General Discussion

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● THIS SYMPOSIUM is a welcome opportunity for pooling knowledge and exchanging views on the subject of evaluation of pulse velocity data; and the organizers of this difficult task deserve special thanks.

The pulse velocity data and discussions presented in this symposium relate primarily to concrete. Actually, pulse velocity technique has been used with a considerable success for the testing of other highway materials such as soils (1, 2) and bituminous mixtures (3). The use of this technique for soil or bituminous mixtures has so far been confined to mostly laboratory samples and so far no data from field observations have been reported for structures (in situ) constructed with these materials. The laboratory data (pulse velocity vs compressive strength, etc.) have a scattering generally similar to that shown by concrete. It is found that pulse velocity data for soils generally follow, with a few exceptions, the pattern obtained in the laboratory testing of concrete under the same conditions. The pulse velocity technique for concrete is based primarily on a correlation of the pulse velocity and some other well known property, such as compressive strength or modulus of elasticity, which is taken to indicate the quality of concrete. Often the quality of concrete is directly interpreted from the relative changes in the pulse velocity observed under a given set of conditions. Due to the existing empirical nature of this technique, a number of limitations are inherent in this test method. Hence, while evaluating the pulse velocity test data, the various limitations should be kept in mind and, as far as possible, such data should be supplemented by all other available test information.

The interpretation of pulse velocity data for concrete, about which there is no other information, is a hazardous task fraught with difficulties and any conclusions derived from trends of pulse velocity alone should be treated with caution. Although it is now considered almost a general rule that changes in quality of concrete are reflected by corresponding changes in pulse velocity, several exceptions are known to exist and two such are reported in this symposium. In their paper, Woods and McLaughlin (1) report that the deterioration of concrete specimens subjected to alternate freezing and thawing cycles in the laboratory was hardly reflected by any consistent changes in pulse velocity. Similarly Meyer (4) shows that after 8 yr of regular observations of pulse velocity for several experimental concrete pavement sections in Kansas, no significant changes in velocity were noticed. In fact, he reports that visual evidence of deterioration was obvious before the condition was reflected by pulse velocity data. It seems that if some of the data reported by Spencer and Laverty (5) are corrected for seasonal variations, as suggested by Meyer, it is quite possible that they may come to a negative conclusion similar to those indicated above. No satisfactory explanation has been attempted for the lack of correlation in these and many other instances.

Such exceptions or negative conclusions point to the inadequacy of the empirical concept alone in interpreting the pulse velocity test data and emphasize the need for a basic theory, as was also pointed out by Pickett during the course of this symposium, which should take into consideration the fundamental principles involved in determining velocity of transient waves. In developing such a theory, consideration should be given to the nature of the stress-strain phenomenon caused by the propagation of transient low energy waves through a material ordinarily regarded as elastic. It is quite possible that the difference between static and dynamic moduli of elasticity might appear as a natural corollary from such a theory.

REFERENCES

1. Woods, K. B., and McLaughlin, J. F., "Application of Pulse Velocity Tests to Laboratory Studies of Materials." This Symposium.

2. Bernhard, R. K., and Finelli, J., "Pilot Studies on Soil Dynamics." Symposium on Dynamic Testing of Soils, ASTM Sp. Tech. Pub. No. 36 (1953).
3. Goetz, W. H., "Sonic Testing of Bituminous Mixtures." Proc., AAPT (Tech. Sess.) Vol. 24, p. 331 (1955).
4. Meyer, R. C., "Eight Years of Pulse Velocity Tests on Concrete Pavements in Kansas." This Symposium.
5. Spencer, R. W., and Laverty, B. R., "Appraising the Quality and Performance of Concrete by Pulse Velocity Measurements." This Symposium.