DEVELOPMENT OF AN EARTHEN DAM BREAK DATA BASE

MAJ Karoline Hood[1]
Dr. T.V. Hromadka[2], Mr. R.A. Perez[3], COL H.D. McInvale[4]

Introduction

Earthen dams and reservoirs are frequently used for flood control purposes and for storage of water supply, sediment and debris traps and storage, among other purposes. The United States Committee on Large Dams (USCOLD) estimates 79% of all operational major dams in the United States are earthen embankment dams. A topic of high interest is the assessment of possible failure of these earthen dams and the possible range of inundation areas, peak flow rates, and peak flow velocities, among other factors that are relevant in the assessment of flood inundation damages and risk assessment due to earthen dam failure.

Problems With Modeling Dam Breaks

Regression equations are often used to estimate some of the key outcome variables of the dam breach process. These regression equations are based upon case studies of earthen dam breach occurrences using measured data. Few equations exist that consider a significant proportion of the available earthen dam breach cases reported in the literature. These regression equations differ in their predicted outcome variable values. An explanation for these differences are the differences in assembled data sets used to develop the equations.

We assembled a database for convenient reference, and plan to present a web application that will help to assess the "goodness of fit" of the test case situation within the population of the case study data that form the underpinnings of the selected regression equation.

Assembled Data Base

Several sources of earthen dam break data were examined in the current study. These sources include reports from the U.S. Department of the Interior Bureau of Reclamation Dam Safety Office, articles published in the Journal of Geotechnical and Geoenvironmental Engineering and the Journal of Hydraulic Engineering, among other journals and texts, and reports submitted to the National Dam Safety Review Board. In our integrated data base, we identified 25 parameters while only 4 parameters are observed being used in the published regression equations for estimating released peak flow rates. Our database considers over 150 earthen dams.

Dam and Location		Built	Failed	Failure Mode	Construction
1	Apishapa, Colorado	1920	1923	Piping	Homogeneous earthfill, fine sand
2	Baimiku, China			Overtopping	
3	Baldwin Hills, California	1951	1963	Piping	Homogeneous earthfill
4	Banqiao, China			Overtopping	
5	Bayi, China			Piping	
6	Bearwallow Lake, North Carolina	1963	1976	Sliding	Homogeneous earthfill
7	Big Bay Dam,USA			Piping	
8	Bradfield, England	1863	1864	Piping	Rockfill/earthfill
9	Break Neck Run, USA	1877	1902		
10	Buckhaven No. 2, Tennessee			Overtopping	
11	Buffalo Creek, West Virginia	1972	1972	Seepage	Homogeneous fill, coal waste

Figure 1. Illustration of the data base

Embankment Dimensions								Hydraulic Characteristics					
Dam Height	Crest Width	Base width	Average width	Upstream slope	Downstream Slope	Length	Peak Outflow		Reservoir Storage	Surface area	Volume stored above breach invert	Depth above breach	Breach Formation Factor
h_d	W_c	W_b	W	$Z_{e/u}$	$Z_{e/d}$	L	Q_p		S	A	V_w	h_w	$V_w h_w$
m	m	m	m	Z:1(h:1)	Z:1 (h:v)	m	m^3/s	Method of Determining Peak Outflow	m^3	m^2	m^3	m	m^4

Figure 2: Part of the database showing the assembled embankment dimensions and hydraulic characteristics used in database

Published Regression Equations Examined

The regression equations we analyzed are all associated with peak flow rate estimation. Future work will analyze failure time equations and breach width equations. The regression equations examined include equations from Froehlich 1995 peak flow equation and three regression equations from Pierce et al. 2010. Below are the regression equations:

- $Q_p = 0.607(V_w^{0.295} \cdot H_w^{1.24})$
- $Q_p = 0.1202(L)^{1.7856}$
- $Q_p = 0.863(V^{0.335} \cdot H^{1.833} \cdot W_{ave}^{-0.663})$
- $Q_p = 0.012(V^{0.493} \cdot H^{1.205} \cdot L^{0.226})$

The "Goodness of Fit" Web Application

The online web application under development provides a graphical display of the actual data reported in the literature that is used in the selected regression equation. The entered case study data for the test situation under study is then entered into the application which then inserts the test data point into the graphical display in order to visualize the appropriateness of the selected regression equation for the considered case study. At issue is whether or not the data population (that the selected regression is based upon) is representative of the test case under study.

Dam and Location		Qp=0.1202(L)^1.7856 Thorton, Pierce, Abt	Qp=0.863(V0.335*H^1.833*W avg^-0.663) Thornton, Pierce, Abt	Qp=0.012(V^0.493*H^1.205*L^0.226) Thorton, Pierce, Abt	Qp=0.607(Vw^0.295*Hw^1.24) Froehlick (1995)
1	Apishapa, Colorado		*		*
2	Baimiku, China				
3	Baldwin Hills, California	*	*	*	*
4	Banqiao, China	*		*	
5	Bayi, China				
6	Bearwallow Lake, North Carolina				
7	Big Bay Dam,USA	*		*	
8	Bradfield, England				
9	Break Neck Run, USA		*		
10	Buckhaven No. 2, Tennessee				
11	Buffalo Creek, West Virginia		*		
12	Bullock Draw Dike, Utah				
13	Butler, Arizona		*		*
14	Canyon Lake, USA				
15	Castlewood, Colorado		*		*
16	Chenying, China				

Figure 3: Database with associated regression equations

Conclusion and Future Work

The discussed web application is still under development and testing, and is anticipated to be online in BETA version in the summer of 2017.

References

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**See the complete list of references in the full manuscript*

Affiliations

[1]Instructor, Department of Mathematical Sciences, United States Military Academy, West Point, New York

[2]Professor of Mathematics, Department of Mathematical Sciences, United States Military Academy, West Point, New York

[3]Hromadka & Associates

[4]Academy Professor and Associate Professor, Department of Mathematical Sciences, United States Military Academy, West Point, New York