May 2015

SEISMIC AND WIND EVALUATION AND RETROFIT MANUAL

for Timber Housing Construction in the Philippines

BUILD CHANGE

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Manual Basis and Criteria

This manual is based on rational engineering principles, the National Structural Code of the Philippines (NSCP), and two US standards, ASCE-31 Seismic Evaluation of Existing Buildings and ASCE-41 Seismic Rehabilitation of Existing Buildings. The aim of these procedures is to outline a methodology that will result in a home that meets the life-safety performance objective for the design basis earthquake and is capable of resisting the code-prescribed wind forces.

Achievement of these objectives does not necessarily ensure that the building meets all requirements for new structures in the NSCP, nor is this required by the NSCP. NSCP Section 108 permits that existing structural elements or additions of new structural elements, which are initiated for the purpose of increasing the strength or stiffness of the lateral-force-resisting system of an existing structure, need not be designed for forces conforming to the NSCP provided an engineering analysis can confirm that:

- The capacity of existing structural elements required to resist forces is not reduced,
- The lateral force demand on existing elements is not increased beyond their capacity,
- New structural elements are detailed and connected to the existing elements as required by the NSCP and,
- New or relocated non-structural elements are detailed and connected to the structure in accordance with the NSCP.

The procedures of this manual were developed to ensure these requirements are met, while adding sufficient strength and stiffness to the structure to meet the objectives stated above.

It is expected that most buildings retrofitted in accordance with this manual would perform within the desired levels when subjected to code-level design earthquake and wind forces. However, compliance with this manual does not guarantee such performance; rather, it represents the current standard of practice in structural design to attain this performance. The fields of earthquake and wind engineering are rapidly evolving, and both our understanding of the behavior of buildings subjected to strong earthquakes and winds and our ability to predict this behavior are advancing. In the future, new knowledge and technology will improve the reliability of accomplishing these goals.

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Background

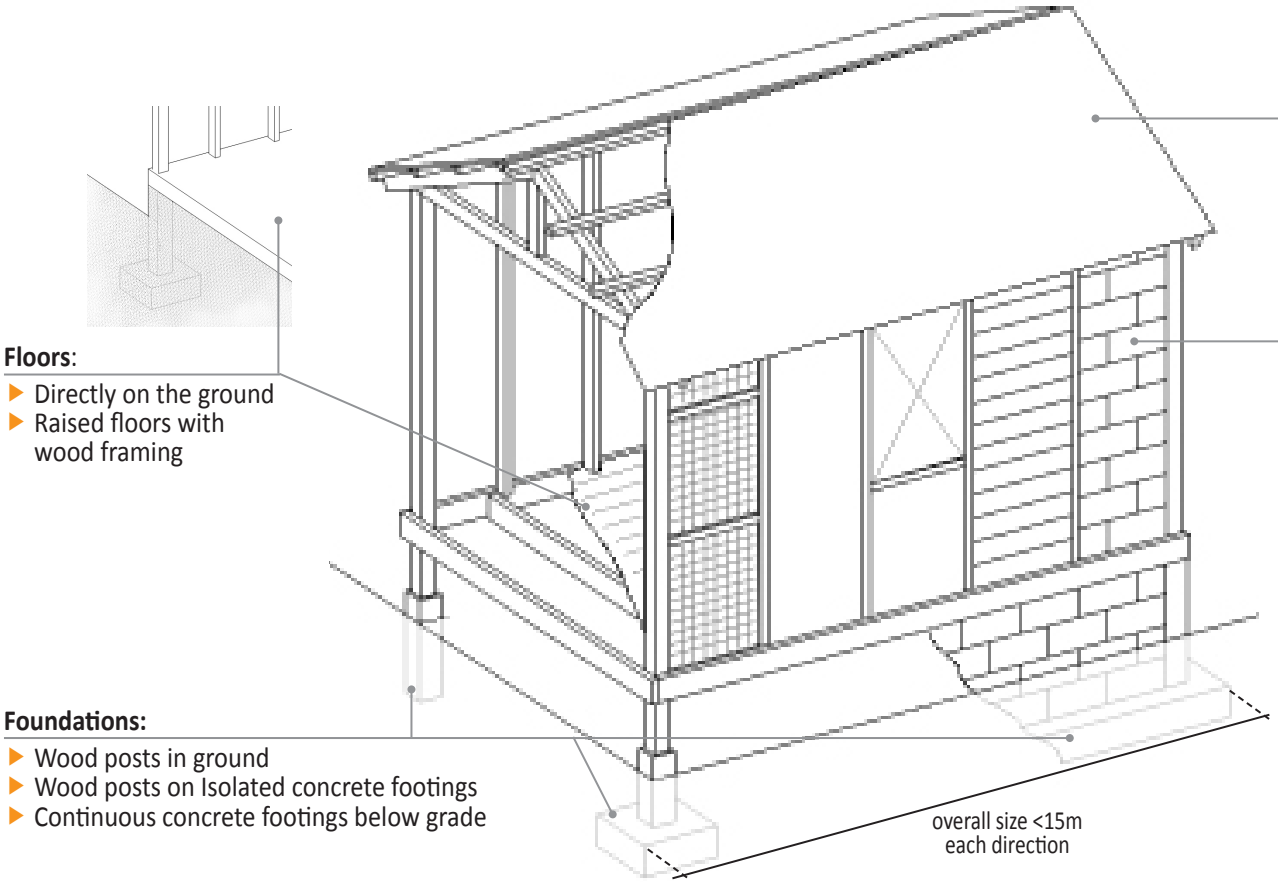
The Philippines is a country with a high risk of earthquakes and typhoons. Two devastating events occurred towards the end of 2013: the M7.1 Central Visayas earthquake, near the city of Catigbian on the island of Bohol, on October 15, 2013, and Typhoon Yolanda, which affected several islands, on November 8, 2013. The M7.1 earthquake affected over 3 million people, damaging over 73,000 houses, with over 14,500 houses considered completely destroyed. Yolanda was the strongest typhoon in the Philippines in recorded history, and affected an estimated 14.4 million people. Although more devastating than most, these events were only the latest in a long list of natural events that have occurred for thousands of years and will continue to occur in the future.

Much of the building damage seen after natural events such as these can be avoided if houses are designed and built according to the requirements of the National Structural Code of the Philippines (NSCP), a government approved set of construction standards for building disaster-resistant buildings. Although some disaster-resistant houses are now being built, many existing houses that were not built according to NSCP standards continue to be at risk from earthquakes and typhoons, even if they have been repaired or have not suffered any damage in the past.

This manual has been created to help construction professionals such as builders, engineers, and architects evaluate whether a damaged, undamaged, or repaired house can resist future seismic and wind forces, and to provide advice and specific retrofitting techniques for when a house does not. This manual was developed to be used in the extreme high wind speed and strongest seismic zones of the Philippines. By using the evaluation and retrofitting techniques in this manual, a house can be strengthened to meet a life-safety performance level for the code-prescribed design basis earthquake and wind forces, greatly increasing a family's safety in future earthquakes and typhoons.

Manual Applicability

This manual cannot be used to evaluate all kinds of buildings; it is limited to common one-story timber framed structures that have the following characteristics:



Roofs:
- Wood-framed
- Light-weight covering

Walls:
Wood-framed with coverings and infills:
- Plywood
- Amakan
- Planks and Boards
- Tarps
- Masonry blocks

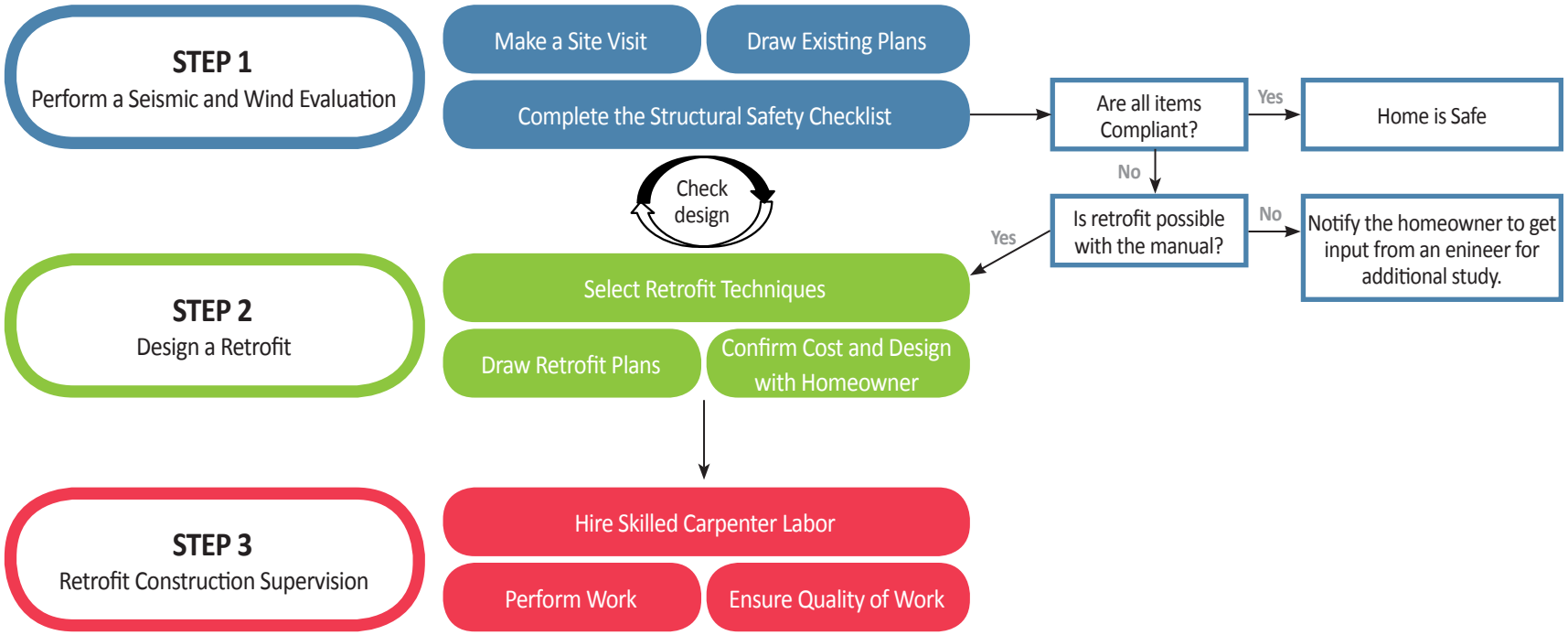
Floors:
- Directly on the ground
- Raised floors with wood framing

Foundations:
- Wood posts in ground
- Wood posts on Isolated concrete footings
- Continuous concrete footings below grade

If the house to be evaluated does not have these characteristics, this manual should not be used and a more detailed evaluation should be conducted by a qualified engineer.

The 3-step Process of Retrofitting

The evaluation and retrofit process can be undertaken in three steps. First, a site visit is conducted during which the user creates a floor plan of the existing building and uses the evaluation checklist to identify critical site and house deficiencies that have been observed to contribute to collapse conditions in past earthquakes and windstorms. Second, the construction professional uses the manual to determine what retrofit measure is suitable to correct the deficiencies and includes each retrofit technique on the plan to discuss and modify according to homeowner needs. Third, the building is retrofit according to the plan using qualified and capable labor. Construction supervision is provided to ensure the quality of the construction work. Each step is addressed in detail below.



Step 1 - Performing a Wind and Seismic Evaluation

Conduct a Site Visit

An essential part of the seismic and wind evaluation and retrofit process is the site visit. To be most efficient with time required on site, it is recommended that site visits be conducted with teams of two people.

What to Bring

- This Manual
- Structural Safety Checklist
- Clipboard, notepaper and pens or pencils
- Camera or camera phone
- Tape measure
- Shovel
- Sturdy footwear or boots
- GPS receiver (if available)
- Nail 3" long
- 12mm Rebar and hammer
- Flashlight

Complete The Structural Safety Checklist

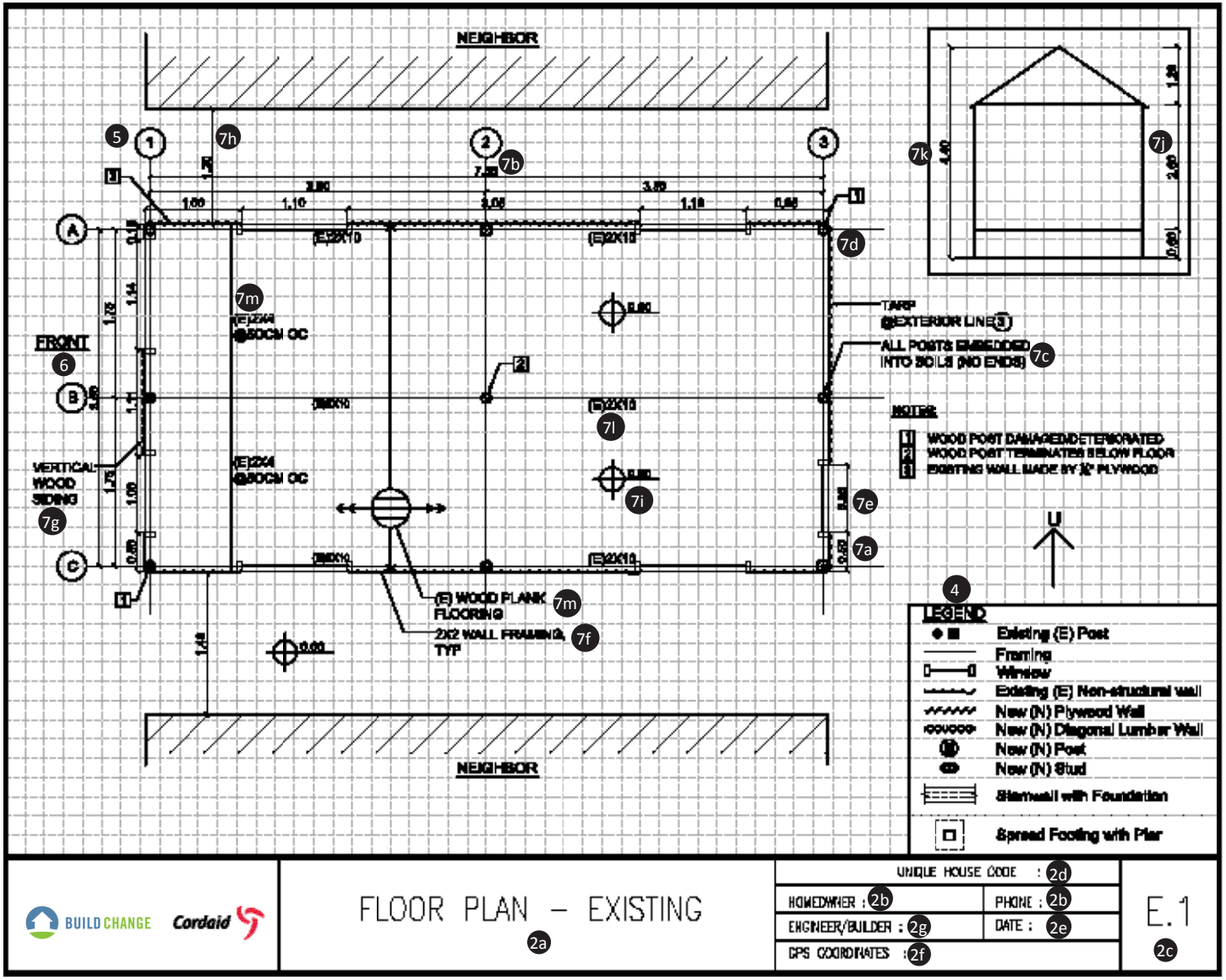
The Structural Safety Checklist is the most important part of the evaluation process. Each item in the checklist identifies a key characteristic or component that contributes to making a safe house. The following section of this manual provides detailed descriptions of each checklist item. Refer to Appendix A for the Structural Safety Checklist that can be filled out on site.

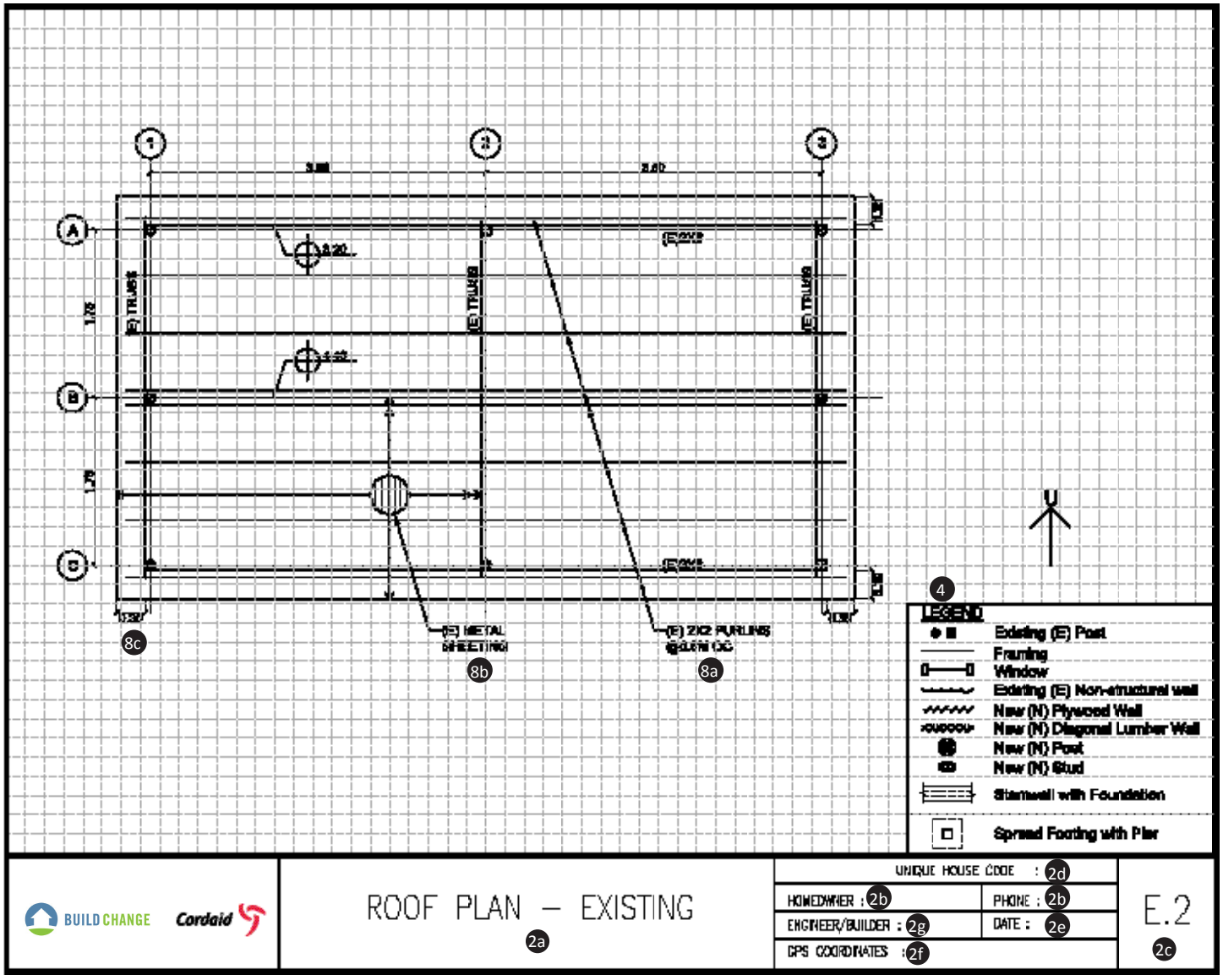
For each checklist item, select the option below that most applies:

C **Compliant** – Make this selection when observations agree with the statement in the checklist.
NC **Non-Compliant** – Make this selection when observations disagree with the statement in the checklist. Non-compliant items must be corrected through retrofit.
N/A **Not Applicable** – Make this selection when the statement in the checklist does not apply to the building being evaluated. Not Applicable items are not considered in evaluating the safety of the building.

Draw Existing Plans

1. Start with a grid and an approximate scale (i.e. 2 cm = 1 m). The plan does not have to be drawn exactly to scale, but use it as a guide.
2. Fill in the title block with the following:
    a. Title (describing floor plan and level)
    b. Name and phone number of homeowner
    c. Sheet number (E.1, E.2, etc for existing)
    d. Project unique code number (eg CVM000X)
    e. Date
    f. GPS coordinates (if possible) or note on map, if available
    g. Name of responsible engineer / retrofit builder
3. Draw the existing floor plan – remember that walls have thickness, they are not just single lines. If the floor is raised, be sure to indicate the floor level, orientation, and spacing, indicating the location and size of any larger beams.
4. Use the correct symbols from the legend to represent the elements of the structure.
5. Add gridlines along the walls.
6. Label the front of the house.
7. Draw the dimensions of the following on the plan:
    a. Lengths of walls
    b. Overall building lengths
    c. Locations and sizes of existing foundations
    d. Positions and sizes of posts
    e. Dimensions and locations of window and door openings
    f. Thickness and size of wall framing
    g. Thickness and type of wall covering
    h. Distance to adjacent buildings
    i. Height of raised floors above adjacent grade
    j. Wall heights from floor to top plate (draw a house section if needed)
    k. Overall building height, including roof
    l. Floor framing size, spacing, and type, where occurs
    m. Floor covering type and thickness
8. Draw the existing roof plan:
    a. Roof framing size, spacing, and type
    b. Roof covering type and thickness
    c. Overhang dimensions
9. Note any other important information about building or site next to plan, such as the site slope.


NEIGHBOR
FRONT
VERTICAL WOOD SIDING
TARP @EXTERIOR LINE
ALL POSTS EMBEDDED INTO SOIL (NO ENDS)
NOTES
WOOD POST DAMAGED/DETERIORATED
WOOD POST TERMINATES BELOW FLOOR
EXISTING WALL MADE BY ½" PLYWOOD
(E) WOOD PLANK FLOORING
2X2 WALL FRAMING, TYP
LEGEND
Existing (E) Post
Framing
Window
Existing (E) Non-structural wall
New (N) Plywood Wall
New (N) Diagonal Lumber Wall
New (N) Post
New (N) Stud
Stemwall with Foundation
Spread Footing with Pier
BUILD CHANGE
Cordaid
FLOOR PLAN – EXISTING
UNIQUE HOUSE CODE :
HOMEOWNER :
PHONE :
ENGINEER/BUILDER :
DATE :
GPS COORDINATES :
E.1


1
2
3
A
B
C
(E) TRUSS
(E) TRUSS
(E) TRUSS
(E) METAL SHEETING
8c
8b
(E) 2X2 PURLINS @ 1'-6" O.C.
8a
4
LEGEND
Existing (E) Post
Framing
Window
Existing (E) Non-structural wall
New (N) Plywood Wall
New (N) Diagonal Lumber Wall
New (N) Post
New (N) Stud
Stemwall with Foundation
Spread Footing with Pier
BUILD CHANGE
Cordaid
ROOF PLAN – EXISTING
2a
UNIQUE HOUSE CODE : 2d
HOMEOWNER : 2b
PHONE : 2b
ENGINEER/BUILDER : 2g
DATE : 2e
GPS COORDINATES : 2f
E.2
2c

Step 2 - Designing a Retrofit

Identifying Appropriate Retrofit Techniques

Once the seismic and wind evaluation is complete and any deficiencies are known, an appropriate retrofit scheme is chosen to convert all of the Non-Compliant items to Compliant. For each item that is non-compliant, identify a retrofit technique that will be used to correct the problem in the "retrofit solution" column of the checklist. For the building to meet the target structural performance goals, all of the items must be "Compliant" in the final condition.

There are several potential deficiencies that can be identified with this checklist but cannot be fixed with this manual. In houses that have these deficiencies, the builder should notify the homeowner that the issue has been identified, tell them that it cannot be fixed directly by the builder themselves, and recommend that an engineer review the issue and propose a solution, or that a total house rebuild may be required. Knowing the issue, the homeowner can decide to seek additional assistance, accept the increased risk due to the un-fixable problem, or either relocate or rebuild a safer house.

Creating A Retrofit Plan

Draw the retrofit floor and roof plans to illustrate the retrofit techniques that have been selected. Follow the steps below to draw a retrofit floor plan.

1. Start by following previous steps 1-8 for drawing existing floor and roof plans.
2. Draw retrofit elements, showing where they will be installed on plan, such as new foundations, walls, posts, or roof framing and ties.
3. Add dimensions to the new elements.
4. Call out the corresponding details on the plan.
5. Note any other important information about retrofits (i.e. rafter spacing) next to plan.

Reference the appropriate retrofit details on the plan. A list of retrofit details is on the following page and the details are contained in Appendix B.

List of Timber Retrofit Details

NUMBER	TITLE
D3	Materials
D3.1	Permitted Notches and Holes in Studs
D3.2	Permitted Notches and Holes in Floor Joists
D4	Foundations
D4.1A	Masonry Knee Wall at Slab-on-Grade
D4.1B	Masonry Knee Wall at Raised Floor
D4.1C	Foundation with Cripple Wall
D4.2	Wood Gravity Post Pier Foundation
D4.3	Plywood Shear Wall Post Foundation
D4.4	Tie/Cap Beam at Knee Wall
~~D4.5~~	(Not Used)
D4.6	Repair of Foundation Degradation
D4.7	Bottom Plate Connection to Knee Wall for Non-Shear Walls
D6	Walls and Posts
D6.1	Infilling Openings
D6.2	Diagonal Lumber Sheathing Shear Wall Elevation
D6.3	Diagonal Lumber Sheathing : Board to Stud Connection
D6.4	Metal X-Bracing Shear Wall Elevation
D6.5	Metal X-Bracing : Connection to the Top Plate
D6.6	Metal X-Bracing : Connection at the Bottom Plate
D6.7	Splice Connection on Strap
D6.8	Plywood Sheathing Shear Wall Elevation
D6.9	Plywood Sheathing: Nailing at Panel Joints
D6.10	Hold Down Post Connection to Foundation
D6.11	Gravity Post Connection to Foundation
~~D6.12~~	(Not Used)
D6.13	Connection to Bottom of Stud with Metal Strap
D6.14	Connection to Top of Stud with Metal Strap
D6.15	Beam-to-Post Connection
D7	Roof
D7.1	Top Plate - Connection to Perpendicular Plates
D7.2A	Top Plate - Splice Connection
D7.2B	Top Plate Stepped Connection
D7.3	Rafter-to-Rafter Connection with Metal Strap
D7.4A	Purlin-to-Rafter Connection with Metal Strap
D7.4B	Purlin-to-Rafter Connection with Blocks
D7.5	Rafter-to-Tie Connection with Metal Strap
D7.6A	Rafter-to-Wall Connection with Metal Strap
D7.6B	Rafter-to-Top Plate Connection with Metal Strap
D7.7	Truss Member Connection with Gusset Plate
D7.8	Wind/Diagonal Bracing Connection
D7.9A	Purlin-to-Truss Connection with Metal Strap
D7.9B	Purlin-to-Truss Connection with Blocks
D7.10	Truss-to-Wall Connection
D7.11	Metal Sheeting Connection to Framing

Step 3 - Retrofit Construction Supervision

Ensuring Construction Quality

Retrofit construction work should be performed by a qualified builder. Even though the builder may be qualified, it is important to take steps to ensure the construction meets the required standards. Visit the site regularly during construction and use the construction quality control checklists to confirm that the construction meets the requirements of the retrofit details. Construction quality checklists for the provided retrofit details are included in Appendix C.

Structural Safety Checklist

1. SITE HAZARDS

Study the site where the house is built to confirm that potential site problems are not present.

1.1 LIQUEFACTION

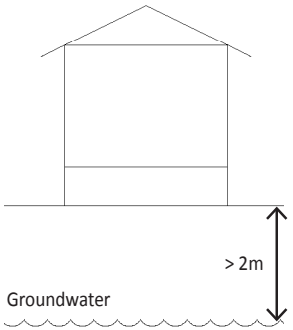
The soil within 2 meters below the house is not made of saturated, loose, granular soils which are susceptible to liquefaction.

Comment: Liquefaction describes a phenomenon in which saturated, loose, sandy soils substaintially lose strength due to ground shaking in an earthquake.

HOW TO CHECK

- Confirm that the site is located outside of known liquefaction hazard zones (refer to the Liquefaction Susceptibility Map of the Philippines in Appendix D), OR
- Check that the ground water table location is deeper than 2 meters by looking in a nearby well or asking homeowners or residents how deep is the groundwater, OR
- Assess the soil condition by excavating the soil to the depth of the bottom of the foundation. Push a 12 mm diameter bar in to the ground. If it cannot be easily hammered into the soil with a 2 kg hammer, then the soil is not loose and it is not susceptible to liquefaction, OR
- Confirm that the site is NOT located in an area that experienced settlement during or before the last earthquake. If evidence of building settlement exists, check neighboring buildings and interview residents to determine the cause of the settlement and associated cracking to see if it was liquefaction-induced.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required.



COMPLIANT

NON-COMPLIANT

1.2 SLOPE FAILURE

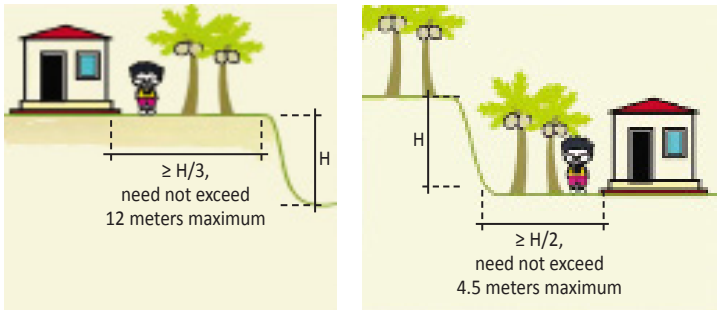
The house is far enough away from tall steep slopes to not be damaged by potential slope failures or rock falls caused by earthquakes or heavy rain. The site below the house does not slope more than 30%.

Comment: Steep slopes are susceptible to slides during an earthquake or storm. Slopes that exhibit signs of prior landslides require the most attention. Buildings uphill or downhill from a steep slope can be affected. The concern for buildings on the uphill side of slopes is collapse or sliding of the supporting oils. The concern for buildings on the downhill side is impact by sliding soil and debris.

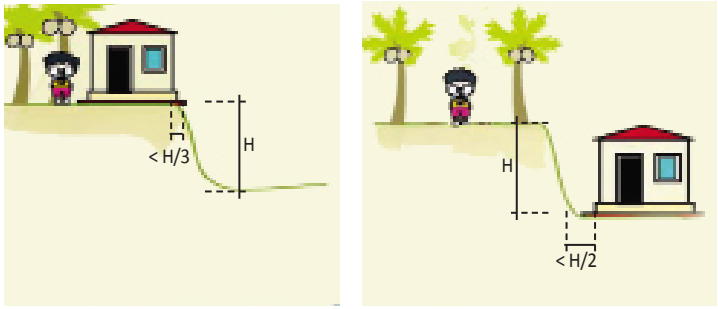
HOW TO CHECK

- Verify that the building offset below a steep slope is at least a distance equal to H/2, where H is the height of the steep slope. H/2 need not exceed 4.5 meters maximum.
- Verify that the building offset above a steep slope is at least a distance equal to H/3, where H is the height of the steep slope. H/3 need not exceed 12 meters maximum.
- If the site below the house slopes, measure the change in elevation of the site from one end of the house to the other. Divide the elevation change by the length of the house to confirm that it is less than 30%.
- If the building is on a flat site not near a steep slope then it is also compliant.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluationis required.



COMPLIANT



NON-COMPLIANT

1.3 SURFACE FAULT RUPTURE

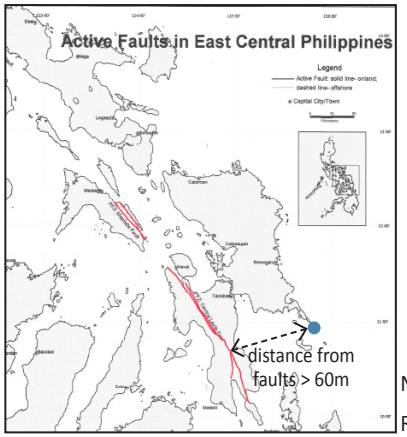
The house is not built along or near a known fault line and therefore surface fault rupture and surface displacement on the house property is not anticipated.

Comment: In the near field of active faults, there is a potential for large fissures and differential movement to occur in the surface soils. Foundations of buildings located above these ruptures will be subjected to large differential movements that will cause large forces and likely failures in the structure above.

HOW TO CHECK

- Refer to Figures 208-2A through 208-2E in the National Structural Code of the Philippines for locations of known faults and verify that the house is not within 60 meters of a known active fault.
- Also verify with the nearby residents that there have not been indications of surface fault rupture in past earthquakes, such as “rising of the ground” in the surface or sudden collapse of certain area or visibly seen fault scarps.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required.



NSCP
Ref. Fig. 208-2C

COMPLIANT

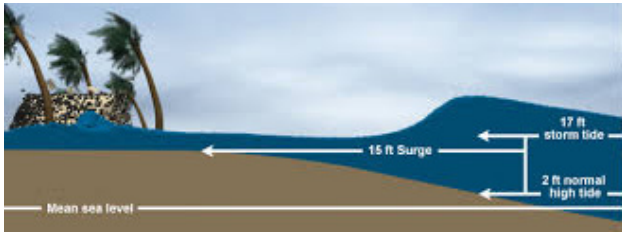
LGU
Philippine

NON-COMPLIANT

1.4. STORM SURGE

The house is not located in an area with known risk of inundation due to storm surges.

Comment: Storm surge is the rising of the sea level during a storm. This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 9 meters or more in some cases. Houses that are farther from the sea and elevated well above sea level have a reduced risk of destruction and inundation due to storm surge. The Water Code of the Philippines (P.D.1067) requires buildings to be constructed more than 40 m from any body of water.

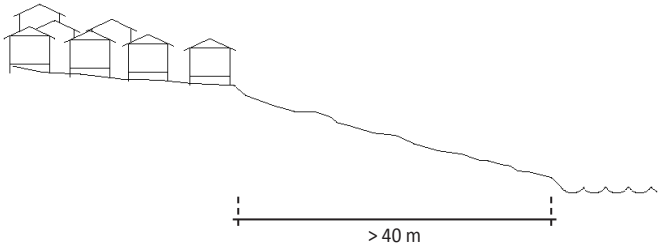


US NOAA

HOW TO CHECK

- Ask residents if the house or property was flooded in past storms when the sea level rose higher than normal.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required. However, raising the ground floor of the house above the storm surge line can help reduce the risk of flooding in the future although it is not guaranteed to keep the house safe in a future severe storm where the impact of waves as well as the water from flooding may harm the house.



COMPLIANT

NON-COMPLIANT

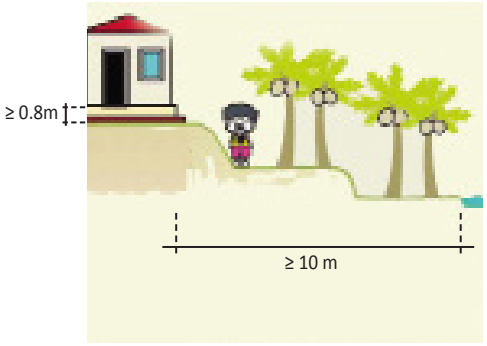
1.5 FLOOD RISK

The house is not located in a known flood zone or is raised 0.8 meters above the ground in areas of flooding, and is located at least 10 meters from rivers and other bodies of water.

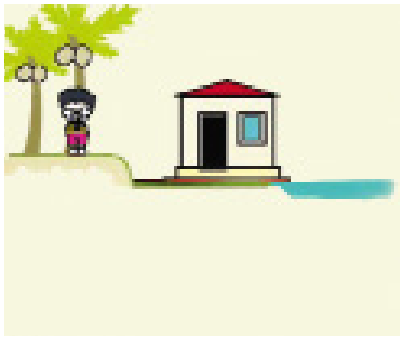
HOW TO CHECK

- Verify that there are no bodies of water within 10 meters of the house and also check with the residents to confirm that flooding of the site does not usually occur.
- If either of these conditions are present, verify that the house is elevated above the ground at least 0.8 meters.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required. However, raising the ground floor of the house above the flood line, at least 0.8m, can help reduce the risk of flooding in the future.



COMPLIANT



NON-COMPLIANT

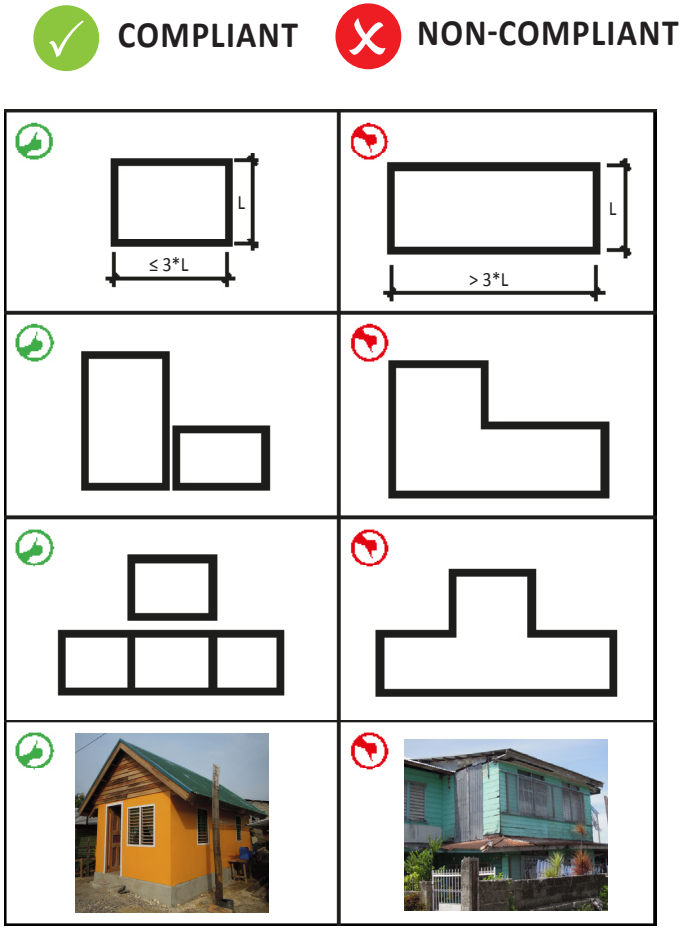
2. CONFIGURATION

Look at the overall house layout, size, and configuration to see if there are any potential safety concerns.

2. 1 PLAN CONFIGURATION

The house has a relatively simple, square, and symmetric configuration. The length of the house is not more than 3 times the width. There should not be L-shaped corners, which catch wind and collect earthquake loads.

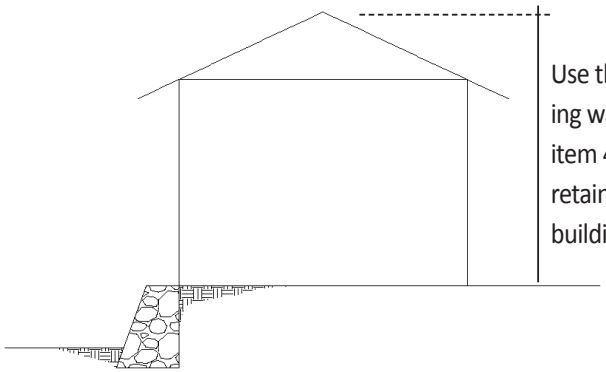
To retrofit a house with NON-COMPLIANT for this checklist item you can add or remove walls or parts of the house or create joints between different portions of the house to change the building configuration to a regular shape in order to make the item COMPLIANT.



2.2 STORY HEIGHT

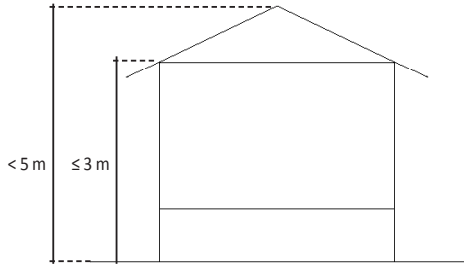
When measured from the ground outside of the house, the height to the top of the walls (measured from the lowest grade elevation) does not exceed 3.0 meters and the height to the top of the roof does not exceed 5.0 meters.

Exception: If the building sits on top of a conforming foundation retaining wall, then the measurement can be taken from the top of the retaining wall to the top of the building wall or roof.

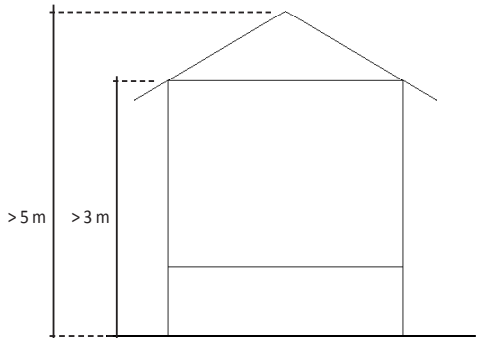


Use this height if the retaining wall conforms to checklist item 4.6. Otherwise add the retaining wall height into the building height.

Houses identified as NON-COMPLIANT for this deficiency shall be retrofitted by reducing the height of the walls and/or roof, through demolition and reconstruction in order to make the structure COMPLIANT.



✓ COMPLIANT



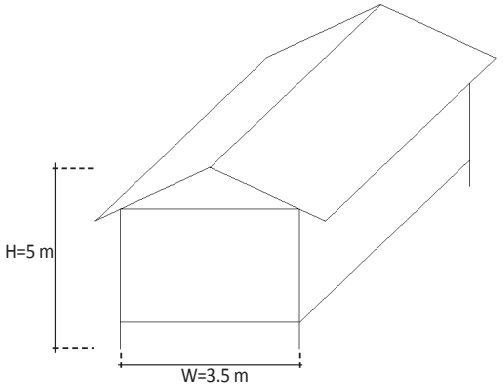
✗ NON-COMPLIANT

2.3 OVERTURNING

The total height of the houses is less than two times the narrowest width of the house.

HOW TO CHECK

- Measure the total height of the house from the ground outside to the top of the roof. Then measure the narrowest width of the house. Divide the measured height by the measured width to check if the result is less than two.

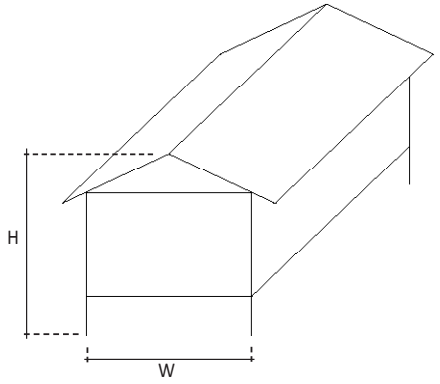


2W = 2 x 3.5 m
2W = 7 m

H < 2W

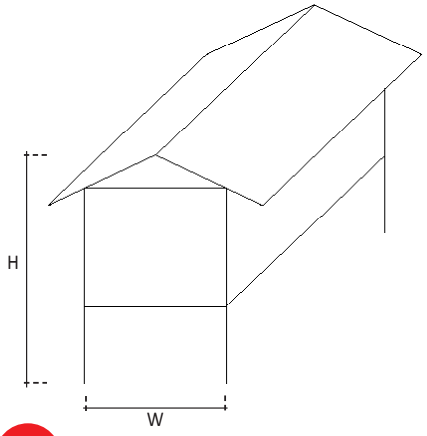
Houses identified as NON-COMPLIANT for this deficiency may be modified by adding walls to increase the narrowest building dimension, or removing stories to reduce the building height in order to make the item COMPLIANT.

H < 2W



COMPLIANT

H > 2W



NON-COMPLIANT

3. MATERIALS

Examine the materials that are used to construct and finish the house to confirm they are safe and strong enough.

3.1 CONCRETE AND MASONRY

Foundations and knee walls are composed of concrete or masonry that is in good condition. There is no evidence that the concrete or masonry has cracked significantly or deteriorated due to corrosion, sulfate attack, material breakdowns, weather, or other reasons in a manner that would affect the integrity or strength of the house.

HOW TO CHECK

- Walk around the perimeter of the house and look below the building (if raised) to observe the exposed portions of the foundations. Looks for signs of deterioration such as brownish stains on the concrete or cracks due to the expansion of the steel inside the concrete, or spalling of the concrete, blocks, or mortar joints.
- Try scraping at the concrete or mortar. If it is easily scraped away with your finger, then it is not in good condition.

Houses identified as NON-COMPLIANT for this deficiency shall be repaired or reconstructed to address the deterioration. See Details D4.1, D4.2 and D4.3 for foundations that require reconstruction and Detail D4.6 for repair of deteriorated foundations.

COMPLIANT

NON-COMPLIANT

3.2 WOOD FRAMING AND PLANKS

Good quality Gmelina, Mahogany, or Lawaan is used for all structural members (framing of structural walls, posts, floor joists, and roof framing). It is straight-grained, free of excessive knots and warps, does not have high moisture content, and is Grade 2 or better. Preservative or moisture barriers are used on all wooden members placed against concrete surfaces or exposed to the elements. There shall be no signs of decay, shrinkage, splitting, fire damage, infestation or sagging in any of the wood members; existing notches and holes in the members must not be structurally detrimental.

All wood structural members that are directly exposed or open to weather, like rain, wind, and sun, should be protected by either painting or varnishing the exposed surfaces. This will help delay or prevent decay and infestation.

HOW TO CHECK

- Visibly inspect wood members for knots, warps, sagging, and moisture or insect damage. Use a pen, or nail 3" to poke the wood members if the condition is questionable. If the wood can be penetrated or easily indented then it is not in good condition.
- Measure the existing notches and holes in the framing studs and joists and confirm that they do not exceed those allowable in Details D3.1 and D3.2.

Houses identified as NON-COMPLIANT for this deficiency shall have the non-compliant wood members removed and replaced with compliant materials in order to make the house COMPLIANT. For decay due to water intrusion, the source of the intrusion shall be identified and remediated to prevent future decay. Members with holes or notches not meeting the requirements of Details D3.1 or D3.2 shall be replaced.

COMPLIANT

NON-COMPLIANT

3.3 PLYWOOD

Plywood used to cover shear walls has a minimum thickness of 10 mm, with 3 layers of veneer minimum. It is in good condition without warping or peeling of the plies. Plywood used on the exterior of the building shall be first class of marine plywood.

Houses identified as NON-COMPLIANT for this deficiency shall have the non-compliant plywood removed and replaced with compliant materials in order to make the house COMPLIANT.

✓ COMPLIANT

✗ NON-COMPLIANT

3.4 METAL FASTENERS

Metal fasteners and connectors are corrosion-resistant, such as stainless steel, hot-dipped galvanized, or bronze coating. They are in good condition and are not deteriorated, broken, or loose.

HOW TO CHECK

- Look carefully at the existing nails, bolts, straps, and metal connectors to make sure that they do not have visible corrosion spots and that they are well-secured.
- Try to move existing connectors and fasteners to make sure they are not loose.

Houses identified as NON-COMPLIANT for this deficiency shall have the non-compliant fasteners removed and replaced with compliant materials in order to make the house COMPLIANT.

COMPLIANT

NON-COMLPIANT

3.5 BUILDING MATERIAL WEIGHT

The house floors, walls, and roof are constructed of light-weight materials such as wood, amakan, or sheet metal without heavy coverings. There are no masonry block infill walls between timber wall framing or heavy or cementitous coverings, such as tile, thick gypsum board, concrete, plaster, or stucco.

Houses identified as NON-COMPLIANT for this deficiency may be modified by removing the heavy elements or coverings and replacing them with light-weight materials in order to make the item COMPLIANT.

COMPLIANT

NON-COMPLIANT

4. FOUNDATIONS

Dig a small hole next to the house foundation confirm that the existing foundations do not have any problems.

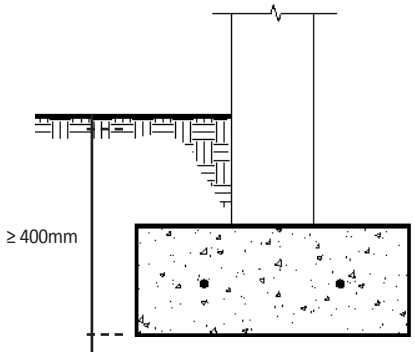
4. 1 FOUNDATION DEPTH

All foundations extend to a minimum depth of 400 mm below grade.

HOW TO CHECK

- Dig a small test pit at the side of the house foundation that is at least 400 mm deep and confirm that the bottom of the existing foundation extends below it.

To retrofit houses that are NON-COMPLIANT with this checklist item, the house can be shored up and foundations installed below all shear walls and posts to meet the minimum requirements of Details D4.1, D4.2, and D4.3.



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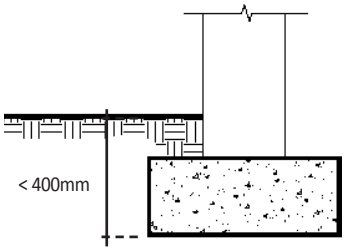


NON-COMPLIANT

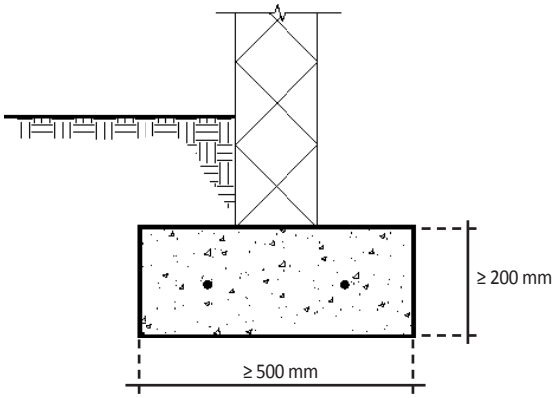
4.2 FOUNDATIONS BELOW SHEAR WALLS

Foundations below shear walls are continuous beneath the shear wall length, are composed of reinforced concrete and have a minimum depth of 200 mm, and a minimum width of 500 mm.

Exception: Continuous foundations are not required below shear walls covered with 3/8" plywood and with hold-down posts spaced no more than 2.4 meters apart. Instead the hold-down posts must be supported on concrete foundations and connected by straps as shown in Detail D2.3.

For more information on shear walls, please refer to Structural Safety Checklist section 6.

To retrofit houses that are NON-COMPLIANT with this checklist item, the house can be shored up and foundations installed below all shear walls in accordance with Details D4.1A, D4.1B, D4.1C, and D4.3.



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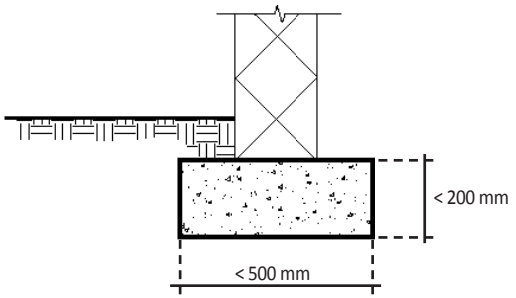
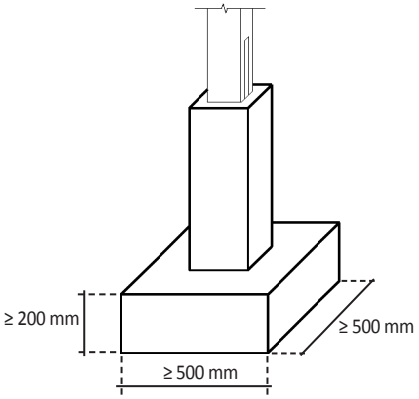


NON-COMPLIANT

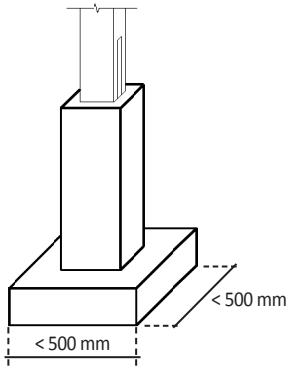
4.3 FOUNDATIONS BELOW GRAVITY POSTS

The foundations below gravity posts shall be composed of reinforced concrete and have a minimum depth of 200 mm, and a minimum width of 500 mm in each direction.

To retrofit houses that are NON-COMPLIANT with this checklist item, foundations shall be installed below all gravity posts in accordance with Details D4.2.



COMPLIANT

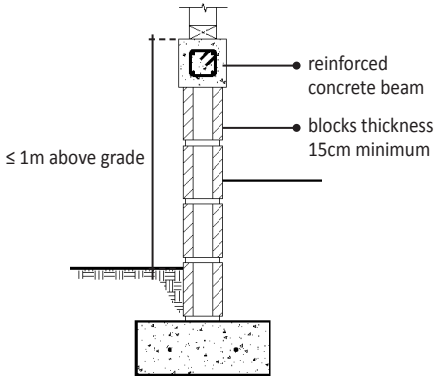


NON-COMPLIANT

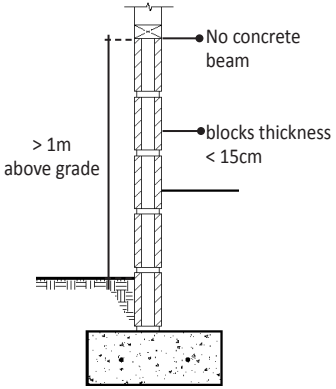
4.4. KNEE WALLS

Knee walls are made of reinforced concrete or concrete masonry (15 cm wide minimum) and do not extend more than 1.0 meter above adjacent grade. Concrete masonry walls are topped with a reinforced concrete beam (15 cm x 15 cm minimum). If the wall above is not a shear wall, then a concrete cap beam is not required.

Houses identified as NON-COMPLIANT for this deficiency shall be repaired or reconstructed to address the inadequate elements. See Detail D4.1A and D4.1B for how to construct a compliant knee wall.



COMPLIANT

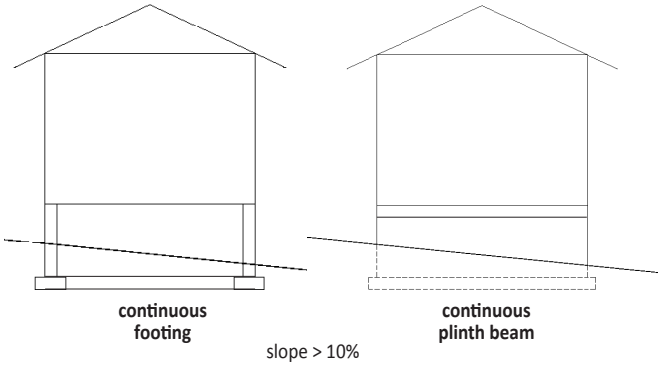


NON-COMPLIANT

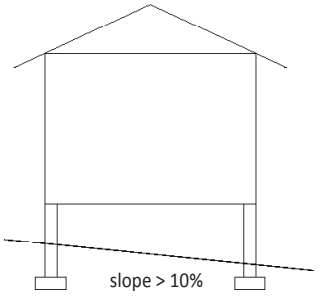
4.5. TIES BETWEEN FOUNDATION ELEMENTS

For all sites sloping more than 10% below the house, or for soft soil sites, the foundation elements shall be interconnected by a reinforced concrete slab, or continuous footings, or a continuous reinforced concrete plinth beam underneath all walls.

Houses identified as NON-COMPLIANT for this deficiency shall have foundation tie beams constructed in accordance with Detail D4.5 to ensure interconnection between the foundation elements in order to make the item COMPLIANT.



COMPLIANT



NON-COMPLIANT

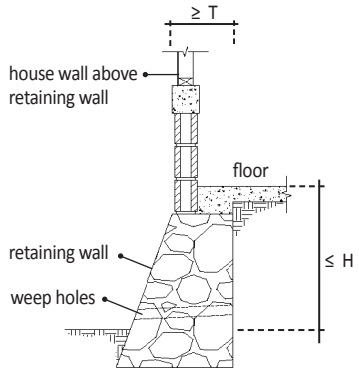
4.6 FOUNDATION RETAINING WALLS

Unreinforced rock foundation retaining walls which directly support the house are in good condition and meet the minimum dimensions listed in Table 4.6, Minimum Requirements for Retaining Walls. Weep holes are present in solid wall systems for drainage.

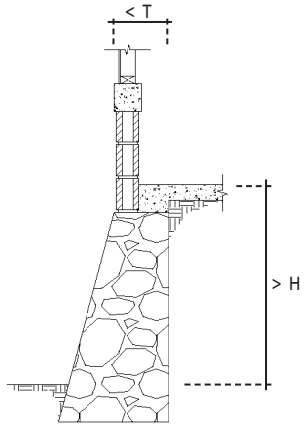
Table 4.6 Minimum Requirements for Retaining Walls

Type of Soil	Minimum Thickness of Wall (T)	Maximum Height of Wall (H)
Dense, Firm Soil	40 cm	2.0 m
Sandy Soil	40 cm	1.0 m

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required.



COMPLIANT



NON-COMPLIANT

4.7 FOUNDATION PERFORMANCE

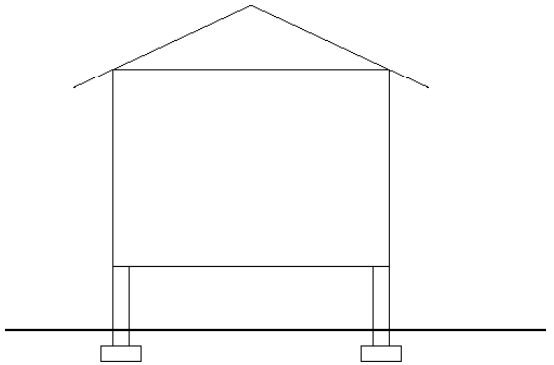
There is no evidence of significant foundation movement such as settlement or heave that would affect the integrity or strength of the house.

Comment: Poor foundation performance, such as cracking or movement due to settlement can indicate that there are problems with the soil below the house and that it is possibly not suitable to support a house.

HOW TO CHECK

- Look to see if the house is relatively level with the ground and does not appear to have settled or lifted significantly (foundations do not appear to have moved over time).
- Study the foundations and walls of the house to confirm that there are no visible cracks indicative of settlement.

A NON-COMPLIANT result for this checklist item cannot be mitigated using this manual and a more detailed evaluation is required.



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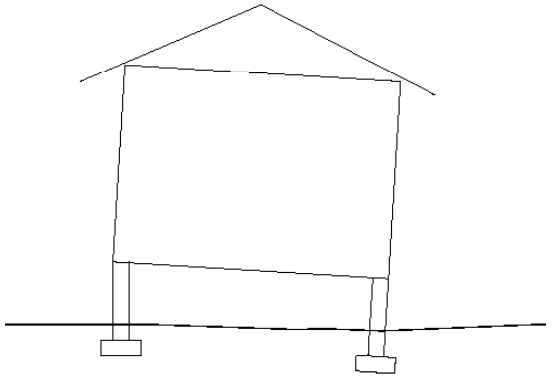
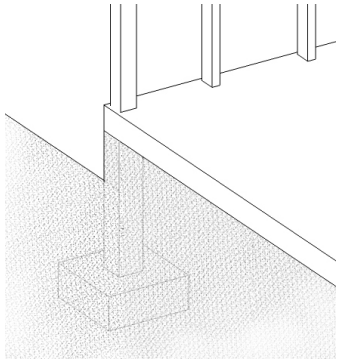
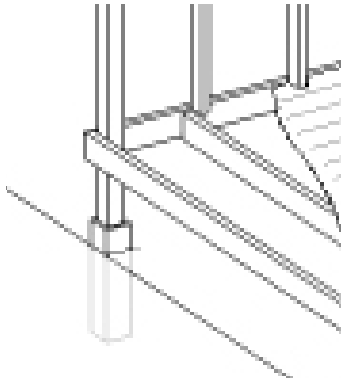


NON-COMPLIANT

5. FLOORS

Study the floor of the house and determine if it is sitting on the ground or if it is raised above the ground, then check for the corresponding safety concerns.





5.1 FLOORS ON GRADE

Floors on grade, such as tamped earth or concrete slab-on-grade, are directly supported on compacted soil and do not span above underground reservoirs.

Comment: Floors directly supported on grade that are composed of wood or other materials susceptible to decay will deteriorate over time.

HOW TO CHECK

- Tap on the floor at grade with a hammer to confirm it has a solid, compacted support below. If there is a hollow sound then the floor may not be well-supported.

To retrofit a structure found to be NON-COMPLIANT for this checklist item, the following can be done in order to make the structure COMPLIANT:

- Wood floors directly supported on the ground shall be removed and replaced with tamped earth or a concrete slab-on-grade.
- Locations where ground-supported floors are not based on compacted earth shall be removed so that compacted infill can be added below and then floors replaced.

COMPLIANT

NON-COMPLIANT

5.2 RAISED FLOOR FRAMINGS

Raised floors are wood-framed with wood joists spanning no more than 3.5 meters between supports. Wood-framed floors are raised up at least 45 cm clear from ground below to prevent decay. The existing raised floors are relatively straight and level without excessive sagging.

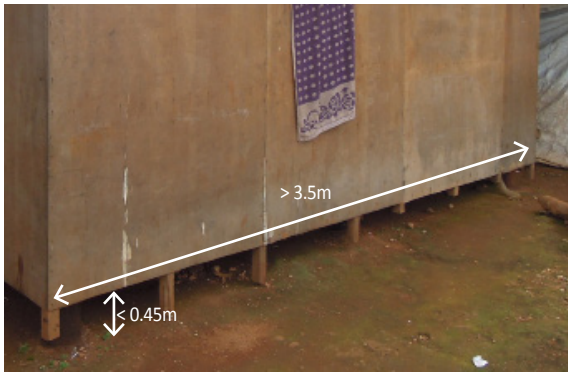
HOW TO CHECK

- Look below the floor and identify the length of the floor framing between supports. Measure the length to confirm that it is less than 3.5 meters.
- Visually observe the framing to confirm that there is no sagging near the center of the joists or along supporting beams.

To retrofit a house found to be NON-COMPLIANT for this checklist item, the following can be done in order to make the structure COMPLIANT:

- Raised floors built of materials other than wood joists shall be removed and replaced with wood joists.
- Add compliant supports below wood-framed raised floors to decrease the span length as needed to make the house conform.
- Add supports or replace framing members to reduce the sagging where it is significant.
- Apply a preservative or use treated wood for floor systems closer than 45 cm to the ground below.

COMPLIANT



NON-COMPLIANT

5.3 RAISED FLOOR SUPPORTS

Raised floors span to and are supported on wood stud cripple walls, wood beams and posts, or knee walls. Raised floors are connected to knee walls, cripple walls, and foundations in conformance with Details D4.1B and D4.1C.

To retrofit a house found to be NON-COMPLIANT for this checklist item, the following can be done in order to make the structure COMPLIANT:

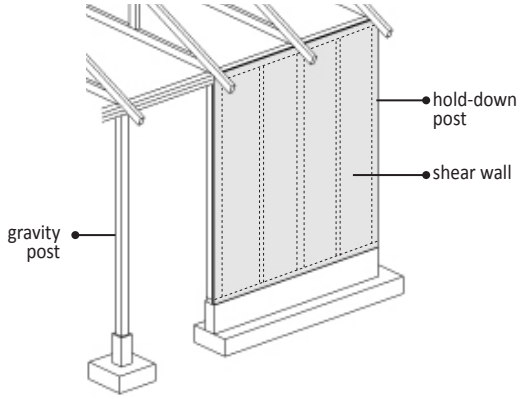
- Add conforming supports below wood-framed raised floors where needed.
- Connect floor framing to supports in conformance with Details D4.1B and D4.1C.

COMPLIANT

NON-COMPLIANT

6. WALLS AND POSTS

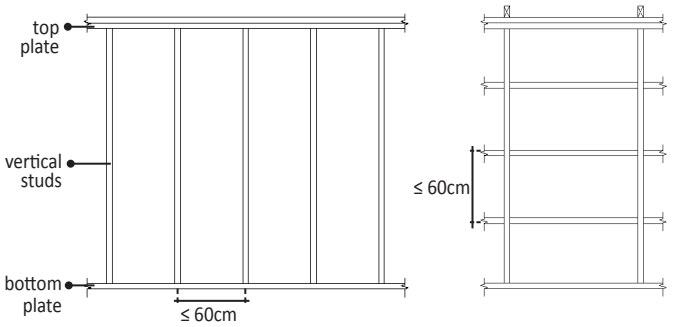
Structural walls can either support the house vertically – such as hold up the roof, or they can support the house laterally – such as brace the house against earthquake and wind loads. Walls that brace the house against lateral loads are called shear walls. Identify which walls in the house are structural walls and check to see if they meet the following requirements for safety. Posts may also be used to support the house vertically, such as holding up a roof beam or truss, or support the floor when it is raised. When posts are not connected to a shear wall, they are called gravity posts. When posts are used at the ends of shear walls to help the walls resist over-turning forces from earthquake or wind loads, they are called holddown posts.



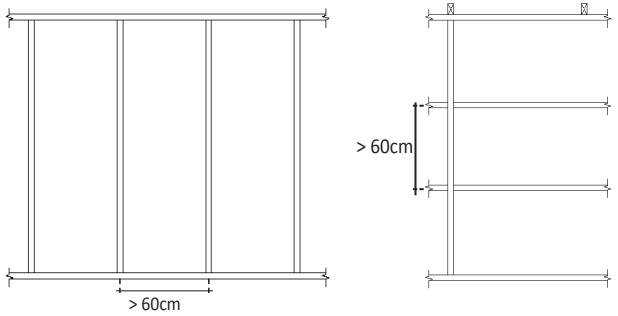
6.1 STRUCTURAL WALL CONSTRUCTION

Load-bearing walls that support the roof are built with a bottom plate (2x4 minimum), vertical or horizontal studs (2x4 minimum) spaced at 60 cm on center maximum, and a doubled 2x4 top plate (or single 4x4 top plate) that is continuous between perpendicular walls. If horizontal wall studs are used, there is a vertical stud aligned below each roof rafter or truss.

Houses identified as NON-COMPLIANT for this deficiency may be corrected by replacing sub-standard members with adequate ones, and by adding additional studs or plates as needed in order to make the item COMPLIANT.



COMPLIANT



NON-COMPLIANT

BUILD CHANGE

Cordaid BUILDING FLOURISHING COMMUNITIES

6.2 SHEAR WALL COVERINGS AND BRACING

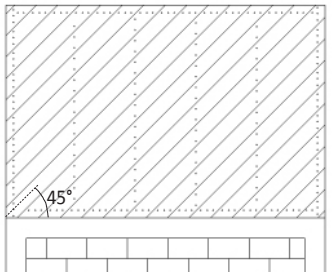
Shear walls are covered by plywood or diagonal planks, or have strapping to brace the wall as described by one of the three options below. In a single wall line, only one option is used for all of the shear walls. There is no mixing of the different wall types within a single wall line.

Comment: The construction professional shall select which type of shear wall is applicable for the wall line and complete the evaluation and retrofit according to that wall type.

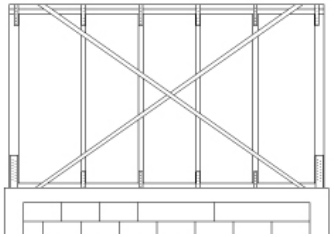
- **OPTION 1 - Diagonal lumber planks**
  1x6 (minimum) boards oriented diagonally at 45 degrees. Refer to Details D6.2 and D6.3 for construction of diagonal lumber shear walls.
- **OPTION 2 - Metal X-bracing with non-structural covering**
  Strapping is in a full-height X-pattern, straps are 12 cm wide x 18 gage thick on both sides of the wall. Refer to Details D6.4, D6.5, D6.6, and D6.7 for construction of metal X-bracing structural walls.
- **OPTION 3 - Plywood sheathing**
  Plywood is used to cover the wall over the full-height. Use plywood that is a minimum of ⅜" thick and make sure there a vertical or horizontal studs along all the edges of each plywood sheet. The plywood is nailed to studs/posts at the edges and along the intermediate studs. Refer to Details D6.8 and D6.9 for construction of plywood structural walls.

Houses identified as NON-COMPLIANT for this deficiency may be corrected by constructing shear walls along each required line in conformance with the requirements of the referenced details in order to make the item COMPLIANT.

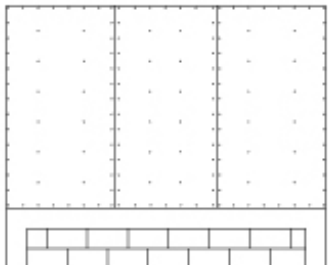
TYPES OF SHEAR WALLS



Diagonal lumber planks



Metal X-bracing

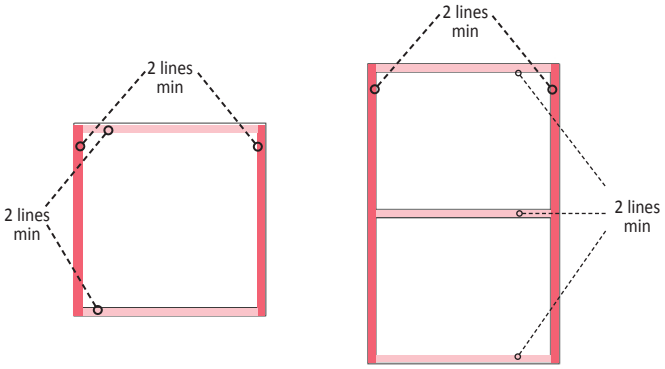


Plywood sheathing

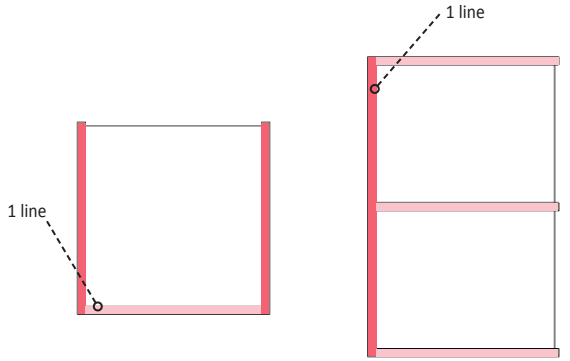
6.3 SHEAR WALL REDUNDANCY

There are at least two shear wall lines in each principal direction of the house.

House identified as NON-COMPLIANT for this deficiency may be corrected by constructing shear walls to achieve at least two shear wall lines in each principal direction to make the item COMPLIANT.



COMPLIANT

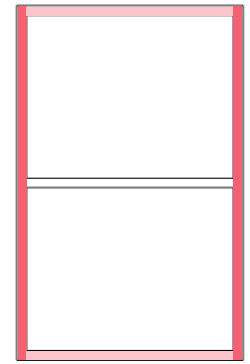


NON-COMPLIANT

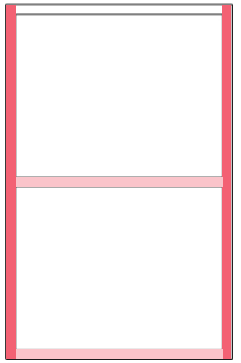
6.4 SHEAR WALL LOCATION

Shear walls are located at each exterior line of the house.

Houses identified as NON-COMPLIANT for this deficiency may be corrected by constructing shear walls to achieve at least one shear wall segment on each exterior wall line to make the item COMPLIANT.



COMPLIANT

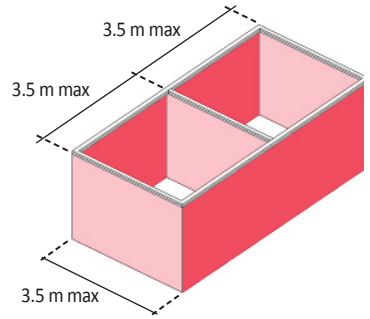


NON-COMPLIANT

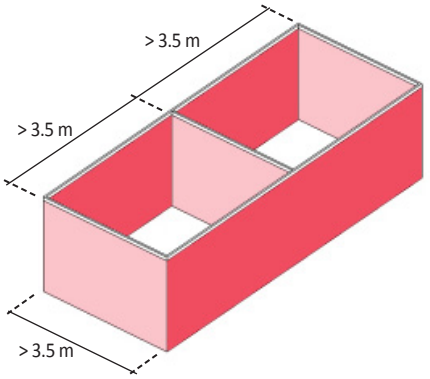
6.5 SHEAR WALL SPACING

Parallel shear walls shall be spaced no more than 3.5 meters apart.

Houses identified as NON-COMPLIANT for this deficiency may be corrected by constructing shear walls to achieve a maximum spacing between parallel shear wall lines of 3.5 meters to make the item COMPLIANT.



COMPLIANT



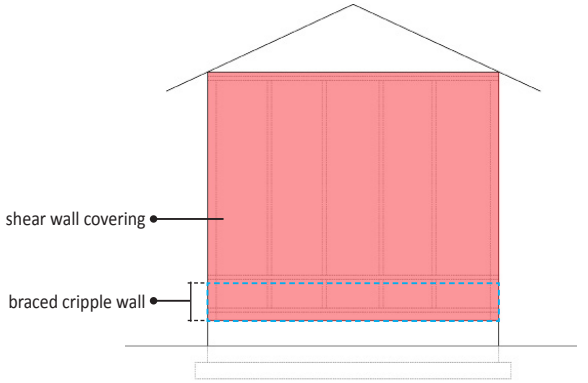
NON-COMPLIANT

6.6 CRIPPLE WALLS

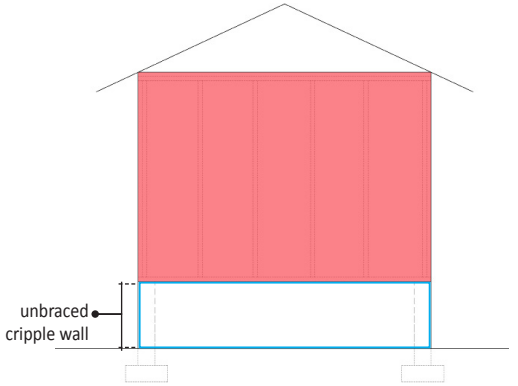
Where there are raised floors supported on post and beam construction and there are not masonry or concrete knee walls directly supporting the floor, cripple walls are framed between the floor framing and the foundation at the locations of shear walls for support, and shear wall coverings and straps connect to the cripple walls as shown in Detail D4.1B and D4.1C.

Exception: For 3/8" plywood shear walls with holddown posts spaced no more than 2.4 meters apart: the cripple wall and plywood extension and connection to the cripple wall can be omitted as long as the holddown posts are connected to foundations per Detail D4.3.

Houses identified as NON-COMPLIANT for this item shall have diagonal lumber planks, plywood or metal X-bracing extended down and connected to the cripple wall as shown in Detail D4.1B and D4.1C in order to make the building COMPLIANT.



COMPLIANT

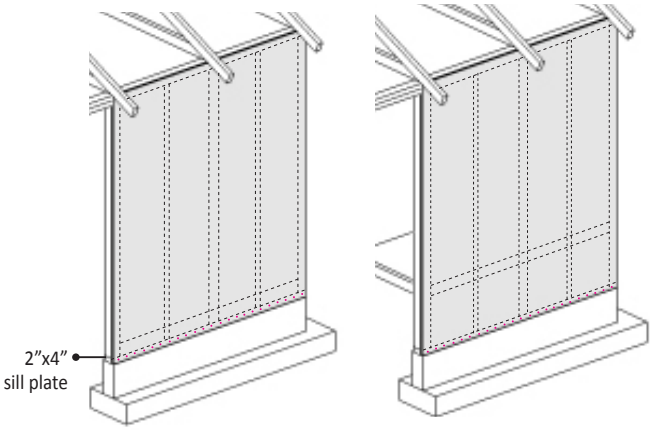


NON-COMPLIANT

6.7 SHEAR WALL CONNECTION TO FOUNDATION

Each shear wall is continuous to the foundation or supported by a conforming knee wall (Checklist item 4.4) or cripple wall (Checklist item 6.6). In all cases, the shear wall plywood or diagonal lumber is nailed to a sill plate (2”x4” minimum) at the base of the wall that is positively connected to the foundation or cap beam below, or for metal strapping, a starter strap is embedded into the reinforced concrete foundation or cap beam at a 45 degree angle and hooked around longitudinal bars in the concrete. The wall studs and sill plate shall be connected to the foundation or cap beam below with straps at each stud per Detail D6.13.

Exception: For 3/8” plywood shear walls with hold-down posts spaced no more than 2.4 m apart: the cripple wall and plywood extension and connection to the cripple wall can be omitted as long as the hold-down posts are connected to foundations per Detail D4.3.



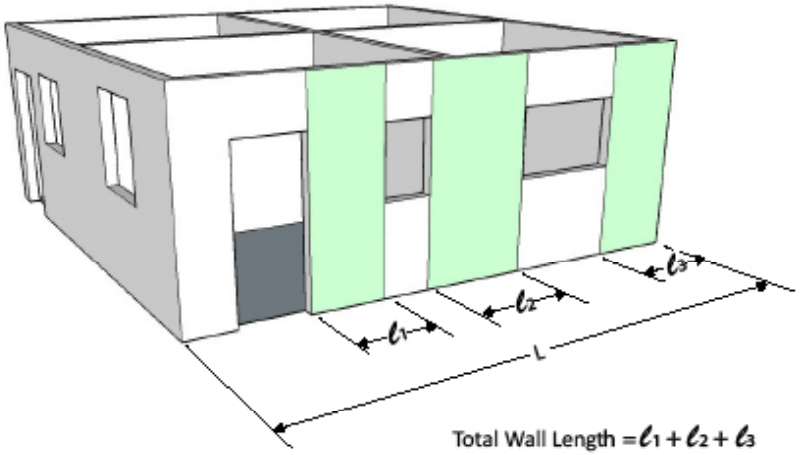
✓ COMPLIANT

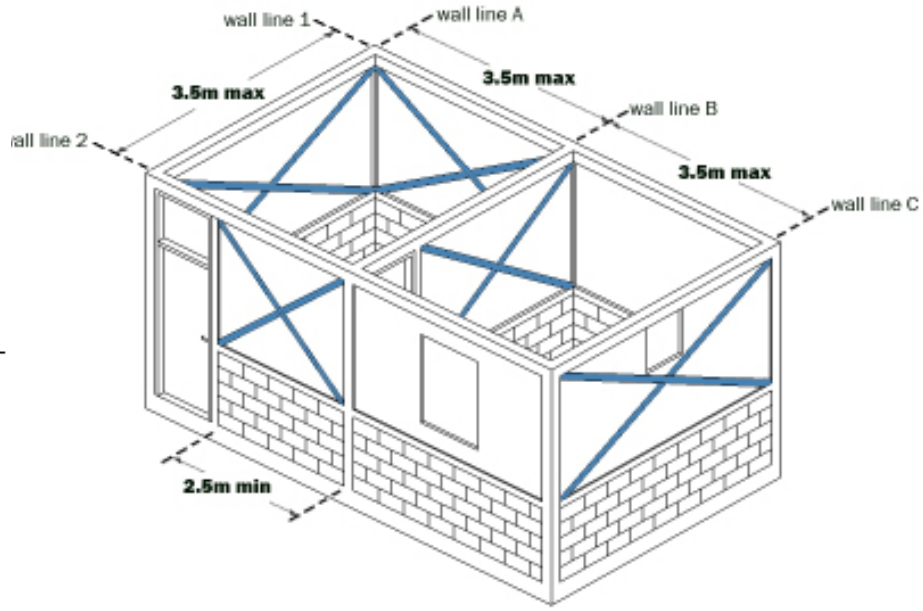
✗ NON-COMPLIANT

Houses identified as NON-COMPLIANT for this deficiency shall be retrofitted by adding elements as needed and connecting the shear walls to the foundations or knee wall cap beams as indicated in Details D4.1A, D4.1B, and D4.1C in order to make the structure COMPLIANT. The deficient sill should be replaced and conforming connections between the sill and concrete element installed in accordance with Detail D6.12. Straps at the bottom of each stud shall be connected per Detail D6.13.

6.8 SHEAR WALL LENGTHS

The total length of shearwall along each building line meets the minimum requirements noted in Table 6.8A.1 and 6.8A.2, Minimum Length of Structural Wall per Line based Shear Wall Spacing, OR Table 6.8B, Minimum Bays of Strapping per Line based on Building Length Parallel to Wall Line. The lengths noted in the tables represent the total wall length required along a wall line. Segments of the shear wall length can be separated by openings; refer to Checklist item 6.9 for the minimum lengths of shear wall segments.





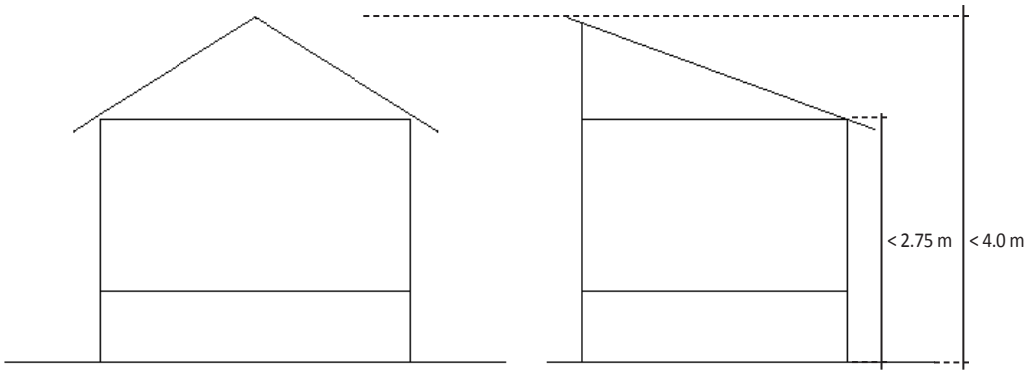


Table 6.8A.1 Minimum Length of Shear Wall (m) per Line based on Shear Wall Spacing (h_{total} < 4.0 m, h_{wall} < 2.75 m)

Wall Type			Average Shear Wall Spacing in Parallel Direction (m)							
			2		2.5		3		3.5	
Covering	Studs	Nailing	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall
3/8" Plywood	2x4 MIN, 60 cm o.c. MAX	8d @ 10 cm Edge, @ 30 cm Field	2.90	1.50	3.50	1.80	4.10	2.20	4.70	2.50
1/2" Plywood	2x4 MIN, 60 cm o.c. MAX	8d @ 10 cm Edge, @ 30 cm Field	2.40	1.20	2.90	1.50	3.40	1.80	3.90	2.10
5/8" Plywood	2x4 MIN, 60 cm o.c. MAX	10d @ 10 cm Edge, @ 30 cm Field	1.80	0.90	2.20	1.20	2.60	1.40	2.90	1.60
Diagonal Lumber	2x4 MIN, 60 cm o.c. MAX	Per Board: (3) 8d Boundary (2) 8d Int Studs	2.10	1.10	2.60	1.40	3.00	1.60	3.50	1.90

Table wall types, spacings, and lengths are applicable for wind zones I, II, or III (up to 250 kph) and seismic zones 2 or 4.

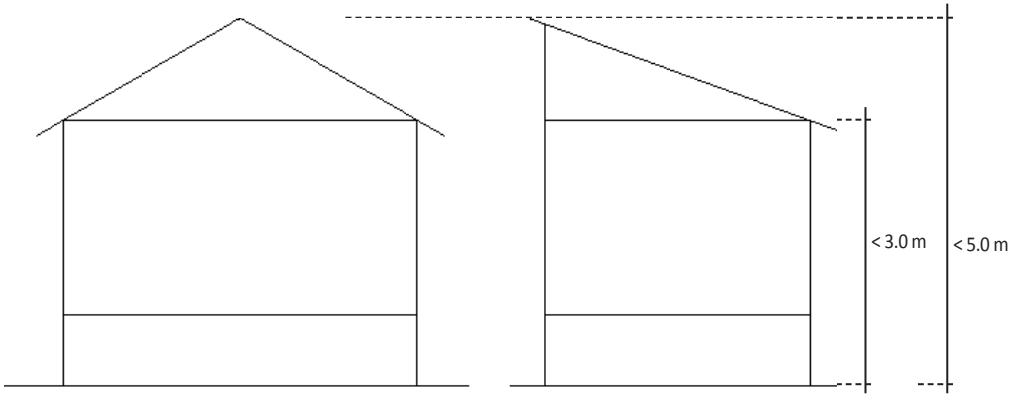
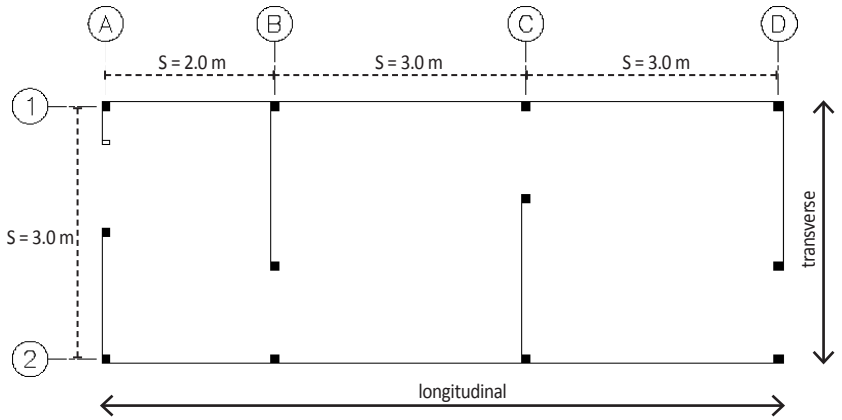


Table 6.8A.2 Minimum Length of Shear Wall (m) per Line based on Shear Wall Spacing (h_{total} < 5.0 m, h_{wall} < 3.0 m)

Wall Type			Average Shear Wall Spacing in Parallel Direction (m)							
			2		2.5		3		3.5	
Covering	Studs	Nailing	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall	Interior Wall	Exterior Wall
3/8" Plywood	2x4 MIN, 60 cm o.c. MAX	8d @ 10 cm Edge, @ 30c m Field	3.70	1.90	4.50	2.40	5.30	2.80	6.10	3.30
1/2" Plywood	2x4 MIN, 60 cm o.c. MAX	8d @ 10 cm Edge, @ 30 cm Field	3.10	1.60	3.80	2.00	4.50	2.40	5.10	2.80
5/8" Plywood	2x4 MIN, 60 cm o.c. MAX	10d @ 10 cm Edge, @ 30 cm Field	2.30	1.20	2.80	1.50	3.30	1.80	3.80	2.10
Diagonal Lumber	2x4 MIN, 60 cm o.c. MAX	Per Board: (3) 8d Boundary (2) 8d Int Studs	2.80	1.40	3.40	1.80	4.00	2.10	4.60	2.50

Table wall types, spacings, and lengths are applicable for wind zones I, II, or III (up to 250 kph) and seismic zones 2 or 4.

Example of Determining Average Shear Wall Spacing:



* **S =** spacing of parallel wall

TRANSVERSE WALLS

- Wall A - Exterior = 2.0 m
- Wall B - Interior = $\frac{2+3}{2}$ = 2.5 m
- Wall C - Interior = $\frac{3+3}{2}$ = 3.0 m
- Wall D - Exterior = 3.0 m

LONGITUDINAL WALLS

- Wall 1 - Exterior = 3.0 m
- Wall 2 - Exterior = 3.0 m

Table 6.8B Minimum Bays of Strapping per Line based on Building Length Parallel to Wall Line

Type of Structural Wall	Building Length = or < 7.0 m	7.0 < Building Length < 15.0 m
Metal X-bracing	One pair of "X" strapping	Two pairs of "X" strapping

Structures identified as NON-COMPLIANT for this deficiency shall have new shear walls added or existing wall openings infilled and converted to shear walls in order to meet the minimum wall length requirements and make the building COMPLIANT. Refer to Detail D6.1 for how to infill existing door and window openings.

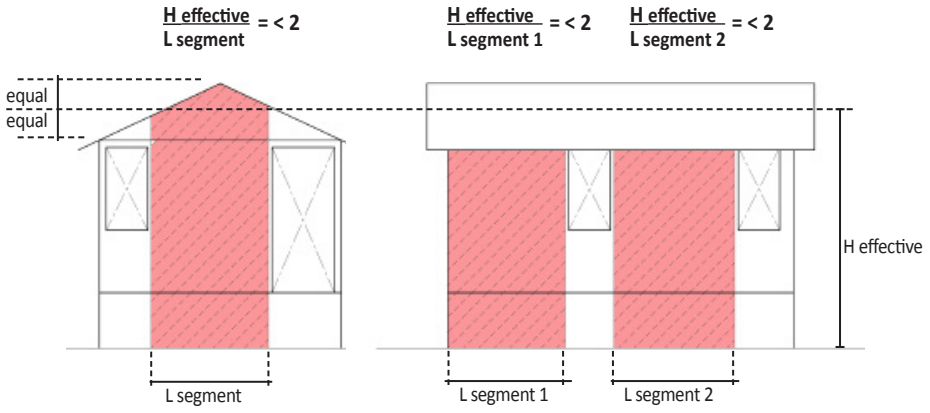
6.9 SHEAR WALL SEGMENTS

The length of any individual segment of shear wall is greater than half the effective height of the wall. The effective height of the segment is measured from the ground elevation or top of knee wall to an elevation halfway between the roof ridge and top of wall.

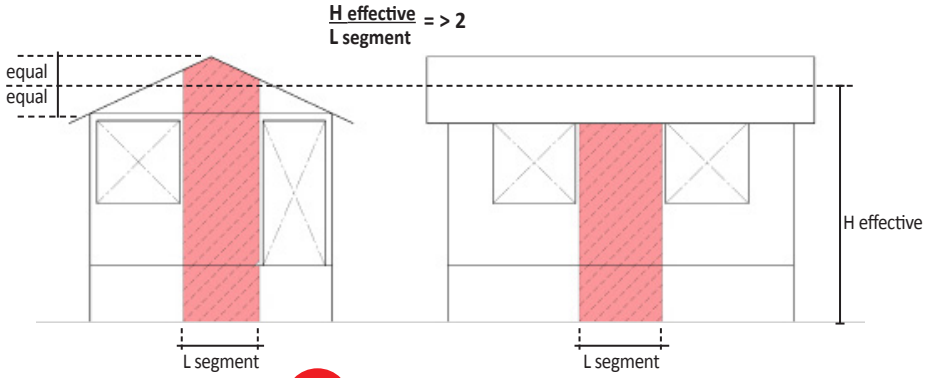
HOW TO CHECK

- Measure the height of the house from the ground outside, or top of knee wall if there is one, to an elevation halfway between the top of wall and top of the roof. Then measure the narrowest shear wall segment width. Divide the measured height by the measured width to check if the result is less than two.

Houses identified as NON-COMPLIANT for this deficiency shall have wall segments lengthened or wall/roof heights decreased in order to decrease the height to length ratio and make the building COMPLIANT.



COMPLIANT

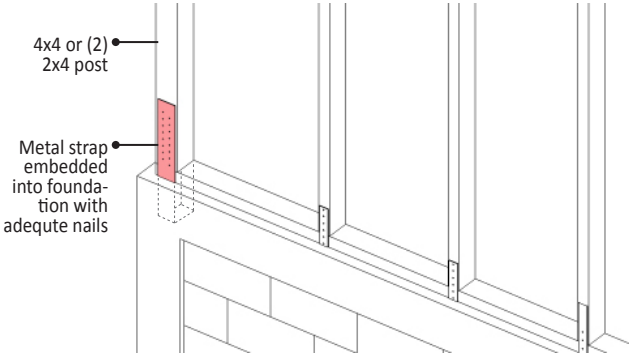


NON-COMPLIANT

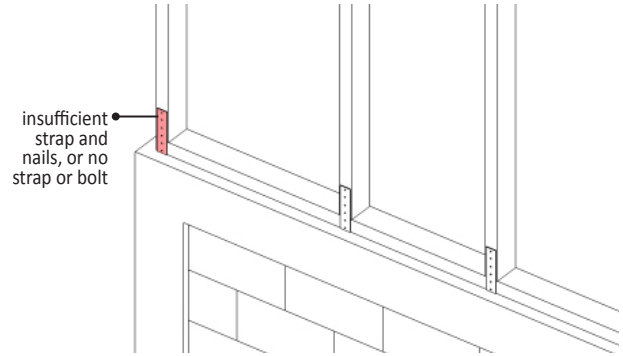
6.10 SHEAR WALL HOLD-DOWNS

There are double 2x4 (nailed together at every 3" on center) or single 4x4 holddown posts at each end of each shear wall segment. The holddown posts are continuous to and connected to the foundation with vertical metal straps embedded in the foundation and fastened to the post at each side as shown in Detail D6.10 or Detail D4.3, where applicable.

Houses identified as NON-COMPLIANT for this deficiency shall have posts and hold down anchors installed in accordance with Detail D6.10 or Detail D4.3, where applicable, in order to make the building COMPLIANT.



COMPLIANT

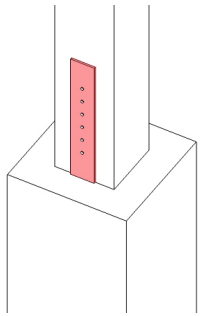


NON-COMPLIANT

6.11 GRAVITY WOOD POSTS

Gravity wood posts not connected to shear walls are connected to the foundation in a way that prevents sideways movement or uplift of the post base from the foundation. Refer to Detail D6.11 for an example of an adequate post-base connection.

Houses identified as NON-COMPLIANT for this deficiency shall have compliant connections between footings and gravity posts installed in accordance with Detail D6.11.



Connected with plate or strap embedded into concrete

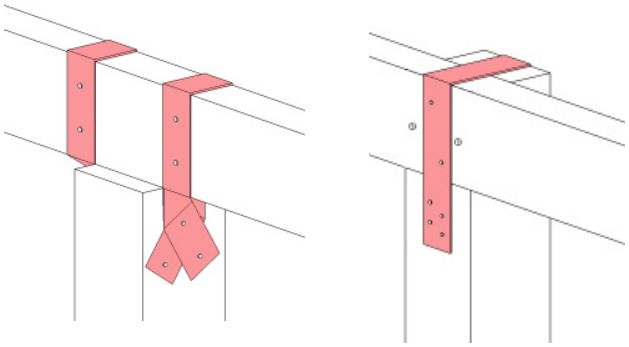
COMPLIANT

NON-COMPLIANT

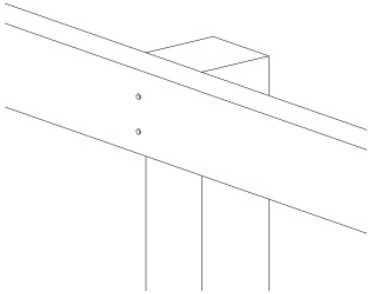
6.12 BEAM-TO-POST CONNECTIONS

Connections between beams and posts are made with plates, connection hardware or metal straps so that the beam is connected to the post to prevent uplift, separation or sideways movement of the beam. See Detail D6.15 for examples of adequate beam-to-post connections.

Houses identified as NON-COMPLIANT for this deficiency shall have compliant connections added between beams and posts in accordance with Detail D6.15.



COMPLIANT



NON-COMPLIANT

7. ROOFS

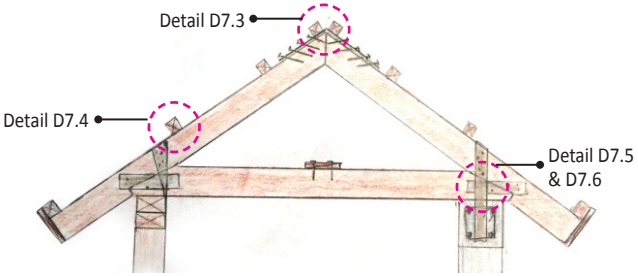
Study the roof framing and coverings to see how they are inter-connected, and how the roof framing is connected to the house walls and posts to determine if there are any potential problems.

7.1 ROOF FRAMING SYSTEM

Timber roofs may be constructed of one of the following two options. The construction professional should select which type of timber roof is applicable for the building and complete the evaluation and retrofit according to the roof type.

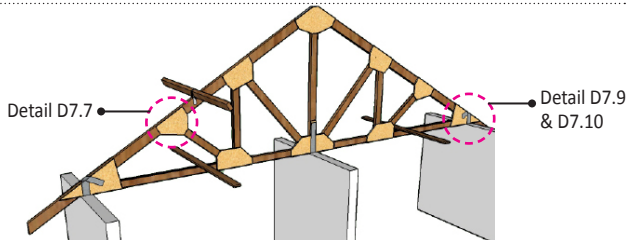
- **OPTION 1 - Rafter and tie system**

  This type of system is comprised of rafters (see Details D7.3 and D7.5) braced by a horizontal 2x4 tie at the top plate level. Rafters (2X4) are positively connected to the top plate (see Detail D7.6) and the wood tie (see Detail D7.5). The purlins (2x2) are fastened by metal straps both ways (see Detail D7.4) and spaced at a maximum of 0.90 meter on center. The rafters are spaced 1.0 meter on center maximum.



- **OPTION 2 - Truss and purlins system**

  The whole truss (2X4) is composed of top and bottom chords supported by king post and diagonal web members. ¾" plywood gusset plates are used in truss member connections (see Detail D7.7). The truss is connected to the top plate by a metal strap (see Detail D7.10). The purlins (2X4) are fastened by metal straps both ways (See setail D7.9) and are set apart 0.90 meter on center. Every truss is spaced 1.75 meters on center maximum from the next truss.



Houses identified as NON-COMPLIANT for this deficiency shall have new members, and compliant connections and fasteners, installed as indicated in the details to make the structure COMPLIANT.

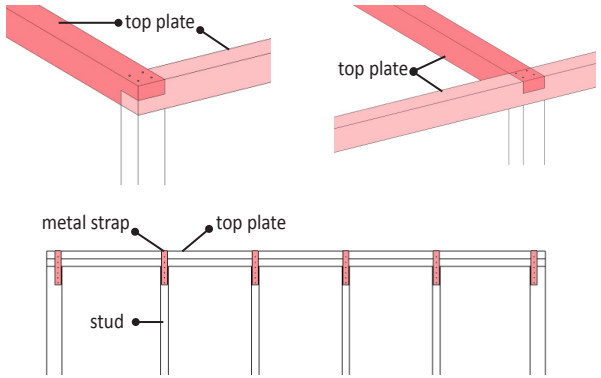
7.2 TOP PLATES

The shear wall top plate is continuous and connects the tops of each shear wall segment to the other walls along the same line. It is continuous between and connected to perpendicular walls and perpendicular top plates. Top plates shall consist of 2-2x4 flat members nailed together or a single 4x4. At perpendicular top plate intersections, the plates from each direction are overlapped and connected together to transfer loads. The top plate shall also be connected with straps at each stud per Detail D6.14.

HOW TO CHECK

- Measure the size of the plate at the top of the wall to see if it meets the size requirements.
- Look along the length to confirm that the top plate framing member does not stop and start between perpendicular top plates. The top plates should form a continuous "ring" around the tops of all walls in the building and connect with each other at intersections.
- Check the connections between the perpendicular top plates at intersections and between the vertical studs in the wall and top plates.

To retrofit houses found to be NON-COMPLIANT for this checklist item, install compliant top plates. Connect top plates along perpendicular walls per Detail D7.1 and splice non-continuous top plates per Details D7.2A and D7.2B. Ensure that vertical studs are strapped to the top plate per Detail D6.14.



COMPLIANT

NON-COMPLIANT

7.3 ROOF VERTICAL SUPPORT

Rood framing is vertically supported by load-bearing walls with top plates, or vertical posts, which have direct support path to the foundation.

To retrofit a house found to be NON-COMPLIANT for this checklist item, install compliant vertical supporting elements that extend to new or existing foundations, see Checklist item 6.1 for the requirements of load-bearing walls.

COMPLIANT

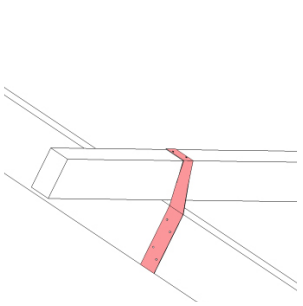
NON-COMPLIANT

7.4 ROOF FRAMING CONNECTIONS

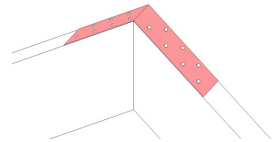
Roof framing members are positively connected to each other:

- Purlins shall be strapped to rafters with metal straps and a total of 4 nails in the purlin and 4 nails in the rafter, or connected with (4) 2x2 blocks with (3) 4" nails to the purlin and (3) 4" nails to the rafter at each block.
- Rafters shall be strapped together at the ridge with a metal strap and 7 nails in each rafter.
- Rafters shall be strapped to the horizontal tie with metal straps and 4 nails at each side of each member,
- Purlins shall be strapped to trusses with metal straps and a total of 7 nails in each wood member, or connected with (4) 2x2 blocks with (3) 4" nails to the purlin and (3) 4" nails to the truss at each block.

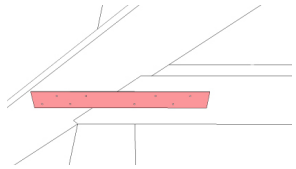
To retrofit a house found to be NON-COMPLIANT for this checklist item, add conforming framing connections in accordance with Details D7.3, D7.4A or D7.4B, D7.5, and D7.9A or D7.9B.



8 nails total for Purlin to Rafter
or
14 nails total for Purlin to Trusses



Rafter-to-Rafter at the ridge



Rafter-to-Horizontal Tie

COMPLIANT

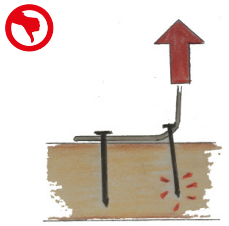
NON-COMPLIANT

7.5 WALL-TO-ROOF CONNECTIONS

All rafters and trusses are positively connected to the top plate with metal straps on each side of the roofing member. Trusses require 20 nails each in the truss and top plate. Rafters require 11 nails each in the truss and top plate.

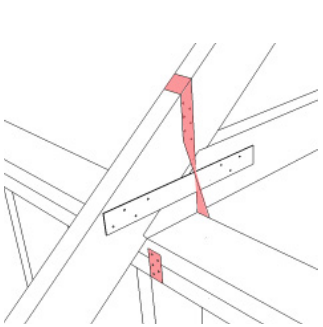
Comment: When the typhoon winds try to lift the roof up, straps aligned and connected vertically will be better able to hold the roof down on the walls.

Shear

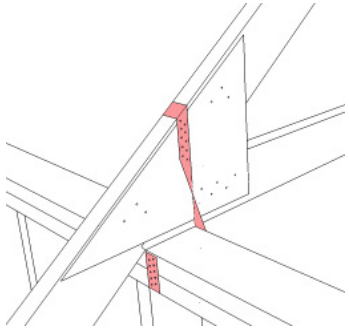


Withdrawl

To retrofit structure for NON-COMPLIANT for this checklist item, install compliant metal straps with proper nailing schedule in accordance with Details D7.6 and D7.10.



Wall-to-Rafter



Wall-to-Trusses

COMPLIANT

NON-COMPLIANT

7.6 ROOF BRACING

Gable roofs shall have diagonal 2x4 "X" bracing between each rafter/tie frame or truss. The bracing members are strapped and/or nailed to the roof framing members to create a solid connection.

To retrofit a house found to be NON-COMPLIANT for this checklist item, install compliant diagonal X-bracing in accordance with Detail D7.8.

COMPLIANT

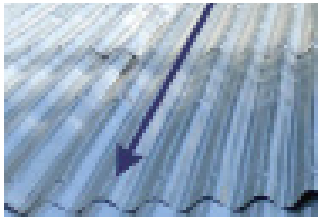
NON-COMPLIANT

7.7 ROOF COVERINGS

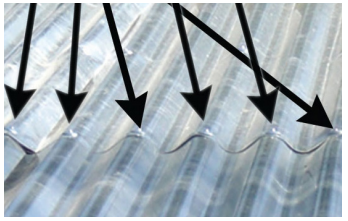
Roofs are covered with corrugated metal sheets (29 gage minimum) that are fastened with roofing nails to the purlins. The waves of sheets that are overlapped are in alignment to facilitate proper water run off. Sheets are lapped by 15 cm minimum and nailed every two waves to purlins and at every wave at roof edges, overhangs and ridges.

To retrofit houses found to be NON-COMPLIANT for this checklist item, install compliant roof sheeting, lapping and nailing in accordance with Detail D7.11.

Aligned wave sheet



Nails at every wave at the sheet edge



COMPLIANT

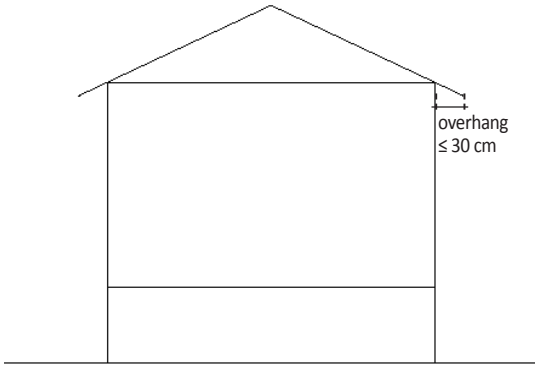
Insufficient roof nails

NON-COMPLIANT

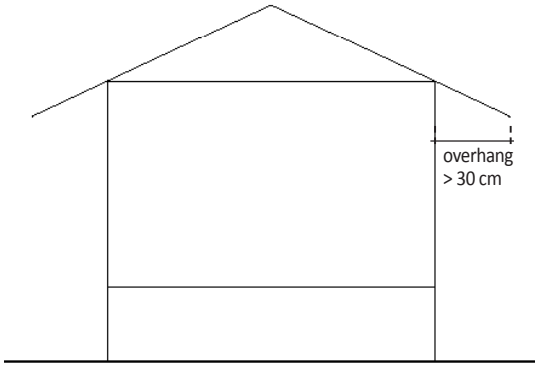
7.8 ROOF OVERHANGS AND EAVES

Roof overhangs or eaves do not extend beyond the building walls by more than 30 cm.

To retrofit houses found to be NON-COMPLIANT for this checklist item, cut back eaves or overhangs that extend beyond 30 cm from the building exterior walls. Install a perimeter fascia board that is end-nailed to the end of each framing member.



COMPLIANT



NON-COMPLIANT

References

- National Structural Code of Philippines, 2010
- ASCE 31-03 Seismic Evaluation of Existing Buildings
- ASCE 41-06 Seismic Rehabilitation of Existing Buildings
- FEMA 547-06 Techniques for the Seismic Rehabilitation of Existing Buildings
- Build Change Post-Disaster Reconnaissance Report Damage Assessment and Housing Markets Survey 2013 Bohol Earthquake and Typhoon Yolanda 31 January 2014, revised 5 February 2014

Appendix A

Structural Safety Checklists and Wall Length Worksheet

BUILD CHANGE

Cordaid BUILDING FLOURISHING COMMUNITIES

	Item	Description	Notes	Proposed Retrofit Solution
	1.0	**SITE HAZARDS**		
C NC N/A	1.1	LIQUEFACTION: The soil within 2 meters below the house is not made of saturated loose granular soils which are susceptible to liquefaction.		
C NC N/A	1.2	SLOPE FAILURE: The house is far enough away from tall steep slopes to not be damaged by potential slope failures or rock falls caused by earthquakes or rain. The site below the house does not slope more than 30%.		
C NC N/A	1.3	SURFACE FAULT RUPTURE: The house is not built along or near a known fault line and therefore surface fault rupture and surface displacement on the house property is not anticipated.		
C NC N/A	1.4	STORM SURGE: The house is not located in an area with known risk of inundation due to storm surges.		
C NC N/A	1.5	FLOOD RISK: The building is not located in a known flood zone or is raised 0.8 m above the ground in areas of flooding, and is located at least 10 meters from rivers and other bodies of water.		
	2.0	**CONFIGURATION**		
C NC N/A	2.1	PLAN CONFIGURATION: The house has a relatively simple, square, and symmetric configuration. The length of the house is not more than 3 times the width. There are no L-shaped corners, which catch wind and collect earthquake loads.		
C NC N/A	2.2	STORY HEIGHT: When measured from the ground outside of the house, the height to the top of the walls (measured from the lowest grade elevation) does not exceed 3.0 meters and the height to the top of the roof does not exceed 5.0 meters.		
C NC N/A	2.3	OVERTURNING: The total height of the house is less than two times the narrowest width of the house.		

	Item	Description	Notes	Proposed Retrofit Solution
	3.0	**MATERIALS**		
C NC N/A	3.1	CONCRETE AND MASONRY: Foundations and knee walls are composed of concrete or masonry that is in good condition. There is no evidence that the concrete or masonry has deteriorated due to corrosion, sulfate attack, material breakdowns, weather, or other reasons in a manner that would affect the integrity or strength of the house.		
C NC N/A	3.2	WOOD FRAMING AND PLANKS: Good quality Gmelina, lawaan, or mahogany is used for all structural members (framing of structural walls, posts, floor joists or roof framing). It is straight-grained, free of excessive knots and warps, does not have high moisture content, and is Grade 2 or better. Preservative or moisture barriers are used on all wooden members placed against concrete surfaces or exposed to the elements . There are no signs of decay, shrinkage, splitting, fire damage, infestation or sagging in any of the wood members; existing notches and holes in the members must not be structurally detrimental.		
C NC N/A	3.3	PLYWOOD: Plywood used in shear walls has a minimum thickness of 10 mm, with 3 layers of veneer minimum. It is in good condition without warping or peeling of the plies. Plywood used on the exterior of the building is exterior grade.		
C NC N/A	3.4	FASTENERS: Fasteners and connectors are corrosion-resistant, such as stainless steel, hot-dipped galvanized or bronze coating. They are in good condition and are not deteriorated, broken or loose.		
C NC N/A	3.5	BUILDING MATERIAL WEIGHT: The house floors, walls and roof are constructed of light-weight materials such as wood, amakan and sheet metal without heavy coverings. There are no masonry block infill walls in the house or heavy or cementitous coverings, such as tile, thick gypsum board, concrete, plaster or stucco.		

	Item	Description	Notes	Proposed Retrofit Solution
	4.0	**FOUNDATIONS**		
C NC N/A	4.1	FOUNDATION DEPTH: All foundations extend to a minimum depth of 400 mm below grade.		
C NC N/A	4.2	FOUNDATIONS BELOW SHEAR WALLS: Foundations below shear walls are continuous beneath the shear wall length, are composed of reinforced concrete and have a minimum thickness of 200 mm, and a minimum width of 500 mm.		
C NC N/A	4.3	FOUNDATIONS BELOW GRAVITY POSTS: The foundations below gravity posts shall be composed of reinforced concrete and have a minimum thickness of 200 mm, and a minimum width of 500 mm in each direction.		
C NC N/A	4.4	KNEE WALLS: Knee walls are made of reinforced concrete or concrete masonry (15 cm wide minimum) and do not extend more than 1.0 meter above adjacent grade. Concrete masonry walls are topped with a reinforced concrete beam (15 cm x 15 cm minimum).		
C NC N/A	4.5	TIES BETWEEN FOUNDATION ELEMENTS: For all sites sloping more than 10% below the house, or for soft soil sites, the foundation elements shall be interconnected by a reinforced concrete slab, or continuous footings, or a continuous reinforced concrete plinth beam underneath all walls.		
C NC N/A	4.6	FOUNDATION RETAINING WALLS: Unreinforced rock foundation retaining walls which directly support the house are in good condition and meet the minimum dimensions listed in Table 4.6 Minimum Requirements for Retaining Walls. Weep holes are present in solid wall systems for drainage.		
C NC N/A	4.7	FOUNDATION PERFORMANCE: There is no evidence of significant foundation movement such as settlement or heave that would affect the integrity or strength of the house.		

	Item	Description	Notes	Proposed Retrofit Solution
	5.0	**FLOORS**		
C NC N/A	5.1	FLOORS ON GRADE: Floors on grade, such as tamped earth or concrete slab-on-grade, are directly supported on compacted soil and do not span above underground reservoirs.		
C NC N/A	5.2	RAISED FLOOR FRAMING: Raised floors are wood-framed with wood joists spanning no more than 3.5 meters between supports. Wood-framed floors are raised off the ground at least 45 cm clear below to prevent decay. The existing raised floors are relatively straight and level without excessive sagging.		
C NC N/A	5.3	RAISED FLOOR SUPPORTS: Raised floors span to and are supported on wood stud cripple walls, wood beams and posts or knee walls. Raised floors shall be connected to knee walls, cripple walls, and foundations in conformance with Details D4.1A, D4.1B and D4.1C.		
	6.0	**WALLS AND POSTS**		
C NC N/A	6.1	STRUCTURAL WALL CONSTRUCTION: Load-bearing walls that support the roof are built with a bottom plate (2x4 minimum), vertical or horizontal studs (2x4 minimum) spaced at 60cm on center maximum, and a doubled 2x4 top plate (or single 4x4 top plate) that is continuous between perpendicular walls. If horizontal wall studs are used, there is a vertical stud aligned below each roof rafter or truss.		

	Item	Description	Notes	Proposed Retrofit Solution
	6.0	**WALLS AND POSTS CONTINUED**		
C NC N/A	6.2	SHEAR WALL COVERINGS AND BRACING: Shear walls are covered by plywood or diagonal planks, or have strapping to brace the wall as described by one of the three options below. In a single wall line, only one option is used for all of the shear walls. There is no mixing of the different wall types within a single wall line.		
	OPTION 1 - Diagonal lumber planks: 1x6 (minimum) boards oriented diagonally at 45 degrees. Refer to Details D6.2 and D6.3 for construction of diagonal lumber shear walls. OPTION 2 - Metal X-bracing with non-structural covering: Strapping is in a full-height X-pattern, straps are 12 cm wide x 18 ga thick on both sides of the wall. Refer to Details D6.4, D6.5, D6.6 and D6.7 for construction of Metal X-bracing structural walls. OPTION 3 - Plywood sheathing: Plywood is used to cover the wall over the full-height. Use plywood that is a minimum of ⅜" thick and make sure there a vertical or horizontal studs along all the edges of each plywood sheet. The plywood is nailed to studs/posts at the edges and along the intermediate studs. Refer to Details D6.8 and D6.9 for construction of plywood structural walls.			
C NC N/A	6.3	SHEAR WALL REDUNDANCY: There are at least two shear wall lines in each principal direction of the house.		
C NC N/A	6.4	SHEAR WALL LOCATION: Shear walls are located at each exterior line of the house.		
C NC N/A	6.5	SHEAR WALL SPACING: Parallel shear walls shall be spaced no more than 3.5 m apart.		
C NC N/A	6.6	CRIPPLE WALLS: Where there are raised floors supported on post and beam construction and there are not masonry or concrete knee walls directly supporting the floor, cripple walls are framed between the floor framing and the foundation at the locations of shear walls for support, and shear wall coverings and straps connect to the cripple walls as shown in Detail D4.1B and D4.1C.		

	Item	Description	Notes	Proposed Retrofit Solution
	6.0	**WALLS AND POSTS CONTINUED**		
C NC N/A	6.7	SHEAR WALL CONNECTION TO FOUNDATION: Each shear wall is continuous to the foundation or supported by a conforming knee wall (Checklist item 4.4) or cripple wall (Checklist item 6.6). In all cases, the shear wall plywood or diagonal lumber is nailed to a sill plate (2x4 minimum) at the base of the wall that is positively connected to the foundation or cap beam below, or for metal strapping, a starter strap is embedded into the reinforced concrete foundation or cap beam at a 45 degree angle and hooked around longitudinal bars in the concrete. The wall studs and sill plate shall be connected to the foundation or cap beam below with straps at each stud per Detail D6.13.		
C NC N/A	6.8	SHEAR WALL LENGTHS: The total length of shear wall along each building line meets the minimum requirements noted in Table 6.8A.1 and 6.8A.2 Minimum Length of Structural Wall per Line based Shear Wall Spacing OR Table 6.8B Minimum Bays of Strapping per Line based on Building Length Parallel to Wall Line. The lengths noted in the tables represent the total wall length required along a wall line. Segments of the shear wall length can be separated by openings; refer to Checklist item 6.9 for the minimum lengths of shear wall segments.		
C NC N/A	6.9	SHEAR WALL SEGMENTS: The length of any individual segment of shear wall is greater than half the effective height of the wall. The effective height of the segment is measured from the ground elevation to the half-way elevation between the roof ridge and top of wall.		

	Item	Description	Notes	Proposed Retrofit Solution
	6.0	**WALLS AND POSTS CONTINUED**		
C NC N/A	6.10	SHEAR WALL HOLD-DOWNS: There are double 2x4 (nailed together at every 3" on center) or single 4x4 holddown posts at each end of each shear wall segment. The hold-down posts are continuous to and connected to the foundation with vertical metal straps embedded into the foundation and fastened to the post at each side as shown in Detail D6.10 or Detail D4.3, where applicable.		
C NC N/A	6.11	GRAVITY WOOD POSTS: Gravity wood posts not connected to shear walls are connected to the foundation in a way that prevents sideways movement or uplift of the post base from the foundation. Refer to Detail D6.11 for an example of an adequate post-base connection.		
C NC N/A	6.12	BEAM-TO-POST CONNECTIONS: Connections between beams and posts are made with plates, connection hardware or metal straps so that the beam is connected to the post to prevent uplift, separation or sideways movement of the beam. See Detail D6.15 for examples of adequate beam-to-post connections.		

	Item	Description	Notes	Proposed Retrofit Solution
	7.0	**ROOFS**		
C NC N/A	7.1	ROOF FRAMING SYSTEM: Timber roofs may be constructed of one of the following two options. The construction professional should select which type of timber roof is applicable for the building and complete the evaluation and retrofit according to that roof type.		
	OPTION 1 - RAFTER AND TIE SYSTEM: This type of system is comprised of rafters braced by a horizontal 2x4 tie at the top plate level. Rafters (2x4) are positively connected to top plate and wood tie. The purlins (2x4) are fastened by metal straps or 2x2 wood blocks both ways and spaced at a maximum of 0.90 m on center. The rafters are spaced 1.0 m on center maximum. OPTION 2 - TRUSS AND PURLIN SYSTEM: The whole truss (2x4) is composed of top and bottom chords supported by king post and diagonal web members. ¾" plywood gusset plates are used in truss member connections. The truss is connected to the top plate by metal strap. The purlins (2x4) are fastened by metal straps or 2x2 wood blocks both ways and are set apart 0.90 m on center. Every truss is spaced 1.75 meter maximum from the next truss.			
C NC N/A	7.2	TOP PLATES: The shear wall top plate is continuous and connects the tops of each shear wall segment to the other walls along the same line. It is continuous between and connected to perpendicular walls and perpendicular top plates. Top plates shall consist of (2) 2x4 flat members nailed together or a single 4x4. At perpendicular top plate intersections, the plates from each direction are overlapped and connected together to transfer loads. The top plate shall also be connected with straps at each stud per Detail D6.14.		
C NC N/A	7.3	ROOF VERTICAL SUPPORT: Roof framing is vertically supported by load-bearing walls with top plates, or vertical posts, which have direct support path to the foundation.		

	Item	Description	Notes	Proposed Retrofit Solution
C NC N/A	7.4	ROOF FRAMING CONNECTIONS: Roof framing members are positively connected to each other; • purlins shall be strapped to rafters with metal straps and a total of 4 nails in the purlin and 4 in the rafter, or with (4) wood cleats with (2) nails each to the rafter and (2) nails each to the purlin. • rafters shall be strapped together at the ridge with a metal strap and 7 nails in each rafter. • rafters shall be strapped to the horizontal tie with metal straps and 4 nails at each side in each member. • purlins shall be strapped to trusses with metal straps and a total of 7 nails in each wood member, or with (4) wood cleats with (3) nails each to the rafter and (3) nails each to the purlin.		
C NC N/A	7.5	WALL-TO-ROOF CONNECTIONS: All rafters and trusses are positively connected to the top plate with metal straps on each side of the roofing member. Trusses require 20 nails each in the truss and top plate. Rafters require 11 nails each in the truss and top plate.		
C NC N/A	7.6	ROOF BRACING: Gable roofs shall have diagonal 2x4 “X” bracing between each rafter/tie frame or truss. The bracing members are strapped and/or nailed to the roof framing members to create a solid connection.		
C NC N/A	7.7	ROOF COVERINGS: Roofs are covered with corrugated metal sheets (29 ga. minimum) that are fastened with roofing nails to the purlins. The waves of sheets that are overlapped are in alignment to facilitate proper water runoff. Sheets are lapped by 15 cm minimum and nailed every two waves to purlins and at every wave at roof edges, overhangs and ridges.		
C NC N/A	7.8	ROOF OVERHANGS AND EAVES: Roof overhangs or eaves do not extend beyond the building walls by more than 30 cm.		

Seismic and Wind Evaluation for Timber Housing in the Philippines

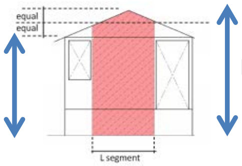
Cordaid

Shear Wall Length Summary for Retrofit Design

$h_{avg} = \frac{[\_\_\_\_\_\_(h_{total}) + \_\_\_\_\_\_(h_{wall})]}{2}$

h_{wall} = ____

h_{avg} = __________



h_{total} = _______

Min. Wall Segment length = $\frac{\_\_\_\_\_\_\_\_(h_{avg})}{2}$

Min. Wall Segment length = _________

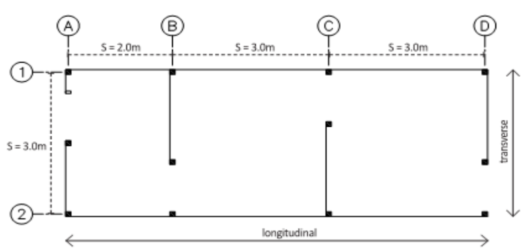
Transverse Direction

Wall Line	S_{avg} (m)	Location *(circle one)*	**Wall Covering Selected** (circle one)	**Wall Length Required (m)** *(See Checklist Items 6.8 and 6.9)*	**Wall Length Provided in Retrofit (m)**
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		

Longitudinal Direction

Wall Line	S_{avg} (m)	Location *(circle one)*	**Wall Covering Selected** (circle one)	**Wall Length Required (m)** *(See Checklist Items 6.8 and 6.9)*	**Wall Length Provided in Retrofit (m)**
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		
		Interior / Exterior	3/8 Plywood / 1/2 Plywood / 5/8 Plywood / Diagonal Lumber / Metal Strap		

Example of Determining Average Shear Wall Spacing:



* **S** = spacing of parallel wall

TRANSVERSE WALLS

- Wall A - Exterior, Savg = 2.0m
- Wall B - Interior, Savg = $\frac{2+3}{2}$ = 2.5m
- Wall C - Interior, Savg = $\frac{3+3}{2}$ = 3.0m
- Wall D - Exterior, Savg = 3.0m

LONGITUDINAL WALLS

- Wall 1 - Exterior, Savg = 3.0m
- Wall 2 - Exterior, Savg = 3.0m

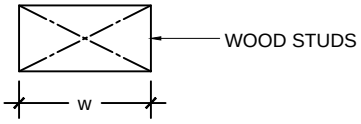
Savg = average spacing of parallel walls

Appendix B

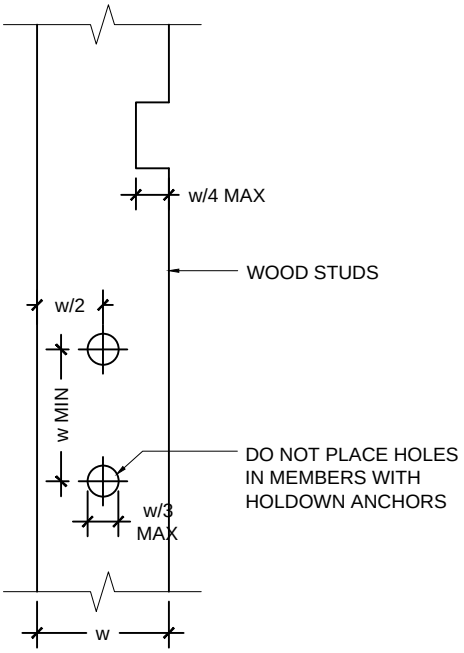
Retrofit Details

BUILD CHANGE

Cordaid BUILDING FLOURISHING COMMUNITIES



PLAN VIEW



* w = WIDTH OF STUD

SIDE VIEW

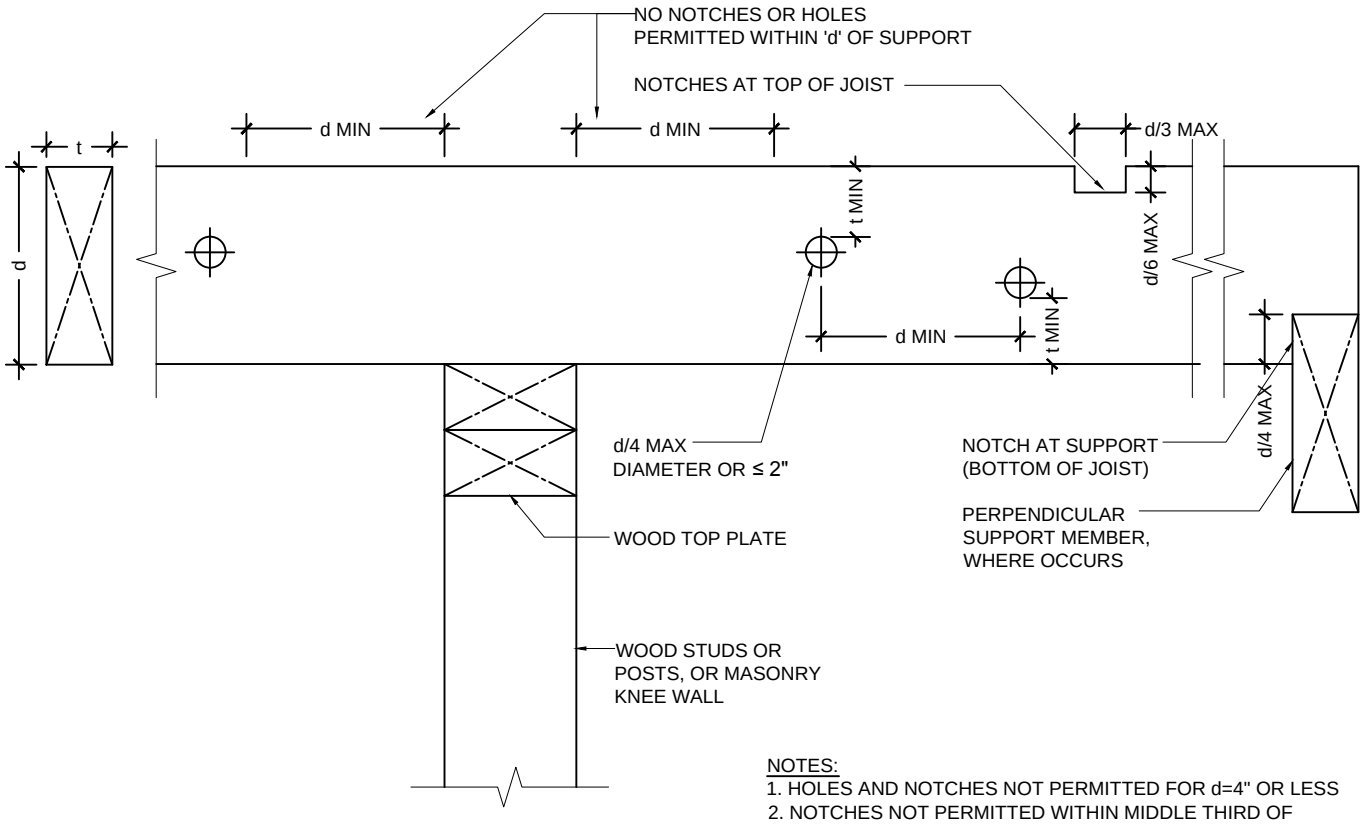
)TES:

BUILD CHANGE

PERMITTED NOTCHES AND HOLES IN STUDS

PROJECT:	DATE:
SCALE:	REVISION DATE:

D3.1



NOTES:
1. HOLES AND NOTCHES NOT PERMITTED FOR d=4" OR LESS
2. NOTCHES NOT PERMITTED WITHIN MIDDLE THIRD OF SPAN
3. NOTCHES NOT PERMITTED IN BOTTOM OF MEMBER UNLESS SPECIFICALLY SHOWN ON THE STRUCTURAL DRAWINGS OR WRITTEN APPROVAL IS OBTAINED FROM THE ENGINEER

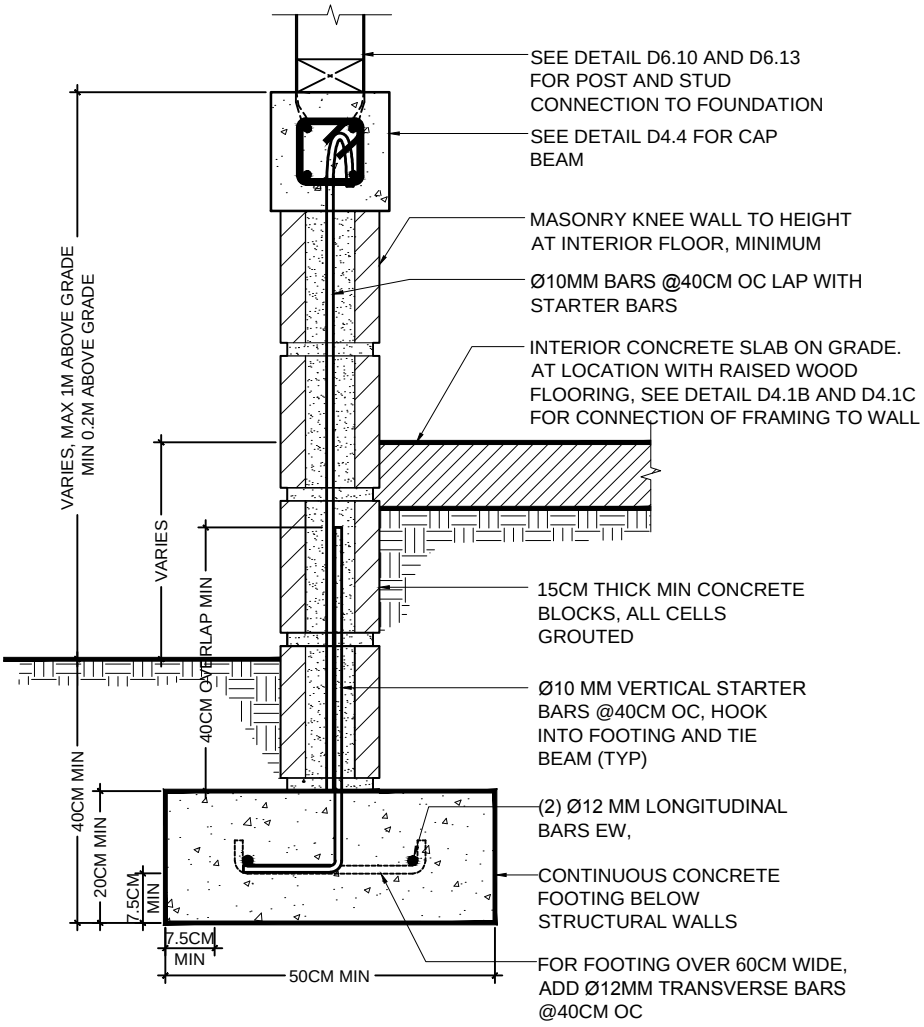
d = DEPTH OF JOIST

BUILD CHANGE

PERMITTED NOTCHES AND HOLES IN FLOOR JOISTS

PROJECT:	DATE:
SCALE:	REVISION DATE:

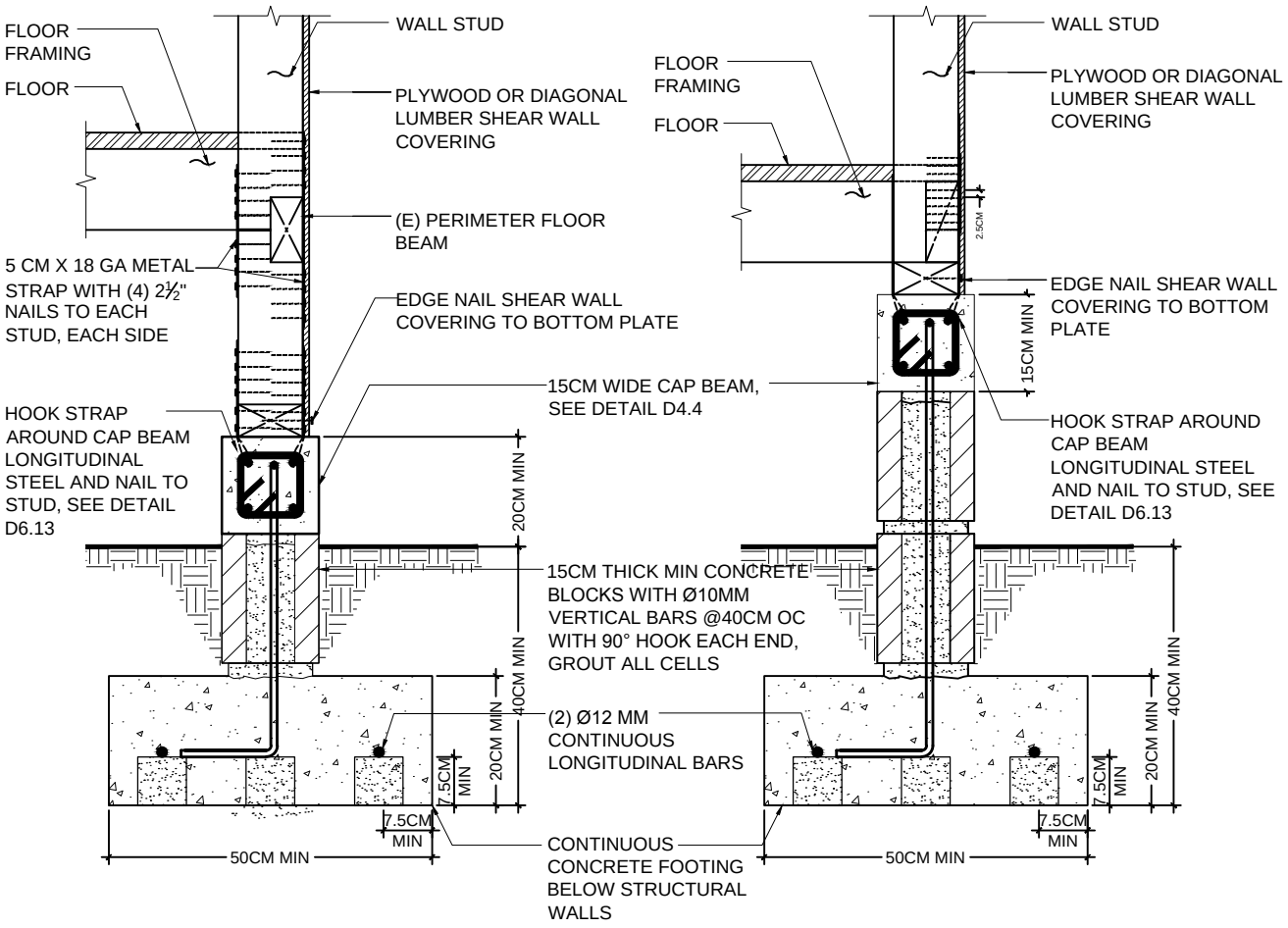
D3.2



BUILD CHANGE

MASONRY KNEE WALL AT SLAB-ON-GRADE

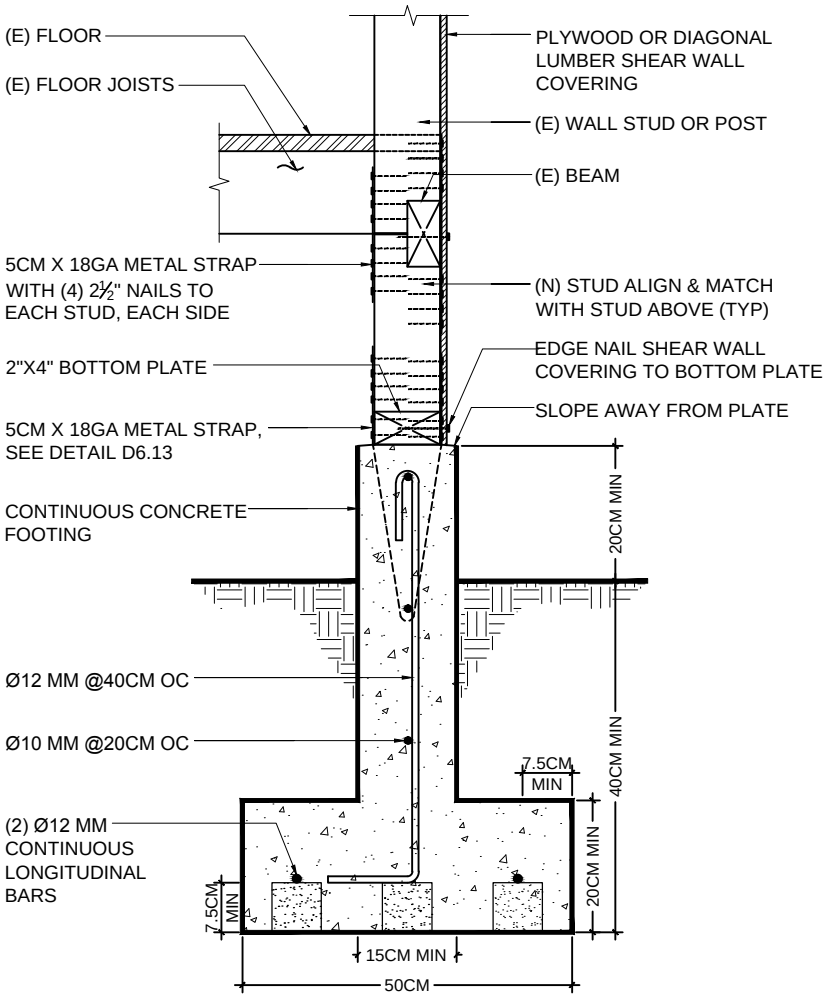
FOUNDATIONS		D4.1A
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

MASONRY KNEE WALL AT RAISED FLOOR

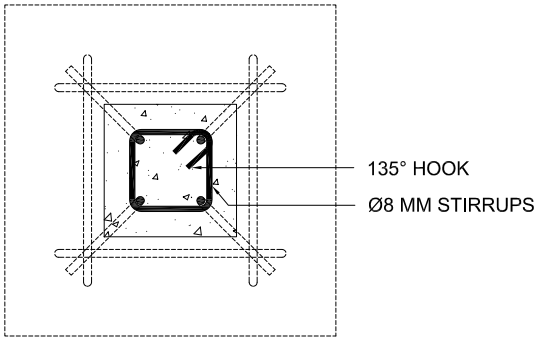
FOUNDATIONS		D4.1B
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



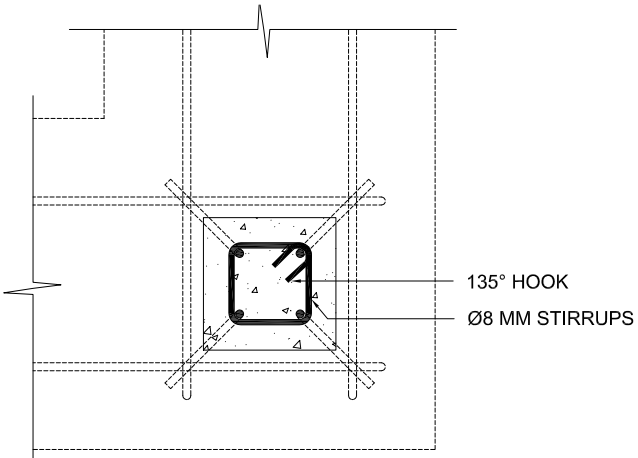
BUILD CHANGE

FOUNDATION WITH CRIPPLE WALL

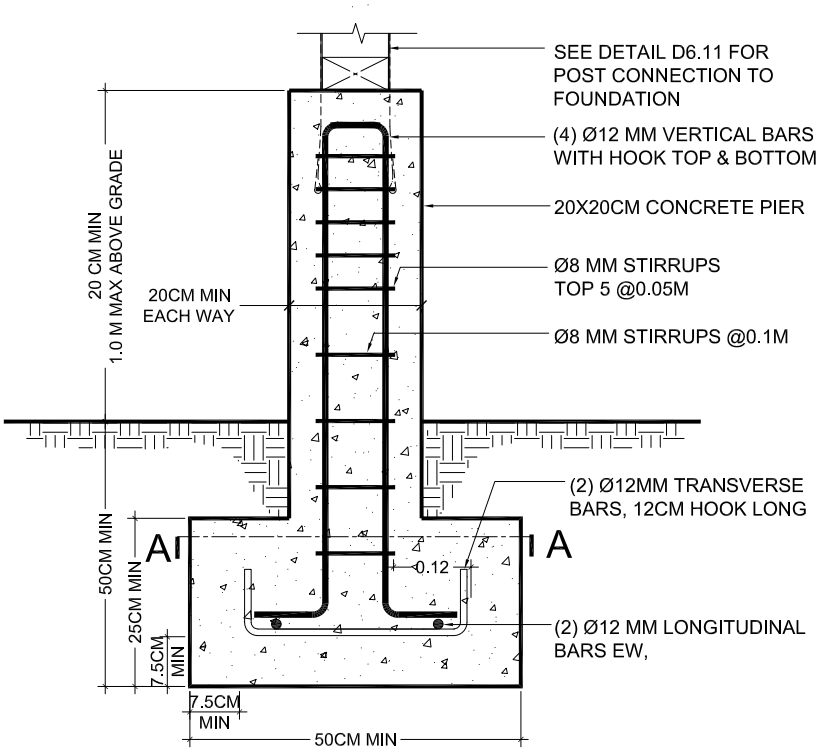
FOUNDATIONS		D4.1.C
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



PLAN A-A AT
ISOLATED FOOTING



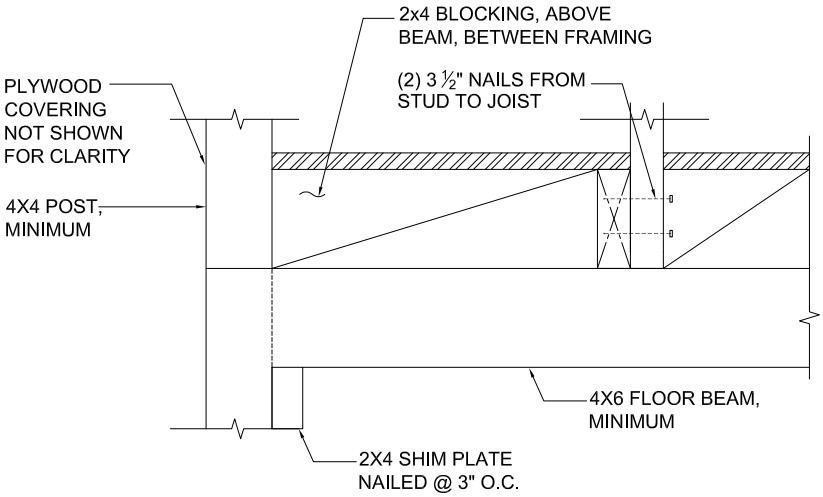
PLAN A-A AT CORNERS



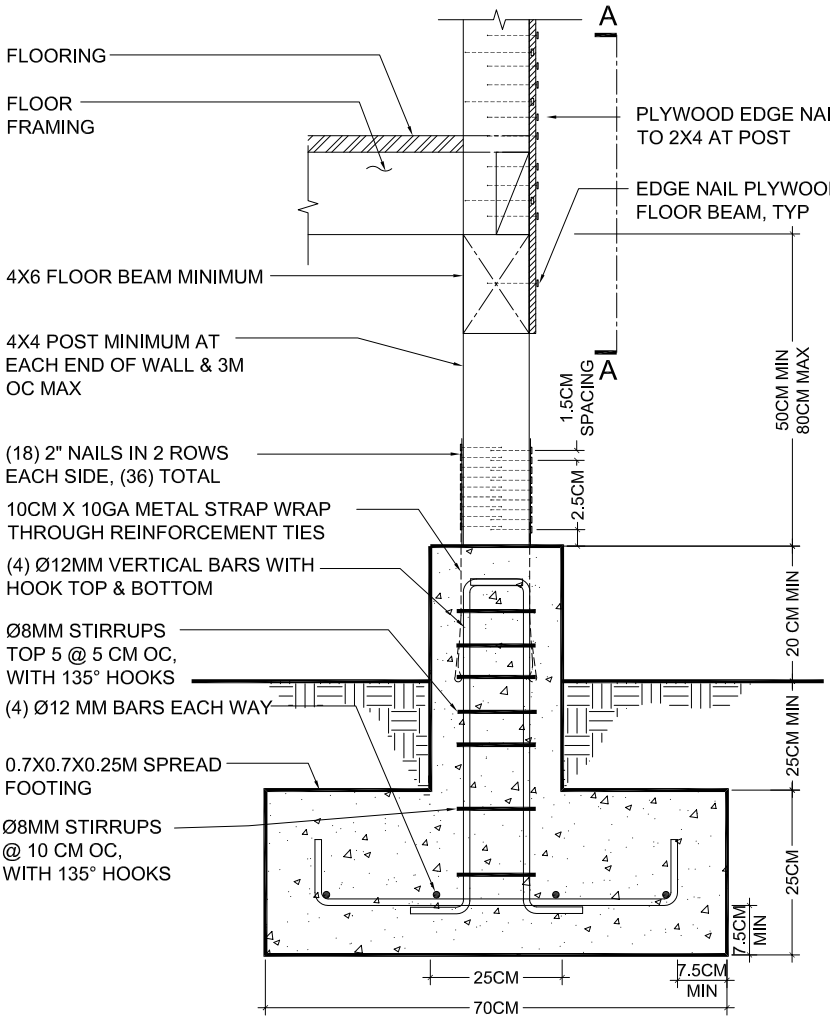
BUILD CHANGE

WOOD GRAVITY POST PIER FOUNDATION

FOUNDATIONS		D4.2
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



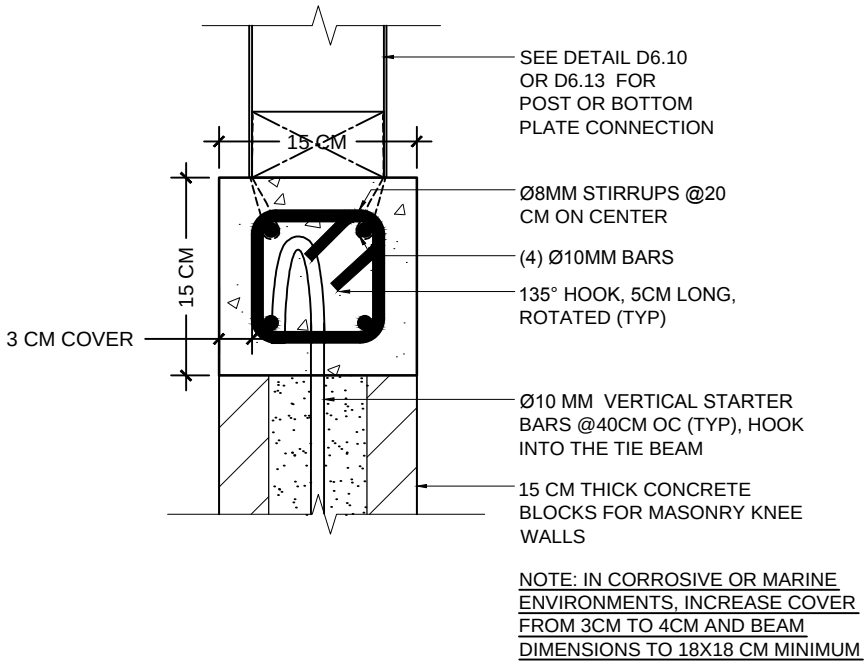
SECTION A-A



BUILD CHANGE

PLYWOOD SHEAR WALL POST FOUNDATION

FOUNDATIONS		D4.3
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

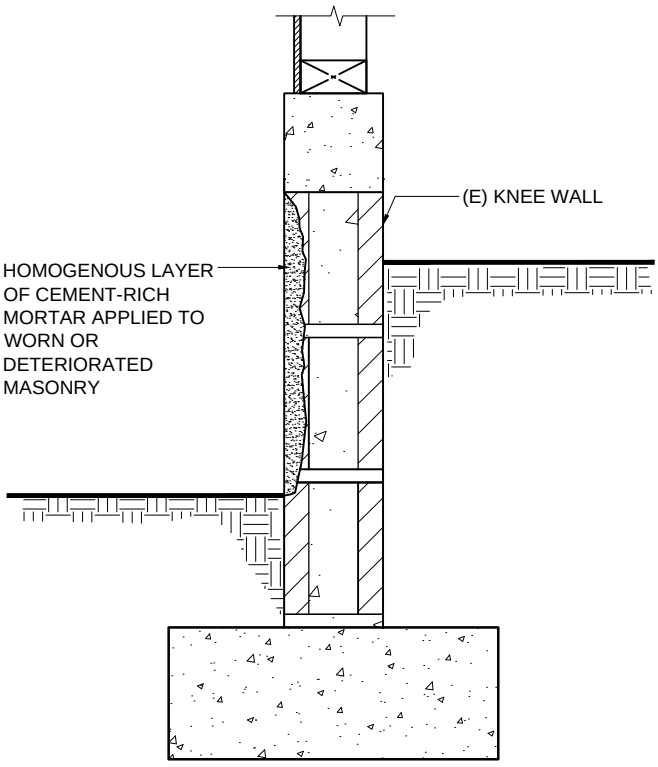


NOTE: IN CORROSIVE OR MARINE ENVIRONMENTS, INCREASE COVER FROM 3CM TO 4CM AND BEAM DIMENSIONS TO 18X18 CM MINIMUM

BUILD CHANGE

TIE / CAP BEAM AT KNEE WALL

FOUNDATIONS		D4.4
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

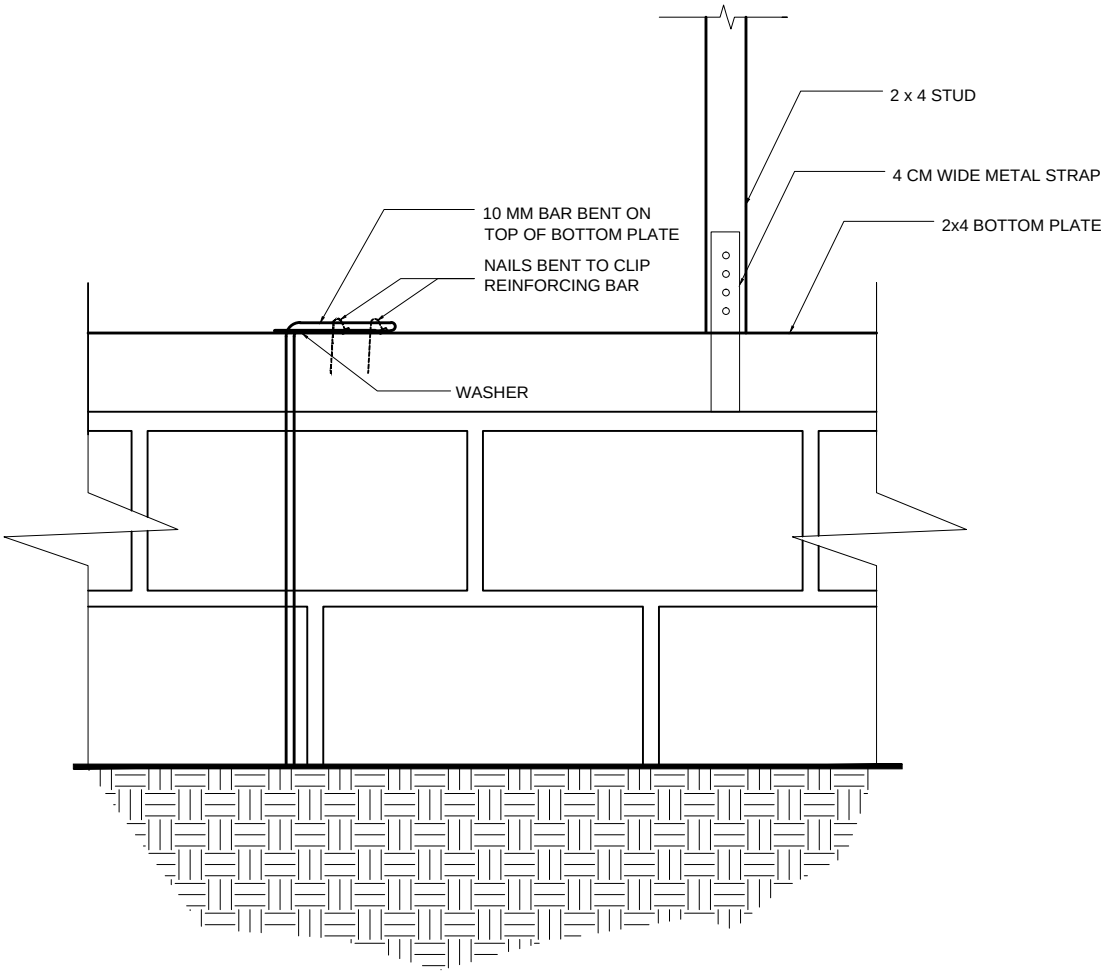


NOTES:
1. IF THE REINFORCED CONCRETE ELEMENTS OF THE FOUNDATION HAVE MINOR DETERIORATION, THE AFFECTED AREAS SHOULD BE CHIPPED OUT TO SOLID CONCRETE AND PATCHED WITH CEMENT - RICH MORTAR
2. IF ANY REINFORCED CONCRETE ELEMENT HAS SIGNIFICANT DETERIORATION SUCH THAT STEEL REINFORCING IS EXPOSED, IT SHOULD BE DEMOLISHED AND REPLACED

BUILD CHANGE

REPAIR OF FOUNDATION DEGRADATION

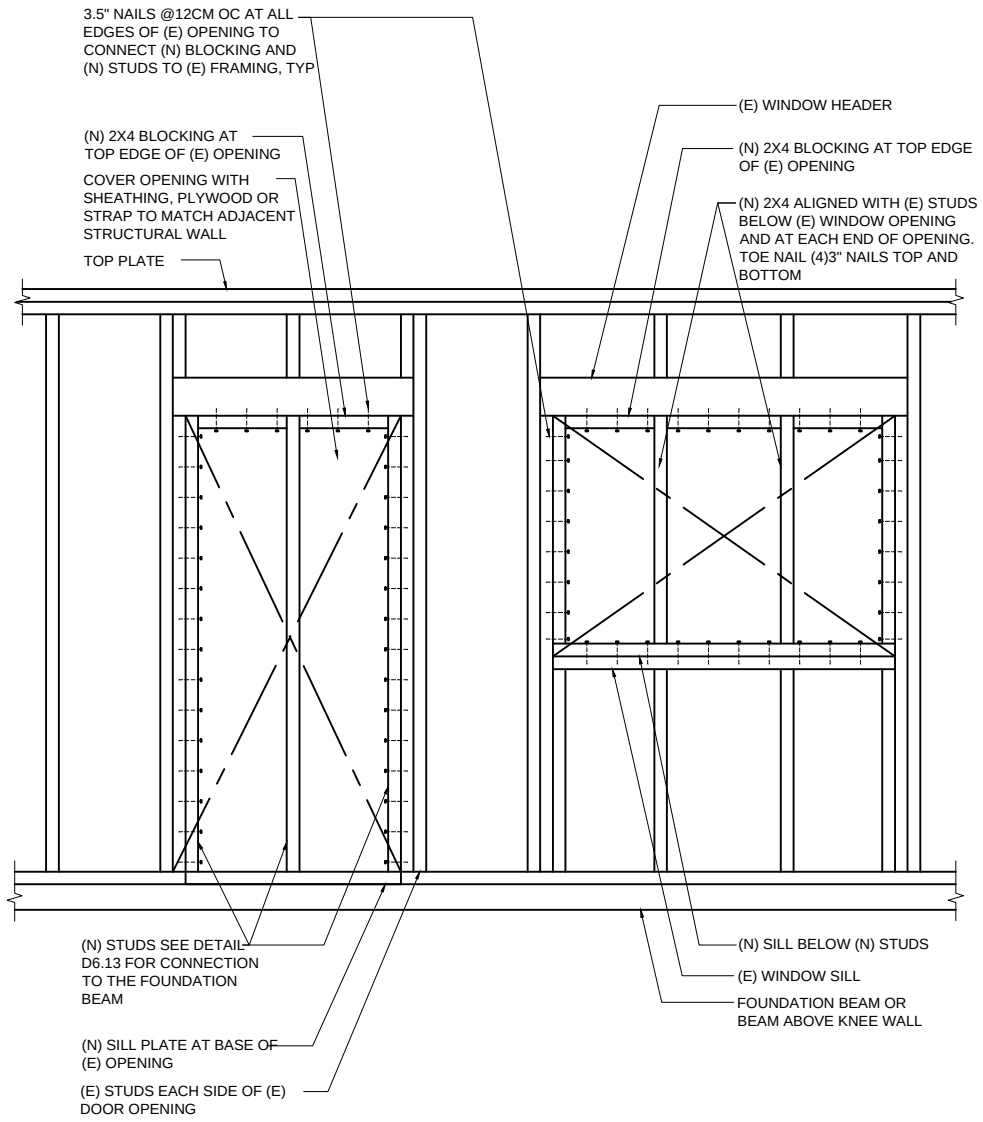
FOUNDATIONS		D4.6
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

BOTTOM PLATE CONNECTION TO KNEE WALL FOR NON-SHEAR WALLS

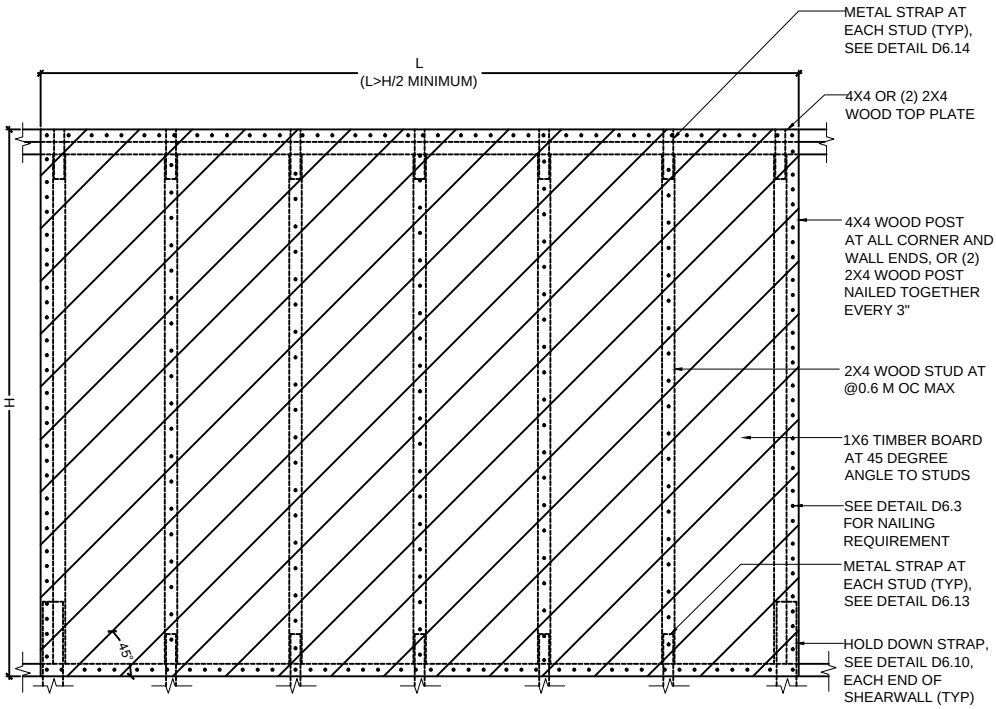
FOUNDATIONS		D4.7
PROJECT:	DATE:	
SCALE:	REVISION DATE: 18MAY 2015	



BUILD CHANGE

INFILLING OPENINGS

WALLS & POSTS		D6.1
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

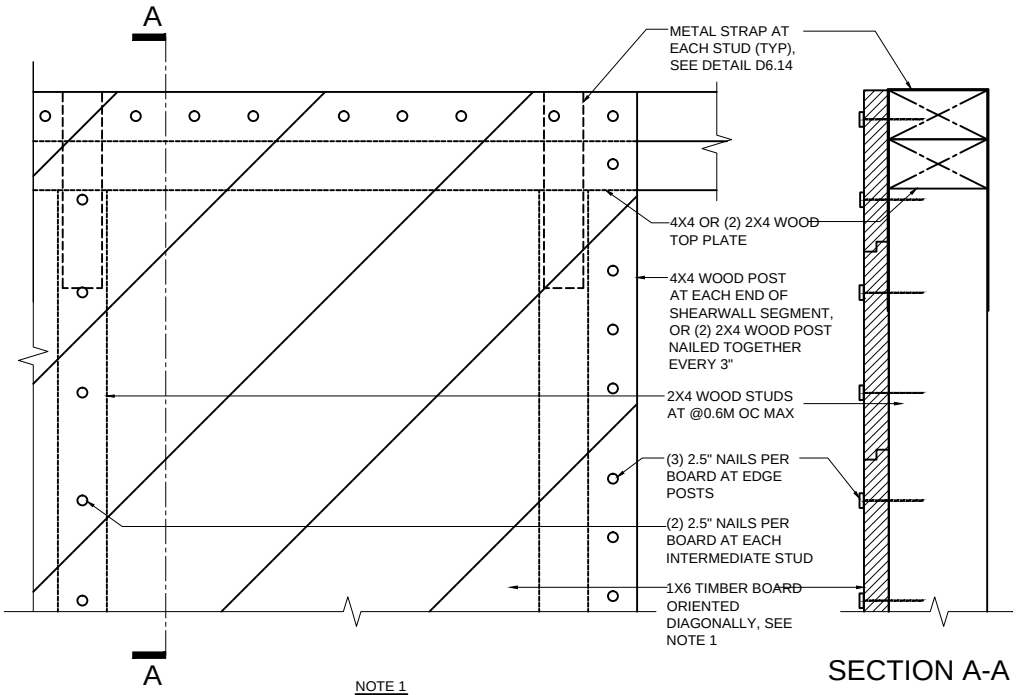


ELEVATION

BUILD CHANGE

DIAGONAL LUMBER SHEATHING SHEAR WALL ELEVATION

WALLS & POSTS		D6.2
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



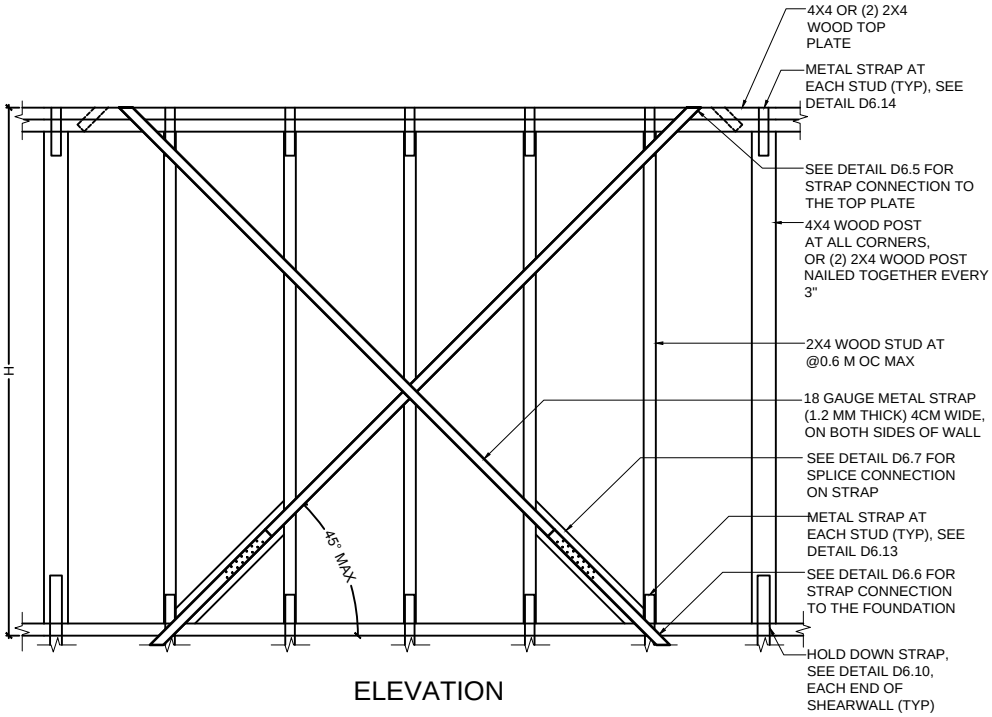
SECTION A-A

NOTE 1
USING GROOVE BOARD REDUCES WATER INTRUSION BUT IS NOT REQUIRED

BUILD CHANGE

DIAGONAL LUMBER SHEATHING : BOARD TO STUD CONNECTION

WALLS & POSTS		D6.3
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

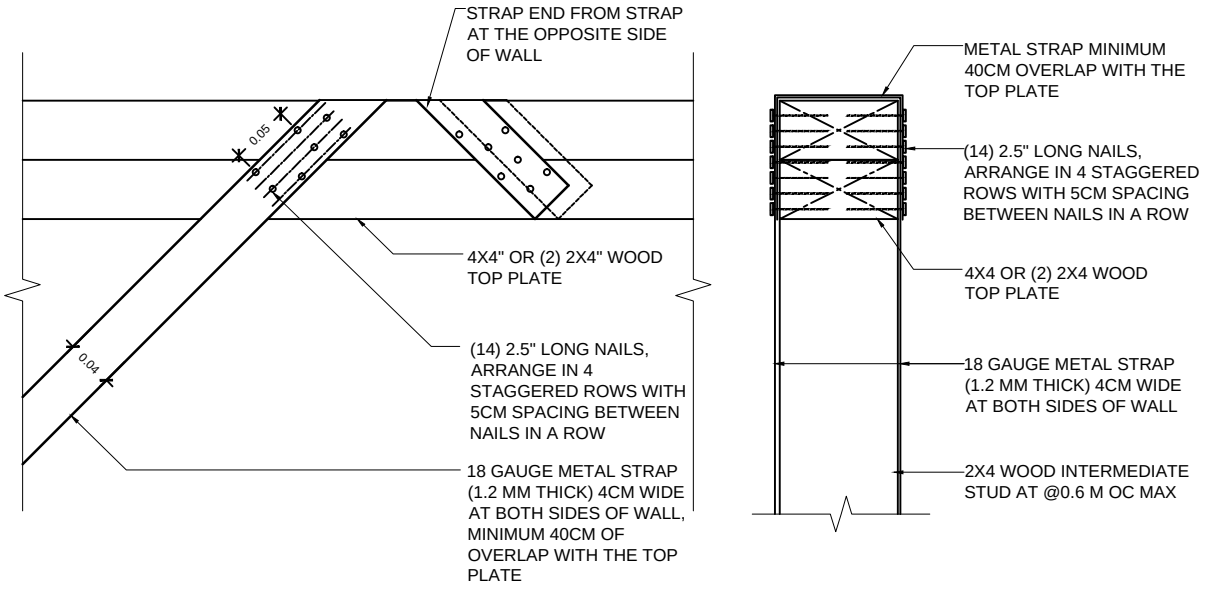


ELEVATION

BUILD CHANGE

METAL X-BRACING SHEAR WALL ELEVATION

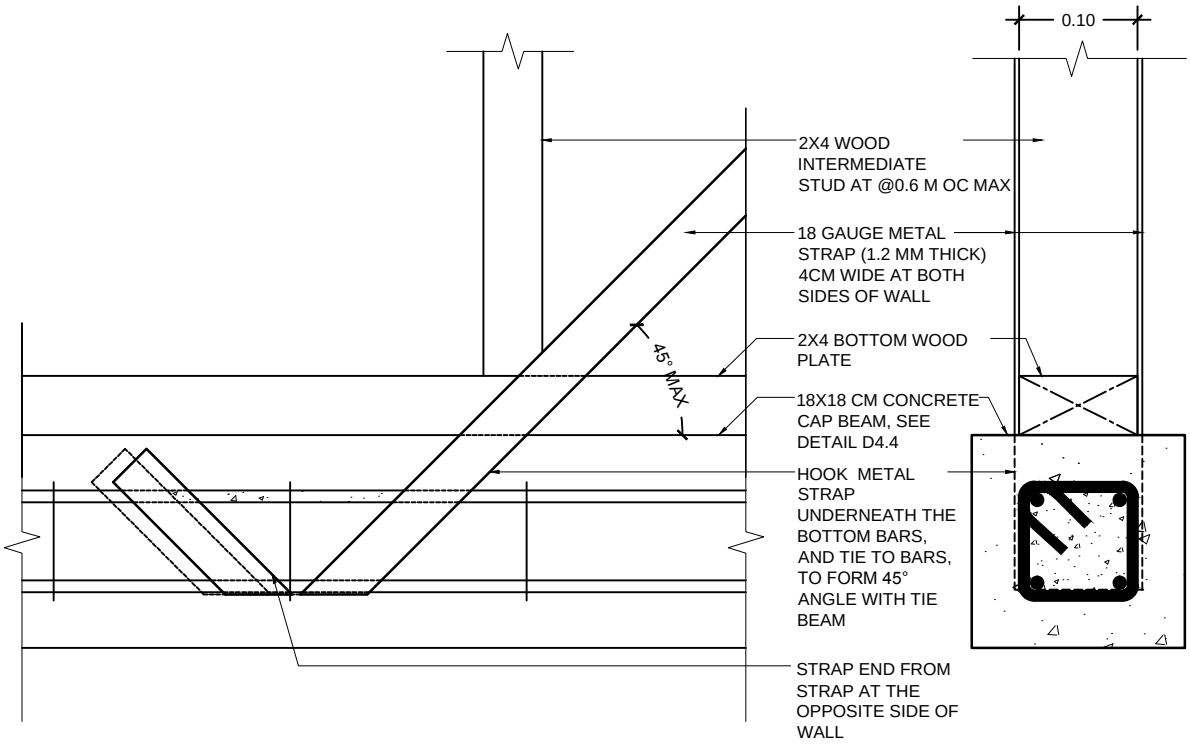
WALLS & POSTS		D6.4
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

METAL X-BRACING: CONNECTION TO THE TOP PLATE

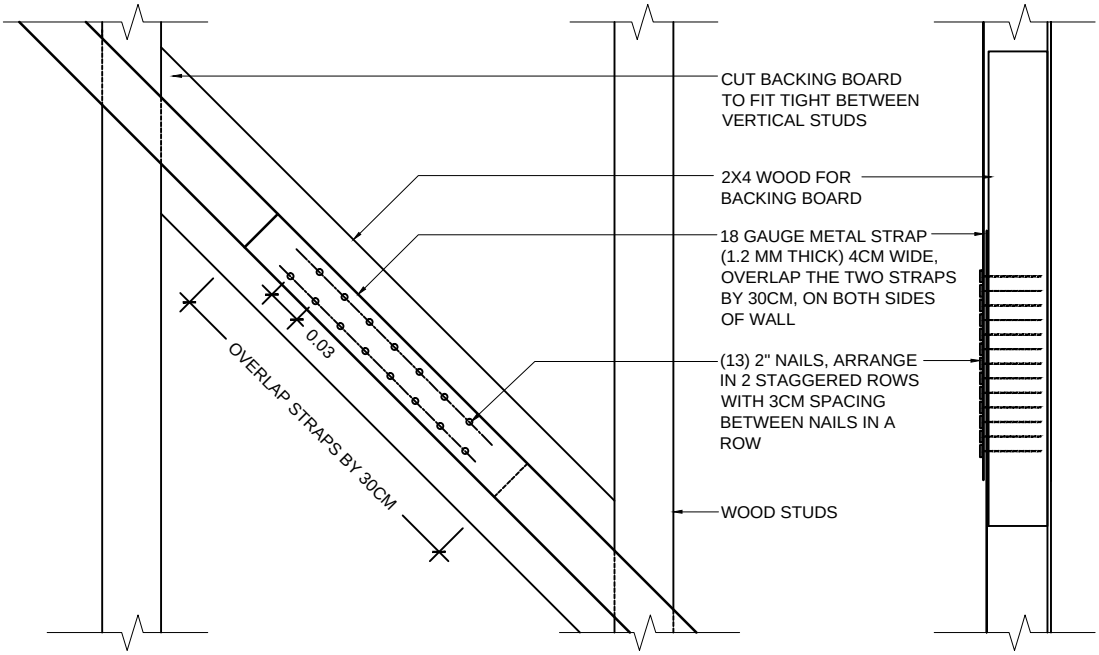
WALLS & POSTS		D6.5
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

METAL X-BRACING: CONNECTION AT THE BOTTOM PLATE

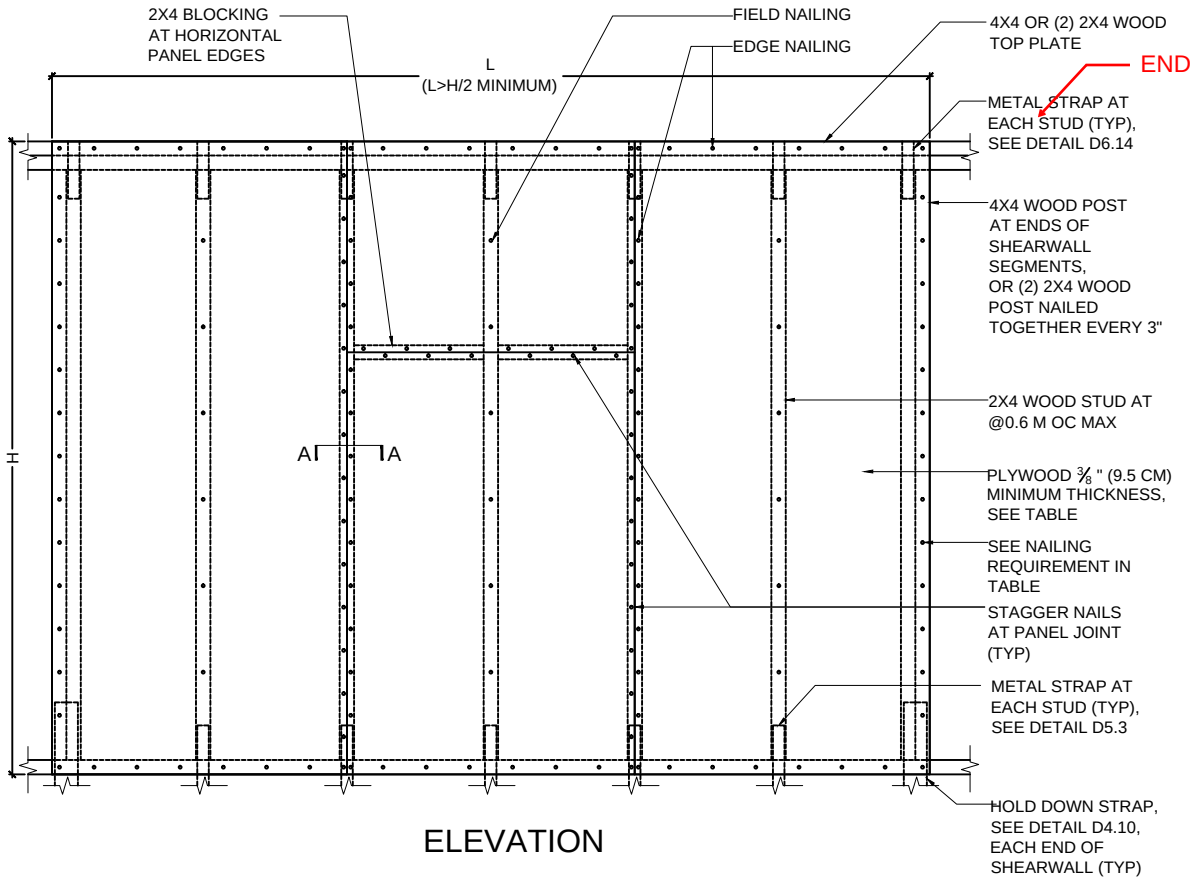
WALLS & POSTS		D6.6
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



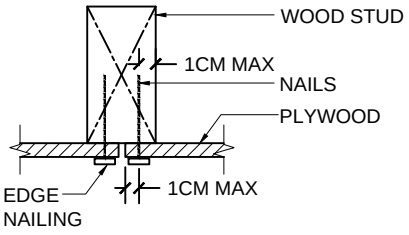
BUILD CHANGE

SPLICE CONNECTION ON STRAP

WALLS & POSTS		D6.7
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



ELEVATION



SECTION A-A

9mm

NAILING SCHEDULE

PLYWOOD THICKNESS	EDGE NAILS	FIELD NAILS
⅜ "	2 ½" @15CM OC	2 ½" @30CM OC
½ "	2 ½" @10CM OC	2 ½" @30CM OC
⅝ "	3" @10CM OC	3" @30CM OC

BUILD CHANGE

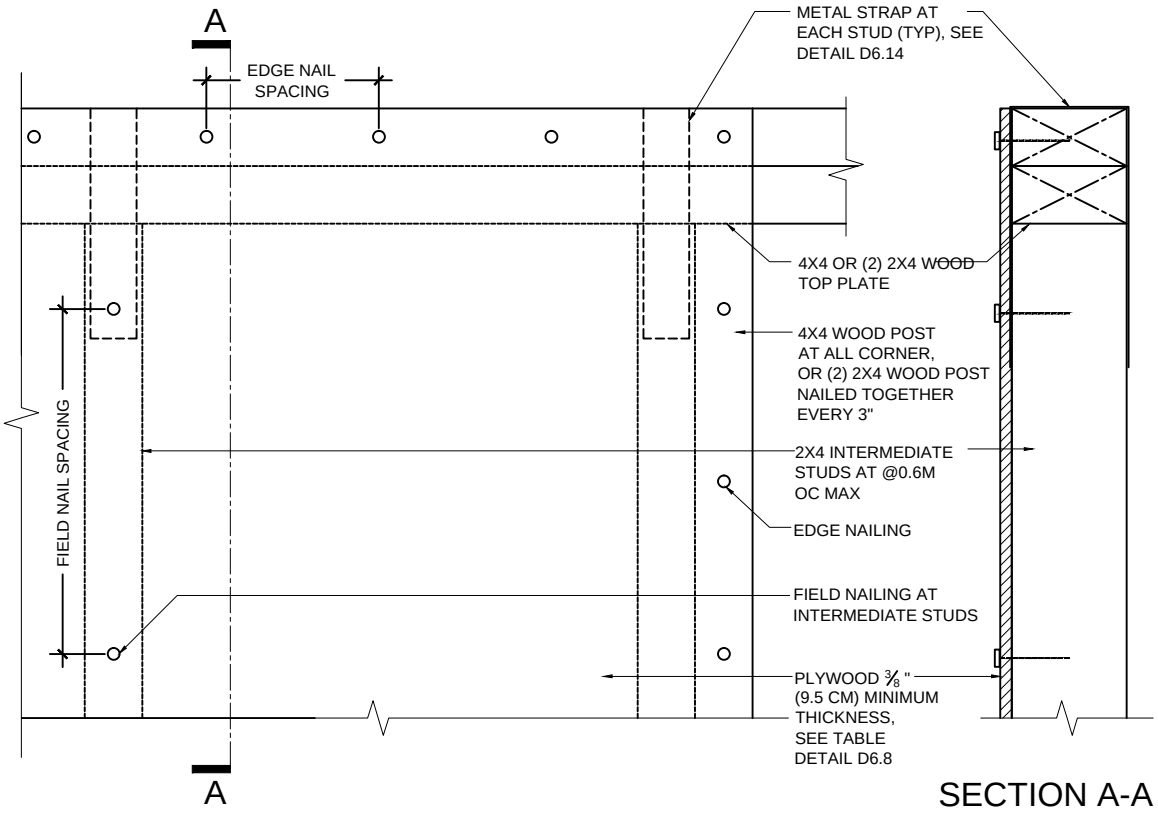
PLYWOOD SHEATHING SHEAR WALL ELEVATION

WALLS & POSTS

PROJECT: DATE:

SCALE: REVISION DATE:

D6.8

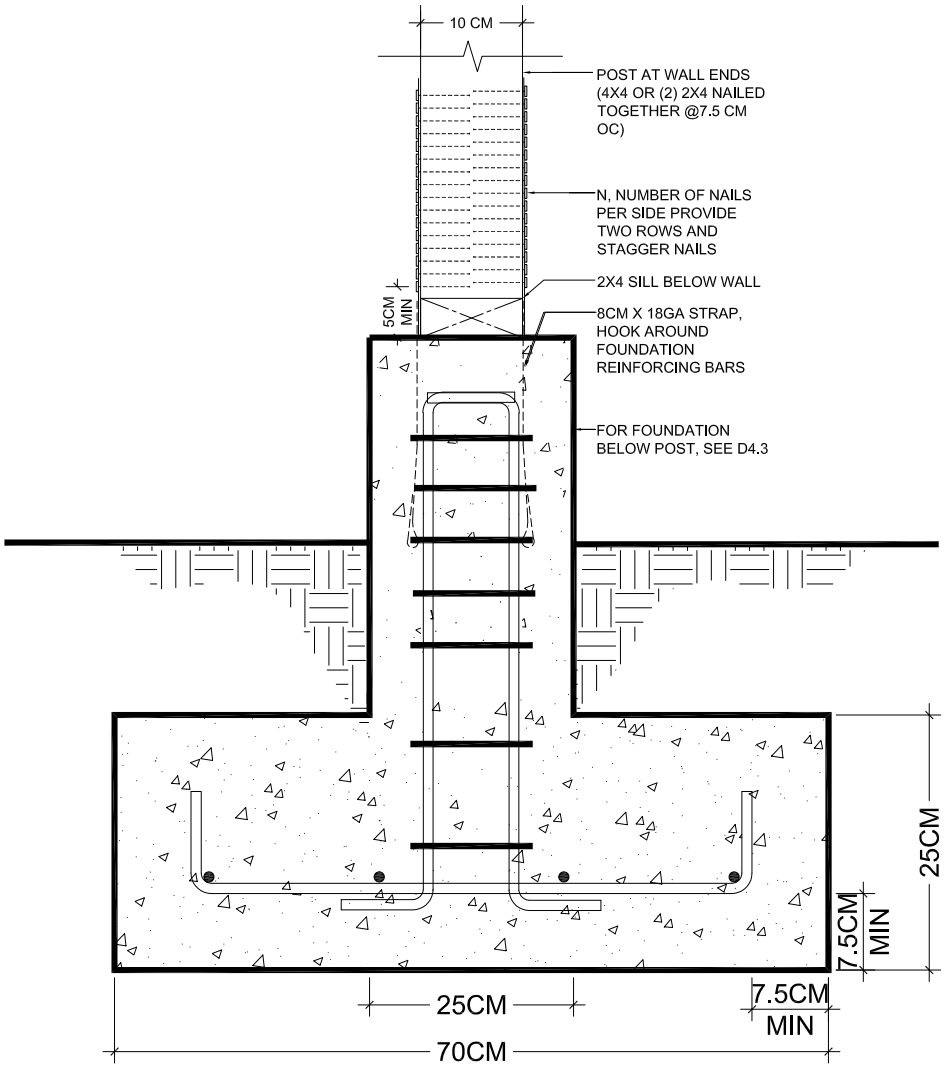


SECTION A-A

BUILD CHANGE

PLYWOOD SHEATHING: NAILING AT PANEL JOINTS

WALLS & POSTS		D6.9
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



TYPE OF WALL	N (NUMBER OF NAILS PER SIDE)	STRAP SIZE
PLYWOOD 3/8	18	18 GAGE, 10CM
PLYWOOD 1/2"	23	18 GAGE, 10CM
PLYWOOD 5/8"	29	18 GAGE, 10CM
DIAGONAL SHEATHING	24	18 GAGE, 10CM
X-BRACING	18	18 GAGE, 10CM

BUILD CHANGE

HOLD DOWN POST CONNECTION TO FOUNDATION

WALLS & POSTS

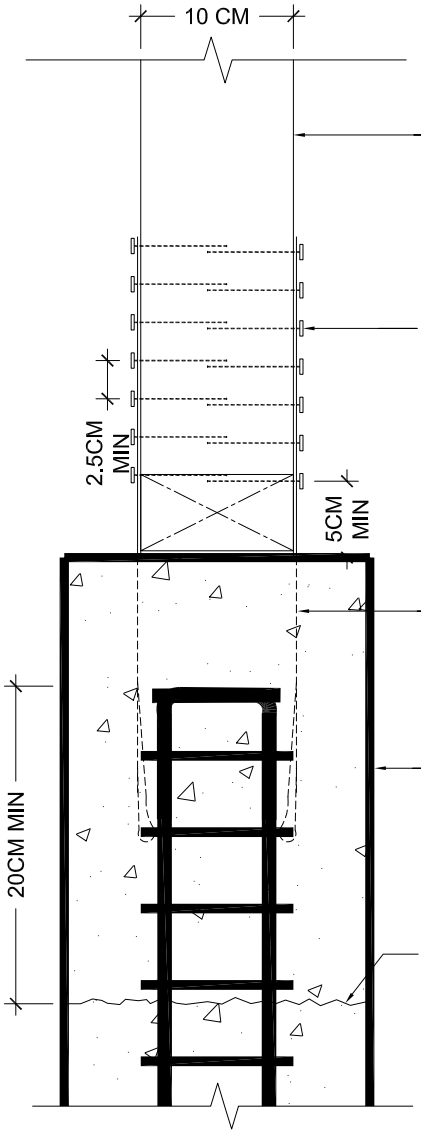
PROJECT:

DATE:

SCALE:

REVISION DATE:

D6.10

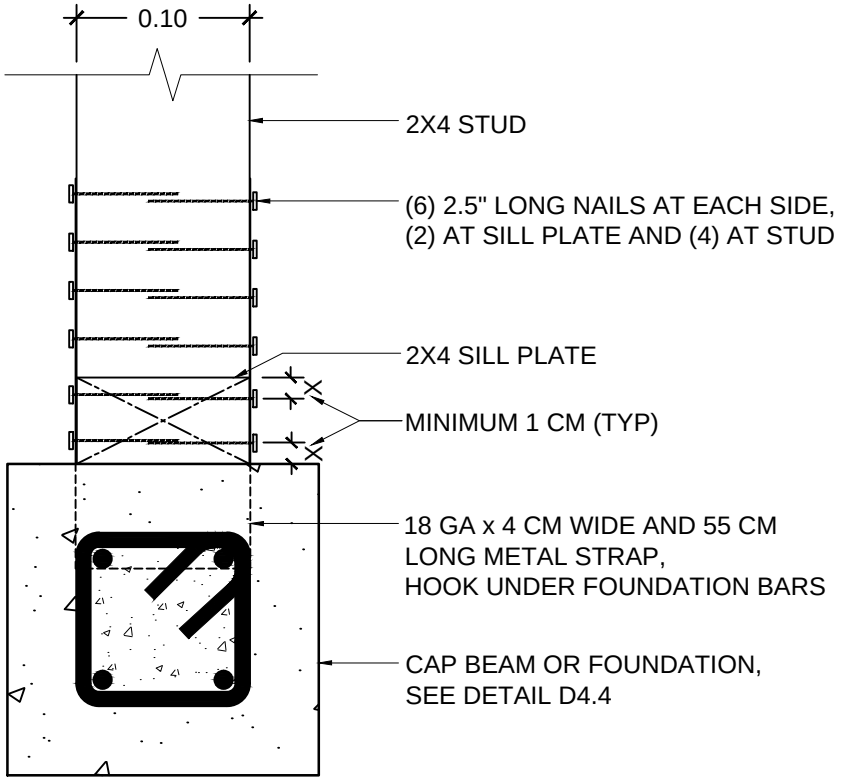


NOTE: SEE DETAIL D6.10 FOR SHEAR WALL HOLD DOWN POST CONNECTIONS TO THE FOUNDATION

BUILD CHANGE

GRAVITY POST CONNECTION TO FOUNDATION

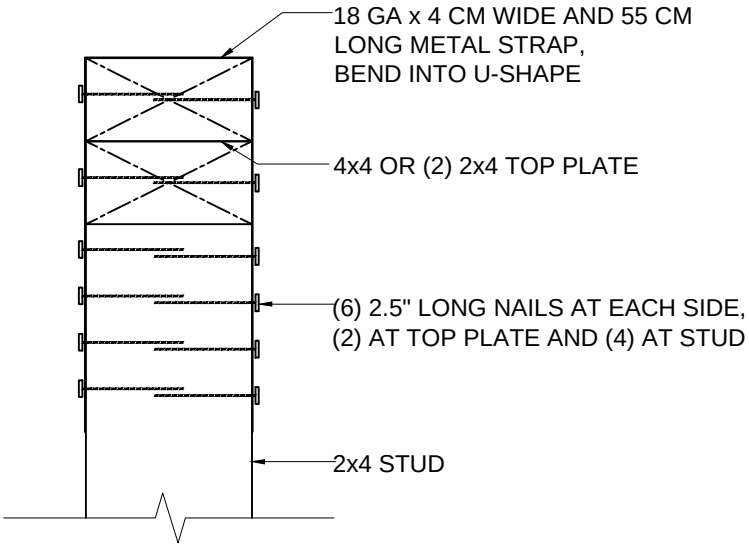
WALLS & POSTS		D6.11
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

CONNECTION TO BOTTOM OF STUD WITH METAL STRAP

WALLS & POSTS		D6.13
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

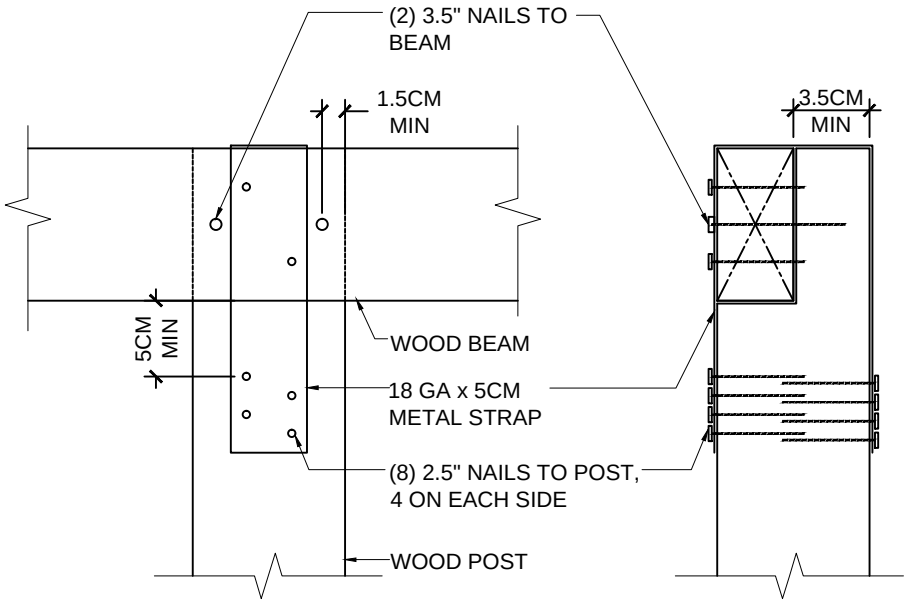


END

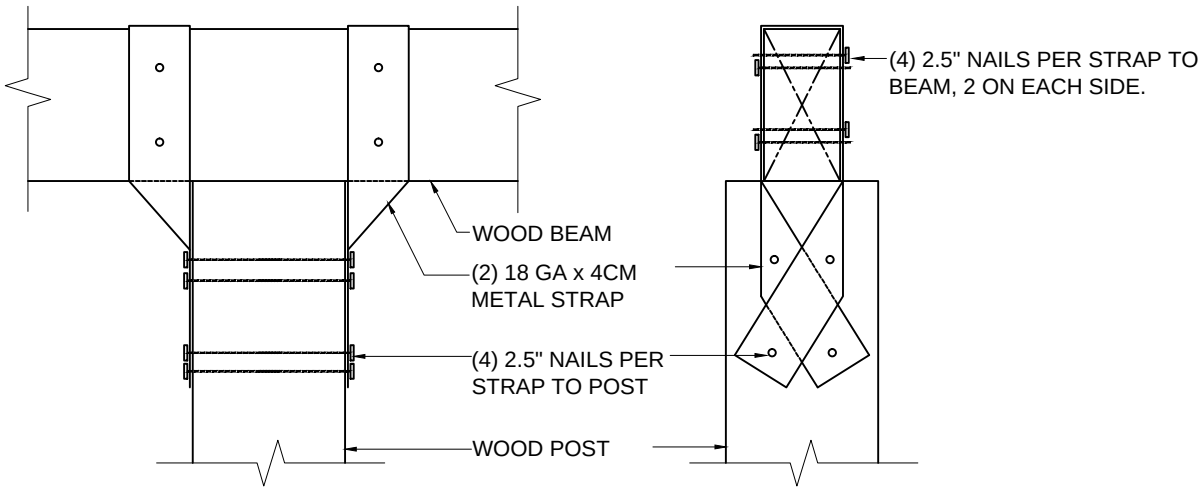
BUILD CHANGE

CONNECTION TO TOP OF STUD WITH METAL STRAP

WALLS & POSTS		D6.14
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



OPTION A

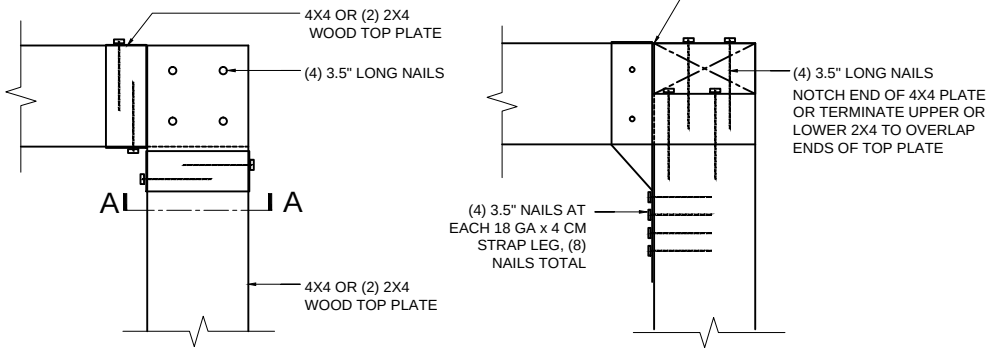


OPTION B

BUILD CHANGE

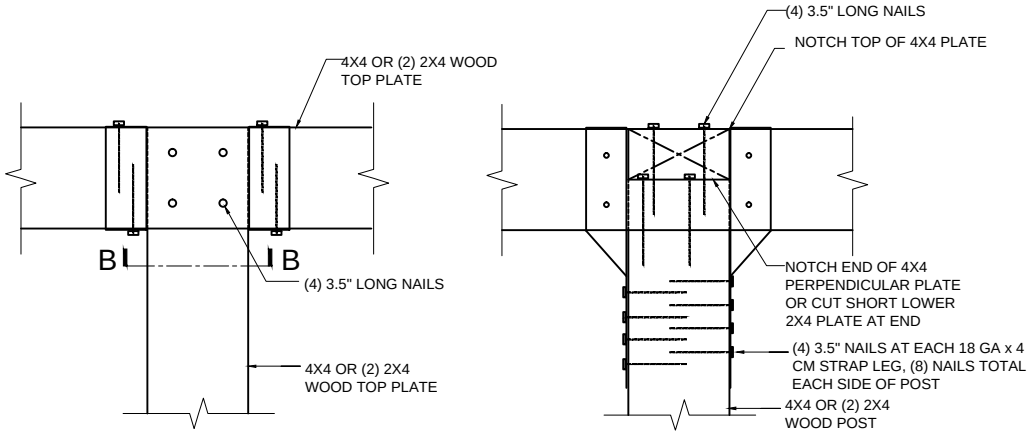
BEAM-TO-POST CONNECTION

WALLS & POSTS		D6.15
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



PLAN SECTION A-A

AT L-CORNER



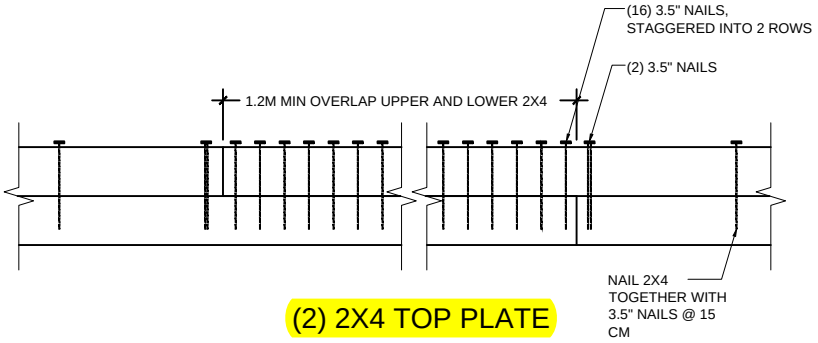
PLAN SECTION B-B

AT T-CORNER

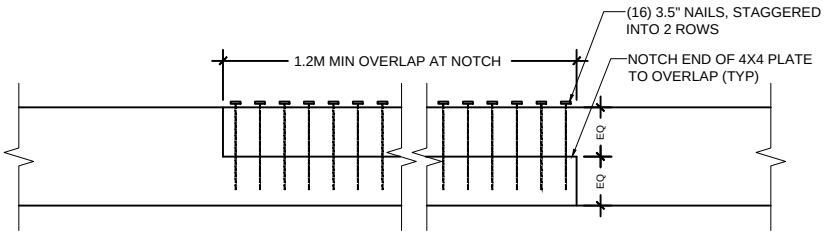
BUILD CHANGE

TOP PLATE - CONNECTION TO PERPENDICULAR PLATES

ROOF		D7.1
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



(2) 2X4 TOP PLATE

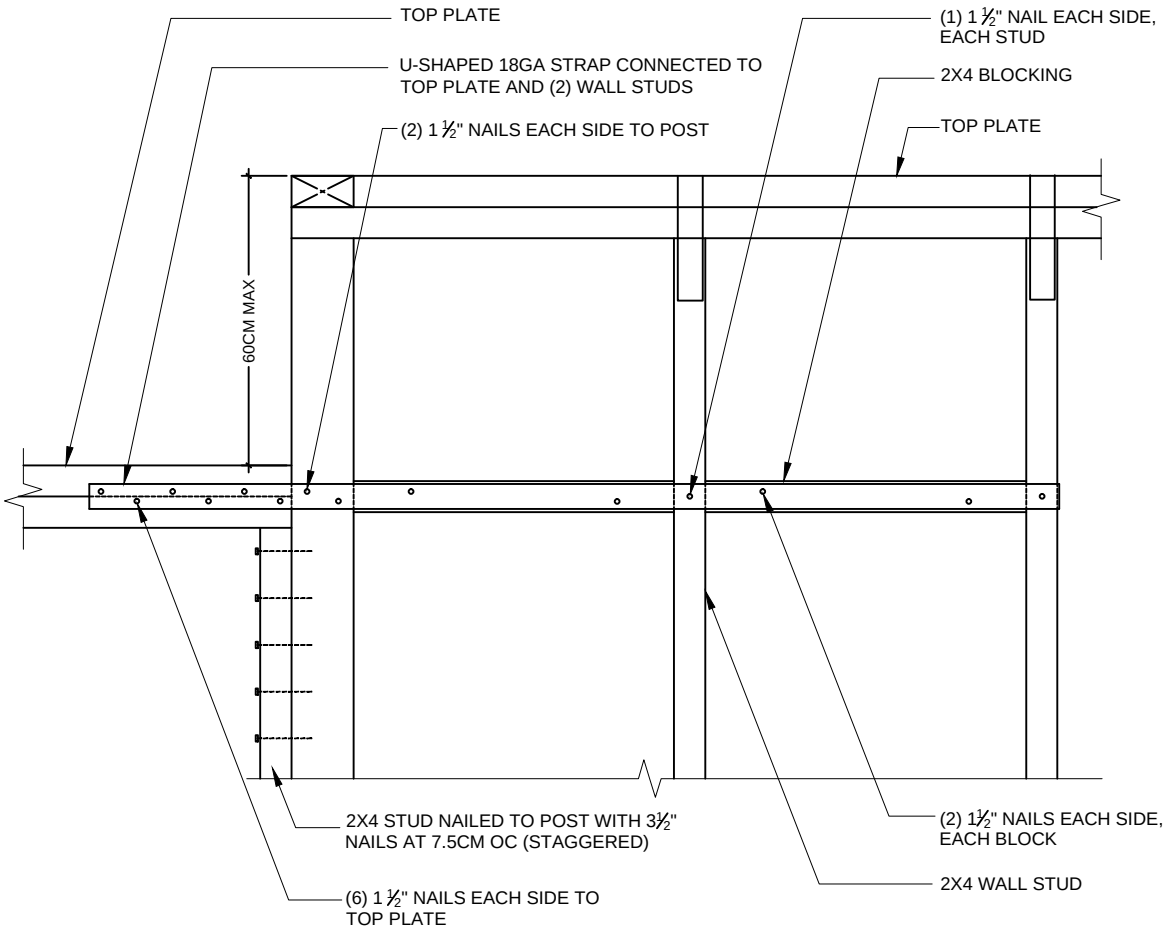


4X4 TOP PLATE

BUILD CHANGE

TOP PLATE - SPLICE CONNECTION

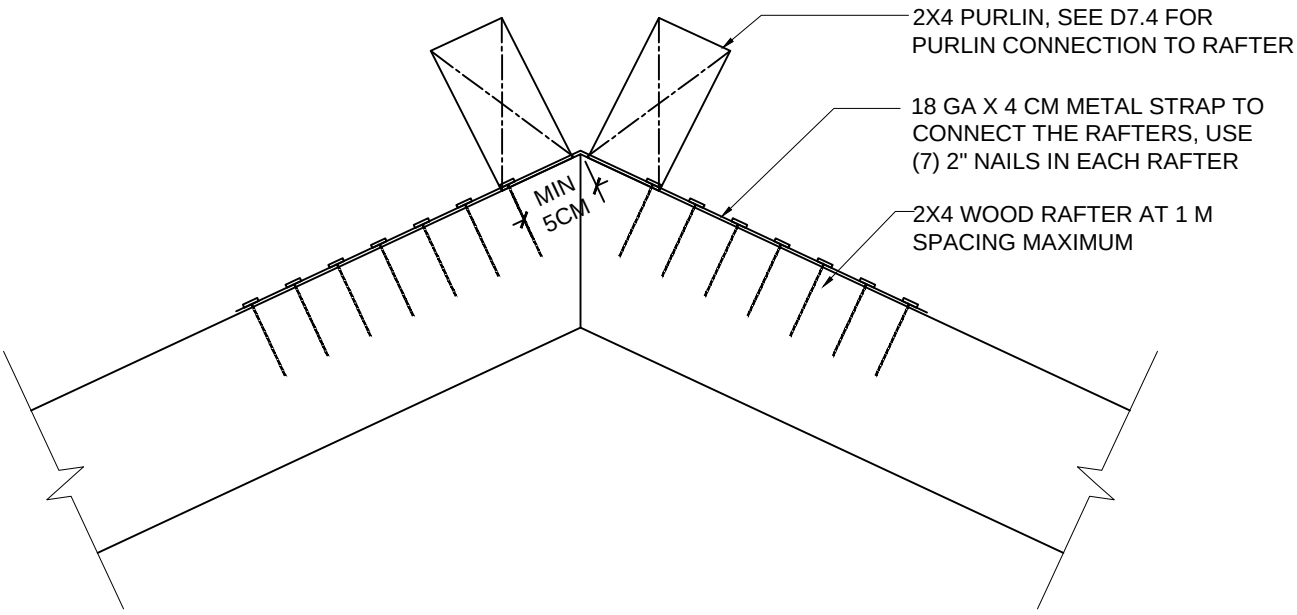
ROOF		D7.2A
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

TOP PLATE STEPPED CONNECTION

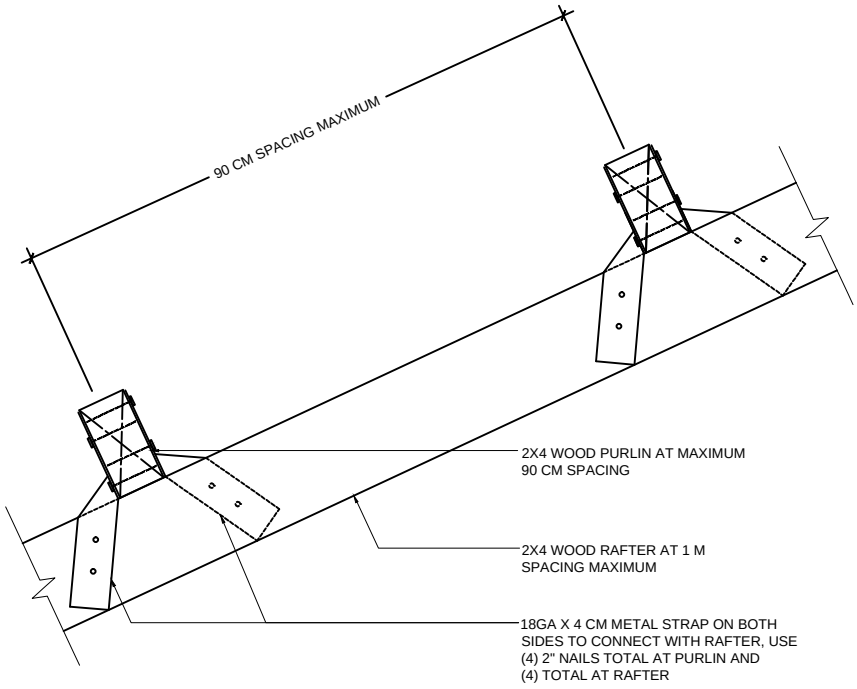
ROOF		D7.2B
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

RAFTER-TO-RAFTER CONNECTION WITH METAL STRAP

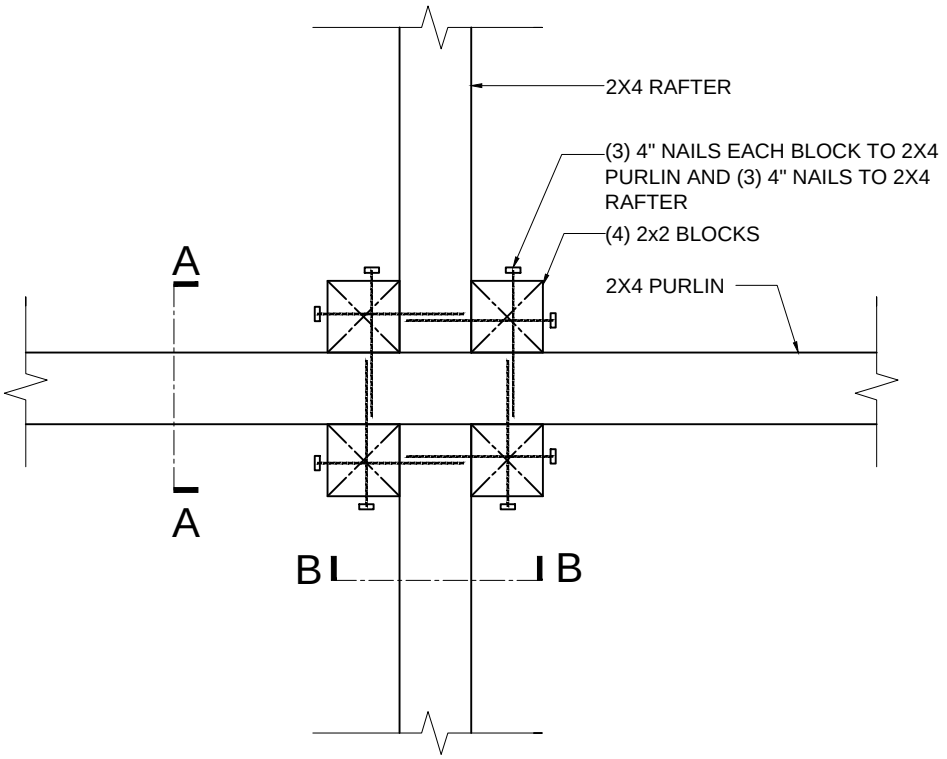
ROOF		D7.3
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



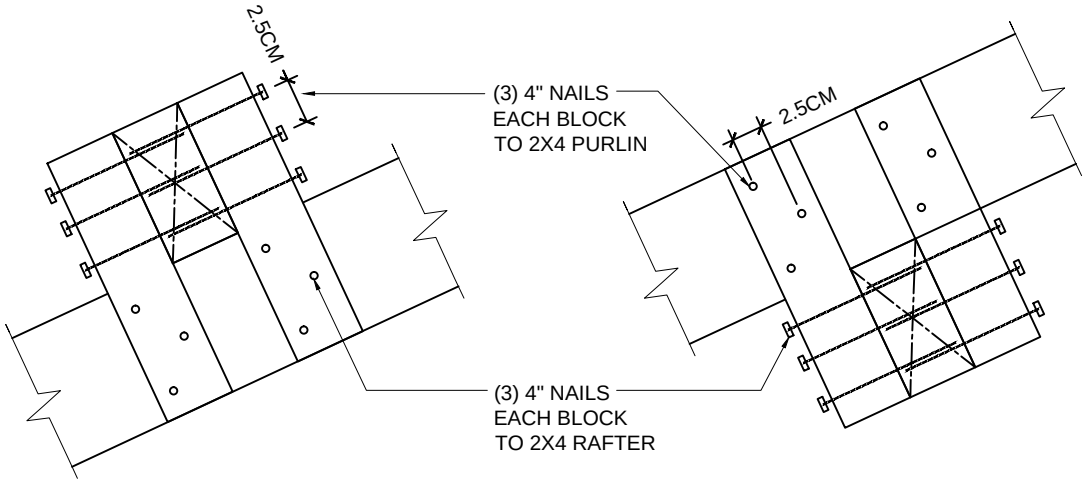
BUILD CHANGE

PURLIN-TO-RAFTER CONNECTION WITH METAL STRAP

ROOF		D7.4A
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



PLAN



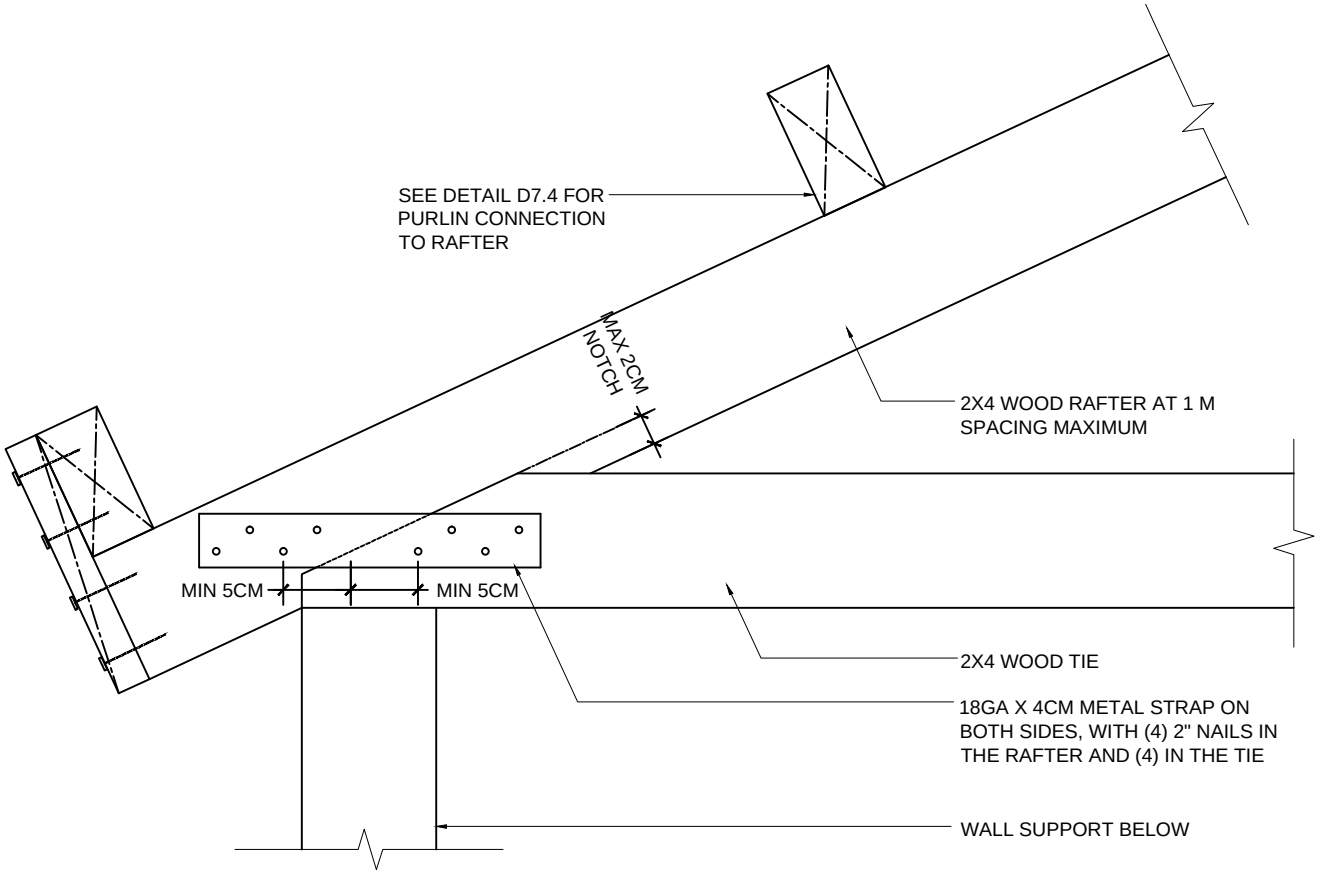
SECTION A-A

SECTION B-B

BUILD CHANGE

PURLIN-TO-RAFTER CONNECTION WITH BLOCKS

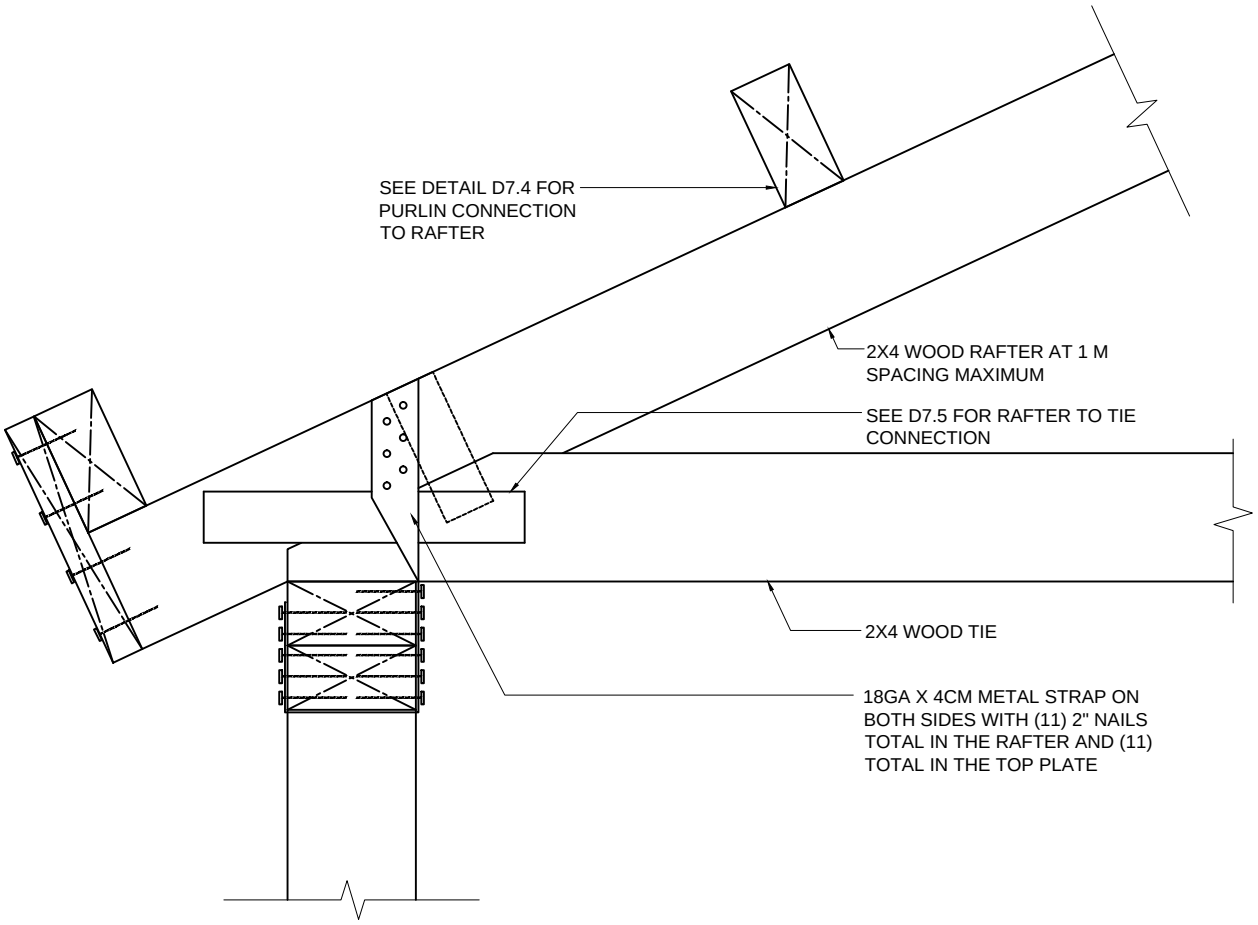
ROOF		D7.4B
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

RAFTER-TO-TIE CONNECTION WITH METAL STRAP

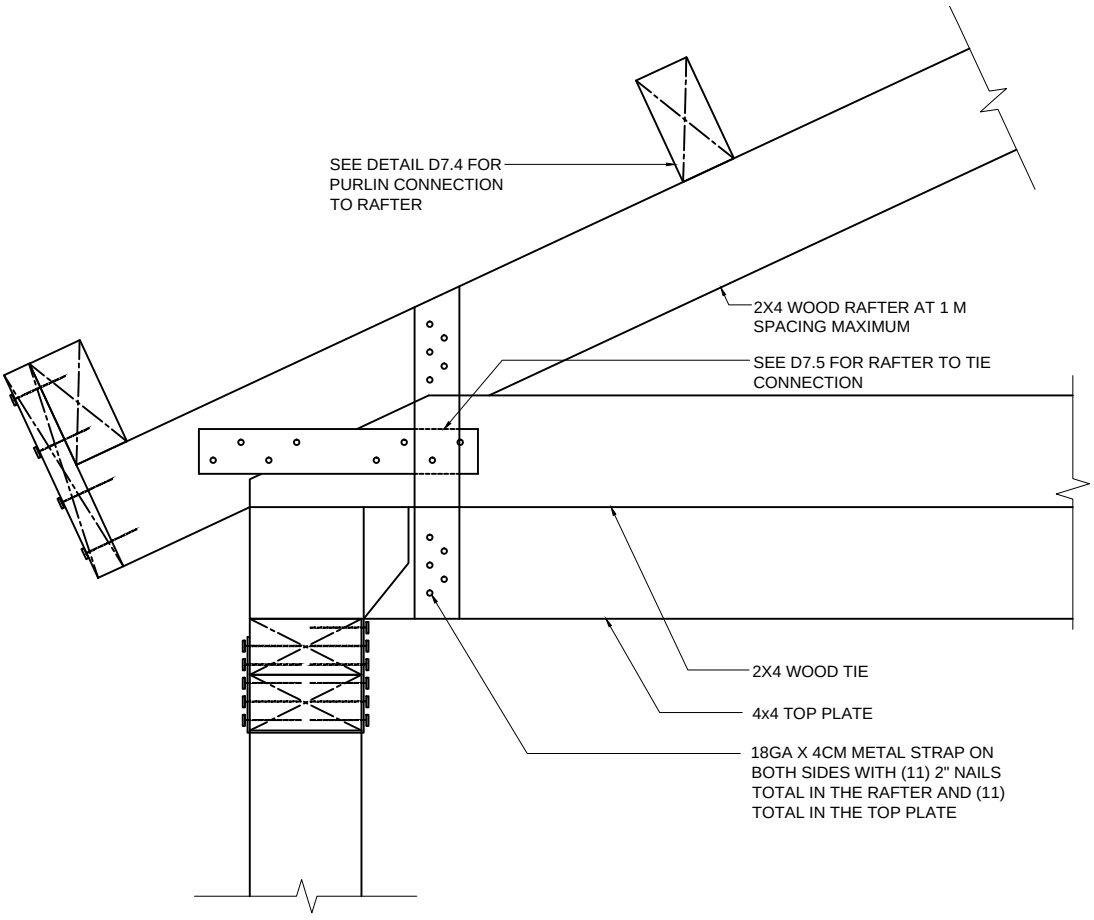
ROOF		D7.5
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

RAFTER-TO-WALL CONNECTION WITH METAL STRAP

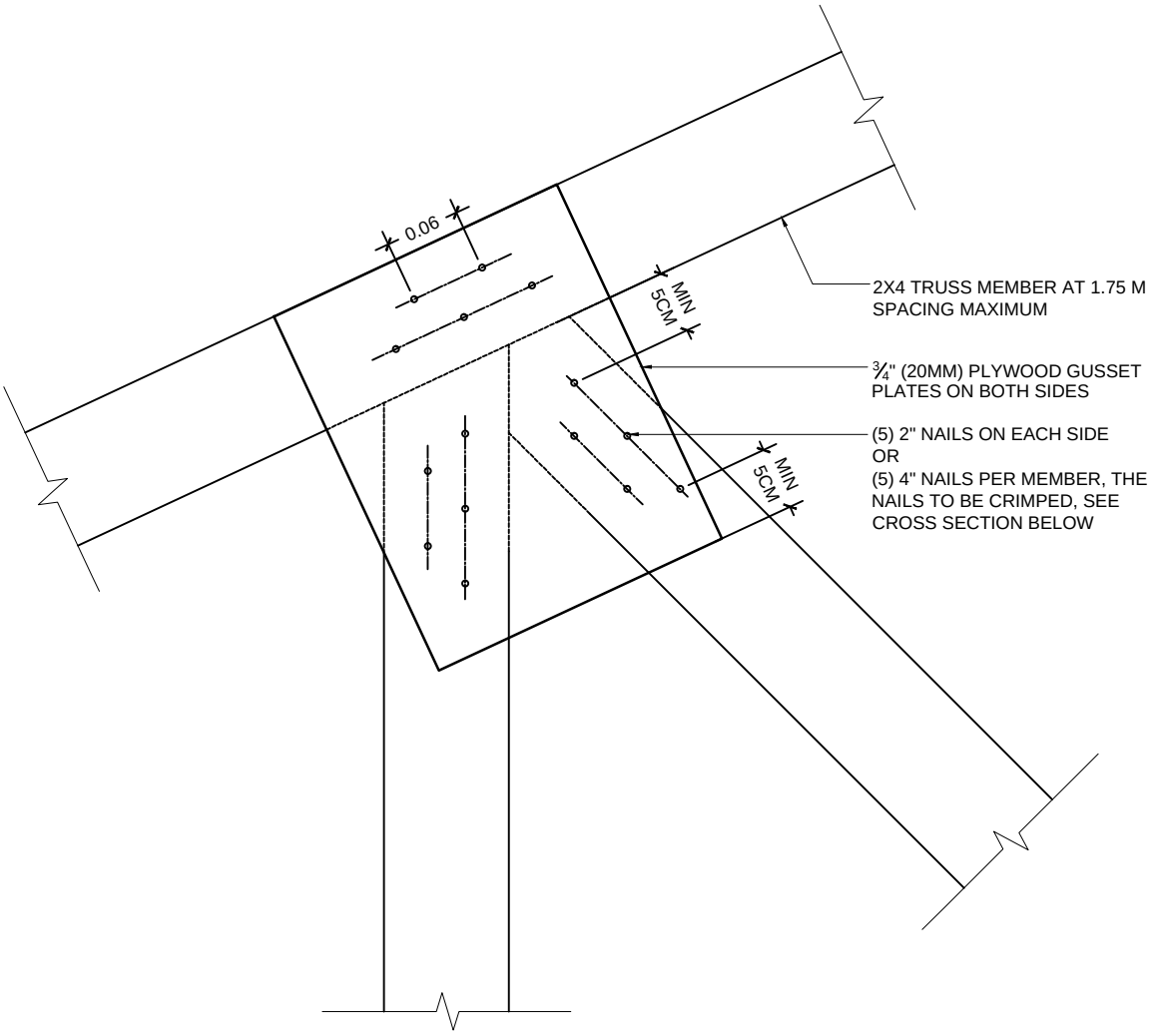
ROOF		D7.6A
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

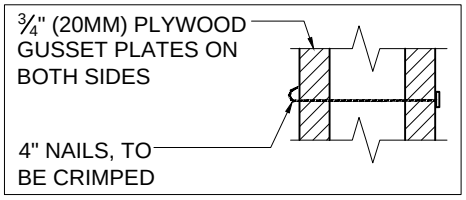


BUILD CHANGE

RAFTER-TO-TOP PLATE CONNECTION WITH METAL STRAP

ROOF		D7.6B
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

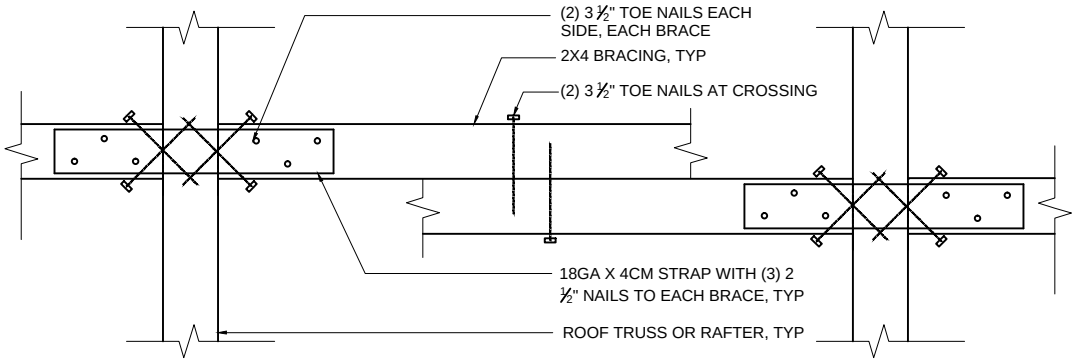




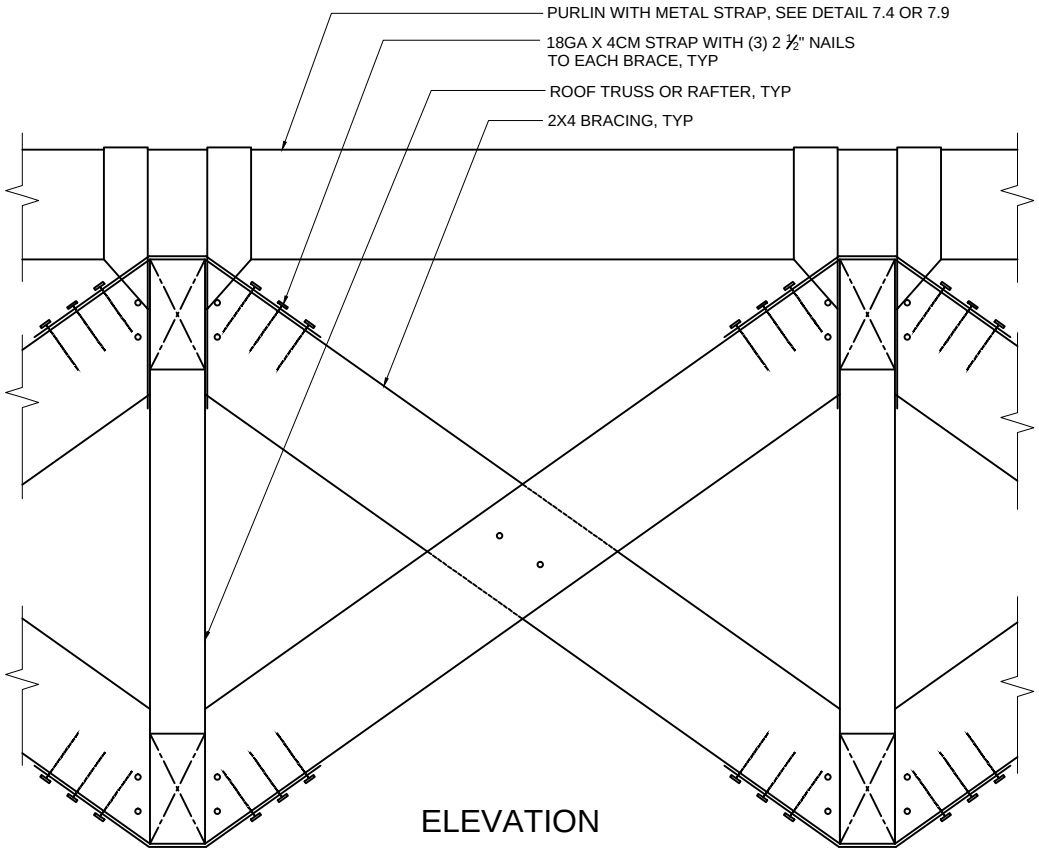
BUILD CHANGE

TRUSS MEMBER CONNECTION WITH GUSSET PLATE

ROOF		D7.7
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



PLAN

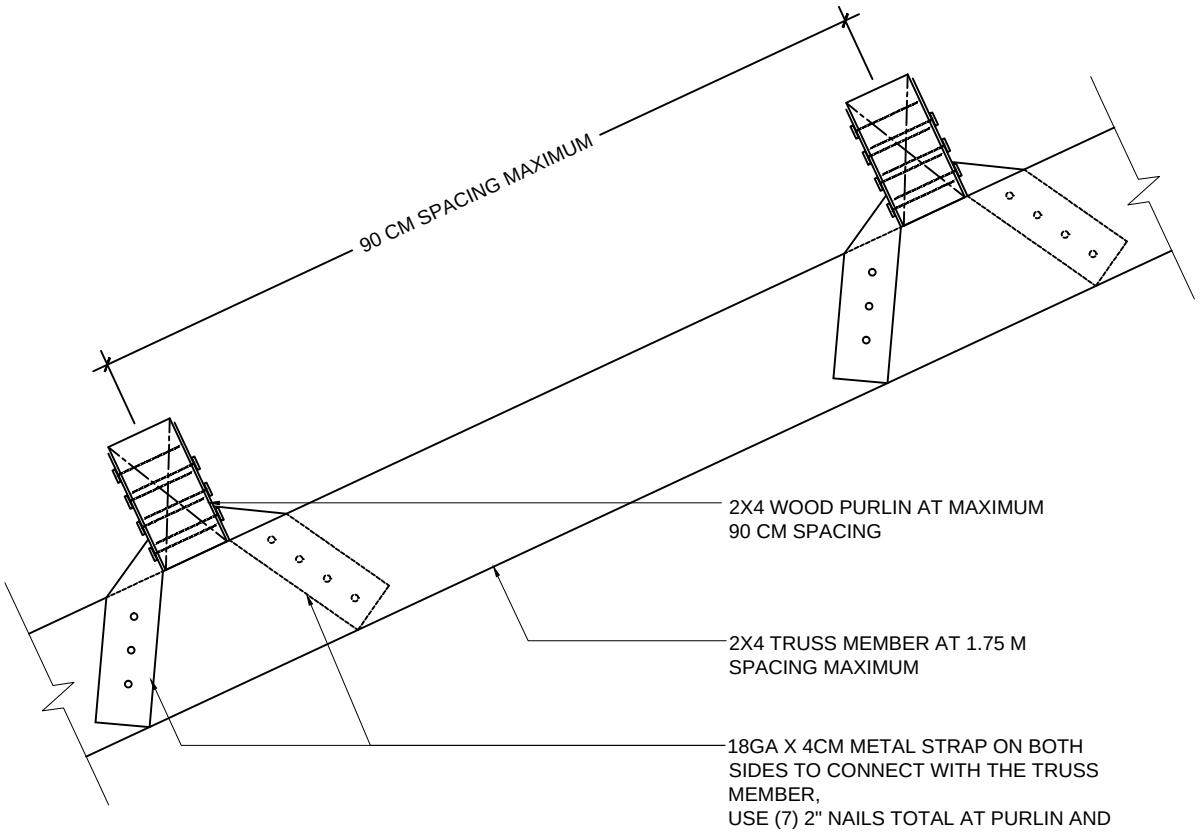


ELEVATION

BUILD CHANGE

WIND/DIAGONAL BRACING CONNECTION

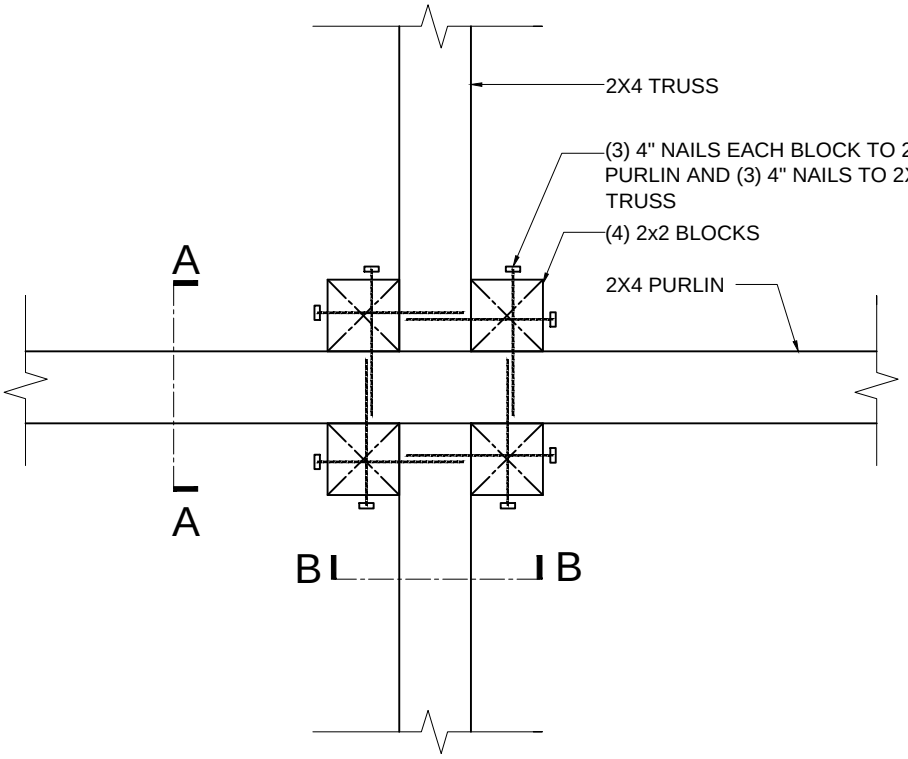
ROOF		D7.8
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



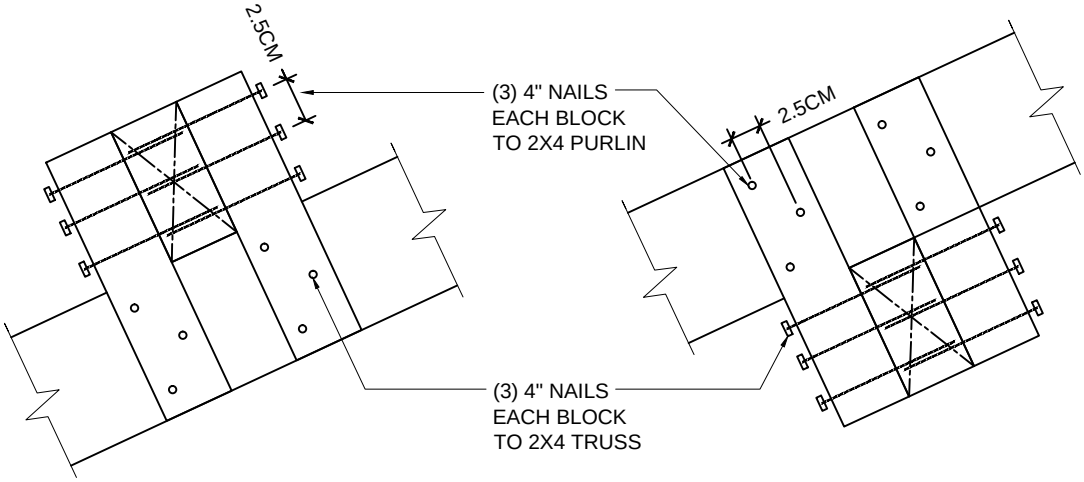
BUILD CHANGE

PURLIN-TO-TRUSS CONNECTION WITH METAL STRAP

ROOF		D7.9A
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



PLAN



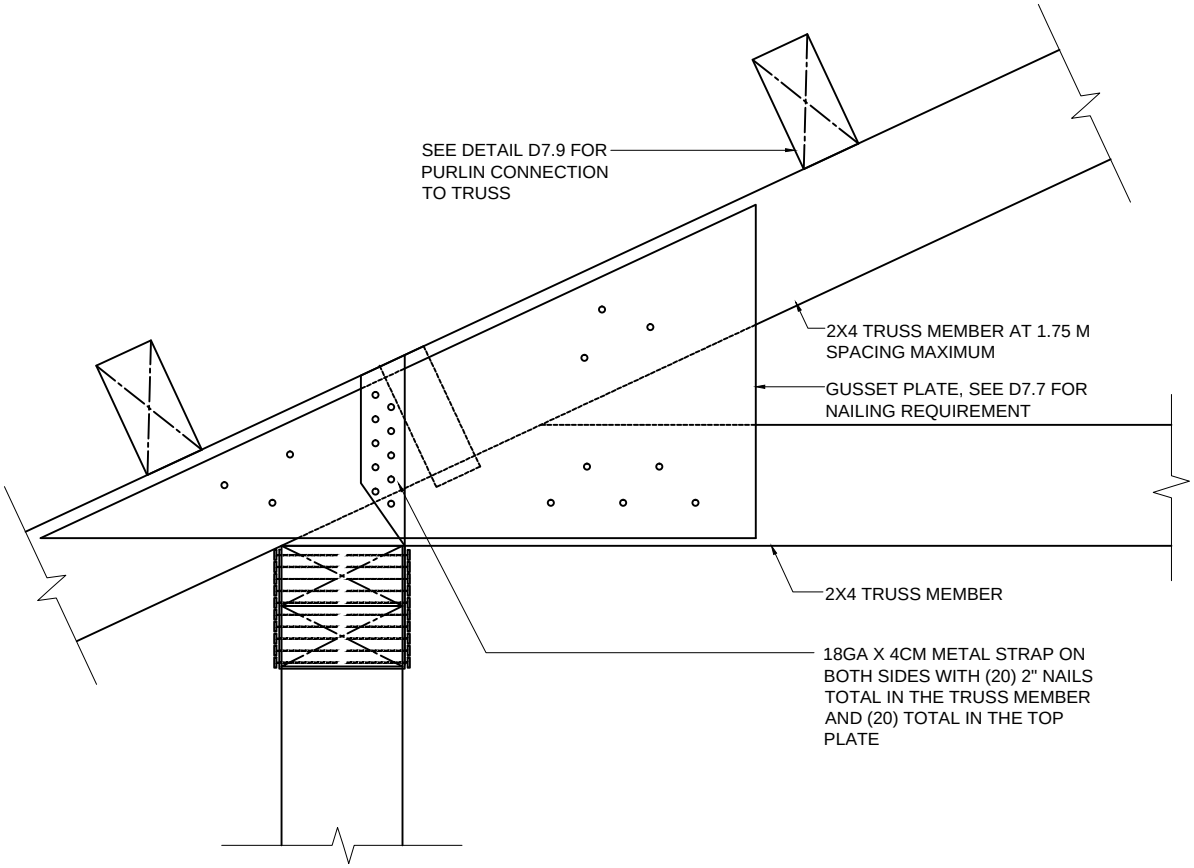
SECTION A-A

SECTION B-B

BUILD CHANGE

PURLIN-TO-TRUSS CONNECTION WITH BLOCKS

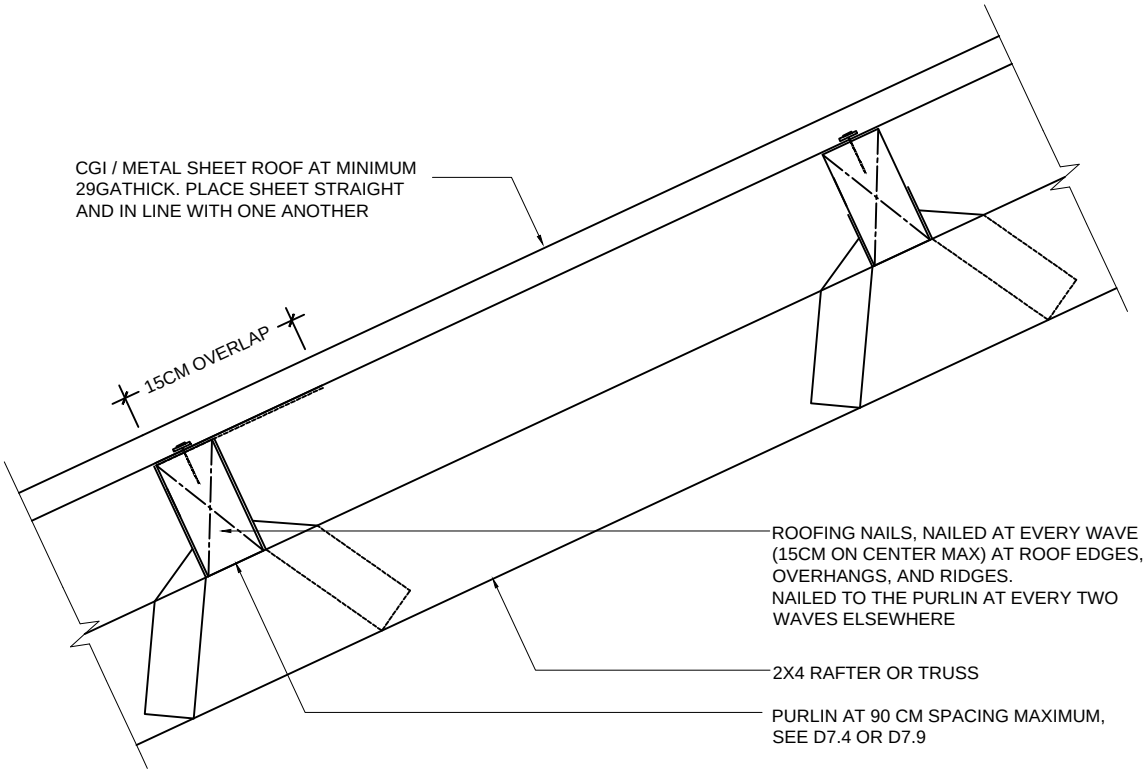
ROOF		D7.9B
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

TRUSS-TO-WALL CONNECTION

ROOF		D7.10
PROJECT:	DATE:	
SCALE:	REVISION DATE:	



BUILD CHANGE

METAL SHEETING CONNECTION TO FRAMING

ROOF		D7.11
PROJECT:	DATE:	
SCALE:	REVISION DATE:	

Appendix C

Construction Quality Control Checklists

Use these checklists to confirm that construction of new elements and all details for the house retrofit are correctly built.

BUILD CHANGE

Cordaid BUILDING FLOURISHING COMMUNITIES

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		NOTCHES AND HOLES IN WOOD FRAMING							
1.		**NOTCHES AND HOLES IN STUDS - D3.1**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Studs should have at most 1/4 of stud width (w/4) notched.	Yes / No / NA				Yes / No / NA		
1.	2	Center of hole must be a minimum of 1/2 the stud width (w/2) distance from face of stud.	Yes / No / NA				Yes / No / NA		
1.	3	Holes must not exceed 1/3 of stud width (w/3).	Yes / No / NA				Yes / No / NA		
1.	4	Members with hold down anchors have no holes.	Yes / No / NA				Yes / No / NA		
2.		**NOTCHES AND HOLES IN FLOOR JOISTS - D3.2**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	No notches or holes within a distance equal to depth of joist from support (within 'd' of support).	Yes / No / NA				Yes / No / NA		
2.	2	Notch width does not exceed 1/3 depth of joist (d/3).	Yes / No / NA				Yes / No / NA		
2.	3	Notch depth does not exceed 1/6 depth of joist (d/6).	Yes / No / NA				Yes / No / NA		
2.	4	Notch depth at support (bottom of joist) does not exceed 1/4 of depth.	Yes / No / NA				Yes / No / NA		
2.	5	Edges of holes are at a distance at least equal to joist thickness from the top or bottom of the joist (t MIN).	Yes / No / NA				Yes / No / NA		
2.	6	Distance between hole centerlines is at least equal to the depth of joist (d MIN).	Yes / No / NA				Yes / No / NA		
2.	7	Maximum diameter of holes are 1/4 of the depth of joist (d/4 max diameter) or less than 2" max.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		CONCRETE & MASONRY BLOCK MATERIALS & PLACING							
1.		**CONCRETE MIX - D4.1A, D4.1B, D4.1C, D4.2, D4.3, D4.4**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Use portland cement; clean, washed, river sand; crushed, angular, 2 cm max gravel.	Yes / No / NA				Yes / No / NA		
1.	2	Concrete mix is 1:2:3 (cement:sand:gravel).	Yes / No / NA				Yes / No / NA		
1.	3	Mix sand & gravel first, then mix in cement.	Yes / No / NA				Yes / No / NA		
1.	4	Use clean water (not salty or muddy); add gradually as needed.	Yes / No / NA				Yes / No / NA		
		POURING & CURING CONCRETE - D4.1A, D4.1B, D4.1C, D4.2, D4.3, D4.4	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Wet formwork and steel before pouring concrete.	Yes / No / NA				Yes / No / NA		
2.	2	Use concrete within 30 minutes after mixing.	Yes / No / NA				Yes / No / NA		
2.	3	Use rod to consolidate concrete around reinforcing.	Yes / No / NA				Yes / No / NA		
2.	4	Complete the entire foundation or tie beam within one day.	Yes / No / NA				Yes / No / NA		
2.	5	If pouring must stop, roughen joints, clean dust and debris out, and moisten concrete before finishing pour.	Yes / No / NA				Yes / No / NA		
2.	6	Cover with waterproof tarp if it rains.	Yes / No / NA				Yes / No / NA		
2.	7	Moisten 5 times per day: 8 am, 10 am, 12 pm, 2 pm, 4 pm	Yes / No / NA				Yes / No / NA		
3.		**MASONRY MATERIALS - D4.1A, D4.1B, D4.6**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	Good quality blocks are not broken or damaged.	Yes / No / NA				Yes / No / NA		
3.	2	Blocks have 3 cells, with minimum solid surface of 50%.	Yes / No / NA				Yes / No / NA		
3.	3	Mortar & grout mix - 1 part cement & 5 parts sand	Yes / No / NA				Yes / No / NA		
3.	4	Use portland cement and clean, washed, river sand. Mix cement and sand before adding water.	Yes / No / NA				Yes / No / NA		
3.	5	Use clean water (not salty or muddy); add gradually as needed.	Yes / No / NA				Yes / No / NA		
3.	6	Turn mortar and grout mix over 3 times or until color is uniform.	Yes / No / NA				Yes / No / NA		
4.		**PLACING MASONRY BLOCKS - D4.1A, D4.1B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
4.	1	Blocks are placed level.	Yes / No / NA				Yes / No / NA		
4.	2	Blocks use 1/2-block running bond configuration.	Yes / No / NA				Yes / No / NA		
4.	3	No partial blocks smaller than 1/2 of a block are used. Partial blocks have at least one entire cell.	Yes / No / NA				Yes / No / NA		
4.	4	Vertical reinforcing is centered in blocks.	Yes / No / NA				Yes / No / NA		
4.	5	All joints are filled with mortar, 1 cm min and 2 cm max thickness.	Yes / No / NA				Yes / No / NA		
4.	6	Grout is placed in block cells up to 1 cm below top of block, using a rod to consolidate.	Yes / No / NA				Yes / No / NA		

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		CONCRETE & MASONRY BLOCK MATERIALS & PLACING							
5.		**REINFORCEMENT & METAL STRAPS - D4.1A, D4.1B, D4.1C, D4.2, D4.3, D4.4**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
5.	1	Reinforcement is Grade 40 minimum, ribbed.	Yes / No / NA				Yes / No / NA		
5.	2	Reinforcement is not rusted. Any rust had been cleaned off before concrete or grout is placed.	Yes / No / NA				Yes / No / NA		
5.	3	Concrete spacers are used below every rebar in the footings.	Yes / No / NA				Yes / No / NA		
5.	4	Concrete spacers are used at every 4 stirrups in the tie beams.	Yes / No / NA				Yes / No / NA		
5.	5	Reinforcement is secured with wire ties to prevent movement during concrete/grout placement.	Yes / No / NA				Yes / No / NA		
5.	6	Metal straps are secured in correct place for connections to wood framing above and to prevent movement during concrete/grout placement.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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Build Change Engineer: _____ GPS: _____ Type of construction: _____

		FOUNDATIONS							
1.		**MASONRY KNEE WALL - D4.1A, D4.1B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Masonry is 6" or 15 cm thick, all cells grouted.	Yes / No / NA				Yes / No / NA		
1.	2	10 mm vertical bars are spaced not more than 40 cm o.c.	Yes / No / NA				Yes / No / NA		
1.	3	10 mm vertical bars are hooked into footings and tie beam.	Yes / No / NA				Yes / No / NA		
1.	4	(2) 12 mm longitudinal bars are used for footing.	Yes / No / NA				Yes / No / NA		
1.	5	7.5 cm minimum concrete cover for footing.	Yes / No / NA				Yes / No / NA		
1.	6	Add 12 mm dia transverse bars @ 40 cm o.c. for footing over 60 cm wide.	Yes / No / NA				Yes / No / NA		
2.		**CONCRETE CRIPPLE WALL - D4.1C**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Concrete cripple wall is 15 cm thick, minimum.	Yes / No / NA				Yes / No / NA		
2.	2	12 mm vertical bars are spaced not more than 40 cm o.c.	Yes / No / NA				Yes / No / NA		
2.	3	12 mm vertical bars are hooked 90 degrees into footing and 135 degrees at top of cripple wall.	Yes / No / NA				Yes / No / NA		
2.	4	(2) 12 mm longitudinal bars are used for footing.	Yes / No / NA				Yes / No / NA		
2.	5	7.5 cm minimum concrete cover for footing.	Yes / No / NA				Yes / No / NA		
3.		**WOOD POST PIER FOUNDATION - D4.2**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	(4) 12 mm bars are used for main bars.	Yes / No / NA				Yes / No / NA		
3.	2	8 mm bars are used for stirrups, first 5 spaced at 0.05 m o.c.	Yes / No / NA				Yes / No / NA		
3.	3	8 mm bars are used for stirrups, spaced at 0.10 m o.c. elsewhere.	Yes / No / NA				Yes / No / NA		
4.		**PLYWOOD SHEAR WALL POST FOUNDATION - D4.3**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
4.	1	Concrete foundation wall at post is 25 cm thick, minimum.	Yes / No / NA				Yes / No / NA		
4.	2	(4) 12 mm vertical bars with hooks top and bottom.	Yes / No / NA				Yes / No / NA		
4.	3	8 mm tie bars with 135 degree hooks are spaced at 10 cm o.c.	Yes / No / NA				Yes / No / NA		
4.	4	(4) 10 mm bars each way are used for footing.	Yes / No / NA				Yes / No / NA		
4.	5	10 ga x 10 mm metal strap is wrapped around tie bars.	Yes / No / NA				Yes / No / NA		
4.	6	10 ga metal strap is nailed to 4x4 post with (18) 2" nails in 2 rows each side at 1.5 cm o.c. (36 nails total).	Yes / No / NA				Yes / No / NA		
4.	7	4x4 post at each end of wall and at 3 meters o.c. max below beam.	Yes / No / NA				Yes / No / NA		
4.	8	Edge nail plywood to floor beam.	Yes / No / NA				Yes / No / NA		
4.	9	Nail each stud to floor joist with (2) 3.5" nails.	Yes / No / NA				Yes / No / NA		
4.	10	Provide 2x4 blocking between stud/joist framing above floor beam.	Yes / No / NA				Yes / No / NA		

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		FOUNDATIONS							
5.		**REPAIR OF FOUNDATION DEGRADATION - D4.6**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
5.	1	Elements that have minor deterioration are chipped out to solid concrete and patched with cement-rich mortar.	Yes / No / NA				Yes / No / NA		
5.	2	Reinforced elements that have significant deterioration such that steel reinforcement is exposed shall be demolished and replaced.	Yes / No / NA				Yes / No / NA		
6.		**BOTTOM PLATE TO KNEE WALL AT NON-SHEAR WALL - D4.7**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
6.	1	10 mm vertical bars from knee wall bent on top of 2x4 bottom plate.	Yes / No / NA				Yes / No / NA		
6.	2	Nails into bottom plate bent to clip over bent 10 mm bars.	Yes / No / NA				Yes / No / NA		
6.	3	Washer between bend of 10 mm bar and bottom plate.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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Build Change Engineer: _____ GPS: _____ Type of construction: _____

		TIE/CAP BEAM							
1.		**TIE/CAP BEAM BELOW WOOD STRUCTURAL WALL - D4.4**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Stirrups are hooked 135 degrees and installed rotated.	Yes / No / NA				Yes / No / NA		
1.	2	8 mm diameter stirrups are spaced at 20 cm o.c. around (4) 10 mm bars.	Yes / No / NA				Yes / No / NA		
1.	3	10 mm vertical bars are hooked into the tie beam.	Yes / No / NA				Yes / No / NA		
1.	4	Straps for studs and posts are hooked around 10 mm bars.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

		TIMBER & PLYWOOD MATERIALS							
1.		**NEW WOOD FRAMING & PLANKS - D4.3, D6.1 to D6.15, D7.1 to D7.11**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Timber boards are good quality gmelina, mahogany, or lawaan, Grade 2 or better.	Yes / No / NA				Yes / No / NA		
1.	2	Timber is straight-grained, free of excessive knots or warping, and does not have a high moisture content.	Yes / No / NA				Yes / No / NA		
1.	3	There are no signs of decay, shrinkage, splitting, or insect infestation.	Yes / No / NA				Yes / No / NA		
1.	4	A preservative or moisture barrier is used on all wood members placed against concrete or exposed to weather elements.	Yes / No / NA				Yes / No / NA		
		PLYWOOD - D6.8, D6.9	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Plywood used for shear walls has a minimum thickness of 10mm, with 3 layers of veneer minimum.	Yes / No / NA				Yes / No / NA		
2.	2	Plywood used on the exterior of the building is exterior grade.	Yes / No / NA				Yes / No / NA		
2.	3	Plywood used is in good condition with no warping or peeling of the plies.	Yes / No / NA				Yes / No / NA		
2.	4	Plywood used on the exterior is treated with a preservative, painted, or has a waterproof finish covering the plywood.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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BUILD CHANGE

		INFILLED OPENINGS							
1.		**Door Opening - D6.1**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Infill wood is good quality gmelina, mahogany, or lawaan, Grade 2 or better, free of excessive knots, warping, or moisture or insect damage.	Yes / No / NA				Yes / No / NA		
1.	2	3.5" nails @ 12 cm o.c. at all edges of existing opening to connect new blocking and new studs to existing frame.	Yes / No / NA				Yes / No / NA		
1.	3	2x4 used for blocking at top edge of existing opening.	Yes / No / NA				Yes / No / NA		
1.	4	Opening is covered with sheathing, plywood, or strap to match the adjacent structural wall.	Yes / No / NA				Yes / No / NA		
1.	5	Base of existing opening is installed with sill plate.	Yes / No / NA				Yes / No / NA		
2.		**Window Opening - D6.1**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Infill wood is good quality gmelina, mahogany, or lawaan, Grade 2 or better, free of excessive knots, warping, or moisture or insect damage.	Yes / No / NA				Yes / No / NA		
2.	2	3.5" nails @ 12 cm o.c. at all edges of existing opening to connect new blocking and new studs to existing frame.	Yes / No / NA				Yes / No / NA		
2.	3	2x4 used for blocking at top edge of existing opening.	Yes / No / NA				Yes / No / NA		
2.	4	New 2x4s are aligned with existing studs below existing window opening and at each end of opening.	Yes / No / NA				Yes / No / NA		
2.	5	The new studs are toe-nailed with (4) 3" nails top and bottom.	Yes / No / NA				Yes / No / NA		
2.	6	New sills are placed below new studs.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		DIAGONAL LUMBER SHEATHING SHEAR WALL							
1.		**DIAGONAL SHEATHING WALL ELEVATION - D6.2**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	New wood is good quality gmelina, mahogany, or lawaan, Grade 2 or better, free of excessive knots, warping, or moisture or insect damage.	Yes / No / NA				Yes / No / NA		
1.	2	Each stud is strapped at each end (top and bottom).	Yes / No / NA				Yes / No / NA		
1.	3	Length of shear wall is more than half the wall height, l > h/2 minimum.	Yes / No / NA				Yes / No / NA		
1.	4	4x4 or (2) 2x4 wood top plate is continuous between perpendicular walls.	Yes / No / NA				Yes / No / NA		
1.	5	4x4 wood post at all corners and wall ends, or (2) 2x4 posts nailed together every 3".	Yes / No / NA				Yes / No / NA		
1.	6	2x4 wood studs at 0.6 meter o.c. max.	Yes / No / NA				Yes / No / NA		
1.	7	Hold down straps at wall ends.	Yes / No / NA				Yes / No / NA		
2.		**BOARD TO STUD CONNECTION - D6.3**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Timber boards are good quality gmelina, mahogany, or lawaan, Grade 2 or better, free of excessive knots, warping, or moisture or insect damage.	Yes / No / NA				Yes / No / NA		
2.	2	1x6 timber boards are oriented diagonally (45 degrees) and installed tight with no gap between boards.	Yes / No / NA				Yes / No / NA		
2.	3	(2) 2.5" nails per stud each board, (3) 2.5" nails per stud each board at edges.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		METAL X-BRACING SHEAR WALL							
1.		**METAL X-BRACING WALL EVELATION - D 6.4**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Each stud is strapped at each end (top and bottom).	Yes / No / NA				Yes / No / NA		
1.	2	4x4 or (2) 2x4 wood top plate is continuous between perpendicular walls.	Yes / No / NA				Yes / No / NA		
1.	3	4x4 wood post at all corners and wall ends, or (2) 2x4 posts nailed together every 3".	Yes / No / NA				Yes / No / NA		
1.	4	2x4 wood studs at 0.6 meter o.c. max.	Yes / No / NA				Yes / No / NA		
1.	5	Hold down straps at wall ends.	Yes / No / NA				Yes / No / NA		
1.	6	18 gauge metal strap 4 cm wide, on both sides of the wall, installed with no slack in strap.	Yes / No / NA				Yes / No / NA		
2.		**CONNECTION TO THE TOP PLATE - D6.5**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Strap end wraps over top plate from strap at opposite side of the wall.	Yes / No / NA				Yes / No / NA		
2.	2	4x4 or (2) 2x4 wood top plate.	Yes / No / NA				Yes / No / NA		
2.	3	(14) 2.5" long nails arranged in 4 staggered rows with 5 cm spacing between nails in a row.	Yes / No / NA				Yes / No / NA		
2.	4	18 gauge (1.2 mm thick) metal strap 4 cm wide has at least 40 cm of overlap with the top plate.	Yes / No / NA				Yes / No / NA		
3.		**CONNECTION TO THE BOTTOM PLATE - D6.6**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	2x4 wood intermediate studs at 0.6 meter o.c. max.	Yes / No / NA				Yes / No / NA		
3.	2	18 gauge (1.2 mm thick) metal strap 4 cm wide at both sides of wall.	Yes / No / NA				Yes / No / NA		
3.	3	Metal strap is hooked underneath cap beam bottom bars, and tied to the bars to form 45 degree angle with the beam.	Yes / No / NA				Yes / No / NA		
4.		**SPLICE CONNECTION ON STRAP - D6.7**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
4.	1	Cut backing board to fit tight between vertical studs.	Yes / No / NA				Yes / No / NA		
4.	2	2x4 wood for backing board.	Yes / No / NA				Yes / No / NA		
4.	3	18 gauge (1.2 mm) metal straps 4 cm wide, overlap the two straps by 30 cm.	Yes / No / NA				Yes / No / NA		
4.	4	(13) 2" nails, arrange in 2 staggered rows with 3 cm spacing between nails in a row.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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BUILD CHANGE

		PLYWOOD SHEATHING SHEAR WALL							
1.		**PLYWOOD SHEATHED WALL ELEVATION - D6.8**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Nails at panel joints are staggered.	Yes / No / NA				Yes / No / NA		
1.	2	4x4 or (2) 2x4 wood top plate is continuous between perpendicular walls and between parallel wall segments.	Yes / No / NA				Yes / No / NA		
1.	3	4x4 wood post at all corners and wall ends, or (2) 2x4 posts nailed together every 3".	Yes / No / NA				Yes / No / NA		
1.	4	2x4 wood studs at 0.6 meter o.c. max.	Yes / No / NA				Yes / No / NA		
1.	5	Minimum thickness of plywood is 3/8" or 9.5 cm. Thickness to meet requirements of retrofit design, as shown on plan.	Yes / No / NA				Yes / No / NA		
1.	6	Each stud is strapped at each end (top and bottom).	Yes / No / NA				Yes / No / NA		
1.	7	Hold down straps at wall ends.	Yes / No / NA				Yes / No / NA		
2.		**NAILING AT PANEL JOINTS - D6.9**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	2.5" nails are @ 0.10 meter o.c. at plywood edges (EDGE NAIL). 3" nails used for 5/8" plywood.	Yes / No / NA				Yes / No / NA		
2.	2	2.5" nails are @ 0.30 meter o.c. at intermediate studs (FIELD NAIL). 3" nails used for 5/8" plywood.	Yes / No / NA				Yes / No / NA		
2.	3	1 cm max from nail to edge of plywood and edge of stud at plywood panel joints.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		CONNECTIONS TO FOUNDATION							
1.		**HOLD DOWN POST CONNECTION TO FOUNDATION - D6.10**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	4x4 post or (2) 2x4 nailed together at 7.5 cm o.c. at hold down.	Yes / No / NA				Yes / No / NA		
1.	2	Minimum distance from concrete to first nail is 5 cm.	Yes / No / NA				Yes / No / NA		
1.	3	8 cm wide metal strap is embedded inside the concrete and hooked around reinforcing bars.	Yes / No / NA				Yes / No / NA		
1.	4	Strap is nailed to each side of post with number of nails to match type of wall and sheathing. Nails are staggered in 2 rows each side of post.	Yes / No / NA				Yes / No / NA		
2.		**GRAVITY POST CONNECTION TO FOUNDATION - D6.11**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	(6) 2.5" nails are on each side of the post, spaced at 2.5 cm.	Yes / No / NA				Yes / No / NA		
2.	2	Minimum distance from concrete to first nail is 5 cm.	Yes / No / NA				Yes / No / NA		
2.	3	4 cm wide metal strap is embedded inside the concrete and hooked around at least one tie bar.	Yes / No / NA				Yes / No / NA		
2.	4	2x4 wood stud is at 0.4 meter o.c. max.	Yes / No / NA				Yes / No / NA		
3.		**CONNECTION OF BOTTOM STUD WITH METAL STRAP - D6.13**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	(6) 2.5" long nails at each side: 2 on sill plate; 4 on stud.	Yes / No / NA				Yes / No / NA		
3.	2	Space a minimum of 1 cm from the concrete face to the first nail at 2x4 plate.	Yes / No / NA				Yes / No / NA		
3.	3	18 ga. x 4 cm wide and 55 cm long metal strap is hooked under the bars.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		TOP OF WALL CONNECTIONS							
1.		**TOP STUD WITH METAL STRAP - D6.14**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	18 ga. x 4 cm wide and 55 cm long metal strap is bent over top plate.	Yes / No / NA				Yes / No / NA		
1.	2	Strap is nailed with (6) 2.5" nails each side, with (2) into top plate and (4) into stud (12 nails total).	Yes / No / NA				Yes / No / NA		
2.		**WOOD BEAM TO WOOD POST - D6.15, OPTION A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	(2) 3.5" nails on both sides of the beam to post.	Yes / No / NA				Yes / No / NA		
2.	2	18 gauge x 5 cm wide metal strap nailed with (8) 2.5" nails to the post staggered, 4 nails each side.	Yes / No / NA				Yes / No / NA		
3.		**WOOD BEAM TO WOOD POST - D6.15, OPTION B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	(2) 18 gauge x 4 cm wide metal straps on both sides of beam strapped to post.	Yes / No / NA				Yes / No / NA		
3.	2	(4) 2.5" nails per strap to beam.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		TOP PLATE CONNECTIONS							
1.		**TOP PLATE CONNECTION TO PREPENDICULAR PLATES - D7.1**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	4x4 plates notched at L- and T-corners.	Yes / No / NA				Yes / No / NA		
1.	2	(4) 3.5" nails downward in each plate where plates overlap at corners.	Yes / No / NA				Yes / No / NA		
1.	3	(2) 18 gauge x 4 cm wide metal straps, one on each side of L- or T-corner, strapped to post.	Yes / No / NA				Yes / No / NA		
2.		**FOR (2) 2X4 TOP PLATE - D7.2A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	(2) 3.5" nails between top plates beyond ends of splice overlap.	Yes / No / NA				Yes / No / NA		
2.	2	Overlap at least 1.2m upper and lower 2x4 plate.	Yes / No / NA				Yes / No / NA		
2.	3	(2) rows of (8) 3.5" nails on overlap.	Yes / No / NA				Yes / No / NA		
2.	4	2x4 are nailed together with 3.5" nails at 15 cm o.c.	Yes / No / NA				Yes / No / NA		
3.		**FOR 4X4 TOP PLATE - D7.2A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	Notch end of 4x4 to overlap.	Yes / No / NA				Yes / No / NA		
3.	2	Overlap at least 1.2m upper and lower at equal thickness.	Yes / No / NA				Yes / No / NA		
3.	3	(2) rows of (8) 3.5" nails on overlap.	Yes / No / NA				Yes / No / NA		
4.		**TOP PLATE STEPPED CONNECTION - D7.2B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
4.	1	(2) 2x4 blocks centered on lower top plate at strap .	Yes / No / NA				Yes / No / NA		
4.	2	(6) 1.5" nails each side at strap to top plate (12 nails total).	Yes / No / NA				Yes / No / NA		
4.	3	(2) 1.5" nails each side sat strap to each 2x4 block.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Homeowner: _____ House ID: _____ Supervisor: _____

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Build Change Engineer: _____ GPS: _____ Type of construction: _____

BUILD CHANGE

		TRUSS AND ROOF CONNECTIONS							
1.		**RAFTER-TO-RAFTER CONNECTION WITH METAL STRAP - D7.3**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
1.	1	Nail is at least 5 cm from the center face of purlin.	Yes / No / NA				Yes / No / NA		
1.	2	(7) 2" nails are used for metal strap to connect the rafters.	Yes / No / NA				Yes / No / NA		
1.	3	Wood rafters are 2x4 spaced at 1.0 meter maximum.	Yes / No / NA				Yes / No / NA		
2.		**PURLIN-TO-RAFTER CONNECTION WITH METAL STRAP - D7.4A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
2.	1	Purlins are spaced at 90 cm maximum.	Yes / No / NA				Yes / No / NA		
2.	2	18 gauge 4 cm wide is strapped on both sides to connect with rafter.	Yes / No / NA				Yes / No / NA		
2.	3	(4) 2" nails are used to strap metal at purlin and (4) nails at rafter.	Yes / No / NA				Yes / No / NA		
3.		**PURLIN-TO-RAFTER CONNECTION WITH BLOCKS - D7.4B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
3.	1	Purlins are spaced at 90 cm maximum.	Yes / No / NA				Yes / No / NA		
3.	2	2x2 wood blocks on both sides to connect with rafter.	Yes / No / NA				Yes / No / NA		
3.	3	(3) 4" nails are used to purlin and to rafter each (6 nails total each block).	Yes / No / NA				Yes / No / NA		
4.		**RAFTER-TO-TIE CONNECTION WITH METAL STRAP - D7.5**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
4.	1	18 gauge 4 cm wide is strapped on both sides to connect tie and rafter.	Yes / No / NA				Yes / No / NA		
4.	2	(4) 2" nails in the rafter and (4) 2" nails in the tie.	Yes / No / NA				Yes / No / NA		
4.	3	Maximum notch is 2 cm.	Yes / No / NA				Yes / No / NA		
5.		**RAFTER-TO-WALL CONNECTION WITH METAL STRAP - D7.6A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
5.	1	Metal strap on both sides with (11) 2" nails in total in the rafter.	Yes / No / NA				Yes / No / NA		
5.	2	Metal strap on both sides with (11) 2" nails in total in the top plate.	Yes / No / NA				Yes / No / NA		
6.		**RAFTER-TO-TOP PLATE CONNECTION WITH METAL STRAP - D7.6B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
6.	1	Metal strap on both sides with (11) 2" nails in total in the rafter.	Yes / No / NA				Yes / No / NA		
6.	2	Metal strap on both sides with (11) 2" nails in total in parallel top plate.	Yes / No / NA				Yes / No / NA		
7.		**TRUSS MEMBER CONNECTION WITH GUSSET PLATE - D7.7**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
7.	1	At least 5 cm minimum from face of truss.	Yes / No / NA				Yes / No / NA		
7.	2	Plywood is 3/4" (20 mm) used as gusset plate on both sides.	Yes / No / NA				Yes / No / NA		
7.	3	(5) 2" nails on each side or (5) 4" nails per member but must be crimped on the other side.	Yes / No / NA				Yes / No / NA		
8.		**WIND/DAIGONAL BRACING CONNECTION - D7.8**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
8.	1	Diagonal 2x4 bracing between tops and bottoms of truss or rafters.	Yes / No / NA				Yes / No / NA		
8.	2	(2) 3.5" toe nails each side of each brace to truss or rafter and (2) 3.5" toe nails at brace crossings.	Yes / No / NA				Yes / No / NA		
8.	3	18 ga x 4 cm straps between braces with (3) 2.5" nails to each brace.	Yes / No / NA				Yes / No / NA		
9.		**PURLIN-TO-TRUSS CONNECTION WITH METAL STRAP - D7.9A**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
9.	1	Purlins are spaced at 90 cm maximum.	Yes / No / NA				Yes / No / NA		
9.	2	Metal strap on both sides to connect wih the truss member.	Yes / No / NA				Yes / No / NA		
9.	3	(7) 2" nails are used at purlin and (7) at rafter.	Yes / No / NA				Yes / No / NA		

Homeowner: _____ House ID: _____ Supervisor: _____

Homeowner's telephone number: _____ Address/ Village: _____ Supervisor's telephone number: _____

Build Change Engineer: _____ GPS: _____ Type of construction: _____

		TRUSS AND ROOF CONNECTIONS							
10.		**PURLIN-TO-RAFTER CONNECTION WITH BLOCKS - D7.9B**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
10.	1	Purlins are spaced at 90 cm maximum.	Yes / No / NA				Yes / No / NA		
10.	2	2x2 wood blocks on both sides to connect with truss.	Yes / No / NA				Yes / No / NA		
10.	3	(3) 4" nails are used to purlin and to truss each (6 nails total each block).	Yes / No / NA				Yes / No / NA		
11.		**TRUSS-TO-WALL CONNECTION - D7.10**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
11.	1	Metal strap on both sides with (20) 2" nails are in the truss member.	Yes / No / NA				Yes / No / NA		
11.	2	Metal strap on both sides with (20) 2" nails are in the top plate.	Yes / No / NA				Yes / No / NA		
12.		**METAL SHEETING CONNECTION TO FRAMING - D7.11**	Conforms?	Date	Photo #	Recommendation Made	Done?	Date	Photo #
12.	1	CGI/Metal sheet roof is at least 2mm thick.	Yes / No / NA				Yes / No / NA		
12.	2	CGI/Metal sheet roof are placed sheet straight and in line with one another.	Yes / No / NA				Yes / No / NA		
12.	3	Roofing nails are nailed at every wave at roof edges, overhangs, and ridges.	Yes / No / NA				Yes / No / NA		
12.	4	Roofing nails are nailed to the purlin at every two waves.	Yes / No / NA				Yes / No / NA		

Homeowner Signature:_____ Date: _____

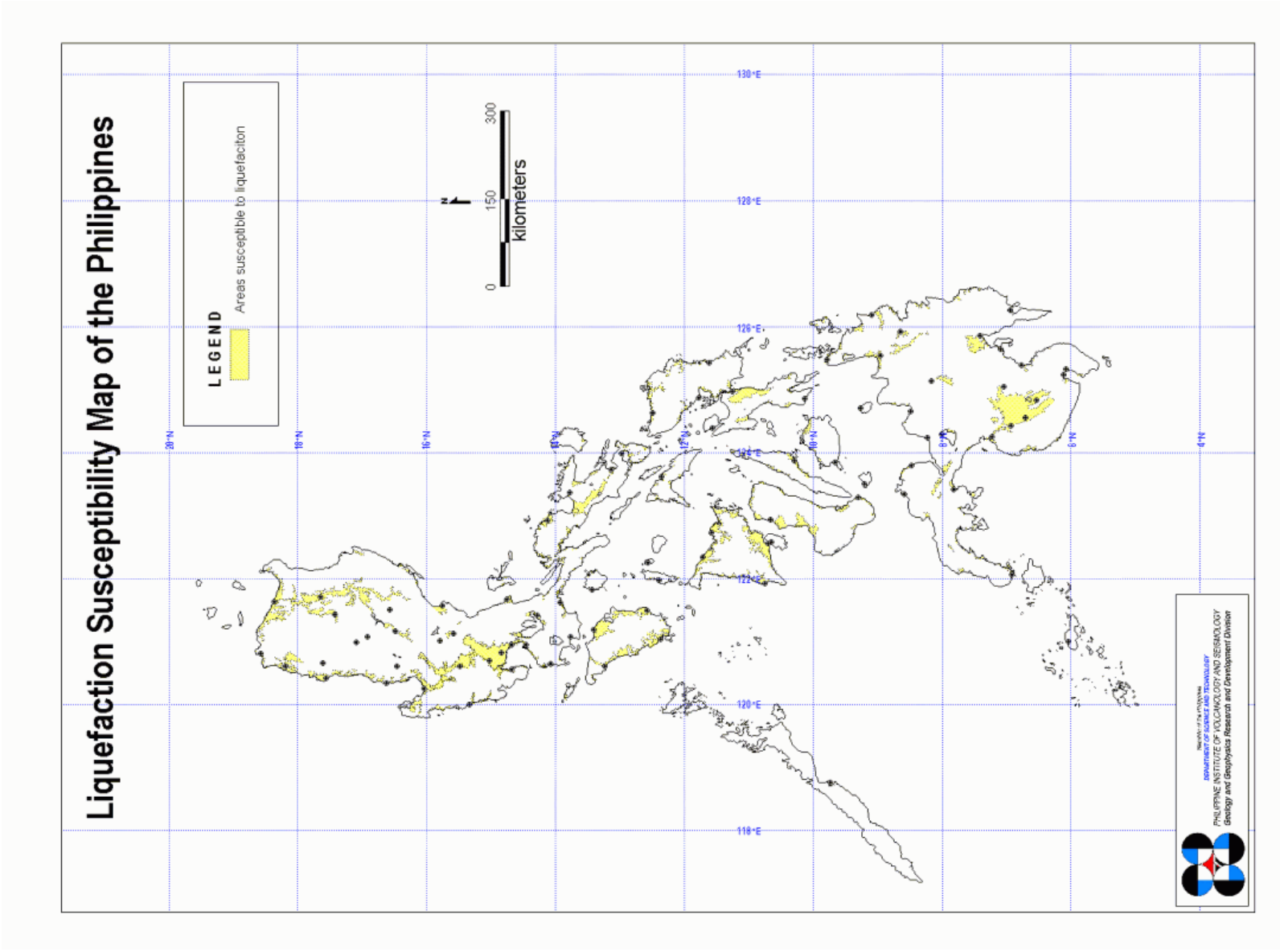
Build Change Engineer Signature: _____ Date: _____

Build Change Manager Signature: _____ Date: _____

Overall Assessment: Meets Minimum Standard? Yes / No

Comments:

Appendix D



BUILD CHANGE

Cordaid BUILDING FLOURISHING COMMUNITIES