Unlike arches, which carry loads in compression, beams and lintels act as flexural members spanning horizontally between supports. Beams are primary supporting members in a structure, but lintels usually are smaller members spanning and carrying only the loads immediately above window and door openings. Whether they’re made of steel, reinforced masonry, stone, concrete, or wood, lintels must resist compressive, bending, and shear stresses.

Arching action

Masonry laid in running bond creates a natural corbeled arch (Figure 1). In fact, before true masonry arches were invented, corbeled arches, vaults, and domes were used to span openings too large for a single block of stone or length of timber.

Lintels must be designed to carry their own weight, plus the weight of the masonry inside the triangle formed by the line of arching action. This triangular area has sides at 45-degree angles to the lintel; therefore, its height is one-half the span length (Figure 2). Outside this area, the weight of the masonry and any uniform loads from the floor or roof above are assumed to be carried to the supporting abutments by natural arching. For this assumption to be true, however, the arching action must be stabilized by 8 to 16 inches of masonry above the top of the triangle.

If arching action cannot be assumed to occur because of inadequate height above the load triangle, or because the masonry is not laid in running bond, the lintel must be sized to carry the full weight of the wall above it, including that occurring outside the triangle. When arching action is assumed, the lintel requires temporary support until the mortar has cured enough to allow the masonry to bear its share of the load.

Arching action produces a horizontal thrust at each abutment...
(Figure 2). The abutments, therefore, must have enough mass to resist this force. If the opening is near a corner or another opening, or if a movement joint occurs at the side of the opening, it also may be necessary to size the lintel to carry all of the loads above it, without assuming any arching action in the masonry.

Whether above or below the top of the arching load triangle, concentrated loads are distributed as uniform loads along the base of a triangle whose sides are at 60-degree angles to the lintel (Figure 3).

Once the total load on the lintel is known, it can be sized to resist the calculated stresses. Deflection should be limited to 1/600 of the span to avoid cracking the masonry.

**Lintel types**

Structural steel shapes are commonly used to span openings in brick masonry. Steel angles are the simplest shapes and are suitable for openings up to 8 feet wide, where superimposed loads are no more than 5,000 pounds per lineal foot. For wider openings or heavier loads, steel beams with suspended plates can be used (Figure 4). Steel angles should be a minimum of ¼ inch thick. The horizontal leg should be at least ½ inches wide to support a nominal 4-inch wythe of masonry adequately. The bearing length at each end of the lintel should be at least 4 inches.

Openings in concrete masonry walls are spanned more commonly with U-shaped lintel blocks, reinforced with deformed steel bars and grouted. Standard brick also may be used to construct reinforced masonry lintels, even though they do not have continuous channels for horizontal steel. Reinforcement can be added in bed joints or in a widened and grouted collar joint created by using half units (Fig. 5).

Reinforced masonry lintels should be the same width as the wall they support, and should have a minimum bearing length of one half the unit length. Design aids have been developed and published in technical notes by both the Brick Institute of America (BIA) (Refs. 1 and 2) and the National Concrete Masonry Association (NCMA) (Refs. 3, 4, and 5). These can be used to select the appropriate amount of reinforcing steel for brick or block lintels (see also “How to Design Reinforced Masonry Lintel,” *Masonry Construction*, March 1991).

Steel and timber industry design manuals can be used to size lintels of these materials. BIA Tech Note 31B (Ref. 6) also contains design tables for the most common steel lintel sizes. Design tables also may be used for concrete, precast concrete, natural stone, and cast stone lintels. Of course, simple engineering analysis can be used in designing lintels of any material. Some proprietary support systems also provide flexural strength for masonry lintels (see *Masonry Construction*, December 1991).

Steel lintels should be hot-dip galvanized for corrosion resistance. Field cuts and welds should be coated with a zinc-rich “galvanizing” primer. Exposed surfaces also may be painted but will then require periodic maintenance.

**Accommodating movement**

Building movement must be considered in any type of construction, and exterior walls are particularly subject to differential thermal, moisture, and structural movements. Walls built of homogeneous materials generally experience less differential movement than those combining dissimilar materials. Interior walls also experience less movement than exterior walls exposed to different thermal and moisture environments on opposite sides.

Control joints in concrete masonry and expansion joints in clay masonry usually are recommended adjacent to windows and doors because walls are weakest at openings and therefore most vulnerable to cracking from thermal and mois-
ture movements. To be most effective, movement joints should separate the masonry carried by the lintel from that in the adjacent wall. This ordinarily means locating them at the end of the lintel.

In multistory buildings, sills and lintels must be the same length in order for the joints to align vertically. If sills and lintels are of unequal lengths, some alternative detailing is needed to align movement joints with the opening and avoid an offset.

A piece of flashing placed under the lintel bearing area prevents bond between the steel and the masonry and allows slippage to occur without cracking. A backer rod or bond-breaker tape and sealant should be used in the joint at the front edge of the lintel because mortar at this location will crack and spall.

Alternatively, reinforced masonry lintels can be designed as continuous bond beams across several openings, allowing greater flexibility in the location of movement joints away from the windows and doors. Even in 4-inch veneer walls carried on steel angle lintels, installing joint reinforcement in the courses just above and below the opening can strengthen the wall section against movement cracks; this way, control and expansion joints can be placed in less noticeable locations.

Thermal and moisture protection

Since any opening in a wall is an opportunity for a leak, moisture protection at lintels is critical. In walls constructed of single-wythe concrete block or through-wall hollow brick, only a thin face shell and a correspondingly thin mortar joint separate the interior of the wall from rain and wind. Moisture that penetrates the exterior face flows down through the open cores of the units and must be redirected back to the outside just as it is in cavity walls.

Flashing should be located above reinforced masonry lintels as well as steel lintels. In single-wythe walls, there are several ways to install flashing. With standard units, metal throughwall flashing can be installed as shown in Figure 6A. The back leg of the flashing is turned up to prevent water from flowing toward the inside, and weep holes or cotton wicks can be used to drain moisture. If the first course of units above the lintel is laid with face-shell bedding, the cotton wicks should be spaced at 16 inches on center, extend-
prevent moisture from flowing toward the inside.

Figure 6C shows the Flashing Block™ design developed by NCMA researchers, with integral weep hole slots and a reglet for the back leg of the flashing. (Because this is a new design, check availability before specifying Flashing Block™.) Single-wythe clay masonry walls can be similarly detailed, as can walls with one-piece precast concrete or stone lintels. Unless solidly grouted, single-wythe walls generally are more suitable in drier climates.

Single-wythe walls insulated only with loose-fill perlite or vermiculite will have a thermal bridge at the flashing and lintel courses, where the thermal resistance is lower than the rest of the wall. In climates where high thermal resistance is required, or where condensation of moisture vapor may be a problem, higher performance is achieved with continuous insulation located at the inside face of the wall. When required, vapor retarders should be located on the warm side of the wall. Air barriers also may be required in some instances to minimize condensation.

Masonry cavity and veneer walls require that flashing at lintels extend from the exterior face of the masonry across the cavity and into the backing wall. Where masonry forms the backing wythe, the flashing should be turned up and inserted into a mortar joint (Figure 7A). If the window or door frame bridges the cavity, soft joints should allow for any potential differential deflection or shortening of the two wythes. Air and vapor movement also should be controlled carefully to prevent heat loss or condensation. Insulation in the wall cavity should continue below as well as above the flashing to reduce thermal bridging.

Lintel flashing should extend behind the sheathing or be lapped underneath the building paper so that its top edge is not exposed (Figure 7B). Air and vapor movement also should be controlled, but the exact location and installation of air barriers and vapor retarders may vary slightly depending on environmental conditions and type of construction. Generally, however, foil-backed gypsum board is not adequate because the joints cannot be sealed.

Flashing should be turned up at the end of lintels to form an end dam, and all joints should be lapped and sealed. If stainless steel or copper flashing is used with galvanized steel lintels, the two metals must be isolated to prevent galvanic corrosion. A piece of 15-pound, asphalt-impregnated roofing felt provides the required separation.

References
2. “Reinforced Brick and Tile Lintels,” BIA Technical Notes on Brick Construction, Number 17H, BIA.
3. “Concrete Masonry Lintels,” NCMA-TEK 25, National Concrete Masonry Association, P.O. Box 781, Herndon, VA 22070.
4. “Concrete Masonry Lintels,” NCMA-TEK 25A, NCMA.
5. “Lintels for Concrete Masonry,” NCMA-TEK 81, NCMA.
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