# Masonry

# Level-II

# Learning Guide-66

**Unit of Competence:** Erect Brick and Block Structures

**Module Title:-** Erecting Brick and Block Structures

**LG Code:** EIS MAS2 M13 LO5 LG-66

**TTLMCode:** EIS MAS2 M13 TTLM 0919v1

## LO5:- Construct brick/block walls

| Instruction Sheet 5 | Learning Guide #66 |
|---|---|

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Constructing brick walls
- lying damp proof courses and flashings
- Building ventilation for solid brick construction
- Constructing walls to be straight and true in plumb, line and level
- Positioning wall ties
- Constructing openings and installing flashing
- Installing lintels
- Forming control joints
- Locating and building in weep holes, brick reinforcing, vermin proofing and wall flashings
- Constructing gables and parapets
- Cutting and laying sill bricks
- Installing tie down and lateral support systems for ceiling/roof structures

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Construct brick walls
- Lay damp proof courses and flashings
- Build ventilation for solid brick construction
- Construct walls to be straight and true in plumb, line and level
- Positioning wall ties
- Construct openings and installing flashing
- Install lintels
- Forming control joints
- Locate and build in weep holes, brick reinforcing, vermin proofing and wall flashings

- Construct gables and parapets
- Cut and lay sill bricks
- Install tie down and lateral support systems for ceiling/roof structures

**Learning Instructions:**

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5, Sheet 6, Sheet 7, Sheet 8 Sheet 9, Sheet 10 Sheet 11 and Sheet 12” **in page 4, 9, 18, 21, 28, 33, 39, 44, 48, 55, 64 and 70** respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7, Self-check 8, Self-check 9, Self-check 10, Self-check 11 and Self-check 12” **in page 7, 16, 19, 26, 31, 37, 42, 46, 53, 62, 68 and 78** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceedto “Operation Sheet 1, Operation Sheet 2, Operation Sheet 3, Operation Sheet 4, Operation Sheet 5, Operation Sheet 6, Operation Sheet 7, Operation Sheet 8, Operation Sheet 9, Operation Sheet 10, Operation Sheet 11 and Operation Sheet 12” **in page – 80,81, 82, 83, 84, 85, 86,87, 88, 89, 90 and 91** respectively.
6. Do the “LAP test” **in page – 90** (if you are ready).

| Information Sheet-1 | Constructing brick walls |
|---|---|

1.1 **brick walls**.

Definition of a brick wall: If you hit a brick wall or come up against a brick wall, you are unable to or make progress because something stops you. What are some things that stop you?

Many times a brick wall is caused by the methods we use in research. We don't begin with ourselves and work back, documenting and sourcing each and every person and finding as much as we can on each.

Many times a brick wall is caused by the methods others research (too fast, too little proof and very little sourcing). A lot of he said she said!

Many times a brick wall is caused by tree grabbing: finding a tree with common information, going back as far on their tree and "claiming" their brick wall as yours. So many times when I help someone I go out online and see how many others are searching for the same exact "brick wall." It's a very common practice in today's method of research.

Many times we have brick walls because we just don't know enough information on the earlier generations. Staying focused on just direct line will cause a brick wall! Many times through a sibling or even a grandchild a new clue will be picked up

**1.2 Methods of Constructing brick walls**

**Description**

Brick walls will be built for internal partition & as well as perimeter walls of the building. All brick walls will be constructed by maintaining the verticality of walls and the location of the wall as per the construction issued Architectural drawings / approved shop drawings for brick walls in each floor.

While constructing the brick walls, opening for the doors, windows & services will be provided according to the dimensions of doors, windows & the dimensions for openings

shown in the service drawings by allowing cement / sand plaster thickness of 15mm in each side of the opening.

***Method of Brick Masonry***

Method of brick will be described as follows,

1. Construction of brick wall.
2. Construction of stiffener columns, beams & lintels.
3. Providing reinforcement anchors to the stiffener columns from the structural beams, walls & columns.

***Construction of brick wall***

- Marking for brick walls & openings will be done on structural floor slab according to approved shop drawings.
- The floor slab where brick walls to be built will be cleaned.
- Reinforcement for stiffener columns will be anchored using chemical at the place where Reinforcement starters would not be provided.
- Brick walls with 225mm thick will be built to around 1.5m height in first stage and balance will be completed after curing the wall.
- Brick walls with 112.5mm will be built to around 1.0m height in each curing.

***Construction stiffener columns, beams & lintels***

· Stiffener columns will be cast after completing each part of brick walls (~1.5m height)

· Lintel beams & stiffener beams will be cast as per the approved drawing at the required level.

· If the Reinforcement starters would not be provided at the location of stiffener beams & columns from the structural elements, chemical anchor will be used for anchoring Reinforcement to the structural elements.

· If the Reinforcement starters would not be provided at the location of lintels from the structural elements, chemical anchor will be used for anchoring reinforcement to the structural elements.

***Providing reinforcement anchors to the stiffener columns from the structural beams, walls & columns***

· These Reinforcement anchors would be provided while concreting the structural elements and construction detailing for anchors will be carried out as per the attached sketches.

· If the anchors have not been provided as per the approved shop drawing / required dimensions chemical anchors will be used for anchoring the missing Reinforcement. (Refer attached sketch No 02 for detail of chemical anchoring)

· Anchors provided for all the stiffeners columns and the perimeter brick walls at the top

Technorati Tags: Building,construction,enginering,block,brick

of wall will be clipped with 22mm diameter PVC pipe clip & 16mm diameter PVC pipe respectively & filled with grease.

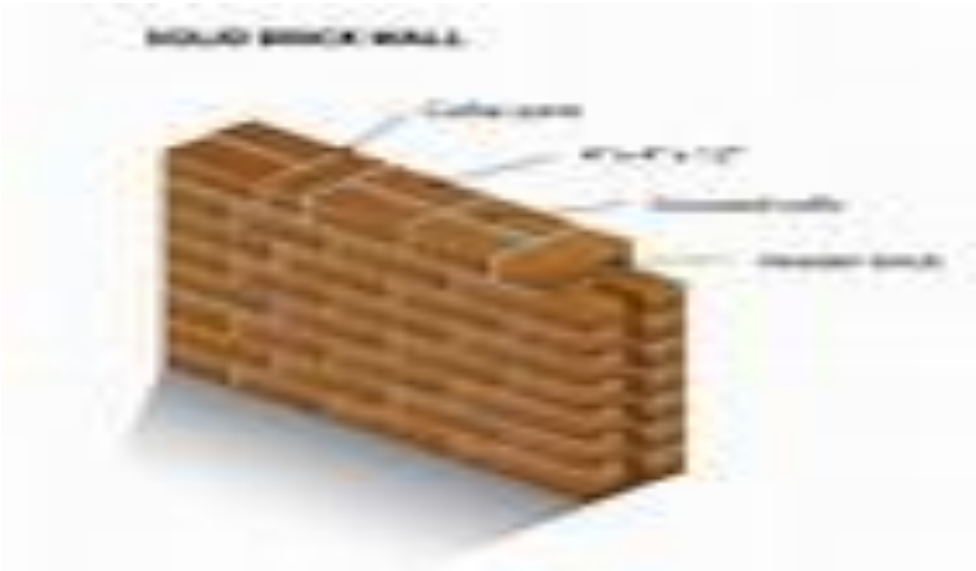
· 12mm thick polystyrene sheet layer will be place at the top of internal brick walls just at the soffit of structural elements (beam / slab)

· 12mm thick polystyrene sheet layer will be placed at the top of perimeter brick walls just at the soffit of perimeter beam. This gap at the external face and the internal face will be filled with waterproofing sealant. Literature of waterproofing material will be provided.

| Self-Check 1 | Written Test |
|---|---|

***Directions:*** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Constructing the brick walls, opening for the doors, windows & services will be provided according to the dimensions of doors, windows.
2. Brick walls will be built for internal partition & as well as perimeter walls of the building.
3. brick walls will be constructed by maintaining the horizontal of walls
4. Brick walls with 225mm thick will be built to around 3 m height in first stage
5. Stiffener columns will be cast after completing each part of brick walls (1.5m height)



***Note:*** **Satisfactory rating – 3 and above points** **Unsatisfactory - below 3 points**

**Answer Sheet**

| |
|---|
| Score = _____ |
| Rating: _____ |

Name: _____ Date: _____

**Answer Questions**

1. _____

2. _____

3. _____

4. _____

5. _____

| Information Sheet-2 | laying damp proof courses and flashings |
|---|---|

## 2.1 damp proof courses

A damp-proof course (often abbreviated to DPC) is a horizontal barrier in a wall designed to prevent moisture rising through the structure by capillary action - a phenomenon known as rising damp

**Wikipedia definition under damp proof course for properties without a damp proof or a failed damp proof course**

Where a DPC is absent or inadequate, there are various means of retrospectively fitting one. A common method in masonry walls is to drill holes into the wall at regular intervals

and inject a penetrating chemical (e.g. silicone) into the holes. The chemical is absorbed into the masonry where it dries to form a waterproof barrier. Some irregular stone walls cannot be drilled for a chemical DPC, so an osmotic electrical system is often fitted.

Alternatively the cement joints can be drilled and the chemical injected there instead, although this is a less satisfactory method. A larger volume of chemical will be needed

**2.2 Different types of damp proof course**

There are many different types of damp proof courses, which can be broadly divided into two sections:

Original damp proof courses have been built in as the property was constructed, and

new damp proof courses that have been added after the property was built. They may be into a property that originally had a damp proof course, or with many older properties (prior to the late 1800's), when damp proof courses were first required.

**We would refer you to our article on Damp proof courses, why? for more information**

Many sources say it was from the Public Health Act 1875, however, Jeff Howell from the Sunday Telegraph and the excellent website askjeff.co.uk , has researched the subject and in his brilliant book The Rising Damp Myth believes the first legislation to be from the local government board's model by-laws of 1877. We are sure in some areas of the country the practice of adding a damp proof course was long established if it was formed as part of a by-law and in other areas of the country it no doubt took some further years these methods were adopted.

**Damp proof courses built in as the property was built**

White painted rendered plinth to the base of the property, built in the 1800s

During the course of our surveys on older Victorian and Edwardian properties, where we can see a damp proof course these tend to be the edge of a slate. In many instances we can't actually see any damp proof course at all, as there is a rendered plinth at the base of the property.

**Lead damp proof course**

We have read about these being used but we have only seen them used retrospectively and this was to a timber frame property, where the sole plate, which is bottom most timber, meets the brick plinth and makes up the very base of the property. The lead flashing had been added relatively recently and we can see this as being both good and bad, depending upon the detailing. Unless the lead was well formed with a suitable slope it would allow water to sit on a ledge, which would ultimately cause problems.

**Modern plastic based damp proof courses**

A variety of different styles have been used over the years, such as plyload, which their website informs us is a bitumen free polymeric damp proof course.

It is flexible to low temperatures, resistant to ageing and shrinkage and can withstand superimposed loads.

Interestingly, it comments:

Traditional damp proof courses were made from textiles with bitumen or pitch and suffered from creep under heavy load and therefore have limited life spans.

They then go on to say that these were superseded by high performance rubber products, but these were generally high priced. Alternative cheap polythene products were used in lower specification applications, despite the low strength of the mortar/polythene bond and an example of a modern damp proof course.

Information from the supplyload.co.uk website.

Another manufacturer is Anderson and they do a variety of damp proof courses; from a standard one that is bitumen free and uses a blend of polymers and elastimers, to a high load variety, to a bitumen and polyester based damp proof course that is advertised as being very robust, to a high performance DPC, that is capable of both gas and damp proof course existence.

Funnily enough, whilst we looked for manufacturers of damp proof courses, the Internet offered us far more companies that inserted damp proof courses as a remedial service. We may have been using the wrong term, or the inserting of a damp proof course may simply be bigger business.

**New damp proof courses that have been added after the property was built**

Damp proof courses that are added at a later date

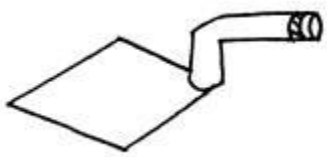
These fall into four areas:

the insertion of a damp proof course

the repairing of a damp proof course

magic tubes tubes

the electronic barrier system



**DIY inserted damp proof courses**

If you look to remmers.co.uk website, who offer drill and cartridge kits for your house for under £100!

Damp-proofing cream soaks in over an hour and reacts with the water in the masonry to form a complete DPC. BBA Certificate /4202. This is based on a silane/siloxane paraffin emulsion and all you do is:

Drill a whole into the wall, along the line of the mortar joint.

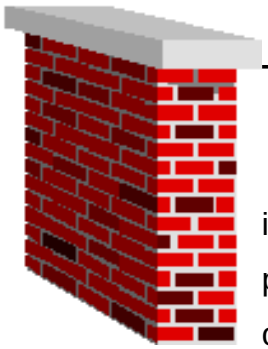
Slot the cartridge into a silicone gun and attach the nozzle, which you will need to buy from them.

Squirt the cream into the hole.

Job done; no more damp.

It says it is suitable for stone, brick masonry rubble on most walls, a full proof DPC every time!

There are many companies offering the insertion of a damp proof course; from large companies, such as Kenwood Plc kenwoodplc.co.uk , RentaKill rentakill.co.uk , Protim protim.ie and Pass & Co. Timber Preservation: londonline.co.uk and many other local companies; search on the Internet or in your Yellow Pages to see that there is plenty of choice.



**The physically inserted damp proof course**

Although we have never seen it, we have heard it talked about. This is where, literally, a section of the wall is removed and a slate damp proof course is inserted, although we can't see why it can't be any other sort, and the building is gradually worked around (we assume) until the damp proof course is in place.

**2.3 Definition of flashings**

**Definition of Flashing in Construction**

Material used to waterproof any change in surfaces of a waterproof system. The heads of windows and doors, the edge component of roof systems, the changes in direction and or plane of masonry, wood siding, etc.

The proper installation of flashing is critical to the waterproofing integrity of a structure. In correct flashings, or flashings that have deteriorated can cause severe water damage to a structure. Synthetic materials have taken the place of copper, lead, aluminum flashings in many cases. Rubberized sheets of material are being used to avoid the negative issues of water infiltration. The most important aspect of flashings is the knowledge and experience of the installer. Properly installed flashings, with the proper exposure and placement, will stop water from infiltrating the structure, improperly installed flashings, can cause water to be channeled into the structure, causing more damage than if they were totally eliminated from the project.

**2.4 types of flashings**

Flashing types are named according to location or shape:

**Roof flashing:-** placed around discontinuities or objects which protrude from the roof of a building to deflect water away from seams or joints and in valleys where the runoff is concentrated.

**Wall flashing:-** may be embedded in a wall to direct water that has penetrated the wall back outside, or it may be applied in a manner intended to prevent the entry of water

into the wall. Wall flashing is typically found at interruptions in the wall, such as windows and points of structural support.

**Sill flashing (or sill pan):-** A concealed flashing placed under windows or door thresholds to prevent water from entering a wall at those points.

**Roof penetration flashing:-** Used to waterproof pipes, supports, cables, and all roof protrusions. Stainless steel penetration flashings have proven to be the longest lasting and most reliable roof flashing type.

**Channel flashing:-** Shaped like a “U” or channel to catch water (e.g., where the edge of a tile roof meets a wall).

**Through wall flashing:-** Spans the thickness of the wall and directs water to weep holes.

**Cap flashing (drip cap):-** Often used above windows and doors.

**Drip edge:-** A metal used at the edges of a roof.

**Step flashing (soaker, base flashing):-** Pieces of flashing material which overlap each other in "steps".

**Counter flashing (cap flashing):-** Covers a base flashing.

**Pipe flashing (pipe boot, vent boot, pipe flange):-** A product used where pipes penetrate roofs.

**Chimney flashing:-** A general term for flashing a chimney.

**Kickout flashing:-** At the very bottom of a roof/wall intersection, the lowermost step flashing specially formed to deflect water away from the wall.

**Valley flashing:-** In the valley of two intersecting roof planes.

**2.5 Purpose of flashing**

The Purpose of Flashings. The purpose of flashing is to **ensure good drainage away from the window and to provide protection from the elements**. Flashings can be used with all types of the centre-pivot windows.

| Self-Check 2 | Written Test |
|---|---|

***Directions:*** Answer all the questions listed below. Use the Answer sheet provided in the next page:

Write the answer for the following page (2 point each)

1. The proper installation of flashing is horizontal to the waterproofing
2. Openings are to be provided in wall for access and ventilation
3. Walls are provide security and protection against natural elements such as wind, rain and sunshine
4. Window is to provide natural light and ventilation to the exterior of a building

***Note:*** **Satisfactory rating – 4 and above points** **Unsatisfactory - below 4 points**

**Answer Sheet**

| Score = _____ |
| --- |
| Rating: _____ |

Name: _____ Date: _____

**Short Answer Questions**

1. _____
2. _____
3. _____
4. _____

| Information Sheet-3 | Building ventilation for solid brick construction |
|---|---|

### 3.1 Building ventilation

Ventilation moves outdoor air into a building or a room, and distributes the air within the building or room. The general purpose of ventilation in buildings is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it

### 3.2 purpose of constructing solid brick ventilation

A proper ventilation system is essential for any building. Without a flow of internal and external air, a whole host of issues ranging from bathroom damp to carbon monoxide poisoning may set in. So whether you're looking to rid yourself of steam from the shower or fumes from the kitchen, at MKM we've got a whole host of ventilation products designed to keep a clean flow of air throughout your home.

Whenever addressing the issue of ventilation, it's probably best to start in the areas where you're going to need it most – that means kitchens and bathrooms should be placed high in your list of priorities.

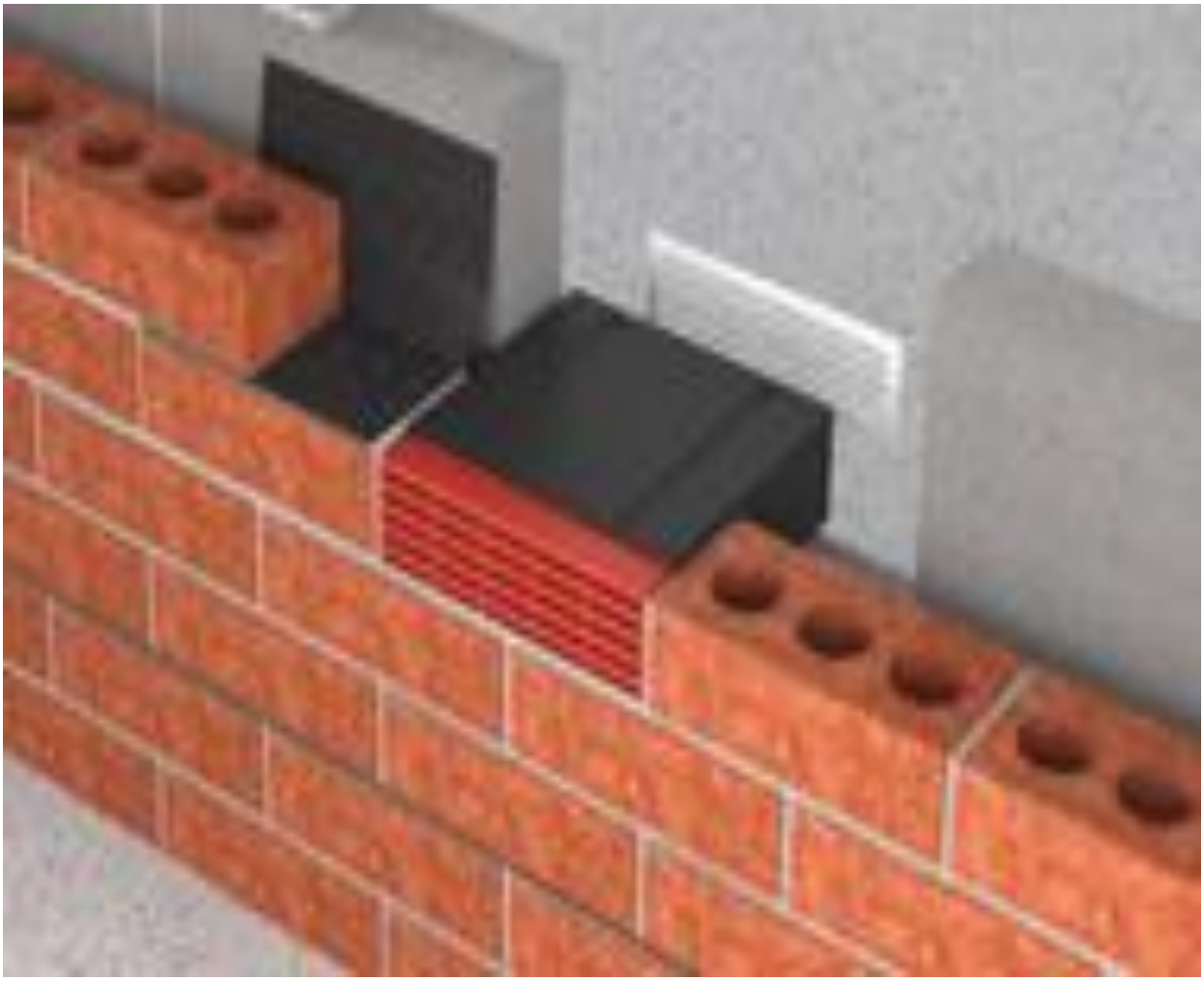
An inline_duct_kit or pull switch axial wall option should go some way to solving any potential problems. Comprising a fan, vent and pipe, you'll be able to relax safe in the knowledge that any harmful fumes will be swiftly exiting the property.

Aside from bathrooms and kitchens, it's also crucial that spaces such as living rooms, dining rooms and hallways are ventilated properly. Offering a quick solution to this issue, Timloc's_fly screens encourage excellent airflow through an easy-to-fit vent. Finished in white and totally resistant to decay, you'll be able to breathe easy for years with this cost-effective solution.

When building any property, it's critical that ventilation isn't overlooked. Thankfully at

MKM Building Supplies, our extensive range of air bricks, designed especially to allow air to flow freely throughout the property, provide a great solution when building a home from the ground up. Available in a range of colours and sizes, we're dedicated to making your home as ventilated and as safe as possible.

Ensuring we have all the tools you need to ventilate your home is of paramount importance to us. That's why we've gone above and beyond in terms of our current range of ventilation equipment and accessories. But if ever you're unsure about what product to use or what vent does what – we'd be only too happy to help you find the perfect piece of kit for you and your home.



| Self-Check 3 | Written Test |
|---|---|

***Directions:*** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. The general purpose of ventilation in buildings is to provide pollutant air for breathing (3 points)
2. A proper ventilation system is not necessary for any building (3 points)
3. An inline_duct_kit or pull switch axial wall option should go some way to solving any potential problems

***Note:*** **Satisfactory rating – 5 and above points** **Unsatisfactory - below 5 points**

**Answer Sheet**

| Score = _____ |
| --- |
| Rating: _____ |

Name: _____ Date: _____

1_____

2._____

3_____

| Information Sheet-4 | Constructing walls to be straight and true in plumb, line and level |
|---|---|

### 4.1 wall

1. an upright structure of wood, stone, brick, etc., serving to enclose, divide, support, or protect; specif.,
   a. such a structure forming a side or inner partition of a building
   b. Such a continuous structure serving to enclose an area, to separate fields, etc.
   c. such a structure used as a military defense; fortification
   d. such a structure used to hold back water; levee; dike
2. something resembling a wall in appearance or function, as the side or inside surface of a container or body cavity
3. something suggestive of a wall in that it holds back, divides, hides, etc.: a *wall* of secrecy

Middle English wall from Old English wall (akin to German wall) from Classical Latin vallum, rampart from vallus, a stake, palisade from Indo-European base an unverified form well-, to turn from source walk

1. of or along a wall
2. placed or growing on, in, or against a wall

1. to furnish, line, enclose, divide, protect, etc. with or as with a wall or walls: to *wall* a room with books, to *wall* off the old wing, a mind *walled* in by fears
2. to close up (an opening) with a wall: usually with *up*

### 4.2 how check wall straightness

When building a wall you must first ensure that it is straight and level. Without these two factors the wall and the structure around or within it will never be structurally sound. Whether you are constructing a new wall or you are checking the straightness of an existing wall, you will require a few basic tools and a good understanding of some basic principles to get the job done.

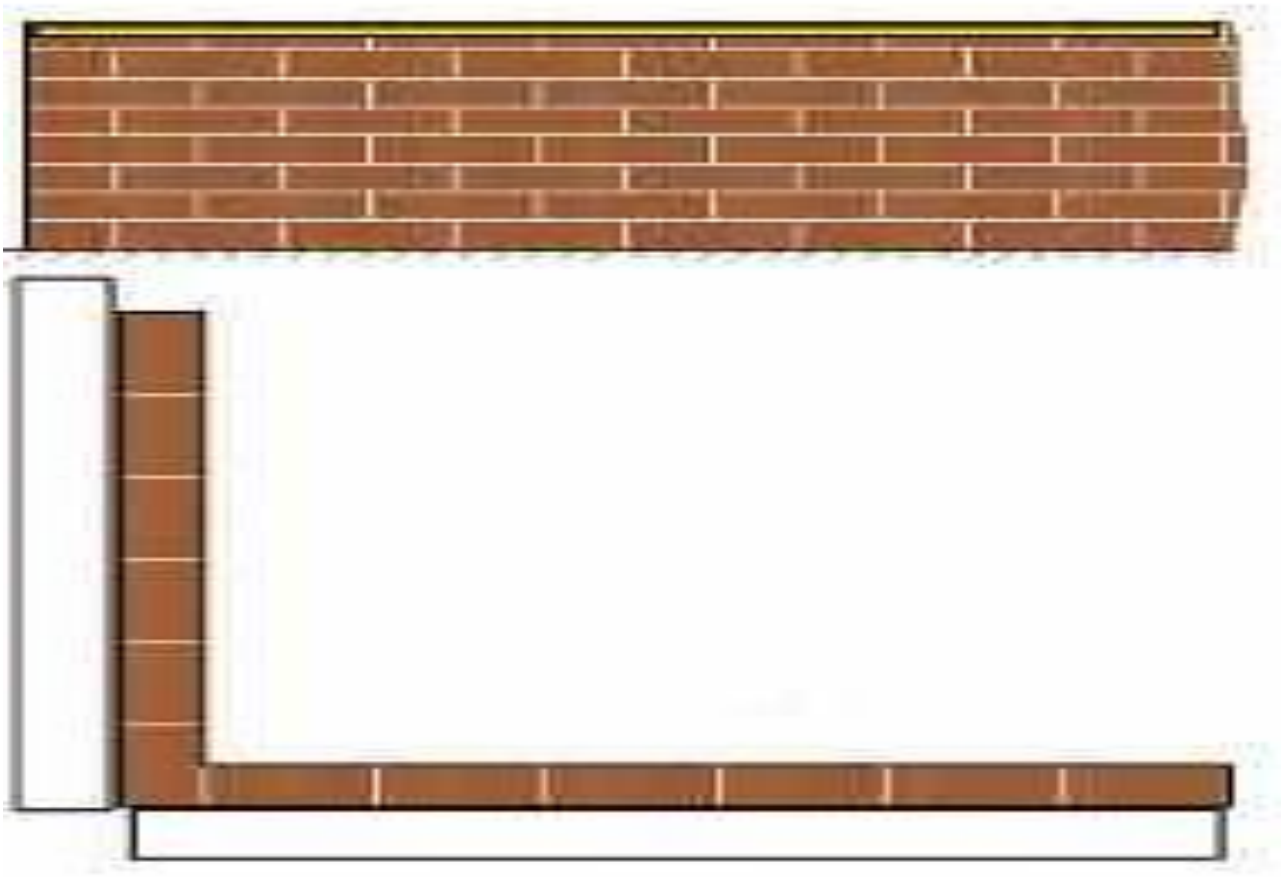
**step 1** Hammer a small nail into the ceiling just next to your wall. Hang your plumb bob from the small nail so that it almost reaches the floor. You will use this plumb bob to check that your wall is straight from top to bottom.

**Step 2** Measure the gap between the plumb bob line and the wall at the top of the wall. Do the same at the bottom of the wall. If the two measurements are equal, the wall is straight up and down, if not then it is not. Remove the plumb bob and install it at the other end of the wall. Perform the same process to check the straightness of that end of the wall.

**Step 3** Locate a wall within your house that runs parallel to the wall in question. Place the end of your tape measure at the base of the parallel wall. Stretch the tape measure out to a distance about 3 inches short of the wall in question and mark the floor. Perform this process at both ends of the wall in question. Perform the same process along the ceiling and mark the two locations.

**Step 4** Snap a chalk line between the two marks you have made on the ceiling. Snap a chalk line between the two marks you have made on the floor. Check the straightness of your wall compared with the chalk lines. To be certain that the wall is straight use your tape measure to gauge the distance between the wall and the chalk line at several points throughout its length. If you are building a wall use these chalk lines as your guide.

**Step 5** Use along straight edge like an extended length level to make sure the interior portion of your wall is straight. Place the straight edge on the wall and hold it horizontally. If there are gaps anywhere between the wall and the straight edge your wall is not straight. The cause may be warped or faulty studs or framework beneath the surface of the wall.



| Self-Check 4 | Written Test |
|---|---|

***Directions:*** Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. building a wall you must first ensure that it is straight and level
2. a plumb bob is a hand tool used to check that the wall is straight or not
3. straight edge is a hand tool used to support an extended length level to make sure the interior portion of your wall is straight

**Note*:* Satisfactory rating – 3 and above points** **Unsatisfactory - below 5 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

1._____

2._____

3._____

| Information Sheet -5 | Positioning wall ties |
|---|---|

## 5.1 wall ties

Wall ties, sometimes called ‘brick ties’, are used in buildings with cavity walls. They are used to join the two leaves of a cavity wall together, allowing the two parts to act as a homogeneous unit. Hidden from view after construction, wall ties play a vital role in ensuring the stability of a building.

Fig 1

5.2 **Positioning_of_walls Ties.** in which both leaves are 90mm or thicker, **ties** should be used at not less than 2.5 per square metre (900mm horizontal x 450mm vertical centres). ... **Ties** should be evenly distributed over the **wall** area, except around openings, and should preferably be staggered.

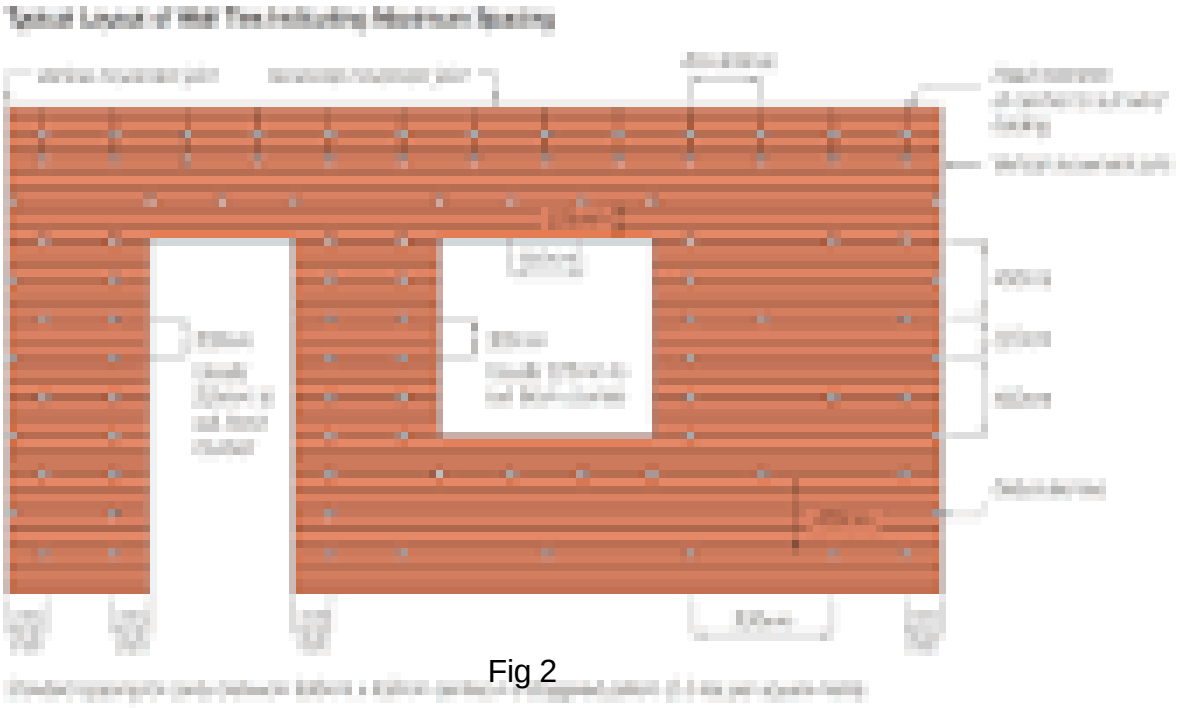


Fig 2

**5.3 purpose of wall ties**

Wall ties are normally nor visible but this does not mean that they are not important. Wall ties in Brighton are used to tie together the external wall and the internal wall, spanning across the cavity between the two. These ties are commonly made from metal, braided wire or plastic. The purpose of wall ties is to effectively enable the loads that are carried by the inner wall to be shared with the outer wall; ties are embedded into the mortar as the house is being built. Walls will certainly outlive the wall ties and sooner or later they will fail and need replacing.

There are several designs of wall ties; they are selected based on the connection required as well as whether they are being used at the time of construction or for retrofit.

Wall ties are little more than flat bands that are embedded in the mortar of one wall, spanning the gap between walls and being embedded in the mortar of the other wall. Wall ties are deformed at the ends to improve their ability to grip, the portion of the tie that spans between the walls is bent into an inverted V shape to help repel water.

Over time wall ties in Brighton will fail, this is particularly true for homes that are located close to the sea or close to an industrial area with higher than normal air pollution. When the ties fail it is very important that they be replaced to ensure structural continuity of the building

| Self-Check 5 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in ***Instructions:***the sheet provided in the next page.

1. The purpose of wall ties is to effectively enable the loads that are carried by the inner wall to be shared with the outer
2. Wall ties are commonly made from metal, braided wire or plastic
3. several designs of wall ties selected based on the disconnection required
4. Wall ties, sometimes called ‘brick ties

**Note*:* Satisfactory rating – 4 and above points** **Unsatisfactory - below 4 points**

**Answer Sheet**

| Score = _____ |
| --- |
| Rating: _____ |

Name: _____ Date: _____

1. _____
2. _____
3. _____
4. _____

| Information Sheet -6 | Constructing openings and installing flashing |
|---|---|

### 6.1 openings

Openings are normally provided in the walls as door, windows and ventilators.doors pr ovide access; windows and ventilators provide light and ventilation.building with many windows provide

### 6.2 types of openings

Openings in Walls and its Parts

Different part of the openings in walls such as opening head and jambs of openings and their limitations to preserve stability and strength of the wall will be discussed and explained in the following sections.

- Rebated jambs
- Head of openings in solid walls

**Jambs of Openings**

In solid walls, windows and doors opening jambs can be either rebated or plain.

The latter is employed for small section windows and door frame that is made from steel. It can be used for large sections where entire external face of frames is to be exposed externally.

It is advised to paint window and door frames that are created from soft wood. This is to protect the wood from rain influences, and the wood would swell and decay when it is wet.

**Head of Openings in Solid Walls**

Lintels or arches should be used to support solid brickwork over the head of openings. As shown in Figure-3, the solid brickwork over either lintels or arches is an isosceles triangle with $60^{o}$ degree that is created by the bonding of bricks.

If the solid brickwork inside the triangle in a bonded wall is taken out the arching effect will take place which means the load of the wall above the triangle would be transferred to the bricks of each side of the opening.

## 6.3 flashing

**Definition of Flashing in Construction**

Material used to waterproof any change in surfaces of a waterproof system. The heads of windows and doors, the edge component of roof systems, the changes in direction and or plane of masonry, wood siding, etc.

The proper installation of flashing is critical to the waterproofing integrity of a structure. In correct flashings, or flashings that have deteriorated can cause severe water damage to a structure. Synthetic materials have taken the place of copper, lead, aluminum flashings in many cases. Rubberized sheets of material are being used to avoid the negative issues of water infiltration. The most important aspect of flashings is the knowledge and experience of the installer. Properly installed flashings, with the proper exposure and placement, will stop water from infiltrating the structure, improperly installed flashings, can cause water to be channeled into the structure, causing more damage than if they were totally eliminated from the project.

## 6.4 types of flashing

Flashing types are named according to location or shape:

- Roof flashing.
- Wall flashing.
- Sill flashing (or sill pan).
- Roof penetration flashing.

- Channel flashing.

. **Roof flashing** represents a very simple and intuitive engineering technique that has been known for hundreds of years. The whole idea depends almost entirely on gravity. If the flashing has been installed correctly, gravity will work with the flashing material to shed the water onto the regular roofing materials, where it is then directed harmlessly to the ground. Roof flashing is commonly used around chimneys, fan vents, plumbing vent stacks, and other items that project out of residential roofs

**Wallflashing** is above grade waterproofing. It protects specific areas within exterior wal l assemblies and creates an impervious barrier for water to follow to the face of the exte rior finish. It protects areas within the exterior wall assembly starting from: The face of t he backing wall to the face of the exterior finish.The innermost face of the structural wyt he to the exterior face of the wythe.The innermost part of a windowsill or door threshold frame in a wall assembly to the exterior face of the sill or threshold.Flashing from the inn ermost face of a single wythe wall or windowsills, or threshold frames in a wall assembly is a variation of TWF called pan flashing. TWF requires dedicated openings in the ext erior finish for water passage. In exterior wall assemblies these openings are called we eps. Without functioning weeps, a TWF would be as ineffective as a gutter without a do wnspout. TWF also requires end dams to close discontinuous sections. Without end d amsa discontinuous TWF would be as ineffective as a gutter without an end cap. Furth ermore cants are used to transition flashing membranes from vertical to horizontal plane s and maintain a continuity of slope to drain. Transitioning membrane flashing with a ca nt helps redue the occurrence of bladder bubbles and fish mouth, which are a common cause of leaking walls.

**Protector Sill** Pan Flashing is a cold applied self-adhering membrane composed of a tough cross laminated high density polyethylene surface coated on one side with a layer of our proprietary asphalt / recycled butyl hybrid adhesive.

Types of penetrations ideally, a building's roof will be completely sealed, in order to protect residents, interior finishes, and furnishings against moisture, wind and dust. This seal constitutes part of your home's building envelope. Far from being a featureless, unblemished

surface though, most roofs are punctured with holes - or penetrations, as they're called. Chimneys, pipes, skylights, exhaust fans, vents and air conditioning units all fall into the category of roof penetrations.

**Channel flashing** A type of flashing used at roof-to-wall junctures and other roof-to-vertical plane intersections where an integral gutter is needed to handle runoff.

| Self-Check 6 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in ***Instructions:***the sheet provided in the next page.

1. What are the two main types of opening?
2. Explain the purpose of opening
3. Write the purpose of flashing
4. List down types of flashing

**Note*:* Satisfactory rating – 4 and above points** **Unsatisfactory - below 4 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

1. _____
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| Information Sheet -7 | Installing lintels |
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## 7.1 lintels

A lintel is a horizontal member which is placed across the opening. Lintels are easy to build and the supporting walls need notBe very strong. However, a proper bearing for lintel ends is very necessary. At least 10cm length of bearing is a minimum Requirement. If the span of the lintel exceeds 1.2m, the end bearing should have a minim um of 15cm. For very long spans, thebearing for the lintel end should equal at least to its depth.

Lintel is a term used for any single solid length of stone, timber, steel, or concrete and which is constructed above the opening to support the above brickwork

Lintels are capable of transferring load to the jambs if the lintel ends are built into the bricks properly. Moreover, the wall area on which the end of a lintel bears is called its bearing at ends.

As the width of opening is increase the load which is required to be transferred by lintels is increased and consequently its bearing at ends are needed to be must be larger. Furthermore, the depth of lintel is usually around 75 mm and its depth is commonly not smaller than 150 mm.

## 7.2Types of Lintels and Arches for Openings in Walls

### Timber Lintels

This type of lintel was employed to support loads over the opening of solid brickwork and were common up to the beginning of twentieth century. The application of timber lintels was decreased because it has no proper resistance against fire.

- **Concrete Lintels for Openings in Walls**

These are economical and practical lintel types and can be casted in different shapes and forms. Concrete are considerably strong in withstanding crushing and will not deteriorate unless it exposed to weather.

The most outstanding disadvantage of concrete lintel is its low tensile strength for which steel bars are introduced to compensate concrete disadvantage.

The diameter of reinforcing steel for lintels of 1.8 m span is 10mm or 12mm diameters and the end of the bars should be either bent up at ninety degree or hooked

Concrete lintel can be either precast or in-situ but the former is more advantages because the latter needs molds and after the concrete is placed and after it hardens then loading the lintel is possible, and this is not the case in precast lintels.

- **Prestressed Concrete Lintels for Openings in Walls**

This type of lintel is employed mostly for internal openings. There are two types of prestressed lintel includes composite lintels and non-composite lintels.

The composite lintels are relatively thin precast lintels that are constructed over openings. If width of opening is higher than 1200 mm, the prestressed lintels have to be supported until the brickwork over is set in order to prevent excessive deflections.

The non-composite prestressed lintels are used when there is large loads and not adequate brickwork over to act compositely with the lintel.

- **Boot Lintels for Openings in Walls**

These lintels are used to decrease the lintel depth which is exposed externally

- **Prestressed Steel Lintels**

It is possible to use this type of lintel instead of concrete lintel to support both non-load bearing and load bearing walls. Generally, hollow box form is used for lintel over door opening in internal load bearing walls.

Prestressed steel lintels with different length and section are constructed to be used for standard openings, thickness of walls, height of brickwork course, and sufficient bearing at ends.

The crushing resistance of hollow prestressed steel lintels must be improved by filling it with concrete when the width of the opening is large. Thin corrugated prestressed steel lintels are produced to suit thin, non-load bearing brickworks over narrow door openings in partition walls.

- **Brick Lintels**

Brick lintels can be constructed as bricks on end, bricks on edge, and coursed bricks laid horizontally

| Self-Check 7 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. Write the meaning of lintel
2. What is the purpose of lintel?
3. Mention types of lintel?

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

**Short Answer Questions**

1. _____
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2. _____
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| Information Sheet -8 | Forming control joints |
|---|---|

### 8.1 control joints

What is the difference between a control joint and an expansion joint? What is their purpose, and how are they formed?

Control joints are typically used in concrete masonry to reduce the occurrence of shrinkage-related cracking. A control joint is a continuous vertical joint filled with mortar, but with a bond breaker on one side so that tensile stress cannot develop across the joint. If control joints are not provided, a concrete masonry wall may crack as it shrinks over time. Where control joints are provided in such a wall, they widen as the concrete masonry shrinks, preventing it from cracking. Control joints should be provided at regular intervals along the wall's length and near corners, returns and changes in the wall's height, support or stiffness. Control joints will not relieve masonry expansion. Although concrete masonry expands during warm weather, it generally expands less than it shrinks. Control joints are often constructed to transfer lateral loads across the joint.

### 8.2 types of control joints

In concrete slabs and floors there are four types of control joints:

**Types of joints in concrete constructions are:**

1. Construction Joints
2. Expansion Joints
3. Contraction Joints
4. Isolation Joints

### 1. Construction Joints

Construction joints are placed in a concrete slab to define the extent of the individual placements, generally in conformity with a predetermined joint layout.

Construction joints must be designed in order to allow displacements between both sides of the slab but, at the same time, they have to transfer flexural stresses produced in the slab by external loads.

Construction joints must allow horizontal displacement right-angled to the joint surface that is normally caused by thermal and shrinkage movement. At the same time they must not allow vertical or rotational displacements.

**2. Expansion joints**

The concrete is subjected to volume change due to many reasons. So we have to cater for this by way of joint to relieve the stress. Expansion is a function of length. The building longer than 45m are generally provided with one or more expansion joint. In india recommended c/c spacing is 30m. The joints are formed by providing a gap between the building parts.

**3. Contraction Joints**

A contraction joint is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane. It regulates the location of the cracking caused by dimensional changes in the slab

**4. Isolation Joints**

***Joints that isolate the slab from a wall, column or drainpipe***

Isolation joints have one very simple purpose they completely isolate the slab from something else. That something else can be a wall or a column or a drain pipe. Here are a few things to consider with isolation joints:

Walls and columns, which are on their own footings that are deeper than the slab sub grade, are not going to move the same way a slab does as it shrinks or expands from drying or temperature changes or as the sub grade compresses a little.

| Self-Check 8 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. The building longer than 45m are generally provided with one or more _____
   A/ expansion joint B/ Isolation Joints C/ Contraction Joints
2. _____is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane.

   A/ contraction joint B/ expansion joint C/ Isolation Joints D/ all
3. _____joints must be designed in order to allow displacements between both sides of the slab
   A/ contraction B/ expansion C/ Isolation D/ construction
4. A control joint is a continuous vertical joint filled with_____,
   A/ aggregate B **/** mortar C/ sand D/ none

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

| Score = _____ |
| --- |
| Rating: _____ |

Name: _____ Date: _____

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|---|---|
| **Information Sheet -9** | Locating and building in weep holes, brick reinforcing, vermin proofing and wall flashings |

## 9.1 weeps holes

A weep hole is exactly as the name implies. This is a hole in masonry, retaining walls, or any vertical surface that will retain water behind it. The purpose of the weep hole is to drain the backside of any vertical surface to ensure that water does not accumulate on the back side. Weep holes are especially important in the performance of any masonry wall or veneer. It is essential that the water be allowed to weep out of the back of any structure to reduce the amount of lateral hydrostatic pressure on the back of the masonry surface. Weep holes must be kept open and there are various materials that have been developed to ensure that these holes are maintained open. Such items as fiberglass mesh and screening is used to keep debris from accumulating and blocking the weep holes.

## 9.2 Types of Weep Holes

The type of weep holes depends on the nature of use of the holes:

1. Open Head Joint Weep Holes.
2. Cotton Rope Wicking Weep Holes.
3. Tubes Weep Holes.

The type of weep holes depends on the nature of use of the holes:

### 1. Open Head Joint Weep Holes

This type of weep holes are formed by eliminating mortar from the vertical joint between bricks. These walls are of same size as the typical joint spacing.

The typical space between Open hands joint is done at 21 inches interval. This is also done by using plastic weeps baffled structure to prevent rain from penetrating the holes

and preventing insert from entering the cavity. A drip is included at the front lip to aid drainage.

**2. Cotton Rope Wicking Weep Holes**

These type of weep holes are formed by using a rope of up to 12 inches in length. This is placed in the joints and the other end is extended up to the cavity wall.

The water from the back of the wall is adsorbed by the cotton and the on the other side it is evaporated. This process is slow when compared to ordinary weep holes.

**3. Tubes Weep Holes**

Tubes weep holes are formed by using hollow plastic or metal tubes. They are spaced around 16 inches apart. This tubes are placed at a slight angle to allow water egress. It must be made sure that the angle is not too steep or too flat.

**9.3 Disadvantages of Weep Holes**

**Blockage of Weep Holes due to Trash Mortar**

When holes are installed in the brick masonry. The mortar squeezes out between the successive courses of bricks and drop down in the weep holes. This can result in partially or totally blockage of weep holes by trash mortar.

**Pest Entry through Weep Holes**

Weep holes can provide access to the pest such as rodents and insects. Entry point to the internal of the building can be through downlights ventilator fans and holes of plumbing and electric purposes. To overcome this problem, Baffled vent can be installed.

**Obstruction in Airflow**

To overcome the above problems of pest entry and trash mortar and to even make the weep holes more pleasing, weep hole may not provide the necessary flow of air to properly ventilate the internal brick wall

## 9.4 definitions Of brick reinforcing

Reinforced Brick Masonry

Brick work strengthened by introduction of mild steel flats, hoop iron, expanded mesh or bars is termed as reinforced brick masonry**.** This reinforced brick masonry is capable of resisting both compressive as well as tensile and shear stress. On account of its ability to resist lateral forces, reinforced brick masonry is extensively used in seismic areas. It is essential to use first class bricks (having crushing strength of 140 kg/sq. cm or more) and rich and dense cement mortar in the reinforced brick work. The reinforcement should be effectively bedded and surrounded with mortar cover of 15 to 25 cm. This is necessary to protect the reinforcement against corrosion.

### Types of Brick Masonry Work

### 1. Brick Work in Mud

- The mud is used to fill up various joints brick masonry work.
- Thickness of the mortar joint is 12 mm.
- it is the cheapest type of brick masonry
- employed for construction of walls with maximum height of 4 m.

*Fig. 1: Brick work in mud*

## 2. Brick Work in Cement

This type of brick masonry is construction by laying bricks in cement mortar rather than mud which is used in brick work in mud. There are three major classes of brick work in cement which are summarized in Table 1.

**Table 1 Different classes of brick work in cement and their descriptions**

| Classes | Descriptions |
|---|---|
| First Class | Cement of lime mortar is used,<br>The surface and edges of bricks are sharp,<br>And the thickness of mortar joints doesn't exceed 10mm |
| Second Class | Ground molded bricks are used,<br>Bricks are rough and shape is slightly irregular,<br>The thickness of mortar joint is 12 mm. |
| Third Class | Bricks are not hard ,rough surface with distorted shape,<br>Used for temporary structures,<br>Used in places where rainfall is not heavy. |

*Fig. 2: Brick work in cement*

### 9.5 vermin proofing

Protecting a building against the entry of rats and mice and other vermin. Particularly at the eaves. Usually by expanded metal mesh. This is mandatory under the BCA in Australia

### 9.6 Wall flashing

Wallflashing is above grade waterproofing. It protects specific areas within exterior wall assemblies and creates an impervious barrier for water to follow to the face of the exteri or finish. It protects areas within the exterior wall assembly starting from: The face of th e backing wall to the face of the exterior finish, and/or; The innermost face of the structu ral wythe to the exterior face of the Wythe, and/or; The innermost part of a windowsill or door threshold frame in a wall assembly to the exterior face of the sill or threshold.

Flashing from the innermost face of a single Wythe wall or windowsills, or threshold fra mes in a wall assembly is a variation of TWF called pan flashing. TWF requires dedicat ed openings in the exterior finish for water passage. In exterior wall assemblies these o penings are called weeps. Without functioning weeps, a TWF would be as ineffective a s a gutter without a downspout. TWF also requires end dams to close discontinuous se ctions. Without end dams a discontinuous TWF would be as ineffective as a gutter with out an end cap. Furthermore cants are used to transition flashing membranes from verti

cal to horizontal planes and maintain a continuity of slope to drain. Transitioning membr ane flashing with a cant helps reduce the occurrence of bladder bubbles and fish mouth, which are a common cause of leaking walls

| Self-Check 9 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. The thickness of mortar joints for First Class brick doesn't exceed _____

   a/ 20mm b/ 15mm c/ 10mm d/ 5mm

2. The purpose of vermin proofing is protecting a building against the entry of

   A/ mice B/ rats C/ water D/ all except c

3. _____ Bricks are rough and shape is slightly irregular

   A/ First Class B/ second Class C/ third Class D/ all

4. _____Used in places where rainfall is not heavy

   A/ second Class B **/** First Class C/ third Class D/ none

5. Second Class brick the thickness of mortar joint is _____

   A/ 12 mm B/ 20 mm C/ 10 mm D/ 15 mm

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

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**5.** _____

| Information Sheet -10 | Constructing gables and parapets |
|---|---|

### 10.1 gables

A gable is the triangular wall formed by a sloping roof. The roof is *not* the gable — the wall is the gable down to the roof line, but you generally need a gable roof to have a gable. It's common to name the triangular area made from a gambrel roof a gable, as well. Some definitions even include the end edges of the roof as part of the gable. When discussing gables with your architect or contractor, don't be shy about asking what their definition is. For example, some people call the *gable wall* as the wall on the gable side right down to the foundation. Others rightly call the gable wall as that part of the siding between the slopes of the roof.

In general, the distinguishing feature of the gable is its triangular shape. Fig 1

### 10.2 Types of Gables

A building with a gable roof may be front-gabled, side-gabled, or cross-gabled.

- Side-Gabled Cape Cod Home Besides the shed roof, the gable roof is one of the most simple types of roofing systems. It's found throughout the world and used for all

types of shelters. When you look at a home from the street and you see roofing in one plane above the facade, the gables must be on the sides — it is a side-gabled home. Traditional Cape Cod homes are side-gabled, often with gabled dormers. Modernist architects of the 20th century took the concept of the gable roof and upturned it, creating the complete opposite butterfly roof. Although gable roofs have gables, butterfly roofs do not have butterflies — unless they're nervous...

fig 2

Cross Gables

Fig 3

Simple cross-gable american country home. Photo by hans palmboom / moment mobile / getty images (cropped)

If the gable roof was simple, the cross-gabled roof gave more complexity to a structure's architecture. An initial use of cross gables is found in ecclesiastical architecture. Early Christian churches, like the Medieval Chartres Cathedral in France, could replicate the floor plan of a Christian cross by creating cross-gabled roofs. Fast forward to the 19th and 20th centuries, and rural America becomes filled with unadorned cross-gabled farmhouses. Home additions would shelter a growing, extended family or provide a singular space for updated amenities like indoor plumbing and more modern kitchens.

Front Gable with Cornice Return

Fig 4

Blue House, Front Gable, Cornice Returns. Photo by J.Castro / Moment Mobile / Getty Images (cropped)

By the mid-1800s, wealthy Americans were building their houses in the style of the day Greek Revival homes with large columns and pediment gables. The less affluent

working families would mimic the Classical style by simple adornment in the gable area. Many American vernacular homes have what are called cornice returns **or** eave returns, that horizontal decoration that begins to transform a simple gable into a more regal pediment.

The simple open gable was evolving into a more box-like gable.

### 10.3 parapets

### Definition of Parapet in Construction

The parapet of a structure, is the upper portion of a structure that normally extends above the roof line.

Many flat roof systems require a parapet to properly waterproof the edge of the structure. This structure ( parapet ) allows a vertical face to be flashed against ,when installing the roof flashings. Parapets, are in many instances designed to hide the roof equipment such as roof top mechanical units or exhaust fans that may be above the roof elevation. Parapets are also architectural features on structures and enhance the appearance of the exterior facade, by making the structure appear larger and higher than it actually is. In many cases, the parapet is decorated with architectural details to add to the design of the exterior facade. The parapet can have scuppers installed to allow the roof to drain off the sides of the structure. In some cases the use of gargoyles are installed to hide the scupper or even used as the scupper to direct the water to the exterior. Drain pipes or leaders are normally installed beneath the scuppers or gargoyles to provide a controlled vertical path for the roof drainage. Parapets are commonly major points of deterioration and therefore, restoration. The top of the parapet is called the coping stone or cap. If these stones or caps start to leak and water infiltrates the interior of the parapet, deterioration is rapid.

### 10.4 Parapet types

Parapet roofs Parapets surrounding roofs are common in London. This dates from the Building which banned projecting wooden eaves in the cities of Westminster and

London as a fire risk] Instead an 18-inch brick parapet was required, with the roof set behind. This was continued in many Georgian houses, as it gave the appearance of a flat roof which accorded with the desire for classical proportions.

Fire wall parapets Many firewalls are required to have a parapet, a portion of the wall extending above the roof. The parapet is required to be as fire resistant as the lower wall, and extend a distance prescribed by building code.

Bridge parapets on bridges and other highway structures (such as retaining walls) prevent users from falling off where there is a drop. They may also be meant to restrict views, to prevent rubbish passing below, and to act as noise barriers.

Bridge parapets may be made from any material, but structural steel, aluminum, timber and reinforced concrete are common. They may be of solid or framed construction.

In European standards, parapets are defined as a sub-category of "vehicle restraint systems" or "pedestrian restraint systems

Parapets in fortification In terms of fortification, a parapet (or breastwork) is a wall of stone, wood or earth on the outer edge of a defensive wall or trench, which shelters the defenders. In medieval castles, they were often crenellated. In later artillery forts, parapets tend to be higher and thicker. They could be provided with embrasures for the fort's guns to fire through, and a banquette or fire-step so that defending infantry could shoot over the top. The top of the parapet often slopes towards the enemy to enable the defenders to shoot downwards; this incline is called the superior talus.

| Self-Check 10 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. Bridge parapets on bridges and other highway structures prevent users from falling off where there is a drop
2. Bridge parapets may be made from exceptional material, such as structural steel, aluminum, timber and reinforced concrete are common.
3. The parapet of a structure is the upper portion of a structure that normally extends below the roof line.
4. A gable is the triangular wall formed by a sloping roof.
5. The simple open gable was evolving into a more box-like gable.

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

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| Information Sheet -11 | Cutting and laying sill bricks |
|---|---|

11.1 **Cutting and laying sill brick**

**Brick Sills**

The purpose of providing window. Sill is to give a suitable finish to the, window o pening and to project the external

Wall below such opening. The following factors are considered at the time of const ruction of a brick sill.

(1) suitable slope is provided to the top of the sill and it is properly throated t o throw off the water out
of theprojection of sill, if given, should not be less than 50 mm.

(2) the top surface of the window sill is smoothly finished.

(3) it should be constructed in suitable course, such that the uniformity of the work as a whole is not disturbed.

(4) dampproof course may be provided below window sills to check the entry of m oisture inside the main wall.

5.for the construction of brick sills, bricks are placed on edge with suitable slope. Sometimes slightly projected tiles are

Inserted below them to have a better appearance. Specially moulded bricks with throatings are also used for theconstruction of brick sills.

**BRICKS FOR WINDOW SILLS**

Randers Tegl bricks for window sills create an attractive, durable finish under the windows.

The bricks for window sills are processed as smooth extruded bricks with a drip edge. They come in red and soft blue, unglazed. Glazed bricks for window sills are available in stock in 5 standard colours. Glazed bricks for window sills are impervious to dirt and water coming down from the window.

**Width:** 68 mm
**Maximum height:** 56 mm
**Length:** 170 mm

**PRE-FABRICATED WINDOW SILL ELEMENTS**
**- THE OPTIMAL SOLUTION FOR DETAIL**

The bricks for window sills can be delivered as a pre-fabricated element of extruded bricks.

The element creates an aesthetically pleasing solution with many advantages:

- Delivery with frost-proof joints with very low water absorption.
- Glazed window sill elements are resistant to algae and similar organisms.
- Time is spent in fitting the element, as opposed to laying individual bricks.
- Elegant and symmetrical distribution

Dimensions: 170 x 68 x 56 mm (maximum length: 2.80 metres)

The window sill elements are available in 3 grout colors:
Dark grey, light grey and light yellow.

## The proper way to build a brick window sill

Builders use brick to construct window sills in residential and commercial buildings. Although appealing, brick window sills create moisture problems due to the number of horizontal joints in the sill. Brick sills constructed with the correct slope, pointing away from the building, provide ample drainage. Preparation of the wall before the brick is installed remedies the moisture problems. Installing flashing and weep holes -- holes that prevent water from entering the building -- before installing the brick sill is crucial for keeping out moisture. The "rowlock" brick pattern is common for window sill applications.

Brick can be used for window sills if installed properly.

**Step1** Measure the distance from the window to the outside of the brick wall. The underneath side of the brick sill must extend past the face of the brick wall a minimum of 1 inch.

**Step2** Lay the brick on a flat surface with the holes facing up. Mark a 15-degree angle on the end of each sill brick. Mark the end closest to the window.

**Step3** Place the brick chisel on the line you marked. Strike the chisel with the hammer to cut an angle on the brick end. This allows the brick to fit under the window trim.

**Step4** Install weep hole wicks by placing them horizontally on the flashing, spaced every 16 inches. Allow the wicks to extend slightly beyond the front of the flashing.

**Step5** Apply mortar to top of the flashing with the trowel.

**Step6** Install the bricks on the wall below the window sill. Place them on a 15-degree angle, sloping away from the window. The brick spacing should match the width of the mortar joint on the wall.

**Step7** Use the level to check for a straight and level surface.

| Self-Check 11 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. Builders use brick to construct window sills in residential and commercial buildings.
2. The bricks for window sills are processed as smooth extruded bricks with a drip edge.
3. brick window sills create moisture problems due to the number of horizontal joints in the sill
4. Brick sills constructed with the correct slope, pointing away from the building, provide ample drainage
5. The bricks for window sills can be delivered as a pre-fabricated element of included bricks.

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

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3_____

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5. _____

| Information Sheet -12 | Installing tie down and lateral support systems for ceiling/roof structures |
|---|---|

### 12.1 tie down for roof structures

Definition of Rafter Tie used in Roof Framing. A rafter tie is a horizontal tension tie that is located in the lowermost third of the span of a pair of opposed sloped or "gable roof" rafters. A rafter tie resists spreading of the building walls by bulges at the wall top that would otherwise occur due to roof loads

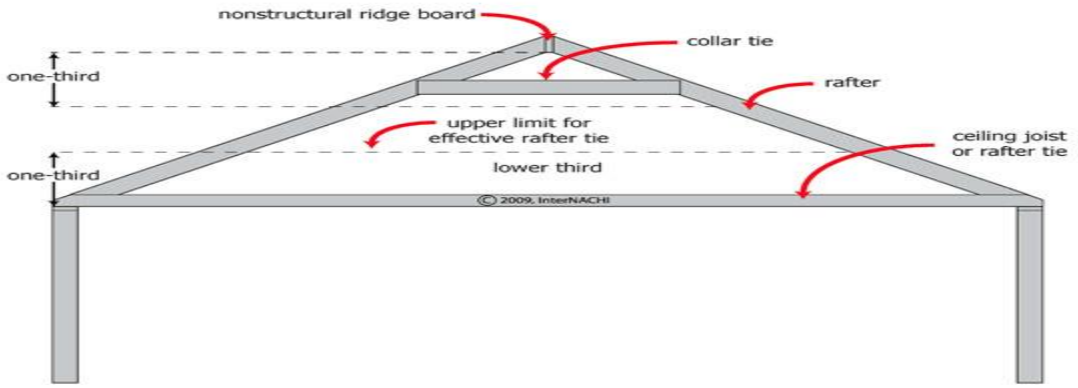
### Collar Ties vs. Rafter Ties

by Nick Gromicko and Ben Gromicko

Collar ties and rafter ties are both horizontal roof-framing members, each with different purposes and requirements. Home inspectors should be familiar with these structural members and the differences between them, as they are not the same.

Please note that, according to the International Standards of Practice for Performing a General Home Inspection, the inspector is required to inspect the visible and accessible structural components and the general structure of the roof system.

In physics, tension is the pulling force exerted by a solid object on another object.



Tension members are solid objects (or structural members) that are subjected to axial tensile forces, or tension. Collar ties and rafter ties are examples of tension members.

**Tension Tie**

A tension tie is a structural member that is subject to net tension.

**Collar Ties**

"Collar tie" is a colloquial phrase that is used among contractors, builders and inspectors, but not usually used in construction or engineering documentation. The correct phrase is actually “collar beam.” In this article, we’ll use "collar tie."

A collar tie is a tension tie in the upper third of opposing gable rafters that is intended to resist rafter separation from the ridge beam during periods of unbalanced loads, such as that caused by wind uplift, or unbalanced roof loads from snow. The 2015 International Residential Code does not require collar ties (or collar beams). However, in those situations when they are specified, collar ties or ridge straps are usually installed in the upper third of the roof between opposing rafters. In high-wind areas, uplift can tear a roof off of a house if it's not properly attached.

Collar ties must be at least 1 x 4 inches (nominal), spaced not more than 4 feet on center.

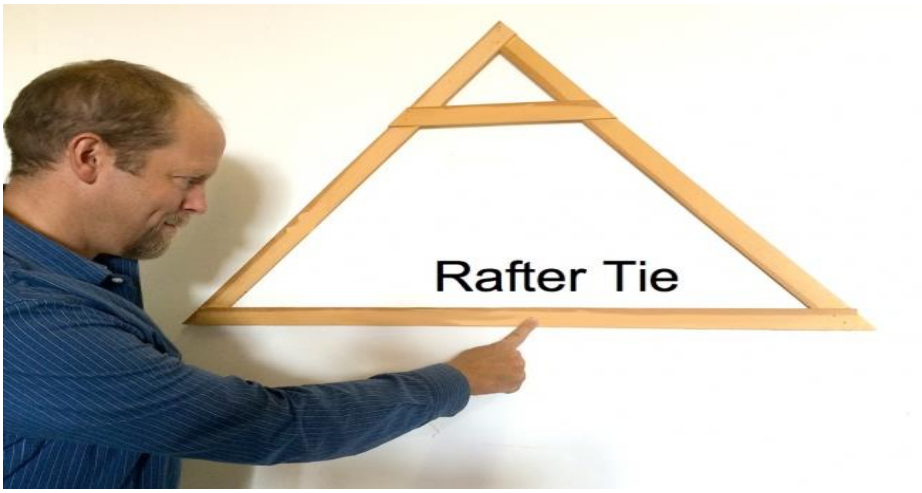
Other facts about collar ties:

- They may or may not be required, depending on jurisdiction. InterNACHI inspectors should not call out a lack of collar ties as a defect unless they know that collar ties were required in the jurisdiction where the home is located at the time the home was built.
- Collar ties are probably not needed if approved metal connectors were used to fasten the rafters to the ridge.
- Where they are required, they should be installed on every other rafter where rafters are on 24-inch centers.

- Collar ties, contrary to popular belief, do not prevent walls from spreading.

**Rafter Ties**

A rafter tie is a tension tie in the lower third of opposing gable rafters that is intended to resist the outward thrust of the rafter under a load. In many situations, you'll find that ceiling joists installed parallel to the rafters are intended to function as rafter ties. The roof framing mock-up below shows a standard rafter tie.




Rafter ties are installed between opposing rafters, and they should be installed as close as possible to the top plate.

Rafter ties resist the outward thrust that rafters exert on the exterior walls. They help keep walls from spreading due to the weight of the roof. When the walls spread, the ridge board might sag. A sagging ridge is one indication that the roof structure may lack adequate rafter ties. A rafter tie forms the bottom chord of a simple triangular roof truss.

When ceiling joists run perpendicular to the rafters, inspectors may find rafter ties installed above ceiling joists as framing members every 4 feet running above the ceiling joists connecting opposing rafters.

Rafter ties should be at least 2 x 4 inches (nominal).

Other facts about rafter ties:

- Rafter ties are always required unless the roof has a structural (self-supporting) ridge, or is built using engineered trusses. A lack of rafter ties is a serious structural issue in a conventionally framed roof.
- In most homes, the ceiling joists also serve as the rafter ties.
- Where rafters are oriented perpendicular to the ceiling joists, rafter ties should be installed just above the ceiling joists. The ties usually rest on the joists.
- When rafters are installed on 24-inch centers, rafter ties are typically installed at every other rafter.
- It's not unusual to see rafter ties of either 2 x 4-inch or 2 x 6-inch.

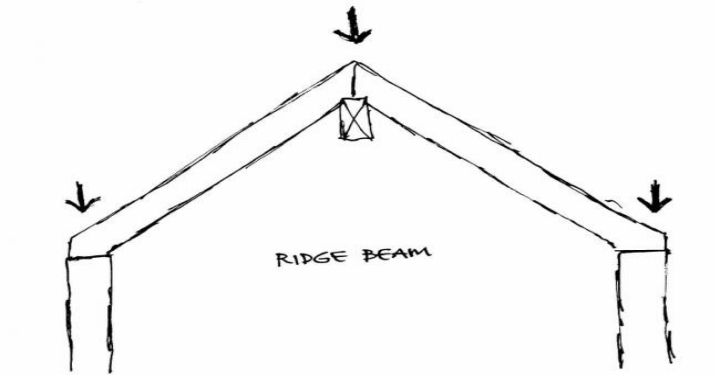
**Tension Forces**

Rafter and collar ties are subject to enormous tension forces. These forces make securing the ties to the rafter boards a critical issue. The force in each tie increases with the inverse of the slope. So, the greater the roof slope, the weaker the outward thrust.

**Outward Thrust**

The load on a structure can be calculated from combining the dead load or weight of the structure itself, the live load that varies for different structures, the snow load, and the wind load.

In a simple gable roof, the rafter boards carry the live and dead loads that push both downward and outward against the top of the load-bearing walls. This horizontal outward thrust can be considerable. To resist this horizontal outward thrust, the International Residential Code calls for each pair of rafters to be securely connected to each other by a continuous ceiling joist, and for a structural ridge beam to be installed for roofs with a slope of less than 3:12 (see illustration below).




## Ceiling Joists

Where ceiling joists are not connected to the rafters at the top wall plate, joists connected higher in the attic shall be installed as rafter ties, or a continuous tie should be provided. Where ceiling joists are not parallel to rafters, rafter ties shall be installed. Where ceiling joists or rafter ties are not provided, the ridge formed by these rafters must be supported by a wall or girder.

The ends of ceiling joists should be lapped a minimum of 3 inches, or butted over bearing partitions or beams and toenailed to the bearing member. Where ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together in accordance with in the IRC. For example, if a house has a 4:12 slope, the rafters are on 16-inch centers, the snow load is 30 psf, and the roof span is 28 feet, you need eight 16d common nails (or 40d box nails) at each rafter-heel joint connection. That's a lot of nails a home inspector can look for.

## Cathedral Ceilings

Cathedral ceilings are popular in many homes, but they have special issues with the downward load on the rafters that push outward on the exterior walls. Open collar ties and ridge beams address many of these issues. The higher the tie is located, the less leverage is available to counteract the outward-thrust forces. Many cathedral ceilings

often display indications of movement, such as cracked drywall. The most effective way to reduce outward thrust is to use a structural ridge beam.

**Bottom Chord of a Truss**

In a conventional roof truss, the bottom chord acts as a tension tie between the exterior walls. Alterations to installed trusses are not permitted. Cutting any truss, particularly at the bottom chord, destroys the structural integrity of the truss. If the inspector finds that the chord of a truss has been cut, he/she should recommend that a structural engineer be consulted.

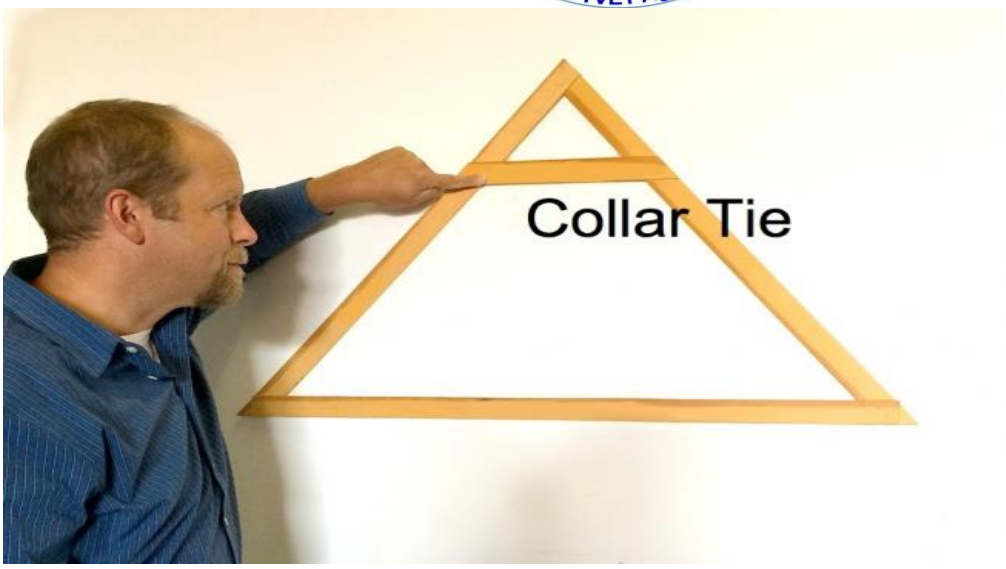
The bottom chord of a truss should not be attached to an interior wall partition. Attaching the bottom chord of a truss to an inside wall can cause the web members designed for tension to become compression members. When the bottom chord is nailed to a top plate of an interior wall, a home inspector might observe cracking interior finishes at the corner of the finished wall and ceiling.

**Lower One-Third**

Older building codes permitted rafter ties to be installed very high above the top wall plate, as much as two-thirds the distance between the top plate and the ridge. The 2012 IRC now limits this to one-third the distance between the plate and the ridge. For example, if an unfinished garage has a roof with a 4:12 slope and the roof span is 24 feet, the rafter ties should be located no more than 16 inches up from the plate, according to modern building standards.

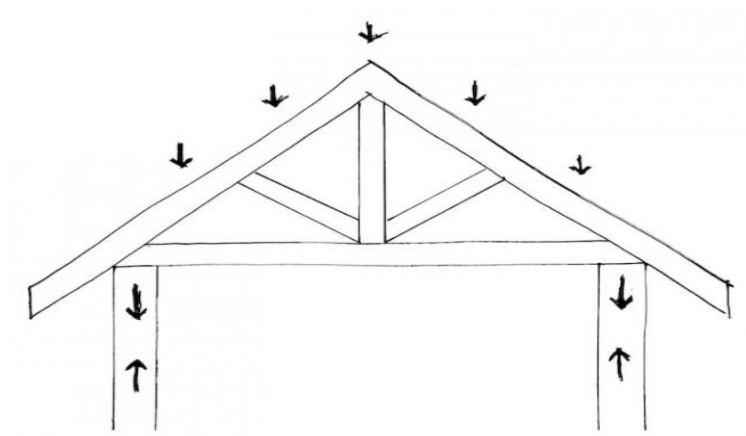
**Tension**

The roof framing mock-up below shows a standard collar tie. As the load is applied downward, tension in the collar tie is increased.



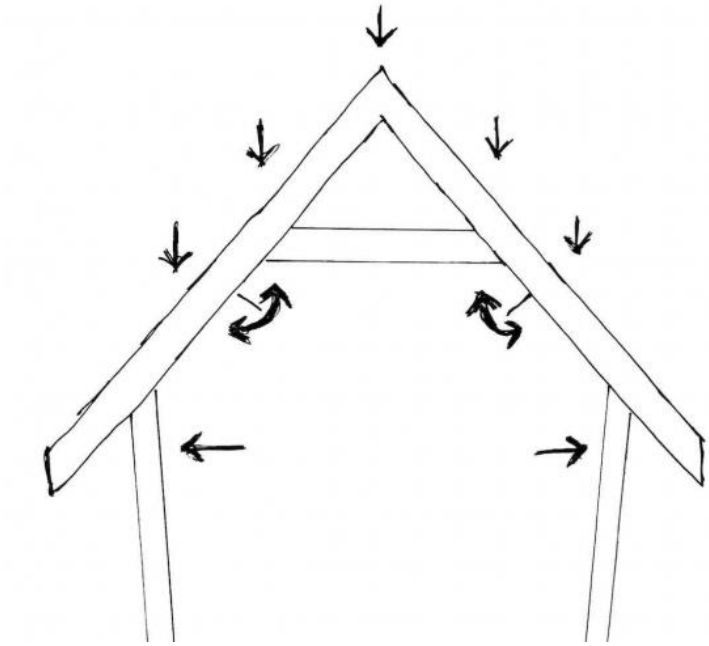

**Compression**

The illustration below shows a king post truss on posts. As the load is applied downward, compression is increased at the posts.



**Bending Moment**

A bending moment occurs when a force changes from a straight form into a curved or angular one. The illustration below shows a collar tie with rafters on top of conventionally framed walls. As the load is applied downward, the rafters go into a bending moment below the collar tie. This bending moment exerts outward thrust on the walls, making them out of plumb.



**Summary**

In summary, collar ties and rafter ties perform different functions, but both are essential roof-framing members, and it's useful for inspectors to be aware of their differences in order to properly call out defects.

| Self-Check 12 | Written Test |
|---|---|

***Instructions:*** all the questions listed below. Illustrations may be necessary to aid some explanations/answers. Write your answers in **Instructions*:*** the sheet provided in the next page

1. ceiling joists are connected to the rafters at the top wall plate
2. The ends of ceiling joists should be lapped a minimum of 3 inches
3. The bottom chord of a truss should be attached to an interior wall partition
4. A rafter tie is a tension tie in the lower third of opposing gable rafters that is intended to resist the outward thrust of the rafter under a load
5. Rafter ties resist the outward thrust that rafters exert on the exterior walls.

***Note:*** **Satisfactory rating – 3 and abve points** **Unsatisfactory - below 3 points**

**Answer Sheet**

Score = _____

Rating: _____

Name: _____ Date: _____

1_____

2_____

3_____

4._____

5. _____

| Operation Sheet 1 | Techniques of Constructing brick walls |
|---|---|

**Follow the techniques of Constructing brick walls**

**Procedures:**

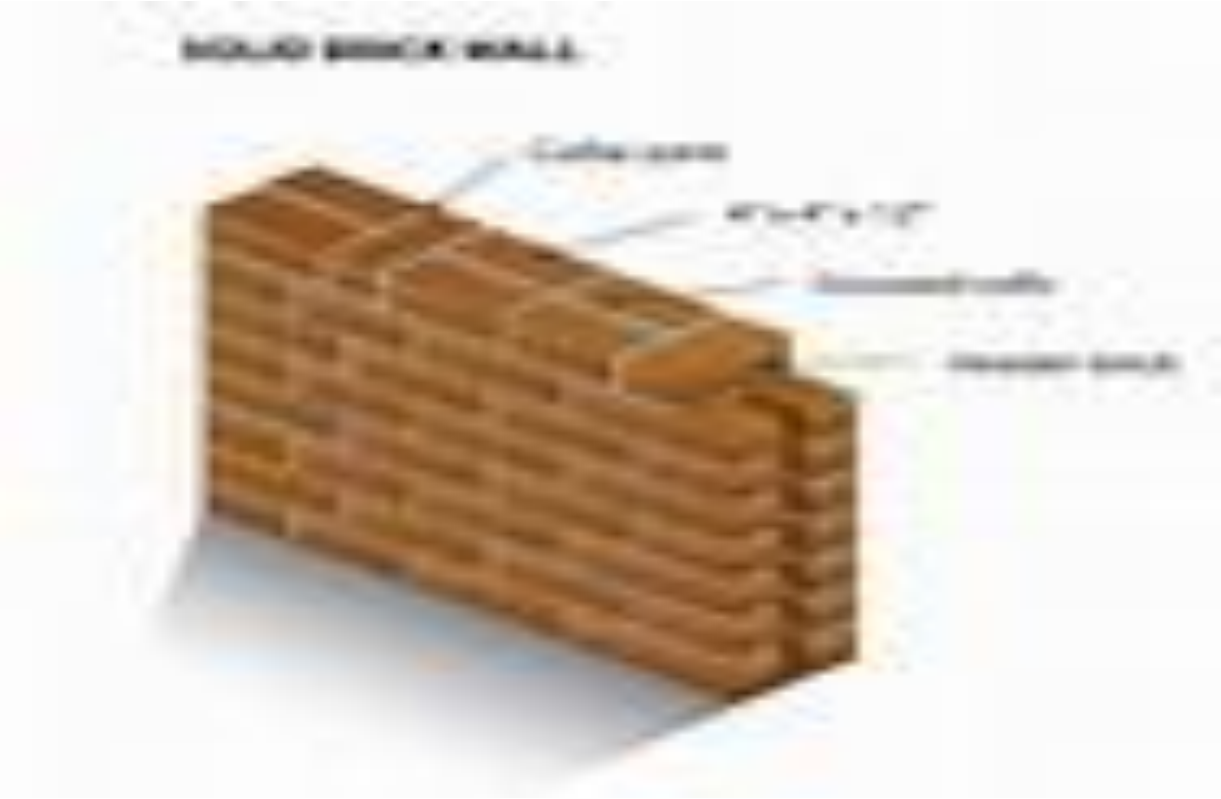
**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**



| Operation Sheet 2 | Techniques of laying damp proof courses and flashings |
|---|---|

**Follow the techniques of laying damp proof courses and flashings**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet- 3 | Techniques of Building ventilation for solid brick construction |
|---|---|

**Follow the techniques of Building ventilation for solid brick construction**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-4 | Techniques of Constructing walls to be straight and true in plumb, line and level |
|---|---|

**Follow the techniques of constructing walls to be straight and true in plumb, line and level**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-5 | Techniques of Positioning wall ties |
|---|---|

**Follow the techniques of Positioning wall ties**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-6 | Techniques of Constructing openings and installing flashing |
|---|---|

**Follow the techniques of constructing openings and installing flashing**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-7 | Techniques of Installing lintels |
|---|---|

**Follow the techniques of installing lintels**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-8 | Techniques of Forming control joints |
|---|---|

**Follow the techniques of Forming control joints**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-9 | Techniques of Locating and building in weep holes, brick reinforcing, vermin proofing and wall flashings |
|---|---|

**Follow the techniques of Locating and building in weep holes, brick reinforcing, vermin proofing and wall flashings**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-10 | Techniques of Constructing gables and parapets |
|---|---|

**Follow the techniques of Constructing gables and parapets**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-11 | Techniques of Cutting and laying sill bricks |
|---|---|

**Follow the techniques of Cutting and laying sill bricks**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| Operation Sheet-12 | Techniques of Installing tie down and lateral support systems for ceiling/roof structures |
|---|---|

**Follow the techniques of installing tie down and lateral support systems for ceiling/roof structures**

**Procedures:**

**Step 1-** wear personal protective clothes

**Step 2-** select the tools which are appropriate that work

**Step 3-** check the tools weather it is functional or not

**Step 4-**select the materials which are necessary

**Step 5 based on these Procedures do the following lap test**

| LAP Test 4 | Practical Demonstration |
|---|---|

**LAP Test -4**

Name: _____ Date: _____

Time started: _____ Time finished: _____

*Instructions:* Given necessary templates /guide , workshop, tools and materials you are required to perform the following tasks within 4:00 hours

Task 1. Construct brick walls

Task 2. lay damp proof courses and flashings

Taske 3 Building ventilation for solid brick construction

Taske 4 Construct walls to be straight and true in plumb, line and level

Taske 5 Position wall ties

Taske 6 Construct openings and installing flashing

Taske 7 Install lintels

Taske 8 Form control joints

Taske 9 Locate and build in weep holes, brick reinforcing, vermin proofing and wall lashings

Taske 10 Construct gables and parapets

Taske 11 Cut and lay sill bricks

Taske 12 Install tie down and lateral support systems for ceiling/roof structures

https://ginninderry.com/wp-content/uploads/2017/03/EPA-Guidelines-for-Construction-and-Land-Development-ACCESS.pdf. accessed on Oct 30/2017

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