Semi-automatic creation of rock support class drawings
Cyclic Excavation

Content

Figures

1 INTRODUCTION

RockSupport is a software based on Visual Studio, AutoCAD and Excel, offering an easy way to create rock support class drawings.

RockSupport includes the following functions:

- Cyclic excavation for tunnels and shafts
  - Full face excavation (cross section types see Figure 7 through Figure 15 and Figure 19 through Figure 22)
    - Spiles at top and bench with constant spacing and length
    - Forepoling sheets at top and bench with constant spacing and length
    - Steel ribs at top, bench and invert
    - Wire mesh for shotcrete
    - Partial shotcrete (partly in the upper region of top and bench)
    - Shotcrete (at top, bench and invert)
    - Spot bolts (1 spot bolt left of vertical centerline and/or 1 spot bolt right of vertical centerline)
    - Rock bolts at top and bench with constant spacing and length
    - Rock bolts at invert with constant spacing and length
    - Foundation piles at invert with constant spacing and length
    - Concrete slab at floor
    - Deformation gaps at top and bench with constant spacing
    - Drainage holes (1 drainage hole left of vertical centerline and/or 1 drainage hole right of vertical centerline)
    - Inner lining
  - Phase 1 and 2 excavation (cross section types see Figure 7 through Figure 15**Error! Reference source not found.** and Figure 19 through Figure 22)
    - Spiles at top and bench with constant spacing and length
    - Forepoling sheets at top and bench with constant spacing and length
    - Steel ribs at top, bench and invert
    - Wire mesh for shotcrete
    - Partial shotcrete (partly in the upper region of top and bench)
    - Shotcrete (at top, bench and invert)
    - Spot bolts (1 spot bolt left of vertical centerline and/or 1 spot bolt right of vertical centerline)
    - Rock bolts
      - for phase 1: at top and bench with constant spacing and length
      - for phase 2: at bench with constant spacing and length
    - Rock Rock bolts at invert with constant spacing and length
    - Foundation piles at invert with constant spacing and length
    - Concrete slab at floor
    - Deformation gaps at top and bench with constant spacing
    - Drainage holes (1 drainage hole left of vertical centerline and/or 1 drainage hole right of vertical centerline)
    - Inner lining

  For both, full face excavation and phase 1 and 2 excavation, following items will be created on the drawing:

    - a cross section showing items listed above
    - a plan view or flat view of the cross section
    - Table showing items and corresponding values listed above including quantities per linear meter excavation
- Continuous excavation for tunnels (please see TBM help)
    - Shotcrete
    - Rock bolts
    - Wire mesh
    - Steel ribs

A template drawing is used to define Linetypes, Text Style, Dimension Style, Multileader Style, LTScale, etc.. Layers defined in sheet SETTINGS, shall exist in the template drawing.

It is recommended to create and use different template drawings for different annotation scales.

The drawing created by the ***RockSupport*** software shall be copied into a final drawing manually, containing headers, notes, etc.

2 NOTATION

Values listed below can be used as variables to be inserted into text (see 5.3).

Value	Unit	Description
A	m	overall width of cross section
B	m	width of cross section at floor level
cCSQ	m	concrete slab - concrete grade
cDGT1		deformation gaps - without compression element - text
cDGT2		deformation gaps - with compression element - text
cFPOT	m	forepoling plate - type (empty = default text)
cGRT1		phase 1 - text
cGRT2		phase 2 - text
cGRT3		phase 2 - text
CHEVB	m²	*) change of bench evaluaton area for the temporary invert surface
CHEVT	m²	*) change of top evaluaton area for the temporary invert surface
cHTX		designation of the cross section
CHXT		header text for the cross section
cINV		invert construction type
cPLT		spile type
cRBT1		phase 1 - rock bolt type
cRBT2		phase 2 - rock bolt type
cRBT3		phase 3 - rock bolt type
cSBT		spot bolt - type
cSCC		Scale for cross section and plan view = CANNOSCALE
cSCD		Scale for development
cSCQ1	m	shotcrete grade for top excavaton
cSCQ2	m	shotcrete grade for bench excavaton
cSCQ3	m	shotcrete grade for invert excavaton
cSCQ4	m	shotcrete grade for temporary invert surface of the top heading
cSCQ5	m	shotcrete grade for tunnel face
cSCT1	m	shotcrete thickness for top excavation
cSCT2	m	shotcrete thickness for bench excavation
cSCT3	m	shotcrete thickness for invert excavation
cSCT4	m	shotcrete thickness for temporary invert surface of the top heading
cSCT5	m	shotcrete thickness for tunnel face
cSRT1		phase 1 - steel ribs text
cSRT2		phase 2 - steel ribs text
cSRT3		phase 3 - steel ribs text
cSST		spot bolt - type (empty = default text)
CST	m	concrete slab - thickness
cTFBT		tunnel face - rock bolt type
cWM1T		phase 1 - mountain side with steel ribs - type
cWM2T		phase 1 - cavitiy side with steel ribs - type
cWM3T		phase 1 - mountain side without steel ribs - type
cWM4T		phase 1 - invert surface of the top heading (temporary) - type
cWM5T		phase 2 - mountain side with steel ribs - type
cWM6T		phase 2 - cavitiy side with steel ribs - type
cWM7T		phase 2 - mountain side without steel ribs - type
cWM8T		phase 3 - type of reinforement
cWM9T		tunnel face - type of reinforecement
DGD1	m	deformation gaps - without compression element - distance
DGD2	m	deformation gaps - with compression element - distance
DGW1	m	deformation gaps - without compression element - width
DGW2	m	deformation gaps - with compression element - width
DHDL	m	distance of the left drainage hole from the center line
DHDR	m	distance of the right drainage hole from the center line
DHL	m	length of drainage holes
DHSL	m	longitudinal spacing of drain holes
EXBA	m²	corrected bench evaluation area
EXBS	m/LM tunnel	demolition of bottom slab for bench excavation
EXC1	m	phase 1 - excess
EXC2	m	phase 2 - excess
EXC3	m	phase 3 - excess

Figure 1: Notation, Part 1 of 3

Value	Unit	Description
EXCI	m³/LM tunnel	demolition of bottom slab
EXCW	m³/LM tunnel	excavation of bench floor enlargement
FPOL	m	spot bolt - developed length in cross section
FPOO	m	spile offset from excavation line
FPOS	m	spile center line spacing
FPOT		development length in cross section plane
FPOT_SH		shift of FPOL_SH anchor from the left to the right side of the centerline
GRW1	kg/LM tunnel	phase 1 - weight of grout
GRW2	kg/LM tunnel	phase 2 - weight of grout
GRW3	kg/LM tunnel	phase 2 - weight of grout
H0	m	distance from reference line to top
H1	m	overall height of cross section (excluding basket arch)
H2	m	height of basket arch
H3	m	distance from crown to floor of partial shotcrete (usually used in combination with spot bolting)
H4	m	height of calotte in case of full face excavation (used for calculation of evaluation area "calotte + bench" only)
H5	m	height of phase 1 excavation
iDGN1		deformation gaps - without compression element - number
iDGN1_SH		shift of iDGN1_SH deformation gaps from the left to the right side of the centerline
iDGN2		deformation gaps - with compression element - number
iDGN2_SH		shift of iDGN2_SH deformation gaps from the left to the right side of the centerline
iEXPA1	pcs/round	Subarea excavation - at top with simueltaneity
iEXPA2	pcs/round	Subarea excavation - at top without simueltaneity
iEXPA3	pcs/round	Subarea excavation - at bench with simueltaneity
iEXPA4	pcs/round	Subarea excavation - at bench without simueltaneity
iPLD	mm	spile diameter
iPLN		number of spiles
iPLN_SH		shift of iPLN_SH anchor from the left to the right side of the centerline
iPLQ	N/mm²	steel quality of spile
iRBD1	mm	phase 1 - rock bolt diameter
iRBD2	mm	phase 2 - rock bolt diameter
iRBD3	mm	phase 3 - rock bolt diameter
iRBFY1	N/mm²	phase 1 - rock bolt yield strenght
iRBFY2	N/mm²	phase 2 - rock bolt yield strenght
iRBFY3	N/mm²	phase 3 - rock bolt yield strenght
iRBN1		number of rock bolts at top and bench
iRBN1_SH		shift of iRBN1_SH anchor from the left to the right side of the centerline
iRBN3		number of rock bolts at invert
iRBN3_SH		shift of iRBN3_SH anchor from the left to the right side of the centerline
iSBD	mm	spot bolt - diameter
iSBFY	N/mm²	steel yield strength of spile
iSCN1	m	phase 1 - number of shotcrete layers
iSCN2	m	phase 2 - number of shotcrete layers
iSCN3	m	phase 3 - number of shotcrete layers
iSCN4	m	invert surface of the top heading (temporary)- number of shotcrete layers
iSSD	mm	spot bolt - diameter
iSSN_SH		shift of iPLN_SH anchor from the left to the right side of the centerline
iTFBN	pcs	tunnel face - number of rock bolts
iTFBO	pcs	tunnel face - mounting of anchor plates with pre-tension
iTFBW	pcs	tunnel face - mounting of anchor plates without pre-tension
iWM1N		phase 1 - mountain side with steel ribs - number of layers
iWM2N		phase 1 - cavitiy side with steel ribs - number of layers
iWM3N		phase 1 - mountain side without steel ribs - number of layers
iWM4N		phase 1 - invert surface of the top heading (temporary) - number of layers
iWM5N		phase 2 - mountain side with steel ribs - number of layers
iWM6N		phase 2 - cavitiy side with steel ribs - number of layers
iWM7N		phase 2 - mountain side without steel ribs - number of layers
iWM8N		phase 3 - number of reinforcement layers
iWM9N		tunnel face - number of reinforcement layers
iWM9P	%	tunnel face - percent of tunnel face covered with reinforecement

Figure 2: Notation, Part 2 of 3

Value	Unit	Description
LT1	m	lining - thichness at top and bench
LT2	m	lining - thickness at invert
MAR1		margin specified in the tender at top
MAR2		margin specified in the tender at bench
MAR3		margin specified in the tender at invert
PLL	m	spile length
PLO	m	spile offset from excavation line
PLS	m	spile center line spacing
R1	m	radius at corwn
R2	m	radius at bench
R3	m	radius at invert
R3R4		ratio radius R3 divided by R4
RBL1	m	phase 1 - rock bolt length
RBL2	m	phase 2 - rock bolt length
RBL3	m	phase 3 - rock bolt length
RBSL1	m	phase 1 - rock bolt longitudinal spacing
RBSL2	m	phase 2 - rock bolt longitudinal spacing
RBSL3	m	phase 3 - rock bolt longitudinal spacing
RBST1	m	phase 1 - rock bolt transversal spacing
RBST2	m	phase 2 - rock bolt transversal spacing
RBST3	m	phase 3 - rock bolt transversal spacing
RL1	m	phase 1 - round length
RL2	m	phase 2 - round length
RL3	m	phase 3 - round length
SBDL	m	spot bolt - distance at left side from crown
SBDR	m	spot bolt - distance at right side from crown
SBL	m	spot bolt - length
SBSL	m	spot bolt - longitudinal spacing
SCCW	m^3/LM tunnel	shotcrete at calotte toe of termporary invert
SCFG1	m3/round	phase 1 - filling in gussets and oberbreak
SCFG2	m3/round	phase 2 - filling in gussets and oberbreak
SCL4	m	development length at temporary invert surface of the top heading
SCP5	%	percent of tunnel face to be covered by shotcrete
SCT1	m	phase 1 - shotcrete thickness
SCT2	m	phase 2 - shotcrete thickness
SCT3	m	phase 3 - shotcrete thickness
SCT4	m	invert surface of the top heading (temporary) - shotcrete thickness
SCT5	m	shotcrete thickness at tunnel face
SRL1	m	phase 1 - longitudinal spacing of steel ribs
SRL2	m	phase 2 - longitudinal spacing of steel ribs
SRL3	m	phase 3 - longitudinal spacing of steel ribs
SSL	m	spot bolt - length
SSN		spot bolt - number of stay sills
SSSL	m	spot bolt - longitudinal spacing
SSST	m	spot bolt - transversal spacing
TFBL	m	tunnel face - rock bolt length
UT1	m	thickness for separating films, sliding films, etc. at top
UT2	m	thickness for separating films, sliding films, etc. at bench
UT3	m	thickness for separating films, sliding films, etc. at invrt
WADB1	kg/LM tunnel	additional reinforcement at top
WADB2	kg/LM tunnel	additional reinforcement at bench
WADB3	kg/LM tunnel	additional reinforcement at invert
WADB4	kg/LM tunnel	additional reinforcement at tunnel face or shaft floor
WADS1	m/LM tunnel	system connection reinforcement at top
WADS2	m/LM tunnel	system connection reinforcement at bench
WADS3	m/LM tunnel	system connection reinforcement at invert
WADS4	m/LM tunnel	system connection reinforcement at tunnel face or shaft foor
XO	m	X-origin of cross section
YO1	m	Y-origin of cross section text and scale
YO2	m	Y-origin of plan view/development of rock bolt pattern
YO3	m	Y-origin of table 1
YO4	m	*) Y-origin of table 2
YO5	m	*) Y-origin of table 3
YO6	m	Y-origin of summary

Figure 3: Notation, Part 3 of 3

Description marked with *) refere only to *AUSTRIA ADD-ON.*

3 ROCKSUPPORT PROGRAM

In the MAIN menu the project folder and the sub-folders for input and output files shall be defined.

Figure 4: RockSupport program – Main menu

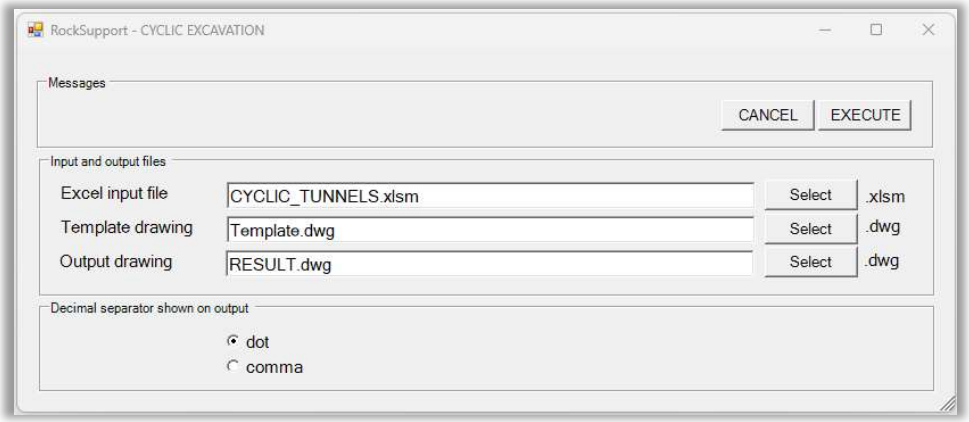


Figure 5: RockSupport program – Cyclic excavation sub-menu

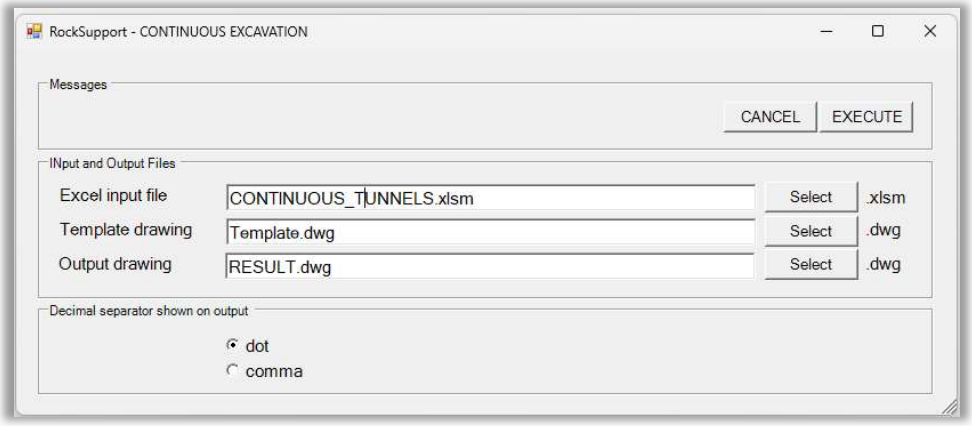


Figure 6: RockSupport program – Continuous excavaton sub-menu

4 CROSS SECTION TYPES

4.1 Tunnels

4.1.1 Predefined Tunnel Cross Sections

Following cross section types can be generated by specifying the width, height and radii with ***Rock-Support***.

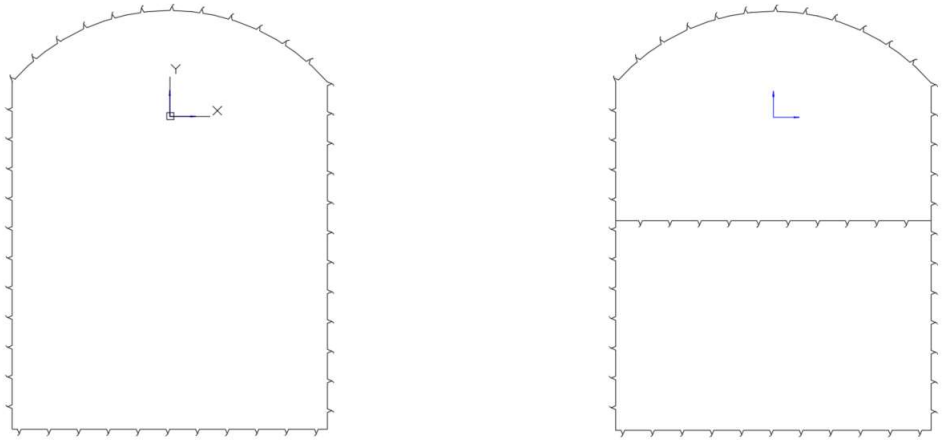


Figure 7: Tunnel type 1 -Full face or phase 1 and 2 excavation

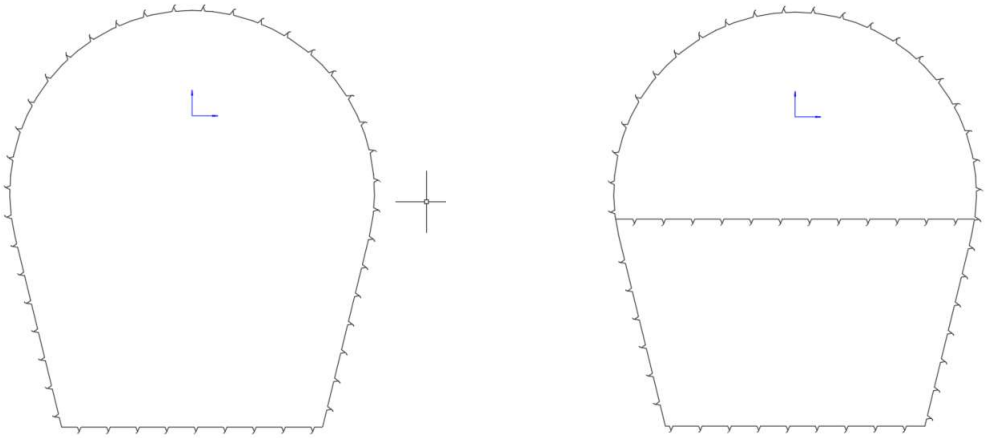


Figure 8: Tunnel type 2 - Full face or phase 1 and 2 excavation

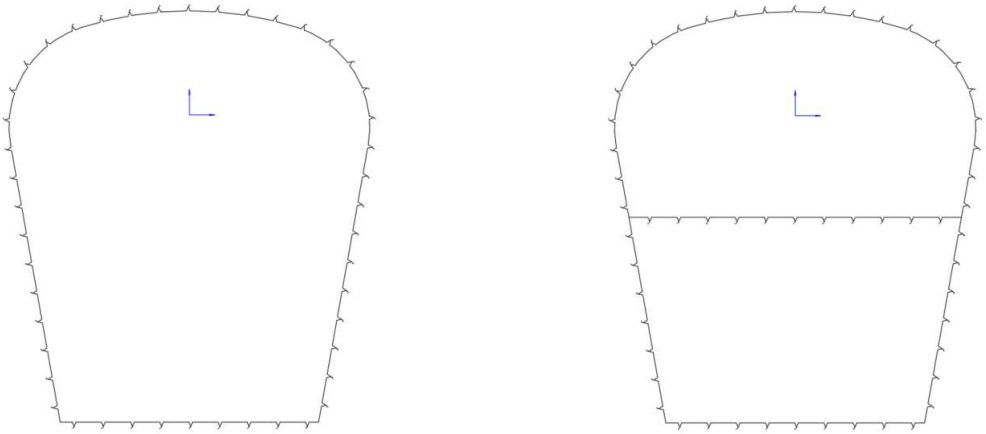


Figure 9: Tunnel type 3 - Full face or phase 1 and 2 excavation

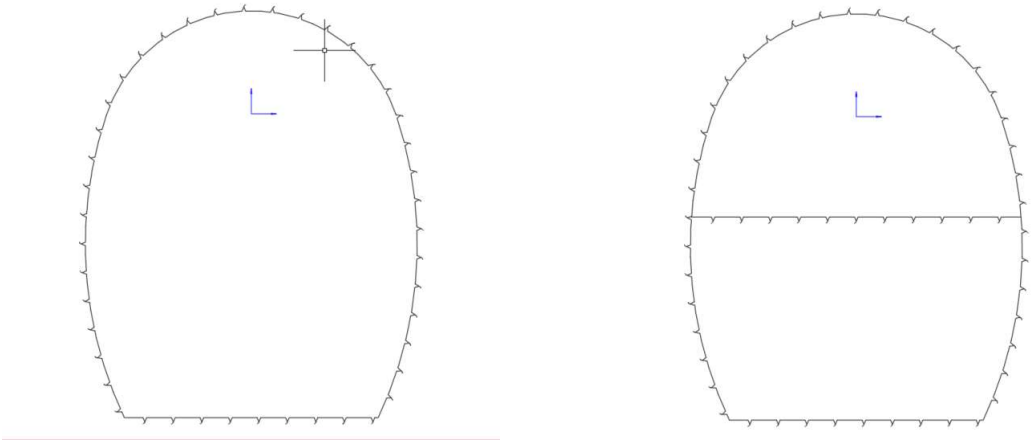


Figure 10: Tunnel type 4 - Full face or phase 1 and 2 excavation

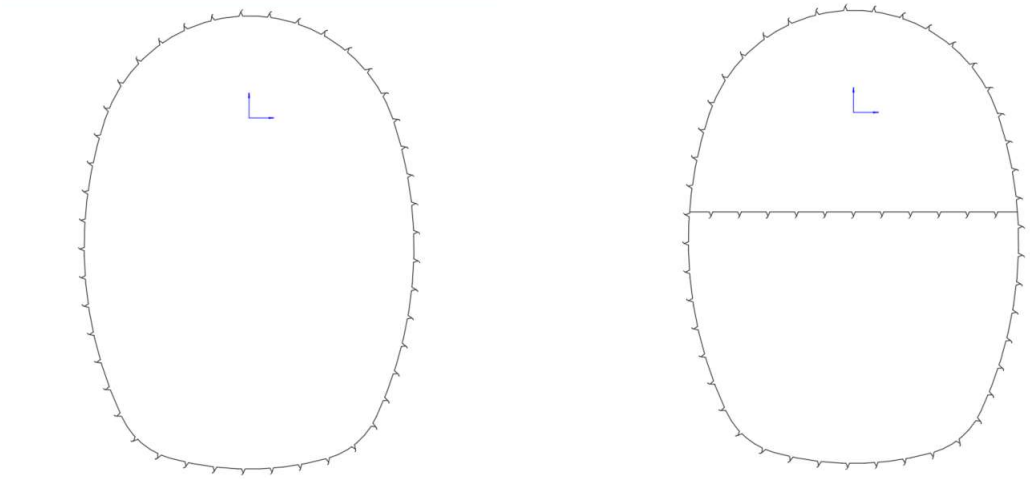


Figure 11: Tunnel Type 5 - Full face or phase 1 and 2+3 excavation

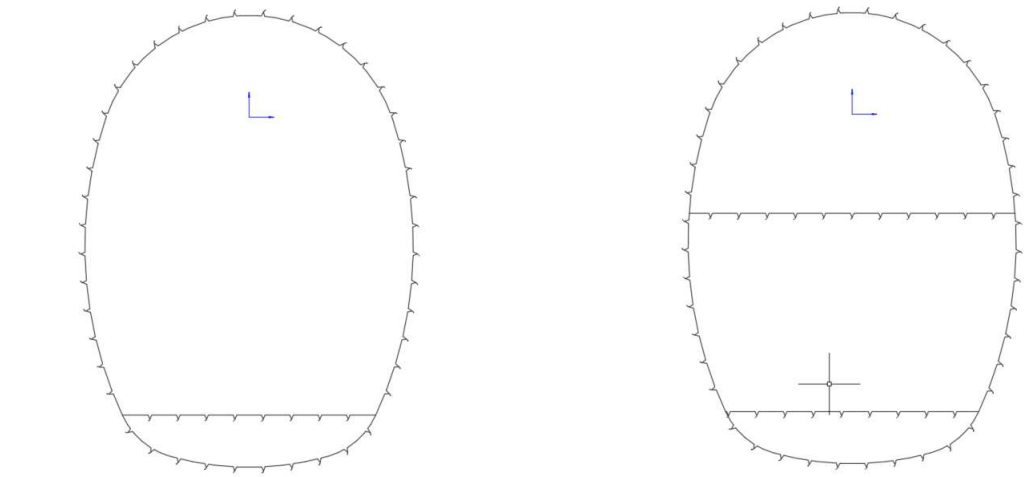


Figure 12: Tunnel Type 5 - Phase 1+2 and 3 or phase 1,2 and 3 excavation

4.1.2 Free-Form Tunnel Cross Sections

4.1.2.1 General

A freeform tunnel cross sections consist of:

- a polyline that defines the tunnel cross section (clearance profile) above the floor (red line). The polyline shall consist of at least 2 entities, such as:
  - line + line
  - line + arc
  - arc + arc, where the radii or the center coordinates of the arcs are not identical
- a line, an arc or a polyline that defines the tunnel floor (blue line).

The polylines shall consist of lines and/or arcs only.

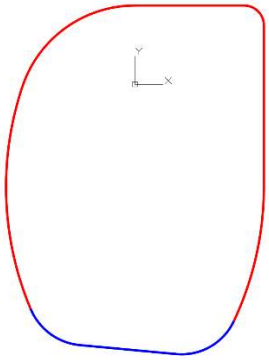


Figure 13: Tunnel type 6 - Cross section (clearance profile)

4.1.2.2 Possible excavation phases

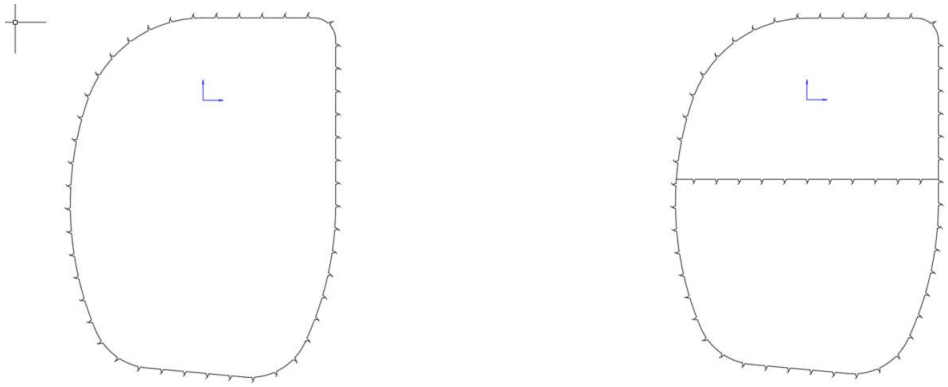


Figure 14: Tunnel type 6 - Full face or phase 1 and 2 excavation

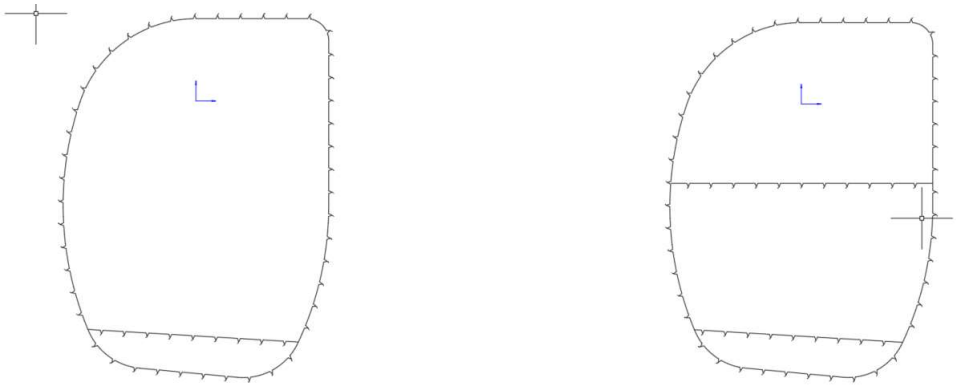


Figure 15: Tunnel Type 6 - phase 1+2 and 3 or phase 1,2 and 3 excavation

4.1.3 *Tunnel Invert Types*

Four invert types are available for cross sections of Type 6 as following:

- Invert types 1 and 2: requires that all corresponding bench/invert lines intersect.
- Invert types 3 and 4: above floor line (top and bench) and below floor line (invert) are separated by a line connecting the bottom left and bottom right end points of the red clearance profile shown in Figure 13.

Whenever appropriate, invert type 3 should be used for curved invert.

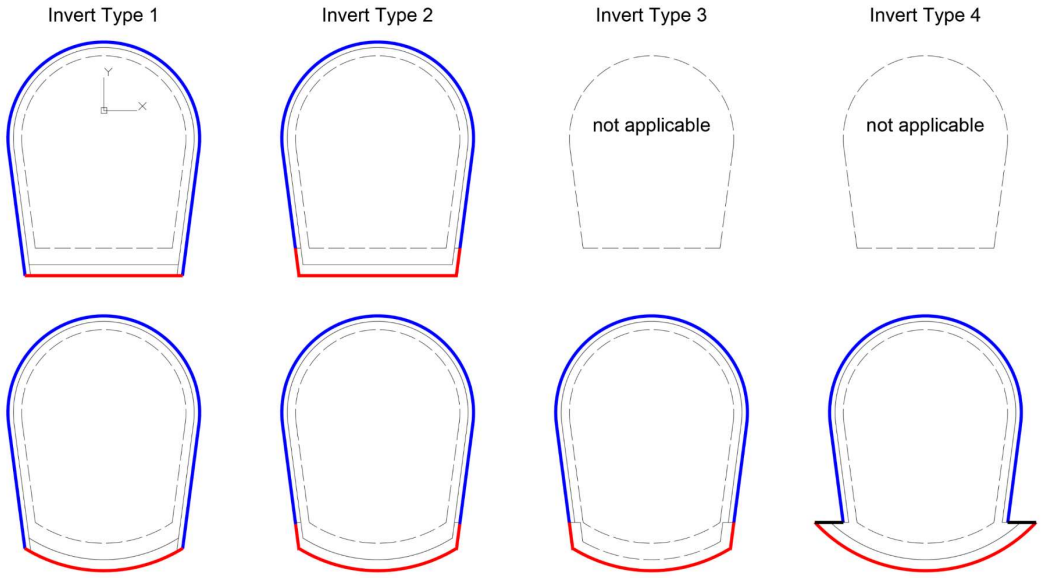


Figure 16: Tunnel invert types 1 through 4

The following illustrations are showing the transition area between bench and invert.

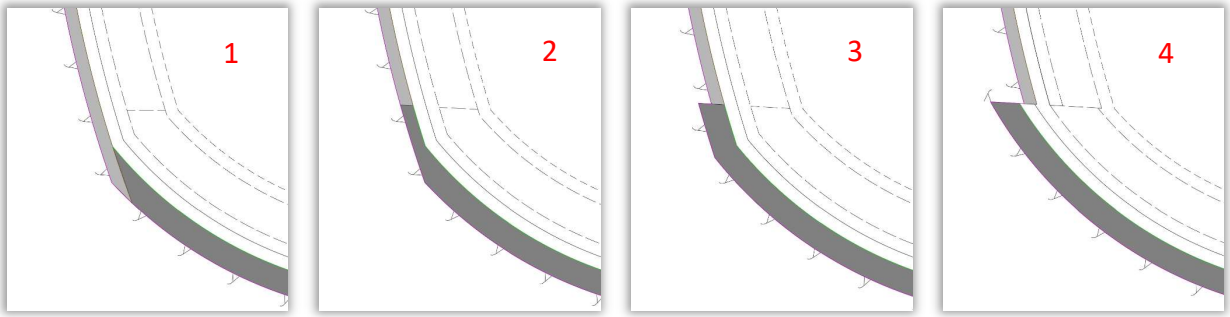


Figure 17: Tunnel invert types

4.1.4 *Limitation*

In order to allow intersection of corresponding bench and invert lines, the angles ALPHA and BETA shall sufficiently be less than 180° for invert types 1 and 2.

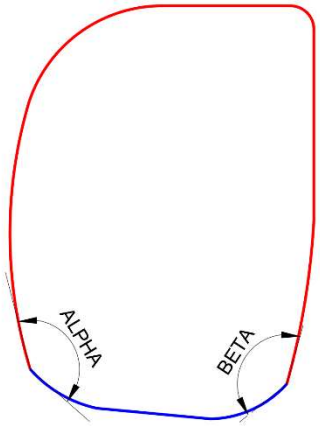


Figure 18: Tunnel cross section Type 6 - Limitation

4.2 Shafts

4.2.1 Predefined Shaft Cross Sections

Following cross section types can be generated by specifying the length, width and radii**.**

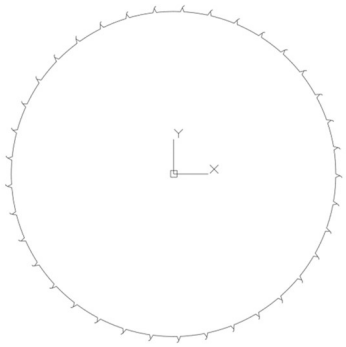


Figure 19: Shaft cross section Type 11

Figure 20: Shaft cross sectionType 12

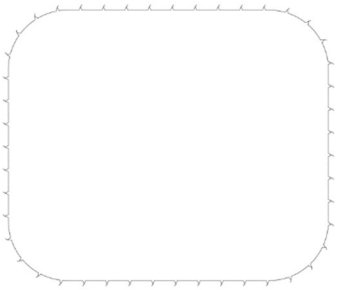


Figure 21: Shaft cross sectionType 13

4.2.2 Free-Form Shaft Cross Sections

A freeform shaft cross sections consist of 1 polyline that defines the shaft cross section clearance profile. The polyline shall consist of lines and/or arcs only. The polyline is defined on a separate drawing.

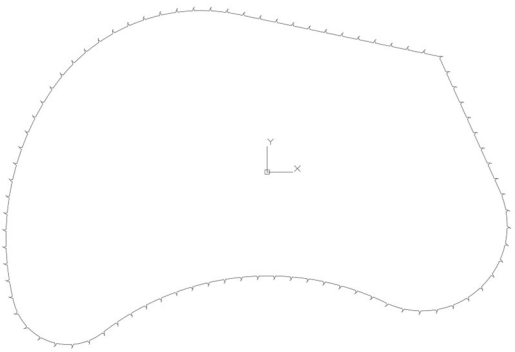


Figure 22: Shaft cross section type 14 with clearance profile defined on a separate drawing file

4.3 Continuous excavaton

For the continuous (TBM) excavation a circular tunnel cross section is used.

5 INPUT FILES

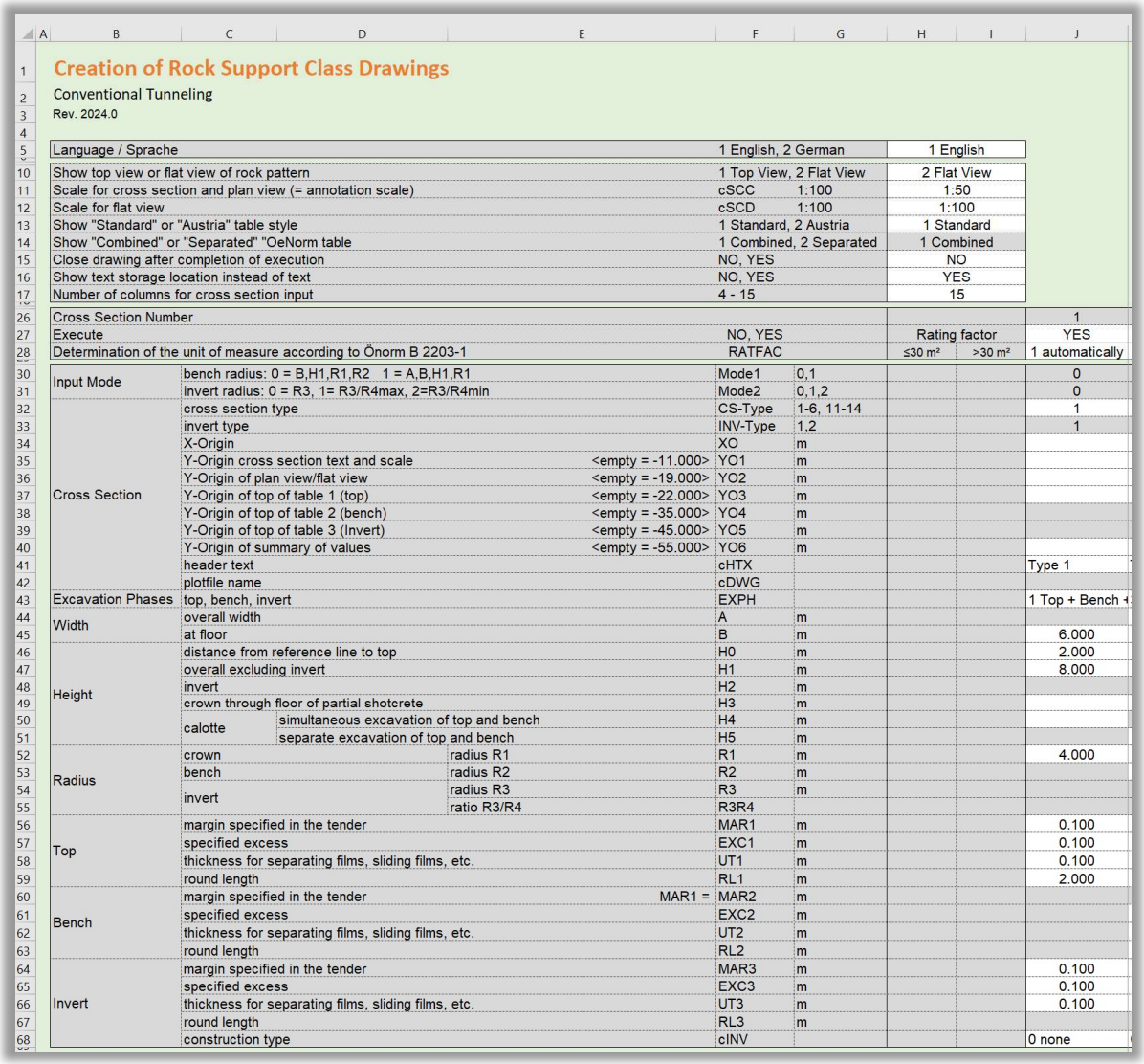
An EXCEL file (for example CYCLIC.xlsm) defines the input values and settings for cyclic excavation. The name of this file can be freely chosen. However, the xlsm extension is to be retained.

This EXCEL file contains following sheets:

- MAIN_CYCLIC
- SETTINGS
- TEXT
- DROP-DOWN
- MENU

5.1 MAIN_CYCLIC sheet

These sheet is the principal input pages for cyclic tunnel and shaft excavation.



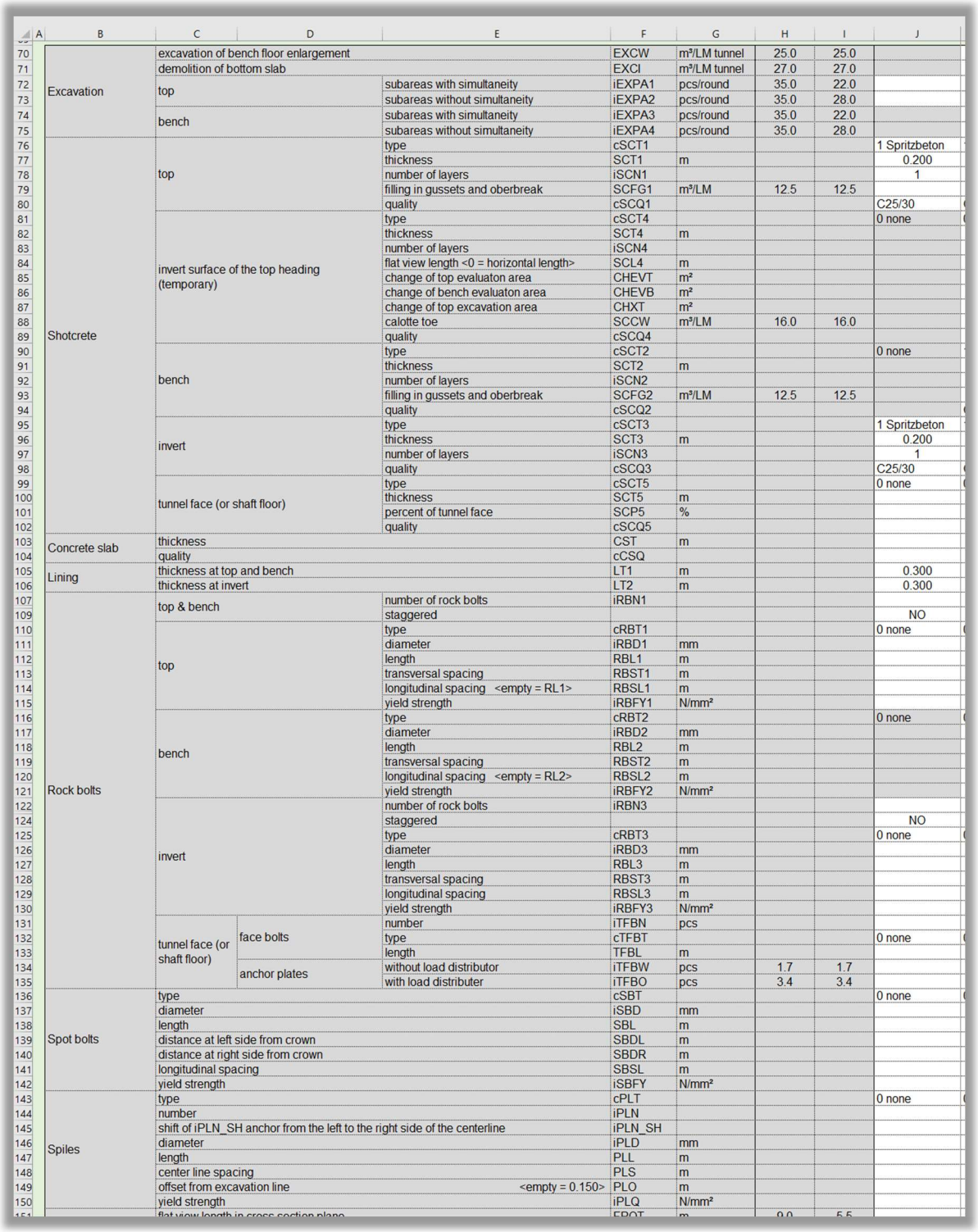
Creation of Rock Support Class Drawings

Conventional Tunneling

Rev. 2024.0

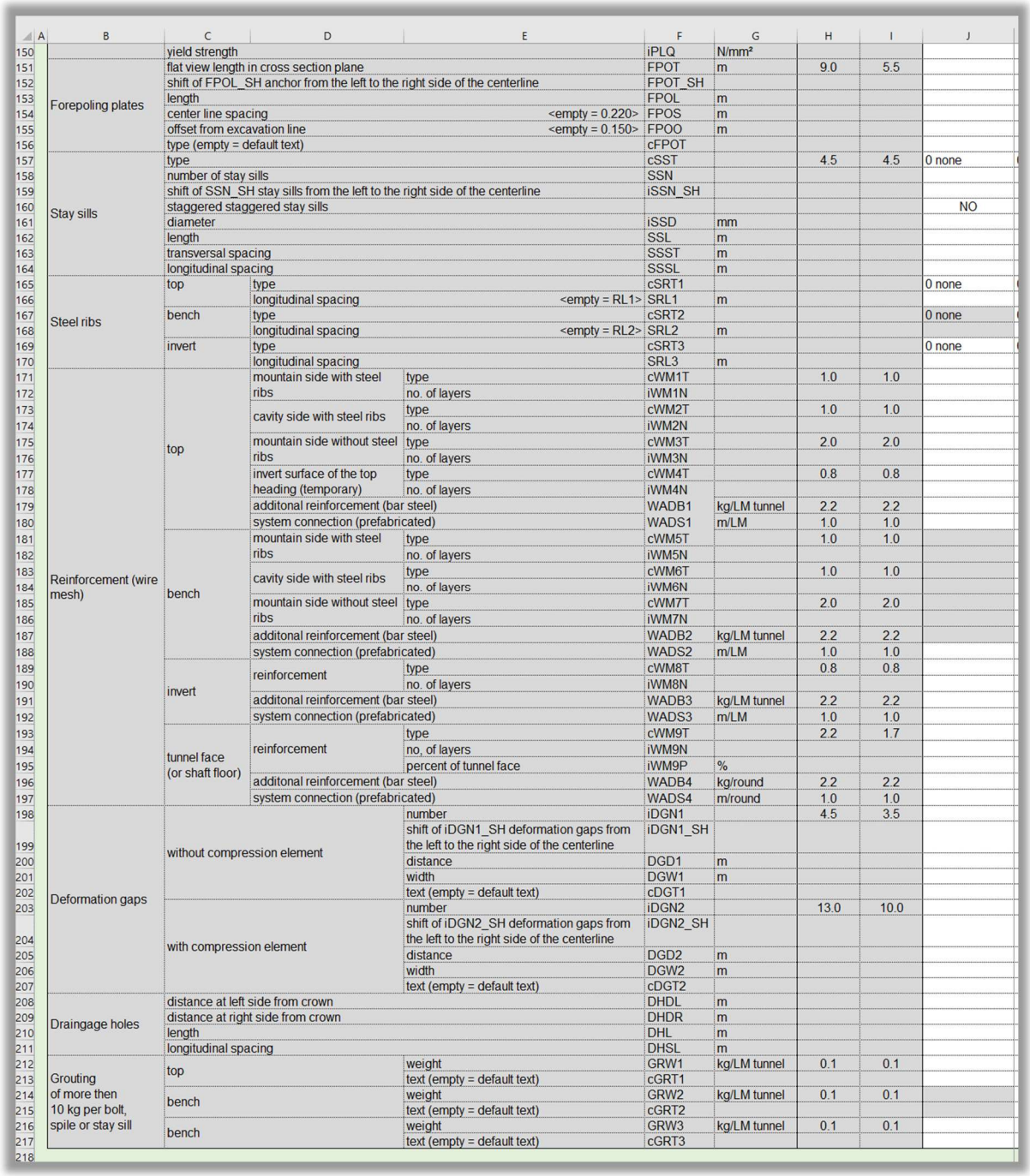
Language / Sprache				1 English, 2 German				1 English
Show top view or flat view of rock pattern				1 Top View, 2 Flat View				2 Flat View
Scale for cross section and plan view (= annotation scale)				cSCC	1:100			1:50
Scale for flat view				cSCD	1:100			1:100
Show "Standard" or "Austria" table style				1 Standard, 2 Austria				1 Standard
Show "Combined" or "Separated" "OeNorm table				1 Combined, 2 Separated				1 Combined
Close drawing after completion of execution				NO, YES				NO
Show text storage location instead of text				NO, YES				YES
Number of columns for cross section input				4 - 15				15
Cross Section Number								1
Execute				NO, YES		Rating factor		YES
Determination of the unit of measure according to Önorm B 2203-1				RATFAC		≤30 m²	>30 m²	1 automatically
Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			1
	invert type			INV-Type	1,2			1
	X-Origin			XO	m			
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 1
	plotfile name			cDWG				
Excavation Phases	top, bench, invert			EXPH				1 Top + Bench +
Width	overall width			A	m			
	at floor			B	m			6.000
Height	distance from reference line to top			H0	m			2.000
	overall excluding invert			H1	m			8.000
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			
Radius	crown	radius R1		R1	m			4.000
	bench	radius R2		R2	m			
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			2.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			
	thickness for separating films, sliding films, etc.			UT2	m			
	round length			RL2	m			
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 23: MAIN_CYCLIC sheet, Part 1 – Geometry definition



	B	C	D	E	F	G	H	I	J
70	Excavation	excavation of bench floor enlargement			EXCW	m³/LM tunnel	25.0	25.0	
71		demolition of bottom slab			EXCI	m³/LM tunnel	27.0	27.0	
72		top		subareas with simultaneity	iEXPA1	pcs/round	35.0	22.0	
73				subareas without simultaneity	iEXPA2	pcs/round	35.0	28.0	
74		bench		subareas with simultaneity	iEXPA3	pcs/round	35.0	22.0	
75				subareas without simultaneity	iEXPA4	pcs/round	35.0	28.0	
76	Shotcrete	top		type	cSCT1				1 Spritzbeton
77				thickness	SCT1	m			0.200
78				number of layers	iSCN1				1
79				filling in gussets and oberbreak	SCFG1	m³/LM	12.5	12.5	
80				quality	cSCQ1				C25/30
81		invert surface of the top heading (temporary)		type	cSCT4				0 none
82				thickness	SCT4	m			
83				number of layers	iSCN4				
84				flat view length <0 = horizontal length>	SCL4	m			
85				change of top evaluaton area	CHEVT	m²			
86				change of bench evaluaton area	CHEVB	m²			
87				change of top excavation area	CHXT	m²			
88				calotte toe	SCCW	m³/LM	16.0	16.0	
89				quality	cSCQ4				
90		bench		type	cSCT2				0 none
91				thickness	SCT2	m			
92				number of layers	iSCN2				
93				filling in gussets and oberbreak	SCFG2	m³/LM	12.5	12.5	
94				quality	cSCQ2				
95		invert		type	cSCT3				1 Spritzbeton
96				thickness	SCT3	m			0.200
97				number of layers	iSCN3				1
98				quality	cSCQ3				C25/30
99		tunnel face (or shaft floor)		type	cSCT5				0 none
100				thickness	SCT5	m			
101				percent of tunnel face	SCP5	%			
102				quality	cSCQ5				
103	Concrete slab	thickness			CST	m			
104		quality			cCSQ				
105	Lining	thickness at top and bench			LT1	m			0.300
106		thickness at invert			LT2	m			0.300
107	Rock bolts	top & bench		number of rock bolts	iRBN1				
109				staggered					NO
110		top		type	cRBT1				0 none
111				diameter	iRBD1	mm			
112				length	RBL1	m			
113				transversal spacing	RBST1	m			
114				longitudinal spacing <empty = RL1>	RBSL1	m			
115				yield strength	iRBFY1	N/mm²			
116		bench		type	cRBT2				0 none
117				diameter	iRBD2	mm			
118				length	RBL2	m			
119				transversal spacing	RBST2	m			
120				longitudinal spacing <empty = RL2>	RBSL2	m			
121				yield strength	iRBFY2	N/mm²			
122		invert		number of rock bolts	iRBN3				
124				staggered					NO
125				type	cRBT3				0 none
126				diameter	iRBD3	mm			
127				length	RBL3	m			
128				transversal spacing	RBST3	m			
129				longitudinal spacing	RBSL3	m			
130				yield strength	iRBFY3	N/mm²			
131		tunnel face (or shaft floor)	face bolts	number	iTFBN	pcs			
132				type	cTFBT				0 none
133				length	TFBL	m			
134			anchor plates	without load distributor	iTFBW	pcs	1.7	1.7	
135				with load distributer	iTFBO	pcs	3.4	3.4	
136	Spot bolts	type			cSBT				0 none
137		diameter			iSBD	mm			
138		length			SBL	m			
139		distance at left side from crown			SBDL	m			
140		distance at right side from crown			SBDR	m			
141		longitudinal spacing			SBSL	m			
142		yield strength			iSBFY	N/mm²			
143	Spiles	type			cPLT				0 none
144		number			iPLN				
145		shift of iPLN_SH anchor from the left to the right side of the centerline			iPLN_SH				
146		diameter			iPLD	mm			
147		length			PLL	m			
148		center line spacing			PLS	m			
149		offset from excavation line		<empty = 0.150>	PLO	m			
150		yield strength			iPLQ	N/mm²			
151		flat view length in cross section plane			FPOT	m	9.0	5.5	

Figure 24: MAIN_CYCLIC sheet, Part 2 – Support measures



	B	C	D	E	F	G	H	I	J
150		yield strength			iPLQ	N/mm²			
151	Forepoling plates	flat view length in cross section plane			FPOT	m	9.0	5.5	
152		shift of FPOL_SH anchor from the left to the right side of the centerline			FPOT_SH				
153		length			FPOL	m			
154		center line spacing		<empty = 0.220>	FPOS	m			
155		offset from excavation line		<empty = 0.150>	FPOO	m			
156		type (empty = default text)			cFPOT				
157	Stay sills	type			cSST		4.5	4.5	0 none
158		number of stay sills			SSN				
159		shift of SSN_SH stay sills from the left to the right side of the centerline			iSSN_SH				
160		staggered staggered stay sills							NO
161		diameter			iSSD	mm			
162		length			SSL	m			
163		transversal spacing			SSST	m			
164		longitudinal spacing			SSSL	m			
165	Steel ribs	top	type		cSRT1				0 none
166			longitudinal spacing	<empty = RL1>	SRL1	m			
167		bench	type		cSRT2				0 none
168			longitudinal spacing	<empty = RL2>	SRL2	m			
169		invert	type		cSRT3				0 none
170			longitudinal spacing		SRL3	m			
171	Reinforcement (wire mesh)	top	mountain side with steel ribs	type	cWM1T		1.0	1.0	
172				no. of layers	iWM1N				
173			cavity side with steel ribs	type	cWM2T		1.0	1.0	
174				no. of layers	iWM2N				
175			mountain side without steel ribs	type	cWM3T		2.0	2.0	
176				no. of layers	iWM3N				
177			invert surface of the top heading (temporary)	type	cWM4T		0.8	0.8	
178				no. of layers	iWM4N				
179			additonal reinforcement (bar steel)		WADB1	kg/LM tunnel	2.2	2.2	
180			system connection (prefabricated)		WADS1	m/LM	1.0	1.0	
181		bench	mountain side with steel ribs	type	cWM5T		1.0	1.0	
182				no. of layers	iWM5N				
183			cavity side with steel ribs	type	cWM6T		1.0	1.0	
184				no. of layers	iWM6N				
185			mountain side without steel ribs	type	cWM7T		2.0	2.0	
186				no. of layers	iWM7N				
187			additonal reinforcement (bar steel)		WADB2	kg/LM tunnel	2.2	2.2	
188			system connection (prefabricated)		WADS2	m/LM	1.0	1.0	
189		invert	reinforcement	type	cWM8T		0.8	0.8	
190				no. of layers	iWM8N				
191			additonal reinforcement (bar steel)		WADB3	kg/LM tunnel	2.2	2.2	
192			system connection (prefabricated)		WADS3	m/LM	1.0	1.0	
193		tunnel face (or shaft floor)	reinforcement	type	cWM9T		2.2	1.7	
194				no, of layers	iWM9N				
195				percent of tunnel face	iWM9P	%			
196			additonal reinforcement (bar steel)		WADB4	kg/round	2.2	2.2	
197			system connection (prefabricated)		WADS4	m/round	1.0	1.0	
198	Deformation gaps	without compression element		number	iDGN1		4.5	3.5	
199				shift of iDGN1_SH deformation gaps from the left to the right side of the centerline	iDGN1_SH				
200				distance	DGD1	m			
201				width	DGW1	m			
202				text (empty = default text)	cDGT1				
203		with compression element		number	iDGN2		13.0	10.0	
204				shift of iDGN2_SH deformation gaps from the left to the right side of the centerline	iDGN2_SH				
205				distance	DGD2	m			
206				width	DGW2	m			
207				text (empty = default text)	cDGT2				
208	Draingage holes	distance at left side from crown			DHDL	m			
209		distance at right side from crown			DHDR	m			
210		length			DHL	m			
211		longitudinal spacing			DHSL	m			
212	Grouting of more then 10 kg per bolt, spile or stay sill	top		weight	GRW1	kg/LM tunnel	0.1	0.1	
213				text (empty = default text)	cGRT1				
214		bench		weight	GRW2	kg/LM tunnel	0.1	0.1	
215				text (empty = default text)	cGRT2				
216		bench		weight	GRW3	kg/LM tunnel	0.1	0.1	
217				text (empty = default text)	cGRT3				
218									

Figure 25: MAIN_CYCLIC sheet, Part 3 – Support measures continued

5.1.1 Data input - Language, drawing scale, table style

Language / Sprache	1 English, 2 German	1 English
Show top view or flat view of rock pattern	1 Top View, 2 Flat View	2 Flat View
Scale for cross section and plan view (= annotation scale)	cSCC 1:100	1:50
Scale for flat view	cSCD 1:100	1:100
Show "Standard" or "Austria" table style	1 Standard, 2 Austria	1 Standard
Show "Combined" or "Separated" "OeNorm table	1 Combined, 2 Separated	1 Combined
Close drawing after completion of execution	NO, YES	NO
Show text storage location instead of text	NO, YES	NO
Number of columns for cross section input	4 - 15	15

Figure 26: EXCEL input - Language, drawing scale, table style – English

Sprache / Language	1 English, 2 German	2 German
Draufsicht oder Abwicklung des Anker-Versetzschemas darstellen	1 Top View, 2 Flat View	2 Flat View
Maßstab für Querschnitt und Grundriss (= CANNOSCALE)	cSCC 1:100	1:50
Maßstab für Abwicklung	cSCD 1:100	1:100
"Standard" oder "Austria" Tabelle darstellen	1 Standard, 2 Austria	1 Standard
"Kombinierte" oder "Getrennte" OeNorm Tabelle darstellen	1 Combined, 2 Separated	1 Combined
Zeichnung nach Beendigung der Erstellung schließen	NO, YES	NO
Text-Speicherort anstatt des Textes anzeigen	NO, YES	YES
Anzahl Spalten für Querschnittseingabe	4 - 15	15

Figure 27: EXCEL input – Language, drawing scale, table style - German

To permanently change standard text and quickly find their storage location, the function "*Show text storage location instead of text*" can be used.

Forepoling plates	flat view length in cross section plane		FPOT	m	9.0 5.5	9.900
	shift of FPOL_SH anchor from the left to the right side of the centerline		FPOT_SH			
	length		FPOL	m		6
	center line spacing	<empty = 0.220>	FPOS	m		
	offset from excavation line	<empty = 0.150>	FPOO	m		
	type (empty = default text)		cFPOT			

Figure 28: EXCEL input file, MAIN sheet

	A	B	C
1	LOCATION	1 English	2 German
193		#cPLT#, %%c #iPLD# mm, #iPLN# pcs\L = #PLL# m, spacing = #PLS# m	#cPLT#, %%c #iPLD# mm, #iPLN# Stk\L = #PLL# m, e = #PLS# m
194			
195			
196		Forepoling, flat view length = #FPOT# m	Getriebedielen, Abwicklungslänge = #FPOT# m
197			

Figure 29: EXCEL input file, TEXT sheet

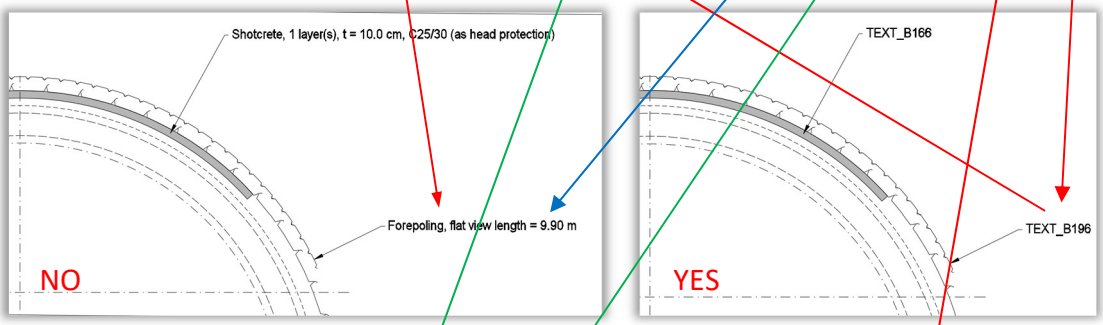


Figure 30: Cross section output on drawing – "*Show text storage location instead of text*" = NO and YES

	A	B	C
1	LOCATION	1 English	2 German
127	Table: Forepoling	Forepoling, plate length = #FPOL# m	Getriebedielen, Dielenlänge = #FPOL# m
128		Forepoling, plate length = #FPOL# m	Getriebedielen, Dielenlänge = #FPOL# m
129			

Figure 31: EXCEL input file, TEXT sheet

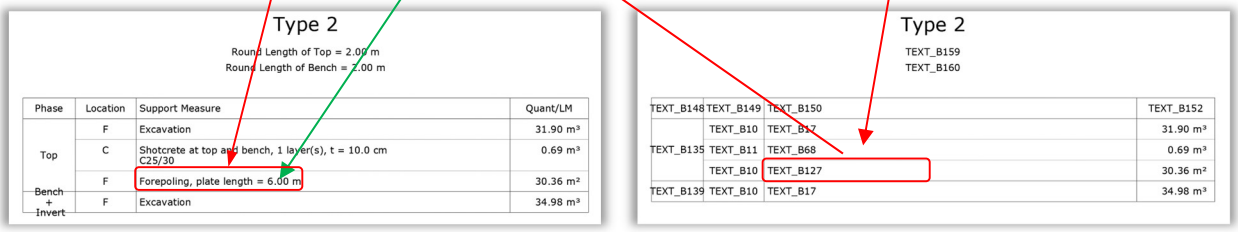


Figure 32: Table output on drawing

5.1.2 *X and Y Origins of Text, Rock Bolt Pattern and Tables*

32			cross section type		CS-Type	1-6, 11-14		2
33			invert type		INV-Type	1,2		1
34			X-Origin		XO	m		25.000
35			Y-Origin cross section text and scale	<empty = -11.000>	YO1	m		
36			Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m		-14.000
37		Cross Section	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m		-17.000
38			Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m		
39			Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m		
40			Y-Origin of summary of values	<empty = -55.000>	YO6	m		-30.000
41			header text		cHTX			Type 2
42			plotfile name		cDWG			

Figure 33: EXCEL input - X and Y-origins of text, rock bolt pattern, tables and summary values

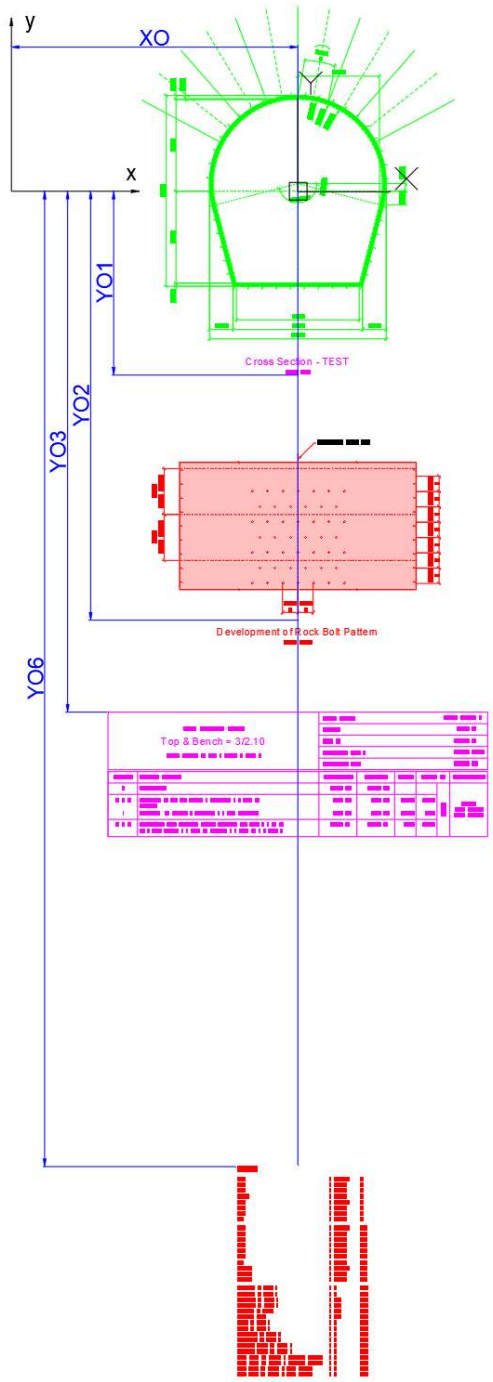
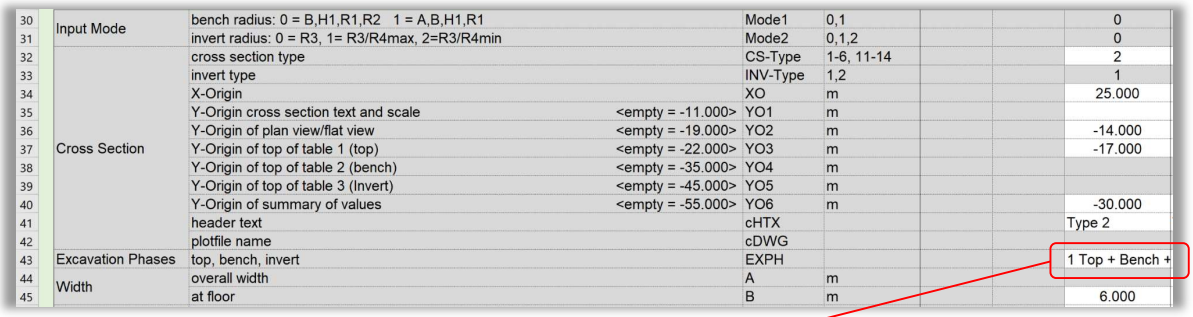


Figure 34: Standard layout on drawing

5.1.3 *Excavation Phases*



30	Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
31		invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
32	Cross Section	cross section type		CS-Type	1-6, 11-14			2
33		invert type		INV-Type	1,2			1
34		X-Origin		XO	m			25.000
35		Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
36		Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			-14.000
37		Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			-17.000
38		Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
39		Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
40		Y-Origin of summary of values	<empty = -55.000>	YO6	m			-30.000
41		header text		cHTX				Type 2
42		plotfile name		cDWG				
43	Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
44	Width	overall width		A	m			
45		at floor		B	m			6.000

Figure 35: EXCEL input . Excavation phases

For cross section types 1 through 4 following *Excavation Phases* are available:

Drop-down menu	
1 Top + Bench + Invert	full face excavation
2 Top + Bench, Invert	not applicable
3 Top, Bench + Invert	first stage excavation = top, second stage excavation = bench+invert
4 Top, Bench, Invert	not applicable

For cross section types 5 and 6 following *Excavation Phases* are available:

Drop-down menu	
1 Top + Bench + Invert	full face excavation
2 Top + Bench, Invert	first stage excavation = top+bench, second stage excavation = invert
3 Top, Bench + Invert	first stage excavation = top, second stage excavation = bench+invert
4 Top, Bench, Invert	first stage excavation = top, second stage excavation = bench, third stage excavation = invert

5.1.3.1 *Tunnel cross section type 1*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			1
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 1
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
Width	overall width		A	m			
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			
Radius	crown: radius R1		R1	m			4.000
	bench: radius R2		R2	m			
	invert: radius R3		R3	m			
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			
	thickness for separating films, sliding films, etc.		UT2	m			
	round length		RL2	m			
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 36: EXCEL input for cross section type 1, full face excavation

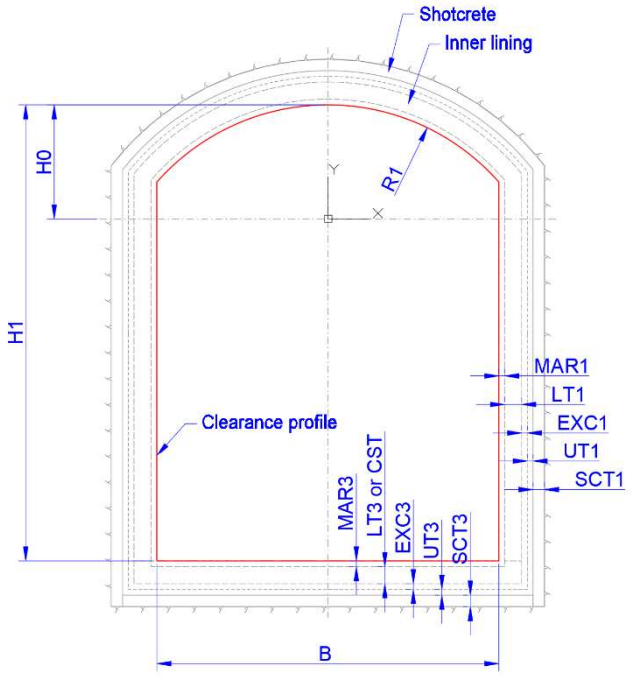


Figure 37: Cross section Type 1, full face excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			1
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 1
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				3 Top, Bench +
Width	overall width		A	m			
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			4.000
Radius	crown: radius R1		R1	m			4.000
	bench: radius R2		R2	m			
	invert: radius R3		R3	m			
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			0.100
	thickness for separating films, sliding films, etc.		UT2	m			0.100
	round length		RL2	m			4.000
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 38: EXCEL input for cross section type 1, phase 1 and 2 excavation

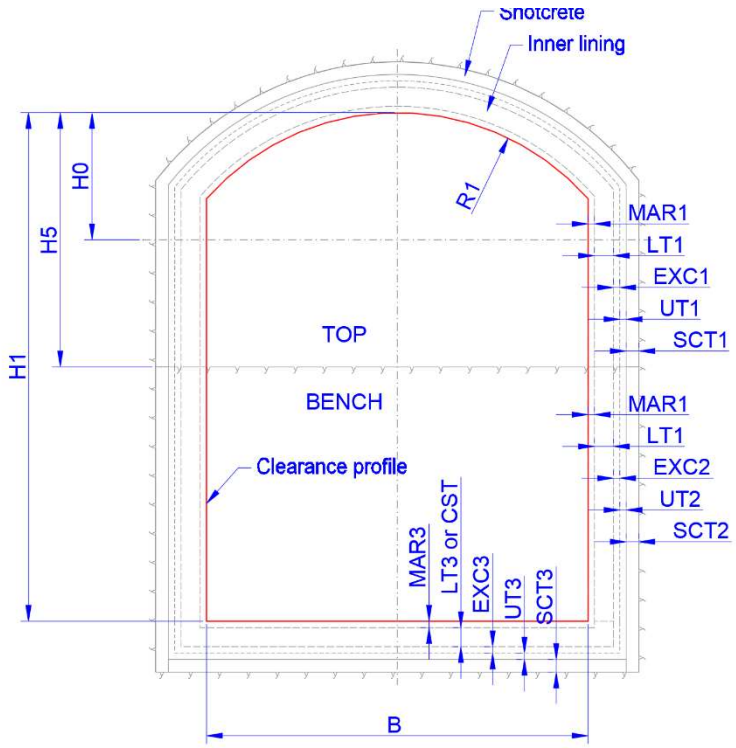


Figure 39: Cross section Type 1, phase 1 and 2 excavation (EXPH=3)

5.1.3.2 *Tunnel cross section type 2*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			2
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			25.000
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 2
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
Width	overall width		A	m			
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			
Radius	crown: radius R1		R1	m			3.500
	bench: radius R2		R2	m			
	invert: radius R3		R3	m			
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			
	thickness for separating films, sliding films, etc.		UT2	m			
	round length		RL2	m			
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 40: EXCEL input for cross section type 2, full face excavation

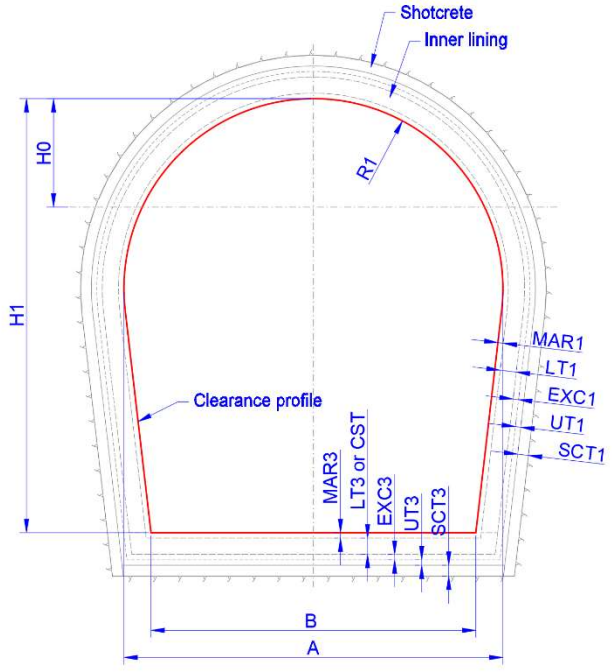


Figure 41: Cross section Type 2, full face excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			2
	invert type			INV-Type	1,2			1
	X-Origin			XO	m			25.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 2
	plotfile name			cDWG				
Excavation Phases	top, bench, invert			EXPH				3 Top, Bench +
Width	overall width			A	m			
	at floor			B	m			6.000
Height	distance from reference line to top			H0	m			2.000
	overall excluding invert			H1	m			8.000
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			4.000
Radius	crown	radius R1		R1	m			3.500
	bench	radius R2		R2	m			
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			0.100
	thickness for separating films, sliding films, etc.			UT2	m			0.100
	round length			RL2	m			0.100
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 42: EXCEL input for cross section type 2, phase 1 and 2 excavation

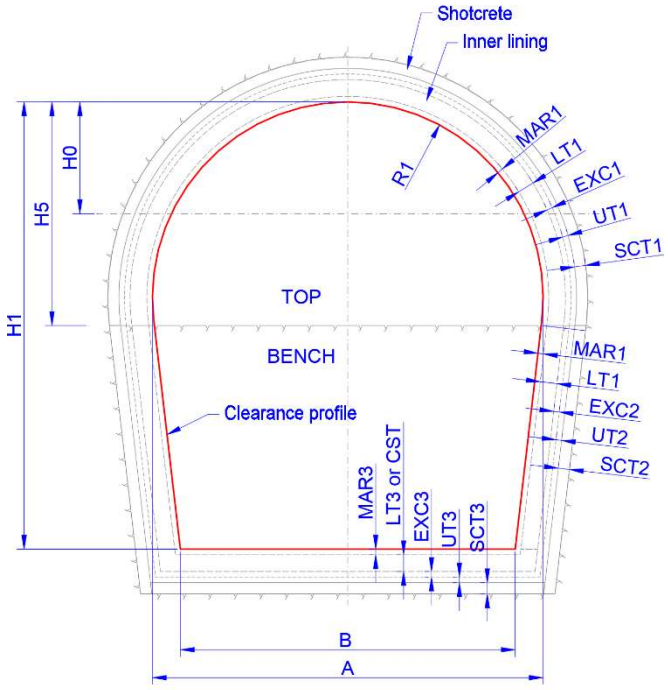


Figure 43: Cross section Type 2, phase 1 and 2 excavation (EXPH=3)

5.1.3.3 *Tunnel cross section type 3*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			3
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			50.000
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 3
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
Width	overall width		A	m			7.000
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			
Radius	crown: radius R1		R1	m			7.000
	bench: radius R2		R2	m			2.000
	invert: radius R3		R3	m			
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			
	thickness for separating films, sliding films, etc.		UT2	m			
	round length		RL2	m			
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 44: EXCEL input for cross section type 3, full face excavation

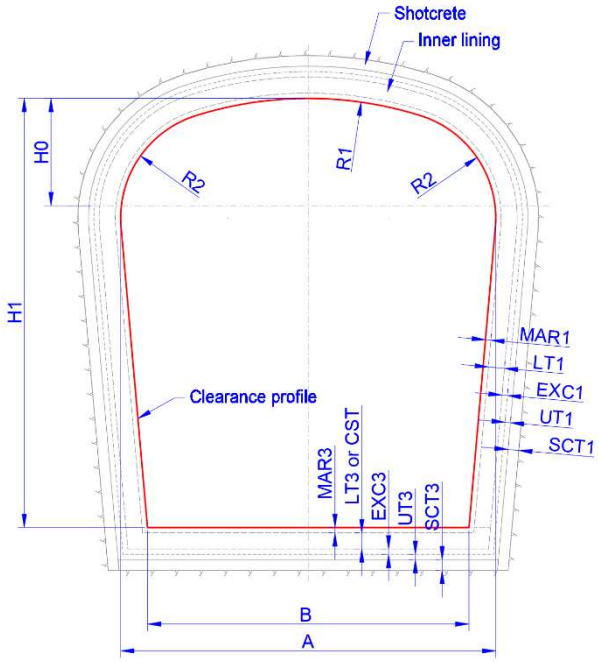


Figure 45: Cross section Type 3, full face excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			3
	invert type			INV-Type	1,2			1
	X-Origin			XO	m			50.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 3
	plotfile name			cDWG				
Excavation Phases	top, bench, invert			EXPH				3 Top, Bench +
Width	overall width			A	m			7.000
	at floor			B	m			6.000
Height	distance from reference line to top			H0	m			2.000
	overall excluding invert			H1	m			8.000
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			4.000
Radius	crown	radius R1		R1	m			7.000
	bench	radius R2		R2	m			2.000
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			0.100
	thickness for separating films, sliding films, etc.			UT2	m			0.100
	round length			RL2	m			4.000
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 46: EXCEL input for cross section type 3, phase 1 and 2 excavation

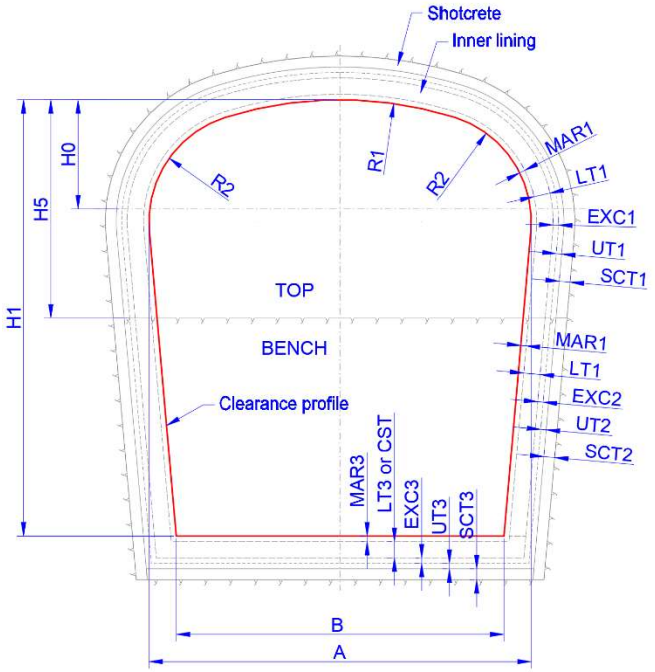


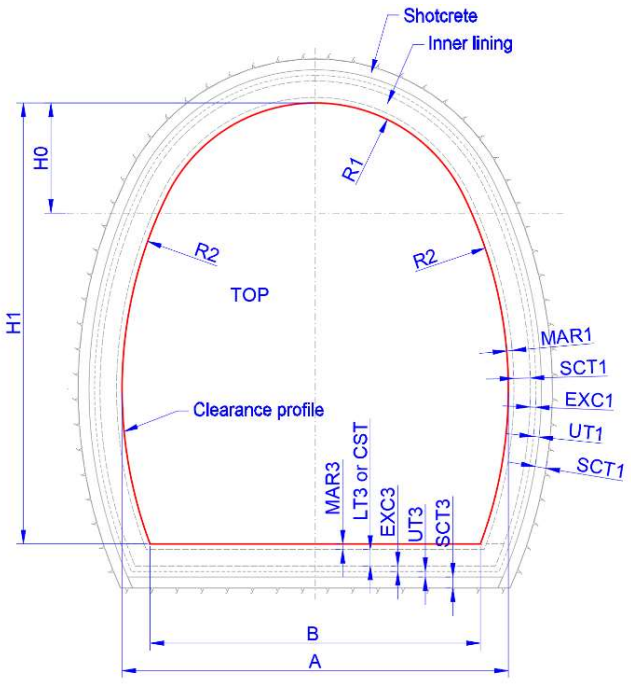
Figure 47: Cross section Type 3, phase 1 and 2 excavation (EXPH=3)

5.1.3.4 *Tunnel cross section type 4*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			4
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			75.000
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 4
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
Width	overall width		A	m			
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte	simultaneous excavation of top and bench	H4	m			
		separate excavation of top and bench	H5	m			
Radius	crown	radius R1	R1	m			3.000
	bench	radius R2	R2	m			8.000
	invert	radius R3	R3	m			
		ratio R3/R4	R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			
	thickness for separating films, sliding films, etc.		UT2	m			
	round length		RL2	m			
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 48: EXCEL input for cross section type 4, full face excavation

Alternative bench radius input with INPUT MODE 1
Required input value is A instead of R2



Mode1	0,1			1
Mode2	0,1,2			0
CS-Type	1-6, 11-14			4
INV-Type	1,2			1
XO	m			75.000
YO1	m			
YO2	m			
YO3	m			
YO4	m			
YO5	m			
YO6	m			
cHTX				Type 4
cDWG				
EXPH				1 Top + Bench +
A	m			7.000
B	m			6.000
H0	m			2.000
H1	m			8.000
H2	m			
H3	m			
H4	m			
H5	m			
R1	m			3.000
R2	m			
R3	m			
R3R4				
MAR1	m			0.100
EXC1	m			0.100
UT1	m			0.100
RL1	m			4.000
MAR2	m			
EXC2	m			
UT2	m			
RL2	m			
MAR3	m			0.100
EXC3	m			0.100
UT3	m			0.100
RL3	m			
cINV				0 none

Figure 49: Cross section Type 4, full face excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0	
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0	
Cross Section	cross section type		CS-Type	1-6, 11-14			4	
	invert type		INV-Type	1,2			1	
	X-Origin		XO	m			75.000	
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m				
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m				
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m				
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m				
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m				
	Y-Origin of summary of values	<empty = -55.000>	YO6	m				
	header text		cHTX				Type 4	
	plotfile name		cDWG					
Excavation Phases	top, bench, invert		EXPH				3 Top, Bench +	
Width	overall width		A	m				
	at floor		B	m			6.000	
Height	distance from reference line to top		H0	m			2.000	
	overall excluding invert		H1	m			8.000	
	invert		H2	m				
	crown through floor of partial shotcrete		H3	m				
	calotte	simultaneous excavation of top and bench	H4	m				
		separate excavation of top and bench	H5	m			4.000	
Radius	crown	radius R1	R1	m			3.000	
	bench	radius R2	R2	m			8.000	
	invert	radius R3	R3	m				
		ratio R3/R4	R3R4					
Top	margin specified in the tender		MAR1	m			0.100	
	specified excess		EXC1	m			0.100	
	thickness for separating films, sliding films, etc.		UT1	m			0.100	
	round length		RL1	m			4.000	
Bench	margin specified in the tender	MAR1 =	MAR2	m				
	specified excess		EXC2	m			0.100	
	thickness for separating films, sliding films, etc.		UT2	m			0.100	
	round length		RL2	m			4.000	
Invert	margin specified in the tender		MAR3	m			0.100	
	specified excess		EXC3	m			0.100	
	thickness for separating films, sliding films, etc.		UT3	m			0.100	
	round length		RL3	m				
	construction type		cINV				0 none	

Figure 50: EXCEL input for cross section type 4, phase 1 and 2 excavation

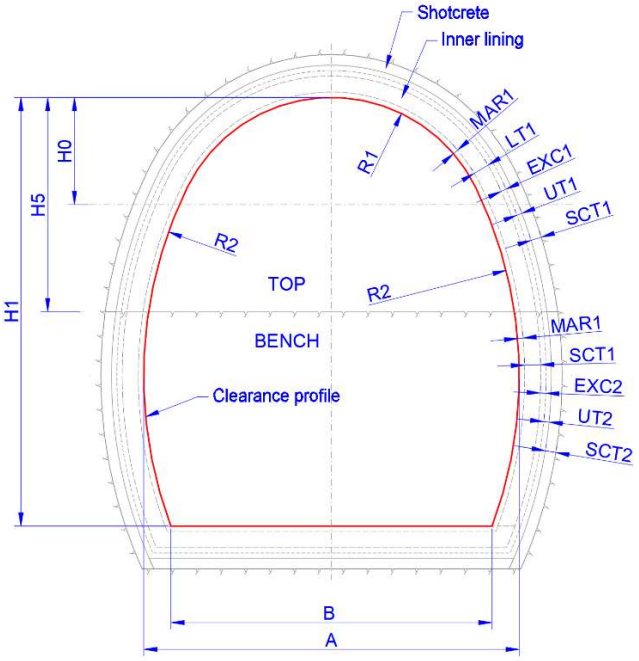


Figure 51: Cross section Type 4, phase 1 and 2 excavation (EXPH=3)

5.1.3.5 *Tunnel cross section type 5*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			5
	invert type		INV-Type	1,2			1
	X-Origin		XO	m			100.000
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 5
	plotfile name		cDWG				
Excavation Phases	top, bench, invert		EXPH				1 Top + Bench +
Width	overall width		A	m			
	at floor		B	m			6.000
Height	distance from reference line to top		H0	m			2.000
	overall excluding invert		H1	m			8.000
	invert		H2	m			1.000
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			
Radius	crown: radius R1		R1	m			3.000
	bench: radius R2		R2	m			8.000
	invert: radius R3		R3	m			8.000
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			
	thickness for separating films, sliding films, etc.		UT2	m			
	round length		RL2	m			
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			
	construction type		cINV				0 none

Figure 52: EXCEL input for cross section type 5, full face excavation

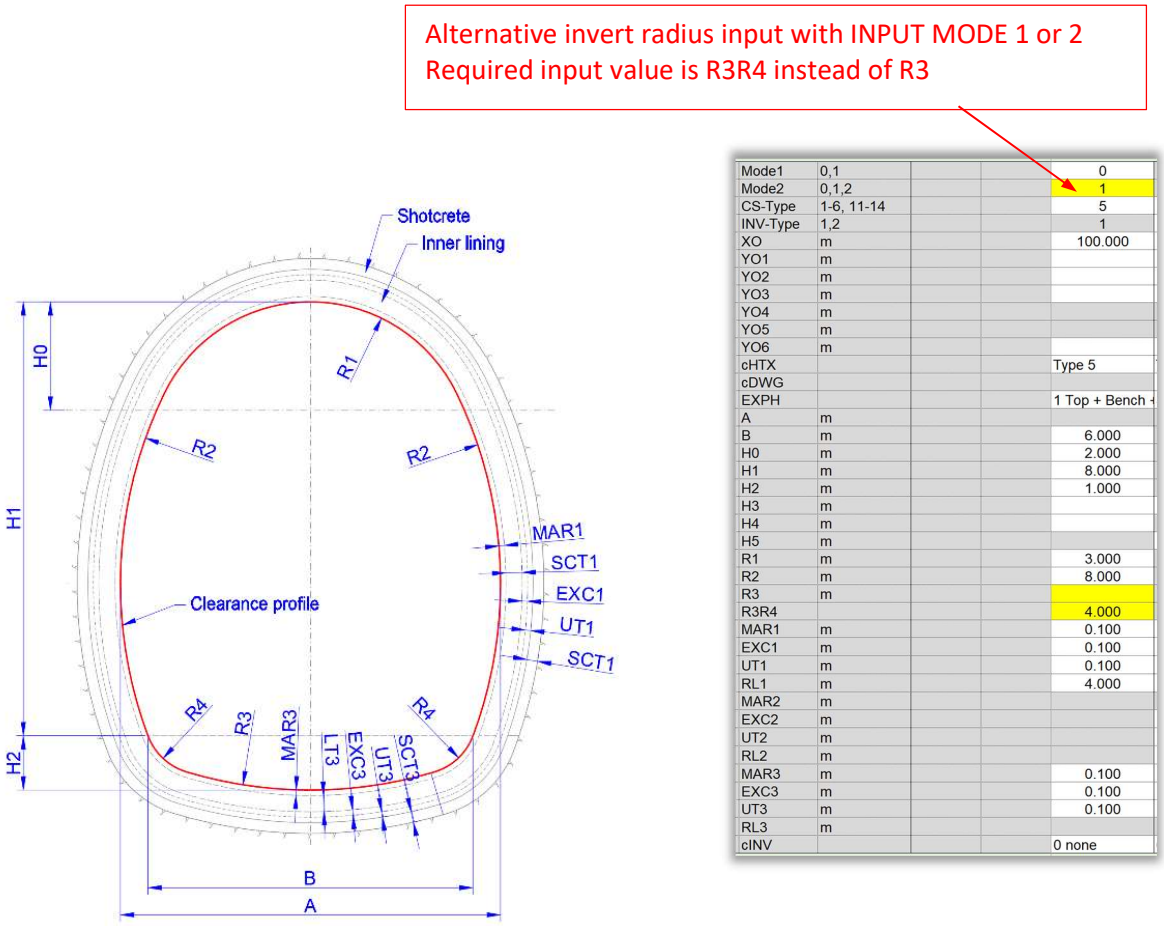


Figure 53: Cross section Type 5, full phase excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0	
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0	
Cross Section	cross section type		CS-Type	1-6, 11-14			5	
	invert type		INV-Type	1,2			1	
	X-Origin		XO	m			100.000	
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m				
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m				
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m				
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m				
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m				
	Y-Origin of summary of values	<empty = -55.000>	YO6	m				
	header text		cHTX				Type 5	
	plotfile name		cDWG					
Excavation Phases	top, bench, invert		EXPH				2 Top + Bench,	
Width	overall width		A	m				
	at floor		B	m			6.000	
Height	distance from reference line to top		H0	m			2.000	
	overall excluding invert		H1	m			8.000	
	invert		H2	m			1.000	
	crown through floor of partial shotcrete		H3	m				
	calotte: simultaneous excavation of top and bench		H4	m				
	calotte: separate excavation of top and bench		H5	m				
Radius	crown: radius R1		R1	m			3.000	
	bench: radius R2		R2	m			8.000	
	invert: radius R3		R3	m			8.000	
	invert: ratio R3/R4		R3R4					
Top	margin specified in the tender		MAR1	m			0.100	
	specified excess		EXC1	m			0.100	
	thickness for separating films, sliding films, etc.		UT1	m			0.100	
	round length		RL1	m			4.000	
Bench	margin specified in the tender	MAR1 =	MAR2	m				
	specified excess		EXC2	m				
	thickness for separating films, sliding films, etc.		UT2	m				
	round length		RL2	m				
Invert	margin specified in the tender		MAR3	m			0.100	
	specified excess		EXC3	m			0.100	
	thickness for separating films, sliding films, etc.		UT3	m			0.100	
	round length		RL3	m			4.000	
	construction type		cINV				0 none	

Figure 54: EXCEL input for cross section type 5, phase1/2 and phase 3 excavation

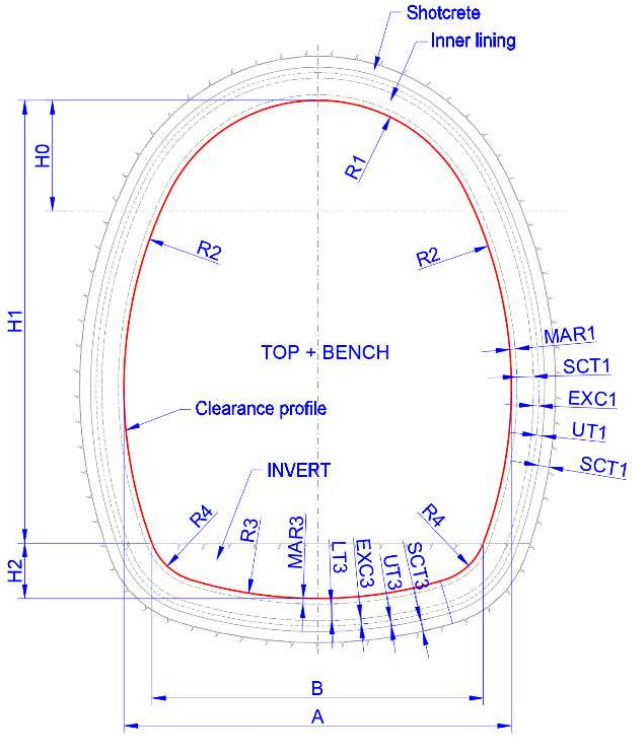


Figure 55: Cross section Type 5, phase1/2 and phase 3 excavation (EXPH=2)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			5
	invert type			INV-Type	1,2			1
	X-Origin			XO	m			100.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 5
	plotfile name			cDWG				
Excavation Phases	top, bench, invert			EXPH				3 Top, Bench +
Width	overall width			A	m			
	at floor			B	m			6.000
Height	distance from reference line to top			H0	m			2.000
	overall excluding invert			H1	m			8.000
	invert			H2	m			1.000
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			4.000
Radius	crown	radius R1		R1	m			3.000
	bench	radius R2		R2	m			8.000
	invert	radius R3		R3	m			8.000
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			0.100
	thickness for separating films, sliding films, etc.			UT2	m			0.100
	round length			RL2	m			4.000
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 56: EXCEL input for cross section type 5, phase 1 and 2/3 excavation

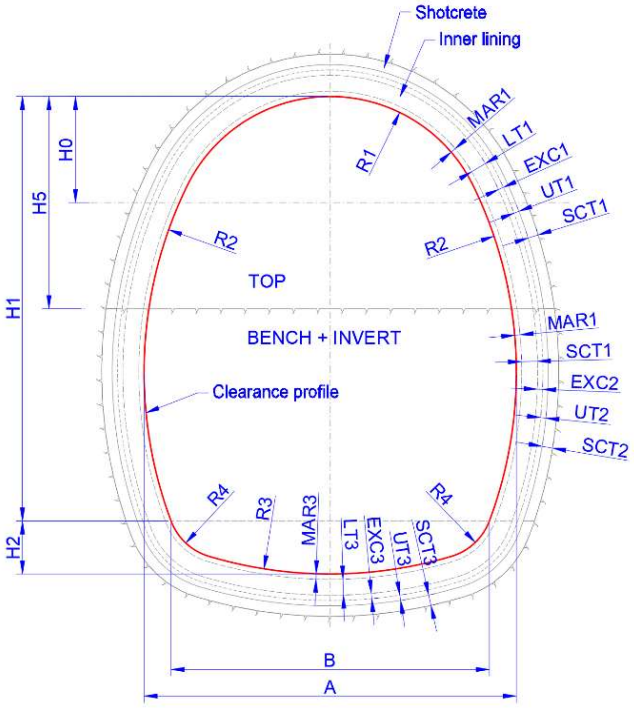


Figure 57: Cross section Type 5, phase 1 and 2/3 excavation (EXPH=3)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			5
	invert type			INV-Type	1,2			1
	X-Origin			XO	m			100.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 5
	plotfile name			cDWG				
Excavation Phases	top, bench, invert			EXPH				4 Top, Bench, Ir
Width	overall width			A	m			
	at floor			B	m			6.000
Height	distance from reference line to top			H0	m			2.000
	overall excluding invert			H1	m			8.000
	invert			H2	m			1.000
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			4.000
Radius	crown	radius R1		R1	m			3.000
	bench	radius R2		R2	m			8.000
	invert	radius R3		R3	m			8.000
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			0.100
	thickness for separating films, sliding films, etc.			UT2	m			0.100
	round length			RL2	m			4.000
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			4.000
	construction type			cINV				0 none

Figure 58: EXCEL input for cross section type 5, phase 1, 2 and 3 excavation

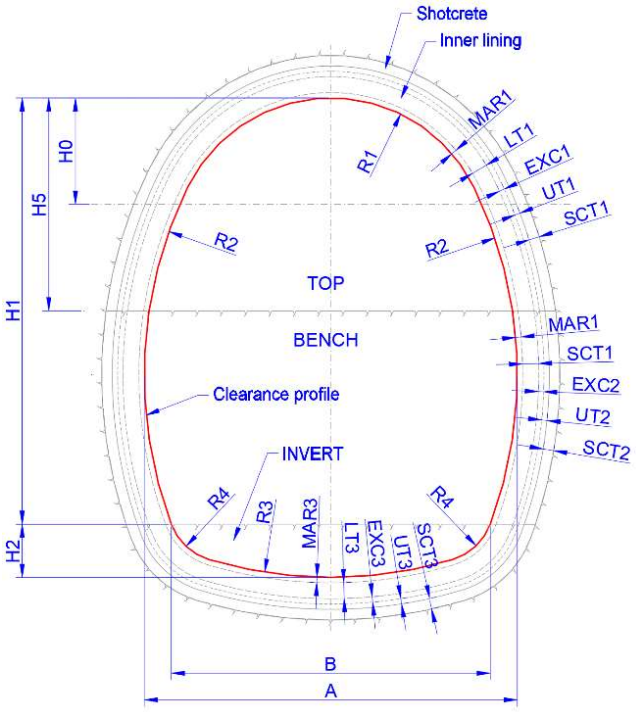


Figure 59: Cross section Type 5, phase 1, 2 and 3 excavation (EXPH=4)

5.1.3.6 *Tunnel cross section type 6 (Freeform)*

Cross section type 6 is to be defined on a drawing consisting of:

- a polyline that defines the tunnel cross section (clearance profile excluding inner linig) above the floor (red line). The polylines shall consist of lines and/or arcs only.
- a line, arc or polyline that defines the tunnel floor (blue line). The polylines shall consist of lines and/or arcs only.

The bottom left end points of the two entities shall be identical and shall have a negative x-coordinate value. The bottom right end points of the two entities shall be identical and shall have a positive x-coordinate value. Please see Figure 13.

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			6
	invert type			INV-Type	1,2			3
	X-Origin			XO	m			125.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 6
	plotfile name			cDWG				Freeform.dwg
Excavation Phases	top, bench, invert			EXPH				1 Top + Bench +
Width	overall width			A	m			
	at floor			B	m			
Height	distance from reference line to top			H0	m			
	overall excluding invert			H1	m			
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			
Radius	crown	radius R1		R1	m			
	bench	radius R2		R2	m			
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			
	thickness for separating films, sliding films, etc.			UT2	m			
	round length			RL2	m			
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 60: EXCEL input for cross section type 6, full face excavation

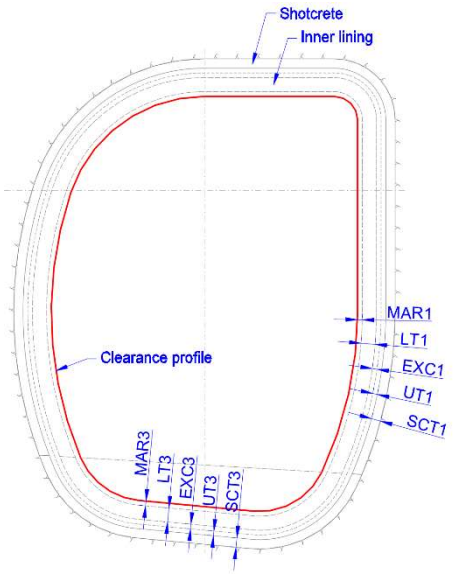


Figure 61: Cross section Type 6, full phase excavation (EXPH=1)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			6
	invert type			INV-Type	1,2			3
	X-Origin			XO	m			125.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 6
	plotfile name			cDWG				Freeform.dwg
Excavation Phases	top, bench, invert			EXPH				2 Top + Bench,
Width	overall width			A	m			
	at floor			B	m			
Height	distance from reference line to top			H0	m			
	overall excluding invert			H1	m			
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			
Radius	crown	radius R1		R1	m			
	bench	radius R2		R2	m			
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			
	thickness for separating films, sliding films, etc.			UT2	m			
	round length			RL2	m			
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			4.000
	construction type			cINV				0 none

Figure 62: EXCEL input for cross section type 6, phase1/2 and phase 3 excavation

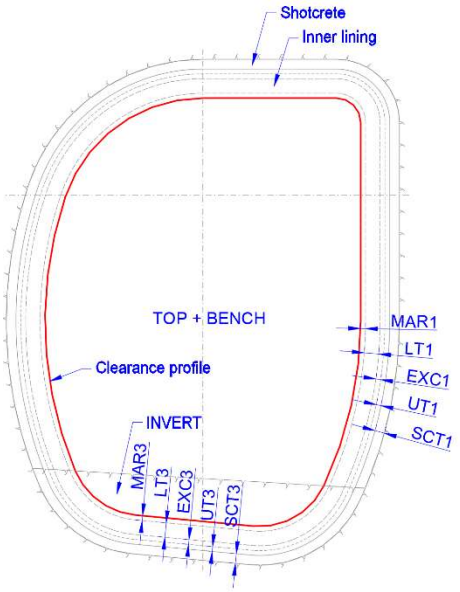


Figure 63: Drawing output for cross section Type 6, phase1/2 and phase 3 excavation (EXPH=2)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1			Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min			Mode2	0,1,2			0
Cross Section	cross section type			CS-Type	1-6, 11-14			6
	invert type			INV-Type	1,2			3
	X-Origin			XO	m			125.000
	Y-Origin cross section text and scale		<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view		<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)		<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)		<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)		<empty = -45.000>	YO5	m			
	Y-Origin of summary of values		<empty = -55.000>	YO6	m			
	header text			cHTX				Type 6
	plotfile name			cDWG				Freeform.dwg
Excavation Phases	top, bench, invert			EXPH				3 Top, Bench +
Width	overall width			A	m			
	at floor			B	m			
Height	distance from reference line to top			H0	m			
	overall excluding invert			H1	m			
	invert			H2	m			
	crown through floor of partial shotcrete			H3	m			
	calotte	simultaneous excavation of top and bench		H4	m			
		separate excavation of top and bench		H5	m			4.000
Radius	crown	radius R1		R1	m			
	bench	radius R2		R2	m			
	invert	radius R3		R3	m			
		ratio R3/R4		R3R4				
Top	margin specified in the tender			MAR1	m			0.100
	specified excess			EXC1	m			0.100
	thickness for separating films, sliding films, etc.			UT1	m			0.100
	round length			RL1	m			4.000
Bench	margin specified in the tender		MAR1 =	MAR2	m			
	specified excess			EXC2	m			0.100
	thickness for separating films, sliding films, etc.			UT2	m			0.100
	round length			RL2	m			4.000
Invert	margin specified in the tender			MAR3	m			0.100
	specified excess			EXC3	m			0.100
	thickness for separating films, sliding films, etc.			UT3	m			0.100
	round length			RL3	m			
	construction type			cINV				0 none

Figure 64: EXCEL input for cross section type 6, phase 1 and 2/3 excavation

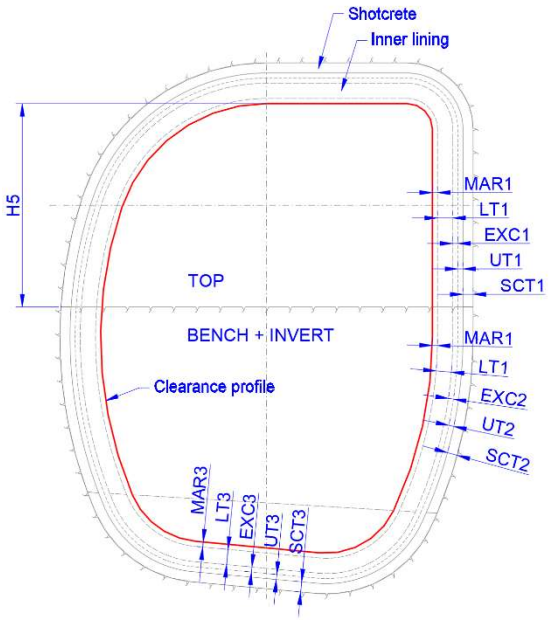


Figure 65: Cross section Type 6, phase 1 and 2/3 excavation (EXPH=3)

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	0,1			0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	0,1,2			0
Cross Section	cross section type		CS-Type	1-6, 11-14			6
	invert type		INV-Type	1,2			3
	X-Origin		XO	m			125.000
	Y-Origin cross section text and scale	<empty = -11.000>	YO1	m			
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m			
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m			
	Y-Origin of top of table 2 (bench)	<empty = -35.000>	YO4	m			
	Y-Origin of top of table 3 (Invert)	<empty = -45.000>	YO5	m			
	Y-Origin of summary of values	<empty = -55.000>	YO6	m			
	header text		cHTX				Type 6
	plotfile name		cDWG				Freeform.dwg
Excavation Phases	top, bench, invert		EXPH				4 Top, Bench, Ir
Width	overall width		A	m			
	at floor		B	m			
Height	distance from reference line to top		H0	m			
	overall excluding invert		H1	m			
	invert		H2	m			
	crown through floor of partial shotcrete		H3	m			
	calotte: simultaneous excavation of top and bench		H4	m			
	calotte: separate excavation of top and bench		H5	m			4.000
Radius	crown: radius R1		R1	m			
	bench: radius R2		R2	m			
	invert: radius R3		R3	m			
	invert: ratio R3/R4		R3R4				
Top	margin specified in the tender		MAR1	m			0.100
	specified excess		EXC1	m			0.100
	thickness for separating films, sliding films, etc.		UT1	m			0.100
	round length		RL1	m			4.000
Bench	margin specified in the tender	MAR1 =	MAR2	m			
	specified excess		EXC2	m			0.100
	thickness for separating films, sliding films, etc.		UT2	m			0.100
	round length		RL2	m			4.000
Invert	margin specified in the tender		MAR3	m			0.100
	specified excess		EXC3	m			0.100
	thickness for separating films, sliding films, etc.		UT3	m			0.100
	round length		RL3	m			4.000
	construction type		cINV				0 none

Figure 66: EXCEL input for cross section type 6, phase 1, 2 and 3 excavation

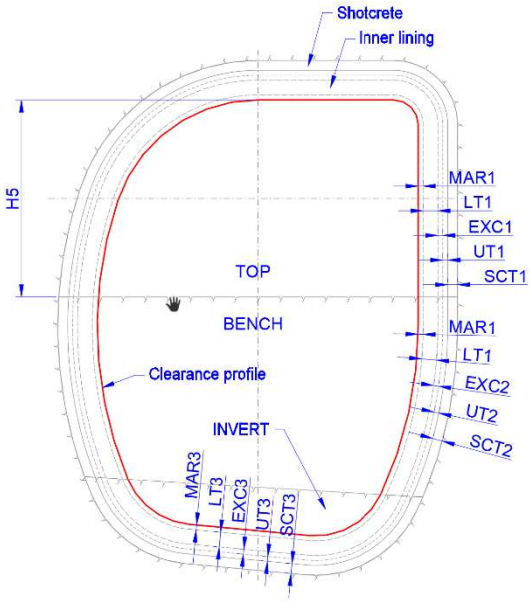


Figure 67: Cross section Type 6, phase 1, 2 and 3 excavation (EXPH=4)

5.1.3.7 *Shaft cross section type 11*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	<0,1>		0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	<0,1,2>		0
Cross Section	cross section type		CS-Type	<1,2,3,4,5,6>		11
	invert type		INV-Type	<1,2>		1
	X-Origin		XO	m		0.000
	Y-Origin cross section text and scale	<empty = -10.000>	YO1	m		
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m		
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m		
	Y-Origin of top of table 2 (bench)	<empty = -27.000>	YO4	m		
	Y-Origin of top of table 3 (Invert)	<empty = -32.000>	YO5	m		
	Y-Origin of summary of values	<empty = -37.000>	YO6	m		
	header text		cHTX			TYPE 11
	plotfile name		cDWG			
Excavation Phases	top, bench, invert		EXPH			1 Top + Bench +
Width	overall width		A	m		
	at floor		B	m		
Height	distance from reference line to top		H0	m		
	overall excluding invert		H1	m		
	invert		H2	m		
	crown through floor of partial shotcrete		H3	m		
	calotte: simultaneous excavation of top and bench		H4	m		
	calotte: separate excavation of top and bench		H5	m		
Radius	crown: radius R1		R1	m		2.500
	bench: radius R2		R2	m		
	invert: radius R3		R3	m		
	invert: ratio R3/R4		R3R4			
Top	excess		EXC1	m		0.030
	round length		RL1	m		2.500
Bench	excess		EXC2	m		
	round length		RL2	m		
Invert	excess		EXC3	m		
	round length		RL3	m		
	construction type		cINV			0 none

Figure 68: EXCEL input for cross section type 11

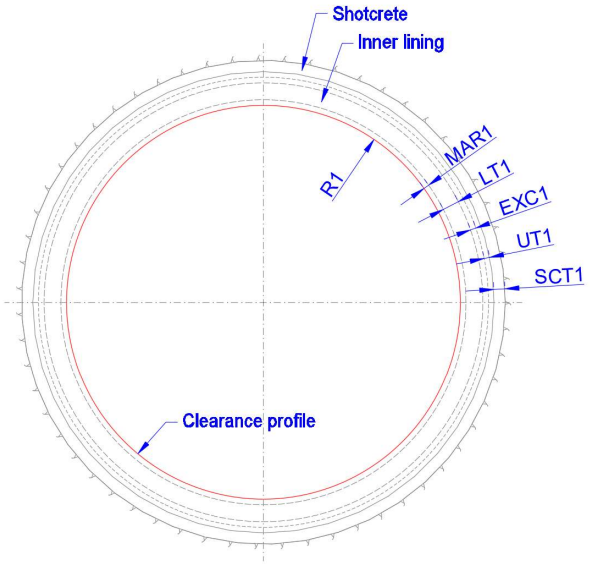


Figure 69: Shaft cross section Type 11

5.1.3.8 *Shaft cross section type 12*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	<0,1>		0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	<0,1,2>		0
Cross Section	cross section type		CS-Type	<1,2,3,4,5,6>		12
	invert type		INV-Type	<1,2>		1
	X-Origin		XO	m		20.000
	Y-Origin cross section text and scale	<empty = -10.000>	YO1	m		
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m		
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m		
	Y-Origin of top of table 2 (bench)	<empty = -27.000>	YO4	m		
	Y-Origin of top of table 3 (Invert)	<empty = -32.000>	YO5	m		
	Y-Origin of summary of values	<empty = -37.000>	YO6	m		
	header text		cHTX			TYPE 12
	plotfile name		cDWG			
Excavation Phases	top, bench, invert		EXPH			1 Top + Bench +
Width	overall width		A	m		6.000
	at floor		B	m		5.000
Height	distance from reference line to top		H0	m		
	overall excluding invert		H1	m		
	invert		H2	m		
	crown through floor of partial shotcrete		H3	m		
	calotte: simultaneous excavation of top and bench		H4	m		
	calotte: separate excavation of top and bench		H5	m		
Radius	crown	radius R1	R1	m		
	bench	radius R2	R2	m		
	invert	radius R3	R3	m		
		ratio R3/R4	R3R4			
Top	excess		EXC1	m		0.030
	round length		RL1	m		2.500
Bench	excess		EXC2	m		
	round length		RL2	m		
Invert	excess		EXC3	m		
	round length		RL3	m		
	construction type		cINV			0 none

Figure 70: EXCEL input for cross section type 12

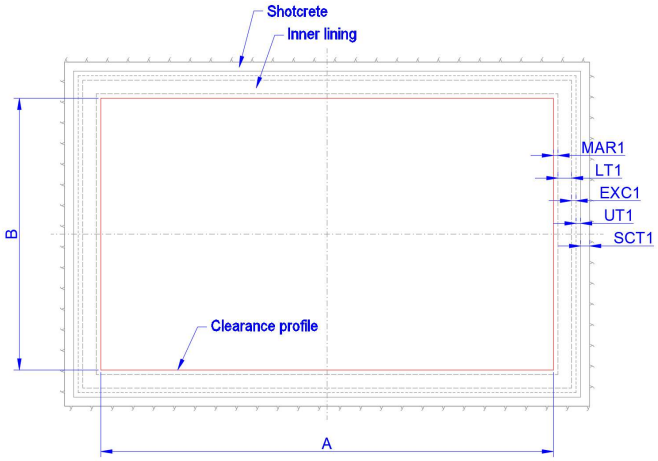


Figure 71: Shaft cross section Type 12

5.1.3.9 *Shaft cross section type 13*

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	<0,1>		0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	<0,1,2>		0
Cross Section	cross section type		CS-Type	<1,2,3,4,5,6>		13
	invert type		INV-Type	<1,2>		1
	X-Origin		XO	m		40.000
	Y-Origin cross section text and scale	<empty = -10.000>	YO1	m		
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m		
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m		
	Y-Origin of top of table 2 (bench)	<empty = -27.000>	YO4	m		
	Y-Origin of top of table 3 (Invert)	<empty = -32.000>	YO5	m		
	Y-Origin of summary of values	<empty = -37.000>	YO6	m		
	header text		cHTX			TYPE 13
	plotfile name		cDWG			
Excavation Phases	top, bench, invert		EXPH			1 Top + Bench +
Width	overall width		A	m		6.000
	at floor		B	m		5.000
Height	distance from reference line to top		H0	m		
	overall excluding invert		H1	m		
	invert		H2	m		
	crown through floor of partial shotcrete		H3	m		
	calotte: simultaneous excavation of top and bench		H4	m		
	calotte: separate excavation of top and bench		H5	m		
Radius	crown: radius R1		R1	m		1.000
	bench: radius R2		R2	m		
	invert: radius R3		R3	m		
	invert: ratio R3/R4		R3R4			
Top	excess		EXC1	m		0.030
	round length		RL1	m		2.500
Bench	excess		EXC2	m		
	round length		RL2	m		
Invert	excess		EXC3	m		
	round length		RL3	m		
	construction type		cINV			0 none

Figure 72: EXCEL input for cross section type 13

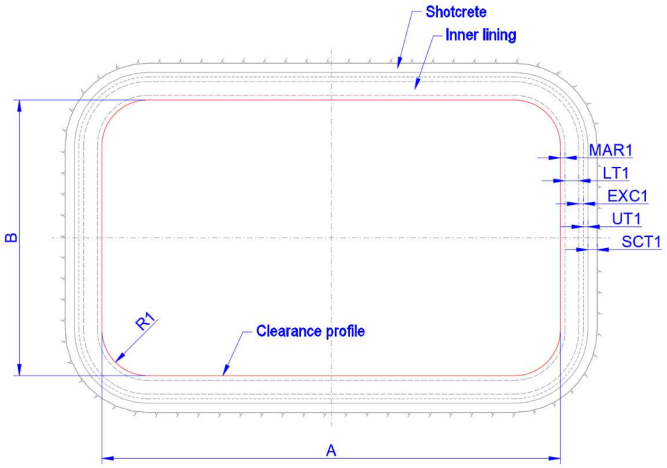


Figure 73: Shaft cross section Type 13

5.1.3.10 Shaft cross section type 14 (Freeform)

Cross section type 14 is to be defined on a drawing consisting of 1 polyline that defines the shaft cross section (clearance profile). The coordindate origin shall be within the polyline. The polyline shall consist of lines and/or arcs only.

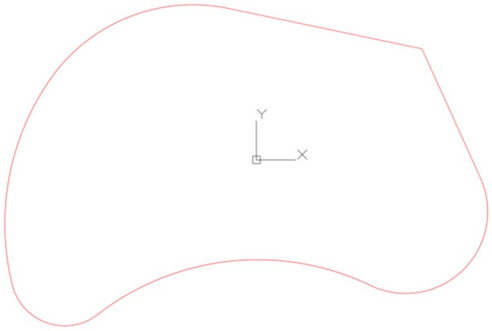


Figure 74: Shaft cross section Type 14, definition in a separate plotfile

Input Mode	bench radius: 0 = B,H1,R1,R2 1 = A,B,H1,R1		Mode1	<0,1>		0
	invert radius: 0 = R3, 1= R3/R4max, 2=R3/R4min		Mode2	<0,1,2>		0
Cross Section	cross section type		CS-Type	<1,2,3,4,5,6>		14
	invert type		INV-Type	<1,2>		1
	X-Origin		XO	m		60.000
	Y-Origin cross section text and scale	<empty = -10.000>	YO1	m		
	Y-Origin of plan view/flat view	<empty = -19.000>	YO2	m		
	Y-Origin of top of table 1 (top)	<empty = -22.000>	YO3	m		
	Y-Origin of top of table 2 (bench)	<empty = -27.000>	YO4	m		
	Y-Origin of top of table 3 (Invert)	<empty = -32.000>	YO5	m		
	Y-Origin of summary of values	<empty = -37.000>	YO6	m		
	header text		cHTX			TYPE 14
	plotfile name		cDWG			SH4.dwg
Excavation Phases	top, bench, invert		EXPH			1 Top + Bench +
Width	overall width		A	m		
	at floor		B	m		
Height	distance from reference line to top		H0	m		
	overall excluding invert		H1	m		
	invert		H2	m		
	crown through floor of partial shotcrete		H3	m		
	calotte	simultaneous excavation of top and bench	H4	m		
		separate excavation of top and bench	H5	m		
Radius	crown	radius R1	R1	m		
	bench	radius R2	R2	m		
	invert	radius R3	R3	m		
		ratio R3/R4	R3R4			
Top	excess		EXC1	m		0.030
	round length		RL1	m		2.500
Bench	excess		EXC2	m		
	round length		RL2	m		
Invert	excess		EXC3	m		
	round length		RL3	m		
	construction type		cINV			0 none

Figure 75: EXCEL input for cross section type 14

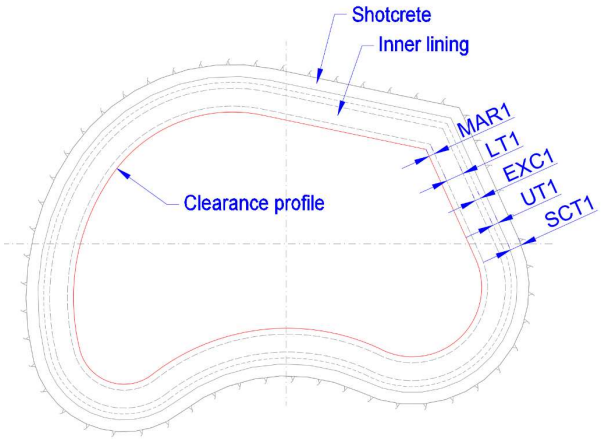


Figure 76: Shaft cross section Type 14

5.1.4 *Additional excavation*

Excavation	excavation of bench floor enlargement		EXCW	m³/LM tunnel	25.0	25.0	11.000
	demolition of bottom slab		EXCI	m³/LM tunnel	27.0	27.0	11.000
	top	subareas with simultaneity	iEXPA1	pcs/round	35.0	22.0	3
		subareas without simultaneity	iEXPA2	pcs/round	35.0	28.0	4
	bench	subareas with simultaneity	iEXPA3	pcs/round	35.0	22.0	5
		subareas without simultaneity	iEXPA4	pcs/round	35.0	28.0	6

Figure 77: EXCEL input for additionl excavation

Additional excavation is not show in the cross sections.

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	30.49 m³
	W	Tilting base enlargement	11.00 m³
	W	Partial area excavation with simultaneity at top, 3 pcs/round	1.50 pcs
	W	Partial area excavation without simultaneity at top, 4 pcs/round	2.00 pcs
Bench + Invert	F	Excavation	34.98 m³
	IS	Demolition of Invert surface of the top heading (temporary)	11.00 m³
	W	Partial area excavation with simultaneity at bench, 5 pcs/round	2.50 pcs
	W	Partial area excavation without simultaneity at bench, 6 pcs/round	3.00 pcs

Figure 78: Table output on drawing - Additional excavation

5.1.5 *Shotcrete*

Shotcrete	top	type	cSCT1				1 Shotcrete
		thickness	SCT1	m			0.100
		number of layers	iSCN1				1
		filling in gussets and oberbreak	SCFG1	m³/LM	12.5	12.5	
		quality	cSCQ1				C25/30
	invert surface of the top heading (temporary)	type	cSCT4				0 none
		thickness	SCT4	m			
		number of layers	iSCN4				
		flat view length <0 = horizontal length>	SCL4	m			
		change of top evaluaton area	CHEVT	m²			
		change of bench evaluaton area	CHEVB	m²			
		change of top excavation area	CHXT	m²			
		calotte toe	SCCW	m³/LM	16.0	16.0	
		quality	cSCQ4				
	bench	type	cSCT2				1 Shotcrete
		thickness	SCT2	m			0.100
		number of layers	iSCN2				1
		filling in gussets and oberbreak	SCFG2	m³/LM	12.5	12.5	
		quality	cSCQ2				C25/30
	invert	type	cSCT3				1 Shotcrete
		thickness	SCT3	m			0.100
		number of layers	iSCN3				1
		quality	cSCQ3				C25/30
	tunnel face (or shaft floor)	type	cSCT5				1 Shotcrete
		thickness	SCT5	m			0.100
		percent of tunnel face	SCP5	%			100%
		quality	cSCQ5				C25/30

Figure 79: EXCEL input for shotcrete

	A	B	C
1	LOCATION	1 English	2 German
166	Drawing	#cSCT1#, #iSCN1# layer(s), t = #SCT1cm:0.0# cm, #cSCQ1# (as head protectio	#cSCT1#, Stärke #SCT1cm:0.0# cm (als Kopfschutz)
167	Cross Section	#cSCT1#, #iSCN1# layer(s), t = #SCT1cm:0.0# cm, #cSCQ1#	#cSCT1#, Stärke #SCT1cm:0.0# cm
168		#cSCT2#, #iSCN2# layer(s), t = #SCT2cm:0.0# cm, #cSCQ2#	#cSCT2#, #iSCN2# Lage, t = #SCT2cm:0.0# cm, #cSCQ2#
169		.	.
170		#cSCT3#, #iSCN3# layer(s), t = #SCT3cm:0.0# cm, #cSCQ3#	#cSCT3#, #iSCN3# Lage(n), t = #SCT3cm:0.0# cm, #cSCQ3#
171		#cSCT3#, #iSCN3# layer(s), t = #SCT3cm:0.0# cm, #cSCQ3#\#cINV#	#cSCT3#, #iSCN3# Lage(n), t = #SCT3cm:0.0# cm, #cSCQ3#\#cINV#
172			

Figure 80: EXCEL extract from sheet TEXT

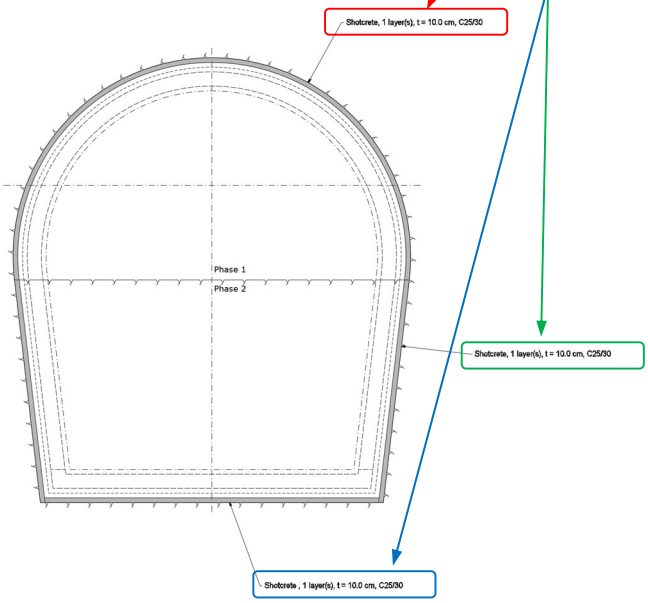
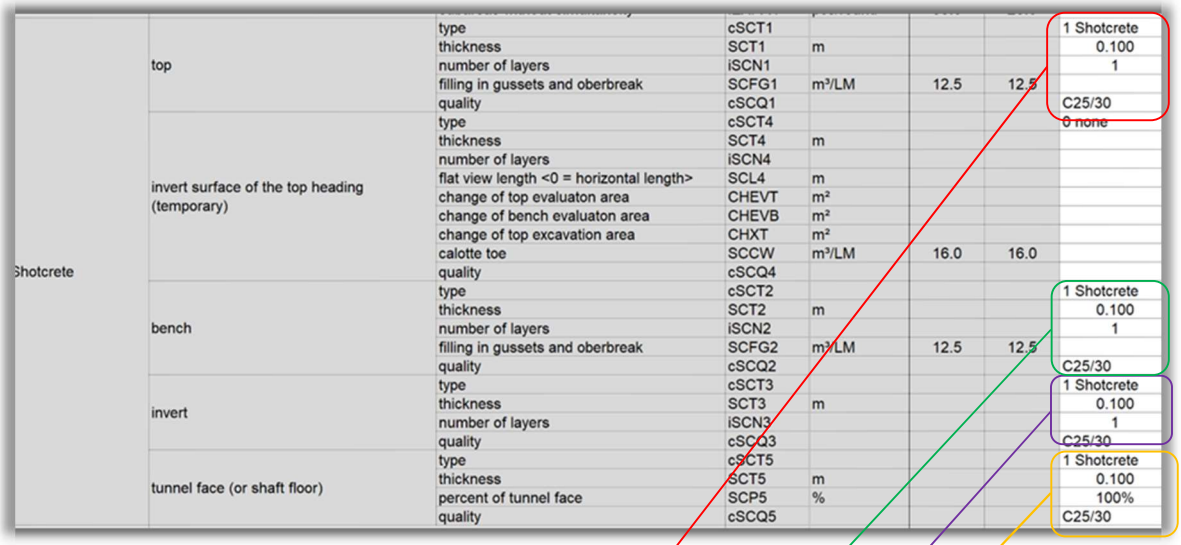


Figure 81: Cross section output on drawing – Shotcrete



Shotcrete	top	type	cSCT1				1 Shotcrete
		thickness	SCT1	m			0.100
		number of layers	iSCN1				1
		filling in gussets and oberbreak	SCFG1	m³/LM	12.5	12.5	
		quality	cSCQ1				C25/30
	invert surface of the top heading (temporary)	type	cSCT4				0 none
		thickness	SCT4	m			
		number of layers	iSCN4				
		flat view length <0 = horizontal length>	SCL4	m			
		change of top evaluaton area	CHEVT	m²			
		change of bench evaluaton area	CHEVB	m²			
		change of top excavation area	CHXT	m²			
		calotte toe	SCCW	m³/LM	16.0	16.0	
		quality	cSCQ4				
	bench	type	cSCT2				1 Shotcrete
		thickness	SCT2	m			0.100
		number of layers	iSCN2				1
		filling in gussets and oberbreak	SCFG2	m³/LM	12.5	12.5	
		quality	cSCQ2				C25/30
	invert	type	cSCT3				1 Shotcrete
		thickness	SCT3	m			0.100
		number of layers	iSCN3				1
		quality	cSCQ3				C25/30
	tunnel face (or shaft floor)	type	cSCT5				1 Shotcrete
		thickness	SCT5	m			0.100
		percent of tunnel face	SCP5	%			100%
		quality	cSCQ5				C25/30

Figure 82: EXCEL input for shotcrete

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	31.90 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 10.0 cm C25/30	1.40 m³
	F	Shotcrete at tunnel face, t = 10 cm 100 % of tunnel face, C25/30	1.59 m³
Bench + Invert	F	Excavation	36.63 m³
	W	Shotcrete at bench, 1 layer(s), t = 10.0 cm, C25/30	0.95 m³
	I	Shotcrete at invert, 1 layer(s), t = 10.0 cm,C25/30	0.71 m³

Figure 83: Table output on drawing – Shotcrete

5.1.6 *Partial shotcrete*

The tunnel excavation in area of partial shotcreting can determined by entering a positive or negative shotcrete thickness.

Height	distance from reference line to top		H0	m			2.000	
	overall excluding invert		H1	m			8.000	
	invert		H2	m				
	crown through floor of partial shotcrete		H3	m			0.750	
	calotte	simultaneous excavation of top and bench	H4	m				
		separate excavation of top and bench	H5	m			4.000	

Shotcrete	top	type	cSCT1				1 Shotcrete	1 Shotcrete
		thickness	SCT1	m			0.200	-0.200
		number of layers	iSCN1				1	1
		filling in gussets and oberbreak	SCFG1	m³/LM	12.5	12.5		
		quality	cSCQ1				C25/30	C25/30
	invert surface of the top heading (temporary)	type	cSCT4				0 none	0 none
		thickness	SCT4	m				
		number of layers	iSCN4					
		flat view length <0 = horizontal length>	SCL4	m				
		change of top evaluaton area	CHEVT	m²				
		change of bench evaluaton area	CHEVB	m²				
		change of top excavation area	CHXT	m²				
		calotte toe	SCCW	m³/LM	16.0	16.0		
		quality	cSCQ4					
	bench	type	cSCT2				0 none	0 none
		thickness	SCT2	m				
		number of layers	iSCN2					
		filling in gussets and oberbreak	SCFG2	m³/LM	12.5	12.5		
		quality	cSCQ2					
	invert	type	cSCT3				0 none	0 none
		thickness	SCT3	m				
		number of layers	iSCN3					
		quality	cSCQ3					
	tunnel face (or shaft floor)	type	cSCT5				0 none	0 none
		thickness	SCT5	m				
		percent of tunnel face	SCP5	%				
		quality	cSCQ5					

Figure 84: EXCEL input for partial shotcrete

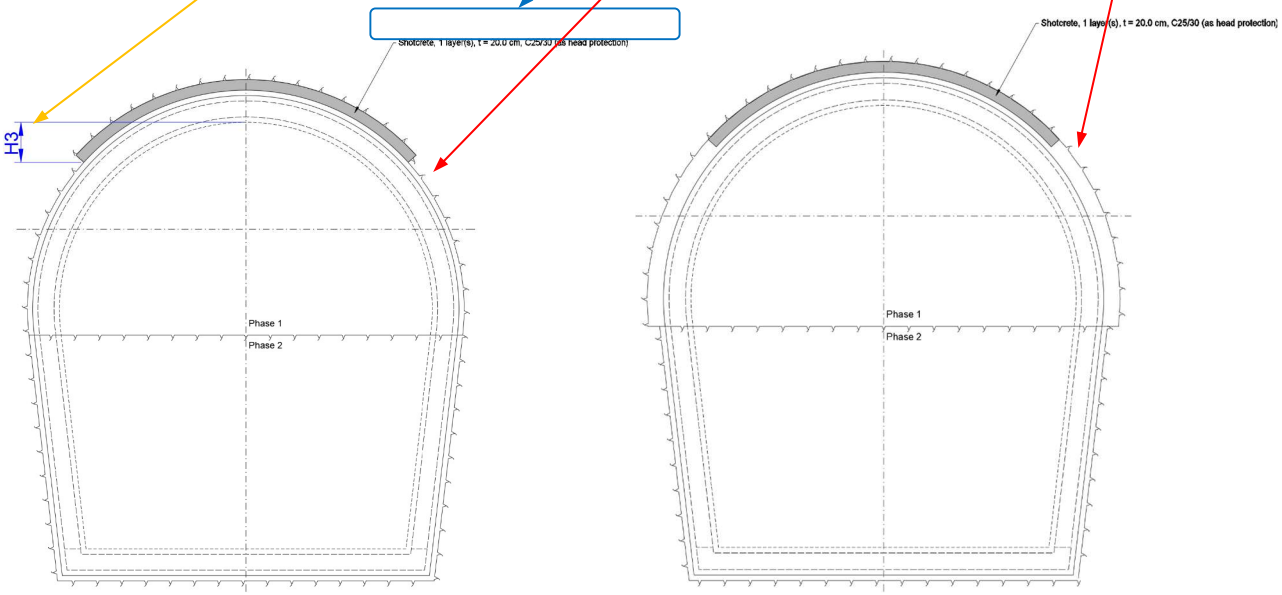


Figure 85: Cross section output on drawing – partial shotcrete

Type 2

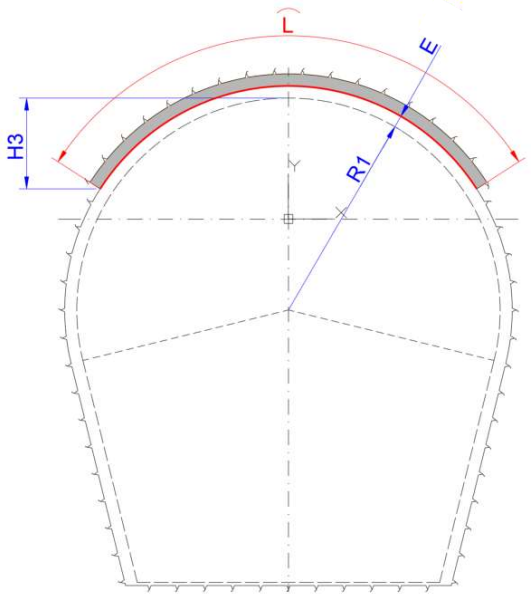
Round Length of Top = 2.00 m

Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	31.90 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	1.40 m³
Bench + Invert	F	Excavation	34.98 m³

Figure 86: Table output on drawing – Partial shotcrete

Height H3 can be calculated from the shotcrete length L, R1 and MAR1, LT1, EXC1 and UT1 as following:



when using calculators where the angles are entered in degrees

$$H3 = (R1 + E) \cdot \left(1 - \cos\left(\frac{90 \cdot L}{\pi \cdot (R1 + E)}\right)\right) - E$$

when using Excel, Mathcad, etc., where the angles are entered in radiants

$$H3 = (R1 + E) \cdot \left(1 - \cos\left(\frac{L}{2 \cdot (R1 + E)}\right)\right) - E$$

with

$$E = MAR1 + LT1 + EXC1 + UT1$$

Figure 87: H3 deduced from L, R1, MAR1, LT1, EXC1 and UT1

5.1.7 *Shotcrete at temporary invert surface*

By default a horizontal temporary invert is calculated with

L_EX1-2 = L - 2·SCT1

where L is the floor width of the top excavation. Shotcrete for the temporary invert shall be added manually on the drawing.

If the length L_EX1-2 is not suitable for any reason, especially with a curved temporary invert, then the length SCL4 shall be entered which overwrites the length L_EX1-2.

Step 1: Enter shotcrete type, thickness, number of layers and shotcrete quality. Start the ***Rock-Support*** progam and measure SCL4 and top heading increase CHXT.

Step 2: Enter values SCL4, CHXT, CHEVT, CHEVB (CHEVT and CHEVB refer to Austria ADD-ON only)

	invert surface of the top heading (temporary)	type	cSCT4				1 Shotcrete
		thickness	SCT4	m			0.200
		number of layers	iSCN4				1
		flat view length <0 = horizontal length>	SCL4	m			
		change of top evaluaton area	CHEVT	m²			
		change of bench evaluaton area	CHEVB	m²			
		change of top excavation area	CHXT	m²			
		calotte toe	SCCW	m³/LM	16.0	16.0	
Shotcrete		quality	cSCQ4				C25/30

Figure 88: EXCEL input for temporary invert – Input step 1

	invert surface of the top heading (temporary)	type	cSCT4				1 Shotcrete
		thickness	SCT4	m			0.200
		number of layers	iSCN4				1
		flat view length <0 = horizontal length>	SCL4	m			8.200
		change of top evaluaton area	CHEVT	m²			2.700
		change of bench evaluaton area	CHEVB	m²			-2.700
		change of top excavation area	CHXT	m²			2.700
		calotte toe	SCCW	m³/LM	16.0	16.0	
Shotcrete		quality	cSCQ4				C25/30

Figure 89: EXCEL input for temporary invert – Input step 2

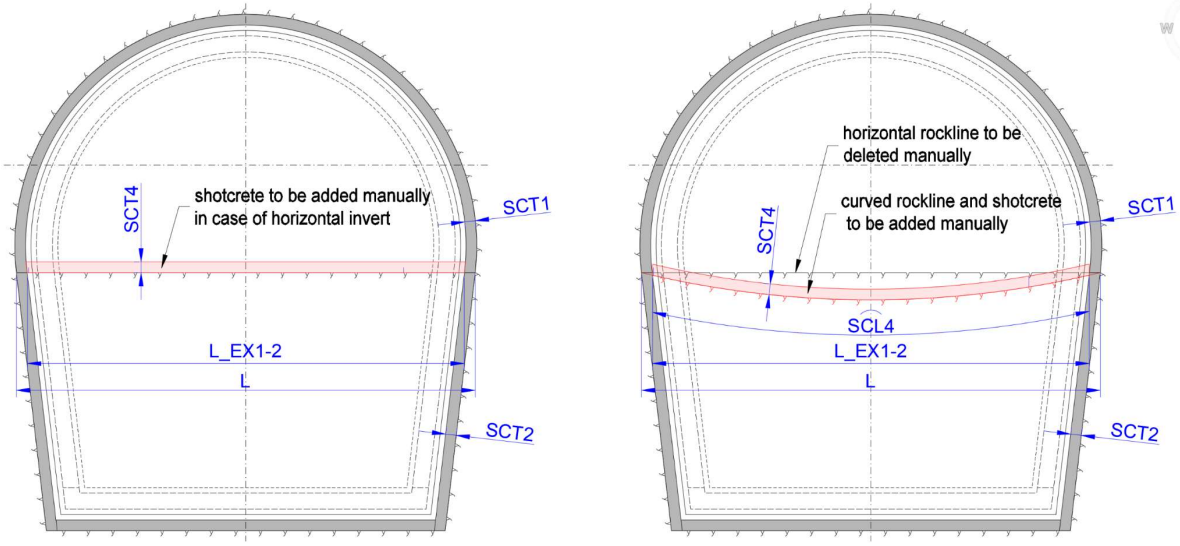
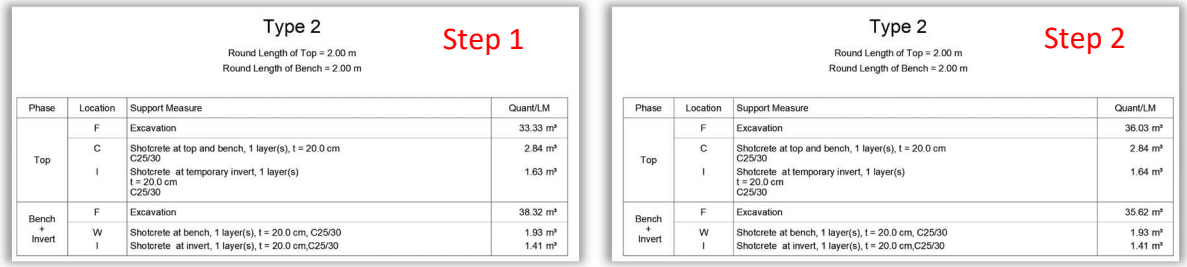


Figure 90: Cross section output on drawing – Shotcrete at temporary invert



Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Step 1

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	33.33 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
	I	Shotcrete at temporary invert, 1 layer(s) t = 20.0 cm C25/30	1.63 m³
Bench + Invert	F	Excavation	38.32 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Step 2

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	36.03 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
	I	Shotcrete at temporary invert, 1 layer(s) t = 20.0 cm C25/30	1.64 m³
Bench + Invert	F	Excavation	35.62 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³

Figure 91: Table output on drawing – Shotcrete at temporary invert

5.1.8 Concrete slab

A concrete slab is not part of the initial support. However, in order to be compatible with AFRY Bangkok style for initial support, input and display of a concrete floor slab is enabled in **ROSUC**.

Concrete slab	thickness	CST	m		0.300
	quality	cCSQ			C25/30

Figure 92: EXCEL input - Concrete slab

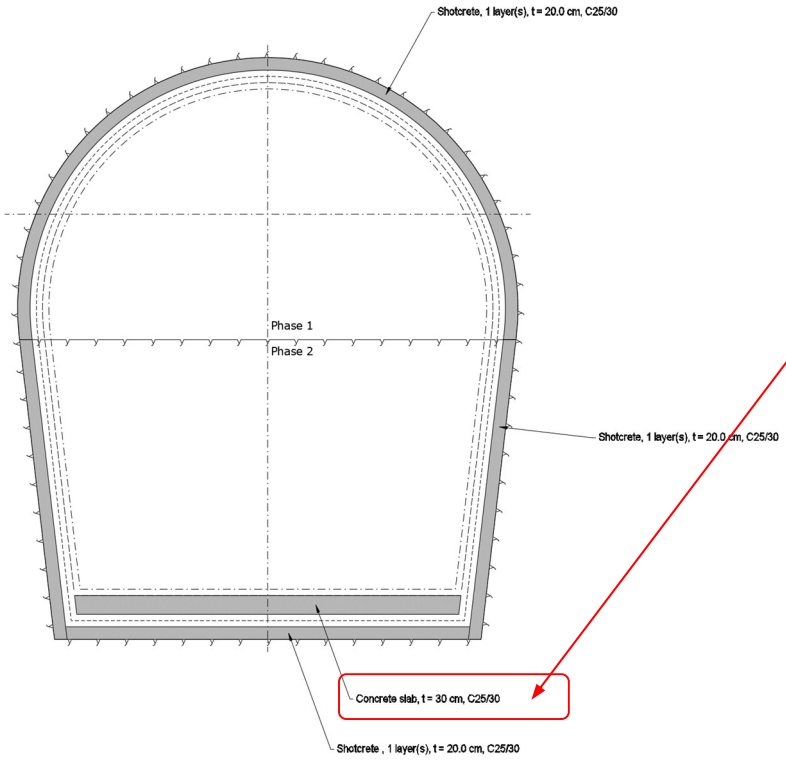


Figure 93: Cross section output on drawing - Concrete slab

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	29.12 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.65 m³
Bench + Invert	F	Excavation	35.42 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.29 m³
	I	Concrete slab, t = 30 cm, C25/30	1.84 m³

Figure 94: Table output on drawing - Concrete slab

5.1.9 *Inner Lining*

Inner lining is not part of the initial support. Therefore it is not shown in the table blow the cross section.

Lining	thickness at top and bench	LT1	m		0.300
	thickness at invert	LT3	m		0.250

Figure 95: Input for lining

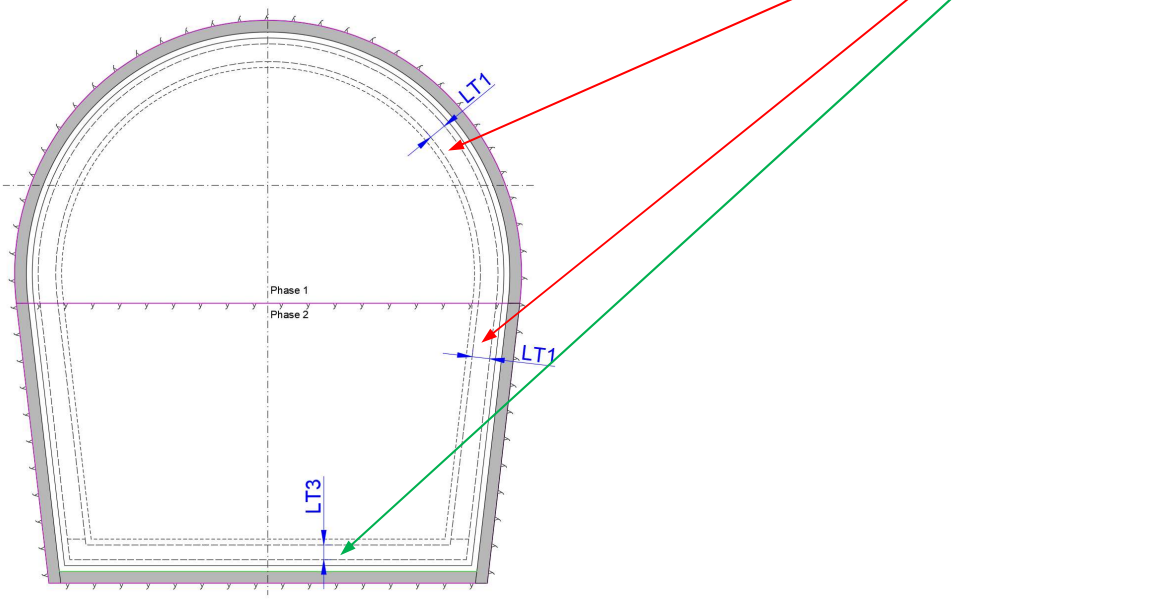


Figure 96: Cross section output on drawing – Inner lining

5.1.10 Rock bolts

Rock bolts	top & bench		number of rock bolts	iRBN1				18
			staggered					YES
	top		type	cRBT1				2 Grouted ancho
			diameter	iRBD1	mm			25
			length	RBL1	m			2.500
			transversal spacing	RBST1	m			1.000
			longitudinal spacing <empty = RL1>	RBSL1	m			1.000
			yield strength	iRBFY1	N/mm²			550
	bench		type	cRBT2				3 Self drilling an
			diameter	iRBD2	mm			30
			length	RBL2	m			3.000
			transversal spacing	RBST2	m			1.500
			longitudinal spacing <empty = RL2>	RBSL2	m			1.000
			yield strength	iRBFY2	N/mm²			550
	invert		number of rock bolts	iRBN3				7
			staggered					YES
			type	cRBT3				2 Grouted ancho
			diameter	iRBD3	mm			25
			length	RBL3	m			2.500
			transversal spacing	RBST3	m			0.750
			longitudinal spacing	RBSL3	m			1.000
			yield strength	iRBFY3	N/mm²			550
	tunnel face (or shaft floor)	face bolts	number	iTFBN	pcs			8
			type	cTFBT				2 Pipe friction an
			length	TFBL	m			2.400
		anchor plates	without load distributor	iTFBW	pcs	1.7	1.7	8
			with load distributer	iTFBO	pcs	3.4	3.4	

Figure 97: EXCEL input for rock bolts

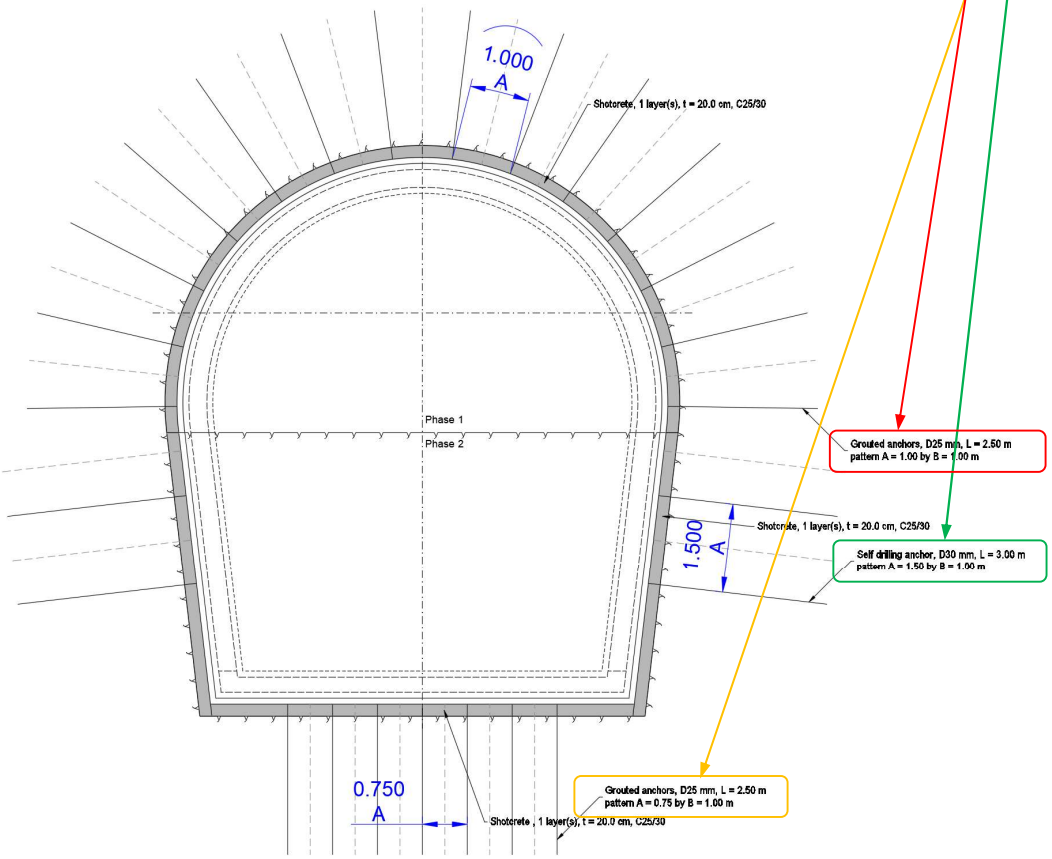


Figure 98: Cross section output on drawing – rockbolts

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	33.33 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
	C	Systematic rock bolting, mortared anchors, 13.5 pcs, D = 25 mm fy = 550, N/mm², L = 2.50 m, pattern A = 1.00 by B = 1.00 m	33.75 m
	F	Tunnel face, pipe friction anchors, 8 pcs, L = 2.40 m	4.00 pcs
	F	Tunnel face: placing of 8 anchor plates without pre-stressing	4.00 pcs
Bench + Invert	F	Excavation	37.95 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.91 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³
	W	Systematic rock bolting, mortared anchors, 4.0 pcs, D = 30 mm fy = 550, N/mm², L = 3.00 m, pattern A = 1.50 by B = 1.00 m	12.00 m
	I	Systematic rock bolting, mortared anchors, 6.5 pcs, D = 25 mm fy = 550, N/mm², L = 2.50 m, pattern A = 0.75 by B = 1.00 m	16.25 m

Figure 99: Table output on drawing - Rockbolts

For cross sections type 11 through 14 (shaft cross sections) either number of rock bolts RBN1 or rock bolt spacing RBST1 shall be entered.

5.1.11 Spot bolts

	type	cSBT			1 Pipe friction ar
	diameter	iSBD	mm		25
	length	SBL	m		2.400
Spot bolts	distance at left side from crown	SBDL	m		2.000
	distance at right side from crown	SBDR	m		3.000
	longitudinal spacing	SBSL	m		2.000
	yield strength	iSBFY	N/mm²		550

Figure 100: EXCEL input for spot bolts

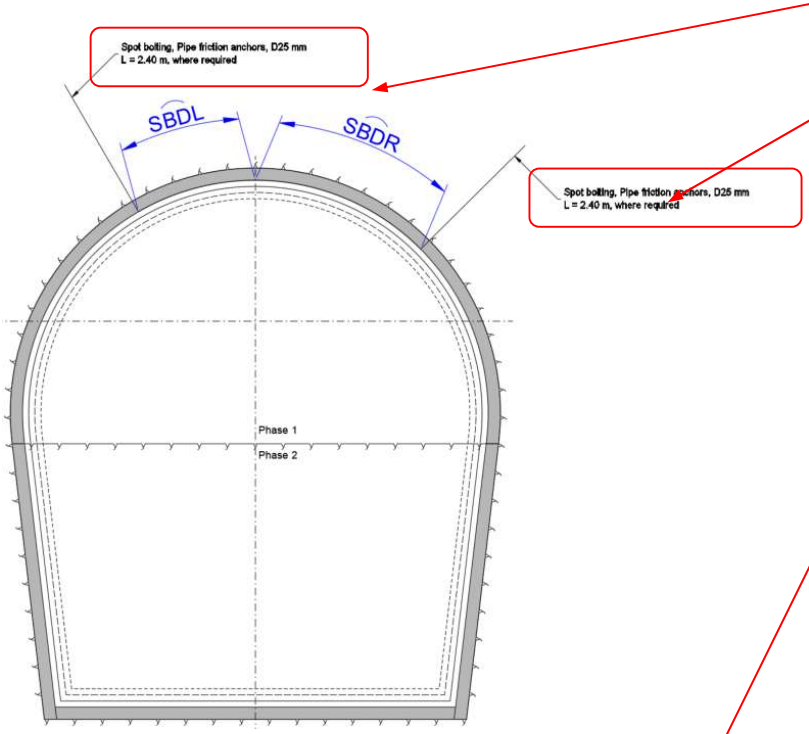


Figure 101: Cross section output on drawing – spot bolts

Type 2

Round Length of Top = 2.00 m

Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	29.12 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.65 m³
	C	Spot bolting, pipe friction anchors, 2 pcs, D25 mm fy = 550, N/mm², L = 2.40 m, B = 2.00 m, where required	2.40 m
Bench + Invert	F	Excavation	33.36 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.81 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.30 m³

Figure 102: Table output on drawing - Spot bolts

5.1.12 *Spiles*

Spiles	type		cPLT		3 Mortared spile
	number		iPLN		30
	shift of iPLN_SH anchor from the left to the right side of the centerline		iPLN_SH		
	diameter		iPLD	mm	25
	length		PLL	m	5.000
	center line spacing		PLS	m	0.300
	offset from excavation line	<empty = 0.150>	PLO	m	
	yield strength		iPLQ	N/mm^2	550

Figure 103: EXCEL input for spiles

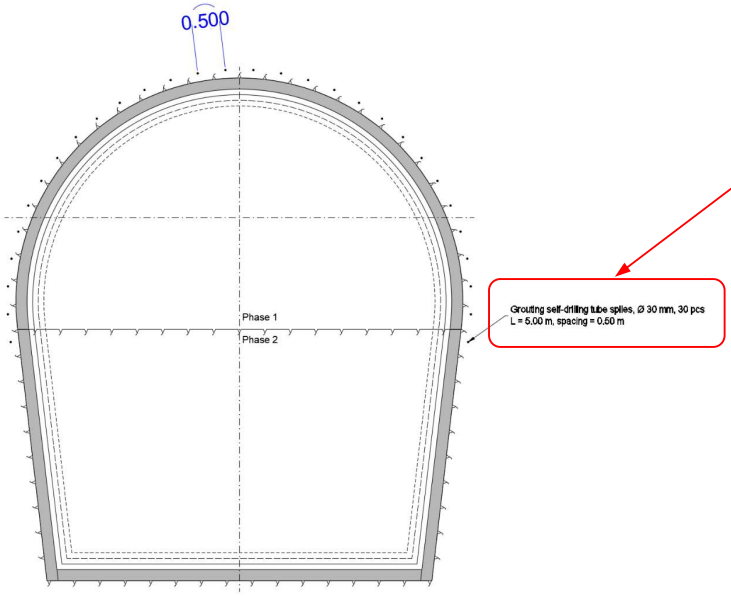


Figure 104: Cross section output on drawing – spiles

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	29.12 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.65 m³
	F	Grouted self-drilling tube spiles, 28 pcs, D30 mm, fy = 550 N/mm² L = 5.00 m, spacing = 0.50 m	70.00 m
Bench + Invert	F	Excavation	33.36 m³
	W I	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30 Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.81 m³ 1.30 m³
	F	Grouted self-drilling tube spiles, 2 pcs, D30 mm, fy = 550 N/mm² L = 5.00 m, spacing = 0.50 m	5.00 m

Figure 105: Table output on drawing - Spiles

For cross sections type 11 through 14 (shaft cross sections) either number of spiles iPLN or spile spacing PLS shall be entered.

5.1.13 Forepoling plates

The forepoling flat view length shown in the cross section is calculated at:

- number of forepoling plates required for FPOL times FPOS.

Forepoling plates	flat view length in cross section plane	FPOT	m	9.0	5.5	8.000
	shift of FPOL_SH anchor from the left to the right side of the centerline	FPOT_SH				
	length	FPOL	m			6
	center line spacing <empty = 0.220>	FPOS	m			
	offset from excavation line <empty = 0.150>	FPOO	m			
	type (empty = default text)	cFPOT				

Figure 106: EXCEL input nput for forepoling plates

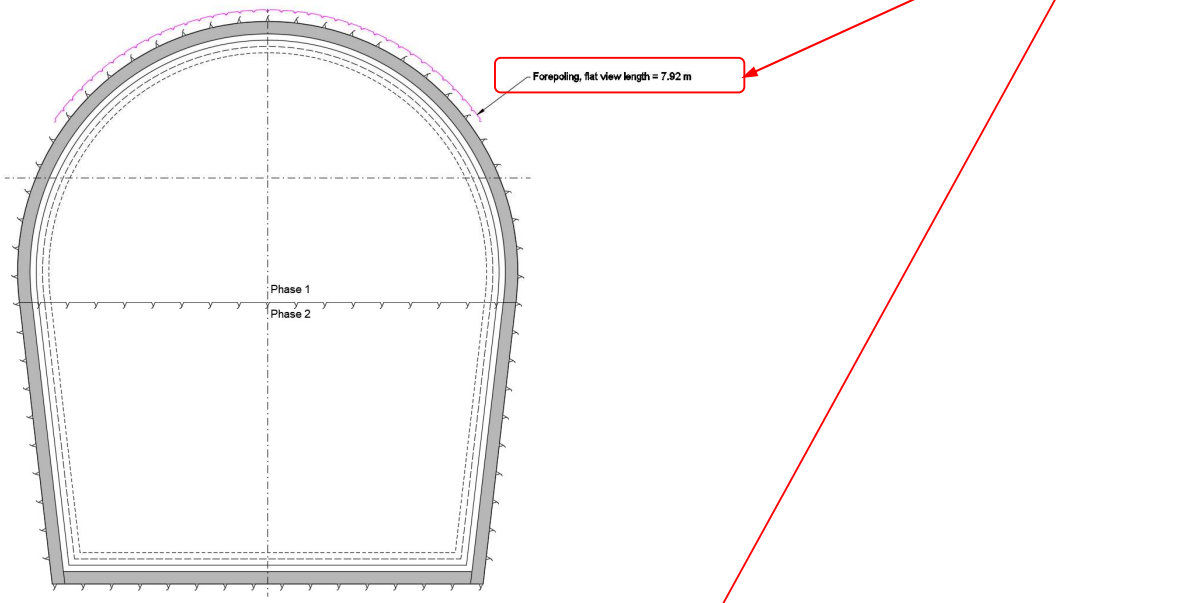


Figure 107: Cross section output on drawing – forepoling plates

Type 2

Round Length of Top = 2.00 m

Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	29.12 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.65 m³
	F	Forepoling, plate length = 6.00 m	24.42 m²
Bench + Invert	F	Excavation	33.36 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.81 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.30 m³

Figure 108: Table output on drawing - Forepoling plates

For cross sections type 11 through 14 (shaft cross sections) the flat view length FPOT shall be set to a value greater than 0 (for example 1.000).

5.1.14 *Foundation piles*

Stay sills	type	cSST		4.5	4.5	2 Grouted anchc
	number of stay sills	SSN				4
	shift of SSN_SH stay sills from the left to the right side of the centerline	iSSN_SH				
	staggered staggered stay sills					YES
	diameter	iSSD	mm			25.000
	length	SSL	m			3.000
	transversal spacing	SSST	m			1.250
	longitudinal spacing	SSSL	m			1.500

Figure 109: EXCEL input nput for foundation piles

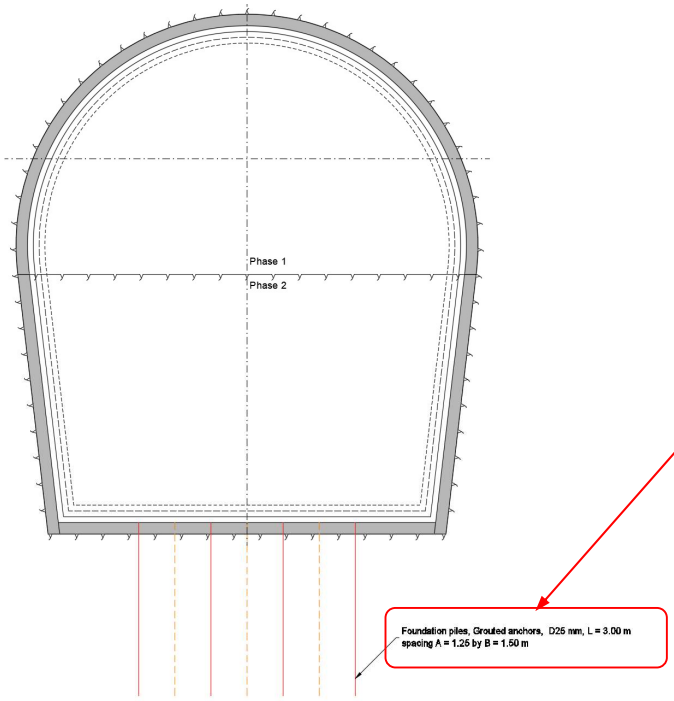


Figure 110: Cross section output on drawing – foundation piles

Type 2

Round Length of Top = 2.00 m

Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	29.12 m³
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.65 m³
Bench + Invert	F	Excavation	33.36 m³
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.81 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.30 m³
	I	Stay sills Grouted anchors, D25 mm, 3.5 pcs L = 3.00 m, spacing A = 1.25 by B= 1.50 m	7.00 m

Figure 111: Table output on drawing – Forepoling

5.1.15 *Steel ribs*

Steel ribs	top	type		cSRT1			1 Latice girders
		longitudinal spacing	<empty = RL1>	SRL1	m		
	bench	type		cSRT2			1 Latice girders
		longitudinal spacing	<empty = RL2>	SRL2	m		
	invert	type		cSRT3			1 Latice girders
		longitudinal spacing		SRL3	m		2.000

Figure 112: EXCEL input nput for steel ribs

Steel ribs are not show in the cross section.

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	33.33 m³
	C	Latice girders, spacing B = 2.00 m	6.94 m
	C	Wire mesh at mountain side with steel ribs, type AQ 50, 1 layer(s)	13.88 m²
	C	Wire mesh at cavity side with steel ribs, type AQ 60, 1 layer(s)	13.88 m²
	C	Additional bar-reinforcement at top, 10.00 kg/LM tunnel	10.00 kg
	F	Wire mesh at tunnel face, type AQ 100, 1 layer(s), 75% of tunnel face	25.00 m²
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
	F	Shotcrete at tunnel face, t = 10 cm 75 % of tunnel face, C25/30	1.25 m³
Bench + Invert	F	Excavation	38.32 m³
	W	Latice girders, spacing B = 2.00 m	4.83 m
	I	Latice girders, spacing B = 2.00 m	3.53 m
	W	Wire mesh at mountain side with steel ribs, type AQ 70, 1 layer(s)	9.66 m²
	W	Wire mesh at cavity side with steel ribs, type AQ 80, 1 layer(s)	9.66 m²
	I	Wire mesh at invert, type AQ 90, 1 layer(s)	7.07 m²
	I	Additional bar-reinforcement at invert, 5.00 kg/LM tunnel	5.00 kg
	I	Pre-fabricated system connection at invert, 4.00 m/LM tunnel	4.00 m
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³

Figure 113: Table output on drawing - Steel ribs

5.1.16 Wire mesh

Reinforcement (wire mesh)	top	mountain side with steel ribs	type	cWM1T		1.0	1.0	AQ 50
			no. of layers	iWM1N				1
		cavity side with steel ribs	type	cWM2T		1.0	1.0	AQ 60
			no. of layers	iWM2N				1
		mountain side without steel ribs	type	cWM3T		2.0	2.0	
			no. of layers	iWM3N				
		invert surface of the top heading (temporary)	type	cWM4T		0.8	0.8	
			no. of layers	iWM4N				
		additonal reinforcement (bar steel)		WADB1	kg/LM tunnel	2.2	2.2	10.000
		system connection (prefabricated)		WADS1	m/LM	1.0	1.0	
	bench	mountain side with steel ribs	type	cWM5T		1.0	1.0	AQ 70
			no. of layers	iWM5N				1
		cavity side with steel ribs	type	cWM6T		1.0	1.0	AQ 80
			no. of layers	iWM6N				1
		mountain side without steel ribs	type	cWM7T		2.0	2.0	
			no. of layers	iWM7N				
		additonal reinforcement (bar steel)		WADB2	kg/LM tunnel	2.2	2.2	
		system connection (prefabricated)		WADS2	m/LM	1.0	1.0	
	invert	reinforcement	type	cWM8T		0.8	0.8	AQ 90
			no. of layers	iWM8N				1
		additonal reinforcement (bar steel)		WADB3	kg/LM tunnel	2.2	2.2	5.000
		system connection (prefabricated)		WADS3	m/LM	1.0	1.0	4.000
	tunnel face (or shaft floor)	reinforcement	type	cWM9T		2.2	1.7	AQ 100
			no. of layers	iWM9N				1
			percent of tunnel face	iWM9P	%			75%
		additonal reinforcement (bar steel)		WADB4	kg/round	2.2	2.2	
		system connection (prefabricated)		WADS4	m/round	1.0	1.0	

Figure 114: EXCEL input nput for wire mesh

Wire mesh is not show in the cross sections.

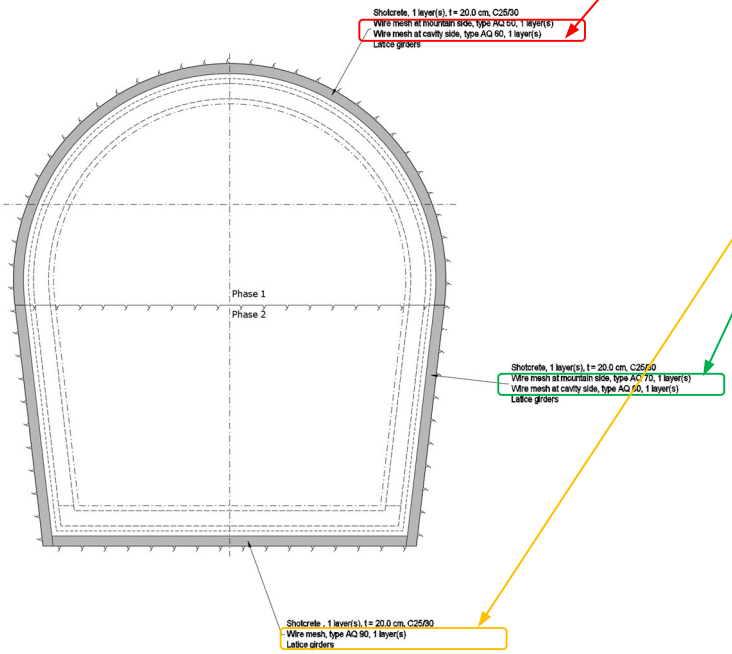
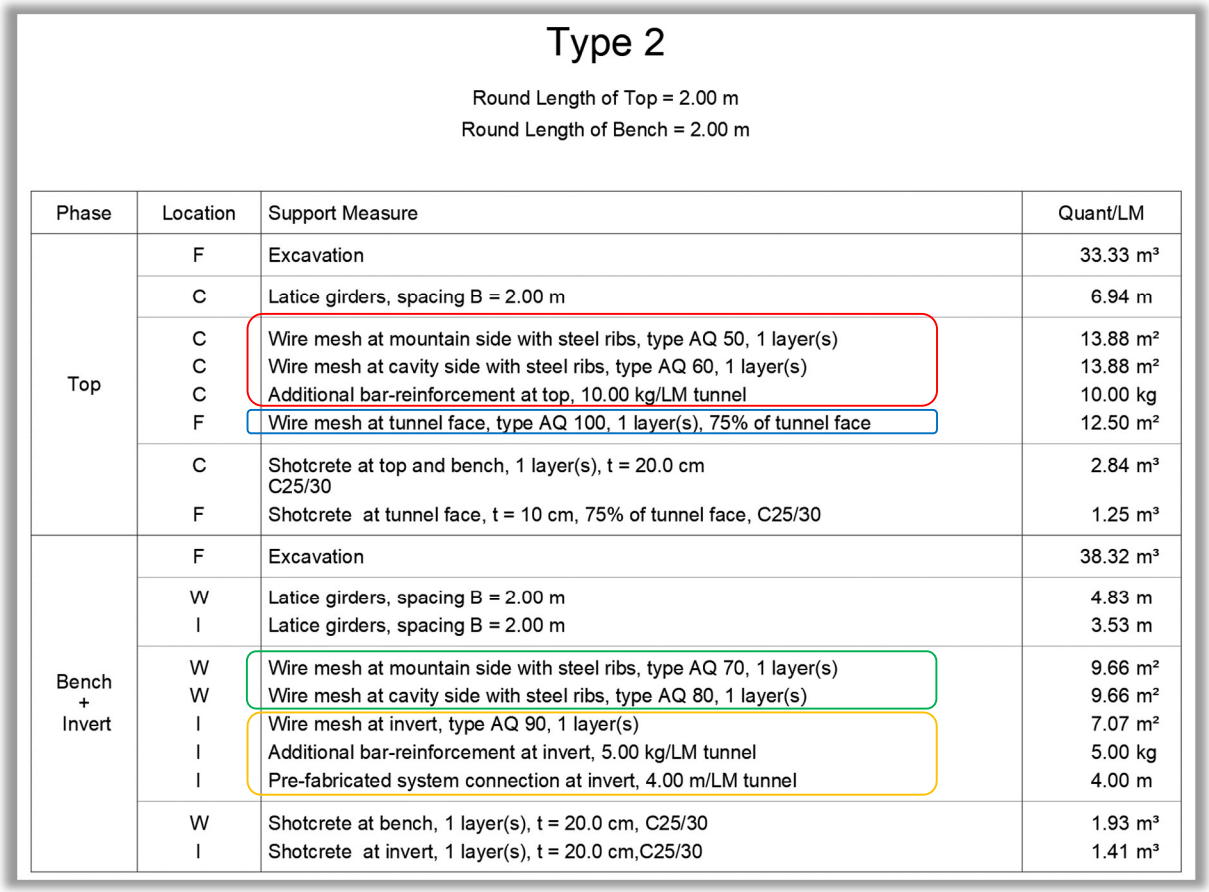


Figure 115: Cross section output on drawing – Wire mesh

Amount of wire mesh at top and/or bench and/or invert is based on shotcrete surface area and number of wire mesh layers.



Type 2

Round Length of Top = 2.00 m

Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	33.33 m³
	C	Latice girders, spacing B = 2.00 m	6.94 m
	C	Wire mesh at mountain side with steel ribs, type AQ 50, 1 layer(s)	13.88 m²
	C	Wire mesh at cavity side with steel ribs, type AQ 60, 1 layer(s)	13.88 m²
	C	Additional bar-reinforcement at top, 10.00 kg/LM tunnel	10.00 kg
	F	Wire mesh at tunnel face, type AQ 100, 1 layer(s), 75% of tunnel face	12.50 m²
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
	F	Shotcrete at tunnel face, t = 10 cm, 75% of tunnel face, C25/30	1.25 m³
Bench + Invert	F	Excavation	38.32 m³
	W	Latice girders, spacing B = 2.00 m	4.83 m
	I	Latice girders, spacing B = 2.00 m	3.53 m
	W	Wire mesh at mountain side with steel ribs, type AQ 70, 1 layer(s)	9.66 m²
	W	Wire mesh at cavity side with steel ribs, type AQ 80, 1 layer(s)	9.66 m²
	I	Wire mesh at invert, type AQ 90, 1 layer(s)	7.07 m²
	I	Additional bar-reinforcement at invert, 5.00 kg/LM tunnel	5.00 kg
	I	Pre-fabricated system connection at invert, 4.00 m/LM tunnel	4.00 m
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³

Figure 116: Table output on drawing - Wire mesh

5.1.17 *Deformation gaps*

Deformation gaps	without compression element	number	iDGN1		4.5	3.5	6
		shift of iDGN1_SH deformation gaps from the left to the right side of the centerline	iDGN1_SH				
		distance	DGD1	m			3.500
		width	DGW1	m			0.100
		text (empty = default text)	cDGT1				
	with compression element	number	iDGN2		13.0	10.0	
		shift of iDGN2_SH deformation gaps from the left to the right side of the centerline	iDGN2_SH				
		distance	DGD2	m			
		width	DGW2	m			
		text (empty = default text)	cDGT2				

Figure 117: EXCEL input for deformation gaps

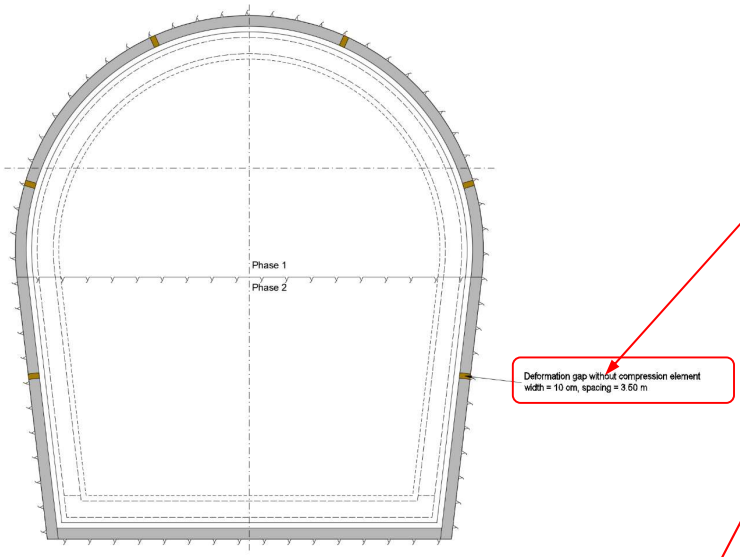


Figure 118: Cross section output on drawing – Deformation gaps

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	33.33 m³
	C	Deformation gap without compression element at top, 4 pcs spacing = 3.50 m, width = 10 cm	4.00 m
	C	Shotcrete at top and bench, 1 layer(s), t = 20.0 cm C25/30	2.84 m³
Bench + Invert	F	Excavation	38.32 m³
	W	Deformation gap without compression element at bench, 2 pcs spacing = 3.50 m, width = 10 cm	2.00 m
	W	Shotcrete at bench, 1 layer(s), t = 20.0 cm, C25/30	1.93 m³
	I	Shotcrete at invert, 1 layer(s), t = 20.0 cm,C25/30	1.41 m³
	I	Stay sills Grouted anchors, D25 mm, 3.5 pcs L = 3.00 m, spacing A = 1.25 by B= 1.50 m	7.00 m

Figure 119: Table output on drawing - Deformation gaps

5.1.18 *Drainage holes*

Draingage holes	distance at left side from crown	DHDL	m	2.000
	distance at right side from crown	DHDR	m	3.000
	length	DHL	m	2.500
	longitudinal spacing	DHSL	m	4.000

Figure 120: EXCEL input for drainholes

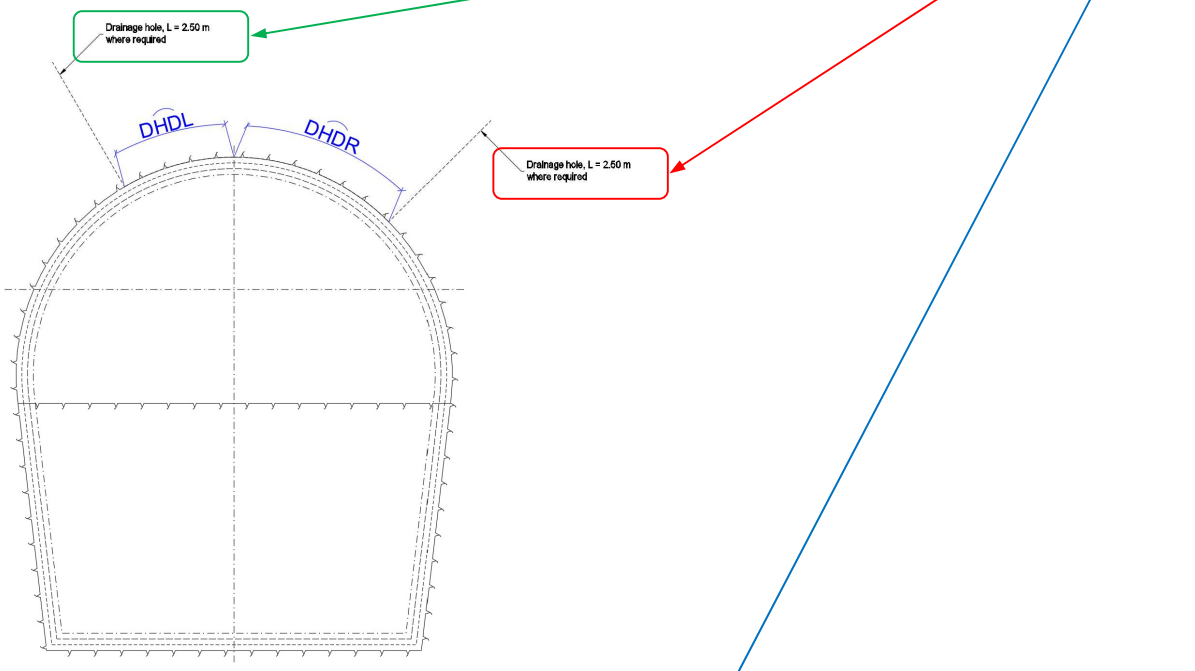


Figure 121: Cross section output on drawing – Drainholes

Type 2

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	26.47 m³
	C	Drainage holes, L = 2.50 m, B = 4.00 m, where required	1.25 m
Bench + Invert	F	Excavation	30.25 m³

Figure 122: Table output on drawing – Drainholes

5.1.19 *Grouting*

Grouting of more then 10 kg per bolt, spile or stay sill	top	weight	GRW1	kg/LM tunnel	0.1	0.1	12.000
		text (empty = default text)	cGRT1				
	bench	weight	GRW2	kg/LM tunnel	0.1	0.1	14.000
		text (empty = default text)	cGRT2				
	bench	weight	GRW3	kg/LM tunnel	0.1	0.1	16.000
		text (empty = default text)	cGRT3				

Figure 123: EXCEL input for grouting of bolts, spiles or stay sills

Grouting is not shown ion the drawing.

Type 4

Round Length of Top = 2.00 m
Round Length of Bench = 2.00 m

Phase	Location	Support Measure	Quant/LM
Top	F	Excavation	24.57 m³
	C	Grouting beyond 10 kg per meter of anchors spiles and foundation piles, 12.00 kg/LM tunnel	12.00 kg
Bench + Invert	F	Excavation	31.45 m³
	W	Grouting beyond 10 kg per meter of anchors spiles and foundation piles, 14.00 kg/LM tunnel	14.00 kg
	I	Grouting beyond 10 kg per meter of anchors spiles and foundation piles, 16.00 kg/LM tunnel	16.00 kg

Figure 124: Table output on drawing - Grouting result

5.2 SETTING sheet

Default values such as:

- Layer names to be used in the templated drawing
- Hatch colors
- Vertical location of plan view, tables etc. on drawings
- Default distances for spiles and forepoling sheets from the excavation surface
- Text sizes
- Standard table column widths increase or decrease

can be amended on this page

5.3 TEXT sheet

Standard texts in German and English are defined on the TEXT sheet for the labeling of cross-sections and tables. The standard text can be adapted to suit the specific project. However, no rows or columns may be inserted or deleted.

The variables shown in **Error! Reference source not found.** can be inserted according to following rules:

For example using the values taken from 5.1.10

cRBT1	= 2 Grouted anchors	…	type of rock bolt
iRBD1	= 25	…	diameter of rock bolt
RBL1	= 2.500	…	length of rock bolt
RBST1	= 1.000	…	transversal spacing of rock bolts
RBSL1	= 1.000	…	longitudinal spacing of rock bolts
iRBFY1	= 550	…	yield strength of rock bolt

and following text (see for example sheet TEXT, cell B188)

#cRBT1#, D#iRBD1# mm, L = #RBL1# m\pattern A = #RBST1# by B = #RBSL1# m

will results in

Grouted anchors, D25 mm, L = 2.50 m
pattern A = 1.00 by B = 1.00 m

to be plotted on drawing based on notation shown below:

%%c	…	Autocad notation for Ø symbol
\	…	a backslash causes a line break
#iRBD1#	…	variables enclosed on both sides with # can be imported into text. • a variable starting with lower case i is deemed to be an integer value • a variable starting with lower case c is deemed to be a charcter string (text) • all other variables are deemed to be of type real value with default format “0.00” (2 decimal places).
#RBL1#	…	real value with default format “0.00”.
#RBL1:0.000#	…	real value with format “0.000”

If a variable referres to a drop down menu like cRBT1, then the corresponding text is defined on the MAIN_CYCLIC sheet.

5.4 DROP-DOWN sheet

This sheet defines the dropdown menu for the support measures such as shotcrete types, rock bolt types, spile types, steel rib types, etc., in English or German.

5.5 MENU sheet

The text (English or German) displayed on the MAIN_CYCLIC sheet is defined on the MENU sheet.