Non-Destructive Testing in Civil Engineering

NDT-CE

SCANNING IMPACT-ECHO of CONCRETE SLAB with EMPTY DUCTS

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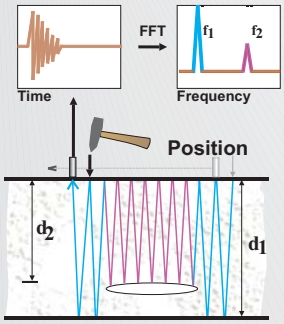
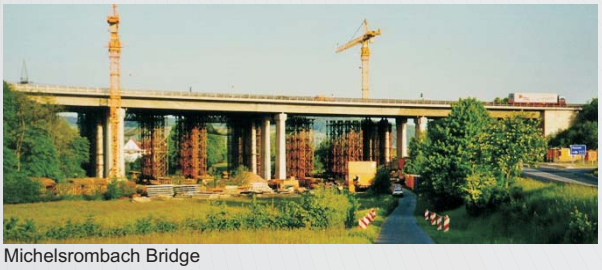


Fig.: 1

Impact-Echo: Applying a mechanical point impact with a small hammer on the object surface, a wave is generated and travels through the material, partly reflected by any internal reflector. The wave is almost completely reflected if the second material is air. A sensor beside the impactor picks up these reflections so that a time waveform is built up by the first and subsequent reflection arrivals. Data analysis is performed on the frequency spectrum of the waveform. The depth (d) of each reflector is calculated by dividing the wave velocity (v) by the measured frequency of the echo signal peak (f): d = v/2f. (Fig. 1)


Fig.: 2

An automated **scanning Impact-Echo** system has been developed at BAM to collect 2- and 3-D sets of data (fig. 2). It uses in-house software for real-time data display and allows viewing 2-D element sections by scanning the concrete surface in discrete regular steps along survey lines. The single spectra can so be plotted in series to obtain 2-dimensional data images. The commercial testing unit containing hammer and receiver (Olson IE II) allows reading frequencies up to 18 kHz.


Michelsrombach Bridge

Aims: in preparation of a measuring campaign on Michelsrombach Bridge (a project coordinated by BAST, the German Highway Agency, and aimed at site-testing a combination of NDT techniques), a specimen of the bridge deck was built in the laboratory with the first aim to locate the post-tensioning ducts (fig. 3 & 4). It has characteristics similar to the real bridge: the 25-cm thick concrete slab has 32-mm max. aggregate size and presents a reinforcement (Ø 12 mm) mat of 40 cm width with 3 cm concrete cover. The three metal ducts (Ø 4-cm and empty at the time of testing) have 6, 10 and 8 cm concrete cover.

Measurements & results

The measurements lines run parallel and transversal to the ducts (fig. 4) and were made up of 1 cm spaced stations. At each point, the average of 3 single readings was recorded. Data presented here are plotted in frequency with depth calculation carried out using a compressional wave velocity of 4000 m/s.


Fig.: 3

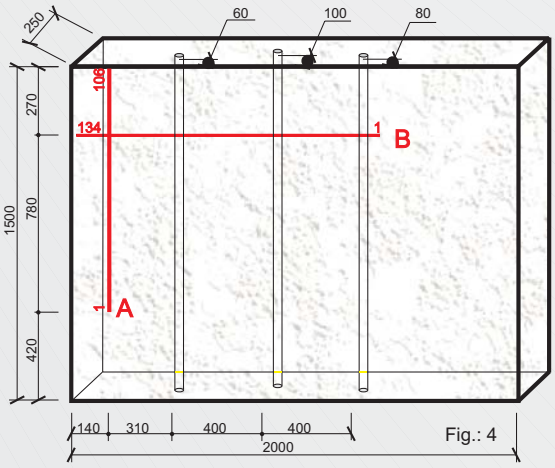


Fig.: 4

On this concrete specimen, the scanning Impact Echo technique proved able to easily identify the slab thickness with good accuracy (fig. 5) and the position of the ducts (fig. 6). Advantages: the concrete was new thus in likely good condition and the ducts were empty. Disadvantage: the ducts have small size, Ø 4 cm. Scanning Impact Echo, by plotting 2-dimensional element sections, greatly facilitates the interpretation of the IE data. Advantage: denser data are collected than for traditional punctual IE, and small features, i.e. the ducts, can be detected.

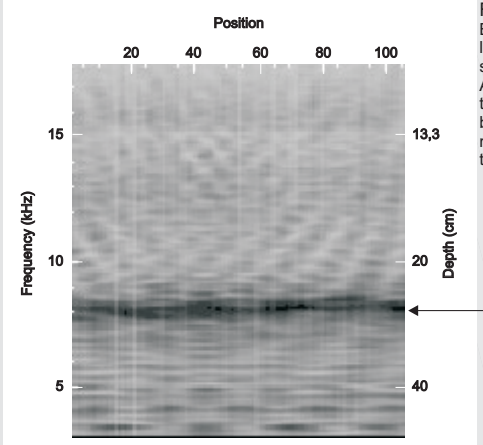


Fig. 5
B-scan from measurement line A: darker grey represents stronger signal reflection. At 8 kHz (equal to 25-cm thickness), the horizontal black line corresponds to the reflection from the backside of the specimen.

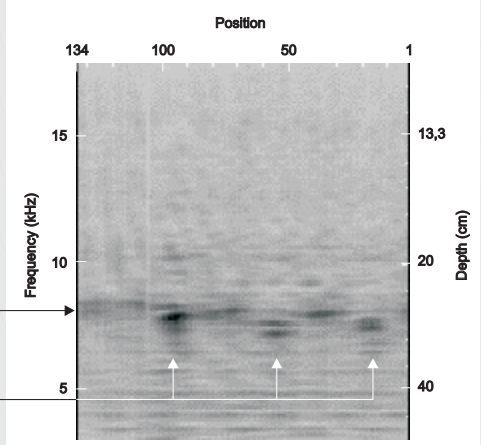


Fig. 6
Line B, across the ducts, presents at 8 kHz the interrupted reflection from the slab backside. The indirect reading of the 3 ducts appears at lower frequencies - between 7 and 8 kHz - approximately at position 15, 55 and 95 respectively. The ducts were not located directly but as an apparent increase of element thickness (longer wave path around the duct). Note the small shift in frequency between the 3 empty ducts (7.7, 7.2 and 7.4 kHz).

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