Damage Engineering Insights:
commercial • energy • infrastructure • manufacturing

SOME STRUCTURAL ENGINEERING ASPECTS OF DAMAGE

Concrete in buildings, structures, energy, and industrial applications

Building a temperature road map — Repairing cracking — Time-sensitive repairs

Concrete: We encounter it in many damage engineering situations. It's the most widely used man-made material in all of construction, used in buildings, equipment foundations, structures, etc.

CAUSE—Fire-damaged concrete can be a temperature road map—useful as part of the reconstruction of the chain of events and helpful in the scoping of the damage. Excessive heat can cause the surface of concrete materials to discolor.

- Under 100° C (215° F) —concrete will usually withstand temperatures up to this point
- 300° C (570° F) and above —concrete will turn pink because of dehydration of iron minerals in the aggregate and cement paste
- 600° C (1,110° F) and above —often a light grey discoloration is visible
- Excess of 1,000° C (1,830° F) —concrete can turn brown and/or yellowish

Often exposure to high temperatures will necessitate the removal and replacement of concrete. Spalling is another common trait of exposure to high temperatures. However, concrete is resistant to most fires and may be undamaged at depth and readily repaired.

COST—Scope of damage usually drives costs so there is always the question: Does it need to be repaired? *Cracking* does not necessarily indicate the need for replacement or repair.

Nearly all structures made of concrete will crack to some extent. Shrinkage cracks that result from drying and thermal effects after the original pour are typical.

The size and general appearance of the cracks as well as the cracking pattern may necessitate examination of causative factors to determine the need for repair. Sometimes crack monitoring is the appropriate next step. The cracks may be due to:

- tension loading
- settlement
- explosions
- fire
- chemical reactions & attack
- vibrations
- impact
- freeze/thaw cycles

Method of repair also drives costs: Cracks can often be cost-efficiently repaired after any causative factors are addressed:

- Injecting epoxy adhesives to "weld the cracks" can create an effective structural repair if the selected epoxy viscosity accommodates the crack width and the appropriate procedures are followed for the application.
- Polyurethanes can provide waterproofing of cracked areas but obviously do not provide a structural repair.

DOWNTIME—In cases where concrete members are on the critical path of a lengthy repair project with significant downtime penalties, increasing the strength of the damaged area can be a cost-effective repair method. These systems can include:

- Push piers: sections of galvanized or coated steel pipe driven into the soil and connected to the structure
- Helical piers: bladed piers are screwed into the ground with a hydraulic torque motor and connected mechanically to the foundation or wall
- Wall anchors: such as anchoring plates and rods to stabilize the concrete structure
- Cables: used as a temporary repair to hold up damaged walls or floor
- Buttresses: structures built against a wall to serve as extra support or reinforcement

Multidiscipline Damage Engineering™: Over 1,000 employees and technical specialists are put at your disposal. You can draw upon a variety of engineering disciplines when dealing with concrete: If the concrete aspects are significant—structural engineers; when underlying soil support is a concern—geotechnical engineers. When it is the concrete itself—our petrographers read the microstructure of concrete like a metallurgist reads steel microstructures. Non-destructive testing (NTD) and laboratory measurement of the compressive strength of the concrete can be performed.

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