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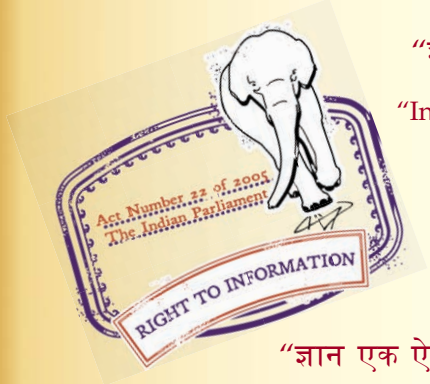

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"Knowledge is such a treasure which cannot be stolen"

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Indian Standard

SPECIFICATION FOR STRUCTURAL TIMBER IN BUILDING

(First Revision)

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SPECIFICATION FOR STRUCTURAL TIMBER IN BUILDING

(First Revision)

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Indian Standard

SPECIFICATION FOR STRUCTURAL TIMBER IN BUILDING

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 25 March 1986, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Timber on account of its non-homogeneous character and the inherent natural defects is generally considered with doubt by the engineers and builders for permanent structures. Conventional ways of working with timber have resulted in wastage of material and labour. Although wood like other materials of nature is subject to attack by various destructive agents, it is now well known that techniques are available to prolong its life so that various practical service requirements can be met with. Developments in the field of timber engineering have helped in wise and economic use of timber for structural purposes.

0.3 This standard was originally published in 1966. The present revision has been undertaken to incorporate the developments and data now available on strength characteristics, durability and treatability of more species. The important changes made in the revision are updating of grouping of timbers for structural use with presently available data and enlisting of permissible defects of timber.

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

1. SCOPE

1.1 This standard covers the various requirements of structural timber for use in buildings. It includes classification and grouping of different species of timber, their suitability for permanent and temporary structures, factors affecting strength, tolerances on dimensions, influence of defects and allowance for such defects in timber.

2. TERMINOLOGY

2.0 For the purpose of this standard, definitions given in IS : 707-1976*, IS : 883-1970† and the following shall apply.

2.1 Permanent Structures — Structural units in timber which are constructed for a long duration and wherein adequate protection and design measures have initially been incorporated to render the structure serviceable for the required life.

2.2 Temporary Structures — Structures which are erected for a short period, such as hutments at project sites, for rehabilitation, temporary defence constructions, exhibition structures, etc.

3. MATERIAL

3.1 Species of Timber — The species of timber recommended for various constructional purposes are given in Table 1. For availability and general characteristics like durability, treatability, refractoriness, etc, of these species reference may be made to IS : 399-1963‡ and IS : 401-1982§. For safe working stresses, reference may be made to IS : 883-1970†. Species of timber other than those mentioned may be used provided the basic strength characteristics are determined to satisfy the limits as specified under **4.2** and also the general principles of designing outlined in IS : 883-1970† are followed.

NOTE — For obtaining strength characteristics of the unlisted species, a reference may be made to the Forest Research Institute and Colleges, Dehra Dun.

3.1.1 Timber species may be identified in accordance with good practice. References may also be made to IS : 4970-1973‖.

3.1.2 Different species of structural timber may be classified according to their:

a) strength characteristics (*see* **3.1.3**, **4.2** and **5**);

b) durability (*see* **3.3.1**); and

c) treatability (*see* **3.3.3**).

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*Glossary of terms applicable to timber technology and utilization (*second revision*).
†Code of practice for design of structural timber in building (*third revision*).
‡Classification of commerical timbers and their zonal distribution (*revised*).
§Code of practice for preservation of timber (*second revision*).
‖Key for identification of commerical timbers (*first revision*).

TABLE 1 GROUPING OF TIMBERS FOR STRUCTURAL USE

(*Clauses* 3.1, 4.1.1.1, 4.1.1.2 *and* 4.1.2)

Heartwood Naturally Durable	Species for Permanent Structures				Species for Temporary Structures or Semi-Structural Uses	
	First Choice		Second Choice			
	Heartwood moderately durable with Class 'a', 'b' and 'c' treatability and of low durability with Class 'a' and 'b' treatability		Heartwood moderately durable but refractory to treatment, that is, of Class 'd' treatability (treatability can be Improved for small dimensioned stocks)		Moderately Durable or Low Durability Species Whose Heartwood is Very Refractory to Treatment or Species Whose Durability and/or Treatability is not Yet Known	
1	2		3		4	
Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name
			GROUP A				
Acacia catechu	Khair	*Manilota polyandra* (Syn. *Cynometra polyandra*)	Ping	*Grewia tiliifolia*	Dhaman (Madras)	*Acacia chundra**	Red Kutch (Lal Khair)
Albizia odoratissima	Black siris (Kala siris)					*Bruguiera* spp.*	Bruguiera (Mangrove)
Hopea utilis (*Balanocarpus utilis*)	Karung						
Hopea glabra and Hopea parviflora	Hopea					*Sageraea elliptica**	Chooi
Mesua ferrea *Mimusops littoralis*	Mesua Bullet-wood					*Stereospermum chelonoides**	Padri (Madras)
Petrocarpus santalinus	Red sanders*						

(*Continued*)

TABLE 1 GROUPING OF TIMBERS FOR STRUCTURAL USE — *Contd*

Heartwood Naturally Durable	Species for Permanent Structures				Species for Temporary Structures or Semi-Structural Use	
	First Choice		Second Choice			
	Heartwood moderately durable with Class 'a', 'b' and 'c' treatability and of low durability with Class 'a' and 'b' treatability		Heartwood moderately durable but refractory to treatment, that is, of Class 'd' treatability (treatability can be improved for small dimensioned stocks)		Moderately Durable or Low Durability Species Whose Heartwood is Very Refractory to Treatment or Species Whose Durability and/or Treatability is not Yet Known	
1	2		3		4	
Botanical Name Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name
Poeciloneuron indicum Ballagi						
Shorea robusta Sal (Uttar Pradesh, West Bengal Bihar, Assam)						
Vitex altissima Milla						
	GROUP B					
Albizia lebbeck Kokko *Anogeissus latifolia* Dhaura (Axle wood, Bakli)	*Acacia nilotica* *Adina cordifolia* *Cullenia rosay-roana*	Babul Haldu Karani	*Carallia lucida* *Grewia vestita*	Maniawga Dhaman (West Bengal)	*Acacia ferruginea** *Acrocarpus raxinifolius*	Safed Khair Mundani
Artocarpus hirsutus Aini (Madras)	(Syn. *C.rexcelsa*)				Adina *Oligoce-phala** (*Arunachal Pradesh*) *Aglaia edulis** (Assam)	 Aglaia
Diploknema butyracea (*Bassia butyracea*) Hill Mabua	*Dipterocarpus* Spp.	Gurjan			Anogeissus *Acuminata**	Yon
Cassia fistula Amaltas	*Dipterocarpus macrocarpus*	Hollong			*Atalantia mono-phylla** (Orissa)	Jungli Nimbu

Dysoxylum malabaricum	White cedar	*Quercus lamellosa*	Oak (West Bengal)
		Schleichera Oleosa (syn. *S. trijuga*)	Kusum (Bihar)
Eucalyptus globulus (Mad.)	Eucalyptus (Blue gum)	*Terminalia bellerica*	Bahera
Gluta travancorica	Gluta	*Terminalia chebula*	Myrobalan (Harda)
*Hard-wickia pinnata**	Piney	*Terminalia manii*	Black chuglam
Heritiera spp.	Sundri		
Kingiodendron pinnatum	Anjan		
Lagerstroemia lanceolata	Benteak		
Mimusops elengi	Bakul, bullet wood (Madras)		
Petrocarpus dalbergioides	Padeuk		
P. marsupium	Bijasal (Maharashtra)		
Shorea robusta	Sal (Madhya Pradesh)		
Soymida febrituga	Rohini (Madras)		
Tectona grandis	Teak (Madras, West Bengal, Maharashtra and Uttar Pradesh)		

Altingia excelsa	Jutili
Amoora spp.	Amari (West Bengal)
*Canarium strictum**	Dhup
*Cassia siamea**	Kasod
Casuarina equisetifolia	Casuarina
Calophyllum teomentosum	Poon (Madras)
*Castenopsis indica**, (Meghalaya)	Chestnut
*Chloroxylon swietenia**	Satinwood
Palaquium sllipticum (Syn. *Dichopsis elliptica*)	Pali
Palaquium polyanthum (Syn. *Dichopsis polyantha*)	Tali
*Diospyros microphylla** (Maharashtra)	Ebony
*Diospyros pyrrhocarpa**	Ebony
*Dipterocarpus bourdilloni** (Kerala)	Gurjan

(*Continued*)

TABLE 1 GROUPING OF TIMBERS FOR STRUCTURAL USE — *Contd*

Heartwood Naturally Durable		Species for Permanent Structures				Species for Temporary Structures or Semi-Structural Use	
		First Choice		Second Choice			
		Heartwood moderately durable with Class 'a', 'b' and 'c' treatability and of low durability with Class 'a' and 'b' treatability		Heartwood moderately durable but refractory to treatment, that is, of Class 'd' treatability (treatability can be improved for small dimensioned stocks)		Moderately Durable or Low Durability Species Whose Heartwood is Very Refractory to Treatment or Species Whose Durability and/or Treatability is not Yet Known	
1		2		3		4	
Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name
Terminalia parrieulata	Kindal					*Eucalyptus citriodora**	Eucalyptus
Terminalia tomentosa	Sain (Laurel)					*Eucalyptus eugenioides*	Eucalyptus (Madras)
Xylia xylocarpa	Irul					*E. tereticornis** (Tamil Nadu)	
Zanthoxylum spp.	Mullilam					*Exbucklandia populnea**	Pipli
						(Syn. *Bucklandia populnea*)	Pipli (West Bengal)
						Franxinus	Ash
						Lagerstroemia Parviflora	Lendi
						Machilus odoratissima	Machilus (West Bengal)
						*Mesua assamica**	Sianohor (Kayea)
						Mesua floribunda (Syn. Kayea)	Karol

						*Morus laevigata**	Bola (Assam
						*Planchonia valida** (Syn. *P. andamanica*)	Red bombwe
						*Pommetia Pinnata** (Andaman)	
						Quercus griffithii	Oak (Meghalaya)
						*Miliusa tomentosa** (Syn. *Saccopetalum tomentosum*)	Hoom
						*Shorea talura** (Maharashtra)	
						Pterygota alata (Syn. *sterculia alata*)	Narikel
						Syzygium spp.	Jaman
						Terminalia bialta	White chuglam
						*Terminalia citrina** (Assam)	
						*Thespesia populnea**	Bhendi (Maharashtra)

GROUP C

Albizia procera	White siris (Safed siris)	*Adina cordifolia*	Haldu	*Artocarpus chaplasha*	Chaplash	*Acacia leucophloea**	Hiwar (Madhya Pradesh)
Artocarpus lakoocha	Lakooch	*Anthocephyalus chinensis* (Syn. A. cadamba)	Kadam			*Acacia melanoxylone**	Black wood (Madras)
						*Acacia mearnsii** (Syn. *A. mollissima* (Madras)	Black wattle

(*Continued*)

TABLE 1 GROUPING OF TIMBERS FOR STRUCTURAL USE — *Contd*

Heartwood Naturally Durable	Species for Permanent Structures			Species for Temporary Structures or Semi-Structural Uses
	First Choice		Second Choice	
	Heartwood moderately durable with Class 'a', 'b' and 'c' treatability and of low durability with Class 'a' and 'b' treatability		Heartwood moderately durable but refractory to treatment, that is, of Class 'd' treatability (treatability can be Improved for small dimensioned stocks)	Moderately Durable or Low Durability Species Whose Heartwood is Very Refractory to Treatment or Species Whose Durability and/or Treatability is not Yet Known
1	2		3	4
Botanical Name / Trade Name	Botanical Name	Trade Name	Botanical Name / Trade Name	Botanical Name	Trade Name
Artocarpus heterophyllum (Syn. *A. Integrifolia*) Jack, Kathal	*Castanopsis hystrix*	Indian chestnut (West Bengal)		*Acer spp.*	Maple
				Aegle marmelos	Bael
Madhuca longifolia var latifolia (Syn. *Bassia latifolia*) Mahua	*Toona ciliata*	Toon		*Aesculus indica*	Horse chestnut (Uttar Pradesh)
	Chukrasia velutina (*C. tabularis*)	Chickrassy		*Ailanthus integrifolia**	Gokul
Aphanamixiz polystachya (West Bengal) Pitraj	*Dillenia penteagyna indica*	Dillenia		*Anogeissus pendula*	Kardhai
(*Amoora rohituka*)	*Holoptelea integrifolia*	Kanju		*Areca nut** (Kerala)	Supari
Boswellia serrata Salai	*Mangifera indica*	Mango, aam		*Albizia lucida** (Arunachal, Andhra Pradesh)	—
Bridelia retusa Kassi	*Mitragyna parvifolia* (Syn. *Stephegyne parvifolia*)	Kaim		*Azadirachta indica*	
				*Betula alnoides**	Birch
				Bischofia	Uriam

Careya arborea	Kumbi	*Phoebe goalparensis* (*P. goalparensis*)	Bonsum
Cedrus deodara	Deodar	*Pinus roxburghii* (Syn. *P. longifolia*)	Chir
Cupressus torulosa	Cypress	*Pinus wallichiana*	Kail
Dalbergia latifolia	Indian rosewood	*Quercus* spp.	Oak (Nefa)
Dalbergia sissoo	Sissoo	*Terminalia arjuna*	Arjun
Garuga pinnata	Garuga	*Terminalia myriocarpa*	White hollock
Gmelina arborea	Gamari	*Terminalia procera*	White bombwe
Hardwickia pinnate	Piney		
Michelia montana	Champ (West Bengal)		
Ougeinia oojeinensis (Syn. *O. dalbergioides*)	Sandan		
Petrocarpus marsupium	Bijasal (Bihar)		
Tectona grandis	Teak (Madhya Pradesh, Orissa)		

Javanica	(Bishop wood)
Borassus flabellifer	Tad (Palm) (Andhra Pradesh)
Bursera serrata (Syn. *Protium serratum*)	Muntenga
Callitris rhomboidea (Syn. *Frenela rhomboidea*)	
Calophyllum teomentosum	Poone
*Canarium strictum Roxb**	Dhuna (Assam) (White Dhup)
*Chlorophora excelsa** (Madras)	(Madras) Coconut
Cocos nueifera	(Kerala)
Dillenia penteagyna	Dillenia
Diospyros melanoxylon	Ebony
Duabanga grandiflora (Syn. *Sonneratioides*)	Lampati
Elaeocarpus tuberculatus	Rudrakshi (Rudrak)
*Eucalyptus hybrid**	Mysore-gum (Tamil Nadu, Karnataka and Gujarat)
*Eucalyptus camaldulensis**	Eucalyptus (Karnataka, Uttar Pradesh)
*E. pilularia**	Eucalyptus (Tamil Nadu)

(*Continued*)

TABLE 1 GROUPING OF TIMBERS FOR STRUCTURAL USE — *Contd*

Heartwood Naturally Durable	Species for Permanent Structures				Species for Temporary Structures or Semi-Structural Use	
	First Choice		Second Choice			
	Heartwood moderately durable with Class 'a', 'b' and 'c' treatability and of low durability with Class 'a' and 'b' treatability		Heartwood moderately durable but refractory to treatment, that is, of Class 'd' treatability (treatability can be improved for small dimensioned stocks)		Moderately Durable or Low Durability Species Whose Heartwood is Very Refractory to Treatment or Species Whose Durability and/or Treatability is not Yet Known	
1	2		3		4	
Botanical Name Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name	Botanical Name	Trade Name
					*E. propinus**	Eucalyptus (Tamil Nadu)
					*E. saligna**	Eucalyptus (Uttar Pradesh)
					*Gardenia latifolia** (Madhya Pradesh)	Gardenia
					Heterophragma roxburghii	Palang
					Intsia bijuga (Syn. *Afzelia bijuga*)	
					Juglans spp.	Walnut
					Lagerstroemia speciosa (Syn. *L. flosreginae* Retz.)	Jarul
					Lannea coromandelica (Syn. *L. grandis*) (Uttar Pradesh)	Jhingan
					Lophopetalum wightianum	Banati
					*Leucaena leucocephala** (Uttar Pradesh)	Subabul†
					Machilus macrantha	Machilus
					Michelia excelsa	Champ

Mallotus philippensis	Raini
Manglietia spp. (Assam)	
*Melia indica**	Neem
Miliusa velutina	Domsal
Morus alba	Mulberry
Morus serrata	Tooli
Parrotiopsis jacouemontiana	Pohu (Parrotia)
Pinus kesia (Syn. *Pinus insularis*)	Khasi Pine
Pistacia integerrima (J & K)	Klakar singhi
Podocarpus nerrifolius	Thitmin
Polyalthia fragrans	Debdaru (Nedunar)
Prunus napaulensis	Arupati (West Bengal)
Pterospermum aceriifolium	Hathipaila
Radermachera xylocarpa (Syn. *Stereospermum xylocarpum*)	Vedankonnai (Madras)
Schima wallichii	Chilauni
Shorea assamica	Makai
Sonneratia apetala	Makai
Stereospermum chelonoides (Syn. *S. suaveolans*)	Padriwood (West Bengal, Uttar Pradesh)
*Taxus baccata** (West Bengal)	Yew
*Tamarindus indica**	Imli
Vateria indica	Vellapine

NOTE — Such species may be used for permanent type of structures provided there is otherwise enough local evidence of their durability by past usages/experience.

*Indicates the inadequacy of available data on durability and/or treatability for choice classification.
†Based on strength properties at three years age of tree.

3.1.3 Based on permissible defects, cut sizes of structural timbers are classified in three grades, namely, select grade, Grade I and Grade II (*see* IS : 1331-1971*, wherein they have been named as Grade 1, Grade 2 and Grade 3 respectively. These grades have also been referred to as select, standard and common grade in some publications). Last category after Grade II, materials may be structural rejects, not suitable for structural members.

3.2 Moisture Content in Timber

3.2.1 Seasoning is an integral part of timber utilization. For classification of timbers for seasoning purposes, preliminary treatment and storage, seasonining methods, kiln schedules for drying different species of timbers, kiln operation procedure, etc, reference may be made to IS : 1141-1973†.

3.2.2 Unless otherwise specified, the moisture content of timber for various situations of buildings in different climatic zones of the country shall conform to the requirement of IS : 287-1973‡.

3.3 Treatment and Protection of Timber

3.3.1 *Durability* — For durability the timbers are classified into the following three classes according to their average life in 'grave yard' (*see* Note below) tests:

a) Class I Natural durable heartwood timbers having average life of 120 months and over (high durability),

b) Class II Natural durable heartwood timber having average life of 60 months and over but less than 120 months (moderate durability), and

c) Class III Timbers having average life less than 60 months (low durability).

The average life will be more than indicated above in case of structural members above ground.

NOTE — Durability of various species is indicated in IS : 401-1982§. Durability of various species in their heartwood is based on the 'Grave Yard' tests carried out in the open in which test specimens of sizes 50 × 50 × 600 mm and/or 38 × 38 × 305 mm of untreated heartwood were buried in the ground to half their length.

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*Specification for cut sizes of timber (*second revision*).

†Code of practice for seasoning of timber (*first revision*).

‡Recommendations for maximum permissible moisture content for timber used for different purposes (*second revision*).

§Code of practice for preservation of timber (*third revision*).

3.3.1.1 In a timber structure using heartwood of secondary species, if one end of the timber column or post is buried in the ground, it will last only for a limited period. But for prolonged service life of a structure well over say 30 years, and to guard against deteriorating agents and other adverse factors, the timber column or post shall not be embedded in the ground but kept well above the floor level.

3.3.2 *Preservation* — Preservative treatment of timber forms a very important part of the national effort in conserving material resources and their most economic utilization. Before use in permanent structures, species of the following types of timber shall be chemically treated for protection against deterioration due to attack by fungi and termites, borers and marine organism, etc, in accordance with IS : 401-1982*:

a) Heartwood of all species of timber of moderate and low durability;

b) Heartwood of all species of timber of high durability containing more than 15 percent sapwood; and

c) Sapwood of all species of timber of any class or durability.

3.3.2.1 Heartwood of all species of timber of high durability do not require preservative treatment except in cases coming under (b) above.

3.3.3 *Treatability* — Treatable timbers may be classified as follows to indicate approximately the degree of resistance offered by the heartwood of a species to the penetration of the prerservative solution under a hydraulic pressure of 1·05 N/mm^2. The treatability of the heartwood of different species is indicated in 5 grades, each grade being defined as under:

a) Class a Heartwood easily treatable;

b) Class b Heartwood treatable but complete penetration of preservative not always obtained, in case when least dimension is more than 60 mm;

c) Class c Heartwood only partially treatable;

d) Class d Heartwood refractory to treatment; and

e) Class e Heartwood very refractory to treatment, penetration of preservative being practically nil even from the end.

*Code of practice for preservation of timber (*third revision*).

4. SUITABILITY AND GROUPING

4.1 The suitability of structural timber for a given purpose depends upon the following:

a) Durability and treatability of the species;

b) Strength characteristics of the species; and

c) Grading in respect of freedom from defects.

4.1.1 *Suitability in Respect of Durability and Treatability for Permanent Structures* — There are two choices and they are given below.

4.1.1.1 *First choice* — The species shall be of any one of the following categories:

a) Untreated heartwood of high durability as listed in Table 1. Heartwood of these species of timber, if containing more than 15 percent sapwood, needs treatment for protection.

b) Treated heartwood of moderate and low durability and Class 'a' and Class 'b' treatability (to obtain maximum penetration and absorption of preservative) as listed in Table 1.

c) Heartwood of moderate durability and Class 'c' treatability after pressure impregnation (to obtain maximum penetration and absorption of preservative) as listed in Table 1.

d) Sapwood of all classes of durability after thorough treatment with preservatives.

NOTE — All such species which can be adequately treated to desired retention of preservative may be used.

4.1.1.2 *Second choice* — The species shall be of heartwood of moderate durability and Class 'd' treatability. Small thicknesses up to 60 mm when treated under pressure impregnation, shall be used for components under cover and out of contact with ground, for example, for roof trusses, columns, beams, lamella arches, solid web type girders using small dimensioned timber fabricated through engineered timber techniques for residential buildings, industrial sheds, etc. Such timbers are listed in col 3 of Table 1.

4.1.2 *Suitability in Respect of Durability and Treatability for Temporary Structures and for Semi-Structural Uses* — Heartwood of low durability and Class 'e' treatability or the species whose durability and/or treatability is yet to be established may be used where life of the structure is not primary consideration. Such timbers are listed in col 4 of Table 1.

4.2 Grouping — Species of timber recommended for constructional purposes are classified in three groups on the basis of their strength properties, namely, modulus of elasticity (E) and extreme fibre stress in

bending and tension along grain (f_t). The characteristics of these groups for Grade 1 structural material are as follows:

Groups	*Modulus of Elasticity* (E) N/mm^2	*Limit* (f_t) N/mm^2
A	Above 12 600	18·0
B	Above 9 800 and up to 12 600	12·0
C	Above 5 600 and up to 9 800	8·5

NOTE — These groups were earlier referred to as super, standard and ordinary. Generally timbers above 0·65 specific gravity fall under Group A, between 0·50 and 0·65 fall under Group B and those below 0·50 fall under the Group C.

5. PERMISSIBLE STRESSES

5.1 Basic stress values of different groups of timber are determined on small clear specimen according to standard practice (IS : 1708-1969*). These values are then divided by the appropriate factors of safety (as given in Table 2) to obtain the permissible stresses.

TABLE 2 FACTORS OF SAFETY TO BE APPLIED TO BASIC STRESS TO OBTAIN SAFE PERMISSIBLE STRESS

SL No.	TYPES OF STRESS	GRADE I (STANDARD) LOCATION		
		Inside	Outside	Wet
(1)	(2)	(3)	(4)	(5)
i)	Extreme fibre stress in beams for broad leaved species, *Min*	5	6	7·5
ii)	Extreme fibre stress for beams in conifers, *Min*	6	7	8·5
iii)	Shear along grain	7	7	7
iv)	Horizontal shear in beams	10	10	10
v)	Compressive stress parallel to grain, *Min*	4	4·5	5·5
vi)	Compressive stress perpendicular to grain	1·75	2·25	2·75

5.2 The values of permissible stresses for Groups A, B and C species appropriate to location of use and applicable to Grade I structural timber shall be as given in Tables 2 and 4 of IS : 883-1970† provided that the following conditions are satisfied:

a) The timbers should be of high or moderate durability and be given suitable treatment where necessary. They may be

*Methods of testing small clear specimens of timber (*first revision*).
†Code of practice for design of structural timber in building (*third revision*).

used on any location. If the location is inside and not in contact with the ground, low durability timber may be used after proper seasoning and preservative treatment.

b) The loads should be continuous and permanent and not impact type.

5.3 For other grades the permissible stresses given in Tables 2 and 4 of IS : 883-1970* shall be multiplied by the following factors to obtain the permissible stresses assuming that the conditions laid down in **5.2** are satisfied:

a) For select grade timber 1·16

b) For Grade II timber 0·84

5.3.1 When low durability timbers are to be used on outside locations, the permissible stresses for all grades of timber, arrived at by **5.2** and **5.3** shall be multiplied by 0·8.

5.3.2 When the timber has not been graded and has certain slope of grain the working stresses shall be as given in Table 3.

TABLE 3 ALLOWABLE PERCENTAGE STRENGTH FOR SLOPE IN GRAIN

Slope	Strength of Beams Joists and Ties *Max* percent	Strength of Posts or Columns *Max* percent
(1)	(2)	(3)
1 in 10	61	74
1 in 12	69	82
1 in 14	74	87
1 in 15	76	100
1 in 16	85	100
1 in 18	85	100
1 in 20	100	100

5.4 Shocks Under Impact — Under impact, wood shall be considered as capable of resisting a force twice that of the static load for which it has been designed.

*Code of practice for design of structural timber in building (*third revision*).

6. DIMENSIONS AND TOLERANCES

6.1 Sawn Timber — The cut sizes of timber for structural purpose and the tolerances shall be those as given in IS : 4891-1968*, except where ne dimensions are specifically mentioned. Permissible tolerances in measurements shall be as follows:

a) For measurements up to and including 100 mm in width or thickness	— 0 mm + 3 mm
b) For measurements above 100 mm in width or thickness	— 3 mm + 6 mm
c) For measurements of all sizes in length	— 0 mm + 10 mm

7. FACTORS AFFECTING STRENGTH OF TIMBER

7.1 Prohibited Defects — All grades of timber with the following defects shall be prohibited for structural use:

a) Timber with loose grain, splits, compression wood in coniferous structural timber, heartwood rot and sap rot and crokedness.

b) Worm holes made by powder post beetles and pitch pockets.

7.2 Permissible Defects — The following defects are permissible for all grades of timber:

a) Wanes are permitted provided they are not combined with knots and the reduction in strength on account of the wanes is not more than the reduction with the maximum allowable knots. Wanes may also be permitted provided there is no objection to its use as bearing area, nailing edge and affects general appearance;

b) Worm holes other than those due to powder post beetles located and grouped to reduce the strength of timber shall be evaluated in the same way as knots; and

c) All other defects which do not affect any of the mechanical properties of timber shall be permitted.

7.3 Other Injurious Defects in Timber — The significance of defects like knots, checks and shakes in timber and their strength reducing parameters are given in **8.**

7.4 Closeness of Grain (Rate of Growth) — As far as possible, closeness of grain shall preferably be not less than 12 rings per 50 mm. Where it is not possible to observe closeness of grains these provisions will not apply. No allowance for changes in moisture content is necessary for structural timber in normal circumstances.

*Specification for preferred cut sizes of structural timbers.

7.4.1 *Unit Weight* — Timber having average unit weight less than 75 percent of the values given in Table 1 of IS : 883-1970* shall not be permitted for use for structural purposes.

7.5 Sapwood — For consideration of strength no distinction shall be made between heartwood and sapwood. While heartwood is more resistant to decay, sapwood, has low resistant but can be improved after preservative treatment.

7.5.1 Sapwood more than 15 percent in heartwood timber of high and moderate durability shall not be allowed in permanent structures unless it is thoroughly impregnated with wood preservatives. The heartwood of all non-durable timbers shall be properly treated with preservatives for permanent structures.

7.6 Pith — Presence of pith shall not be considered as a defect to reduce the strength but checks, shakes and softness in the pith as compared to the neighbouring portions adversely affect strength and so shall be duly taken into consideration.

7.7 Live and Dead Trees — Timber from dead trees, provided they are totally free from decay, cross checks and insect attack, shall be considered to have the same strength as timber from a living tree of corresponding moisture content.

7.8 Moisture Content — Strength of timber is considerably influenced by moisture content. It will generally decrease from oven-dry condition to fibre-saturation point and thereafter, will not appreciably change for any increase of moisture content. For seasoned timber having minimum thickness below 100 mm and moisture content not more than 18 percent, an increase of 20 percent in strength values listed in Table 2 of IS : 883-1970* may be allowed for bending and compression members for inside location only.

7.8.1 *Air-dried and Kiln-dried Timber* — For purposes of design no distinction shall be made between the strength of air-dried timber and kiln-dried timber, unless it has developed drying defects, such as case hardening owing to drastic drying conditions developed in the kiln-dried timber.

7.9 Treatment — Wood preservatives and fire retardants shall not be considered to impair the strength of wood except in the case of some treating process at high temperatures. In the latter case, due allowance for the loss of strength shall be made in the design. With increasing temperature, the strength of timber decreases; but at the temperature to which structural timbers are normally exposed, serious permanent effects are unlikely.

*Code of practice for design of structural timber building (*third revision*).

8. INFLUENCE OF DEFECTS ON STRUCTURAL TIMBER AND DATA REGARDING ALLOWANCE IN STRENGTH

8.1 Being a biological product of nature, timber is not uniform in its characteristics. A completely defect-free timber, though desirable will rarely be available for structural use. The data is intended to provide guidance regarding reduction parameters in the strength, where defects of various kinds are present in structural timber. Precautionary measures to be taken into account during the selection, conversion, design and fabrication stages of timber are also included to reduce the extent of influence of defects. For identification and measurements of defects, reference may be made to IS : 3364 (Part 2)-1976*.

8.2 Allowance of Defects

8.2.1 *Slope of Grain* (*Cross Grain*) — (*see* Fig. 1).

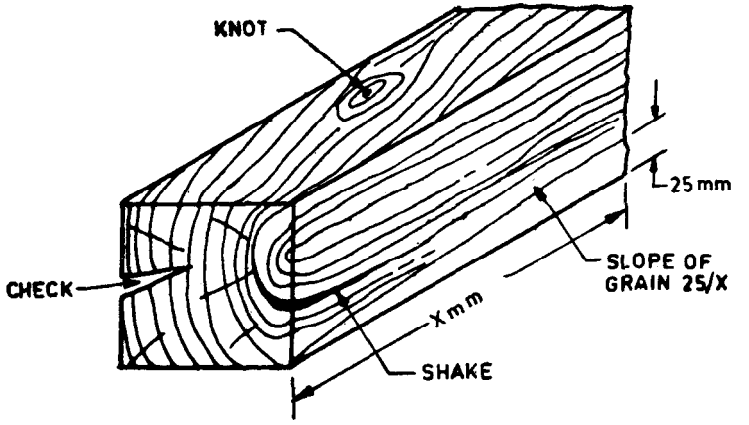


FIG. 1 KNOTS, CHECKS, SHAKES, AND SLOPE OF GRAINS

8.2.1.1 *Significance* — Wood offers much greater resistance to load parallel to the direction of fibres than across. If there is slope of grain with reference to longitudinal axis, allowance for reduction of strength shall be made as given in Table 3.

8.2.1.2 *Permissible values* — The maximum limits for sloping grain will be as given below:

1 in 20	For select grade
1 in 15	For Grade I
1 in 12	For Grade II

*Methods of measurements and evaluation of defects in timber: Part 2 Converted timber (*first revision*).

8.2.1.3 *Method of allowance* — For various values of slope of grain and also for different situations of use, the allowable strength for timber for sloping grains as a percentage of the permissible values for perfectly straight grained timber without defects will be as specified in Table 3.

8.2.2 *Knots*

8.2.2.1 *Significance* — When a limb or branch takes off from the trunk of a tree, there will be continuous growth, at the junction of the branch and the trunk, when the branch is cut away the section of the cut away portion on the trunk, is called a knot. A knot is, therefore, a distortion or deviation of the fibres which invariably depreciates the strength of timber.

During the process of seasoning the timber, checks (that is splits) are likely to develop in and around the knotty portion of the wood, thus causing further seasoning degrades (*see* Fig. 2). The strength reducing effects of knots are more pronounced on tensile strength of timber, compared to those on compression and shear. The effect of knots on the stiffness of a beam is very small. Thus, deflection is not affected to an appreciable degree by knots.

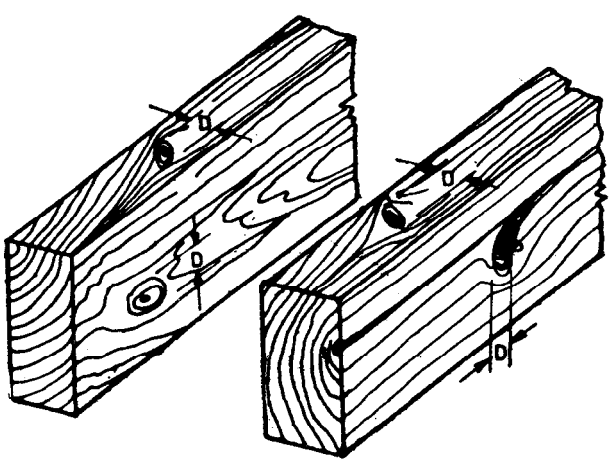


FIG. 2 MEASUREMENT OF KNOTS IN BEAMS

8.2.2.2 *Permissible values* — The permissible sizes of knots would depend upon the size and grade of the structural timber and shall be in accordance with the relevant provisions of IS : 1331-1971*, as given in Table 4.

*Specification for cut sizes of timber (*second revision*).

TABLE 4 MAXIMUM ALLOWABLE DEFECTS FOR GRADE I (STANDARD) WOOD

(*Clause* 8.2.2.3)

All dimensions in millimetres.

WIDTH OF FACE	SIZE OF KNOTS *D*, *Max* (*see* FIG. 2)		CROSS* GRAIN MAXIMUM SLOPE
	Narrow Face and ¼ of the Width of Wide Face Close to Top and Bottom Edges	The Remaining Central Half of the Width of the Wide Face	
(1)	(2)	(3)	(4)
75	19	19	
100	25	25	
150	38	38	
200	44	50	
250	50	57	
300	54	75	1 in 15
350	57	81	
400	63	87	
450	66	93	
500	69	100	
550	72	103	
600	75	106	

*The angle of grain shall be measured by the deviation of fibres from the edge of the timber and shall not exceed 1 in 15 in the Grade I timber.

8.2.2.3 *Method of allowance* — No knot beyond permissible sizes should occur in beams, joists and other members in bending as shown in Fig. 3 and 4. If the sizes of knots present are not more than half as large as those provided in Table 4, increase in permissible stress to 7/6 times over those for Grade I may be permitted. However, if the sizes of knots are larger than those provided in Table 4, but in no case exceeding 1½ times than those sizes, the permissible stress shall be reduced to 5/6 times the values for Grade I.

8.2.3 *Checks* (*see* Fig. 1) and *Shakes* (*see* Fig. 5)

8.2.3.1 *Significance* — Checks and shakes refer to cracks of timber due to defects in growth or seasoning. Presence of checks and shakes will reduce the resistance to shear considerably and will also give access to moisture entry; they are more serious in the case of bending members than in directly stressed members.

8.2.3.2 *Method of allowance* — Shakes and checks are generally measured at the ends of timber piece. Size of the shake is the distance between lines enclosing the shake and parallel to wide faces of the piece. The width of shake shall be taken as the length of its vertical projections measured on either end of timber. In beams, joists and planks, only

middle half portion is considered for measurement. In seasoned material of Grade I (standard) timber, shake is permitted at the end to the extent of about 1/3 of the width of timber piece. This is also applicable to checks measured appropriately. The size of checks is taken within the middle half of the height of the piece and within a distance of three times the height from the end.

When checks on two parallel faces are opposite to each other, the sum of their sizes is taken for measurement. The sum of the sizes of shakes and checks should not exceed the permissible sizes of shakes. If the sizes of checks and shakes are greater or lesser than those corresponding to Grade I, the allowance for increased or decreased values of permissible stresses shall be made in the same manner as for knots.

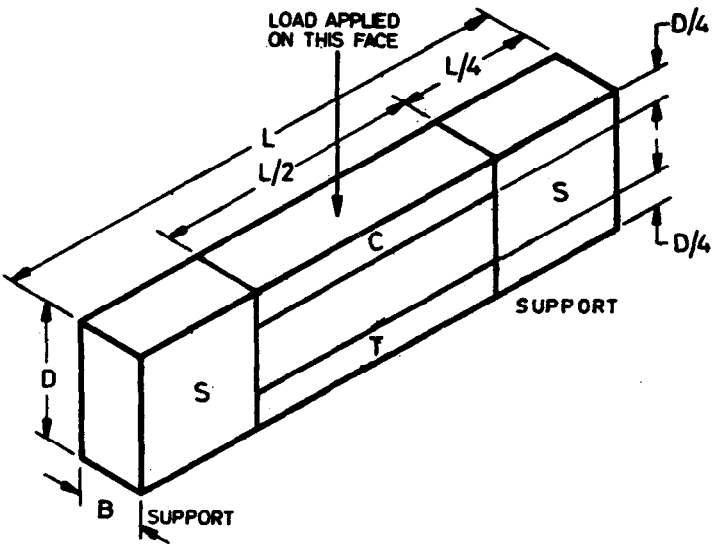
8.3 Measures to Minimize the Effects of Defects on Structural Timber — The precaution to be observed in the conversion, design, fabrication and erection stages shall be as covered in **8.3.1** to **8.3.4**. These precautions at the same time will facilitate all the tolerable defects in timber consistent with economy and conservation of material.

8.3.1 *Conversion of Logs into Structural Timber*

8.3.1.1 While converting it may be ensured that the slope of grain is as minimum as possible preferably not exceeding 1 : 15. Edge-grain scantlings (*see* Fig. 6) provide better structural members. Tangentially cut scantlings, preferably those which have slope of grain less than 1 : 15 shall be used.

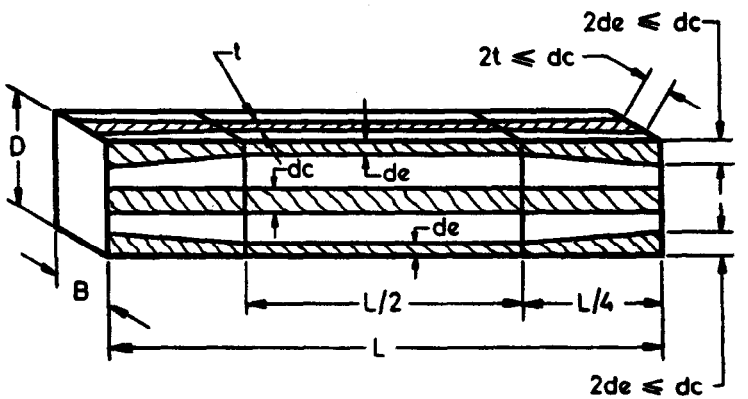
8.3.1.2 The sizes of members and the portions of the log from which they are cut shall be suitably adjusted to reduce the adverse effects of knots, checks and shakes (*see* **8.2.2** and **8.2.3**).

NOTE — Considering the effect of differential shrinkage of timber when subjected to moisture variation, the structural timber obtained from various portions of the log may be selected for various types of structural use as shown in Fig. 7.



Zone of critical tension (T), compression (C), and shear (S). The allowable sizes, numbers, etc, of the strength reducing defects such as knots, for any particular grade of timber, are generally worked out with respect to these zones.

FIG. 3 SKETCH OF A BEAM SHOWING CRITICAL ZONES

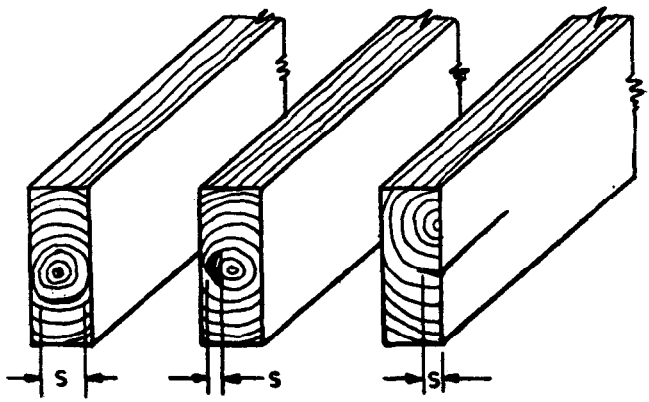


dc = Maximum size of the allowable knot in centre line of the wider face (allowable size to be determined by grading rules).

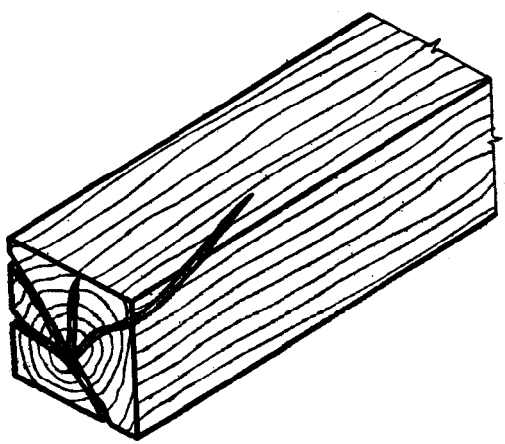
de = Maximum size of the allowable knot in the edges of the wider face.

t = Maximum size of the allowable knot in the middle half length of the beam on its narrow face.

FIG. 4 ALLOWABLE SIZES OF KNOT IN THE DIFFERENT REGIONS OF NARROW AND WIDER FACES OF A BEAM



5A Measurement of Shakes in Beams, Joists and Planks



5B Star Shake

FIG. 5 SHAKES

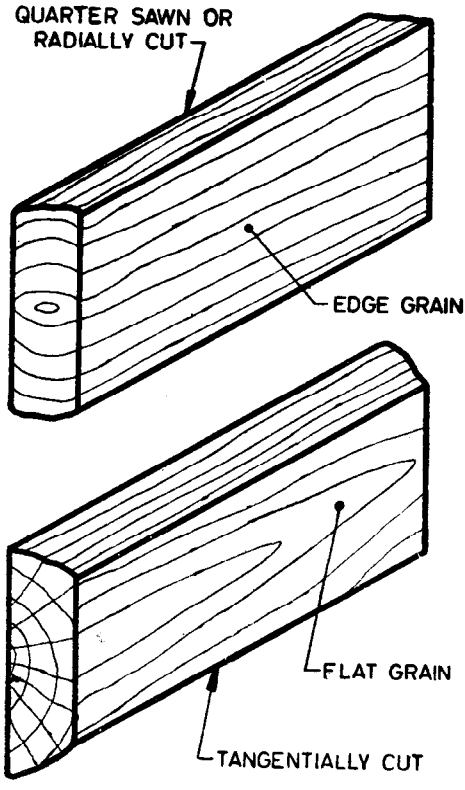
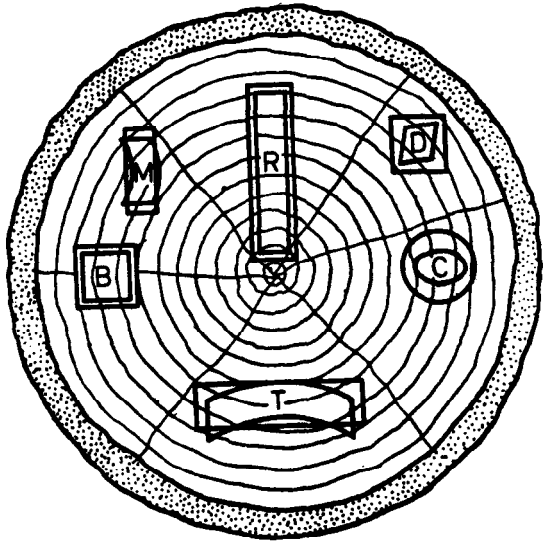


FIG. 6 FLAT AND EDGE GRAIN TIMBER



R — Best for dowel and planks (structural).
T — Not good for structural planks.
M — Intermediate between '*R*' and '*T*'.
B — Best for joists and beams.
D — Discarded for joists and beams.
C — Showing circular shrinkage.

NOTE — The outer lines indicate the shape and size of various pieces in green condition and the inner ones after shrinkage on drying.

FIG. 7 SKETCH SHOWING DIFFERENTIAL SHRINKAGE IN THE TANGENTIAL AND RADIAL DIRECTIONS

8.3.1.3 Long logs may be cut into shorter length before conversion into structural timber to avoid severe slope of grain if anticipated.

8.3.2 *Design Stage* — While selecting timber, preferably locally available species shall be specified only (*see* IS : 399-1963*). The selection should not be restricted to durable timber but also to timbers which give satisfactory service after proper treatment and seasoning.

8.3.2.1 While specifying the actual size for structural members, the following points may also be considered:

a) Generally thinner sizes of timber are easier to seasoning;

b) In choosing timber planks it may be noted that wider the section the more it is liable to warp and twist; and

*Classification of commerical timbers and their zonal distribution (*revised*).

c) Where small dimensional timber is used, consider nail-jointed timber construction in accordance with IS : 2366-1983*.

8.3.3 *Fabrication Stage*

8.3.3.1 Members shall be so arranged that serious knots; shakes and checks do not occupy regions of maximum stress intensities.

8.3.3.2 Knots, shakes and checks shall not occur where joints are to be provided.

8.3.3.3 Out of available timber stock the best pieces shall be used for tension and flexural members because the adverse effects of natural defects on compression members are not as severe as those on flexural and tension members.

8.3.3.4 In nailed and glued timber beams where outer laminations experience greater tension and compression than the inner layers nearer to neutral axis, sound pieces with lesser defects shall be used.

8.3.4 *Erection Stage*

8.3.4.1 The engineer shall check up the general arrangement of members and satisfy himself before the structure is erected in position, that is, beams, joists, trusses, etc, because even after a careful selection of the pieces, if a mistake is made during fixing the member in position, its strength properties may be adversely affected. For instance severe knots, which according to the designer should occupy the 'compression regions' only may occupy the 'tension zone' if the beam is just kept upside down (*see* Fig. 3). Such erection mistakes which may be due to inadequate or lack of proper engineering supervision need careful observation.

8.3.4.2 Development of stresses during erection (not provided for by designer) shall be minimized by careful handling of timber units.

9. STORING OF TIMBER

9.1 After selection and prior to fabrication and/or erection all structural timber shall be stored so as to prevent decay and renewed development of defect. A recommended practice for storing timber is given in **9.1.1** and **9.1.2.**

9.1.1 All timbers shall be piled into stacks upon well treated and even-surfaced beams, sleepers or brick pillars so as to be above the ground level by at least 150 mm. The various members shall be stored depending on their lengths, and material of equal lengths shall be piled together in layers with wooden battens called crossers separating one layer from another. The crossers shall be of sound wood, straight and uniform in thickness. In cases where separate crossers are not available smaller sections of the available structural timber may be used in their

*Code of practice for nail-jointed timber construction (*first revision*).

place. In any layer, an air space about 25 mm shall be provided between adjacent members. The longer pieces shall be placed in the bottom layers and shorter pieces in the top layers but one end of the stack shall be in a true vertical plane. The crossers in the different layers shall be in vertical alignment. The most suitable width and height of stack are recommended to be about 1·5 and 2·0 m. Distance between adjacent stacks is recommended to be at least 300 mm. A side view of such a stack is shown in Fig. 8. In case the stacking with the help of battens is not possible, the timber may be close-piled in heaps on raised foundations with the precautions specified above.

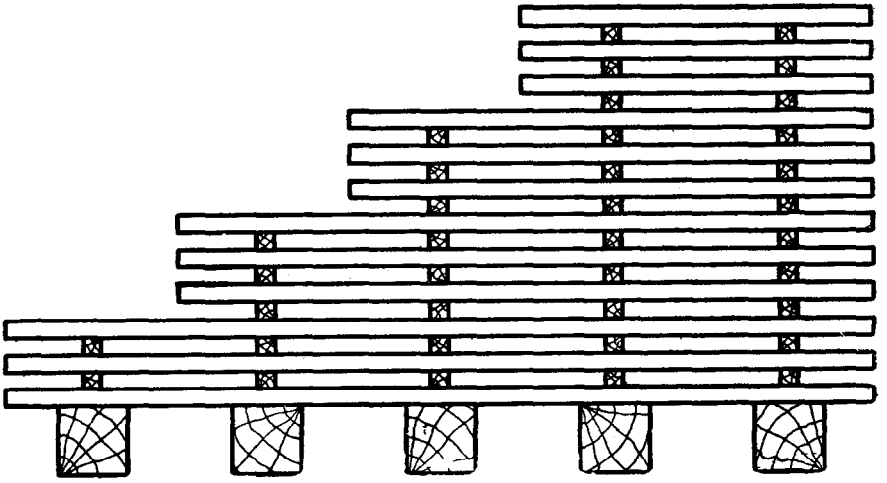


FIG. 8 TIMBER STACK

9.1.2 The stack shall be protected from hot dry winds or direct sun and rain. A sloping roof made of rejected planks may be used to drain off the rain water. Decayed or insect attacked planks should not be used. Heavy weights, such as metal rails or large section of wood, are recommended to be placed on the top of the stack to prevent distortion or warping the timber in the stack. To prevent end-cracking in the material the ends of all members shall be coated with thick coal tar, aluminium lead paint (hardened gloss oil) or any other suitable material as specified in IS : 1141-1973*.

9.1.3 As far as possible, seasoned timber should be promptly used before its moisture content gets time to alter due to climatic changes. However, when storage becomes unavoidable, it should be stored in close stacks under a shed maintained under dry conditions to retard moisture content changes.

*Code of practice for seasoning of timber (*first revision*).

(*Continued from page* 2)

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Headquarters:
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