#410

Grade Stabilization Structure (No.)

Definition

A structure used to control the grade and head cutting in natural or artificial channels.

Scope

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels (587).

Purpose

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

Conditions where practice applies

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

Planning considerations

Water Quantity

1. Effects on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.

2. Effects of the structure on soil water and resulting changes in plant growth and transpiration.

Water Quality

1. Ability of structure to trap sediment and sediment-attached substances carried by runoff.

2. Effect of structure on the susceptibility of downstream stream banks and stream beds to erosion.

3. Effects of the proposed structure on the movement of dissolved substances to ground water.

4. Effects on visual quality of water resources.

Design criteria

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilized upstream head cutting.

Embankment dams. Class (a) dams that have product of storage times the effective height of the dam of 3,000 or more, those more than 35 ft in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft or less shall meet or exceed the requirements specified for ponds (378).

The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

Pond size dams. If mechanical spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in table 1, less any reduction because of detention storage.

If the effective height of the dam is less than 20 ft and the emergency spillway has a stable grade throughout its length with no overfalls and has good vegetation extending to its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in table 1 or the storage capacity is more than 50 acre-ft, the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 ft and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping.

The mechanical spillway, regardless of size, may be considered in design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for water and sediment control basins (638) rather than the requirements for ponds (378).

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable SCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration showing table 2, less any reduction because of detention storage, If site conditions exceed those shown in table 2, the minimum design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical slope is 4 ft or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypassed flow as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

Landscape resources. In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

General criteria. Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

The earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative covering such as gravel or other mulches may be used.

Plans and specifications

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet.

Maximum drainage area for indicated rainfall*			Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in	3.5 in	5+ in		
----------acres----------			feet	year
200	100	50	35 or less	2
400	200	100	20 or less	2
400	200	100	20-35	5
600	400	200	20 or less	5

* In a 5-year frequency, 24-hour duration storm

Table 2. - Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall*			Frequency of minimum design, 24-hour duration storm		
			Vertical drop	Principal spillway capacity	Total capacity
0-3 in	3-5 in	5+ in			
---------acres----------			feet	year	year
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25

*In a 5-year frequency, 24-hour duration storm.

Table 3. - Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure.

Maximum drainage area for indicated rainfall*			Frequency of minimum design, 24-hour duration storm		
			Receiving Vertical drop	channel depth	Total capacity
0-3 in	3-5 in	5+ in			
---------acres----------			feet	feet	year
1,200	450	250	0-5	0-10	--
1,200	450	250	5-10	10-20	10
2,200	900	500	0-10	0-20	25

*In a 5-year frequency, 24-hour duration storm.

GRADE STABILIZATION STRUCTURE
COLORADO SUPPLEMENT (CO-410)

General

Construction operations shall be carried out in a manner to ensure that erosion, air, and water pollution are minimized and held within legal limits.

Equipment and methods used in construction shall be in accordance with the US Department of Labor, Occupational Safety and Health Administration.

Conditions where practice applies

Embankment structures planned under this standard must have erosion control as their primary purpose and must be located across a normally dry watercourse, as determined by the State of Colorado. This standard does not apply to structures planned primarily to trap sediment, control flooding or store water.

Design criteria

Erosion Control Dams. All dams will conform to the "Rules and Regulations for Dam Safety and Dam Construction" issued by the State of Colorado.

Embankments shall be limited to a vertical height of 15 feet from the upstream toe to the crest of the emergency spillway and must not have more than l0-acre-feet storage at the emergency spillway level unless approved by the State Conservation Engineer. All erosion control dams must have un-gated outlet works such that the structure can not store more than 2 acre-feet of runoff longer than 36 hours.

All erosion control dams will have a mechanical principal spillway, except where the emergency spillway is non-erosive and the volume of runoff from the principle spillway design storm, (table 1, NHCP 410-5), and sediment can be stored below the crest of the emergency spillway. Principle spillway capacity requirements shall not be reduced for specific site conditions, except as described for structures designed as Water and Sediment Control Basins (638). The principal spillway shall be sized to pass the required amount of storm runoff without flow through the emergency spillway. The crest of the principal spillway shall be set to stabilize the upstream watercourse and drain storm runoff.

Emergency spillways may be natural or constructed. Earth spillways shall be considered non-erosive if the outlet grade has no overfalls, is stable under design flows, and extends downstream to the outlet channel beyond the toe of the embankment. Vegetated emergency spillways shall be used only where appropriate plants can be established within a reasonable time after construction to ensure safety of the structure. Emergency spillways shall be designed using the procedures in Chapter 11 of the Engineering Field Manual, or from criteria of the Colorado State Engineer. The minimum width of an excavated emergency spillway shall be 8 feet. The type of vegetation, fertilizer, and mulch shall be selected from the critical area planting standard, (342).

Open Flow Structures. The minimum hydraulic capacity required for specific structures can be determined from the appropriate section of the National Standard. Capacity will be increased when necessary to prevent damage to the structure and/or assure success of its planned purpose.

Concrete, rock, masonry blocks, steel, plastic and wood are acceptable materials for construction of structures under this standard. The materials shall be durable and appropriate for the intended purpose of the structure.

Design procedures for specific open flow structures shall be in accordance with appropriate section of the National Engineering Handbook and/or Engineering Field Manual for Conservation Practices.

Plans and Specifications

A copy of the plans and specifications for all dams subject to state regulation will be filed with the Office of the State Engineer.

Specifications for the construction of metal, wooden, or rock grade stabilization structures shall describe installation requirements on the drawings in sufficient detail to achieve the intended purpose.

Colorado construction specification “Erosion Control Dam” shall be used for the construction of erosion control dams.

Colorado construction specification “Reinforced Concrete” shall be used for concrete structures.

Specifications for structures designed under TR-60 criteria and submitted to the Office of the State Engineer shall meet the requirements of National Engineering Handbook Section 20.

Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.

Operation and Maintenance

Specific requirements for the operation and maintenance of grade stabilization structures shall be included on the standard plan, (O&M-410). Operation and maintenance needs shall be discussed with the cooperator prior to design and construction of the practice. A complete operation and maintenance plan shall be included with the construction plans and specifications for the practice.