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Business Center

Friction Sensors Help CDOT Save Money and Improve Winter Road Safety [Winter Operations]

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Over the course of three statewide snowstorms in the Winter of 2017, Colorado Department of Transportation's (CDOT) Division of Highway Maintenance reduced their use of solid materials by 21% and their use of liquid materials by 56% on a small selection of roads in Colorado. These reductions resulted in $180,000 of savings in material costs for CDOT.

These reductions can be attributed to the testing of a new technology, called 'friction sensors'-- electronic radars attached to the back end of supervisor trucks, which collect data on the amount of friction, or grip, present on the roadway. The project to test and implement the use of these sensors was led by the Manager of Winter Operations, David Johnson, and the Director of Highway Maintenance, Kyle Lester.

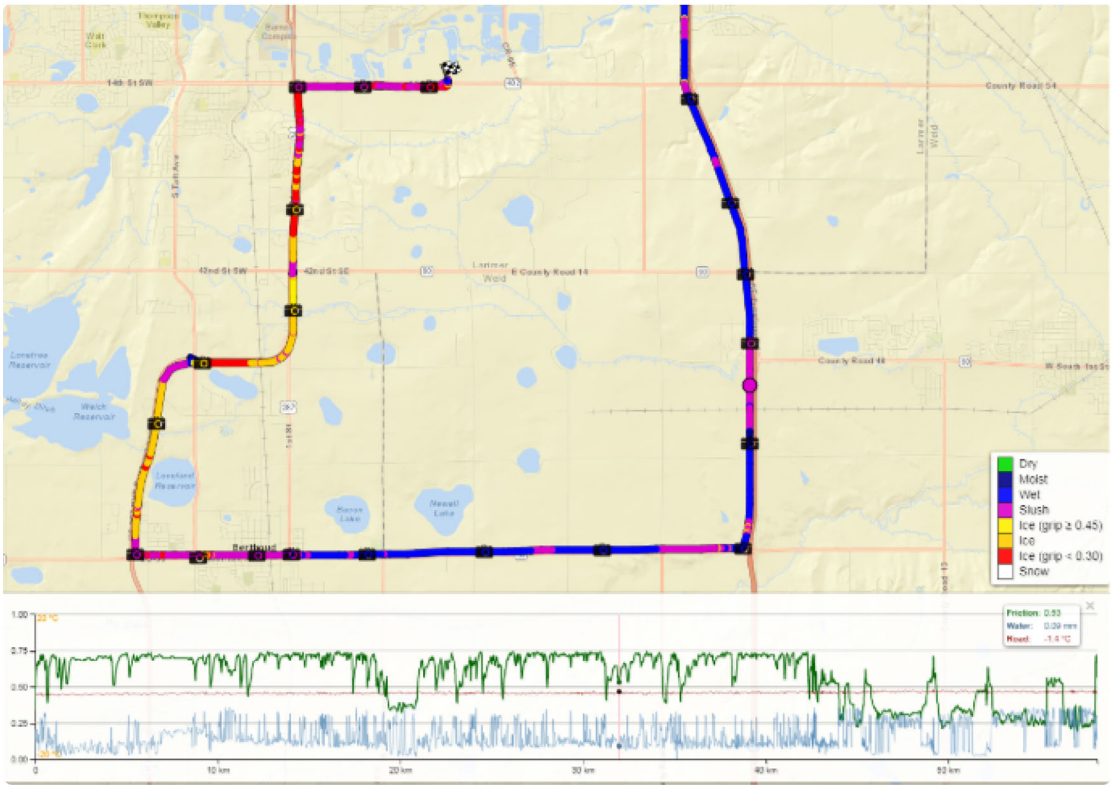
One of the Teconer Friction Sensors installed on the back of a light fleet vehicle.

How it Works

The sensor relays information on pavement temperature changes, along with the level of friction and moisture present along with a roadway, to the Maintenance Decision Support System (MDSS)-- a web database that houses and maps all the weather data used by CDOT. Currently, Winter Operations utilizes the MDSS to determine which segments of roadway need salt, liquid materials, plowing, or a combination of treatments.

"If a worker is looking at the MDSS to understand the condition of the roadway and what sort of treatments need to be applied, but the nearest point of data collection is 30 miles from them, then that data is no longer helpful when determining the appropriate treatment of the roadway" explained Johnson, "The emphasis behind our study (https://drive.google.com/file/d/0B0Nw1RONA1yEVGJ0emNmNkVGUGtFaEQ2eFZHRTc0WWxQMnpZ/view?usp=sharing) was to figure out how we take the roadway friction information gathered from the sensors and use it for operational decision making, through real-time data".

By mapping site-specific data from the friction sensors, maintenance workers are able to focus in on the areas that need treatment rather than treating whole sections of roadways. The main advantage of using this software is a decreased usage of snow and ice removal materials. So much so, that implementing this technology has shown to create impressive savings for CDOT even during the pilot test study.



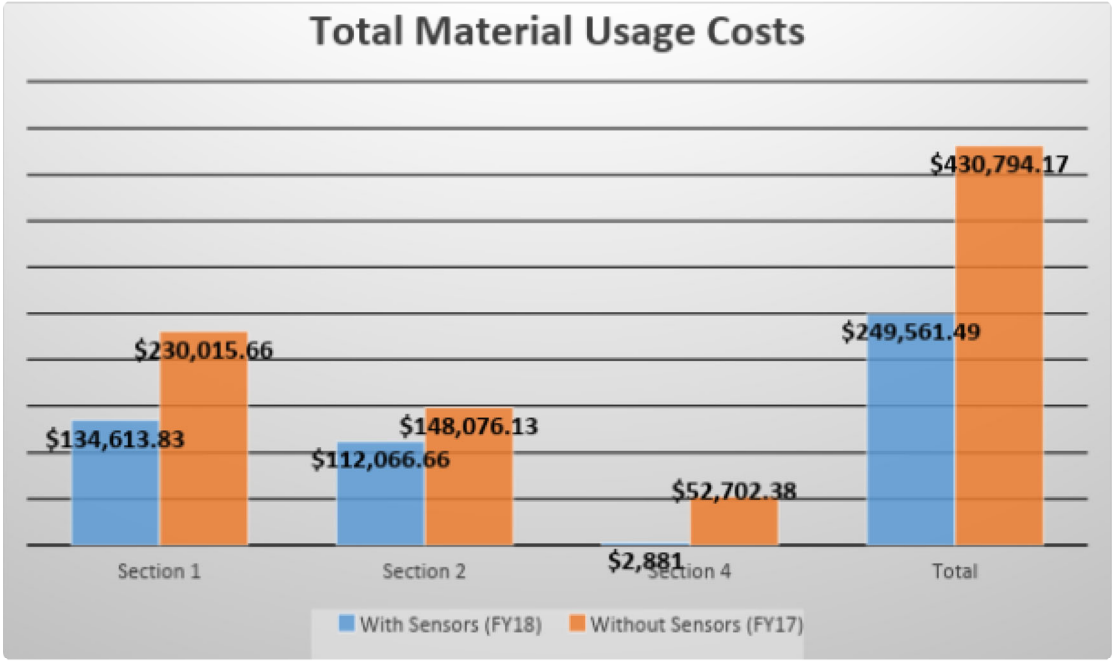
The input of friction data updates the MDSS interface to keep employees up-to-date on the severity of road conditions.

Why CDOT Started Testing Friction Sensors

Johnson and Lester became involved in utilizing friction sensors after being approached by a company named Vaisala, that asked if CDOT would be interested in piloting their sensors. Vaisala is a company located in Colorado that, according to their website (http://www.vaisala.com/en), “develops, manufactures, and markets products and services for environmental and industrial measurement”.

Johnson and Lester used this piloting experience as an opportunity to evaluate the potential of friction sensors by comparing material usage between recent storms that had similar severity index ratings, where friction sensors were and were not deployed. As previously mentioned, in just three storms, Winter Operations saved $180,000 and decreased their environmental impact through the decreased use of roadway treatments.

Because this test was done in a limited area of roadways over the course of just three storms, it is projected that when implemented state-wide, with Colorado's average 15 snowstorms per winter, that these sensors will save CDOT over a million dollars a year.



As you can see in the graph above, the savings in material costs between when sensors were and were not used are significant.

This graph was developed by the Winter Operations team as a part of their August 2018 RTD Update (https://docs.google.com/presentation/d/1FoUadq88wCMm9gXpE9cjttG7V1RfxtcxkcFOKK4Ping/edit?usp=sharing) presentation.

Winter Operations tested four vendor's friction sensors to compare the reliability of their data; High Sierra, Teconer, Lufft, and Vaisala. Next, CDOT put the project out to bid for the vendors that had a quality product. By selecting a sensor vendor through this type of bidding process, CDOT can achieve the best quality results while making a financially conscious choice.

Each sensor costs anywhere between $6,000 - $8,000. Currently, the bidding process for these sensors is still active. Once a vendor has been selected, twenty-eight sensors will be installed over two phases. The first fourteen sensors will be going out sometime between October-November of 2018. The second phase will begin next Fall (2019).

Where the Sensors will be Implemented

The selection of locations that sensors would be installed was determined through a multifaceted study that examined where the sensors would have the most positive impact to the roadway maintenance. "We really want to put eyes and ears on every section of the State," explained Johnson.

2018-19 Priority List

Sensor Rank	Primary Route	Secondary Routes	Patrols	Maint. Section	Max ADT	WX Suitability Scale	Historic Material Usage Scale	Existing ITS Coverage Risk	Crash/LOSS Scale	Known WX Problem Area Scale	Total Risk Score	Risk/Reward Grade	Bustang Route?	Complete?
1	070A	36/40/79	1/2	5	207000	5	5	5	2	3	20	A	N	N
2	025A	83/85/86	3/24/25/26	5	126000	5	4	4	3	4	20	A	Y	N
3	025A	47/50	4/5/6/20/68	4	76000	3	4	5	3	3	18	B	N	N
4	070A	6/70B/141	1/5/8/9/11	2	34000	4	4	3	2	4	17	B	N	N
5	040A	9/14/131/134	12/13/14/21/23	6	24000	3	4	4	3	3	17	B	N	N
6	050A	90/92/348/550	25/27/28	2	22000	3	4	5	3	2	17	B	N	N
7	285D	9/24/67	28/32/38	4	13000	3	3	3	3	5	17	B	N	N
8	285C	24/50/291	8/9/10/17/27	7	8400	3	3	4	3	4	17	B	N	N
9	070A	6/88/287	4/10/15	5	152000	5	4	1	3	3	16	B	N	N
10	025A	10/12/160	1/2/3	4	13000	3	4	2	3	4	16	B	N	N
11	070A	6/103/119	35/41/45	9	83000	3	5	1	3	3	15	B	Y	N
12	024G	21/94	9/10/39/53/67	4	61000	4	3	3	2	3	15	B	N	N
13	070A	6/82	10/12/42	2	28000	4	3	3	2	3	15	B	Y	N
14	040A	13/318	3/5/8/12	6	15000	2	4	3	4	2	15	B	N	N
15	025A	88/225/470	4/7/8	5	260000	5	3	1	2	3	14	C	Y	N
16	076A	22/44/85/270	19/28	5	85000	5	4	1	3	1	14	C	N	N
17	050A	92/141/348	2/29/30	2	30000	4	3	3	2	2	14	C	N	N
18	160A	141/145/184	1/2/3/4/20	3	23000	2	3	3	3	3	14	C	N	N
19	013A	40/64/317	5/33/36	6	17000	2	4	3	3	2	14	C	N	N
20	034B	59/61/385	37/38/39	1	8000	2	1	5	2	4	14	C	N	N
21	025A	70/76	11/13	5	157000	5	3	1	2	2	13	C	Y	N
22	C470	8/121/285	9/17/30	5	111000	5	3	1	2	2	13	C	N	N
23	160A	140/172/550	4/5/10/11/24	3	37000	3	3	3	2	2	13	C	N	N
24	082A	133	12/15/16	2	27000	3	4	1	3	2	13	C	N	N
25	160A	17/112/285	3/4/5/7	7	20000	2	2	2	2	4	12	C	N	N
26	050A	45/47/96/115	20/29/59	4	50000	2	3	2	2	2	11	C	N	N
27	040H	59/71/94	22/46/40	1	5000	2	2	4	1	1	10	C	N	N
28	287A	50/116/160	12/14/16	4	18000	1	2	4	1	1	9	D	N	N

The table used to weigh the needs for sensors across the 28 locations in Colorado.

While the sensors will be installed in locations state-wide, the snow removal routes that would benefit the most are the ones that are generally warmer and at lower elevations. Those areas tend to have more difficult operational decisions since their ice and frost conditions are more sporadic and less predictable. In contrast, there is often bad roadway friction and snowpack in mountain passes, making it more obvious what sort of maintenance these roads require. For this reason, the focus of sensor deployment will be more highly concentrated on the Eastern Plains (between I-25 and the State border) and the Western slope (around Grand Junction and Craig).

Updating COtrip System

COtrip (http://cotrip.org/map.htm) is a website that CDOT utilizes to disperse information to the public on the condition of roadways, which typically gets over a million hits during storm events. Currently, the website gives the public access to images and videos of the roadways, travel alerts, temperatures and weather conditions at different weather stations, as well as lane and road closures. Johnson and Lester plan to add friction data to this website as well so that the public can see the real-time condition ratings of the roadways.

Leading the Way for Other DOTs

“Other DOTs are starting to use friction sensor technology, but we are the furthest ahead in quantifying the benefits of it. They are probably about one winter behind us,” estimated Johnson. According to Johnson, after much discussion of friction sensors with other states, there are a number of DOTs who are beginning to implement similar technology. “It’s sort of

a collaboration in a sense, but certain DOTs take it and make it their own," explained Johnson. CDOT is certainly making it their own and leading the way with the implementation of this technology.

Office of Process Improvement (https://www.codot.gov/business/process-improvement/copy_of_processoverview.html)

Larger Process Improvement Efforts (https://www.codot.gov/business/process-improvement/larger-process-improvement-efforts)

Lean Everyday Ideas (https://www.codot.gov/business/process-improvement/lean-everyday-ideas)

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