

(3) Final depths of pit of:

- (a) 600 feet) with the corresponding values
- (b) 800 feet) of ore reserves and overall
- (c) 1000 feet) stripping ratios.

Ore reserve and stripping ratio figures for the valuation example were obtained from the geometric analyses carried out on the two pits.

To convert volumes of ore and overburden, given in cu.ft. in the analyses, to tons, the following conversion factors were employed.

Ore	13.5 cu.ft/ton
Overburden . .	16.0 cu.ft/ton

The volumetric stripping ratios were converted into tonnage stripping ratios accordingly.

The present value aspect of the valuation also had to be simplified quite considerably. It was assumed that a constant annual income was obtained from the pit, whereas in practice the value of annual income would vary considerably depending on the mining policy of the company.

An example of this is that a mining company might decide to carry out excessive overburden stripping operations in the early stages thus keeping profits down to a reasonable minimum with the idea in view of having low stripping ratios and large profits towards the end of the life of the mine. This is also

a safeguard against deteriorating market conditions and/or increase in working costs with time. This procedure, however, does reduce the present value of the mine in that profits made in the near future have a higher present value than those made in the more distant future.

Present value calculations are, however, at best only rough estimates, because of uncertainty of the future, and it is thought that one is justified in making reasonable simplifying assumptions.

The calculation of the present value was based on an annuity yielding interest on capital at 8% and replacing capital by accumulation at 4%.

The figures given for "Capital Adjustment" are both estimates.

The example of the comparative valuation calculation follows:-

PIT	A	B
Cut-off grade	1.5%	1.5%
Final Depth	800'	800'
Final Slope angle β . . .	45°	45°
Ore Reserve (tons)	34,400,000	45,000,000
Overburden (tons)	175,000,000	315,000,000
Overall Stripping ratio .	5.1 : 1	7 : 1
Average Mill Head grade .	2.5%	2.5%
Tons of Copper in reserve.	860,000	1,125,000
Yearly production of copper	57,400	75,000

PIT		A	B
<u>DAILY PRODUCTION.</u>			
Copper	(tons) . . .	185	242
Ore	(tons) . . .	7,400	9,700
Overburden	(tons) . . .	37,800	68,000
Life of Pit	(years) . . .	15	15
Prod. cost/ton of copper	£	104	98
Amortization on Capital	£	12	12
Total cost/ton of copper	£	116	110
Revenue/ton of copper	£	200	200
Gross yearly profit (A)	£	5,500,000	7,650,000
Amortization	£	<u>690,000</u>	<u>900,000</u>
		4,810,000	6,750,000
Allowance for depletion	£	<u>1,300,000</u>	<u>1,900,000</u>
Taxable income	£	3,510,000	4,850,000
Tax at 25% ... (B)	£	<u>880,000</u>	<u>1,210,000</u>
Net annual profit (A-B)	£	4,620,000	6,440,000
Total Profit	£	<u>69,500,000</u>	<u>96,600,000</u>
Present value	£	36,000,000	50,000,000
Capital adjustment	£	<u>15,000,000</u>	<u>25,000,000</u>
Net Present Value	£	<u>21,000,000</u>	<u>25,000,000</u>

C H A P T E R 8.

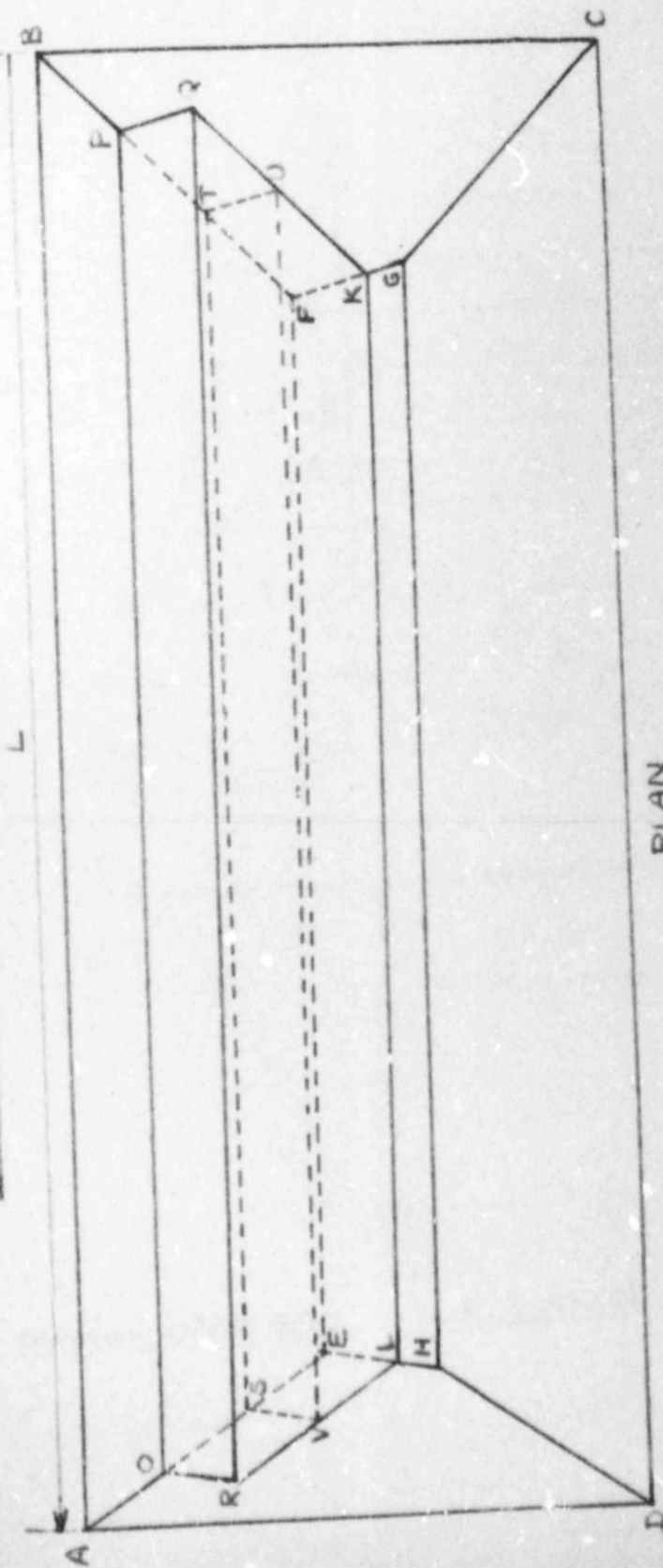
SUMMARY OF CONCLUSIONS.

- (1) Slope stability problems can be approached theoretically, and they can be analysed by using existing methods of analysis.
- (2) The results obtained from a theoretical slope stability analysis are at best only a fair indication of what exists in practice. Because of the imponderable geological variations in a large open cast mine, it cannot be expected that tests, field observations and calculations will provide absolute answers to slope stability problems.
- (3) The final outcome is invariably that the engineer has to make a decision based on his own experience of the problem. This type of work is done to provide a background so that judgment in this field can be developed, enabling "educated" decisions to be made.

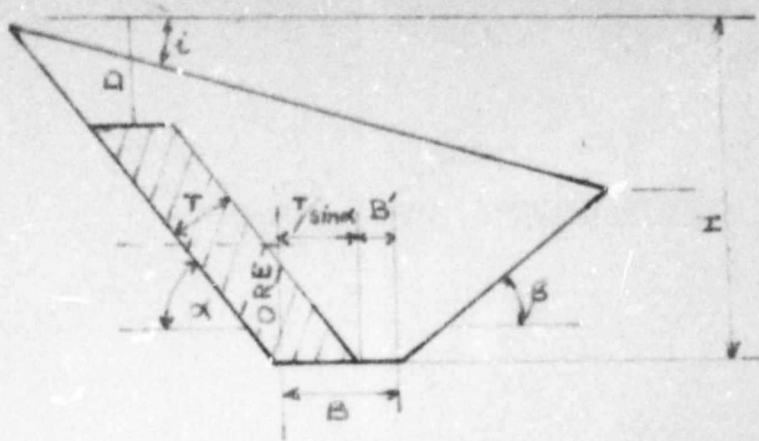
R E F E R E N C E S.

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SHAPE AND SPECIFICATIONS OF PIT A.



PLAN



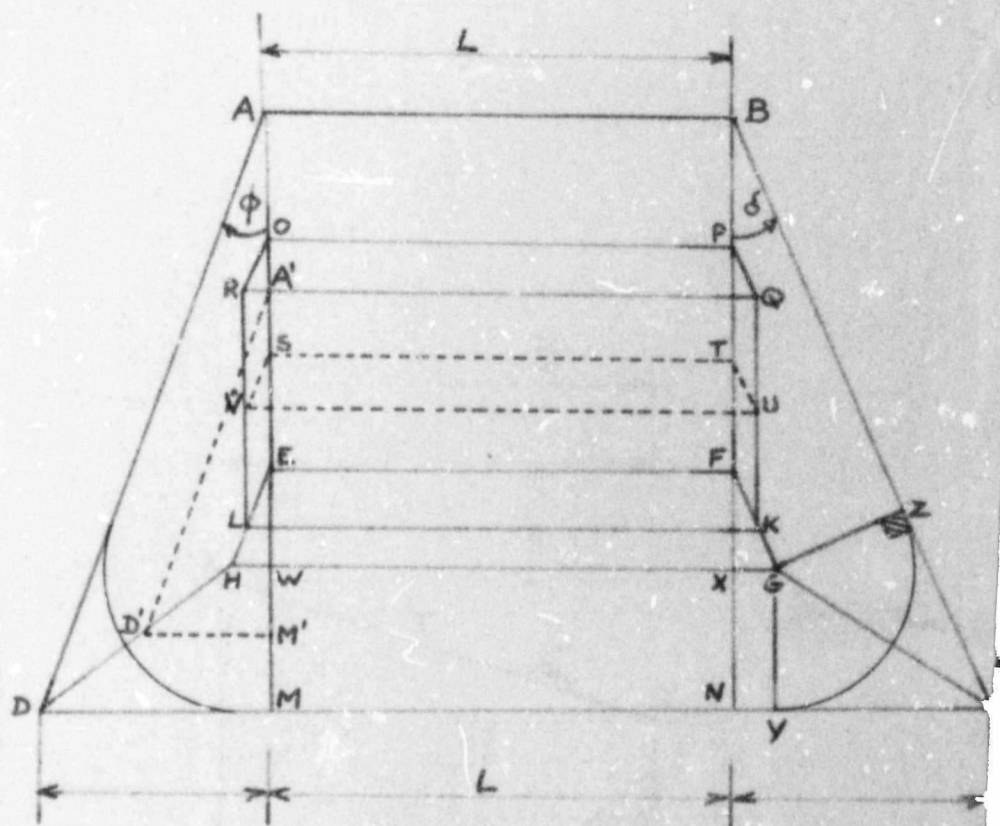
Orebody OPQR-EFKL

Cent. area STUV-----

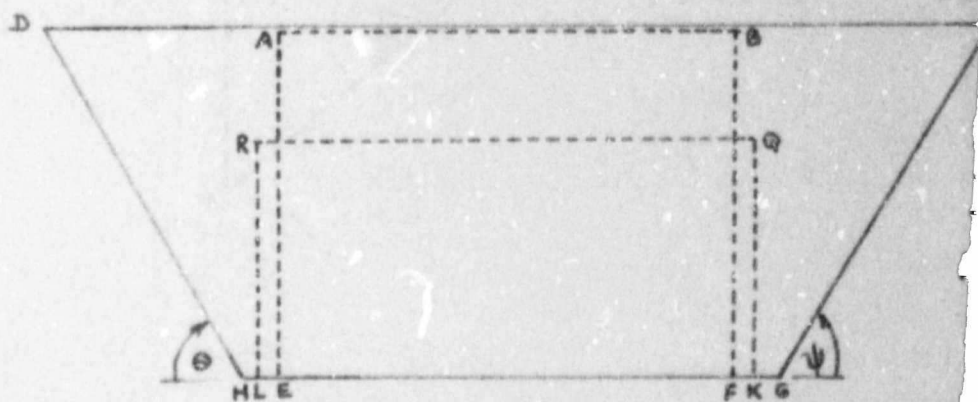
$$B = \frac{T}{\sin \alpha} + B'$$

B' represents space for

SHAPE AND SPECIFICATIONS OF PIT B.



PLAN

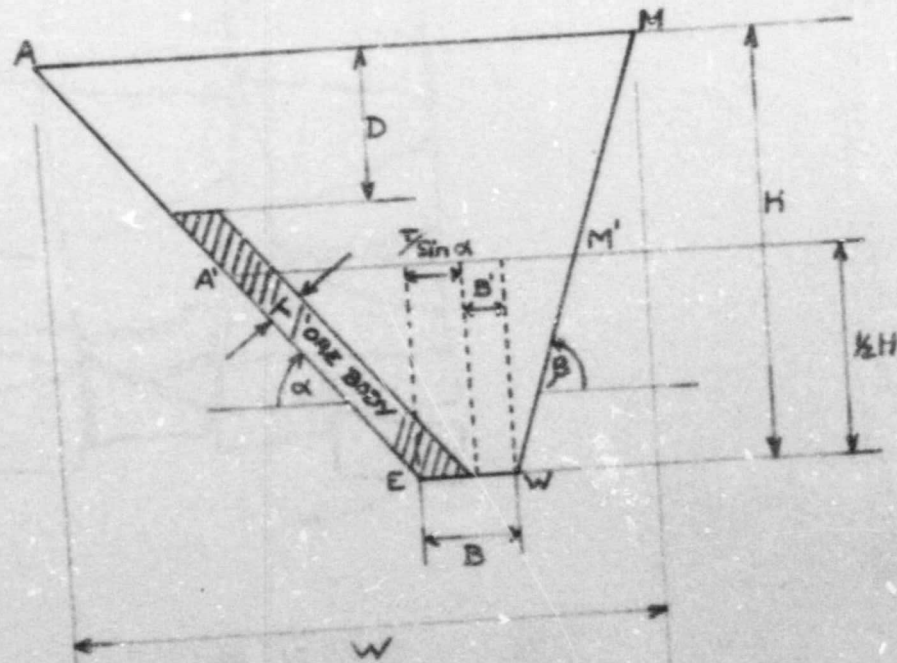


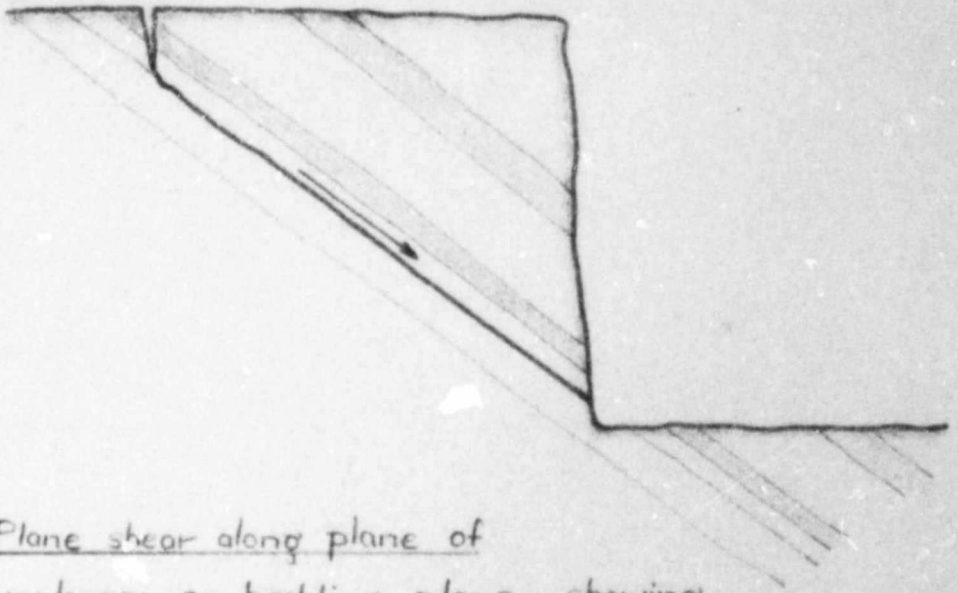
OREBODY OPQR-EFKL.

ELEVATION

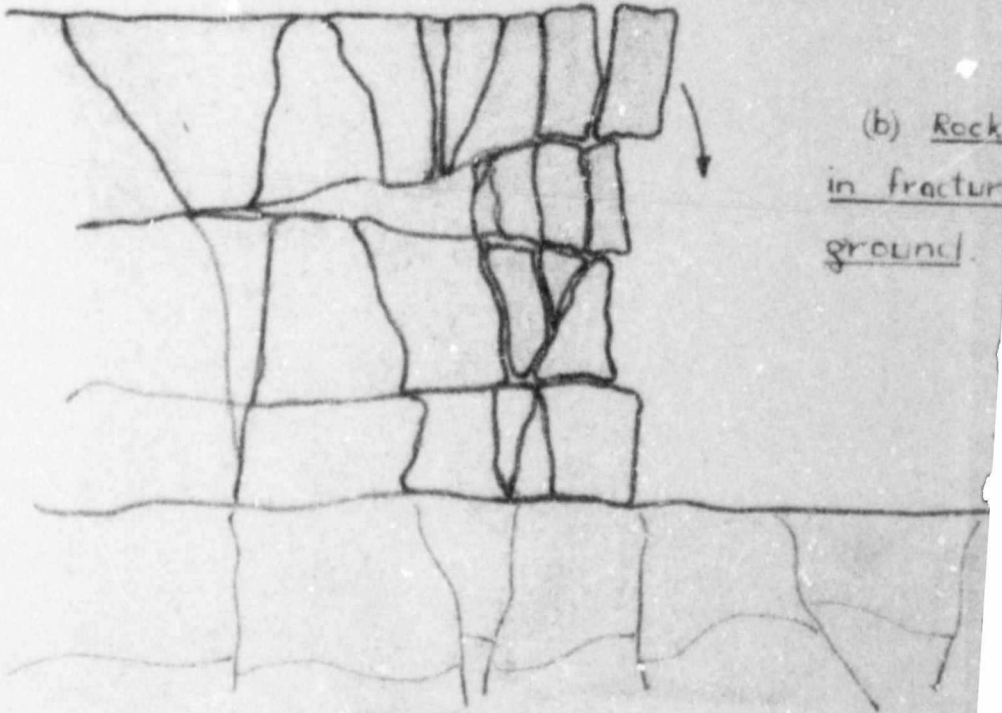
Fig 2

SECTION THROUGH PIT B.





- (a) Plane shear along plane of weakness or bedding plane, showing formation of tension crack at surface.



- (b) Rock in fractured ground.

For Fig 5 see
last fiche

For Fig 6 see
last fiche

For Fig 7 see
last fiche

SAMPLES 31 & 32
 Nos 33 & 34 DISPLACED TO
 EAST OF SECTION

SAMPLES 12 & 13 ON SCOT
 DISPLACED TO EAST OF
 SECTION

SAMPLES 1 & 2

G.L. 5105

MEAN SLOPE 14 1/2°

NATURAL GROUND

DOLOMITE SHIST

UPPER BANDED
 SHALE

T.F.G.

SECTION No 3

SHOWING SOIL SAMPLES

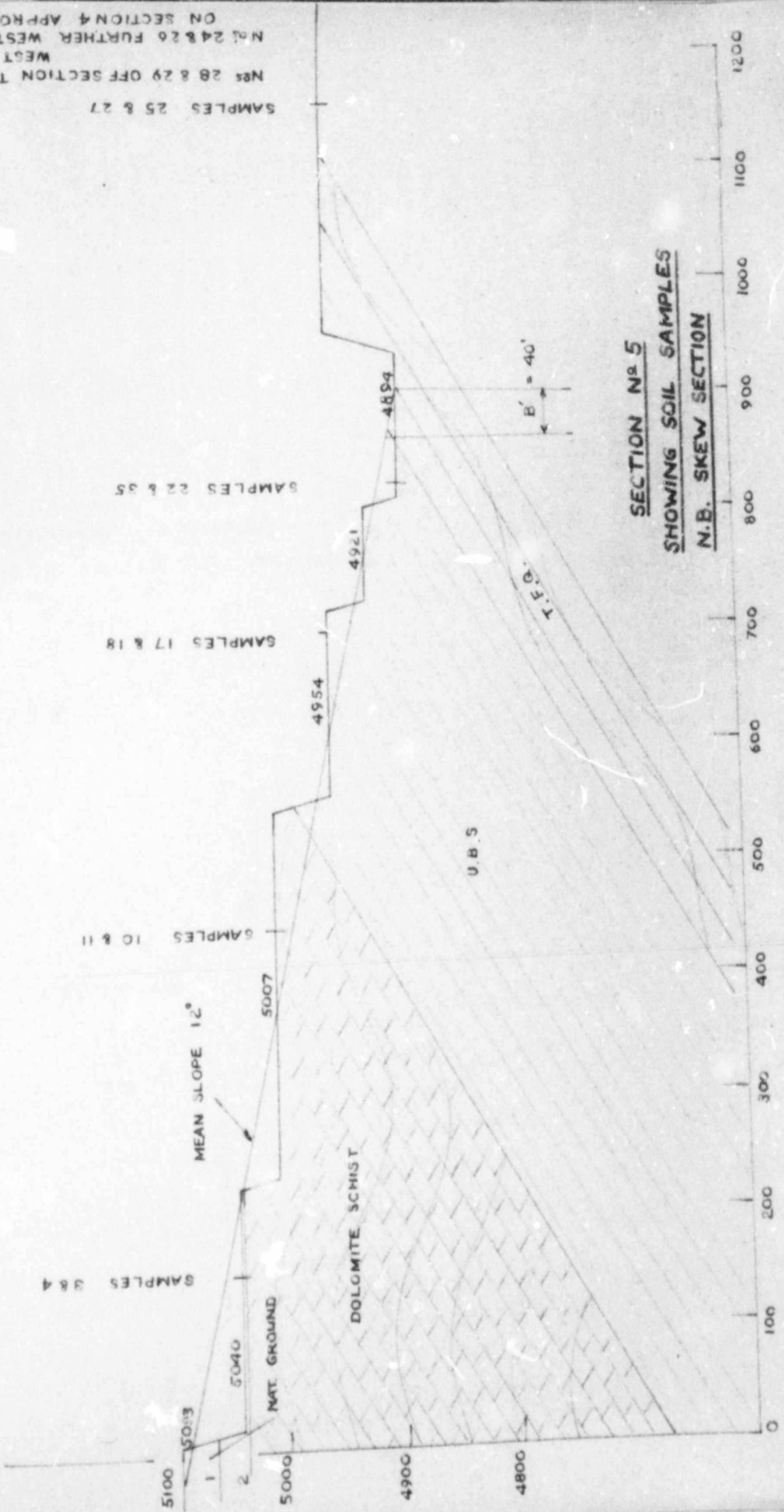
N.B. SKEW SLOPE.

B' = 43'

DISTANCE FT. FROM SOUTH RIM OF PIT

Fig 3

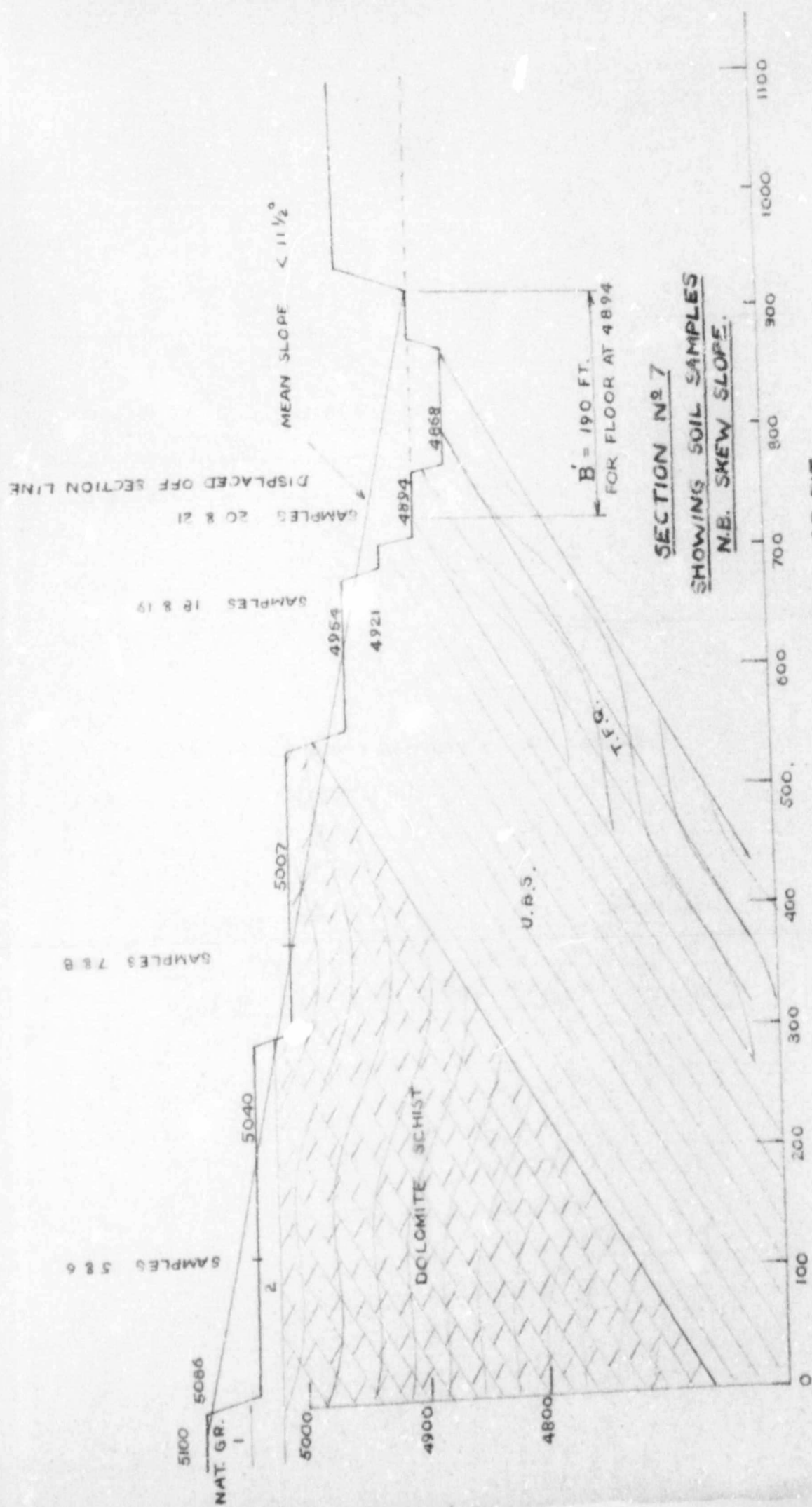
SAMPLES 25 & 27
 Nos 28 & 29 OFF SECTION TO
 WEST
 Nos 24 & 26 FURTHER WEST
 ON SECTION 4 APPROX.

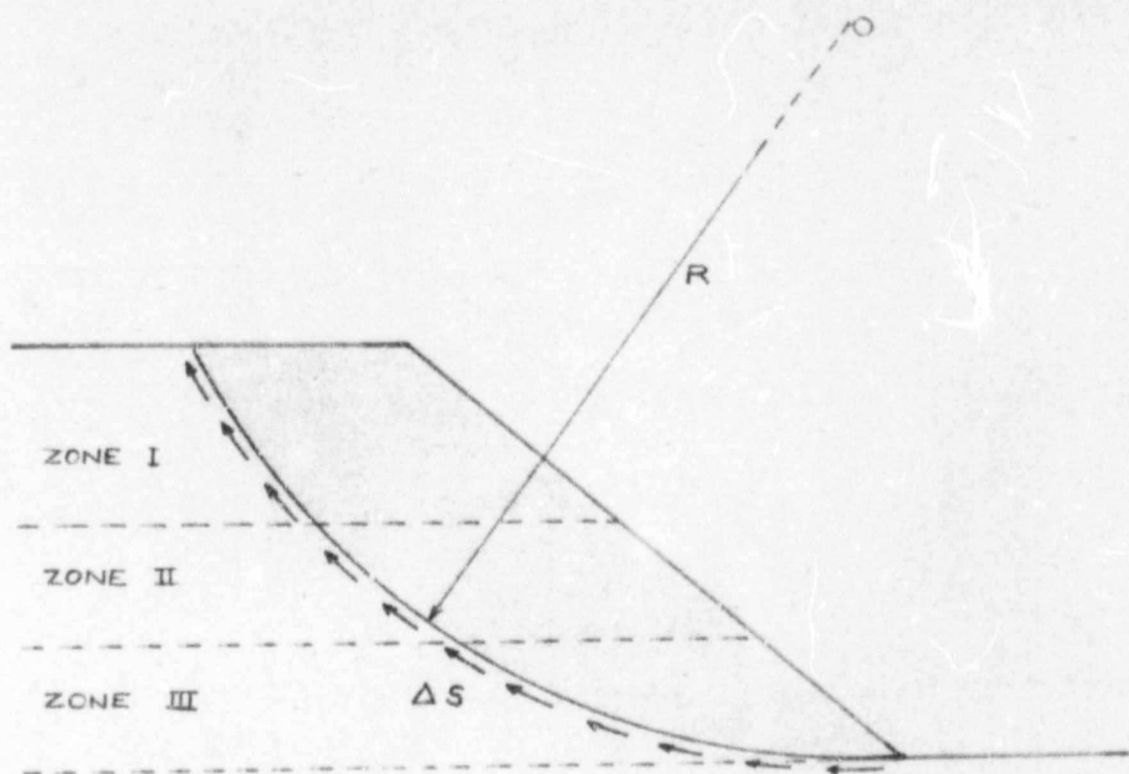


SECTION No 5
SHOWING SOIL SAMPLES
N.B. SKEW SECTION

DISTANCE FT. FROM SOUTH RIM OF PIT.

Fig 9

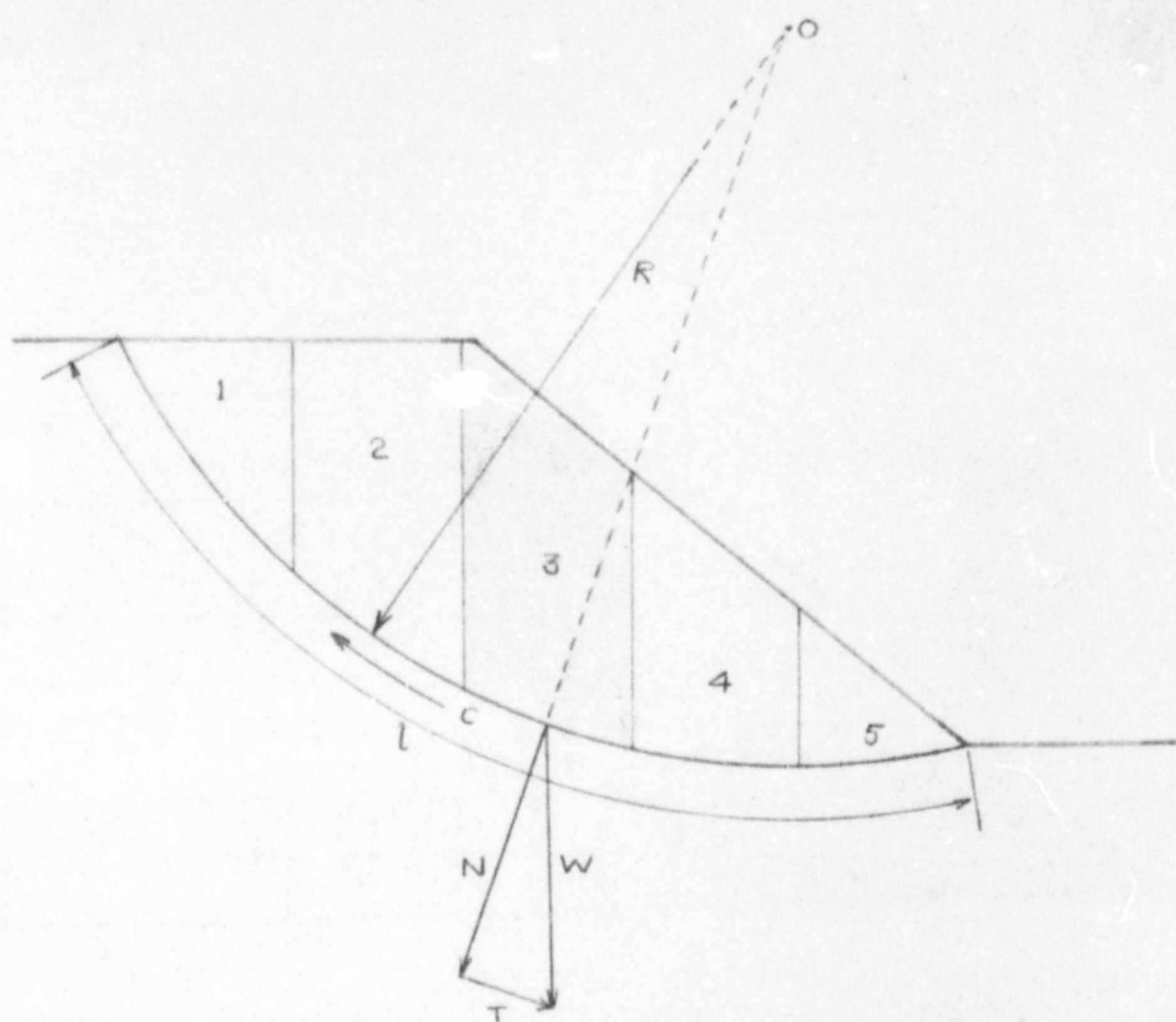




ΔS = Shear resistance of length
of arc ΔL

Failure of a slope by a circular
arc through the toe. No flow of
water through the slope.

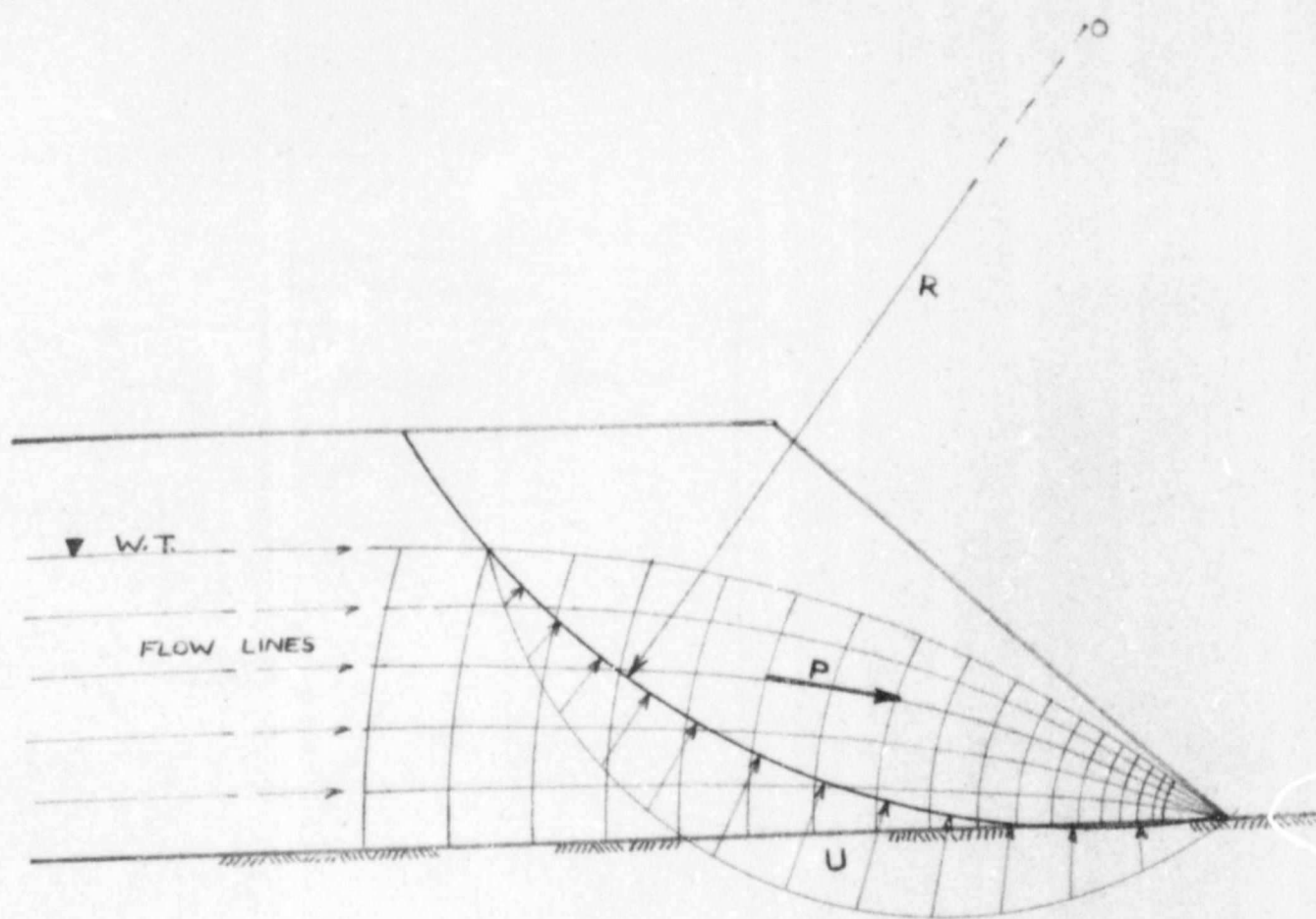
Fig 11



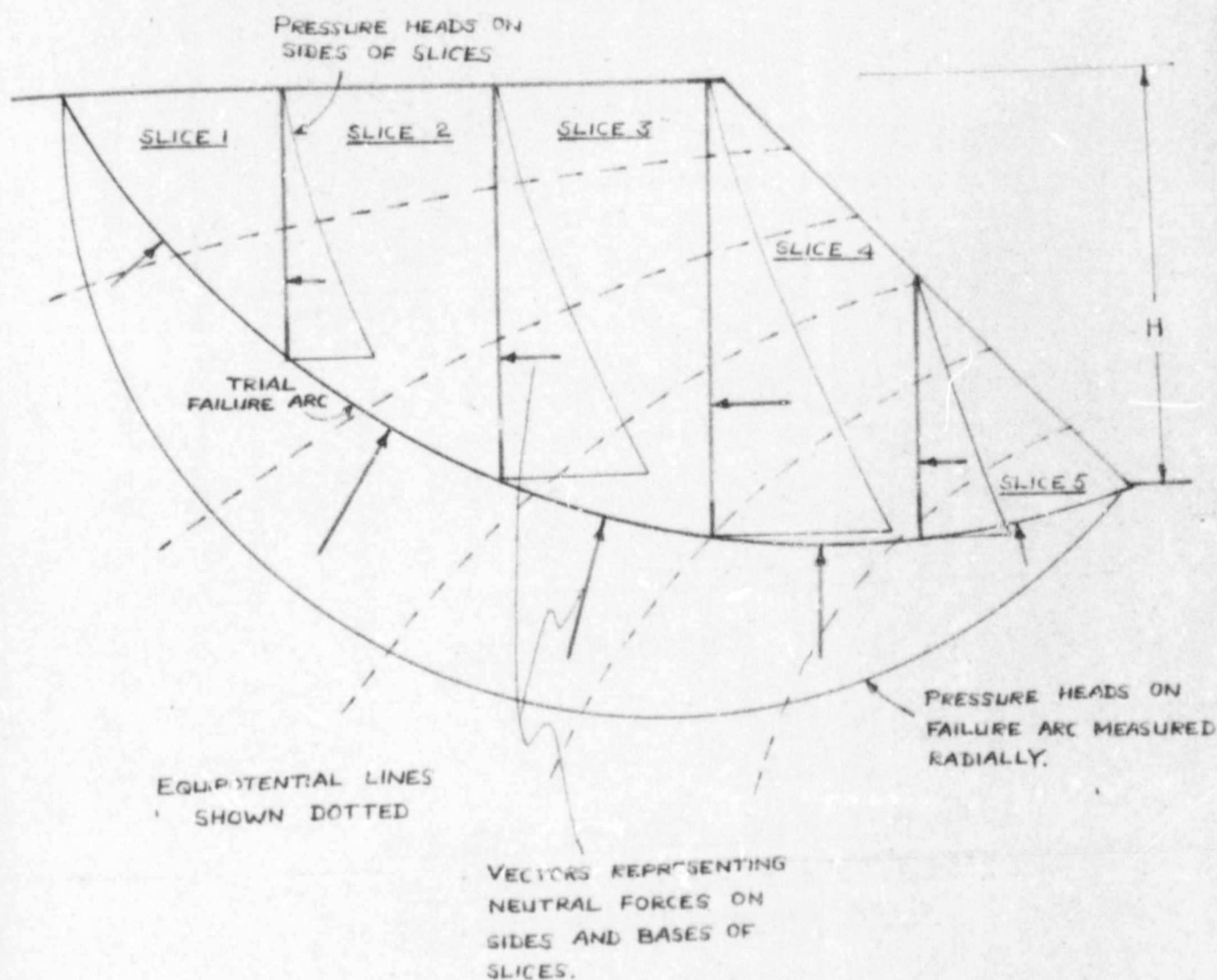
Cross section illustrating analysis
by means of the
Swedish Method of Slices.

- l = length of failure arc
- c = cohesion per unit length of arc l .
- W = gravitational force.
- N = component of gravity normal to failure arc.
 (friction inducing force).
- T = component of gravity tangential to the
 failure arc. (actuating force)

Fig 12.

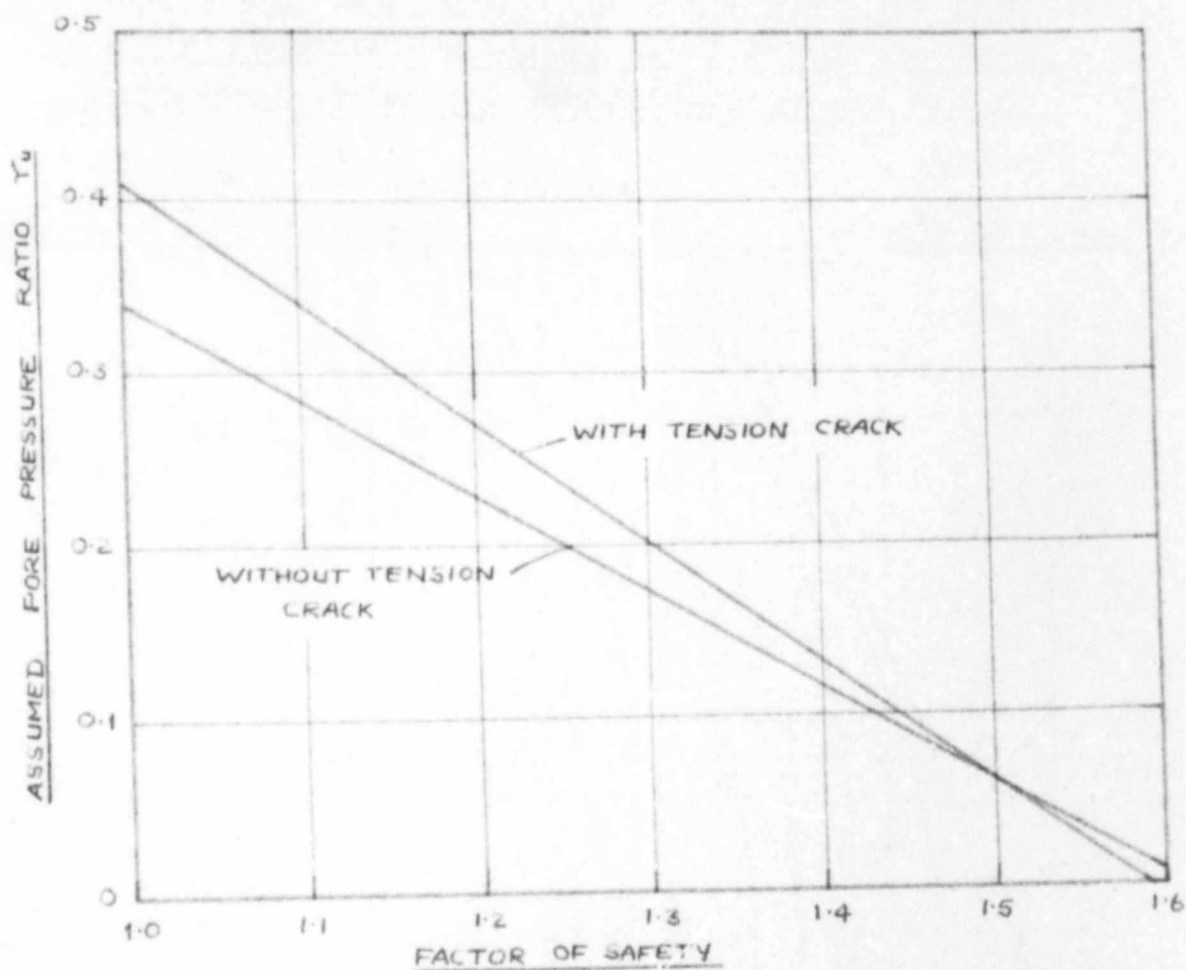


Seepage flow into an excavation
from an elevated water table.



Cross section showing slices and neutral forces.

Fig 14



ANALYSIS OF LOCAL BENCH FAILURE.
VARIATION OF FACTOR OF SAFETY WITH
ASSUMED FORE PRESSURE RATIO.

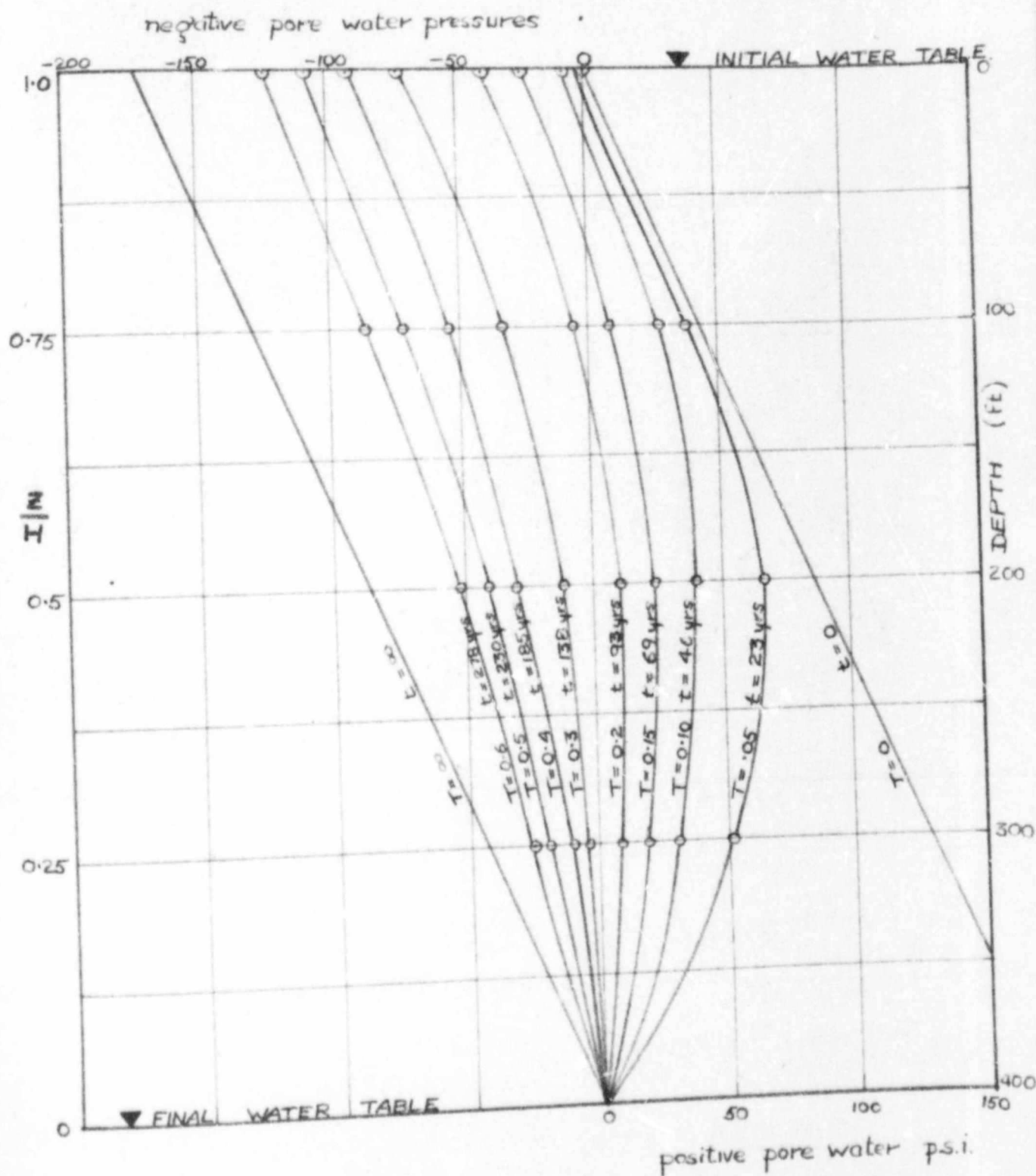
SOIL PROPERTIES

$$C' = 720 \text{ LB.FT}^2 \quad \phi' = 35^\circ$$

$$\gamma = 127 \text{ LB.FT}^{-3}$$

Fig 15.

ISOCHRONES SHOWING PORE WATER PRESSURE DISTRIBUTION WITH DEPTH OVER A 400 ft LAYER OF SOIL WHICH IS CONSOLIDATING DUE TO A DROP IN THE LEVEL OF THE WATER TABLE, ASSUMING THAT NO AIR ENTRY TAKES PLACE.



ISOCHRONES AS BEFORE, EXCEPT THAT
AIR-ENTRY IS NOW ACCOUNTED FOR.

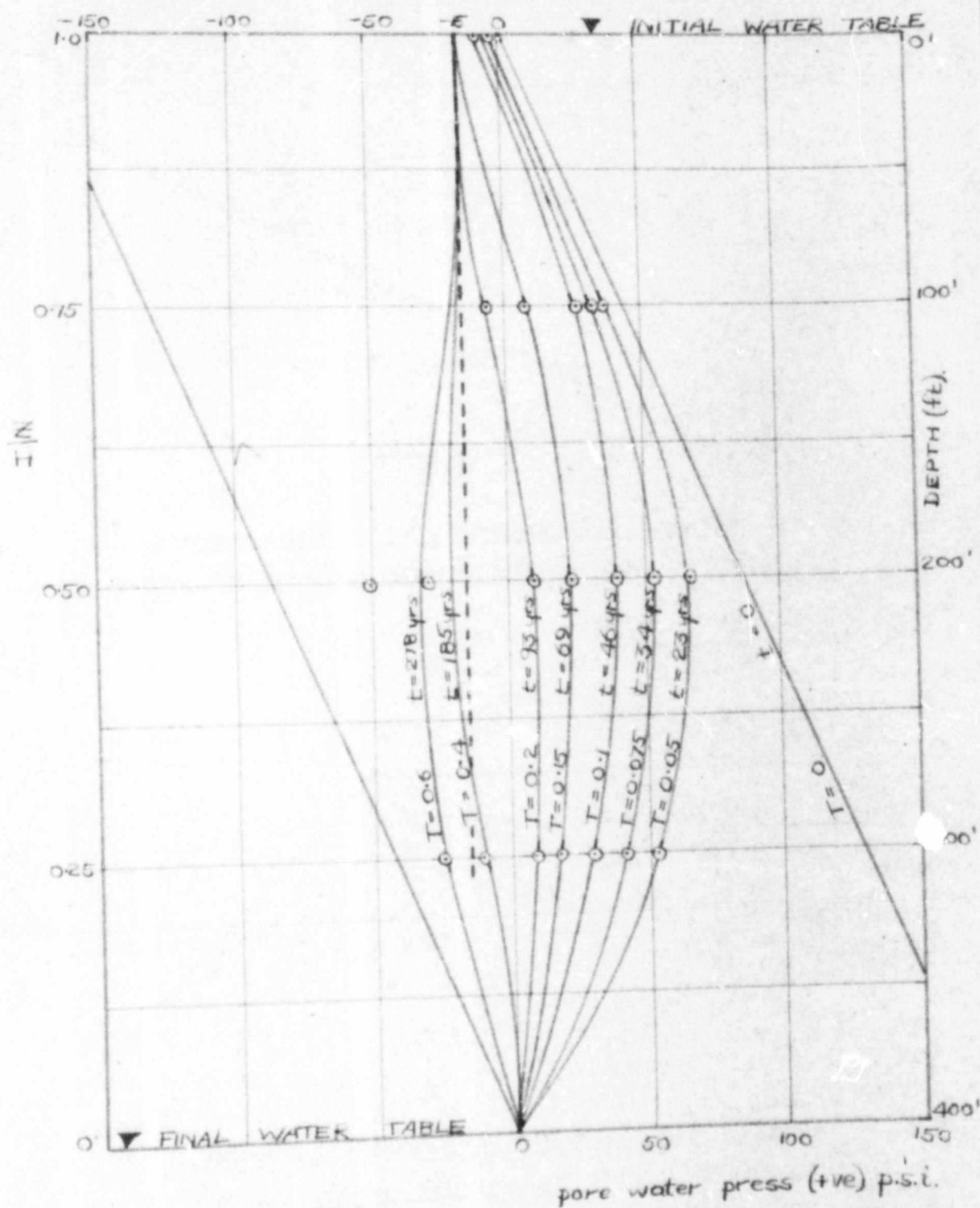
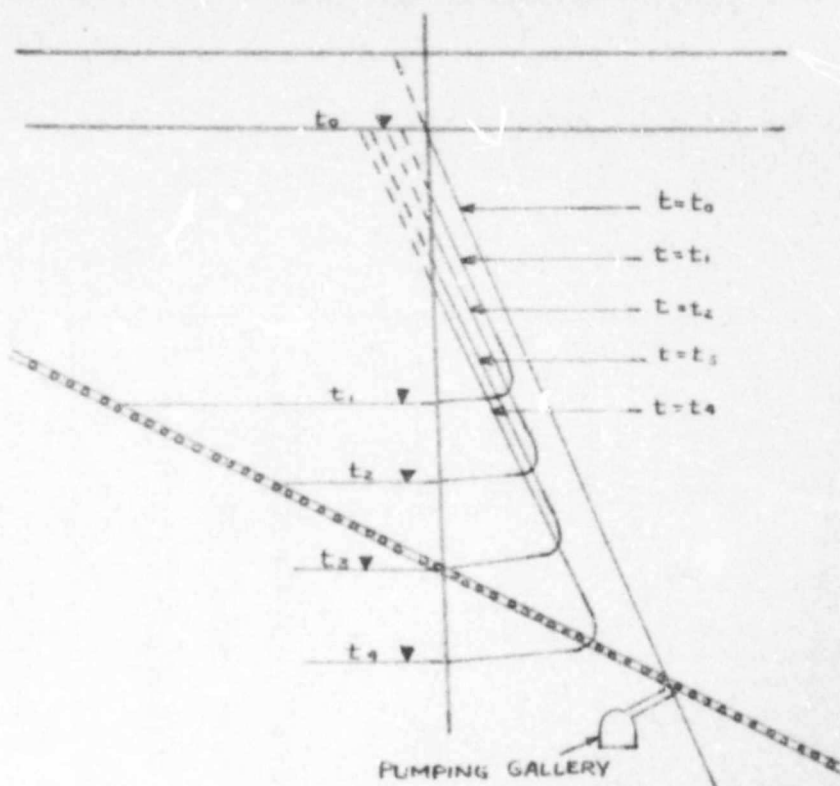
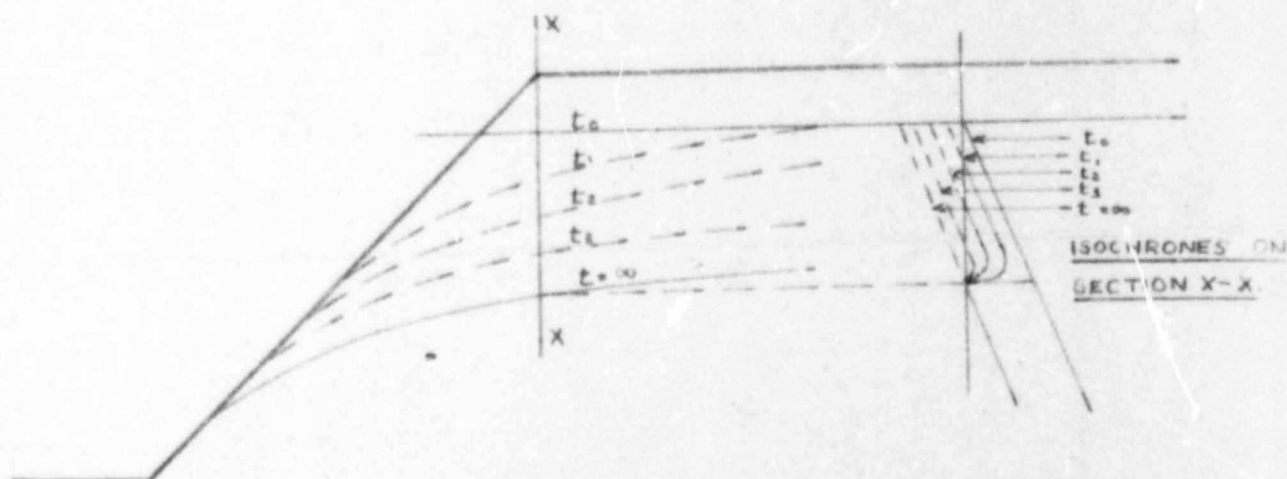


Fig 16 (b)



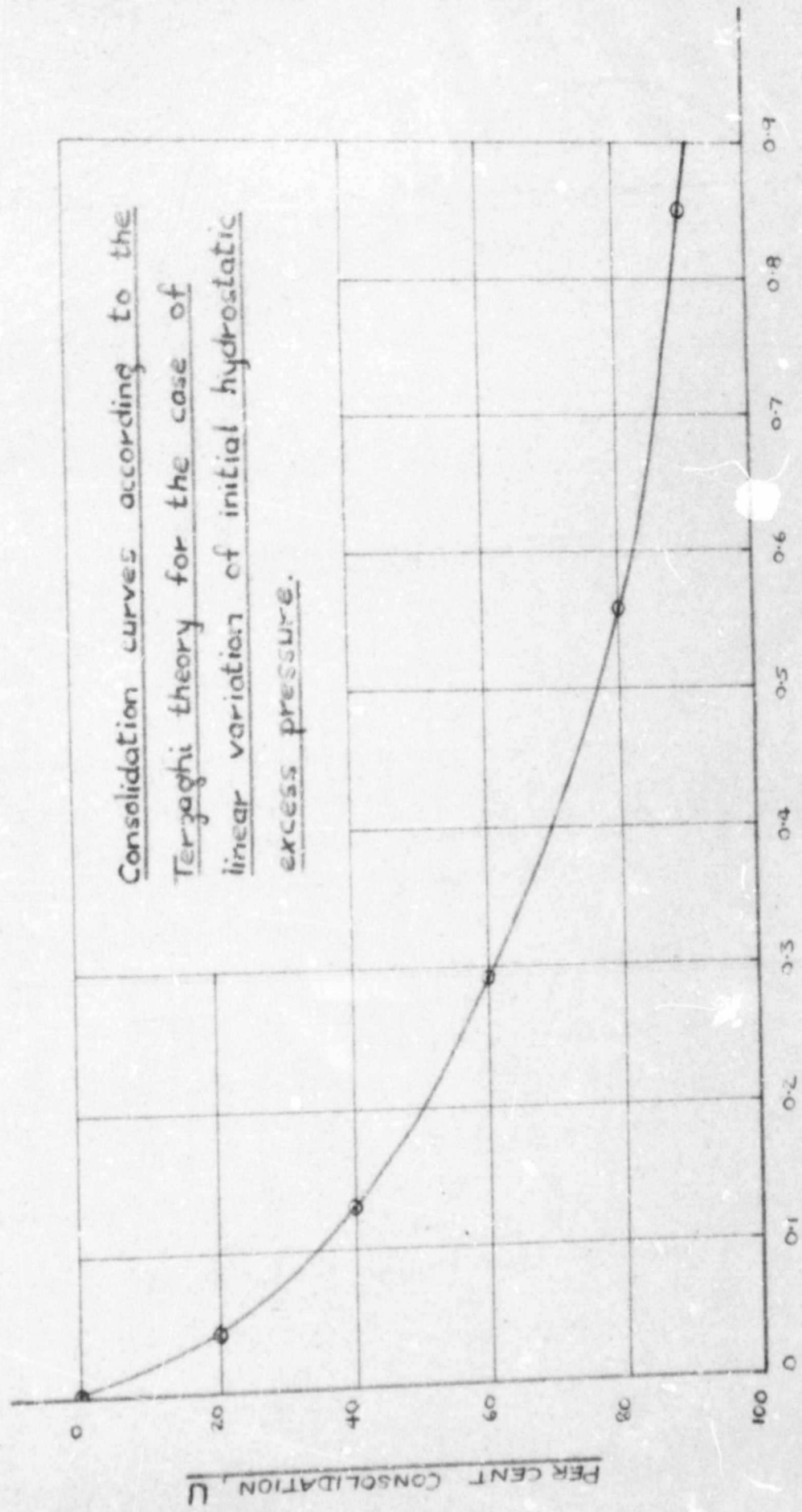
DRAINAGE PROCESS IN COMPRESSIBLE STRATUM
DUE TO PUMPING FROM A DIPPING SINK FORMATION

Fig 17



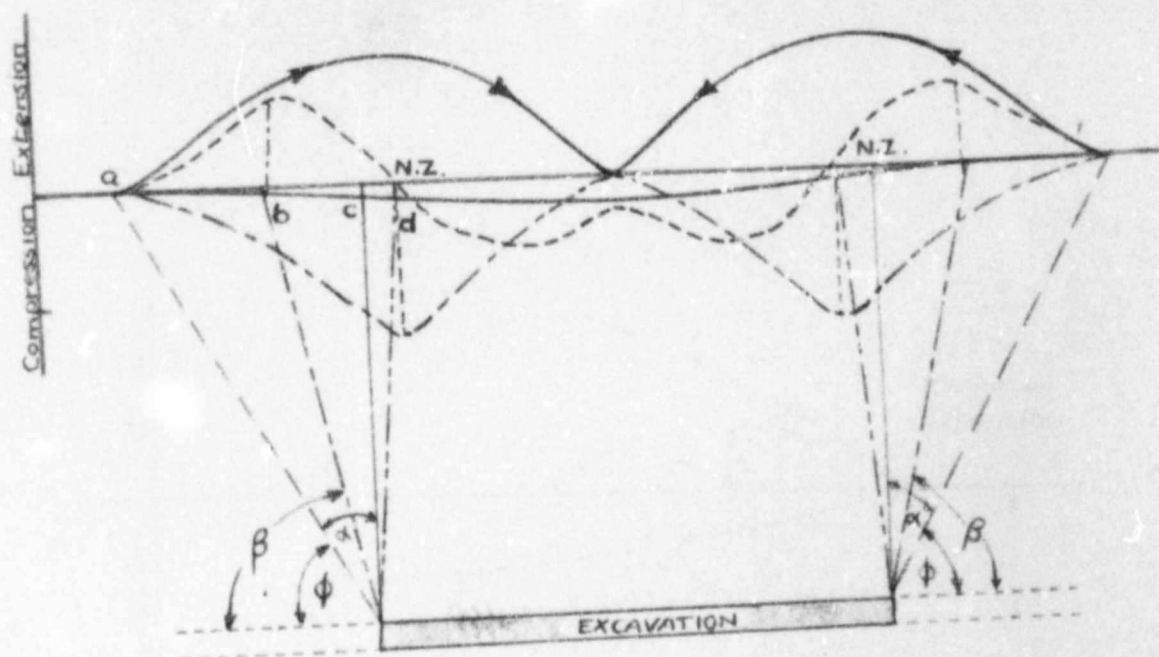
DRAINAGE PROCESS IN COMPRESSIBLE STRATUM
DUE TO FLOW INTO A CUT MADE RAPIDLY AT
TIME $t = t_0$

Fig 18



TIME FACTOR, T

Fig 19



- Vertical movement curve (Subsidence)
- Lateral displacement curve
- - - Lateral differential movement curve
- - - Vertical differential movement curve

N.Z. Neutral zone

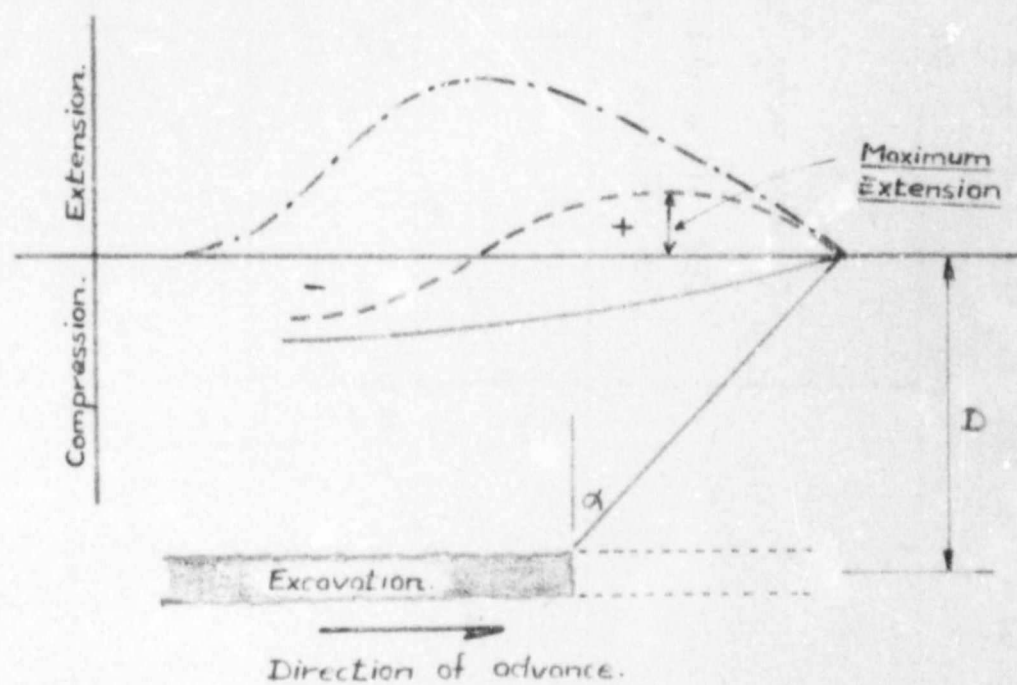
ϕ Angle of influence to horizontal (draw)

α Angle of influence to vertical

β Angle to point of maximum extentional movement (fracture angle)

- a Point of minimum subsidence and lateral movement.
- b Subsidence value at maximum extentional movement.
- c Subsidence over solid rib side of extraction
- d Subsidence at neutral zone or fracture point.

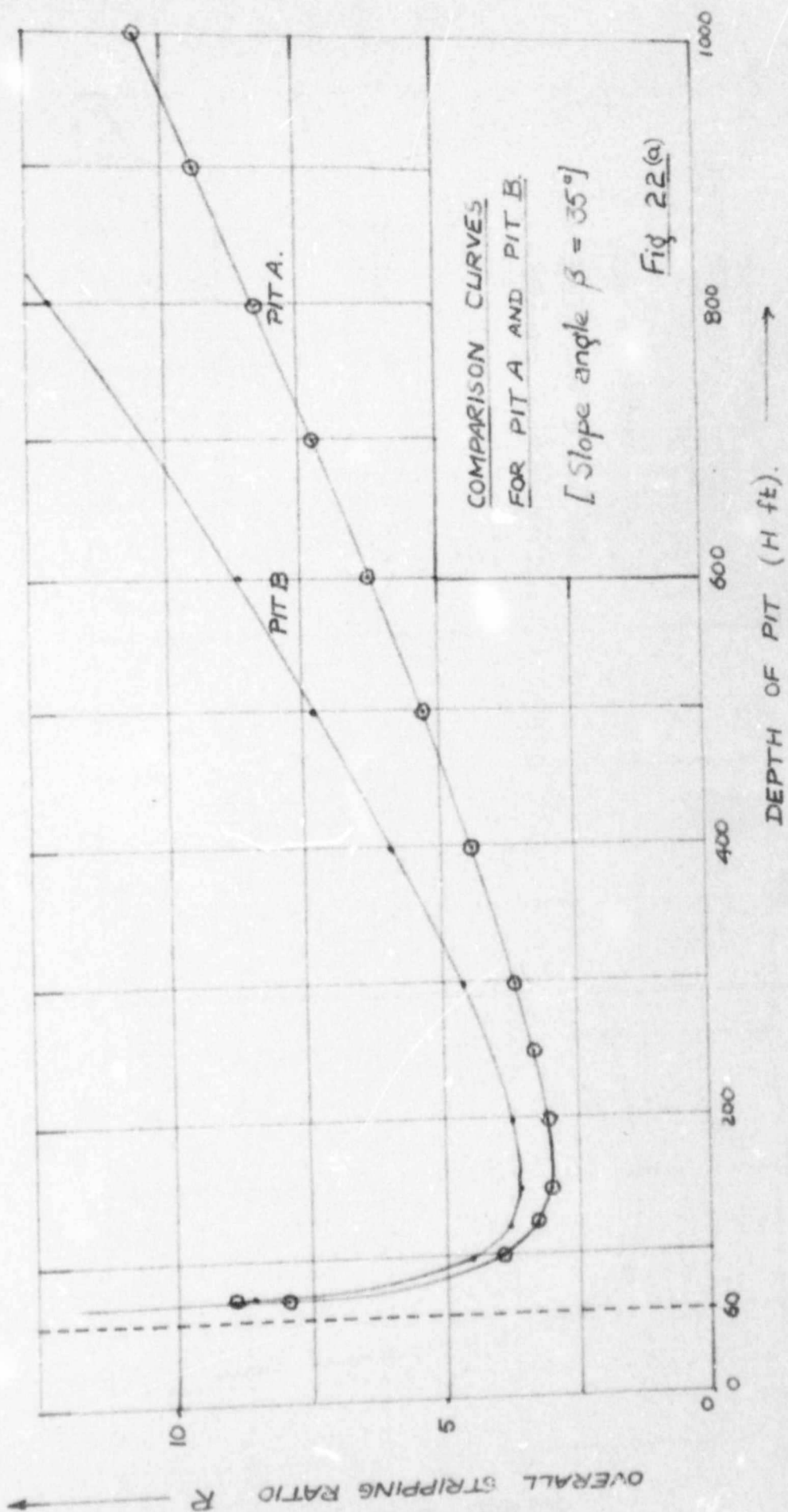
Fig 20

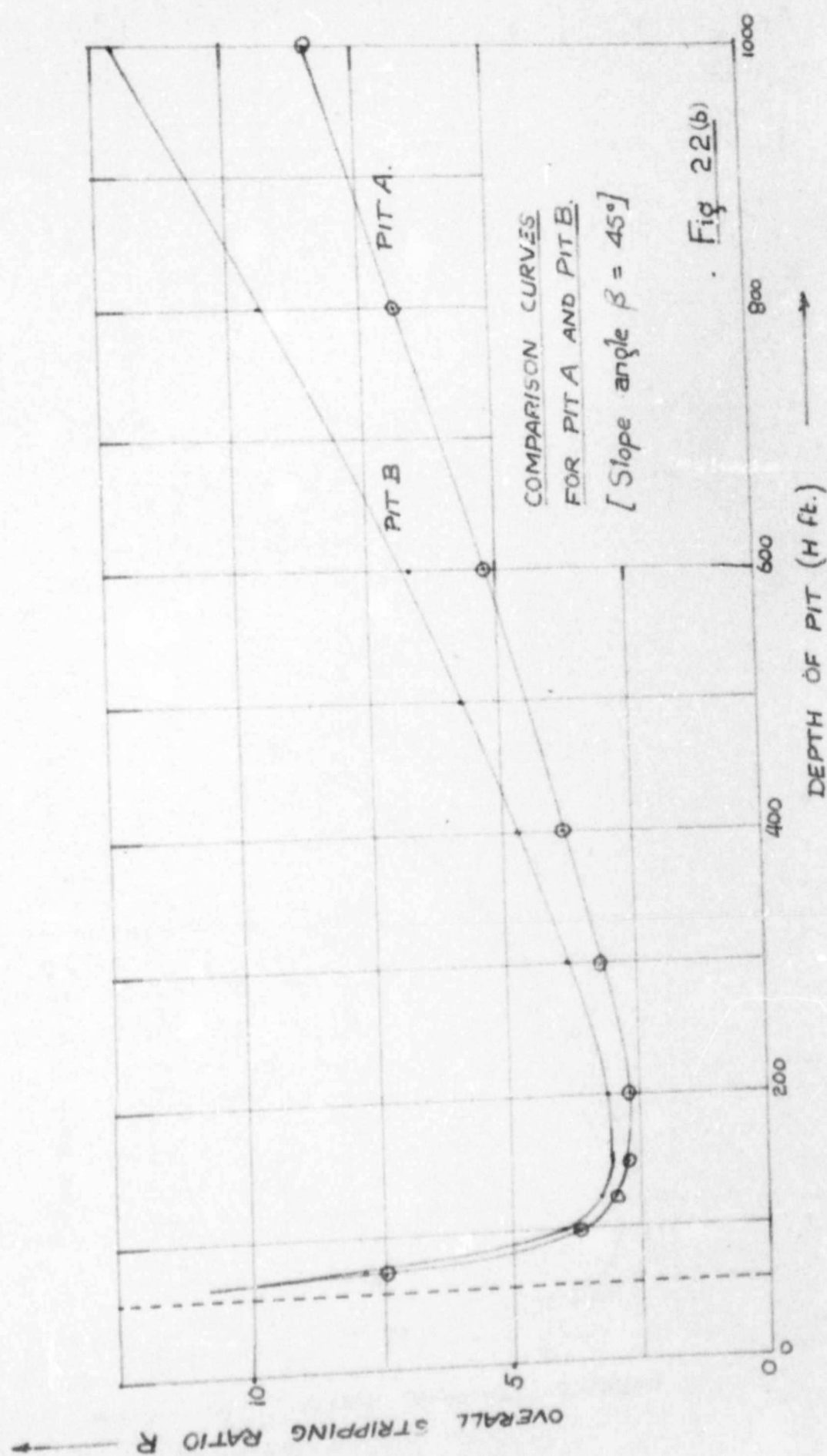


DYNAMIC CASE

- Subsidence
- Extension
- - - - - Compression
- Displacement.

Fig 21





COMPARISON CURVES
FOR PIT A AND PIT B.

[Slope angle $\beta = 35^\circ$]

15

R. $\rightarrow$

10

OVERALL STRIPPING RATIO

5

0.0

PIT A

PIT B.

Fig 23(a)

TOTAL VOLUME OF ORE RECOVERED (cu ft $\times 10^8$)

9

8

7

6

5

4

3

2

1

0

10

COMPARISON CURVES
FOR PIT A AND PIT B.

[Slope angle $\beta = 45^\circ$]

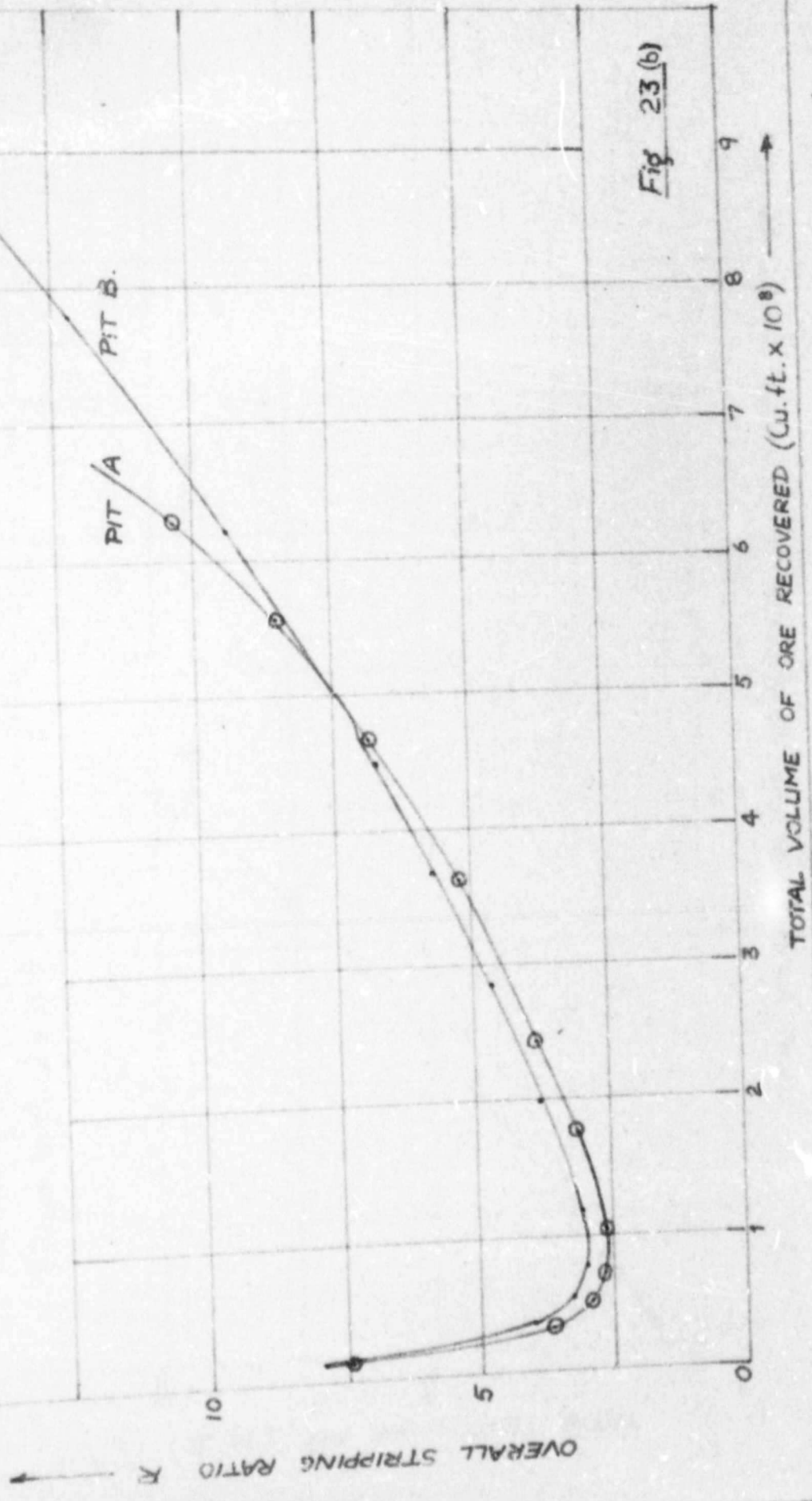
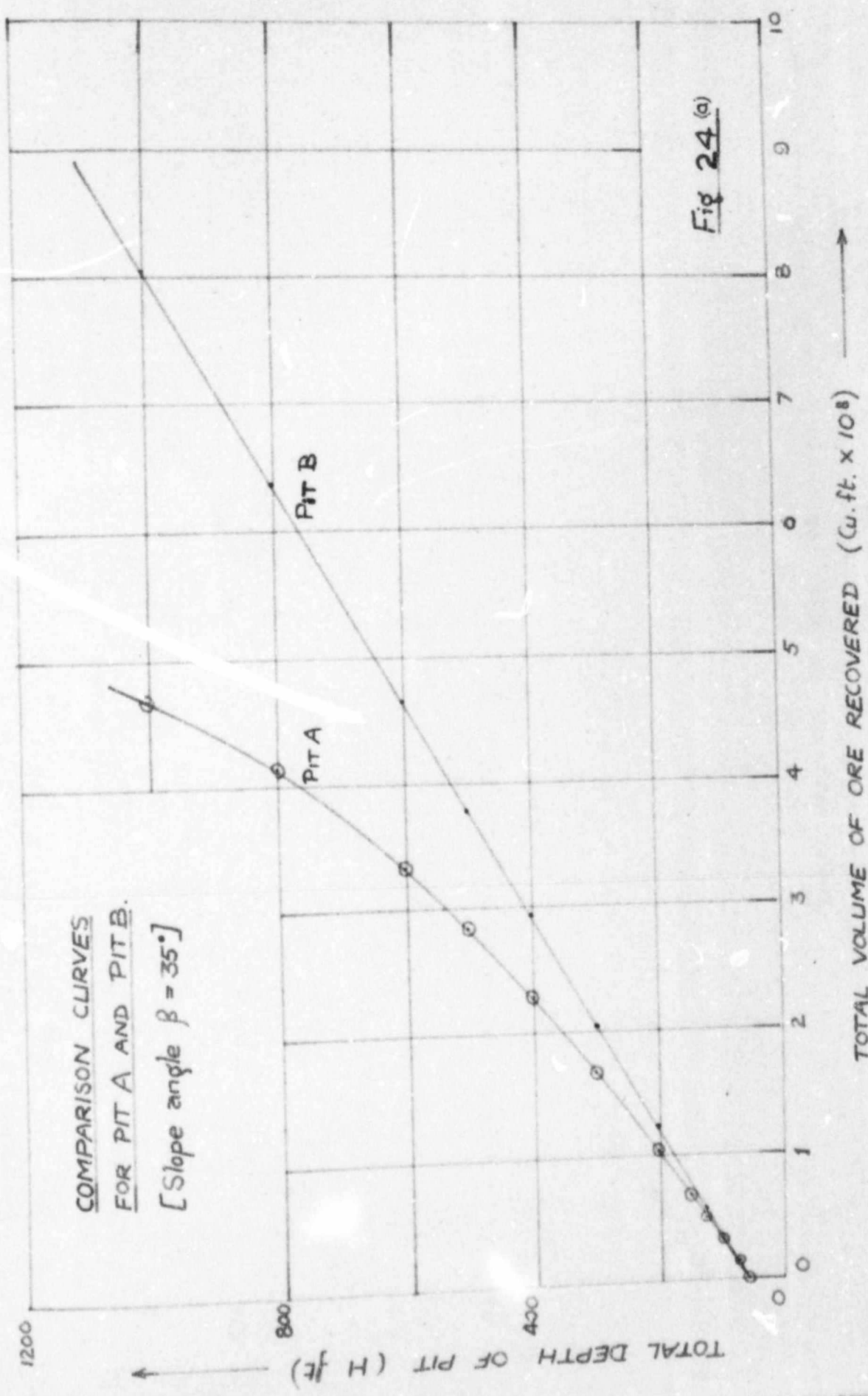


Fig 23(b)



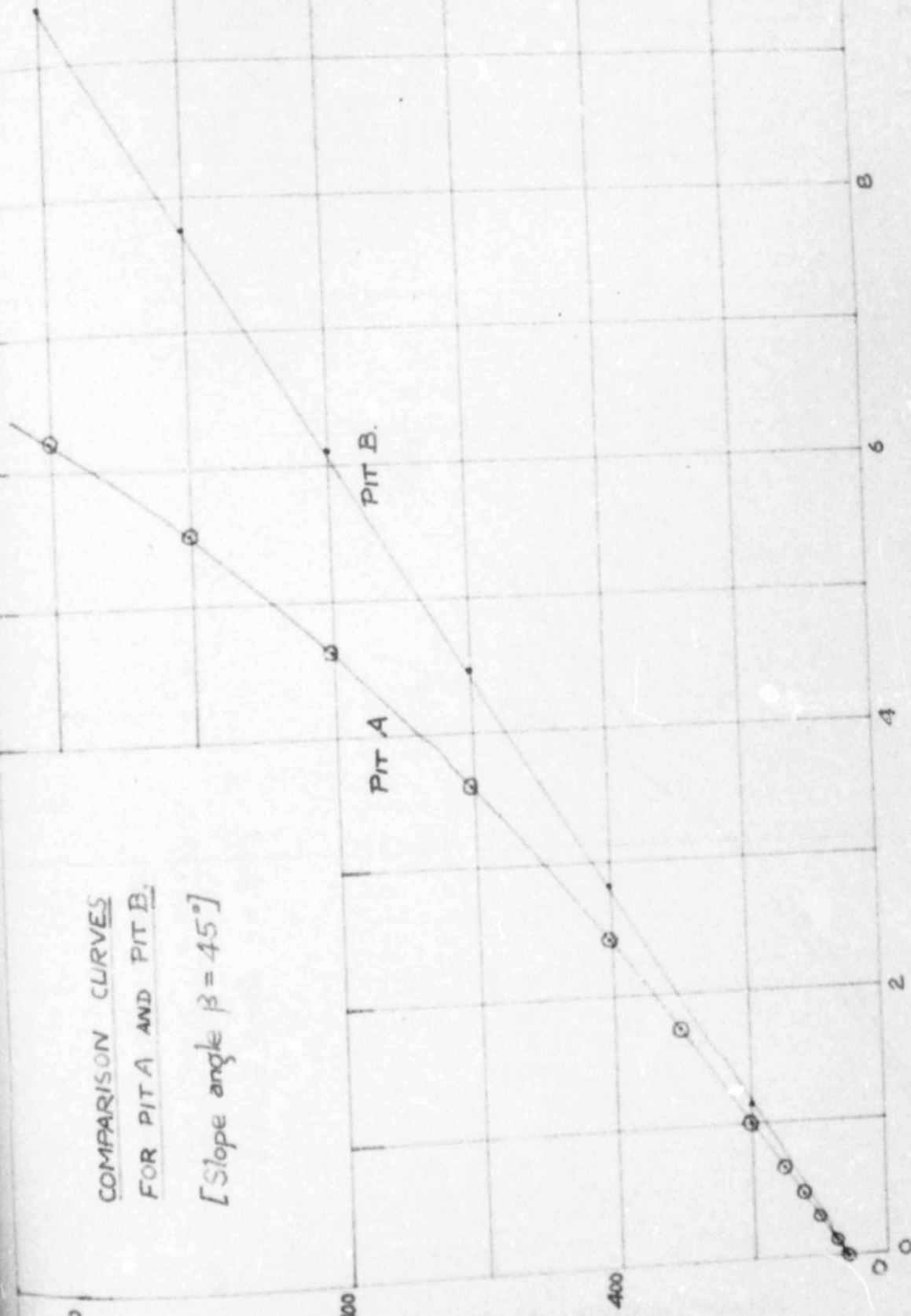
COMPARISON CURVES
FOR PIT A AND PIT B.

[Slope angle $\beta = 45^\circ$]

Fig 24(b)

TOTAL DEPTH OF PIT (H ft)

TOTAL VOLUME OF ORE RECOVERED (cu. ft. $\times 10^6$)



COMPARISON CURVES
FOR PIT A AND PIT B.

[Slope angle $\beta = 35^\circ$]

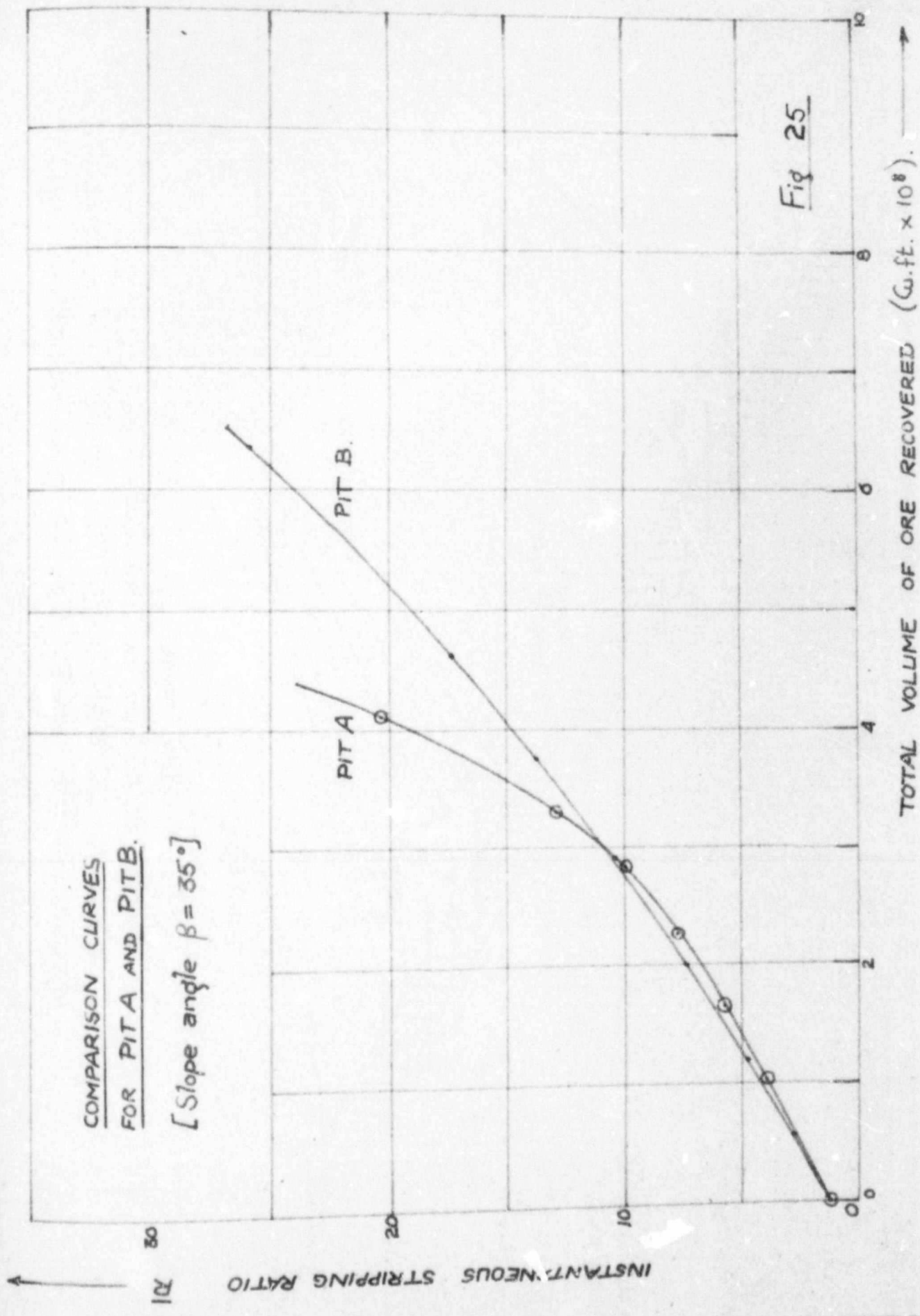


Fig 25

SECTION THROUGH PIT B SHOWING HYPOTHETICAL
EXAMPLE OF VARIATION OF PIT SLOPE
ANGLES DEPENDING ON THE POLICY OF
THE MINE.

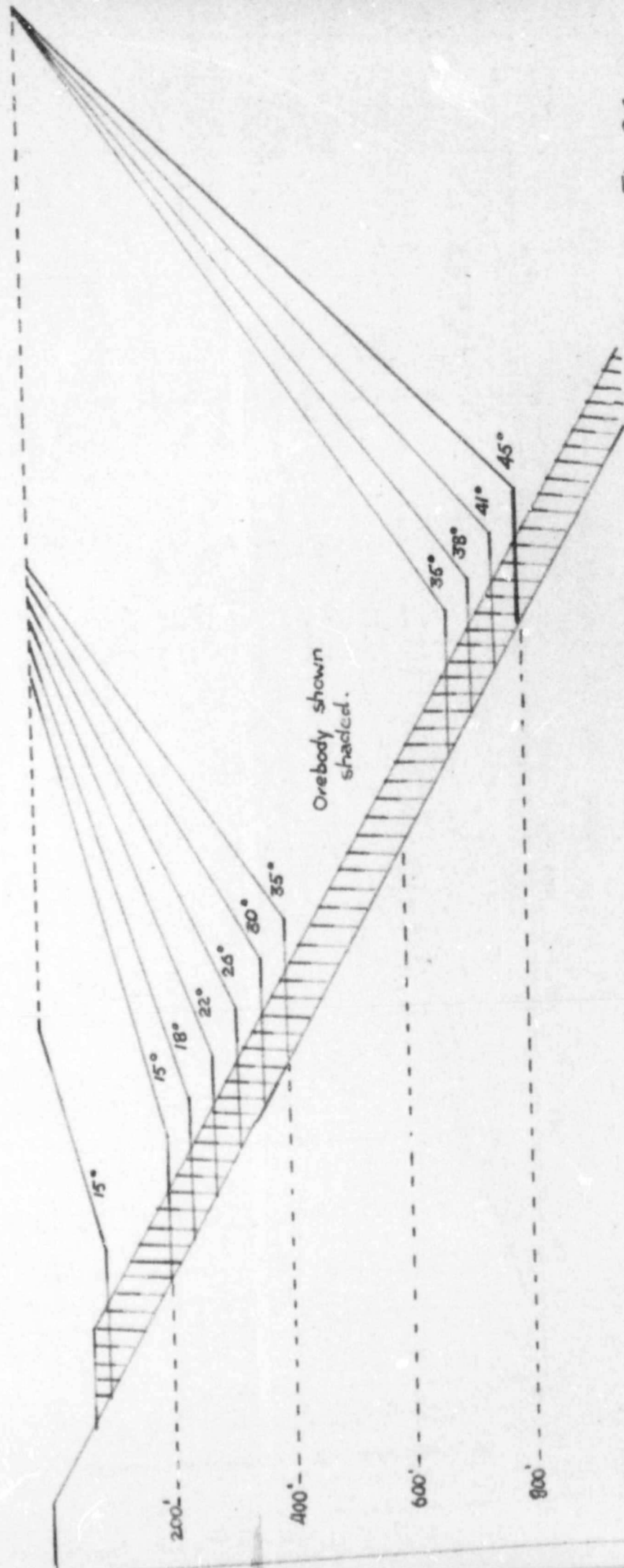
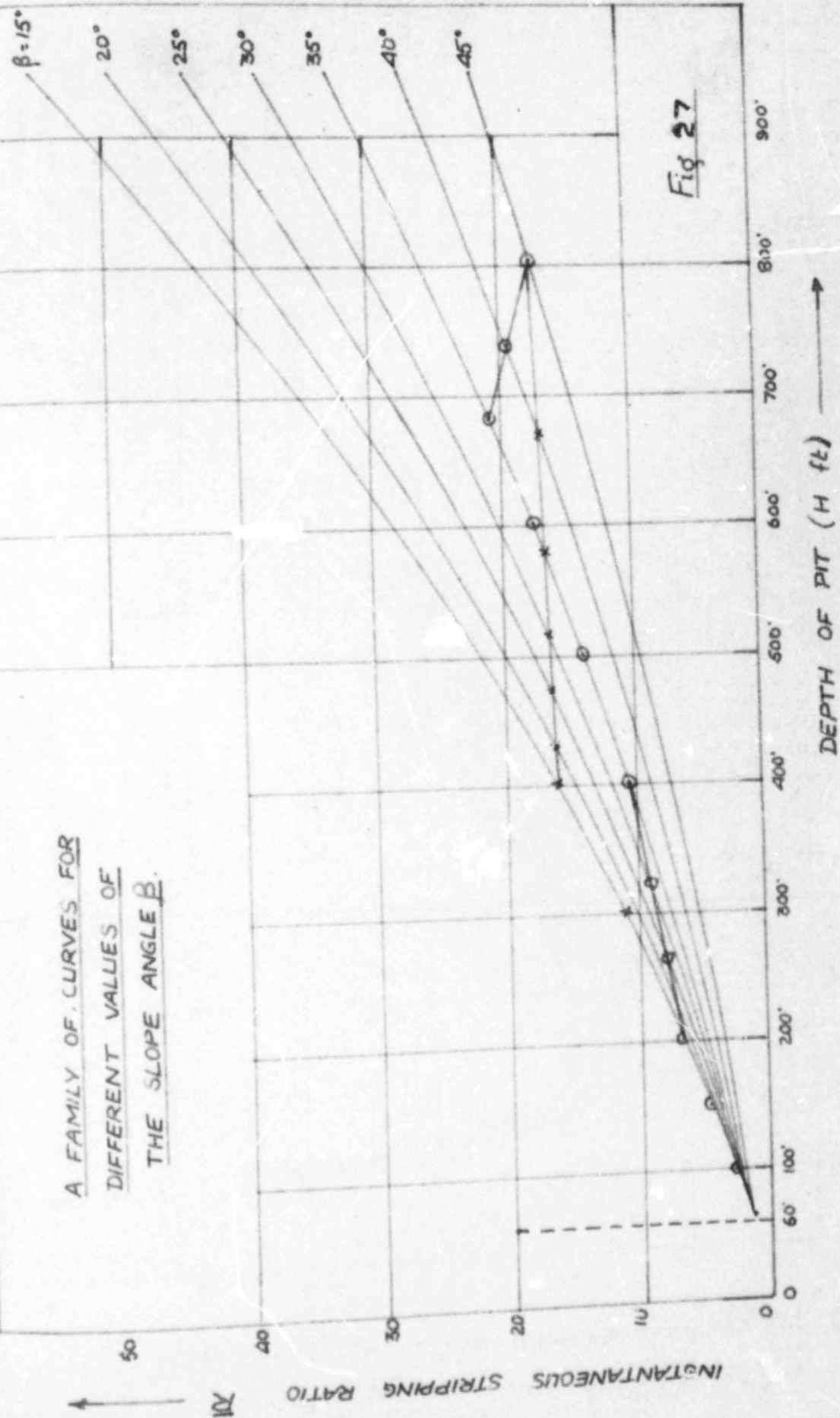
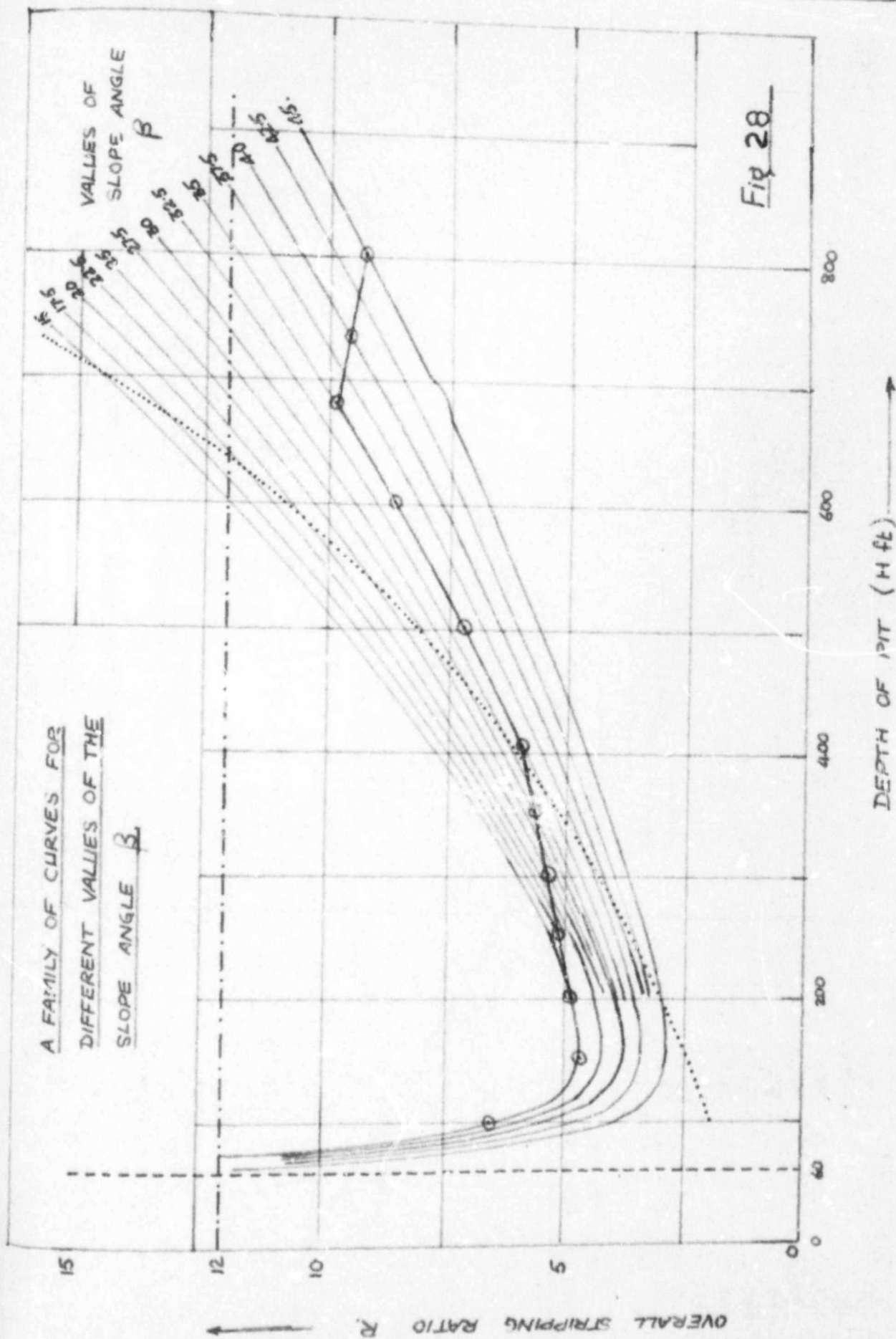


Fig 26

A FAMILY OF CURVES FOR
DIFFERENT VALUES OF
THE SLOPE ANGLE β .

Fig 27





SECTION SHOWING PIT PLANNED TO HAVE A FINAL SLOPE OF 45° AT 800 ft, HAVING A FLAT-DIPPING INSTANTANEOUS STRIPPING RATIO CHARACTERISTIC FROM AS EARLY A STAGE AS POSSIBLE.

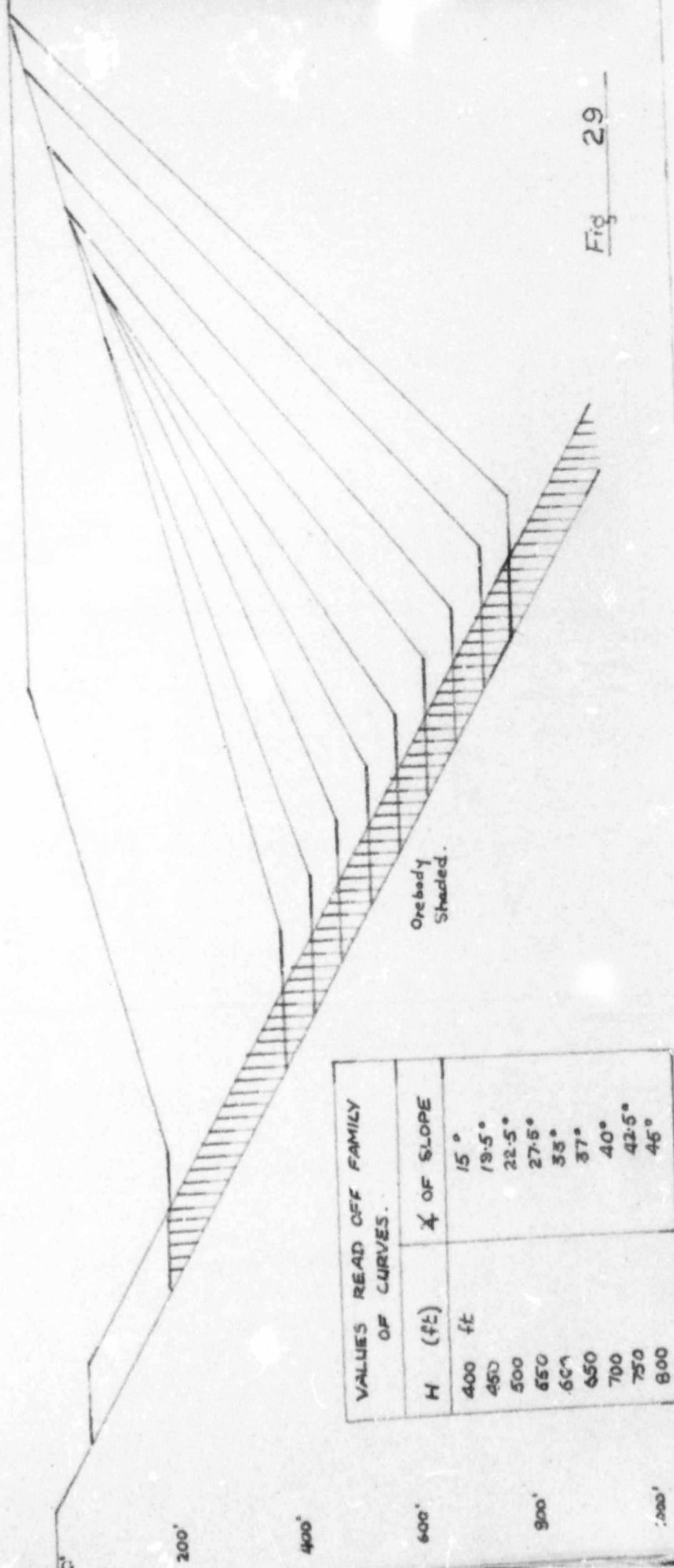


Fig 29

Author Brink David Charles

Name of thesis The Stability Of Slopes In Open Cast Mines And The Economic Implications Thereof. 1962

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