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METHODS OF MEASUREMENT AND EVALUATION OF DEFECTS IN TIMBER

PART II CONVERTED TIMBER

(First Revision)

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Indian Standard

METHODS OF MEASUREMENT AND EVALUATION OF DEFECTS IN TIMBER

PART II CONVERTED TIMBER

(First Revision)

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AMENDMENT NO. 1 MARCH 1990
TO
IS 3364 (Part 2) : 1976 METHODS OF MEASUREMENT AND EVALUATION OF DEFECTS IN TIMBER

PART 2 CONVERTED TIMBER

(First Revision)

(*Page* 11, *Table* 8, *Note* 3) — Substitute '0·5 m^2' *for* '0·5 cm^2'.

(CED 9)

Reprography Unit, BIS, New Delhi, India

Indian Standard

METHODS OF MEASUREMENT AND EVALUATION OF DEFECTS IN TIMBER

PART II CONVERTED TIMBER

(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (Part II) (First Revision) was adopted by the Indian Standards Institution on 24 September 1976, after the draft finalized by the Timber Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This standard was first published in 1965. The earlier version of the standard covered defects both in logs and converted timber. However since some of the defects which are found in logs may not be there in converted timber and vice-versa, it was felt desirable, for the sake of easy reference, to deal with logs and converted timber in separate standards. Accordingly, the standard is now being published in two parts, Part I dealing with defects in logs, and Part II dealing with defects in converted timber.

0.3 There are several Indian Standards and also individual specifications of various government departments which cover the use of timber of various species for various purposes. Timber being a natural product contains several defects which may considerably influence its utilization. Being an important raw material for various industrial and engineering purposes the quality of species requires to be graded in several cases. Several international grading rules are available for various forms of hardwoods, conifers and teak. In order that a suitable and common basis may be provided for satisfactory grading, an attempt is made to standardize methods of measuring the various defects and establishing a system of quantitative evaluation of the commonly occurring ones. While occurrence, location and distribution of defects may serve as acceptance criteria for selection of material for any purpose, the cumulative effect of defects as indicated in their quantitative evaluation will help ultimate grading of the material, which is again reflected in price structure.

0.4 The provisions contained in this standard are based on many of the existing Indian Standards on timber and grading rules of Asia Pacific Forestry Commission. In cases where no guidance is available from these specifications, a logical projection is made for such defects which have not been covered anywhere else so far.

0.5 While it may be remembered that an approximate relationship may exist between the grade of a material and the percentage of the utility value and price structure of the same, it requires to be emphasized that the quantitative evaluation of defects cannot be merely a result of mathematical calculations, but of a collection of the different aspects of a natural product brought on as close as possible to a technological pattern. As such, the use of the present standard is subject to the limitations of the best and worst of human elements in inspectors of timber, who depend on this standard for their guidance.

0.6 Despite every attempt to harmonize different points of consideration in framing these rules it is anticipated that there would be several gaps between theory and practical work. It is, therefore, suggested that in the application of these rules many facts will come into light which would be incorporated in successive revisions of the present standard.

0.7 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in this field in this country.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard (Part II) deals with methods of identification, measurement and quantitative evaluation of commonly occurring defects in converted timber which includes baulks, sleepers, scantlings, planks and battens.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 707-1976† and the following definitions, shall apply.

2.1 Defect — An abnormality or irregularity in wood which lowers its technical quality or commercial value by decreasing it in strength and affecting adversely its use or its appearance or in further conversion. For the purpose of this standard defects are divided according to kind and evaluated in units with regard to their sizes.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms applicable to timber technology and utilization (*second revision*).

2.2 Equivalent Defect — Anv defect not listed but which can be rated the same as a defect mentioned in the standard and which causes equal degrade in further utilization.

2.3 Units of Defects — It is a quantitative representation of the approximate degrade of the utilizable material for each defect. A sum of units of various defects gives a total estimate of entire degrade due to all defects present simultaneously in the material under consideration. The units of various defects are mentioned in the corresponding tables given under each defect.

3. IDENTIFICATION AND MEASUREMENT OF DEFECTS

3.1 Check — It is identified as a fine crack indicating separation of fibres along the grain, not extending through the piece from one surface to another. This is measured by the length and maximum width of separation of fibres. When the width of check is less than 2 mm and the checks are numerous on any surface, they are evaluated on the basis of their average length and the affected area on the surface, expressed as a percentage of the whole area on which they appear as given in Table 1. When the width of check is more than 2 mm, this is evaluated in the same manner as shake (**3.9** and Table *8*).

3.2 Cross Grain — It is identified by the inclination of fibres on the surface of the material and it includes spiral grain, diagonal grain, inclined grain and slanting grain. It is measured by the slope of the grain on the surface to the edge of the piece. When it is present on two adjacent surfaces, the combined slope is given by the following equation:

$$\frac{1}{x^2} = \frac{1}{a^2} + \frac{1}{b^2}$$

where $\frac{1}{a}$ and $\frac{1}{b}$ are the slopes on the two faces and $\frac{1}{x}$ is the combined slope. It is quantitatively evaluated as given in Table 2.

3.3 Decay or Rot — These are identified as brownish or light grey patches on the lateral surface of the material and also in the cross section. The condition of decay is judged by the degree of the softness as detected by the relative ease of penetration of a sharp knife or a similar tool. The decay is estimated by the approximate affected area expressed as a percentage area of the entire surface. The units of defects for decay or rot are given in Table 3.

3.4 Distortion or Warp — This is identified by any deviation in converted timber from a true plane surface causing departure from its original planes. It includes bow, cup, spring, twist and any combination thereof.

TABLE 1 DEFECT VALUES FOR CHECKS OF LESS THAN 2 mm WIDTH

(*Clause* 3.1)

Length of an Average Check	Affected Area Expressed as Percentage of the Whole Area on Which They Appear				
	20	40	60	80	100
(1)	(2)	(3)	(4)	(5)	(6)
cm					
5	0·01	0·02	0·04	0·08	0·16
10	0·02	0·04	0·08	0·16	0·32
15	0·03	0·06	0·12	0·24	0·48
20	0·04	0·08	0·16	0·32	0·64
25	0·05	0·10	0·20	0·40	0·80
30	0·06	0·12	0·24	0·48	0·96
35	0·07	0·14	0·28	0·56	1·12
40	0·08	0·16	0·32	0·64	1·28
45	0·09	0·18	0·36	0·72	1·44
50	0·10	0·20	0·40	0·80	1·60

NOTE 1 — Group of checks less than 5 cm in length or fine checks shall be ignored.

NOTE 2 — The area affected by checks is given by a minimum rectangle in which all the checks of a particular group are enclosed and the area affected is expressed as percentage of the surface on which they appear.

NOTE 3 — The above values are applicable for material of length of 5 m and fraction thereof. For material of greater length the values shall be multiplied by $5/L$ where L is the length of the material in metres.

NOTE 4 — For intermediate values, the next higher measurement of defect shall be taken.

TABLE 2 DEFECT VALUES OF SPIRAL GRAIN

(*Clause* 3.2)

Slope	Unit
5° to 10°	0·20
11° ,, 20°	0·45
21° ,, 30°	0·65
31° ,, 40°	0·80
41° ,, 50°	0·90
above 50°	1·00

NOTE — Slope up to 5° will not be considered.

TABLE 3 DEFECT VALUES FOR DECAY OR ROT

(*Clause* 3.3)

Percentage Area of Decay and Rot	Unit
1	0·01
2	0·02
5	0·05
10	0·10
15	0·15
20	0·20
25	0·25
30	0·30
35	0·35
40	0·40
45	0·45
50	0·50

Note — More than 50 percent area decayed shall not be considered.

3.4.1 *Bow* — It is identified as a distortion of a piece of timber in which the face becomes concave or convex longitudinally. It is measured by the chord which the curvature makes between the extreme ends and by the depth at the middle portion. It is evaluated by the ratio of maximum deviation (*d*) to the length of the chord (*l*) according to Table 4.

TABLE 4 DEFECT VALUES FOR BOW AND SPRING

Ratio of Maximum Deviation to the Length of the Chord (d/l)	Unit
0·01	0·01
0·02	0·02
0·03	0·05
0·04	0·08
0·05	0·12
0·06	0·16
0·07	0·22
0·08	0·30
0·09	0·40
0·10	0·50

Note — For intermediate values the next higher measurement of defect shall be taken.

3.4.2 *Cup* — It is identified as a deviation of a piece of timber in which the face becomes concave or convex across the grain or the width of the piece. It is measured by the chord which the curvature makes between the extreme edges and by the depth at the middle portion. It is evaluated by the ratio of maximum deviation (d) to the length of the chord (l) as given in Table 5.

TABLE 5 DEFECT VALUES FOR CUP

Ratio of Maximum Deviation to Length of the Chord (d/l)	Unit
0·01	0·01
0·025	0·02
0·050	0·05
0·075	0·10
0·100	0·20

Note — For intermediate values the next higher measurement of defect shall be considered.

3.4.3 *Spring* — It is identified as an edgewise deviation in a piece of timber forming a flat arch if laid on its tangential edge. It is measured by the chord which the curvature makes between the extreme ends and by the depth at the middle portion. It is evaluated by the ratio of maximum deviation (d) to the length of the chord (l) as given in Table 4.

3.4.4 *Twist* — It is identified as the spiral distortion of the edges of a piece of timber so that the four corners of any face are not in the same plane. It is measured by the degree of twist and is generally expressed qualitatively as slight, moderate and heavy, depending on whether the twist is less than 10° or between 10° and 25° and more than 25°, as estimated on the basis of relative rotation between the two ends.

3.5 Hole — It is identified as cavities caused by worms, insects, birds or mechanical means and is expressed by the diameter of the hole. When occurring in large numbers, it shall be described by the number present in any 100 cm^2 area of the surface on which it occurs. This includes borer holes, grub holes, insect holes but pin holes and knot holes (loose knot) are excluded. This is quantitatively evaluated as in Table 6.

3.6 Knot — This is identified as basal portion of branches which has been cut off at the trunk, appearing as embedded material in the timber generally circular in shape. In case of round and oval shaped knots, the maximum diameter shall be taken as the size of the knot and shall be described according to its form, quality* and position on the surfaces of the timber. These are quantitatively evaluated in terms of number of knots on a surface and the mean of the maximum diameter of knots as given in Table 7.

TABLE 6 DEFECT VALUES FOR HOLES

(*Clause* 3.5)

Concentration of Holes per 100 cm² not More Than	Diameter of the Largest Hole in any Concentration				
	Up to 5 cm	Above 5 Up to 10 cm	Above 10 Up to 15 cm	Above 15 Up to 20 cm	Above 20 Up to 25 cm
(1)	(2)	(3)	(4)	(5)	(6)
1	0·01	0·03	0·06	0·09	0·18
2	0·02	0·06	0·12	0·18	0·36
3	0·03	0·09	0·18	0·27	0·54
4	0·04	0·12	0·24	0·36	0·72
5	0·05	0·15	0·30	0·45	0·90

NOTE 1 — If holes are concentrated separately at more than one place the defect units will be added for all places.

NOTE 2 — Pin holes are not evaluated quantitatively.

NOTE 3 — Knot holes (loose knot) shall be evaluated as unsound knots.

TABLE 7 DEFECT VALUES FOR SOUND KNOTS

(*Clause* 3.6)

No. of Knots	Mean of Maximum Diameter of Knots			
	Up to 5 cm	Above 5 Up to 10 cm	Above 10 Up to 15 cm	Above 15 Up to 20 cm
1	0·01	0·04	0·08	0·12
2	0·02	0·08	0·16	0·24
3	0·03	0·12	0·24	0·36
4	0·04	0·16	0·32	0·48
5	0·05	0·20	0·40	0·60
6	0·06	0·24	0·48	0·72
7	0·08	0·30	0·60	0·90
8	0·10	0·40	0·80	1·20
9	0·13	0·54	1·08	1·62
10	0·17	0·70	1·40	2·10
11	0·21	0·84	1·60	2·42
12	0·25	1·00	2·00	3·00
13	0·29	1·16	2·32	3·48
14	0·33	1·32	2·64	3·96
15	0·38	1·50	3·00	4·50

NOTE 1 — Defect values shall be doubled for unsound or decayed knots.

NOTE 2 — When the spike or slay knot appears on the other face of the material the defect value for each face shall be added.

*Live knot, sound knot, decayed knot, tight knot, dead knot, loose knot, knot hole.

3.6.1 *Spike or Slay Knot* — This is identified as a knot revealed in a section cut approximately parallel to its axis and so having an elongated shape. In this case the average of the two projections in the parallel and perpendicular direction to the grain on that surface as shown in Fig. 1 shall be taken as size of the knot and evaluated as given in Table 7.

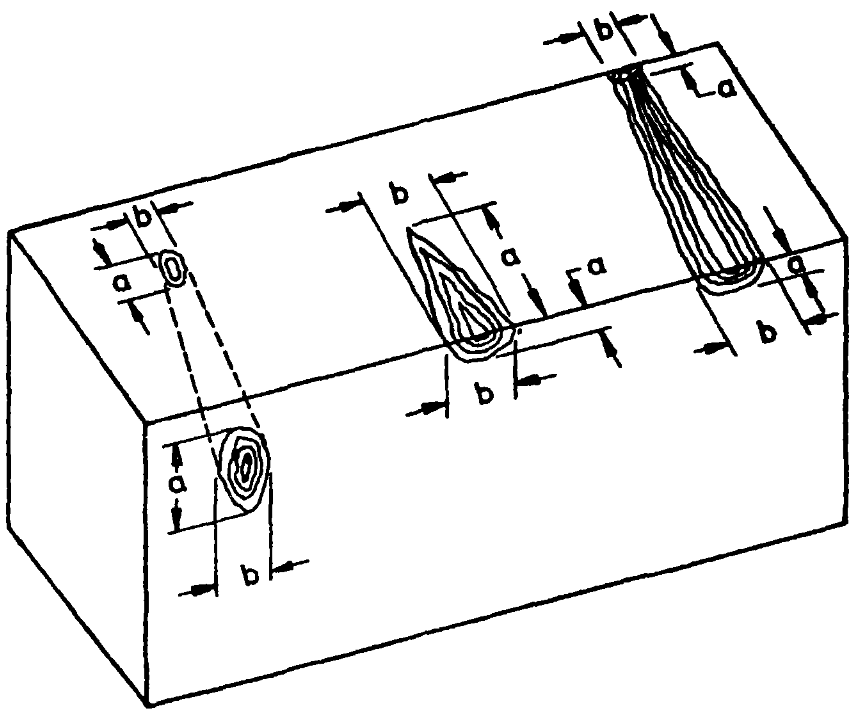

FIG. 1 MEASUREMENT OF TWO PROJECTIONS (*a* AND *b*) ON EACH FACE IN SPIKE OR SLAY KNOTS

3.7 Mould — It is identified as a woolly or powdery growth that forms on wood in damp stagnent atmosphere. It is confined usually to the surface of the sapwood and is not evaluated quantitatively for units of defects.

3.8 Sap Stain — It is identified as discolouration usually in the sapwood on the surface of the material. It is not evaluated quantitatively for units of defects.

3.9 Shake — This is identified as partial or complete separation between adjoining layers of tissues as seen on the end surfaces of the material and is classified as heart shake, ring or cup shake and star shake. All shakes other than star shakes shall be measured by the length and the maximum width of the opening, the latter serving also as an indication of the approximate depth of the opening. The shakes shall be described alongwith the form and location on the cross section of the material and quantitatively evaluated as given in Table 8.

3.9.1 *Star Shake* — These are identified as a number of shakes occurring at or near the pith giving the appearance of a star on the end surface of the material and shall be evaluated by the length and width of the longest shake in the star and multiplying it with half the number of shakes in the star as in Table 8.

TABLE 8 DEFECT VALUES OF SHAKES

Length of Shake	Width of the Shake							
	0·2 cm	0·4 cm	0·6 cm	0·8 cm	1·0 cm	1·5 cm	2·0 cm	2·5 cm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
cm								
2	0·06	0·06	0·06	0·08	0·10	0·10	0·12	0·14
4	0·10	0·12	0·14	0·16	0·18	0·20	0·24	0·26
6	0·14	0·16	0·20	0·26	0·28	0·30	0·36	0·40
7	0·20	0·24	0·26	0·32	0·36	0·40	0·46	0·54
8	0·26	0·30	0·34	0·42	0·46	0·50	0·58	0·66
9	0·30	0·36	0·40	0·50	0·56	0·60	0·70	0·80
10	0·34	0·40	0·46	0·58	0·64	0·70	0·82	0·94
12	0·40	0·48	0·54	0·66	0·74	0·80	0·94	1·06
14	0·50	0·58	0·66	0·84	0·92	1·00	1·16	1·34
16	0·54	0·64	0·74	0·92	1·02	1·10	1·28	1·46
18	0·60	0·70	0·80	1·00	1·10	1·20	1·40	1·60
20	0·66	0·76	0·86	1·08	1·20	1·30	1·52	1·74

NOTE 1 — For more than one shake the values may be added.

NOTE 2 — When applying these values for star shakes, only the largest shake is taken into consideration but the values may be taken by multiplication of the above with half the number of shakes in the star.

NOTE 3 — These values are applicable for converted material whose area of cross section does not exceed 0·5 cm^2. For material of larger cross section, the values shall be halved.

NOTE 4 — This table is also used for checks of width more than 2 mm.

NOTE 5 — For intermediate values the next higher measurement of the defect shall be taken.

3.10 Split — It is identified as a separation of fibres as seen both on the cross section as well as on the longitudinal surfaces of the converted material. It is measured by the length on the longitudinal surface and by the depth at the end section (that is, the extent of the split as measured on the end section). This is quantitatively evaluated as given in Table 9.

TABLE 9 DEFECT VALUES FOR SPLITS

Length of Split in cm on the Longitudinal Surface	Depth of the Split at the End Surface						
	1·0 cm	1·5 cm	2·0 cm	2·5 cm	3·0 cm	3·5 cm	4·0 cm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0·25	0·06	0·06	0·06	0·08	0·10	0·10	0·12
0·50	0·10	0·12	0·14	0·16	0·18	0·20	0·24
0·75	0·14	0·16	0·20	0·26	0·28	0·30	0·36
1·00	0·20	0·24	0·26	0·32	0·36	0·40	0·46
1·25	0·26	0·30	0·34	0·42	0·46	0·50	0·58
1·50	0·30	0·36	0·40	0·50	0·56	0·60	0·70
1·75	0·34	0·40	0·46	0·58	0·64	0·70	0·82
2·00	0·40	0·48	0·54	0·60	0·74	0·80	0·94
2·25	0·46	0·54	0·60	0·76	0·84	0·90	1·06
2·50	0·50	0·58	0·66	0·84	0·92	1·00	1·16
2·75	0·54	0·64	0·74	0·92	1·02	1·10	1·28
3·00	0·60	0·70	0·80	1·00	1·10	1·20	1·40
3·25	0·66	0·76	0·86	1·08	1·20	1·30	1·52
3·50	0·70	0·82	0·94	1·16	1·28	1·40	1·64
3·75	0·74	0·88	1·00	1·26	1·38	1·50	1·76
4·00	0·80	0·94	1·06	1·32	1·46	1·60	1·86

NOTE 1 — For more than one split but less than three, the values may be added.

NOTE 2 — For splits more than three in number, the largest split may be considered and multiplied by half the number of total splits.

NOTE 3 — The above values are applicable for material of length of 5 m and fraction thereof. For material of greater length the values should be multiplied by $5/L$ where L is the length of the material in metres.

NOTE 4 — For intermediate values the next higher measurement of the defects shall be taken.

3.11 Streak — It is identified by the presence of foreign material in timber and includes black streak, gum streak, mineral streak, pitch streak and radial streak. No standard method is recommended for its measurement.

3.12 Texture — This is only judged by the feel and appearance of the wood as seen on the freshly prepared surface and described qualitatively as coarse textured or fine textured.

3.13 Wane — It is identified by the presence of the original sapwood surface lying immediately below the bark, on any face or edge of a piece of sawn timber and is measured at its deepest portion on any face. If it is present along both edges the sum of the depths along both the edges will be the measure of the wane. It is usually expressed as a percentage or a fraction of the width of the surface on which it occurs and it is not evaluated quantitatively as a unit of defect.

4. OTHER DEFECTS

4.1 Any defect not listed above but which will debar any piece from its expected utility can be considered as equivalent defect to any of the above for the purposes of measurement and evaluation depending on the appearance, size, location and distribution.

4.2 Defect values for those which cannot be considered as equivalent defects but which can be definitely categorized as those which reduce the utility of timber, a value of 0·10 may be added to the total for safety.

5. TOLERANCES IN MEASUREMENT OF DEFECTS AND THEIR EVALUATION

5.1 All linear measurements of defects shall be made correct to 1 mm and surface area measurements shall be calculated correct to 1 cm^2 based on linear measurements.

5.2 The units of defects shall be evaluated correct to a second place of decimal.

5.3 Where ready figures for the units are not available in Tables 1 to 9 and an estimate is required to be made, the same shall be proportionately obtained in accordance with the general pattern of the concerned table. In all cases of doubts the next higher point will be chosen from the table.

5.4 All faces of the material shall be examined and defect values for each defect shall be added. If however, the same defect appears on more than one surface, the higher value of the defect only shall be taken.

5.5 All defects are expected to be evaluated with the material squarely sawn to a fairly smooth surface.

5.6 A lot shall consist of material of the same size or cross section though varying in length.

6. INFLUENCE OF DEFECTS ON THE PROPERTIES OF TIMBER

6.1 The following indicates the general influence of some of the defects mentioned in the standard. In some cases influence of defects not mentioned in the standard is also given for general guidance.

6.1.1 *Checks, Splits and Shakes* — These defects lower the resistance to shear in converted timber.

6.1.2 *Compression Wood* — Compression wood has an increased density and shrinkage along the grain and decreased shock resistance. At the same time compression wood has lower water absorbing capacity and increased hardness and crushing strength parallel to grain.

6.1.3 *Tension Wood* — It has high longitudinal shrinkage tending it to warp and split. On machining the surface tends to be fibrous or woolly especially when green.

6.1.4 *Heartwood Rot* — This defect lowers the mechanical properties of wood. The development of fungi which attack heartwood, usually stops in cut sizes of timber.

6.1.5 *Knots* — The influence of knots on the mechanical properties of sawn timber varies according to size, shape, quality and occurrence of knots in the timber. Further, knots tend to weaken timber in tension but may improve the strength in compression. Knots make working of the wood difficult.

6.1.6 *Sap Rot* — The wood damaged by sap rot has a decreased shock resistance and increased water absorption. If wood damaged by sap rot is insufficiently seasoned or is again moistened after drying, fungi may develop in the wood in service.

6.1.7 *Slope of Grain* — Slope of grain lowers the tensile strength parallel to the grain and the modulus of rupture. This lowering is greater in case of radial slope of grain.

6.1.8 *Loosen Grain* — Loose-grained timber is weaker than 'close grained' timber; and loose grain reduces the strength of structural material.

6.1.9 *Wane* — Wane reduces the mechanical properties of wood and the volume.

6.1.10 *Worm Holes* — Shallow worm holes as well as deep small holes do not affect the quality of cut timber considerably. Deep large worm holes spoil the appearance and reduce the mechanical properties of timber.

6.1.11 *Pith Pockets* — Pith pockets affect the appearance of timber and destroy the integrity of the wood.

6.1.12 *Boxed Heart* — Boxed heart in cut sizes of timber, if sound, does not affect the quality appreciably.

6.1.13 *Discolouration of Heartwood* — The wood of the coloured spots and streaks does not differ in mechanical properties appreciably from normal wood. Fungi, causing discolouration of heartwood, usually stop their development in cut timber. Where timber has been given a preservative treatment, this defect may be ignored.

6.1.14 *Mould* — Mould spoils the appearance of wood. When conditions are favourable for its development, mould can pass on to other organic material from mouldy timber. Where timber has been given a preservative treatment, this defect may be ignored.

6.1.15 *Sap Stain* — Sap stain, of which blue stain is more important, does not affect the strength properties of timber, but spoils its appearance. Sap stain may be taken to indicate that wood is in a receptive condition for the attack of wood rotting fungi under favourable conditions. Where timber has been given a preservative treatment, this defect may be ignored.

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Conversion*
Force	newton	N	1 N = 1 kg.1 m/s²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m²
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Pressure, stress	pascal	Pa	1 Pa = 1 N/m²

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