Masonry Defects: Arches

Article and photos by Gregory Havel

Masonry is made up of brick, stone, or concrete masonry units (CMUs or concrete blocks) connected by mortar. Walls of masonry, whether load-bearing or veneer, may have weaknesses because of the following:

- Use of soft or porous stone for exposure to loads or weather.
- Poor quality of bricks or concrete masonry units because of inferior raw materials or manufacturing processes.
- Deterioration of mortar because of to moisture, weathering, or overloading.
- Unstable foundations or failing structural elements that support the masonry (photo 1).
When masonry walls are weakened, the most common sign is cracking. Mortar (the connector) often fails first, and the crack will follow the mortar joints (photo 2). However, if the mortar is stronger than the masonry unit, the brick or stone may break. Even if the cracks in a masonry wall have been repaired, assume them to be weaknesses in the wall.

Arches in masonry walls deserve extra attention since the failure of an arch on a lower floor may cause the collapse of a large part of the wall and roof. These arches may be one of the varieties of flat arches as shown in photos 1 and 2 or they may be the more traditional semicircular arches as shown in photos 3 and 4.
An arch is made up of several structural members, which follow:

- The **piers** are the vertical sides of the opening below the arch itself. They carry the load supported by the arch and direct it downward toward the foundations. In photo 3, the piers are the masonry on the sides of the window openings. Piers must have significant mass to prevent their collapse because of the arch attempting to flatten under its load and tip the tops of the piers outward. If the piers do not have enough mass, they can be tied together at the top of the pier.

- The **voussoirs** are the individual masonry units that make up the arch. In photo 3, the voussoirs are made of brick that is the same size and shape as the rest of
the masonry units in the wall and tapered mortar joints to form the curve. In other arches, the voussoirs are tapered, while the mortar joints have parallel sides.

- The **keystone** is placed between the top voussoirs to complete the arch. In photo 3, the keystone is a brick that is the same size and shape as the rest of the masonry units in the arch. Often, keystones are larger and more decorative than voussoirs.

Any cracking of any shape in masonry arches is a sign of a critical weakness in that part of the wall, whether the masonry is load-bearing, nonload-bearing, or decorative (photo 4).

Defects in masonry and masonry arches can be most clearly seen during daylight visits to a structure and deserve notes in our preincident plans. These notes on defects may be the only warning we have at an incident of impending structural collapse, especially at an incident at night or when the building is obscured by fog or smoke.

---

**Gregory Havel** is a member of the Town of Burlington (WI) Fire Department; retired deputy chief and training officer; and a 30-year veteran of the fire service. He is a Wisconsin-certified fire instructor II, fire officer II, and fire inspector; an adjunct instructor in fire service programs at Gateway Technical College; and safety director for Scherrer Construction Co., Inc. Havel has a bachelor's degree from St. Norbert College; has more than 30 years of experience in facilities management and building construction; and has presented classes at FDIC.

[CLICK HERE](#) for more 'Construction Concerns' articles!