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Proposed Strength Grouping of some Commercial Burmese Timber

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And
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Abstract

More efficient use of timber is possible with the selection of timbers within an appropriate strength group for any structural use rater than the use of a particular species itself alone. The information available now on the strength properties of Burmese timber is relatively limited. As such the present proposed grouping, hopefully will be of practical value till a better system is established. Two series of strength groups:- consisting of five groups ion the first and seven groups in the second, basing on an adequate data, are now proposed. In such a grouping, the strength of green timber is used, because the use of timber in the green state is widely practiced in construction works in Burma. Comparison on the timber groupings currently adopted by the Forest Department and the Timber Corporation with the present proposal is also made.

စီးပွားရေးအသုံးဝင်မြန်မာ့သစ်မျိုးအချို့အင်အားအလိုက် အုပ်စုခွဲခြားခြင်းကိုအဆိုပြုချက်

ဦးစိုးတင့်? B.Sc. (For.) (Rgn.), M.Sc. (ANU) ဌာနမှူး
နှင့်
ဦးသန်းဆွေ? B.Sc. (For.) (Rgn.) သုတေသနမှူး
သစ်တောသုတေသနဌာန

အကျဉ်းချုပ

ဆောက်လုပ်ရေးလုပ်ငန်းများတွင် အသုံးပြုလိုသော သစ်တစ်မျိုးတည်းကိုသာ ရှာဖွေအသုံးပြုခြင်းထက် အင်အားခြင်းတူညီသော သစ်အုပ်စုမှ ရရာသစ်တစ်မျိုးမျိုးအား အစားထိုးသုံးစွဲခြင်းဖြင့် ပိုမိုအကျိုးများစေပါသည်။ ဤစာတမ်းတွင် လတ်တလောအခြေအနေအရ၊ မြန်မာသစ်မျိုးများ၏ အင်အားပိုင်းဆိုင်ရာ ကိန်းဂဏန်းများ ပြည့်စုံစွာ မရရှိနိုင်မှီကာလအတွင်း သစ်မျိုးများအုပ်စုခွဲခြားခြင်း နည်းစနစ်ကိုသုံး၍၊ အုပ်စုခွဲခြား အဆိုပြုထားပါသည်။ အဆိုပြုရာတွင် အုပ်စု(၅)စုအနေဖြင့်၎င်း၊ အုပ်စု(၇)စုအနေဖြင့်၎င်း၊ နှစ်မျိုးတင်ပြထားပါသည်။ ၎င်းအုပ်စုနှစ်မျိုးအနက်မှ သင့်တော်သော အုပ်စုကို အသုံးပြုရန် အဆိုပြုထားပါသည်။ ယခုကဲ့သို့ အုပ်စုခွဲခြားရာတွင် မြန်မာနိုင်ငံတွင် သစ်အစိုအနေအထားကို သုံးစွဲလေ့ရှိပါသဖြင့် အစိုအနေအထားကိန်းဂဏန်းများပေး မူတည်၍ အုပ်စုခွဲခြား အဆိုပြုထားပါသည်။ ထို့အပြင် သစ်တောဦးစီးဌာနနှင့် သစ်လုပ်ငန်းကော်ပိုရေးရှင်းတို့မှ အုပ်စုခွဲခြားထားသော သစ်အုပ်စုများနှင့် ယခုအဆိုပြုထားသော သစ်အုပ်စုများအား နှိုင်းယှဉ် ဆွေးနွေးထားပါသည်။

Contents

1. Introduction

1.1 If most of the structural timber in a country or region comes from a few distinct species., then it would be more efficient and economical when each has its own set of working stresses. Country like Burma, where one can find many species suitable for structural use, it is convenient to group species of reasonably similar properties. The use of strength grouping overcome many of the practical problems encountered by producer, designers and timber users in the structural utilization of timber. This is particularly so where it is intended to use multiple species, and lesser known species. The grouping systems are also useful for international and domestic trades. In such a condition a timber user may select any other timber within an appropriate strength group, rather than looking for a particular species itself. In such strength grouping, there is some theoretical loss in deficiency because species in a group is grouped based on the minimum properties specified for that certain group. However, much less accurate knowledge of the species is need to group a species with reasonable precision than to derive individual working stresses for it. For Burma, which has numerous species that have not been intensively tested, strength grouping is probably the only satisfactory solution. It is found economically desirable to utilize a very wide range of timber species. With this concept in mind, attempt has been made to group some commercial timbers of Burma. Two series of groups, one consists of five groups and another of seven are classified. The classification of five groups seemed to be suitable at the present circumstances where data are limited.

1.2 The classification of Burmese timbers into groups is done jointly by the Forest Department and the Timber Corporation. A brief description of how this grouping is made together a comparison of the proposed strength groups is made with a short discussion.

2. Literature Review

2.1 In Australia, strength grouping was introduced since 1939 and had been developed and refined to simplify the presentation and utilization of this information obtained on some hundreds of timber species (AS 2878-1986). It was established on clear – wood strength properties of timber species that had similar and generally slightly higher mean strength values. The group limits had been chosen so that the ratio between representative strength values of groups was constant.

2.2 Previously four strength groups, namely A,B, C and D were classified. The average properties of these groups were as follows;-

Table (1) – Average properties of Strength Groups*
(The figures apply for defect-free timber only).

Group	Mod. of Rupture (lb/sq.in)		Mod. of Elasticity (lb/sq.in)x10^3		Crushing Strength (lb/sq.in)		Shear Strength (lb/sq.in)	
	Green	12% m.c	Green	12% m.c	Green	12% m.c	Green	12% m.c
1	2	3	4	5	6	7	8	9
A	15,000	24,000	2,400	3,000	7,500	12,000	2,000	2,500
B	12,000	20,000	2,100	2,600	6,000	10,000	1,500	1,900
C	10,000	16,000	1,700	2,200	5,000	8,000	1,200	1,600
D	7,000	12,000	1,500	1,900	3,500	6,000	800	1,100

*Reproduced from Timber Engineering Design Handbook.
Pearson, Kloot and Boyd
m. c. = moisture content.

2.3 Bending strength (Modulus of Rupture-MR), Stiffness (Modulus of Elasticity-ME), Compression strength and shear strength were taken into consideration in such grouping. Such grouping had few cases in which it was not possible to classify a species simply by using the above group classification. River red gum (*Eucalyptus camaldulensis*)for instance had to be placed in group D for bending , tension, and stiffness and at the same time in group B for other properties. Similarly spotted gum (*E. maculata*) had been placed in both groups A and B, because of its variability to different localities. This classification into four strength groups was used till 1965, when a review to regroup the species had called for. It was found out that, the four group classification did not cover the full range of properties for all the species used. At the same time more informations were gathered about the Australian species. More experience on the structural investigation were also obtained and hence Pearson (1965,1966,1967),Pearson, Kloot and Boyd (1971, supplement 1 to second edition 1971), Australian Standard CA 65-1972 and Kloot (1973) had proposed a new classification of strength groups. In The revised strength grouping,S1, S2, S3,S4,S5,S6 and S7 were introduced for green condition and S1 to S8 for seasoned timber. The finalized Australian Standard was puplished in 1986 as Australian Standard 2878-1986- "Timber-Classification into Strength Groups." This standard contained detailed procedures for the strength grouping strength group classification of timbers and list of Australian frown and imported timbers accordingly classified into strength groups. In this standard, shear values were not considered as they were said to be not closely related with modulus of rupture. Table 2.1 and 2.2 of the Australian standard 2878-1986 are reproduced below for further reference (A permission in writing to reproduce the above tables and use of some portions of the standard will be asked in due course).

Table (2) - Preliminary Classification Values for Unseasoned Timber

Minimum species mean	**Strength group**						
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
1	2	3	4	5	6	7	8
Mod. of Rupture Mpa	103	86	73	62	52	43	36
Mod. of Elasticity Mpa	16300	14200	12400	10700	9100	7900	6900
Compression Strength MPa	52	43	36	31	26	22	18

* As measured or estimated at a moisture content above the fibre saturation point.

Table (3)- Preliminary Classification Values for Seasoned* Timber

Minimum species mean	**Strength group**							
	SD1	**SD2**	**SD3**	**SD4**	**SD5**	**SD6**	**SD7**	**SD8**
1	2	3	4	5	6	7	8	9
Mod. of Rupture MPa	150	130	110	94	78	65	55	45
Mod. of Elasticity MPa	21500	18500	16000	14000	12100	10500	9100	7900
Compression Strength MPa	80	70	61	54	47	41	36	30

* As measured or adjusted to a moisture content of 12% (1 MPa = N/mm^2 = 145 lbf/in^2 = 10.2 f/cm^2)

2.4 These strength groups were further stress graded either by visual or mechanical means in the Australian Timber Enginnering Code (Australian Standard CA 65-1972). A classification of the species into four groups-J1,J2, J3 and J4 was also carried out for the purpose of Joint designs .This timber grouping for Joint design was not the same as that grouping for general structural use.

2.5 In the United Kingdom, only softwood species having similar strength and stiffness properties had been grouped together into three groups to simplify in design procedure. This grouping also was based on the weakest species of a particular group. The basic stress for individual are reproduced below:- (Sunley 1965, British Standard Code of Practice c.p. 112 Part I).

Table (4) - Green and dry basic stresses and moduli of elasticity for grouped softwoods (lb/sq.in)

Species group	**Bending & tension // to grain**		**Comp // to grain**		**Comp // to grain**		**Shear // to grain**		**Mod. of Elasticity xlo^3**	
	Green dry		**Green dry**		**Green dry**		**Green dry**		**Green dry**	
1	2	3	4	5	6	7	8	9	10	11
S_1	2000	2500	1400	1900	250	360	200	220	1300	1400
S_2	1600	2000	1200	1600	200	300	200	220	1000	1200
S_3	1100	1500	800	1200	150	220	160	180	850	1000

N.B. Green - Timber having a moisture content exceeding 18%.
Dry - Timber having a moisture content not exceeding 18%.
The above three groups had also been stress graded into three stresses for individual groups.

2.6 In the United Kingdom, hardwoods having a wide variation in physical characteristic and properties than softwoods, no recommendation was made to group the), hardwoods. On the other hand, the same as in Australia, both softwoods and hardwoods and hardwoods, having similar strength properties had been grouped for the purpose of the Joint design. The classified groups were J1, J2, J3 and J4 respectively.

2.7 Strength grouping in countries such as Africa, Malaysia, Singapore, Philippings, Indonesia, Loas, Papus New Guinea, Solomon Islands and South America was reported by Leicester (1981). It was also found out that the current Australian System of strength classification had been used in Kenya, Tanzanian, Nigeria, Popua New Guinea, FiJi, and the Solomon Islands. There had been much evident that the correlation between differe4nt properties of Australian species are very much in alliance with those of the Burmese species and hence the Australian system is favoured for use in Classifying the Burmese species. Detail discussion will be made in the appropriate section of the paper.

3. Method

3.1 The method of classification of the Burmese timbers into strength groups is mainly based on the Australian method of classification. The basis of this method was described by Pearson (1965), Kloot (1973), and Australian Standard AS 2878-1986.

Some modifications were made to suit the Burmese condition and as first proposal for strength grouping, some reactions on this paper will be reviewed in later proposal.

3.2 The marketing system of timber in Burma is in green state and at the same time the traditional use of structural timber in vast proportion is green. Hence it is regarded that the use of the green strength data in classifying the strength groups will lesson the complication. Again moisture content factor in strength grouping is a general accepted technological data for the purposes of comparison throughout the world. It is assumed that moisture content of 12% for dry condition will not be necessary for most building purposes. Surely, certain works will call for due regard to be paid to the use of seasoned timber, but for larger engineering sixes, it is not possible to get well seasoned timber and so "green" strength figures only will be used in strength grouping in this paper.

3.3 For grouping to be of a much practical value, Pearson (1952) suggested that , it is necessary that each group should include limitting values for several properties, particularly those used in structural design. Accordingly, the group limits for each group would be placed in the same group, no matter which property was used as the basis of grouping. He further suggested tat the most satisfactory way of setting up group limit is probably to fix them to suit a number of structural species which have been exhaustively tested, which cover the range of strength value between them and which do not exhibit any pecularities sufficient to prevent their use as typical species.

3.4 If most properties indicate higher group, with only one property indicating the lower group, the species was usually up graded.

3.5 Following the experience gained in Australia the group limit values are firstly decided on the values of modulus of Rupture-MR(G) in green state. The group limits had been chosen so that the ratio between representative strength values of the groups is constant. The maximum and minimum values of MR(G) of Burmese timbers are very much identical to the Australian species. Then the regression equations connecting the species mean values of various properties of structural importance of (46) species are obtained mostly from Rodger (1963), and few are results from present tests in the Forest Research Institute in Yezin. The regression equations are between MR(G) Vs Basic Density (BD), MR(G) Vs Density at 12% m.c. D (D); MR(G) Vs Modulus of Elasticity (green) ME (GE); MR(G) Vs ME (D) Dry etc. These linear regression equations are shown in table(5). The correlation coefficients of each equation are also stated. For a better view of comparison, the regression equations of the Burmese species are shown together with those of the (81) Australian species. It

3.6 Will be observed, apart from the relation between MR(G) and Basic Density of Burmese timbers, that the rest are well related and identical to the Australian condition. This could be seen more clearly in the graphical presentations in figures(1) to (12).

3.6 The group limit values predetermined for MR(G) are substituted in the above regression equations to obtain the group limits for the other properties. With some rounding off to fit a suitable preferred number series, the limits are determined. The proposed minimum standard test values for a series of seven groups and five groups are given in tables (6) and (7).

3.7 Although many properties were proposed in the previous proposals, the final classification of the Australian standard AS 1878-1986 considers only three properties, namely modulus of rupture, Modulus of Elasticity and Compression Strength.

3.8 Some commercially important structural species of Burma are classified into strength groups according to the minimum strength group limits set in tables (6) and (7). As mentioned earlier, tow sets of strength groups, one consisting of five groups and the other consisting of seven groups are classified. The purpose of classifying into two series of strength groups is to see which one is more feasible for the Burmese condition.

3.9 In such a classification a species is placed is placed in a certain group, of all three properties Modulus of Rupture, Modulus of Elasticity and Maximum crushing strength fall in the same group.

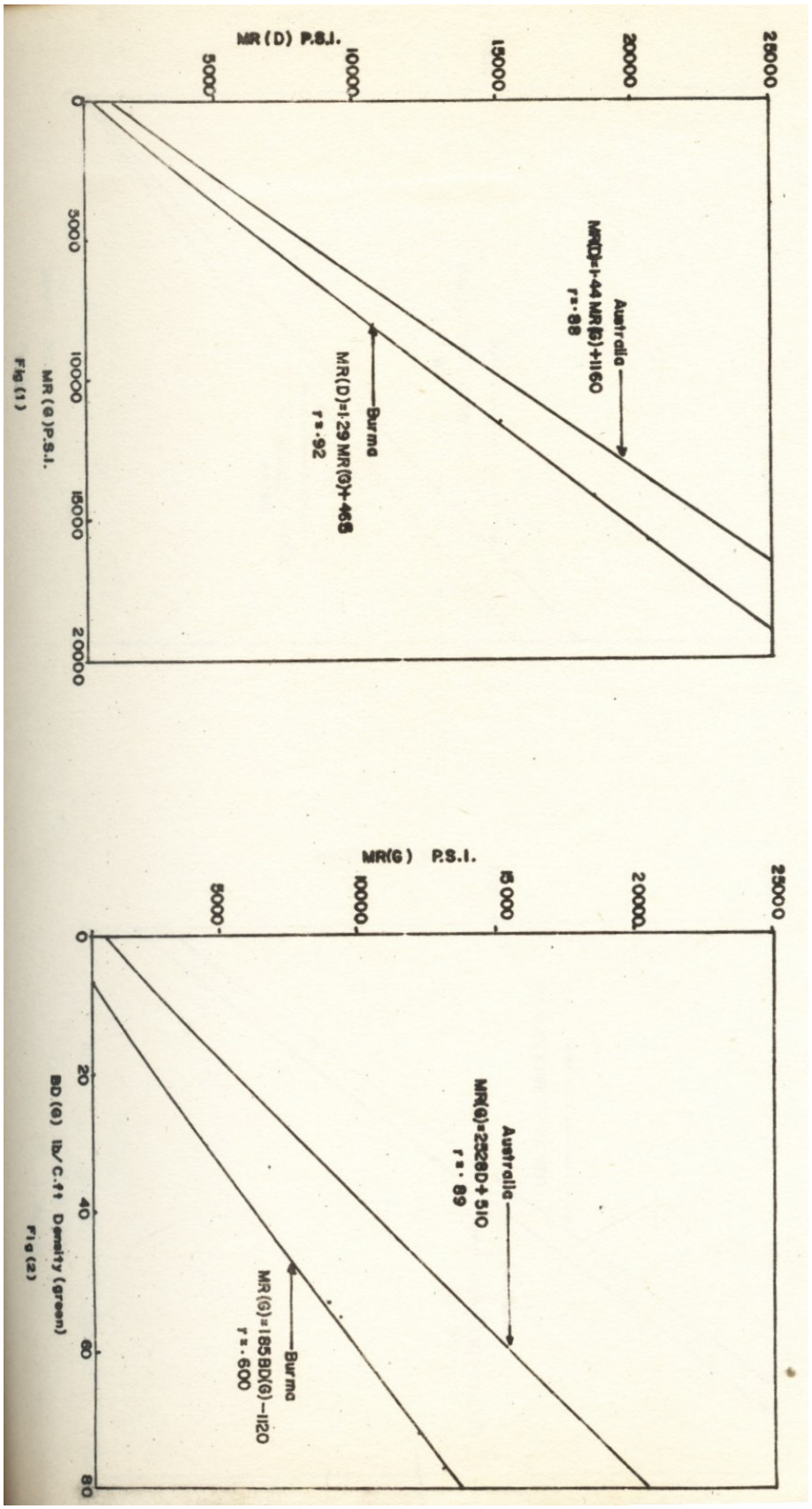
3.10 A species is assigned to a lower group, if two properties out of three are in the lower group limit, even of the last property may be in the group one step above the assigned group.

3.11 Again if any of the two properties have fallen into the higher group limits, that species is assigned to that higher group , even if the third property lies in the lower group than the assigned higher group.

Table (5) - Regression equations relating Modulus of Rupture (MR) and other properties for both Australian and Burmese Timbers **

Property	Origin	Regression equation	Correlation Coefficient
1	2	3	4
Density	Australia	MR (G) = 252 BD+510	0.89
	Burma	MR (G) = 185 BD-1120	0.60
	Australia	MR (G) = 182 D(D)+1350	0.86
	Burma	MR (G) = 234 D(D)+250	0.87
Bending	Australia	ME (G) = 129 MR(G)+310,000	0.84
	Burma	ME (G) = 129 MR(G)+194,000	0.90
	Australia	ME (D) = 161 MR(G)+360,000	0.79
	Burma	ME (D) = 143 MR(G)+306,000	0.87
	Australia	ME (D) = 115 MR(D)+180,000	0.93
	Burma	ME(D) = 109 MR(D)+271,000	0.93
	Australia	MR(D) = 1.44 MR(G)+1160	0.88
	Burma	MR(D) = 1.29 MR(G)+465	0.92
Compression	Australia	C(G) = .532 MR(G)-220	0.97
II to grain	Burma	C(G) = .542 MR(G)-350	0.96
	Australia	C(D) = .680 MR(G)+1750	0.92
	Burma	C(D) = .586 MR(G)+1460	0.89
Compression	Australia	L(G) = .147 MR(G)-500	0.78
I to grain	Burma	L(G) = .144 MR(G)-400	0.79
	Australia	L(D) = .198 MR(G)-580	0.84
	Burma	L(D) = .177 MR(G)-400	0.84
Shear	Australia	S(G) = .134 MR(G)-40	0.92
	Burma	S(D) = .088 MR(G)+225	0.88
	Australia	S(D) = .140 MR(G)+620	0.78
	Burma	S(D) = .120 MR(G)+170	0.92

*Source:- R.G Pearson (1965).
** Species mean values from standard tests on small clear specimens.
MR = Modulus of Rupture (lb/sq. in) G = Green, D=Dry)
BD = Basic Density
D(D) = Density at 12% m.c (lb/c.ft.)
ME(G) = Modulus of Elasticity (lb/sq.in) (G=Green, D=Dry)
C = Maximum crushing strength (ln/sq.in)
(G = Green, D = Dry)
L = Stress at proportional limit (ln/sq.in)
(G = Green, D - Dry)
S = Maximum shear strength (lb/sq.in)
(G = Green, D = Dry)
Lower of two values for shear in radial and tangential planes.)


MR (D) P.S.I.
25000
20000
15000
10000
5000
0
Australia
MR(D)=1·44 MR(G)+1160
r s · 88
Burma
MR(D)=1·29 MR(G)+465
r s · 92
0
5000
10000
15000
20000
MR (G) P.S.I.
Fig (1)
MR(G) P.S.I.
25000
20000
5000
10000
5000
0
Australia
MR(G)=2·28D+510
r s · 89
Burma
MR (G)=1·85 BD(G)—1120
r s · 600
0
20
40
60
80
BD (G) lb/C.ft Density (green)
Fig (2)

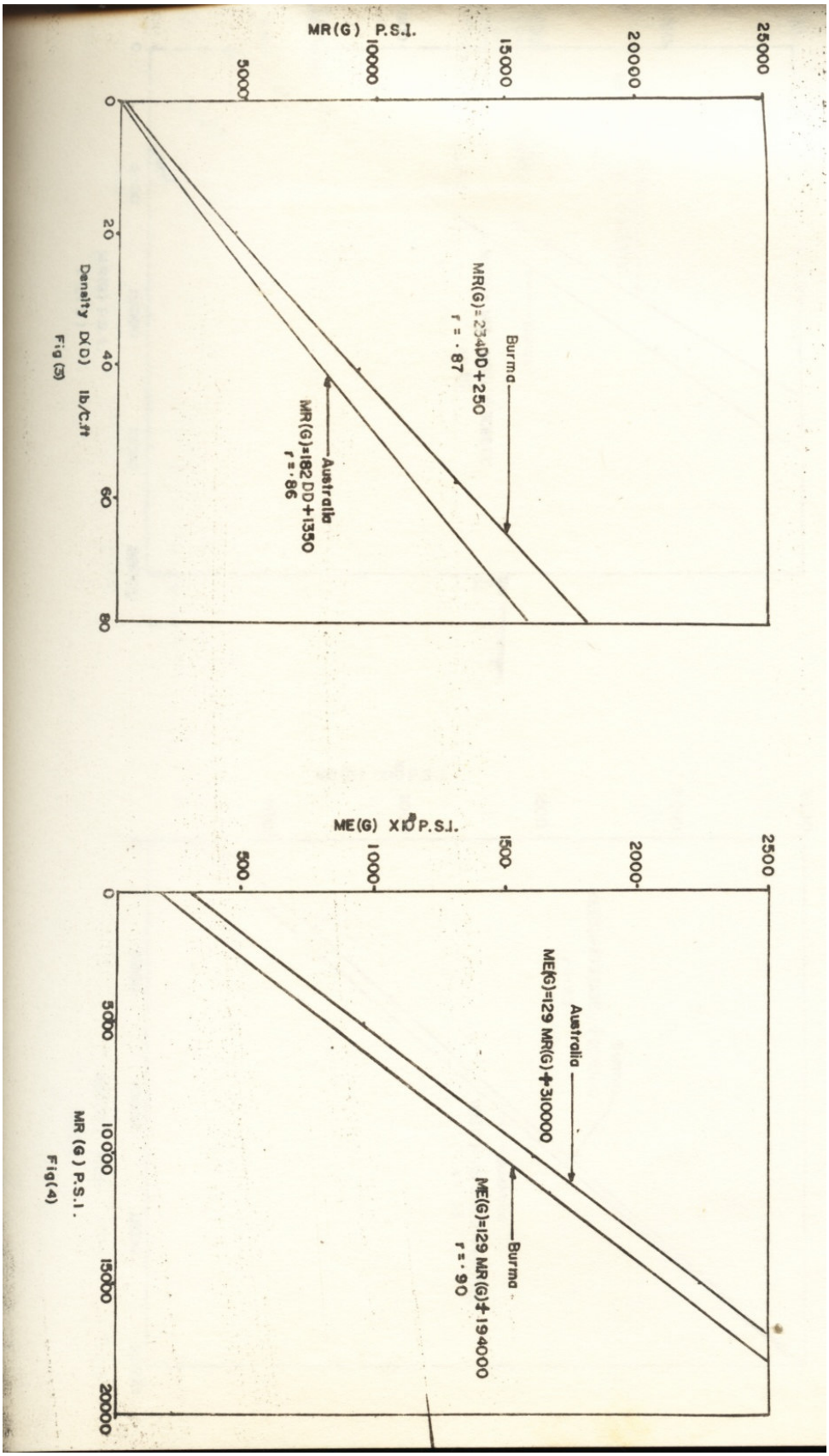
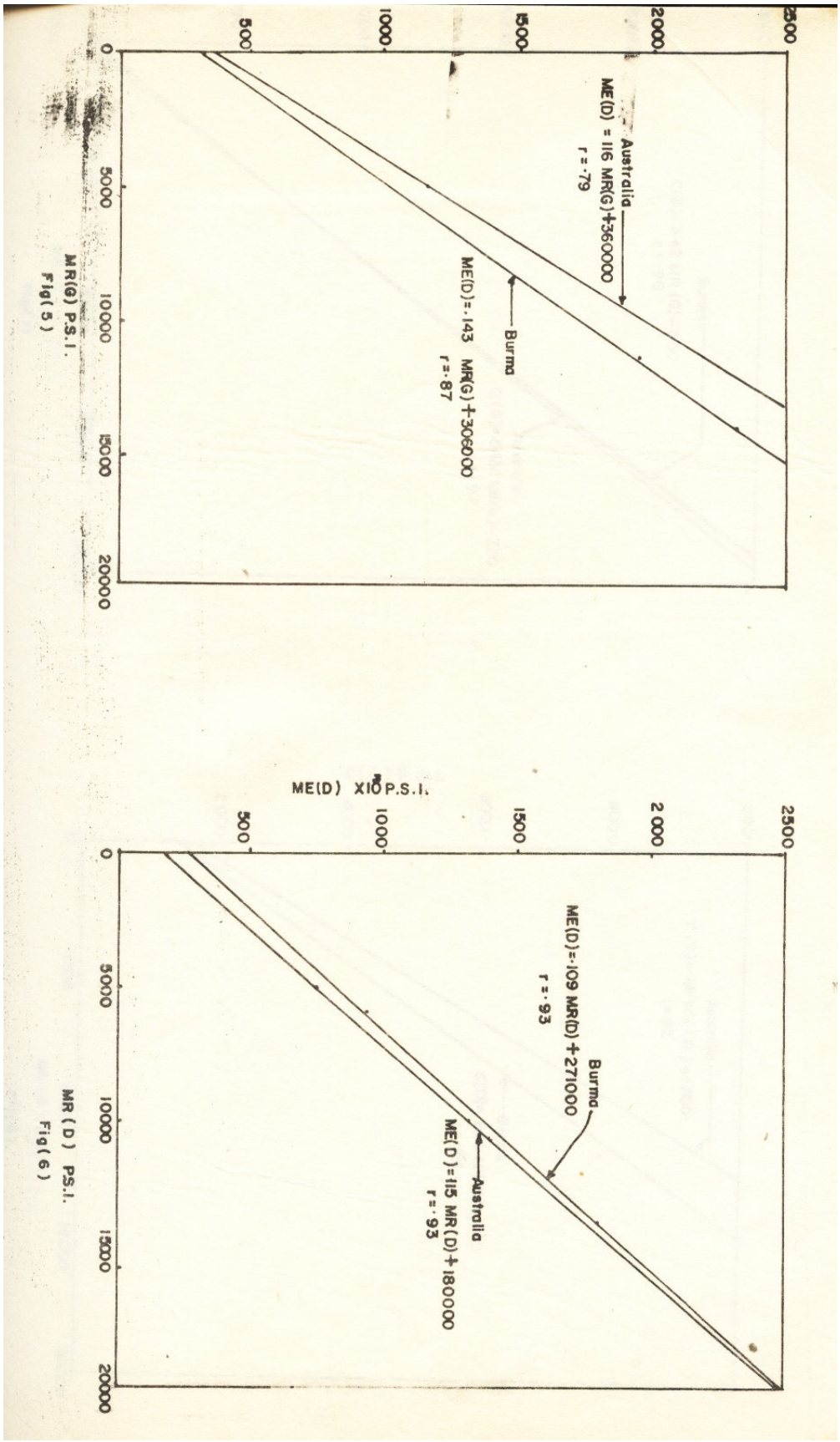
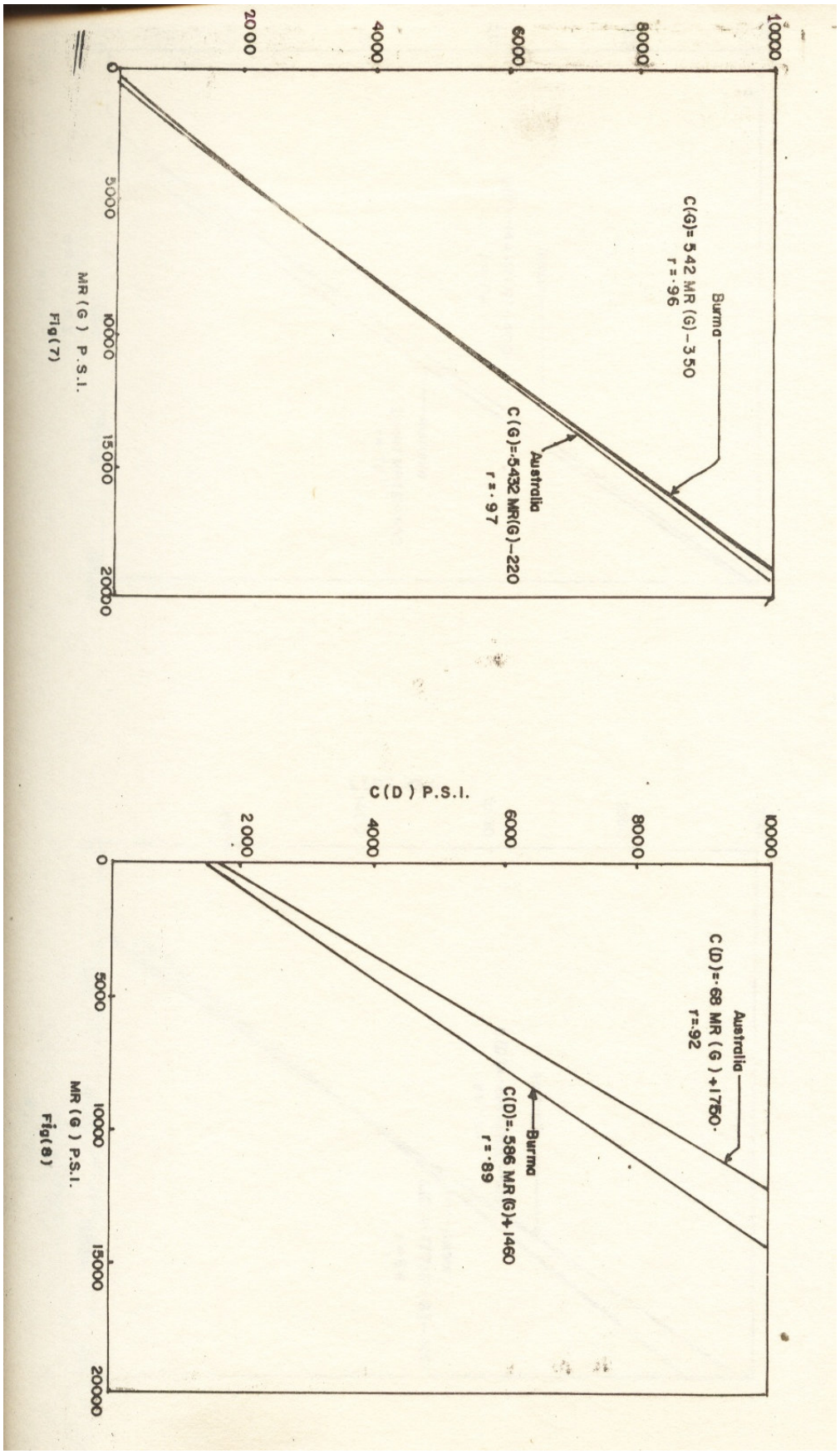

MR(G) P.S.I.
25000
20000
15000
10000
5000
0
20
40
60
80
Density D(D) lb/C.ft
Burma
MR(G)=2340D+250
r = .87
Australia
MR(G)=182DD+1350
r = .86
ME(G) X10³ P.S.I.
2500
2000
1500
1000
500
0
5000
10000
15000
20000
MR (G) P.S.I.
Australia
ME(G)=129 MR(G)+310000
Burma
ME(G)=129 MR(G)+194000
r = .90

Fig (3)

Fig(4)


ME(D) = 116 MR(G)+360000
r = ·79
Australia
Burma
ME(D)=·143 MR(G)+306000
r=·87
2500
2000
1500
1000
500
0
5000
10000
15000
20000
MR(G) P.S.I.
Fig(5)
ME(D) X10 P.S.I.
Burma
ME(D)=·109 MR(D)+271000
r = ·93
Australia
ME(D)=·115 MR(D)+180000
r = ·93
2 000
MR (D) PS.I.
Fig(6)


C(G)= 542 MR (G)-3.50
r=.96
Burma
C (G)=.532 MR(G)-220
r=.97
Australia
C(G) P.S.I.
MR (G) P.S.I.
C (D)=.68 MR (G)+1750
r=.92
Australia
C(D)=.586 MR (G)+1460
r=.89
Burma
C(D) P.S.I.
MR (G) P.S.I.

Fig(7)

Fig(8)

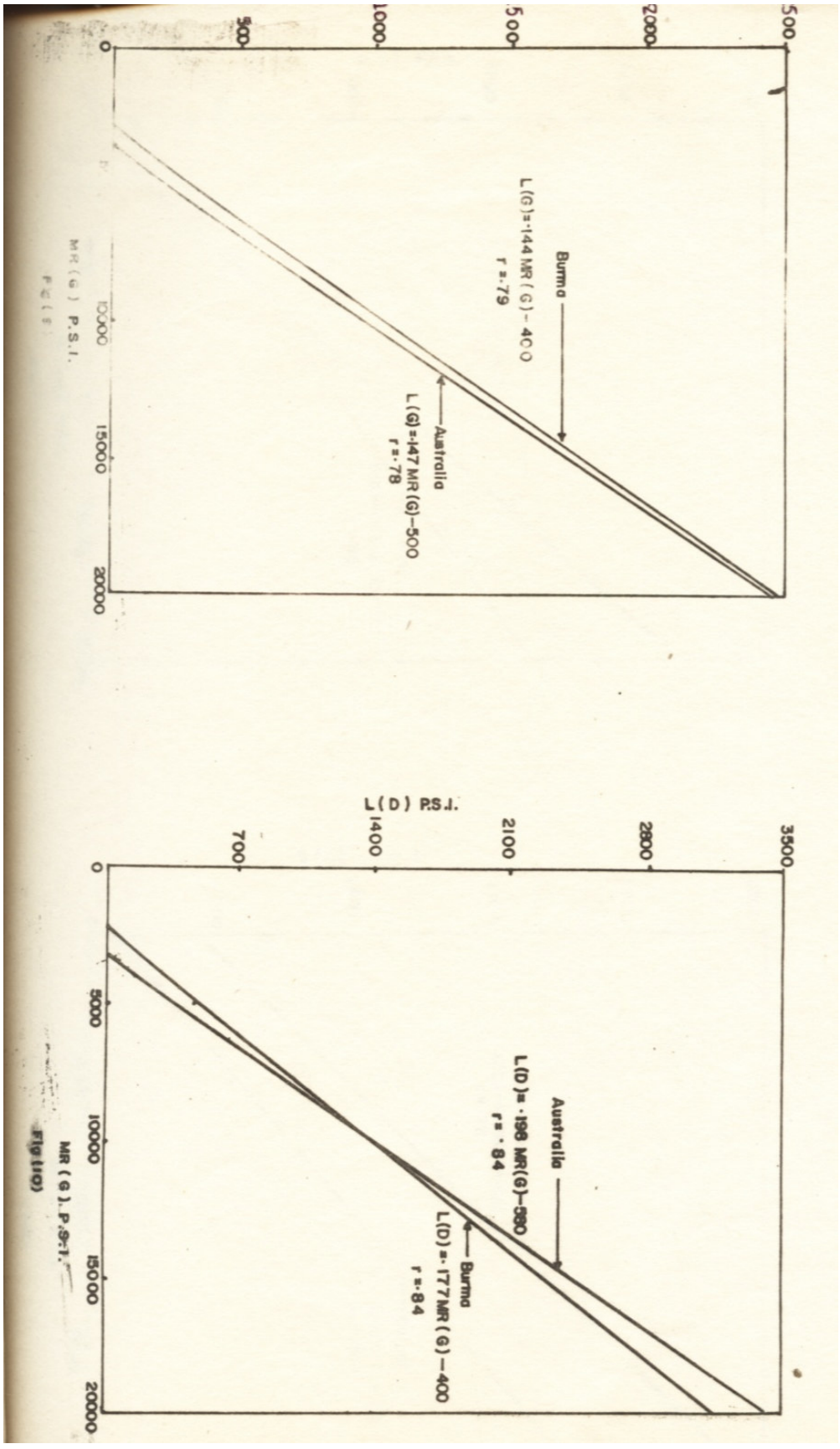

Burma
L(G)=·144 MR(G)-400
r=·79
Australia
L(G)=·147 MR(G)-500
r=·78
MR(G) P.S.I.
Australia
L(D)=·198 MR(G)-580
r=·84
Burma
L(D)=·177 MR(G)-400
r=·84
L(D) P.S.I.
MR(G) P.S.I.

Fig (10)

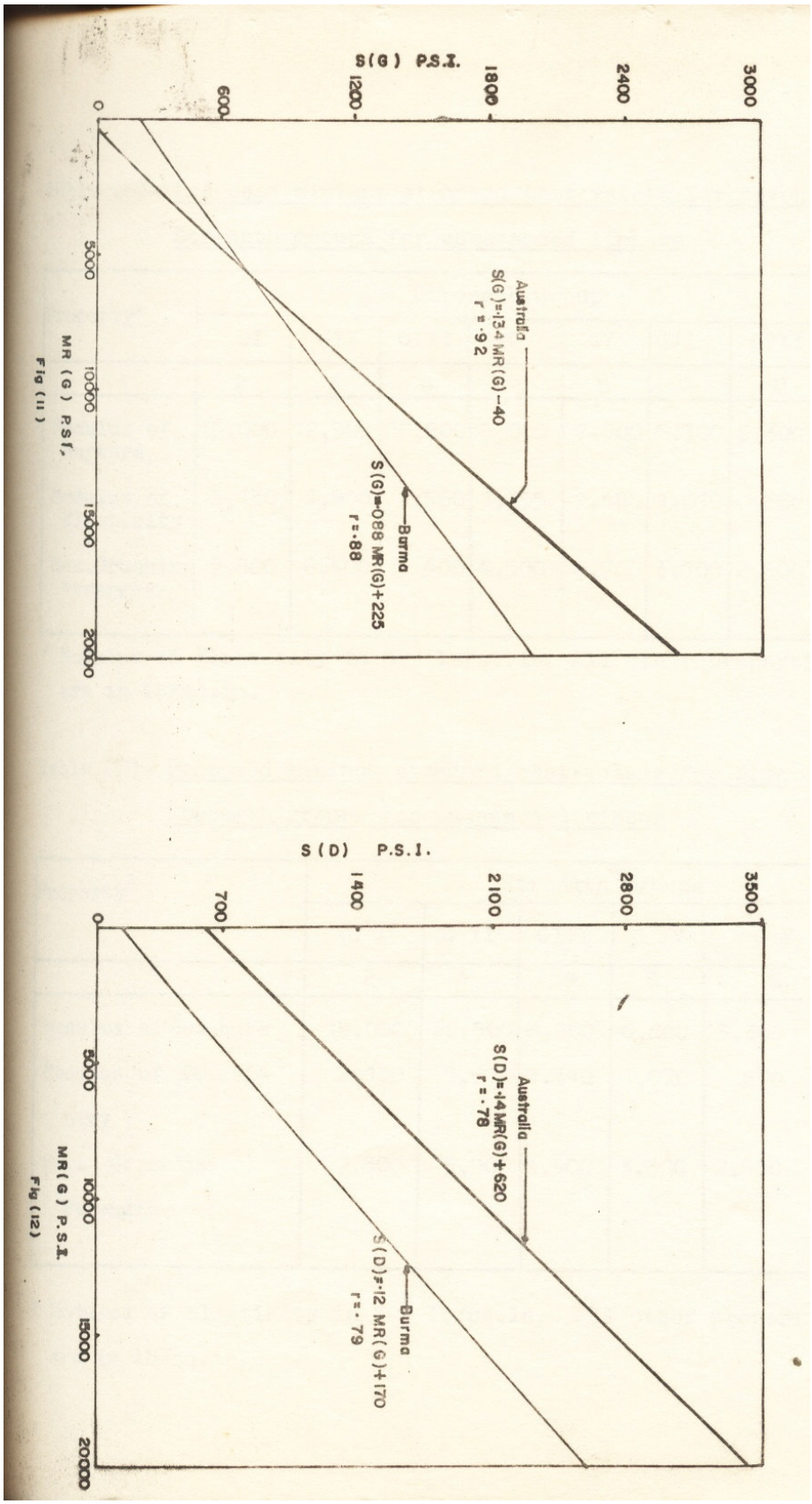

S(G) P.S.I.
3000
2400
1800
1200
600
0
5000
10000
15000
20000
MR (G) P.S.I.
Australia
S(G)=1.34 MR(G)-40
r = .92
Burma
S(G)=0.88 MR(G)+225
r=.88
Fig (11)
S(D) P.S.I.
3500
2800
2100
1400
700
0
5000
10000
15000
20000
MR(G) P.S.I.
Australia
S(D)=1.14 MR(G)+620
r = .78
Burma
S(D)=.12 MR(G)+170
r=.79
Fig (12)

Table (6) - Proposed minimum standard test values for seven Strength groups for unseasoned timbers

Property*	Strength Group						
	G I	G II	G III	G IV	G V	G VI	G VII
1	2	3	4	5	6	7	8
Modulus of Rupture	15,000	12,500	10,600	9,000	7,500	6,300	5,300
Modulus of Elasticity	2,130	1,800	1,560	1,355	1,160	1,010	880
Max. Crushing Strength	7,800	6,400	5,400	4,500	3,700	3,100	2,500

* Modulus of Elasticity in 10^3 lb/sq. in. All other properties are in lb/sq. in.

Table (7) - Proposed minimum standard test values for five Strength groups for unseasoned timber

Property*	Strength Groups				
	G I	G II	G III	G IV	G V
1	2	3	4	5	6
Modulus of Rupture	15,000	22,500	8,900	6,800	5,300
Modulus of Elasticity	2,130	1,670	1,340	1,070	870
Max. Crushing Strength	7,800	5,900	4,500	3,300	2,500

*Modulus of Elasticity in 10^3 lb/sq. in. All other properties are in lb/sq. in.

4. Results

4.1 The classification into strength groups of the commercial species of Burmese timbers according to the proposed method are given in colums (2)and (3) in table (B). Column (2) is classified into seven groups and column (3) into five groups, In column (1) of the same table given the grouping of the timbers as agree between the Forest Department and the Timber Corporation on 24th April 1984. This grouping is said to be superceded the grouping stated in the Standing Orders for Extraction Staff of the Timber Corporation. It is also assumed that the previous grouping of timber species by the Forest Department has also been superseded (Personal Corporation). This grouping in column (1) is normally used in royalty assessment and based on general utilization point of view. Apart from that it has been based on the experience gained on the timber species, natural durability, general experienced strength properties and the end uses.

4.2 Again in the same table-table (8)- the classification of the timber species by the Milling and marketing Department of the Timber Corporation is given in column (4). Obviously it is based mainly on the marketing point of view. Major considerations in this grouping are said to be hardness, density, durability and the end uses.

Table (8) - Classification of Burmese Timbers into species and Strength Groups

Species groups by the Forest Department and Timber Corporation	Seven Strength group series (proposed)	Five Strength group series (proposed)	Species groups by Milling and Marketing
1	**2**	**3**	**4**
GROUP I	**GROUP I**	**GROUP I**	**GROUP I**
1. Tamalan	1. Padauk	1. Padauk	1. Padauk
2. (Padauk)	2. Pyinkado	2. Pyinkado	2. Pyinkado
3. Pyinkado	3. Gyo	3. Gyo	3. Thingan
4. Thingan	4. Thitya	4. Thitya	4. Thitya
5. (Thitya)	5. Gangaw	5. Gangaw	5. Tamalan
6. Ingyin			6. Ingyin
			7. Yamane
			8. Thingan
GROUP II	**GROUP II**	**GROUP II**	**GROUP II**
1. Kanyin	1. Ingyin	1. Thingan	1. Hnaw
2. Karaway*	2. Thinwin	2. Ingyin	2. Sagawa
3. Kashit	3. Yon	3. Pinle-kanazo	3. Binga
4. Kokko	4. Myaukchaw	4. Thinwin	4. Yinma
5. Kyana	5. Pethan	5. Panga	5. Taungtama
6. Sagawa	6. Tamalan	6. Yon	6. Thitka
7. Sit		7. Myaukchaw	7. Thitshl*
8. Tinyu		8. Pethan	8. Kashit
9. Hnaw		9. Tamalan	9. Thadi
10. (Pinle-kanazo)	**GROUP III**	**GROUP III**	10. Thitkado
11. Binga	1. Thingan	1. Kanyin	11. Thitsi
12. Magyi-bwe*	2. Kanyin	2. Kashit	12. Kokko
13. Hmanthin*	3. Kashit	3. Kokko	13. Thitmagyi*

Species groups by the Forest Department and Timber Corporation	Seven Strength group series (proposed)	Five Strength group series (proposed)	Species groups by Milling and Marketing
1	2	3	4
14. Yinma	4. Kyana	4. Kyana	14. Sit
15. Yemane	5. Pinle-kanazo	5. Sit	15. Hmanthin*
16. Yindaik	6. Yindaik	6. Hnaw	16. Thinwin
17. Thadi	7. Thadi	7. Binga	17. Yindaik
18. (Thinwin)		8. Yindaik	18. Pinlekanazo
19. Thitkado	**GROUP III** (Cont.)	9. Thadi	
20. Thitkaya*	8. Thitka		**GROUP III**
	9. Thitsi	**GROUP III** (Cont.)	1. In
GROUP II (S_2) (Cont.)	10. Anan	10. Thitka	2. Kanyin
21. Thitka	11. In	11. Thitsi	3. Taukkyan
22. Thitsi	12. Taukkyan	12. Anan	4. Ma-ni-aurgo*
23. Thitmagyi*	13. Panga	13. In	5. Thitcha*
24. Thitsho*	14. Thabye	14. Nyan	6. Thitee*
25. Anan	15. Thingadu	15. Taukkyan	7. Yingat*
26. In	16. Leza	16. Thabye	8. Pyinma
	17. Teak	17. Thingadu	9. Kaunghmu
GROUP III (S_3)	18. Zaungbale	18. Leza	10. Thingadu
1. Kanyaung*	19. Thitsein	19. Teak	11. Peinne-bo*
2. Gangaw		20. Zaungbale	12. Kyet-to-ywesa*
3. Kaunghmu	**GROUP IV**	21. Thitsein	13. Tahlain-gaung*
4. Kyelan*	1. Kokko	22. Lein	14. Tha-ra-pi*
5. Kyet-tu-ywe-sa*	2. Sit		15. Kanyaung*
6. Sandawa*	3. Hnaw	**GROUP IV**	16. Sandawa*
7. Nyan	4. Binga	1. Sagawa	17. Anan
8. Tahlain-gaung*	5. Thitsi	2. Yinma	18. Kyana
9. Taw-thayet	6. Nyan	3. Yemane	19. Karaway*
10. Taungpeinne	7. Lein	4. Thitkado	20. Yon
11. Taungthayet		5. Kaunghmu	21. Taungthayet
12. (Taukkyan)	**GROUP V**	6. Tawthayet	22. Auckchinsani
13. Peinne-bo*	1. Sagawa	7. Taungpeinne	23. Kyelan*
14. Pyinma	2. Yinma	8. Taungthayet	24. Nabe
15. (Panga)	3. Thitkado	9. Pyinma	25. Chinyok
16. Ma-ni-aw-ga*	4. Kaunghmu	10. Chinyok	26. Panga
17. Yingat*	5. Taw-Tha-yet	11. Myaukngo	27. Naungpeinne
18. Yon	6. Taungpeinne	12. Tein	28. Thabye
19. (Thaye)	7. Taungthayet	13. Thabyu	29. Gangaw
20. Tha-ra-pi*	8. Pyinma	14. Zinbyun	
21. (Thingado)	9. Chinyok		**GROUP V**

22. Thitcha	10. Thabyu	**GROUP V**	1. Letpan
23. Thit-e*		1. Tinyu	2. Thitpyu*
24. Aukchinsani*	**GROUP VI**	2. Nabe	3. Didu
	1. Tinyu	3. Maulet-tanshe	4. Sawbya*
GROUP IV (S_4)	2. Yamane	4. Didu**	5. Ma-u-lettan-she
1. Kok-he*	3. Ma-u-let-tan-she	5. Kuthan	6. Kokhe*
2. (Chinyok)	4. Myaukngo	6. Pyaukseik	7. Gwe*
3. Gwe*	5. Pyaukseik	7. Baing**	8. Satkadon*
4. Satkadon	6. Tein	8. Letpan**	9. Baing
5. Sawbya*	7. Zinbyun		10. Letkok*
6. Didu			11. Wetshaw*
7. Baing	**GROUP VII**		12. Linlun*
8. Ma-u-let-tan-she	1. Didu*		13. Odein*
9. (Myaukngo)	2. Nabe		14. Kuthan
10. Letkok*	3. Baing**		15. Lamu*
11. Letpan	4. Letpan**		16. Thayaw*
12. Linlun*	5. Kuthan		
13. Wetshaw*			
14. Thitto*			
15. Odein*			

GROUP V (S_5)			
1. Kyunbo*			
2. (Kuthan)			
3. (Paukseik)			
4. Myaukchaw			
5. Myauklok*			
6. Lamu*			
7. Leza			
8. Tayaw*			
9. Thitpyu*			
10. Ondon*			

*Data not available. ** Lower than minimum limits. Not suitable for structural use.

4.3 Between the group I and the rest of the groups is approximately K 300/-per ton (personal communication). Four groups are classified in this Milling and Marketing system of grouping and the last fourth group consists mainly of softer hardwoods. No significant price differentiation is noticed between the group II, III & IV.

4.4 The results in table (8) has to be adjusted to made a comparison Between different methods of grouping. This has to be carried out because the strength data of some species are not available, and at the same, more species has been added where strength informations are readily available. On the otherhand, some species stated in the first three columns of table (8) are not mentioned in the Milling and marketing system of grouping is in column (4). Table (9) has been prepared and shown below to indicate the number of species commonly consisted in ass methods of grouping for further discussion.

Table (9) - Number of tree species consisted in different groups in four series of classifications.

Group	Group by Forest Department and Timber Corporation	Seven strength group series	Five strength group series	Milling and Marketing system
1	2	3	4	5
I	6	4	4	8
II	20	5	8	16
III	12	16	18	16
IV	7	6	11	5
V	4	8	8	
VI		5		
VII		5		
Total	49	49	49	45

5. Discussions

5.1 The strength grouping proposed consists of two series, one consists of seven groups and the other consists of five groups. Studying from the seven series in columns (2)it will be observed that there are few species in group I and VII, and so, for practical purpose, this seven groups could be condensed into five groups and so, system of five grades as in column (4) is feasible at this moment. Strength grouping should be a compromise between simplicity (achieved by reducing the number of groups) and utilization efficiency (achieved by increasing the number of group to include all grades of the major species).Too many groups will lead to unnecessary complexities and again too few groups will lead to inefficiency in utilization. It is therefore more feasible t use the five group series of classification in Burma.

5.2 Again, the existing grouping by the Forest Department and the Timber Corporation given in column (1) of table (8) has also five groups and this encourage the use of the five strength group series in Burma. With the availability of full information on the timber species in future, division of more groups can be achieved.

5.3 Comparing column (2) and (4) of the table (9), it will be observed that, the number of species consisted in group I, IV and V in both column are not significantly different. On the otherhand the number of species consisted in grade II of column (8) is higher than that in column (4) and almost the same number in grade III of that column. Reversely those in grade III of column (2) is less than those in column (4) and almost the same in grade II of column (4). This indicates that the grouping by the Forest Department and the Timber Corporation seems to have up-graded the species a little. This can be seen by studying table (8) for the individual species. For an example, Kanyin, Kokko, Hnaw, Binga etc in column (1) are classified in group II whereas in column (3), they are in group III. In fact, this sort of up-grading is of no great important, because strength is rarely a factor of great importance in the selection of the timber species to be used, as dimensions can usually varied according to the particular stress required. A through evaluation of working stress should only be taken care of.

5.4 The proposed strength grouping into five groups is rather different from the Milling and Marketing classification. The Milling and Marketing grouping has more species in the group I and II. There is justification to up-grade some outstanding species such as Tamalan, Yindaik, Thitsi and Thinwin, which can be used for special ornamental purpose. The market grouping may not be the same as strength grouping for such beautiful, colourful and ornamental species. This paper is proposing to group the species for structural use only. Availability is another factor to be considered for special grading. For an example, Magyibwe and Yindaik, which are rather limited in availability should be marketed separately for higher price. Strength grouping of such scarce species to use as structural timber is not advisable.

5.5 Another conspicuous example is teak, an all round utilization species, although strength grouped in this proposal is in group III in term strength, should usually be treated as an elite species.

6. Conclusions

6.1 The species grouping by the Forest Department and the Timber Corporation, as revised on 24th April 1984 seemed to have up-graded the species a little bit if considered for structural use. Dimensional increment could be done to stand for a particular working stress if lower strength group timbers are to be used.

6.2 The Milling and Marketing Department may select some special featured timbers for different price, rather than grouping them into structural timber groups.

6.3 As a whole, classification methods based on the properties of small clear specimens required to be very conservative because it is very hard to relate these properties to, those of the structural size timbers. However such classification are often useful as they are simple and suitable where technological strength data of the species are limited. Country like, Burma, where it is intended to use many species and especially where known species, the use of strength grouping method is essential.

6.4 The strength classification into five groups rather than seven groups is recommended for Burma.

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