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Standard Product Manual For The Production Of Malaysian Basic Structural Grade (MBSG) Rated Plywood

by

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1.0 Scope

This product manual is intended for any Malaysian mill in producing plywoods that possess defined strength characteristics known as structural plywood. By following the stipulations given here in, the plywoods produced will deem to be regarded as MBSG rated and will have the minimum section and strength properties given in this manual. This manual is produced based on several testings performed on representative plywood specimens at the Forest Products Division Forest Research Institute Malaysia (FRIM). To justify any plywood to be regarded as MBSG rated plywood the producers have to strictly follow the guidelines given in this manual. Since consistency is the keyword in the production of structural plywood the following factors have to be given emphasis.

1) Minimum quality of veneers that shall be used in the lay-up;
2) The acceptable ply thicknesses;
3) The standard panel thicknesses and configurations;
4) The type of adhesive and bond performance.

2.0 Choice of species

Any peelable Malaysian species having Specific Gravity of 0.45 or more is allowed to be used in the production of MBSG rated plywood.

3.0 MBSG rated plywood specifications

3.1 *Quality of Veneers*

The requirements on the grade of veneers are based on stipulations given in BS 6566:Part 6: 1985 that categorise veneers by visual assessment into the category of grades as in Table 1.

Table 1. Quality of Veneer

Category of veneer grades
GRADE B
GRADE BB
GRADE C

The veneers shall be graded according to the conditions and limitations given in *Appendix 1*.

3.1.1 Panel Grades

The panel grades are usually as sessed by the quality of appearance of the face and the back surface of the plywood. The possible combinations of face and backgrades for MBSG rated plywood are as in **Table 2**.

Table 2. Panel Grades

Combinations of face and back Grades
GRADE B / BB
GRADE B / C
GRADE BB / C

The Acceptable Ply Thicknesses

The thickness of each individual ply after hot pressing shall be within the following limits:

Outer ply: The minimum thickness of outer ply for any ply configuration is 0.6mm

For a 3-ply panel

The central ply shall be less than 70% of nominal panel thickness for plywood of a thickness up to and including 6.5mm.

or,

The central ply shall be less than 60% of the nominal panel thickness for plywood of a thickness greater than 6.5 mm.

For more than 3 plies panel

The outer plies and all the plies in the same grain direction as the outer plies shall have a total thickness of not less than 40% and not more than 65% of the nominal thickness of the panel.

3.3 *Nominal Panel Thicknesses and Ply Lay-Up*

Plywood panels for MBSG rated plywoods shall be produced according to the configurations given in Table 3

Table 3. Nominal Panel Thicknesses And Ply Lay-Up for MBSG Rated Plywood

Nominal Panel Thickness	4	6	8	9	10	12	15	16
No. Of Plies	3	3	5	5	5	5	5	7
Nominal Panel Thickness	18	20	21	22	24	25	28	
No. Of Plies	7	9	9	9	9	9	9	

3.3.1 Panel Tolerances

MBSG rated plywood panels shall be produced either in a sanded or unsanded form with the thickness tolerances as in Table 4

Table 4. Thickness tolerances for MBSG rated plywood

Maximum deviations perffutted between the mean thickness of a panel and its nominal thickness			Maximum permitted difference between thickness measurements of an individual sample panel		
Nominal thickness	Sanded	Unsanded	Nominal thickness	Sanded	Unsanded
Up to and including 4 mm	+ 0.2 - 0.4 mm	+0.8-(0.3 + 3% of t)*	Up to and including 12 mm	0.4 mm	0.8 mm
Over 4 mm	+ 0.2 - (O.4 + 3% of t)*		Over 12 mm	0.6 mm	1.0 mm

* t is the non-dnal panel thickness in nun.

3.4 *Type of Adhesive and Bond Performance*

For the climate condition that Malaysia has, ie. high temperature and high humidity, the Interior Grade (ie. MR - Moisture Resitant) type of adhesive bond will found to be unsuitable when the plywood are used for the exterior Experiences in many countries have shown that the **Exterior Grade** (ie. WBP Weather-Boil-Proof), equivalent or better) type is the most widely and confidently used bond from structural plywoods. Therefore, to eliminate the uncertainly in usage due to problems that might be caused by delamination, **MBSG plywoods must be produced using Exterior Grade bond only.**

3.4.1 Specification for Bond Performance of MBSG Plywood

The bond performance level shall be assessed according to the procedure described under British Standards 6566 : Part 8 : 1985 (for WBP bond type). The procedure involves the cold and hot (boiling) pretreatments of the specimens before they are tested for their tensile shear strength. The plywood is considered to have satisfactory bond if, when tested according to the above method, it has one of the combinations of shear strength and percentage of wood failure as given in Table 5.

Table 5.Specification for the bond perfomance

AVERAGE SHEAR STRENGTH	AVERAGE WOOD FAILURE	MINIMUM AVERAGE WOOD FAILURE IN ANY TEST PIECE
N/mm^2 (1Mpa)	%	%
$0.35 \leq t \leq 0.7$	≥ 75	25
$0.7 \leq t \leq 1.7$	≥ 50	15
$1.7 < t \leq 2.5$	≥ 25	5
$2.5 < t$	≥ 15	0

3.4.2 Bond Quality

For the purpose of quality control, the bond quality can be assessed by the knife test as stapulated in Appendix C of the British Standard 6566: Part 8:1985.

4.0 Moisture content

The moisture content of the veneers during gluing shall be between 6% to 14% or as appropriate according to the type of species and glue mix specifications.

5.0 Quality assurance and marking scheme for MBSG rated plywood

Quality control procedures might vary from mill to mill since there are always the influence of human judgement during grading of veneers and allowance of ply and panel thicknesses variations. To ensure that plywoods produced from any mill are MBSG rated as claimed, the following quality compliance scheme has to be adhered to.

1) To ensure that the mill abides to the guidelines in producing MBSG rated plywoods random sampling evaluation on the production shall be made. Not less than five (5) numbers of panels for each thickness shall be randomly selected from the mill's production line. The sampling shall be done by a representative of FRIM or a third party agreed by FRIM.

2) The samples shall be sent to the Wood Technology Lab of FRIM for performance evaluation as in section 6.0.

3) Upon positive performance evaluation an approval shall be given to the mill to use the MBSG rated plywood insignia on their products. The approval is valid for a period of one year.

4) To sustain the use of the MBSG rated plywood insignia random sampling evaluation shall be done again after one year. If the evaluation is found positive, the mill will be allowed to continue to use the MBSG rated plywood insignia on its plywoods. Otherwise, the certification will be revoked, and thus nullify the mill's claim for MBSG rated plywood production.

5.1 The MBSG Rated Plywood Insignia

The MBSG Rated Plywood Insignia, as shown below will bear the panel grade, panel thickness, mill's identification number, Malaysian Standard Code and FRIM's Approval code.

6.0 Performance evaluation

To justify the claim that the plywood panels are MBSG rated the following evaluations shall be made by FRIM on the random samples taken from the mill.

1) Requirement on the minimum thickness of individual plies;
2) Tolerances of the panel thickness;
3) Bond performance;
4) The minimum strength properties performance.

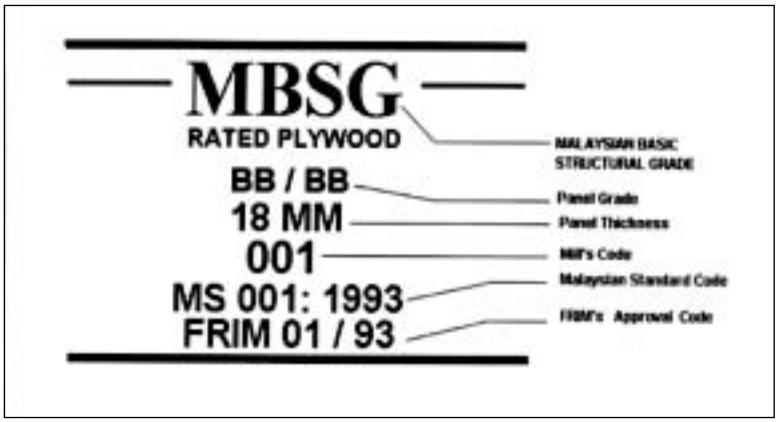

Figure 1. The MBSG Rated Plywood Insignia

8.0 Section properties

Plywood panels produced according to the configurations and specifications as stipulated in this manual will deem to have the section properties as in Table 6 (sanded) and Table7 (unsanded). These section properties are derived by the *Parallel-Ply Method* which assumes that only the plies parallel to the face grain (or span for bending) will provide the strength.

Table 6. Minimum Section Properties For MBSG Rated Plywood; By Parallel-ply *Method* (*Sanded*)

Nominal Panel Thickness (mm)	Net Panel Thickness (mm)	Min. No. of plies	Approx. mass per unit area (kg/m^2)	For 1 metre width					
				Plies perpendicular to face grain			Plies parallel to face grain		
				Area (mm^2/m)	Moment of Inertia (mm^4/m)	Section Modulus (mm^3/m)	Area (mm^2/m)	Moment of Inertia (mm^4/m)	Section Modulus (mm^3/m)
4	3.6	3	2.4	800	43	107	1200	2740	1520
6	5.4	3	3.6	1200	144	240	1200	6950	2570
8	7.4	5	4.9	2200	4850	2420	3200	14600	3940
9	8.3	5	5.5	2600	7020	3120	3700	19100	4610
10	9.3	5	6.2	3000	10300	4030	4100	24800	5330
12	11.2	5	7.4	3400	16500	5510	4800	37600	6720
15	14.2	5	9.4	4600	36800	9440	6000	64700	9120
16	15.1	7	10.0	4500	53800	10900	6400	105000	14000
18	17.1	7	11.4	5500	82800	14600	7200	146000	17000
20	19.0	9	12.6	6000	127000	18400	9200	152000	16000
21	20.0	9	13.3	6320	148000	20400	9600	176000	17700
22	20.9	9	13.9	6640	171000	22500	10000	204000	19500
24	22.9	9	15.2	7280	224000	26900	10800	267000	23300
25	23.9	9	15.9	7600	254000	29300	11200	303000	25400
28	26.8	9	17.8	8560	361000	37000	12400	429000	32100

Table 7. Minimum Section Properties For MBSG Rated Plywood; By Parallel-ply *Method* (*Unsanded*)

Nominal Panel Thickness (mm)	Net Panel Thickness (mm)	Min. No. of plies	Approx. mass per unit area (kg/m^2)	For 1 metre width					
				Plies perpendicular to face grain			Plies parallel to face grain		
				Area (mm^2/m)	Moment of Inertia (mm^4/m)	Section Modulus (mm^3/m)	Area (mm^2/m)	Moment of Inertia (mm^4/m)	Section Modulus (mm^3/m)
4	3.6	3	2.4	800	43	107	1200	2740	1520
6	5.5	3	3.7	1300	183	282	1200	7240	2630
8	7.5	5	5.0	2400	5330	3600	3300	15100	4020
9	8.4	5	5.6	2600	7450	3240	3600	19400	4630
10	9.4	5	6.2	3000	10800	4170	4000	25100	5340
12	11.3	5	7.5	3600	17600	5780	4900	38600	6830
15	14.3	5	9.5	4600	38100	9640	6100	66100	9250
16	15.2	7	10.1	4800	57500	11500	6400	108000	14200
18	17.2	7	11.4	5400	84400	14800	7200	149000	17300
20	19.1	9	12.7	6100	131000	18800	9200	153000	16000
21	20.1	9	13.4	6420	152000	20800	9600	178000	17700
22	21.0	9	13.9	6740	176000	22900	10000	206000	19500
24	23.0	9	15.3	7380	230000	27400	10800	269000	23400
25	24.0	9	15.9	7700	260000	29800	11200	305000	25500
28	26.9	9	17.9	8660	368000	37600	12400	432000	32200

9.0 **Strength properties**

Plywood panels produced according to the configurations and specifications as stipulated in this manual will deem to have strength properties as in Table 8. These values are applicable for all of the panel grades of MBSG rated plywoods.

Table 8. Basic Unit Stresses for Standard Construction of MBSG rated Plywood (According to Parallel-Ply.Method)

TYPE OF STRESS	BASIC UNIT STRESSES (EITHER IN PARALLEL OR PERPENDICULAR TO FACE GRAIN) (MPA)
Extreme Fibre in Bending	24.0
Tension	24.0
Compression	18.0
PanelShear	
(Shear-Through-1hickness)	1.6
Modulus of Elasticity	16 000

Appendix 1

Permissible defects for the classification by appearance of plywood with outer plies of tropical hardwood

Categories of defects	Grade		
	B (face)	**BB**	**C (back)**
1.Pin knots	Permitted if tight and not clustered.	Permitted	Permitted
2.Sound intergrown knots, exceeding 3 nun in diameter ply, to a maximum individual	Four permitted per 3 square metres of the surface of the outer ply, to a maximum individual diameter of 13 mm (not clustered)	Five permitted per 3 square metres of the surface of the outer ply, to a maximum individual diameter of 25 mm.	Permitted
3. Partially intergrown knots, unsound knots and non-adhering knots; also holes except those due to borers and parasitic plants.	Not permitted	Permitted to a maximum individual diameter of 9 mm, provided their cumulative diameter does not exceed to 40 mm per square metre and they are properly filled.	Permitted
4. Irregularities in the structure of the wood; sound burls (curly grain)	Permitted if smooth	Permitted	Permitted
5. Splits a) Open splits (puttied)	Two permitted at each end of a panel, to a maximum individual width of 3 mm and a maximum individual length of 6% of the panel length.	Two permitted at each end of a panel, to a maximum individual width of 15 mm and a maximum individual length of 12.5% of the panel length.	Eight permitted per panel, to a maximum individual width of 15 mm and a maximum individual length of 40% of the panel length.
b) Closed splits (hairline)	Three permitted per panel at the ends and to a maximum individual length of 100 mm.	Permitted	Permitted
c) Compression failure (cross break)	One permitted per outer ply provided hairline and of a length not exceeding 10% of the panel width.	One permitted per outer ply provided hairline and of a length not exceeding 10% of the panel width.	
6. Bark pockets-	Not permitted	Permitted if very slight	Permitted
Resin pockets	Permitted	One permitted per square meter of the outer ply, to a maximum individual width of 4 mm and to a maximum individual length of 100 mm.	Permitted
Resin exudation	Not permitted	Permitted if slight	Permitted
7.Defects due to borers, vines and parasitic plants			
a) Worm holes and channels	Not permitted	Pinworm holes permitted provided they are occasional, scattered and well puttied. No discoloration permitted. worm channels not permitted.	Permitted
b) Marks of parasitic plants and vines	To permitted per outer ply, to a maximum individual width of 4 mm and maximum individual length of 100 mm, provided they are smoothly sanded and levelled.	Permitted if occasional and smoothly sanded and levelled.	Permitted
c) Chicken track	Permitted it isolated and slight	Permitted	Permitted

continued...

continued

Categories of defects	Grade		
	B (face)	BB	C (back)
8.Sound discolouration (natural), stain/mineral streak.	Permitted if very slight	Permitted if not excessive	Permitted
9. Rot	Not permitted	Not permitted	Not permitted
10. Open joints	Not permitted	Three permitted per outer ply, to a maximum individual width of 3 mm. and to a maximum individual length of 10% of the panel length, if properly filled.	Permitted to a maximum individual width of 15 mm and to a maximum individual length of 60% of the panel length.
Mechanical defects, e.g. chainmarks, machinery stain, sander bums, metal stain, grease, oil or coloured chalk on face.	Not permitted	Permitted if slight and occasional	Permitted
14. Roughness, brashness or tom grain.	Permitted if very slight and occasional	Permitted if slight	Permitted if not excessive
17. Inclusion of metal particles.	Permitted if non-ferrous and in inner plies or cores only	Pern-dued if non-ferrous and in inner plies or cores only	Permitted if non-ferrous and in inner plies or cores only
Sanding	Smooth	Reasonably smooth	No special requirements
18. Repairs, boat or symmetrical patch	Not permitted	Five permitted per outer ply, to a maximum individual width of 100 mm and to a maximum individual length of 150 mm, provided they are well made, are of similar grain and are colour matched.	Permitted
Shims	Not permitted	Permitted to a maximum individual width of 5mm and to a maximum individual length of 300 mm, provided they are well made, are of similar grain and are colour matched.	Permitted
Tape or glue residue, putty mark	Not permitted	Permitted if slight and smoothly sanded.	Permitted
Knifemark	Not permitted	Permitted to a width of 0.8 mm if slight.	Permitted
20. Other defects which are not indicated	Not permitted unless they resemble a defect already defined in which case they shall be considered under that category.	Not permitted unless they resemble a defect already defined in which case they shall be considered under that category.	Not permitted unless they resemble a defect already defined in which case they shall be considered under that category.

Appendix 11

In drawing up this Standard Product Manual references have been made to the following publications:

British Standards Institution. 1985. B.S. 6566: Part 1: Specification for Construction of Panels and Characteristics of Piles Including Marking. British Standards Institution, London.

British Standards Institution. 1985. B.S. 6566: Part 2: Glossary of Terms. British Standards Institution, London.

British Standards Institution. 1985. B.S. 6566: Part 4: Specification for Tolerances on the Dimension of Plywood Panels. British Standards Institution, London.Malaysia.

British Standards Institution. 1985. B.S. 6566: Part 5: Specification for Moisture Content. British Standards Institution,London.

British Standards Institution. 1985. B.S. 6566: Part 6: Specification for Limits of Defects for the Classification of Plywood by Appearance. British Standards Institution, London.

Standards and Industrial Research Institute of Malaysia. 1974. MS 3.22: Specification for Plywood. SIRIM, Shah Alam, Malaysia.

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