AD-A157 842 EVALUATION OF THE SELF-BORING PRESSUREMETER IN SANDS (U) CENTRO DI RICERCA IDRAULICA E STRUTTURALE MILAN (ITALY) R BELLOTTI ET AL. MAY 85 R/D-4227-EN-01 1/1

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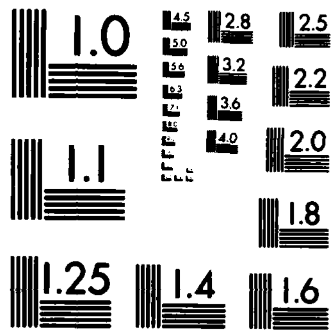

MICROCOPY RESOLUTION TEST CHART

DARDS-1963-A

R+D-4227-EN-01

Research Project:

"Evaluation of the Self-Boring Pressuremeter in Sands"

(2)

Principal Investigators:

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DAJA 45-84-C-0034

SECOND INTERIM REPORT

(Jan.1985 through May 1985)

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1. Present Research Status

This report describes the work performed under the writers supervision during the period of time from January to May 1985:

a. Eleven SBPT's in Ticino sand (TS) whose results together with those of the first test run on Hokksund sand (HS) are summarized on Table 1. All these tests have been performed using the ideal installation procedure consisting of the following steps:

- the SBP is placed in the calibration chamber (CC);
- the specimen is constructed by means of pluvial deposition;
- the specimens are then stressed under 1-D conditions according to the desired stress history;
- the pressuremeter test is performed with three unload-reload loops during the expansion phase and one reload-unload loop during the unloading phase.

b. It has been discovered during the 1-D stressing that the three Camkometer strain arms are subjected to a pronounced mechanical compliance which is responsible, according to the writers opinion, for the following highly undesirable phenomena:

- the observed lift-off pressure (p_o) does not correspond to the applied horizontal boundary stress σ_o: The difference ($p_o - \sigma_{h_o}$) increases with an increase of relative density (D_R) and with the magnitude of the stress applied to the specimen; see Figs. 1 to 3.
- The lift-off of the three strain arms does not occur simultaneously.

In view of these compliance problems, a number of simple checks on the Camkometer strain arms have been performed. These results have been summarized in Figs. 4 and 5. They indicate that all the previously described discrepancies observed between p_o and σ_{h_o} in field measurements probably could be attributed to the above examined mechanical compliance problems [Ghionna et al. (1981), Dalton and Hawkins (1982), Benoit (198[illegible]) .

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c. It was decided to expand the present research programme with a number of flat dilatometer tests |Marchetti (1980)| performed in the CC. The aim was to investigate the reliability of this device to deliver information about the existing in situ lateral stress σ_{h_o}. The results of these tests are summarized on Table 2. Fig. 6 shows the comparison between K_o yielded by the DMT, evaluated according to Schmertmann (1983) procedure, and those resulting from the stress applied on the specimen boundaries.
These tests have been performed simulating field conditions; the dilatometer has been inserted into the CC specimen after 1-D stressing and then the DM expansion has taken place.

d. A series of shear tests on both TS and HS have been performed using the Bishop type ring shear apparatus with the aim of assessing the "constant volume" angle of shearing resistance ϕ'_{cv} of the test sands. The results obtained up to now yielded:

$$\text{TS :} \quad 33° \leq \phi'_{cv} \leq 34°$$

$$\text{HS} \quad 33° \leq \phi \quad \leq 35°$$

2. Research Plans

The plans for further research activity are summarized as follows:

a. Modifications to the existing strain arms will be made in order to eliminate or at least to reduce drastically their mechanical compliance. The modifications will consist mainly in :

- modifying the existing pivot by inserting into a it a miniature roller bearing;
- making new strain arms of stainless steel in order to obtain much mor rigid "beam" elements;
- changing the arms' support in order to eliminate their torsional and flexural deformation under applied external pressure.

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b. Repetition of the tests on which a large difference between p_o and σ_{h_o} has been observed using the modified probe.

c. Execution of the additional DMT's for investigating the influence of the CC size and boundary effects on the tests results.

d. Conversion of the self boring device to use compressed air for inserting the Camkometer probe into the CC specimens.

e. Analysis of the previously available SBPT's in relation to their possible use in practice.

f. Triaxial and direct shear tests on pluvially deposited specimens of the test sands used, in order to improve their geotechnical characterization.

Table 1

SBPT's Results

Test No.	Sand -	γ_d t/m^3	D_R %	σ'_v kPa	K_o -	OCR -	p_o^* kPa	G_{ur}^{**} MPa
201	HS	1.638	67.0	112.8	0.662	2.8	76.2	47.7
207	TS	1.563	43.9	109.9	0.586	3.3	65.1	44.0
208	TS	1.510	43.2	112.8	0.400	1	28.1	25.2
209	TS	1.528	49.2	116.7	0.441	1	46.1	34.5
210	TS	1.541	53.3	511.1	0.479	1	81.2	75.8
211	TS	1.586	67.4	512.1	0.473	1	58.1	72.5
212	TS	1.577	64.6	110.8	0.747	2.9	104.4	48.0
213	TS	1.523	47.5	112.8	0.740	2.8	120.4	48.0
214	TS	1.507	42.4	112.4	0.476	1	49.3	32.3
215	TS	1.672	92.3	514.6	0.439	1	254.6	93.8
216	TS	1.519	46.3	60.9	0.927	7.7	73.4	41.0
218	TS	1.579	65.3	71.5	0.990	7.7	80.3	45.9

* Lift-off pressure as read, in order to obtain the applied boundary lateral stress σ_{ho}, multiply σ'_v times K_o

** First unload-reload cycle

Table 2

DMT'S Results

Test No.	Sand -	γ_d t/m^3	σ'_v kg/cm^2	K_o -	OCR -	p_o kg/cm^2	p_1 kg/cm^2	K_D -	BC -
97	TS	1.628	1.16	0.445	1	3.95	12.33	3.405	B-1
98	TS	1.669	1.14	0.448	1	6.52	18.44	5.719	B-1
99	TS	1.676	1.13	0.758	2.8	10.75	25.13	9.513	B-1
100	TS	1.628	1.15	0.762	2.8	6.78	16.97	5.896	B-1
101	TS	1.626	1.12	0.585	1.5	5.03	13.90	4.491	B-1
102	TS	1.500	1.11	0.529	1.0	4.07	11.96	3.667	B-1
103	TS	1.534	1.12	0.586	1.5	3.55	10.35	3.170	B-1
104	TS	1.532	1.14	0.780	2.8	4.21	12.18	3.693	B-1
105	TS	1.539	3.20	0.490	1	8.39	20.20	2.622	B-1
106	TS	1.535	1.14	0.470	1	4.53	13.25	3.974	B-3
107	TS	1.537	1.13	0.780	2.8	5.77	15.20	5.106	B-4
108	TS	1.535	1.13	0.790	2.8	5.68	15.27	5.027	B-3
109	TS	1.626	1.15	0.440	1	4.65	13.10	4.04	B-3
110	TS	1.629	1.14	0.755	2.8	6.87	17.59	6.02	B-3
111	TS	1.680	1.14	0.794	2.8	12.20	28.81	10.70	B-4
191	HS	1.687	1.17	0.473	1	2.65	7.80	2.27	B-3
195	HS	1.663	1.20	0.436	1	6.56	22.70	5.47	B-3
197	HS	1.660	0.89	0.910	7.4	7.15	22.30	8.03	B-4
198	HS	1.658	0.65	0.719	3.0	4.80	16.70	7.39	B-3
199	HS	1.655	0.64	0.460	1	3.50	11.80	5.47	B-1
200	HS	1.655	0.64	0.690	3.0	5.70	18.00	8.91	B-1
202	HS	1.655	0.65	0.877	7.4	4.70	16.70	7.23	B-1
203	HS	1.655	0.66	0.450	1	3.90	13.40	5.91	B-1
204	HS	1.581	1.16	0.440	1	2.30	9.70	1.98	B-1
205	HS	1.598	1.13	0.850	8.3	6.80	21.10	6.02	B-1
206	HS	1.597	1.13	0.660	3.30	3.40	12.70	3.01	B-1

Notes:

BOUNDARY CONDITIONS

B-1: CONSTANT STRESS

B-3: σ'_v CONSTANT; $\varepsilon_h = 0$

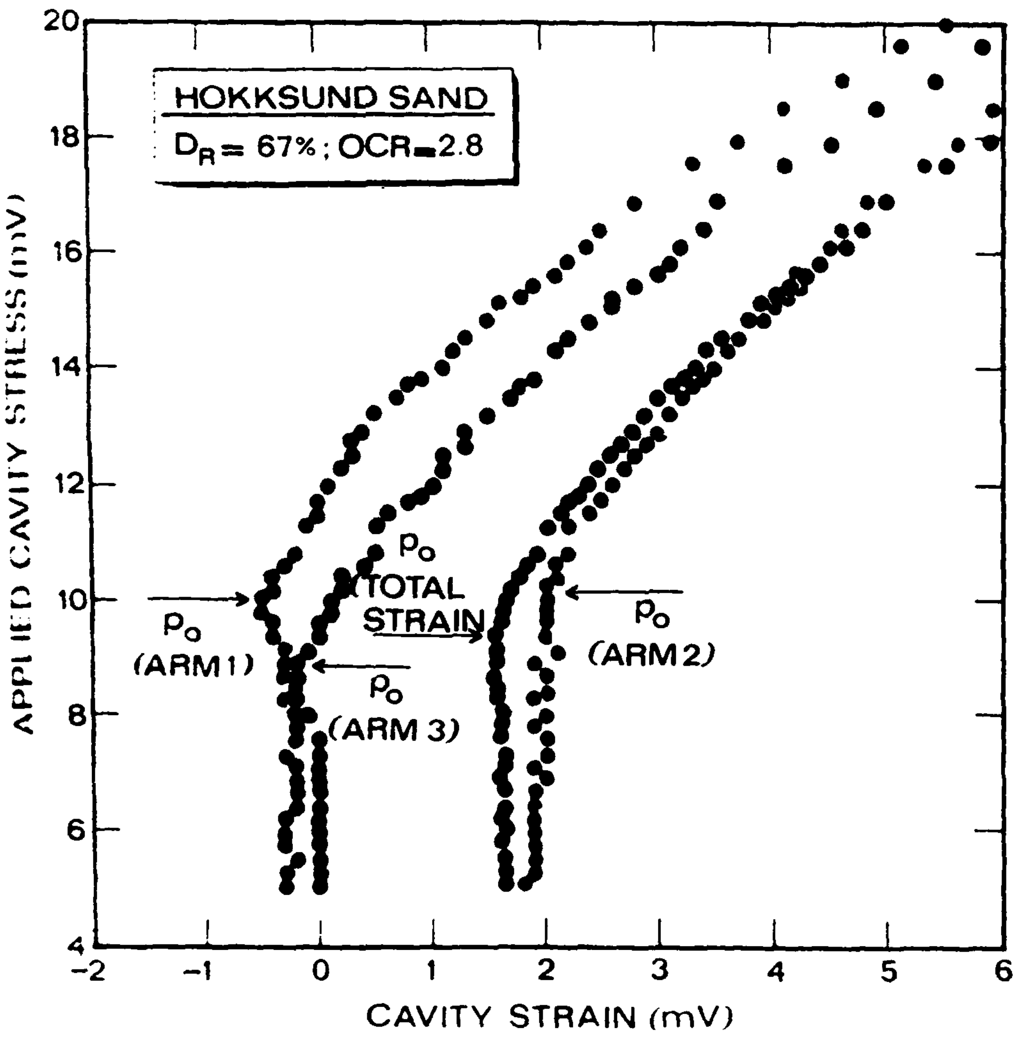
B-4: σ'_h CONSTANT; $\varepsilon_v = 0$

TICINO SAND

$\gamma_{max} = 1.701$ t/m^3; $\gamma_{min} = 1.391$ t/m^3

Fig. 1

SBPT IN CALIBRATION CHAMBER – LIFT-OFF PRESSURE STRAIN ARMS WITH LIMITED MECHANICAL COMPLIANCE



STRAIN OF	"LIFT-OFF" p_o (kPa)	
TOTAL	76.2	APPLIED LATERAL BOUNDARY STRESS σ_h = 74.7 kPa
ARM 1	82.2	
ARM 2	84.2	
ARM 3	71.2	

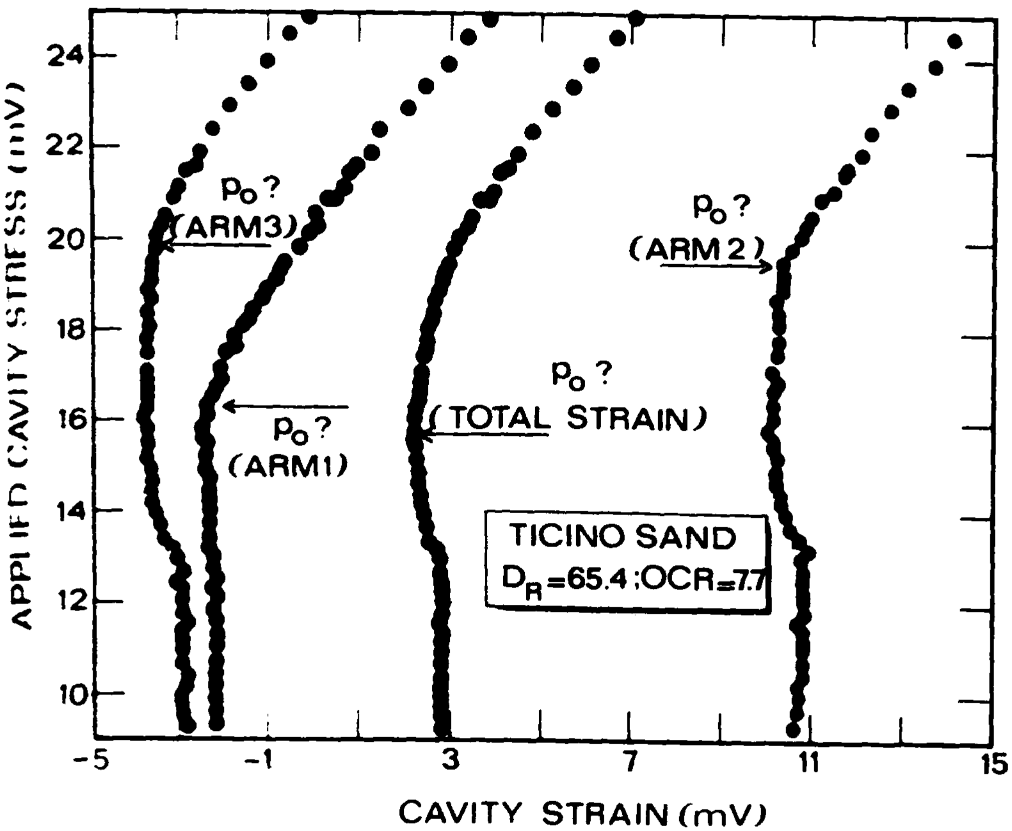
TOTAL STRAIN : 1mV = $9.5 \cdot 10^{-3}$ mm

SINGLE ARM : 1mV = $2.8 \cdot 10^{-2}$ mm

CAVITY STRESS : 1mV = 10.02 kPa

Fig. 3

SBPT IN CALIBRATION CHAMBER – LIFT-OFF PRESSURE STRAINS ARMS WITH A PRONOUNCED MECHANICAL COMPLIANCE



STRAIN OF	"LIFT OFF" p_o (kPa)
TOTAL	80.3
ARM 1	85.3
ARM 2	117.5
ARM 3	120.9

APPLIED LATERAL BOUNDARY STRESS
$\sigma_h = 67.3$ kPa

TOTAL STRAIN : $1\,mV = 6.9 \cdot 10^{-3}$ mm

SINGLE ARM : $1\,mV = 2.1 \cdot 10^{-2}$ mm

CAVITY STRESS : $1\,mV = 10.02$ kPa

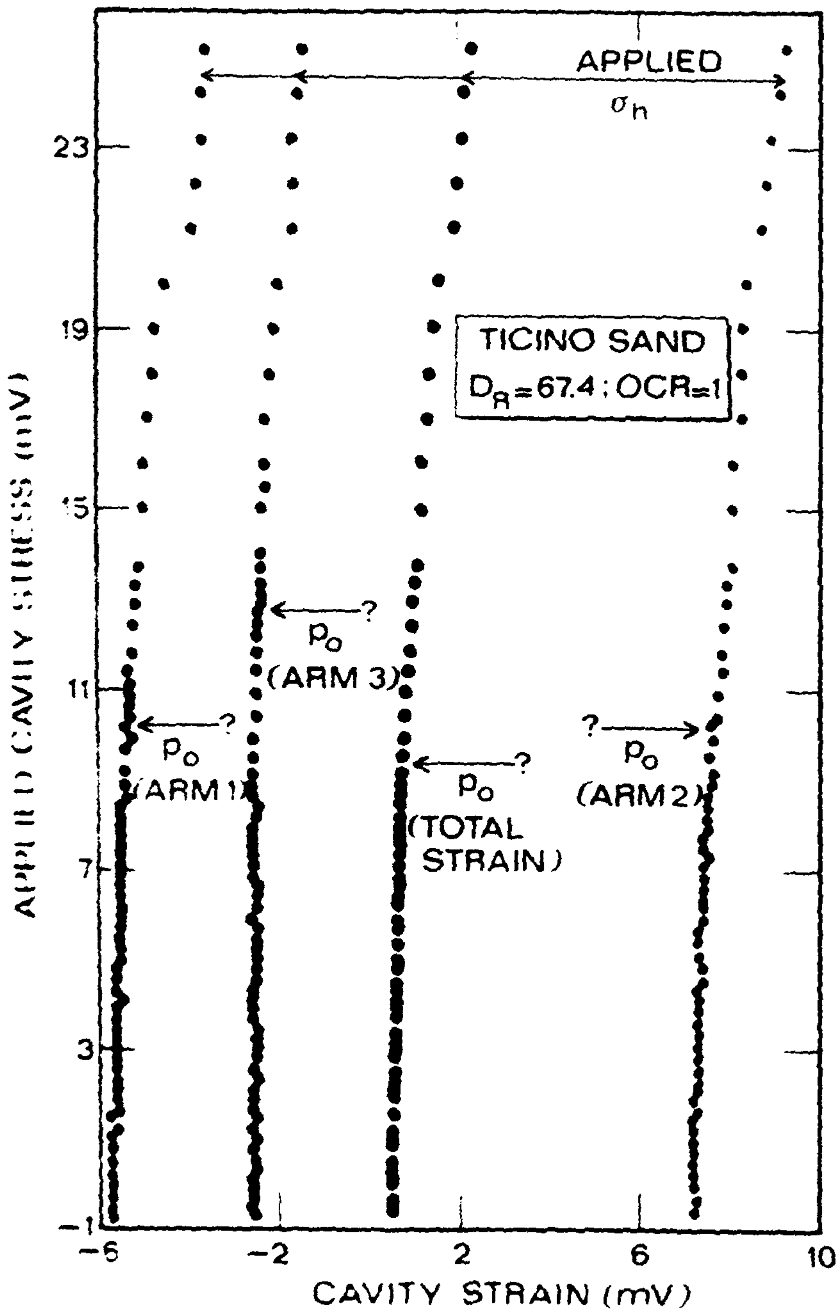


Fig. 2

SBPT IN CALIBRATION CHAMBER – LIFT-OFF PRESSURE STRAINS ARMS WITH A PRONOUNCEI MECHANICAL COMPLIANCE

STRAIN OF	"LIFT-OFF" p_o (kPa)
TOTAL	91.4
ARM 1	100.2
ARM 2	100.2
ARM 3	124.7

$\Big\}$ APPLIED LATERAL BOUNDARY STRESS $\sigma_h = 242$ kPa

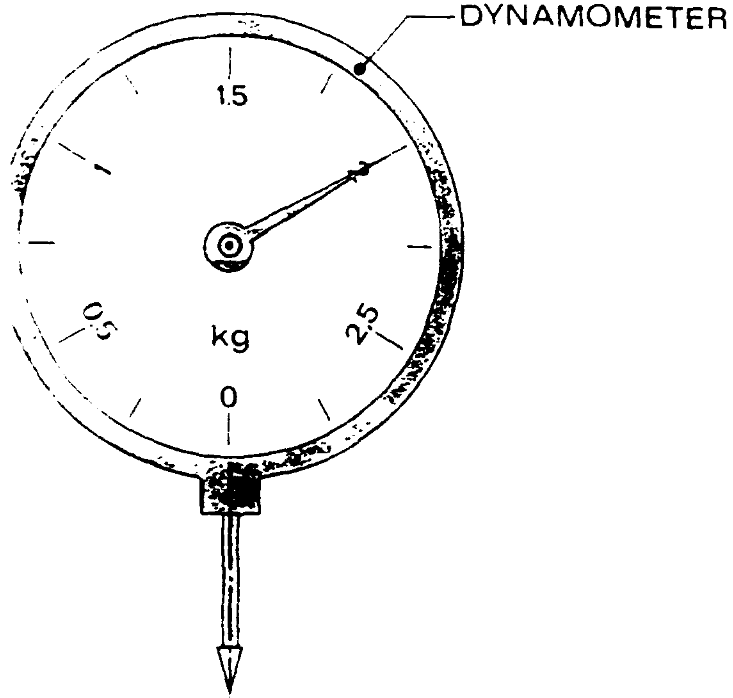
TOTAL STRAIN : $1 mV = 6.9 \cdot 10^{-3}$ mm

ARM 1 : $1 mV = 2.1 \cdot 10^{-2}$ mm

CAVITY STRESS : $1 mV = 10.02$ kPa

Fig. 4

CHECK OF STRAIN ARMS FLEXIBILITY UNDER NORMAL EXTERNAL STRESS



ZERO READING SHIFT IN mV

STRAIN ARM	POINT 1		POINT 2		POINT 3	
	APPLIED FORCE IN N					
	5	30	5	30	5	30
1	−3.5	−4.0	−4.8	−7.1	−5.1	−7.5
2	+9.4	+10.8	+11.4	+11.7	+10.6	+9.5
3	−3.1	−0.8	−2.7	−1.3	−2.9	−2.5

NOTE: PRECISION REQUESTED FOR A RELIABLE ESTIMATE OF LIFT-OFF PRESSURE $p_0 \simeq 1\,mV$

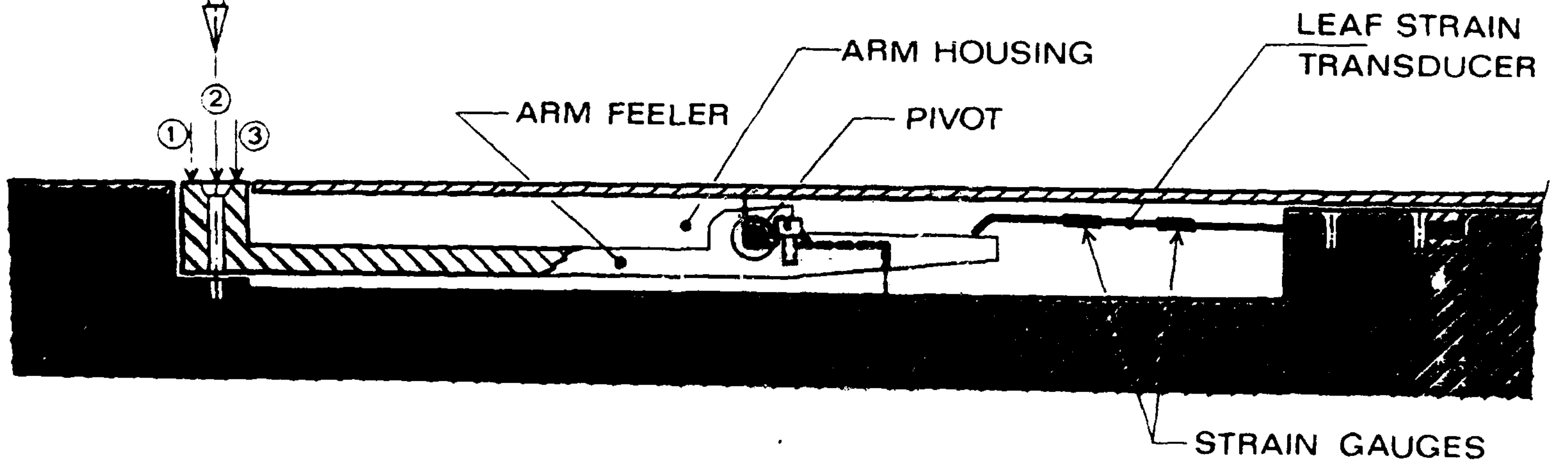


Fig. 5

CHECK OF STRAIN ARMS FLEXIBILITY UNDER INCLINED EXTERNAL STRESS

ZERO READING SHIFT IN mV UNDER APPLIED LOAD OF 10 N

ARM N.	10N ↙ 30°	30° ↘ 10N
1	- 6.0	-4.8
2	-12.0	-10.8
3	- 3.2	-2.0

NOTE: PRECISION REQUESTED FOR A RELIABLE ESTIMATE OF LIFT-OFF PRESSURE $p_o \simeq 1 mV$

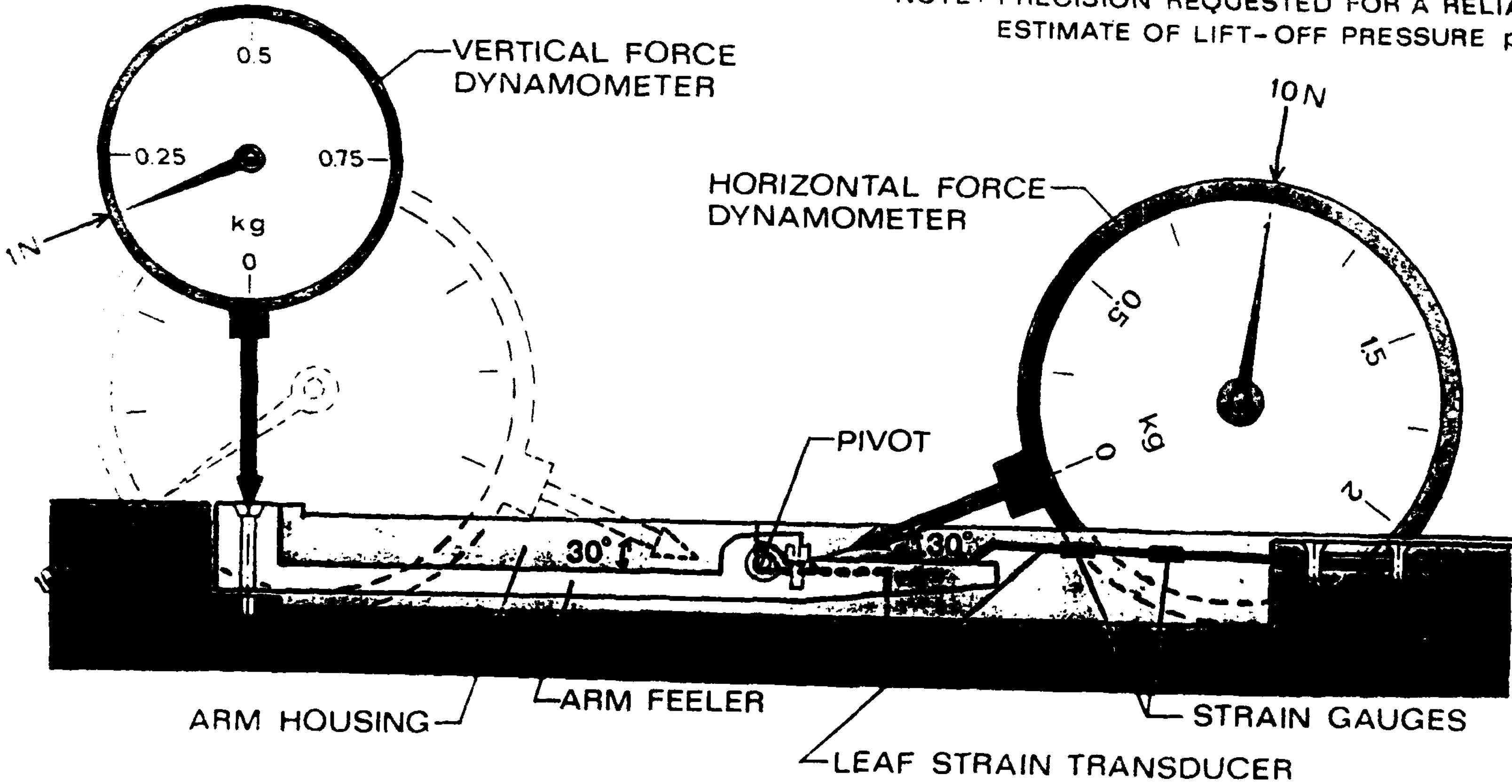
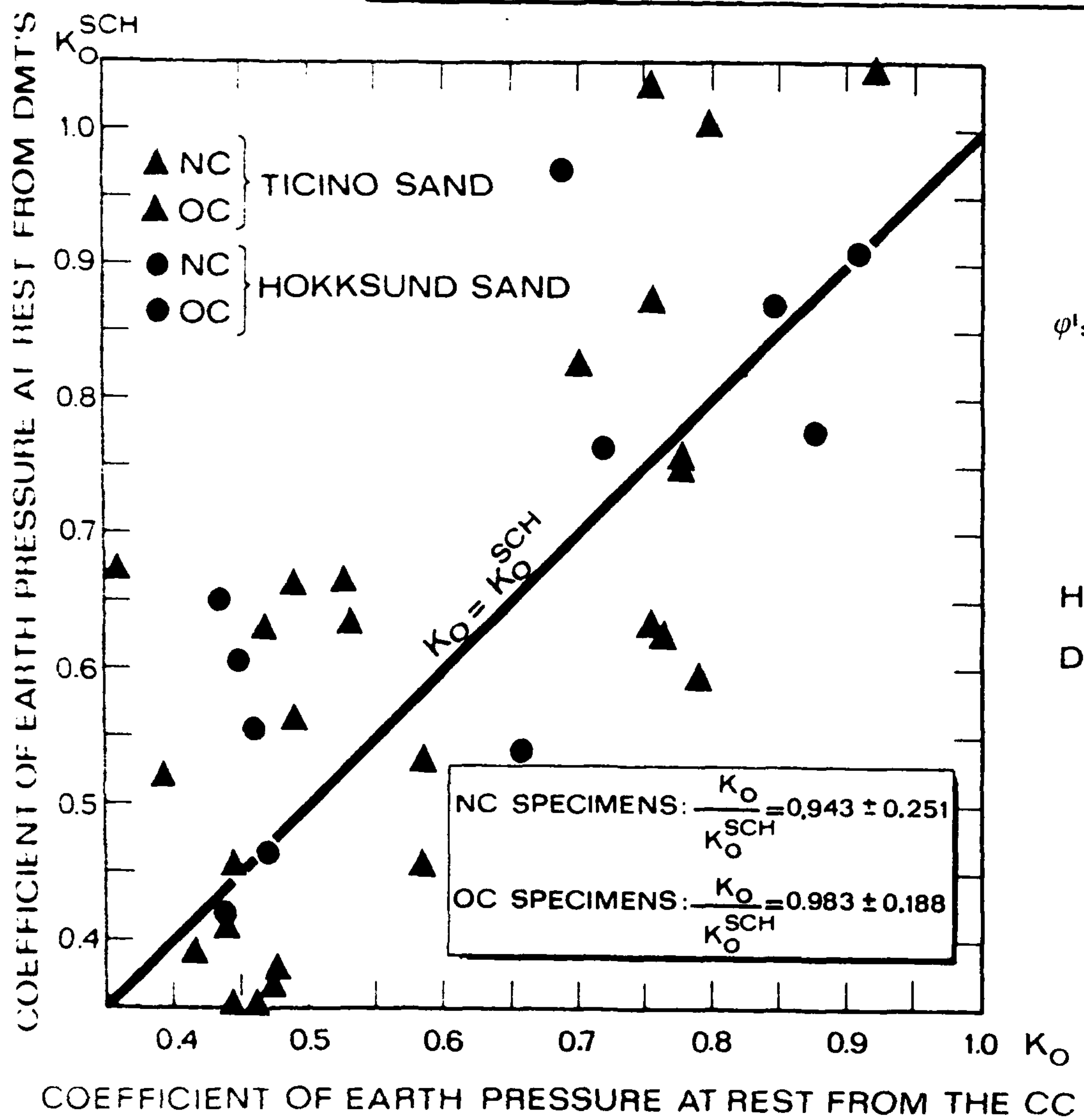


Fig. 6

K_o FROM THE CALIBRATION CHAMBER COMPARED TO THOSE FROM DMT'S OBTAINED ACCORDING TO SCHMERTMANN (1983)



q_c [CPT] ← MEASURED → K_D (DMT)

↓

$\varphi' = f(q_c; K_o)$ [DURGUNOGLU & MITCHELL (1973

↓

$K_o^{SCH} = f(\varphi'; K_D)$

HENCE $\varphi' = f(q_c; K_o)$ WHEN USING <u>FIELD</u> DATA ITERATION ON K_o IS NECESSARY

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