圃場試験法　　Farm Machinery Testing for Farm Mechanization

TEST CONDITION

Institute of Agricultural Machinery (IAM)
Bio-Oriented Technology Research Advancement Institution (BRAIN)

Tsukuba International Centre (TBIC)
Japan International Cooperation Agency (JICA)

Testing and Evaluation of Agricultural Machinery

TEST CONDITION

I CONDITION OF SEED AND FERTILIZER

II CONDITION OF FIELD

Soil Management Machinery Laboratory
Crop Production Machinery and System Department

Agricultural Machinery Testing and Evaluation Course
Institute of Agricultural Machinery (IAM)
Bio-oriented Technology Research Advancement Institution (BRAIN)

I TEST CONDITION OF SEED AND FERTILIZER

1. Seed

(1) Crop name and variety

(2) Weight per 100 or 1000 grain

It is usually used in the calculation of 'Ratio of established plants to seed planted' in the test of small seed crops.

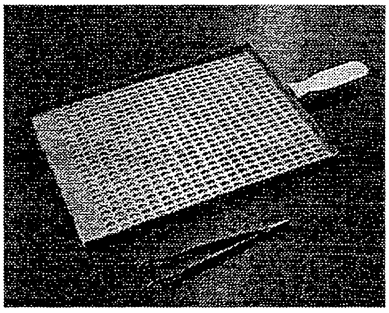


Fig. I -1-1 Grain Counter

(3) Germination rate in the laboratory

Germination rate is measured by counting the number of germinated seeds in a laboratory dish in which filter papers are laid and water is supplied.

Usually the laboratory dishes are put into an incubator at 25-30℃.

Ratio of germinated seeds to all seeds after three days is called 'germination rate'.

Same ratio after ten days is called 'germination percentage'.

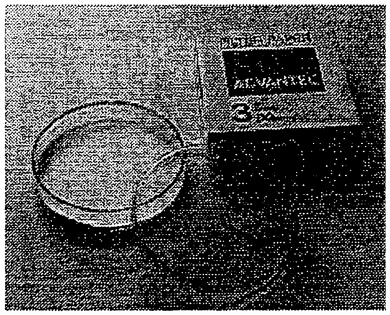


Fig. I -1-2 Laboratory Dish

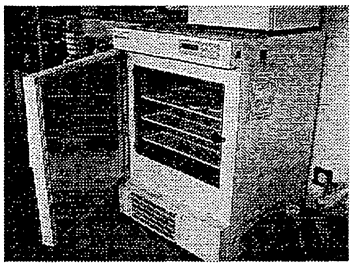


Fig. I -1-3 Incubator

(4) Bulk density

It is measured by filling the material in the cube or cylinder of which the volume and weight is known.

(5) Three dimentional diameter

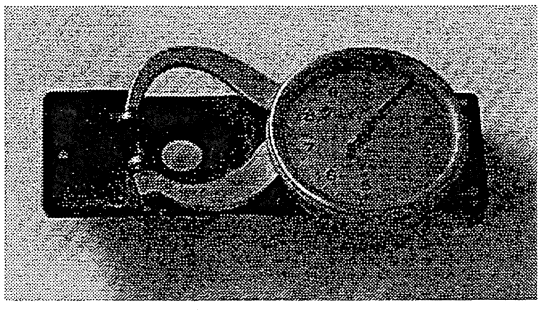


Fig. I -1-5 Dial Caliper
(Three dimensional diameter)

2. Fertilizer

(1) Distribution of granule size

It is measured by shieving. (1.0, 2.0, 2.8, 4.0mm). Shieving shall be carried out using an machanical sieve shaker. Sieving time shall confort to the instructions by the sieve shaker manufacturer.

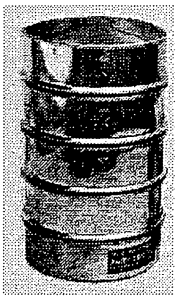


Fig. I -2-1 Meshy Sieve

(2) Bulk density

(reference Fig. I -1-4)

(3) Angle of repose

There is a matural relation between the angle repose and the discharging rete in some kinds of fertilizer distributors which meter fertilizers by an adjustable gate or openings.

In BRAIN I.A.M. angle of repose of granular fertilizer is measured as shown.

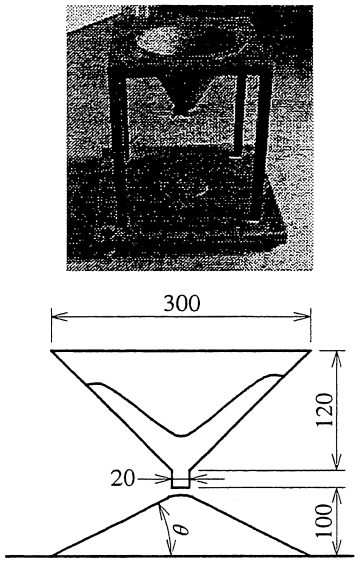


Fig. I -2-2 Angle of Repose Measuring Method (pouring method)

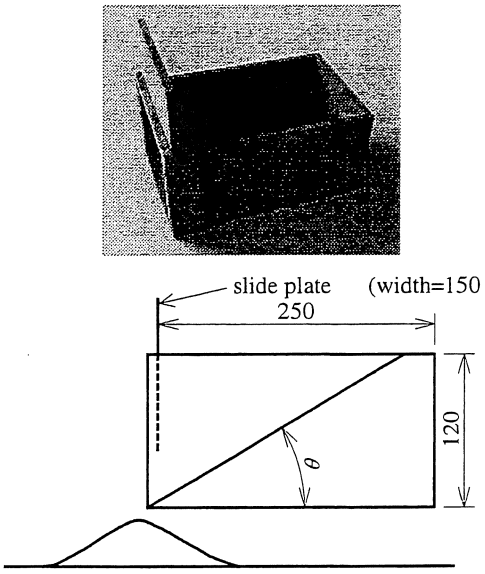


Fig. I -2-3 Angle of Repose Measuring Method (discharging method)

(4) Hardness

Hardness of fertilizers has influence on the crush of fertilizers. Hardness of granular fertilizer is sometimes measured by hardness measuring apparatus.

(5) Water content

Water content og granular fertilizer is measured by drying 5 hours at 100℃.

(4 hours at 75 ℃ in urea containing fertilizer)

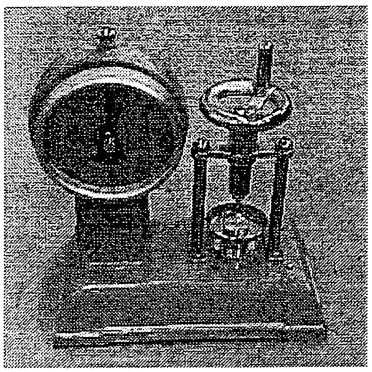


Fig. I -2-3 Hardness Tester

Ⅱ TEST CONDITION OF FIELD

— Test items and instruments —

1. Soil Analysis

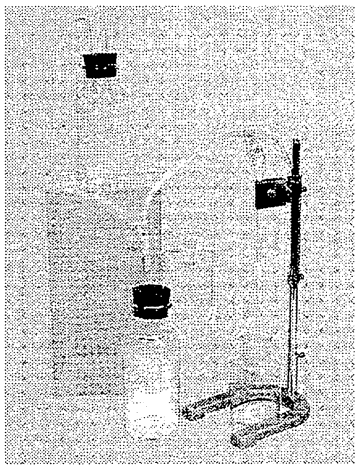
The results of perticle size analysis of soil is used to define soil texture,and the soil structural condition has a profound infuluense on water movement and on gaseous exchange,both process being of great importance to plant grouth.

In genrally, the evaluation of soil structure are performed on the results of aggregate analysis and mechanical particle analysis.

Perticle size analysis	(clay, silt)	Pipete method
		Hydrometer method
	(gravel, coarse sand)	Sieving method
	(fine sand)	Beaker method
Soil aggregate analysis	Aggregate analysis	Submerged sieving method
		Sedimentation method
		Washing method
	Clod Analysis	Sieving method

(1) Perticle size analysis

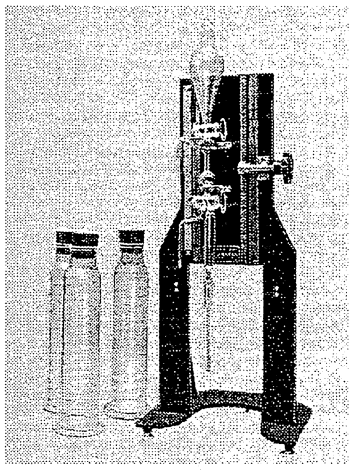
DIK-2020



Perticle Size Analyzer
(pipette method)

Sieving method is used for analyzing the particle size distribution which is made the soil disperse individual grain, but in case of analyzing such a fine particle size as not sieving, pipette method is suitable.

DIK-2030



Perticle Size Analyzer
(pipette method)

In case of sieving such a fine grain as a silt or a clay, make the soil grain sinked in a still water and sieved them by taking difference of sedimentation speed due to size of grain.

Fig. Ⅱ-1-1 Particle Analyzer

DIK-2050

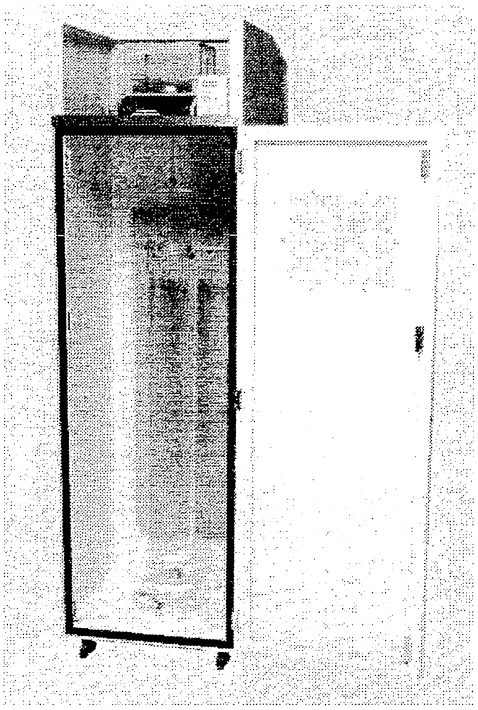
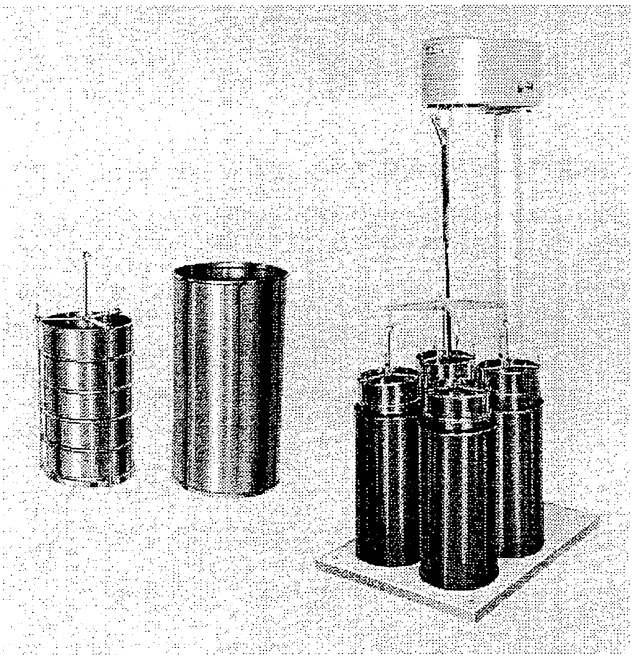


Fig. Ⅱ-1-2 Perticle Size Analyzer

This instrument analyzes a primary particle of soil. Remarking that it makes difference of soils sedimentation speed depending on size of soil grain, this is produced to measure the time taken soil particle's sinking in a certain situation and weigh the quantity of soil particle by electric balance and personal computer, then analyze these data automatically.

(2) Aggregate analysis

DIK-2000



DIK-2010

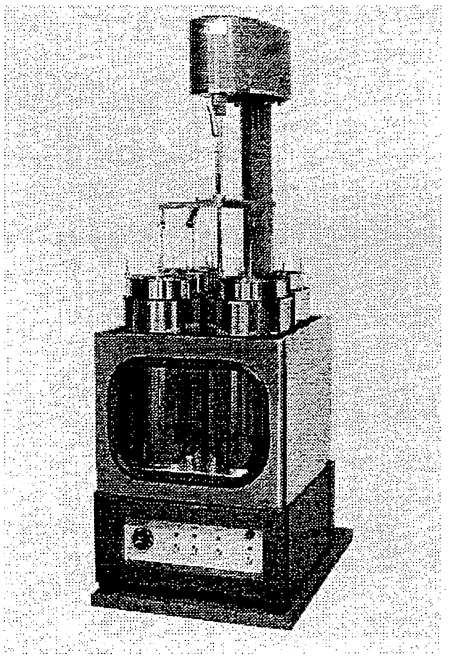


Fig. Ⅱ-1-3 Aggregate Analyzer

By analyzing soil aggregate, the quality of soil structure can be judged. Put soil samples in sets of 5 standard meshy sieve and analyze them per each sieve into the analyzing water tank by giving constant rotation and stroke with up and down moving.

(3) Clod Analysis

Fig. Ⅱ-1-4 Meshy Sieve

DIK-2400,2410,2430,2450

particle size mm	2.0	0.2	0.02	0.002
International Society of Soil Science	gravel G	coarse sand CoS	fine sand FS	silt Si	clay C
Japanese Society of Agricultural Sciences	gravel	coarse sand	fine sand	very fine sand	clay
		0.25	0.05	0.001
Japanese Industrial Standard	gravel	coarse sand	fine sand	silt	clay	colloid
				0.05	0.001
US Department of Agriculture	gravel	① ② ③	fine sand ④	silt	clay
		0.5	0.1		
England	gravel	coarse sand	fine sand	silt ⑤	clay
		1.0	0.2	0.04	0.25
U.S.S.R.	stone	gravel	② ③	fine sand	coarse silt	⑥ fine silt	⑦ ⑧	0.0005 ⑨
	0.25		0.5 0.25	0.05		0.005	0.001	0.0001

① quite coarse sand ② coarse sand ③ medium sand ④ quite fine sand
⑤ quite very fine sand ⑥ medium silt ⑦ Coarse clay ⑧ fine clay ⑨ colloid

Fig. Ⅱ-1-5 Classification of Primary of Soil

HC : heavy clay
SC : sand clay
LiC : light clay
SiC : silty clay
SCL : sand clay loam
CL : clay loam
SiCL : silty clay loam
SL : sandy loam
L : loam
SiL : silt loam
LS : loamy sand
S : sand

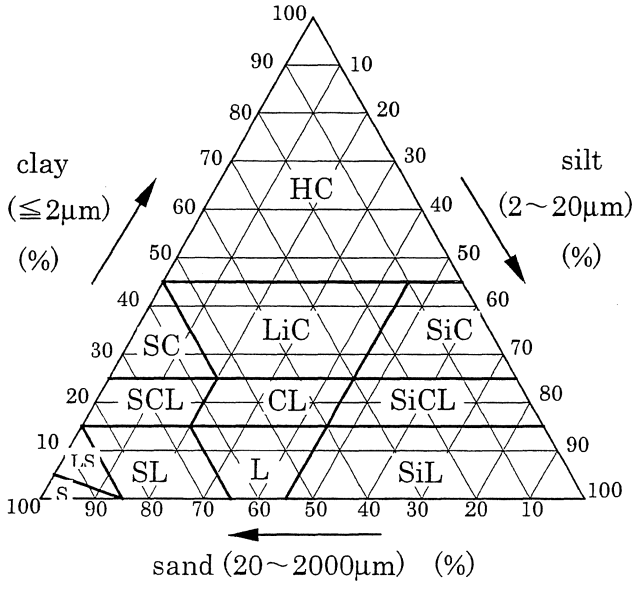
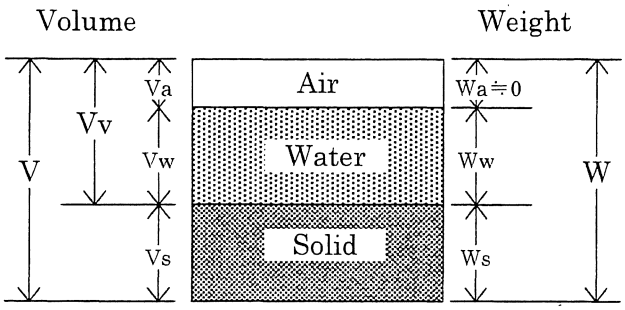


Fig. Ⅱ-1-6 Division of soil texture

2. Soil Three Phase

The soil three phase distribution is a most important factor relating to soil fertility, and it is a necessary theme in soil diagnosis.



Void ratio	e	=	Vv/Vs
Porocity	n	=	Vv/V
degree of saturation	Sr	=	Vw/Vv
water content	w	=	Ww/Ws
weight water content	w'	=	Ww/W
Volumetric water content	θ	=	Vw/V
Specific gravity of solids	Gs	=	Ws/Vsγw
unit weight of soil	γ	=	W/V
unit weight of water	γw	=	(≒1t/m^3)

Fig. Ⅱ-2-1 Modal of Soil Three Phase

DIK-1801

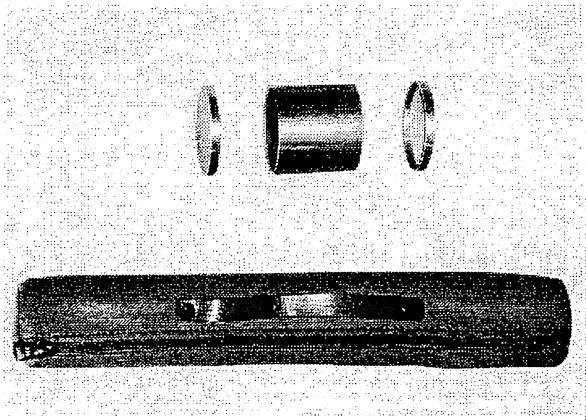


Fig. Ⅱ-2-2 Stainless Sampling Tube

By setting a sampling tube of 100ml to the soil sampler, gather soil up to 20cm in depth into the sampling tube without destroying the soil structure.

DIK-1600

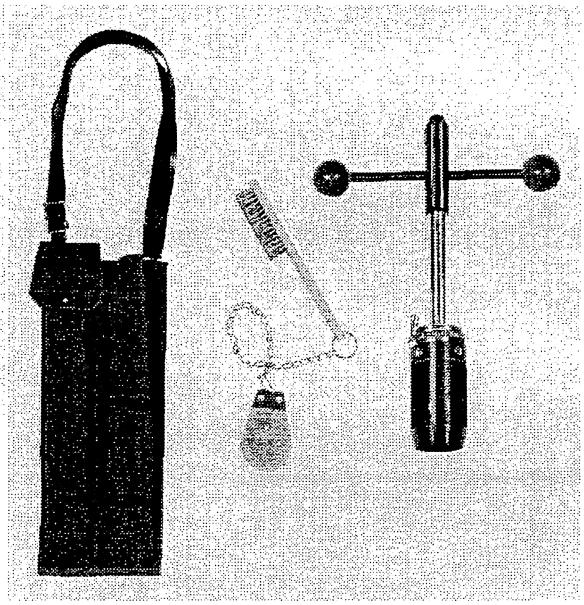
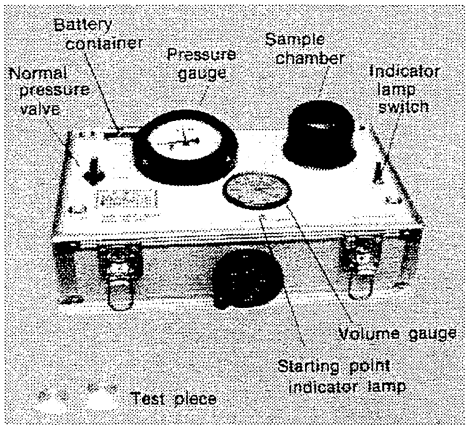


Fig. Ⅱ-2-3 Soil Sampler

DIK-1120



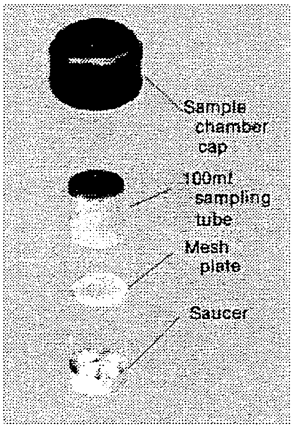
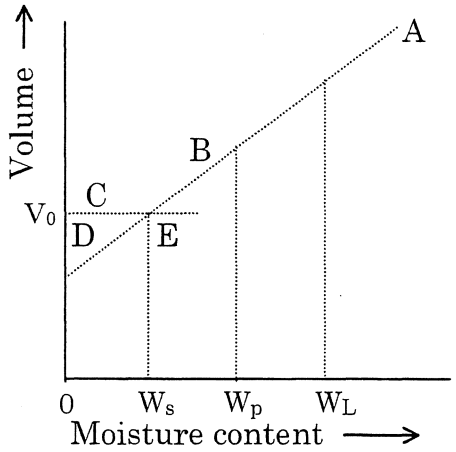


Fig. Ⅱ-2-4 Three Phase Meter

This meter is made to measure actual volume (solid phase + liquid phase) and air phase volume of 100ml soil promptly in the field

3. Liquidity Index



W_S : shrinkage limit (S.L.)

W_P : plastic limit (P.L.)

W_L : liquid limit (L.L.)

Fig. Ⅱ-3-1 Consistency Limit

(1) Plasticity Index (S.I. : I_p)

$I_p = W_L - W_P$

(2) Consistency Index (I_C)

$I_C = W_L - W / I_p = W_L - W / W_L - W_P$

(3) Liquidity Index (P.I. : I_L)

$I_L = W - W_P / I_p = W - W_P / W_L - W_P$

DIK-5700

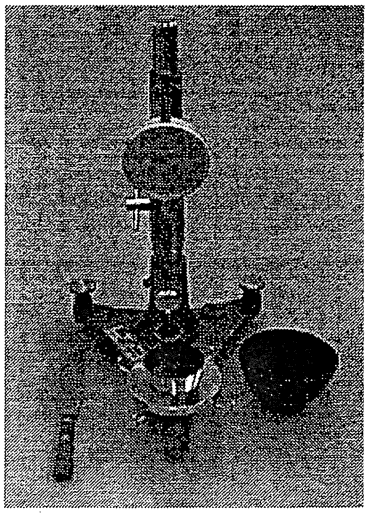


Fig. Ⅱ-3-2 Liquid Limit Tester (fall-cone method)

This tester makes the cone with specified tip angle and weight fall freely into the sample surface of the soil by its own weight reached the desired value and then obtain the moisture ratio of the sample to be the index of this tester and be it the liquid limit.

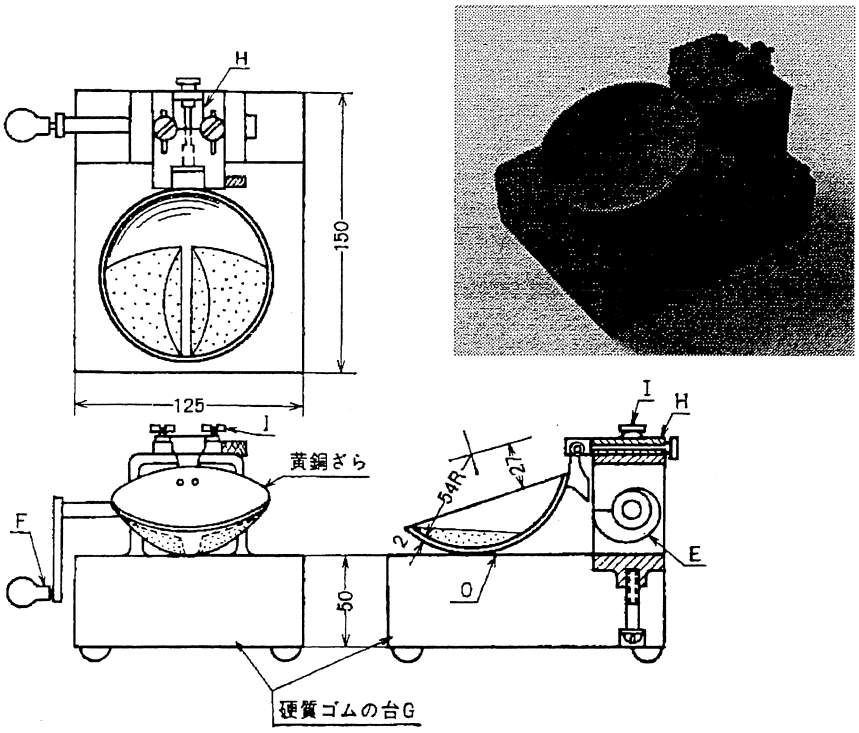


Fig. Ⅱ-3-3 Liquid Limit Tester (JIS* 1205)

*JIS : Japanese Industrial Standard

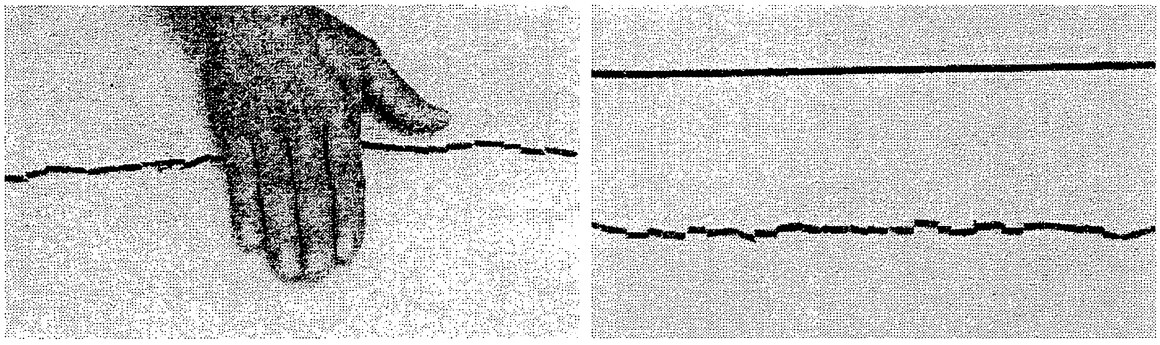


Fig. Ⅱ-3-4 Plastic Limit Test Method (JIS* 1206))

MANUFACTURER

Daiki Rika Kogyo Co.,Ltd.
60-3 Nishiogu 7-chome, arakawa-ku, Tokyo, 116 Japan.
TEL 03-3810-2181 FAX 03-3810-2185

DIK-2020, DIK-2030, DIK-2050, DIK-2000, DIK-2010, DIK-1801
DIK-1600, DIK-1120, DIK-5700, DIK-5520, DIK-5550, DIK-2010

4. Soil Hardness

(1) Penetrating Resistance

DIK-5520

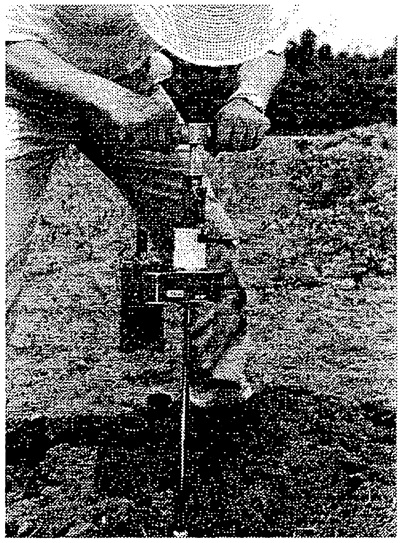


Fig. Ⅱ-4-1 Cone Penetrometer
(Automatic drum rotary recording system)

This penetrometer records penetration resistance (kg/cm²) in depth continuously by penetrating the cone into the soil.

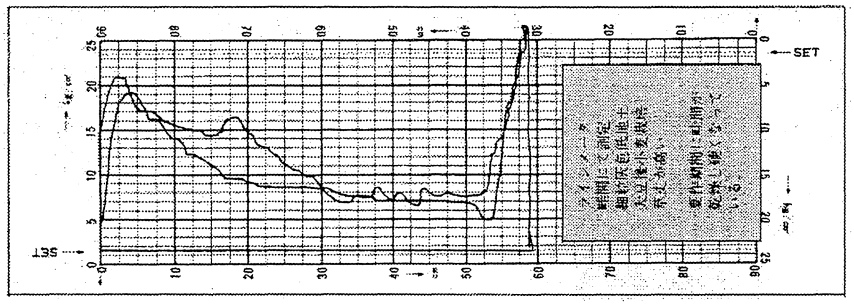


Fig. Ⅱ-4-2 Sample Data of Penetrometer Profile

DIK-5551

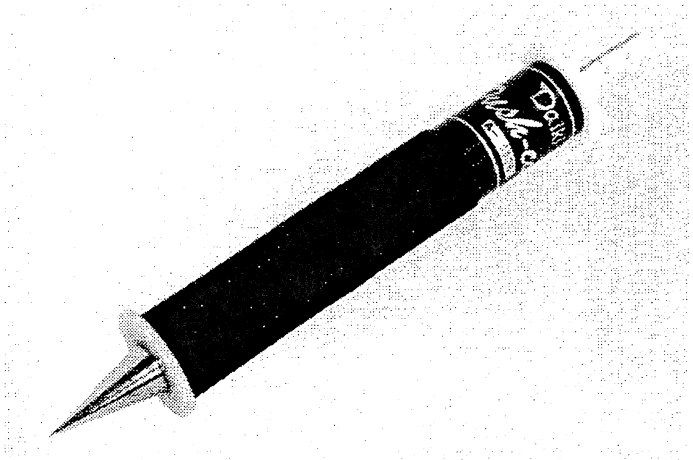


Fig. Ⅱ-4-3 Soil Hardness Meter , "Push-Cone"

The Push-Cone can measure a resistance value of soil (kg-cm²) easily by pushing the cone vertically into the soil profile scraped

(2) Shearing Resistance , Friction Resistance (Internal friction angle , Cohesion)

DIK-2010

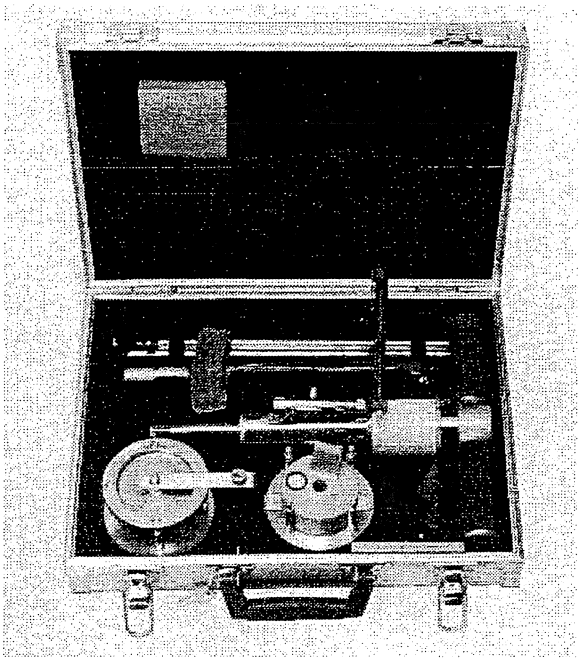


Fig. Ⅱ-4-4 Soil Penetrometer , SR-2 type

This penetrometer is used to predict trafficability of agricultural machinery travelling on the ground and resistance of work machinery that are indispensable to agricultural work.

By measuring penetrating resistance , rectangular sinkage,shearing resistance or friction resistance, sinkage and traction of traveling parts and resis-tance of work machinery can be calculated.

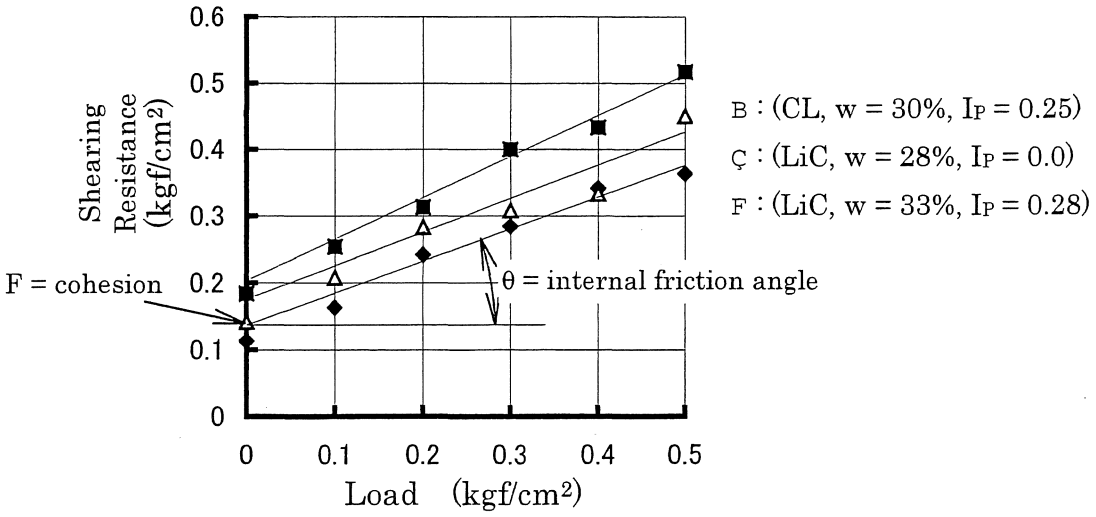


Fig. Ⅱ-4-5 Relation between vertical load and Shearing Resistance


Japan
International
Cooperation
Agency
国際協力事業団