

PROJECT PROFILE

GROUND PENETRATING RADAR EVALUATION OF ARCH-CULVERT TUNNELS

D'Appolonia evaluated the condition of two arch-culvert tunnels formerly used by the Bessemer and Lake Erie Railroad as bridges for track crossings over Little Deer Creek and Rich Hill Road in Harmar Township near Pennsylvania Turnpike. The two cast-in-place concrete arch culverts were constructed in about 1910. After having been abandoned for many years, the structures were planned to be re-used to carry heavy construction vehicle traffic. D'Appolonia was retained to evaluate the condition of the structures and their capacity for safely handling the new projected traffic loadings.

Each tunnel comprises three primary structural elements: (1) spandrel walls (one at each tunnel entrance), (2) one large arch culvert and (3) two abutment walls. Two wingwalls also extend from each side of each spandrel wall. The tunnels were first evaluated in a conventional manner with the following scope of work:

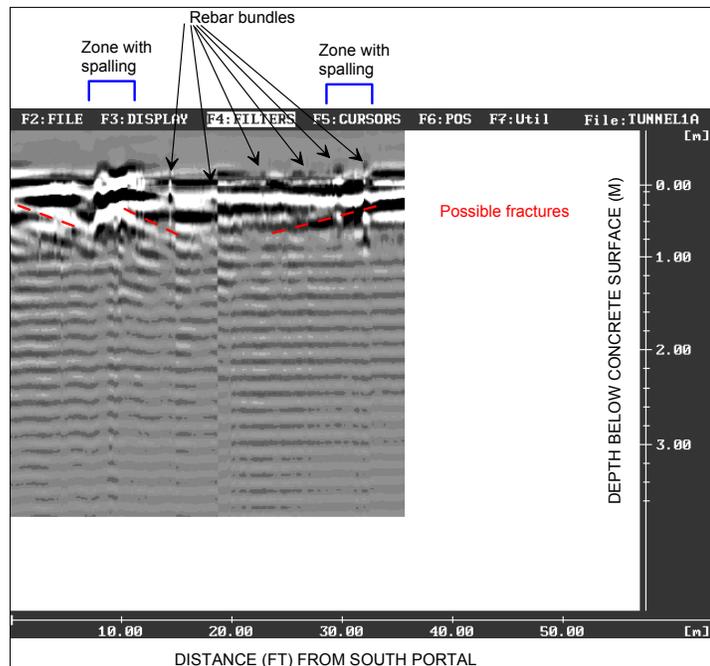
- Review of design records from the B&LE Railroad,
- Review of inspection reports from Harmar Township
- Field reconnaissance and a

- serviceability evaluation,
- Non-destructive testing of concrete,
- Coring and compression testing of concrete samples, and
- Structural evaluation.

Based on D'Appolonia's field reconnaissance of the two tunnels, the serviceability of the primary structural elements (arches and abutment walls) was judged to be fair. Although significant surface and joint deterioration was observed in both tunnels (as evidenced by spalling, discoloration, and cracks — particularly in the road tunnel), the deterioration did not appear to have reduced the structural capacity of the tunnels below acceptable levels. Nevertheless, it was noted that surficial spalling, erosion and cracking of the concrete, particularly on the spandrel walls and interior arch sections of the roadway tunnel, presented a debris fall hazard to



Non-destructive testing of concrete with Ground Penetrating Radar (GPR) at Rich Hill Road test site.



GPR profile of Rich Hill Test site taken parallel to the tunnel axis from the south portal one meter from the tunnel floor. The record indicates the presence of reinforcing bars and possible fractures.

road traffic through the tunnel. For both structures, continued unchecked concrete deterioration could eventually compromise the structural integrity, foundation support and load carrying capacities of the arch structures.

The tunnel at Rich Hill Road was targeted for a geophysical research investigation to determine whether the ground penetrating radar (GPR) geophysical technique could provide useful information

on the nature of the structure that was not apparent from a visual inspection.

The RAMAC 2 GPR system with 200-MHz antennas manufactured by Malå Geosciences in Sweden was used to image the concrete in the roadway tunnel. The data obtained from the GPR survey indicated that meaningful results could be obtained to an effective depth of penetration in the range of 20 to 40 inches below the surface.

Observed GPR reflections arriving at a shallow angle to the tunnel surface were interpreted to be fractures in the concrete. Sharp disturbances in the signal were interpreted to be reinforcing bars.

The survey demonstrated that GPR can be useful for relatively deep imaging into structural concrete. The most important application of this technology is that it provides information to aid the engineer in planning a productive program of sampling and testing.