Fundamenty linii energetycznych w trudnych warunkach geologicznych

WG B2.82

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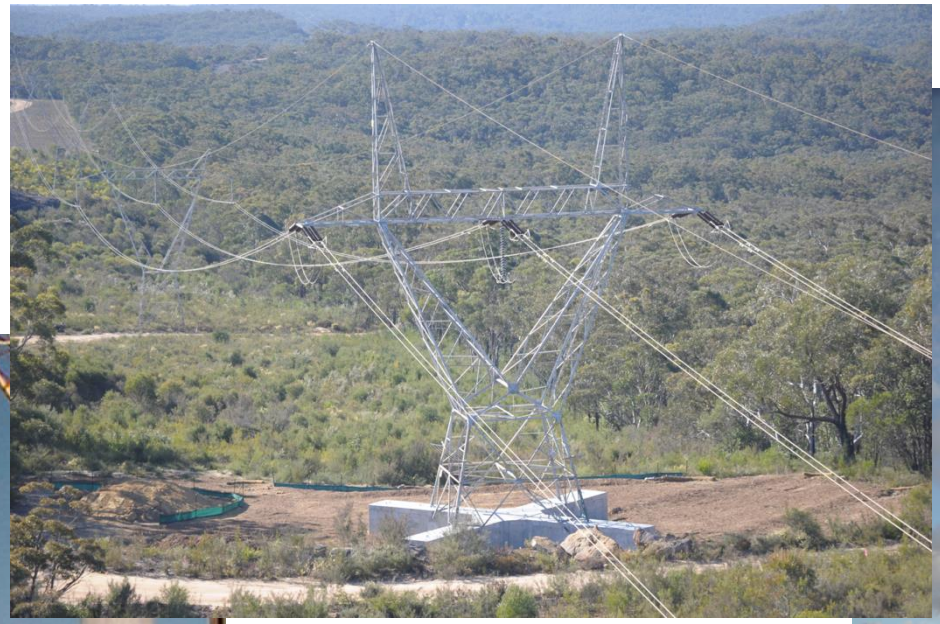
01

Wstęp

Earthquake



Flood areas

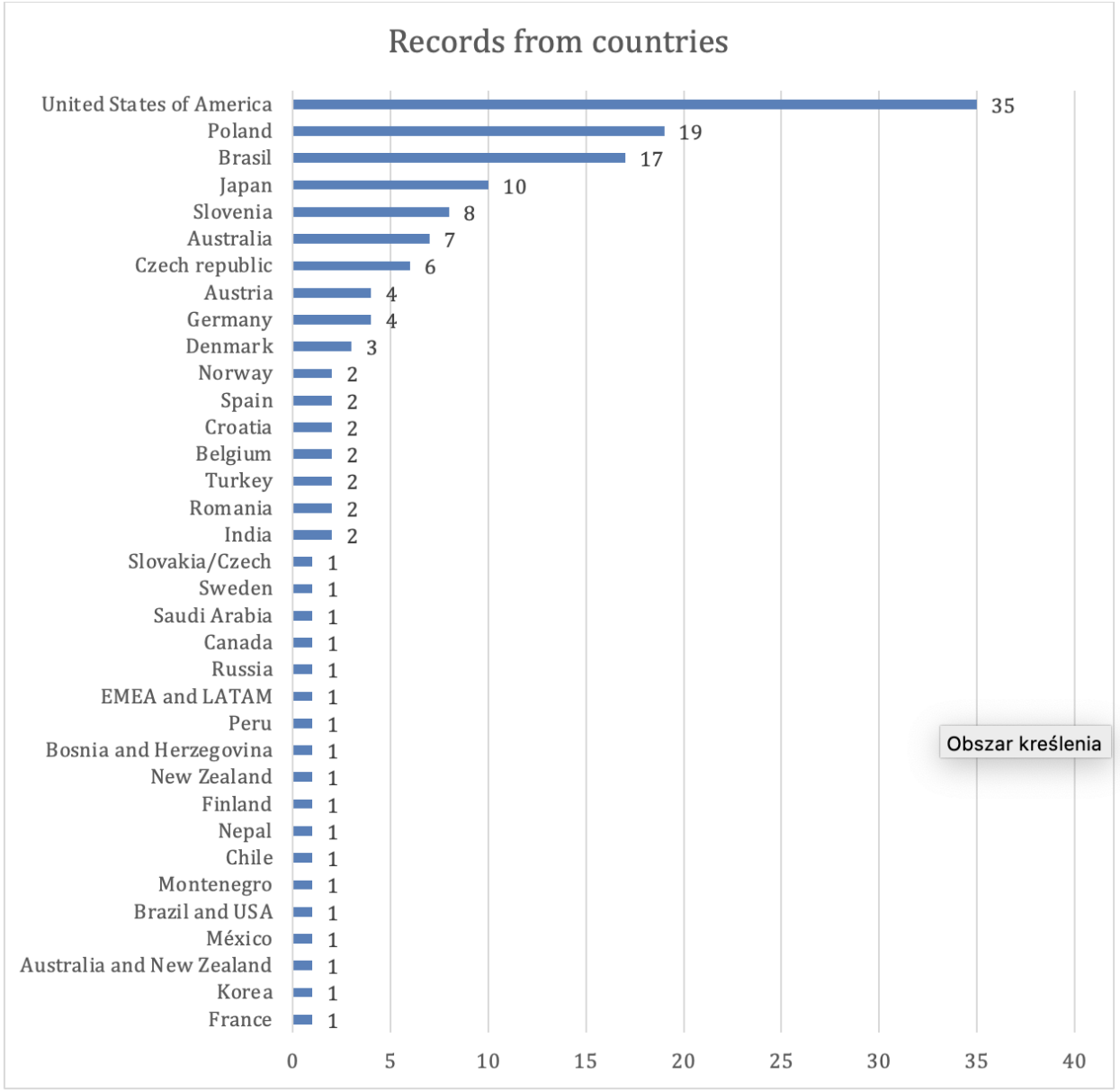
Minning deformations

River crossing

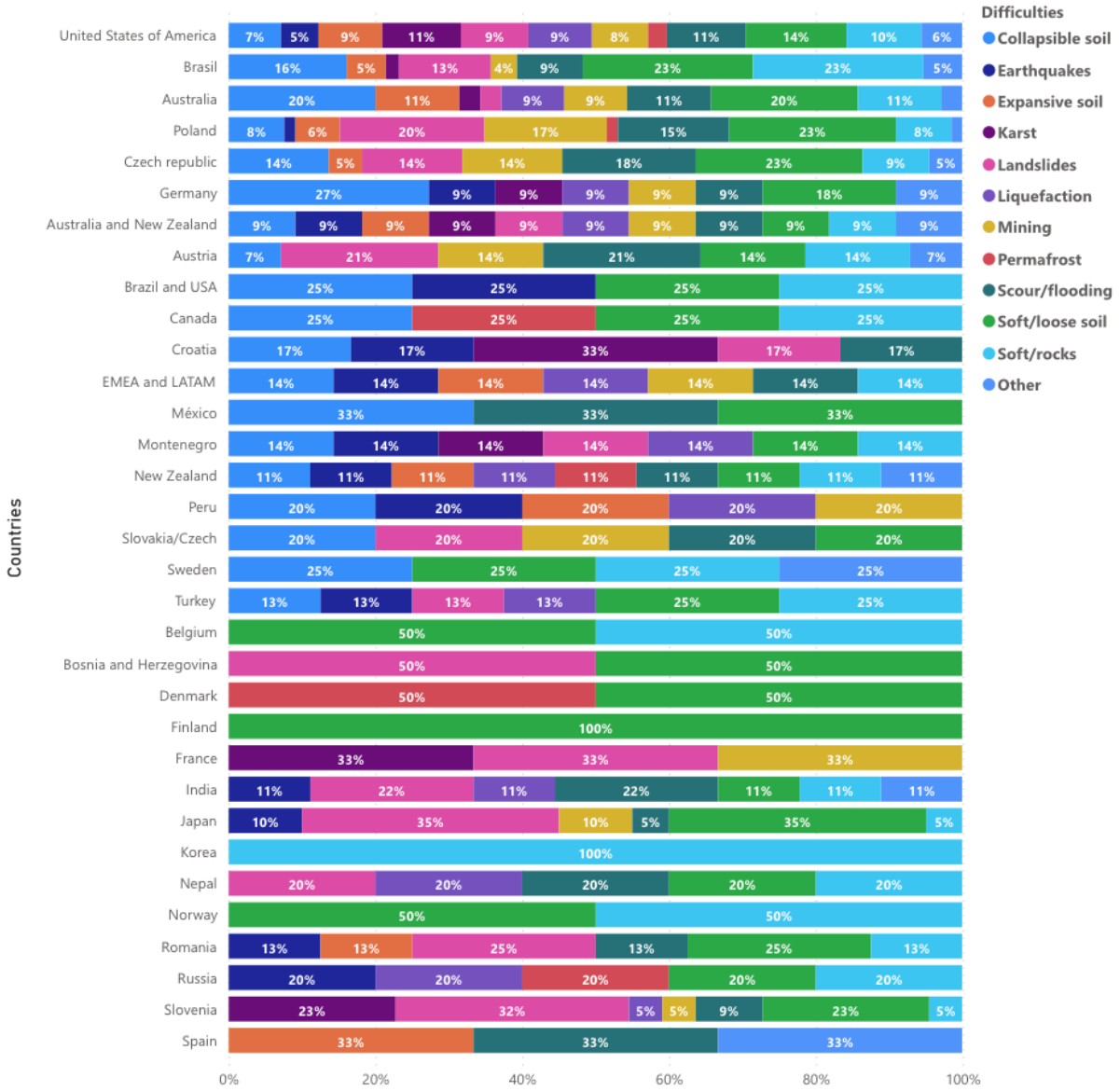
Special solutions for difficult soil condition

02

Kwestionariusz


Records from countries
United States of America 35
Poland 19
Brasil 17
Japan 10
Slovenia 8
Australia 7
Czech republic 6
Austria 4
Germany 4
Denmark 3
Norway 2
Spain 2
Croatia 2
Belgium 2
Turkey 2
Romania 2
India 2
Slovakia/Czech 1
Sweden 1
Saudi Arabia 1
Canada 1
Russia 1
EMEA and LATAM 1
Peru 1
Bosnia and Herzegovina 1
New Zealand 1
Finland 1
Nepal 1
Chile 1
Montenegro 1
Brazil and USA 1
México 1
Australia and New Zealand 1
Korea 1
France 1
0 5 10 15 20 25 30 35 40
Obszar kreślenia

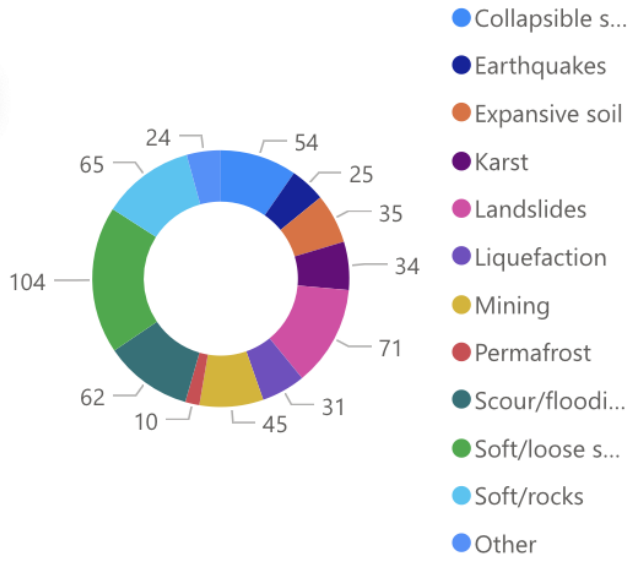
Difficulties in individual countries



560

Sum of responses

Number of difficulties



03

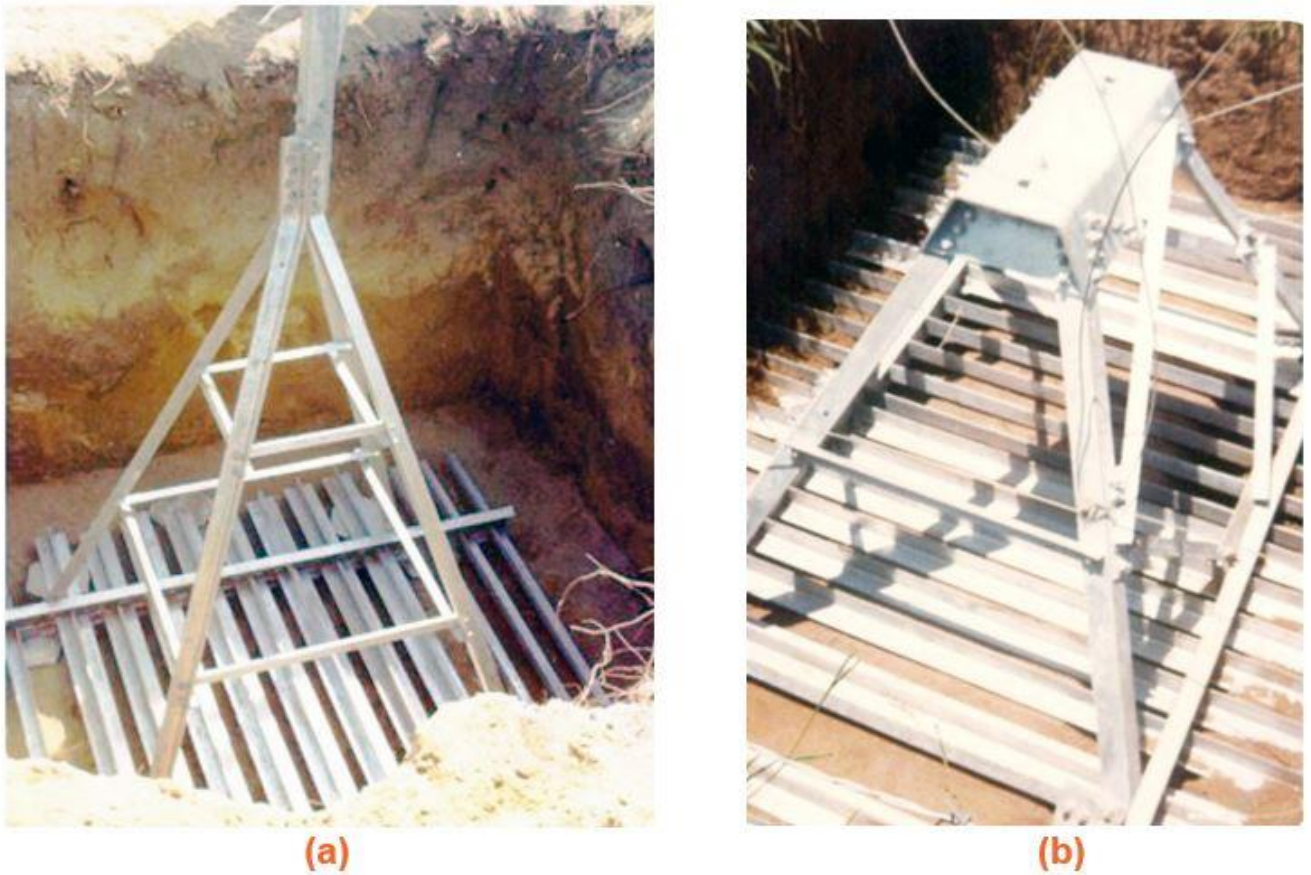
Przegląd typowych fundamentów linii energetycznych

Foundation Type	Type of loading/Typ obciążenia			Soil capacity/Nośność podłoża		
	Separate Foundation Fundamenty dzielone wyciągane/ściskane	Single Pole Monopale zginane	Guy Z odciągami	Soft Niska	Medium Średnia	Stiff Wysoka
Raft or Spread foundation/Płyty i ławy	X			X	X	X
Pad and Chimney (Weight foundation for leg, Pyramid/ Fundamenty grzybkowe	X	X	X	X	X	X
Grillages/Ruszty	X		X		X	X
Direct Embedment/Zakotwienia bezpośrednie	X	X	X		X	X
Drilled Shafts/Pale wiercone	X	X	X		X	X
Driven pile (only 1 pile) Monopale wbijane	X	X	X		X	X
Head driven pile (Multiple piles) Pale wbijane	X	X	X	X	X	X
Anchors/Kotwy			X			X
Screw piles/Pale wkręcane	X		X		X	X
"Deadman" for guy foundations/Zakotwienia odciągów			X		X	X

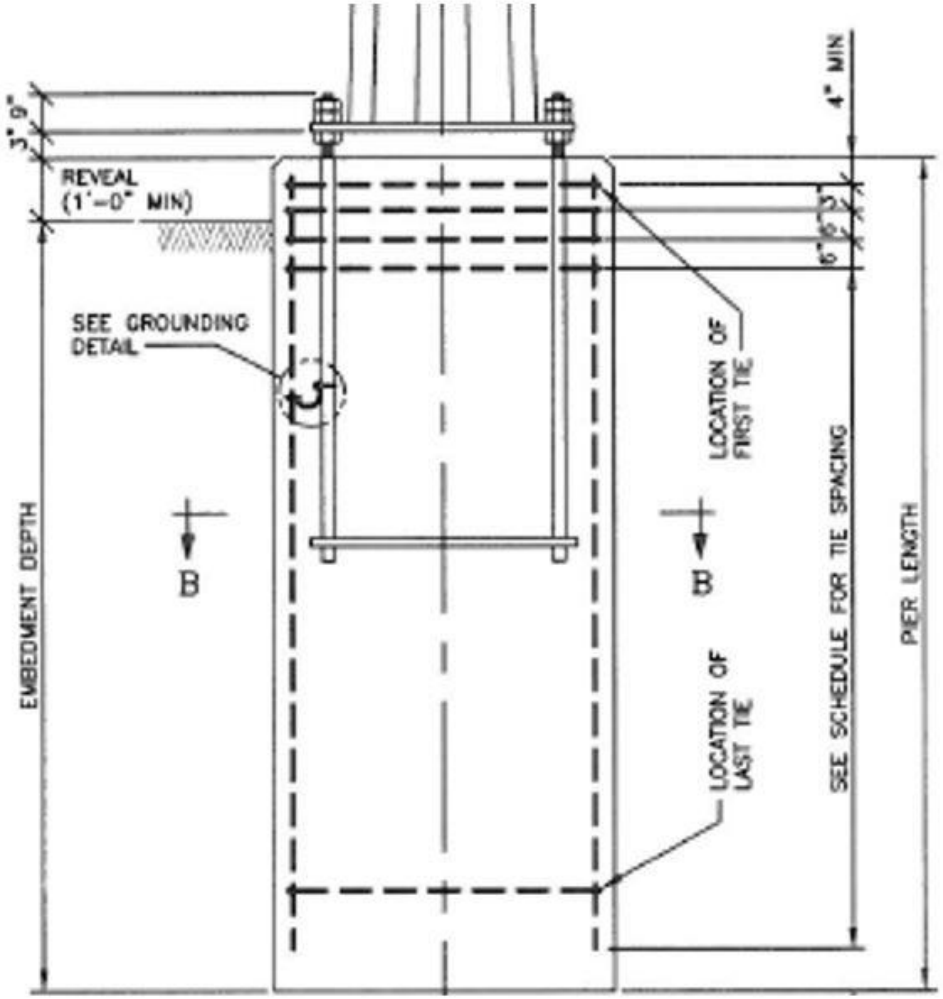
Type of loading and soil the different foundations are good for

Raft foundations/Płytowe

Pad and chimney foundations/Grzybkowe

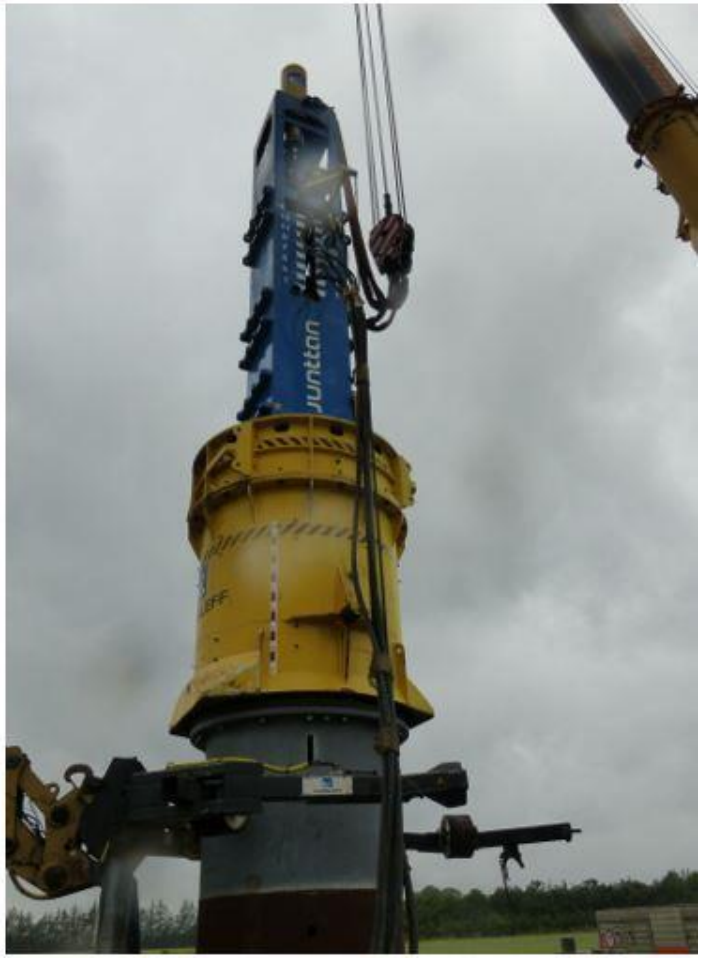


Foundations in steel grillage/Ruszty stalowe, (a) for self-supporting tower leg/czterostopowe (b) for masts of guyed-V tower/dla masztów z odciągami



Drilled Pier, Caisson foundation/Pale i kesony wiercone

Direct embedment foundation/Bezpośrednie pogrążenie



Driven pile/Pale pogrążane wibracyjnie

Anchors/Zakotwienia odciągów

Screw piles/Pale i kotwy wkręcane

"Deadman" for guy foundations/Zakotwienia oporowe

04

Opis rodzajów badań geologicznych

Test	Fine soil (clay, silt)	Coarse soil (sand, gravel)	Rock	Standard
Compressibility	x			EN ISO 17892-5:2017 ASTM D 2435
Unconfined compression test	x			EN ISO 17892-7:2018
				ASTM D 2166
			x	ASTM D 7012-10
Fall cone test	x			EN ISO 17892-6:2017
Vane shear test	x			ASTM D 4648-05 BS 1377: Part 7:1990
Direct shear	x			EN ISO 17892-10:2019 ASTM D 6528-17
		x		BS 1377: Part 7:1990
Residual shear	x	(x)		BS 1377: Part 7:1990 (point 6)
Unconsolidated-undrained triaxial test	x			EN ISO 17892-8:2018 ASTM D 2850-03
Consolidated-undrained triaxial test	x			EN ISO 17892-9:2018
Consolidated-drained triaxial test	x			EN ISO 17892-9:2018
Direct shear strength of rock and joint			x	ASTM D 5607-16
Point load test			x	ASTM D 5731-16
Durability			x	ASTM D 4644-8
Tensile strength of rocks			x	ASTM D 3967-16
Abrasion test		x	x	ASTM C 535-16 ASTM D 6928-17
Coefficient of water permeability	x	x		EN ISO 7892-11:2019
Pulse velocities			x	ASTM D 2845-8

Overview of the laboratory test for determining the mechanical properties

Test	Fine soil (clay, silt)	Coarse soil (sand, gravel)	Rock	Standard
Trial pit	x	x		
Borehole	x	x	x	ASTM D 1452-09 ASTM D 6286-98 BS EN ISO 22475-1
Borehole-logging	x	x	x	ASTM D 5434-9
Sampling	x	x	x	EN ISO 22485-1
Geophysical measurements	x	x	x	
Standard pressuremeter test (SPT)	x	x		EN ISO 22476-3ASTM D 1586-11
Cone penetration test (CPT)	x			EN ISO 22476-1 ASTM D 3441-5 ASTM D 5778-7
Cone penetration test (CPTU)	x			EN ISO 22476-1
Pressuremeter test (PMT)	x	x	x	ASTM D 4719-20
Flexible dilatometer test (FDT)	x	x	x	EN ISO 22476-5
Dynamic probe test (DP)	x	x		EN ISO 22476-2
Vane shear test (VST)	x			ASTM D 4648-16
Field vane test (FVT)	x			EN ISO 22476-9 ASTM D 2573-8
Weight sounding test (WST)	x	x		CEN ISO/TS 22476-10
Flat dilatometer test (DMT)	x			CEN ISO/TS 22476-11
Plate loading test (PLT)	x	x	x	EN ISO 22476-13
Groundwater measurements	x	x	x	EN ISO 22475-1
Seismic characteristics	(X)	(X)		EN 1998

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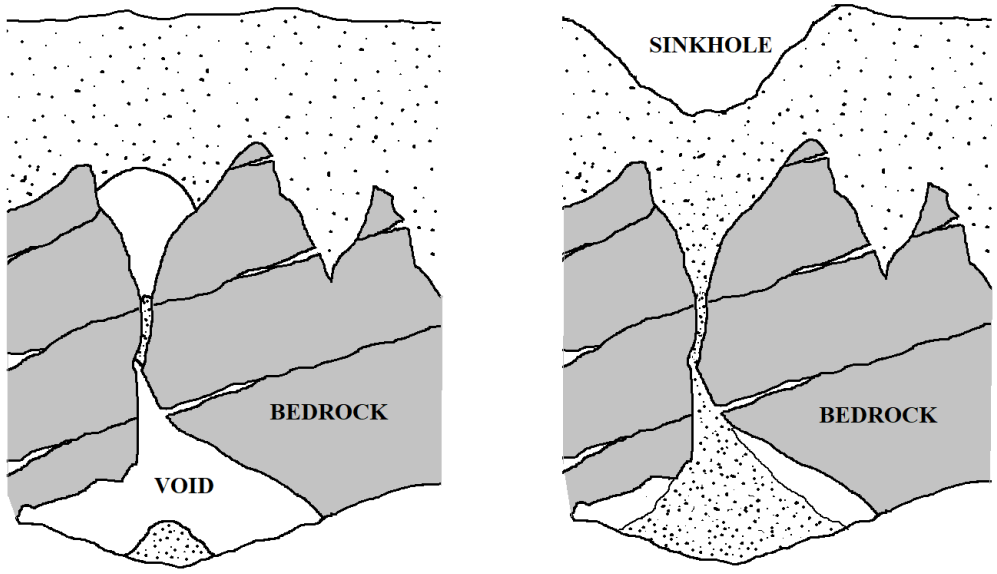
Overview of the basic field tests

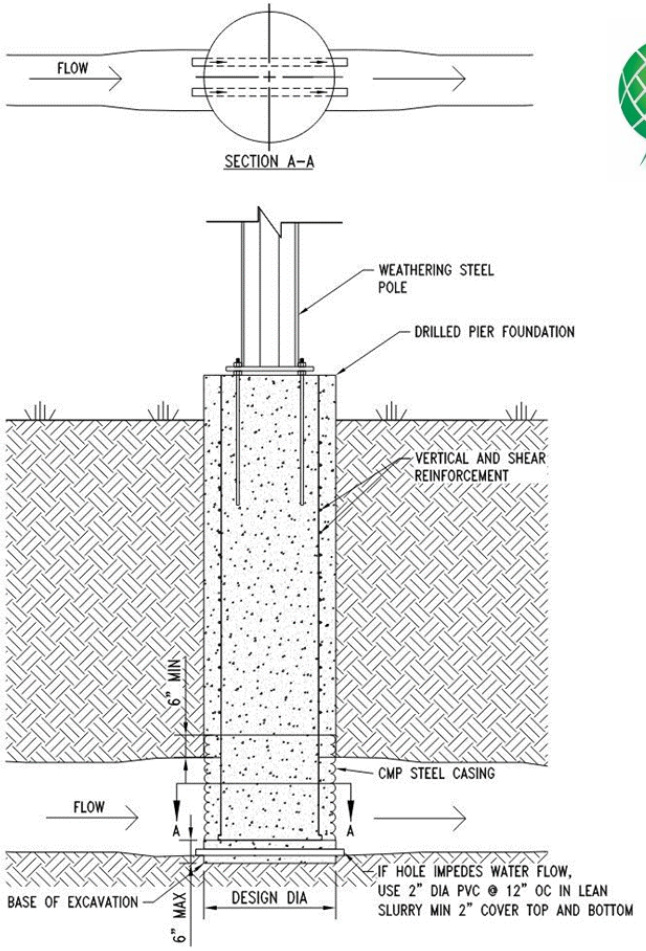
05

Opis rodzajów trudnych warunków geologicznych

5.1 Karst



Subsurface voids and sinkhole development



DRILLED PIER STEEL POLE WITH KARST FEATURE WITH FLOWING WATER, BOTTOM OF HOLE

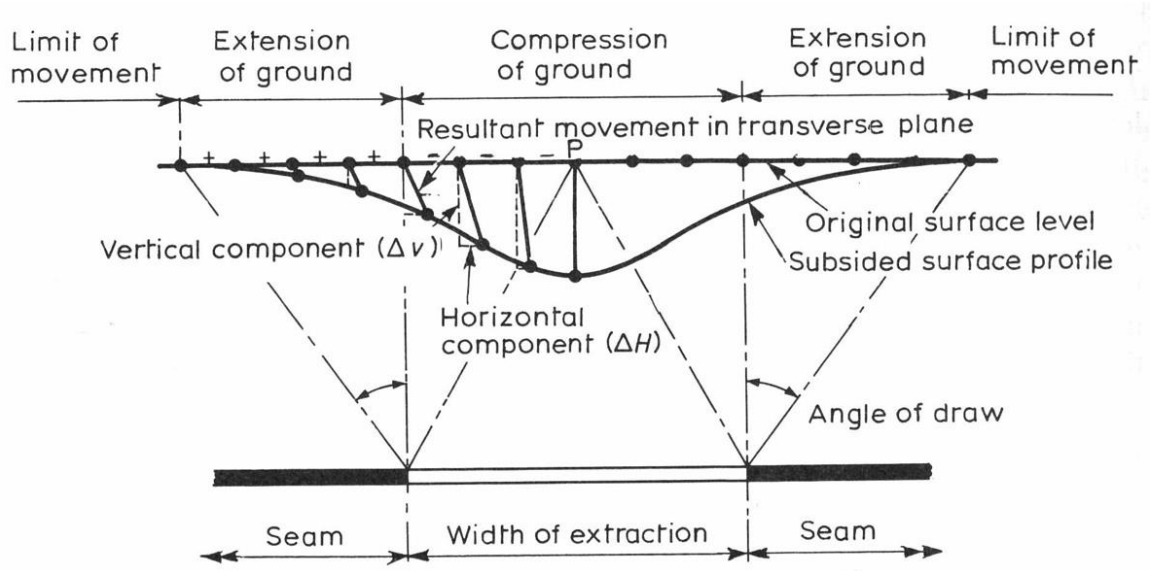
TD–KARST 4

5.2 Landslide

A landslide near Cusco, Peru

Special type of landslide foundation, Poland

5.3 Mining Operations

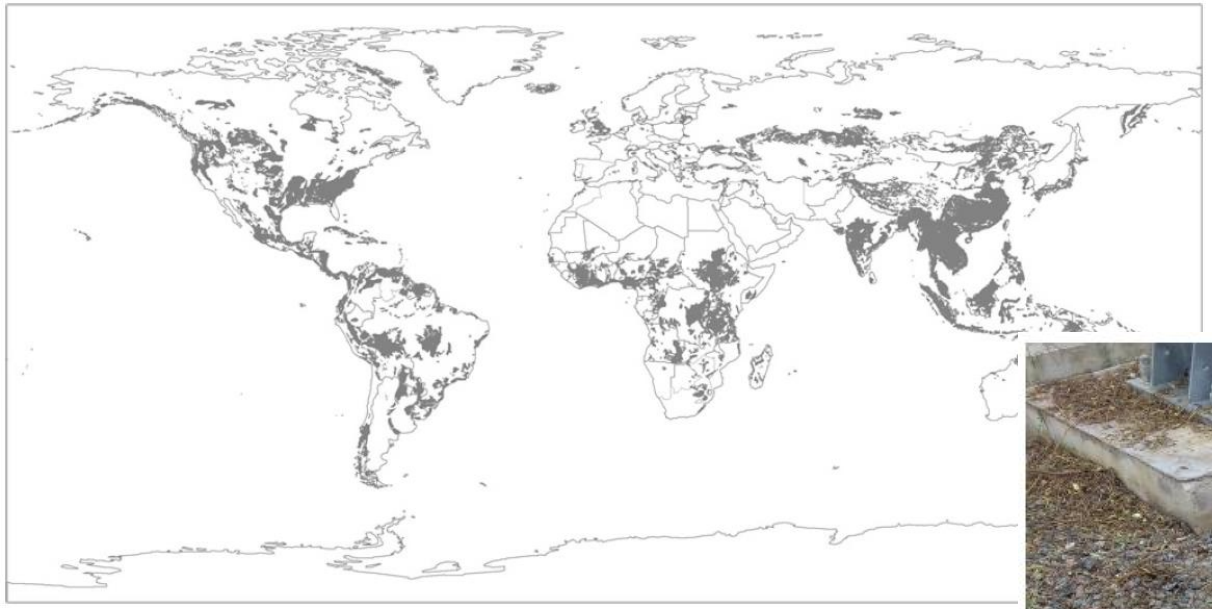


The basic form of the subsidence

Tower 220kV plunged in water 5 m deep

Top concrete frame

5.4 Expansive Soils



Global distribution of shrink-swell soil

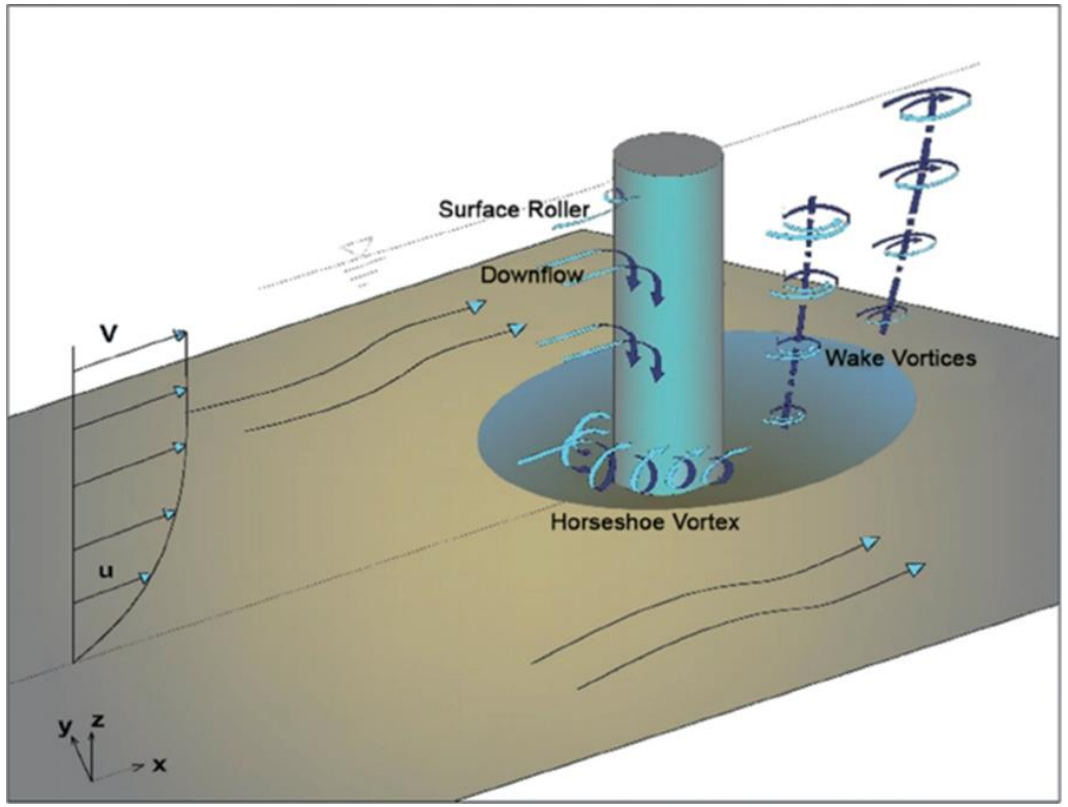
Settlement of landfill near foundations

5.5 Extremely soft Soils

Excavation in Peat

Pile installation

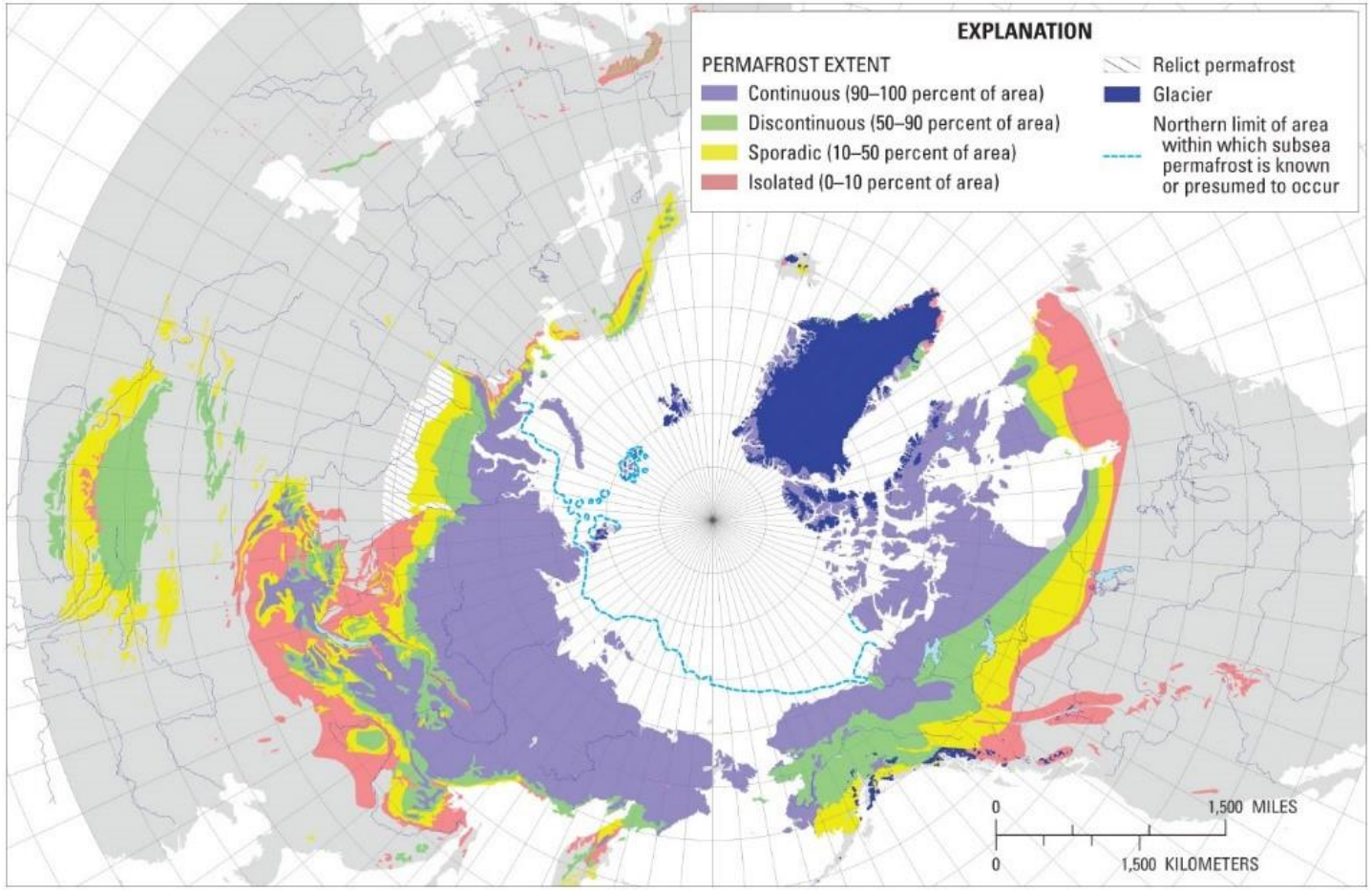
5.6 Scour



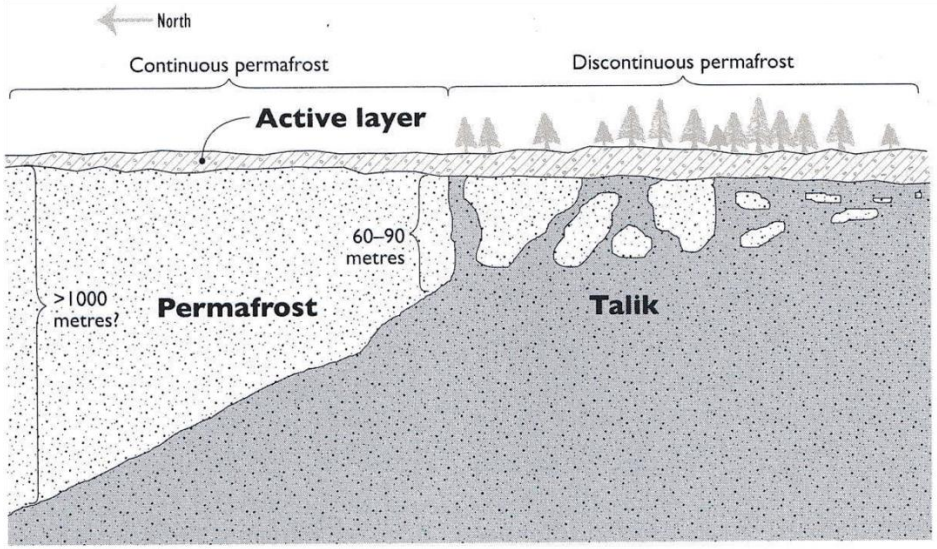
Scour around a Pier Foundation

Scour around piled foundation

5.7 Permafrost



General distribution or permafrost in the northern hemisphere



Main features of the ground profile in permafrost affected areas

5.8 Collapsible Soils

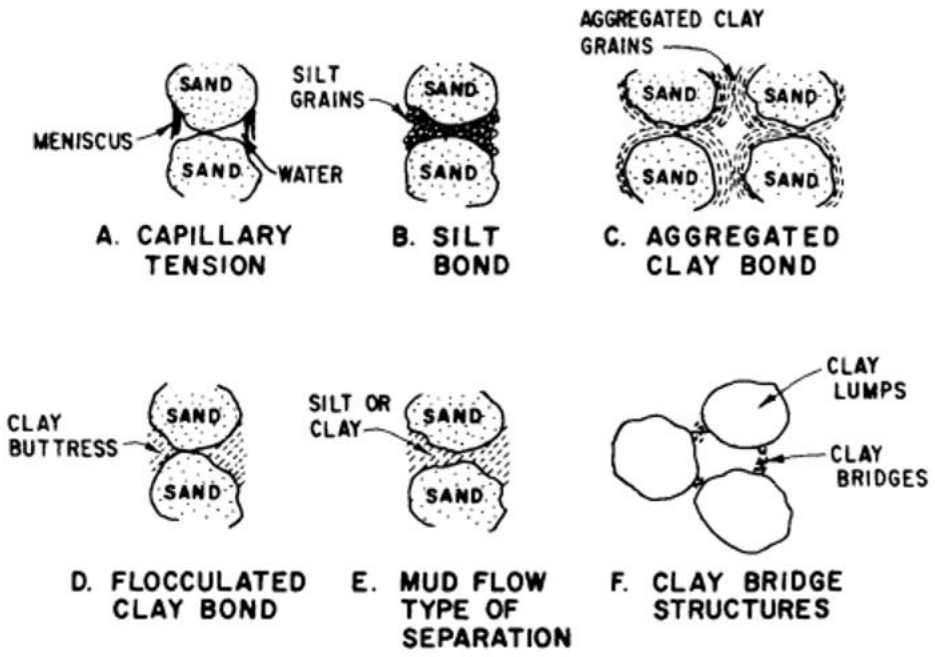
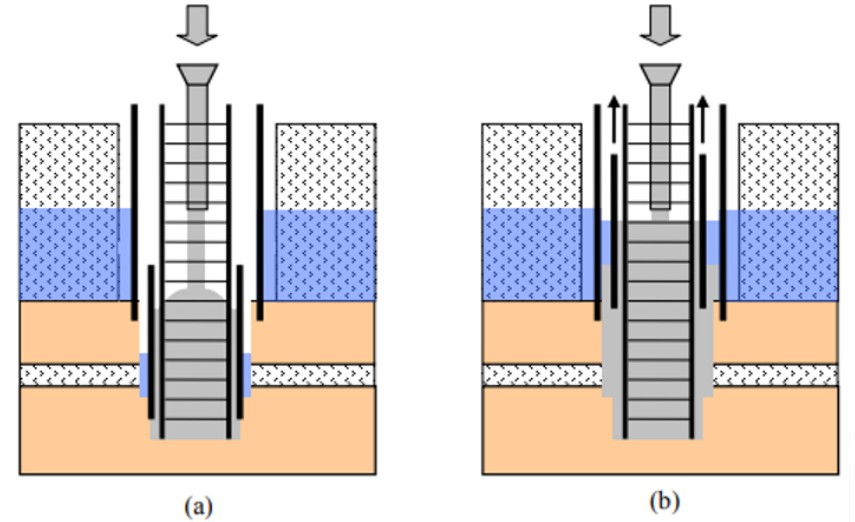


Figure 1. - Typical collapsing soil mechanisms which hold loose, bulky grains in place.

Typical collapsing soil mechanisms which hold loose, bulky grains in place



Initial Placement of Concrete; (b) Initial Extraction of Inner Casing

Telescopic casing

5.9 Flood areas

Crossing the Vistula River

Tension tower, pile foundation (Franki piles),

5.10 Earthquake areas

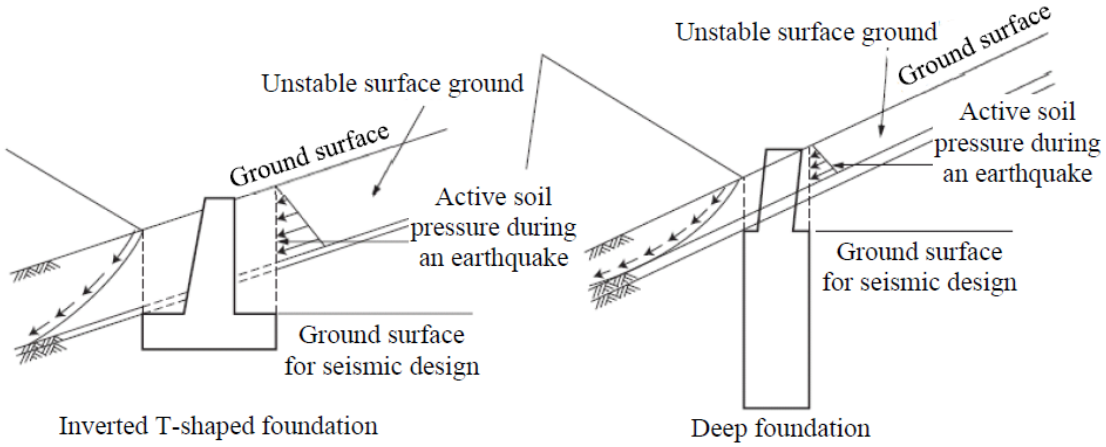


Image of active soil pressure during an earthquake due to unstable surface layer

06

Przykłady

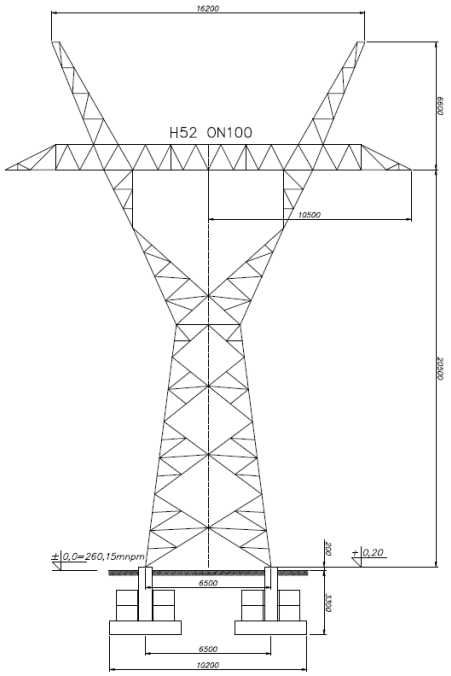
6.2. Landslides

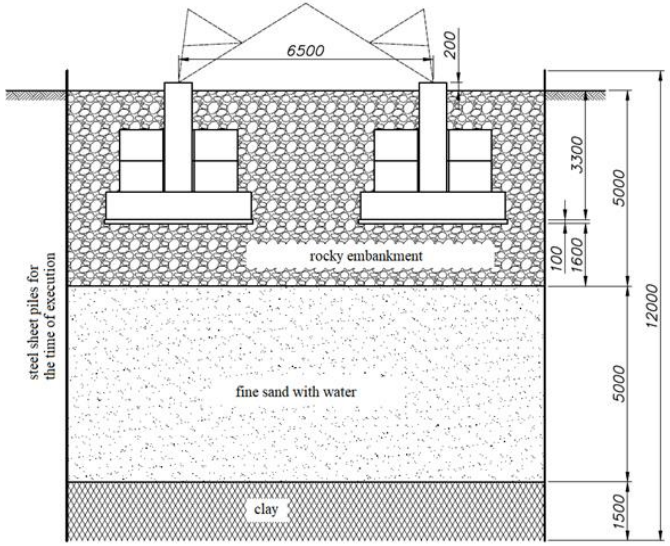
Execution of the foundation on the slope (Poland)

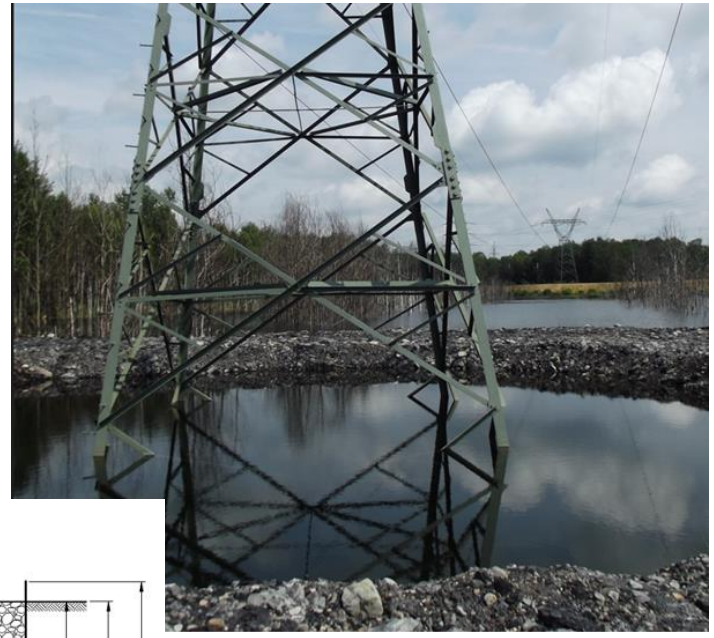
Damage of the tower structure (Slovenia)

Cut excavation near the tower (New Zealand)

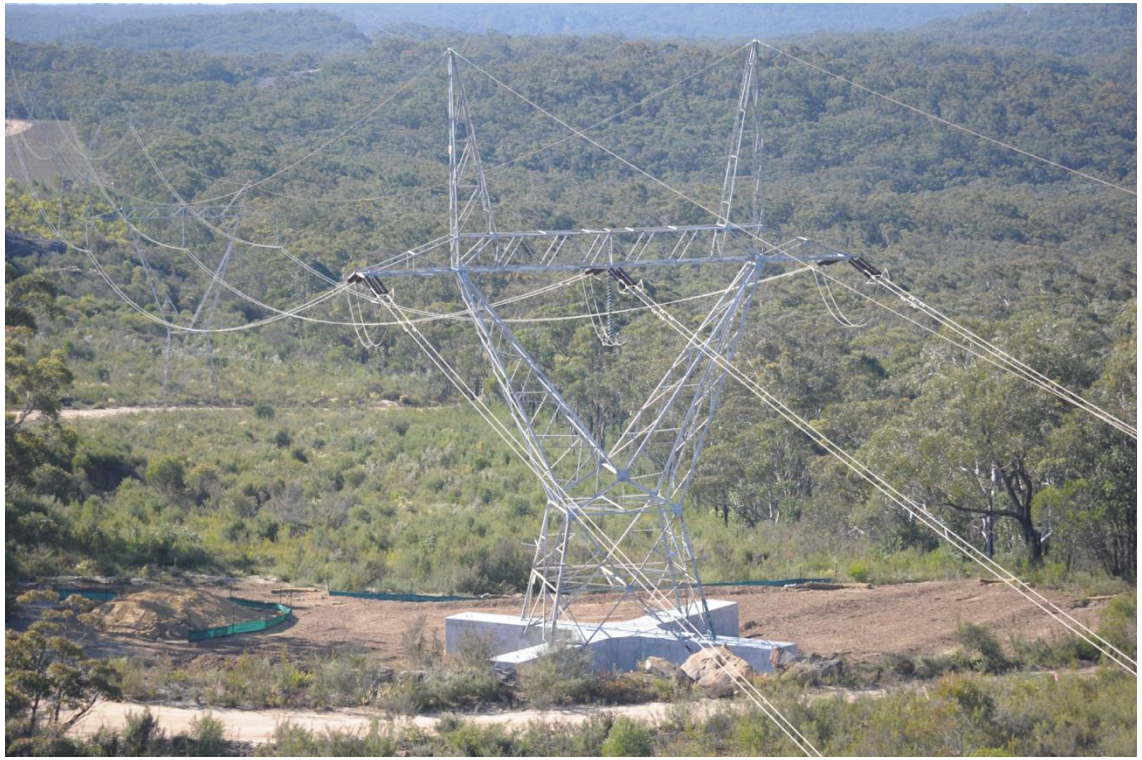
6.3 Mining Operation







Tower plunged into deep water (Poland)



Tension tower with the cruciform tie-beams (Australia)

6.4 Expansive Soils

Settlement of landfill near foundations (Brasil)

6.5 Extremely Soft Soils

110kV Tower (Ireland)

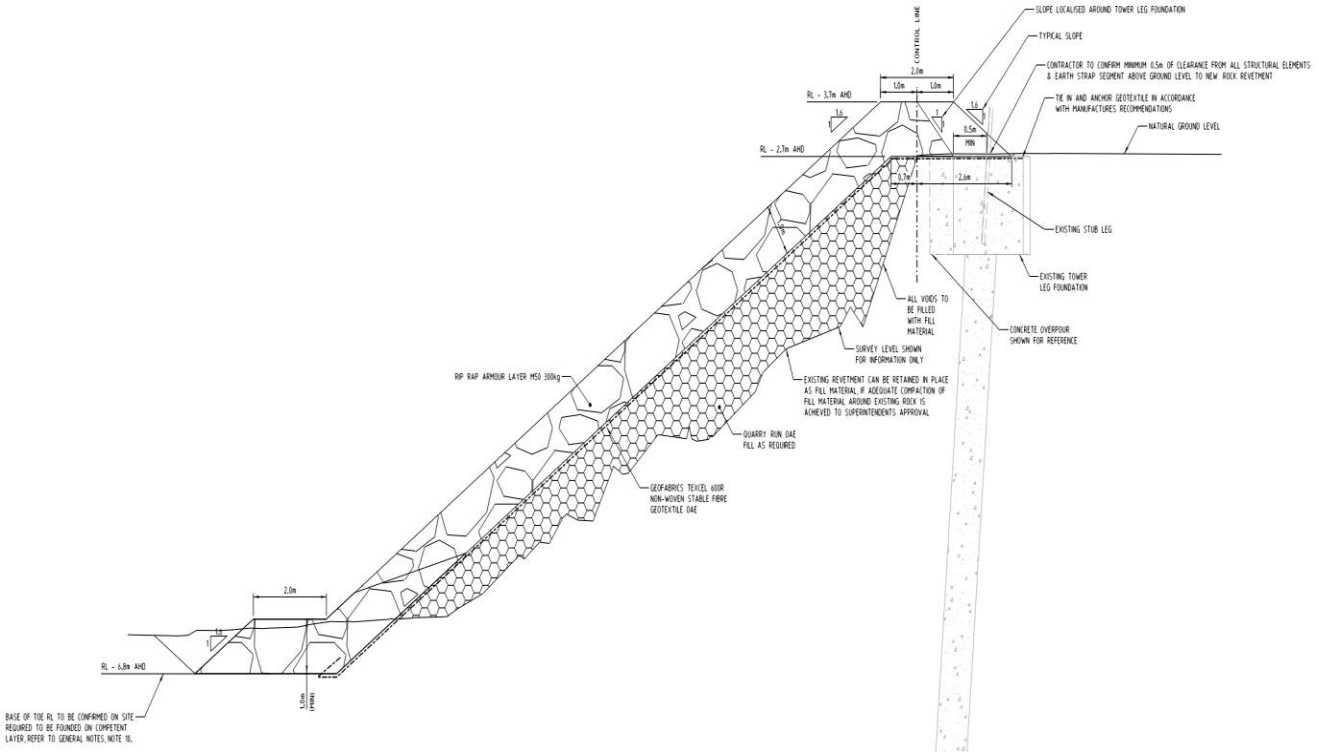
Piles installed showing outer sacrificial casing and inner CHS (Ireland)

6.5 Extremely Soft Soil

Line 110 kV (Latvia)

6.6 Scour

Observed scour at the tower site (Australia)



Design consisting of rip-rap armour layer over geofabric and fill, revetment tying into existing sections, toe to be founded on competent material (Australia)

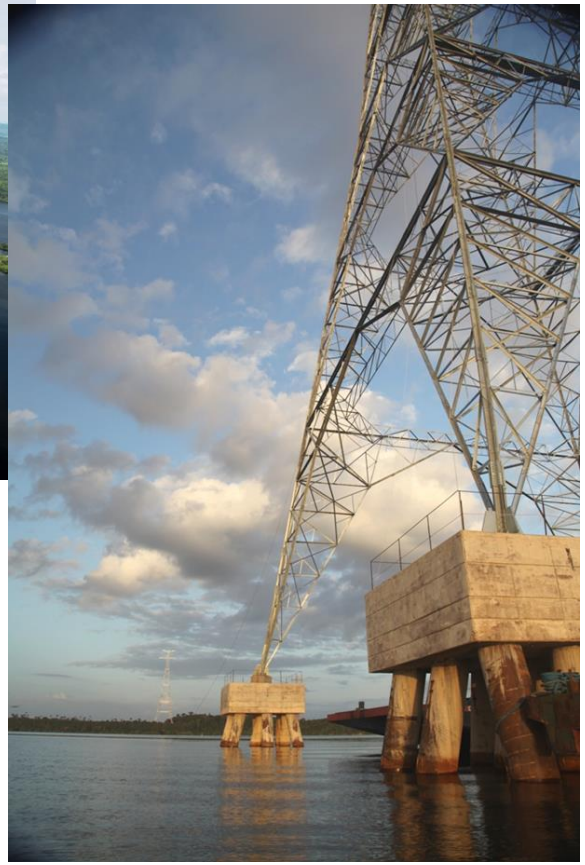
6.8 Collapsile Soil

Geotechnical rupture of the helical pile (Brasil)

Installation of the helical piles to connection on the structural beam (Brasil)

6.9 Flood Areas

Uruguay river crossing (Argentina-Brasil)



Trombetas river crossing (Brasil)

6.10 Earthquake Areas

Line 2x66 kV, monobloc foundation (Chile)

Line 2x220 kV, piles deep foundations (Chile)

6.10 Earthquake Areas

Line 220 kV (Iceland)

7.11 Other

R&D works, field tests and practice implementations for soft solis

View of the test system (Poland)

Additional steel anchors used in testing

Innovative precast-monolithic foundations (Poland)

07

Q&A

Dziękuję za uwagę!

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