US Army Corps of Engineers®
Engineer Research and Development Center

National Regional Sediment Management Program
Hydrologic Engineering Center (HEC):
Ensemble Riprap Calculator in HEC-RAS

Description

The USACE Rip-Rap software does not work on contemporary operating systems and does not include the full suite of useful, contemporary algorithms USACE modelers are applying to our projects. This proposal builds multiple methods into a "cumulative evidence" calculator in HEC-RAS, giving USACE engineers the capability to quickly apply multiple classic and more contemporary computations to Rip-Rap sizing problems.

Figure 1. ERDC (WES) "Curved Channel Model" used to develop classic equations to compute influence of curvature on riprap size.

Issue/Challenge To Address

The USACE has a class of tools the HH&C COP calls "orphaned software." These programs are still the best available tool for important, standard, USACE analyses. But the developers have retired, the source code is not available (or compliable), the interface requires old DOS command line and text file input foreign to a new generation of engineers, and some do not even run on recent operating systems. Some Districts keep old computers around with outdated operating systems just to run these old command line codes because we have not replaced them with sufficient alternatives. Additionally, they do not include any of the new science or insight that has emerged from decades of research and practice.

Channel Pro, the program our agency used to size riprap, is the prototypical example of orphan software. It does not work on some operating systems, the source code is not available, and ERDC experience suggests that some districts have actually returned to hand calculations to design rock placement.

Calculating scour and sizing riprap is fundamental to multiple USACE mission areas.

This initiative incorporates the classic USACE rock sizing computations with a suite of supporting methods, directly within HEC-RAS, which is already part of the required work flow, and is familiar to most USACE H&H modelers.

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Successes Lessons Learned

HEC reviewed existing literature and worked on a preliminary interface design in FY19, preparing for FY20 implementation. The project delivery team is in place for FY20 execution.

$$D_{30} = S_f C_s C_v C_t d \left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right)^{0.5} \frac{V}{\sqrt{K_1 g d}}^{2.5}$$

Figure 2: Classic USACE riprap sizing equation.

Projected Benefits Cost Savings Value Added

This tool will increase the efficiency of rock sizing approaches by streamlining the workflow and building the analyses into the hydraulic tools engineers already use to generate the hydraulic data required for the analysis. Adding multiple, more recent algorithms to provide an ensemble-approach to rock sizing will also optimize rock placement sizing and reduce project costs by providing a risk-and-uncertainty based approach to rock sizing. Finally, by standardizing the methodology, the initiative could avoid costly rock sizing mistakes that lead to project failures.

Expected Products

- Ensemble Scour Calculator in the Hydraulic Design tool in HEC-RAS
- Ensemble Riprap calculator in the Hydraulic Design tool in HEC-RAS
- Documentation – User Guide and Video

Stakeholders/Users

Multiple districts and divisions have expressed interest in these capabilities. Riprap sizing and scour calculations are ubiquitous activities in the USACE. Additionally, HEC-RAS is downloaded over 100,000 times per year in over 200 countries. Incorporating these tools in HEC-RAS and providing good user guidance will, likely, make them industry standard making the benefits described above scale globally

Leveraging Opportunities

The proposal will leverage ongoing efforts to update the HEC-RAS interface and Hydraulic Design features. HEC is currently redesigning the Hydraulic Design features and plans to re-write them in a modern .NET framework. HEC will develop this editor in the new code framework and leverage the code modernization initiatives.

Points of Contact

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