HYDRAULIC CRITERIA USED IN THE INSPECTION AND EVALUATION OF NON-FEDERAL DAMS

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Recent dam failures on federal and non-federal dams have increased the public interest in dam safety. The Corps of Engineers has initiated the inspection and evaluation program of non-federal dams. This paper addresses the hydraulic analyses necessary to determine spillway capacities and the downstream hazard potential. The analyses determine probable maximum precipitation (PMP) for the particular drainage basin, and investigate the capability of the reservoir to route the PMP through the outlet works without overtopping the dam. On-site investigations are made to determine the hazard potential of a dam break.

There have been more than 50 major dam failures throughout the United States in the past 25 years. These dams have varied in size, purpose, and ownership. The damage resulting from the dam failures has been immense.

In February of 1972, a coal mine tailings dam at Buffalo Creek, West Virginia, failed, causing $50 million of property damage, killing 125, and leaving 4000 homeless. This dam failure provided the catalyst to enacting the National Dam Inspection Act, PL 92-367, which was signed by President Nixon on August 8, 1972. Sufficient funds for inspection of non-federal dams were not available until November 1977, following the failure of the Toccoa Falls Dam in Georgia. President Carter made $70 million available for inspection of 9000 non-federal dams by the Corps of Engineers over the next four years.

The inspection and evaluation program consists of two separate, but integral parts. The first entails an inventory of all non-federal dams being at least 25 feet high or having a storage capacity of at least 50 acre-feet. Not included are barriers which are six feet in height or less, regardless of storage capacity, or barriers with less than 15 acre-feet regardless of height. The second entails a physical inspection of each dam. The inspection program of the non-federal dams is divided into two phases: Phase I, expeditious identification of dams which pose hazards; and Phase II, more detailed investigation. This paper will address only the hydraulics requirements which are the same for both Phase I and Phase II investigations. The original inventory of dams in Mississippi was completed in 1974 with a total of 2732 non-federal dams; and update of that inventory is in progress. Included in the inventory is the determination of hazard potential of each dam. As shown on the following table, the hazard potential is divided into three categories. The hazards pertain to potential loss of human life or property damage in the area downstream of the dam in the event of failure or misoperation of the dam or appurtenant facilities. Dams conforming to criteria for the low hazard potential category generally will be located in rural or agricultural areas where failure may damage farm buildings, limited agricultural land, or rural roads, and no anticipated loss of life. Significant hazard potential category structures will be those located in predominantly rural or agricultural areas where failure may damage isolated homes, secondary highways, or minor railroads or cause interruption of use or service of relatively important public roads, and possibility of loss of a few lives. Dams in the high hazard potential category will be those located where failure may cause serious damage to homes, extensive agricultural, industrial, and commercial facilities, important public utilities, main highways, or railroads, and possibility of loss of more than a few lives.

Hazard Potential Classification

Category	Loss of Life	Economic Loss
Low	None expected. No permanent structures for human inhabitation	Minimal (undeveloped to occasional structures or agriculture).
Significant	A few (no urban development and no more than a small number of inhabitable structures).	Appreciable (notable agriculture, industry, or structures).
High	More than a few.	Excessive (extensive community industry or agriculture).

The inventory which contained 2732 non-federal dams indicated 70 Category 1 or high hazard potential, six of which were Corps' dams which are not inspected under this program.

It might be interesting to note that the hazard potential is independent of the condition of the dam. It is determined solely on the potential damage and/or loss of life of a dam break. The original inventory determines the classification of the hazard potential by an on-site judgment of each dam. Further studies have been conducted on some of the dams to verify the classification. These studies include aerial reconnaissance, on-site determinations and computer routings. Presently, only Category 1 dams are being inspected. Only a few select Category 2 dams

will be inspected; Category 3 dams will not be inspected under this program.

It has been established that dams should be classified by size and hazard potential in order to formulate a priority basis for selecting dams to be included in the inspection program and also to provide compatibility between guideline requirements and involved risks. The height of the dam is established with respect to the maximum storage potential measured from the natural bed of the stream or water course at the downstream toe of the dam to the maximum water storage elevation. For the purpose of determining project size, the maximum storage elevation may be considered equal to the top of the dam elevation. The size classification may be determined by either storage or height, whichever gives the larger size category.

Size Classification

	Storage	Impoundment (Ac-Ft)	Height	(Ft)
Small	1,000	50	40	25
Intermediate	1,000	50,000	40	100
Large	50,000		100	

The Phase I inspection is to identify expeditiously those dams which pose hazards to human life or property. A review is made of all available existing and available engineering data relative to the design and operation of the dam and appurtenant structures. When records are available, the assumptions for the hydraulic and hydrology design are assessed to determine acceptability. Most dams do not have any design data available; and as a result reservoir routings are required to determine capacity of outlet works. All constraints on water control such as blocked entrances, restrictions on operation of spillway and outlet gates, inadequate energy dissipators or restrictive channel conditions, significant reduction in reservoir capacity by sediment deposits and other factors are considered in evaluating the validity of discharge ratings, storage capacity, hydrographs, routings, and regulation plans. The discharge capacity and/or storage capacity should be capable of safely handling the recommended spillway design flood for the size and hazard potential classification of the dam as shown below:

Hydrologic Evaluation Guidelines

Recommended Spillway Design Floods

Hazard	Size	Spillway Design Flood (SDF)
Low	Small	50 to 100 yr. freq.
	Intermediate	100 yr. to ½ PMF
	Large	½ PMF to PMF
Significant	Small	100 yr. to ½ PMF
	Intermediate	½ PMF to PMF
	Large	PMF
High	Small	½ PMF to PMF
	Intermediate	PMF
	Large	PMF

The recommended design floods represent the magnitude of the spillway design flood (SDF), which is intended to represent the largest flood that need be considered in the evaluation of a dam, regardless of whether a spillway is provided.

The PMF represents the Probable Maximum Flood. It is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF as derived from probable maximum precipitation (PMP) for a 10 sq. mi. drainage area for the central portion of Mississippi is approximately 30.9 inches.

For dams that will not safely pass the SDF without overtopping, an analysis is necessary to determine the percent of the SDF that reaches the top of the dam. The percentage of the SDF which can be contained by the dam can be determined by routing approximately four storms which are all percentages of the PMP. A rating curve of stage vs. percent PMP can be plotted and the percent of the PMF contained by the dam can be directly determined.

CONCLUSIONS

The inspection and evaluation program of non-federal dams is divided into two portions, the inventory which establishes the hazard potential for each dam and the physical inspection which establishes the condition of the dam and its outlet works. Small dams with high hazard potential are required to pass between the ½ PMF and PMF without overtopping, whereas intermediate and large dams with high hazard potential are required to pass the PMF without overtopping.

REFERENCES

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