WSDOT 2023 Scour Training

5/30/2023 – 6/01/2023

Q&A for Module 7: Contraction Scour (Casey Kramer and Scott Hogan)

- **Q: Do we have a recommended table for critical velocity and D_{50}?**
  - No. As always, professional judgement is required to determine how applicable a relationship is on a project-by-project basis. For example, Hydraulic Toolbox will use Laursen's equation by default. This may not be suitable for many streams in western Washington because Laursen's equation was developed for primarily sandy streambeds, whereas many of our streams have gravel beds and larger substrate.

- **Q: How applicable is the critical velocity approach? Those equations by Laursen were developed for sand-sized sediments not gravel-bed rivers/streams?**
  - Other equations may be necessary to check in order to confirm results are reasonable and reflect anticipated contraction scour given the sediment size of a particular stream. There is a whole other suite of equations available for gravel bed streams.

- **Q: At the PHD level, do you recommend using toe-to-toe or top-to-top for bank arcs?**
  - Consistency is important here; the bank arcs in the contracted and approach section should be drawn both toe-to-toe or top-to-top. The bank arcs should match field observations of widths capable of transporting sediment.

- **Q: Where is the recommended location of the bank arcs if we have clear water conditions throughout the entire reach?**
  - Toe-to-toe is likely to provide the most conservative and representative computation in that case. The more you spread the location of the bank arcs, the more you're including the areas of slower velocity in the average velocity used in calculations.

- The bank arcs at the approach section are needed initially to define the limits of the main channel that could be transporting sediment. This portion is used to compute the average depth and critical velocity. If the scour condition is determined to be a clear water case, only the hydraulic parameters at the contracted section are used for contraction scour. However, the unit discharges at both the approach and contracted sections are still needed for determining the amplification factor for abutment scour (for both live-bed and clear-water conditions).

- **Q: Do we take into account man-made armoring of the stream and the spill through slope?**
  - Yes, it is best to use the toe to toe reference width for determining the scour potential. The average velocity across this width would be representative of the portion that can actively be eroding the channel bed. If there are existing countermeasures that would prohibit sediment movement through the system, then that width should not be included. If riprap, concrete, or other protection on abutments are proposed it's important to consider this for scour calculations, especially if they encroach upon the channel and will affect sediment transport.

- **Q: What if the abutment toe is not within the flow field?**
  - For a channel that is able to laterally migrate, main channel hydraulics should be used.

- **Q: How do we handle confluences or multiple tributaries upstream in our approach section where 1 arc may not be possible to draw?**
  - This is a case where Laursen's equation for live bed does not apply. You have to use either on the clear water scour estimate which will rely on the contraction at the crossing or use the sediment transport function in SRH-2D. However, the latter can *only* be used if you have enough sediment characteristic information of both channels. Regardless of which method is chosen, you should not rely on the live bed scour estimate in this case.

- **Q: How do we select an approach section if there are two bridges close together?**

- Use the same approach section for both bridges. Identify which bridge has the greatest contraction and use that information to compute scour for both structures. One exception to that might be if you have a very steep channel.

- **Q: Is the recommendation to compute clear-water and live-bed and use the method that produces the least amount of scour?**
    - Yes and engineering judgement is required. Clear bed will usually be deeper than live bed scour, but you want to get in and understand what the inputs were and the effects it might have on the ultimate design of the structure foundations. If you have a case where the clear bed scour is significantly less than the live scour, take a closer look at the D_{50} and other inputs at the contracted section to make sure calculations are done correctly.

- **Q: Is there a way to launch the most current version of the Hydraulic Toolbox? Mine always opens an older version.**
    - Yes, you can change your preferences of that program under Hydraulic Toolbox > Preferences > file location tab.

- **Q: Could you please elaborate more on when you expect live bed vs. clear water conditions?**
    - Live bed would have material that is readily available upstream of the crossing that will mobilize during flood flows. Therefore, you want to look upstream and sample the material that's readily available upstream of the impact of the bridge and assess that material. If it can move during your flood flows, then you have a live bed condition. If the velocity is not high enough to mobilize that material, then the scour at the bridge is going to be purely dependent on the clearwater case. In other words, the scour can only go as deep as it can until the average velocity no longer exceeds the critical velocity of that material.

- **Q: The example you went through was for a newer fish passage project where stream simulation that follows WDFW guidelines is being implemented. Why is**

there 0.6 feet of contraction scour during the 2-year event if we should be typically spanning the stream with the proposed new structure for all flow events?

- This project incorporates meander bars that are currently intended to be immobile and create a minor amount of scour. Sometimes complexity features do create some local/ abutment scour, which is one of the intentions of meander bars. It's worth noting here that the scour is caused by streambed features intended to create hydraulic diversity, and not caused by the structure or any countermeasures. It is important to coordinate with HQ Hydraulics how to account for scour for complexity features during the PHD/FHD phase. Additionally, spanning the stream for all flow events is something most designs strive for, but it is not always feasible.

- **Q: How do we compute scour when we have multiple layers of streambed material with varying D_{50} values and scour is expected to pass through the 1st layer into other material?**
  - In Washington, new bridges and crossings are typically designed with a streambed that includes a streambed sediment layer. If your anticipated scour does go below the gradation used in design and/or the top layer of existing sediment that was analyzed, you will have to take a close look at the subsequent layers. This is touched on more in the module on pier scour as pier scour calculations tend to generate deeper scour estimates than what is seen from contraction and at abutments.
    It's also worth noting that there are some limitations to our methods. FHWA is currently conducting research to better assess scour in the presence of multiple stratifications of sediment.