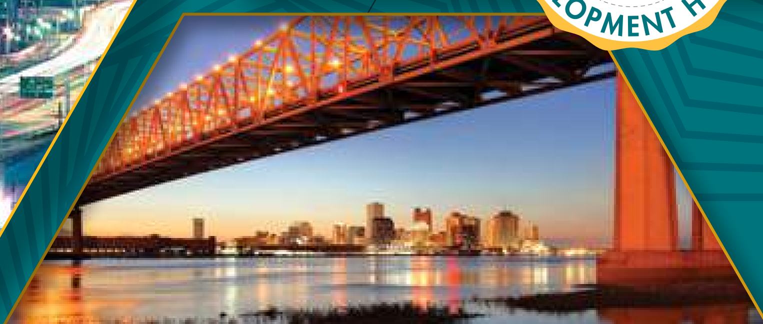
ASCE 2017 CONVENTION

NEW ORLEANS, LOUISIANA
OCTOBER 8–11, 2017

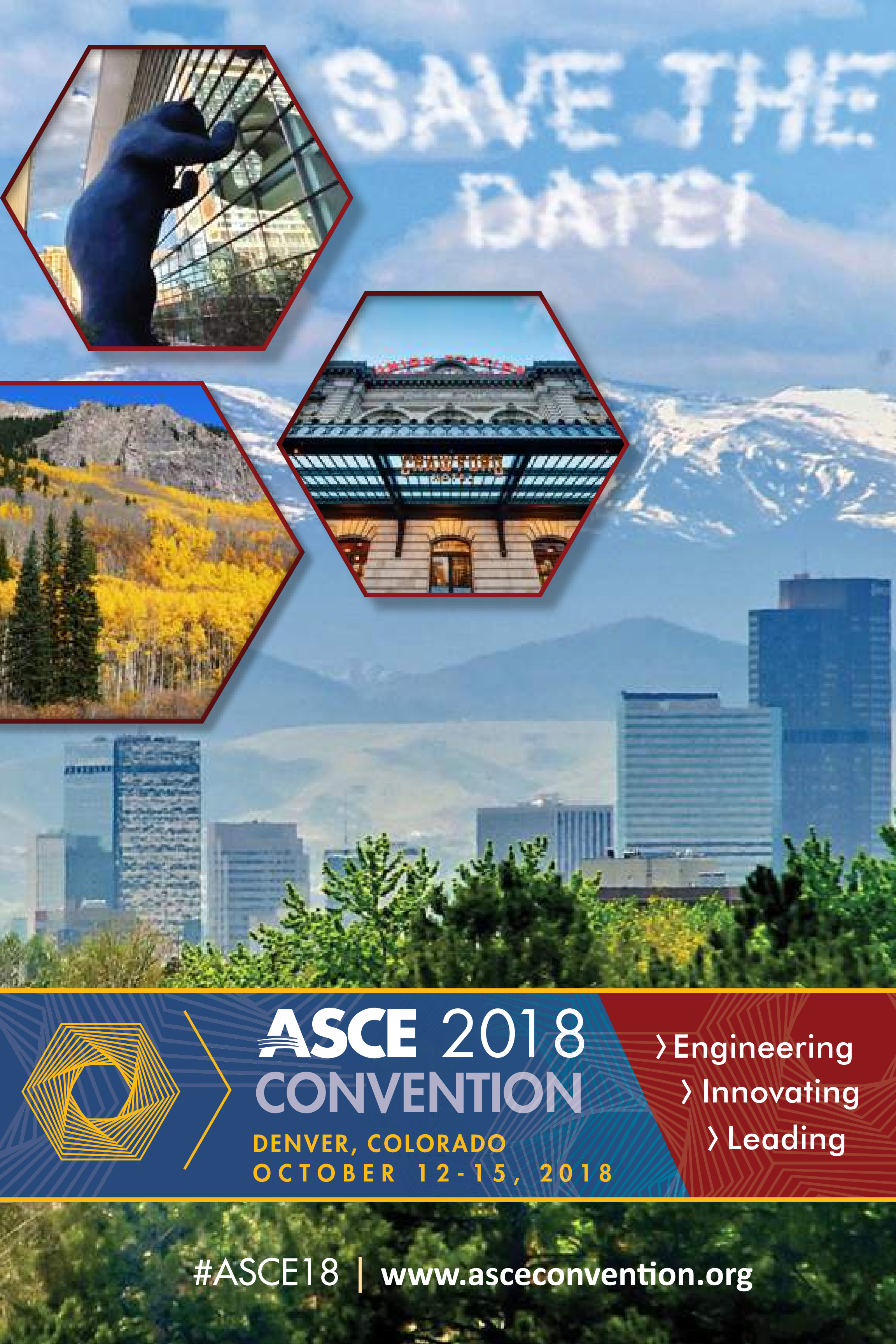
FINAL PROGRAM

PROFESSIONAL DEVELOPMENT HOURS
EARN UP TO 20



Convention Venue: New Orleans Marriott Hotel

#ASCE17 | www.asceconvention.org


SAVE THE DATE!
ASCE 2018
CONVENTION
DENVER, COLORADO
OCTOBER 12-15, 2018
Engineering
Innovating
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Earthen Dam Break Regression Equations Assessment

http://www.newtonconsultants.com/Nwtn_Page_DamE&R.html

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Outline

- Development of a Database
- Analysis and Regression Equations
- Earthen Dam Regression Selection Tool (EDRST): A web base application
- Conclusion
- Future Work

Introduction

- 70,000 dams documented in the United States
- 85% of all dams in the United States are earthen dams
- Computational models and regression equations to address failure
- Three categories for regression equations
  - Breach Width
  - Failure Time
  - **Peak Flows**

Teton Reservoir After Failure
http://damfailures.org/lessons-learned/

Development of a Database

- Dam failure: overtopping, seepage, piping, and sliding
- Over 160 dam failures with over 23 different characteristics categorized in 4 groups
- Development of a database from an extensive literature review
- Four categories of characteristics
    - Embankment dimensions
    - Hydraulic characteristics
    - Breach characteristics
    - Time parameters

	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

Snapshot of Database

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Database Snapshot

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

Breach Characteristics							Time Parameters			
								Maximum		
	Height	Top width	Bottom width	Average width	Average side slopes	Eroded volume	Formation Time	Failure Time	Development Time	Breach and empty Time
	h_b	B_{top}	B_{bottom}	B	Z	V_{er}	t_f	t_f	t_f	t_f
Breach Shape	m	m	m	m	Z:1(h:v)	m^3	hr	hr	hr	hr

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Analysis

- Analyzed 9 common regression equations found in literature
- All peak flow rate regression equations
- Extensive research was done to find data used to develop regression equations
- Data Used to Develop Regression Equations:
  - Peak Outflow (Embankment Characteristic)
  - Volume Stored Above Breach Invert (Hydraulic Characteristic)
  - Dam Height (Embankment Characteristic)
  - Depth Above Breach (Hydraulic Characteristic)
  - Reservoir Storage (Hydraulic Characteristic)
  - Length (Embankment Characteristic)
  - Average Width (Embankment Characteristic)
- Data was normalized to provide model comparison

Regression Equations

- Froehlich (1995)
  - 22 data points

$$Q_p = 0.607(V_w^{0.295} \cdot H_w^{1.24})$$

- Singh and Snorrason (1982)
  - 8 data points

$$Q_p = 13.4(H_d)^{1.89}$$

$$Q_p = 1.776(S)^{0.47}$$

- Pierce et al. (2010)
  - 14 and 25 data points

$$Q_p = 0.1202(L)^{1.7856}$$

$$Q_p = 0.863(V_w^{0.335} \cdot H_w^{1.833} \cdot W_{ave}^{-0.663})$$

$$Q_p = 0.012(V_w^{0.493} \cdot H_w^{1.205} \cdot L^{0.226})$$

- MacDonald and Langridge-Monopolis (1984)
  - 23 data points

$$Q_p = 1.154(V_w \cdot H_w)^{0.412}$$

$$Q_p = 3.85(V_w \cdot H_w)^{0.411}$$

- US Bureau of Reclamation (1982)
  - 21 Data points

$$Q_p = 75(D)^{1.85}$$

Earthen Dam Regression Selection Tool (EDRST)

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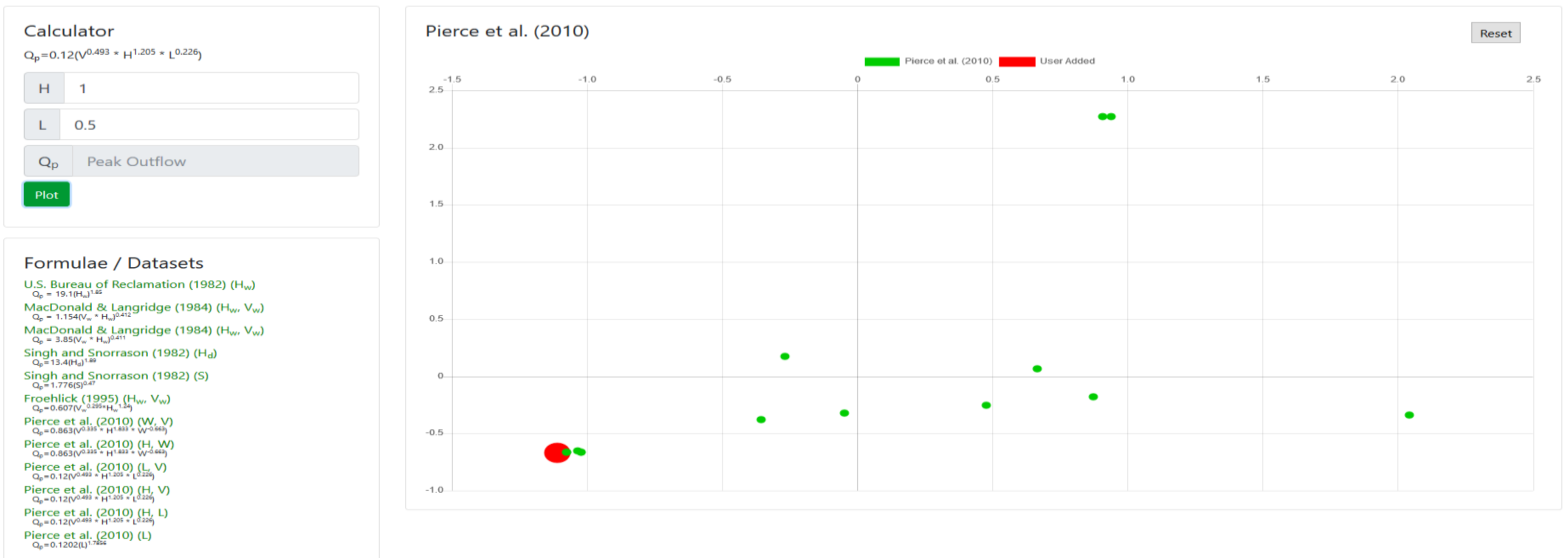

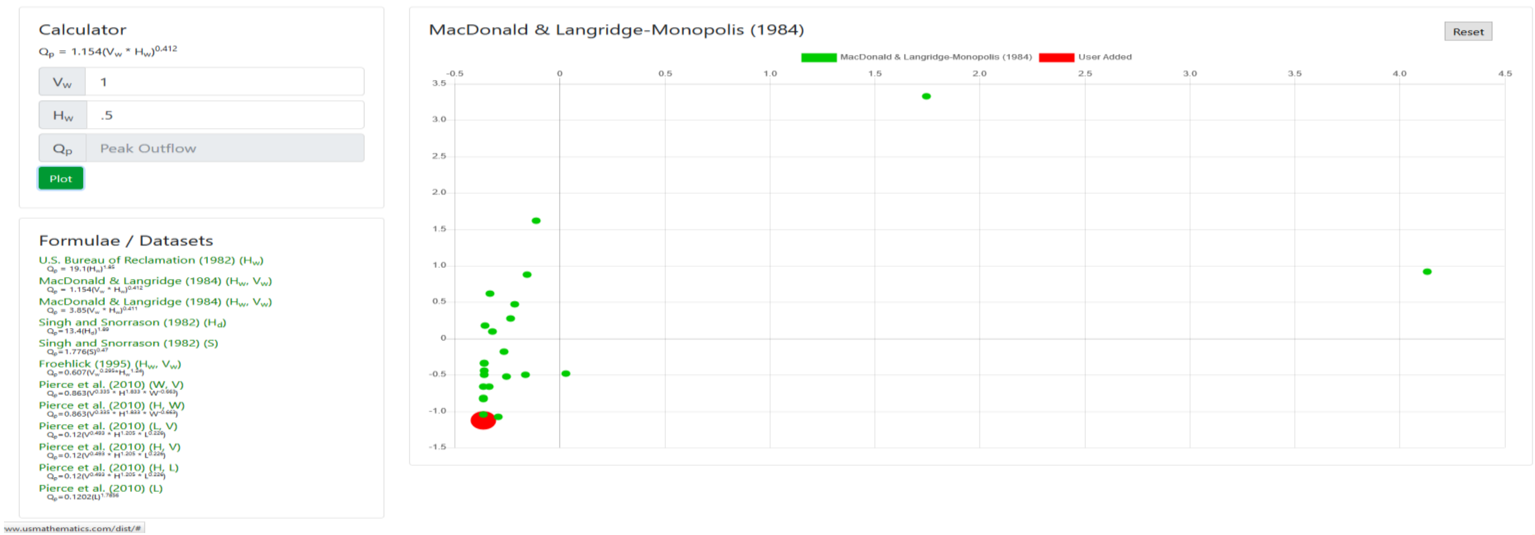

[Demo Site]

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Conclusion

- Created extensive database of earthen dam failures
- Analyzed regression equations used to model failures
- Created a visualization of regression equations
- Developed a tool useful for practitioners to select appropriate regression equations (EDRST)

Future Work

- Data continues to be collected
- Further development of other metrics:
  - Failure time
  - Breach width equations
- Analyze cluster of characteristics ("Regions of Influence")

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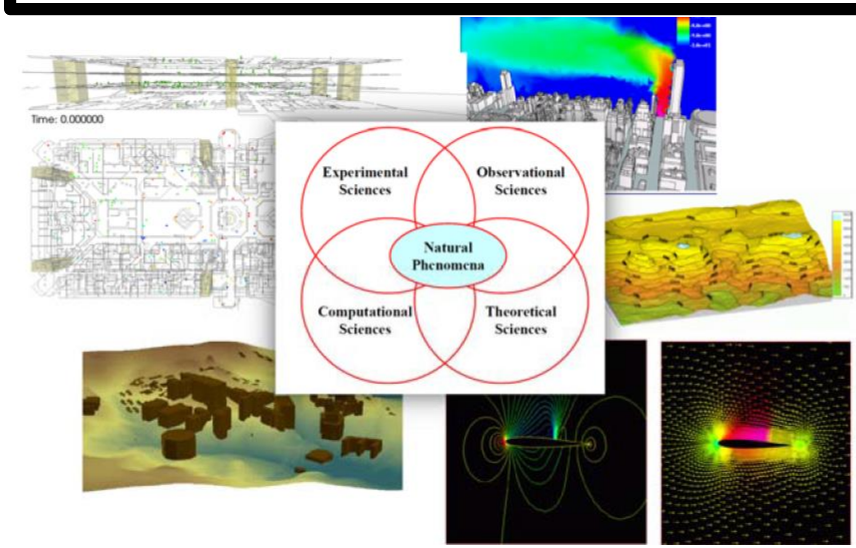
Computational Engineering Mathematics

(intersecting Applied Mathematics, Engineering, Science and Computer Science)

Serving Inter-Disciplinary Areas of Study

- Engineering - Social Sciences - Finance - Biological Sciences - Environmental Studies - Cyber and Big Data Applications



Six Local Computational Mathematics Thrusts

(1) Internships for Cadets (2) Directed Research, Senior Thesis/Projects
(3) Journals (i.e., Applications in Computational Engineering Mathematics (ACEM))
(4) Courses, Integrative Experiences, Capstones
(5) Seminars/Conferences
(6) Regularly fund Computational Mathematics Research and Applications

Leverage Some of West Point's Centers

- Center for Environmental and Geographical Science
- Center for Innovation and Engineering
- Center for Molecular Science
- Center for Nation Reconstruction & Capacity Development
- Center for the Study of Civil-Military Operations
- West Point Center for the Rule of Law
- Cyber Research Center
- Mathematical Sciences Center
- Network Science Center
- Operations Research Center

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Contact Info

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