IT’S FLOODIN’ DOWN IN TEXAS

LESSONS LEARNED FROM SEVEN MAJOR FLOOD EVENTS

2018 Committee on Bridges & Structures National Meeting
Gregg Freeby, P.E.
Texas Flooding in 2015 and 2016

1. Memorial Day 2015 in Central Texas
2. Summer 2015 North Texas (Red River)
3. Halloween Flooding 2015 in Central Texas
4. Spring Break (March) 2016 East Texas (Sabine River)
5. Sustained Rain Events April, May, and June 2016 East Texas (especially Houston)
6. June 2016 Central Texas
And Then Came Harvey...

- Tropical Storm Allison was previous benchmark for highest rain totals in Texas.

- Hurricane Harvey dwarfed the Allison numbers and set the record for the highest rain total in the Continental United States.

- After making landfall and moving away from Corpus Christi, forward movement slowed and Harvey stalled over Southeast Texas (Houston and Beaumont).
Lessons Learned

- The six major floods in Texas prior to Hurricane Harvey provided many lessons learned. This was highly beneficial to our response to Hurricane Harvey.
IH 69 at San Jacinto River ~ During the Flood

Truss from previous slide.
IH 10 in Beaumont

‘An island’
Flooding cuts off Beaumont, kills city water supply, 3A
Lesson No. 1 – Be Prepared

- Establish bridge-specific command center separate from overall Emergency Operations Center (EOC).

- Not everyone gets to go to the field. Some knowledgeable personnel, especially geotechnical engineers, need to support from the office.

- Need ready access to current bridge files.
  - Channel profiles.
  - Inspection reports (to determine whether damage was pre-existing).
  - Design/As-Built plans. This can be problematic for bridges owned by cities and counties.

- Harvey: we staffed both the agency EOC and ran the bridge EOC, which created several headaches but overall worked very well.

- National Incident Management System (NIMS) Training for key EOC staff.
Lesson No. 1 – Be Prepared (Cont’d)

- Keep Equipment Readily Available.
  - Depth-Detection Devices
  - Weighted Tapes
  - GPS-Enabled Cameras
  - Safety Equipment and Other Standard Tools

- Ensure that out of date equipment is replaced.

- Make sure there are sufficient numbers of personnel that know how to use the equipment.

Harvey Go-kits with all the necessary equipment.
Lesson No. 2 – Don’t Get Ahead of Yourself

- Weather events can shift dramatically from predictions.
- Often little to accomplish by responding while event is ongoing.
  - Maintenance personnel must check roadways and bridges, but...
  - not much can be evaluated.
  - Focus on identifying critical structures, especially scour critical bridges.
- Be prepared as soon as water recedes.
Before and after shots. The first photo was taken Saturday, 9/3/17, and the second on Sunday, 9/4/17. Damage doesn’t occur only when the water comes up; frequently scour and erosion can be significant as water levels drop.
Scour Critical is the Exception – Can’t Wait for Those

- Identify scour-critical bridges and evaluate as soon as you can safely do so.

- Evaluating for scour:
  - Weighted tapes, probes, and gauges work very well for rapid assessments.
  - Depth-gauges (we call them shi-flos, which is a fancy word for a fish finder attached to a water ski) are more accurate, especially if there is a fast-moving current.
  - Underwater Imaging/Side-Scan Sonar.
Depth-Gauge (or Shi-Flo, in Texan)
Lesson No. 3 – Do Initial Evaluations

- Vast majority of structures do not sustain damage, even in extreme events.
- Better served to direct initial investigations performed by others (e.g. Maintenance forces).
- Allow bridge specialists to focus on structures where damage is identified.
Lesson No. 3 – Do Initial Evaluations (Cont’d)
Lesson No. 3 – Do Initial Evaluations (Cont’d)

- As water levels rise and debris clogs hydraulic openings, water moves to the bridge approaches.
- For approaches built well out of the main channels there are frequently no effective erosion controls in place.
Lesson No. 4 – Effective Communication

- Field Response
  - Bridge Command Center does the leg work.
  - Have overall leads attend tailgate meetings, briefings, etc.
  - Allow field personnel to remain focused on field evaluations.

- Do not allow others to derail field team efforts! Must be responsive to emergencies, but also stay systematic in overall approach.

- Get out ahead of logistical issues like lodging, fuel, food, and water.

Happy Labor Day 2017!
Lesson No. 4 – Effective Communication (Cont’d)

- Generate lists of bridges and place them on a map (e.g. KMZ files imported to GoogleEarth).

- Teams may be covering large geographic areas, avoid bouncing around.

- Worked great during Harvey. “Find My Friends” iPhone app to track team locations proved to be very effective.

- Particularly effective when we needed to find the closest team when an emergency was reported.
Lesson No. 4 – Effective Communication (Cont’d)

- Traffic Control – striking a good balance.
- Overly elaborate traffic control can take 2+ hours to set up, severely limiting the number of bridges that can be evaluated.
- Inadequate traffic control can lead to unacceptable levels of exposure.
- Typically needed only to measure channel profiles and to identify scour (short duration).
- Having two traffic control teams can vastly increase productivity.
- Communicate intent and duration. Distributed standard procedure during Harvey.
Lesson No. 5 – Standard Operating Procedures

- Prepare Standard Operating Procedures for primary tasks.
- Short and sweet (we aim for one page each).

Tasks
- Command Center Responsibilities
- Querying Data, Generating Maps
- Initial Bridge Evaluations
- Setting up Traffic Control
- Measuring Channel Profile

This was a homerun during Harvey. Distributed standard procedures for Traffic Control, Initial Evaluations, and In-Depth (Scour) Evaluations. We can now get out and communicate procedures during regular meetings instead of during the actual emergency event.
Lesson No. 6 – Have Statewide Standards for Scour

- How to determine bridge criticality and susceptibility to catastrophic damage?
- Over the course of the various flood responses we found that criteria differed significantly from District to District.
- Must avoid overly-conservative criteria. Otherwise it becomes difficult to identify the truly critical structures.
- Establish statewide criteria for categorizing structures as scour critical.
- This was a major pain point during Harvey.
Lesson No. 6 – Have Statewide Standards for Scour (Cont’d)

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1,102 Bridges!
Lesson No. 7 – Be Willing to Make Difficult Decisions

- Cannot afford to be overly conservative in assessing damage.
- Closing bridges, especially during emergencies, can have serious ramifications to traveling public and emergency responders.
- Close when appropriate, but don’t play it too safe. This is a difficult thing for many engineers.
Everybody needs one of these guys. A “courageous engineer”. During Harvey he made difficult decisions on dozens of bridges that sustained scour damage.
Lesson No. 8 – Effective Scour Evaluation

- Ensure that scour evaluations are performed at the appropriate time.

- The second scour event, when water recedes, can be more severe than the initial event. Frequently a second evaluation is needed.

- Oftentimes unable to get divers in the water.

- Use depth-detection devices.

- Expand use of underwater imaging/side scan sonar (many, many thanks to Infrastructure Engineers, Inc for their help in Texas).
Lesson No. 9 – Damage Isn’t Always Obvious

- Look under all bridges along flooded waterways – damage (sometimes even severe damage) isn’t always obvious from the roadway.
Lesson No. 10 – Manage Media and Public Expectations

- News media is interested in getting a story quick, they are not interested in getting it right.
Lesson No. 10 – Manage Media and Public Expectations

- Don’t forget Twitter!

ALERT from @HCSOTexas: Bridge over Greens Bayou collapse at Woodforest Blvd and Normandy, near Clo...

10:16 AM - 29 Aug 2017

38 Retweets 6 Likes
Bridge Approaches Saw the Greatest Impacts
Erosion at Bridge Ends
Debris is a major problem, regardless of whether there is a fast or slow rise in the water.

Particularly during Harvey, we observed bridges where the hydraulic openings were so clogged with debris that substantial channel migration occurred.

Fast moving debris can cause damage to bridge substructure elements.
Additional Lessons ~ Debris

- Particularly problematic where older bridges with short spans have lots of columns and other superstructure elements to collect debris.

- What NOT to do? Seems obvious but we’ve seen it happen:
  - DO NOT try to set the debris on fire.
  - DO NOT pick up debris from one side of the bridge and place it in the waterway on the other side of the bridge.
Additional Lessons Hydrographs

- Hydrographs are a powerful and useful tool.
- Helpful in planning where to be and when to be there.
Our Conclusion?

- Post-Harvey, we put eyes on every single on-system water crossing in the Houston and Beaumont regions (over 4,000 bridges).

- Overall, our bridges performed very well. Our past insistence on using deep foundations really paid off.

- Current design and construction practices, and the National Bridge Inspection Program, with respect to scour, are doing their job.

- You will find there are those on your staff who will rise to the occasion in ways that will truly amaze you.
QUESTIONS?

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