CDEMA
CARIBBEAN DISASTER EMERGENCY MANAGEMENT AGENCY
Resilient States · Safer Lives

Learner's Guide

Construction Site Supervision of Houses

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The Learner's Guide is one of six resources developed by CDEMA for safer building in the Caribbean, that includes, an Answer Booklet, Pocket Guide, Curriculum, the Occupational Standard for the Caribbean Vocational Qualification (CVQ) - Level 3 in Construction Site Supervision (CCBCM30123), and CRCP 10: 2023. Thanks are extended to the team that coordinated the development of these resources which was led by Dr. Nicole Greenidge in partnership with CROSQ and the Caribbean Association of National Training Authorities (CANTA). Special thanks are also extended to the CDEMA Coordinating Unit's management team, project coordinators and other team members for their invaluable contributions.

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PREFACE

The economic cost of disasters in the Caribbean has been substantial, exceeding US$28 billion over the last seven decades. Between 1950 and 2016 these costs surpassed $22 billion (in constant 2009 dollars). Since then, several other hazards have wreaked havoc in the region. Some of the costliest disasters include Hurricane Maria in 2017, which resulted in $1.3 billion in damages and losses in Dominica. In 2019, Dorian, the strongest hurricane on record to affect The Bahamas, resulted in $3.2 billion in damages and losses. In 2021, the eruption of La Soufrière resulted in $233 million in damages and losses in Saint Vincent and the Grenadines. That same year, on August 14th, a 7.2 magnitude earthquake affected the southern peninsula of Haiti resulting in more than $1.6 billion in damages and losses. At least 137,500 buildings were damaged or destroyed. Disasters are costly, and they also take lives. In the Caribbean, more than 250,000 people were killed from disasters over the period 1950 to 2022. The August 2021 Haiti-earthquake resulted in 2,246 deaths, 12,763 injured and 329 missing persons. More than 660,000 people were affected.

Post disaster damage and loss assessments reveal that in the Caribbean, a significant portion of damage from disasters has been in the housing sector. Moreover, much of this damage could be avoided as repeatedly, the application of building codes was found to be inconsistent and there was weak to no legislation in place to address safe building. Poor building practices were evident as was the absence of sensitization to safe building practices. There are also indications that a substantial portion of the housing stock in the Caribbean has been built through the informal construction sector which does not necessarily adhere to formal building codes and standards. Moreover, many practitioners within the informal sector, in most instances, have never received formal skills training or certification. These realities provide the basis for the development of the Learner's Guide for Construction Site Supervision of Houses which is one of six resources developed by the Caribbean Disaster Emergency Management Agency (CDEMA) for safer building in the Caribbean:

- CARICOM Regional Code of Practice for the Construction of House (CRCP 10:2023), developed under the authority of the CARICOM Regional Organisation for Standards and Quality (CROSQ).
- Caribbean Vocational Qualification (CVQ) Occupational Standard- Level 3 in Construction Site Supervision (CCBCM30123), developed under the authority of the Caribbean Association for National Training Authorities (CANTA).
- Curriculum for the Short course in Construction Site Supervision of Houses
- Learner's Guide for Construction Site Supervision of Houses
- Answer Booklet for Construction Site Supervision of Houses
- Pocket Guide for Construction Site Supervision of Houses

The Learner's Guide is a training guide to help participants learn at their own pace with assessment exercises. It is developed from CRCP 10:2023 and is a resource for training in CCBCM30123 which was approved as a revised CVQ in 2022 at the 44th meeting of the Caribbean Community (CARICOM) Council for Human and Social Development (COHSOD). CRCP 10:2023 was approved as a CARICOM Regional Standard by the CARICOM Council for Trade and Economic Development (COTED) at its 56th Meeting. Whilst CRCP 10:2023 outlines the specifications for constructing houses in CARICOM Member States to a common standard for strength and durability for improved resilience; the CVQ Occupational Standard which is a competency-based occupational regional qualification, establishes

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[1] İnci Ötker and Krishna Srinivasan (2018) Bracing For The Storm, Finance & Development, March 2018, Vol. 55

[2] Government of the Commonwealth of Dominica (2017) Post-Disaster Needs Assessment Hurricane Maria

[3] ECLAC, IDB, PAHO, WHO (2019) Assessment of the Effects and Impacts of Hurricane Dorian in the Bahamas - Executive Summary

[4] Government of Saint Vincent and the Grenadines (2021) La Soufrière Volcanic Eruption Post Disaster Needs Assessment Saint Vincent and the Grenadines

[5] Government of the Republic of Haiti, Ministry of Planning and External Cooperation (2021) Post Disaster Needs Assessment in Haiti

[6] EM-DAT, Centre for Research on the Epidemiology of Disasters (CRED) / UCLouvain, Brussels, Belgium – www.emdat.be

the skills and competencies needed to meet the CRCP 10: 2023 standard according to the CARICOM Qualifications Framework at Level 3- Independent or Autonomous Skilled Worker.

As the regional inter-governmental agency for disaster management in CARICOM, CDEMA is the facilitator, driver, coordinator and motivating force for the promotion and engineering of Comprehensive Disaster Management (CDM) in its nineteen (19) Participating States, which encompasses the 15 CARICOM Member States. CDM requires leadership by all people and sectors in building the resilience of the region. This ethos underpins the Regional CDM Strategy and Results Framework 2014-2024. Since the Caribbean Association of National Training Authorities (CANTA) is the implementation arm of the CARICOM Regional Coordinating Mechanism for Technical and Vocational Education and Training (TVET) and is also responsible for establishing the regional certification system, labelled as CVQs, CDEMA therefore partnered with them to revise the CVQ for Construction Site Supervision to address CRCP 10:2023. Developing this revised CVQ is pivotal to resilience since it provides a standard as well as basis for uniform delivery of competency-based technical and vocational education and training and certification within the Caribbean Single Market and Economy (CSME) for resilient houses to disasters. It provides a means for certifying persons practicing in the industry within the CSME.

The CVQ in Construction Site Supervision will be the basis for delivering training through the CANTA network of National Training Authorities and vocational training providers that will build capacity amongst foremen and experienced artisans and the next generation of builders, for the safe construction of houses in the region. CANTA therefore plays a critical role in advancing the regional goal of a Safer, more resilient and sustainable CDEMA Participating States through Comprehensive Disaster Management " and is contributing to achieving Pillar II, Safeguarding Infrastructure, of the "Caribbean Pathway for Building Resilience' adopted by CARICOM Heads of Government in July 2018.

The development of these safer building resources, was done under an overarching project implemented by CDEMA from 2021-2024 with five components that included review and revision of the Code of Practice for the Construction of Houses (first developed by CDEMA in 2005) as a CARICOM Regional Standard, the development/ revision of an accompanying CVQ to the Code of Practice to support institutionalisation and sustainability; offering of certified training in the rudiments of CRCP 10:2023 through the CVQ; and the provision of training by vocational institutions in eight Member States, Antigua and Barbuda, Barbados, British Virgin Islands, Dominica, Grenada, Saint Lucia, St. Kitts and Nevis and St. Vincent and the Grenadines. Special acknowledgement is given to the development partners that supported the development of regional standards- CRCP 10:2023, and CVQ Level 3 in Construction Site Supervision (CCBCM30123); and delivery of training and marketing. Namely, the Government of Norway Support to the Advancement of Comprehensive Disaster Management (CDM) in the CDEMA Participating States, the United States Agency for International Development (USAID) under the Caribbean Climate Resilience Initiative (CCRI) project, the Caribbean Development Bank (CDB), and the Building the Resilience of the CARIFORUM States to Disaster Risks and Climate Change Impacts project, financed by the European Union through the 11th European Development Fund.

Safe housing is a basic need of society, and adequate housing is a human right. These safer building resources are commended to training providers, artisans, contractors, building authorities, policy makers and financial institutions for the construction of safer, and more resilient housing in the Caribbean region.

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[7] Articles – CANTA (cantaonline.org)

1

INTRODUCTION

INTRODUCTION 1

1.1 WELCOME

Welcome to this Learner's Guide for the short course in Construction Site Supervision. Whether you are an artisan, construction supervisor, building inspector, or merely a person interested in building, this Guide is intended to help you supervise and check the construction of a strong and durable house in the Caribbean.

This Guide provides construction details to the strength of Category 5 hurricanes Irma (which caused catastrophic damage in Anguilla, Barbuda, The Bahamas, Sint Maarten, the Virgin Islands and Turks and Caicos Islands in 2017), Maria (which directly struck Dominica in 2017 leaving 90 percent of all roofs damaged or destroyed), and Dorian (which struck The Bahamas in 2019), as well as Magnitude 7 earthquakes (which struck Haiti in 2010 and 2021).

This Guide also provides construction details to the strength of Category 2 hurricanes. Builders may provide quotations for both Category 2 and 5 hurricanes to allow their clients (normally the home-owner) to make an informed decision on affordability.

The higher standard of strength is important because the Caribbean risks being impacted by a diverse set of natural hazards including earthquakes, hurricanes, floods, landslides, volcanoes, tsunamis, torrential rainfall, and the predicted negative effects of climate change. Houses may also be prematurely weakened by corrosion, moisture, insects, heat, and the sun's ultraviolet rays.

The content was developed from the 'CARICOM Regional Code of Practice- Construction of Houses (CRCP 10: 2023)' and supports the Occupational Standard for Caribbean Vocational Qualifications (CVQ) - Level 3 in Construction Site Supervision. For easy reference, the tables and table numbers in this Learner's Guide correspond to the tables and table numbers in the 'CARICOM Regional Code of Practice- Construction of Houses (CRCP 10: 2023)' unless otherwise noted.

1.2 LIMITS

This Guide is applicable to the structural construction of houses in the Caribbean. It applies to single-storey houses up to 7.62 m x 12.19 m or 92.9 sq-m (25 ft x 40 ft or 1,000 sq-ft) plan, with hollow block masonry or timber framed walls, and timber framed or concrete roofs. It provides the user with the technical information to:

(i) supervise the construction of a safe and durable house, and
(ii) check whether a safe and durable house is being built.

A house with an area of 92.9 sq-m (1,000 sq-ft) might include three bedrooms, two bathrooms, one pantry and one open-concept space comprising living, dining and kitchen areas.

This Guide does not include construction details for utilities (including plumbing, electrical, communications, security, and natural gas), since these are normally outsourced to specialist sub-contractors. It also does not include construction details for solid brick masonry.

1.3 HOW TO USE THIS LEARNER'S GUIDE

This Learner's Guide is designed to help you learn at your own pace. You are encouraged to read each section and complete the Assessment Exercises associated with each section.

With that introduction, let's get started.

2

PRE-CONSTRUCTION PLANNING

2 PRE-CONSTRUCTION PLANNING

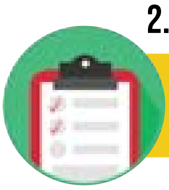
2.1 PLANNING APPROVAL

Before construction starts, Development Planning approval must be obtained. Obtaining Planning approval is the responsibility of the Employer or Client (normally the home-owner). A property that has planning approval should have, among other things:

(i) accurate and identifiable boundary markers,
(ii) dimensions to set out the house,
(iii) materials of construction, and
(iv) provision for sewage disposal.

Any variations to the contract that change the internal or external geometry of the building should be resubmitted for Development Planning approval.

2.1.1 ASSESSMENT EXERCISE 1



Follow the below steps to consider when seeking development planning approval before construction starts.

A. Contact your development authority and record the following:
   a. Name of the authority
   b. Telephone number
   c. E-mail
   d. Web address

B. Describe the application process for a 92.9 sq-m (1,000 sq ft) masonry house.
   a. What drawings are required?
   b. How many copies of the drawings must be submitted?
   c. What is the application fee?
   d. What is the estimated time for planning approval?
   e. After approval, what are the next steps before you are allowed to build?

C. Download the building guidelines and the application form if they are available.

2.2 CONTRACT

Before construction starts, the Contractor (builder) should have a written contract with the Employer (normally home-owner). The contract should include:

(i) contractor's obligations,
(ii) employer's obligations,
(iii) procedures for making changes to the contract,
(iv) procedures for resolving disputes, and
(v) insurance requirements.

2.2.1 CONTRACTOR'S OBLIGATIONS

The Contractor's obligations should include the agreement to build the house that was approved by the planning authorities, using specified construction standards, for a specified amount of money, and within a specified period of time.

2.2.2 EMPLOYER'S OBLIGATIONS

The Employer's obligations should include the agreement to pay a specified sum of money, within a specified period of time after receiving the Contractor's invoice, and according to a specified payment schedule based on stages of construction (for example, the completion of: foundations, floor, walls, roof, finishes, cabinetry and fixtures).

2.2.3 VARIATIONS

Whenever an Employer requests a change to their building project (or Contract), the Contractor should provide the Employer with:

(i) the additional cost (or saving) of the change, and
(ii) the extension or reduction in time to complete the change, for the Employer's written approval.

2.2.4 RESOLVING DISPUTES

Contracts should have a named independent adjudicator, who shall be agreed to by both parties, who may be invited by either side to decide on an unresolved dispute within two weeks. The adjudicator's decision shall be final and binding, unless one party notifies the other in writing, within two weeks of the decision, of their intent to appeal the decision through arbitration or litigation. In that case, the adjudicators' decision is binding until practical completion, or should the contract be terminated.

2.2.5 ASSESSMENT EXERCISE 2

Review a residential construction contract and identify any missing information.

2.3 INSURANCE

The Contractor should indemnify (protect from legal responsibility) the Employer, and insure against personal injury or death of any person, and damage to property, in the course of completing the contracted work. The insured amount should be for a minimum of five (5) years of individual earnings if no national legislation exists. If the Contractor fails to secure this insurance, the Employer shall obtain the insurance and deduct the cost from amounts due to the Contractor.

2.3.1 ASSESSMENT EXERCISE 3

Examine an insurance policy for building a house and identify any items that are missing.

2.4 DRAWING REVIEW

The Contractor shall examine all drawings to check whether they contain sufficient information to both build the house and calculate the cost of building the house. The Contractor should request any missing information from the Employer. The Contractor should state any assumptions used in the price quotation if the missing information is not provided. The Contractor should state the assumed depth of the footings.

2.4.1 ASSESSMENT EXERCISE 4

Conduct a review of construction drawings for a residential property, and include the missing information (to be done at the end of this Guide – see section 9.6).

The remainder of this Guide will be referring to measurement terminology, which is covered in the next section.

3

SYMBOLS AND ABBREVIATED TERMS

3 SYMBOLS AND ABBREVIATED TERMS

To reduce the risk of misinterpreting information in this Guide, the following symbols and abbreviated terms are used.

CoP	CARICOM Regional Standard - Construction of Houses - Code of Practice (CRCP 10:23)
dia	Diameter
ft	Foot or feet
gal	US gallon
in	Inch (“)
km	Kilometre
kN	Kilonewton
kg	Kilogram
m	Metre
m^2	Square metre (sq-m)
m^3	Cubic metre (cu-m)
mm	Millimetre
MPa	Megapascal (N/mm2)
mph	Miles per hour
m/s	Meters per second
Mw	Moment magnitude
N	Newtons
No.	Number
psi	Pounds per square inch
sq-ft	Square feet
SS	Structural Select
US	United States of America

The remainder of this Guide will be referring to construction materials, which are to be assembled to build a house. The assembling may be done by: mixing, nailing, screwing, bolting, cementing, fitting, and compacting.

4

CONSTRUCTION MATERIALS

4 CONSTRUCTION MATERIALS

The first materials we shall examine are cementitious materials. Cement is used to bond sand grains together to make mortar by mixing cement, sand, and water. Mortar is then used to bond concrete blocks to make walls. Cement is also used to bond sand and stones (also called aggregates) together to make concrete by mixing cement, sand, aggregates and water. Concrete is then poured in forms to make concrete elements like footings, slabs, beams and columns.

4.1 CEMENT

For normal use above ground, and for footings bearing on limestone, cement should be Ordinary Portland Cement (Type I, CEM I, or equivalent). For footings in high sulphate soils, the cement should be Sulphate Resistant Cement (Type V or equivalent). For concrete or plaster in dense urban areas, with high automobile traffic, the cement may also be Sulphate Resistant (Type V or equivalent). This is because automobiles that use petrol emit sulphates which can reduce the strength of concrete and plaster.

4.2 SAND (FINE AGGREGATE)

Sand (fine aggregate) should be clean and natural from an inland source, free of clay, organic (living or dead) material, and broken shells. Beach sand should not be used since it contains salt which can corrode steel reinforcement. Where sand is not available, it may be made by crushing larger aggregates. Sand used for mortar and plaster must be sifted through a sieve to remove larger-sized particles.

4.3 STONE (COARSE AGGREGATE)

Stone (coarse aggregate) for reinforced concrete should be crushed stone or gravel with a minimum size of 6 mm (1/4") and a maximum size of 20 mm (3/4"), free of a coating of dust. However, a maximum size of 25 mm (1") may be used as directed by a professional engineer considering the concrete cover, spacing of reinforcement and the element used. A maximum size of 37.5 mm (1.5") may be used for unreinforced concrete.

4.4 WATER

Water should be clean and free of impurities such as salt, chlorides, sulphates, and organic matter, which may affect the concrete quality. A continuous supply of water should be available during all concrete mixing, placing and curing operations – you do not want to run out of water.

4.5 CONCRETE

Concrete is a specific mixture of cement, sand, aggregate, and water, with a slump between 50 mm (2”) and 100 mm (4”). Concrete mixed in a mixer is to be used within 1.25 hours (75 minutes) after adding water. Admixture agents may be added to achieve:

(i) better flow with a higher slump (superplasticiser),
(ii) delayed setting (retarder), or
(iii) rapid setting.

In this standard, concrete is used to construct concrete: footings, walls, beams, columns, and slabs.

4.5.1 SLUMP

Slump is a measure of the workability (how easy it is to work – not too stiff or not too flowing) of concrete. It is measured by filling a 300 mm (12”) high x 100 mm (4”) to 200 mm (8”) diameter frustum Slump Cone (see figure 1), in three equal compacted lifts of 100 mm (4”).

The concrete is compacted using the 16 mm (5/8”) diameter rod with the end-rounded as the tamping rod, and tamping for 25 times for each lift; then lifting the cone, and measuring the slump, which is the distance between the height of the cone and the height of the concrete.

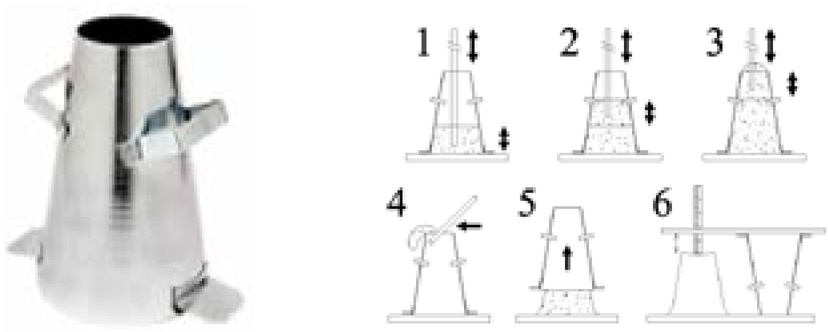


FIGURE 1 - SLUMP TEST

4.6 GROUT

Grout is a specific mixture of cement, sand, aggregate, and water with a slump of between 115 mm (4.5”) and 230 mm (9”). Grout must be used within one and one quarter (1.25) hours after adding water. In this standard, grout is used to fill cores in concrete masonry blocks.

4.7 MORTAR

Mortar is a specific mixture of cement, sand, and water. In this standard, mortar is used to:

(i) bond concrete blocks together, and
(ii) plaster concrete walls and the underside of concrete slabs.

Lime is highly recommended to improve the waterproofing capability and durability of mortar plaster used on external walls. Mortar must be used within one (1) hour of adding water.

4.8 MIXING CEMENTITIOUS MATERIALS

Concrete, grout and mortar should be mixed:

(i) in a concrete mixer, or
(ii) on a hard, smooth and relatively impermeable (non-absorptive) surface (e.g. on a concrete blinding bed).

Examples are shown in Figure 2 below.

Mixing concrete in a concrete mixer

Mixing concrete on a concrete blinding bed

FIGURE 2 - MIXING CONCRETE

The mixes are provided in Table 1 for concreted and grouted elements, and Table 2 for mortar. The mixes are also provided using 5-gallon buckets since they are normally used on residential construction sites in the Caribbean.

TABLE 1 - MIXTURES FOR CONCRETED AND GROUTED ELEMENTS

Elements	28 - Day Compressive Cube Strength MPa = N/mm^2	Cement	Sand	Aggregate	Water	Slump
Footings, Slab on grade	21 MPa (3,000 psi)	1 cu-ft (1.5 x 5 gal)	2 cu-ft (3 x 5 gal)	4 cu-ft (6 x 5 gal)	5 gal	50 to 100 mm (2” to 4”)
Beams, Suspended slabs, Columns	25 MPa (3,600 psi)	1 cu-ft (1.5 x 5 gal)	1.5 cu-ft (2.25 x 5 gal)	3 cu-ft (4.5 x 5 gal)	5 gal	50 to 100 mm (2” to 4”)
Walls (grout for block’s cores)	15.8 MPa (2,300 psi)	1 cu-ft (1.5 x 5 gal)	3 cu-ft (4.5 x 5 gal)	6 cu-ft (9 x 5 gal)	5 gal	115 to 230 mm (4 ½” to 9”)

NOTE:
One (1) bag of cement = 94 lb bag = 1 cu-ft = 1.5 x 5-gallon buckets.

TABLE 2 - MIXTURES FOR MORTAR					
Elements	**28 - Day Compressive Cube Strength MPa = N/mm^2**	**Cement**	**Lime (optional, but highly recommended for plaster)**	**Water**	**Sifted Sand**
Mortar for repairs and below grade masonry work	16.8 MPa (2,400 psi)	1 cu-ft (1.5 x 5 gal)	½ cu-ft (0.75 x 5-gal)	5 gal	3 cu-ft (4.5 x 5-gal)
Beams, Suspended slabs, Columns	11.2 MPa (1,600 psi)	1 cu-ft (1.5 x 5 gal)	½ cu-ft (0.75 x 5-gal)	5 gal	4 cu-ft (6 x 5-gal)

The five (5) gallons of water is provided as a guide, since other factors like the dampness and absorption of the aggregate may affect the amount of water required. The slump measure should be recorded and used to determine whether less or more than five (5) gallons of water is required.

The compressive strength of concrete is normally measured at 28 days. It is sampled at the site in either 150 mm (6") cubes or 100 mm (4") diameter, 200 mm (8") long cylinders, and crushed. The cylinder strength is approximately 80% of the cube strength (BS EN 1992-1-1:2004, Table 3.1) as shown in Table 3.

TABLE 3 - CYLINDER AND CUBE COMPRESSIVE STRENGTH		
28-day Compressive Strength class	**Minimum characteristic Cylinder strength**	**Minimum characteristic Cube strength**
C12/15	12MPa (1,700psi)	15MPa (2,100 psi)
C16/20	16 MPa (2,300 psi)	20 MPa (2,900 psi)
C20/25	20 MPa (2,900 psi)	25 MPa (3,600 psi)
C25/30	25 MPa (3,600 psi)	30 MPa (4,300) psi
Source: BS EN 206:2013+A1:2016, Table 12		

4.9 CONCRETE CURING AGENT

Curing is the method of allowing concrete to attain its design compressive strength, by keeping it continuously moist, damp, or wet, and avoiding it from becoming dry, for a duration of seven (7) days.

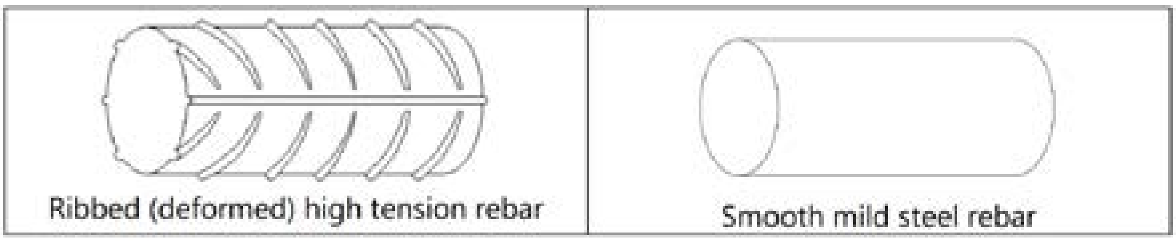
Concrete curing agents may be spray-on curing compounds specified for tropical weather. Alternative curing methods are to cover the concrete with sand and keep it continuously wet for at least three (3) days or cover the concrete with a plastic (polythene) sheet for at least 3 days.

4.10 FORMWORK RELEASE AGENT

Formwork release agent is used to allow the formwork to be effectively stripped from the hardened concrete. Vegetable, mineral and engine oil are effective formwork release agents. Used oil should not contain sulphate (SO4) – a sample of the oil may be tested in an analytical laboratory.

4.11 REINFORCEMENT (REBAR)

Steel reinforcement (rebar) may be ribbed (deformed) high tension (high yield) steel rods (bars), or smooth mild steel rods (bars) (see figure 3). All main structural rebars should be ribbed (deformed). The rebar should be reasonably free from loose rust (which should be removed with a wire brush), and tied together using mild steel tying wire.



Ribbed (Deformed) High Tension Smooth Mid Steel Rebar

FIGURE 3 - RIBBED AND SMOOTH REBARS

The rebar normally used in the Caribbean is manufactured to the American standard ASTM A615, and the British standards BS 4449 and 4482. The common American ASTM A615 rebar grades are Grade 60 for high tension 420 MPa (60,000 psi), and Grade 40 for mild steel 280 MPa (40,000 psi).

The common British BS 4449 rebar grade is B500B for high tension 500 MPa (72,500 psi). The common British BS 4482 rebar grade for mild steel is 250 MPa (36,260 psi). Table 4 describes the diameters of each grade.

TABLE 4 - REBAR DIAMETERS OF EACH GRADE			
ASTM A615		BS 4449 and 4482*	
Bar Designation. [No.] Metric (imperial)	Nominal Diameter. Metric (imperial)	Bar Diameter. Metric (imperial)	Nominal Diameter. Metric (imperial)
-	-	6 mm (1/4")*	6.0 mm (0.236")*
-	-	8 mm (5/16")*	8.0 mm (0.315")*
10 mm (3/8")	9.5 mm (0.345")	10 mm (3/8")*	10.0 mm (0.345")*
13 mm (4/8")	12.7 mm (0.5")	12 mm (4/8")*	12.0 mm (0.5")*
16 mm (5/8")	15.9 mm (0.625")	16 mm (5/8")	16.0 mm (0.625")
19 mm (6/8")	19.1 mm (0.75")	20 mm (6/8")	20.0 mm (0.75")
25 mm (8/8")	25.4 mm (1")	25 mm (1")	25.0 mm (0.984")
Source: ASTM A615-15, Table 1. BS 4449:2005, Table 7. BS 4482:1985, Table 1.			

In this Guide, high-tension rebar diameters are prefixed with "H". For example, a 12 mm (1/2") diameter high tension rod is referenced H12. Mild steel diameters are prefixed with "R". For example, an 8 mm (5/16") diameter mild steel rod is referenced R8.

4.12 REBAR BEND DIAMETERS

Rebars should be bent around minimum bending diameters (see Figure 4). For ASTM A615 high tension (Grade 60) rebars, the minimum bending diameter of the round former (mandrel), for rebar diameters 10 mm (3/8”) to 25 mm (1”) is six (6) times the diameter of the rebar (ACI 318-14, Table 25.3.1). For mild steel links (stirrups) it is four (4) times the diameter of the rebar (ACI 318-14, Table 25.3.1).

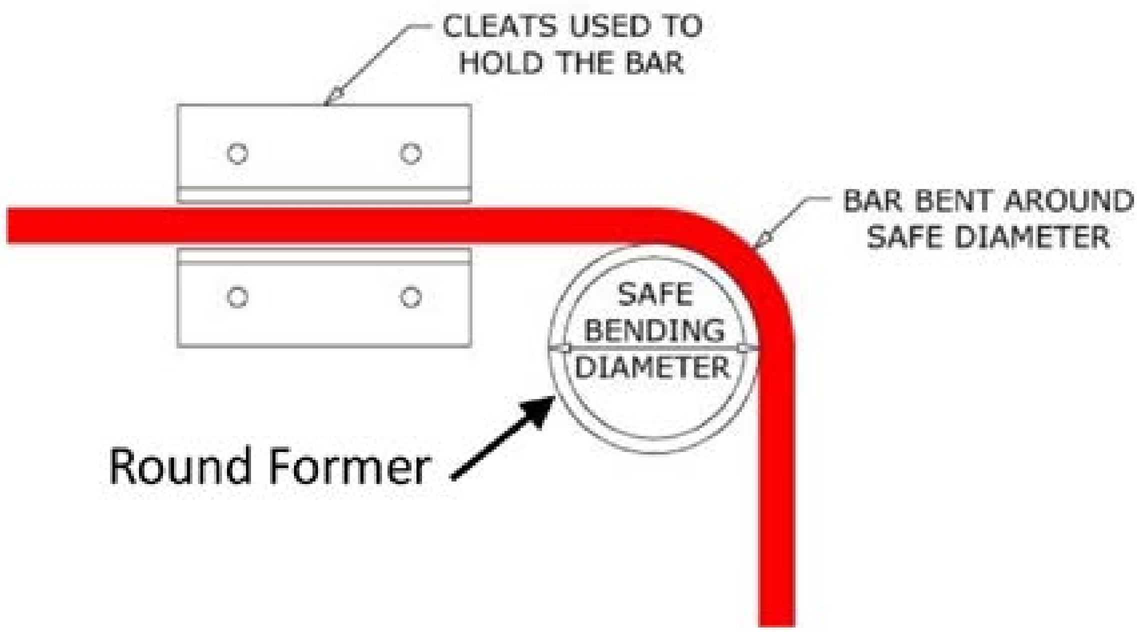


FIGURE 4 - BENDING REBARS

For BS 4449 high tension 500 MPa and BS 4482 mild steel 250 MPa, the minimum diameter of the bending mandrel (round former), for rebar diameters less than or equal to 16 mm (5/16”) is four (4) times the rebar diameter. For rebar diameters greater than 16 mm (5/16”), the minimum diameter of the bending mandrel (round former is seven (7) times the rebar diameter (BS 8666-2020, Table 2. BS EN 1992-1-1:2004, Table 8.1N). Tables 5a and 5b show the minimum rebar inside diameters for the different grades of rebar.

TABLE 5A - MINIMUM BEND DIAMETERS FOR MILD STEEL (GRADE 40) (CoP TABLE 5)			
Rebar Manufacturing Standard			
ASTM A615 (Grade 40)		BS 4482 (Mild Steel)	
Bar Designation. [No.] Metric (Imperial)	Minimum Inside Bend Diameter. Metric (Imperial)	Bar Diameter. Metric (Imperial)	Minimum Inside Bend Diameter. Metric (Imperial)
-	-	6 mm (1/4”)	24 mm (0.94”)
-	-	8 mm (5/16”)	32 mm (1.26”)
[3] 10 mm (3/8”)	40 mm (1.5”)	10 mm (3/8”)	40 mm (1.57”)
[4] 13 mm (1/2”)	52 mm (2.0”)	12 mm (4/8”)	48 mm (1.90”)

TABLE 5B - MINIMUM BEND DIAMETERS FOR HIGH TENSION (GRADE 60) (COP TABLE 5)			
Rebar Manufacturing Standard			
ASTM A615 (Grade 60)		BS 4449 (High Tension)	
Bar Designation. [No.] Metric (Imperial)	Minimum Inside Bend Diameter. Metric (Imperial)	Bar Diameter. Metric (Imperial)	Minimum Inside Bend Diameter. Metric (Imperial)
-	-	6 mm (1/4”)	24 mm (0.94”)
-	-	8 mm (5/16”)	32 mm (1.26”)
10 mm (3/8”)	57 mm (2.24”)	10 mm (3/8”)	40 mm (1.57”)
13 mm (1/2”)	76 mm (3.0”)	12 mm (4/8”)	48 mm (1.90”)
16 mm (5/8”)	95 mm (3.75”)	16 mm (5/8”)	64 mm (2.52”)
19 mm (3/4”)	115 mm (4.5”)	20 mm (6/8”)	140 mm (5.51”)
25 mm (1”)	152 mm (6.0”)	25 mm (1”)	175 mm (6.90”)

If the grade of rebar is unknown, then the larger inside bend diameters in Tables 5a and 5b should be used.

4.13 REBAR LAP LENGTHS

To effectively transfer the tension load from one bar to another, the minimum lap length of fifty (50) times the rebar diameter should be used as shown in Table 6.

TABLE 6 - LAP LENGTHS (NOT IN COP)

Bar Diameter, mm (in)	Lap Length, mm (in)
6 (1/4")	300 (12")
8 (5/16")	400 (16")
10 (3/8")	500 (20")
12 (1/2")	600 (24")
16 (5/8")	800 (32")
20 (3/4")	1000 (40")
25 (1")	1250 (48")

4.14 ANCHOR BOLTS IN CONCRETE

Anchor bolts in concrete should be high-strength Grade 8.8 or equivalent ASTM option. Washers in contact with timber should be minimum 40 mm (1.5") diameter, 3 mm (1/8") thick galvanised steel.

4.15 REINFORCED CONCRETE

Reinforced concrete requires:

(i) an accurate concrete mixture to obtain a minimum compressive strength and durability,
(ii) safe reinforcement bend diameters and lap lengths to allow load transfer,
(iii) spacers installed on all sides of the formwork to obtain sufficient protective concrete cover to the reinforcement,
(iv) compaction with a concrete vibrator to obtain a dense concrete, and
(v) curing to attain the intended (design) strength.

4.16 CONCRETE COVER

The concrete cover is used to protect the steel reinforcement from:

(i) corrosion from exposure to the natural environment, and
(ii) deformation from exposure to fire.

An example of a concrete cover is shown in Figure 5.

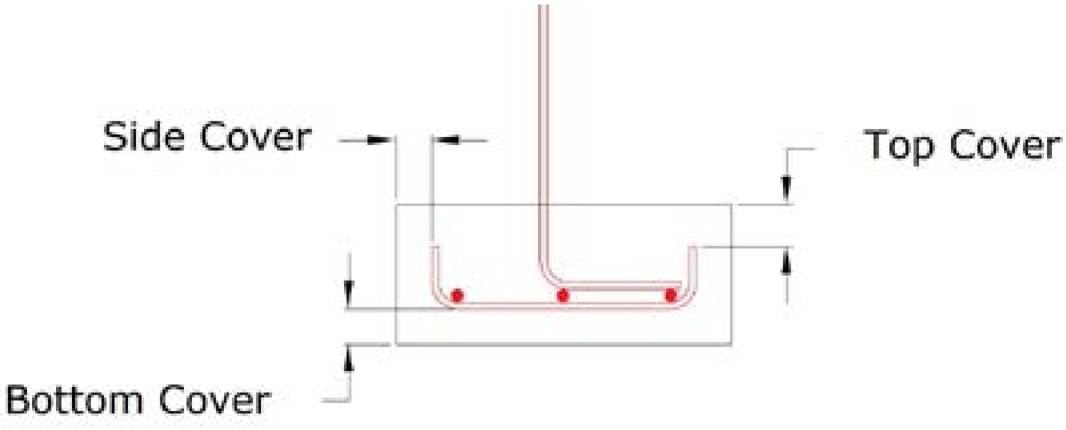


FIGURE 5 - CONCRETE COVER TO A REINFORCED CONCRETE STRIP FOOTING

The minimum cover requirements are determined from the most conservative American (ACI 314-14, Table 20.6.1.3.1) and British (BS EN 1991-1-1 and BS EN 1991-1-2) requirements, and are provided in Table 7.

TABLE 7 - CONCRETE COVER TO A REINFORCED CONCRETE STRIP FOOTING	
Element	**Concrete Cover Metric, (Imperial)**
Foundations – in contact with the ground	75 mm (3”)
Slabs, walls, beams and columns exposed to weather	40 mm (1.5”)
Slabs not exposed to weather	25 mm (1”)
Walls not exposed to weather	25 mm (1”)
Beam not exposed to weather	40 mm (1.5”)
Column not exposed to weather	40 mm (1.5”)

4.17 CONCRETE BLINDING

Concrete blinding may be used if the compacted fill on which the rebar is to be supported is uneven. A thin (generally 50 mm (2”) thick to address localised ridges and depressions) mass concrete blinding layer should provide a flat surface to accommodate the placement of reinforcement. A concrete blinding mixture that gives a 28-day compressive strength of approximately 7 MPa (1,000 psi) is 1 (cement) : 4 (sand) : 8 (aggregate), with 5 gallons of water for each cubic-foot bag of cement.

4.18 CONCRETE FORMWORK

Formwork is used to form concrete footings, beams, slabs, and columns. Formwork may be comprised of timber that is made stable by bracing to prevent movement, and having close-fitting joints to reduce leakage of fine aggregate, cement or water. Figure 6 shows formwork for strip footings showing an example of bracing and close-fitting joints.

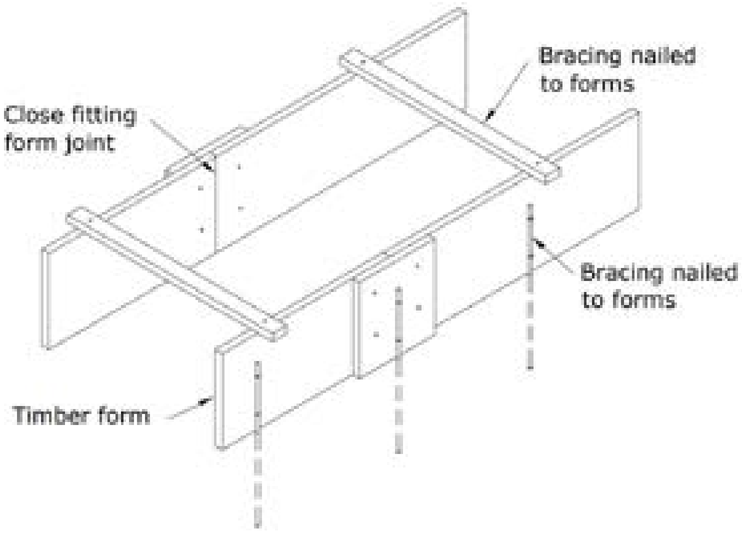


FIGURE 6 - FORMWORK FOR STRIP FOOTINGS

4.19 CONCRETE SPACER BLOCKS

Concrete spacer blocks or plastic or metal chairs are used to provide the specified concrete cover to the steel reinforcement, to protect the rebars from corrosion and fire. They should be connected to the rebar closest to the formwork as shown in Figure 7. For footings, they are also to be used to raise the rebar off the ground surface. The concrete used for the spacer blocks should be of similar strength to the concrete being formed.

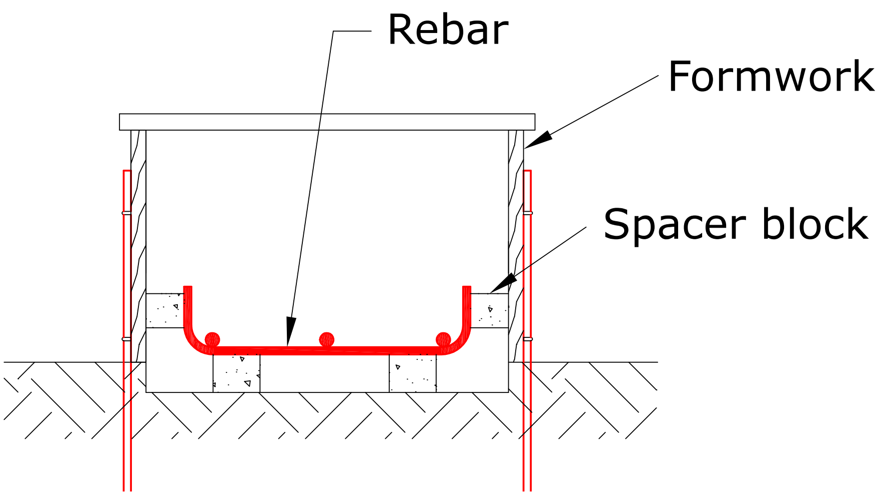


FIGURE 7 - SPACER BLOCK ARRANGEMENT FOR STRIP FOOTINGS

4.20 CONCRETE AND CLAY BLOCKS

Hollow concrete blocks should comply with the requirements of ASTM C90. Hollow clay blocks should comply with the requirements of ASTM C652. The dimensional requirements are provided in Figure 8 and Table 8. This standard does not include solid bricks.

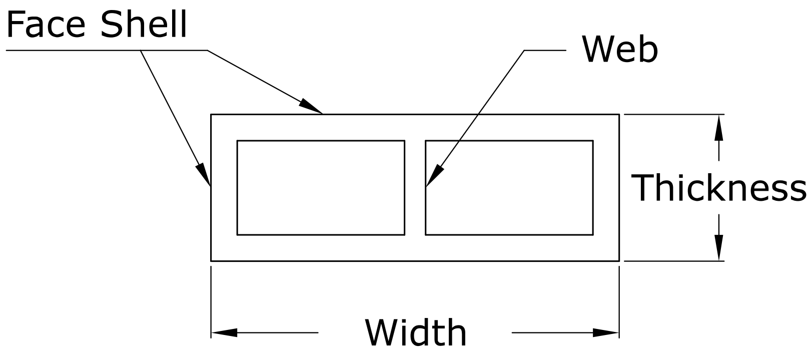


FIGURE 8 - PLAN OF CONCRETE BLOCK

TABLE 8 - DIMENSIONS OF CONCRETE BLOCKS				
Nominal block size (Thickness x Width)	Concrete blocks		Clay blocks	
	Face shell thickness Metric (Imperial)	Web thickness Metric (Imperial)	Face shell thickness Metric (Imperial)	Web thickness Metric (Imperial)
150 x 400 mm (6" x 16")	25 mm (1")	19 mm (3/4")	25 mm (1")	25 mm (1")
200 x 400 mm (8" x 16")	32 mm (1.25")	19 mm (3/4")	32 mm (1.25")	25 mm (1")

Concrete blocks should have two hollow cores and provide a minimum 28-day compressive strength of 7 MPa (1,000 psi) over the gross cross-sectional plan area. [In Trinidad & Tobago, the minimum compressive strength of one concrete block should be 12.4 MPa (1,800 psi), and the average of three (3) blocks should be a minimum of 13.8 MPa (2,000 psi).]

The clay blocks should have two hollow cores and provide a minimum 28-day compressive strength of 15.2 MPa (2,200 psi) over the gross cross-sectional plan area.

During the construction of the supporting footings and slabs, cement should be washed off of the top surface of the aggregate in areas where walls are to be built, to improve the bond.

Block walls below ground level should be 200 mm (8”) thick. Block walls above ground level should be a minimum of 150 mm (6”) thick for single-storey houses. Note: Should the developer choose the option of adding another storey in the future, the single-storey blocks above ground should be 200 mm (8”) thick.

All cores on external walls below ground level should be filled solid with grout. Above ground, those cores with rebars, and those damaged by chasing (normally to include plumbing and electrical pipes), should be filled solid with grout. The grout should be poured in maximum lifts of three rows (courses) of blocks (or 600 mm (24”)), leaving a 25 mm (1”) key to resist lateral loads.

4.21 CONCRETE AND CLAY BLOCK REBARS

Rebars should be placed and grouted at all wall junctions and ends, and at the open cores bounding window and door openings. Exterior wall rebars should be high tension H12 (1/2”) at 600 mm (24”) centres. Interior wall rebars should be H12 (1/2”) at 800 mm (32”) centres). Wall rebars are shown in Figure 9 and Figure 10.

At block wall junctions, one H12 (1/2” diameter) rebar should be placed and grouted in the intersecting core, and in all cores bounding that intersecting core. Horizontal reinforcement (galvanised 3.6 mm (0.14”) nominal diameter ladur or truss type high tension (Grade 60) must be placed in every other row (spaced 400 mm (16”)). R6 (1/4” diameter mild steel) horizontal ties must be used to tie the vertical rebars at junctions. The ties should be spaced 400 mm (16”) apart vertically.

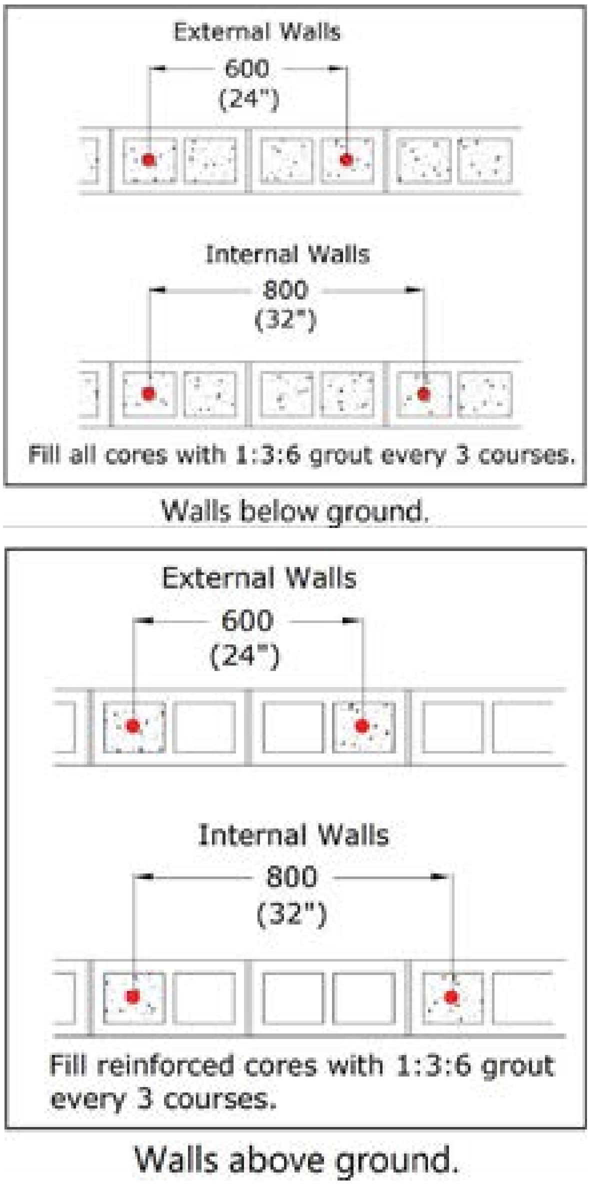


FIGURE 9 - REBAR SPACING IN WALLS

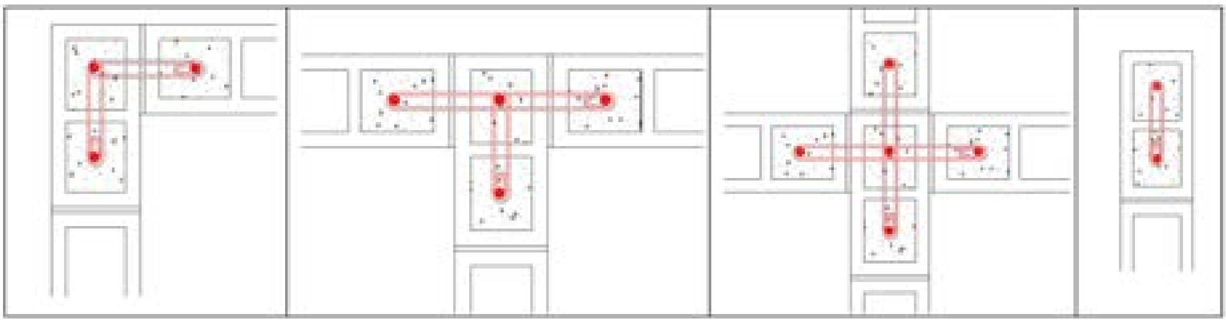


FIGURE 10 - REBAR TIES (R6@400) AT WALL JUNCTIONS AND END

4.22 FILL

Fill should be well-graded granular fill, well compacted and placed in layers not exceeding 200 mm (8”) thick before compaction.

4.23 UTILITY PIPES (PLUMBING, ELECTRICAL, AND COMMUNICATIONS)

Cold water supply pipes should be minimum Schedule 40 PVC pipes. While optional, it is highly recommended that plumbing pipes that are to be permanently exposed to sunlight should be Schedule 80 PVC.

To join PVC pipes:

(i) the contact surfaces of the pipe and the connector to be joined should be cleaned with pipe cleaner and then have pipe cement applied,
(ii) the pipe should be inserted into the connector fully, and then turned one-quarter of the circumference,
(iii) the pipe should be held in the connector for at least 15 seconds to prevent it from moving out.

Plumbing pipes should be pressure tested for leaks:

(i) before pipes are covered by concrete,
(ii) before pipes are sealed in walls, and
(iii) before finishes (normally tiles and paint) are applied to floors and walls.

Other utility pipes should be checked for blockages at these times. Pipes should be pressure tested to 1.5 times the operating pressure, and that pressure should be maintained for 24 hours.

Concrete or clay block walls should not be cut diagonally or horizontally to install pipes. Only vertical chases are permitted (preferably using an electric saw with a masonry blade to avoid excessive damage), and the blocks should be repaired by filling with grout.

All pipelines should be capped once the pipes in the line are laid and connected. The cap should then be removed to connect the line to junction boxes or fixtures.

4.24 TIMBER FRAMES

Timber should be sound, straight, and well-seasoned, with a moisture content between 15% and 19%. Softwoods (for example, Pine) should be pressure treated against insect attack.

4.25 TIMBER WALLS ON CONCRETE

Anchor bolts, 12 mm (1/2") in diameter, should be installed at 800mm (32") centres to connect the wall to the concrete beam or slab. A damp-proof membrane should be placed between the timber and the concrete to reduce the risk of wet-rot.

4.26 NAILS AND SCREWS

Nails should be minimum 8d (8 penny, 3.4 mm (1/8") diameter) galvanised common wire nails. They should mainly be used to hold timber in place until a permanent connection is made with wood-grip screws. Screws should be No.12 wood grip screws of galvanised or stainless steel. To determine the length of nails and screws, they should be embedded 40 mm (1.5") into the receiving timber.

Screws and nails should be placed a minimum of four (4) times the screw diameter from the edge of the timber (edge distance), and a minimum of seven (7) times its diameter from the end of the timber (end distance).

4.27 ROOF METAL CLADDING

Corrugated metal roof cladding should be a minimum 0.6 mm (24 gauge) thick profiled metal sheeting, connected to the timber frame with No.12 wood grip screws for external use. The metal cladding should be protected from corrosion by complying with the following standards, or their equivalent, ASTM A653, or ASTM A924. In Guyana and Suriname, the roof cladding thickness may be 0.5 mm (26 gauge) or as determined by the competent authority in Suriname and Guyana.

4.28 DAMP PROOFING MEMBRANE (DMP)

Damp proofing membrane (DPM) should be minimum 500-gauge (125 microns) polythene vapour membrane barrier with 350 mm (14") taped laps. Utility pipes protruding through the DPM should also be taped.

4.29 ASSESSMENT EXERCISE 5

1) Visit a construction site and photograph all of the construction materials described in this section.

2) Place the photos in a table (using Microsoft Word or equivalent) and label them.

With the construction materials identified, it is time to prepare the site.

5

SITE PREPARATION

5 SITE PREPARATION

5.1 SITE INSPECTION

The contractor shall inspect the site to determine:

(i) the location of: boundary markers, resident neighbours, access roads, trees on the site, and nearby drainage or sewage wells,
(ii) the direction of prevailing winds,
(iii) the slope of the site,
(iv) the condition of nearby drains and any flooding concerns, and
(v) the locations for storing: excavated soil, materials and equipment delivered to the site, and waste materials (components of a waste management plan).

The contractor should obtain professional advice as required.

5.1.1 ASSESSMENT EXERCISE 6

1) Visit a construction site and photograph the items (i) to (v) mentioned in Section 5.1 above.

2) Place the photos in a table (using Microsoft Word or equivalent) and label them.

5.2 SITE INVESTIGATION

The contractor should investigate the site by:

(i) protecting boundary markers,
(ii) clearing the site of overgrown vegetation,
(iii) setting out the external walls of the house,
(iii) excavating to hard formation at the corners and approximate centre of the building to determine the likely depth of footings, and
(iv) excavating any contractual sewage or drainage disposal wells to determine likely subsoil conditions.

Professional engineering advice should be obtained if any: voids (caves), cracks (joints or fissures), large boulders, large trees, compressible material (peat, other organic material, refuse), fill, groundwater, or weak soil layers below the planned footings are observed.

The Employer should be notified in writing about any new issue that may:

(i) increase construction costs,
(ii) delay construction activities, and/or
(iii) extend the duration of the construction contract.

5.3 WORK PLAN

Based on the results of the site inspection and investigation, the Contractor should prepare a workplan (project schedule) of construction activities, including an ordered list of activities, and when they are planned to be done given the available Contractor resources. Additional resources may be required to complete the project within the specified time.

5.3.1 ASSESSMENT EXERCISE 7

Write a work plan for the construction drawings (see section 2.4) identifying the major construction activities (to be done at the end of the Guide – see section 9.6).

5.4 SETTING OUT

A dimensioned grid, aligned with the middle of the walls, should be drawn on the plan. Any missing dimensions to prevent the accurate setting out of the grid on the site, should be requested from the Employer.

5.5 MATERIAL STORAGE

Cement bags, timber, and rebars should be stored in a dry location and elevated at least 100 mm (4") off the ground. Sand and stone should be covered to prevent them from being blown or washed away, and to prevent excessive wetting which may alter the water content of the concrete and/or mortar mixture.

5.6 BATTER BOARDS

Batter boards should be aligned to the grids. Batter boards, where the horizontal member is greater than 300 mm (12") from the ground surface, should have a 25 mm x 100 mm (1" x 4") diagonal bracing member installed, as shown in Figure 11. Three nails should be installed at the top of the horizontal members, representing the middle and edges of the proposed element
(e.g., wall).

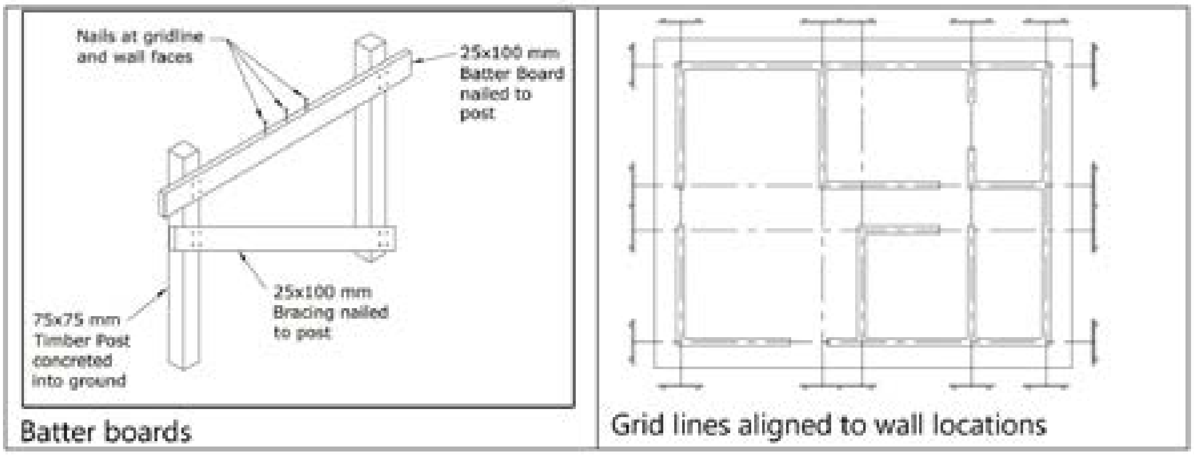


FIGURE 11 - BATTER BOARDS AND GRID LINES

5.6.1 ASSESSMENT EXERCISE 8

Visit a construction site, photograph the batter boards, and explain how they might be improved.

5.7 RISK ASSESSMENTS

The health and safety of workers and visitors to the construction site can be improved through assessing health and safety risks and developing effective risk mitigation measures. A risk assessment for the site preparation activities is provided in Table 9.

TABLE 9 - RISK ASSESSMENT		
Activities	**Risks**	**Risk Mitigation Measures**
Walking around the site.	Stepping on nails.	Wear hard shoes.
Walking around the site.	Being accused of trespassing.	Wear a safety vest.
Constructing batter boards.	Harm to body with hand tools (hammer and saws).	Wear safety gloves. Wear safety glasses. Wear hardhat.
Excavating well.	Falling in open well.	Securely cover the open well when not being excavated.

Once the site has been prepared it is time to build with permanent construction.

5.7.1 ASSESSMENT EXERCISE 9

Prepare risk assessments for each stage of construction (foundations, ground floor, walls, roof, finishes).

6

FOUNDATIONS

6 FOUNDATIONS

Foundation activities include:

(i) assessing the bearing capacity of the layer of soil on which footings are to be founded,
(ii) excavating to that bearing layer,
(iii) applying termite treatment to that layer, and
(iv) constructing the footing.

6.1 BEARING CAPACITY

Where available, national soil maps with bearing capacities, and national authorities with jurisdiction to determine soil bearing capacities, should be consulted to determine the bearing capacity of the soil. If there is uncertainty, then civil engineering advice should be obtained. The maximum allowable safe bearing capacity for various soils is provided in Table 10.

TABLE 10 - MAXIMUM ALLOWABLE SAFE BEARING CAPACITY OF SOILS

Soil	Maximum Allowable Safe Bearing Capacity when Dry [Wet]	
	(kN/m^2)	(Tons/sq-ft)
1. Thick layers (beds) of hard unweathered limestones and sandstones	4,000 [4,000]	40 [40]
2. Strong shales, mudstones and siltstones	2,000 [2,000]	20 [20]
3. Thin layers (beds) of limestones and sandstones	1,000 [1,000]	10 [10]
4. Compact well-graded fill	400 [200]	4 [2]
5. Loose well-graded sand	200 [100]	2 [1]
6. Compact uniform sands	200 [100]	2 [1]
7. Loose uniform sands	100 [50]	1 [0.5]
8. Stiff clays and sandy clays	200 [100]	2 [1]
9. Firm clays and sandy clays	100 [50]	1 [0.5]
10. Soft clays and silts	50 [0]	0.5 [0]
Source: OECS Building Code, 2016. Table 13-1.		

6.2 EXCAVATIONS

Excavate a minimum of 900 mm (3 ft) to a good foundation layer (dense sand, stiff clay), or to rock, to reduce or prevent settlement. If the depth of excavation is greater than 1.2 m (4 ft), then:

(i) support the sides by installing vertical planks and horizontal struts, or
(ii) cut back the sides to a slope of 1.5 horizontal :1 vertical as shown in Figure 12.

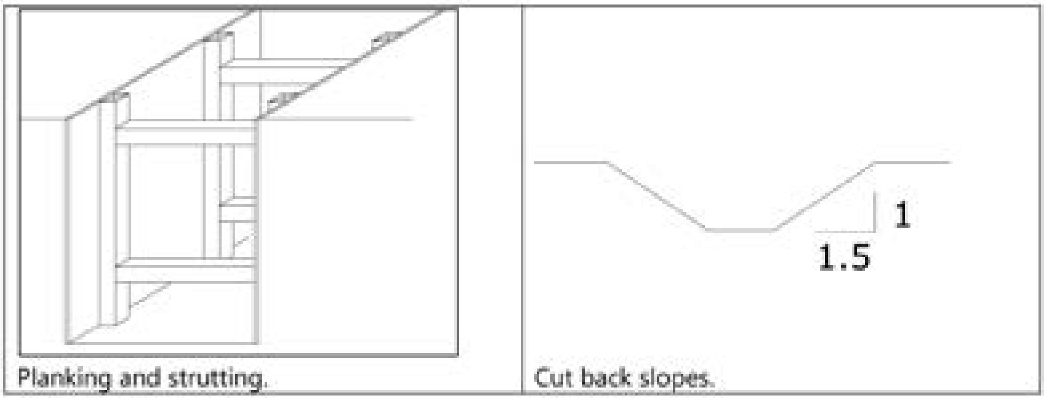


FIGURE 12 - TRENCH STABILITY

Inspect the bottom of the excavation. If the foundation is rock, then provide a key by excavating at least 50 mm (2”) into the rock as shown in Figure 13. If the bottom of the excavation is loose, then the foundation bottom can be compacted by ramming. If pockets of unsuitable material (e.g., clay) are found, then they should be removed. Deep areas and over excavated areas may be backfilled with compacted granular material or with mass concrete (1 (cement) : 3 (sand) : 6 (stone)). If clay is found or if there is uncertainty, then engineering advice should be obtained.

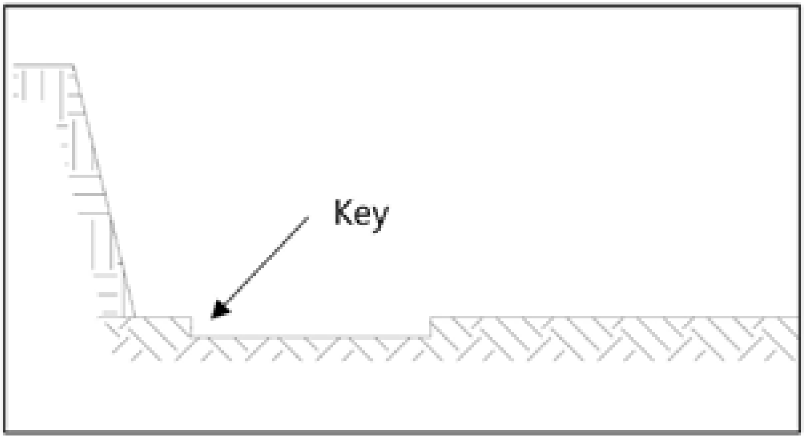


FIGURE 13 - KEY CUT IN ROCK

6.3 TERMITE TREATMENT

After excavating to a good bearing layer, the ground under the footings and floors should be treated for termites. A reputable pesticide company that offers a minimum 5-year warranty should be used.

6.4 FOOTINGS

Footings should be designed to support the building by the underlying material (including soil: type, moisture content, and slope), and to prevent the building from moving during natural hazards.

Masonry-walled houses should be founded on reinforced concrete:

(i) strip footings,
(ii) pad footings, or
(iii) slab-on-ground foundations.

Timber-walled houses should be founded on one of the same type of footings for masonry-walled houses, or on timber posts.

6.4.1 STRIP FOOTINGS

On relatively flat ground, with a slope, less than 1 (Vertical): 8 (Horizontal), reinforced concrete strip footings may be a more economical option. Strip footings should have the size and reinforcement specified in Table 11, that corresponds to the soil type and bearing capacity. A typical strip footing is shown in Figure 14.

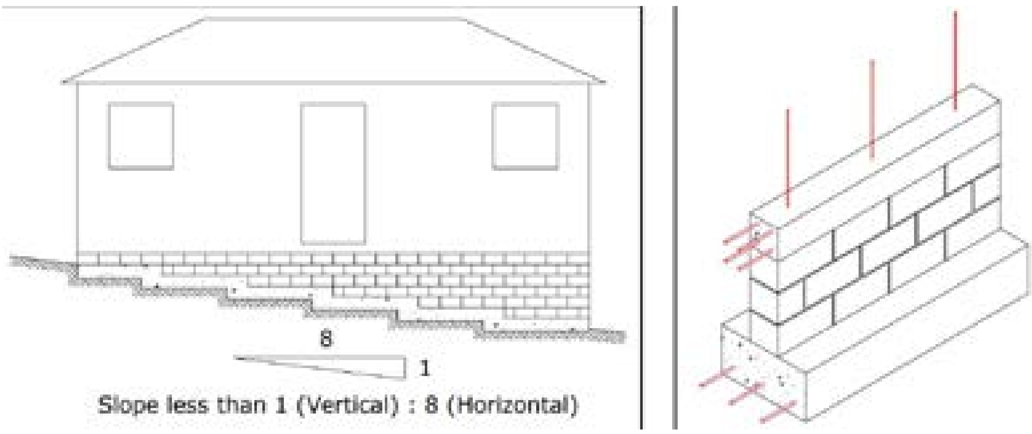


FIGURE 14 - STRIP FOOTING

TABLE 11 - STRIP FOOTING SIZES AND REINFORCEMENT			
Structural Element [Bearing Capacity]	**Minimum Size (width x depth)**	**Minimum Concrete 28-day compressive cube strength (see Table 3 for equivalent cylinder strengths)**	**Minimum Reinforcement (Placed at bottom of footing with required cover.) [Equivalent Grade 60 rebar sizes in Table 4 may be used]**
Strip footing on stiff clays. [100 kN/m2 (1 Ton/sq-ft)]	760 mm x 300 mm (30"x12")	21 MPa (3,000 psi)	2 x H12 (1/2") rebars longitudinally + H12 mm rebars spaced at 300 mm (12") centres transversely.
Strip footing on compacted granular soil. [200 kN/m2 (2 Tons/sq-ft)]	600 mm x 275 mm (24"x11")	21 MPa (3,000 psi)	2 x H12 (1/2") rebars longitudinally + H12 mm rebars spaced at 300 mm (12") centres transversely.
Strip footing on rock. [450 kN/m2 (4.5 Tons/sq-ft)]	400 mm x 275 mm (16"x11")	21 MPa (3,000 psi)	2 x H12 (1/2") rebars longitudinally + H12 mm rebars spaced at 300 mm (12") centres transversely.
Ring beam at floor level	200 mm x 200 mm (8"x8")	25 MPa (3,600 psi)	4xH12mm (1/2") bars with R6 (1/4") links at 150 mm (6") spacing.
Note: The bearing capacities in Table 11 were used to determine the prescriptive footing sizes. Building on other soils will require civil engineering advice.			

The construction method includes the following:

(i) excavate to a good bearing layer,
(ii) apply termite treatment to the soil under the footings,
(iii) place mass concrete (1:4:8) blinding,
(iv) erect formwork to fit the strip footings,
(v) place reinforcement, including wall starter bars, in the formwork,
(vi) install spacers to the bottom and sides,
(vii) remove any debris from within forms,
(viii) apply a release agent to the formwork surface to be in contact with concrete, and
(ix) pour, compact, level, trowel finish, and cure the concrete.

Once the concrete has been cured, the foundation walls should be built as shown in Figure 15. The method includes the following:

(i) install foundation wall rebars,
(ii) lay foundation blocks,
(iii) grout foundation blocks every three (3) courses, leaving a key.

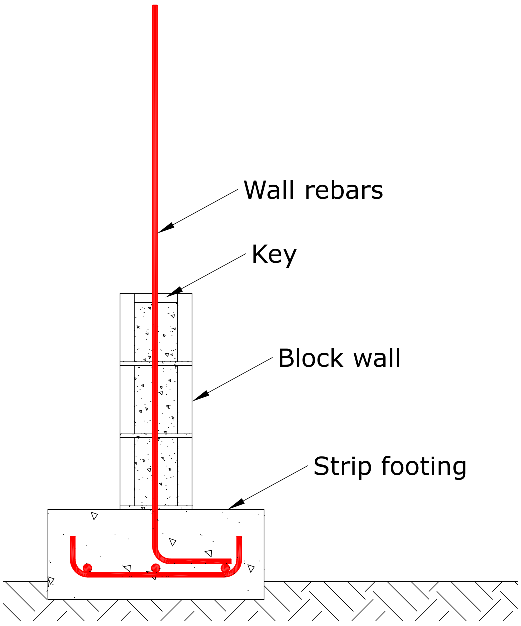


FIGURE 15 - STRIP FOOTING REINFORCEMENT

Remember to plaster the external walls to the footing (see Figure 16).

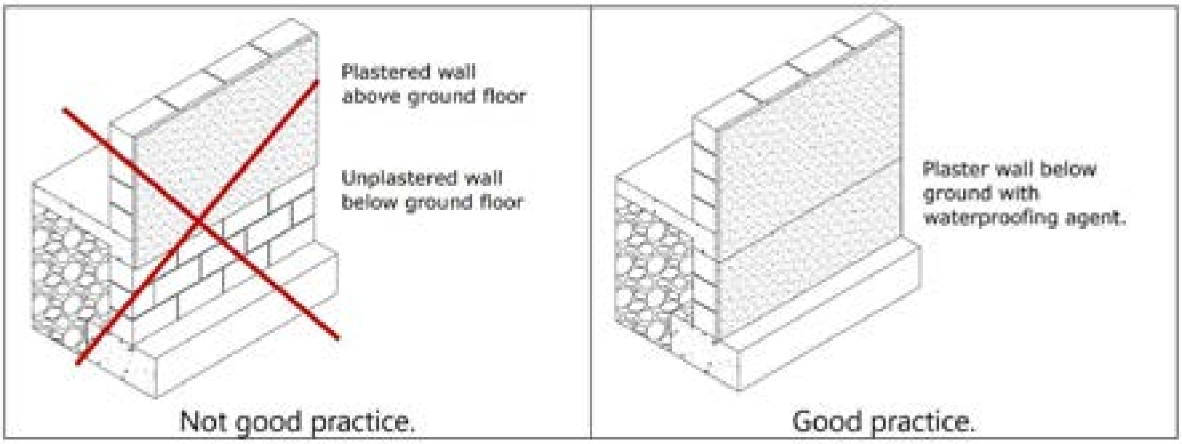


FIGURE 16 - PLASTER THE WALL TO THE FOOTING

6.4.2 PAD FOOTINGS

If the land is sloping steeply, undulating severely, or good bearing soil is deep, then reinforced concrete (RC) pad footings supporting RC columns and beams may be an economical option.

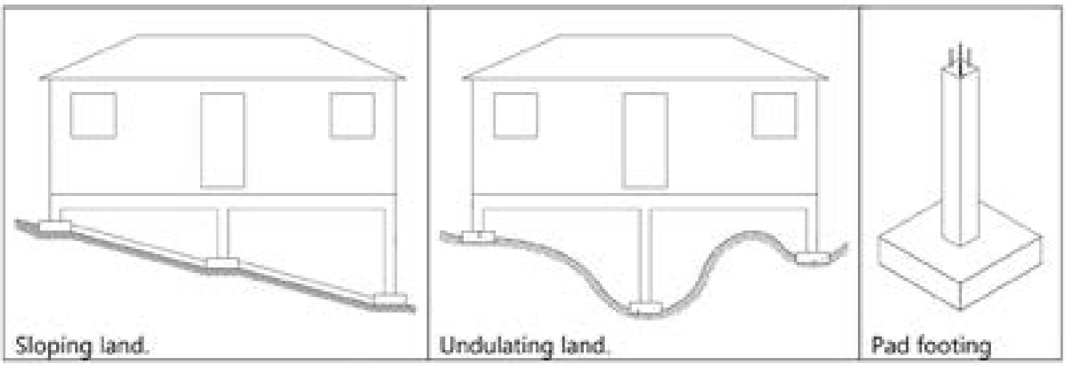


FIGURE 17 - PAD FOOTINGS

Pad footings are to have the size, strength, and reinforcement specified in Table 12, that corresponds to the soil type and bearing capacity. They are to be connected with 200 mm x 300 mm (8" x 12") RC tie beams (with 2 H12 (two 12 mm diameter high tension) longitudinal rebars and R6 @ 200 links (6 mm diameter mild steel links spaced 200 mm apart)) to prevent them from moving during seismic loads. A typical pad footing with a column is shown in Figure 17.

TABLE 12 - PAD FOOTING SIZES AND REINFORCEMENT

Pad Footing [Bearing Capacity]	Minimum Size (length x width x depth) (Note 1)	Minimum Concrete 28-day compressive cube strength (Note 2)	Minimum Reinforcement – each way top and bottom. (Note 3)
Pad footing on stiff clays. [100 kN/m2 (1 Ton/sq-ft)]	1,200 mm x 1,200 mm x 300 mm (48"x48"x12")	21 MPa (3,000 psi)	H12 at 150 mm (6") spacing.
Pad footing on compacted granular soil. [200 kN/m2 (2 Tons/sq-ft)]	950 mm x 950 mm x 300 mm (39"x39"x12")	21 MPa (3,000 psi)	H12 at 150 mm (6") spacing.
Pad footing on rock. [450 kN/m2 (4.5 Tons/sq-ft)]	650 mm x 650 mm x 300 mm (27"x27"x12")	21 MPa (3,000 psi)	H12 at 150 mm (6") spacing.

NOTES:
1. The bearing capacities in Table 11 were used to determine the prescriptive footing sizes. Building on other soils will require engineering advice.
2. See Table 3 for equivalent cylinder strengths.
3. Equivalent Grade 60 rebar sizes in Table 4 may be used.

The construction method includes the following:

(i) excavate to a good bearing layer,
(ii) apply termite treatment to the soil under the footings,
(iii) place mass concrete (1:4:8),
(iv) erect formwork to fit the pad,
(v) place reinforcement including column starter bars in the formwork,
(vi) install tie-beam reinforcement,
(vii) install spacers to the bottom and sides,
(viii) remove any debris from within the forms,
(ix) apply a release agent to the formwork surface to be in contact with concrete, and
(x) pour, compact, level, trowel finish, and cure the concrete.

Once the concrete has cured, the columns and beams should be constructed.
The method includes the following:

(i) lap column rebars at midspan, and install the column links (stirrups),
(ii) install the formwork on three sides,
(iii) install the spacers,
(iv) install formwork release agent,
(v) install the final formwork side,
(vi) pour, compact, level, trowel finish, and cure the concrete,
(vii) install beam formwork,
(viii) install beam rebars,
(ix) install starter bars for concrete block walls, or anchor bolts for the timber frame,
(x) install spacers,
(xi) install formwork release agent, and
(xii) pour, compact, level, trowel finish, and cure the concrete.

6.4.2.1 COLUMNS

Columns are to have the size, strength, and reinforcement specified in Table 13, and arranged in Figure 18, which corresponds to the column height.

TABLE 13 - CONCRETE COLUMN SIZES AND REINFORCEMENT

Column Height	Minimum Size	Minimum Concrete 28-day compressive cube strength (Note 1)	Minimum Reinforcement (Note 2)
Less than 3.0m (10 ft) high.	200 mm x 200 mm	25 MPa (3,600 psi)	Main rebars: 4xH12 Links: H6 at 150 mm spacing.
3.0m (10 ft) to 3.65m (12 ft) high.	250 mm x 250 mm (10”x10”)	25 MPa (3,600 psi)	Main rebars: 4xH16 Links: H8 at 200 mm spacing.
3.65m (12 ft) to 4.3m (14 ft) high.	300 mm x 300 mm (12”x12”)	25 MPa (3,600 psi)	Main rebars: 4xH20 Links: H8 at 250 mm spacing.

NOTES:
1. See Table 3 for equivalent cylinder strengths.
2. Equivalent Grade 60 rebar sizes in Table 4 may be used.

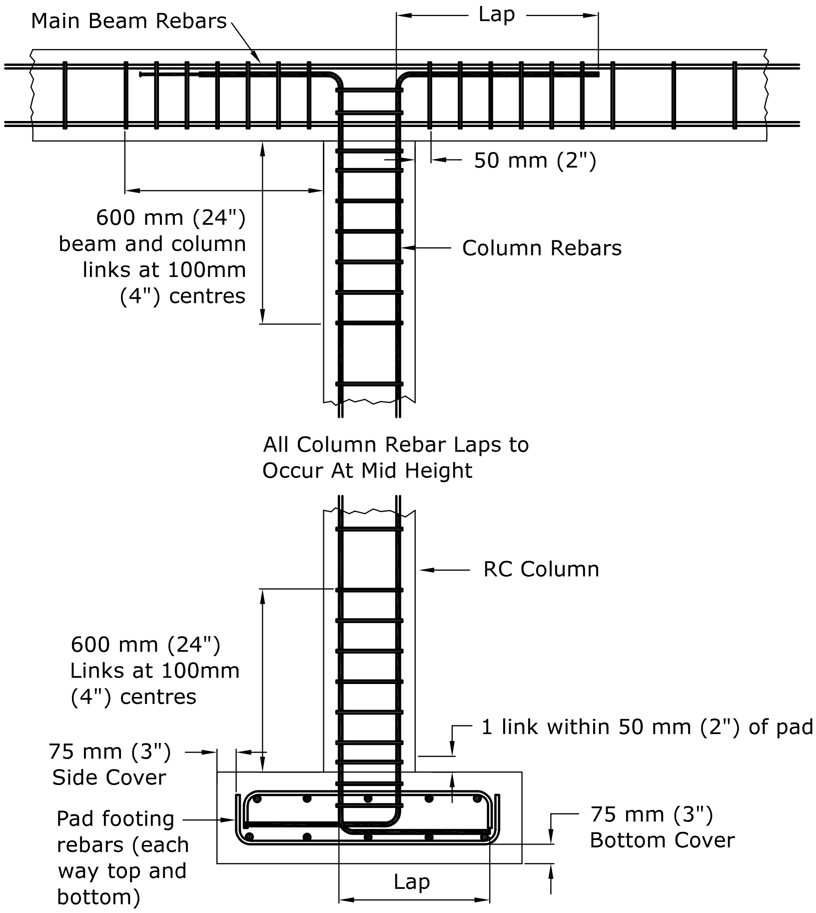


FIGURE 18 -RECOMMENDED DESIGN FOR PAD FOOTING AND COLUMNS

6.4.3 SLAB-ON-GROUND FOOTINGS

When good-bearing soil is deep, then a slab-on-ground foundation, which integrates the footings into the ground floor slab, can be supported on well-compacted granular fill material. A slab-on-ground foundation can also be used on relatively flat land, where hard rock is close enough to the surface to allow the footings to be cast on the rock, or on fill on the rock.

Slab-on-ground footings (with masonry walls) should have the minimum geometry as shown in Figure 19. The minimum 28-day concrete compressive cube strength should be 21 MPa (3,000 psi). The rebar layout for masonry walls is shown in Figure 20. The rebar layout for timber framed walls is shown in Figure 21.

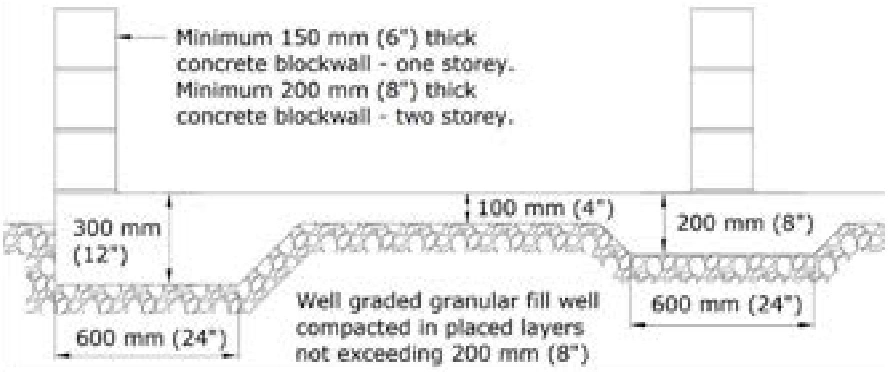


FIGURE 19 - LAYOUT OF SLAB-ON-GROUND FOOTING

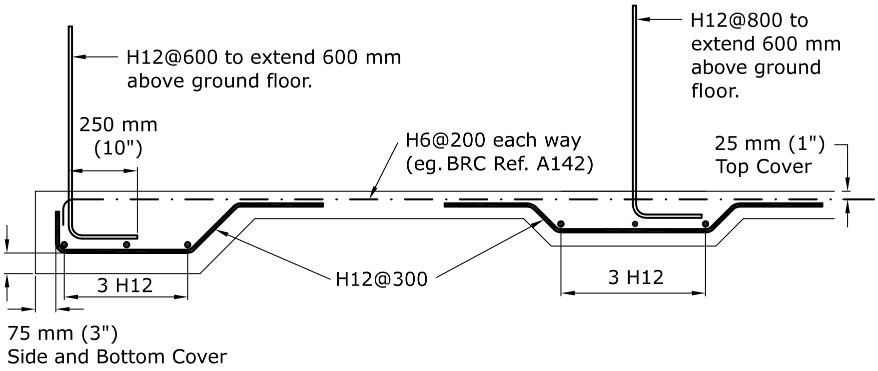


FIGURE 20 - REBAR LAYOUT OF SLAB-ON-GROUND FOOTING (MASONRY WALLS)

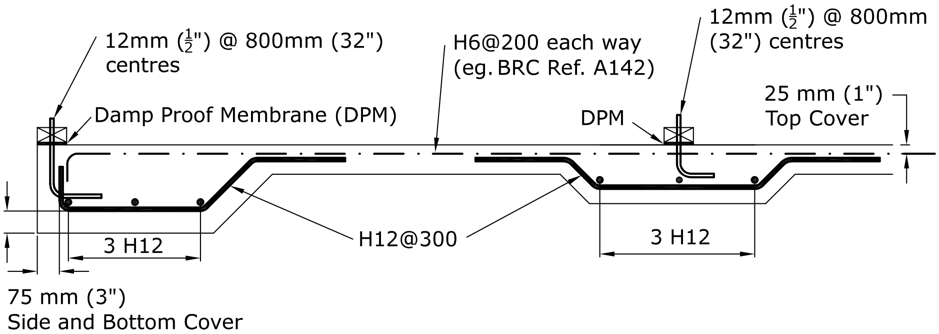


FIGURE 21 - LAYOUT OF SLAB ON GROUND FOOTING

Note: BRC Ref. A142 is a square mesh or 6 mm (1/4”) rebar at 200 mm (8”) square pattern.

The construction method includes the following:

(i) Excavate to a good bearing layer,
(ii) Apply termite treatment to the soil under the slab and footings,
(iii) Install fill,
(iv) Cut trenches for slab thickenings ,
(v) Install plumbing waste, electrical, communications, and security pipes in the fill,
(vi) Install termite treatment,
(vii) Erect formwork,
(viii) Place damp proof membrane,
(ix) Place reinforcement,
(x) Place wall starter rebars for masonry walls or anchor bolts for timber walls,
(xi) Install spacers to the bottom and sides,
(xii) Remove any debris from within forms,
(xiii) Apply a release agent to the formwork surface to be in contact with concrete,
(xiv) Pour, compact, level, float-finish, and cure the concrete,

6.4.4 TIMBER POSTS

A relatively inexpensive foundation for a timber building, is to drive 100 mm x 100 mm (4"x4") minimum Greenheart or termite treated braced timber posts, at least 1.2 m (4 ft) into the ground, as shown in Figure 22. The posts may also be placed in an excavated (augured) hole and concrete around. The embedded posts should be waterproofed, for example, with bituminous paint.

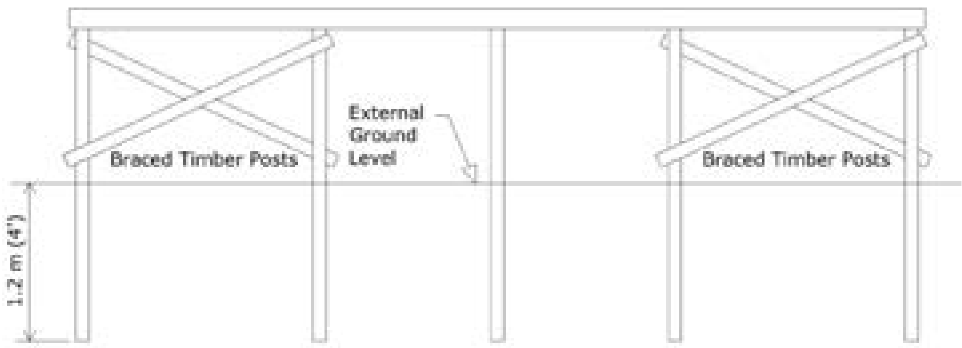


FIGURE 22 - BRACED TIMBER POST FOUNDATION

For concreted posts, the construction method includes the following:

(1) excavate a hole,
(ii) apply termite treatment to the sides and top,
(iii) place the timber post in the hole,
(iv) pour, compact, level, trowel finish, and cure the concrete, and (v) brace the posts.

7

FLOORS

FLOORS 7

The floor is used to support the floor loads and to transmit them to the foundations. There are 3 types described in this standard:

(i) reinforced concrete slab on fill,
(ii) suspended reinforced concrete slab, and
(iii) suspended timber floor.

7.1 REINFORCED CONCRETE SLAB ON FILL

There are two types of concrete slabs on fill:

(i) the slab-on-ground foundation covered in Section 6.4.3, and
(ii) the slab on strip footings as shown in Figure 23. The strip footings were covered in Section 6.4.1.

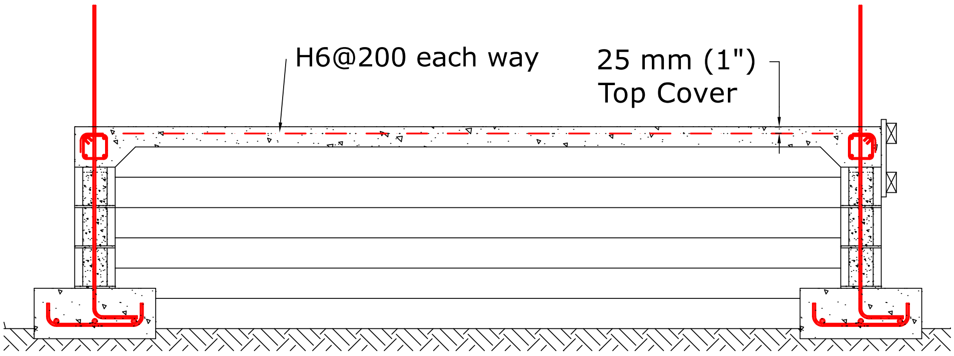


FIGURE 23 - SLAB ON STRIP FOOTINGS

Once the footings have been built, the construction method includes the following:

(i) install fill,
(ii) install utility pipes,
(iii) install termite treatment pesticide,
(iv) install damp proof membrane (including blinding where necessary),
(v) install beam and slab rebars,
(vi) install starter bars for concrete block walls, or anchor bolts for timber frame,
(vii) install formwork,
(viii) install spacers,
(ix) install water supply pipes,
(x) install formwork release agent,
(xi) pour, compact, level, float-finish, and cure the concrete, and
(xii) plaster the external walls.

7.2 SUSPENDED REINFORCED CONCRETE FLOOR SLAB

Suspended reinforced concrete slabs are supported by reinforced concrete beams on:

(i) strip footings, or
(ii) columns.

Suspended reinforced concrete slabs (shown in Figure 24) should have the strength, size and reinforcement as specified in Table 14, which corresponds to the span. These suspended slabs are applicable for floors and roofs. For clarity, Figure 24 is divided into Figure 24A and 24B.

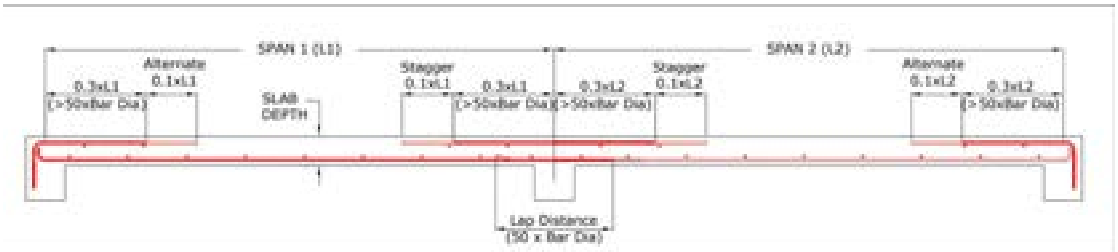


FIGURE 24 - SLAB REBAR LAYOUT

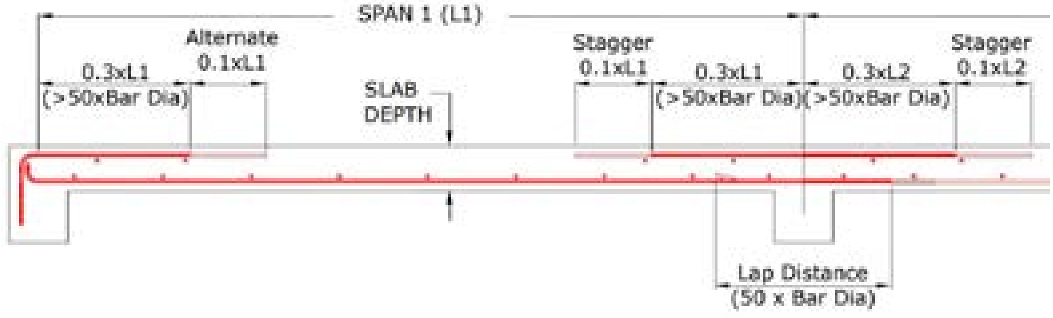


FIGURE 24A - SLAB REBAR LAYOUT - SPAN 1

FIGURE 24B - SLAB REBAR LAYOUT - SPAN 2

TABLE 14 - SLAB THICKNESS AND REINFORCEMENT (NOTES 1 TO 5)						
Slab Thickness mm(inch)	Span Between Supporting Walls					
	1.8 m (6 ft)	2.4 m (8 ft)	3 m (10 ft)	3.6 m (12 ft)	4.3 m (14 ft)	4.8 m (16 ft)
100 (4”)	H12@300					
125 (5”)		H12@300	H12@300			
150 (6”)			H12@300	H12@300		
175 (7”)				H12@300	H12@250	
200 (8”)					H12@250	H12@200
225 (9”)						H12@200

NOTES:

1. Minimum secondary rebars to be H10 (3/8”) at 300 mm (12”) centres.
2. Use the thicker slab: (i) for higher than normal loads (eg. library, storage, home-gym), (ii) for stone floor tiles where smaller deflections (eg span/720) are required (eg porcelain), and/or to accommodate utility pipes, but engineering advice should be obtained for verification.
3. Concrete 28-day compressive cube strength to be 25 MPa (3,600 psi).
4. Equivalent Grade 60 rebar sizes in Table 4 may be used.
5. 300 mm (12”). 250 mm (10”), 200 mm (8”). H12 (1/2” diameter Grade 60 rebar).

7.3 CANTILEVERED REINFORCED CONCRETE SLAB

The main reinforcement in cantilevered reinforced concrete slabs (shown in Figure 25) should have the strength, size and reinforcement as specified in Table 15 which corresponds to the span.

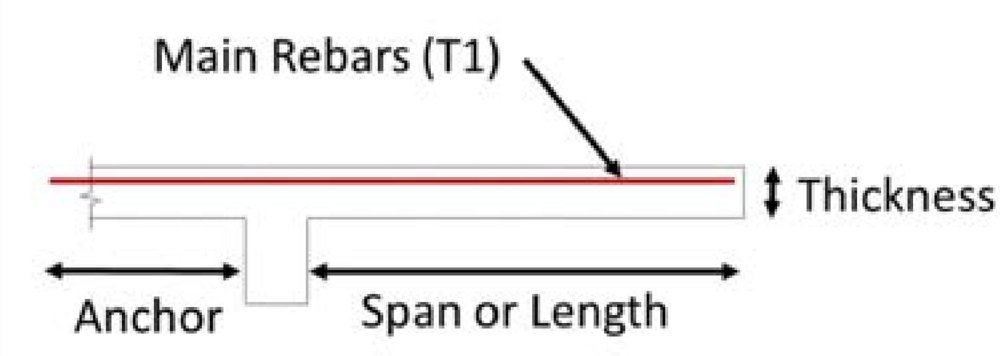


FIGURE 25 - CANTILEVER SLAB (ONLY MAIN REBARS SHOWN)

TABLE 15 - CANTILEVER SLAB THICKNESS AND REINFORCEMENT (NOTES 1 TO 6)				
Cantilever Slab Thickness mm (inch)	Cantilever span or length.			
	1.2 m (4 ft)	1.8 m (6 ft)	2.4 m (8 ft)	3.0 m (10 ft)
125 (5”)	H12@300			
150 (6”)	H12@300	H12@300		
150 (6”)		H12@300		
200 (8”)			H12@200	
200 (8”)			H12@200	H12@150
250 (8”)				H12@150

NOTES:
1. Minimum anchorage to be the greater of: (i) 1.5 x cantilever span, (ii) 0.3 x supported span, or (iii) 50 x bar diameter.
2. Minimum secondary rebars to be H10 (3/8”) at 300 mm (12”) centres.
3. Use the thicker slab: (i) for higher than normal loads (e.g., library, storage, home-gym), (ii) for stone floor tiles where smaller deflections (e.g., span/720) are required (e.g., porcelain), and/or to accommodate utility pipes, but civil engineering advice should be obtained for verification.
4. Concrete 28-day compressive cube strength to be 25 MPa (3,600 psi).
5. Equivalent Grade 60 rebar sizes in Table 4 may be used.
6. 300 mm (12”). 200 mm (8”). 150 mm (6”). H12 (1/2” diameter Grade 60 rebar).

7.4 SUSPENDED TIMBER FLOOR

Suspended timber floor joists are to have the sizes of Pine (Structural Select or SS) and Purpleheart (Greenheart may also be used) specified in Table 16 for 400 mm (16”) spacing, and Table 17 for 600 mm (24”) spacing.

TABLE 16 - TIMBER JOIST SIZES AT 400MM (16”) SPACING		
Span Range	Joist Size at 400mm centres	
	Pine SS	Purpleheart
1.5 m to 1.8 m (5 ft to 6 ft)	50 mm x150 mm (2”x6”)	50 mm x 100 mm (2”x4”)
1.8 m to 2.4 m (6 ft to 8 ft)	50 mm x 200 mm (2”x8”) or 75 mm x 150 mm (3”x6”)	50 mm x150 mm (2”x6”)
2.4 m to 3.3 m (8 ft to 10 ft)	50 mm x 250 mm (2”x10”) or 75 mm x 200 mm (3”x8”)	50 mm x 200 mm (2”x8”) or 75 mm x 150 mm (3”x6”)
3.3 m to 3.6 m (10 ft to 12 ft)	75 mm x 200 mm (3”x8”)	50 mm x 200 mm (2”x8”)
3.6 m to 4.3 m (12 ft to 14 ft)	75 mm x 250 mm (3”x10”)	50 mm x 250 mm (2”x10”) or 75 mm x 200 mm (3”x8”)
4.3 m to 4.8 m (14 ft to 16 ft)	75 mm x 300 mm (3”x12”)	75 mm x 250 mm (3”x10”)

TABLE 17 - TIMBER JOIST SIZES AT 600MM (24") SPACING		
Span Range	Joist Size at 600mm centres	
	Pine SS	Purpleheart
1.5 m to 1.8 m (5 ft to 6 ft)	50 mm x150 mm (2"x6")	50 mm x 100 mm (2"x4")
1.8 m to 2.4 m (6 ft to 8 ft)	50 mm x 200 mm (2"x8") or 75 mm x 150 mm (3"x6")	50 mm x 150 mm (2"x6")
2.4 m to 3.3 m (8 ft to 10 ft)	75 mm x 200 mm (3"x8")	50 mm x 150 mm (2"x6")
3.3 m to 3.6 m (10 ft to 12 ft)	75 mm x 250 mm (3"x10")	50 mm x 200 mm (2"x8") or 75 mm x 150 mm (3"x6")
3.6 m to 4.3 m (12 ft to 14 ft)	75 mm x 300 mm (3"x12")	50 mm x 200 mm (2"x8") or 75 mm x 200 mm (3"x8")
4.3 m to 4.8 m (14 ft to 16 ft)	100 mm x 300 mm (4"x12")	50 mm x 250 mm (2"x10") or 75 mm x 200 mm (3"x8")

When placing timber on concrete, a damp-proof membrane must be placed between the timber and the concrete member.

If the size of timber joists is not available or is uneconomical, then the joist's span may be reduced by installing a timber bearer beam on concrete or masonry piers (plinths), as shown in Figure 26.

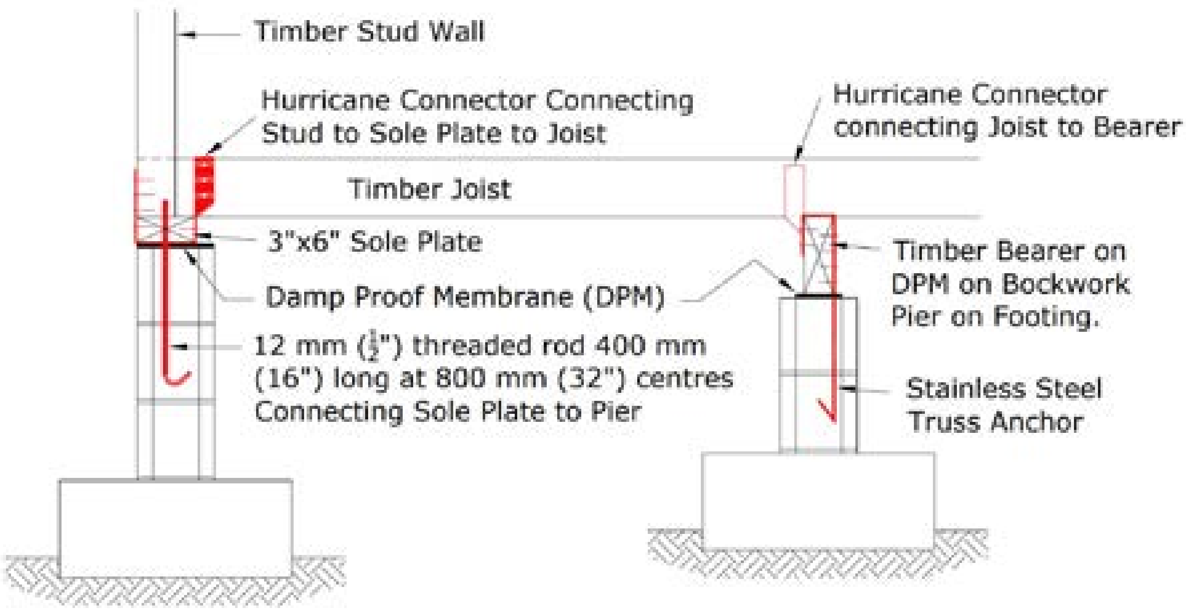


FIGURE 26 - TIMBER BEARER ON MASONRY PLINTH

The construction method includes the following:

(i) construct the supporting beam,
(ii) install a damp-proof membrane,
(iii) bolt a 75 mm x 150 mm (3"x6") timber sole plate/sill to the concrete beam,
(iv) connect timber joists to the sole plate,
(v) install 25 mm (1") thick tongue and groove floor planks to the joists, and
(vi) install joist bracing (as shown in Figure 27) at 2.1 m (7 ft) intervals if the joist depth is 200 mm (8") or more.

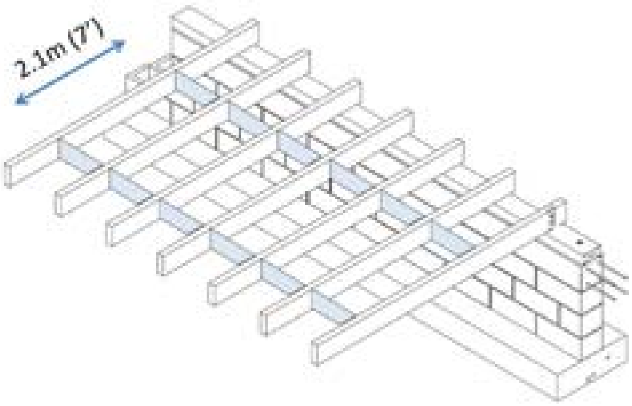


FIGURE 27 - JOIST BRACING

7.5 STAIRS

Reinforced concrete stairs are to have the geometry as shown in Figure 28 and Table 18, and the strength and reinforcement as specified in Table 19 that corresponds to the span. The maximum rise (riser) is 210 mm (8.25") (OECS 2016, Table 5-5), but 150 mm (6") is comfortable and practical. The minimum run (tread) is 227 mm (9"), but 300 mm (12") is comfortable and practical. The minimum landing is 915 mm (36") (OECS 2016, Section 505.10).

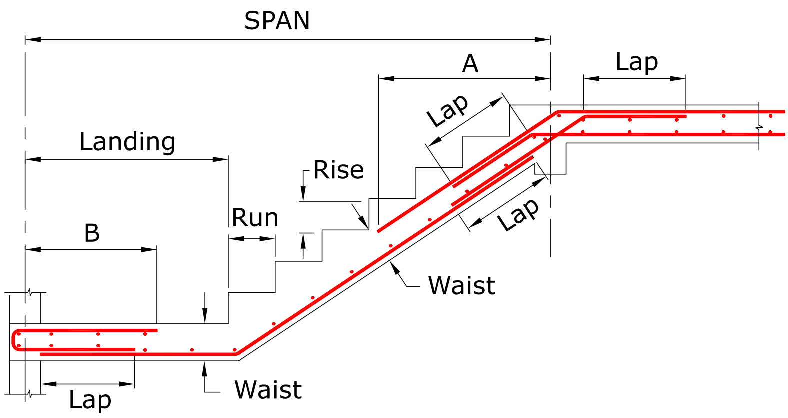


FIGURE 28 - STAIRS LAYOUT AND REBARS

TABLE 18 - STAIRS GEOMETRY			
Span	**A (m)**	**B (m)**	**Waist (mm)**
2.4 m (8’)	0.7 m (28”)	0.6 m (2’)	125 mm (5”)
3 m (10’)	0.9 m (3’)	0.6 m (2’)	150 mm (6”)
3.6 m (12’)	1.1 m (3’-6”)	0.6 m (2’)	175 mm (7”)
4.2 m (14’)	1.3 m (4’-3”)	0.65 m (26”)	200 mm (8”)

TABLE 19 - SLAB THICKNESS AND REINFORCEMENT (NOTES 1 TO 5)						
Slab Thickness mm(inch)	**Span Between Supporting Walls**					
	1.8 m (6 ft)	**2.4 m (8 ft)**	**3 m (10 ft)**	**3.6 m (12 ft)**	**4.3 m (14 ft)**	**4.8 m (16 ft)**
100 (4”)	H12@300					
125 (5”)		H12@300	H12@300			
150 (6”)			H12@300	H12@300		
175 (7”)				H12@300	H12@250	
200 (8”)					H12@250	H12@200
225 (9”)						H12@200

NOTES:

1. Minimum secondary rebars to be H0 (3/8”) at 300 mm (12”) centres.
2. Use the thicker slab: (i) for higher than normal loads, (ii) for stone floor tiles where smaller deflections (e.g., span/720) are required (e.g., porcelain), and/or to accommodate utility pipes, but civil engineering advice should be obtained for verification.
3. Concrete 28-day compressive cube strength to be 25 MPa (3,600 psi).
4. Equivalent Grade 60 rebar sizes in Table 4 may be used.
5. 300 mm (12”). 250 mm (10”), 200 mm (8”). H12 (1/2” diameter Grade 60 rebar).

8

WALLS AND BEAMS

Two types of walls are specified in this Guide and CRCP 10:2023:

(i) concrete block masonry, and
(ii) timber framed.

8.1 CONCRETE BLOCK WALLS

Masonry walls can fail in both horizontal and vertical planes. Therefore, these walls must be reinforced both horizontally and vertically as shown in Figure 29.

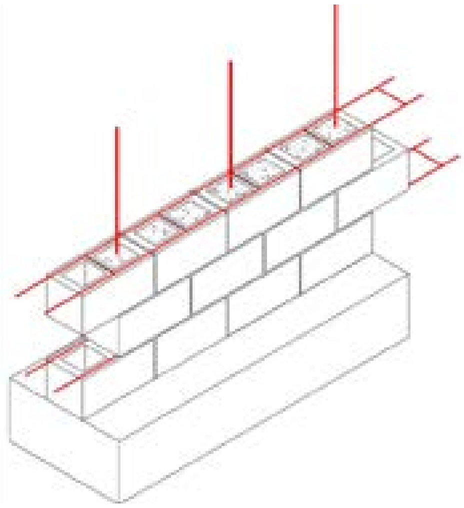


FIGURE 29 - HORIZONTAL AND VERTICAL MASONRY REINFORCEMENT

Each wall elevation must have shear resistance, consisting of either one 3.0 m (10 ft) long shear panel, or two 1.8 m (6 ft) long shear panels. These shear wall panels must be constructed from foundation to roof, with no openings (windows or doors).

Vertical Reinforcement for external walls is to be H12@600 (1/2" bars at 24" centres). Vertical reinforcement for internal walls is to be H12@800 (1/2" bars at 32" centres). Horizontal reinforcement is to be 3.6 mm diameter galvanised wire at each face, at 400 mm (16") centres.

The construction method includes the following:

(i) construct the floor with wall starter bars extending 600 m (2 ft) above the floor level,
(ii) install wall vertical reinforcement,
(iii) lay three block courses, including horizontal rebar and links every other course, and raked joints,
(iv) grout the courses with rebar every three courses, and include a key,
(v) repeat items ii to iv until the roof beam level,
(vi) install beam formwork,
(vii) install beam rebars,
(viii) install spacers,
(ix) install hurricane truss anchors,
(x) pour, compact, level, trowel finish, and cure the concrete, and
(xi) plaster the wall.

8.1.1 CONCRETE STIFFENERS

Reinforced concrete stiffeners are required every 7.6 m (25 ft) of unbraced wall. If the unbraced length is long, then multiple stiffeners must be installed at 6 m (20 ft) maximum spacing. Stiffeners should be at least 300mm (1 ft) wide, and toothed into the wall as shown in Figure 30. The thickness of the concrete stiffener is the wall thickness.

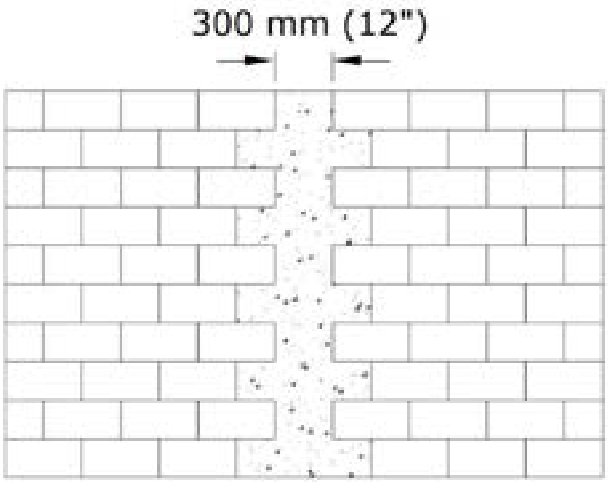


FIGURE 30 - CONCRETE STIFFENER IN MASONRY WALL

Minimum vertical rebars are to be 4 H12 (1/2") anchored to the foundation and perimeter beam. Minimum links are to be R6 (1/4") spaced at 300 mm (12") centres.

8.2 REINFORCED CONCRETE SUSPENDED BEAM SUPPORTING A MASONRY WALL

The components of a reinforced concrete suspended beam are shown in Figures 31 and 32. Reinforced concrete suspended beams are to have the strength, size, and reinforcement as specified in Table 20, that corresponds to the span.

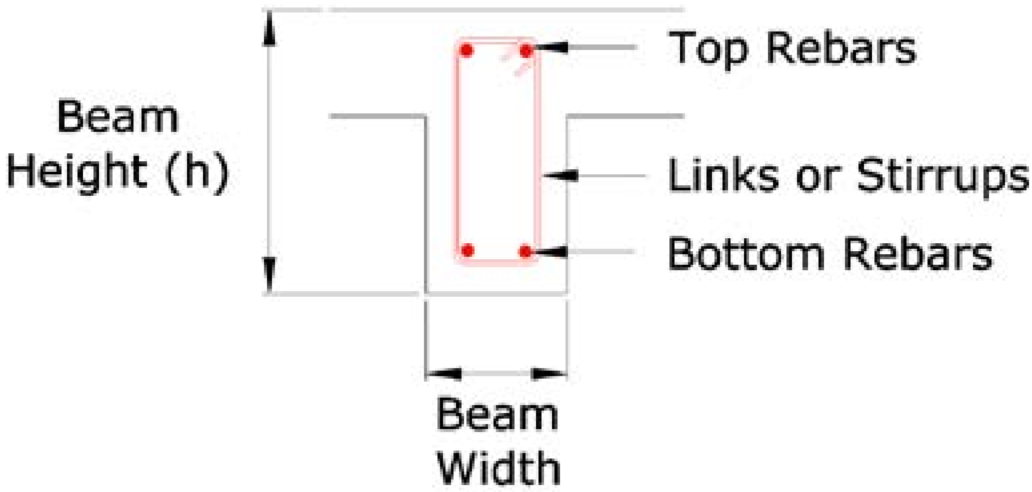


FIGURE 31 - REINFORCED CONCRETE SUSPENDED BEAM

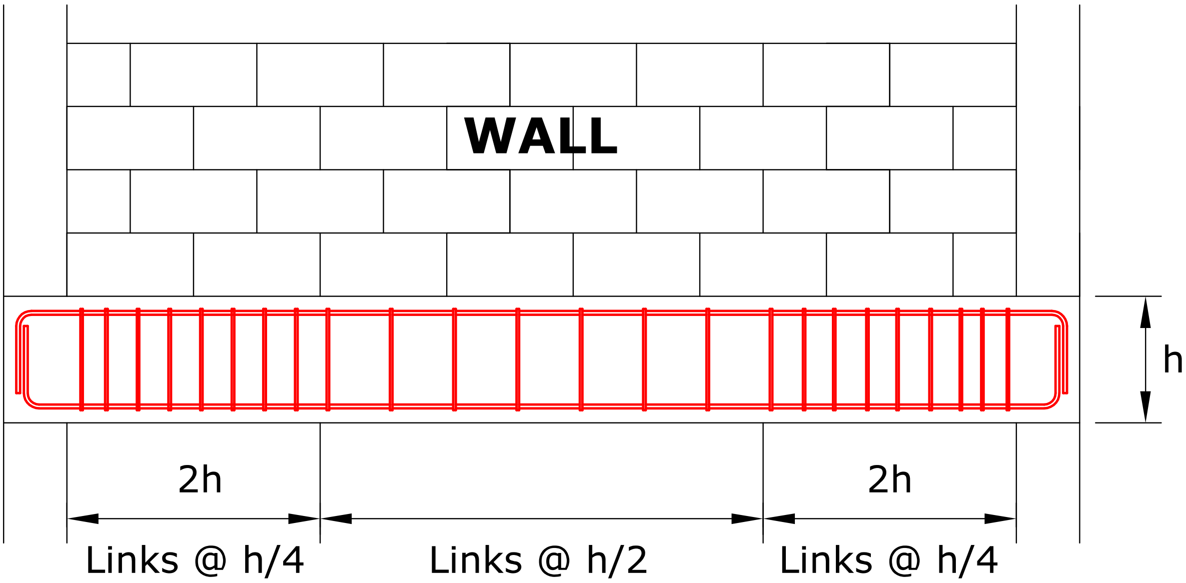


FIGURE 32 - LINK SPACING FOR REINFORCED CONCRETE SUSPENDED BEAM

TABLE 20 - BEAM SIZES AND REBARS (NOTES 1 TO 4)				
Maximum Span (m)	**Minimum Depth (mm)**	**Top Rebars**	**Bottom Rebars**	**Links @ Spacing (mm)**
2.4 m (8')	325 mm (13")	2H12 (1/2")	2H16 (5/8")	H8 (5/16") @150 (6")
3.0 m (10')	350 mm (14")	2H12 (1/2")	2H16 (5/8")	H8 (5/16") @150 (6")
3.6 m (12')	375 mm (15")	2H16 (5/8")	2H20 (3/4")	H8 (5/16") @200 (8")
4.3 m (14')	400 mm (16")	2H20 (5/8")	2H25 (1")	H8 (5/16") @200 (8")

NOTES:
1. Concrete 28-day compressive strength to be 25 MPa (3,600 psi).
2. If using less than the specified minimums, engineering advice should be obtained for verification.
3. Assumes beam supports a concrete block wall and part of the roof.
4. Equivalent Grade 60 rebar sizes in Table 4 may be used.

8.3 REINFORCED CONCRETE LINTEL BEAMS

Reinforced concrete lintel beams are to have the strength, size, and reinforcement as specified in Table 21, that corresponds to the span as shown in Figure 33.

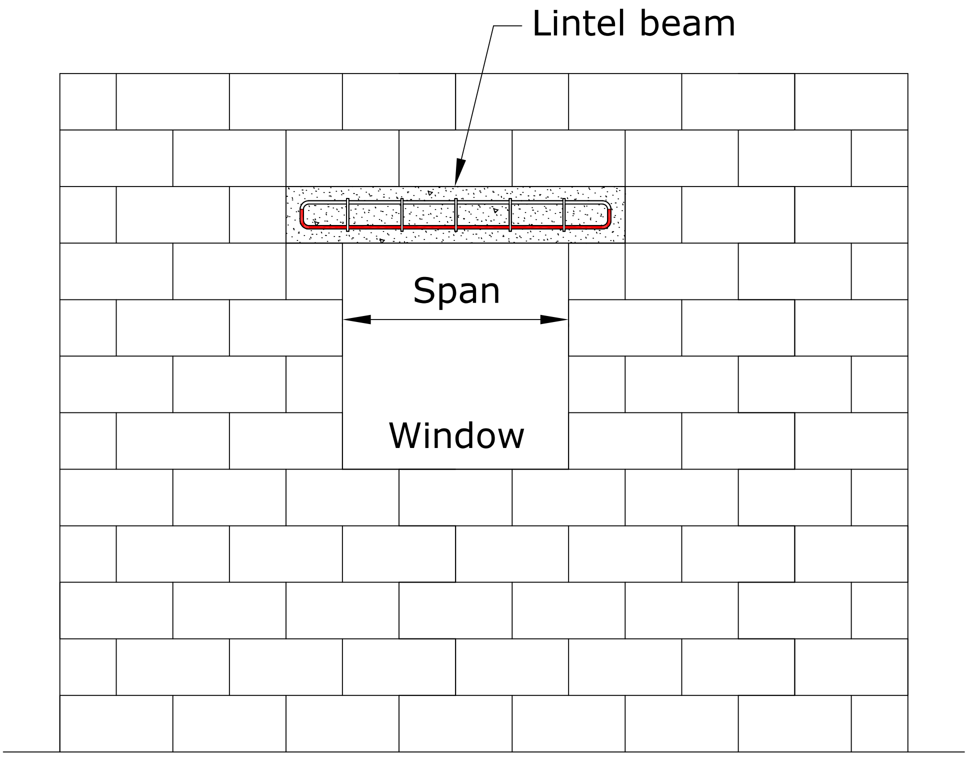


FIGURE 33 - LINTEL BEAM

TABLE 21 - LINTEL BEAM SIZES AND REBARS (NOTES 1 TO 3)			
Span of Lintel m (ft)	**Beam Size Width x Depth**	**Main Rebar Number x Size**	**Links Diameter @ mm Centres**
Up to 1.0 m (0 to 3')	150x200 mm (6"x8")	4xH12 (1/2")	H8 (5/16") @150 mm (6")
1.0 to 1.8 m (3' to 6')	200x200 mm (8"x8")	4xH12	H8 (5/16") @150 mm (6")
1.8 to 2.4 m (6' to 8')	200x400 mm (8"x16")	2xH12 (1/2") (top) 2xH16 (5/8") (bottom)	H8 (5/16") @200 mm (8")

NOTES:
1. Concrete 28-day compressive cube strength to be 25 MPa (3,600 psi).
2. If using less than the specified minimums, engineering advice should be obtained for verification.
3. Equivalent Grade 60 rebar sizes in Table 4 may be used.

8.4 TIMBER WALLS

Timber walls are to be constructed of 2.4 m (8') high 50 mm x 100 mm (2"x4") timber studs. Pine SS (Structural Select) studs should be pressure-treated for termites and have a minimum spacing of 450 mm (18") on centre. Greenheart and Purpleheart studs should have a minimum spacing of 600 mm (24") on centre. Studs should be doubled at the wall's ends, top, and around openings, or the size should be 100 mm x 100 mm (4"x4"). A typical stud layout is shown in Figure 34. Wall cladding is specified in section 8.4.1.

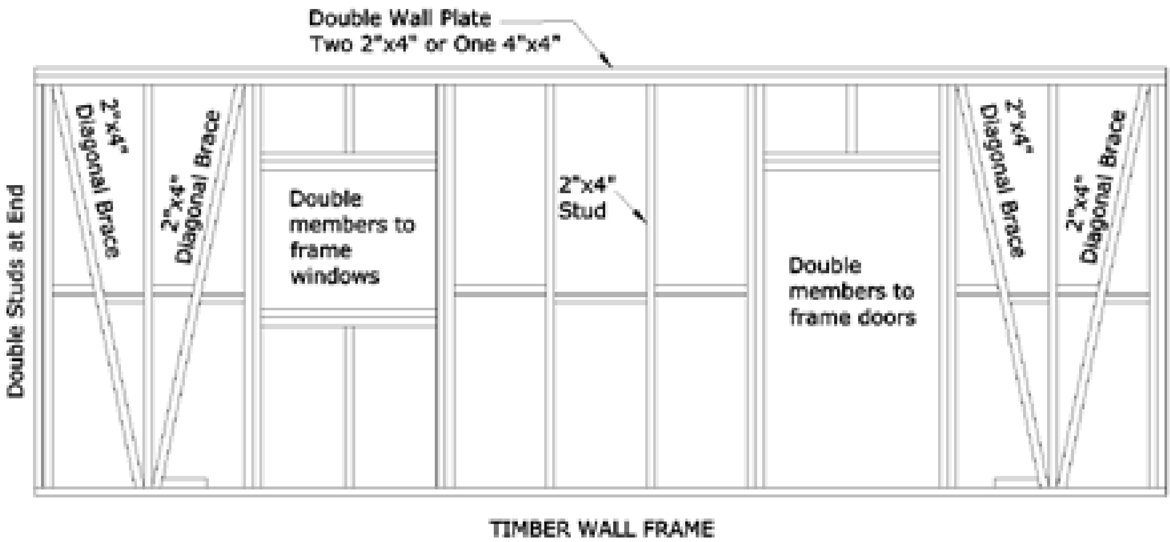


FIGURE 34 - LAYOUT OF WALL TIMBER FRAME

The frame should be connected using nails or No. 12 wood grip screws embedded 40 mm (1.5") into the connecting timber. The frame should then be reinforced with hurricane connectors. These connectors should be 1 mm (0.04") thick x 25 mm (1") wide stainless steel or galvanised metal multi-purpose straps, fastened with 3.75 mm (0.15") diameter galvanised nails. For each connector, a minimum of six nails should be installed in each stud (3 each side).

All wall junctions are to be braced as shown in Figure 35 *(overleaf).*

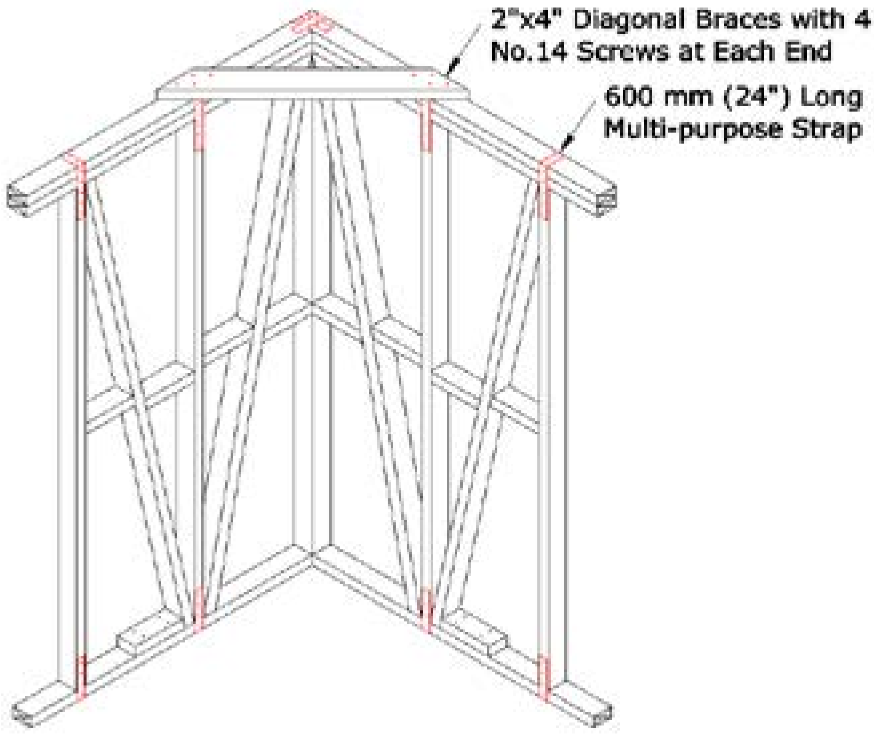


FIGURE 35 - TIMBER FRAME BRACING AT WALL JUNCTIONS

The construction method includes the following:

(i) construct the sole plate or timber beam to support the studs,
(ii) install the vertical studs,
(iii) install additional studs at the corners, and the sides of windows and doors,
(iv) install the top plate,
(v) install diagonal bracing and noggins,
(vi) install utility pipes and junction boxes,
(vii) install hurricane straps to support the rafters, and
(viii) install wall cladding.

The diagonal bracing must be installed at the ends of both internal and external walls.

8.4.1 WALL CLADDING

Wall cladding for external walls should be:

(i) 20 mm (3/4") thick ship lap boards or
(ii) 16 mm (5/8") thick CDX plywood or equivalent.

For internal walls, 12 mm (1/2") thick CDX plywood or equivalent should be used. Timber wall cladding should be pressure-treated for termites and painted with a waterproof paint. The plywood should be fixed to the timber frame using 50 mm (2") long No.12 wood grip screws at 300 mm (12") spacing.

9

ROOF

9 ROOF

This Guide specifies timber roof frames supported by:

(i) reinforced concrete beams on masonry walls, and
(ii) timber framed walls.

The roof consists of cladding, supported on purlins (battens) supported on plywood, which are then supported on rafters, which are supported on walls. The purlins may be supported directly on the rafters as shown in Figure 36.

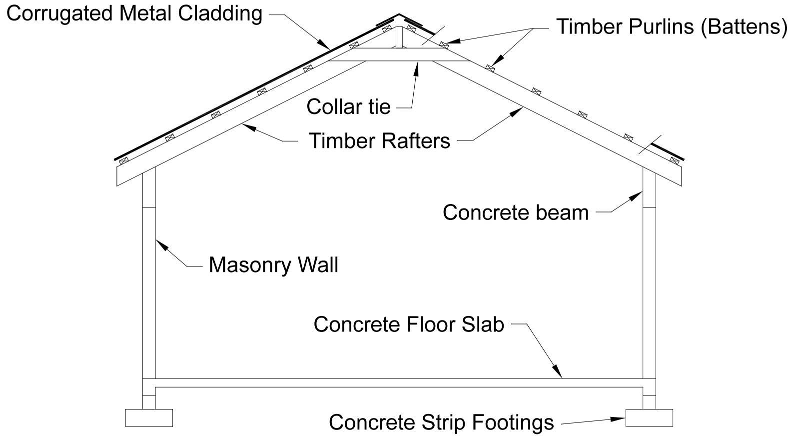


FIGURE 36 - SECTION THROUGH HOUSE SHOWING ROOF

9.1 RAFTERS

A description of the rafter types is shown in Figure 37.

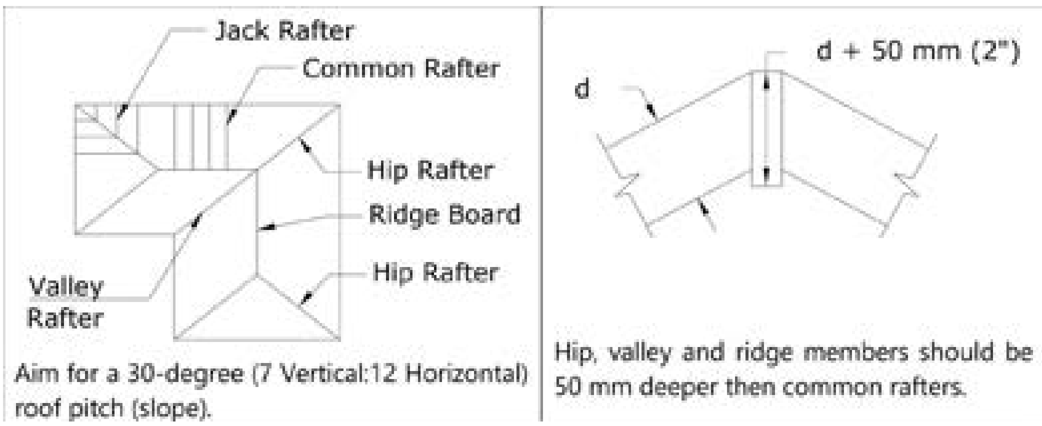


FIGURE 37 - RAFTER TYPES

Main (common) timber rafters for hipped roofs are to have the strength, size and spacing as specified in Tables 22 and 23 for Category 5 hurricanes, that corresponds to the rafter span. For comparison, common rafters for a Category 2 hurricane are shown. Hip, valley and ridge members should be 50 mm (2") deeper than the connecting rafters.

TABLE 22 - RAFTER SIZES AT 400MM (16") SPAN				
Span	**Category 5 Hurricane**		**Category 2 Hurricane**	
	Rafter Size at 400mm (16") centres		**Rafter Size at 400mm (16") centres**	
	Pine SS	**Purpleheart**	**Pine SS**	**Purpleheart**
1.5-1.8 m (5-6ft)	50x150 (2"x6")	50x100 (2"x4")	50x100 (2"x4")	50x100 (2"x4")
1.8-2.4m (6-8ft)	75x150 (3"x6")	50x150 (2"x6")	50x150 (2"x6")	50x100 (2"x4")
2.4-3.3 (8-10ft)	75x200 (3"x8")	75x150 (3"x6",) or 50x200 (2"x8")	50x150 (2"x6")	50x150 (2"x6")
3.3-3.6m (10-12')	75x200 (3"x8")	75x150 (3"x6",) or 50x200 (2"x8")	50x150 (2"x6")	50x150 (2"x6")
3.6-4.3m (12-14')	75x250 (3"x10")	50x200 (2"x8")	75x150 (3"x6")	50x150 (2"x6")
4.3-4.8m (14-16')	75x300 (3"x12")	75x200 (3"x8")	75x150 (3"x6")	50x150 (2"x6")

NOTE:
If using less than the specified minimums, engineering advice should be obtained for verification.

TABLE 23 - RAFTER SIZES AT 600MM (16") SPAN				
Span	Category 5 Hurricane		Category 2 Hurricane	
	Rafter Size at 600mm (24") centres		Rafter Size at 600mm (24") centres	
	Pine SS	Purpleheart	Pine SS	Purpleheart
1.5-1.8 m (5-6ft)	50x150 (2"x6")	50x100 (2"x4")	50x150 (2"x6")	50x100 (2"x4")
1.8-2.4m (6-8ft)	50x200 (2"x8")	50x150 (2"x6")	50x150 (2"x6")	50x150 (2"x6")
2.4-3.3 (8-10ft)	75x250 (3"x10")	75x150 (3"x6",) or 50x200 (2"x8")	75x150 (3"x6",) or 50x200 (2"x8")	50x150 (2"x6")
3.3-3.6m (10-12')	75x250 (3"x10")	75x200 (3"x8")	75x200 (3"x8")	50x150 (2"x6")
3.6-4.3m (12-14')	75x300 (3"x12")	75x200 (3"x8")	75x200 (3"x8")	75x150 (3"x6")
4.3-4.8m (14-16')	75x300 (3"x12")	75x250 (3"x10")	75x250mm (3"x10")	75x150 (3"x6")

NOTE:
If using less than the specified minimums, engineering advice should be obtained for verification.

9.1.1 REDUCING THE RAFTER'S SPAN.

Rafter sizes can be reduced by reducing the span by:

(i) supporting the rafter on an internal wall,
(ii) installing a 50 mm x 150 mm (2"x6") timber collar tie at a lower level (including making an A frame), and
(iii) building a truss. Some reduced span concepts are shown in Figure 38. Connection details at the apex are shown in Figures 39 and 40.

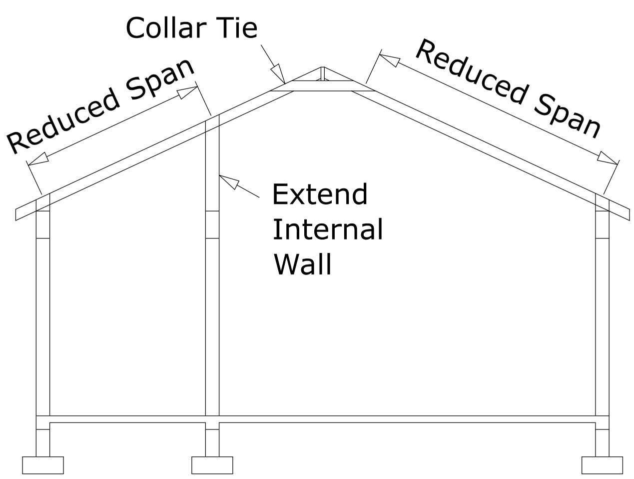


FIGURE 38 - SPAN REDUCING CONCEPTS

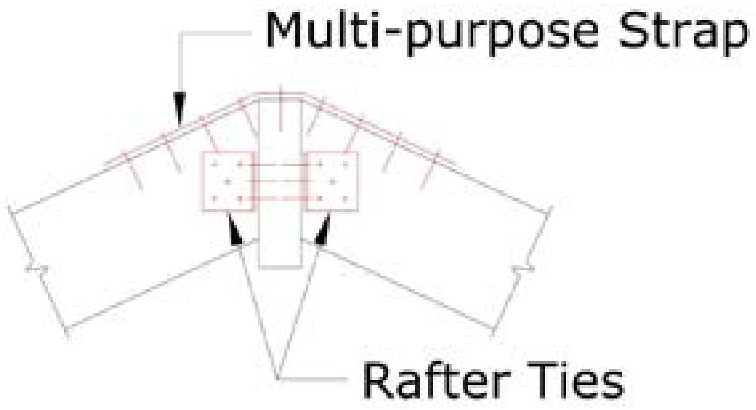


FIGURE 39 - RAFTER CONNECTIONS AT THE RIDGE

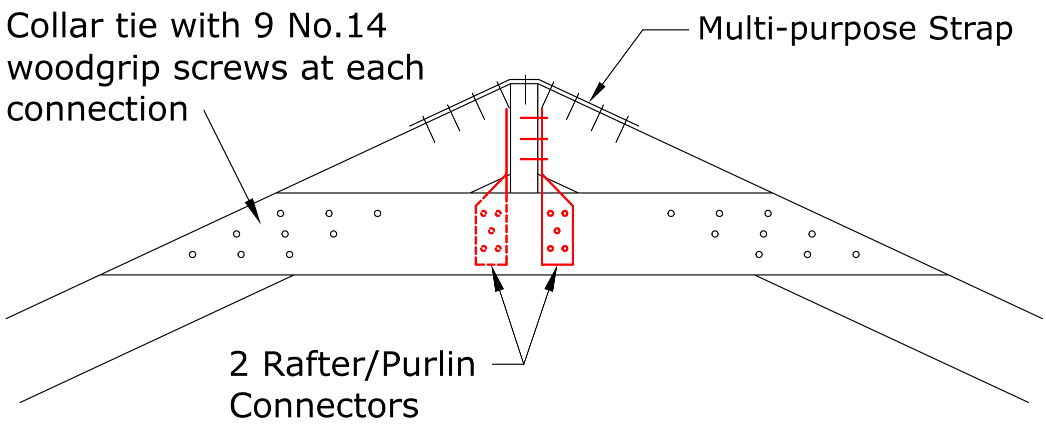


FIGURE 40 - COLLAR TIE AT RIDGE

The hurricane connectors should be minimum 1.0 mm thick (18 gauge) galvanised metal with a minimum tensile strength of 450 MPa.

9.2 RAFTERS ON MASONRY WALLS

For a roof on masonry walls, the construction method includes the following:

(i) erect falsework to support the ridge members,
(ii) install the ridge members, including any hips,
(iii) install the rafters,
(iv) install hurricane connectors,
(v) install concrete to fill the space between rafters,
(vi) install tongue and groove close-boards or CDX plywood,
(vii) install purlins (battens),
(viii) install insulation (optional),
(ix) if metal cladding is to be used, install a damp proof membrane, rubberised paint, or rubberised tape on top of purlins, and
(x) install cladding.

The rafter to wall connection is shown in Figure 41.

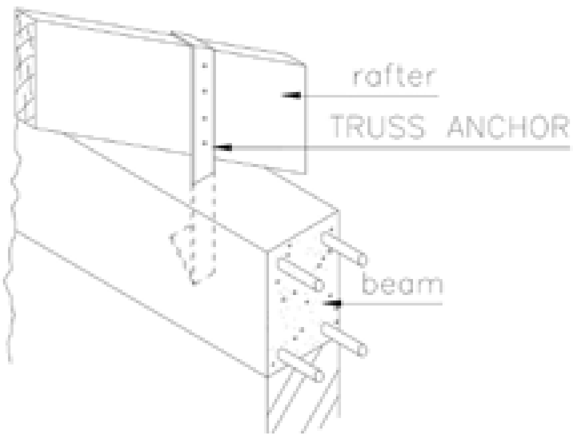


FIGURE 41 - RAFTERS ON MASONRY WALL
(Two Truss Anchors Should Be Used for Each Rafter)

Truss anchors are to be 1 mm (0.04”) thick x 40 mm (1-9/16”) wide stainless steel or galvanised metal straps with 3.75 mm (0.15”) diameter galvanised nails.

9.3 RAFTERS ON TIMBER FRAMED WALLS.

For a roof on timber framed walls, the construction method includes the following:

(i) erect falsework to support the ridge member,
(ii) install the ridge members, including any hips,
(iii) install the rafters,
(iv) install hurricane connectors,
(v) install tongue and groove close-boards or plywood (for example T1-11),
(vi) install purlins (battens),
(vii) install insulation (optional),
(viii) if metal cladding is to be used, install a damp proof membrane, rubberised paint, or rubberised tape on top of purlins, and
(ix) install cladding.

The rafter to wall connection is shown in Figure 42.

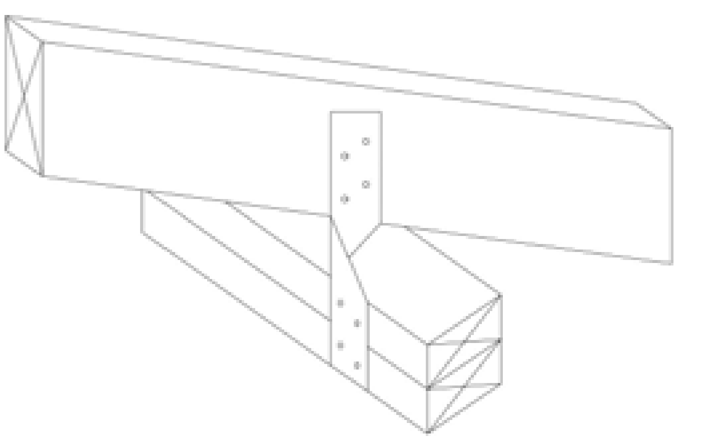


FIGURE 42 - RAFTERS ON TIMBER WALL
(Two Hurricane Straps Should Be Used for Each Rafter)

9.4 PURLINS

The purlins (battens) are to be 50 mm x 100 mm (2”x4”) treated Pine SS laid flat and spaced at 600 mm (24”) for Category 5 hurricanes. The purlins may be supported on rafters, or on 16 mm (5/8”) thick pressure treated CDX plywood which are then supported on rafters.

At each purlin rafter intersection, two No.12 screws are to be embedded 40 mm (1.5”) into the rafter. All timbers are to be pressure-treated against termites.

9.5 CLADDING CONNECTIONS

The pattern of corrugated metal roof cladding connections is shown in Figure 43. Note the additional screws to reinforce the stitching screws at the panel laps.

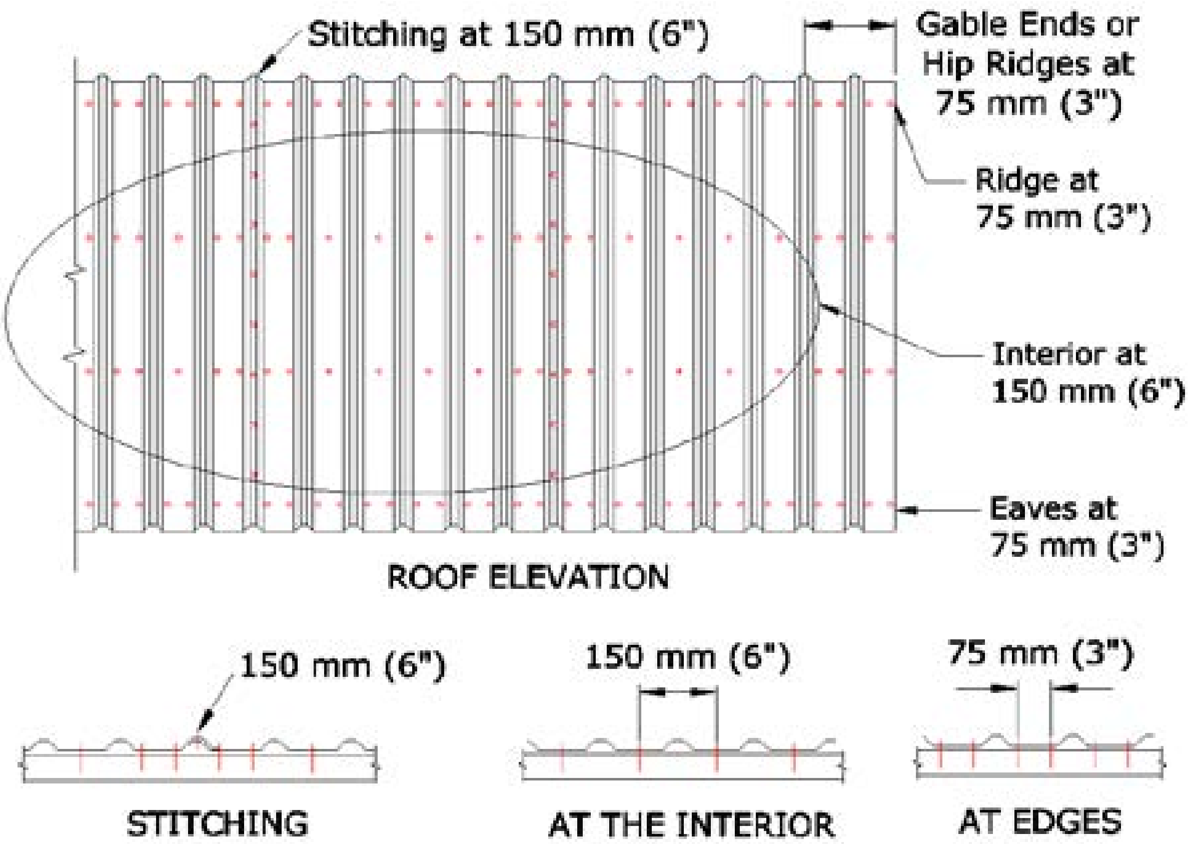


FIGURE 43 - ROOF CLADDING CONNECTIONS

9.6 ASSESSMENT EXERCISE 10

1) Do a drawing review of construction drawings for a residential property, and include the missing information (See Section 2.4.1)

2) Write a work plan for the construction drawings, identifying the major construction activities (See Section 5.3.1).

A

ANNEX

ANNEX A

A.1 POST-CONSTRUCTION MAINTENANCE

A.1.1 PRINCIPAL CONSTRUCTION PHASES

There are four (4) principal construction phases:

(i) design,
(ii) construction,
(iii) maintenance, and
(iv) demolition.

Neglecting the maintenance requirements can hasten the start of the demolition phase. Addressing the building's maintenance may prolong the design life of the building.

A.1.2 CAUSES OF DETERIORATION

Houses in the Caribbean may deteriorate rapidly if their materials are not protected from the environment. Examples of deterioration are:

(i) corrosion of metal reinforcement, cladding and fixings,
(ii) moisture damage to timber and paints,
(iii) insect damage to timber,
(iv) tree root damage to footings and walls,
(v) air pollution damage to concrete,
(vi) heat and ultra-violet light damage to paint, pipes, plastic gutters, and
(vii) soil chemistry damage to concrete footings.

A.1.3 RECOMMENDATIONS

To reduce the maintenance requirements, low-maintenance materials and construction methods should be used. The following are recommended:

a. Use compacted concrete and grout.
b. Protect reinforcement with adequate concrete cover.
c. Use strong blocks and mortar.
d. Install damp-proof membrane below ground floor slabs.
e. Use suspended ground floor slabs or slabs supported on well-compacted fill on rock.
f. Use treated timber.
g. Use stainless steel straps and fixings.
h. Use stainless steel or bronze hinges.
i. Use cleaned and cemented schedule 80 PVC pipes externally.
j. Use paint with fungicide (e.g., Trowel Plastic).
k. Seal all open spaces (around pipes, around openings, between rafters.)
l. Install roof gutters and discharge stormwater away from foundations.
m. Seal joints and paint all exposed timbers.
n. Apply capillary waterproofing agent (Vandex, Penetron, Xypex, or equivalent) to basement walls, and install a drain.

A.2 DESIGN FOR ELDERLY AND PEOPLE WITH DISABILITIES

A.2.1 MAINTENANCE

Elderly and disabled persons normally have a challenge in maintaining their properties. If good quality materials are used and assembled properly, then the house may not attract high maintenance requirements.

A.2.2 BUILDING ACCESS

The walkway from the street to the house should be at least 1.5 m (5 ft) wide, with a slope of at least 1:20. Allowance should be made for a ramp width of 914 mm (32") and slope of 1:12. At the entrance, the length of the landing should be at least 2 m (80") as shown in Figure A.1.

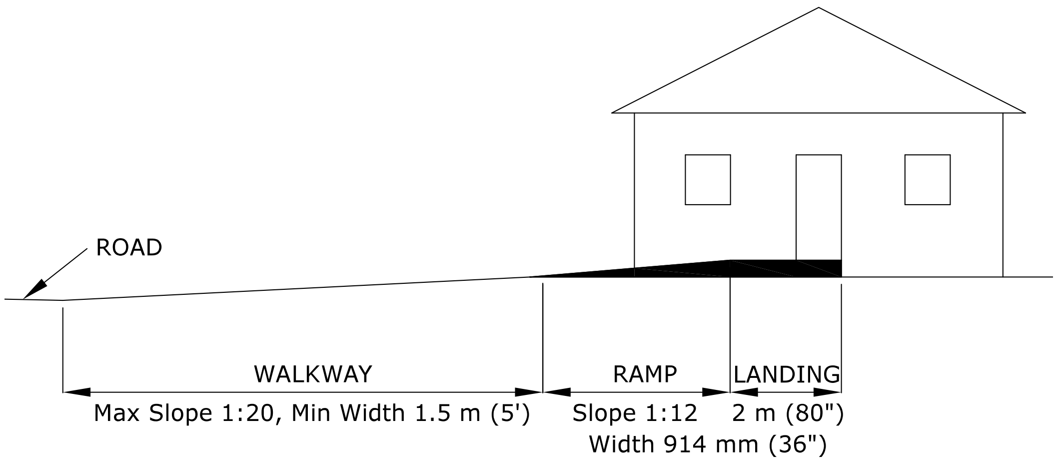


FIGURE A.1 - ACCESS FOR DISABLED

A.2.3 DOORS AND CORRIDORS

All external doors and bathroom doors should open outwards. All door openings should be 810 mm (32") wide. Door levers should be used, not door knobs. All corridors should be a minimum width of 1 m (40").

A.2.4 KITCHEN, LAUNDRY AND BATHROOMS

A clearance of 1,370 mm (54") should be provided around all: cabinets, counter tops, ovens, washers, driers, tubs, and any other furniture or appliance. Faucet levers should be used at sinks, showers and baths.

A.2.5 ELECTRICAL LIGHT FIXTURES

All electrical light bases are to accommodate screw type bulbs – not bayonet.

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