Figure 9-6 Opposing moisture expansion of brick and curing shrinkage of concrete slab can cause cracking at building corners if differential movement is not accommodated.

develop shearing stresses in areas of minimum cross section, so diagonal cracks often occur between window and door openings, usually extending from the head or sill at the jamb of the opening. When masonry walls are built on concrete foundations that extend above grade, thermal and moisture expansion of the masonry can work against the drying shrinkage of the concrete, causing extension of the masonry wall beyond the corner of the foundation or cracking of the foundation (*Fig. 9-6*). The concrete contracts with moisture loss and lower temperatures, the brick expands with moisture absorption, and cracks form near the corners. Flashing at the base of the wall serves as a bond break between the masonry and the foundation and allows independent movement without such damage.

Brick parapet walls can be particularly troublesome because, with two surfaces exposed, they are subject to temperature and moisture extremes. Differential expansion from the building wall below can cause parapets to bow, to crack horizontally at the roof line, and to overhang corners (*Fig. 9-7*). Through-wall flashing, although necessary, creates a plane of weakness at the roof line that may amplify the visual problem, but allows the differential movement to occur without physical damage to the masonry. If parapets are included in a building design, additional expansion joints can accommodate movements in the parapet without excessive sliding at the flashing plane, and without bowing or cracking in the parapet itself. Adding steel reinforcement also helps to counteract the tensile forces created and prevent excessive

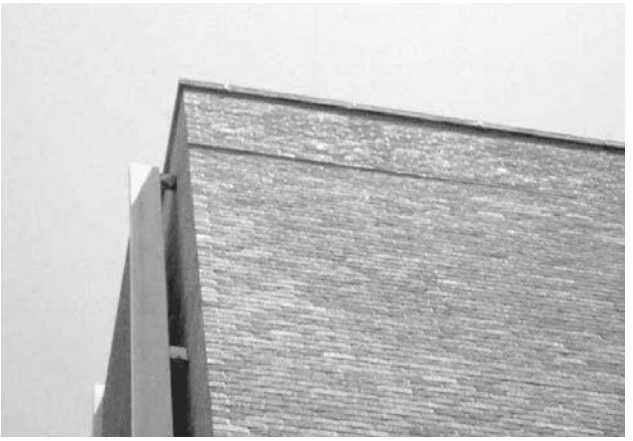

Figure 9-7 Parapets can expand and contract at a different rate than the building walls below.

movement. The same material should be used for both wythes of multi-wythe parapets so that the back and front of the wall expand and contract at the same rate.

Floor and roof slabs poured directly on masonry bearing walls can curl from shrinkage, deflection, and plastic flow of the concrete. If the slab warps, it can rupture the masonry at the building corners and cause horizontal cracks just below the slabs. To permit flexibility, a horizontal slip plane should be installed between the slab and wall, running 12 to 15 ft back from the corners and terminating at a movement joint. This will relieve the strain at the points where movement is greatest (*see Fig. 9-8*).

Vertical shortening of concrete structural frames from shrinkage or creep can transfer excessive stress to masonry cladding. Failures are characterized by bowing, by horizontal cracks at shelf angles, by vertical cracks near corners, and by spalling of masonry units at window heads, shelf angles, and other points where stress is concentrated. Horizontal soft joints must be provided to alleviate these stresses and allow the frame to shorten without damage to the masonry (see Chapter 10 for details). Where structural steel columns are protected by masonry, the greater temperature movement of the column can be inadvertently transmitted to the masonry and cause cracking. To prevent this problem, a bond break material should isolate the masonry from the steel to prevent mortar bond, and flexible anchors should be used to accommodate the differential movement.

To avoid problems of cracking and subsequent moisture leakage, differential movement between various types of masonry, and between masonry and other materials, must be accommodated by isolation, by flexible anchorage, and by vertical and horizontal expansion joints.

9.2 FLEXIBLE ANCHORAGE

When masonry walls are connected to steel or concrete frame buildings, differential movement must be accommodated in the anchorage of one material to another. Even if the exterior masonry veneer carries its own weight to the foundation without shelf angles or ledges, the columns or floors provide the lateral support which is required by code. Flexible connections should allow relative vertical movement without inducing stresses which could cause damage (i.e., they should resist the lateral tension and compression of wind loads, but not in-plane shear movements). Various types