

DATE: May 22, 1990

TO: Unit Leaders, Staff Designers and Consulting Engineers

FROM: A. J. Siccardi

Subject: Technical Memorandum #6
Footing Location Relative to Streambed with Footing
Supported on Pile Groups

This memorandum is intended to provide you with a summary of the results of recent model studies which investigated scour relative to the above subject. The model studies were conducted at the FHWA laboratories in McLean, Virginia. The findings seem consistent enough that I believe they should guide the design of footing location relative to the streambed. This memorandum does not address scour predictions. Such predictions will be furnished as a result of the hydraulic studies.

The model studies reflected real life bridge conditions; specifically,

- (1) Acosta Bridge over the St. Johns River in Jacksonville, Florida.
- (2) US 51 bridge over the Hatchie River near Covington, Tennessee.
- (3) Baldwin Bridge over the Connecticut River.

Based on the results of the studies of the Acosta Bridge, it was concluded that when the footing was flush with the bed the local scour was approximately 20% less than other situations tested. Those other situations were variation of the elevation of the footing projecting into the depth of flow. Attached is Figure 1 to identify the configurations studied.

In the Hatchie River study the results also suggest the scour depth will be less when the footing is placed at or slightly

below the streambed as compared to the smaller columns alone projecting below the streambed any significant amount. These results were observed by injecting dye into the flow. The dye swept by the columns before it reached the bed until the injection point of the dye was below the top of the footing. The observed reason for the beneficial effects of the pier footing at the top of the bed of the stream were:

- (1) The footing projected sufficiently beyond the column (at least one column width).
- (2) As a result the "diving currents, generated by the flow against the column which would cause scour of the bed without the footing at streambed, were "suppressed" for a period of time.
- (3) Once scour did reach to a depth such that the footing width and pile group were exposed, the combined cross section of footing and exposed piles were the cause of local scour.

The Baldwin Bridge studies confirmed these generalized results. The location of the footing was varied from a slight depression below the streambed, 10% of flow depth, at the streambed. The footing was also modeled to include extension on the upstream face of the footing, (see Figure 2 attached). Note this is an extension of only about 8%. The results of the study indicates the following:

- (1) The footing tended to reduce the pier scour when it was located flush or below the bed.
- (2) The upstream lip on the footing without the extension, was too small to have much effect on scour.
- (3) The extension did have a slightly beneficial effect in reducing pier scour.
- (4) The footing extensions, laterally and into the flow, were observed to have the scour "suppressor" effect previously mentioned.

Attached is a copy of Figure 3 and 4, showing the scour hole cross sections for various increments of exposed footings. Again, the footing located at or below the bed showed a significant improvement over a pier with no footing (Figure 3). The modified footing (upstream extension) was beneficial. The depressed top of footing as relates to scour (Figure 4). It does appear, however, that the footing located at the bed of the stream generally produced a lower scour depth. The modified pier (footing depressed 10% of the flow depth) does appear to have beneficial results in certain instances.

Conclusions and Design recommendations for Colorado Bridges.

1. There is no benefit to be gained in the reduction of local scour by placing the top of the footing at an elevation other than flush with the streambed. This is especially the case in those instances where neither contraction scour nor general degradation are expected to be significant. As a general rule the disturbance of the streambed beyond the level described herein is discouraged.
2. In those cases where contraction scour or general degradation is predicted in the hydraulic analysis the designer may consider locating the top of the footing at the elevation of the projected level of scour. Should contraction scour be predicted to exceed about 10% of the design depth of flow the contracted opening should be re-evaluated. General degradation may be more difficult to control or even be aware of because of the potential lack of historical knowledge to predict at all stream locations.
3. Nothing in this memorandum should be interpreted to apply to structures on spread footings, in which case AASHTO minimums and other criteria shall apply except when otherwise controlled by hydraulic scour predictions.

AJS:cev

cc: Hydraulics
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