



CHECKLIST

FOR

SITE INVESTIGATION

SI

Rev: October 2008

Project:

Introduction

Site Investigations (SI) are eminent for the determination of the subsurface condition. All underground constructions start with the evaluation of the interpreted data from the SI.

This checklist is a guideline to carry out a broad SI and/or to check the completeness of the available data.

This document is based on

- EN 1997
- DIN 4020 (German Standard)
- B 4402 (Austrian Standard)
- TGB 1990 (Dutch Standard)
- Geotechnical Baseline Report for Underground Construction (American society of Civil Engineers)

Any additional input of other European standards and/or local experience should be used when applicable or available.

Content:

1. General Information
2. Review of Ground Investigation
3. Classification into Geotechnical Categories
4. Geotechnical Category 1
5. Geotechnical Category 2
6. Geotechnical Category 3
7. Detailed recommendations

Theme	Source of information	Issue
1. General Information		
1.1 Project description		
1.2 Scope of geotechnical work		
1.3 Available previous / relevant Ground Investigation reports		<input type="checkbox"/> No <input type="checkbox"/> Yes, see annex
1.4 Desk Study Findings geology, soil conditions, groundwater etc.		<input type="checkbox"/> No <input type="checkbox"/> Yes, see annex
1.5 Main Hazards <ul style="list-style-type: none"> - hydrological or hydraulic effects - soil subsidence - flood risk - earth quakes - avalanches - landslides - mudflows - gas - others 		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
1.6 Stage of available ground investigation		<input type="checkbox"/> Preliminary <input type="checkbox"/> Final for tender purpose
1.7 Limitations of available ground investigation		<input type="checkbox"/> Yes, due to limited access (existing buildings, etc.) o.e. <input type="checkbox"/> No
1.8 Design modifications		<input type="checkbox"/> Client's design <input type="checkbox"/> Contractor's design
1.9 Additional investigations		<input type="checkbox"/> Ongoing <input type="checkbox"/> If necessary, responsibility of the contractor
1.10 Contaminated site to be expected		<input type="checkbox"/> Yes according to available documents <input type="checkbox"/> Yes according to local experience <input type="checkbox"/> To be checked
1.11 Unexploded ordnance		<input type="checkbox"/> Risk <input type="checkbox"/> Investigation required
1.12 Geotechnical monitoring		<input type="checkbox"/> No monitoring ongoing <input type="checkbox"/> Becoming part of the contract
1.13 Geotechnical Category		<input type="checkbox"/> Not defined in tender documents <input type="checkbox"/> Expected to be GC 2 <input type="checkbox"/> Expected to be GC 3

Theme	Source of information	Issue
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2. Review of Available Site Investigation

2.1 Date of Investigation		Date: and Available documents listed in annex.....
2.2 Basis for design		Derived values for design provided: <input type="checkbox"/> Yes <input type="checkbox"/> No
2.3 Type and extent		<input type="checkbox"/> Extent of the investigated area with respect to the influence of the construction works <input type="checkbox"/> permits judgment of feasibility of foundation options and construction works <input type="checkbox"/> carried out according to standards <input type="checkbox"/> provides sufficient information to evaluate characteristic values <input type="checkbox"/> Field testing <input type="checkbox"/> Laboratory testing
2.4 Method and diameter of exploratory drilling		<input type="checkbox"/> Suitable for necessary number and quality of samples <input type="checkbox"/> Diameter suitable for the kind of sampling and testing
2.5 Requirements for relevant geotechnical Category		Ground investigation fulfils the requirements for relevant Geotechnical Category <input type="checkbox"/> GC 2 <input type="checkbox"/> GC 3
2.6 Content of Ground Investigation		<input type="checkbox"/> Inconsistencies between existing ground investigation documents <input type="checkbox"/> Foundation conditions of adjacent structures and services <input type="checkbox"/> Assessment of Geology <input type="checkbox"/> Investigation for contamination <input type="checkbox"/> Ground water measurements and pumping tests

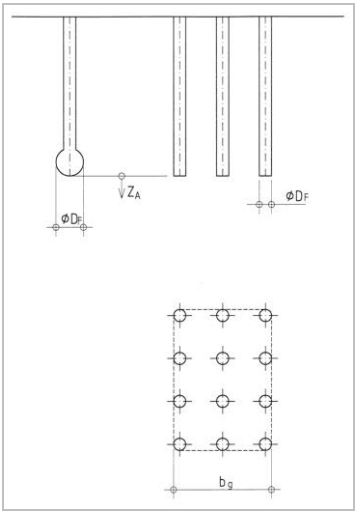
Theme	Source of information	Issue
2.7 Consideration of typical construction risks for foundation contractors		<input type="checkbox"/> Cavities <input type="checkbox"/> Very soft soils <input type="checkbox"/> Artesian groundwater <input type="checkbox"/> Tidal groundwater <input type="checkbox"/> Unfavourable chemistry <input type="checkbox"/> Boulders <input type="checkbox"/> Sloping or highly variable rockhead level <input type="checkbox"/> Ground water velocity <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
3. Classification into Geotechnical Categories		
3.1 Construction		<input type="checkbox"/> Small and simple -> Geotechnical Category 1 => chapter 4 <input type="checkbox"/> Usual -> Geotechnical Category 2 => chapter 5 <input type="checkbox"/> Difficult -> Geotechnical Category 3 => chapter 6
3.2 Stability		<input type="checkbox"/> According to general experience -> Geotechnical Category 1 -> chapter 4 <input type="checkbox"/> According to design including normal geotechnical experience -> Geotechnical Category 2 -> chapter 5 <input type="checkbox"/> According to design including special geotechnical experience -> Geotechnical Category 3 -> chapter 6
3.3 Geotechnical Engineer necessary?		<input type="checkbox"/> GC 1 -> Geotechnical Engineer not necessary <input type="checkbox"/> GC 2 or GC 3 -> Geotechnical Engineer necessary
3.4 Experience with the scope of work available within the company		<input type="checkbox"/> No <input type="checkbox"/> Yes, references are

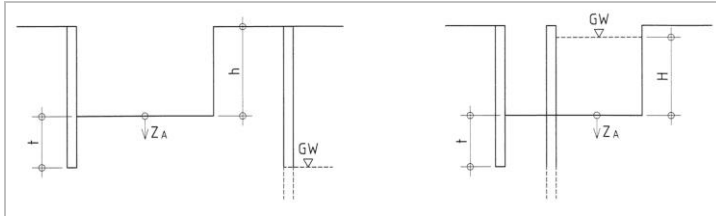
Theme	Source of information	Issue
3.5 Review of Geotechnical Category		<input type="checkbox"/> Proposed Category acceptable <input type="checkbox"/> Proposed Category not acceptable <u>Comment:</u>
4. Geotechnical Category 1		
4.1 SI necessary?		<input type="checkbox"/> Data available from nearby locations, subsoil is homogeneous according to geological maps, similar type of foundation, driven piles used > No SI necessary <input type="checkbox"/> Detailed SI necessary => chapter 5
4.2 Minimum SI		<input type="checkbox"/> Information about subsoil and general local experience (investigation of soil and layers, groundwater before and during construction works) <input type="checkbox"/> Visit and inspect deep excavation <input type="checkbox"/> Minimum two CPTs (Cone Penetration Test or boreholes)
5. Geotechnical Category 2		
5.1 Minimum SI		<input type="checkbox"/> Field investigation and laboratory testing / correlation <input type="checkbox"/> Record ground water levels and laboratory testing <input type="checkbox"/> Outcrops are necessary; SI by means of CPTs => chapter 5.1.1 boreholes => chapter 5.1.2 <input type="checkbox"/>
5.1.1 Cone Penetration Tests CPTs		<input type="checkbox"/> Number of CPTs < 25 lm <input type="checkbox"/> Minimum one CPT per 25 x 25 m <input type="checkbox"/> Distance between CPT and future limit of planned construction < 5 m
5.1.2 Boreholes required? (in special cases)		<input type="checkbox"/> To identify upper soil layers <input type="checkbox"/> Necessary to install piezometer, recording water levels and variations in time

Theme	Source of information	Issue
5.2 Laboratory testing (special purposes)		Type of test:: <input type="checkbox"/> classification tests <input type="checkbox"/> soil/rock strength tests <input type="checkbox"/> soil/rock stiffness tests <input type="checkbox"/> chemical tests
6. Geotechnical Category 3		
6.1 Further investigations than GC 2 necessary?		<input type="checkbox"/> No <input type="checkbox"/> Yes => chapter 6.2
6.2 Special attention to the reason why the building categorised as GC 3		<input type="checkbox"/> Additional soil investigation to obtain information to assess soil – structure deformation <input type="checkbox"/> Deeper boreholes - to get information on subsoil - to take samples for laboratory testing - to install deep piezometers for groundwater monitoring <input type="checkbox"/> Additional laboratory testing to identify special soil parameters <input type="checkbox"/>

Theme	Source of information	Issue
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7. Detailed recommendations

7.1 Foundations		<input type="checkbox"/> Pile foundations => chapter 7.1.1 <input type="checkbox"/> Shallow foundations => chapter 7.1.2 <input type="checkbox"/> Single base, strip foundations and small shallow foundations with smallest width of slab $b_B \leq 5$ m => chapter 7.1.3 <input type="checkbox"/> Raft foundations and buildings with several foundation elements, with overlaying influences => chapter 7.1.4 <input type="checkbox"/> Foundations of hydraulic structures => chapter 7.1.5																		
7.1.1 Pile foundations		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 1 * b_g$ - $z_a \geq 5$ m, i. e. approximately 10 m embedment in bearing layer - $z_a \geq 3 * D_F$ - At one location to minimum 10x least size of pile tip below pile tip level (if > 5 m) - One CPT to depth of 1,5 x largest width of the construction (if reasonable) <div style="text-align: right;">  </div> <p style="text-align: right;">Figure 1 Depth of SI for pile foundations</p>																		
7.1.2 Shallow foundations		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 1,5 * b_B$; b_B – least width of construction - Theoretical: Minimum depth 1 to 3 times the width of the foundation - Practical: 5 to 10 m below base level of foundations 																		
7.1.3 Single pad, strip foundations and small shallow foundation elements, which may interact with each other		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 3 * b_B$; b_B – least width of construction - $z_a \geq 5$ m 																		
7.1.4 Raft foundations and buildings with several foundation elements, which may interact with each other		<p>Depth:</p> <ul style="list-style-type: none"> - According Table 2: z_a referring to least side length b [m]; but $z_a \geq 5$ m <p>Table 2: Depth of SI for raft foundations, z_a referring to least side length of foundation</p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <th style="border: none;">b [m]</th> <th style="border: none;">≤ 5</th> <th style="border: none;">10</th> <th style="border: none;">15</th> <th style="border: none;">20</th> <th style="border: none;">30</th> <th style="border: none;">40</th> <th style="border: none;">50</th> <th style="border: none;">≥ 60</th> </tr> <tr> <td style="border: none;">z_a (b) [m]¹⁾</td> <td style="border: none;">3,00</td> <td style="border: none;">2,50</td> <td style="border: none;">1,75</td> <td style="border: none;">1,40</td> <td style="border: none;">1,00</td> <td style="border: none;">0,75</td> <td style="border: none;">0,60</td> <td style="border: none;">0,50</td> </tr> </table> <p style="text-align: center; font-size: small;">¹⁾ Intermediate values are allowed to be interpolated</p>	b [m]	≤ 5	10	15	20	30	40	50	≥ 60	z_a (b) [m] ¹⁾	3,00	2,50	1,75	1,40	1,00	0,75	0,60	0,50
b [m]	≤ 5	10	15	20	30	40	50	≥ 60												
z_a (b) [m] ¹⁾	3,00	2,50	1,75	1,40	1,00	0,75	0,60	0,50												

Theme	Source of information	Issue	
7.1.5 Foundation of hydraulic structures		Depth: <ul style="list-style-type: none"> - Guide value for excavation depth (from base level) is the hydrostatic pressure, but $z_a \geq 5$ m 	Distance: <ul style="list-style-type: none"> - Spacing 15 to 75 m
7.2 Deep excavations		Depth: <ul style="list-style-type: none"> - In general: Depth = width of excavation, but $z_a \geq 5$ m - Groundwater table below base level of deep excavation (Figure 2) $z_a \geq 0,4 * h$ $z_a \geq t + 2$ m - Groundwater table above bottom of deep excavation (Figure 2) $z_a \geq 1 * h + 2$ m $z_a \geq t + 2$ m - If no impermeable layer is reached within this depth: $z_a \geq t + 5$ m  <p>Figure 2: Depth of SI for deep excavations with existing ground water level above and below formation level</p>	
7.3 Cut-off walls		Depth: <ul style="list-style-type: none"> - $z_a \geq 2$ m below surface of impermeable layer (Figure 3) - $z_a \geq 5$ m from toe of cut-off wall, if no impermeable layer is reached 	Distance: <ul style="list-style-type: none"> - Spacing 25 to 50 m
7.4 Linear structures		Distance: <ul style="list-style-type: none"> Spacing 50 to 200 m 	

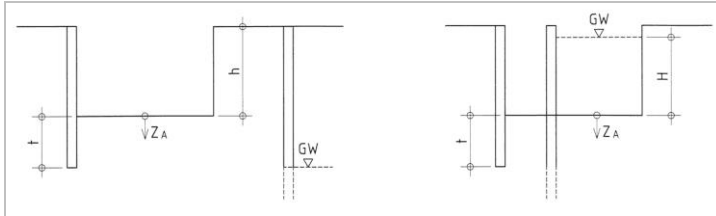


Figure 2: Depth of SI for deep excavations with existing ground water level above and below formation level

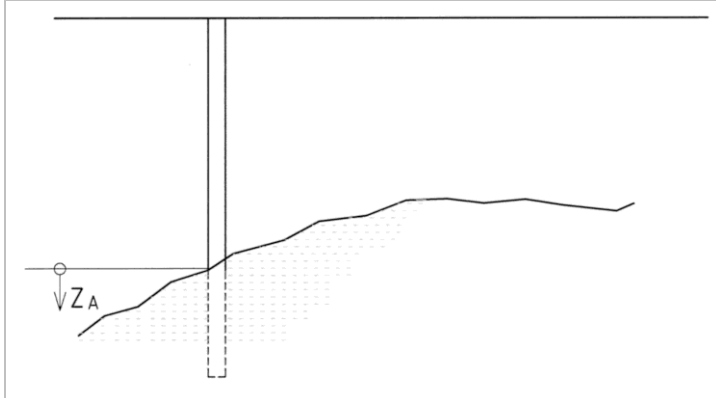
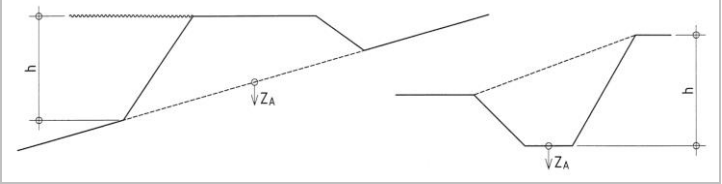
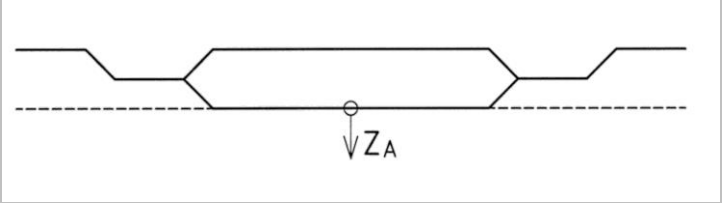
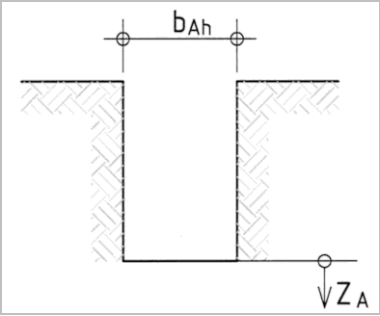
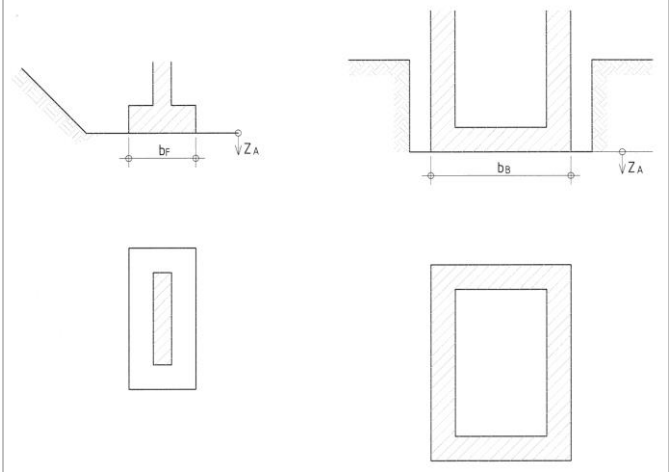
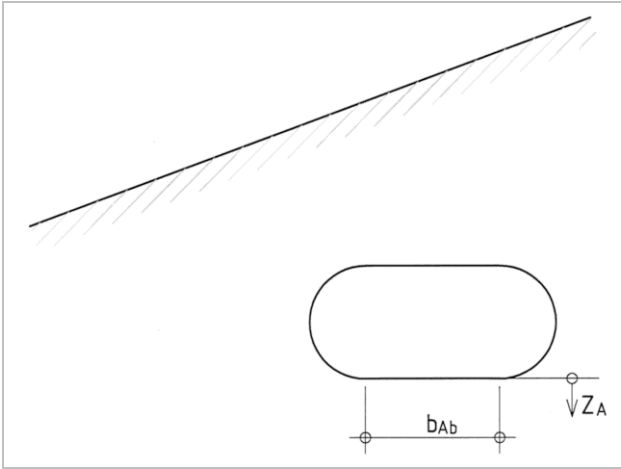


Figure 3: Depth of SI for cut-off walls, if impermeable layer is reached

Theme	Source of information	Issue
7.4.1 Earthworks		<p>Depth of cutting:</p> <ul style="list-style-type: none"> - $z_a \geq 2 \text{ m}$ - $z_a \geq 0,4 * h$ <p>Depth of embankment:</p> <ul style="list-style-type: none"> - $0,8 * h < z_a \leq 1,2 * h$ - $z_a \geq z \Delta \sigma_{dam} \leq 0,3 * \sigma_{insitu}$ - $z_a \geq 6 \text{ m}$  <p>Figure 4: Depth of SI for earthworks (embankment and cutting)</p>
7.4.2 Transportation (road and rail)		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 2 \text{ m}$ below bottom of excavation level  <p>Figure 5: Depth of SI for transportation</p>
7.4.3 Underground services and canals (belonging to GC 2 or GC 3)		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 2 \text{ m}$ below bottom of excavation level - $z_a \geq 1,5 * b_{Ah}$ b_{Ah} – width of excavation  <p>Figure 6 Depth of SI for underground services and canals</p>
7.5 Land deposits		<p>Distance:</p> <ul style="list-style-type: none"> - Grid less than 60 m
7.6 Bridges, etc.		<p>Quantity:</p> <p>2 to 4 numbers per foundation</p>
7.7 Extensive building construction		<p>Distance:</p> <p>Grid less than 60 m</p>

Theme	Source of information	Issue
<p>7.8 Structural buildings and industrial structures</p>		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a \geq 3 * b_F$ b_F – least width of foundation - $z_a \geq 6$ m <p>Distance:</p> <ul style="list-style-type: none"> - Grid 20 to 40 m  <p>Figure 7: Depth of SI for structural buildings and industrial structures</p>
<p>7.9 Underground caverns</p>		<p>Depth:</p> <ul style="list-style-type: none"> - $z_a = \text{depth of outbreak ??}$ - $z_a \geq 5$ m  <p>Figure 8: Depth of SI for underground caverns</p>

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8. Notes

This document was prepared using:

- EN 1997
- DIN 4020 (German Standard)
- B 4402 (Austrian Standard)
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- Geotechnical Baseline report for Underground construction (American society of Civil Engineers)

Any additional input of other European standards and/or local experience should

Conclusion:

Prepared:		Date:
Reviewed:		Date:
Approved:	:	Date: