



Profilograph Operations

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October 1, 2000

Research Division Established

State Study No. 144

to

Improve MDOT's Current

Pavement Smoothness Procedures



Actual Profilograph Data

9.5 mm Surface Lift - May 2000

3.9 Miles Production = Lot

Mile 0.0 - 1.0	2.5	7.5	15.0	8.0	5.5	5.0	11.5	9.0	17.0	5.5
Mile 1.0 - 2.0	3.0	4.0	5.5	5.5	7.5	5.0	4.5	7.5	5.0	16.5
Mile 2.0 - 3.0	11.6	14.0	7.5	1.5	2.0	5.5	9.0	9.0	9.5	15.0
Mile 3.0 - 3.9	15.5	7.5	11.5	8.0	8.5	2.0	4.0	0.5	7.5	

PI > 7.0

PI > 10.0

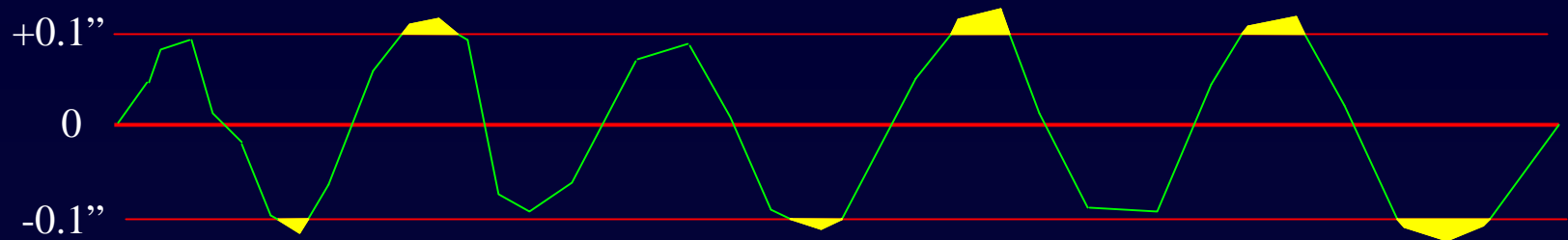
22 out of 39 tenth of a mile segments exceeded PI of 7.0 - 2.2 miles (56%)

9 out of 39 tenth of a mile segments exceeded PI of 10.0 - 0.9 miles (23%)

Lot Average PI = 8.0, thus Contractor was only penalized 5%

Some Pavements with Low PI's, Still Ride Rough Why???

Current 0.2" Blanking Band Masks Too Many Scallops



Special Provisions Number 907-403-9 & 907-401-20 with respect to Pavement Smoothness need to be “tightened up”



MDOT's Profilograph Status as of October 1, 2000

- Collect Profile Index (Geometric measurement without consideration for the dynamic frequency effects of a moving wheel load)
- 4' Low Pass Filter (Butterworth)
- 0.2" Blanking Band
- Allowed any 528' Section to Remain in Place, provided days lot did not exceed average PI of 10 inches/mile
- No Calibration Sites to validate accuracy of Contractor's equipment
- Misconception that Contractor could improve the 528' sections and receive above 100% pay based on the improved PI



State Study No. 144 Work Plan

Target Implement

Task

Date

1. Reduce Low Pass Filter Setting to 2' & Correct any 528' section with PI above 10 in/mi

January 2001

2. Eliminate the 0.2" Blanking band and establish statewide calibration sites

March 2002

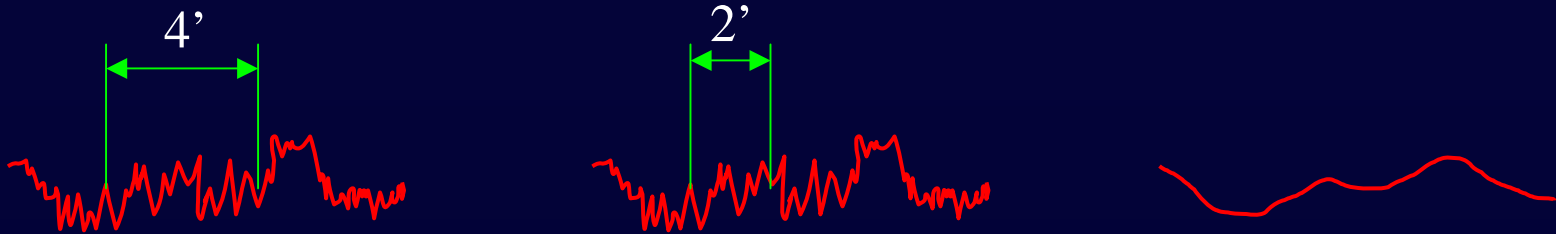
3. Approve the light-weight profiler for Profile Index collection

July 2002

4. Require IRI (International Roughness Index) for smoothness acceptance

January 2004

Reduce Low Pass Butterworth Filter Setting to 2'



Low Pass Filter uses an average over the filter distance to “smooth the chatter” in the Profile.

Profilograph manufacturer recommends a setting of 2' as opposed to 4'.

Data indicates reduction in the Low Pass Filter from 4' to 2' increases the Profile Index approximately 1 in/mi.

Beware of “Moving Average” Filter!



Current MDOT Special Provision No. 907-401-22 reflects this change.



Contractor Must Correct Any 528' Segment With a Profile Index Above 10 inches/mi

Mile 0.0 - 1.0	2.5	7.5	15.0	8.0	5.5	5.0	11.5	9.0	17.0	5.5
Mile 1.0 - 2.0	3.0	4.0	5.5	5.5	7.5	5.0	4.5	7.5	5.0	16.5
Mile 2.0 - 3.0	11.6	14.0	7.5	1.5	2.0	5.5	9.0	9.0	9.5	15.0
Mile 3.0 - 3.9	15.5	7.5	11.5	8.0	8.5	2.0	4.0	0.5	7.5	

PI > 10.0 Contractor must correct

Current MDOT Special Provision No 907-401-22 states: "...when the profile index requirement of the lift is 7 inches per mile, no individual segment of the lift with a profile index greater than 10 inches per mile shall be allowed to remain in place without correction."

Contractor shall correct the defective sections according to MDOT Special Provision No 907-403-12 : Lift Corrections - Surface Lift

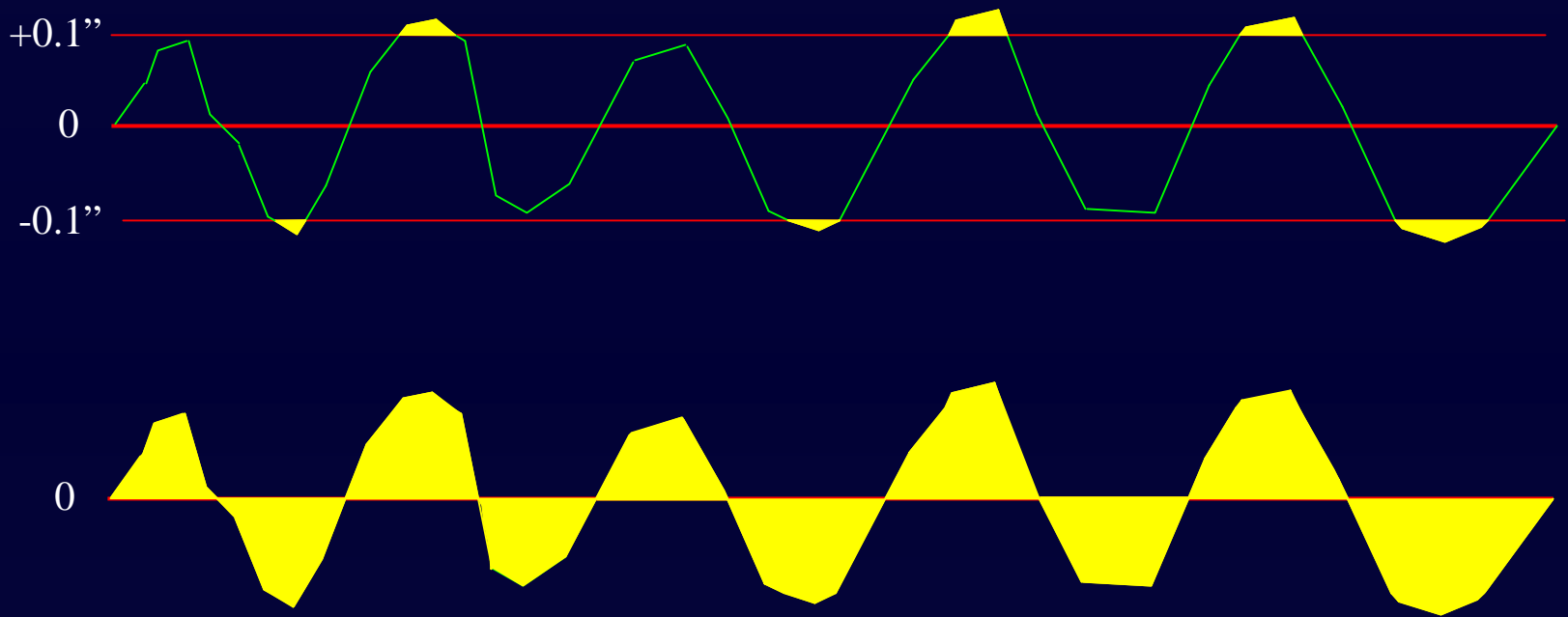


State Study No. 144 Work Plan

<u>Task</u>	<u>Target Implement Date</u>
1. Reduce Low Pass Filter Setting to 2' & Correct any 528' section with PI above 10 in/mi	January 2001
2. Eliminate the 0.2" Blanking band and establish statewide calibration sites	March 2002
3. Approve the light-weight profiler for Profile Index collection	July 2002
4. Require IRI (International Roughness Index) for smoothness acceptance	January 2004

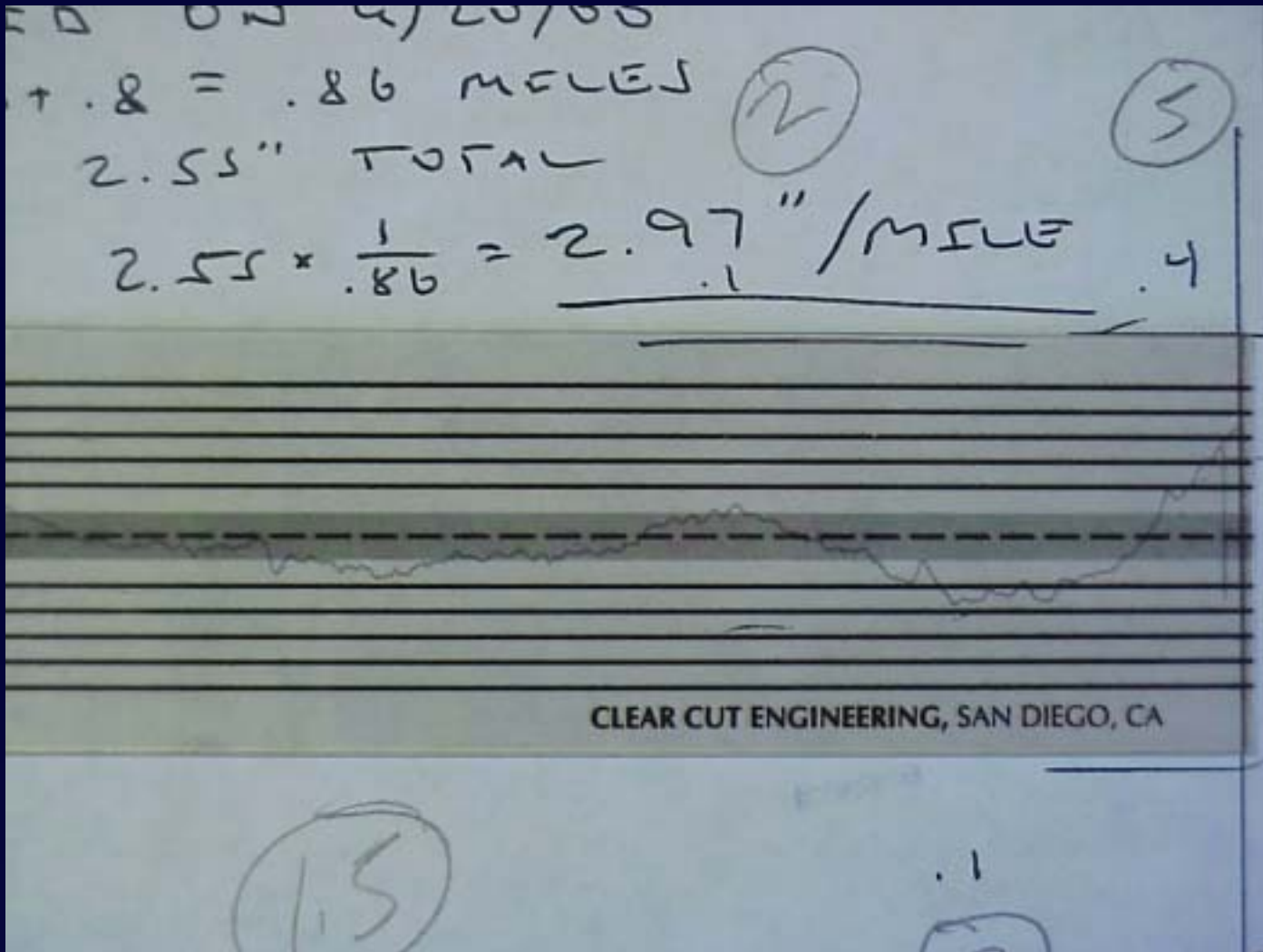


Eliminate the 0.2" Blanking Band



Profilograph S.O.P.

“Zero” Blanking Band Scale (Sect 1.2)





Profilograph S.O.P.

Operation of Profilograph

- Section 2.1 - “profilograph shall be moved at a speed no greater than 3 miles per hour”
- Section 2.1 - “Air pressure in the tires shall be maintained at a constant level and shall be checked daily”



Profilograph S.O.P.

Calibration of Profilograph

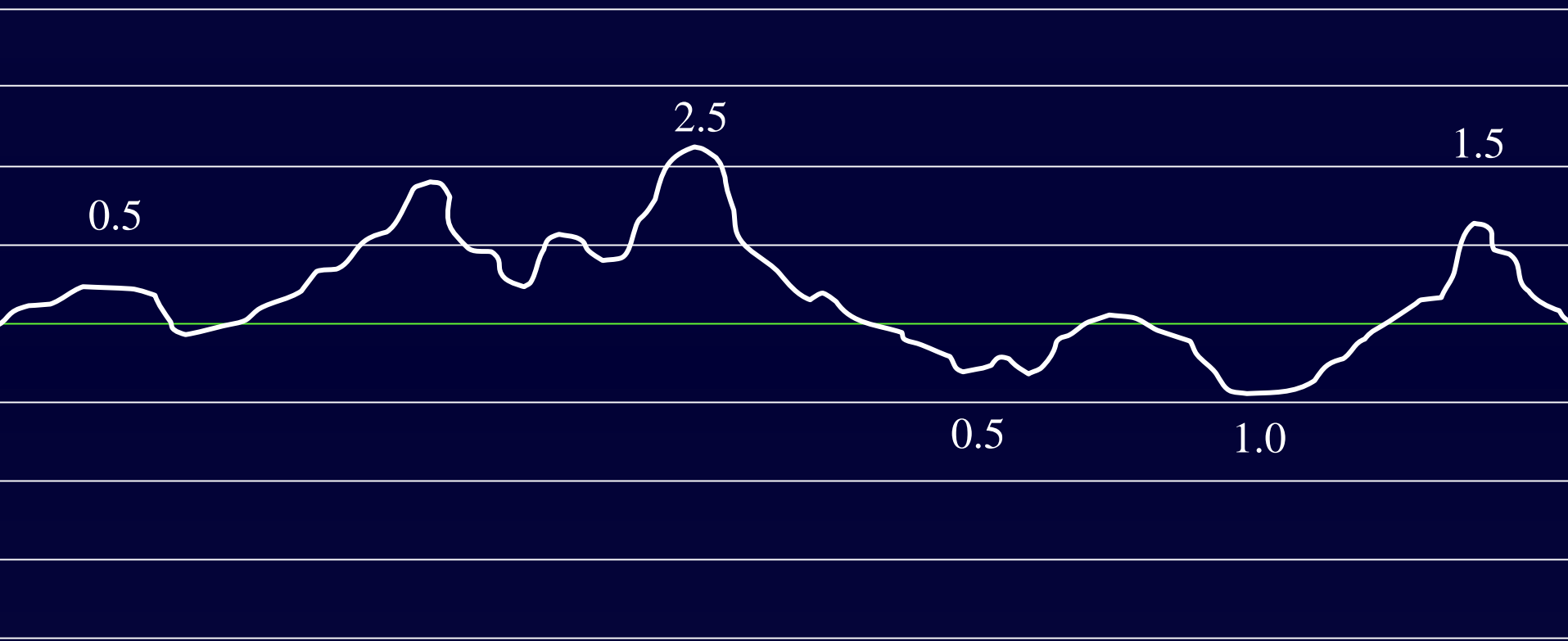
- Section 2.2 - “Vertical calibration of the manual and computerized profilograph shall be checked daily”
- Section 2.2 - “Horizontal calibration of the manual and computerized profilograph shall be performed at the start of the project and once a week thereafter.”



Profilograph S.O.P.

Determination of Profile Index

- Section 4.1.3 - “measure each scallop to the nearest 0.05 inch (or half the distance between parallel scribed lines on the scale)”
- Section 4.1.3 - “Short portions of the profile line may be visible above or below the center reference line, but unless they project 0.03 inch or more and extend longitudinally for two feet or more, they are not to be included in the count.”





Profilograph S.O.P.

Determination of Profile Index

- Section 4.1.4 - “Each days production shall be divided into sections which terminate at a day’s work joint, bridges or other interruptions. Each section shall be subdivided into 0.1 mile segments. If a segment less than 0.1 mile occurs at the end of a section, it shall be combined with the preceding 0.1 mile segment for calculation of the profile index.”
- Section 4.1.4 - “Each 0.1 mile segment shall “stand alone” for calculation of the profile index.”



Smoothness Scenerios

		Profile Index With Blanking Band (<u>inch/mile</u>)	Profile Index Zero Blanking (<u>inch/mile</u>)	
1	Bridge	20	65	
2	Surface	17 or 60%	60 or 60%	
	If Milled to Grade Prior to Placement Treat as #2			
3	Surface Leveling	17 or 60% N/A	60 or 60% N/A	
4	Surface Intermediate Leveling	7 17 N/A	30 60 N/A	← INCENTIVE
5	Surface Top Intermediate Low Intermediate Leveling	7 10 N/A N/A	30 45 N/A N/A	← INCENTIVE



Zero Blanking Band Incentive Levels

10.0 or less	108%
>10.0 to 14.0	106%
>14.0 to 18.0	104%
>18.0 to 22.0	102%
>22.0 to 30.0	100%
>30.0	correct to 30.0 & 100%



Example of Data - MS 33 Franklin County (Blain)

	<u>PI w/.2" BB</u>	<u>2001 MDOT</u>	<u>PI w/o BB</u>	<u>2002 MDOT</u>
	5.3	100%	19.3	102%
	4.7	102%	23.1	100%
	4.3	102%	18.1	102%
	4.7	102%	21.8	102%
	1.7	105%	19.1	102%
	0.3	105%	15.6	104%
	1.4	105%	18.7	102%
	0.7	105%	16.2	104%
	12.8	correct	33.7	100% & correct
	<u>2.8</u>	<u>105%</u>	<u>17.9</u>	<u>104%</u>
Average	3.87	102%	20.35	102%

Zero Blanking Summary: 3 sections 104%, 5 sections 102%, 2 sections 100%
 =102.2%



Example of Data - I55 Yalobusha County (LR)

	<u>PI w/.2" BB</u>	<u>2001 MDOT</u>	<u>PI w/o BB</u>	<u>2002 MDOT</u>
	2.1	105%	30.5	100% & correct
	4.3	102%	32.2	100% & correct
	3.0	105%	31.9	100% & correct
	1.4	105%	30.9	100% & correct
	1.2	105%	25.6	100%
	2.3	105%	19.2	102%
	3.1	102%	27.4	100%
	5.6	100%	38.0	100% & correct
	2.4	105%	33.4	100% & correct
Average	2.82	105%	29.90	100%

Zero Blanking Summary: 1 sections 102%, 8 sections 100%
 =100.2% with 6 corrected segments



Establish Statewide Calibration Sites

- Prefer one in each District (6 total), however may have to settle for one in each Commissioner's District (3 total).
- Contractor will be required to validate equipment annually at a calibration site and show proof of current "calibration sticker" before operating on MDOT projects.
- Currently have 1 usable location identified :
District 3 - Warren County I-20 asphalt crossover near weigh station
- Probably should construct a dedicated calibration track



State Study No. 144 Work Plan

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Approve Light-Weight Profiler for Profile Index Collection

- Collects either PI or IRI
- Ability to collect at speeds up to 15 mph as opposed to 3 mph
- Can be equipped to collect both wheelpaths with a single pass
- Safer than profilograph, can be fitted with a lightbar
- Costs approximately \$40,000 compared to \$15,000 for profilograph
- Approved in many states, including Arkansas, Texas, Pennsylvania and Connecticut



Approve Light-Weight Profiler for Profile Index Collection

- Research Division should have one any day now
 - “wheels of government agency procurement turn very slowly”
- Need to approve its usage to allow Industry to begin transitioning from Profile Index to International Roughness Index (IRI).



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Require IRI for Smoothness Acceptance

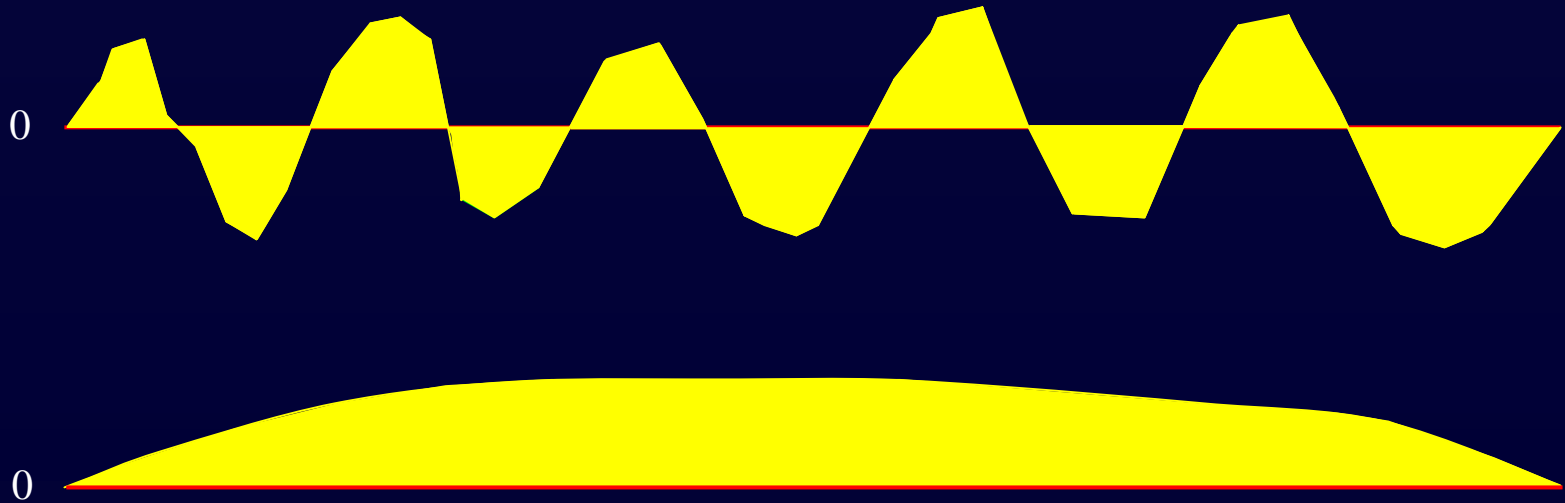
What is International Roughness Index (IRI)?

IRI is a quarter-car simulation which calculates the suspension deflection of a simulated mechanical system with a response similar to a passenger car. The simulated suspension motion is accumulated and divided by the distance traveled to give an index with units of inch/mile or meter/kilometer, etc.

IRI differs from PI in that PI is simply a geometric measure of the variation in profile. IRI accounts for the dynamics of a moving vehicle over that profile.

IRI is the statistic used in the AASHTO 2002 Design Guide.

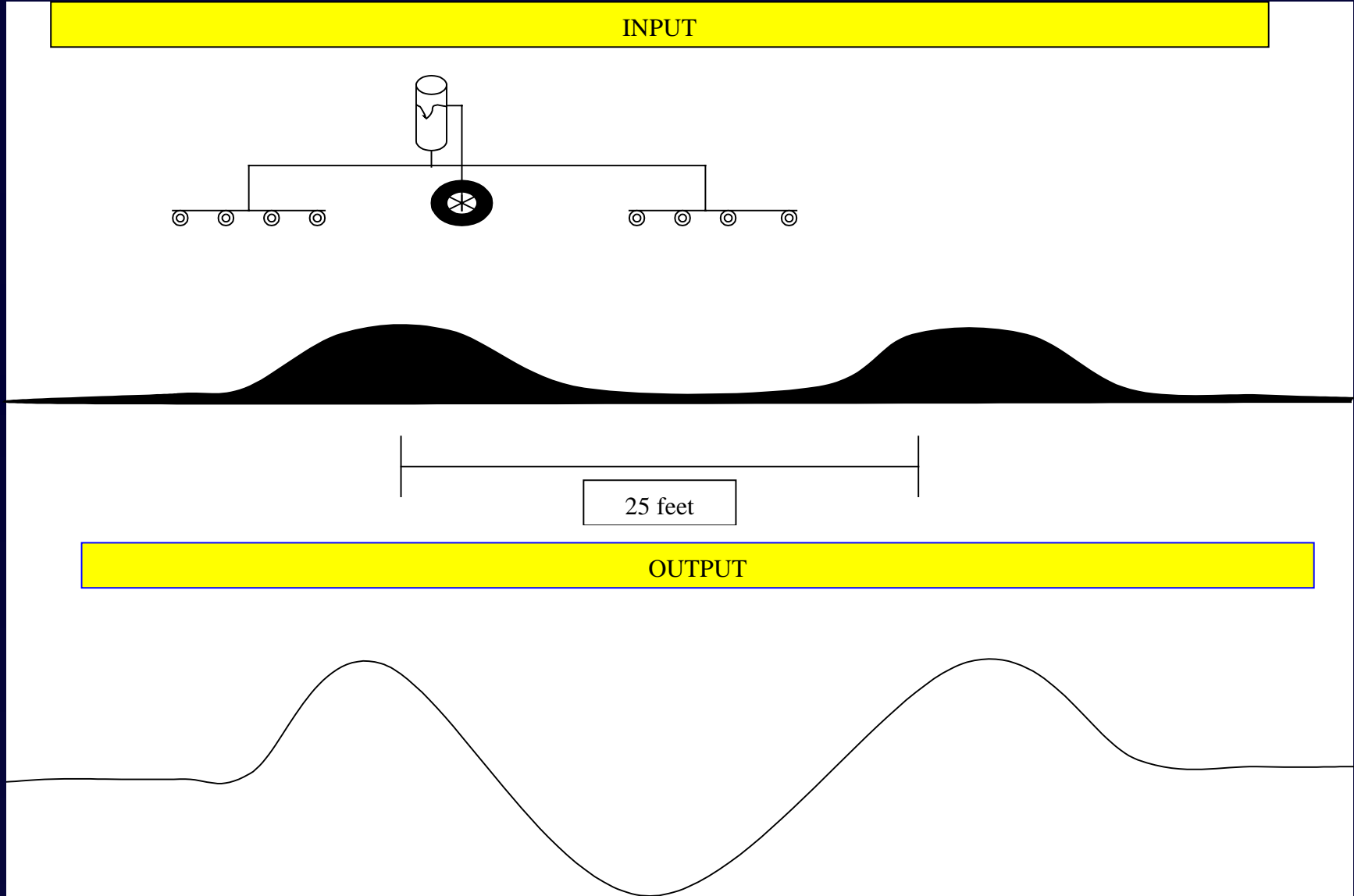
IRI vs. PI



Since Profile Index is strictly a geometric measurement, the PI of both of these examples would be approximately the same. (same area varies from zero line)

Certainly would not feel the same when driving over the two sections.

IRI accounts for the dynamics, thus top example would have a higher IRI.

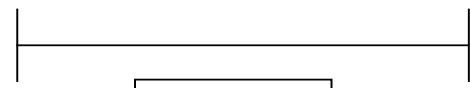
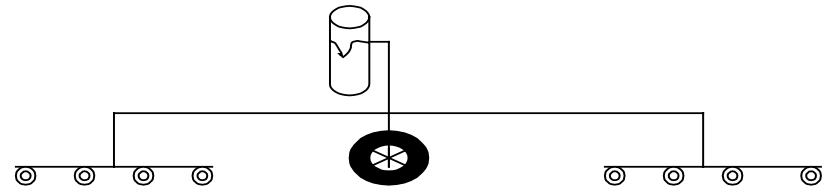


INPUT

25 feet

OUTPUT

INPUT



15 feet

OUTPUT

