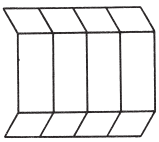
6.33

PAVED FLUME (Chutes)



Definition

A small concrete-lined channel to convey water on a relatively steep slope.

Purpose

To conduct concentrated runoff safely down the face of a cut or fill slope without causing erosion.

Conditions Where Practice Applies

Where concentrated storm runoff must be conveyed from the top to the bottom of a cut or fill slope as part of a permanent erosion control system. Paved flumes serve as stable outlets for diversions, drainage channels, or natural drainageways that are located above relatively steep slopes. Restrict paved flumes to slopes of 1.5:1 or flatter.

Planning Considerations

Conveying storm runoff safely down steep slopes is an important consideration when planning permanent erosion control measures for a site (Figure 6.33a). Paved flumes are often selected for this purpose, but other measures such as grassed waterways, riprap channels, and closed storm drains should also be considered. Evaluate the flow volume, velocity and duration of flow, degree of slope, soil and site conditions, visual impacts, construction costs, and maintenance requirements to decide which measure to use.

When planning paved flumes, give special attention to flow entrance conditions, soil stability, outlet energy dissipation, downstream stability, and freeboard or bypass capacity. Setting the flume well into the ground is especially important, particularly on fill slopes.

Paved chutes often have the upper portion of their side slopes grassed. This saves on materials and improves appearance. The paved portion carries the design flow, and the grassed area provides freeboard.

Design Criteria

Capacity—Consider peak runoff from the 10-year storm as a minimum. Provide sufficient freeboard or bypass capacity to safeguard the installation from any peak flow expected during the life of the structure.

Slope—Ensure that the slope of a chute does not exceed 1.5:1 (67%).

Cutoff walls (curtain walls)—Provide cutoff walls at the beginning and end of paved flumes. Make the cutoff wall as wide as the flume, extend it at least 18 inches into the soil below the channel, and keep it a minimum thickness of 6 inches. Reinforce cutoff walls with 3/8-inch reinforcing steel bars placed on 6-inch centers.

Anchor lugs—Space anchor lugs a maximum of 10 feet on the center for the length of the flume. Make anchor lugs as wide as the bottom of the flume, extend them at least 1 foot into the soil below, and keep them a minimum thickness of 6 inches. Reinforce anchor lugs with 3/8-inch steel reinforcing bars placed on 6-inch centers.

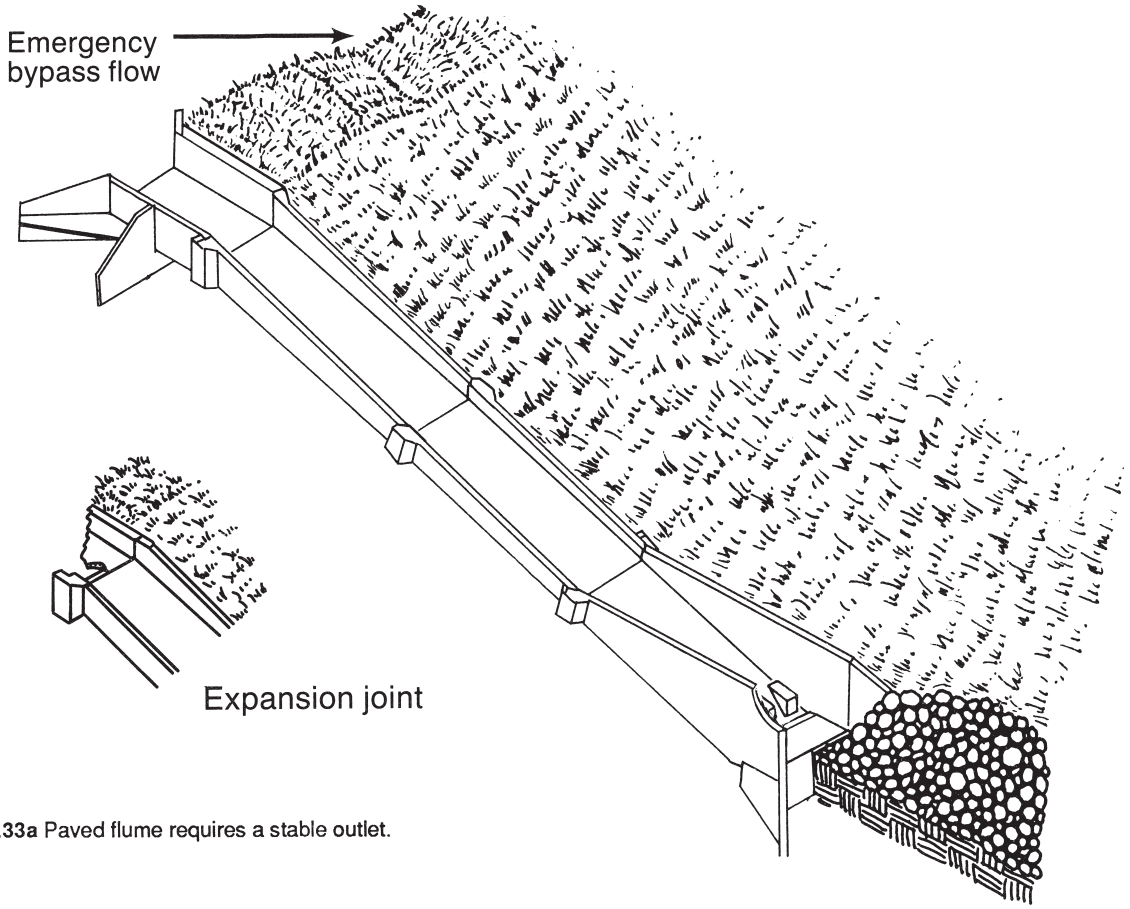


Figure 6.33a Paved flume requires a stable outlet.

Concrete—Keep concrete in the flume channel at least 5 inches thick and reinforce it with 3/8-inch steel bars. Ensure that the concrete used for flumes is a dense, durable product and sufficiently plastic for thorough consolidation but stiff enough to stay in place on steep slopes. As a minimum, use a mix certified as 3,000 lb/inch^2.

Cross section—Ensure that flumes have a minimum depth of 1 foot with 1.5:1 side slopes. Base bottom widths on maximum flow capacity.

Alignment—Keep chute channels straight because they often carry supercritical flow velocities.

Drainage filters—Use a drainage filter to prevent piping and reduce uplift pressure wherever seepage or high water table may occur (*Appendix 8.05*).

Inlet section—Ensure that the inlet to the chute has the following minimum dimensions: side walls 2 feet high, length 6 feet, width equal to the flume channel bottom, and side slope same as flume channel side slopes.

Outlet section—Protect outlets for paved flumes from erosion. Use an energy dissipator to reduce high chute velocities to nonerosive rates. In addition, place riprap at the end of the dissipator to spread the flow evenly over the receiving area. Other measures, such as an impact basin, plunge pool, or rock riprap outlet structure, may also be needed (Practice 6.41, *Outlet Stabilization Structure*).

Table 6.33a
Flume Dimensions

Drainage[1] Area (acres)	Min. Bottom Width (ft)	Min. Inlet Depth (ft)	Min. Channel Depth (ft)	Max. Channel Slope (Ft)	Max. Side Slope (ft)
5	4	2	1.3	1.5:1	1.5:1
10	8	2	1.3	1.5:1	1.5:1

[1]Due to complexity of inlet and outlet design, drainage areas have been limited to 10 acres per flume.

SMALL FLUMES
Where drainage areas are 10 acres or less, the design dimensions for concrete flumes may be selected from Table 6.33a.

Construction Specifications

1. Construct the subgrade to the elevations shown on the plans. Remove all unsuitable material and replace them with stable materials. Compact the subgrade thoroughly and shape it to a smooth, uniform surface. Keep the subgrade moist at the time concrete is poured. On fill slopes, ensure that the soil adjacent to the chute for at least 3 feet is well-compacted.

2. Place concrete for the flume to the thickness shown on the plans and finish it in a workman-like manner.

3. Form, reinforce, and pour together cutoff walls, anchor lugs, and channel linings.

4. Take adequate precautions to protect freshly poured concrete from extreme temperatures to ensure proper curing.

5. Provide transverse (contraction) joints to control cracking at approximately 20-feet intervals. Joints may be formed by using a 1/8-inch thick removable template or by sawing to a depth of at least 1 inch.

6. In very long flumes, install expansion joints at intervals not to exceed 50 feet.

7. Place filters and foundation drains, when required, in the manner specified, and protect them from contamination when pouring the concrete flume.

8. Properly stabilize all disturbed areas immediately after construction.

Maintenance

Inspect flumes after each rainfall until all areas adjoining the flume are permanently stabilized. Repair all damage noted in inspections immediately. After the slopes are stabilized, flumes need only periodic inspection, and inspection after major storm events.

References

Surface Stabilization
6.11, Permanent Seeding

Runoff Conveyance Measures
6.30, Grass-lined Channels
6.31, Riprap-lined and Paved Channels

Outlet Protection
6.40, Level Spreader
6.41, Outlet Stabilization Structure

Other Related Practices
6.81, Subsurface Drain

Appendices
8.03, Estimating Runoff
8.05, Design of Stable Channels and Diversions