آزمایش نفوذ استاندارد

SPT

(**S**tandard **P**enetration **T**est)

انجام آزمایش

Crown sheave(s) or pulleys(s)

Typically 1 inch dia manila rope

Rotating cathead

Doughnut hammer

Slip or guide pipe
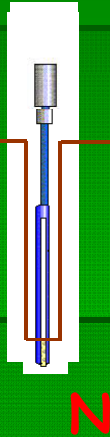
30 inch fall

Anvil

Drill rod

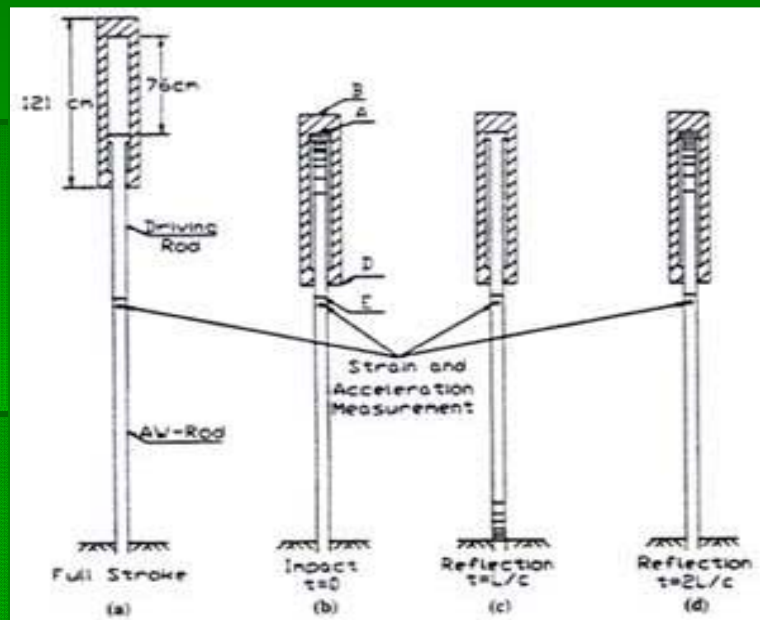Ground surface

Borehole

18 inch

درس شناسایی های ژئوتکنیکی زمین
علی فاخر
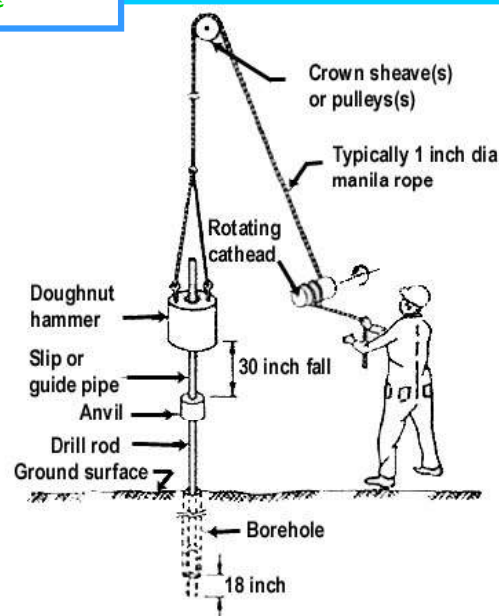
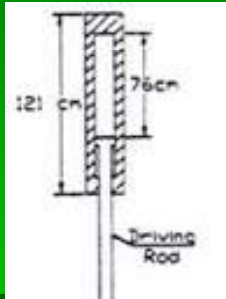انجام آزمایش

مراحل آزمایش

- **driving a standard sampler into the bottom of a borehole using a hammer.**

- اندازه گیری تعداد ضربه در سه ۱۵۰ میلیمتر متوالی

- N: تعداد ضربه در ۳۰۰ میلیمتر نفوذ.

نمای کلی از دستگاه SPT

چکش: **63.5 kg**
ارتفاع سقوط: **0.76 m**

• vertically

• as freely as possible

نمونه گیر

20739
Split Barrel Sampler

Split barrel sampler + retainer rings

(Stainless steel and brass)
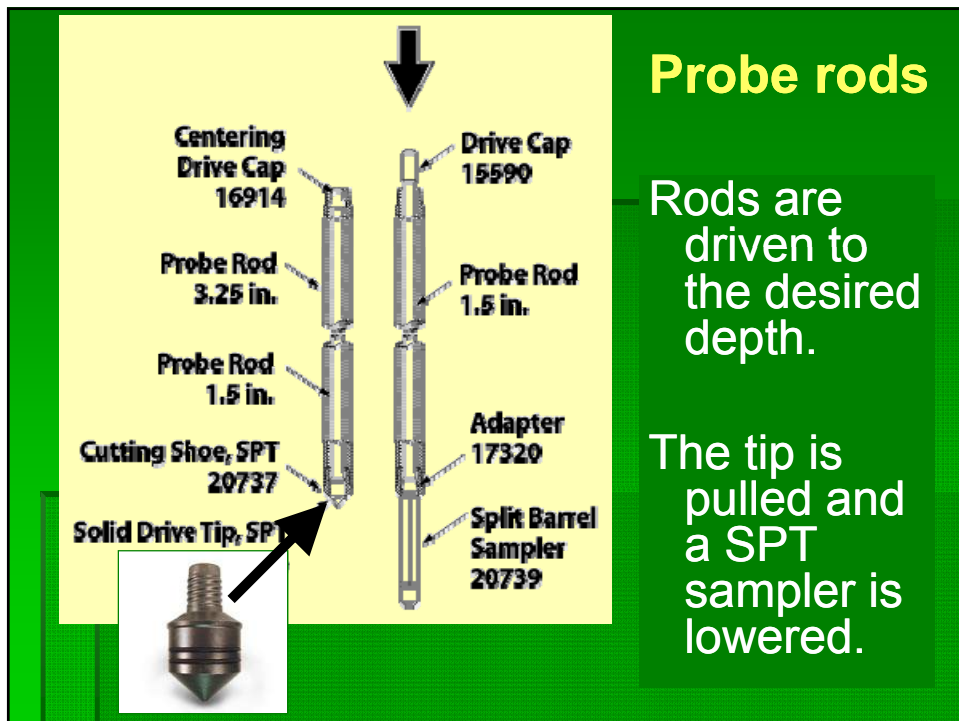

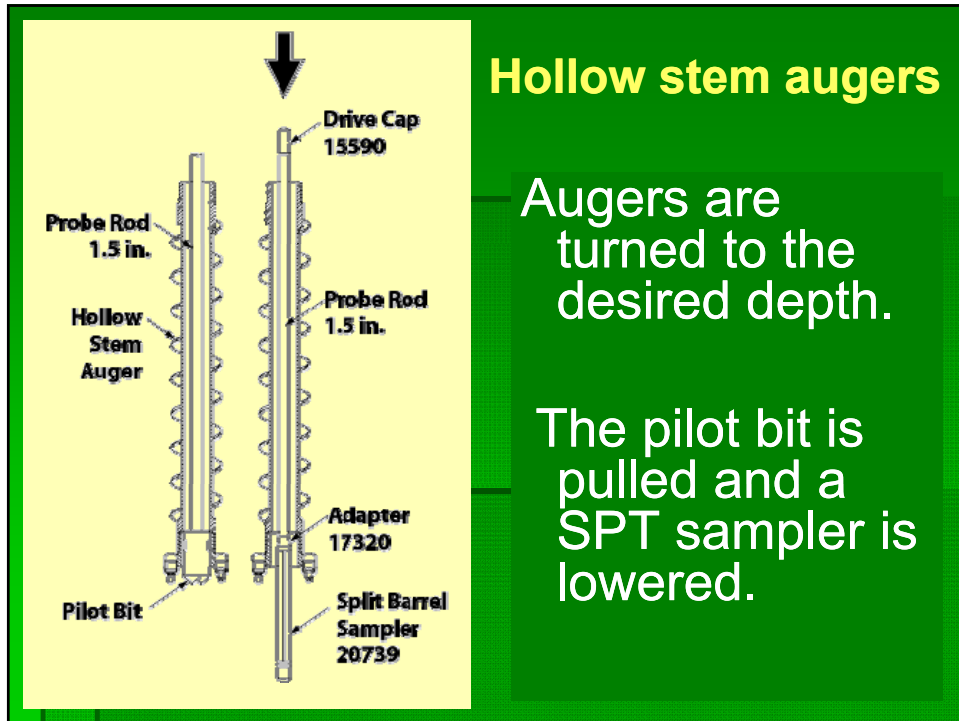Catcher for Split barrel samplers

بعد از آزمایش

After test

After test

روشهای جایگزین حفر گمانه
برای انجام این آزمایش

- Hollow stem augers.

- Probe rods.

Hollow stem augers

Augers are turned to the desired depth.

The pilot bit is pulled and a SPT sampler is lowered.

Probe rods

Rods are driven to the desired depth.

The tip is pulled and a SPT sampler is lowered.

Soil Type

- BS 5930:1999
- " The main purpose :
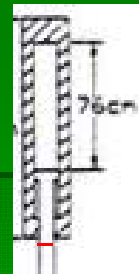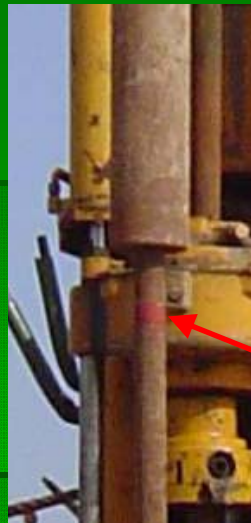
… the relative density of **sand** and **gravels**

the consistency of **silt**, **clay** & **rocks**.

مقادیر غیر قابل اعتماد

- N > 50

- Small N

عدم دقت و بکارگیری تجهیزات نامناسب
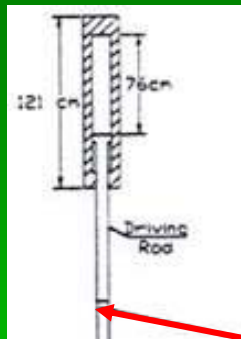
- eye control
- reverse hammer

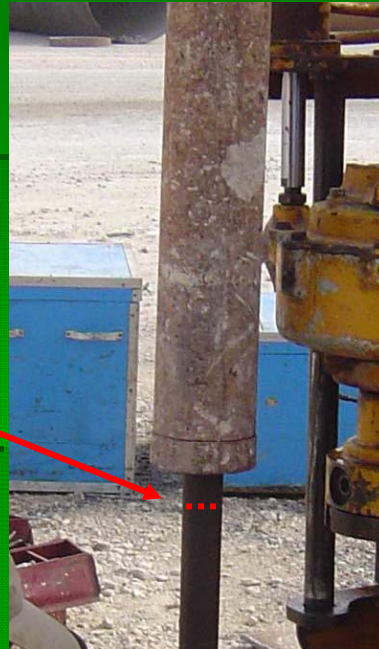Non-vertical position

درس شناسایی های ژنوتکنیکی زمین
علی فاخر

Non-central rope

درس شناسایی های ژنوتکنیکی زمین
علی فاخر

Non-fixed Connections

درس شناسایی های ژئوتکنیکی زمین
علی فاخر

چکش نامناسب

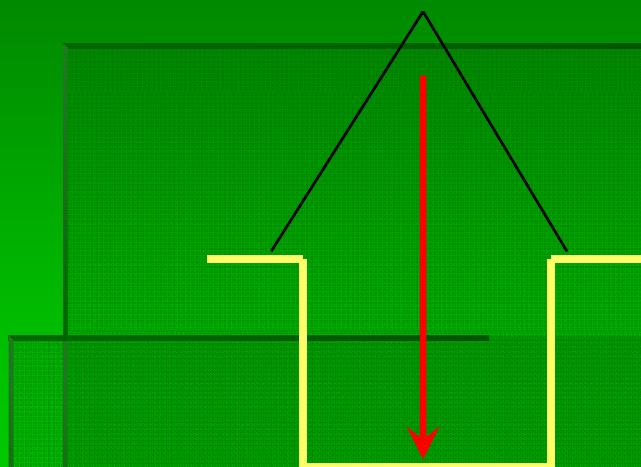12

مراحل ضربه زدن

1

مراحل ضربه زدن

2

مراحل ضربه زدن

3

مشارکت طناب و کارگر در کاهش انرژی ضربه

Automatic Hammer

چکش
مناسب

SPT in hand excavated pits

Due to the effect of borehole diameter

آزمایش انجام شده در کف چاهک استاندارد نیست

لزوم روابط تجربی محلی

- BS 5930:1999
- SPT results and soil parameters derived from data from other countries may not correlate with results …in accordance with BS 1377-9.

- **So local correlations are required**

Energy measurements are required in Iran

- For different hammer &

- different combinations of
    drill rig,
    hammer,
    rods &
    drillers

Example:
Results of various methods of energy measurements for various hammer in Korea

Hammer Type		F2 Method		FV Method	
		Mean (%)	Standard Deviation	Mean (%)	Standard Deviation
WD	<10m	44.9	9.1	57.9	7.4
	>10m	58.9	7.3	60.2	7.8
CA	<10m	57.4	3.1	60.0	4.5
	>10m	64.9	2.6	66.4	3.4
RS	<10m	54.7	3.4	58.2	3.9
	>10m	58.0	3.1	59.0	4.1
RD	<10m	36.9	9.5	38.0	10.8
	>10m	38.6	6.7	41.4	11.7

Kim et al (2004)

In Iran:

Any important decision should not be taken based upon SPT results
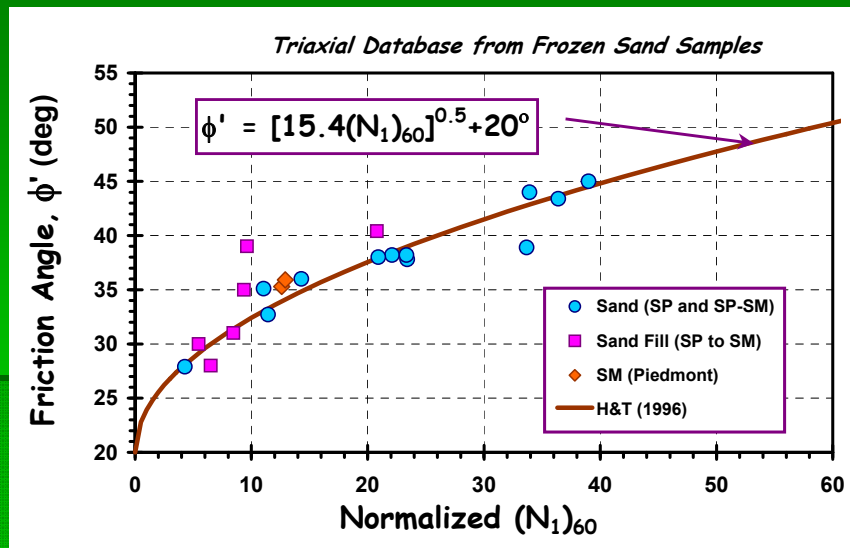
An example of wrong decision:

- 1- SPT results
- 2- Correlation with Liquefaction
- 3- Expensive Soil improvement

Suggestion for important decisions about liquefaction:

▪ A proper Site Characterization by:

CPT, and other in-situ tests

improvement of sampling methods,

Friction Angle of Sands from SPT

Triaxial Database from Frozen Sand Samples

$$\phi' = [15.4(N_1)_{60}]^{0.5}+20^{\circ}$$

Legend:
- ● Sand (SP and SP-SM)
- ■ Sand Fill (SP to SM)
- ◆ SM (Piedmont)
- — H&T (1996)

Y-axis: Friction Angle, ϕ' (deg)

X-axis: Normalized $(N_1)_{60}$

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Correction for overburden

- $N' = C \cdot N$

  - proposed for sands

درس شناسایی های ژئوتکنیکی زمین
علی فاخر

$$(N_1)_{60} = C_N N_{60} = \left(\frac{100}{\sigma'_{vo}}\right)^{0.5} N_{60}$$

C_N = correction factor to account for the overburden pressure. As indicated in Eq. 2.5, C_N is approximately equal to $(100/\sigma'_{vo})^{0.5}$ where σ'_{vo} is the vertical effective stress, in kPa.

The effect of borehole diameter

- If the test is performed in a large diameter borehole, it is not standard.

Test in gravels is ambiguous

- Measurement of engineering properties of gravels is a challenge.
- The cutting shoe of the sampler may be replaced by a cone (60 $_{deg}$) but it affects results.
- The use of tools of larger diameter than SPT sampler (Large Penetration Test)

Research on the effect of grain size

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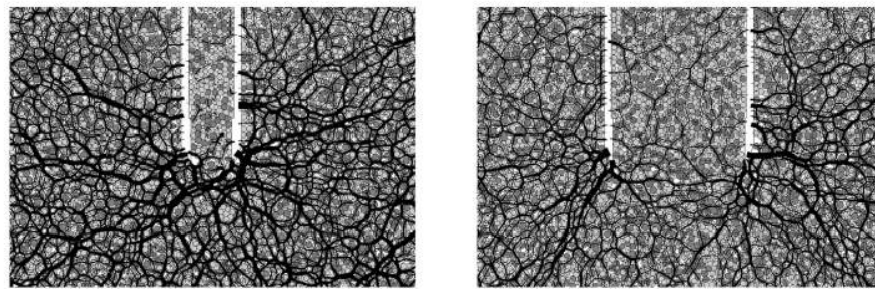
Correction for grain size

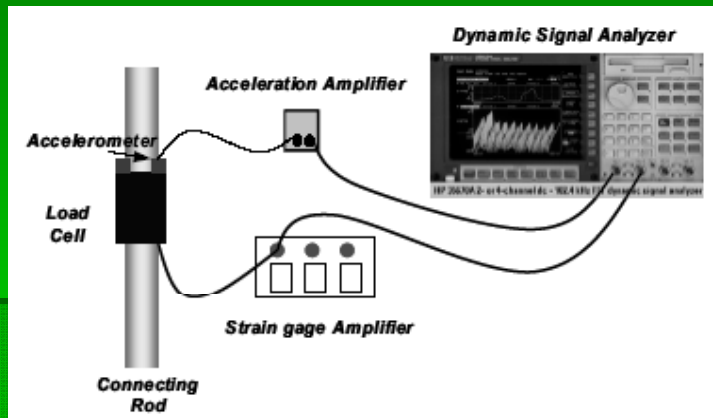$$\frac{N_1}{D_r{}^2} = 9 \cdot \left(0.23 + \frac{0.06}{D_{50}}\right)^{-1.7}$$

Effect of Energy

- **N is inversely proportional to the energy**

- N should be corrected to reference value of 60% of the potential energy of the hammer.

Energy measurement

Two questions?

- **Energy delivered to the rod?**
- **Energy delivered to the sampler?**

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Effect of rod length ?

Energy measurement in

 (1) immediately below the anvil,

(2) mid-height

(3) Immediately above the sampler
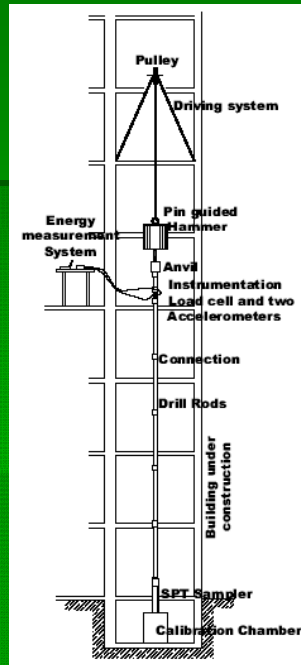
Contradictory conclusions

SPT - T

- Brazilian Development

- Recently investigated in USA (Kelley & Lutenegger, 2004)

درس شناسایی های ژئوتکنیکی زمین
علی فاخر

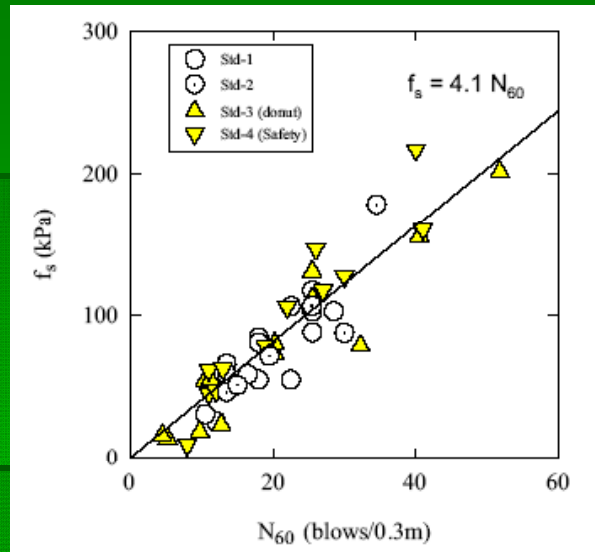درس شناسایی های ژئوتکنیکی زمین
علی فاخر

SPT-T

$$f_s = 4.1\, N_{60}$$

- For designing **piles** in sands where undisturbed sampling is difficult.

موفق باشید

علی فاخر