STEPPER

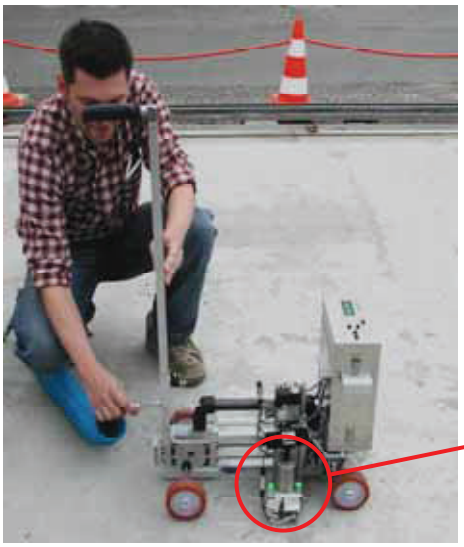
Purpose

The **STEPPER** is an automated impact-echo test system for increasing the speed of testing. It is especially suited when large areas need to be tested with close spacing between test points, such as for:

- Locating voids in grouted tendon ducts
- Accurate assessment of regions of delamination or honeycombing

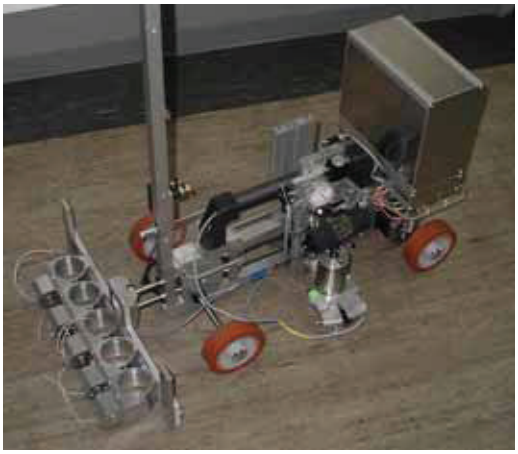
Principle

Manual impact-echo testing, such as by using the **DOCter** system, can be time consuming when test points need to be closely spaced because the defects to be detected are small or an accurate assessment is desired of the extent of internal defects. The **STEPPER** permits automated impact-echo testing along a given scan line. As shown, a **DOCter** impact-echo receiver is attached to a cart that moves automatically from test point to test point. The spacing between test points can be as small as 20 mm. A pneumatic system is used to activate two spherical impactors: a small impactor provides high frequency input for locating small, near surface defects and a larger impactor provides for deeper penetration to identify the back face of the test object.



*The **STEPPER** unit contains an electrical drive system for automated scanning and a pneumatic system for automated testing*

*A close up view of the **DOCter** transducer and one of the two spherical impactors*

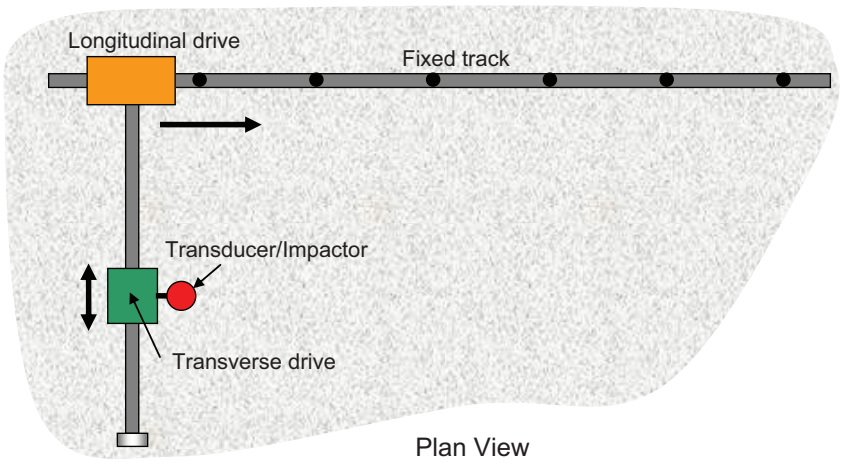


As the **STEPPER** moves along a scan line, data are automatically recorded for subsequent post processing by software developed at the Federal Institute for Materials Research and Testing (BAM). The software analyzes the data and provides a 2-D image that shows the depth of reflecting interface as a function of distance along the scan line (known as a B-scan). An example of such an image is shown on page 123.

To further increase the rate of testing, the **STEPPER** can be augmented with an array attachment for five **DOCter** transducers as shown to the left. With the array attachment, testing can be done simultaneously along five scan lines.

Scanning Frames

The **STEPPER** is suited for automated impact-echo testing on horizontal surfaces. When testing needs to be done on a vertical surface or on a soffit (overhead surface), special frames are available to support the impact-echo test unit and carry out an automated scan of the test area. A scanning frame is composed of a longitudinal track that is fixed to the test surface and a transverse track that travels along the longitudinal track. An impact-echo unit is attached to the transverse track and travels in discrete steps from test point to test point. When a transverse scan is completed, the longitudinal drive moves the transverse track to the next scan line and the scan is repeated. Thus tests are completed automatically on a grid of test points. The grid points can be as close as 10 mm.



Scanning frames can be attached to surfaces by anchor bolts or they can be held in place with a vacuum attachment system. The vacuum attachment system is typically faster to install, but as a safety precaution the scanner needs to be secured with cables or chains.

The vertical wall scanner that is anchored to the surface has a 1.7 m limit for the transverse scan, but the longitudinal scan is not limited to any specific distance. For the vacuum system, the scan limits are 1.4 m in one direction and 1.6 m in the perpendicular direction.

The 2-D scanning system requires two computers. One computer is used to control the movement of the longitudinal and transverse drives. The other computer is for data acquisition and data processing.

For a grid spacing of 50 mm, the rate of testing is about 1 m^2/h and it takes about 1 h to process the data for each m^2 of testing.

Testing Examples

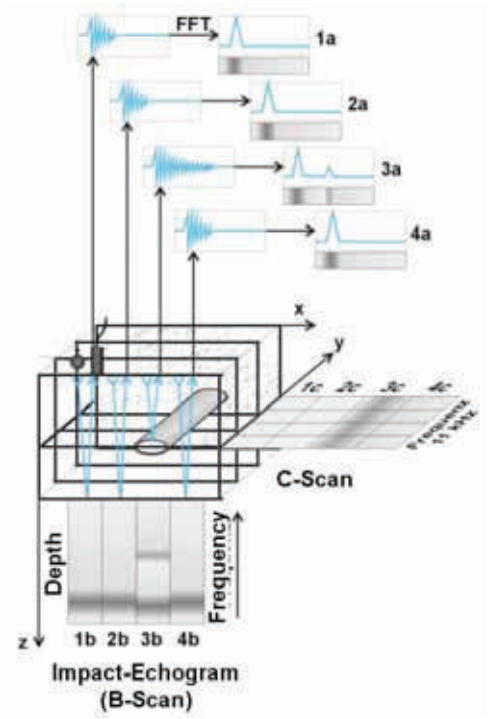
Vertical wall scanner system attached to web of post-tensioned bridge

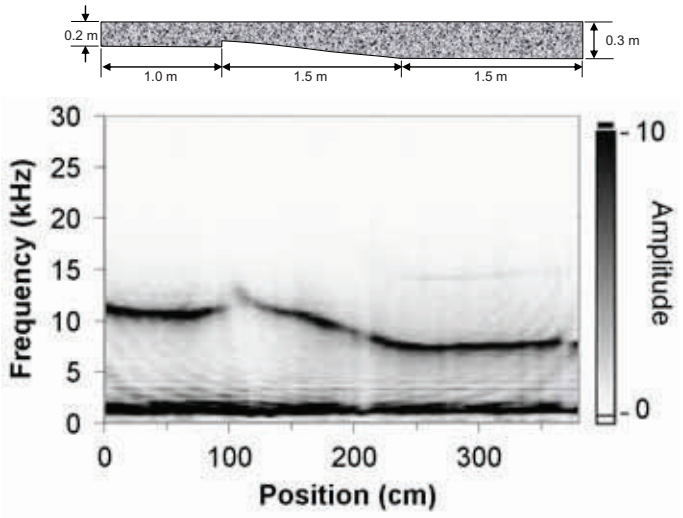
Vacuum scanner attached to soffit of post-tensioned bridge

STEPPER

Impact-Echograms

The large number of data obtained during a 2-D impact-echo scan can be used to generate images of the internal structure of the test object, known as **impact-echograms**. The technique is illustrated in the schematic below on the left. For each scan line, each amplitude spectrum is replaced by a dash at each peak in the spectrum. The amplitude of the peak is indicated by grayscale. When these dashes are placed next to each other, the result is a cross-sectional image of the reflecting interface (or a B-scan). A lower frequency corresponds to a deeper reflector as indicated by the basic impact-echo equation shown on page 41. Alternatively, a plan view can be obtained for a selected frequency (or depth). This is called a C-scan and shows the extent of reflectors that are present at the selected depth. This analogous to a "slice" in a medical tomogram.





Example of a cross-sectional image (B-scan) created by processing impact-echo data along a scan line. The test object was a concrete slab with an irregular cross section as shown above. The resulting impact-echogram shows correctly the varying thickness of the slab. The low frequency peak at about 2 kHz is an artifact of the transducer.

STEPPER Ordering Numbers

Item	Order #
STEPPER drive unit, including pneumatic system	STEP-1000
Adapter for single transducer	STEP-1010
Mark IV DOCter transducer	DOC-50
12 V Battery	STEP-1020
BAM software	STEP-1030

Optional Items

Array attachment for 5 Mark IV transducers	STEP-1040
Four additional Mark IV transducers	STEP-1050
Software for transducer array	STEP-1060

Scanning Frames Ordering Numbers

Item	Order #
Vertical wall scanner frame including X and Y drive motors , motor controllers, and pneumatic system	STEP-1070
Adapter for transducer	STEP-1080
Computer and software for controlling frame (specify Linux or Windows)	STEP-1090
Computer and software for data acquisition and data processing	STEP-1100

Optional Items

Vacuum scanner frame: X and Y drive motors, controllers, and vacuum plates	STEP-1110
Vacuum pump	STEP-1120

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