Technical Bulletin No.9

GOVERNMENT OF MADHYA PRADESH
FOREST DEPARTMENT

STANDARD VOLUME TABLES

FOR

TEAK

(TECTONA GRANDIS)

FOR

SOUTH CHHINDWARA FOREST DIVISION

IN

MADHYA PRADESH

BY

V.N. CHITTRANSHI

AND

S.S. CHITWADGI

ISSUED BY

THE STATISTICAL BRANCH (1971-72)

REPRINT ISSUED BY EXTENSION & CONSULTANCY DIVISION

OF

STATE FOREST RESEARCH INSTITUTE

JABALPUR (M.P.)

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Director's Note

Q. How to apply the tables in the field ?

Ans. Professionally well trained staff can make the application of tables as per prescriptions described in the body of publication. For the field staff who may be less qualified the following simplified note is being provided.

The main ready reckoner for use by the subordinate field staff is table No.10 contained in the publication. The table is derived from data collected from 479 Teak trees, belonging to various heights and g.b.h. classes in S. Chhindwara Forest Division. The tabulated volume figures have been compared by the authors with the actual volume of the aforesaid basic trees and found to be within acceptable limits of accuracy. It is, therefore, not necessary again to test the table for applicability to South Chhindwara Forest Division, when the division as a whole or a large terrain bearing all the quality classes (M.P. II, III & IVa) of Teak forest is taken into account. In such tracts of the divisions the table can be directly applied by g.b.h./height measurements.

When the tables are intended to be applied to a particular area in South Chhindwara Division or in other Chhindwara Division viz. East and West Chhindwara Division bearing one and the same quality class crop, the applicability of tables to such areas shall be tested before use as under :

(1) Fell 4 to 5 teak trees in each g.b.h./height class as given in table 10. Before felling such trees g.b.h. (o.b.), g.b.h. (u.b.) shall be recorded and position of breast height marked in two opposite directions.

(2) Measure total heights and make other necessary measurements on the felled trees by d.b.h./height classwise so that its total timber volume (u.b.) (standard stem timber plus branch timber) and stem small wood volume (o.b.) could be calculated. The measurements and the calculations shall be done in metric system.

(3) From step 2 calculate average timber volume (u.b.) in cdms. of a mean tree for each g.b.h./height class and compare it with corresponding tabulated values given in table no.10, if the calculated values fall within corresponding confidence intervals (column 3,5,7,9 or 11 as the case may be), the table 10 is directly applicable to the tract under consideration, otherwise table can not directly be applied.

(4) When the tables are intended to be applied elsewhere out of Chhindwara forest Division the same test procedure as discussed above in steps 1 to 3 shall be applied before use.

(5) If table 10 is found applicable to the tract, table 11 (which is a subsidiary of table 10) can also be directly applied for stem small wood and branch small wood volumes.

In case the average calculated volume figures do not fall within corresponding confidence interval of table 10 fresh local volume tables will have to be derived from the existing table 10. For compilation of such local volume tables each type of locality should be separately dealt with. The procedure in brief for deriving local volume table is as under :

(1) From table 10 draw smooth volume curves for each height class (given in first line), by taking g.b.h. classes (given in first column along 'x' axis) and volume figures along 'y' axis. All the sets of volume curves shall be drawn on the same graph sheet taking common 'x' axis for g.b.h. classes. Mid values of g.b.h. classes shall be plotted along 'x' direction and corresponding volume figures for each height class along 'y' direction. For each height class a smooth volume curve will thus be obtained.

(2) In each g.b.h. class (given in first column of table 10) select 4 to 5 typical trees and carefully measure their total height and g.b.h. The trees selected should conform with the following specifications :

(a) They should have, as nearly as can be judged the average height of dominant trees of their g.b.h. class for the particular site quality.

(b) They should be as widely and as regularly distributed as possible over the whole area in question.

(3) Calculate the average of height and g.b.h. for each g.b.h. class and draw a smooth height/g.b.h. curve.

(4) From this curve read heights corresponding to middle values of g.b.h. classes given in column 1 of table 10.

(5) Heights obtained at step 4 should be interpolated, between the general volume curves obtained at step 1, at the corresponding g.b.h., and a smooth curve drawn through the points.

(6) The volumes corresponding to the middle of g.b.h. classes should be read from this interpolated curve and tabulated as local volume tables. These local volume tables can be used for the area under consideration.

Whenever conversion from diameter values to corresponding girth values or vice versa is required table no.12 can be freely used.

Jabalpur

Dt. 2.4.1971

Director

State Forest Research
Institute Jabalpur

STANDARD VOLUME TABLES FOR 0 TEAK (*TECTONA GRANDIS*) FOR SOUTH CHHINDWARA FOREST DIVISION (M.P.)

BY

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I. INTRODUCTION

Teak (*Tectona grandis*) the paragon of timbers is finding immense use and its demand is ever increasing. The utilisation percent of a teak tree has increased substantially and even its small wood which was, hither to considered as useless, has been now finding pronounced demands in the markets. Therefore assessment of estimates of the quantity of timber available from a teak tree in any of the specified girth-height class within permissible reliance limit is the paramount need in the efficient, systematic and scientific management of the forests.

Wide variations in the quantity of timber assessed in the standing crop and the actual quantity obtained after felling in the coupes is a common experience. This variation contributes one of the major cause in the significant gaps between the upset prices calculated and the final bids offered in auctions. The utility of local volume tables as a means to assess the cubical contents of the standing crops within the acceptable limits needs no emphasis.

Calculation of more reliable ones based on statistical considerations was taken up in the South Chhindwara Division in preference to the existing ones, since the latter were not based on statistical design.

II. SALIENT FEATURES OF THE TRACT

An area of 897.94 Sq.Km. (346.60 Sq.miles) of the division is covered by reserved forests and 385.10 Sq.km. (148.49 Sq.miles) by protected forests. The entire area is hilly, characterised by the main valleys of Pench and Kanhan rivers. The hill tops area are often flat and constitute extensive plateau.

The Chief Geological formations are Deccan trap and gneiss with small patches of Sausar Series, granites, pegmatites, Gondwana and intra trappean formations. Varieties of Goils from reddish shallow lateritic loam, in the trap zone to alluvium deposits in the valleys of Kanhan and Pench are met with. Average annual rainfall ranges between (35" to 41") 889.1041 mm., though periods of heavy droughts and heavy rainfall are also experienced in between the normal years.

'Teak' is the main species of the Division. It is a deciduous tree with rounded crown and under favourable conditions with clear bole, which is often buttressed or fluted at the base. Trap zone contains well stocked teak forests of III to IVa quality (M.P. site quality) and occassionally M.P. site quality II. Teak forms a varying proportion between 20 percent to 80 percent of the crop. The upper slopes in general contain mixed forests with poor quality teak and some times without teak. in gneiss zone, teak forests of M.P. II & III quality are found and the fresh alluvium contains M.P. quality I forests. The proportion of teak fluctuates from 40 percent to 60 percent and density of stocking is almost full. In this zone mixed forests with little teak also occur.

The type of forests belongs to Southern tropical dry deciduous forests according to Champion's classification. The teak forests are managed under teak conversion working circle (area 36238.6 ha. and rotation 100 years), Coppice with Reserve Working circle (area 35966.4 ha and rotation 40 years) and Selection cum Improvement Working Circle (area 20821.4 ha. selection girth 120 and 135 cms.).

III. GRANDING OF SAMPLE TREES

Considering the shape, size and form of teak trees in the division and the classification in vogue in the local markets, the sample trees were graded into following girth and height classes in the metric units.

Height classes	**Corresponding M.P. quality classes**
1. 9 to under 12 metres	IVb
2. 12 to under 15 metres	IVa
3. 15 to under 18 metres	0.5 III
4. 10 to under 21 metres	1.5 III
5. 21 to under 24 metres	0.5 II

Girth Classes

1. 15 to 20 Cms.
2. 21 to 30 Cms.
3. 31 to 40 Cms.
4. 41 to 50 Cms.
5. 51 to 60 Cms.

6.61 to 80 Cms.
7.81 to 100 Cms.
8.101 to 120 Cms.
9.121 to 150 Cms.
10.151 to 180 Cms.

IV. ALLOTMENT AND DISTRIBUTION OF SAMPLE TREES

The past experience indicated that collection of volume data from 400 to 500 trees well distributed in the whole range of girth and height classes of the division would lead to the results within fair degree of accuracy. Accordingly and in absence of any previous data it was considered fairly satisfactory to collect standard out-turn data from 479 teak trees covering evently the whole range of girth and height classes of the division. The allotment of sample trees to the reserved and protected and then further to various working circles was made rateably on the basis of areas. They were stratified into felling series and the latter were sub-stratified into groups of compartment containing nature, middle-aged and young crops. Compartments in each sub-stratums were selected on restricted random principles and sample trees of specified girth and height groups were allotted to these selected compartments.

Thus 173 trees were allotted to teak compartments working circle and 69 trees to selection-cum-improvement working and 146 trees to Coppice with reserves Working circle of the Reserved forests. The protected forests consist of 46 felling series and out of this only 25 felling series were sampled randomly and 91 teak trees were allotted to these randomly selected felling series.

The distribution of sample trees by girth, height and localities is shown in table no.1.

TABLE 1

Distribution of sample trees for stem small wood volumes

Girth Class in Cms.			Height classes in metres			
	9/12 Felling Series Comptt.No.& No.of trees)	12/15 Felling Series Comptt.No.& No.of trees)	15/18 Felling Series Comptt.No.& No.of trees)	18/21 Felling Series Comptt.No.& No.of trees)	21/24 Felling Series Comptt.No.& No.of trees)	Total Felling Series Comptt.No.& No.of trees)
1.	2	3.	4.	5.	6.	7.
	Bhimalgondi H.F.199 (I) Panch H.F. 279 (I) Kanhan C.W.R. 102 (I) Manikhapa C.W.R. 108 (I)					
15-20	Majiapar C.W.R. 187 (I) Ramudhana S.C.I. 80 (I) 82 (I) Boria S.C.I. 211 (I) Thuepani S.C.I. 237 (I) 241 (I) Sank S.C.I. 285 (3) Marram Adhoc (I) Nandewani Adhoc (I) Ionangi Adhoc (I) Forest Village Narayanghat 86 (I)					
Total -	18 Tree					18
	Raghadevi H.F. 215 (1) Borpani H.F. 35 (I) Raghadevi H.F. 215 (1) Amla H.F. 164 (2)	Bhudkum H.F. 243 (1) Amla H.F. 169 (2) Bhudkum H.F. 225 (1) Borpani H.F. 34 (I)				
21/30	Majiapar C.W.R.187 (I) Nandhudhana C.W.R. 195 (I) Teegaon C.W.R. 3 (I) Thota C.W.R. 102 (I) 103 (I)	Gajandoh H.F. 44 A (I) Kanhan C.W.R. 103 (I) Mainikhapa C.W.R. 108 (I)				

1.	2	3.	4.	5.	6.	7.
	Kanhan C.W.R. 102 (I) 102 (I) 103 (I)	Thota C.W.R. 277 (I)				
	Palaspani C.W.R. 244 (I)	Nandudhana C.W.R. 160 (I)				
	Bhudkum H.F. 222 (I)					
	Mainikhapa C.W.R. 104 (2) 108 (1)					
	Ramudhana S.C.I. 80 (1) 81 (1)	Ramudhana S.C.I. 81 (1)				
	Boria S.C.I. 211 (1)	Boria S.C.I., 211 (1)				
	Thuepani S.C.I. 237(1) 241 (1)	Khadveli Adhoc (1)				
	Dhutmur S.C.I. 294 (1)					
	Sank S.C.I. 285 (2)					
	Tekapur S.C.I. 208 (1)					
	Kauli Adhoc (1)	Mohpani Adhoc (1)				
	Nandewani Adhoc (1)					
	Lohangi Adhoc (1)					
	Wadda Adhoc (1)					
	Borpani H.F. 34 (1), 35 (1)					
	Boria S.C.I. (1)					
	Pench H.F. 279 (1)					
	Dhawalpur Adhoc (1)					
Total :	25 Trees	14 Trees				49

1.	2	3.	4.	5.	6.	7.
	Pench H.F. 255 (1) Bhudkum H.F. 225 (1)	Pench H.F. 243 (1) 258 (1) 279 (1) 230 (1) Amla H.F. 167 (1) 170 (1)	Bhudkum H.F. 223 A (1) Amla 164 (1) Borpani H.F. 34 (1)			
	Gajandoh H.F. 43 (1)	Bhudkum H.F. 226 (1)	Gajandoh H.F. 43 A (1)			
	Raghadei H.F. 215 (1)	Gajandoh H.F. 43 A (1)	Raghadei H.F. 215 (1)			
31/40	Palaspani C.W.R. 244 (2), 230 (1) Teegan C.S.R. 3 (1)	Raghadei H.F. 215 (1) Borpani H.F. 33 (1)	4 (1)	Tegson C.W.R.		
	Nandhudhana C.W.R. 195 (1)	Dudhgaon C.W.R. 245 (1) Ambada C.W.R. 66 (1)	Ambada C.W.R. 65 (1)			
	Nandudhana C.W.R. 195 (1)	Nandudhana C.W.R.162 (1)				
	Dhutmur S.C.I. 295 (1)	Kamthi S.C.I. 141 (1)				
	Sank S.C.I. 285 (1)	Majiapar C.W.R. 52 (1)				
	Tekapar S.C.I. 208 (1) 209 (1)					
	Kamthi S.C.I. 140 (1)					
	Umrighat 285 (1) Adhoc (1)	Khadveli Adhoc (1)				
	Amakuhi Adhoc (1)	Johni Adhoc (1)				
	Amajhiri Adhoc (1)	Kaudia Adhoc (1)				
	Piplapani Adhoc (1)	Nandewani Adhoc (1)				
	Ambuana C.W.R. 64 (1)					
	Majiabar C.W.R. 182 (1)	Amakuhi Adhoc (1)				
	Nandewani Adhoc (1)	Umrighat Adhoc (1)				
	Jobni Adhoc (1)	Wadda Ad (2) Pipalpani Adhoc (1)				
	Kaudia Ad. (1)	Sirata Ad. (1)				
	Badda Adhoc (1)					
	Khadbeli Ad. (1)					
	Mohpani Ad (1)					
Total -	26 Trees	25 Trees	7 Trees			58

1.	2	3.	4.	5.	6.	7.
	Bhudkum H.F. 222 (1)	Bhudkum H.F. 223 A (1)	Pench H.F. 258 A (1)			
	Gajandoh H.F. 43 A (1)	Gajandoh H.F. 34 (1) 43 A (1)	Amla H.F. 168 (2) 170 (1)			
	Borpani H.F. 53 (2)	Pench H.F. 255 B (1) 266 (1)				
	Dera C.W.R. 29 (2)	Bhimalgondi 196 (1)	Borpani H.F. 34 (2)			
41/50	Dhutmur S.C.I. 294 (1)	Dudhgaon C.W.R. 245 (1)	Bhudkum H.F. 221 (1)			
	Kamthi S.C.I. 140 (1)	Jamlapani C.W.R. 214 C (1)	Bhimalgondi H.F.199 (1)			
	Boria S.C.I. 212 (1)	Kanhan C.W.R. 97 (1)	Temni C.W.R. 119 (1)			
	Chakara Adhoc (1)	Temni C.W.R. 114 (1) 118 (1)	Teegaon C.W.R. 4 (1)			
	Kuddum Adhoc (1)	Nandudhana C.W.R. 195 (1)	Ambara C.W.R. 65 (1) 66 (1)			
	Mehrakhapa Adhoc (1)	161 A (1) Sank S.C.I.	Nandudhana C.W.R. 159 (1)			
	Ambara C.W.R. 64 (1)	285 (1) Dhutmur	Jamrapani 203 (1)			
	Pench H.F. 265 (1)	S.C.I. 395 (1) Kamthi	Dera 30 (1) C.W.R. 32 (1)			
	Sank S.C.I. 285 (1) S.C.I. (1)	S.C.I.141 (1) Ramudhana				
	Khadveli Adhoc (2)					
	Chakara Adhoc (1)					
	Mohpani Ad. (1)					
	Kuddum Ad. (1)					
Total -	15 Trees	23 Trees	16 Trees			54
	Bhudkum H.F. 222 (1)	Bhudkum H.F. 222 (2) 223A (1)	Bhudkum H.F. 221 A (1)			

1.	2	3.	4.	5.	6.	7.
51/60	Gajandoh H.F. 43 A (1)	Gajandoh H.F.43 A (2)	Gajandoh H.F.36 A (1) 40 (2)			
	Bhimalgondi H.F. 196 (1)	Bhimalgondi H.F. 192 (1)	Borpani H.F. 69 A (1)			
	Borpani H.F. 49 (1)	Pench H.F. 266 (1)				
	Penon H.F. 255 A (1) 243 (1)	265 (1) Amla H.F. 169 (1)				
	Kumbhpani C.W.R. 283 (1)	Kumbhpani C.W.R. 278 (1)	Kumbhpani C.W.R. 282 (1)			
	Nandudhana C.W.R. 195 (1)	Temni C.W.R. 114 (1)	Jamrapani C.W.R. 214 (2)			
	Dera C.W.R. 29 (1)	Dera 30 (1)	204 (1) 204 (1)			
	Tekapar S.C.I. 210 (1)	Gumtara S.C.I.257A (1)	Teegaon 2 (1) Tekapar S.C.I.			
	Narayanghat	259 (1) S.C.I. 73 (1) S.C.I. 210 (1)	208 (1) 209 (1) Tekapar			
	Umrighat Adhoc (1)	Narayanghat S.C.I. 75 (1)				
	Boria S.C.I. 211 (1) 212 (2)					
	Amakuhi Adhoc (1)	Umrighat Adhoc (1)	Umrighat Adhoc (1)			
	Boragaon Adhoc (1)	Borgaon Adhoc (1)	Khadbeli Adhoc (1)			
	Jobni Adhoc (10)	Jobni Adhoc (1)				
	Siratha Adhoc (1)	Siratha Adhoc (1)				
	Khadbeli Adhoc (1)					
	Khadbeli Adhoc (2)					
	Amakuhi Adhoc (1)					
Total -	14 trees	26 Trees	18 Trees			58

1.	2	3.	4.	5.	6.	7.
	Bhudkum H.F. 224 (1)	Amla H.F. 193 (1), 163 (1)	Bhudkum 223 A (1)	Bhimalgondi H.F.201 (1)	Amla H.F. 167 (1)	
	Gajandoh H.F. 46 (1) H.F.46 (1)	Gajandoh Pench H.F.	Gajandoh H.F.37 (1) 72 A (1)	Borpani H.F. 168 (1) 69 A (1)		
	Kumbhpani C.W.R. 283 (2)	Borpani H.F. 49 (1) 74 (1)	270 (1) 269 (1)	Pench H.F. 258 A (1)		
	Dera C.W.R. 29 (1)	Temni C.W.R. 118 (1) 119 (1)	Amla H.F. Nandudhana 164 (1)	271 (1)		
	Nandudhana C.W.R. 195 (1)	Kumbhpani C.W.R.283 (2)	Bhimalgondi H.F.199 (1)	C.W.R.162 (1) Dera C.W.R.		
61/80	Narayanghat S.C.I. 73 (1) Borgaon Adhoc (1) Jobni Ad. (1)	278 (1) Bhull C.W.R. 14 (1) Nandudhana C.W.R. 195 (1)	Jamuniya C.W.R. 253 (1) Palaspani C.W.R. 254 (1)	29 (1)		
	Nandewani Adhoc (1)	Narayanghat	Kumbhpani			
	Siratha Ad. (1)	S.C.I. 75 (1) Ramudhana S.C.I.79 (1) Borgaon Adhoc (1) Nandewani Adhoc (1) Badda Ad.(2) Khadbeli Adhoc (2) Umrighat Adhoc (1) Gumtara S.C.I.259 (1) Amakuhi Adhoc (1)	278 (1) C.W.R.282 (2) Dera C.W.R. 30 (1) 32 (1) Elkapar C.W.R.220 (1) Bhuli C.W.R. 11 (1) Narayanghat S.C.I.75 (1) Ramudhana S.C.I.80 A (1) Gumtara S.C.I. 257 A (1) Jobni Ad. (1) Nandewani Adhoc (1) Siratha Ad. (1) Khadbeli Adhoc (1) Umrighat Adhoc (1)			
Total - 11 Trees		21 Trees	22 Trees	7 Trees	2 Trees	63

1.	2	3.	4.	5.	6.	7.
		Gajandoh H.F.36 A (1) 40 (1) Chicholi Bhuli CWR. 14 (1)	Amla H.F. 165 (1) Bimalgondi H.F.199 (1) CWR. 8 (2)	Gajandoh H.F. 38 (1) 45 A (1) Raghadei Chicholi Borpani H.F. 49(1)	Bhimlagondi H.F.199 (1) Pench H.F. 271 (1) H.F.215 (1)	
		Tekapar SCI. 210 (1)	Tekapar SCI. 209(1) Gajandoh	Bhimalgondi H.F.190 (1)		
		Nandewani Adhoc (1) Chakara Adhoc (1) Badda Adhoc (1) Khadbeli Adhoc (1)	H.F. 43 A (1) 45 A(2) Raghadei H.F.215 (1) 216 (1) Bhimalgondi H.F.197 (1) 200 (1)	198 (1) Gummaj CWR. 247 (1) Nandudhana CWR. 195 A (2) Bhuli CWR 11(1) Tekapar SCI. 210 (1)		
81/100		Elkapar CWR.220(1) Comptt. 238 (1) Thuepani S.C.I. Umrighat Adhoc (1)	Borpani H.F. 35(1) 49 (1) Amla H.F. 163 (1) Bhuli CWR. 10 (1) Nandhudhana CWR.161(1) 162 (1) Elkapar CWR. 220 (2) 231 (1) Boria SCI. 213 (2) Badda Ad. (1) Umrighat Adhod (2) Amakuhi Adhoc (2)	Thuepani 242 (1) Boria SCI. 213 (1) Elkapar CWR. Singardeep CWR. 260 (1)	230 (1)	
Total-	12 Trees	27 Trees	16 Trees	2 Trees		57

1.	2	3.	4.	5.	6.	7.
		Bhudkum H.F. 224 (1)	Gajandoh H.F.35 A(1) 40 (1)	Bhudkum H.F. 223 A (1)	Bhudkum H.F. 223 A (1)	
		Borpani H.F. 52 (1)	Raghadei H.F.215 (1) 215 (1)	Amla H.F. 164 (1)	Borpani H.F. 74 (1)	
		Ramudhana SCI. 79 (1)	Bhudkum H.F.222 (1)	Gajandoh 165 (1)	Bhimalgondi H.F.191 (1)	
		Thuepani SCI. 238 (1)	Bimalgondi H.F.200 (1)	H.F.45 A (1) 46 (1)	Pench H.F. 265 (1) 266 (1)	
		Dhutmur SCI. 295 (1)	Jam C.W.R. 16 (1) 18(2)	Bhimalgondi H.F.191(1) 197 (1)	Amla H.F. 166 (1)	
		Nandewani Adhoc (1)	Gummaj CWR. 253 (1)	Borpani H.F.49 (1) 72 (1)		
		Badda Adhoc (1)	Palaspani CWR. 254 (1)	Pench H.F.272 (3)	Dhanora CWR.91 (2)	
		Amakuhi Adhoc (1)	Majiapar CWR. 183 (2)	279 (1)	Singardeep CWR. 263 (1)	
		Chicholi CWR.8 (1)	Bhuli CWR. 10 (1)	Nandudhana 280 (1)	CWR. 195 (1)	
			Elkapar CWR. 231 (2)	Gummaj CWR. 247 (1)	Jam C.W.R. 20 (1)	
			Ramudhana SCI. 80 (1)		Gajandoh H.F. (1) 45 (1)	
			Thuepani SCI.242 (1)	Dhanora CWR. 88 (1)		
			Chakara Adhoch (1)	Elkapar CWR. 230 (2)		
			Wadda Adhoc (1)	Singardeep CWR. 262 (1)		
101/120			Amakuhi Adhoc (1)	Jam CWR. 16 (1)		
			Umrighat Adhoc (1)	Majiapar CWR. 185 (2)		
				Boria SCI. 213 (1)		
				Chakara Adhoc (1)		
				Umrighat Adhoc (2)		
				Amakuhi Adhoc (1)		
Total-	9 Trees	22 Trees	28 Trees	11 Trees		70

1.	2	3.	4.	5.	6.	7.
		Gajandoh H.F.44 (1) Jam CWR. 21 (2) 216 (1) Borpani H.F.52 (1)	Bhudkum H.F.223A(1) Raghadei H.F.215 (1) Borpani H.F. 69 A (1) Raghadei H:F.216 (2) 215 (1)	Bhudkum H.F.222 (1) Gajandoh H.F.44 A (1) 169 (1) Pench H.F.267 (1)	Bhimalgondi H.F.196 (1) Amla H.F. 167 (1)	
121/150			Singardeep CWR. 262 Majiapar 183 (1) Jam CWR. 22 (1) Amakuhi Adhoc (1) Chicholi CWR. 8 (1)	Bhimalgondi H.F.190 (1) (2) 196 (1) 198 (1) Singardeep CWR. 262(1) Dhanora CWR. 88 (1) Jam CWR. 16 (1) 22(1) Majiapar CWR. 186 (2) 187 (1) Chakara Adhoh (1)	Singardeep CWR. 263 (1) Jam C.W.R. 80 (1) 22 (2) Majiapr	CWR. 28 (1)
Total-	3 Trees		10 Trees	17 Trees	9 Trees	39
			Singardeep 262 (1) Borpani 53 (1)	Gajandoh H.F.43A (1) Jam CWR. 22 (1)	Gajandoh H.F.44 A (1) Borpani H.F.(1) Raghadei H.F. 216(1) Borpani H.F. 35 (1) Bhimalgondi H.F.196 (1) Majiapar CWR. 186 (2) Singardeep CWR. 269 (1) 263 (1)	
Total-			2 Trees	2 Trees	9 Trees	13

ABSTRACT

(1) No. of trees in High Forest Conversion Working Circle (H.F.) 173

(2) No. Of trees in Coppice with Reserves Working Circle (C.W.R.) 146

(3) No. of trees in Selection-Cum-Improvement Working Circle (S.C.I.) 69

(4) No. of trees in Adhoc Fellinh series (Ad.) 91

Total- 479

V. COLLECTION OF FIELD DATA.

Following measurements were recorded in the prescribed F.R.I. form No. 28 on each sample tree.

(i) Two diameters over bark and under bark at breast height were measured in Cms. nearest to 2 mm.

(ii) Total height was measured in meters nearest to one tenth of a metre.

(iii) Two diameters O.B./U.B. at mid height and at half height above 1.37 metres.

(iv) Bark thickness in Cms. at B.H., Crown-length, height of first green branch and height of green branches alround in metres nearest to 1/10th metre were recorded.

(v) Number of rings on stumps and height of stump in Cms. nearest to 2 mm. were recorded.

(vi) The length from ground level to a point where d.b.h. (OB.) is 20 Cms. was divided into sections of 3 metres each, the last section not exceeding 4.5.m. and, not lesser than 1.5 mm. at the mid point of each section. The bole length between 20 Cm. over bark and 5 Cms. over bark i.e. standard small-wood bole was divided into sections and measurements recorded on similar lines as that of standard timber bole section. Branches containing timber and small wood were measured as per procedure followed for stem bole.

VI. METHOD ADOPTED IN PREPARING STANDARD VOLUME TABLE

(1) The graphical method was rejected for the purposes of stem and branch timber calculations because of its too subjective nature and personal bias involved in fitting the free hand curves. The regression methods are not only free from above defects but also ensure assessment of accuracy and dependability of the volume tables and therefore were adopted in the present study. Regression methods for total wood (stem and branch timber stem small wood) were tried for each height class. The regression of total wood over basal area for individual teak tree within a particular height class showed significancy at 0.0001 probability level. But when the regression of regression coefficients of volume basal area lines were tested against average height of individual height class, it was found that they were non-significant for even 0.05 probability level. Therefore an attempt for estimating the stem small wood by deducting stem and branch timber from total wood had to be rejected. For the purposes of stem and branch small wood volumes, the usual graphical methods had to be adopted, for the did not exibit any known mathematical models. With a view to facilitate they field staff the present tables were based on usual measurements of breast height girth and total height.

(2) A study of the available data indicated that high degree of positive correlation exists between the stem branch timber volume combined and basal area i.e. sectional area at breast height of individual trees within a particular height class. Data for 9/12 metre height class were scanty and as such well defined path of the curve is not visualised in the figure I, but the degree of correlation is sufficiently high. The correlation coefficients and determination coefficients for the various height classes were found to be as under. The determination coeffients show that 82 present to 94 percent volume in the stem volume for various height classes is attributed to corresponding basal areas considered as $\pi r2$ at breast height and the rest may be accounted for the deviation in the stem form from the circular shape.

TABLE 2.

Coefficient of correlation between stem branch timber volume and basal area of teak trees.

Height Class (metres.)	Correlation coefficient.	Significance	Determination coefficient.
9-∠12	+0.892	Highlysignificant at 0.001 probability level.	0.80
12-∠15	+ 0.958	do	0.92
15-∠18	+ 0.967	do	0.94
18-∠21	+ 0.941	do	0.88
21-∠24	+ 0.954	do	0.92

(3) Further, the regression of stem + branch volume combined on basal area was found to be linear for trees of a given height class, except for 9-∠12 metres height class where the relationship appears to deviate from straight line in the figure I merely because of non-availability of data for 81 Cms and above girth classes. The significancy of the regression coefficient for this height class i.e. 9-∠12metres at less than. 001 probability level goes to prove that the straight line relationship holds good in that case too.

(4) The linear relationship of the regression of stem branch timber volume combined over basal area for each height class is further evidenced from figures 1 to 5. Some of the points belonging to abnormal group and showing large deviations from the relationship can also be spotted out in above figures.

(5) The significance of the regression coefficients for each height class were tested in each case and they were found to be highly significant on a probability much less than 0.001 probability level. This shows that there is definite increases in the stem + branch timber volume corresponding to an increase in the basal area of the teak trees in a particular height group. The table reproduced below indicate the position of significance of regression coefficeints to for various height classes.

TABLE NO.3

Analysis of Variance

Height Class	Degree of freedom	Regression coeficient	Standard error of regression coefficients.	Significance.
9-∠12 m	23	39.53242	4.169	Highly significant at .001 probability level.
12-∠15 m	43	51.52880	2.338	
15-∠18 m	81	65.37618	1.903	do
18-∠21 m	68	63.37614	2614	do
21-∠24 m	31	83.76695	4.533	do

VII. COMPUTATION OF VOLUME TABLES.

(i) Individual Tree Computations. Volume in the round

Two mid diameters under bark recorded at the mid length for each log of the timber bole were averaged. Stem timber volume under bark for each section was calculated by multiplying the full sectional area (πr^2) at the mid point and the length of the log.

The under bark volumes of item timber logs were added to arrive at the total stem timber volume under bark of a tree in the round. Similarly the branch timber volume (u.b.) and stem and branch small wood volume (o.b.) were determined separately for each tree.

(ii) Classification of AVERAGING

The trees were classified and grouped into Five height classes viz 9/12 m, 12/15 m, 18/21 m, and 21/24 m, for the purposes of stem+ branch timber calculation. Classification by 5 height and 9 girth classes as per gradings described earlier were done for the purposes of stem and branch small-wood calculations. Averages were worked out for stem small-wood (u.b.) and branch small-wood (o.b.) volumes separately for each group. But for the estimation of timber volumes, individual volume and basal area were considered.

(iii) Method of Compilation.

(A) Stem & branch Timber volume.

(1) The total of stem and branch timber volume of each tree within a height class was plotted over its basal area. The relationship adquately approximated to be a linear (See fig. 1 to 5), within each height class. Hence, a straight line regression equation, indicated below, was fitted to the data for each height class separately.

Y= a+ bx———(1)

The above equation may be written in the modified form as

Y= y+b (x-x)————(2)

Where Y= extimated stem + branch timber volume (u.b.) of a teak tree.

X- Basal area of a teak at breast height.

@- Regression Constant

b- Regression coefficient

y= Mean stem + branch timber volume (u.b.) of a teak tree in a particular height class.

x= Mean basal area of a teak tree in particular height class.

(2) The values of regression coefficients and regression constants within each height class were found to be as under:-

TABLE No. 4

Height Class (meters)	Actual mean height of the group (meters)	Regression coefficients	Regression constants.
9-∠12	11.7	39.53242	- 00.77934
12-∠15	14.2	51.52880	- 113.38537
15-∠18	16.7	65.37618	- 154.77053
18-∠21	19.1	63.37614	- 105.96140
21-∠24	22.5	83.76695	- 172.75721

(3) The regression coefficient for each height class was found to be progressively increasing with the increase in height except 18-∠21 metres height group. Similarly, the regression constant for each height class was found to be progressively decreasing with the increase of height except 18-∠21 metres height class.

The exception indication an abnormality in the selection of trees and collection of field data in the 18-∠21 metres height class.

(4) To harmonise such and other abnormalities, regression of 'b' (regression coefficient on 'H' (Mean height) was determined. The nature of relationship was found to be more approximated to a straight line than any other curve.

(5) A straight line (regression) between the actual mean height.

(H) and corresponding regression coefficient (b) was taken as:-

b'= b+2H—(3)

Where b1 and b2 are coefficients of the equation and b' is the adjusted regression coefficient.

The regression equation was obtained as:-

b' = 3.49124+ 3.81290 H-..... (4)

From equation (4) adjusted values of regression coefficient denoted by (b') were obtained against mid height interval of each height class. The adjusted values of (a) denoted by (a') interim regression constant) were obtained for each height class by inserting the values of (b') in the equation (2).

(6) The abnormality existing in the basic data and consequently in the unadjusted regression coefficients was harmonised.

(7) A study of the adjusted interim regression constants (a') and actual mean height indicated a linear relationship except the value at 15-∠18 m height group. It appears that inspite of harmonisation of regression coefficient with the actual mean height, vide para 5, the regression constant at 15-∠18 m height group could not take up a clearly defined trend. A straight line relationship between the values of (a') and corresponding mean heights was derived by excluding the abnormal value of (a') for 15∠18 metres height group. The straight line regression of a' on the actual mean height (H) was taken as:-

a"= al+a2 H....(5)

Where al and a2 are constants of the equation.

The line of the best fit (excluding 15-∠18 metres height group) was found to be :-

a"= -31.60729-5.27436 H...(6)

(8) For the final volume basal area lines-the modified values for (a') denoted by (a") and for (b) denoted by b' were calculated against middle of the height interval including 15∠18 m group from the equation (4) and (6) respectively. The finally modified values for regression coefficients and constants were tabulated in the table 5.

TABLE NO.5

Height class (metres)	Actual mean Height (Metres)	Mid Height (metres)	Adjusted final regression coefficient (b').	Interim regression constant.	Finally adjusted regression constant.
9-∠12	11.7	10.5	+ 39.68633	- 95.39830	- 86.98807
12-∠15	14.2	13.5	+ 47.98291	- 107.83317	- 102.81115
15-∠18	16.7	16.5	+ 59.42161	- 113.90957	- 118.63423
18-∠21	19.1	19.5	+ 70.86031	- 165.55150	- 134.45731
21∠-24	22.5	22.5	+ 82.29961	- 152.64646	- 150.280309

(9) A glance of the table 5...indicates that though the total deviations in the final value of regression constant is greater than the interim ones, yet the spun of the deviations has been reduced to a great extent in the abnormal 15∠18 m height group in particular and in other height groups in general.

(10) Finally the general volume basal area equation were obtained as :-

y= a"+ b' x and have been presented in table No. 6.

TABLE NO. 6

FINAL VOLUM BASAL AREA LINES.

Height class (metres)	Volume besal area line.			Remarks.	
9-∠12	Y= -86.98801	+ 39.68638	X	Applicable for stem + branch timber volume.	
12-∠15	Y= -102.81115	+ 47.98291	X	-do-	-do-
15-∠18	Y= -118.63423	+ 59.42161	X	-do-	-do-
18-∠21	Y= -134.45731	+ 70.86031	X	-do-	-do-
21-∠24	Y= -150.28039	+ 82.29901	X	-do-	-do-

The stem + branch timber content (U.B.) for the mid basal area (calculated on full (πr^2) for mid of each girth classes and height classes were finally tabulated for the standard volume tables.

B. STEM SMALL-WOOD VOLUME.

1. The stem small-wood volumes and basal areas of teak trees were grouped as per girth and height classifications separately and average values were worked out.
2. The average stem small-wood was plotted as dependent variable and average basal area as independent variable on the graph for each height class separately. The curves were harmonised and smooth free hand curves were drawn for each height class separately.

In few cases, where the average values could not lead to well defined curves, weightage was given to the number of points and smooth curves were drawn. (See fig 6). There were few points available for 9-∠12 metres height class and there were the figures beyond 61-80 Cms. gbh. classes were based on extrapolations.

3. The curved values of stem small-wood volumes were read against corresponding average basal areas calculated for all the mid girth interval for 15-20 Cms gbh. to 51-60 Cms. gbh. were tabulated finally for the volume tables from the smoothened curves (See fig..6.:). The remaining curved values for 61-80 Cms. and onwards gbh. classes for actual average values were further and harmonised by expressing them as percentage of the corresponding stem +branch timber volumes calculated by regression methods (See part A).
4. These percentages were plotted against average basal areas corresponding to the mid points of the standard girth classes for each height class separately. The curves were harmonised and smooth curves were drawn for each height class. The percentages showed very minor changes in few girth height classes and the majority of the girth height classes indicated no change in their original values.
5. The curved percentages from the above smoothened curves were read against corresponding basal areas for the standard mid-girth classes. The curved percentages were multiplied by the corresponding finally tabulated stem + branch timber values and the product was divided by 100. These calculated values of stem smallwood were replotted against the corresponding basal areas and smooth curves were drawn for each height class separately. Final values were read from these curves against corresponding basal areas for mid girth intervals and tabulated for the tables (See fig. 6.)

C. BRANCH SMALL-WOOD.

1. The branch smallwood volumes and basal areas were grouped by standard girth and height classes as was done for stem smallwood. Average values of branch small wood and basal area for each group was calculated.
2. The average values of branch smallwood were plotted against average basal areas for each height-class separately. The branch smallwood data presented much difficulties and at places the weightage of the number of points was given in determining the path of the curves. The harmonised and smoothened curves were drawn for each class separately.
3. The curved values were read against the basal areas corresponding to the mid-points of the standard girth classes and tabulated finally for the volume tables (See fig..7).

VIII. APPLICABILITY AND ACCURACY OF THE VOLUME TABLES.

1. The present tables will be applicable for all the height girth classes of the South Chhindwara Division containing large number of teak trees or stand as a whole within the accuracy limits mentioned here after. They are not expected to give exactly the same volume for individual trees because of the wide variance of the tree form met-with in nature for the same height and girth. But certainly they are expected to give accurate results within the prescribed accuracy when applied to large number of trees. The table can be applied safely to other localities too, provided a sample of teak trees representing all girth-height classes closely agree with the Aggregate difference percent, average deviation percent and reliance interval of the basic tables. The sample should further satisfy the condition that its Aggregate difference should not exceed the quantity given by $\frac{2 \times \text{Average}}{n}$ Deviation of the tables where n is the number of the trees in the sample. Local volume tables will have to be prepared for the locality if the above conditions are not satisfied by it.

2. The accuracy of the tables pertaining to stem + branch timber and small-wood volumes was tested against the corresponding actual volumes of all the basic trees numbering 479 of the tables. The standard errors derived have been presented in the table No. 7.

TABLE NO.7

Standard Errors of the Estimated stem + Branch Volume.

Height class (Metres)	Degrees of freedom	Standard Errors in Cubic decimetres.
9-∠12	23	± 15.01
12-∠15	43	± 56.49
15-∠18	81	± 76.03
18-∠21	68	± 109.72
21-∠24	31	± 120.24

The reliance interval Stem+Branch timber volumes and the average volumes by girth-height classes have been furnished in the table No. 11.

3. The aggregate difference percent, and average deviation percent for the estimated stem + branch timber and stem small wool volume for the various girth classes of the table have been presented in table No. 8. The branch small wood are considered as fuel out-turn and does not matter much in value considerations. Its accuracy, therefore, does not find place in the tables:-

TABLE NO. 8.

Aggregate difference and average deviation percentages.

Height class (Metres)	Aggregate of estimated actuals.	difference per-cent volume over	Average deviation percent of estimated volume over actuals.	
	Stem + Branch timber.	Stem+ branch smallwood.	Stem +branch timber	Stem +branch small wood.
1.	2.	3.	4.	5.
9-∠12	+13.9 %	+4.67%	50.33%	24.85 %
12-∠15	-5.60 %	-1.91%	17.83%	20.50 %
15-∠18	-2.94 %	+1.40%	16.88%	16.84 %
18-∠21	+8.55 %	-3.63%	16.01%	21.71 %
21-∠24	+0.02 %	+7.63%	8.24 %	25.07 %
Total for the volume table	+ 1.64%	+ 0.56%	17.12%	20.41%

3. The aggregate difference percent for stem + branch timber volume fluctuates with the height class and the same is observed for stem smallwoods. The Aggregate difference percent is well within the limits for stem+branch timber and small wood prescribed for the volume tables, though the values of average deviation percents have gone high.

IX MINIMUM NUMBER OF TREES REQUIRED FOR A SPECIFIED PRECISION.

It has been a common query to know the minimum number of observations required for a specified precision viz ± 10 percent of the mean. An attempt has been made to utilize the basic data of present tables to meet this requirement.

Prior to construction of the present tables no data were available for the study of variability in timber and smallwood volume of teak trees occurring in the division. Therefore, the number of teak trees sampled in the present study had to be based on practical experience gathered with the working of teak in these forests.

To provide a statistical basis on this aspect, minimum number of trees required for a precision of ± 10 percent of the mean have been calculated and the same has been furnished in table No. 10.

The minimum for girth classes 61-80 Cms. and above were based on stem+branch timber data and for girth classes below 60 Cms. were based on stem small wood data.

TABLE NO.9

Minimum number of sample trees required for a = ± 10 percent precision of the mean.

Girth Classes (Cms.)	Minimum No. of sample trees required. Height classes in metres. 9-∠12	12-∠15	15-∠18	18-∠21	21-∠24	Total for girth class.
15-20	122	-	-	-	-	122
21-30	75	51	-	-	-	126
31-40	39	27	5	-	-	71
41-50	21	25	26	-	-	72
51-60	16	17	10	-	-	43
61-80	90	143	130	96	5	464
81-100	-	23	44	24	49	140
101-120	-	22	15	19	12	68
121-150	-	27	15	12	7	61
150-180	-	-	1	11	7	19
Total for Height class.	363	335	246	462	80	1186

XII. CUBICAL CONTENTS CF AN AVERAGE TEAK TREE OF DIFFERENT HEIGHT CLASSES.

An estimated average standard stem + branch timber volumes under bark with a confidence interval at 5 percent probability level have been furnished in Table 10. Thus out of every 20 teak trees, there will be 10 trees containing the standard stem timber volume (u.b.) within the upper and lower limits indicated against each height-girth class. These limits can be utilised in estimating the maximum and minimum standard stem +branch timber volumes available in a coupe or stand. Accordingly such limits can guide approxmately in the calculation of maximum or minimum upset prices which a Forest Manager can accept in a public auction. The standard stem and branch smallwood volumes available from an average teak tree of particular height girth class have been presented in table 10 and 11.

Conversion tables for conversion of Girth to Diametre and Diameter to Basal area have been furnished in Table No. 13 & 14 so that direct use of different height class regression equations for the estimation of standard stem timber volumes may be made speedily. A set of adjusted regression lines on graph paper have been appended for estimating standard stem timber volumes directly without going into elaborate calculations (See figures 1 to 7).

TABLE NO.10.

Standard stem and branch timber volume in the round for an average teak trees by Mid height-girth classes.

Girth classes at Breast Height in Cm.	HEIGHT CLASSES: 9.12 metres Estimated volume (U.B.) in Cu. dm.	9.12 metres Confidence interval in Cu. Dm.	12to15 metres Estimated valume (U.B) in Cu.dm.	12to15 metres Confidence interval in Cu. Dm.	15-18 metres Estimated valume (U.B) in Cu.dm.	15-18 metres Confidence interval in Cu. Dm.	18-21 metres Estimated valume (U.B) in Cu.dm.	18-21 metres Confidence interval in Cu. Dm.	21-24 metres Estimated valume (U.B) in Cu.dm.	21-24 metres Confidence interval in Cu. Dm.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
61-80	68.03	37.12 to 99.24	84.61	29.20 to 198.80	113.47	-37.83 to 265.33	142.32	-73.61 to 361.83	171.18	-74.27to 417.2
81.100	(167.96)	(136.74) to (99.86)	205.43	91.24 to 319.24	263.09	111.32 to 414.38	320.75	101.25 to 539.69	378.41	132.30 to 623.86
101-120	(292.65)	(249.02) to (311.14)	356.19	231.83 to 459.80	449.79	285.43 to 588.49	543.39	308.87 to 747.31	636.99	373.43 to 864.99
121-150	(483.98)	(453.04) to (615.16)	587.52	473.66 to 791.66	736.26	584.91 to 887.97	885.01	666.00 to 1104.44	1033.76	788.22 to 1279.78
151-180	(765.59)	(734.41) to (796.53)	928.01	(813.86) to (1041.86)	1157.92	1006.21 to 1309.27	1387.83	1668.40 to 1606.30 1606.84	1617.75	1371.72 to 1863.28

Note: 1. Confidence interval has been calculated at 95 % confidence limit.
2. The figures shown into brackets are based on extrapolations.
3. U.b. and Cu.dm. stands for under bark and cubic decimetres respectively.

TABLE NO.11

STANDARD STEM AND BRANCH SMALL WOOD VOLUME OF TREES BY HEIGHT GIRTH CLASSES.

Girth class in Cms.	Height class in Metres.									
	9-12 Smallwood		12-15 Smallwood		15-18 Smallwood		18-21 Smallwood		21-24 Smallwood	
	Stem.	Branch	Stem	Branch	Stem	Branch	Stem	Branch	Stem	Branch
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
15-20	10.5	-	-	-	-	-	-	-	-	-
21-30	18.0	-	25.5	-	-	-	-	-	-	-
31.40	31.5	-	40.0	-	54.5	-	-	-	-	-
41.50	72.0	-	80.0	-	136.0	-	-	-	-	-
51.60	112.0	-	133.5	1.0	149.5	2.8	-	-	-	-
61.80	105.8	7.4	133.5	10.0	156.8	13.0	195.0	15.23	202.20	20.3
81.100	83.0	27.3	100.7	32.8	122.8	39.0	126.35	43.8	143.8	49.2
101.120	(70.0)	(60.3)	83.0	69.0	103.2	76.0	103.16	82.5	116.0	99.04
121.150	(60.0)	(134.0)	70.0	142.0	83.0	150.0	84.8	155.7	87.8	175.7
151.180	(58.0)	(221.2)	(65.0)	(226.0)	71.2	240.5	80.5	240.3	90.8	265.0

Note:- The figures shown into brackets () are based on extrapolations.

TABLE NO.12.

TECTONA GRANDIS (TEAK)
Girth/Diameter Conversion table
(Conversion Factor d/9= 0.316)

Centimeters Girth.	Centimoteres of Girth.									
	0	1	2	3	4	5	6	7	8	9
	Corresponding diameter in C.M.S.									
10	3.2	3.5	3.8	4.1	4.4	4.7	5.1	5.4	5.7	6.0
20	6.3	6.6	7.0	7.3	7.6	7.9	8.2	8.5	8.8	9.2
30	9.5	9.8	10.1	10.4	10.7	11.1	11.4	11.7	12.0	12.3
40	12.6	13.1	13.3	13.6	13.9	14.2	14.5	14.9	15.2	15.5
50	15.8	16.1	16.4	16.7	17.1	17.4	17.7	18.0	18.3	18.6
60	19.0	19.3	19.6	19.9	20.2	20.5	20.9	21.2	21.5	21.8
70	22.1	22.4	22.8	23.1	23.4	23.7	24.0	24.3	24.6	25.0
80	25.3	25.6	26.0	26.2	26.5	26.9	27.2	27.5	27.8	28.1
90	28.4	28.8	29.1	29.4	29.7	30.0	30.3	30.7	31.0	31.3
100	31.6	31.9	32.2	32.6	32.9	33.2	33.5	33.8	34.1	34.4
110	34.8	35.1	35.4	35.7	36.0	36.3	36.7	37.0	37.3	37.6
120	37.9	38.2	38.6	38.9	39.9	39.5	39.8	40.1	40.4	40.8
130	41.1	41.4	41.7	42.0	42.3	42.7	43.0	43.3	43.6	43.9
140	42.2	44.6	44.9	45.2	45.5	45.8	46.2	46.5	46.8	47.1
150	47.4	47.7	48.0	48.3	48.7	49.0	49.3	49.6	49.9	50.2
160	50.6	50.9	51.2	51.5	51.8	52.1	52.5	52.8	53.1	53.4
170	53.7	54.0	54.4	54.7	55.0	55.5	55.6	55.9	56.2	56.6
180	56.9	57.2	57.5	57.8	68.2	58.5	58.8	59.1	59.4	59.7

Example:- Girth 158 C.M.S. Corresponds to 49.9 C.M.S. diameter.

TABLE NO. 13

Årea of Circles of Diametres 1.0 Centimetre to 60.0 Centimetres.

Diameter in Centimetres	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	Area of Circle in Squire Meters.									
1.	0.00008	0.00010	0.00011	0.00013	0.00015	0.00018	0.00020	0.00023	0.00025	0.00028
2.	0.00031	0.00035	0.00038	0.00042	0.00045	0.00049	0.00053	0.00057	0.00062	0.00066
3.	0.00071	0.00075	0.00080	0.00086	0.00091	0.00096	0.00102	0.00108	0.00113	0.00119
4.	0.00136	0.00132	0.00139	0.001 45	0.00152	0.00159	0.00166	0.00173	0.00181	0.00189
5.	0.00196	0.00204	0.00212	0.00221	0.00229	0.00238	0.00246	0.00255	0.00264	0.00276
6.	0.00283	0.00292	0.00302	0.00312	0.00322	0.00332	0.00342	0.00353	0.00363	0.00374
7.	0.00385	0.00396	0.00407	0.00419	0.00430	0.00442	0.00454	0.00466	0.00478	0.00490
8.	0.00503	0.00515	0.00528	0.00541	0.00554	0.00567	0.00581	0.00594	0.00608	0.00622
9.	0.00638	0.00650	0.00665	0.00679	0.00694	0.00709	0.00724	0.00739	0.00754	0.00770
10.	0.00785	0.00801	0.00817	0.00833	0.00849	0.00366	0.00882	0.00999	0.00916	0.00933
11.	0.00950	0.00968	0.00985	0.01003	0.01021	0.01039	0.01057	0.01075	0.01094	0.01112
12.	0.01131	0.01150	0.01169	0.01188	0.01208	0.01227	0.01247	0.01267	0.01287	0.01307
13.	0.01327	0.01348	0.01368	0.01389	0.01410	0.04431	0.01453	0.01474	0.01496	0.01517
14.	0.01539	0.01561	0.01584	0.01606	0.01629	0.01651	0.01674	0.01697	0.01720	0.01744
15.	0.01767	0.01791	0.01815	0.01839	0.01863	0.01887	0.01911	0.01936	0.01961	0.01986
16.	0.02011	0.02036	0.02061	0.02087	0.02112	0.02138	0.02164	0.02190	0.02217	0.02243
17.	0.02270	0.02297	0.02324	0.02351	0.02378	0.02405	0.02433	0.02461	0.02488	0.02516

18.	0.02545	0.02573	0.02602	0.02630	0.02659	0.02688	0.02717	0.02746	0.02776	0.02806
19.	0.02835	0.002865	0.0895	0.02926	0.02956	0.02986	0.03017	0.03048	0.03079	0.03110
20.	0.03142	0.03173	0.03205	0.03237	0.03269	0.03301	0.03333	0.03365	0.03398	0.03431
21.	0.03464	0.03497	0.03530	0.03563	0.03597	0.03631	0.03664	0.03698	0.03733	0.03767
22.	0.03831	0.03836	0.03871	0.03906	0.03941	0.03976	0.04011	0.04047	0.04033	0.04190
23.	0.04155	0.04191	0.04227	0.04264	0.04301	0.04337	0.04374	0.04412	0.04449	0.04486
24.	0.04524	0.04562	0.04600	0.04638	0.04676	0.04714	0.04753	0.04792	0.04831	0.04870
25.	0.04909	0.04948	0.04988	0.05027	0.05067	0.05107	0.05147	0.05187	0.05228	0.05269
26.	0.005709	0.05350	0.05391	0.05433	0.05474	0.05515	0.05557	0.05599	0.05641	0.05683
27.	0.05726	0.05768	0.05811	0.05853	0.05896	0.05940	0.05983	0.05026	0.06070	0.06114
28.	0.06158	0.06202	0.06206	0.06290	0.06335	0.06379	0.06424	0.06469	0.06514	0.06560
29.	0.06605	0.06651	0.06697	0.06743	0.06789	0.06835	0.06881	0.06928	0.06975	0.07022
30.	0.07069	0.07116	0.07163	0.07211	0.07258	0.07306	0.07354	0.07402	0.07451	0.07499
31.	0.07548	0.07596	0.07645	0.07694	0.07744	0.07793	0.07843	0.07892	0.07942	0.07992
32.	0.08042	0.03093	0.08143	0.08194	0.08245	0.08296	0.08347	0.08398	0.08450	0.08501
33.	0.08553	0.08605	0.08657	0.08709	0.08762	0.08840	0.08867	0.08920	0.08973	0.09026
34.	0.09079	0.09133	0.09186	0.09240	0.09294	0.09348	0.09402	0.09457	0.09511	0.09566
35.	0.09621	0.09676	0.09731	0.09787	0.09842	0.09898	0.09954	0.10010	0.10066	0.10122
36.	0.10179	0.10235	0.10292	0.10349	0.10406	0.10463	0.10521	0.10578	0.10636	0.10694
37.	0.10752	0.10810	0.10869	0.10927	0.10986	0.11045	0.11104	0.11163	0.11223	0.11282
38.	0.11341	0.11401	0.11461	0.11521	0.11581	0.11642	0.11702	0.11763	0.11824	0.11885
39.	0.11946	0.12007	0.12069	0.12130	0.12192	0.12254	0.12316	0.12379	0.12441	0.12504

40.	0.12566	0.12629	0.12692	0.12756	0.12819	0.12882	0.12946	0.13010	0.13074	0.13138
41.	0.13203	0.13267	0.13332	0.13396	0.13461	0.13527	0.13592	0.13657	0.13723	0.13780
42.	0.13854	0.13920	0.13987	0.14053	0.14120	0.14186	0.14253	0.14320	0.14387	0.14455
43.	0.14522	0.14590	0.14657	0.14725	0.14793	0.14862	0.14930	0.14999	0.15067	0.15136
44.	0.15205	0.15274	0.15344	0.15413	0.15483	0.15553	0.15623	0.15693	0.15763	0.15834
45.	0.15904	0.15975	0.16046	0.16117	0.16188	0.16260	0.16331	0.16403	0.16475	0.16547
46.	0.16619	0.16691	0.16764	0.16836	0.16909	0.16882	0.17055	0.17129	0.17202	0.17276
47.	0.17349	0.17423	0.17497	0.17572	0.17646	0.17721	0.17795	0.17870	0.17945	0.18020
48.	0.18396	0.18171	0.18247	0.18792	0.18398	0.18475	0.18551	0.18627	0.18704	0.18781
49.	0.18957	0.18934	0.19012	0.19089	0.19167	0.19344	0.19322	0.19400	0.19478	0.19556
50.	0.19035	0.18714	0.19792	0.19871	0.19950	0.20030	0.20109	0.20189	0.20268	0.20348
51.	0.20028	0.20508	0.20589	0.20679	0.20750	0.20831	0.20912	0.20993	0.21074	0.21156
52.	0.21637	0.21319	0.21401	0.21483	0.21565	0.21648	0.21730	0.21813	0.21896	0.21979
53.	0.22262	0.22145	0.22229	0.22312	0.22396	0.22130	0.22564	0.22648	0.22733	0.22817
54.	0.22902	0.22987	0.23072	0.23157	0.23234	0.23328	0.23414	0.23500	0.23586	0.23672
55.	0.23758	0.23845	0.23931	0.24018	0.24105	0.24192	0.24279	0.24367	0.24454	0.24542
56.	0.24679	0.24718	0.24806	0.24895	0.24983	0.25072	0.25161	0.25250	0.25339	0.25428
57.	0.25518	0.25607	0.25697	0.25787	0.25877	0.25967	0.26058	0.26148	0.26239	0.26330
58.	026421	0.26512	0.26603	0.26695	0.26786	0.26878	0.26970	0.27062	0.27155	0.27247
59.	0.27340	0.22722	0.27525	0.27618	0.27712	0.27805	0.27899	0.27992	0.28086	0.28180
60.	0.28274	0.28369	0.28463	0.28558	0.28653	0.28748	0.28843	0.28938	0.29033	0.29129

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Division of Forestry, Forest Research Institute, Dehra Dun.

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2. Hummel F.C. The volume Basal area line 1955.
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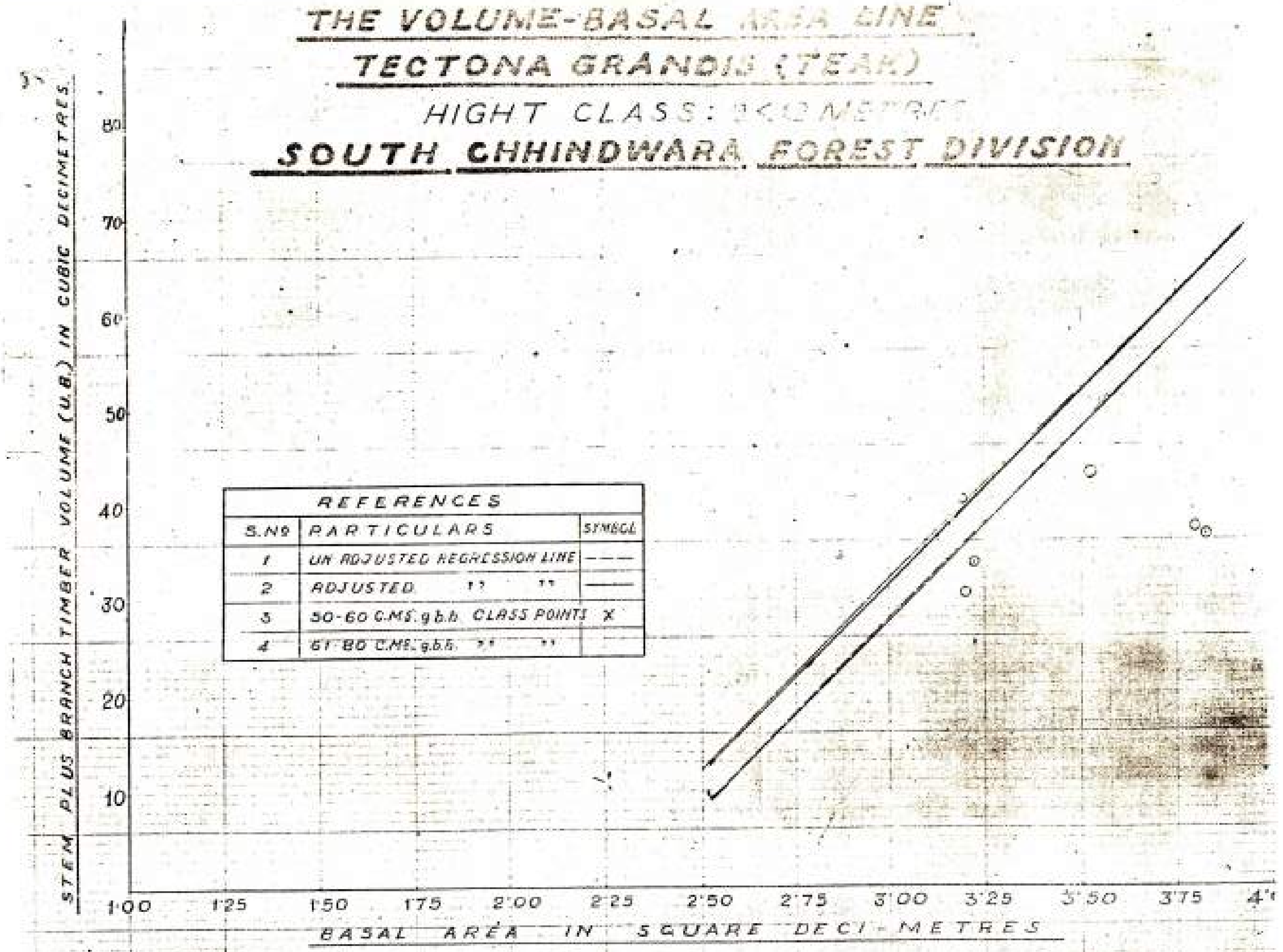

THE VOLUME-BASAL AREA LINE
TECTONA GRANDIS (TEAK)
HIGHT CLASS:
SOUTH CHHINDWARA FOREST DIVISION
REFERENCES
S.No | PARTICULARS | SYMBOL
1 | UN ADJUSTED REGRESSION LINE
2 | ADJUSTED " "
3 | 50-60 C.MS. g.b.b. CLASS POINTS | X
4 | 61-80 C.MS. g.b.b. " "
STEM PLUS BRANCH TIMBER VOLUME (U.B.) IN CUBIC DECIMETRES
10
20
30
40
50
60
70
80
1·00
1·25
1·50
1·75
2·00
2·25
2·50
2·75
3·00
3·25
3·50
3·75
BASAL AREA IN SQUARE DECI-METRES

FIGURE 1

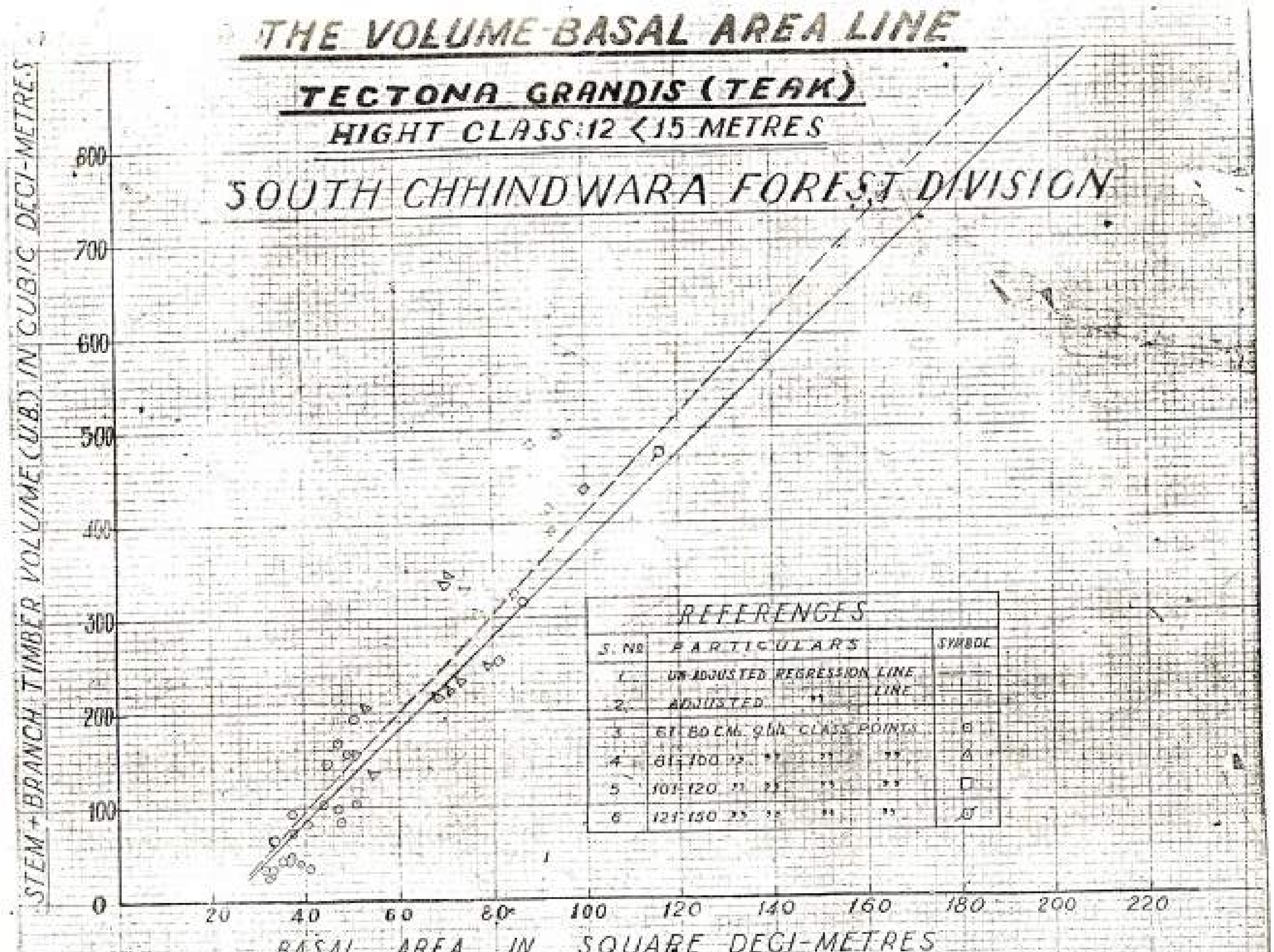

THE VOLUME-BASAL AREA LINE
TECTONA GRANDIS (TEAK)
HIGHT CLASS: 12 < 15 METRES
SOUTH CHHINDWARA FOREST DIVISION
STEM + BRANCH TIMBER VOLUME (U.B.) IN CUBIC DECI-METRES
800
700
600
500
400
300
200
100
0
20
40
60
80
100
120
140
160
180
200
220
BASAL AREA IN SQUARE DECI-METRES
REFERENCES
S. No.
PARTICULARS
SYMBOL
1. UN-ADJUSTED REGRESSION LINE
2. ADJUSTED " LINE
3. 61-80 C.M. G.B.H. CLASS POINTS
4. 81-100 " " " "
5. 101-120 " " " "
6. 121-150 " " " "

FIGURE-2

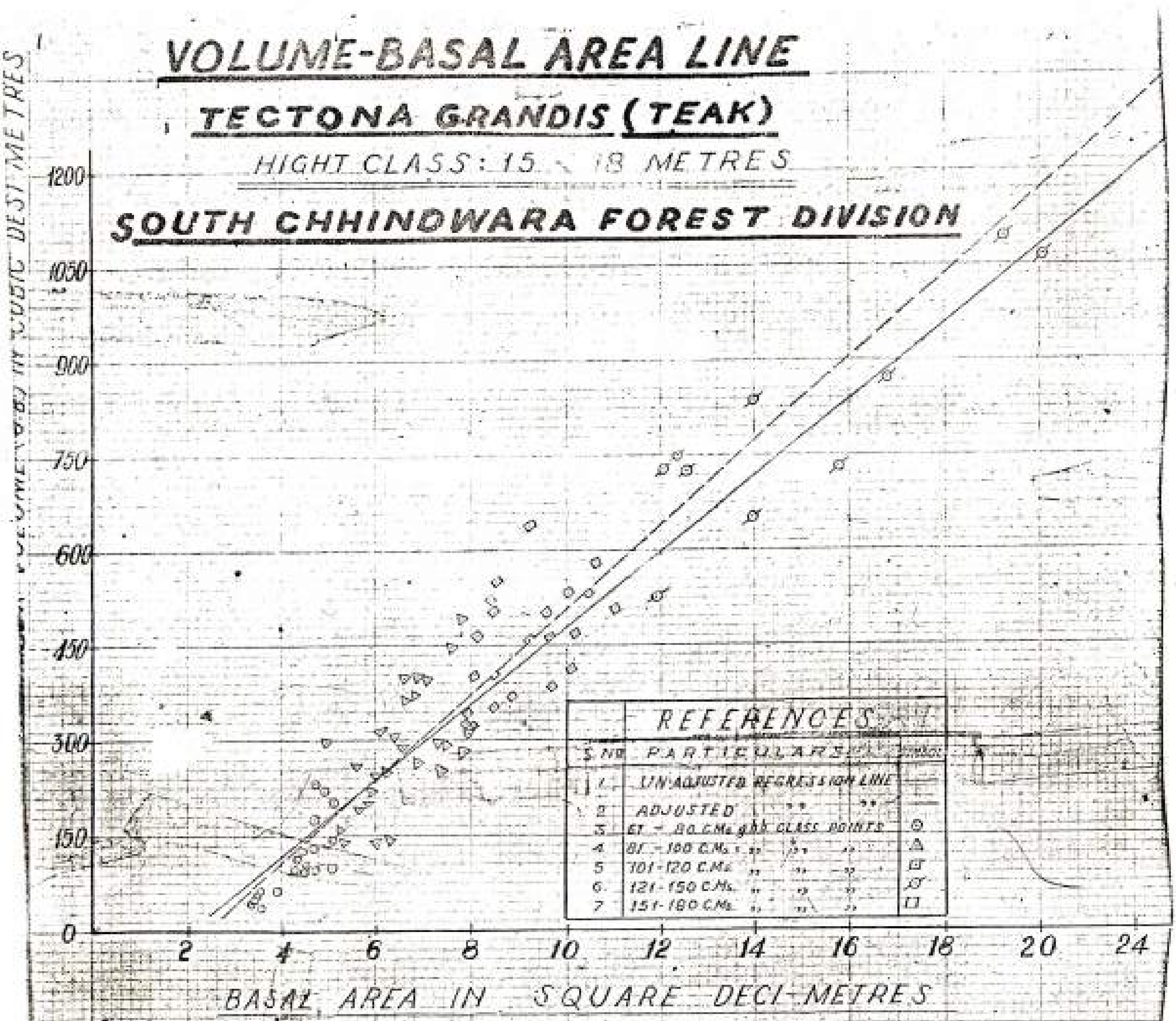

VOLUME-BASAL AREA LINE
TECTONA GRANDIS (TEAK)
HIGHT CLASS: 15 - 18 METRES
SOUTH CHHINDWARA FOREST DIVISION
VOLUME (V.B.) IN CUBIC DESI METRES
0
150
300
450
600
750
900
1050
1200
2
4
6
8
10
12
14
16
18
20
24
BASAL AREA IN SQUARE DECI-METRES
REFERENCES
S.NO. PARTICULARS SYMBOL
1. UN-ADJUSTED REGRESSION LINE
2. ADJUSTED " "
3. 61 - 80 C.M. girth CLASS POINTS
4. 81 - 100 C.M. " " "
5. 101-120 C.M. " " "
6. 121-150 C.M. " " "
7. 151-180 C.M. " " "

FIGURE - 3

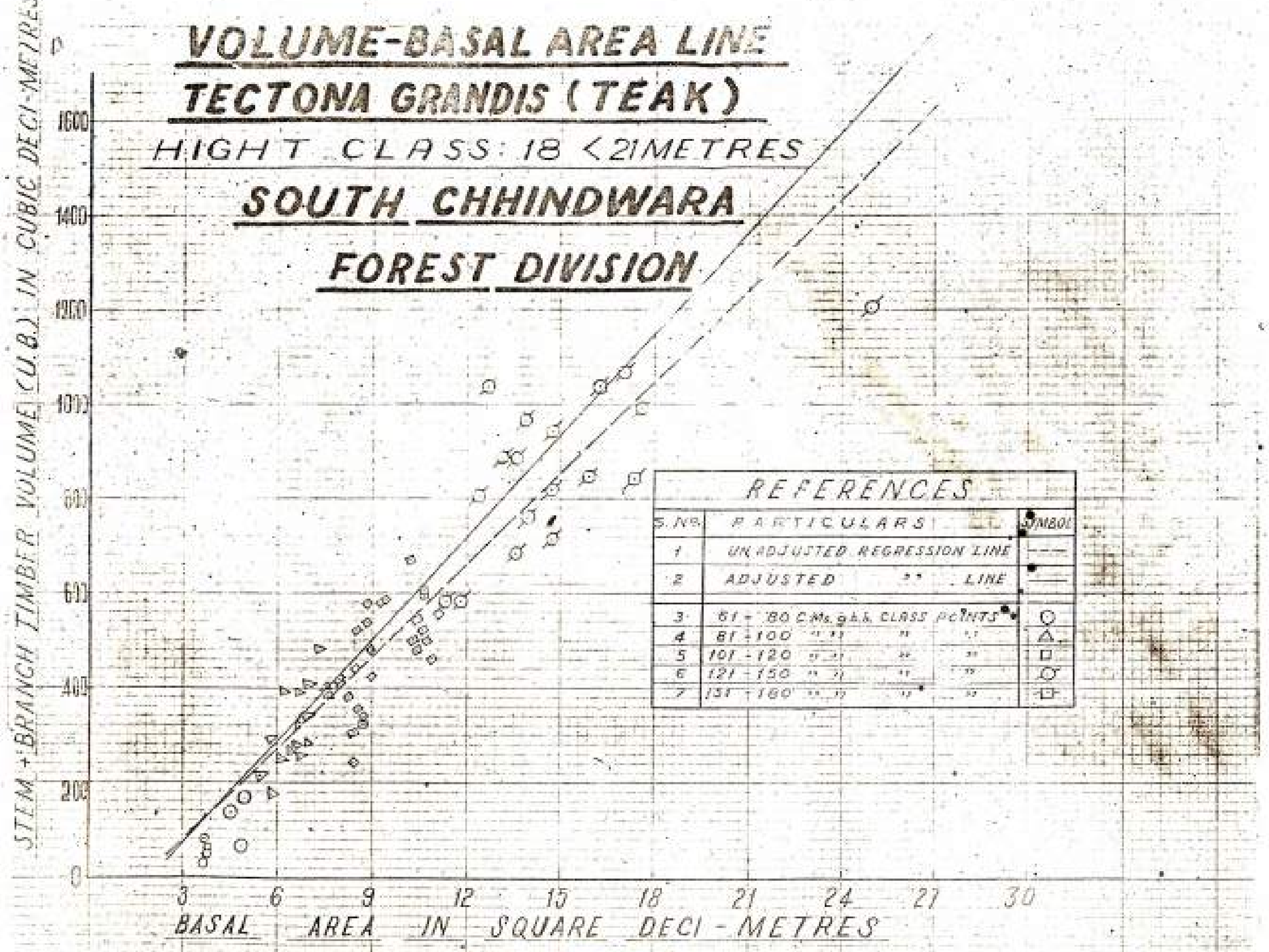
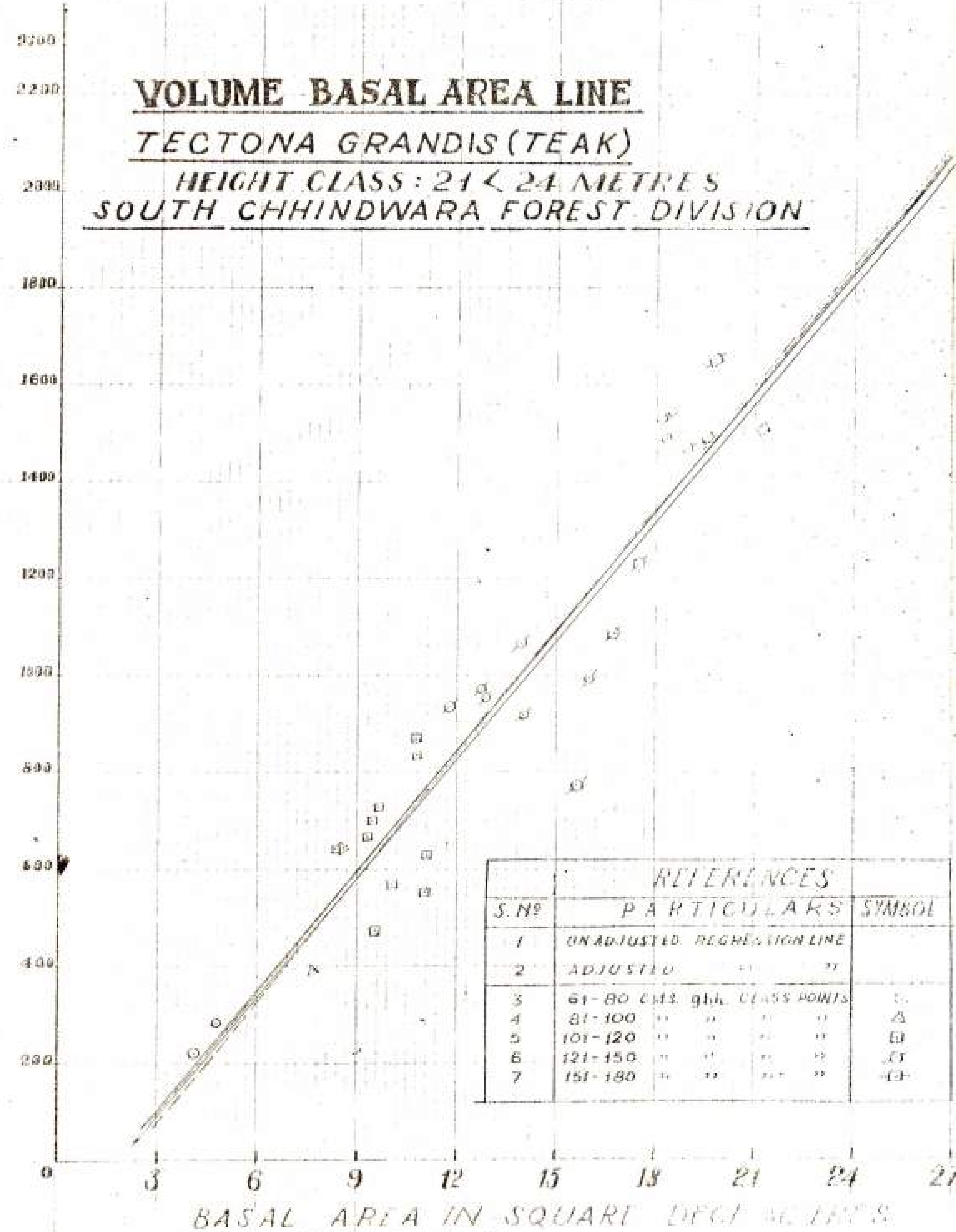

VOLUME-BASAL AREA LINE
TECTONA GRANDIS (TEAK)
HIGHT CLASS: 18 <21METRES
SOUTH CHHINDWARA
FOREST DIVISION
REFERENCES
S.No. PARTICULARS SYMBOL
1 UNADJUSTED REGRESSION LINE
2 ADJUSTED " LINE
3 61 - 80 C.Ms. g.b.h. CLASS POINTS
4 81 - 100 " " " "
5 101 - 120 " " " "
6 121 - 150 " " " "
7 151 - 180 " " " "
STEM + BRANCH TIMBER VOLUME (U.B.) IN CUBIC DECI-METRES
0
200
400
600
800
1000
1200
1400
1600
3
6
9
12
15
18
21
24
27
30
BASAL AREA IN SQUARE DECI-METRES

FIGURE - 4


VOLUME BASAL AREA LINE
TECTONA GRANDIS (TEAK)
HEIGHT CLASS : 21 < 24 METRES
SOUTH CHHINDWARA FOREST DIVISION
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
3
6
9
12
15
18
21
24
BASAL AREA IN SQUARE
REFERENCES
S. No
PARTICULARS
SYMBOL
1 UNADJUSTED REGRESSION LINE
2 ADJUSTED ,, ,,
3 61-80 CMS. gbh. CLASS POINTS
4 81-100 ,, ,, ,, ,,
5 101-120 ,, ,, ,, ,,
6 121-150 ,, ,, ,, ,,
7 151-180 ,, ,, ,, ,,

STEM SMALLWOOD VOLUME-BASAL AREA CURV[E]

TECTONA GRANDIS

SOUTH CHHINDWARA FOREST DIVISION

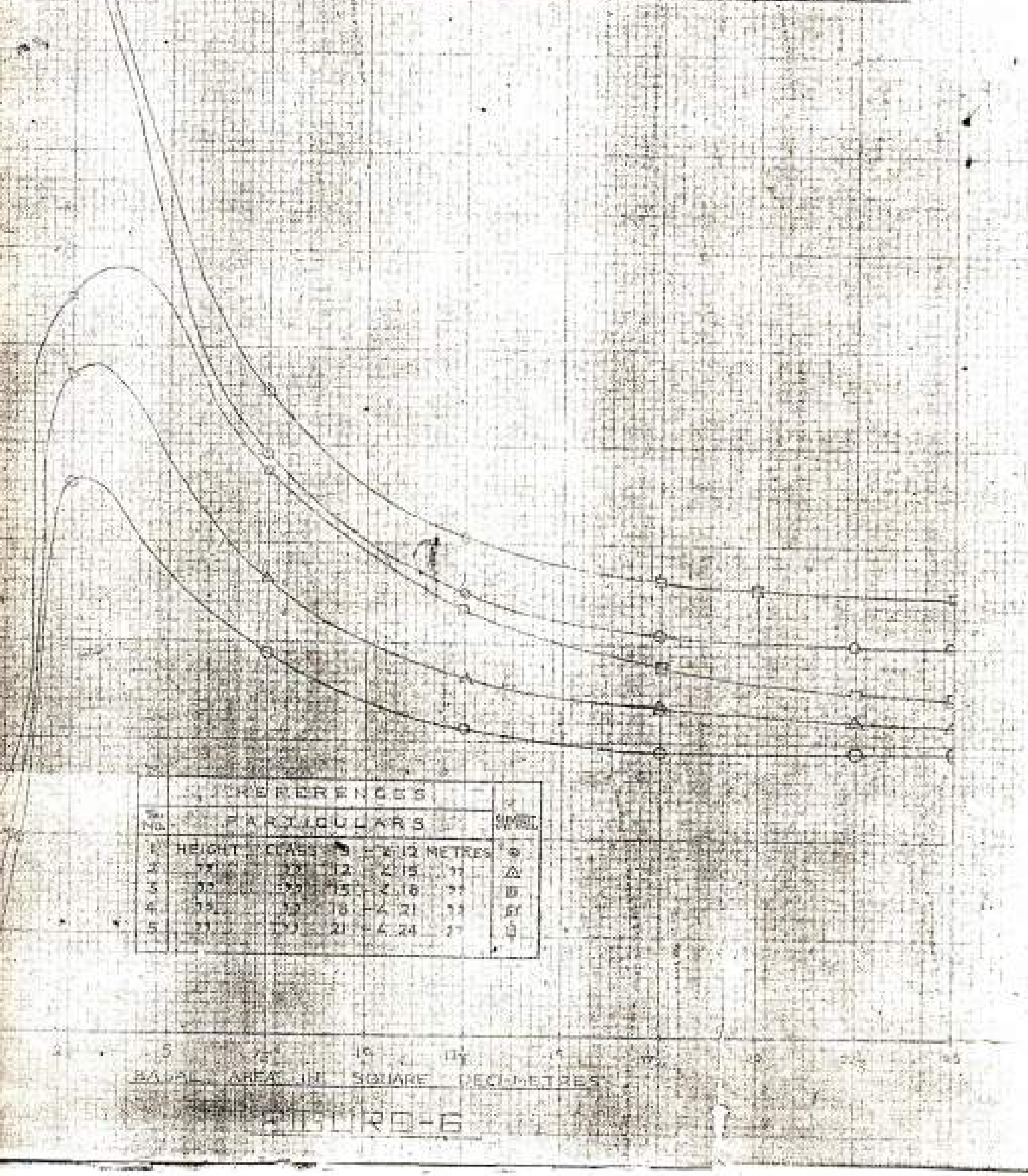


FIGURE-6

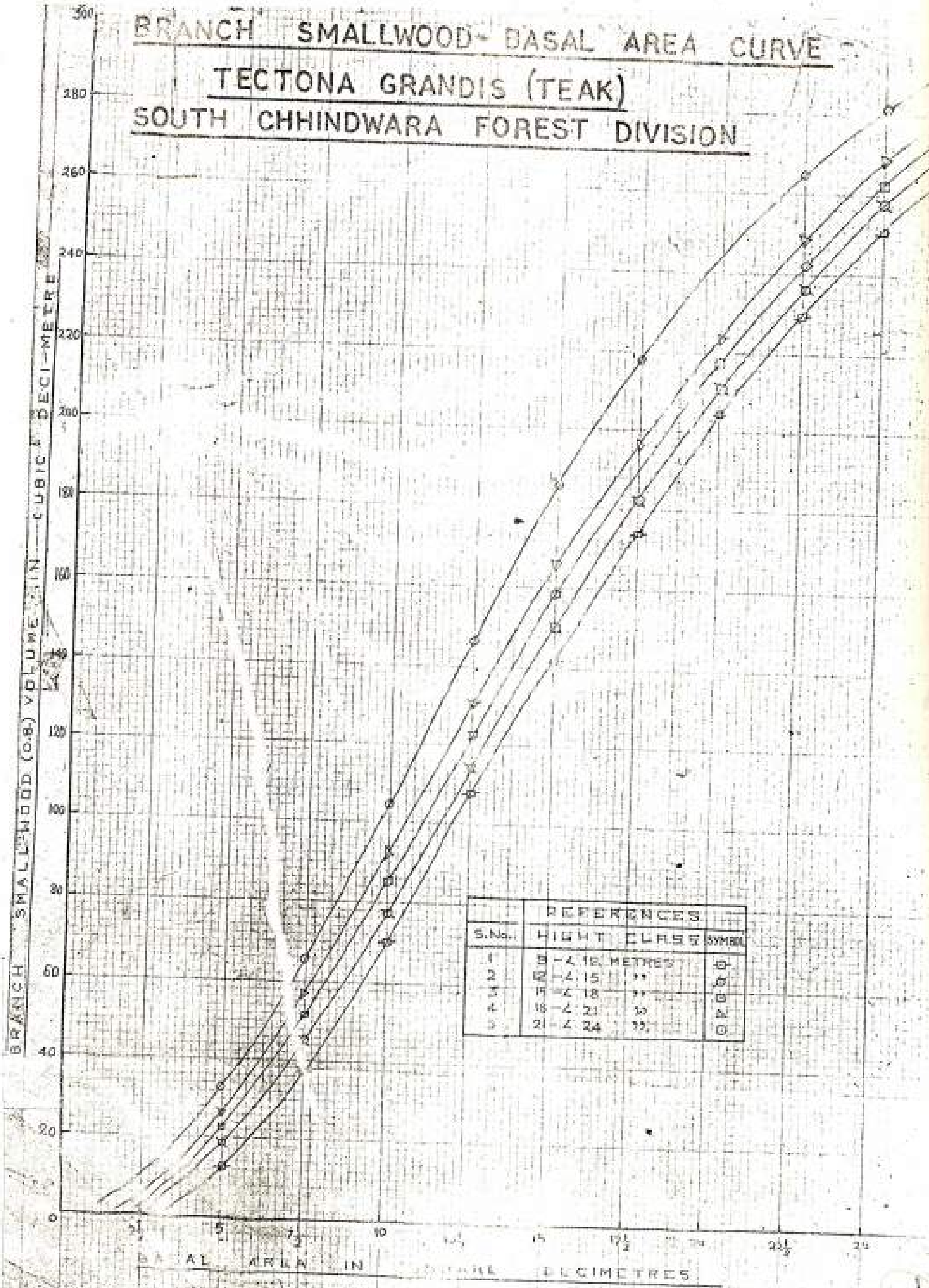

BRANCH SMALLWOOD- BASAL AREA CURVE
TECTONA GRANDIS (TEAK)
SOUTH CHHINDWARA FOREST DIVISION
BRANCH SMALLWOOD (O.B.) VOLUME IN — CUBIC DECI-METRE
BASAL AREA IN SQUARE DECIMETRES
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
5
10
15
25
REFERENCES
S.No.
HIGHT CLASS
SYMBOL
1 9 -∠ 12 METRES
2 12 -∠ 15 ,,
3 15 -∠ 18 ,,
4 18 -∠ 21 ,,
5 21 -∠ 24 ,,

FIGURE-7