November 2016

How to Spec Riprap

The Monthly Dirt
A Monthly Newsletter on the California Construction General Permit
By WGR Southwest, Inc.

Riprap is a valuable erosion control technique, but we've noticed that not many SWPPP developers know how to properly specify and use it – and with the wet season officially begun in California, now is the time to think about using riprap for velocity dissipation and erosion prevention. While properly specifying riprap is fairly complicated and will require you to work in conjunction with a Civil Professional Engineer, our goal in this edition of ***The Monthly Dirt*** is to provide some resources and give you a good start in the right direction.

Riprap involves a whole lot more than just dumping rocks onto a slope. In many cases, riprap consists of three or more layers of consecutively larger rocks, backed by a geotextile material. The number of layers and the average size of rocks in each layer is determined in part by the direction and volume of water along the slope or in the culvert. An installation where the water flow is parallel to the riprap installation will require a smaller rock size than an installation where the water flows perpendicular to (or is "impinging") the riprap. Before deciding which class of riprap to use, you will need to do some homework. Collect as much data about the project site as you can – flow rates, velocities, different stages of the water body, flooding records, slope angles, soil types, and whether there are springs or seeps in the area. Keep in mind that the project may require permits from the Department of Fish and Wildlife, the U.S. Army Corps of Engineers, the State Water Board and/or the Regional Water Board, and possibly others. This is especially important if the riprap installation involves a U.S. Water Body or tributary, such as a stream or lake. You may also need to take into account things such as endangered plant or animal species, wild and scenic river reviews, fish habitat or passage, restricted work times due to life cycles or local biota, and even aesthetic concerns.

Light-class riprap (D_{50} size = 18") at George Reed's Jackson Valley quarry.

Once you have determined the flow angle, the slope angle, and velocity of the water where the riprap will be installed, you can use these numbers to calculate the size of the outside layer – the layer which will contain the largest rocks. Page 23 of the CalTrans California Bank and Shore Rock Slope Protection Design manual contains a useful calculation to determine the minimum stone weight for your riprap project *(see the Helpful Links section on the next page)*. Using the results of your calculation, reference Tables 5-1 and 5-2 to determine which RSP-Class rock to use for the outside layer, which RSP-Classes to use for the inside layers, and how many inside layers you will actually need. Of course, this is a greatly simplified explanation of the riprap selection process. There are many other considerations and requirements you will want to be aware of, so make sure to read the materials listed in the Helpful Links section.

¼ Ton Class riprap (D_{50} size = 23") at George Reed's Jackson Valley quarry.

Also, there's a couple confusing things you may run across while researching riprap, so here's a quick explanation of some of the more common ones. First, in most of the materials on riprap design and engineering, the term "D_{50}" pops up all over the place. What does it mean? Simply put, D_{50} is roughly equivalent to arithmetic median – in other words, the D_{50} for a particular RSP-Class is the median rock size (median weight is referred to as W_{50}), where half of the rocks are smaller and weigh less than D_{50}, and half are larger and weigh more than D_{50}. Now, don't mistake D_{50} as the *average* rock size (which would be D_{10} for you math fanatics); rather, look at D_{50} as the middle-of-the-road rock size.

Also, be aware that there are different classifications for riprap, and some classifications may share the same name but not the same specs. Probably the best riprap standard, in terms of cataloging a wide range of rock sizes, is the Ton-based system invented by CalTrans and used throughout California. Be especially wary of the seemingly universal "Class I-V" system – the size of each class varies from state to state, sometimes as much as a whole class larger or smaller than another state. Because of these discrepancies, it's best to call out which classification system you are using in your riprap specifications, along with the D_{50} and W_{50} (median size and weight, respectively). Finally, it's common to install a geotextile material underneath the bottom layer of riprap, but it's important to choose the right one. Some geotextiles (such as woven-tape or slit-films) are not appropriate for riprap applications, because they do not allow water to flow easily through the material, which can cause the soil to slough off and result in complete failure of the riprap.

1 Ton Class riprap (D_{50} size = 36") at George Reed's Jackson Valley quarry.

Riprap is a valuable and effective erosion control BMP, but it requires some data collection and homework to ensure a proper installation that will remain effective. In fact, as mentioned earlier, you will need to work with a civil engineer to correctly specify and implement this BMP. Also, don't forget that some installations will require one (or even several) permits, especially if the installation involves a U.S. Water Body. Though it may seem like a hassle, failure to obtain these permits can spell big trouble. ***MD***

Left: 8 Ton Class riprap (D_{50} size = 71").

Below: View of George Reed's Jackson Valley quarry.

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  - Inspecting Construction Sites - **December 13, 2016**
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(For more information about these classes, please email steravskis@wgr-sw.com)

Helpful Links

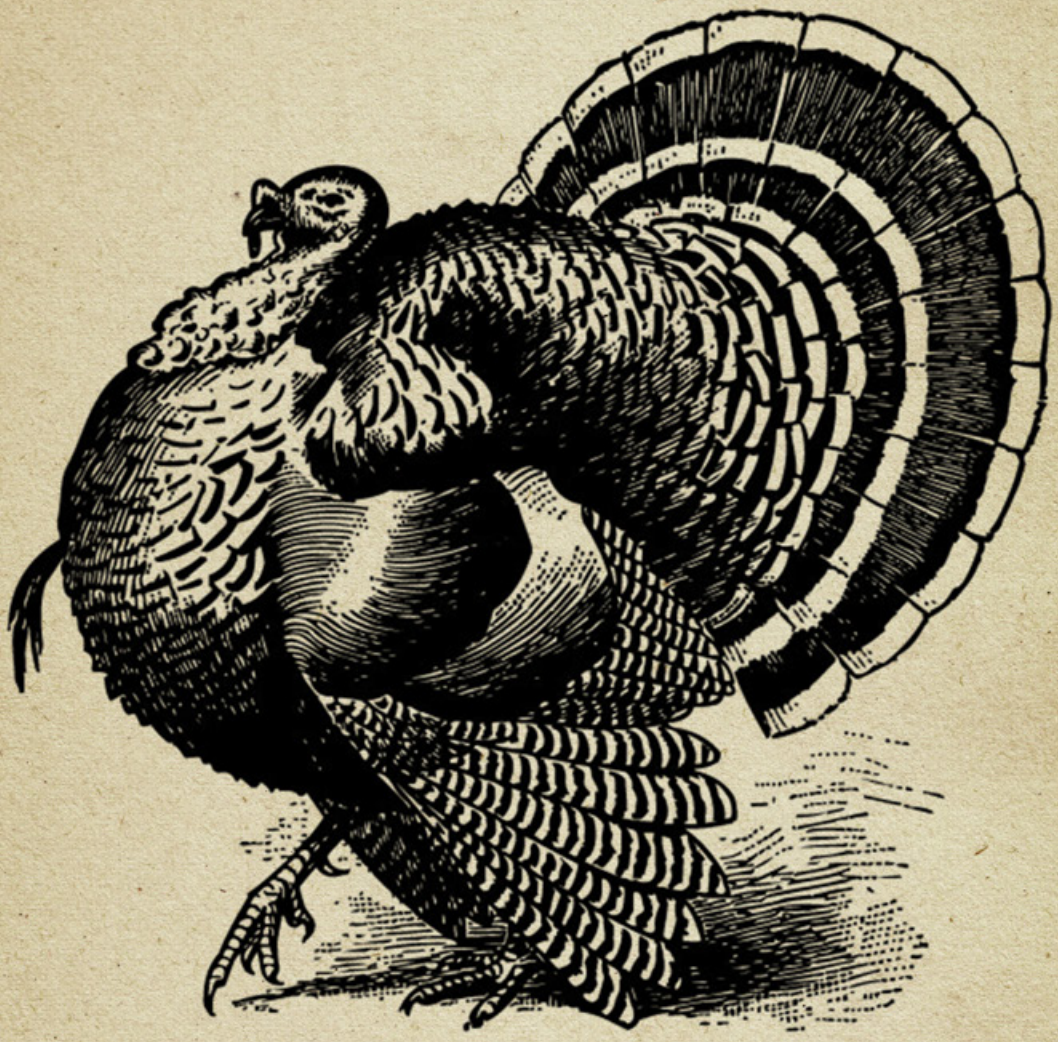
1. **California Bank and Shore Rock Slope Protection Design: Practitioner's Guide and Field Evaluations of Riprap Methods.** Published by the State of California Department of Transportation (CalTrans).
   http://www.dot.ca.gov/hq/oppd/hydrology/ca_riprap_thru_b.pdf
2. **CalTrans Riprap Size.** Published on Plainwater.com.
   http://plainwater.com/content/caltrans-riprap-size
3. **Hydraulic Design of Flood Control Channels.** Published by the U.S. Army Corps of Engineers.
   http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-1601.pdf
4. **Design of Riprap Revetment.** Published by the U.S. Department of Transportation.
   http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hec/hec11sl.pdf

Please contact us if you have any questions ...

The Monthly Dirt Newsletter Editor:
John Teravskis, QSP/QSD, CPESC, QISP, ToR
jteravskis@wgr-sw.com
(209) 334-5363 ext. 110 or (209) 649-0877

Technical Questions about Environmental Compliance?
Call …
Mike Lewis, QSP, CESSWI (Northern California)
mlewis@wgr-sw.com, (209) 334-5363 ext. 116

Gray Martz, QSP/QSD, PG (Southern California)
jgmartz@wgr-sw.com, (562) 799-8510 ext. 1002



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