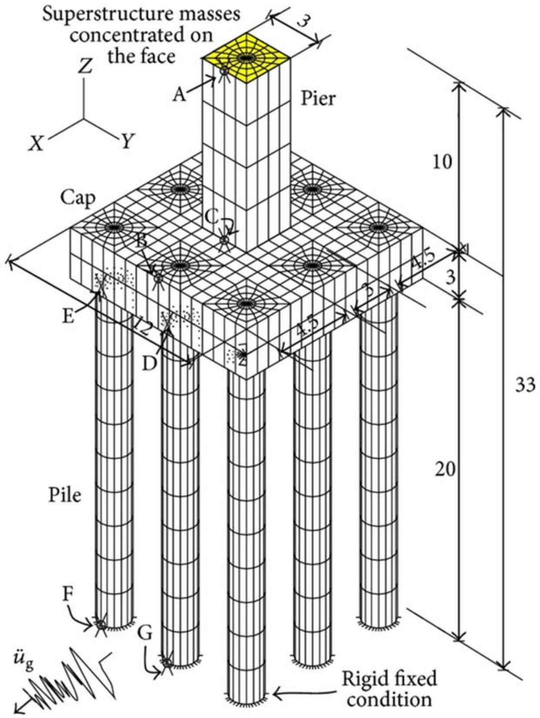
SOIL STRUCTURE INTERACTION

DESIGN OF PILE FOUNDATIONS II.



János Szendefy, PhD
Department of Engineering Geology and Geotechnics

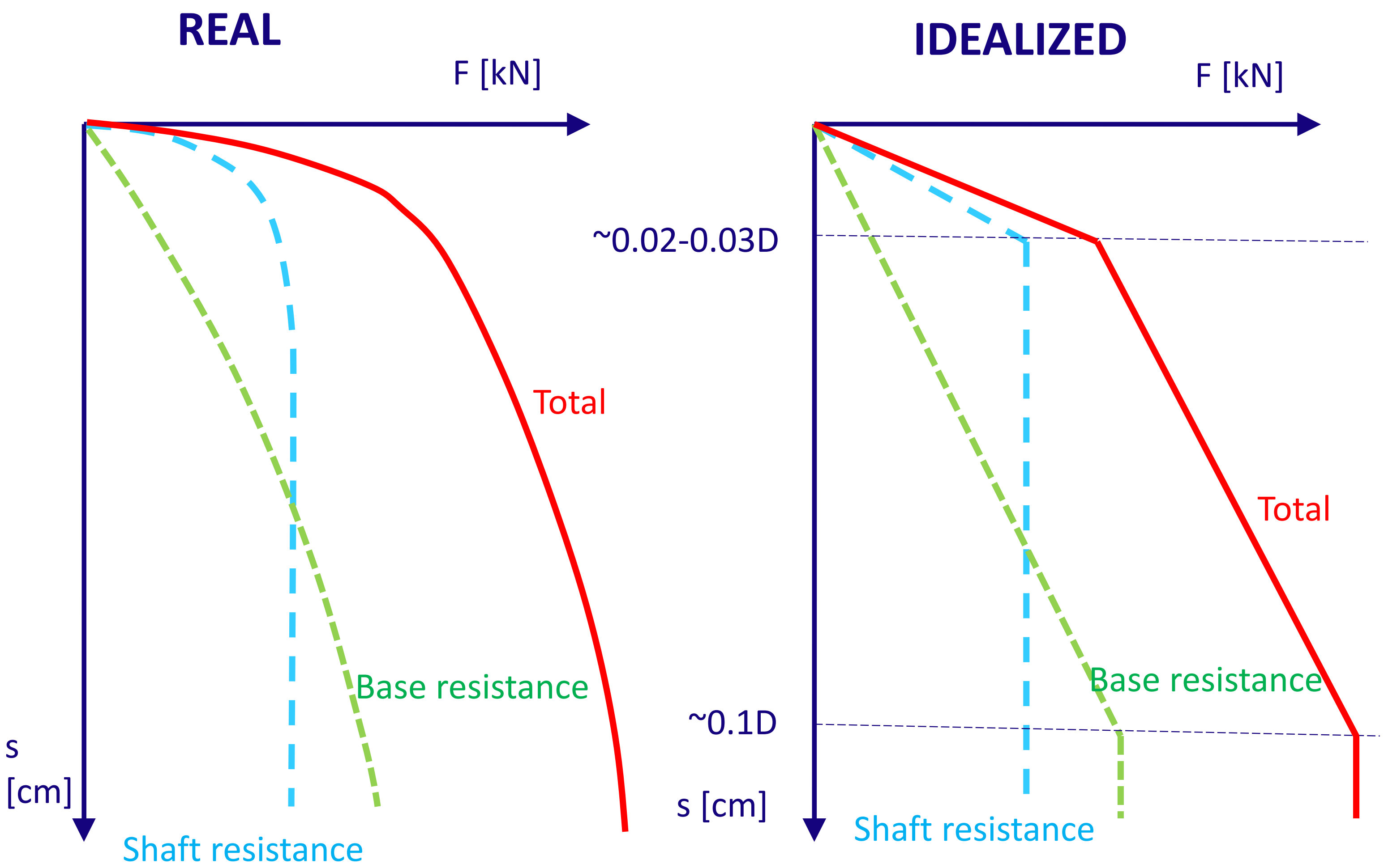
04.10.2017 - Budapest

SETTLEMENT OF SINGLE PILE

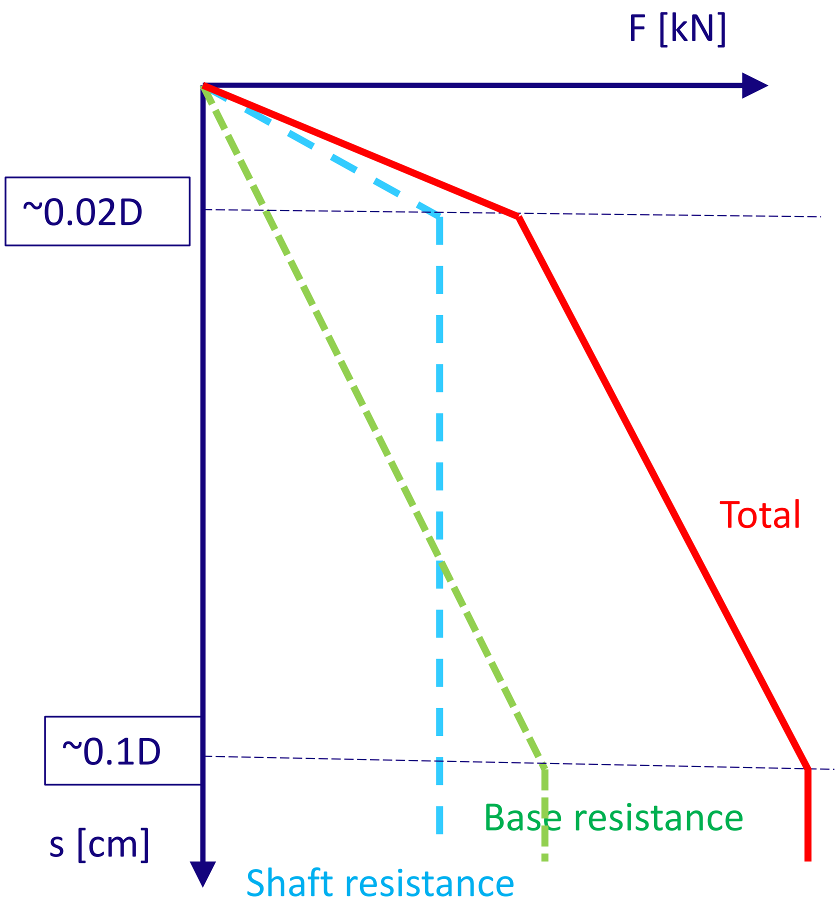
It comes from the compression of 2D thick soil layer under the pile, generally a quite small value, because

- In case of skin friction pile the dominant resistance is the shaftresistance, which results app. 1cm settlements,
- In case of end-bering piles, the piles stands in high bearing capacity layers,
- The experiences of the pile load tests shows, that the settlements are around 5-10mm at the SLS load.

Load-Settlement curve



LOAD-SETTLEMENT CURVE



q-z curve:

Describes the relationship between the displacement of the pile base and the mobilizing soil resistance:

- o generally linear relationship
- o after a certain displacement (settlement) the resistance does not increases

t-z curve:

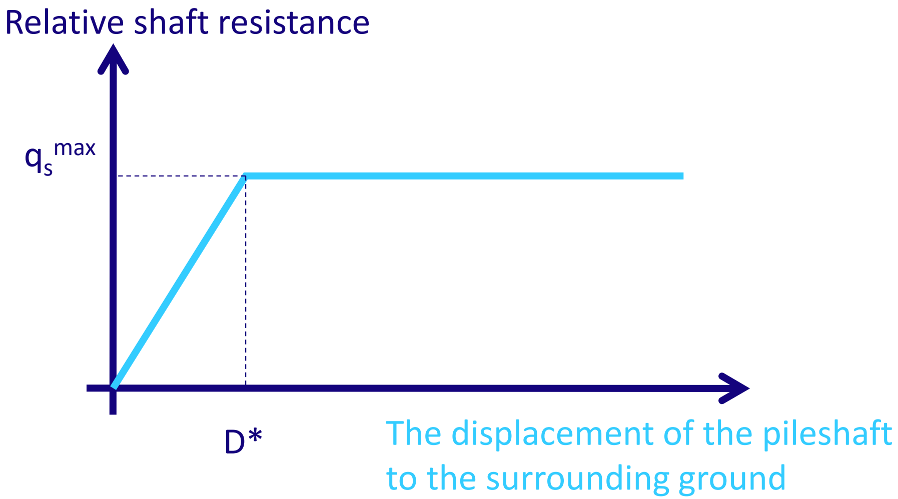
Describes the relationshipe between the displacement of the pile shaft and the monilizing skin friction resistance:

- o the shaft resistance is mobilized at smaller displacement
- o after a certain displacement the resistance does not increases

THE Q-Z AND T-Z CURVES

Shaft resistance

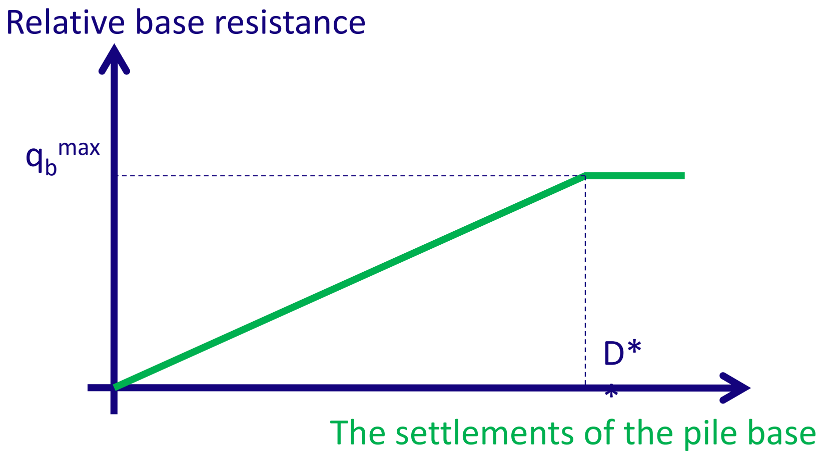
t-z curve



	Bored and CFA piles	Displacement piles
D*	0.015÷0.03 · D	0.01÷0.015 · D

Base resistance

q-z curve

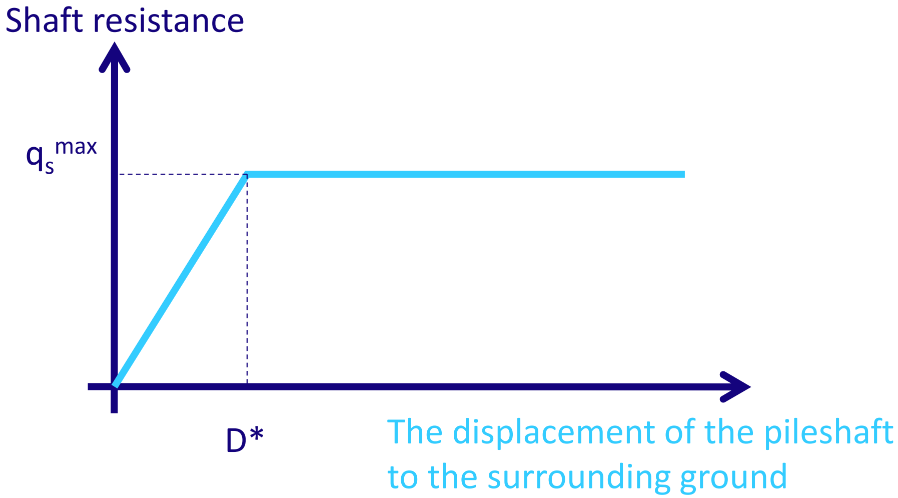


	Bored and CFA piles	Displacement piles
D*	~0.1 · D	~0.05 · D

THE Q-Z AND T-Z CURVES

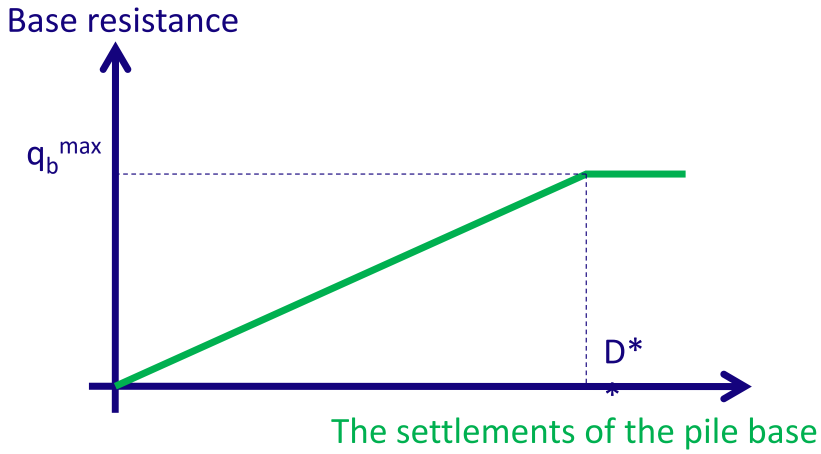
Shaft resistance

t-z curve



Base resistance

q-z curve



Relative settlements	Mobilization of the shaft resistance	Mobilization of the base resistance
s/D	**qs (s)/qs;k**	**qb (s)/qb;k**
0,01	0,7	0,2
0,02	1	0,35
0,05	1	0,65
0,1	1	1

BEARING CAPACITY OF THE PILE-GROUPS

- **In general we can talk about the pile-groups, if the distance between the pile axis are smaller than 5D.**
- **The distance between the pile axis should be higher than 3D. In critical cases it can be 2,5D, smaller distance requires special analyeses about the pile interaction with eachother.**
- **The resistance of single piles.**
- **The limit of the soil resistance under the pile group, which is the ultimate bearing capacity of the soil at the level of the toe of the piles based on shallow foundation equations. Because of the shaftresistance the base is a bit bigger, than the soil mass rounded by the piles.**
- **Determinate the bearing capacity of the soil mass with the piles as one big diameter pile.**

Cofficient in general

β=1,0

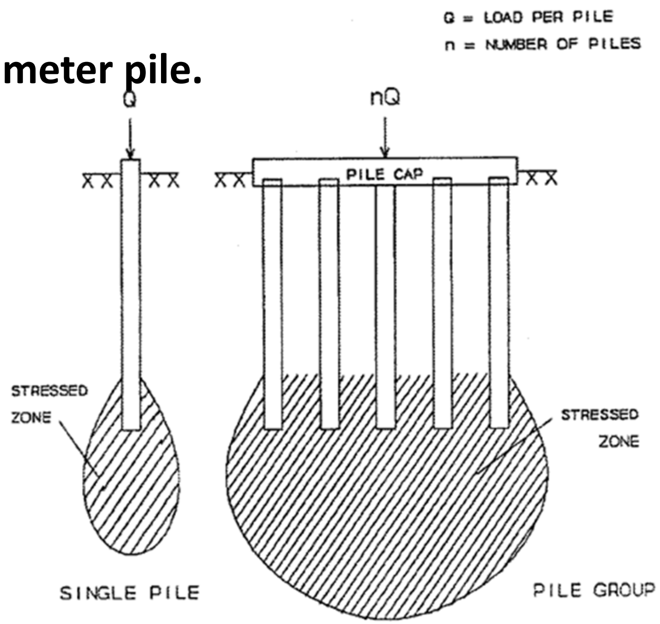
Driven skin friction piles in closed formation pilegorup in granular soils

β=1,1

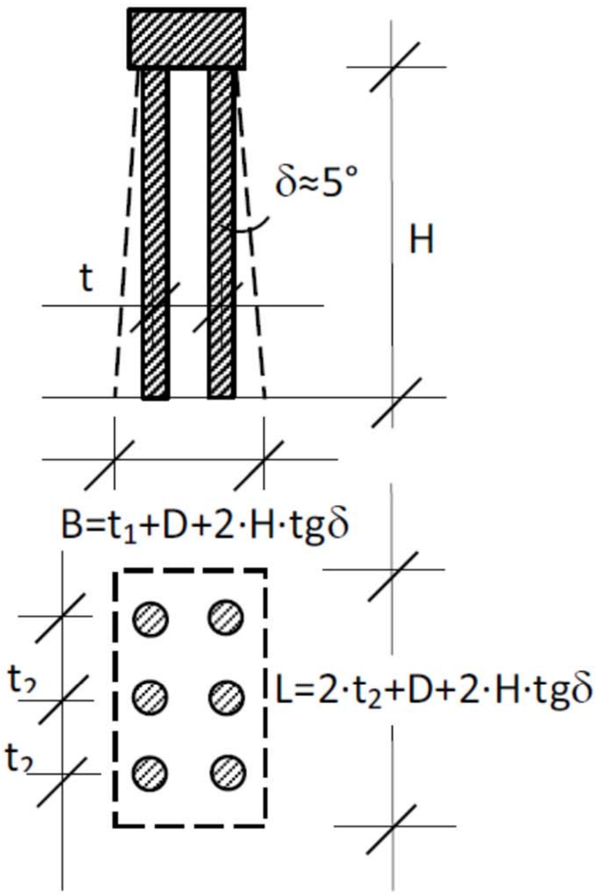
Piles in line depend on the number of piles in the group

β=1,0…0,6

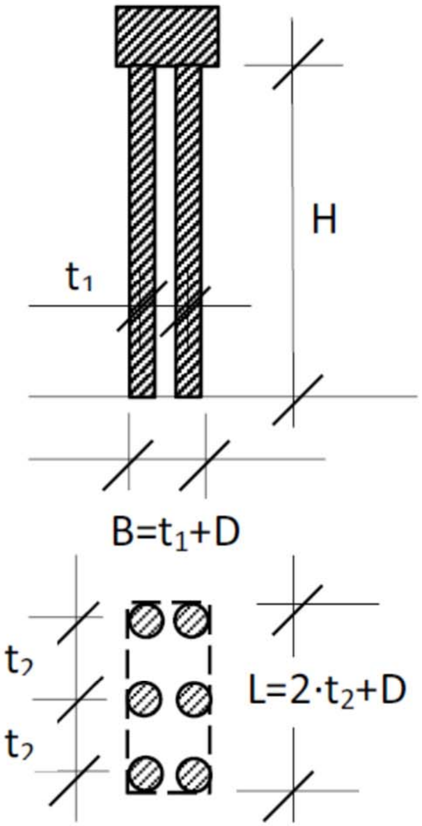
$$R_H = \beta . \sum_i P_{Hi}$$



BEARING CAPACITY OF THE PILE-GROUPS

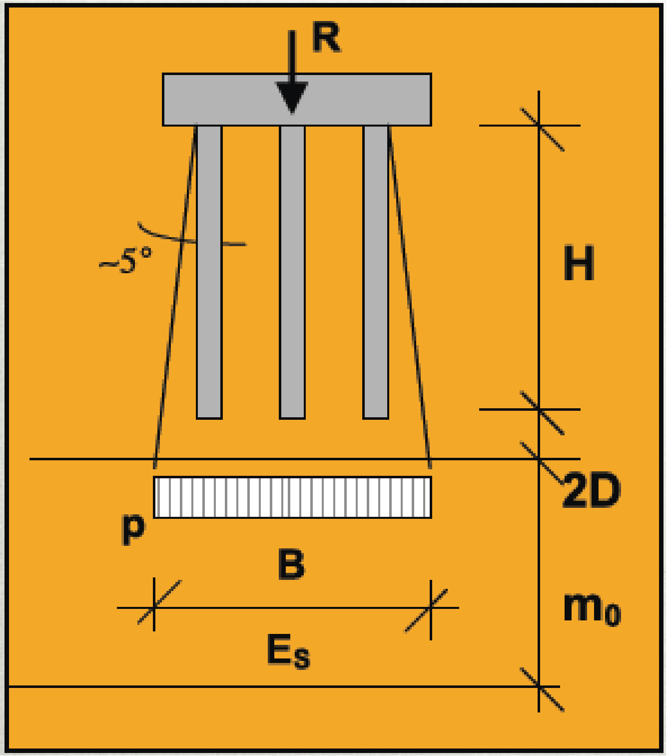


The base area of the substitute shallow foundation



The geometry of the substitute pile foundation

SETTLEMENTS OF THE PILEGROUPS



General method

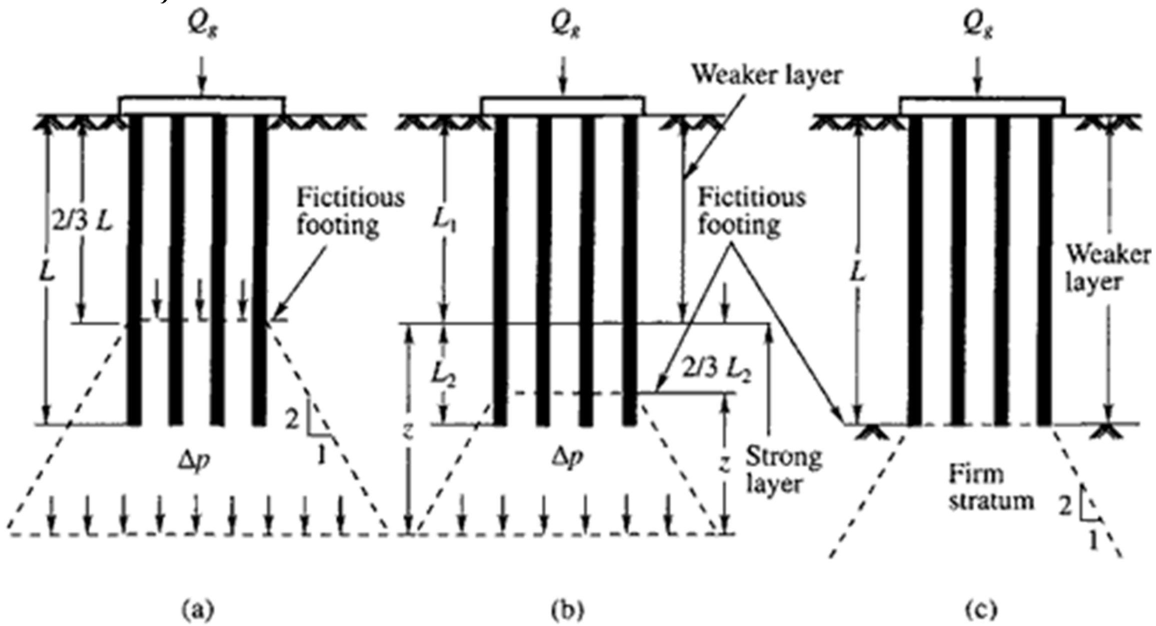
$S_g = (p*m_0)/(2*E_s)$ $S_s = k*p*D/E_s$ $S = S_{single} + S_{group}$

Skempton (1953)

$$S_g = S_i * \frac{S_g}{S_i} = S_i * \left(\frac{4B + 2,7}{B + 3,6}\right)^2$$

Vesic (1977)

$$S_g = S_i * \sqrt{B}$$



DESIGN PROCEDURE OF THE PILES

- Define and analyes the base data, information
  structure, site, geotechnical condition and GWL,
- Pile selection
  type, diameter, length, number of piles
- Draft calculation
  comparing the estimated load and resistance
- The formation of the pile foundation
  layout of the piles, construction requirements, foundation-pile relation
- Deatailed geotechnical and statical calculation
  proof of fulfillment of the requirements
- Construction plans
  type, geometry, reinforcement, layout, number of piles,
  technolgy requirements, monitoring plan
- Supervising of the construction
  pileing protocol, integrity measuring, pile load test

STANDARDS OF PILE DESIGN AND EXECUTION

MŰEGYETEM 1782

Standard of pile design :

- **MSZ EN 1997-1:2006**

Standards of pile construction :

- **MSZ EN 1536:2012 Execution of special geotechnical work.**

  Bored piles

- **MSZ EN 12699:2002 Execution of special geotechnical work. Soildisplacament piles**
- **MSZ EN 14199:2005 Execution of special geotechnical work. Micropiles**

Criteria for pile selection

- soil and GWL conditions of the site, including the known or possible barriers;
- generated stresses by the pileing;
- possibilities to preserve and control the integrity of the pile will be made;
- the effect of the pileing technology and order on the piles already built, thae adjacent structures and and public utilities;
- tolerances to be reliably enforced during pileing;
- unfavorable effects of chemicals in the soil;
- the possibility of interconnection of different groundwaters;
- handling and transportation of piles;
- the effects of piling on the surrounding structures;
- the distance between the piles in the pilegroup;
- movements or vibrations caused by pileing in surrounding structures;

CRITERIA FOR PILE SELECTION

- **the type of vibrating device or vibrator to be used;**
- **the dynamic stresses caused by the driving of the piles;**
- **in case of slurry casing, the need to keep the slurry level, to prevent the falling peaces from the borhole and the hidraulic faiulre of the base;**
- **clean the pile base and - in some cases, especially using bentonite slurry – tha shaft to remove loose scrap;**
- **the local disruption of the borehole wall during concreting, which interrupts the pile continuity;**
- **the penetration of soil or groundwater into the concrete of the pile body and the possible interfering effects of the flowing water in the concrete;**
- **extracting water from the concrete by the unsaturated sand layers surrounding the pile;**
- **unfavourable effect of chamicals in the soil to the hidraulic bindigs of the concrete**
- **soil compacting effect of displacement piles;**
- **disruption of the soil caused by pile drilling.**

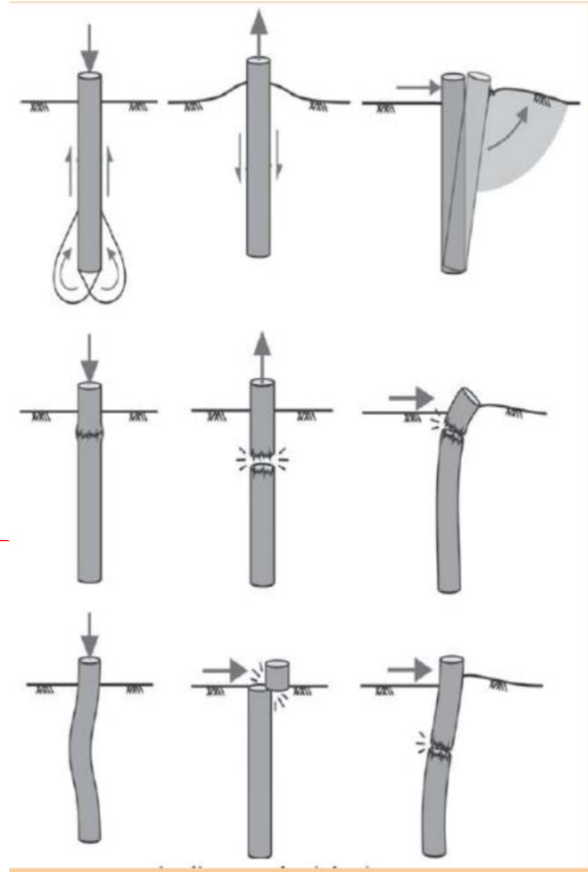
LIMIT STATES TO BE CONSIDERED AT DESIGN

ULS

- Loss of overall stability;
- Bearing resistance failure of the pile foundation;
- Uplift or insufficient tensile resistance of the pile foundation;
- Failure in the ground due to transverse loading of the pile foundation;
- Structural failure of the pile in compression, tension, bending, buckling or shear;
- Combined failure in the ground and in the pile foundation;
- Combined failure in the foundation and in the structure;

SLS

- Excessive settlements
- Excessive heave
- Excessive lateral displacment
- Unacceptable levels of vibration



Items should be verified during the design

- Ground compressive or tensile resistance of single pile ultimate limit states.
- Ground compressive or tensile resistance of pilegroup ultimate limit states.
- Ultimate limit states of collapse or severe damage of the structure caused by settlements or settlement differences of pile (pile group).
- Serviceability limit states problem of the structure caused by the settelments of the pile or pile group.

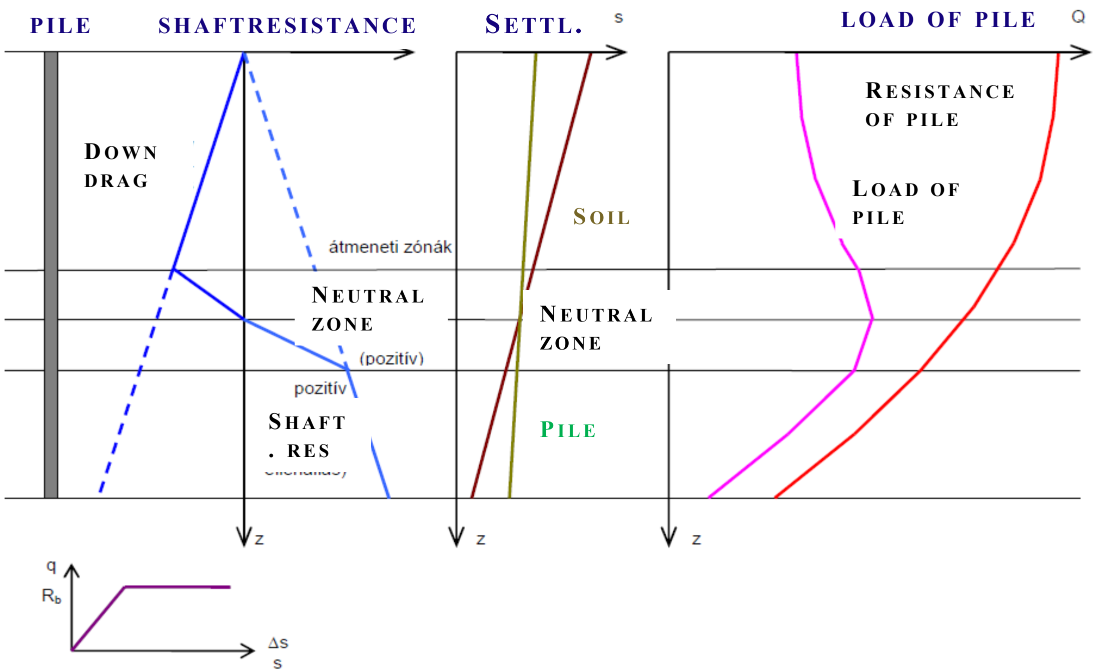
In generally the DA-2* should be used.
The 3. design approach only should be used for overall stability.

DOWNDRAG – NEGATIVE SKIN FRICTION

MŰEGYETEM 1782

(1) If ultimate limit state design calculations are carried out with the downdrag load as an action, its value shall be the maximum, which could be generated by the downward movement of the ground relative to the pile.

(2) Calculation of maximum downdrag loads should take account of the shear resistance at the interface between the soil and the pile shaft and downward movement of the ground due to self-weight compression and any surface load around the pile.



DOWNDRAG – NEGATIVE SKIN FRICTION

(3) An upper bound to the downdrag load on a group of piles may be calculated from the weight of the surcharge causing the movement and taking into account any changes in groundwater pressure due to ground-water lowering, consolidation or pile driving.

(4) Where settlement of the ground after pile installation is expected to be small, an economic design may be obtained by treating the settlement of the ground as the action and carrying out an interaction analysis.

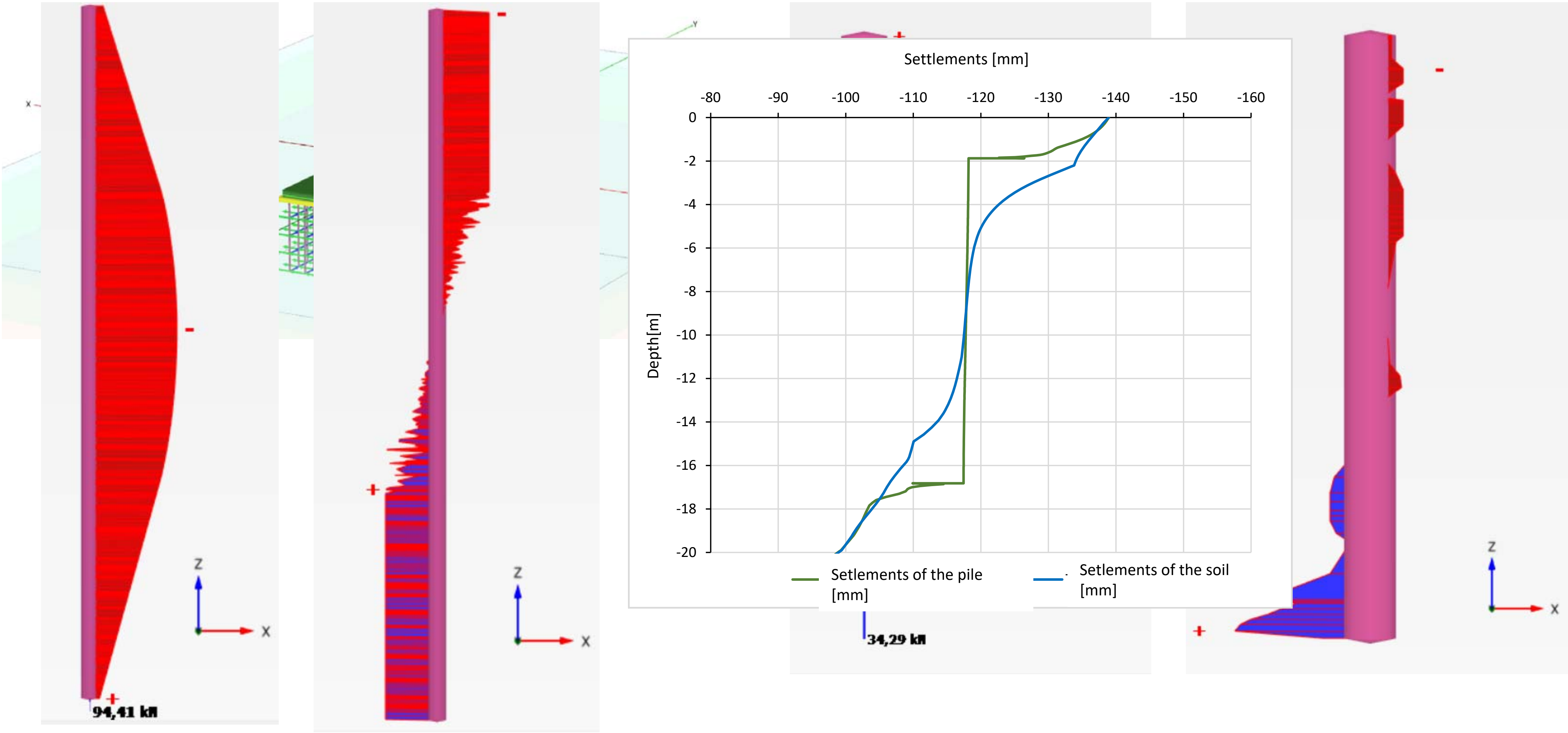
(5) The design value of the settlement of the ground shall be derived taking account of material weight densities and compressibility

(6) Interaction calculations should take account of the displacement of the pile relative to the surrounding moving ground, the shear resistance of the soil along the shaft of the pile, the weight of the soil and the expected surface loads around each pile, which are the cause of the downdrag.

(7) Normally, downdrag and transient loading need not be considered simultaneously in load combinations.

DOWNDRAG – NEGATIVE SKIN FRICTION

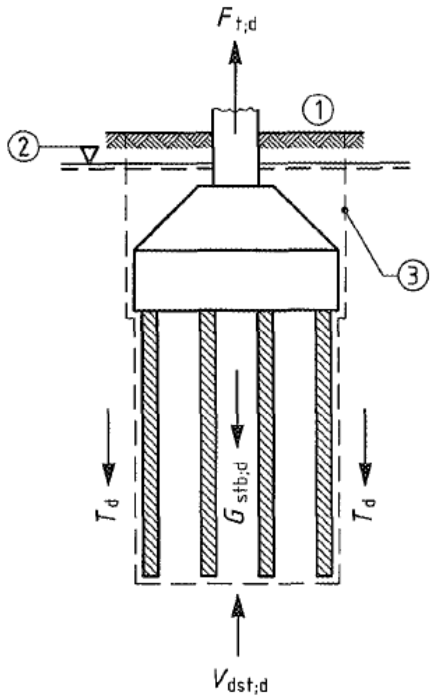
MŰEGYETEM 1782



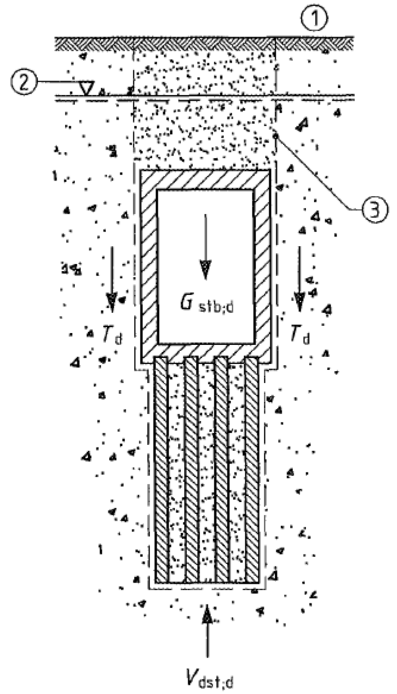
HEAVE – TENSILE PILES

- In considering the effect of heave, or upward loads, which may be generated along the pile shaft, the movement of the ground shall generally be treated as an action.
- Expansion or heave of the ground can result from unloading, excavation, frost action or driving of adjacent piles. It can also be due to an increase of the ground-water content resulting from the removal of trees, cessation of abstraction from aquifers, prevention (by new construction) of evaporation and from accidents.
- Heave may take place during construction, before piles are loaded by the structure, and may cause unacceptable uplift or structural failure of the piles.

Heave from the soil



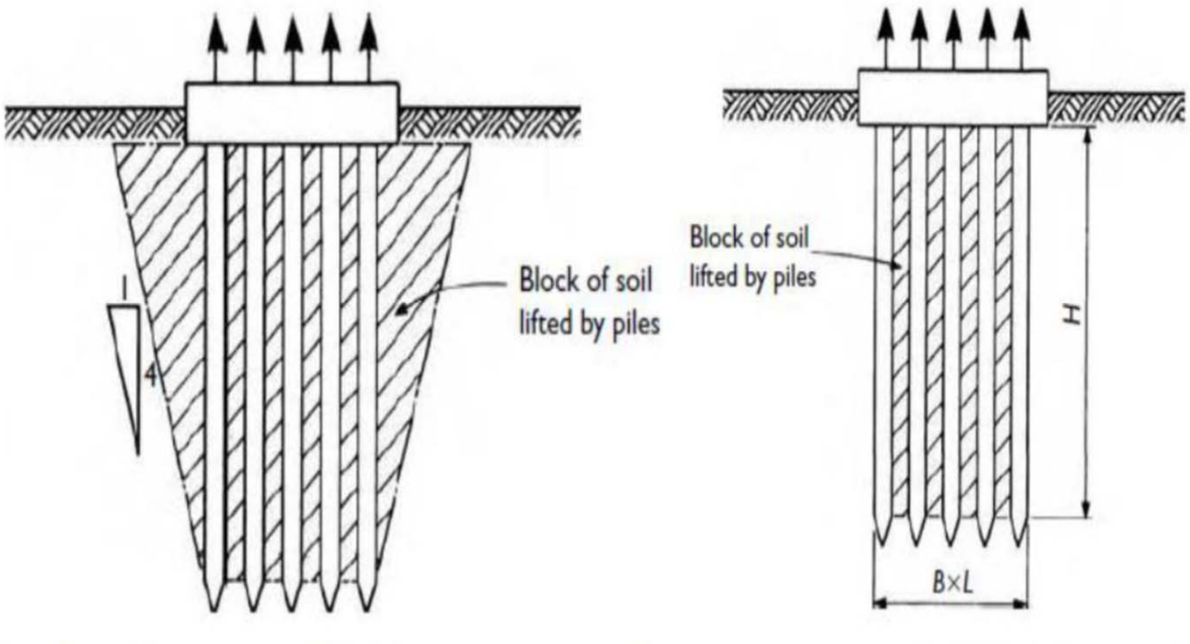
Uplift of the structure



In case of tensiel piles, more pile load tests are required.

In case of numerous tensile piles, min. 2% of test piles are required.

HEAVE – TENSILE PILES



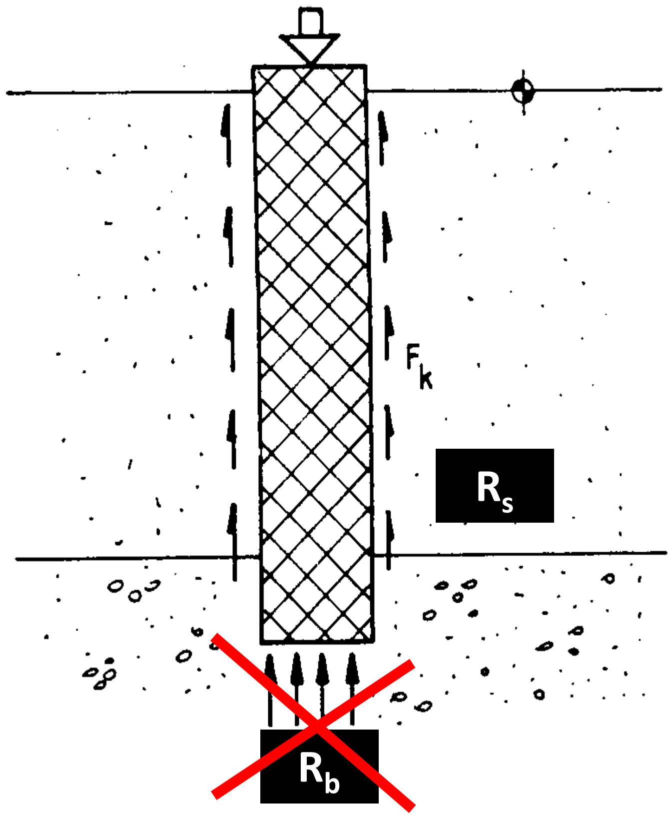
Block failure caused by tension in granular and in cohesive soils (Tomlinson&Woodward 2008)

Ratio of compression and tension

Publikáció	$R_{c,s}/R_{t,s}$
Shertman (1978)	0,67
Poulos & Davis (1980)	0,67
Muprhy (1980)	~1 (agyag)
U.S. Army Corps of Engineers (1991)	1/3 (szemcsés)
U.S. Army Corps of Engineers (1991)	2/3 (kötött)
Fang szerk. (1991)	0,5
De Nicola és Randolph (1993)	0,70…0,85
Bowles (1997)	1
Lehane et al. (2005)	0,75
Tomlinson & Woodward (2008)	1
Fleming et al (2009)	>0,5

HEAVE – TENSILE PILES

MŰEGYETEM 1782



Bearing capacity of the pile= Base resistnace + shaft resistance

$$R = R_b + R_s$$

$$\tau_k = q_s = 0{,}7 * \alpha \cdot q_{c,\acute{a}tl}$$

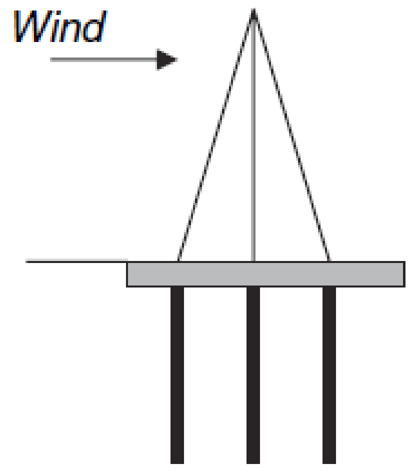
$$R_d = R_{s;k} / \gamma_s$$

Recommended EN 1997-1 (national annex)

Pile type		γ_b	γ_s	γ_t
Compression	Driven	1.10	1.10	1.10
	Drilled	1.25	1.10	1.20
	CFA	1.20	1.10	1.15
Tension			1.25	

TRANSVERSELY LOADED PILES

1. Transversely effect caused by the soil displacment around the pile.
2. Effects cause transversely loads:
    - Load differences (fill or surround of it)
    - Different ground level (cut, pilwall)
    - Pilewall in slope creep
    - Inclined pile in underconsolidated soilmass
    - Eartquake



Transmission tower

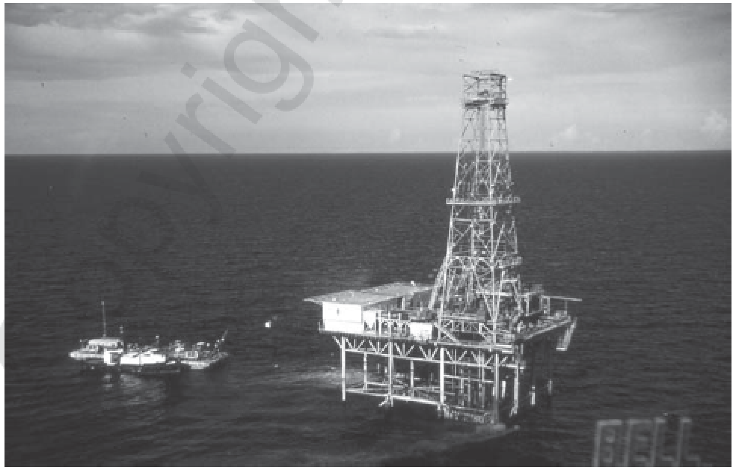
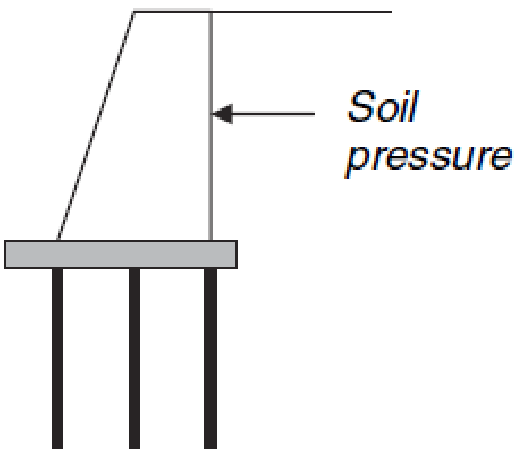


Figure 12.1 Helicopter view of an offshore drilling platform in the Gulf of Mexico.



Earth retaining structure

TRANSVERSELY LOADED PILES

Design based on the assumed pressure distribution

–assumed centerpoint of the rotation (0,33÷0,40·H above the base)
–assumed width of the pile (B=D+n·x·tgj)
–assumed distribution of the load (sand -parabolic, clay -constant)
–equilibrium analyses
–Terzaghi-model, Broms-diagrams, Sherif-tables

Design based on the bedding coefficient using structure FEM softwares

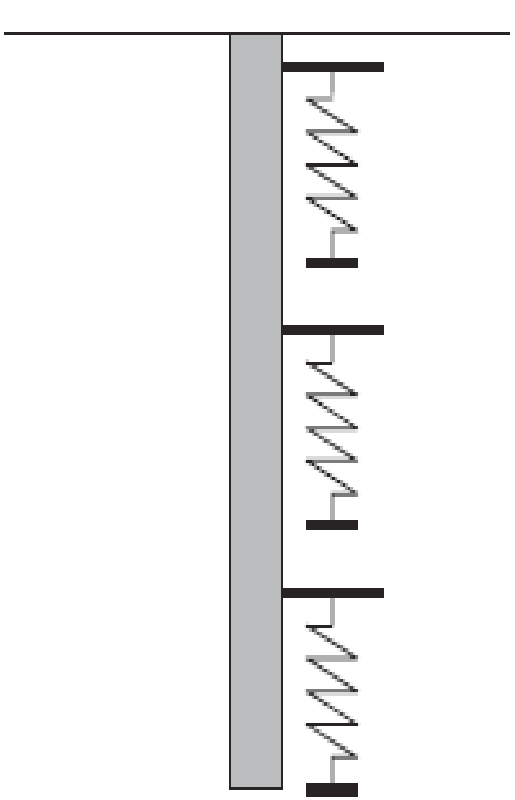
–determination of the bedding coefficiant (C=a·Es/D; tables)
–assumed width of the pile (B=D+n·x·tgj)
–FEM software model for the structure (AXIS; GEO5)

Design based on geotechnical FEM softwares

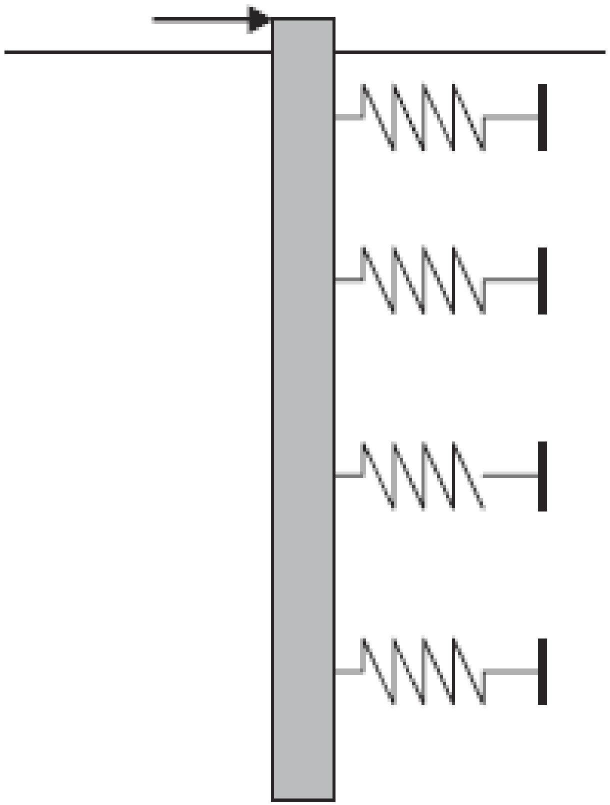
–normal or special soil models (MC; HS)
–2D model with assumed pile width
–3D model with the real pile geometry
–FEM software (PLAXIS, MIDAS)

Always must be checked, that the pressure on the soil is under the passive earthpressure!

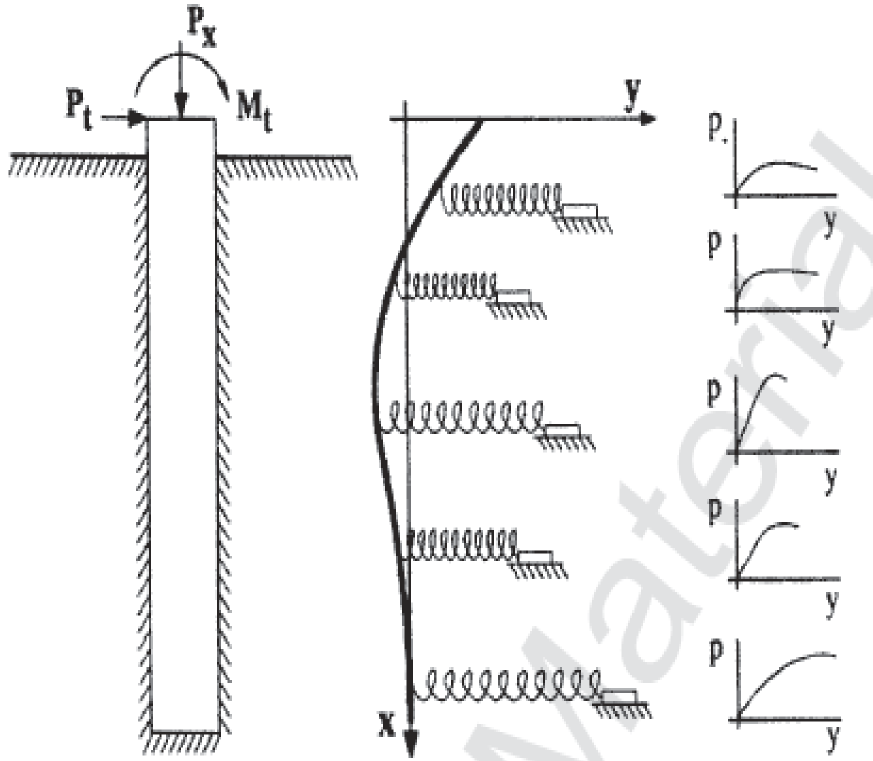
TRANSVERSELY LOADED PILES



Springs to model vertical forces (Skin friction)



Springs to model horizontal forces

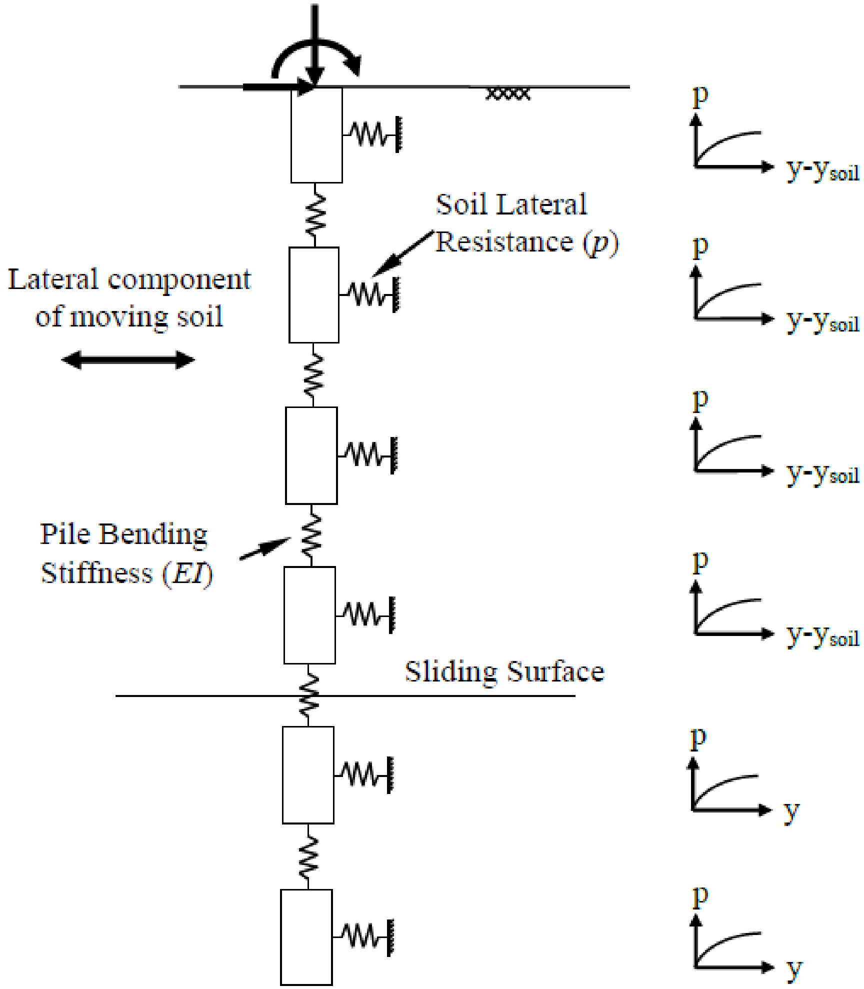


(a) (b) (c)

Ruwan Rajapakse – Pile Deisgn for structural and Geotechnical Engineers

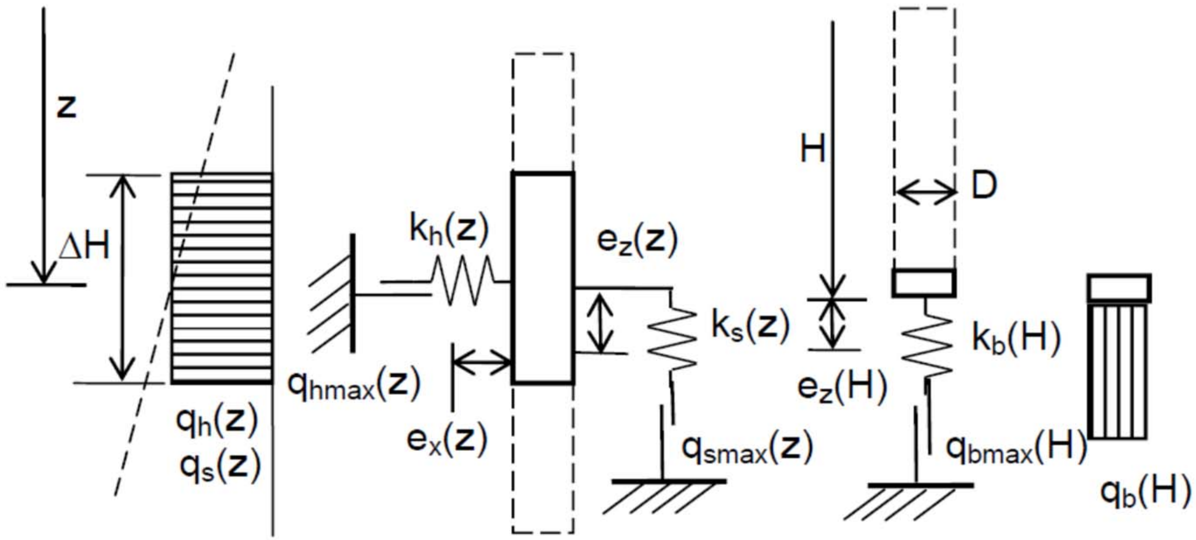
L. C. Reese, W. M. Isenhower, S-T. Wang:
Analysis and design of shallow and deep foundations

TRANSVERSELY LOADED PILES



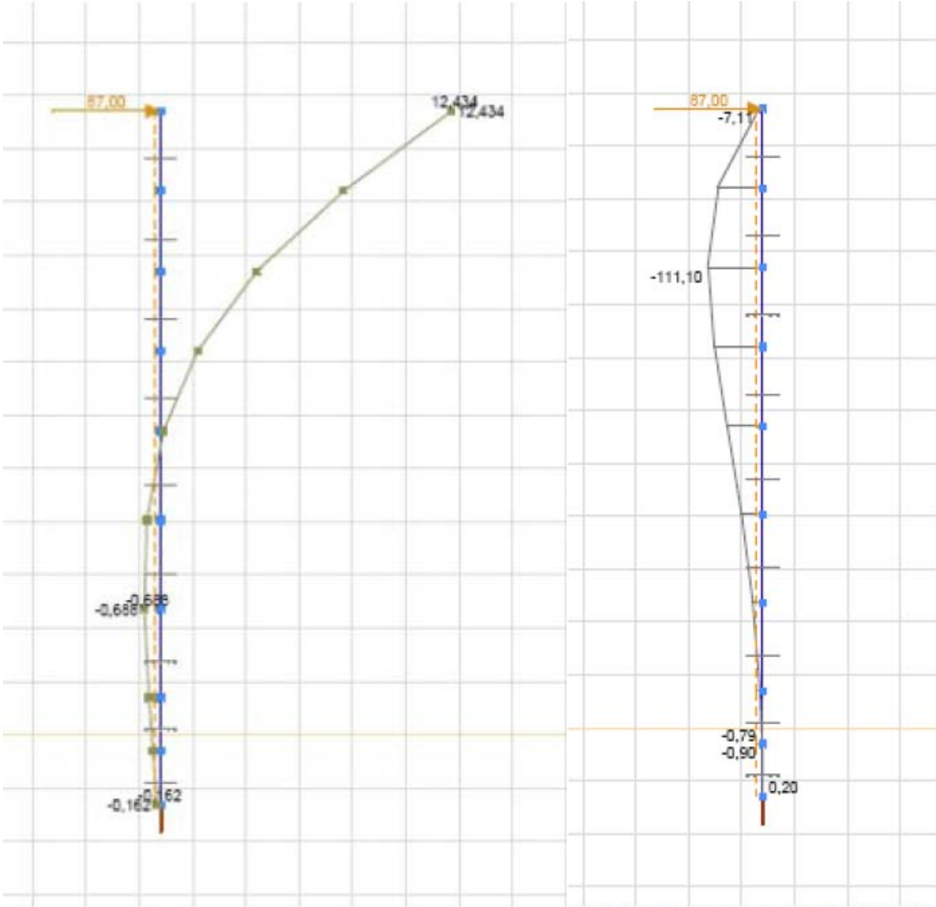
TRANSVERSELY LOADED PILES

MODELLING THE PILES IN AXIS



$k_h(z)=C_h(z)\times D=E_s(z)/D\times D=$	$k_s(z)=q_{smax}(z)/e_{smax}=$	$k_b(H)=q_{bmax}(H)/e_{bmax}=$
$=E_s(z)=E_{s0}+z\times(E_{sH}-E_{s0})/H$	$=q_{smax}(z)/(0{,}02\times D)$	$=q_{bmax}(H)/(0{,}10\times D)$
$q_h(z;e_x)=k_h(z)\times e_x(z)$	$q_s(z;e_z)=k_s(z)\times e_z(z)$	$q_b(H;e_z)=k_b(H)\times e_z(H)$
$q_{hmax}(z)=(K_p-K_a)\times(p+z\times\gamma)\times D$	$q_{smax}(z)=\pi\times D\times q_s(z)$	$q_{bmax}(H)=\pi\times D^2/4\times q_b(H)$
$q_h(z)=q_h(z;e_x)$ ha $q_h(z;e_x)<q_{hmax}(z)$	$q_s(z)=q_s(z;e_z)$ ha $q_s(z;e_z)<q_{smax}(z)$	$q_b(H)=q_b(H;e_z)$ ha $q_b(H;e_z)<q_{bmax}(H)$
$q_h(z)=q_{hmax}(z)$ ha $q_h(z;e_x)>q_{hmax}(z)$	$q_s(z)=q_{smax}(z)$ ha $q_s(z;e_z)>q_{smax}(z)$	$q_b(H)=q_{bmax}(H)$ ha $q_b(H;e_z)>q_{bmax}(H)$

MODELLING THE PILES IN AXIS



(a) horizontal displacements [mm] (b) bending moments [kNm]

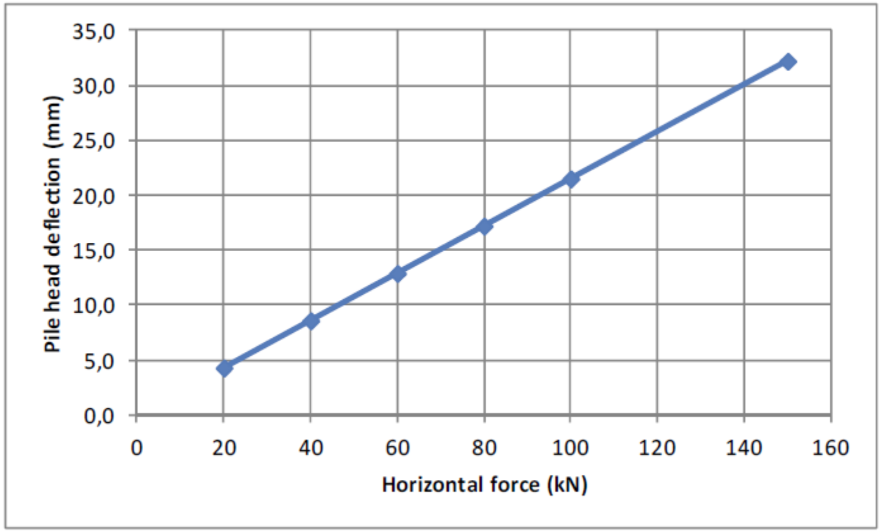


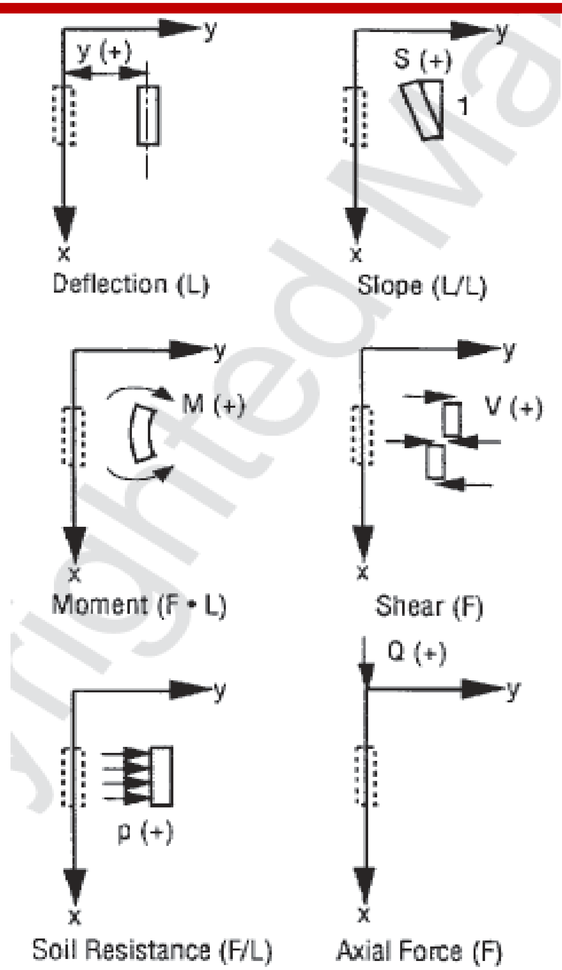
Figure 21. Pile head deflection – horizontal force

TRANSVERSELY LOADED PILES

At the transverse displacement calculation the following should be considered:

- The stiffness of the soil and its change to the degree of deformation.
- The bending stiffness of the pile.
- The capture rate of the pile at the join of the superstructure.
- The group effect.
- Reversal or cyclic repetition of the impact of the load.

- Rigid or flexible timber as appropriate model.
- For short piles like the rigid body rotation and shift should to be calculated.
- For long, slender pile bending fracture, accompanied by local soil failure around the pile head.



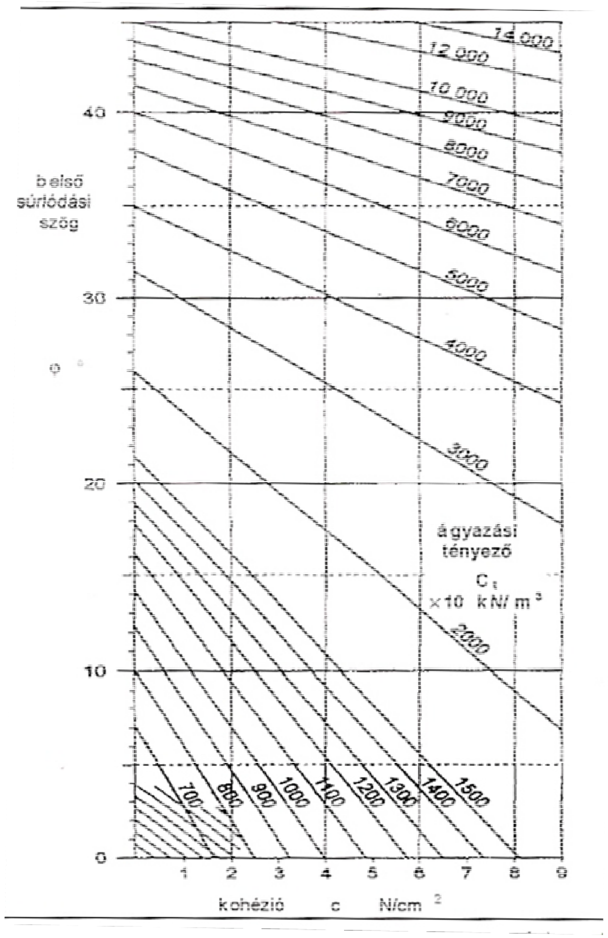
Note: All of the responses of the pile and soil are shown in the positive sense; F = Force; L = Length.

BRIAUD J.-L.: The presuremeter test: Expanding its use

BRIAUD J.-L.: The presuremeter test: Expanding its use

TRANSVERSELY LOADED PILES

Monnet-method



Terzaghi-method $C = 1{,}4 * E_{oed} \ /D$

MSZ15005:1989 $C = 2 * E_{oed} \ /D$

where:

- C is the coeff. of subgrade reaction in kN/m^3
- E_{oed} Young modulus of the soil [kN/m^2]
- D diamater of the pile [m]

CLAY: **k_h = (40÷50)·Cu**

SAND: **k_h = (700÷1000)·N**

where:

k_h is the coeff. of subgrade reaction in kN/m^3

Cu is the undrained shear strength in kN/m^3

N is the SPT N_{30} value

TRANSVERSELY LOADED PILES

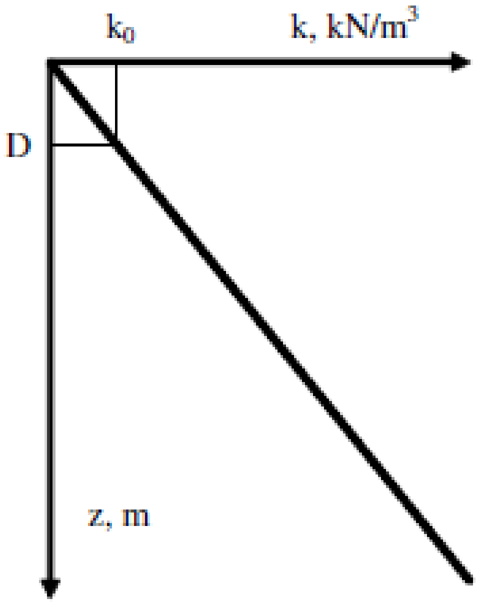
Vesic-method

$$k_h = \frac{0,65}{D} + \sqrt[12]{\frac{E_s * D^4}{E_p * I_p}} + \frac{E_s}{1 - v^2}$$

ahol:

- $E_p * I_p$ Bedding stiffness of pile
- E_s a talaj rugalmassági modulusa [MPa]
- v Poisson~s ration [-]
- D Diameter of the pile [m]
- k_h Subgrade horizontal coefficient [kN/m^3]

Smoltczyk-method



$$k_i = k_{0i} \cdot \frac{z}{D},$$

ahol

k_{0i}: Bedding coef. in depth D [kN/m²]:

$$k_{0i} = \frac{E_{si}}{D} \geq \frac{E_{si}}{1\,m},$$

z [m]: Disance of the middle of the layer i from the piletoe

mélysége,

E_{si} [kPa]: Compression modulus of layer i

Springconstant:

$$r_{xi} = r_{yi} = k_i \cdot D = \frac{E_{si} \cdot z}{\min\begin{cases} D \\ 1\,m \end{cases}}$$

Using separeted springs

$$R_{xi} = R_{yi} = r_{xi} \cdot h_i$$

Recommended at the mid of the layers, or at the borders of the layers.
If the thickness of the layer layers should be divided to parts.

$$h_i > 3 \cdot D,$$

TRANSVERSELY LOADED PILES

TABLE 14.3 Representative Values of K_{py} for Sands

Relative Density of Sand	Loose	Medium	Dense
	Submerged Sand		
MN/m³	5.4	16.3	34.0
psi	20.0	60.0	125.0
	Sand Above Water Table		
MN/m³	6.8	24.4	61.0
psi	25.0	90.0	225.0

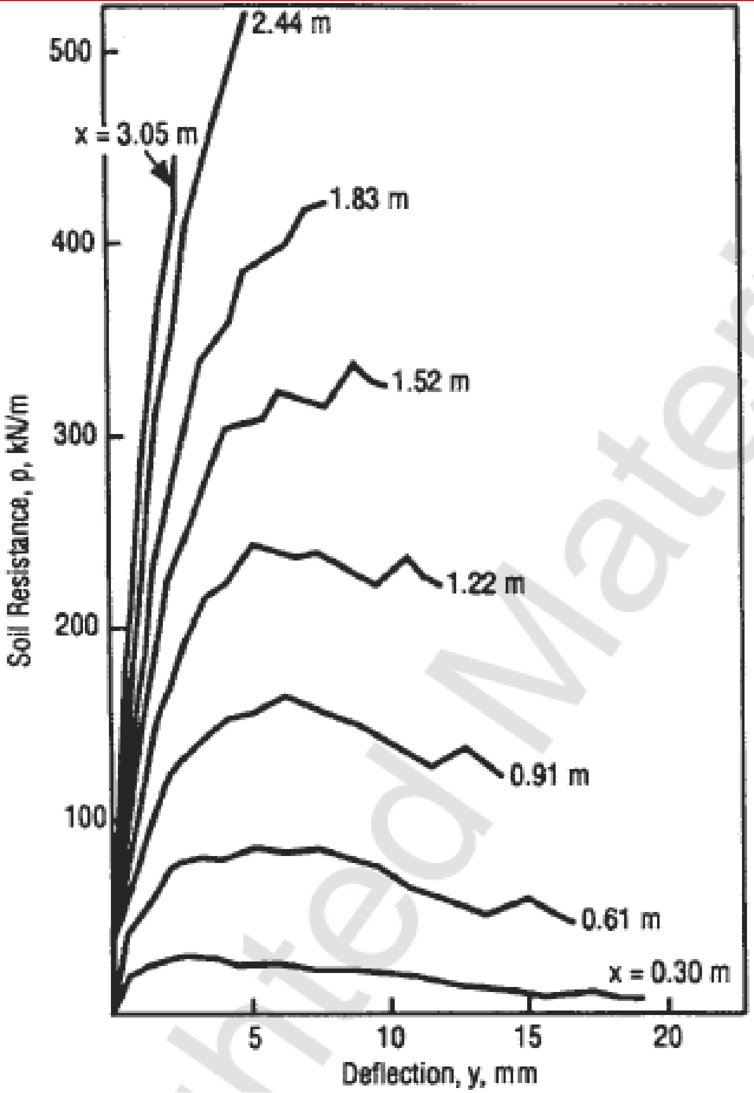
TABLE 14.1 Representative Values of K_{py} for Clays

	Average Undrained Shear Strength*		
kPa	50–100	200–300	300–400
K_{py} (static) MN/m³	135	270	540
(lb/in.³)	(500)	(1000)	(2000)
K_{py} (cyclic) MN/m³	55	110	540
(lb/in.³)	(200)	(400)	(2000)

*The average shear strength should be computed to a depth of five pile diameters. It should be defined as half of the total maximum principal stress difference in an unconsolidated, undrained triaxial test.

L. C. Reese, W. M. Isenhower, S-T. Wang: Analysis and design of shallow and deep foundations

TRANSVERSELY LOADED PILES



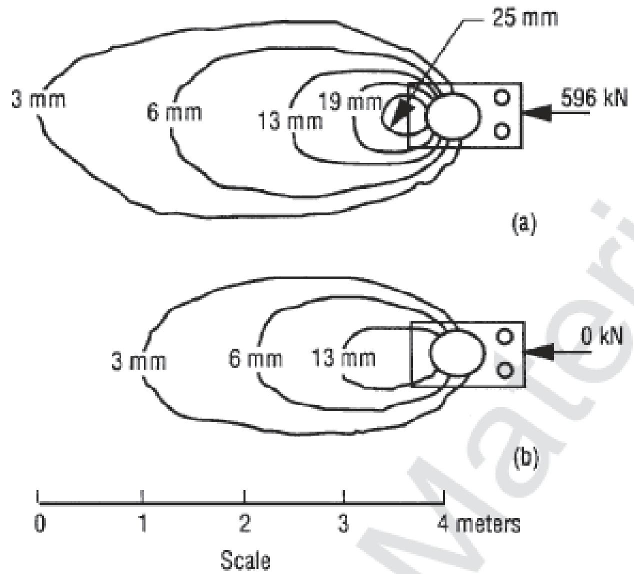


Figure 14.5 Ground heave due to static loading of pile 1: (a) heave at the maximum level; (b) residual heave.

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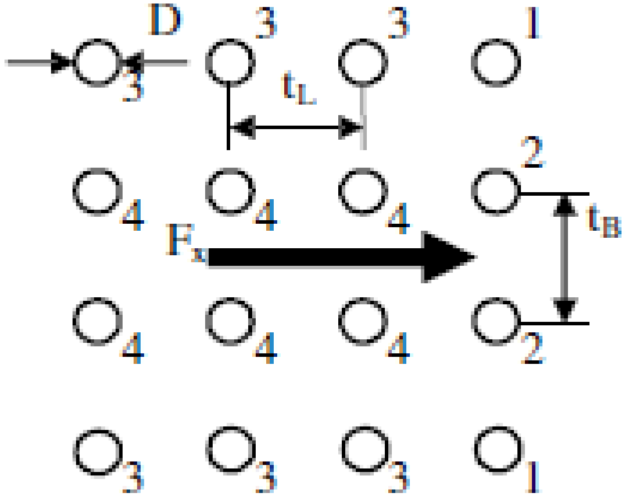
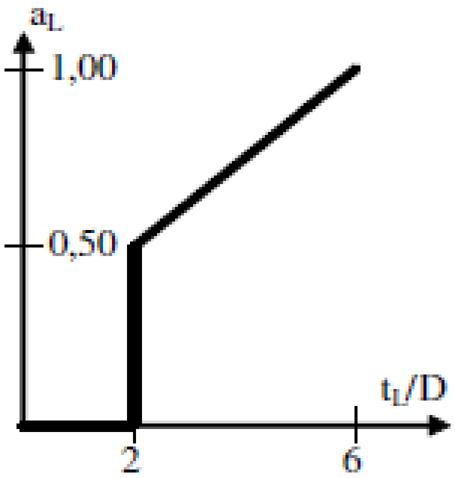
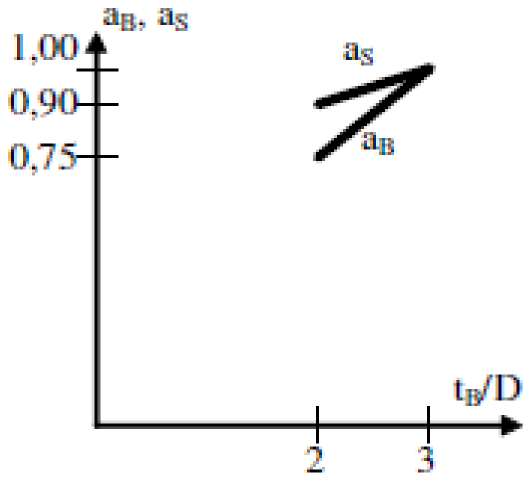
Analysis and design of shallow and deep foundations

TRANSVERSELY LOADED PILES







Raw of the piles	Reduction factor
1. raw	aS
2. raw	aB
3. raw	aL*aS
4. raw	aL*aB

$a_L=0{,}563$

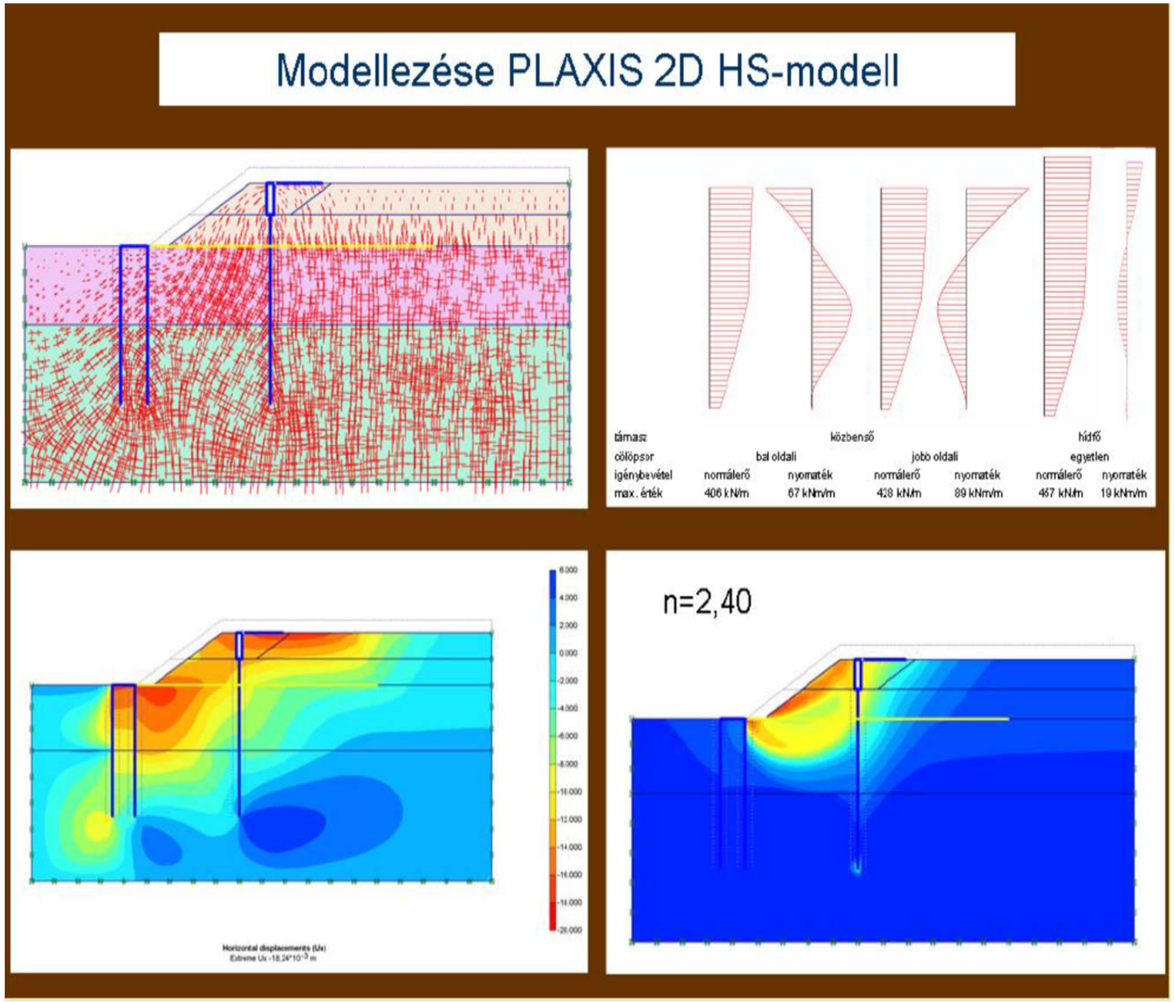
$a_B=0{,}875$

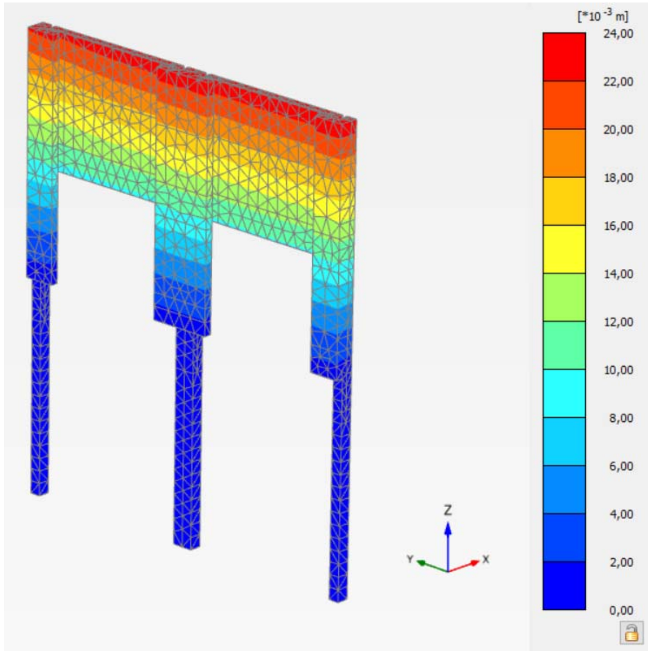
$a_S=0{,}95$

A row of piles parallel to the row in the x direction				
0,563	0,563	0,563	0,563	1
A row of piles in the y direction perpendicular to the row				
0,95	0,875	0,875	0,875	0,95
Two rows of piles parallel to the row in the x direction				
0,625	0,625	0,625	0,625	0,95
0,625	0,625	0,625	0,625	0,95
Two rows of piles in the y direction perpendicular to the row				
0,95	0,875	0,875	0,875	0,95
0,534	0,492	0,492	0,492	0,534

Czap Z,:Tervezési segédlet geotechniakai paraméterek cölöpök modellezéséhez

TRANSVERSELY LOADED PILES





TRANSVERSELY LOADED PILES

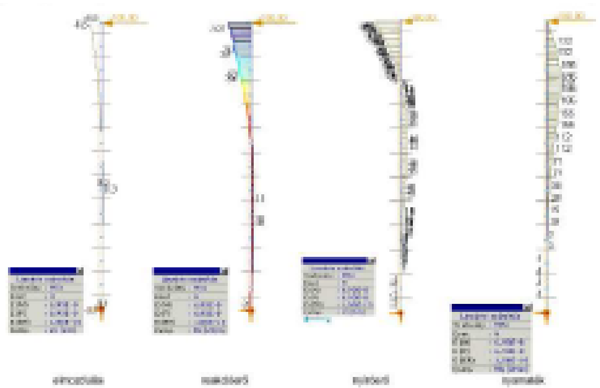
1. **Elastic embedded beam model**

Structure FEM software

Simple soil model

Complex pile model

The whole structure can be built in to a model



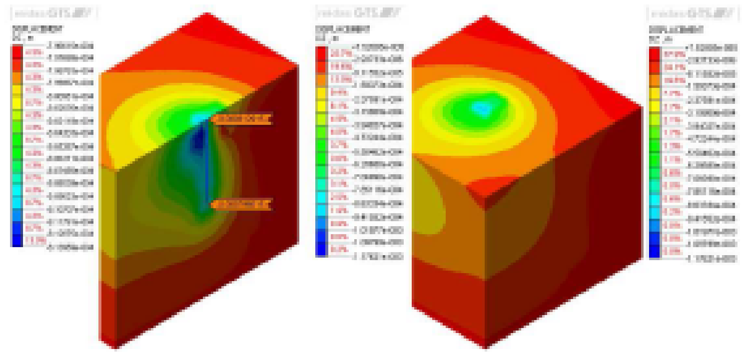
2. **Pile/pilegroup model in geotechnical FEM software**

More expensive, special softwares

Complex soil model

Simple pile model

Superstructure can not be modeled

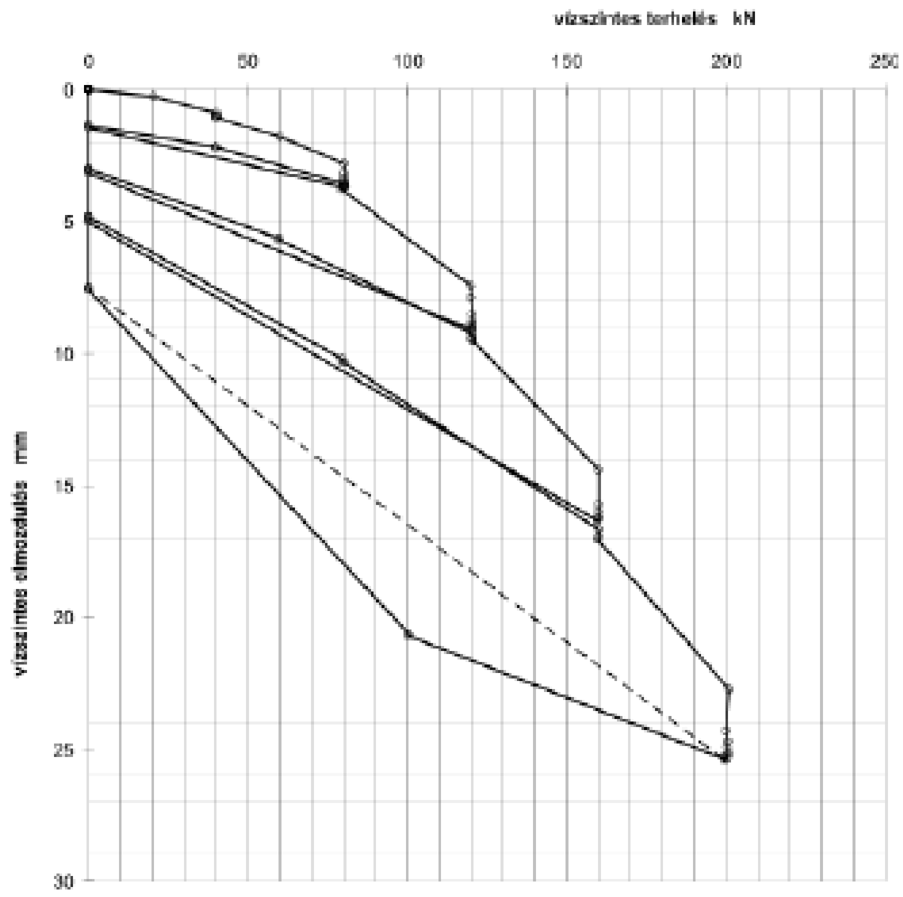


TRANSVERSELY LOADED PILES

The test pile

The anchores

TRANSVERSELY LOADED PILES



Maximum lateral load

$F_{H.MAX}$= 200 kN

Displacement of pilehead

→ maximum

$u_{H.MAX}$= 25 mm

→ residual

$u_{H.RES}$=8 mm

REINFORCMENT OF THE PILES AND PILECUPS

The cast-in place plies should be reinforced in total length, accept no other agreement about that.

The cast-in place piles can be made without reinforcment, if:

- During the construction and the lifetime of the pile only compression is generated in the pile;

and

- The piles are in non earthquake risk area.

Special analyses has to be done about the shearsterength at the border of the layers caused by earthquake.

If there is no any other regulation, it is reccomended to install reinforcment at the sections of the pile where soft or loose layers layes around the pile.

Calculating the coincidence (eg from local building operations, pile eccentricity, etc.), minimum 4 m of load-bearing piles should be placed in minimum.

The tensile piles must be reinforced in the total length.

REINFORCMENT OF THE PILES AND PILECUPS

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The minimum reinforcement is:

Diamter of the pile: A_C	Diameter of the steelbars: A_S
$A_C \leq 0{,}5\ m^2$	$A_S \geq 0{,}5\%\ A_C$
$0{,}5\ m^2 < A_C \leq 1{,}0\ m^2$	$A_S \geq 0{,}0025\ m^2$
$A_C > 1{,}0\ m^2$	$A_S \geq 0{,}25\%\ A_C$

The minimum reinforcement is min. 4 pieaces of d=12 mm steelbar at the top 4m.

Minimum concrete cover is:

- 75 mm diaphragma piles;
- 60 mm, if the diameter of the pile: $D > 0{,}6$ m,
- 50 mm, if the diameter of the pile : $D \leq 0{,}6$ m,
- 40 mm, if permanent casing used.

PLANS OF PILEFOUNDATION

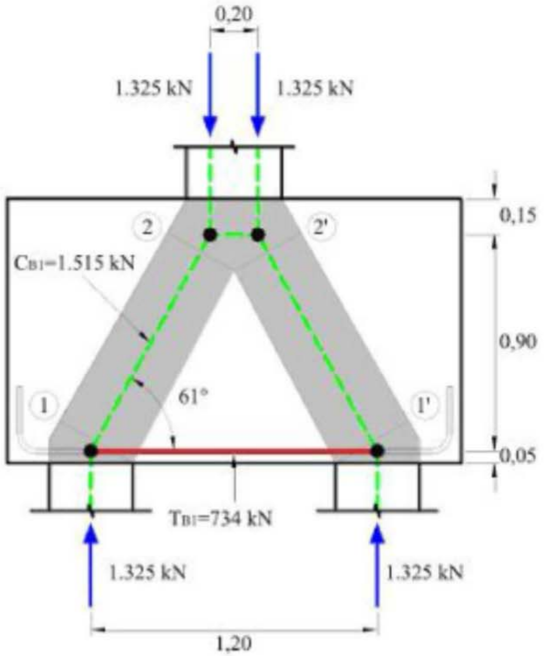


Fig. 1.3-5: Model B1: compressive forces of concrete in column (dimensions in m)

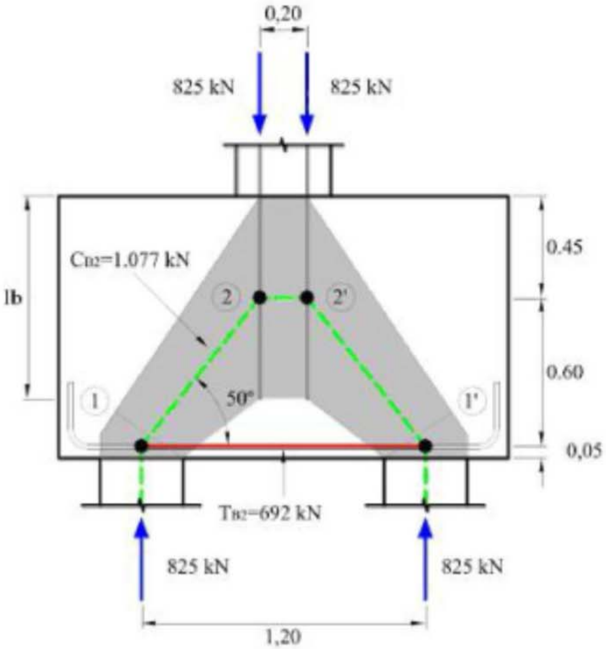


Fig. 1.3-6: Model B2: compressive forces of column reinforcement (dimensions in m)

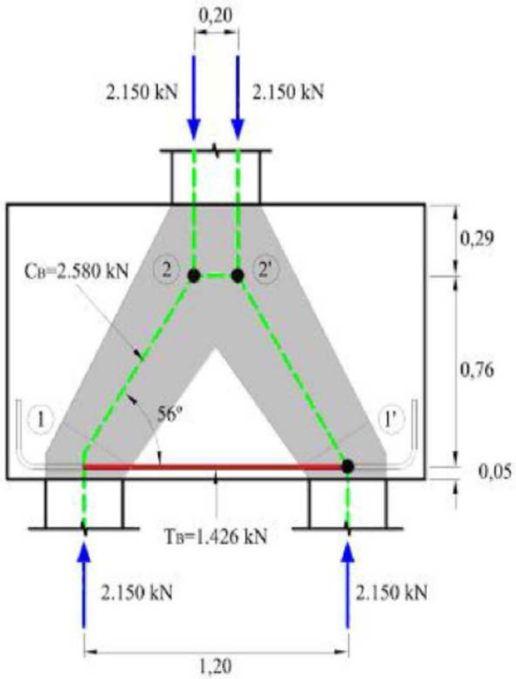
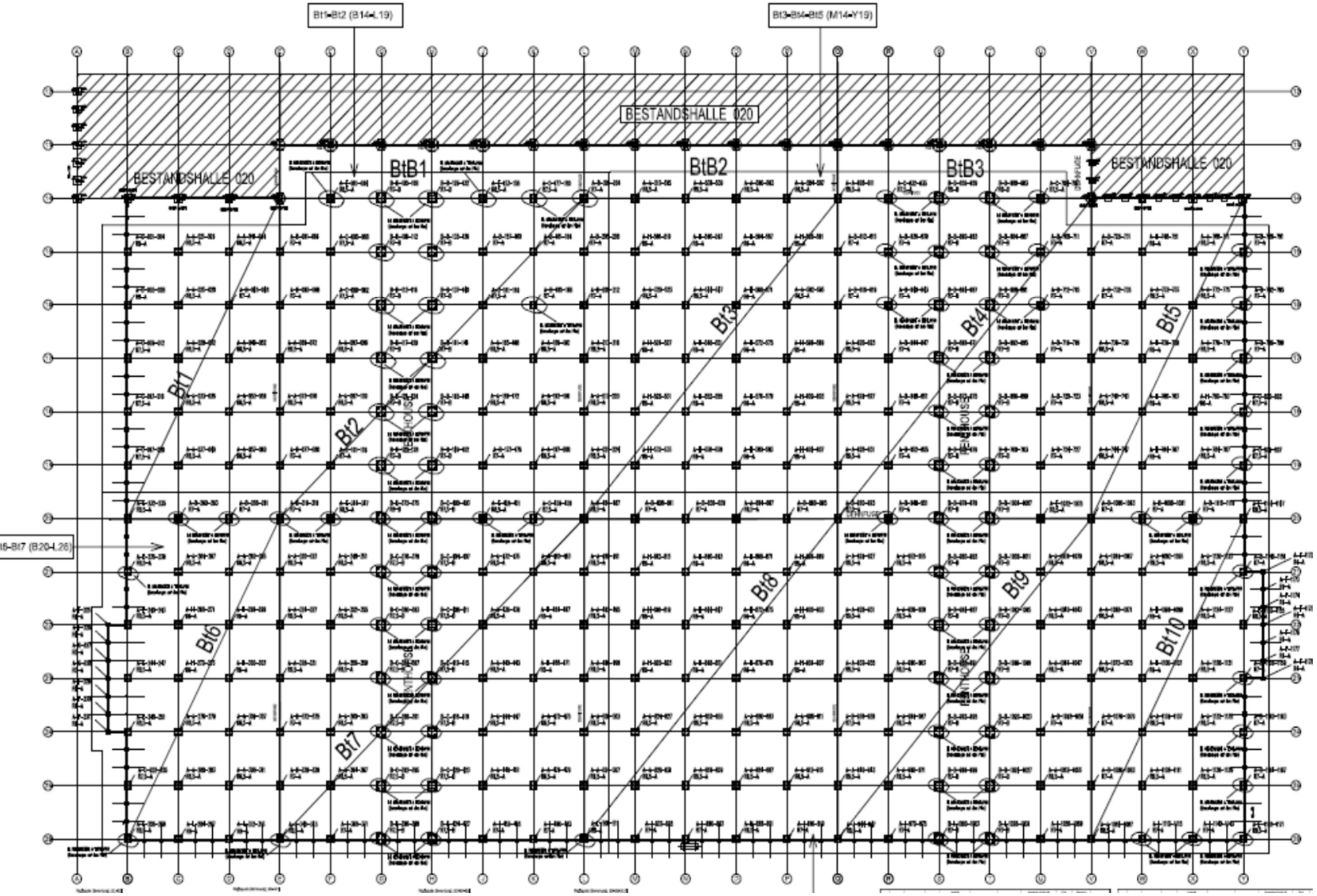
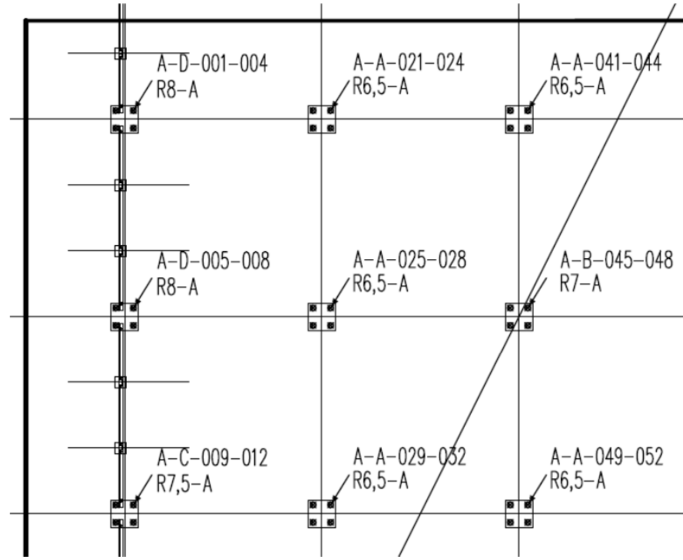


Fig. 1.3-7: Model B. Superposition of models B1 and B2 (dimensions in m)

PLANS OF PILEFOUNDATION





Cölöp jelölés (Pfahlkennzeichnung):

Cölöp típusa
(Typ des Pfahles)
A=SS33/50
B=SS53/70

Cölöp talp síkja (Pfahlfußniveau):

A=107,6mBf	H=108,1mBf
B=107,1mBf	I=106,7mBf
C=106,6mBf	J=105,2mBf
D=106,1mBf	K=106,2mBf
E=105,6mBf	L=105,7mBf
F=109,9mBf	M=107,2mBf
G=108,9mBf	

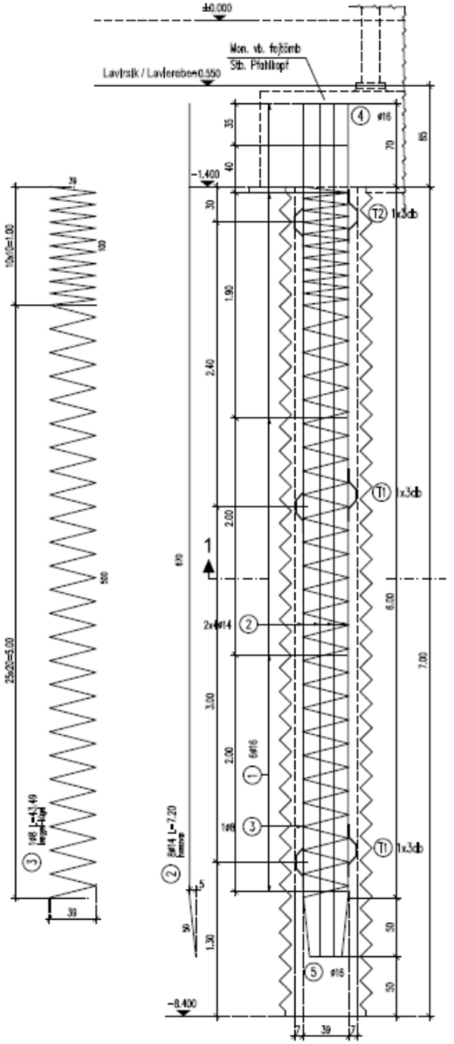
X-Y-xxx
Ri-X

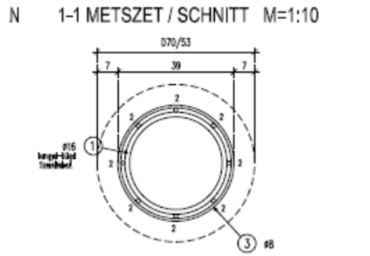
Ri=armatúra hossza m-ben
(Bewehrungslänge in m)
R4=4m-es cölöp (Pfahllänge 4m)
R5=5m-es cölöp (Pfahllänge 5m)
R6=6m-es cölöp (Pfahllänge 6m)
R6,5=6,5m-es cölöp (Pfahllänge 6,5m)
R7=7m-es cölöp (Pfahllänge 7m)
R7,5=7,5m-es cölöp (Pfahllänge 7,5m)
R8=8m-es cölöp (Pfahllänge 8m)
R8,5=8,5m-es cölöp (Pfahllänge 8,5m)

Cölöp sorszáma 001-től
(Pfahlnummer,
beginnend bei 001)

Armatúra típusa (Typ der Bewehrung):
A- SS33/50-es cölöphöz (für Pfähle SS33/50)
B- SS53/70-es cölöphöz (für Pfähle SS53/70)

REINFORCMENT OF THE PILES AND PILECUPS



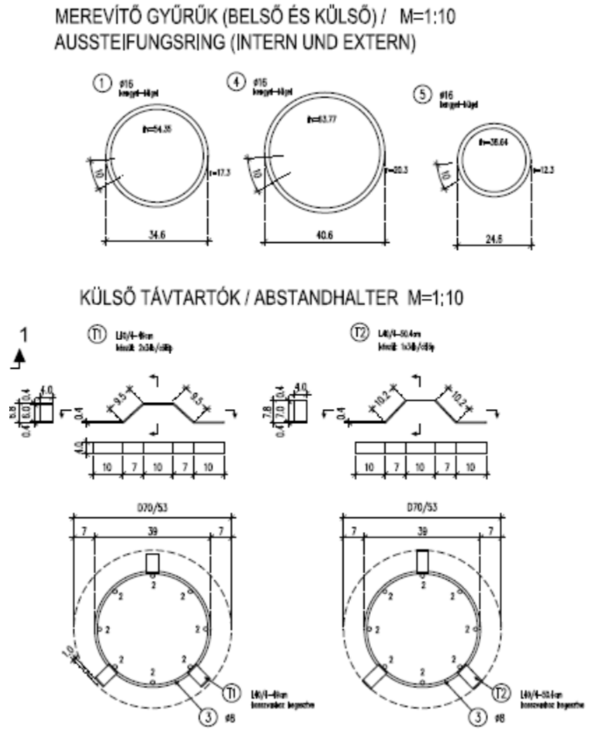


Megjegyzés:

- Betonminőség: - cölöp beton: C30/37-XC2-XA1-16-F5
- Betonacél minőség: B 500 B
- Betontakarás: 70mm

Csatlakozó tervek: SA-101 és SA-102
Csatlakozó műszaki leírás: S-101

±0,00 = 115,50 mBf



BETONSTAHLLISTE- ÁTMÉRŐ–TÖMEG ÖSSZESÍTÉS

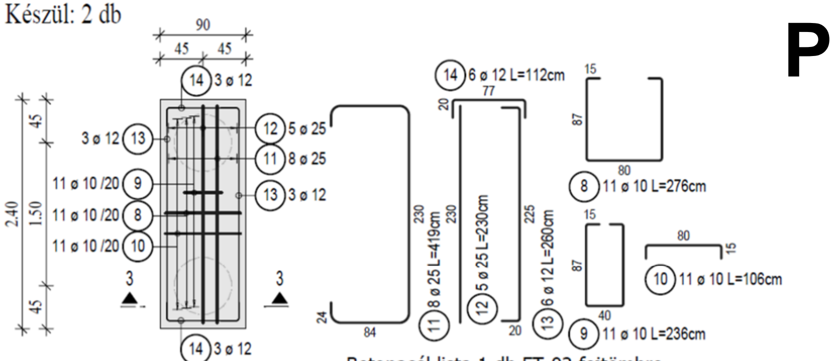
Jel	db	ø	Vasalat	Hossz	ø8	ø14	ø16	T1	T2
		[mm]		[m]					
1	6	16	ih=54.35 r=17.3	1.19			7.14		
2	8	14	50 670	7.20		57.60			
3	1	8	19 100 500	43.49	43.49				
4	1	16	ih=63.77 r=20.3	1.38			1.38		
5	1	16	ih=38.64 r=12.3	0.87			0.87		
T1	6	L40/4		0.49				2.94	
T2	3	L40/4		0.50					1.50
				Összhossz / ø [m]:	43.49	57.60	9.39	2.94	1.50
				Fm. tömeg / ø [kg/m]:	0.395	1.21	1.58	0.615	0.628
				Össztömeg / ø [kg]:	17.18	69.70	14.84	1.81	0.94
				Össztömeg [kg]:			104.47		

Die Stahlliste bezieht sich auf 1 St. Pfahl!/ A MEGADOTT VASMENNYISÉG 1 DB CÖLÖPRE VONATKOZIK!

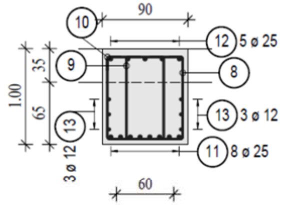
Plans of pilefoundation

FT-02 fejtömb vasalási terve M=1:50

Készül: 2 db



Metszet 3 - 3

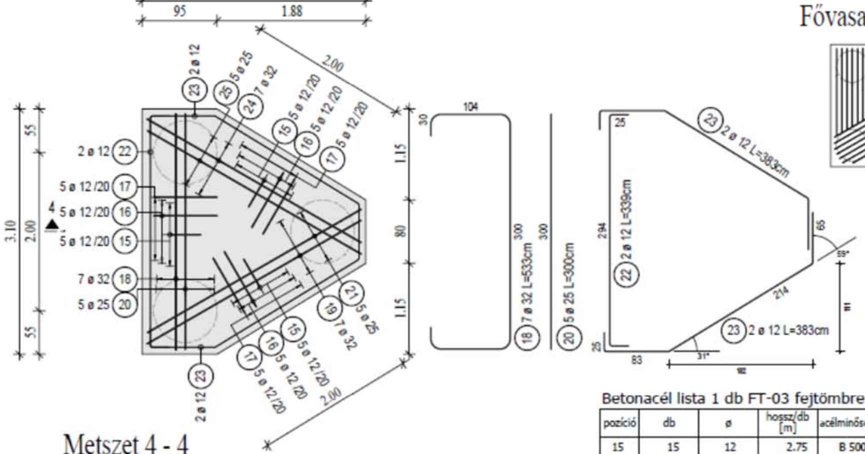


Betonacél lista 1 db FT-02 fejtömbre

pozíció	db	ø	hossz/db [m]	acélminőség	összhossz [m]	tömeg [kg]
8	11	10	2.76	B 500	30.36	18.70

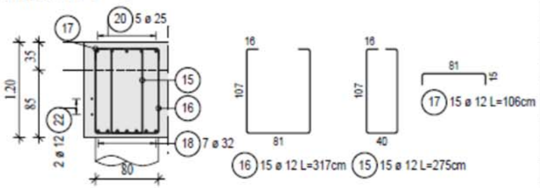
FT-03 fejtömb vasalási terve M=1:50

Készül: 1 db



Fővasak elhelyezése

Metszet 4 - 4



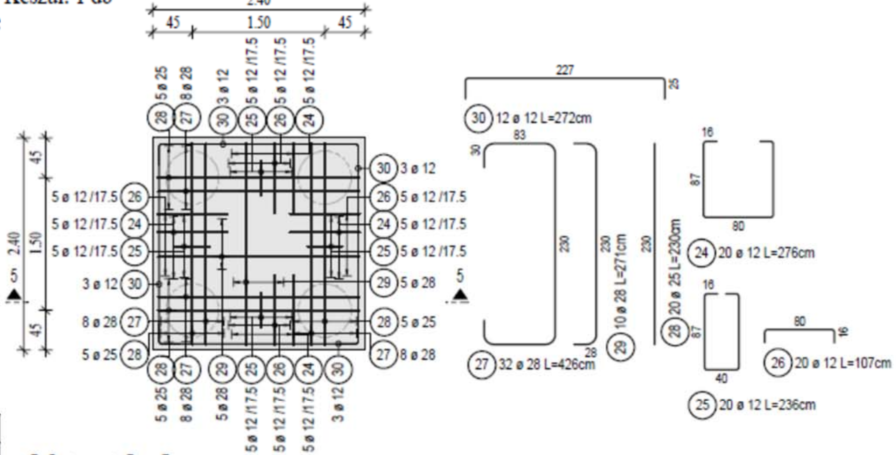
Betonacél lista 1 db FT-03 fejtömbre

pozíció	db	ø	hossz/db [m]	acélminőség	összhossz [m]	tömeg [kg]
15	15	12	2.75	B 500	41.25	36.59
16	15	12	3.17	B 500	47.55	42.18
17	15	12	1.06	B 500	15.90	14.10
18	7	32	5.33	B 500	37.31	235.43
19	7	32	-X-	B 500	36.65	231.26
20	5	25	3.00	B 500	15.00	57.77
21	5	25	-X-	B 500	14.89	57.34
22	2	12	3.39	B 500	6.78	6.01
23	4	12	3.83	B 500	15.32	13.59
24	7	32	-X-	B 500	36.65	231.26
25	5	25	-X-	B 500	14.89	57.34

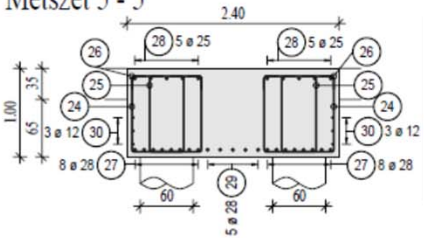
982.87 kg

FT-04 fejtömb vasalási terve M=1:50

Készül: 1 db



Metszet 5 - 5



Betonacél lista 1 db FT-04 fejtömbre

pozíció	db	ø	hossz/db [m]	acélminőség	összhossz [m]	tömeg [kg]
24	20	12	2.76	B 500	55.20	48.96
25	20	12	2.36	B 500	47.20	41.87
26	20	12	1.07	B 500	21.40	18.98
27	32	28	4.26	B 500	136.32	658.56
28	20	25	2.30	B 500	46.00	177.15
29	10	28	2.71	B 500	27.10	130.92
30	12	12	2.72	B 500	32.64	28.95

1105.39 kg

MŰEGYETEM 1782

MŰEGYETEM 1782

THANK YOU FOR YOUR ATTENTION!