



MINISTRY OF FORESTRY
FOREST DEPARTMENT
MYANMAR



AND
COMMON FUND FOR COMMODITY (CFC)
AND
INTERNATIONAL TROPICAL TIMBER ORGANIZATION (ITTO)

Study on Utilization of Plantation Teak Pre-project
CFC/ITTO 73 FT PPD 68/03 Rev.2 (I)

Handbook on Properties of Plantation Teak in Myanmar



ACKNOWLEDGEMENT

During the implementation period of the pre-project “ Utilization of Plantation Teak”, the CFC/ITTO Project PPD 68/03 Rev.2(I), tireless efforts have been provided by technical staff members of the Forest Research Institute, Yezin, who examined various properties of plantation teak in this book. Most of the information provided in this handbook was investigated by the staffs of the wood utilization Division, Forest Research Institute and their efforts were greatly appreciated.

It is a great honor to express our appreciation and gratitude to U San Lwin, the Director General of the Planning and Statistic Department, Ministry of Forestry and Chairman of the Project Steering Committee (PSC) who is responsible for the successful implementation of the project. Invaluable thanks are due to U Soe Win Hlaing and U Aye Myint Maung, the past and present Director General of the forest Department. Who had provided invaluable guidance and directives successful implementation of the project. We are greatly indebted to Dr. Nyi Nyi Kyaw, Director of Forest Research Institute, U Khin Maung Oo, Project Manager, U Win Kyi, National Consultant of Timber Utilization, U Mehm Ko Ko Gyi, National Consultant of project proposal formulation for their guidance in the pre- project.

Lastly, almost honor and appreciation the work of Dr. Tetra, the project manager of the International Tropical Timber Organization must be mentioned, who had supervised the project and provided unremitting effort and continuous guidance in the successful implementation of the project.

Khin May Lwin
Research Officer
Forest Research Institute
Yezin, Nay Pyi Taw, Myanmar

TABLE OF CONTENTS

<i>Introduction</i>		1
<i>14-Years Old Plantation Teak</i>		3-7
<i>20-Years Old Plantation Teak</i>		8-12
<i>25-Years Old Planation Teak</i>		13-17
<i>30- Years Old Platation Teak</i>		18-22

Introduction

Among world teak, Myanmar teak, special and in a class of its own, has become renowned since the mid eighteen century. It has been known to be exceptionally suitable for shipbuilding, veneer, high class furniture & construction works, especially for decorative joinery.

Teak is recognized as one of the most valuable premium woods in the world. Naturally inherited desirable wood characteristics such as lightness and durability, hardness and stability, straight grain and workability, beautiful grain pattern and golden colour, and termite resistant etc, are major attributes to teak to be a versatile timber for various uses

The government is taking measures to introduce the market-oriented economic system in the nation for national development. In the process, in order to contribute towards the development of the private sector as well as the perpetual existence and sustainable development of timber extraction, the Ministry of Forestry is making efforts for enabling the national entrepreneurs to run teak farming by their own.

The oldest teak plantation had been established in Myanmar about in year 1700. Teak plantations established up to 1906 totaled 24,282 ha (Anon, Forest Department 1999). The establishment of teak plantation over an area of 324,000 ha will have

been completed at the end of the 40-year rotation. At the end of 2008, special teak plantations amounted to 89,100 ha.

In fact, teak plantation in Myanmar has originated with “Taung-ya” method in modest scales with the compensatory concept since 1856. However the extensive plantation programme has been set since 1978 with an annual target at 80,000 acres of which about 40 percent is for commercial species, mainly teak. In light of farsighted view towards market economy, Myanmar has step up to the emergence of private owned forest plantations. As for teak plantation, a total of 20,500 acres for 11 Companies has been permitted and commenced establishment since 2006. Receiving the growing interests of entrepreneurs to invest in this lucrative business, further thousands of acres are under the process for permission.

In Myanmar, as the earliest large scale teak plantations have not yet reached harvestable size, domestic wood-based industries and timber merchants who have traditionally dealt with large diameter size of natural teak are still lack of experience dealing with small diameter size of plantation teak. General public perception in the domestic market is also that properties of teak wood from plantation grown are inferior to that of natural grown.

Plantation teak could not match old growth teak in terms of market prices. The best quality plantation

teak price is lower than even that of the lowest grade old growth Myanmar teak (Keogh, 2008). This is due primarily to high sapwood content and high juvenile wood content in the timber obtained from the trees of young teak plantations. Sapwood content, juvenile wood content and growth rate are some of the basic properties in assessing the wood quality, especially for the timbers obtained from the trees of young forest plantations.

Teak is commonly accepted as one of the most durable wood species in the world. It was recorded that on some dry sites, it had lasted for more than 700 years. In contact with the ground, it can remain serviceable for more than twenty-five years because of the natural preservatives present in the heartwood. The extractives present in the heartwood are believed to be mainly responsible for teak durability.

However, it is without a doubt that the quality of teak extracted from plantation cannot compare with the quality of teak extracted from natural forests. Fast growing and high yielding forest plantations are becoming an important source to increase wood productivity. For fast growing species, a relative short rotation period and the wood quality may be lower than expected. For outdoor construction, variation in durability is still of great importance.

Young teakwood is produced from thinning & final felling at the end

of short rotation. Mature teak wood (to be cut about 60-80 years of age) mainly consist of heartwood, while younger one consist of bigger portion of sapwood. About 10 years old teak trees consists of 70% sapwood, while at 20-30 years of age the wood almost has 50% of heartwood.

Specific gravity of teak wood is lower in young teak. Yudodibroto (1985) reported that specific gravity of teak was as low as 0.48. The mechanical strength of wood will be lower at about 30% on average.

Trees harvested in shorter rotations and thinning trees have higher proportion of juvenile and tension woods, generally characterized by shorter fibers & elements, small diameter and thinner cells with higher fibrile angle.

Some properties of plantation teak of different ages have been done during ITTO/CFC pre-project "Study on utilization of plantation teak" which are basic requirements to the utilization potential of plantation teak.



Plantation Teak Wood

Quality

14-Years Old Plantation Teak

General characteristics of the wood

Sapwood and heartwood consist of 57.04 % and 42.96 % respectively; heartwood golden yellow turning pale brown, dull, odour present, strongly and characteristically scented when fresh; growth ring distinct; sapwood 4 rings and average heartwood 6 rings respectively; pores medium-sized, visible to the naked eye.

Microscopic characters

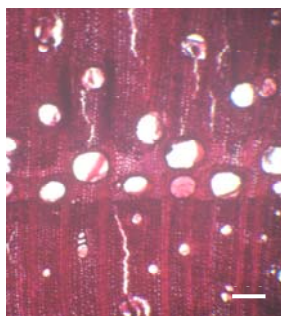
Vessels: Ring porous wood; 6 - 16/mm², moderately few to moderately numerous; solitary 73 %, in radial multiple of 2-4 and 27%; solitary pores rounded or oval, mean tangential diameter 124.46 μm (range 35.88-252.41 μm), fine-texture, medium-sized; mean length 318.78 μm (range 117.88 - 445.88 μm), moderately short; perforation plate sample, end walls transverse or oblique, one end or both end tailed; intervessel pits alternate, 5.31 μm , small, oval or elongated in shape; reddish-brown gum deposits present; tyloses abundant,

Fiber: Medium-sized, mean length 1044.06 μm (range 461.25-1701.50 μm); mean fiber width 23.36 μm (range 14.38-32.5 μm), mean fiber wall thickness 4.36 μm , (range 2.5-7.19

μm), thin-walled; septate; libriform; slit-like.

Rays: Heterogeneous; 3-4 cell wide, (mostly 4); 5-10 /mm tangentially, widely space to fairly close; mean height of multiseriate rays is 585.70 μm (range 102.39-1601.56 μm), very low;; mean width 35.92 μm (range 17.94-55.09 μm), moderately fine, and 5-72 cells high; ray vessel pitting 3.63 μm in diameter, small, oval or rounded or elliptical in shape.

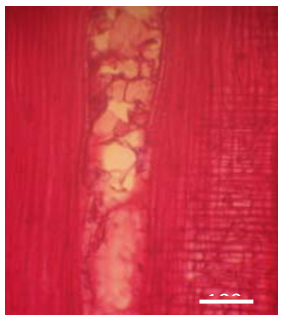
Axial parenchyma: Abundant, paratracheal parenchyma connecting vessel pores forming 5-11 seriate bands, initial and confluent.



Transverse section



Tangential section



Radial section

Qualitative characters

Growth rings	Distinct
Colour	Pale golden brown to dark golden brown
Luster	Dull
Grain	Straight or interlock grained
Texture	Fine to coarse textured
Odour	Distinct
Porosity	Ring porous

Quantitative characters

Vessel No/mm ²	6-16
Vessel diameter	124.46
Vessel length	318.78
Fiber length	1044.06
Fiber width	23.36
Fiberwall thickness	4.36
Lumen width	14.38
Multiseriate ray height	585.70
Multiseriate ray width	35.92
Multiseriate ray high	5-72
Ray/mm tangentially	5-10



Some Physical Properties

Moisture content%

	Green	Air Dry
Base	97.2	12.0
Middle	93.6	12.0
Top	85.7	12.0
Average	92.2	12.0

Specific gravity

	Green	Air Dry
Base	0.535	0.585
Middle	0.507	0.552
Top	0.513	0.559
Average	0.518	0.565

Density (Kg/m³)

	Green	Air Dry
Base	1056	655
Middle	978	618
Top	951	615
Average	995	629



Shrinkage (Green to Oven Dry)

	Longitudinal %	Radial %	Tangential %	Volumetric %
Base	0.368	2.15	4.98	7.48
Middle	0.274	2.32	5.19	7.47
Top	0.259	2.42	5.38	7.39
Average	0.300	2.3	5.2	7.45

Dimensional stability

Base	2.33
Middle	1.88
Top	1.76
Average	1.99



Some mechanical properties

Static bending (Nmm⁻²)

MOR	95
MOE	9578
FS@PL	58

Axial compression (Nmm⁻²)

MCS	44
FS@PL	36

Side compression (Nmm⁻²)

FS@PL	12
-------	----

Hardness (kN)

Side	1.5
End	2.9

Natural Durability

Average MC%	52.56
Average weight lost%	5.642
Durability class	2
Description of Durability	Durable

Air Drying

Quick Drying Test

Initial Check	1
Deformation	1
Internal Check	1
Initial DBT (°C)	60
Initial WBD (°C)	5
Final DBT (°C)	85
Initial moisture content %	86.9
Estimated Drying Time (days)	3-4
Schedule Code	D ₄₄ /W ₄₄



Ash content%

	Heart	Sap
Base	2.167	2.783
Middle	1.581	2.279
Top	1.385	1.958
Average	1.711	2.340

Alcohol/ Benzene Soluble %

	Heart	Sap
Base	10.736	7.861
Middle	9.047	7.004
Top	8.568	6.913
Average	9.450	7.259

Hot Water Soluble %

	Heart	Sap
Base	5.706	6.907
Middle	5.767	6.644
Top	5.668	6.247
Average	5.714	6.699

Lignin Content %

	Heart	Sap
Base	27.800	25.980
Middle	28.480	26.720
Top	29.280	27.340
Average	28.520	26.680

1% NaOH Soluble %

	Heart	Sap
Base	13.528	12.397
Middle	13.141	11.765
Top	13.064	11.700
Average	13.244	11.954

Cellulose Content %

	Heart	Sap
Base	47.901	47.989
Middle	48.232	48.154
Top	49.044	48.227
Average	48.392	48.123

20-Years Old Plantation Teak

General characteristics of the wood

. Sapwood and heartwood consist of 65.02 % and 34.98 %; heartwood golden yellow turning reddish- brown, dull, odour present, strongly and characteristically scented when fresh; growth ring distinct, sapwood 7 rings and average heartwood 10 rings respectively; pores medium-sized, visible to the naked eye.

Microscopic characters

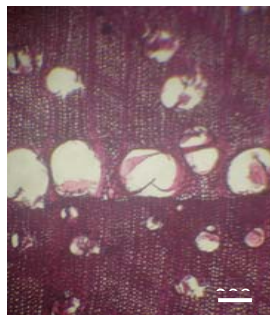
Vessels: Ring porous wood; 4-14 /mm², few to moderately numerous; solitary 72 %, in radial multiple of 2-5 and 28%; solitary pores rounded or oval, mean tangential diameter 161.10 μm (range 33.31-353.63 μm), medium-textured, medium-sized; mean length 336.51 μm (range 140.94-494.56 μm), moderately short; perforation plate sample, end walls oblique or transverse, one end or both end tailed, intervessel pits alternate, 3.13 μm , small, rounded or oval; reddish-brown gum deposits present; tyloses present,

Fiber: Medium-sized, mean length 1086.60 μm (range 458.69-1447.81 μm); mean fiber width 14.68 μm (range 16.25-34.56 μm), mean fiber wall thickness 4.38 μm , (range 2.5-7.5 μm), thin -walled; septate; libriform; slit-like. Wavy fibers and

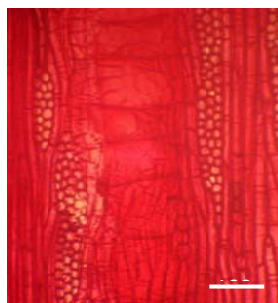
helical thickening were found in 20-year-old plantation teak.

Rays: Heterogeneous, 3-4 cell wide, (mostly 4), 3-7/mm tangentially, widely spaced to normally spaced, mean height of multiseriate rays is 484.06 μm (range 110.19-1091.63 μm), extremely low, mean width 50.13 μm (range 25.63-72.77 μm), medium-sized, and 5-44 cells high, ray vessel pitting 3.75 μm in diameter, oval or rounded in shape.

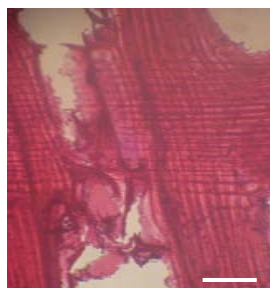
Axial parenchyma: Abundant, paratracheal parenchyma connecting vessel pores forming 3-9 seriate bands, initial and confluent.



Transverse section



Tangential section



Radial section

Qualitative characters

Growth rings	Distinct
Colour	Pale golden brown to dark golden brown
Luster	Dull
Grain	Straight or interlock grained
Texture	Medium to coarse textured
Odour	Distinct
Porosity	Ring porous



Quantitative characters

Vessel No/mm ²	4-14
Vessel diameter	161.10
Vessel length	336.51
Fiber length	1086.60
Fiber width	24.68
Fiberwall thickness	4.38
Lumen width	15.96
Multiseriate ray height	484.06
Multiseriate ray width	50.13
Multiseriate ray high	5-44
Ray/mm tangentially	3-7



Some Physical Properties

Moisture content%

	Green	Air Dry
Base	91.0	12.0
Middle	101.3	12.0
Top	92.9	12.0
Average	95.3	12.0

Specific gravity

	Green	Air Dry
Base	0.625	0.694
Middle	0.568	0.689
Top	0.581	0.640
Average	0.591	0.674

Density (Kg/m³)

	Green	Air Dry
Base	1199	778
Middle	1147	699
Top	1123	717
Average	1156	731

Shrinkage (Green to Oven Dry)

	Longitudinal %	Radial %	Tangential %	Volumetric %
Base	0.335	2.5	5.0	8.17
Middle	0.213	2.60	5.10	7.86
Top	0.229	2.99	5.63	7.29
Average	0.259	2.7	5.2	7.77

Dimensional stability

Base	1.99
Middle	1.96
Top	1.93
Average	1.96



Some mechanical properties

Static bending (Nmm⁻²)

MOR	103
MOE	10484
FS@PL	61

Axial compression (Nmm⁻²)

MCS	48
FS@PL	40

Side compression (Nmm⁻²)

FS@PL	13
-------	----

Hardness (kN)

Side	1.55
End	2.9

Natural Durability

Average MC%	86.49
Average weight lost%	5.301
Durability class	2
Description of Durability	Durable

Air Drying

Quick Drying Test

Initial Check	1
Deformation	1
Internal Check	2
Initial DBT (°C)	60
Initial WBD (°C)	5
Final DBT (°C)	85
Initial moisture content %	100.20
Estimated Drying Time (days)	7-8
Schedule Code	D ₄₄ /W ₄₅



Chemical Properties

Ash content%

	Heart	Sap
Base	3.449	3.262
Middle	2.941	2.923
Top	2.584	2.480
Average	2.991	2.888

Alcohol/ Benzene Soluble %

	Heart	Sap
Base	17.564	14.247
Middle	16.350	13.031
Top	15.964	12.876
Average	16.959	13.385

Hot Water Soluble %

	Heart	Sap
Base	6.504	6.544
Middle	6.439	6.136
Top	6.174	5.796
Average	6.372	6.159

Lignin Content %

	Heart	Sap
Base	31.240	29.080
Middle	32.780	30.540
Top	32.880	30.880
Average	32.300	30.167

1% NaOH Soluble %

	Heart	Sap
Base	16.669	14.721
Middle	16.225	14.014
Top	15.855	13.660
Average	16.250	14.132

Cellulose Content %

	Heart	Sap
Base	49.127	49.511
Middle	49.102	49.763
Top	49.773	50.280
Average	49.334	49.851

25-year- old plantation Teak

General characteristics of the wood

Sapwood and heartwood consist of 43.95 % and 56.05 % respectively; heartwood dark reddish- brown, black stripe present, dull, odour present, strongly and characteristically scented when fresh; growth ring distinct; sapwood 8 rings and average heartwood 12 rings respectively; pores medium-sized, visible to the naked eye.

Microscopic characters

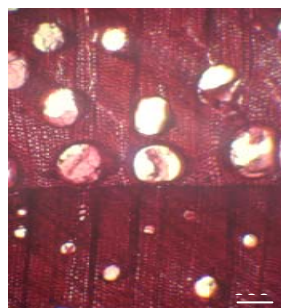
Vessels: Ring porous wood; 5-14 /mm², moderately few to moderately numerous; solitary 79 %, in radial multiple of 2-5 and 21%; solitary pores rounded or oval, mean tangential diameter 145.64 μm (range 30.75-307.50 μm), fine-textured, medium-sized; mean length 243.03 (range 84.56-386 μm), very short; perforation plate sample, end walls oblique or transverse, one end or both end tailed; intervessel pits alternate, 4.69 μm , small, rounded in shaped; reddish -brown gum deposits present; tyloses present.

Fiber: Medium-sized, mean length 919.49 μm (range 438.19-1449.69 μm); mean fiber width 23.89 μm (range 15.63-32.50 μm), mean fiber wall thickness 4.20 μm (range 2.5-

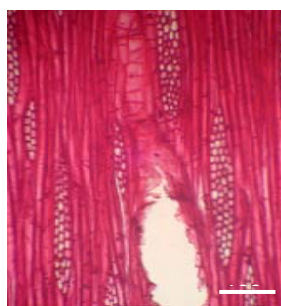
6.25 μm), thin- walled; septate; libriform; slit-like.

Rays: Heterogeneous; 2-4 cell wide, (mostly 3- 4), 4-8 /mm tangentially, widely spaced to normally spaced; mean height of multiseriate rays is 543.62 μm (range 123-1224.88 μm), very low; mean width 39.88 μm (range 19.22-60.22 μm), moderately fine, and 6-56 cells high, ray vessel pitting 4.06 μm in diameter, small, rounded or oval in shape.

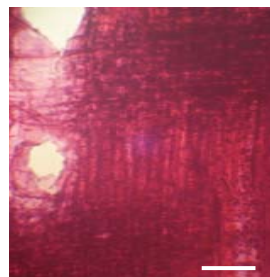
Axial parenchyma: Abundant, paratracheal parenchyma connecting vessel pores forming 3-7seriate bands, initial and confluent



Transverse section



Tangential section



Radial section

Qualitative characters

Growth rings	Distinct
Colour	Pale golden brown to dark golden brown
Luster	Dull
Grain	Straight or interlock grained
Texture	Fine to coarse textured
Odour	Distinct
Porosity	Ring porous



Quantitative characters

Vessel No/mm ²	5-14
Vessel diameter	145.64
Vessel length	243.01
Fiber length	919.49
Fiber width	23.89
Fiberwall thickness	4.20
Lumen width	15.09
Multiseriate ray height	543.62
Multiseriate ray width	39.88
Multiseriate ray high	6-56
Ray/mm tangentially	4-8



Some Physical Properties

Moisture content%

	Green	Air Dry
Base	71.2	12.0
Middle	63.4	12.0
Top	50.0	12.0
Average	61.5	12.0

Specific gravity

	Green	Air Dry
Base	0.604	0.671
Middle	0.574	0.633
Top	0.557	0.612
Average	0.578	0.639

Density (Kg/m³)

	Green	Air Dry
Base	1036	752
Middle	936	708
Top	885	686
Average	952	715

Shrinkage (Green to Oven Dry)

	Longitudinal %	Radial %	Tangential %	Volumetric %
Base	0.280	2.40	4.40	7.00
Middle	0.240	2.70	5.20	7.29
Top	0.250	3.00	5.30	8.64
Average	0.257	2.7	5.0	7.64

Dimensional stability

Base	1.83
Middle	1.93
Top	1.76
Average	1.84



Some mechanical properties

Static bending (Nmm⁻²)

MOR	111
MOE	11272
FS@PL	69

Axial compression (Nmm⁻²)

MCS	51
FS@PL	43

Side compression (Nmm⁻²)

FS@PL	13
-------	----

Hardness (kN)

Side	1.85
End	3.3

Natural Durability

Average MC%	37.97
Average weight lost%	5.947
Durability class	2
Description of Durability	Durable

Air Drying

Quick Drying Test

Initial Check	1
Deformation	1
Internal Check	1
Initial DBT (°C)	60
Initial WBD (°C)	5
Final DBT (°C)	85
Initial moisture content %	88.30
Estimated Drying Time (days)	3-4
Schedule Code	D ₄₄ /W ₄₄



Chemical Properties

Ash content%

	Heart	Sap
Base	1.748	2.097
Middle	1.552	2.070
Top	1.462	2.055
Average	1.587	2.074

Alcohol/ Benzene Soluble %

	Heart	Sap
Base	12.287	8.450
Middle	9.848	7.966
Top	9.352	7.860
Average	10.496	8.092

Hot Water Soluble %

	Heart	Sap
Base	6.780	7.284
Middle	6.760	7.176
Top	6.724	6.415
Average	6.755	6.958

Lignin Content %

	Heart	Sap
Base	27.820	26.900
Middle	28.480	26.960
Top	30.160	27.220
Average	28.820	27.027

1% NaOH Soluble %

	Heart	Sap
Base	14.966	13.808
Middle	14.792	13.414
Top	14.294	13.223
Average	14.684	13.482

Cellulose Content %

	Heart	Sap
Base	51.452	51.982
Middle	51.829	51.995
Top	52.031	52.438
Average	51.771	52.138

30-year- old plantation Teak

General characteristics of the wood

Sapwood and heartwood consist of 24.04 % and 75.96 % respectively, sapwood pale yellow, heartwood dark golden- brown, dull, odour present, strongly and characteristically scented when fresh; growth ring distinct, sapwood 10 rings and average heartwood 16 rings respectively; pores medium-sized, visible to the naked eye.

Microscopic characters

Vessels: Ring porous wood, 4-18 /mm², few to moderately numerous, solitary 73 %, in radial multiple of 2-5 and 27 %; solitary pore rounded , mean tangential diameter 146.01 μ m (range 33.31-302.38 μ m), fine-textured, medium-sized, mean length 294.38 μ m (range 125.56 – 356.26 μ m), moderately short; perforation plate sample, end walls oblique or transverse, one end or both end tailed, intervessel pits alternate, 5 μ m, small, rounded or oval in shape; reddish -brown gum deposits present; tyloses present.

Fiber: Medium-sized, mean length 1069.02 μ m (range 604.75 - 1517 μ m), mean fiber width 23.33 μ m (range 16.25-31.25 μ m), mean fiber wall thickness

4.01 μ m(range 2.5-5.62 μ m), thin-walled, septate, libriform, slit-like.

Rays: Heterogeneous, 2-5 cell wide, (mostly 3), 4-9 /mm tangentially, widely spaced to fairly close, mean height of multiseriate rays is 568.98 μ m (range 123-1224.88 μ m), very low, mean width 45.97 μ m (range 20.5-69.19 μ m), medium-sized, and 6-66 cells high, ray vessel pitting 5 μ m in diameter, rounded or oval in shape.

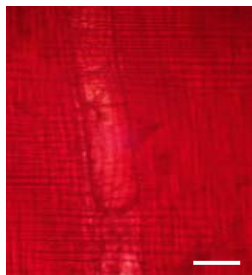
Axial parenchyma: Abundant, paratracheal parenchyma connecting vessel pores forming 3-9 seriate bands, initial and confluent



Transverse section



Tangential section



Radial section

Qualitative characters

Growth rings	Distinct
Colour	Pale golden brown to dark golden brown
Luster	Dull
Grain	Straight or interlock grained
Texture	Fine to coarse textured
Odour	Distinct
Porosity	Ring porous



Quantitative characters

Vessel No/mm ²	4-18
Vessel diameter	146.01
Vessel length	294.38
Fiber length	1069.02
Fiber width	23.33
Fiberwall thickness	4.01
Lumen width	15.12
Multiseriate ray height	568.98
Multiseriate ray width	45.97
Multiseriate ray high	6-66
Ray/mm tangentially	4-9



Some Physical Properties

Moisture content%

	Green	Air Dry
Base	82.0	12.0
Middle	79.4	12.0
Top	72.7	12.0
Average	78.2	12.0

Specific gravity

	Green	Air Dry
Base	0.565	0.621
Middle	0.537	0.588
Top	0.530	0.579
Average	0.544	0.596

Density (Kg/m³)

	Green	Air Dry
Base	1025	696
Middle	957	659
Top	909	649
Average	964	668

Shrinkage (Green to Oven Dry)

	Longitudinal %	Radial %	Tangential %	Volumetric %
Base	0.280	2.50	5.70	7.71
Middle	0.206	2.60	5.62	7.57
Top	0.209	2.86	5.56	8.07
Average	0.232	2.7	5.6	7.78

Dimensional stability

Base	2.30
Middle	2.16
Top	1.94
Average	2.13



Some mechanical properties

Static bending (Nmm⁻²)

MOR	93
MOE	10241
FS@PL	57

Axial compression (Nmm⁻²)

MCS	43
FS@PL	37

Side compression (Nmm⁻²)

FS@PL	10
-------	----

Hardness (kN)

Side	1.25
End	2.6

Natural Durability

Average MC%	28.52
Average weight lost%	2.351
Durability class	1
Description of Durability	Very Durable

Air Drying

Quick Drying Test

Initial Check	1
Deformation	1
Internal Check	1
Initial DBT (°C)	70
Initial WBD (°C)	5
Final DBT (°C)	90
Initial moisture content %	67.10
Estimated Drying Time (days)	4-5
Schedule Code	D ₅₃ /W ₄₃



Chemical Properties

Ash content%

	Heart	Sap
Base	1.484	2.188
Middle	0.963	1.581
Top	1.061	1.334
Average	1.145	1.701

Alcohol/ Benzene Soluble %

	Heart	Sap
Base	13.641	9.379
Middle	13.652	9.189
Top	14.211	9.711
Average	13.835	9.427

Hot Water Soluble %

	Heart	Sap
Base	6.272	6.300
Middle	6.143	6.068
Top	6.198	6.194
Average	6.204	6.187

Lignin Content %

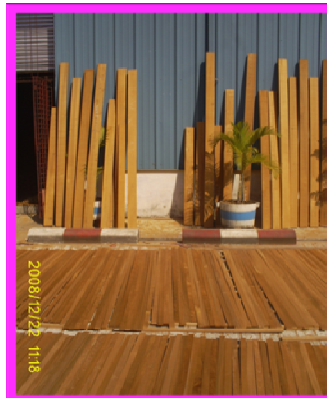
	Heart	Sap
Base	34.56	31.78
Middle	36.84	34.48
Top	39.22	35.56
Average	36.873	33.940

1% NaOH Soluble %

	Heart	Sap
Base	14.110	12.975
Middle	13.630	11.678
Top	13.694	11.399
Average	13.811	12.351

Cellulose Content %

	Heart	Sap
Base	51.008	50.200
Middle	52.043	50.891
Top	52.596	51.805
Average	51.882	50.969



References

1. U Zaw Win, The Role of Plantation Teak in Myanmar, MFPTMA, Myanmar, 2009.
2. U Aung Myint, et.al, Production and Marketing of Teak Wood Products in Myanmar, Myanmar Timber Enterprise, Myanmar, 2009.
3. U Kyaw Win Maung et.al, Investigation on Sapwood Contents, Juvenile Wood Content and Growth Rate, Anatomical Characteristics, Physical and Mechanical Properties of Plantation Teak at Different Ages, Forest Research Institute, Yezin, Myanmar, 2009.
4. Daw Cho Cho Win, et.al, Investigation on Natural Durability and Drying Behavior of Plantation Teak at Different Ages, Forest Research Institute, Myanmar, 2009.



