Symposium on New Techniques for Design and Construction in Soft Clays.

Vacuum consolidation
The environmental friendly consolidation of very soft poluted mud at the AIRBUS A-380 factory site

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Chairman TC221

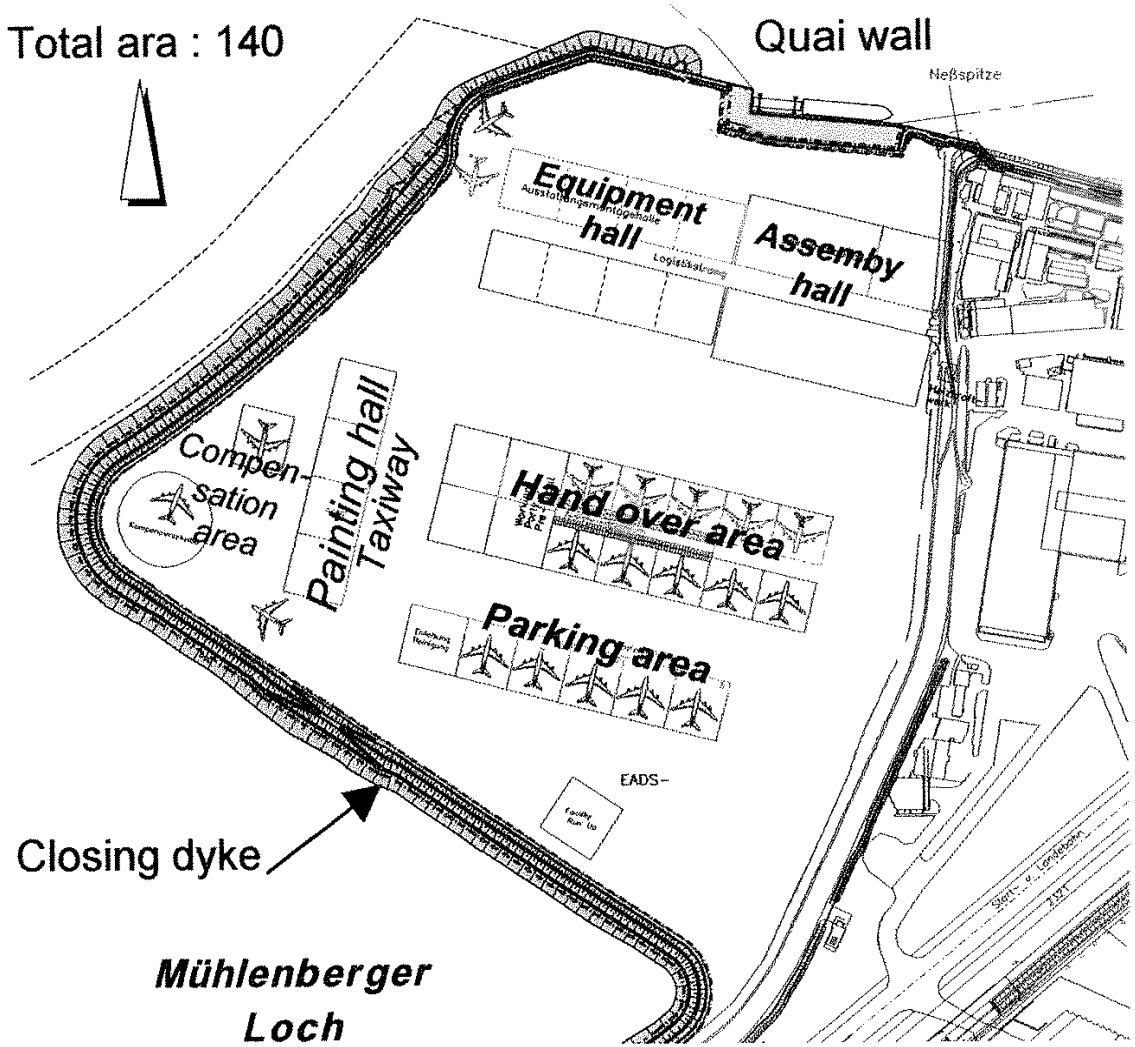

A380
A380


Aireal view of the site

Case history – Hambourg (Germany) – 2002/2003

General overview of Airbus site

General site layout

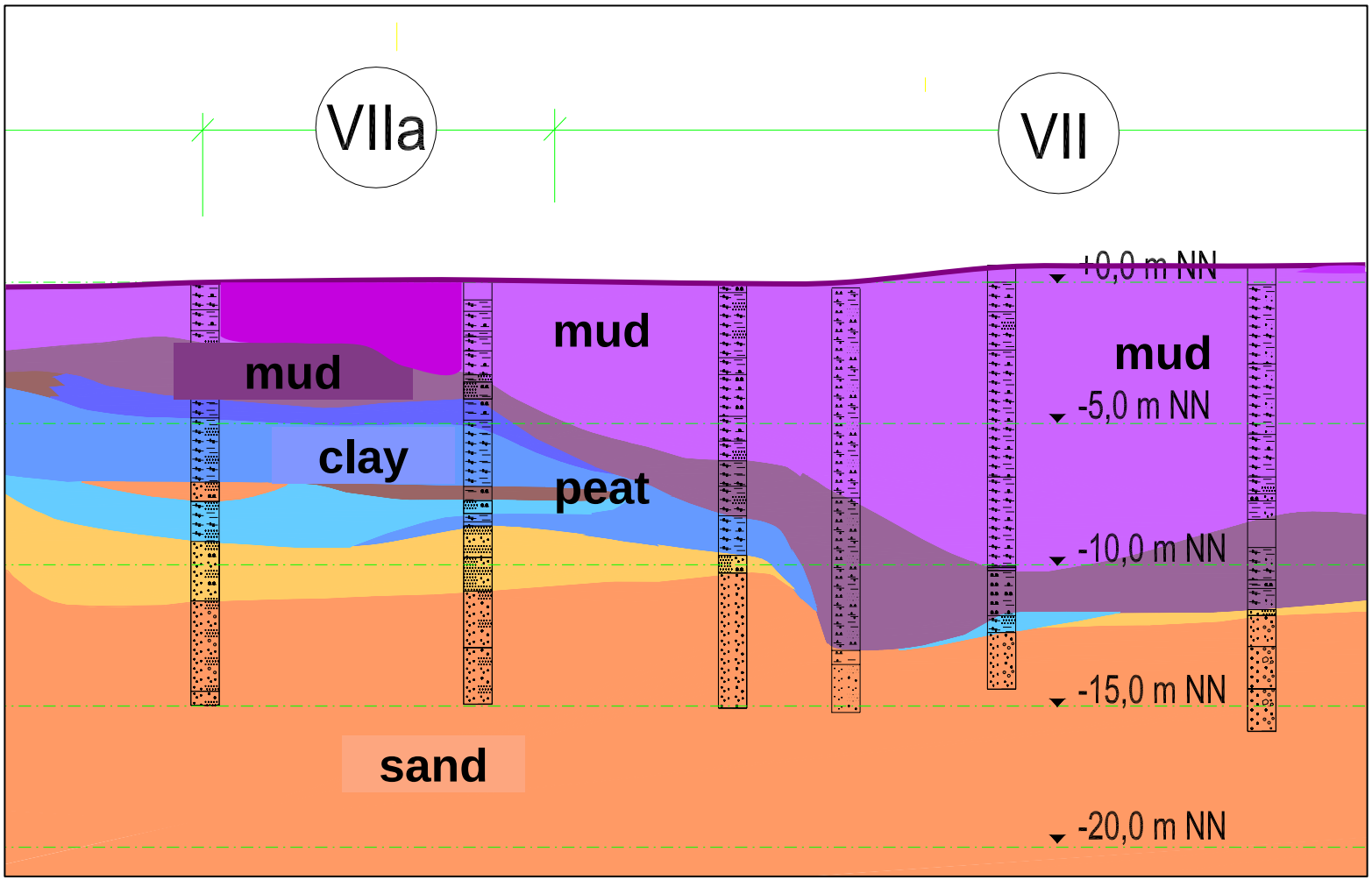


Case history – Hambourg (Germany) – 2002/2003

So etwa wird das neue Airbus-Gelände auf Finkenwerder von Süden her aussehen. Für die Erweiterung des Werks müssen 140 Hektar des Mühlenberger Lochs aufgeschüttet werden. Das entspricht etwa einem Fünftel dieses einzigartigen Süßwasserwatts und verdoppelt die Fläche des bestehenden Airbus-Werks. Der Bau der ersten Halle beginnt im Novembe

General overview of Airbus site

Geological profile

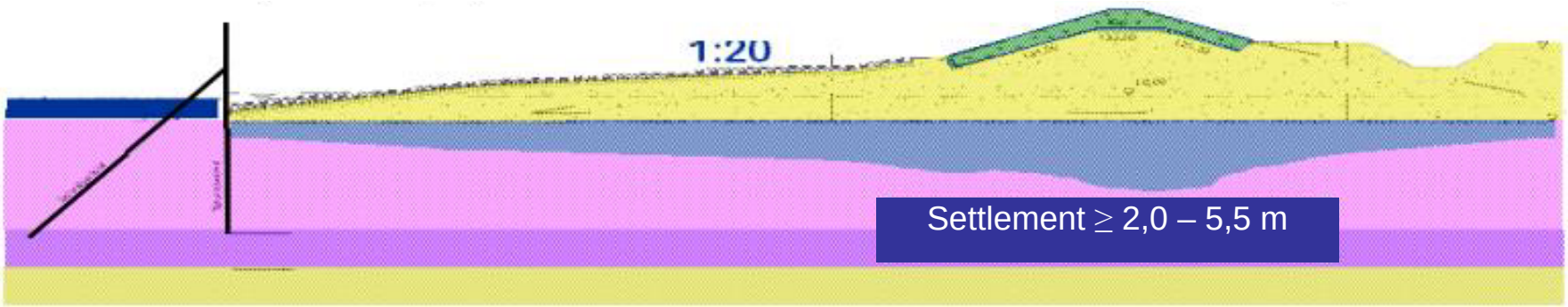


Subsoil characteristics

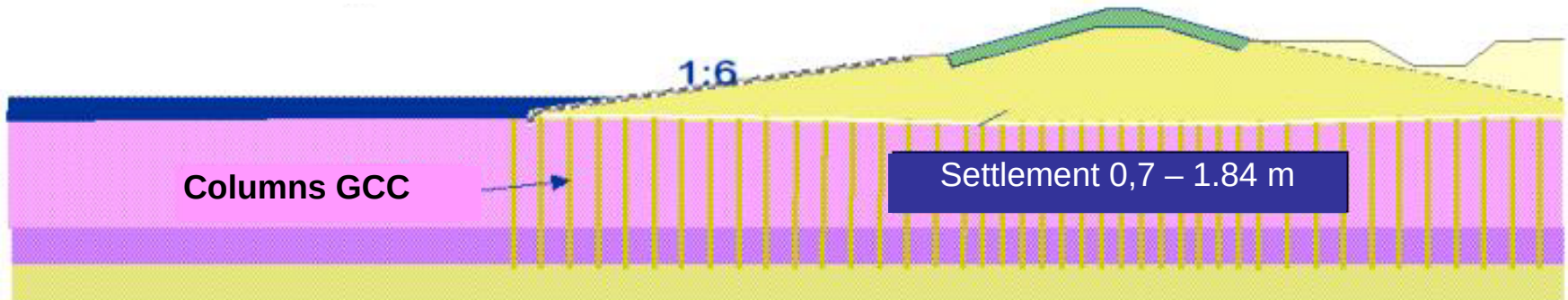
Soil type	Water content	Density	Shear strength		Deformation Modulus (under σ_z = 100 kN/m²)	Coefficient of consolidation	Coefficient of secondary consolidation
	W (%)	γ/γ' – kN/m³	$\delta'(°)/c'$ (kN/m²)	C_u (kN/m²)	E_S (MN/m²)	C_V (m²/year)	$C\alpha$ (-)
Mud	142	13/3	20/0	0.5-5	0.8	0.35	0.03
Young clay	119	14/4	20/0	2-10	0.9	0.35	0.03
Clay	70	15/5	17.5/10	5-20	1.5	0.5	0.02
Peaty clay	139	14/4	20/5	5-20	0.9	0.4	0.03
Peat	240	11/1	20/0	5-15	0.5	$\geq$ 0.4	0.04

Basic design and alternate concept of Moebius–Menard

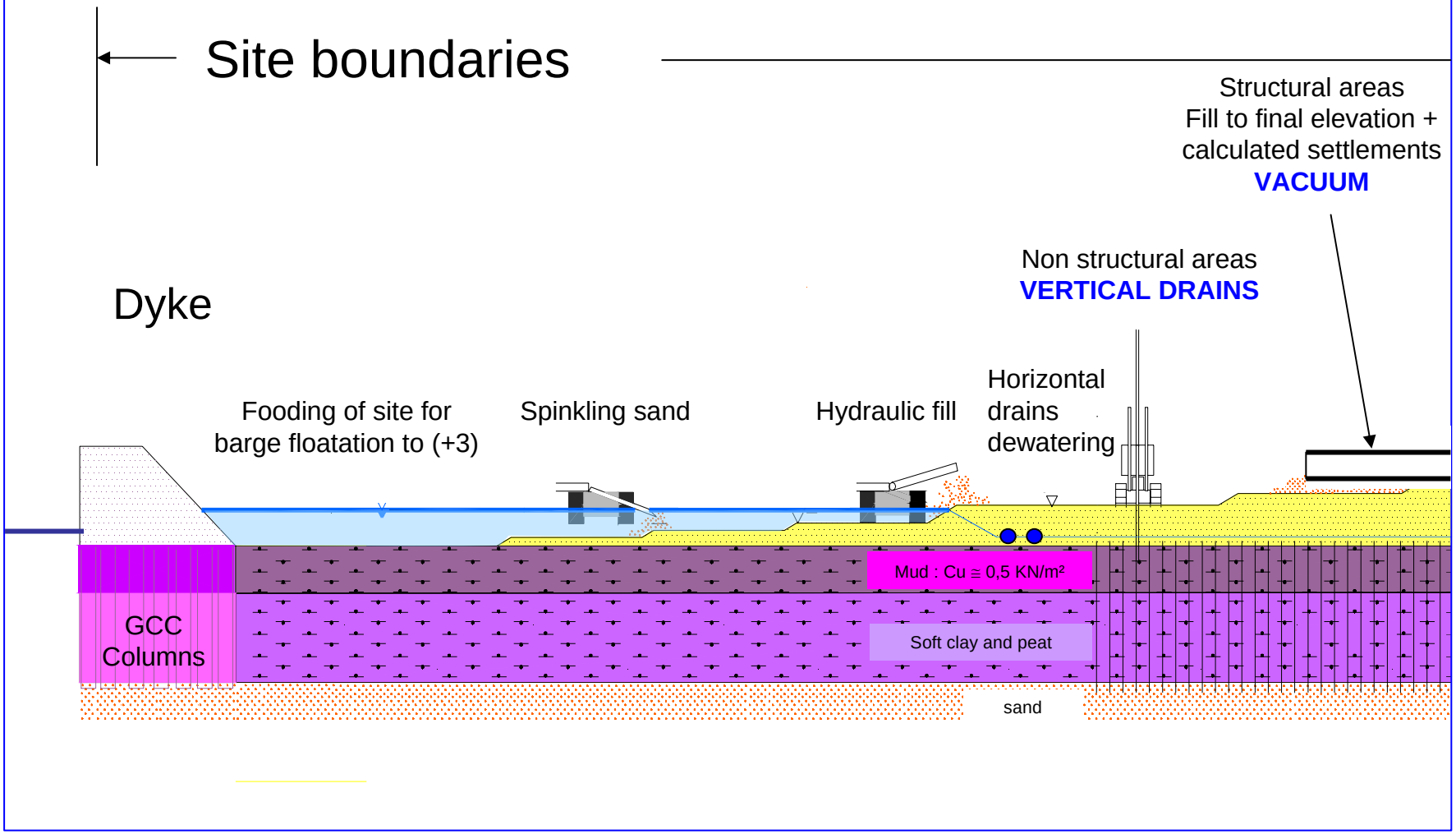
Temporary sheet pile wall – in 5 month – dyke construction in 3 years



Dyke construction to +6.5 in 8.5 month and to + 9.00 in 16 month



Site boundaries



Dyke construction for the polder formation

EADS
Airbus A380

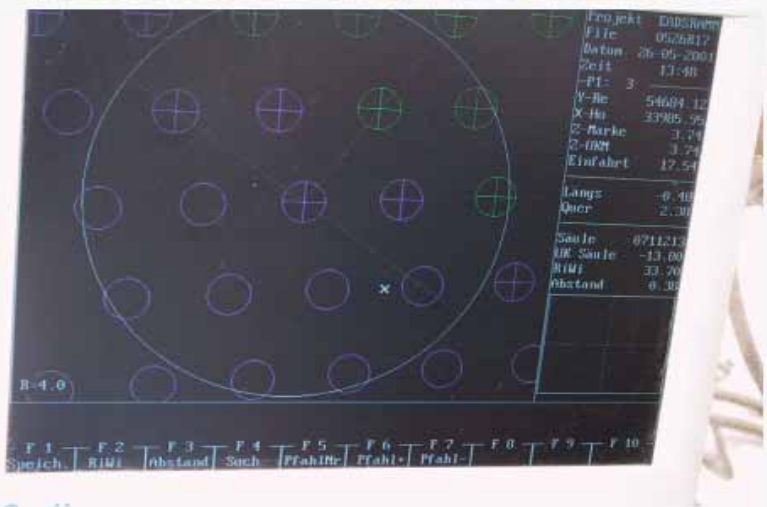
View before works

Lot 1 : Dyke construction

Case history – Hambourg (Germany) – 2002/2003

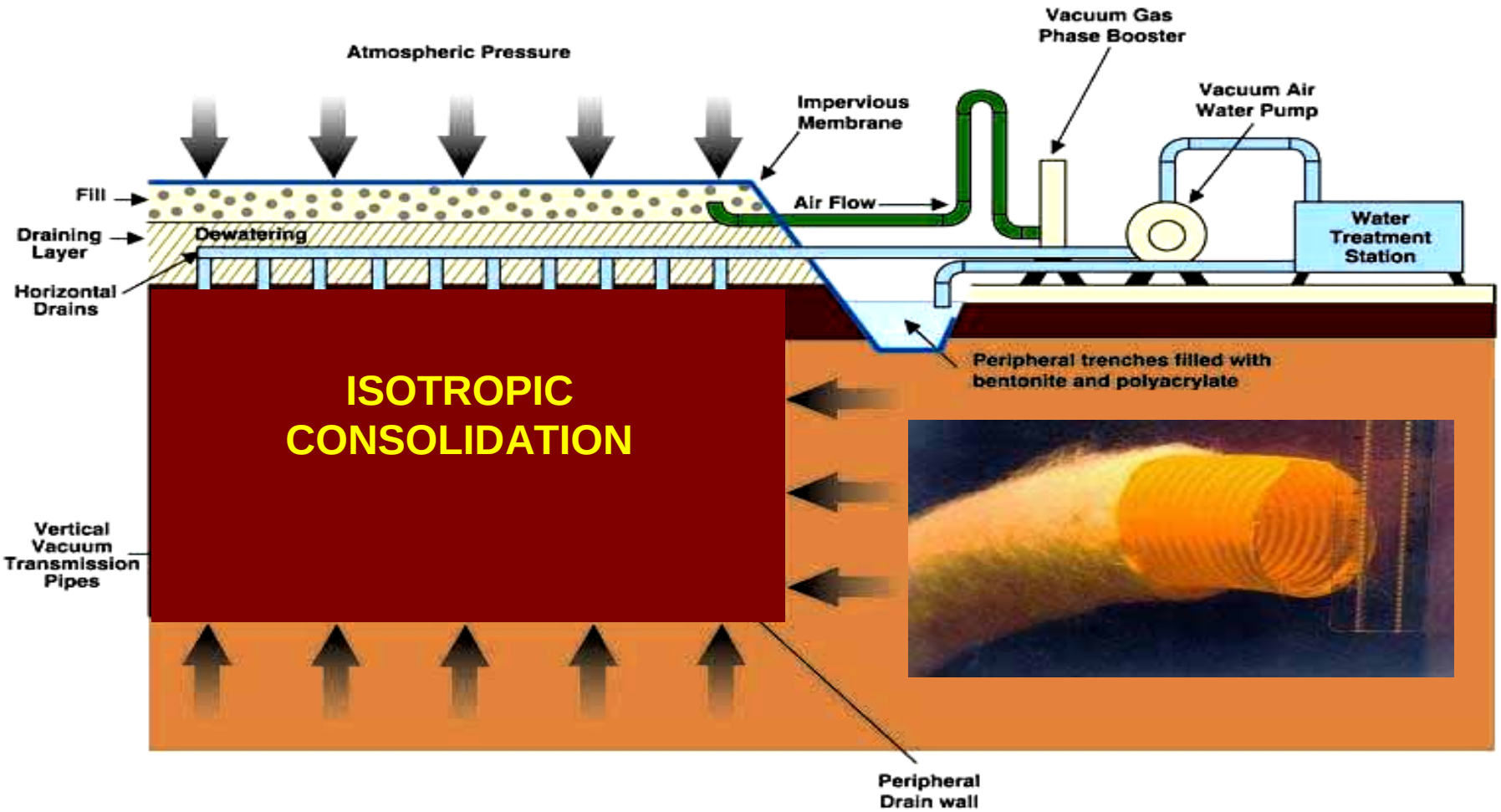
How to move on the mud !

G.C.C. Installation process

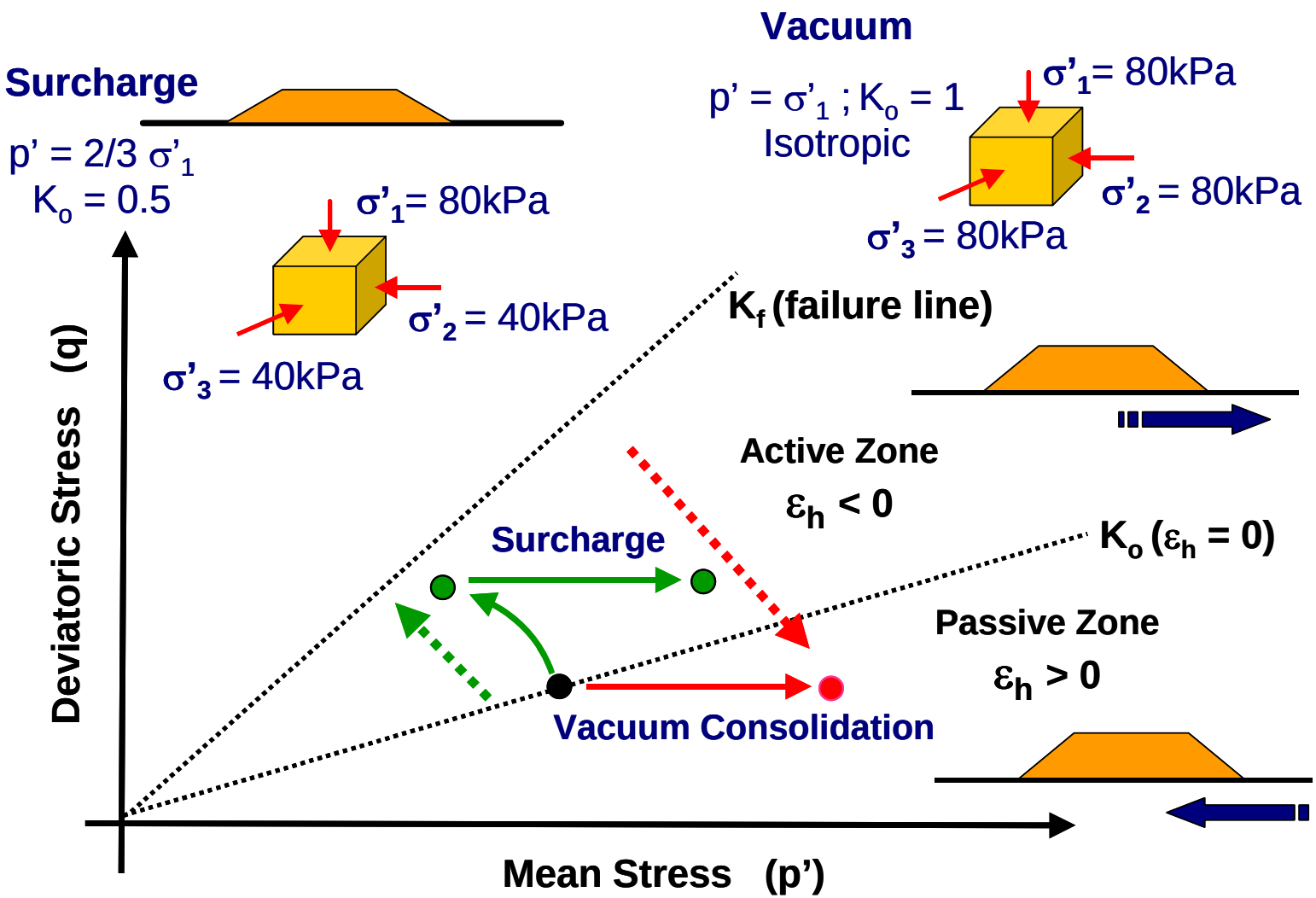


SPRINKLING PONTOON

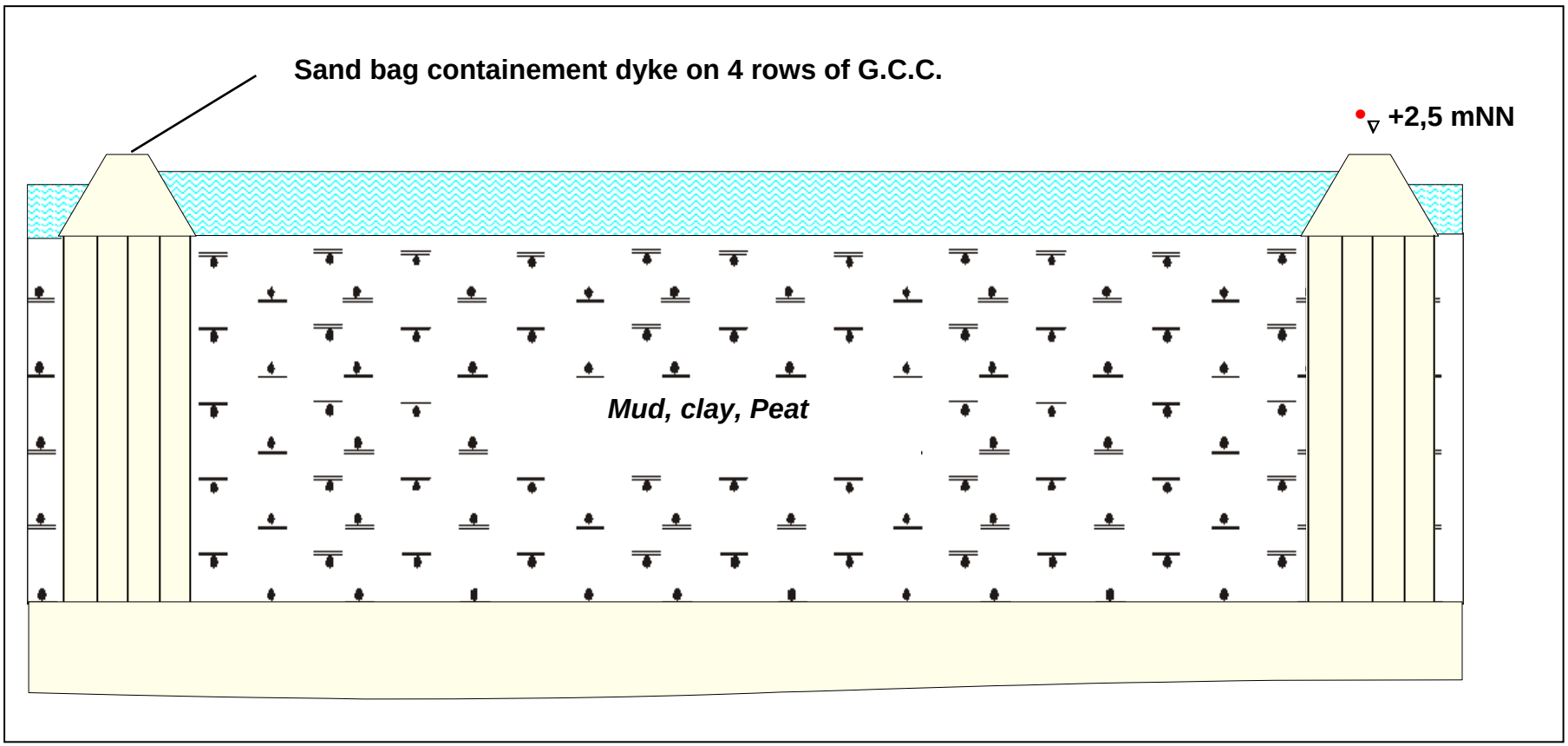
MENARD VACUUM PROCESS



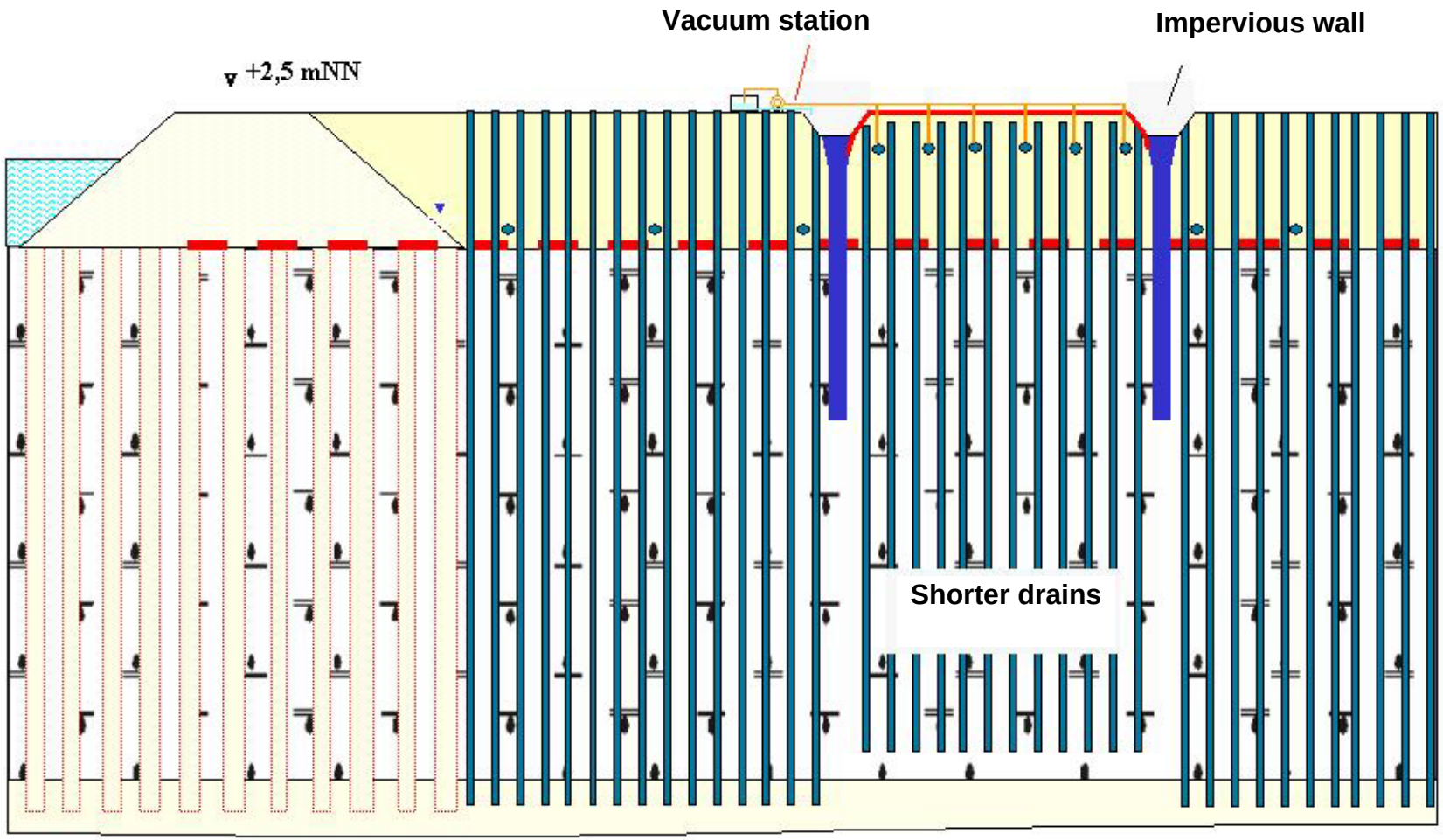
Stress path for Vacuum Process



NORTH AREA / 1st PHASE



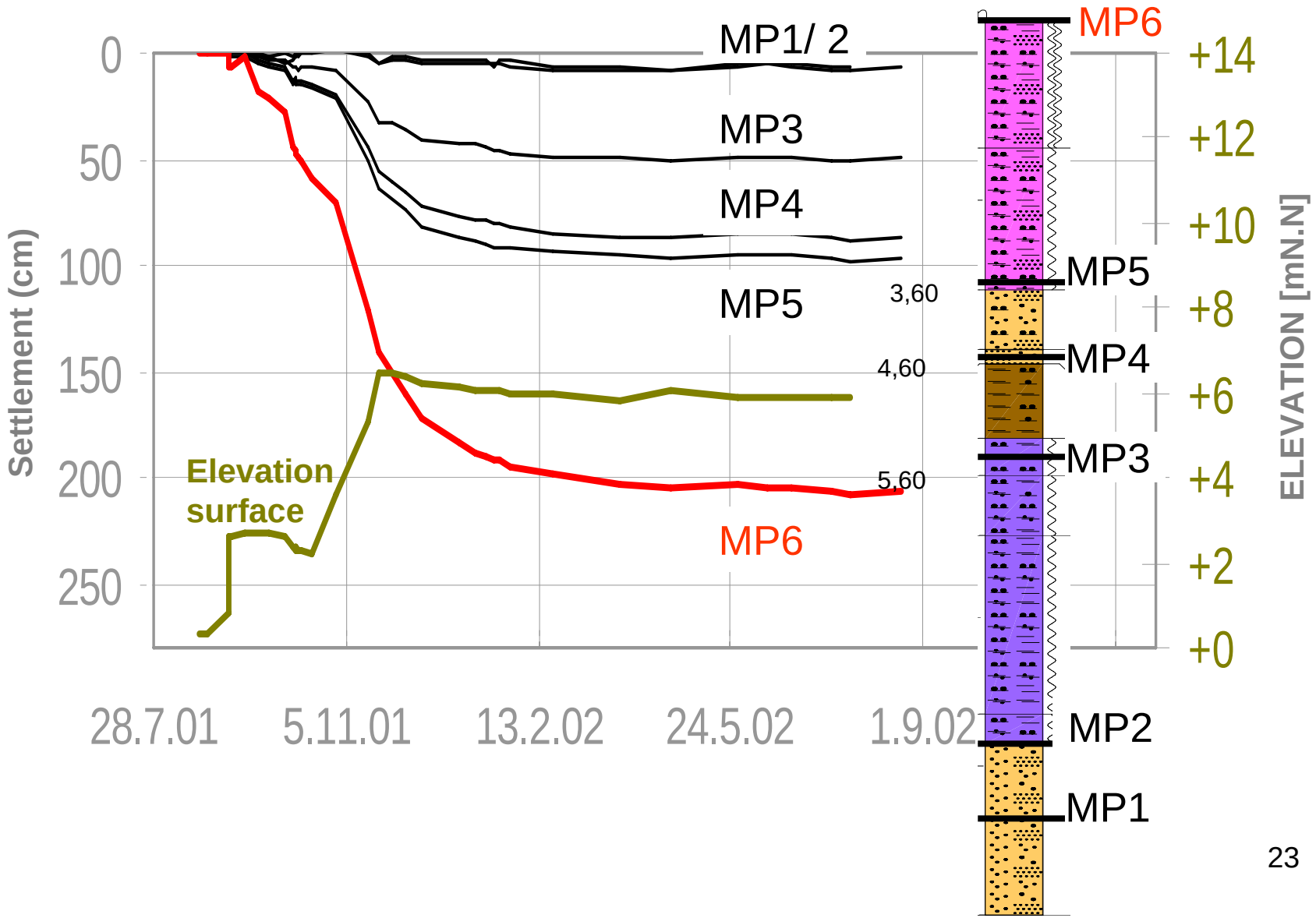
Installation of a "Menard Vacuum" corset



Vacuum Taxiway – Construction of the impervious wall


9 10'01

Deep settlement gages – North area




Vacuum application on taxiway area

TARAO

Hambourg A380
Tassements Zone 1 - Profil R2 - 14-03-2001 - Vacuum

Fill parameters :	
Density (KN/m³):	18
Cohesion (KPa):	0
Friction angle (°):	30

LOAD PARAMETERS	***Initial fill thickness above GWT :***				0,00	***Initial fill thickness below GWT :***				1,70
Parameter	**unit**		**Step1**	**Step2**	**Step3**	**Step4**	**Step5**	**Step6**	**Step7**	**Step8**
Fill density	KN/m³	γ_t	18	18	18	18	18			
Fill height above GWT (incl. exist. fill, begining of step, no settlement considered)	m		0,00	0,00	2,00	7,43	7,43			
Maintain elevation (yes=1, no = 0) ?			0	0	1	0	0			
Fill height above GWT (incl. exist. fill, end of step)	m	H_f	-0,41	-0,80	2,00	5,25	4,78			
Fill thickness below GWT (incl. settl, end of step)			2,11	2,50	3,06	3,88	4,35			
Fill settlement (end step)	m	W_t	0,41	0,80	1,36	2,18	2,65			
Fill width and length	mxm	(Lxl)	infinite	infinite	infinite	infinite	infinite			
Vacuum pressure	KPa	V	0	70	70	70	0			
Coefficient of Vacuum		α_V	1,00	1,00	1,00	1,00	1,00			
Duration of loading	days	t	16	17	28	67	1825			
Time at beginning of step	days		0	16	33	61	128			
Date at beginning of step			01/10/01	17/10/01	03/11/01	01/12/01	06/02/02			
Fill elevation from GWT (begining step)	m		0,00	0,00	3,36	7,43	7,43			
Fill elevation from GWT (end step)	m		-0,41	-0,80	2,00	5,25	4,78			

INITIAL SOIL PARAMETERS										
Layer	**unit**		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Thickness	m	H	3,80	1,50	5,00					
Void ratio		e_o	2,3	2,3	2,3					
Primary consolidation		C_c	0,56	0,56	0,56					
Secondary consolidation		$C_{\alpha e}$	0,099	0,099	0,066					
Density	KN/m³	γ_s	13,00	14,00	15,00					
Cohesion	KPa	C	0,00	5,00	10,00					
Cohesion increase		$\Delta C_u/\Delta\sigma'$	0,20	0,20	0,20					
Internal friction angle	°	ϕ	20,00	20,00	17,50					
Effective stress	KPa	σ_o'	5,70	14,40	29,90					
Influence factor of surcharge	%	I	100	100	100					
Calibration coefficient		β	1	1	1					

DRAINAGE PARAMETERS										
Parameter	**unit**		**Layer 1**	**Layer 2**	**Layer 3**	**Layer 4**	**Layer 5**	**Layer 6**	**Layer 7**	**Layer 8**
Drain spacing (square)	m	D	0,5	0,5	0,5					
Drain diameter (MCD)	m	d	0,05	0,05	0,05					
Coefficient of horizontally drained consolidation	m²/yr	C_h	0,35	0,4	0,5					

SIGMA TEC INGENIERIE

TARAO

Hambourg A380
Tassements Zone 1 - Profil R2 - 14-03-2001 - Vacuum
Target calulation

Initial fill thickness above GWT :			1,00	***Initial fill thickness below GWT :***	1,00
LOAD PARAMETERS	***unit***	***symbol***	***value***	***LOADS***	***value***
Fill density	KN/m^3	γ_t	18,00	Fill thickness to reach FGL (m)	5,00
Equivalent fill height above GWT (incl. existing fill)	m	H_f	6,00	Foundation depth from FGL (m)	0,00
Fill height below GWT (incl. settlement)	m		3,70	Design load (kPa)	0,00
Fill width and length	mxm	(LxI)	infinite	***Total load for target calculation (kPa)***	90,0
Vacuum pressure	KPa	V	0,00	***Equivalent fill thickness***	5,00
Coefficient of Vacuum	no unit	αv	1,00		
Period of secondary settlement	days	t	3113,00		
Fill settlement	m	W_t	2,70		

SOIL PARAMETERS	***unit***	***symbol***	***Value***								
Layer			***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Thickness	m	H	3,80	1,50	5,00						10,30
Void ratio	no unit	e_o	2,30	2,30	2,30						
Primary consolidation	no unit	C_c	0,56	0,56	0,56						
Secondary consolidation	no unit	$C_{\alpha e}$	0,10	0,10	0,07						
Density	KN/m^3	γ_s	13,00	14,00	15,00						
Initial effective stress	kPa	σ_o'	5,70	14,40	29,90						
Influence factor of surcharge	no unit	I	100	100	100						
Calibration coefficient	no unit	β	1	1	1						

SETTLEMENT CALCULATION	***unit***	***symbol***	***value***								
Layer			***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***Total***
Additionnal effective stress	kPa	$\Delta\sigma$'	137,63	137,63	137,63						
Primary settlement	m	W_p	0,90	0,26	0,64						1,80
Secondary settlement	m	W_s	0,40	0,16	0,35						0,90
Total settlement	m	W	1,30	0,42	0,98						2,70

ESTIMATION OF SETTLEMENT	2,70
EQUIVALENT FILL HEIGHT FROM GL (incl. Design load)	9,70
TRUE FILL HEIGHT FROM GL (= total fill thickness)	9,70

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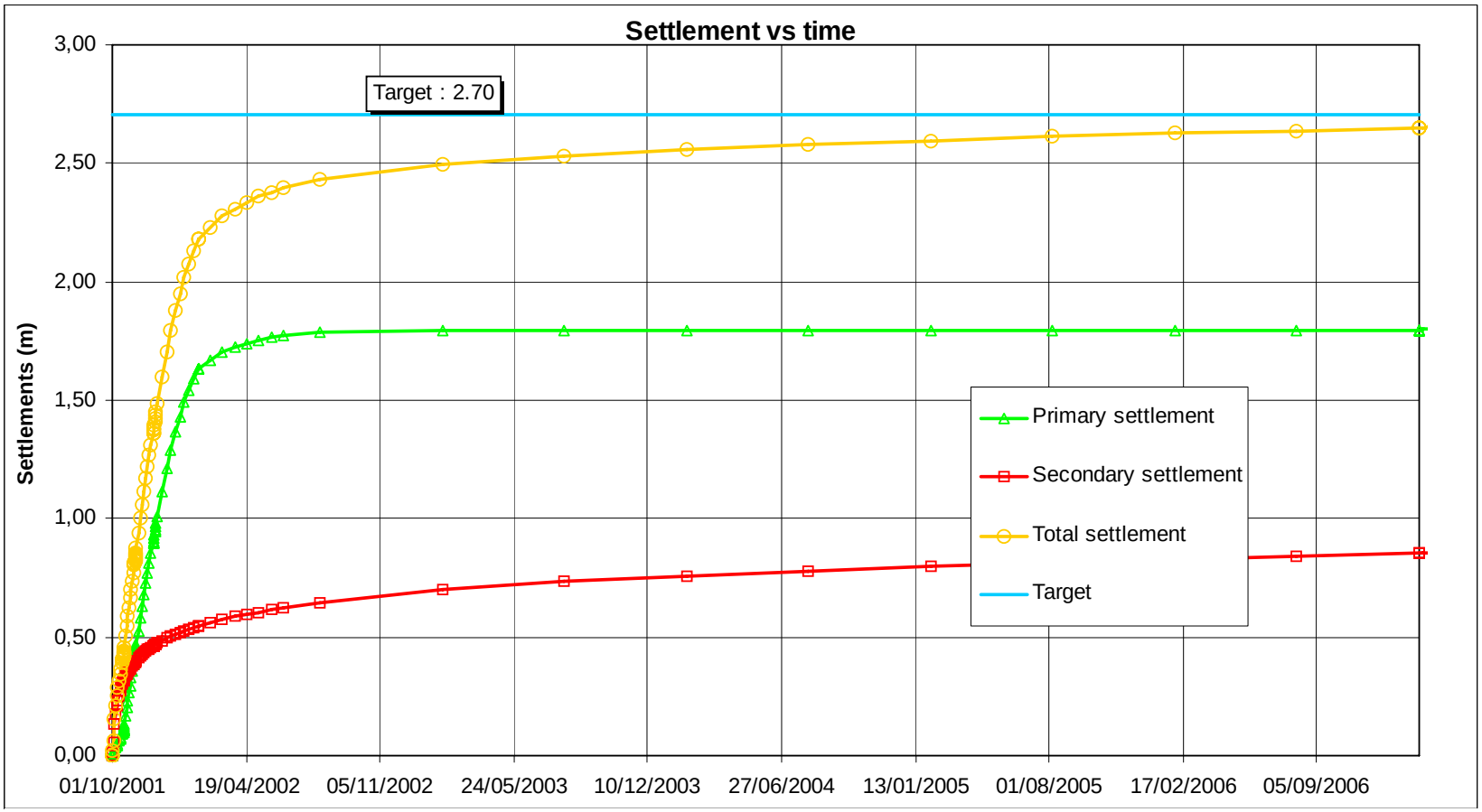

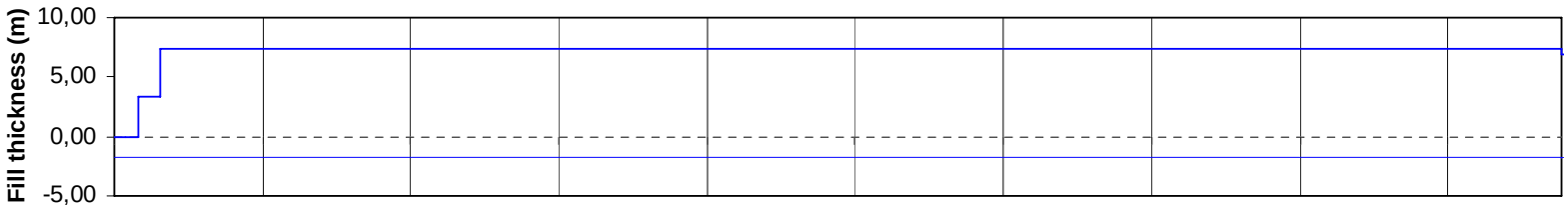

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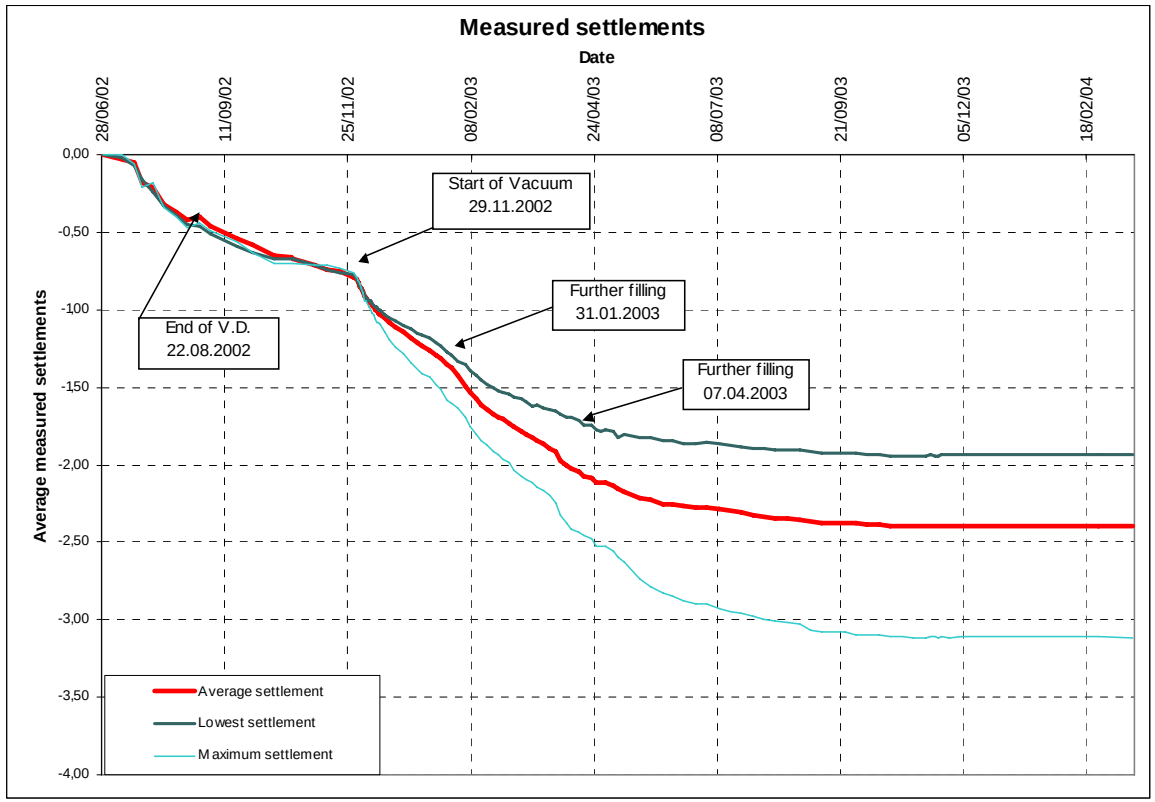
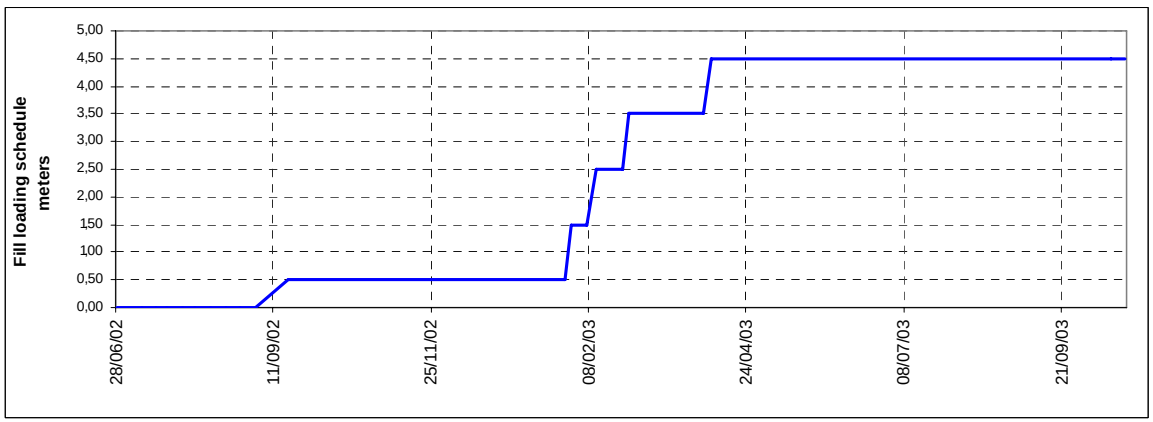
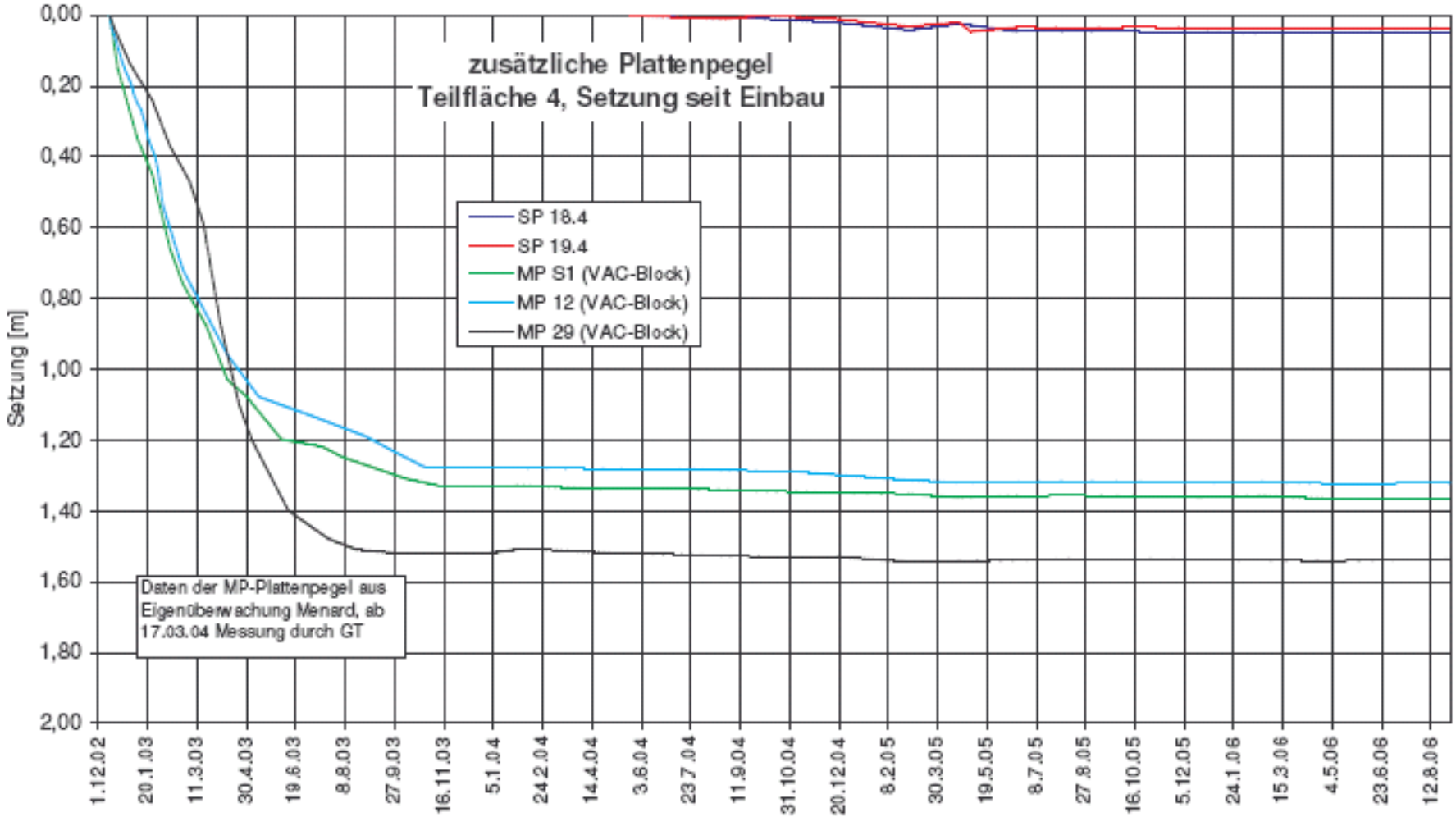
Settlement and fill record





Longtime post construction settlement records



OBRIGADO!