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MALAYSIAN TIMBERS FOR MARINE SCAFFOLD BOARD APPLICATION

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Introduction

In oil and gas industry, timbers are being used for various applications such as mudmat, vessel's deck, marine fender, scaffold board, etc. Timber is one of the most economical and suitable material to withstand the offshore and nearshore environment, both surface and under water applications. Solid timber planks are widely used as scaffold boards and working platforms during offshore construction and maintenance works. Timber as a scaffold board material has the following advantages compared to other materials such as metals and composites:

(1) High specific strength
Solid timber boards possess high strength-to-weight ratio compared to most metals. This quality suits timber scaffold boards as structural components and at the same time allows for ease of handling and logistic.

(2) Vibration reduction
A sudden load or impact load could lead to excessive vibration and probably a structural failure. An excellent structural material is able to absorb and then dissipate much of the vibration energy. Whenever a vibration is excited on a solid timber working platform, the dampening effect can be achieved fairly quickly.

(3) Corrosion free
Deterioration of metallic matters due to the anodic activity especially in marine condition is extensive. Corroded material formed sharp and spiky edges that may be harmful to platform workers. On the other hand, timber scaffold boards do not corrode and subsist longer in corrosive environment.

(4) Electrical insulator
Timber is a very good insulator for electrical current. Theoretically, solid timber material of zero moisture content offers zero conductances to electricity. Therefore, scaffold board made of solid timber is very suitable for voltage-sensitive working zone. On the contrary, activities such as welding and works using power tools on metallic platforms can be very risky to the workers.

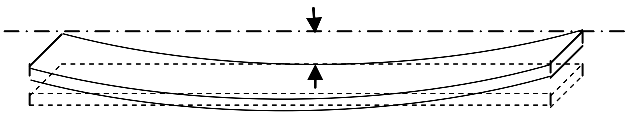
(5) High specific heat
The specific heat capacity of solid timber is about double that of aluminium and concrete. This characteristic makes timber suitable for offshore works where platforms are exposed to continuous heat convection and radiation. Heated platforms will not only impose more harm to the workers, but also could damage some of the equipments used.

(6) Availability and economy
Malaysia is endowed with more than 2500 tree species. More than a hundred timber species which are suitable for scaffold board application are commercially available. In term of procurement, installation, maintenance and disposal costs, timber board is an economical selection compared to most metals and composite boards.

Some technical requirements for timber scaffold boards

At present, there is no national standard to regulate the use of local timbers as scaffold board and very limited technical records regarding Malaysian timbers use as scaffold boards. The only related local standard on specifications of Malaysian timbers for structural uses is MS 1714 (2003), which specifies a method of strength grading tropical hardwoods through visual assessment. Other than that, Factories and Machinery Act 1967 (Anon. 1986) highlights several legal requirements regarding the use of solid timber as scaffold board in the construction sector. Some basic requirements are based on foreign standards such as BS 2482 (2009) and AS 1577 (1993). Below are some basic technical requirements as a practical guideline for the use of Malaysian timbers for scaffold board application (Table 1). These specifications are by no means an official comprehensive guideline. Nevertheless, these basic requirements will certainly improve the quality of the overall scaffolding system and reduce the risk of the construction failure.

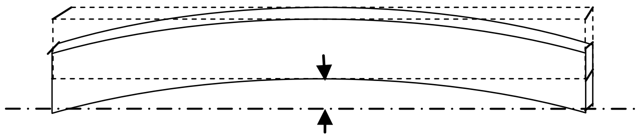
Table 1 Several technical requirements for timber as scaffold board.

Requirement	Detail	Source
Types of timber	Shall be of keruing, or equal or higher Modulus of Rupture	Anonymous 1986
	Shall be of SG5 or better	MS 1714: 2003
	Timber intended for marine use shall possess some degree of resistance against biological attacks	Anonymous 1986
Dimension of board	Thickness shall be of either 32, 38 or 50 mm	Anonymous 1986
	Tolerance on thickness shall be ±2 mm	BS 2482: 2009, AS 1577: 1993
	Boards forming a working platform shall be of reasonable uniform thickness	Anonymous 1986
	Width shall not less than 200 mm; for boards ≥50 mm thick, width shall not less than 150 mm	Anonymous 1986
	Tolerance on width shall be ±5 mm	BS 2482: 2009, AS 1577: 1993
	Length shall not project beyond its end support to a distance exceeding four times the thickness of the board	Anonymous 1986
Timber quality	Faces shall be rough sawn	Anonymous 1986
	Shall have the bark completely stripped off	Anonymous 1986
	Shall be seasoned to 20% moisture content or below	BS 2482: 2009
	Shall be free from defective heart and loose knot	AS 1577: 1993
	Board shall be rejected if it contains wormhole or wasp hole	BS 2482: 2009
	Shall be free from dry-rot or fungal decay; however blue stain in sapwood is permissible	Anonymous 1986
	Knot shall not exceed 75 mm in diameter; minimum spacing of 1 m between 2 adjacent knots	MS 1714: 2003
	Board with a length of 3 m shall be rejected if: a) bow exceeds 12 mm 	BS 2482: 2009

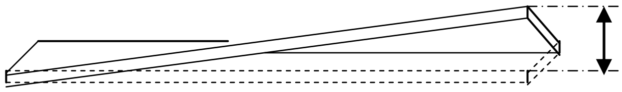
(continued)

Table 1 (continued)

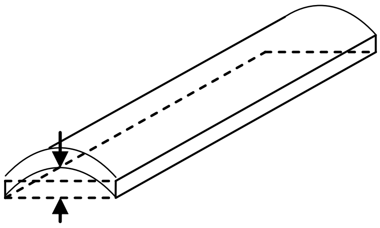
b) spring exceeds 10 mm



c) twist exceeds 12 mm



d) cup exceeds 5 mm



	Maximum permissible end split is 75 mm	MS 1714: 2003
	Surface checks shall not exceed 1/3 thickness	MS 1714: 2003
	Board shall be rejected if wane reduces thickness surface by more than 12 mm or reduces width surface by more than 25 mm	BS 2482: 2009
	Boards must not be painted that defects cannot be easily seen, except for colour identification at position commencing not more than 300 mm from the ends of the board	Anonymous 1986, AS 1577: 1993
Safety factor	Shall be capable of supporting the intended load with a safety factor of at least four	Anonymous 1986
	The ends of each board shall be secured with end bands or nail plates	BS 2482: 2009
	Each board shall have information on the date of grading and installation	MS 1714: 2003
Board inspection	Grading operation shall be carried out by a qualified timber grader registered under the grading authority	MS 1714: 2003
	Each graded board shall be clearly indicated by marking, stamping or stenciling	MS 1714: 2003
	Shall be inspected by designated person before use	Anonymous 1986

Timbers suitable for scaffold board application

Under practical consideration, characterisation of mechanical properties of Malaysian timbers based on each botanical species is almost impossible. Moreover, in term of trading, stocking of too many species is uneconomical and may cause a lot of difficulties. As a result, an established practice in the local construction industry is to specify timber based on trade names instead of species names. This has been beneficial not only to the engineers but also to the timber traders as well. Besides, the concern on timber availability is considerably reduced. Thus, in the same way, timber scaffold boards are usually marketed based on trade names.

Table 2 lists timbers that are suitable for scaffold board application, particularly for marine construction compiled from Wong 2002 and Lee et al. 1993. These timbers are suggested based on several criteria. The main criterion is that the timbers shall be listed between Strength Group 1 and 5. Timbers having high Modulus of Rupture (MOR) and density values are recommended. In cases of timbers without MOR records, other properties such as compressive strength or shear strength could be referred to as an indicator of the MOR. As an exposed structural component, timber scaffold board entails for durability consideration as well, indicated by the durability class and common uses of the timber (Wong 2002). Timbers classified as non-durable are not recommended. Although resistance against biological attacks is a major requirement for the intended usage, timber that are widely known for heavy constructional applications such as keruing is applicable with a prior visual or machine grading appraisal to ensure the timber is free of fungi attack or rotting when selected for use. Nevertheless, the use of Malaysian timbers as scaffold board is not limited to the timber groups in Table 2. Selection of an appropriate timber group is possible provided that the design and loading requirement are properly defined by engineer.

In the utilisation of timber as a structural component, the most important issue is the inconsistency of quality even within the same log. In fact, it is the main reason for the misconception of timber as an inferior building material. The selection of suitable timber groups and the establishment of grades are the main keys for reliable utilisation of timber as scaffold board. A straightforward and inexpensive mechanical test is recommended on random samples to estimate the loading capacity for each batch of timber.

Table 2 Timbers suitable or potentially suitable for scaffold board application, names, properties, durability and common uses.

Trade name	Botanical name	Other vernacular name	Density at air-dried condition (kg m^{-3})	Strength group	Modulus of rupture (MPa)	Common uses	Durability
Balau	*Shorea spp.*	damar laut, selangan batu	850–1155	1	142	Boat building	Durable to very durable
Bekak	*Amoora spp.*	merelang, pasak lingga	705–1025	3	117	Boat decking	Moderately durable
Belian	*Eusideroxylon zwageri*	tambulian	835–1185	2	n.a.	Marine piling, wharves	Very durable
Bitis	*Madhuca spp.*	n.a.	820–1200	1	171	Piers, bridges	Durable
Chengal	*Neobalanocarpus heimii*	n.a.	915–980	1	149	Boat building	Very durable
Giam	*Hopea spp.*	n.a.	865–1220	4	122	Bridges, wharves	Very durable
Kekatong	*Cynometra spp.*	katong-katong, belangkan	880–1155	2	135	Heavy construction	Moderately durable
Kempas	*Koompassia malaccensis*	impas, menggris	770–1120	2	122	Beams, roof trusses	Moderately durable
Keranji	*Dialium spp.*	n.a.	755–1250	3	134	Heavy construction	Moderately durable
Keruing	*Dipterocarpus spp.*	n.a.	595–945	5	96	Heavy construction	Not durable to durable, variable in properties
Kulim	*Scorodocarpus borneensis*	bawang hutan	640–975	3	107	Marine structures	Moderately durable, resistant to marine borers.
Mata ulat	*Kokoona spp.*	bajan	895–1055	2	102*	Bridges	Moderately durable

(continued)

Table 2 (continued)

Trade name	Botanical name	Other vernacular name	Density at air-dried condition (kg m^{-3})	Strength group	Modulus of rupture (MPa)	Common uses	Durability
Merbatu	*Parinari spp.*	kemalau, mentelor	690–975	2	119	Salt water piling, marine construction	Moderately durable
Mertas	*Ctenolophon parvifolius*	besi-besi, litoh	800–930	2	122	Marine construction	Moderately durable
Pauh kijang	*Irvingia malayana*	kabok	930–1250	3	n.a.	Heavy construction	Moderately durable
Penaga	*Mesua ferrea*	n.a.	945–1185	1	155	Heavy construction	Moderately durable
Penyau	*Upuna borneensis*	upun	945–1040	3	n.a.	Heavy construction	Very durable
Petaling	*Ochanostachys amentacea*	degong, petikai, sentikal	800–1105	3	n.a.	Piling	Moderately durable
Resak	*Vatica spp.*	n.a.	655–1155	4	105*	Bridges, piling	Very durable
Tembusu	*Fagraea spp.*	n.a.	640–1075	5	95	Heavy construction	Durable
Tualang	*Koompassia excelsa*	kayu raja, mengaris, tapang	800–865	3	121	Heavy construction	Moderately durable

*denotes value in green condition; n.a. = not available

An example of the design load calculation

Timber: keruing
Referring to Lee et al. 1993,
Modulus of rupture = 96 MPa (N. mm^{-2})
Standard deviation = 7.8 MPa (N. mm^{-2})

Board dimensional specification:
38 mm (thickness, *t*) by 200 mm (width, *w*) by 1800 mm (*l*)

Referring to Factories and Machinery Act 1967, Regulation 76,
Distance between 2 consecutive putlogs, *s* shall not exceed 1.5 m

Referring to Factories and Machinery Act 1967, Regulation 87, unless effectively secured to prevent tipping, the length, *l* of a board over 2 putlogs shall not exceed:
$l = s + (8 \times t)$
$= 1.5 + (8 \times 0.038)$
$= 1.8$ m

Design stress $= (\text{MOR} - (2.33 \times \text{Standard deviation})) / \text{Factor of safety}$
$= (96 - (2.33 \times 7.8)) / 4$
$= 19.5$ N. mm^{-2}

Based on critical loading condition, the maximum load for the board over 2 putlogs:
Maximum Load $= (2 \times \text{Design stress} \times w \times t^2) / (3 \times s)$
$= (2 \times 19.5 \times 200 \times 1444) / (3 \times 1500)$
$= 2503$ N or 255 kgf

For a 38 × 200 × 1800 mm keruing board over two putlogs, 1500 mm apart, the loading shall not exceed 255 kgf.

For application where the loading requirement is less than 250 kgf and using the same board dimensional specification, all the timbers listed in Table 2 may be used. This generally facilitates the procurement process for the boards.

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