

Selecting the right joint reinforcement for the job

Consider function, wall configuration, and construction sequence to make the right choice

Joint Reinforcement Selection Guide

By Mario J. Catani

Joint reinforcement can be used to control cracking, tie masonry wythes together, boost structural performance, or serve any combination of these functions. With at least 10 different configurations of joint reinforcement, three principal types of corrosion protection, and two standard wire sizes to choose from, selecting the best product for a project can be a daunting task.

In the past, many designers simply specified that joint reinforcement be used and left the wire sizes, finish, and configuration up to the contractor. However, Section 1.2.1 of the Masonry Standards Joint Committee's *Building Code Requirements for Masonry Structures* (ACI 530/ASCE 5/TMS 402) requires project drawings to show reinforcement and connector details. Now that the use of this standard is becoming more widespread, more and more designers must actually

WALL CONFIGURATION	Truss-type	Ladder-type	Seismic ladder	Tri rod	Double side rod	Continuous tab tie	Adjustable truss	Adjustable ladder	Adjustable tab tie	Seismic adjustable truss w/pencil rod or ladder	Seismic adjustable ladder w/pencil rod or ladder
SINGLE-WYTHE WALLS:											
with vertical steel	○	●	●								
without vertical steel	●	○	●								
MULTIWYTHE WALLS:											
Both wythes "course out" and are laid simultaneously											
Backup Veneer											
Concrete masonry Concrete masonry				●	●	○ ¹	○ ¹	○ ¹	○ ¹	●	●
Concrete masonry Clay brick						●	●	●	●		
As above in seismic performance category C											
Backup Veneer											
Concrete masonry Concrete masonry				●	●					●	●
Concrete masonry Clay brick				●						●	●
Wythes do not "course out" or are laid at different times											
Backup Veneer											
Concrete masonry Concrete masonry							○ ¹	○ ¹	○ ¹	●	●
Concrete masonry Clay brick							●	●	●		
As above in seismic performance category C											
Backup Veneer											
Concrete masonry Concrete masonry										●	●
Concrete masonry Clay brick										●	●
<ul style="list-style-type: none"> ● Recommended ○ Acceptable ¹ This can be used if ladder reinforcement is installed in course above or below pinto course 											

select a specific type of joint reinforcement. The following guidelines can help in making the appropriate choice.

Single-wythe walls

For single-wythe walls there are three configurations of joint reinforcement: truss, ladder, and seismic ladder (Figure 1). Truss-type reinforcement is the best configuration for all single-wythe walls except those that are vertically reinforced. The diagonal cross wires contribute to the reinforcement's tensile capacity to resist shrinkage stresses, tension due to bending in the horizontal plane, and in-plane shear. Truss-type reinforcement also provides about 35% more steel area than ladder-type.

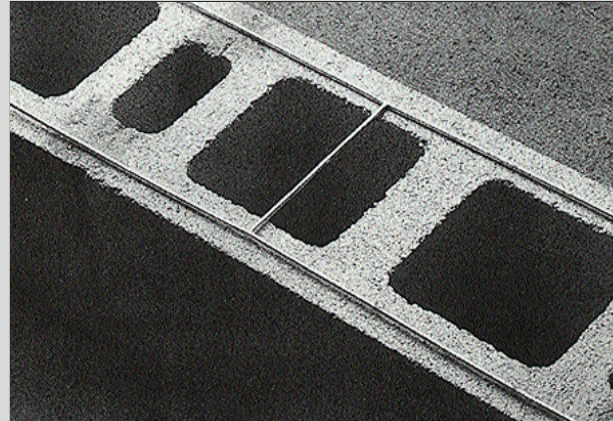
In vertically reinforced single-wythe walls, ladder-type joint reinforcement is preferred. Though not as strong as the truss-type, it interferes less with the placement of vertical steel.

Seismic ladder is a special type with two connected wires for each face shell but no wires that span the width of the masonry units. It is designed for use where vertical bars are installed first, and the concrete masonry units are laid around the bars. Seismic ladder-type eliminates the need to thread joint reinforcement over the vertical steel. It also provides twice the steel area of the regular ladder-type, which helps in meeting the minimum steel requirements for reinforced masonry in high seismic areas.

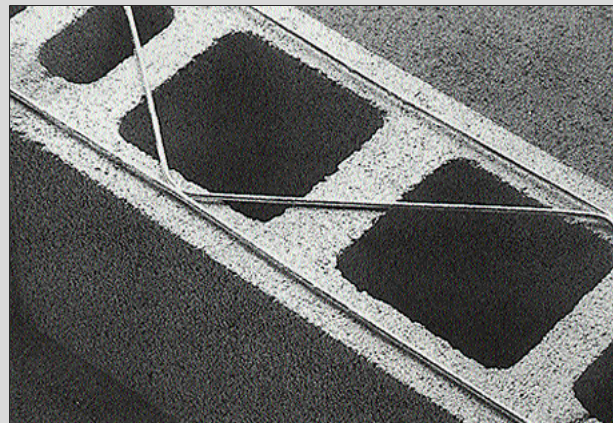
Multiwythe walls

Since the 1950s, most multiwythe walls have been made up of a concrete block backup with a clay brick veneer or outer wythe. In this application, the joint reinforcement is used both to reinforce the block backup against shrinkage and to act as a wall tie connecting the outside brick wythe. No shrinkage steel is needed in clay brick masonry. However, when architectural concrete masonry units are used in the outer wythe, joint reinforcement is needed for shrinkage control in both wythes. The cross wires still serve as wall ties.

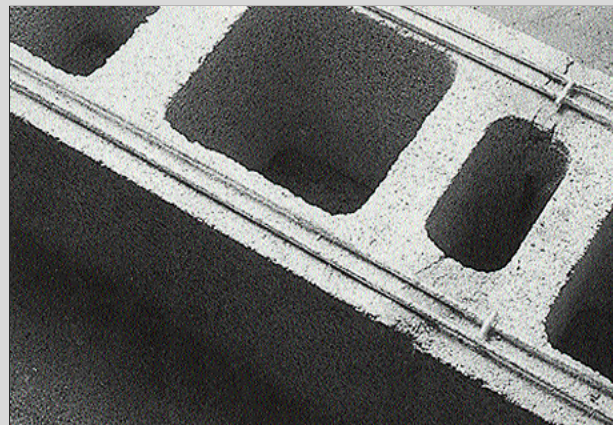
Figure 1. Joint reinforcement for single-wythe walls



A. Ladder

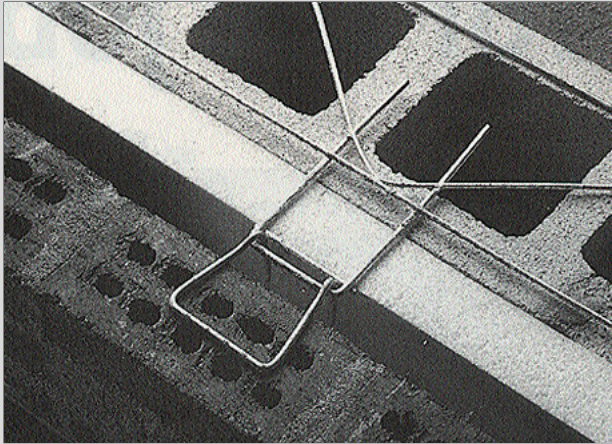


B. Truss

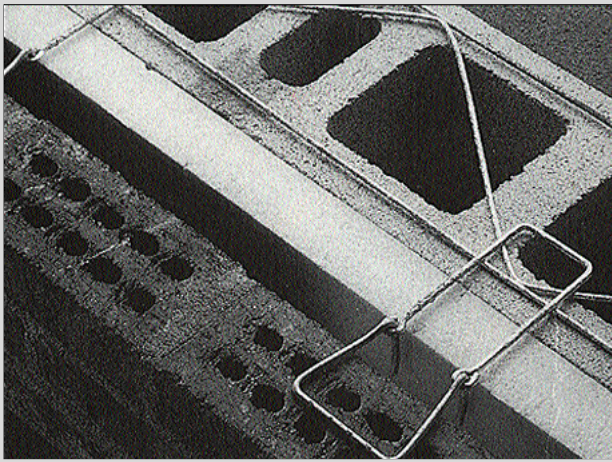


C. Seismic ladder

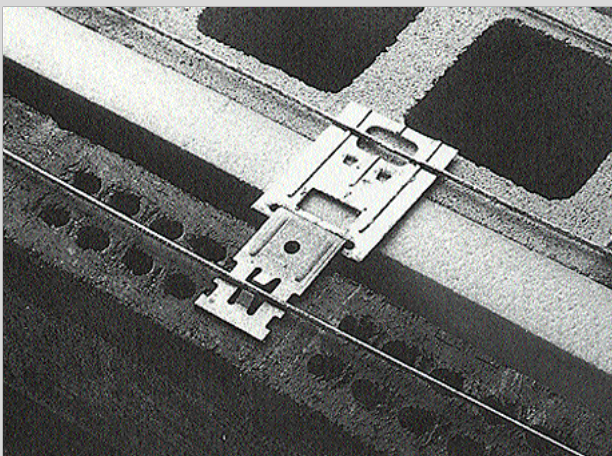
Figure 2. Adjustable tie joint reinforcement



A. Truss-type adjustable tab tie

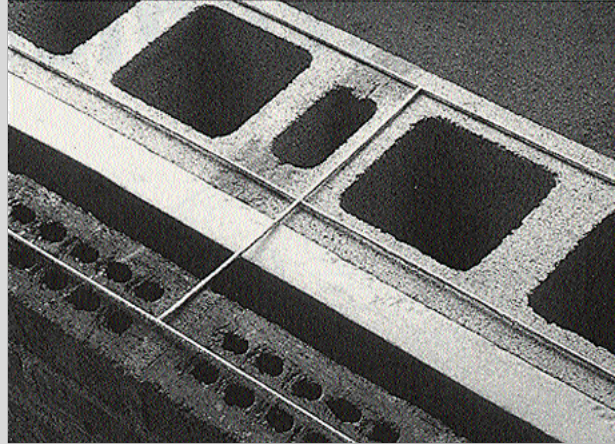


B. Truss-type eye and pintle tie

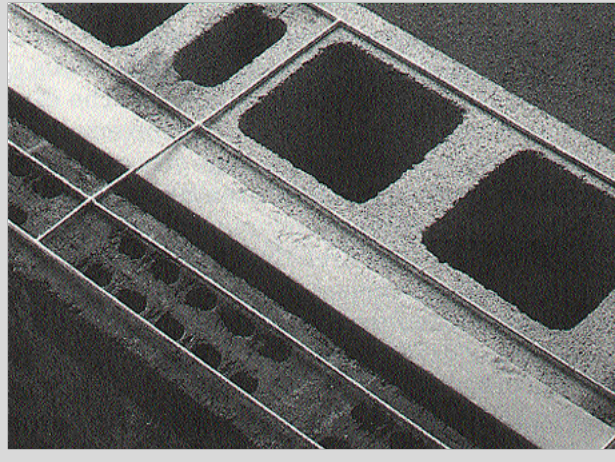


C. Ladder-type seismic tab tie

Figure 3. Reinforcement for multiwythe concrete masonry walls



A. Ladder-type trirod



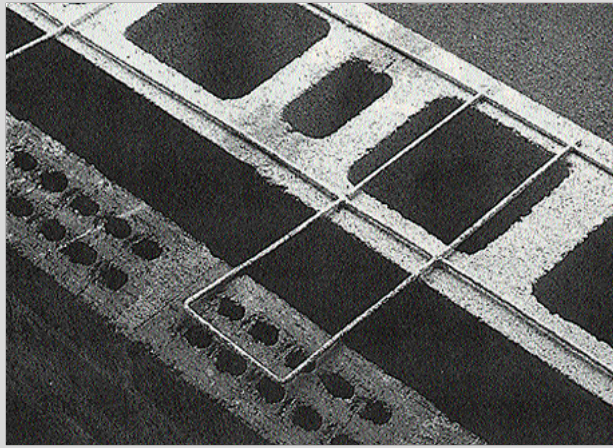
B. Ladder-type double side rod

Adjustable assemblies

Adjustable assemblies (Figure 2), truss- or ladder-type backups with eye and pintle or tab connectors, are the best choice for multiwythe walls. Regardless of the materials used in the wall, the sequence of construction, or the seismicity of the area, adjustable assemblies offer significant benefits. Because they require additional manufacturing steps, adjustable assemblies cost more than other joint reinforcement. But many contractors find the cost difference is balanced by increased productivity on the job.

Adjustable assemblies resist lateral movements, but allow up to 1¼ inches of vertical movement between wythes. Therefore they can accommodate the differential vertical movements that occur between wythes of clay and concrete masonry units. They al-

Figure 4. Continuous tab tie reinforcement for multiwythe brick and concrete masonry walls



so allow for differential thermal movements of concrete masonry veneers and insulated concrete masonry backup wythes.

Besides thermal and moisture movement, adjustable assemblies accommodate slight coursing variations between wythes, which is especially important when the backup and veneer wythes are built sequentially rather than simultaneously. The vertical sections of adjustable wall ties also can be used to hold rigid insulation in place in a wall cavity.

In some cases, adjustable assemblies alone are insufficient. When concrete masonry veneers are used, the outer wythe needs additional joint reinforcement to control shrinkage cracks. This “extra” steel can be laid in the mortar joint next to the pintle or installed in the bed joint one course above or below the pintle course.

In areas of high seismic activity, a single wire reinforcement is required in both clay and concrete masonry veneers. The sheet metal tab tie shown in Figure 2C is designed for seismic areas and contains a clip to hold the additional wire.

When adjustable ties are used, they must meet specific requirements to satisfy the code. One code provision to keep in mind limits the vertical misalignment of the bed joints in adjacent wythes

to 1¼ inches. This misalignment can be up or down since pintles can be installed either way.

Trirod and double side rod

Trirod and double side rod joint reinforcement (Figure 3), available in a truss or ladder configuration, is appropriate for multiwythe concrete masonry walls.

One longitudinal wire should be provided for each mortar bed joint. For a hollow block backup with a solid concrete masonry veneer, use trirod.

Trirod also works well for brick veneer/block backup walls erected in high seismic areas, where a single continuous wire is needed in the veneer for ductility and better anchorage.

Trirod and double side rod should not be used when the wythes are laid at different times or when wide insulation boards are used. And the truss configuration should never be used when insulation is installed between the wythes—the additional steel can restrain normal differential in-plane thermal movements between the wythes and lead to cracking.

Continuous tab ties

Continuous tab tie reinforcement (Figure 4) combines truss or ladder type reinforcement for the concrete masonry backup with factory-welded rectangular ties to connect the clay masonry veneer. Lower in cost than adjustable assemblies, it can be used in uninsulated cavity and composite walls where the inner and outer wythes are laid simultaneously. If insulation is used, it should be only 16 inches wide so it does not interfere with the pro-

jecting tabs.

Continuous tab ties should not be used when both wythes are concrete masonry; these ties lack a continuous wire to control shrinkage cracking in the outer wythe.

Wire size

Joint reinforcement can be made in many sizes but the two most common are standard 9 gauge (W1.7) and extra-heavy 3/16-inch (W2.8). When deciding on the size, consider three factors: the area of steel needed to resist stress; the bond strength of the mortar; and the mortar joint thickness.

For crack control, joint reinforcement made with 9 gauge wire and spaced at 16 inches on center vertically generally is adequate. For joint reinforcement required to resist bending in reinforced masonry, calculate the steel area using standard design procedures. Whenever possible, specify standard reinforcement spaced at 8 inches or less rather than extra-heavy reinforcement spaced at 16 inches.

Tests show that Type N mortar is not strong enough to fully develop the strength of 3/16-inch-diameter joint reinforcement. In other words, a wall built with Type N mortar with 3/16-inch joint reinforcement at 8 inches on center is no stronger than one with 3/16-inch joint reinforcement at 16 inches on center. Therefore, using 3/16-inch joint reinforcement makes sense only when Type M or S mortar is used.

One compelling reason to use 9 gauge reinforcement is for fit and constructability. While the code allows joint reinforcement to have a diameter one half the mortar joint width, the tolerances allowed for units, joints, and the wire itself can hinder the placement of large diameter reinforcement. Use it only when there is no other choice.

Finish

The issue of corrosion protection for joint reinforcement and

wall ties has been clarified in recent editions of the code. There are two ways to provide corrosion protection—by galvanizing carbon steel or by using ASTM A 167 Type 304 stainless steel (Ref. 1).

Galvanized reinforcement must be hot-dipped galvanized after fabrication, according to ASTM A 153 (Ref. 2). This process is required for any material in an outside wall or an inside wall subject to a relative humidity over 75%. Other inside walls need only be made of galvanized wire conforming to ASTM A 641 (Ref. 3) with 0.1 ounce of zinc per square foot of surface area.

Conclusion

Choosing the correct configuration, size, and finish for joint reinforcement is not a difficult task. To do it right, simply consider the function of the reinforcement, the configuration of the wall, and the products available. The table on page 8 can serve as a general guide. The proper joint reinforcement can simplify masonry detailing, facilitate construction, and reduce costs.

Mario J. Catani is president of Dur-O-Wal Inc., Arlington Heights, Ill., a manufacturer of ties, anchors, and joint reinforcement.

References

1. ASTM A 167, "Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip," American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.
2. ASTM A 153, "Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware," ASTM.
3. ASTM A 641, "Specification for Zinc-Coated (Galvanized) Carbon Steel Wire," ASTM.

Other useful information on joint reinforcement

NCMA-TEK 12-2, "The Structural Role of Joint Reinforcement in Concrete Masonry," National Concrete Masonry Association, 2302 Horse Pen Rd., Herndon, VA 22071

Technical Bulletin No. 93-1, "How Does $\frac{3}{16}$ " Diameter Fit In?" Dur-O-Wal Inc., 3115 N. Wilke Rd., Arlington Heights, IL 60004

Technical Bulletin No. 92-1, "Joint Reinforcement/Connector Detailing Guide," Dur-O-Wal Inc.

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