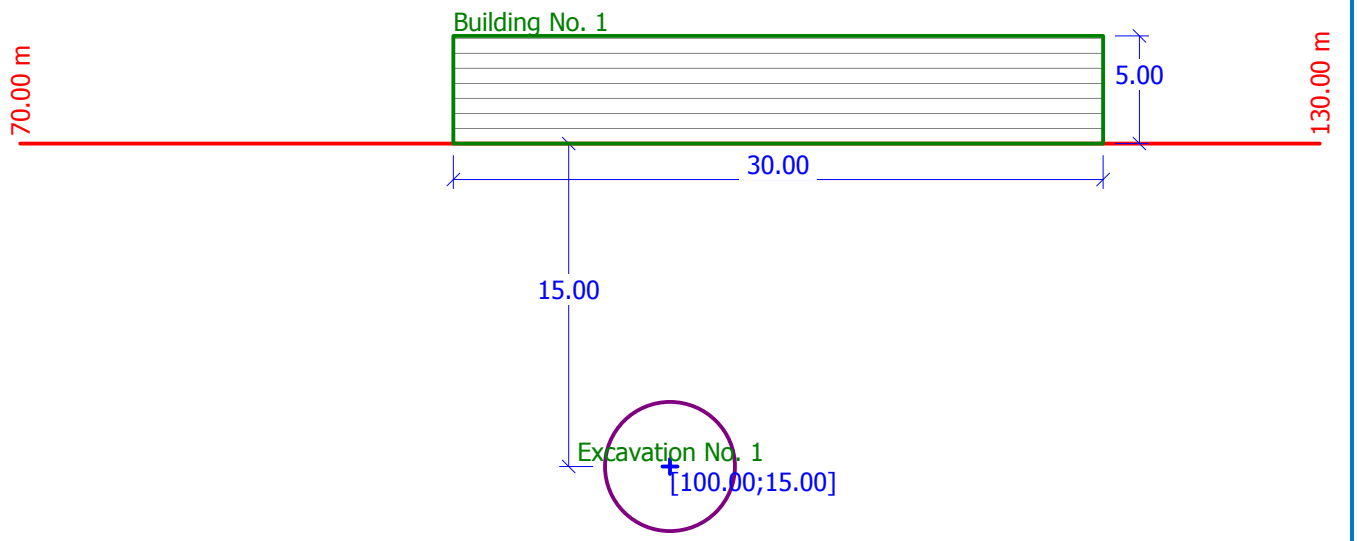
Analysis of ground loss

Input data

Project

Date : 8/28/2009

Name : Project	Stage : 1



Buildings

No.	Description	Coordinate x_1 [m]	Coordinate x_2 [m]	Height v [m]	Depth h [m]
1	Building No. 1	90.00	120.00	5.00	0.00

Analysis settings

Analysis carried out according to theory - Volume Loss
Shape of settlement trough - Gauss
Analysis performed with default values of settings for inputted buildings.

Geometry

No.	New excava	Description	Coordinate X [m]	Depth Z [m]	Radius r [m]	Area A [m²]
1	YES	Excavation No. 1	100.00	15.00	3.00	28.27

No.	Description	Trough param. k [-]	Volume loss VL [%]
1	Excavation No. 1	0.50	3.00

Verification No. 1 (Stage of construction 1)

Analysis result - Excavation No. 1

Distance of point of inflexion from center point L_{inf} = 7.50 m
Maximum settlement s_{max} = 45.1 mm
Length of settlement trough L_{max} = 30.00 m

Overall results

Depression computed at terrain surface.
Max. settlement s_{max} = 45.1 mm
Max. horizontal deformation h_{max} = 17.1 mm
Begin of settlement trough x_1 = 70.00 m
End of settlement trough x_2 = 130.00 m

Length of settlement trough l = 60.00 m

Digital distributions of variables

Shape of settlement trough (Gauss) - Excavation No. 1

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
70.00	0.02	-0.04	0.00	-
70.60	0.02	-0.05	-0.03	-
71.20	0.03	-0.07	-0.03	-
71.80	0.04	-0.09	-0.04	-
72.40	0.05	-0.12	-0.05	-
73.00	0.07	-0.16	-0.07	-
73.60	0.09	-0.20	-0.09	-
74.20	0.12	-0.26	-0.11	-
74.80	0.16	-0.34	-0.14	-
75.40	0.21	-0.43	-0.17	-
76.00	0.27	-0.54	-0.21	1/8626
76.60	0.35	-0.68	-0.25	1/6874
77.20	0.44	-0.84	-0.31	1/5517
77.80	0.56	-1.04	-0.37	1/4460
78.40	0.71	-1.28	-0.43	1/3631
79.00	0.90	-1.57	-0.51	1/2977
79.60	1.12	-1.90	-0.60	1/2458
80.20	1.38	-2.28	-0.69	1/2045
80.80	1.70	-2.73	-0.79	1/1714
81.40	2.08	-3.23	-0.90	1/1447
82.00	2.53	-3.80	-1.01	1/1230
82.60	3.06	-4.44	-1.12	1/1054
83.20	3.67	-5.14	-1.23	1/910
83.80	4.38	-5.91	-1.34	1/792
84.40	5.19	-6.74	-1.44	1/694
85.00	6.11	-7.63	-1.52	1/613
85.60	7.14	-8.57	-1.60	1/546
86.20	8.30	-9.55	-1.65	1/491
86.80	9.59	-10.55	-1.67	1/444
87.40	11.00	-11.55	-1.67	1/406
88.00	12.54	-12.54	-1.62	1/374
88.60	14.21	-13.50	-1.55	1/347
89.20	16.00	-14.40	-1.42	1/326
89.80	17.89	-15.21	-1.26	1/309
90.40	19.89	-15.91	-1.05	1/295
91.00	21.96	-16.47	-0.80	1/285
91.60	24.10	-16.87	-0.50	1/278
92.20	26.27	-17.08	-0.17	1/275
92.80	28.46	-17.08	0.19	1/275
93.40	30.63	-16.85	0.58	1/279
94.00	32.76	-16.38	0.98	1/287
94.60	34.82	-15.67	1.40	1/300
95.20	36.76	-14.71	1.81	1/320
95.80	38.57	-13.50	2.20	1/348
96.40	40.21	-12.06	2.57	1/390

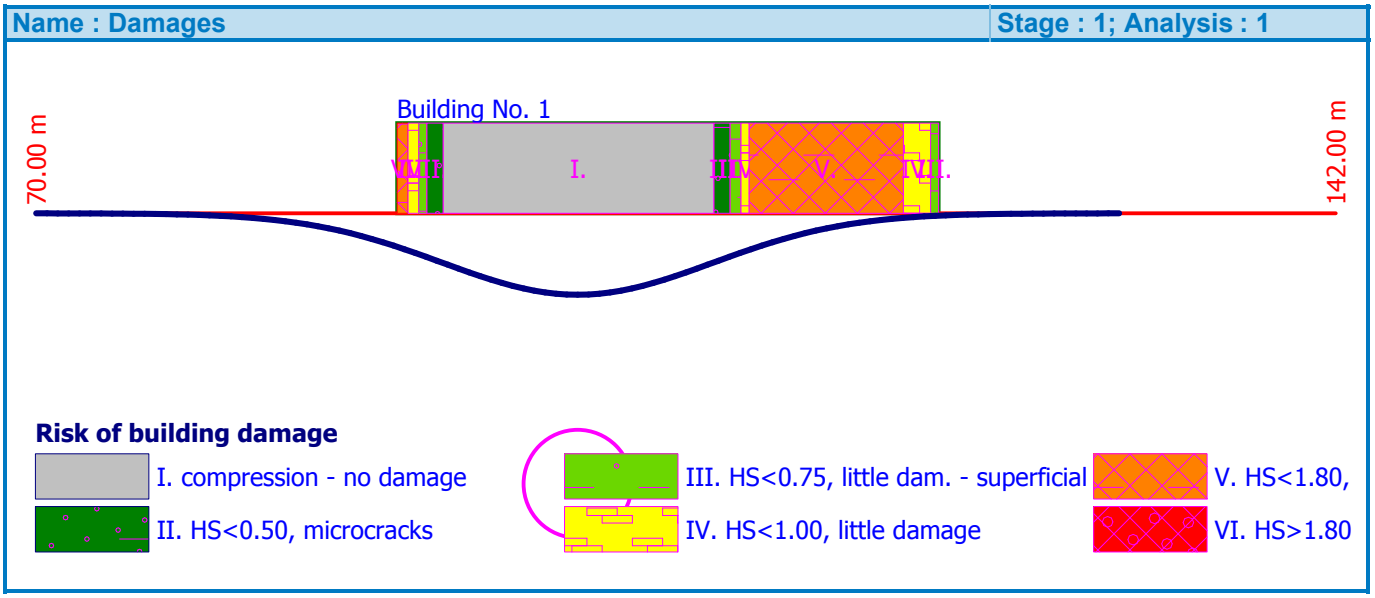
X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
97.00	41.65	-10.41	2.91	1/452
97.60	42.87	-8.57	3.20	1/548
98.20	43.84	-6.58	3.43	1/715
98.80	44.55	-4.45	3.61	1/1056
99.40	44.98	-2.25	3.71	1/2091
100.00	45.12	0.00	3.75	-
100.60	44.98	2.25	3.71	1/2091
101.20	44.55	4.45	3.61	1/1056
101.80	43.84	6.58	3.43	1/715
102.40	42.87	8.57	3.20	1/548
103.00	41.65	10.41	2.91	1/452
103.60	40.21	12.06	2.57	1/390
104.20	38.57	13.50	2.20	1/348
104.80	36.76	14.71	1.81	1/320
105.40	34.82	15.67	1.40	1/300
106.00	32.76	16.38	0.98	1/287
106.60	30.63	16.85	0.58	1/279
107.20	28.46	17.08	0.19	1/275
107.80	26.27	17.08	-0.17	1/275
108.40	24.10	16.87	-0.50	1/278
109.00	21.96	16.47	-0.80	1/285
109.60	19.89	15.91	-1.05	1/295
110.20	17.89	15.21	-1.26	1/309
110.80	16.00	14.40	-1.42	1/326
111.40	14.21	13.50	-1.55	1/347
112.00	12.54	12.54	-1.62	1/374
112.60	11.00	11.55	-1.67	1/406
113.20	9.59	10.55	-1.67	1/444
113.80	8.30	9.55	-1.65	1/491
114.40	7.14	8.57	-1.60	1/546
115.00	6.11	7.63	-1.52	1/613
115.60	5.19	6.74	-1.44	1/694
116.20	4.38	5.91	-1.34	1/792
116.80	3.67	5.14	-1.23	1/910
117.40	3.06	4.44	-1.12	1/1054
118.00	2.53	3.80	-1.01	1/1230
118.60	2.08	3.23	-0.90	1/1447
119.20	1.70	2.73	-0.79	1/1714
119.80	1.38	2.28	-0.69	1/2045
120.40	1.12	1.90	-0.60	1/2458
121.00	0.90	1.57	-0.51	1/2977
121.60	0.71	1.28	-0.43	1/3631
122.20	0.56	1.04	-0.37	1/4460
122.80	0.44	0.84	-0.31	1/5517
123.40	0.35	0.68	-0.25	1/6874
124.00	0.27	0.54	-0.21	1/8626
124.60	0.21	0.43	-0.17	-
125.20	0.16	0.34	-0.14	-

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
125.80	0.12	0.26	-0.11	-
126.40	0.09	0.20	-0.09	-
127.00	0.07	0.16	-0.07	-
127.60	0.05	0.12	-0.05	-
128.20	0.04	0.09	-0.04	-
128.80	0.03	0.07	-0.03	-
129.40	0.02	0.05	-0.03	-
130.00	0.02	0.04	0.00	-

Damage verification No. 1 (Stage of construction 1)

Type of damage: tensile cracks
Building description: Building No. 1

Sectio	Beg. x_1 [m]	End x_2 [m]	Description of damage
1	90.00	90.60	V. HS<1.80, medium damage
2	90.60	91.20	IV. HS<1.00, little damage
3	91.20	91.65	III. HS<0.75, little dam. - superficial
4	91.65	92.55	II. HS<0.50, microcracks
5	92.55	107.55	I. compression - no damage
6	107.55	108.45	II. HS<0.50, microcracks
7	108.45	109.05	III. HS<0.75, little dam. - superficial
8	109.05	109.50	IV. HS<1.00, little damage
9	109.50	118.05	V. HS<1.80, medium damage
10	118.05	119.55	IV. HS<1.00, little damage
11	119.55	120.00	III. HS<0.75, little dam. - superficial



Damage verification No. 2 (Stage of construction 1)

Type of damage: relative deflection
Building description: Building No. 1
Max. relative deflection upwards: 0.47 mm/m in distace of: 23.70 m from building starting point.
Max. relative deflection downwards: 1.18 mm/m in distance of: 10.05 m from building starting point.
Hogging

Section	Beg. x_1 [m]	End x_2 [m]
2	0.00	2.55
3	17.55	30.00

Sagging

Section	Beg. x_1 [m]	End x_2 [m]
2	2.55	17.55

Damage verification No. 3 (Stage of construction 1)

Type of damage: section of building
Building to be analyzed: Building No. 1
Distance from building starting point: point 1 = 5.00 m, point 2 = 25.00 m.

Maximum horizontal strain = 1.67 ‰
Relative gradient between x_1, x_2 = 1/666
Maximum gradient = 1/275
Relative deflection (hogging) = 0.28 mm/m
Relative deflection (sagging) = -1.02 mm/m

Damage verification No. 4 (Stage of construction 1)

Type of damage: gradient damage
Building description: Building No. 1

Sectio	Beg. x_1 [m]	End x_2 [m]	Description of damage
1	90.00	90.30	IV. GR<1/300, little damage
2	90.30	94.65	V. GR<1/150, medium damage
3	94.65	97.35	IV. GR<1/300, little damage
4	97.35	98.40	III. GR<1/500, little dam. - superficial
5	98.40	99.00	II. GR<1/800, microcracks
6	99.00	101.10	I. GR<1/1200, no damage
7	101.10	101.70	II. GR<1/800, microcracks
8	101.70	102.75	III. GR<1/500, little dam. - superficial
9	102.75	105.45	IV. GR<1/300, little damage
10	105.45	109.95	V. GR<1/150, medium damage
11	109.95	114.00	IV. GR<1/300, little damage
12	114.00	116.25	III. GR<1/500, little dam. - superficial
13	116.25	118.05	II. GR<1/800, microcracks
14	118.05	120.00	I. GR<1/1200, no damage

Input data (Stage of construction 2)

Geometry

No.	New excava	Description	Coordinate X [m]	Depth Z [m]	Radius r [m]	Area A [m^2]
1	NO	Excavation No. 1	100.00	15.00	3.00	28.27
2	YES	Excavation No. 2	112.00	15.00	3.00	28.27

No.	Description	Trough param. k [-]	Volume loss VL [%]
1	Excavation No. 1	0.50	3.00
2	Excavation No. 2	0.50	3.00

Verification No. 1 (Stage of construction 2)

Analysis result - Excavation No. 1

Distance of point of inflexion from center point L_{inf} = 7.50 m
Maximum settlement s_{max} = 45.1 mm
Length of settlement trough L_{max} = 30.00 m

Analysis result - Excavation No. 2

Distance of point of inflexion from center point L_{inf} = 7.50 m
Maximum settlement s_{max} = 45.1 mm
Length of settlement trough L_{max} = 30.00 m

Overall results

Depression computed at terrain surface.
Max. settlement s_{max} = 65.5 mm
Max. horizontal deformation h_{max} = 20.2 mm
Begin of settlement trough x_1 = 70.00 m
End of settlement trough x_2 = 142.00 m
Length of settlement trough l = 72.00 m

Digital distributions of variables

Shape of settlement trough (Gauss) - Excavation No. 1

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
70.00	0.03	-0.08	0.00	-
70.72	0.04	-0.09	-0.03	-
71.44	0.05	-0.11	-0.04	-
72.16	0.06	-0.14	-0.05	-
72.88	0.08	-0.19	-0.07	-
73.60	0.11	-0.24	-0.09	-
74.32	0.14	-0.31	-0.12	-
75.04	0.19	-0.41	-0.15	-
75.76	0.26	-0.53	-0.19	1/9411
76.48	0.35	-0.69	-0.24	1/7177
77.20	0.46	-0.88	-0.31	1/5495
77.92	0.61	-1.13	-0.38	1/4257
78.64	0.80	-1.43	-0.47	1/3342
79.36	1.04	-1.80	-0.56	1/2642
80.08	1.34	-2.24	-0.67	1/2119
80.80	1.72	-2.76	-0.79	1/1710
81.52	2.18	-3.38	-0.92	1/1393
82.24	2.75	-4.09	-1.07	1/1145
82.96	3.44	-4.91	-1.21	1/950
83.68	4.27	-5.84	-1.35	1/802
84.40	5.24	-6.86	-1.49	1/681
85.12	6.38	-7.98	-1.61	1/586
85.84	7.70	-9.18	-1.71	1/510
86.56	9.20	-10.45	-1.79	1/448
87.28	10.91	-11.76	-1.83	1/399
88.00	12.81	-13.08	-1.83	1/358
88.72	14.93	-14.39	-1.78	1/326
89.44	17.24	-15.65	-1.69	1/300
90.16	19.73	-16.83	-1.54	1/279
90.88	22.40	-17.87	-1.35	1/263
91.60	25.21	-18.77	-1.10	1/250
92.32	28.15	-19.46	-0.81	1/241

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
93.04	31.18	-19.93	-0.49	1/236
93.76	34.26	-20.16	-0.14	1/233
94.48	37.36	-20.13	0.22	1/233
95.20	40.43	-19.85	0.58	1/237
95.92	43.44	-19.30	0.92	1/243
96.64	46.35	-18.52	1.24	1/254
97.36	49.12	-17.52	1.52	1/268
98.08	51.72	-16.33	1.75	1/287
98.80	54.13	-15.00	1.93	1/313
99.52	56.32	-13.55	2.06	1/346
100.24	58.29	-12.03	2.14	1/390
100.96	60.02	-10.47	2.18	1/448
101.68	61.50	-8.90	2.17	1/526
102.40	62.76	-7.34	2.15	1/638
103.12	63.76	-5.81	2.10	1/808
103.84	64.54	-4.31	2.05	1/1084
104.56	65.09	-2.85	2.01	1/1644
105.28	65.41	-1.42	1.98	1/3277
106.00	65.53	0.00	1.97	-
106.72	65.41	1.42	1.98	1/3277
107.44	65.09	2.85	2.01	1/1644
108.16	64.54	4.31	2.05	1/1084
108.88	63.76	5.81	2.10	1/808
109.60	62.76	7.34	2.15	1/638
110.32	61.50	8.90	2.17	1/526
111.04	60.02	10.47	2.18	1/448
111.76	58.29	12.03	2.14	1/390
112.48	56.32	13.55	2.06	1/346
113.20	54.13	15.00	1.93	1/313
113.92	51.72	16.33	1.75	1/287
114.64	49.12	17.52	1.52	1/268
115.36	46.35	18.52	1.24	1/254
116.08	43.44	19.30	0.92	1/243
116.80	40.43	19.85	0.58	1/237
117.52	37.36	20.13	0.22	1/233
118.24	34.26	20.16	-0.14	1/233
118.96	31.18	19.93	-0.49	1/236
119.68	28.15	19.46	-0.81	1/241
120.40	25.21	18.77	-1.10	1/250
121.12	22.40	17.87	-1.35	1/263
121.84	19.73	16.83	-1.54	1/279
122.56	17.24	15.65	-1.69	1/300
123.28	14.93	14.39	-1.78	1/326
124.00	12.81	13.08	-1.83	1/358
124.72	10.91	11.76	-1.83	1/399
125.44	9.20	10.45	-1.79	1/448
126.16	7.70	9.18	-1.71	1/510
126.88	6.38	7.98	-1.61	1/586

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
127.60	5.24	6.86	-1.49	1/681
128.32	4.27	5.84	-1.35	1/802
129.04	3.44	4.91	-1.21	1/950
129.76	2.75	4.09	-1.07	1/1145
130.48	2.18	3.38	-0.92	1/1393
131.20	1.72	2.76	-0.79	1/1710
131.92	1.34	2.24	-0.67	1/2119
132.64	1.04	1.80	-0.56	1/2642
133.36	0.80	1.43	-0.47	1/3342
134.08	0.61	1.13	-0.38	1/4257
134.80	0.46	0.88	-0.31	1/5495
135.52	0.35	0.69	-0.24	1/7177
136.24	0.26	0.53	-0.19	1/9411
136.96	0.19	0.41	-0.15	-
137.68	0.14	0.31	-0.12	-
138.40	0.11	0.24	-0.09	-
139.12	0.08	0.19	-0.07	-
139.84	0.06	0.14	-0.05	-
140.56	0.05	0.11	-0.04	-
141.28	0.04	0.09	-0.03	-
142.00	0.03	0.08	0.00	-

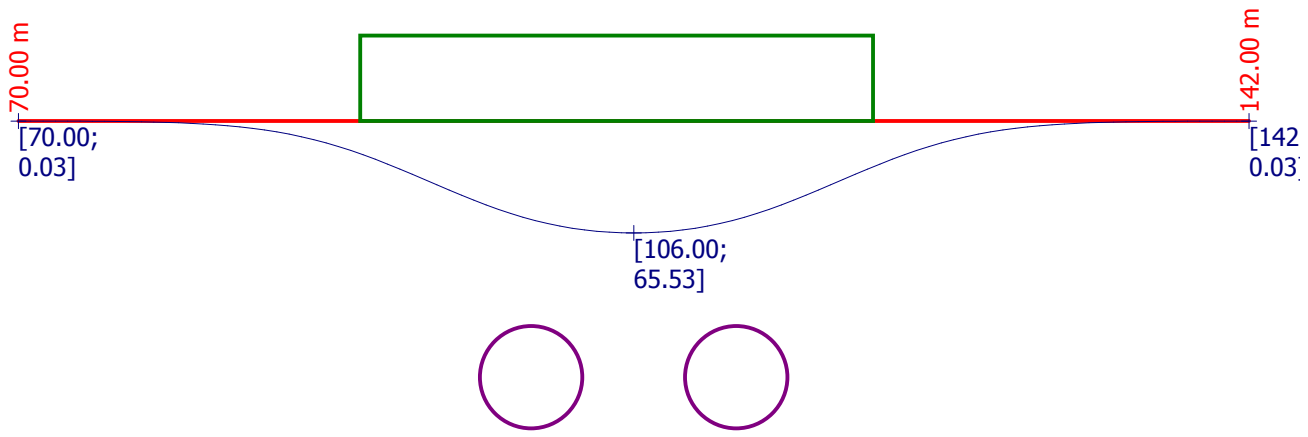
Shape of settlement trough (Gauss) - Excavation No. 2

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
70.00	0.03	-0.08	0.00	-
70.72	0.04	-0.09	-0.03	-
71.44	0.05	-0.11	-0.04	-
72.16	0.06	-0.14	-0.05	-
72.88	0.08	-0.19	-0.07	-
73.60	0.11	-0.24	-0.09	-
74.32	0.14	-0.31	-0.12	-
75.04	0.19	-0.41	-0.15	-
75.76	0.26	-0.53	-0.19	1/9411
76.48	0.35	-0.69	-0.24	1/7177
77.20	0.46	-0.88	-0.31	1/5495
77.92	0.61	-1.13	-0.38	1/4257
78.64	0.80	-1.43	-0.47	1/3342
79.36	1.04	-1.80	-0.56	1/2642
80.08	1.34	-2.24	-0.67	1/2119
80.80	1.72	-2.76	-0.79	1/1710
81.52	2.18	-3.38	-0.92	1/1393
82.24	2.75	-4.09	-1.07	1/1145
82.96	3.44	-4.91	-1.21	1/950
83.68	4.27	-5.84	-1.35	1/802
84.40	5.24	-6.86	-1.49	1/681
85.12	6.38	-7.98	-1.61	1/586
85.84	7.70	-9.18	-1.71	1/510
86.56	9.20	-10.45	-1.79	1/448

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
87.28	10.91	-11.76	-1.83	1/399
88.00	12.81	-13.08	-1.83	1/358
88.72	14.93	-14.39	-1.78	1/326
89.44	17.24	-15.65	-1.69	1/300
90.16	19.73	-16.83	-1.54	1/279
90.88	22.40	-17.87	-1.35	1/263
91.60	25.21	-18.77	-1.10	1/250
92.32	28.15	-19.46	-0.81	1/241
93.04	31.18	-19.93	-0.49	1/236
93.76	34.26	-20.16	-0.14	1/233
94.48	37.36	-20.13	0.22	1/233
95.20	40.43	-19.85	0.58	1/237
95.92	43.44	-19.30	0.92	1/243
96.64	46.35	-18.52	1.24	1/254
97.36	49.12	-17.52	1.52	1/268
98.08	51.72	-16.33	1.75	1/287
98.80	54.13	-15.00	1.93	1/313
99.52	56.32	-13.55	2.06	1/346
100.24	58.29	-12.03	2.14	1/390
100.96	60.02	-10.47	2.18	1/448
101.68	61.50	-8.90	2.17	1/526
102.40	62.76	-7.34	2.15	1/638
103.12	63.76	-5.81	2.10	1/808
103.84	64.54	-4.31	2.05	1/1084
104.56	65.09	-2.85	2.01	1/1644
105.28	65.41	-1.42	1.98	1/3277
106.00	65.53	0.00	1.97	-
106.72	65.41	1.42	1.98	1/3277
107.44	65.09	2.85	2.01	1/1644
108.16	64.54	4.31	2.05	1/1084
108.88	63.76	5.81	2.10	1/808
109.60	62.76	7.34	2.15	1/638
110.32	61.50	8.90	2.17	1/526
111.04	60.02	10.47	2.18	1/448
111.76	58.29	12.03	2.14	1/390
112.48	56.32	13.55	2.06	1/346
113.20	54.13	15.00	1.93	1/313
113.92	51.72	16.33	1.75	1/287
114.64	49.12	17.52	1.52	1/268
115.36	46.35	18.52	1.24	1/254
116.08	43.44	19.30	0.92	1/243
116.80	40.43	19.85	0.58	1/237
117.52	37.36	20.13	0.22	1/233
118.24	34.26	20.16	-0.14	1/233
118.96	31.18	19.93	-0.49	1/236
119.68	28.15	19.46	-0.81	1/241
120.40	25.21	18.77	-1.10	1/250
121.12	22.40	17.87	-1.35	1/263

X-coord. [m]	Settlement [mm]	Horizontal deformation [mm]	Horizontal strain [‰]	Gradient [-]
121.84	19.73	16.83	-1.54	1/279
122.56	17.24	15.65	-1.69	1/300
123.28	14.93	14.39	-1.78	1/326
124.00	12.81	13.08	-1.83	1/358
124.72	10.91	11.76	-1.83	1/399
125.44	9.20	10.45	-1.79	1/448
126.16	7.70	9.18	-1.71	1/510
126.88	6.38	7.98	-1.61	1/586
127.60	5.24	6.86	-1.49	1/681
128.32	4.27	5.84	-1.35	1/802
129.04	3.44	4.91	-1.21	1/950
129.76	2.75	4.09	-1.07	1/1145
130.48	2.18	3.38	-0.92	1/1393
131.20	1.72	2.76	-0.79	1/1710
131.92	1.34	2.24	-0.67	1/2119
132.64	1.04	1.80	-0.56	1/2642
133.36	0.80	1.43	-0.47	1/3342
134.08	0.61	1.13	-0.38	1/4257
134.80	0.46	0.88	-0.31	1/5495
135.52	0.35	0.69	-0.24	1/7177
136.24	0.26	0.53	-0.19	1/9411
136.96	0.19	0.41	-0.15	-
137.68	0.14	0.31	-0.12	-
138.40	0.11	0.24	-0.09	-
139.12	0.08	0.19	-0.07	-
139.84	0.06	0.14	-0.05	-
140.56	0.05	0.11	-0.04	-
141.28	0.04	0.09	-0.03	-
142.00	0.03	0.08	0.00	-

Name : Analysis | **Stage : 2; Analysis : 1**



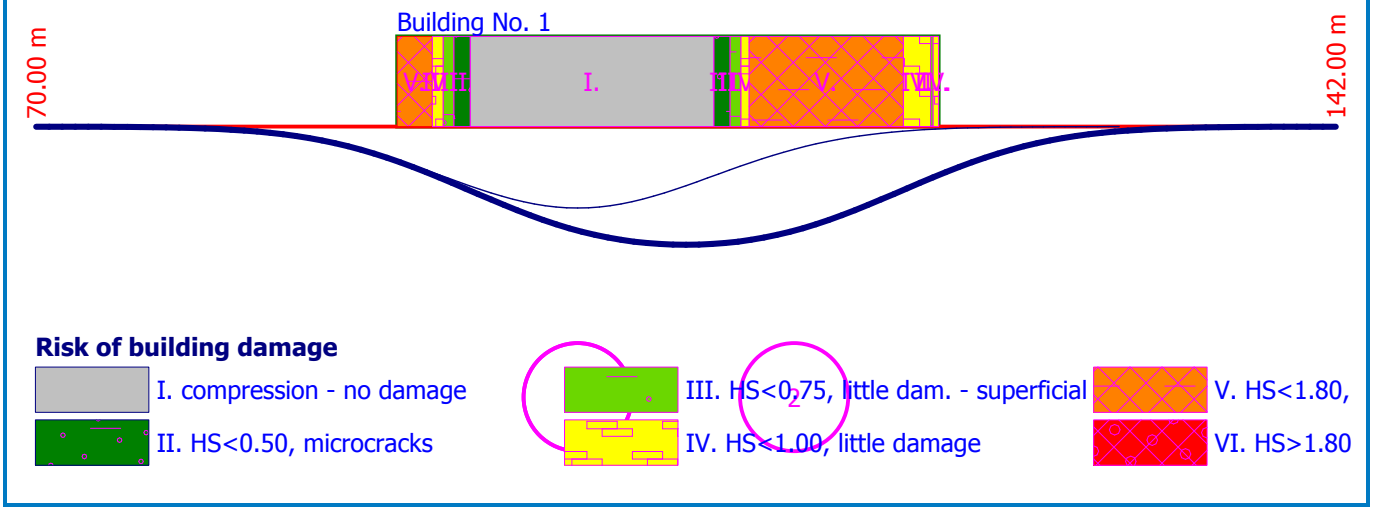
Damage verification No. 1 (Stage of construction 2)

Type of damage: tensile cracks
Analysis performed for all stages.

Building description: Building No. 1

Sectio	Beg. x_1 [m]	End x_2 [m]	Description of damage
1	90.00	91.95	V. HS<1.80, medium damage
2	91.95	92.55	IV. HS<1.00, little damage
3	92.55	93.15	III. HS<0.75, little dam. - superficial
4	93.15	94.05	II. HS<0.50, microcracks
5	94.05	107.55	I. compression - no damage
6	107.55	108.45	II. HS<0.50, microcracks
7	108.45	109.05	III. HS<0.75, little dam. - superficial
8	109.05	109.50	IV. HS<1.00, little damage
9	109.50	118.05	V. HS<1.80, medium damage
10	118.05	119.55	IV. HS<1.00, little damage
11	119.55	119.70	III. HS<0.75, little dam. - superficial
12	119.70	120.00	IV. HS<1.00, little damage

Name : Damages **Stage : 2; Analysis : 1**



Damage verification No. 2 (Stage of construction 2)

Type of damage: gradient damage
Analysis performed for all stages.
Building description: Building No. 1

Sectio	Beg. x_1 [m]	End x_2 [m]	Description of damage
1	90.00	98.55	V. GR<1/150, medium damage
2	98.55	101.55	IV. GR<1/300, little damage
3	101.55	102.75	III. GR<1/500, little dam. - superficial
4	102.75	105.45	IV. GR<1/300, little damage
5	105.45	109.95	V. GR<1/150, medium damage
6	109.95	113.55	IV. GR<1/300, little damage
7	113.55	120.00	V. GR<1/150, medium damage

Damage verification No. 3 (Stage of construction 2)

Type of damage: relative deflection
Analysis performed for all stages.
Building description: Building No. 1
Max. relative deflection upwards: 0.47 mm/m in distace of: 23.70 m from building starting point.
Max. relative deflection downwards: 1.26 mm/m in distance of: 16.05 m from building starting point.

Hogging

Section	Beg. x_1 [m]	End x_2 [m]
2	0.00	4.05
3	17.55	30.00

Sagging

Section	Beg. x_1 [m]	End x_2 [m]
2	2.55	28.05

Name : Damages | **Stage : 2; Analysis : 3**