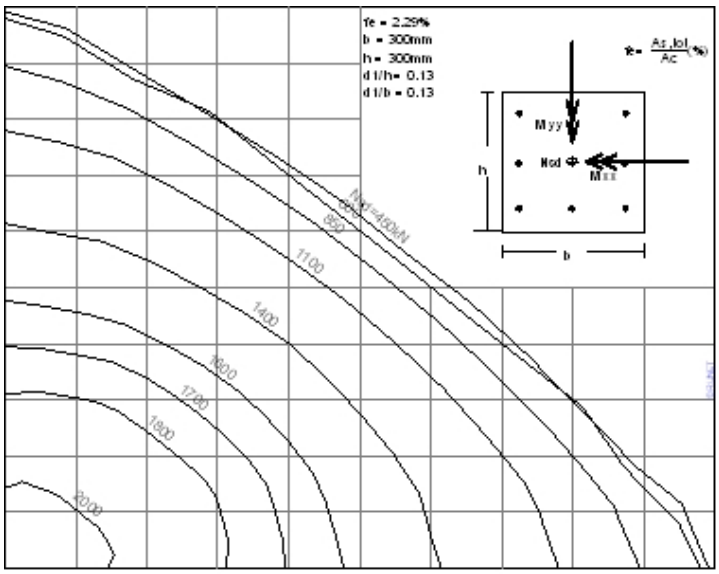
Dimensions and loads
Column of rectangular cross section b=0.300 m, h=0.300 m
Reinforcement 4Ø20+4Ø16(20.60cm²) Astot/Ac=2.29%
Effective depth of cross section d=h-d1, d1=d2=Cnomc+Øs+Ø/2=20+8+20/2=38mm, dx=262mm, dy=262mm

3.1. Capacity of column cross-section (double eccentricity)

(EC2 EN1992-1-1:2004, §6.1)

Design chart for column capacity
obtained from numerical
integration using a
grid of 10x10=100
cross-section subdivisions

b=0.30m, h=0.30m
d1/h=0.13, d1/b=0.13
Fe=4Ø20+4Ø16
Astot=(20.60cm²)
Astot/Ac=2.29%



Neutral axis slope θ=0.00°								Neutral axis slope θ=7.50°							
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	1619	Mxx=	56	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1950	Mxx=	24	Myy=	4	(ec2/es1=-3.50/-3.50)	
N=	1527	Mxx=	64	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1906	Mxx=	28	Myy=	5	(ec2/es1=-3.50/-3.50)	
N=	1443	Mxx=	70	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1849	Mxx=	33	Myy=	5	(ec2/es1=-3.50/-3.50)	
N=	1343	Mxx=	78	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1780	Mxx=	40	Myy=	6	(ec2/es1=-3.50/-3.50)	
N=	1250	Mxx=	84	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1696	Mxx=	47	Myy=	7	(ec2/es1=-3.50/-3.50)	
N=	1137	Mxx=	91	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1591	Mxx=	57	Myy=	8	(ec2/es1=-3.50/-3.50)	
N=	1030	Mxx=	98	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1471	Mxx=	67	Myy=	8	(ec2/es1=-3.50/-3.50)	
N=	772	Mxx=	112	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1205	Mxx=	85	Myy=	9	(ec2/es1=-3.50/-3.50)	
N=	520	Mxx=	120	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	892	Mxx=	102	Myy=	10	(ec2/es1=-3.50/-3.50)	
N=	327	Mxx=	117	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	510	Mxx=	117	Myy=	10	(ec2/es1=-3.50/-3.50)	
N=	69	Mxx=	108	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	196	Mxx=	108	Myy=	13	(ec2/es1=-3.50/-3.50)	
N=	-50	Mxx=	97	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3	Mxx=	98	Myy=	13	(ec2/es1=-3.50/-3.50)	
N=	-227	Mxx=	77	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-264	Mxx=	73	Myy=	12	(ec2/es1=-3.50/-3.50)	
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-888	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)	
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=10.00°												Neutral axis slope θ=15.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	1932	Mxx=	25	Myy=	5	(ec2/es1=-3.50/-3.50)						N=	1898	Mxx=	28	Myy=	8	(ec2/es1=-3.50/-3.50)				
N=	1885	Mxx=	30	Myy=	6	(ec2/es1=-3.50/-3.50)						N=	1846	Mxx=	33	Myy=	10	(ec2/es1=-3.50/-3.50)				
N=	1825	Mxx=	35	Myy=	7	(ec2/es1=-3.50/-3.50)						N=	1781	Mxx=	38	Myy=	11	(ec2/es1=-3.50/-3.50)				
N=	1753	Mxx=	42	Myy=	8	(ec2/es1=-3.50/-3.50)						N=	1701	Mxx=	45	Myy=	13	(ec2/es1=-3.50/-3.50)				
N=	1664	Mxx=	50	Myy=	9	(ec2/es1=-3.50/-3.50)						N=	1605	Mxx=	54	Myy=	14	(ec2/es1=-3.50/-3.50)				
N=	1556	Mxx=	59	Myy=	10	(ec2/es1=-3.50/-3.50)						N=	1494	Mxx=	63	Myy=	16	(ec2/es1=-3.50/-3.50)				
N=	1434	Mxx=	69	Myy=	11	(ec2/es1=-3.50/-3.50)						N=	1370	Mxx=	72	Myy=	16	(ec2/es1=-3.50/-3.50)				
N=	1165	Mxx=	87	Myy=	12	(ec2/es1=-3.50/-3.50)						N=	1087	Mxx=	89	Myy=	18	(ec2/es1=-3.50/-3.50)				
N=	844	Mxx=	103	Myy=	13	(ec2/es1=-3.50/-3.50)						N=	746	Mxx=	102	Myy=	22	(ec2/es1=-3.50/-3.50)				
N=	463	Mxx=	115	Myy=	14	(ec2/es1=-3.50/-3.50)						N=	362	Mxx=	108	Myy=	22	(ec2/es1=-3.50/-3.50)				
N=	130	Mxx=	103	Myy=	17	(ec2/es1=-3.50/-3.50)						N=	14	Mxx=	93	Myy=	26	(ec2/es1=-3.50/-3.50)				
N=	-55	Mxx=	92	Myy=	16	(ec2/es1=-3.50/-3.50)						N=	-168	Mxx=	79	Myy=	23	(ec2/es1=-3.50/-3.50)				
N=	-334	Mxx=	65	Myy=	16	(ec2/es1=-3.50/-3.50)						N=	-467	Mxx=	50	Myy=	23	(ec2/es1=-3.50/-3.50)				
N=	-889	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	-891	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)				
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=22.50°												Neutral axis slope θ=30.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	1856	Mxx=	31	Myy=	13	(ec2/es1=-3.50/-3.50)						N=	1825	Mxx=	32	Myy=	18	(ec2/es1=-3.50/-3.50)				
N=	1799	Mxx=	36	Myy=	15	(ec2/es1=-3.50/-3.50)						N=	1759	Mxx=	37	Myy=	21	(ec2/es1=-3.50/-3.50)				
N=	1726	Mxx=	42	Myy=	17	(ec2/es1=-3.50/-3.50)						N=	1679	Mxx=	43	Myy=	24	(ec2/es1=-3.50/-3.50)				
N=	1638	Mxx=	49	Myy=	20	(ec2/es1=-3.50/-3.50)						N=	1584	Mxx=	49	Myy=	28	(ec2/es1=-3.50/-3.50)				
N=	1534	Mxx=	57	Myy=	22	(ec2/es1=-3.50/-3.50)						N=	1476	Mxx=	56	Myy=	31	(ec2/es1=-3.50/-3.50)				
N=	1415	Mxx=	65	Myy=	24	(ec2/es1=-3.50/-3.50)						N=	1353	Mxx=	63	Myy=	34	(ec2/es1=-3.50/-3.50)				
N=	1282	Mxx=	73	Myy=	26	(ec2/es1=-3.50/-3.50)						N=	1217	Mxx=	70	Myy=	37	(ec2/es1=-3.50/-3.50)				
N=	980	Mxx=	87	Myy=	30	(ec2/es1=-3.50/-3.50)						N=	893	Mxx=	82	Myy=	41	(ec2/es1=-3.50/-3.50)				
N=	610	Mxx=	98	Myy=	35	(ec2/es1=-3.50/-3.50)						N=	514	Mxx=	89	Myy=	46	(ec2/es1=-3.50/-3.50)				
N=	227	Mxx=	96	Myy=	34	(ec2/es1=-3.50/-3.50)						N=	120	Mxx=	84	Myy=	46	(ec2/es1=-3.50/-3.50)				
N=	-120	Mxx=	78	Myy=	34	(ec2/es1=-3.50/-3.50)						N=	-219	Mxx=	66	Myy=	41	(ec2/es1=-3.50/-3.50)				
N=	-309	Mxx=	63	Myy=	31	(ec2/es1=-3.50/-3.50)						N=	-407	Mxx=	51	Myy=	37	(ec2/es1=-3.50/-3.50)				
N=	-584	Mxx=	36	Myy=	26	(ec2/es1=-3.50/-3.50)						N=	-640	Mxx=	29	Myy=	25	(ec2/es1=-3.50/-3.50)				
N=	-893	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-895	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)				

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=37.50°												Neutral axis slope θ=45.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	1798	Mxx=	30	Myy=	23	(ec2/es1=-3.50/-3.50)						N=	1790	Mxx=	27	Myy=	27	(ec2/es1=-3.50/-3.50)			
N=	1730	Mxx=	35	Myy=	27	(ec2/es1=-3.50/-3.50)						N=	1720	Mxx=	32	Myy=	32	(ec2/es1=-3.50/-3.50)			
N=	1649	Mxx=	40	Myy=	31	(ec2/es1=-3.50/-3.50)						N=	1638	Mxx=	37	Myy=	37	(ec2/es1=-3.50/-3.50)			
N=	1553	Mxx=	46	Myy=	35	(ec2/es1=-3.50/-3.50)						N=	1544	Mxx=	42	Myy=	42	(ec2/es1=-3.50/-3.50)			
N=	1443	Mxx=	52	Myy=	39	(ec2/es1=-3.50/-3.50)						N=	1432	Mxx=	47	Myy=	47	(ec2/es1=-3.50/-3.50)			
N=	1318	Mxx=	58	Myy=	43	(ec2/es1=-3.50/-3.50)						N=	1303	Mxx=	52	Myy=	52	(ec2/es1=-3.50/-3.50)			
N=	1174	Mxx=	64	Myy=	47	(ec2/es1=-3.50/-3.50)						N=	1157	Mxx=	56	Myy=	56	(ec2/es1=-3.50/-3.50)			
N=	838	Mxx=	74	Myy=	53	(ec2/es1=-3.50/-3.50)						N=	817	Mxx=	64	Myy=	64	(ec2/es1=-3.50/-3.50)			
N=	451	Mxx=	78	Myy=	57	(ec2/es1=-3.50/-3.50)						N=	425	Mxx=	68	Myy=	68	(ec2/es1=-3.50/-3.50)			
N=	54	Mxx=	73	Myy=	56	(ec2/es1=-3.50/-3.50)						N=	34	Mxx=	64	Myy=	64	(ec2/es1=-3.50/-3.50)			
N=	-285	Mxx=	57	Myy=	46	(ec2/es1=-3.50/-3.50)						N=	-322	Mxx=	51	Myy=	51	(ec2/es1=-3.50/-3.50)			
N=	-448	Mxx=	44	Myy=	39	(ec2/es1=-3.50/-3.50)						N=	-460	Mxx=	41	Myy=	41	(ec2/es1=-3.50/-3.50)			
N=	-679	Mxx=	25	Myy=	24	(ec2/es1=-3.50/-3.50)						N=	-681	Mxx=	24	Myy=	24	(ec2/es1=-3.50/-3.50)			
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=52.50°												Neutral axis slope θ=60.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	1798	Mxx=	23	Myy=	30	(ec2/es1=-3.50/-3.50)						N=	1825	Mxx=	18	Myy=	32	(ec2/es1=-3.50/-3.50)			
N=	1730	Mxx=	27	Myy=	35	(ec2/es1=-3.50/-3.50)						N=	1759	Mxx=	21	Myy=	37	(ec2/es1=-3.50/-3.50)			
N=	1649	Mxx=	31	Myy=	40	(ec2/es1=-3.50/-3.50)						N=	1679	Mxx=	24	Myy=	43	(ec2/es1=-3.50/-3.50)			
N=	1553	Mxx=	35	Myy=	46	(ec2/es1=-3.50/-3.50)						N=	1584	Mxx=	28	Myy=	49	(ec2/es1=-3.50/-3.50)			
N=	1443	Mxx=	39	Myy=	52	(ec2/es1=-3.50/-3.50)						N=	1476	Mxx=	31	Myy=	56	(ec2/es1=-3.50/-3.50)			
N=	1318	Mxx=	43	Myy=	58	(ec2/es1=-3.50/-3.50)						N=	1353	Mxx=	34	Myy=	63	(ec2/es1=-3.50/-3.50)			
N=	1174	Mxx=	47	Myy=	64	(ec2/es1=-3.50/-3.50)						N=	1217	Mxx=	37	Myy=	70	(ec2/es1=-3.50/-3.50)			
N=	838	Mxx=	53	Myy=	74	(ec2/es1=-3.50/-3.50)						N=	893	Mxx=	41	Myy=	82	(ec2/es1=-3.50/-3.50)			
N=	451	Mxx=	57	Myy=	78	(ec2/es1=-3.50/-3.50)						N=	514	Mxx=	46	Myy=	89	(ec2/es1=-3.50/-3.50)			
N=	54	Mxx=	56	Myy=	73	(ec2/es1=-3.50/-3.50)						N=	120	Mxx=	46	Myy=	84	(ec2/es1=-3.50/-3.50)			
N=	-285	Mxx=	46	Myy=	57	(ec2/es1=-3.50/-3.50)						N=	-219	Mxx=	41	Myy=	66	(ec2/es1=-3.50/-3.50)			
N=	-448	Mxx=	39	Myy=	44	(ec2/es1=-3.50/-3.50)						N=	-407	Mxx=	37	Myy=	51	(ec2/es1=-3.50/-3.50)			
N=	-679	Mxx=	24	Myy=	25	(ec2/es1=-3.50/-3.50)						N=	-640	Mxx=	25	Myy=	29	(ec2/es1=-3.50/-3.50)			
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-895	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=67.50°												Neutral axis slope θ=75.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	1856	Mxx=	13	Myy=	31	(ec2/es1=-3.50/-3.50)						N=	1898	Mxx=	8	Myy=	28	(ec2/es1=-3.50/-3.50)					
N=	1799	Mxx=	15	Myy=	36	(ec2/es1=-3.50/-3.50)						N=	1846	Mxx=	10	Myy=	33	(ec2/es1=-3.50/-3.50)					
N=	1726	Mxx=	17	Myy=	42	(ec2/es1=-3.50/-3.50)						N=	1781	Mxx=	11	Myy=	38	(ec2/es1=-3.50/-3.50)					
N=	1638	Mxx=	20	Myy=	49	(ec2/es1=-3.50/-3.50)						N=	1701	Mxx=	13	Myy=	45	(ec2/es1=-3.50/-3.50)					
N=	1534	Mxx=	22	Myy=	57	(ec2/es1=-3.50/-3.50)						N=	1605	Mxx=	14	Myy=	54	(ec2/es1=-3.50/-3.50)					
N=	1415	Mxx=	24	Myy=	65	(ec2/es1=-3.50/-3.50)						N=	1494	Mxx=	16	Myy=	63	(ec2/es1=-3.50/-3.50)					
N=	1282	Mxx=	26	Myy=	73	(ec2/es1=-3.50/-3.50)						N=	1370	Mxx=	16	Myy=	72	(ec2/es1=-3.50/-3.50)					
N=	980	Mxx=	30	Myy=	87	(ec2/es1=-3.50/-3.50)						N=	1087	Mxx=	18	Myy=	89	(ec2/es1=-3.50/-3.50)					
N=	610	Mxx=	35	Myy=	98	(ec2/es1=-3.50/-3.50)						N=	746	Mxx=	22	Myy=	102	(ec2/es1=-3.50/-3.50)					
N=	227	Mxx=	34	Myy=	96	(ec2/es1=-3.50/-3.50)						N=	362	Mxx=	22	Myy=	108	(ec2/es1=-3.50/-3.50)					
N=	-120	Mxx=	34	Myy=	78	(ec2/es1=-3.50/-3.50)						N=	14	Mxx=	26	Myy=	93	(ec2/es1=-3.50/-3.50)					
N=	-309	Mxx=	31	Myy=	63	(ec2/es1=-3.50/-3.50)						N=	-168	Mxx=	23	Myy=	79	(ec2/es1=-3.50/-3.50)					
N=	-584	Mxx=	26	Myy=	36	(ec2/es1=-3.50/-3.50)						N=	-467	Mxx=	23	Myy=	50	(ec2/es1=-3.50/-3.50)					
N=	-893	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-891	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)					
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=82.50°												Neutral axis slope θ=90.00°											
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	2171	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	1950	Mxx=	4	Myy=	24	(ec2/es1=-3.50/-3.50)						N=	1619	Mxx=	0	Myy=	56	(ec2/es1=-3.50/-3.50)					
N=	1906	Mxx=	5	Myy=	28	(ec2/es1=-3.50/-3.50)						N=	1527	Mxx=	0	Myy=	64	(ec2/es1=-3.50/-3.50)					
N=	1849	Mxx=	5	Myy=	33	(ec2/es1=-3.50/-3.50)						N=	1443	Mxx=	0	Myy=	70	(ec2/es1=-3.50/-3.50)					
N=	1780	Mxx=	6	Myy=	40	(ec2/es1=-3.50/-3.50)						N=	1343	Mxx=	0	Myy=	78	(ec2/es1=-3.50/-3.50)					
N=	1696	Mxx=	7	Myy=	47	(ec2/es1=-3.50/-3.50)						N=	1250	Mxx=	0	Myy=	84	(ec2/es1=-3.50/-3.50)					
N=	1591	Mxx=	8	Myy=	57	(ec2/es1=-3.50/-3.50)						N=	1137	Mxx=	0	Myy=	91	(ec2/es1=-3.50/-3.50)					
N=	1471	Mxx=	8	Myy=	67	(ec2/es1=-3.50/-3.50)						N=	1030	Mxx=	0	Myy=	98	(ec2/es1=-3.50/-3.50)					
N=	1205	Mxx=	9	Myy=	85	(ec2/es1=-3.50/-3.50)						N=	772	Mxx=	0	Myy=	112	(ec2/es1=-3.50/-3.50)					
N=	892	Mxx=	10	Myy=	102	(ec2/es1=-3.50/-3.50)						N=	520	Mxx=	0	Myy=	120	(ec2/es1=-3.50/-3.50)					
N=	510	Mxx=	10	Myy=	117	(ec2/es1=-3.50/-3.50)						N=	327	Mxx=	0	Myy=	117	(ec2/es1=-3.50/-3.50)					
N=	196	Mxx=	13	Myy=	108	(ec2/es1=-3.50/-3.50)						N=	69	Mxx=	0	Myy=	108	(ec2/es1=-3.50/-3.50)					
N=	3	Mxx=	13	Myy=	98	(ec2/es1=-3.50/-3.50)						N=	-50	Mxx=	0	Myy=	97	(ec2/es1=-3.50/-3.50)					
N=	-264	Mxx=	12	Myy=	73	(ec2/es1=-3.50/-3.50)						N=	-227	Mxx=	0	Myy=	77	(ec2/es1=-3.50/-3.50)					
N=	-888	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					
N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	-896	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)					

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

4. COLUMN-004

Strength of Column with FRP jacket (double eccentricity)

(EC2 EN1992-1-1:2004, EC0 EN1990-1-1:2002)

b =0.300 m, h =0.300 m

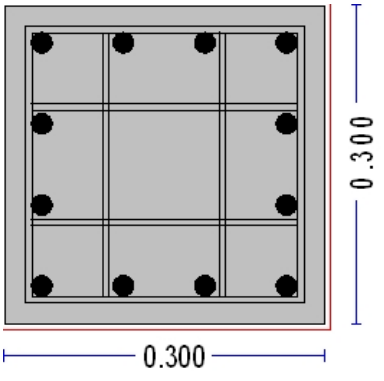
As=8Ø20+4Ø16 (33.16cm²)

GFRP Glass fiber-epoxy, t(FRP)= 3.50 mm

Concrete-Steel class: C25/30-S500 (EC2 §3)

Concrete cover : Cnom=20 mm (EC2 §4.4.1)

γc=1.50, γs=1.15 (EC2 Table 2.1N)



Dimensions and loads

Column of rectangular cross section b=0.300 m, h=0.300 m
Reinforcement 8Ø20+4Ø16(33.16cm²) Astot/Ac=3.68%
Effective depth of cross section d=h-d1, d1=d2=Cnomc+Øs+Ø/2=20+8+20/2=38mm, dx=262mm, dy=262mm

Fibre Reinforced Polymer material (FRP)

Characteristic name : GFRP Glass fiber-epoxy
Total thickness : 3.50 mm
Modulus of elasticity : 35 GPa
Tensile strength : 800 MPa

4.1. Increase of column shear strength

Vsf=a.ef.Ef.tf.b=2.86x0.002x35.0x3.500x300=210kN
(assumed effective design strain εf=0.002, shape coefficient a=2.86)

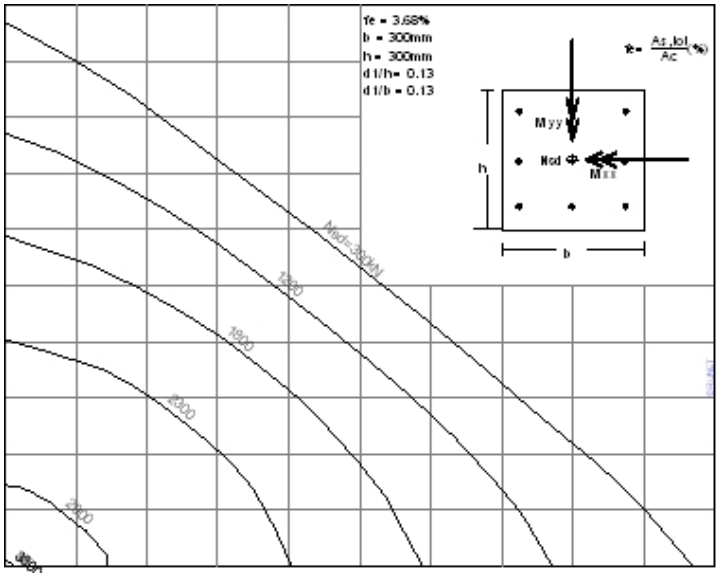
4.2. Capacity of column cross-section strengthened with FRP jacket (double eccentricity)

(EC2 EN1992-1-1:2004, §6.1)

Design chart for column capacity obtained from numerical integration using a grid of 10x10=100 cross-section subdivisions

b=0.30m, h=0.30m
d1/h=0.13, d1/b=0.13
Fe=8Ø20+4Ø16
Astot=(33.16cm²)
Astot/Ac=3.68%

FRP:GFRP Glass fiber-epoxy
FRP: t=3.50 mm
FRP: Ef=35 GPa



Neutral axis slope θ=0.00°								Neutral axis slope θ=7.50°							
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3227	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3228	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3222	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3224	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3206	Mxx=	3	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3212	Mxx=	2	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3181	Mxx=	5	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3191	Mxx=	4	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3146	Mxx=	9	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3164	Mxx=	6	Myy=	1	(ec2/es1=-3.50/-3.50)	
N=	2233	Mxx=	99	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2709	Mxx=	52	Myy=	8	(ec2/es1=-3.50/-3.50)	
N=	2107	Mxx=	111	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2639	Mxx=	59	Myy=	9	(ec2/es1=-3.50/-3.50)	
N=	1984	Mxx=	121	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2553	Mxx=	66	Myy=	10	(ec2/es1=-3.50/-3.50)	
N=	1841	Mxx=	132	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2451	Mxx=	75	Myy=	11	(ec2/es1=-3.50/-3.50)	
N=	1700	Mxx=	143	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2329	Mxx=	86	Myy=	12	(ec2/es1=-3.50/-3.50)	
N=	1532	Mxx=	155	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2182	Mxx=	99	Myy=	13	(ec2/es1=-3.50/-3.50)	
N=	1363	Mxx=	166	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	2014	Mxx=	113	Myy=	14	(ec2/es1=-3.50/-3.50)	
N=	949	Mxx=	194	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1626	Mxx=	142	Myy=	16	(ec2/es1=-3.50/-3.50)	
N=	520	Mxx=	218	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	1144	Mxx=	173	Myy=	18	(ec2/es1=-3.50/-3.50)	
N=	143	Mxx=	227	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	518	Mxx=	207	Myy=	19	(ec2/es1=-3.50/-3.50)	
N=	-425	Mxx=	238	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-69	Mxx=	210	Myy=	26	(ec2/es1=-3.50/-3.50)	
N=	-743	Mxx=	241	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-470	Mxx=	210	Myy=	28	(ec2/es1=-3.50/-3.50)	
N=	-1433	Mxx=	257	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-1182	Mxx=	207	Myy=	31	(ec2/es1=-3.50/-3.50)	
N=	-3471	Mxx=	186	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-3537	Mxx=	170	Myy=	24	(ec2/es1=-3.50/-3.50)	
N=	-3704	Mxx=	163	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	-4012	Mxx=	116	Myy=	28	(ec2/es1=-3.50/-3.50)	

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=10.00°								Neutral axis slope θ=15.00°							
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3228	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3228	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3224	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3223	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3211	Mxx=	2	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3210	Mxx=	2	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3190	Mxx=	4	Myy=	1	(ec2/es1=-3.50/-3.50)		N=	3188	Mxx=	4	Myy=	1	(ec2/es1=-3.50/-3.50)	
N=	3162	Mxx=	6	Myy=	1	(ec2/es1=-3.50/-3.50)		N=	3158	Mxx=	6	Myy=	2	(ec2/es1=-3.50/-3.50)	
N=	2678	Mxx=	54	Myy=	10	(ec2/es1=-3.50/-3.50)		N=	2621	Mxx=	57	Myy=	16	(ec2/es1=-3.50/-3.50)	
N=	2605	Mxx=	61	Myy=	12	(ec2/es1=-3.50/-3.50)		N=	2542	Mxx=	64	Myy=	18	(ec2/es1=-3.50/-3.50)	
N=	2515	Mxx=	69	Myy=	13	(ec2/es1=-3.50/-3.50)		N=	2444	Mxx=	72	Myy=	20	(ec2/es1=-3.50/-3.50)	
N=	2408	Mxx=	78	Myy=	14	(ec2/es1=-3.50/-3.50)		N=	2329	Mxx=	82	Myy=	22	(ec2/es1=-3.50/-3.50)	
N=	2281	Mxx=	89	Myy=	16	(ec2/es1=-3.50/-3.50)		N=	2193	Mxx=	93	Myy=	24	(ec2/es1=-3.50/-3.50)	
N=	2130	Mxx=	102	Myy=	18	(ec2/es1=-3.50/-3.50)		N=	2036	Mxx=	106	Myy=	26	(ec2/es1=-3.50/-3.50)	
N=	1958	Mxx=	116	Myy=	19	(ec2/es1=-3.50/-3.50)		N=	1861	Mxx=	119	Myy=	28	(ec2/es1=-3.50/-3.50)	
N=	1564	Mxx=	144	Myy=	21	(ec2/es1=-3.50/-3.50)		N=	1444	Mxx=	146	Myy=	32	(ec2/es1=-3.50/-3.50)	
N=	1069	Mxx=	174	Myy=	24	(ec2/es1=-3.50/-3.50)		N=	913	Mxx=	173	Myy=	39	(ec2/es1=-3.50/-3.50)	
N=	440	Mxx=	203	Myy=	26	(ec2/es1=-3.50/-3.50)		N=	276	Mxx=	193	Myy=	41	(ec2/es1=-3.50/-3.50)	
N=	-181	Mxx=	204	Myy=	35	(ec2/es1=-3.50/-3.50)		N=	-378	Mxx=	189	Myy=	52	(ec2/es1=-3.50/-3.50)	
N=	-574	Mxx=	201	Myy=	35	(ec2/es1=-3.50/-3.50)		N=	-773	Mxx=	183	Myy=	50	(ec2/es1=-3.50/-3.50)	
N=	-1317	Mxx=	196	Myy=	40	(ec2/es1=-3.50/-3.50)		N=	-1572	Mxx=	172	Myy=	59	(ec2/es1=-3.50/-3.50)	
N=	-3607	Mxx=	161	Myy=	30	(ec2/es1=-3.50/-3.50)		N=	-3729	Mxx=	144	Myy=	42	(ec2/es1=-3.50/-3.50)	
N=	-4125	Mxx=	99	Myy=	35	(ec2/es1=-3.50/-3.50)		N=	-4298	Mxx=	73	Myy=	43	(ec2/es1=-3.50/-3.50)	

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=22.50°								Neutral axis slope θ=30.00°							
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3223	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)		N=	3222	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)	
N=	3208	Mxx=	2	Myy=	1	(ec2/es1=-3.50/-3.50)		N=	3207	Mxx=	2	Myy=	1	(ec2/es1=-3.50/-3.50)	
N=	3185	Mxx=	3	Myy=	1	(ec2/es1=-3.50/-3.50)		N=	3183	Mxx=	3	Myy=	2	(ec2/es1=-3.50/-3.50)	
N=	3153	Mxx=	6	Myy=	2	(ec2/es1=-3.50/-3.50)		N=	3149	Mxx=	5	Myy=	3	(ec2/es1=-3.50/-3.50)	
N=	2551	Mxx=	59	Myy=	25	(ec2/es1=-3.50/-3.50)		N=	2500	Mxx=	60	Myy=	33	(ec2/es1=-3.50/-3.50)	
N=	2465	Mxx=	67	Myy=	28	(ec2/es1=-3.50/-3.50)		N=	2404	Mxx=	67	Myy=	38	(ec2/es1=-3.50/-3.50)	
N=	2359	Mxx=	76	Myy=	30	(ec2/es1=-3.50/-3.50)		N=	2288	Mxx=	75	Myy=	42	(ec2/es1=-3.50/-3.50)	
N=	2235	Mxx=	86	Myy=	34	(ec2/es1=-3.50/-3.50)		N=	2151	Mxx=	83	Myy=	47	(ec2/es1=-3.50/-3.50)	
N=	2086	Mxx=	96	Myy=	37	(ec2/es1=-3.50/-3.50)		N=	1997	Mxx=	93	Myy=	52	(ec2/es1=-3.50/-3.50)	
N=	1916	Mxx=	107	Myy=	41	(ec2/es1=-3.50/-3.50)		N=	1822	Mxx=	103	Myy=	56	(ec2/es1=-3.50/-3.50)	
N=	1726	Mxx=	119	Myy=	44	(ec2/es1=-3.50/-3.50)		N=	1625	Mxx=	114	Myy=	61	(ec2/es1=-3.50/-3.50)	
N=	1279	Mxx=	143	Myy=	52	(ec2/es1=-3.50/-3.50)		N=	1146	Mxx=	134	Myy=	70	(ec2/es1=-3.50/-3.50)	
N=	700	Mxx=	165	Myy=	62	(ec2/es1=-3.50/-3.50)		N=	554	Mxx=	151	Myy=	81	(ec2/es1=-3.50/-3.50)	
N=	61	Mxx=	176	Myy=	64	(ec2/es1=-3.50/-3.50)		N=	-106	Mxx=	157	Myy=	86	(ec2/es1=-3.50/-3.50)	
N=	-603	Mxx=	167	Myy=	71	(ec2/es1=-3.50/-3.50)		N=	-775	Mxx=	147	Myy=	87	(ec2/es1=-3.50/-3.50)	
N=	-1025	Mxx=	158	Myy=	71	(ec2/es1=-3.50/-3.50)		N=	-1210	Mxx=	136	Myy=	89	(ec2/es1=-3.50/-3.50)	
N=	-1828	Mxx=	148	Myy=	78	(ec2/es1=-3.50/-3.50)		N=	-1972	Mxx=	133	Myy=	88	(ec2/es1=-3.50/-3.50)	
N=	-3879	Mxx=	122	Myy=	56	(ec2/es1=-3.50/-3.50)		N=	-3990	Mxx=	103	Myy=	67	(ec2/es1=-3.50/-3.50)	
N=	-4425	Mxx=	54	Myy=	42	(ec2/es1=-3.50/-3.50)		N=	-4482	Mxx=	45	Myy=	39	(ec2/es1=-3.50/-3.50)	

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=37.50°												Neutral axis slope θ=45.00°											
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3222	Mxx=	1	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3222	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3207	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	3206	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3181	Mxx=	3	Myy=	2	(ec2/es1=-3.50/-3.50)						N=	3181	Mxx=	3	Myy=	3	(ec2/es1=-3.50/-3.50)			
N=	3147	Mxx=	5	Myy=	4	(ec2/es1=-3.50/-3.50)						N=	3146	Mxx=	4	Myy=	4	(ec2/es1=-3.50/-3.50)			
N=	2459	Mxx=	56	Myy=	42	(ec2/es1=-3.50/-3.50)						N=	2444	Mxx=	50	Myy=	50	(ec2/es1=-3.50/-3.50)			
N=	2358	Mxx=	63	Myy=	48	(ec2/es1=-3.50/-3.50)						N=	2342	Mxx=	56	Myy=	56	(ec2/es1=-3.50/-3.50)			
N=	2241	Mxx=	70	Myy=	54	(ec2/es1=-3.50/-3.50)						N=	2225	Mxx=	63	Myy=	63	(ec2/es1=-3.50/-3.50)			
N=	2104	Mxx=	78	Myy=	59	(ec2/es1=-3.50/-3.50)						N=	2090	Mxx=	70	Myy=	70	(ec2/es1=-3.50/-3.50)			
N=	1946	Mxx=	87	Myy=	65	(ec2/es1=-3.50/-3.50)						N=	1931	Mxx=	77	Myy=	77	(ec2/es1=-3.50/-3.50)			
N=	1768	Mxx=	96	Myy=	71	(ec2/es1=-3.50/-3.50)						N=	1744	Mxx=	84	Myy=	84	(ec2/es1=-3.50/-3.50)			
N=	1559	Mxx=	104	Myy=	77	(ec2/es1=-3.50/-3.50)						N=	1534	Mxx=	92	Myy=	92	(ec2/es1=-3.50/-3.50)			
N=	1062	Mxx=	121	Myy=	89	(ec2/es1=-3.50/-3.50)						N=	1031	Mxx=	106	Myy=	106	(ec2/es1=-3.50/-3.50)			
N=	461	Mxx=	135	Myy=	100	(ec2/es1=-3.50/-3.50)						N=	425	Mxx=	118	Myy=	118	(ec2/es1=-3.50/-3.50)			
N=	-209	Mxx=	139	Myy=	106	(ec2/es1=-3.50/-3.50)						N=	-239	Mxx=	122	Myy=	122	(ec2/es1=-3.50/-3.50)			
N=	-892	Mxx=	130	Myy=	102	(ec2/es1=-3.50/-3.50)						N=	-953	Mxx=	115	Myy=	115	(ec2/es1=-3.50/-3.50)			
N=	-1293	Mxx=	122	Myy=	101	(ec2/es1=-3.50/-3.50)						N=	-1317	Mxx=	111	Myy=	111	(ec2/es1=-3.50/-3.50)			
N=	-2069	Mxx=	118	Myy=	99	(ec2/es1=-3.50/-3.50)						N=	-2084	Mxx=	109	Myy=	109	(ec2/es1=-3.50/-3.50)			
N=	-4054	Mxx=	90	Myy=	75	(ec2/es1=-3.50/-3.50)						N=	-4076	Mxx=	82	Myy=	82	(ec2/es1=-3.50/-3.50)			
N=	-4508	Mxx=	41	Myy=	38	(ec2/es1=-3.50/-3.50)						N=	-4511	Mxx=	39	Myy=	39	(ec2/es1=-3.50/-3.50)			
(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])																							

Neutral axis slope θ=52.50°												Neutral axis slope θ=60.00°											
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3222	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	3222	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3207	Mxx=	1	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	3207	Mxx=	1	Myy=	2	(ec2/es1=-3.50/-3.50)			
N=	3181	Mxx=	2	Myy=	3	(ec2/es1=-3.50/-3.50)						N=	3183	Mxx=	2	Myy=	3	(ec2/es1=-3.50/-3.50)			
N=	3147	Mxx=	4	Myy=	5	(ec2/es1=-3.50/-3.50)						N=	3149	Mxx=	3	Myy=	5	(ec2/es1=-3.50/-3.50)			
N=	2459	Mxx=	42	Myy=	56	(ec2/es1=-3.50/-3.50)						N=	2500	Mxx=	33	Myy=	60	(ec2/es1=-3.50/-3.50)			
N=	2358	Mxx=	48	Myy=	63	(ec2/es1=-3.50/-3.50)						N=	2404	Mxx=	38	Myy=	67	(ec2/es1=-3.50/-3.50)			
N=	2241	Mxx=	54	Myy=	70	(ec2/es1=-3.50/-3.50)						N=	2288	Mxx=	42	Myy=	75	(ec2/es1=-3.50/-3.50)			
N=	2104	Mxx=	59	Myy=	78	(ec2/es1=-3.50/-3.50)						N=	2151	Mxx=	47	Myy=	83	(ec2/es1=-3.50/-3.50)			
N=	1946	Mxx=	65	Myy=	87	(ec2/es1=-3.50/-3.50)						N=	1997	Mxx=	52	Myy=	93	(ec2/es1=-3.50/-3.50)			
N=	1768	Mxx=	71	Myy=	96	(ec2/es1=-3.50/-3.50)						N=	1822	Mxx=	56	Myy=	103	(ec2/es1=-3.50/-3.50)			
N=	1559	Mxx=	77	Myy=	104	(ec2/es1=-3.50/-3.50)						N=	1625	Mxx=	61	Myy=	114	(ec2/es1=-3.50/-3.50)			
N=	1062	Mxx=	89	Myy=	121	(ec2/es1=-3.50/-3.50)						N=	1146	Mxx=	70	Myy=	134	(ec2/es1=-3.50/-3.50)			
N=	461	Mxx=	100	Myy=	135	(ec2/es1=-3.50/-3.50)						N=	554	Mxx=	81	Myy=	151	(ec2/es1=-3.50/-3.50)			
N=	-209	Mxx=	106	Myy=	139	(ec2/es1=-3.50/-3.50)						N=	-106	Mxx=	86	Myy=	157	(ec2/es1=-3.50/-3.50)			
N=	-892	Mxx=	102	Myy=	130	(ec2/es1=-3.50/-3.50)						N=	-775	Mxx=	87	Myy=	147	(ec2/es1=-3.50/-3.50)			
N=	-1293	Mxx=	101	Myy=	122	(ec2/es1=-3.50/-3.50)						N=	-1210	Mxx=	89	Myy=	136	(ec2/es1=-3.50/-3.50)			
N=	-2069	Mxx=	99	Myy=	118	(ec2/es1=-3.50/-3.50)						N=	-1972	Mxx=	88	Myy=	133	(ec2/es1=-3.50/-3.50)			
N=	-4054	Mxx=	75	Myy=	90	(ec2/es1=-3.50/-3.50)						N=	-3990	Mxx=	67	Myy=	103	(ec2/es1=-3.50/-3.50)			
N=	-4508	Mxx=	38	Myy=	41	(ec2/es1=-3.50/-3.50)						N=	-4482	Mxx=	39	Myy=	45	(ec2/es1=-3.50/-3.50)			
(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])																							

Neutral axis slope θ=67.50°												Neutral axis slope θ=75.00°											
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3227	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3228	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3223	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	3223	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3208	Mxx=	1	Myy=	2	(ec2/es1=-3.50/-3.50)						N=	3210	Mxx=	0	Myy=	2	(ec2/es1=-3.50/-3.50)			
N=	3185	Mxx=	1	Myy=	3	(ec2/es1=-3.50/-3.50)						N=	3188	Mxx=	1	Myy=	4	(ec2/es1=-3.50/-3.50)			
N=	3153	Mxx=	2	Myy=	6	(ec2/es1=-3.50/-3.50)						N=	3158	Mxx=	2	Myy=	6	(ec2/es1=-3.50/-3.50)			
N=	2551	Mxx=	25	Myy=	59	(ec2/es1=-3.50/-3.50)						N=	2621	Mxx=	16	Myy=	57	(ec2/es1=-3.50/-3.50)			
N=	2465	Mxx=	28	Myy=	67	(ec2/es1=-3.50/-3.50)						N=	2542	Mxx=	18	Myy=	64	(ec2/es1=-3.50/-3.50)			
N=	2359	Mxx=	30	Myy=	76	(ec2/es1=-3.50/-3.50)						N=	2444	Mxx=	20	Myy=	72	(ec2/es1=-3.50/-3.50)			
N=	2235	Mxx=	34	Myy=	86	(ec2/es1=-3.50/-3.50)						N=	2329	Mxx=	22	Myy=	82	(ec2/es1=-3.50/-3.50)			
N=	2086	Mxx=	37	Myy=	96	(ec2/es1=-3.50/-3.50)						N=	2193	Mxx=	24	Myy=	93	(ec2/es1=-3.50/-3.50)			
N=	1916	Mxx=	41	Myy=	107	(ec2/es1=-3.50/-3.50)						N=	2036	Mxx=	26	Myy=	106	(ec2/es1=-3.50/-3.50)			
N=	1726	Mxx=	44	Myy=	119	(ec2/es1=-3.50/-3.50)						N=	1861	Mxx=	28	Myy=	119	(ec2/es1=-3.50/-3.50)			
N=	1279	Mxx=	52	Myy=	143	(ec2/es1=-3.50/-3.50)						N=	1444	Mxx=	32	Myy=	146	(ec2/es1=-3.50/-3.50)			
N=	700	Mxx=	62	Myy=	165	(ec2/es1=-3.50/-3.50)						N=	913	Mxx=	39	Myy=	173	(ec2/es1=-3.50/-3.50)			
N=	61	Mxx=	64	Myy=	176	(ec2/es1=-3.50/-3.50)						N=	276	Mxx=	41	Myy=	193	(ec2/es1=-3.50/-3.50)			
N=	-603	Mxx=	71	Myy=	167	(ec2/es1=-3.50/-3.50)						N=	-378	Mxx=	52	Myy=	189	(ec2/es1=-3.50/-3.50)			
N=	-1025	Mxx=	71	Myy=	158	(ec2/es1=-3.50/-3.50)						N=	-773	Mxx=	50	Myy=	183	(ec2/es1=-3.50/-3.50)			
N=	-1828	Mxx=	78	Myy=	148	(ec2/es1=-3.50/-3.50)						N=	-1572	Mxx=	59	Myy=	172	(ec2/es1=-3.50/-3.50)			
N=	-3879	Mxx=	56	Myy=	122	(ec2/es1=-3.50/-3.50)						N=	-3729	Mxx=	42	Myy=	144	(ec2/es1=-3.50/-3.50)			
N=	-4425	Mxx=	42	Myy=	54	(ec2/es1=-3.50/-3.50)						N=	-4298	Mxx=	43	Myy=	73	(ec2/es1=-3.50/-3.50)			

(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

Neutral axis slope θ=82.50°												Neutral axis slope θ=90.00°											
N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3230	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)			
N=	3228	Mxx=	0	Myy=	0	(ec2/es1=-3.50/-3.50)						N=	3227	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3224	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)						N=	3222	Mxx=	0	Myy=	1	(ec2/es1=-3.50/-3.50)			
N=	3212	Mxx=	0	Myy=	2	(ec2/es1=-3.50/-3.50)						N=	3206	Mxx=	0	Myy=	3	(ec2/es1=-3.50/-3.50)			
N=	3191	Mxx=	0	Myy=	4	(ec2/es1=-3.50/-3.50)						N=	3181	Mxx=	0	Myy=	5	(ec2/es1=-3.50/-3.50)			
N=	3164	Mxx=	1	Myy=	6	(ec2/es1=-3.50/-3.50)						N=	3146	Mxx=	0	Myy=	9	(ec2/es1=-3.50/-3.50)			
N=	2709	Mxx=	8	Myy=	52	(ec2/es1=-3.50/-3.50)						N=	2233	Mxx=	0	Myy=	99	(ec2/es1=-3.50/-3.50)			
N=	2639	Mxx=	9	Myy=	59	(ec2/es1=-3.50/-3.50)						N=	2107	Mxx=	0	Myy=	111	(ec2/es1=-3.50/-3.50)			
N=	2553	Mxx=	10	Myy=	66	(ec2/es1=-3.50/-3.50)						N=	1984	Mxx=	0	Myy=	121	(ec2/es1=-3.50/-3.50)			
N=	2451	Mxx=	11	Myy=	75	(ec2/es1=-3.50/-3.50)						N=	1841	Mxx=	0	Myy=	132	(ec2/es1=-3.50/-3.50)			
N=	2329	Mxx=	12	Myy=	86	(ec2/es1=-3.50/-3.50)						N=	1700	Mxx=	0	Myy=	143	(ec2/es1=-3.50/-3.50)			
N=	2182	Mxx=	13	Myy=	99	(ec2/es1=-3.50/-3.50)						N=	1532	Mxx=	0	Myy=	155	(ec2/es1=-3.50/-3.50)			
N=	2014	Mxx=	14	Myy=	113	(ec2/es1=-3.50/-3.50)						N=	1363	Mxx=	0	Myy=	166	(ec2/es1=-3.50/-3.50)			
N=	1626	Mxx=	16	Myy=	142	(ec2/es1=-3.50/-3.50)						N=	949	Mxx=	0	Myy=	194	(ec2/es1=-3.50/-3.50)			
N=	1144	Mxx=	18	Myy=	173	(ec2/es1=-3.50/-3.50)						N=	520	Mxx=	0	Myy=	218	(ec2/es1=-3.50/-3.50)			
N=	518	Mxx=	19	Myy=	207	(ec2/es1=-3.50/-3.50)						N=	143	Mxx=	0	Myy=	227	(ec2/es1=-3.50/-3.50)			
N=	-69	Mxx=	26	Myy=	210	(ec2/es1=-3.50/-3.50)						N=	-425	Mxx=	0	Myy=	238	(ec2/es1=-3.50/-3.50)			
N=	-470	Mxx=	28	Myy=	210	(ec2/es1=-3.50/-3.50)						N=	-743	Mxx=	0	Myy=	241	(ec2/es1=-3.50/-3.50)			
N=	-1182	Mxx=	31	Myy=	207	(ec2/es1=-3.50/-3.50)						N=	-1433	Mxx=	0	Myy=	257	(ec2/es1=-3.50/-3.50)			
N=	-3537	Mxx=	24	Myy=	170	(ec2/es1=-3.50/-3.50)						N=	-3471	Mxx=	0	Myy=	186	(ec2/es1=-3.50/-3.50)			
N=	-4012	Mxx=	28	Myy=	116	(ec2/es1=-3.50/-3.50)						N=	-3704	Mxx=	0	Myy=	163	(ec2/es1=-3.50/-3.50)			

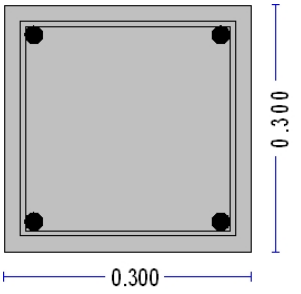
(Nsd [kN], Msd [kNm], ec2 es1 [o/oo])

5. COLUMN-005

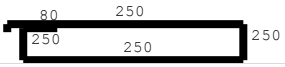
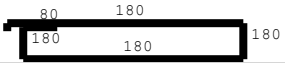
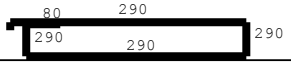
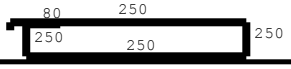
Isolated Column (stability control)

(EC2 EN1992-1-1:2004, EC0 EN1990-1-1:2002)

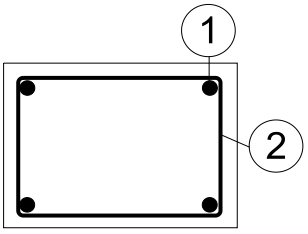
Concrete-Steel class: C25/30-S500 (EC2 §3)
Concrete cover : Cnom=20 mm (EC2 §4.4.1)
γc=1.50, γs=1.15 (EC2 Table 2.1N)



Reinforcing bar schedule

Num	Structure object	type	reinforcing bar [mm]	items	ø [mm]	g/m [kg/m]	length [m]	weight [kg]
1	COLUMN-001	C1		8	16	1.580	3.000	37.92
2	COLUMN-001	C2		13	8	0.395	1.160	5.96
3	COLUMN-001	C2		13	8	0.395	0.880	4.52
4	COLUMN-002	C1		8	14	1.210	3.000	29.04
5	COLUMN-002	C2		13	8	0.395	1.320	6.78
6	COLUMN-005	C1		4	22	2.980	3.000	35.76
7	COLUMN-005	C2		13	8	0.395	1.160	5.96
			Total weight [kg]					**125.94**

Reinforcing bar numbering for columns(C)

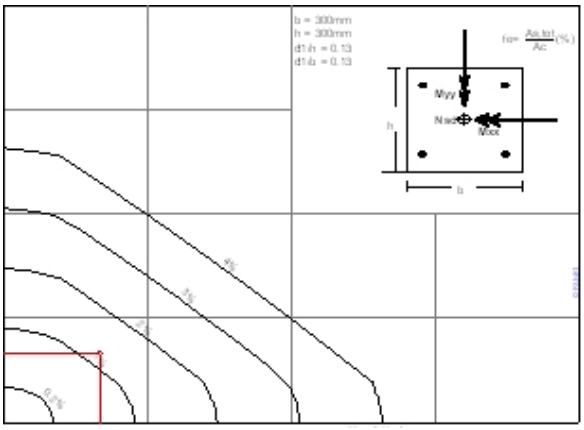


5.1. Dimensions and loads

Column of rectangular cross section b=0.300 m, h=0.300 m
Loads at top , axial Nsd=200.00 kN (compression), moments Msdxx=50.00 kNm, Msdyy=50.00 kNm
Loads at bottom, axial Nsd=100.00 kN (compression), moments Msdxx=50.00 kNm, Msdyy=50.00 kNm
Effective depth of cross section d=h-d1, d1=d2=Cnomc+Øs+Ø/2=20+8+20/2=38mm, dx=262mm, dy=262mm

5.2. Dimensioning with first order theory

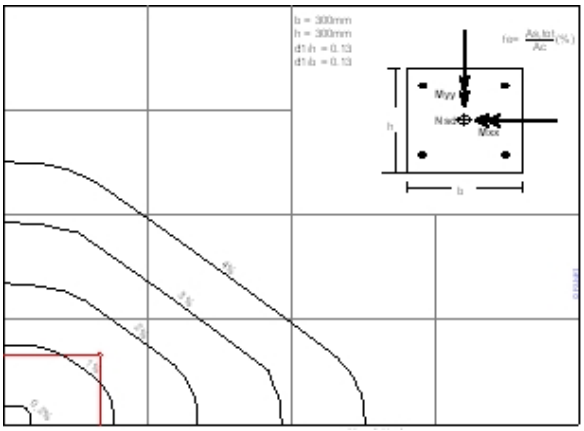
5.2.1. Column top Design for compression with small eccentrici (EC2 EN1992-1-1:2004, §6.1, §9.2.1)



Design using numerical integration
Design chart for double bending and axial force
obtained from numerical integration using a
grid of 10x10=100 cross-section subdivisions
Nsd=200.00kN (compression),
Msdxx=50.00kNm, Msdyy=50.00kNm
C25/30-S500
b=300mm, h=300mm
dx=262mm, dy=262mm, d1=d2=38mm
d1/h=0.127, d2/b=0.127
ey=Msdxx/Nsd= 50.00/200.00=0.250m=250mm
ex=Msdyy/Nsd= 50.00/200.00=0.250m=250mm
zsy=h/2-d1=300/2-38=112mm, e=250mm>szy=112mm
zsx=b/2-d1=300/2-38=112mm, e=250mm>szx=112mm
As,tot=1125mm², As,tot/Ac=1.25%

As,tot=11.25cm²

5.2.2. Column bottom Design for compression with small eccentr (EC2 EN1992-1-1:2004, §6.1, §9.2.1)



Design using numerical integration
Design chart for double bending and axial force
obtained from numerical integration using a
grid of 10x10=100 cross-section subdivisions
Nsd=100.00kN (compression),
Msdxx=50.00kNm, Msdyy=50.00kNm
C25/30-S500
b=300mm, h=300mm
dx=262mm, dy=262mm, d1=d2=38mm
d1/h=0.127, d2/b=0.127
ey=Msdxx/Nsd= 50.00/100.00=0.500m=500mm
ex=Msdyy/Nsd= 50.00/100.00=0.500m=500mm
zsy=h/2-d1=300/2-38=112mm, e=500mm>szy=112mm
zsx=b/2-d1=300/2-38=112mm, e=500mm>szx=112mm
As,tot=1350mm², As,tot/Ac=1.50%

As,tot=13.50cm²

5.3. Dimensioning with second order theory

Ultimate limit state induced by structural deformation (EC2 EN1992-1-1:2004, §4.3.5)
We consider isolated column in a non-sway structure (EC2 §4.3.5.3.4)
From graph EC2 fig 4.27 we have β=0.73, λox=β.s=0.73x3.000=2.178 m
From graph EC2 fig 4.27 we have β=0.73, λoy=β.s=0.73x3.000=2.178 m
slenderness ratio λ=sk/i, λx=2.178/(0.289x0.300)=25.1, λy=2.178/(0.289x0.300)=25.1

Total eccentricity etot=eo+ea+e2, eo first order eccentricity (EC2 §4.3.5.6.2)
ea additional eccentricity due to imperfections, e2 second order eccentricity
Eccentricities in x-x, eo1x= 50.00/ 200.00= 0.250m, eo2x= 50.00/ 100.00= 0.500m
Eccentricities in y-y, eo1y= 50.00/ 200.00= 0.250m, eo2y= 50.00/ 100.00= 0.500m
Equivalent eccentricities of first order, eox=0.400m, eoy=0.400m (EC2 §4.3.5.6.2)

λcrit=25(2-e01/e02), λcrit(x-x)=37.5, λcrit(y-y)=37.5 (EC2 §4.3.5.5.3)
vu=Nsd/(Ac·fcd)=0.200/(0.300x0.300x16.67)=0.13, 15/vu½=41.6, λlim=max(25,41.6)=41.6

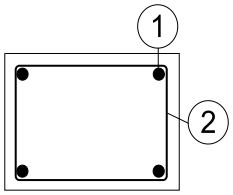
additional eccentricity due to imperfections ea=(1/(100L½)(Lo/2)<(1/200)(Lo/2)
eax=(1/(1003.00½)(2.178/2)=0.006m, eay=(1/(1003.00½)(2.178/2)=0.006m (EC2 §2.5.1.3)

λx=25.1 <= 41.6=λlim and λy=25.1 <= 41.6=λlim
The column is not slender, check with 2nd theory is not necessary. (EC2 §4.3.5.6.3)

Minimum longitudinal reinforcement, As>=0.0020Ac, Øs>=8, As,min=4Ø8(2.01cm²) (EC2 §9.5.2.2)
Maximum longitudinal reinforcement, As<=0.04Ac, (As,max=36.00cm²) (EC2 §9.5.2.3)
Transverse reinforcement, links with minimum Øs at maximum spacing Scl,t (EC2 §9.5.3)
at column heights from 0.30m to H-0.30m: Links Øs>=6, Scl,t<=300mm
at regions 0 to 0.30m and H-0.30m to H : Links Øs>=6, Scl,t<=180mm
Basic required anchorage length Lbd=540mm =0.540m (EC2 Eq.8.3)

Longitudinal reinforcement: 4Ø22 (15.20cm²)

Tranverse reinforcement: Links Ø8/30.0 [h:0.30m~H-0.30m] , **Ø8/18.0** [h:0~0.30m, H-0.30m~H]

5.4. Reinforcing bar schedule

Num	type	reinforcing bar [mm]	items	∅	g/m [kg/m]	length [m]	weight [kg]
6	1	3000	4	22	2.980	3.000	35.76
7	2	80 250 80 250 250 250	13	8	0.395	1.160	5.96
		Total weight [kg]					**41.72**