TIMBER TECHNOLOGY BULLETIN

Published by Forest Research Institute Malaysia, 52109 Kepong, Selangor Darul Ehsan No. 37, 2005 ISSN:139-258

# Durability of timbers for indoor applications in Malaysia

S. Ani, S. Salamah, M. J. Dahlan, U. Salmiah, & K. Roszaini

## Introduction

The durability of timber is defined as 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 last under a particular service condition, against wood destroying organisms and the elements of the weather (Willeitner & Liese 1992; Zabel & Morell 1992; Eaton & Hale 1993). The natural durability of timber, however, usually refers only to its degree of resistance to attack by biological agents.

Resistance of wood to fungal and insect attack varies enormously from one species of timber to another. No wood is completely and permanently resistant to all forms of biodeterioration. However, some woods such as Chengal (*Neobalanorcarpus heimii*) and Balau (*Shorea maxwelliana*) will endure fungal and insect attack for many years while others such as Jelutong (*Dyera costulata*) and Rubberwood (*Hevea brasiliensis*) are highly susceptible to decay (Jackson 1957; Dahlan & Tam 1985, 1987). Factors affecting durability are diverse of which some are related to conditions within the wood itself while others are due to circumstances pertaining to its use.

The durability classification of timbers is usually based on the results of field trials, where assessments are made on the actual performance of each individual species against fungal and termite attacks. The first series of field tests for Malaysian timbers were started in 1918 at a site within the Weld Hill Forest Reserve, Kuala Lumpur and the results were published by Foxworthy & Woolly (1930). Tests were continued but at new sites in the Forest Research Institute Malaysia (FRIM), Kepong. Durability results reported by Jackson (1957) were based on data from the new test sites at Kepong after inspection in July 1956. Subsequently, two more reports on the durability of Malaysian timbers were published, summarizing the durability rating of more than 200 timber species from Peninsular Malaysia (Dahlan & Tam 1985, 1987). These timbers were grouped into four durability classes ranging from non-durable to very durable, depending on their years of service life. The graveyard tests were conducted under extreme environmental conditions, where the situations were favourable to the wood attacking organisms but not to the timber samples.

The main purpose of the field trials is to provide general comparison of the relative natural durability of various timber species at particular service conditions. When the same timbers are used under a more favourable environment, they are expected to give a much better performance in terms of service life. Service life of timber refers to the usefulness of the timber in its finished form while in usage before it is destroyed by fungi or termites. The length of service life of timbers resulting from the graveyard test has been misconstrued as being similar to other uses in milder and less severe conditions. This is a very common misconception in the durability rating, even among experienced timber users. Timbers that are supposed to be rated on their durability for usage outdoor was indiscriminately used to rate timbers intended for indoor applications. This resulted in incorrect assessment of timber durability when the intended application is dissimilar. To date, there is no published data on the serviceability of timbers for indoor applications in Malaysia. This article presents the estimated service life of timbers for indoor applications derived from observations made on wood samples kept above ground and under shelter over a long period of time. This estimate is useful for approximating the durability of these timbers under indoor applications.

## Materials and methods

Timbers from 125 species representing 81 timber groups were left exposed on three storey shelves under shed in FRIM premises. They were first exposed at varying period of time starting from as early as 1946 to as late as 1995. The number of samples used in the test ranged from 20 to 100 stakes for different species of timber, and each sample measured 50 × 50 × 600 mm. Durability of timbers for indoor applications was derived from the data collected on these wood samples of different species that have been exposed for many years under shed and out of ground contact. For timbers that have a very clear demarcation of sapwood and heartwood, samples constituting the latter were selected. For those derived from the so-called "sapwood tree" or with indistinct heartwood such as Jelutong (*Dyera costulata*), Pulai (*Alstonia angustiloba*) and Rubberwood (*Hevea brasiliensis*), no differentiation of sapwood and heartwood was attempted.

## Results and discussion

Results on the estimated service life of timbers for above-ground usage in Malaysia are given in Table 1. These results are estimated for indoor applications and should be used with caution as the tested samples were exposed to natural environmental conditions under shed and not in a 'controlled environment' where its temperature and humidity are well controlled. Elsewhere, the conditions may be different and the service life of the timbers may be prolonged or shortened. A test stake was considered to have reached its maximum useful service life when 50% of its cross-sectional area was destroyed by wood borers or dry-wood termites. This was discussed at some lengths by Jackson (1957). The present assessments were made in terms of service life or the number of years the timbers can last in service before they deteriorated based on 50% cross-sectional area damaged. They represent a documentation of the durability of Malaysian timbers including service life data obtained from the indoor performance of 125 species representing 81 timber group names known in the trade. Data from field trials of the graveyard test as reported by Dahlan & Tam (1987) in ground contact were also presented in Table 1 for reference and comparison.

It was observed that "all sapwood" timbers or timbers with indistinct heartwood rated non-durable under field tests were heavily attacked towards the end of their service lives by powder post beetles (*Minthea rugicolis* and *Heterobostrychus aequalis*) (Figure 1), longhorn beetles (*Batocera rufomacula*) and dry wood termites (*Cryptotermes* sp.) (Figure 2). Jelutong (*Dyera costulata*), Ludai (*Sapium baccatum*) and Pulai (*Alstonia angustiloba*) represent this group of timber, having service life of 13, 8 and 6 years respectively. However, compared to their field trial results, the duration of this service life is significantly longer than values of 1.4, 1.0 and 0.7 years respectively. Sapwood of almost all timbers is non-durable. When dealing with timber comprising a high proportion of sapwood, a short average life would be expected (Willeitner & Liese 1992; Eaton & Hale 1993).

By allowing a longer exposure period, the same beetles and termites were also observed attacking timbers that are classified as moderately durable under field tests. Timbers such as Kelat (*Syzygium griffithii*), Keledang (*Artocarpus lanceifolius*), Kekatong (*Cynometra malaccensis*) and Keranji (*Dialium kunstleri* and *Dialium platysepalum*) were heavily infested after 30 to 35 years of exposure, even though these timbers are made up of heartwood. On the other hand, highly durable timbers such as Bitis (*Madhuca utilis*), Balau (*Shorea maxwelliana*) and Chengal (*Neobalanocarpus heimii*) were free from signs of insect attack. They remained sound after 50 years of exposure.

Better resistance to biodegradation of heartwood in timber could be attributed to the presence of extractives such as tannins, essential oils and other complex phenolic compounds (Fengel & Wegener 1989; Willeitner & Liese 1992; Zabel & Morell 1992). Some of these extractives are toxic to wood deteriorating organisms and they can act as natural preservatives for timber. Polyphenols e.g. stilbenes and flavonoids are the most common heartwood extractives, occurring in the heartwood of most species (Zabel & Morrell 1992). Thus, the resistance of timber against fungal and insect attack can be closely related to the content of various extractives i.e. the higher the content, the more durable is the timber (Findlay 1985). Most of these extractives that confer durability to the heartwood are not soluble in water and these woods retain their resistance to infection for a very long time.

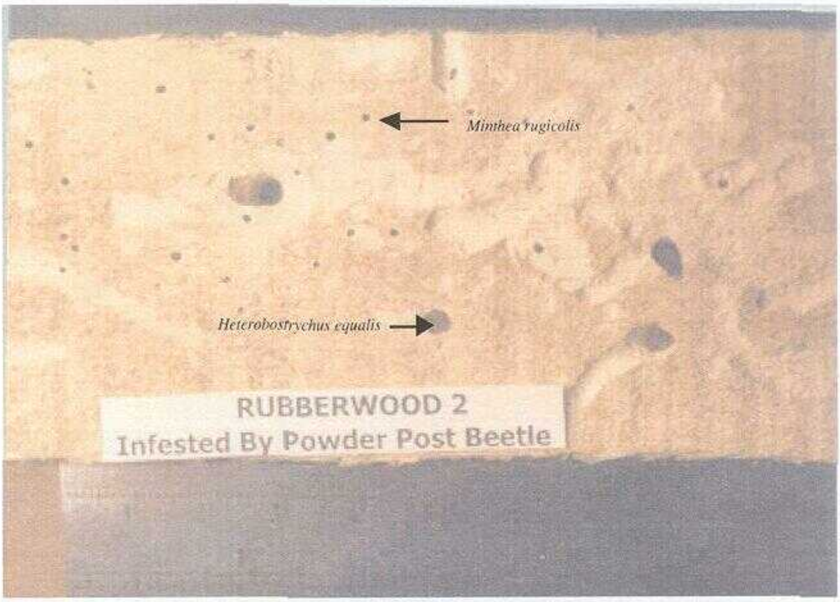


**Figure 1** Rubberwood infested by *Minthea rugicolis* and *Heterobostrychus equalis*

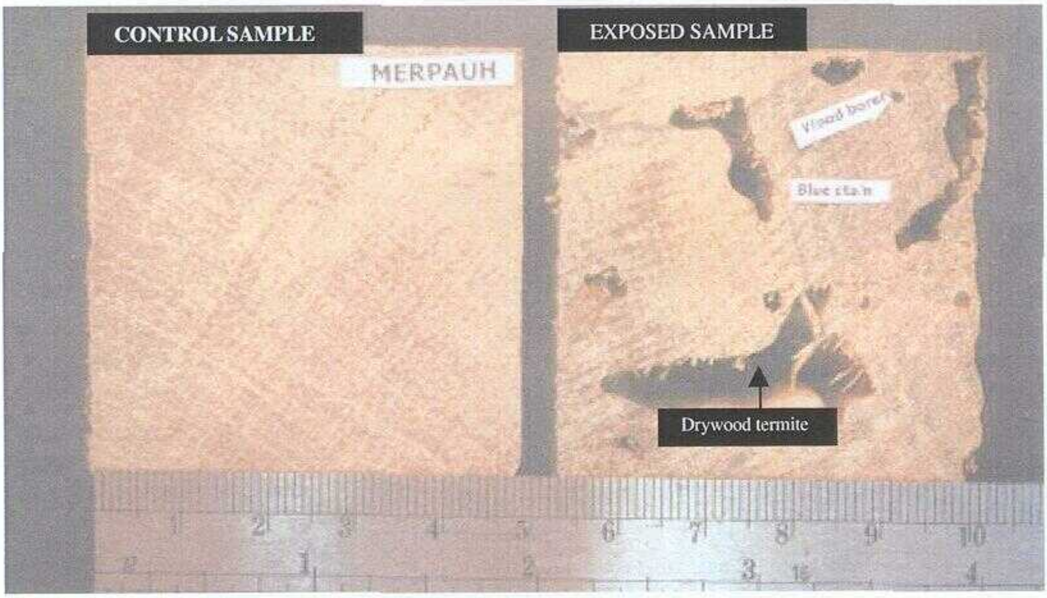


**Figure 2** Merpauh infested by *Cryptotermes* sp.

## Conclusion

While some timbers are commonly used in contact with the ground especially those from the durable groups, the majority of them are utilized in buildings where they are protected from the elements of weather and totally free from subterranean termites. As such, results of the present study are important in providing an indication to the length of service life that could be expected from a particular timber when used indoors under Malaysian conditions. Generally, the service life of timbers that are used for above ground contact is approximately 10 times longer than the value obtained from the graveyard test. In addition, the same timbers that are destined for use in temperate environment are expected to have a longer service life than those used locally. Furthermore, the expected life span could be further enhanced should suitable coating and/or presevative be applied, and the moisture content be controlled below a reasonable level throughout its service life. Wood used in contact with the ground is more liable to fungal and insect attack than wood used above ground or indoors. Therefore, when choosing any timber species for a specific use, the nature of the service conditions should be taken into account. It should be noted also that results of the present study only apply to timbers that contain no sapwood (except timber derived from the "sapwood tree"). Should inclusion of sapwood in a piece be unavoidable then treatment with recommended preservative and treatment process should be adopted. Being susceptible to insect and fungal attacks, proper preservative treatment would ensure that the sapwood portion of the member be protected, and its durability could be extended to be equal or better than the corresponding heartwood portion.

## Acknowledgements

Our thanks are due to previous researchers and personnel of Timber Research Laboratory of FRIM who have collected the timbers and kept them in storage, enabling us to use them as research materials. We are grateful to the two reviewers for their constructive comments on the manuscript and to H. T. Chan for finalizing the manuscript for publication.

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**Table 1** Estimated average service life of timbers for interior applications in Malaysia

| No. | Timber[1] | Botanical name | Starting year | No. of samples | No. of samples remained sound at last inspection (June 2004) | Estimated service life above ground (years) @ | Estimated service life in ground contact (years) * |
|---|---|---|---|---|---|---|---|
| 1 | Acacia[2] | *Acacia mangium* | 1972 | 20 | 0 | 20 | 3.5 |
| 2 | API-API | *Avicennia* sp. | 1975 | 30 | 0 | 7 | 0.6 |
| 3 | Ara | *Ficus callusa* | 1985 | 20 | 1 | 15+ | 1.4 |
| 4 | Bakau | *Bruguiera gymnorrhiza* | 1968 | 20 | 0 | 30 | 3.5 |
| | | *Rhizophora apiculata* | 1968 | 20 | 0 | 30 | 1.5 |
| 5 | BALAU | *Shorea ciliata* | 1958 | 20 | 0 | 43 | 4.5 |
| | | *Shorea laevis* | 1953 | 20 | 12 | 50+ | 8.0 |
| | | *Shorea maxwelliana* | 1953 | 20 | 20 | 50+ | 15.8 |
| | | *Shorea sumatrana* | 1950 | 20 | 0 | 43 | 4.5 |
| 6 | BALAU, RED | *Shorea guiso* | 1976 | 20 | 18 | 28+ | 3.1 |
| | | *Shorea kunstleri* | 1976 | 20 | 20 | 28+ | 4.5 |
| 7 | Balek angin | *Mallotus leucodermis* | 1984 | 20 | 0 | 15 | 1.6 |
| 8 | BATAI | *Paraserianthes*[3] *moluccana* | 1982 | 20 | 0 | 20 | 2.2 |
| 9 | BINTANGOR | *Calophyllum inophyllum* | 1975 | 20 | 0 | 15 | 1.4 |
| | | *Calophyllum retusum* | 1980 | 20 | 0 | 21 | 2.0 |
| 10 | BITIS | *Madhuca utilis* | 1946 | 20 | 20 | 56+ | 5.5 |
| 11 | CHENGAL | *Neobalanocarpus heimii* | 1953 | 20 | 20 | 50+ | 14.7 |
| 12 | Coconut | *Cocos nucifera* | 1988 | 80 | 1 | 10+ | 1.4 |
| 13 | DAMAR MINYAK | *Agathis alba* | 1980 | 20 | 0 | 10 | 0.7 |
| 14 | DURIAN | *Coelostegia griffithii* | 1980 | 20 | 0 | 13 | 1.5 |
| | | *Durio lowianus* | 1982 | 20 | 0 | 14 | 1.7 |
| | | *Neesia altissima* | 1988 | 20 | 0 | 12 | 1.5 |
| 15 | Flindersia[2] | *Flindersia* sp. | 1984 | 20 | 4 | 18+ | - |
| 16 | Gaham badak | *Blumeodendron tokbrai* | 1974 | 20 | 0 | 13 | 1.4 |
| 17 | GERONGGANG | *Cratoxylum arborescens* | 1984 | 20 | 0 | 12 | 1.3 |
| 18 | GERUTU | *Parashorea stellata* | 1980 | 20 | 0 | 18 | 1.9 |
| 19 | GIAM | *Hopea helferi* | 1963 | 20 | 20 | 40+ | 10.2 |
| | | *Hopea nutans* | 1963 | 20 | 20 | 40+ | 14.2 |
| 20 | JELUTONG | *Dyera costulata* | 1980 | 30 | 1 | 13+ | 1.4 |
| 21 | KAPUR | *Dryobalanops aromatica* | 1948 | 20 | 0 | 56 | 6.0 |
| | | *Dryobalanops oblongifolia* | 1980 | 30 | 0 | 19 | 1.9 |
| | | *Dryobalanops rappa* | 1974 | 30 | 0 | 24 | 2.5 |
| 22 | KARAS | *Aquilaria* sp. | 1980 | 20 | 14 | 12+ | |
| 23 | KASAI | *Pometia pinnata* | 1964 | 20 | 0 | 34 | 5.0 |
| 24 | KAYU MALAM | *Diospyros polyalthioides* | 1990 | 20 | 0 | 5 | 0.6 |
| 25 | KEDONDONG | *Canarium grandifolium* | 1968 | 20 | 0 | 34 | 4.0 |
| | | *Canarium littorale f. rufum* | 1970 | 20 | 0 | 30 | 2.9 |
| | | *Santiria laevigata* | 1975 | 20 | 0 | 25 | 2.8 |

continued...

Table 1 (continued)

| No. | Timber[1] | Botanical name | Starting year | No. of samples | No. of samples remained sound at last inspection (June 2004) | Estimated service life above ground (years) @ | Estimated service life in ground contact (years) * |
|---|---|---|---|---|---|---|---|
| 26 | KEKATONG | *Cynometra malaccensis* | 1960 | 40 | 0 | 35 | 3.9 |
| 27 | KELAT | *Syzygium*[3] *griffithii* | 1972 | 40 | 0 | 30 | 3.3 |
| 28 | KELEDANG | *Artocarpus heterophyllus* | 1980 | 20 | 0 | 15 | 1.2 |
| | | *Artocarpus lanceifolius* | 1972 | 60 | 58 | 32+ | 3.9 |
| 29 | KEMBANG SEMANGKOK | *Scaphium macropodum* | 1975 | 20 | 0 | 24 | 2.3 |
| 30 | KEMPAS | *Koompassia malaccensis* | 1976 | 100 | 100 | 28+ | 2.7 |
| 31 | KERANJI | *Dialium kunstleri* | 1958 | 20 | 0 | 44 | 5.5 |
| | | *Dialium platysepalum* | 1972 | 20 | 0 | 30 | 3.4 |
| 32 | KERUING | *Dipterocarpus cornutus* | 1974 | 100 | 100 | 30+ | 4.0 |
| | | *Dipterocarpus crinitus* | 1968 | 20 | 0 | 34 | 3.0 |
| | | *Dipterocarpus kunstleri* | 1964 | 20 | 0 | 38 | 4.0 |
| | | *Dipterocarpus sublamellatus* | 1960 | 40 | 0 | 25 | 2.9 |
| 33 | KERUNTUM | *Combretocarpus rotundatus* | 1966 | 20 | 0 | 29 | 2.8 |
| 34 | KETAPANG | *Terminalia subspathulata* | 1982 | 30 | 0 | 9 | 1.1 |
| 35 | KULIM | *Scorodocarpus borneensis* | 1966 | 20 | 0 | 38 | 4.0 |
| 36 | KUNGKUR | *Pithecellobium confertum* | 1968 | 20 | 0 | 25 | 3.1 |
| 37 | LARAN | *Neolamarckia cadamba*[3] | 1981 | 40 | 0 | 9 | 0.8 |
| 38 | LELAYANG | *Parishia* sp. | 1981 | 25 | 0 | 6 | 0.5 |
| 39 | LUDAI | *Sapium baccatum* | 1990 | 20 | 0 | 8 | 1.0 |
| 40 | MACHANG | *Mangifera foetida* | 1980 | 20 | 0 | 23 | 2.1 |
| | | *Mangifera indica* | 1978 | 20 | 0 | 21 | 2.0 |
| 41 | Mahogany[2] | *Swietenia* sp. | 1979 | 40 | 38 | 25+ | |
| 42 | MATA ULAT | *Lophopetalum reflexum* | 1950 | 20 | 0 | 50 | 4.2 |
| 43 | MEDANG | *Cinnamomum porrectum* | 1982 | 50 | 49 | 21+ | 2.3 |
| | | *Litsea firma* | 1986 | 30 | 0 | 18 | 1.6 |
| 44 | MELANTAI | *Shorea macrophylla* | 1972 | 20 | 0 | 15 | 1.3 |
| 45 | MELUNAK | *Pentace triptera* | 1984 | 20 | 0 | 20 | 2.1 |
| 46 | MEMPENING | *Quercus lamponga* | 1968 | 20 | 0 | 35 | 3.7 |
| 47 | MEMPISANG | *Cathocalyx maingayi* | 1980 | 40 | 0 | 11 | 1.3 |
| | | *Mezzettia leptopoda* | 1980 | 30 | 0 | 14 | 1.7 |
| 48 | MENGKULANG | *Heritiera littoralis* | 1977 | 40 | 2 | 26+ | 3.0 |
| | | *Heritiera simplicifolia* | 1978 | 30 | 0 | 23 | 2.1 |

continued...

Table 1 (continued)

| No. | Timber[1] | Botanical name | Starting year | No. of samples | No. of samples remained sound at last inspection (June 2004) | Estimated service life above ground (years) @ | Estimated service life in ground contact (years) * |
|---|---|---|---|---|---|---|---|
| 49 | MERANTI, DARK RED | *Shorea curtisii* | 1974 | 40 | 3 | 30+ | 3.1 |
| | | *Shorea pachyphylla* | 1964 | 40 | 0 | 20 | 2.3 |
| | | *Shorea pauciflora* | 1960 | 20 | 0 | 35 | 3.7 |
| | | *Shorea platyclados* | 1967 | 20 | 0 | 32 | 3.5 |
| | | *Shorea singkawang* | 1970 | 20 | 0 | 18 | 2.0 |
| 50 | MERANTI, LIGHT RED | *Shorea acuminata* | 1976 | 100 | 0 | 27 | 2.9 |
| | | *Shorea hemsleyana* | 1970 | 20 | 0 | 19 | 2.1 |
| | | *Shorea leprosula* | 1980 | 20 | 0 | 13 | 1.5 |
| | | *Shorea macroptera* | 1980 | 20 | 0 | 9 | 1.1 |
| | | *Shorea ovalis* | 1970 | 20 | 0 | 21 | 2.0 |
| | | *Shorea parvifolia* | 1970 | 20 | 0 | 23 | 2.5 |
| | | *Shorea teysmanniana* | 1984 | 20 | 0 | 10 | 1.2 |
| 51 | MERANTI, WHITE | *Shorea bracteolata* | 1972 | 30 | 0 | 23 | 2.6 |
| | | *Shorea henryana* | 1968 | 40 | 0 | 31 | 3.6 |
| | | *Shorea hypochra* | 1968 | 30 | 0 | 33 | 3.6 |
| | | *Shorea roxburghii* | 1950 | 40 | 0 | 42 | 4.5 |
| 52 | MERANTI, YELLOW | *Shorea longisperma* | 1990 | 20 | 0 | 10 | 1.1 |
| | | *Shorea multiflora* | 1972 | 30 | 0 | 17 | 1.9 |
| 53 | MERAWAN | *Hopea nervosa* | 1974 | 20 | 0 | 29 | 3.2 |
| | | *Hopea sangal* | 1974 | 30 | 0 | 27 | 3.0 |
| | | *Hopea sulcata* | 1975 | 30 | 0 | 26 | 3.1 |
| 54 | MERBATU | *Parinari rubiginosa* | 1970 | 20 | 0 | 33 | 3.1 |
| 55 | MERBAU | *Intsia palembanica* | 1954 | 45 | 45 | 48+ | 5.7 |
| 56 | Merbau kera | *Crudia curtisii* | 1974 | 20 | 0 | 27 | 2.9 |
| 57 | MERBAU LALAT | *Sympetalandra borneensis* | 1950 | 20 | 0 | 45 | 5.2 |
| 58 | MERPAUH | *Swintonia penangiana* | 1970 | 30 | 0 | 27 | 2.9 |
| | | *Swintonia schwenkii* | 1980 | 100 | 0 | 19 | 1.8 |
| 59 | MERSAWA | *Swintonia spicifera* | 1980 | 30 | 0 | 14 | 1.6 |
| 60 | NYATOH | *Anisoptera laevis* | 1948 | 40 | 10 | 35 | 5.9 |
| | | *Diploknema sebifera* | 1970 | 20 | 0 | 27 | 2.5 |
| | | *Palaquium gutta* | 1980 | 30 | 0 | 16 | 1.7 |
| | | *Palaquium impressinervium* | 1948 | 30 | 0 | 50 | 5.5 |
| | | *Palaquium maingayi* | 1972 | 20 | 0 | 26 | 2.8 |
| | | *Planchonella maingayi* | 1980 | 40 | 0 | 14 | 1.3 |
| 61 | PAUH KIJANG | *Irvingia malayana* | 1970 | 20 | 0 | 32 | 3.1 |
| 62 | PENARAHAN | *Myristica gigantea* | 1980 | 30 | 0 | 13 | 1.1 |
| 63 | PERAH | *Elateriospermum tapos* | 1988 | 20 | 0 | 15 | 1.7 |
| 64 | PERUPOK | *Lophopetalum floribundum* | 1980 | 30 | 0 | 17 | 1.9 |
| 65 | PETALING | *Ochanostachys amentacea* | 1972 | 30 | 0 | 27 | 3.2 |
| 66 | Pine[2] | *Pinus caribaea* | 1990 | 20 | 0 | 7 | 1.0 |
| 67 | PULAI | *Alstonia angustiloba* | 1990 | 30 | 6 | 6 | 0.7 |
| 68 | PUNAH | *Tetramerista glabra* | 1966 | 80 | 0 | 35 | 3.6 |

continued...

Table 1 (continued)

| No. | Timber[1] | Botanical name | Starting year | No. of samples | No. of samples remained sound at last inspection (June 2004) | Estimated service life above ground (years) @ | Estimated service life in ground contact (years) * |
|---|---|---|---|---|---|---|---|
| 69 | RAMIN | *Gonystylus bancanus* | 1980 | 40 | 0 | 15 | 0.9 |
| 70 | RENGAS | *Melanochyla torquata* | 1985 | 40 | 30 | 19+ | 2.4 |
| 71 | RESAK | *Vatica cuspidata* | 1948 | 20 | 18 | 56+ | 14.3 |
| 72 | Ru[2] | *Casuarina equisetifolia* | 1970 | 30 | 0 | 25 | 3.0 |
| 73 | Rubberwood[2] | *Hevea brasiliensis* | 1995 | 40 | 0 | 6 | 2.0 |
| 74 | SEPETIR | *Sindora coriacea* | 1984 | 20 | 0 | 20 | 2.1 |
| 75 | SESENDOK | *Endospermum malacense* | 1990 | 100 | 0 | 10 | 1.0 |
| 76 | SIMPOH | *Dillenia grandifolia* | 1990 | 50 | 0 | 9 | 1.0 |
| 77 | Teak[2] | *Tectona grandis* | 1948 | 30 | 0 | 50 | 5.6 |
| 78 | TEMBUSU | *Fagraea fragrans* | 1948 | 80 | 70 | 54+ | 6.4 |
| 79 | TERAP | *Artocarpus elasticus* | 1985 | 30 | 0 | 7 | 1.1 |
| | | *Parartocarpus bracteatus* | 1990 | 40 | 0 | 10 | 1.4 |
| 80 | TERENTANG | *Campnosperma auriculatum* | 1986 | 30 | 0 | 8 | 0.5 |
| 81 | TUALANG | *Koompassia excelsa* | 1970 | 30 | 26 | 34+ | 3.4 |

1 Upper case denotes Malaysian standard name and lower case vernacular or common name
2 Species not indigenous to Malaysia
3 New botanical name
+ Test is still in progress
* Data from Dahlan & Tam (1987)
@ Where all specimens of a particular species are totally destroyed, its exact average service life is given. However, where exposure test is still in progress, the number of specimens remained undestroyed so far is given together with the estimated service life of the particular species by averaging the service life of all the specimens used in the test. The positive (+) sign in the average service life value indicates that the test is still continuing

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Series Editor: Y. E. Tan
Typesetter : Rohayu Yunus

No: 0110461 No: 1124 No: 0111014

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Printed by Publications Branch, Forest Research Institute Malaysia