

DB-6

2020

Typical Failure Modes for Dam Spillways

Failure of dam spillways may be caused by a combination of factors. It is important to be aware of the prominent causes of failures and the telltale signs that may foretell failure. A brief description of the major causes of spillway failures is given below.

Foundation Failures – Leakage and Piping

Spillway sections are usually founded on pilings, ledge, natural soils or a combination of these materials. The effect of uncontrolled leakage through the foundation material over time can cause internal erosion of soils or deterioration of rock. The loss of foundation material from seepage forces may leave voids beneath the spillway, which decreases the overall support for the spillway. Settlement and cracking of concrete structures and the displacement of stone masonry structures may be attributable to foundation piping.

Concrete/Mortar Deterioration

The aging of concrete and mortar in stone dams can be attributed to both physical and chemical factors, such as:

- Defective or inferior materials used in the concrete or mortar can result in deterioration and possible failure of the structure. Many structures built in the 19th century were of stone masonry with lime mortar. This material is very susceptible to deterioration and loss of strength over long periods of exposure to seeping water.
- Disintegration of concrete and mortar may be caused by freezing and thawing, thermal expansion and contraction, or wetting and drying.
- The strength of concrete may also be reduced by a chemical reaction with water, which is referred to as an alkali-aggregate reaction. The results of this chemical breakdown of concrete is seen in many dams in New Hampshire and is evidenced by spalling of concrete, characteristic cracking, chalky surfaces, and gel-like discharges from cracks in the surface.
- Erosion of concrete and mortared stone surfaces may be caused by flowing ice, rocks, logs, wind, or excessive water turbulence.
- Whatever the cause of the deterioration of the concrete or mortar, the end result is detrimental to the integrity of the dam and could ultimately lead to a failure of the spillway structure.

Flow Erosion

Flow erosion failures of spillway structures pertain primarily to the external erosion of either the

immediate adjoining earthen embankment toe, or foundation material and erosion of the earth spillways.

- Gullyng (rainfall erosion) of the earth on the outside edge of a spillway abutment wall will cause a displacement of soil material. This, in turn, causes two additional concerns:
 - Lack of outside support for the abutment wall.
 - A low area susceptible to outflow from the impoundment during major storm events when the pond or lake will be high.
- Downstream erosion of soil or foundation material at the outlet end of a spillway or outlet pipe and eventually undercutting, which results from turbulent flow, can also be a cause for spillway failure. Installation of aprons or cutoffs in these areas can help prevent this situation. Failures could ultimately result from loss of support for a concrete apron, abutment wall, or outlet pipe header due to undercutting.

Timber Deterioration

Structures such as wooden cribbing beneath a wooden overflow structure will decay from water content cycling, insects, and attack from organisms. These actions will ultimately affect the strength of the timber members and weaken the structure to a point where they will no longer provide support for the spillway.

For more information, relative to the design, construction, maintenance and operation of dams, please contact the NHDES Dam Bureau at (603) 271-3406 or email damsafety@des.nh.gov. General information is available at NHDES Dam Bureau Webpage. You may also visit our office at 29 Hazen Drive, Concord, NH.

This fact sheet is accurate as of December 2019. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.