Characterization of an Old Concrete Pavement using the Pulse Velocity Method

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Abstract

A twenty year old concrete pavement block was characterized using the Pulse Velocity method. The compression wave velocity through the concrete (bulk velocity) varied significantly from the Pressure wave velocity near and along the surface (surface velocity).The surface velocity was in the range of 86%-88% of the bulk velocity along the driving direction and the direction perpendicular to it. ASTM 1383-98a[(1)] uses surface velocity as a representative of the bulk velocity for the thickness measurements of concrete plates. The results of the study revealed that ASTM 1383-98a might not be applicable in the cases where there is a noticeable difference between the surface and bulk velocity.

1 Introduction

When ultrasonic sound waves travel through solids, they interact with the material in ways that could be predicted and represented mathematically. By cerebral interpretation of the data various sub-surface anomalies can be predicted to a sufficient degree of accuracy.[(2)] Ultrasonic NDE method can also predict the thickness of concrete plates when only one surface is accessible to a fairly reasonable level of accuracy, subjected the surface stress wave velocity is a true representative of the bulk wave velocity. However, deviation between surface and bulk velocity is observed in real scenarios. This difference may be attributed to the fact that the top concrete surface has more of cement paste after casting and vibrating the concrete, and hence the composition could vary with the rest of the bulk concrete, thereby making the surface velocity different from the bulk velocity. Secondly, with ageing and use (traffic flow) the concrete surface deteriorates as compared to the bulk and hence creating the difference between the surface and bulk velocity.

2 Objective

The objective of the study was to characterize an aged concrete pavement block using the pulse velocity method (PV) and quantify the surface P-wave velocity(V_{ps}) and the bulk P-wave velocity (V_{pb}).

3 Instrumentation and Testing Program

The block dimensions were 72”X48”X12” and the measurements were taken using 50 kHz pulse velocity transducers (Figure1). Measurements were taken on all six faces of the block, along grid lines spaced 6 inches apart. The data was statistically analyzed and the mean surface and bulk velocities in various directions were calculated.

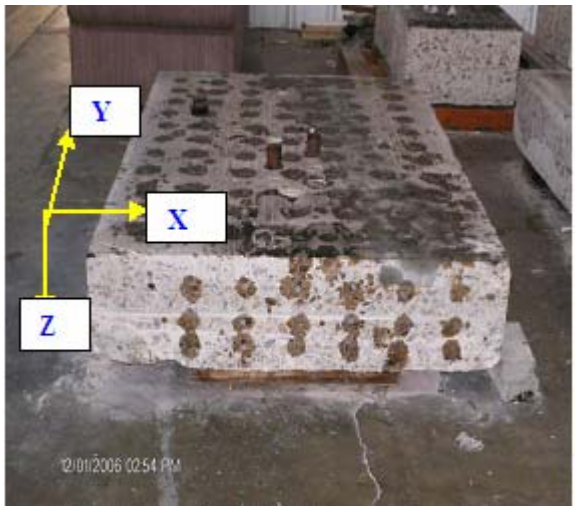

Figure 1. Concrete Block

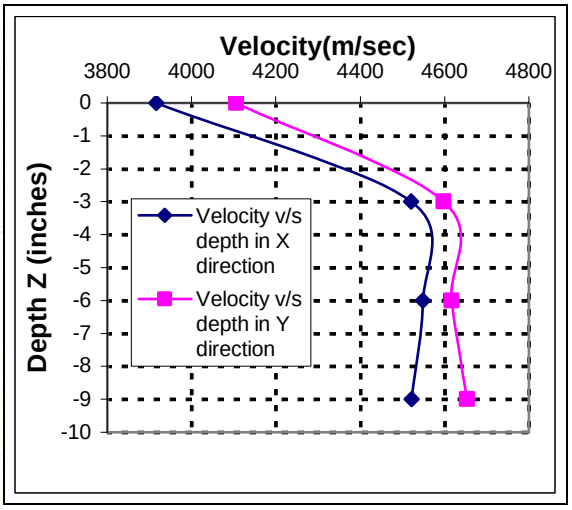

Figure 2. Variation of Bulk velocity v/s Depth

4 Results and Discussions

As shown in Figure 2. it can be observed that there is an increase in the bulk velocity with depth in either direction. Number of factors could cause this deviation, based on initial construction to wear and tear near the surface due to traffic. In the X direction the average bulk velocity (V^x_{pb}) was 4530 m/sec and the average surface velocity (V^x_{ps}) was 3915 m/sec. Similarly, in the Y direction the average bulk velocity (V^y_{pb}) was 4622 m/sec and the average surface velocity (V^y_{ps}) was 4106 m/sec.

5 Conclusions

A twenty year old concrete pavement block was tested to determine the pulse velocity on the surface and in the bulk material. The bulk velocity was 12% to 14% higher than the surface velocity.

6 Acknowledgement

Funding provided by TxDOT is very much appreciated. The funding agency is not responsible for any of the findings in this study.

7 References

1. ASTM 1383-98a, “Standard Test Method for Measuring the P-wave Speed and the Thickness of Concrete Plates Using the Impact-Echo Method”, ASTM International, 1998.

2. Shull. P.J, “Nondestructive Evaluation – Theory, Techniques, and Applications”, Marcel Dekker, Inc., New York, ISBN: 0-8247-8872-9.