FHWA Floodplain, Hydrology and Hydraulics Activities

July 17, 2017

AASHTO SCOD/E Meeting, Des Moines, IA
Highways & Floodplains

614,387 Bridges
509,358 over water

Source: 2016 NBI
Highways & Floodplains

U.S. highways affected by floods & flood risks even before the 1915 creation of the Bureau of Public Roads

1915: Creation of the Bureau of Public Roads

From 1900 to 1937 floods caused roughly 9,000 highway bridges failures

1956: Interstate Standards included future flood considerations

1966: Beginning of Federal Action Executive Order 11296

1974: FHWA Floodplain Regulation

23 CFR 650 A
- “Hydraulic Design of Highway Encroachments on Flood Plains”
- October 9, 1974

Elements
- 100-year event as base flood
- Set design standards
- Required hydrologic & hydraulic computations & data
- Instituted consideration of RISK
- No NEPA elements!

2015: Creation of the U.S. Department of Transportation Federal Highway Administration

1977: Executive Order 11988

Federal Agencies must develop floodplain management policies to:
- Reduce Flooding
- Minimize Impact of Flooding
- Restore or Preserve Floodplain Values

Elements
- NEPA alignment
- FIA (pre-FEMA)
- Avoidance

From 1900 to 1937 floods caused roughly 9,000 highway bridges failures.
26 November 1979 :: 23 CFR 650 A

Location & Hydraulic Design of Encroachments on Flood Plains
- covers all aspects of project delivery -

- Planning & NEPA alignment
  - Public Involvement
  - Environmental documents
  - Location hydraulics studies
  - Significant encroachments
  - Preliminary Engineering
  - Right of Way
  - NEPA Findings

- Design & Construction
  - Design Standards
  - Risk analysis / assessments
  - Consistency with NFIP
  - Shall contain H&H data and design computations
  - Floodplain permits
  - ER exemptions
1981 to Present :: Status Quo

- FHWA Floodplain Program
  - Part of Planning Process
  - Alignment with NEPA on projects
  - > 200,000 bridges built using regulation
  - Informs Construction, Maintenance, and ER activities
  - Integrated in State DOT & AASHTO approaches
End of Status Quo?
2005 :: Coastal Storm Events

US 90 – Ocean Springs
2012 :: MAP-21

- July 2012
- Codified Data Driven, Risk Based approaches
- Required Asset Management approaches & regulation
- Allowed Projects to Consider “Extreme Events”
FHWA Approaches

- MAP-21 & FAST Act
  - “Extreme Events”
- FHWA Order 5520
  Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events
  - Defines & places context of “Extreme Events”
  - FHWA decides what are appropriate scientific approaches
- FHWA “Eligibility Memo”
EO 13690


Standard

Federal Flood Risk Management Standard

Guidelines

Guidelines for Implementing Executive Order 11988, Floodplain Management, as Revised

Implementation Plan
FHWA

- Awaiting direction from the Administration
- Has a good history of involving and communicating with our transportation partners
- Will continue to do so with floodplains to the extent possible
- Will build upon risk based, data driven approaches
- Will align approaches with MAP-21 and FAST ACT initiatives

Presidential Executive Orders are implemented by Federal Agencies. States do not self- implement a Presidential Executive Order but comply with Federal Agency regulations.

**NO** FHWA programs or project delivery should deviate from existing requirements of 23 CFR 650 Subpart A until promulgation of any new/revised regulation, policies, and guidance.
Bridges
EDC-4 – Exciting New Initiative!

• Time for CHANGE!
  • Collaborative
  • Hydraulics:
  • Advancing to the
  • Next
  • Generation of
  • Engineering
What is CHANGE all about?

CHANGE promotes the use of current two-dimensional hydraulic modeling technology that provides a better representation of complex bridge hydraulics, and graphical visualization tools that significantly enhance the ability to communicate results with others (especially other DOT disciplines and resource agencies)
Bridge Deck - Vertical Contraction of Flow

Laboratory Experiments

Computational Fluid Dynamics (CFD) Modeling
Bridge Deck - Vertical Contraction of Flow

Laboratory Experiments

Computational Fluid Dynamics (CFD) Modeling
Scour
**Pier Scour**

I-64 bridge crossing the Wabash River, IN
**Scour: Concept of Hydraulic loading and Erosion force Decay Function**

Current HEC-18 Estimated $y_s$

Conservative?

ASSUMED UNIFORM SOIL

True $y_s$
Scour: Concept of Hydraulic loading and Erosion force Decay Function
Scour: Concept of Hydraulic loading and Erosion force Decay Function
Concept of Hydraulic loading and Erosion force Decay Function

![Diagram showing hydraulic loading and erosion force decay function](image)
Scour: Concept of Hydraulic loading and Erosion force Decay Function

![Diagram showing Scour, Erosion Force, Decay Function]
Scour: Concept of Soil Erosion Resistance
Assumed Uniform Soil Erosion Resistance

- Factored Resistance
- Nominal Resistance
- Load
- True $y_s$
- Estimated $y_s$
- Uncertainty

ASSUMED UNIFORM SOIL
Scour: Concept of Soil Erosion Resistance

Soil Erosion Resistance from In-situ Scour Testing Devices

In-situ Scour Testing Devices (ISTD)

- Factored Resistance
- Nominal Resistance
- True $y_s$
- Estimated $y_s$
- Uncertainty

$y$

Load
In-situ Scour Testing Device Concept
In-situ Scour Testing Device Concept (cont’d)
In-situ Scour Testing Device Concept (cont’d)
Step 1: Standard drilling using auger with casing
Thank you!