Symposium Summary

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THE SUMMER of 1957 represented the tenth anniversary of the first rather extensive use of the soniscope in testing concrete. It seems most appropriate, therefore, that this symposium has been held to review such use, to summarize the experiences of those who have used the instrument, to define the present state of knowledge with respect to interpretation of test results, to delineate areas of investigation in which sufficient information is not available for adequate analysis of tests results, and to point out potentially promising fields for further research.

It should be immediately appreciated that this symposium has dealt only with the measurement of pulse velocities through the use of the soniscope. It is acknowledged that other devices are being used for measuring pulse velocities through concrete and that the users of these devices and the users of soniscopes have not always agreed upon the interpretation of test results. It is believed, however, that the papers presented during the symposium represent an excellent cross-section of those who have made use of the soniscope. Indeed, practically every organization which has had extensive experience in such use was represented on the program.

In summarizing the opinions expressed in the formally presented papers and in the discussions following their presentation, it is quite clear that most investigators believe that there are two rather distinctly different categories of use of the soniscope. The first might be termed routine use. Such use is characterized by general agreement concerning procedures to be followed and by comparative ease in interpretation of results. The second category is research use, the characteristics of which are lack of agreement in regard to appropriate techniques, lack of information sufficient to permit adequate interpretation of test results, and the need for further investigative work.

ROUTINE USES

Several routine uses have been repeatedly detailed in the papers presented during the symposium. Foremost among these, and apparently agreed to be of greatest value at the present time, is the evaluation of uniformity in structure. Such evaluations have been made by a number of organizations. The testing normally involves the performance of many tests, frequently quite close to one another and usually in some form of grid pattern. Differences in measured velocities are taken to be indicative of variations in quality unless the observed velocity differences may be accounted for through some known physical variation in the structure. Investigations of this nature are particularly valuable where there is some visual indication of distress in the structure but where such indications and other test methods do not provide adequate information concerning the extent of the distress.

Another routine use of the soniscope lies in the determination of a trend in the performance of concrete over a period of time. Such tests may be made either on laboratory specimens or on structures. They involve the repeated performance of velocity tests on the same specimens or at the same locations on the same structures over a period of time, in some cases many years. Systematic trends in velocity variations during a number of such tests are believed to be indicative of similar systematic trends in the condition of the concrete.

A third use of the soniscope is the determination of a general level of concrete quality. It is agreed that high velocities are associated with concrete of good quality and low velocities with that of poor quality. It is realized that no very sharp delineation may be demonstrated between high and low velocities as used in this sense, and that many concretes will fall into a velocity zone which does not, per se, permit

adequate evaluation of concrete quality. It seems to be agreed, however, that either very good or very poor concretes may be readily identified through pulse velocity tests.

Crack detection might also be considered in some cases a routine use of velocity techniques. Certainly such techniques may prove useful in demonstrating the absense of major cracks in monolithic concrete. The full usefulness of this method in establishing the exact location and extent of cracks has probably not yet been realized.

RESEARCH USES

Some applications of soniscope testing have been described which it is generally agreed are not yet routine in nature, although in time they may become so. One of these, as suggested above, is the determination of the exact location and extent of cracks in concrete. Rather considerable work has been done in this area, particularly by the Ontario Hydro Electric Power Commission. Detailed information concerning such matters as the minimum width of crack which may be detected or the effect of water within the crack is not yet available. This does not eliminate the usefulness of the instrument in studies of this nature but suggests that extreme care be employed in interpreting test results.

Several authors commented upon the usefulness of soniscope tests in evaluating the setting or hardening of concrete. It has been clearly demonstrated that major variations in the velocity occur during the first hours or days after concrete is placed. Again the exact interpretation of such variations is not yet clear. This, however, does not obviate the usefulness of the technique in observing early changes in the nature of concrete.

Finally, rather considerable discussion was given to the evaluation of various other properties of concrete, notably strength, on the basis of pulse velocity tests. It was generally agreed that such evaluation is very difficult. In some cases useful and helpful information may be developed, but interpretation of the velocity tests must be undertaken with great caution. Such usage was certainly agreed to be other than routine.

AREAS OF AGREEMENT

In reviewing the several papers presented during the symposium, it is clear that in a number of instances there is almost complete unanimity of opinion among the authors. These areas are as follows:

1. There appears to be no urgency for further major developmental work on the soniscope itself. Few questions were raised concerning instrumentation or the ability of the instrument to perform in the desired manner.
2. It was universally agreed that the soniscope does not replace other testing techniques but rather supplements them. No author suggested that the testing of concrete be limited in any way because of the availability of pulse velocity testing techniques.
3. There was almost complete agreement that little was to be gained by computing anything except pulse velocity from soniscope tests. If anything further must be computed, it was agreed that this should be the dynamic modulus of elasticity.
4. There was uniform awareness among the authors of the grave difficulties associated with predicting either flexural or compressive strength on the basis of pulse velocity tests. Warnings were repeatedly given against such interpretation of velocity data.
5. It was generally agreed that pavement slabs represent the most challenging structural form for evaluation through pulse velocity tests. Comments ranged from complete lack of faith in their usefulness for testing slabs to mild statements of optimism concerning such tests.

During the course of the symposium, it was suggested that soniscope tests might prove useful and would doubtless be attempted in certain applications not previously widely made. With respect to concrete, the principal suggested use was in the quality control of products. It was specifically suggested that a plant producing precast concrete products in large numbers, over a period of time, and from presumably uniform materials and mixes, might well employ frequent pulse velocity tests of its products

to evaluate the uniformity thereof. It was clearly pointed out that such testing would not replace more routine physical testing to establish the level of quality of the product, but would merely assist in uncovering any deviations from this level.

Although the symposium dealt with the testing of concrete, several comments were made concerning the testing of other materials. It is apparent that the next few years will see rapid advances in the use of the soniscope in the testing of timber, soil, and bitumen-aggregate mixtures. Limited investigations are reported to have already been made in each of these fields.

RECOMMENDATIONS FOR FUTURE DEVELOPMENTS

The very real accomplishments in the field of pulse velocity testing of concrete during the past ten years notwithstanding, the symposium has brought to light certain areas in which additional work is clearly indicated. Some of these involve basic studies of the manner in which certain variables affect pulse velocity. Some data were presented which indicate that pulse velocities through concrete are not truly independent of size and shape of specimen, but may vary with path length or with volume of concrete normal to the path. Data were also presented to show that the pulse velocity was dependent upon the maximum size of aggregate used in the concrete and the percentage of paste incorporated therein. Questions were raised concerning the effect of moisture content of the concrete upon its pulse velocity. In all of these areas extensive basic research appears to be indicated.

Some discussion was given to the development of a suitable "test bar" or "standard" which could be tested repeatedly for the purpose of providing assurance that the instrument was operating in the proper manner. Several such standards have been developed by various organizations. There does not appear to be agreement upon which are best or whether any are truly satisfactory. This, too, is an area requiring further investigation.

Attention was called from a practical point of view to the very real need for an operating manual or some other form of publication which would clearly describe appropriate techniques in operating the soniscope, collecting information with it, and interpreting the results thereof. This information is probably available at the present time but is spread through the publications of several societies and has been published over a ten-year period. A material service to those interested in employing soniscope tests would be made by the preparation and publication of such a manual.

Finally, considerable discussion was given to the necessity for better programing in the testing of a structure. It was pointed out that tests made in a haphazard fashion are likely to give results which are of relatively little value. For the results of such tests to be of greatest value, transducer positions and test paths must be carefully selected. Attention was repeatedly directed to the work of Breuning and Roggeveen, which has been the most outstanding to date in this field.

SUMMARY

The papers presented during this symposium and discussions thereof show clearly the vast development in this field during the past ten years. The instrumentation has been completely developed during approximately this time and is satisfactory. The technique has progressed from one assigned solely to the research laboratory to one having numerous practical applications. Useful interpretation of test results may now be made in many instances although a complete understanding of all of the factors influencing such results has not yet been reached. The term "pulse velocity" has now become a proper fragment of the concrete engineers' vocabulary.