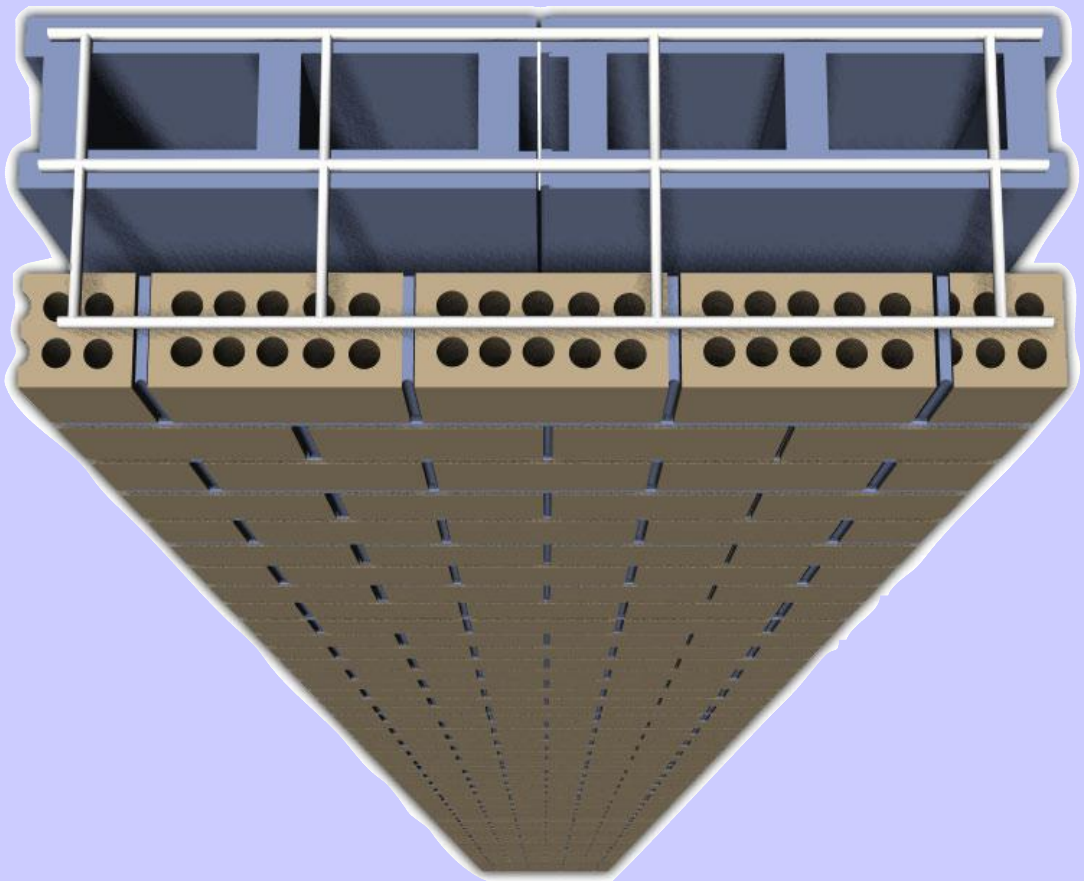
CAVITY WALLS



INTRODUCTION

Simply stated, a cavity wall is two wythes of masonry, separated by a cavity of varying dimension. The masonry wythes may consist of solid brick, structural clay tile, or concrete masonry units and are bonded together with masonry ties. The cavity (ranging from 2 inches to 4 1/2 inches in width) may or may not contain insulation. See Figure 1. Combining these elements with a sound structural design, appropriate details, quality materials and good workmanship will result in high performance cavity walls.

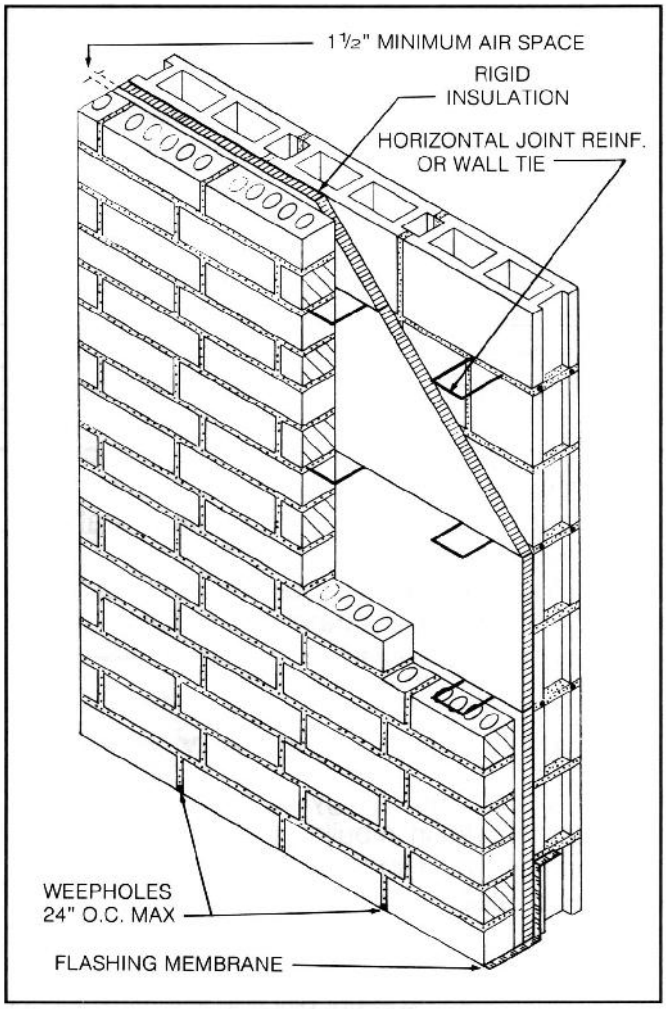
HISTORY

Cavity walls are not new, they have been observed in ancient Greek and Roman structures. At the Greco Roman town of Pergamum, on the hills overlooking the Turkish town of Bergama, a stone wall of cavity type construction still exists.

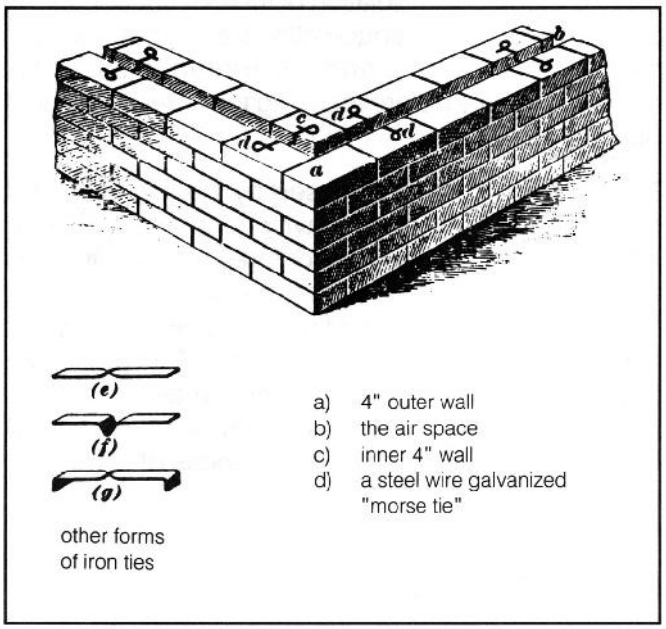
Sometime in the early part of the 19th century, the cavity wall was probably reinvented by the British. Plans dating as early as 1805 suggest a type of construction, featuring two leaves of brickwork, bonded by headers spanning across a 6-inch cavity. An early British publication (dated 1821) suggests the use of cavity walls as a means of protection against moisture penetration. The use of metal ties was introduced in Southern England sometime after 1850. These original ties were made of wrought iron.

Cavity walls were first built in the United States late in the 19th century. Figure 2 illustrates an alternate type of cavity wall system originally featured in an 1899 text book assembled for people engaged in the engineering professions and construction trades. However, it was not until 1937 that this type of construction gained official acceptance by any building or construction agency in the United States. Since then, interest in and use of cavity walls in this country has increased rapidly. This has resulted in extensive testing to determine cavity wall properties and performance.

The early use of cavity walls in this country was limited primarily to exterior load-bearing walls in low rise construction. In the 1940s, designers began to recognize the advantages of cavity walls in high-rise buildings. Today, masonry cavity walls are used extensively throughout the United States in all types of buildings. The primary reasons for their popularity are superior resistance to rain penetration, excellent thermal properties, excellent resistance to sound transmission and high resistance to fire.



Typical cavity wall with insulation
FIG. 1



A cavity wall type from the publication, "Masonry-Carpentry-Joinery, The Art of Architecture, Engineering and Construction in 1899".

FIG. 2

PROPERTIES OF CAVITY WALLS

RESISTANCE TO MOISTURE PENETRATION

No single unreinforced 4" wythe of masonry is totally impervious to moisture penetration. A cavity wall is designed and built as a moisture-deterrent system. This system takes into account the possible moisture penetration through the outer wythe. Moisture will penetrate masonry walls where hairline cracks exist between masonry unit and mortar. Water which runs down the exterior wall surface will be drawn towards the inner cavity due to wind pressure exerted on the exterior of the wall and the negative pressure present within the cavity. Providing a clean air space will allow this moisture to flow unobstructed down the cavity face of the outer wythe. Flashing installed at recommended locations will then divert this moisture back to the building's exterior through weepholes. Proper drainage of moisture will reduce the chance of efflorescence and freeze-thaw damage.

THERMAL ENERGY EFFICIENCY

At one point in time, energy conservation was not a major consideration in building design. Cavity walls were primarily built for their structural and moisture diverting qualities. During the mid 1970's, designers became aware of the life cycle cost of buildings so the design of energy efficient walls were initiated. The cavity became an excellent place to insert insulation, minimizing heat loss and heat gain. Both wythes act as a heat reservoir, positively affecting heating and cooling modes. The isolation of the exterior and interior wythes by the air space allows a large amount of heat to be absorbed and dissipated in the outer wythe and cavity before reaching the inner wythe and building interior.

This ability is further increased by the use of closed cell rigid insulation in the cavity. A foil faced, polyisocyanurate insulation is the most beneficial for three reasons: it yields an R value of 8.0 per inch of thickness, its R value is not affected by the presence of moisture, and its foil back enclosure creates a reflective air space that increase the walls overall R value by approximately 2.8. The R value of a typical cavity wall may range from 14 to 26 depending on the type and thickness of insulation selected.

FIRE RESISTANCE

Results of the ASTM E-119 Fire Resistance Tests and the contents of both the Fire Protection Planning Report (CMIFC)[2] and the Fire Resistance Ratings. Report (AISG)[3] clearly indicate that masonry cavity walls have excellent fire resistance. All cavity walls have a fire rating of 4 hours or greater.

STRUCTURAL PROPERTIES

Masonry's capacity as a load bearing material is superb, yet its structural potential is often overlooked.

Three principle factors affecting the overall compressive strength of a wall are: the compressive strength of the individual units, the type of mortar, and the quality of workmanship. Tables 2 and 3 lists the assumed compressive strength (f'm) for brick and concrete masonry. For large projects prism testing is preferred since actual values are usually higher than the assumed strengths.

The tables indicate that a standard concrete masonry unit with a type N mortar (1:1:6 by proportion) will yield a minimum f'm of 1500 psi. This strength is sufficient for most mid to low-rise bearing wall structures.

In addition to its excellence capacity as a bearing element, concrete masonry's performance as a back-up system is superb. Each wythe in a cavity wall helps resist wind loads by acting as a separate wall. The cross wire of the horizontal joint reinforcement transfer direct tensile and compressive forces from one masonry wythe to the other. Tests have indicated that joint reinforcement also provides some transfer of shear, approximately 20 to 30 percent, across the wall cavity. For a reference on allowable heights of cavity wall see Table 4.