AVALANCHE SIMULATORS FOR SCIENCE EDUCATION, NADARANGER 1-2-3

Yasuaki Nohguchi

ABSTRACT: It is important for not only practical problems but also science education to simulate avalanche motion in a reduced scale experiment. We are developing toys for science education (named *Nadaranger* 1, 2, 3; *Nadare* is a Japanese which means *avalanche*) showing avalanche motion. These simulators are made of transparent plastic water tank filled with fluid and granular materials. By changing the granular materials several kinds of avalanches can be simulated. Nadaranger 1 is a standard type avalanche simulator whose slope length is 150cm, and Nadaranger 2 is a desk top type simulator 30cm in length, and Nadaranger 3 is a key holder type simulator 7cm in length whose nick name is Nadaretchi. In these simulators the similarity on head- tail structure is essential to show them real.

KEYWORDS: Avalanche, Simulator, Science Education, Scientific Toy, Similarity

1. INTRODUCTION

Though avalanches are dangerous and hateful for a suffer related to the avalanche disaster, they are exciting and interesting phenomena such as a lion in a cage for a safe observer. This sense is important for science education.

Some of simulators for natural phenomena are being sold commercially as a toy; e.g. a toy simulating a tornado of the movie, Twister, by rotating water with babble and that for a big wave such as surfing in Hawaii by two layered fluids are popular. In such physical models with a reduced scale for natural phenomena, the similarity is important for such toys to show themselves real.

In this paper we introduce some avalanche simulators developing for natural science education.

2. AVALANCHE SIMULATOR FOR SCIENCE DISPLAY

Avalanche simulators for science display need to satisfy the conditions as follows :

1 Reality:
For this the similarity law is necessary for the simulator.

2 Simplicity:
The simulator should be simple even if the phenomenon might be complex.

3 Toughness:
For a rough observer it should be tough.

4 Many times changing condition:
The observer have to be able to experience the experiment many times of himself changing conditions.

5 Visual understanding:
It should be visual and intuitional.

3. SIMILARITY LAW FOR AVALANCHE

Nohguchi et al. (1997) proposed a characteristic length,

$$L_c = V_e^2/g, \qquad (1)$$

as a scale for the similarity of avalanches in motion. V_e and g are the terminal velocity of the avalanche and the acceleration of gravity, respectively. When the difference of the density between the environmental fluid and the granular material cannot be neglected, (1) must be

$$L_c = V_e^2/(\Delta\rho/\rho)g. \qquad (2)$$

Then, if the slope length, L is

$$L >> L_c, \qquad (3)$$

the avalanche has a head-tail structure (Fig.1).

National Research Institute for Earth Science and Disaster Prevention, Tsukuba, 305-0006, Japan
TEL +81-298-51-1611, FAX +81-298-51-1622, E-mail nhg@ess.bosai.go.jp

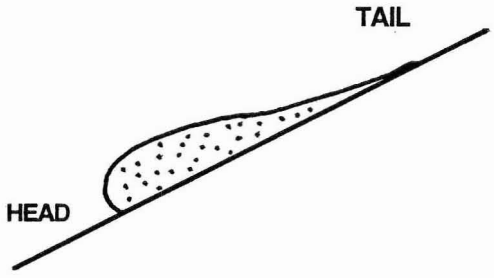

Fig.1 Head- tail structure of avalanche.

This indicates that a high V_e needs a long slope for the same similarity on the head-tail structure. The other way, the avalanches with a low V_e will have a head-tail structure in a reduced scale. Then the ratios of time scales and spatial scales of two systems with the terminal velocities V_{e1} and V_{e2} are represented as follows:

$$T_2/T_1 = V_{e2}/V_{e1} \qquad (4)$$

$$L_2/L_1 = (V_{e2}/V_{e1})^2 \qquad (5)$$

The dimension-less number

$$L_2/L = N \qquad (6)$$

represents the similarity on the head-tail structure.

When the granular material and the environmental fluid are common in deferent type Nadarangers, the terminal velocity can be adjusted by changing the bulk volume of the granular material , that is, the number of the particles.

4. NADARANGER 1-2-3

A Nadaranger is composed of a water tank and a stand, the water tank can be manually inclined to both a right side and a left side such as a seesaw to repeat avalanche flow in many times by inclining (Fig. 2). The water tank is made of transparent plastic plate, and water and granular material are contained in it. The observers can easily examine the effect of the slope inclination on the avalanche flow by manually changing it.

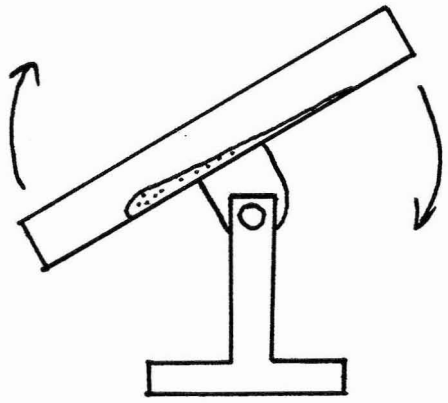

Fig.2 Nadaranger.

4.1 *Nadaranger 1*

Nadaranger 1 (Fig.3) is a standard type simulator for display in science museums or educational material in school. By exchanging the granular material or environmental fluid contained in the Nadaranger, some kinds of avalanches can be simulated. Figs. 4 and 5 shows an avalanche on a steep slope with a big eddy such as a powder snow avalanche and an avalanche on a gentle slope such as a flow avalanche. In a wide avalanche wavy pattern appears at the leading front (Fig. 6).

Fig. 3 Nadaranger 1.

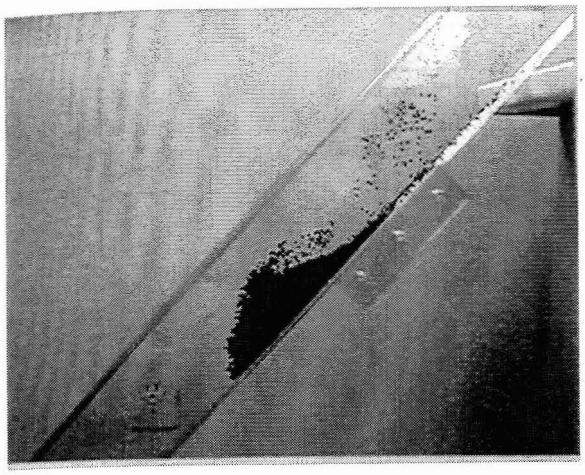

Fig. 4 An avalanche of Nadaranger 1 on a steep slope.

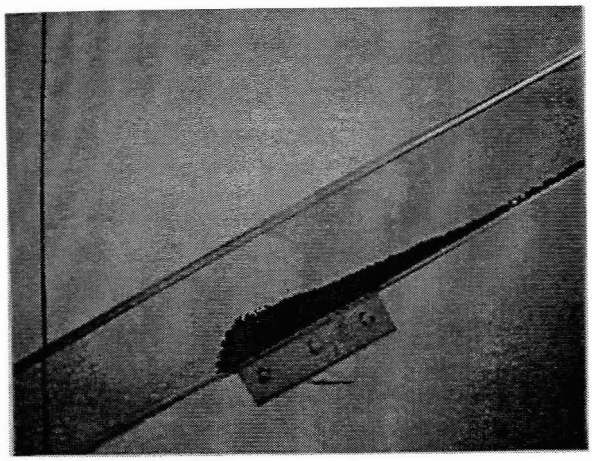

Fig. 5 An avalanche of Nadaranger 1 on a gentle slope.

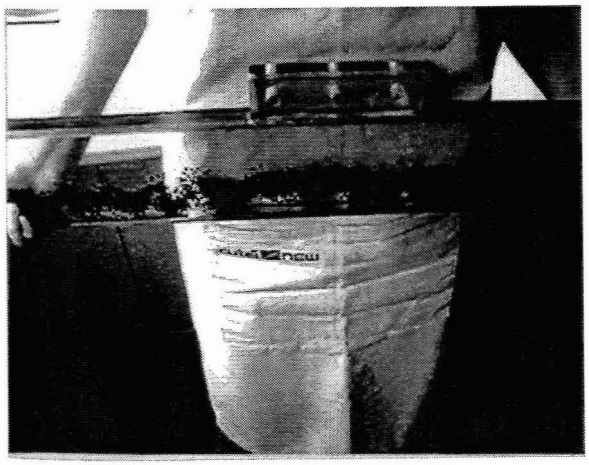

Fig. 6 Wavy pattern at the leading edge of a wide avalanche of Nadaranger 1.

Now this type simulator is displayed at Tateyama Cardera Sabo Museum and Nagaoka Institute of Snow and Ice Studies and will soon be displayed at Toyama Science Museum in Japan.

4.2 *Nadaranger 2*

Nadaranger 2 (Fig.7) is a desk top type simulator suitable for personal demonstration.

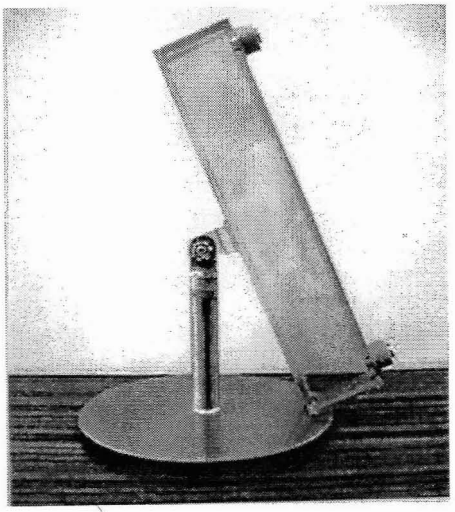

Fig. 7 Nadaranger 2.

4.3 *Nadaranger 3*

Nadaranger 3 (Fig.8) is a key holder type avalanche simulator. Since this is small and portable for anywhere, it might be suitable for an avalanche researcher to qualitatively image up the phenomenon. In other words it is a kind of toys for scientists.

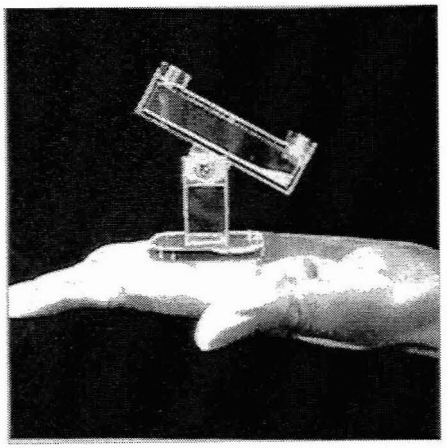

Fig. 8 Nadaranger 3.

5. CONCLUSIONS

The natural disasters are good materials for science education, because it is well known in comparison with other phenomena, even though it might be dangerous in the relation to human life. We should not hate the avalanche, but the disaster.

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