

SOIL EXPLORATION COMPRISING SITE INVESTIGATION AND SAMPLING DEFINITIONS

By

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I/I Introduction – Definition and Purpose of Site Investigation

- ▶ The process of collection soil data for the assessment soil properties at a site through series of laboratory and field investigation is collectively called Sub-soil Exploration or site investigation
- ▶ **Purpose of site investigation**
- ▶ Determining the nature of soil at the site and its stratification.
- ▶ Selecting the type and depth of foundation suitable for a given structure.

1/2 Introduction – Definition and Purpose of Site Investigation

- ▶ Evaluating the load-bearing capacity of the foundation.
- ▶ Estimating the probable settlement of a structure.
- ▶ Determining the location of water table.
- ▶ Determining the depth and nature of bedrock, if and when encountered
- ▶ Enables the engineers to draw soil profile indicating the sequence of soil strata and the properties of soil involved.

2/1 Site Investigation Stages

- The Stages In Subsoil Exploration are: Planning cum Collection of Preliminary Information, Reconnaissance, and Site Investigation
- Collection Of Preliminary Data/Information involves obtaining information regarding the type of structure to be built and its general use. Some examples of data needed re as follows:
 - For the construction of building:
 - ✓ The approximate column loads and their spacing.
 - ✓ Local building-codes.
 - ✓ Basement requirement.
 - For the construction of bridge:
 - ✓ The length of their spans.
 - ✓ The loading on piers and abutments

2/2 Site Investigation Stages - Reconnaissance

- ▶ The engineer should always make a visual inspection (field trip) of the site to obtain information about:
- ▶ The general topography of the site, the possible existence of drainage ditches, and other materials present at the site.
- ▶ Evidence of creep of slopes and deep, wide shrinkage cracks at regularly spaced intervals may be indicative of expansive soil.
- ▶ Soil stratification from deep cuts, such as those made for the construction of nearby highways and railroads.

2/3 Site Investigation Stages - Reconnaissance

- ▶ The type of vegetation at the site, which may indicate the nature of the soil.
 - ▶ Groundwater levels, which can be determined by checking nearby wells.
 - ▶ The type of construction nearby and the existence of any cracks in walls (indication for settlement) or other problems.
 - ▶ The nature of the stratification and physical properties of the soil nearby also can be obtained from any available soil-exploration reports on existing structures.
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- The **detailed Site Investigation stage** involves Planning (adopting stepped to Site Investigation, and future vision for the Site), Drilling Test Boreholes, Collecting Soil Samples at desired intervals for Visual Examination in-situ (Logging) and Laboratory Tests

2/4 Site Investigation Planning & Exploration

- **Spacing of boring:**
 - depends on type, size, weight of proposed structure

Sl. No	Name of Project	Spacing , (m)
1	Highway	300-600
2	Earth dam	30-60
3	Borrow pit	30-120
4	Multistory building	15-30
5	Single story building	30-90

2/5 Site Investigation Planning and Exploration

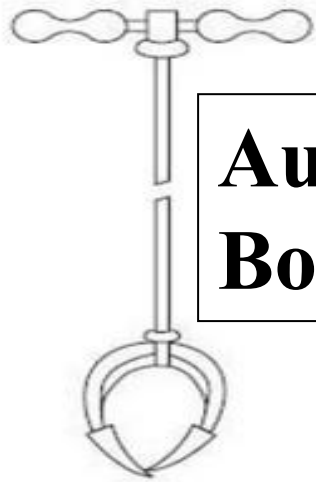
- Contrary to the impressions of many arm-chair practitioners, Soil exploration is never intuitive but possesses a lot of precision and guidelines
- **Depth of boring:**
 - Type of structure
 - Should penetrate all strata that could consolidate
 - For bridge and tall building the boring should extend to rock
 - 1.5 times the width of footing below foundation level
 - For embankment and dam
 - 0.5 – 2 times the height
 - Single storey – 3.5 m, Double storey – 6.5 m

2/7 Soil Exploration Methods: Pits, Trenches.....

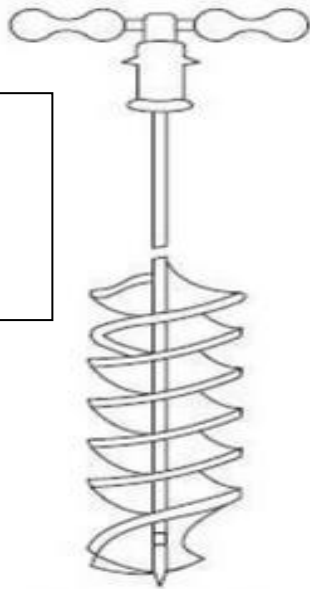
- **BORING:** Drilling a hole into the soil strata up to specified depth is Boring comprises of Auger boring, Auger and Shell boring, Wash boring, Percussion drilling and Rotary drilling.



2/8 Soil Exploration Methods: Pits, Trenches.....



**Auger
Boring**



(b) Helical auger

(a) Post-hole auger



Power Driven Auger Boring



10/04/2026

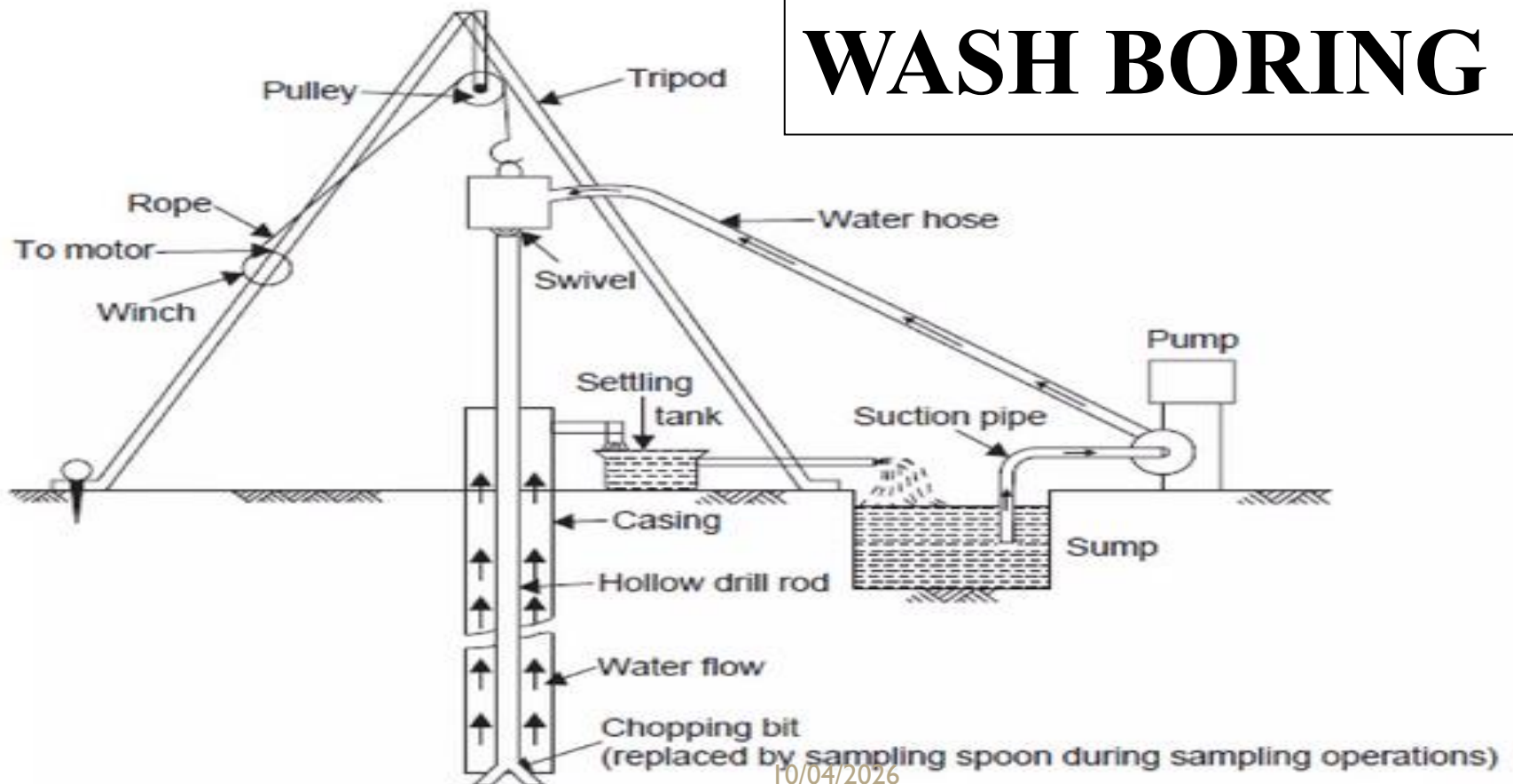
2/9 Soil Exploration Methods

Power Driven Auger Boring



2/10 Soil Exploration Methods – Sampling Methods

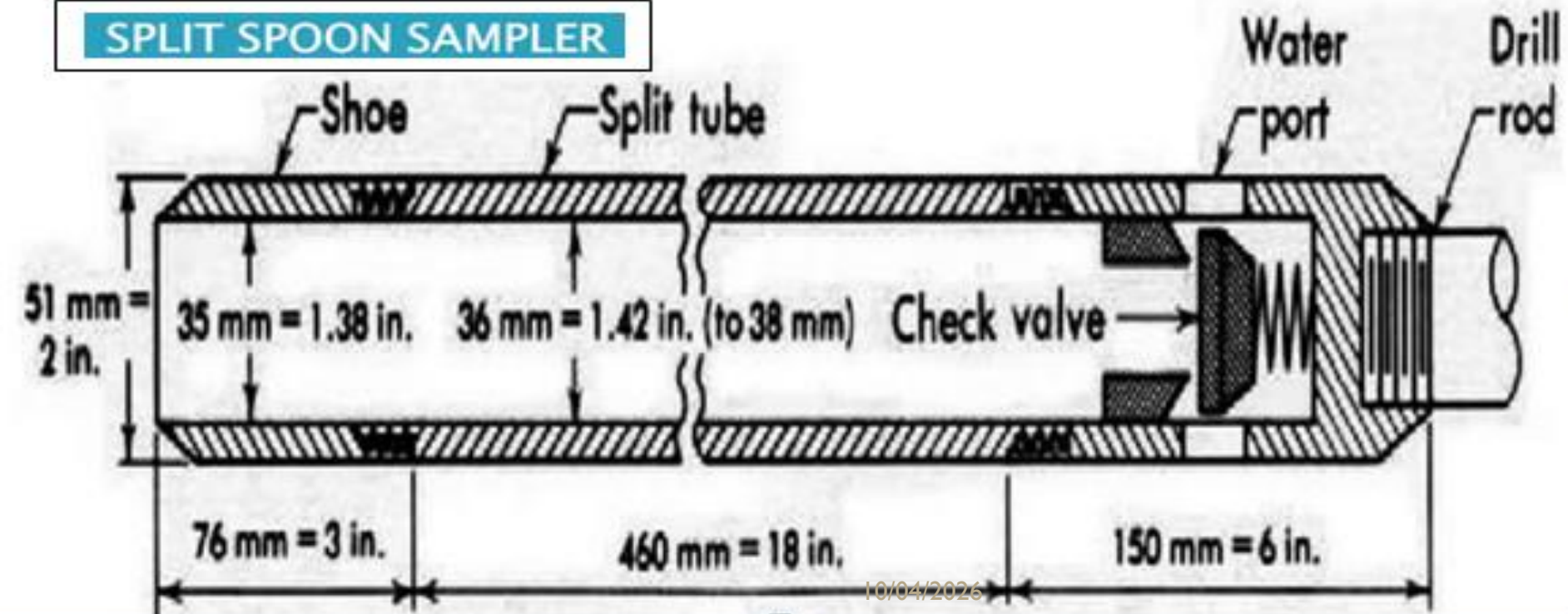
- **Soil Sampling and Types of Soil Sample:** A soil sample is the representative of the whole depth from which it has been taken.
- **Types of Samples:** Disturbed Soil Samples (DS), Undisturbed Soil Samples (UDS)



2/1 | Soil Exploration Methods – Sampler Types

- ▶ Open drive sampler
 - Split spoon sampler
 - Shelby tube – thin walled sampler
- ▶ Stationary Sampler
- ▶ Rotary Sampler

SPLIT SPOON SAMPLER



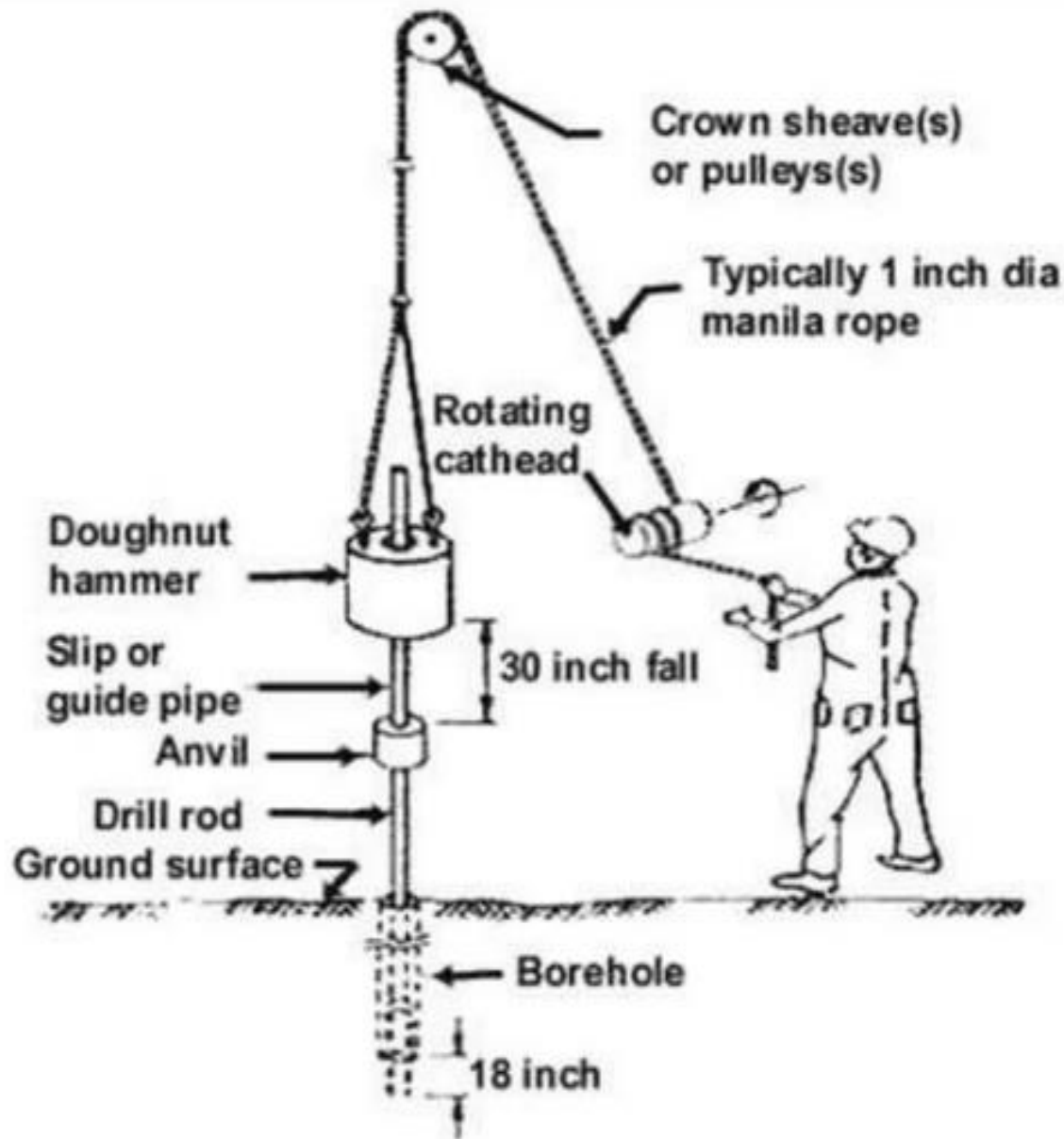
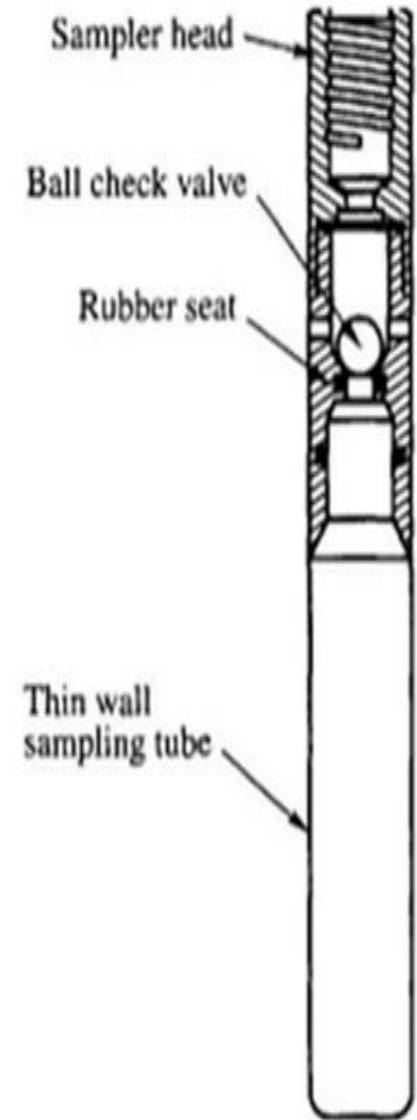
2/12 Soil Exploration – Standard Penetration Tests

- ▶ Generally used for Cohesion less soils
- ▶ To determine relative density , angle of shearing resistance, UCC
- ▶ A bore hole is made using drilling tools and a hammer of weight 63.5 falling from the height of 750 mm at the rate of 30 blows/minute
- ▶ After reaching the specified depth, the drilling tool is replaced by a split spoon sampler to collect soil sample.

2/13 Soil Exploration – Standard Penetration Tests

- ▶ First 150 mm penetration is taken as seating drive and the no. of blows required for that penetration is discarded
- ▶ No of blows required for next 300mm penetration after seating drive is taken as standard penetration number (N)
- ▶ No of blows greater than 50 are taken as refusal and the test is discontinued
- ▶ Corrections are applied to the observed N value

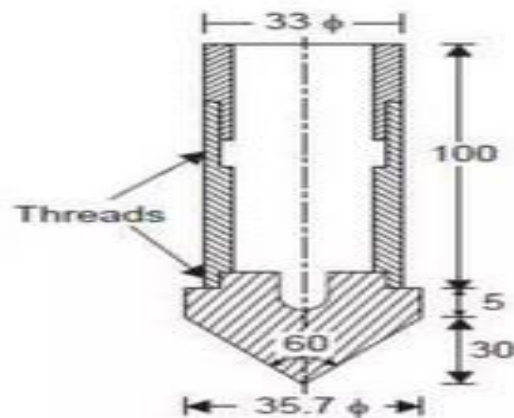
2/14 Soil Exploration – Standard Penetration Tests



2/15 Soil Exploration – Dutch Cone Penetrometer

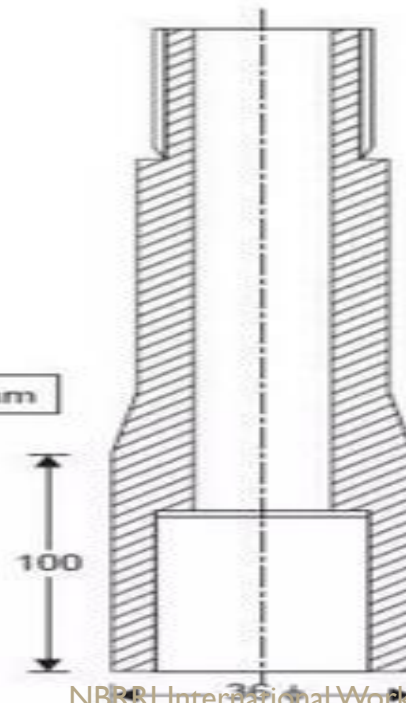
- ▶ Frictional resistance = Combined resistance – Cone resistance
- ▶ Modified Cone penetrometer is known as Refined Dutch Cone
- ▶ Cone penetration resistance is denoted as q_c in kN/m^2
- ▶ Unlike SPT, this method is also suitable for clayey deposits
- ▶ Unsuitable for gravels and dense sand. For such soil dynamic Cone penetration is used

CONE and FRICTION ASSEMBLY for SCPT (Standard Cone Penetration Test)



(a) Cone assembly

All dimensions in mm

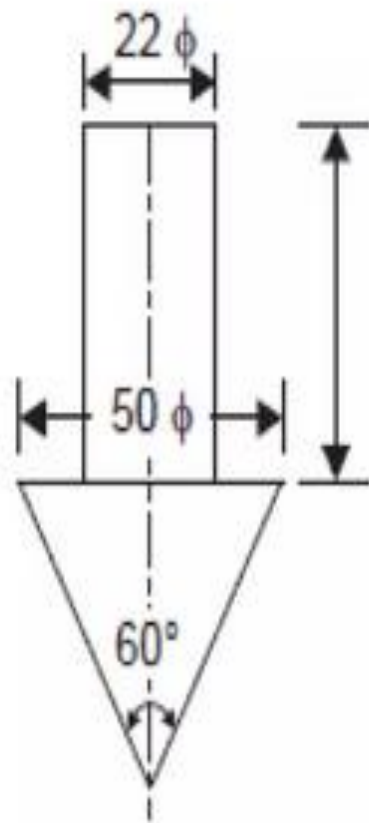


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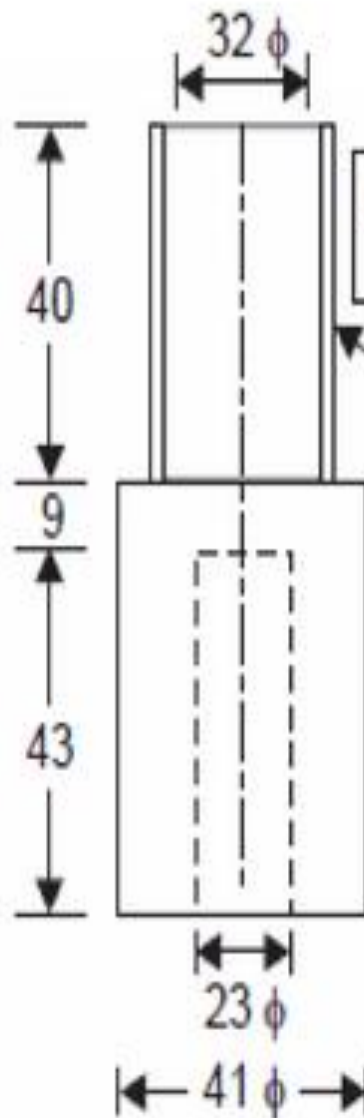
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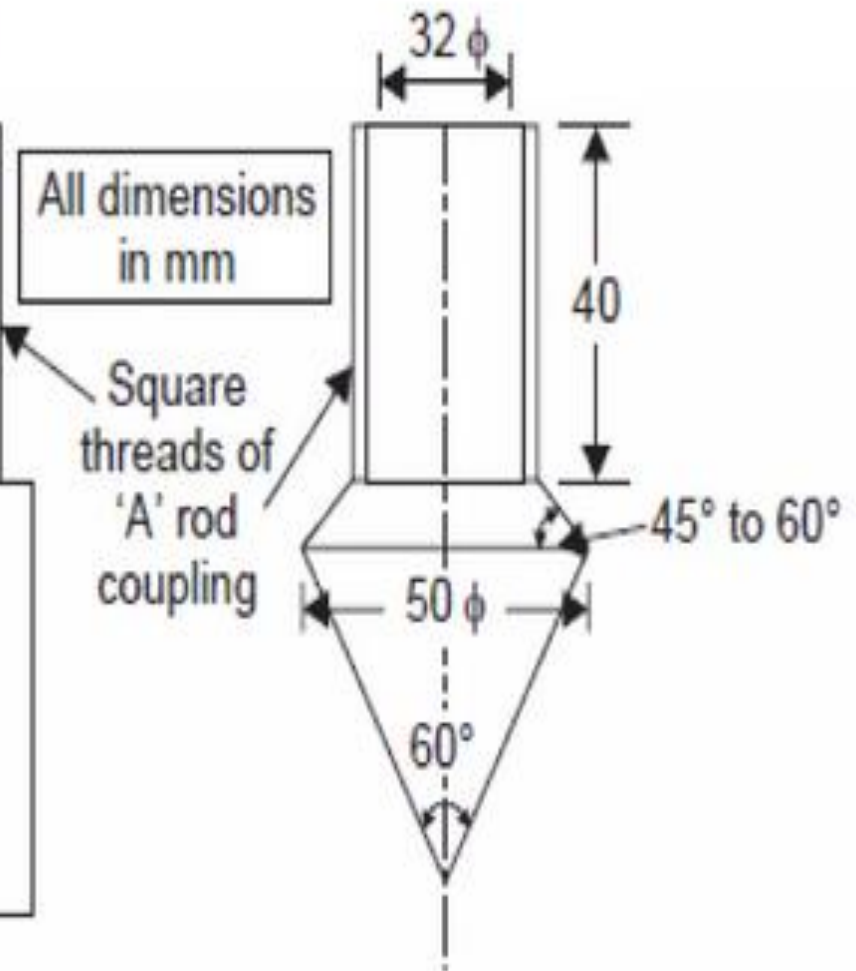
2/16 Soil Exploration – Dutch Cone Penetrometer



(a) Cone without threads



(b) Cone adopter



(c) Threaded cone

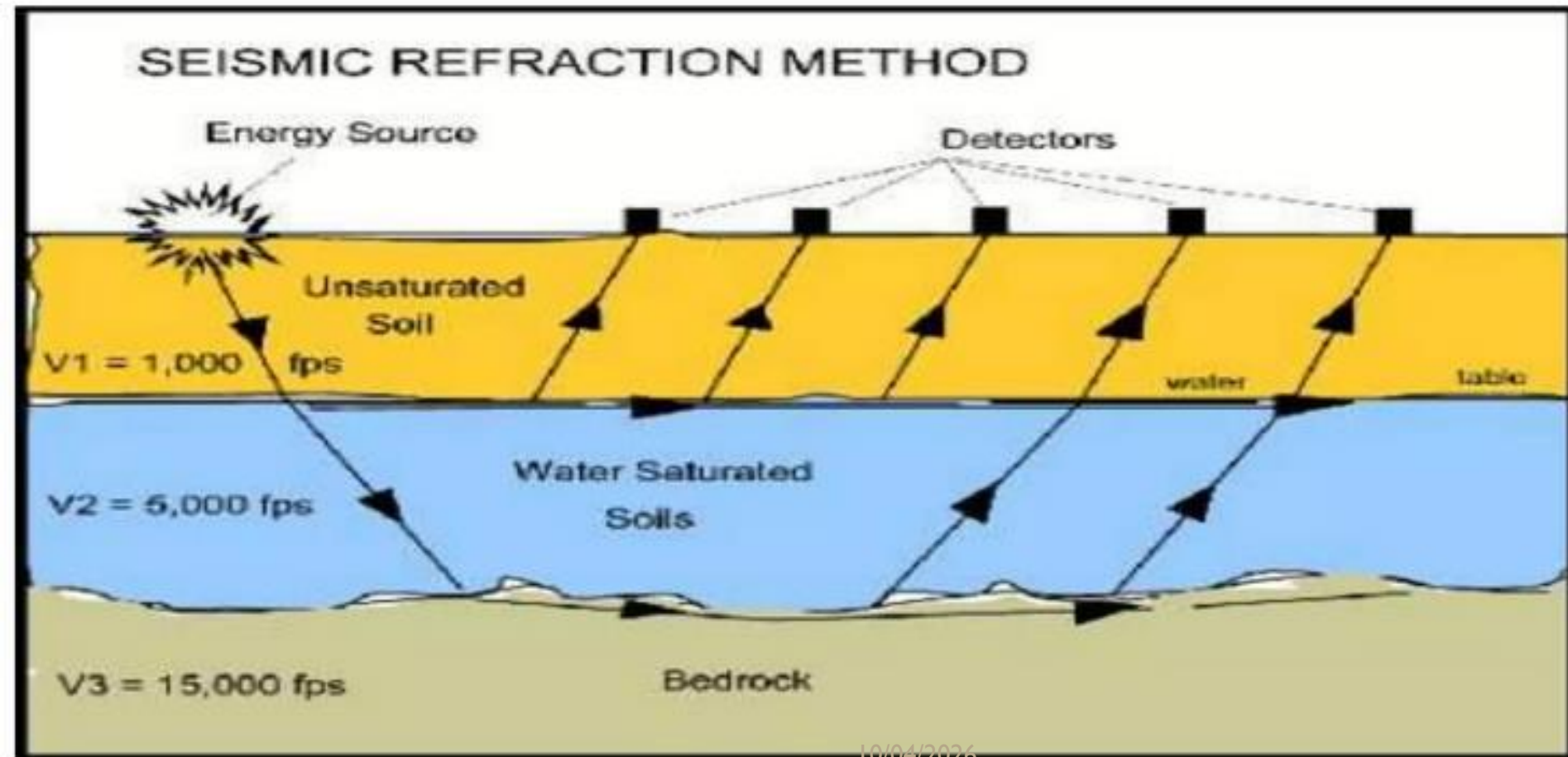
2/17 Soil Exploration – Geophysical Methods

- ▶ The stratification of soils and rocks can be determined by geophysical methods of exploration which measures changes in certain physical characteristics of these materials, for example density, magnetism, electrical, resistivity etc.
- ▶ The following two geophysical methods are commonly used:
 - (i) Seismic refraction method
 - (ii) Electrical resistivity method

2/18 Soil Exploration – Geophysical Methods

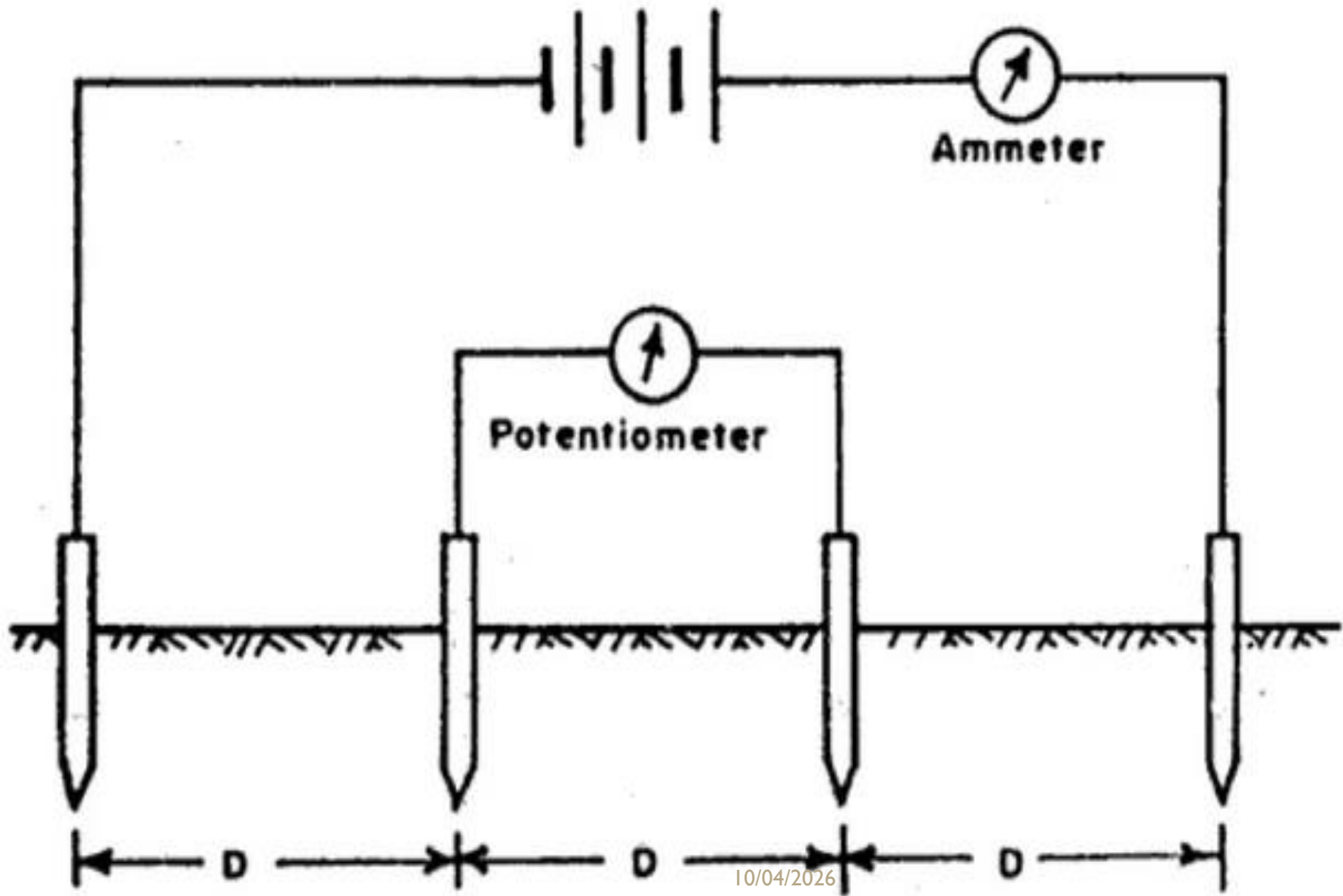
SEISMIC REFRACTION METHOD

The seismic refraction method is based on the principal that seismic waves have different velocities in different types of soil.





2/19 Soil Exploration – Electrical Resistivity



3/I Soil Exploration - Sampling Definitions

There are 2 types of soil sample

- Disturbed sample

- Undisturbed sample

Disturbed sample :- Natural structure of the soil gets modified or destroyed during the sampling operation. These are also called representative samples.

Non-representative samples are those in which soils from other layers get mixed up.

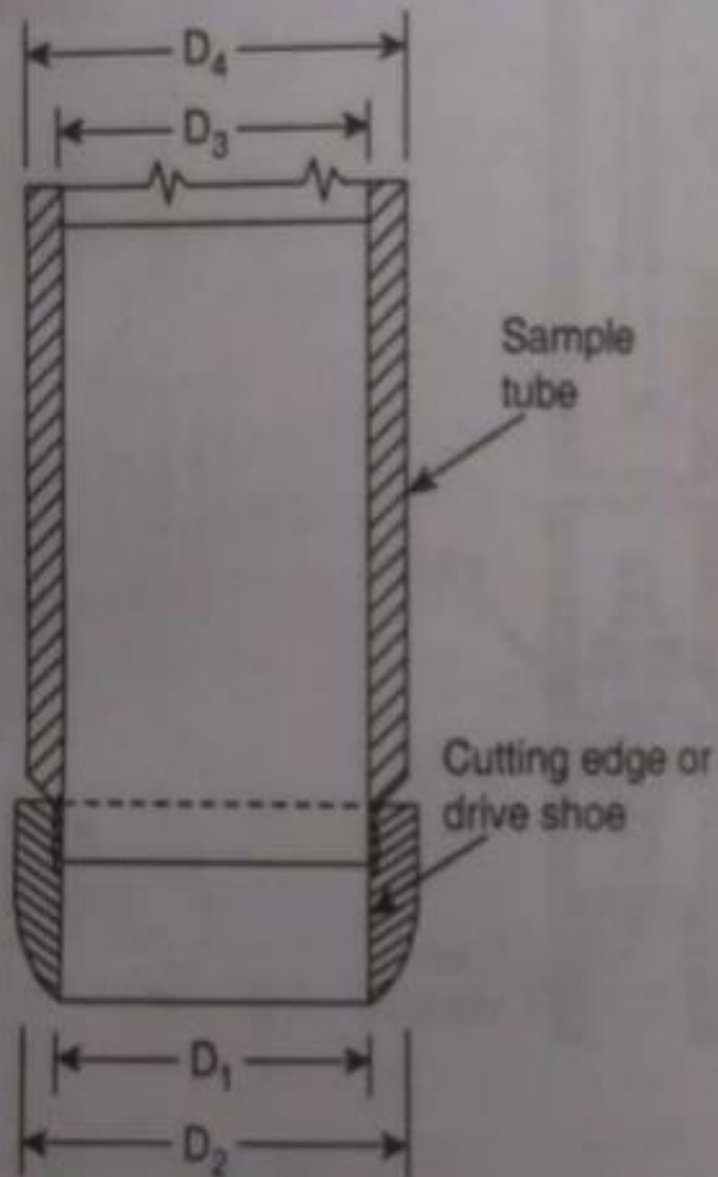
Undisturbed sample :- Natural structure of the soil and material properties remain preserved.

3/2 Soil Exploration - Sampling Definitions

- Depends upon design samplers and method of sampling,
- Design features governing the degree of disturbance
 - Cutting edge
 - Inside wall friction
 - Non-return valve

The following ratios of the cutting edge and the sampler are shown :-

3/3 Soil Exploration - Lower Auger definitions



$$\text{Inside clearance} = [(D_3 - D_1) / D_1] \times 100 \%$$

- Should lie in between 1 to 3 %

$$\text{Outside clearance} = [(D_2 - D_4) / D_4] \times 100 \%$$

- Outside clearance should not be much greater than the inside clearance .

$$\text{Area ratio} = [(D_2^2 - D_1^2) / D_1^2] \times 100 \%$$

- Should be as low as possible
- For soft sensitive soil, > 25%
- Preferably, $\leq 10 \%$

3/4 Soil Exploration – Sampler Types

- Depending upon the area ratio
 - Thick wall sampler
 - Thin wall sampler

Thick wall samplers :-Used for obtaining disturbed but representative soil samples.

- Area ratio $> 10\%$

Thin wall samplers :-Used for obtaining undisturbed samples.

- Area ratio $< 10\%$

Depending upon the mode of operation

1. Open drive sampler
2. Piston sampler
3. Rotary sampler

3/5 Soil Exploration – Open Drive Sampler

- Undisturbed samples are obtained from boreholes by open drive samplers.
- Open drive samplers consist of thin walled tubes which are pushed or driven in to the soil at the bottom of the hole and then rotated detach the lower end of the sample from the soil.
- Most soft or moderately stiff cohesive soil can be sampled without extensive disturbance in thin walled seamless steel tubes having diameter not less than 50 mm.

3/6 Soil Exploration – Open Drive Sampler

- The lower end of the tube is sharpened to form a cutting edge and the other end is machined for attachment to the drill rods.
- The entire tube is pushed or driven in to the soil at the bottom of the hole and is removed sample with inside.
- The two ends of the tube are then sealed and sample shifted to the laboratory.

3/7 Soil Exploration – Sampling Tubes



1



3



4



2

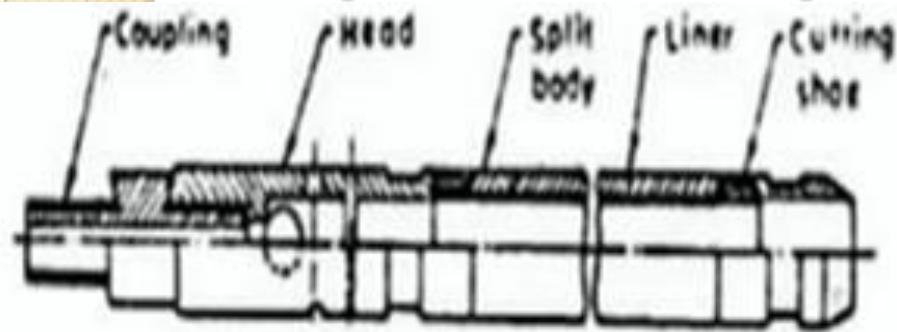
Requirements of Sampling Tubes

Inside diameter, mm	38	70	100
Outside diameter, mm	40	74	106
Minimum effective length, cm	30	45	45

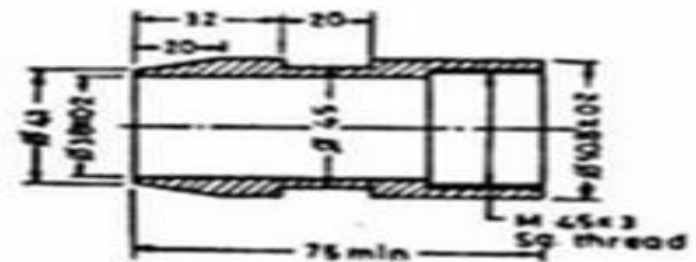
3/8 Soil Exploration – Rotary Sampler

- A Rotary Sampler is a double –walled tube sampler with an inner removable liner.
- The outer tube or the rotating barrel is provided with a cutting bit.
- The bit cuts an annular ring when the barrel is rotated.
- The inner tube which is stationary, slides over the cylindrical sample cut by the outer rotating barrel. The sample is collected in the inner liner.
- Rotary samples are useful for sampling in firm to hard cohesive soils and particularly in rocks

3/9 Soil Exploration – Split Spoon Samplers

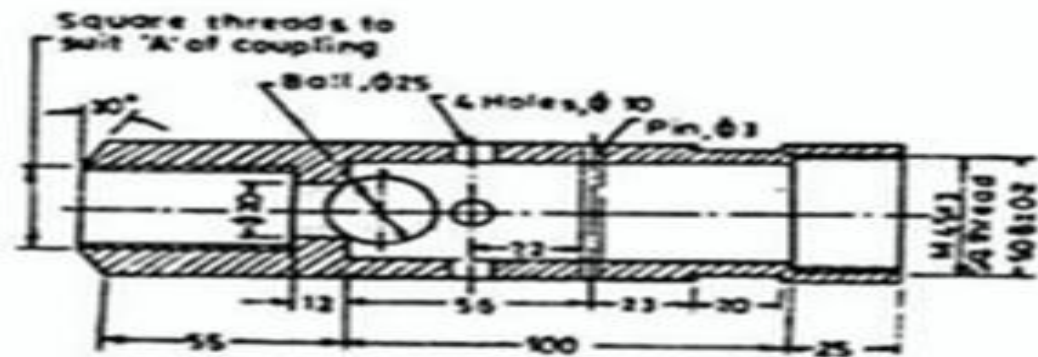


(a) Assembly of split spoon sampler



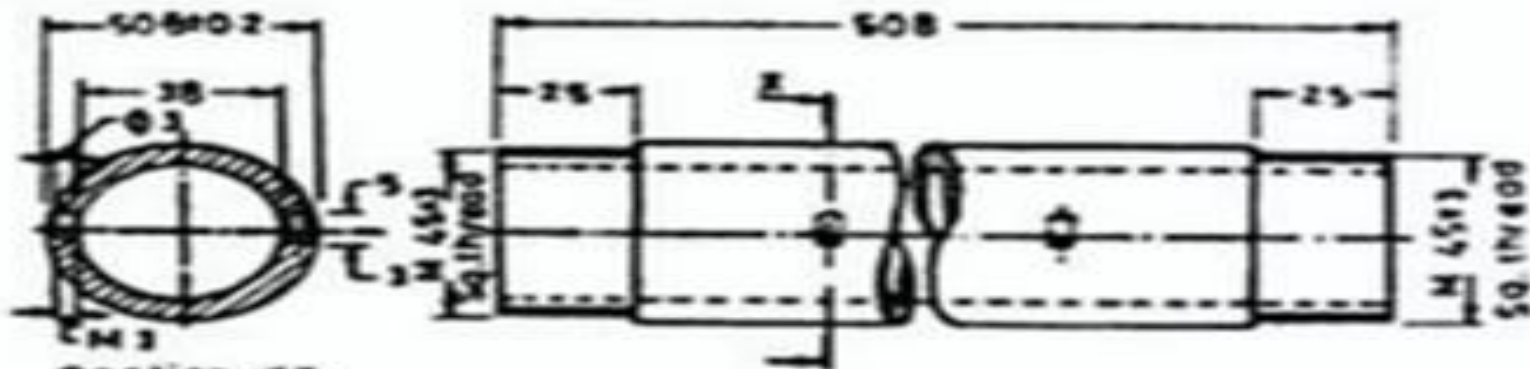
All dimensions in mm

(b) Cutting shoe



All dimensions in mm

(c) Head



All dimensions in mm

(d) Split body

3/10 Soil Exploration – Split Spoon Samplers

SPLIT SPOON SAMPLERS

Move cursor over names for more information

SPLIT SECTION



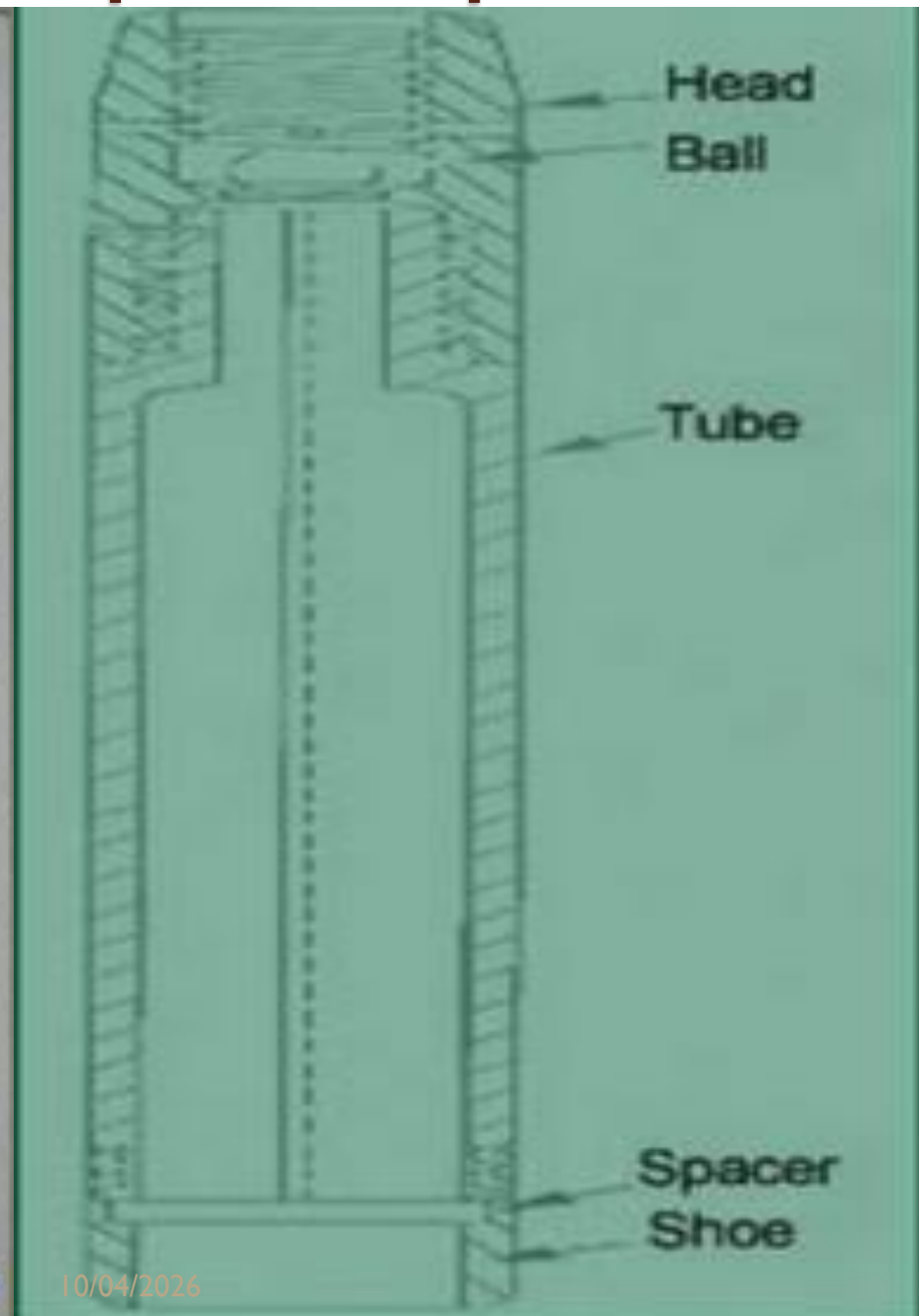
HEAD

RETAINER

SHOE

COMPLETE SAMPLERS

SPACERS, LINERS, FLAP VALVES



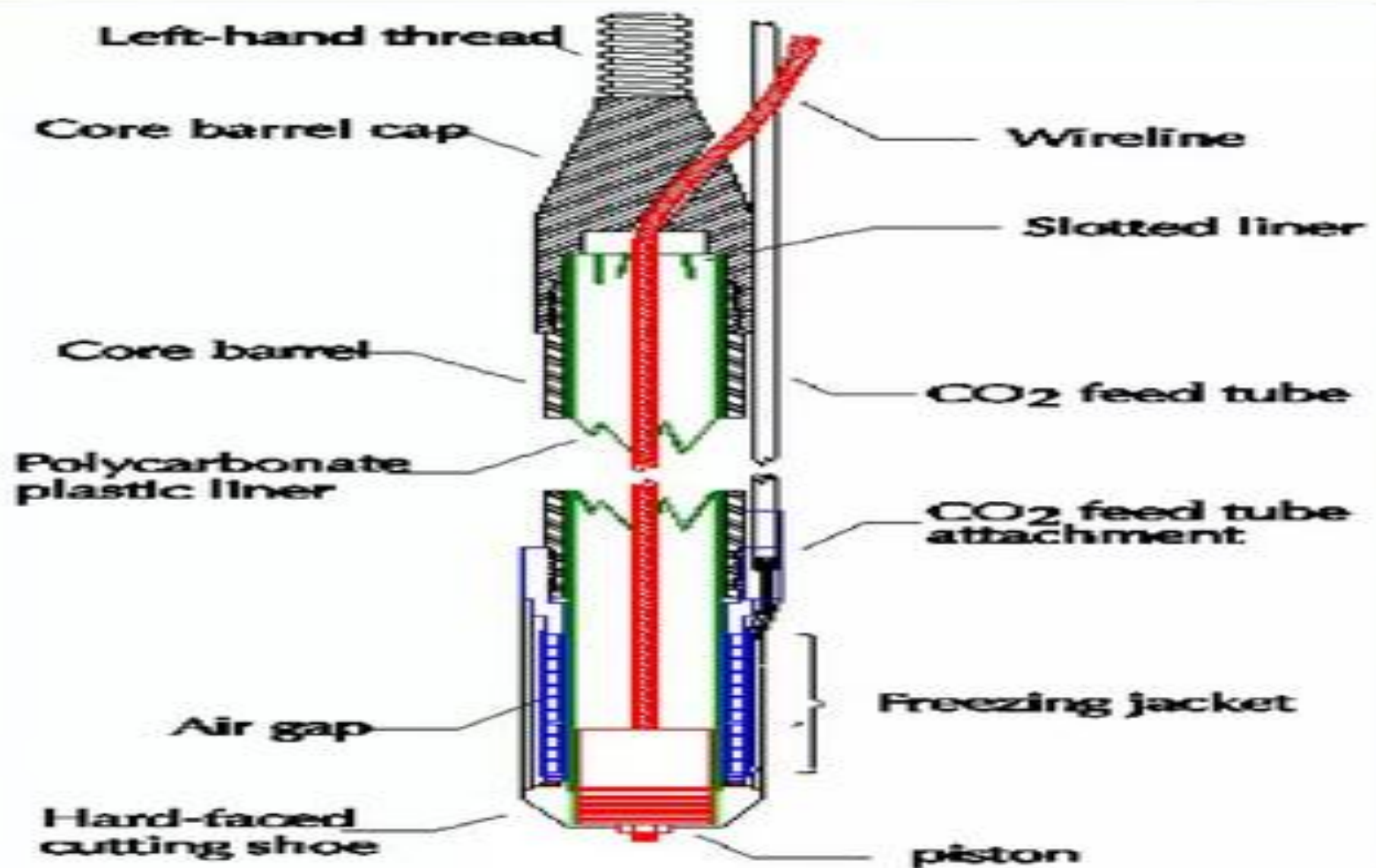
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3/11 Soil Exploration – Piston Sampler

Piston sampler consists of two parts-

- Sampler Cylinder
- Piston system
- The piston fits tightly in the sampler cylinder.
- Good quality undisturbed samples are obtained from piston samplers which use thin –walled sampling tubes with a piston inside.
- The tube is being lowered to the bottom of the drill hole, the piston rods and piston are held at the bottom of the sampler by means of a drill rod which rises to the top of the bore hole.
- The presence of the piston prevents excess soil from squeezing in to the tube and thus, maintains the integrity of the sample.

3/12 Soil Exploration – Piston Sampler



A cross-sectional view of the sample-freezing drive shoe attached to the Solinst core barrel. The scale is broken; the sampler is about (2 m) long and (75 mm) in diameter.

3/13 Soil Exploration – Conclusion

Soil sampling is the process of obtaining samples of soil from the desired depth at the desired location in a natural soil deposit, with a view to assessing the engineering properties of the soil for ensuring a proper design of the foundation. The devices used for the purpose of sampling are known as soil samplers. With the help of soil samplers, various kinds of soil samples can be obtained and studied.



THANK YOU!