

APPENDIX C

STRUCTURAL TESTS RESULTS FROM COMPOSITE PILE CUTOFF SECTIONS FROM THE ROUTE 40 BRIDGE PROJECT

This appendix contains results from structural tests carried out on cutoff Lancaster composite pile samples obtained the Route 40 bridge project. The structural tests include:

- C.1. Pushout tests to assess the bond strength between the concrete core and the inner surface of the FRP tubes, and
- C.2. A creep bending test carried out on a 18 ft long pile piece.

The results are summarized in the following pages.

C.1 Pushout Test Results

Pushout tests were performed to investigate the strength of the bond between the concrete and the FRP shell of Lancaster composite piles. The pushout test specimens were prepared by cutting slices from composite pile cutoff sections from the Route 40 bridge project. The pushout specimens had a nominal diameter of 0.6 m (24 in.), and ranged from 75 mm to 150 mm (3 to 6 in.) in length.

Some of these tests were performed by the Virginia Transportation Research Council (VTRC), and some were performed by Virginia Tech (VT). Each institution used a different test setup. The VTRC tests were performed by setting the test specimens on a block with a carefully fabricated hole that permits the block to support the FRP shell but allows the concrete core to pass through the hole. The load was applied at a rate of 3000 lbs/min. The VTRC test setup is shown in Figure C.1.



Figure C.1 VTRC Pushout Test Setup

The Virginia Tech tests were performed by bonding the outside of the FRP shell to a slightly larger steel pipe section, supporting the steel pipe section, and pushing the concrete core so it begins to move out of the FRP shell. Tests were carried out at a displacement rate of 0.002 in per minute. The Virginia Tech test setup for the pushout tests is shown in Figure C.2.



Figure C.2 VT Pushout Test Setup

The test results are summarized in Tables C.1.

Table C.1 Summary of Pushout Test Results

	VTRC ⁽¹⁾	VT ⁽²⁾	Total
Number of Tests	13	6	19
Average Peak Bond strength (psi)	29.95	14.1	24.9
Standard Deviation (psi)	9.75	20.1	15.3

Notes: (1): Load controlled test at 3000 lb/min
 (2): Displacement controlled tests. Bond strengths were corrected for voids in the bond area.

As shown in Table C.1, regardless of the test setup, the bond strength values obtained are fairly low, with an overall bond strength average of 24.9 psi (170 kPa). Test results also show a wide scatter of bond strength values. This wide variability of results could be related to factors such as: the presence of voids between the concrete core and the interior of the FRP shell; possible damage to bond during cutting, shipping, and handling; temperature effects (expansion and contraction); and scale or size effects. Smaller bond strengths were obtained using the VT test setup compared to the VTRC test results. The bond strength magnitude differences are likely related to inherent differences in the test setup and load application procedure, as well as possible additional specimen disturbance of the VT specimens during the extra shipping and handling required to ship the specimens from VTRC to VT.

C.2 Creep bending test

A four-point creep bending test setup was designed and built to perform a creep test on an 18 ft long section of 24 in. diameter Lancaster composite pile. This pile was left over from the Route 40 VDOT bridge project, on which Lancaster composite piles were used for one bent. The test facility was built at Virginia Tech's Kentland Farms, approximately 10 miles west of Blacksburg, Virginia.

A photograph of the creep bending test setup is shown in Figure C.3. As shown in this photo, two dead weights of about 32 kN (7.2 kips), are hung at the middle thirds of the beam. These loads induce a maximum moment of about 58 kN-m (43 kip-ft). This moment is not a large percentage of the expected ultimate moment, but it is a moment that can be applied economically.

The centerline deflection curve obtained from the test is shown in Figure C.4.



Figure C.3 Creep bending test setup

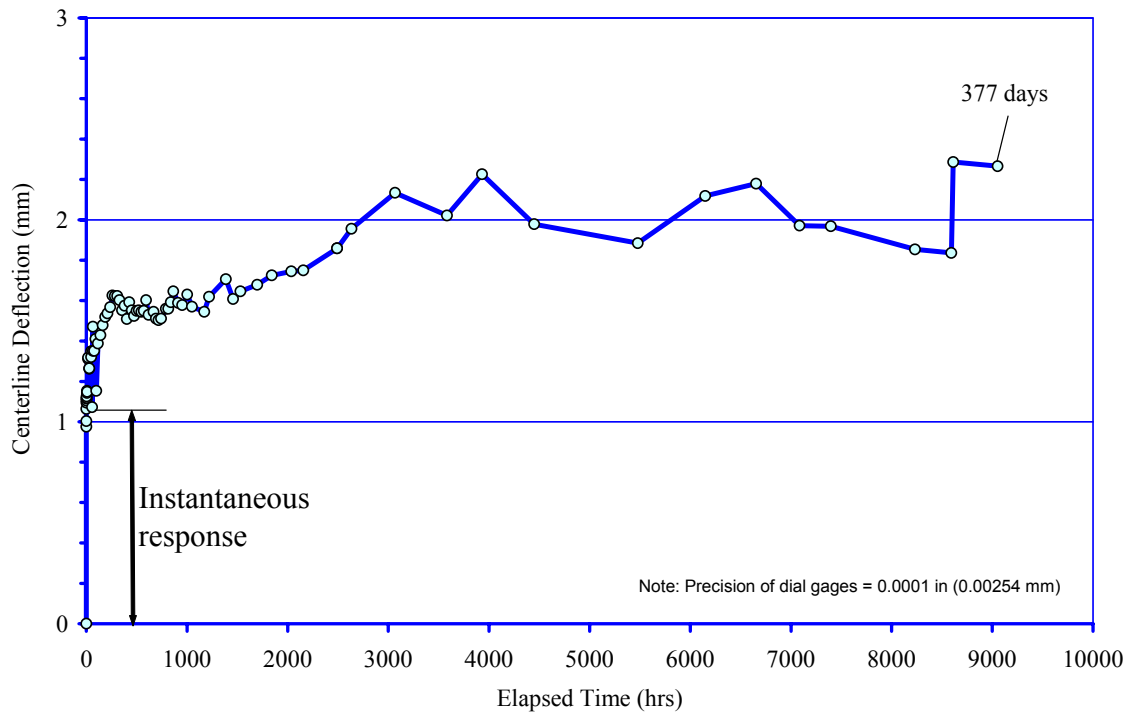


Figure C.4 Creep deflection test results