CE Report
Civil Engineering Classroom

Teruhiko TANAKA
Fellow, Former engineer of Kajima Corporation

<u>What is aggregate?</u>

When I was a university student, I was asked the question "What does the civil engineering term "aggregate" mean?" When I think back, it is a very interesting term. I thought then that some devices would be necessary to explain civil engineering to the general public in an easy-to-understand manner. Subsequent to that, I wrote Great Authority on Gravity (Iwanami Junior Books) and Introduction to Civil Engineering—Usual Passages and Bridges (Kajima Institute Publishing Co., Ltd). Taking advantage of this writing, I am performing the activity "Civil Engineering Classroom" that supports the Civil Engineering Museum (tentative name) in Kobe City now in the conceptual stage.

As written by Nanami Shiono in his book, basically civil engineering creates facilities for everyone to live their lives in a humane manner. I want the general public to understand that it is necessary in daily life to know well the civil engineering that plays a role in creating the facilities. I devise teaching materials for use in the classroom that is mostly a parent-child classroom. In the classroom I do my utmost to start with the explanation of civil engineering job. I think many people in many parts of the country are practicing activities for similar purposes. I would like to introduce part of my activities to receive their impressions and advice of the activities.

<u>Amazed at the power of an arch</u>

Arch bridge model made of gypsum

Forms are made of heavy paper (Photo 1), gypsum is poured into the forms to make the blocks of an arch (Photo 2), and an arch support is made of heavy paper to teach the principle of arch blocks assembly (Photo 3). At the same time I teach how to handle gypsum and that gypsum is similar in properties to concrete. Heavy bricks are placed on the completed arch to teach the power of the arch. At the moment when the arch supports the heavy bricks, classroom students' eyes widen in amazement (Photo 4). They take the arches home and can use them for homework during the summer vacation. I introduce the history of arches and famous arch bridges at home and abroad in Power Point. The classroom time, including forms preparation time and gypsum, is about 3 hours.

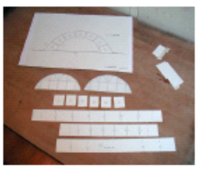

Photo 1 Heavy paper for forms

Photo 3 Assembling arch blocks

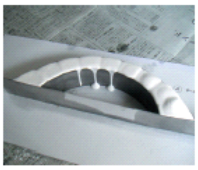

Photo 2 Pouring gypsum into the forms

Photo 4 Heavy bricks placed on the arch

<u>Wonder of a triangle</u>

Truss bridge model made of matchsticks

Before making a truss bridge model, a triangle and quadrangle are made of chopsticks to teach that the triangle is strong and quadrangle is shaky (Photo 5). I tell the story of bridges, including the mechanics of a truss structure that makes it possible to build long strong bridges by a combination of triangles using thin materials. A mat board is prepared to facilitate the assembly of a truss (Photos 6 and 7). They bring home the completed bridge models (Photo 8). The classroom time is about 2 hours.


Photo 5 Explanation of a truss


Photo 6 Making a truss on a mat board


Photo 7 Assembling a truss


Photo 8 A beautifully painted bridge model


Photo 9 -


Photo 10 Various types of bridges can be made.

<u>A small-scale experiment that can be done using a postcard</u>

Various forms of bridges

Cut a used postcard to 2 cm wide pieces. Place 10-yen coins on the bridges having cross sections of various shapes to compare the strength of the bridges. The experiment is done along with the story of bridges (Photos 11, 12 and 13).

<u>1 + 1 + 1 = 9</u>

Story of section modulus

The students learn through experience the wonder of the effect of a cross section. I hand out plates of different thicknesses to the students to experience the three arrows stronger than listening to a parable by actually breaking the plates. I also teach that the strength increases by a factor of five when three plates are tied up firmly. I explain that the reason the students feel safe to cross bridges is that strong materials are selected and calculations are made thoroughly (Photos 14, 15 and 16).


Photo 11 Simple girder bridge


Photo 12 Arch bridge


Photo 13 Truss bridge

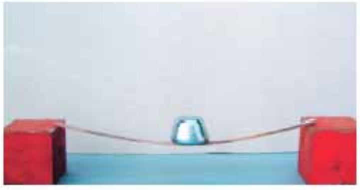
Photo 14 A plate (one weight)


Photo 15 Three plates stacked (three weight)


Photo 16 A plate with three-plate thickness (nine weights)

Pudding and sweet jelly of beans

Story of earthquakes and power of bracing

A house model is made of paper to do an experiment on the shaking of the house. I explain the properties of the ground by the difference in the shaking of houses on a pudding and sweet jelly of beans (Photo 17). Paper patterns of two-, three- and five-story houses are prepared to verify the difference in the shaking of houses by the height (story) of the houses (Photo 18). In addition, the model house is shook to demonstrate that bracing can dramatically increase the strength of the house. This experiment is made a set with the experiment of liquefaction described below. The classroom time, including the story of earthquakes, is about 2 hours.

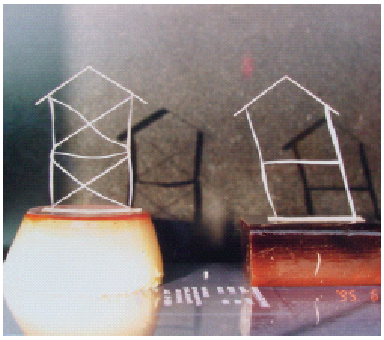

Photo 17 Experiment of the shaking of houses on a pudding and sweet jelly of beans

Photo 18 House models of different stories

Sand flows like water

An experiment of liquefaction

A simplified experiment of liquefaction is done using a small water tank (Photo 19). A hand vibrator is used to produce vibrations in the tank. Students start raising their voices when they see the house model tilt in a few seconds. The pipe that models a sewer also floats to the surface. One of the house models is provided with chopstick piles. They understand when they see the house model with the piles does not tilt (Photo 20). Six sets are prepared for the experiment.

An experiment of sand in a cup flowing out of the cup by vibrations is done before the experiment of liquefaction to help understand the mechanism of liquefaction (Photo 21). The cup is shook to demonstrate that a roll film case that represents a manhole floats to the surface (Photo 22).

Photo 19 House models set for the experiment

Photo 21 Sand in a cup on the right flows out by vibrations like the cup on the left.

Photo 20 House model without piles tilts. House model with piles do not.

Photo 22 A film case floats to the surface in a cup on the left

Flattening a slope

Angle of repose and a wall supporting the soil (retaining wall)

Rice grains and sand are gently heaped up to show the formation of small slopes. Sand is heaped up into small mounds of different heights to show that the two mounds have the same angle of repose (Photo 23). The difference in the shape of small mounds made of dry and wet sand is shown (Photo 24). I explain that soil properties are investigated to build dikes and roads.

I explain a retaining wall that plays a large role in making Japan where flatlands are extremely limited secure and comfortable to live in. The state that a slope fails by the shaking using a hand vibrator is shown (Photos 25 and 26) to conduct an experiment for comparing the strength of upright and sloped retaining walls constructed of blocks in earthquakes (Photos 27 and 28). I explain that the slope can be flattened by the use of T-shaped retaining walls (Photos 29 and 30).

Photo 23 Rice grains heaped up to make small mounds of different heights. They

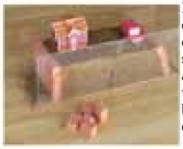

Photo 27 An experiment for comparing the strength of upright and sloped retaining walls constructed of blocks in earthquakes

Photo 24 Dry and wet sand heaped up to make small mounds.

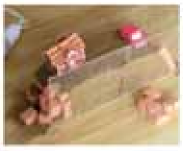

Photo 28 Failed slope. The sloped retaining wall constructed of blocks does not fail.

Photo 25 An experimental setup for a slope failure by vibrations

Photo 29 Slope model

Photo 26 Failed slope

Photo 30 The slope can be flattened by the use of T-shaped retaining walls for building houses and roads.

Measuring heights using water

A PET bottle level

I explain that construction work starts with surveying. Levels are taken with a device made of PET bottles and a vinyl hose (Photo 32) and compared with the measurements with a level to understand the accuracy of measurement. The accuracy of measurements is compared with that taken with the water level in the Edo period (restored by Assistant Kazuo Kamiyoshi, Department of Engineering, Kobe University) (Photo 33). Surveying technology that dates back to ancient Egypt is explained and at the same time the demonstration of an electro-optical distance meter is given.

To promote better understanding while enjoying the lesson, an event "hunt for treasure with a treasure map" is held. This event is to hunt for treasure using a treasure map based on the measurement of distance in paces and the use of a compass by the united efforts of parent and child.

Refer to Page 93 of January's issue of the JSCE Journal for the details of related events. The event was a great success because Kobe Gazette could be used, but I have heard that similar events have difficulty in inviting participants. I feel the parent-child classroom is very effective as a PR activity because adults participate in the classroom. Three years have elapsed since the start of events and I am painfully aware of the need for ideas and efforts required for the events to continue.

Photo 31 Surveying classroom

Photo 32 A level made of PET bottles and a vinyl hose

Photo 33 Comparative surveying

Web site: http://members.aol.com/ecolecvil01/

Director: Katsuhiko Kuroda, Professor, Department of Engineering, Kobe University

Executive office: Road Planning Section, Construction Bureau, Kobe City