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Shrinkage Allowance of Some Malaysian Timbers

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Introduction

The shrinkage of wood normally occurs when the moisture content (mc) dips below the fibre-saturation point (FSP), which in most cases, ranges from 25% to 30%. The magnitude of shrinkage of a piece of timber is not equal in all directions, but is significantly different across the grain in both the radial and tangential directions. While the relation of radial to tangential shrinkage varies considerably in different woods, the average tangential shrinkage for all woods is approximately twice the radial shrinkage. For the purpose of comparison, the usual method of measuring shrinkage is to determine the total contraction undergone in shrinking from the fully 'expanded' condition at saturation to the oven-dry condition. Grewal (1979) reported that the average radial shrinkage of Malaysian woods (from green to oven-dry) ranges from 1.6% in meranti bakau (*Shorea uliginosa*) to 7.3% in penaga (*Mesua ferrea*). The average tangential shrinkage ranges from 4.4% in meranti bakau (*Shorea uliginosa*) to 13.5% in keruing merah (*Dipterocarpus verrucosus*). The slight longitudinal shrinkage may be disregarded in practice, as its total amount is minimal when compared to the total length of the board, except for woods which contain a large amount of juvenile or tension wood e.g. rubberwood (*Hevea brasiliensis*) (Lim & Ani 1979).

This article attempts to present to the timber processors a relatively quick and practical way of estimating the shrinkage allowances at 3 common mc levels of 10%, 15% and 20% which approximately correspond to $\frac{2}{3}$, $\frac{1}{2}$ and $\frac{1}{3}$ respectively of the total shrinkage at oven-dry condition.

Shrinkage allowance to be considered

This article lists the shrinkage allowances required when drying the green timber to 20%, 15% and 10% mc at various widths and thickness of 1 to 10cm (Table 1). These moisture levels generally represent the Equilibrium Moisture Contents (EMC) of most Malaysian hardwoods which have been exposed to the respective end-use service conditions of partially air-dried, air-dried and kiln dried. The differential shrinkage in wood has a direct bearing on the amount of distortion during drying and subsequent utilization of the wood. It is important to note that every timber species behaves differently and consequently the resultant shrinkage varies from one to another.

Calculation of shrinkage at various moisture content levels

For the purpose of calculating the shrinkage allowance, shrinkage at oven dry (0%) mc (Grewal, 1979) is taken as the basis. However, if the oven-dry data is not available, an estimation based on air-dry shrinkage is used. In addition, it is assumed that the shrinkage values follow a linear relationship from 0% mc to 30% with the FSP taken as 30% mc.

Therefore, the equation for shrinkage calculation can be generally expressed as:-

$$\frac{S_o}{S_t} = \frac{30}{(30 - mc_t)} \qquad \text{.....(1)}$$

where

mc_t = target mc level

S_o = total shrinkage (%) to oven-dry condition

S_t = shrinkage from green to target mc level

or, at any mc level, say mc_t, the shrinkage S_t is given by the formula,

$$S_t = \frac{(30 - mc_t)}{30} \times S_o \qquad \text{.....(2)}$$

It follows that sawn size, G, of green timber with allowance for shrinkage (based on 1 cm board width or thickness) is given by the formula,

$$G = \frac{100}{100 - S_t} \qquad \text{.....(3)}$$

Typical calculations on sawn size required for Ramin timber whose shrinkage is 3.4% from green to an mc of 15.0% at air-dry condition, should the targeted mc be 10%,15% and 20%, respectively.

Total shrinkage

The total (maximum) shrinkage S_o % at oven-dry (0% mc) level will be given by equation (1)

$$\frac{S_o}{3.4} = \frac{30}{(30 - 15.0)}$$

$$S_o = 6.80\ \%$$

10% mc level

Using equation (2), the shrinkage S_t at 10% mc is given by,

$$S_t = \frac{(30 - 10)}{30} \times S_o$$

$$= \frac{2}{3}(6.80)$$

$$= 4.5333$$

ie., the shrinkage at 10% mc is $\frac{2}{3}$ of 6.80 or 4.533 %

For board to be dried to 10% mc, the green dimension (freshly sawn) required is given by,

$$G = \frac{100}{(100 - S_t)}$$

$$G = \frac{100}{(100 - 4.533)}$$

$$= 1.0475 \text{ or approximately } 1.05 \text{ cm}$$

Thus, a freshly sawn board of 1.05 cm thick is needed if the targeted thickness of 1 cm is required at mc level of 10%.

Shrinkage at 15%

The shrinkage at 15% mc is $\frac{1}{2}$ of 6.80 or 3.40 %.

If the board is only to be dried to 15% mc, its green dimension (freshly sawn) is given by

$$G = \frac{100}{(100 - S_t)}$$

$$G = \frac{100}{(100 - 3.40)}$$

$$= 1.035 \text{ or approximately } 1.04 \text{ cm}$$

Thus, a freshly sawn board of 1.04 cm thick is required to achieve 1 cm thickness if the targeted mc is 15%.

Shrinkage at 20%

Similarly, the shrinkage at 20% mc is $\frac{1}{3}$ of 6.80 or 2.267 %.

Hence, if the board is only to be dried to 20% mc, the green dimension (freshly sawn) required is given by

$$G = \frac{100}{(100 - S_t)}$$

$$G = \frac{100}{(100 - 2.267)}$$

$$= 1.0232 \text{ or approximately } 1.02 \text{ cm}$$

Thus, a freshly sawn board of 1.02 cm thick will dry down to 1 cm thickness if the targeted mc is 20%.

Application

The shrinkage allowances for boards of various dimensions, destined for critical end-uses which require specific service moisture content levels can be easily worked out as multiples of the 1cm board allowance. In this article, the shrinkage allowances based on average tangential shrinkages have been calculated and tabulated for quick reference by the timber processors (Table 1). Such information is useful to ensure that the incidence of hit-or-miss or unnecessary undersize could be minimized, or undesirable oversize could be avoided.

Table 1 Shrinkage allowances based on average tangential shrinkages with various widths or thicknesses (up to a maximum of 10cm)

Species	To a moisture content (%)	Width or thickness allowance (mm)					
		10 cm	8 cm	6 cm	4 cm	2 cm	1 cm
Bintangor	20	3.1	2.5	2.0	1.3	0.6	0.3
(*Calophyllum*	15	4.7	3.8	3.0	2.0	0.9	0.4
ferrugineum var.	10	6.2	5.0	4.0	2.6	1.2	0.6
ferrugineum)							
Chengal	20	1.7	1.4	1.0	0.7	0.3	0.2
(*Neobalanocarpus*	15	2.6	2.0	1.5	1.0	0.5	0.3
heimii)	10	3.4	2.7	2.0	104	0.7	0.3
Geronggang	20	3.0	2.4	1.8	1.2	0.6	0.3
(*Cratoxylum*	15	4.5	3.6	2.7	1.9	0.9	0.4
arborescens)	10	6.0	4.8	3.6	2.4	1.2	0.6
Gerutu	20	2.9	2.3	1.7	1.2	0.6	0.3
(*Parashorea stellata*)	15	4.3	3.5	2.6	1.7	0.9	0.4
	10	5.8	4.6	3.5	2.3	1.2	0.6
Jelutong	20	1.3	1.3	0.8	0.5	0.3	0.1
(*Dyera costulata*)	15	2.1	1.7	1.3	0.9	0.4	0.3
	10	3.0	2.4	1.8	1.2	0.6	0.3
Kapur	20	3.2	2.6	1.9	1.3	0.6	0.3
(*Dryobalanops*	15	4.8	3.8	2.9	1.9	1.0	0.5
aromatica)	10	6.4	5.1	3.8	2.6	1.3	0.6
Kedondong	20	2.2	1.8	1.3	0.9	0.4	0.2
(*Santiria laevigata*)	15	3.3	2.7	2.0	1.3	1.7	0.3
	10	4.4	3.5	2.6	1.8	0.9	0.4
Kelat Jambu	20	2.3	1.8	1.4	0.9	0.5	0.2
(*Syzygium griffthii*)	15	3.5	2.8	2.1	1.4	0.7	0.3
	10	4.6	3.7	2.8	1.8	0.9	0.4
Kekatong	20	2.8	2.2	1.7	1.1	0.6	0.3
(*Cynometra*	15	4.1	3.3	2.5	1.7	0.9	0.5
malaccensis)	10	5.5	4.4	3.3	2.2	1.1	0.6
Kembang	20	5.4	2.2	1.6	1.1	0.5	0.3
Semangkok	15	8.1	3.2	2.4	1.6	0.8	0.4
(*Scaphium*	10	10.8	4.3	3.2	2.2	1.1	0.5
macropodum)							
Kempas	20	2.5	2.0	1.5	1.0	0.5	0.3
(*Koompassia*	15	3.8	3.0	2.2	1.5	0.8	0.4
malaccensis)	10	5.0	4.0	3.0	2.0	1.0	0.5
Keranji	20	2.5	2.0	1.5	1.0	0.5	0.2
(*Dialium* spp.)	15	3.8	3.0	2.2	1.5	0.8	0.4
	10	5.0	4.0	3.0	2.0	1.0	0.5

Species	To a moisture content (%)	Width or thickness allowance (mm)					
		10 cm	8 cm	6 cm	4 cm	2 cm	1 cm
Keruing	20	5.0	4.0	3.0	2.0	1.0	0.5
(*Dipterocarpus*	15	7.5	6.0	4.5	3.0	1.5	0.8
verrucosus)	10	9.9	7.9	5.9	4.0	2.0	1.0
Mata ulat	20	2.3	1.8	3.0	2.0	1.0	0.5
(*Kokoona* spp.)	15	3.5	2.8	4.5	3.0	1.5	0.8
	10	4.6	3.7	5.9	4.0	2.0	1.0
Melantai	20	2.4	1.9	1.4	0.9	0.5	0.2
(*Shorea macroptera*)	15	3.6	2.9	2.1	1.4	0.7	0.3
	10	4.8	3.9	2.8	1.8	0.9	0.5
Mempisang	20	2.99	2.3	1.4	1.0	0.5	0.2
(*Mezzettia*	15	4.4	3.5	2.1	1.4	0.8	0.3
leptopoda)	10	5.8	4.6	2.9	1.9	1.0	0.5
Mengkulang	20	2.8	2.2	1.7	1.1	0.6	0.3
(*Heritiera*	15	4.2	3.3	2.5	11.7	0.9	0.4
simplicifolia)	10	5.6	4.4	3.3	2.2	1.1	0.6
Meranti bakau	20	1.8	1.4	1.1	0.7	0.4	0.2
(*Shorea uliginosa*)	15	2.7	2.2	1.6	1.1	0.5	0.3
	10	3.6	2.9	2.2	1.4	0.7	0.4
Dark red meranti	20	2.9	2.3	1.7	1.1	0.6	0.3
(*Shorea curtisii*)	15	4.3	3.4	2.6	1.7	0.9	0.4
	10	5.7	4.6	3.4	2.3	1.1	0.6
Light red meranti	20	3.8	3.0	2.3	1.5	0.8	0.4
(*Shorea leprosula*)	15	5.7	4.4	3.4	2.2	1.1	0.6
	10	7.6	6.1	4.6	3.0	1.5	0.8
White Meranti	20	3.1	2.5	1.8	1.2	0.6	0.3
(*Shorea sericeiflora*)	15	4.6	3.7	2.7	1.8	1.4	0.4
	10	6.1	4.9	3.6	2.4	2.2	0.6
Yellow Meranti	20	3.1	2.5	1.9	1.2	0.6	0.3
(*Shorea multiflora*)	15	4.7	3.7	2.8	1.9	0.9	0.5
	10	6.2	5.0	3.7	2.5	1.2	0.6
Merawan	20	2.3	1.8	1.4	0.9	0.5	0.2
(*Hopea nervosa*)	15	3.4	2.8	2.1	1.3	0.7	0.3
	10	4.6	3.7	2.8	1.8	0.9	0.5
Mersawa	20	2.6	2.1	1.6	1.0	0.5	0.3
(*Anisoptera laevis*)	15	3.9	3.1	2.3	1.6	0.8	1.4
	10	5.2	4.2	3.1	2.1	1.0	0.5
Nyatoh	20	2.7	2.1	1.6	1.1	0.5	0.3
(*Palaquium*	15	4.0	3.2	2.4	1.6	0.8	0.4
maingayi)	10	5.3	4.3	3.2	2.1	1.1	0.5
Pulai	20	2.7	2.2	1.6	1.1	0.5	0.3
(*Alstonia*	15	4.1	3.2	2.4	1.6	0.8	0.4
augustiloba)	10	5.4	4.3	3.2	2.2	1.1	0.5
Punah	20	3.2	2.6	1.9	1.3	0.6	0.3
(*Tetramerista*	15	4.9	3.9	2.9	2.0	1.0	0.4
glabra)	10	6.5	5.2	3.9	2.6	1.3	0.6
Ramin	20	2.3	1.8	1.4	0.9	0.5	0.2
(*Gonystylus*	15	3.5	2.8	2.1	1.4	0.7	0.3
bancanus)	10	4.6	3.7	2.8	1.8	0.9	0.5
Rubberwood	20	1.4	1.2	0.8	0.5	0.2	0.1
(*Hevea brasiliensis*)	15	2.1	1.7	1.2	0.8	0.3	0.2
Sepetir	20	2.0	1.6	1.2	0.8	0.4	0.2
(*Sindora coriacea*)	15	3.0	2.4	1.8	1.2	0.4	0.2
	10	4.0	3.2	2.4	1.6	0.8	0.4

Species	To a moisture content (%)	Width or thickness allowance (mm)					
		10 cm	8 cm	6 cm	4 cm	2 cm	1 cm
Sesendok	20	1.3	1.1	0.8	0.5	0.3	0.1
(*Endospermum*	15	2.0	1.6	1.2	0.8	0.4	0.2
diadenum)	10	2.7	2.1	1.6	1.1	0.5	0.3
Simpoh	20	2.8	2.2	1.7	1.1	0.6	0.3
(*Dillenia*	15	4.2	3.4	2.5	1.7	0.8	0.4
grandifolia)	10	5.6	4.5	3.4	2.4	1.1	0.6
Tualang	20	1.6	1.3	1.0	0.6	0.3	0.2
Koompassia	15	2.5	1.8	1.5	0.9	0.5	0.2
excelsa)	10	3.3	2.6	2.0	1.3	0.7	0.33

References

GREWAL, G. S. 1979. *Air seasoning properties of some Malaysian Timbers.* Timber Trade Leaflet No.41. The Malaysian Timber Industry Board and Forest Research Institute Malaysia, Kuala Lumpur. 26pp.

HALE, J. D. 1952. *The Structure of Wood.* Department of Resources and Development, Forestry Branch, Canada. 52pp.

LIM, S. C. & ANI, S.1999. Structure and Characteristics of Rubberwood. Pp 17–26 in Hong Lay-Thong and Sim Heok-Choh (Eds.) *Rubberwood Processing and Utilization,* Malayan Forest Records No. 39, Forest Research Institute Malaysia (FRIM), Kepong, 52109 Kuala Lumpur.

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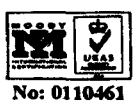

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