Early Loading to Deploy Overlay Joints: Does It Work?

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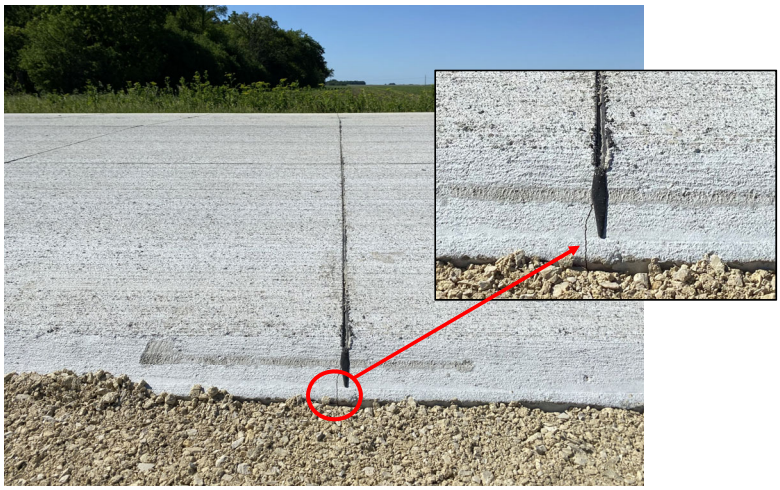
Outline

- **Background**
- **Study Objectives**
- **Case Histories**
- **Conclusions**

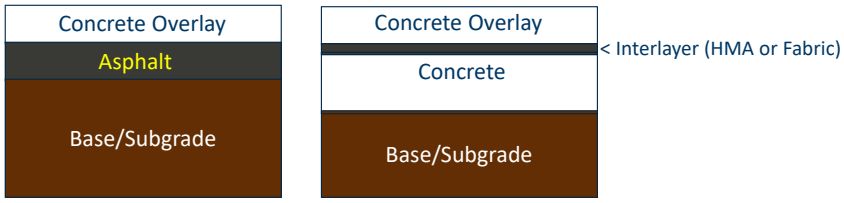
Natural Joint Deployment

- **Friction resists shrinkage = cracking at sawed joints**



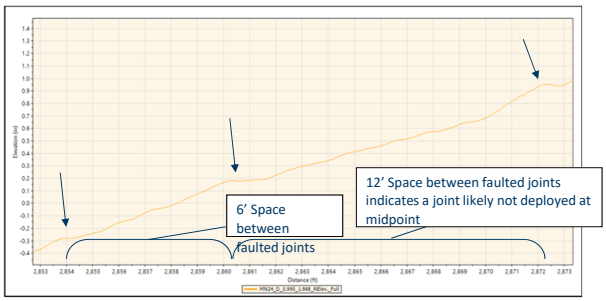
Concrete Overlays

- **Concrete Overlay on Asphalt (COA)**
- **Concrete Overlay on Concrete (COC)**



Non-Uniform Joint Deployment in COAs

- **Dominant joints (sealant bumps)**
- **Inconsistent faulting patterns**
- **Increased potential for buckled panels?**



4/6/22 5

Thin Concrete Overlays on Asphalt

- **Causes for Joint Deployment Issues**
  - **Strong early bond to underlying asphalt**
  - **Many more joints, often formed using "skip" sawing technique**

4/6/22 6

Impact of Traffic?

3/19/2021 Location B (Age: 9 months)	
Joint	Deployed?
0	N
1	Y
2	N
3	Y
4	N
5	Y
6	N
7	N
8	Y
9	N
10	N
11	N
12	Y
13	N
14	N
15	N
16	N
17	Y
18	N
19	N
20	N

3/19/2021 Location C (Age: 9 months)	
Joint	Deployed?
0	Y
1	Y
2	N
3	N
4	N
5	N
6	N
7	N
8	Y
9	N
10	N
11	Y
12	Y
13	Y
14	N
15	Y
16	Y
17	N
18	N
19	Y
20	N

Benefit of Deployed Joints

- **COAs designed for small panels to reduce warp and curl**
- **More joints = smaller openings after shrinkage = increased aggregate interlock**
- **Better long term performance?**

Joint Deployment via Early Loading

- **Apply heavier loads earlier to encourage joint deployment**
  - **Must be careful not to damage pavement**

4/6/22 9

Early Loading Criteria

- **Timing of load application**
  - **Minimum time after saw cutting?**
  - **Degree of set and hydration of mix (maturity)**
  - **Mitigate pavement damage**
- **Loading configuration**
  - **Axle weight**
  - **Axle spacing**
  - **Vehicle speed**
  - **Number of passes**
- **Site conditions affect rate of slab shrinkage**
  - **Windy weather**
  - **Extreme changes in temperature**

4/6/22 10

Study Objectives

- **Visit COA construction sites where early loading applied**
- **Document deployment of loaded and unloaded joints**
  - **Shortly after early loading**
  - **1 week, 3 weeks, 6 months, 1 year**

Methods

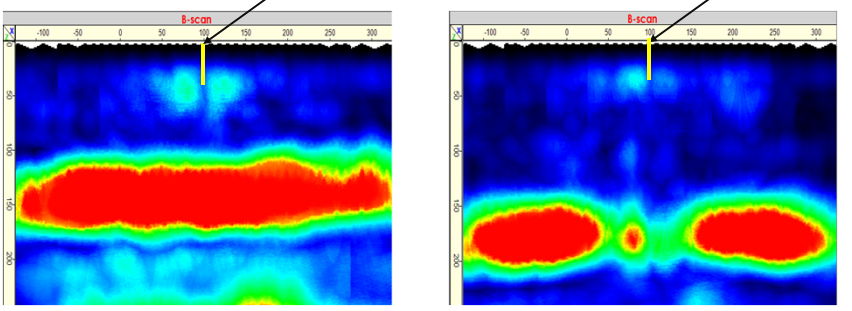
Visual surveys

Methods

Ultrasonic tomography (MIRA device)

Ultrasonic Tomography

Profile views



Joint not deployed **Joint deployed**

Case Histories

- **CSAH 1 (Filmore County, MN)**
  - **5-inch thick COA on 7-inch thick HMA, constructed in 2020**
  - **6-foot by 6-foot panel size**
  - **High and low air temperatures during paving were 76°F and 40°F**
  - **1000-foot stretch of roadway subjected to early loading**
  - **Load vehicle: 3-axle water truck filled to estimated 58,000 lbs total weight**
  - **Two passes of truck approximately 19 and 25 hours after paving**
  - **Maturity of the concrete was 422.4 C-hours at the time of the first pass**
  - **Deployment surveys done @ 1 week, 3 weeks, and 9 months**

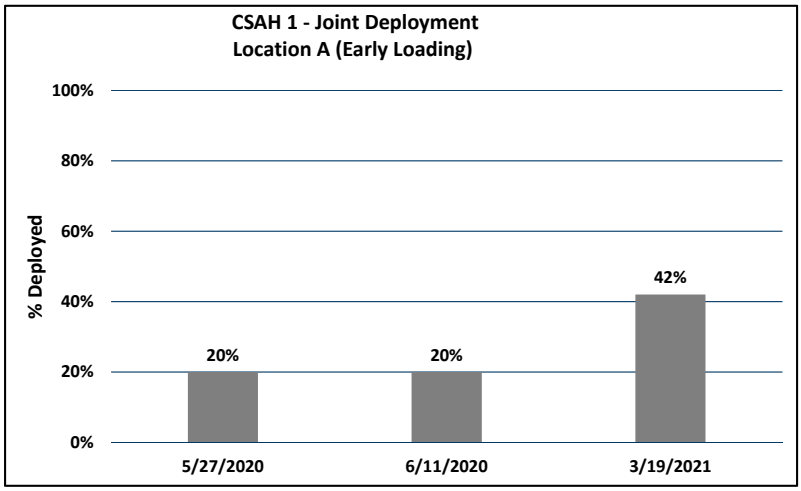
Joint Deployment Observations – CSAH 1

5/27/2020 Location A (Early Loading)	
Joint	Deployed?
17	Y
28	N
29	Y
39	N
47	Y
49	N
62	N
64	Y
74	Y
75	N
84	N
89	N
93	N
95	N
97	N
105	N
107	N
108	N
115	Y
115	N
123	N
130	N
132	N
133	Y
138	N
139	N
143	N
148	N
150	N
152	N
153	Y
154	N
155	N

6/11/2020 Location A (Age: 3 weeks)	
Joint	Deployed?
17	Y
28	N
29	Y
39	N
47	Y
49	N
62	N
64	Y
74	Y
75	N
84	N
89	N
93	N
95	N
97	N
105	N
107	N
108	N
115	Y
115	N
123	N
130	N
132	N
133	Y
138	N
139	N
143	N
148	N
150	N
152	N
153	Y
154	N
155	N

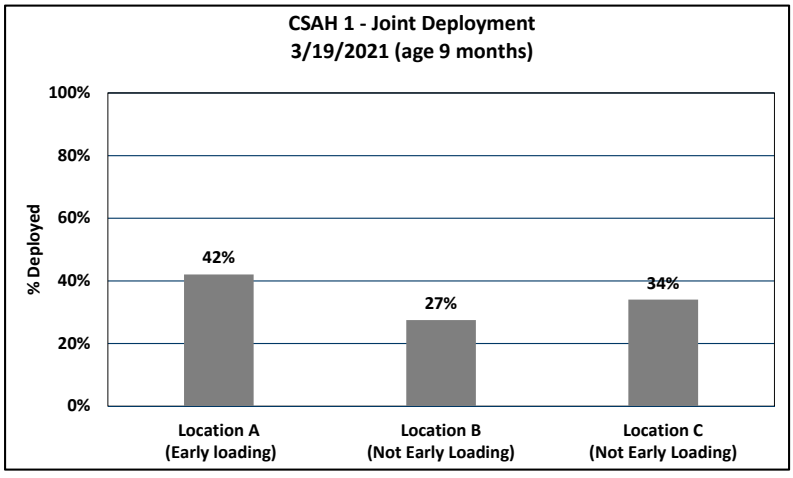
3/19/2021 Location A (Age: 9 months)	
Joint	Deployed?
17	Y
28	Y
29	Y
39	Y
47	Y
49	N
62	Y
64	Y
74	Y
75	N
84	N
89	N
93	N
95	N
97	N
105	N
107	N
108	Y
115	Y
115	Y
123	N
130	N
132	N
133	Y
138	Y
139	N
143	N
148	Y
150	N
152	N
153	Y
154	N
155	N

Joint Deployment Observations – CSAH 1



4/6/22 17

Joint Deployment Observations – CSAH 1



4/6/22 18

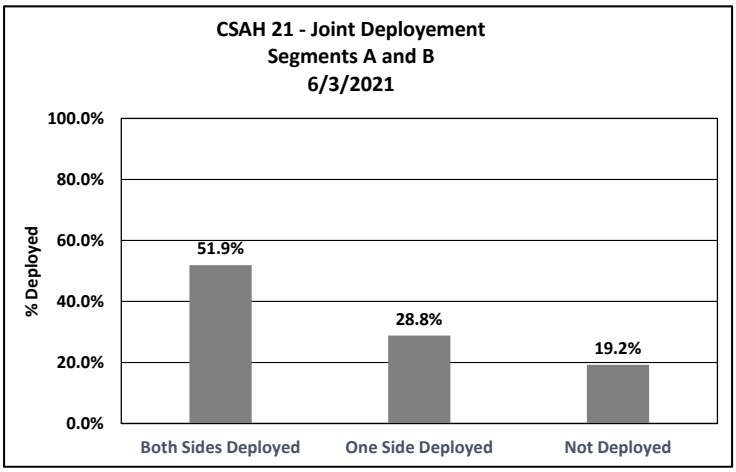
Case Histories

- **CSAH 21 (Filmore County, MN)**
  - 5-inch thick COA on variable thickness HMA, constructed in 2021
  - 6-foot by 6-foot panel size
  - High and low air temperatures during paving were 84°F and 45°F
  - Entire project subjected to early loading
  - Load vehicle: 3-axle water truck filled to estimated 58,000 lbs total weight
  - Two passes of approximately 13, 22 and 26 hours after paving
  - Maturity of the concrete was 678.9 C-hours at the time of the first pass
  - Deployment survey done @ various ages (1 day to 10 days)

Joint Deployment Observations – CSAH 21

	Segment A (Age 10 days) (Loaded approx. 26 hrs. after paving)		Segment B (Age 6 days) (Loaded approx. 22 hrs. after paving)		Segment C (Age 1 day) (Loaded approx. 13 hrs. after paving)	
Joint	Northbound	Southbound	Northbound	Southbound	Northbound	Southbound
0	Y	Y	Y	Y	N	N
1	N	N	N	Y	N	N
2	Y	Y	N	N	N	N
3	N	Y	Y	Y	N	N
4	Y	N	N	N	N	N
5	Y	Y	Y	Y	N	N
6	Y	N	Y	N	N	N
7	Y	N	Y	Y	N	N
8	Y	Y	N	Y	N	N
9	Y	Y	Y	Y	N	N
10	N	N	N	N	N	N
11	Y	Y	Y	Y	N	N
12	N	N	N	N	N	N
13	N	N	Y	Y	N	N
14	Y	Y	Y	Y	N	N
15	N	Y	N	Y	N	N
16	Y	N	Y	Y	N	N
17	N	N	Y	Y	N	N
18	Y	Y	Y	Y	N	N
19	N	N	Y	N	N	N
20	Y	Y	Y	Y	N	N
21	Y	Y	N	Y	N	N
22	Y	Y	Y	N	N	N
23	Y	Y	Y	N	N	N
24	Y	Y	Y	Y	N	N
25	Y	Y	Y	N	N	N
Deployed	18	16	18	17	0	0
Not Deployed	8	10	8	9	26	26

Joint Deployment Observations – CSAH 21



4/6/22 21

Case Histories

- **TH 63 (Zumbro Falls, MN)**
  - 5-inch thick fiber-reinforced COA on 8 to 11 inch thick HMA, constructed in 2018
  - 6-foot by 6-foot panel size
  - High and low air temperatures during paving were 89°F and 77°F
  - Multiple 1000-foot stretches of roadway subjected to early loading
  - Load vehicle: 3-axle water truck filled to two different total weights (25,000 & 58,000 lbs)
  - Four passes of truck at various times and weights
  - Deployment surveys done @ 1 day, 2 years

4/6/22 22

Early Loadings

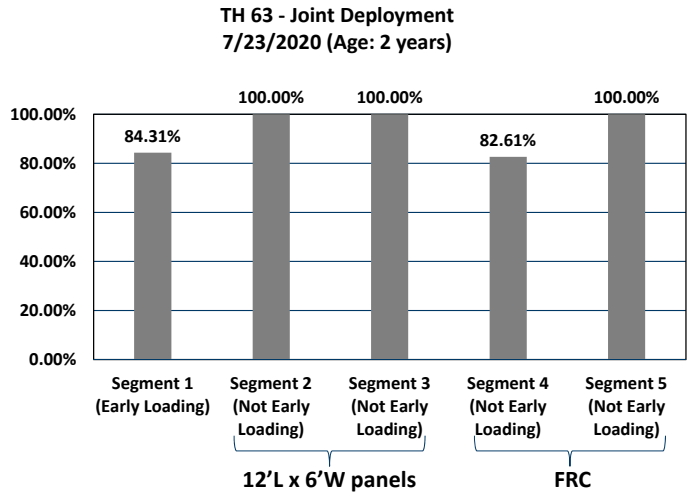
- **TH 63 (Zumbro Falls, MN)**

Load (lbs)	Maturity (C-hours)	Deployment
0	370	5/166
25000	720	7/166
58000	370	17/166

Joint Deployment Observations – TH 63

7/23/2020 (Age: 2 years)					
	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Early loading:	Yes	No	No	No	No
Panel size:	6'x6'	6'x12'	6'x12'	6'x6' with fibers	6'x6' with fibers
Joint	Northbound	Northbound	Northbound	Northbound	Northbound
1	Y	Y	Y	Y	Y
2	N	Y	Y	N	Y
3	Y	Y	Y	Y	Y
4	Y	Y	Y	Y	Y
5	Y	Y	Y	Y	Y
6	Y	Y	Y	N	Y
7	Y	Y	Y	Y	Y
8	Y	Y	Y	Y	Y
9	Y	Y	Y	Y	Y
10	Y	Y	Y	Y	Y
11	Y	Y	Y	Y	Y
12	Y	Y	Y	Y	Y
13	Y	Y	Y	Y	Y
14	N	Y	Y	Y	Y
15	Y	Y	Y	Y	Y
16	Y	Y	Y	Y	Y
17	Y	Y	Y	Y	Y
18	N	Y	Y	Y	Y
19	Y	Y	Y	Y	Y
20	Y	Y	Y	N	Y
21	N	Y	Y	N	Y
22	Y	Y		Y	
23	Y	Y		Y	
24	Y	Y			
25	Y	Y			
26	Y	Y			

Joint Deployment Observations – TH 63



Case Histories

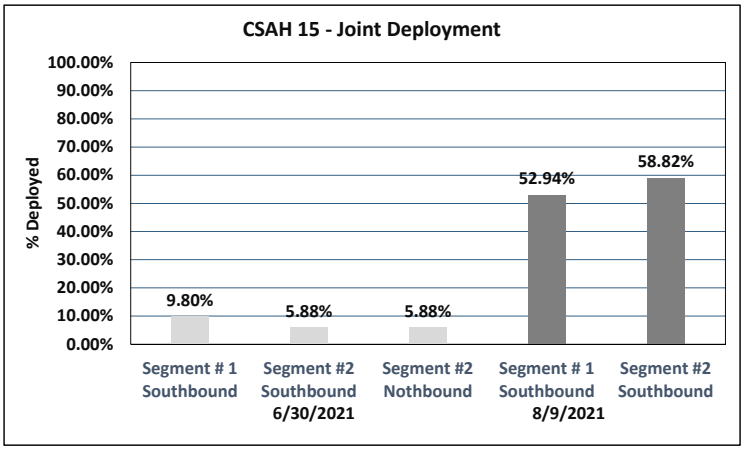
- **CSAH 15 (McLeod County, MN)**
  - 6-inch COA on variable thickness HMA, constructed in 2021
  - 6-foot by 6-foot panel size
  - High and low air temperatures during paving were 75°F and 52°F
  - Load vehicle: 3-axle water truck filled to estimated 58,000 lbs total weight
  - One pass over entire paved segment at approx. 24 hours
  - Deployment surveys done @ 1 week, 5 weeks (construction traffic only)

Joint Deployment Observations – CSAH 15

	6/30/2021 (Age 1 week)		
	Segment #1	Segment #2	
Joint	Southbound	Southbound	Northbound
0	N	N	N
1	N	N	N
2	N	N	N
3	Y	N	N
4	N	N	N
5	N	N	N
6	N	Y	Y
7	N	N	N
8	N	N	N
9	N	N	N
10	N	N	N
11	N	N	N
12	N	N	N
13	Y	N	N
14	N	N	N
15	N	N	N
16	N	N	N
17	N	N	N
18	N	N	N
19	N	N	N
20	N	N	N
21	N	N	N
22	N	Y	Y
23	N	N	N
24	N	N	N
25	N	N	N
26	Y	N	N

	8/9/2021 (Age: 5 weeks)	
	Segment #1	Segment #2
Joint	Southbound	Southbound
0	Y	Y
1	N	N
2	Y	Y
3	Y	Y
4	Y	Y
5	Y	N
6	N	Y
7	Y	N
8	N	Y
9	Y	N
10	N	Y
11	Y	N
12	N	Y
13	Y	N
14	N	Y
15	Y	Y
16	N	Y
17	Y	N
18	N	Y
19	Y	N
20	N	Y
21	N	N
22	Y	Y
23	N	N
24	Y	Y
25	N	N
26	Y	Y

Joint Deployment Observations – CSAH 15



Discussion

Early loading of COA

- Experimental technique so far
- Empirical in nature
  - Variables: weather, mix design, concrete maturity, load magnitude, repetitions, axle spacing
- Results have not been consistent
- Small differences between loaded and unloaded at early age
- No clearly defined definition of success
- Does not cause visible damage to the overlay

Conclusions

Does it work?

- Current procedures have resulted in inconsistent results
- Highest rate of deployment has been 52% @ 1 week

Recommendation:

Discontinue procedure until a controlled research study can be carried out.

Questions?

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