

Current status of education about earth reinforcement in Japan

S. Imaizumi
 Utsunomiya University

K. Kumagai
 Hachinohe Institute of Technology

J. Otani
 Kumamoto University

ABSTRACT: The TC-9 Japanese Supporting Committee, SC-4, has made an effort to summarize current status of Education about Geosynthetic in Japan. They sent questionnaires to 108 departments of university and 50 companies. Relating to the education in University, there is no subject in which geosynthetics is taught throughout all hours. Geosynthetics is taught in a part of other geotechnical subjects. About 20 undergraduate students and 10 graduate students at master course a year conducted the research about geosynthetics to get their degree. Relating to company, materials to be used for education are catalogs of the product, CC-ROMs, Videos or data books.

1 INTRODUCTION

The TC-9 Japanese Supporting Committee, SC-4, has made an effort to summarize current status of Education for Geosynthetic, especially about Earth Reinforcement, in Japan. They made two questionnaires, one was to departments of university and other was to companies.

Today, there are about 100 departments in university or college in Japan, where geotechnical engineering or soil mechanics are taught and studied. National or public ones are about 50 and private ones about 50. In November 1999, SC-4, first, sent questionnaires to all the laboratories. The purpose was to know how many hours in a term the student learns about geosynthetics, what materials or what textbook the teacher uses in the class and about what engineering problems the student researches for his thesis. The full quota of student in total departments is about 10,000 for undergraduate course, about 2,300 for course to Master degree, and about 500 for Doctoral course. The real number of doctoral students whose special field is civil engineering is seem to be far less than 500 because the department of course to Doctor Degree in many university is composed of many special fields including civil engineering and others.

Relating to the company who deals with geosynthetics for manufacturing, construction and sale, the number of the Corporate Members of the IGS is 24. There are 85 companies who have cooperated the works such that the Japanese Chapter of IGS has investigated the volume of used geosynthetics in each

four years. In September 2000, SC-4 sent the questionnaires to 50 companies among them to know what materials they used for educating the staff and for encouraging the ability of their customers.

Table 1 shows the numbers of the departments and the companies that SC-4 sent the questionnaires and the response from them. Relating to university, SC-4 sent it to 108 departments for undergraduate course and 104 departments for graduate course, and got a response of 53 and 52, respectively. So, the percentages of response are 49 % and 50 %. Relating to company, SC-4 sent the questionnaires to 50 companies and got 19 responses. The percentage is 38 %.

Table 1. Number of departments and companies to be sent the questionnaires

A Universities (November, 1999)

	Sending	Response	Percent
National Univ.	54 ¹⁾ (45) ²⁾	30	57
Public Univ.	3 (3)	2	67
Private Univ.	51 (41)	21	51
Total	108 (89)	53	49

- 1) Number of department
 2) Number of university

B Companies (September, 2000)

Sending	Response	Percent
50	19	38

2 CURRENT STATUS OF CLASS IN THE UNIVERSITY

2.1 Undergraduate course

Twenty-two departments among 53 responses have a class about geosynthetics for undergraduate students. The ratio is 41.5 %.

Figure 1 shows the name of subject in which the student learn about geosynthetics. It is found that the geosynthetic is taught not in its own subject named "Geosynthetics" but in a part of various subjects, namely "Geotechnical Engineering" (33.3 %), "Soil Mechanics" (25 %), "Foundation Engineering" (20.8 %), "Environmental Geotechnical Engineering" (%), "Ground Improvement" (%) and so on.

Though the geosynthetics is taught in many subject, the hours spent for teaching it is very short. Figure 2 shows the distribution of total hours for two credit. About 75 % of subjects spend less than 2 hours. As two credit in Japan needs 30 hours in total, only one fifteenth of the contents relates to geosynthetics. Hopefully, 3 departments spend teaching the geosynthetics for more than 15 hours. From this fact, it is clearly said that the field of geosynthetics does not establish their own position in a curriculum for undergraduate students.

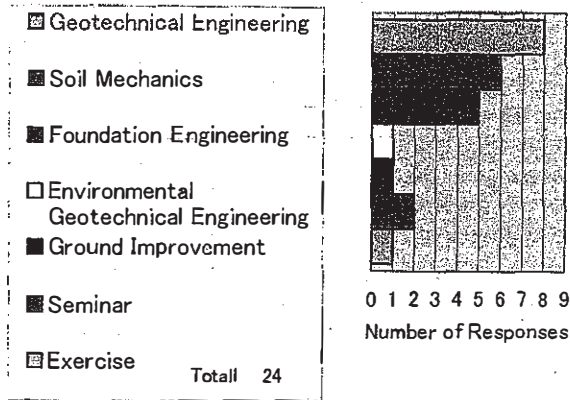


Figure 1. The name of subject where geosynthetics is taught

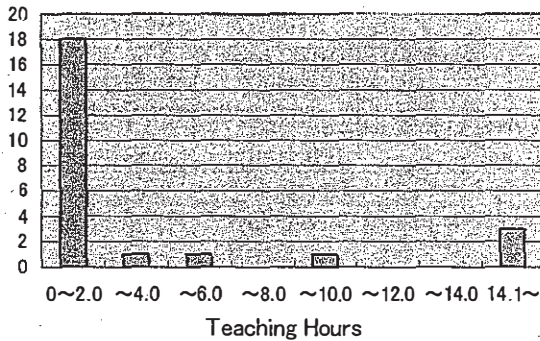


Figure 2. Distribution of hours spent for geosynthetics in one credit

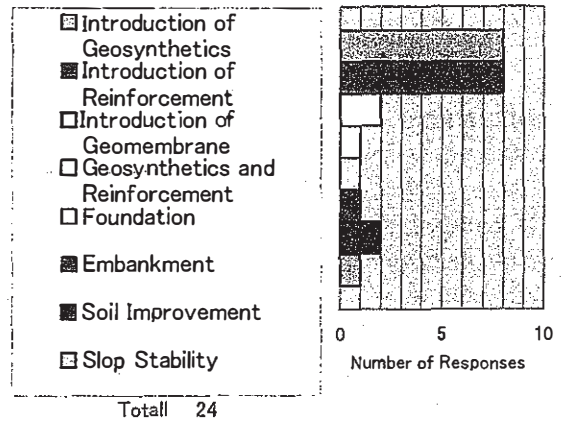


Figure 3. Distribution of the contents taught in the subjects

Figure 3 shows the content that is taught in the subject. The content is just an introduction of geosynthetics and reinforcement. That is explanation about classification, types, names, physical and mechanical properties, applications of geosynthetics, and so on. The most of professor use not textbook but OHP of picture or slides.

2.2 Graduate course to Master degree

Relating to the graduate course to Master degree, 13 departments open a class that deals with geosynthetics.

Figure 4 shows a name of the subjects in graduate course. The name of the subject is very different, such as "Advanced Geotechnical Engineering" (15.4%), "Advanced Civil Engineering" (15.4%), "Advanced Disaster Prevention Engineering" (15.4%) and so on. Even in graduate course, there is no subjects of which name indicate "Geosynthetics" or "Soil Reinforcement", directly.

Figure 5 shows the distribution of hours spent for teaching geosynthetics in the subject. The departments of 53% spend less than 2 hours. Three departments (23%) teach geosynthetics for more than 14 hours. So, the geosynthetics is very minor subject even in graduate course to Master degree.

Figure 6 shows what is taught in the subject at graduate course. It can be seen that 2 departments deal with designing of reinforcement or landfill and 3 departments deal with construction method of reinforcement. In these subjects, students learn details about geosynthetics. But, the majority of department in Japan teach the outline and/or applications of geosynthetics. Relating to teaching materials, professors commonly use a copy of paper of journal or proceedings and OHP. Some professor use "Designing with Geosynthetics" by Dr. Koerner.

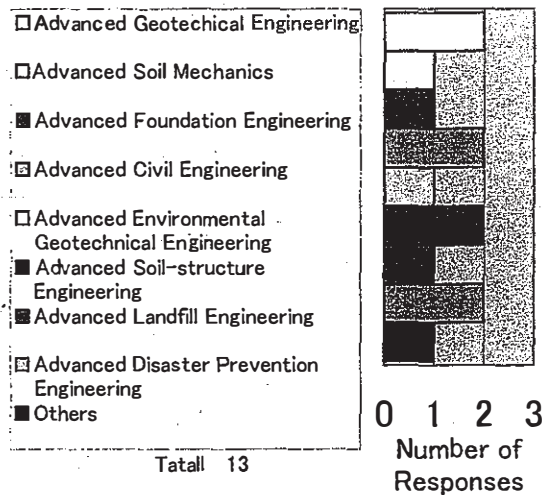


Figure 4. The name of subject where geosynthetics is taught in graduate course

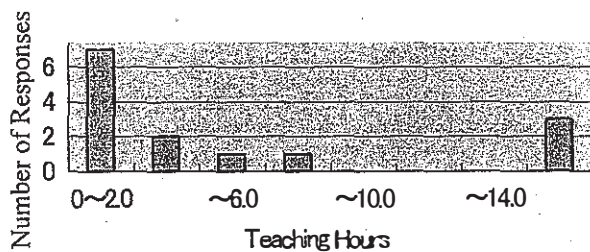


Figure 5. Distribution of hours spent for geosynthetics in one credit

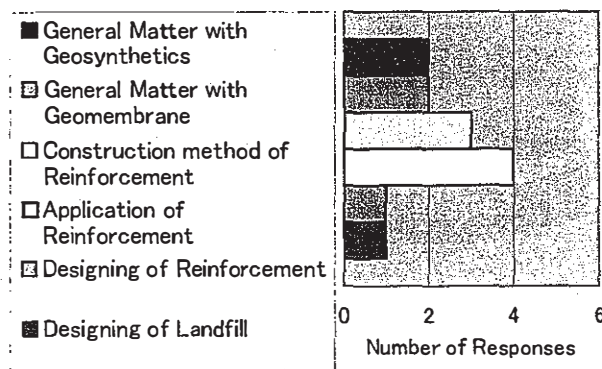


Figure 6. Distribution of the contents relating to geosynthetics in the subject.

3 GRADUATION THESIS, MUSTER'S THESIS AND DOCTRAL THESIS

3.1 Graduation Research

In Japan, undergraduate students at the fourth grade

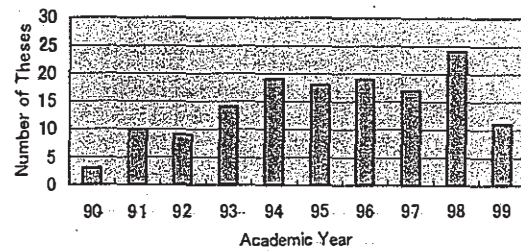


Figure 7. Number of graduate thesis submitted in academic year

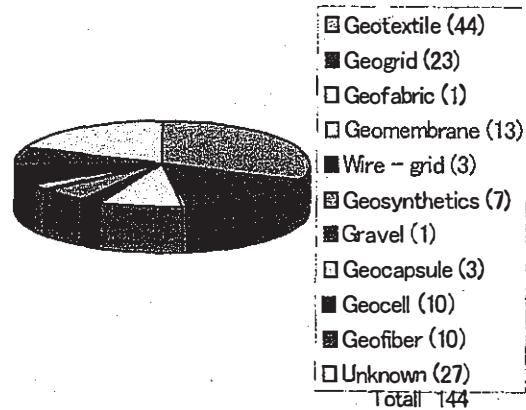


Figure 8. Types of geosynthetic used in the research for graduation

have to conduct a research for their graduation. In the questionnaires, the title of the graduation thesis which was conducted for last 10 years, from 1990 to 1999, was asked.

According to the responses, students in 16 departments have performed the research relating to geosynthetics. Total number of graduation theses is 144.

Figure 7 shows the number of graduation thesis relating to geosynthetics for these 10 years. About 20 students a year have been interested in this field since 1994. But the ratio to all the students who studied in the department of civil engineering and the related is only 0.2 %.

Figure 8 shows the distribution of the materials that were used in the research. The kinds of materials were presumed based on the terms found in the title of the thesis. From this figure, 44 students (31 %) studied about geotextiles, 23 students (16 %) about geogrid and 13 students (9 %) about geomembrane. Some students studied experimentally about properties of geosynthetics, such as frictional resistance or permeability. Others studied about the behavior of geosynthetics embedded in the ground.

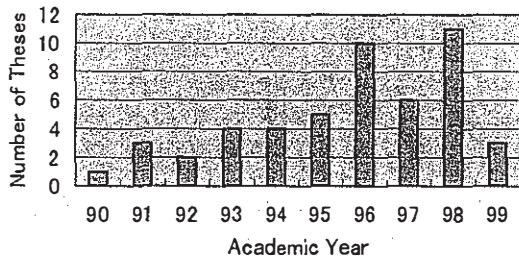


Figure 9. Number of theses for Master degree

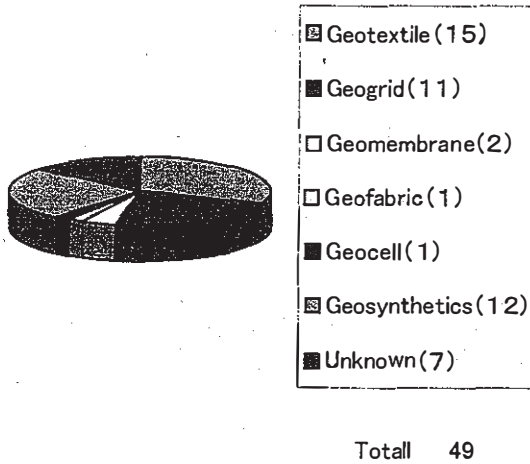


Figure 10. Types of geosynthetics in Master's theses

3.1 Master theses

Forty-nine graduate students have studied about geosynthetics in their master's research in last 10 years.

Figure 9 shows a change of the number of theses. Before 1996, a few students have been interested in geosynthetics. But after then the number increased a little. It can be said that about 10 students has, recently, conducted the research about geosynthetics.

The title of master's thesis was also surveyed in the questionnaire. Figure 10 shows the distribution of type of the material which was found in the title of theses. Fifteen students conducted the theme relating to geotextile and 11 students to geogrid. Unfortunately, 19 theses were not classified into any type of geosynthetics according to the titles.

Figure 11 indicates the engineering theme in which the master's students have engaged. Eleven students have studied about basic properties of geosynthetics such as frictional resistance on its surface (7 students, 14.3 %) and permeability of geotextile (4 students, 8.2 %). Twenty-three students have related to reinforcement. That is, 8 students studied about embankment on weak soil (16.3 %), 5 students retaining wall (10.2 %) and 5 students bearing capacity (10.2 %).

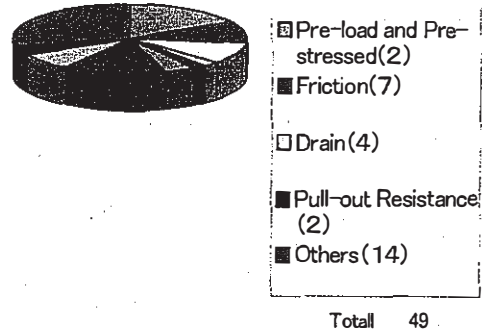


Figure 11. Engineering theme on which the Master thesis focused

3.2 Doctor theses

Fourteen students have got the Doctoral degree from 7 universities for last 10 years. The engineering problems that the student dealt in the thesis are shown in Figure 12. Reinforcement, embankment, bearing capacity and slope stability were focused on. There is one thesis which dealt with waste landfill.

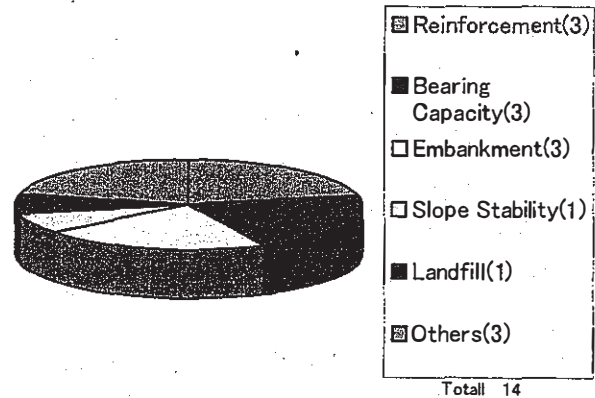


Figure 12. Engineering theme on which the Doctor theses focused

4. EQUIPMENTS AND DEVICES

Seventeen departments returned responses about equipments and/or devices applicable to geosynthetics that they possessed.

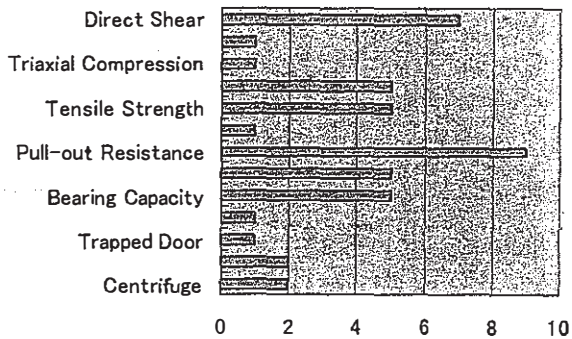


Figure 13. Types of equipment or device for geosynthetic study

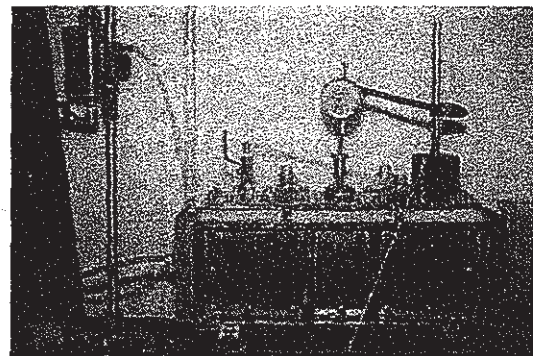


Photo 2. In-plane Permeability test meter for geotextile

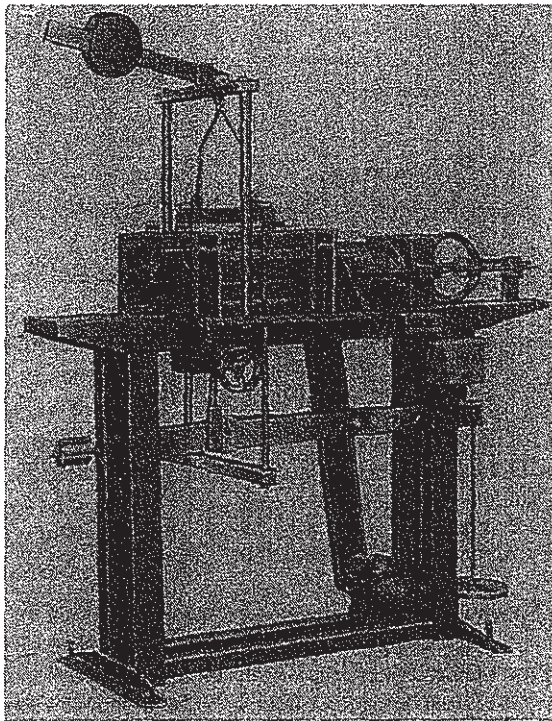


Photo 1. Direct shear test device to evaluate frictional resistance

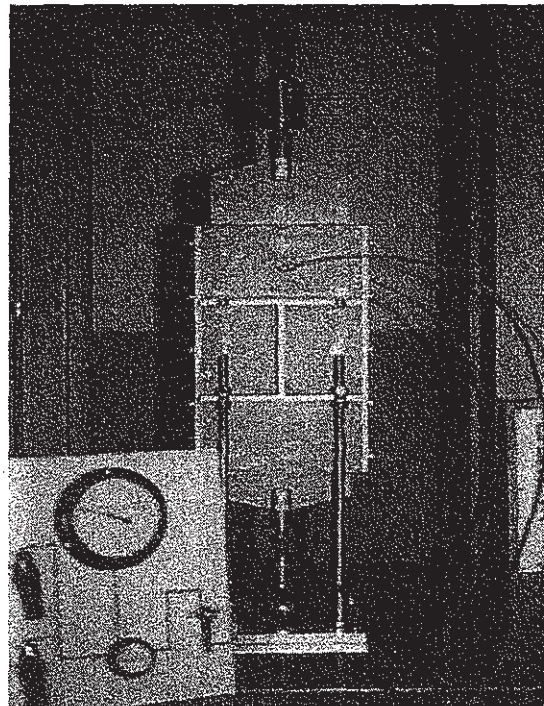


Photo 3. Tensile test equipment for geosynthetics embedded in soil

Figure 13 shows the types of equipments and the number. They were roughly grouped into two. One is for estimating the index properties of geosynthetics itself. Other is for understanding or measuring the behavior of the structure in which the geosynthetics were used.

The former includes direct shear test device to evaluate the frictional resistance (7 units), permeability test device (5 units), tensile test device (5 units) and others. Photo 1 shows direct shear test device with shear box of $0.3 \times 0.3 \text{ m}^2$. Photo 2 is a set-up of in-plane permeability test of geotextile which is acted by constrained pressure. Photo 3 shows a set-up of tensile test of geosynthetics which

is embedded in soil.

Relating to the latter, Pull-out test equipments (9 units), equipment for modeled reinforced wall (5 units), and equipments for the bearing capacity (5 units) are used for the research. They are shown in Photo 4 to 6.

5 EDUCATION IN COMPANY

In recent years, the works using the geosynthetics have been increased in number by many teaching materials. The publications about the geotechnical methods in which geosynthetics are used are more

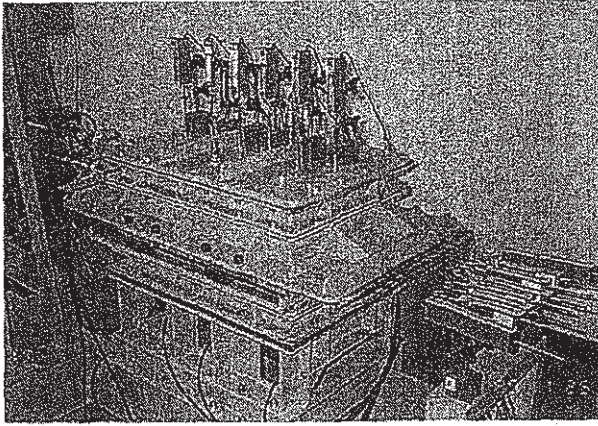


Photo. 4 Set up of pull-out test of geogrid embedded in soil

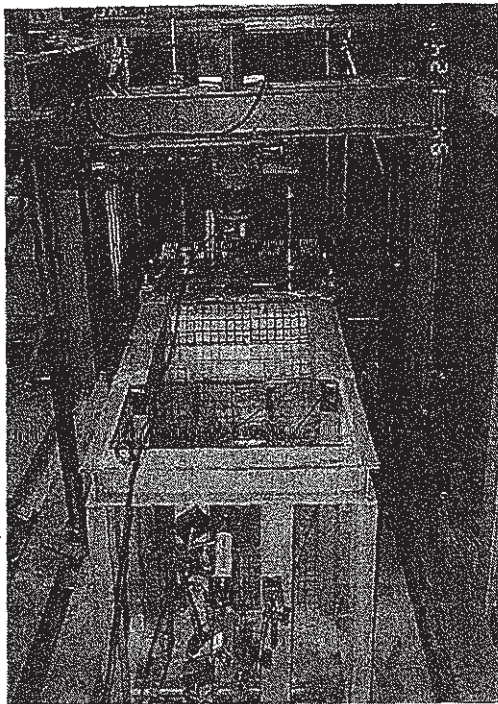


Photo. 5 Set up of stability test of steep slope reinforced by geogrid

than twenty. And a department of the earth reinforcement is a majority of them and is not less than two-thirds.

5.1 Activity of company

Nineteen companies which responded to our questionnaires include 4 general constructors, 12 manufactures, 2 consultants and 1 laboratory. The materials to be used for training of the staff and/or for explanation to the user are follows;

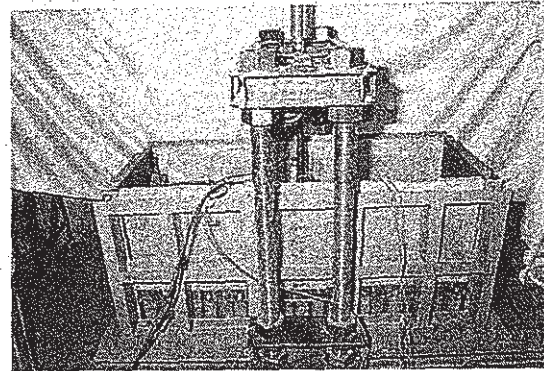
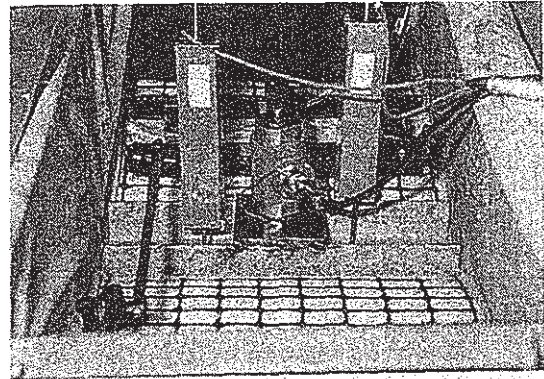


Photo. 6 Set up of bearing capacity test of foundation reinforced by geogrid

Catalog of the products	15 companies	(79%)
CD-ROM	1	5%
Video (10 titles)	6	(32%)
Data book	5	(26%)

5.2 Activity of Associations and Societies

The public education about the geosynthetics is positively carried into effect by The Japanese Geotechnical Society (JGS) and Japan Chapter of The International Geosynthetics Society (JIGS). For example, the seminars for beginners sponsored by the Education Committee of JIGS have been held annually since 1997. Its contents were as follows;

1997.7 (100 participants)

General by Prof. M.Fukuoka

Geosynthetics in Road by Mr. K.Iwasaki

Geosynthetics in Landfill by Prof. S.Imaizumi

1998.9 (80 participants)

Earth reinforcement by Prof. F.Tatsuoka

Drain of geosynthetics by Mr. K.Iwasaki

Geomembranes by Dr. K.Kumagai

1999.6 (50 participants)

Earth Reinforcement by Prof. F.Tatsuoka

Geomembranes by Dr. H.Arai

Earth Reinforcement by Dr. M.Tateyama

Floating Cover by Mr. Y.Higuchi

2000.9 (80 participants)

Earth Reinforcement by Prof. F.Tatsuoka
Earth Reinforcement by Prof. J.Koseki
Foundation by Mr. K.Nakamura
Landfill by Dr. T.Hirai
2001.9 (80 participators)
Case History by Prof. K.Kumagai
Geogrid by Mr. N.Toriumi
Geomembranes by Dr. T.Hirai
Earth Reinforcement by Prof. F.Tatsuoka

JCIGS published a textbook titled "Geosynthetics Primer" in July, 2001. This text is intended to serve understanding of geosynthetics and its applications of students and beginners of engineers. Its contents were as follows;

General/ Geotextiles/ Geogrids/ Geoknet/ Geocomposite/ PB DRAIN/ Block mat/ Geomembranes/ GCLs/ Geopipe

6 ACKNOWLEDGMENTS

The authors are grateful to many professors who kindly sent the response of the questionnaires, though they are sorry not to list the names. They also thank Professor N.Yasufuku at Kyushu University and Professor T.Nishigata at Kansai University who produced the pictures as shown in this report.