

The French NF P 94-500 standard applied to geotechnical surveys for directional drilling
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1. The Challenges of the feasibility study

The success of a directional drilling job site is dependent on many factors :

Experience taught us that a lack of knowledge of the soil conditions was prejudicial to a well achievement of the directional drilling site. This lack of knowledge concerning geological and geotechnical context may cause technical difficulties and financial problems, even a failure which could call into question the success of the whole job site.

The main factor that could affect the feasibility of a project is the geological and geotechnical soil context.

A good knowledge of the physical and mechanical soil conditions is vital but not sufficient. The geometrical distribution of the different soil layers all along the bore path layout is absolutely necessary.

This information will enable the drilling contractor to define the bore path layout and the technical characteristics of the equipment to be used.

- ⊕ The bore path layout should be compatible with the characteristics of the drilling tools and the acceptable bend of the product pipe.
- ⊕ Size of the casing when it is necessary
- ⊕ Drill head
- ⊕ Mud motor
- ⊕ Reamers
- ⊕ Drilling fluid capability
- ⊕ Product pipe coating

The engineer responsible of the feasibility study has European, international and national standards at his disposal to achieve his mission :

- ⊕ Eurocode 7 as European standard
- ⊕ NF P 94-500 as French standard, concerning the series of the geotechnical missions
- ⊕ ASTM F1962-11 as American standard (Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of PE pipe or Conduit Under Obstacles, Including River Crossing)
- ⊕ The technical manual from D.C.A

2. French and European standards

The European Eurocode 7 is totally devoted to the basic rules of the geotechnical calculation.

Reading this document shows us that it is not adapted to the study of a longitudinal project, which requires a most global study, including the regional and local geological context.

A reliable study of a directional drilling project requires many techniques in order to have a global approach, so that the risks would be reduced.

Thus any study should begin by :

- A bibliographic investigation completed by a visit on site
- A geophysical survey
- Tests and corings in situ
- Tests in laboratory in order to know the soils and rocks

This process is complex, but ensures to have the best definition of the geological context concerning the drilling project.

The French standard completes the Eurocode 7 by suggesting a series of geotechnical missions which develop gradually the feasibility study.

This process is intended to control the risks and to plan the bore path layout of the drilling by taking into account the geological and geotechnical context but also to enable the contractor to consider and carry out the work with the maximum of information.

This standard is organized in two steps :

- The first step, under the responsibility of the contracting authority or the project supervisor, realization of the preliminary studies in order to have a feasibility file.
- The second step is distributed between the project supervisor and the contractor, concerns the work phase.

The first step is organized in two kinds of missions :

- ⊕ G1 : geotechnical study mission that enables to define :
 - The preliminary geological type and the identification of the first risks
 - The parameters to be taken into account for the geophysical and geotechnical study
- ⊕ G2 : geotechnical study of conception. This mission is organized in three steps :

- First : adjustment of the proposed project (G2AVP) in order to complete the geotechnical model and identify the risks as well as the effects on the drilling project
- Second : project mission (G2PRO) to definite the geotechnical hypothesis for writing the technical notices and make choices for the construction.
- Third : this mission (G2 DCE) concerns the writing of the technical documents intended to the drilling firms in order to achieve the execution file.

The second step is organized in two missions :

- ⊕ G3 mission : supported by the contractor, it concerns essentially the writing of the calculation notes, (during the job) and the survey during the job of the characteristics of the geotechnical model chosen for the project
- ⊕ G4 mission : supported by the contracting authority, it concerns the accreditation of the executing documents and the supervision of the geotechnical survey of the works.

These series are all the more important that the works engaged are more important and take more place than the traditional foundation works concerned by the Eurocode 7.

A spatial vision of the different facies and geological layers is essential during a drilling job site.

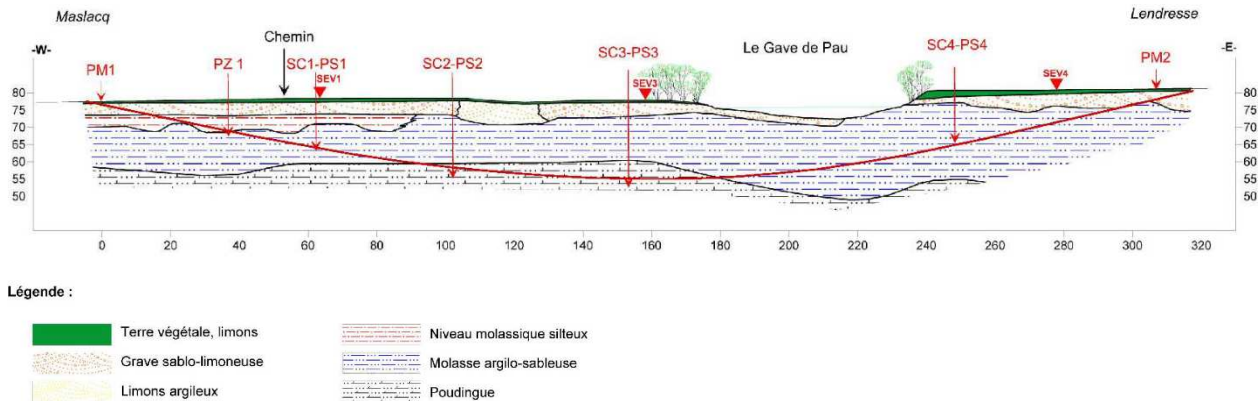
The mind of this standard with the series of missions described above is to have the possibility during the works to adapt the way of construction.

This suppose a continuous verification of the good alignment between the forecast and the reality of the behavior of the drilling.

This standard and the series of missions are complex because of the particular environment, the spatial spreading, and because the mineral world is alive :

- ⊕ Natural or artificial fluctuation of the groundwater
- ⊕ Landslide due to artificial or natural flow
- ⊕ Natural erosion
- ⊕ Anthropogenic disturbance
- ⊕ Destabilization of the environment due to the activity of the tools and to the drilling mud
- ⊕ Lateral fluctuations of the facies
- ⊕ Etc ...

Within a directional drilling, the feasibility study during the project phase should enable to establish a geological and geotechnical profile and describe the whole of the different facies and discontinuities encountered.



The analysis of the vulnerability of the work to construct depends on the characteristics of the formations. It is feasible only with the geological/geotechnical profile.

Only the combination of the results of the geophysical study with the results of the recognition survey, the results of the tests in-situ as well as the tests in laboratory could enable to construct the synthetical profile.

Concretely, the implementation of this standard within the HDD framework require some adjustments in the definition of the different missions.

Efforts will be accepted by all parties :

- ➔ By the contracting authority and the supervisor project, respecting scrupulously steps 1 and 2 and making do a G4 mission. This will mean for the supervisor project to know the technics of directional drilling and to adapt each step of the standard to the specificities of the works to be realized.
- ➔ By the drilling contractor, realizing a G3 mission, which is the only way to ensure the traceability of his drilling operations.

This process, even well adapted to the feasibility studies of a directional drilling, is rarely respected by the whole stakeholders of a directional drilling job (Contracting authority, supervisor project, drilling contractor).

3. Proposal of a process adapted to directional studies

Specificities liable to the study of a directional drilling involve that the different steps of the standard should be adapted to the particular context of a directional drilling project.

The progress of the different steps could be as following :

➡ Step n° 1 : Feasibility study phase

This step is organized in three phases

⊕ Phase n° 1 = G1 mission for preliminary study, including :

- A site investigation including a minima
 - Bibliographical research
 - Visit on site
 - Establishment of an expectable geological schema
- Establishment of the general construction principles :
 - The design of the bore path layout
 - Establishment of the geological and geophysical studies program

⊕ Phase n° 2 = G2 mission : conception of the proposed project (G2 AVP), including a minima :

- Geophysical investigations
- Geotechnical investigations
- Geological profile construction
- Identification of the geotechnical risks and the consequences on the work

⊕ Phase n° 3 = G2 mission : conception of the project (G2 PRO), including a minima :

- Synthesis of all the data collected
- The effects of the geological context on the choice of one or another technique implemented
- Finalization of the technical recommendations
- To write the technical notices justifying the construction choices

➔ Step n° 2 : Work phase :

The work phase is divided into two missions, one ensured by the contracting authority or the supervisor project, and the other by the drilling contractor.

⊕ G3 mission = supported by the drilling contractor, including :

- Writing of the execution operating procedures and the calculations notes
- Follow-up of the works and clear daily traceability of the progress of the drilling
 - Daily report
 - Drilling report for each joint
 - Mud report
 - Survey report

⊕ G4 mission = supported by the contractor authority, it is a mission of project management, or project management assistance and includes two points :

- Carrying out phase, including an opinion on the relevance of the geotechnical carrying out study file and on the adjustment or the optimizing of the geotechnical works proposed by the contractor
- Carrying out survey phase, including supervision of the geotechnical survey, an opinion on the relevance of the geotechnical model chosen and the progress of the works

This conceptual model of feasibility study and works survey enable to study and to manage the realization of a complex directional drilling and to anticipate the possible technical problems as well as the financial excesses.

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