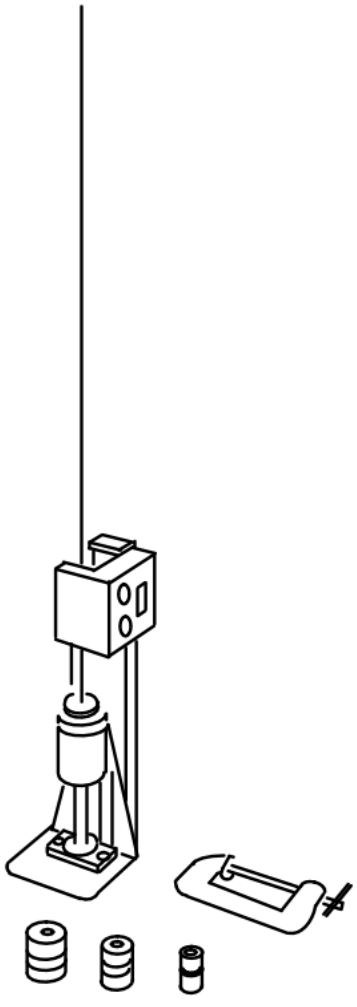
NaRiKa

Instruction Manual

Mechanical Energy Equipment Apparatus DE-45Y

CatNo.C15-2352-W0



2019/09

Safety Instruction

This is an important information for your usage. Be sure to read it carefully and thoroughly before using this product.

	The warning symbol is to show you matters that you may have possibilities of serious injury when using this product in the wrong way.
	The caution symbol is to show you that you may get possibilities of slight injury and mechanical damage when using this product in the wrong way.
	The prohibition symbol is to show you matters to prohibit operation of the product.
	The enforcement symbol is to show matters you always have to do on the operation.

	Put a safety glasses on to protect harming your eyes with the rod of product. Mind the rod tip of the product.
	Do not disassemble, repair and remodel the product because of leading to the product be damaged.
	Do not let a student to experiment alone without any teachers or instructors.
	Do not use the product on an unstable surface. Please do experiment on a stable surface.
	Do not make a big shock to the product such as dropping it.
	Do not get the product wet.
	Stop using the product when you feel something is wrong with the product such as unusual behavior.
	Be sure to explain how to operate this product to your students before starting the experiment.
	Do not let to catch your finger in a weight block of the product when it drops.
	Please check the product's operability after prolonged storage before starting to use the product. If you find any problems, please do not use the product.

Introduction

Purpose and feature of the product

Purpose of the product is that students confirm and understand the theory of mechanical energy conservation based on the results of their experiments while using this product. This product does not guarantees giving you highest accuracy results because it is a science equipment for education in school, not university level equipment.

The mechanical energy (E) is defined by sum of the potential energy (U) and the kinetic energy (K) (see eq. 1). And you may get Eq. 2 from Eq. 1 under a condition of gravity only such as a free fall. Finally, Eq. 3 is given by Eq. 2 changed. "Work" is defined by product of Force and displacement of an object. Equation of "Work" is given by difference between primary kinetic energy and final kinetic energy (see. eq. 4).

$$E = U + K \quad (1)$$

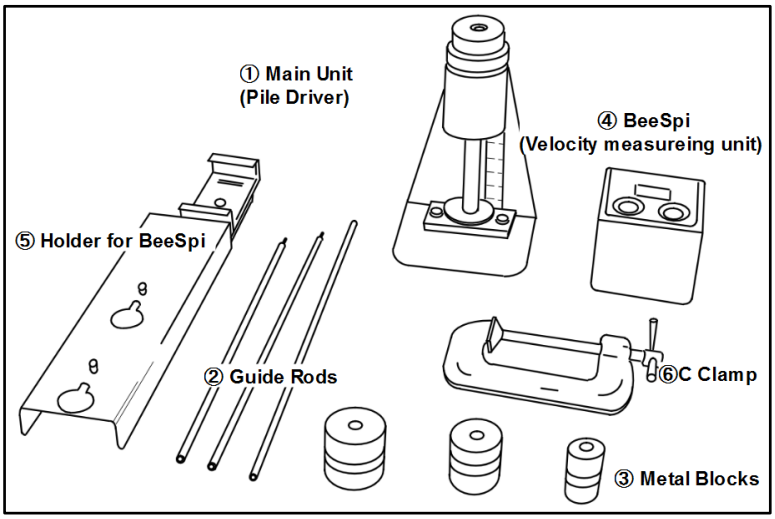
$$E = mgh + \frac{1}{2}mv^2 = \text{Constant} \quad (2)$$

$$mgh = \frac{1}{2}mv^2 \quad (3)$$

$$W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = \frac{1}{2}m(v_2 - v_1)^2 \quad (4)$$

The product will help your student to confirm and understand above mentioned relations among equations, especially eq. 3 and eq. 4, through experiments of actually using it.

Contents of product



① Main Unit (Pile Driver): 1 ②Guide Rod: 3 ③Metal Block: 3 (50g, 100g,150g)
④BeeSpi v: 1 ⑤Holder for BeeSpi v: 1 ⑥C Clamp: 1

[Function of each part]

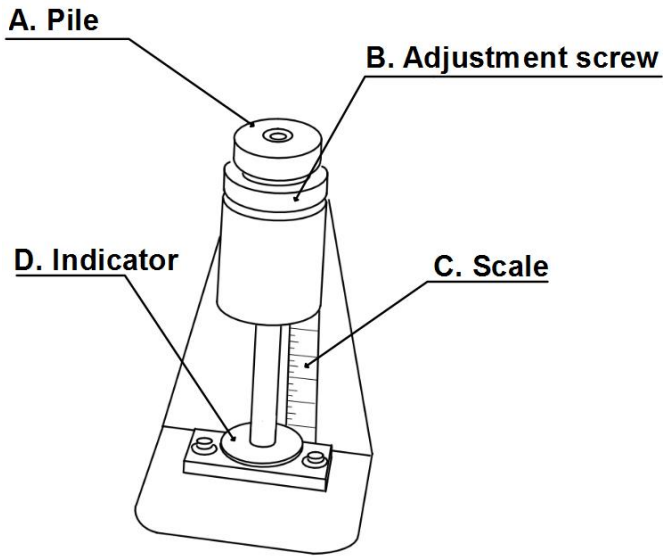
①Main Unit (Pile Driver)

A. Pile

Pile of the pile driver consists of an impact receiver, a friction block and an indicator and there is a hole for guide rod on the center of its top.

B. Adjustment screw

Adjustment screw controls the squeeze friction force against the pile. When you turn the screw clockwise, the friction force against the pile is increase. When you turn the screw anti-clockwise, the friction force against the pile decrease.



C. Scale

Scale is for reading distance of moving pile by impact of metal block onto the pile. Its scale is in mm.

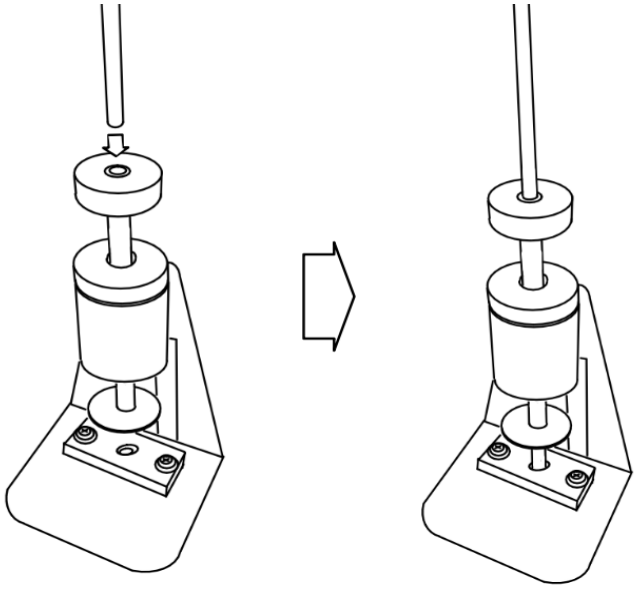
D. Indicator

A disc plate that functions as an indicator points to the pile moving distance on the scale.

② Guide Rod

Guide rods are divided in 3 short rods for storage in a package and have 4 range slits on rods which be every 10 cm on it. Please screw these 3 rods together to make one guide rod in the experiment.

To set up the equipment, insert an end of screw of the guide rod into a hole of the top pile to the bottom. Then screw the guide rod to the hole at the bottom of the pile driver.

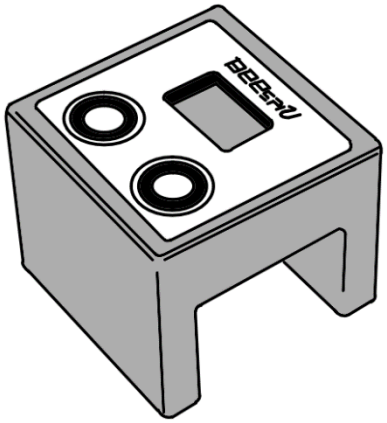


③ Metal Block

There are 3 kinds of metal blocks which have 50g, 100g and 150g with a hole in center. Mass ratio is 1:2:3.

④ BeeSpi v (S77-1321-W0)

BeeSpi v is a sensor equipped velocity measuring instrument.
Speed Measurement Range: 0 to 999.9 cm/s, 0 to 99.99 m/s, 0 to 99.99 km/h
Lap Time: 0 to 99.99 sec
Accumulated Lap Time: 0 to 99.99 sec
Power Source: Two size AAA batteries (sold separately)
Size: 60 x 60 x 50mm, Inside Dimension 40 x 30mm
Weight: 65g (excluding batteries)
Functions: Memory function for saving up to 5 latest measured data, Speed measurement, Lap time measurement.

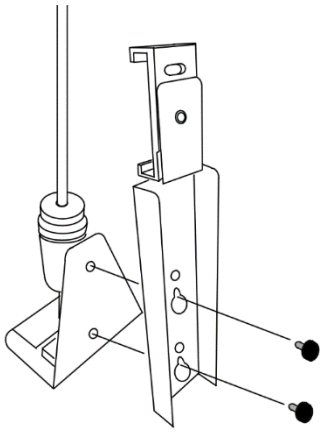


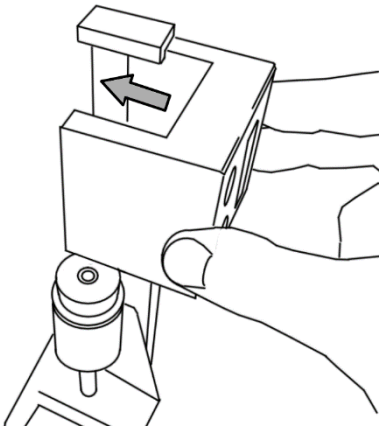
⑤ Holder for BeeSpi v

The holder is for BeeSpi v to measure a dropping speed of object and is specially designed for it.

[Setting the holder for BeeSpi v to the main unit]

When you want to measure velocity of dropping metal block, you must set BeeSpi v into its holder. Assemble the holder for BeeSpi v with the main unit by fastening knurled screws well (see fig. below) and then insert BeeSpi v into the holder (see fig. below). Before measurement of velocity using BeeSpi v, check whether or not the guide rod blocks the photogates of BeeSpi v. If they are blocked, move the BeeSpi v to clear the space, so that the photogates can do the measurement.





⑥ C Clamp

The C type clamp is to be used with the main unit. In case of doing experiments with cart collision, you need the clamp to fix the main unit to a table etc.

Experiment
Relationship of Kinetic energy and Potential energy

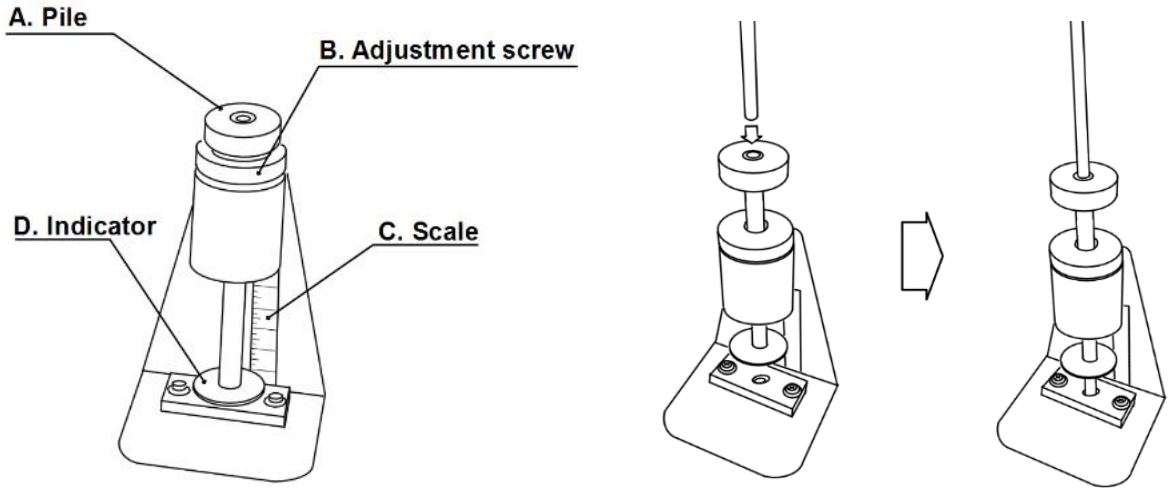
[Calibration of friction force]

As a preparation, calibration of friction force is necessary for measuring the kinetic energy. You should adjust force of friction against the pile to set up suitable condition for experiment, in which the indicator of pile moves 50 mm when Metal block (150g) is dropped from 400 mm height which is position of the first slit from the top of guide rod.

1. Inserts an end of screw of the guide rod into a hole on the top pile to the bottom (see fig. below). Pull the pile up to top position.

2. Drop the metal block (150g) from 400mm height, use the first slit from the top of the guide rod as indicator.

3. Check a numerical value on the scale of pile driver (main unit). Adjust the friction force of the pile to about 50 mm on the scale of the pile driver using the adjustment screw. During the experiment, do not change the friction force of the pile driver.



[Measurement of Pile depth]

[Purpose & Experiment]

The purpose is to confirm the relationship between kinetic energy and potential energy from a graph of data from the result. Measure the pile depth by dropping each metal block (50g, 100g, 150g) from each 100mm height (100mm, 200mm, 300mm, 400mm) after calibration. Then fill out the results in table similar to the one below. After that make a graph of the average data.

[Experiment tips]

When you decide the height of dropping metal block, it is useful to align the bottom of block and the slit of the guide rod. On the other hand, to get same height when an upper side or a center of block is tried to match with the slit of rod, the dropping height of block may become unstable.

Table.1 Result of Pile depth by dropping each weight from each height.

Weight (g)	Height (mm)	100			200			300			400		
150	Depth of Pile (mm)	16.0	17.0	16.0	32.0	31.0	30.0	45.0	45.0	42.0	53.0	52.0	55.0
	Advantage (mm)	16.3			31.0			44.0			53.3		
100	Depth of Pile (mm)	9.0	10.0	9.0	17.0	19.0	18.0	26.0	28.0	29.0	34.0	34.0	34.0
	Advantage (mm)	9.3			18.0			27.7			34.0		
50	Depth of Pile (mm)	4.0	4.0	4.0	8.0	7.0	7.5	10.0	11.0	10.0	14.0	14.0	15.0
	Advantage (mm)	4.0			7.5			10.3			14.3		

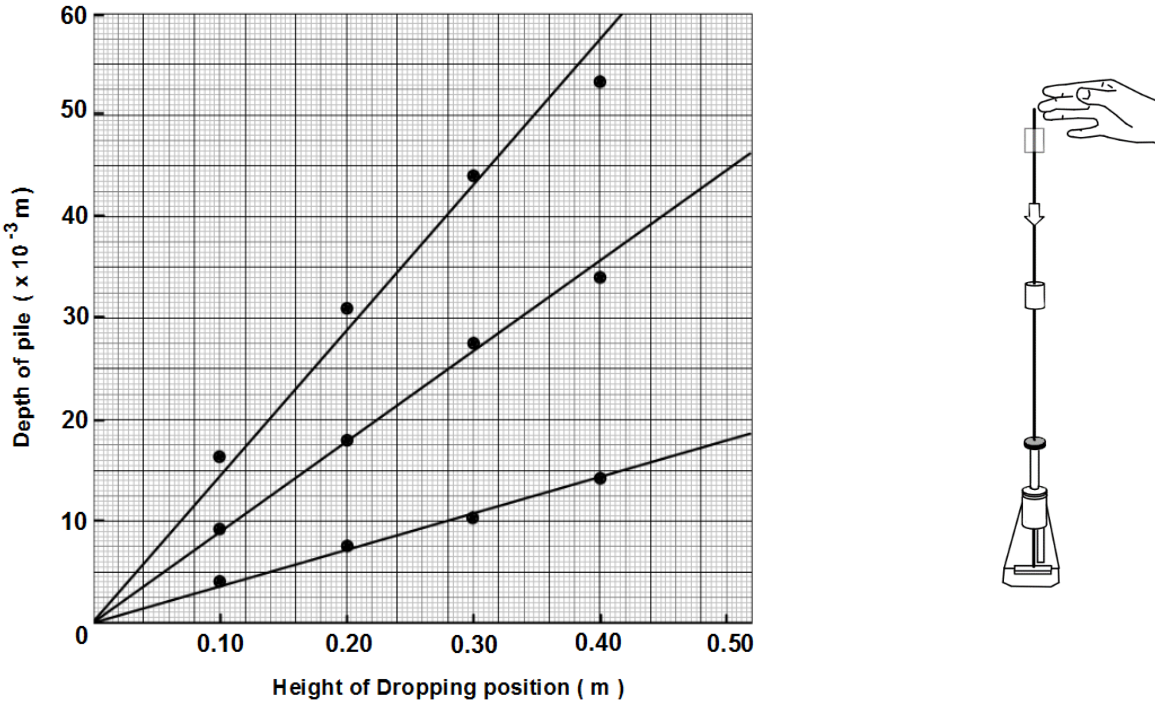


Fig. 1 Result of Pile depth by dropping each weight from each height

The result of this experiment is shown Table 1 and Fig. 1. The graph in Fig. 1 means that the relationship of the depth of the pile and height of dropping (drop distance) are in a direct proportion with each other and can be shown as a linear function. On the other hand, theoretical formula (5) is given from equation (1), (2) and (3). The kinetic energy K means a direct function an inclination mg and height h.

$$K = mgh \qquad (5)$$

Students can confirm the relationship between the kinetic energy and the potential energy is eq.5 through their graph and result of experiment using this equipment.

[Measurement of Velocity of metal block dropping]

[Purpose & Experiment]

The purpose is to confirm the relationship between kinetic energy and potential energy from a graph made from the result data. Measure the velocity of metal block dropping, and the pile depth by dropping each metal block (50g, 100g, 150g) from each 100mm height (100mm, 200mm, 300mm, 400mm) after finishing the calibration.

[Experiment tips]

When you decide the height of dropping metal block, it is useful to match the bottom of block and the slit of the guide rod. On the other hand, to get same height when an upper side or a center of block is aligned with the slit of rod, the dropping height of block may become unstable.

When setting up BeeSpi with its holder, you should be careful about the position of its photogates. Please check whether the guide rod blocks the photogates of BeeSpi v or not. If the guide rod blocks the photogates, change the position of BeeSpi v in the holder to make some space for the photogates not to be blocked by the guide rod, then conduct the experiment.

Table 2. Result of Pile depth and Velocity by dropping each weight from each height.

Heigth(mm)	100		200		300		400	
Weight of Block	Depth of Pile	Velocity (m/s)	Depth of Pile	Velocity (m/s)	Depth of Pile	Velocity (m/s)	Depth of Pile	Velocity (m/s)
150 g	13	1.18	28	1.82	34	2.27	50	2.66
	14	1.17	29	1.83	40	2.31	43	2.62
	15	1.18	28	1.83	34	2.28	39	2.61
Ave.	14.0	1.177	28.3	1.827	36.0	2.287	44.0	2.630
100g	9	1.20	18	1.83	23	2.29	33	2.67
	10	1.21	18	1.84	25	2.30	31	2.65
	10	1.19	16	1.85	25	2.30	30	2.67
Ave.	9.7	1.200	17.3	1.840	24.3	2.297	31.3	2.663
50g	3	1.2	8	1.84	12	2.32	13	2.68
	3	1.19	8	1.84	11	2.27	14	2.72
	4	1.21	8	1.84	11	2.31	13	2.62
Ave.	3.3	1.200	8.0	1.840	11.3	2.300	13.3	2.673

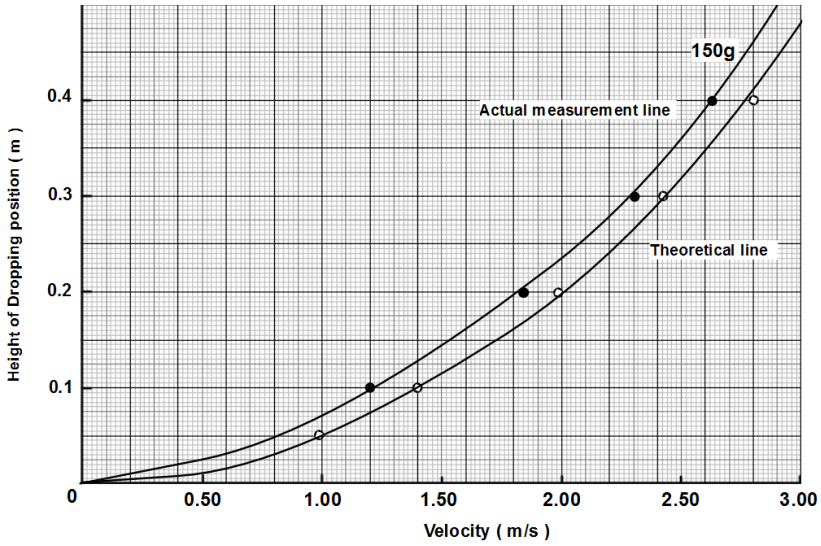


Fig 2. Relationship with height of dropping position and velocity

Measure the depth of pile and velocity at the impact to the pile of height dropped (100, 200, 300, 400 mm) of Metal block with weight (50, 100 and 150g). The result in table 2 shows that the velocity relates with only height of dropping position not with the weight of the metal block. The graph of results of 150g metal block are typical results and based on the results, theoretically calculated value is shown in Fig. 2. Its graph has the vertical axis (y-axis) of the height of dropping position and the horizontal axis (x-axis) of the velocity.

On the other hand, you may transform equation 3 to be equation 6 & 7. The equation 7 means a quadratic function of height and velocity.

$$v^2 = 2gh \qquad (6)$$

$$h = \frac{v^2}{2g} \qquad (7)$$

The graph shows both curves are similar to the quadratic function which is based on equation 7. You may see that curve of measured values (150g) and of theoretically calculated values are similar in Fig. 2. And those are shown in quadratic function curve.

Maintenance

There is no special maintenance for this product. However, if you find any problem with it, please contact your local distributor about what happened.

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