研 究 速 報
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Stress History During Sample Preparation for Triaxial Test II
——Test Results——
三軸試験用の供試体作成中の応力径路 II
——実験結果——

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Introduction

The stress paths measured during the stage of sample preparation will be shown. It was found that the details of testing procedures affect such stress paths considerably. A great care should be paid to control stress paths during the stage of sample preparation of sample if precise data of stress-strain behaviors of sand sample under a low confining pressure are needed.

An enlarged cap the diameter of which is larger than the diameter of sample is often used for triaxial compression tests with lubricated ends. In such a case, the inner diameter of the mold is smaller than the diameter of the cap. A method will be suggested to allow a free drop of the enlarged cap when a vacuum pressure is applied to a sand sample in a mold. This method was originally proposed by Mr. Tadokoro and Mr. Fukushima, Institute of Industrial Science, the University of Tokyo.

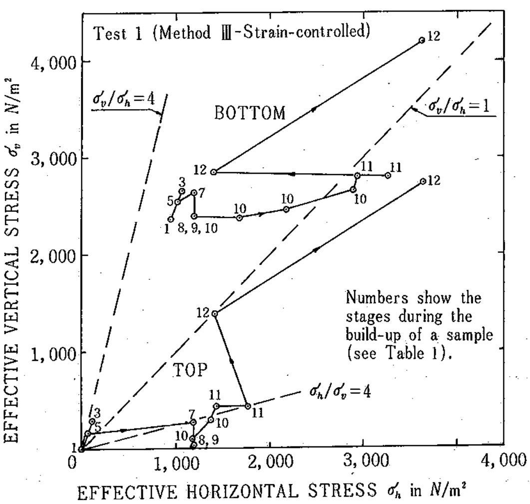

Fig. 8　Stress path during build-up of sample in Test 1

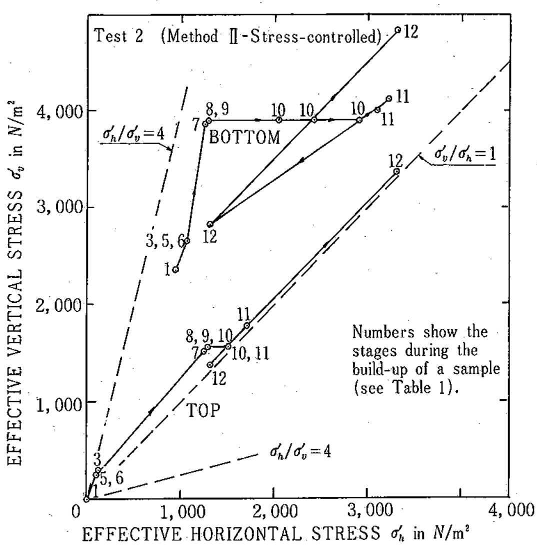

Fig. 9　Stress path during build-up of sample in Test 2

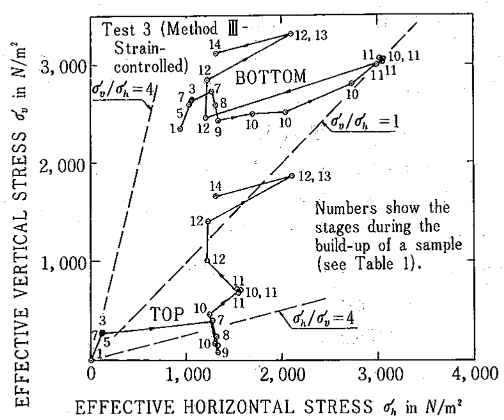

Fig. 10　Stress path during build-up of sample in Test 3

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Table 1　Procedure of sample preparation

<table>
<tr><th>Method / Stage</th><th>I</th><th>II</th><th>III</th></tr>
<tr><td>1</td><td colspan="3">Pour sand into mold and finish the top surface.</td></tr>
<tr><td>2</td><td>$(\sigma_v)_{TOP} = 20.0kN/m^2$
P = 68N</td><td></td><td></td></tr>
<tr><td>3</td><td colspan="3">← $(\sigma_v)_{TOP} = 0.29kN/m^2$
P = 1N →</td></tr>
<tr><td>4</td><td colspan="3">Set displacement transducers and displacement control　(Clamp vertical displacement)</td></tr>
<tr><td>5</td><td colspan="3">← Sealing →</td></tr>
<tr><td>6</td><td colspan="2">Stress control (Unclamp vertical displacement)</td><td></td></tr>
<tr><td>7</td><td colspan="3">Release the vacuum to mold and apply a vacuum of $1.176kN/m^2$ or $12cmH_2O$ and measure sample dimensions.</td></tr>
<tr><td>8</td><td colspan="3">← Remove mold →</td></tr>
<tr><td>9</td><td colspan="3">← Assemble triaxial cell →</td></tr>
<tr><td>10</td><td colspan="3">← Fill cell water →</td></tr>
<tr><td>11</td><td colspan="3">← Replace vacuum with cell air pressure →</td></tr>
<tr><td>12</td><td colspan="3">← Saturate sample →</td></tr>
<tr><td>13</td><td colspan="3">← Connect "balance" to sample →</td></tr>
<tr><td>14</td><td></td><td></td><td>Stress Control (Unclamp vertical displacement)</td></tr>
<tr><td>15</td><td colspan="3">← Increase cell air pressure to $20kN/m^2$ →</td></tr>
<tr><td>16</td><td colspan="3">← Triaxial compression test →</td></tr>
</table>

Table 2　Test Conditions

	Method	Diameter (mm)	Height (mm)	Dry weight (g)	Void ratio (e)	Grease Thickness	
						TOP	BOTTOM
TEST 1	III	67.01	150.705	809.90	0.739	60.2μm	64.5μm
TEST 2	II	66.64	149.622	808.20	0.711	84.0μm	57 μm
TEST 3	III	66.60	150.102	816.20	0.697	92.4μm	70 μm

$G_s = 2.65$

Test Results

The procedures of sample preparation dicussed in the prevous paper[1)] is summarized in Table 1. Three tests were performed (see Table 2).

These are: Test 1——Method III,
Test 2——Method II, and
Test 3——Method III.

The stress paths during the stages 1 through 14 are shown in Figs. 8 through 10. For the stages 1 through 6, a K_0-value of 0.4 is assumed. It can be seen from Figs. 8 through 10 that the stress paths can be quite different among the different sample preparation methods. In Method III where the vertical movement of cap was fixed during the major portion of sample preparations, the triaxial extension stress condition was induced to a much larger extent than in Method II where the cap was free to fall if necessary. In particular, in Method III, by the application of vacuum and also by additional disturbances, the stress condition at the top became really critical. At this moment, some top portion of the sample was in the plastic equilibrium condition. Compared to this, in Method II the stress condition even at the top of the sample was always in the triaxial compression stress condition. Furthermore, the maximum value of σ'_1/σ'_3, which was achieved at the bottom just after the application of vacuum, was much less than that in Method III.

Suggestions for Future Work

The test results shown in this report should be considered as preliminary ones. More detailed and comprehensive tests will be necessary after modifying the apparatus and testing procedures to obtain a whole picture of the stress and strain histories during building-up a sample and its effects on the stress-strain behaviours during the following shear stages. In particular, the lateral strains of a sample were not measured in these tests.

A Method to Allow "Free Drop" of Enlarged Cap During Application of Vacuum to Sample

(1) Counterbalance the cap and the loading rod which are fixed together (Fig. 11).

(2) Prepare the "mold system" as shows in Figs. 12(a) and 12(b), which consists of the parts shown in Fig. 13;

1. *Split brass mold*; originally made for "straight" samples where both the cap and pedestal and the sample have the same diameter of 75 mm (Fig. 15).

2. *Split acryl cylinder*; to reduce the inner diameter of the mold from 75 mm to 70 mm. The cap and the pedestal have a diameter of 75 mm.

3. *Enlarged lubricated ends of acryl*; having a diameter of 75 mm.

4. *Latex membrane*; having a diameter of 68 mm which is slightly less than the inner diameter of the acryl split cylinder. The difference between 68 mm and 70 mm gives a very small confining pressure σ_c^* to a sample having a diameter of 70 mm; namely

$$\sigma_c^* = \frac{2 \times t \times E \times 2/70}{d} = 0.0038\ \mathrm{kgf/cm^2},$$

where t is the thickness of latex membrane (0.03 cm), E is the Young's modulus of latex membrane (15.5 kgf/cm^2), and d is the diameter of sample (7.0 cm). This small confining pressure σ_c^* will be helpful to support the sample located at the "gap" as described latter.

5. *Collar*, having an inside diameter of 70 mm,

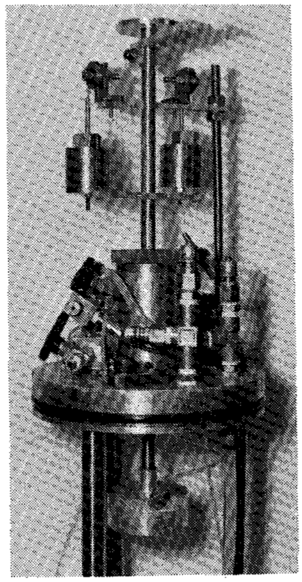

Fig. 11 Top of triaxial cell

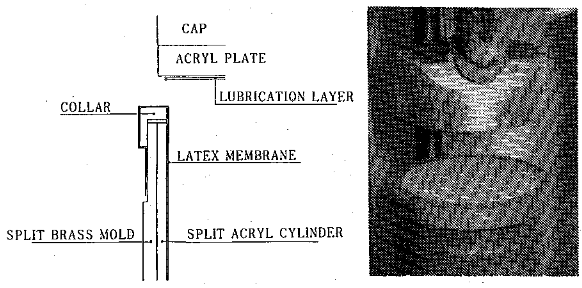

Fig. 12 (a) Top surface of sample smoothened, and (b) details of arrangement for making "enlarged cap"

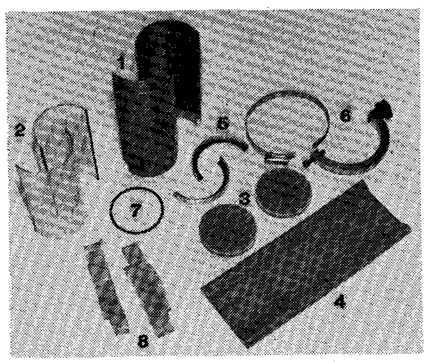

Fig. 13 Tools needed to make "enlarged cap"

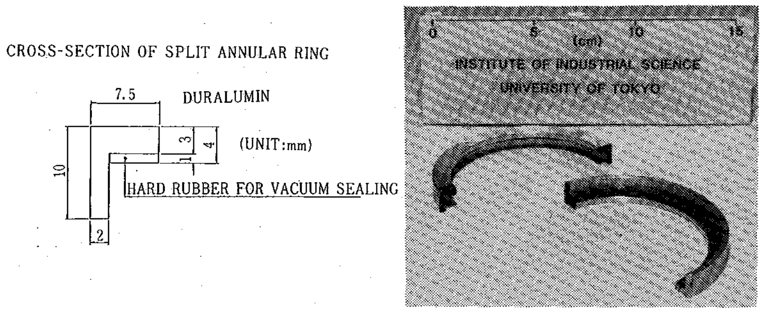

Fig. 14　Detailed figure of collar

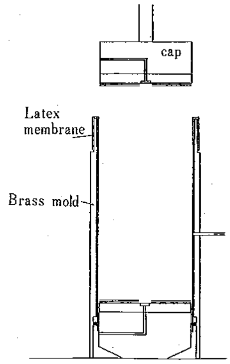

Fig. 15　Arrangement to make "straight sample"

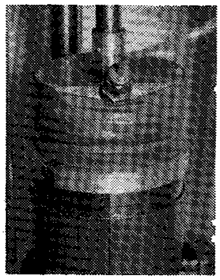

Fig. 16　Sealing with cap being fixed

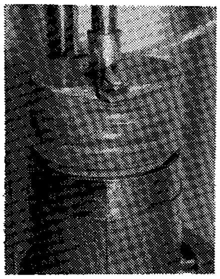

Fig. 17　Removing collar under no vacuum

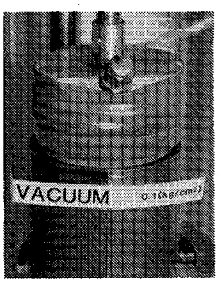

Fig. 18　Application of vacuum with free drop of cap

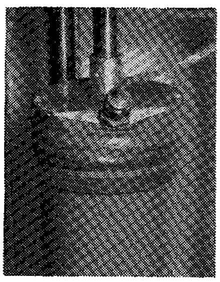

Fig. 19　After removing of mold

prepared in order to make a free gap of 4 mm between the bottom face of the acryl top end platen and the top end of the brass mald (see Fig. 14). The collar consists of a split annular ring of duralumin and annular rubber sheet attached to it. The rubber sheet is for sealing of vacuum which is applied to the void between the latex membrane and the mold.

6. *Tools*, to fix the mold in place,

7. *O-ring*, and

8. *Latex membrane bands*, to use for sealing around the cap and the pedestal.

(3) Fill the sand up to the top of the mold system (see Fig. 12) and smooth and flat the sand surface.

(4) Place the cap on the sand surface, with the seating stress being a vemy small value, say 3 gf/cm^2.

(5) Clamp the loading ram.

(6) Seal the menbrane to the top cap (see Fig. 16).

(7) Unclamp the loading ram.

(8) Remove the collar carefully (see Fig. 17). It can be considered that the most of the sand mass located between the bottom surface of the top acryl platen and the level of the top end of the brass mold is not disturbed, although some amount of the sand mass adjacent to the unsupported latex membrane may be in the critical stress condition (in the active earth pressure condition). This can be expected because the free gap is only 4 mm and some friction may exist between the top lubricated end and the sample under a so low normal stress of 3 gf/cm^2.

(9) Apply a vacuum to the sample. The vacuum for the case shown in Fig. 18 was 0.1 kgf/cm^2. Because of the presence of the free gap, it can be expected that the top cap falls freely when the vacuum is applied.

(10) Disassemble the brass mold (Fig. 19). So far in all the cases, the top corners of the sample were in good shapes; the appearance of the surface of sample at the top corners looked very smooth and having the same diameter as at the lower portions of sample.

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Reference

1) Tatsuoka, F., Molenkamp, F., Deventer, V.J., Pedersen, A. and Smith, L., "Stress History during Sample Preparation for Triaxial Test I (Discussions on Test Procedure." Seisankenkyu, Vol. 35, No. 7, pp. 340., 1983.