HYDROLINK

A Hydrology and Hydraulics Newsletter

December 2013 Issue: 9

AASHTO Technical Committee on Hydrology and Hydraulics

Message from the Technical Committee on Hydrology & Hydraulics Chair

Karuna Pujara, Maryland DOT

Welcome to the 2013 winter edition of Hydrolink! We have successfully completed the fifth year of this publication that we feel, we just started. Thanks to many who contribute their time and remain dedicated to bring you a newsletter twice a year. We are hoping that this publication reaches other practitioners, enlarging our virtual technical group, getting input from professionals across the country, and improving our services back to the greater community of hydraulics engineers.

In This Issue:

By the time this newsletter reaches you, it will be hard set winter with plenty of snow for some while others may take sigh of relief that the hurricane season is over or finally flood waters have receded. Many of you are working hard towards restoring the systems that were impacted by recent floods. With that being said, we know that hydraulics engineers deal with managing precipitation and runoff that arrive in variety of fashion and in any amounts. There is a big buzz about how we deal with what some may think as change in those precipitation patterns or events or others may think of it as simply lower design standards. TCHH is actively listening, consulting, and thinking as to how this can be addressed or dealt with, we will get back to you surely on this subject. Earlier this year, AASHTO facilitated a workshop on this subject that covered variety of topics, please read on this new letter to learn more.

While climate may be a topic in minds of some, others simply find it challenging to deliver services that we have for many years; now with fewer resources and more demands of aging infrastructure, worsening response of the infrastructure with each large or small precipitation event, increased attention to the environment, changing demands of the project delivery, or creating jobs. My predecessors spoke of building roads that would last and support the environment or the economy.

Having knowledge of practices deployed successfully elsewhere, having access to technical guidance and technology are some of the ways we could relieve the demands of the changing needs. Please be on the lookout for updated Drainage Manual in 2014. Also this

committee is energized to provide more frequent updates to the manual but updating certain chapters as needed. This technical committee and the Transportation Research Board Committee on Hydrology, Hydraulics, and Water Quality (AFB60) are pleased to announce the 2014 National Hydraulic Engineering Conference (NHEC) will be hosted by the Iowa Department of Transportation in Iowa City, IA. Dates for the conference are August 19 through 22, 2014. This National Conference is supported by our Federal partners: the Federal Highway Administration and the Corps of Engineers. Additional information concerning hotel reservations, registration, field trips, etc., can be found at: http://www.uiowa.edu/~confinst/nhec2014/index.html.

I am excited and privileged to be new Chairwoman of this technical committee and look forward to serving you and furthering the mission of being your national voice and leading source of innovation as well as the technical guidance. Feel free to contact me at kpujara@sha.state.md.us. Thank you and I hope you have safe and joyful holiday season. I will see you soon.

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Engineers Reflect on the September 2013 Flood Event in Colorado

Steven Griffin, PE, CFM, CDOT, Region 4 Hydraulics Engineer
Ryan Nataluk, PE, Stantec Consulting Services, Bridge Inspection Program Manager

Unlike the flood events that have occurred along the nation's major river basins like the Missouri and Mississippi, where communities generally have some time to prepare for rising water levels, the historic rainfall upon Colorado's Front Range Mountains and adjacent foothill cities - including the metropolitan areas of Boulder, Longmont, Loveland and Fort Collins – served as an important education in the speed and uncompromising force of flash floods in these areas of the West. Steven Griffin, P.E., CFM of the Colorado Department of Transportation (CDOT), and Ryan Nataluk, P.E. of Stantec Consulting Services, who is a provider of routine and emergency bridge inspections for the CDOT, reflect on their experiences during the flood event as it relates to the bridge and roadway infrastructure along the Front Range of Colorado.

By the evening of Friday, September 13th, 2013 it was clear to most engineers that the unrelenting heavy rains over the preceding days was rapidly turning into a dangerous historical event. News reports began to multiply by the hour of impassable roads, culverts washing out and horror stories of people trapped in cars caught in flash flood waters. Mudslides were reported in canyons, homes and entire communities were soon reported to be under water and large open floodplain areas in the flat lands were completely inundated by flood waters. One of the first major roadways in Colorado to close due to the flooding was Interstate I-25 over the Big Thompson River near the City of Loveland. This river typically has an average September flow of around 40 cfs but, during this storm event the USGS stream gage on the Big Thompson at Loveland went out of service after recording flows of over 5350, cfs. This closure signaled to the public, state and local authorities the severity of what was rapidly unfolding along across the eastern faces of the Rocky Mountains. *(Ryan Nataluk)*

As a hydraulics engineer for CDOT, there were two items throughout this unprecedented flood which left the deepest impressions upon me. The first was the swiftness with which the flooding rivers and channels realigned their paths and exploded onto their floodplains.

But the second was the resiliency of our infrastructure. Though many roads washed out, almost all of the bridges and structures generally held firm, precisely as they were designed to do. In the receding waters, some of the scour mitigation measures looked haggard – but by and large the protection measures were effective in protecting the integrity of the structure.

It was clear that many bridges became pressurized during the event, and at some locations this exacerbated the scour at piers and abutments. Other sites, particularly in the mountain canyons, exhibited sediment aggradation on the order of eight or nine feet from pre-flood conditions. East of the foothills, floodplains stretched out their arms to full width, which in some places was nearly two miles in breadth of saturated fields, storage sheds, parks and residences. Fences littered with debris quickly developed into weirs; massive headcuts, sometimes multiple and side-by-side, formed and ate away from the submerged banks onto the adjacent land. We were able to see, in real time, the effect of manufactured (as well as unintended) water storage areas – while some rivers swelled from one structure to the next with minimal delay, others were able to find depressions in the land which delayed and metered the peak flows between structures. These delays allowed our engineers, inspection crews, and maintenance personnel the time they needed to close roads and to target specific structures for closer observation. *(Steven Griffin)*

As one of the many bridge inspectors with Stantec to witness the severity of the flood, it was amazing to see firsthand the power of the water. In particular, I was shocked by the enormous surge in velocity and flow volume which lifted and carried massive amounts of debris. Trees the diameter of small steam engines and as long as subway cars were wedged at the nose of piers and jammed between bridge girders; you could literally hear the bedload (large rocks and boulders) pounding downstream and against the bridge piers. In most situations during the peak flow periods, trying to sound the channel and record the changing streambed profiles with 25 pound weights tied to strong ropes was impossible and a waste of time. The currents were just too strong and the velocity and debris in the water too great. In some instances at bridges located in the steep canyons above Boulder and Fort Collins, the streambeds scoured to bedrock due to the extreme energy gradients. Lateral migration of the waterway was common as the once docile creeks along and under local roads jumped their banks and took the easier straight path into the flood plains, completely rerouting around the bridge and culvert structures. Some scour and erosion protection systems held firm as designed, and other more haphazardly placed or designed systems eventually failed. It was visually evident which riprap protection system were properly design and anchored.

While the total amount of damage to private property, crops, business, and livestock is an astounding figure in the hundreds of millions of dollars, the cost to repair the network of bridges and culverts in the area is disproportionately lower. Bridges listed on the state's scour critical list did sustain further scour at the foundations coupled with riverbed degradation; yet in many locations the depth of scour was less than the scour models predicted for such an event. Over-estimates may be attributed to the cohesive quality of the soils east of the mountains, or the shallow bedrock profiles for bridges located in the canyons and the difficulty in properly accounting for the scour resistance of the soil in the scour analysis. Colorado design engineers commonly employ driven HP piles or drilled caissons for deep foundations in erodible soils that proved to be suitably designed in depth and breadth in most cases, even under pressurized flows and moderate scour conditions. So even though there is much more to learn in the coming months about the true extent of the flood damage, the findings at this time indicate that the bridge hydraulics, scour

susceptibility and structural resiliency of most of the bridges in the Colorado Front Range were favorably working together, which allowed better than expected performance in such a historic flood event. *(Ryan Nataluk)*

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AASHTO Extreme Weather Event Symposium - May 2013

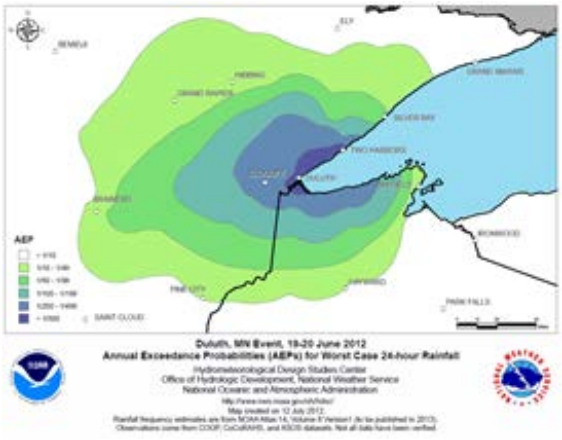
Comments from Karuna Pujara, Maryland DOT
On May 21-22, 2013, AASHTO held a national symposium, Impacts of Extreme Weather Events on Transportation, in Washington, D.C. The event covered state DOT case studies related to experiences with extreme weather events; an overview of trends and projections for extreme weather in the United States; costs of extreme weather events; and risk management strategies in design, operations and maintenance, and asset management, and emergency response. **Bud Wright**, Executive Director, AASHTO and **Gloria Shepherd**, Associate Administrator, FHWA Office of Planning, Environment & Realty gave opening remarks. The symposium was well attended by cross section of various disciplines ranging from maintenance, hydraulics, emergency responders to high level DOT officials responsible in managing these extreme events. Karuna Pujara, TCHH's new Chair, moderated a session regarding State DOT experience with recent extreme weather event. It was eye opening how DOT deals with them during the event to long after the even in preparing and educating public on how to best respond as an individuals and users of the transportation system. It was also interesting to see how an event considered normal to some parts of the country were more severe to others due to local conditions or sensitivity of the region and the population served. They all have different challenges and vary significantly on how response is conducted. Although widely different types and magnitude of events across the nation, there were surprising similarities in certain best practices or the lessons learned such as training, standard operating procedures, identification of lead staff etc. However more importantly strong leadership, early preparedness, communication through use of all sorts of media outlets and team work within and across the organization were key factors to the events better managed.

A white paper on this topic summarizing the information presented at the conference can be found at:
http://environment.transportation.org/center/products_programs/conference/2013_extreme_weather_symposium.aspx

If you are more interested in agenda and all individual presentations, please follow this link found on AASHTO's Center for Environment's website at:
http://environment.transportation.org/center/products_programs/conference/2013_extreme_weather_symposium.aspx

Comments from Andrea Hendrickson – Minnesota DOT
Andrea Hendrickson, TCHH's past Chair, also attended the AASHTO Extreme Weather Event Symposium in May of this past year and presented on "Flooding in the Midwest – A Minnesota Case Study". She discussed some of the main impacts of extreme flooding events including the differences between snowmelt events and summer time flash floods. Minnesota has experienced the unexpected situation of having the counties designated for federal disaster assistance for drought while adjacent counties were designated as federal disaster areas for flood or severe storms.

The case study for this presentation was The city of Duluth's 2012 event where rainfall exceeded the 500 year event. What contributed to the damage was that rainfall occurred over a large area, there were steep slopes and at the bottom of the slope was an urbanized area. Impacts included overflow of a dam, failure of forebay embankment, wash out of roadway (slope failures as well as water), failure of roadways, culverts, storm drain, flooding of homes and business including the city zoo (with loss of animals). The good news was there was no loss of life, though one young boy washed through a storm sewer and ended up over 1000 feet downstream.



Lessons learned included:

- Be prepared with an incident response plan before an emergency happens – this includes even the small things such as having stashes of cones and traffic control devices for troopers to use.
- Team work – take advantage of offers of resources and staff from other DOT Districts and Offices, other Agencies and local governments. Make sure to keep track of borrowed equipment, people do eventually want it back.
- Communication is essential; use technology i.e. GIS tools to track road closures.
- Accelerated repair is possible by early damage assessments, emergency contracting authority and having materials on hand.

This symposium was a multi-discipline event with attendees and presentations from a wide range of regions and perspectives. Two of the things Andrea thought were most interesting were how other parts of the country have different types of problems such as dust storms in Arizona. The second was how important it is to have different functional groups work together and bring their perspectives and skills to the table when dealing with extreme events.

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Newly Established TCHH Work Groups

As part of the changing times the number and duration of TCHH meetings has nearly been cut in half. One way the TCHH is planning on continuing to get things done is to work in smaller teams focusing on specific priority topics. Six work groups are kicking off. In future issues of the *Hydrolink* we will provide more information on the results of the work group's efforts. These groups and their primary goals are:

LRFD Bridge Design Work Group
Review LRFD Bridge Design Manual sections related to hydraulics, determine if that document and TCHH documents are in synch. Promote cross functional coordination and consistency.

Bridge Work Group
Update Drainage Manual Chapter 17 Volumes I and 2; consider comments from SCOD and recent updates to FHWA HEC manuals. Review and determine if Bridge Chapter in HDG needs to be updated.

Exchange Work Group
Explore possibility of web publication information with information such as: state of practice, highway hydrology and hydraulics tools and technology, research. Recommend potential format and content for a TCHH hosted Information Exchange. Develop process and procedures for collecting ideas in the hopper, peer reviewing submittals and running exchange. Follow up on implementing and promoting an internal TCHH Discussion board with alert options.

Climate Change Work Group
Develop work plan, white paper/fact sheet, research needs. Be a point of contact for other groups interested in climate change impacts to hydrology and hydraulic design of highway infrastructure such as SCOE's development of 20-05 Synthesis on climate change impacts on hydrology. Explore feasibility of a meeting on climate change impacts to hydrologic/hydraulic design.

Water Quality Work Group
Determine if white paper or chapter update is needed. May need work plan to determine work group's direction and goals for the next year.

Hydrolink Newsletter Work Group
Publish up to two issues per year.

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Modeling of Pavement Drainage

Michael Barrett, Ph.D - University of Texas at Austin

It is often assumed that DOTs already have the tools at their disposal to provide appropriate drainage for highway surfaces. However, there are several situations where concentrated flow occurs across the traveled lanes potentially impacting the safety of the traveling public. Consequently the Texas Department of Transportation (TxDOT) has funded a number of modeling projects at the Center for Research in Water Resources at the University of Texas at Austin to better understand and manage surface flow on pavements.

One of the first projects funded by TxDOT was focused on predicting flow depths in superelevation transitions. Because of the curved nature of the flow paths present in curved highway sections and the abrupt changes in depth associated with flow near the pavement edge a 2 dimensional, diffusion wave model is required to accurately represent flow. The model developed for TxDOT results in some rather surprising predictions regarding the location and direction of the concentrated flow. Figure 1 presents some of the modeling results of this effort in which S_x is the longitudinal slope of the centerline towards

the right and the rainfall intensity is about 4 inches/hr. One unexpected result is that at very low slopes the edge of pavement of the side of the highway being superelevated actually slopes in the opposite direction of the centerline resulting in a direction of flow that appears to be heading upstream. As the longitudinal slope increases the maximum water depth moves from near the centerline to the downstream edge of pavement. The complete report describing the model and results can be accessed at:
http://www.utexas.edu/research/ctr/pdf_reports/0_4875_1.pdf

TxDOT has also been a leader in the development and application of thin lift, permeable asphalt overlays, termed the Permeable Friction Course (PFC, aka OGFC). These roughly 2 inch thick lifts allow runoff to flow towards the edge of pavement both within (at low rainfall intensities) as well as on the pavement surface (higher rainfall intensities). The model described above for 2 dimensional surface flow was modified to also incorporate conveyance within the pavement as well. This model can be used to compare the surface flow depth for the same highway geometry, with and without a PFC layer. It can also be used to demonstrate the attenuation in peak flow rates discharged from the pavement during brief, high intensity events. This model as well as the stormwater quality improvements associated the use of PFC are described in:
http://www.utexas.edu/research/ctr/pdf_reports/0_5220_2.pdf

A physical and numerical modeling effort was also conducted to determine the magnitude of the error in predicting ponding width on roadways with mild slopes. On slopes of less than about 0.5% flow in the gutter is subcritical, but passes through critical depth at inlets. This transition results in additional forces associated with acceleration and pressure differences that propagate upstream, reducing the ponded width compared to that predicted by Manning's equation. Our modeling results indicate that the difference between the ponded width predicted by Manning's equation and a dynamic wave model is limited to an area just upstream of the transition to supercritical flow. In terms of highway drainage design, Manning's equation can be confidently used to determine inlet spacing, even on mild slopes with downstream control. At slopes as low as 0.1%, inlets would only be about 25 feet closer together compared to the predictions of a diffusion or dynamic wave model. This distance is insignificant in the context of drainage design and has little impact on overall project cost. Since Manning's equation always over-predicts spread adjacent to curbs, its use results in a slightly conservative design. We are planning to submit the report on this modeling effort for presentation at the TRB annual conference in 2015, so stay tuned!

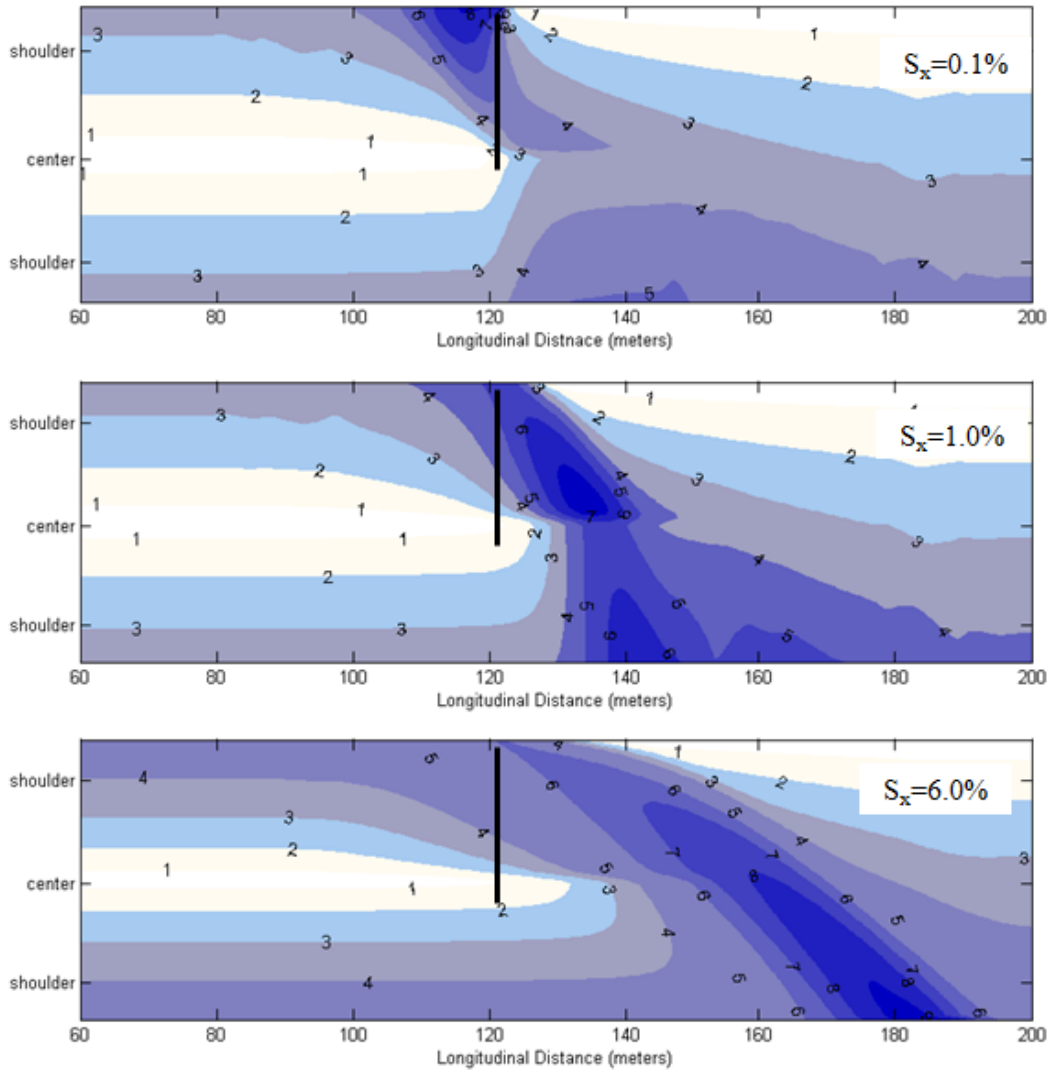

Figure 1 Model of Surface Water Depths (in mm) for various Longitudinal Slopes

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NCHRP Synthesis 20-05/Topic 45-01 "Service Life of Culverts"

This study will update Synthesis 254 "Service Life of Drainage Pipe (1996), which in turn updated NCHRP Synthesis 50 "Durability of Drainage Pipe".

The Panel of this synthesis, including 6 DOT members, 1 FHWA member and 1 retired Professor member, has its first meeting on August 23, 2013 at the Beckman Center in Irvine, CA. The Panel has choose Golder Associates Inc. as contractor for this project.

A teleconference meeting with Dr. Michael Maher, Ph. D, Principal of Golder Associates Inc. has occurred on September 27, 2013. During this meeting, the Panel tried to answer all the questions from Dr. Maher about the final scope of this synthesis. A second meeting of the

Panel is scheduled on May 2, 2014 at the same Beckman Center in Irvine, CA. This NCHRP Synthesis 20-05/Topic 45-01 is expected to be completed at the end of 2014.

For more details about this synthesis, please contact Mr. Jon M. Williams, TRB Program Director, IDEA and Synthesis Studies at (202)334-3245 or email him at jwilliams@nas.edu.

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Announcements

2014 National Hydraulic Engineering Conference

The 2014 National Hydraulic Engineering Conference is scheduled on August 19-22, 2014 at the Sheraton Iowa City Hotel in Iowa City, Iowa. The Conference is being hosted by Iowa DOT. A request for presentations has gone out. If you would like to submit a presentation for consideration send an abstract to Cynthia Nurmi Cynthia.Nurmi@dot.gov In the future information for this conference will be posted at http://www.uiowa.edu/~confinst/nhec2014/index.html

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Membership News

We congratulate Karuna Pujara for taking over as the new Chair of the Technical Committee on Hydrology and Hydraulics (TCHH). She has been a member of TCHH since 2005. Karana's full time job is the Chief of Highway Hydraulics Division at the Maryland Department of Transportation.

Amy Ronnfeldt has taken on the position of Vice Chair of of the Technical Committee. She has been a member of TCHH since 2006. Amy's full time job is the Chief Hydraulics Engineer, Design Division at the Texas Department of Transportation.

Calendar of Events

Transportation Research Board (TRB)
Washington, DC
January 12 – 16, 2014
See the Interactive Program for Hydraulics and Hydrology Workshops and Presentations

http://www.trb.org/AnnualMeeting2014/annualmeeting2014.aspx

The 2014 National Hydraulic Engineering Conference
Iowa City, Iowa
August 19-22, 2014

Sheraton Iowa City Hotel

http://www.uiowa.edu/~confinst/nhec2014/index.html

This newsletter is published biannually by the AASHTO Technical Committee on Hydrology and Hydraulics. Please send suggestions for articles and comments to: *Andrea.Hendrickson@ state.mn.us*, ***or call 651-366-4466.***

To be added to the mailing list please send your email to Kelley Rehm at: krehm@aashto.org

For more information on the Technical Committee on Hydrology and Hydraulics see:
http://design.transportation.org

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