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BASICS FOR GEOTECHNICAL ENGINEERING EXPLORATIONS CONSIDERING NEEDED LEGAL CHANGES

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Nowadays legal system of Estonia does not cover essential aspects related to geotechnical engineering explorations for assessing environmental risks to be considered during planning processes and for providing designers with reliable geotechnical parameters for sustainable construction solutions. The absence of appropriate legal regulation does not support the reuse of mined areas and sustainable use of mineral recourses. The article deals with analysis on planning and building sectors with concrete suggestions for changes in legal regulations. Additionally radon level survey and geotechnical inspection related issues have analysed in the frame of risk assessment. Both of the above issues are especially important to be considered in mined areas. The utilisation of previous research data and re-establishment of Geotechnical Fund will enable a much more economical use of the available resources and a better management of possible risks.

Introduction

All types of planned (or unplanned) changes to the natural or man-made environment are accompanied by a certain impact, the scope of which depends upon the vulnerability of the affected environment and the current load on it as well as on the characteristics of other changes. The same goes for activities which change soil stress conditions.

In order to estimate and, if possible, prevent/minimise the environmental impact accompanying human activities, including extraction of mineral recourses, we must be able to predict them in advance.

The Building Act [1], above all its § 20, deals with geotechnical site investigations. According to section 1, the objective of the geotechnical and geodetic survey (hereinafter referred to by a single definition – site investigations) is to obtain the necessary primary data for site planning, designing

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of construction projects and construction. Site planning is prescribed in the Planning Act [2].

Plans

Unfortunately, at the moment, the requirement for the performance of geotechnical engineering studies for preparation of plans is totally absent from the Planning Act [2]. This may lead to construction and infrastructure planning of unsuitable plots.

Pursuant to the Planning Act [2], plans fall into four cateories: national spatial plans, county plans, general plans and detailed plans. The objective of national spatial planning is generalised strategic treatment of the development of state territory and human settlements, in the course of which there is created, above all, a spatial basis for the regional development of the state, which means that in the case of that planning phase the location of constructions is not designated.

The objective of county planning is generalised treatment of the development of county territories, the terms for the development of settlements and the designation of locations for critical infrastructure objects. Regarding this planning, spatial construction is planned more specifically, among other things general terms of use of land and water are designated; corridors for roads, railroads, waterways and technical networks, the locations of airports, harbours and waste storage sites and other technical constructions are designated as well.

The objective of general planning is the designation of policies and conditions for the development of the territories of local municipalities, cities and the preparation of basis with the obligation of detailed planning for sites outside cities and rural settlements. At the same time, during the general planning stage, possible dangers and risks occurring afterwards during the course of construction and development activity are to be evaluated. Pursuant to risk assessment, limits or conditions can be assigned to construction sites. Risk analysis establishes the consequences and effects, and the extent to which the process is manageable.

The objective of risk analysis is to provide an answer to the question of whether the given enviromental risk is acceptable. This can be evaluated using criteria and norms authorised by legislation, the levels of risk accepted by the public, and limit values established in specific conditions. A critical part of risk assessment is the observation network and monitoring of processes which, in addition to control of the situation, allow of the necessary corrections to be made.

Risk factors are ranked in the course of risk management according to priorities; methods have been developed for their removal or mitigation. In order to do so, the necessary resource for the management of risks must be mapped and designated, on the level at which the management (agency, city

or government level) of one or another risk takes place. In the absence of resources, the management of risks is not possible.

The objective of detailed plans is the establishment of land use and construction conditions in cities, rural settlements and other sites and cases requiring detailed plans.

As for the total land use strategy, it is prescribed in territorial planning – at estimation of construction or building sites the accompanying changes to the basement of the existing soil stress conditions and also frequently the surface water and groundwater regime should be considered. Availability of sufficient detailed data regarding the geotechnical engineering of the observable sites, as well as environmental conditions (flooding or the danger of landslides, etc.) and man-made conditions (for example, mined areas), enables to ensure the rational planning of construction work (including selection of infrastructure trace lines) as for the economy and environment, to prevent waste of (natural) resources and to reduce the maximum risk to peoples' health and their property.

Unfortunately during the last couple decades not enough attention has been paid to investigation of Earth crust's bearing capacity in mined areas. There are also problems with planning buildings and infrastructures on mineral deposits investigated already. The mineral deposits may be already depleted, still in the mining phase, or just perspective ones.

The necessary representative limit (including density and depth of investigation net) of the geological engineering data required for making of planning decisions depends, above all, on the complexity of geotechnical structure of the planned territories, the occurence of geotechnical processes increasing risk (above all the danger of landslides, changes of the water regime, karst phenomenon, and the emanation of radon) and phenomena resulting from human activities – for example, possible extensive pollution of soil and groundwater, and the presence of cultural layer or mined areas.

Geotechnical engineering investigations are necessary in the case of county planning, general planning and detailed planning, considering also widespread mineral (especially oil shale) deposits and areas mined already.

In the case of state-wide planning involving generalised, strategic level for development of state territories and settlements, the level of generalisation in state engineering geological maps is sufficient.

The volumes of investigations for detailed planning must provide input for the rational placement of planned construction works (buildings and civil engineering works), to enable the later maximum, as for resources, economy of planning and construction, to designate primary risk factors ensuring at the same time the stability and safety of constructions.

Construction

Prerequisites for optimal foundation and construction solutions are the availability of primary data of high quality for design work. Geotechnical engineering data describing the area to be occupied by construction works are of great importance. Under the current conditions of an ever increasing deficiency in natural construction materials it is especially important to find as many opportunities for the most economical use of natural resources as possible.

According to Building Act § 3 (4) [1], the structure must not pose a danger to the lives of its users or other persons, their health, property or the environment. According to the Chemicals Act [3], emanation of dangerous chemicals from the structure must be prevented. In addition, emanation of noise and radiation harmful to people, poisoning or pollution of the soil and water, emanation of waste water, smoke, and poor disposal of solid or liquid residues from the construction works must be prevented. Humidity may not accumulate in the parts or surfaces of the structure in such a manner that it poses a threat to the lives, health, or property of the people. The Building Act does not prescribe a sufficient amount of mechanisms or necessary regulations in order to satisfy such a requirement.

It is possible to revoke a building permit if the structure being built is hazardous to the lives of people, their health, property, or to the environment. Pursuant to section 40, the owner of such a structure must bring the structure into compliance with the corresponding requirements presented for the building or destroy it by the date designated in the precept, and according to the method and conditions therein. The described provision in itself should ensure that the structures not complying with standards are not built. At the same time, the provision is too general in its contents to allow it to be successfully implemented in practice.

The regulation in the Building Act [1] regarding geotechnical engineering surveys is unclear. The regulation given in the Building Act does not uniformly designate whether the performance of site investigations is required before the preparation/construction work of the building design documentation or not. Also, contents of the term of validity of geotechnical engineering survey works performed is not prescribed – whether works prepared several years ago can serve as the basis for the construction of specific structures. The regulation does not foresee the procedure of return and repair of the survey works in the case of their non-compliance with the performance of laws. Thus, the Building Act regulation requires supplementation in terms of its conditions, for which the performance of a site investigation is mandatory and in which designing stage it is to be conducted.

The procedure for the performance of site investigations lacks specific requirements for the performance of investigations and the minimum volume of investigation required.

The representative limit of the necessary geotechnical engineering data needed to ensure economical solutions of the project depends on both the complexity of the building and its loads as well as on the strength of the foundation and variation in soil properties, possible geologic processes, including underground water regime, the possible emanation of radon, and the occurrence of mined areas. The output of economical solutions of projects is an economically effective stable building constructed environmentally friendly and efficiently , which at the same time ensures a secure and healthy man-made environment.

All this holds also for structures (railroads and highways, airports, dams, wharfs, garbage dumps, collectors, and other infrastructure elements).

As the methodology for geotechnical engineering explorations and technical equipment needed are largely similar to those used for mineral survey, it is reasonable to consider the possibility of drafting necessary amendments to the Earth Crust Act instead of amending the Building Act.

Radon level surveys

The air in every house contains a certain amount of radon, although the level of radon varies, depending upon the geological conditions, the construction of the house and the quality of the structure. Radon levels also change over time. The Radiation Act [4] does not regulate exposure caused by radon in dwellings and mined areas. Pursuant to § 6 (1) of Minister of the Environment regulation No 45 of 26 May 2005 [5], "The surveillance of exposed workers and residents, the values of doses, dose factors, radiation and tissue factors caused by the intake of radionuclides", the surveillance of radon in the air of premises is part of the surveillance series. The frequency of surveillance measurements in the case of radon and the surveillance of its long-term progeny in drinking water is at least once per year, radon surveillance in the air of premises – at least once every three years.

The radon risk map has to be taken into consideration during the preparation of the planning phase. It is also possible through legislation to prescribe a soil classification on the basis of radon emissions and, basing on that, to prescribe the application of inevitable measures, by adding the corresponding authorisation standard in the Building Act [1]. In the mined areas – especially in the oil shale basin and the phosphorite field (Maardu) where the Dictyonema argillite has been opened – radon-related risks are considerable.

Since the given survey involves environmental research, the supplementation of the Environmental Impact Assessment Act and the Environmental Management System Act [6] may be weighed in terms of the assessment of environmental impact. According to the mentioned legislation, the environmental impact of planned activities may be evaluated during the preparation of the construction project as well as during the proceedings for

obtaining the building permit. A separate provision could be added to the law, according to which the specific effects of the environmental impact would be assessed during the proceedings for obtaining the building design documentation or the building permit. At the same time, the law does not consider all types of construction work to be activities characterized by significant environmental impact, which is why all types of construction activity are not preceded by an environmental impact assessment. The supplementation of the law can be weighed in such a manner that surveys should be conducted separately before the beginning of environmental impact assessments.

Geotechnical inspection and surveillance

While the geotechnical engineering surveys and the primary data produced on the basis of those surveys are predictive in terms of content, geodetic measurement of structures in the performance period and afterwards, as well as fixing of changes in building structures, provides us with feedback on geological engineering surveys and the quality/validity of engineering calculations and analysis conducted on their basis. The emergence of problems may cause the need for additional surveys in order to determine the reasons for the variations in the predicted and actual placements in the structures.

Geotechnical inspection is necessary in the case of both complex/high liability structures and the occurrence of variable or weak soils and geological processes. The specific geotechnical problems related to mined areas, considering spoil areas of oil shale quarries and opened phosphorate fields, require careful geotechnical inspection as well. Its duration is determined by the measured rate of weakening of displacements and may, depending upon the foundation construction and soil properties, last for decades.

Surveillance is critical especially for determining the development of natural processes (ground water regime, radon level in interior premises, floods, occurrence of slide blocks, etc.), related reflections on construction affecting the safe use of construction elements, allowing comparison with the results predicted during geotechnical engineering surveys. Surveillance must provide a conclusive survey of natural processes taking place, the effects between the natural and man-made environment, enabling the assessment of the effectiveness of planned protection measures. This allows, in the future, to evaluate the competence of today's decisions, and to direct processes in the direction of risk management.

To protect the above-mentioned public interests and to ensure the economical planning and construction, the need for geotechnical engineering surveys for plans, structures (buildings and civil engineering works) as well as geotechnical inspection, must be prescribed by laws. It is possible in subacts to establish the representative limits to the amount of research, follow-

ing the objective of the research, the object and predicted geotechnical engineering conditions, and to make suggestions for the use of suitable standard documents.

The utilisation of previous research data

It is important here to prescribe the "useful life" of research data. If the data describing the geological structure of a site are of permanent value, the conditions concerning underground water and pollution may be subject to change in a period of only a few years, based on the effects of nearby construction works. Here, in turn, changes in the physical-mechanical properties of the foundation's soil are possible as well.

The above-mentioned phenomena demonstrate the need to prescribe a provision for the use of original data and correlations and previous research data in geotechnical engineering surveys. It is necessary in the case of construction works of a certain level of complexity, and on soils which may be highly deformed and subject to large variability, to designate a minimum volume of original research, which ensures sufficient presentability of research data.

The problem requiring solution is the creation of a geotechnical engineering database, in which at least the following data should be recorded:

- the exact location of the research object;
- types and volumes of research;
- a short description of the geological conditions;
- a short description of the hydrological conditions;
- a short description of geotechnical processes and phenomena;
- the utilisation of previous research data;
- the location of the geotechnical engineering research report, and its contact information.

The above-mentioned database allows, at planning of a new research, to evaluate the suitability of the previous research data, to plan the research more economically, and to reduce the impacts on the environment that accompany the research. As an additional value, the availability of such a database allows investigation of several geotechnical engineering processes and phenomena over time. Since a research report is generally a property of the financier of the research, creation of the above-mentioned database should be prescribed by law, which obliges the owners of reports to preserve it within a reasonable period of time and after this period of time to hand it over to the Geotechnical Fund.

An alternative to be weighed is the immediate transfer of the report to the Fund, where it is made available for public use after passing of a designated period of time. In such a case, the same Fund could also ensure the uniform operation of the database.

It would be necessary to weigh also assigning of the current issuing of permits for geotechnical research, which belongs to the competence of local governments, to the Geotechnical Fund, which would have the obligation to accord the issuing of permits with local governments. This would give the Fund a control mechanism for ensuring archiving of research reports. Today's practice (unregulated legal space and lack of control mechanisms) unfortunately does not ensure uniform issuing of research permits, taking into consideration possible environmental impact accompanying research (local governments have no obligation to consult the environmental authority) and the receipt of reports by the Fund.

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