DEVELOPMENT OF [illegible] ABASE SYSTEM FOR

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A thesis submitted in fulfillment of the requirements for the award of the Bachelor of Civil Engineering

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JUN 2012

ABSTRACT

One of the vital works before a construction begin was a site investigation which was the site exploration to gain the result for the soil characteristics at the construction area. By undergo some necessary required test such as deep borehole logs, water level measurement, JKR Probe, standard penetration test (SPT) and others, the engineers able to design a suitable, safety and economic structures for the building. Usually, the report for the site investigation was in a hard copy and it required a lot of papers for one site investigation report. Other than that, it hard to retrieve the data for site investigation report from all places in one time because of the data was in different hard copy. To solve this matter, a database system for soil characteristic was developed to make all the site investigation data report easily to retrieve in one time and able to be updated from time to time if there was any new result obtained. This database system was developed for Kuantan area only. There were 16 site investigation report data was successfully collected and had been placed in one database system. The tools that had been used to develop this database system were Geographical Information System (GIS) and Visual basic 6.0 (VB6.0). GIS tool was used to provide the map for Kuantan areas. Meanwhile, VB6.0 was used to make the interface design and created the database system for the site investigation data report. To ensure that the map from GIS tools were able to relate with the database system from VB6.0, a hyperlink was created. So, by selecting the site investigation point from the map in GIS, the result of the site investigation appeared easily without used much time. Lastly, this database system would be one of the necessary database systems in construction field because of it availability to retrieve data easily and all the site investigation data was placed in one database system.

ABSTRAK

Sebelum sesuatu kerja pembinaan dijalankan, salah satu kerja yang penting adalah kerja-kerja penyiasatan tapak yakni dengan melakukan kerja-kerja penyiasatan tapak ini, ciri-ciri tanah dapat diperoleh bagi kawasan pembinaan. Beberapa ujian akan dilaksanakan dalam kerja-kerja penyiasatan tapak seperti ujian kedalaman lubang jara, ujian paras air bawah tanah, JKR proba, ujian tusukan piawaian dan lain-lain ujian. Dengan melaksanakan ujian-ujian ini, jurutera dapat membuat reka bentuk struktur yang sesuai, selamat dan tidak melebihi kos pembinaan. Laporan penyiasatan tapak biasanya dalam bentuk salinan kertas laporan dan ia memerlukan penggunaan kertas yang banyak. Selain itu, ia juga sukar untuk mendapatkan maklumat ujian penyiasatan tapak bagi kawasan yang berlainan dalam satu masa. Bagi menyelesaikan masalah ini, satu sistem pangkalan data untuk ciri-ciri tanah telah direka bagi memastikan semua laporan penyiasatan tanah mudah dicapai dalam satu masa dan boleh diubah dari semasa ke semasa jika maklumat-maklumat baru yang berkaitan dengan ujian penyiasatan tanah diperolehi. Sistem pangkalan data ini direka untuk kawasan Kuantan sahaja. Terdapat 16 laporan ujian penyiasatan tanah telah berjaya diperolehi dan telah diletakkan dalam satu sistem pangkalan data. Kaedah yang digunakan untuk menghasilkan sistem pangkalan data ini adalah dengan menggunakan sistem Geographical Information System (GIS) dan Visual Basic 6.0 (VB6.0). Sistem GIS digunakan untuk menghasilkan peta bagi kawasan Kuantan manakala sistem VB6.0 digunakan untuk mereka bentuk sistem pangkalan data bagi semua laporan ujian penyiasatan tanah. Satu pautan direka untuk mengaitkan sistem GIS dan sistem VB6.0. Titik laporan penyiasatan yang terdapat dalam peta boleh dipilih dan keputusan laporan tapak penyiasatan akan dapat diperolehi dengan mudah. Kesimpulannya, sistem pangkalan data ini sangat diperlukan dan dapat membantu kerja-kerja pembinaan dengan lebih cekap.

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CHAPTER 1

INTRODUCTION

1.1 General

One of the challenging and popular work fields that attract many companies all over the world is construction industry. This field also contribute to the economy development for a country such as Malaysia. There are many parties involved in this field such as geotechnical engineers, structural engineers, technicians, contractors, labourer and others. All of them work together as a team to produce a great construction works. In order to produce a great construction works which can fulfil the customers need, a good plan and project management is very necessary. Construction works is not an ease works and it need to follow the right guidelines or procedures. The guidelines or procedures can avoid any problems in the future. Some of the critical works in construction process are geotechnical investigation and structural design.

Geotechnical site investigation is the process where all the information and evaluations of the condition of the site for the purpose of designing and constructing the foundation for a structure such as building, bridge and plant. This process is very important to examine the potential of the development site areas before the construction work start, to explore the subsoil conditions, ground water table, soil properties for the proposed areas and others. Geotechnical site investigation involved many process such as boring test, Standard Penetration Test (SPT), soil sampling,

termination criteria, laboratory test and ground water level measurement. For the government project, it may involve the Public Work Department (PWD) probe. Good management and planning in geographical site investigation is the key to obtain correct and sufficient information for designing a structure. Some of the key for successful geographical site investigation are comprehensive planning, collection of sufficient data, clear reporting and compliance with site investigation report data. During the geographical site investigation process, all the utilities or equipments needed should be provided in order to smooth the works progress and can reduce the time and cost planning.

From day to day the construction technologies are updated such as equipments, process in construction works or software system. One of the technology or software systems that had been widely used all over the world is Geographical information System or GIS. Geographical Information System (GIS) can be effective tools for geotechnical engineers since many data in geotechnical work is in the types of spatial data or geographical data. Thus, Geographical information System (GIS) can be used to create better database for site investigation report which give benefit to the geotechnical engineer and construction work progress. Moreover, the system is expected can be connect to the other existing GIS applications for further applications.

1.2 Problem Statements

From many years ago, before the technologies in construction industry had been developed, the practical way to record the data for construction work is in variety of hardcopy or paper formats from site works or referenced books. This way require many sheet of papers, cannot update the latest information or collection data, ease to lose if there is no proper facilities and asset management from the person in charge and other peoples cannot access the data easily. This can affect the quality of construction work. Moreover, it requires a lot of work space which is the suitable

place to keep all the collection data and ensure that the place can access easily by the users.

Other than that, in site investigation data record, an effective data record such as by developing the database for site investigation report is not practice widely in this country. So, it may affect the cost of the project and the time consuming of the construction project. These factors can burden the contractor and owner of a project. They need to reschedule their progress work in order to make sure the project finish on the planned time. Moreover, without effective and proper recording data, the engineers will difficult to retrieve data they need easily. It also may exist a problem where some important collection data for site investigation missing or lost. This required them to do the same work in order to complete the data they needed.

In site investigation work, there are only some chosen points are taken to do the test such as boring, soil sampling, water table measurement and other. For other points or area which not having the tests, the soil properties is undefined. To overcome this problem, the correlation between two points for the construction area is important to identify the soil properties or characteristics for the area. This also can make the engineer work easier without doing too many site explorations at same places and can save the costs. This also can help the future project to identify the soil properties at the nearer areas.

1.3 Objectives

The objectives of this study are:

a) To develop soil database system in Kuantan by using Geographical Information System (GIS) and Visual Basic (VB).

b) To compile soil properties through soil investigation (SI) existing data using GIS and VB database at Kuantan, Pahang.

1.4 Scope of Study

This study was conducted at Kuantan, Pahang. The data was taken from the site investigation report of some construction project in Kuantan areas. All the data required such as deep boreholes results, soil profile results, vane shear test results, laboratory test results, and site plan were found in the site investigation report. These data was taken from Public Work Department of Kuantan, Pahang and Kumpulan Ikram Sdn. Bhd. All the collection data ware analysed and processed. Then, the database system was developed based on the data information from site investigation report. To obtain the database system, Geographical Information System (GIS) and Visual Basic 6.0 were the tools that used as medium to analyse and process the data.

The Geographical Information System (GIS) was the tool used to analyzed, manipulated and processed the existing spatial data. This system also produces a unique visualization and geographic analysis benefits offered by maps. The maps or images of Kuantan areas were needed to identify the coordinates of the selected area. In order to get the images of Kuantan areas, Google earth, map window GIS and shape to earth tools were used to capture the entire image in Kuantan areas. Other method that can be used to produce the image of Kuantan area is by converting the plan image from AutoCAD into the ArcMap. After that, the spatial data collected will be processes by using ArcGIS which involved the uses of the ArcCatalog, ArcGlobe, ArcMap, ArcReader and ArcScene. After all the procedures or steps finish, the database system for site investigation report obtained.

So, this study was done to create an effective system or database for soil from the site investigation report data by using Geographical Information System (GIS), Google earth, map window GIS and shape to earth. This database system can easily to update by time to time if there any new information about the soil properties. Other than that, this study also made to provide correlation of site investigation existing data between two points. This correlation is very important to know and obtain the soil properties at the areas which not having the site investigation tests.

This can save the cost and time consuming for construction project and ease to retrieve by the engineers that involve in a project.

1.5 Significance of the Proposed Research

To develop effective soil database system which can easily to retrieve the data by the geotechnical engineer is very important in construction industry. This can help the engineers to do their work easily without using much period of time. The data collected in site investigation report were analyzed, organized and structured into geographical database. Then it was turned to information system which can be used by the engineers as a guide for the preliminary design in construction process. The correlation of the site investigation report data between two points can produce the characteristic of the soil around the two point's boundary. Correlation between two points can help the geotechnical engineers obtain the soil properties at the point which not having the soil investigation tests. All the data can be updated anytime. This can reduce the cost and time of the project and ease the engineers work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Before construction works begin, the exploration of the site area which is site investigation was done first to identify the soil properties for the area. This is a common step that was done in every construction project in order to do the preliminary design which is foundation design. Identifying and collecting the data information of the soil properties can help the geotechnical engineer to design the most economical foundation, able to support maximum load and can resist any major problems regarding to the soil sliding issues. This is important to avoid any hazardous incident during the construction progress and after the project completed.

Site investigation works have its own phases that need do in order to get the data information. There are many methods and devices can be use which is from simple method to the complex method. Usually, some of the methods are applicable in subject study. The tests that cover in site investigation work can be done in laboratory or at the site or field area. The results from doing this site investigation will be analysed and recorded for engineers uses. Other than that, the correlation at the site area can be also obtained by doing some calculation.

2.2 The Site Investigation

Subsurface exploration program is one of the major and necessary works that need to be implemented properly in civil engineering work. The processes of subsurface exploration are to identify the layers of deposits and their physical characteristics that underlie the proposed structured. Sometimes, it will be done for project which are altering and additional of existing structure. There are many purposes of subsurface exploration program such as to obtain information in determining the location of the water table, estimate the probable settlement of a structure, evaluate the load bearing capacity of the foundation and identify the potential foundations problems (M. Das, 2011). Some steps are included in subsoil exploration program which is collecting the preliminary or existing information data for the subsoil condition, reconnaissance of the proposed construction site and detailed site investigation (M. Das, 2010).

There are many definitions regarding to site investigation process. One of the explanations of the site investigation is the process whereby all relevant information concerning the site of a proposed civil engineering or building development and its surrounding area is gathered (Simons, et al., 2002). All the collected information is obtain through some lab test and insitu test. After that, the result are recorded in a report which also known as site investigation report. Standard Penetration Test (SPT), boring, termination criteria, soil sampling, ground water level measurement and laboratory testing are the scope of work that to be done in site investigation work. Sometimes, if the client of the project is from government, the site investigation work will include the *Jabatan Kerja Raya (JKR)* probe. These are the necessary standard that had been used in Malaysia when doing the site investigation work.

The objectives of handling site investigation are to obtain geotechnical information at the site, explore the subsoil condition at the proposed site by exploratory boreholes, obtain disturbed and undisturbed soil samples for visual examination, determine the parameters of the soil, obtain the shear strength values on soft soil and measure the ground water table at the site (Kumpulan Ikram Sdn. Bhd.).

Other than that, by doing site investigation work, the access of general suitability of the site with the environments can be obtained, enable adequate and economic design to be prepared, and the best method of construction can be planned (Simons, et al., 2002). There are some procedures that need to plan and manage properly for site investigation works. Without proper planning, it may cause a problem such as delay in time and error in the test results. It will also affect the future construction of the building whether during or after construction completed.

The other two phase of subsurface exploration program which are collection of preliminary information and reconnaissance of the proposed construction site will be done first before starting the site investigation work. The collection of preliminaries information can be divided into two which are compilation of the existing information regarding the structure and collection of existing information for the subsoil condition. This phase is important to obtain the information about the type of structure that will be constructed and its general used. All the loads that related to the structure, the important factors or characteristic required for the structure, the topography and the types of soil involved at the site areas need to be known. For the reconnaissance phase, the engineer should make visual inspection of the site and surrounding area to obtain some information such as type of vegetation at the site and general topography of the site (M. Das, 2011).

2.2.1 The Site Investigation Phase

A good planning and management of site investigation work will produce a good result and information about the type of soil for the construction area. The site investigation phase of the exploration program consist of planning, making test boreholes and collecting soil samples at desired intervals for subsequent observation and laboratory test (M. Das, 2010). Therefore, there many factors that needs to be considered to obtain good quality result of site investigation work. There are some critical success factors such as identification of ground hazard, provision for better

management of ground risk, provision for better value for clients and users, and efficient processes which continually improved (Simons, et al., 2002). Figure 2.1 shows the information and activities flowchart for geotechnical site investigation.

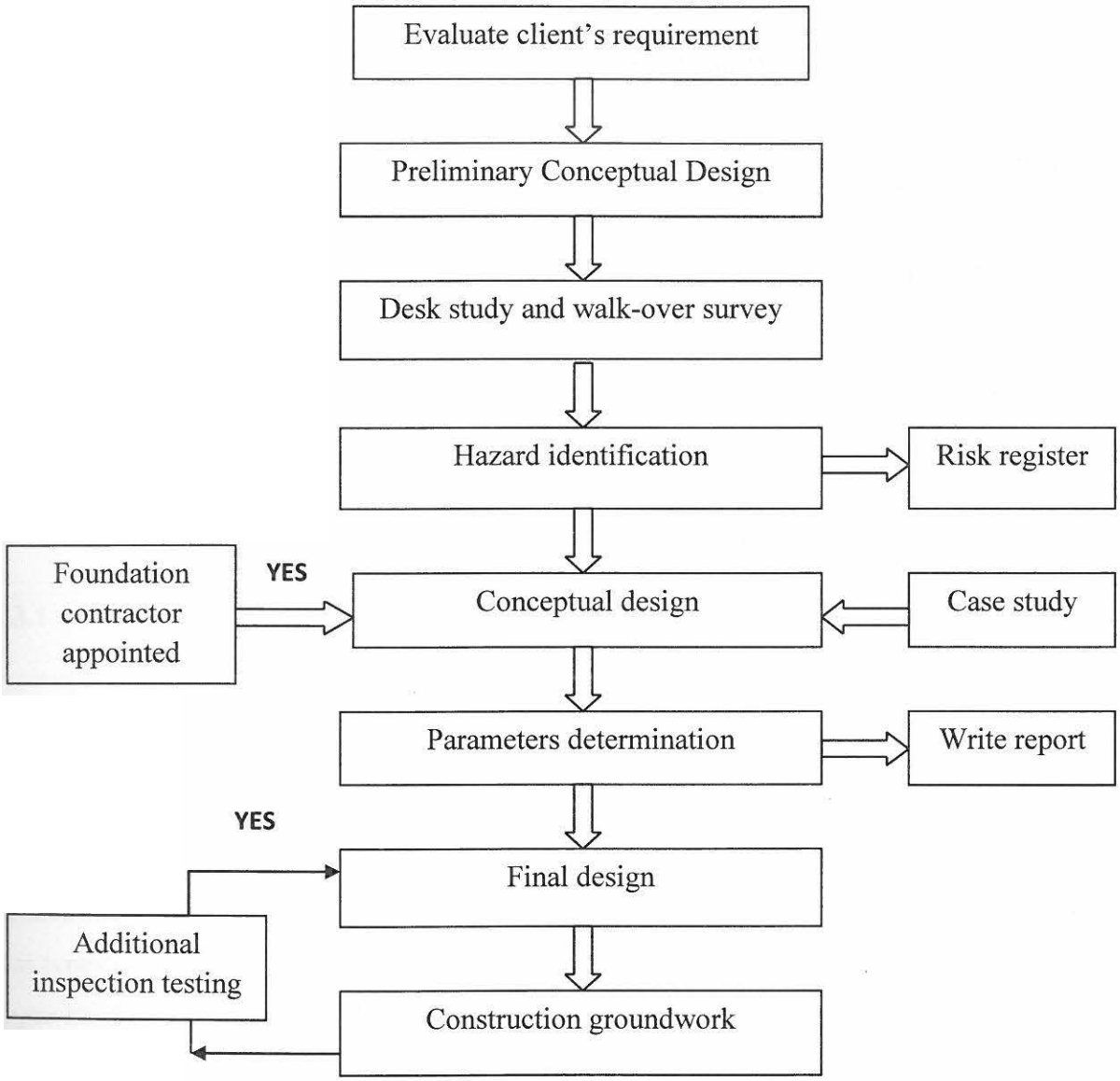

Figure 2.1: Information and activity flow chart for geotechnical site investigation (Simons, et al., 2002).

2.3 Field Exploration in Site Investigation (SI) Work.

Field exploration is the exploration of the site to obtain the sample and result for in-situ test. There are some test had been carried out at the construction site such as boring, standard penetration test (SPT), termination criteria, soil sampling, mackintosh probe and ground water level management. Basically, in Malaysia the SI work was done by Kumpulan Ikram Sdn. Bhd. This organization usually carried out all the field exploration and provides the complete SI report to the client such as *Jabatan Kerja Raya (JKR)*. Only qualified person can perform the listed tests at the site. In the SI report, there are also the stated the proposed recommendation type of foundation for the site which is involve the size of the foundation, length (for the purpose of the tendering process), the allowable bearing capacity, negative friction of the pile and the loading test for the pile.

2.3.1 Boring

There are many types of boring test that carried out during field exploration. The simplest method and usually used at site is auger boring. There many types of auger boring which is depend on the deep of the boring and the size of the project structure. First type of auger boring is hand auger. Hand auger can be divided into two types of hand auger which are posthole auger and the helical auger. This type of auger boring can only used for advancing hole to depth exceeding 3m to 5m only. Other type of boring which can deeper advancing hole is continuous-flight auger. This type of auger was used when the power available. This type of boring is the most common method that had been used for advancing hole. Boreholes up to about 60m to 70m can easily made by this method (M. Das, 2011).

In Malaysia, the most common boring method that had been carried out was rotary boring or also known as rotary wash boring. This boring method was capable

to drill until 100m depths. For this boring, a boring hole used a drilling fluid such as water or mud pumped down a rod fitted at the bottom some sort of cutting bit. The soil below the road caused by the cutting bit dislodged. This means the advancing hole achieved. The drilling fluid under some pressure transported the cutting to the surface. The multi-speed rotary wash boring machine was used for the field exploration. The boreholes were drilled by trained driller. To circulating water washed the boreholes and the disturbed samples were collected for visual examination. The rotary drilling had been used as the procedure because this kind of procedure can be used in sand, clay and rock (M. Das, 2010). This technique can make the diameters of the boreholes ranging from 50mm to 200mm.

Figure 2.2 shows one of the examples of hand auger which id helical auger. Meanwhile, in Figure 2.3 and Figure 2.4 show the rotary-wash boring machine. The process of boring work in these figures was taken from boring work for the school project at Kuantan, Pahang area. The project was *'Cadangan Membina dan Menyiapkan Blok Dewan Perhimpunan dan Blok Kantin serta Kerja-Kerja Berkaitan di Sekolah Menengah Agama Al-Ihsan, Kuantan, Pahang.*

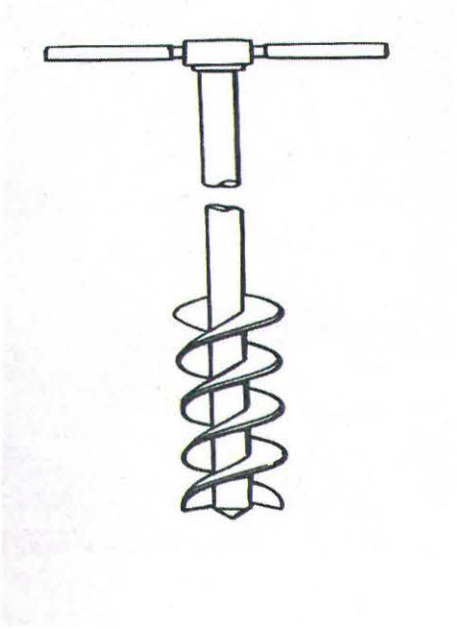

Figure 2.2: Helical auger (M. Das, 2011)

Figure 2.3: Boring work process (JKR).

Figure 2.4: Multi-speed rotary wash boring machine (JKR).

2.3.2 Standard Penetration Test (SPT)

Standard Penetration Test or SPT is the test used to obtain soil samples for the site. This test method is used extensively in a great variety of geotechnical exploration projects. Moreover, many local correlations and widely publishes correlations which relate blow count or N-value, and the engineering behaviour of earthworks and foundation are available by this test method (ASTM 1999-2012). In Malaysia, usually SPT was carried out by using split-barrel sampler. This method used in field to obtain soil samplers which are generally disturbed but still representative. For very soft and soft clays soil, this method is not suitable to be used as a method to obtain the sample of the soil. The necessary equipment for this test is drilling equipment, sampling rods, split-barrel sampler, and drive weight assembly.

Figure 2.5 shows the section or standard dimension of SPT split-spoon sampler while Figure 2.6 shows the component of SPT split-spoon sampler.

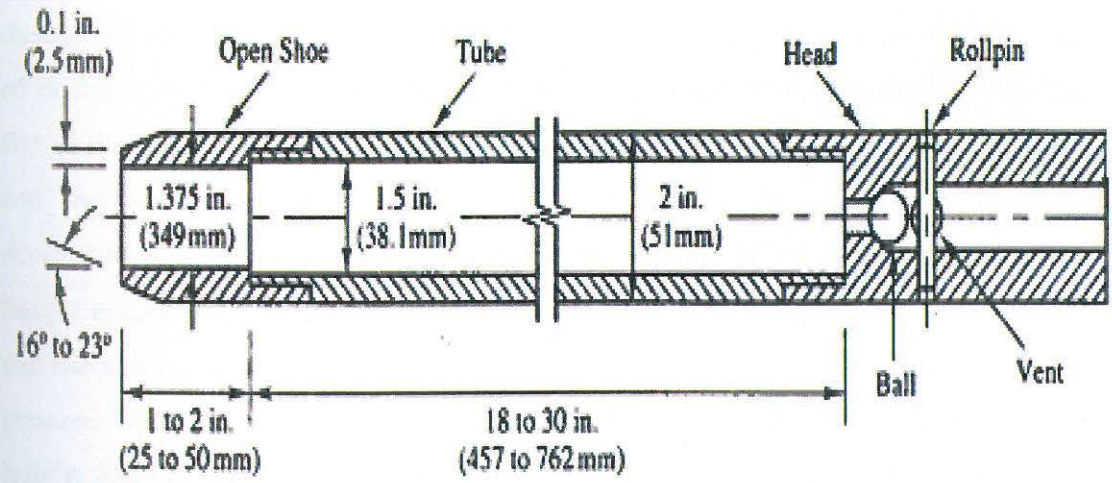

Figure 2.5: Standard dimension of SPT split-spoon sampler (ASTM, 1996-2012).

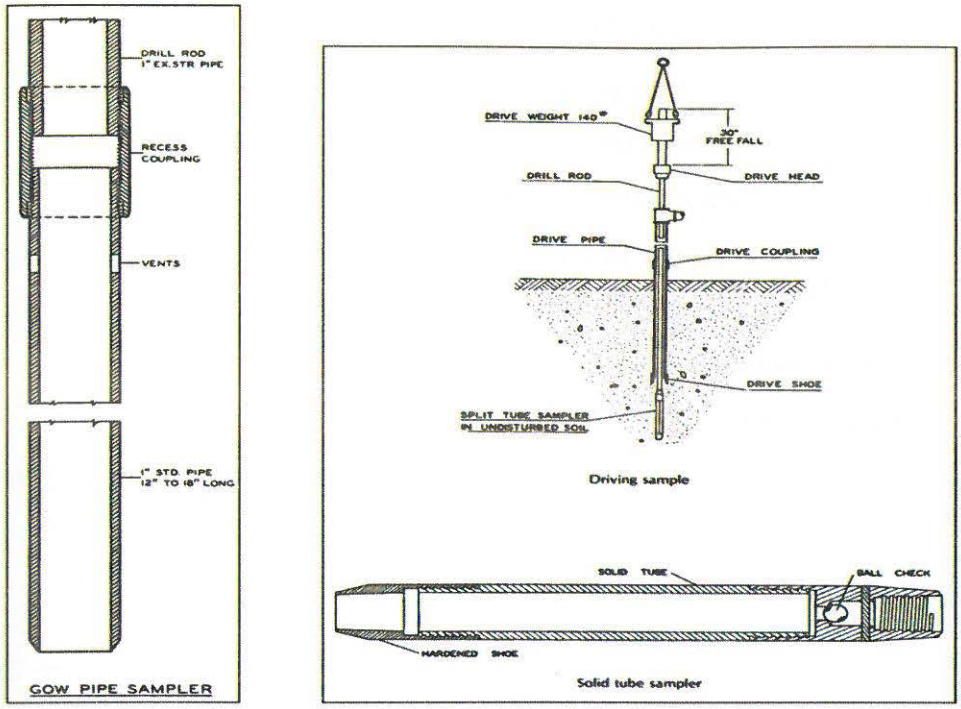

Figure 2.6: Component of SPT split-spoon sampler (Mohr, 1940).

The procedure for this test is started with test hole. The hole drilled to the desired sampling depth and all the disturbed materials were cleaned out. If the type of drill that had been used was wet drill, so the cuttings need to flush out. After that, the equipment needs to set up properly. The split-barrel sampler attached to the A-rod and lowers it into the hole until it reached on the undisturbed materials. Assembly attached the drive weight to it. A hammer lifted with a predetermined height and allowed it to fall on the anvil delivering for one seating blow. The drill rod marked in three successive with 0.15m increment. After setting up the equipment, proceed with the penetration test. Raised and dropped the hammer at predetermined height. Do not use more than 2.025 wraps around the cathead. Other than that, the hammer operated between 40 to 60 blows per minute and should drop freely. Then, continue driving until 100 blows had been applied.

Every 0.15m of penetration, the number of blow recorded. For the first 0.15m increment was the seating drive. Then, the summation of blow for second and third