

OFFICE MEMORANDUM

124



MICHIGAN

STATE HIGHWAY DEPARTMENT

JOHN C. MACKIE, COMMISSIONER

February 23, 1962

To: W. W. McLaughlin
Testing and Research Engineer

From: E. A. Finney

Subject: Cracks in Retaining Wall on James Couzens Extension of Lodge Expressway. Research Project 61 F-63. Report No. 374.

The following are Gene R. Cudney's comments in connection with P. Daavettila's report of wall cracking on James Couzens Extension of the Lodge Expressway, dated January 10, 1962. The Research Laboratory Division reported on this cracking and made certain recommendations for future construction in a letter by J. E. Simonsen, dated August 15, 1961.

First, Item 1 in Mr. Daavettila's report states that there has been no observed reduction in the number of cracks formed in wall sections where an increased steel percentage was used, as recommended in Mr. Simonsen's letter dated August 15, 1961. The purpose of this recommendation was not that it would reduce the frequency of cracking, but rather would better control the crack opening. To quote from this letter, "We do think, however, that the control of crack openings could be improved since possible future water seepage through these cracks would be undesirable." No assertion was made to the effect that increasing the steel percentage would reduce the number of cracks.

With regard to Item 2 in Mr. Daavettila's report, any curing procedure which will limit water evaporation will also reduce the rate at which shrinkage occurs. However, if the concrete is fully or partially restrained from volume changes associated with temperature drops, the tensile strength of the concrete may readily be surpassed and cracks will form. As was pointed out in the August 15, 1961 letter, if the longitudinal resistance to movement was enough to restrain the ends of a 100-ft length of wall by about 1/16-in., this restraint would be sufficient to cause cracking solely as a result of temperature change. This would explain the relatively few cracks which formed in the bottom walls, where restraint to movement is concentrated only at the bottom of the wall at the footing. The top wall sections, on the other hand, are restrained by the lower wall, by the side fill, and by the caissons. The caissons, in turn, are tied into the heavily reinforced beam section, which comprises better than half the height of the top wall. In connection with this latter point, it would be of interest to determine whether the crack frequency was higher in wall types having the greater number of caissons in the 100-ft sections between expansion joints. For example, compare the Type A-20 and Type C-26 walls of the W-2 contract.

W. W. McLaughlin

- 2 -

February 23, 1962

We agree with the recommendation for a trial wall section with a reduced expansion joint spacing. Of course, any change in the expansion joint spacing would necessitate a change in the caisson spacing. In line with our previous suggestion of reducing expansion joint spacing to 65 ft, Fig. 1 shows a proposed 200-ft trial section of a Type A-20 wall with expansion joints spaced at 64 and 36 ft. All wall details with the exception of the construction joint, expansion joint, and caisson spacing, and appropriate re-steel length and splice modifications to accommodate these spacings, would be the same as shown on the plans. As originally planned this wall type had expansion joints every 100 ft with construction joints spaced at 32 ft 9 in. and 34 ft 6 in. The caisson spacing was 18 ft, with a 5-ft edge distance between an expansion joint and the nearest caisson. This arrangement requires two more caissons than would have originally been utilized. We would also again suggest the increased steel percentage recommended in the August 15 report, as representing the minimum 0.25 percent as prescribed by the American Concrete Institute. Because we have not gone into the design quantitatively, the proposed caisson spacing or any similar trial wall section should be verified by the wall designers.

As a further suggestion, Research Laboratory Division personnel could place plugs at selected expansion joints on the existing wall as well as any trial wall, and make comparative observations on joint movement and subsequent wall restraints.

It is assumed in the above discussion that it is more advantageous to provide more expansion joints with the increased risk of water leakage through a series of wider wall openings, than to provide for larger percentages of longitudinal steel (0.5 to 1 percent, perhaps) to maintain small crack openings for a greater number of randomly spaced cracks.

In regard to Item 5, the proposed additional thickening of the caisson beam on the back of the wall would probably be of little use in preventing cracks at the caisson boxouts. The restrained wall will crack at sections of weakest tensile strength, and the recess in the wall in addition to forming a reduced section, provides a source of stress concentration.

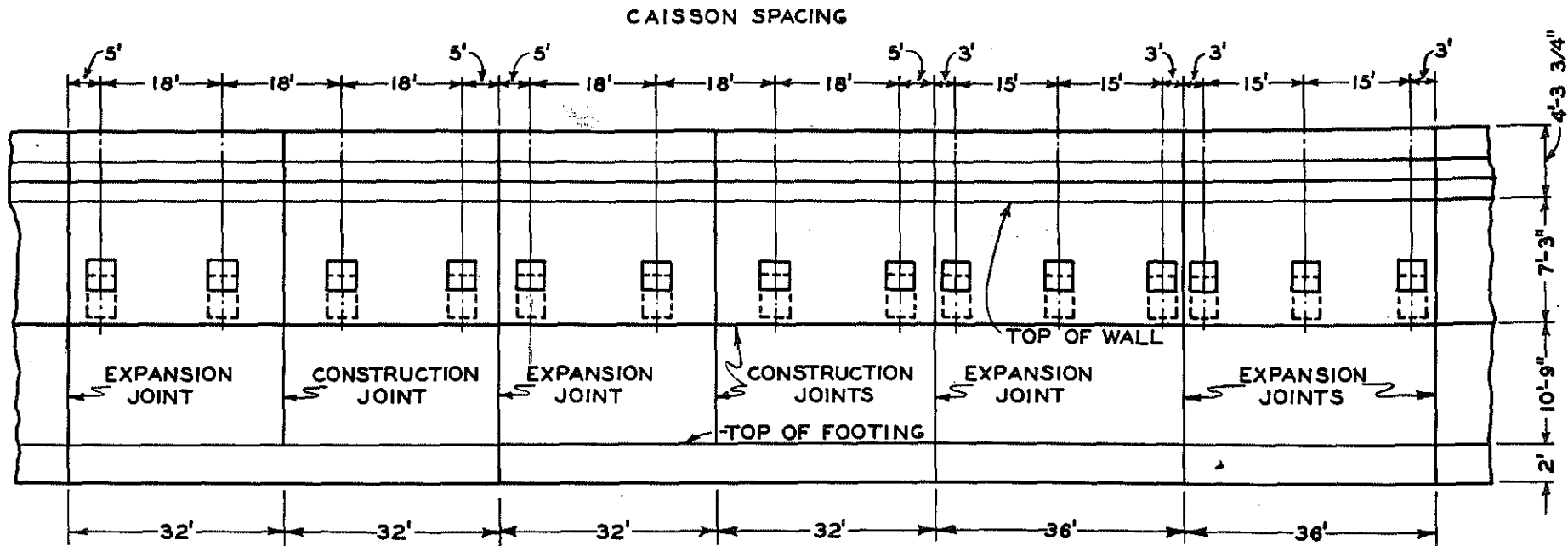
Finally, the spacing of dummy or false joints every 10 ft in the parapet wall should confine wall cracking to the locations of these joints with relatively few cracks occurring between them.

OFFICE OF TESTING AND RESEARCH

EAF:GRC:js
Attachment

cc: N. C. Jones
C. B. Laird
P. A. Nordgren
P. Ueberhorst
P. Daavettila

E. A. Finney, Director
Research Laboratory Division



NOTE:

ALL WALL DETAILS ARE TO BE SHOWN ON THE PLANS WITH THE EXCEPTION OF THE JOINT AND CAISSON SPACING AND APPROPRIATE RE-STEEL LENGTH AND SPLICE MODIFICATIONS.

Figure 1. Proposed 200-ft Trial Wall Section