Performing Under Smoothness Specifications

IAPA Annual Meeting
March 12, 2019

Don Matthews, PE
Pavement Recycling Systems, Inc.

The International Roughness Index (IRI)

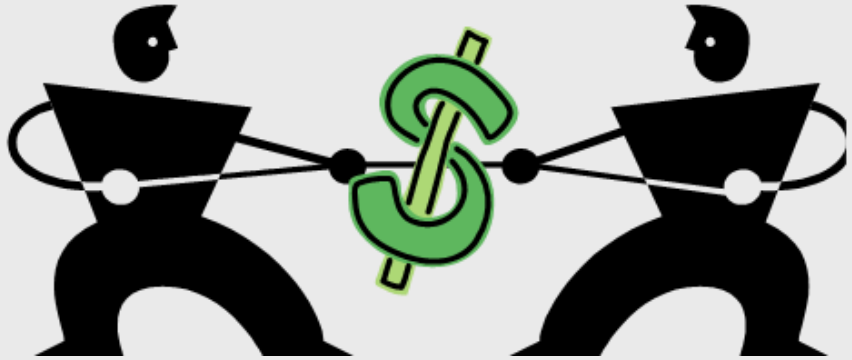
Smoother Roadways

Or

Bumpy Roads Ahead

In California Caltrans and Contractors Spent Nearly 100 Million Dollars on Claims and Excessive Grinding Since the Original IRI Smoothness Specification Was Released in 2014!

So Why All the Issues?



In a Word:

Ignorance

Determined That Few Understood:

What the Specification Numbers Meant

- Profilograph Specification
  - Profile Index of 2.5 inches per 0.1 mile
  - Must Grinds – Localized roughness of 0.3 inch or more in 25 feet
- Inertial Profiler with IRI Specification
  - Mean Roughness Index (MRI) – 60 or 75 in/mi depending on depth of HMA
  - Area of Localized Roughness (ALR) – 160 in/mi localized roughness based on a 25 feet sliding scale
- They Seem Similar Concept Maybe Numbers No!

Few On Contractors Side Understood:

What it took to achieve the new smoothness requirements during construction

What best paving practices are really required for smoothness

The Killer Phrase -
“I am not worried about it. I have been paving for 30 years”

Get out the checkbook!

Also Realized Few In State Understood:

If smoothness could be achieved for a given roadway condition using standard design strategies

HMA[a] Pavement Smoothness Acceptance Criteria

HMA thickness	MRI requirement
> 0.20 foot	60 in/mi or less
≤0.20 foot	75 in/mi or less

← One Lift

No Consideration of Roadway Location or Type

Little Consideration to Existing Roughness

TYPES OF ROADS
Both Mill and Fill of 0.10’
Both Have a Final MRI Requirement of 75 in/mi

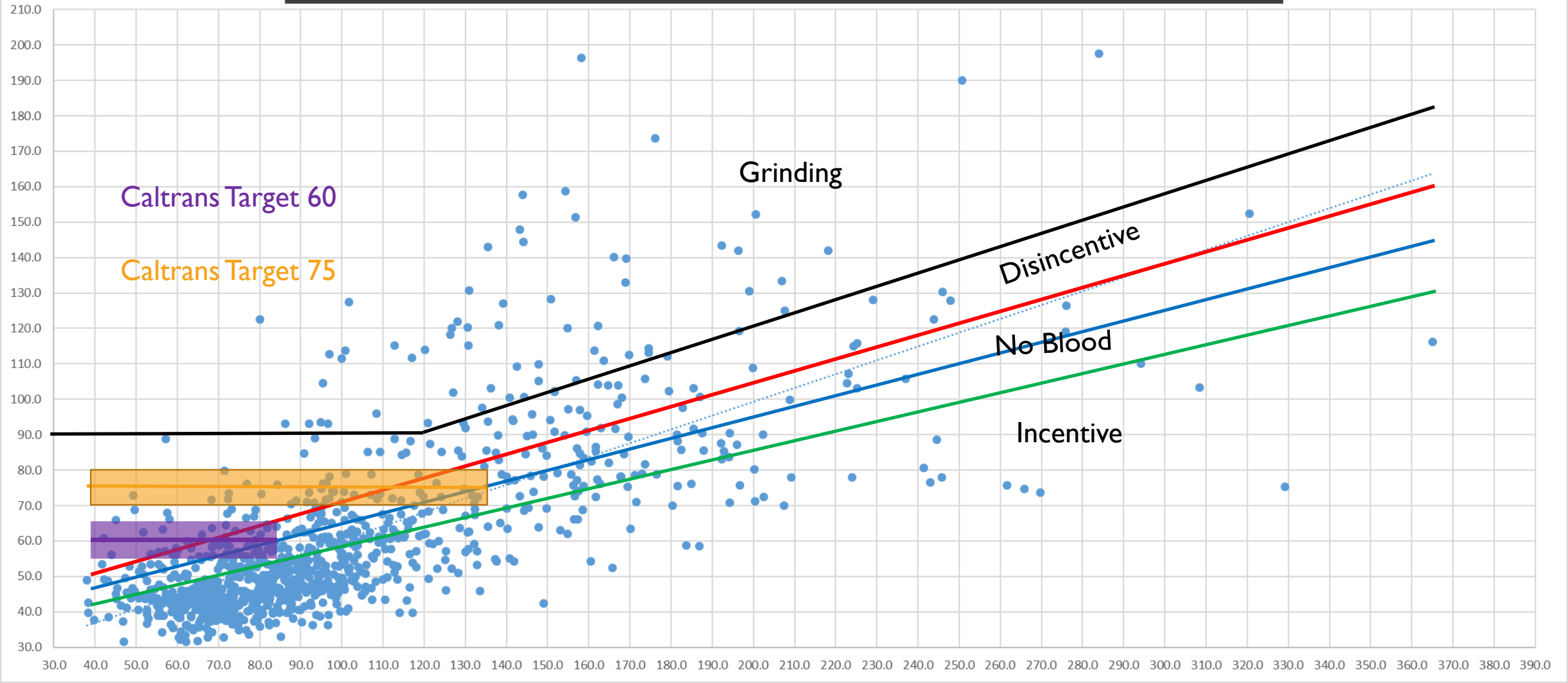
The roadway on the right will likely take much more effort then the left

SUMMARY OF 12 COMPLETED PROJECTS

	Data Pts	Ave. % Imp.	Exist MRI	HMA Pave MRI	% Imp.	< 60	60's	70's	80's	90's	100	110-135	136-150	150-200	201-250	>250
0.15' HMA-A / 0.33' CIR	33	34.1	77.0	48.7	36.8%	-4%	30%	34%	45%	49%	57%			59%		
0.15' HMA-A / 0.33' CIR	39	39.3	95.1	57.0	40.1%			37%	33%	38%	46%	50%		51%		
0.15' HMA-A / 0.33' CIR	150	40.8	87.3	50.6	42.0%		37%	36%	42%	41%	47%	51%		51%	67%	
0.10' RHMA-G / 0.33'CIR	53	40.6	121.2	70.1	42.2%				29%	30%	36%	43%	44%	54%	67%	
CIR TotalsAverage	**275**	**38.7**	**93.7**	**55.0**	**41.3%**	**-4%**	**35%**	**36%**	**40%**	**39%**	**43%**	**45%**	**44%**	**53%**	**67%**	
0.1' CP w/ 0.1' RHMA-G OL	46	39.5	125.4	73.1	41.7%		7%	-1%	38%	31%	44%	45%	43%	45%	51%	
0.1' CP w/ 0.1' RHMA-G OL	96	38.5	160.0	93.2	41.8%				-15%	5%	4%	20%	30%	47%	54%	72%
0.1' CP w/ 0.1' RHMA-G OL	294	38.7	82.3	48.0	41.7%	2%	35%	39%	44%	48%	49%	53%	58%	55%		
0.35' CP w/ two lifts same shift	7	35.6	81.4	51.3	37.0%			30%	45%		57%					
020' CP w/ 0.1' HMA	44	40.8	203.4	111.6	45.1%						26%	19%	20%	34%	51%	56%
Mill and Fill Totals	**487**	**38.6**	**112.6**	**65.0**	**42.3%**	**2%**	**34%**	**38%**	**42%**	**42%**	**44%**	**38%**	**36%**	**46%**	**52%**	**59%**
Bonded Wearing Course	70	35.1	112.7	73.4	34.9%		38%	30%	39%	33%	33%	42%	38%	24%	44%	
Bonded Wearing Course	109	19.1	66.4	51.3	22.7%	11%	22%	29%	32%	31%	11%	44%	52%			
HMA	54	40.7	93.6	53.9	42.4%	17%	36%	33%	37%	43%	43%	55%	61%	50%		
BWC and 2nd Lift Paving Total	**233**	**31.6**	**86.6**	**58.6**	**32.3%**	**11%**	**27%**	**31%**	**36%**	**36%**	**34%**	**46%**	**42%**	**33%**	**44%**	

Existing MRI	< 55	55.1 - 60	60.1 - 65	65.1- 70	70.1 - 75	75.1- 80	80.1- 85	85.1- 90	90.1- 95	95.1- 100	101.1 -110	110.1 -120	120.1 -130	130.1 -140	140.1 -150	150.1 -175	175.1 -200	200.1 -250	>250
All Projects	1%	15%	31%	34%	33%	38%	39%	42%	40%	40%	41%	44%	39%	39%	40%	42%	49%	54%	62%

% IMPROVEMENT



Where We Are Now:

A) Two Lifts Overlay and MRI_0 <165 in/mi or New Construction

Target 60 Pay Adjustment

MRI_{seg}(in/mi)	Pay Adjustment/0.1 mi	Corrective Action
≤ 45.00	+ $900.00	None
45.01 – 55.00	+ ((55.00 – MRI_{seg}) x $90.00)	None
55.01 - 65.00	**Full Pay**	None
65.01 – 80.00	- ((MRI_{seg} – 65.00) x $190.00)	Optional
> 80.00	Not Applicable	Mandatory

B) One Overlay and MRI_0 <135 in/mi

Target 75 Pay Adjustment

MRI_{segt}(in/mi)	Pay Adjustment/0.1 mi	Corrective Action
≤ 60.00	+ $450.00	None
60.01 –70.00	+ ((70.00 – MRI_{seg}) x $45.00)	None
70.01 - 80.00	**Full Pay ($0.00)**	None
80.01 – 90.00	- ((MRI_{seg} – 80.00) x $135.00)	Optional
> 90.00	Not Applicable	Mandatory

Does Not Meet A or B Go To C – Percent Improvement

C) % Improvement

Calculate Target MRI of Finished HMA Based Upon MRI_0

1 opportunity: $MRI_t = 0.3 \times MRI_o + 35$ or 60 (whichever is greater)

Opportunities:

- Single Lift of Asphalt (Overlay)
- Micro Milling or Cold planing Not in the Same Shift as the Paving
- Mill and Fill in the Same Shift

In Incentives When Final Paved Surface MRI is 90% or Lower Than Target MRI

In Disincentives When Final Paved Surface MRI is 110% or Higher Than Target MRI

Mandatory Correction @ 90 MRI or 125% of Target Whichever Is Greater

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IN THIS ISSUE

Caltrans releases long-awaited guidance on HMA pavement smoothness relief for existing projects

CalAPA 'citizen lobbyists' walk the halls of the Capitol to promote transportation

A gathering of bright minds, bright ideas at the 12th

Dear Don,

This weekly bulletin contains the latest news and information of interest to the asphalt pavement industry in California. Please feel free to distribute this newsletter to others who may be interested in asphalt pavements.

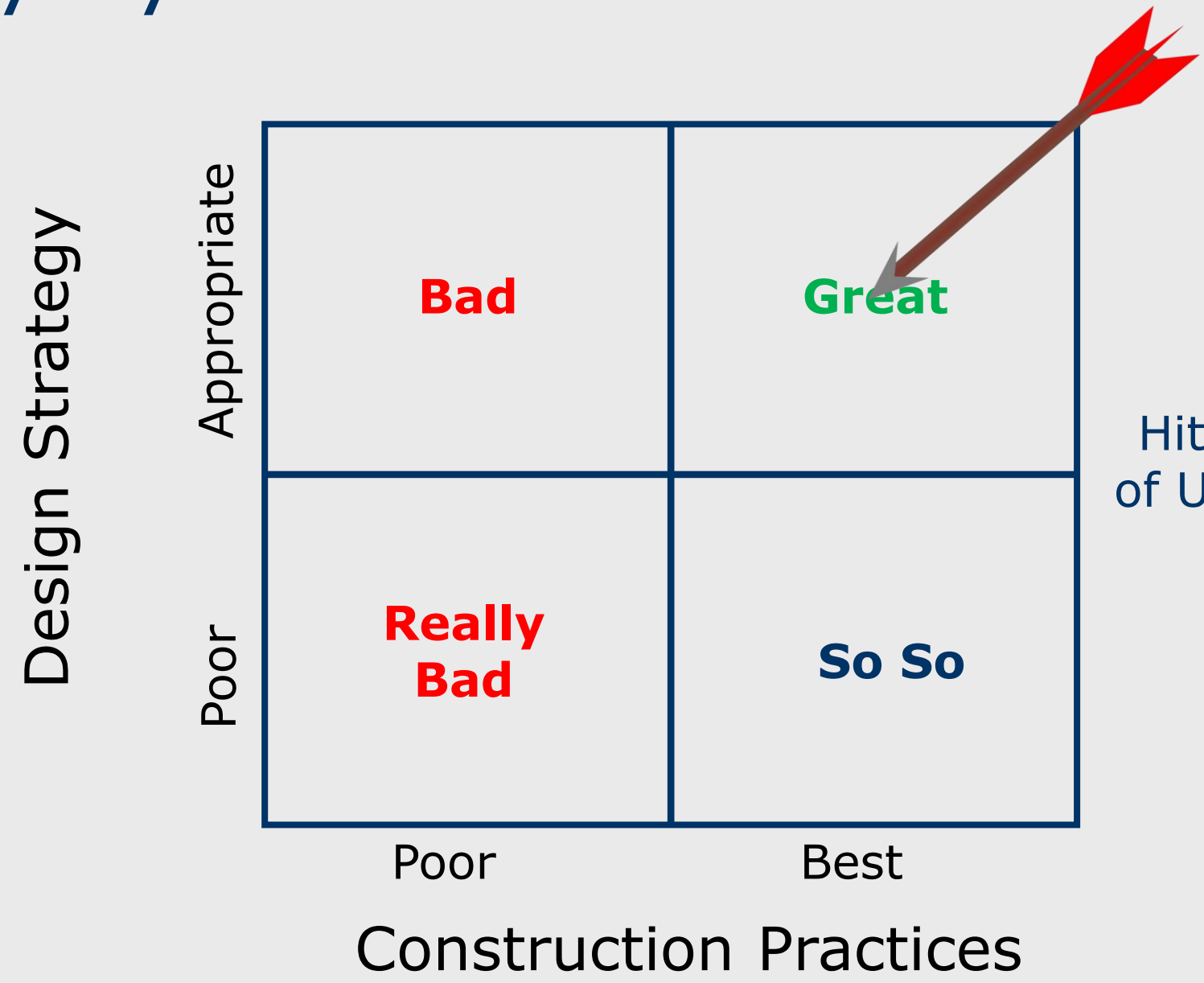
Caltrans releases long-awaited guidance on HMA pavement smoothness relief for existing projects

The California Department of Transportation (Caltrans) last week released its long-awaited guidance to Caltrans engineers that makes major changes to its pavement smoothness specifications for existing asphalt pavement projects.

The Construction Procedure Directive (CPD 19-6), dated March 4, 2019, was posted on the Caltrans website and can be viewed HERE. The various supporting documents can be found HERE.

Bob Finney, acting chief of the Division of Construction, signed the

Antonymy of the Smoothness of a Roadway



Hitting Here is What All of Us Owe the Tax Payers

Goals for Today's Presentation

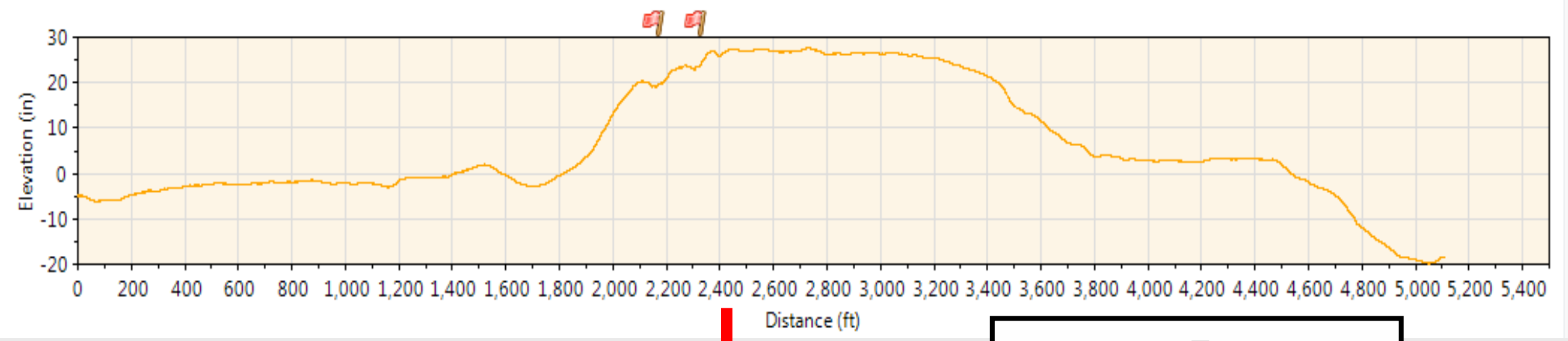
- Review Smoothness Terminology
- Review Issues on Projects for Smoothness
- Brief Overview of 2D and 3D Technology
- Come to the Only Logical Solution to Obtain Smoothness

Terminology Overview - International Roughness Index (IRI)

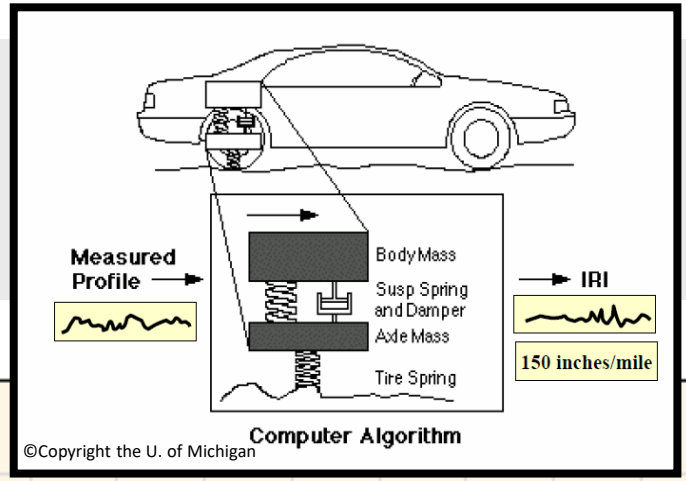
IRI is a smoothness value obtained by processing a profile through the ProVAL computer program (algorithm)

It is based on a golden car (representing 70% of vehicles)

It analyzes roughness inputs in a single wheel path



ProVAL



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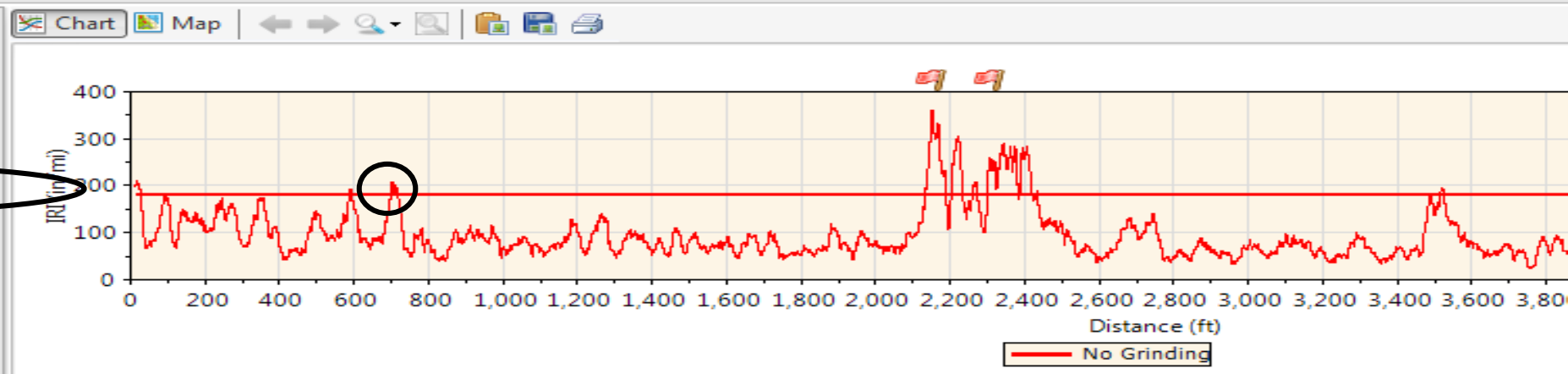
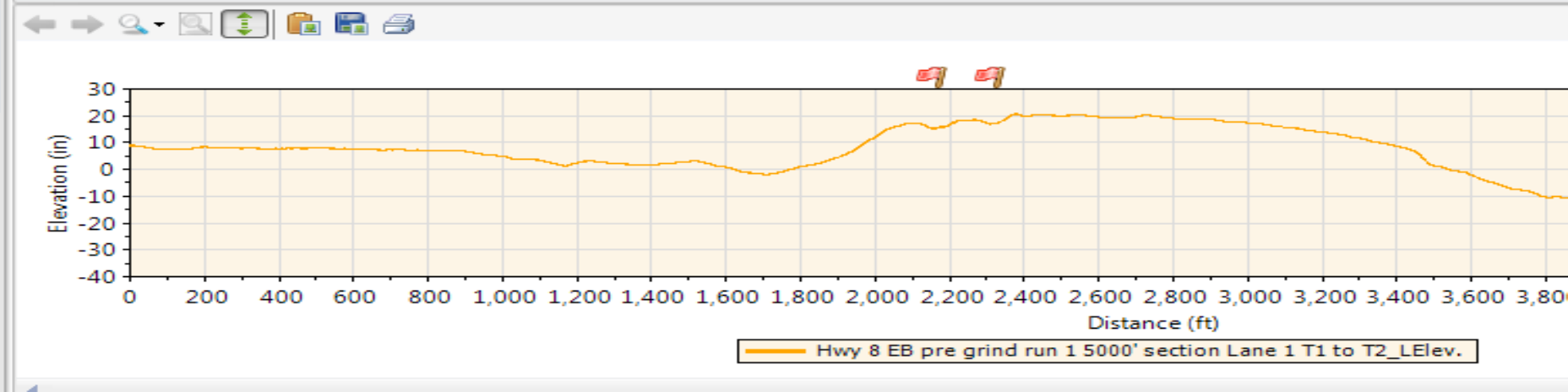
Areas of Localized Roughness (ALR)

ALRs are individual roughness locations (caused by **bumps or dips**) where the IRI of the existing surface exceeds a specified IRI level. It is expressed by peak IRI value

Smoothness Assurance: Short Continuous

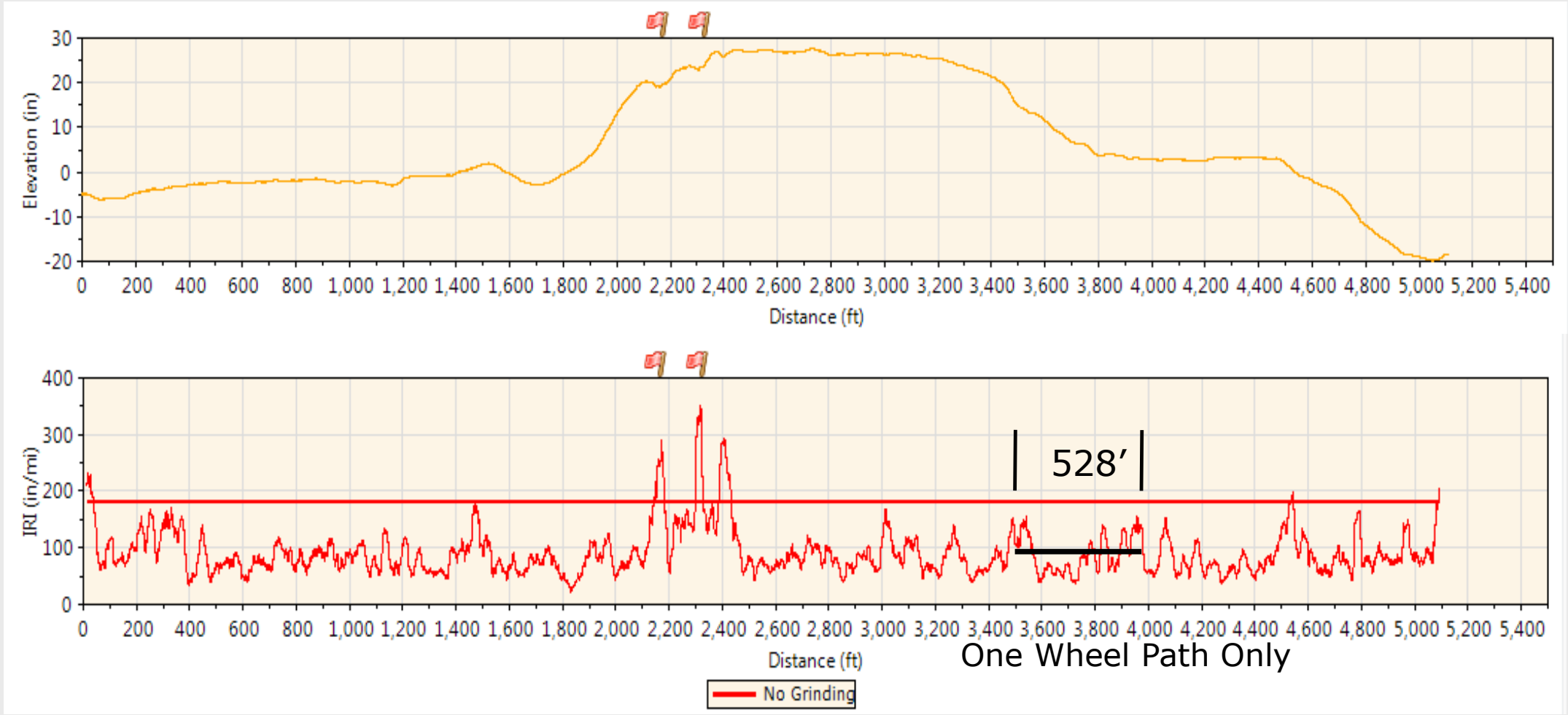
Start Distance (ft)	Stop Distance (ft)	IRI (in/mi)
12.50	27.42	211.09
91.00	92.08	181.50
586.17	594.33	193.71
698.25	708.17	206.28
708.33	718.58	201.61
2,131.75	2,189.25	359.71
2,202.08	2,232.58	304.13
2,259.17	2,272.67	207.17
2,298.75	2,383.17	290.35
2,386.25	2,419.67	283.26
2,427.25	2,428.08	180.91
2,431.92	2,434.75	189.31
3,490.58	3,491.67	181.01
3,515.50	3,525.25	195.88
4,570.42	4,581.67	202.98
5,043.67	5,092.83	316.40





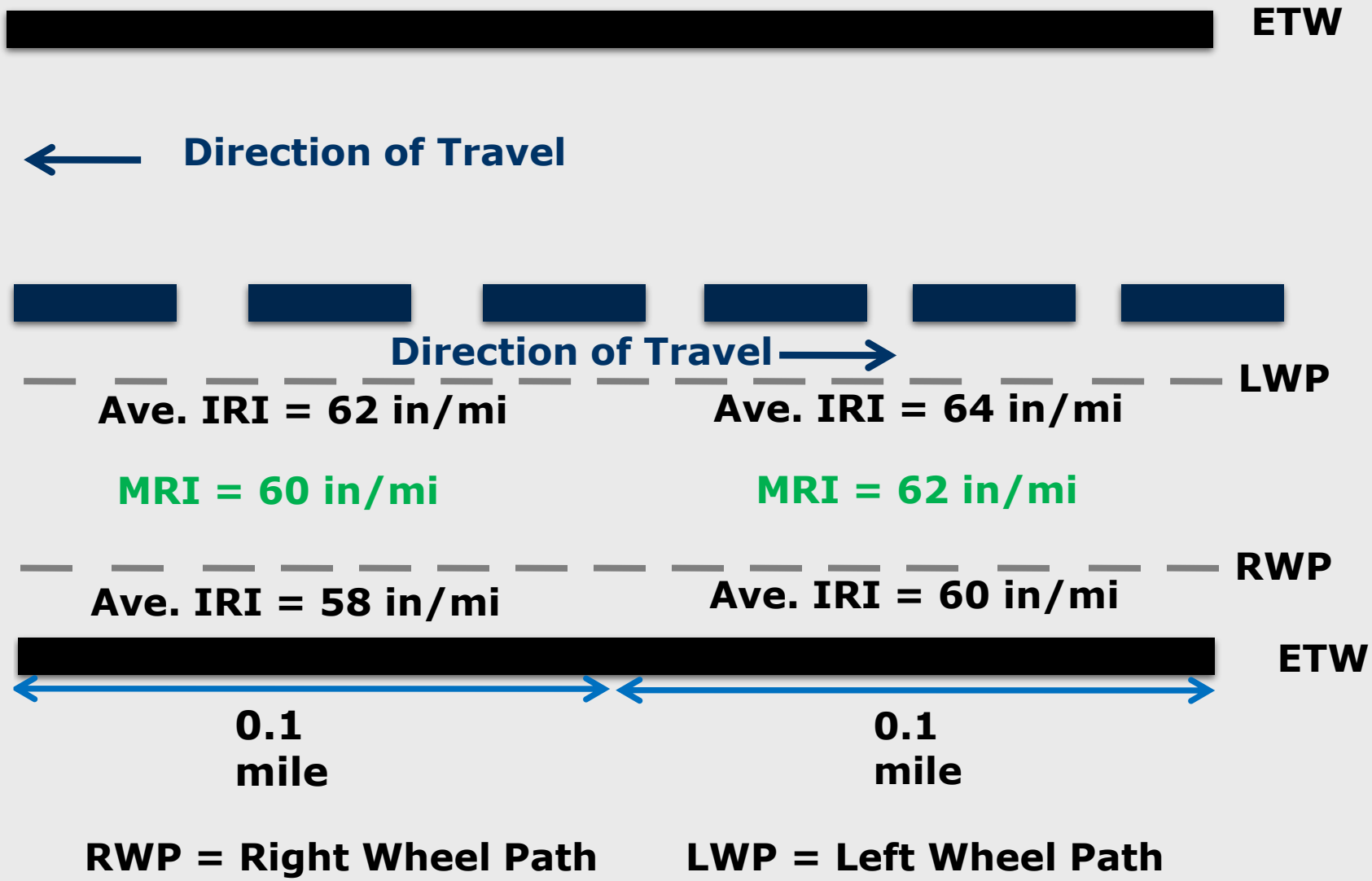
Mean Roughness Index (MRI)

MRI is the average of the IRIs from the left and right wheel paths over a 0.1 mile (528) section of a lane



One Wheel Path Only

Definitions –MRI



Terminology - This is NOT a Grinder

This is a:

- Cold Planer
- Mill
- Cold Mill

It typically has conical carbide tipped cutting tools (teeth)
Therefore prohibited by most specifications for final surfaces

It can have diamond tipped tools. A few have flat teeth

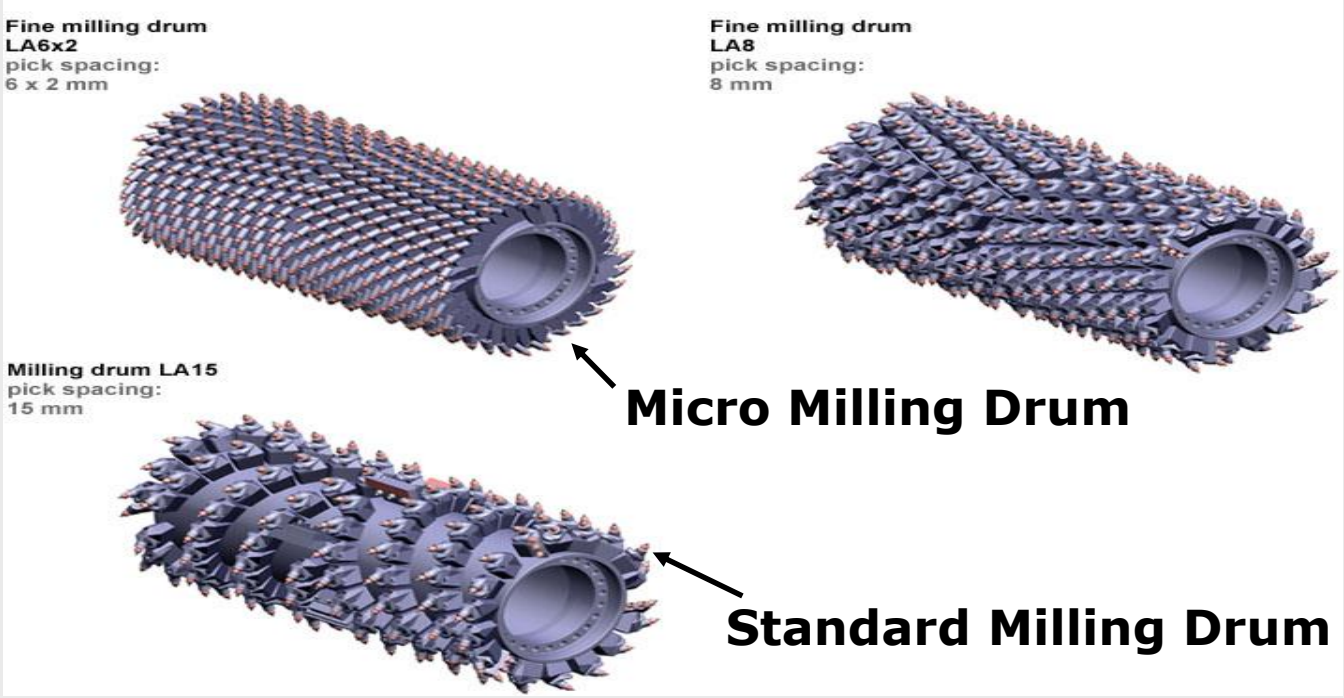
Its head height can change continuously based on a referencing system or automated machine control system

Micro Mill vs Standard Cold Planer

Smooth surfaces can be obtained with a standard cold planer

A micro mill finer tool pattern provides:

- Less raveling of exposed aggregate from traffic
- Smaller ridges and valleys for less cover needed
- Better surface control for smaller removals
- Less surface impact due to teeth wear

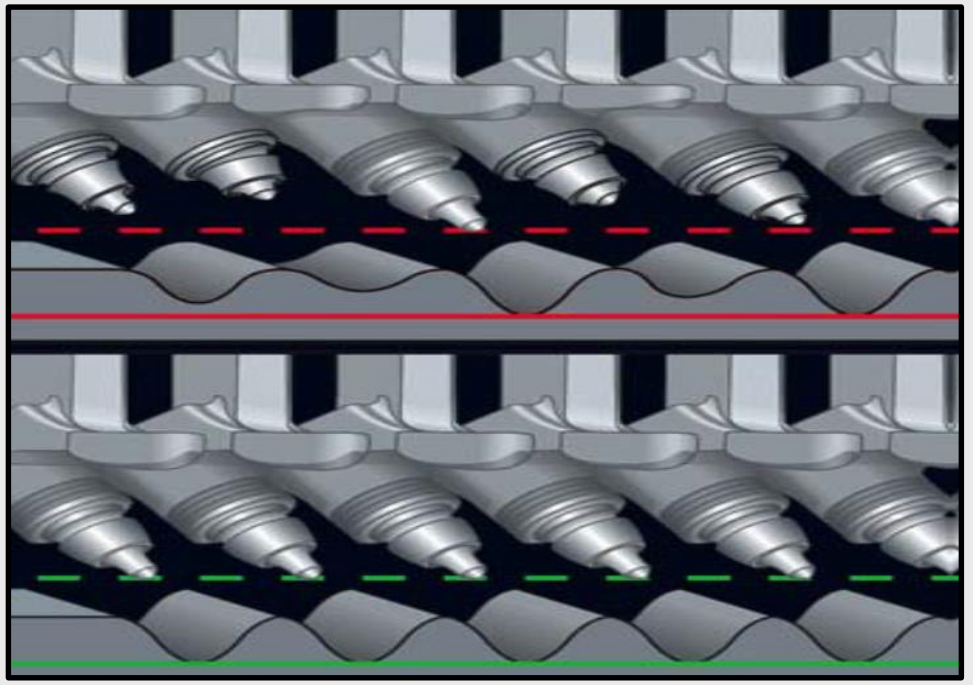


Micro Milled Surface

Standard Milled Surface

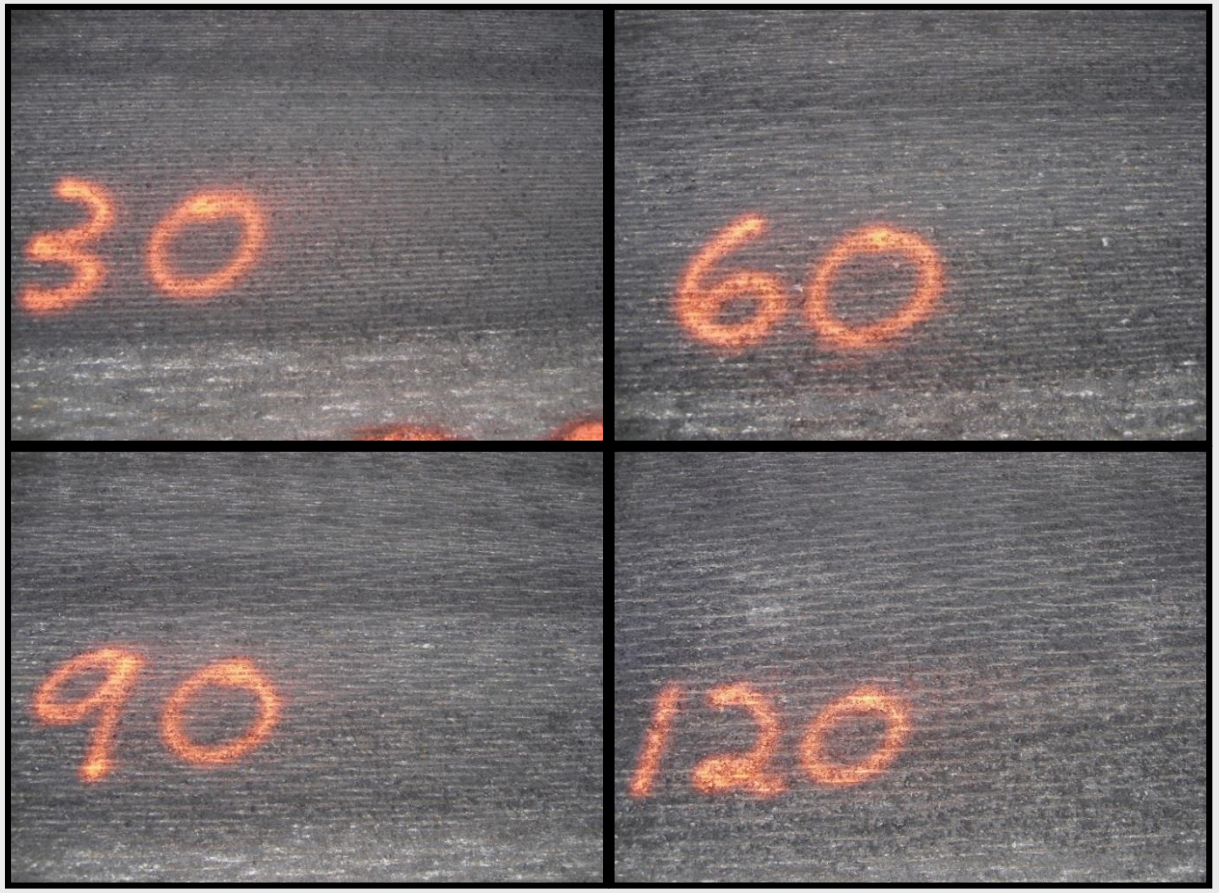
In All Cold Planing Best Practices Must Be Followed:

Transitions into and out of cuts must be smooth
The milled surface must be cleaned well
The drum must not be stopped while still in the cut
The mill's mechanical systems must be maintained
The cutting tools and blocks must be maintained and/or replaced as needed



Appropriate Continuous Speeds Must be Maintained

Do not out run the pattern – The texture changes as speed increases. Don’t overrun averaging system



It may not be about production!!

Terminology - This is a Diamond Grinder

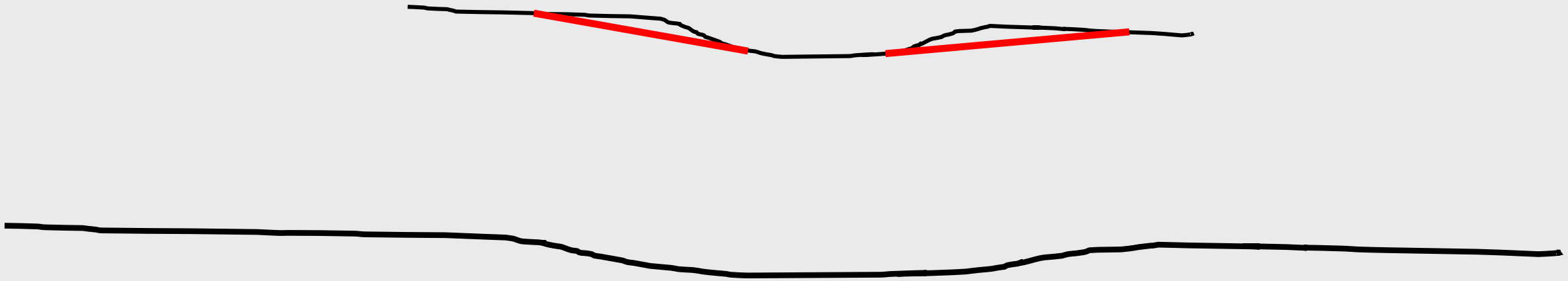
Is a “rigid” frame planer equipped with diamond tipped blades

Head height is set and fixed to the position of the front and rear wheels

Gives a smooth finish surface. Good for final surface corrections

Should Remove High Spots

Correcting a Dip



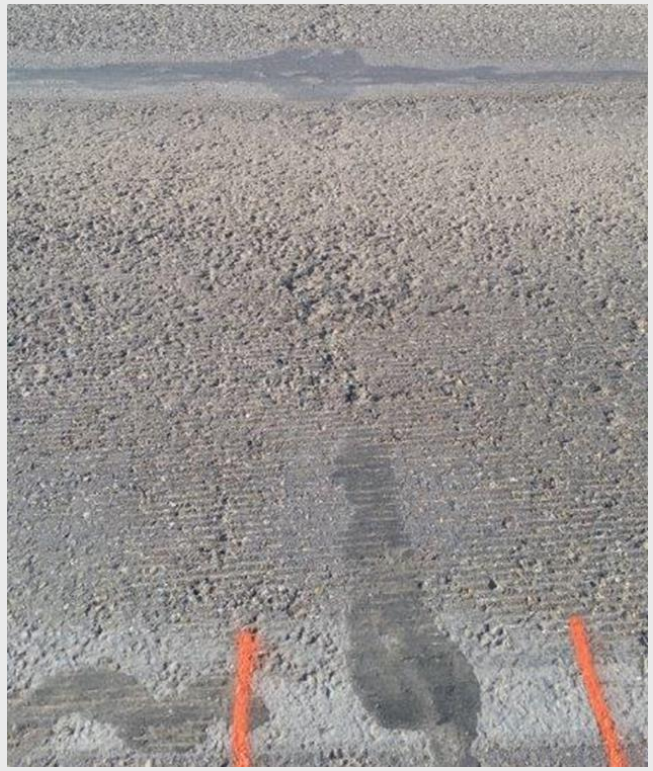
Diamond Grinding or Cold Planing Corrections Can Only Do So Much

Can only go deeper or wider

Can’t fix a pavement or subgrade

WORKING CRACKS – Respond Dynamically to Vehicles, Including Inertial Profiler

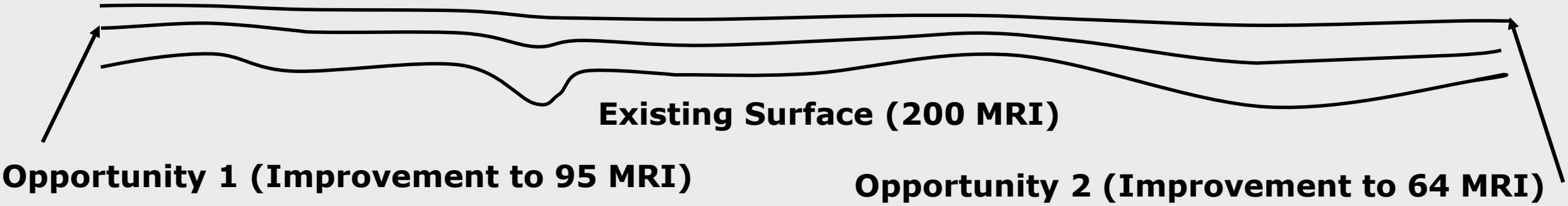
Working – Not correctible by grinding or cold planing



Non Working – Likely correctible by grinding or cold planing

Definitions of Opportunities and Referencing

Must Be Variable Depth



Reasonable Expected Improvement Values For One Smoothness Opportunity

Existing Surface MRI (in/mi)	New Surface MRI (in/mi)
300	125
200	95
150	80
135	75
100	65
85	60

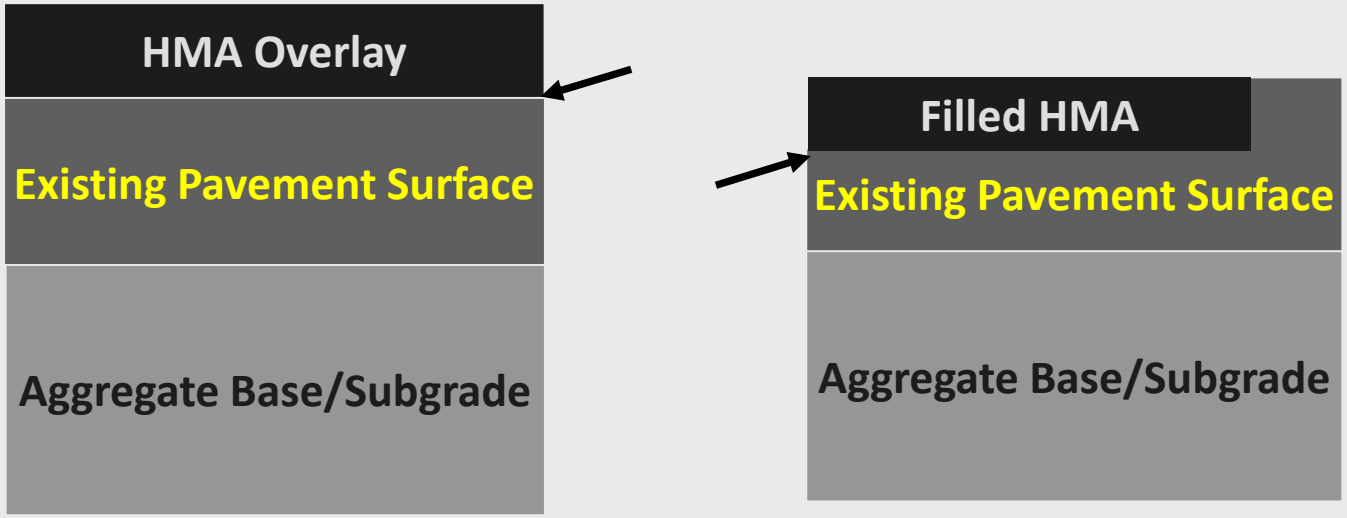
The Equation:

$$MRI_{Expected} = 0.30 \times MRI_{Existing} + 35$$

“Smoothness Opportunities” in HMA

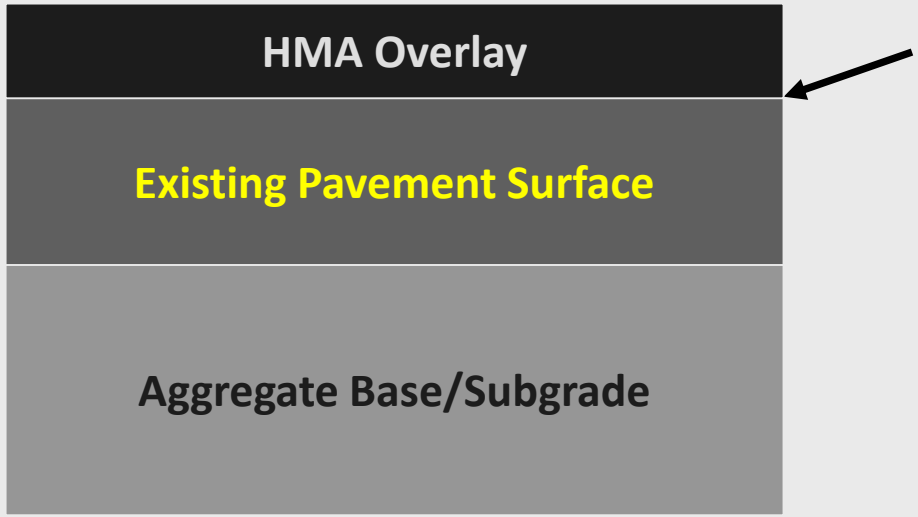
Pre-pave Corrections

Cold Planing
(Mill and Fill)



Pre-Pave Corrections

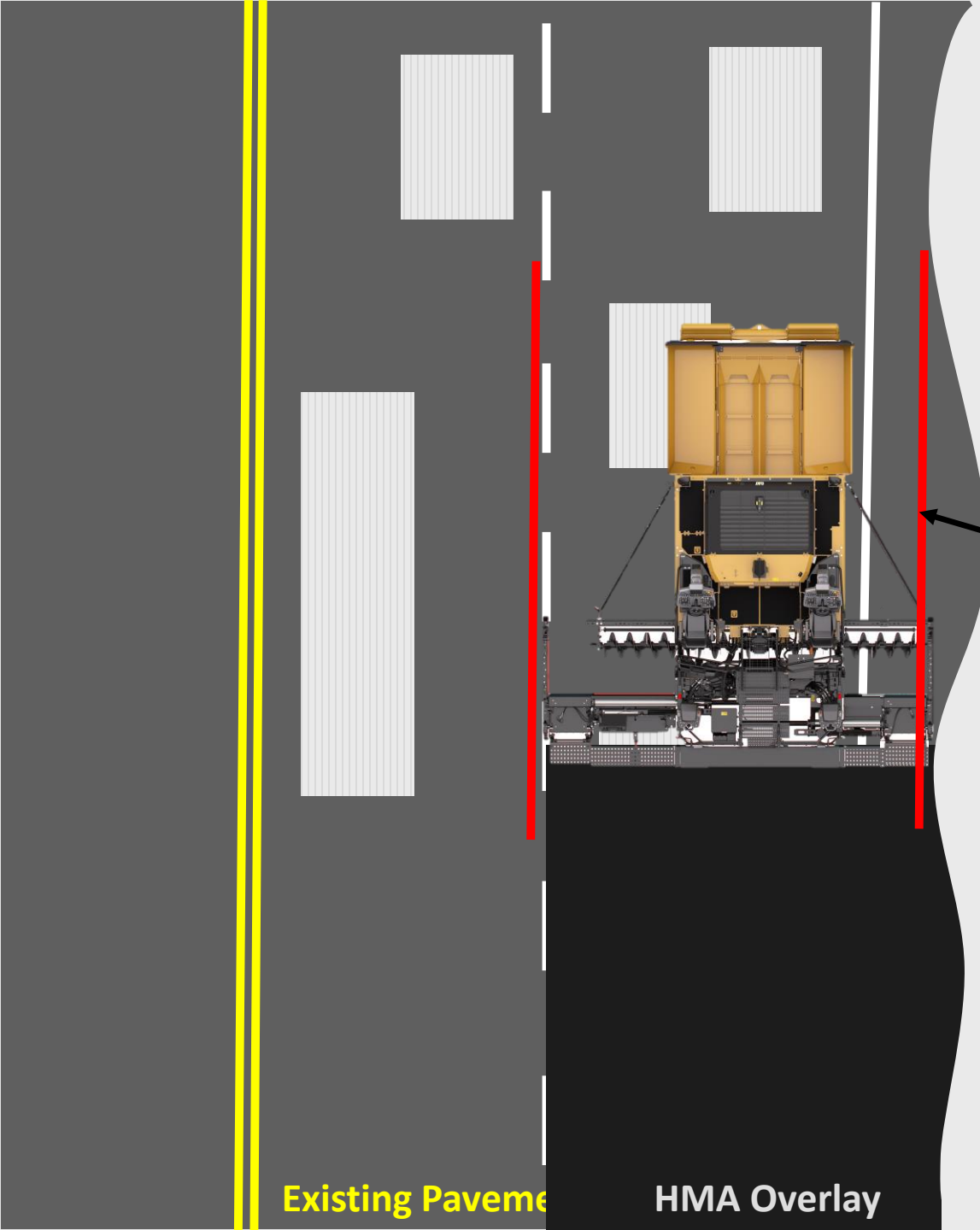
Existing Asphalt Surface Prior to Overlay



Pre-Pave Correction Should be a Smoothness Opportunity

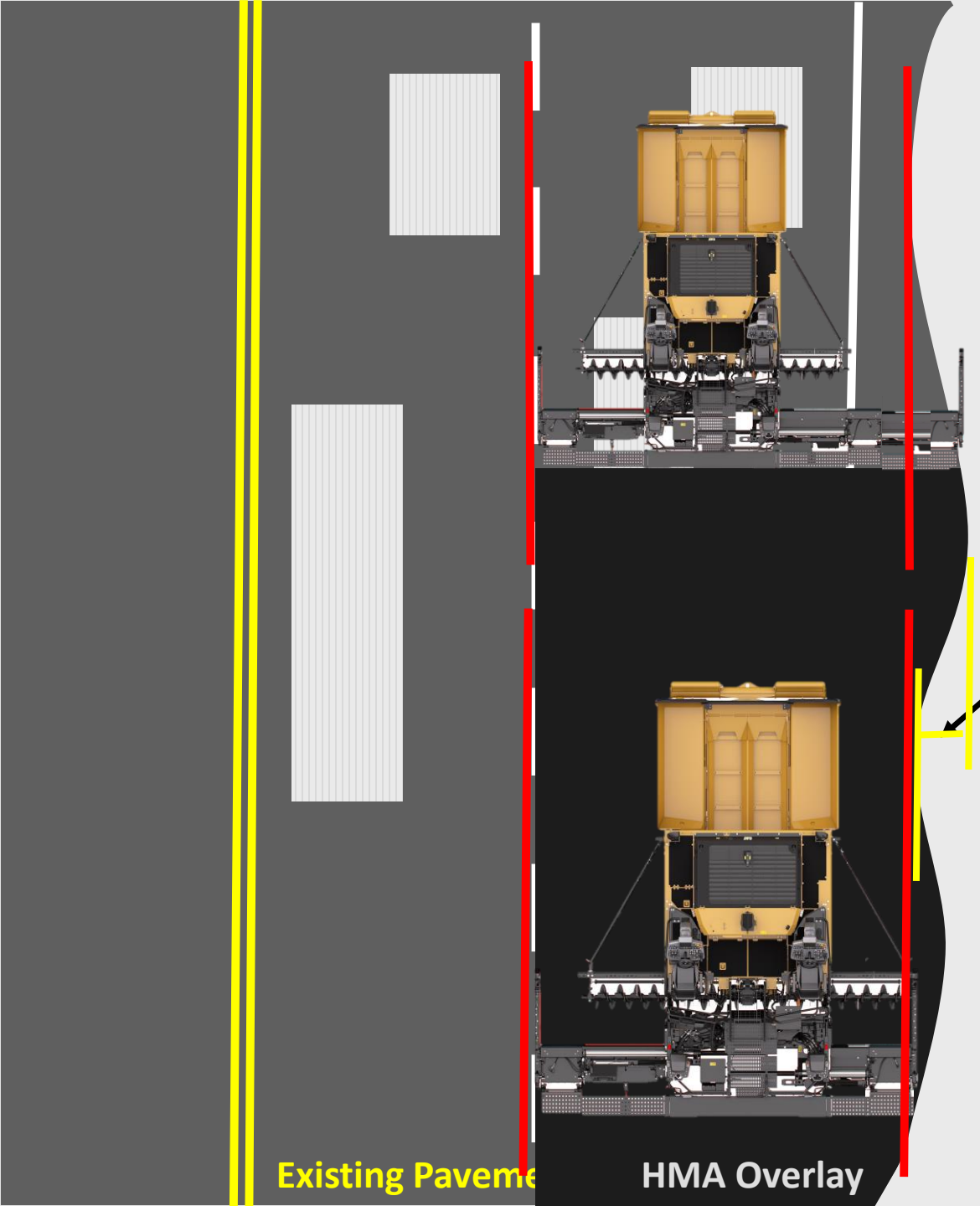
But is it?

Pre Pave Correction With Overlay Example



Referencing system not using pre pave corrections – Using rougher shoulder and not corrected pavement

Correct with micro mill in the referencing locations



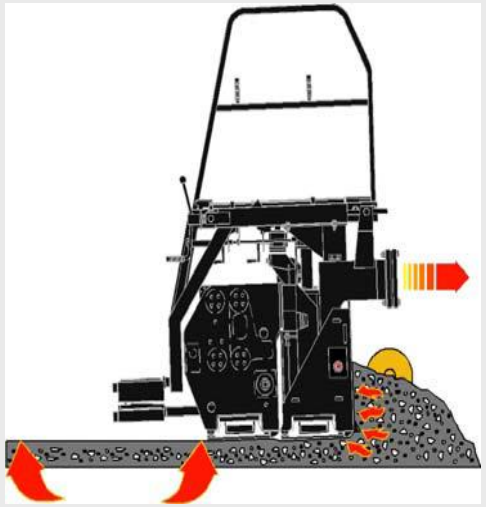
Variable Width Paving

Variable width paving causes a change to the head of material against the screed

Difficult to produce a level, smooth pavement surface if the head of material fluctuates against the screed

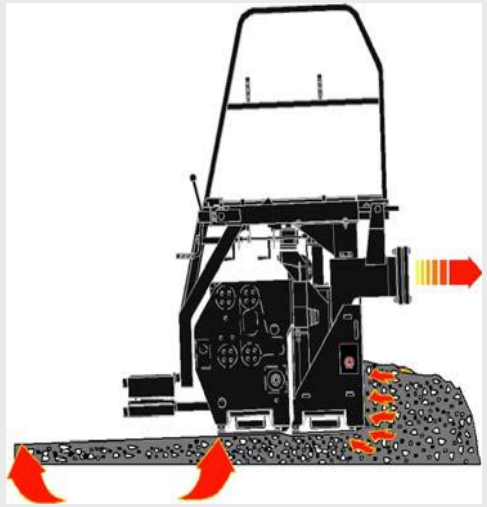
Head of Material in Front of the Screed

Screed will change its height (relative position) due to the resistance from the head of material in the auger chamber



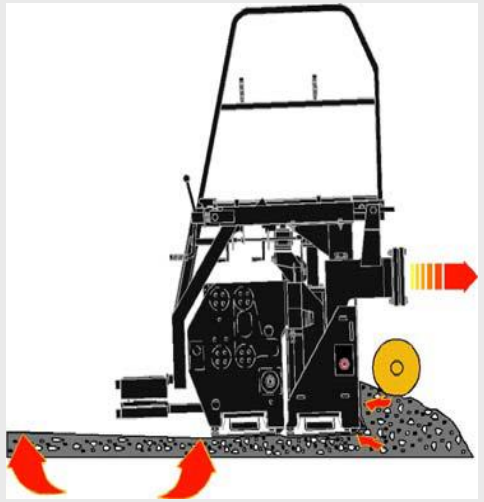
Constant Head of Material

- **Half auger level**
- **Constant resistance**
- **Constant depth**



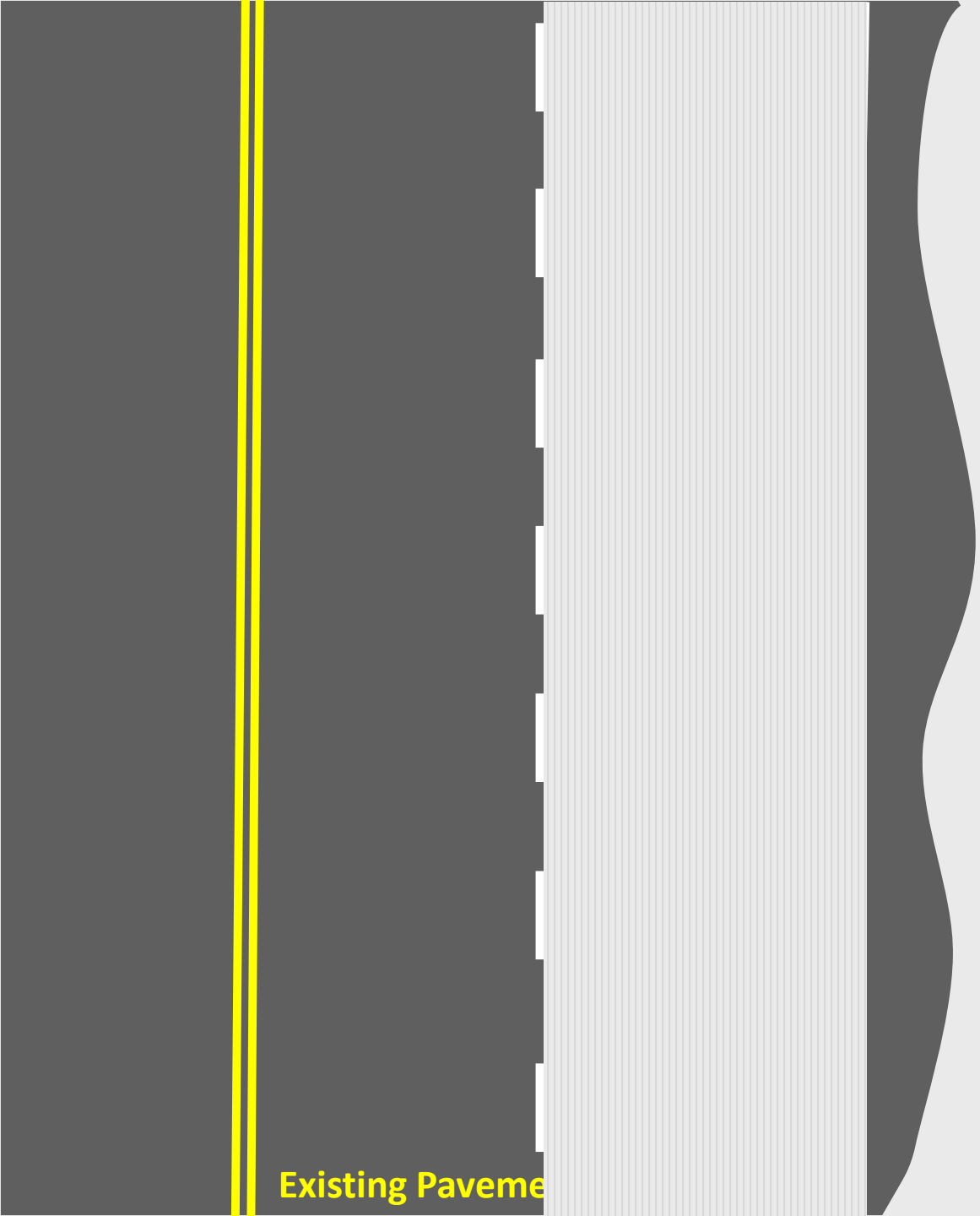
Increased Head of Material

- **Increased height**
- **Resistance increased**
- **Depth increases**



Decreased Head of Material

- **Decreased height**
- **Resistance decreased**
- **Depth decreases**



Cold Planing as an Opportunity

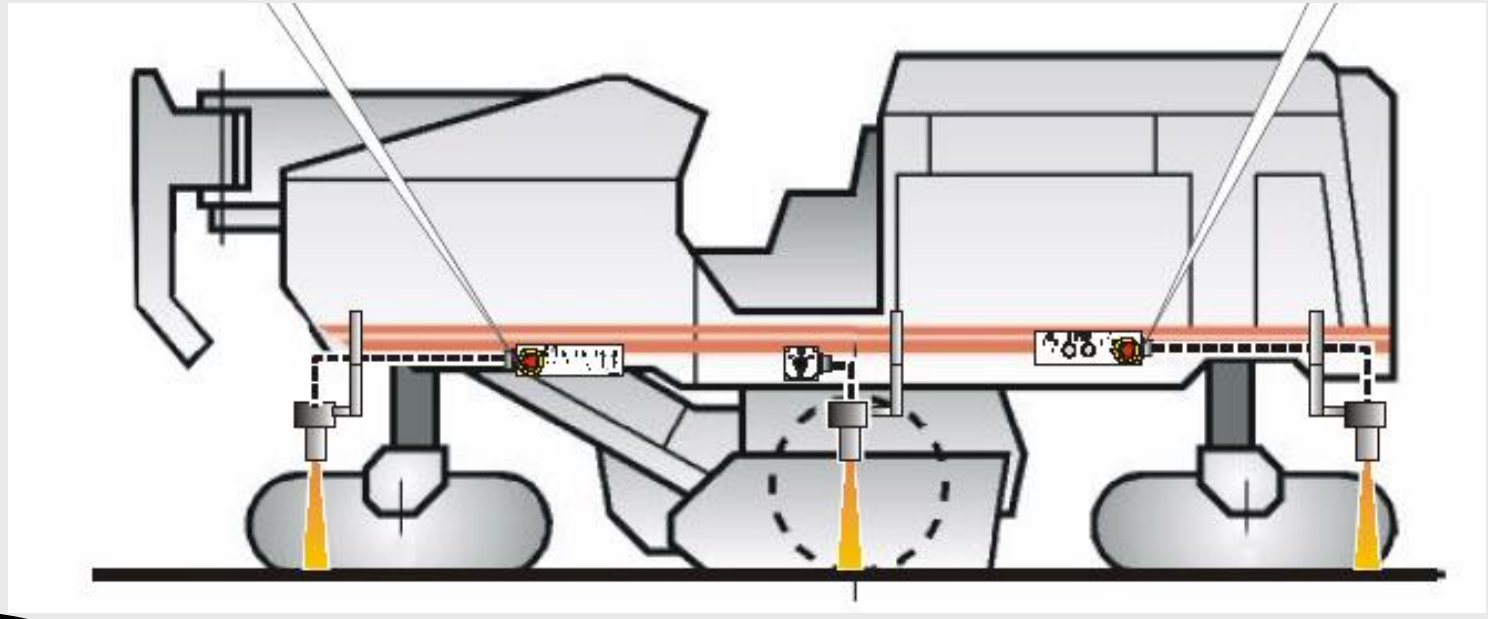
Is Cold Planing a Smoothness Opportunity?

Maybe

Variable Depth Cold Planing Must be Used

Constant depth will transfer the roughness to the bottom of the cold planed surface

Good averaging systems should be used when cold planing the existing surface

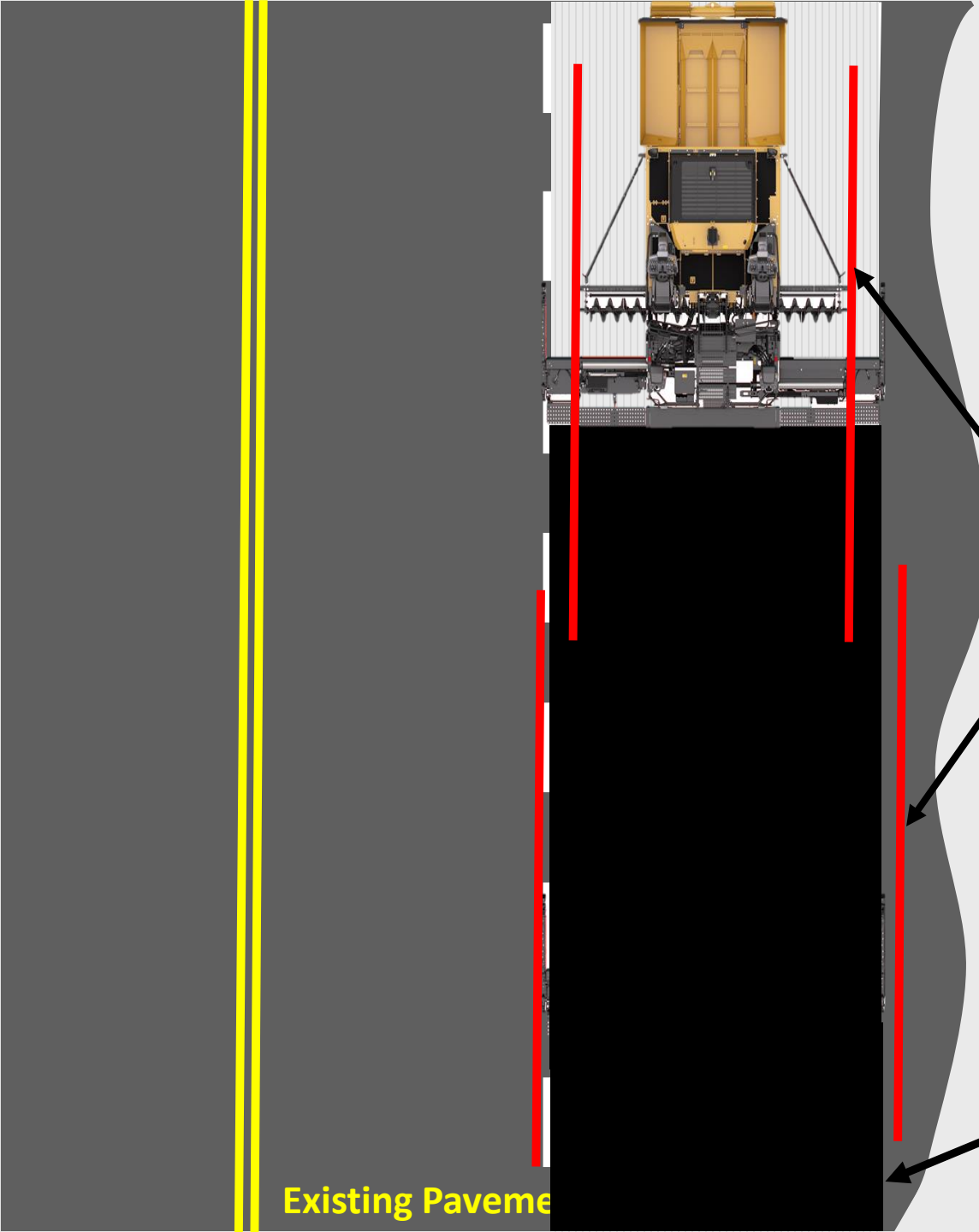


2D Averaging - Sufficient for the Majority of Applications if an Effective Correction Strategy is Designed

For 2D Averaging, Referencing Is Important!

Need to Find Smoothest Referencing Surface Available

Cold Planing Could be an Opportunity



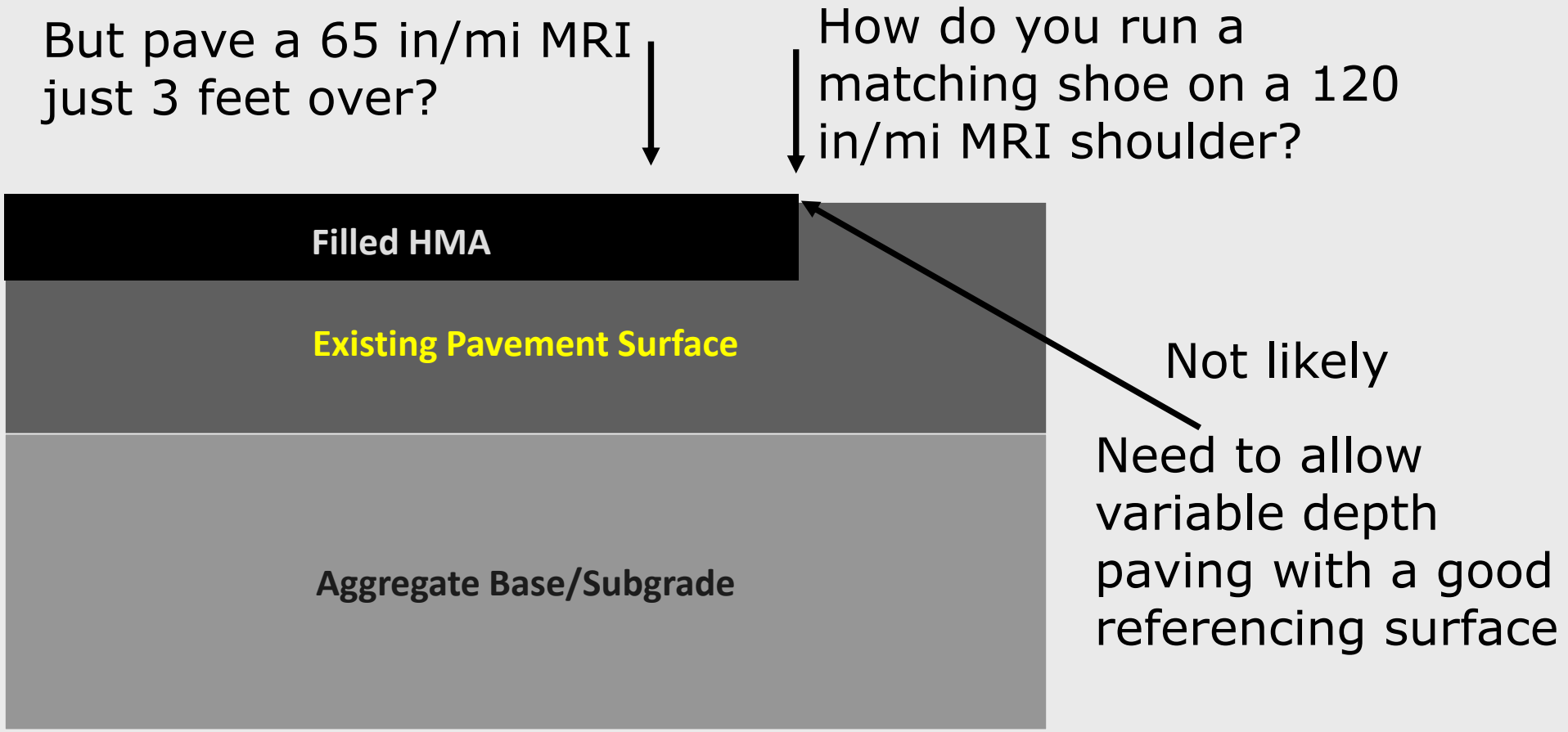
But not if the paver does not use it for 2D referencing

Paver 2D referencing needs to be on cold planed surface if smoother

Must also consider matching constraints

May Need to Set Up Referencing System Differently

Matching Constraints and Challenges with Smoothness



In Some Instances Cold Planing May Not Improve Smoothness

Highway Project

4” Mill Depth

Made Worse in Many Cases

Pre Milling MRI (in/mi)		Post Milling MRI (in/mi)	Change in MRI	% Change
127		96	31.2	25%
120		98	21.6	18%
74		77	-2.4	-3%
95		94	1.5	2%
83		145	-61.9	-75%
96		101	-4.8	-5%
77		99	-22.7	-29%
88		114	-26.7	-31%
80		128	-48.1	-60%
78		118	-40.0	-52%
86		88	-2.1	-2%
64		112	-47.7	-74%
65		104	-39.0	-60%
90		123	-33.5	-37%
63		91	-27.8	-44%
72		97	-25.1	-35%
101		96	5.0	5%
79		110	-30.4	-38%
61		140	-78.8	-129%
61		113	-51.5	-84%
70		91	-21.2	-30%
71		105	-33.3	-47%
123		130	-7.0	-6%
72		125	-53.0	-74%
81		75	5.3	7%
77		107	-30.3	-40%
98		106	-8.2	-8%

Delamination

If delamination occurs, the cut depth must be increased

Paving over a delaminated surface can result in differential compaction

A delaminated surface will also provide a rough reference line for the paver

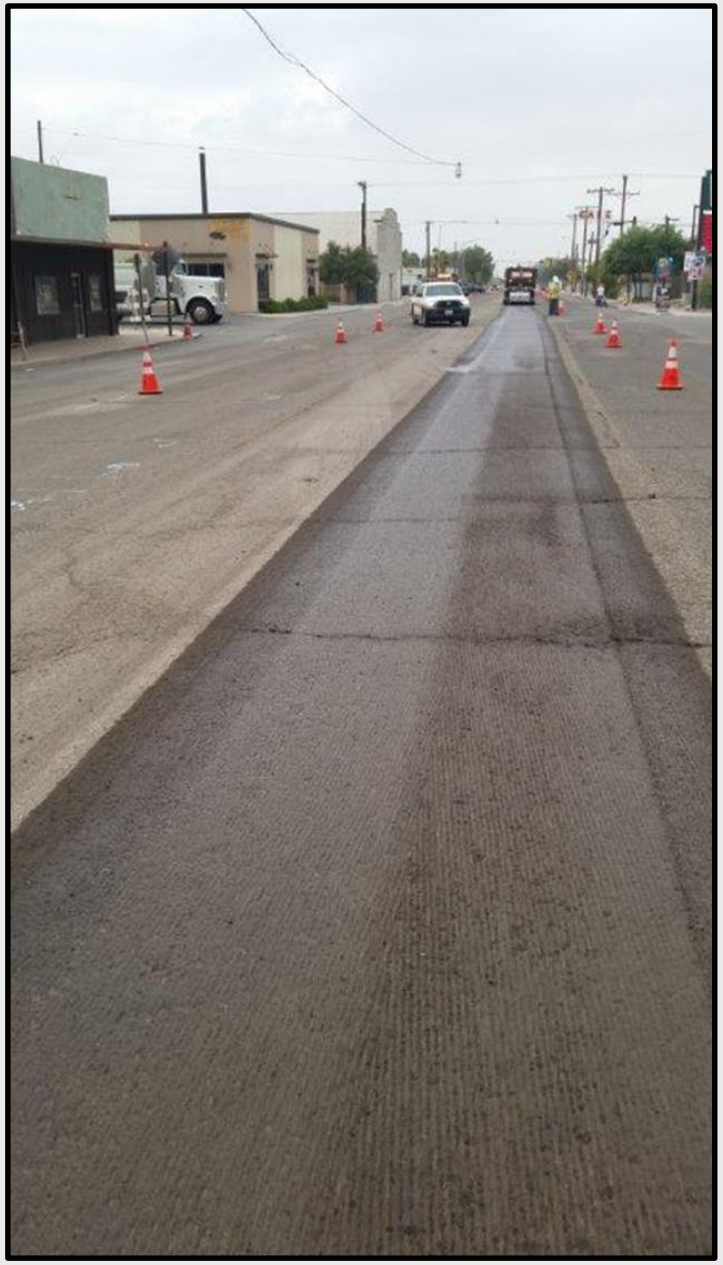
For 2D, Referencing Has a Major Impact on Smoothness

The longer and smoother the reference, the smoother the pavement

Variable depth thin cut ski runs for a cold planer or paver can be made if necessary

And Please! –
Once a good reference line is set, the equipment should be trusted!

Manual adjustment = ALR



Besides Referencing Consistency = Best Paving Practices

Consistency - Head of Material on Screed
Consistency - Paving Speed
Consistency - Mix Temperature

Check Your Crew Against a Reasonable Expectation Metric

- Mark Collection Start of Your IP Run Before Paving
- Determine MRI of the Existing Before Paving
- Determine MRI After Paving
- Compare Each 0.1 mile Section With the Equation

$$MRI_{Expected} = 0.30 \times MRI_{Existing} + 35$$

$$MRI_{Actual} < MRI_{Expected}$$

The Better Alternative:

3D Automated Machine Control

1) Total Station For New Construction or On Closed Sites With Precise Elevations

2) Topcon’s Smoothride for Rehabilitation Projects

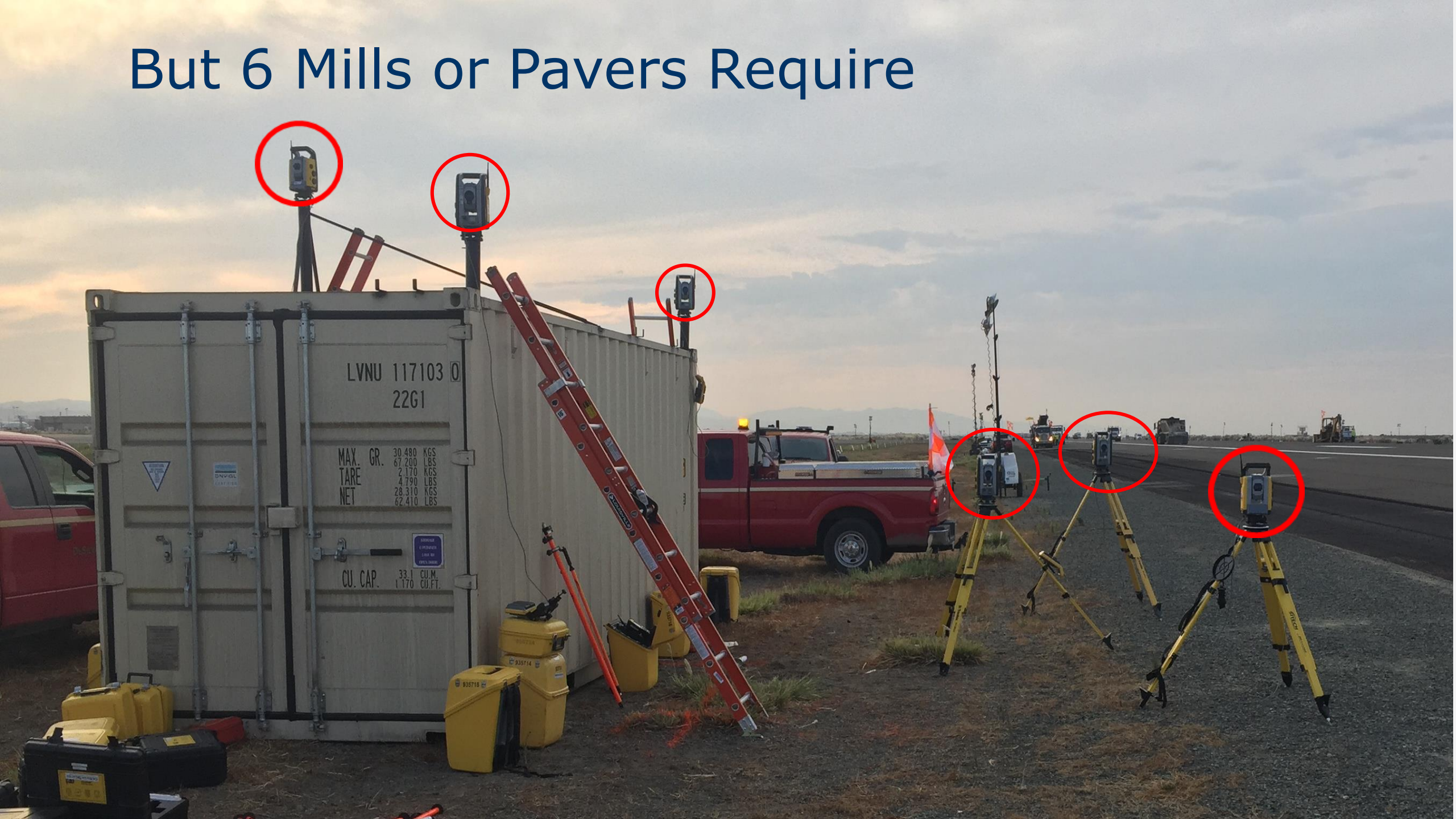
Total Station Machine Control

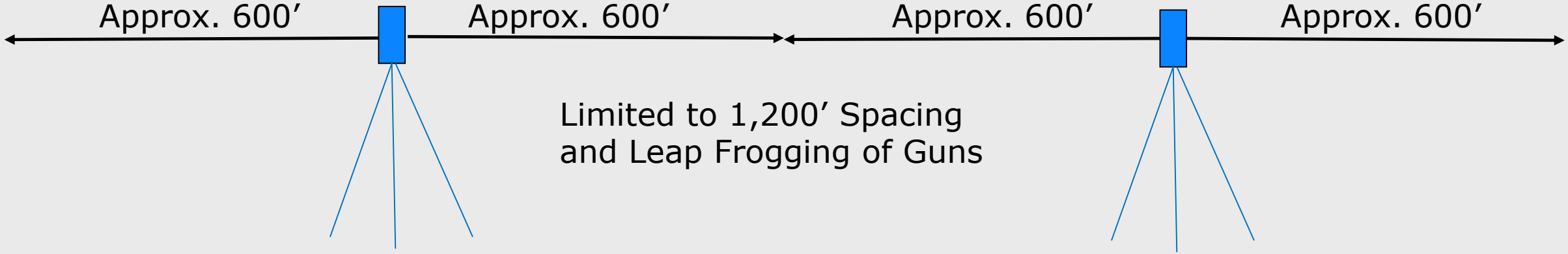
The Preferred Choice When Required to Cut to Specific Grades at Specific Elevations

Oakland Airport With 6 Automatic Machined Controlled Mills Working Simultaneously

Hit Multiple Precise Grade Changes

But 6 Mills or Pavers Require




Approx. 600’
Approx. 600’
Approx. 600’
Approx. 600’
Limited to 1,200’ Spacing
and Leap Frogging of Guns

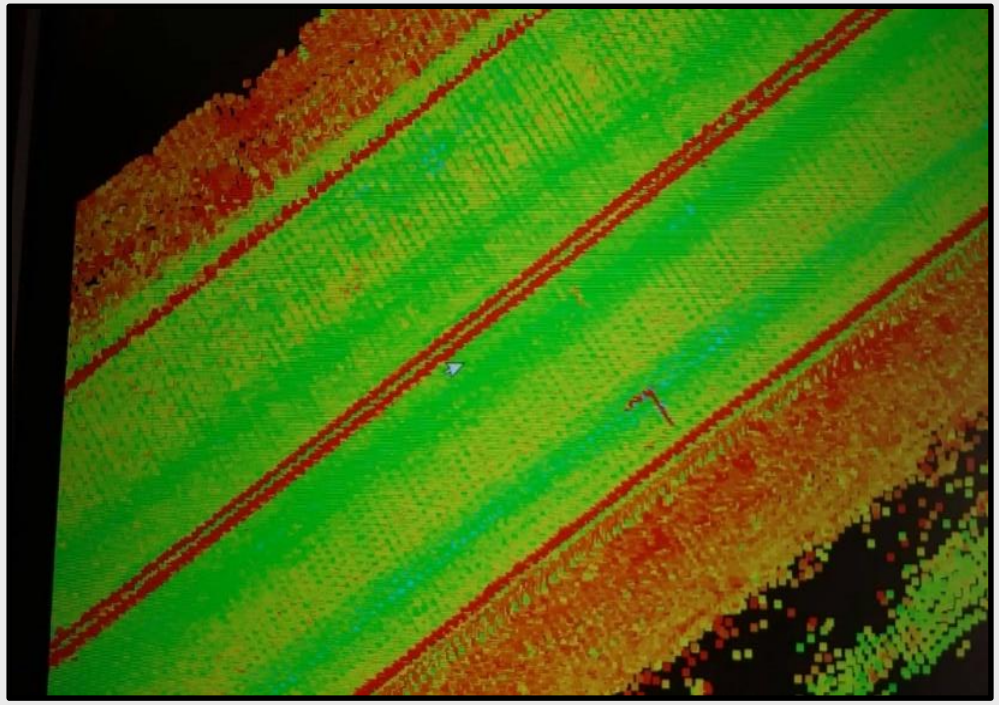
Total Station Modeling

Traffic control is typically required to take existing surface readings to build model

With one set of existing surface readings models can be made for control of the cold planer and multiple paving lifts

An Alternative 3D Solution for Rehab Projects

Relative Surface Scanning

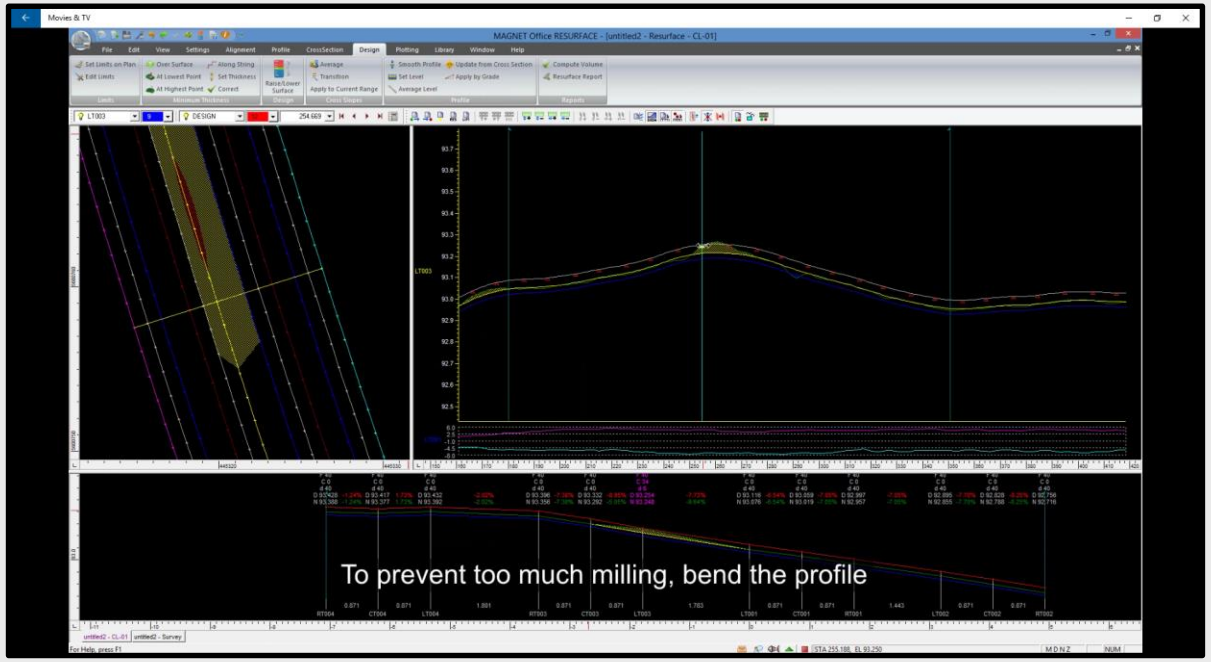


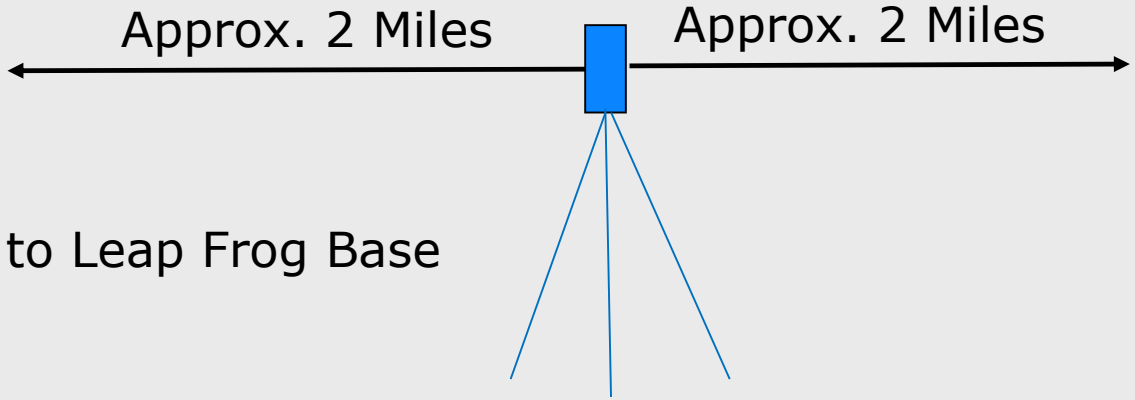
Uses GPS to Position Horizontally with Scanned Surface for Vertical Road Surface

Machine Control is Based Upon Relative Depth and Not Elevation

Traffic control is not required to take readings to build model

A new model is required for paving or if surface has changed at all



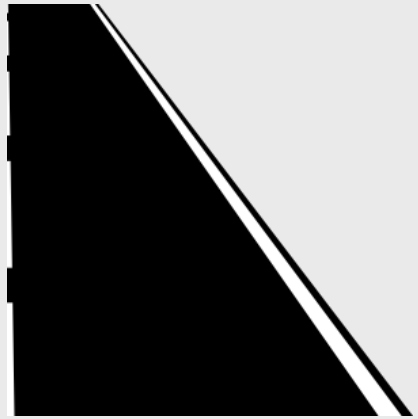


No Need to Leap Frog Base Station

Conclusion –
How To Get A Smooth Road

Agency -

Incorporate A Design Strategy Appropriate for Existing Roadway Conditions



Contractor -

Use Best Construction Practices

Agency + Contractor

Together

The Only Way to Get The Best Roadways!

Thank You!

Questions?

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(951) 232-7384

PREDICT PARTNER PERFORM