Leaflet No. 7/1991

Government of the Union of Myanmar
Ministry of Forestry
Forest Department
Forest Research Institute
Yezin

Optimum Moisture Contents of Four Commercial Myanmar Timbers for Three Different Environments

U Thein Myint, B.Sc. (For.) (Rgn.), Researcher
and
U Win Kyi (1) , B.Sc. (Hons.) (Mdy.), D.S. (R.I.E), M.S. (VPI & SU),
M.Sc. (SUNY, CESF),
Head of Division
Forest Research Institute
1991

ပတ်ဝန်းကျင်အခြေအနေ (၃) မျိုးနှင့် သင့်တင့်ကိုက်ညီမည့် မြန်မာသစ် (၄) မျိုးတို့၏ အစိုဓါတ်များကိုရှာဖွေခြင်း

ဦးသိန်းမြင့် B.Sc. (For.), (Rgn.), သုတေသနမှူး
နှင့်
ဦးဝင်းကြည် (၁) B.Sc. (Hons.), (Mdy.); D.S. (RIE)
M.S (VPI &SU) ဌာနမှူး
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်းချုပ်

မြန်မာနိုင်ငံတွင် အများဆုံး အသုံးပြုလျက်ရှိသော သစ်မျိုးများအနက်မှ ကျွန်း၊ ပျဉ်းကတိုး၊ သစ်ယာနှင့် အင်သစ် (၄) မျိုးတို့ကို နေရောင်ခြည် စွမ်းအင်သုံး သစ်ပေါင်းဖိုဖြင့် အခြောက်ခံခဲ့ပါသည်။ အခြောက်ခံပြီးသစ်များကို ပတ်ဝန်းကျင် အခြေအနေချင်း မတူသည့် (၁) အကာအရံ မရှိသောတဲ (၂) သာမန်ဓါတ်ခွဲခန်းနှင့် (၃) လေအေးစက်တပ်ဆင်ထားသော ဓါတ်ခွဲခန်းများတွင်ထားရှိပြီး ၄င်းသစ်မျိုးတစ်မျိုးစီ၏ အစိုဓါတ်ပြောင်းလဲမှုကို မှတ်သားတွက်ချက်၍ ပတ်ဝန်းကျင် တစ်ခုစီ အတွက် အသုံးပြုရန် သင့်တင့်ကိုက်ညီမည့် အစိုဓါတ်များကို ရှာဖွေခဲ့ပါသည်။ တွေ့ရှိချက်များအရ ရေဆင်းဒေသ၍ အကာအရံ မရှိသော အဆောက်အဦးများတွင် အသုံးပြုမည့် သစ်များသည် သစ်မျိုးကိုလိုက်၍ အစိုဓါတ် (၁၂) ရာခိုင်နှုန်းမှ (၁၄) ရာခိုင်နှုန်း၌ ၄င်း၊ သာမန်အခန်းများတွင် အသုံးပြုမည့်သစ်များသည် သစ်မျိုးကိုလိုက်၍ အစိုဓါတ် (၉) ရာခိုင်နှုန်းမှ (၁၁) ရာခိုင်နှုန်း၄င်း၊ လေအေးစက်တပ်ဆင်ထားသော အခန်းများတွင် အသုံးပြုမည့် သစ်များသည် သစ်မျိုးကို လိုက်၍အစိုဓါတ် (၉) ရာခိုင်နှုန်းမှ (၁၁) ရာခိုင်နှုန်း၌ ၄င်း၊ အခြောက်ခံထားရှိပြီးမှသာ ဖော်ပြပါနေရာ (၃) မျိုးတို့တွင် အသုံးပြုရန် သင့်တင့်ကိုက်ညီမည်ဖြစ်ကြောင်းတွေ့ရှိရပါသည်။

Optimum Moisture Contents of Four Commercial Myanmar Timbers for Three Different Environments

U Thein Myint, B.Sc. (For.), (Rgn.), Researcher
and
U Win Kyi (1), B.Sc. (Hons.), (Mdy.); D.S. (RIE)
M.S (VPI & SU), Head of Division,
Forest Research Institute

Abstract

Four commercial Myanmar timbers, Kyun (T*ectona grandis* Linn), Pyinkado *(Xylia dolabriformis* Benth), Thitya (*Shorea oblongifolia* Thw.) and In (*Dipterocarpus tuberculatus* Roxb.) were dried by using solar lumber dryer. These solar-dried boards were stacked in three different environments:-open-shed, normal room and air-conditioned room. The variation of moisture contents of these boards were recorded and the optimum moisture contents of each species for three different environments were determined. According to this study, for outdoor atmosphere under shelter one inch thick lumber obtained at about 12 percent to 14 percent moisture content will give satisfactory service. For indoor atmosphere 1 inch lumber obtained at about 9 percent to 11 percent moisture content will be appropriate. Similarly, for air- conditioned room one inch thick lumber obtained at about 9 percent to 11 percent moisture content will give satisfactory service.

Contents

1. Introduction

Wood is a hygroscopic material; that is, it is able to remove water from the atmosphere and maintains a moisture equilibrium with the water vapor in the air. Its various physical properties as mass, dimensions and density, as well as its mechanical properties are affected by the moisture content.

When wood is used in its final form as a part of furniture or as a building material, it is subsequently subjected to environmental conditions. Even after wood has been dried, it is still prone to pick up or lose moisture in response to the surrounding weather conditions. It is well known that, during a prolonged dry spell timber in use tends to contract or shrink and conversely under humid conditions it expands or swells. These effects are caused by the moisture content changes which in turn causes the timber to undergo frequent dimensional changes. These dimensional changes in wood constitute ' working ' or ' movement ' of the timber and is responsible for the checking, splitting and distortion of timber in use.

Thus, it is cleared that the moisture content to which wood should be dried prior to use depends on the environment where it will be exposed during use. It should be dried to equilibrium with the mean conditions to which it is to be exposed in use.

The experiment, therefore, is to investigate the optimum moisture content to which wood should be dried prior to use for different environments.

Four, commercial Myanmar timbers which are among the primary species in Myanmar, Kyun (*Tectona grandis* Linn), Pyinkado *(Xylia dolabriformis* Benth), Thitya (*Shorea oblongifolia* Thw.) and In (*Dipterocarpus tuberculatus* Roxb.) are selected for this study. And three different environments which are common places of using timber in this country, open shed, normal room and air-conditioned room are chosen for the experiments to carry out.

2. Objective

To determine the optimum moisture content of four commercial Myanmar timbers which will be used in three different environments.

3. Literature Review

Grewel and Sanad (1983) studied the stabilized moisture content of three Malaysian timbers of various thickness (7 mm to 25 mm) in different air- conditioned environments. The selected timber species were reported to be Rubberwood (*Hevea brasiliensis)* Meranti, Light Red (*Shorea teysmanniana)* and Ramin (*Gonystylus bancanus).*

To obtain more factual information on the moisture content range, the authors conducted their experiments in various offices and laboratories of the Forest Research Institute, Kepong, Malaysia. According to their report it was learned that, all the offices and laboratories where the experiments were conducted were all air-conditioned . And the air-conditionings were switched off after office hours.

It was reported that the temperature range and the relative humidity range at the tested environments were 20°C-25°C and 50 percent -94 percent, respectively. The initial air-dry moisture content of the tested boards were 15.0 percent to 19.0 percent. After 3 to 7 weeks, moisture content of the tested boards were found to be stabilized. It was reported that , the range of stable moisture content was 10.1 percent to 13.4 percent .

A large body of equilibrium moisture content (EMC) - temperature - relative humidity data is given in table 3- 4 of Wood Handbook (U.S. FPL, 1974). The EMC data

start at a temperature of 30°F and increase in 5°F increments up to 130°F, and then in 10°F increments up to 210°F. The EMC values for a number of relative humidities are tabulated for each temperature. The data obtained are reported to be based largely on Siltka spruce (*Picea sitchenis*) of green specific gravity 0.37 during what has been termed "oscillating desorption " from the initial green condition. To get a general guidance fore the timber users,. that EMC table is given in Appendix A.

4. Materials and Methods

Four commercial Myanmar timbers, Kyun, Pyinkado, Thitya and In were purchased from Myanmar Timber Enterprise, Pyinmana. The sizes of the lumber for each species was 6 inches in width and 1 inch in thickness (i.e. 6" x 1").

6" x 1" lumber of different lengths were cut into 30 inches. Both ends of each and every board were coated with Thitsi (resin from *Melanorrhoea usitata* tree) in order to reduce fast drying from the end- surfaces.

All boards were then dried in a semi-greenhouse type solar lumber dryer which was constructed at this institute. The range of the initial moisture content of the boards was 32.5 percent to 40.6 percent. The average final moisture was 9.5 percent (range 7.5 - 12.5), after 22 days of drying. Solar drying was made during April, 1987 at Yezin, Pyinmana (19°· 47' N, 96°· 15' E).

Then, all solar-dried boards were divided into three groups. Each group consisted of 24 boards of Kyun, 24 boards of Pyinkado, 24 boards of Thitya and 24 boards of In, respectively. In grouping these boards, the boards were selected randomly.

Each group was then properly stacked in three different environments: - air drying shed (open-shed), wood drying lab (normal room, without air-conditioning) for each temperature. The data obtained are reported to be based and chemistry lab (with air-condition). All these places are situated in the Forest Research Institute, Yezin.

The size of the open-shed is 32 feet long, 24 feet wide and 18 feet high. The root of this shed is constructed by bamboo shingle.

The dimension of the wood drying lab is 38 ft x 30 ft x 12 ft. The walls are constructed with brich and there are six windows (4' x 3') and one door (7' x 6'). Four ceiling fans are also provided in this room for the warm weather.

Air- conditioned lab is 24 feet long, 18 feet wide and 9 feet high. This room is situated in a large room (30' x 18'x 12') which was constructed by bricks. Two walls are constructed by double layer of plywood, one wall constructed by brick and the other constructed by glass. One air-conditioning heat transfer rate of 17,000 Btu per hour is provided in this room and the system of air-conditioning is window unit. The air- condition was switched on during the office hours.

Just before stacking, 4 boards from each species were selected from each group and were used as the sample boards. Thus, there were totally 16 sample boards in each pile. All sample boards and the remaining boards (i.e. non-sample boards) were weighed and recorded in order to obtain the initial weight of each board.

A hygrometer was placed in each environment in order to record the temperature and relative humidity.

The weights of each and every sample board was recorded twice a week. Temperature and relative humidity of each environment were also recorded throughout the course of the experiments.

This study was started in May, 1987 and was ended in July, 1989.

At the end of the study, (two moisture- content) sections were cut from each sample board. Moisture contents of these two sections were calculated by using oven-dried method. Based on the average moisture content of two moisture-content sections, calculated oven-dried weight of each sample board was calculated and recorded.

Based on the calculated oven-dried weight and previous weights of each sample boards at different time, the moisture contents of the sample boards at different time were then recalculated.

To compare the average initial and final moisture contents between the sample boards (i.e. average of the 4 sample boards for one species) and non-sample boards (average of the 20 boards for one species), each of the non-sample board was also weighed at the end of this study. Calculated oven-dried weight of each of the non-sample boards was calculated following the same method that was applied for the sample boards. Then, based on this calculated oven-dried weight, initial weight and final weight of each boards, initial and final moisture contents of each board (non-sample board) was calculated.

From the moisture content sections which were cut from the sample boards, average specific gravity of each species was also calculated by using water displacement method.

In this study, the dried-lumber was tested instead of testing the green lumber because of the following reasons.

(1) To show the timber users that even the dried lumber can absorb or desorb the moisture depending on the environment where it is exposed in use.

(2) To get the fixed duration for the test. It will be uncertained to test the green lumber in the air- conditioning room. Testing period might take so long because of the low temperature and very less air- circulation inside that room.

5. Results and Discussion

Average moisture content, minimum moisture content and maximum moisture content of the sample boards from each species according to different month for three different environments are given in Tables 1,2,3 and 4, respectively.

Table 1. Variation of MC for Kyun (Green Sp. Gr. 0.521) at Three Different Environments.

Month	Open -shed			Normal Room			Air-Con Room		
	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)
May, 87	8.6	9.3	8.9	8.0	9.5	8.5	8.0	9.0	8.6
June	8.6	12.8	10.3	8.4	11.4	10.5	8.0	9.6	8.9
July	11.8	14.2	13.2	10.8	12.3	11.8	8.9	9.9	9.6
Aug.	13.4	14.6	14.2	11.4	12.8	12.0	9.1	9.9	9.4
Sep.	14.3	15.5	14.8	11.7	13.1	12.6	9.1	9.6	9.3
Oct.	13.8	14.7	14.6	11.0	12.7	11.7	8.4	9.9	9.4
Nov.	14.1	15.1	14.5	11.3	12.6	11.9	9.2	9.9	9.4
Dec.	11.7	12.7	12.0	10.4	12.7	11.3	9.0	9.9	9.3
Jan, 88	11.4	12.2	11.8	9.9	11.7	10.7	8.9	9.6	9.2
Feb.	11.3	11.9	11.6	9.8	11.3	10.5	8.6	9.3	9.0
Mar.	11.2	12.3	11.7	9.1	10.7	9.7	8.6	9.0	8.8
Apr.	11.5	12.3	11.8	8.3	10.0	9.3	8.4	9.0	8.7
May	11.9	12.5	12.2	8.1	9.6	8.5	8.2	8.9	8.5
June	12.0	12.9	12.5	10.5	12.0	11.0	8.8	9.7	9.2
July	12.6	13.8	13.3	10.9	12.3	11.7	8.6	9.3	9.0

Initial MC of sample boards in the open shed = 9.0 - 9.3
Initial MC of sample boards in the normal room = 8.3 - 9.5
Initial MC of sample boards in the air-con room = 8.0 - 8.8

Table 2. Variation of MC for Pyinkado (Gr. Sp. Gr. 0.789) at Three Different Environments.

Month	Open -shed			Normal Room			Air-Con Room		
	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)
May, 87	10.2	10.9	10.4	9.0	10.4	10.1	9.0	10.5	10.0
June	10.3	14.8	12.3	9.9	13.4	12.5	9.1	11.5	10.3
July	13.5	16.3	14.8	12.5	14.3	13.8	9.7	12.1	10.7
Aug.	15.1	17.3	16.1	13.1	14.6	13.9	9.8	11.8	10.5
Sep.	16.1	17.8	16.8	13.3	15.0	14.1	9.9	11.9	10.8
Oct.	15.7	17.0	16.3	12.9	14.3	13.7	10.0	11.8	10.9
Nov.	15.9	16.3	16.0	13.2	14.3	13.8	10.0	11.8	10.9
Dec.	14.7	15.5	14.9	12.1	14.6	13.4	9.9	11.8	10.6
Jan, 88	14.3	14.5	14.4	12.0	14.0	13.0	9.8	11.4	10.6
Feb.	14.1	14.7	14.5	11.9	14.6	13.2	9.6	11.3	10.4
Mar.	13.8	14.8	14.2	10.6	13.3	12.1	9.4	10.9	10.2
Apr.	13.8	14.8	14.1	10.4	12.2	11.0	9.2	10.9	10.1
May	13.8	15.9	14.1	10.0	11.8	10.7	9.1	10.9	10.0
June	13.9	17.5	15.8	12.3	14.9	13.4	10.1	11.7	10.9
July	15.0	17.6	16.4	12.4	14.9	13.7	9.8	11.8	10.5

Initial MC of sample boards in the open shed = 10.8 - 11.0
Initial MC of sample boards in the normal room = 10.2-10.6
Initial MC of sample boards in the air-con room = 8.6-10.3

Table 3. Variation of MC for Thitya (Gr Sp. Gr. 0.858) at Three Different Environments.

Month	Open -shed			Normal Room			Air-Con Room		
	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)
May, 87	8.5	10.0	9.5	8.7	9.3	9.0	9.7	10.7	10.2
June	8.6	11.4	10.6	9.0	10.7	9.8	10.6	12.2	11.4
July	11.0	14.5	13.0	10.0	11.9	11.0	11.1	11.8	11.4
Aug.	12.7	15.0	13.8	10.7	12.4	11.6	11.3	11.7	11.5
Sep.	13.5	15.5	14.5	11.4	12.6	12.0	11.3	11.6	11.4
Oct.	13.3	15.0	14.1	10.4	12.4	11.5	11.2	11.7	11.4
Nov.	13.2	14.8	14.0	10.7	12.3	11.3	11.2	11.7	11.4
Dec.	13.1	14.7	13.6	10.9	12.0	11.2	11.1	11.7	11.2
Jan, 88	12.8	14.2	13.4	10.6	11.4	11.0	10.9	11.4	11.2
Feb.	12.6	14.1	13.3	10.6	10.9	10.8	10.7	11.4	11.1
Mar.	12.4	14.1	13.2	9.5	10.6	10.1	10.6	11.1	10.8
Apr.	12.4	13.7	13.1	9.1	10.0	9.6	10.5	11.1	10.8
May	12.4	14.5	13.5	8.5	9.1	8.8	10.2	11.1	10.7
June	12.9	14.6	13.8	9.8	11.2	10.5	10.6	11.3	10.9
July	13.2	15.0	14.0	10.1	11.6	10.9	10.4	11.2	10.6

Initial MC of sample boards in the open shed = 10.0 - 12.0
Initial MC of sample boards in the normal room = 8.9 - 9.3
Initial MC of sample boards in the air-con room = 9.8-10. 5

Table 4. Variation of MC for In (Green Sp. Gr. 0.726) at Three Different Environments.

Month	Open -shed			Normal Room			Air-Con Room		
	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)	Min ^{m} MC(%)	Max^{m} MC(%)	AV MC(%)
May, 87	9.6	12.1	11.0	10.9	11.2	11.1	9.7	10.4	10.0
June	9.7	16.5	12.5	11.2	13.6	12.6	9.8	11.1	10.5
July	13.2	17.8	15.7	13.4	14.6	14.2	10.5	11.7	11.0
Aug.	15.3	18.3	16.8	14.1	15.0	14.5	10.6	11.4	11.0
Sep.	15.6	18.6	17.0	14.6	15.5	15.1	10.6	11.5	11.0
Oct.	15.1	18.4	16.8	14.3	14.9	14.4	10.5	11.6	10.8
Nov.	15.2	18.1	16.0	14.7	15.0	14.5	10.5	11.7	10.9
Dec.	13.0	15.2	14.5	13.5	14.5	14.0	10.6	11.6	11.0
Jan, 88	12.8	14.7	13.5	13.2	13.7	13.4	10.5	11.3	10.8
Feb.	12.6	14.6	13.4	13.1	13.7	13.2	10.3	11.3	10.8
Mar.	12.4	14.2	13.2	11.4	13.2	12.4	10.2	11.0	10.6
Apr.	12.8	14.8	13.8	11.2	11.8	11.4	10.1	11.0	10.5
May	13.5	15.2	14.6	10.8	11.0	10.9	9.9	10.8	10.3
June	14.1	15.9	15.2	13.1	14.2	13.0	9.6	11.2	10.4
July	14.6	17.2	15.6	13.3	14.4	13.9	9.4	10.6	10.0

Initial MC of sample boards in the open shed = 10.1-12. 3
Initial MC of sample boards in the normal room = 11. 3 - 11. 4
Initial MC of sample boards in the air-con room = 9.7 - 10.2

Variation of average moisture content of four species which were placed at three different environments according to different months are also shown in figure 1, 2 and 3. Figures (1) gives the variation of average moisture content of each of the tested species which were stacked in the open shed. Similarly, figures (2) and (3) shoe the moisture content variations of the boards which were placed in the normal room and air-conditioned room respectively.

To know the circumstances of the environments where the experiments were conducted, the ranges of temperature and the ranges of relative humidity at the different months are also given in Table 5.

According to the tables, minimum moisture contents of Kyun, Pyinkado, Thitya and In which were stacked in the open-shed are 11.2 percent, 13.8 percent, 12.4 percent and 12.4 percent, respectively. From these figures, it can be seen that for the outdoor atmosphere under shelter, 1- inch lumber of Kyun and Pyinkado are not necessary to dry below 11 percent and 13 percent moisture content. Similarly, Thitya and In species are also not necessary to dry below at 12 percent moisture content.

On the otherhand , since the minimum average moisture content of Kyun is 11.6 percent and that of Pyinkado, Thitya and In are 14.1 percent, 13.1 percent and 13.2 percent respectively, 1- inch lumber of Kyun obtained at about 12 percent moisture content and Pyinkado, Thitya and In lumber obtained at about 14 percent moisture content will generally give satisfactory service for the outdoor atmosphere under shelter.

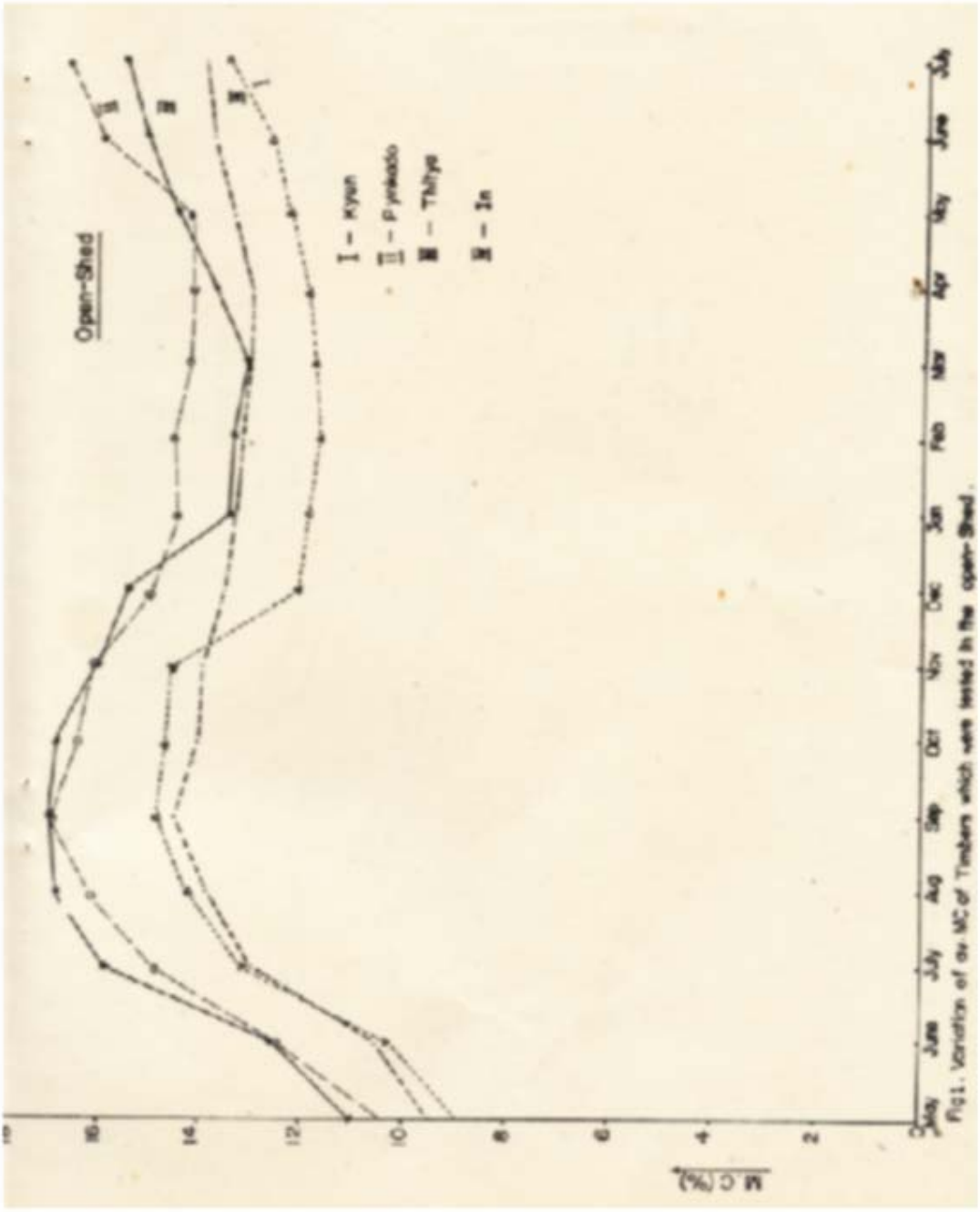

Fig1. Variation of ov MC of Timbers which were tested in the open-Shed.

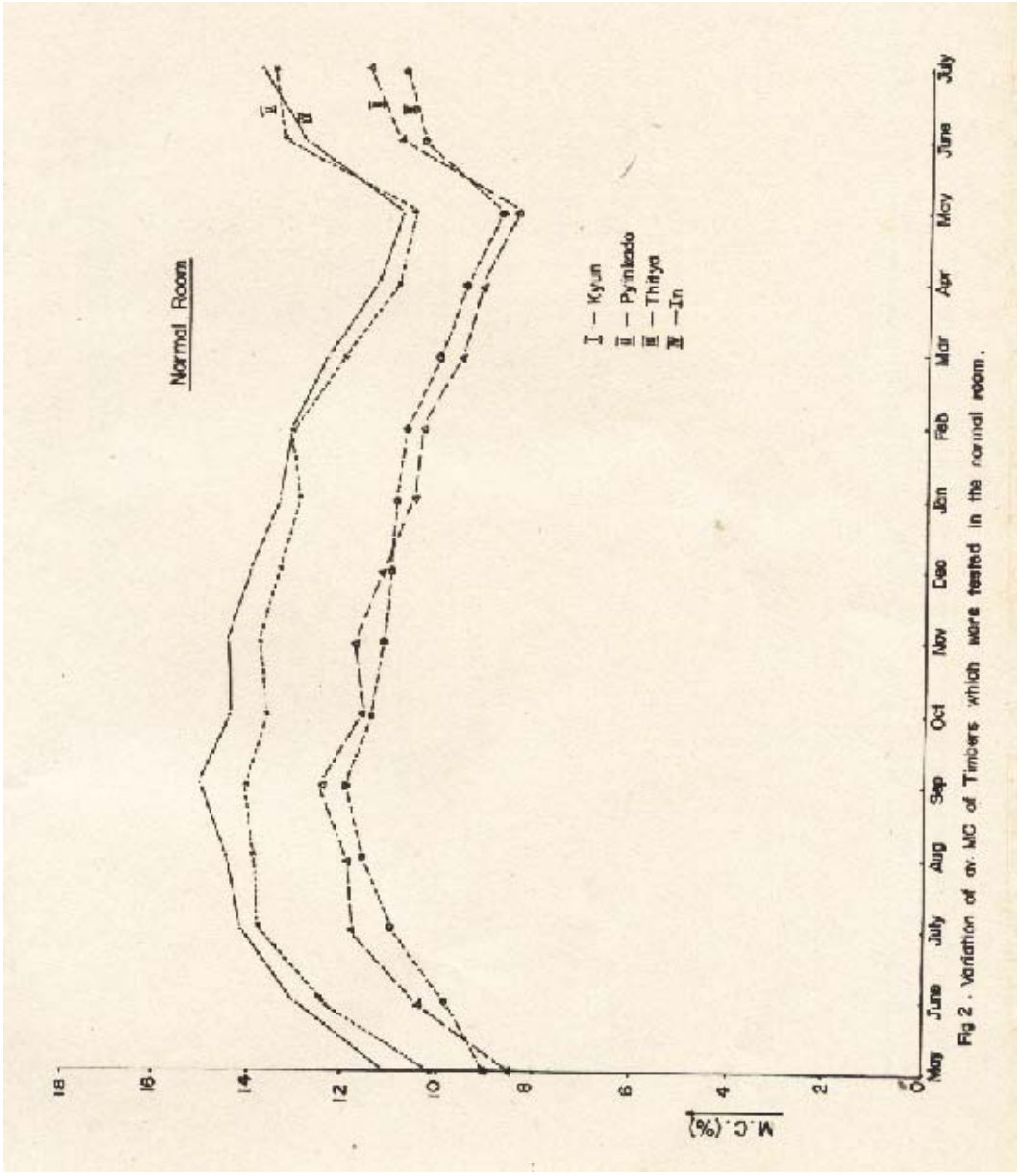

Fig 2. Variation of av. MC of Timbers which were tested in the normal room.

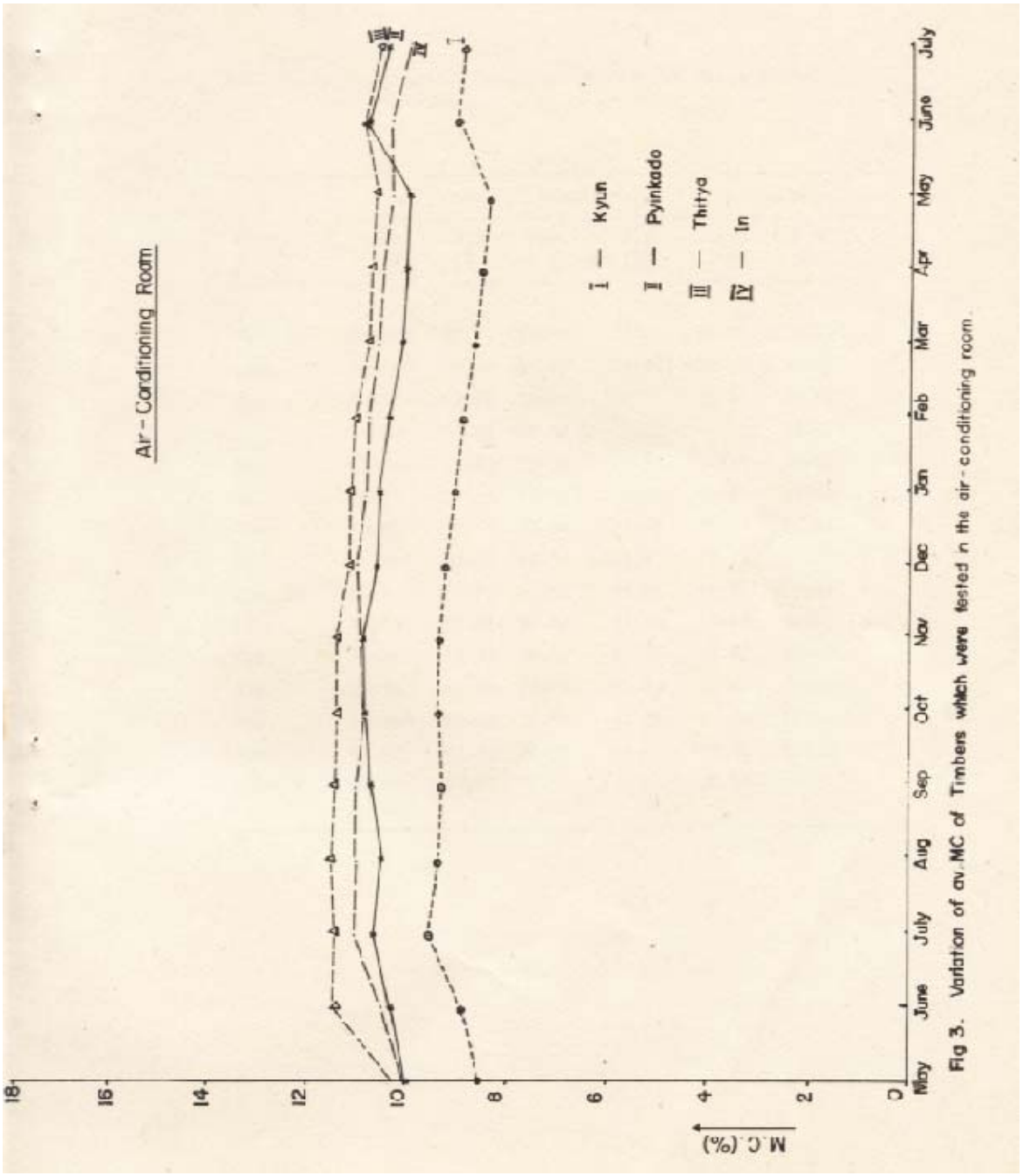

Fig 3. Variation of av. MC of Timbers which were tested in the air-conditioning room.

Table 5. Temperature & Relative Humidity at Three Different Environments.

Month	Open –shed		Normal Room		Air-Con Room	
	Temp: (°F)	R.H (%)	Temp: (°F)	R.H (%)	Temp: (°F)	R.H (%)
May, 87	87-100	42-71	80-96	12-76	80-90	34-77
June	80-90	65-84	82-90	40-92	80-88	30-84
July	84-98	49-85	80-92	41-92	76-84	41-92
Aug.	86-100	42-85	80-86	44-92	74-82	34-62
Sep.	84-92	50-92	78-86	46-92	74-84	36-60
Oct.	76-90	58-88	72-84	45-92	70-86	35-77
Nov.	76-89	71-92	74-84	63-92	72-84	54-74
Dec.	70-80	72-92	68-76	51-82	68-78	55-82
Jan, 88	68-74	60-92	68-72	72-91	68-74	56-86
Feb.	70-76	52-91	70-76	50-74	68-80	51-91
Mar.	74-96	67-72	78-92	54-74	70-80	51-90
Apr.	74-98	66-88	78-94	54-82	72-80	57-92
May	71-100	66-92	70-96	54-92	74-90	65-92
June	80-98	74-96	72-84	55-92	78-86	57-92
July	82-98	52-92	78-92	44-92	70-78	50-60

According to figure (1) average moisture content of each species are increased from June, 87 to September, 87 and decreased from October, 87 to April, 88 and increased again in May, 88. Thus, in Yezin (rainfall 40" - 45 ") air- drying of lumber under shelter should be started during October to December. In May, although the temperature is high enough for drying lumber, the rain is not reliable. Sometimes the rain comes early in May. Therefore, to safe and sound air drying of lumber should be stopped not later than the end of April.

From the tables (1 to 4), minimum average moisture contents of Kyun, Pyinkado, Thitya and In lumber which were placed in the normal room are 8.5 percent, 10.7 percent, 8.8 percent and 10.9 percent, respectively. Thus, for the indoor atmosphere, 1- inch lumber of Kyun and Thitya obtained at about 9 percent moisture content and Pyinkado and In lumber obtained at about 11 percent moisture content will generally give satisfactory service.

According to Fig 2, it can be seen that variations of average moisture content of each of the four species are almost the same as those of the variations of moisture content of the open-shed. However, range of the moisture contents of these boards are not too high, since they were stacked in the room which has low temperature and less air-circulation than those of the outdoor atmosphere.

Minimum average moisture contents of Kyun, Pyinkado, Thitya and In which were stacked in the air-conditioned room are 8.5 percent, 10.0 percent, 10.7 percent and 10.3 percent, respectively (Table 1 to 4). Therefore, for the air-conditioned environment Kyun lumber obtained at about 9 percent moisture content and Pyinkado, Thitya and In lumber obtained at about 11 percent moisture content will generally give satisfactory service.

From figure 3, it can be seen that variation of moisture content of each species which were placed in the air-conditioned room according to different months are very low. It was happened because the air- conditioned room had only low temperature and low range of temperature but also it obtained very less air-circulation.

Conclusions

From this study the following conclusions can be drawn for Yezin area.

(1) For outdoor atmosphere under shelter, one inch thick lumber of Kyun (Green Sp. Gr. 0.521) obtained at about 12 percent moisture content and 1 inch lumber of Pyinkado (Green Sp. Gr. 0.789), Thitya (Green Sp. Gr. 0.858) and (Green Sp. Gr. 0.726) obtained at about 14 percent moisture content will give satisfactory service.

(2) For indoor atmosphere 1-inch lumber of Kyun and Thitya obtained at about 9 percent moisture content and 1- inch lumber of Pyinkado and In obtained at about 11 percent moisture content will be appropriate.

(3) For air- conditioned room, Kyun lumber of one inch thick obtained at about 9 percent moisture content and one inch thick lumber of Pyinkado, Thitya and In obtained at about 11 percent moisture content will give satisfactory service.

Based on the results obtained for the seasonal variation of moisture content of lumber which were stacked in the open shed, it can also be concluded that.

(1) In Yezin area (19 °47' N, 96°15'E, 40"-45" rainfall) air- drying of lumber should be started during October to December and it should be ended not later than the end of April.

(2) In Yezin, one inch thick lumber (Green Sp. Gr. 0.521 to 0.853) can attain a final moisture content of 11.6 to 14.1 percent by air-drying.

Appendix (A) Moisture content of wood in equilibrium with stated dry - bulb temperature and relative humidity

Temp dry-bulb	Relative humidity, percent																		
F	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	98
30	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3	26.9
40	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.4	11.3	12.3	13.5	14.9	16.5	18.5	21.0	24.3	26.9
50	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.2	12.3	13.4	14.8	15.4	18.4	20.9	24.3	26.9
60	1.3	2.5	3.6	4.6	5.4	6.2	7.0	7.8	8.6	9.4	10.2	11.1	12.1	13.3	14.6	15.2	18.2	20.7	24.1	26.8
70	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2	10.1	11.0	12.0	13.1	14.4	16.0	17.9	20.5	23.9	26.6
80	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1	9.9	10.8	11.7	12.9	14.2	16.7	17.7	20.2	23.6	26.3
90	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3	26.0
100	1.2	2.3	3.3	4.2	5.0	5.8	6.5	7.2	7.9	8.7	9.5	10.3	11.2	12.3	13.6	15.1	17.0	19.5	22.9	25.6
110	1.1	2.2	3.2	4.0	4.9	5.6	6.3	7.0	7.7	8.4	9.2	10.0	11.0	12.0	13.2	14.7	16.6	19.1	22.4	25.2
120	1.1	2.1	3.0	3.9	4.7	5.4	6.1	6.8	7.5	8.2	8.9	9.7	10.6	11.7	12.9	14.4	16.2	18.6	22.0	24.7
130	1.0	2.0	2.9	3.7	4.5	5.2	5.9	6.6	7.2	7.9	8.7	9.4	10.3	11.3	12.5	14.0	15.8	18.2	21.5	24.2
140	.9	1.9	2.8	3.6	4.3	5.0	5.7	6.3	7.0	7.7	8.4	9.1	10.0	11.0	12.1	13.6	15.3	17.7	21.0	23.7
150	.9	1.8	2.6	3.4	4.1	4.8	5.5	6.1	6.7	7.4	8.1	8.8	9.7	10.6	11.8	13.1	14.9	17.2	20.4	23.1
160	.8	1.6	2.4	3.2	3.9	4.6	5.2	5.8	6.4	7.1	7.8	8.5	9.3	10.3	11.4	12.7	14.4	16.7	19.9	22.5
170	.7	1.5	2.3	3.0	3.7	4.3	4.9	5.6	6.2	6.8	7.4	8.2	9.0	9.9	11.0	12.3	14.0	16.2	19.3	21.3
180	.7	1.4	2.1	2.8	3.5	4.1	4.7	5.3	5.9	6.5	7.1	7.8	8.5	9.5	10.5	11.8	13.5	15.7	18.7	21.3
190	.6	1.3	1.9	2.6	3.2	3.8	4.4	5.0	5.5	6.1	6.8	7.5	8.2	9.1	10.1	11.4	13.0	15.5	18.1	20.7
200	.5	1.1	1.7	2.4	3.0	3.5	4.1	4.6	5.2	5.8	6.4	7.1	7.8	8.7	9.7	10.9	12.5	14.6	17.5	20.0
210	.5	1.0	1.6	2.1	2.7	3.2	3.8	4.3	4.9	5.4	6.0	6.7	7.4	8.2	9.2	10.4	12.0	14.0	16.9	19.3

Appendix B . Weather Data from Yezin Weather Station for the Year 1987.

Month	Total Raing Days	Rainfall (inch)	Temperature		Average Relative Humidity (%)
			Min m ((F)	Max m ((F)	
Jan	1	0.02	59	84	30
Feb.	1	0.06	61	88	24
March	2	0.44	68	91	18
April	6	4.40	73	95	30
May	-	-	77	99	29
June	20	2.30	75	88	44
July	22	15.76	73	82	48
Aug.	19	12.74	73	84	47
Sept.	11	3.46	73	86	46
Oct.	9	4.23	72	86	46
Nov.	2	0.55	70	82	43
Dec.	-	-	70	84	30
Total	93	43.96	-	-	-
Average	-	-	-	-	36

Appendix C . Weather Data from Yezin Weather Station for the Year 1988

.

Month	Total Raing Days	Rainfall (inch)	Temperature		Average Relative Humidity (%)
			Min [m] (°F)	Max [m] (°F)	
Jan	-	-	58	86	26
Feb.	1	0.07	58	95	26
March	-	0.44	60	97	22
April	1	5.36	65	102	27
May	11	5.48	65	95	41
June	20	9.20	64	86	44
July	21	5.44	62	84	47
Aug.	20	3.31	62	82	47
Sept.	9	6.41	65	86	45
Oct.	11	6.28	65	90	44
Nov.	7	-	60	84	45
Dec.	-	-	55	84	41
Total	101	41.99	-	-	-
Average	-	-	-	-	38

References

1. Forest Products Laboratory - USDA Forest Service 1974. Wood handbook - wood as an engineering material. USDA Agric. Handbook No. 72. U.S Govt. Print Off., Washington, DC.
2. Grewal. G.S. & Samad, R. 1983. Moisture content of timber for air-conditioned environments. Information series on the utilization on Malaysian Timbers. No. 58. Sep. 1983. 3pp.
3. Mc. Millan, J.M . & Wengert, E.M. 1978. Drying Fastern hardwood lumber. FPL, USDA- Agric. Handbook No. 528.U.S. Govt. Print. Off., Washington, DC. 104 pp.
4. Simpson, W.T. 1971. EMC prediction for wood. For. Prod. J.vol 21, No. 5. pp 48-49. Simpson, W.T. 1982. Importance of RH & Temp: control in conditioning wood products. Wood & Fiber, 14(2), pp 94-103.
5. Taylor, F.W. 1982. A comparison of energy requirements for kiln drying southern pine at diff: drying temperatures. Wood & fiber, 14 (4) 1982, pp 246-253.
6. Wengert, E.M. 1976. Predicting average moisture content of wood in a changing environment. Wood & Fiber, 7 (4) 1976, pp 264-273.