United States Department of Agriculture
Soil Conservation Service
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April 10, 1986

TECHNICAL RELEASE NO. 59 (TR-59)
210-VI
AMENDMENT 1

SUBJECT: ENG - REVISIONS TO TR-59

Purpose. To transmit new pages for Technical Release No. 59, "Hydraulic Design of Riprap Gradient Control Structures."

Effective Date. Effective when received.

Explanation of Changes. This amendment provides new pages for Technical Release No. 59. Page 20 contains a recommended minimum rate of divergence, DIV=16, for the downstream transition of a riprap gradient control structure. This recommended value has been determined from a series of prototype tests conducted by the Corps of Engineers at Vicksburg, Mississippi. The heading "Recommended Value for DIV" has been added to the new contents page *i*.

In addition to the new pages, make the following change in your copy of TR-59: On the upper part of page 25, change "DIV=4.0" to read "DIV=16.0".

Filing Instructions. Remove pages *i* and 19 from Technical Release No.#59 and insert the enclosed pages.

Distribution. Distribute this amendment to all SCS offices that have copies of Technical Release No. 59. Additional copies may be obtained from Central Supply by ordering Form Catalog Order No. TR 059C.

Jw Haas

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Deputy Chief for Technology

Enclosure

DIST: TR-59

TECHNICAL RELEASE NUMBER 59

HYDRAULIC DESIGN OF RIPRAP GRADIENT CONTROL STRUCTURES

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Summary of Design Criteria

The following basic criteria govern the design of the riprap structure:

1. The specific energy head, H, at every section of the riprap structure is set equal to the specific energy head at the junction of the downstream transition and the downstream channel, Section A-A of Figure 1. Specific energy head is given by

$$H = d + \frac{v^2}{2g} = d + \frac{Q^2}{2ga^2}$$

2. The prismatic channel bottom slope, s_n, is set equal to or less than 0.7 of the critical slope, s_c. The bottom slope, s_n, is expressed as a fraction of the critical slope, i.e.,

$$s_n = CS(s_c)$$

where $0 < CS \leq 0.7$

3. Manning's coefficient of roughness, n, is a function of the D_{50} size of the riprap and has been evaluated to be

$$n = 0.0395\ (D_{50})^{1/6}$$

4. The critical tractive stress is a linear function of the D_{50} size of the riprap, i.e.,

$$\tau_{bc} = 4.0\ D_{50}$$

$$\tau_{sc} = K(4.0\ D_{50})$$

5. The riprap size and structure dimensions are selected so that for the design discharge the maximum tractive stress on the riprap does not exceed the allowable tractive stress. Either side or bottom tractive stress may control.

For a given design discharge, Q, specific energy head, H, and side slope, z, the variables that must be adjusted to meet these conditions are bottom width, b; bottom slope, s_o; and riprap size, D_{50}.

The length of the prismatic channel, LPC, is equal to the vertical drop of the prismatic channel divided by the bottom slope, s_n. The vertical drop of the prismatic channel depends on the amount of gradient control required.

Recommended Value for DIV

The outlet transition of a riprap gradient control structure has a rate of divergence of the bottom width of DIV. If this rate of divergence is too rapid, the flow in the transition tends to separate from the boundary and concentrate in the center of the transition and hence on into the exit channel. This flow condition causes eddies to form on the sides of the transition and causes an uneven velocity distribution throughout the transition and into the downstream channel. If the flow velocity is sufficiently high, scour will develop at the end of the structure.

The Corps of Engineers at the Waterways Experiment Station in Vicksburg, Mississippi conducted a series of prototype tests of the downstream transition to determine the minimum rate of divergence, DIV, that would produce a uniform distribution of flow in the downstream transition, thus minimizing scour downstream of the riprap structure. From the tests, the Corps concluded and recommended that a rate of divergence of DIV = 16 should be used in design.

* U.S. Government Printing Office : 1991 - 311-362/40630