Montana Department of Transportation
Research Programs
January 2015

SHRINKAGE REDUCING ADMIXTURE (SRA) AND SYNTHETIC POLYOLEFIN FIBERS (SPF) TO REDUCE SHRINKAGE CRACKING IN BRIDGE DECKS

Location:	Interstate Highway 90: Stillwater County/Hensley and Keyser Creek Structures – Gallatin County/East Belgrade
Project Name:	Br Deck Rehab / Repair 11 – East Belgrade Interchange – North
Project Number:	NHPB STWD (44) / IM-MT-STPU 90-6(112)300
Experimental Project No:	MT-12-12/14-03
Type of Project:	Bridge Deck Cracking
Principal Investigator:	Craig Abernathy, Experimental Project Manager (ExPM)

Experimental Design Description

Early age bridge deck cracking has been an issue for MDT and other states for several years. Bridge deck cracking allows water and deicing chemicals to infiltrate the deck, which can result in reduced service life.

MDT's current special deck (SD) concrete mix was modified with a combination of a Shrinkage Reducing Admixture (SRA) and Synthetic Polyolefin Fibers (SPF) for use on three selected bridge decks to be compared with adjacent decks using conventional SD.

For reference, when in the report the SRA is mentioned, it also infers the SPF additive as well.

The following details the selection of the admixtures:

Shrinkage Reducing Admixture (SRA) Synthetic Polyolefin Fibers (SPF)

Provide a commercial, pre-packaged SRA/SPF. Label each container with mixing instructions, lot number, date of manufacture and shelf life. An expiration date may be used in lieu of the date of manufacture and shelf life. Admixture will be rejected if the shelf life or expiration date has been exceeded.

Products selected:

-**MasterLIFE SRA 20** (BSAF)

-**MasterFiber MAC 100 Plus** (BSAF)

Mix designs for both SD and SD-SRA Concrete. Representative materials of those to be used in both SD and SD-SRA concrete mixes to run the tests ASTM C 157 Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete and ASTM C 1581 Standard Test.

Structure Descriptions

The test project has within its limits 3 sets of bridges. Two involving deck replacement; and as with the Belgrade interchange, a new structure. One bridge in each set would have the deck cast with current SD concrete and the other bridge deck would be cast with the modified SD-SRA concrete, the bridges selected are shown below.

Structure Number	Location	Structure	Direction	Concrete Type
N/A	East Belgrade	Belgrade North	E.B.	**SD-SRA**
N/A	East Belgrade	Belgrade North	W.B.	SD
I00090407+08621	2 KM W Columbus	Keyser Creek	E.B.	SD
I00090407+08622	2 KM W Columbus	Keyser Creek	W.B.	**SD-SRA**
I00090414+02351	9 KM E Columbus	Hensley Creek	E.B.	**SD-SRA**
I00090414+02352	9 KM E Columbus	Hensley Creek	W.B.	SD

Research Documentation

This report attempts to compare the SD and SRA decks by documenting visual deck cracking, above and below once the forms were removed. This was done by either providing photographs with deck cracking, cracks superimposed for better clarity; or actual crack maps.

Information with this type of documentation is subjective at best. As much as possible MDT staff involved with the project onsite were asked their opinion on the performance (specifically the level of cracking between the structures) of the SRA admixture as compared to the conventional SD. Those questioned, on average, were positive that the addition of the chosen admixtures reduced the severity of shrinkage cracking.

Only three decks to date have implemented the addition of the SRA admixture, and as this report will present, there is evidence of positive results. However as Doug Payne, P.E., Structural Engineer/Butte District has stated regarding the Belgrade structures:

"*Both decks have some cracking in the end ¼ (1st diaphragm to abutment) at each end of the two bridges. The EB/SRA bridge has less cracking. The middle half of the EB bridge looked good with one or two cracks. The WB bridge has a few more.*
It is my opinion the east bound bridge with SRA and fiber did have less full depth cracks than the west bound bridge.

The use of SRA and fiber may have some benefit but requires further evaluation."

Research agrees with Mr. Payne's initial assessment of SRA performance, and that additional bridge projects should be selected to test the SRA overall effectiveness in an effort to establish a base of statistical consistency in the use of these admixtures.

It should be noted that testing sponsored by MDT and conducted in June of 2014 by Wiss, Janney, Elstner Associates (WJE), Inc. (Project Mix No. JH40Y1G2SF); confirmed positive results in the use of SRA admixtures. That, coupled with the average cost of adding the SRA/SPF blend at 15K (Belgrade structure excluding the mix design cost) in comparison with the overall expense of a new structure or deck replacement, may offer an economical, cost-effective supplement in potential increased longevity of the service life of a bridge.

Results to Date

Belgrade: Based on visual inspections on the east bound deck with the SRA/SPF admixture, the reduction of cracks compared to the conventional (SD) west bound deck appeared to be on average of fifty (50%) percent.

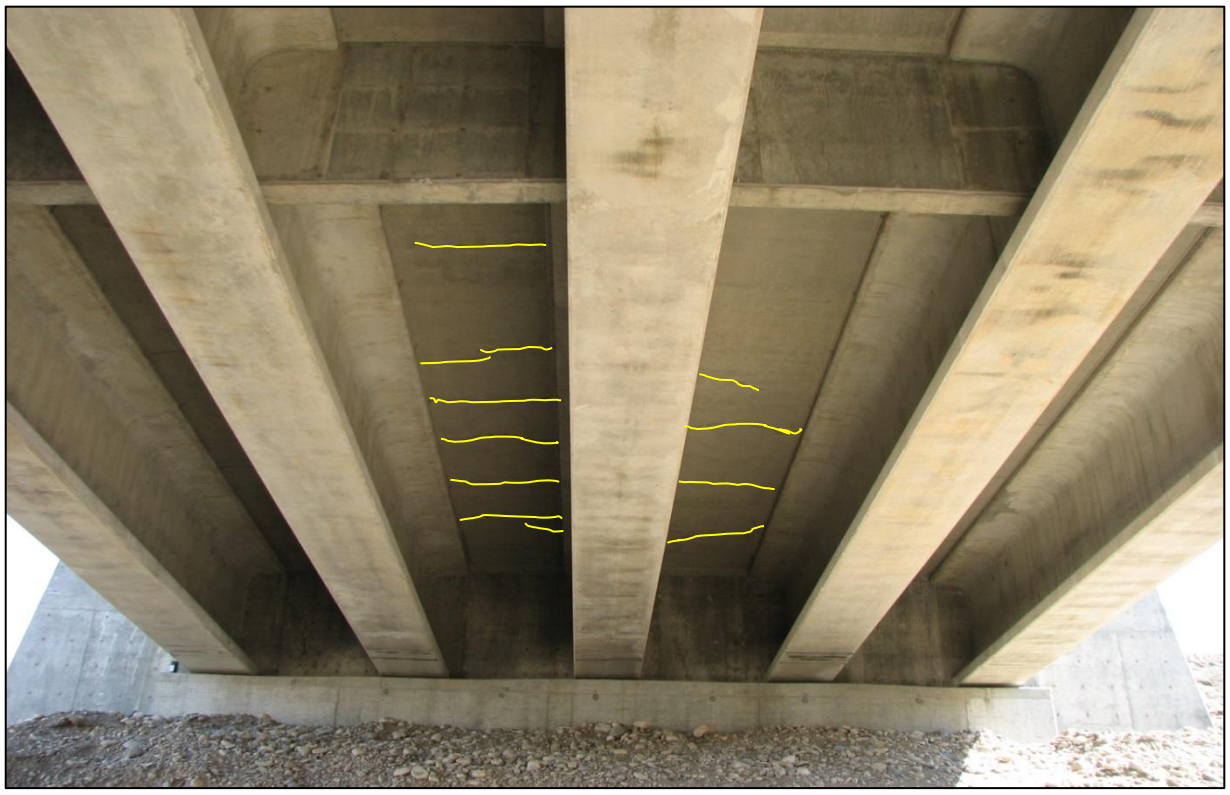
Hensley Creek: The east bound SRA/SPF deck had two full depth cracks on the east end. Three underside cracks were visible with one on the east end and two on the west end of the deck.

The west bound deck (SD) displayed no visible cracking top or bottom during the October inspection.

Keyser Creek: The west bound SRA/SPF deck had significantly less full depth cracking (three) than the east bound SD deck (eleven). There were four cracks visible on the underside of the deck not detected on the deck surface.

Note: The following documentation of the selected bridge decks include examples of visual documentation, with cracks superimposed for added reference or crack maps. The maps are not to scale and are for reference only.

East Belgrade Interchange North: I-90/Reference Point 300



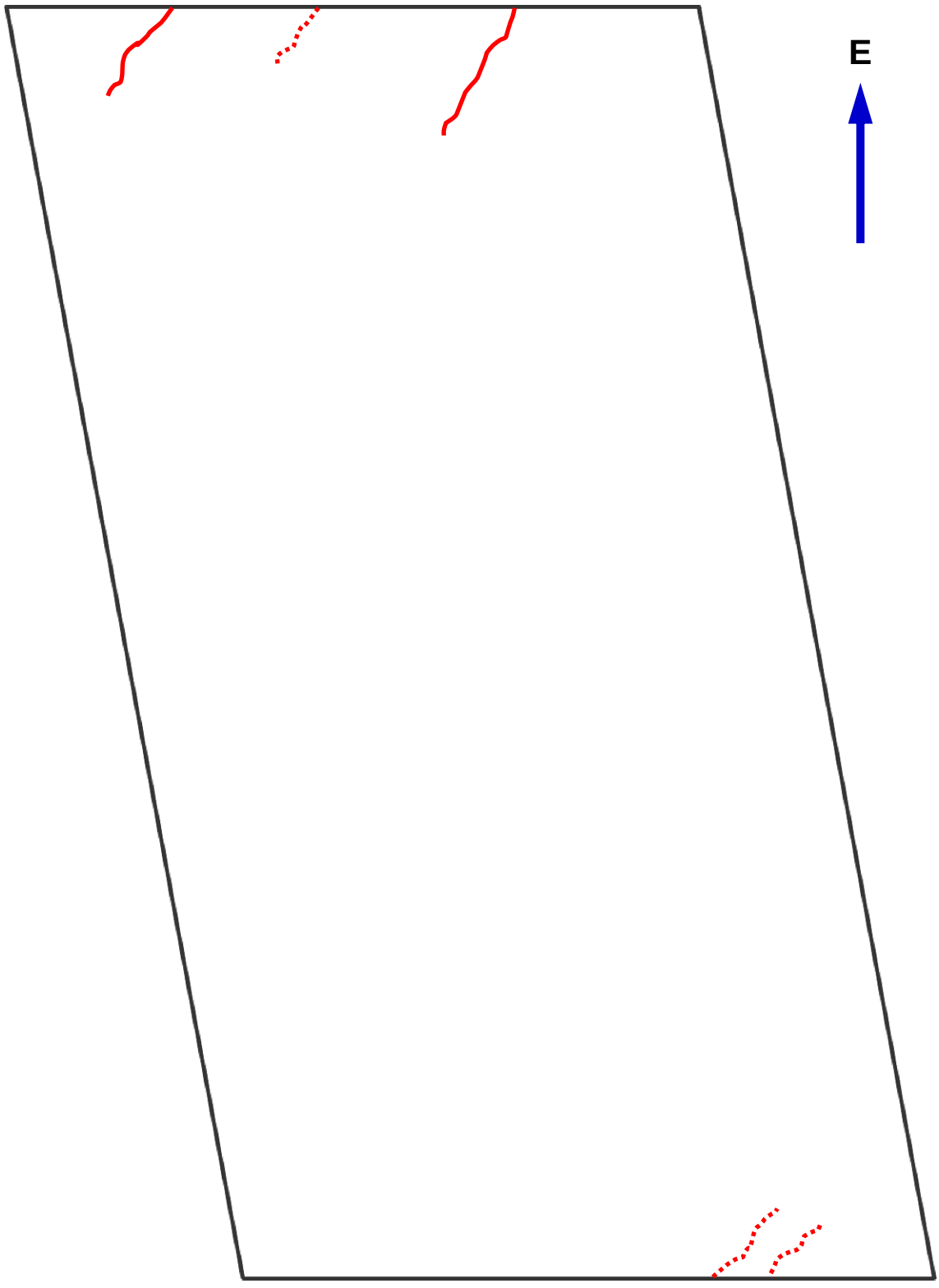
⬆ West Bound Deck – **East End**: **SD Placement**; a yellow line is superimposed to better delineate the crack.

⬆ East Bound Deck – **East End**: **SRA/SPF placement**.

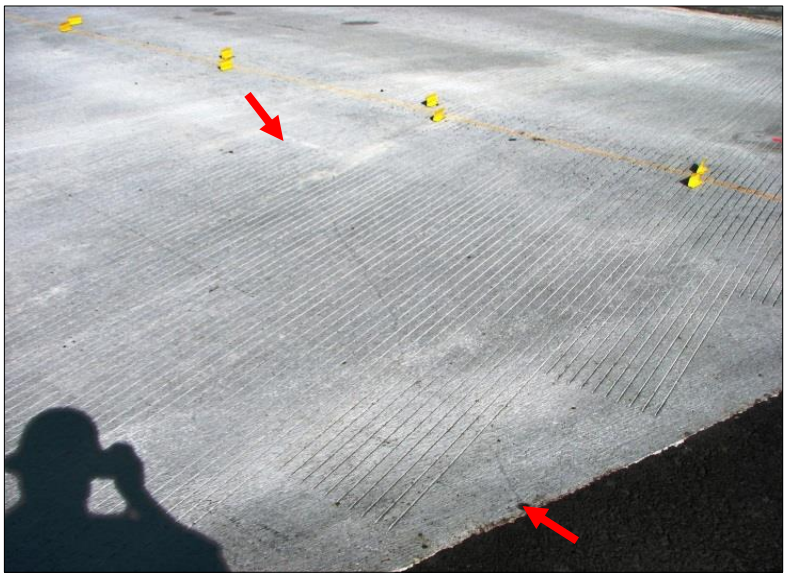
⬆ West Bound Deck – **West End**: **SD placement**; south-side abutment end.

⬅ East Bound Deck – **West End**: **SRA/SPF placement**; south-side abutment end.

Hensley Creek – East Bound: SRA/SPF – Crack Map



Hensley Creek – East Bound: SRA/SPF – Images



🡸 View of east bound, east-end deck. Example of full depth crack in the travel lane.

🡸Top side of west end of east bound deck; no visible cracking observed.

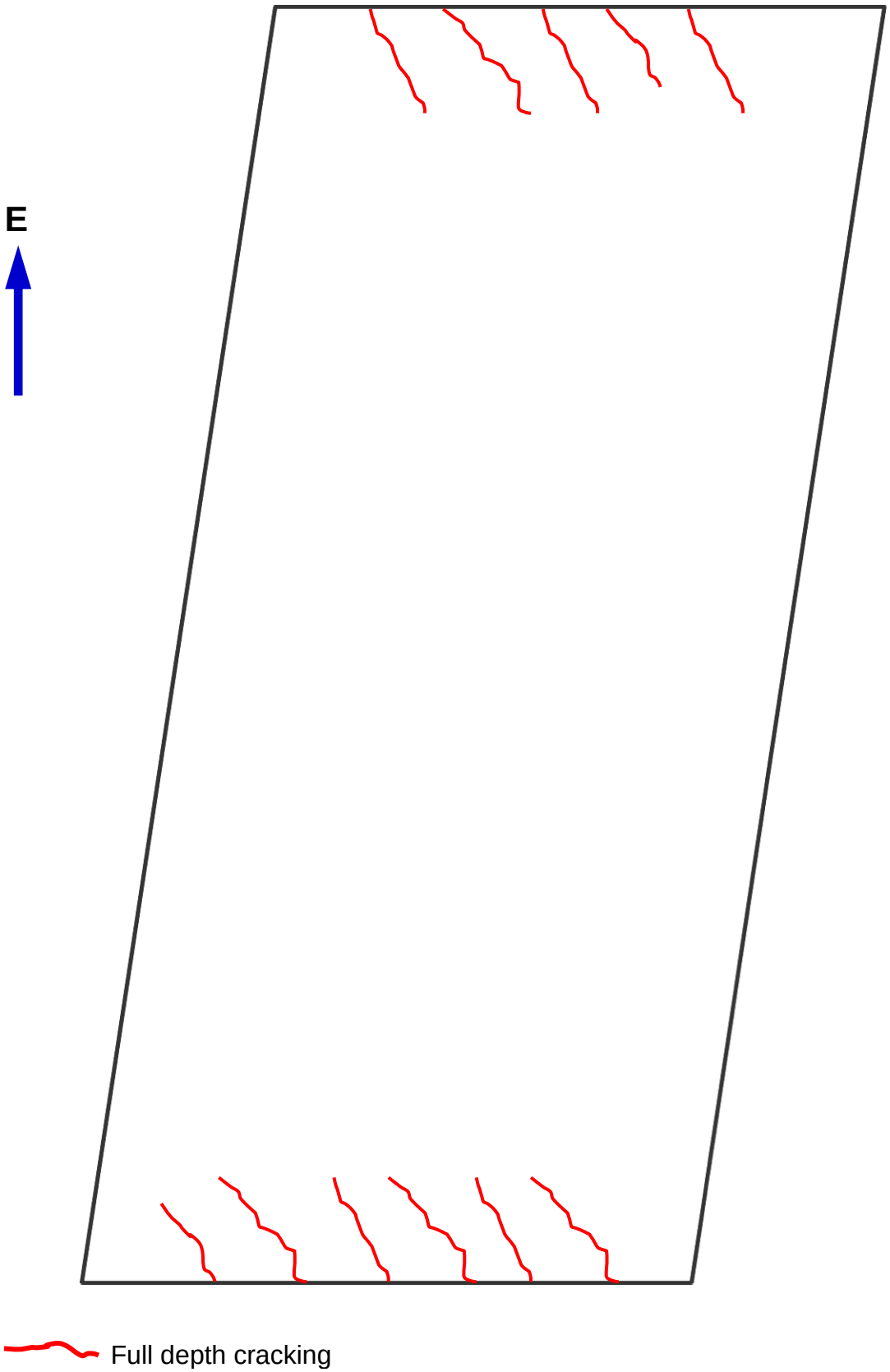
🡸 Example image of full depth crack underside in the travel lane, east bound.

Hensley Creek – West Bound: SD – Images

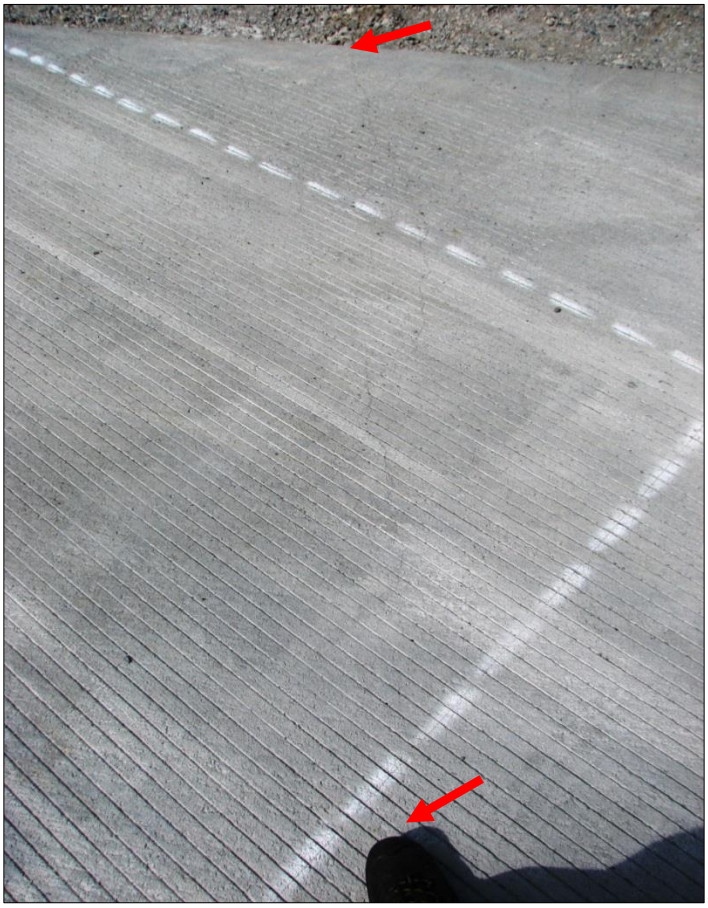
Note: During this inspection (late October) no cracks were visible either on the deck surface or beneath the deck.

🡅 🡇 Representatives images of top and bottom of the west bound deck (view west), no cracking observed

Keyser Creek – East Bound: SD – Crack Map



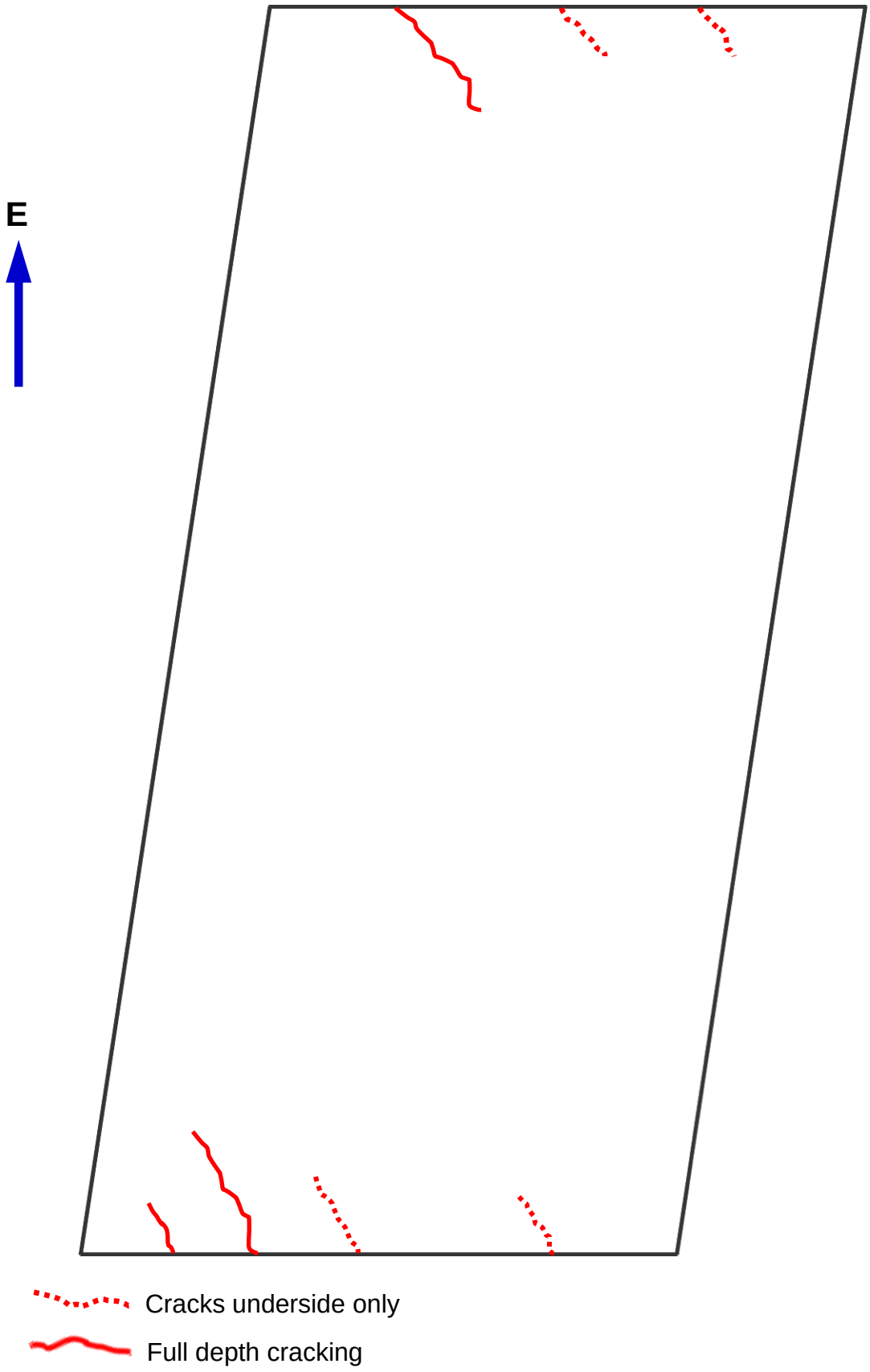
Keyser Creek – East Bound: SD – Images



🡸 Example image of full-depth crack, east end of deck.

🡻 Example of full-depth cracking under the deck, east end.

Keyser Creek – West Bound: SRA/SPF – Crack Map



Keyser Creek – West Bound: SRA/SPF – Images

🡸 Example image of full-depth crack, east end of deck; south side.

🡸 Overview of deck; view west.

Deck cracking not visible with this image.

Disclaimer

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