Consultants Corner

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Cracks

Cracks in stucco, cracks in drywall, cracks in concrete, cracks in masonry and mortar. Most buildings have them; many of them are too small to be noticed. We are going to explore some of the factors that lead to cracks and why some are of concern and others are not.

The basic reason that cracks occur is the lack of flexibility in relatively rigid building materials. Obviously, that flexibility would be unnecessary if there was no movement in buildings. The problem is that there is always movement in buildings. All buildings settle and conform to their loads as they are constructed. Many building materials shrink as they cure or dry. Thermal expansion and contraction can cause structures to swell and shrink between day and night, summer and winter.

Long term settlement of soils in response to building loads and seasonal movement of expansive soils can cause flexing that exceeds the capacity of rigid building materials to adapt. Stresses on buildings due to minor earthquakes, wind, snow, or even changes in loads, such as furniture, large numbers of people, remodeling, adding/removing walls, counters, etc., can cause building elements to shift or warp over long periods of time.

While these events are all considered "normal" building movement, movement due to excessive differential settlement, significant lateral or vertical earth movement, significant earthquakes, failure of structural elements or connections, impacts or forces from moving objects, such as falling trees, floods or vehicles, are considered unusual building movement. Unusual building movement can be minor, resulting in only cosmetic damage, or it can result in structural damage that requires major repair to restore the building's previous integrity.

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Most outdoor cracks are due to a combination of shrinkage/curing of materials and thermal expansion and contraction. Stucco walls will frequently crack in the area where large panels join narrow panels. That's because the tension that develops from the shrinkage in the large panel makes it pull away from the small one. This frequently results in cracks between the small panels above doors and windows and the large panels of adjacent walls. This same crack pattern appears in concrete slabs if large panels are cast contiguously with small or narrow ones.

Some of these cracks are virtually invisible at first, but widen as repeated thermal changes cause movement. Stucco on a house may have the same initial shrinkage cracking all around the house, but the extra thermal activity on the sunny side will cause the cracks there to widen and become more obtrusive.

New houses today seem to suffer more cracks than those of the past. There are several reasons for this. One is the speed with which new houses are constructed. When houses took longer to build, the structure had time to adjust to its own load and the initial settlement of the foundation had time before rigid finishes were applied. In addition, more cured lumber was used, as well as other materials that experience curing/shrinkage, such as masonry, concrete and wood. All had time to complete

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Earth Systems

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their initial shrinkage prior to finishes being applied.

Concrete slabs often have cracks. Most of these are due to differential shrinkage of the concrete. Concrete shrinks as it cures and dries. If the shrinkage occurs before the concrete has developed enough tensile strength to resist the internal tension caused by the shrinkage, the concrete will crack.

A concrete panel that is significantly longer than it is wide will have more shrinkage in the long direction than the shorter width. Cracks are more likely to appear crossing the short dimension (more tension, less cross sectional area to provide tensile resistance). Shrinkage cracks are often crested; that is, there is a high point in the slab at the location of the crack. This is a result of the differential curing and shrinkage between the top of the slab and the bottom of the slab. The top dries, shrinks, and develops tension before the bottom does and the pieces of the slab tend to curl, causing lift at the crack. This is similar to the process that causes curled pieces of soil in a dried mud puddle.

The more wet the concrete, the more it shrinks; concrete with higher proportions of fine grained material shrink more than that with larger aggregate. Temperature is a factor in overly rapid drying, but wind is just as important and humidity is a key factor. Proper curing involves maintaining moisture and temperature in concrete for several days after casting the slab.

Cracks that are due to differential movement in buildings and slabs are frequently harder to interpret. A 45-degree crack in a wall could be due to downward movement of the foundation below the wall, settlement of one end of the wall, or movement of the rest of the building relative to the wall. Displacement along the crack is a major clue. If a jagged crack is wider in sections going in one direction, then movement in the direction aligned with the narrow segments can be inferred. If the crack is of relatively even width, then tension perpendicular to the cracks is likely.

Cracks can appear in slabs with relatively minor differential movement. A floor level survey is frequently necessary to determine what movement has taken place. If a slab appears to have a hump in the middle, then the movement may be due to heaving of expansive soils under the slab or settlement of the footings at the slab's perimeter.

If the slab is flat, but tilted, there could be settlement of one side or the slab might have been built out of level. Truly random and closely spaced cracking can be an indication of cement-aggregate reaction. The swelling of the aggregate or formation of crystals by the reaction can cause stresses in the slab that cause cracking and/or flaking of the concrete.

Some cracks may only *indicate* a problem; some may *be* a problem. Most cracks are cosmetic, but cracks can also be detrimental to the system's functionality. One of the purposes of stucco is to keep water from the interior of a wall. A crack in the stucco can allow water access. This is not necessarily an immediate problem because if the flashing and papering under the stucco is properly done, the water still won't reach the interior. But if the papering is faulty or if water is allowed access for an extended period, problems can result.

The life of a pavement depends, to a degree, on the protection of the soil subgrade from water. Soil saturation can result in a subgrade with little resistance to flexing and eventual deterioration of the pavement. Cracks become potholes. Cracks in floor slabs can allow access to bugs and moisture, two items that houses are built to keep out. Cracks in structural members can actually weaken a structure, making it less resistant to earthquakes or other forces.

Cracks should not be taken lightly, but neither are they reasons for panic. They are most often the result of complicated interaction of building systems, and their cause is not always obvious or easy to determine. Cracks should be evaluated by knowledgeable professionals. A consultation with your local soil engineer is a good place to start, particularly if there are other signs of soil movement, but to fully understand a cracking building it may be necessary bring aboard structural engineers, specialty contractors, building material manufacturers or others.