DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

ENGINEERING DIVISION

PROPOSED RAILWAY/ROAD GRADE SEPARATION - CROYDON

Railway Reserve Hd. Yatala

FOUNDATION INVESTIGATION - DESIGN STAGE

- South Australian Railways -

by

B.J. MORRIS
GEOLOGIST
ENGINEERING GEOLOGY SECTION

4th May, 1971

Rept.Bk.No. 71/72

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SOUTH AUSTRALIA

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Rept.Bk.No. 71/72
G.S. No. 4649
DM. No. 1167/70

4th May, 1971

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 71/72
G.S. No. 4649
DM. No. 1167/70

PROPOSED RAILWAY BRIDGE/ROAD GRADE SEPARATION - CROYDON
RAILWAY RESERVE, HUNDRED YATALA

FOUNDATION INVESTIGATIONS
DESIGN STAGE

Client: South Australian Railways

SUMMARY AND CONCLUSIONS

Two cable-tool holes (CH.1 is 70 ft. deep, CH.2 is 60 ft. deep) on the site of the proposed railway bridge and road excavation at Croydon, passed through a horizontal succession of sediments consisting of 5 to 7 ft. of top soil (mainly dense SAND and very stiff CLAY SOIL*) overlying soils of the Hindmarsh Clay Formation. This consists of stiff to very stiff CLAY SOIL of high plasticity above the water table, while below the water table the sandy CLAY SOIL is often at a moisture content greater than plastic limit, soft to stiff, and of medium plasticity. There are also lenticular layers of medium dense to dense SAND and GRAVEL layers.

The regional groundwater as measured during the summer months is 32 feet below ground surface.

There does not appear to be any continuous strong horizon on which piles of piers could be founded. It would be advisable that any foundations should be constructed in the stronger clays above the water table (32 ft.), preferably no deeper than 20 ft., in preference to the softer almost saturated sandy clays below the water table. These clays only become stronger again at a depth of 50 (hole CH.2) to 65 ft. (hole CH.1).

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* These terms are defined in Appendix A.

If piles are considered a programme of test piles may be necessary to determine the depth at which refusal would occur.

INTRODUCTION

In a letter dated 30th September, 1970, the South Australian Railways asked the Department of Mines to determine soil characteristics at the South Road level crossing, Croydon, in order to decide on foundation details for the bridge.

Two exploratory cable-tool drill holes were proposed, (Fig. 1), with depths of the holes to be from 40ft. to 60ft. depending on the type of material encountered.

Hole CH.1 was drilled from the 8 to 30 of March, 1971, to a depth of 70 ft.

Hole CH.2 was drilled from the 25th February, 1971 to 1st March, 1971, to a depth of 60.5 ft.

Continuous sealed tube samples were taken to a depth of 30 ft. and then every 10 ft. or at change of material. Standard penetration tests were carried out every 10 ft. and immediately sandy material was encountered, thence every 5 ft. in sandy material. Open tube samples were taken throughout the remainder of the hole. The sealed tube samples were sent for testing at the University Soil Laboratory.

REGIONAL GEOLOGY

According to the Adelaide Geological sheet, (Thomson 1969) the proposed bridge is situated just to the west, i.e. on the downthrow side, of the Para fault. Deposition of the Hindmarsh Clay was tectonically controlled by movements along the fault, so that a large thickness of this clay (about 100 ft. was deposited on the downthrow side and only 20ft. or so on the uplifted side.

The Para Fault Block is one of a number of elongate, faulted crustal blocks that make up the Mt. Lofty Ranges. The surface exposures in the area are depignated Pleistocene to Recent alluvial clays and sands.

SITE GEOLOGY

Topography and Geology

The site is flat and grass covered with no rock outcrops. Hole CH.1 is located on a grassy area between the railway line and a galvanised iron fence. Hole CH.2 is located on a grassy area between the railway line and a sealed road. Geological observations are limited to the drill cores which are logged as shown in Appendix A, and then summarized in Table 1, and on Figure 2.

The sequence of strata (The Hindmarsh Clay) below the top soil is essentially horizontal, and consists of sediments laid down under lacustrine to fluvial conditions and consists of mainly high plasticity mottled red-brown and grey clays with lenticular sand and gravel layers.

Groundwater

Water was cut at 32 ft. depth, in sandy layers of the Hindmarsh Clay, in both holes. The static water level is also 32 ft. below the surface in both holes, as measured during the summer months. This level can be expected to rise during the winter months.

DISCUSSION

The clays of the Hindmarsh Clay are usually strong soils (very stiff) at a moisture content less than plastic limit. However at this locality the clays are stiff to very stiff only to a depth of about 30 ft.

TABLE I

Hole	Depth in ft.	Thickness (ft.)	Stratigraphic Units	Lithology	Description	ENGINEERING PROPERTIES Consistency etc.	Moisture content
CH.1 CH.2	0 to 8 0 to 6	8 6	Topsoil	Sand and clay with modern soil profile, calcareous in places also some sand and gravel patches.	SAND (SM), excess silty fines, plus red-brown CLAY SOIL (CH) high plasticity.	Sand is loose to medium dense. Clay is hard to very stiff.	Sand is humid. Clay is less than plastic limit.
CH.1 CH.2	8 to 36 6 to 36.5	28 30.5	Hindmarsh Clay	Clay with quartz and mica sand with grains 0.5 mm in diameter.	CLAY SOIL (CH) high plasticity, mottled red-brown and grey with up to 40% SAND with clay fines, and poorly graded.	Clay is stiff to very stiff, but weaker below 32ft. depth. Sand is dense.	Clay is less than plastic limit, but greater than equal to plastic limit below 32ft. depth. Sand is moist to saturated
CH.1 CH.2	36 to 70 36.5 to 60.5	34 24	Hindmarsh Clay	Quartz and mica sand, grains 0.5 mm in diam., with clay and also gravels up to 2cms. in diam.	SAND (SC) excess clay fines with CLAY SOIL (CH), high plasticity. GRAVEL (GC) with excess clay fines. Sand and gravel layers are from 3 to 10ft. thick.	Sand is medium dense to dense. Clay is soft to very stiff.	Sand and gravel is wet to saturated. Clay is greater than or equal to plastic limit. Some layers of clay are less than the plastic limit.

At 32 ft. the water table is cut and below this depth the clays range from soft to very stiff with numerous sand and gravel layers which are saturated. The sand and gravel layers are lenticular and not readily correlated between the two holes (Fig. 2). At a depth of 65 ft. in hole CH.1 and 50 ft. in hole CH.2 a very stiff clay is encountered. There is no indication whether these stronger clays persist below a depth of 70 feet (bottom of hole CH.2).

B.J. Morris

B.J. MORRIS
GEOLOGIST
ENGINEERING GEOLOGY SECTION

BJM:PdcA
4.5.71

REFERENCES

THOMSON, B.P., 1969. Adelaide Sheet, Geol. Atlas of S.Aust. 1:250,000 series, Geol. Surv. S.Aust.

APPENDIX A

Logs of cable-tool holes, CH.1, CH.2, and explanatory notes.

DEPARTMENT OF MINES · SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE	CH 1
SERIAL No.	
R.L. Surface	FT.
R.L. Collar	FT.
Datum	

PROJECT RAILWAY BRIDGE CROYDON

FEATURE SOUTH ROAD BRIDGE

LOCATION Adjacent to track NE corner of Bridge.

SECTION Railway Reserve

HUNDRED Yatala

CO-ORDS

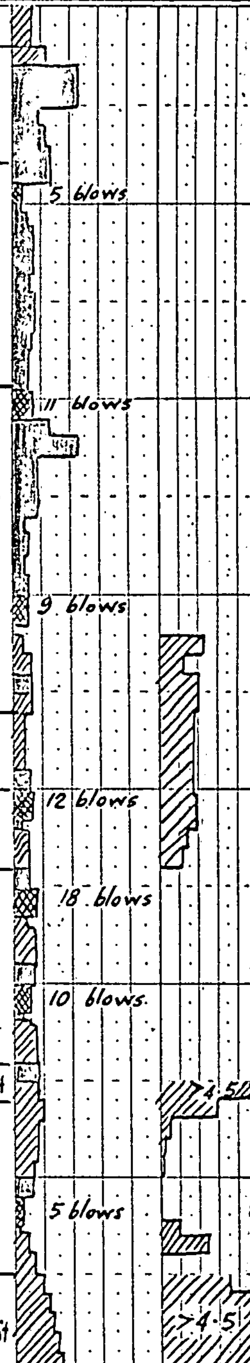
GEOLOGICAL NOTES AND CLASSIFICATION

- Filling — Sand rounded quartz grains plus silt size lime
- Topsoil — rounded quartz grains plus patches of silt size lime.
- PLEISTOCENE TO RECENT, Hindmarsh Clay — Mottled clays, sandy clays, with sandy & gravel lenses
  - rounded quartz grains mica flakes & limonite grains. No lime.
  - rounded quartz grains and mica flakes to 0.5 mm. in size.
  - Sand grains, rounded quartz & mica flakes. Gravel is rounded quartz & quartzite.

R.L. / DEPTH (FEET)	GROUP SYMBOL	SOIL DESCRIPTION — GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966)	WATER LEVEL / Casing	MOISTURE CONTENT	Consistency / Compact. Dens.
0	S.M	SAND excess silt fines grain size up to 1mm plus rock fragments up to 1" of quartzite brown. Numerous plant roots.		H	L
	CH/SC	SAND excess clay fines (0.5 mm) plus CLAY SOIL high plasticity red brown with some gravel fragment of quartz (2mm) near top. Numerous plant tubules.		<PL	D
10	CH	CLAY SOIL high plasticity with up to 10% fine grained sand particles and mica flakes. Numerous plant tubules. Mottled red brown color, prismatic structure near top		<PL	St
20	CH/SC	CLAY SOIL high plasticity, glassy surface, mottled, red brown & grey. SAND excess clay fines makes up about 20% of sample. Numerous plant tubules up to 1mm in size.	29 Mar '71	<PL	St
30		Sandy layer	WC	≥PL	
	SC/CH	SAND excess clay fines plus CLAY SOIL, high plasticity both in about equal proportion.		<PL	D
40	CH/SC	CLAY SOIL high plasticity mottled red brown to grey. Glassy surface SAND excess clay fines		<PL	St
	GC/SC + CH	SAND excess clay fines, poorly sorted GRAVEL excess clay fines occurs in top 2 feet poorly graded gravel-sand-clay mixture. Grains rounded & up to 2 cm. in size. Mottled red brown to yellow		≥PL / ≤PL	D
50	CH	CLAY SOIL high plasticity, deep red brown & grey glassy surface with 10% sand		<PL	VSt
60	SC/CH	SAND excess clay fines poorly sorted grains up to 1 mm in size. 40% CLAY SOIL high plasticity glassy surface, mottled red brown-grey.		≤PL	D
	CH	CLAY SOIL high plasticity mottled red brown to grey. Some black plant roots, some sand grains		<PL	VSt
70		END OF HOLE 70 ft.			

NOTE: Continuous sealed tube taken to 30 ft.

FIELD TEST DATA — BLOWS PER FOOT (20 40 60 80) — SOILTEST P'TR'METER Units* (1 2 3 4)



TYPE OF SAMPLE		CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	MOISTURE CONTENT
A Shoe (SA)	Water level, (date) 7 Dec. '66	VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	Casing	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	WC ▶ Water cut	F — Firm	C — Compact	MD — Medium Dense	M — Moist
G " (SG)		St. — Stiff	VC — Very Compact	D — Dense	W — Wet
Sealed Tube - A Shoe - SAL		V. St. — Very Stiff		VD — Very Dense	S — Saturated
Standard Penetration Test - SPT		H. — Hard			LL — Liquid Limit
					PL — Plastic Limit

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No.	23	LOGGED BY	B. J. Morris
TYPE	DM 500	DATE	5th April '71
DRILLER	A. Sturak	TRACED	B.S.G.
START	8th March '71	CHECKED	B.J.M.
FINISH	30th Mar '71		
SHEET 1 OF 1		DRG No.	S 9245 Ha5

PF Nº SG676 MB

DEPARTMENT OF MINES · SOUTH AUSTRALIA

LOG OF CABLE TOOL HOLE

HOLE CH 2

SERIAL No.

PROJECT: RAILWAY BRIDGE CROYDON

FEATURE: SOUTH ROAD BRIDGE

LOCATION: Adjacent to tracks, S.W. corner of bridge

SECTION: Railway Res.

HUNDRED: Yatala

CO-ORDS

R.L. Surface. FT.

R.L. Collar. FT.

Datum.

GEOLOGICAL NOTES AND CLASSIFICATION	DEPTH (FEET)	GROUP SYMBOL	SOIL DESCRIPTION GROUP NAME (Unified Soil Classification, U.S.B.R. Earth Manual 2nd Edition 1966)	WATER LEVEL	MOISTURE CONTENT	Consistency / Compact. Density
Filling. Sand is rounded quartz grains, some silt sized lime.		SM.	SAND excess silty fines up to 1mm. plus gravel fragments & plant roots light brown color, some lime.		H	L
Topsoil		SC/CH	SAND excess clay fines. CLAY SOIL high plasticity some lime.		H	L
Sand is rounded quartz grains & some lime.		SC	SAND, excess clay fines, up to 1mm. yellow red color.			D
	10	CH	CLAY SOIL high plasticity, plus 10% quartz sand (0.5mm in size) Red brown color.		<PL	V.St.
		SC	SAND excess clay fines up to 1mm red color.			D
		CH	CLAY SOIL, high plasticity, red brown color with some fine grained sand & silt.		<PL	
Sand is rounded quartz up to 0.5mm in size, also some mica flakes	20	CH/SC	CLAY SOIL high plasticity with up to 40% SAND, poorly graded, red colored becoming mottled green, red at 30'.	26 Feb '71 WC	<PL, ≥PL	St.
	40	SC/CH	SAND excess clay fines (up to 40%) poorly graded. Matrix is CLAY SOIL, high plasticity mottled red grey-green color.	WC	W, S	D
rounded grains of quartz & mica flakes.	50	SC.	SAND, excess clay, fines, poorly graded, red color, grains up to 1mm in size		W	D
		CH	CLAY SOIL, high plasticity mottled grey-red with up to 10% fine sand & silt		<PL	V.St.
rounded quartz grains & mica flakes.	60	SC.	SAND excess clay fines, poorly graded, red grey color, grains up to 0.5mm in size.		W	D

Pleistocene to Recent. Hindmarsh Clay

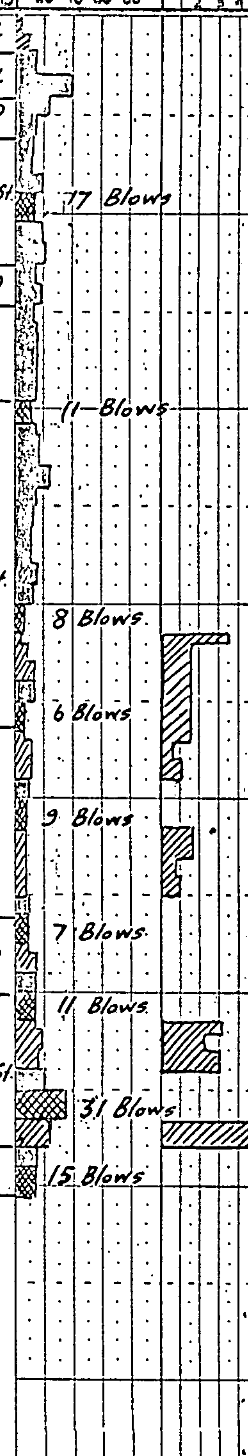
Mottled clays, sandy clays with sandy lenses.

End of hole at 60.5 ft.

Note:- Continuous sealed tubes taken to 30ft. Samples logged are from shoes only.

70

FIELD TEST DATA — BLOWS PER FOOT (20 40 60 80) — SOILTEST P'TR'METER Units * (1 2 3 4)



TYPE OF SAMPLE	CONSISTENCY (Clays)	COMPACTNESS (Silts)	RELATIVE DENSITY (Sands)	MOISTURE CONTENT
A shoe (SA)	VS. — Very Soft	Ls — Loose	VL — Very Loose	H — Humid
D " (SD)	S — Soft	MC — Moderately Compact	L — Loose	D — Damp
E " (SE)	F — Firm		MD — Medium Dense	M — Moist
G " (SG)	St. — Stiff	C — Compact		W — Wet
Sealed Tube - A Shoe - SAL	V. St. — Very Stiff	VC — Very Compact	D — Dense	S — Saturated
Standard Penetration Test - SPT	H. — Hard		VD — Very Dense	LL — Liquid Limit
				PL — Plastic Limit

Water level, (date) 7 Dec. '66 — Casing — WC Water cut

* These values refer to clay soils only and provide an indication of their consistency.

ENGINEERING GEOLOGY SECTION

DRILL No. 23

TYPE D.M. 500.

DRILLER R. Sturak

START 25th Feb. 71.

FINISH 1st March 71

LOGGED BY B.J. Morris

DATE 4th Mar 71.

TRACED B.S.G.

CHECKED B.J.M.

SHEET 1 OF 1

DRG No. S 9191

Ha5.

PF Nº S6676 MB

APPENDIX

LOGS OF CABLE TOOL HOLES AND EXPLANATORY NOTES

NOTES ON DRILLING PROCEDURES

Equipment

The drilling is carried out with a cable tool drilling plant using sampling tubes attached, through a vacuum head, to the sampling tools (Figs. 1 and 2).

Sampling Procedures

S.A. Samples

To obtain, for logging purposes, an almost continuous series of samples, with a relatively small amount of sample disturbance, SA type samples are taken. These are obtained by driving an "S" tube, fitted with a Mark A shoe (Fig. 2), into the material to be sampled.

The assembly is lowered carefully to the bottom of the hole, and the tube driven exactly 1 foot, and the number of blows required for the 1 foot of penetration recorded.

The sample, or core, is extruded from the sampling tube using an hydraulic ram. The extruded core is sealed in a labelled plastic bag and stored in a core box (Fig. 3).

The hole is reamed with a "D" or "E" shoe (Fig. 2) and then the next sample is taken, using the same procedure as above. Thus the hole proceeds by alternate sampling, reaming (and where required, casing) operations, and the samples form a continuous record of the materials penetrated except for a few inches which may be lost between samples during reaming operations.

SA sampling equipment is a composite sampler for simple class sampling. Details are as follows:-

"S" SERIES CUTTING SHOES

MARK	FEATURES	USES
A	Inside clearance 3%. Area Ratio 33%.	Continuous open-tube sampling in strong soils, in which it causes little deformation. Samples extruded and used for logging purposes. Hole is reamed after each sample.
D	Shoe belled out to 4 29/32 in. (just greater than outside dia. of vacuum head)	Continuous open tube sampling where considerable deformation of sample is permissible. Essentially self-reaming.

MARK	FEATURES	USES
E	Shoe belled out to 5 7/16 in. (just less than internal dia. of 6 in casing)	Cleaning hole and reaming out hole.

Sealed Tube (LB) Samples

Sealed tube samples, for laboratory testing, are taken at various intervals during drilling. These are obtained by driving an "L" type sampling tube with a Mark B cutting shoe (Fig. 4) a distance of 1 foot into the material to be sampled.

Before the sample is taken the hole is cleaned out to the depth specified. The hole is not reamed or cased for at least 1 foot from the bottom, however, because these operations can cause considerable disturbance in the soil below. The sampling assembly is lowered carefully to the bottom of the hole, the sampling tube driven exactly 1 foot, and the number of blows recorded.

The sample is sealed in the tube by inserting in each end, plastic seals with rubber sealing rings, and the tube is then labelled and stored in a Laboratory Sample Box.

LB sampling equipment is a composite sampler for obtaining samples with the least possible disturbance. Details are as follows:

Sampler tube -ASSAB tube cadmium plated
"L" type
4.016 in I.D.
4.282 in O.D.

Mark B shoe - ASSAB tube, heat treated, cadmium plated
Area ratio 15%
Inside clearance - ~~nil~~ 0.4%
Outside clearance - nil
Cutting edge angle - 7°

Standard Penetration Test

The Standard Penetration Test (Terzaghi et al 1948) is used to test the in-situ density of sands and to give an indication of the consistency of clays, and compactness of silts. However the test results can be affected by several geological factors such as degree of cementation, and size and shape of grains. These factors should be taken into account in interpretation of results.

The equipment is illustrated in Fig. 5 and consists of a 2in. diameter, sampling spoon (tube) and a hammer of standard weight (140 lbs).

With the equipment assembled as in Fig. 5 the hammer is allowed to fall on to the drill rods until the sampling shoe has penetrated 6 in. into the soil. The Standard Penetration Test is the number of blows (N) required to produce the next foot of penetration.

NOTES ON DRILL LOG SHEETS

The logs are plotted on a standard cable-tool log form.

Near the centre of the form a graphic log of the materials encountered is shown.

In the column to the right of the graphic log, the soils are classified and described according to the Unified Soil Classification (U.S. Dept. of Interior, Bureau of Reclamation 1966) as shown on Figure 6.

To the left of the graphic log is a geological description of the materials sampled. This includes:-

........Geological age)
........Soil unit name) Printed vertically
........Type of material)
........Mineral composition
........Grain shape
........Cementation
........Organic materials

Water levels are indicated by a small arrow with the date at which the observation was made.

In the blows per foot column, a continuous histogram is made of the number of blows required to drive the sampling tube through each foot of material. A hatching code is used to distinguish various types of sample. This code is reproduced at the bottom of each log sheet.

In the column on the far right of the log sheet, readings of unconfined compressive strength (qu) made with a Soiltest Penetrometer, are recorded. The readings are plotted as a histogram. The Soiltest Penetrometer only gives true values of qu when used in clays in which $\phi = 0$.

REFERENCES

TERZAGHI, K. and PECK, R.B., 1948. Soil Mechanics in Engineering Practice. John Wiley and Sons.

UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION, 1966. Earth Manual, 2nd Edition.

DESCRIPTIVE TERMS

1. CLAY SOILS

CONSISTENCY

CONSISTENCY	SYMBOL	UNCONFINED COMPRESSIVE STRENGTH (kg/sq. cm)	FIELD TEST	N
Very Soft	V.S.	less than 0.25	Easily penetrated several inches by fist.	2
Soft	S	0.25 to 0.5	Easily penetrated several inches by thumb.	2 to 4
Firm	F	0.5 to 1.0	Can be penetrated several inches by thumb with moderate effort.	4 to 8
Stiff	St	1.0 to 2.0	Readily indented by the thumb but penetrated only with great effort	8 to 15
Very Stiff	V.St.	2.0 to 4.0	Readily indented by thumb nail.	15 to 30
Hard (Extremely stiff)	H	over 4.0	Indented with difficulty by thumb nail.	30 and over

Based partly on Terzaghi, K. and Peck. R.B. 1966. Soil Mechanics in Engineering Practice, Wiley - New York.

MOISTURE CONTENT

Abbreviation	Meaning
MC ≃ LL	Moisture Content near liquid limit.
MC < LL	" " less than liquid limit.
MC > PL	" " greater than plastic limit.
MC ≃ PL	" " near " "
MC ≤ PL	" " less or equal to plastic limit.
MC < PL	" " less than " "
MC << PL	" " much less than " "

2. SILT SOILS

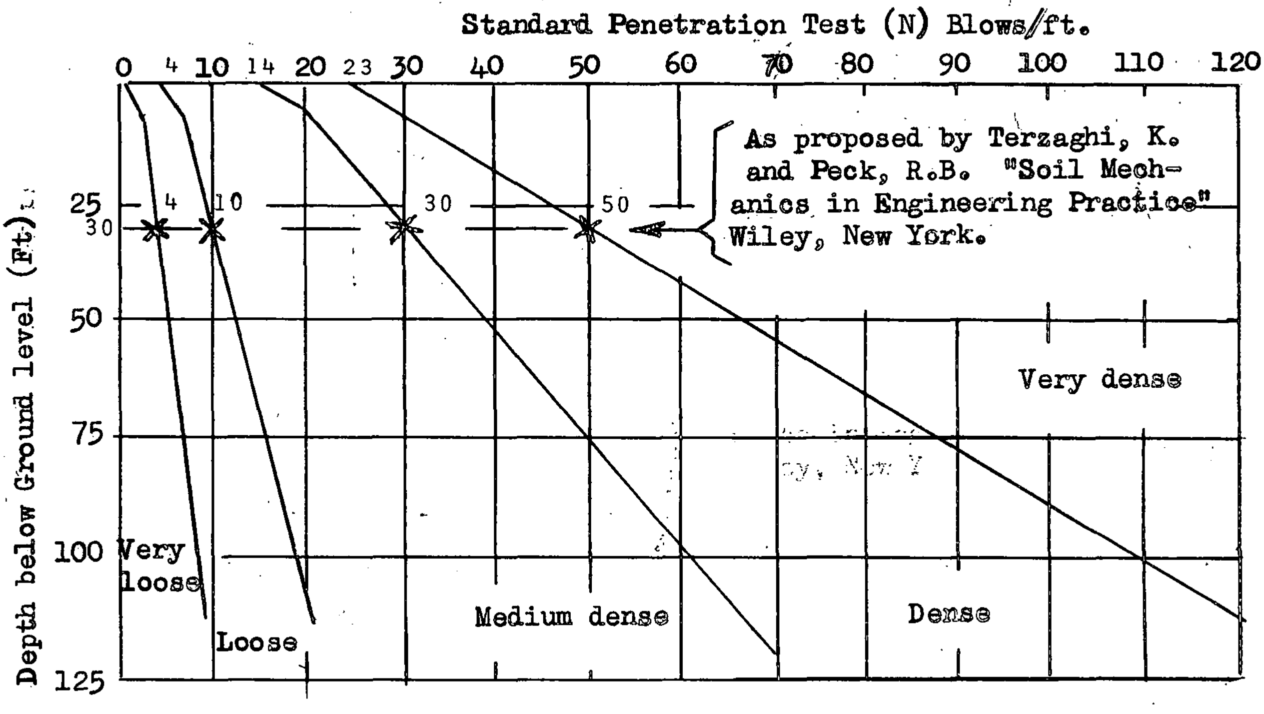
COMPACTNESS	SYMBOL	N
Loose	Ls	0 to 8
Moderately compact	MC	8 to 15
Compact	C	15 to 30
Very Compact	VC	greater than 30

3. SANDS

CLASSIFICATION OF SANDS BY STANDARD PENETRATION TEST

The relative density of granular soils has been judged from the results of Standard Penetration Tests carried out by the procedure described by Terzaghi and Peck (1948) bearing in mind the limitations of the method as discussed by Gibbs and Holtz (1957). At all times the water in the drill hole was kept at the level of surrounding groundwater.

EFFECT OF OVERBURDEN PRESSURE ON STANDARD PENETRATION TEST

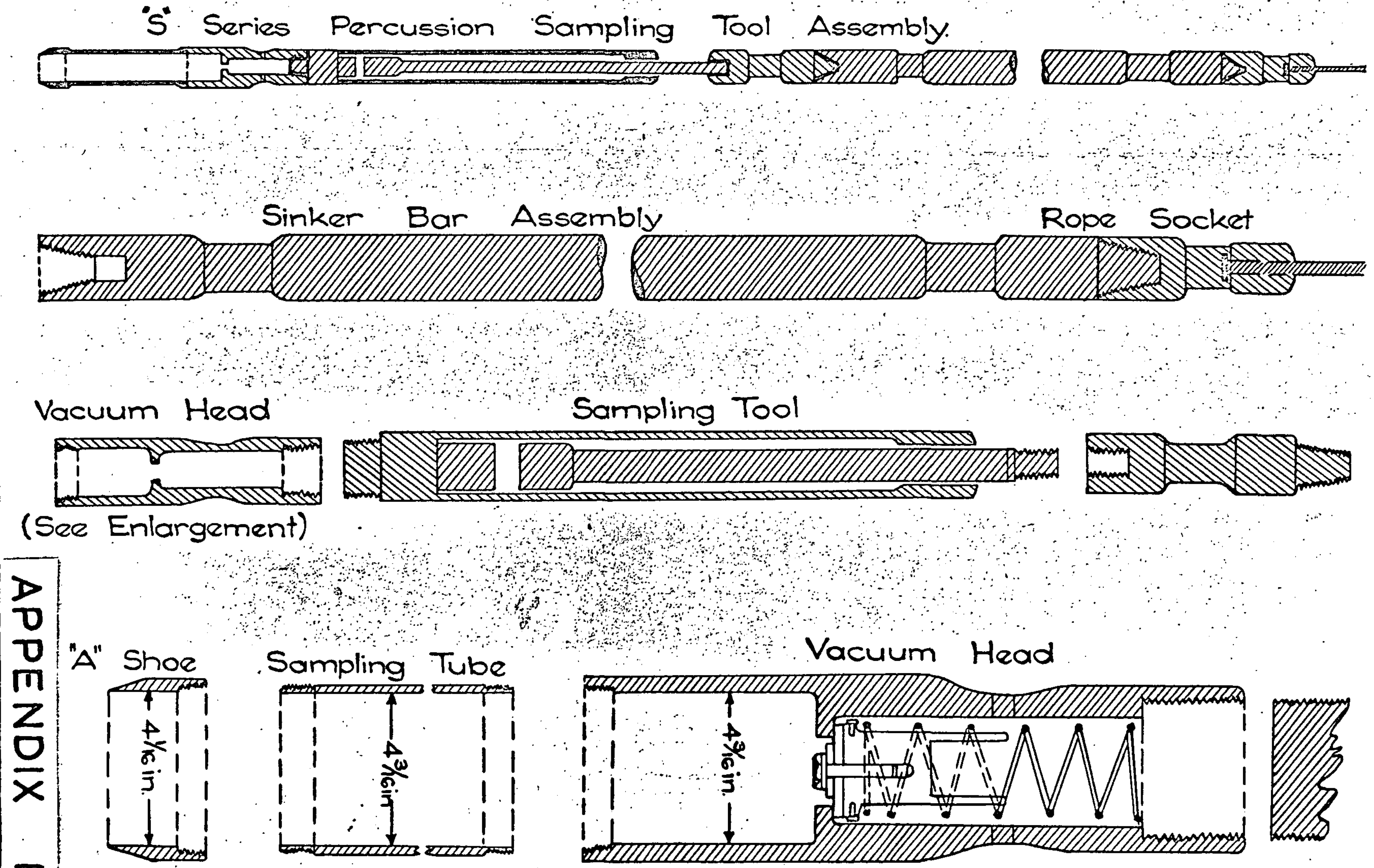


Based on Gibbs, H.J. & Holtz, W.G. (1957) "Research on Determining the Density of Sands by Spoon Penetration Testing" Vol. I Proc. 4th Int. Conf. SM & FE, London.

REFERENCES

TERZAGHI, K., and PECK, 1948. "Soil Mechanics in Engineering Practice". Wiley. New York.

GIBBS, H.T. and HOLTZ, W.G., 1957. Research on Determining the Density of Sands by Spoon Penetration Testing. Proc. 4th Inter. Conf. SM & FE, London, Vol. 9.



APPENDIX FIG. I

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION

SENIOR GEOLOGIST

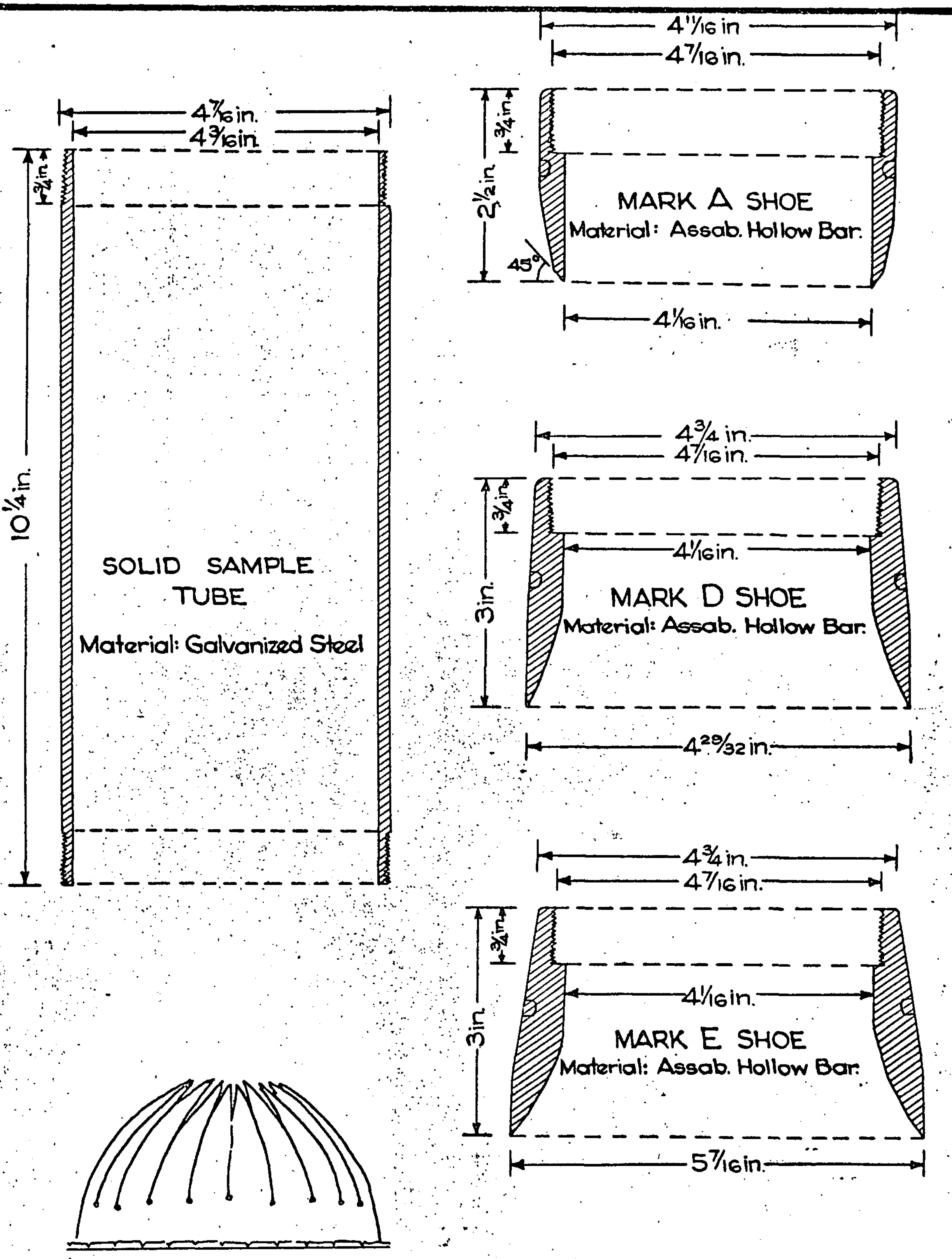
Drn. DHS
Tcd. AMS D
Ckd. LVW.
Exd. DA

CABLE-TOOL DRILLING SAMPLING TOOL ASSEMBLY WITH "S" SERIES SHOES

SCALE: NOT TO SCALE

S 4416 MB

DATE: 21 Oct '69

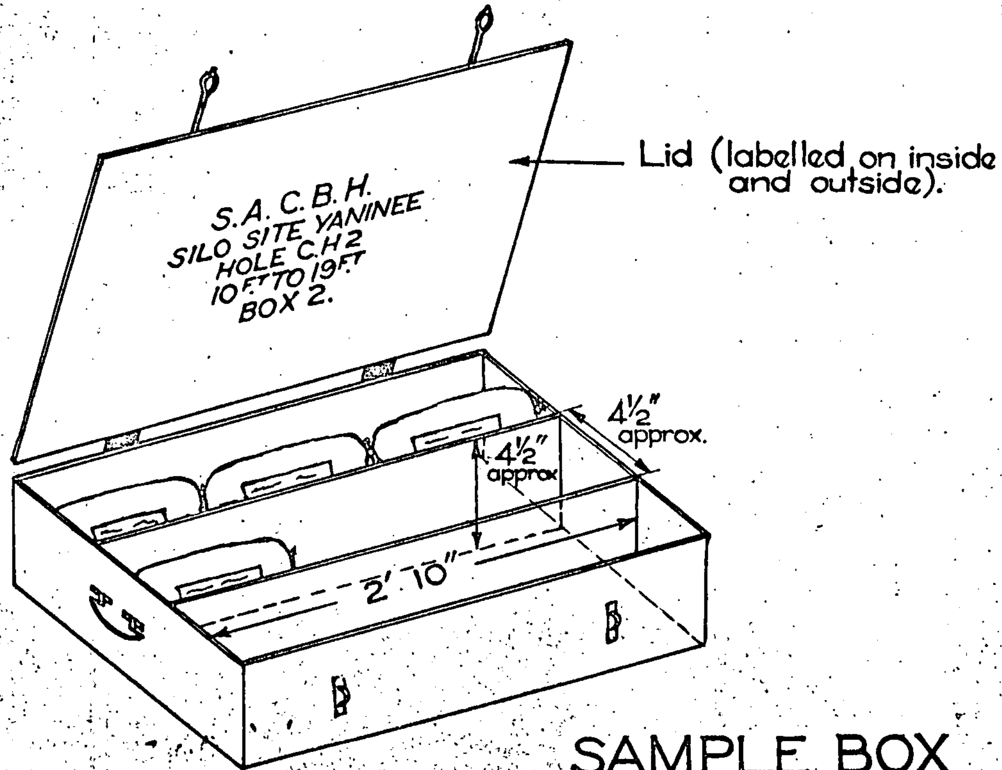


(Copper Basket Retainer)

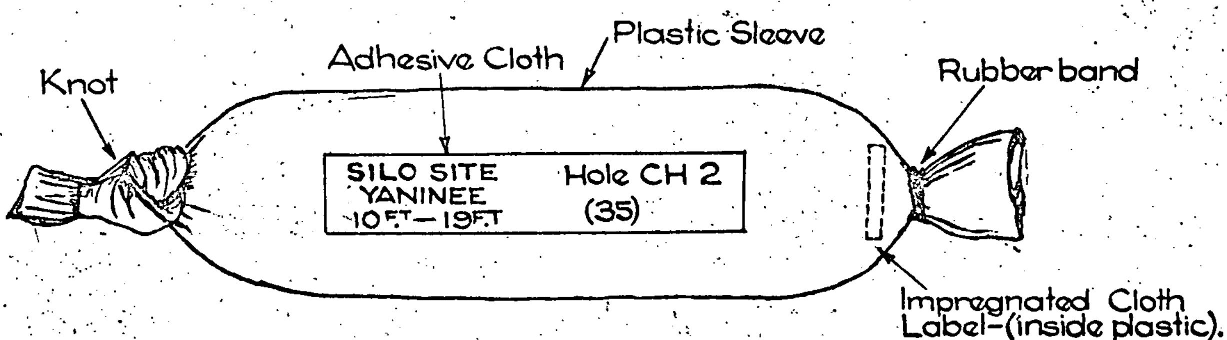
APPENDIX FIG. 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA

ENGINEERING GEOLOGY SECTION	Drn D.H.S.	CABLE-TOOL DRILLING S SERIES SAMPLING TUBE AND SHOES	SCALE: NOT TO SCALE
	Tcd. AMcD		S4418 MB
[signature] for SENIOR GEOLOGIST	Ckd. L.V.W.		
	Exd. DH		DATE: 21 Oct '69



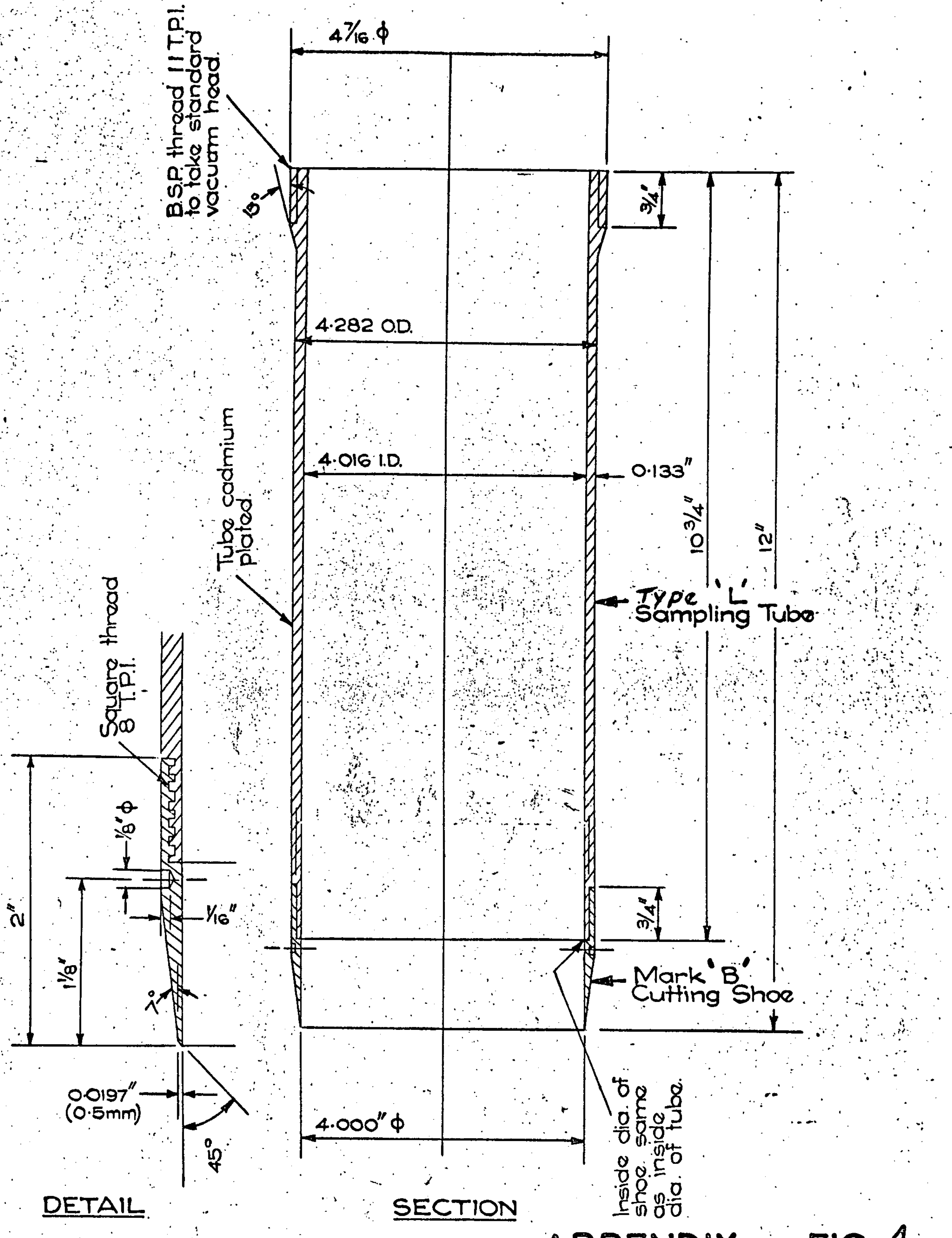
SAMPLE BOX



EXTRUDED SAMPLE
SEALED IN PLASTIC SLEEVE.

APPENDIX FIG. 3

ENGINEERING DIVISION	DEPARTMENT OF MINES - SOUTH AUSTRALIA	Scale:
Compiled: W.R.P.B	CABLE TOOL DRILLING LABELLING AND BOXING OF EXTRUDED SAMPLES	Date: 17 Dec. '69
Drn AM&D. Ckd.		Drg. No S7580 MD

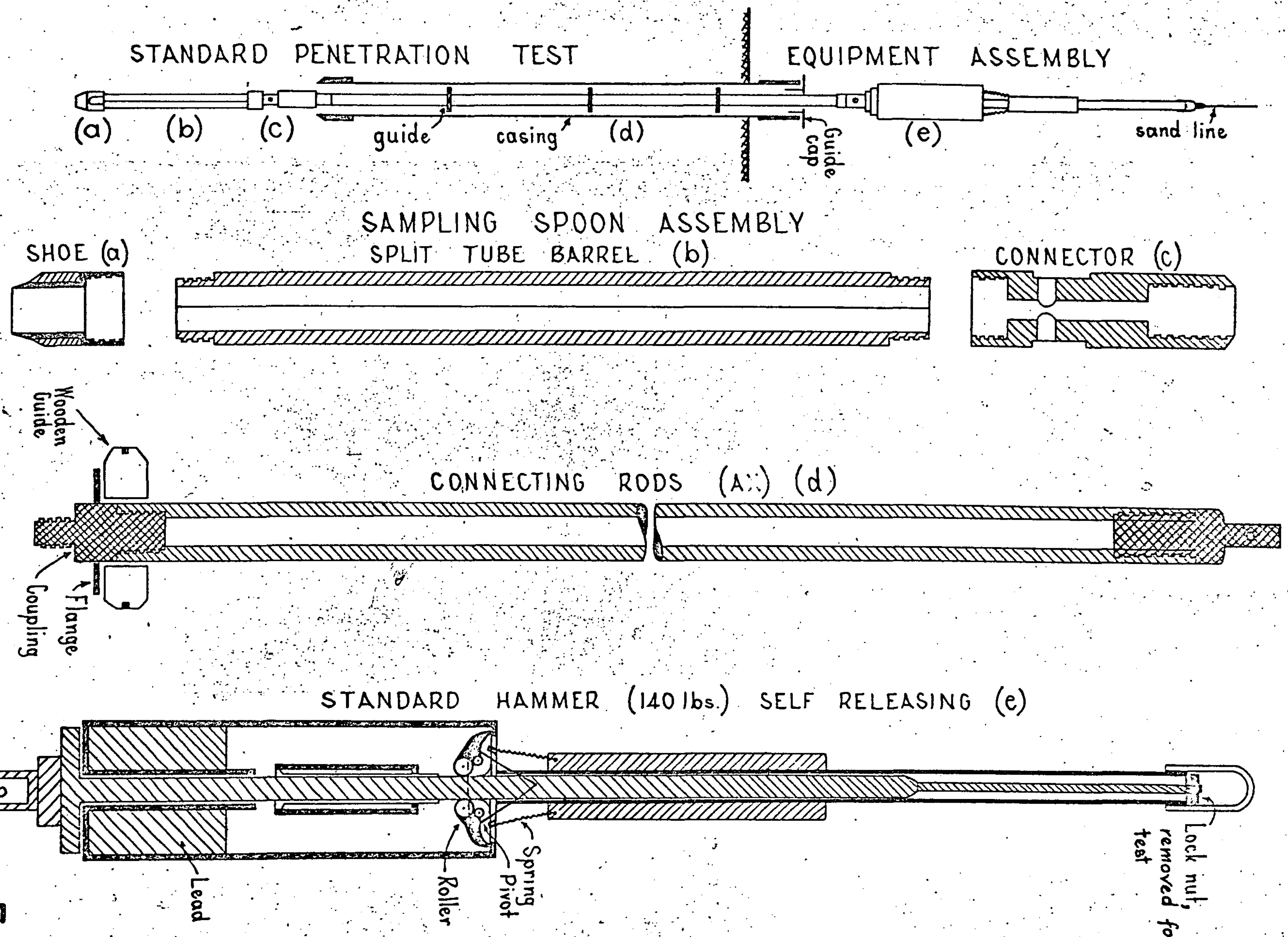


APPENDIX , FIG. 4.

ENGINEERING DIVISION	DEPARTMENT OF MINES - SOUTH AUSTRALIA	Scale: Half and Full size
Compiled: J. Trudinger	CABLE TOOL DRILLING THIN-WALLED "L" SAMPLE TUBE AND "B" SHOE	Date: 19 Feb '70
Drn. AMcD / Ckd. L.V.W.		Drg. No S7636 MB.

APPENDIX

FIG. 5



ENGINEERING DIVISION

Compiled: W.R.P.B.

Drn. R.H. | Ckd.

DEPARTMENT OF MINES - SOUTH AUSTRALIA

STANDARD PENETRATION TEST EQUIPMENT

Scale: Not to scale

Date: 22 Dec 1969

Drg. No S4420 MB

ENGINEERING GEOLOGY SECTION

SOILS CLASSIFICATION CHART

DEPARTMENT OF MINES SOUTH AUSTRALIA

COARSE GRAINED SOILS More than 50% of material is larger than No. 200 B.S. Sieve size.		FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 0.25 ft. and basing fractions on estimated weights)		GROUP SYMBOL	GROUP NAME and typical materials
GRAVELS More than 50% of the course fraction is larger than 2 mm (retained on B.S.7 sieve)	CLEAN GRAVELS Little or no fines	Wide range in grain size and substantial amounts of all intermediate particle sizes		GW	GRAVEL, well graded; gravel sand mixtures, little or no fines
		Predominantly one size, or a range of sizes, with some intermediate sizes missing		GP	GRAVEL, poorly graded; gravel sand mixtures, little or no fines.
	DIRTY GRAVELS Appreciable amount of fines	Non-plastic fines – for identification see ML below		GM	GRAVEL, excess silty fines; poorly graded gravel-sand-silt mixtures
		Plastic fines – for identification see CL below		GC	GRAVEL, excess clayey fines; poorly graded gravel sand-clay mixtures
SANDS More than 50% of the coarse fraction is smaller than 2mm. (passing B.S.7 sieve)	CLEAN SANDS Little or no fines.	Wide range in grain sizes, and substantial amounts of all intermediate particle sizes		SW	SAND, well graded; well graded sands, gravelly sands, little or no fines
		Predominantly one size or a range of sizes, with some intermediate sizes missing		SP	SAND, poorly graded; poorly graded sands gravelly sands, little or no fines
	DIRTY SANDS Appreciable amount of fines	Non plastic fines – for identification see ML below		SM	SAND, excess silty fines; poorly graded sand-silt mixtures
		Plastic fines – for identification see CL below		SC	SAND excess clayey fines; poorly graded sand-clay mixtures.

FINE GRAINED SOILS More than 50% of material is smaller than No. 200 B.S. sieve size.	FIELD INVESTIGATION PROCEDURES on fraction smaller than 0.4 mm. (passing B.S. 36 sieve) SOIL CAST (wet soil)	SOIL THREAD	SHINE	DILATANCY	ODOUR	DRY STRENGTH	GROUP SYMBOL	GROUP NAME (and typical materials)
SILTS AND CLAYS Liquid limit less than 50	Forms fragile cast Cracks form when kneaded while moist	Thick crumbly thread; easily broken	None to very dull	Distinct	Not significant	None to slight	ML	SILT SOIL, low plasticity; inorganic silts and very fine silty or clayey sands, rock flour
	Cast maybe handled freely without breaking. Can be kneaded moist without cracking. Material adheres to the hand.	Thread can be pointed as fine as a lead pencil, but is fragile.	Moderate	None to slight	Not significant	Moderate	CL	CLAY SOIL, low plasticity; inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays
	Cast fragile to cohesive material will adhere somewhat to the hand	Soft, weak thread	None to very dull	Slight to distinct	Decayed organic matter	Low	OL	ORGANIC SOIL low plasticity; organic silts and silt clays of low plasticity
SILTS AND CLAYS Liquid limit more than 50	Moderately plastic and cohesive. Material adheres somewhat to the hand	Weak to medium thread. May be crumbly.	Dull	None to slight	Not significant	Moderate Powdered soil feels floury	MH	SILT SOIL, high plasticity; inorganic silts, micaceous or diatomaceous fine sand, or silty soils elastic silts
	Very plastic and cohesive Material very sticky to the hand Greasy to to touch	Very tough thread Can be rolled to a pin point.	Very glossy	None	Strong earthy.	High Cannot be powdered by finger pressure	CH	CLAY SOIL, high plasticity; inorganic clays of high plasticity, fat clays
	Plastic and cohesive Feels slightly spongy Greasy to touch.	Weak to medium thread Often soft and fibrous	Moderate to very glossy	None	Decayed organic matter	Moderate to high. Powdered soil may be fibrous.	OH	ORGANIC SOIL, high plasticity; organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture.						Pt	PEATY SOIL; Peat and other highly organic soils.

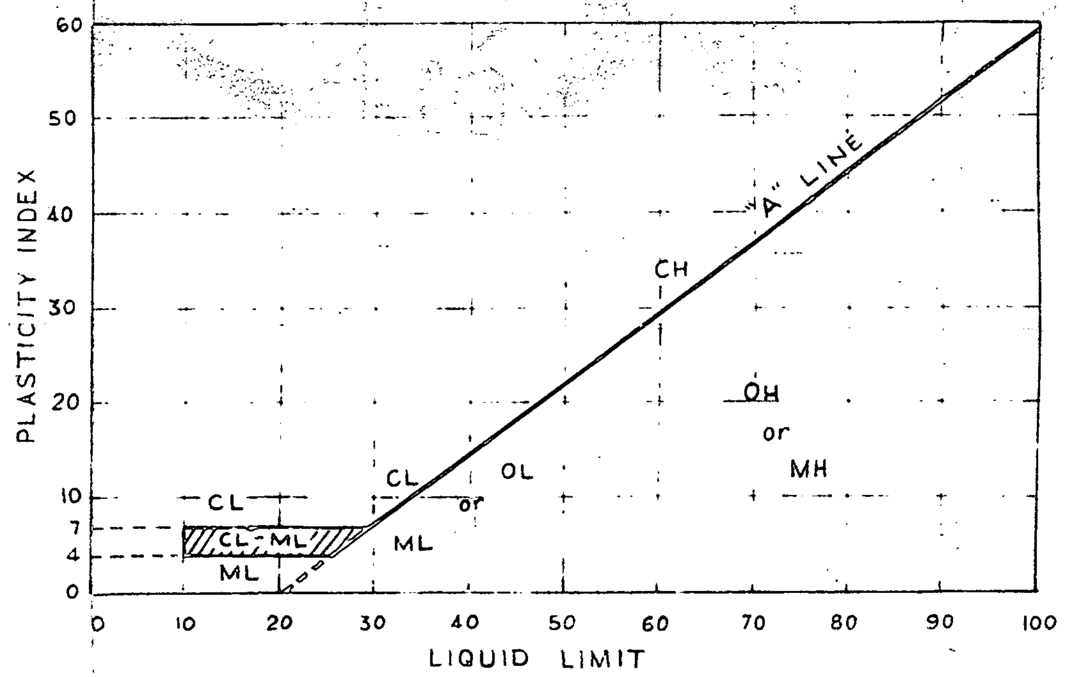
GRAIN SIZE CURVE to be used to identify soil fractions

LABORATORY CLASSIFICATION CRITERIA

Coarse grained soils classified on basis of percentage of fines, as follows: PERCENT OF FINES — GRAVELS — SANDS

PERCENT OF FINES	GRAVELS	SANDS
Less than 5	GW, GP	SW, SP
More than 12	GM, GC	SM, SC
5 to 12	Borderline cases, use 2 symbols	

GW	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with PI greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with PI greater than 7	



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

NOTE : BOUNDARY CLASSIFICATIONS : Soils possessing characteristics of two groups are shown as a combination of two group symbols, e.g. GW-GC, well graded gravel with clay binder.

Based on "The Unified Soil Classification System" United States Department of the Interior, Bureau of Reclamation "Earth Manual" First Edition, Denver COLORADO 1960

ENGINEERING GEOLOGY SECTION

SOILS CLASSIFICATION CHART

DEPARTMENT OF MINES SOUTH AUSTRALIA

Coarse grained soils

Major division	Subdivision	Type	FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 0.25 ft. and basing fractions on estimated weights)	GROUP SYMBOL	GROUP NAME and typical materials
COARSE GRAINED SOILS More than 50% of material is larger than No. 200 B.S. Sieve size.	GRAVELS More than 50% of the coarse fraction is larger than 2mm. (retained on B.S.7 sieve)	CLEAN GRAVELS Little or no fines	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	GRAVEL, well graded; gravel sand mixtures, little or no fines
			Predominantly one size, or a range of sizes, with some intermediate sizes missing.	GP	GRAVEL, poorly graded; gravel sand mixtures, little or no fines.
		DIRTY GRAVELS Appreciable amount of fines	Non-plastic fines – for identification see ML below.	GM	GRAVEL, excess silty fines; poorly graded gravel-sand-silt mixtures
			Plastic fines – for identification see CL below	GC	GRAVEL, excess clayey fines; poorly graded gravel-sand-clay mixtures
	SANDS More than 50% of the coarse fraction is smaller than 2mm. (passing B.S.7 sieve)	CLEAN SANDS Little or no fines.	Wide range in grain sizes, and substantial amounts of all intermediate particle sizes	SW	SAND, well graded; well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes, with some intermediate sizes missing.	SP	SAND, poorly graded; poorly graded sands gravelly sands, little or no fines
		DIRTY SANDS Appreciable amount of fines	Non plastic fines – for identification see ML below	SM	SAND, excess silty fines; poorly graded sand-silt mixtures
			Plastic fines – for identification see CL below	SC	SAND excess clayey fines; poorly graded sand-clay mixtures.

GRAIN SIZE CURVE to be used to identify soil fractions.

LABORATORY CLASSIFICATION CRITERIA

Coarse grained soils classified on basis of percentage of fines, as follows

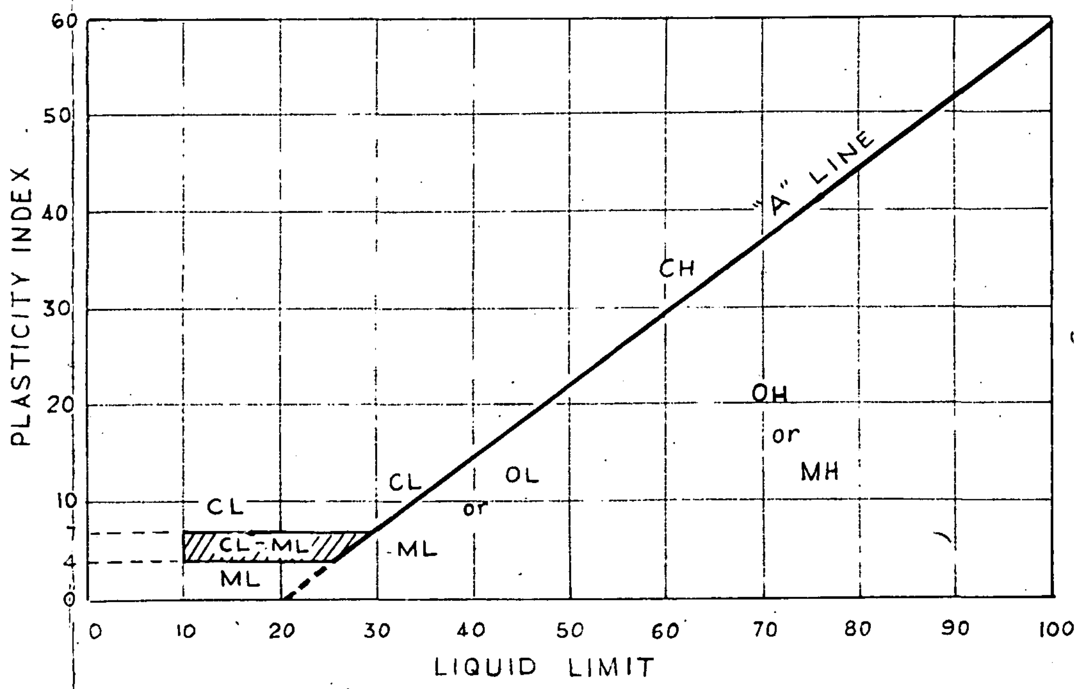
PERCENT OF FINES	GRAVELS	SANDS
Less than 5	GW, GP	SW, SP
More than 12	GM, GC	SM, SC
5 to 12	Borderline cases, use 2 symbols	

Group symbol	Criteria	
GW	$Cu = \frac{D_{60}}{D_{10}}$ Greater than 4; $Cc = \frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ Between one and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with PI greater than 7	
SW	$Cu = \frac{D_{60}}{D_{10}}$ Greater than 6; $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with PI greater than 7	

Fine grained soils

FIELD INVESTIGATION PROCEDURES on fraction smaller than 0.4mm. (passing B.S. 36 sieve)

Major division	Subdivision	SOIL CAST (wet soil)	SOIL THREAD	SHINE	DILATANCY	ODOUR	DRY STRENGTH	GROUP SYMBOL	GROUP NAME (and typical materials)
FINE GRAINED SOILS More than 50% of material is smaller than No. 200 B.S. sieve size.	SILTS AND CLAYS Liquid limit less than 50	Forms fragile cast Cracks form when kneaded while moist	Thick crumbly thread; easily broken	None to very dull	Distinct	Not significant	None to slight	ML	SILT SOIL, low plasticity; inorganic silts and very fine silty or clayey sands, rock flour.
		Cast maybe handled freely without breaking. Can be kneaded moist without cracking. Material adheres to the hand.	Thread can be pointed as fine as a lead pencil, but is fragile.	Moderate	None to slight	Not significant	Moderate	CL	CLAY SOIL, low plasticity; inorganic clays of low to medium plasticity, gravelly clays, sandy clays silty clays, lean clays
		Cast fragile to cohesive material will adhere somewhat to the hand.	Soft, weak thread.	None to very dull	Slight to distinct	Decayed organic matter	Low	OL	ORGANIC SOIL low plasticity; organic silts and silt clays of low plasticity
	SILTS AND CLAYS Liquid limit more than 50	Moderately plastic and cohesive. Material adheres somewhat to the hand	Weak to medium thread. May be crumbly.	Dull	None to slight	Not significant	Moderate Powdered soil feels floury	MH	SILT SOIL, high plasticity; inorganic silts, micaceous or diatomaceous fine sandy or silty soils elastic silts.
		Very plastic and cohesive. Material very sticky to the hand. Greasy to to touch.	Very tough thread Can be rolled to a pin point.	Very glossy	None	Strong earthy.	High to very high. Cannot be powdered by finger pressure	CH	CLAY SOIL, high plasticity; inorganic clays of high plasticity, fat clays
		Plastic and cohesive. Feels slightly spongy Greasy to touch.	Weak to medium thread. Often soft and fibrous	Moderate to very glossy	None	Decayed organic matter	Moderate to high. Powdered soil may be fibrous.	OH	ORGANIC SOIL, high plasticity; organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by colour, odour, spongy feel and frequently by fibrous texture.						Pt	PEATY SOIL; Peat and other highly organic soils.



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

NOTE: BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are shown as a combination of two group symbols, e.g. GW – GC, well graded gravel with clay binder.

Based on "The Unified Soil Classification System" United States Department of the Interior, Bureau of Reclamation "Earth Manual" First Edition, Denver COLORADO 1960

APPENDIX

64-246
M.G.

FIG. 6

TRIM LINE

REPORT ON FOUNDATION INVESTIGATION FOR

THE CROYDON GRADE SEPARATION

Prepared for:

THE HIGHWAYS DEPARTMENT

By:

KINNAIRD HILL deROHAN and YOUNG PTY. LTD.

ADELAIDE

JANUARY 1973

AN-5202

REPORT NO. AN5202/1

CONTENTS

APPENDICES

APPENDIX A

Item	Reference No.
Test Hole Log Bore No. CH1	S73-011
Test Hole Log Bore No. CH2	S73-012
Test Hole Log Bore No. CH3	S73-013
Test Hole Log Bore No. CH4	S73-014

FIGURES

1.0 INTRODUCTION

This foundation investigation has been carried out in connection with the proposal to grade separate South Road and the railway line from Adelaide to Pt. Adelaide.

It is proposed to raise the rail level about 1.5m and to take South Road below the railway line. This will necessitate a bridge to carry the double railway track over the full width of the roadway and the battered slopes of the excavation.

Four test bores (CH1, CH2, CH3 and CH4) have been put down with a percussion drill by the Department of Mines, and samples from CH1 and CH2 were tested at the University of Adelaide by an officer of the South Australian Railways. Samples from CH3 and CH4 were tested in the laboratory of Kenneth W.G. Smith and Associates.

The location of the test bores is shown on Figure 1, the bore logs are given in Appendix A and the test results are summarised in Figure 2.

2.0 DESCRIPTION OF SITE

The site of the test drilling was relatively flat and is in a closely built up area crossed by a major road and railway line.

No severely adverse drainage conditions were observed.

3.0 DESCRIPTION OF SOIL PROFILE

Detailed bore logs have been prepared from the Department of Mines logs and these are given in Appendix A.

All the bores showed alluvial materials for the full depth of drilling (up to 21.4m) but there was some variation in the materials occurring at the same depth in the different holes. Bore CH4 showed more silt throughout the profile than the other bores. Materials encountered were sands, silts and clays together with a minor amount of gravel in CH1 and CH3 at a depth of about 15m. All materials were considerably intermixed, and clayey sand, sandy clay, silty clay and clayey silts were predominant.

A watertable was encountered at a depth of about 9 to 11m in each bore. Water level readings taken over a period of 9 months showed a fluctuation of only 0.5m.

The consistency of the materials within the profiles was classified as moderately compact to compact for the sandy materials and stiff to very stiff for the clayey materials. However, the Standard Penetrometer Test readings taken during the drilling were relatively low for this classification (about 8 to 12) with the exception of a firmer layer at 14 to 16m which gave readings of 31, 22, 18 and 37 blows per foot.

3.0 DESCRIPTION OF SOIL PROFILE (Cont'd)

Below this firmer layer the S.P.T. values reduced to 15, 17, 5 and 16 blows per foot.

The soil profiles in general consist of firm or compact silty clay and silty sands with a slightly firmer layer at a depth of about 15m. No hard bearing layer was encountered to a depth of 21m.

4.0 SOIL CHARACTERISTICS

Part of the testing was carried out in each of two independant laboratories. The test results were quite consistent between the two laboratories.

Although the visual identification of the bore logs indicated a considerable variation in materials the test results showed relatively good agreement between the four test holes. This similarity of test properties is also confirmed by the Atterberg Classification tests (Liquid Limit and Plastic Limit) carried out on samples from CH1 and CH2. These results were as follows:

Depth (m)	Bore	Visual Identification	Liquid Limit (%)	Plastic Limit (%)	Linear Shrinkage (%)
6	CH1	Sandy CLAY	30	18	9
	CH2	Sandy CLAY	25	14	7
9	CH1	Sandy CLAY	37	21	9
	CH2	Sandy CLAY	38	23	10
12	CH1	Clayey SAND	34	20	9
	CH2	Clayey SAND	27	13	6
15	CH1	Clayey SAND	46	26	11
	CH2	Clayey SAND	37	20	10
18	CH1	Clayey SAND	29	11	6
	CH2	Clayey SAND	33	19	9
21	CH1	CLAY	59	39	16

This tabulation indicates the similarity of test results for the sandy clays and the clayey sands.

The important test results are those which indicate the soil strength and the soil compressibility. The apparent cohesion and the angle of internal shearing resistance enable the shear strength of the soil to be calculated while the coefficient of compressibility enables the consolidation settlement to be estimated.

The cohesion was found to be relatively low, while the corresponding angle of internal shearing resistance showed a wide variation (from 5 to 25°) for the materials from the surface down to a depth of 6m. Between 6 and 12m the value reduced from 20° to 5° and it remained at 5° until a depth of 16m was reached. Between 16 and 18m the value increased slightly to about 10°.

The coefficient of compressibility showed considerable variation, particularly above a depth of 12m. Below 12m the value was in the medium to low range, but above 12m the range was from high to low.

5.0 SELECTION OF FOOTING TYPES

The high coefficient of compressibility values in some of the materials above 12m indicated that consolidation settlement of high level spread footings could be a problem. The variability of the coefficient of compressibility also indicated that differential settlement of this type of footing system could be excessive.

An alternative system using piles or piers also has problems due to the absence of a hard stratum for end bearing piles, and the low angle of internal shearing resistance of the materials throughout the profile which would lead to extremely long friction piles being necessary.

To enable the most economical and satisfactory footing system to be selected a preliminary design of these two different footing types has been carried out.

6.0 SPREAD FOOTINGS

The most heavily loaded footings on the bridge are those under the piers and a preliminary design for these was carried out by, firstly, calculating the soil allowable bearing pressure at varying depths and determining the required footing size, and then calculating the consolidation settlement due to long term loading of this footing.

Due to the geometry of the bridge the highest possible founding level for the piers was about 6m, and the calculated allowable bearing pressure at varying depths below this level was found to be:

Depth (m)	Allowable Bearing Pressure (k.s.f.)
6.4	4.4
7.6	3.1 + 0.03 x B
8.9	0.94
10.4	3.0

Where B is the footing width in feet.

A design value of 3.0 k.s.f. at a depth of 6m was selected as the low value at a depth of 8.9m was a thin local layer found in CH4 only.

This allowable bearing pressure gave a pier footing 12m long x 2.1m wide.

6.0 SPREAD FOOTINGS (Cont'd)

The likely consolidation of this footing under the action of Dead Load plus 50% of Live Load was then calculated using the following coefficients of compressibility which were obtained from the test results:

Depth	Coefficient of Compressibility (ft^2/ton)
6 - 7.6m	5×10^{-3}
7.6 - 10.7m	20×10^{-3}
10.7 - 18m	8×10^{-3}

The calculated consolidation settlement was found to be 30mm (1.2 inches).

Spread footings are not suitable for this bridge as a long term settlement of 1.2 inches could occur at the piers, and the differential settlement between the piers and the abutments could be excessive. The differential settlement could also be increased by the variability which occurs in the compressibility of the upper soil layers.

It appears that differential settlement of the order of 0.5 inches could be expected if spread footings were used, and as the bridge superstructure must be provided with continuity over the piers to avoid an excessively deep deck, a differential settlement of this order would introduce excessive stresses into the deck system.

7.0 PILED FOOTINGS

As an alternative to the use of spread footings the use of piered or piled footings was investigated.

The allowable shaft resistance, and end bearing capacity for a common sized pile was calculated to assess the relative merits of frictional or end bearing type piles.

This calculation showed that shaft resistance would be relatively low and an excessively long pile would be required to develop a suitable pile working load if pure friction piles were adopted.

The end bearing calculation showed that a reasonable working capacity could be developed if the end bearing area of the pile was increased above the shaft diameter. The depth of pile founding did not have a very significant effect on the end bearing capacity.

As the allowable pile capacity was extremely sensitive to any increase in the end bearing area the use of piers having large under-reamed bases was considered, but as the under-reams would need to be constructed below the ground watertable in materials such as, sandy and silty clays and silty and clayey sands the possibility of under-ream collapse was considered to be very high.

7.0 PILED FOOTINGS (Cont'd)

The use of a formed insitu concrete pile having an enlarged base was then investigated as the most economical satisfactory alternative.

A pile having a shaft diameter of 20 inches and an enlarged base of 3'-0" diameter founded at a depth of about 15m below the natural surface level would give an ultimate load of 270K and a working load of 135K (60 tons) using a factor of safety of 2.

This pile is equivalent to a pile which is normally rated at 90 tons but it is down rated to 60 tons due to the absence of a stiff bearing layer at this particular site.

8.0 RECOMMENDATIONS

Piled footings are recommended to transfer the footing loads through the compressible soil layers to a depth of about 15m. This could be achieved economically by the use of a cast-insitu concrete pile with an enlarged base such as a Frankipile or Situpile. Piles of this type would need a shaft diameter of 20" and a base diameter of 3'-0" giving a working load of 135K (60 tons). The founding level is estimated to be about 15m below the original natural surface level.

Pile tests are normally carried out on piles of this type to confirm that an adequate load carrying capacity has been reached, and it is recommended that two tests be carried out at this site.

TEST HOLE LOG

BORE NO. CH1

R.L. of Surface 47.5 m. Logged 5/4/71

SOIL TYPE Geological Description	DEPTH (METRES)	GRAPHIC LOG	CONSIST REL. DENSITY	MOISTURE CONTENT	WATER LEVELS	PENETRATION DATA BLOWS/FT	PENETRATION DATA TYPE
Brown SAND (FILLING			Loose	Dry			
Red brown clayey SAND	1 2		Dense	Dry to Moist			
Red brown sandy CLAY	3 4 5		Stiff	Dry to Moist		5	SPT
Red brown and grey sandy CLAY	6 7 8 9 10		Stiff	Dry to Moist	29/3/71	11 9	SPT SPT
Brown clayey SAND	11 12		Dense	Dry to Moist			
Red brown to grey sandy CLAY	13		Stiff	Dry to Moist		12	SPT
Mottled red brown to yellow clayey SAND and GRAVEL	14 15 16		Dense	Moist		18 10	SPT SPT
Red brown & grey CLAY	17		Very Stiff	Moist			
Mottled red brown and grey clayey SAND	18 19 20		Dense	Moist		5	SPT
Red brown to grey CLAY	21		Very stiff	Dry to Moist			
	22	End of Hole					

CROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
APPENDIX A

SCALE	DATE	JOB NUMBER
-	JAN '73	AN 5202
DRAWN	**EXAMINED**	**SKETCH NUMBER**
R.G.P.	-	S73-011

KINNAIRD HILL de ROHAN and YOUNG PTY. LTD.

TEST HOLE LOG

BORE NO. CH2

R.L. of Surface 48.0 m.

Logged 4/3/71

SOIL TYPE Geological Description	DEPTH (METRES)	GRAPHIC LOG	CONSIST REL. DENSITY	MOISTURE CONTENT	WATER LEVELS	PENETRATION DATA BLOWS/FT	TYPE
Light brown silty SAND (FILLING)			Loose	Dry			
Brown clayey SAND	1		Loose	Dry			
Yellow red clayey SAND	2		Dense				
Red brown slightly sandy CLAY	3		Very Stiff	Dry		17	SPT
Red clayey SAND	4		Dense				
Red brown, sandy silty CLAY	5–6			Dry		11	SPT
Red, mottled green sandy CLAY	7–10		Stiff	Dry		8	SPT
					26/2/71		
				Moist		6	SPT
Mottled red, grey-green clayey SAND	11–14		Dense	Wet		9	SPT
						7	SPT
Red clayey SAND	15		Dense	Wet		11	SPT
Mottled grey-red sandy silty CLAY	16–17		Very Stiff	Moist		31	SPT
Red grey clayey SAND	18		Dense	Wet		15	SPT
	19–22	End of Hole					

CROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
APPENDIX A

SCALE	DATE	JOB NUMBER
-	JAN '73	AN 5202
DRAWN	EXAMINED	SKETCH NUMBER
R.G.P.	-	S73-012

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TEST HOLE LOG SHEET 1 OF 1

BORE NO. CH.3

R.L. of Surface 48.4 m.

Logged 12/7/72

SOIL TYPE Geological Description	DEPTH (METRES)	GRAPHIC LOG	CONSIST REL. DENSITY	MOISTURE CONTENT	WATER LEVELS	PENETRATION DATA BLOWS/FT	TYPE
Dark grey sandy SILT			Moderately Compact to very Compact	Dry			
Pale brown to red brown slightly sandy SILT	1 2 3					9 12	SPT SPT
Red brown silty CLAY	4 5		Stiff			8	SPT
Dark brown to reddish brown silty CLAY	6 7 8 9		Stiff to very stiff	Moist		18 8	SPT SPT
Orange brown silty SAND			Medium Dense	Moist	29/6/72	12	SPT
Reddish brown silty CLAY	10		Very Stiff	Moist			
Mottled yellow-grey clayey SILT with - some sand	11 12 13		Medium Compact to Compact	Wet		10 11	SPT SPT
Sandy, silty GRAVEL	14 15		Medium dense to dense	Moist to Wet		37	SPT
Silty SAND and orange brown clayey SILT	16 17 18		Compact	Moist to Wet Moist		15 16	SPT SPT
	19 20 21 22	End of Hole					

CROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
APPENDIX A

SCALE	DATE	JOB NUMBER
-	JAN '73	AN 5202
DRAWN	EXAMINED	SKETCH NUMBER
R.G.P.	-	S73-013

KINNAIRD HILL de ROHAN and YOUNG PTY. LTD.

BORE NO. CH4

R.L. of Surface 48.2 m.

Logged 13/7/72

SOIL TYPE Geological Description	DEPTH (METRES)	GRAPHIC LOG	CONSIST REL. DENSITY	MOISTURE CONTENT	WATER LEVELS	PENETRATION DATA BLOWS/FT	PENETRATION DATA TYPE
Dark brown sandy SILT			Loose to Compact	Dry			
Reddish brown sandy SILT	1						
	2					10	SPT
Reddish brown silty CLAY	3		Very Stiff	Moist			
Yellow brown sandy SILT	4		Mod. Compact to compact			12	SPT
Dark brown to red-brown silty CLAY	5		Very Stiff			9	SPT
	6						
Sandy silty CLAY	7					19	SPT
Brown clayey slightly sandy clayey SILT	8		Mod-erately compact to compact	Moist to Wet		13	SPT
	9				6/7/72	7	SPT
	10						
	11					14	SPT
	12						
Mottled red brown and grey silt fine SAND	13		Loose to medium dense	Moist to wet		9	SPT
	14					13	SPT
Medium to coarse grained SAND	15						
Mottled orange brown and grey fine sandy SILT	16		Compact	Moist to wet		22	SPT
	17					17	SPT
Silty CLAY	18						
Silty fine SAND							
	19	End of Hole					
	20						
	21						
	22						

CROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
APPENDIX A

SCALE	DATE	JOB NUMBER
-	JAN'73	AN 5202
DRAWN	EXAMINED	SKETCH NUMBER
R.G.P.	-	S73-014

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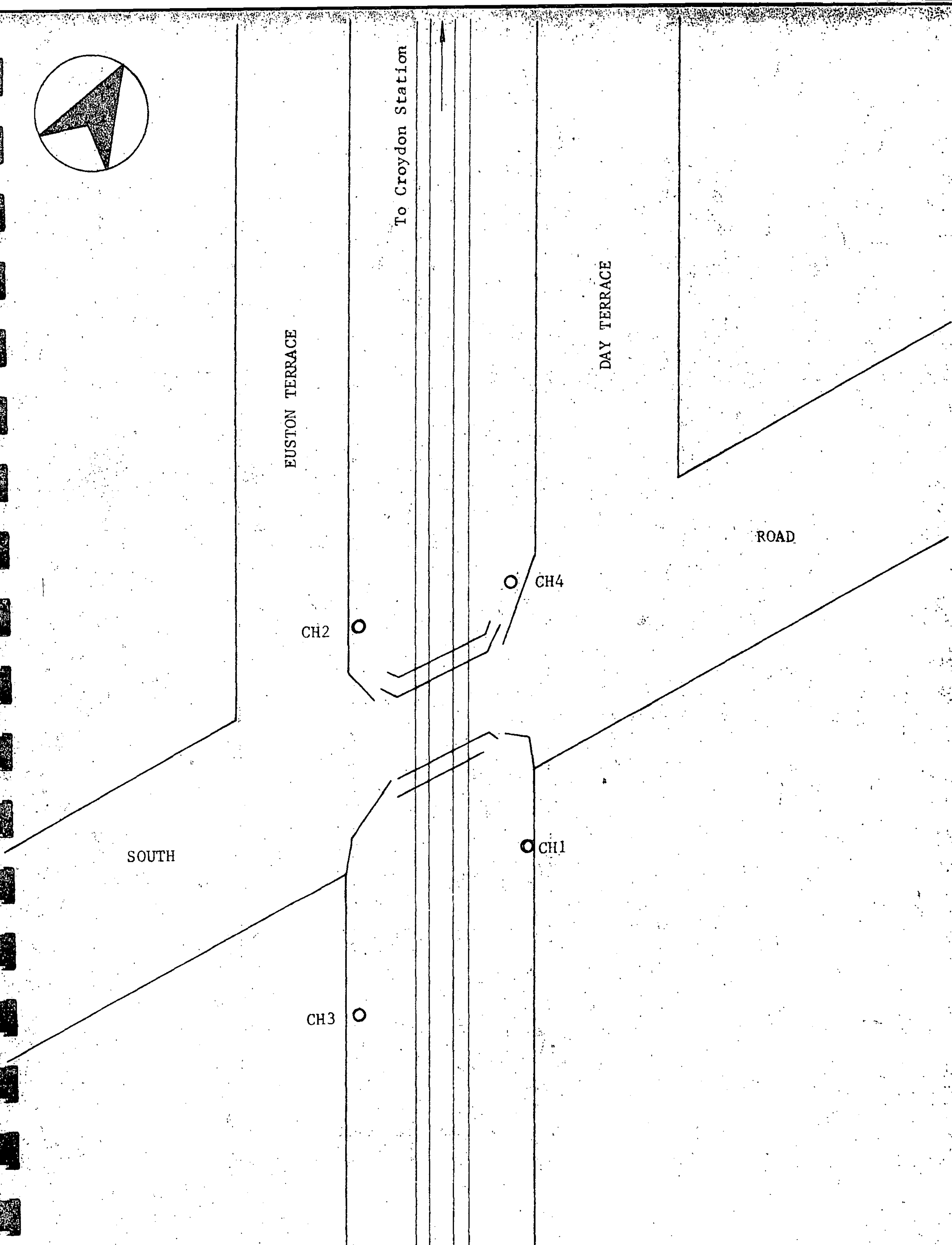

FIGURE 1

CROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
LOCATION OF TEST HOLES

SCALE	DATE	JOB NUMBER
1:500	Jan'73	AN5202
DRAWN	EXAMINED	SKETCH NUMBER
R.G.P.	-	S73-015

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GROYDON GRADE SEPARATION
FOUNDATION INVESTIGATION
SOIL TEST RESULTS

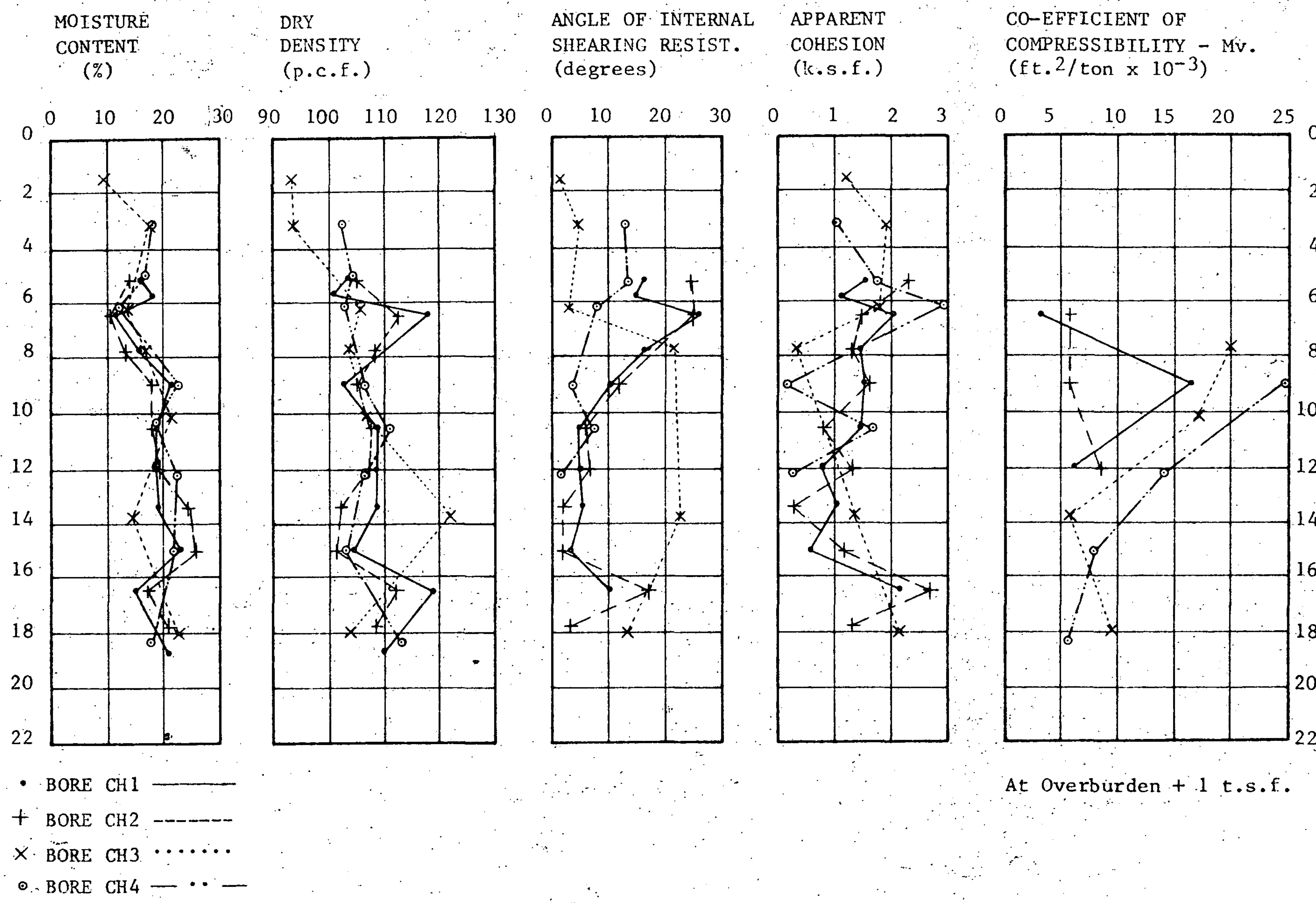


FIGURE 2

SCALE -	DATE JAN '73
DRAWN R.G.P.	EXAMINED -
JOB NUMBER AN5202	SKETCH NUMBER S73-016

KINNAIRD HILL de ROHAN and YOUNG PTY LTD

KENNETH W. G SMITH & ASSOCIATES
CONSULTING CIVIL ENGINEERS
KENNETH W. G. SMITH, B.E., M.I.C.E., M.I.E.Aust.
JOHN ~~N. YEATES, C.B.E., F.I.E.Aust., L.S., M.I.Mun.E. (Lond.), F.R.A.P.I.~~
~~TREVOR M. COAD, B.Tech., M.I.E.Aust.~~
STEFAN WAWRYK, B.E., M.I.E.Aust.

RESEARCH HOUSE
209 GREENHILL ROAD
EASTWOOD, S.A. 5063

TESTING LABORATORY:
BIRKIN STREET ENTRANCE
SOILS : CONCRETE : ASPHALT

Phone: 71 7892

BOB EVANS

SW/LVDB

REF. Nos. 184/72
Your Ref. AN-5202

Kinnaird Hill de Rohan & Young,
46 Fullarton Road,
NORWOOD. S.A. 5067.

21st August, 1972.

Attention: Mr. D. F. Fisher.

Dear Sir,

Soil Tests for the Croydon Grade Separation

We have completed the laboratory tests on samples from two bores. The results of 8 consolidation tests and 12 triaxial tests are being forwarded herewith.

The test samples and testing procedures were selected in consultation with Mr. R. G. Perry. The details were as follows:

(1) Consolidation tests were done in the loading range 1/8 - 4 tons/sq.ft., with unloading from 2 to 1 t.s.f. during the test run. The samples were:

Bore CH3	7.5 - 7.8 m
	10.5 - 10.8 m
	13.5 - 13.8 m
	17.85 - 18.15m
Bore CH4	9.0 - 9.3 m
	12.0 - 12.3 m
	15.0 - 15.3 m
	18.0 - 18.3 m

(2) The triaxial tests were quick undrained tests (8) with the first stage at the estimated O/B pressure. 4 tests were on samples consolidated to the estimated average effective stress after a 20ft excavation. The samples were:

Bore CH3	1.5 - 1.8 m (QU)	7.5 - 7.8 m (CU)
	3.0 - 3.3 m (QU)	13.5 - 13.8 m (CU)
	6.0 - 6.3 m (QU)	17.85 - 18.15m (CU)
Bore CH4	3.1 - 3.3 m (QU)	9.0 - 9.3 m (QU)
	4.5 - 4.8 m (QU)	10.5 - 10.8 m (CU)
	6.0 - 6.3 m (QU)	12.0 - 12.3 m (QU)

The 10.5 - 10.8 m sample was substituted for one from the same depth in Bore CH3, which was damaged during setting up and could not be tested.

Tests on the following samples were also requested by Mr. Perry:

Bore CH3, 4.5 - 4.8 m - the sample was too friable for specimen preparation.
Bore CH4, 1.5 - 1.8 m - the sample was of quartzite gravel in clayey sand matrix, unsuitable for specimen preparation. The water content and dry density were measured:

$w = 5.4\%$, $\gamma_d = 107.2$ p.c.f.

This completes the work requested to date. Please advise us about the disposal of six samples still held.

Yours faithfully,
Kenneth W. G. Smith & Associates.

Chartered Engineer (Aust)

Enc.

KENNETH W. G. SMITH & ASSOCIATES.

Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref. No. 184/72

Bore No. CH 3 Depth 7.5-7.8 m Date ______ Sample No. A88

Description of Material Red - brown

SANDY CLAY

Other tests

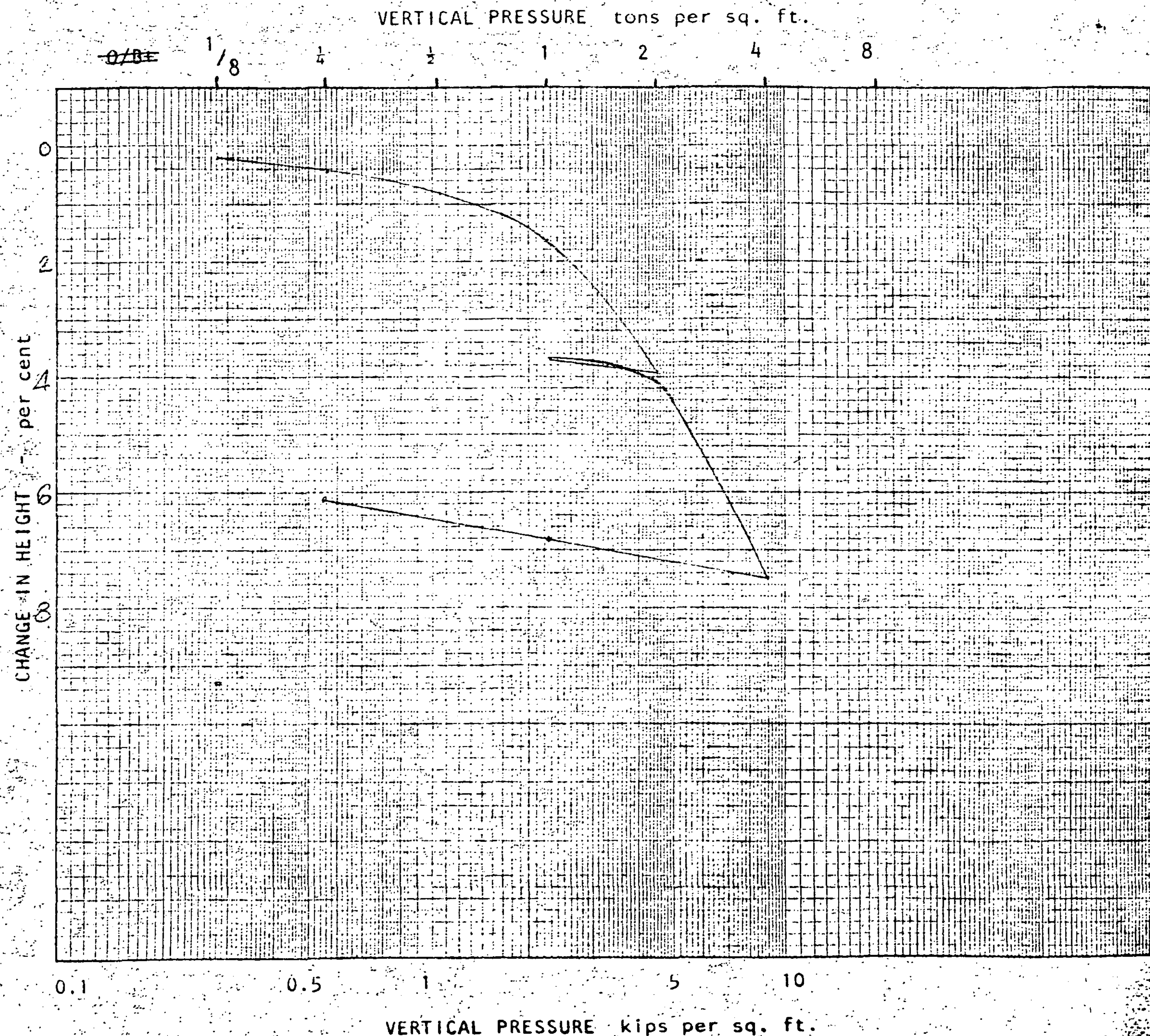
	Initial	Final
Moisture content %	16.0	18.5
Dry Density p.c.f.	103.9	110.5

Void ratio

Overburden pressure - Swell pressure —

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
0/B+ 1/8		
0/B+ ¼		
0/B+ ½		
0/B+ 1		
0/B+ 2		
0/B+ 4		
0/B+ 8		
0/B+ 16		



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Client Kinnaird Hill deRohan & Young

Project Croydon Grade Separation Ref.No. 184/72

Bore No. CH3 Depth 10.5-10.8 m Date ______ Sample No. A196

Description of Material Red-brown

SANDY CLAY

Other tests

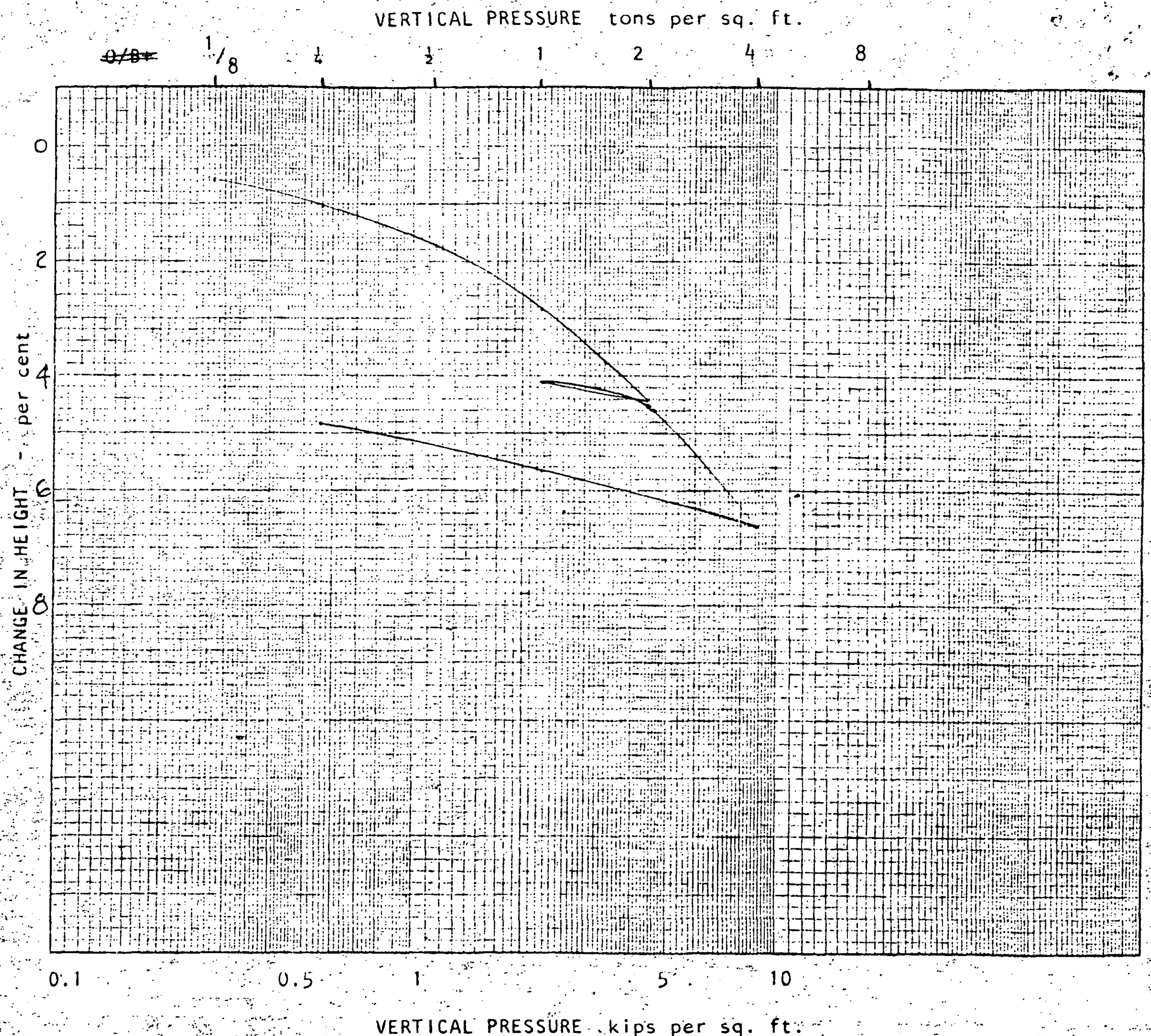
	Initial	Final
Moisture content %	21.4	19.5
Dry Density p.c.f.	107.7	112.1

Void ratio

Overburden pressure ______ Swell pressure ______

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
0/B+ 1/8		
0/B+ 1/4		
0/B+ 1/2		
0/B+ 1		
0/B+ 2		
0/B+ 4		
0/B+ 8		
0/B+ 16		



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Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref. No. 184/72

Bore No. CH3 Depth 13.5-13.8 m Date ______ Sample No. A92

Description of Material Red-brown SILTY SAND

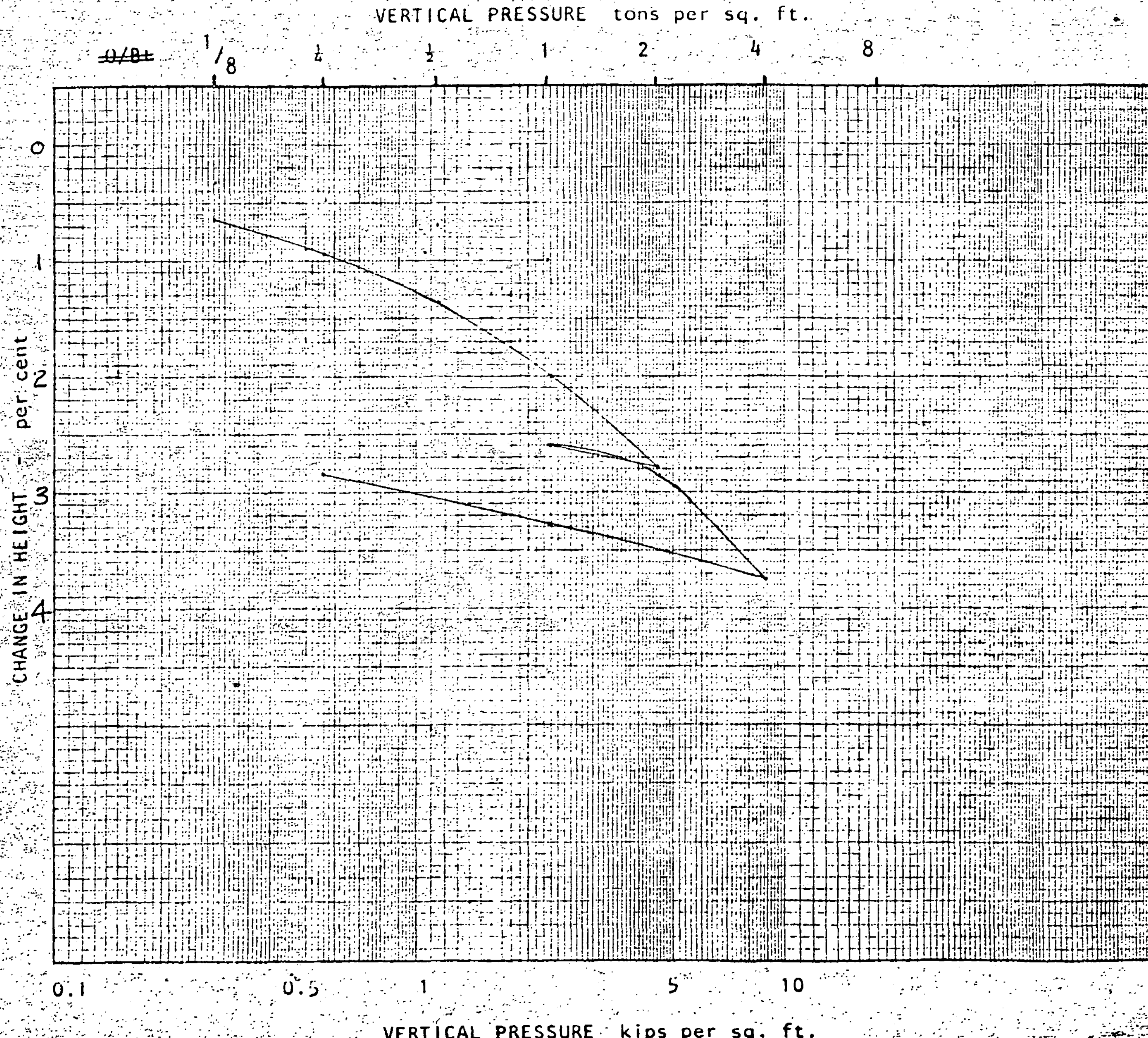
Other tests

	Initial	Final
Moisture content %	15.0	13.2
Dry Density p.c.f.	121.6	124.9
Void ratio		

Overburden pressure ______ Swell pressure —

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
O/B+ 1/8		
O/B+ 1/4		
O/B+ 1/2		
O/B+ 1		
O/B+ 2		
O/B+ 4		
O/B+ 8		
O/B+ 16		



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Client Kinnaird Hill deRohan & Young

Project Croydon Grade Separation Ref.No. 184/72

Bore No. CH3 Depth 17.85 -18.15m Date ______ Sample No. A212

Description of Material Light brown SANDY CLAY

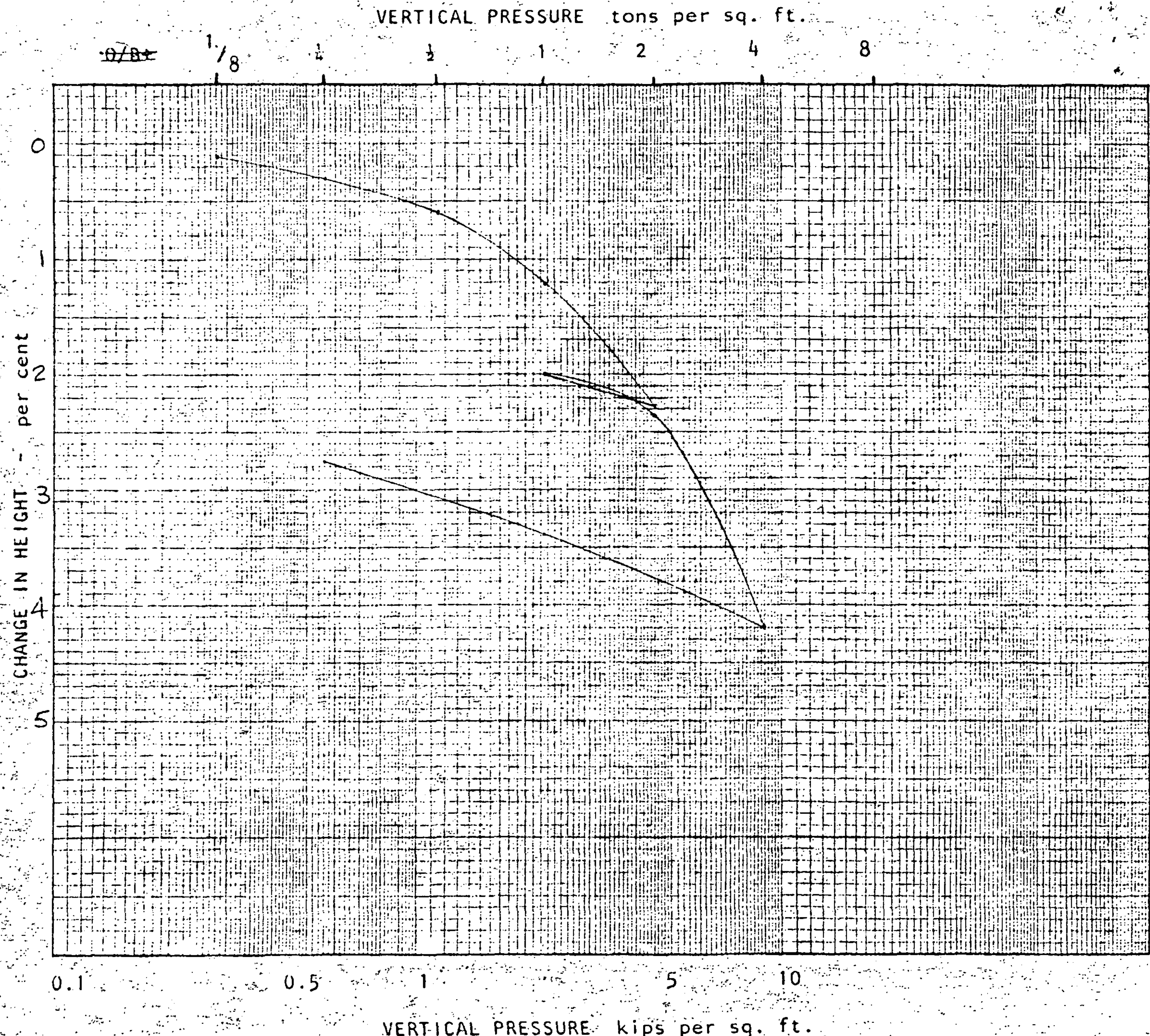
Other tests

	Initial	Final
Moisture content %	22.9	22.2
Dry Density p.c.f.	104.1	106.5
Void ratio		

Overburden pressure ______ Swell pressure —

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
0/B+ 1/8		
0/B+ 1/4		
0/B+ 1/2		
0/B+ 1		
0/B+ 2		
0/B+ 4		
0/B+ 8		
0/B+ 16		



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Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref.No.184/72

Bore No. CH4 Depth 9.0-9.3 m Date ______ Sample No. A 73

Description of Material Light brown SILTY CLAY

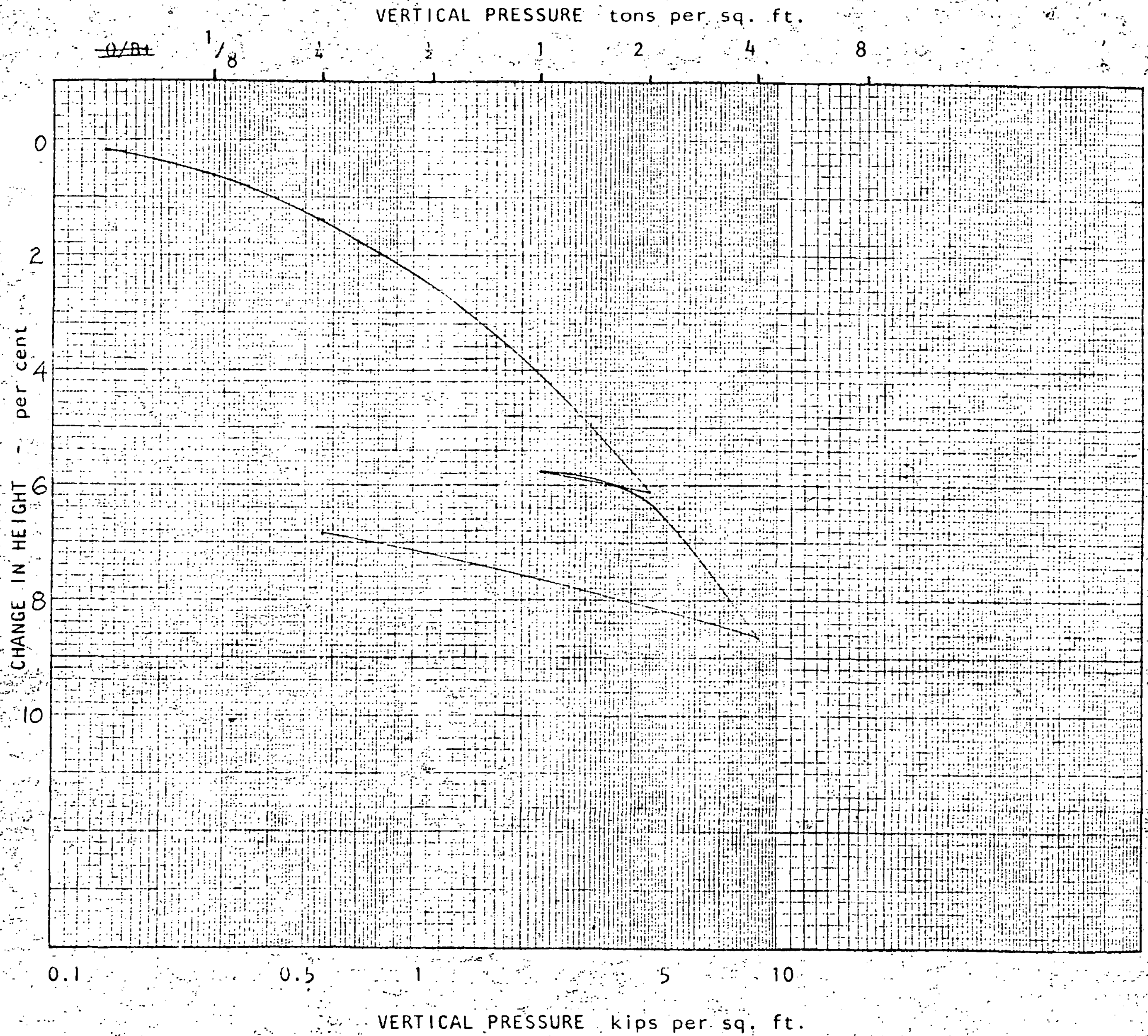
Other tests

	Initial	Final
Moisture content %	23.4	18.6
Dry Density p.c.f.	105.6	112.6
Void ratio		

Overburden pressure ______ Swell pressure —

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
O/B+ 1/8		
O/B+ ¼		
O/B+ ½		
O/B+ 1		
O/B+ 2		
O/B+ 4		
O/B+ 8		
O/B+ 16		



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Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref.No. 184/72

Bore No. CH4 Depth 12.0-12.3 m Date ______ Sample No. A114

Description of Material Yellow-brown

SILTY CLAY

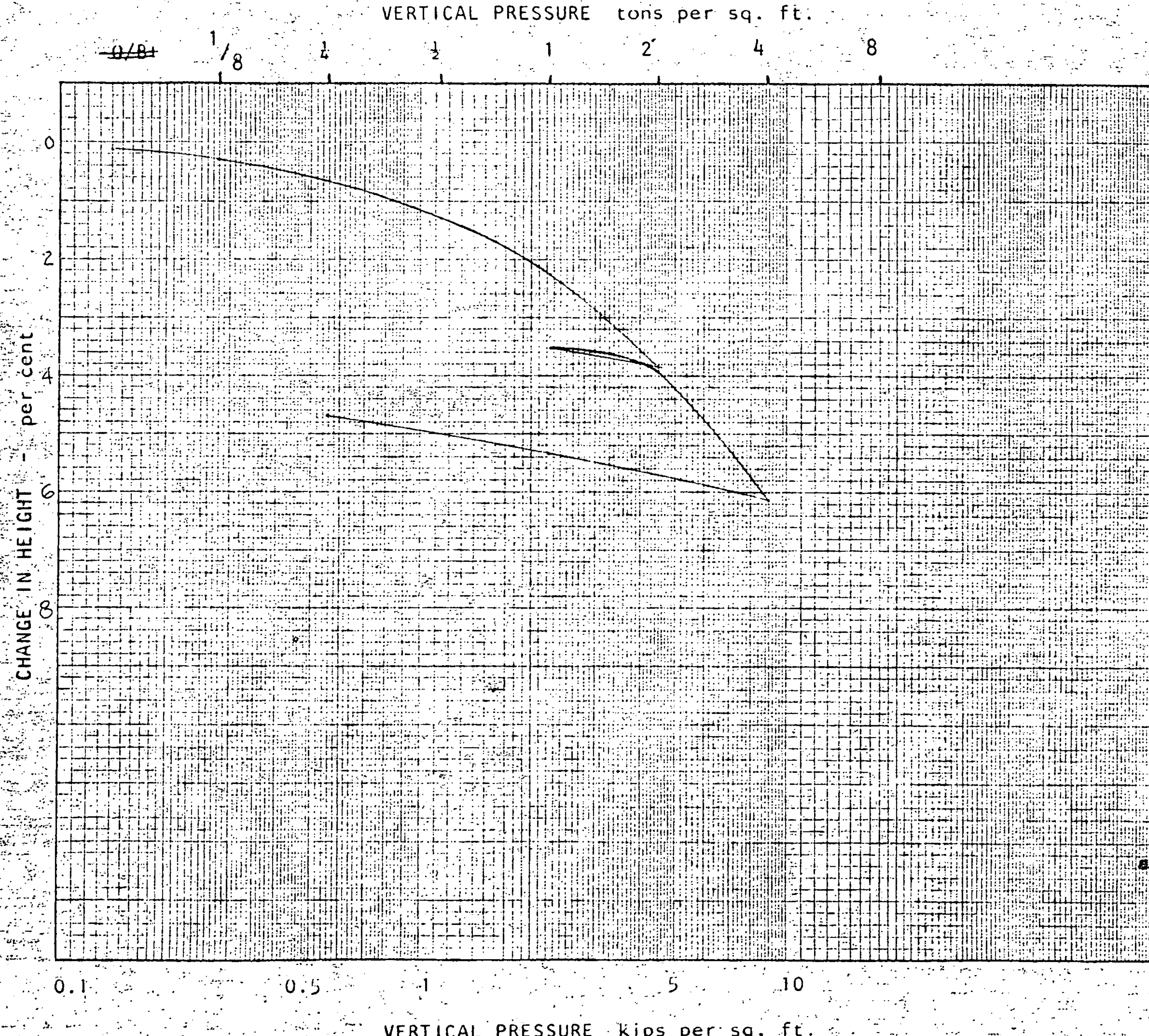
Other tests

	Initial	Final
Moisture content %	21.8	19.2
Dry Density p.c.f.	107.0	112.0
Void ratio		

Overburden pressure ______ Swell pressure ______

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
O/B+ 1/8		
O/B+ ¼		
O/B+ ½		
O/B+ 1		
O/B+ 2		
O/B+ 4		
O/B+ 8		
O/B+ 16		



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Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref.No. 184/72

Bore No. CH4 Depth 15.0-15.3 m Date ______ Sample No. A124

Description of Material Brown SILTY SANDY CLAY

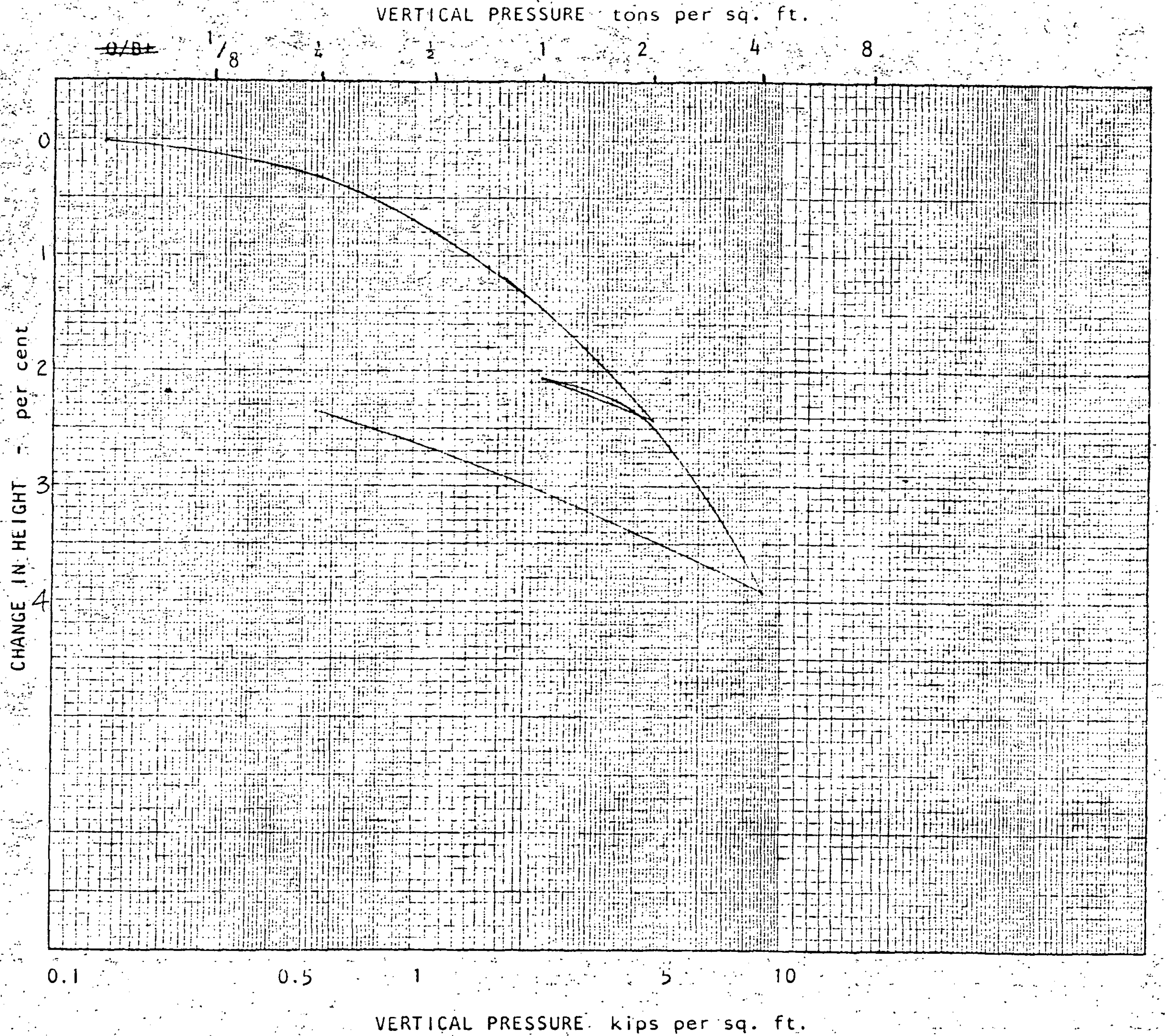
Other tests

	Initial	Final
Moisture content %	23.3	22.8
Dry Density p.c.f.	103.3	105.6
Void ratio		

Overburden pressure ______ Swell pressure —

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
0/B+ 1/8		
0/B+ 1/4		
0/B+ 1/2		
0/B+ 1		
0/B+ 2		
0/B+ 4		
0/B+ 8		
0/B+ 16		



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Client Kinnaird Hill de Rohan & Young

Project Croydon Grade Separation Ref.No. 184/72

Bore No. CH4 Depth 18.0-18.3 m Date ______ Sample No. A29

Description of Material Yellow - brown SANDY SILT

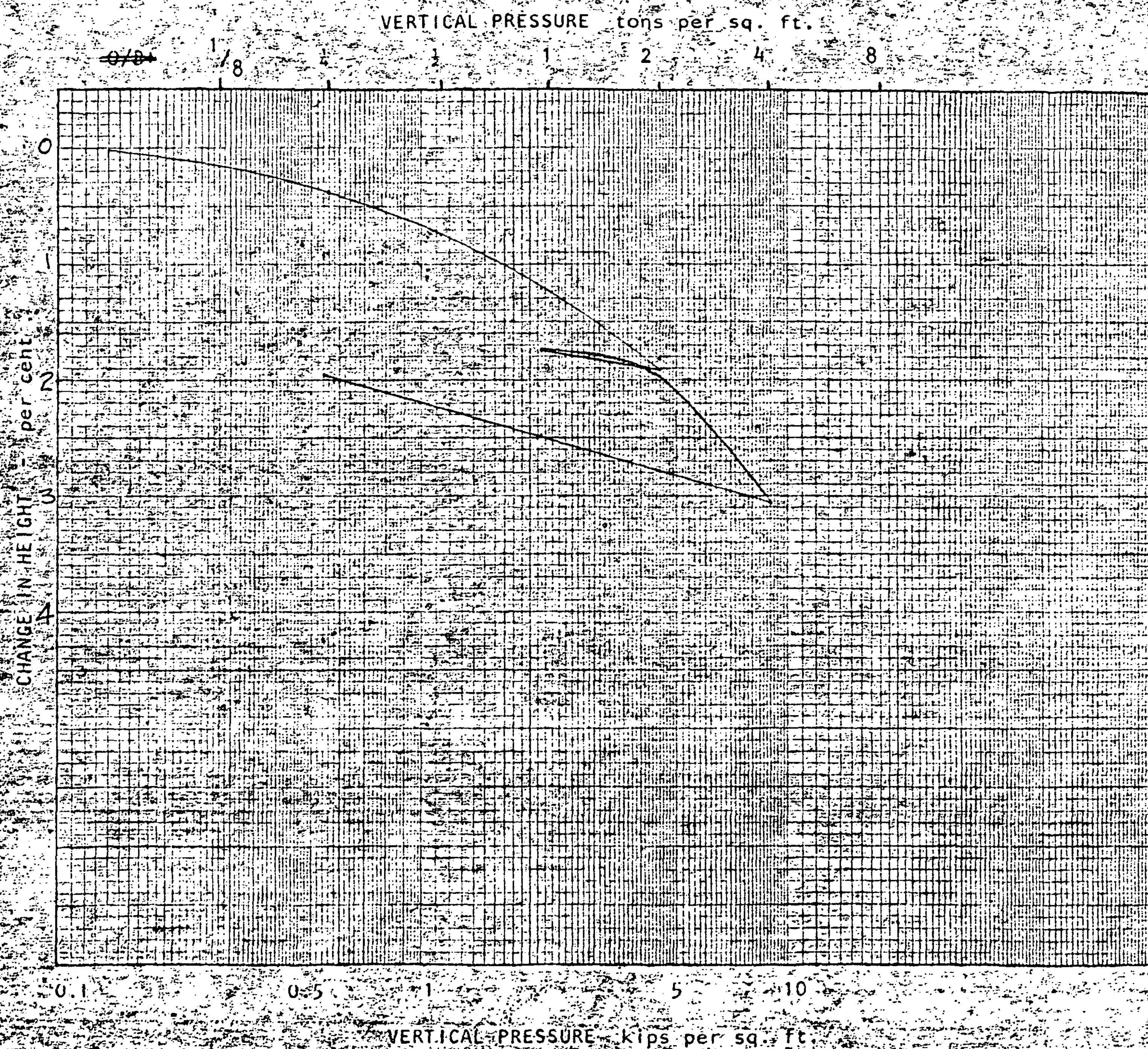
Other tests ______

	Initial	Final
Moisture content %	18.7	18.3
Dry Density p.c.f.	113.3	115.4
Void ratio		

Overburden pressure ______ Swell pressure ______

CONSOLIDATION TEST RESULTS

Vertical pressure Units	Units	Units
O/B+ 1/8		
O/B+ 1/4		
O/B+ 1/2		
O/B+ 1		
O/B+ 2		
O/B+ 4		
O/B+ 8		
O/B+ 16		



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Ref. No. 184/72 Sample No. A 182

Bore: CH3
Depth: 1.5-1.8m

Sample Length: 3.25
Sample Dia.: 1.5"

Cell Pressure: 5 p.s.i.
Water Content: 9.7%
Dry Density: 93.2 p.c.f.
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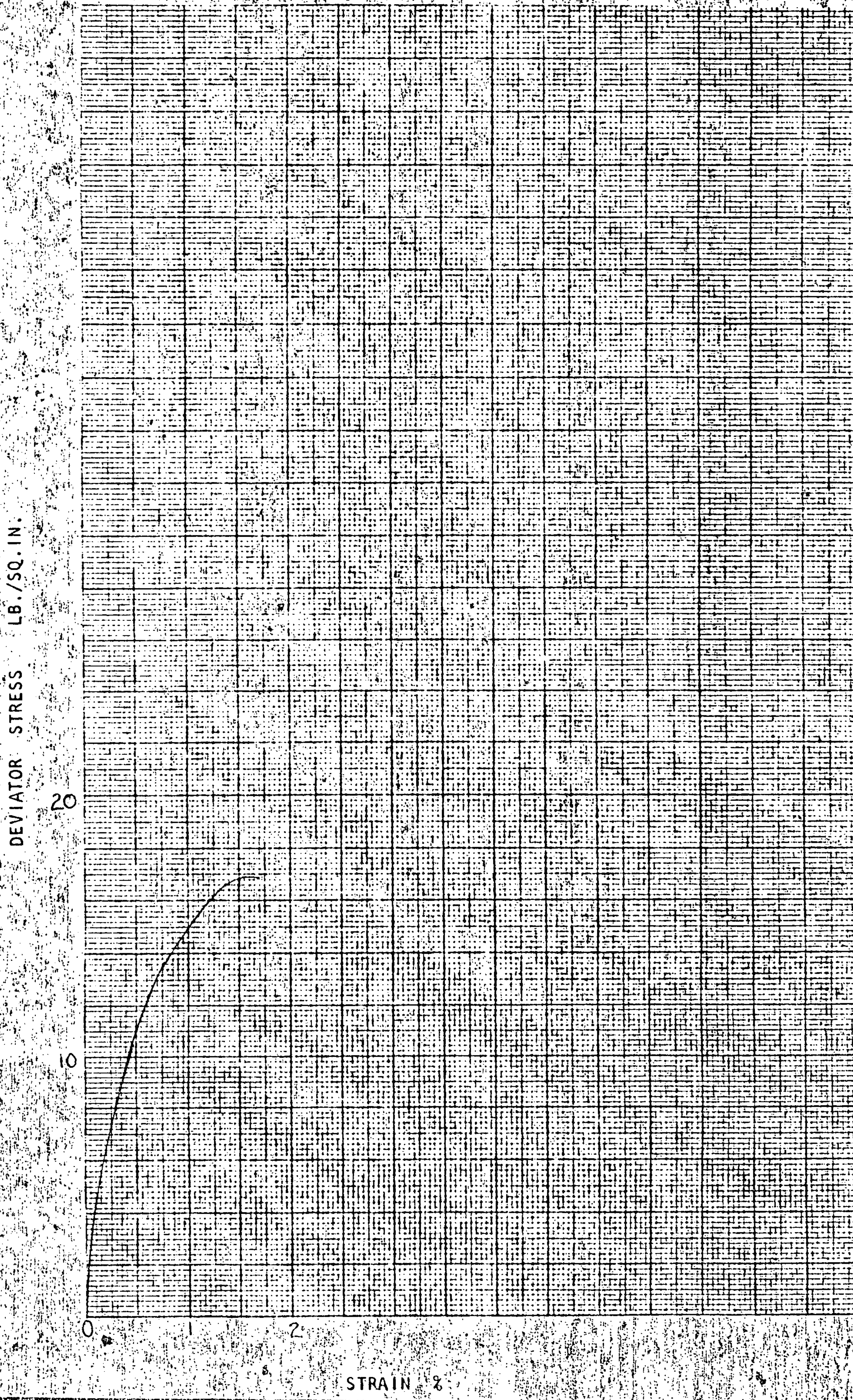
TRIAXIAL SHEAR TEST
STRESS – STRAIN DIAGRAM



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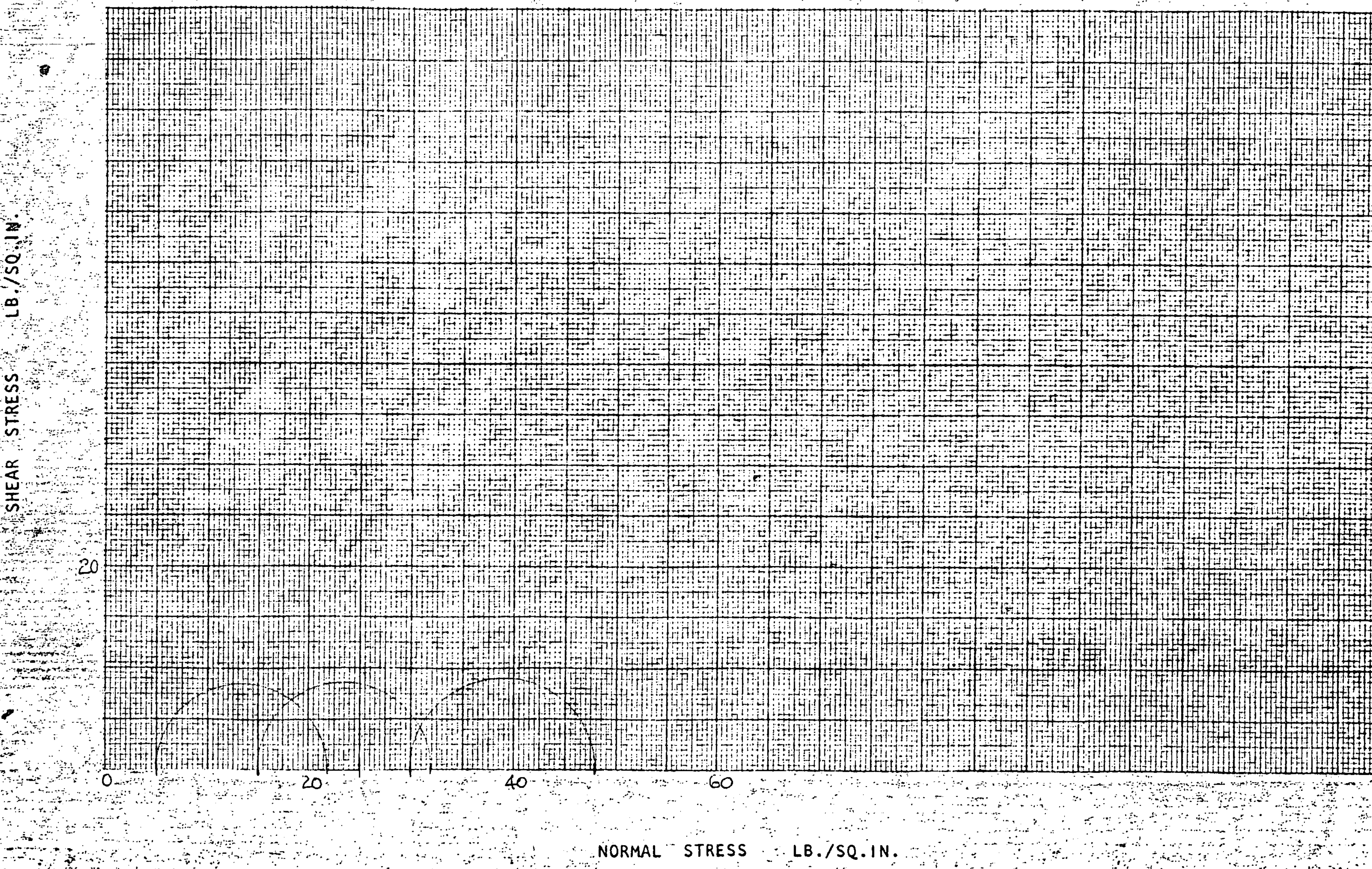
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A182
Bore: CH3
Depth: 1.5–1.8m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 5, 15, 30 p.s.i.
Water Content: 9.7%
Dry Density: 93.2 p.c.f.



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Ref. No. 184/72 Sample No. A270
Bore: CH 3
Depth: 3.0 – 3.3 m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 9.0 p.s.i.
Water Content: 17.6 %
Dry Density: 93.5 p.c.f.
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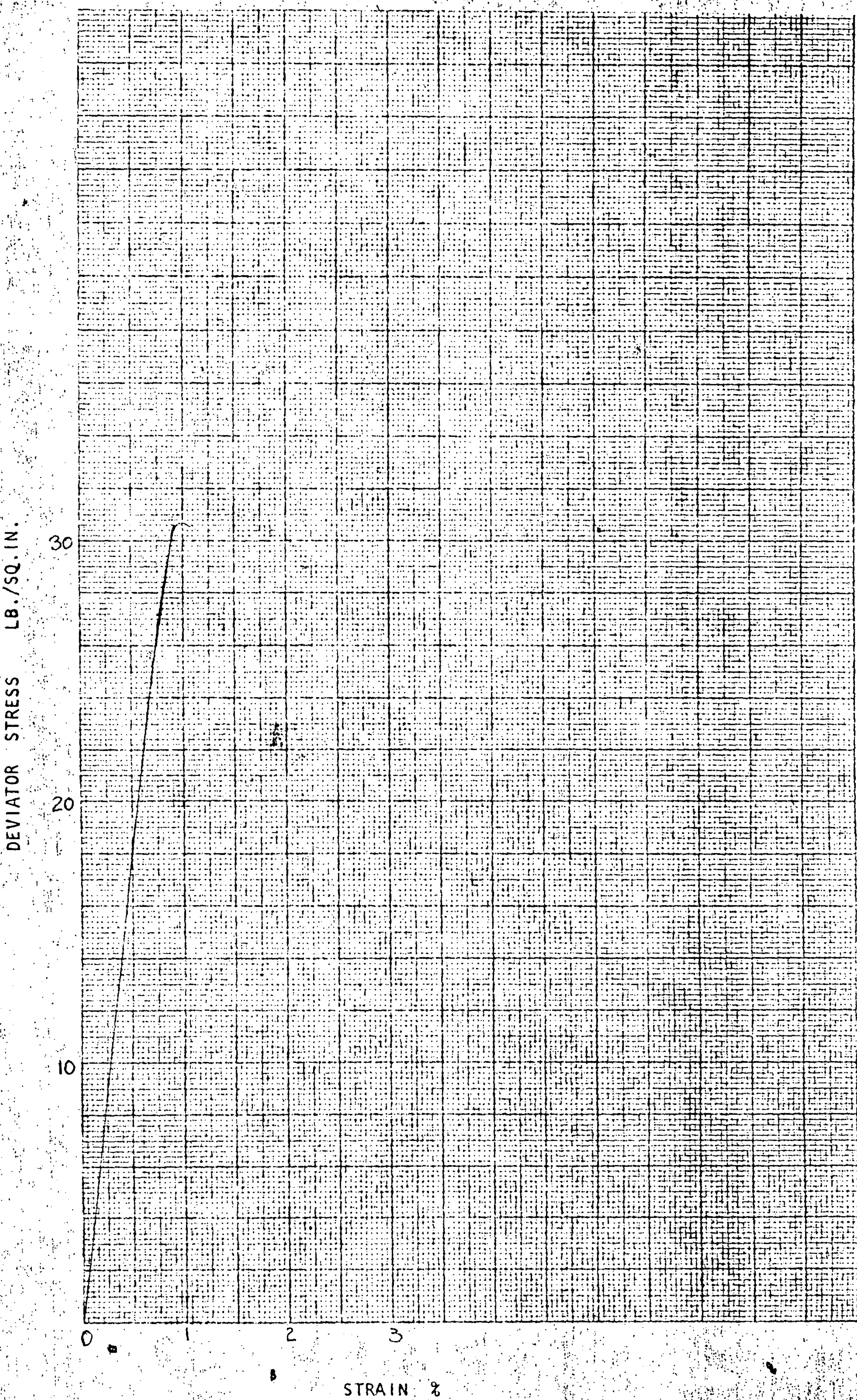
TRIAXIAL SHEAR TEST
STRESS—STRAIN DIAGRAM



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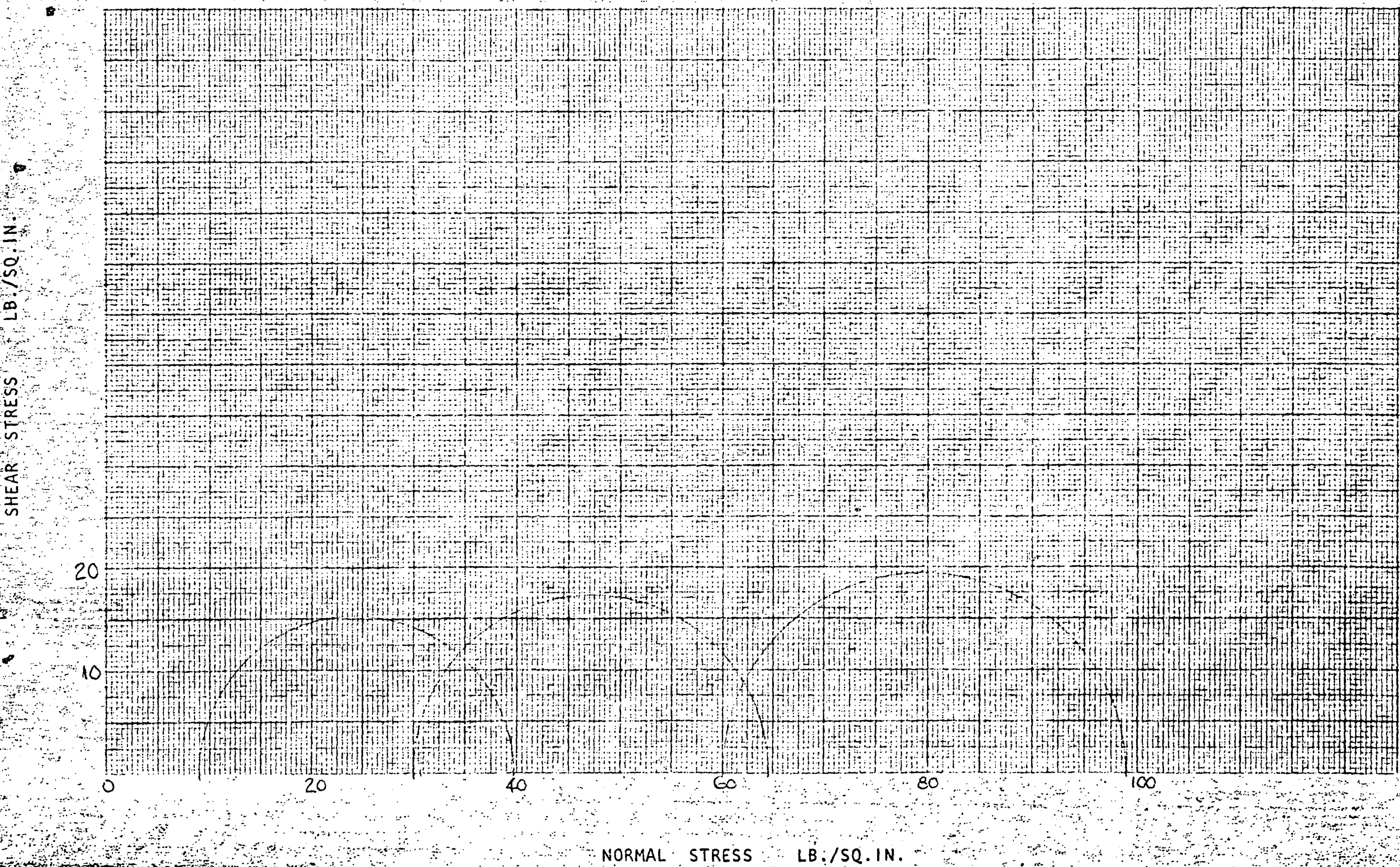
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref: No. 184/72 Sample No. A270
Bore: CH 3
Depth: 3.0 - 3.3 m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 9, 30, 60 p.s.i.
Water Content: 17.6 %
Dry Density: 93.5 p.c.f.



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Ref. No. 184/72 Sample No. A 216

Bore: CH 3
Depth: 6.0 - 6.3 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 18 p.s.i.
Water Content: 13.7%
Dry Density: 106.0 p.s.i.

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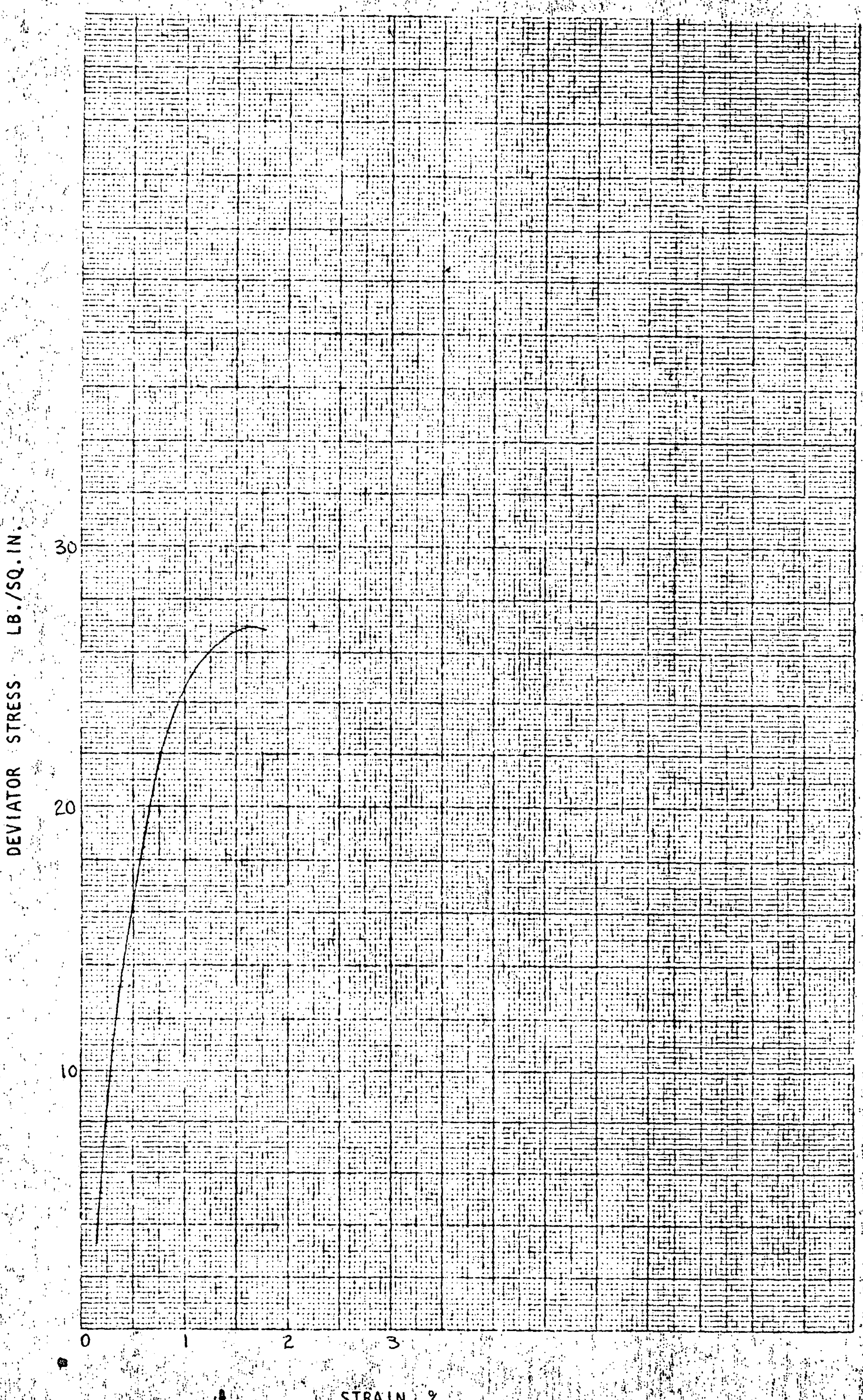
TRIAXIAL SHEAR TEST
STRESS—STRAIN DIAGRAM



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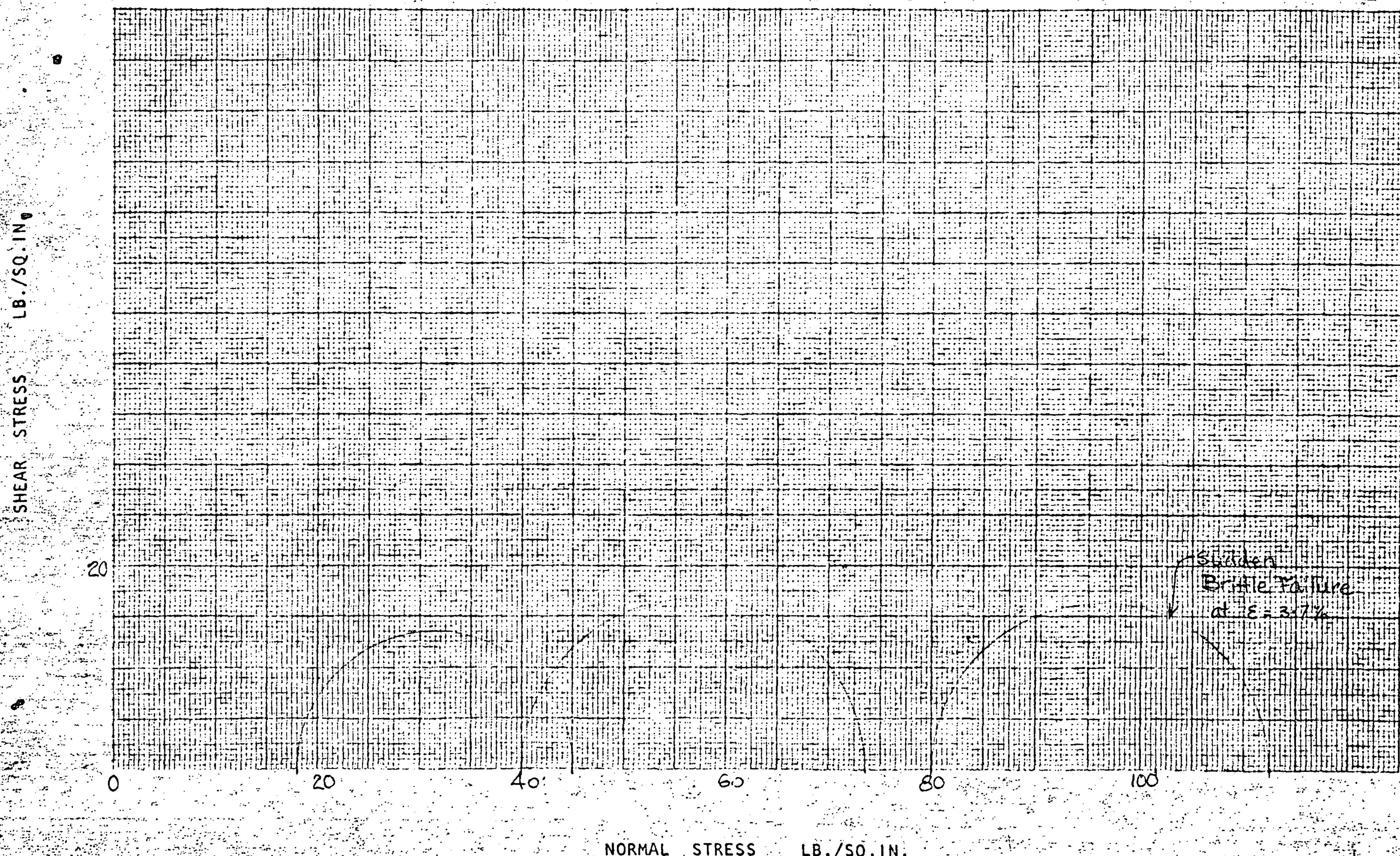
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A216
Bore: CH3
Depth: 6.0–6.3m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 18, 40, 80 p.s.i.
Water Content: 13.7%
Dry Density: 106.0 p.c.f.



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Ref. No. 184/72 Sample No. A88

Bore: CH3
Depth: 7·5 – 7·8 m

Sample Length: 3·25"
Sample Dia.: 1·5"

Cell Pressure: 4·3 p.s.i. (Consolidation pressure)
Water Content: 18·9 %
Dry Density: 104·2 p.c.f.
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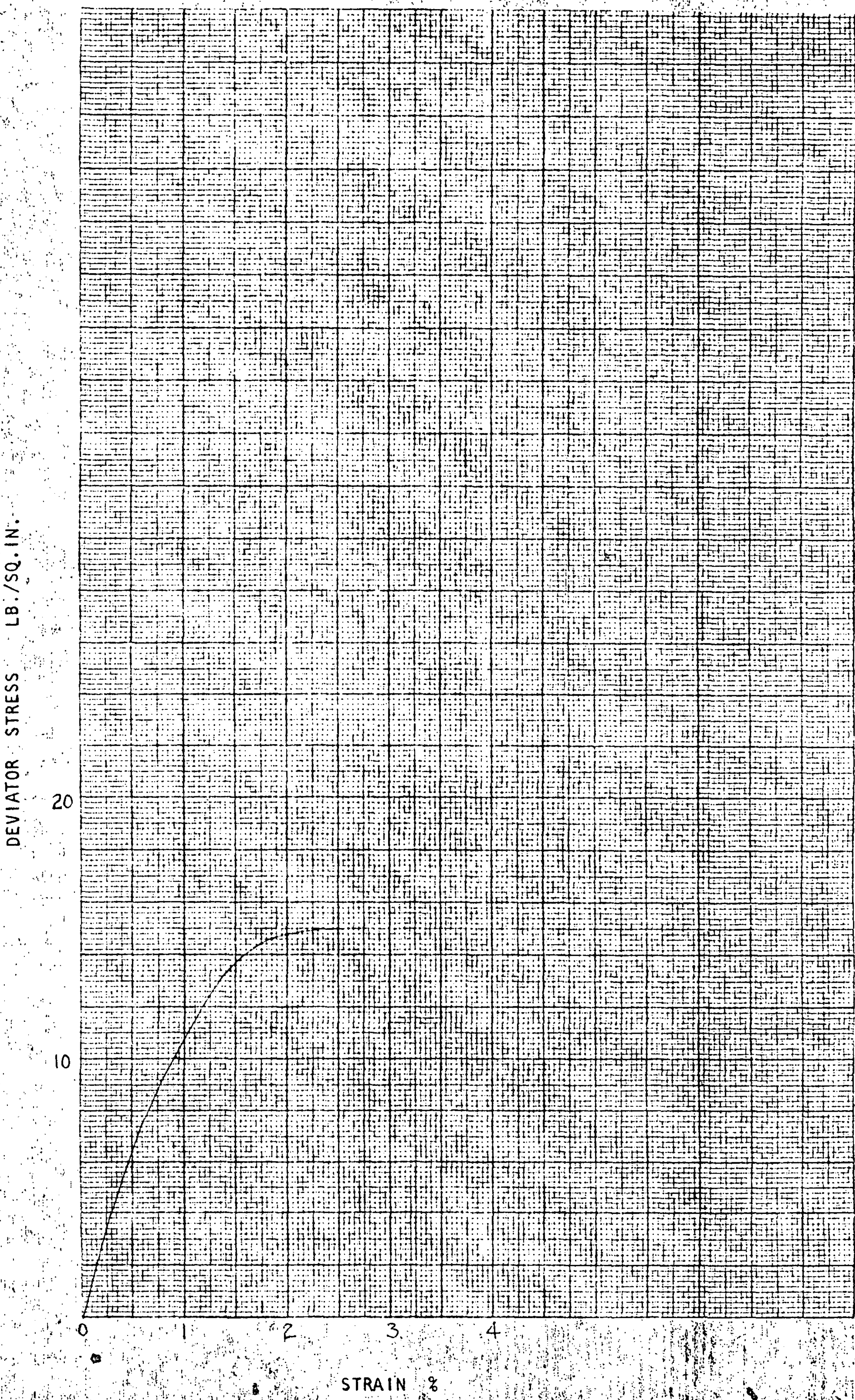
TRIAXIAL SHEAR TEST
STRESS—STRAIN DIAGRAM



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Ref. No. 184/72 Sample No. A 88

Bore: CH3
Depth: 7.5 - 7.6 m

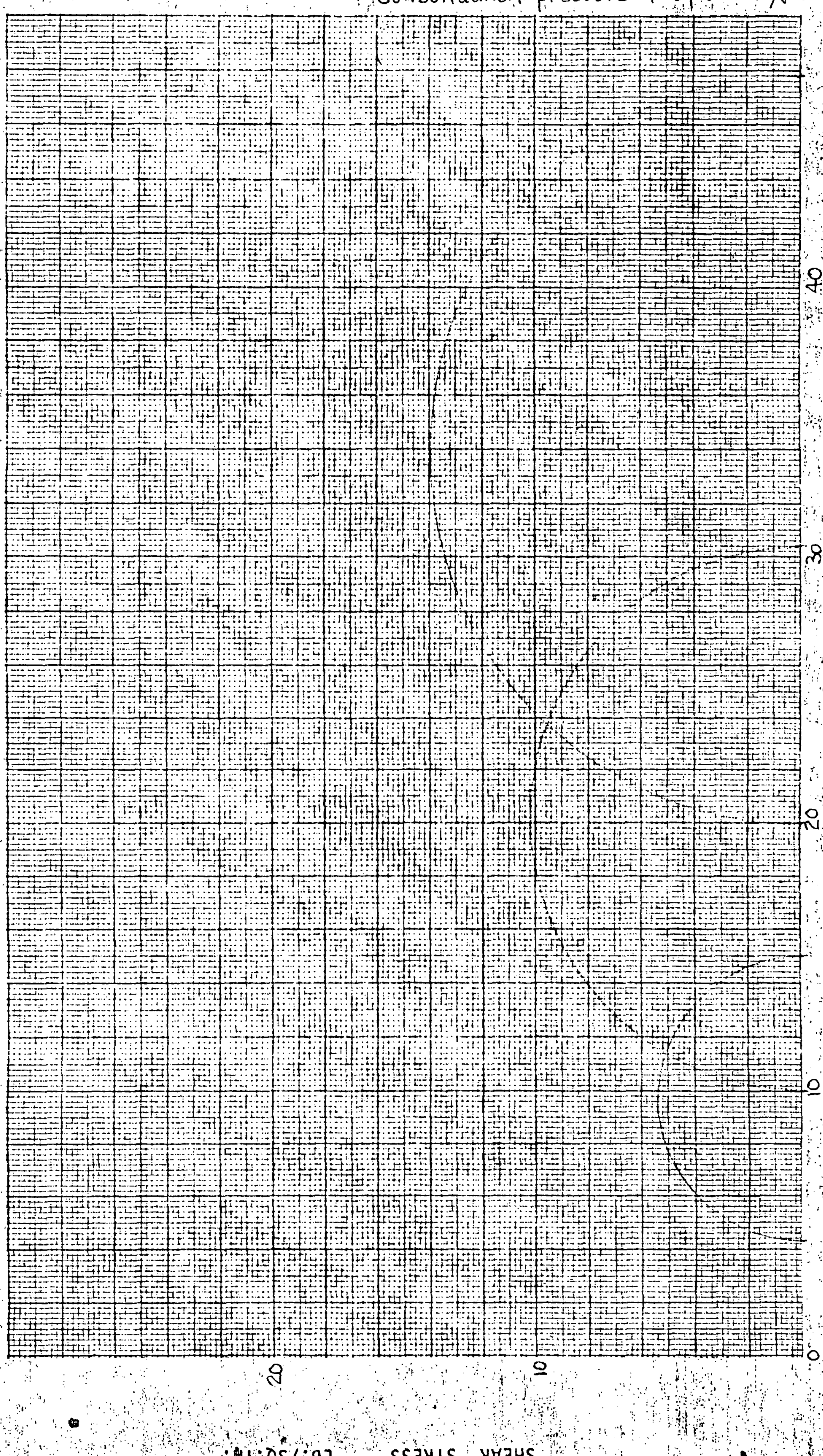
Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 4.3, 10, 20 p.s.i.
Water Content: 18.9%
Dry Density: 104.2 p.c.f.

TRIAXIAL SHEAR TEST

MOHR DIAGRAM

Consolidation pressure 4.3 p.s.i. $\Delta V/V$ very small



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Ref. No. 184/72 Sample No. A92

Bore: CH 3
Depth: 13.5 – 13.8 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 16.0 p.s.i. (Cons. pres.)
Water Content: 16.3% initial, 13.9% consol.
Dry Density: 117.0 p.c.f. " , 120.0 p.c.f. "

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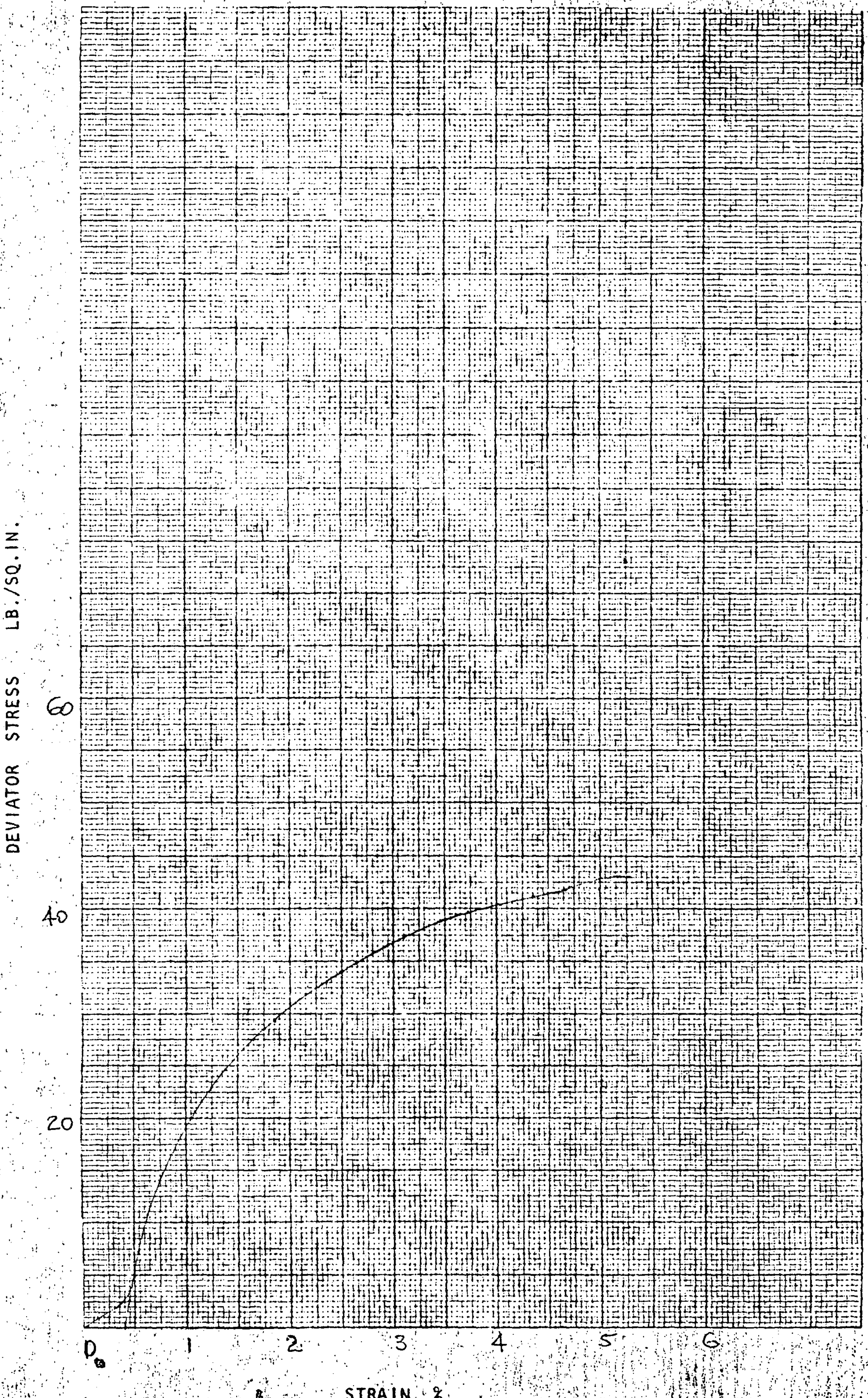
TRIAXIAL SHEAR TEST
STRESS—STRAIN DIAGRAM



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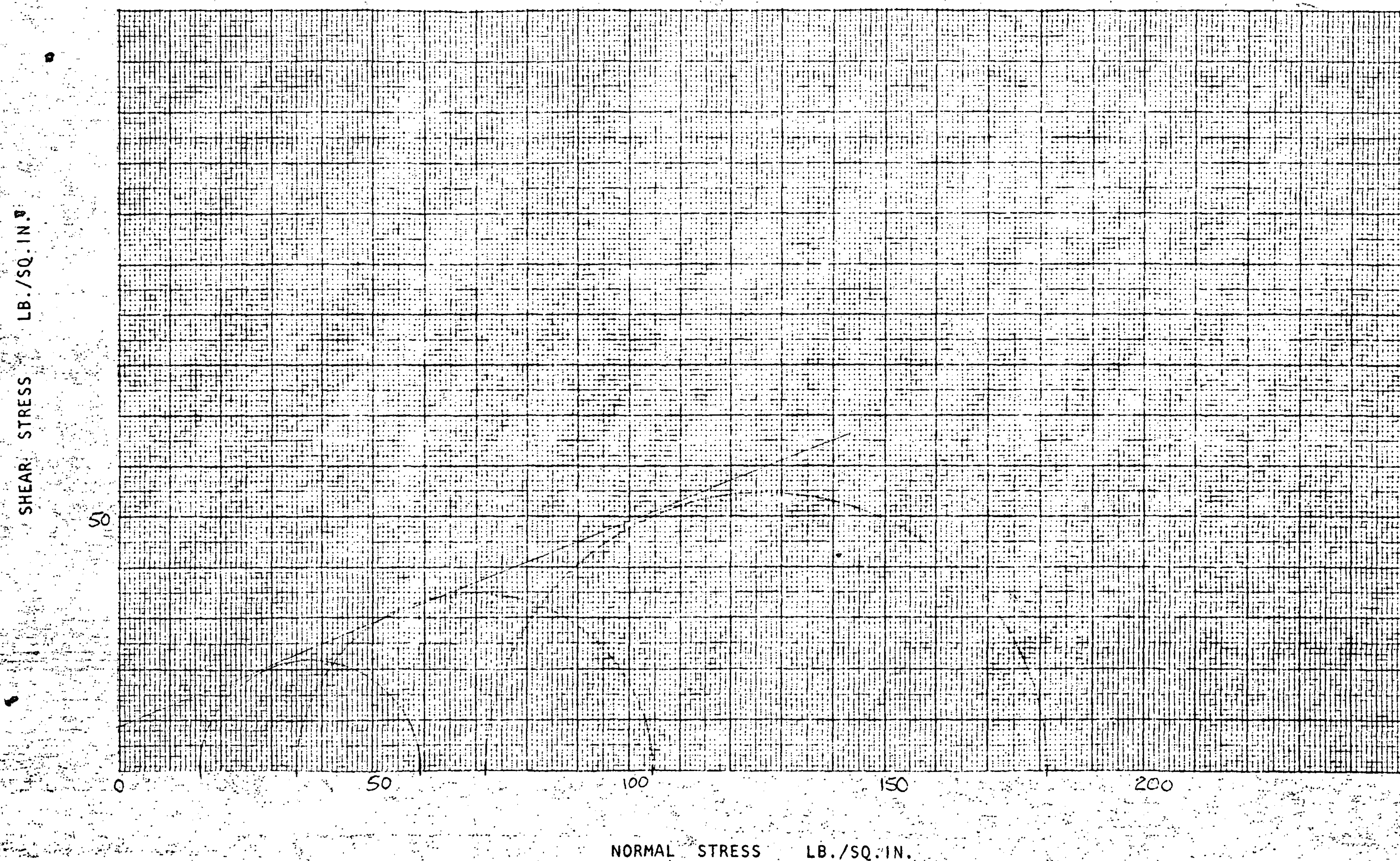
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A92
Bore: CH 3
Depth: 13.5 – 13.8 m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 16, 35, 72 p.s.i.
Water Content: 16.3% initial, 13.4 consol.
Dry Density: 117.0 p.c.f. " , 120.0 p.c.f. "

Consolidation pressure 16.0 p.s.i. $\Delta V/V = 4.6\%$



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Ref. No. 184/72 Sample No. A 212

Bore: CH 3

Depth: 17.95 – 18.15 m

Sample Length: 3.25"

Sample Dia.: 1.5"

Cell Pressure: 26.5 p.s.i. (cons. pressure)

Water Content: 20.4% initial, 17.9% cons.

Dry Density: 106.2 p.c.f. " , 110.8 p.c.f. "

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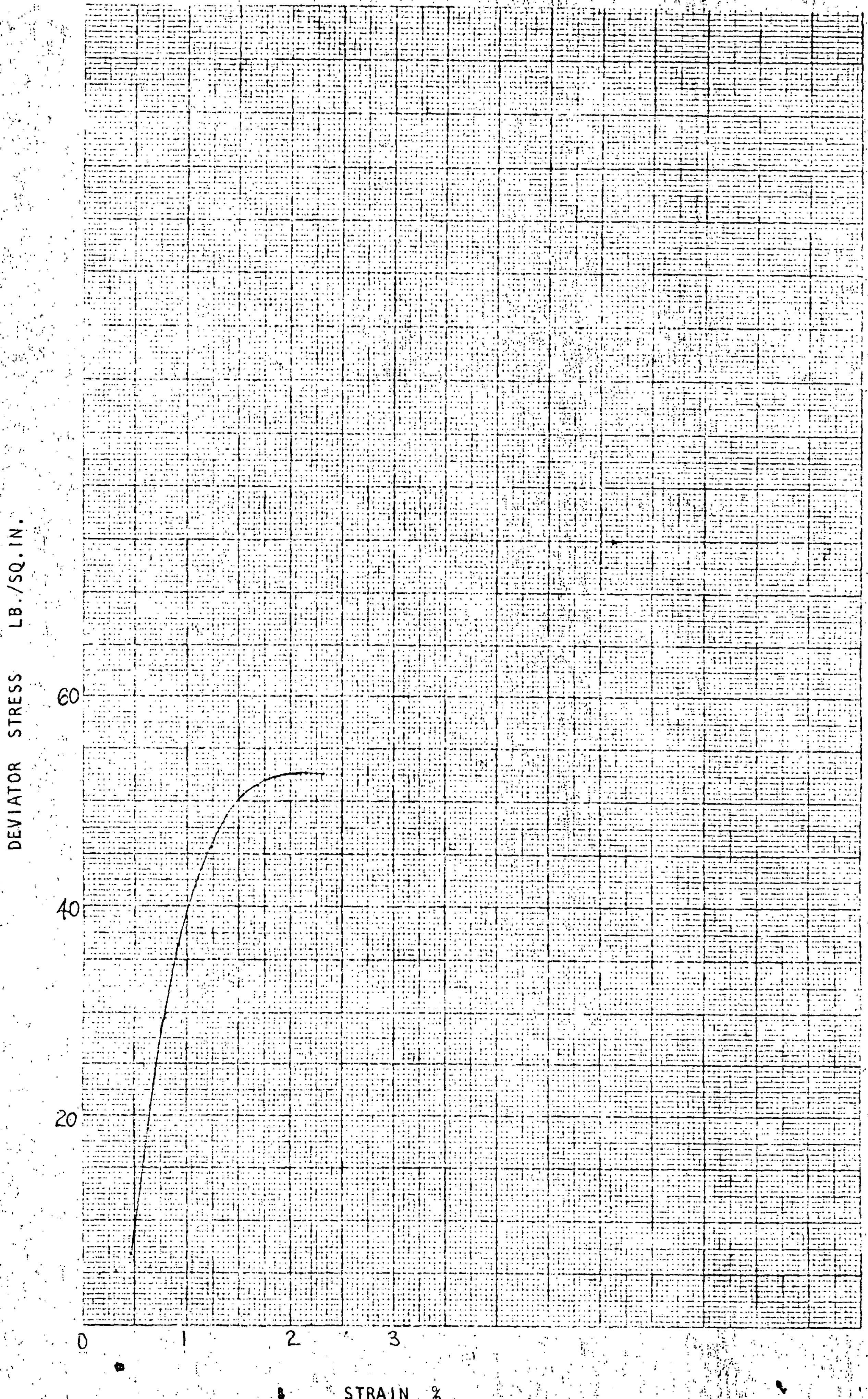
TRIAXIAL SHEAR TEST

STRESS–STRAIN DIAGRAM



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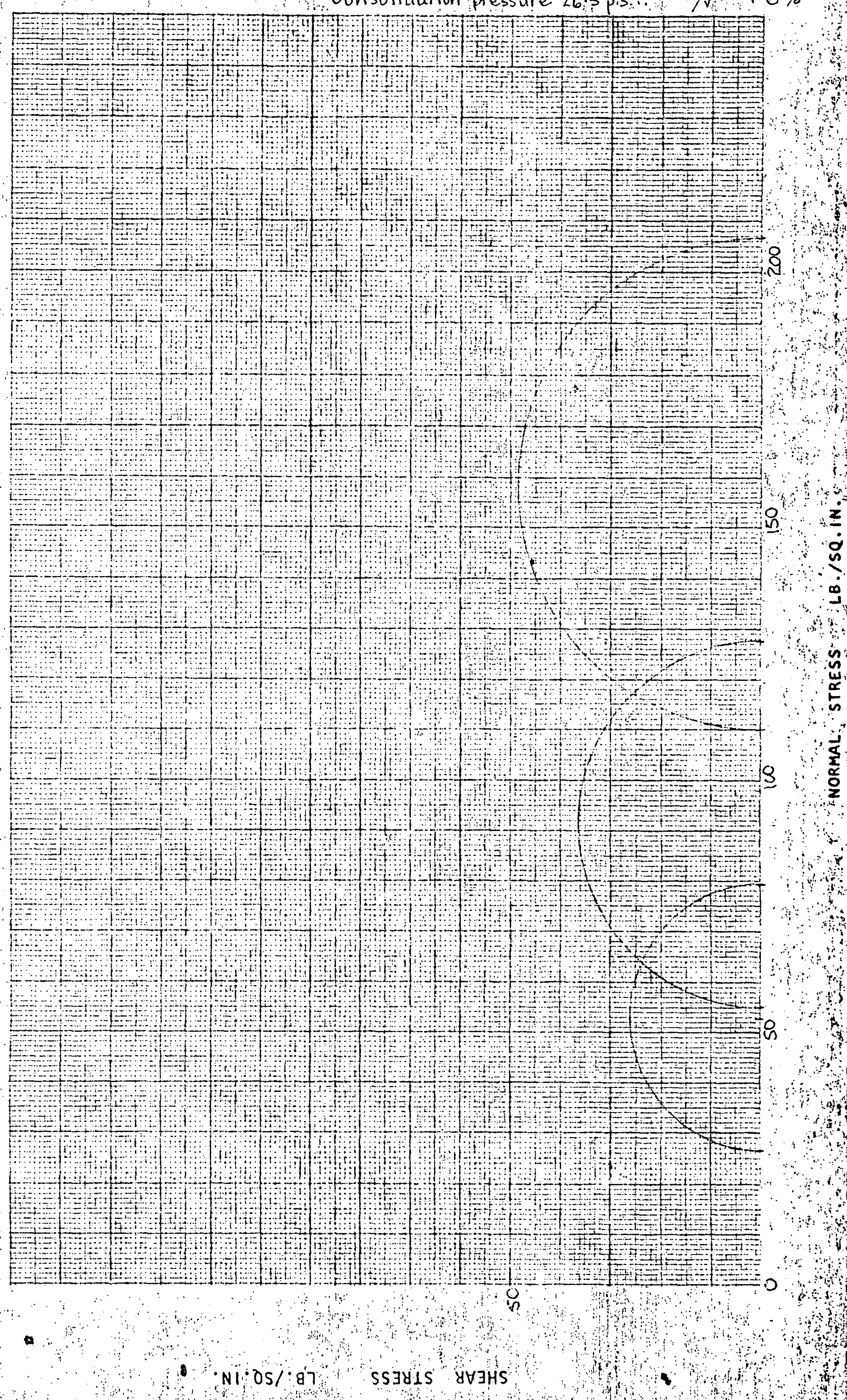
Ref. No. 184/72 Sample No: A 212
Bore: CH 3
Depth: 17·85 – 18·15 m
Sample Length: 3·25"
Sample Dia.: 1·5"
Cell Pressure: 26·5, 55, 110 p.s.i.
Water Content: 20·4% initial, 17·9% consol.
Dry Density: 106·2 p.c.f. initial, 110·8 p.c.f.

TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Consolidation pressure 26·5 p.s.i. $\Delta V/V = 4{\cdot}6\ \%$



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Ref. No. 184/72 Sample No. A22

Bore: CH4
Depth: 3·1 – 3·3 m

Sample Length: 3·25"
Sample Dia.: 1·5"

Cell Pressure: 9·0 p.s.i.
Water Content: 18·0 %
Dry Density: 101·7 p.c.f.

TRIAXIAL SHEAR TEST
STRESS–STRAIN DIAGRAM

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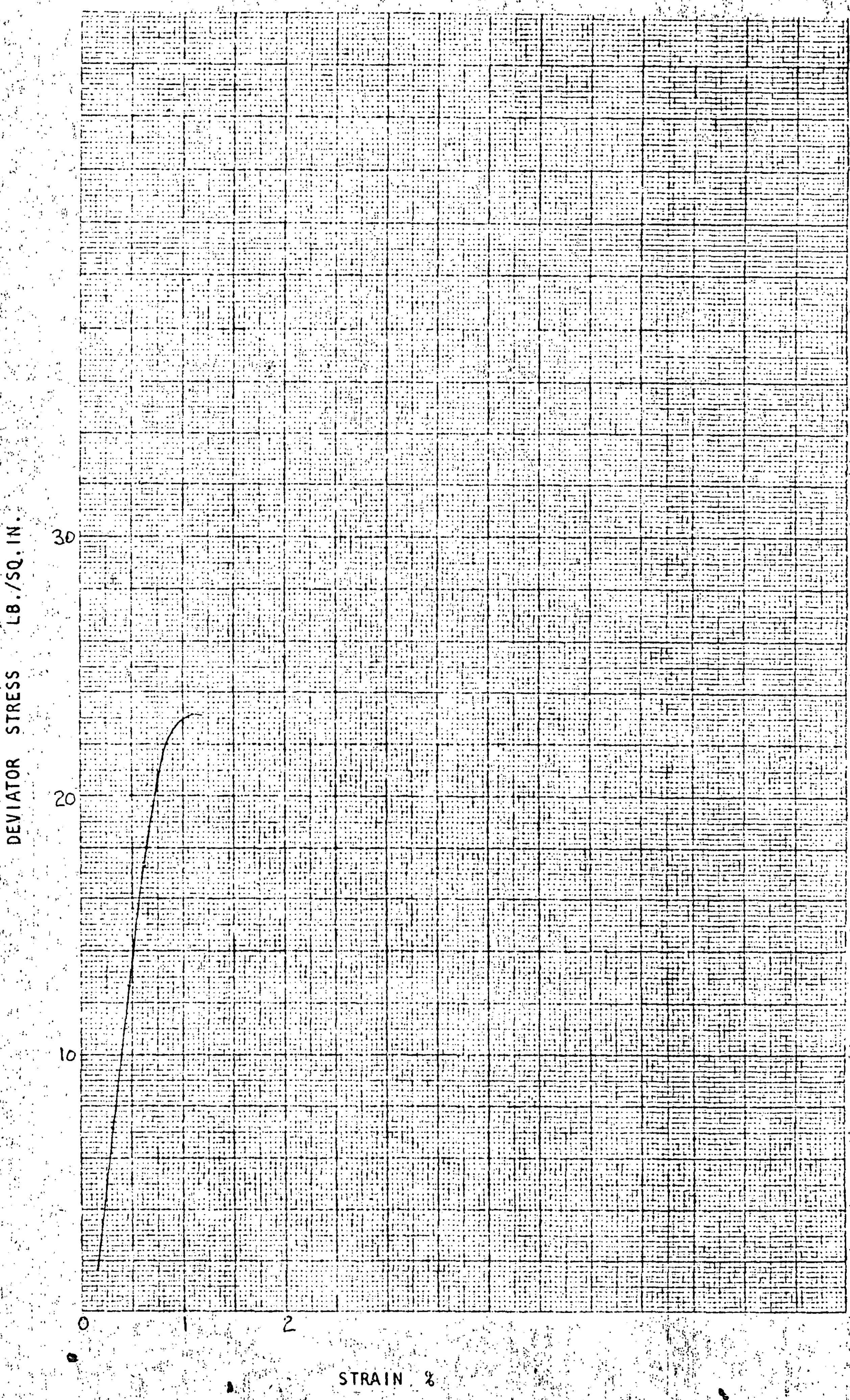

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TRIAXIAL SHEAR TEST

MOHR DIAGRAM

Ref. No. 184/72 Sample No. A 226

Bore: CH 4

Depth: 3.1 – 3.3 m

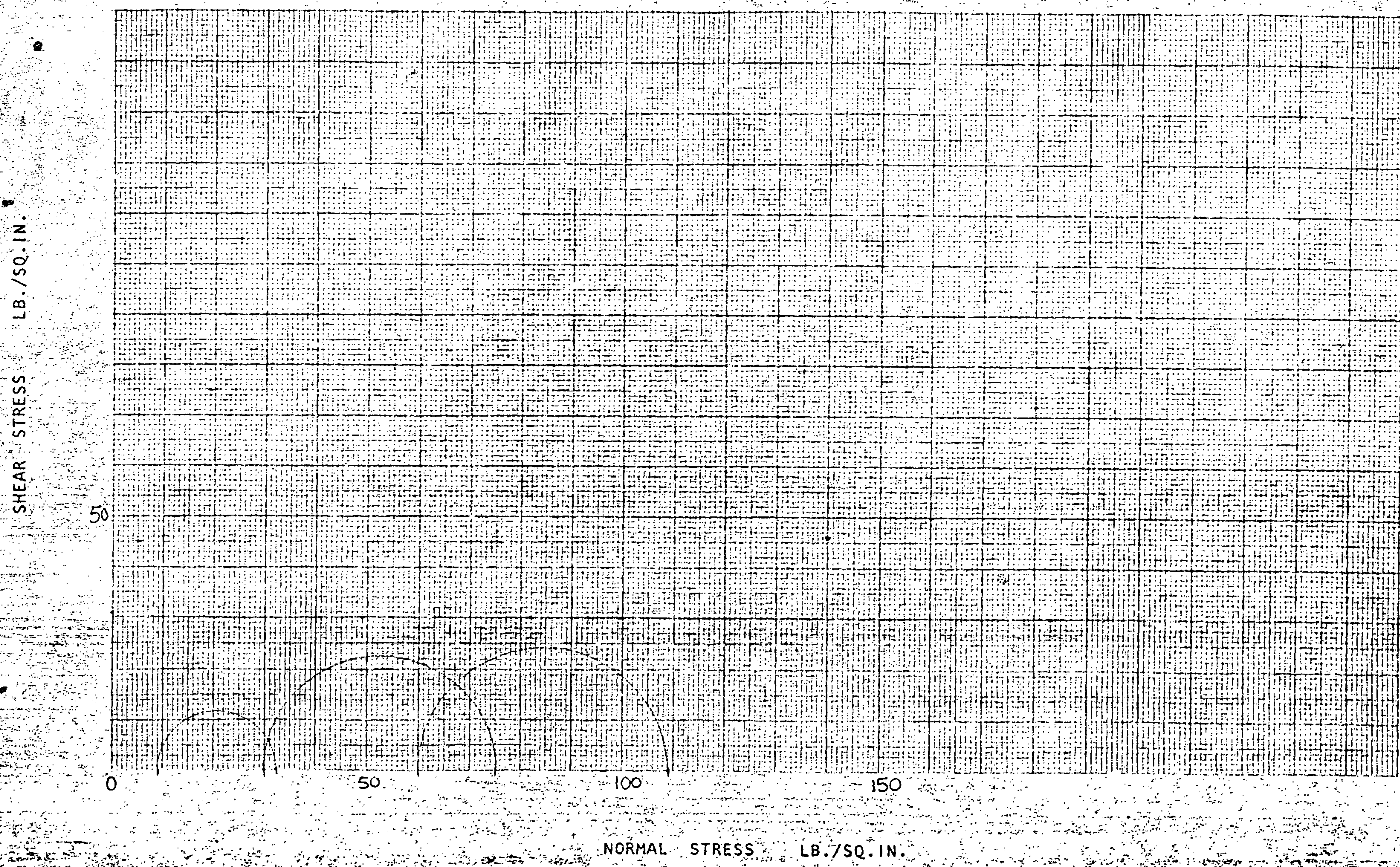
Sample Length: 3.25"

Sample Dia.: 1.5"

Cell Pressure: 9, 30, 60 p.s.i.

Water Content: 18.0%

Dry Density: 101.7 p.c.f.



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TESTING LABORATORY
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Ref. No. 184/72 Sample No. A74

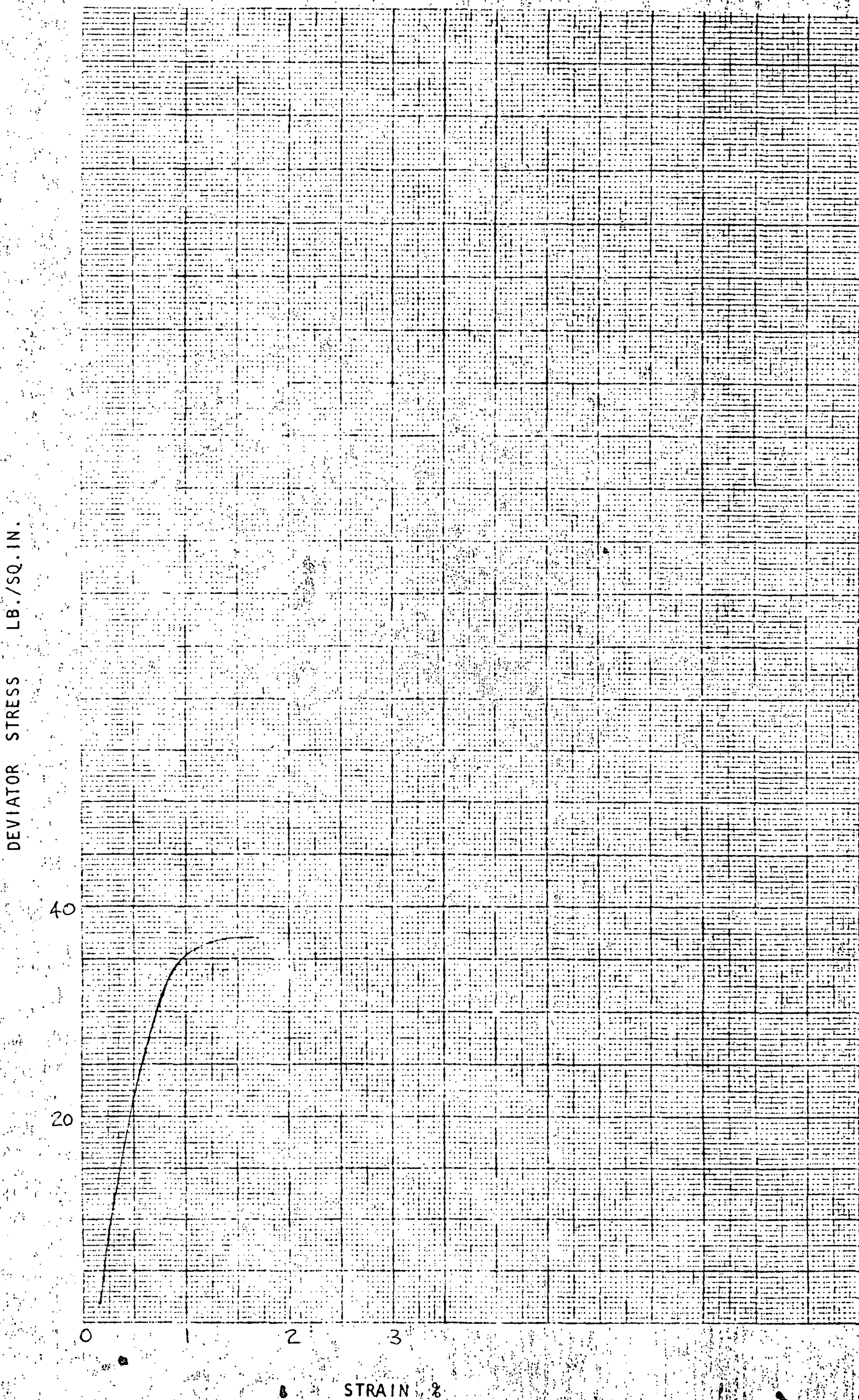
Bore: CH4
Depth: 4.5 - 4.8 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 13.5 p.s.i.
Water Content: 16.6%
Dry Density: 104.0 p.c.f.

C_u
ϕ_u

TRIAXIAL SHEAR TEST
STRESS-STRAIN DIAGRAM



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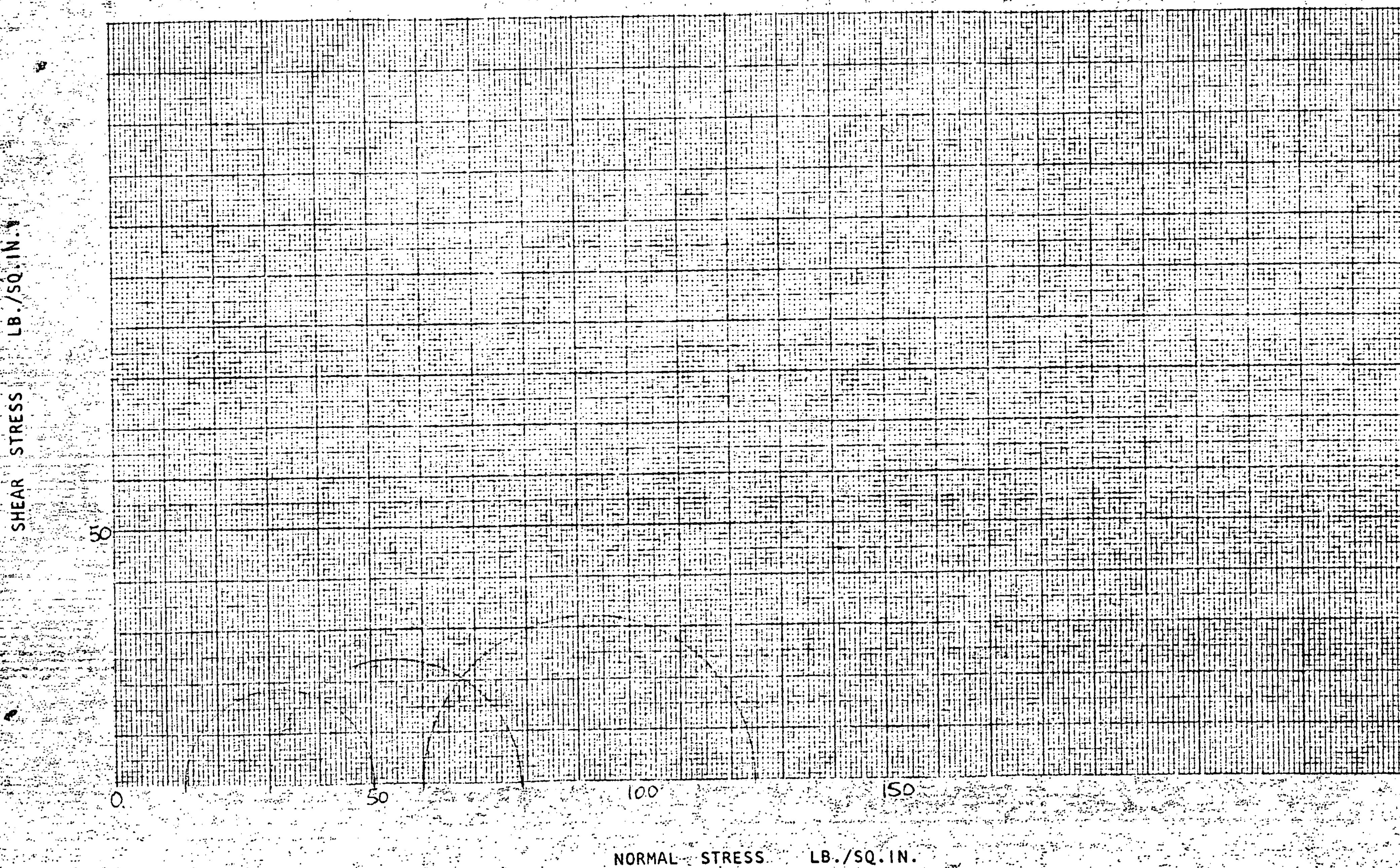
Consulting Civil Engineers
TESTING LABORATORY
Soils Concrete Asphalt
209 Greenhill Rd., Eastwood, S.A. 5063. 71 7892

TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A74
Bore: CH4
Depth: 4.5-4.8m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 13.5, 30, 60 p.s.i.
Water Content: 16.6%
Dry Density: 104.0 p.c.f.



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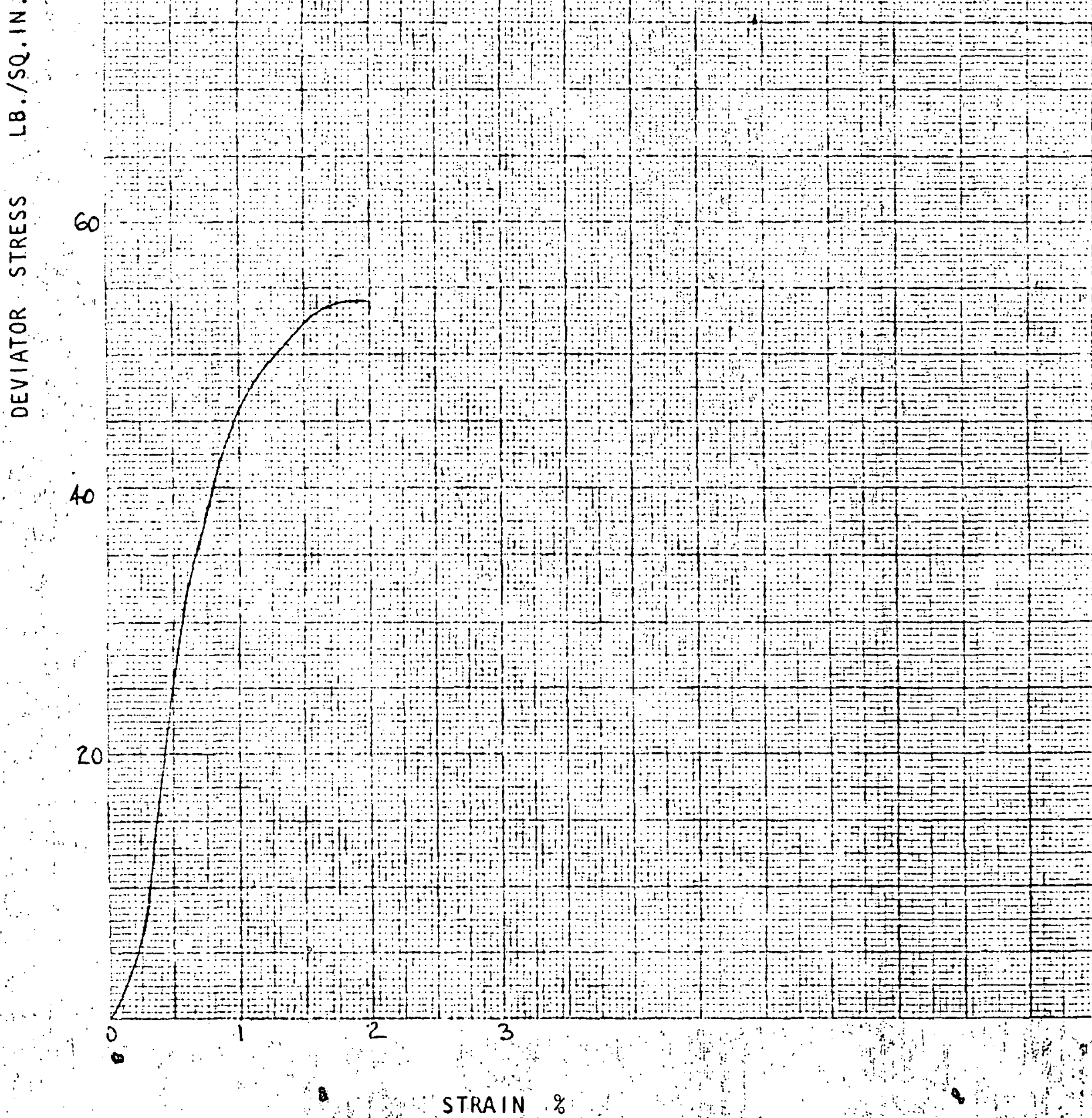
TRIAXIAL SHEAR TEST

STRESS–STRAIN DIAGRAM

Ref. No. 184/72 Sample No. A71
Bore: CH4
Depth: 6.0 – 6.3 m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 18 p.s.i.
Water Content: 12.8%
Dry Density: 113.0 p.c.f.
C_u
$\emptyset_u$



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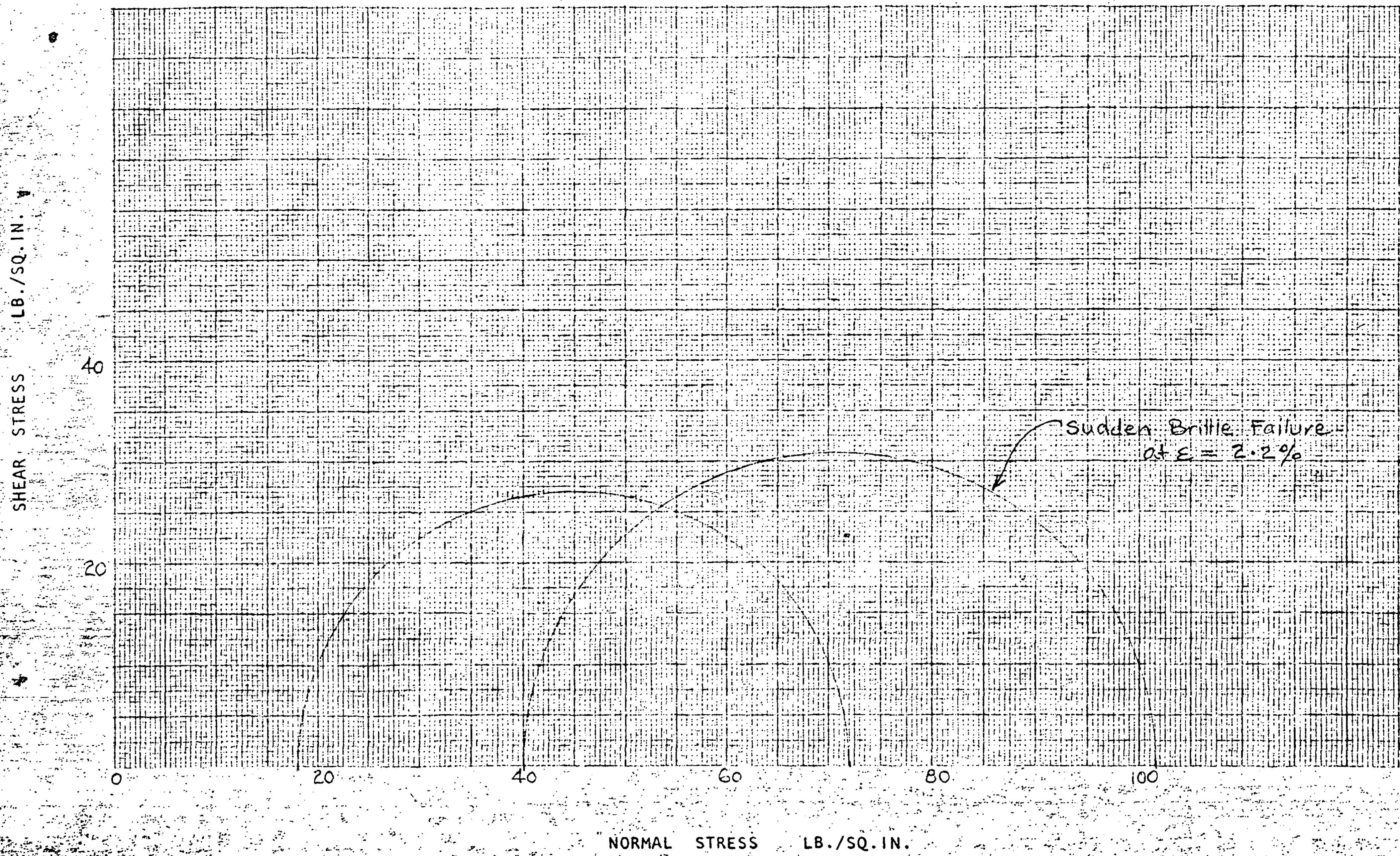
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A71
Bore: CH4
Depth: 6.0 – 6.3 m
Sample Length: 3.25"
Sample Dia.: 1.5"
Cell Pressure: 18, 40 p.s.i.
Water Content: 12.8%
Dry Density: 113.0 p.c.f.



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Ref. No. 184/72 Sample No. A13

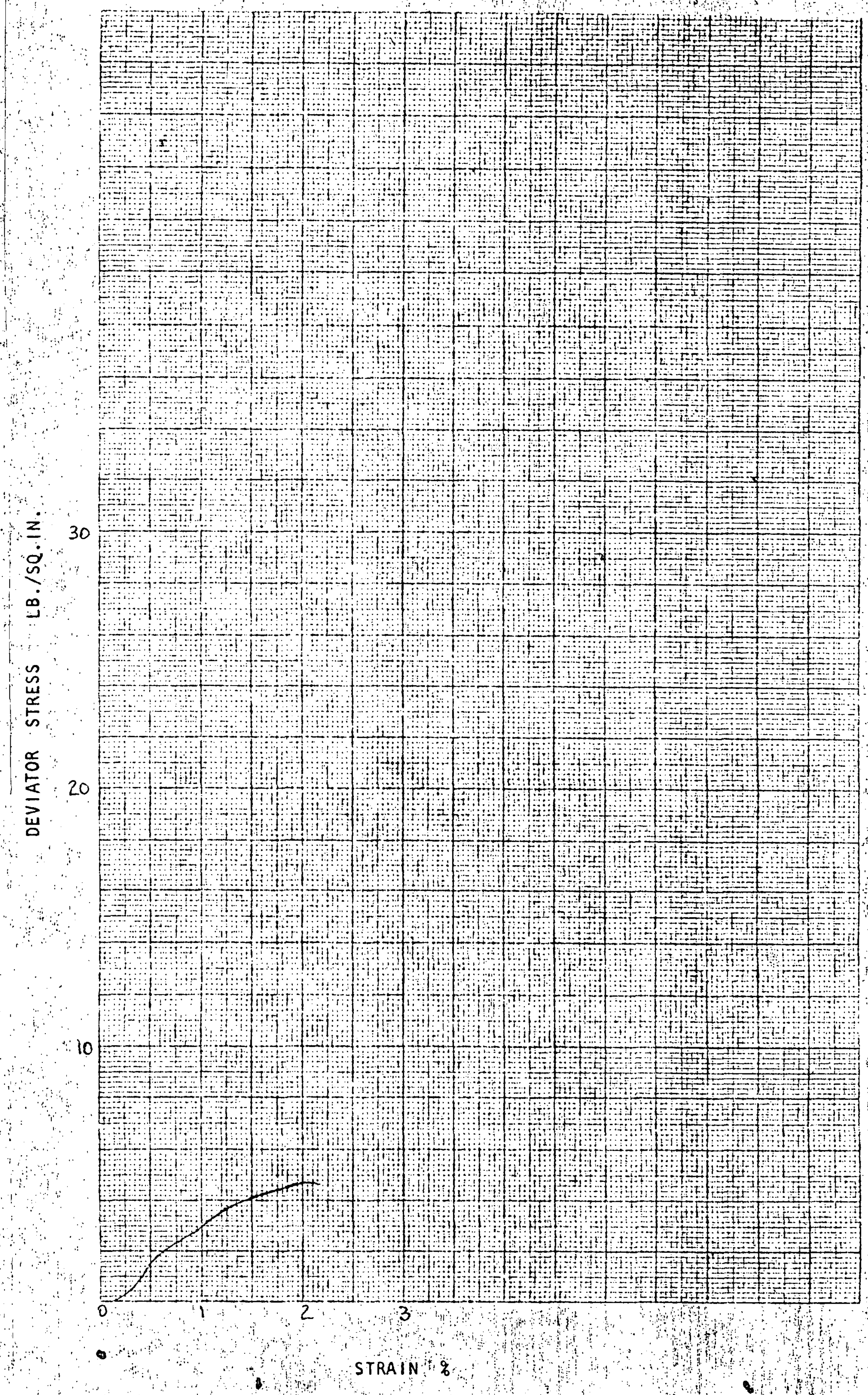
Bore: CH 4
Depth: 9.0–9.3 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 26.0 p.s.i.
Water Content: 21.9%
Dry Density: 106.5 p.c.f.

C_u
ϕ_u

TRIAXIAL SHEAR TEST
STRESS–STRAIN DIAGRAM



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Ref. No. 184/72 Sample No. A 73

Bore: CH 4
Depth: 9.0 – 9.3m

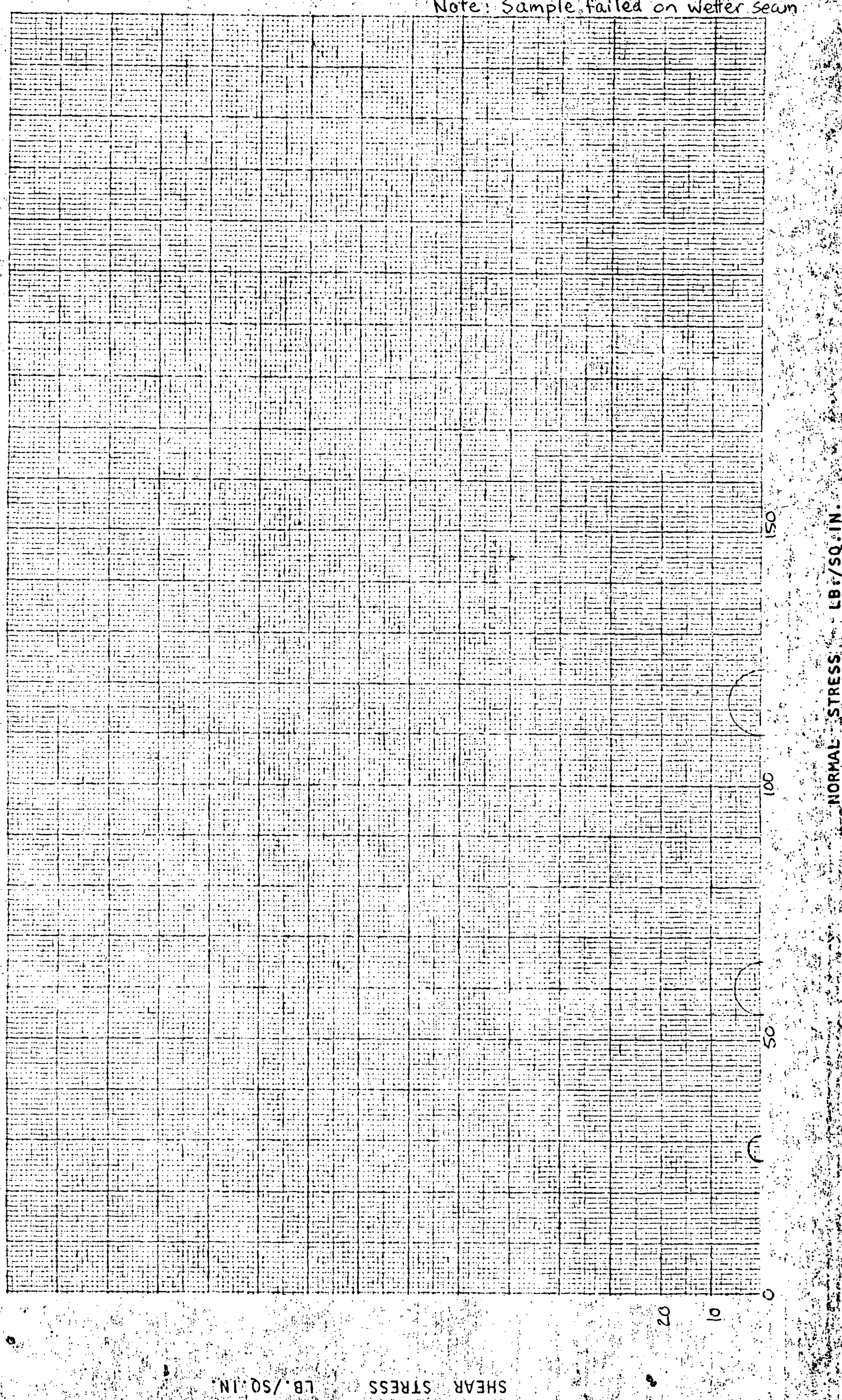
Sample Length: 3·25"
Sample Dia.: 1·5

Cell Pressure: 26, 55, 110 p.s.i.
Water Content: 21·9% (overall)
Dry Density: 106·5 p.c.f.

TRIAXIAL SHEAR TEST

MOHR DIAGRAM

Note: Sample failed on wetter seam



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Ref. No. 184/72 Sample No. A 14.

Bore: CH4
Depth: 10·5 – 10·8 m

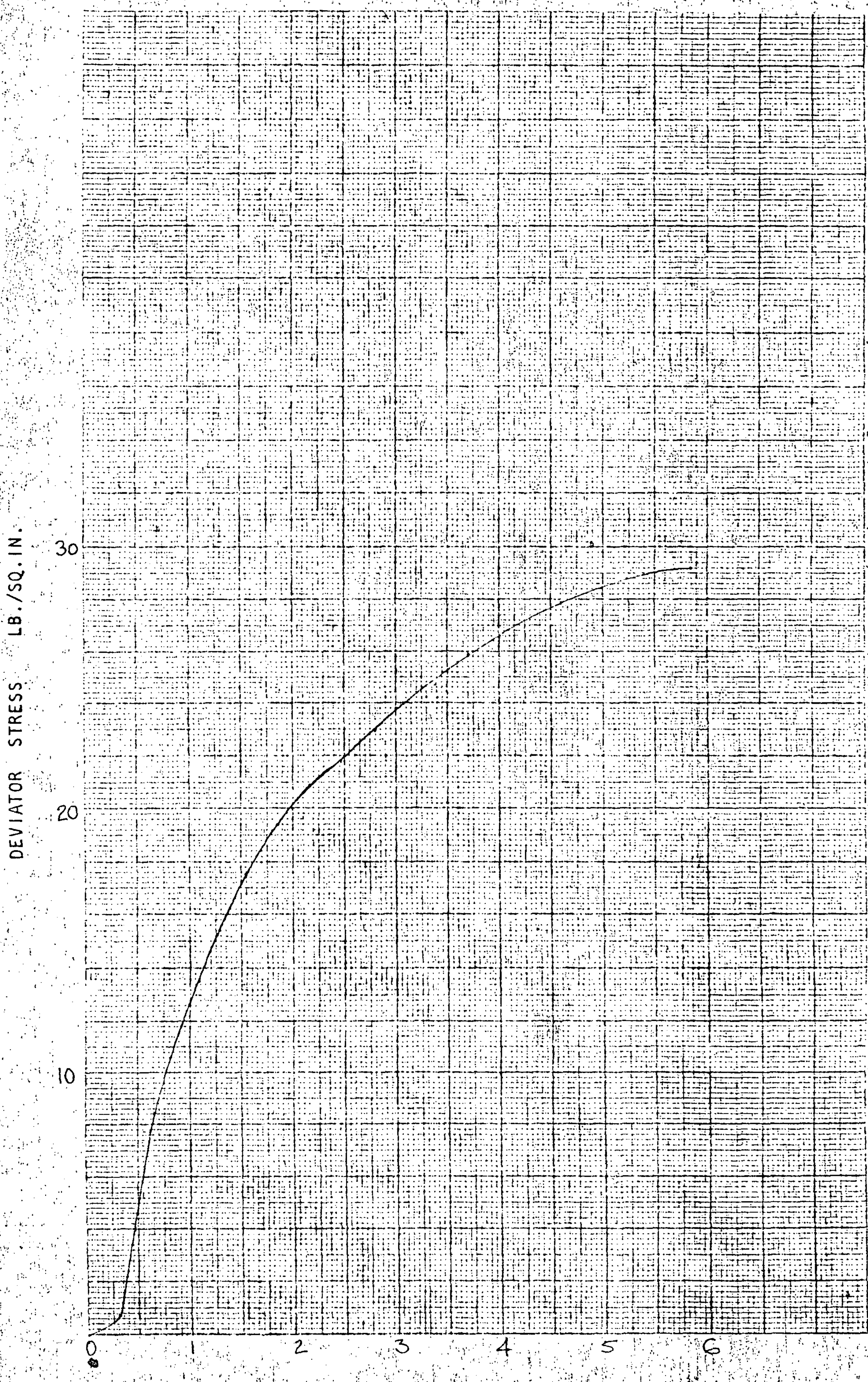
Sample Length: 3·25"
Sample Dia.: 1·5"

Cell Pressure: 16·0 p.s.i. (Consolidation pr.)
Water Content: 18·8% initial, 18·4% consol.
Dry Density: 110·8 p.c.f. " , 111·6 p.c.f. "

C_u

$\emptyset_u$

TRIAXIAL SHEAR TEST
STRESS–STRAIN DIAGRAM



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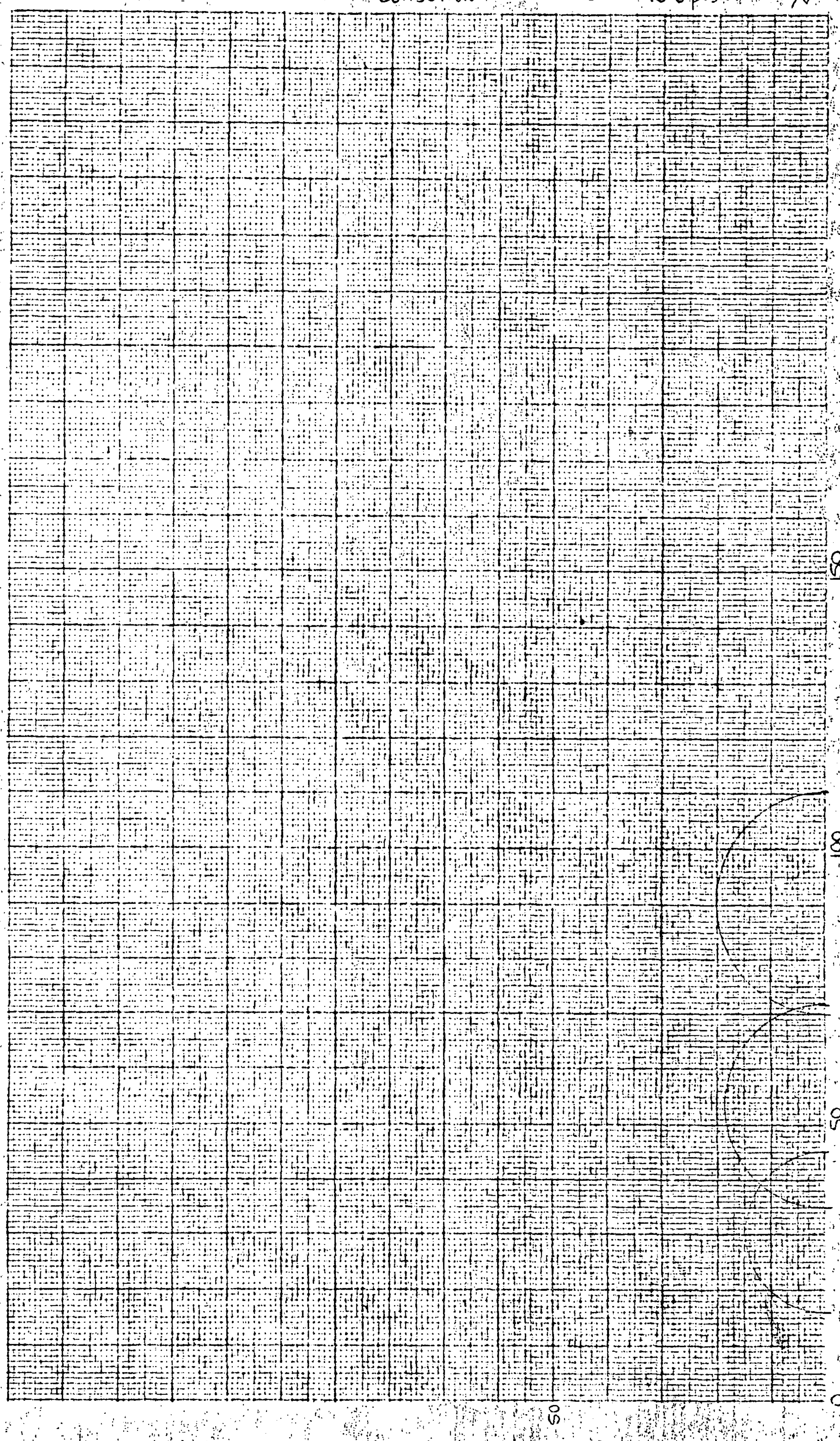
TRIAXIAL SHEAR TEST
MOHR DIAGRAM

Ref. No. 184/72 Sample No. A J4
Bore: CH4
Depth: 10.5 – 10.8 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 16.0, 35, 70 p.s.i.
Water Content: 18.8% initial, 18.4% consol
Dry Density: 110.8 p.c.f. " , 111.6 p.c.f. "

Consolidation Pressure 16.0 p.s.i. $\Delta V/V = 1.9\%$



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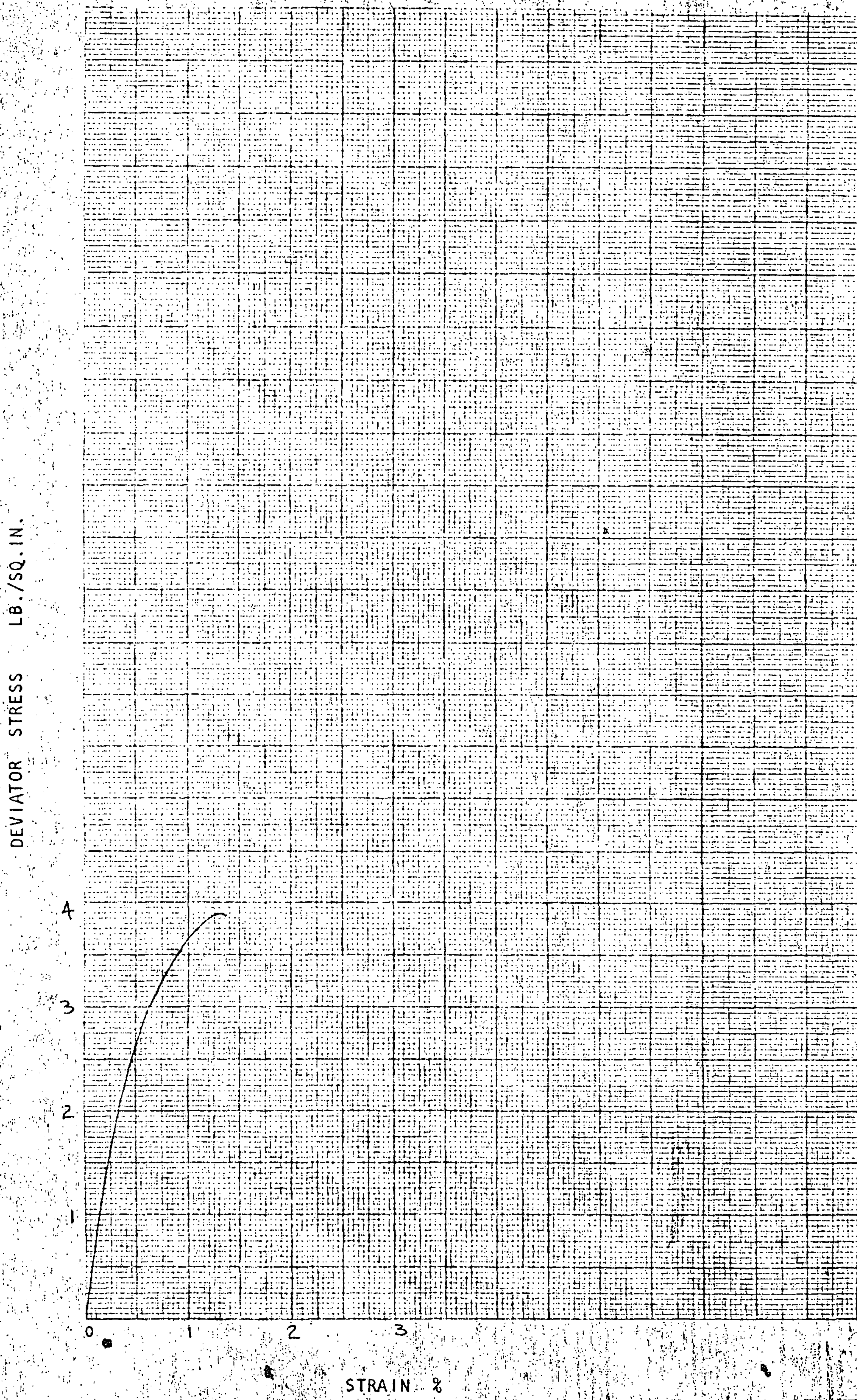
Ref. No. 184/72 Sample No. A114
Bore: CH 4
Depth: 12.0 – 12.3 m

Sample Length: 3.25"
Sample Dia.: 1.5"

Cell Pressure: 30.0 p.s.i.
Water Content: 20.3%
Dry Density: 109.0 p.c.f.
C_u
$\emptyset_u$

TRIAXIAL SHEAR TEST
STRESS – STRAIN DIAGRAM



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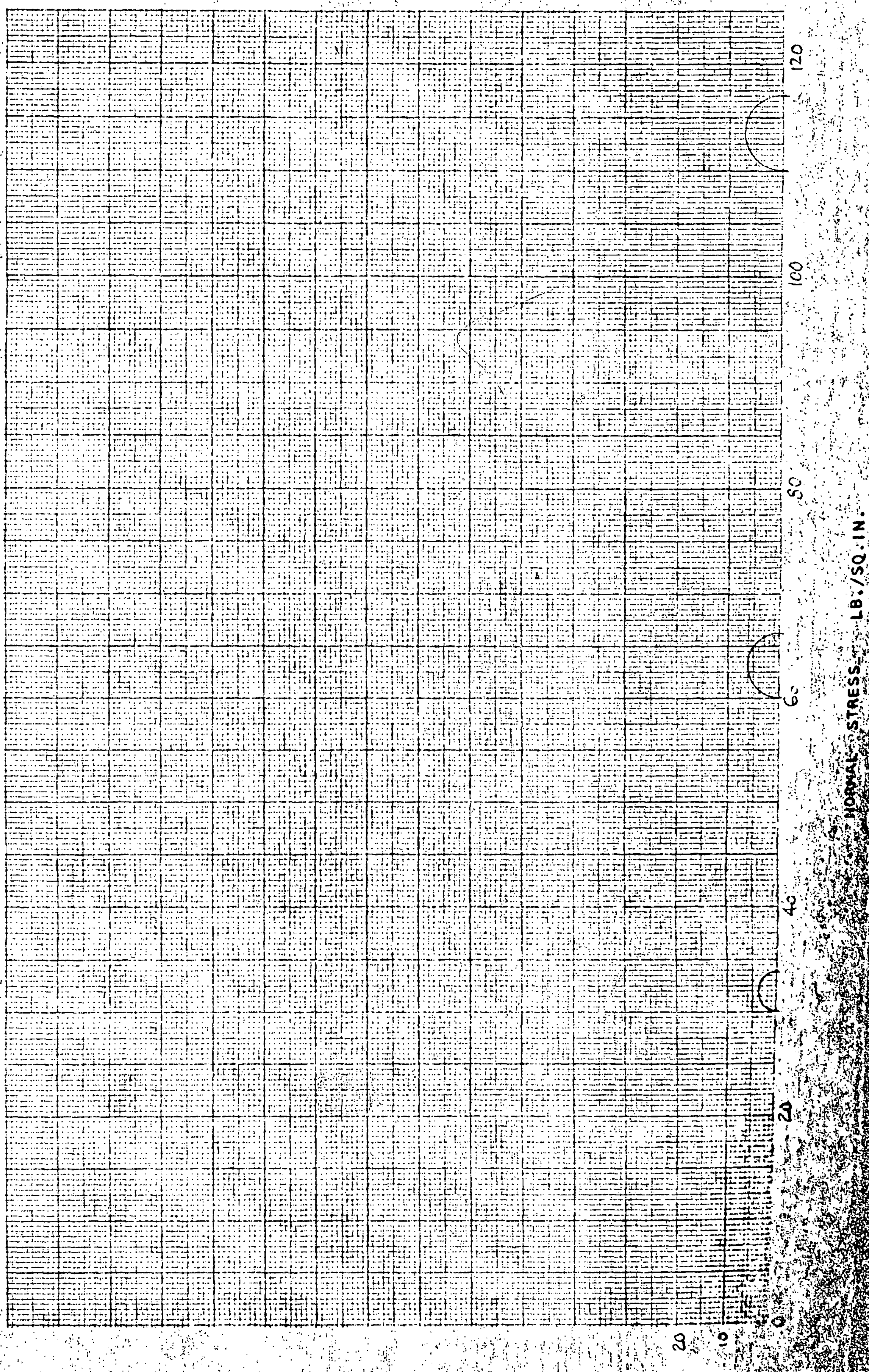
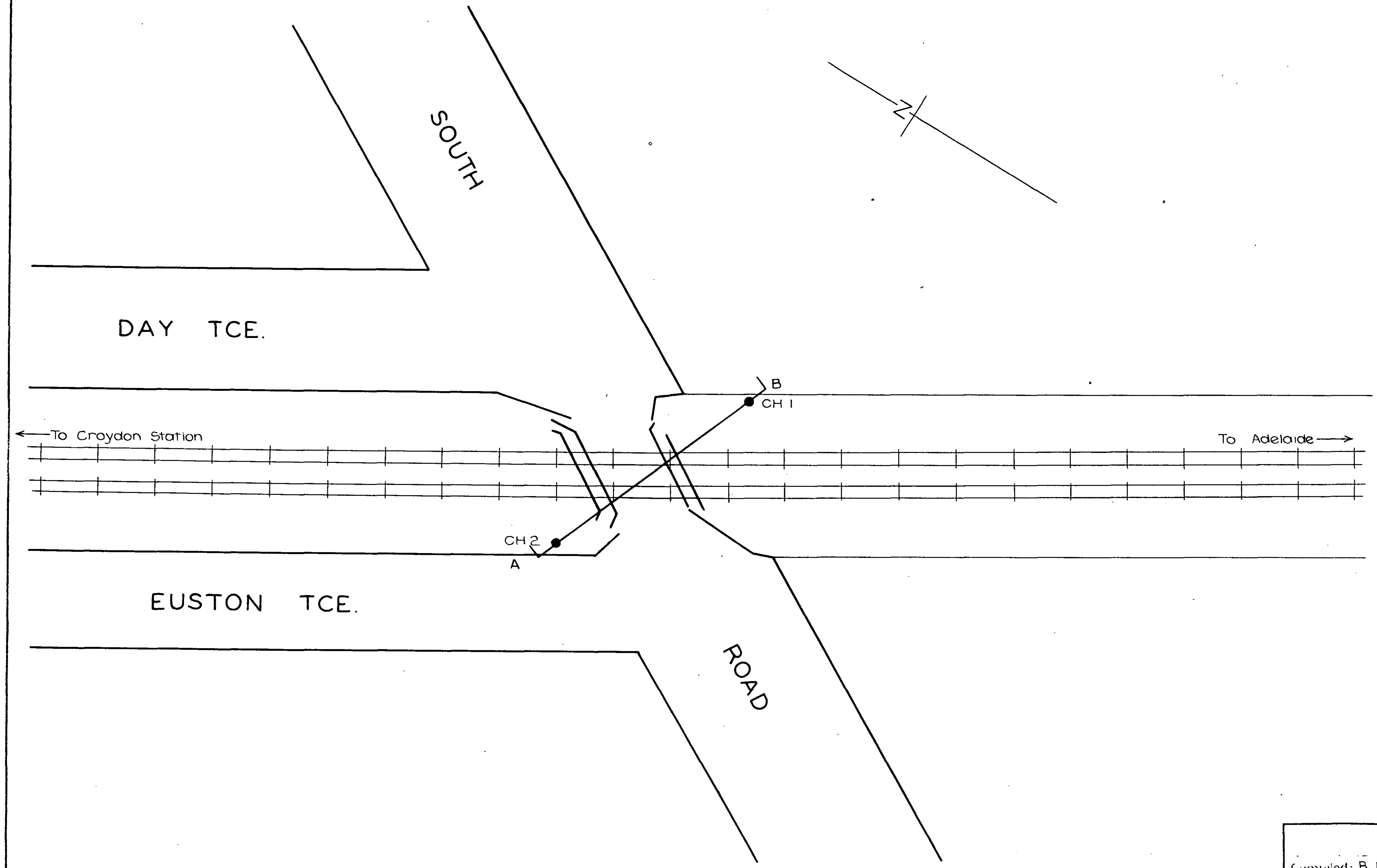
Ref. No. 184/72 Sample No. A 114
Bore: CH 4
Depth: 12·0 – 12·3 m

Sample Length: 3·25"
Sample Dia.: 1·5"

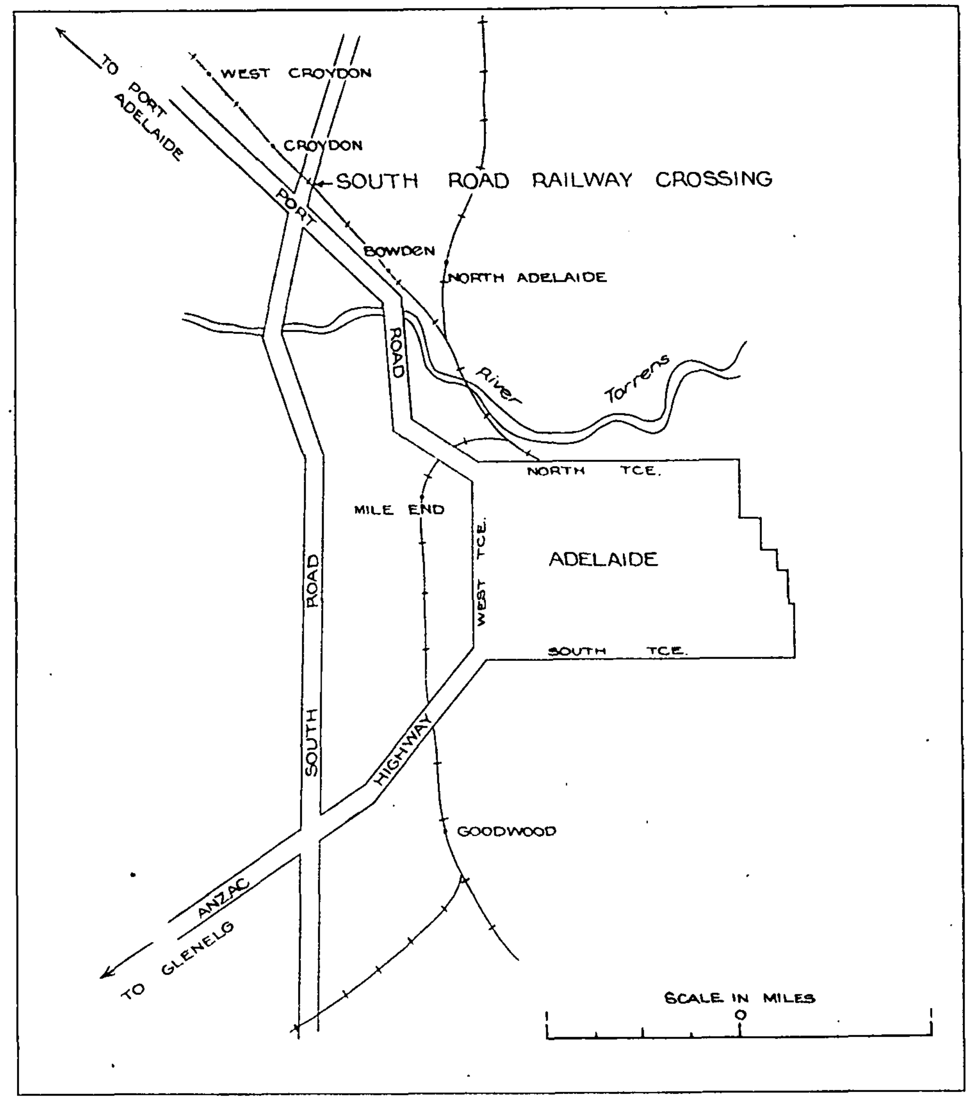
Cell Pressure: 30, 60, 110 p.s.i.
Water Content: 20·3 %
Dry Density: 108·0 p.c.f.

TRIAXIAL SHEAR TEST
MOHR DIAGRAM





LOCALITY PLAN



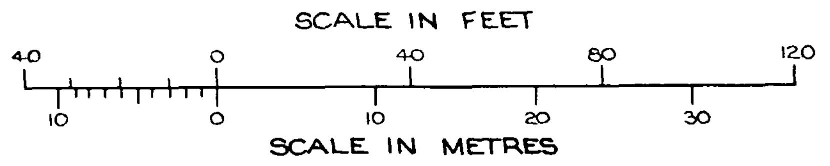
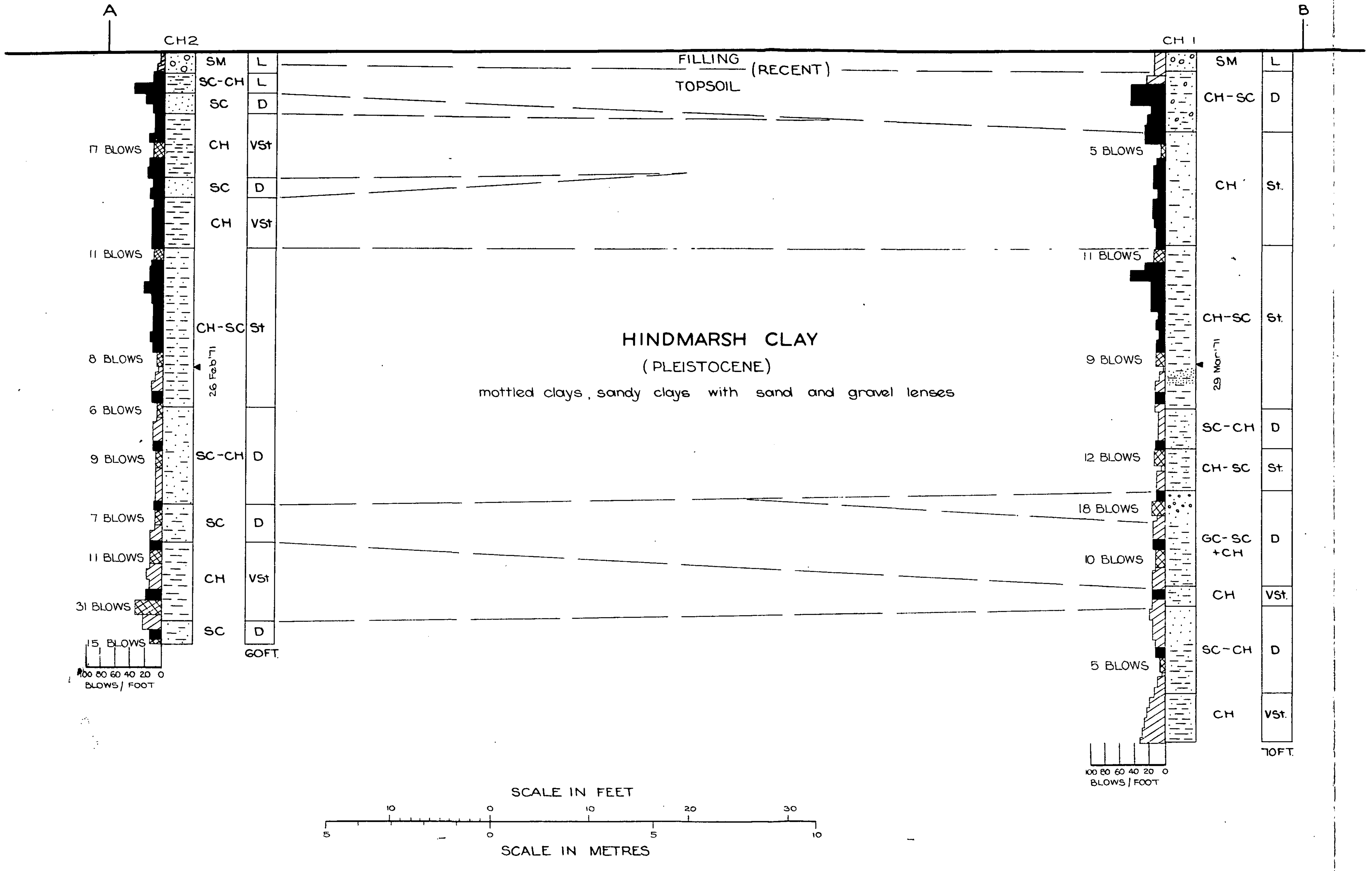
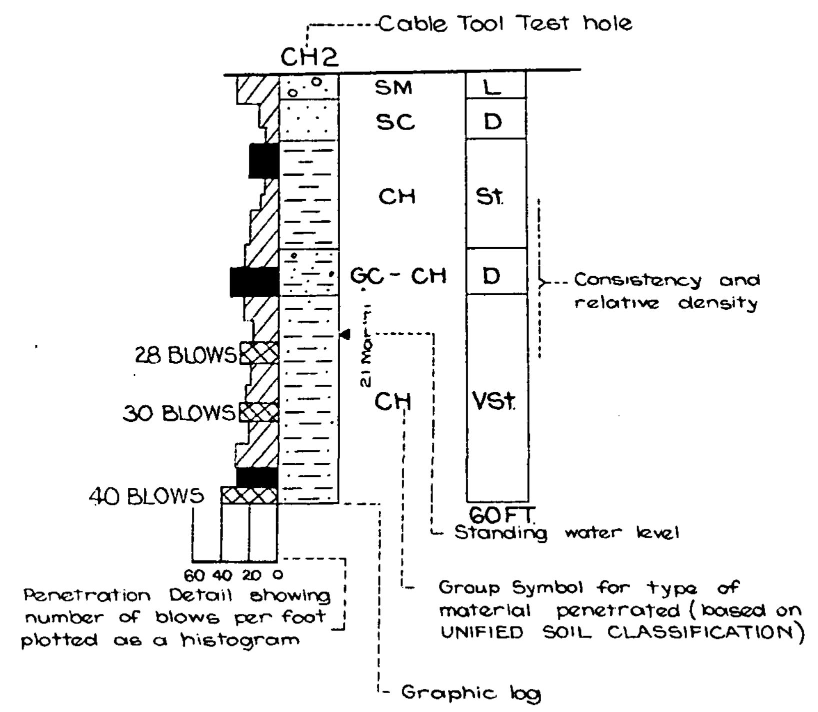


FIG. 1

	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 40 ft. to 1 in.
Compiled: BJM	PROPOSED RAILWAY BRIDGE ROAD GRADE SEPARATION CROYDON LOCATION OF DRILL HOLES	Date: 21 APRIL '71
Drn SLT Ckd. LVW.		Drg. No. 71-379 ~~Ha5~~



LEGEND



CONSISTENCY (CLAYS)		RELATIVE DENSITY (SANDS)	
Vs	Very Soft.	VL	Very Loose
S	Soft.	L	Loose
F	Firm	MD	Medium Dense
St.	Stiff	D	Dense
Vst	Very Stiff	VD	Very Dense
H	Hard		

TYPE OF SAMPLE

- 'S' Series 'A' shoe (SA)
- Sealed Tube
- Standard Penetration Test (S.P.T)

UNIFIED SOIL CLASSIFICATION			
Graphic Symbol	Group Symbol	SOIL DESCRIPTION	
	SM	SAND	excess silt fines, poorly graded sand- silt mixture.
	SC	SAND	excess clay fines, poorly graded sand- clay mixture
	GC	GRAVEL	excess clay fines, poorly graded gravel- sand- clay mixture.
	CH	CLAY SOIL	high plasticity - inorganic clays of high plasticity, fat clays

FIG 2

	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 10 FT. TO 1IN.
Compiled: BJM	PROPOSED RAILWAY BRIDGE ROAD GRADE SEPARATION CROYDON GEOLOGICAL SECTION	Date: 21 APRIL '71
Drn. SLT | Ckd. L.V.W.		Drg. No. 71-380 H65

1M-2.70 A1811