# Emerald Book Training Manual

## About the GBR: from scientific data to ground support and hindrances


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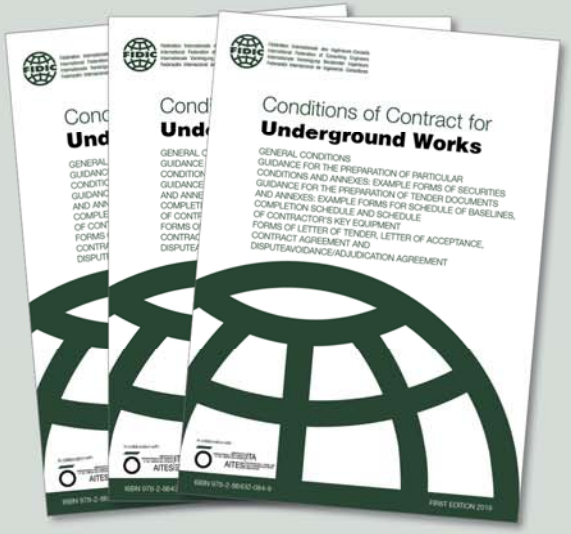

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# Contents

- Definitions of GBR and GDR
- Priority of documents
- Stipulations in the GCC
- Information required for the GBR
- Preparation of the GBR
- The Geotechnical Baseline Report

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# Definitions of GBR and GDR

1.1.52 "**Geotechnical Data Report**" or "**GDR**" means the report entitled Geotechnical Data Report as included in the Contract containing the geological, geotechnical and hydrogeological data deemed to be in the Employer's possession at the Base Date.

1.1.51 "**Geotechnical Baseline Report**" or "**GBR**" means the report entitled geotechnical baseline report as included in the Contract that describes the subsurface physical conditions to serve as the basis for the execution of the Excavation and Lining Works, including design and construction methods, and the reaction of the ground to such methods. The GBR sets out the allocation of the risk between the Parties for such subsurface physical conditions.

1.1.101 "**Unforeseeable**" means not reasonably foreseeable by an experienced contractor by the Base Date. Notwithstanding the foregoing, **all subsurface physical conditions described in the GBR are deemed to be foreseeable, and all subsurface physical conditions outside the scope of conditions defined in the GBR are deemed to be Unforeseeable.**

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# Priority of Documents

## 1.5 Priority of Documents

(a) the Contract Agreement;
(b) the Letter of Acceptance;
(c) the Letter of Tender;
(d) the Particular Conditions Part A – Contract Data, the Completion Schedule and the Schedule of Baselines;
(e) the Particular Conditions Part B – Special Provisions;
**(f) the Geotechnical Baseline Report;**
(g) these General Conditions;
(h) the Employer's Requirements;
(i) the other Schedules;
(j) the Contractor's Proposal;
(k) the JV Undertaking (if the Contractor is a JV); and
(l) any other documents forming part of the Contract, including the **Geotechnical Data Report,** the Contract Risk Register and the Contract Risk Management Plan.

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# Stipulations in the General Conditions of Contract

**From the introductory Notes:**

The **Geotechnical Baseline Report** or GBR is defined as the **single contractual source of risk allocation related to subsurface physical conditions to the Parties**.

Equally important to the physical conditions of the ground, the GBR addresses **the reaction of the ground to excavation and support** under the **contractually agreed construction methodology**.

The risks arising out of the foreseen properties of the ground, obstacles and adverse reaction to the excavation and ground support processes are assigned to the Contractor…

Conversely, the risks arising out of unforeseen physical conditions of the ground, obstacles, and adverse reaction to the excavation and ground support processes are allocated to the Employer…

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# Stipulations in the General Conditions of Contract

**1.9 Errors in the Employer's Requirements and/or in the Geotechnical Baseline Report**

If there is an error, fault or defect in the GBR the Contractor shall give notice to the Engineer

**2.5 Site Data and Items of Reference**

…the Employer shall have made available, prior to the Base Date:(a) the Geotechnical Baseline Report (GBR); and (b) the Geotechnical Data Report (GDR).

**4.10.2 Use of the Geotechnical Baseline Report**

The Contractor shall base the Tender and the Contractor's Proposal for the Excavation and Lining Works on the GBR

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# Stipulations in the General Conditions of Contract

**4.10.3 Use of the Geotechnical Data Report**

Is for information (very low order in priority of documents) and might become important when an alternative construction method for the Excavation and/or Lining Works is agreed between the Parties and add info is required.

**5.1 General Design Obligations**

The Contractor shall carry out, the design of the Works in accordance with the Geotechnical Baseline Report.

**13.8.2 Bill of Quantities for Excavation and Lining Works**

**The initial quantities** shall be determined by the Employer, **consistent** with the Employer's reference design, **the Geotechnical Baseline Report**

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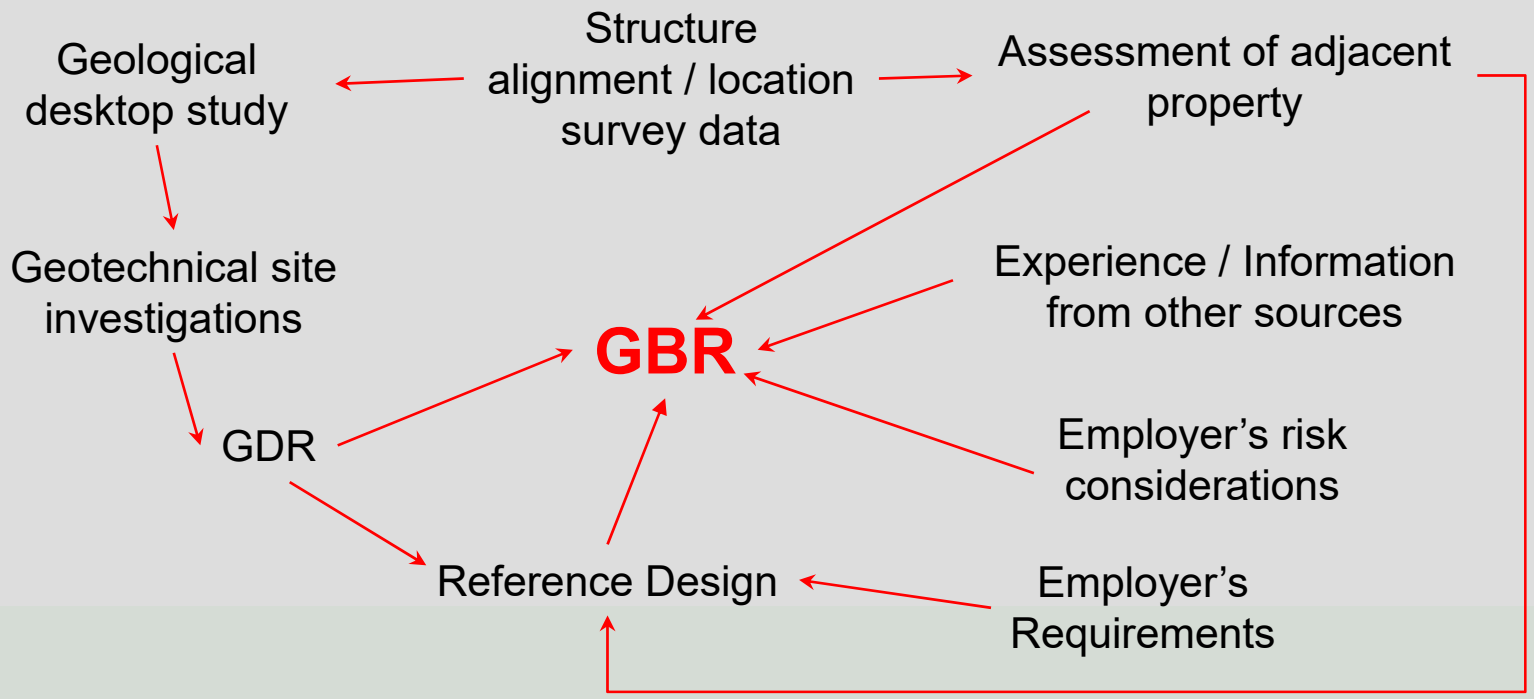
# Information required for the GBR



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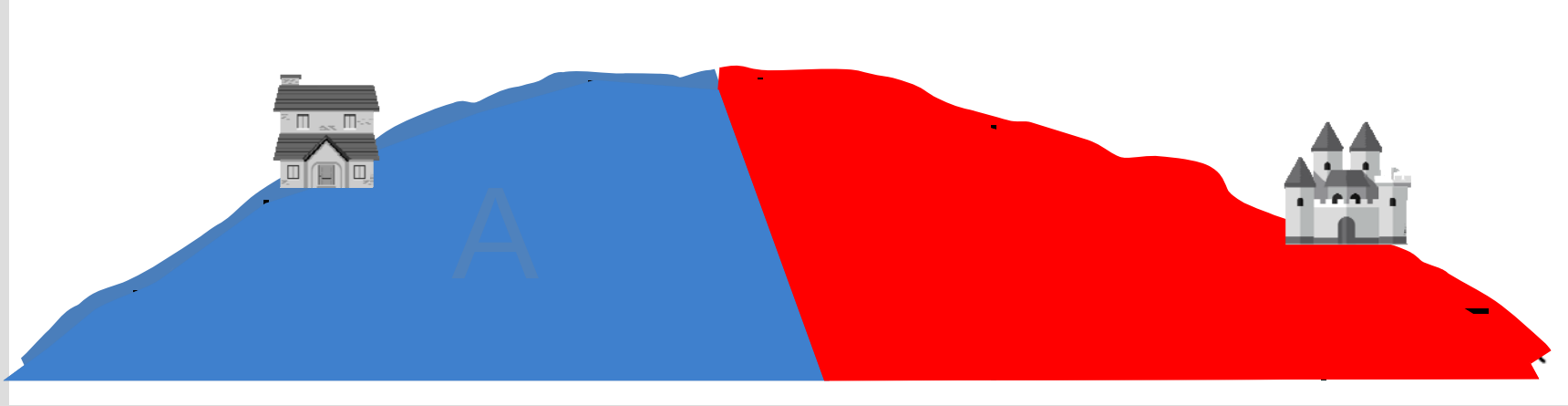
# Preparation of the GBR, site investigation



- Structure, alignment and survey data
- Geological desktop study
- Geotechnical site investigation
- Assessment of adjacent property

# Preparation of the GBR, Geotechnical Data Report


## Section A

Permeability coefficient $10^{-6}$ to $10^{-8}$ m/s
Unit weight 2,5-2,7 t/m³
Cohesion 10-50 MPa
Friction angle 40-50°
E-modulus 20-70 GPa
Uniaxial compressive strength 100-220 MPa
RQD 100
No weathering
Abroy abrasivity high

## Section B

Permeability coefficient $10^{-3}$ to $10^{-5}$ m/s
Unit weight 2,1-2,4 t/m³
Cohesion 0,25-2 MPa
Friction angle 15-30°
E-modulus 7-65 GPa
Uniaxial compressive strength 5-50 MPa
RQD 0
High weathering
Abroy abrasivity low

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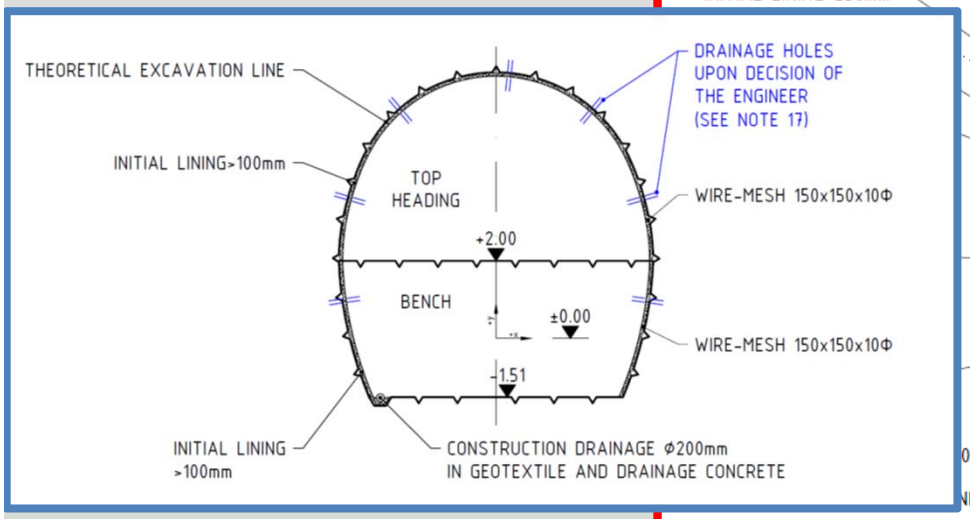
# Preparation of the GBR, Interpretation of Geotechnical Data

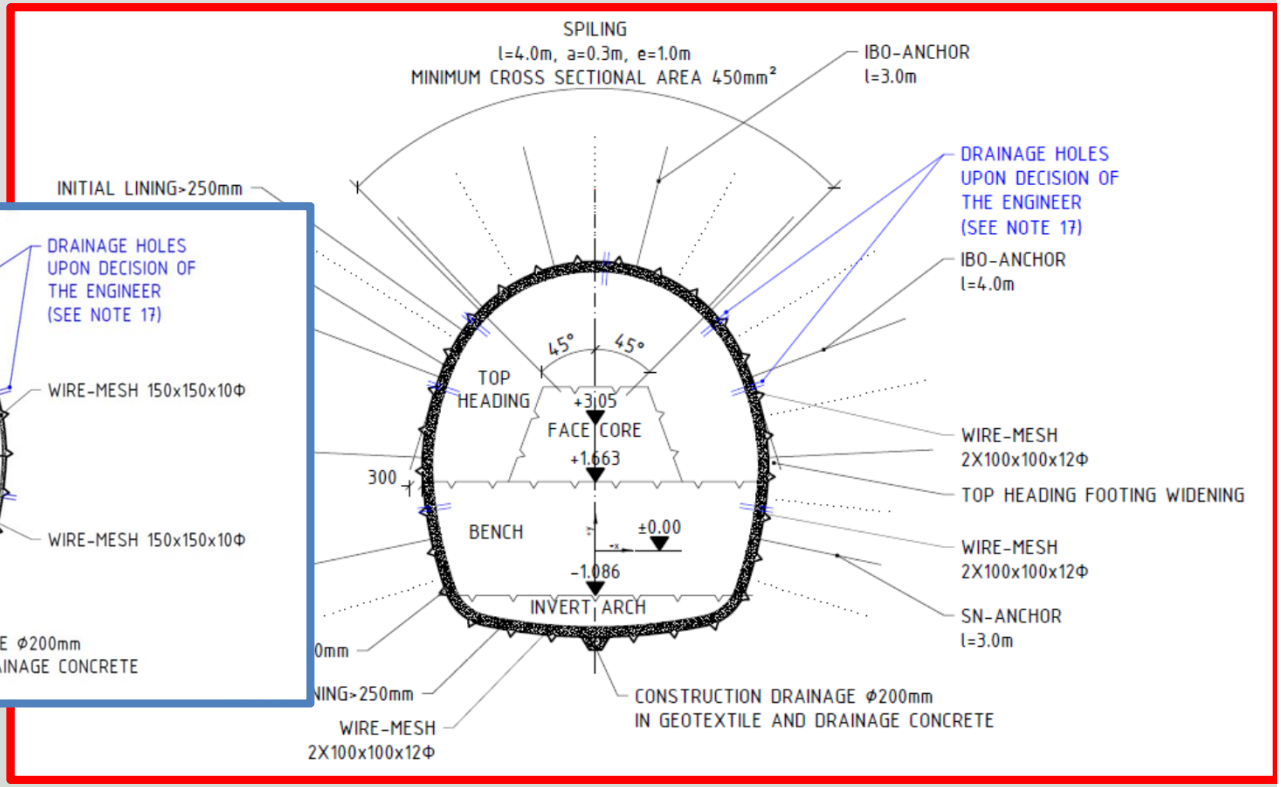
| Basic categories of Behaviour Types (BT) | | Description of potential failure modes/mechanisms during excavation of the unsupported ground |
|---|---|---|
| 1 | Stable | Stable ground with the potential of small local gravity induced falling or sliding of blocks |
| 2 | Potential of discontinuity controlled block fall | Voluminous discontinuity controlled, gravity induced falling and sliding of blocks, occasional local shear failure on discontinuities |
| 3 | Shallow failure | Shallow stress induced failure in combination with discontinuity and gravity controlled failure |
| 4 | Voluminous stress induced failure | Stress induced failure involving large ground volumes and large deformation |
| 5 | Rock burst | Sudden and violent failure of the rock mass, caused by highly stressed brittle rocks and the rapid release of accumulated strain energy |
| 6 | Buckling | Buckling of rocks with a narrowly spaced discontinuity set, frequently associated with shear failure |
| 7 | Crown failure | Voluminous overbreaks in the crown with progressive shear failure |
| 8 | Ravelling ground | Ravelling of dry or moist, intensely fractured, poorly interlocked rocks or soil with low cohesion |
| 9 | Flowing ground | Flow of intensely fractured, poorly interlocked rocks or soil with high water content |
| 10 | Swelling ground | Time dependent volume increase of the ground caused by physical-chemical reaction of ground and water in combination with stress relief |
| 11 | Ground with frequently changing deformation characteristics | Combination of several behaviours with strong local variations of stresses and deformations over longer sections due to heterogeneous ground (i.e. in heterogeneous fault zones; block-in-matrix rock, tectonic melanges) |

# Preparation of the GBR, Reference Design

## Section A




## Section B



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# Preparation of the GBR, Information required

**Assessment of adjacent property**

On top of the alignment is an old building which is the property of Mr. Nice.

The building can tolerate 80 mm settlements before causing damage.

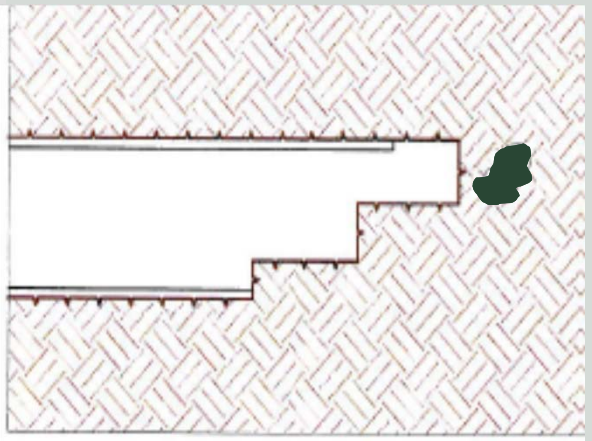
**Employer's risk consideration**

The castle above the alignment is the property of Lord Mean. The castle can tolerate 80 mm settlements before causing damage as well.

However, Lord Mean is very influential and could stop the project when there is some damage to his property.

**Experience / Information from other sources**

From a previous project executed the Employer knows that there are intrusions in section A, which will slow down the constructions.



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# The Geotechnical Baseline Report

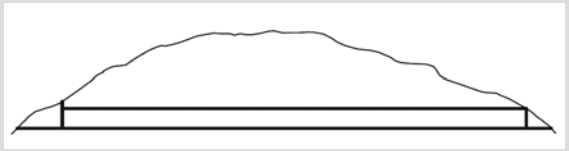
as per Appendix A of the Guidance for the Preparation of Tender Documents

## Part A: General Information

1 Introduction: the Employer wants to build a **road tunnel**

2 General Project Information: the road tunnel (1000m long) will lead from Vienna to Linz

2.1 General project layout



2.2 Excavation and lining works subdivision
There is **one tunnel** to be excavated **from one portal**

2.3 Construction methodology: the tunnel will be build by **drill and blast**

3 Geological and hydrogeological context

3.1 Geology in the project area
There are geological **formations A and B**

3.2 Hydrogeology in the project area
In formation B there is **ground water**

4 Risk scenarios and mitigation measures for Excavation and Lining Works

4.1 Risks related to geological formations
Risks in regard to **fault between** formation **A and B**
Risk of **intrusions** in formation A

4.2 Risks related to groundwater
**Ground water inflow** in formation B

4.3 Risks related to third parties
**Settlements** can cause risks to adjacent properties

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# The Geotechnical Baseline Report

as per Appendix A of the Guidance for the Preparation of Tender Documents

## Part B: Contractual geotechnical baselines

5 Agreed subsurface physical and behavioral conditions, excavation and support classes:
In section A (500m) the ground behavior is **stable** with 20% potential **discontinuity controlled block fall.** Excavation **support class A**
In section B (500m) the ground behavior is **crown failure** to **raveling ground**. Excavation **support class B**

5.1.1 Subsurface physical conditions
5.1.1.1 Ground types and relevant geotechnical properties:
Ground type A: Granite, UCS* 150-180 MPa, highly abrasive*, E-module+ 40-50 GPa
Ground type B: Shale, UCS* 80-100 MPa, moderately abrasive*, E-module+ 10-15 GPa

5.1.1.2 Ground water
In section A there is no ground water
In section B water **inflow of 20-30l/sec/10m tunnel** is anticipated

5.1.1.4 Obstacles
In formation A 10 **intrusions** with 5m³ with USC* of 250-300 MPa, extremely abrasive*

* Relevant for excavation
+ Relevant for design / design parameter

# The Geotechnical Baseline Report

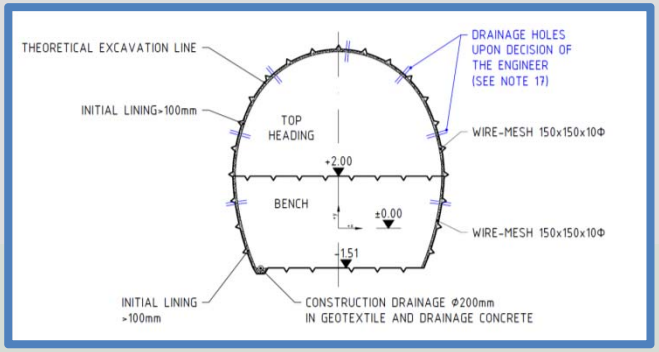
as per Appendix A of the Guidance for the Preparation of Tender Documents

5.1.2 Relevant risk scenarios and adverse behaviours

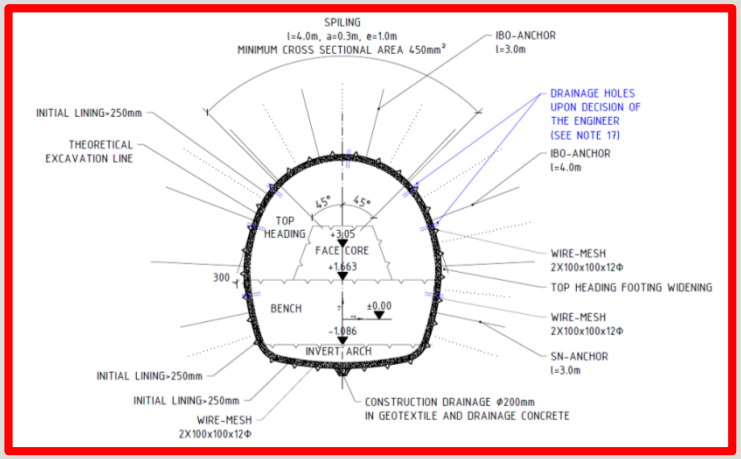
High water inrush at fault between formation A and B 50l/sec

5.1.3 Excavation and support classes, ancillary and control measures

5.1.3.1 Excavation and support class A




5.1.3.2 Excavation and support class B




5.3 Limitations of allowable settlements

Stretch under building of Mr. Nice max. 80 mm

Stretch under castle of Lord Mean max. 20 mm

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**Questions & Answers**

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## Thank you for your kind attention!

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