REPORT ON GEOTECHNICAL TALK ON "AWARENESS OF SOIL INVESTIGATION"

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On 29 May 2004, there was an interesting talk organised by the Geotechnical Engineering Technical Division and delivered by Ir. Eddie Ng Teng Soon on the abovementioned topic. There were a total of 48 participants present at the talk. Ir. Eddie Ng started with the following common questions on Soil Investigation (SI) works:

- Why do we need to carry out SI?
- How do we organise and manage the SI?
- What information do we want from the SI?
- What plants or equipment do we require to carry out the SI?
- What in-situ and laboratory testing do we need?
- When do we take undisturbed samples?

The main reasons to carry out SI works are to have an adequate knowledge of the subsurface conditions of a construction site in order to properly carry out a safe and economical design of civil engineering structures. At the same time, SI will provide information to the construction engineer about the materials and conditions that will be encountered in the field.

Generally, most civil engineering structures can be divided into the following categories:

- Structures that interact with the surrounding ground (eg. foundations, retaining walls, tunnels, buried pipes, etc.)
- Structures constructed with earth (eg. fills, dams, bases and sub-bases, etc.)
- Structures on natural earth and rocks (eg. natural and cut slopes.)

The information required from SI works for the design of the above-mentioned civil engineering structures can be summarised as follows:

- The real extent of the depth and thickness of each identified stratum with description of each soil encountered (eg. primary soil name, plasticity, moisture condition, cohesion, cohesionless, stiffness, colour etc.) via the method of investigation undertaken.
- Depth to top, type and characteristics of rock encountered (eg. thickness, state of weathering, information on joints and bedding planes, fault zones etc.)
- Location of groundwater and any artesian water sources.
- In-situ engineering properties of soil and/or rock (eg. permeability, compressibility and shear strength.)

Normally, the procedures to obtain subsurface information involve the following:

a) Indirect Method

- Geological mapping.
- Aerial photography and topographical map interpretation.
- The use of existing geological reports, maps and soil investigations.

b) Direct Method

- Field reconnaissance (eg. examination of the – site's natural and manmade exposures etc.)
- Sounding and probing (eg. geophysics etc.)
- Borings, test pits, trenches and shafts to obtain in-situ disturbed and undisturbed samples for laboratory testing.
- Carry out simple field tests (eg. SPT & SCPT) and specific field tests (eg. vane shear test, seepage and water pressure tests, plate bearing test, CBR test, pile load test etc.)

PURPOSE AND PLANNING FOR SI WORKS

This is the most important part of SI information that will be used in the design and therefore, the following have to be considered:

- determine the categories of civil engineering structures that are present on the new proposed site and the information required in the design,
- indirect methods of exploration,
- drilling equipment and techniques,
- sampling equipment and techniques,
- field test procedures, and
- reporting of SI information.

The planning of the SI should also include:

- the number of boreholes and test pits required,
- survey coordinates and levels of the boreholes and test pits,
- type and amount of in-situ testing required, and
- number of undisturbed samples required and when they are taken.

It should be noted that the above are usually provided in the tender document of the SI works.

Ir. Eddie Ng also presented slides on some SI equipment and the procedures of drilling and sampling. In one case, a caisson was used to investigate an existing known

historical slip surface where a road will be constructed on an area within this slip surface of the slope.

Finally, he concluded the talk by asking a few relevant and critical questions:

- Do you understand now why we need to carry out Soil Investigation works? If not, why or what further explanation do you require.
- What equipment do we need and how many boreholes do we need? Are you confident in your SI programme?
- Ask yourself: Is SI just another part to construction or is it definitely an important part in construction? Yes or no? Why?
- Do you think supervision of SI works is important? Why?

In addition, slides showing failures were shown and some interesting questions were posed to the audience to ponder as follows:

- What has SI got to do with the failures highlighted?
- Can SI help to reduce or overcome the problem of construction failures?
- Is the additional cost of SI justified?

During the question and answer session, the following questions were asked and discussed by speaker and the participants.

Q1. Would it be more appropriate to rephrase "Soil Investigation" as "Subsurface Investigation", since the investigation works do involve recovery of rock cores and groundwater regime?

Ans: Yes, it would be more appropriate to use the term to cover the subject of investigation. According to the latest British Standard (BS 5930 : 1999), the term of "Ground Investigation" has been used to address the discussed issue.

Q2. As for detecting the bedrock profile, are there any appropriate techniques to be used?

Ans: Geophysical survey can be an effective preliminary investigation tools for large area coverage. However, there is a limitation on the vertical extent of the bedrock depth that can be investigated via a geophysical survey. A larger energy source, likes explosives, would be required for a greater depth of investigation. It should be noted that geophysical results should always be supplemented with boreholes of the site surveyed.

Q3. How does SI supervision relate to design responsibility? If an engineer undertakes an engineering design, which involves construction of a structure over the filled platform by other engineers, does the engineer also has to investigate the ground before designing the structure?

Ans: Yes, it is the designer's responsibility to ensure the suitability of the ground for the design of the proposed structure over such ground.

Q4. Is percussion equipment available in Malaysia?

Ans: Yes, it is available, but only a few contractors have the equipment and it is not commonly used in SI work nowadays.

Q5. What are the differences between rotary drilling and wash boring?

Ans: Rotary drilling involves rotational action of the drill bit to cut the subsoil and recover the sample in the sampling tubing, whereas wash boring is to use water as a flushing means to wash the soil and remove the soil debris to the ground surface by water circulation.

Q6. Is there any guideline on the minimum required spacing of boreholes for investigating a limestone formation?

Ans: It is normally advisable to carry out the SI on a two-stage approach. The preliminary SI would provide a general overview of the subsurface conditions by optimising the development layout and avoiding the problematic features at the project site. Once this is understood, the stage II, detailed SI would then be carried out if necessary, for the detailed foundation design.

Q7. How do the prices of SI work in Malaysia compares to work done in other countries?

Ans: In some countries, SI contractors are called "drillers" and their primary role is to take instruction from the site engineer who will supervise their work full-time, and who will ensure the quality of the samples and that tests are undertaken appropriately as instructed. It is not their role to decide where and when to take samples or to carry out the necessary in-situ testing. As such, they are paid for what they have carried out based on remeasured amount, including idling time for unforeseen delays (eg. waiting for instructions, chiseling time etc.).

Q8. Is it appropriate for a normal C&S engineer to plan and interpret the SI factual information? Or is a geotechnical engineering required to interpret the information for the geotechnical design.?

Ans: This shall be based on the training and the competency of the respective C&S engineers. However, if the works are complicated, it would then be best to seek advice from a geotechnical specialist. ■