TECHNICAL SPECIFICATION FOR:

ADDITIONAL GEOTECHNICAL STUDIES

- WORKS EXECUTION PHASE -

1.MINIMUM REQUIREMENTS

Requirements regarding the construction equipment:

In order to perform all borings and the in situ tests which shall be carried out during the execution of works, the boring installation must be capable to drill holes with depths of minimum 50m at a diameter $\geq$ 150mm.

Requirements regarding the laboratory equipment:

The laboratory/laboratories must be equipped with a minimum amount of equipment, as listed:

• equipments for determining the granulometric composition (sieving and sedimentation)

- equipments for determining the plasticity limits;
- equipments for determining the specific density and the apparent density;
- equipments for determining the moisture;
- equipments for oedometer tests;

• equipments for tri-axial tests;

• equipments for direct shearing tests;

Requirements of the site equipment for the geophysical investigation campaign

For the geophysical method which shall be applied during the geotechnical investigations the following equipments shall be used:

Requirements for the terrain inclinometer equipment

- Length of the inclinometer bore = 500 mm

- Length of the inclinometer bore cable = minimum 50 m

- Reading interval = 0.5 m

- Calibrating interval = $\pm$ 30° ($\pm$ 250 mm)

- Resolution = 0.01 mm

- Sensor precision: 0.02 % FS (± 0.1 mm)

- Repeatability ± 0.008 % full scale

- The precision of the 25m system (obtained from analyses which include systematical and accidental errors introduced by the piping, bore and operator) = ± 2 mm

- Reading unit, computing checksums on the two perpendicular directions in real time on site, and data storage.

Requirements for the field data processing program:

- Calculation and graphical representation of the horizontal displacement on each of the two measured directions

- Calculation and graphical representation of the resultant of the horizontal displacement (magnitude, amplitude, velocity)

Mode of execution

After the fitting of inclinometer boring and the stabilization of the inclinometer piping, an initial calibrating measurement is performed.

Next, measurements at periodic intervals are performed (in general, once or twice a month).

At each measurement stage the deviation of the borehole is measured on the two perpendicular directions corresponding to the grooves in the piping embedded in the boring. Are to be performed from 0.5 to 0.5 m. Also, the hydrostatic level existing in the boring at that certain instant o time is measured.

For each measuring stage the horizontal displacement are calculated and are graphically represented, with respect to the initial measurement. the calculation is performed for each reading point in the borehole, on the two perpendicular directions and on the resultant direction, by means of a specialized computation program. The graphical representation of the horizontal displacement evolution of the boring on each measured direction and on the resultant direction is performed on successively overlapped curves, corresponding to each measuring stage.

The interpretation of the horizontal displacement evolution of the boring over the investigation period performed on measuring stages is done in relationship with the

geotechnical and geological information from the stratigraphic column of teh boring and the evolution of the hydrostatic level from the borehole.

Geotechnical Studies

The current chapter describes the operational techniques and modalities of the geotechnical studies which must be carried out and sets the procedures and methodologies for sampling.

The geotechnical, geomorphologic and hydrologic studies are intended to describe the physical environment for infrastructures where all the lithological, geomorphologic, geotechnical and geostructural characteristics of the soil shall be defined.

Additionally, it will also describe the geomorphological processes and the hydrological characteristics, as well as the water circulation in the underground.

The aim of the geotechnical studies is to describe all the aspects of the zone perimeter in order to allow the best solutions from technical point of view for designing the railway infrastructure in accordance with all environment components. Also, the situation of the environment shall be analyzed and comprised in these studies, before and after the end of the works.

2. GEOLOGICAL AND GEOTECHNICAL REPORT

The report regarding the geological and geotechnical study must comprise all geological-technical parameters necessary for the correct carrying out of the designed works, the eventual execution details as well as defining the influence of the building on the subsoil and on the underground water. The report (review) regarding the geotechnical and geological study must be drafted in accordance to the Romanian regulations and/or the EU regulations in use.

- ***Requirements concerning the performance of the investigation works***

• General information

The selection of the boring equipment must be done keeping in mind the geo-litological aspects, function of the depth of the probing, the local conditions, the type of access to those specific locations. In order to carry out the boring operations, a sufficient number of boring equipments must be prepared. In case the existence of underground water or some contaminated anthropogenic deposits are detected, the Contracting authority must be immediately announced in order to establish the measures which require implementation.

One must take all precautions in order to avoid oil and fuel leaks from equipments as well as them infiltrating the soil.

• **Responsibility and Insurance**

The contractor of the boreholes must gather information concerning the terrain configuration and the existence of utilities and active ammunition in the investigation perimeter. The contractor of the boreholes is responsible for all damages produced and caused by the destruction of the utilities.

• **Utilities and cable networks**

The boreholes contractor has the obligation that before the beginning of the works he must inform the service and utilities vendors regarding the works which are pending to be carried out, to obtain from them all the necessary approvals and the necessary training, with respect to the terrain corresponding to that certain construction site and on site.

- The expenses related to locating and signing some insurance policies for utilities and cable networks are included in the UP. The confirmation regarding the listing of that certain zone as a “utilities free” zone for each investigation location must be handed to the Purchasing Contracting Authority before the beginning of the works in that certain location. The provider is fully responsible for the integrity of utilities and of the cable networks.

3. PRELIMINARY TECHNICAL REQUIREMENTS

➢ ***The ongoing of investigation works, of the borings and the corresponding equipment***

• ***Establishing the location for the deployment points of the investigation works, measuring, documentation***

The location wanted for the investigation points shall be determined by the General Contractor. The marking on site will be performed with the aid of wooden hobs in the exact location, a short time before beginning the investigation in that certain point after checking the existence of utilities and of ammunition/explosives and after receiving the agreement from behalf of the owners and the authorities.

It is compulsory to introduce in 1:500 respectively 1:10000 scale tables the exact location for the investigation works according to the measured and accepted coordinates and to present these tables to the parts involved in the project in the most expedient way possible.

The supplementary investigation works must be measured and introduced in tables, as described above.

- ***Produced damages***

The remediation of the damages produced to the public roads with restricted access, to the roads which are on private properties and to those of different nature due to the carried out activity for performing the geotechnical investigations is the responsibility of the borehole contractor, who, on his on expense, will restore those certain zones to their initial state.

The borehole contractor must draft a testimonial signed by the affected owners which should draft a proof as a chart signed by the affected owners showing that all damages produced during the investigation and boring activity have been resolved.

The procedures for resolving the problems and for granting the compensations as well as adjusting them, respectively the associated expenses, must be included in the PU for developing the construction works.

➢ ***Conditions imposed before the deployment of the geotechnical investigation works***

- ***Drafting the petition, Execution advice, Ensuring the perimeter safety from circulation point of view***

The locations for the investigation points are placed on private and/or public properties.

The borehole contractor must obtain all necessary grants and notifications for access to the location for works before the beginning of the beginning of the activity. These must ensure and coordinate all the necessary safety measures. The general necessary notifications, drafts and approvals are the following:

a) owner's approval;

b) notification form the source/water network Owner's behalf;

c) the discharge notification of the residual water in the sewerage system;

d) notification from the electricity source Owner's behalf;

e) request for fencing/detour/circulation ensuring;

f) checking the environment /the safety requests, preservating the monuments;

g) notifying the responsibly authorities regarding the subsoil investigation measures;

h) evidence attesting the zones as utility-free;

i) evidence attesting that there is no ammunition;

j) other documents necessary according to the legislation in force.

- ***Confirmations concerning the listing of the zones as utility-free, confirmations regarding the cables and ammunition for the perimeter associated to the investigation works***

The provider has the obligation to obtain the confirmations from the competent services regarding the absence of the utilities, of the cables or of the ammunition/explosives in the location for investigations.

The provider shall verify on site the positioning of the investigation location and shall set the final position for each boring or inspection location.

➢ ***Specifications regarding the investigation points***

- ***Boreholes***

- ***Prospecting excavations and other responsibilities***

In order to avoid the damage to the eventual utility networks, they will be executed in principle, in case there are doubts regarding the presence of some utilities, in the track zone prospecting excavations shall be performed before the proper. The excavations shall be filled with anti-freeze material, the filling will be compacted in order to prevent ulterior settlings. In the interior of the streets and sidewalks, temporary asphalted areas will be built in order to be safe for the participants of the road traffic and the pedestrians. The responsibility regarding those areas belongs to the Borehole Contractor up to the point of the final acceptance inspection effectuated by the resort service which is responsible for the roads and bridges. The reconstruction of the road to the initial state is the responsibility of the Borehole Contractor and will be accepted by the resort service responsible for roads and bridges.

- ***Procedure regarding the boring***

The use of machinery and modern equipments which respect the actual corresponding standards is proposed. Nevertheless, the rotation speed and the throw speed must be continuously adjusted or at least in short stages in order to adjust the boring parameters function of the subsoil. Norms: EN 1997-2(2007), Eurocode 7 Geotechnical Design - Part 2 - Investigation and testing of the terrain; EN ISO 22475-1- Investigation and Geotechnical testing - Specimen sampling methods and measurings regarding the surface waters - Part 1, norms concerning the Execution Technical principle. The applicable norms, the measures concerning the applicability and the boring shall be documented consequently.

All works and activities must be performed according to the Romanian and the international (EU) legislation, with the norms and normatives in force.

Only the boring devices with continuous sample recovery are accepted, which are percussive boring devices or rotating boring devices with double auger.

The rotating boring devices with simple auger or with rolling auger are not accepted. The material recovery must be ≥ 85%.

The introduction of water in the borehole in order to facilitate the removal of material is prohibited.

The puncture of the road structure shall be done only by means of rotating boring using boring liquid; in the case when the water supply is at distance with respect to the construction site, the water supply is ensured by using a truck with a reservoir tank. The thickness and the type of road structure may be made from asphalt or another material and that's why the costs for these bored sectors are included in the PU.

For quaternary soft rock layers are allowed only percussive boring procedures and tertiary layers are accepted procedures percussive boring (sand, gravel) and / or rotating boring procedures with double cylindrical cap. The boring liquid must not modify the granular structure and the natural moisture of the bored rocks. Boring procedures which allow the "column" utilization must be used. All the other boring procedures, ex. with a single cylindrical cap or with interrupted recovery of the materials are not accepted.

- ***Starting diameter***

The starting diameter for the boreholes must be chosen as for great depths and samples must be collected for the tests in the I category (undistracted) by perforations with diameter of at least 100 mm, in exceptional cases with diameters up to 150 mm.

The use of some casing with different diameters must be kept in mind, and for borings at great depths telescopic casing must be taken into account.

- ***Front casing***

In order to avoid the widening of the borehole into soft instable rocks, the collapse of the borehole walls at the lower part and in order to avoid the layer contamination with the fallen material, the boring shall be carried out using casing.

- ***Rock layers and obstacles***

The borings must be carried out through all existing layers. “The layers” represent all the soft rock and hard rock deposits as well as the anthropogenic deposits/rockfills. These elements are not considered obstacles.

"The obstacles" consist of excavations, foundations, walls, concrete, tubes or steel anchors when the boring can't go further. Masonry or reinforced concrete-type obstacles may be penetrated by chiseling or by rotating boring. If obstacles (ex. unknown cables, pipes etc.) occur during boring, the Contractor must be notified.

- ***Sampling***

The materials must me immediately protected against weathering and against freezing (even in the boring location). The materials should be stored in special boxes for materials function of the lithological profile and will be deposited in the material storing space, until their evacuation.

The boring Contractor supplies the boxes for materials throughout the entire maintenance duration of the storage space for materials.

The provider shall cover the materials in rupture-resistant plastic foil until their evaluation/analysis (protection against drying).

The following conditions are valid for both the materials and the samples:

a) The materials/samples extracted by boring:

The materials/samples extracted through boring shall be immediately arranged, in the forwarding order, into material boxes (the dimension of the space for materials: 1,00 x 0,20 x 0,20 m). The number of the boring and the boring depth shall be marked on the boxes. The materials/samples extracted by means of boring must be protected against

weathering, freezing and drying. Furthermore, the boxes must be carefully transported in order to avoid vibrations and the destruction of samples.

During the freezing periods, the materials/samples extracted by boring must be stored in a heated space. At the boring location one must take all necessary measures in order to avoid the freezing of materials during the execution of the boring.

b) Undisturbed samples (specimens extracted by boring)

The collection of undisturbed samples shall be done according to EN 1997-2(2007) Eurocode 7 - Geotechnical Design - Part 2 - Investigation and testing of the terrain; EN ISO 22475-1 Geotechnical investigation and testing - Methods for collecting Samples and measurements for surface waters - Part 1 - Technical principles for Execution norms. The accepted diameter for undisturbed samples for cohesive soils, after removing the moist area, is of minimum 80 mm.

c) Disturbed sample

The collection of disturbed samples shall be done according to the norms in force, usually all layers, from various types of soft rocks by collecting disturbed samples from category nr. 3 according to EN 1997-2(2007) Eurocode 7 Geotechnical Design - Part 2 - Investigation and testing of the terrain; EN ISO 22475-1 Geotechnical investigation and testing - Methods for collecting Samples and measurements for surface waters - Part 1 - Technical principles for Execution norms, in various containers, as example: gravels (in buckets of 5 - 10 l), sands and clays (in bowls of 1 l). The disturbed samples shall be marked in the same way as the undisturbed samples, without mentioning the superior and inferior position of the sample. After collecting the samples, they will immediately transported to the storage house.

d) Samples for analyzing water

Samples will be collected for the chemical analysis of water according to the norms in force.

The sampling and transport the water samples for aggression analysis and for the proper analysis will be carried out according to the the Norm EN ISO 22475-1 Geotechnical investigation and testing - Methods for collecting Samples and measurements for surface waters - Part 1 - Technical principles for Execution norms.

Covering over the boreholes

After the beneficiary accepts the borings, these shall be covered over. Covering the boreholes may be executed using soft and hard rock wastes extracted during the boring if these rocks are not contaminated. At the surface of the superior tunnels and in the zones connected to the foundations, the boreholes shall be covered with water resistant materials. The filling material must correspond from physical and material point of view in order to ensure the blocking of the spaces where the boreholes are carried out. The covering over with a water resistant material shall be done with a filling assembly pipe/hose starting from the bottom part of the retreating face of the borehole. Covering over the water resistant zone shall be executed after strengthening it.

- ***Underground water***

The position and the height of the underground water shall be recorded in the boring journal. The boring level, respectively in each coating, shall be measured daily before continuating the work. The inferior height of the coating (coatings), at the moment of the water level measurement, shall be recorded in the boring journal. When completing the borehole, the water level in the borehole shall be reduced, by pumping, with up to 2 meters, after which the time interval up to the point when the water level reaches the initial maximum level is measured. The confirmation of the initial level after the pumping shall be done by means of two measurements at an interval set with at least 2 hours between one measuring and the other. The hydrostatic level shall be measured weekly in all piezometers executed until the closing of the investigation works.

In the case when the existence of a pressurized surface water level is noticed, it will be noted in the boring journal and in the daily journal of the construction site, and not only the reached elevation but also the elevation where the hydrostatic level is rising and also the discharge.

➢ ***Specifications: tests carried out on site and determinations in the interior of the boring cavity, Generalities***

- ***SPT testing***

SPT will perform a test according to EN ISO 22476-3:2005, geotechnical investigation and testing-site testing - Part 3: Standard Penetration test, ASTM D1586-67 (1984) Standard Test Method for Penetration and Split-Sampling of soil, (EN ISO 22476-3 - 2006 standard penetration test (SPT). ASRM D4633-86:

Standard Test Method for energy measuring wavelength effort for testing systems with dynamic penetrometer; ISSMFE Technical Committee (1988) - Standard Penetration Test (SPT) The rules under International benchmarking test procedure.

The number of testing, location and depth will be set as the research progresses. SPT testing will be done by removing waste from the bottom of the borehole, usually with a sharp probe and not with a boring drill (below the hydrostatic testing will be done with a drill longer). It will prepare a report which will indicate the hydrostatic level.

If groundwater pressure at the bottom of the drilling will be filled with water under high pressure. The end of fall required for testing will be checked after each SPT test. The test report shall be represented graphically as a chart, the number of attempts N30 depending on the depth of probing / penetration. Reports on testing will be presented with the final documentation relating to drilling.

- ***Inclinometers pipe***

Installing the inclinometers pipe on the inside of cavity drilling and boring allows the measurement through the set of measurements taken at time of horizontal movement along the vertical soil. These measurements made using a special inclinometers probe fixed inside the pipe with high precision sensor to measure the inclination of the pipe section.

Standards and specifications to be followed are ASTM D 4622-86 (1993) - Standard Test Method for Monitoring of rocks using inclinometers.

Inclinometers pipe must be plastic or aluminum and to have provided a circular section four slots, and these function to guide the probe inclinometers.

The dimension of the inclinometer pipe, for a 101 mm boring, must be the following:

- ϕint pipe=76mm
- ϕint guiding=82mm
- ϕext guiding=86mm

Inclinometers different pipe sizes, depending on various drilling diameters should be specified in the plan of investigation or should be communicated to the Building Construction by the Works Supervisor.

On site before the installation, must be checked as follows:
- Pipes and sleeves shall have no defects or be hit due to transport, particularly at the

end section;
- Section at the end of the pipe and joints shall not have imperfections that can affect the correct coupling of pipes and flow measuring of the probe;
- Heads of at the surface of inclinometers will be fixed with cover that can be locked (type HT, Seba or other).

➢ ***Documentation of research***

- ***Journal of daily activities***

The provider is required to produce journals of daily activities based on established forms.

The journals of the daily activities will include:

a) Data on weather, temperature, number and type of staff working on the site;

b) all equipment in service;

c) activity;

d) different incident, directions and requirements of the site supervisor.

The collection consisting of these diaries of daily activities with their attachments are Site Journal.

- ***The report on drilling activities***

The report on drilling activities will be mentioned the type of drilling, the diameter and drilling pressure used for hydraulic system. Also, please mention the the execution of investigation ditches, possible contamination, liners, drilling method, the surface water level, the absolute height of the drilling location, facilities and test equipment, lithologic profile.
The report on drilling activities with lithological column will be made during the drilling operation. The report will be completed in order to be legible.

- ***Description of rocks, lithologic file / drilling profile. survey diagram***

Rock description will be made in accordance with the rules, and in their absence in accordance with EN ISO 14688-1 Geotechnical investigation and testing - Identification and classification of soil - Part 1: Identification and description of Part 1, EN ISO 14688-

2.2 testing and geotechnical investigation - identification and classification of soil - Part II: Principles for classification, EN ISO 14689-1 geotechnical investigation and testing - identification and classification of the rocks - Part I: rules for identification and description. (STAS 1243-88 foundation field. Classification and identification of land).

Characteristics of the rocks will be written entirely, abbreviations are not allowed.

Absolute coordinates of drilling will be mentioned in on the header of the lithologic file / drilling profile, respectively of the sounding diagram.

All the documents will be registered in accordance with current standards. The used scale for the representation of depth of drilling will be 1:100. Drilling to a depth of 25 m will be represented in A4 format. Paper format for the representation of final drilling depth will depend on its final depth, the number of layers found. Drilling data in documents and tables must comply fully with those described in lithologic characterizing / drilling profile (text will be played in full).

Lithologic characterizations / drilling profiles edited by PC computer and printed on paper. Final representation will include all topographic data concerning the drill, correction of lithologic characterization and of the drilling profile.

- ***Documentation concerning surface waters / the hydrostatic level***

All levels of the surface water / hydrostatic levels found during the drilling will be mention in the report on drilling activity. Will be mention the surface waters / the hydrostatic level, date, time depth lining and increase / decrease unusual level.
All measurements concerning the the surface water levels after the execution of the piezometer will be centralized as tabular and graphical form and form (on paper and in digital format: Excel file).

- ***Photographing materials issued from drilling***

Materials resulting from drilling will be photographed with a digital camera. Images will have a minimum resolution of 2048 x 1536 pixels in 10 x 15 cm format and will be stored as photographic reports, for each drill and will include information on the drilling number, depth from ... to ... Also there must be a lighting without shadows when shooting. Each picture will cover up to 4.0 ml of material resulting from drilling in the picture will be

immortalized the number of drilling and appropriate depth a table of standard colors and gray scale such as that used on copies of photographic reproductions.
Do not use over-angular. Camera parameters will be adapted to existing conditions on-site lighting (daylight / artificial light). Materials will be photographed immediately after their delivery at the materials store before destruction them after the analysis / evaluation, respectively before these materials lose their natural moisture and dry. For all photographic records will be used the same type of lighting.

Samples will be replaced in the boxes of materials with pieces of white polyurethane foam that will note no. sample and the depth from which they are taken. Any drilling intervals free materials and they will be marked.

The photographic journals of the drilling will be presented on photographic quality paper in JPEG format on CD.

- ***General information: Document***

The following documents in the order listed will be included in the final documentation:

-Tabular scheme of the surveys position;

- Data from drilling;

- Linings plan with lithologic description;

- Attachment for ground measurements / hydrostatic levels found with details of date, time and measured depth.

After obtaining laboratory results, will make a new evaluation of lithological characteristics / drilling journals. This may result in additional corrections required to be resolved and put in paperwork.
Evidence delivery, Results.

- ***Delivery of evidence, results***

The selected samples, after the analysis, disturbed and undisturbed and chemical samples will be sorted by no. of research point and depth.

Disturbed samples will be delivered as specified in current regulations.

- ***Sampling and laboratory analysis***

To determine the geotechnical characteristics will be taken disturbed and undisturbed samples in order to establish an underground geotechnical profile. To the sampling stays a professional description of the lithological characterizing . In well justified cases can be taken samples containing multiple layers (eg in case of fine alternations of slightly cohesive rock or noncohesive). The maximum sample is 1.0 m. The layers with a greater thickness will be divided into several horizontal substrates.

All samples should be stored in waterproof containers and protected from light.

The samples of the cores sounding will be taken up gradually to no more than 1.0 m. in Losses from the cores (> 10%) are not supported. The rubble from the research work must be removed. Unless stated whether the extracted material is rubble or not , it is automatically considered rubble and will be removed. The cores losses , compression of drilling hole debris and the quantity of rubble will be documented.

All the facilities / equipments, materials, etc.. must correspond in terms of technical standards. Drilling machines wich use drilling fluid are forbidden from physico-chemical sampling and chemical analysis.

- ***Water sampling***

Water sampling will be done in the accordance with EN ISO 22475-1 Geotechnical Investigation and testing - Sampling methods and groundwater measurements - Part 1 Technical principles for normative execution of quality piezometers.

4. DETERMINANT STAGE

In accordance with the norms and rules of construction works, during construction phases for each main work (building, bridge, viaduct, support wall, embankment, etc..) Is necessary to continue the training of the in the early stages so-called "decisive phase" .

This is to prepare the first phase - related to the soil – each work (first column for each viaduct or bridge foundation, the first excavation for a section, of the first building the excavation of the foundation), in which the provided soil conditions should be compared with the actual situation that was encountered at the beginning or during work.

The contractor is obligated to participate in this Decisive Phase by this Geologist Engineer to assess whether soil conditions are consistent with those provided as a result of the Geotechnical Report prepared at the end of geotechnical investigation works and then to cover the main stages of the final result.

As a consequence of the obligations described above, services which the Executor must provide , will complete through the Decisive Phase conclusions and not to the delivery of the Final Report.

5. APPLICABLE REGULATIONS

Norms and regulations that can be applied in conducting the geotechnical research:

EN ISO

EN 1997-2(2007) Eurocode 7 Geotechnical design - Part 2 Investigation and soil testing

NP 074 – 2007 Legislation concerning geotechnical documentation

EN ISO 14688-1 Investigation and geotechnical testing - The identification and classification of soil - Part 1: Identification and description (STAS 1243-88 foundation field. Classification and identification of lands)

EN ISO 14688- Investigation and geotechnical testing - The identification and classification of soil - Part 2: Identification and description (STAS 1243-88 foundation field. Classification and identification of lands)

EN ISO 14689-1 - Investigation and geotechnical testing - The identification and classification of rock - Part 1: Identification and description

EN ISO 22475-1 Investigation and geotechnical testing - Sampling by drilling and excavation and groundwater measurements - Part 1: Technical principles for execution.

EN ISO 22476-2 Investigation and geotechnical testing - Field testing - Part 2: Dynamic drilling (C 159-89 work instructions for field research)

EN ISO 22476-3 Investigation and geotechnical testing – Field testing - Part 3: Standard penetration test (ISO 22476-3 - 2006 standard penetration test (SPT)

CEN ISO/TS

CEN ISO/TS 17892-1 Geotechnical investigation and testing. Laboratory testing of soil Part 1: Determination of water content

CEN ISO/TS 17892-2 Geotechnical investigation and testing. Laboratory testing of soil Part 2 Determination of fine grained soil density

CEN ISO/TS 17892-12 Geotechnical investigation and testing. Laboratory testing of soil Part 12 Determining Atterberg limits STAS 1913/4-86 of foundation soil. Determining the limits of plasticity)

CEN ISO/TS 17892-4 Investigation and geotechnical testing. Laboratory of testing soil Part 4 Setting particle size distribution

CEN ISO/TS 17892-3 Investigation and geotechnical testing. Laboratory testing of soil Part 3 Determination of particle density - pycnometer method

CEN ISO/TS 17892-8 Geotechnical investigation and testing. Laboratory testing of soil Part 8 unconsolidated undrained triaxial test

CEN ISO/TS 17892-9 Geotechnical investigation and testing. Laboratory testing of soil Part 9 triaxial reinforced tests on soil saturated with water

CEN ISO/TS 17892-9 Geotechnical investigation and testing. Laboratory testing of soil Part 9 triaxial consolidated compression tests on soil saturated with water

CEN ISO/TS 17892-10 Geotechnical investigation and testing. Laboratory testing of soil Partea 10 Direct shearing tests

CEN ISO/TS 17892-7 Geotechnical investigation and testing. Laboratory testing of soil Partea 7 Unconfined compression test on fine-grained soil

CEN ISO/TS 17892- Geotechnical investigation and testing. Laboratory testing of soil Partea 5 Incremental load test mileage meter (STAS 8942/1-89)

ASTM

ASTM D1586-67(1984) The standard method for penetration testing and soil sampling on drum cut (EN ISO 22476-3 - 2006 standard penetration test (SPT)).

ASTM D4633-86: Standard test method for measuring the wave energy for dynamic systems with penetrometer , Technical Committee ISSMFE (1988) - the standard penetration test (SPT) international reference test procedure

ASTM D 2434-68 (2000) Standard Test Method of the permeability granular soils (constant head) (STAS 1913/6 -76 foundation soil. Determination of permeability in the laboratory)

ASTM D 4719-87 (1994) - Standard test method for testing manometer in the soil

ASTM D 6230 – 98 - Standard test method for monitoring soil movement using probe inclinometer

ASTM D 4633-86: Standard test method for measuring wave power for dynamic systems of penetrometer test

ASTM D75-82 Standard practice for sampling. Aggregates (STAS 1242/ 2; 1242/3 - 87; 1242/4 - 85)

ASTM D420-98 Characterization of terrain for engineering design and construction

ASTM D2487-85 Standard practice for soil classification for technical purposes (unified soil classification system)

ASTM D2488-84 Description and identification of soil

ASTM D2488-93 - Standard practice for describing and identifying soil - visual- manual procedure

ASTM D 2216 - 92 - Standard test method for determining water content in the laboratory (humidity) of soil and rock (STAS 1913 / 1-82 foundation soil. Determination of moisture)

ASTM D 4318 - 84 - Standard test method for yield limit of plasticity and plasticity index of soils (STAS 1913/4-86 foundation soil. Determining the limits of plasticity)

ASTM D 422 - 63 (90) - Standard method of test for analyzing of particle soil size

ASTM D 421 - 85 (93) - Standard Practice for dry penetration of soil samples for particle soil size analyzing and constants setting

ASTM D 422 - 85 (93) - Standard method of test for analyzing the particle soil size (STAS 1913/5-85 determination of the granularity)

ASTM D 854 - 92 - Standard test method for specific gravity of foundation soil (STAS 9137 / 2-76. Earth substructure density determination)

ASTM D 2974-87(95) - Standard method of test for moisture, ash and organic matter of peat and other organic soils. (STAS 7106 / 1-76 foundation soil. Determination of organic matter)

ASTM D 2850-87- Standard test method for unconsolidated triaxial testing of cohesive soils to compression strength (STAS 8942/5-75 foundation soil. Determination of resistance to shear triaxial by pressure on unconsolidated tests - undrained (UU), - to land)

ASTM D 4767 - 88 - Standard test method for consolidated undrained triaxial testing of cohesive soils resistance to compression

ASTM D 3080 - 90 - Standard method for direct shear test in consolidated drained condition (STAS 8942 / 2-82 foundation soil. Determination of shear resistance of earth by direct shear testing)

ASTM D 2166 - 91 - Standard method of test for confined compression strength of cohesive soil (STAS 8942/- 76 foundation soil. One-axis compressive Soil Testing)

ASTM D 2435 - 90 - Standard method of test for dimensional consolidation properties of soils (STAS 8942/1-89 foundation soil, to determining the earth compressibility

ASTM D 4648-94- Standard test method for laboratory shear with miniature blades for clay soil saturated with fine grit

ASTM D 2434-94 - Standard method of test for permeability of granular soil (constant head) STAS 1913 / - 76 foundation soil. Determination of permeability in the laboratory

ISSMFE

ISSMFE Technical Committee on Penetration test (1998) - dynamic testing (DP9): an international reference test procedure

ISSMFE Technical Committee (1988) - the standard penetration test (SPT) : international reference test procedure

BS

BS 1377 (1990) - Methods of test for soils in order of civil engineering - Part 2:

Tests of classification (STAS 1913/3 - 76 foundation soil. Determine the soil density)

BS 1377- Part 8

HRB- AASHTO

HRB-AASTHO M 145-49