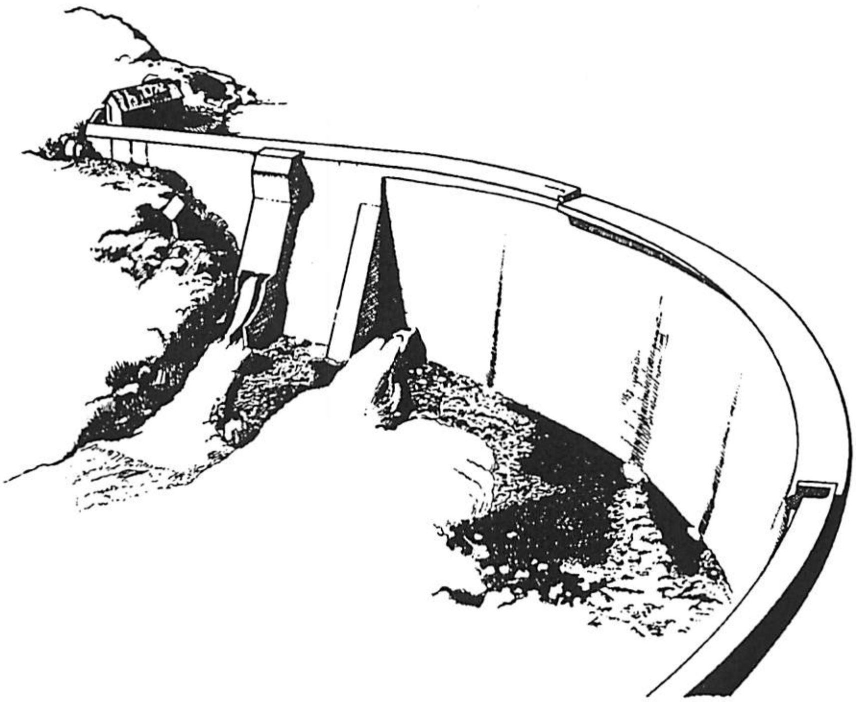
STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

In the Matter of:	)	
	)	
PROPOSED AMENDMENT TO 20.6.2 NMAC (Copper Rule)	)	No. WQCC 12-01(R)

EXHIBIT SCOTT – D-19

A DAM OWNER'S GUIDANCE MANUAL

New Mexico Edition



Technical Division Design and Construction Report 89-1

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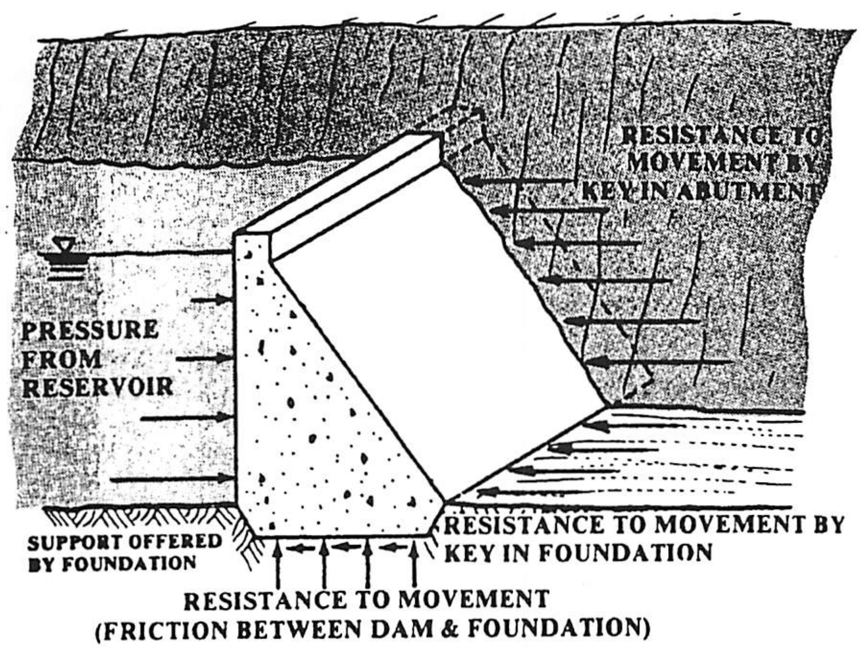

Figure 2.3 Concrete Gravity Dam

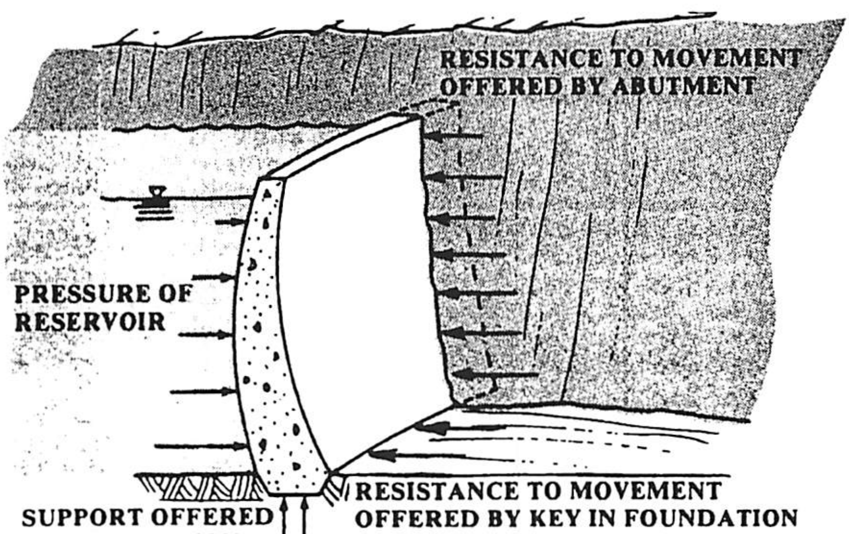

Figure 2.4 Concrete Arch Dam

Concrete arch dams are typically rather thin in cross-section (Figure 2.4). The reservoir water forces acting on an arch dam are carried laterally into the abutments. The shape of the arch may resemble a segment of a circle or an ellipse, and the arch may be curved in the vertical plane as well. Such dams are usually constructed of a series of thin vertical blocks that are keyed together; waterstops are provided between the blocks. Variations of arch dams include multi-arch dams in which more than one curved section is used and arch-gravity dams which combine some features of the two types of dams.

A recently developed method for constructing concrete gravity dams involves the use of a relatively lower strength concrete mix which is placed and compacted in a manner similar to that used for earthfill dams. This "roller compaction" construction technique has the advantage of both decreased cost and time. In addition, there are no joints where seepage could occur, although seepage can occur along lift lines or through cracks.

3. *Tailings Dams* - In the mining industry, tailing dams are used to impound tailings slurry which is composed of mine waste which has been transported in a water medium. In New Mexico, there are approximately 30 tailings dams. Typically, a starter dam is constructed of suitable material to provide lateral stability and seepage control of the tailings structure. Because of the cohesionless characteristics of most tailings material, tailings dams are not considered to be hydraulic structures because seepage, rather than retention, of water is a most desirable characteristic of such structures. Stability of such structures is most sensitive to the phreatic level within the embankment. For this reason, minimum freeboard and beachwidth for such structures are strictly enforced.

Typically, deposition of tailings is achieved either by spigoting or cycloning of the slurry. The desired result is to place tailings sand near the embankment to create a sand beach and allow the finer tailing slimes to accumulate in the central portion of the impoundment. The upstream method (shown in Figure 2.5) is preferred by the industry over the centerline or downstream methods as it is the most economical. In any case, deposition rate limitations, or rest periods are needed to allow the phreatic surface within the embankment to be maintained at acceptable levels. Tailings impoundments require large surface areas of land if they are to be economically and structurally feasible.

4. *Other Types* - Various construction techniques could be used in a single dam. For example, a dam could include an earth or rockfill embankment as well as a portion made of concrete. In such a case, the concrete section would normally contain the spillway or other outlet works.

   Other construction materials such as timber or timber faced with steel sheeting have been used for dam construction in the past. In other cases, crib walls constructed of timber, steel, or steel mesh filled with soil or rock were used. In addition, many types of embankment and crib-wall dams employed a concrete or the impermeable facing to aid in water retention. Masonry dams (usually designed as gravity dams) were also popular about 100 years ago.

   A recent and increasingly popular design for low-head dams (minimum height of water behind dam) involves the use of inflatable rubber or plastic materials anchored at the bottom by a concrete slab.

   Some dams are constructed for special purposes such as to divert water or permit construction of other facilities in river valleys. These dams are termed diversion dams and cofferdams, respectively.

2.3 WATER RETENTION ABILITY

Because the purpose of a dam is to retain water effectively and safely, the water retention ability of a dam is of prime importance. Water may pass from the reservoir to the downstream side of a dam by:

- Seeping through the dam
- Seeping through the abutments
- Seeping under the dam
- Overtopping the dam
- Passing through the outlet works
- Passing over an emergency spillway

The first three modes are considered undesirable, particularly if the seepage is not limited in areal extent or volume. Overtopping of an embankment dam is also very undesirable because the embankment material may be eroded away. Additionally, only a small number of concrete dams have been designed to be overtopped. Water normally leaves a dam by passing through an outlet works; it should pass over an emergency spillway only during periods of very high reservoir levels and high water inflow.

A. Seepage Through a Dam - All embankment dams and most concrete dams have some seepage through the dam. The earth or other material used to construct embankment dams has some permeability, and water under pressure from the reservoir will eventually seep through. However, it is important to control the quantity of seepage by using low permeability materials in the construction of the dam and by channelling and restricting the flow so that erosion of embankment materials does not occur.

   Seepage through a concrete dam is usually minimal and is almost always through joints between blocks or through cracks or deteriorated concrete which may have developed. Maintenance of these joints and cracks is therefore essential. The seepage water should be collected and channelized, so that the quantity of water can be measured and erosion can be minimized.

B. Seepage Around a Dam - Seepage under a dam, through the dam foundation material, or around the ends of a dam through the abutment materials may become a serious problem if the flow is large or if it has sufficient velocity to cause erosion. Seepage under a dam also creates high hydrostatic uplift (pore water) pressures which have the effect of an upward pressure diminishing the mass weight of the dam, making the weight of a gravity dam less effective and therefore, the dam less stable.

   Seepage through abutments or foundations can dissolve the constituents of certain rocks such as limestone, dolomite, or gypsum so that any cracks or joints in the rock become progressively larger and in turn allow more seepage. Abutment or foundation seepage may also result in "piping" internal erosion in which the flow of water is fast enough to erode away small particles of soil. This erosion progresses from the water exit point backward to the water entrance point. When that point is reached, water may then flow unrestricted resulting in even greater erosion and probable dam failure.

   Obviously, it is not desirable to allow large unrestricted seepage to occur. To minimize this possibility, dams are constructed with internal impermeable barriers and internal drainage facilities such as drain pipes, filter systems, or other drainage systems such as toe drains, blanket drains, or chimney drains.

   Flow through a dam foundation may be diminished by grouting known or suspected highly permeable material, constructing a cutoff wall or trench below a dam, or constructing an upstream impermeable blanket. Figure 2.6 illustrates a cutoff trench and an upstream blanket.

   In summary, the overall water retention ability of a dam depends, on the permeability of the dam, the abutments, the foundation, and the efforts made to reduce that permeability or restrict the flow of water through those components.

2.4 RELEASE OF WATER

Intentional release of water, as stated earlier, is confined to water releases through outlet works or over emergency spillways. An outlet works commonly has a principal or mechanical spillway and a drawdown facility. Additionally, dams should be equipped with emergency spillways to manage extreme floods.

A. **Principal or Mechanical Spillway** - The principal or mechanical spillway maintains the normal water level in the reservoir. Its function is to pass expected flood flows past the dam in a safe and nonerosive manner. It may consist of a simple metal or concrete pipe through the dam or a system of gates that discharge water over the top into a concrete spillway. Either method uses the overflow principle. When the reservoir reaches a certain level, water flows into a stand pipe or riser pipe or over a gate. Intake structures for spillways must have systems that prevent clogging due to accumulations of trash or debris.

B. **Drawdown Facility** - All dams should have some type of drawdown facility which can:

- Quickly lower the water level if failure of the dam is imminent
- Serve the operational purposes of the reservoir
- Lower the water level for dam repairs
- Purposely fluctuate the pool level to kill weeds and mosquitoes

The valve regulating the drawdown facility should be on the upstream end of the conduit to minimize the risk to the dam posed by a possible internal rupture of the pipe.

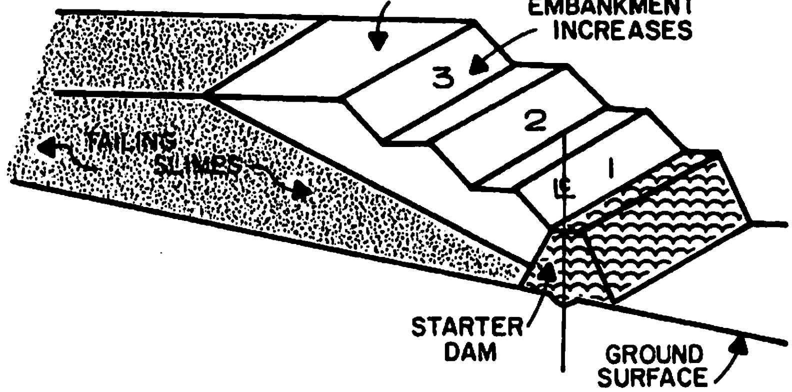

Figure 2.5 Upstream Method of Tailings Dam Construction

C. **Emergency Spillway**- As the name implies, an emergency spillway functions during emergency conditions to prevent overtopping of a dam. A typical emergency spillway is an excavated channel in earth or rock near one abutment of a dam. An emergency spillway should always discharge away from the toe of a dam, so that erosion of the toe will not occur. Furthermore, the spillway should be constructed in such a manner that the spillway itself will not seriously erode when it is in use. Obviously, erosional failure of the spillway could be as catastrophic as failure of the dam itself. An emergency spillway should be sized to convey the so-called "design flood" the rare, large magnitude flood used to establish design criteria. The spillways of many existing dams are now considered undersized because standards for the design flood have increased over the years. Chapter 3 discusses the spillway design flood in further detail.

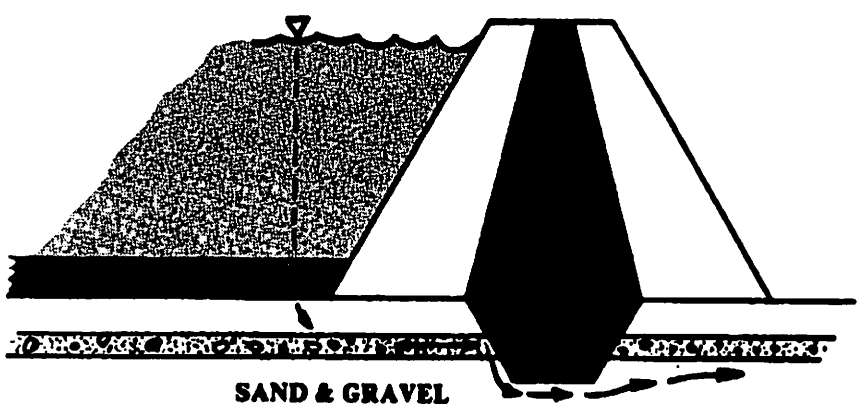

Figure 2.6 Cutoff Trench and Upstream Blanket