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GUYANA STANDARD

Building Code -
Section 7 : Use of Guyanese hardwood in construction

Prepared by
GUYANA NATIONAL BUREAU OF STANDARDS

Approved by
NATIONAL STANDARDS COUNCIL

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Contents

Foreword

This Guyana Standard was developed by the Guyana National Bureau of Standards in 1999, after the draft was finalised by the **Technical Committee - Civil engineering** and approved by the National Standards Council.

This standard was developed to provide guidance on the use of Guyanese hardwood for construction purposes.

This standard is intended to be made mandatory.

Members of the Technical Committee

Name	Affiliation

Building Code -
Section 7 : Use of Guyanese hardwood in construction

1 Scope

This Code provides guidance on the use of Guyanese timber species for construction purposes. It includes recommendations on quality, engineering properties and the various design considerations and principles for simple members, build-up components, composite structures and sub-structures incorporating other materials. Requirements and recommendations for sound construction and typical details for residential construction are also included. Further, recommendations for the design of heavy engineered structures, nailed, screwed, and bolted joints are also presented.

2 Definitions

For the purpose of this Code the following definitions shall apply:

2.1 **dry stress:** Stress applicable to solid timber exposed in conditions which would result in it having a specified maximum moisture content. For the purpose of this Code the moisture content for dry stress shall not exceed 18% in service.

2.2 **grade:** The classification of timber based on visual characterisation of the strength reducing features.

2.3 **grade stress:** Stress which can safely be permanently sustained by timber of a specified specie, grade, strength class and section size.

2.4 **green timber:** Timber, freshly felled or still containing original free moisture in its cell cavities and cell walls.

2.5 **loading sharing system:** Assembly of members which are constrained to act together to support a common load.

2.6 **member:** Structural component which may either be an element of solid timber or built up from pieces of timber, plywood etc. (for example, floor joist, plywood beam, truss members etc.).

2.7 **nominal size:** The actual size of a surfaced piece of timber including allowance for tolerances.

2.8 **permissible stress:** Stress that can be permanently sustained by timber under a particular condition, and represents the grade stress modified for size, service and loading.

2.9 **strength class:** Classification of various species of timber based on similarity of engineering properties such as modulus of rupture, modulus of elasticity (stiffness), density etc.

2.10 **structural unit:** Assembly of members forming the whole or part of sub-component of framework (for example, building skeleton or a complete structure).

2.11 **wet stress:** Stress applicable to solid timber exposed in conditions which would result in it exceeding a moisture content of 18%.

3 General

3.1 Materials and species

This Code is based on Guyanese timber species visually graded to the Guyana Timber Grading Rules for Hardwoods and other tropical hardwood timbers complying to the **British Standards**, **BS 4978 : 1996**, "**Specification for visual strength grading of softwood**" and **BS 5756 : 1997**, "**Specification for visual strength grading of hardwood**". Tropical hardwood timber complying with these standards are conforming to this Code.

The Guyanese timber species which are considered suitable for construction purposes and to which the provisions of this Code are applicable as listed in **Table 1**.

3.2 Durability

The heartwood of many local timber species is naturally durable. However, the sapwood of all species is susceptible to biodeterioration. The durability characteristics of the primary local species are given in the Guyana Timber Grading Rules for Hardwoods. Structural members in contact with the ground shall be of species that are highly durable naturally or preservative-treated.

3.3 Preservative-treated timber

Timber that have high natural durability may be used for structural members without preservative treatment provided that sapwood content is excluded or minimised. Species that have low natural durability shall be treated with preservative as recommended in the Guyana Timber Grading Rules for Hardwoods for use in construction.

3.4 Dimensions and preferred sizes

The sizes, dimensions and tolerances of members presented in this Code are stated in metric units. The preferred sizes for constructional purposes are presented in **Appendix 1**. These indicate nominal sizes and tolerances based on Industry Standards. Recommended nominal sizes for hardwoods are also presented in **BS 5450 : 1995**.

Table 1
Guyanese timber species for structural application

Standard name	Botanical name	Approximate density (kg/m^3) at 18%moisture content
Aromata	*Clathrotropis bachpetala*	1000
Asepoko	*Pouteria guianensis*	950
Baromalli	*Catostemma altsonii*	490
Bulletwood	*Manilkara bidentata*	900
Black kakaralli	*Eschweilera subglandulosa*	1000
Crabwood	*Carapa guianensis*	610
Determa	*Ocotea rubra*	620
Dukali	*Parahancornia fasciculata*	490
Hububalli	*Loxopterygium sagotii*	800
Greenheart	*Chlorocardium rodiei*	1030
Kabukalli	*Goupia glabra*	830
Kurokai	*Protium decandrum*	700
Locust	*Hymenaea courbaril*	910
Manni	*Symphonia globulifera*	780
Manniballi	*Moronobea coccinea*	860
Mora	*Mora excelsa*	910
Morabukea	*Mora gonggrijpii*	1010
Purple heart	*Peltogyne pubescens*	860
Red cedar	*Cedrela odorata*	490
Silverballi	*Ocotea spp.*	600
Simarupa	*Simaruba amara*	430
Shibadan	*Aspidosperma album*	850
Tatabu	*Diplotropis purpurea*	935
Tauroniro	*Humira balsamifera*	900
Wallaba	*Eperua falcata*	950

Wamara	*Swartzia leicocalycina*	120

4 Design considerations

4.1 Methods of design

This Code specifies design requirements for two general categories of structures:

(a) light-frame domestic buildings and other similar structures requiring minimal engineering design inputs; and

(b) heavy structures, including industrial, commercial, institutional and other public buildings, and other major engineering structures requiring significant engineering design inputs.

4.1.1 The methods of design available for the design of timber structures can be generalised as:

(a) **Working stress design**

This is an elastic design method and involves the application of standard engineering principles and design standards for proportioning structural members such that stresses or deformations induced by all relevant conditions of loading do not exceed the permissible stresses or deformation limits for the material or the service conditions determined in accordance with the relevant Code (**for example, British Standard, BS 5268 - Parts 1-5 : 1985**, "**Structural use of timber and Australian Standard AS 1720 : 1982**"). All structures in **4.1** (**a**) and (**b**) may be designed using this method.

(b) **Limit state design**

This method is based on the application of limit state and reliability theories for timber, and ultimate stresses and partial factors of safety to ensure that various limit stated (that is, ultimate and serviceability) are not exceeded.

(c) **Simplified design methods**

These are required to satisfy minimum design standards and are based on load-span tables, design monograph and other design aids. Such methods may be applied in the design of all structures in **4.1** (**a**) and some in **4.1** (**b**) to ensure robust and stable structures.

Clause 5 presents requirements for simplified designs based on load-span tables and minimum construction details sufficient for design of structures in **4.1** (**a**) to ensure a robust and stable structure.

Clause 8 gives general recommendations for the utilisation of Guyanese timbers in the design of structures in **4.1** (**b**) by the application of engineering design principles with the relevant design codes (for example, **BS 5268 Parts 1-5 : 1985**, "**Structural use of timber**" and **AS 1720 : 1982**).

4.1.2 To ensure robust and stable designs for all methods of design it is necessary for the designer to:

(a) consider the structural form of the building or structure;

(b) ensure that any required interaction and connections between timber load-bearing elements and between such elements and other parts of the structure; and

(c) provide suitable bracing or diaphragm effect in planes parallel to the direction of lateral forces acting on the whole structure.

4.2 Grades

In the absence of machine grading, timber for structural applications shall be visually graded in accordance with the specifications set out in the **Guyana timber grading rules for hardwoods and BS 5756 : 1980**, "**Tropical hardwoods graded for structural use**".

4.2.1 For timber graded to the Guyana timber grading rules for hardwoods, two grades are applicable to the requirements of this Code:

(a) select Grade - SG; and

(b) merchantable Grade - MG.

Basic stresses for selected Guyanese timber species for the wet and dry exposure conditions are presented in **Tables 2** and **3** respectively. Grade stresses for the SG and MG Grades are presented in **Tables 4** and **5**.

Table 2
Wet basic stresses for selected Guyanese species

Standard name	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
Greenheart	33.4	20.1	22.0	6.69	3.19	19100	16000
Purpleheart	20.4	12.2	15.0	4.08	3.43	16800	11200
Wallaba	24.3	14.6	19.0	4.86	-	18000	14900
Mora	22.0	13.8	15.3	4.59	2.87	17800	14900

Table 3
Dry basic stresses for selected Guyanese species

Standard name	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
Greenheart	39.1	23.4	27.1	7.81	3.83	22700	19000
Purpleheart	23.3	14.0	18.5	4.65	3.86	18500	12400
Wallaba	29.7	17.8	23.1	5.93	-	17800	14900
Mora	31.4	18.8	21.9	6.27	3.67	20400	17100

Table 3
Wet grade stresses for selected Guyanese species (SS Grade)

Standard name	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
Greenheart	22.3	13.4	19.2	5.02	2.14	18100	15200
Purpleheart	13.6	8.16	13.1	3.06	2.30	16000	10600
Wallaba	16.2	9.73	16.7	3.65	-	17100	14100
Mora	15.3	9.18	13.4	3.44	1.92	16900	14100

Table 5
Dry grade stresses for selected Guyanese species (SS Grade)

Standard name	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
Greenheart	26.1	15.6	23.7	5.86	2.57	21600	18000
Purpleheart	15.5	9.31	16.2	5.49	2.61	17600	11800
Wallaba	19.8	11.9	20.2	4.45	-	16900	14100
Mora	20.9	12.6	19.2	4.70	2.46	19400	16200

4.3 Strength group

For the purpose of this Code, a strength grouping system is proposed for Guyanese structural species. The basic criteria for assigning species to the various strength groups are the modulus of rapture (MOR). However, where the data on this characteristic was not available grouping was based on density.

Five strength groups are defined, namely, F1, F2, F3, F4 and F5. Thus, F1 is the weakest group and F5 the strongest. The species in the various strength groups are presented in **Table 6**, and grade stresses for the strength groups are presented in **Table 7** and **8** for the wet and dry exposure conditions, respectively.

Table 6
Strength groups for Guyanese structural timbers

Strength group	Species	Approximate density (kg/m^2)
F1	Baromalli Duka Dukali Futui Maho Red cedar Simarupa Suya White cedar	400 - 550
F2	Crabwood Determa Fukadi Kurokai K. silverballi Maporokon	551 - 700
F3	Hububalli Kabukalli Manni Purpleheart Shibadan Tatabu Wallaba	701 - 900
F4	Aromata Bulletwood Locust Maniballi Mora Tauromiro	901 - 1000
F5	Greenheart Black kakaralli Morabukea Wamara	1001 - 1200

	Yururu	

Table 7
Wet grade stresses for strength groups (SS Grade)

Standard group	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
F1	10.5	7.18	12.0	2.52	1.65	16000	13000
F2	13.6	8.16	13.1	3.06	1.92	16900	14000
F3	15.3	9.18	13.4	3.44	2.14	17100	14100
F4	16.2	9.73	16.7	3.65	2.30	18100	15200
F5	22.3	13.4	19.2	5.02	2.50	19600	16600

Table 8
Dry grade stresses for strength groups (SS Grade)

Standard group	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)	Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)	
						Mean	Minimum
F1	14.5	8.25	14.2	3.01	1.95	15600	10600
F2	15.5	9.31	16.2	3.49	2.30	16900	11800
F3	19.8	11.9	19.2	4.45	2.46	17600	14100
F4	20.9	12.6	20.2	4.70	2.57	19400	16200
F5	26.1	15.6	23.7	5.86	2.61	21600	18000

5 Minimum design standards and typical details for low rise buildings

5.1 General

5.1.1 The recommendations and requirements presented in the clause of the Code are applicable to light-framed domestic buildings and other minor structures which do not require significant engineering design inputs.

5.1.2 The sizes of timber framing members of typical construction details described in this clause are based on:

(a) experience of constructing with local species for providing acceptable resistance against loading conditions applicable to Guyana; and

(b) standard engineering formulae for bending moment and deflection using the strength properties for Strength Classes F1 - F5 as presented in **Tables 7** and **8**.

5.2 Floor structure and framing

5.2.1 Beams and bearers

(a) **Spans:** Tables for floor beams and bearers for various strength groups are presented in **Table 9** for single span.

(b) **Sizes:** The sizes in **Table 9** are based on maximum dead loads of 0.8 kN/m^2. The size of floor beams shall be as specified in **Table 9** and shall have a minimum thickness of 100 mm.

(c) **Bearing:** Floor beams shall not have less than 100 mm bearing on timber wall plates or columns.

Table 9
Floor beams - Single span

Maximum imposed load = 2.0 kN/m^2

Beam size (width x depth) (mm)	Spacing (m)	Maximum span (m)			
		Greenheart	F3	F4	F5
100 x 150	2.0	3.3	2.7	3.0	3.3
100 x 200		4.2	3.6	3.9	4.2
100 x 250		5.5	4.6	5.0	5.5
100 x 300		6.1	5.4	5.8	6.1
100 x 150	3.0	2.7	2.0	2.4	2.7
100 x 200		3.6	2.7	3.1	3.6
100 x 250		4.5	3.6	4.0	4.5
100 x 300		5.4	4.5	5.0	5.4
100 x 150	4.0	2.5	1.8	2.2	2.5
100 x 200		3.2	2.2	2.8	3.2
100 x 250		4.0	3.0	3.6	4.0
100 x 300		5.0	3.8	4.3	5.0

(c) **Support and anchorage**

(i) Beams may be supported directly on concrete walls or on timber wall plates. In either case the minimum bearing length shall be 100 mm.

(ii) Shims may be used to ensure leveling of the top edges of beams in a floor framing.

(iii) Beams bearing on wall plates may be anchored by toe-nailing, as set out in **Table 14**. Alternatively , metal brackets may be used to achieve anchorage.

(iv) In post-and-beam construction bolted beam-to-column connections may be used to provide support and anchorage.

(d) **Notching**

Beams may be notched on either the bottom or top edge to achieve support. The following rules shall apply:

(i) the notch shall be square and true to ensure effective bearing and verticality;

(ii) the depth of a notch shall not exceed one-third the depth of the beam; and

(iii) beams shall be notched on the bottom edge within the middle _ of the span.

5.3 Floor joists

The span tables for floor joists for various spacing are presented in **Table 10** for one and two spans respectively.

(a) **Size:** The size of floor beams shall be as specified in **Table 9** and shall have a minimum thickness of 50 mm.

(b) **Bearing:** Floor joists shall not have less than 75 mm bearing on timber plates or beams.

(c) **Notching:** The recommendations of **5.2.1** (**d**) also apply to joists.

(d) **Anchorage and support:** Joists may be anchored to top faces of floor beams by:

(i) toe-nailing;

(ii) by a combination of notching and toe-nailing; or

(iii) the use of metal angle brackets.

Alternatively, joists may be supported by metal joists hangers connected to the faces of beams where the top edges of beams and joists are required to be at the same level.

(e) **Splicing of joists:** Floor joists shall not be spliced between points of support except in special cases where a properly designed and connected splice is provided by a qualified engineer.

(f) **Bridging and bracing:** Joists 250 mm or more in depth shall be provided with bridging or X-bracing at not more than 2 m intervals to ensure lateral stability.

(g) **Cantilevers:** Floor joists of 50 x 200 mm or more may be cantilevered to 15% of their span to a maximum of 2 m in a one or two storey building.

Table 10
Floor joists - Single span
Maximum dead load = 0.8 kN/m^2
Live load = 2.0 kN/m^2

Joist size (width x depth) (mm)	Spacing (mm)	Maximum span (m)			
		Greenheart	F3	F4	F5
50 x 100	450	2.5	1.8	2.0	2.5
50 x 150		3.7	2.0	2.5	3.7
50 x 200		5.0	2.5	3.7	5.0
50 x 250		6.2	3.7	5.0	6.2
50 x 300		7.5	5.0	6.2	7.5
50 x 100	610	2.2	1.5	1.8	2.2
50 x 150		3.4	1.8	2.2	3.4
50 x 200		4.5	2.2	3.0	4.5
50 x 250		5.6	3.5	4.7	5.6
50 x 300		6.7	4.0	5.5	6.7
50 x 100	750	2.0	1.2	1.5	2.0
50 x 150		3.1	1.5	1.8	3.1
50 x 200		4.2	1.8	2.4	4.2
50 x 250		5.2	2.4	4.0	5.2
50 x 300		6.3	4.5	5.2	6.3

5.4 Roof structure and framing

5.4.1 General

The roof structure for timber buildings may be in the form of roof trusses or trussed rafters or constructed or individual framing members in the form of rafters, ceiling joists and purlins.

This Clause sets out the requirements for construction utilising rafters, ceiling joists and purlins. Trusses and trussed rafters are addressed at **Clause 9** of this Code.

5.4.2 Rafters and ceiling joists

(a) **Size:** The minimum size of rafters and ceiling joists where a plastered ceiling is directly supported on the bottom of such members shall not be less than 38 mm nominal width.

(b) **Spacing:** The maximum spacing of rafters and ceiling joists shall be as follows:

(i) rafters where close-boarded ceiling is used - 900 mm;

(ii) rafters where purlins are used - 1200mm;

(iii) ceiling joists supporting plastered ceiling - 400 mm centres; and

(iv) ceiling joists supporting other forms of lightweight ceiling, such as fibreboard, plywood or tempered hardboard - 600 mm.

(c) **Bearing:** Rafters and ceiling joists shall have not less than 75 mm bearing on timber plates.

(d) **Anchorage:** Roof members shall be effectively anchored to satisfy uplift requirements.

(i) In areas where relatively high wind loads resulting in uplift pressures are not normally expected each individual rafter may be notched over and nailed to tie beams, plates etc, on which it beams.

(ii) At a ridge, the rafters shall also be effectively nailed.

(iii) Where relatively high wind loads and uplift pressures are normally expected, each rafter shall be anchored to the tie beam, plate or truss on which it beams with steel straps or equivalent metal fastener.

(iv) Ceiling joists shall be nailed to the bearing plates, to each other where they lap.

(e) **Ridges, hip and valley rafters**

Ridge boards, hip and valley rafters shall have sizes not less than the largest rafter framing thereto.

Table 11
Rafters and ceiling joists

Span (m)	Spacing (mm)	Maximum dimensions (mm x mm)		
		F3	**F4**	**F5**
Rafters	450	38 x 100	38 x 100	38 x 100
	600	38 x 150	38 x 125	38 x 125
2.4	900	38 x 175	38 x 150	38 x 150
2.8	450	50 x 125	50 x 100	50 x 100
	600	50 x 150	50 x 125	50 x 125
	900	50 x 175	50 x 150	50 x 125
3.2	450	50 x 150	50 x 125	50 x 125
	600	50 x 175	50 x 150	50 x 150
	900	50 x 175	50 x 175	50 x 175
3.7	450	50 x 150	50 x 150	50 x 150
	600	50 x 200	50 x 175	50 x 150
	900	50 x 200	50 x 200	50 x 200
4.5	450	50 x 200	50 x 175	50 x 150
	600	50 x 225	50 x 200	50 x 175
	900	50 x 250	50 x 225	50 x 200
Ceiling joists				
1.8	600	50 x 100	38 x 100	38 x 100
2.1		50 x 125	38 x 125	38 x 100
2.7		50 x 150	50 x 125	38 x 125
3.3		50 x 150	50 x 125	38 x 125

5.4.3 Purlins

Purlins shall be provided to support metal roof sheeting and shall be effectively; fixed to withstand uplift forces.

(a) **Size:** Is dictated by the type of sheeting and spacing of the rafters. These shall have a minimum dimension of 50 mm thickness and a depth of 75 mm. The recommended sizes and spacing for purlins supporting metal sheeting are given in **Table 12**.

(b) **Anchorage:** Purlins shall be effectively anchored to the supporting rafters by metal hangers or brackets or by nailing.

(c) **Splicing:** Purlins shall not be spliced between points of support. Where splicing between supports are necessary such splicing shall be properly designed by a qualified engineer.

Purlins are not required where close boarding is attached to rafters as support for roof sheeting.

Table 12
Minimum sizes of purlins

Purlin spacing (m)	Rafter spacing (mm)	Maximum dimensions (mm x mm)		
		F3	F4	F5
0.61	450 600 900	50 x 100 50 x 125 50 x 150	50 x 100 50 x 125 50 x 125	50 x 100 50 x 100 50 x 125
0.90	450 600 900	50 x 150 50 x 150 50 x 175	50 x 125 50 x 150 50 x 150	50 x 100 50 x 125 50 x 150
1.22	450 600 900	50 x 150 50 x 200 50 x 225	50 x 150 50 x 175 50 x 200	50 x 125 50 x 150 50 x 175

6 Compression members

6.1 General

This Clause presents recommendations on compression members such as solid and built-up columns, posts and wall studs. Compression members in trusses and other triangulated frameworks are not covered by these recommendations.

6.2 Solid columns

6.2.1 All columns or posts shall be squared to true end bearing and shall be securely anchored against lateral and vertical forces.

6.2.2 All columns at ground level shall be raised on plinths or concrete pedestals at least 200 mm above the ground or have the bottom end protected by an effective moisture barrier.

(a) **Slicing:** Splicing of columns shall only be done at locations where adequate support about both axes is provided.

(b) **Notching:** Notching of columns of cross sectional dimension smaller than 150 x 150 mm shall not be permitted.

For larger columns, notching may be permitted provided that the area at the notched section is not reduced by more than 10%.

(c) **Size and height:** The size of columns is influenced by the clear height and the loading.

Table 13 gives recommendations on the height and size of columns for varying areas of supported domestic floors.

Table 13
Columns supporting floors in domestic buildings

Column		Maximum area of floor supported (m^2)			
Height (m)	**Size (mm x mm)**	**Greenheart**	**F3**	**F4**	**F5**
2.5	100 x 100	16.0	9.3	14.4	16.0
2.5	150 x 150	20.2	7.5	60.0	20.2
3.0	150 x 150	25.0	9.3	20.2	25.0
3.0	200 x 200	30.2	12.5	25.0	30.2
4.0	200 x 200	36.0	13.4	30.2	36.0
4.5	250 x 250	42.2	18.2	36.0	42.2

6.3 Stud walls

6.3.1 **Placement of studs:** Studs in exterior and load bearing walls shall be placed with the longest dimension perpendicular to the wall.

6.3.2 Double studs: Stud walls shall:

(a) be squared to corners using double studs and battens; and

(b) have double studs at the sides of all doors, windows or other openings in bearing walls, and openings wider than 1.50 m in non-load bearing walls.

6.3.4 Bracing: Bracing shall be provided for all load-bearing stud walls.

6.3.5 Studs joining masonry: Studs in walls or partitions which join masonry walls shall be secured against lateral movement by nailing, bolting or similar stud connections to the masonry.

6.4 Plates

6.4.1 Top plates in load-bearing walls

These shall:

(a) be doubled for the entire length of exterior walls;

(b) be doubled or lapped at each intersection with walls and partitions; and

(c) have joints in upper or lower member of top plate lapped not less than 1.2 m.

6.4.2 Plates on masonry or concrete

Plates or sills in stud-bearing walls resting on masonry or concrete shall not be less than:

(a) 75 x 150 mm, bolted to the masonry or concrete at the corners and at spacings not more than 1.2 m with 12 mm bolts embedded 175 mm into the masonry; and.

(b) stud walls resting on masonry shall have base plates or sills of timber treated with a suitable preservative.

6.4.3 Base plates concrete

Base plates or stud walls resting on concrete slab floors shall have a suitable damp-proof course under the plate. In no circumstance shall base plates be embedded in concrete or mortar.

7 Connections

7.1 This Clause presents general requirements for nailed and bolted joints in light-framed timber structures. For the designs of joints in heavy engineered structures the principles set out in various design standards, such as **BS 5268 : 1985**, "**Structural use of timber**" may be utilised.

Timber joints with stud-type connections, such as nails and bolts, may be classified as:

7.1.1 Laterally loaded joints: Nails or bolts penetrating the side faces of members and perpendicular to the grain direction.

7.1.2 End-loaded or withdrawal joints: Nail joints with nails driven through the face of one member and into the end and parallel to the grain direction of the connected member.

7.1.3 Toe-nailed joints: Nail driven at an angle through the side face and close to the end of one member and penetrating the face of the connected member.

7.2 Nailed joints

7.2.1 The minimum requirements for various types of nailed joints are given in **Table 14**.

(a) **Number of nails:** The number of nails required for connecting members in various types of joints are presented in **Table 14**.

(b) **Nail spacing:** Timber joints shall have a minimum of two nails. The spacing requirements for laterally nailed joints are given in **Table 15** and shown in **Appendix 5**.

(c) **Nail penetration:** In general, the point side penetration of nails is laterally loaded joints shall not be less than the thickness of the head side member.

Table 14
Nailing requirements for common timber joints

Type of joint	Nailing requirements (Wire nails)		Connection
	Number type	Length	
Joist-to-beam	2 - 16d	75	Toe nailed
Bridging-to-joint	2 - 8d	65	Toe nailed
Plate-to-joist or blocking	2 - 16d	75	4000 mm crs
Stud-to-plate	2 - 16d	75	End nailed
	or		
	2 - 16d	65	End nailed
Top plates, spiked together	2 - 16d	65	Face nailed
Plate to stud	2 - 16d	65	End nailed
Ceiling joist to top plate	2 - 16d	65	Toe nailed
Rafters to plate	4 - 16d	65	Toe nailed
Parallel rafters	2 - 16d	65	Face nailed
Purlins to rafters	2 - 16d	65	Toe nailed
Cladding to studs:			
-Boards 100 mm wide	2 - 16d	65	Face nailed
-Boards 150 mm wide	3 - 16d	65	Face nailed
-Boards 200 mm wide	4 - 16d	65	Face nailed
Roof close - Boarding to rafters:			
-Boards 100 mm wide	2 - 16d	65	face nailed
-Boards 150 mm wide	3 - 16d	65	Face nailed
-Boards 200 mm wide	4 - 16d	65	Face nailed
Floor boards to joists:			
-Boards 75 mm wide	2 - 16d	65	Face nailed
-Boards 100 mm wide	3 - 16d	65	Face nailed

Table 15
Nail spacing for laterally loaded joints without pre-boring

Type of joints	Spacing		End distance (diameter)	Edge distance (diameter
	Along the grain (diameter)	Across the grain (diameter)		
Timber-to-timber	20	10	20	5
	10	10	20	5
Plywood-to-timber	10	5	10	5
Metal-to-timber				

7.3 Bolted joints

7.3.1 Joint construction

(a) **Spacing, edge and end distances**

The minimum spacing, edge and end distances for bolted joints for loads acting parallel and perpendicular to the grain are given in **Appendix 6**. For loads acting at an angle of _ to the grain, the value for the loads acting parallel to the grain may be used when _ ≤ 20^0, and the value given for loads acting perpendicular to the grain when _ > 20^0.

8 Heavy engineered timber structures - Minimum design requirements and construction details

8.1 General

8.1.1 For the purpose of this Code heavy engineered timber structures include all structures incorporating large timber members and specially designed connections for supporting relatively heavy loads. These include public, commercial, industrial and institutional buildings, sports facilities, grandstand, pavilions, bridges, wharves and other marine construction.

8.1.2 Such structures shall be designed by competent qualified engineers in accordance with the requirements set out in appropriate design Code and Standards **(for example**, **BS 5268 : 1985**, "**Structural use of timber**" and **AS 1720 : 1982**).

8.1.3 For use with these Codes, the strength classes and grade stresses set out in **Clause 4** of this Code shall be applied.

8.1.4 This Clause of the Code presents general guidelines on the design and construction of elements in such members.

8.2 Flexural members

Flexural members are generally designed from solid timber, built-up, composite or glued-laminated timber. Because of the difficulty of glue-laminating, Guyanese and other tropical hardwoods, sold and build-up timbers are the predominant structural form.

8.2.1 Joists and girders

(a) **Floor framing**

(i) Joists, beams and girders for floor structure applications shall not be less than 150 mm nominal depth.

(ii) Lattice girders or trusses supporting floor loads shall have members of nominal depth or less than 50 mm.

(b) **Roof framing**

(i) Roof joists, beams and rafters shall not be less than 50 mm nominal and depth not less than 100 mm nominal.

(ii) Roof trusses shall have members of depth or width not less than 50 mm nominal and depth not less than 100 mm nominal.

8.2.2 Flooring and roof decks

(a) flooring may be square edged plank, splined, or tongue and grooved, of not less than 38 mm nominal thickness.

(b) Planks shall:

(i) have joints staggered such that a continuous line of joints will not occur, except at points of supports; and

(ii) have gaps not less than 10 mm to the wall to provide an expansion joint, which shall be covered at top and bottom.

(c) Roof decks may be:

(i) square edge planks, spline, or tongue and grooved, and shall have a thickness not less than 38 mm nominal dimension;

(ii) of double thickness, of nominal 25 mm planks or tongue and grooved boards with staggered joints; or

(iii) Nail - laminated decking of nominal thickness not less than 50 mm.

8.3 Columns

Timber columns may be solid, spaced or built-up and shall not be less than 200 mm nominal depth when supporting roof or floor locals.

8.3.1 Solid columns

(a) Solid columns shall be:

(i) continuous or directly superimposed one above the other with no girders or bolsters between columns, throughout all storeys by means of metal caps with brackets; and

(ii) connected by properly designed steel or iron caps with pintles and base plates, or by timber splice plates affixed to the columns by means of metal connections housed within the contact faces, or other suitable methods.

8.3.2 Spaced columns

(a) Each leaf of space columns shall have a nominal thickness not less than 50 mm.

(b) The leaves of spaced columns shall be separated by spacer blocks of nominal size 50 mm x 100 mm x column depth of centres not greater than _ x clear column height

8.4 Joints

8.4.1 The joints in heavy timber structures may be of the following:

(a) **Nailed joints**

(i) Timber-to-timber.

(ii) Timber with plywood gussets.

(iii) Timber with metal nail plates gussets.

(b) **Bolted joints**

(i) Without gussets.

(ii) Gusseted - plywood.

(iii) Gusseted - metal gussets.

(c) **Connector joints**

(i) Shear plate connections and bolt.

(ii) Split-ring connectors and bolts.

The minimum spacings given in **Clause 5** of this Code shall be used with nailed and bolted joints in heavy; timber structures.

9 Trusses and trussed rafters

9.1 General

This Clause covers trusses used in roof construction for engineered and non-engineered residential buildings. The latter type of trusses are generally classified as trussed rafters.

9.2 Design and general construction requirements

Trusses are designed as pin-jointed, plane frame structures. Construction requirements shall ensure that this structural form and behaviour are achieved. This implies that symmetry in the plane of the structure shall be achieved in practice. Lack of planar symmetry would affect the stability of the structure and could result in undesirable out-of-plane deflections and distortions which would be detrimental to the stability of the entire roof structure.

9.3 Typical configurations

Typical configurations for trusses and trussed rafters are shown in **Appendix 8**. In general, the top and bottom chords may be form with single or double members. Internal members are usually single members.

9.4 Minimum member sizes

9.4.1 For single chord construction, the minimum size of the top and bottom chords is 38 mm x 75 mm.

9.4.2 For duo-chord construction, the minimum size of the top and bottom chords is 32 mm x 75 mm.

9.4.3 The minimum size of internal members is 38 mm x 75 mm.

9.5 Joints

joints in trusses and trussed rafters shall be arranged such that secondary moments are minimised. This is assured if the centre lines of all members meeting at the joint coincide. This is easy to achieve with gusseted joints. With timber-to-timber joints this could be achieved by using double chords (that is, duo-chord truss).

9.5.1 Nailed joints

Nailed joints in trusses shall be formed with gussets or nail plates. For plywood gussets the minimum recommended thickness is 12 mm. The minimum recommended thickness for nail plates is 8 mm. Typical nailed joints for trusses are shown in **Appendix 9**.

9.5.2 Bolted joints

Bolted joints in trusses may be formed with bolts only or with plywood or metal gusset plates. All bolts shall have washers on both faces of the joint. For plywood gussets, the minimum recommended thickness is 12 mm. The minimum recommended thickness for nail plates is 8 mm. Typical nailed joints for trusses are shown in **Appendix 10**.

9.6 Support and anchorage

Trusses shall be supported and adequate bearing on timber wall plates or roof beams. Effective anchorage shall be provided by the use of metal brackets designed to achieve pinned supports and prevent uplift.

9.7 Bracing

Trussed roof systems shall be provided with adequate bracing against lateral forces due to wind loads.

Appendix 1
Preferred nominal sizes for structural lumber

Thickness (mm)	Width (mm)														
	50	75	100	125	150	175	200	225	250	275	300	350	400	450	500
12	x	x	x												
16	x	x	x												
19	x	x	x	x											
25		x	x	x	x	x	x	x	x						
32		x	x	x	x	x	x	x	x						
38		x	x	x	x	x	x	x	x						
44		x	x	x	x	x	x	x	x						
50	x	x	x	x	x	x	x	x	x	x	x				
62		x	x	x	x	x	x	x	x	x	x				
75		x	x	x	x	x	x	x	x		x				
100			x	x	x	x	x	x	x		x	x			
125			x	x	x	x	x	x	x	x	x	x			
150					x	x	x	x	x	x	x	x	x		
175						x	x	x	x	x	x	x	x		
200							x	x	x	x	x	x	x	x	x
225								x	x	x	x	x	x	x	x
250									x	x	x	x	x	x	x
300												x	x	x	x
350													x	x	x
400														x	x
450															x

Appendix 2
Anchorage of floor beams

Appendix 3
Anchorage of floor joist

Appendix 4

Notching of beams and joists

Appendix 5
Minimum spacing, edge and end distances for nailed joints

Appendix 6
Minimum spacing, edge and end distances for bolted joints

Appendix 7
Typical base connections for columns

Appendix 8
Trusses and trussed rafters

Appendix 9
Single cord truss - Typical details

Appendix 10
Double chord truss (Bolted joints)