Sta4CAD console wall calculations

Units
Length:	Meter
Force:	KiloNewton
Weight:	Kilogram
Angle:	Degree

Site characteristics:
Ao	0.3
ImportanceFactor:	1
Cohesion	20 kN/m²
Soil internal Friction Angle(Φ)	30 °
Wall-Soil Friction Angle over water level(δd)	20 °
Soil-Wall Friction coeff.(μ)	0.55
Soil Allowable Stress	200 kN/m²
Moist(not saturated to fluid or over the water level) Soil Density(γ)	1800 kg/m³
Wet(saturated to fluid) Soil Density(γs)	1900 kg/m³
Fluid Density	1000 kg/m³
Live Load (for unit length)	5 kN/m
Density of concrete	2500 kg/m³
Concrete allowable stress	20 MPa
Steel allowable stress	420 MPa
Use passive forces	Use
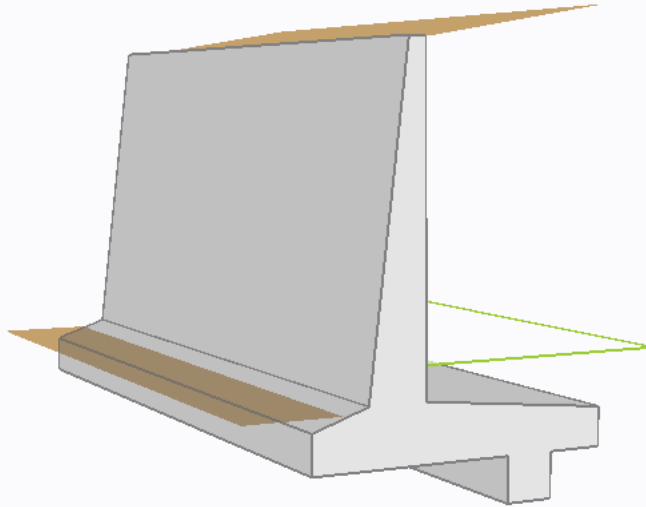
Wall Dimensions
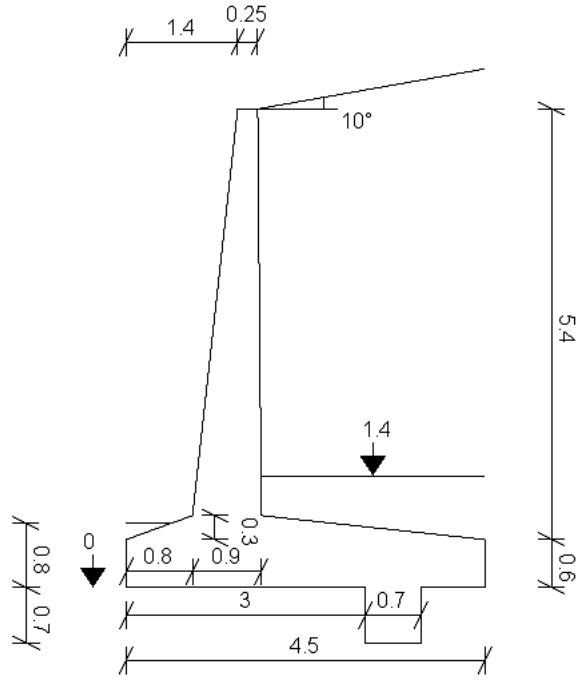
Analyse Time/Date:14:58:52 ; 24/12/2008
All calculations are for 1 meters of section

●Loads and Sections●

Density of buoyant soil(γb) = 900
Wall weight =167.57 kN
Wall Center of Gravity=1.9188 m
Weight of the moist/bou. section of right wall zone is 242.33 / 16.089 kN
Weight of the dry/wet section of left wall zone is 0 / 1.1032 kN

●Coefficients●

Ch = 0.2 (I + 1) Ao = 0.2 (1 + 1) 0.3 = 0.12
Cv = 2/3 Ch = 2/3 0.12 = 0.08
Equv. Quake Load Angle (Moi): λd = arctan(Ch / (1 ± Cv)) = arctan(0.12 / (1 ± 0.08)) = 6.3402 °
Equv. Quake Load Angle (Bou): λw = arctan(γs/γb Ch/(1 ± Cv)) = arctan(1900/900 0.12/(1 ± 0.08)) = 13.201 °
Wall surface angle on active(right) side α = 0.5305 °
Wall/Soil friction under water level δw = δd / 2 = 20 / 2 = 10 °
Soil angle i = 10 °

○Active pressure coefficients over water level:
Active pressure coefficient KatDry = 0.48772
Active pressure static coefficient KasDry = 0.34463
Active pressure dynamic coefficient KadDry = KatDry - KasDry =0.1431

○Active pressure coefficients under water level:
Active pressure coefficient KatWet = 0.67079
Active pressure static coefficient KasWet = 0.35385
Active pressure dynamic coefficient KadWet = KatWet - KasWet = 0.31694

○Pasive pressure coefficients over water level:
Passive pressure coefficient KptDry = 5.9263
WARNING: KpsDry = 6.1054 is greater than KptDry , assuming KpsDry=0.9 KptDry
Passive pressure static coefficient KpsDry = 5.3337
Passive pressure dynamic coefficient KpdDry = KptDry - KpsDry = 0.59263


○Pasive pressure coefficients under water level:
Passive pressure coefficient KptWet = 3.6509
WARNING: KpsWet = 4.1433 is greater than KptWet , assuming KpsWet=0.9 KptWet
Passive pressure static coefficient KpsWet = 3.2859
Passive pressure dynamic coefficient KpdWet = KptWet - KpsWet = 0.36509

●Static Loads●

Height of dry / wet soil section on active(right) side = 5.1025 / 1.4 m
Height of dry / wet soil section on passive(left) side = 0 / 1.5 m

Soil safety calculations
The bottom load value of active static load from dry layer(PasMoi): 31.04 kN/m
The bottom load value of active static load from saturated layer(PasBou): -19.422 kN/m
*Note that this value can be negative because of the effect of cohesion
The bottom load value of water pressure(PasWater): 13.729 kN/m
The bottom load value of passive static load from saturated layer(PpsBou): -29.006 kN/m
*Note that this value can be negative because of the effect of cohesion
The bottom load value of water pressure(PpsWater): 14.71 kN/m
The bottom load value of live load from dry layer(QasMoi): 1.7231 kN/m
The bottom load value of live load from saturated layer(QasBou): 1.7692 kN/m
WARNING: The passive forces from seismic loads (water) are greater than active forces, they accepted as equal.
(Pactive/Ppasive=0.871110933091915 --> 1)
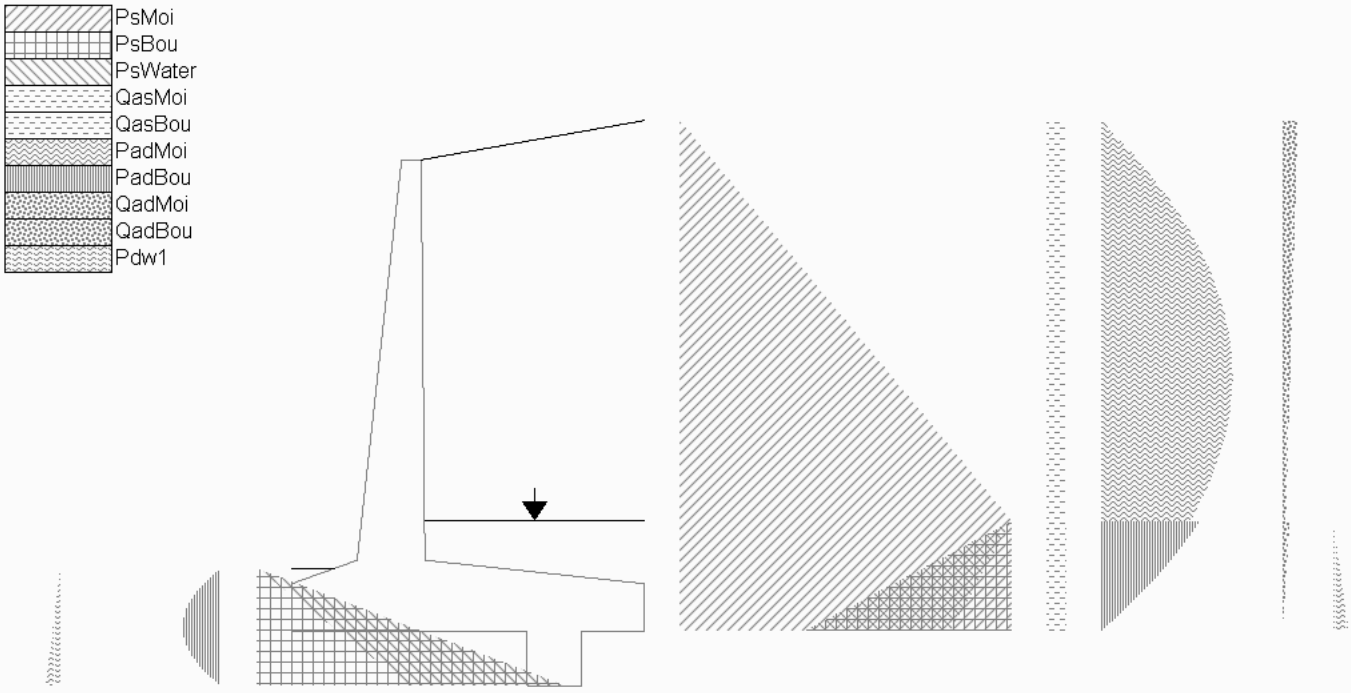
Wall Calculations

ABBR.	Explanation	Conc Load kN	App Point m	Moment kNm
PasMoi1	Active static load on Moist Layer	79.192	3.1008	-245.56
PasMoi2	Active static load of Moist L. on Buoyant L.	43.456	0.7	-30.419
QasMoi	Active static live load on Moist Layer	8.7923	3.9513	-34.741
QasBou	Active static live load on Buoyant L.	2.4769	0.7	-1.7339
PasBou	Active static load of Buoyant L.	-13.595	0.46667	6.3445
PasWater	Water Pressure on active side	9.6105	0.46667	-4.4849
PadMoi	Active dynamic load on Moist Layer	47.041	3.5673	-167.81
PadBou	Active dynamic load on Buoyant Layer	7.0437	-17.86	125.8
QadMoi	Active dynamic load f. surcharge load	4.4979	4.5004	-20.242
QadBou	Active dynamic load f. surcharge load under water lev.	0.47766	0.93333	-0.44582
Pdw1	Dynamic water pressure on active side	1.3455	0.84	-1.1302
PpsBou	Pasive static load f. Buoyant Layer	-21.755	-0.2	4.351
PpsWater	Water Pressure on pasive side	11.032	-0.2	-2.2065
PpdBou	Pasive dynamic load f. Buoyant layer	3.6251	1.55	5.6189
Pdw2	Dynamic water pressure on pasive side	1.3455	0.2	0.26909

Soil safety calculations

Area and Section Modulus (for one meter) = 4.5 m² / 3.375 m³

<u>Soil Allowable Stress Checks:</u>
Moments for point (2.25 ; 0) :
Total vertical load due to moist soil layer: 242.33 kN
Total moment due to moist soil layer: 208.37 kNm
Total vertical load due to bouant soil layer: 17.193 kN
Total moment due to bouant soil layer: 13.197 kNm
Total vertical load due to surchage load: 14.25 kN
Total moment due to surchage load: 11.756 kNm
Total vertical load due to water lifting: -44.079 kN
Total moment due to water lifting: 0 kNm
N / M at point O under (1G+1Q) = 397.26 kN / -130.63 kNm
Stress check: Max and Min stresses are :126.99 / 49.576, Allowable values : 200 / 0 are satisfied
N / M at point O under (1G+1Q+1E) = 397.26 kN / -259.79 kNm
Stress check: Max and Min stresses are :165.26 / 11.306, Allowable values : 300 / 0 are satisfied

Slipping checks:

N = 397.26 kN

Total force agains slipping = Fkk = µ N = 0.55 397.26 kN = 218.49 kN

Total force causing slipping = Fk = 140.66 kN

Shear factor(βk)1.5534 is greater then safety factor (β) 1.5 under dead loads.

Total force agains slipping = Fkk = µ N = 0.55 397.26 kN = 218.49 kN

Total force causing slipping= Fk = 246.36 kN

!! SLIPPING SAFETY FACTOR EXCEEDED UNDER QUAKE LOADING !!

Shear factor(βk)0.88689 is less then safety factor (β) 1.1 under dead and seismic loads.

Overturning Checks:

Moments for point (0 ; 0) :

Total vertical load due to moist soil layer : 242.33 kN

Total moment due to moist soil layer : 753.61 kNm

Total vertical load due to bouant soil layer : 17.193 kN

Total moment due to bouant soil layer : 51.88 kNm

Total vertical load due to surchage load : 14.25 kN

Total moment due to surchage load : 43.819 kNm

Total vertical load due to water lifting : -44.079 kN

Total moment due to water lifting : -99.178 kNm

The total moment (G+Q) against overturning is 1173 kN , causing overturning is -409.77 kN(under dead loads)

Overturning factor(βd) 2.8625 is greater then safety factor(β)1.5 under dead loads.

The total moment (G+Q+E) against overturning is 1173 kN , causing overturning is -396.49 kN under dead and seismic loads

Overturning factor(βd) 2.9584 is greater then safety factor(β) 1.3 under dead and seismic loads.

Totally Collapsing Calculation::

The results are for point: C(-1.276;8.0257) with R = 10.045 m

!! TOTALLY COLLAPSING SAFETY FACTOR EXCEEDED UNDER SEISMIC LOADING !!

Totally collapsing factor 1.2372 is less then safety factor 1.5 under dead loads.

C(-1.276;8.0257)
R = 10.045

O(0;0)

Factor of safety: 1.2372
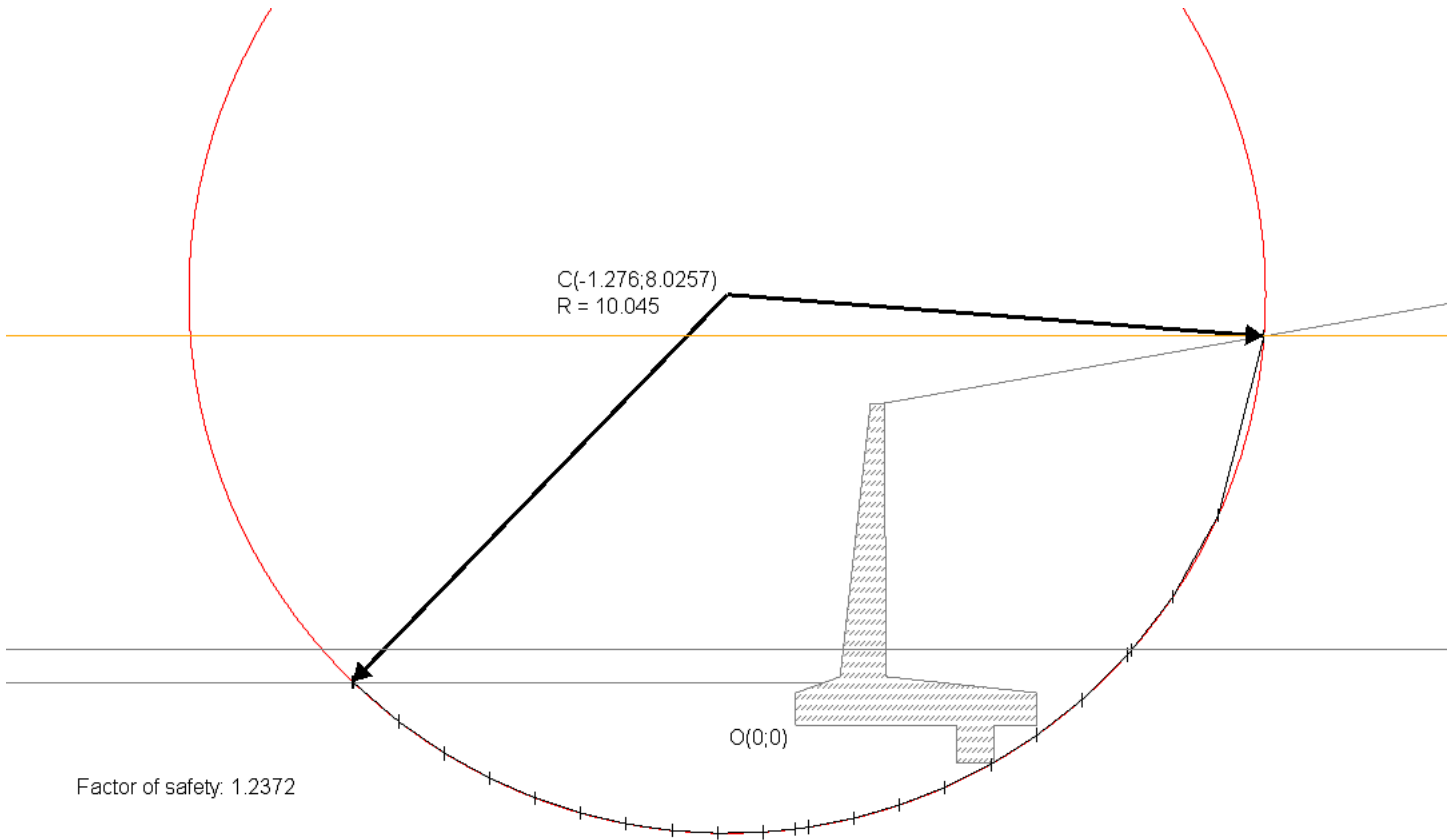
Slice No	Angle 1	Angle2	Wt	Tan(PHI)	Wt Sin(A2)	WtC(A2)T(P)
1	225.94	-44.029	0.00022249	0.57735	-0.00015464	9.236E-05
2	226	-40.797	2.7494	0.57735	-1.7964	1.2017
3	232.41	-34.648	7.7004	0.57735	-4.3779	3.6574
4	238.3	-28.931	11.663	0.57735	-5.6419	5.8931
5	243.84	-23.518	14.81	0.57735	-5.9096	7.8402
6	249.13	-18.321	17.251	0.57735	-5.4227	9.455
7	254.23	-13.277	19.057	0.57735	-4.3768	10.709
8	259.21	-8.3369	20.276	0.57735	-2.9399	11.583
9	264.11	-3.4589	20.935	0.57735	-1.2631	12.065
10	268.97	1.394	21.05	0.57735	0.51209	12.15
11	273.82	5.5584	14.827	0.57735	1.4362	8.5202
12	277.3	7.9968	32.908	0.57735	4.5781	18.815
13	278.7	11.166	106.53	0.57735	20.63	60.343
14	283.64	16.16	92.564	0.57735	25.763	51.33
15	288.68	21.285	77.983	0.57735	28.309	41.952
16	293.89	26.598	62.729	0.57735	28.085	32.384
17	299.31	32.173	50.22	0.57735	26.741	24.542
18	305.04	35.07	0.50401	0.57735	0.28959	0.23816
19	305.1	38.15	86.147	0.57735	53.216	39.113
20	311.2	44.605	83.72	0.57735	58.789	34.414
21	318.01	48.37	8.0337	0.57735	6.0048	3.0813
22	318.73	52.304	67.421	0.57735	53.348	23.802
23	325.88	60.861	58.074	0.57735	50.724	16.326
24	335.84	75.71	23.879	0.57735	23.14	3.403
			Total	349.84	432.82	

RC DESIGN

Section Wall Base section
1.4 G 1.6 Q Dead Case ►►► M/V:292.6 kNm/147.37 kN
1 G 1 Q 1 E Quake Case ►►► M/V:391.44 kNm/180.72 kN
0.9 G 1 E Quake Case ►►► M/V:346.59 kNm/161.62 kN
M_g = 178.08 kNm M_q = 27.049 kNm M_e = 186.31 kNm
 --> Area needed::0.0013531(%0.16), Area used:0.0019242(%0.22) Bar: 13ø14/8
 Design warning:Needed bar perc. less then Min.
 Design warning:-->Using minimum percentage

Section Front Console section
1.4 G 1.6 Q Dead Case ►►► M/V:55.633 kNm/129.74 kN
1 G 1 Q 1 E Quake Case ►►► M/V:50.91 kNm/117.57 kN
0.9 G 1 E Quake Case ►►► M/V:43.988 kNm/101.56 kN
M_g = 35.934 kNm M_q = 3.3286 kNm M_e = 11.648 kNm
 --> Area needed::0.00017982(%0.02), Area used:0.0003927(%0.04) Bar: 5ø10/20
 Design warning:Needed bar spacing more than Max.
 Design warning:-->Using maximum spacing

Section Back Console section
1.4 G 1.6 Q Dead Case ►►► M/V:239.06 kNm/142.42 kN
1 G 1 Q 1 E Quake Case ►►► M/V:250.88 kNm/140.35 kN
0.9 G 1 E Quake Case ►►► M/V:212.68 kNm/118.77 kN
M_g = -143.51 kNm M_q = -23.844 kNm M_e = -83.522 kNm
 --> Area needed::0.00082092(%0.09), Area used:0.0025133(%0.28) Bar: 13ø16/8
 Design warning:Needed bar perc. less then Min.
 Design warning:-->Using minimum percentage

Section Wall tooth section
1.4 G 1.6 Q Dead Case ►►► M/V:4.1409 kNm/10.741 kN
1 G 1 Q 1 E Quake Case ►►► M/V:3.3785 kNm/8.682 kN
0.9 G 1 E Quake Case ►►► M/V:3.0828 kNm/7.9148 kN
M_g = 2.9578 kNm M_q = 0 kNm M_e = 0.42078 kNm
 --> Area needed::1.7451E-05(%0), Area used:0.0019242(%0.27) Bar: 13ø14/8
 Design warning:Needed bar perc. less then Min.
 Design warning:-->Using minimum percentage

Section Wall Base section2
Section Wall Base section2: is constructive section
 --> Area needed::0.00083542(%0.1), Area used:0.00087266(%0.1) Bar: 12ø10/9
 Design warning:Designed for shrinkage effect

Section Wall back face
Section Wall back face: is constructive section
Constructive section: Bar: 12ø12/9

Section Wall front face
Section Wall front face: is constructive section
Constructive section: Bar: 5ø12/24

Section Found. bottom face
Section Found. bottom face: is constructive section
Constructive section: Bar: 4ø12/25
 Design warning:Needed bar spacing more than Max.
 Design warning:-->Using maximum spacing

Section Found. top face
Section Found. top face: is constructive section
Constructive section: Bar: 4ø12/25
 Design warning:Needed bar spacing more than Max.
 Design warning:-->Using maximum spacing

Section Wall tooth face
Section Wall tooth face: is constructive section
Constructive section: Bar: 4ø12/25
 Design warning:Needed bar spacing more than Max.
 Design warning:-->Using maximum spacing

Section Wall center section
1.4 G 1.6 Q Dead Case ►►► M/V:105.36 kNm/75.612 kN
1 G 1 Q 1 E Quake Case ►►► M/V:151.18 kNm/103 kN
0.9 G 1 E Quake Case ►►► M/V:132.04 kNm/91.639 kN
M_g = 60.26 kNm M_q = 13.121 kNm M_e = 77.803 kNm
 --> Area needed::0.00069211(%0.1), Area used:0.001131(%0.17) Bar: 10ø12/10
 Design warning:Needed bar perc. less then Min.
 Design warning:-->Using minimum percentage

Section Wall top section
1.4 G 1.6 Q Dead Case ►►► M/V:21.854 kNm/26.73 kN
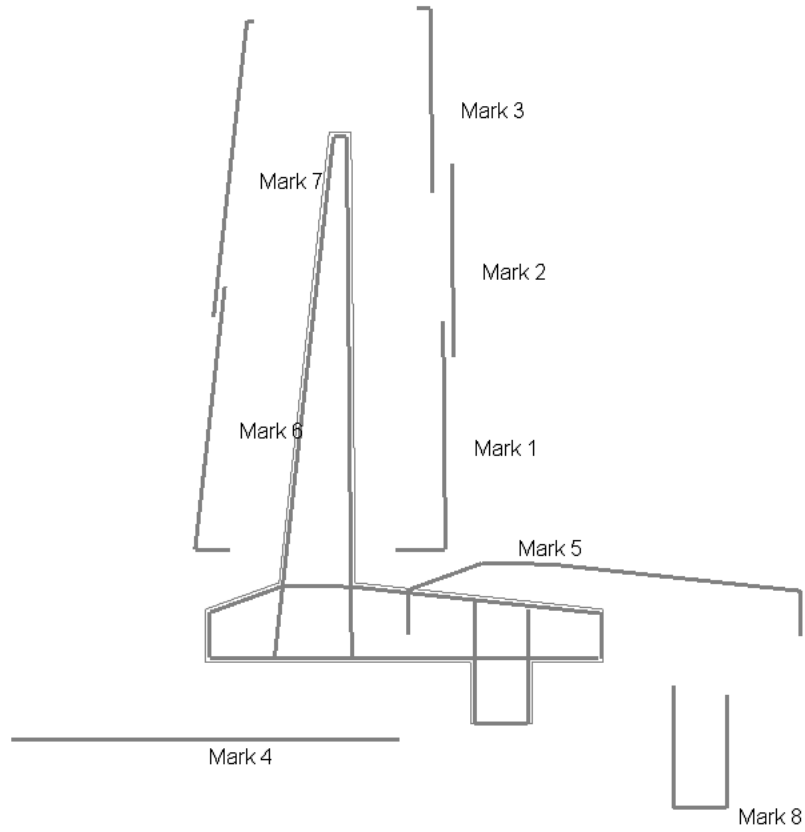1 G 1 Q 1 E Quake Case ►►► M/V:32.725 kNm/39.84 kN
0.9 G 1 E Quake Case ►►► M/V:27.462 kNm/34.569 kN
M_g = 10.833 kNm M_q = 4.1796 kNm M_e = 17.712 kNm
 --> Area needed::0.00022344(%0.05), Area used:0.0005236(%0.12) Bar: 7ø10/15
 Design warning:Needed bar perc. less then Min.
 Design warning:-->Using minimum percentage

Mark	Numb.	Diam.	Length m	Weight kg
1	130	ø 14	3.15	495
2	100	ø 12	2.2	195
3	70	ø 10	2.25	97
4	50	ø 10	4.4	136
5	130	ø 16	5.55	1139
6	120	ø 10	3.4	252
7	120	ø 10	3.45	255
8	130	ø 14	3.3	518
9	57	ø 12	10	506
10	23	ø 12	10	204
11	21	ø 12	10	186
12	19	ø 12	10	169
13	10	ø 12	10	89
				4241 kg