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Common Mistakes in the Evaluation Process of Input Data for Geotechnical Design

Erreurs courantes lors de la saisie des données d'entrée pour les structures géotechniques de conception

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ABSTRACT: As each building structures and geotechnical structures in its proposal requires the assignment of the input data. They must be always for their accuracy as possible. In the case of concrete, steel or wooden structures are the basic input always the same and depend on the type or class specific use or mixture. For geotechnical design it is necessary to put the greatest emphasis on non-homogeneity environment, which must be for the correct calculation modeled as accurately as possible with the most trusted source data.

RÉSUMÉ: Comme chacun construit des structures et des structures géotechniques dans sa proposition pour exiger l'attribution des données d'entrée. Ils doivent toujours être aussi précis que possible. Dans le cas du béton, les structures en acier ou en bois sont toujours les mêmes et dépendent du type ou de la classe d'utilisation ou de mélange. Pour les structures géotechniques, il est nécessaire de mettre l'accent sur la non-homogénéité de l'environnement, qui doit être modélisé aussi précisément que possible avec les données sources les plus fiables.

Keywords: Geotechnical design, Design, Mistakes, Software

1 ASSESSMENT OF GEOTECHNICAL CONSTRUCTIONS

The basis for each design of a geotechnical design (and not only for geotechnical, but of all structures) is the static assessment of the life of the proposed work. However, a static assessment involves inputting a plurality of input data, which needs to be correctly defined and subsequently entered into the calculation. As we all know, geotechnical constructions are the most difficult for the correct interpret the geological conditions and influences that will affect the proposed structure. Also, the correct determination of the load is an important factor for the correct calculation.

If we use any computing program, we are largely using by European standards in our area, and we apply limit state method (LSM) or Finite Element Method (FEM) calculations. In both cases, the initial inputs are similar, and without right interpretation into a static calculation, we commit the major mistakes.

At the beginning, it should be noted that most of the errors were detected during the static calculation control, input geological survey data and project documentation, respectively, due to the incorrect design of the shape and elements of the construction under consideration.

2 THE MOST FREQUENT ERRORS AND MYSTAKES

Whether it is building, highway or water (hydraulic) constructions, geotechnics as part of the construction industry geotechnics is located in each of those areas.

In this article, nevertheless, we will, for the sake of the extends, only deal with geotechnical constructions such as supporting or retaining walls, pile foundations, reinforced earth structures and the like.

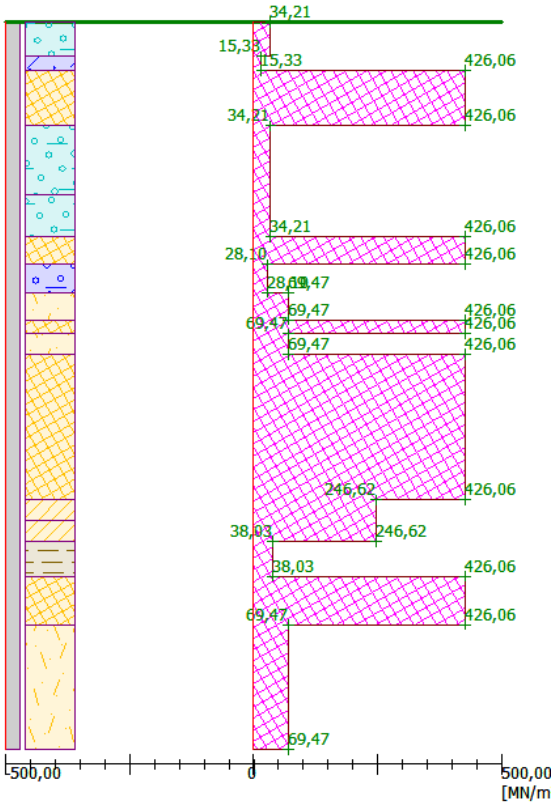


Figure 1. Segmentation sublayer of ground and different Kh values

As is clear from the above-mentioned structure specifications, all the above structures have in common a large surface which is in contact with the surrounding rock environment. It is therefore important to state that input data entered as parameters of soil and their exact interpretation are the most frequent reason of errors in static calculation and assessment (see Figure 1).

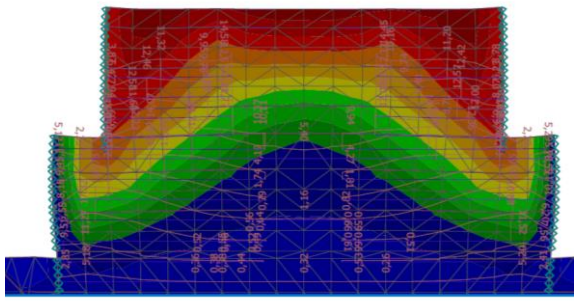
2.1 Parameters of soils

The basis for correct input of soil input parameters is not just the correct determination of their mechanical properties. Their correctness is also important in terms of global issues.

Figure 2. A thin layer of high-plastic clay that was not included in a static assessment

For example, we can speak about the correct determination of parameters due to changes in the subsurface water table, the influence of rock swelling, the consolidation of the rock

environment or the change in the climatic conditions during the lifetime of the construction (see Figure 2). It must be remembered that the building structure must meet its purpose for much more than 100 years. However, in such a long horizon and nowadays rapidly changing climatic conditions it is necessary to take also this factor into account.



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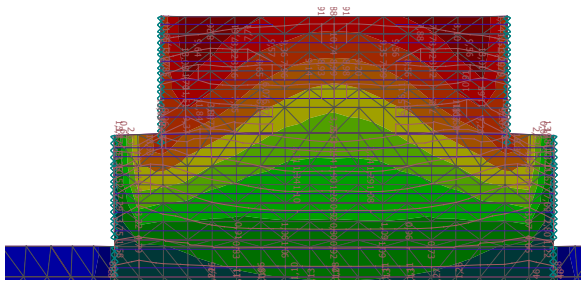

b)

Figure 3. Incorrect interpretation of the geological environment has led to a change in the foundation and reinforcement of the system of retaining walls

Table 1. Different results of one computational model with misinterpreted results

Input data	dz [mm]	dx [mm]
Incorrect	70,6	36,3
Correct	319,4	282,6
Difference	-248,8	-246,3

where:
dz – construction sink (vertical displacement)
dx – horizontal displacement

Therefore, mistakes caused by poorly interpreted results of the engineering-geological and hydrogeological survey can be repeatedly found in static calculations (see Figure 3). In particular:

- input of better soil parameters than are real on site e.g. residual parameters in the slope slide area,
- static calculation does not take in account change of subsurface water table,
- if the static calculation assumes a change of water table, the influenced parameters of the soil influence are not adjusted,
- in a static calculation, the rock environment is modeled too simplistically.

Other serious errors of input data of geotechnical structures are:

- failure to respect the state and direction of discontinuities of rock and semi-solid rock environment,
- neglect of the impact of seismicity (also caused by construction and operation),
- neglect of the setup building phases,
- setting of small ranges of the surrounding rock environment into the calculation model,
- neglect of temporary effects during construction,
- over estimating of construction -soil design parameters construction - soil,
- setting a less appropriate calculation method.

As mentioned above, the simplification of the basic model of calculation, the failure to take proper engineering and geological investigation into account and the neglect of the effects of construction significantly affects the inaccuracy of the calculation. The above applies to any calculation method for any kind of geotechnical construction. With a simplified model, the omitting, for example, a very thin layer of clay can cause lapse the slip plane which is already predefined. Or, in the case of frequent layer

alternation, for exam-ple 20 layers of geological environment is commonly replaced by 4 layers. For the design of the foundation of bridge or other structures where the coat friction is decided, this fact is significantly negative and decisive for the correctness of the result. Subsequently, there occurs the design of either undersized or over-dimensioned building structure.

2.2 Procedure of construction

Another important part of static assessments is, of course, staged construction - the construction process. In this part, all stages of earthworks and building construction should be modeled as they will be carried out on site.

The problem is the omission this part of the assessment or excessive simplification of the calculation model. At that time, complications occur also in simple constructions, when this fact is neglected most often. Indeed, it is not a complete rarity when the proposed retaining walls in the landslide area are modeled in the 15 stages, only to ensure stability at each stage of construction.

2.3 Determination of load

The definition of load is the action of physical pressure to the design. We have a number of normative prescriptions to determine it according to design of the construction. The problem in this part of the proposal occurs when geotechnics / statics inappropriately determine the load class (e.g. traffic load) or do not provide for certain load effects, such as the presence of underground water. It is often the case that the static calculation does not show an increase in the weight of the soil from saturation with water. But an even more complex problem arises when it is forgotten to assess the construction during construction e.g. load by a con-struction traffic transport or a material storage. The resulting operation load is larger than construction ground traffic. However, temporary load can have a significant impact on the work that has not yet been completed, e.g. uncompleted rock anchors, activated stretches or incomplete stiffening ribs.

3 REDUCING RISK IN GEOTECHNICS

Theories and calculations do not replace engineering judgment, but they are the basis for rationalization (R. Peck). This is a quote that makes the most accurate assessment of the impact of logical judgment on the proposed construction. First of all, it is necessary to consider how all the influences can affect the structure and how the geological and hydrogeological conditions can change due to the lifetime of the structure. Only on the basis of a comprehensive impact assessment it is possible to determine which input can be neglected and which can be simplified or replaced by others.

Because of the extent of the topic, we will not deal directly with geotechnical hazards, forecasting prediction, or mathematical modeling to predict the change of the rock environment. The role of the article is to emphasis geotechnical hazards that are usually not taken into account in the static assessment or taken into account only marginally.

3.1 Gradual changes in the physical properties of soils and rocks

It is a big mistake if the static calculation is based only on the observed physical parameters of the soils and rocks and does not take into account changes in the surface water level or the impact of discontinuities in the rock environment. A common phenomenon is so-called progressive breakdown predominantly in clay and rocks, and transformation of cohesive soils due to changes in pore pressure. And also neglecting the direction of discontinuities, and their scattering often influences the emergence (in static assessment) of unexpected slides of semi-rocks, which may appear shortly after the extraction of part of the rock environment.

3.2 Application of the observation method

Natural or artificial environment from natural materials never can be considered homogeneous, even though we are thinking in static assessment. Its real characteristics and the type of behavior of building structures in the rock environment can not be reliably determined at the stage of preparation the design documentation. And it can not reach even the finest computational procedures.

The use of the observation method during construction will allow improvement of the quality of construction projects. To a certain extent, take into account the behavior of each part of the construction in specific cases. Indeed, the behavior of the construction structure after completion is decisive. It is therefore necessary to pay increased attention to the design of monitoring. However, in order to be able to proceed with the design of the observation method during construction, it is necessary to accept a certain acceptable risk during the design.

3.3 Risk analysis and likelihood of occurrence of an undesirable event

As mentioned above, frequent errors in the process of geotechnical design are neglect or simplifying undesirable effects on the building structure. But, if we are aware of these risks, it is possible to analyze them and determine the likelihood of an undesirable occurrence with regard to other aspects of the design under consideration.

Generally, the risk can be understood as a probability of occurrence of an undesirable and unintended event and a negative consequence of this event. So, if we talk about risk, we are talking about the probability that a threat situation may occur. The risk is accompanied by uncertainty, i.e. the event with which the risk is associated may or may not occur. On the other hand, it is a loss, which is the result of unexpected consequences.

The first stage in risk analysis and identification. of the risks that may affect the building structure (see Figure 4). Creating a list of possible risks is based on facts that can go into solving a static calculation and which events lead to it. At present, there are many techniques and methods for identifying risks.

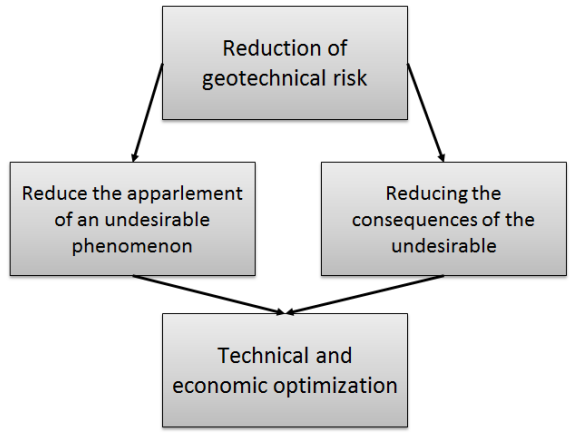

Figure 4. Reduction of geotechnical risk

The next step is the risk analysis itself. It serves to sort the risks according to their impact on project goals. Quantitative risk analysis serves to determine the likelihood of risks and to link these risks to the objectives of the project. Various risk analysis methods can also be used for building and designing building structures. However, the mathematical method, the method of scenario analysis and the method of using experience are the most optimal.

The main advantage of the matrix method is the ability to capture a great deal of interrelationships between the rock environment and the building structure. The Scenario Analysis method has the ability to use simulation patterns of construction behavior. In practice, it is being used decreasingly. The method of exploiting experiences is in turn based on similarities with other similar constructions, which have been proposed under similar geological conditions. However, as geological conditions are predominantly

different in each building, this method of analysis is rarely applicable.

3.4 Prevent incorrect data entry into static calculations

It is necessary to realize that there is no possibility of entering an exact geological environment conditions into a static assessment. There is only the best possible interpretation of the results of the geological survey into the entire design under consideration and the creation of the most accurate calculation model.

In practice, also been proven that misinterpretation of survey results and inaccurate or inadequate calculation models are directly proportional to the time that is intended for the design of the structure. In order to reduce this fact of assigning not totally relevant data, it is therefore necessary to provide more time for the preparation of calculation models. Investors must realize that rigorous preparation of project preparation will ultimately ease and simplify the construction phase itself, and also will significantly eliminate the occur-rence of undesirable events.

Geotechnical constructions costs are for about 5-10 % of all costs on the financial side of the construction site. For civil engineering, it is 30 %, and for water constructions the share of geotechnics is up to 50 % of the total cost of the construction works. The largest share of these constructions is of course underground, where the share of geotechnics represents up to 95 % of all costs. Based on these statistics, it is clear that the impact of geotechnics is significant for all types of construction and can not be neglected under normal conditions.

4 CONCLUSION

The rapid trend of construction of geotechnical constructions was reflected in their proposals. Calculations must also be carried out frequently during construction almost on site, which negatively affects their accuracy. For the most part, it is not the correctness of the static schema of the calculation model, but the correctness of the input data and the calculations of the particular calculation model.

As stated above in the article, it is extremely im-portant the correct interpretation all input data and partial results that result in the accuracy of the calculation. Even a minimal deviation in poor interpretation of rock parameters results in a fatal failure of the structure. therefore it is necessary to know not only the geological and hydrogeological ratios of the area of interest but also a wider part of the morphology of the terrain, the climatic conditions, the ways of loading the structure and, in particular, the phasing of the construction, which significantly affects the static function of the construction at its initial stage of construction.

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