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# Anatomical, Physical and Mechanical Properties of Myaukngo [*Duabanga grandiflora* (Roxb.) Walp.]

U Soe Tint, Head of Division
U Thein Kywe, Research Officer
Forest Research Institute
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# မျောက်ငိုသစ်၏ အင်္ဂါဗေဒနှင့်ဂုဏ်သတ္တိများကိုလေ့လာခြင်း

ဦးစိုးတင့်၊ B.Sc. (For.) (Rgn.), M.Sc. (ANU)၊ ဌာနမှူး
နှင့်
ဦးသိန်းကြွယ်၊ M.Sc. (Rgn.)၊ သုတေသနမှူး
သစ်တောသုတေသနဌာန၊ ရေဆင်း။

## စာတမ်းအကျဉ်းချုပ်

မျောက်ငိုသစ်ပင်သည် သစ်ပင်ကြီးမျိုးဖြစ်သော်လည်း လူသုံးနည်းသော သစ်တစ်မျိုးဖြစ်ပါသည်။ သို့ပါ၍ မျောက်ငိုသစ်၏ အသုံးဝင်မှု အလားအလာကို သိရှိနိုင်ရန် ၎င်းသစ်၏ အင်္ဂါဗေဒ၊ သစ်အရည်အချင်းနှင့်အင်အားများကို လေ့လာကာ အသုံးပြုနိုင်မည့် အခြေအနေကို ဤစာတမ်းတွင် ပဏာမအနေဖြင့် တင်ပြထားပါသည်။ တွေ့ရှိသည့် အသုံးဝင်မှု အလားအလာကို လက်တွေ့ စက်မှုလုပ်ငန်းများတွင် စမ်းသပ်၍ ဆက်လက်တင်ပြသွားမည် ဖြစ်ပါသည်။

# Anatomical, Physical and Mechanical Properties of Myaukngo [*Duabanga grandiflora* (Roxb.) Walp.]

U Soe Tint, B.Sc. (For.) (Rgn.), M.Sc. (ANU), Head of Division
and
U Thein Kywe, M.Sc. (Rgn.), Research Officer
Forest Research Institute

## Abstract

Myaukngo is a lesser used timber species found in the forests of Burma in relatively large useable volume. This paper presents the anatomical, physical and mechanical properties of this species with a view of increasing its use as an industrial raw material.

# Contents

# Anatomical, Physical and Mechanical Properties of Myaukngo [*Duabanga grandiflora* (Roxb.) Walp.] 1*

## 1. Introduction

Myaukngo is also known as *Thitkazaw* in Burma, *Lampati* in India, *Banderhola* in Pakistan, *Phay* in Vietnam and Linkwai in Thailand. It is a large and tall tree, producing relatively a large useable volume of wood and yet it has been of little or no in use at all. The percent stocking per acre of this species in Toungoo forest area, as compared to other species are given below. (From National Forest Inventory data)

| | | |
|---|---|---|
| 1. | Teak | 5.88 |
| 2. | Pyinkado | 7.20 |
| 3. | Yon | 0.63 |
| 4. | Kuthan | 0.09 |
| 5. | Leza | 1.67 |
| 6. | Thitsi | 0.02 |
| 7. | Thanthe | 0.89 |
| 8. | Aukchinsa | 0.34 |
| 9. | Myaukngo | 0.68 |

If this species can be put to wider use, the following advantages will be obtained.

(1) The export volume of valuable species will be increased because of the use of timber like Myaukngo for domestic purposes.
(2) The output of timber for domestic and foreign trade will be increased.
(3) The cost of timber to the consumer will be reduced as the harvesting cost per acre will be borne by a grater volume produced.
(4) The species composition of the next generation will be improved with a higher percentage of valuable species due to the removal of less valuable species.

With the object of exploring the possible uses of this species, a study of the anatomical, physical and mechanical properties was made and potential end uses suggested.

## 2. Literature Review

### The Tree

It is a large tree with pendant drooping branchlets and attains a height of 120' and over with a girth of up to 12' in favourable localities. A girth of 8' is common and a clear bole of 30'-35' is available. It occurs in low lying damp, but well drained areas generally along the river banks Deciduous (M.U.M.D) forests. Great numbers of this species can be found in the forests of the Prome, Myittha, Upper Chindwin and Pegu Yoma areas. It is a fairly fast-growing species with a growth rate of 4-5 rings per inch.

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* See appendix for scientific names of species discussed in this paper.

**The Timber**

The timber is greenish grey when exposed and turns grey to light brown later on. There is no apparent distinction between the sapwood and the heartwood. It is a light timber with a specific gravity of 0.37 and a density of 27-30 lb per c.ft. at 12% m.c. the timber has a rough feel, straight or shallowly interlocked grain with coarse or very coarse texture.

It seasons well without difficulty both in air or kiln seasoning. An immediate conversion of the log is desirable as insect and fungi attack occurs producing bad result in sawing. Again quick drying of sawn timber is also necessary.

Myaukngo is a non-durable timber, and yet it lasts well under cover and in water. Preservative treatment is needed which can be done quite readily. In a graveyard test it is said to last for 4 years (Trotter).

The timber saws easily and is easy to work with hand tools although it requires a considerable care to get a good surface. It is said to offer itself readily to peeling on a rotary lathe and makes up into strong plyboard (Anon 1961). It takes polish fairly well and is good for furniture (Pearson & Brown).

## 3. Materials and Methods

Five trees of marketable size (girth at breast height 5' and over) were collected from Taungnyo Reserved Forests in Yamethin Township. The trees were authenticated from the herbarium materials. The measurements of the trees collected are as below.

| Tree No. | Girth at Breast Height (ft) | Height (ft) |
|---|---|---|
| 1. | 5' 2" | 128 |
| 2. | 5' 5" | 142 |
| 3. | 5' 6" | 148 |
| 4. | 5' 0" | 130 |
| 5. | 5' 4" | 120 |

The trees were made into bolts and converted as soon as possible. 9½" x 2½" x 4' sticks were prepared and the sticks were matched for green and dry tests. Selection and numbering of bolts, marking of test sticks and matching of specimens for green and air dry tests followed the A.S.T.M.D. 143-52 (Reapproved 1965).

Green materials for immediate tests were temporarily stored under damp saw dust and they were planed on four surfaces to get the required sizes of 2" x 2" in cross section. The green test specimens were kept to maintain them green by wrapping with damp cloth until the time of test.

Test materials for air dry were properly stacked and air dried until the time of test. Kiln seasoning could not be carried out due to lack of drying kiln. On the other hand, the air dried specimens were reconditioned in the conditioning cabinet to get nearest to 12% moisture content at the time of test. Care was taken to obtain only clear straight grain material, free of decay and defects for both green and air dry tests.

**(1) Physical Properties Test Material**

Six specimens each for specific gravity and volumetric shrinkage were selected and four specimens for each of the radial and tangential shrinkages were taken. Water displacement method was used in determining the volume.

Measurements were taken nearest to the thousandth of an inch and their respective weights were read correct to 0.001 gm.

**(2) Mechanical Properties Test Material**

The dimensions of specimens prepared for various tests were shown below. Test on Impact, Bending, Cleavage and Tension parallel to Grain were not carried out due to lack of facilities in the Forest Research Institute, Yezin. The Avery Universal Testing Machine was used for the tested performed.

| Sr.No | Test | Size of Specimen |
|---|---|---|
| 1 | Static Bending | 2" x 2" x 30" |
| 2 | Compression parallel to grain | 2" x 2" x 8" |
| 3 | Compression perpendicular to grain | 2" x 2" x 6" |
| 4 | Hardness | 2" x 2" x 6" |
| 5 | Shear | 2" x 2" x 2½" |

The properties evaluated from the above mentioned tests were as follows:-

**1. Static Bending**

(i) Fiber Stress at Proportional Limits (FS (at) PL)
(ii) Modulus of Rupture (MR)
(iii) Modulus of Elasticity (ME)

**2 Compression parallel to grain**

(i) Fiber Stress at Proportional Limits (FS (at) PL)
(ii) Maximum Crushing Strength

**3. Compression perpendicular to grain**

(i) Fiber Stress at Proportional Limits (FS (at) PL)

**4. Hardness**

(i) Radial (Rad)
(ii) Tangential (Tan)
(iii) End (End)

**5. Shear**

(i) Radial (Rad)
(ii) Tangential (Tan)

### (3) Anatomical Properties

Microscopic analysis was necessary to determine the anatomical properties. Slides were prepared of Myaukngo to give transverse, tangential longitudinal and radial longitudinal views for microscopic study.

## 4. Results

### (1) Physical Properties

Results of the tests of physical properties are given in Table 1. Test results of some other species are stated for comparison. Three types of timber were selected. First were species with a higher density and specific gravity than Myaukngo (Teak and Taungthayet), was one of similar, density and specific gravity (Kuthan), and the last was one of lower density and specific gravity (Letpan).

### (2) Mechanical Properties

Test results given in Table 2. together with the results of other selected species for comparison. The data given in Table 3. compares Teak as to the properties of sixteen species including Myaukngo, with suitability for different purposes. This Table provides an easy comparison among species and was prepared according to the method stated by Limaye and Seaman.

### (3) Anatomical Properties

Microscopic examination and measurements determined the following data for Myaukngo. Plate 1. illustrates the structure of this species.

**a. Tracheids and fibers**: Non-septate fibers, usually thinwalled, 3-5 μ thick, inter-fiber pits numerous, bordered, slit-like, oblique orifice, each member length ranges from 540-1926 μ and most frequently from 924-1344 μ with a mean length 18.1128 μ.

**b. Vessel elements** : Number per sq mm. ranges from 2-9 and most frequently from 3-7, pore distribution solitary, pore in radial multiples or clusters diffuse porous, pores oval or elliptical in shape as seen in the cross section, thin-walled, the tangential diameter ranges from 210-340 μ, tyloses presents, perforation plate simple, end walls horizontal to oblique. Inter vessel pitting numerous, opposite or alternate, crowded, size of pits 6-9 μ, shape of pits oval or elliptical, length of vessel elements ranges from 236 –955 μ and most frequently from 357-6514 μ, with a mean length of 15.421 μ, pits to vessel alternate in arrangement, crowded, bordered, rounded or oval, size of pits 7-10 μ, pits to parenchyma alternate to opposite, not crowded, circular or oval in shape, 6-10 μ in size.

**c. Vascular rays** : Number per mm. ranges from 7-9, heterogeneous type I, 1-8 cells wide, height of uniseriate rays ranges from 127.5 -3 82.5 μ and most frequently from 161.5-212 μ , the height of triseriate rays ranges from 153-1079.5 μ, most frequently from 425-714 μ, pits between ray cells and contiguous parenchyma cells few and small.

**d. Xylem parenchyma** : Abundant, apotracheal parenchyma diffuse, scattered to continuous bands of 1-2 cells wide, paratracheal parenchyma scanty, pitting between xylem parenchyma cells medium in size and few in number.

## 5. Discussion

Myaukngo is 36% lower than Teak in transverse strength and is 50% lower in hardness. In terms of stiffness, it is 34% softer than Teak and Taungthayet, as hard as Kuthan and 15% harder than Letpan. Letpan is presumably the softest wood of commercial species. In static bending tests the modulus of rupture of Myaukngo is 36% lower than Teak, 20% lower than Thaungthayet, and almost identical to Kuthan, but 38% higher than Letpan. In maximum crushing force, it stands fourth, where Letpan stands fifth. Therefore from Table 1 and 2, Myaukngo stands second last among the species compared.

Again, Table 3 shows that, for use as a beam it is only 64% as good as Teak and a little bit better than Nabe, Letpan, Taungmeok, Didu, Yemane and Kuthan, which are not considered suitable for beams. Column (4) shows a similar indication. It also can be seen that, the timber is not suitable for use as post. Retention of shape of Myaukngo is pretty fair, even better than Kanyin, Pyinma, In, Binga, Leza and Letpan. Myaukngo again is as stable as Taungthayet, and Kuthan and less stable than Teak, Hnaw, Sagawa, Nabe, Didu and Yemane. This suggests that the timber would be suitable for cheap and plain knock-down furniture of the type that can be made out of Kanyin, Pyinma, In, Binga, Leza, Taungthayet, and Kuthan.

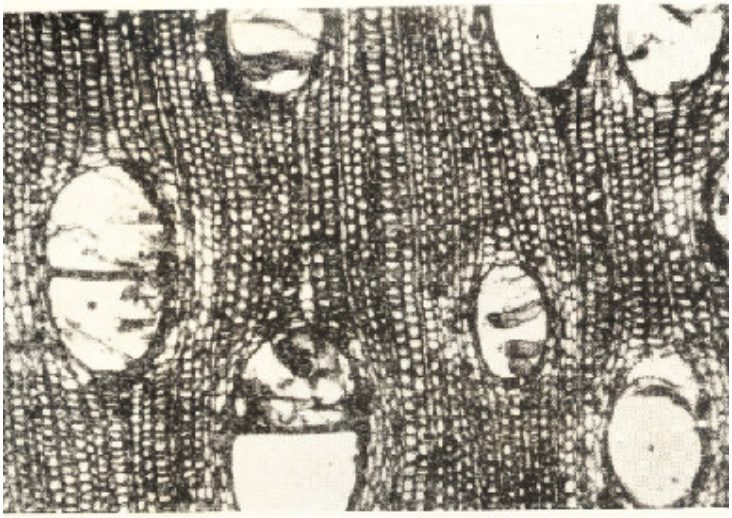
Myaukngo as a whole is inferior in strength to most of the species mentioned in Table 3, but similar to Yemane or even a little better than Nabe, Taungmeok, Kuthan, Letpan and Didu. Being a little stronger than Letpan and Didu means this wood can be put into use as those of Letpan and Didu for match wood. It is said that Myaukngo peels well (Pearson and Brown), which increase the possibility of using it as a match wood, or even for plywood of utility grade as the wood does not have a good appearance.

## Plate I

### Myaukngo Microphotographs (x 83)

A. Transverse section showing incomplete vasicentric parenchyma.
B. Tangential longitudinal section depicting heterogeneous rays having multiseriate centers with uniseriate margins longer than the multiseriate part.
C. Radial longitudinal section showing marginal upright cells and procumbent cells.

**PlateI.** ***Duabanga grandiflora*** **(Roxb) (Myaukngo)**



A

B

C

**Table 1. Physical Properties of Myaukngo and Other Species**

| Species | Seasoning | Specific Gravity | Moisture Content | Weight lb/c.ft | Shrinkage Percent | | | Shrinkage ratio T/R |
|---|---|---|---|---|---|---|---|---|
| | | | | | Rad. | Tan. | Vol. | |
| **( 1 )** | **( 2 )** | **( 3 )** | **( 4 )** | **( 5 )** | **( 6 )** | **( 7 )** | **( 8 )** | **( 9 )** |
| Myaukngo | Green | 0.429 | 110 | 45 | 3.7 | 6.6 | 9.2 | 1.78 |
| | Air dry | 0.433 | 12 | 27 | | | | |
| Teak | Green | 0.586 | 49.4 | 55 | 2.1 | 3.3 | 6.8 | 1.57 |
| | Air dry | 0.568 | 14.1 | 40 | | | | |
| Taungthayet | Green | 0.551 | 58.5 | 54 | 3.2 | 6.0 | 10.8 | 1.85 |
| | Air dry | 0.575 | 13.7 | 41 | | | | |
| Kuthan | Green | 0.418 | 114.8 | 56 | 2.4 | 5.6 | 9.8 | 2.3 |
| | Air dry | 0.441 | 6.3 | 31 | | | | |
| Letpan | Green | 0.329 | 121.5 | 45 | 2.3 | 5.1 | 7.4 | 2.2 |
| | Air dry | 0.333 | 11.6 | 23 | | | | |

**Table 2. Mechanical Properties of Myaukngo and Other Species**

| Species | Seasoning | Moisture Content | Statistic Bending psi | | | Compression parallel to grain psi | | Comp. perp. to grain | Hardness (lb) | | | Shear psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FS(a)PL | MR | MEx103 | FS(a)PL | Max.crush | Psi | Rad | Tan | End | Rad | Tan |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Myaukngo | Green | 110 | 4249 | 7366 | 1120 | 2738 | 3649 | 432 | 560 | 575 | 638 | 772 | 785 |
| | Air dry | 12 | 6125 | 9881 | 1201 | 3796 | 5514 | 517 | 586 | 594 | 776 | 932 | 1237 |
| Teak | Green | 49.4 | 6935 | 11460 | 1640 | 3815 | 5710 | 930 | 980 | 960 | 910 | 990 | 1080 |
| | Air dry | 12 | 10215 | 15680 | 1855 | 5950 | 9225 | 1414 | 1020 | 1052 | 1080 | 951 | 1477 |
| Taung–thayet | Green | 58.5 | 4655 | 8625 | 1638 | 2885 | 4095 | 565 | 750 | 735 | 755 | 1100 | 1290 |
| | Air dry | 12 | 6498 | 12212 | 1900 | 3754 | 6065 | 938 | 888 | 903 | 1100 | 1392 | 1608 |
| Kuthan | Green | 114.8 | 3325 | 5585 | 914 | 1905 | 2685 | 465 | 505 | 505 | 460 | 815 | 975 |
| | Air dry | 6.3 | 6710 | 9660 | 1270 | 3665 | 6465 | 940 | 600 | 645 | 630 | 890 | 1030 |
| Letpan | Green | 121.5 | 3160 | 5435 | 726 | 2050 | 2575 | 375 | 350 | 390 | 405 | 560 | 695 |
| | Air dry | 11.6 | 3485 | 6130 | 851 | 2715 | 3500 | 420 | 375 | 440 | 540 | 570 | 780 |

**Table 3. Relative Suitability of Myaukngo and other selected species as percentage strength of Teak.**

| Sr. No. | Species | Strength as a beam | Stiffness as a beam | Suitability as a post | Retention of shape | Shear | Hardness | Weight |
|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| 1. | Teak | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 2. | Myaukngo | 64 | 66 | 65 | 76 | 75 | 50 | 67 |
| 3. | Kanyin | 105 | 125 | 100 | 55 | 90 | 105 | 110 |
| 4. | Pyinma | 73 | 78 | 76 | 67 | 100 | 110 | 95 |
| 5. | In | 104 | 110 | 100 | 57 | 105 | 147 | 140 |
| 6. | Binga | 90 | 83 | 92 | 69 | 111 | 107 | 102 |
| 7. | Hnaw | 77 | 74 | 81 | 88 | 111 | 110 | 102 |
| 8. | Sagawa | 62 | 72 | 69 | 88 | 83 | 68 | 75 |
| 9. | Taungthayet | 73 | 100 | 80 | 74 | 108 | 77 | 102 |
| 10. | Leza | 91 | 103 | 95 | 70 | 110 | 104 | 105 |
| 11. | Nabe | 55 | 51 | 51 | 85 | 76 | 76 | 90 |
| 12. | Letpan | 45 | 45 | 45 | 60 | 55 | 35 | 55 |
| 13. | Taungmoke | 50 | 55 | 50 |  | 65 | 35 | 60 |
| 14. | Didu | 45 | 50 | 50 | 90 | 45 | 35 | 55 |
| 15. | Yemane | 65 | 65 | 65 | 80 | 95 | 80 | 85 |
| 16. | Kuthan | 50 | 55 | 50 | 75 | 75 | 50 | 70 |

## 6. Conclusion

Myaukngo is a light timber with low strength value and should not be used where great strength is required. It can be recommended for use in light construction. It will be good for making door and window frames, panelling, partitions and ceilings. Other possible uses for the species are boards, battens and general carpentery work such as cupboard construction.

Myaukngo is suitable for cheap plain knock-down furniture because it is steady and dimensionally stable and smooth. Boxes, packing cases, crates, plywood and match wood are other possible uses for the timber. It has been said that Myaukngo is also good for making canoes and oars. Finally, it is recommended that the timber be used for medium construction purposes indoors, and light construction outdoors. Whatever the product, care should be taken to treat prior to use.

## Appendix

## Botanical Names of Timber Species

| Local Name | Botanical Names |
|---|---|
| Aukchinsa | *Diospyros ehretioides* Wall. |
| Binga | *Mitragyna rotundifolia* O.Ktze |
| Didu | *Salmalia insignis* Schott & Endl |
| Hnaw | *Adina cordifolia* Hook. f. |
| In | *Dipterocarpus tuberculatus* Roxb. |
| Kanyin | *Dipterocarpus turbinatus* Gaertn. f. |
| Kuthan | *Hymenodictyon excelsum* Wall. |
| Letpan | *Salmalia malabarica* Schott. & Endl. |
| Leza | *Lagerstroemia tomentosa* Presl. |
| Myaukngo | *Duabanga grandiflora* Roxb. |
| Nabe | *Lannea grandis* Engler. |
| Pyinkado | *Xylia dolarbriformis* Benth. |
| Pyinma | *Lagerstroemia speciosa* Pers. |
| Sagawa | *Michelia champaca* L. |
| Taungmeok | *Alstonia scholaris* R.Br |
| Taungthayet | *Swintonia floribunda* Griff. |
| Teak | *Tectona grandis* Linn. f. |
| Thitsi | *Melanorrhoea usitata* Wall. |
| Yemane | *Gmelina arborea* Roxb. |
| Yon | *Anogeissus acuminata* Wall. |

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