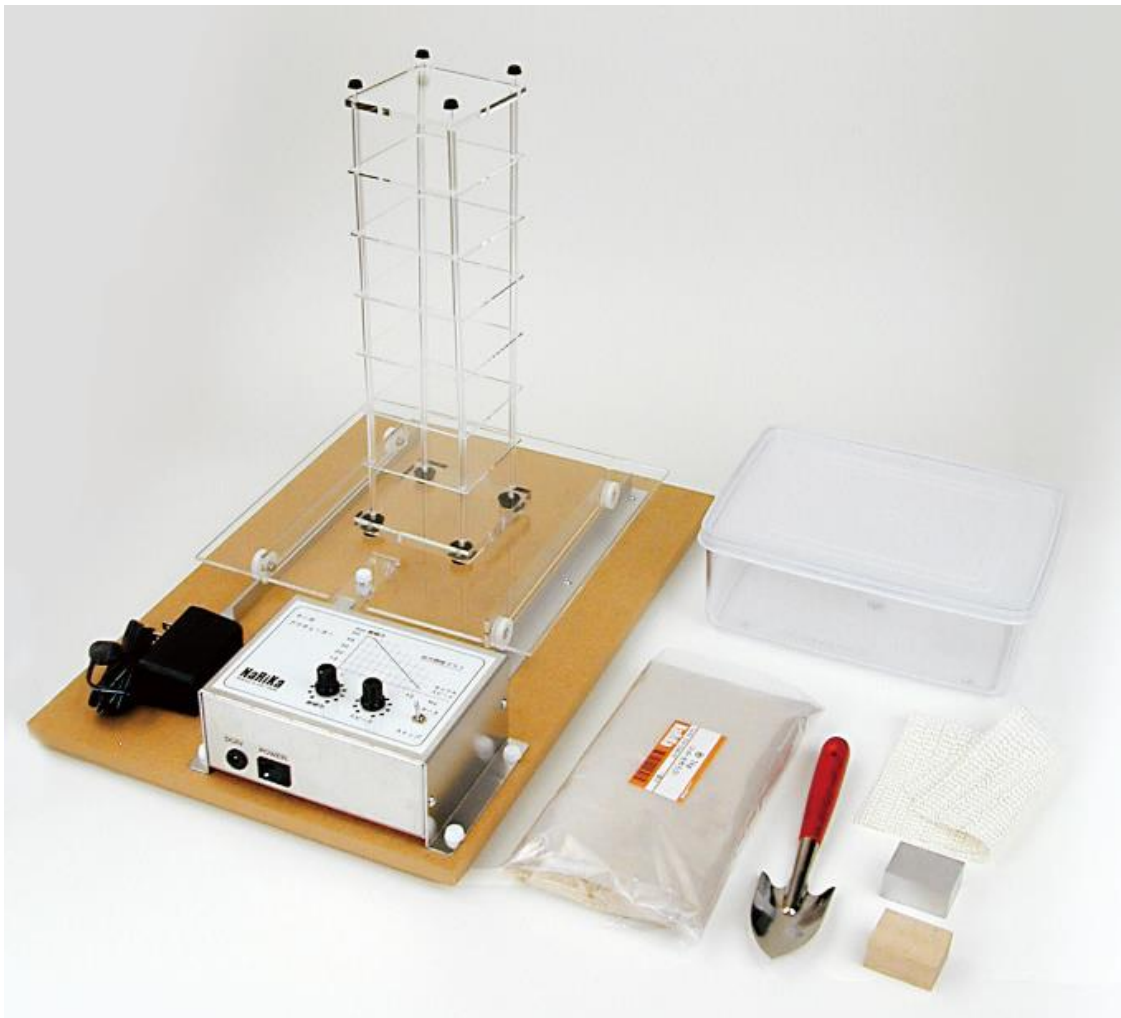


# Instruction manual

K50-1208-W0

## Liquefaction Experiment Apparatus



 **Safety Precaution**

- ⊘ Do not disassemble, repair, or remodel this product. This product might stop working and warranty will be void.
- ⊘ Teacher or trainer must provide safety instruction to students before using this product.
- ⊘ When any failure is found with this product, contact your local distributor without repairing it by yourself.
- ⊘ Do not place anything that weighs over 2kg on the vibration plate. Violation may cause damage to this product.
- ⊘ Be sure to take measures not to overturn or drop this product during experiments, as it may cause damage to this product.

**Specification**

[Seismic Waves Reproduction Apparatus, K50-1207-W0]

- Material: Base (with rubber legs) – Wood, Vibration plate – Acrylic
- Drive unit: DC servomotor type actuator
- Vibration mode: Horizontal seismic vibration (surface wave) (pseudo-sine wave)
- Vibration amplitude: 1.5-50mm
- Frequency: 0.1-12Hz
- Power Source: Four (4) size AA batteries (sold separately) or AC adapter (6V, 2A) (not included)
- Size and weight
  - 1) Main body: 450 x 300 x 53mm, 2300g (including vibration plate)
  - 2) Vibration plate: 250 x 250mm
- Accessory: model building (Acrylic, 7 stories, 90 x 90 x 320mm, 250g)

[Accessories for Soil Liquefaction Phenomenon Reproduction Experiment]

- Bag of Sand for Experiment (1kg) (S76-3240-W1)
- Aluminum Block (x1 pc)
- Wooden Block (x1 pc)
- Slip-proof Mat (x1 pc)
- Small Shovel (x1 pc)

## Introduction

Liquefaction Experiment Apparatus consists of Seismic Waves Reproduction Apparatus (K50-1207-W0) and some other accessories such as a bag of sand, an aluminum block, and a wooden block to reproduce soil liquefaction phenomena that occurs during earthquake. It is a table-top vibration generator to observe how simulated horizontal seismic waves represented as a pseudo-sine wave cause soil liquefaction phenomenon and damage to a mock building.

Furthermore, Liquefaction Experiment Apparatus is designed to learn about phenomena of natural disaster in the classroom by reproducing seismic activity to observe 1) the process of how a tall building (or a house) collapses, and 2) the mechanism of and the damage from liquefaction.

[What is the “soil liquefaction” phenomenon?]

The phenomena occur when sandy soil saturated by water is liquefied by seismic vibration, which causes significant damages to structures on liquefied soil that may become tilted and to buried water/gas pipes that may emerge and float in the liquefied soil.

[Mechanism of the “soil liquefaction” phenomenon:]

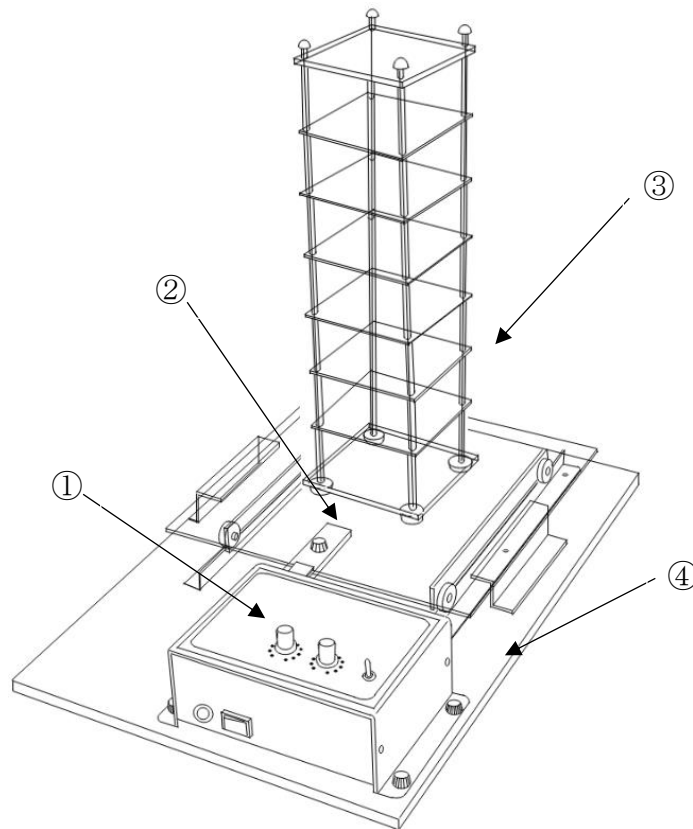
The phenomenon is most often observed in sandy soil saturated by water like the ground next to rivers or reclaimed area, where the water fills the gaps between soil (or sand) grains. The phenomenon is also observed where the force (contact stresses) between the grains of soil is kept in balance. If the force is rapidly applied and large enough like earthquake shaking, the force will be no longer in balance and the grains move, and then the water attempts to flow out from the soil. This change in soil structure causes it to lose the strength, and it may be observed to flow like a liquid (hence “liquefaction”). When this is the case, sand and water may blow out onto the ground surface after passing through the superior stratum or concrete (sand boiling), or ground subsidence may occur.

[Conditions of the soil prone to liquefy are:]

- 1) the sandy soil of which soil grains are almost uniformly sized less than 0.5mm, and
- 2) the soil is below the water table or sea level and contains enough water, then the water fills the gaps between soil grains.

After the force is rapidly and repeatedly applied to the soil of above conditions, it is most likely to liquefy.

## Seismic Waves Reproduction Apparatus (K50-1207-W0)



- ① Drive-control unit
- ② Vibration plate (table)
- ③ Model (mock) building (Acrylic, 7 stories)
- ④ Wooden base with rubber legs

- ① Drive-control unit has a DC servo motor type actuator to control and adjust the vibration plate motion with a built-in microprocessor.
- ② Vibration plate is equipped with four wheels for easier placement on guide rails. Possible to put on the plate a model building or other object for demonstration.
- ③ Model building (Acrylic, 7 stories) is pre-assembled. Therefore, this instruction manual does not include how to assemble it.
- ④ Wooden base (with rubber legs) has rails guiding the vibration plate.

## Operating Procedure

This product (Seismic Waves Reproduction Apparatus) is designed to shake the “Vibration plate” horizontally as if horizontal seismic vibration happens to the surface on the plate. Possible to independently set each condition of the vibration amplitude and vibration period (stroke speed). Set conditions for your experiment referring to the graphic label adhered to the drive-control unit that expresses the relationship between two output values of the vibration amplitude (mm) and frequency (Hz).

Note that, as shown in the graph, the maximum vibration amplitude is controlled by setting of the frequency. For instance, maximum vibration amplitude is controlled and determined by setting of frequency (see Fig. 3 and its downward line) even if the knob for controlling vibration amplitude is turned maximally to the right.

Controlled by the microcomputer built into the drive-control unit, the vibration plate generates vibration waveform that is similar to pseudo-sine wave but contains some distortion.

### 1. Power source

You can use two types of power source.

1) In case of using four (4) size AA batteries (sold separately):

Remove all the four (4) knurled screws securing the drive-control unit to the wooden base, as well as the knurled screw connecting the drive-control unit with the vibration plate (see Fig. 1). Remove the cover of the battery box found on the back surface of the drive-control unit to load four (4) size AA batteries (see Fig. 2).

2) In case of using an AC adapter (not included):

Plug the AC adapter (DC6V, 2A) into the “Input” port found on the side of the drive-control unit (see Fig. 1). Use an AC adapter with rated output of “DC6V, 2A” only.

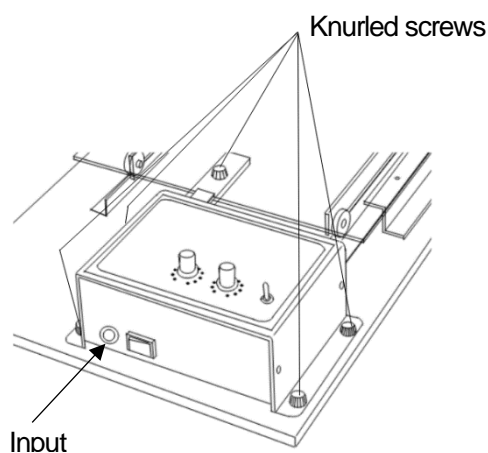


Fig. 1

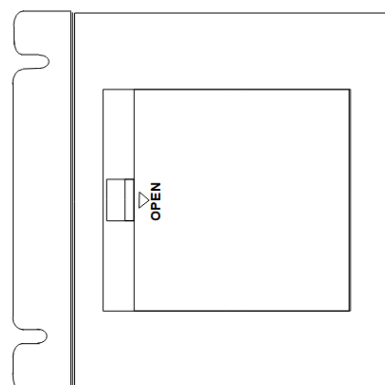


Fig. 2

## 2. Operating panel:

Drive-control unit has an operating panel, as shown in Fig. 3, that has a toggle-type on-off switch, as well as two (2) knobs for independently controlling vibration amplitude and frequency.

1) Knob for controlling vibration amplitude:

For controlling vibration amplitude of the vibration plate in the range of up to 50mm.

2) Knob for controlling vibration period (stroke speed):

For controlling vibration period of the vibration plate in the range of up to around 10Hz.

3) Frequency (x-axis) - Vibration amplitude (y-axis) graph:

Graphic label adhered to the operating panel expresses the characteristic of the DC servo motor type actuator built in the drive-control unit. As already mentioned, the graph indicates that the vibration amplitude is constrained by the setting of the frequency. Refer to this graph when using the Seismic Waves Reproduction Apparatus.

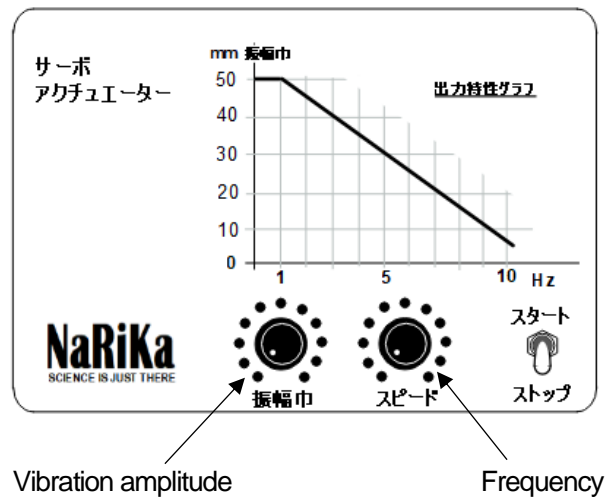
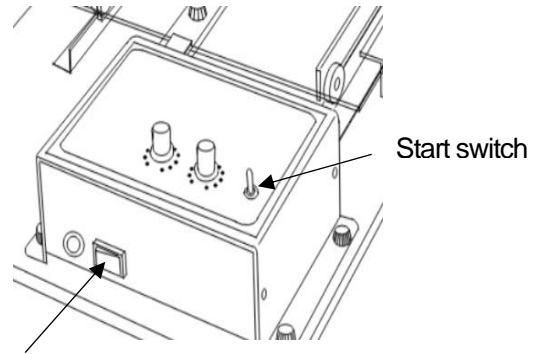


Fig.3

## 3. How to operate (see Fig. 3 and 4):

- 1) Ensure that both the main power-supply switch and toggle-type on-off switch (start switch) are off.
- 2) Set the vibration condition adjusting the vibration amplitude knob and the frequency knob respectively.
- 3) Place the model building (or other test object) on the vibration plate.
- 4) Turn on the start switch after turning on the main power-supply switch.
- 5) The vibration plate starts shaking.

Note: Make sure to check first, without placing the model building (or other test object), if the vibration plate actually shakes in accordance with the intended vibration condition and/or if the setting of the vibration condition is what was supposed to be. Otherwise, the model building (or another test object) may be damaged by overturning or falling from the table.



Main switch

Fig.4

## Guide for liquefaction experiment

### 1. What to prepare:

[Accessories that come with K50-1208-W0]

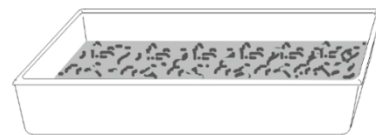
- Bag of Sand for Experiment (1kg) (S76-3240-W1)
- Aluminum Block (x1 pc)
- Wooden Block (x1 pc)
- Slip-proof Mat (x1 pc)
- Small Shovel (x1 pc)

[What to prepare by yourself]

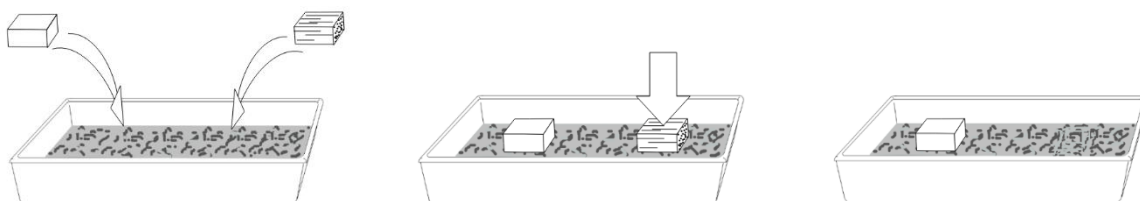
- Plastic container
- Water (500ml)

### 2. Experiment:

1) Put the sand (1kg) in the container. Add the water (less than 500ml) and stir to mix the sand and water to prepare the soil (mock foundation). Condition of the soil should be maintained during the demonstration so that the water does not flow out from the soil. As needed, add water to keep the soil in optimum condition.



- 2) Put the aluminum block and wooden block on the soil already prepared following the procedure above.
- 3) Embed the wooden block into the soil with a finger, so that it is not visible.



- 4) Place an anti-slip mat on the vibration plate.
- 5) Put the container with soil already prepared following the above procedure 1) – 3) on the mat.
- 6) Adjust the vibration amplitude control dial to the level 5 and the frequency control dial to the level 8 respectively.
- 7) Turn on the toggle-type switch to start shaking the vibration plate.
- 8) Observe the soil liquefaction phenomenon that will occur in the container. Turn off the switch once you finish the observation.
- 9) Prior to resuming the experiment, take out the blocks and stir to mix the sand and water again using the small shovel, so that the once liquefied soil can be returned to its initial condition. Then, repeat the procedure 2) – 8) to observe the soil liquefaction phenomena again.

In this experiment, the aluminum block represents structures on the ground, while the wooden block represents buried hume/water/gas or other pipes.

Soil in the container behaves like a liquid (muddy water) when stress such as shaking during an earthquake is applied. Buried wooden block should float up (emerges on) the liquefied soil due to the lower relative density, while the aluminum block subsides due to the higher relative density.

<b>Troubleshooting Guide</b>		
Problem	Possible cause	Countermeasure
Failure of soil liquefaction phenomenon to occur or to be observed.	Water content in the soil (sand) is not adequate (not enough or too much).	Recommended amount of water is around 500ml per 1kg of dry sand. Check if proper amount of water and sand are put in the container.  This recommendation does not apply if you prepare sand by yourself. Find the optimum blend of sand and water for your experiment by yourself.
The vibration table does not move.	Wheels of the vibration plate are not on the guiding rails.  Dry cell batteries are exhausted.	Bring the wheels securely back on the guiding rails.  Change the batteries to new ones, or use an appropriate AC adapter.



## Tips for long-term storage

- Be sure to take out the batteries from the Seismic Waves Reproduction Apparatus (K50-1207-W0) before storage. It may cause malfunction to the apparatus if electrolyte leakage occurs, and the electrodes are corroded.
- Be sure to dry after experiment the sand and blocks well that become wet.
- Be sure to sufficiently clean the surface and edges of the vibration plate after experiment. If sand and/or dust remains, they may scratch the surface.