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MASONRY WALL BRACING

Introduction

Masonry walls can be constructed with concrete blocks, bricks, clay tile, glass block, or stone and are used for both loadbearing and non-loadbearing designs. Walls may be single, double or triple wythe (thickness). Six inch single wythe masonry walls are common on one-story buildings with walls less than 9 feet high. The most commonly constructed masonry wall uses masonry blocks, which are precast concrete blocks that are joined in place by mortar. Blocks are manufactured in standard or light weight units, may be solid or hollow, and are often colored and/or have architectural finishes.

Masonry walls serve a variety of purposes. They are used to enclose a building, for partitions to subdivide large floor areas, to construct fire walls and to serve as barriers for heat loss and sound. Unreinforced masonry walls are usually not designed to carry as much load and stress as reinforced masonry walls. Unreinforced masonry walls are not recommended for areas prone to earthquakes or seismic activity. Masonry walls with reinforcing can carry heavy loads and withstand high stresses. Reinforcing may be done horizontally in the joints and/or vertically in the cells.

Most types of masonry units are joined together by mortar which is a combination of Portland cement, sand, hydrated lime and water. When mixed together, chemical reaction (hydration) occurs and the masonry sets. After the initial set, the masonry continues to harden and gain compressive strength. Temperature plays an important part in the curing process; similar to concrete, cool temperatures retard the cure and warm temperatures accelerate the cure. Thus, time is a major factor in mortar gaining strength.There are four general types of masonry walls as follows:

- ***Solid masonry walls*** may be single, double or triple wythe, with no space between.
- ***Cavity walls*** are at least two wythes with an air space between. The air space provides some insulation and a moisture barrier, in effect. The inner and outer wythes are typically joined with metal ties.
- ***Reinforced masonry*** walls are double wythe with steel reinforcement embedded in grout in the space between the wythes. This type of construction is common in earthquake areas.
- ***Veneer walls*** are wood frame walls with a single wythe of brick or stone applied on the outside. In this case, the masonry is acting as a siding rather than a structural component. The heavy masonry has to sit on the foundation and footing system. A masonry veneer cannot rest on a wood frame wall.

Forces Acting on a Wall

During the construction of exterior masonry, two external forces are acting on the wall:

- Vertical forces
- Horizontal forces

The vertical force is imposed on the wall by its own weight which must be supported by the mortar joints and structural members, such as spandrels. Masonry,

similar to concrete, requires time after hydration (set) to gain compressive strength. Masonry has very little strength (approximately 10% of compressive strength) in tension and thus advancing the wall faster than the masonry can gain strength to support the weight can cause an unbalance and failure.

Horizontal forces are less obvious or predicable than vertical forces since they arise from a variety of sources. The most common and least predictable horizontal force on an exterior masonry wall is wind. Other external sources of horizontal force include out of plumb erection, vibration from blasting operations or equipment working in the area, or being accidentally struck by a vehicle or equipment.

Winds cause both push and pull forces on a masonry wall. When the wind strikes a free standing wall, the wind is forced to diverge and pass around the edges of the wall which causes changes in pressure resulting in suction. The forces exerted on the wall are a combination of a windward direct force and a leeward suction force. Other factors that must be considered are wind speed, gusts, elevation, shelter and location.

Wall Bracing

For many years, building codes have required masonry walls to be braced during construction but did not specify when bracing is needed. In addition, OSHA 1926.706, requires masonry walls be "adequately" braced during construction. Specifically, OSHA 1926.706(b) states that "all masonry walls over eight feet in height shall be adequately braced to prevent overturning and to prevent collapse unless the wall is adequately supported so that it will not overturn or collapse. The bracing shall remain in place until permanent supporting elements of the structure are in place."

For years, the masonry industry had only this OSHA standard regarding the bracing of masonry walls. Unfortunately, the OSHA standard is written only for worker protection from collapse and does not provide adequate methods for bracing. Therefore, in the spring of 1997, the Mason Contractors Association of America (MCAA) decided to "standardize" the means and methods of bracing masonry walls. In order to achieve this goal, the MCAA sought the help of masonry industry experts by forming the *Council for Masonry Wall Bracing*. The Council consisted of contractors, structural engineers and other masonry design professionals as well as a representative from OSHA. The Council conducted research and, from the data, developed a standard set of guidelines to show the contractor where typical masonry walls needed to be braced. As a result, in July 1999, the *Standard Practice for Bracing Masonry Walls Under Construction* was published. This new Standard Practice was the first industry-supported document giving specific procedures for bracing masonry walls during construction. The goal of this Standard Practice was to provide life safety for masons and other workers on a construction site during the time when a masonry wall is being constructed.

The *Council for Masonry Wall Bracing* recognizes that it is impossible to prevent the collapse of all masonry walls during construction and that life safety is the primary concern. The Standard Practice has a procedure whereby the wall and area around the wall is evacuated at a prescribed wind speed. Masonry construction is drastically different from other forms of construction. For example, when precast and tilt-up walls are erected, they have the majority of their final design strength and can resist most wind loads. However, masonry walls are subjected to wind loads before the final design strength is achieved. This means that masonry walls can fall down under less severe wind conditions. This being the case, the Council needed to determine what the wind speed was at which the mason's safety was being compromised.

After testing, data indicated that masonry walls started to severely alter their shapes when wind speeds approached 60 miles per hour. Testing also showed that wind speeds at that level limited the ability of masons to accurately place the masonry unit, especially when on scaffolding. Therefore, it was agreed upon by the Council that the wall bracing in the Standard Practice be designed to resist a wind speed of 40 mph and evacuated at 35 mph. Once evacuated, a restricted zone was established where no worker was allowed until the winds had slowed down. This would keep the Standard Practice in line with both OSHA and MCAA's goal of protecting the mason and other workers.

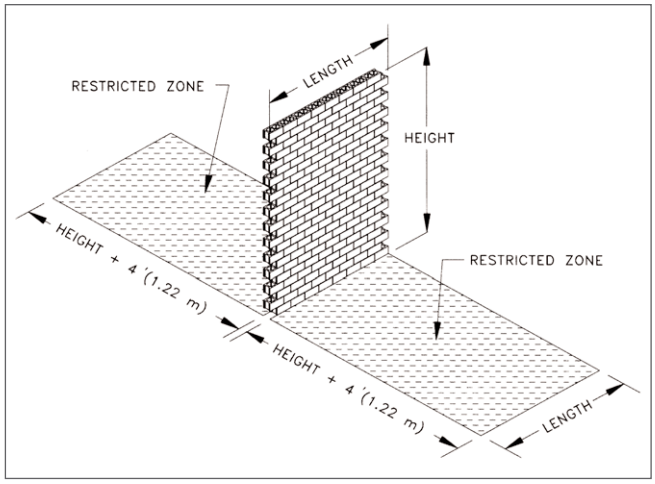
There was a very specific scope that the Standard Practice covered that received OSHA acceptance. The Standard Practice:

- provides an acceptable level of life safety for masons and others working on the construction site
- provides requirements for evacuation of a restricted zone on either side of braced masonry walls and walls being constructed subjected to wind loads during construction resulting from specified wind speeds

- provides design procedures for temporary bracing of masonry walls to resist wind loads during construction resulting from specified wind speeds or other wind speeds selected by the bracing system designer to reflect local wind conditions
- provides for alternative bracing design and alternative means of providing for life safety
- recommends bracing when masonry walls are built higher than 10 times their thickness

General Guidelines For Wall Bracing

- Ensure that masonry walls are not built higher than 10 times their thickness unless they are adequately braced.
- Ensure that masonry walls constructed with joint reinforcing wire and/or cell rebar reinforcing are not built higher than 10 times their thickness unless they are adequately braced.
- Ensure that braces are inclined 30° to 40° to the horizontal and adequately fastened to remain in position.
- Bracing systems should be installed, spaced, and anchored according to manufacturers' specifications.
- Understand that mortar bonds will crack before a masonry wall tips and thus look for telltale cracks in the mortar joints immediately after a windstorm.
- Check local laws or regulations pertaining to wall bracing, as they maybe more specific.
- Understand that soils also play an important part in the effectiveness of a masonry wall bracing system. Loose, frozen, or wet soil can dangerously weaken a wall bracing system. When very soft, soft or firm soil or fill is encountered, different or additional bracing is necessary.
- When standard wall bracing techniques cannot be applied, an engineer familiar with wall bracing systems should be consulted.
- Do not remove bracing until walls are laterally supported by the permanent structural connections.
- A limited access zone equal to the height of the wall plus 4 ft. along the entire length of the wall should be determined before construction of the wall (see below diagram).



RESTRICTED ZONE FOR MASONRY WALLS