DOMINICA HOME RETROFIT GUIDE

A guide to increase the resilience of existing housing in Dominica against natural hazards and climate change, produced by the Ministry of Housing and Urban Development.

Government of the Commonwealth of Dominica

CDRI Coalition for Disaster Resilient Infrastructure

IRAF | IRIS

Build Change

Forword

This guide has been developed under the **Data and Systems for Resilient Housing project,** an initiative funded under the Coalition for Disaster Resilient Infrastructure's (CDRI) Infrastructure for Resilient Island States (IRIS) Program.

IRIS is a flagship initiative of the CDRI which aims to equip Small Island Developing States with knowledge, tools, and partnerships to build climate- and disaster-resilient infrastructure. Through IRIS, CDRI advocates for resilient infrastructure, deploys experts, shares best practices, and funds technical support to enhance infrastructure resilience in SIDS.

The Dominica Climate Resilience and Recovery Plan 2020-2030 clearly outlines the Government of Dominica's commitment to achieving climate resilience through 20 key targets, the third of which is for 90 percent of housing stock built or retrofitted to resilient building codes.

In support of national climate resilient housing goals, the Data and Systems for Resilient Housing project began in 2024 with a statistically viable national survey of over 500 existing houses in Dominica. The survey results highlighted the successful progress towards resilient housing since Hurricane Maria, as well as a significant opportunity to further reduce disaster risk through housing retrofits. In particular, 63 percent of roofs and 89 percent of timber houses were found to be **highly vulnerable**, **increasing to 70 percent and** 100 percent respectively when considering only the households with increased socioeconomic vulnerability.

This guide has been developed in response to the national target and the vulnerabilities identified by the survey. It is part of a series of technical guidance aimed at providing practical and affordable structural interventions to increase the resilience of typical homes in Dominica. Additional guidance includes:

- Homeowner Awareness Manual
- Retrofit Construction Supervision Manual

For more information on the survey results and other available technical guidance for improving existing housing, visit survey.housing.gov.dm.

Acknowledgements

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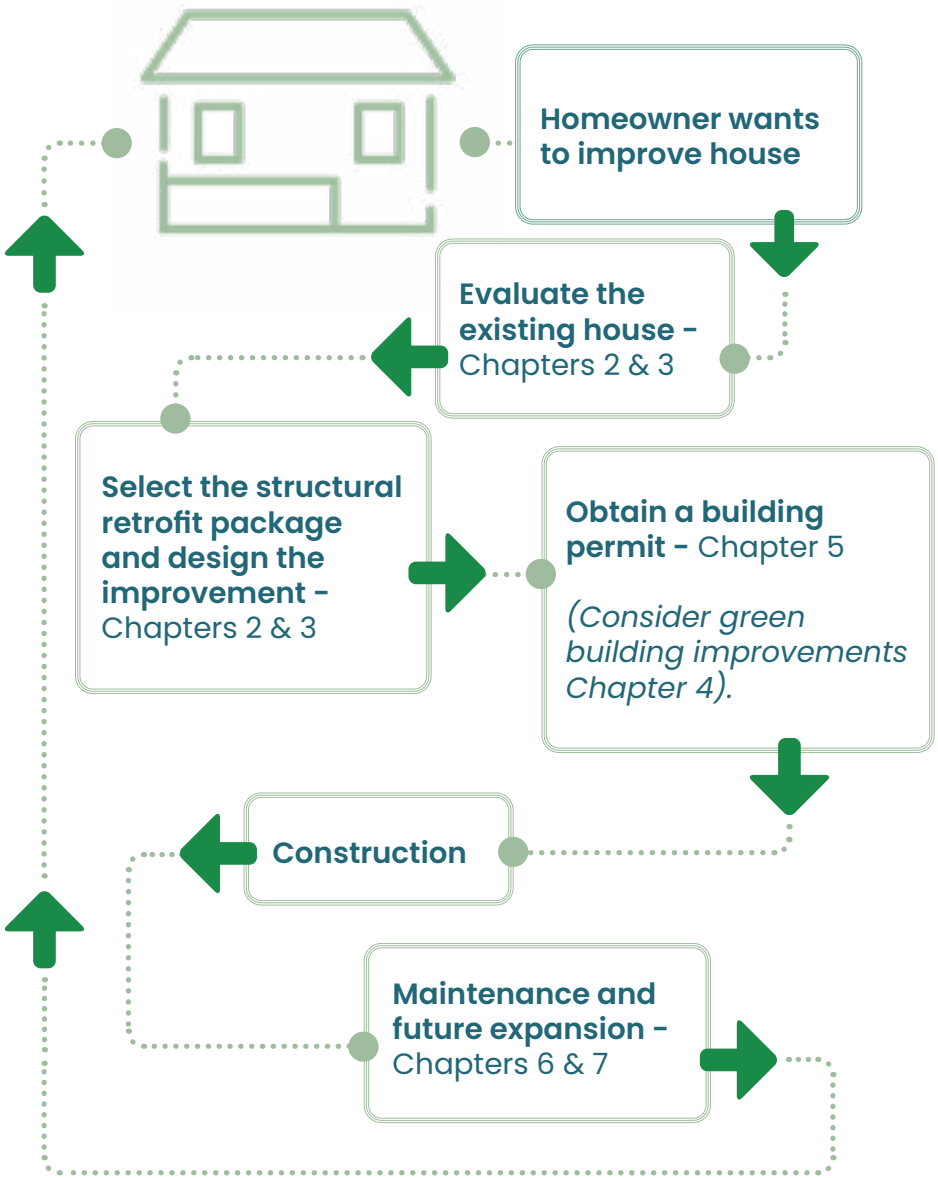
Ministry of Housing and Urban Development:
Honourable Minister, Mrs. Melissa Poponne-Skerrit
Permanent Secretary Dr. Kyra Paul
Permanent Secretary, Mr. Reginald Severin
Ms. Tracy Peltier, Project Coordinator
Ms. Larissa Frederick, Project Assistant

Build Change
Ms. Louise Foulkes, Caribbean Director and Engineering Program Manager
Ms. Anna Pavan, Engineering Program Associate
Mr. Oluwaseun Okusanya, Engineering Program Associate
Mr. Nicolas Daniel Andres Ortega Cardenas, Structural Civil Engineer
Mr. Rendy Chandra, Architect and BIM Specialist

Blue Curtain Creative
Ms. Petrea Honychurch Seaman

Technical Review Committee
Mr Chris Cadette, Safety Officer, Fire and Ambulance Service
Mr Claude Lauture, Architect, Independent
Mr Derrick Guiste, Engineer and Lecturer, Dominica State College
Mr Dirk St. Jean, Housing Technician, Ministry of Housing and Urban Development
Mr Joshua Kelshall, Project Engineer, Emergency Agr
Ms. Kaylyn Rodney, Architect, Independent
Mr Oliver Joseph, General Contractor, Independent
Ms Rebekah Joseph, Development Control Officer, Planning Division. Ministry of Housing and Urban Development
Ms Soriah Williams, Junior Development Control Officer, Planning Division. Ministry of Housing and Urban Development
Mr Mikael Gartner, Technical Expert, CDRI

How to Use This Guide



Unlike new construction, **retrofitting starts with an evaluation** of the house to understand the existing conditions.

The evaluation **identifies vulnerabilities** in the existing structure that require correction in the retrofit design. Chapter 2 provides guidance on **structural evaluations and retrofit designs**. Chapter 3 provides guidance on unsafe zones and civil/structural evaluations and retrofit designs for **zones with moderate site hazards.**

- A **building permit** is required for any retrofit intervention that changes more than 25% of the roof, or any of the walls. Chapter 5 provides some guidance on this process.
- A construction supervision checklist is provided in the Retrofit Construction Supervision Manual to ensure quality during the construction process. For more details, refer to survey.housing.gov.dm.
- Some homeowners may wish to make **green building improvements** to their home to improve their health and well-being, mitigate the effects of extreme heat, or lower their utility bills. Chapter 4 provides guidance on effective strategies.
- For homeowners who would like to **expand** their home, either vertically by adding another storey, or horizontally by with an extension, Chapter 6 provides guidance on when expansion is appropriate and what to consider.

Continued **maintenance** is essential for a resilient home. **Chapter 7 provides guidance.**

TABLE OF
CONTENTS

1

Dominica Home Retrofit Guide

INTRODUCTION

WELCOME TO THE DOMINICA HOME RETROFIT GUIDE!

This guide was developed to **support building professionals** make houses in Dominica **more resilient against natural hazards and climate change.**

This guide is intended to be used by:

BUILDING PROFESSIONALS

Engineers, Architects, Contractors, and Development Control Officers who want to:

- Advise homeowners on how best to improve their homes
- Evaluate the condition of existing houses
- Design retrofit solutions to address structural, habitability and green building deficiencies
- Prioritise and group cost effective, complementary interventions

This guide is intended to be used for:

EXISTING HOUSES (IN DOMINICA)

1-2 storeys high and built with timber or masonry. The recommendations focus on:

- Improving resilience against natural and climate hazards, including: hurricanes, earthquakes, flooding due to heavy rainfall, and extreme heat.
- Increasing energy and water efficiency while reducing emissions and costs by maximizing natural ventilation, cooling and lighting, and installing more efficient systems, fixtures and appliances.

What is Retrofitting?

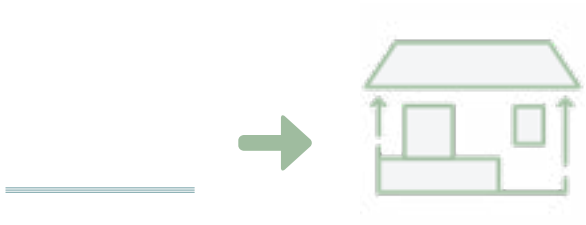
In this guide retrofitting means **upgrading elements of the house to improve** the:

- Structural performance during earthquakes and hurricanes, to save lives and protect against damages.
- Thermal performance and ventilation, for a more comfortable space on hot days
- Energy and water efficiency, to lower bills and reduce emissions.

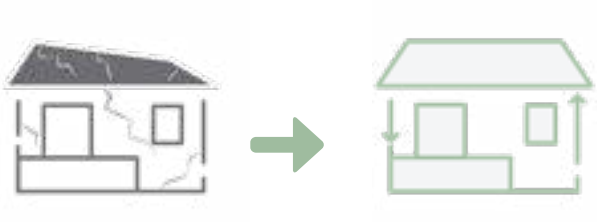
For resilient new construction, users should refer to the 2022 Building Regulations and the Guide to Dominica's Housing Standards.

Available at physicalpnanning.gov.dm

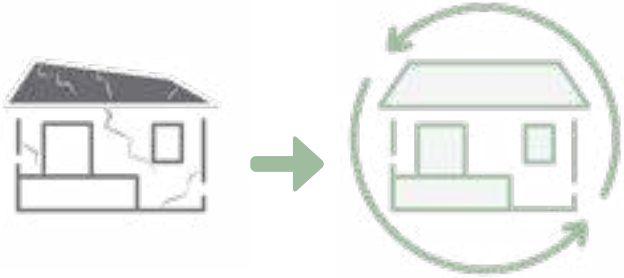
Retrofitting goes beyond repair, which focuses only on fixing damages and returning them to their original state. Retrofitting may include elements of new construction, but primarily **focuses on retaining and upgrading the existing structure rather than building new.**



New construction:
A new house is built on an empty plot.



Repair:
Damage is repaired and the house is returned to its original condition.



Retrofitting:
Any damage is repaired AND key elements of the house are strengthened and upgraded to increase resilience.

Why Retrofit?

Houses in Dominica are at risk of damage from natural hazards and climate change.

Dominica's location, climate and geology mean houses on the island are exposed to numerous hazards, many of which are being exacerbated by climate change.

For details of the key hazards and their effect on housing, refer to the Guide to Dominica's Housing Standards.

... The safest and most cost effective way to protect property and families is to retrofit.

EFFECTIVE

Global research consistently shows that retrofitting before a disaster saves lives and cost. It is quicker and simpler to implement than new construction.

COST EFFICIENT

Studies for Dominica have shown that for every dollar invested, retrofitting for hurricanes could save up to four dollars, and that retrofitting is approximately one quarter of the cost of new construction.

MORE SUSTAINABLE

New land is not required, and far fewer materials are needed. Compared to resilient new construction, retrofitting saves two thirds of the embodied carbon.

When is Retrofitting Appropriate?

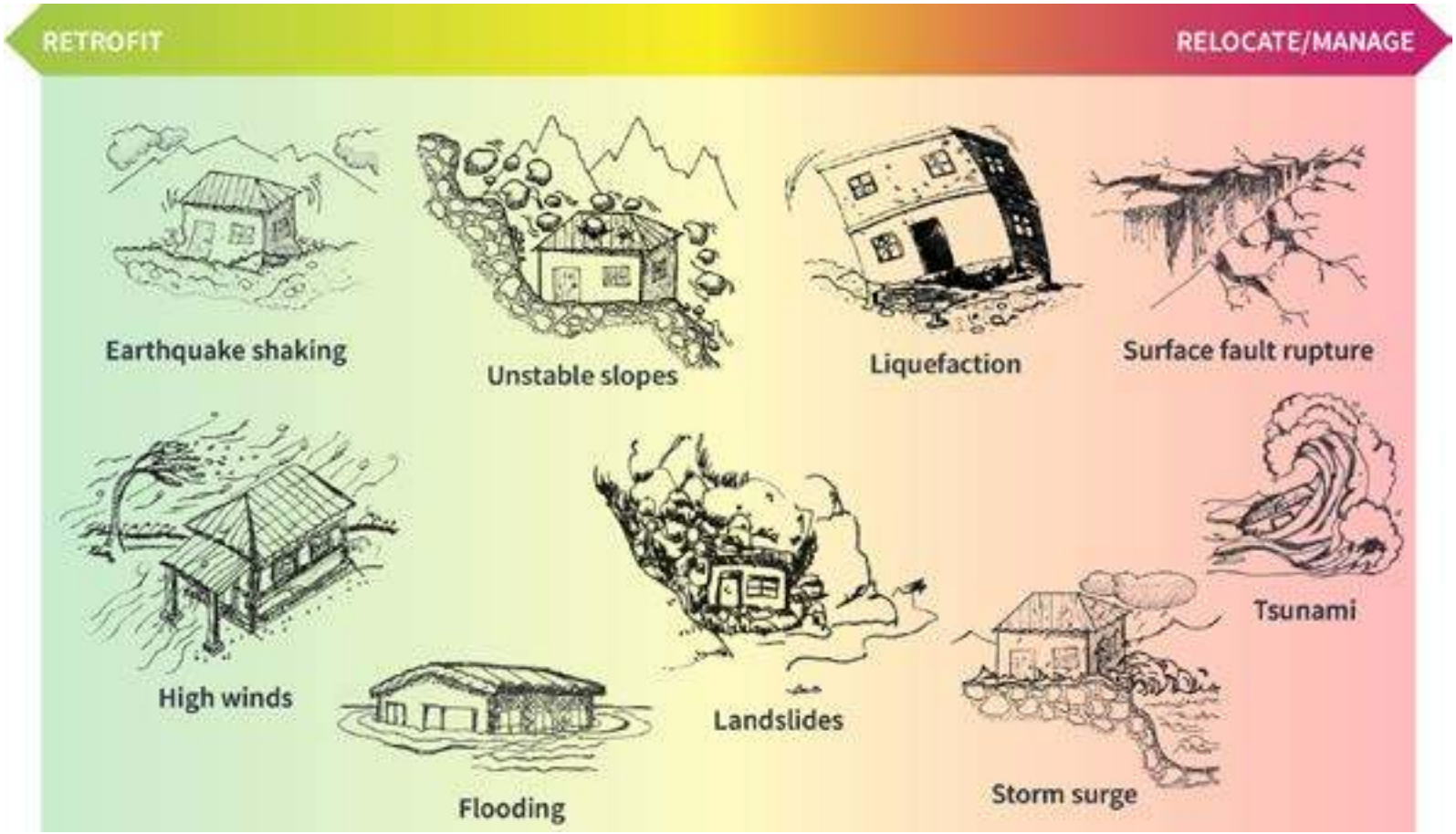
Most houses can be retrofitted. However, this guide focuses on the houses where retrofitting is most cost effective.

Retrofitting is appropriate and cost effective for **approximately 80% of houses in Dominica!**

This guide includes information to support users in identifying unsafe sites and structural deficiencies to determine whether retrofitting is appropriate or not.

! Retrofitting is not Is in an unsafe zone.

- Refer to Chapter 3 and the Guide to Dominica's Housing Standards for details.
- Has a very high level of damage.



Housing Types that Can Be Retrofitted with this Guide

MASONRY HOUSES

Sloped roofs
Timber framing and lightweight covering.

Flat roofs
Reinforced concrete slab.

Masonry walls
Can be stone or concrete block, plastered or unplastered, reinforced, confined or unreinforced.

Two storeys maximum

Existing foundations
House can be either on grade, or raised on piers or on columns.

Housing Types that Can Be Retrofitted with this Guide

TIMBER HOUSES

- **Sloped roofs**
  Timber framing and lightweight covering.
- **Historical (Ti Kais) or modern construction**
- **Timber walls**
  Stud framing, covered with plywood or boards
- **One storey maximum**
- **Existing foundations**
  House can be either on grade or raised on piers

Housing Types that Cannot Be Retrofitted with this Guide

HOUSES IN UNSAFE ZONES, SUCH AS AREAS WITH:

- Evidence of landslide
- Severely damaged site retaining walls
- Liquefaction or very soft soil

Refer to Chapter 3 for further guidance on identifying unsafe zones. In this case, the best option is likely to be **relocation.**

HOUSES WITH SIGNIFICANT DAMAGE

In this case, retrofitting may not be the most cost effective solution, and the best option is likely to be **reconstruction**.

HOUSING TYPES NOT COVERED BY THIS MANUAL, SUCH AS:

- More than 2 storeys above ground
- Other construction materials

In this case, **customized engineering design and calculations** are likely required.

Technical Specification of this Guide

Reference Regulations, Codes and Standards

The following regulations, codes and standards have been referenced in the development of this guide:

- Dominica Building Regulations, 2022
- Caribbean Uniform Building Code (CUBiC), 1985
- Guide to Dominica's Housing Standards, 2018
- Organisation of East Caribbean States (OECS) Building Code, 2015
- American Concrete Institute Building Code Requirements for Structural Concrete, ACI 318-19
- American Society of Civil Engineers, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE 7-22
- American Society of Civil Engineers, Seismic Evaluation and Retrofit of Existing Buildings, ASCE 41-17
- American Wood Council, National Design Specification for Wood Construction, 2018 NDS
- American Wood Council, Special Design Provisions for Wind and Seismic, 2015 SDPWS

Basis of Design

The calculations supporting the recommendations in this guide are based on the following loads and materials assumptions:

Loads:

- **Wind load:** Calculated using the 2022 Building Regulations 159 miles/hour basic wind speed for use with ASCE 7, multiplied by a climate change factor of 1.13. Exposure Category C has been assumed, described as *"Open terrain with scattered obstructions that have heights generally less than 30 ft (9.1 m)…. includes flat, open country and grasslands."* Design recommendations will be conservative for houses situated in more urbanised or forested areas. Additional calculations may be required to confirm applicability of the recommendations for houses in the most exposed coastal locations.
- **Seismic load:** Calculated using ASCE 7-22 and ASCE 41-17 using mapped spectral accelerations from the University of the West Indies SS = 1.6 and S1 = 0.5 for 2,475 year return period (available at: https://uwiseismic.com/downloads/seismic-hazard-map) . Design accelerations were calculated assuming Site Class C, based on the findings from the University of West Indies publication "FINAL REPORT For Work Underdone On The Island Of Dominica For The Connecting Communities For Climate And Disaster Risk Preparedness (CCC-DRIP) Initiative".

cont.

Materials:

- **Timber:** Southern Pine No.2. Alternative existing or retrofit timber elements are permitted provided the species and grade meets or exceed the design properties of Southern Pine No. 2. Nominal sizes are referenced throughout this guide; actual sizes have been used in calculations.
- **Masonry**: Assumed minimum 1,000 psi (6.9MPa) mean compressive block strength and 55% solid area of blocks.
- **Reinforced concrete:** Assumed minimum compressive strength 2,500 psi (17.5 MPa), reinforcement yield strength 40,000 psi (275 MPa).

Alignment with the 2022 Building Regulations

The recommendations in this guide are based on rational engineering principles and are aimed risk reduction, not full code compliance.

Housing retrofits are permitted in Dominica as alterations under Section 103 of the 2022 Building Regulations. Retrofits may be made to any existing building without requiring the whole building to comply with all Code requirements, provided that the alteration work conforms to the Code for new construction to the extent determined by the Authority. In addition, the alteration must not cause the existing building to be weakened, nor change the occupancy classification.

This guide satisfies the requirements of Section 18 of the 2022 Building Regulations for residential buildings classified as E(a), with a maximum of two storeys and a floor area not exceeding 2,500 sq ft (232 m²). The guide may also be applied to residential buildings of up to two storeys with larger floor areas; however, additional compliance with the 2022 Building Regulations may be required, as this guide does not address all regulatory requirements for such buildings.

Disclaimer

It is important to note the following:

- The guide does not provide a full strong wind, flood or earthquake design. In some cases, the application of these techniques in isolation may not lead to a demonstrable improvement in wind, flood or seismic resistance, especially in houses more complex in nature.

- Application of the techniques described in this guide does not mean the building meets building code requirements for new construction. There may be strengthening options other than those provided that may be applied to the house for strengthening. Before adopting alternative strengthening solutions or for a code compliant strengthening solution, please consult a registered civil engineer or architect.

- Houses built or improved following this may still experience damage in strong wind storms, floods and earthquakes. The recommendations are not intended for strengthening a home to be a safe shelter to evacuate to during emergencies. Please continue to follow emergency and evacuation guidance from the government in the event of an impending disaster.

- Nothing contained in these materials shall create a contractual relationship with or a cause of action in favor of a third party against Build Change. Third party use and/or reliance of these materials or the information contained therein is at the third party's sole risk. Build Change shall have no liability or responsibility for changes or alterations to these materials by others.

2

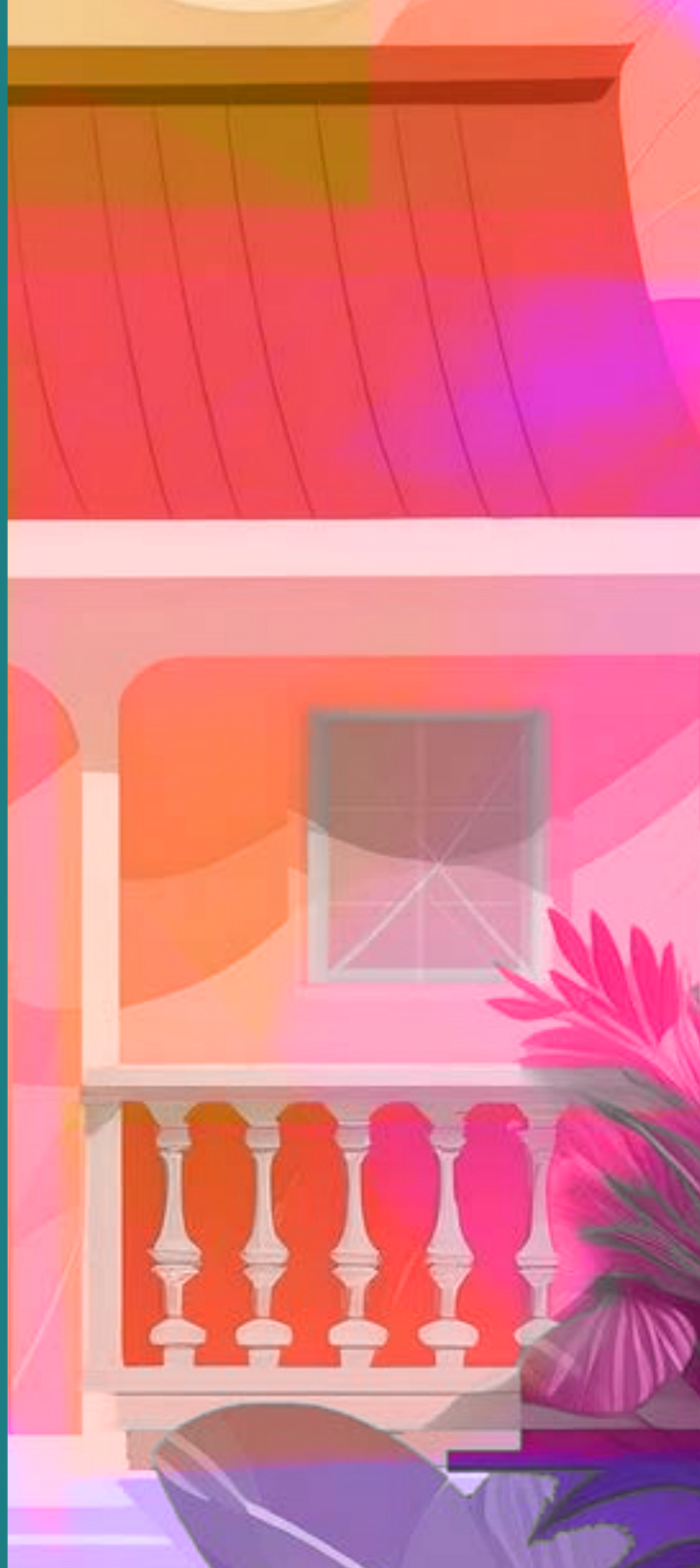
Dominica Home Retrofit Guide

STRUCTURAL RETROFIT EVALUATION AND DESIGN

2.1

Structural Retrofit Evaluation and Design

INTRODUCTION



How To Use This Chapter

Chapter 2 contains guidance on how to evaluate an existing house and how to design a structural retrofit to address any identified deficiencies.

Retrofit evaluation and design guidance is provided for each element of the building. Elements are grouped into one of five structural retrofit packages:

1. **Basic roof:** Includes roof covering condition, roof drainage.
2. **Advanced roof:** Includes roof framing, roof connection to walls, and slab roofs.
3. **Masonry walls and foundations:** Includes everything below the ring beam.
4. **Timber walls and foundations:** Includes everything below the top plate.
5. **Mixed timber and masonry houses:** Basic considerations for mixed systems.

Guidance for retrofit evaluation and design is split into **three steps** for each building element:

STEP 1: MINIMUM CRITERIA

For each element, there is a statement describing the minimum criteria for resilience. Retrofit is only required if the existing element does not meet these criteria.

STEP 2: WHAT TO CHECK

When necessary, additional guidance is provided on how to evaluate whether or not the existing structure meets the requirement. This may include example photos or investigative techniques.

STEP 3: HOW TO RETROFIT

If the element does not meet the minimum criteria, retrofit solutions are provided. Multiple options may be provided giving the user the options to select the best solution for the house.

Overview of Evaluation and Design Process

EVALUATION

DESK STUDY

Identify location of house and cross reference with available hazard maps and data to confirm the site is not in a high risk or prohibited zone. References may include: past soil investigations, flood maps, slope stability studies and maps, and land use and development plans.

SITE VISIT

Visit the site. Draw a detailed plan of the existing house and conduct a visual inspection to complete the evaluation checklist (see Annex 1).

Talk to the homeowner to understand their budget, preferences, and their experience of construction, damage and repair.

GO / NO GO

Determine whether it will be possible to retrofit the house using this guide based on the evaluation findings.

DESIGN

RETROFIT DESIGN

Based on the evaluation findings, determine the necessary retrofit packages and prescribe the retrofit interventions. Retrofit packages can be adopted progressively over time.

DESIGN REVIEW AND PERMIT

Present the proposed retrofit design and cost to the homeowner and adjust with their feedback their feedback and preferences for prioritisation as necessary.

Ensure the homeowner has a copy of the evaluation checklist and retrofit designs.

* For available hazard maps and the national land use plan, consult with the Physical Planning Division or visit: https://physicalplanning.gov.dm/land-use-and-development/maps

Unless this manual is used as part of a retrofit program with specific funding, policies and procedures, it is intended that the evaluation and design are conducted by a professionally qualified engineer or architect. The "Go/No Go" decision of whether to retrofit or not should be made by the design professional in discussion with the homeowner.

Site Visits

It is recommended that the site visit is conducted by someone with experience and expertise in structural design and construction, for example an engineer, architect, builder, or Development Control Officer.

RECOMMENDATIONS FOR SITE VISITS

- **Communicate with the homeowner**
  Schedule site visits with the occupants beforehand to ensure access and avoid wasted trips.

- **What to bring**
  - This manual
  - Evaluation checklist (see Annex 1)
  - Pencil and paper
  - Tablet or phone, with a camera and GPS
  - Tape measure / laser meter
  - Personal protective equipment
  - Level
  - Rebar detector

- **Work in Pairs**
  To optimize time efficiency during the field visit, it is recommended that the visit be conducted in teams of two people.

Build evaluations should be limited to visual inspection only!

C

Compliant:

The building meets the checklist requirement.

NC

Non-Compliant:

The building does not meet the requirement. These deficiencies must be addressed using the recommended reinforcement measures in this manual or equivalent solutions.

N/A

Not Applicable:

The statement does not apply to the building being evaluated and is not considered in the safety assessment.

Once the evaluation is complete, the engineer determines the necessary interventions to bring all "Non-Compliant" items to "Compliant" status.

2.1.1 TERMINOLOGY

This section provides definitions of the key terms used in Chapter 2.

Where applicable, these definitions are aligned with the definitions in the 2022 Building Regulations and CUBiC.

Key Terminology

GENERAL

Repair: Work undertaken to restore a building or part of a building to its condition prior to damage or deterioration, without increasing or extending any non-conformity or hazard.
Retrofit: Work carried out to improve the structural performance, safety, or resilience of an existing building beyond its original condition, including resistance to wind, seismic, or other hazards.
Permit: A written approval issued by the Physical Planning Division authorising construction, alteration, repair, or demolition work.
Engineer: A person technically qualified to design and supervise the construction of building and civil engineering structures, electrical, mechanical and sanitary installations and systems, and who is registered to practice engineering in Dominica.
Disability: Any physical or mental impairment that may restrict a person's ability to access or use a building without appropriate design provisions.
Site: A portion of land registered by title as a unit.
Flooding: The temporary inundation of land by water resulting from rainfall, river overflow, coastal surge, or surface runoff.
Landslide: A movement of a mass of rock, earth or debris down a slope.
Load path: The continuous route through which loads are transferred from the roof, floors, and walls through the structure to the foundation and ground.
Loadbearing: Any part of a building, including foundations, that supports and transfer load other than its own weight. Synonymous with structural.
Non-structural: Building elements that do not contribute to the primary load-resisting system of the building.
Out of plane: The bending or displacement of a wall or element perpendicular to its plane.
Shear: A force or deformation acting parallel to a surface or structural plane, typically induced by wind or seismic loads.
Structural: Refers to elements that form part of the building's load-resisting system and are essential to its stability and strength.

FOUNDATIONS AND SITE

Foundation: The structural element that transfers building loads to the ground.
Retaining wall: A wall constructed to retain soil at a change in ground level.
Foundation retaining wall: A structural wall forming part of a building foundation that both supports vertical building loads and retains surrounding soil.
Integral retaining wall: A retaining wall that is structurally connected to, and acts as part of, the building's load-resisting system.
Site retaining wall: A wall constructed on a site to retain soil at a change in ground level and not forming part of the building foundation.
Piers: Short isolated sections of wall with large cross-sectional dimensions relative to height that provide concentrated support for loads. May be unreinforced masonry, reinforced masonry, or reinforced concrete.
Short RC columns: Reinforced concrete columns with a low height-to-depth ratio, resulting in high stiffness and increased shear demand. Typically less than 1.5m tall.

WALLS

Confined masonry: Masonry wall construction in which unreinforced masonry panels are confined by reinforced concrete tie columns and beams.
Reinforced masonry: Masonry wall construction incorporating steel reinforcement embedded in mortar or grout.
Unreinforced/unconfined masonry: Masonry construction without embedded steel reinforcement and without reinforced-concrete confining elements such as tie columns or ring beams.
Isolated column: A single column supported by an individual footing and not forming part of a frame or wall system.
Lintel: A horizontal structural member spanning an opening and supporting loads above it.
Opening: Any void or penetration in a wall, including doors, windows, or vents.
Plaster: A cementitious, lime-based, or gypsum-based coating applied to walls or ceilings for finish, protection, or fire resistance.
Ring beam: A reinforced concrete beam continuous above

Key Terminology

interior and exterior masonry walls to tie the structure together and distribute lateral loads.
Shear wall: A wall designed to resist lateral forces acting parallel to its plane, such as wind or seismic loads.
Sill plate: A horizontal structural member anchored to a foundation or slab that forms the base of timber stud wall construction above. May also refer to the horizontal timber element above a reinforced concrete ring beam that is used to connect timber rafters to the walls.
Solid wall length: The total length of a wall that is without openings. May be made up of multiple wall segments.
Top plate: The uppermost horizontal member of a timber stud framed wall to which roof framing is attached.
Wall studs: Vertical framing members forming the primary structure of a timber wall.

ROOF

Collar tie: A horizontal tension member connecting opposing rafters in the upper portion of a roof.
Eaves: The lower edge of a sloped roof that projects beyond the exterior wall to provide weather protection.
Fascia board: A horizontal board fixed to the ends of rafters or trusses at the eaves, forming the roof edge and providing support for gutters.
Flashing: Thin sheet metal or flexible waterproofing material installed at joints or transitions in roofs and walls to prevent water penetration.
Gable wall: The triangular or rectangular portion of wall situated between sloped roof framing and the ring beam or top plate.
Hip: The external sloping intersection formed where two roof surfaces meet, running from the ridge down to the eaves.
Purlin: A horizontal roof framing member installed perpendicular to rafters or trusses to support roof sheathing or roofing materials.
Rafter: Inclined framing members in roof construction that extend from the eaves to the ridge or hip ridge.
Ridge board: A horizontal structural board located at the apex where opposing rafters meet; it provides alignment and nailing support for rafters but is not a primary load-carrying member.
Sheathing: Boards or panels fixed to framing members to provide a substrate for finishes or to contribute to structural performance.
Sister rafter: An additional rafter fixed alongside an existing rafter to strengthen or repair it.
Truss: A prefabricated structural assembly of interconnected members designed to act as a single unit to support loads. Typically used for larger spans which cannot be achieved by rafters.

GENERAL BUILDING

Bracing: Structural elements (diagonal members, sheathing, straps, or rigid panels) designed to resist lateral forces and maintain the stability of a structure.
Cantilever: A structural member that is fixed or supported at one end only and extends beyond that support to carry loads.
Spacing: The center-to-center distance between adjacent elements, for example between rafters or floor joists.
Car port: A covering area for sheltering a motor vehicle, not fully enclosed by walls.
Fasteners: Mechanical devices used to connect building components. For example, nails, screws, bolts, anchors, straps, or clips.
Joist: A horizontal structural member used to support floors or ceilings.
Ledger: A horizontal structural member attached to a wall or beam for the purpose of supporting joists, rafters, or similar framing members.
Masonry: Construction using individual units such as concrete blocks, bricks, or stones laid in mortar.

2.1.2 PREREQUISITES

The structural retrofit evaluation and design criteria presented in Chapter 2 are based on calculation assumptions for the size and condition of the existing house. These assumptions are listed here as prerequisites. If the house does not meet the prerequisites, it is recommended that an engineer is consulted. A custom design solution with additional calculations may be required that is beyond the prescriptive recommendations in this guide.

In many cases these prerequisites will also help guide the user away from retrofits that are impractical or excessively costly. While it is technically possible to repair and retrofit houses in almost any condition, it is not always practical or cost effective to do so.

This section should be reviewed to confirm applicability of the house before proceeding with the full evaluation checklist in Annex 1 and any retrofit design packages.

Retrofit Prerequisites - Masonry Houses

SITE HAZARDS
(Refer to chapter 3 for details)

- The house is not in a high risk zone for landslides
- Retaining walls meet the criteria for configuration and condition
- The house is not in a high risk zone for coastal or river flooding

CONFIGURATION

NUMBER OF STOREYS:

- **Maximum 2 storeys for masonry houses founded on grade.** Full or partial-height reinforced concrete columns, with or without bracing or infill walls, are considered as one storey.
- Maximum 1 storey for masonry houses on pier foundations.

BUILDING SHAPE AND WALLS CONFIGURATION:

- **Regular plan**. Rectangular or squared, or with small reentrant corners.
- **Distance between parallel structural walls:**
  - One storey building, any roof type: maximum 13ft (4m)
  - Two storey building, galvanise roof: maximum 11.5ft (3.5m)
  - Two storey building, slab roof: maximum 10ft (3m
- Height of walls maximum 12ft (3.6m)
- **Walls are continuous across storeys. Balconies are adequately supported by shelves or beam.**

FOUNDATIONS

HOUSES ON GRADE:

- **Visible foundations are stone with cement mortar, mass concrete or reinforced concrete strip footings.** They are continuous under all interior and exterior walls. There is a continuous reinforced concrete plinth beam at the base of all walls and column reinforcement is dowelled into the foundation.

HOUSES ON COLUMNS:

- **The reinforced concrete (RC) columns are maximum 13ft (4m) tall and minimum 8" x 8" (20cm x 20xm) section**.

  Their reinforcement is anchored into the suspended house slab.

HOUSES ON PIERS:

- **Piers are constructed of stone, block masonry, or concrete,** with a maximum height above grade of 4ft (1.2m).

Retrofit Prerequisites - Masonry Houses

MATERIALS

WALLS:

- **Blocks:** concrete masonry units - 6" typical thickness- with cement-based mortar. Walls might be plastered.
- **Reinforcement**: walls might be confined with tie-columns and beams and, in some locations (e.g. around window openings) they might be reinforced with bars grouted.
- **Timber:** All timber is Southern Pine No. 2, or any other species with equivalent or greater structural design properties. For tabulated values of alternative species, refer to the American Wood Council National Design Specification for Wood Construction.

ROOF:

- **Galvanise roofs:** Lightweight, sloped roofs are framed with timber elements connected with metal fastenings and covered with wood or asphalt shingles, or galvanize metal sheets.
- **Roofing:** typically made with CGI or shingles.
- **Slab Roof:** solid flat slab, made with reinforced concrete, with or without a sloped screed or water proof membrane.

DAMAGE STATE

HOUSES ON GRADE:

- **Walls:** No severe damage observed. If severe, demolition and reconstruction may be preferable.
- **Columns/Piers (house supports):** No visible settlement. *(Note that while no visible signs of settlement generally indicates good slope stability and foundation performance, it is not a guarantee. Further investigation may be required - refer to Chapter 3 for details).*
- **Roofs (lightweight or slab):** Any damage level can be repaired using this manual. (Severe damage may require demolition and reconstruction per these guidelines).
- **Interstory/Suspended Slabs:** Should not have severe damage. If present, demolition and reconstruction are required, with specific provisions for temporary propping and stability not covered by this manual.
- **Concrete Elements (e.g., beams, columns, piers):** Damage may require repair (general repair techniques are included in this manual) and the house retrofitted.

Retrofit Prerequisites - Timber Houses

CONFIGURATION

NUMBER OF STOREYS:

- **Maximum 1 storeys houses, founded on grade or raised on piers.**

BUILDING SHAPE AND WALLS CONFIGURATION:

- **Regular plan.** Rectangular or square, or with small reentrant corners.
- **Distance between parallel structural walls maximum 11.5 ft (3.5m). Height of walls 8ft (2.4m) max.**

DAMAGE STATE:

- If more than 50% of the timber elements in the walls and floors are damaged, rotten, infested, retrofit is not recommended and new build shall be considered instead.

FOUNDATIONS

HOUSES ON GRADE:

- **Visible foundations are stone with cement mortar, mass concrete or reinforced concrete strip footings.** They are continuous under all interior and exterior walls.
- **Alternatively, the house is founded on an RC slab** on grade, thickened below walls.

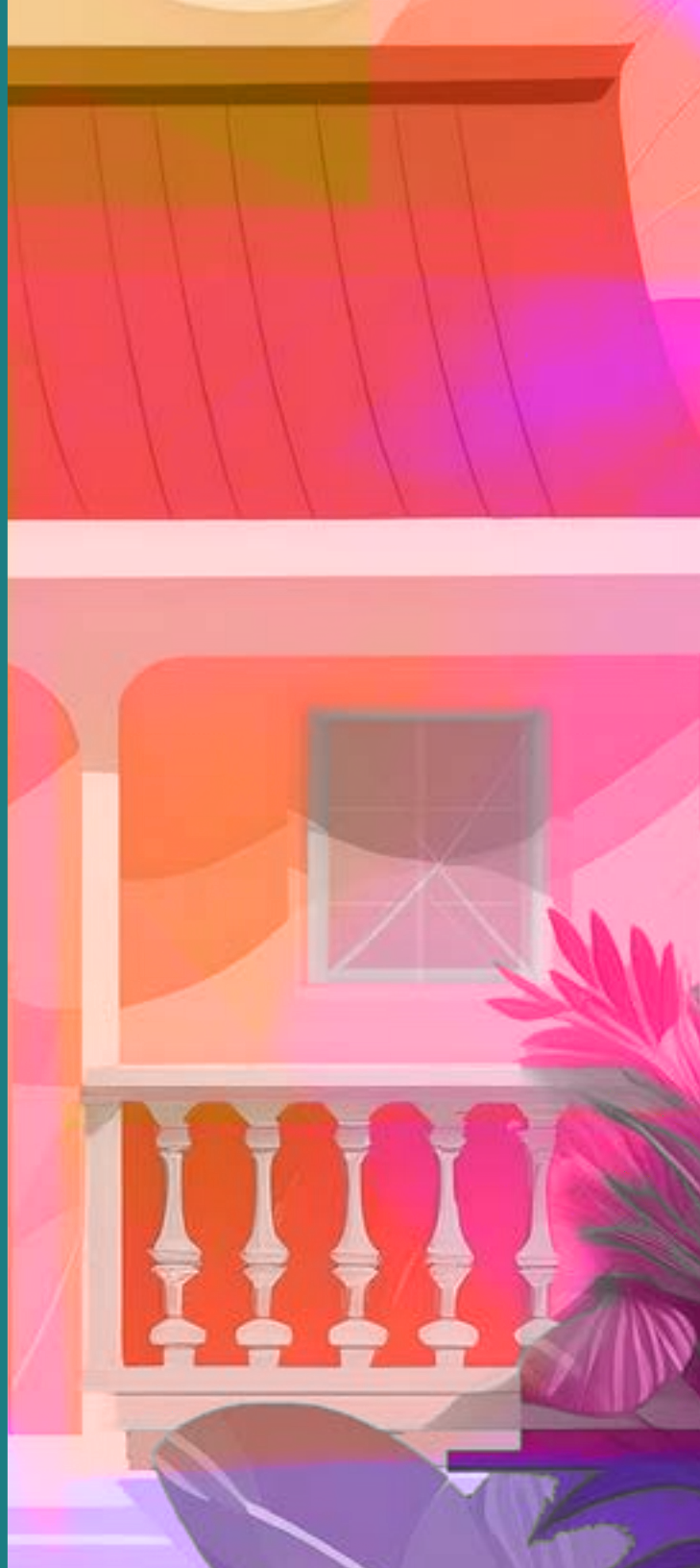
HOUSES ON PIERS:

- **Piers are constructed of stone, block masonry, or concrete,** with a maximum height above grade of 4ft (1.2m).
- The timber superstructure is adequately anchored to the piers to prevent uplift or sliding.

2.2

Structural Retrofit Evaluation and Design

ROOF PACKAGES



2.2.1 BASIC ROOF

The basic roof package addresses vulnerabilities in the roof covering and drainage.

During the 2024 national survey of existing housing, roof coverings and drainage were identified as highly vulnerable in 44 percent of houses. However, a basic roof retrofit is often quick and cost effective.

Note that if more than 25 percent of the roof is replaced, a building permit is required under Clause 103.4 of the 2022 Building Regulations.

Covering: **Galvanise Sheets**

MATERIAL

- Roofs are covered in galvanised metal sheets (minimum gauge 24, recommended minimum profile depth 7/8" (22mm).
- There are no plastic panels (including polycarbonate sheets), tarps, or other types of non-structural materials.
- The roof sheets are in good condition, and there are no signs of leakage.

WHAT TO CHECK

HOW TO RETROFIT

Replace damaged panels (or panels that are not compliant with the minimum material specifications).

- Minimum overlap of sheets: Ends = 10" (25cm); sides = 6" (15cm). Add butyl sealant tape between sheets at all side and end laps.
- Maximum cantilever beyond timber elements = 2" (5cm).

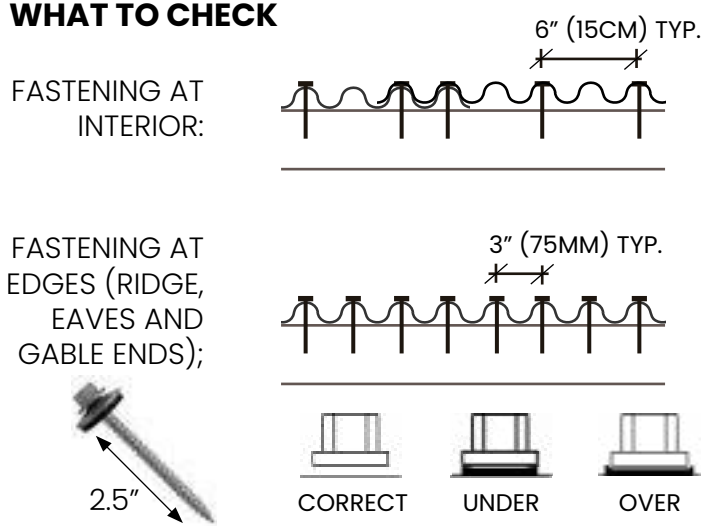
Source: https://www.youtube.com/watch?v=ksD4nKXKmMU

Covering: **Galvanise Sheets**

FASTENERS

- The galvanised sheets are connected to the supporting structure with #9 roof screws (2 ½" long, with a neoprene washer) every 3" (75mm) at the eaves, ridge, hip ridges and gables ends, and every 6" (150mm) in the interior area of the roof (or according to manufacturer specifications).
- Fasteners are placed on the upper side of the roof panel wave.

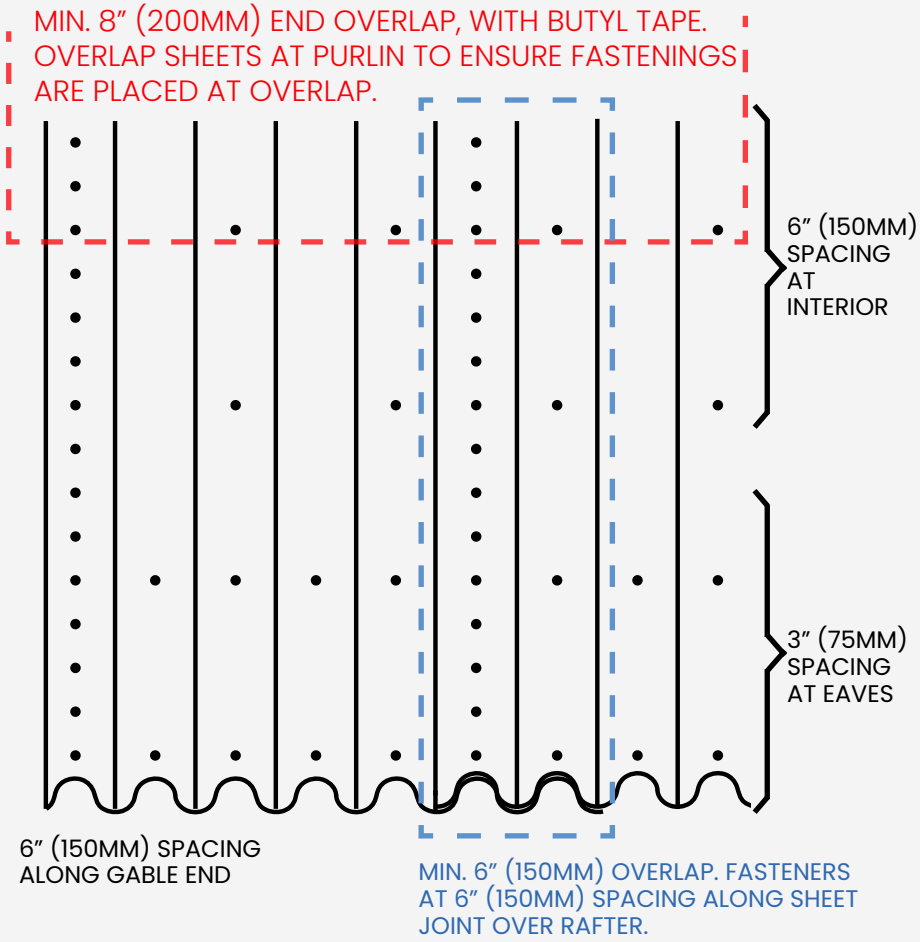
WHAT TO CHECK



DO NOT OVER- OR UNDERTIGHTEN ROOF SCREWS!

HOW TO RETROFIT

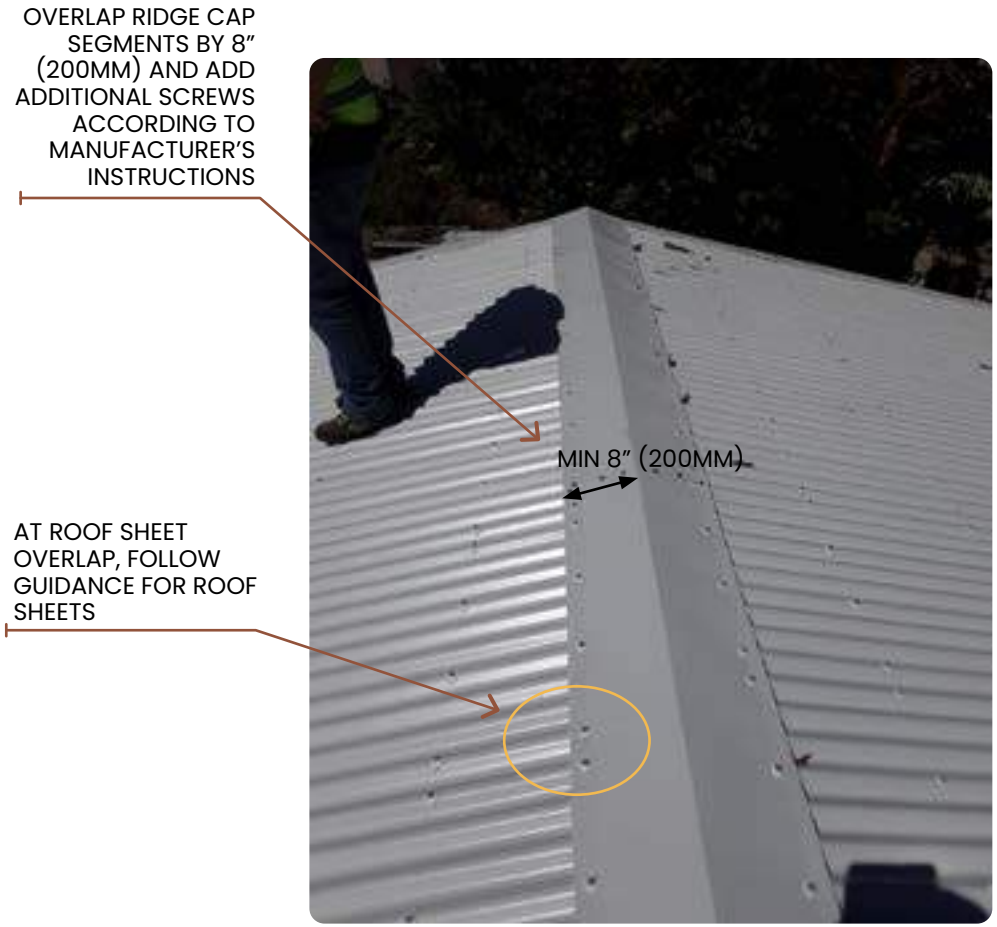
Install new fastenings as required to meet minimum requirements.



Covering: **Galvanise Sheets**

RIDGE CAP

- The ridge cap is a metal element, min. gauge 24.
- It is installed with #9 roof screws (2 ½" long and neoprene washer) located every 3" (75mm).
- The ridge cap overlaps the roof sheets by at least 8" (200m) on each side and is installed with waterproof sealant tape such as Flashband below (unless otherwise specified by manufacturer).



Covering: **Asphalt Shingles**

ASPHALT SHINGLES

Roof slope

Roof slope is less than 2:12 (17%, 10°) [CUBIC 3.626.11 *(slopes less than 4:12 (33%, 18%) not recommended).* For shallow slopes where the homeowner also reports leaks, recommend switching to a galvanized metal roof covering.

Sheathing

- Sheathing has a minimum thickness of." (12mm) and is connected to the supporting structure with 8d nails (ring shank recommended) at:
  - 6" (15cm) centres on all sides and end laps,
  - 12" (30cm) centres horizontally and vertically between laps.

Underlayment and Shingles:

- Minimum two layers of No.15 bituminized felt (or
- similar) underlayment required [CUBIC 3.626.11].
- Underlayment laid parallel to and starting from the eave and lapped 4" (5cm), end laps 6" (15cm) with fasteners at:
  - 6" (15cm) centres on all sides and end laps,
  - 12" (30cm) centres horizontally and vertically between laps.

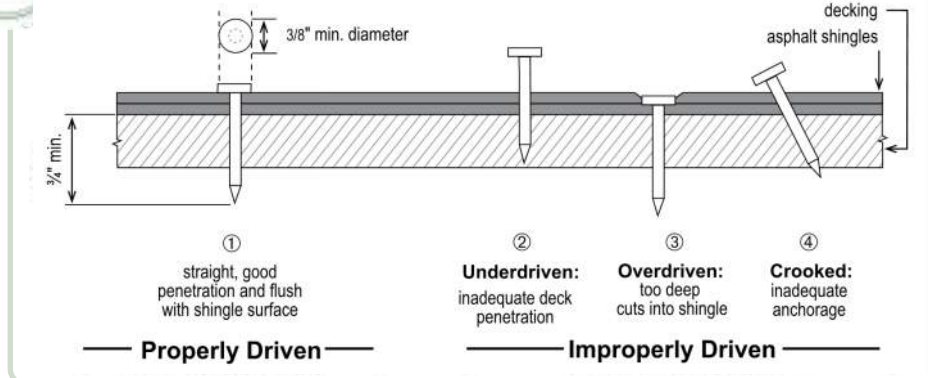
Note: Recommendations from the 2023 Florida Building Code, Residential, and the FORTIFIED Program by the Insurance Institute for Business & Home Safety.

- Recommend that shingles are hurricane rated to ASTM D7158 Class H or ASTM D3161 Class F.

Shingle and Underlayment Fasteners:

- Nails are annular ring or deformed shank, galvanized or stainless steel, roofing nails.
- Minimum gauge 12 (0.105", 2.7mm) shank with 3/8" (9.5mm) diameter head. Recommended 1" (25mm)button caps.
- Length must be thickness of shingles and underlay, plus minimum **3/4"** (19mm) embedment into the sheathing below.
- Minimum two nails per shingle, or more if specified by manufacturer.
- **Staples are not permitted.**

WHAT TO CHECK



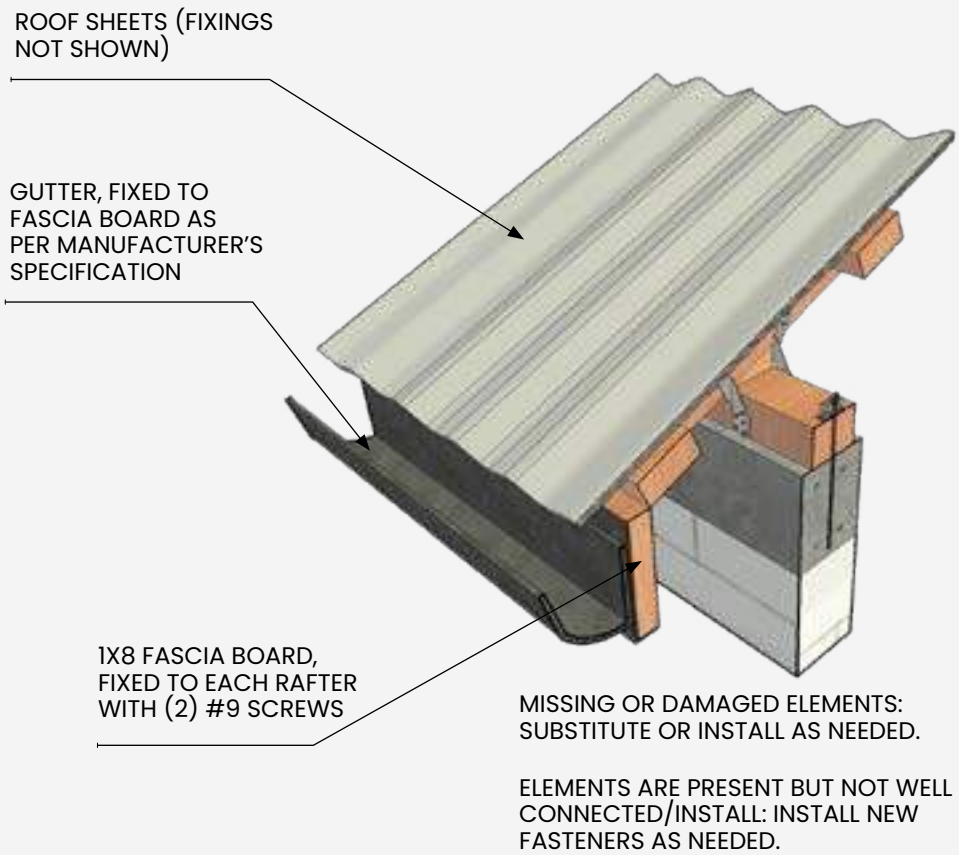
SOURCE: RESIDENTIAL ASPHALT ROOFING MANUAL DESIGN AND APPLICATION METHODS 2022 EDITION, ASPHALT ROOFING MANUFACTURERS ASSOCIATION

Waterproofing and Drainage

FASCIA BOARD AND FLASHING:

- There is a 1” x 6” or 1” x 8” fascia board at the eaves of roof, nailed to each rafter end with minimum 2 x #9 2.5” screws.
- There is a metal flashing or drip edge above the fascia board to prevent leaks and water damage.

HOW TO RETROFIT



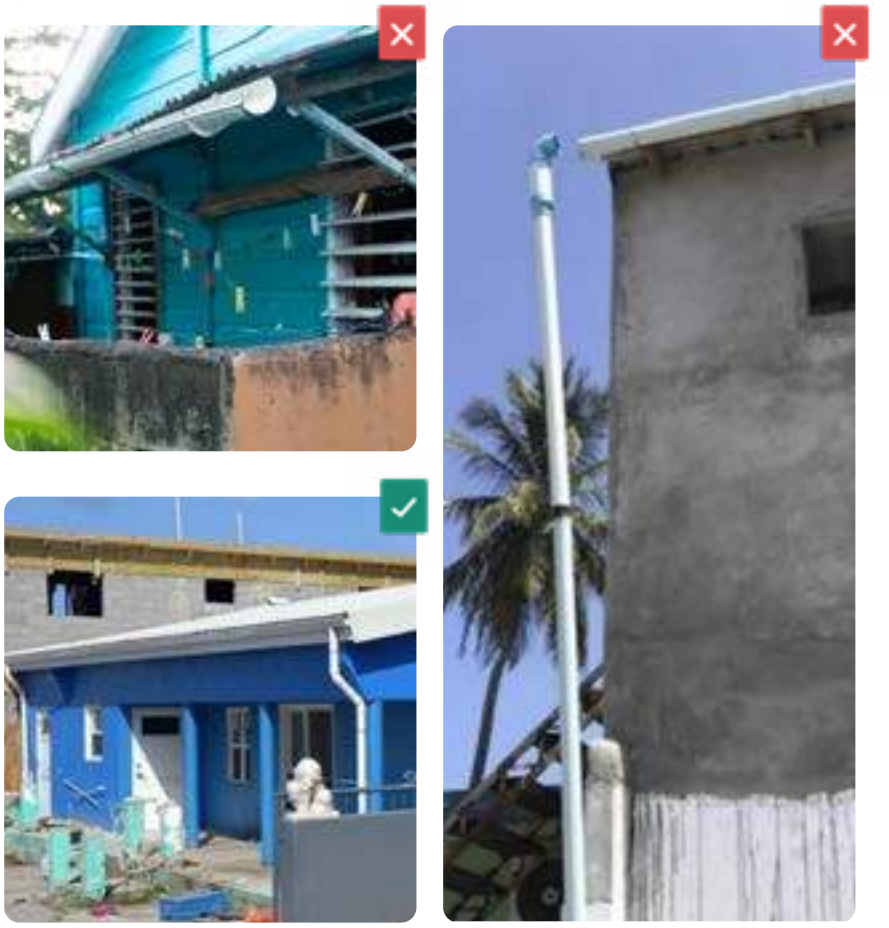
WHAT TO CHECK

Waterproofing and Drainage

GUTTERS AND DOWNSPOUTS

- Are present and in good condition. They have a minimum diameter of 4" (10cm).
- Gutters are positioned with a minimum slope of 0.5% (1/8" per foot).
- Gutter joints are overlapped and sealed.
- Gutters are supported on brackets fixed to the fascia every 18" (45cm). Brackets are also placed at both ends of every gutter section, at every joint between gutter lengths, next to corners, and at every downspout connection.
- Downpipes are well fixed to the walls with brackets at a maximum distance of 3ft (1m).

WHAT TO CHECK



HOW TO RETROFIT

- Missing or damaged elements: **substitute or install as needed.**
- Elements are present but not well connected/install: **install new fasteners as needed.**

2.2.2 ADVANCED ROOF

The advanced roof package addresses vulnerabilities in the roof framing and connections.

Advanced roof retrofits are critical for reducing disaster risk, particularly for hurricanes. During the 2024 national survey of existing housing, roof framing and connections were identified as highly vulnerable in 78 percent of houses.

This section 2.2.2 guides the user through evaluation and retrofit design for a timber framed roof with light covering.

Masonry houses: **Ring Beam**

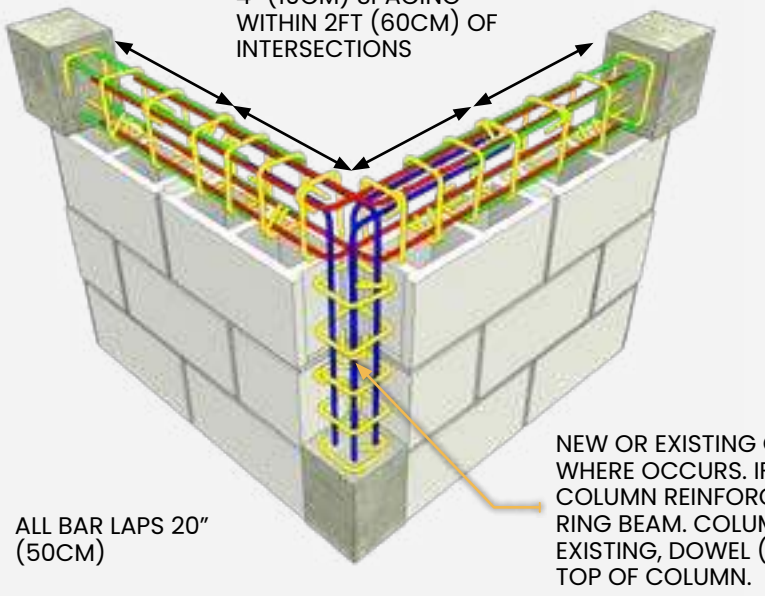
RING BEAM

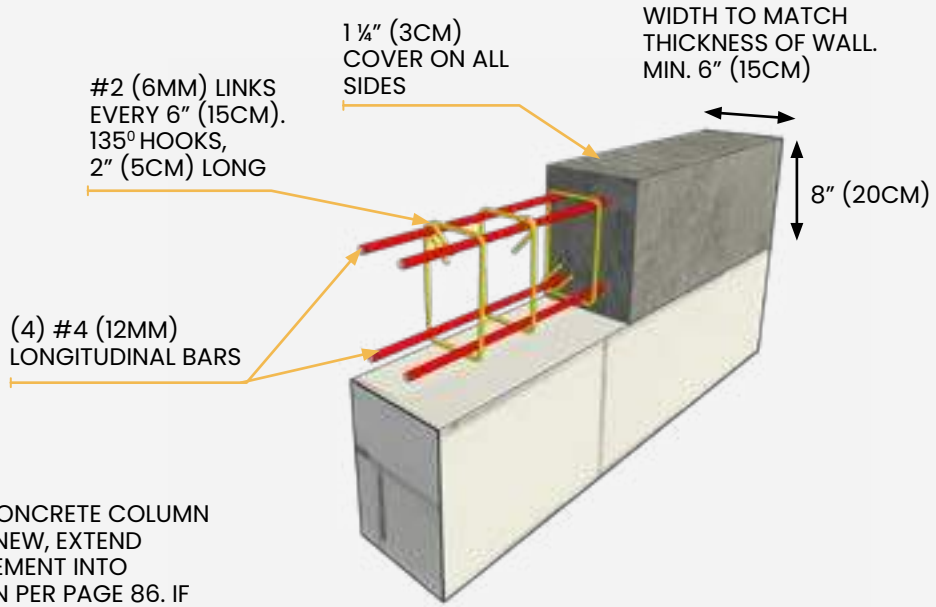
There is a continuous reinforced concrete ring beam above all masonry walls.

HOW TO RETROFIT

Build a new ring beam where necessary, in accordance with 2022 Building Regulations 1504.4:

- Build ring beam where necessary.
- Height: 8" (20cm) minimum,
- Width: matching the thickness of wall.
- 4 x 1/2" longitudinal bars and ¼" closed links at 6" (15cm) typical spacing along ring beam and at 4" (10cm) spacing close to the joints.





Masonry houses: **Roof Framing Connection to Ring Beam**

ROOF TO RING BEAM CONNECTION:

There is a sufficient load path from the roof framing to the wall ring beam or top plate via connection hardware, straps, wall plates, bolts. They are stabilized out of plan by a spine gable wall.

HOW TO CHECK CONNECTIONS:

Acceptable existing connections between roof framing and ring beam include:

Metal fasteners *(e.g. hurricane clips, metal straps)* connecting the rafter to a sill plate bolted to the ring beam.

Rafters cast into concrete above the ring beam with a continuous dowelled bar.

Unacceptable connections between roof framing and ring beam include:

Rafters supported on the ring beam **without reinforcement or fasteners.**

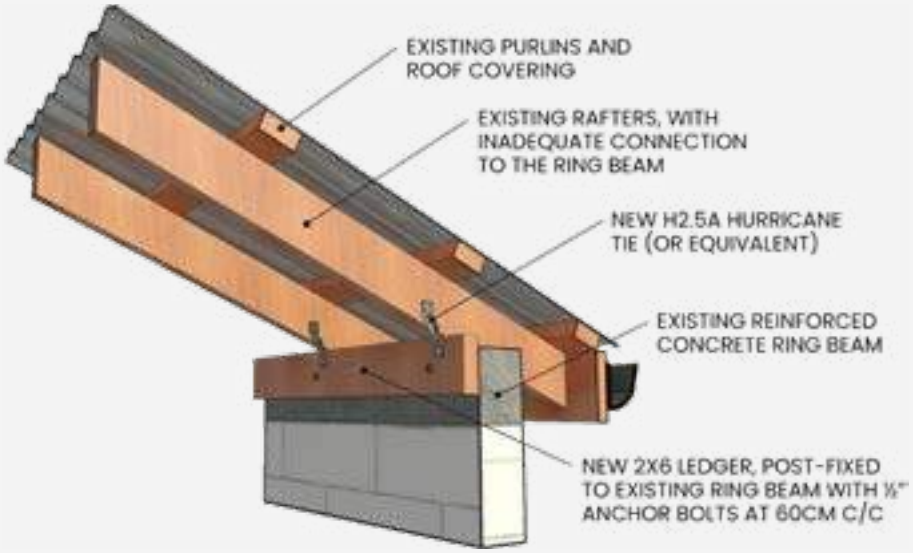
Rafters connected to the ring beam **with non-engineered hooks.**

Masonry houses: **Connections to Ring Beam**

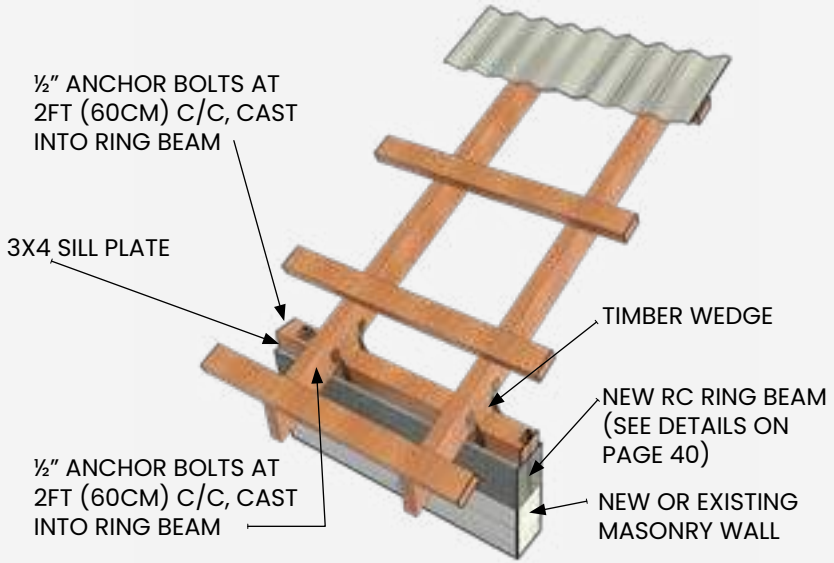
HOW TO RETROFIT

Install new connection hardware as required.

1. **Strengthen connection to an existing ring beam using a ledger:**
   - Ledger dimensions: 2" x 6".
   - Ledger connection: ½" anchor bolt at 24" (60cm) on centre, post fixed to existing beam.
   - Rafters to ledger connection: 2 x hurricane clips per rafter *(as per manufacturer's specifications, as a reference 2 x RT7a from Mitek).*



2. **Strong connections when building a new RC ring beam (sill plate connection):**
   - Sill plate dimension: minimum 2" x 4" (3" x 4" recommended).
   - Sill plate connection: ½" anchor bolt at 24" (60cm) on centre cast into ring beam.
   - Rafters or trusses to sill plate connection: 2 x hurricane clips per rafter *(Simpson Strongtie H2.5A, or equivalent).*



Timber houses: **Top Plate**

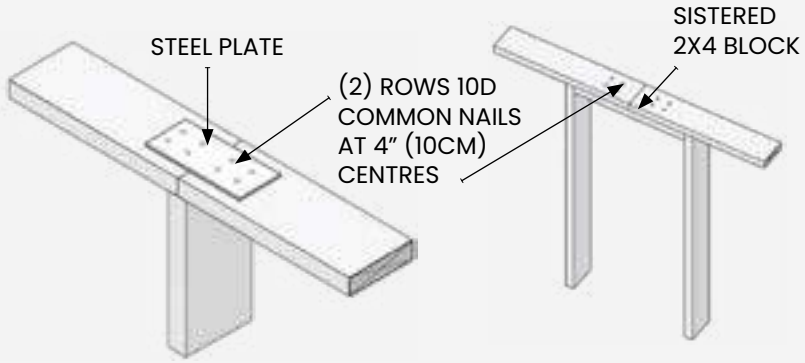
TOP PLATE:

- There is a continuous double 2" x 4" (or 4" x 4") top plate at the top of all walls that connects perpendicular walls.
- The plates are lapped at splices and wall intersections and are in fair condition.

HOW TO RETROFIT

Single 2x4 or inadequate laps:

- Add double 2x4, or
- Add splices at all intersections via a steel plate or a 2x block sistered to the underside of the top plate between studs with (2) rows of 10d common nails at 4" (10cm) centres (minimum (4) nails per block) [2022 Building Regulations 1406.10]



HOW TO CHECK TOP PLATE

Timber houses: **Connections to Top Plate**

ROOF TO TOP PLATE CONNECTION:

- There is a **sufficient load path** from the roof framing to the walls via connection hardware, straps, wall plates, or bolts.

HOW TO RETROFIT

Install new connection hardware as required.

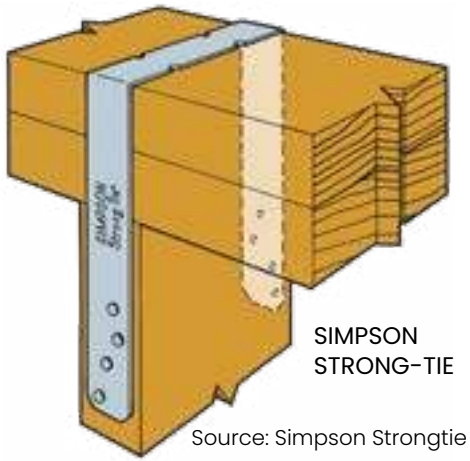
HOW TO CHECK CONNECTIONS:

- Check rafters (or trusses) are connected to the top plate with hurricane ties placed as close as possible to wall studs.
- Use Simpson Strongtie H2.5A ties or equivalent. **Ensure the manufacturers installation instructions are followed.**

Source: Simpson Strongtie

H6 STUD
TOP PLATE
INSTALLATION.

Source: Simpson Strongtie



SIMPSON
STRONG-TIE

Source: Simpson Strongtie

- Check wall studs are connected to the top plate with hurricane straps or metal connectors.
- Use Simpson Strongtie TSP or SP4 ties. Alternatively, use strap gauge 20 (minimum), length

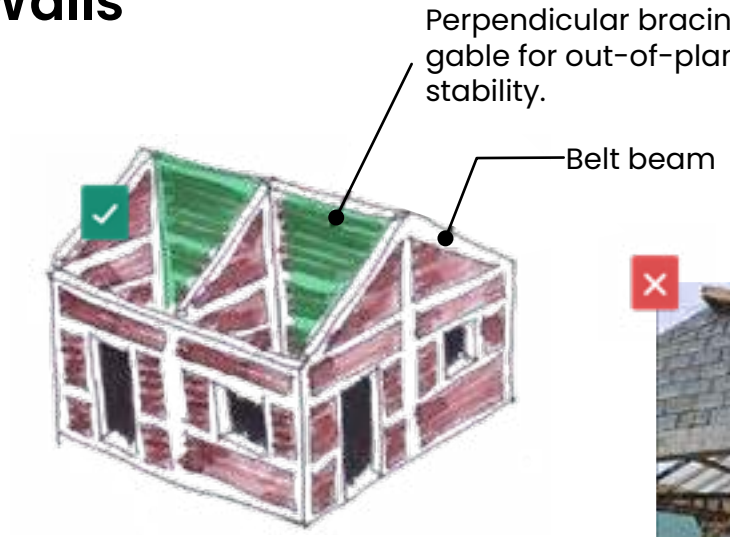
Masonry Houses: **Gable End Walls**

MASONRY GABLES:

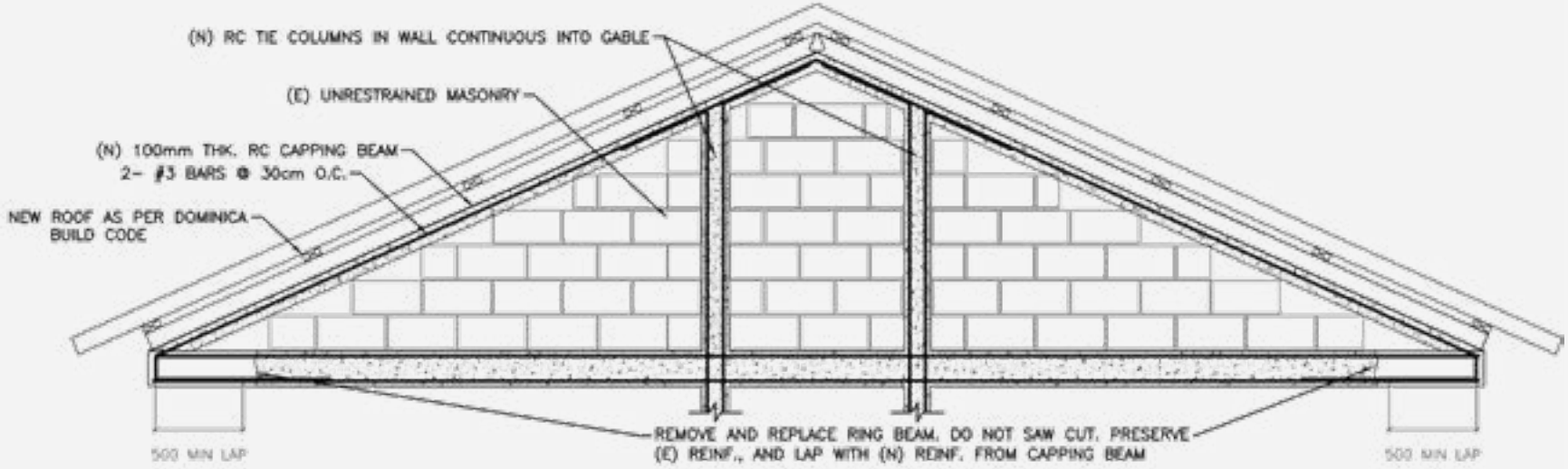
Existing masonry gables are less than 5ft (1.5m) tall.

When taller than 15" (40cm, 2 courses), they are internally reinforced or confined with tie columns and belt beam.

They are stabilized out of plan by a spine gable wall.

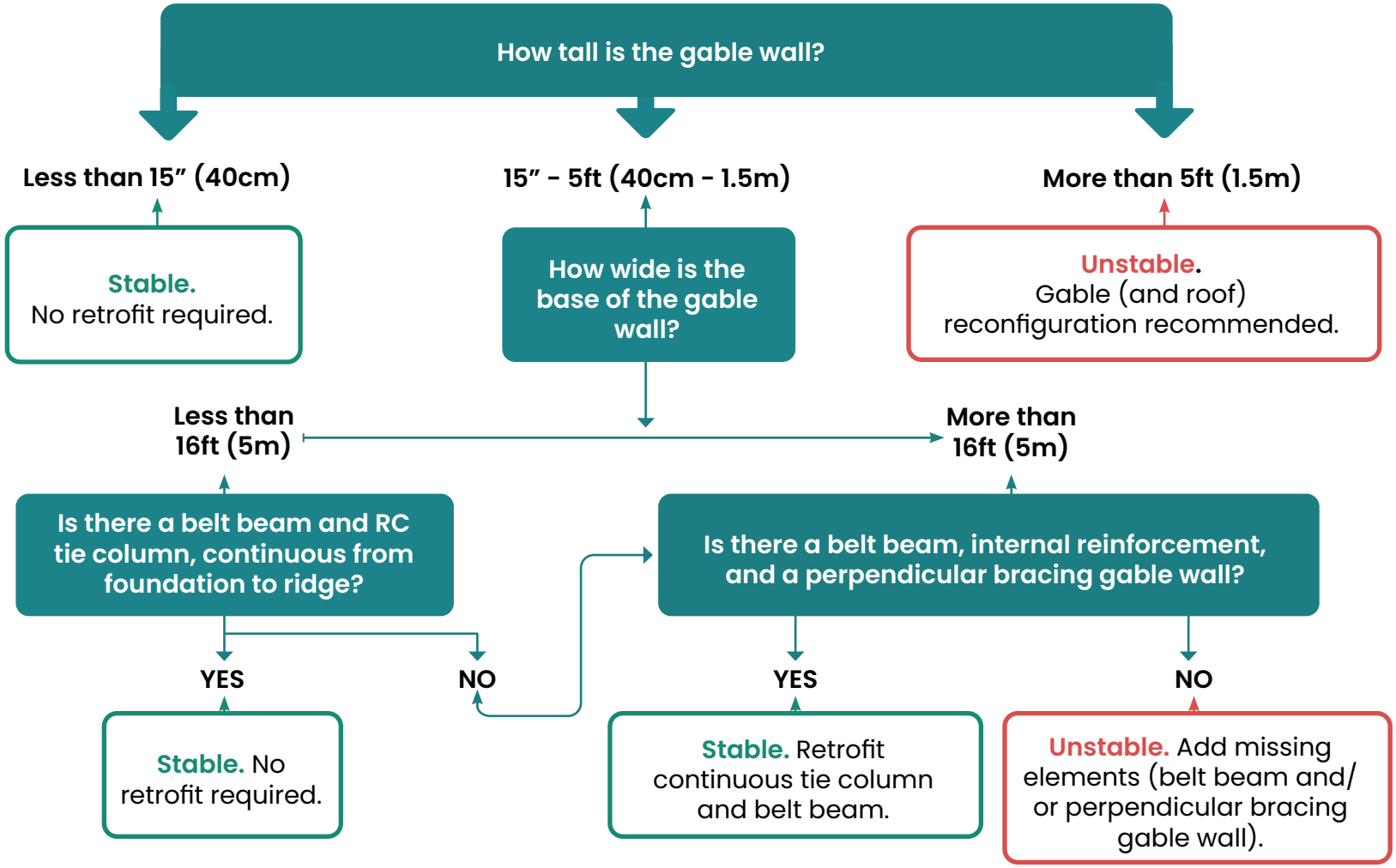


HOW TO RETROFIT



Masonry Houses: **Gable End Walls**

HOW TO CHECK EXISTING GABLES



Timber houses: **Gable End Walls**

TIMBER GABLE WALLS:

Timber gable walls: Vertical studs (2" x 4" minimum) every 2ft (60cm) connected to an inclined double 2" x 4" (or 4" x 4") beam with metal straps.

Timber gables are connected to the top plate of the timber wall with hurricane clips (every 3ft (90cm) max).

HOW TO CHECK CONNECTIONS:

TIMBER GABLES POSSIBLE RETROFIT ACTIONS:

- Install additional vertical studs (2" x 4") to reduce the spacing to a maximum of 2ft (60cm) on centre.
- Replace or strengthen exterior sheathing or plywood securely nailed or screwed to the vertical studs (8d nails at 4" (10cm) centres along posts and plates).
- Install diagonal braces (2" x 4" or larger timber) between the vertical studs and the ring beam to provide out-of-plane stability.
- Consider adding cross-bracing (X-shaped braces) between the vertical studs to resist wind and seismic forces more effectively.
- Use metal straps at critical joints to improve bracing performance.

Roof Framing

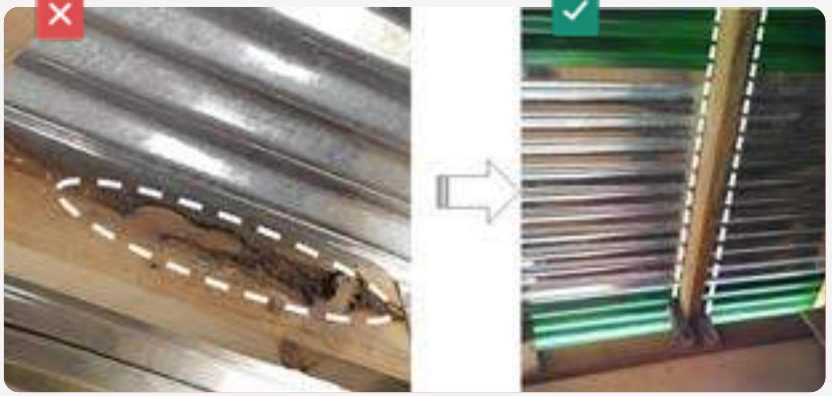
CONDITION

- Timber roof elements show no signs of breakage, damage, termite infestation, or rot.

WHAT TO CHECK

HOW TO RETROFIT

Replace damaged elements:



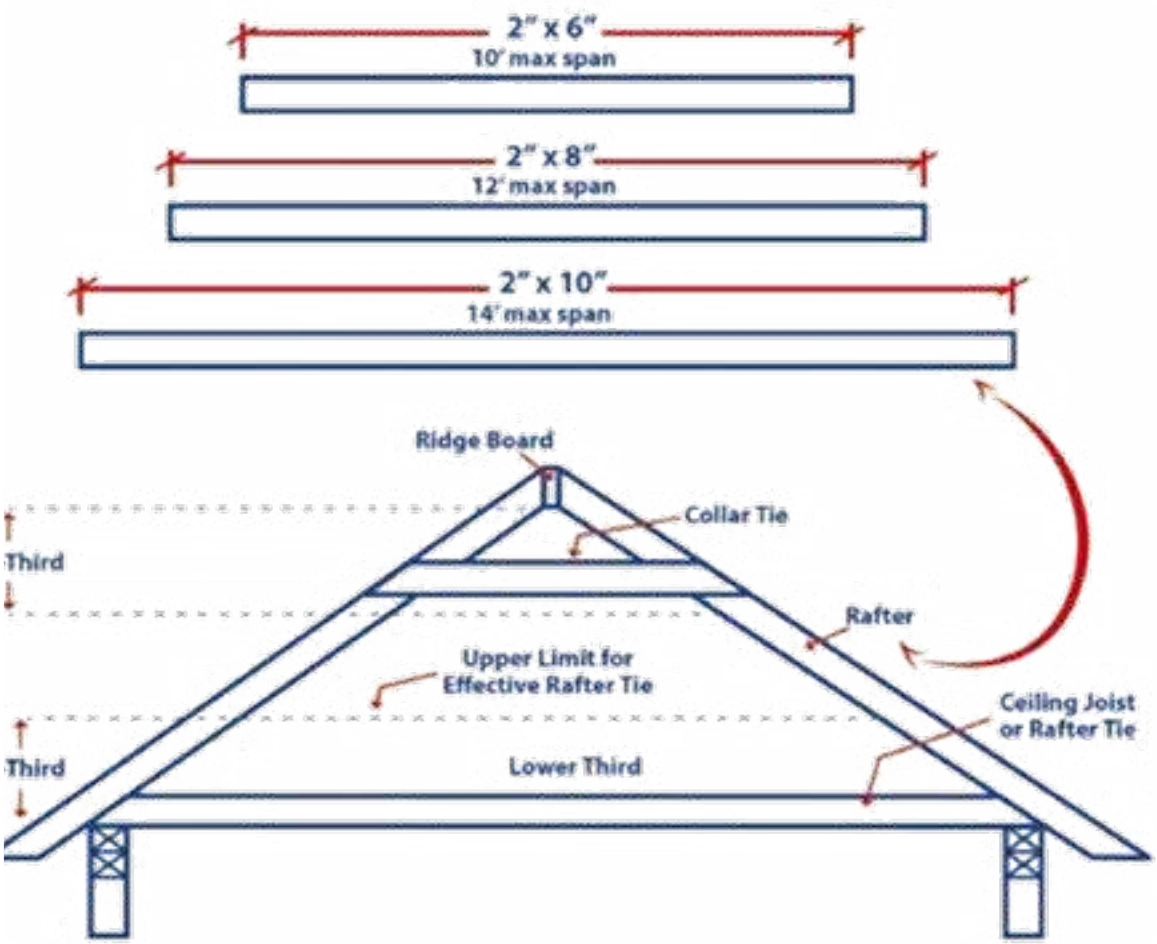
Roof Framing & Connections

MEMBERS AND CONNECTIONS:

The size and spacing of timber roof framing elements **meet the minimum standards outlined in the Guide to Dominica's Housing Standards**.

Roof elements are adequately connected with a sufficient number of nails and metal hurricane straps/clips, or with screws.

BASED ON 24" SPACING



HOW TO CHECK

Roof framing members meet the following minimum requirements:

- Ridge board: 2x8
- Hip rafters: 2x8
- Rafters: Refer to table on page 50
- Collar tie: 2x4, placed within top third of roof height

General Configuration

Dominica (160 mph wind speed)

ROOF JOIST/ RAFTER SPAN #2

SPACING	10' or less	12'	14'	16'	18'	20'
12" o.c.	2 x 6	2 x 6	2 x 6	2 x 8 / 3 x 6	2 x 8 / 3 x 6	2 x 10
16" o.c.	2 x 6	2 x 6	2 x 8 / 3 x 6	2 x 8 / 3 x 6	2 x 10	2 x 10
19.2" o.c.	2 x 6	2 x 8 / 3 x 6	2 x 8 / 3 x 6	2 x 10	2 x 10	None
24" o.c.	2 x 6	2 x 8 / 3 x 6	2 x 10	2 x 10	None	None

HOW TO RETROFIT:

1

Install new ceiling joists:

- As well as supporting the ceiling, ceiling joists also provide important lateral stability to the roof framing, particularly in timber wall structures or in masonry structures with very shallow roofs (slope less than 1.5 : 12 (7°).
- Ceiling joists should be connected to the top plates at the eaves and any interior wall line with metal clips.

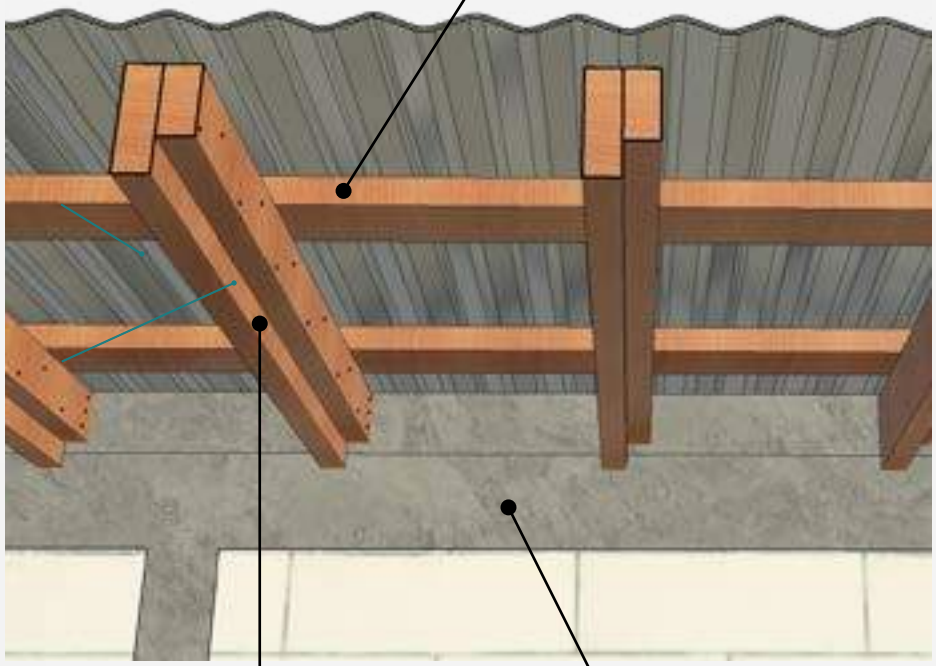
Roof Framing & Connections

HOW TO RETROFIT:

2

Strengthen the framing:

- If rafters are spaced wider than 2ft (60cm) or are less than the minimum size required for the span, sister a new rafter.
- New sister rafters should meet the span requirements (see Page 50), be at least 2"x6", and may be up to 2" deeper than the existing rafters.
- Sister rafters do not need to be connected to the ring beam or ridge if the existing rafter already has an adequate connection.



Roof Framing & Connections

HOW TO RETROFIT:

3

Strengthen the ridge connection:

Option 1: Add a metal strap

- If the roof covering **is also** being replaced, add straps over the rafters and ridge board to resist the uplift and other tension forces.
- Ensure there are also toe nails between the rafters and ridge to resit gravity loads.

ROOF SLOPE	RAFTERS MAX SPAN (FT)	NUMBER OF 8D COMMON NAILS IN EACH SIDE OF METAL STRAP
3:12 to 4:12	12	6
	16	8
5:12 to 12:12	12	4
	16	6

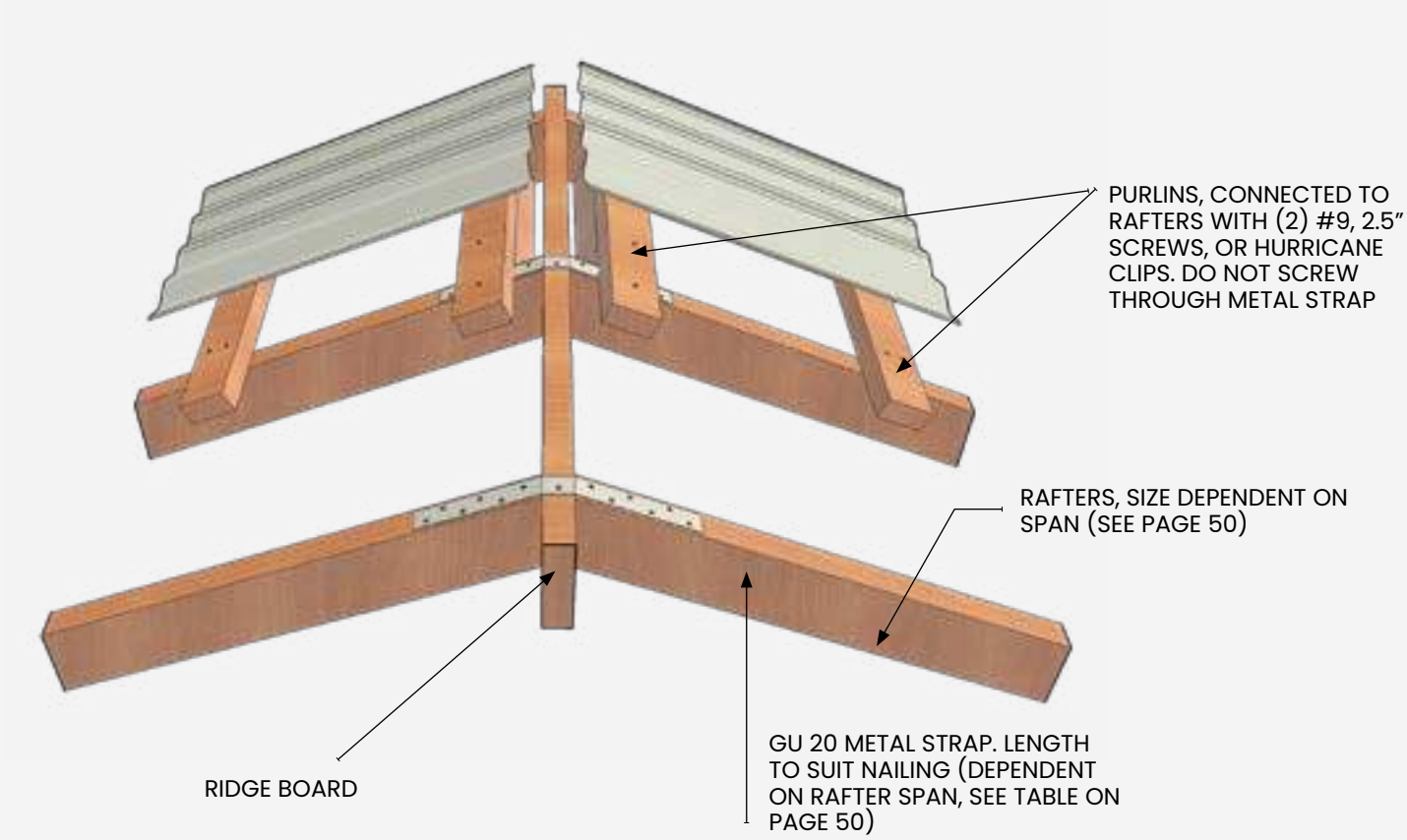
Table notes:

- Extract from table A 3.6 of 2018 American Wood Council Wood Frame Construction Manual.
- Assumed design wind speed =160 mph (3-sec gust), Exposure C.
- Assumed distance between rafters = 2ft (60cm).

Roof Framing & Connections

HOW TO RETROFIT:

3



Roof Framing & Connections

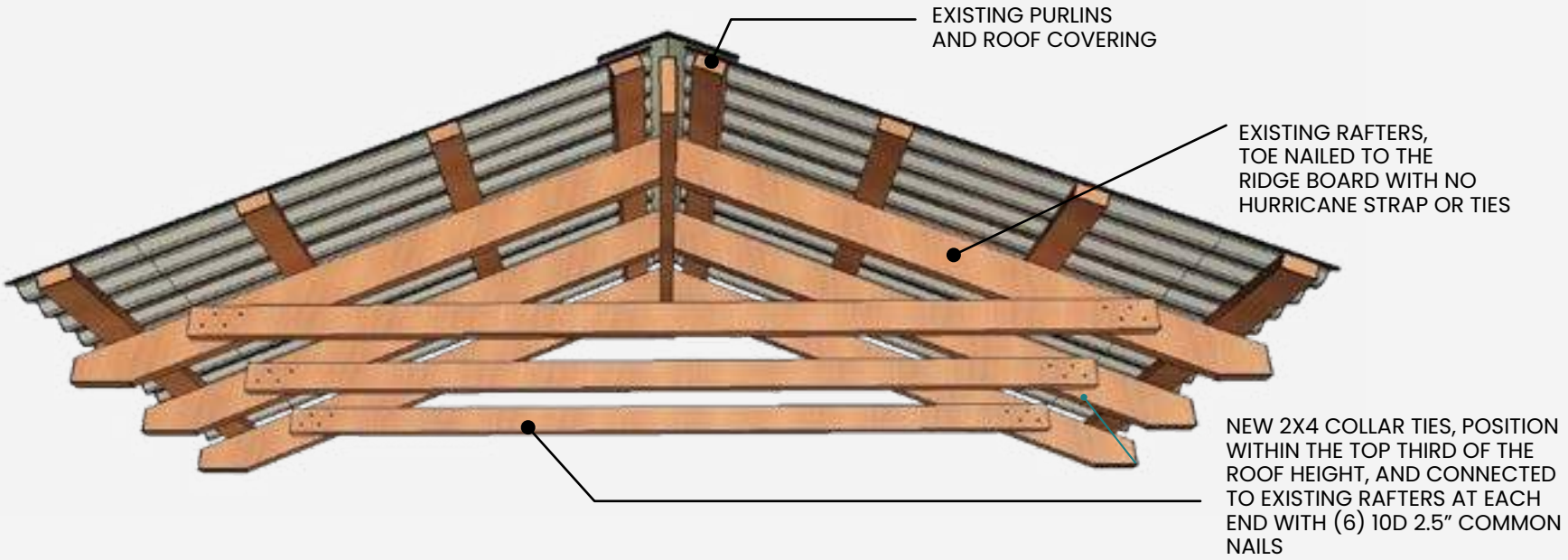
HOW TO RETROFIT:

3

Strengthen the ridge connection:

Option 2: Add a collar tie

- If the roof covering **does not** need to be replaced and the tops of the rafters are not accessible, a 2x4 collar tie can be used instead of the metal strap to resist uplift.
- Collar ties must be placed on every pair of rafters.



Roof Framing & Connections

HOW TO RETROFIT:

4 **Purlins dimensions and spacing:**

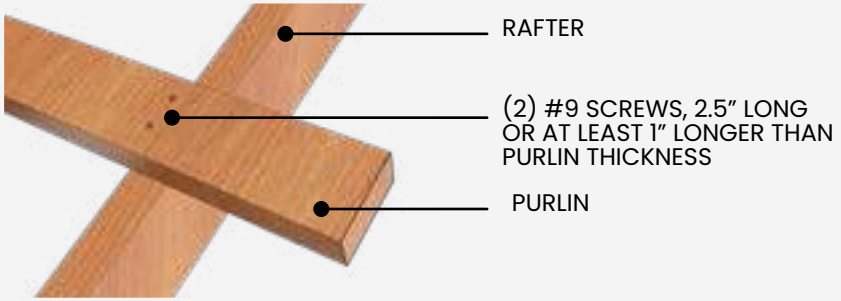
Add or replace purlins to ensure all purlins are 2x2 or larger and spacing does not exceed:

- 2ft (60cm) generally
- 1ft (30cm) at rafter overhang at the eaves.

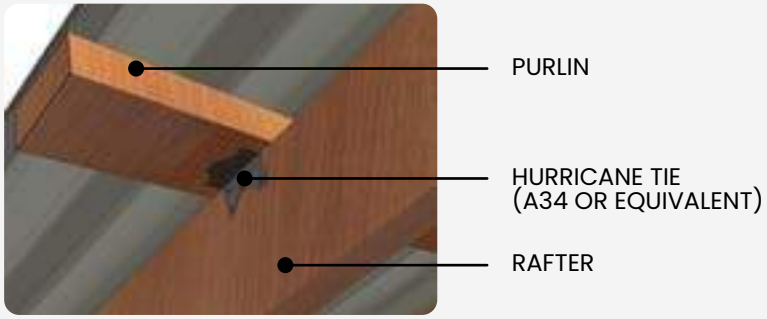
5 **Purlins connection to rafters**

Ensure purlins are connected to every rafter with either screws, or hurricane ties or strap.

Retrofit if the purlin is **accessible from above:**



Retrofit if the purlin is **not accessible from above:**



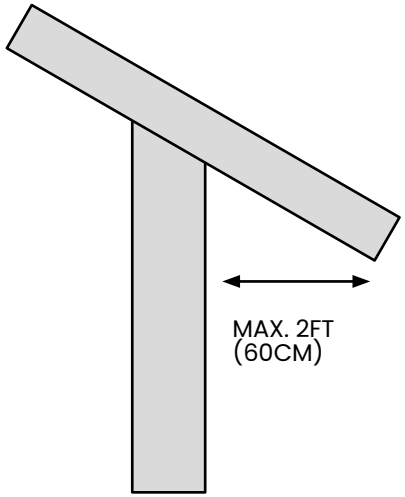
Overhang

RAFTERS OVERHANG

- Rafters extend a maximum of 2ft (60cm) from the exterior face of walls. Purlins extend 4" (10cm) maximum beyond the last supporting rafter or gable.

HOW TO CHECK OVERHANGS

Measure horizontally from the exterior face of wall.



HOW TO RETROFIT

Remove fascia board and overhang ceiling. Shorten the overhang as needed and reinstall.

2.2.3
SLAB ROOF

The slab roof package addresses vulnerabilities in reinforced concrete slab roofs.

The 2024 national survey of existing housing found 27 percent of slab roofs to have moderate vulnerability; no slab roofs were found to be highly vulnerable. Key issues that were observed and are addressed in this guidance were: localised concrete spalling or honeycombing, exposed reinforcement, and poor drainage.

This section 2.2.3 guides the user through evaluation and retrofit design for a reinforced concrete slab roof and reinforced concrete stairs. The guidance could also be applied to reinforced concrete inter-storey slabs or suspended porch slabs.

Suspended Slab

The recommended minimum slab thickness has been calculated using ACI 318-14 Table 7.3.1.1.

GEOMETRY AND CONDITION:

Roof and inter-storey slabs have a minimum thickness of 5" (12cm) if they span up to 10ft (3m), or 8" (20cm) if they span up to 16ft (5m).

They do not present extensive spalling, honeycombing, cracking, exposed reinforcement, or visible deflections.

HOW TO CLASSIFY DAMAGE IN SUSPENDED SLABS

Light / Moderate

- Small, isolated surface cracks, less than 1/16" (2 mm) wide.
- Minor spalling, surface layer only.
- Superficial honeycombing
- No visible deflection
- No exposed reinforcement

Severe

- Cracks wider than 1/16" (2mm)
- Exposed reinforcement
- Concrete spalling
- Moisture passing through the slab
- Corrosion of reinforcing or structural steel.
- Obvious, excessive deformations.
- Efflorescence on the concrete surface

Suspended Slabs

HOW TO RETROFIT

Slab less than 5" (12cm) thick AND no damage: no action required.

Slab at least 5" thick, **light / moderate damage:**

- Remove any damaged, loose and deteriorated concrete using a chipping hammer till exposing solid, sound concrete and any rusted reinforcement.
- If repairing an area of spalling, extend the repair zone beyond the visibly damaged area (around 1ft, 30cm) to ensure full coverage of damaged material. Brush clean any exposed, rusted rebars. Clean the area to remove any dust, debris, or loose material.
- Patch the area or fill the honeycomb void with cement mortar. If possible, apply a bonding agent to the cleaned concrete surface to ensure proper adhesion between the old and new concrete. For large spalled areas (larger than 3ft x 3ft (1m x 1m) or deeper than 1" (25mm)) the mortar should be placed in layers to reduce shrinkage.
- If cracks are smaller than 1/8" (3mm), fill with epoxy resin.

Slab at least 5" thick, **severe damage:**

- Repair cracks by injecting epoxy resin. Stitch cracks wider than ½" (1cm) with steel rods or mesh plaster layers.
- Brush exposed, rusted reinforcement with a wire brush. If after brushing the rebar has lost more than 25% of its cross-sectional area due to corrosion, it must be replaced with new bars.
- Recast the area with repair cement-mortar. If possible, apply a bonding agent to the concrete surface and rebar to ensure a strong bond. Ensure the new concrete fully encapsulates the rebar.

RETROFIT OPTIONS *CONTINUED*.

Slab less than 5" (12cm) thick, visible deflection:

If accessible from below:

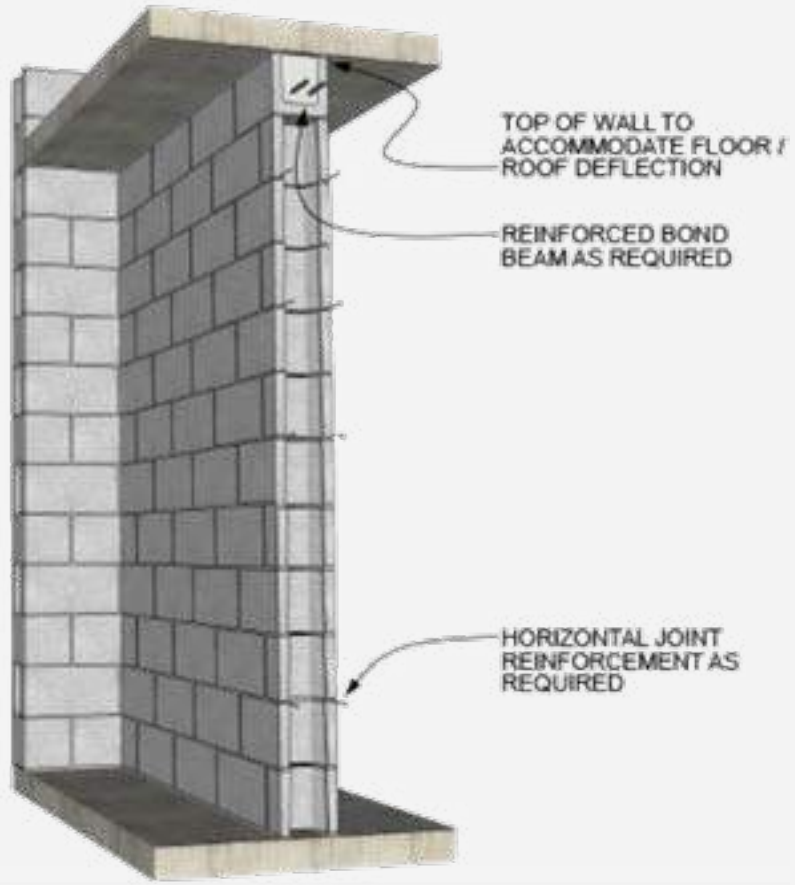
- Construct new supporting walls with 6" (15cm) block, aligned with existing columns and with new foundations.
- Build new walls up to 4" (10cm) below the underside of the slab and then cap with a ring beam, reinforced with 2 x 3/8" and 1/4" hooks every 15 cm.
- Pour the beam from above by perforating holes in the slab above the new walls (80mm x 80mm every 1.5m).

If not accessible from below:

- Retrofit not recommended using this manual. Consider demolition.

Slab less than 5" thick, severe damage: The house cannot be retrofitted using this guide.

Detailed engineering assessment required to assess technical and cost feasibility of demolition and re-placement of the slab.



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Suspended Slabs

WATERPROOFING

The roof slab has a sloped screed finish (minimum 1%) and drains such that there is no ponding of water.

It is coated in a waterproof membrane or paint.

RETROFIT ABSENT OR DETERIORATED WATERPROOF MEMBRANE:

Apply a new liquid-applied or rolled-sheet membrane in accordance with manufacturer's specifications. Rolled-sheet membranes are preferable as they are more durable.

RETROFIT TO IMPROVE ROOF DRAINAGE:

- Add a concrete screed with a minimum slope of 1-2% (1/4" per foot) to add drainage. Shape the sloped surfaces such that the maximum screed thickness is limited to 2" (5cm) and water flows towards the drainage points.
- Screed must not be added to slabs in poor condition, with cracks or exposed reinforcement, or slabs with depth less than 6" (15cm) thick (up to 3m span) or 8" (20cm) thick (up to 4.5m span).

- Install roof drains, 3" (8cm) diameter, at all low points of the roof, in valleys or near parapet walls. Install strainers on drains to prevent debris from clogging the drainage system.
- If applicable, use downpipes to channel water away from the building's walls and foundation.

Suspended Slabs

OPENINGS

The length of openings in slabs next to shear walls is less than 25% of the total length of the adjacent wall and not greater than 12ft (3.6m).

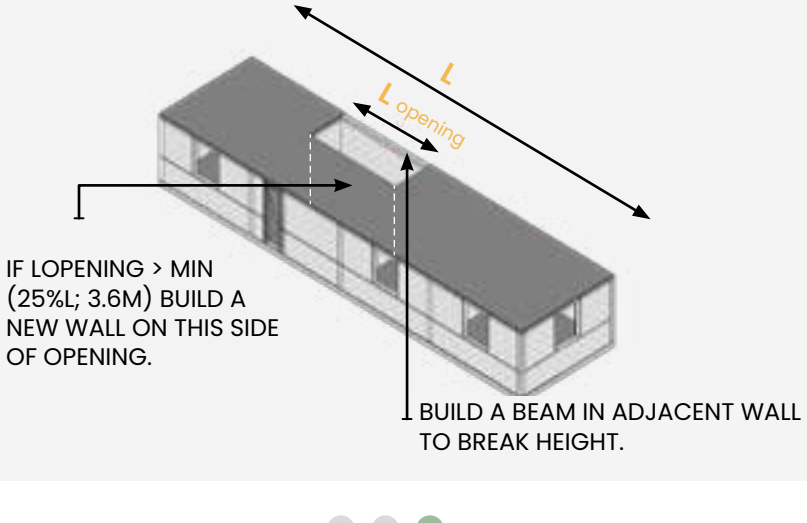
There is a reinforced concrete beam along the entire length of the adjacent wall.

WHAT TO CHECK

RETROFIT OPTIONS

- **Missing ring beam along shear wall:** build a 6" x 8" (wide) ring beam, anchor longitudinal reinforcement to roof slab.

- **Opening bigger than 12ft (3.6m):** build a new confined masonry wall on the side of the opening



Reinforced Concrete Stairs

CONCRETE STAIRS

Stairs are minimum 5" (12cm) thick and connected to the floor plate at each storey by a continuous reinforced concrete landing.

Stairs and landings do not rely on walls for vertical support. Vertical support is provided by isolated columns that are adequately sized and reinforced, or by masonry walls at least 2ft (60cm) in length.

Stair foundations are mass concrete or reinforced concrete, with a depth of at least 1ft (30cm) below grade. On sloped sites (greater than 17%) or with soft soils, the stair foundation is continuous with that of the rest of the building.

RETROFIT OPTIONS

Inadequate connection to floor plates:

- Introduce structural anchors to secure stairs to floor plates. Requires demolition to overlap bars.

Insufficient vertical support:

- Add isolated columns or masonry walls.

Foundation issues:

- Install a proper foundation with cyclopean or reinforced concrete, ensuring 1ft (30cm) embedment in the ground (needs underpinning). Extend the foundation to be continuous with the main building if on soft soil or a sloped site.

Stairs in poor condition:

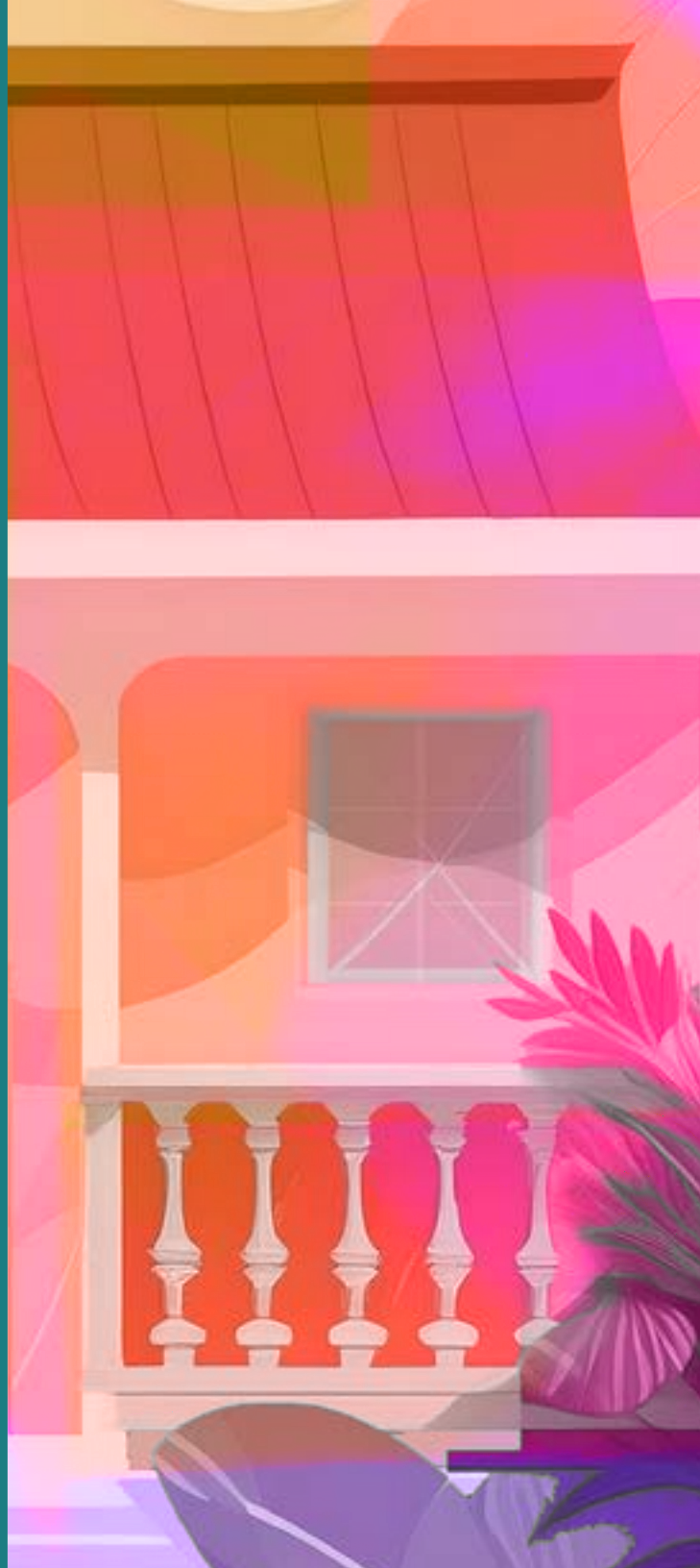
- Cracks 1/8"-3/8" (3-10mm) wide: fill with epoxy resin (ideal) or cement mortar.
- Cracks wider than 3/8" (10mm): wire brush exposed bars, clean rust and patch back concrete. (If exposed bars are severely rusted and degraded, consider demolishing and rebuilding the stairs).

*NOTE: If the retrofit requires construction of new stairs, design must be in accordance with Section 505 of the Building Regulations.

2.3

Structural Retrofit Evaluation and Design

MASONRY WALLS AND FOUNDATIONS PACKAGE



2.3.1 FOUNDATIONS

The foundations package addresses vulnerabilities in the foundations of masonry block houses.

Strong foundations are critical to ensuring building safety in hurricanes and earthquakes, but it is often difficult to assess how well existing foundations are performing.

This section 2.3.1 guides the user through evaluation and retrofit design for common vulnerabilities in the four most common foundation typologies for Dominica.

Types of Foundations for masonry houses

ON GRADE

A continuous strip foundation runs below all load-bearing walls.

ON TALL REINFORCED CONCRETE COLUMNS

Approximately one storey (10ft, 3m) high.

ON PIERS

(masonry or concrete): that support the structure at intervals, elevating it above the ground.

ON SHORT REINFORCED CONCRETE COLUMN

About 2ft high.

Foundation Performance

FOUNDATION PERFORMANCE

There is no evidence of excessive foundation movement, such as settlement or lift, that may indicate inadequate or absent foundations.

If the foundation performance is thought to be inadequate based on "severe" wall damage, the house should not be retrofitted using this manual. Reconstruction should be considered instead.

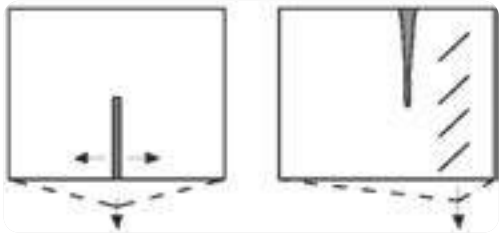
How to classify wall cracks due to inadequate foundation performance:

LIGHT	Narrow cracks (up to 0.2mm) in less than 50% of walls.
MEDIUM	Cracks between 0.2mm and 3mm on maximum 30% of walls.
SEVERE	Cracks beyond 1/8" (3mm) in 30% or more

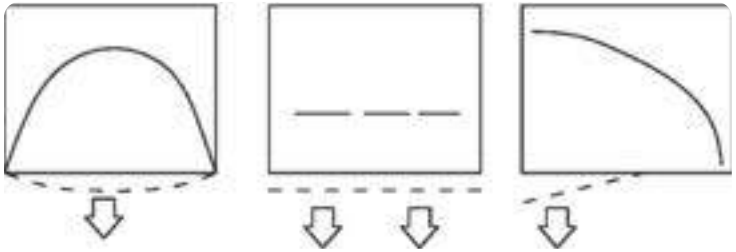
HOW TO IDENTIFY FOUNDATION POOR FOUNDATION PERFORMANCE:

Vertical, diagonal or horizontal cracks in walls may indicate problems due to inadequate foundations, such settlement. Cracks in tiles and at floor and wall joints, and vertical gaps between foundation and the natural ground also indicate foundation movement.

LOCAL SETTLEMENT



CONTINUOUS SETTLEMENT



Masonry on Piers

MATERIALS AND STATUS:

- The piers are stone, block masonry.
- They are in good condition, with no excessive damage or degradation, and no signs of excessive settlement.

HOW TO CHECK:

- Examine the piers to determine the material type.
- Look for any cracks, chipping, spalling, or other visible signs of material degradation. Pay special attention to mortar joints in stone or block masonry piers and any visible surface defects in concrete.
- Observe alignment, plumbness (use a plumb line or laser level) and tilting. Inspect the base of each pier for gaps or uneven ground around it, which can also suggest settlement.

RETROFIT PIERS IN POOR CONDITION:

- Fill cracks with epoxy resin or cement mortar. For deterioration caused by moisture, remove damaged concrete (use a chisel or hammer) and patch with cement mortar.
- Next, apply a waterproof coating (bituminous paint or cement plaster) to the pier surface to protect against further moisture penetration.
- If cracks are significant (wider than 3/8" (10mm)) or if the pier integrity is compromised, consider encapsulating the existing pier with a new layer of concrete reinforced with mesh (constructing a form around the damaged pier and pouring new concrete). The mesh should be 4mm @ 6" (15cm) minimum, anchored to the bottom with 3/8" dowels @ 30cm cast into a reinforced concrete foundation.

Masonry on Piers

GEOMETRIC REQUIREMENTS

The piers are at least 16" (40cm) wide, with a maximum height above grade of 4ft (1.2m). They are embedded at least 1.5ft (45cm) below grade. The plan area of all piers is at least 70% of the plan area of the shear walls in each orthogonal direction.

HOW TO CHECK

- Measure the width, height and embedment depth of the piers (if feasible, expose the base of a sample pier through local excavation) and calculate the plan area.
- Based on the measurements, conclude whether the piers meet the geometrical requirements.

When calculating the area of piers, only the solid area should be considered.

RETROFIT TO INCREASE THE SHEAR AREA OF PIERS:

Increase the area of each pier:

- Excavate around the existing piers, taking care not to undermine the footing. Wrap piers in steel mesh, position formwork and pour concrete jacket, minimum 2" (5cm) thick.

Add supplemental RC piers:

- Where access allows, it may be possible to add supplemental piers. New piers should have adequate foundation, be designed with reinforced concrete, and directly align with load bearing walls.

Masonry on Short RC Columns

MATERIALS AND STATUS:

Geometric requirements and condition:

- The columns support a single storey house
- Cross sectional dimensions of each column are at least 6" x 6" (15cm x 15cm).
- Columns are reinforced with a minimum of 4 x ½" (12mm) longitudinal bars and transverse links at 4" (10cm).
- Columns are supported by either pad foundations connected by a continuous grade beam, or by a continuous strip footing. There are no cracks, spalling, exposed reinforcement bars, or any other form of damage.

HOW TO CHECK:

- Use a reinforcement scanner to confirm the size, location and quantity of reinforcement. If reinforcement cannot be confirmed, assume a non-compliance and retrofit.
- If columns support a house with more than one-story, it cannot be retrofitted through this manual.

! The stability of these houses is governed by their performance under seismic load.

RETROFIT TO STABILISE SHORT RC COLUMNS:

- Construct new masonry walls between all short columns using 6" (15cm) blocks. It is likely this will only be feasible under the exterior perimeter walls.
- Excavate the area between the columns to create a new strip footing for the walls, then reinforce and pour concrete for the footings. Fill any gaps between the masonry walls, the underside of the suspended slab, and the sides of the existing columns with mortar to ensure proper adhesion.

Masonry on Short RC Columns

GEOMETRIC REQUIREMENTS:

The columns support a single storey house and have the following minimum dimensions:

- 6" x 6" (15cm x 15cm), maximum height 10ft (3m)
- 8" x 8" (20cm x 20cm), maximum height 13ft (4m)

Columns are adequately braced by existing concrete or masonry walls, with a minimum length equal to 70% of the length of the wall of the house in the storey above.

The columns show no signs of settlement and are supported by either pad foundations connected by a continuous grade beam or by a continuous strip footing. They exhibit no cracks, spalling, exposed reinforcement bars, or any other form of damage.

! The stability of these houses is governed by their performance under seismic load.

! If columns present visible signs of settlement, they cannot be retrofitted using this manual.

If columns support a house with more than one-story, it cannot be retrofitted using this manual.

Masonry on Tall RC Columns

RETROFIT TO REPAIR DAMAGE

- If cracks are narrower than ⅛" (3mm): fill crack with epoxy resin (ideal) or cement mortar.

- If cracks are wider than ⅛" (3mm): fill the crack with epoxy resin or cement mortar and build segments of masonry walls in the two orthogonal directions, dowelled into the column. Minimum masonry wall length: 3ft (1m). Masonry must be built on foundation.
- If spalling of concrete or exposed bars: brush clean any rust present in rebars. touch up locally to repair. Use cement mortar.

RETROFIT FOR UNBRACED TALL COLUMNS

- Build new masonry walls to reach the required minimum length (70% of the length of the wall of the house in the storey above).
- Minimum wall thickness should match the thickness of walls above. Walls must be dowelled into existing columns with ¼" bars every three courses (use epoxy resin). Walls should be constructed on a continuous foundation beam connected to pad foundations and a ground bearing slab.

2.3.2 WALLS

The walls package addresses vulnerabilities in the walls of masonry block houses.

The 2024 national survey of existing housing found 16 percent of masonry walls and foundations to have high vulnerability. Key issues observed were missing lintels, minor cracking around openings, and an absence of tie columns in some areas.

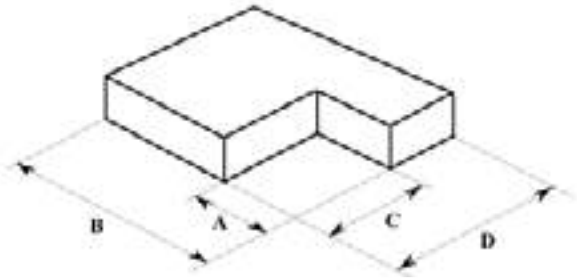
This section 2.3.2 guides the user through evaluation and retrofit design for the walls of block masonry homes.

General Configuration

PLAN SHAPE

The building has a regular plan shape, such as square or rectangular. The length is not more than four times the width. L shaped buildings meet the following requirements:

A>0.15B AND C>0.15D



PLAN SHAPE RETROFIT

- **Introduce seismic joints:** Separate the structure into two or more independent structures that are regular on plan. Construction joints should be a least 2" (5cm) for 1 storey buildings, 4" (10cm) for 2 storey buildings.
- **Build new walls** to create a more regular configuration. Refer to Chapter 6 for recommendations for horizontal expansion.

MATERIAL

All exterior walls are constructed from masonry.

MATERIAL RETROFIT

- **Build new walls:** If exterior walls of the house are missing, shared with neighbouring structures, or are built with temporary materials, build new confined masonry walls, minimum 6ft (2m) long, that are adequately tied in to the existing structure.

Wall Configuration

WALL LENGTH

Each wall elevation (exterior and interior) has an adequate length of continuous solid wall extending from the foundation to the ring beam, free from door or window openings.

HOW TO CHECK

- Calculate the minimum total continuous solid wall length required based on the building type using the table below. Measure the walls and compare the measured values against the calculated minimum requirements.
- The tabulated minimum lengths are expressed as a percentage of the total wall length. The total length of solid wall can be made of multiple individual segments that are minimum 3ft (1m) in length.

REINFORCED OR CONFINED MASONRY

Maximum Perpendicular Wall Spacing		Exterior Walls	Interior Walls
1 storey galvanize roof	13ft (4m)	20%	40%
1 storey slab roof	11.5ft (3.5m)	30%	60%
2 storey galvanize roof, 1st floor	11.5ft (3.5m)	15%	30%
2 storey galvanize roof, 2nd floor	11.5ft (3.5m)	25%	50%
2 storey slab roof, 1st floor	10ft (3m)	25%	50%
2 storey slab roof, 2nd floor	10ft (3m)	40%	75%

UNREINFORCED/UNCONFINED MASONRY

Maximum perpendicular wall spacing		Exterior Walls	Interior Walls
1 storey light roof	13ft (4m)	20%	40%

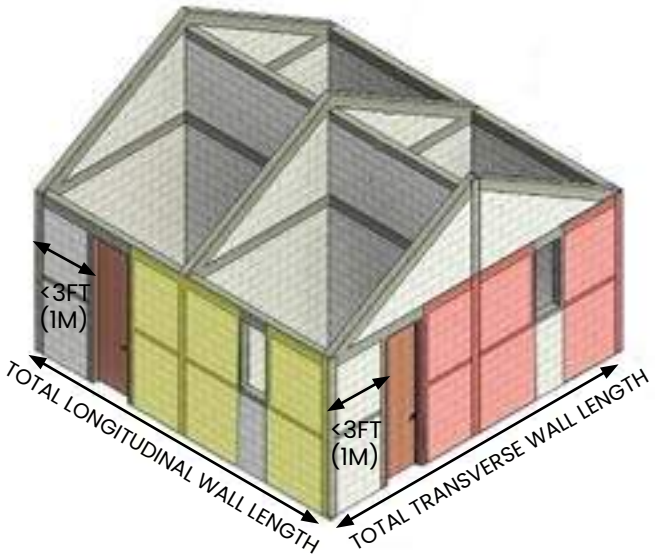
Example
The house shown is a 26ft (7.9m) x 20ft (6m) 1 storey confined masonry house with a galvanize roof.

In the longitudinal direction, the required minimum solid wall length is:

- Exterior walls: 20% x 26ft (7.9m) = 5.2ft (1.6m). Yellow highlighted wall segments total 15ft (4.5m), OK.
- Interior wall: 40% x 26ft (7.9m) = 10.4ft (3.2m)

In the transverse direction, the required minimum solid wall length is:

- Exterior walls: 20% x 20ft (6m) = 4ft (1.2m). Red highlighted walls total 10.5ft (3.2m), OK.
- Interior wall: 40% x 20ft (6m) = 8ft (2.4m)



Wall Configuration

The required wall lengths are for 6" (15cm) thick walls.

For 1 storey dwellings, if walls are 8" (20cm) thick, the lengths can be reduced by 10%.

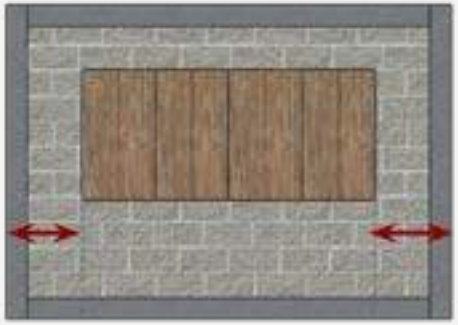
For walls more closely spaced, the required lengths can be reduced proportionally to the ratio between the wall spacing and the wall spacing in the table.

RETROFIT TO INCREASE WALL LENGTH

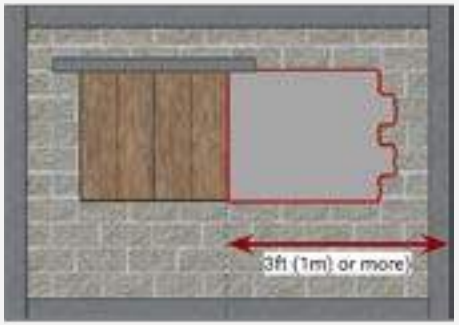
Build new confined masonry walls, adequately tied in to the existing structure.

Reconfigure openings:

Reduce window opening size or move doors and windows to ensure adequate wall length in both plan directions. Confirm any changes to openings are acceptable to the homeowner and meet the minimum light and ventilation requirements in Chapter 4.



Less than 3ft (1m)



Less than 3ft (1m)

Wall Configuration

PERPENDICULAR WALL SPACING

Perpendicular wall spacing does not exceed the limits in the table on page 75, based on the roof type and number of storeys.

PERPENDICULAR WALL SPACING RETROFIT

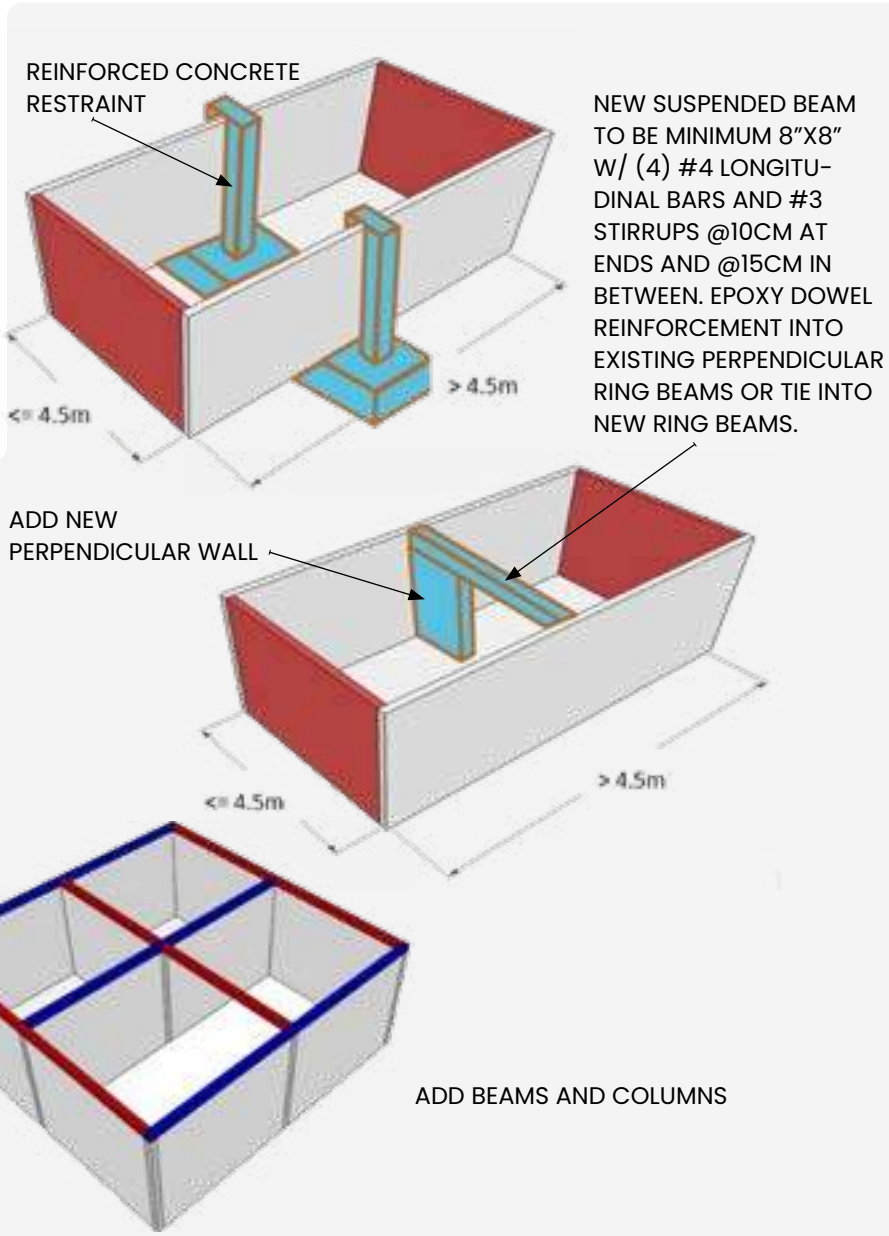
- As perpendicular walls brace and support each other, long walls can be unstable in an earthquake. For houses where the walls are spaced beyond the recommended maximum, the retrofit can include:

Masonry restraints:

- Minimum 2ft (60cm) long and adequately bonded to external walls at intersections with a 6" x 6" (15cm x 15cm) tie column. The free edge should be restrained with a 2 bar reinforced concrete tie column.

Reinforced concrete restraints:

- The new RC restraint should be embedded in the thickness of the existing wall and extend minimum 4" (10cm) beyond the internal surface.



Wall Configuration

SLENDERNESS

For all walls on all storeys, the maximum wall height is 12ft (3.6m) and the height:thickness ratio is less than 25. Wall height is measured from top of slab to underside of ring beam.

RETROFIT OPTIONS

Masonry walls are taller than 12ft (3.6m) and roof and ring beam needs replacement:

- Remove masonry courses as needed to limit the height to 12ft (or a slenderness ratio of 25, whichever is smaller).

Masonry walls are taller than 12ft (3.6m) and roof or ring beam do not need replacement:

- If wall is 8" (20cm) thick - no action required.
- If wall is 6" (15cm) thick - Add buttresses, or two bands of mesh plaster (1" (3cm) thick, 1ft (30cm) wide) positioned at 1/3 and 2/3 of the wall height.

RETROFIT TO REDUCE SLENDERNESS

Increase wall thickness:

- Add ½" (1.5cm) thick sand-cement plaster to each wall face.

Reduce wall height:

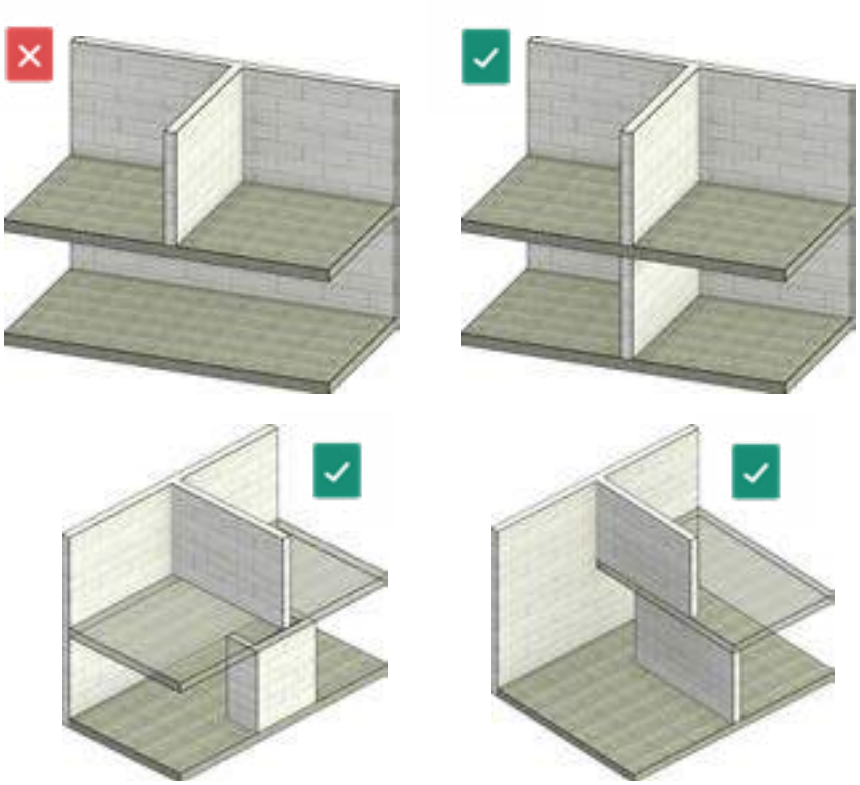
- Remove top courses of blocks until the height:thickness ratio is less than 25.

Wall Configuration

VERTICAL CONFIGURATION:

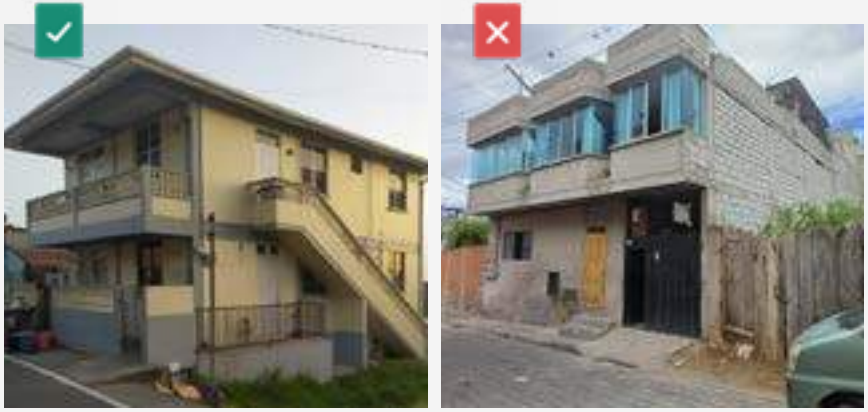
All balconies and other habitable spaces above cantilevers are adequately supported with no risk of collapse, and walls are vertically continuous from roof to foundation. **Only applicable to 2 storey homes.**

Walls can be considered vertically continuous if they meet any of the following configurations:



CANTILEVER RETROFIT

- **If the cantilever does not support enclosed spaces (e.g balconies):** no action required.
- **If the cantilever supports an enclosed space, and slab is 5”-7” (12-18cm) thick and cantilevers up to 2ft (60cm):** use a rebar scanner to detect bar size and spacing.
- **If top reinforcement is absent or is less than 3/8” (10cm) at 8” (20cm) c/c:** add support columns.
- **If top reinforcement is present and at least ⅜” (10cm) @ 8” (20cm) c/c AND no cracks are present at the support:** no action required.
- **If Slab is less than 5”-7” (12-18cm) thick or cantilevers more than 2ft (60cm):** add supports (columns or beams).



Masonry

MASONRY:

- Masonry units are concrete blocks or stone laid in a running bond with horizontal and vertical joints fully filled with mortar. Mortar joints are ½"-1" (1-2cm) thick.
- The minimum thickness of walls is 6" (15cm) for two storey houses and 4" (10cm) for single storey houses. Plaster can be included in the thickness, if it is in good condition.

HOW TO RETROFIT

Poor construction quality:

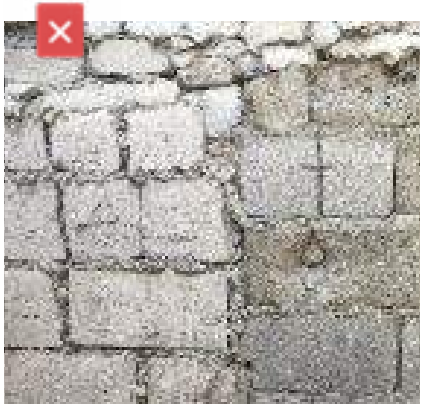
- Such as incorrect mortar joints or poor quality blocks: plaster all accessible surfaces with 1.5cm thick sand-cement plaster.

New Walls are required:

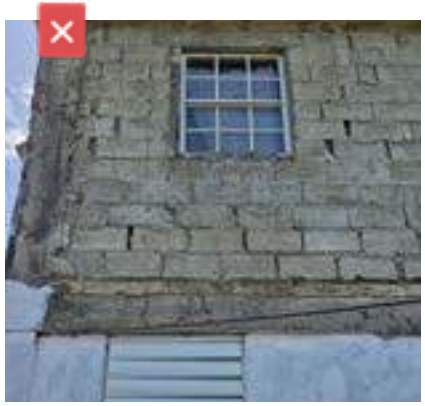
- New walls with foundations should be built with either confined or reinforced masonry in accordance with the Guide to Dominica's Housing Standards. Key details of both construction techniques are reproduced on pages 81-82.

HOW TO CHECK

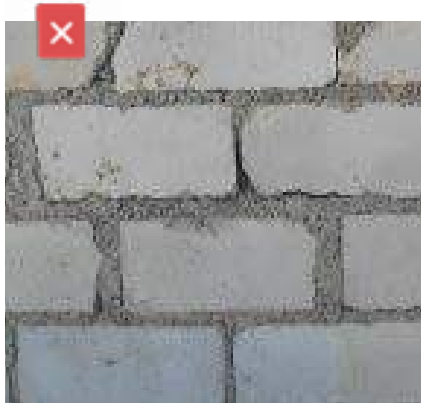
Placement not in a running bond



Placement, mortar joints too thin



Vertical joints not filled with mortar



Mortar joints too thick

Masonry

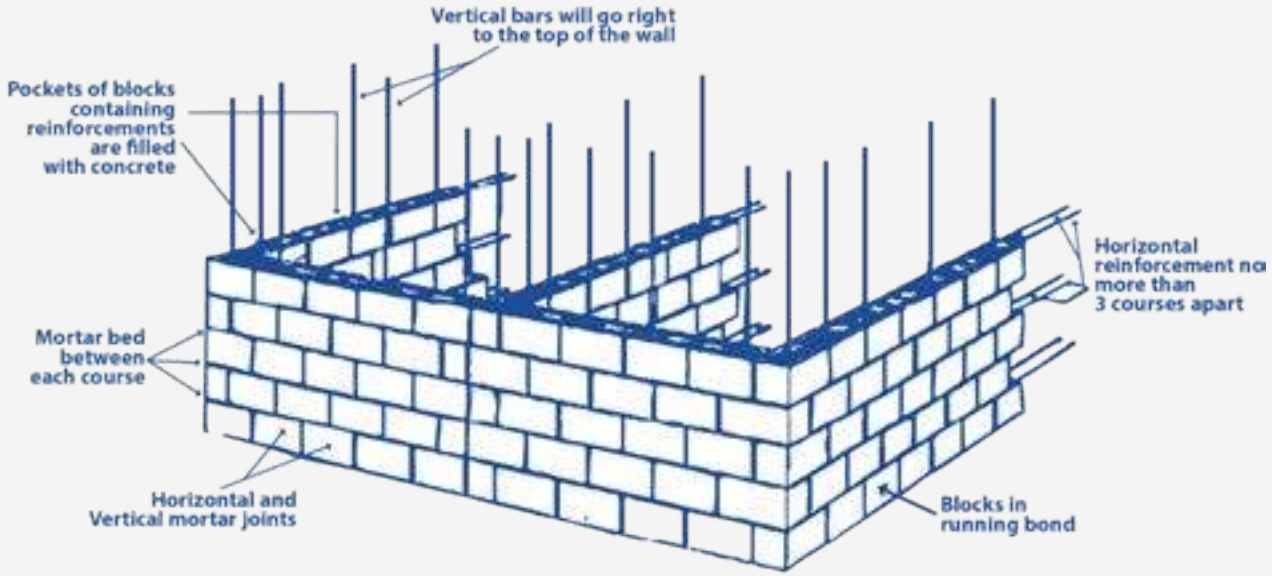
NEW WALL CONSTRUCTION OPTION 1: REINFORCED MASONRY

Masonry: Thickness 6" (15cm) minimum

Mortar: 1:3 mix, joints ½" to **3/4" (1-2cm) horizontally AND vertically**

Reinforcement:

- **Horizontal:** (2) 3/8" dia bars (or brickforce) laid every **three courses.**
- **Vertical:** ½" bars at 32" (80cm) spacing, and at all junctions, window and door openings. Continuous from foundation to belt beam. 18" (45cm) laps.



SOURCE: GUIDE TO DOMINICA'S HOUSING STANDARD

The 2022 Building Regulations adopt the latest version of the Building Guidelines under Clause 1801(b) for single storey houses up to 2500sqft (232m2). For new wall construction in larger homes, follow Section 15 of the 2022 Building Regulations.

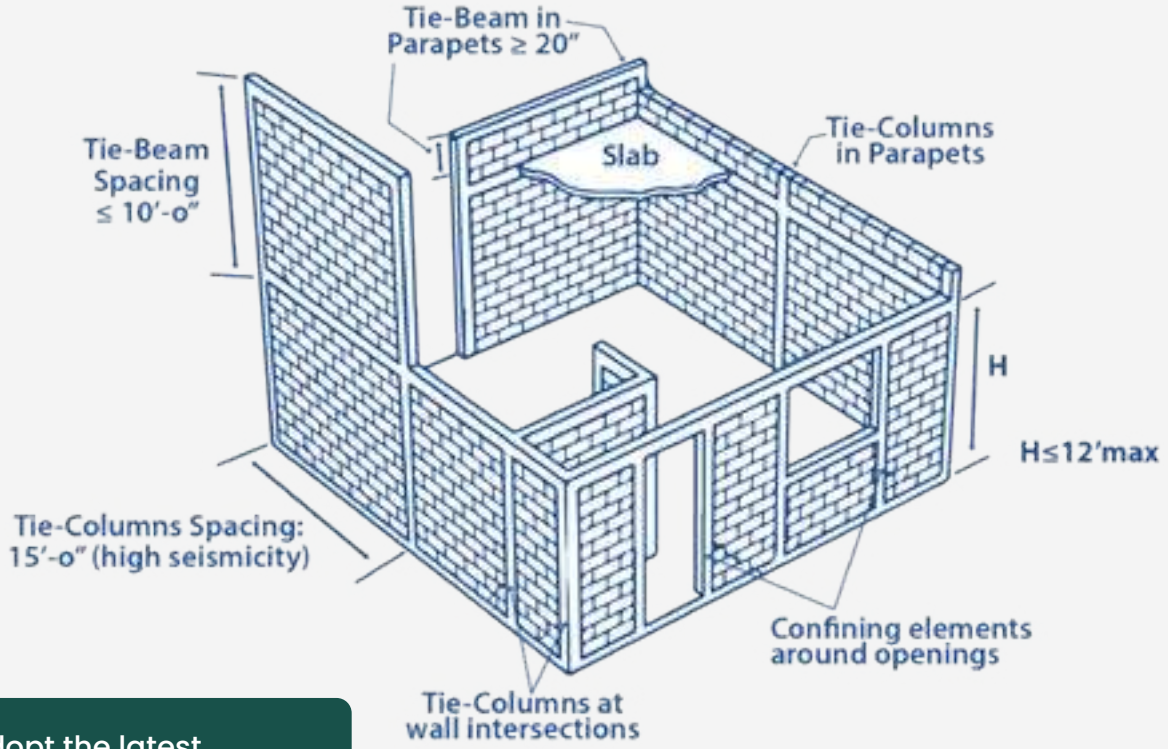
Masonry

NEW WALL CONSTRUCTION OPTION 2: CONFINED MASONRY

RC ties:

- **Dimensions:** Minimum 6" (15cm) (depth and width)
- **Reinforcement:** Minimum 4 bars, deformed steel, size #4 (½" diameter) with 24" (60cm) straight bar laps and 90 degree hooks at intersections. #2 (6mm) links every 6" (15cm), reduced to every 4" (10cm) within 2ft (60cm) of intersections. 135o hooks, 2" (5cm) long.
- **Concrete:** Minimum 3000psi; 1:2:4 mix

Masonry: Minimum 6" (15cm) blocks



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The 2022 Building Regulations adopt the latest version of the Building Guidelines under Clause 1801(b) for single storey houses up to 2500sqft (232m2). For new wall construction in larger homes, follow Section 15 of the 2022 Building Regulations.

Plaster

PLASTER:

Plaster on interior and exterior walls is in good condition, with no swelling due to humidity, no severe cracks, or other significant deterioration.

HOW TO CHECK

Plaster

HOW TO RETROFIT PLASTER IN POOR CONDITION

- Gently chip away the existing plaster using a hammer or a chisel. Begin removing the plaster from the top, working downwards. Remove all loose or damaged plaster until you reach a solid, stable surface.
- Clean the wall surface with a wire brush to remove any remaining plaster, dust, and debris.
- Inspect the underlying wall to identify any existing damage such as cracks or loose bricks and ensure it is free of moisture.
- Repair cracks or fix blocks with mortar.If moisture is present, ensure that the source of the moisture is fixed before rebuilding the plaster (fixing leaks, improving drainage, or applying a moisture barrier).
- Apply a bonding agent to the masonry wall and allow the requisite time to elapse so that it takes effect before re-plastering.
- Replaster the wall using a 1:4 sand-cement ratio 5/8" - 1.5cm thick on each surface).

Wall Reinforcement or Confinement

Masonry walls are either confined with tie columns or internally reinforced:

COLUMNS:

There is a reinforced concrete tie column, minimum 6" x 6" (15cm x 15cm), at all wall corners, intersections and ends.

INTERNAL REINFORCEMENT:

Walls are reinforced with:

- Vertical reinforcement: ½" at 32" (80cm) max.
- Horizontal reinforcement: ⅜" at 24" (60cm) max. or brickforce.

Unreinforced masonry buildings are particularly vulnerable to earthquake damage and have been a leading cause of loss of life in past events. They can also be dangerous in hurricanes. It is strongly recommended to retrofit unreinforced masonry walls.

HOW TO CHECK

- Visually verify there are columns at all wall corners, intersections, and ends.
- If columns are not visible, use a rebar scan to confirm if internal reinforcement meets the requirements for bar size and spacing.

Wall Reinforcement or Confinement

HOW TO RETROFIT UNREINFORCED OR PARTIALLY REINFORCED WALLS

If there are no columns and no internal reinforcement, or the columns and reinforcement do not meet the minimum requirements:

- Build new RC columns at all wall corners, intersections and ends, and comply with configuration requirements for confined masonry (see page 82)
- If there is an existing ring beam, epoxy (4) dowels and lap splice with column reinforcement. If there is a new ring beam, extend column reinforcement into new ring beam,

OR

- Comply with configuration requirements for unreinforced masonry.

See pages 74-79 for more details on wall configuration.

Geometry of Openings

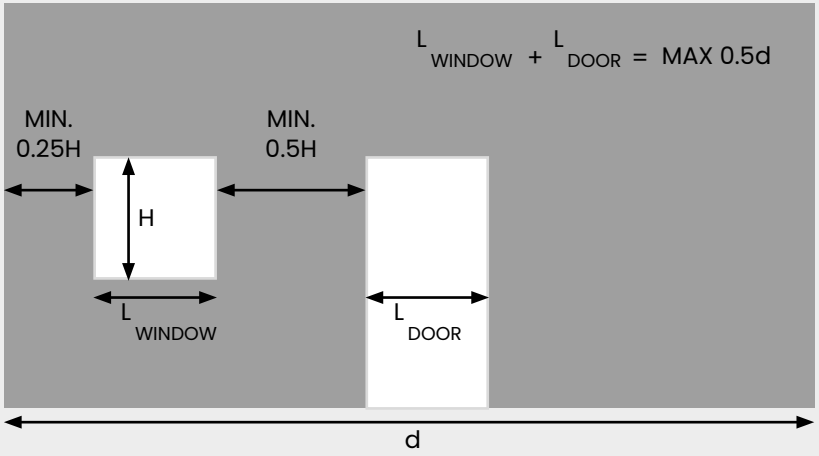
GEOMETRIC REQUIREMENTS

Window and door openings are at least 0.25H from wall corners, where H is the height of the opening.

The distance between two consecutive openings is at least ½ the height of the shortest opening.

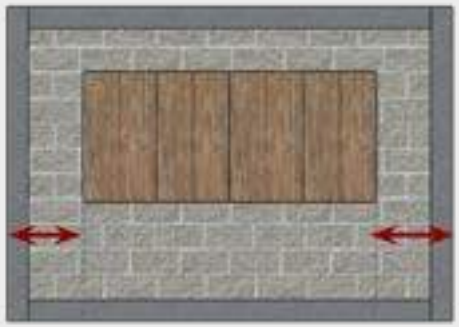
The total length of openings does not exceed ½ length of the wall between two consecutive cross-walls.

HOW TO CHECK:



HOW TO RETROFIT:

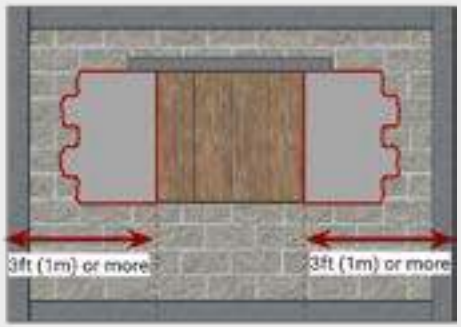
Rearrange or reduce opening sizes to ensure compliance with geometrical limits.

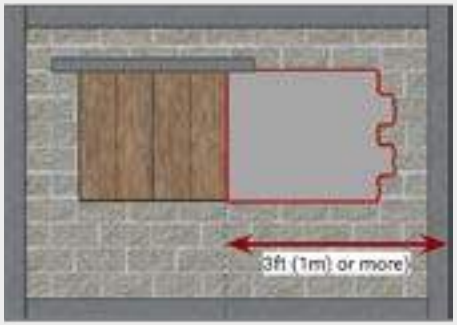


Less than 3ft (1m)

Less than 3ft (1m)

THE WINDOW OPENING CAN BE FILLED ON BOTH SIDES OR ONE SIDE TO CREATE A 3FT (1M) SECTION OF SOLID WALL.

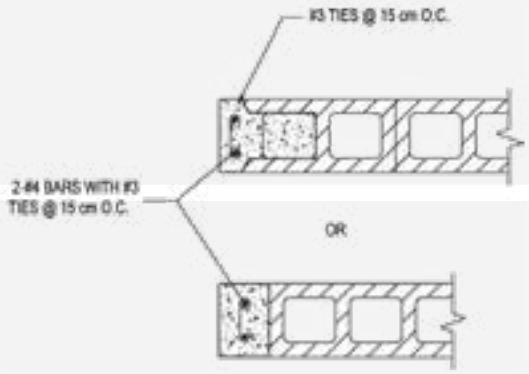




Framing of Openings

MASONRY:

Openings:
Window and door openings that are wider than 2ft (60cm) have a lintel with minimum depth 6" (15cm) or extend to the underside of the ring beam. There are no severe cracks at the corners of openings, which might indicate a lack of vertical reinforcement.



HOW TO RETROFIT LINTELS AND OPENING REINFORCEMENT:

Chip away existing masonry, add (2) 1/2" bar columns and beam, and recast. Provide temporary props as necessary for stability.

For the structure to be classified as reinforced or confined masonry, all windows and doors must be framed with vertical columns or vertical reinforcement cast into the wall.

Hurricane Shutters

SHUTTERS

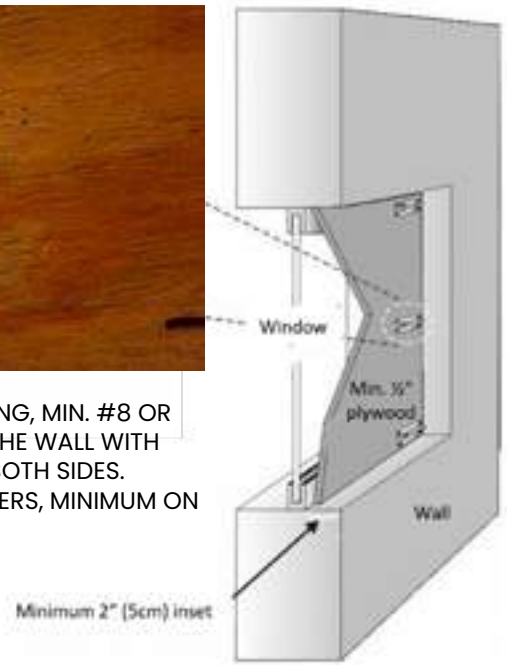
Are provided for all wall openings that are not impact resistant.

HOW TO INSTALL TEMPORARY SHUTTERS

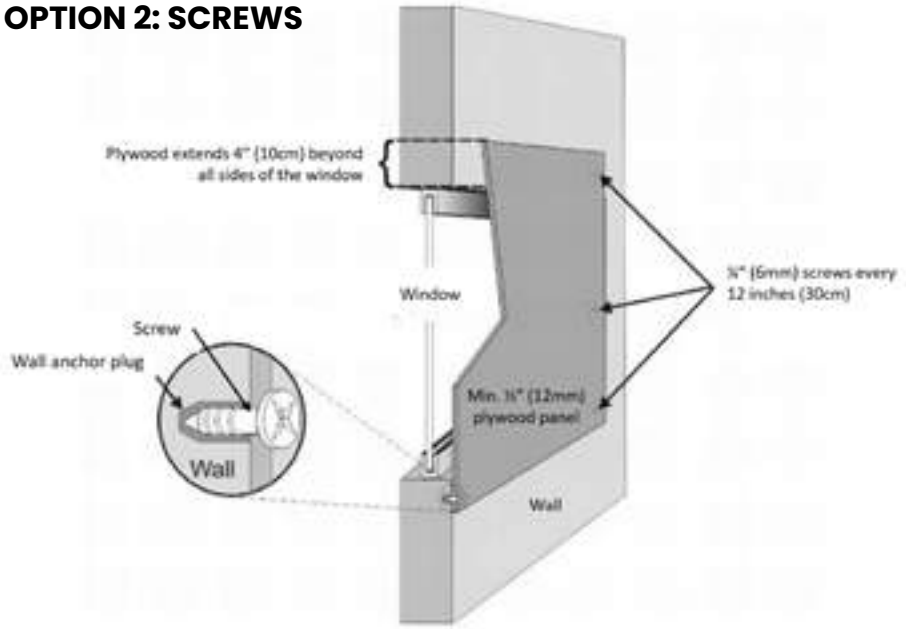
- Plywood panels can be used to protect openings. They should have a minimum thickness of ½" (12mm) and a span of maximum 8 ft (2.4m).
- Panels should be pre-cut, pre-drilled as required for the anchorage method and attached to the framing surrounding the opening.

OPTION 1 (PREFERRED): BARREL BOLTS

BARREL BOLTS (4" (10CM) LONG, MIN. #8 OR 4.2MM DIA.) ANCHORED TO THE WALL WITH SCREWS AND WASHERS ON BOTH SIDES. SPACED AT 18" (45CM) CENTERS, MINIMUM ON BOLT ON EACH SIDE.



OPTION 2: SCREWS



Isolated Columns

ISOLATED COLUMNS

Made from reinforced concrete and are in good condition, with a height of at least 5ft (1.5m) and minimum cross-sectional dimensions of 6" x 6" (15cm x 15cm) (or 6" diameter of circular column).

HOW TO EVALUATE DAMAGE STATUS:

Severe damage: Cracks wider than ⅜" (1cm), spalling, exposed bars.

Poor condition: Cracks up to ⅜" (1cm), exposed Bars.

Good condition: Minimal to no cracking, intact concrete surface, uniform cross-section.

RETROFIT TO STABILISE SHORT RC COLUMNS:

Columns in poor condition:

- Cracks less than ⅜" (1cm): fill crack with epoxy resin (ideal) or cement mortar.
- Exposed bars: wire brush clean rust and patch back concrete.

Columns with severe damage:

Demolish and rebuild column. Temporary props required.

Small column:

Add a layer of reinforced concrete around the existing column.

- Roughen the surface of the existing column to enhance bonding.
- Install additional reinforcement around the existing column: vertical ⅜" (10mm) bars and horizontal ¼" (6mm) at 8" (20cm) centres around the existing column.
- Apply formwork and pour new concrete around the column, ensuring proper vibration and curing.

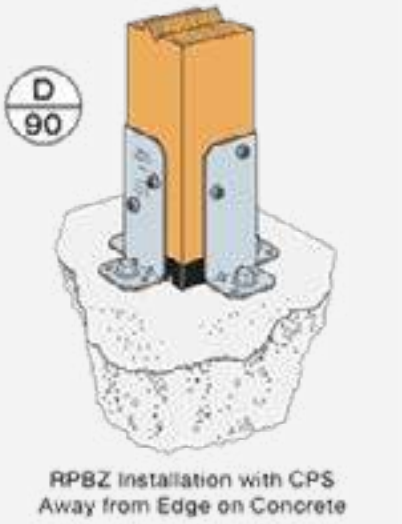
Apendages

Appendages, such as carports or veranda roofs, built with timber or metal frames, are detached from the main house structure. Their connections to the ground are secure, anchored on reinforced concrete pads or slabs, and show no signs of rust at the base plates or anchors.

WHAT TO CHECK

HOW TO RETROFIT:

Appendage connected to the house and poor ground connection: strengthen ground connection using new brackets, welding, bolts as needed. If the columns are too close to the concrete slab or pad border, u-shaped plates with stiffeners to generate distance and space for anchorages.

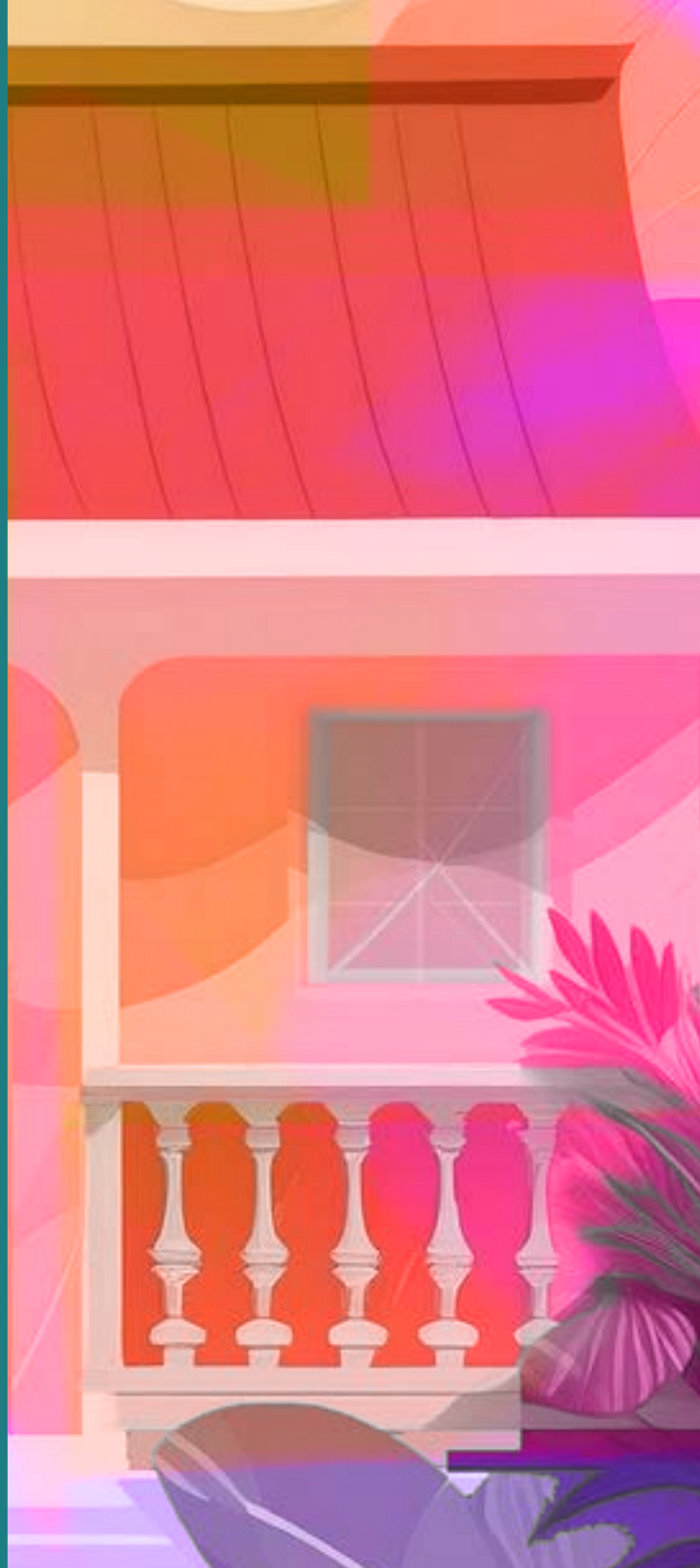


Appendage connected to the house and weak structure: retrofit structure as needed including new timber and steel elements.

2.4

Structural Retrofit Evaluation and Design

TIMBER HOUSE PACKAGE



2.4.1 FOUNDATIONS

The timber house package addresses vulnerabilities in single storey, timber stud wall houses, either founded on grade or raised foundations.

The 2024 national survey of existing housing found 89 percent of timber houses to have high vulnerability. For households with increased socioeconomic vulnerability, this increased to 100 percent of households. Timber houses are a priority area for retrofit.

It is strongly recommended that the deficiencies in timber houses are addressed together in one package.

This section 2.4.1 guides the user through evaluation and retrofit design for the two most typical foundation types for timber houses: on grade and raised on piers.

Timber Houses on Grade

CONNECTION OF WALLS TO FOUNDATIONS:

There is a min. 2" x 4" sill plate at the base of all walls, bolted to the foundation at wall ends and at max. 4ft (1.2m) centres. Hold-down bolts are also located at wall intersections, wall ends and door jambs.

The sill plate is in fair condition, and is protected from moisture in the slab or foundation, or is pressure-treated.

The studs are connected to the sill plate with metal straps (min 6 + 6 nails on each side of post - metal strap length 24").

RETROFIT BASED ON DEFICIENCY

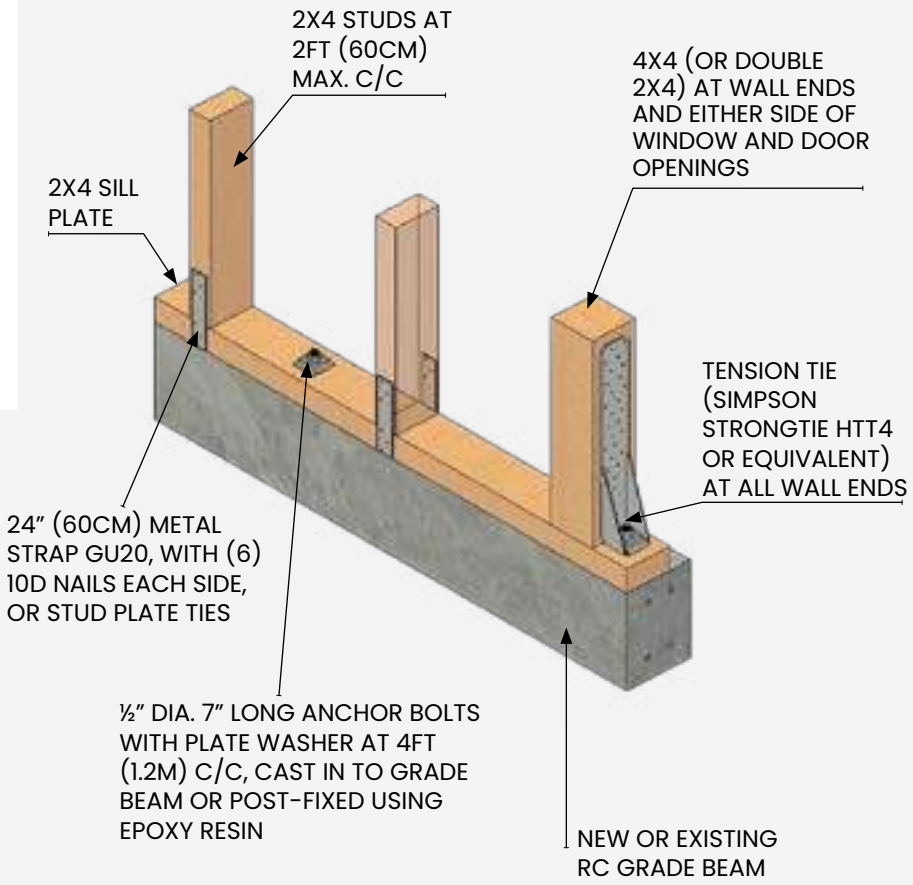
Insufficient sill plate: Add or replace sections of the sill plate.

Insufficient anchor bolts: Using epoxy resin, post-install new ½" anchor bolts, length 7", spaced at max. 4ft (1.2m) centres, and at wall intersections, wall ends and door jambs.

Insufficient studs connections: Hold down metal straps added to studs

Strengthen Studs connections: using metal clips or straps.

Plate Anchorage: add bolts as necessary



Timber Houses on Piers

PIER GEOMETRY AND CONDITION:

Piers are stone, block masonry, or concrete, min. 16" x 16" (40 x 40cm), and located at 6ft (2.4m) maximum spacing.

Piers' height is less than 4ft (1.2m) and they are embedded into the ground by min. 1.5ft (50cm).

They are in good condition, with no signs of excessive damage, degradation or settlement.

RETROFIT BASED ON DEFICIENCY

Insufficient sill plate: Add or replace sections of the sill plate.

Insufficient anchor bolts: Using epoxy resin, post-install new ½" anchor bolts, length 7", spaced at max. 4ft (1.2m) centres, and at wall intersections, wall ends and door jambs.

Insufficient studs connections: Hold down metal straps added to studs

HOW TO RETROFIT

The retrofit techniques for piers supporting timber houses are the same as those used for masonry houses. Refer to pages 69-70 for details.

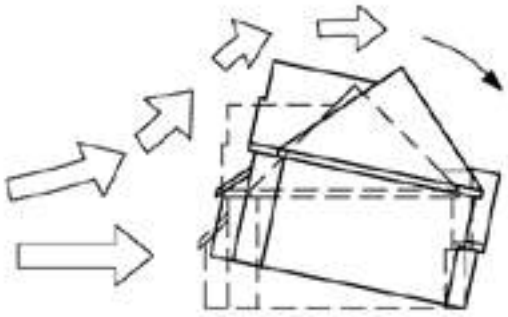
Timber Houses on Piers

ANCHORAGE:
The timber superstructure is adequately anchored to the piers to prevent uplift or sliding.

RETROFIT BASED ON DEFICIENCY

- Look for metal straps, bolts, or brackets that secure the timber frame to the piers.
- The connectors should be intact and show no signs of rust, corrosion, or looseness.
- Ensure that each pier has a minimum of one anchor connection to the superstructure.
- Anchors should be evenly distributed to resist uplift and sliding forces.

SLIDING



OVERTURNING

Timber Houses on Piers

HOW TO RETROFIT HOUSE ANCHORAGE TO PIERS:

Damaged timber:

Remove and replace with pressure-treated, structural grade timber (minimum Southern Pine grade **2 or equivalent).**

Insufficient connection:

The connection between the timber walls, floor and pier foundation is critical for stability in earthquakes and hurricanes. As there is a lot of variation in the configuration of pier foundations and the type of connection, it is recommended to an engineer carry out site specific design calculations based on the following considerations:

- **Replace rusted or corroded fasteners** (bolts, screws) with new corrosion-resistant materials (hot-dip galvanized or stainless steel fasteners). If necessary, increase the number or size of fasteners. Ensure all fasteners are fully tightened.
- **Add galvanized or stainless steel connectors** (e.g., L-brackets, U-brackets, angle brackets) to tie the timber to the pier. Anchor the brackets to the pier using expansion bolts or epoxy-embedded bolts, ensuring adequate embedment depth. Fix the bracket to timber screws or nails. Always follow manufacturer installation instructions.
- **Improve uplift resistance by adding metal tie-down straps or hold-down brackets** that tie the timber frame to the piers more securely.

Timber Houses on Piers

ANCHORAGE:

Suspended floor: The floor deck has joists spaced at max. 2ft (60cm) centres with maximum spans as follows:

- 2" x 6": max. span 8' 6" (2.6m)
- 2" x 8": max. span 10' 10" (3.3m)

The joists are supported by a timber beam anchored to the piers below and are covered with either:

- **Boards:** min. 1x6, nailed with (2) 8d common nails at intermediate supports and (3) 8d common nails at boundary members.
- **Plywood:** min. ⅜" (10mm) thick, 4ft x 8ft (1.2m x 2.4m) panels (except at edges), nailed to joists at 6" (15cm) centres with 8d common nails.

All elements are in good condition with no sign of damage, rot or water damage, or insect attack.

HOW TO RETROFIT HOUSE ANCHORAGE TO PIERS:

- **Damaged elements:** replace rotten, cracked or damaged timber elements.
- **Visibly sagging or undersized joists:** add new joist or sister existing joists with new ones (remove deck to execute the work) or add an additional supporting beam.

Timber Stairs

STAIRS:

All timber elements are in acceptable condition, without signs of significant decay, rot, termite or other insect attack, or cracking or warping.

There are sufficient fasteners or connectors between timber elements, and the fasteners are not rusted or loose.

There are no signs of settlement, tilting or gaps between the stairs and the main house structure.

HOW TO CHECK

HOW TO RETROFIT STAIRS:

- **Timber is damaged or in poor condition:** Remove and replace any rotten or damaged timber (treads, risers, stringers, and posts) with pressure-treated wood.
- **Loose or rusted connections:** Securely fasten connections. Replace existing fasteners with stainless steel or galvanized screws, nails, and brackets
- **Visible settlement, tilting or gaps:** Demolish existing stairs and foundation. Recompact soil (excavate deeper if needed) and improve site drainage if necessary. Build a new foundation and new stairs.

2.4.2 WALLS

The timber house package addresses vulnerabilities in single storey, timber stud wall houses, either founded on grade or raised foundations.

It is strongly recommended that the deficiencies in timber houses are addressed together in one package.

This section 2.4.2 guides the user through evaluation and retrofit design for common structural deficiencies with timber walls. Follow the guidance in section 2.4.1 for timber house foundations, and section 2.2 for timber house roofs.

Walls Configuration

WALL LENGTH

In each wall, the total length of solid wall (excluding windows or doors) is at least:

REINFORCED OR CONFINED MASONRY

	Perimeter Walls	Interior Walls
15/32" wood structural panels - sheathing	10%	15%
19/32" wood structural panels - sheathing	10%	15%
3/8" plywood siding	15%	30%
1 x 6 diagonal lumbar sheathing	15%	25%

Total length can be made up of several wall segments. Minimum length for each segment: 3ft (1.0m)

Parallel walls are spaced a maximum of 11.5ft (3.5m) apart.

RETROFIT BUILDING NEW WALLS

Insufficient wall lengths (or walls are built with temporary materials):

- Build new structural timber wall to meet length requirements. Build new foundations if necessary.
- Infill or move an opening or change plywood until minimum length requirements are met.

The principals behind the guidance for timber and masonry wall configuration is similar. Refer to page 75 for graphics and an example for masonry walls.

Framing

FRAMING:

Walls are max. 8ft (2.4m) tall, measured from floor to top of top plate, and framed with min.

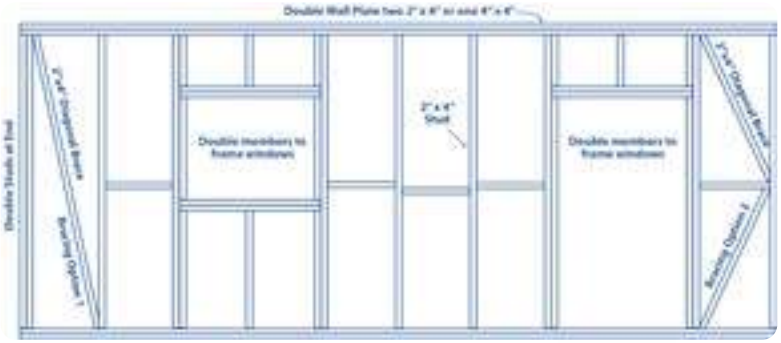
2''x 4'' vertical studs spaced at max. 2ft (60cm) centres. Framing is in fair condition.

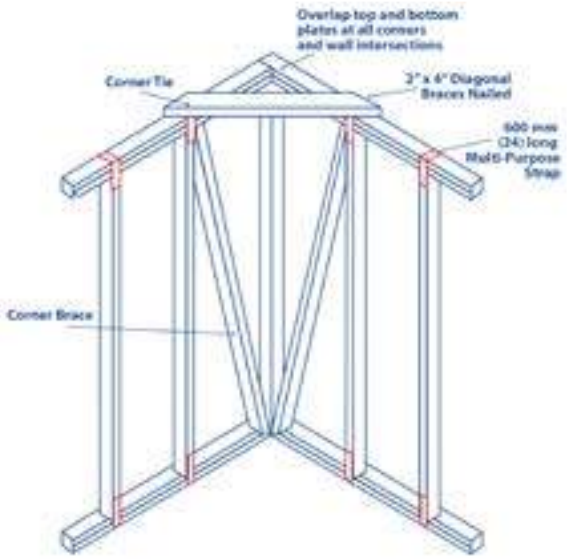
Wall intersections, wall ends and door jambs have double 2"x4" studs or 4"x4" posts.

Wall openings are framed on either side, above and below by double 2"x4" members (or a single 4" x 4").

The wall studs are connected to the top plate with hurricane straps or metal connectors Strap min. gauge 20, length 24" (60cm) with 6+6 8d nails.

WALL FRAMING ACCORDING TO THE GUIDE TO DOMINICA'S HOUSING STANDARDS





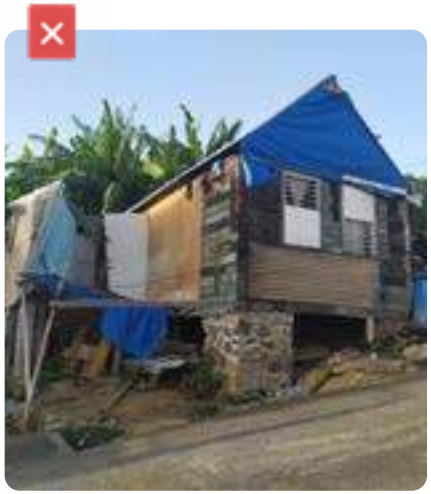
HOW TO RETROFIT TIMBER WALL FRAMING TO PIERS:

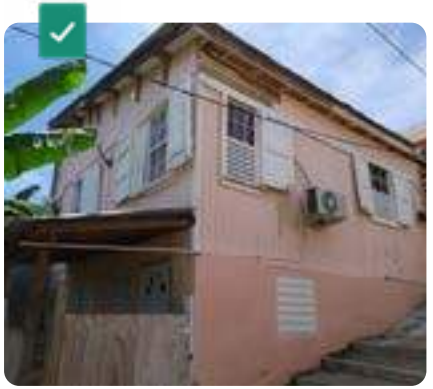
- **Insufficient framing:** Install new 2"x4"s to meet requirements for max. stud spacing and openings.
- **Framing in poor condition:** Replace damaged or rotten elements, or elements with mold. Install or repair moisture barriers.
- **Insect attack:** Treat existing timber with a wood preservative that deters termites and other wood-boring **insects.**

Cladding

TIMBER CLADDING:

All framing is covered on at least the exterior side with diagonal boards (min. ⅝" thick) or plywood (min. ½" thick), adequately fastened to the wall framing. Covering and fasteners are in fair condition.





HOW TO CHECK ADEQUATE FASTENING:

½" plywood: 8d nails at 4" (10cm) centres at wall edges (corners, doors and windows) and at 1ft (30cm) centres at intermediate studs.

⅝" plywood: 10d nails at 4" (10cm) centres at wall edges (corners, doors and windows) and at 1ft (30cm) centres at intermediate studs.

HOW TO RETROFIT WALL CLADDING:

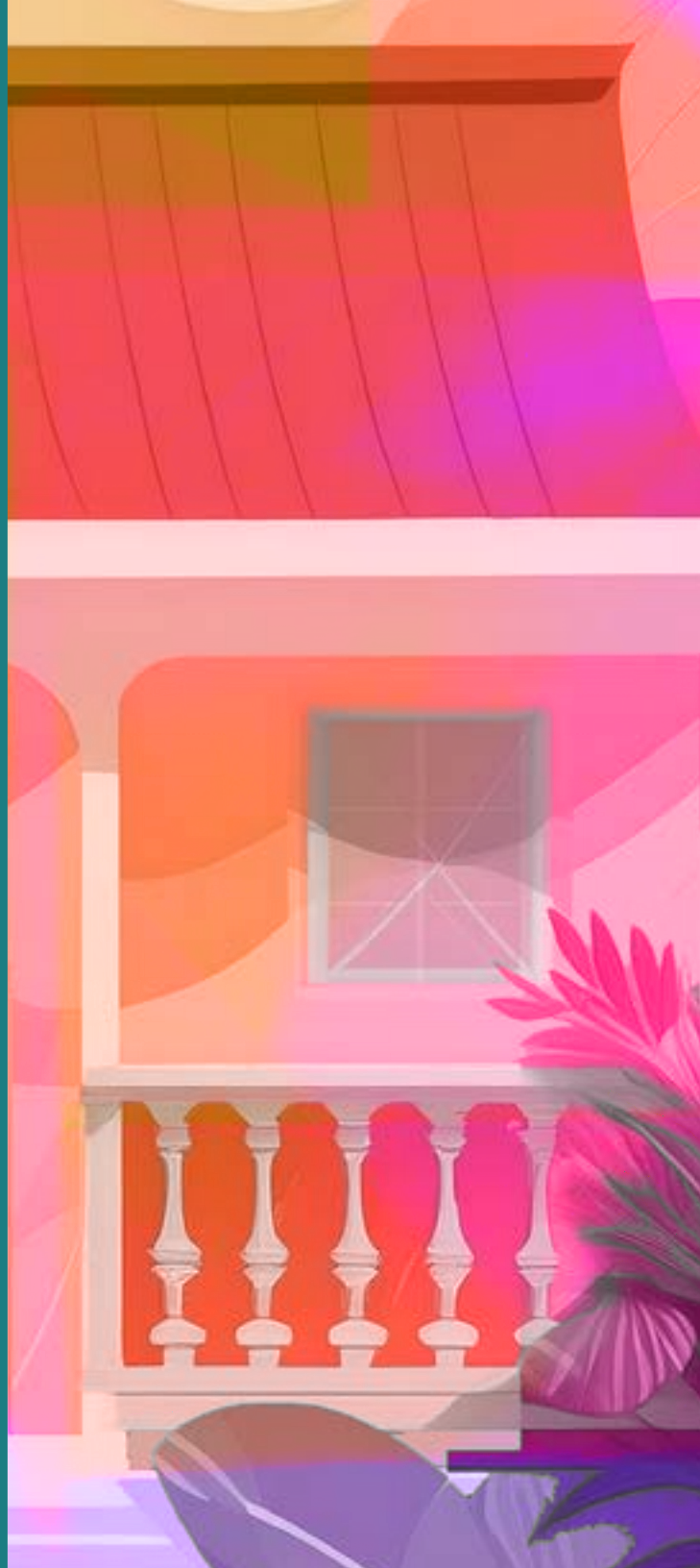
Panels and boards: Replace cladding in all areas that are damaged, badly deteriorated or missing.

Insufficient fastening: Add nails as necessary to meet minimum requirements. Replace all rusted metal connectors. Use galvanized or stainless steel fasteners resistant to rust and corrosion in exterior applications.

2.5

Structural Retrofit Evaluation and Design

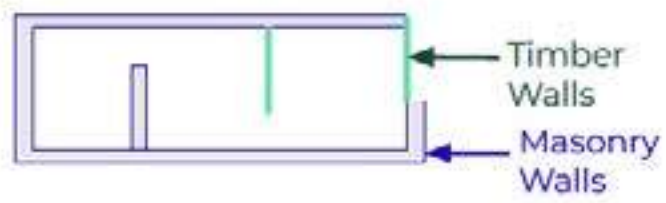
MIXED TIMBER & MASONRY HOUSES



Introduction

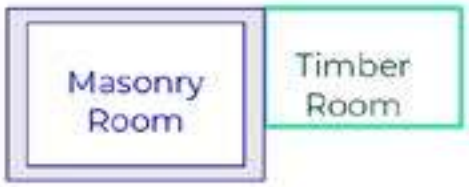
CASE 1: TIMBER WALLS

The majority of the walls are masonry. Only a few walls—either interior partitions or sections of the exterior perimeter—are timber.



CASE 2: TIMBER ROOMS

The house has some rooms that are built with three or more masonry walls, and some that are built with three or more timber walls.



CASE 3: TIMBER STOREYS

The house has two storeys. The ground floor is built will masonry walls, the first floor is built with timber walls.

! The main challenges with mixed houses are because:

- Timber and masonry behave differently in termsof how they move, resist moisture, and resist hurricane and earthquake loads.
- Joints between the two materials have the potential to be weak structural connections and thermal bridging between parts built with different materials.

Retrofit Case 1: Timber Walls

The simplest and most effective retrofit is to demolish the timber walls and replace them with block walls.

This approach eliminates compatibility and connection issues between different materials, resulting in a fully masonry structure with more predictable structural behavior. It also reduces the risk of leaks.

For more information, see:

- **Chapter 6** for details of connecting new to existing masonry walls.
- **Dominica Guide to the Housing Standards** for details of reinforced or confined masonry block construction.

Examples of unstable masonry walls due to adjacent timber walls

! Block masonry walls that are not supported at each end by a perpendicular block wall may be unsafe in a hurricane or earthquake.

Retrofit Case 2: Timber Rooms

The simplest and most effective retrofit is to demolish the timber walls and replace them with block walls.

1. **Create two independent structures** separated by a 1" (3cm) wide gap. Each structure should be evaluated and retrofitted according to Sections 2.1-2.4
2. **Strengthen the connection between the timber and masonry rooms** using steel brackets, tie rods, or hybrid timber-masonry anchoring systems. The required force resistance and connection details will vary depending on the specific house configuration and should be determined through engineering design and structural analysis.

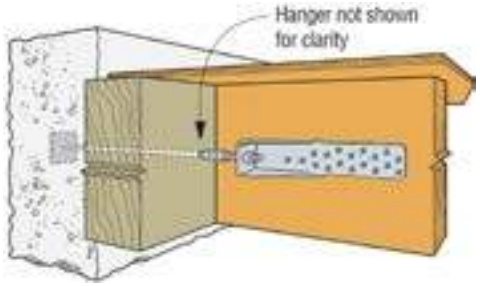
CASE 2 EXAMPLE STRUCTURE

! Timber is vulnerable to moisture, especially where it meets masonry, leading to decay and mold.

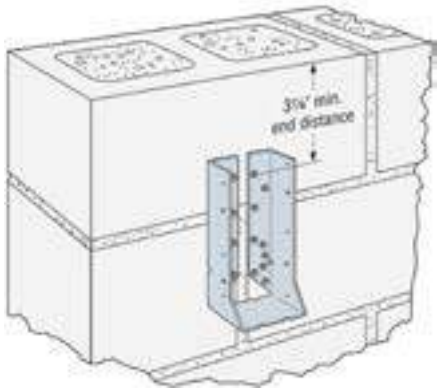
A capillary break shall be placed between timber and masonry to prevent moisture from wicking into the wood.

This non-absorbent barrier can be done with bitumen felt, polyethylene sheeting, or a metal flashing.

Examples of connections for timber to masonry (Source: Simpson Strongtie)



SIMPSON STRONGTIE
HTT5 TENSION TIES



SIMPSON STRONGTIE
HUC JOIST HANGERS

Retrofit Case 3: Timber Storeys

Evaluate and, if necessary, retrofit each storey separately.

Follow the guidance in Sections 2.1-2.4 for timber and masonry structures.

Is is particularly important that the timber first floor is securely anchored to the reinforced concrete slab or ring beam. This connection can be retrofitted in the same way as a timber house on grade, see Section 2.4.

EXAMPLE OF MIXED HOUSE ON ELEVATION - LOCATION: SAINT GEORGE, ROSEAU.

! The anchoring method for the timber structure follows the same principles as those used for securing timber walls to foundations, utilizing steel anchors and plates.

3

Dominica Home Retrofit Guide

SITE AND SURROUNDINGS

Introduction to Site Hazards and Retrofits

The guidance in Sections 2.1-2.5 focuses on mitigating the risks from hurricanes and earthquakes through structural retrofits.

Houses in Dominica are also exposed to many other hazards, such as flooding and landslides, which are more difficult to mitigate at the building level. They are best managed through larger scale interventions, or even relocation if in high risk areas.

The section presents guidance on site level mitigation measures for houses in moderate risk areas or with localised flooding or slope stability issues.

! This guide does not provide retrofit measures for sites at high risk of landslides, flooding or sea surge.

HOW TO CHECK:

For all site hazards, take the following first steps:

1. **Consult available hazard and risk maps**, or site specific hazard studies that were done for construction on nearby sites. Hazard maps can be found at:
   https://physicalplanning.gov.dm/land-use-and-development/maps
2. **Take site measurements.**
   Using a long measuring tape, laser meter, or GPS-based measuring tool, measure the horizontal distance between the house and cut slopes, retaining walls, the coast and any type of waterway.
3. **Talk to the homeowner and neighbouring residents** to understand how site hazards have affected the area in the past and what mitigating action that has been taken.

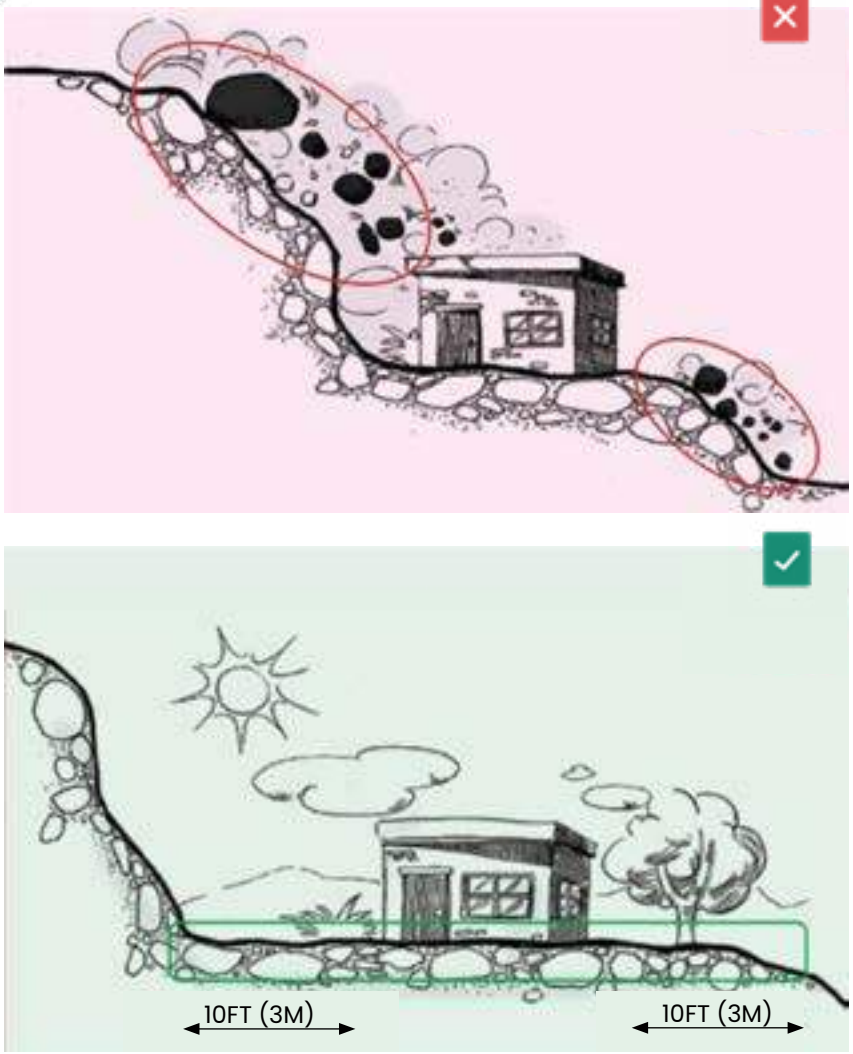
Slope Stability

SLOPE STABILITY:

The site is not observed to be in a high risk area for landslide due to at least one of the following reasons:

- The site has a slope of less than 15%.
- The building is at least 10 feet (3m) from steep slopes or cliffs (slope >30%).
- Steep slopes or cliffs (slope >30%) located less than 10 feet (3m) from the building are supported by adequate retaining walls.
- There is no evidence of past landslides above or below the site.

HOW TO CHECK:



! This manual does not provide retrofit measures for unstable or high-risk slopes.

Retaining Walls

ALL SITE AND FOUNDATION RETAINING WALLS ARE:

- Adequately drained with weep holes and drain pipes.
- In acceptable condition, with no evidence of deterioration, damage, cracks, settlement or tilting, spalling, or corroded reinforcement..

SITE RETAINING WALLS ARE ONE OF THE FOLLOWING:

- More than 10ft (3m) from the house.
- Less than 10ft (3m) from the house and less than:
- 6ft (2m) tall if they are gravity walls
- 10ft (3m) tall if they are reinforced concrete
- Supported by buttresses, RC columns, or other adequate system.

FOUNDATION RETAINING WALLS ARE EITHER:

- Less than 5ft (1.5m) tall
- Supported by buttresses, RC columns, or other adequate system.

INTEGRAL RETAINING WALLS ARE:

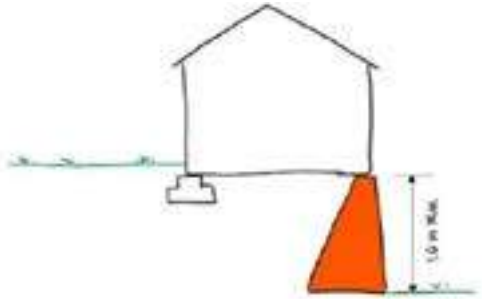
- Sufficiently restrained at the top by a beam or slab to prevent outward movement, AND
- Less than 8ft (2.4m) tall, OR
- Supported by buttresses, RC columns, or other adequate system.

Retaining Wall

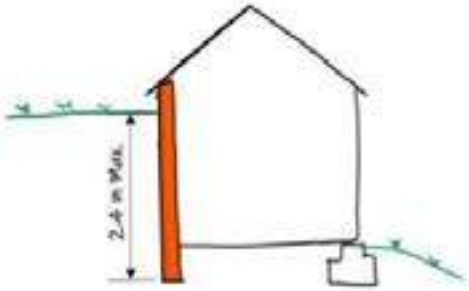
HOW TO CHECK

Identify existing retaining walls and measure their height and distance from the house:

Site Retaining Walls do not form part of the foundations or walls of the structure of the house.



Foundation Retaining Walls occur when the house is built on fill. The downslope foundation is also a retaining wall for the fill material.



Integral Retaining Walls are integrated into the house and form part of its wall system. They occur when the house is built on a cut slope.

Retaining Walls

HOW TO RETROFIT:

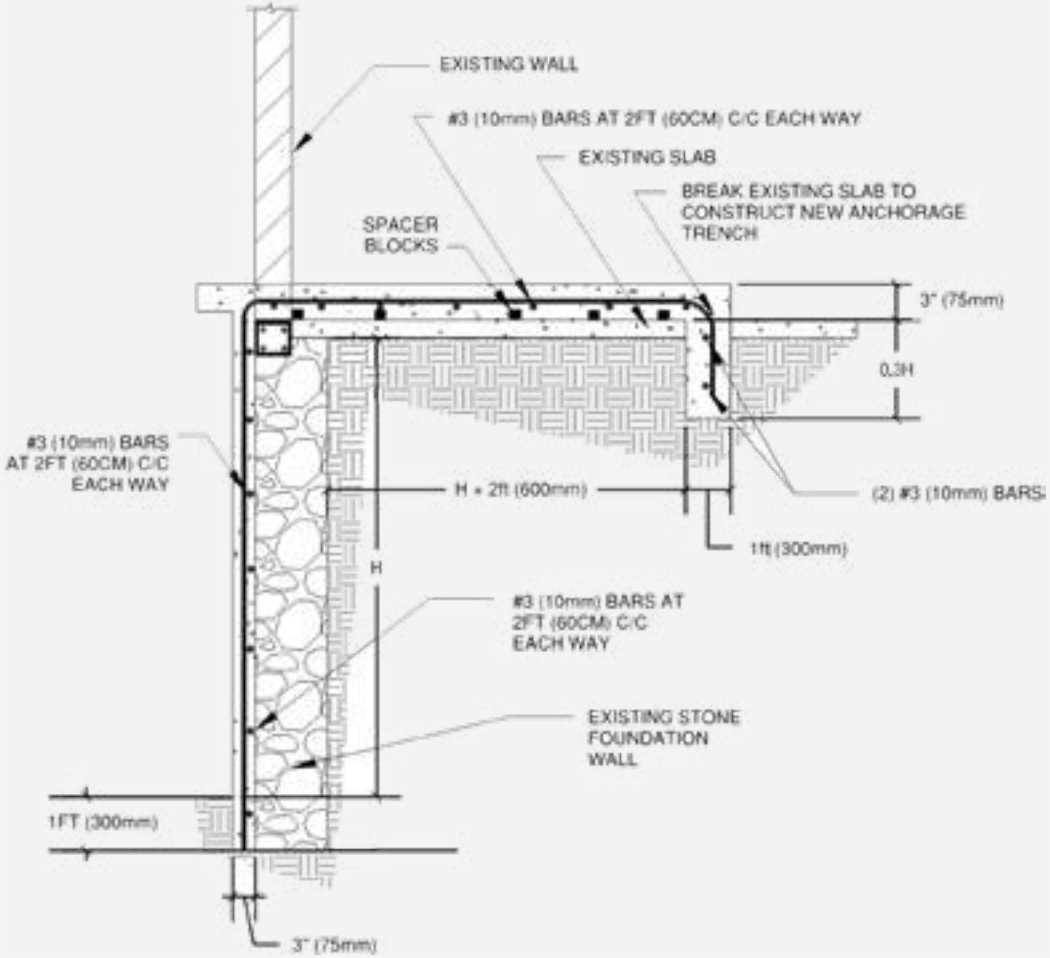
For tall walls, add lateral restraint through RC columns at 11.5’ (3.5m) or buttresses or mesh plaster.

Build weep holes:

- Drill 100mm diameter hole through the wall thickness.
- Drill a hole every 2m along the wall, with a slope of 2%, located right above the ground level.
- Install a PVC pipe (3” diameter) and seal with fluid mortar as needed.

Repair minor damage and cracking with cement mortar.

For foundation retaining walls in poor condition:



! Site or foundation retaining walls in severe conditions, with damages, settlements and/ or tilting might generate no-feasibility of the retrofit project through this guide.

Flooding

The site is not observed to be in a high risk area for flooding or sea surge because:

SEA SURGE

- The horizontal distance between the building and the coastline (spring tides high water mark) is at least 100ft (30m) (reduced to 50ft (15m) if cliffs), **AND**

FLOODING

- There is no standing water on the site and the homeowner has not raised this as a common issue, **AND**
- The site is at least 4ft (1.2) above mean sea level and the building is at least 30ft (10m) from the nearest river, **OR**
- The building is elevated at least 3ft (1m) above

! The topsoil that is removed when constructing site drainage systems is a valuable resource. Store the topsoil separately, in shallow piles, and reuse it as quickly as possible.

HOW TO RETROFIT

Regrade the site to ensure surface water is directed away from the foundations by land slopes away from the house (2-5% min.) to direct surface water away from the foundation.

Inspect and clean out existing drainage systems: *such as* stormwater pipes or culverts, to ensure they are not blocked and are functioning properly.

Install or repair drainage systems:

- **French Drains:** Install a french drain system (a perforated pipe buried in gravel) to channel water away from the site.
- **Surface Drains:** Add surface drains (e.g., catch basins) to collect water in low spots and divert it to an appropriate discharge point.
- **Install swales** (shallow ditches with gentle slopes) to direct water toward drainage points or away from the property.
- **Gutters and Downspouts:** Ensure that gutters and downspouts are in good condition, free of clogs, and extended far enough away from the house to prevent water pooling **near the foundation.**

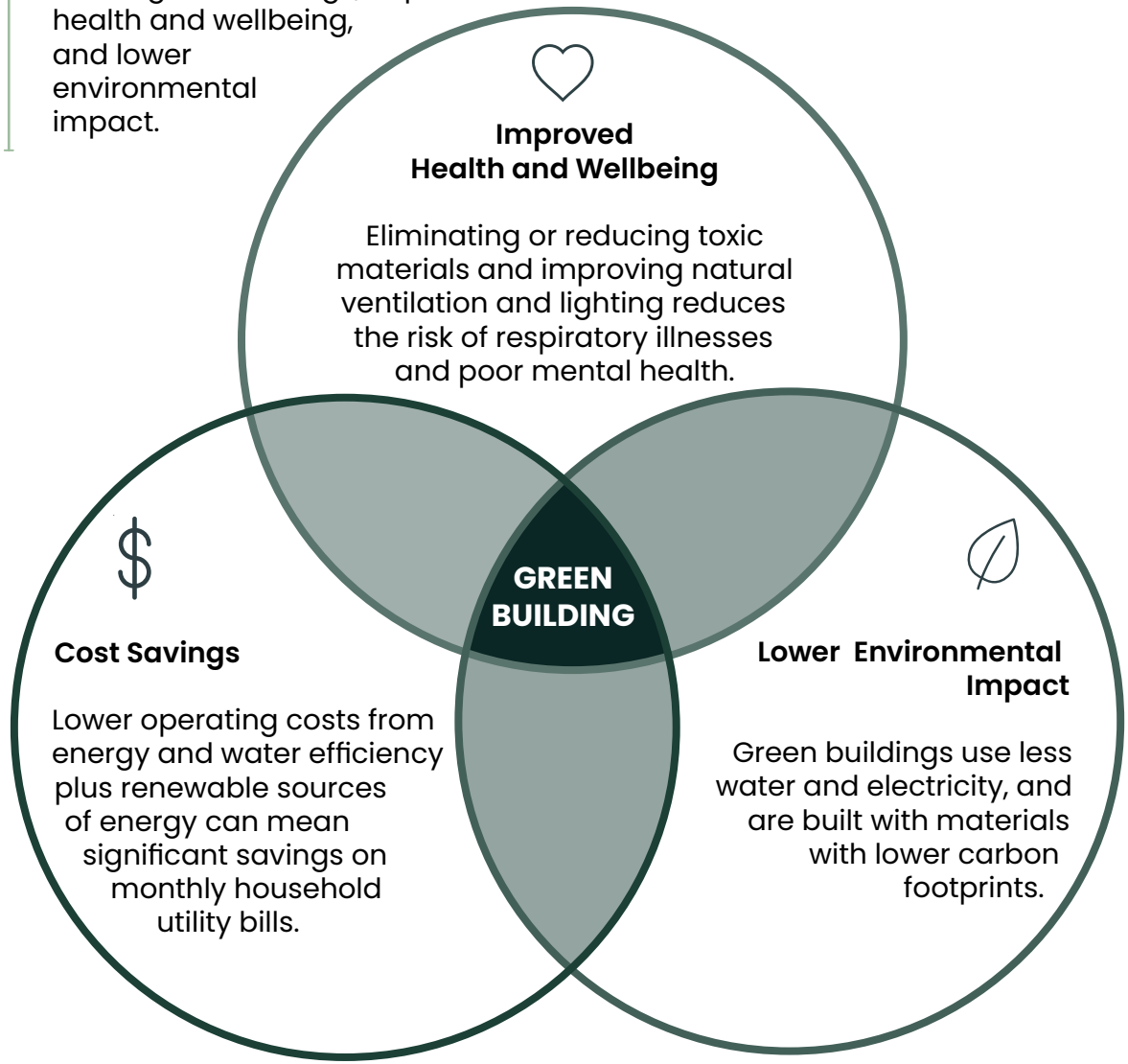
4

Dominica Home Retrofit Guide

HABITABILITY AND GREEN BUILDING

What is green building?

Green building means using fewer and more environmentally friendly resources, both in construction and during building use. There are three main benefits to green building: cost savings, improved health and wellbeing, and lower environmental impact.



Key considerations for green building in Dominica:

- Natural lighting and ventilation
- Shading and the building envelope
- Energy efficient lighting and appliances
- Renewable Energy
- Water Efficiency
- Sustainable, non-toxic materials

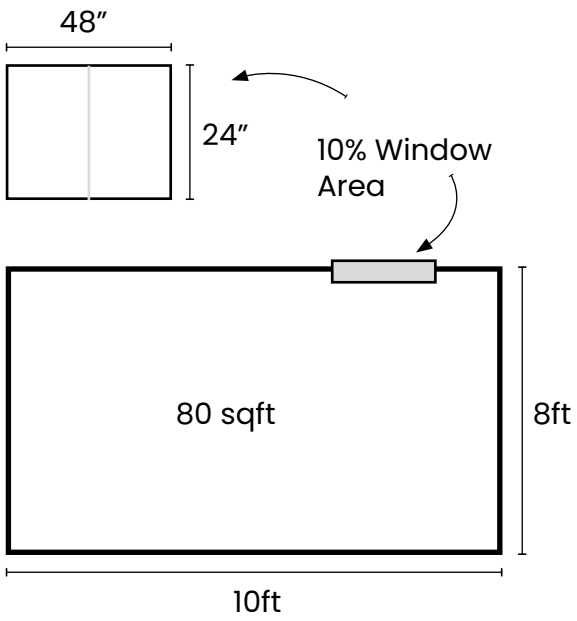
Natural Lighting and Ventilation

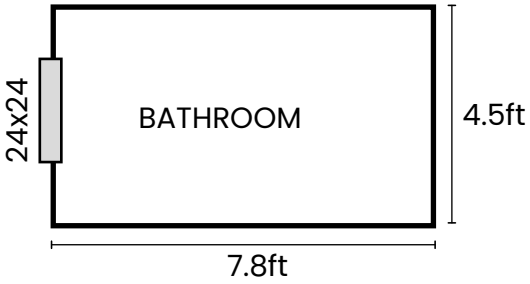
According to the building code, **all efforts shall be made to provide natural lighting and natural ventilation to each space in the building in such a way that artificial lighting and/or ventilation is not necessary or reduced to a minimum**. [503.6a]

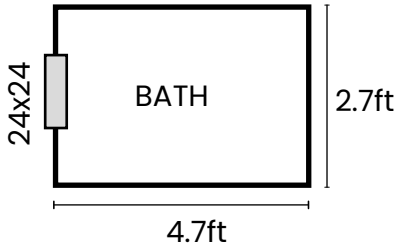
Each room must have [503.6b]:
- at least one window.
- windows with a combined area not less than 10% of the floor area of the room.

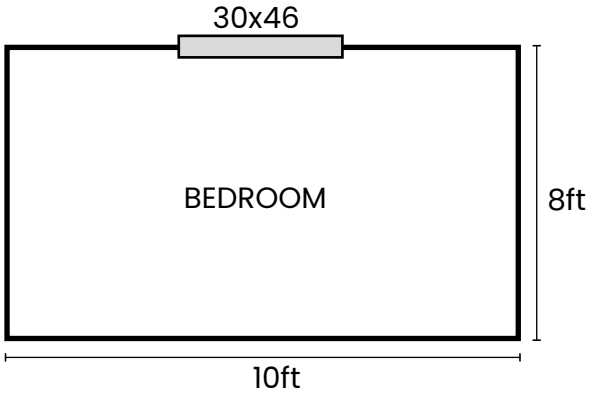
Each window must have [503.6b]:
- 50% area that can be opened to allow free flow of air.

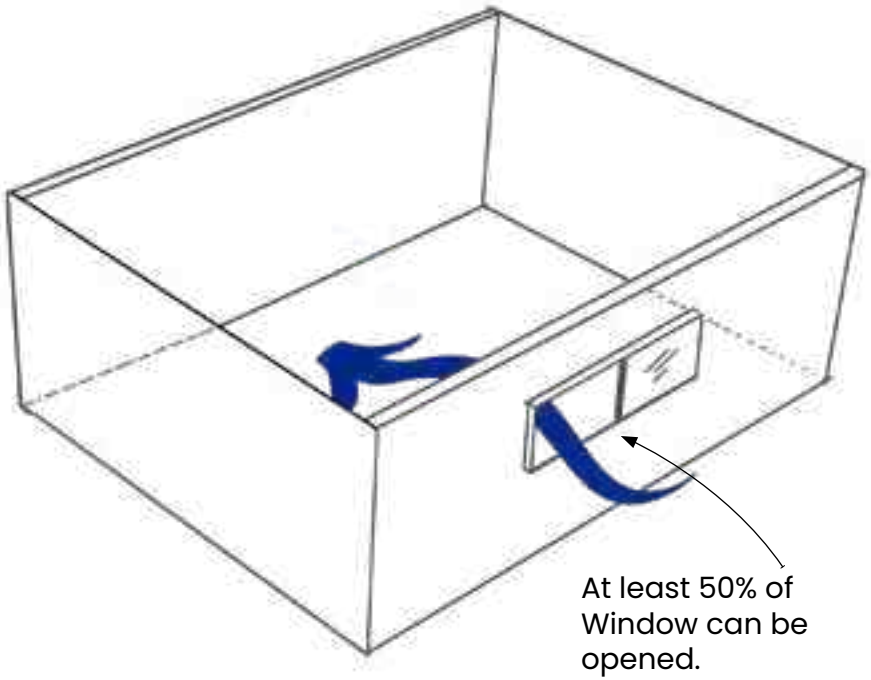
ROOM TYPE	ROOM SIZE Width (ft)	Length (ft)	Area (sqft)	MINIMUM REQUIRED WINDOW AREA (SQFT)	EXAMPLE WINDOWS(IN)
Living, Dining or Open Plan	8.0	10.0	80	8	(1) 30 X 46
	10.0	12.0	120	12	(1) 48 X 36
					(2) 24 X 46
	10.0	20.0	200	20	(2) 36 X 48
Bedroom	8.0	11.3	90	9	(1) 30 X 46
					(2) 24 X 36
Kitchen or Bathroom	2.7	4.7	12.5	1.25	(1) 24 X 24
	4.5	7.8	35	3.5	(1) 24 X 24

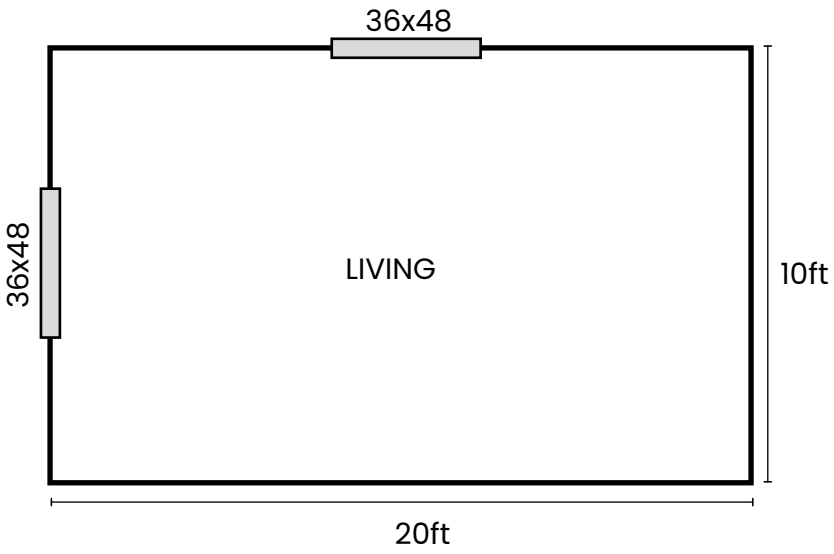

48″
24″
10% Window Area
80 sqft
8ft
10ft


24x24
BATHROOM
4.5ft
7.8ft


24x24
BATH
2.7ft
4.7ft


30x46
BEDROOM
8ft
10ft


At least 50% of Window can be opened.

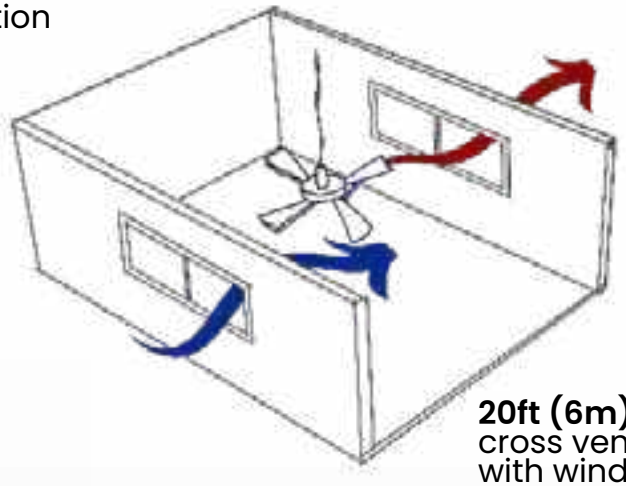

36x48
36x48
LIVING
10ft
20ft

Natural Ventilation

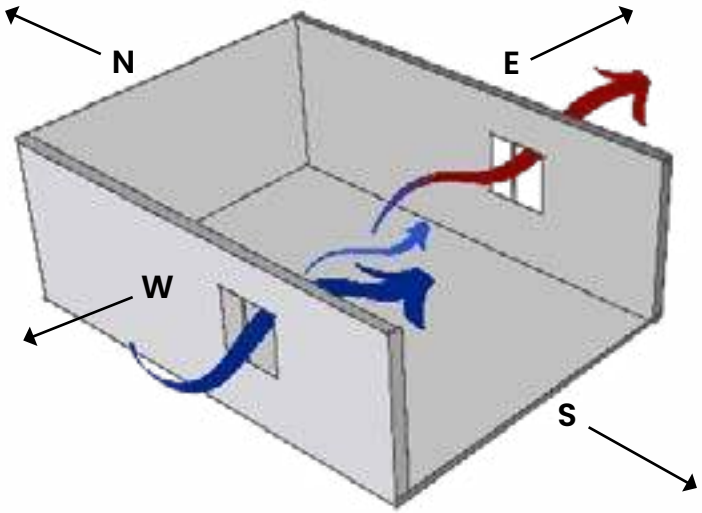
NATURAL VENTILATION IS MOST EFFECTIVE IF ROOMS HAVE:

- Multiple windows.
- Windows opposite each other. Windows facing East, North East, or South East.
- Windows that are not blocked by other buildings.
- Open floor plans.

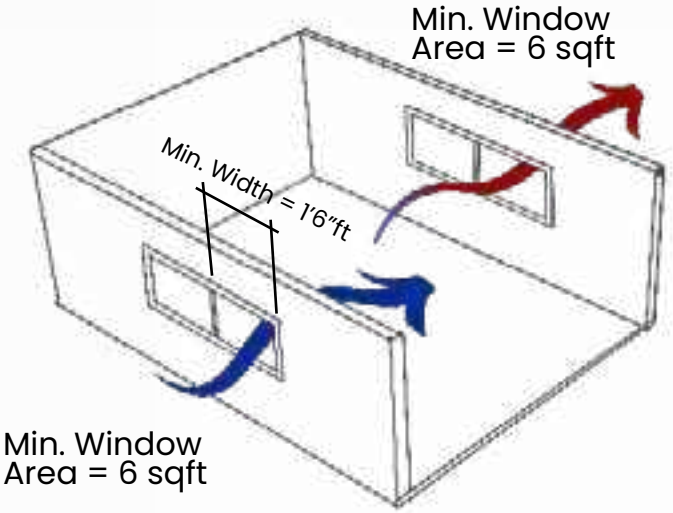
Fan for mixed-mode ventilation



20ft (6m) depth = cross ventilation with windows on opposite walls.



Placing windows at the east and west will ease cross ventilation.

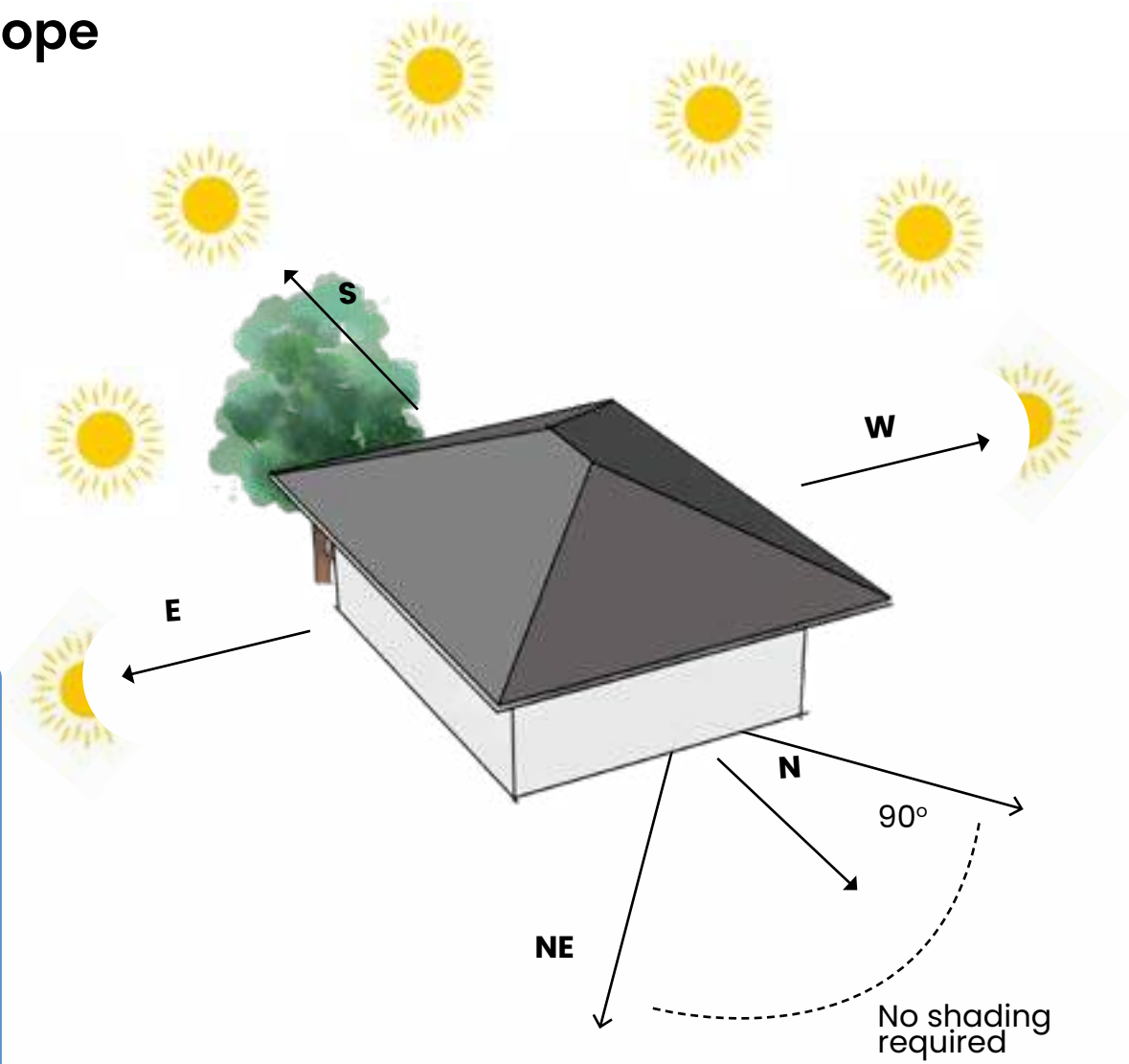


Min. Window Area = 6 sqft

Room Area = 120 sqft

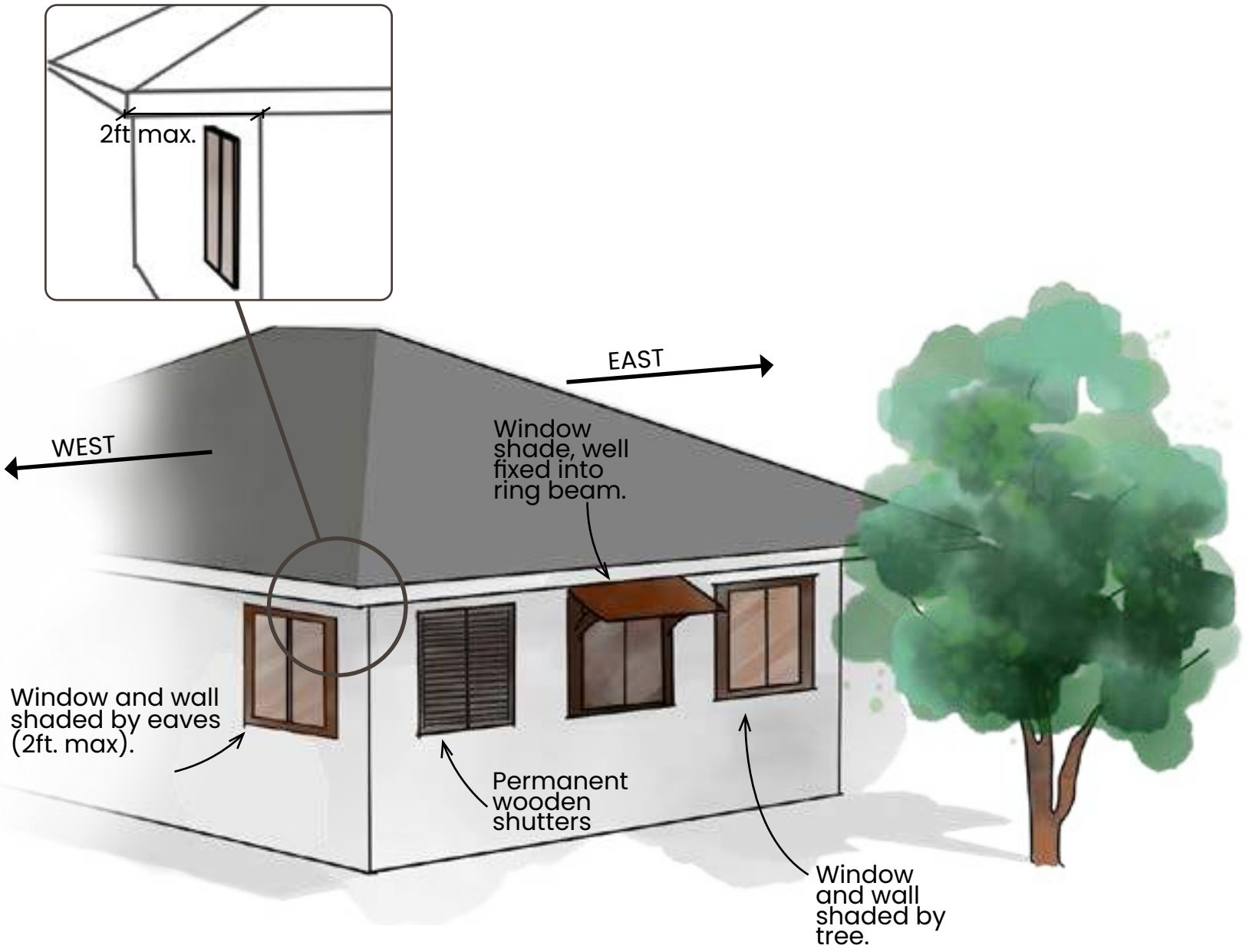
Shading and Building Envelope

- Optimizing the building envelope and shading helps to keep the house naturally cooler.
- Some materials, such as glass, transfer heat quicker than others. To keep homes cool, the building code recommends shading as a top priority.
- It is essential that shading structures are designed for hurricane winds and well attached to the main structure. Trees should be well maintained.



- All windows not within 45 degrees of North shall be shaded with either an overhanging eave or a permanent shading device [502.1d]
- If shading is not possible, a low-E or reflective glass can be used [502.1d]
- Low slope roofs (less than 2:12) must be minimum 75% shaded or have an initial solar reflectance index of 75 [502.1d] (ie a white galvanize)

Shading and Building Envelope



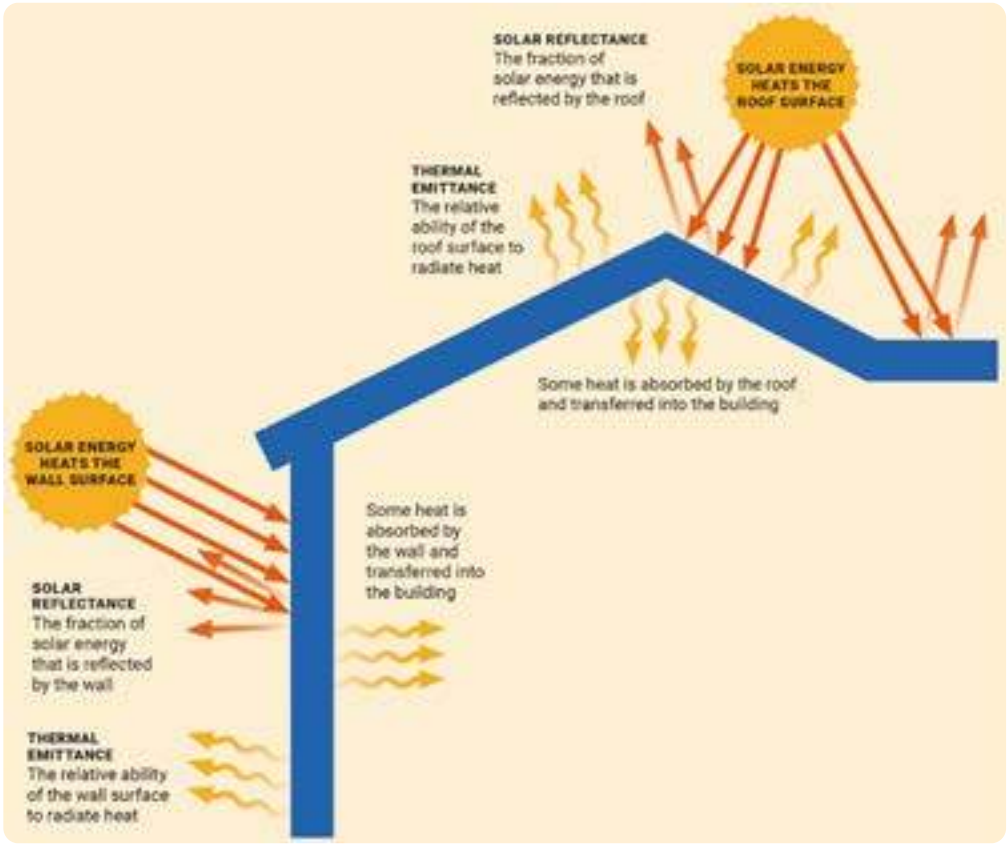
Shading and Building Envelope

Where shading is not possible, it is best to **use roof and wall materials that are reflective, light colours, and with low heat transmissivity** (low U-values) to keep the house cool.

For houses without air conditioning, this will help to keep the house **naturally cool.** For houses with air conditioning, this will **reduce how often and how high the unit needs to be run.**

When existing roof sheets or wall paint need replacement, consider using more reflective options by choosing:

- **White, or very light coloured materials**
- Paints of any colour with added infrared reflective **pigments**
- Materials with a **high solar reflective index** (75 or higher) using tools like the Cool Roof Rating Council's roof directory https://coolroofs.org/directory/roof



Low-sloped roofs (less than 2:12) shall be either at least 75% shaded, or shall provide an Initial solar reflectance index of 75 [502 (d)]

Shading and Building Envelope

COOL ROOFS

Using highly reflective materials on the roof is often referred to as a cool roof. Cool roofs have been proved to be **one of the most effective strategies for lowering indoor temperatures**, and some can also **increase the longevity** of the roof and **improve watertightness.** Cool roof coatings can been applied to existing roofs, and can be silicone-, acrylic-, or polyurethane-based.

APPLYING A COOL ROOF COATING TO AN EXISTING ROOF:

1. **Clean the roof.** The roof must be clean, free from dust, grease, mildew and any previous coatings. Wait until the roof is completed dry.
2. **Repair any cracks (slab roof only)**. For details of crack repair, refer to section 2.
3. **Apply the coating.** Mix well and apply by spray, roller or brush. If multiple coats are applied, apply the first coat horizontally and the second coat vertically. Strictly follow the manufacturer's instructions on method, timing, and number of coats.
4. **Maintenance**. Follow any manufacturer instructions for ongoing maintenance.

Source: South African National Energy Development Institute

Artificial cooling and Ventilation

Design, installation and operation of mechanical HVAC systems are to [1102.1]:

- Provide a building environment that is safe, energy efficient, cost effective, healthy and comfortable
- Be sustainable, energy efficient, conserve water, minimize waste and reduce harmful emissions to the environment
- Operate at minimum 24oC, and provide at least 2 air changes per hour

Maintenance of Mini Split AC Units

Mini Split AC units do not bring fresh air into the home, they cool and recirculate the air in the room. This can lead to poor air quality and respiratory illness if the house is not well ventilated when the AC is switched off, or if the AC is not well maintained.

Once a month: clean the filter(s)

- Turn off the AC, open the front cover and take out the filter.
- Rinse with water and mild soap. If there is mold, wear a mask and gloves, and clean the filter outside. If the mold is heavy or the filter looks damaged, replace it.
- Allow to dry completely in the sun before replacing.

Twice a year: check the outdoor unit

- Remove leaves, dust, and rubbish from around the condenser.
- Make sure air can flow freely all around it and it is well shaded.

Once a year: service the unit(s)

- Full cleaning of the indoor coil and blower
- Check the refrigerant levels
- Confirm system is functioning safely and efficiently

Energy efficient lighting and appliances

ENERGY EFFICIENT APPLIANCES:

Energy efficient appliances such as fridges and washing machine, minimise the energy they consume.

After AC units, fridges are the biggest energy consumers in a home as they are working continuously. Consider switching to an energy efficient model when existing fridges need to be replaced or upgraded.

Energy efficient fridges should:

- **Be the right size** for the household. Consider refrigerators with a capacity of 14 to 20 cubic feet (>4 people).
- **Have a high efficiency compressor** (350kWh/year or less).
- **Have the freezer on top** (rather than bottom-mounted or side-by-side model).
- **Not have an automatic ice-maker** and/or through-the-door ice dispenser.

For all appliances, look for **energy efficiency certifications** by: *Energy Star, EU Energy Efficiency Labeling Scheme, Energy Technology Product List (ETL), or equivalent.*

Installing a smart meter can help to identify and manage how and when energy is being used.

LIGHTING

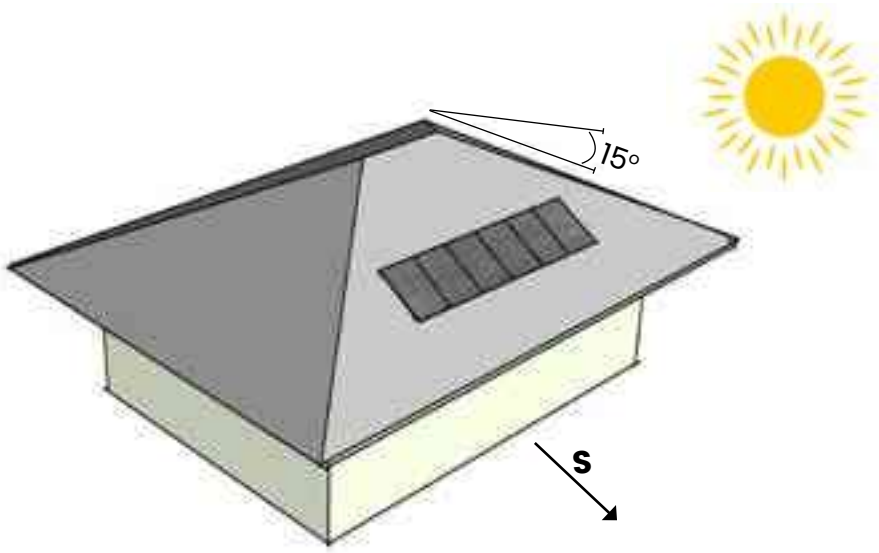
Switching standard incandescent bulbs for high efficiency LED bulbs reduces the energy used for lighting. It also reduces maintenance costs as the service life of LED bulbs is much longer.

Renewable Energy

SOLAR HOT WATER HEATERS

Solar hot water heaters are required by the building code for most homes as they offer a sustainable, low maintenance way to produce hot water and can provide significant savings on household electricity bills.

Buildings with average demand for 10 gallons (45 litres) or more of hot water per day shall provide a solar hot water heater for at least 75% of demand. Exemptions only permitted by demonstrating economic disadvantage. [902.5b]



SOLAR PHOTOVOLTAIC (PV) PANELS

Installing solar PV panels (or other renewable energy sources) has several key advantages:

- **Energy independence,** useful when the grid (DOMLEC) is down after hurricanes, or during load shedding or power outages.
- **Cost savings** due to lower or no use of electricity from the grid (DOMLEC). It usually takes around 10 years to pay back the initial investment before households see cost savings.

As the majority of Dominica's electricity is soon to be generated by geothermal energy, installing household solar will not reduce overall emissions.

Solar PV panels or collectors for hot water heaters should be:

- **Placed on a south facing roof,** ideally orientated as close as possible to 15o, and not blocked or shaded by trees or adjacent buildings.
- **Rated for hurricane-prone areas and anchored directly to the roof framing.** The roof framing should be designed for the additional load. Check with the wind load rating with the supplier.
- **Located in the centre of the roof,** at least 3ft (1m) away from the ridge, hip, gable end, or eaves, and not raised more than 10in (25cm) above the roof surface.

Water efficiency and storage

Dominica is fortunate to have abundant fresh water.

However, future projections indicate that **drought due to climate change will become more prevalent** in coming decades. Hurricanes, earthquakes, floods and other **hazards can temporarily interrupt fresh water supply systems.**

The following recommendations for water efficiency and storage will make homes more resilient against current and future hazards.

1. **Water storage and rainwater harvesting**

   Use of rainwater: Rainwater collected from roofs and stored in tanks may be used for irrigation, bathing, flushing toilets, and laundry.
   Rainwater should not be used for drinking or cooking unless it has been properly filtered and boiled (or otherwise treated).

   Roof materials: The preferred roof materials for rainwater collection are galvanised steel sheets or factory-coated metal roofing, as they produce cleaner runoff and are easy to maintain.

Storage tanks: HDPE or PVC tanks are recommended because they are lightweight, resistance to high temperatures and durable in humid, coastal environments.

Tank sizing: For a household of four people with normal, non-potable use: 1,200 litres ≈ water for ~15 days.

SOURCE: CARICOM EHI HANDBOOK ON RAINWATER HARVESTING FOR THE CARIBBEAN

Water efficiency and storage

Hurricane and earthquake safety: Tanks must be securely anchored to a concrete base or slab. Use straps, brackets, or restraint frames to prevent sliding or overturning. Elevated tanks should be structurally supported and braced; ground-level tanks are generally safer. Tank lids must be tight-fitting and secured to prevent wind uplift and contamination.

Water quality protection: Install a leaf screen at gutters and a first-flush diverter to reduce dirt, bird droppings, and debris entering the tank. Tanks should be fully covered, opaque, and mosquito-proof to prevent algae growth and mosquito breeding. Provide an overflow pipe directed away from the building foundation.

[814] The buoyancy of buried pipework will be increased by rising sea levels and rising groundwater levels [for coastal communities]. Design of buried pipework shall provide adequate anchorage against buoyancy for present conditions and expected conditions over the design life of the system.

2. Water efficiency

Consider the following water efficiency measures to help reduce the amount of water used in the home:

- **Install low-flow water fixtures** when toilets, faucets, or shower heads need replacing. Check with a plumber that the size and gradient of existing pipework will still be functional with a lower flow of water before making the change.

- **Upgrade to a high efficiency washing machine** when buying or replacing the washing machine

For houses on a metered supply, this will also help to **lower monthly bills.**

Sustainable, non-toxic and durable materials

Material durability

The tropical, coastal environment in Dominica is harsh on building materials. Sometimes the most sustainable (and cost-effective) choice is one that will be in use for the longest time. Consider using:

- **Galvanised fastenings,** and upgrading to stainless steel fastings in marine environments
- **High quality acrylic or silicate paint** for exterior walls
- Galvanised roof sheets with a factory-applied **UV-resistant finish.**

Sustainable timber

- **Look for FSC and PEFC certified timber** to guarantee it has come from sustainable forests and traceable supply chains
- **Prioritise timber that is locally/ regionally produced** - Trinidad, Guyana and Suriname.

Chemicals of concern

Chemicals of concern exist in many materials that are used in housing construction, with potentially severe impacts on the environment and human health. Two common chemicals of concern in homes are VOCs and formaldehyde:

- Choosing paint, solvents and caulking that are **low VOCs** (volatile organic compounds) with <50g/L. Most water-based acrylic paints meet this.
- **Avoiding plywood containing formaldehyde**, a toxin that can be common in cheap plywood, MDF or particleboard. Look for E0 or E1 or CARB Phase 2 / TSCA Title VI compliant rated boards where possible.

Moisture and mold

With Dominica's hot, humid climate it is important to use materials that allow homes to "breathe" without trapping moisture that will encourage mold growth. Avoid vinyl flooring or wall paper, or other materials that trap moisture.

5

Dominica Home Retrofit Guide

CONSTRUCTION PERMIT

What Regulations Must Home Retrofits Follow?

All retrofit packages in this guide are compliant with the building regulations.

New and existing single family residential buildings that are less than 2,500sqft (230m2) and have less than three storeys only need to comply with the building guidelines and Section 18 of the Building Regulations 2022.

! A retrofit does not have to bring the whole house up to full code compliance!

Changes can be made to any existing building without requiring the whole building to comply with all the requirements of the Code. Anything that is changed must comply with the code (Building Regulations 2022, 103.1)

CAN A HISTORIC BUILDING BE RETROFITTED?

Yes. Retrofits to historic buildings can be made without conformance to all the requirements of the Code, provided:

- The house is listed as having special interest (architectural, historical, etc.).
- The retrofitted building will be no more hazardous than the original building.
- Approval is granted by PPD

For more information, see:

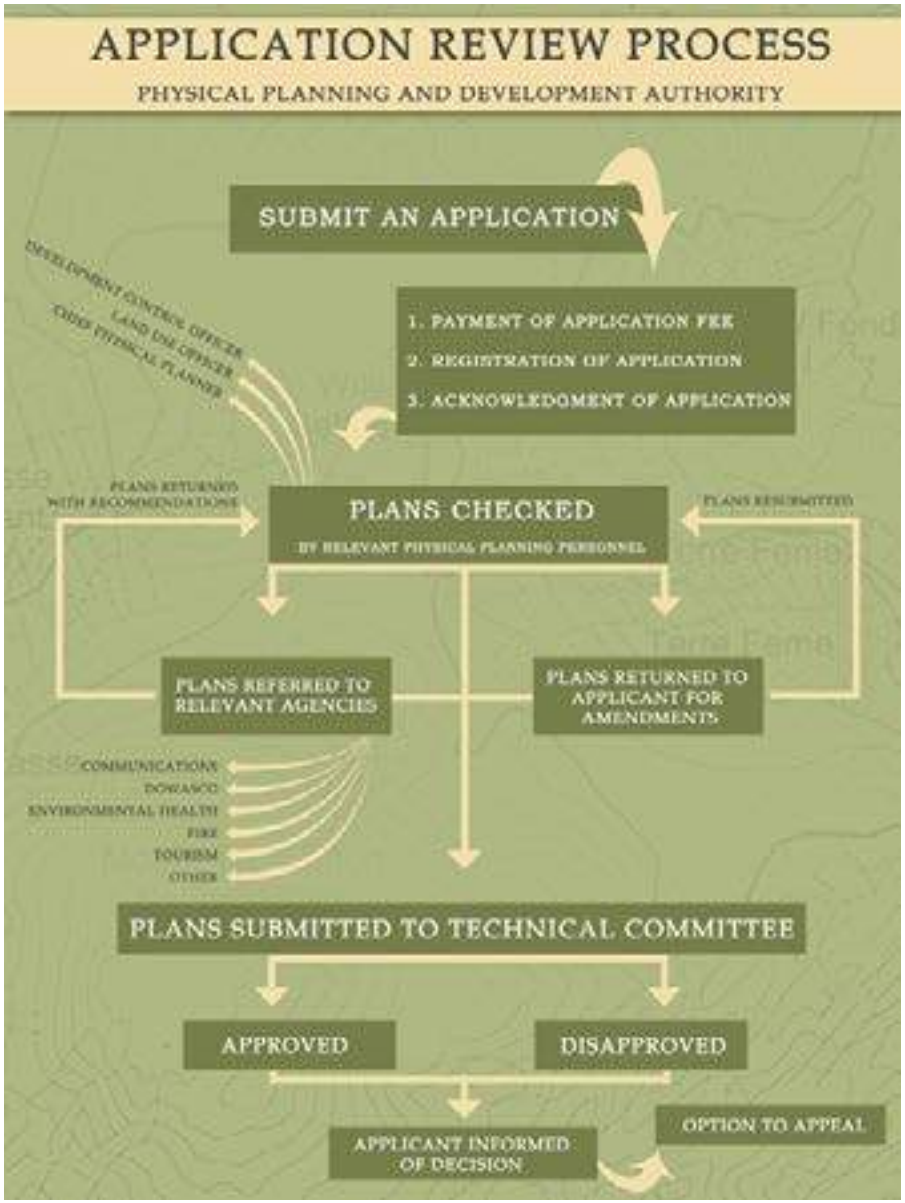
Building Regulations 2022
Physical Planning Act 2002
Guide to Dominica's Housing Standards
Minimum Property Standards
Physical planning Division website

When is a Building Permit Required?

According to the Building Regulations 2022, a permit from Physical Planning is required when the retrofit includes:

- **More than minor repairs,** including changes to remove or cut walls, partitions, structural beams or load-bearing supports; or remove or change egress (BR2022 102.7)
- **Replacement of more than 25% of the roof covering** (BR2022 103.4)
- **Change of occupancy** (BR2022 103.3). For example, if retail space is added to the house.
- **Building demolition** (BR2022 103.5)

For more details of when a permit is required for each retrofit package, see page 134.



SOURCE: PHYSICAL PLANNING DIVISION

Which Retrofit Packages Require a Building Permit?

RETROFIT PACKAGE	PERMIT REQUIRED?	EXCEPTIONS
Basic Roof Roof covering, fastenings, waterproofing and drainage.	NO	**Permit required if:** More than 25% of the roof covering is replaced.
Advanced Roof - Galvanize RC ring beam, timber framing and connections, masonry gable end walls.	NO	**Permit required if:** Construction of new ring beam.
Advanced Roof - Slab Suspended RC slab, waterproof membrane.	NO	**Permit required if:** Slab is severely damaged (see classification on page 58) and requires demolition or new support walls, or beams and columns.
Masonry Walls & Foundations Building configuration, on grade or raised foundations, masonry walls.	YES	**Permit required if:** additions or extensions are made, or if the structural building materials are changed.
Timber Houses	YES	**Permit not required if:** repairs affect less than 10%
Site Retaining walls, site drainage.	NO	**Permit may be required if:** retaining wall or drainage size is considerable. recommend discussing with PDD.
Habitability & Green Building Solar panels, air conditioning, passive cooling, water & energy efficiency.	NO	May need to check with DOMLEC for grid disconnection information.

6

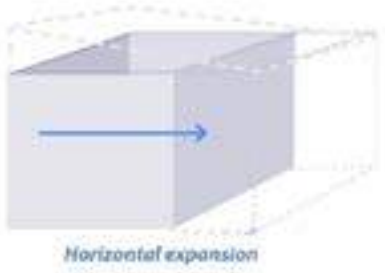
Dominica Home Retrofit Guide

EXPANSION

Introduction

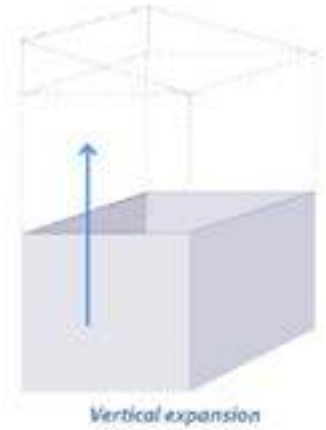
HORIZONTAL EXPANSION

Enclosed, habitable space is added to one (or more) side of the house. The building plan area, or footprint, increases, and the house grows outwards.



VERTICAL EXPANSION

New storeys are added and the house grows upwards.



WHAT HOUSES CAN BE EXPANDED USING THIS GUIDE?

Structural System	No. of Storeys	Foundation Type	Vertical Expansion	Horizontal Expansion
Masonry Houses	1 Storey	On Grade	✓	✓
		On Piers	✗	✓
		on Short or Tall RC collumns	✗	✗
	2 Storey	Any type	✗	✗
Timber	1 Storey	On Grade	✗	✓
		On Piers	✗	✓

CAN THE HOUSE BE EXTENDED?

Before starting a home expansion, it is essential to consider the following:

For all expansion:

Is the house located in a high risk landslide or flood hazard area? If so, it is not worth investing in a home expansion.

For vertical expansion:

Is the house safe? All retrofit packages (roof, walls and foundations) should be applied to the existing house before adding a second storey.

For horizontal expansion:

Is the site sloped? Horizontal expansion should only occur perpendicular to the slope.

Basic Steps of Home Expansion

1. EVALUATION OF THE EXISTING HOUSE

An engineer assesses the safety of the site and the existing house to confirm the feasibility of the intervention. See Chapter 2 for more details.

2. DESIGN

The architect and/or engineer design a strengthening proposal for the house (if necessary) and the expansion.

3. BUILDING PERMIT

The expansion design documents, prepared by the designer, are submitted (either by the homeowner or the designer) to the Physical Planning Department to obtain the building permit. See Chapter 5 for more details.

4. CONSTRUCTION

The homeowner hires a builder/ contractor to execute the works. If possible, the homeowner also contracts an engineer for construction supervision. The engineer checks compliance with the approved project documents, and guides the builder.

5. ENJOY AN EXPANDED HOME

Once the work is completed, the safe expansion and the home can be enjoyed. Regular maintenance should be performed to keep the house in good condition.

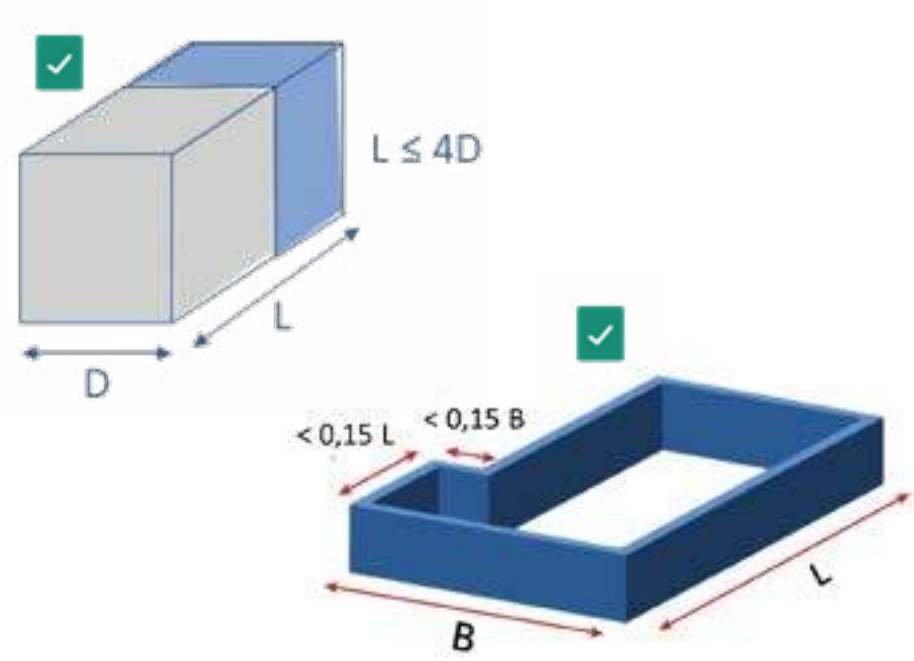
Minimum Requirements for Horizontal Expansion

BUILDING SHAPE

Symmetrical building shapes like square rectangular **perform better** than L shapes in hurricanes and earthquakes.

The total length of the house (existing structure plus the extension) should not exceed **four times the structure's width.**

L- shapes are permitted provided the notched area has length less than 15% of the total length and width less than 15 percent of the total width.



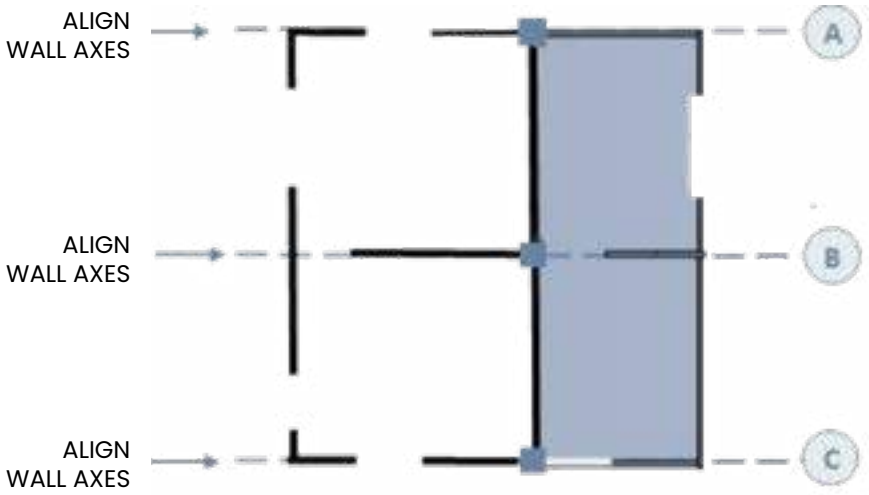
CONNECTIONS

It is essential that new walls are connected to existing columns, and new ring beams are adequately connected to the existing ring beam.

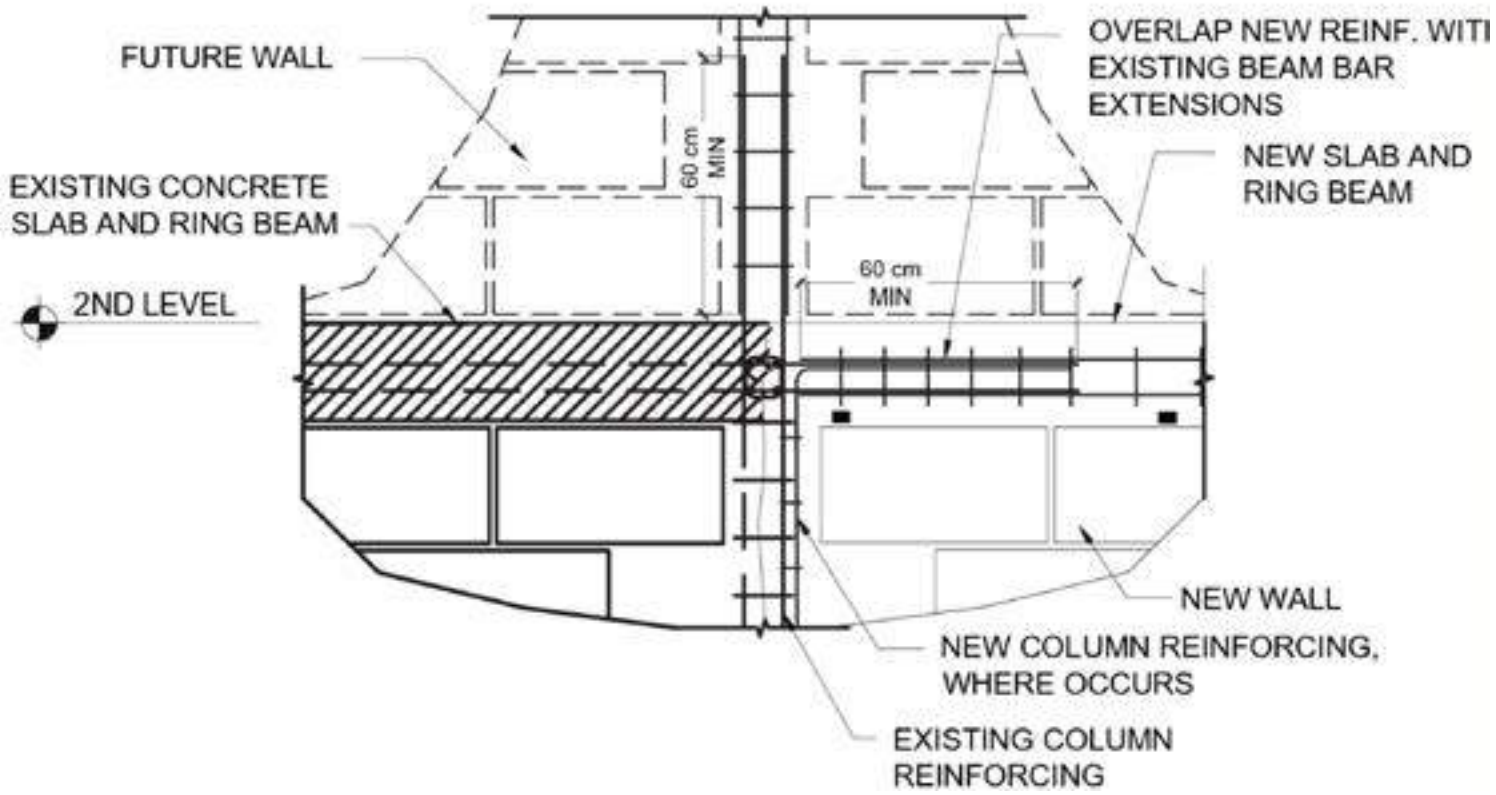
If existing columns are not present where the expansion connects to the existing house, then a new column can be added to link the two portions (existing and new) together.

NEW WALL LOCATIONS

The walls of the extension should align with the interior and exterior walls of the existing house.

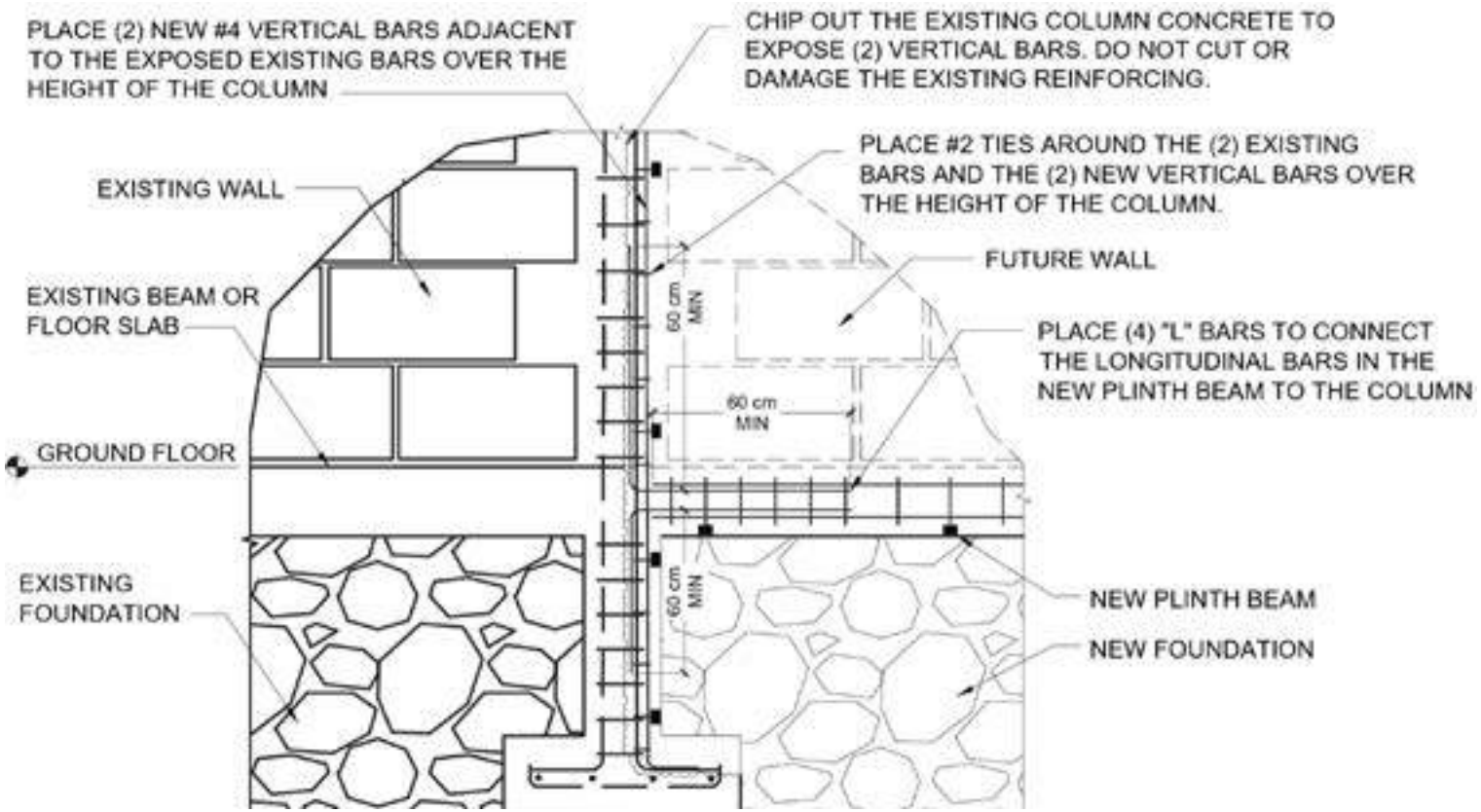


Key Details for Horizontal Expansion



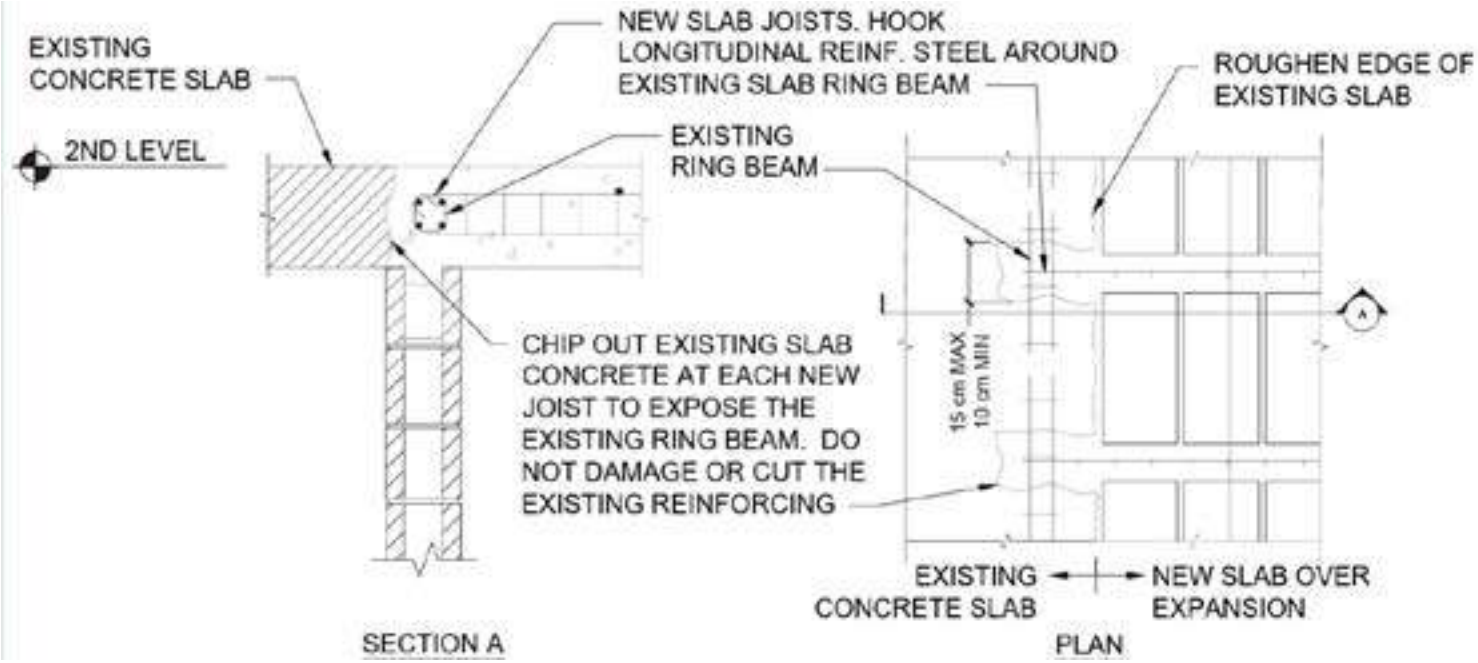
TYPICAL DETAIL: CONNECTION OF NEW MASONRY WALL AND RING BEAM TO EXISTING

Key Details for Horizontal Expansion



TYPICAL DETAIL: CONNECTION OF NEW MASONRY WALL AND FOUNDATION TO EXISTING

Key Details for Horizontal Expansion



TYPICAL DETAIL: CONNECTION OF NEW RC SLAB TO EXISTING

Minimum Requirements for Vertical Expansion

EXISTING STRUCTURE:

An engineer should check:

Foundations are present below all walls and columns, are in good condition and of adequate size for the soil conditions.

Columns and walls are continuous to foundation, in good condition and, have adequate capacity to carry the additional load of a second storey.

Roof slabs are in good condition and have adequate load capacity.

Lightweight roofs will need to be converted to a slab.

COLUMNS

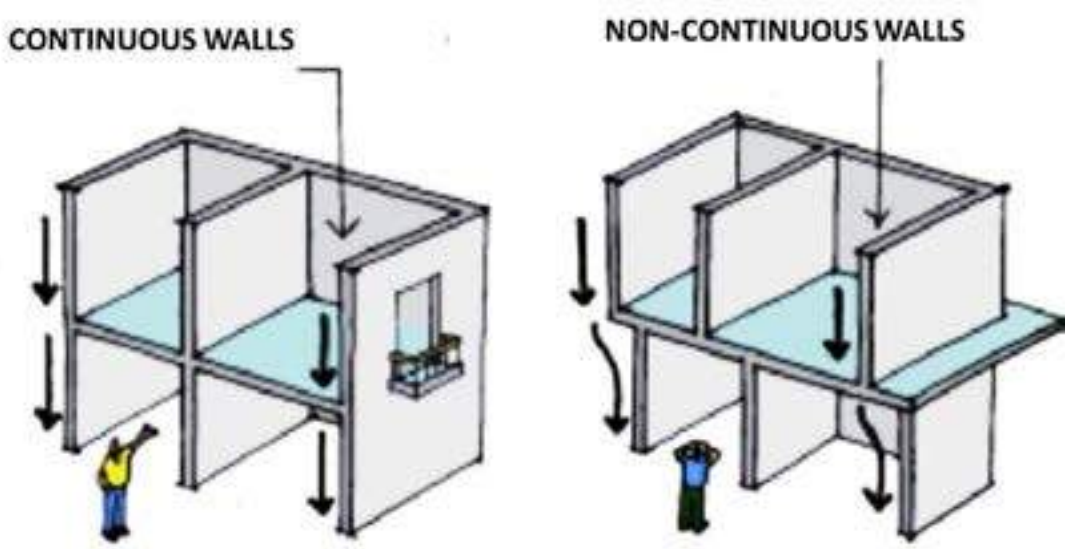
Reinforced concrete columns should be continuous from roof level to foundation.

STAIRS

Vertical support should be provided by free standing columns or by masonry walls at least 0.6m long. Stairs should not depend on the building walls for vertical support. Refer to the building code for all stair sizing and material requirements.

WALLS

Perimeter and interior walls should align at both storeys.



Minimum Requirements for Vertical Expansion

OPENINGS:

Window and door openings should be vertically aligned through the entire height of the building.

GEOMETRY:

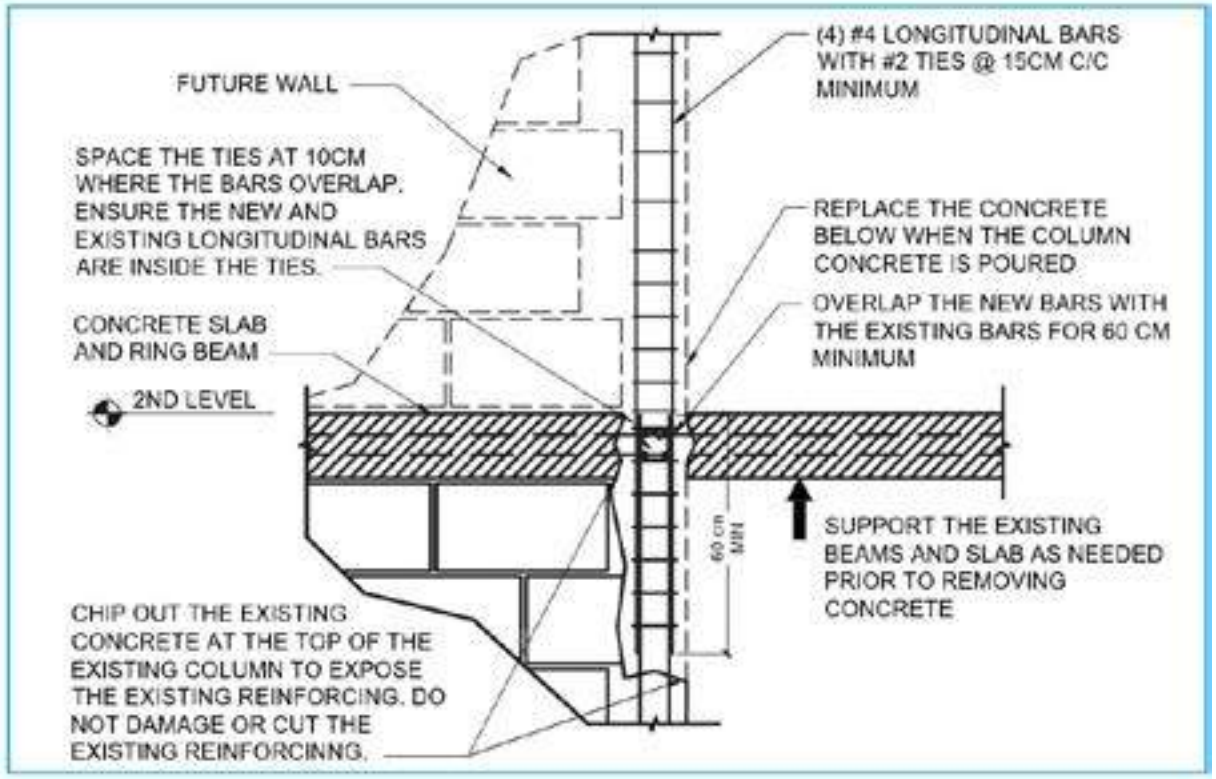
The geometry of the expansion should be regular, respect the geometry of the lower floor plan and there should be no overhanging floor portions.

! **Retrofit may be required** to strengthen the existing structure before the expansion can be built.

Key Details for Vertical Expansion

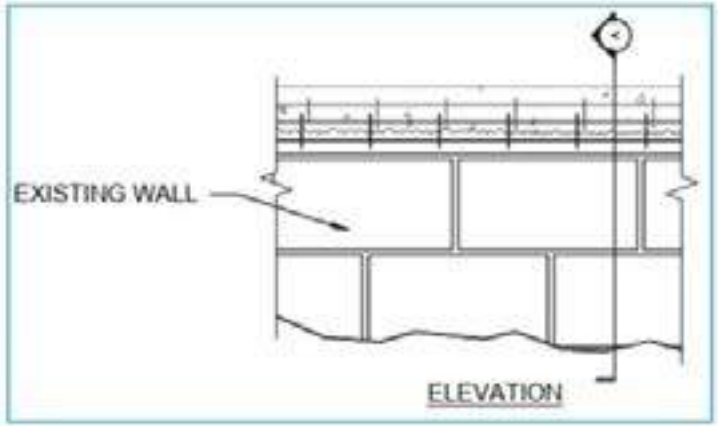
If the engineer determines that the existing slab is adequate to be used as the floor of the new vertical expan- sion, then the primary concern for ex- pansion work will be to make sure the new columns are continuous, aligned and well-connected to the existing columns below.

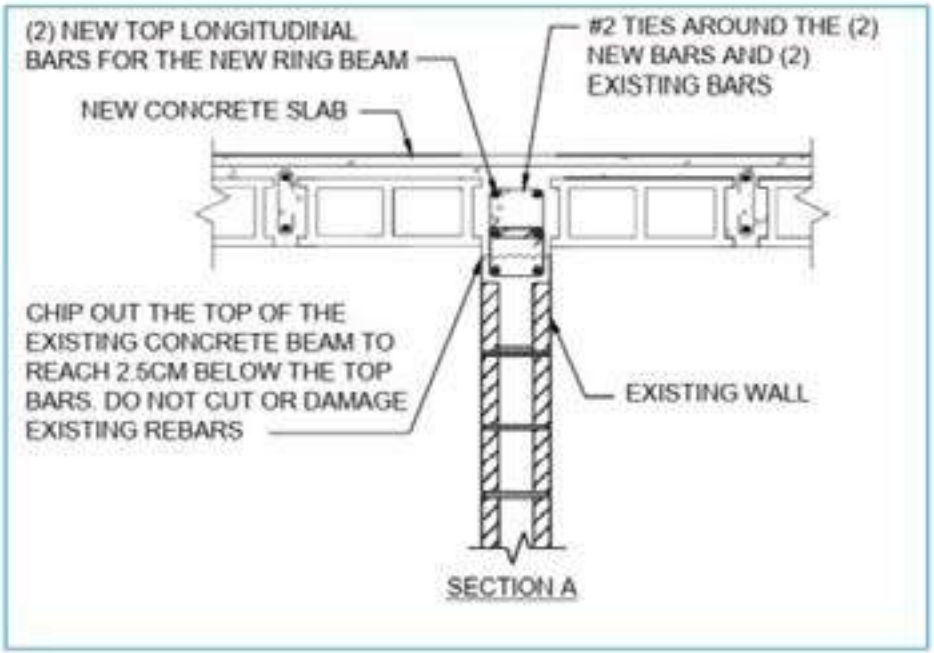
The existing columns may or may not have sufficient extensions above the existing slab. The following detailed steps show:



Key Details for Vertical Expansion

If there is an existing ring beam, in good condition, the slab can be connected to it. In this case, add two longitudinal reinforced bars, linked with ties, to the lower part of to the existing ring beam in order to create a 6 bar ring beam. The slab beam will be connected to 4 upper rebar that will be used like a new ring beam, to support the slab beams.





7

Dominica Home Retrofit Guide

HOME MAINTENANCE

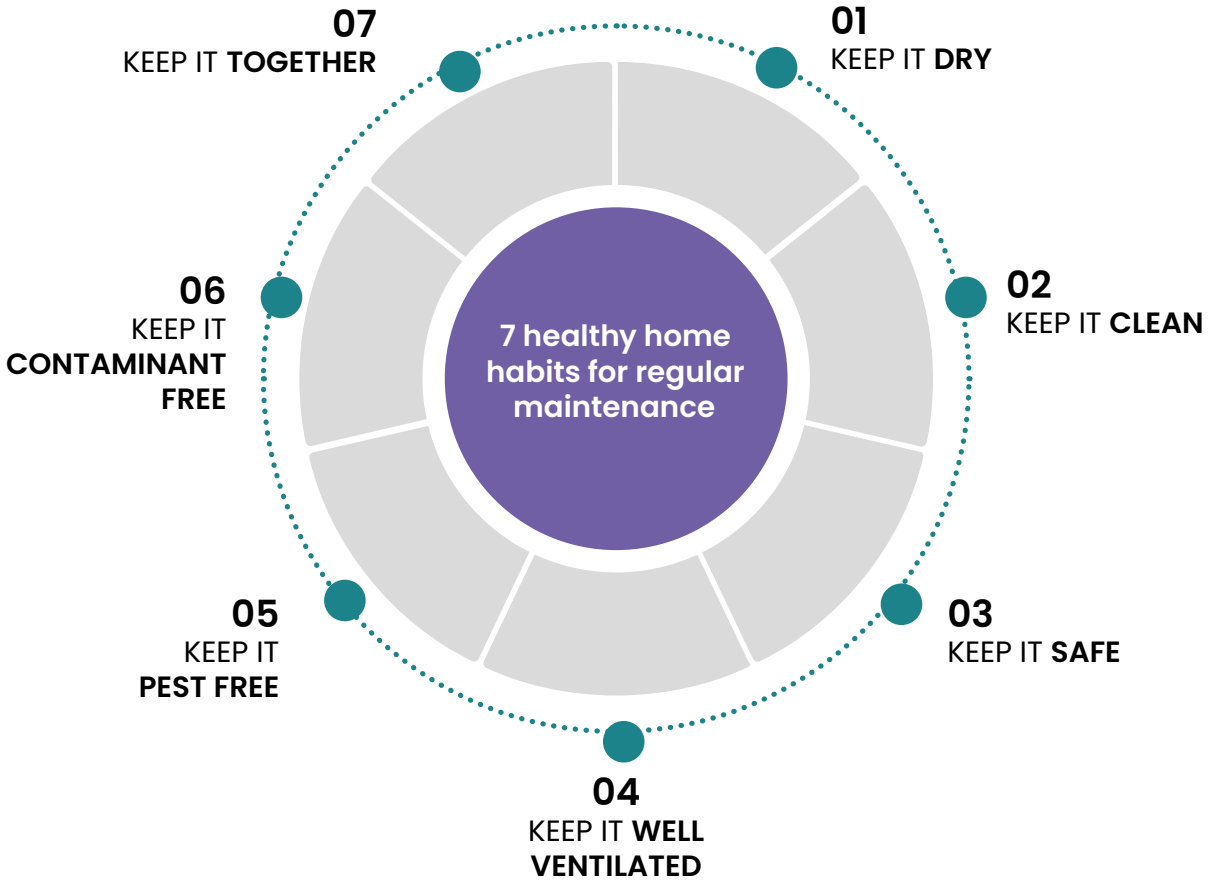
The importance of maintenance

Regular maintenance helps to extend the lifespan of a structure and its systems, saving money on premature replacement or repair costs.

Regular maintenance will:

- ✓ Save money
- ✓ Maintain the appearance of the home
- ✓ Increase the home's value
- ✓ Improve the home's resilience to climate
- ✓ Impacts and disasters

Maintenance **prolongs the service life** of the house and **ensures the safety** of the people living in it.



Who is responsible for home maintenance

The maintenance needs of a house begin after the construction is completed and who is responsible depends on the timing after construction. The stages of responsibility can be divided into three main streams:

! **Manufacturer Warranties on Materials:** After installation, the homeowner usually takes on responsibility for contacting the manufacturer if materials or equipment fail, unless it's proven to be a contractor error.

DEFECTS LIABILITY PERIOD

Period after construction completion during which any defects that arise due to poor workmanship, faulty materials, or construction errors.

Responsibility of the **contractor**

REGULAR MAINTENANCE (ANNUAL)

Homeowner - all maintenance tasks (like cleaning gutters, inspecting for leaks, and servicing systems).

Tenants (where present) - basic upkeep (l*ike keeping the space clean, changing light bulbs, and notifying the landlord about issues).*

Responsibility of the **homeowner** and the **tenants.**

MINOR & MEDIUM REPAIR (1-5 YEARS)

Larger repairs (such as fixing roofs, replacing windows, or appliance replacements)

Responsibility of the **homeowner**

What to check during the liability period

WALLS AND CEILINGS

- [ ] Stains, scratches, hairline cracks or marks
- [ ] Uneven surfaces
- [ ] Water seepage
- [ ] Mold or cracks

DOORS AND WINDOWS

- [ ] Difficulties in fully opening, closing, locking or unlocking
- [ ] Scratches, cracks, rusting, leaks
- [ ] Improper installation or integration

ELECTRICAL

- [ ] Power points not working properly
- [ ] Lights, fans or air-conditioning not functioning

PLUMBING

- [ ] Leaks, faulty taps or shower heads, low water pressure
- [ ] Fault flushing system
- [ ] Blocked drainage

BUILT-IN CARPENTRY

- [ ] Difficulties in fully opening, closing, locking or unlocking
- [ ] Proper finishing (no scratches or blemishes)

BATHROOM FIXTURES

- [ ] Cracks, scratches or water seepages
- [ ] Uneven surfaces or misalignment

CONCRETE

- [ ] Visible cracks
- [ ] Voids
- [ ] Exposed reinforcement

FLOORING

- [ ] Scratches or discolouration
- [ ] Gaps, misalignment in tiles
- [ ] Uneven, jagged or rough surfaces

What to check for regular maintenance & repairs

TIMBER ELEMENTS

Timber elements, such as roof framing, should be inspected for:

- Termite damage
- Water damage and rot
- Cracks and weathering

ELECTRICAL SYSTEM

The electrical system should be regularly inspected, looking for:

- Sparks in outlets, flicks in lights, burnt bulbs
- Buzzing of the electric panel
- Distribute devices plugs into different outlets around the home
- Unplug and store unused devices
- Check ground-fault circuit interrupters to ensure they are functioning well (these are special outlets with a button to be pushed seen in kitchens and bathrooms).

PLUMBING

Regularly inspected for:

- Leaks in pipes (check water bills: if they are unusually high, there might be a leak)
- Leaks in the water heater;
- Problems in angle stops behind toilets and sink

DOORS AND WINDOWS

Doors and windows should be regularly cleaned. Additionally, they should be periodically inspected, looking for:

- Damage
- Water and air tightness (caulking) – are there any signs of leaks?
- Functionality (hinges) – do they open and close as they should?
- Safety (locking) – do the locks work?

Hurricane Season Maintenance

ROOF AND GUTTERS

Roofs and gutters should be inspected every three months, and again before the hurricane season. Check for and repair (see Chapter 2.2.1):

- Damage to galvanised roof sheets and flashing;
- Loose, missing, or corroded screws or nails;
- Rusting or corrosion at fixings and overlaps;
- Blocked or damaged gutters and downpipes;
- Weak joints, detached pipes, or sagging gutters.

PAINTS AND PLASTERS

Exterior finishes protect walls from moisture and wind-driven rain. Exterior repainting is recommended if pre-hurricane season inspections identify any of the following:

- Cracks in plaster;
- Peeling, blistering, or flaking paint;
- Signs of water penetration or dampness.

Treat mold and address any sources of moisture before repainting.

WINDOWS, DOORS AND SHUTTERS

Inspect and maintain:

- Window and door frames for rot, corrosion or loose fasteners;
- Shutters (wood or metal) for: secure hinges, functional locks/latches, signs of corrosion or damage;
- Ensure shutters can be closed or installed quickly and fully.
- Replace any missing or damaged fasteners- Signs of water penetration or dampness
- Treat mold and address any sources of moisture before repainting.

TREES

While trees provide excellent natural shading, they can become a hazard in strong winds. To minimise the risk:

- Trim branches that hang over the roof or are close to windows, walls, or power lines
- Remove dead, cracked, or unstable branches
- Avoid planting large trees too close to the house
- Check that root systems are not undermining foundations or retaining walls
- Blocked or damaged gutters and downpipes
- Weak joints, detached pipes, or sagging gutters

EXTERNAL FIXTURES AND ATTACHMENTS

Loose external items often fail first in high winds and can become dangerous projectiles.

Inspect and ensure all of the following are well connected to the house structure (not just to finishes):

- Gutter and downspouts
- Solar panels and solar hot water heaters
- Awnings or shade structures
- Railings and handrails
- Water tanks and tank supports

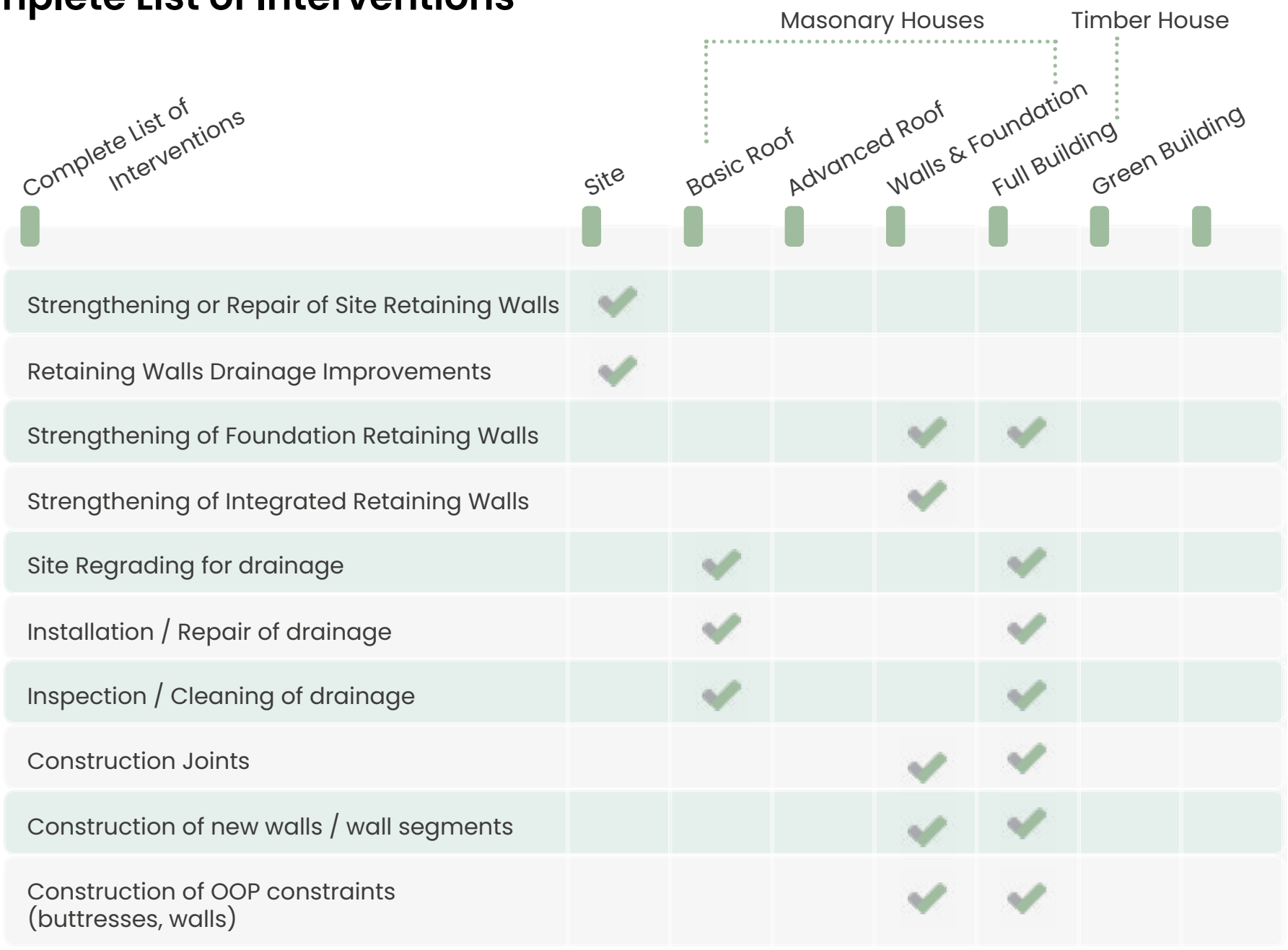
DRAINAGE

Flood water damaged is often worsened by poor drainage. Check and ensure all drains and channels are clear from leaves, rubbish and debris prior to the start of and every two weeks during hurricane season.

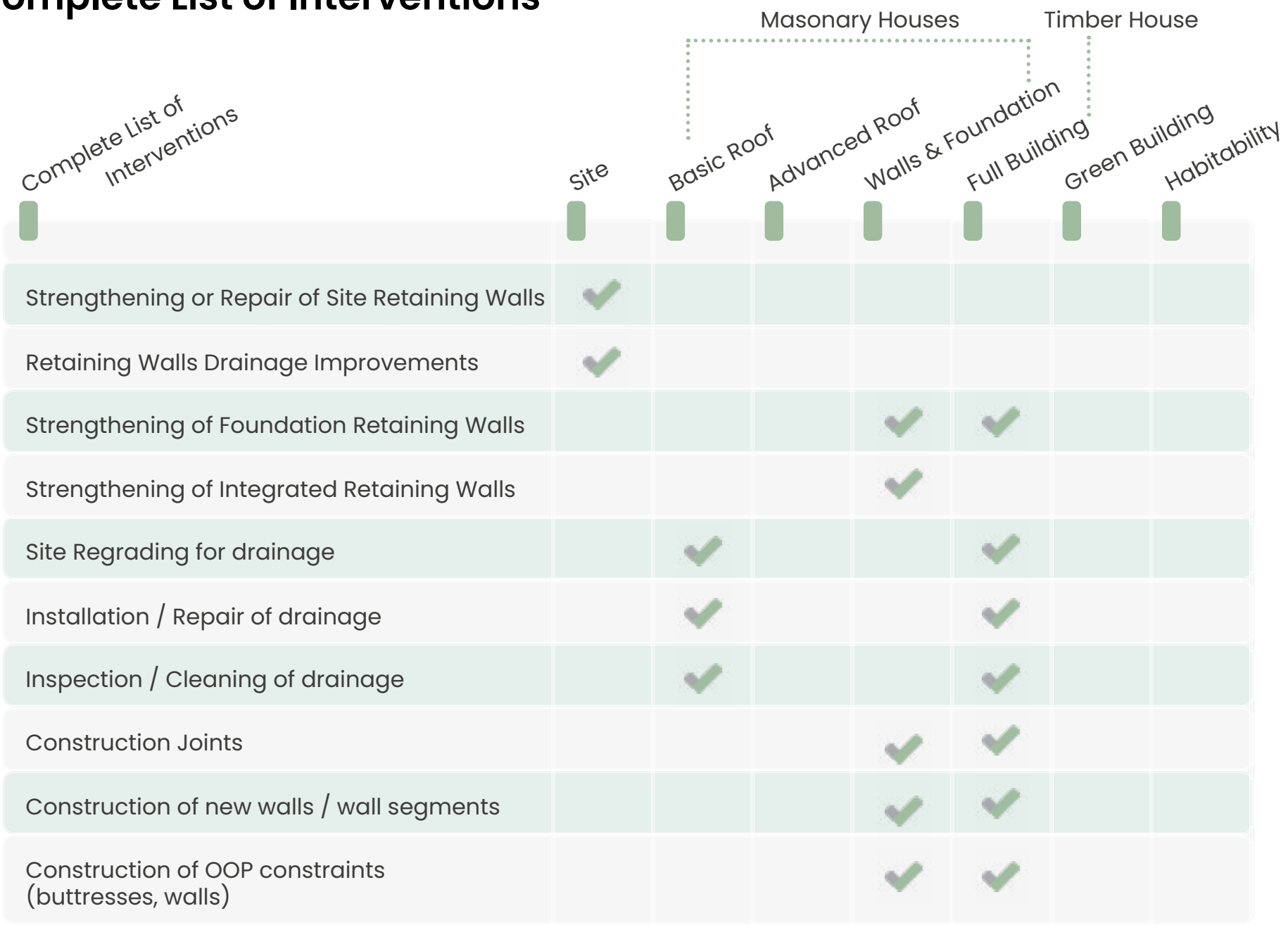
Dominica Home Retrofit Guide

APPENDICES

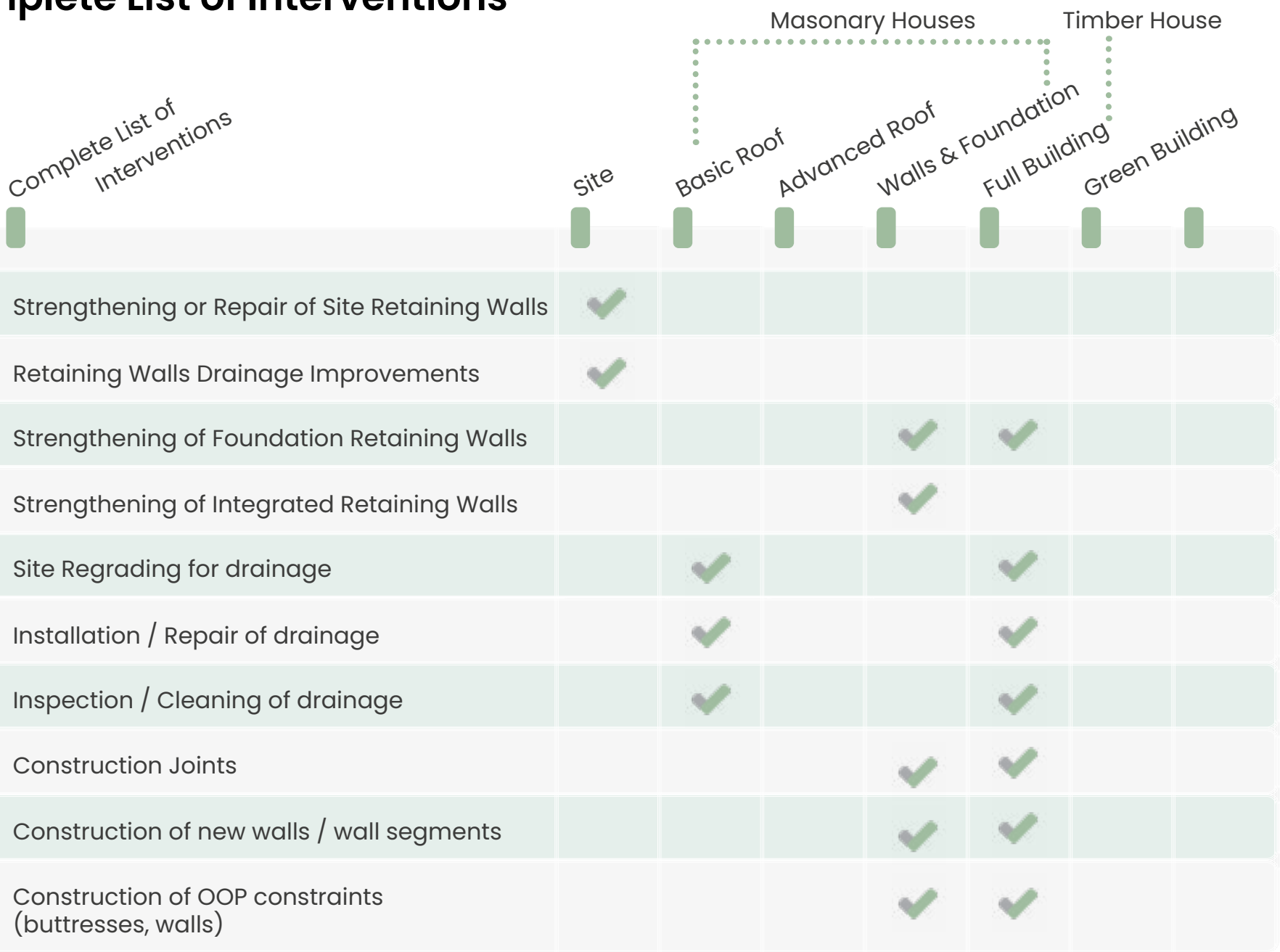
Complete List of Interventions



Complete List of Interventions

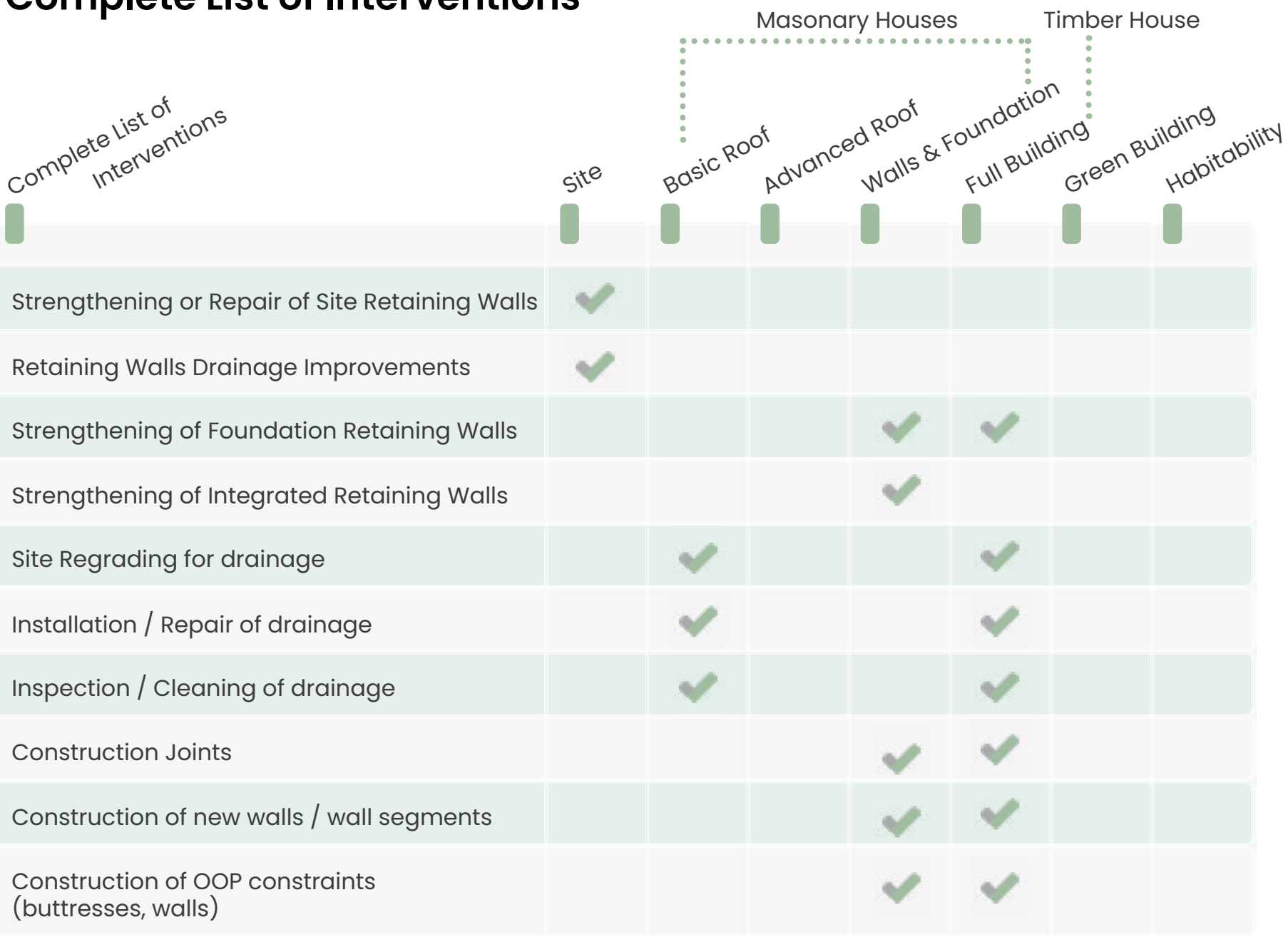


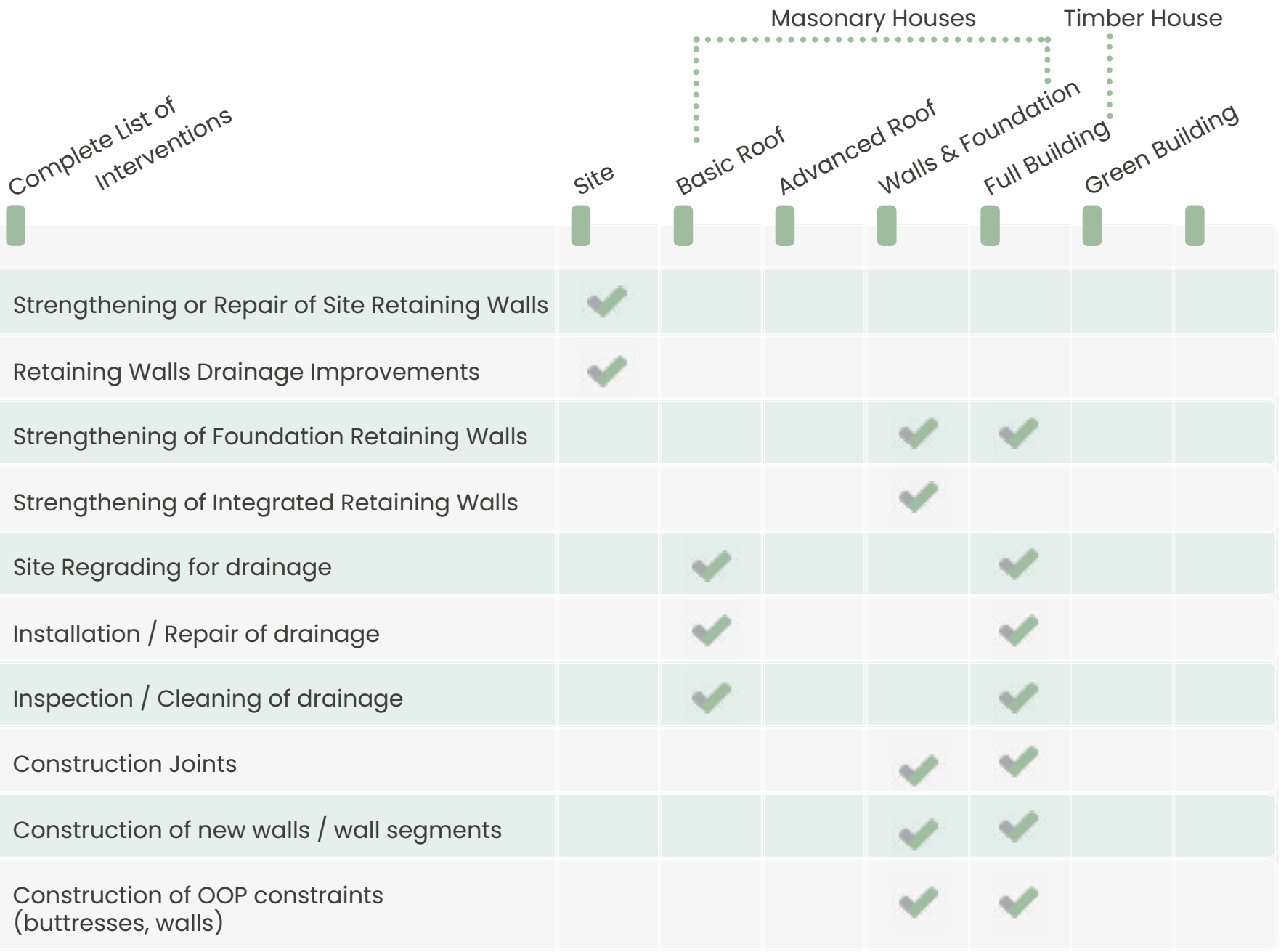
Complete List of Interventions



Complete List of Interventions	Site	Masonary Houses: Basic Roof	Masonary Houses: Advanced Roof	Masonary Houses: Walls & Foundation	Masonary Houses: Full Building	Timber House: Green Building	Timber House: Full Building
Strengthening or Repair of Site Retaining Walls	✓						
Retaining Walls Drainage Improvements	✓						
Strengthening of Foundation Retaining Walls				✓	✓		
Strengthening of Integrated Retaining Walls				✓			
Site Regrading for drainage		✓			✓		
Installation / Repair of drainage		✓			✓		
Inspection / Cleaning of drainage		✓			✓		
Construction Joints				✓	✓		
Construction of new walls / wall segments				✓	✓		
Construction of OOP constraints (buttresses, walls)				✓	✓		

Complete List of Interventions




Masonary Houses
Timber House
Complete List of Interventions
Site
Basic Roof
Advanced Roof
Walls & Foundation
Full Building
Green Building
Strengthening or Repair of Site Retaining Walls
Retaining Walls Drainage Improvements
Strengthening of Foundation Retaining Walls
Strengthening of Integrated Retaining Walls
Site Regrading for drainage
Installation / Repair of drainage
Inspection / Cleaning of drainage
Construction Joints
Construction of new walls / wall segments
Construction of OOP constraints (buttresses, walls)