Chapter 3:

Earthquake Analysis

Chapter 3. Earthquake Analysis

3.1. General

A flowchart for the analysis is shown in Figure 3.1.1. The first step is to decide on a scenario earthquake. The next step is to construct a fault model for the numerical calculation. For the analysis of the earthquake motion, the empirical Green' s function method is used. The waveform at the engineering bedrock is synthesised at this stage. The subsurface amplification factor is indispensable in order to assess the earthquake motion at the ground surface. For this purpose, the ground of the whole area is classified into several models. The ground model for numerical calculation is constructed from the ground classification and its soil properties. The subsurface amplification factor is analysed by response analysis. The waveform at the ground surface is calculated from the waveform at the engineering bedrock and the subsurface amplification function.

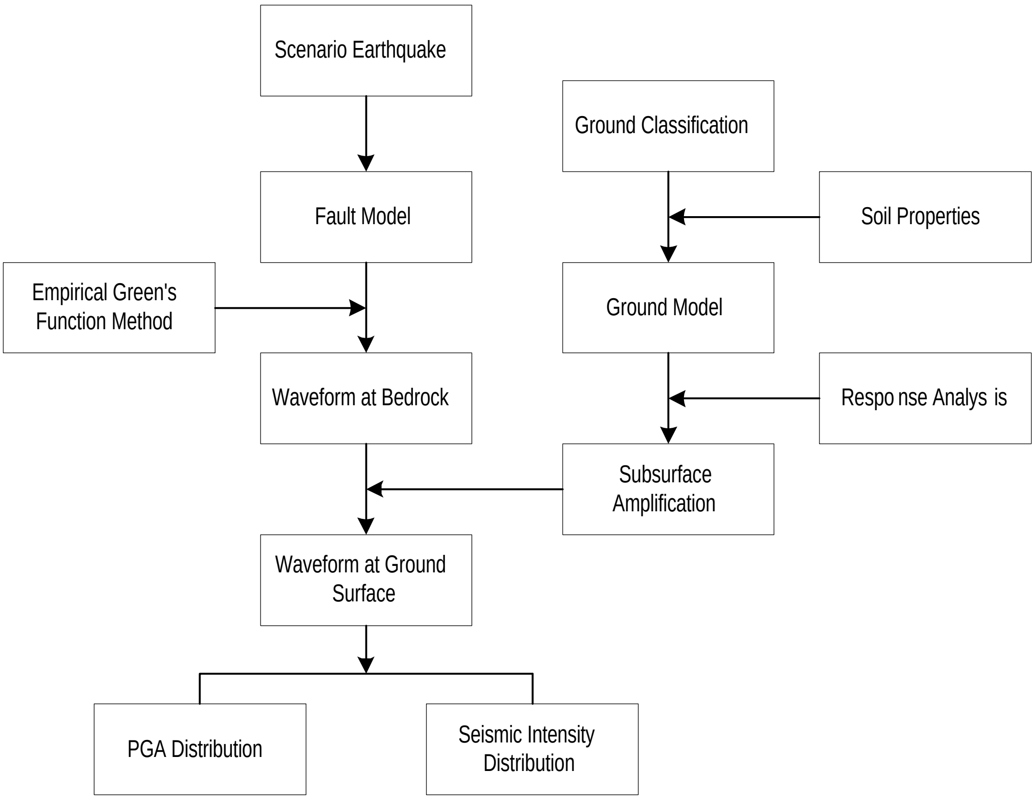


Figure 3.1.1 Flowchart for Earthquake Analysis

3.2. Ground Classification

The ground condition of the Study Area was analysed and classified to construct the ground model for seismic analysis. The outline of the ground classification is summarised as follows:

3.2.1. Data Used for the Ground Classification

Fifty boreholes were drilled in the Study Area in order to collect essential ground information. Details of the investigation were summarised in the Field Report. Shear wave velocities of ground were measured in technical cooperation with Exploration Division, Institute of Geophysics, Tehran University (IGTU). Suspension PS logging method and downhole PS logging method were introduced. This borehole data served as the framework for the ground classification. The location of these boreholes is shown in Figure 3.2.1. Typical borehole logs are shown in Figure 3.2.2, Figure 3.2.3, and Figure 3.2.4. Further, about 400 borehole data were used to analyse the ground condition of the Study Area. Most of these borehole data were collected courtesy of Geotechnical and Strength of Material Study Center, Tehran Municipality (GSMSC). The general geological cross section of the Study Area is shown in Figure 3.2.5.

3.2.2. Seismic Bedrock

Normally, it is very difficult to investigate the distribution of the geological seismic bedrock (i.e., hard rock with high shear wave velocity (Vs>3000m/sec)) in plain areas. Therefore, the concept of engineering seismic bedrock is employed for the seismic microzonation analysis. The Technical Committee for Earthquake Foundation Engineering, TC4, ISSMFE (1993) recommends the use of engineering seismic bedrock of shear wave velocity Vs of around 600m/sec.

As described in Chapter 3.2.4, shear wave velocity and the N values obtained from standard penetration tests are mutually related. The N values are recalculated as equivalent to 30cm penetration Neq. Based on this relationship, Vs = 600m/sec corresponds to Neq =100. Therefore, the engineering seismic bedrock for the Study is defined as follows:

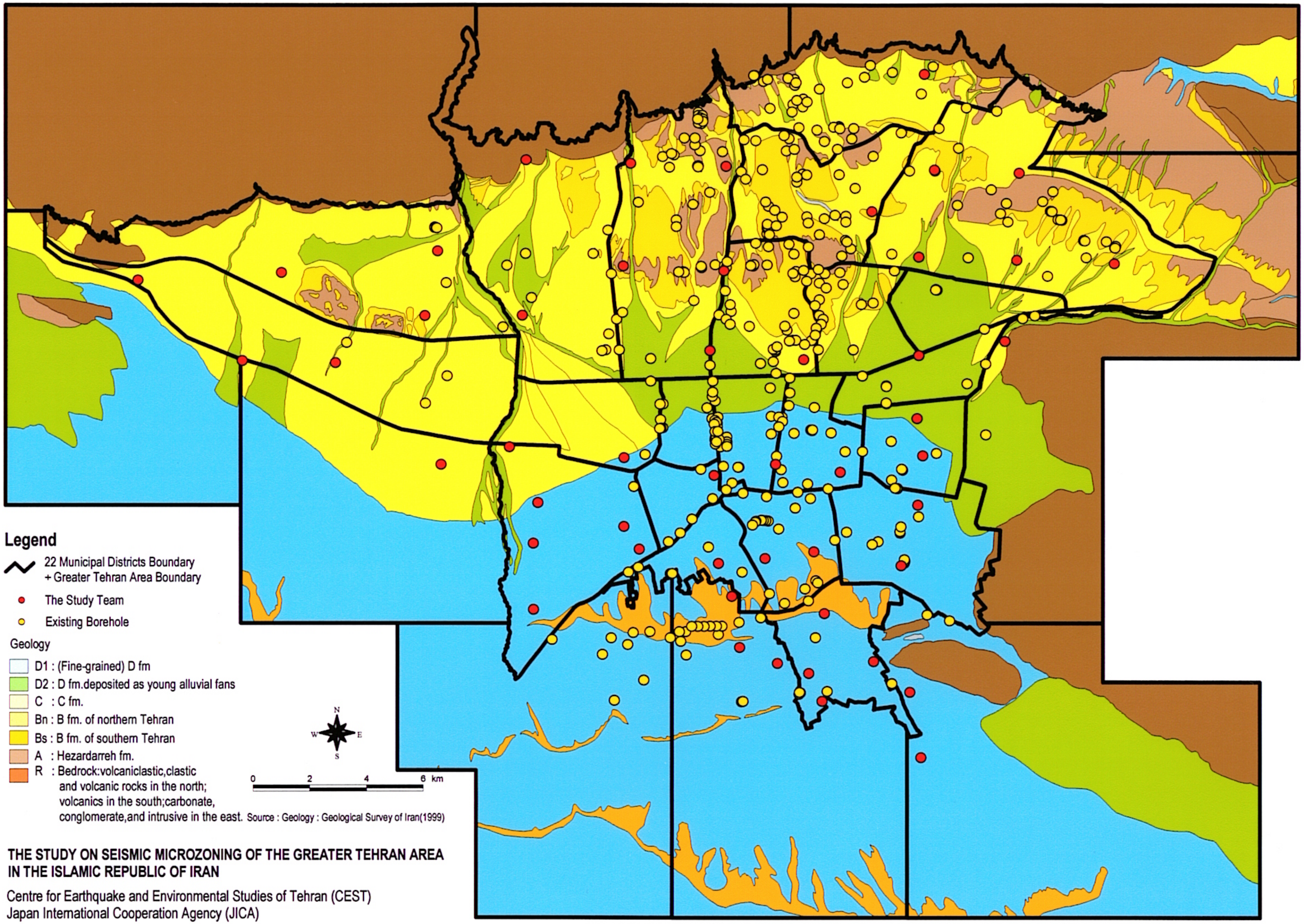
Engineering Seismic Bedrock in this Study

- The layer at which the shear wave velocity Vs exceeds 600m/sec
  or the Neq value exceeds 100, and
- The continuity and thickness of the engineering seismic bedrock is adequate for wave propagation

Based on the above definition, the distribution of the engineering seismic bedrock in the Study Area is estimated. In the eastern alluvial plain, the engineering seismic bedrock is situated at a depth of around GL-150m. This is the deepest part in the Study Area. From this area, the depth of the engineering seismic bedrock becomes shallower towards the north and east. The depth becomes approximately GL-35m at the boundary of the fan and the plain. The depth of the engineering seismic bedrock in ***C*** and ***D₂*** formations is estimated at approximately GL-20 to 35m from the Neq value and the PS logging result. ***A*** and ***B*** formations are firmly cemented, therefore these formations are regarded as an engineering seismic bedrock from their surface. In addition, ***R*** formations are regarded as engineering seismic bedrock from the ground surface.

Figure 3.2.1

Location Map of Boreholes



THE STUDY ON SEISMIC MICROZONING OF THE GREATER TEHRAN AREA IN THE ISLAMIC REPUBLIC OF IRAN

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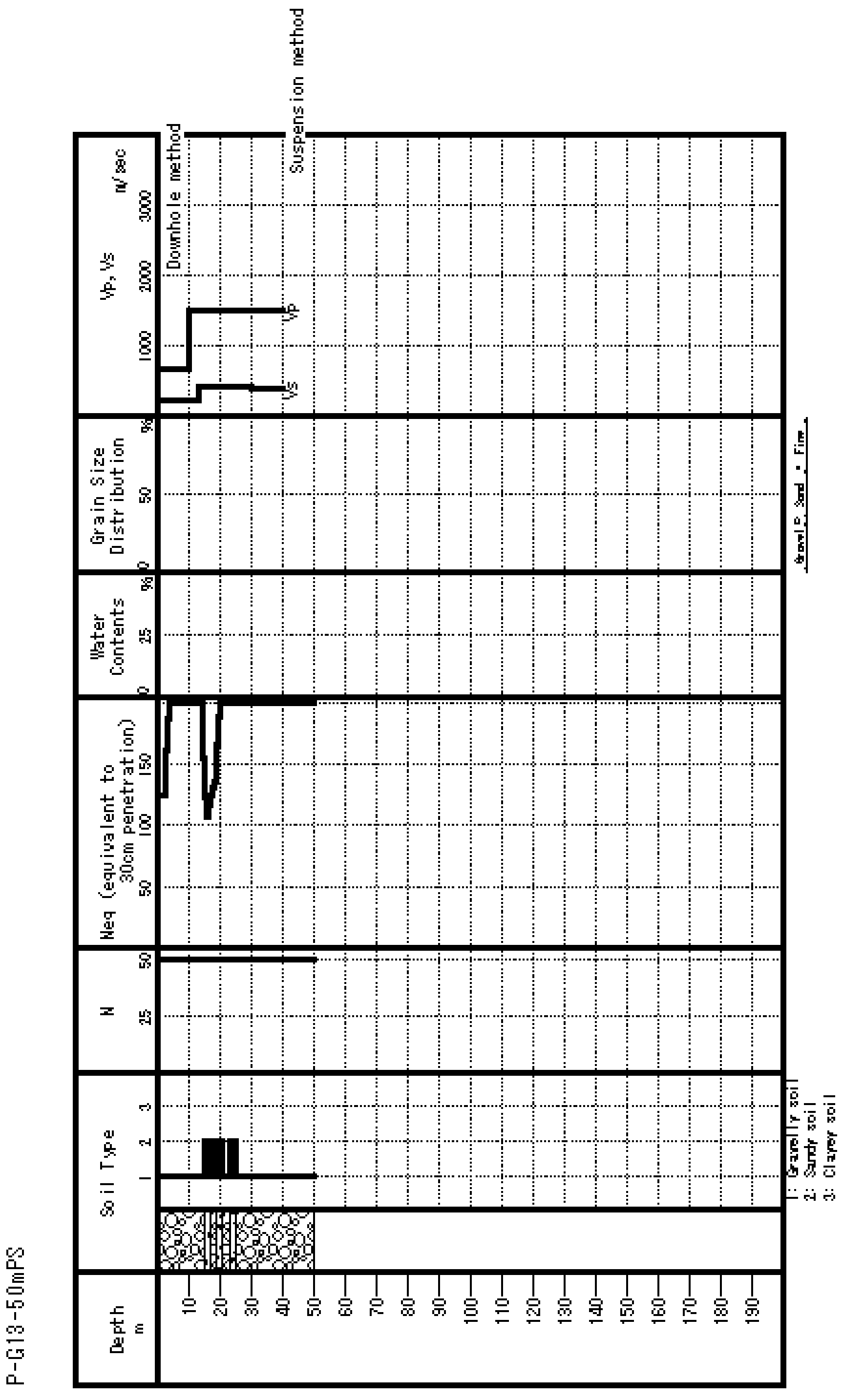

Figure 3.2.2 Soil Property Chart (Boring G13)

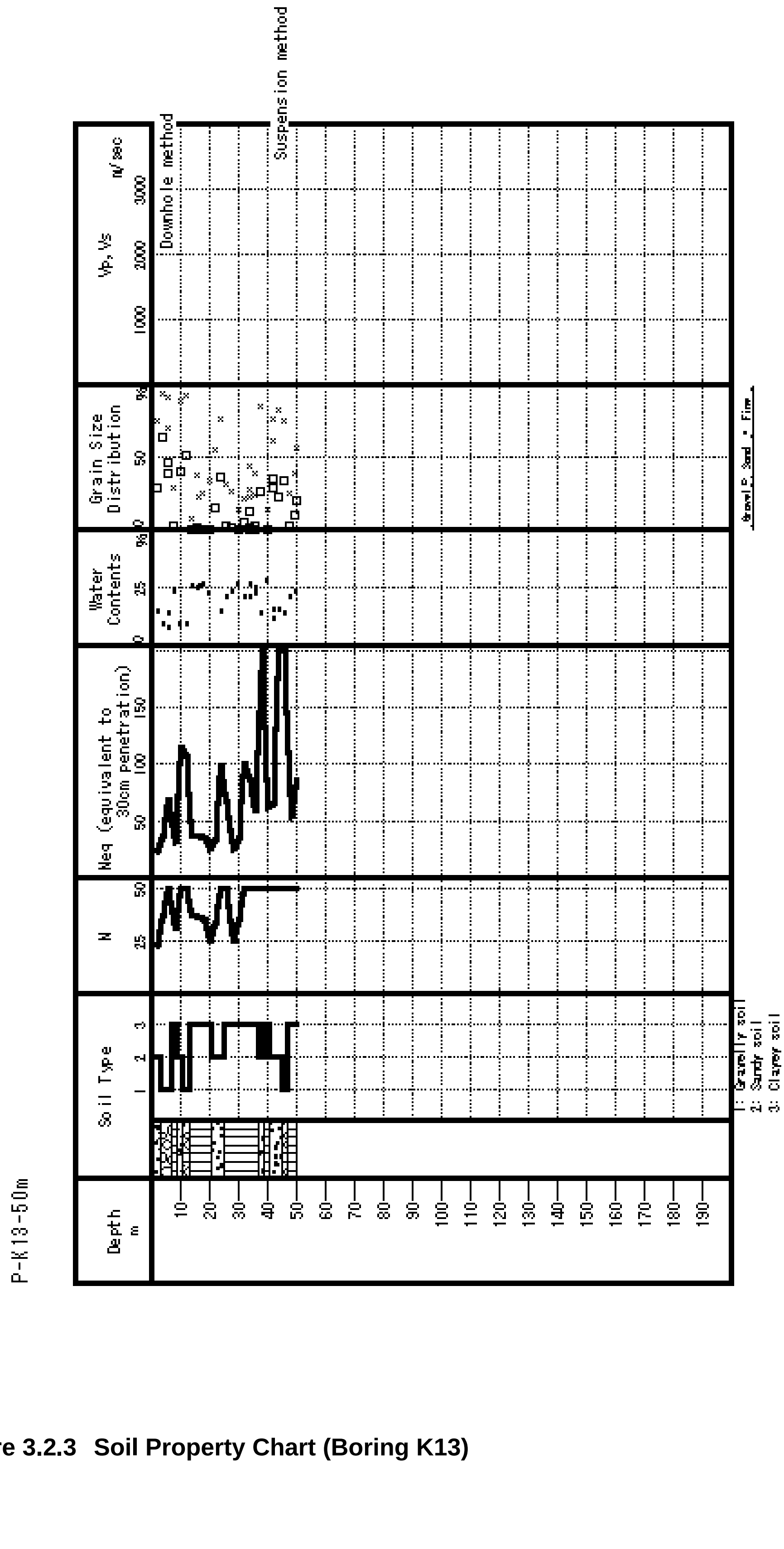

Figure 3.2.3 Soil Property Chart (Boring K13)

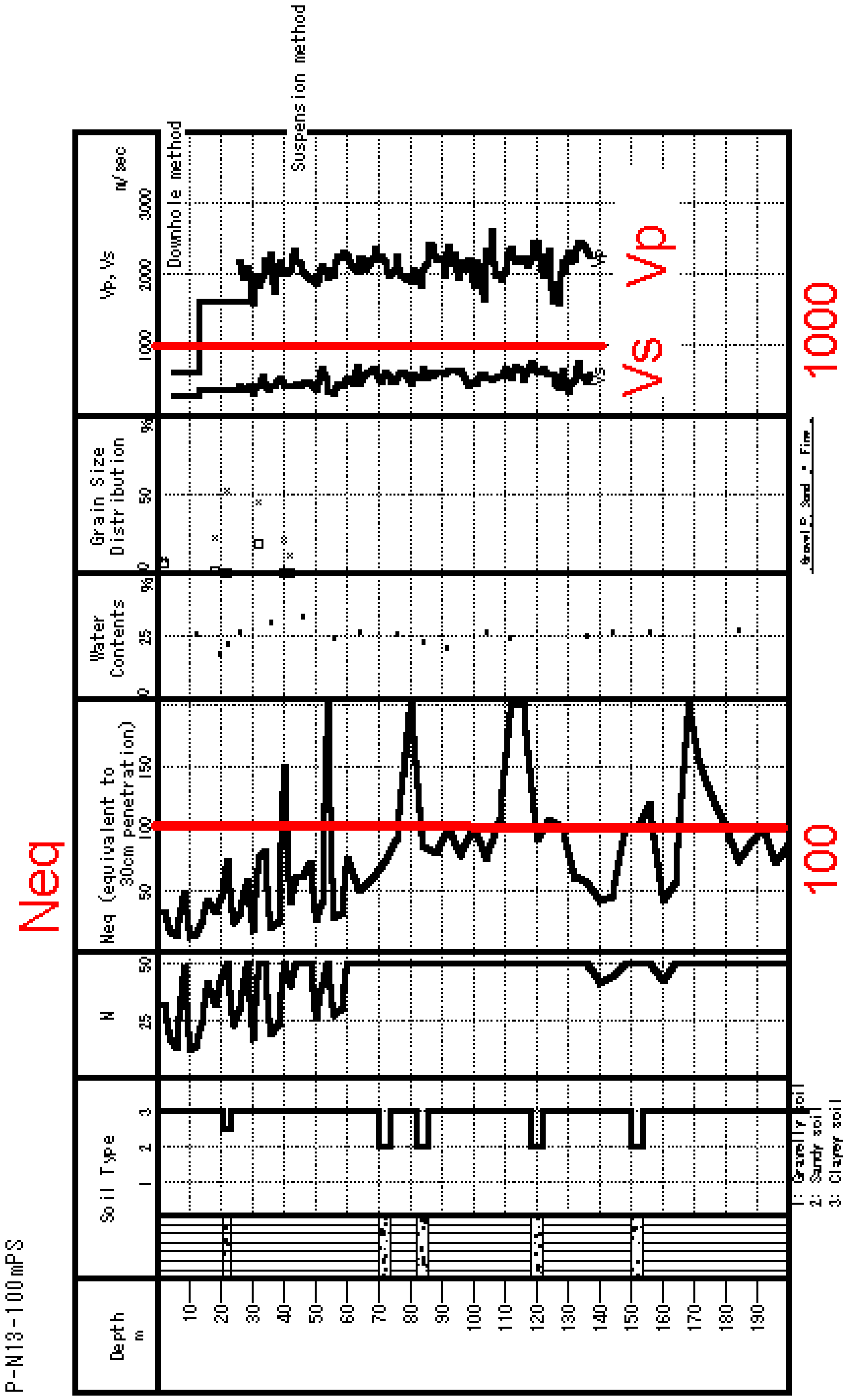

Figure 3.2.4 Soil Property Chart (Boring N13)

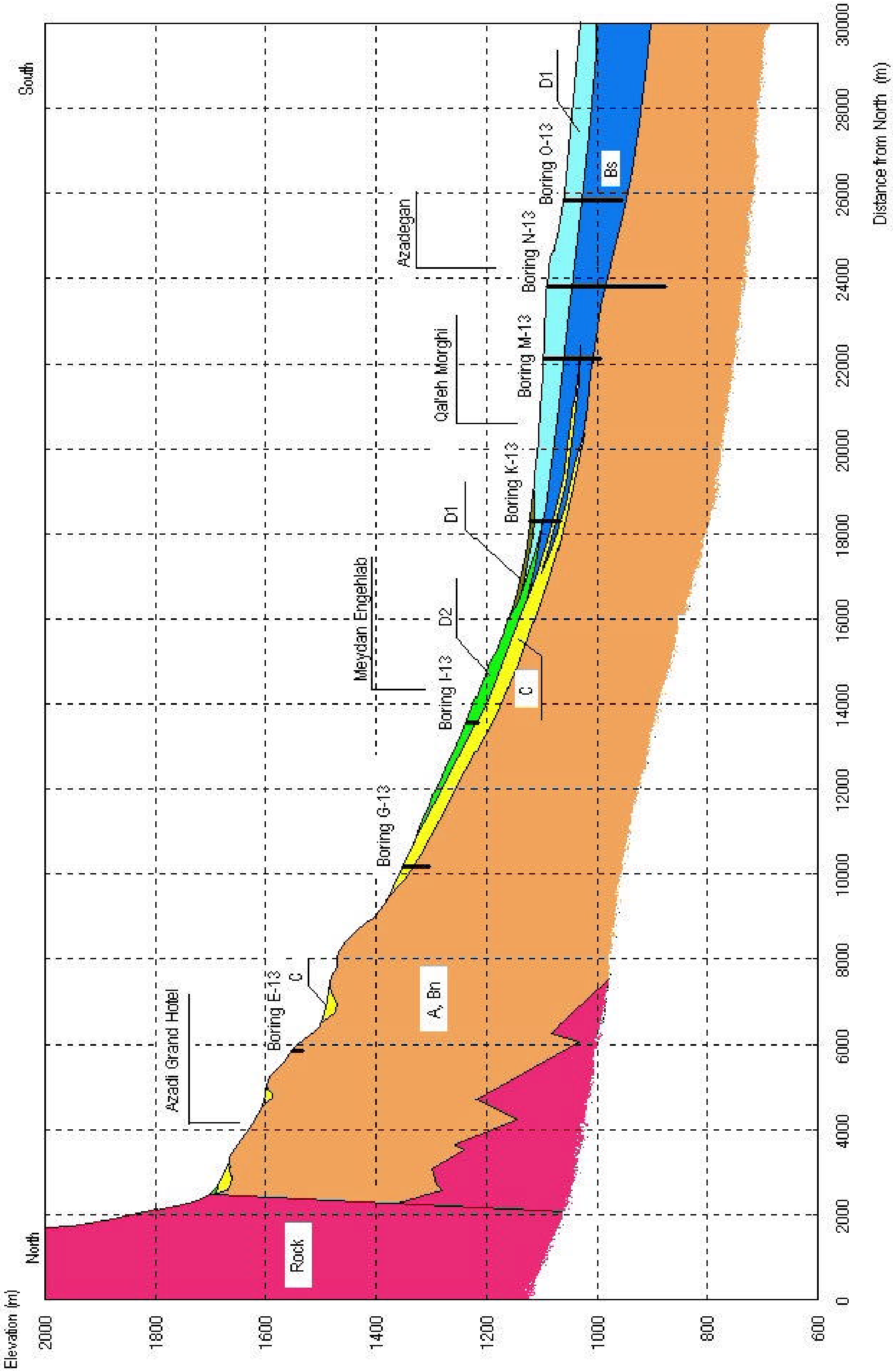

Figure 3.2.5 Geological Cross Section