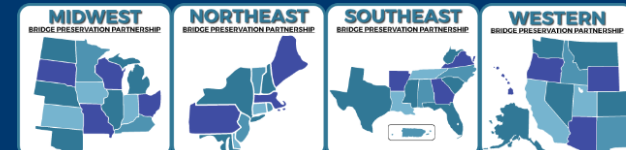


# Enhancing Safety and Efficiency in Bridge Maintenance: Implementing Steel Bridge Deck Formwork Retrofits at the Colorado Department of Transportation

Tristan R Siegel, MCE, PE

Colorado Department of Transportation (CDOT)

Staff Bridge Branch



# Outline

- History of the Problem
- Previous Solutions
- Steel Deck Panels
- Design Discussion
- Cost Discussion
- Construction Discussion
- Deck Pans In Action
- Lessons Learned
- Questions



# History of the Problem

- CO uses Magnesium Chloride salts in winter
- Historically, waterproofing membrane was not a standard when these older bridges were built
- Water and chloride would penetrate the deck
- Black rebar would corrode, concrete spalling and delamination occurs
- Deck potholes open up which need emergency repairs



# History of the Problem

- Typical case
- Freeze-thaw of snowmelt
- Chloride Penetration
- Unknown amount of damage until you open it up

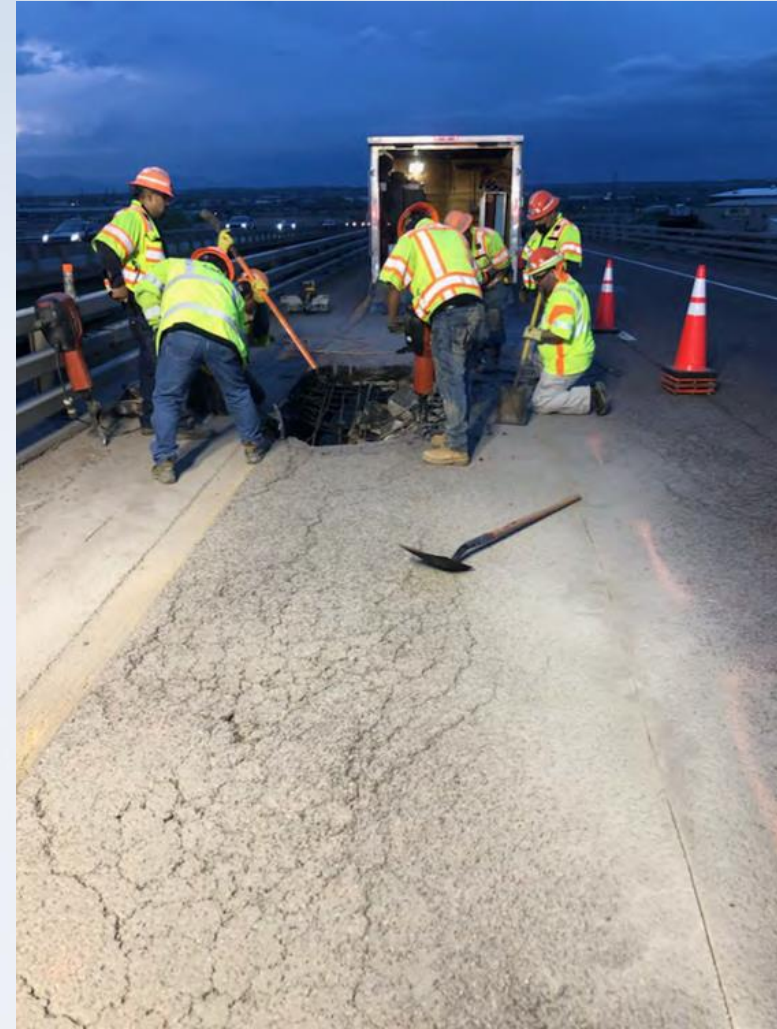




# History of the Problem

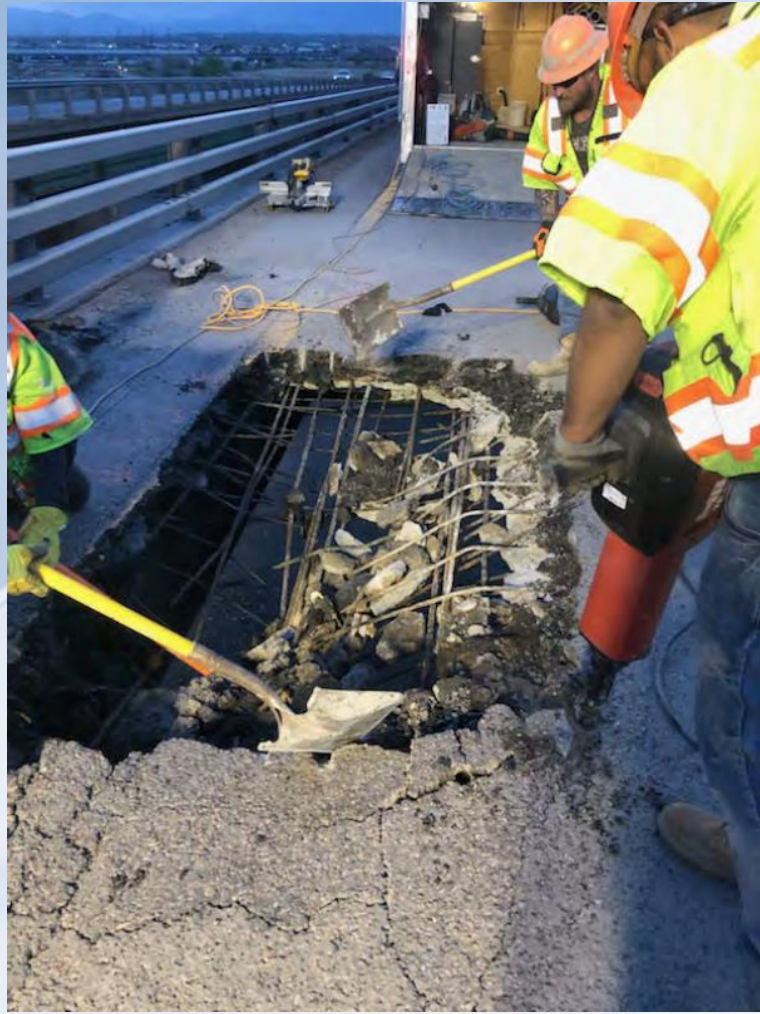
I-270 over  
UPRR, BNSF

May 2021





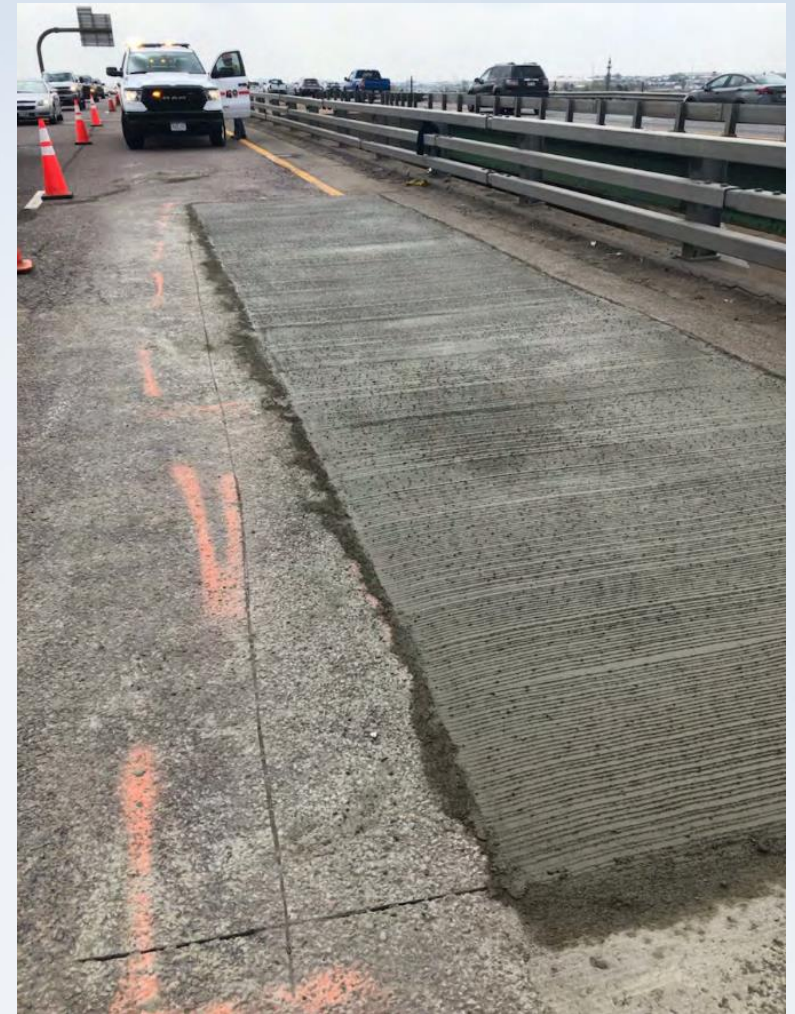
# History of the Problem





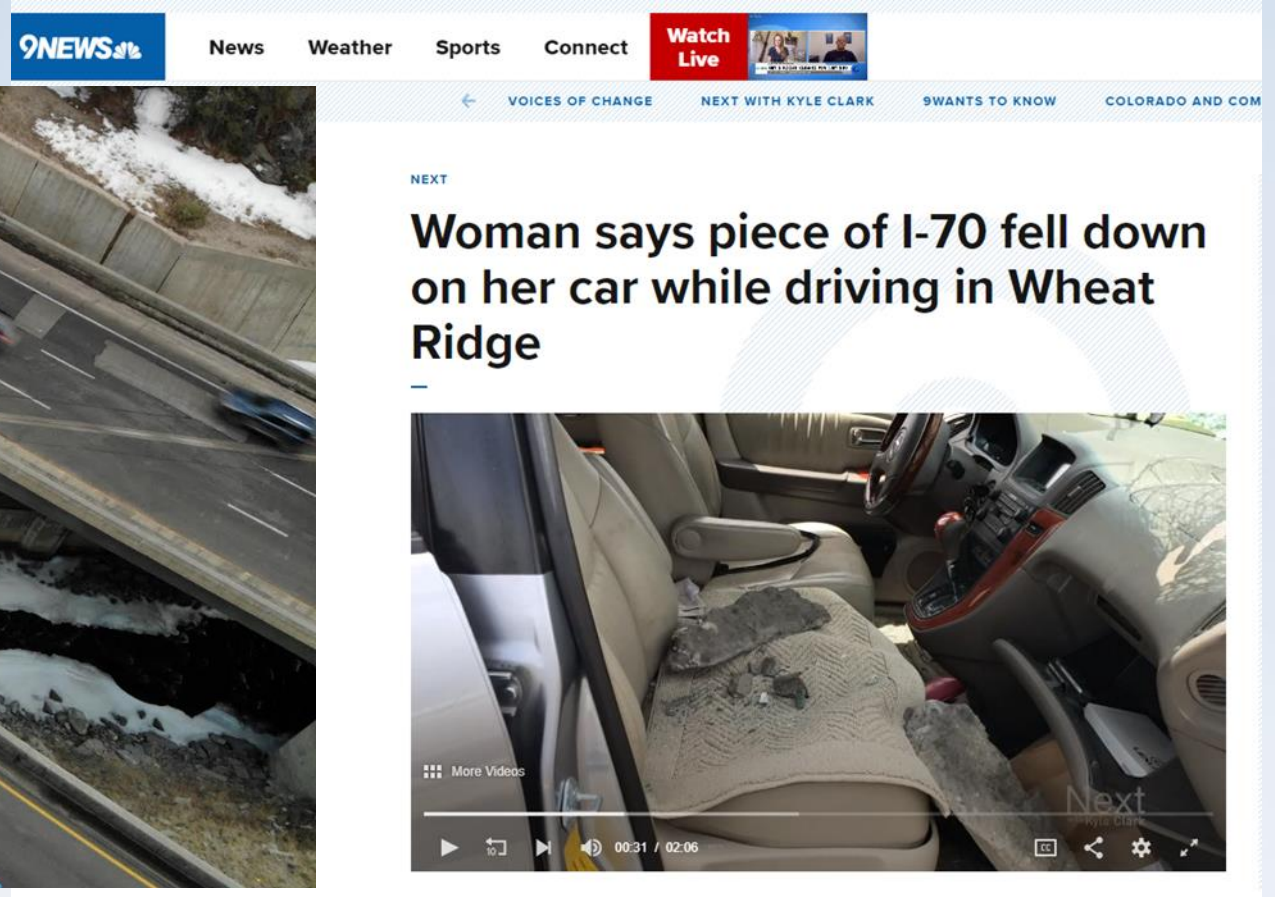
# History of the Problem

- Total Closure time:  
~48hours
- Keep this timing in  
mind for later





# History of the Problem



The screenshot shows a news article from 9NEWS. The top navigation bar includes "9NEWS at 9", "News", "Weather", "Sports", "Connect", and "Watch Live". Below the navigation are links for "VOICES OF CHANGE", "NEXT WITH KYLE CLARK", "9WANTS TO KNOW", and "COLORADO AND COM". The article title is "Woman says piece of I-70 fell down on her car while driving in Wheat Ridge". Below the title is a video player showing the interior of a car with a large piece of concrete debris on the passenger seat. The video player includes a "More Videos" link, a "Next" logo, and a progress bar showing 00:31 / 02:06.





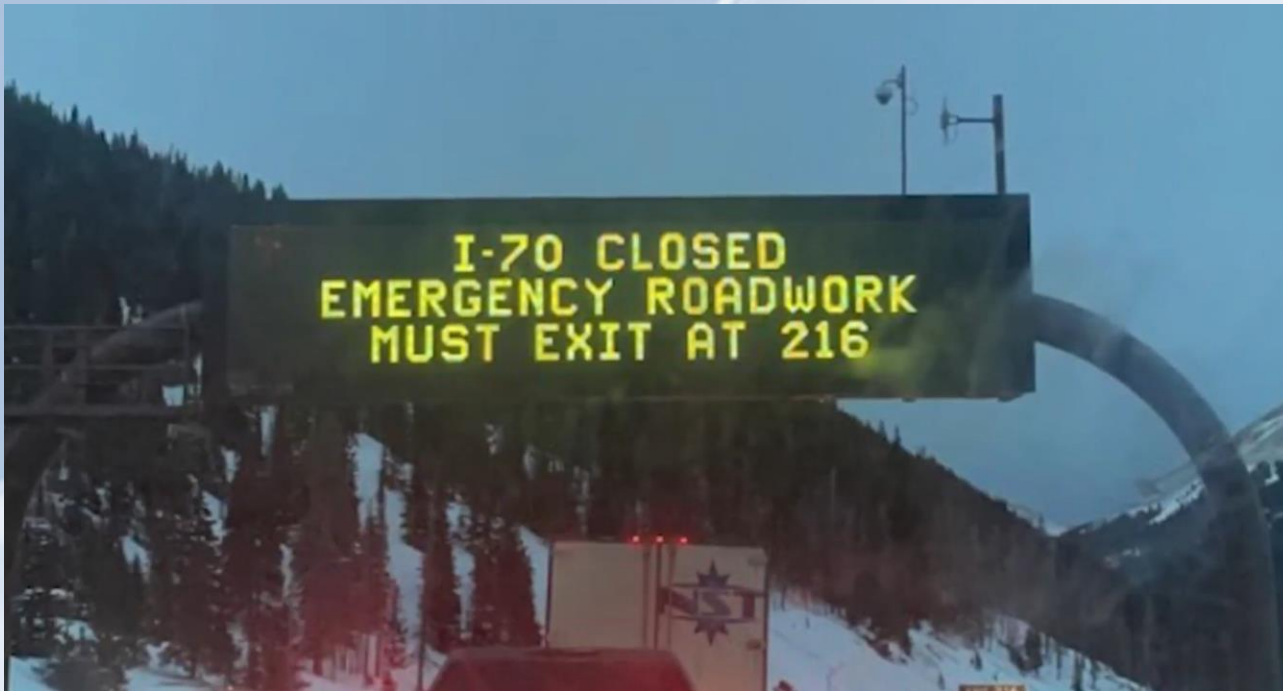
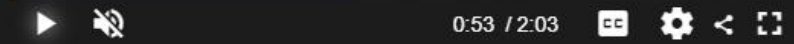
LOCAL NEWS

# Wild crash, allegedly caused by I-70 pothole, caught on camera

by: Vicente Arenas

Posted: Mar 8, 2023 / 05:58 PM MST

Updated: Mar 9, 2023 / 08:59 AM MST



# Previous Solutions

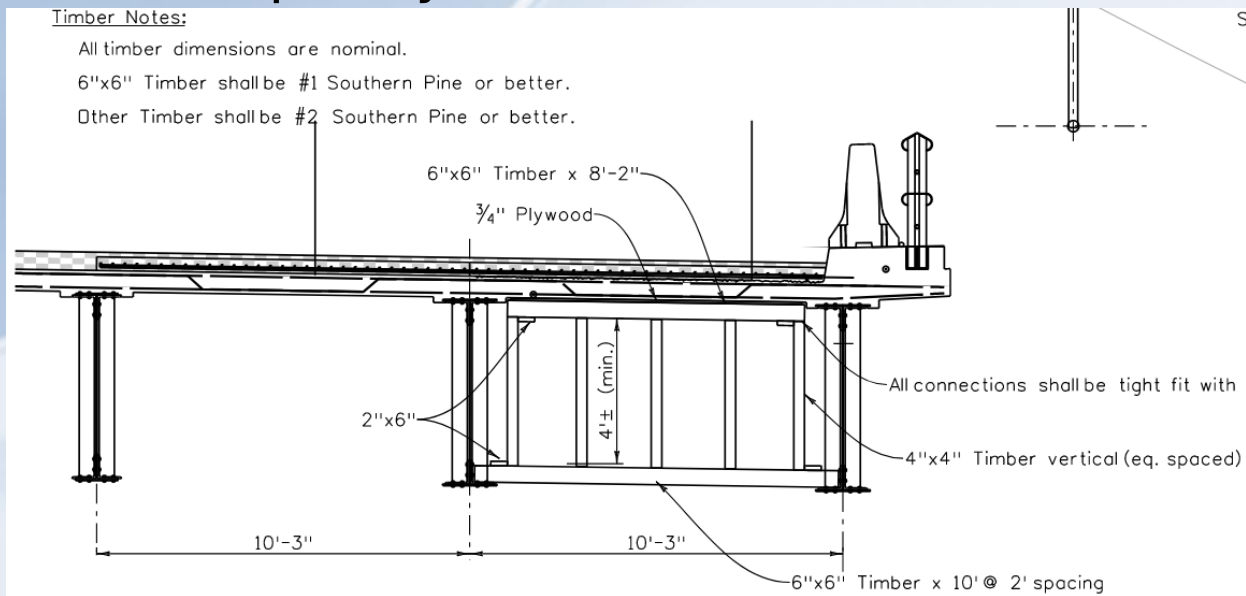
- Wood formwork design
  - Bulky and inefficient
  - Very Expensive
  - Carpentry + Install = Time

## Timber Notes:

All timber dimensions are nominal.

6"x6" Timber shall be #1 Southern Pine or better.

Other Timber shall be #2 Southern Pine or better.





# Previous Solutions



# Steel Deck Panels

- Recognizing that we were having a growing problem, we needed to develop an actionable solution
- Workshopped with CDOT Bridge Maintenance to develop a list of high priority bridges with recurring issues
- Our solution needed to address both safety and public perceptions
- CDOT also received 2021 Federal Apportionment of Highway Infrastructure Program Funds and Staff Bridge received \$6M for “Bridge Repairs”



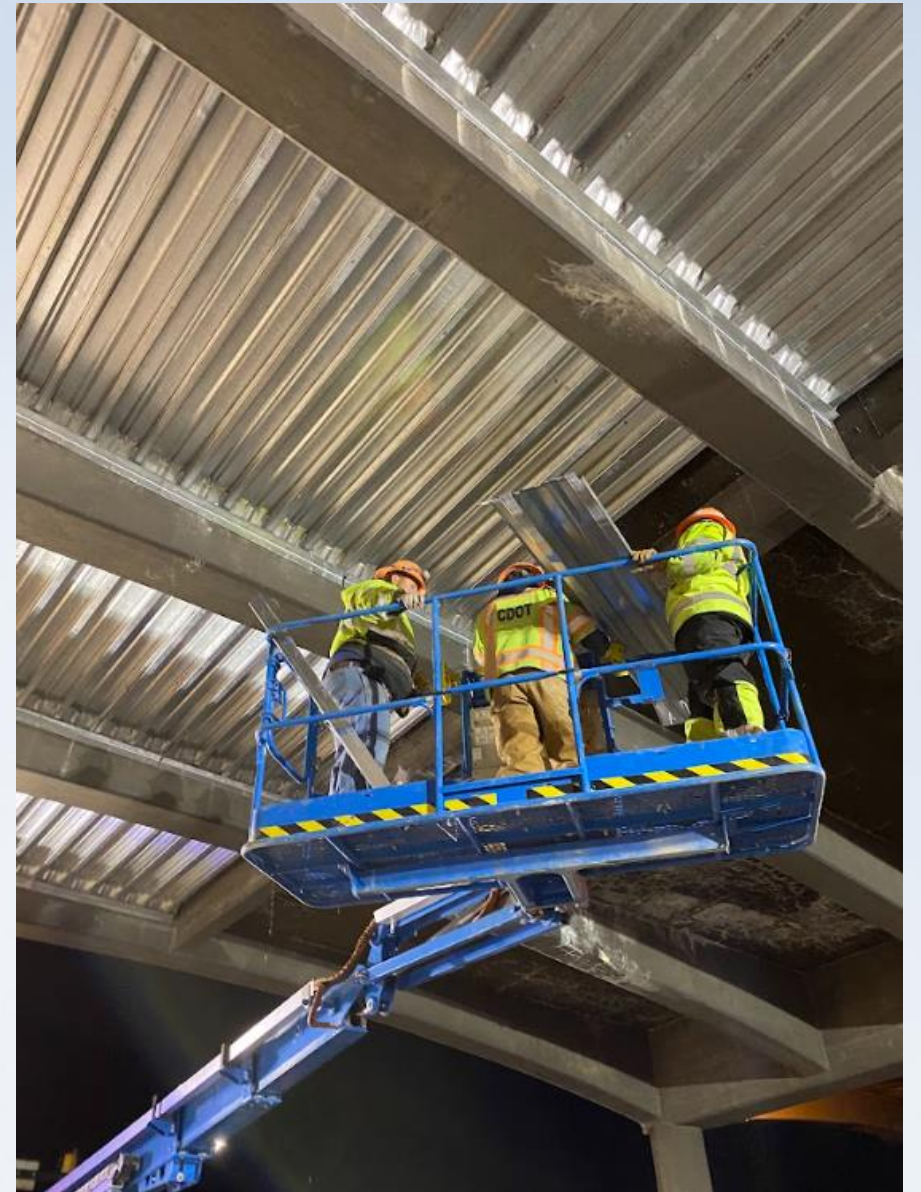
# Steel Deck Panels

- Short-term, economical solution
- Provides solution for immediate deck concerns
- Provides formwork for quick repair in the event of new deck potholes
- Aesthetically pleasing



# Steel Deck Panels

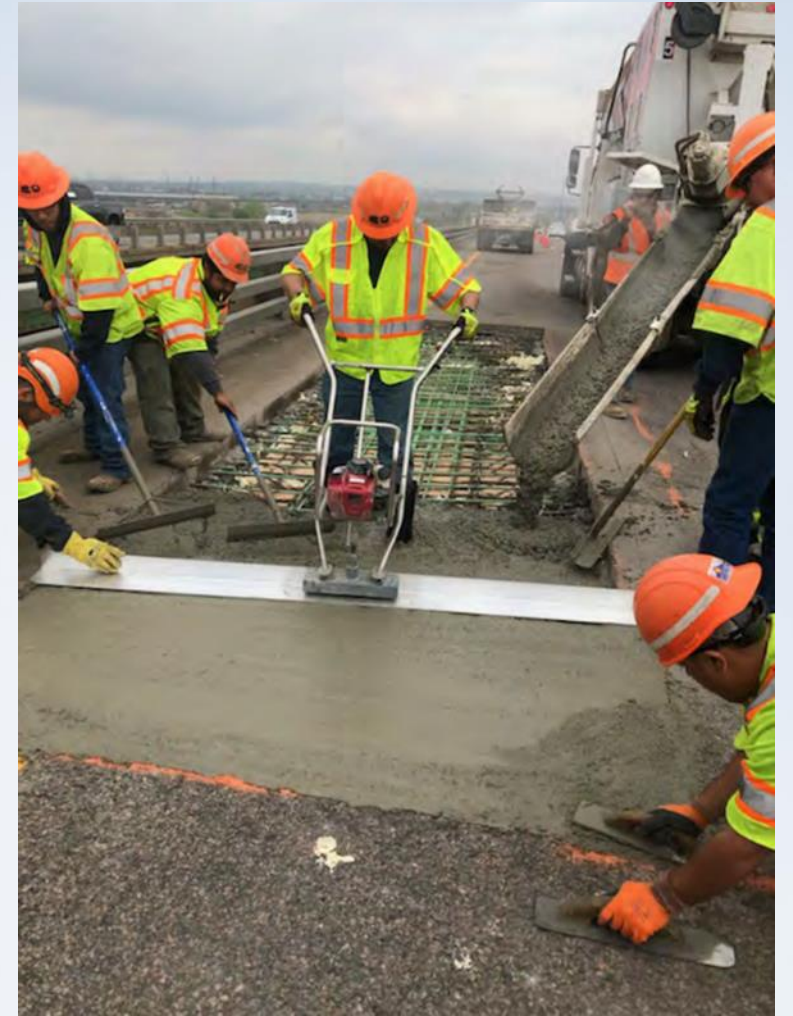
- Opportunity for Maintenance staff training
- Reusable on other similar structures
- No need to impede traffic carried by the bridge
- Can be installed at night
- Lighter than traditional temporary repairs
- Buys time for permanent repairs (5-10 years depending on other applied treatments)
- Does not improve bridge condition





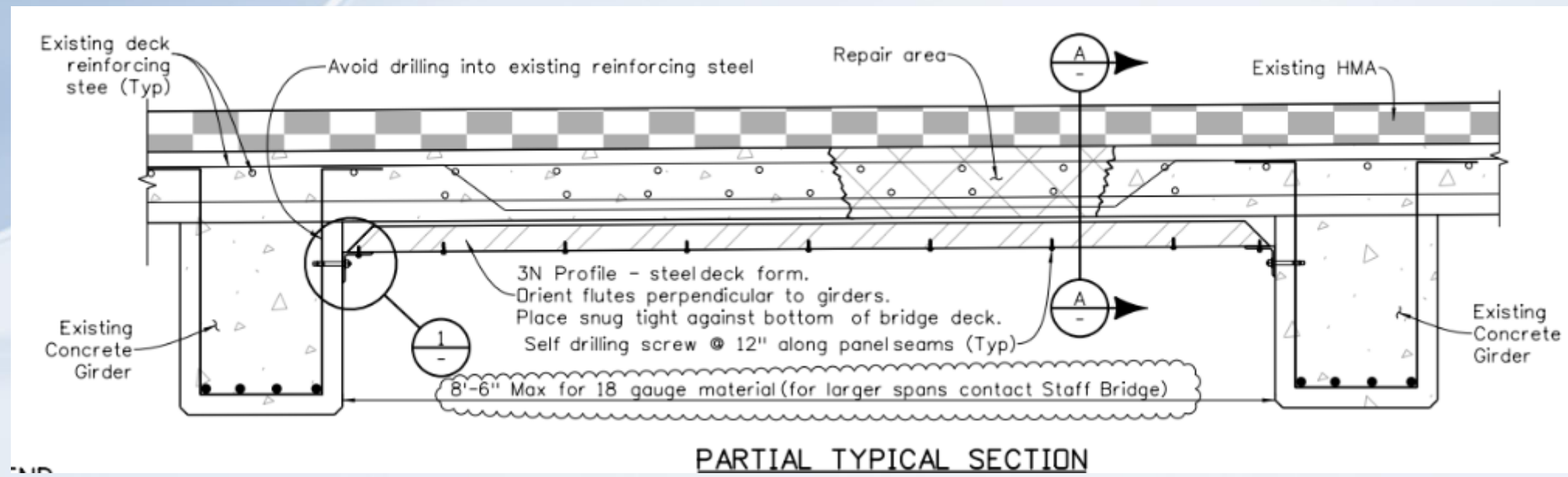
# Design Discussion

- Dead load of wet concrete + Pedestrian Live Load (Maintenance and construction workers) AASHTO 9.7.4.1
- Formwork and concrete are non-composite
- Vehicular Live Load not considered



# Design Discussion

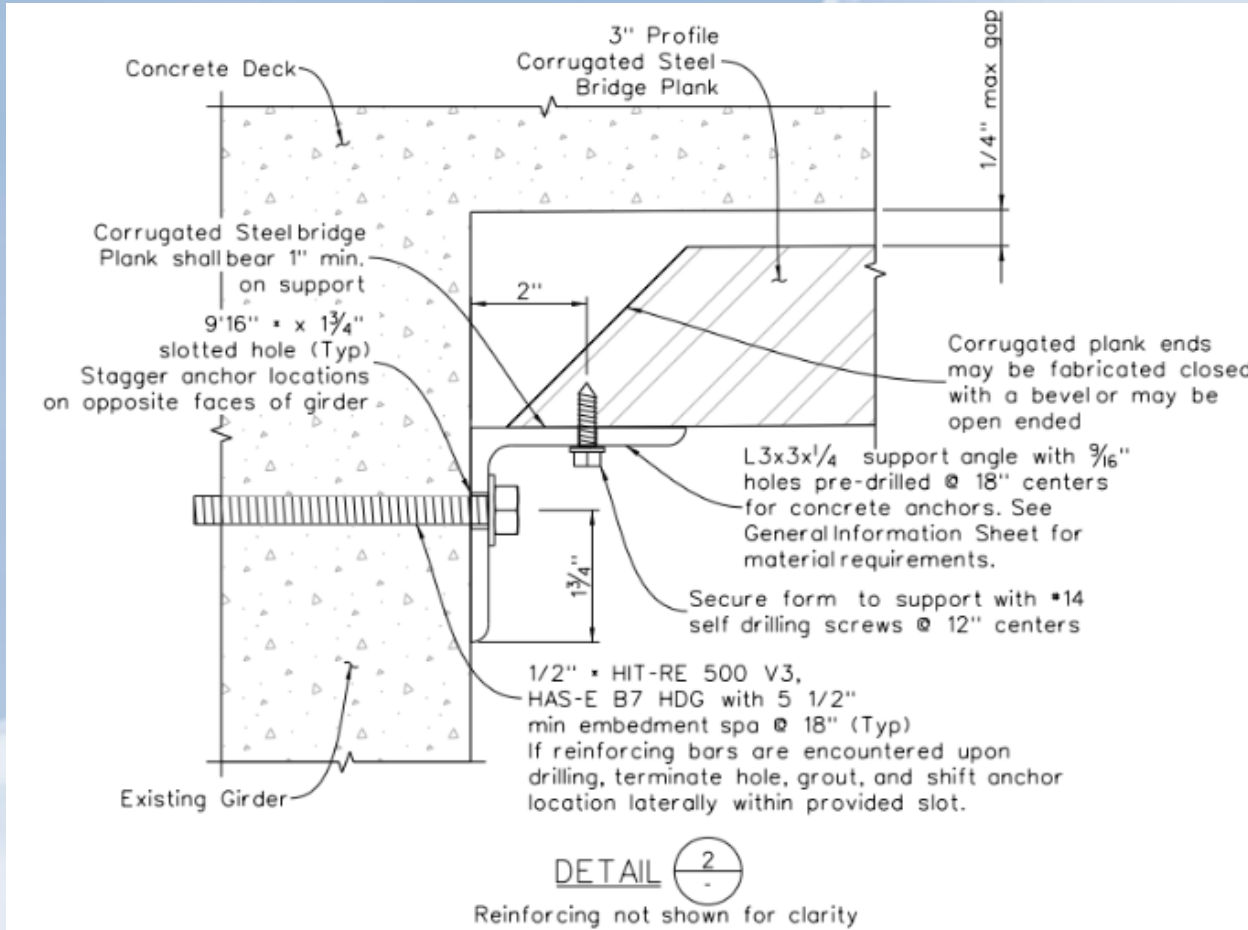
- Concrete Superstructures
- 16ga (min.) Designed to span up to 9' width bays
- Flutes aligned transversely
- Support Angles along entire length, anchored





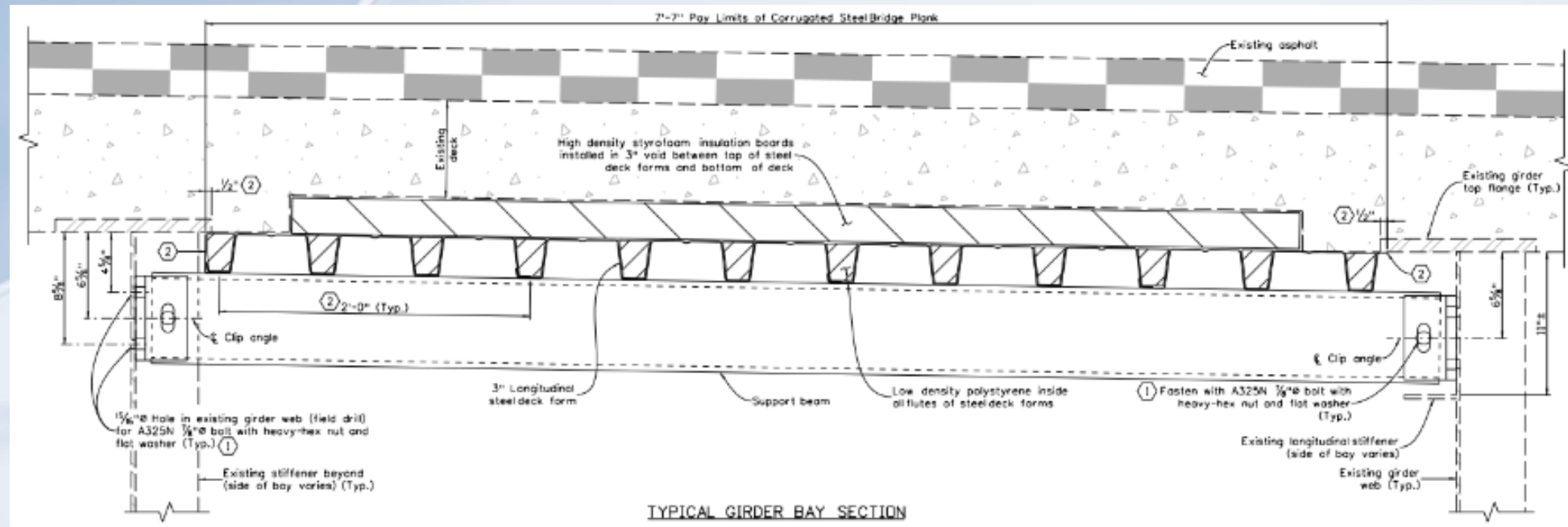
# Design Discussion

- Concrete Anchor Detail and photo example



# Design Discussion

- Steel Superstructure
- Designed with the flutes aligned longitudinally
  - Steel Channels installed attached to the webs w/ clip angles = Less holes in the webs





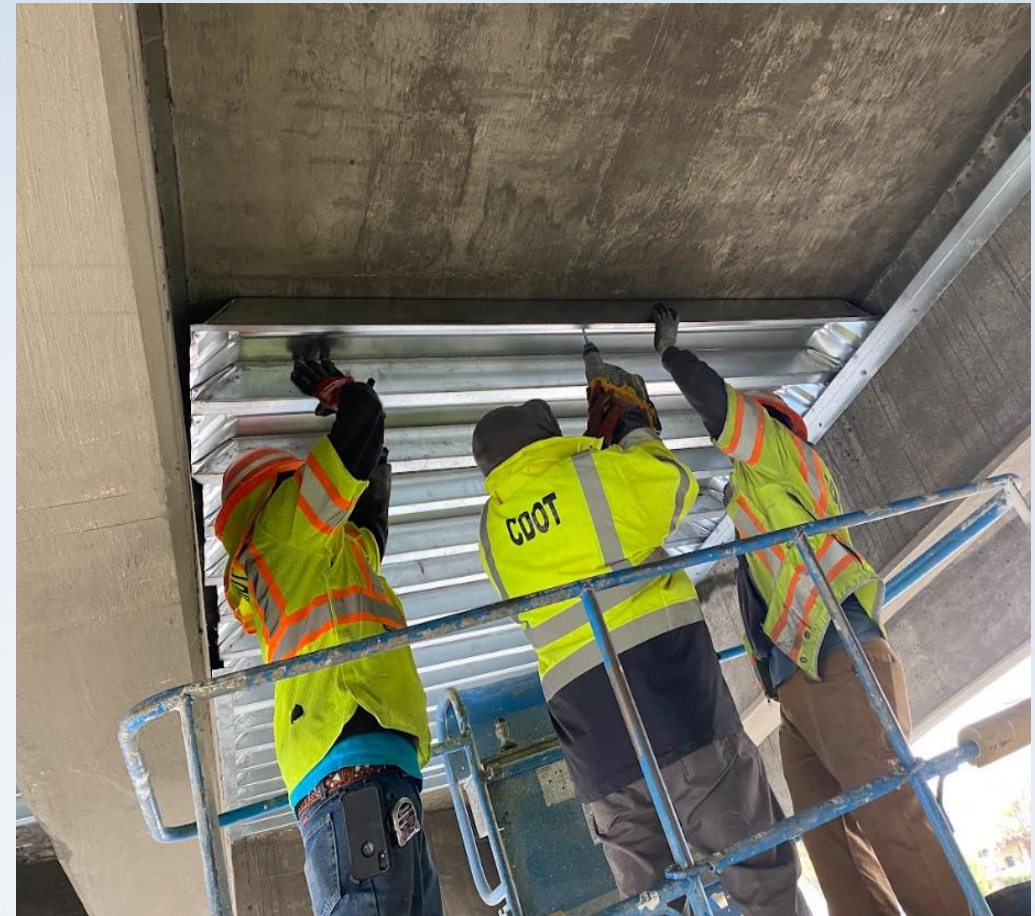
# Design Discussion

- Steel Superstructure
- Installed example
- “Why aren’t the channels galvanized like you specified?”



# Cost Discussion

- Approximate Cost of Steel Decking(2022)
  - Contractor Install           \$45-50/SF
    - Ancillary items included (nuts and bolts)
  - Maintenance Install         \$15-20/SF
    - That's all-in (nuts, bolts, labor and equipment)
- CDOT pays a 3x premium to bid this work out
- Moral of the story – if you have a great maintenance team, let them do the job!





# Construction Discussion

- Common Issues
  - Access
  - Tight Corners on skewed bridges were an issue
  - Fit-Up
  - Lifting into place



# Construction Discussion

- Access at Clear Creek
  - Special manlift was needed here
  - No Access to abutment side that wouldn't require a lane closure
  - Special reach manlift extended over the creek





# Construction Discussion

- Fit-Up of angles and anchor bolt spacing



# Before & After



“Why did you leave the wood up??”



# Before & After



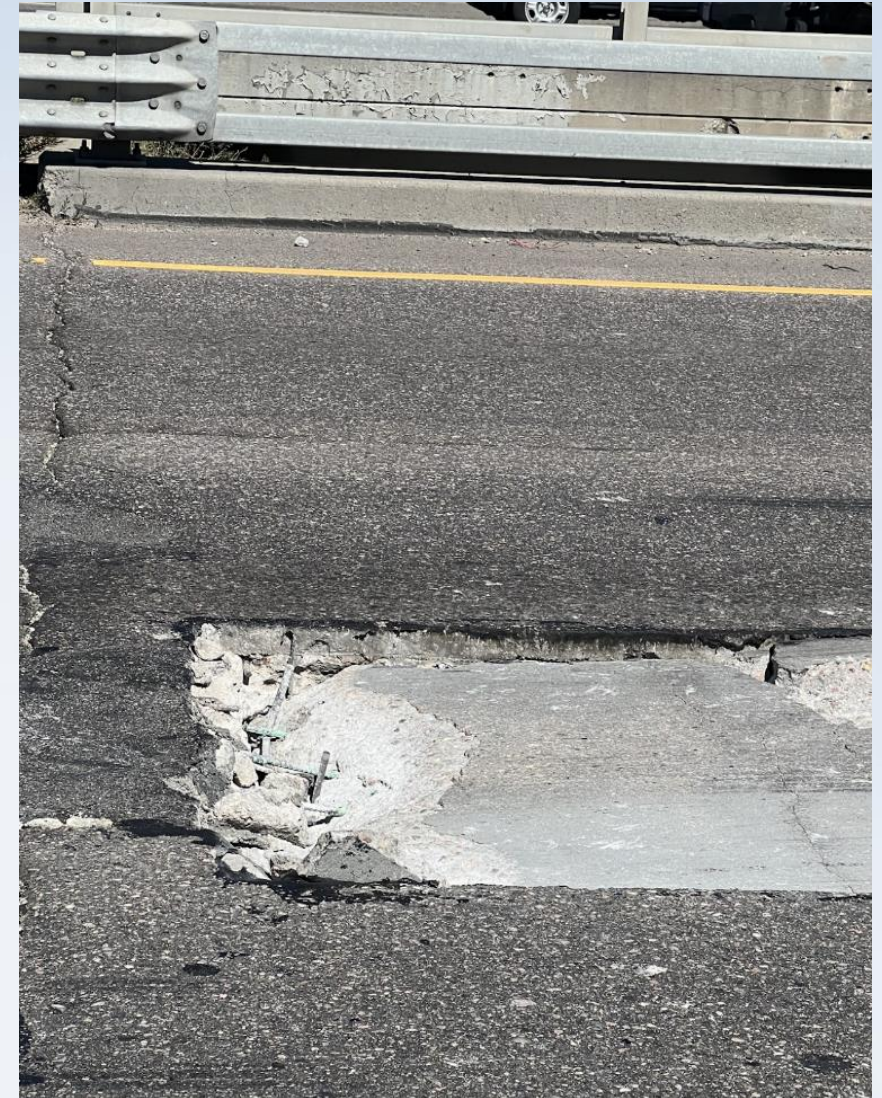
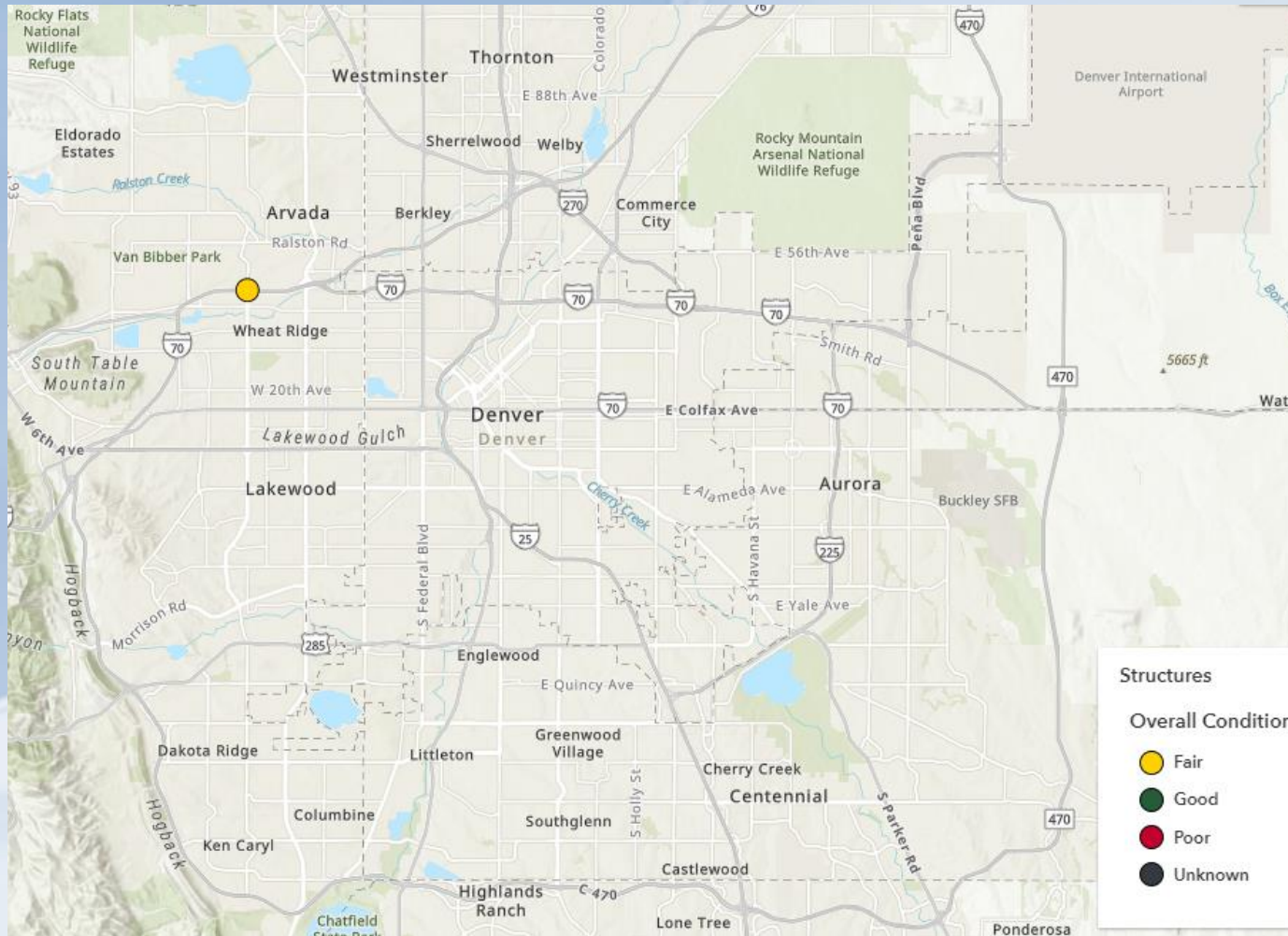


# Before & After



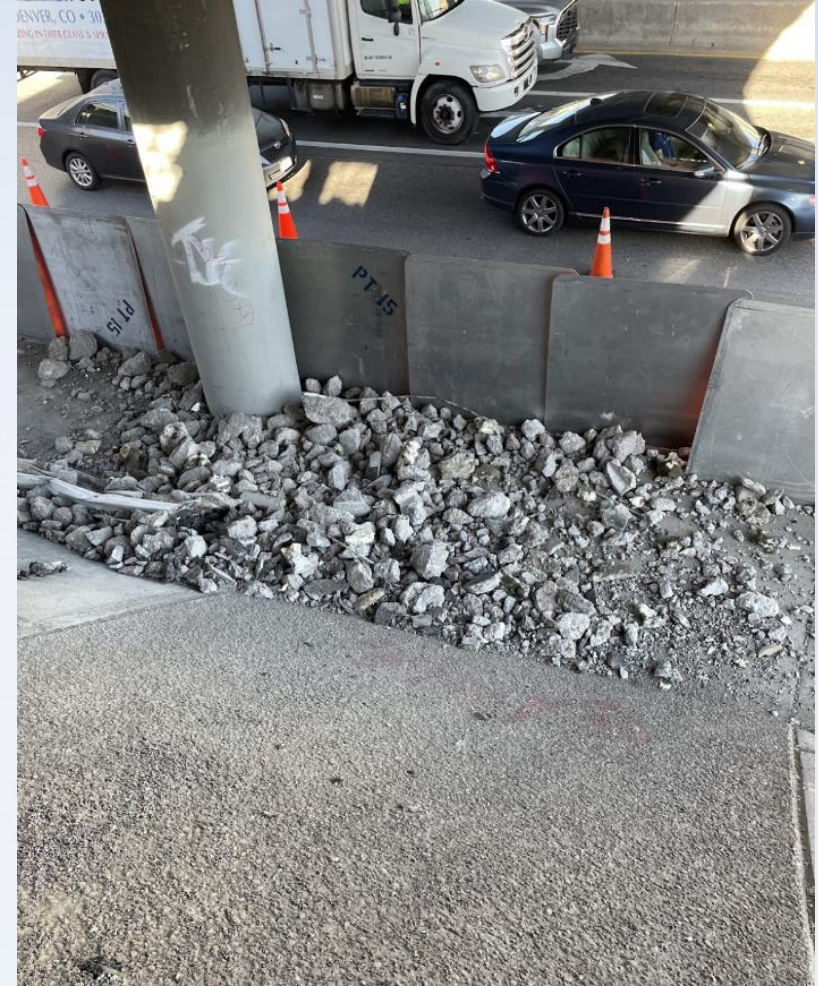


# Deck Pans In Action



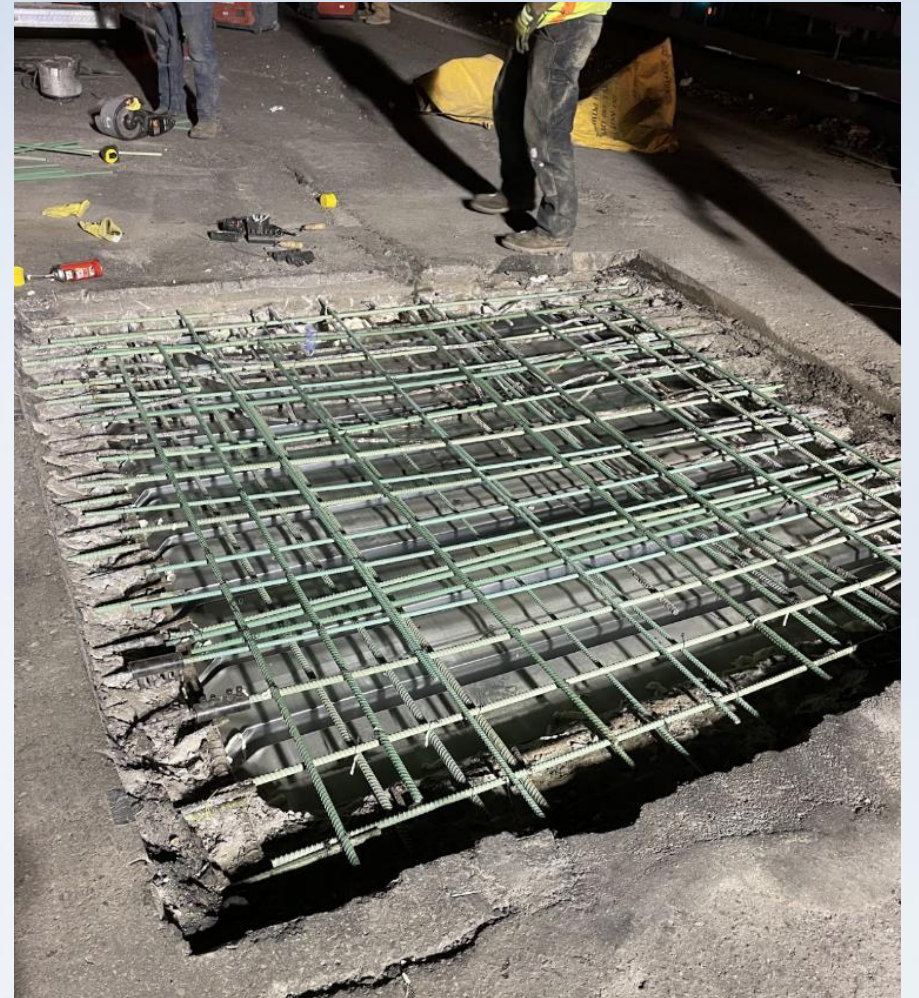
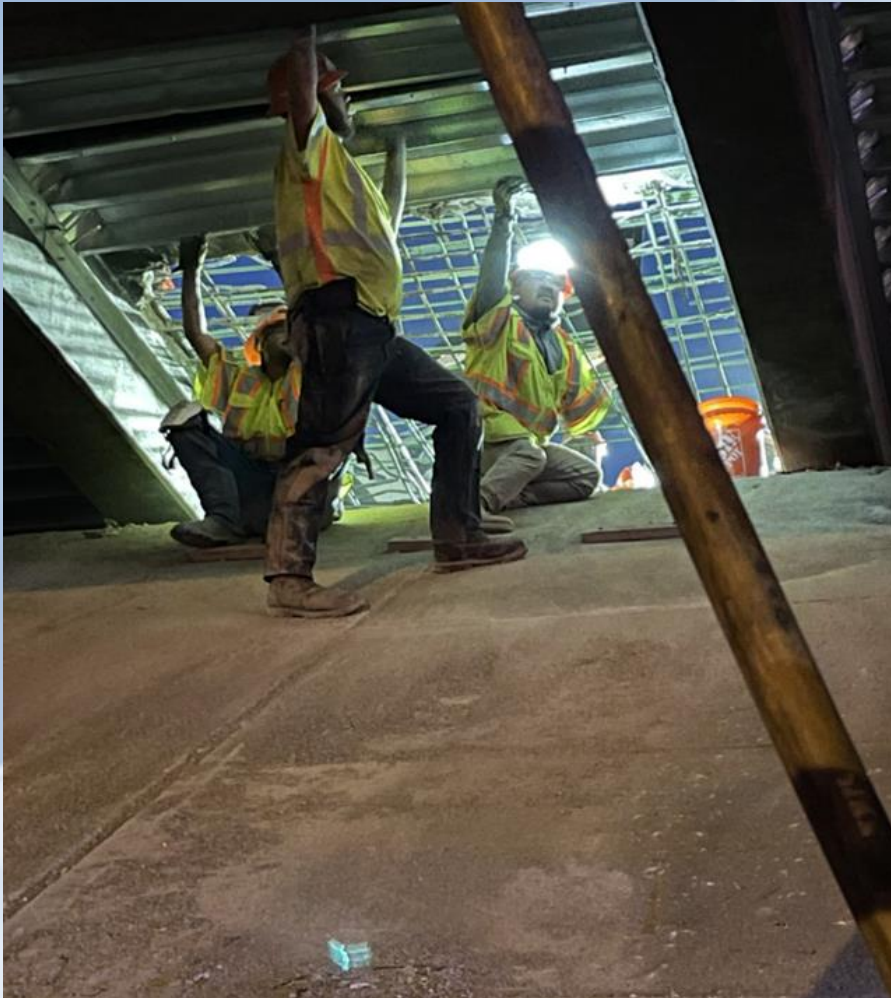


# Deck Pans In Action



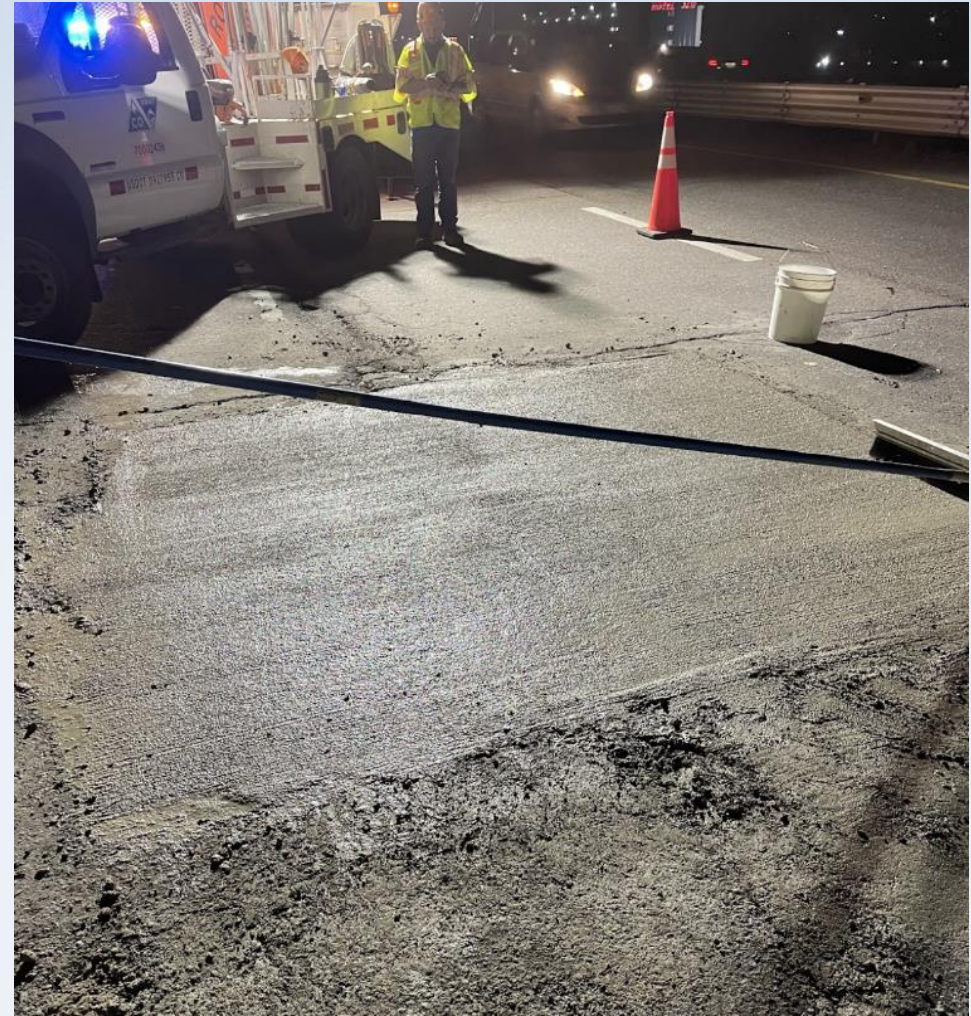
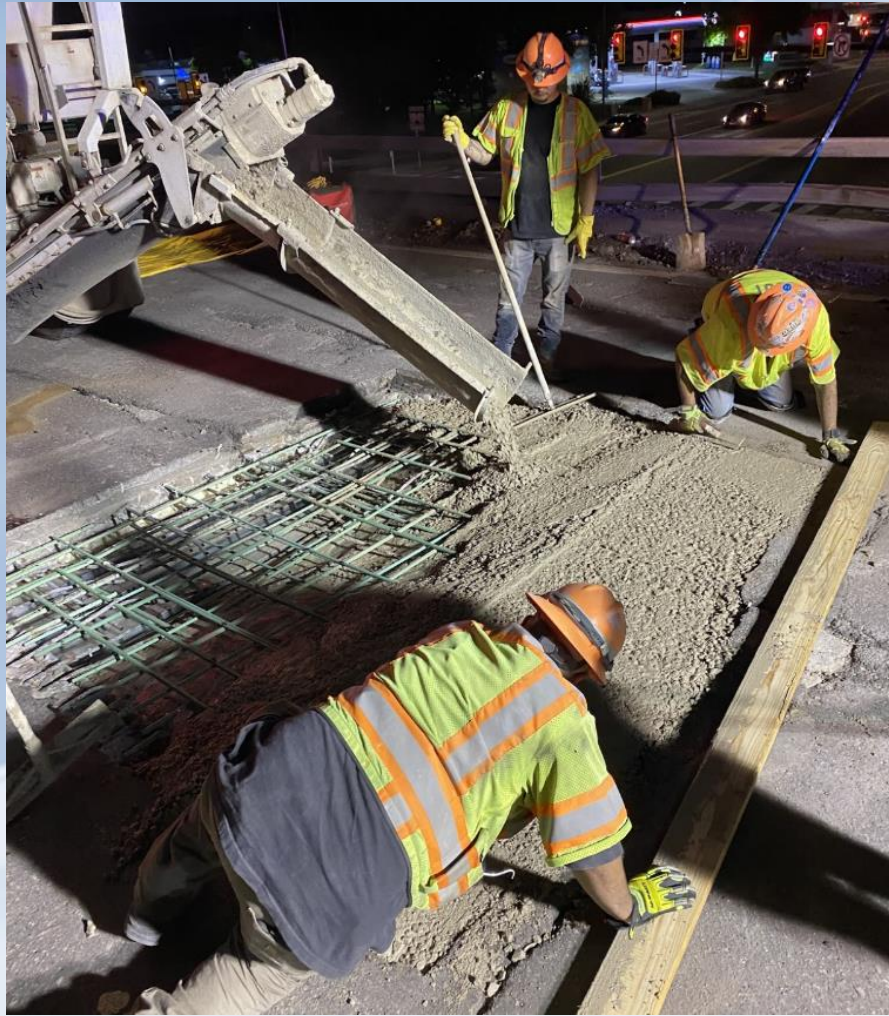


# Deck Pans In Action





# Deck Pans In Action





# Deck Pans In Action

- 12 hours, 35 mins duration
- Still holding up!



# Lessons Learned

- This application should be considered only for bridges that are planned to be replaced in the next 5-10 years
- Maintenance Forces can perform this work, at cost of parts, labor and equipment
- Communication with the crews goes such a long way
- Contracting out the more complex work mostly due to Maintenance time constraints



# Lessons Learned

- The Real MVPs!!!





# Questions?

- Thank You!

Tristan R Siegel, MCE, PE

Colorado Department of Transportation  
(CDOT)

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[Tristan.Siegel@state.co.us](mailto:Tristan.Siegel@state.co.us)

