Concrete Repair Or Replacement Requires A Thorough Evaluation

by George W. Seegel recht
Evaluation Engineer
Kaml Farahmandpour
Evaluation Engineer
Steven H. Gebler
Senior Principal
Evaluation Engineer
Construction Technology
Laboratories, Inc.
Skokie, Illinois

Whether you are involved with the preservation, rehabilitation, repair, restoration or replacement of a structure, understanding the reason it has deteriorated is the first step toward a successful fix. Although each repair situation needs to be approached based on its particular circumstances, some basic principles apply.

Determination of the cause, severity, and extent of concrete deterioration, provides essential information needed to make decisions concerning the correct repair approach and selection of appropriate materials. This information also helps the owner decide whether it would be more beneficial in the long term to consider complete removal and replacement instead of repair.

When evaluating distressed concrete, it is important to clearly distinguish between symptoms and causes. Cracking as well as leakage are common symptoms visible as a result of earlier problems with design, workmanship or materials.

Fixing only an unsightly symptom without determining the actual cause is sure to result in another repair project in the near future.

The American Concrete Institute provides numerous guidelines and checklists of items to cover when examining structures (ACI 224, 364).

An evaluation will generally involve the following steps:

A. Document review: Plans, specifications, maintenance and repair records.
B. Site Observations : Visual inspection of distress and overall structural condition.
C. Field measurement of pertinent items such as settlement, expansion, crack width etc.
D. Non-destructive testing of in-place concrete.
E. Exploratory openings to inspect condition of hidden materials.
F. Sample removal, testing of specimens and analysis of results.

The above items will help provide information to explain the observed structural deterioration.

As an engineer begins an evaluation and examines the background or history of a structure, a review of available project documents saves time and money by providing information that may otherwise require costly "as-built" surveys or testing.

Owners should retain such documents as drawings and construction records which help direct a more efficient use of time in the field when conducting site observations. Use of this information can preclude the use of repair techniques or materials which were successful.

Field measurements of cracks, settlements or deformations, and observations of leakage or water related damage help to build a picture of the mechanisms involved with the observed deterioration. Non-destructive testing methods such as impulse radar, pulse-velocity and pulse-echo can give a relative indication of the location of reinforcing steel, voids, delaminations, etc., and thereby, provide a basis for the location of subsequent exploratory openings and required sampling frequency needed to provide representative information of the in-place materials.

Corrosion of the reinforcing steel is often found to be the cause of concrete delamination and spalling.

Once the cause of the deterioration is determined, a suitable repair technique can be developed. The development of repair methodology will likely include the following steps:

1. Define the objectives of the repair. The objectives should address the durability requirements of the repairs, and in some cases may include an improvement of the original structure.

For example, the objectives of repair for a chloride contaminated parking deck should include the removal and replacement of the delaminated concrete, and keeping moisture away from the concrete to reduce future corrosion. The addition of a waterproofing membrane would be an improvement of the original structure.

2. List all feasible conceptual options for the repairs. Options will always include the complete removal and replacement of the structure. The owner's options may also

(Continued on Page 31)

CTL

(Continued from Page 29)

include judicious neglect which may be the most economical option in the short term.

This may be the case where the intended service life of the structure has been reached, yet only minor surgical damage is evident in a structure scheduled for replacement in the near future.

Conceptual repair options also often include various application methods such as shotcreting, placement by pumping into the forms, hand patching, or conventional cast-in-place methods. Based on the intended service life of the repair the engineer may recommend the application of secondary protection such as waterproofing membranes.

3. Once the best repair approach has been developed, suitable materials should be selected. The selected materials should be resistant to the elements that caused the original materials to deteriorate. They should also be compatible with the original materials, other repair materials and the application method. Each of the relevant properties should be considered before selecting or specifying a material.

4. The feasibility of the repair approach should be evaluated. Site limitations such as expected weather conditions, access for large equipment, and time constraints should be considered.

5. The refined conceptual repair methodology should be evaluated to determine its economic value. In many cases, the most durable repair is the most expensive one.

If the structure can be easily put out of service periodically, a less expensive (and less durable) repair may be the most economically justified approach. However, if the structure cannot be put out of service without a cost penalty, the most durable (and most expensive) repair should be selected. Life cycle analysis of the repair costs are routinely performed by owners to economically evaluate repair alternatives.

6. Once a conceptual repair alternative has been selected, a set of specifications should be prepared to assure that all repair alternatives are met.

At this stage, all details related to the repairs should be worked out. In some cases structural analysis may be needed to determine the size and spacing of supplementary reinforcing steel. Of course, good specifications will not be effective without proper field monitoring.

At any given stage in the development of repairs, the engineer may have to repeat the above process. For example, if the economical evaluation of a repair alternative indicates that a certain alternative is cost prohibitive, he may have to re-define the repair objectives to provide short-term "band aid" repairs.

It is important that the owner, the engineer and the contractor communicate in the above process. It is obvious that the evaluation process should be initiated by the owner and performed by the engineer.

However, many engineers and owners neglect the importance of involving the contractors in the development of repairs. The evaluation of feasibility of a repair procedure should involve a contractor experienced with that particular type of repair.

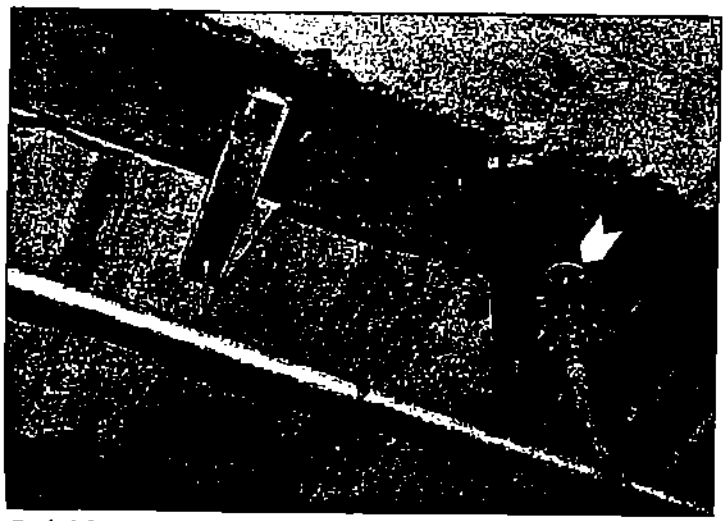
Another area where the input of a contractor is needed is the economical evaluation of the repairs. Once again, the contractor is the only party who can provide reliable cost estimates for the work.

Keep in mind that each specialty repair can be intricate and specific to the project, and cannot necessarily be estimated using standard estimating guides such as Means Construction Cost Data.

In preparation of repair alternatives, economical evaluation is probably the most frequently neglected step. However, without the knowledge of repair cost, remaining useful life of the structure, life cycle analysis cannot be performed.

In summary, a successful repair project begins with a thorough evaluation to determine the cause of deterioration. Repair procedures should be developed to meet the particular objectives and limitations of the project.

Repairs are most successful with proper quality control and quality assurance. It is important to understand the roll of the owner, the engineer and the contractor in this process.



For the ledge repairs, a pumpable cementitious patch mix was pumped through a port at the bottom of the form work (arrow).