

Zerstörungsfreie Prüfung im Bauwesen



Reinforced concrete plates are positioned 4-5 cm above asphalt. The air layer is then filled with bitumen mix material. Voids of circular shape were created under plate 4 at position A and B.

Combined NDT for System Assurance in Railway Construction: Impact Echo, Ultrasonic and Radar Techniques

C. Colla, B. Milman, J. Wöstmann, F. Mielentz, J. Henschen, H. Wiggenhauser
Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin

Zusammenfassung

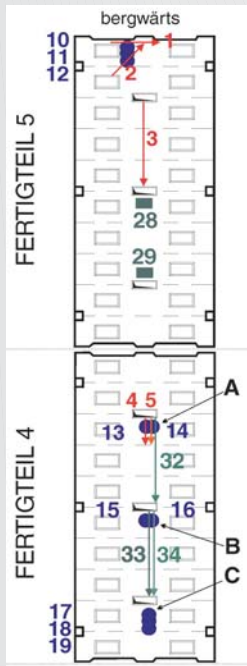
Der Untergießvorgang bei der Erstellung fester Fahrbahnen wurde mit Radar zur Qualitätskontrolle meßtechnisch verfolgt. Radar wurde eingesetzt zum Nachweis, daß das Untergußmaterial alle Stellen erreicht. Der Verbund zwischen der Betonplatte und dem Untergrund wurde nachträglich mit Ultraschall, Impact-Echo und Radar gemessen. Diese Verfahren können zur Qualitätskontrolle bei der Erstellung fester Fahrbahnen eingesetzt werden.



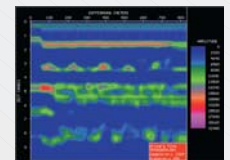
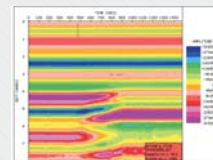
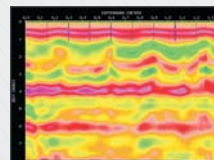
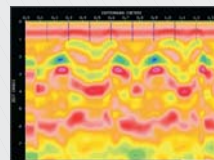
Objectives

On-Site quality control with NDT ensures that the design parameters for railway constructions are met. "Feste Fahrbahnen" do have the stability for the high speed traffic but their construction must be done in a different way. State of the art NDT techniques were used to monitor the correct on-site assembly of pre-fabricated concrete plates with a bitumen mix layer. The investigations, which included both the filling under the sleepers and, after setting, testing of the fill, were aimed at:

- monitoring the bitumen injection
- detecting the possible presence of defects in the bond or voids in the bitumen mix.



Radar



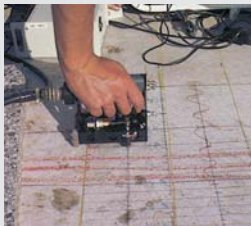
Radar emits EM waves by an antenna which moves in contact with the structure. The waves are reflected from material interfaces i.e. air voids, metal and other inhomogeneities. Radar uses the wave reflections to build 2-D plots of the structure.

Different antenna polarisation show that reinforcement can mask the reflection from the bottom of the plate; when the influence from the reinforcement is reduced, this reflection can be clearly seen at 4 ns

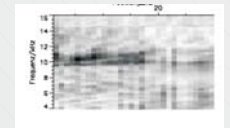
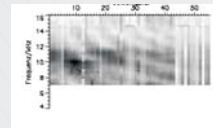
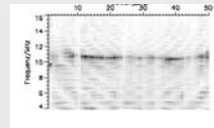
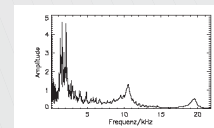
To monitor the injection, the antennae were kept stationary. Testing proved successful with the fluid front clearly identifiable. The rise of the fluid level is also visible until the whole air gap is filled and the injection can be considered completed.

After data processing, the void was located close to the edge of the concrete and under dense reinforcement.

Impact-Echo



A mechanical point impact is used to generate a pulse which propagates into the concrete. Multiple propagation of low frequency waves between the external surface and internal reflectors are used to measure transient resonance frequencies and to calculate depths and evaluate structure integrity.

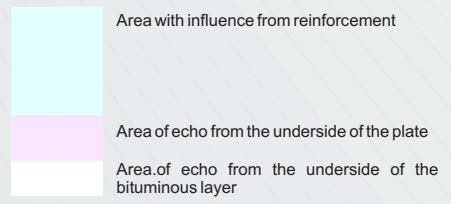
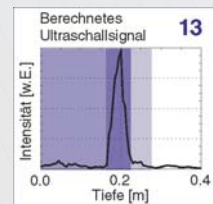
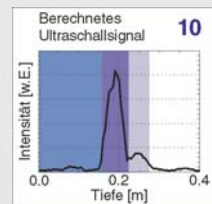
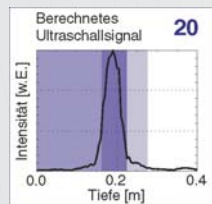


On an un-injected plate, data shown in frequency highlight the concrete thickness: the peaks at 10.5 kHz correspond to the reflection from the bottom of the concrete: averaged row data (left), 2-D plot through the concrete thickness (right).

The air void in the bitumen mix layer can be seen between stations 5 and 15 on the x-axis (along line 4).

Possible areas of good bonding between concrete and underlying bitumen-mix.

Ultrasound



Ultrasonic pulse echo on concrete uses low frequency transducers (50 to 200 kHz) with synthetic aperture. Ultrasonic A-scans are recorded at different points on the surface and internal reflections are evaluated using a reconstruction algorithm.

The maximum at 19 cm is the echo from the concrete backside.

Good bonding of the bitumen layer to the underside of the concrete plate is shown with a maximum at 190 mm (interface concrete/bitumen) plus a maximum at 24 cm (bitumen backface).

At the artificial void, only the interface concrete/air appears at 190 mm, as the US waves are totally reflected in this region.

Conclusions

Regarding the bitumen mix injection, the fast radar data acquisition rate permitted to successfully monitor the rapid changes in the fill and to follow data collection in real time on the screen, thus allowing to see when the injection could be considered concluded. The novelty of Impact-Echo is the possibility to obtain 2-D plots of data and to produce 2D sections of the concrete element. Ultrasound demonstrated to be well suited for de/bond investigation. Only the combination of the three NDT techniques was successful in locating and dimensioning the voids. The investigation of the bonding between concrete and set bitumen mix gave initial encouraging results in discriminating between good and bad areas.