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AN INSTRUMENT FOR DETECTING DELAMINATION IN CONCRETE BRIDGE DECKS

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Delamination detector in operation.

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An Instrument for Detecting Delamination in Concrete Bridge Decks

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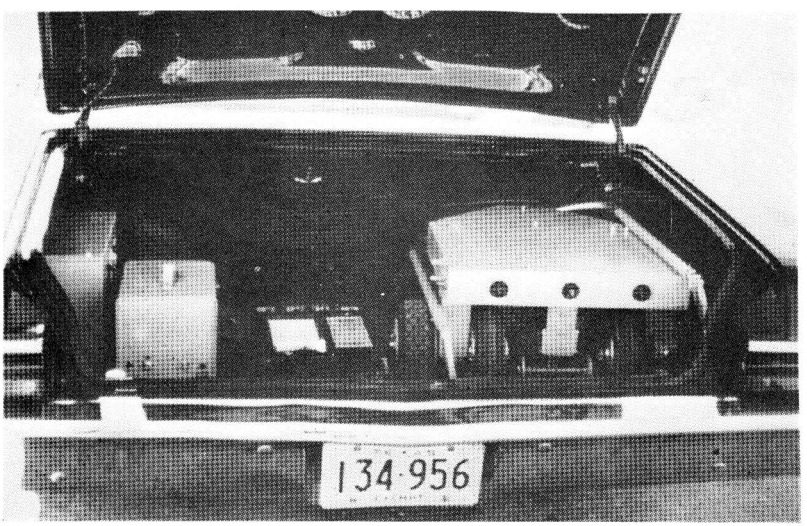
This report describes the results of a research effort directed toward finding a means for detecting delamination, one of the more serious forms of deterioration found in concrete bridge decks.

Early in the study it was decided that, although many factors are required to characterize the extent of deterioration in a bridge deck, there are two defects which can be considered to be of paramount importance. These are (a) delamination, which is a separation of the original slab into two or more approximately horizontal layers, and (b) poor quality concrete. Thus the major emphasis of this research has been directed toward methods and apparatus for detecting delamination and for detecting poor quality concrete. This report covers the results attained with respect to delamination detection.



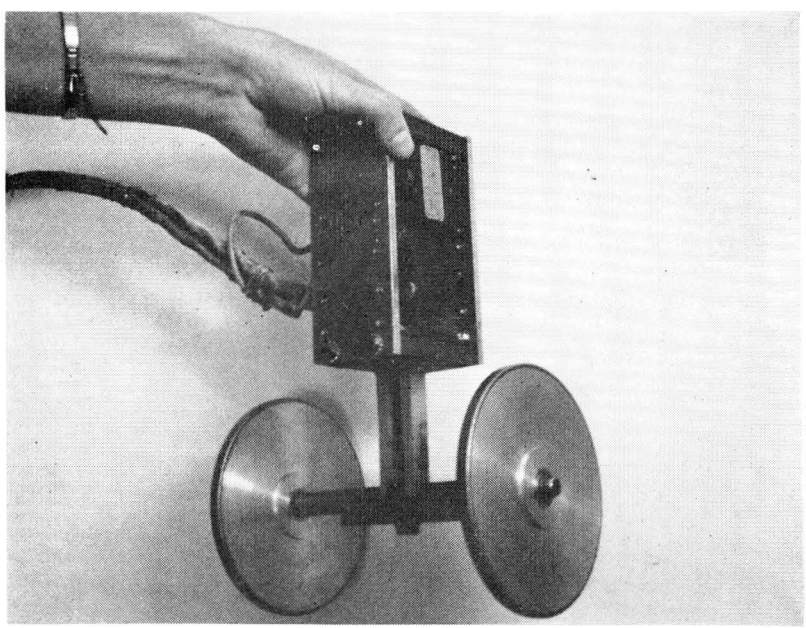
Delamination detector disassembled and stowed in an automobile trunk.

Methods of Detection

Upon investigation of existing methods for detecting delamination it was concluded that the best previous techinque consisted of tapping the bridge with a solid object and subjectively judging the resulting sound. A delaminated area produces a distinctive "hollow" type sound when the surface is struck. The sound produced when the concrete is struck depends greatly upon the vibrational characteristics of both the hammer and the concrete. If the hammer is highly resonant its sound is confused with the sound from the slab. Accordingly, the judgment of this sound by testing personnel remains a somewhat unreliable detection method.

After investigating several alternatives it was concluded that the acoustic response to a tapping-type stimulus offers substantial advantages over other possible approaches. The concept of an automatic device operating on this principle leads to requirements for the following three basic components: (1) a tapping device, (2) an acoustic receiver, (3) a signal conditioner to distinguish and produce the desired output.

Starting with these concepts a sonic instrument, referred to herein as a "Delamination Detector," was developed which indicates the presence of delaminated areas on concrete bridge



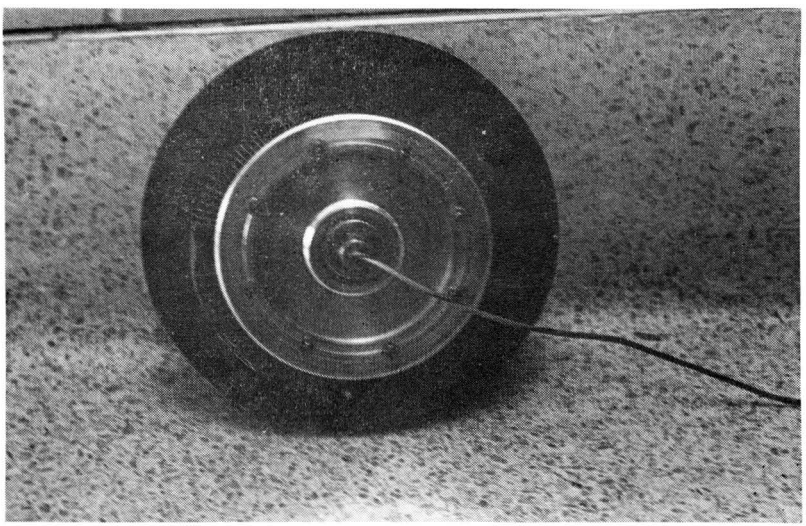
Oscillating solenoid causes wheels to tap deck 60 times per second.

decks. It develops a strip-map of the bridge showing the location and extent of the delaminated areas as it is rolled across the bridge.

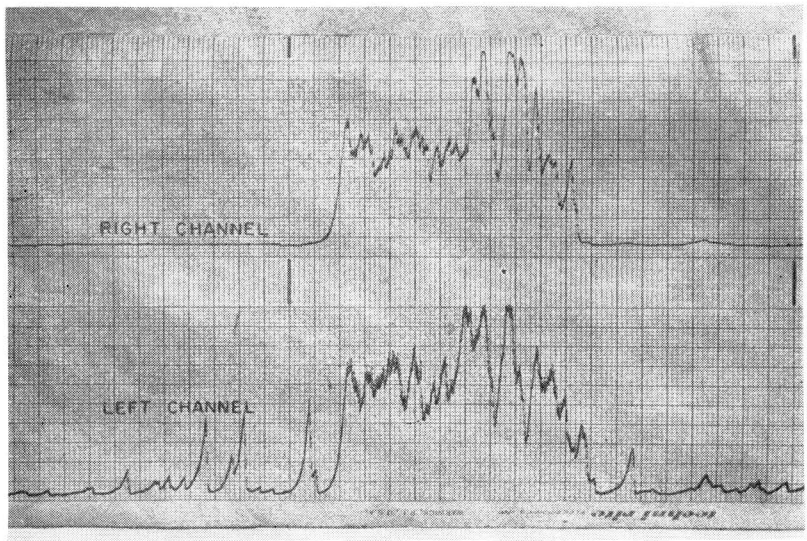
Description of Instrument

The Delamination Detector consists of a small cart, similar in appearance to a power lawn mower. It is equipped with a dual-wheel tapping device, a pair of sonic receiver wheels, and a two-channel pen recorder. The tapping device consists of an oscillating solenoid mounted on a pair of steel-rimmed wheels in contact with the concrete. The oscillating force is sufficiently strong to cause the wheels to "chatter" against the bridge deck surface. Each receiving wheel consists of an immersion-proof microphone (pressure transducer) mounted internally near the bottom of a soft rubber tire (innertube). Acoustic coupling to the slab is obtained by filling the tire with a mixture of ethylene glycol and water. This receiver has almost no sensitivity to ambient noises or surface texture.

As the cart is propelled at a fast walk, while the surface is being tapped sixty times per second, the acoustic signals received from the surface are analyzed and displayed on two independent traces of the pen recorder. The recorder indicates the presence of delamination by upward pen deflection and the location is indicated by position along the chart which is scaled in proportion to distance. On each traverse the detector surveys a pair of three-inch wide paths nine inches apart.



The rolling acoustic receiver consists of a pressure sensitive crystal microphone inside a liquid-filled tire.



Typical records obtained with the delamination detector. Smooth line indicates no delamination present.

Evaluation

Results were verified by taking pairs of cores on six different bridges. On each bridge one core was taken at a location where delamination was not indicated and another at a nearby location where delamination was indicated. In every case visual examination of the concrete confirmed the indications of the detector, including two cases in which the concrete deck was overlaid with a thin (approximately one-half inch) asphaltic surfacing material.

Findings

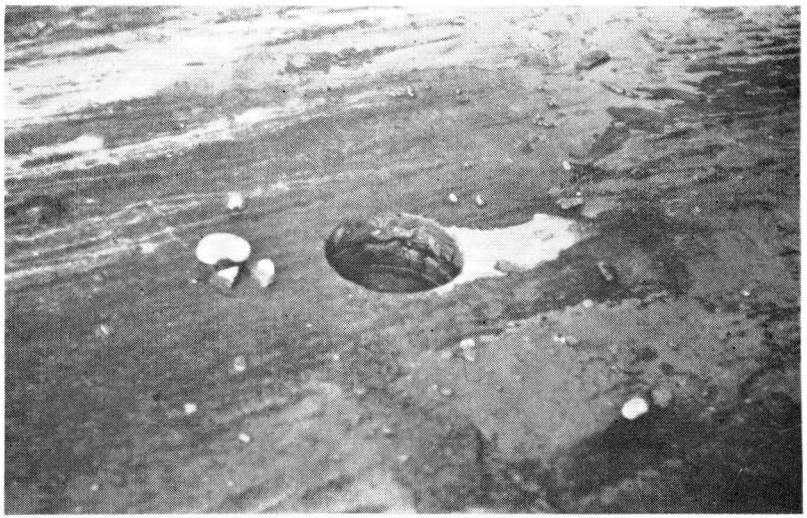
The following conclusions appear warranted:

1. The delamination detector developed in this study provides an effective means for determining the extent of delamination in concrete bridge decks.

2. The detector is easy to operate and practical for routine use.

3. The detector is insensitive to deck texture or thin asphaltic surfacing layers.

4. The operation of the instrument is not impaired at rolling speeds up to about ten miles per hour.



Note typical horizontal separation visible in core hole at a location where delamination was indicated by the unit.

Implementation

The results reported clearly indicate that multiple-path, automatic delamination detection is practical and possible. A detector can be designed and constructed that will survey a lane of a bridge at one time. Using modern data acquisition and reduction techniques, a map showing the delaminated areas of the deck can be automatically produced with such a detector.

The present detector can be used in an investigation to determine the growth pattern of deck delamination and uncover its causes.

The published version of this report may be obtained by addressing your request as follows:

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