1 General

The aim of the document is to provide information about the required input parameters and the necessary steps for the calculation of a face support pressure. This calculation is carried out under the project name "Sample Project", at the location "Section 1 - Mixed Face" and calculation section "Station 21+000". The calculation has following features:

Type of TBM	EPB TBM
Unit of Calculation	Metric
Safety Concept in General	Partial safety factor
Method of Calculation	DIN 4085
Safety Concept for Ordinate Check	Factor

The selected combination of the type of TBM, method of calculation, safety concept etc. in this project is aimed to illustrate various possibilities available in the program. It should not be interpreted as the combination to be followed always. Users are completely free to decide these parameters as per the suitability of their project.

1.1 Input Data

Tunnel diameter (Excavation diameter)	D	12.00	[m]
Depth of tunnel (measured from the highest surface, either ground surface or water surface)	h	21.30	[m]
Depth of groundwater table	h_{GWL}	7.70	[m]
Unit weight of support medium (Advance)	γ_b	14	[kN/m³]
Unit weight of support medium (Drawdown)	γ_b	14	[kN/m³]
Operational tolerance support medium	Δ_{pM}	30	[kN/m²]
Operational tolerance compressed air	Δ_{pCAP}	10	[kN/m²]

1.2 Safety Concept

Partial safety factor for earth pressure	γ_E	1.50	[-]
Partial safety factor for water pressure	γ_W	1.05	[-]
Factor for favorable loads in blow out check	$\gamma_{G,stb}$	0.90	[-]

1.3 Ordinate Check

Combined ordinate check, crown: coefficient earth pressure	$\gamma_{kF,ea}$	1.30	[-]
Combined ordinate check, crown: coefficient water pressure	$\gamma_{kF,W}$	1.05	[-]
Ordinate check bottom edge compressed air, coefficient water pressure	$\gamma_{DL,W}$	1,05	[-]
Ordinate check invert, coefficient water pressure	γ_W	1.05	[-]

1.4 Surface Loads [as total load or [thickness x unit weight]

1.4 Surface Loads [as total load or [thickness x unit weight]	Thickness [m]	Unit weight [kN/m³]	Pressure [kN/m²]
Temporary surface load	-	-	10
Permanent surface load	1.0	18	18

1.5 Soil Layers

1.5 Soil Layers	Thickness	Unit weight [γ]	Submerged unit weight	Angle of friction	Cohesion	Earth pressure coefficients	
	d_i [m]	γ_i [kN/m³]	γ'_i [kN/m³]	φ_i'[-]	c'_i [kN/m²]	K_{agh} [-]	K_{ach} [-]
1. Clay, silty	3.3	18.0	8.0	27	30	0.30	1.2
2. Fine gravel, clayey	1.7	21.0	12.0	40	0	0.20	0.9
3.Silt, sandy	22.8	19.0	10.0	30	0	0.30	1.1
4. Fine gravel, clayey	1.2	21.0	12.0	40	0	0.20	0.9
5. Medium sand	6.0	20.2	11.5	33	0	0.30	1.0

K_{agh} and K_{ach} are the coefficient of active earth pressure for the self weight of soil and cohesion respectively.

2   Basic Information

1.1   Before starting calculation, select your language "English" and start from the page "Basic Information".

1.2   **TBM Type:** *EPB*. In Earth Pressure Balance TBM, tunnel face is supported with earth paste formed by excavated soil and conditioning agents.

1.3   **System of Unit:** *Metric*. In this unit system, length is given in meter, force in kilonewton and the support pressure will be returned in bar.

1.4   **Support Medium Unit Weight (Advance):** *14 [kN/m³]*. It is the unit weight of support medium during excavation.

1.5   **Support Medium Unit Weight (Drawdown):** *14 [kN/m³]*. It is the unit weight of support medium during drawdown condition for the area which is still filled.

1.6   **Tunnel Diameter:** *12 [m]*. It is the excavation diameter of the tunnel.

1.7   **Tunnel Depth:** 21.*3 [m]*, from the ground surface to tunnel reference level (in this case, tunnel crown is taken as the reference level.)

1.8   **Relates to**: *Crown*, is the reference level for tunnel depth.

1.9   **Additional Drawdown:** *2 [m]*. Calculation can be carried out for an extra drawdown in addition to the standard one third, half and full drawdowns.

1.10   **Miscellaneous Information:** "Three soil layers in tunnel face". This field is allocated for the additional information about the calculation. It will be presented in the report together with the input information.

1.11   **Save and Proceed to Succession of Strata:** to save the provided data and proceed to the next page.

3   Succession of Strata

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Project: Sample Project

Location: Section 1 - Mixed Face

Back to Project Administration

Basic Information | Succession of Strata | Calculation Method | Safety Concept | Project Verification

Groundwater

Depth of Groundwater Table: 7.7 m

Surfaceloads

Surface Load	Thickness		Unit Weight		Pressure
Permanent Surface Load	1	m x	18	kN/m³ =	18	kN/m²
Temporary Surface Load		m x		kN/m³ =	10	kN/m²

Geology

Add Layer

Water Layer	Type of Soil	t.	Admixture	t.	Layer Thickness	Unit Weight	Submerged Unit Weight	Cohesion	Angle of Friction			
☐	Clay	C	silty	m	3.3	18	8	30	27	+	▓	-
	Fine gravel	fG	clayey	c	1.7	21	12	0	40	+	▓	-
	Silt	M	sandy	s	22.8	19	10	0	30	+	▓	-
	Fine gravel	fG	clayey	c	1.2	21	12	0	40	+	▓	-
	Medium sand	mS			6	20.2	11.5	0	33	+	▓	-

Back | Save | Proceed to Calculation Method

2.1   **Depth of Groundwater Table:** *7.7* [m]

2.2   **Permanent Surface Load:**   *1.0 x 18 = 18* [kN/m²]

2.3   **Temporary Surface Load:**   *10* [kN/m²]

2.4   For the soil layer silty Clay

Water Layer: Do not select the check box, (select only for water layers like in the case of tunnel below river, lake or sea.)

Type of Soil: *Clay* (Name of the soil layer, major division)

Sub Group: *silty* (Name of the soil layer, minor division)

t: *C* for clay and *m* for silty, are the symbols for soil layer.

Layer Thickness:	h = *3.3*	[m]
Unit Weight:	γ_i = *18.0*	[kN/m³]
Submerged Unit Weight:	γ_i' = *8.0*	[kN/m³]
Cohesion:	c´= *30*	[kN/m²]
Angle of Friction:	φ' =*27*	[°]

2.5   **+** : To add another soil layer underneath the selected layer. Insert the rest soil layers similarly. The total depth of the layers must not be smaller than the depth of tunnel invert.

2.6   ▓ : In order to change the color of the soil strata.

2.7   **-** : To delete the respective soil layer.

2.8   **Proceed to Calculation Method:** Save the provided data and proceed to next page for the selection of calculation method.

4 Calculation Method

3.1 **Calculation Method:** *DIN 4085*

3.2 **Earth Pressure Coefficients:** It provides the opportunity to supply the coefficients of earth pressure for the calculation. The soil layer will be automatically taken from geological profile from page "Succession of Strata".

As example for the first soil Layer:

$K_{ach, default}$: *1.226*. Coefficient of active earth pressure for cohesion for respective soil layer. It is the default value calculated by the program.

$K_{ach, new}$: *1.2*. Coefficient of active earth pressure for cohesion for the calculation. Initially this field also contains the same value as in $K_{ach, default}$. This value can be modified by the user if required. Care should be taken that the program only takes the values supplied in these field.

$K_{agh, default}$: *0.376*. Coefficient of active earth pressure for self weight for respective soil layer. It is the default value suggested by the program.

$K_{agh, new}$: *0.3*. Coefficient of active earth pressure for cohesion for calculation. Initially this field also contains the same value as in $K_{agh, default}$. This value can be modified by the user if required. Care should be taken that the program only takes the values supplied in these field.

3.3 **Save and proceed to Safety Concept:** to save the provided data for the method of calculation and proceed to next page "Safety Concept".

5 Safety Concept

4.1 Under "Predefined Safety Concept", select the *"ZTVING EPB"* to carry out the calculation with this safety concept. This safety concept is according to the German technical regulation „ZTV-ING" (Additional Technical Specifications and Guidelines for Civil Engineering Constructions). It will automatically select following parameters:

Operational Tolerance, Support Medium	*30* [kN/m²]
Operational Tolerance, Compressed Air	*10* [kN/m²]
Partial Safety Factor, Earth Pressure	*1.5*
Partial Safety Factor, Water Pressure	*1.05*
Factor for Favorable Loads in Blow Out Check	*0.9*
Combined Ordinate Check, Crown	*Factor*
(**Factor for earth pressure)**	*1.3*
(**Factor for water pressure)**	*1.05*
Ordinate Check, Bottom Edge Compressed Air	*Factor*
(**Factor for Water Pressure)**	*1.05*
Ordinate Check Invert	*Factor*
(**Factor for Water Pressure)**	*1.05*

4.2 User can also define his own safety concept. Please refer to the next sample project. For selecting "Addition" instead of "Factor" in ordinate check is shown in the same project.

In ordinate check with factor, the earth and water pressure will be multiplied with the respective factors while in addition, the pressure will be added to earth and water pressure respectively.

4.3 **Next to Overview and Calculation:** to navigate to the next page "Project Verification".

6 Project Verification

This page presents the summary of the given data, selected calculation method and safety concepts. Please review these parameters before calculating. Navigate back to the respective pages if any corrections or modification are required.

Before executing the calculation, read the terms and conditions and accept check boxes.

Calculate now:
You will be directed to "clickandbuy" for the purpose of payments of the calculation. You have to create an account. The cost of the calculation will be booked from this account. After completion of the payment process, reports of your calculation will be available as a PDF documents in the project administration page under your project (see next page).

7   Results of Calculation

Reports will be available in two languages, German and English separately. The first report describes the model of calculation in general and the second report presents the results of your calculation.

For further inquiries, comments and suggestions please use feedback@facesupport.org.