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COMPARISON BETWEEN GRAVEYARD AND LABORATORY TEST METHODS TO DETERMINE NATURAL DURABILITY

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Introduction

The natural durability of timber is defined as 'the inherent resistance of timber to attack by destroying organisms such as wood decaying fungi and wood destroying insects'. In other words it is also a method to determine the degree of resistance to deterioration by the whole range of biological, chemical, mechanical and physical wood-destroying agents or simply as the number of years the timber can sustain under a particular service condition, against wood destroying organisms and the elements of the weather (Ani S et al. 2005).

Previously, the natural durability of Malaysian timber species were determined based on graveyard method since 1918 at Weld Hill Forest Reserve and Timber Research Laboratory at Sentul in Kuala Lumpur. However, these testing sites was destroyed in a bombing raid during the World War 2 between 1942 and 1945. Hence, new testing sites (at higher and lower soil grounds) were established in 1950s at the Forest Research Institute in Kepong.

The results of the natural durability of 30 timber species tested at Weld Hill and another 21 species tested at Sentul were reported by Foxworthy (1930). The results of the natural durability of 135 timber species were later reported by Jackson (1957). The durability study at FRIM on 91 timber species was reported by Mohd Dahlan and Tam (1985, 1987). Another graveyard site for durability test was established at FRIM Sub-station Research at Mata Ayer, Perlis in 2005, which concentrated on the durability of selected Malaysian timber species against temperate species treated with CCA and light organic solvent preservative (LOSP). Based on the above graveyard tests, there were only 16 species classified as durable when the test specimen sustained more than 10 years exposure under stringent hot and high humidity of Malaysian soil condition. Thus there were many species being used for plywood manufacture industry such as Meranti (*Shorea* spp) was classified as non-durable plywood (Class 5) (MPMA) and received lowest premium when exported to Europe. Obviously, the graveyard tests gave disadvantages to the Malaysian species as the samples were tested under the most stringent condition and long period to classify them.

This paper entails to a study that was carried out to determine the selected timber species which were mostly used for plywood manufacture using the similar laboratory method established by European Standard BS EN 350-1: 1994. The advantage of this study is due its reliability to obtain results within 16 weeks of exposure to fungi under controlled laboratory condition. Thus the influence of different environmental conditions on decay was eliminated and the result can be directly compared with other species from other parts of the world.

Natural durability based on BS EN 350-1 :1994 and BS EN 113 :1996

The natural durability of 22 Malaysian timber species was determined based on the European Standard BS EN 350-1: (1994) for sampling method and EN 113 (1996) for basidiomycetes in the laboratory. The basidiomycetes test explains how the exposure test was carried out for this study. Both standards provide guidance on the requirements for natural durability of wood against wood decaying organisms in different rating classes. The durability rankings obtained could be directly compared with other species assessed using the similar standard. The objectives of this research were as follows:

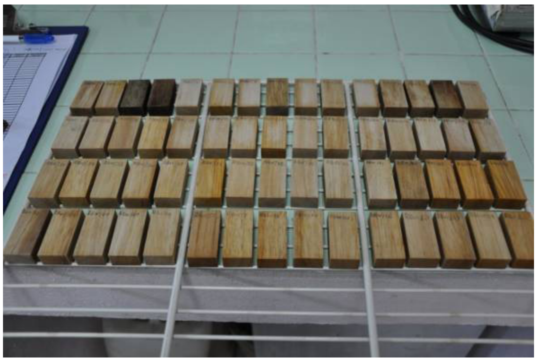
a) To determine the natural durability of selected Malaysian timbers by using BS EN for effectiveness against wood destroying fungi
b) To compare natural durability of selected Malaysian timber based on graveyard method against wood decayed by laboratory test
c) To establish a durability rating database as a guide for the industry

Malaysia has to adopt the European standard testing (EN 350-1 and EN 113) in order to convince the European community into accepting our timbers at premium price due to their better durability classification, especially for those species not yet been tested according to EN standard.

(a) Fieldworks to obtain the authenticated species from the forest

b) Break down at the sawmill

(c) Kiln drying process to achieve 12% moisture content



(d) Specimens to be tested

(e) Specimens tested according to BS EN 350-1: 1994

Figure 1 (a-e): Sampling of the authenticated species that include felling, breakdown, drying and testing

Exposure test

The average weight loss for each set of testing blocks was determined and the durability rankings were determined using guidelines given in BS EN 350-1. In this method, an x value for each species was calculated by dividing the average mass loss of each set of Malaysian species blocks by the average mass loss of the references (beech) upon completion of exposures to the fungus within 16 weeks. This x-value was then used to assign a durability class for each species.

$$x = \frac{\text{average corrected mass loss of test specimens}}{\text{average mass loss of reference specimens}}$$

Table 1 Natural durability classification based on EN 350-1 :1994

Durability class	Description	x- value
1	Very durable	x ≤ 0.15
2	Durable	x > 0.15 but ≤ 0.30
3	Moderately	x > 0.30 but ≤ 0.60
4	Slightly durable	x > 0.60 but≤ 0.90
5	Not durable	x > 0.90

Weight loss was used to classify the durability of timber. Table 1 shows the classes of natural durability of wood to fungi attack based on weight loss as described in BS EN 350-1: 1994.

Discussion

Based on the results as shown in Table 3, there were some similarities in the durability classification between BS EN 350 and the earlier graveyard studies. For example *Acacia mangium*, binuang, jelutong, kekatong, kelat, keruing, kulim and mengkulang are classified as moderately durable by both methods. In some cases the durability of certain species was elevated to higher durability classes when tested according to BS EN 350 such as geronggang, kedondong, kelempayan, medang, meranti bukit and sesenduk from non-durable to moderately durable and moderately durable to durable. Among the species tested, only mersawa was classified as durable by both methods. Obviously, the BS EN 350 method has better advantage against graveyard method as the result was obtained within shorter period of time. However, there were some exceptional cases whereby kapur and tembusu that were tested durable by earlier graveyard but were classified as moderately durable by BS EN 350, even though the test was repeated twice. This was probably due to the timber sample taken for this study were younger as compared to the similar species tested using graveyard method. The average density of both species were found to be in the lowest density range of both matured species.

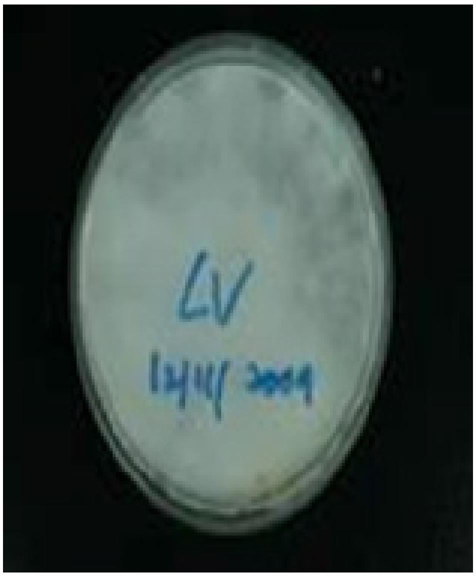


Figure 2 *Coriolus versicolor* (CV) strain

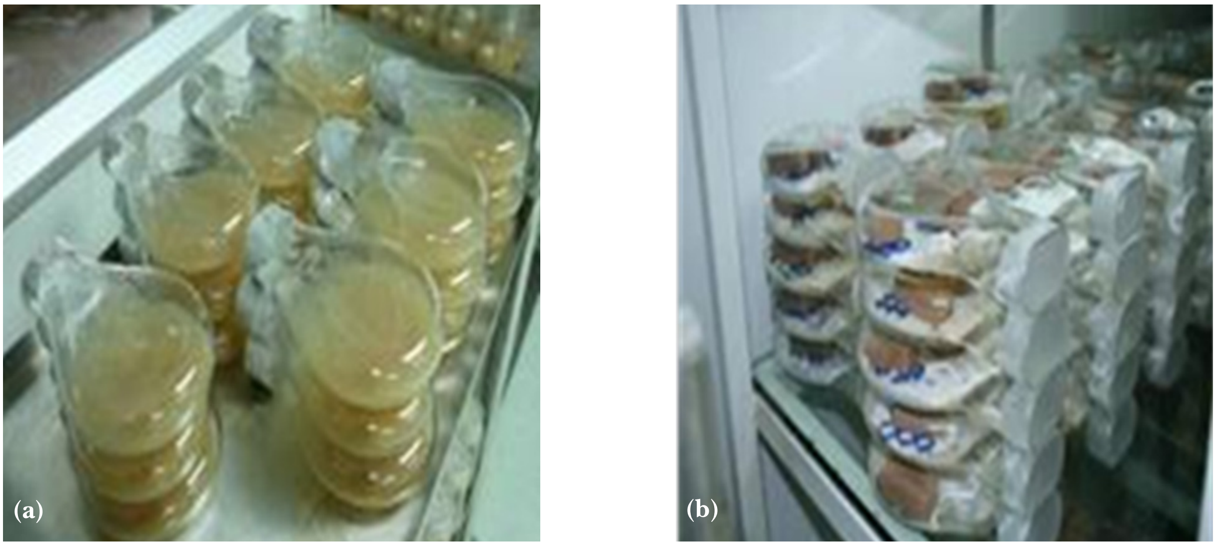


Figure 3 Laboratory decay fungi test (BS EN350-1: 1994) where (a) 3% malt extract agar containing white rot fungi, *Coriolus versicolor* (CV) in Kolle flask and (b) timber samples were placed into Kolle flask containing 3% malt extract agar inoculated with CV

Figure 4 Removal of mycelium of CV from timber samples after 16 weeks of incubating with *Coriolus versicolor* (CV)

Table 2 The average density of testing blocks used in this study

Local name	Scientific name	Density at oven dried condition (12% MC) (kg/m^3)
Acacia	*Acacia mangium*	735.54
Binuang	*Octomeles sumatrana*	258.90
Geronggang	*Cratoxylum arborescens*	480.14
Gerutu	*Parashorea* spp	570.86
Jelutong	*Dyera costulata*	391.63
Kapur	*Dryobalanops aromatica*	803.47
Kedondong	*Canarium* spp.	658.56
Kekatong	*Cynometra malaccencis*	1158.87
Kelat	*Syzigium* spp	856.41
Keledang	*Artocarpus* spp	548.87
Kelempayan	*Neolamarckia cadamba*	407.23
Keruing	*Dipterocarpus* sp	894.76
Kulim	*Scorodocarpus borneensis*	978.24
Machang	*Mangifera indica*	574.13
Medang	*Cinnamomum* sp	536.06
Mengkulang	*Heritiera* sp	742.80
Meranti bukit	*Shorea platyclados*	684.53
Meranti sarang punai	*Shore parvifolia*	489.74
Mersawa	*Anisoptera* sp	486.69
Pelong	*Pentaspadon velutinus*	663.74
Sesenduk	*Endospermum malaccense*	369.00
Tembusu	*Fagraea fragrans*	767.66

Conclusion

The durability study based on BS EN 350 has better advantages as compared to graveyard tests as the results are more reliable and can be obtained within 16 weeks of exposure. Moreover, the results of the study can directly be compared with other timber species from temperate or other parts of the world using similar method.

Graveyard test requires longer period (more than 10 years) to conclude the durability classes of timber species. In addition, the results may vary due to environmental factors such as type of soil, rainfall, weathering condition at different testing sites which may affect the biodegradation activities on the test specimen. It is difficult to compare the results from field and laboratory tests as a greater range of wood destroying organisms are present in the field. Therefore, the users should use these results on durability with caution and being judicious. Nevertheless, it has been shown that the Malaysian species are normally more durable than species of the temperate countries such that it is justifiable for Malaysian species to be sold at premium price.

Table 3 The durability classes of Malaysian timbers based on EN 350 as compared to the graveyard test (Foxworthy, 1930; Jackson, 1957; Dahlan & Tam 1985, 1987)

No.	Beech as a reference		BS EN 350 (Beech as a reference)			Graveyard Foxworthy, 1930; Jackson, 1957; Dahlan & Tam 1985, 1987)	
	Species	Scientific name	x value	Durability rating	Description	Avg. Service life (yrs)	Durability class
1	Acacia	*Acacia mangium*	0.3199	3	Moderately Durable	3.5	Moderately durable
2	Binuang	*Octomeles sumatrana*	0.3691	3	Moderately Durable	2.5	Moderately durable
3	Geronggang	*Cratoxylum arborescens*	0.2191	2	Durable	1.3	Non durable
4	Gerutu	*Parashorea* sp.	0.2605	2	Durable	1.9	Non durable
5	Jelutong	*Dyera costulata*	0.5267	3	Moderately Durable	1.4	Non durable
6	Kapur	*Drybalanops aromatica*	0.3746	3	Moderately Durable	6.0	Durable
7	Kedondong	*Canarium* sp.	0.2984	2	Durable	1.6	Non durable
9	Kekatong	*Cynometra malaccencis*	0.4560	3	Moderately Durable	4.2	Moderately durable
10	Kelat	*Syzigium* sp.	0.3420	3	Moderately durable	2.9	Moderately durable
11	Keledang	*Artocarpus* sp.	0.2428	2	Durable	n.a	n.a
12	Kelempayan	*Neolamarckia cadamba*	0.1823	2	Durable	1.4	Non durable
13	Keruing	*Dipterocarpus* sp.	0.4169	3	Moderately Durable	n.a	n.a
14	Kulim	*Scorodocarpus borneensis*	0.4416	3	Moderately Durable	4.0	Moderately durable
15	Machang	*Mangifera indica*	0.2491	2	Durable	2.1	Moderately durable
16	Medang	*Cinnamomum* sp.	0.2481	2	Durable	2.0	Moderately durable
17	Mengkulang	*Heritiera sp.*	0.3157	3	Moderately Durable	n.a	Not Durable
18	Meranti bukit	*Shorea pauciflora*	0.2846	2	Durable	3.5	Moderately durable
19	Meranti sarang punai	*Shorea parvifolia*	0.2251	2	Durable	na	na
20	Mersawa	*Anisoptera* sp.	0.2181	2	Durable	5.9	Durable
21	Pelong	*Pentaspadon velutinus*	0.2914	2	Durable	na	na
22	Sesenduk	*Endospermum malaccense*	0.4960	3	Moderately Durable	1.0	Non durable
22	Tembusu	*Fagraea fragrans*	0.3301	3	Moderately Durable	6.4	Durable

na : data not available

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