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ANALYZED

BY

T. RITCHIE

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NOTES SUR L'HISTOIRE DES MURS DE MAÇONNERIE A CAVITE

SOMMAIRE

Les murs de maçonnerie comportant deux parois séparées par un espace d'air, appelés murs creux ou murs à cavité, sont souvent employés dans les constructions modernes pour empêcher la pénétration de la pluie et pour augmenter l'isolation thermique. L'usage de ces murs est très répandu en Grande-Bretagne (1) et on les retrouve aussi dans des constructions modernes en Amérique du Nord, la cavité y étant parfois remplie d'un calorifuge (2). L'usage des murs de maçonnerie à cavité remonte au moins aux premières décennies du 19^e siècle et plusieurs méthodes de construction ont été employées. Le présent article est un bref exposé de l'évolution des murs creux, fondé sur les documents publiés et sur certains exemples de murs creux découverts au cours de travaux de réfection ou de démolition de vieilles constructions.

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NOTES ON THE HISTORY OF HOLLOW MASONRY WALLS

by

T. Ritchie

Building Materials Section, Division of
Building Research, National Research Council of
Canada, Ottawa

Walls constructed with an air space within the masonry, termed hollow or cavity walls, are commonly used in modern building construction as a means of protecting the wall against rain passing through it, and enhancing the thermal insulation of the wall. Such walls are widely used in Great Britain¹ but are also a part of modern building techniques in North America, where the cavity is sometimes filled with insulating material². In the history of the use of hollow masonry walls, which extends back at least to the early decades of the 19th century, various methods have been employed for their construction. The purpose of these notes is to review the development of hollow wall construction by reference to the literature, as well as by reference to certain hollow wall constructions revealed in the alteration and demolition of old buildings.

LITERATURE REVIEW

Thomas Wilsford³, Balthazar Gerbier⁴ and Joseph Moxon⁵, three of England's 17th-century writers on the techniques of building, made no mention of hollow or cavity walls, nor is there reference to such construction in the 1758 edition of Abraham Swan's *"The British Architect"*⁶. The term "hollow wall", however, appears in Peter Nicholson's *"Architectural Dictionary"* as edited and revised in 1852 by Lomax and Gunyon⁷, but it is not known if the term was used in the original of this work, first published in 1812. The hollow wall is defined in Nicholson's Dictionary as "a wall built in two thicknesses, having a cavity between, either for the purpose of saving materials, or to preserve a uniform temperature in the apartments," but Nicholson gave no details of its construction.

The earliest description of a hollow wall, according to S.B. Hamilton⁸, who prepared a history of hollow bricks (i.e., bricks made to contain void spaces), is that given in Thomas Dearn's *"Hints on an Improved Method of Building,"* published in London in 1821. The wall described was 11 in. thick, apparently made up of two walls each 4.5 in. thick, separated by a 2-in. air space. The brick width (probably half its length) was not given,

but the length was 9 in., thus the headers which tied the two walls together were 2 in. shorter than the wall thickness, this missing space being filled by a 2-in. closer.

Much earlier use may have been made of the hollow wall, however, since the instability of rubble-filled masonry walls prompted Vitruvius (in *"The Ten Books on Architecture"*) to suggest, as a possible solution, a hollow wall tied with iron clamps. He does not state, however, that such construction was actually applied to building.

Hamilton mentioned briefly two other hollow wall constructions used in England, the first employing iron ties for bonding, the second header bricks. The thickness of the first type of wall, in which ties of cast, hoop or wrought iron were used, was not given, but the second wall was 9 in. thick, its outer and inner leaves consisting of bricks laid on edge, separated by a 3-in. cavity, but tied together by headers also laid on edge which alternated with the stretchers of a course, providing a Flemish bond arrangement. The iron-tied wall, according to Hamilton, had been used in 80 per cent of the working-class dwellings built in Southampton during the 1850s, while the brick-tied wall, which was termed "rat-trap" bond, "has had a long but occasional usage...." Hamilton noted, however, that "the cavity wall did not become general in Britain until the 1920s...."

Asher Benjamin, perhaps the first writer on building and architecture in the United States, made no reference to hollow or cavity walls in his *"American Builder's Companion"*⁹, but mention of the hollow wall was made in Minard Lafever's *"The Modern Builder's Guide"*¹⁰. Lafever, however, acknowledging that he had drawn heavily from Peter Nicholson's works, repeated in his glossary Nicholson's definition of the hollow wall, but the use of such walls was not mentioned in the text.

According to A.J. Downing¹¹, the hollow wall was first introduced to the United States by Ithiel Town, an American-born architect and engineer (1784-1844) who began work as a house carpenter, then trained as an architect with Asher Benjamin, and later as an engineer with Isaac Damon the bridge designer, before entering his own practice. Downing noted that "nearly all the best villas at New Haven [Conn.], where he [Town] resided, are built in this mode [hollow wall]," presumably to Town's designs. Perhaps these examples persuaded Downing to become an advocate of hollow walls which he claimed were "by far the best mode of building brick houses," the advantages being a saving in materials, the prevention of dampness, better heat insulation and the saving of the cost of lathing, since the hollow brick wall could be plastered directly on its inside surface. In addition, the elimination of the furring and lathing, along with the substitution of brick partitions instead of those of wood studs, rendered the building almost fireproof.

Downing provided plans for three hollow walls that were sixteen, twelve, and eight inches thick (Figure 1); the first of

Redrawn from A.J. Downing, "THE ARCHITECTURE OF COUNTRY HOUSES", 1854

Figure 1 Hollow wall constructions of brick.

these he considered sufficient for all country houses, the second for low additions to buildings, while the third was considered suitable for partitions and, if stuccoed, for the outside walls of small cottages. The 16-in. wall, consisting of an outer 8-in. wall and an inner 4-in. wall separated by a 4-in. air space, contained bonding bricks (Figure 1-a, b, c and d) which were embedded in the one wall but merely butted against the other; they were bonded, however, by being overlapped from one course (A) to that above (B). The bricks forming the outside surface of the wall could be arranged in alternate courses of headers and stretchers (Course B over Course A) or in "running bond" (Course D over Course C).

In the 12-in. hollow wall, Downing showed two 4-in. walls separated by a 4-in. air space but bonded by header bricks embedded in one wall and butting the other. The headers overlapped, however, thus the bonding bricks "a" and "c" are overlain in the next course by bricks "b" and "d" respectively, to tie the walls together.

The 8-in. hollow wall depicted by Downing consisted of two walls, constructed of bricks laid on edge ("a"), tied together with a course of header bricks ("c") laid flat, these bricks governing the width of the wall. Alternate courses of headers and stretchers were laid as the wall was constructed.

Another writer to commend the use of hollow walls was Calvert Vaux (1824-95), an English architect who came to the United States in 1850 and served as assistant to Downing. In his book on *"Villas and Cottages"*¹⁷ Vaux wrote of the many advantages of hollow brick walls, but he recommended that they be bonded by "strips of iron, painted or tarred" rather than by bricks, since they could carry dampness through the wall.

In a more recent book on brick construction, R.P. Stoddard¹³ has described many brick-bonded hollow walls, 8 in. and 12 in. thick, of which all or part of the bricks are rowlocks, i.e., bricks laid on edge. The walls accordingly are termed "rolok" or "rolok-bak," the latter term indicating that the rowlocks form the backing of the wall, whose facing bricks are laid in the normal way.

The hollow walls illustrated by Stoddard (redrawn in Figure 2) include two 8-in. walls, one of which, termed the rolok wall in Flemish bond, is identical to the English "rat-trap" bond. The other rolok wall is similar to that described by Downing but consists of two courses (instead of a single course) of rowlocks overlain by a course of normal (not rowlock) headers. A third 8-in. wall, termed rolok-bak, consists of a brick facing laid in common bond with six courses of stretchers between the header courses, but the backing of the wall consists of four courses of rowlocks between the headers.

Two 12-in. rolok walls and two 12-in. rolok-bak walls described by Stoddard (redrawn in Figure 2 from his illustration)

8" THICK ROLOK WALLS

12" THICK ROLOK WALLS

Redrawn from R.P. STODDARD

Figure 2 Cross-sections of rolok and rolok-bak walls.

contain three air spaces. One of these walls consists entirely of rowlock bricks laid in Flemish bond, in an arrangement similar to that of the corresponding 8-in. wall, while another 12-in. wall consists of two courses of rowlock stretchers overlain with a course of flat headers. Of the two rolok-bak walls described by Stoddard, one is similar in construction to the 8-in. rolok-bak wall, but with an extra wythe of rowlocks. The other 12-in. rolok-bak wall, termed the heavy duty wall, has three instead of four stretcher courses of rowlocks, the fourth course being rowlock headers.

BUILDINGS

Of the early Canadian building projects involving hollow wall construction undoubtedly the most important was the Parliament Buildings in Ottawa, the designs of which were drawn by four architects - Thomas Fuller, Chilion Jones, Thomas Stent and Augustus Laver - all trained in England before coming to Canada. Their specifications for the buildings, as recorded in 1861¹⁴, called for the external walls to be of stone backed with 9 in. of brick, but with a 3-in. space between them. The two walls were to be bonded together "by brick and flat bedded stones, and hoop iron bond where necessary."

Two churches were specifically mentioned in J. Ross Robertson's account of Toronto churches¹⁵ as having hollow walls, but unfortunately without details of construction. The Church of Our Lady of Lourdes, completed in 1886 to the designs of architect F.C. Law, was built "of white brick and the walls have an air space between the outer and inner parts." Of the second example mentioned, Zion Congregational Church, designed by architects Smith and Gemmell and completed in 1883, Robertson noted that "the walls are double and the church is not plastered... [its interior walls are] of white brick, tastefully ornamented with intersecting lines and arches of red brick".

Hollow walls were frequently employed when, in the early 1900s, concrete came into extensive use as a walling material, in the form of blocks or cast-in-place concrete. An article in the *Canadian Cement and Concrete Review* of April 1908, described concrete houses in Montreal constructed with hollow walls, the concrete cast with a 4-in. space separating two 4-in. walls. In the same Review of March 1909, a large residence in North Toronto was described, constructed of 12-in. hollow walls made of two 4-in. blocks laid with a 4-in. air space between them, but the two walls were bonded by means of 12-in. concrete blocks. A further development in hollow walls of concrete was reported in the Review for April 1910, which described moulds patented by Donald Hope of Calgary, for producing hollow walls of cast-in-place concrete.

BUILDING ALTERATION OR DEMOLITION

Many instances of the bygone use of hollow wall construction have been revealed by the alteration and demolition of old buildings. Thus in the opening of one of its walls for making an addition to the building, the Halifax High School, built in 1878 to the designs of architect H.F. Busch, was revealed to have cavity walls. They consisted of two 8-in. brick walls with a space of 4 in. between them, bonded by heavy I-shaped iron ties whose length of 12 in. located the ends of the ties within the vertical joints on the centre-lines of the two walls.

Several brick houses in Aultsville, Ontario, built between 1878 and 1895 and demolished in 1958 in connection with the construction of the St. Lawrence Seaway, were seen to have been built of cavity walls. The brickwork of the walls was about 10 in. thick, consisting of two 4-in. walls with a 2-in. space between them, bonded by header bricks in every eighth course. The bonding courses consisted of alternate headers and stretchers, but since the headers were 2 in. short of reaching the inside surface of the wall, this space was filled with mortar. The inside of the wall was furred, lathed and plastered.

The demolition of old brick buildings in Ottawa has revealed several cavity wall constructions, such as that of the rectory of St. Bartholomew's Church which had been built in 1873 and demolished in 1963. Its 12-in. walls consisted of two 4-in. walls, separated by a 4-in. air space, but bonded by means of thin strips of iron (hoop iron?) about 18 in. long and 1½ in. wide laid diagonally across the wall with the ends of the strips embedded in the mortar joints. In certain parts of the wall, header bricks that projected from the interior wall into the cavity butted against the outer wall, their purpose probably being to increase its strength. Plaster applied directly to the brickwork provided the inside finish of the walls of this building.

Another metal-tied brick cavity wall, plaster-finished on the inside, was seen in a building being demolished in Ottawa in 1966, situated in an area swept by the great fire of 1900, presumably, therefore, having been built after that date. Its construction was similar to the preceding example except that a 2-in. cavity was used (providing a 10-in. wall) and substantial metal ties were employed. These ties, about 6 in. by 1 in. by 1/8 in., with turned-up ends, appeared identical to "Weese's Patent Wall Brace or Tie," manufactured by the Mac Machine Co. of Belleville and advertised in the Canadian Architect and Builder 16. They extended 2 in. into each wall and were arranged in rows about 5 courses apart vertically and spaced about 8 in. apart in the rows.

In a brick house constructed about 1880 in Ottawa's neighbouring community of Vanier, two different cavity wall constructions were used; this house was demolished in 1963. The

house, located at a street intersection, had the two walls facing the streets constructed as cavity walls with concealed bonding bricks, while the other two walls were constructed as cavity walls with header bonding bricks, arranged in the same manner as those of the walls of the houses at Aultsville, previously described, except that they were finished with plaster applied directly to the brickwork. The walls facing the streets, however, probably for reasons of appearance, showed no header bricks. Their bonding bricks were concealed within the wall, laid diagonally so that their opposite corners projected into the two walls, fitting into spaces provided by cutting corners from bricks of the opposite walls. These diagonal bonding bricks were spaced about 30 in. apart along the bonding courses, which occurred in every sixth course of the brickwork.

MODERN APPLICATIONS

In its modern applications¹⁷, the cavity wall has been used in small buildings and also in tall buildings where the wall is supported by the building's structural frame. The wall is usually 10 in. thick, made up of a facing of brick, a 2-in. air space and a backing of brick, concrete block, or hollow clay tile, the two walls bonded by metal ties of various configurations. Since its main purpose in modern construction is the exclusion of rain, the cavity wall is fitted at its base with a flashing beneath the outer wall which is bent up into the cavity to form a gutter, so that rain passing through the outer wall and flowing down its inner surface is caught in the gutter, from which it leaks outwards through drain holes provided along the base of the outer wall. Provision for such drainage has not been seen in any old examples of cavity wall construction.

CONCLUSIONS

The hollow or cavity wall has been a part of masonry and brick construction for at least the last century and a half, apparently having come into use early in the 19th century in England and in North America. The main purposes behind its introduction were the saving of materials, the making of walls more resistant to dampness, and the enhancement of their thermal insulation.

Hollow walls of brick have been constructed in a variety of designs, varying in thickness and in bonding arrangements, in some cases bonded by bricks, in others by metal ties. In some instances hollow walls have been constructed of bricks laid as rowlocks.

Literature references to hollow wall construction indicate the general development and application of such construction, while observations on the alteration and demolition of old buildings have supplied additional information concerning this interesting form of wall construction.

FOOTNOTES:

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