

DOCUMENTING THE DESIGN AND USE OF DIFFERENT TYPES OF GRADE CONTROL AT CULVERTS

SPONSORS

Hungry Canyons Alliance
Iowa Highway Research Board (TR-750)

PRINCIPAL INVESTIGATOR

John T. Thomas (Orcid: 0000-0002-9198-8450)
Project Director and Fluvial Geomorphologist
Hungry Canyons Alliance
Golden Hills RC&D Office
712 S. Hwy. 6, Oakland, IA 51560-0189
712-482-3029 – john@goldenhillsrcd.org

Technical Brief - January 2020

PROBLEM STATEMENT AND BACKGROUND

While existing literature sufficiently discusses how to properly design a culvert after choosing what type of grade control will be used, there are no preliminary design aids available to easily compare different types of grade control for culverts. Engineers often don't have the time, staff, or budget to research the most cost-effective method of grade control. This especially pertains to new engineers or those who deal with grade control at culverts infrequently due to the geomorphic landscape they typically practice in.

The Hungry Canyons Alliance (HCA) was formed locally to research and implement solutions to widespread stream channel incision and erosion in a 19-county area of the deep loess soils region of western Iowa. Since 1992, the HCA has provided state and federal cost share to build grade control structures to protect county infrastructure. Over that time, the HCA has cost-shared on at least 175 culvert grade control structures.

PURPOSE AND DISCLAIMER

This "state of the practice" report evaluates and summarizes current methods of grade control at culverts with photographic examples of each type of culvert grade control. It is intended to be used as a reference to help engineers in the preliminary design stage select the most cost-effective and constructible type of culvert grade control based primarily on the amount of grade needing controlled. While some culvert projects are designed to include grade control to achieve hydraulic efficiency and capacity at the inlet or to dissipate energy at the outlet, here we give engineers an end product to shoot for to reverse engineer a culvert that requires a significant drop in elevation. This publication does not replace other design considerations, methodologies, guidance, or manuals.

TYPES OF CULVERT GRADE CONTROL

Each type of culvert grade control has sections on general description, best usage, advantages, limitations, and examples with photographs, plans, and other pertinent information. The statements regarding each type are generalized based on the HCA's and member county engineer's experiences using these structures in loess soils. The types of grade control at culverts discussed are:

1. Variable slopes within all culvert types
2. Drop inlets on a culvert (3 material combinations)
3. Reinforced concrete weir inlet on an RCB culvert
4. Broken-back culvert (2 material types)
5. Sloped or slope-tapered inlet RCB culvert
6. Flume outlet RCB culvert
7. Slope-tapered inlet and flume outlet RCB culvert
8. Armored sloped outlet (often with grouted riprap) and stilling basin
9. Weir/drop spillway/chute downstream from culvert outlet
10. Low-water crossing with culvert(s)

RECOMMENDATIONS

We recommend an attempt be made to create an easy-to-use spreadsheet-based decision-matrix tool, along with any associated graphs/charts/other tools, to help engineers select the most cost-effective and constructible type of culvert grade control that also provides the longest-term performance with the least amount of ongoing maintenance. We also recommend that this “state of the practice” be updated every five years to keep the information in it as current and useful as possible.