

Introduction:

The Passage Bench is a gravel bench incorporated into bridge riprap. Its primary function is to allow wildlife to pass beneath bridges uninterrupted as they travel along the streambank. In 2005 the Passage Bench was considered an 'experimental design'. This was a collaborative effort of the Minnesota Department of Natural Resources (MnDNR), the US Fish and Wildlife Service (USFWS Twin Cities Field Office), and the Minnesota Department of Transportation (MnDOT). Early designs were installed at several bridge locations around Minnesota. These experimented with design parameters such as bench width, vertical clearance, and location. Initial study and continued observations have shown that this feature is utilized successfully by wildlife throughout Minnesota and in a variety of settings. Simultaneously, other benefits were realized for MnDOT, such as ease in bridge inspection, a riprap design change from aggregate base to a geotextile base, and flexibility in design for defining the cross-section of the normal channel and its flood profile. Bridge length also is not necessarily increased with this design. While the initial design of the Passage Bench was primarily for wildlife crossings, these additional benefits worked in its favor. In 2011 the feature became part of the MnDOT Standard Plan Set for use on all bridges over water in Minnesota. This feature is now being installed as a standard practice. We have learned a few things along the way, a summary of these observations is provided here.

The Success

In 2009, MnDOT funded a two year study of the passage bench as a wildlife underpass. Data was collected at three locations in northern Minnesota. This report remains unpublished, though data show a wide variety of species utilized the benches during the study period. Myriad small creatures, including seventeen vertebrate species were identified, including black bear, red fox, gray fox, bobcat, whitetail deer, and humans



Encouraging trends

Very few benches are fenced, yet almost all are utilized by animals. One crossing is providing evidence that whitetail deer are taking much longer way to get under the bridge rather than the short way over the highway. No deer tracks were observed on the shoulders for a direct over the road crossing, yet the passage bench does have active use with trails forming to surrounding habitat. There is no fencing at this location. These bridges were constructed in 2009.



Installation lessons (too low or too high)

Benches installed too low are more vulnerable to turbulent flood waters. Installed too high and they appear to be less likely to be utilized by animals. There is a range of not too low and not too high that is just right. **Solution:** Plans should allow for on-site adjustment to existing conditions.



Installation lessons (not wide enough)

The plan shows a required three foot minimum width, yet many have been constructed with less width. Narrow benches are more prone to longitudinal scour during flood events. They also appear to be utilized by animals less than the three foot width versions. **Solution:** More education is needed for contractors and inspectors on the importance of the three foot minimum width.



Installation lessons (staging)

Several projects have had benches eliminated from plans after contractors discovered the impossibility of mechanical installation after beams are set. **Solution:** Installation of the passage bench should be prior to setting of bridge beams, preferably at the time of riprap installation. Photo: Paul Munsterheger, MnDOT



Design lessons (grading plans)

The passage bench is the default standard in the bridge plan, but is not always carried through in the grading plan. This results in a disconnected (and unused) bench. **Solution:** Check during design and permit review.



Design lessons (stormwater outfalls)

Crossflow from drainage set above the bench elevation will wash out the bench, making it impassable. **Solution:** Water resource design folks need to be aware of the passage bench and set outfall elevations below the bench.



Design lessons (low beam)

Benches placed on low profile bridges are utilized, though only by smaller animals. However, reducing the number of small animals from a bridge approach is still a safety improvement measure for vehicles. **Solution:** None, MnDOT continues to install passage benches on lower profile bridges.



Flood Flow

Floods can and do take out materials from the benches. Typically enough remains that they are still passable. Subsequent floods redeposit sediment and reform a bench to some degree.

Solution: None, we have accepted this variability and have not required maintenance.



Human Use

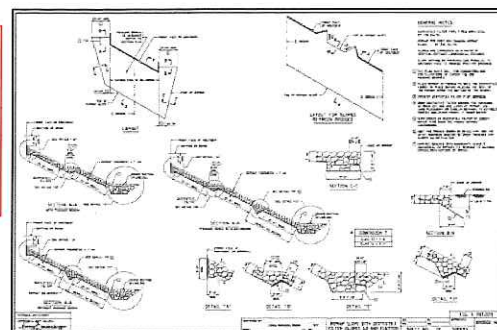
Benches have been utilized by people while fishing or hiking. They are also utilized by bridge inspection crews and bridge maintenance crews. Concern regarding congregations of party animals (*Partai animalis*) continue, but have not been reported as a problem.



Standard Plan

Two critical plan details during installation:

- 3ft minimum width
- Tie benches to natural ground lines outside of bridge



PDF file: dot.state.mn.us/bridge/pdf/cadd/files/bdetailspart2/pdf/fig7309e.pdf
DGN file: dot.state.mn.us/bridge/pdf/cadd/files/bdetailspart2/dgn/fig7309e.dgn

Maintenance lessons (drainage repair)

Maintenance folks may not be aware of the existence of a passage bench when making repairs to road ditch drainage. **Solution:** Work with district maintenance folks to identifying Passage Bench locations.



Location lessons (sighting)

- Outside bends of a river are not good locations for a passage bench. Higher velocity and more turbulent flows during flood events tend to wash them out. They also are less likely to reestablish with successive flood events.
- Fencing to direct animals under the bridge has not been a required feature in Minnesota. Considerations for such a feature should include incidence of road kills in the area, presence of rare species or target species, and tree maintenance concerns.
- The presence of large roadside ditches or stormwater outfall structures should include additional design to prevent damaging crossflow (set outfalls below the bench or design broad swales).
- Costs are minimal, thus they are being built even when there are known limitations with a site. Installation is a standard practice, however when justified, they may be eliminated from the plan.
- When target species are in the area, additional diligence in sighting and construction is to be prioritized.

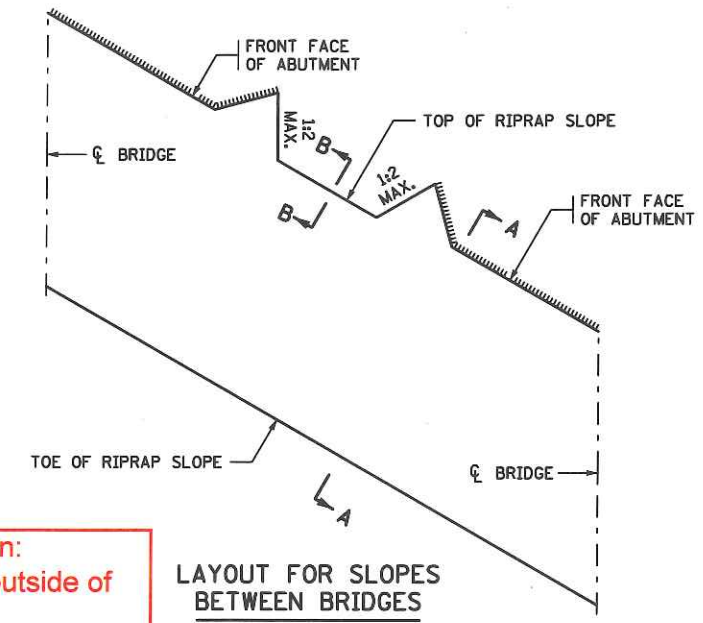
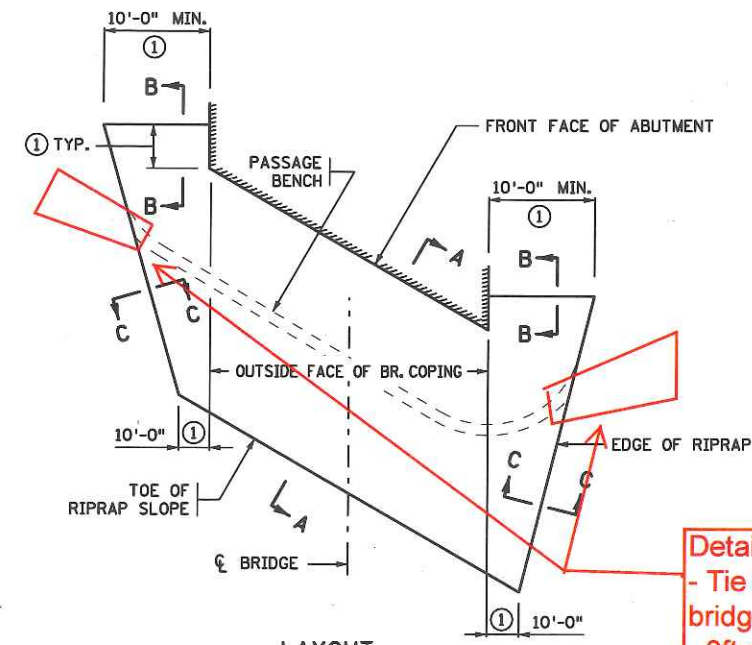
Modification by other states

- Nebraska Department of Roads has utilized interlocking block on their passage bench design to protect against erosion.
- Wisconsin Department of Transportation has a construction provision to fill voids in the entire slope of riprap with smaller aggregate. This is being considered in Minnesota where riprap installations are without a Passage Benches.

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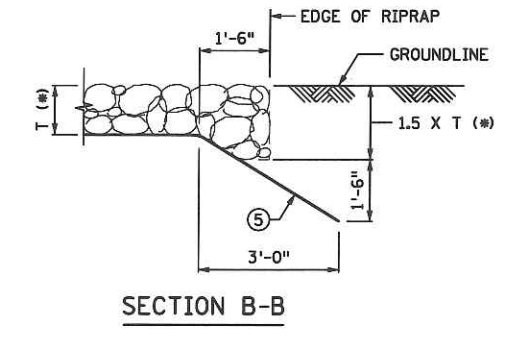
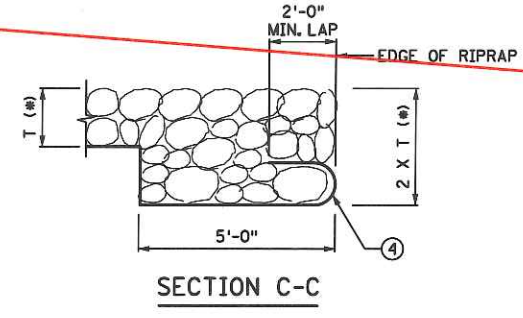
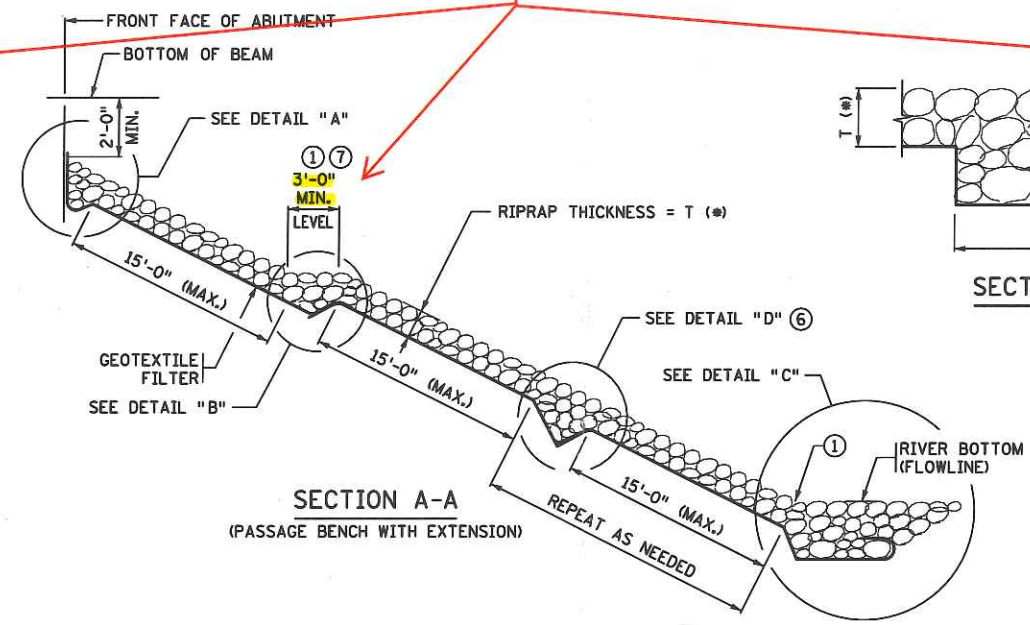
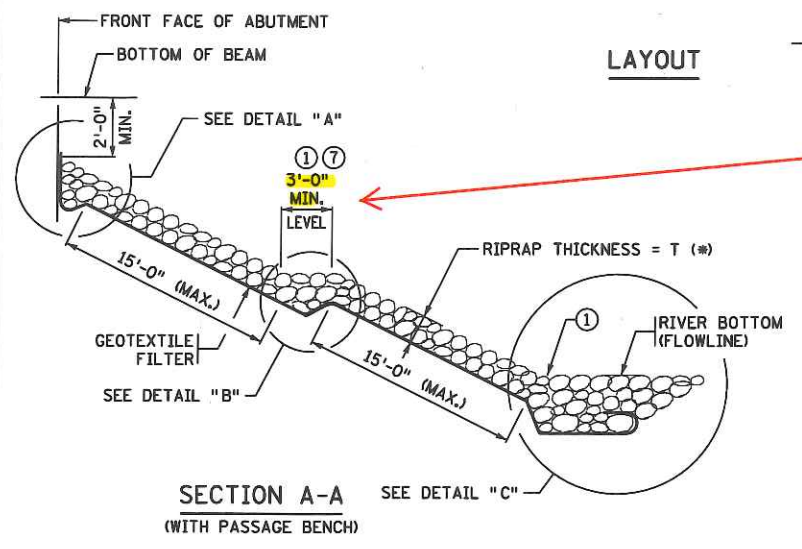
All photography by Peter Leete, unless noted on photo. October 17, 2016



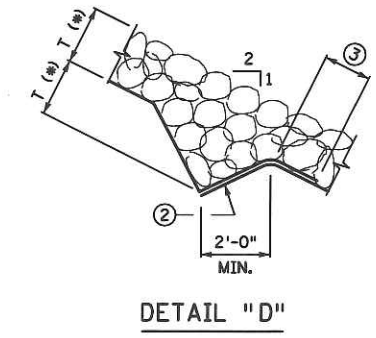
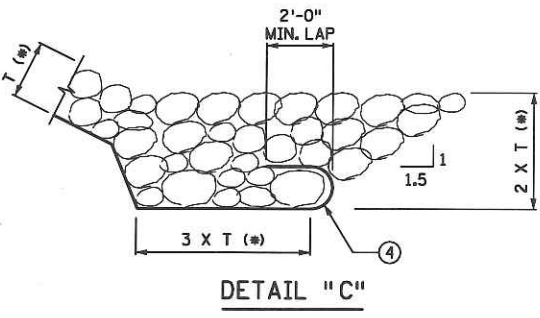
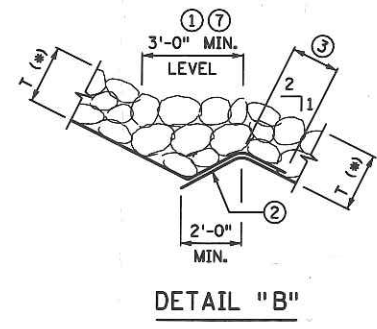
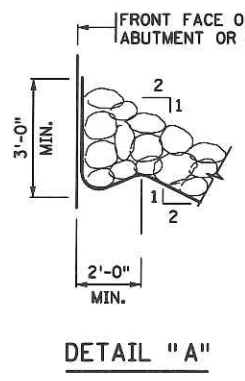
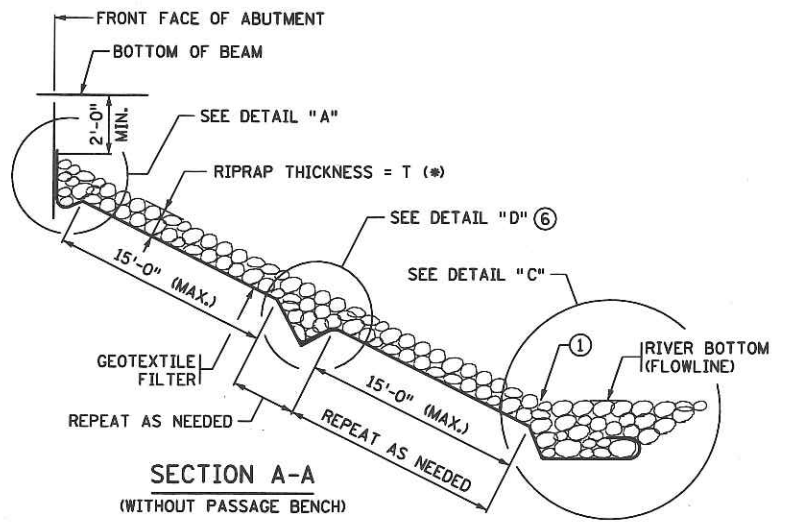
Details to watch for during construction:
 - Tie benches to natural groundlines outside of bridge
 - 3ft minimum width

GENERAL NOTES

- GEOTEXTILE FILTER TYPE VII PER SPEC. 2511, GEOTEXTILE FILTER TYPE VII BY THE SQ. YD.
- RIPRAP PER SPEC. 2511, RANDOM RIPRAP CLASS ___ BY THE CU. YD.
- SLOPES ARE EXPRESSED AS A RATIO OF VERTICAL DISTANCE : HORIZONTAL DISTANCE.
- SLOPE BOTTOM OF TRENCHES 1:20 PARALLEL TO ABUTMENT FACE TO PROVIDE POSITIVE DRAINAGE.
- ① SEE PLAN SHEET NO. ... FOR DIMENSIONS, AND FOR ELEVATIONS OF RIPRAP TOE AND PASSAGE BENCHES.
- ② PLACE RIPRAP IN TRENCH TO HOLD THE GEOTEXTILE FABRIC IN PLACE BEFORE PLACING THE REST OF THE RIPRAP (FROM THE BOTTOM OF THE SLOPE).
- ③ OVERLAP GEOTEXTILE FILTER 2'-0" MINIMUM.
- ④ WRAP GEOTEXTILE FILTER AROUND TOE, OVERHANG BETWEEN 1ST AND 2ND LAYER OF RIPRAP. USE HAND PLACEMENT OR SIMILAR METHODS TO ESTABLISH PROFILE AND PLACE FABRIC IF UNDER WATER.
- ⑤ BURY EDGES OF GEOTEXTILE FILTER TO DIRECT WATER FLOW OVER THE FABRIC WITHOUT UNDERMINING.
- ⑥ OMIT THE TRENCH SHOWN IN DETAIL "D" AND THE 15'-0" MAXIMUM SPACING BETWEEN TRENCHES FOR SLOPES 1:3 OR FLATTER.
- ⑦ SURFACE BENCHES WITH AGGREGATE CLASS 5 (INCIDENTAL TO RIPRAP). TIE BENCHES TO NATURAL GROUNDLINES OUTSIDE OF BRIDGE.



* DIMENSION T	
CLASS III = 1'-6"	
CLASS IV = 2'-0"	



REVISED: 11-06-2013
 APPROVED: MAY 24, 2011
 Nancy Suberberger
 STATE BRIDGE ENGINEER

This standard plan (11" x 17") can be downloaded from:
 DGN file: <http://www.dot.state.mn.us/bridge/pdf/cadd/files/bdetailspart2/dgn/fig7309e.dgn>
 PDF file: <http://www.dot.state.mn.us/bridge/pdf/cadd/files/bdetailspart2/pdf/fig7309e.pdf>

CERTIFIED BY	TITLE:	DES:	DR:	APPROVED:	FIG. 5-397.309
LICENSED PROFESSIONAL ENGINEER	RIPRAP SLOPE WITH GEOTEXTILE FILTER (SLOPES 1:2 AND FLATTER)	CHK:	CHK:	BRIDGE NO.	
NAME:	LIC. NO.	SHEET NO. OF SHEETS			

