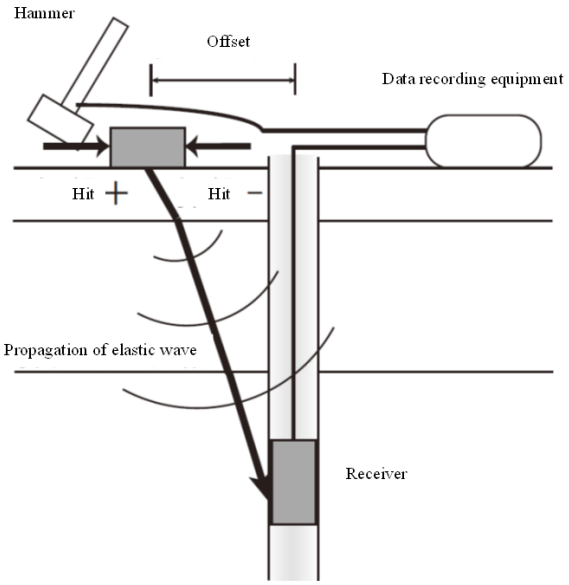
Downhole Seismic Velocity Logging Test

Objective

In this experiment, Velocity Logging Test (Downhole method) is done to find the physical properties of the soil ground from site investigation. Velocity logging test includes the measurement of travel time, i.e., the time from generating the elastic wave which propagates through the ground till it is observed by the receiver and to predict the propagating velocities required by elastic waves generated; P-wave (primary wave) and S-wave (shear wave) to propagate through the soil ground concerned.

Testing Method and Procedure



1. A wooden board or a metal plate which is fixed on the ground surface is hit to generate elastic waves (P-waves and S-waves). Observation of both waves is done by the receivers set up inside the borehole.
2. From the observed waveform data, readings for the initial point at which the waves were generated are made and then the time required by each of P-wave and S-wave to reach the position at which receivers are placed is determined. Travel time required by the waves for the different changed positions (depths) of receivers is measured.
3. Travel time data thus obtained is then arranged in the form of receiver's position (depth) and travel time relationship. Measured travel time data is then corrected for the case where the generation of wave is done within the borehole itself. Plot a graph taking vertical axis for depth and horizontal axis for the corrected travel time.
4. Considering the measurement error, "travel~time curve" is plotted from the relationship of depth and travel time. From the slope (gradient) of the travel~time curve, P-wave and S-wave velocity profiles are predicted.

Report

The report should contain the following items:

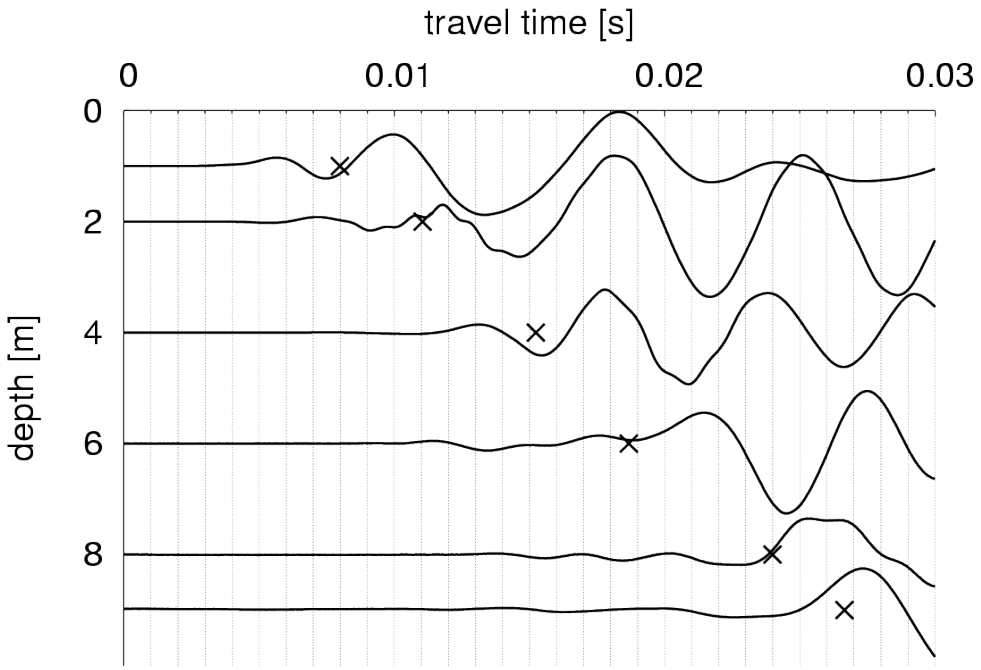
1. The objective, principle, method and procedure of the downhole seismic velocity logging test.
2. Analyze the test data following the procedure and obtain the velocity profiles for S-wave.
   Note the followings:
   1. Soil ground is assumed to be three horizontally stratified layers. For the depths of these soil layer boundaries, refer to the data sheet/s distributed on the experimental day.
   2. Consider the offset as 50 cm and ignore the effect of wave refraction.
3. Comment on the relationship between N-value, results of velocity profile and hardness of the ground, etc., by referring to descriptions such as soil classification (rough classification of soil), report items (description of soil condition), N-value, etc. given on the data sheet provided.
4. Note your impressions about the test.

***Submit the reports of Standard Cone Penetration test, Centrifuge Modeling test, and Velocity Logging test, separately.

・Record of horizontal movement (after Reverse Stacking)

Recording for 3m, 5m and 7m are done on the experimental day. Data of each group will be uploaded on the site given below.

http://wwwcatfish.dpri.kyoto-u.ac.jp/~goto/lecture.html


travel time [s]
0
0.01
0.02
0.03
depth [m]
0
2
4
6
8

Practice on Velocity Logging Test

Objective:

From the view point of velocity logging practices and problems, following items are learnt:

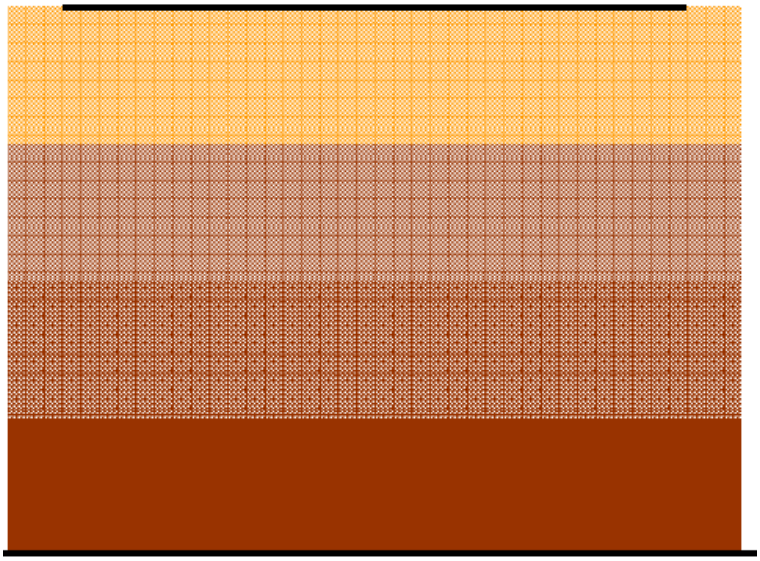
1. Method of knowing the internal condition of the ground.
2. One can understand meaning of "dynamic behavior of the ground".
3. Importance of knowing the behavior of ground.

From the velocity logging test, following things are predicted:

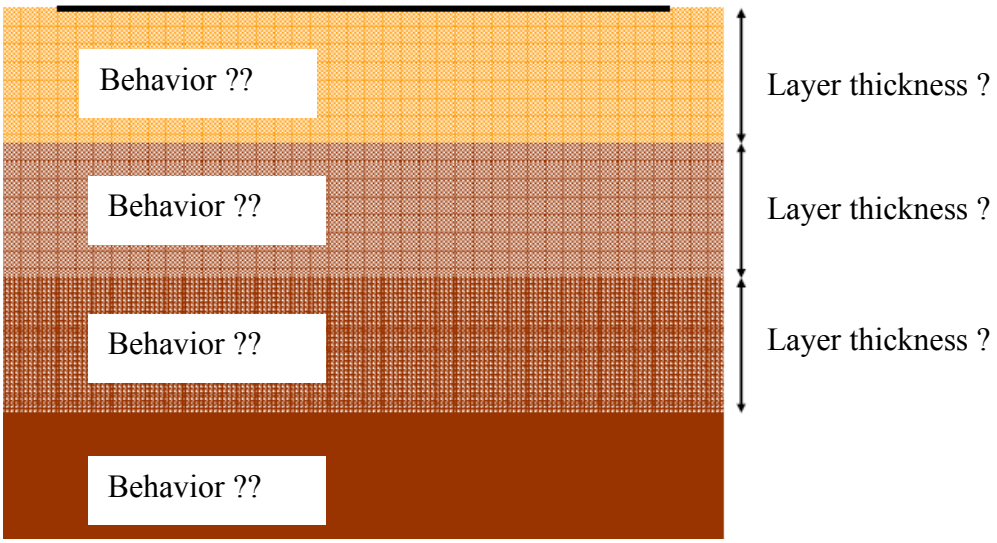
1. Thickness of the ground layer.
2. P-wave and S-wave velocity of ground layer.

What is Velocity logging?

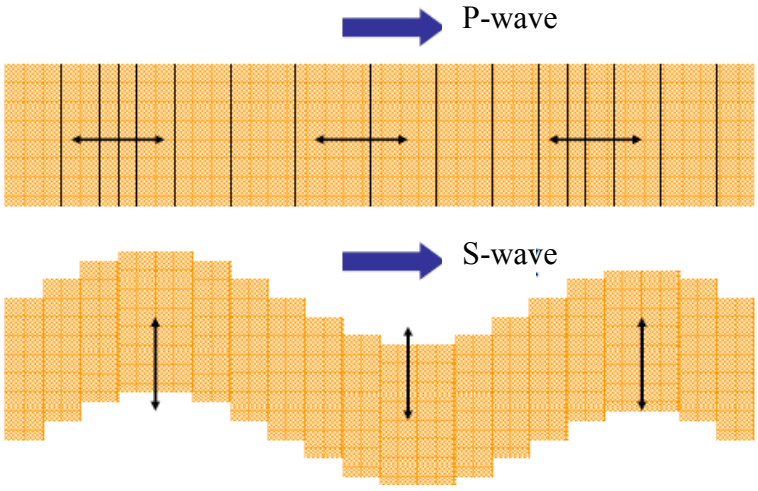
Assume the ground is made up following layers (stratification).



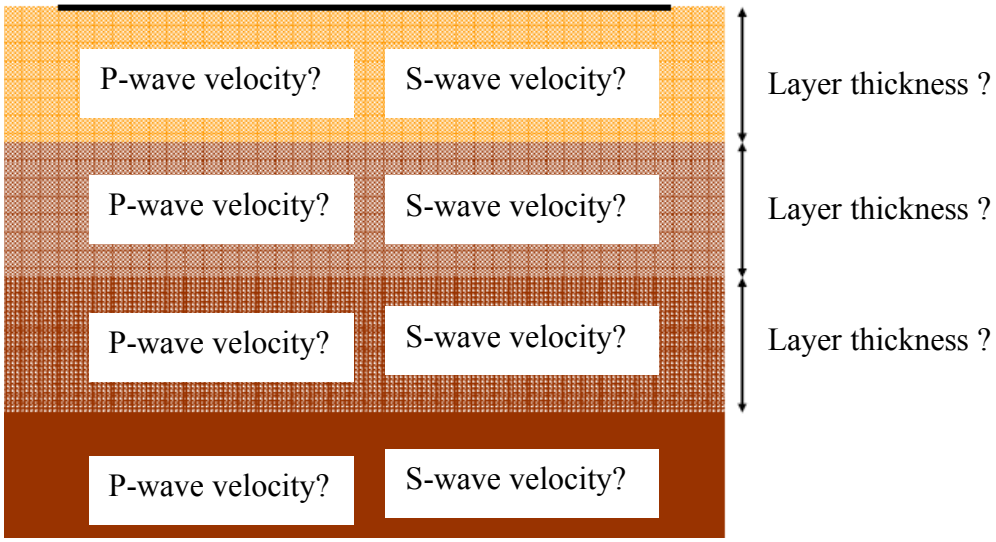
In this condition, it is difficult to know the thickness as well as behavior of the each ground layers.



By saying behavior of the ground, there are different things to consider. Here, consider the behavior of the ground as how fast the wave can propagate through that ground.

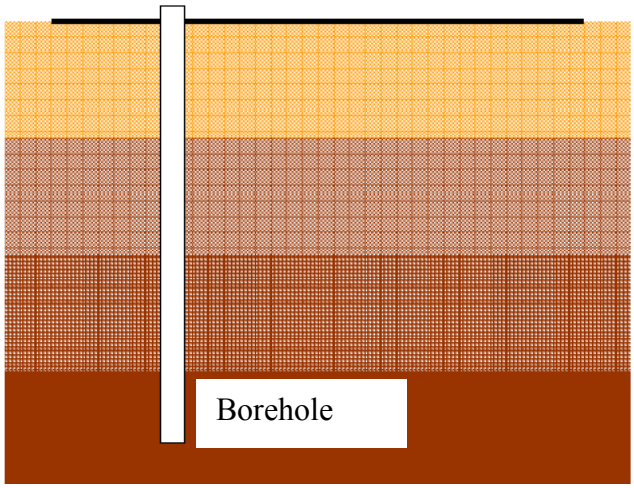


Let's try to find the thickness, S-wave and P-wave of each layer.

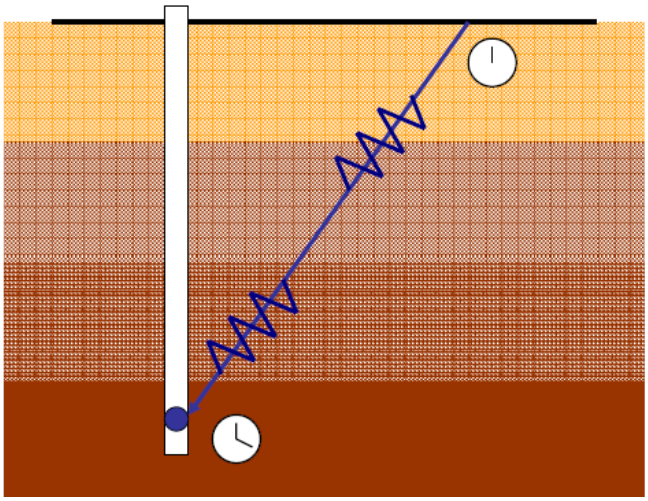


Structure of Velocity Logging

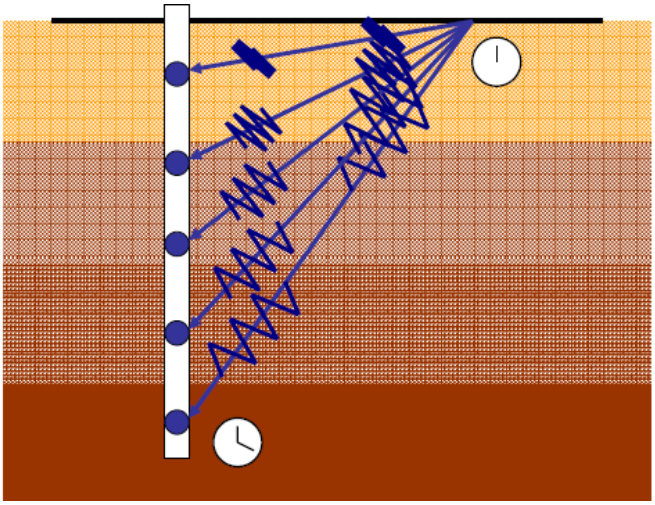
How about using the borehole?



Measure the time required for propagating the waves.

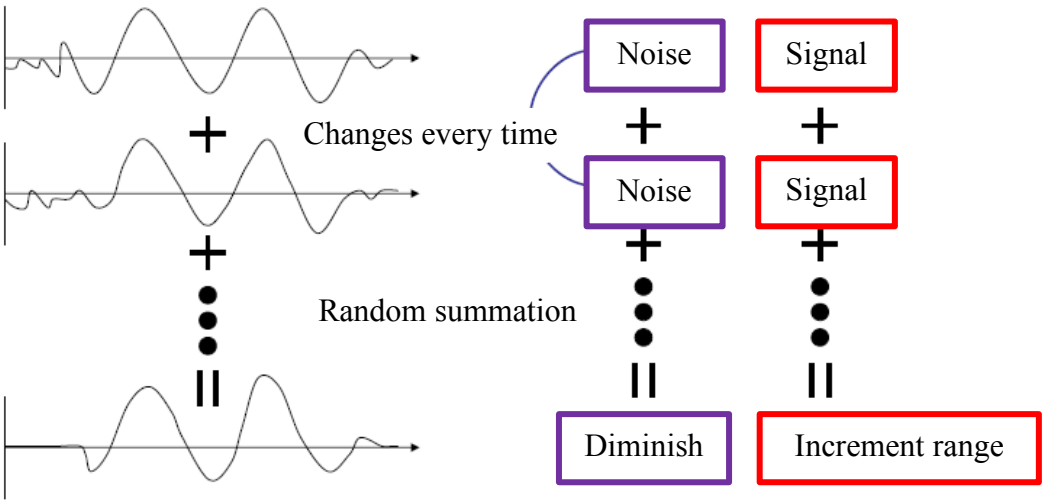


Measurement is made at different depths.

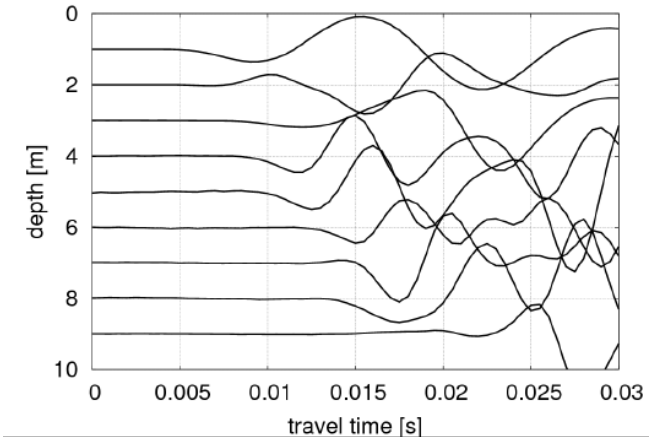


Stacking

Methods of selecting the signal structure by piling up the waveforms recorded.



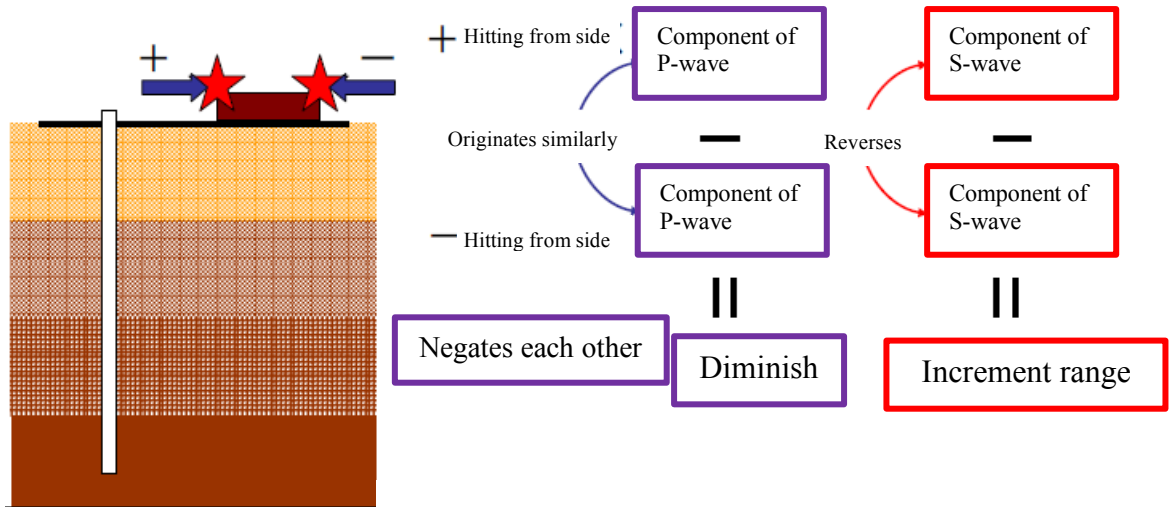
Records of vertical movement



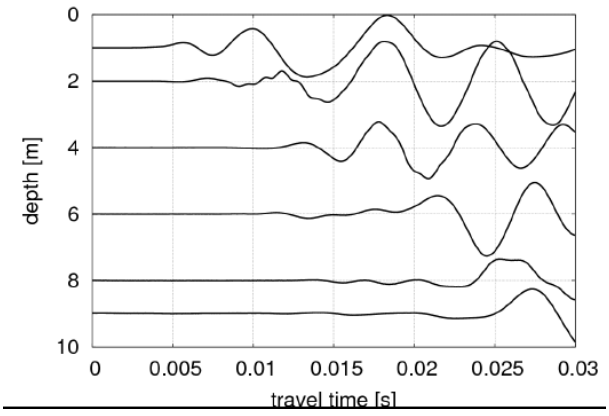
Reverse Stacking

Records obtained by hitting from different directions are piled up

Method of selecting the components of S-wave



Records of horizontal moment



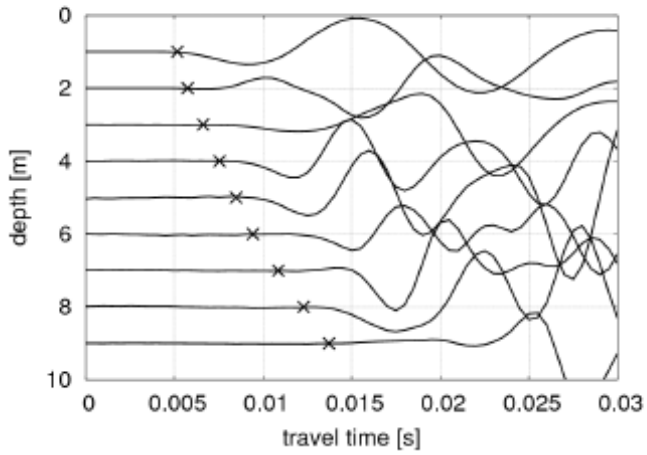
Reading of arrival time of wave

Reading of arrival time of wave for each depth is read.

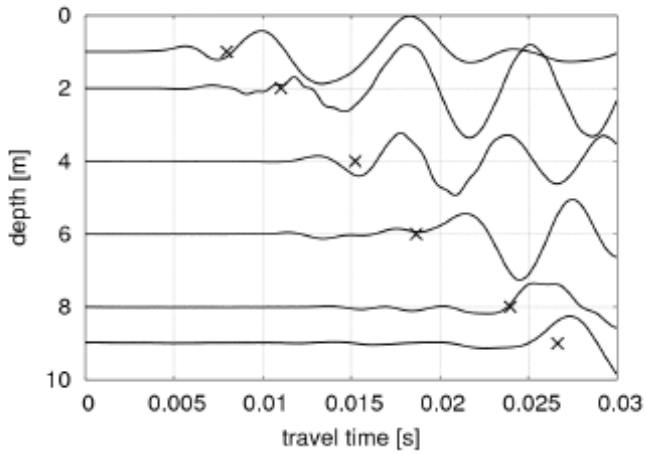
P-wave is obtained from the record of vertical movement

S-wave is obtained from the record of horizontal movement

Records of vertical movement

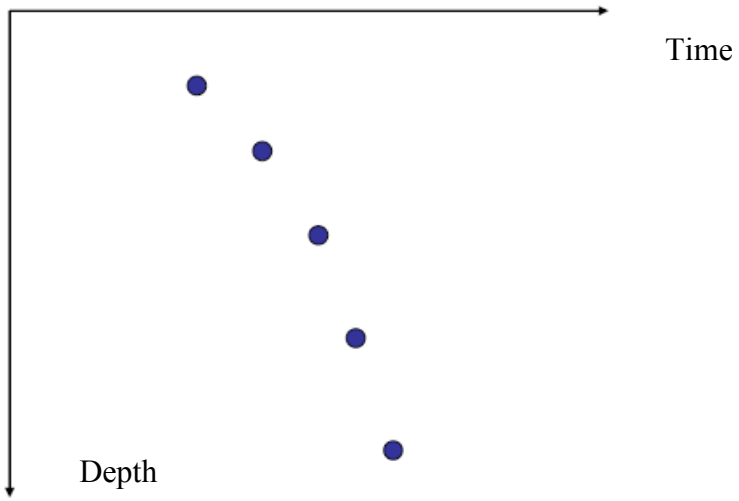


Records of horizontal movement

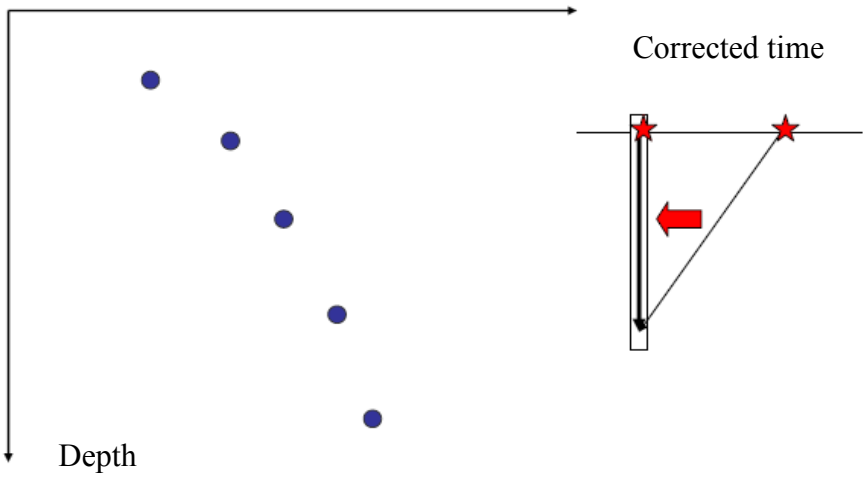


Way of finding velocity of ground layer

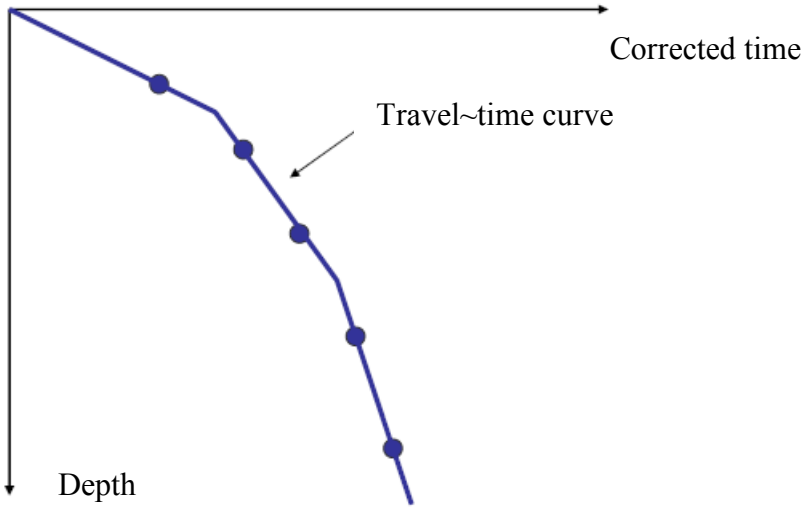
Relationship between the propagation of time and depth can be obtained.



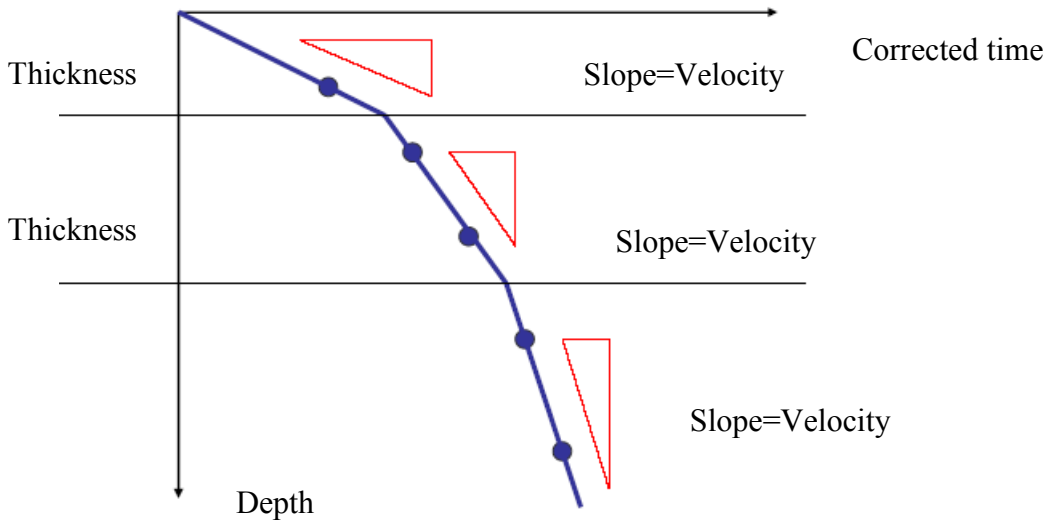
If the arrival time calculated is for the case as shown below (the top of the borehole), then correction for the time is necessary to make.



An appropriate travel~time curve is plotted.



Slope (gradient) of the travel-time curve represents the velocity.



A model of velocity structure is made.

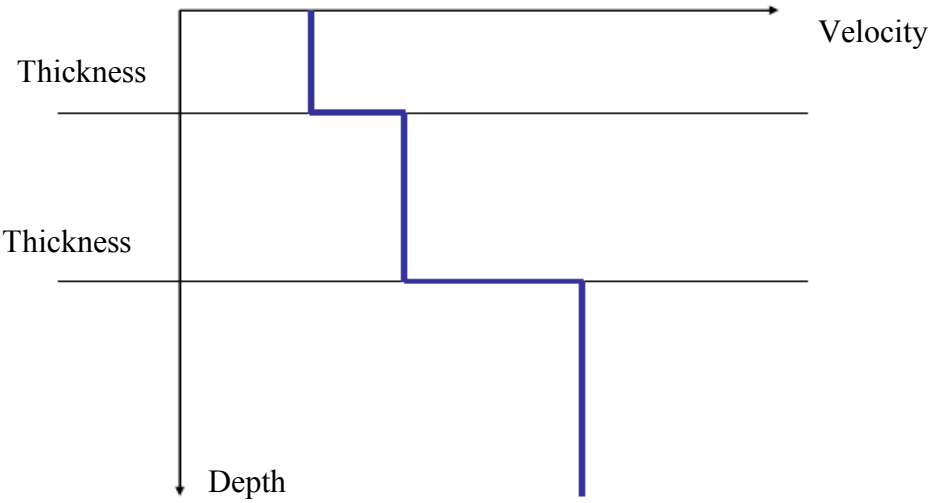


表1: 土質実験を行う地点のボーリングデータシート（抜粋）

ボーリング名	ＰＳ検層観測孔	調査位置	京都大学防災研究所敷地内	北緯	34° 54' 22.0"
発注機関	京都大学・大学院　工学研究科・防災研究所	調査期間	平成　年 12月 12日 ～　年 12月 13日	東経	135° 48' 9.0"

標尺 (m)	標高 (m)	層厚 (m)	深度 (m)	柱状図	土質区分	色調	相対密度	相対稠度	記事	孔内水位(m)／測定月日	深度 (m)	標準貫入試験 10cmごとの打撃回数 0～10	10～20	20～30	打撃回数／貫入量 (cm)	N値 0 10 20 30 40 50 60	P波速度 S波速度
1	-1.20	0.00	0.00		礫混り粘質土	暗灰		中ぐらい	砂を多く混入した粘りけの弱い粘土。 混入する礫径はϕ2～5mm。		0.45	2	2	4	8/30	6	
	-1.90	0.70	1.80		礫混り砂粘土	暗灰		中ぐらい	粘りけ中ぐらいの粘土。 混入礫径は、ϕ2～5mm。		1.15 1.45	31	28		60/9	95	
2					粘土質砂質礫	褐灰	非常に密な		ϕ2～10mmの礫主体。 全体に風化礫を混入している。 礫種は、頁岩・チャート。 マトリックスは粘土質砂であるが、GL-3.0m以深では粘土の混入が少なくなる。 含水は、3.0m以浅では少なく、以深より中ぐらい。		2.15 2.34	40	20/2		60/12	150	
3											3.15 3.27	60			60/10	180	
4	-4.30	2.40	4.00								4.00 4.10						
5					砂質礫	灰	非常に密な		ϕ2～10mmの礫主体。 部分的にϕ20～30mmの亜円礫混在。 所々にϕ100～150mmの礫が混在。 礫種は、頁岩・チャート。 マトリックスは中～粗砂。 含水は多い。		5.15	60			60/10	180	
6	-6.80	2.50	6.50								6.25 6.15	60/7			60/7	257	
7	-8.10	1.30	7.80		砂	暗灰	密な		細砂主体で均質である。 含水は中ぐらい。		6.32 7.15	5	13	19	37/30	37	
8											7.45 8.15	3	5	6	14/30	14	
9					砂質粘土	暗灰		硬い～非常に硬い	粘りけ中ぐらいの均質な粘土。 全体に細砂を混入。 GL-9.0m以浅には、木片が多く混入する。		8.45 9.15	7	7	8	22/30	22	
10	-10.30	2.20	10.00								9.45						
11																	