

Investigation of Concrete in Service

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•A REPORT on procedures, techniques, and examples of investigation of concrete in service is timely because of the increasing frequency with which such studies are undertaken and because new methods for analysis and evaluation of concrete in service have been developed recently. It is quite appropriate that the application of these methods be examined with a view toward determining their accuracy and reliability. Examples of such methods are nondestructive tests of concrete in place, new concepts on sampling of concrete, new physical tests of concrete, and new analytical techniques by which the composition of concrete can be determined or estimated.

An investigation of performance of concrete in service usually deals with failure or with some substantial inadequacy of the work. On the other hand, an investigation might be made to evaluate the condition of the concrete and concrete construction without any immediate consideration of failure. Or, a study might be made to determine why a particular concrete has performed outstandingly under severe conditions. In general, support is readily available for investigation of concrete that has failed in service, but we should not overlook the probability that examination of outstanding concrete construction will lead to improvement in standards for accomplishment of future work.

Diagnosis of real or apparent failure or unsatisfactory performance of concrete may be undertaken for any of several reasons. Concrete involved in unsatisfactory performance might be investigated to establish the ability of the concrete to continue to perform under anticipated conditions of service. The study might be made to identify processes that have caused or contributed to unsatisfactory performance. The objective may be to discover any defects in the concrete or the construction that contributed to the unsatisfactory condition. The study might be made primarily to establish remedial methods or protective measures that should be applied to provide for continuing service. A common objective of such investigations is the fixing of financial or legal responsibility for the failure or unsatisfactory performance. The scope of investigation and the procedures that are most appropriate depend to a great degree on the objectives to be achieved.

Investigations of unsatisfactory performance of concrete in service usually are based on a conclusion by the owner or his representative that unacceptable conditions have developed or are imminent. This decision is subjective to some extent because what is unsatisfactory performance in one region or in one condition of service may be acceptable elsewhere, or one owner or architect-engineer may be disturbed by a condition that is acceptable to another who is more phlegmatic, sophisticated, experienced, or cynical. That is, is the crack, the strain, the deflection, or the surface scaling sufficient to justify concern and at what point in time should an investigation be undertaken in an effort to assess the condition of the concrete and its future prospects? Such conclusions vary also over the course of time. It is to be hoped that standards or criteria of performance will rise so that we are less content to accept the "inevitable" cracks, pop-outs, scaling, or deflections.

Investigation of any substantial failure of concrete should be undertaken in accordance with an agreed-upon scope, objective, plan of attack, and prospective time schedule. At an early stage, a suitable budget of manpower and facilities should be arranged and the line of responsibility for prosecution of the investigation should be established. These decisions are based initially on preliminary observations and information available at that time. However, the investigation usually can be developed most effectively in stages, each successive stage depending on what has previously occurred. This process is most efficient in terms of manpower and facilities, but the overall elapsed time

may be so great that less efficient expedients will be dictated by the requirements of safety and maintenance. Consequently, from an engineering standpoint, the two most important objectives of the examination of concrete in service are, first, to establish the probable nature and extent of actual or imminent failure and, second, to choose appropriate remedial or protective measures. Hence, these objectives should be given primary emphasis in the plan of investigation.

It is our hope that the papers that follow will provide guidance in the development of more effective investigations of performance of concrete in service, and that the promising potential and the limitations of new investigational techniques will be more clearly evident.