RESEARCH OF APPLICATION OF DYNAMIC PENETRATION TEST FOR IMPROVEMENT OF ENGINEERING GEOLOGICAL INVESTIGATION POSSIBILITIES IN OSTRAVA BASIN

VÝZKUM APLIKACE DYNAMICKÉ PENETRACE PRO ZLEPŠENÍ MOŽNOSTI INŽENÝRSKOGEOLOGICKÉHO PRŮZKUMU V OSTRAVSKÉ PÁNVI

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Abstract

The study deals with a dynamic penetration representing a field survey method using which according to a resistance occurred during penetration of rods provided with a tip into the soils being surveyed their selected physical or mechanical properties and layers interface are investigated. The dynamic penetration is performed so that the rods are driven in by hammer strokes with a specified mass and height of drop, during which time the number of strokes is recorded required for penetration of rods of a specified length (as a rule 10-20 cm). A measured characteristics is a specific dynamic penetration resistance representing the tip resistance in the dynamic penetration test. A study localization is bound to a chosen part of the Ostrava Basin. A goal of the study is an investigation of an application of the dynamic penetration in a chosen part of the Ostrava Basin for needs of improvement of engineering geological investigation possibilities in this area, hereat typical dynamic resistances for corresponding categories of foundation soils were investigated.

Abstrakt

Studie se zabývá dynamickou penetrací představující polní průzkumnou metodu, při které se na základě odporu při vnikání soutyčí opatřeného hrotem do zkoumaných zemin zjišťují jejich vybrané fyzikální nebo mechanické vlastnosti a rozhraní vrstev. Dynamická penetrace se provádí zarážením soutyčí údery kladiva s předepsanou hmotností a výškou pádu, přičemž se zaznamenává počet úderů potřebných na vniknutí soutyčí o předepsané délce (obvykle 10-20 cm). Měřenou charakteristikou je měrný dynamický penetrační odpor, který představuje odpor hrotu při dynamické penetrační zkoušce. Lokalizace studie je vázána na vybranou část Ostravské pánve. Cílem studie je studium aplikace dynamické penetrace ve vybrané části Ostravské pánve pro potřeby zlepšení možností inženýrskogeologického průzkumu v této oblasti, přičemž byly studovány typické dynamické odpory pro odpovídající třídy základových půd.

Key words: dynamic penetration, engineering geological investigation, Ostrava Basin

1 INTRODUCTION

A goal is the dynamic penetration application in a chosen part of the Ostrava Basin for needs of improvement of engineering geological investigation possibilities in this area. A further intention is an investigation of typical dynamic resistances for appropriate categories of foundation soils in areas of specific engineering geological wards of the interested area.

On the first stage of the study a choice of the interested area of the Ostrava Basin is realized with a maximum variety of expected dynamic resistances further to the above mentioned categories of foundation soils and specific engineering geological wards. On the second stage, measurements through the use of the method of dynamic penetration in the interested area is realized related to the realized investigations within the cooperation with the firm K-Geo. During the penetration measurements a number of strokes is tracked, required to driving-in a standardized tip (90° point angle, 44 mm diameter) by a unit of length indicated on the 32 mm diameter measuring rods. From a plotted graphic dependence between the measured amount of strokes and the reached depth, depth intervals of quasihomogenous blocks will then be interpreted, which will be at the same time correlated with the interfaces that were documented in surrounding exploration boreholes. The following stage is then an interpretation and record into relevant map details.

In the final assessment the executed measurements and found out results are divided into separated groups which will define the appropriate categories of foundation soils (engineering geological wards) in relation to dynamic resistances.

2 WORK METHODOLOGY

2.1 Methodology of soil testing via dynamic penetration

The test deals with the determination of the resistance of soils and semirocks in-situ via the dynamic penetration by a cone. To perform the test a dynamic penetration dig consisting of a known-mass and known-drop-height drive block is used to drive the cone. The penetration resistance is defined as the number of strokes required the cone to be driven-in by a specified length of sinking. A continuous record is performed with a length of sinking (depth). The test does not allow to make a sampling.

Four methods of the dynamic penetration exist (see Tab. 1), covering a broad spectrum of the specific work per stroke. The first method is a light dynamic penetration (DPL), a test representing the lower edge of the driving equipment mass range. The second method is a middle dynamic penetration (DPM), a test representing the middle part of the driving equipment mass range. The third method is a heavy dynamic penetration (DPH), a test representing the middle-to-heavy part of the driving equipment mass range. The last method is a very heavy dynamic penetration (DPSH), a test representing the heaviest part of the driving equipment mass range. (EN ISO 22476)

Tab. 1 Instrumentation size and mass of four dynamic penetration device types

Dynamic penetration sevice	*Symbol*	*Units*	*DPL (light)*	*DPM (middle)*	*DPH (heavy)*	*DPSH (very heavy)*	
						DPSH-A	*DPSH-B*
Drive block weight, new one	m	kg	10 ± 0,1	30 ±0,3	50 ± 0,5	63,5 ± 20	63,5±0,5
Drop height	h	mm	500±10	50 ± 10	500 ± 10	500 ± 100	750 ± 20
Anvil							
Diameter	d	mm	50<d<0,5Dh a	50<d<0,5Dh a	50<d<0,5Dh	50<d<0,5Dh	50<d<0,5Dh a
Weight (max) (including guide rod)	m	kg	6	18	18	18	30
90° Cone							
Nominal area of base	A	cm^2	10	15	15	16	20
Diameter of base, new	D	mm	35,7±0,3	43,7±0,3	43,7±0,3	45,0±0,3	50,5±0,5
Diameter of base, worn (min)		mm	34	42	42	43	49
Surface length (mm)	L	mm	35,7 ± 1	43,7±1	43,7±1	45,0±0,3	51 ±2
Cone tip length		mm	17,9±0,1	21,9±0,1	21,9±0,1	22,5±0,1	25,3 ±0,4
Max permitted tip wear		mm	3	4	4	5	5
Driving rods c							
Mass (max)	m	kg/mm	3	6	6	6	8
OD diameter (max)	dr	mm	22	32	32	32	35
Rod deviation d							
Lowest 5 m		%	0,1	0,1	0,1	0,1	0,1
Rest		%	0,2	0,2	0,2	0,2	0,2
Specific work per stroke	mgh/a En	kJ/m^2	50	100	167	194	238

Legend:
a - Dh - the drive block diameter; in case of a square shape the minor drive block dimension is reflected as identical with the diameter
b - only for a cone disposable
c - the maximum rod length may not exceed 2 m
d - the rod deflection of the vertical
NOTE The given tolerances are manufacturing tolerances.
(EN ISO 22476)

While carrying out the test the rods and the cone must be driven in vertically and without excessive moving of protruding parts of lengthening rods above the ground level. Further, while raising the drive block no load may affect on the anvil and the rods. The penetrometer must be driven into the earth smoothly. The drive block rate is maintained between 15 and 30 strokes per minute. All interruptions lasting for more than 5 minutes are recorded. At least after every 1.0 m of penetration the rods has to be turned through 1½ turn or so long, until a maximum torque is reached. The maximum torque required the rods to be turned has to be measured using a torque wrench or other applicable device and has to be recorded. When it is difficult to drive in, the rods must be turned through 1 ½ turn always after 50 strokes the rods joints to be tightened. In order to reduce skin friction, sludge or water may be injected through the horizontal or rise holes in the hollow rods nearby the cone. For this same reason sometimes a legging may be used. The number of strokes must be recorded every 100 mm of the penetration in DPL, DPM and DPH testing and every 100 mm or 200 mm of the penetration in DPSH testing. The current working amount of strokes should be within $N10$ = 3 up to 50 in DPL, DPM and DPH testing and $N20$ = 5 up to 100 in DPSH testing. For special purposes the limits may be exceeded. Besides these limits at the lower penetration resistance, e.g. in soft clays, a penetration depth per stroke may be recorded. In hard soils or semirocks, where the penetration resistance is too high or exceeds a normal range of the strokes amount, the penetration may be recorded at a specific number of strokes as alternative one to the *N*- value.

As a rule, the test must stop provided that either number of strokes exceeds double maximum values mentioned above, or the maximum value is permanently exceeded after 1 m of penetration.

Results from the dynamic penetration test are in most cases presented as the number of strokes per 10 cm of penetration *(N10)* against the depth as a direct field record and should be in the range of standardized values (usually 3 up to 50). The values *N10* may be evaluated so that they indicate the unit resistance at the tip *rd* and the dynamic resistance at the tip *qd.* The *rd* value is an estimation of the driving work executed while penetrating soils. The next calculation to get *qd* changes the *rd* value so that the rods and drive block persistence is considered after the drop with the anvil. The calculation of *rd* involves differing weights of the drive block, the drop height and differing shapes of the cone.

The tests along with a direct investigation are suitable especially for a determination of an underbed relief or for a relative comparison of next tests being performed in-situ. Further, they can be applied to a determination of strength and deformation properties of soils, especially incoherent ones and while using adequate correlations even for soils fine-grained. The results may be used to determine the depth of very compact underbed layers, e.g. to determine the depth of the foot of recumbent piles and to determine very mellow, porous, backfilling or filling soils.*(EN ISO 22476)*

2.2 Instrumentation according to a standard

As a *driving equipment* a *drive block* is used, which must be handled in a way guarantying a minimum resistance during the drop. The mechanism of the automatic drive block release has to secure its smooth free fall with an insignificant drive block rate during its release and without any induced parasitic movements in the driving rods. The steel driving head or the anvil should be attached closely to the upper part of the driving rods. Even a loosen connection may be used. A part of the driving equipment should be a guide system securing verticality and horizontal support of parts of rods protruding over the terrain *(EN ISO 22476).*

An *anvil* must be made from a high-strength steel. Between the drive block and the anvil an absorber or a cap cushion can be placed. *(EN ISO 22476)*

A *cone* is of steel, it must have the 90° point angle, top cylinder expanding surface, reducing sleeve to the lengthening rods as shown in Fig. 1. The cone may be either secured (fixed) for reapplication, or disposable (see Fig. 1). While using an disposable cone, the ends of the penetration rod must be inserted closely to the cone.

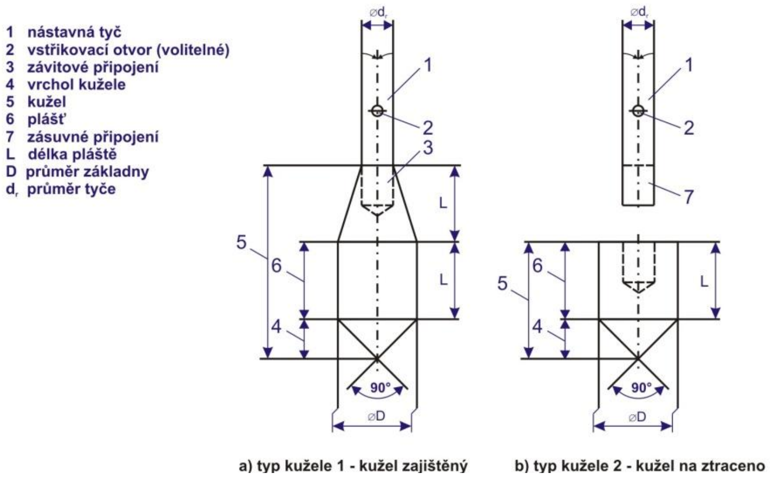


Fig. 1 Cone types for dynamic penetration (EN ISO 22476)

1 lengthening rod
2 injecting hole (optional)
3 thread connection
4 apex of the cone
5 cone
6 surface
7 slide-in connection
L surface length
D base diameter
d rod diameter
a) cone type 1 - secured cone (fixed)
b) cone type 2 - disposable cone (free)

Driving rods must be made from a high-strength steel of such properties guarantying the execution of appropriate activities without occurring excessive deformations and wear. The rods must have smooth joints, must be level and may have facets the key could be inserted. Any deformations must be removable. A deflection in the centre of the lengthening rod, measured from the connecting line led to the rod end may not exceed 1/1000 of length, i.e. 1 mm per 1 m. Hollow tubes should be used. *(EN ISO 22476)*

A *device for measuring torque* measures the torque required to turn the driving rods. It can be measured using a torque wrench or a special measuring device. The device must have a range at least 200 Nm and its scale must be divided so that it is possible to read increments at least by 5 Nm. A sensor may be applied, recording the torque. To attach the torque wrench or the measuring device the key facets on the driving rods may be used. *(EN ISO 22476)*

A *stroke counter* is involved in *the optional equipment*, which can be installed in the system, counting the drive block strokes by measuring mechanical or electrical impulses .

A *device for measuring penetration depth*, which is measured either by a direct reading on the scale of the rods or by means of recording sensors. When using a recording sensor, its resolving power must be over 1/100 of the measured length.

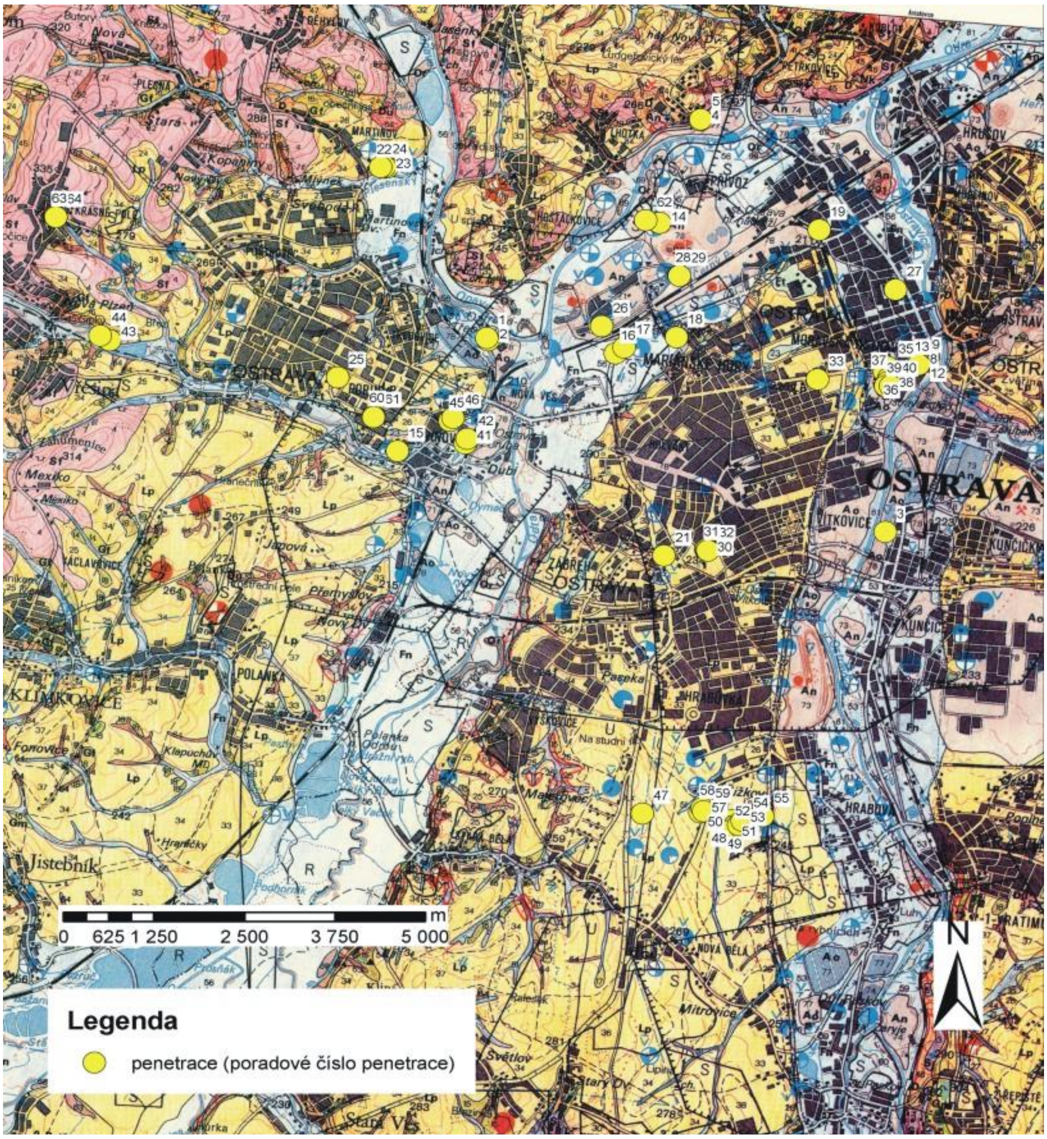
An injecting system, which involves hollow rods (the full back end of a lowermost placed tube when using a disposable cone), a flush pump attached to the fixture under the anvil intended for filling the round gap between the soil and the driving rods, created by the extended cone. The pump performance should be sufficient to ensure always filling the circular ring formed between the soil and the driving rods.

Device for measuring cone size - we use a slide calliper with a measurement resolution of 1/10 mm or another equivalent system.

Device for inspecting the rod deflection of the vertical uses a guide bar securing and checking the vertical position of the driving rods. *(EN ISO 22476)*

2.3 Methodology of dynamic resistance assessment within investigation

The study subject was to evaluate the dynamic resistances for individual categories of foundation soils in an interested area of a chosen part of the Ostrava Basin (see Fig. 2).



Legend:
Penetration (sequence number of penetration)

Fig. 2 Map of the interested area of the Ostrava Basin with an indication of the penetration

The investigation itself passed over in two stages. The first stage was an archive study and the second one, fundamental, was realized in situ by measuring the dynamic resistances using a penetration dig of the Borros system (Fig.3), within the cooperation with the firm K-Geo on running construction surveys.

Fig. 3 Heavy dynamic penetration dig of the Borros system

Within both stages it was necessary to record a series of information related to the study of dynamic resistances. It concerns particularly data on the locality of the test performed, its coordinates, determining the needful amount of strokes and the average dynamic resistance Qdyn, data on the appropriate layer - its type, thickness and depth, soil category, layer genesis, groundwater level and layer properties.

In this way 104 layers have been processed, hereat on the first stage measurements on 46 layers was performed and on the second one measurements on 58 layers was realized. The localization of the performed measurements in a chosen part of the Ostrava Basin has involved particularly those parts of the town of Ostrava - Mariánské Hory, Svinov and Zábřeh. The dynamic resistance was calculated according to the Dutch formula, hereat the theory of dynamic resistances and the reason of using this formula and its description are presented in the following chapter.

3 THEORY TO DYNAMIC RESISTANCE

The method of the dynamic penetration test is based on the rocks' capability to put-up a different resistance to a dynamic penetration of rods provided with a tip in relation to their lithological composition and physical mechanical properties.

Carrying out the test consists in driving of rods with a special tip into a soil by strokes of a drive block falling down from a constant height. An amount of the strokes N is recorded, required the tip with rods to penetrate into a soil by a standardized depth (drive-in length). On the first stage of the test assessment the record is plotted in a form.

The number of strokes required the tip to penetrate by a standardized depth serves just for an orientation. While evaluating the geological environment the mass impact of the rods of the driving penetrometer in relation to the test depth is not considered, and the rods friction is ignored etc. Therefore the specific value of the dynamic penetration resistance Qdyn is determined involving all mentioned facts. As the specific dynamic penetration resistance can be determined according to various authors (see Fig. 4), it is important to know according to which author the Qdyn value was calculated. The Qdyn results according to various authors differ up to several times. (Matys et al., 1990)

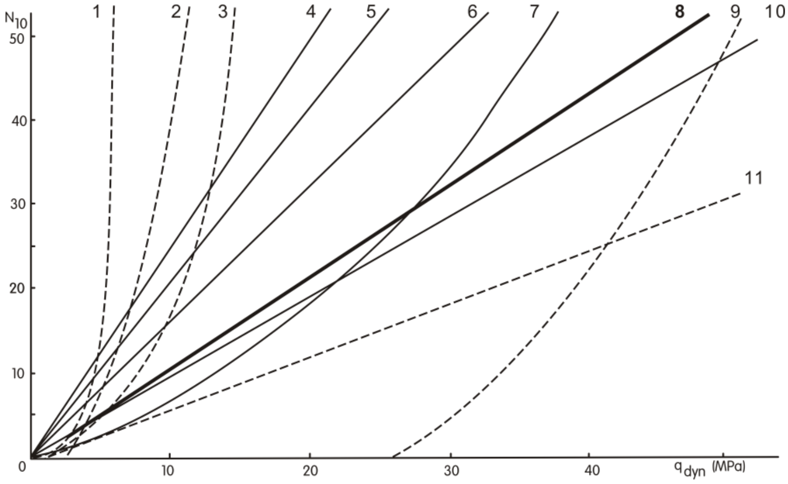


Fig. 4 Graph for determination of specific dynamic penetration resistance Qdyn based on strokes amount N10 according to various authors **(**Matys et al., 1990)

1 – Eng. News k=2,5, 2 – Gersevanov, 3 – Hiley (max), 4 – Brix,, 5 - Trofimenkov (k=0,49, j=0,6), 6 – Hiley (min), 7 – Eng. News k=0,25, 8 – Ritter (Dutch formula), 9 – Gersevanov, 10 – Trofimenkov (k=0,65, j=1,0), 11 - Haefeli

In this study it was necessary to chose for assessment a sole calculation of the dynamic resistance from many relevant ones that are projected in the graph of the Fig. 4. The chosen one is so-called: Dutch formula by Ritter as it is used in practice the most.

The calculation according to the Dutch formula by Ritter is as follows:

$$\text{Qdyn} = \frac{Q}{Q+q}\,\frac{Qh}{As}$$

where Q – drive block gravity (kN), q – gravity of rods, anvil and tip at an advisible depth, where we determine Qdyn (kN), h – drive block drop height (m), A – area of tip cross section (m²), s – tip drive-in by 1 stroke (m) (Matys et al., 1990)

4 ASSESSMENT OF DYNAMIC PENETRATION ACCORDING TO INVESTIGATED CATEGORIES OF FOUNDATION SOILS

Within the archive assessment and the measurement itself 104 layers have been processed. It concerns the soil categories F4 (CS), F6(CL-CI), F8 (CH-CV-CE), G3 (G-F), G4 (GM), S3 (S-F),S4 (SM) and S5 (SC). Each foundation soil category is rated separately by reason of a practical utilization of the study results, because when performing an engineering geological survey we evaluate each engineering geological, or geotechnics type independently and with this one just one type of foundation soils is uniquely connected. The next reason is that for each category of foundation soils identical genetic types were not available, hence any unique compatibility would not be achieved. In the subchapter all acquired data are evaluated in a comprehensive way. The general overview of the foundation soil categories in the monitored terrain is given in Tab. 2.

Tab.2 General overview of foundation soils categories with their genetic types and corresponding average dynamic resistances Qdyn.

Soil cathegory	***Average Qdyn***	***Layers genesis***	***Average Qdyn***	***Layers amount***	***Seq.of penetrations***
F4 (CS)	*15,1737*	Loam fluvial F4	7,6069	3	17,43,44
		Loam loess F4	13,1718	1	57
		Clay fluvial F4	10,3775	4	17,28,29,59
		Clay boulder F4	29,4002	3	25,61,60
F6 (CL-CI)	*9,5074*	Loam fluvial F6	3,0396	11	1,2,8,9,10,11,12
					13,18,15,63
		Loam loess F6	5,3757	6	7,25,34,56,58,57,
		Clay fluvial F6	6,7737	6	14,28,29,60,59,58
		Clay loess F6	6,9044	4	30,31,32,57
		Clay Miocene F6	43,2924	2	45,52
F8 (CH-CV-CE)	*16,6521*	Loam loess F8	6,3362	5	4,4,5,5,6
		Clay Miocene F8	26,9679	16	15,48,22,23,27,42,49
					51,38,39,40,41,25,35
					36,37
G3 (G-F)	*55,9639*	Gravel fluv. unsaturated G3	59,0881	20	46,52,53,54,55,56,62,
					27,1,2,19,20,21,21,24,
					26,27,33,33,41,42
		Gravel fluv. saturated G3	43,4991	7	2,45,47,48,19,50,51
		Gravel glaciofluvial G3	65,3044	1	16
G4 (GM)	*16,3842*	Gravel fluvial G4	16,3842	2	15,44
S3 (S-F)	*13,0669*	Sand fluvial S3	13,0668	4	19,24,61,59
S4 (SM)	*8,9181*	Sand fluvial S4	8,9181	5	43,43,44,47,62
S5 (SC)	*20,1670*	Sand fluvial S5	20,1670	2	34,36

The data in the classification triangle (Fig. 5) is determined by an occurrence of foundation soils in the investigated terrain of interest followed by performed survey localized in Fig.2.

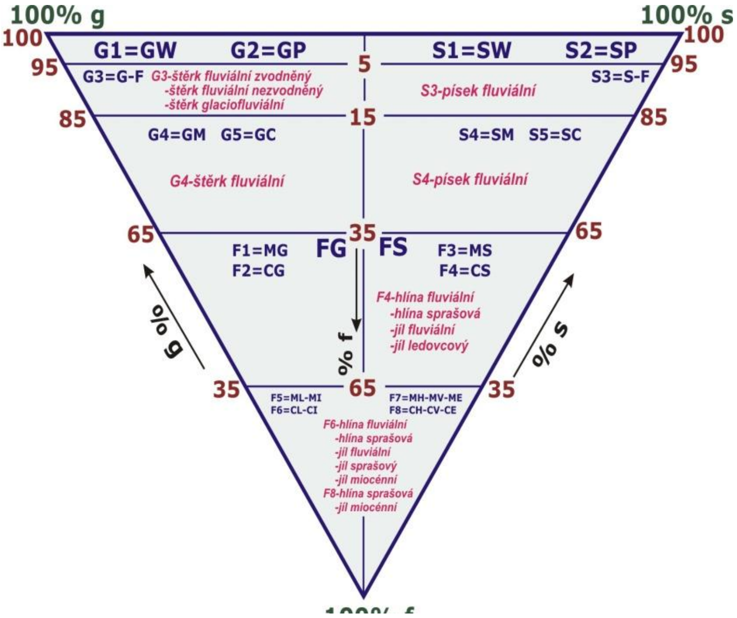


Fig.5 Classification diagram of soils for building (ČSN 731001) with measured categories of foundation soils with indication of genesis

G3-gravel fluvial saturated
-gravel fluvial unsaturated
-gravel glaciofuvial
G4-gravel fluvial
S3-sand fluvial
S4-sand fluvial
F4-loam fluvial
-loam loess
-clay fluvial
-clay boulder
F6-loam fluvial
-loam loess
-clay fluvial
Clay loess
-clay Miocene

Tab. 3 shows the chosen physical mechanical properties of soils, on which the dynamic penetration was carried out. These soil properties are mentioned by reason of their relation to the dynamic resistance.

Tab. 3 Examples of properties of investigated foundation soil categories

Soil type	*Average Qdyn*	*Number of samples*	*Moisture*	*Specific mass*	*Volumetric mass*	*Yield point*	*Plastic limit*	*Plastic index*	*Consistency degreet*	*Volumetric mass of aridity*	*Porosity*
Gravel fluv. G3	59,0881	7	0	2,71	0	21,71	17,88	3,83	0	0	0
Clay fluv. F6	6,7737	2	194,46	2,66	2,03	29,52	16,48	3,83	0,77	1,7	36,1
Clay Miocene F8	26,9679	3	26,79	2,67	1,95	46,94	17,04	28,77	0,69	1,54	42,4
Loam fluv. F4	7,6069	1	21,19	2,74	2,03	37,3	19,67	17,63	0,91	1,68	38,87
Gravel fluv. G4	16,3842	2	0	2,7	0	23,65	17,78	5,87	0	0	0
Loam loess F6	5,3757	2	17,03	2,68	2,1	33,24	15,85	17,39	0,93	1,79	33,04
Clay boulder F4	29,4002	1	17,13	2,73	1,95	34,73	18,63	16,1	1,09	1,66	39,02
Clay loess F6	6,9044	3	23,83	2,64	1,96	34,66	17,71	16,95	0,64	1,58	39,89

4.1 General overview of all genetic soil types on the monitored terrain.

On the territory being monitored these **types of foundation soils** occur: loam fluvial F6 (CL-CI), loam loess F6 (CL-CI), loam loess F8 (CH-CV-CE), clay fluvial F6 (CL-CI), clay loess F6 (CL-CI), loam fluvial F4

(CS), sand fluvial S4 (SM), clay fluvial F4 (CS), sand fluvial S3 (S-F), loam loess F4 (CS), gravel fluvial G4 (GM), sand fluvial S5 (CS), clay Miocene F8 (CH-CV-CE), clay boulder F4 (CS), clay Miocene F6 (CL-CI), gravel fluvial saturated G3(G-F), gravel fluvial unsaturated G3 (GF), gravel glaciofluvial G3 (G-F). They show a range of values of the average dynamic resistances between 3.0396 kN and 65.3044 kN, as obvious from the graph (Fig. 6).

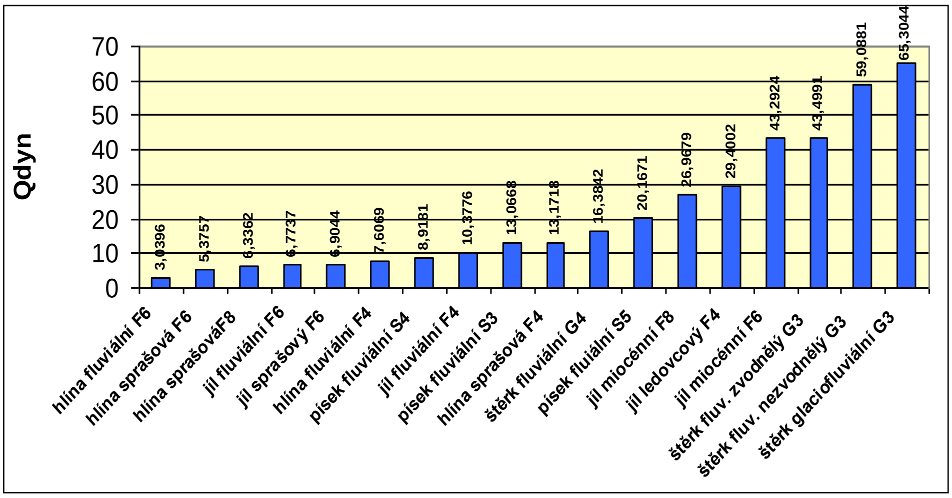


Fig. 6 Graph with a total overview of all soil types on the territory monitored depending on average dynamic resistance Q_{dyn} [kN]

Loam fluvial F6
Loam loess F6
Loam loess F8
Clay fluvial F6
Clay loess F6
Loam fluvial F4
Sand fluvial S4
Clay fluvial F4
Sand fluvial S3
Loam loess F4
Gravel fluvial G4
Sand fluvial S6
Clay Miocene F8
Clay boulder F4
Clay Miocene F6
Gravel fluvial saturated G3
Gravel fluvial unsaturated G3
Gravel glaciofluvial G3

In a basic **comparison of the groups** one can observe the lowest values of the dynamic resistance are achieved by fine-grained soils, the F category, as corresponds to general knowledge of properties of this group of foundation soils and their physical mechanical properties in comparison with other tracked categories of foundation soils. Exceptions are clays boulder and Miocene. These are consolidated and have gone through lithification as compared with soils (sediments) Quaternary. The maximum values of the dynamic resistance are achieved by gravelly soils, the G category. The S category, sandy soils, we could call a “transition type” between the F and G categories, as representatives of this group are in the middle part of the general overview of genetic types.

Fine-grained soils show a range of average values of the dynamic resistance from 3,0396 kN to 43,4991 kN. Contents of clay minerals, especially their interactions such as electromolecular forces (they have the largest specific surface), and further the way of their arrangement (structure) dramatically affect the dynamic resistance. These soils sensitively react to quantity of saturated water. With increasing moisture the value of the dynamic resistance decreases. The resistance is affected as well by plasticity. The higher the plasticity, the lower the value of the resistance. In the general overview we can see it like a sequence, for soils with the lowest values belong to more plastic fine-grained soils of the F6, F8 categories and in contrary the soils with higher values belong to fine-grained soils with a lower plasticity of the F4 category. The reason, why loam loess F8 does not start the sequence, consists in a water amount in its structure that affects consistency state of soil. The higher the consistency degree $I_{C,}$ the higher the dynamic resistance. It is necessary to realize that the measured categories of foundation soils F8 with a higher plasticity could have, as for the performed measurements, a minor water content manifesting itself in the consistency state than categories F6 (CL-CI), as their opposite sequence shows in the graph (Fig. 6).

A range of average dynamic resistances for **gravelly soils G** is from 16,3842 kN to 65,3044 kN. The dynamic resistance is affected especially by a density and screening out of grains and a grain shape. The higher the density the higher the dynamic resistance and the higher the screening the lower the dynamic resistance. The reason is that with increasing density and decreasing screening, or good grain size (gravel well grained), gravel grains are not able to change easily a position (deflect) while driving the penetration tip. This results in the higher value of the resistance. The resistance is affected also by a fine-grained portion that increases or decreases the resistance value in relation to its quantity portion and the degree of saturation S_r and consistency state so as it is presented in the paragraph evaluating fine-grained soils.

The average dynamic resistance of **sandy soils** shows values from 13,0668 kN to 20,1670 kN and is affected by the phenomenon of specific surface, density and state of fine-grained portion. Electromolecular forces and capillary forces have a greater effect as for sandy grains than relatively large gravel grains. The influence by the state and quantity portion of the fine-grained component is also stronger than for gravel soils, again by reason of the grain size. Most significantly the resistance is affected by the several times mentioned fine-grained portion, whose behaviour is described above while assessing fine-grained soils. In general for them the resistance decreases with increasing moisture.

5 CONCLUSION

A goal of the paper was to perform the investigation of dependences of dynamic resistances Qdyn and a geological structure that was specified by categories of foundation soils in a chosen part of the Ostrava Basin.

A motivation for of he study realization is the actual trend to increase the proportion of dynamic penetrations in engineering geological investigations that results from possibilities to survey well modifications of geotechnical parameters during the realization of this direct vertical line method in comparison with other possibilities, especially then boreholes and their point samplings. Another reason is the application of European standards in the Czech republic and widespread utilization of these methods in the EU countries, e.g. in Germany and Denmark. A limiting factor in our conditions is a complicated geological structure not allowing a comparable application in the mentioned countries.

Although the work has a regional character, its results have even a general nature that is given by utilization of the categories of foundation soils and their genetic types. However, the degree of generalization is not quantifiable, and at the same time it is obvious that the degree of generalization depends on quantity of performed tests and on size of the area of interest within the Czech republic. It results from that it would be convenient to apply the approach in other parts of CR and consequently to evaluate this file statistically. The approach like that would make possible creating in future “quasi-directive standardized characteristics” of dynamic resistances. The study has according to this opinion a character of local characteristics of dynamic resistances.

The realized measurements and found out results were split into separate groups that were in relation to the appropriate categories of foundation soils (engineering geological wards) expressed in dynamic resistances (see Tab.2).

It was determined that for the F4 (CS) category of foundation soils the average dynamic resistance values range from 7,61 to 29,40 kN. For the F6 (CL-CI) category of foundation soils the average dynamic resistance values range from 3,04 to 43,29 kN. The F8 (CH-CV-CE) category shows a range of the average dynamic resistance values from 6,34 to 26,97 kN. The G3 (G-F) category shows a range of the values from 43,49 to 26,97 kN. The average dynamic resistance for the G4 (GM) category of foundation soils is 16,38 kN. For the (S-F) category of foundation soils the average dynamic resistance is 13,07 kN. For the S4 (SM) category of foundation soils the average dynamic resistance is 8,92 kN. The S5 (SC) category of foundation soils shows the average dynamic resistance 20,17 kN.

Important are dependences of the categories of foundation soils on their properties. Within the F4 (CS) category the dynamic resistance will change with a change of consistency namely so that it will increase with increasing consistency index I_c and decrease with increasing saturation degree S_r. Contents of clay minerals, especially their interactions such as electromolecular forces (they have the largest specific surface), and further the way of their arrangement (structure) dramatically affect the dynamic resistance for categories F4 (CS), F6 (CL-CI), F8 (CH-CV-CI). With increasing moisture the dynamic resistance value decreases for these soils. The resistance is affected as well by plasticity. The higher plasticity, the lower resistance value. The dynamic resistance is affected especially by density and screening of grains and grain shape. With increasing density of gravelly soils the dynamic resistance increases and with increasing screening the dynamic resistance decreases. The dynamic resistance of sandy soils of the S group is affected by the phenomenon of specific surface, density and state of fine-grained portion.

It does not concern all categories of foundation soils, which is caused by a character of Quaternary geologic structure in the Ostrava Basin, area portion of individual engineering geological wards in the area of interest and technical possibilities of realized testing.

Newly assessed dynamic resistances may be compared with newly performed investigations by this method. Thus it will facilitate identification of foundation soils and call attention to potential gross errors in measurements.

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RESUMÉ

Studie se zabývala měrným dynamickým penetračním odporem, který je jednou z tzv. indexových charakteristik hornin, které jsou dobře korelovatelné s hodnotami fyzikálních, přetvárných a pevnostních charakteristik hornin. Získáváme ho penetračními zkouškami, přičemž do této skupiny zkoušek zařazujeme ještě například presiometrické, dynamické zkoušky tvrdosti apod. Penetrace představují polní průzkumnou metodu, při které se na základě odporu při vnikání soutyčí opatřeného hrotem do zkoumané zeminy zjišťují jejich některé fyzikální nebo mechanické vlastnosti a rozhraní vrstev. Penetrace se může provádět staticky, dynamicky, vibračně, nebo kombinovaně. Studie se zabývala dynamickou penetrací, která se provádí zarážením soutyčí údery kladiva s předepsanou hmotností a výškou pádu, přičemž se zaznamenává počet úderů potřebných na vniknutí soutyčí o předepsané délce (obvykle 10-20 cm).

Velmi důležitý pro tuto metodiku je penetrační hrot, přičemž se jedná o ocelový válec opatřený kuželovou špičkou, který se připojuje na začátek penetračního soutyčí. Mívá různou konstrukci, průměr, délku pláště hrotu apod. Při dynamických penetračních zkouškách se nejvíce používají penetrační hroty ztracené (po zkoušce zůstávají v penetrační sondě).

Měřenou charakteristikou je měrný dynamický penetrační odpor, který představuje odpor hrotu při dynamické penetrační zkoušce. Lokalizace studie byla vázána na vybranou část Ostravské pánve ve vztahu k převažujícím třídám základových půd.

Cílem je přispět k zlepšení možností inženýrskogeologického průzkumu v této oblasti. Byly studovány typické dynamické odpory pro odpovídající třídy základových půd, které bude možno v budoucnu srovnávat s nově provedenými průzkumy touto metodou. Usnadní to tak identifikaci základových půd a upozorní na potenciální hrubé chyby v měřeních.

Bylo zjištěno, že pro třídu základových půd F4 (CS) je rozpětí hodnot průměrných dynamických odporů od 7,61 do 29,40 kN. Pro třídu základových půd F6 (CL-CI) je rozpětí hodnot průměrných dynamických odporů od 3,04 do 43,29 kN. Třída F8 (CH-CV-CE) vykazuje rozpětí hodnot průměrných dynamických odporů od 6,34 do 26,97 kN. Třída G3 (G-F) vykazuje rozpětí hodnot od 43,49 do 26,97 kN. Průměrný dynamický odpor pro třídu základových půd G4 (GM) je 16,38 kN. Pro třídu základových půd S3 (S-F) je průměrný dynamický odpor 13,07 kN. Pro třídu základových půd S4 (SM) je průměrný dynamický odpor 8,92 kN. Třída základových půd S5 (SC) vykazuje průměrný dynamický odpor 20,17 kN.

Důležité jsou závislosti tříd základových půd na jejich vlastnostech. V rámci třídy F4 (CS) se dynamický odpor bude měnit se změnou konzistence, a to tak, že poroste se zvyšujícím se indexem konzistence I_c a bude klesat s rostoucím stupněm nasycení S_r. U tříd F4 (CS), F6 (CL-CI), F8 (CH-CV-CI) má na dynamický odpor významný vliv obsah jílových minerálů, zejména jejich vzájemné interakce jako jsou elektromolekulární síly (mají největší specifický povrch), dále způsob jejich uspořádání (struktura). S rostoucí vlhkostí u těchto zemin, klesá hodnota dynamického odporu. Odpor rovněž ovlivňuje plasticita s jejímž růstem hodnota odporu klesá. Dynamický odpor u štěrkovitých zemin G ovlivní ulehlost, vytříděnost zrn i tvar zrn. S rostoucí ulehlostí štěrkovitých zemin roste dynamický odpor a s rostoucí vytříděností dynamický odpor klesá. Dynamický odpor písčitých zemin skupiny S je ovlivněn fenoménem specifického povrchu, ulehlostí a stavem jemnozrnného podílu.