UR1984_58

1984/58. Stability assessment of the Leichhardt subdivision proposal

P.C. Stevenson

Abstract

A 100 ha tract of land in the valley of Jinglers Creek, near Relbia, is underlain mainly by Tertiary sand and clay. Active landsliding is taking place in several parts of the area. Failure has occurred on slopes of 10°-11°, and slopes steeper than this should be excluded from development.

INTRODUCTION

The Department was asked by H.A. Mackay and Associates, Consulting Surveyors, to prepare an assessment of the slope stability of an approximately 100 ha tract of land bounded by Opossum Road, Glenwood Road and Lorne Street, Youngtown. The approximate centre of this tract is at EQ152078.

One day of field work, on 17-18 July, and one day of office calculations have been used in the preparation of this report.

The area was commented on briefly in 1980 for Bushbys of Launceston.

The area consists of the valleys of Jinglers Creek and a tributary, together with the high land between and on either side of the creeks. The total relief is about 55 m. The creeks divide the area into three sections. Opossum and Glenwood Roads form the north-east side and the Western railway line also cuts across this side.

The land is open grass paddocks along Jinglers Creek and over the interfluve, while much of the tributary creek valley and sides is wooded.

GEOLOGY

The creek valleys are cut into clay and sand of the Tertiary Launceston Beds. This soft formation is notorious for its landsliding propensities. In this area the main plateau between the creeks (the interfluve) is capped by some 4 m of clayey and sandy quartzite and sandstone gravel, which are exposed in a small gravel pit on the north of the plateau. Elsewhere exposures of the Launceston Beds are poor.

Dolerite rock, marking the trace of one of the Launceston Basin boundary faults, is present in the high ground along the south-west boundary and where the tributary creek enters the area. At this point massive dolerite columns crop out in the creek bed.

SLOPE STABILITY

Active landsliding is taking place in several parts of the area on slopes of 10 to 25 degrees. The main occurrence is along the south bank of Jinglers Creek where about 5 ha of slope has moved down hill on slopes of 10 to 13 degrees. The sliding appears to be not continuous but occurs in wet seasons. Active head scarps and toes are clearly present.

Other failures occur on steeper slopes and some small failures have taken place on the artificial cuts above the railway line.

The stability of slopes depends on their steepness, the strength of the clay and sandy materials of which they consist, and the presence of water in more or less saturating conditions. These factors are combined in a mathematical model in Bishop's Simplified analysis, which is generally used to clarify their statical balance.

Because no subsurface work has been done at this location the soil strength parameters are derived from work in similar geology from the Glenwood Road landslip and from recent work in the Benwerrin Subdivision on Opossum Road. Both these locations are within sight close by and a similar range of properties has been assumed.

Slope profiles were determined on site, and water conditions are varied over a range in the process of calculation. Similar variations have been observed over a period of years at the Glenwood Road slip.

The calculation is an iterative process resulting in a factor of safety which is exactly 1 for a critically stable slope. Less than 1 indicates failure, and greater than 1 indicates marginal stability. Conventionally a factor less than 1.3 is regarded as unsafe.

Input parameters and ambit calculations for four sections are shown in Appendix 1. Two are measured sections A-A' and B-B' and two are restored sections on A-A' and B-B'.

The first pair of sections explore the conditions producing continued movement of the present profiles, while the second 'restored' pair explore the kinds of conditions that gave rise to the original 'first time' failure and which might be expected to cause similar slopes in the area to fail. In neither case are conditions extreme.

In section A-A' the initial conditions are incorrect and variation of ϕ' to a median rather than a lower value gives a factor of safety (F) just over 1. Variation of Yc (the radius of the slip surface) to give a deeper or shallower slip is relatively insensitive. Increase of saturation from a low to a moderate value is sufficient to render the slip marginally stable at F = 1.04.

In B-B' initial input is similar, but variation of saturation is a powerful factor in reducing stability. A low value of ϕ' derived from nearby hillslopes, combined with a median saturation value, results in F = 1.04.

In A-A' *restored*, higher values of cohesion (C') are used as in a first time slide together with lower saturation and F is immediately low. Using values as in B-B' results in complete failure at F = 0.92. This is expected from the steeper restored slope.

In B-B' *restored* initial values derived from previous calculations give moderate stability but values as in A-A' *restored* give immediate failure. Even reasonable C' values cannot give adequate stability.

This analysis cannot be pushed too far. The only real fact to come from it is that slopes around 10°-11° have failed and there is no reason why they should not do so in future.

When this central fact is applied to a 10° slope class map of the area the useable area is revealed. All slopes of 10° and over are shown shaded in Figure 2. This analysis is limited by the coarse contour

interval but analyses at greater angles are not markedly different.

RECOMMENDATIONS

The useable area should be treated conservatively, that is to say that dwellings should be sited set back from slopes by 30 m, although roads may be closer.

Trees should be retained and encouraged.

In view of the presence of active landsliding in the area, further subsurface work would not be justified.

Detailed subdivision layout should be done in consultation with a Departmental geologist, and excluding the >10° areas and their 30 m buffer zones.

General accord with Part IV Division 5 of the Building Regulations is desirable.

[28 August 1984]

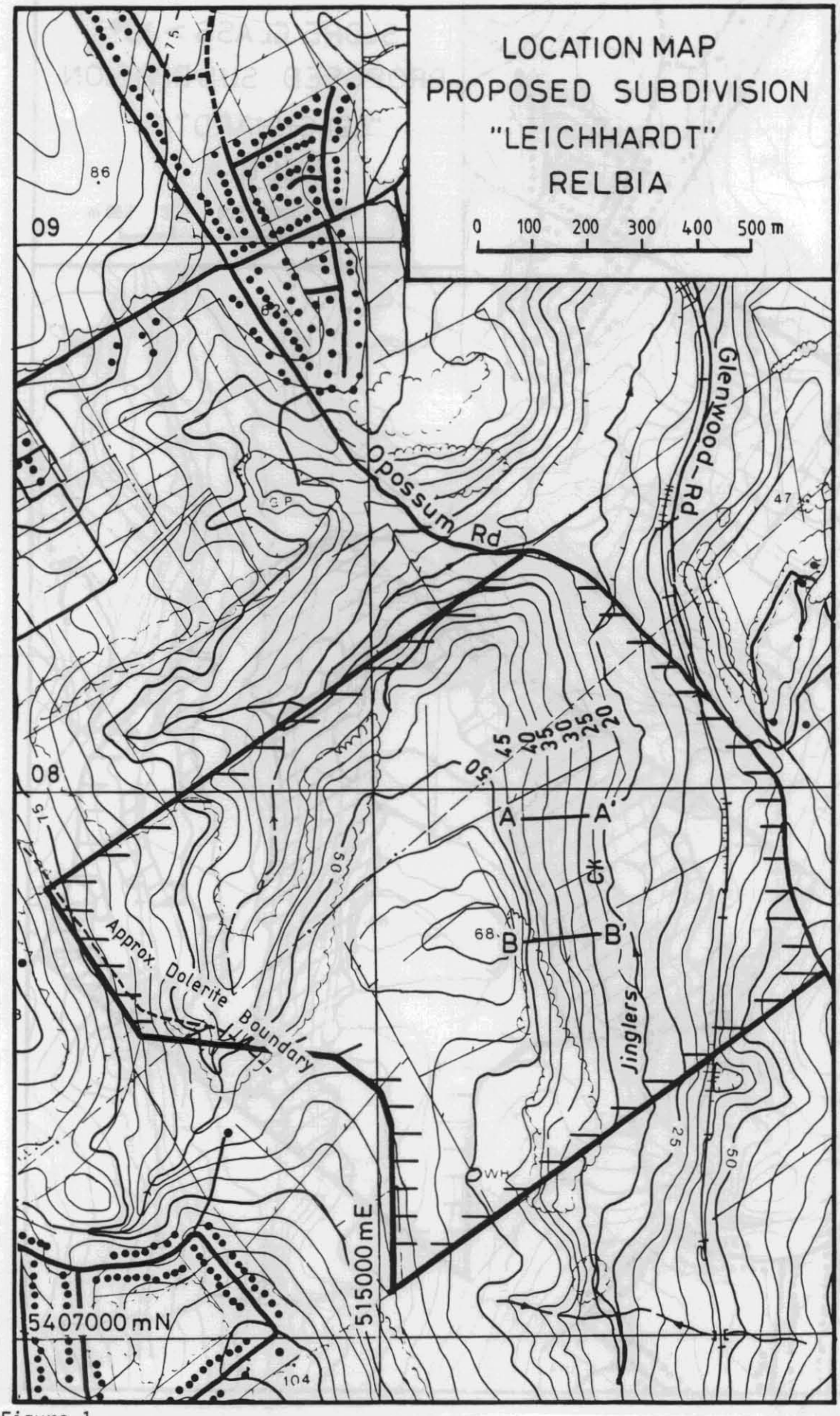

LOCATION MAP
PROPOSED SUBDIVISION
"LEICHHARDT"
RELBIA
0 100 200 300 400 500 m
09
08
Opossum Rd
Glenwood Rd
Jinglers Ck
Approx. Dolerite Boundary
A
A'
B
B'
45
40
35
30
25
20
50
75
86
47
68
104
25
50
515000 mE
5407000 mN

Figure 1.

5 cm

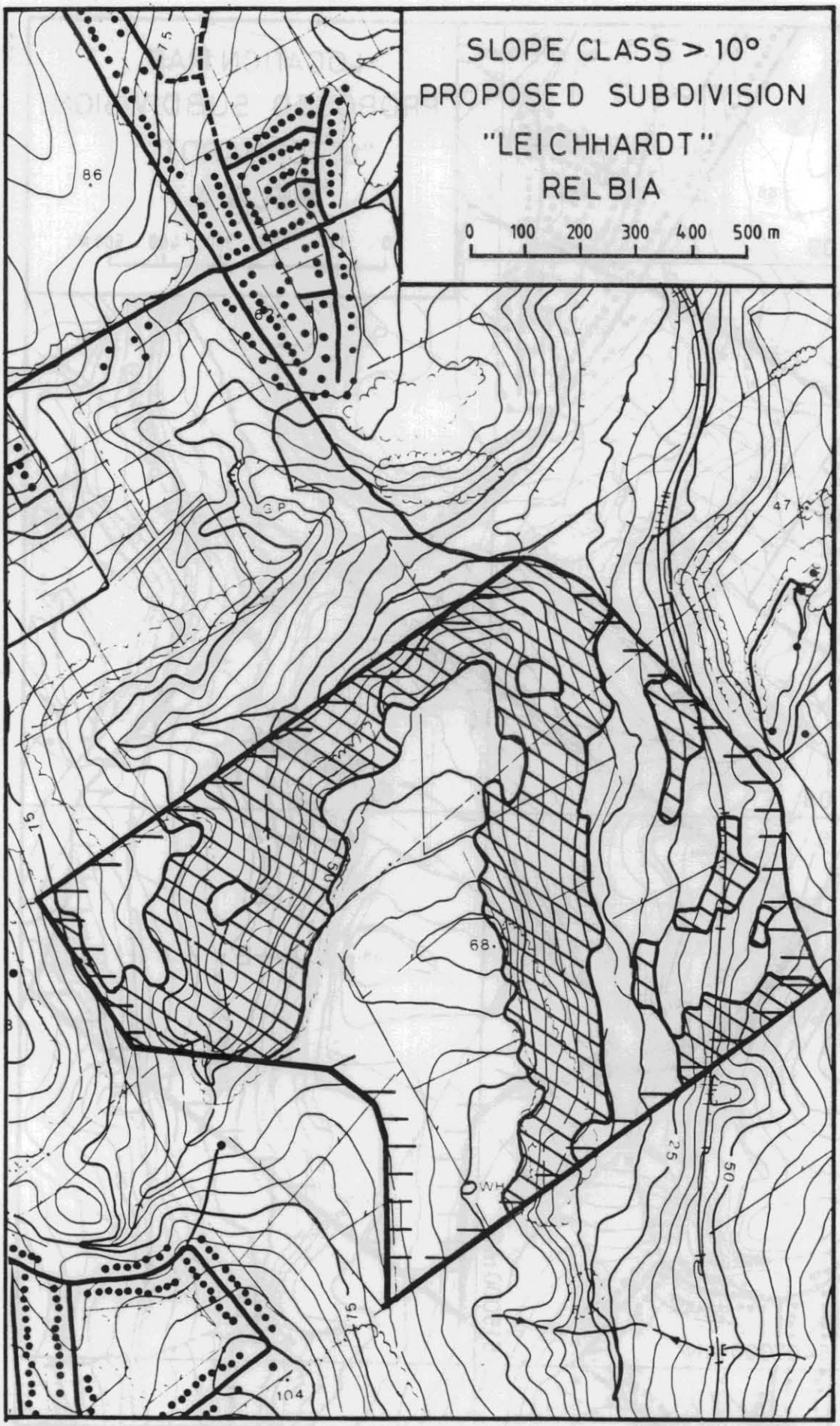

SLOPE CLASS > 10°
PROPOSED SUBDIVISION
"LEICHHARDT"
RELBIA
0 100 200 300 400 500 m
86
75
47
68
25
50
104

Figure 2.

5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP LEICHHARDT AA'... MAP REF ...EQ 152078.....

ANALYSIS BY PCS
DATE 10/8/84.....
CHECKED BY.....

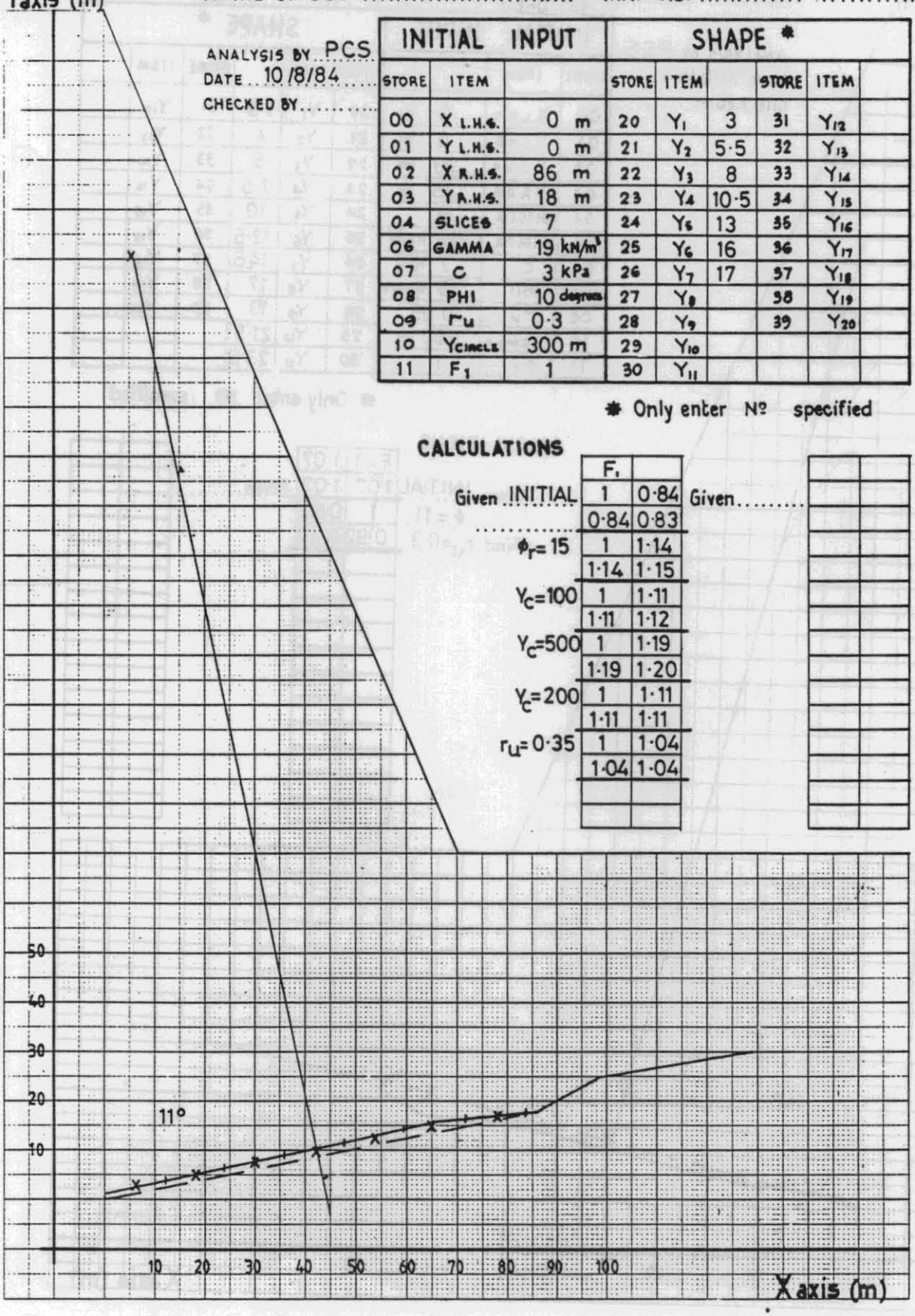
INITIAL INPUT			SHAPE *					
STORE	ITEM		STORE	ITEM		STORE	ITEM	
00	X L.H.S.	0 m	20	Y_1	3	31	Y_{12}	
01	Y L.H.S.	0 m	21	Y_2	5·5	32	Y_{13}	
02	X R.H.S.	86 m	22	Y_3	8	33	Y_{14}	
03	Y R.H.S.	18 m	23	Y_4	10·5	34	Y_{15}	
04	SLICES	7	24	Y_5	13	35	Y_{16}	
06	GAMMA	19 kN/m³	25	Y_6	16	36	Y_{17}	
07	C	3 kPa	26	Y_7	17	37	Y_{18}	
08	PHI	10 degrees	27	Y_8		38	Y_{19}	
09	r_u	0·3	28	Y_9		39	Y_{20}	
10	Y_{CIRCLE}	300 m	29	Y_{10}				
11	F_1	1	30	Y_{11}				

* Only enter Nº specified

CALCULATIONS

	F_1	
Given INITIAL	1	0·84
	0·84	0·83
ϕ_r= 15	1	1·14
	1·14	1·15
Y_c=100	1	1·11
	1·11	1·12
Y_c=500	1	1·19
	1·19	1·20
Y_c=200	1	1·11
	1·11	1·11
r_u= 0·35	1	1·04
	1·04	1·04

Given.....



5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP LEICHHARDT AA' RESTORED MAP REF EQ 152078

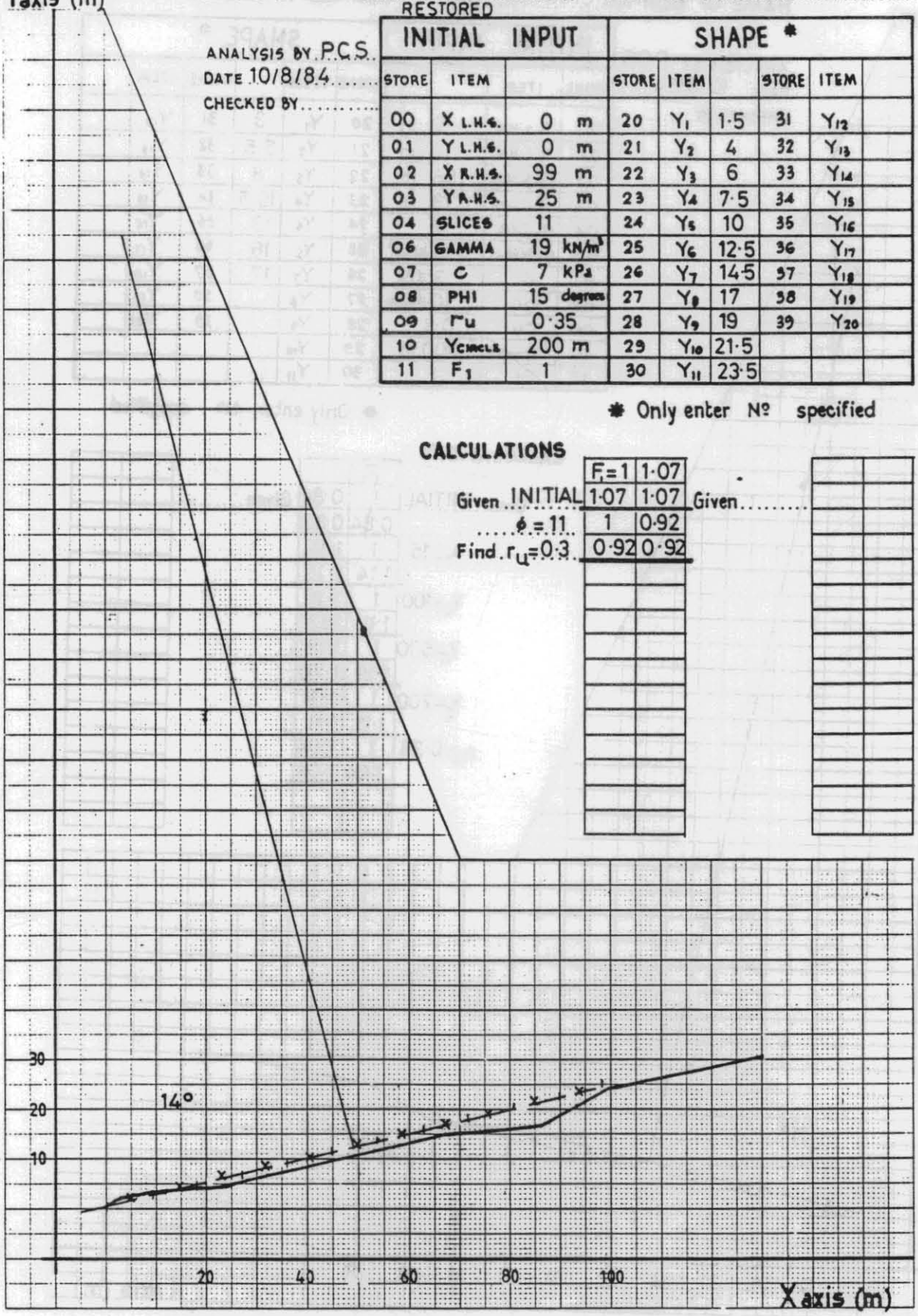
ANALYSIS BY P.C.S.
DATE 10/8/84
CHECKED BY.....

INITIAL INPUT			SHAPE *					
STORE	ITEM		STORE	ITEM		STORE	ITEM	
00	X L.H.S.	0 m	20	Y_1	1·5	31	Y_{12}	
01	Y L.H.S.	0 m	21	Y_2	4	32	Y_{13}	
02	X R.H.S.	99 m	22	Y_3	6	33	Y_{14}	
03	Y R.H.S.	25 m	23	Y_4	7·5	34	Y_{15}	
04	SLICES	11	24	Y_5	10	35	Y_{16}	
06	GAMMA	19 kN/m³	25	Y_6	12·5	36	Y_{17}	
07	C	7 kPa	26	Y_7	14·5	37	Y_{18}	
08	PHI	15 degrees	27	Y_8	17	38	Y_{19}	
09	ru	0·35	28	Y_9	19	39	Y_{20}	
10	YCIRCLE	200 m	29	Y_{10}	21·5			
11	F_1	1	30	Y_{11}	23·5			

* Only enter Nº specified

CALCULATIONS

	$F_1=1$	1·07	
Given INITIAL	1·07	1·07	Given.....
.....$\phi = 11$	1	0·92	
Find $r_u=0.3$	0·92	0·92	



5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP LEICHHART BB'..... MAP REF EQ152078.....

ANALYSIS BY PCS
DATE 10/8/84.....
CHECKED BY.....

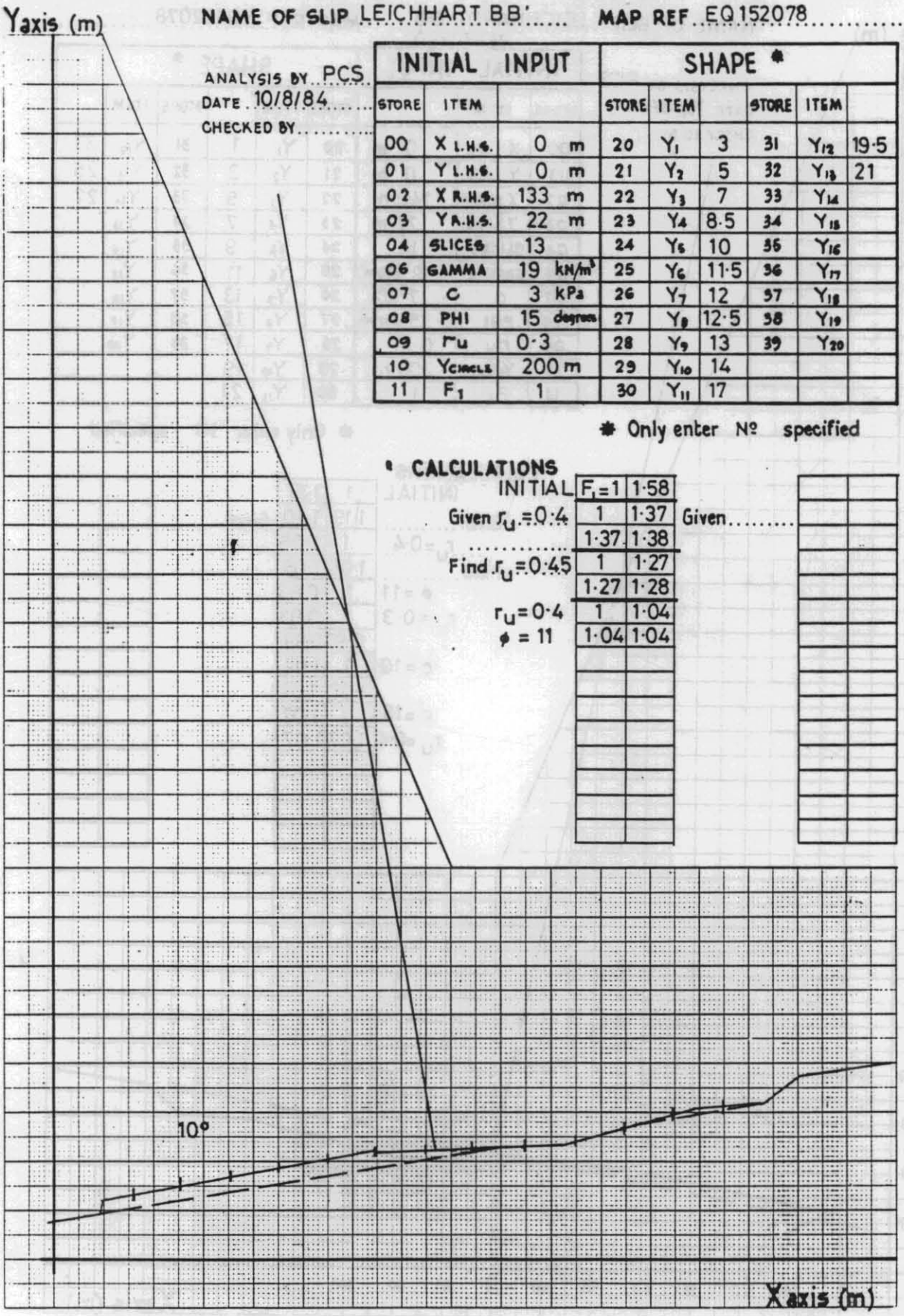
INITIAL INPUT			SHAPE *					
STORE	ITEM		STORE	ITEM		STORE	ITEM	
00	X L.H.S.	0 m	20	Y_1	3	31	Y_{12}	19·5
01	Y L.H.S.	0 m	21	Y_2	5	32	Y_{13}	21
02	X R.H.S.	133 m	22	Y_3	7	33	Y_{14}	
03	Y R.H.S.	22 m	23	Y_4	8·5	34	Y_{15}	
04	SLICES	13	24	Y_5	10	35	Y_{16}	
06	GAMMA	19 kN/m³	25	Y_6	11·5	36	Y_{17}	
07	C	3 kPa	26	Y_7	12	37	Y_{18}	
08	PHI	15 degrees	27	Y_8	12·5	38	Y_{19}	
09	r_u	0·3	28	Y_9	13	39	Y_{20}	
10	YCIRCLE	200 m	29	Y_{10}	14			
11	F_1	1	30	Y_{11}	17			

* Only enter Nº specified

* CALCULATIONS

INITIAL	F_1=1	1·58
Given r_u=0·4	1	1·37
	1·37	1·38
Find r_u=0·45	1	1·27
	1·27	1·28
r_u=0·4	1	1·04
ϕ = 11	1·04	1·04

Given.....



5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP LEICHHARDT BB' RESTORED MAP REF EQ 152078

ANALYSIS BY PCS
DATE 10/8/84
CHECKED BY.....

INITIAL INPUT			SHAPE *					
STORE	ITEM		STORE	ITEM		STORE	ITEM	
00	X L.H.S.	0 m	20	Y_1	1	31	Y_{12}	23
01	Y L.H.S.	0 m	21	Y_2	3	32	Y_{13}	25
02	X R.H.S.	140 m	22	Y_3	5	33	Y_{14}	27
03	Y R.H.S.	27 m	23	Y_4	7	34	Y_{15}	
04	SLICES	14	24	Y_5	9	35	Y_{16}	
06	GAMMA	19 kN/m³	25	Y_6	11	36	Y_{17}	
07	C	7 kPa	26	Y_7	13	37	Y_{18}	
08	PHI	15 degrees	27	Y_8	15	38	Y_{19}	
09	r_u	0·3	28	Y_9	17	39	Y_{20}	
10	YCIRCLE	200 m	29	Y_{10}	19			
11	F_1	1	30	Y_{11}	21			

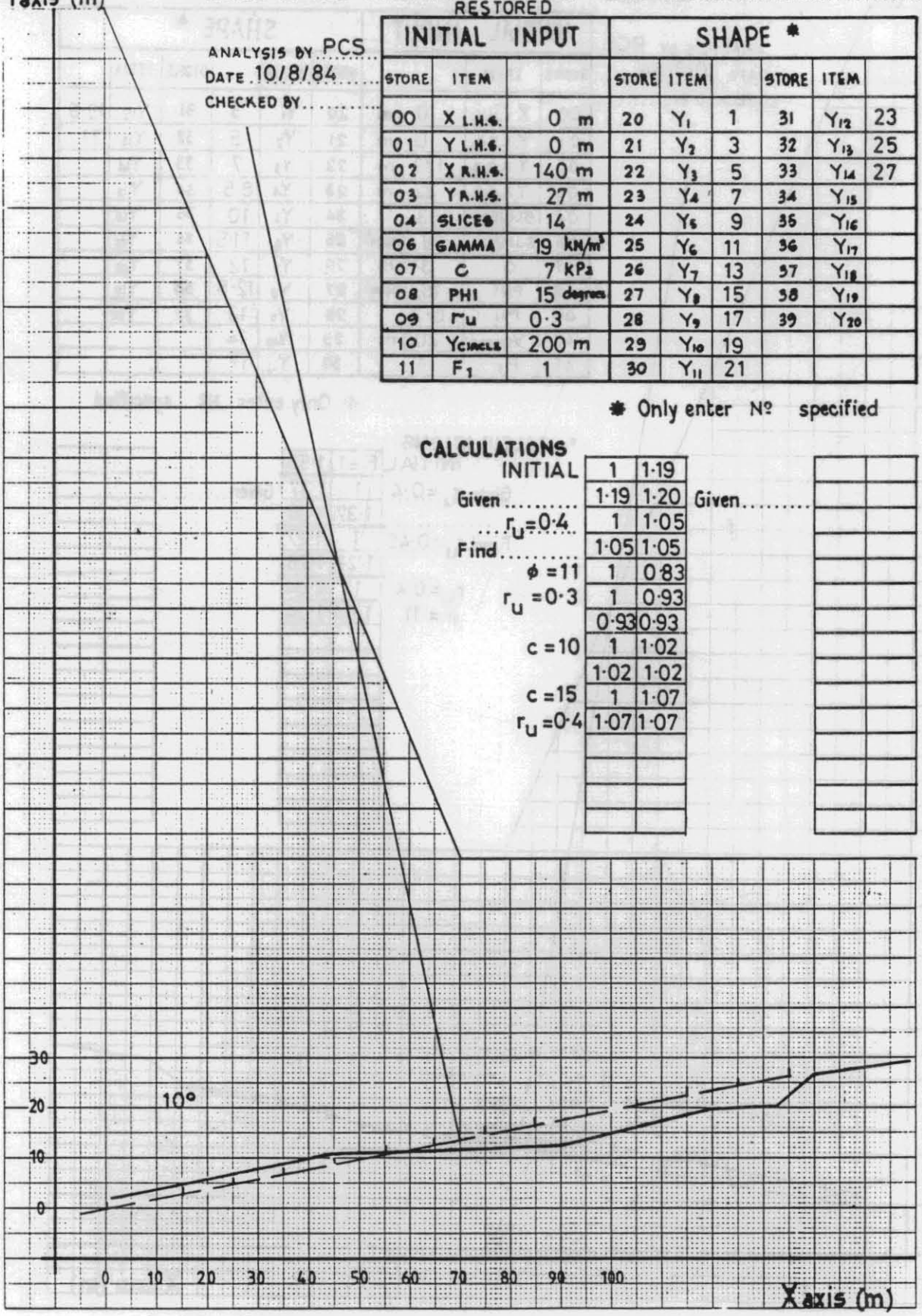
* Only enter Nº specified

CALCULATIONS

INITIAL
Given.....
...r_u=0·4...
Find.....
ϕ =11
r_u =0·3
c =10
c =15
r_u =0·4

1	1·19
1·19	1·20
1	1·05
1·05	1·05
1	0·83
1	0·93
0·93	0·93
1	1·02
1·02	1·02
1	1·07
1·07	1·07

Given.....



5 cm