

## OFFICE MEMORANDUM



MICHIGAN  
STATE HIGHWAY DEPARTMENT

December 9, 1964

To: E. A. Finney, Director  
Research Laboratory Division

From: R. H. Merrill

**Subject:** Study of Defective Concrete in Structures on US 2 West of Watersmeet (B02, B03, B04 of 27023B). Research Project R-64 B-77. Research Report No. R-488.

At the request of J. C. Brehler on October 16, 1964, the Concrete Unit received 9 beam sections and 25 cores from the subject structures with instructions to test the beams in modified cube compression and obtain compressive strength, cement content, and if possible, air content on the cores. Tests have now been completed with the results reported in the attached Tables. As added information four beam ends from a box culvert at Station 189+00, built under the same contract as the subject bridges, were broken in modified cube compression and tested for cement content.

The construction projects were under contract to Caspian Construction Co., Caspian, Michigan, with E. P. Saletta as the Highway Department Project Engineer. A six sack per cubic yard mix with Manitowoc Type 1A cement, 6AA gravel and 2NS sand were used throughout the project. The field air check ranged between 6.0 and 6.8 percent entrained air which agrees very closely with the laboratory results on the hardened concrete cores.

The basis for requesting this study was low modulus of rupture obtained on the beams when broken in the field. The modified cube compression tests on the beam ends seem to verify the field results by showing that only four of the 13 beam ends reached a value of 3,500 psi 28 or more days after casting. Cores taken from the pours from which these beams were cast indicate in general a low strength concrete, with 9 of the 25 cores below the 3,500 psi limit when tested in compression.

The cement determination conducted by W. L. Frederick of the Spectroscopy and Photometry Section indicated a consistent cement content of about six sacks per cubic yard. These results were based on the calcium oxide content and checked against a standard sample cast in this laboratory.

E. A. Finney

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Air contents determined on a high strength and low strength core from each structure indicated a satisfactory amount of entrained air giving no reason to believe that this might be a contributing factor to the low strengths obtained.

OFFICE OF TESTING AND RESEARCH

R. H. Merrill, Civil Engineer  
Concrete Unit  
Research Laboratory Division

RHM:nl

Attachments

## SUMMARY OF TEST CORE DATA

| Laboratory Number | Core No.       | Structure No. | Pour             | Pour Date | Comp. Strength* | Lab Air Content** | Cement Content |
|-------------------|----------------|---------------|------------------|-----------|-----------------|-------------------|----------------|
| 64 CR- 78         | 1              | B02 of 27023  | D Abut A         | 7-7-64    | 4,284           | 6.5%              | ---            |
| - 79              | 2              | "             | F Abut A         | 7-7-64    | 3,656           | ---               | ---            |
| - 80              | 3              | "             | E Pier 2         | 6-4-64    | 3,582           | ---               | ---            |
| - 81              | 4              | "             | "                | 6-4-64    | 3,844           | ---               | ---            |
| - 82              | 5              | "             | "                | 6-4-64    | 3,721           | ---               | ---            |
| - 83              | 6              | "             | G Deck           | 8-25-64   | 2,886           | ---               | 6.1            |
| - 84              | 7              | "             | H Deck           | 8-25-64   | 2,905           | ---               | 6.0            |
| - 85              | 8              | "             | D Deck           | 8-25-64   | 4,511           | ---               | ---            |
| - 86              | 9              | "             | B Abut B         | 6-25-64   | 4,003           | ---               | ---            |
| - 87              | 10             | "             | C Abut B         | 6-25-64   | 3,452           | 6.0               | 5.9            |
| - 88              | 11             | B04 of 27023  | C Abut A         | 7-9-64    | 3,199           | 6.7               | 6.6            |
| - 89              | 12             | "             | A Abut A         | 7-9-64    | 3,582           | 5.7               | ---            |
| - 90              | 13             | "             | A Deck           | 9-17-64   | 3,668           | ---               | ---            |
| - 91              | 14             | "             | A Deck           | 9-17-64   | 2,848           | ---               | 5.8            |
| - 92              | 15             | "             | D Deck           | 9-17-64   | 2,685           | ---               | 5.8            |
| - 93              | 16             | B03 of 27023  | E Abut B         | 8-28-64   | 3,232           | ---               | 6.5            |
| - 94              | 17             | "             | F Abut B         | 8-28-64   | 2,995           | 6.0               | 6.1            |
| - 95              | 18             | "             | E Pier 2         | 6-26-64   | 4,635           | ---               | ---            |
| - 96              | 19             | "             | E Pier 2         | 6-26-64   | 4,660           | ---               | ---            |
| - 97              | 20             | "             | "                | 6-26-64   | 4,146           | ---               | ---            |
| - 98              | 21             | "             | E Pier 1         | 6-16-64   | 4,921           | 3.4               | ---            |
| - 99              | 22             | "             | "                | 6-16-64   | 4,456           | ---               | ---            |
| -100              | 23             | "             | "                | 6-16-64   | 4,292           | ---               | ---            |
| -101              | 24             | "             | B Pier 2         | 6-14-64   | 3,705           | ---               | ---            |
| -102              | 25             | "             | E & F Abut A     | 6-14-64   | 3,036           | ---               | 5.8            |
| 64 CR-109(a)      | I <sub>1</sub> | Box Culvert   | E & Center Walls |           | -----           |                   | 6.1            |
| -109(c)           | I <sub>2</sub> | "             | W Wall & Top     |           | -----           |                   | 6.1            |
| Std. Cyl.         |                |               | Slab             |           | 3030, 7 day     |                   | 6.1            |
|                   |                |               |                  |           | 4346, 28 day    |                   |                |

\* All strengths corrected to L/D ratio of 2 and obtained at least 28 days after pouring.

\*\* Linear Traverse Method.

## SUMMARY OF COMPRESSIVE TESTS ON FIELD BEAM ENDS

| Laboratory Number | Beam No.        | Structure No.        | Pour                 | Comp. Strength Mod. Cube* |
|-------------------|-----------------|----------------------|----------------------|---------------------------|
| 64 CR-71 (a)      | C8A             | B03 of 27023         | E Abut B             | 3,130                     |
| (b)               | T8A             | B02 of 27023         | D & F Abut A         | 3,860                     |
| (c)               | M6A             | B04 of 27023         | A & C Abut A         | 3,440                     |
| (d)               | M6B             | B04 of 27023         | A & C Abut A         | 3,130                     |
| 64 CR-75 (a)      | C4A             | B03 of 27023         | E Pier 2             | 4,390                     |
| (b)               | C4B             | B03 of 27023         | E Pier 2             | 3,600                     |
| (c)               | M8A             | B04 of 27023         | A & D Deck           | 3,470                     |
| (d)               | T5A             | B02 of 27023         | B & C Abut B         | 3,970                     |
| (e)               | T9B             | B02 of 27023         | G, H, C & D Deck     | 3,320                     |
| 64 CR-109(a)      | I <sub>1</sub>  | Box Culvert<br>27023 | East & Center Walls  | 3,180                     |
| (b)               | II <sub>1</sub> | Box Culvert<br>27023 | East & Center Walls  | 3,190                     |
| (c)               | I <sub>2</sub>  | Box Culvert<br>27023 | West Wall & Top Slab | 3,020                     |
| (d)               | II <sub>2</sub> | Box Culvert<br>27023 | West Wall & Top Slab | 3,040                     |

\* Obtained at least 28 days after pouring.