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Please note

The term «cavity wall» is applied to a type of masonry wall construction in which a continuous air space or cavity is provided inside the wall. A cavity wall therefore is actually two walls separated by an air space, but joined by means of metal des for structural strength. They are extensively used in European countries, particularly Great Britain, where they have been developed as a means of obtaining protection from penetration of rain through masonry walls. In recent years in North America many important buildings have been constructed with cavity walls.

This type of construction is by no means modern. Traditionally solid masonry was used to enclose buildings and support the loads of roof, floors, furnishing and occupants, but as long ago as the last century it was not unusual for Canadian builders to use cavity walls instead of solid masonry and many such buildings are still in use.

Advantages

The most obvious advantage of cavity walls over those of solid masonry is the possible reduction in the amount of masonry used in construction, but other advantages such as improved thermal insulation are obtained from them. If a 12-inch solid brick wall consisting of three bricks side-by-side is compared with a 10-inch cavity wall composed of two bricks separated by a 2-inch air space, it is found that even though the latter wall is 2 inches thinner than the solid wall it bas slightly greater resistance to flow of heat through the wall (i.e. it has greater insulating value).

The most important advantage of cavity over solid masonry walls, however, is the positive protection against rain penetration which cavity walls can provide. In many buildings solid masonry walls have been used under severe conditions of exposure to wind-driven rain, and frequently under these conditions the result bas been penetration of moisture through the masonry to the interior, producing "damp wall" problems. Cavity walls, on the other hand, do not permit rain penetration; by their design, water cannot reach the inside surface of the wall. When rain falls on a cavity wall it may penetrate the outer wall, but the water then trickles down the inner surface of the outer wall and cannot traverse the cavity. The base of the wall is provided with metal flashings that direct any water that has entered the cavity outward through openings (weep holes) provided for the purpose.

Construction of Cavity Walls

Cavity walls do not require special masonry units. Conventional ones are employed although metallics instead of bonding units tie the masonry together. The outer part of the cavity wall is usually brick masonry. The inner wall may also be of brickwork, but it is often constructed of structural clay tile, concrete blocks, or plain or reinforced concrete.

When a cavity wall is constructed on a foundation wall it is essential that a properly-designed gutter be installed between the foundation and the wall The metal flashing which forms the gutter is placed beneath the outer part of the wall, and is shaped so that it turns up behind the outer wall and is carried into a mortar joint of the inner wall. A typical arrangement is shown in Fig. 1.

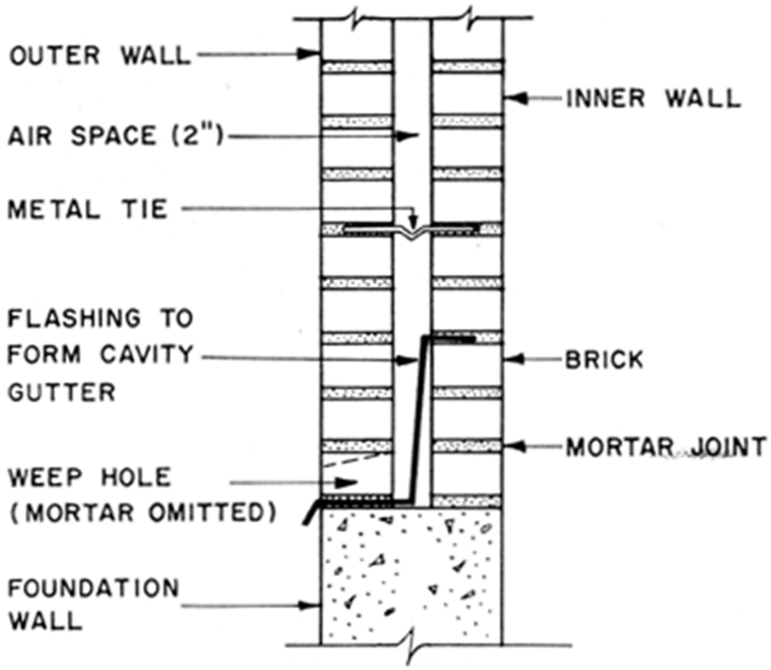

Figure 1. Typical Flashing Installation at Bearing Support of Cavity Wall.

The gutter collects water that moves down the cavity and must be drained. For this purpose mortar may be omitted from the vertical joints of the bottom course of bricks in the outside wall; usually every third joint along the course is left open.

During construction of a cavity wall the inner and outer parts are anchored by metal ties laid in the horizontal mortar joints. They are arranged in a definite pattern. It is essential that the air space be kept continuous and not bridged by mortar or other material that will allow water to pass across the cavity. To ensure this, wooden strips are usually used to collect mortar that drops into the cavity as the bricks are laid. They are placed on a row of ties and as they are pulled up to allow installation of the next series of des, the collected mortar is removed from the cavity. Fresh mortar that may have fallen into the gutter at the base of the wall may be removed by a hosed stream of water.

Ties

It is the function of ties to anchor the two parts of the cavity wall together so that adequate strength may be obtained from the wall assembly. The tie must be strong in itself, and enough of it must be embedded in mortar to provide adequate anchorage. It should be at least 3/16 inch in diameter and should be bent at both ends to form 2-inch legs. In addition, it must be corrosion-resistant so that it is not destroyed by rusting in service; for this reason the use of non-ferrous ties is desirable. Copper and bronze are suitable materials, as is steel with copper welded to the surface or steel that bas been galvanized by hot dipping. Uncoated steel ties or those coated with cement, tar or paint are not considered suitable for cavity walls. Corrugated metal strips of the type frequently used to tie veneer to a backing material should not be used in cavity wall construction.

Ties of several shapes are available, but that most commonly used is Z-shaped. Rectangular and U-shaped ties are also, common (Fig. 2). Cavity wall ties are usually provided with a "drip" feature so that any water passing along the tie falls off at the drip into the cavity. They should not slope downward to the inner wall as this encourages passage of water across the cavity.

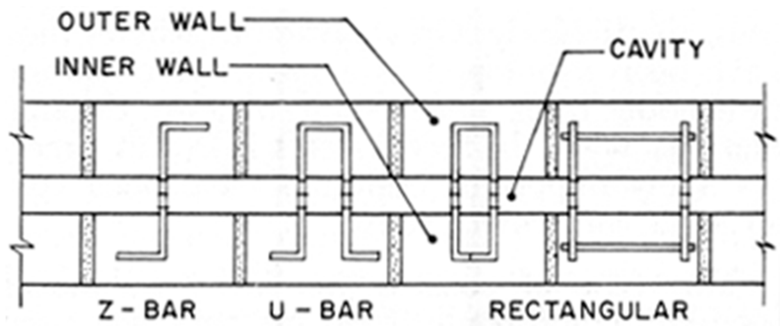

Figure 2. Shapes of Cavity Wall Ties.

Spacing of Ties

Provisions for cavity walls in the National Building Code of Canada require that ties be spaced vertically not more than 18 inches apart and horizontally not more than 36 inches apart. The des must be staggered from course to course and each tie must extend at least 2½ inches into the masonry. Additional des are required around openings in a cavity wall. These are installed not more than 12 inches from the opening, and are spaced less than 3 feet apart around it.

Structural Frame Buildings

A structural frame of steel or reinforced concrete members is usual in North America in the construction of buildings higher than three stories, and is often used for lower buildings as well. In this type of construction the frame rather than the masonry walls is used to support the loads on the building. Masonry merely shields the interior from the weather and resists the spread of fire.

Cavity walls have been combined effectively with structural members of frame-type buildings to provide excellent protection from weather. Frequently the outer surfaces of spandrel beams and columns are placed in the same plane and the inner part of the cavity wall is constructed flush with the surfaces of the beams and columns and anchored to them, while the outer part is carried on a shelf formed by a steel angle attached to a beam, usually at each floor level. A typical arrangement is shown in Fig. 3. The outer wall is anchored to the inner wall by metal ties. It is also anchored to the columns; in the case of concrete columns this may be done by dove-tailed anchors that fit into anchor-slots provided in the concrete members. Similar details are used when the structural frame is of steel members.

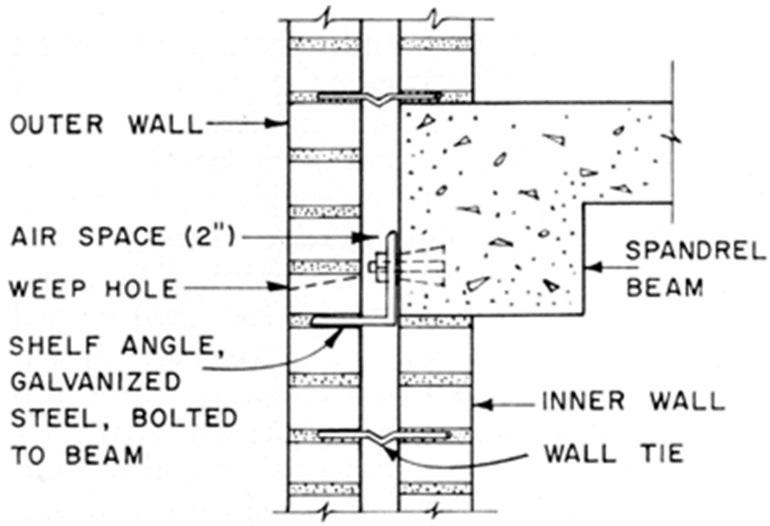

Figure 3. Typical Arrangement of Cavity Wall at a Spandrel Beam.

The shelf angle supporting the outer part of the cavity wall acts as a flashing to form a gutter. Where adjacent angles abut flashing must be placed over the angles to cover the joint. To drain the gutter, weep-holes are provided in the course of bricks resting on the angle by the omission of vertical mortar joints. The shelf angles should be galvanized steel in order to resist corrosion.

Door and Window Openings

Where a door or window is fitted into a cavity wall the continuity of the air space is broken, and care must be taken to prevent water from passing along the door or window frame to the interior. If a window is installed immediately beneath the shelf angle attached to a spandrel beam the normal flashing details for the shelf angle are sufficient to preserve the water-tightness of the wall along the top of the window. If openings are made elsewhere, however, a separate angle is provided as the lintel, and over the angle proper flashing must be installed to collect water moving down the cavity and weep-holes provided for drainage.

The sides of door-and window-frames must be designed so that water cannot travel along them to the interior. Diverter strips that project from the sides of the frame into the cavity are usually provided for this purpose.

Control joints

The outer part of a cavity wall forms a relatively thin skin around a building and may be subjected to appreciable changes in temperature and moisture content, producing stresses which lead to cracking. In addition, the outer part of the wall may be affected by movements taking place in other components of the building. Experience in the design of cavity walls has indicated the value of providing vertical control joints in the outer part of the wall to accommodate these movements. It has been found that the corners of cavity walls are particularly susceptible to cracking when a structural frame has been used. Accordingly, a vertical control joint is usually provided in the outer part of the wall about 3 or 4 feet from the corner. In addition, to reduce the chance of cracking, the outer part of a cavity wall should not be tied to corner columns of concrete.

There is an even greater tendency for movement to take place in parapet walls than in the main walls of a building, and there is therefore a special need for control joints. Continuing the cavity upwards from the main walls into the parapet appears to be a desirable feature.

Cavity Insulation

In recent years special insulating materials have been developed for filling the air space of cavity walls in order to improve the thermal insulation value of the wall. The materials are pour-type insulations treated to render them water-repellent.

Since the main advantage of cavity walls - resistance to rain penetration - depends on keeping the air space free of anything that might form a "water bridge", it might be expected that filling the cavity would destroy its resistance to rain penetration. Laboratory tests have indicated, however, that this is not the case if specially prepared insulating materials treated to be water repellent are used.

Condensation

In the north-eastern area of the United States the performance of many cavity walls has been studied for several years. No special vapour barrier was installed in the buildings to control movement of water vapour from the inside to the outside, and there appeared to be no harmful effects of condensation in the walls. When high relative humidity is maintained in a building, however, and the outside air temperature is very low, as may be the case in many areas of Canada in the winter, there is danger of condensation of water vapour in the walls and of frost action. Under these conditions it seems wise to provide vapour barrier protection to cavity walls, particularly if the cavity contains insulating material.

Building Code Requirements

Special requirements for construction of cavity walls, particularly limitations on height are contained in most building codes. The National Building Code of Canada 1960, for example, states that the maximum height to which a cavity wall may be built above its bearing support is 36 feet. For buildings taller than this it is necessary to provide intermediate bearing support so that the allowable height above the support is not exceeded.

The minimum thickness of a cavity wall is 10 inches, the cavity being not less than 2 nor more than 3 inches wide. For load-bearing cavity walls the National Building Code requires that the minimum thickness of the top 12 feet be 10 inches, that of the portion more than 12 feet but not more than 24 feet from the top, 12 inches, while that part of the wall more than 24 feet from the top must be at least 14 inches thick. As for solid masonry walls, lateral support, either horizontal or vertical, must be provided for cavity walls.

It is generally required by building codes that mortars of relatively high strength be used in cavity wall construction, probably because resistance of the thin outer part of the wall to lateral force is important. A general rule seems to be that mortar for cavity wall construction should be at least as strong as a mortar containing equal proportions by volume of lime and portland cement (1:1:5 or 1:1:6 by volume of portland cement : lime : sand). At the same time it should possess good workability and water-retention properties.

Conclusion

Cavity walls provide an important advantage over walls of solid masonry in that they can afford complete protection against rain penetration even when exposed to conditions of severe wetting by wind-driven rain. Under similar conditions rain leakage through solid masonry walls is not uncommon. There are three essential requirements for cavity wall construction: the cavity wall must have a gutter at its base to collect leakage water and drains to direct water out of it; the two parts of the wall must be anchored together with metal ties that are corrosion resistant and adequately strong; the wall must have a cavity free of mortar or other material that may form a water bridge across it.

Cavity walls have been used in many countries over a long period of time and have established their excellent performance record under widely varying conditions.