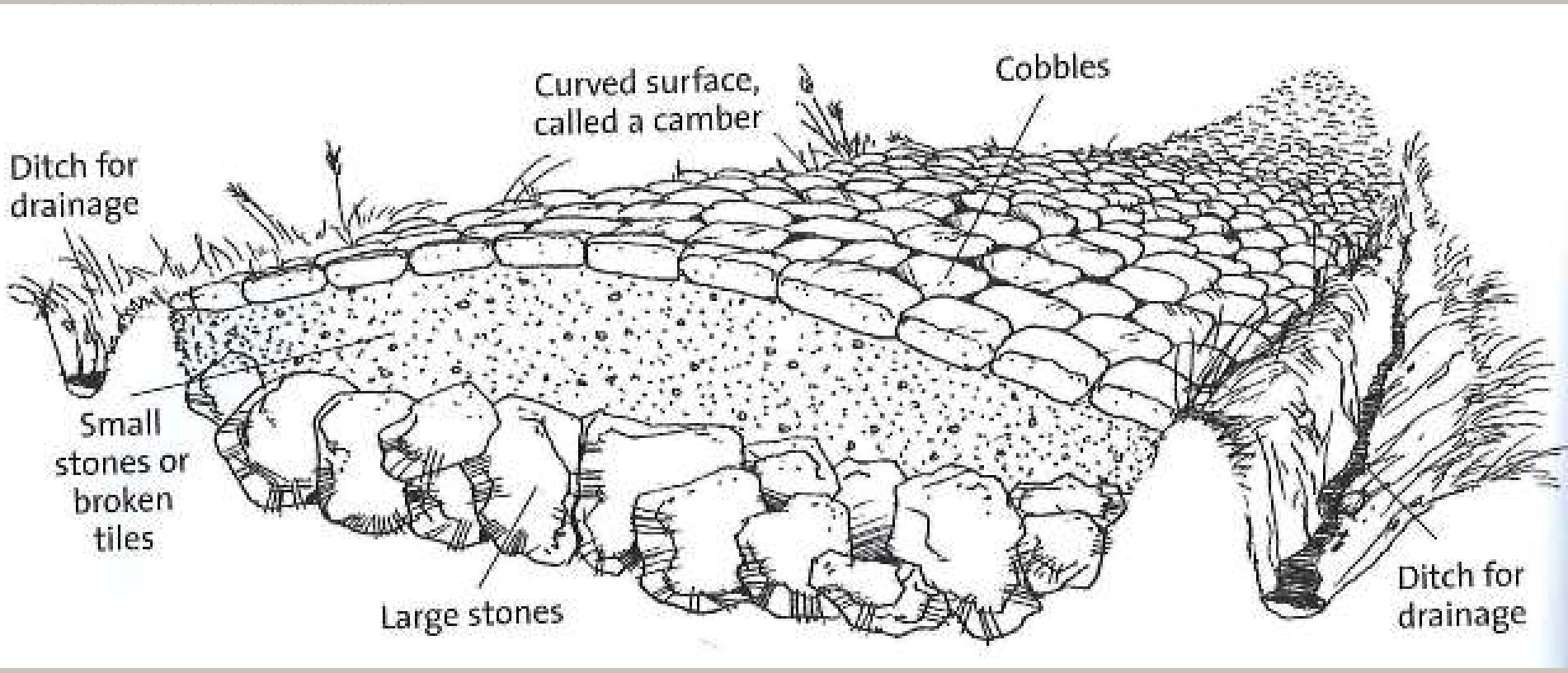
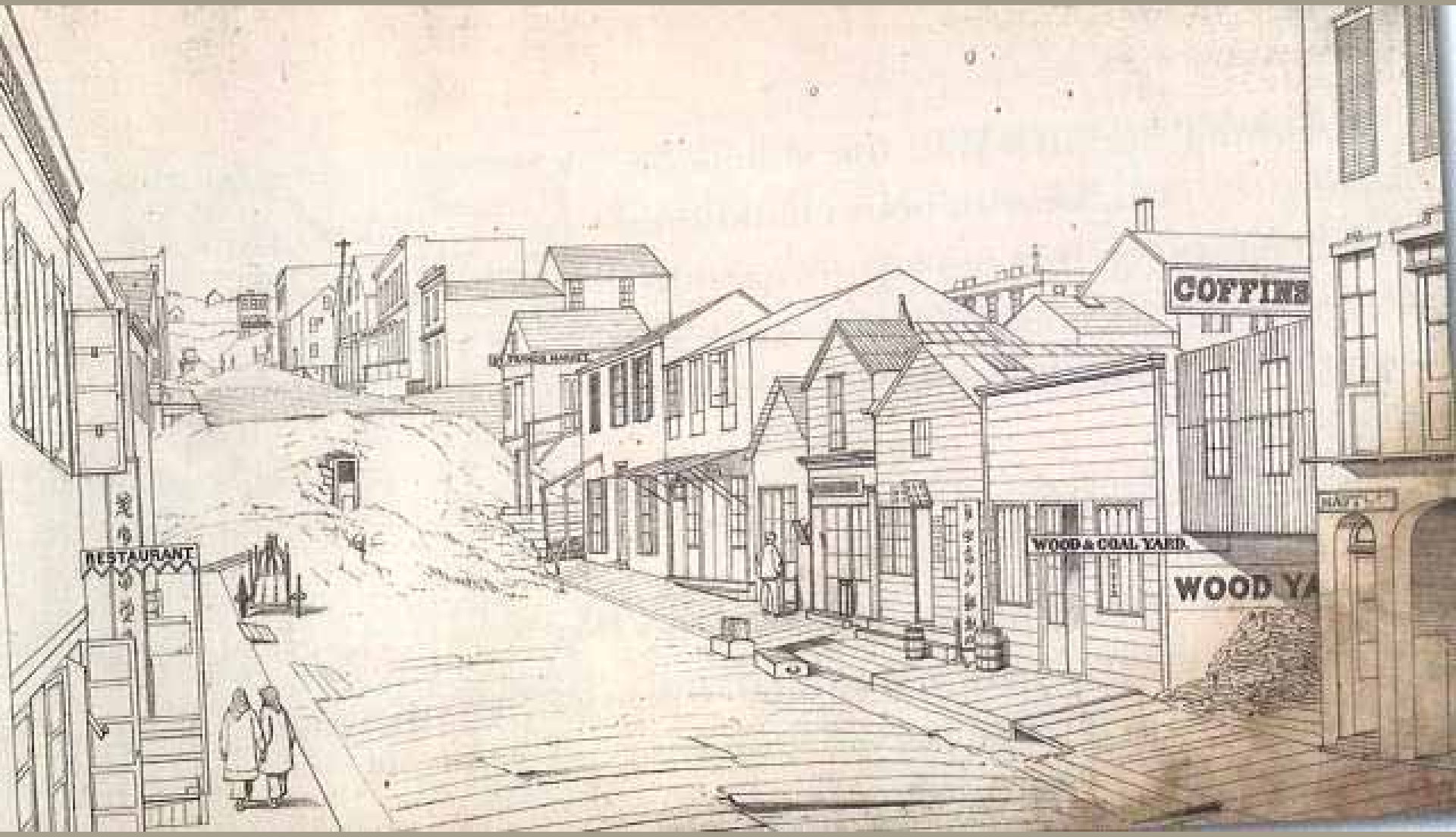
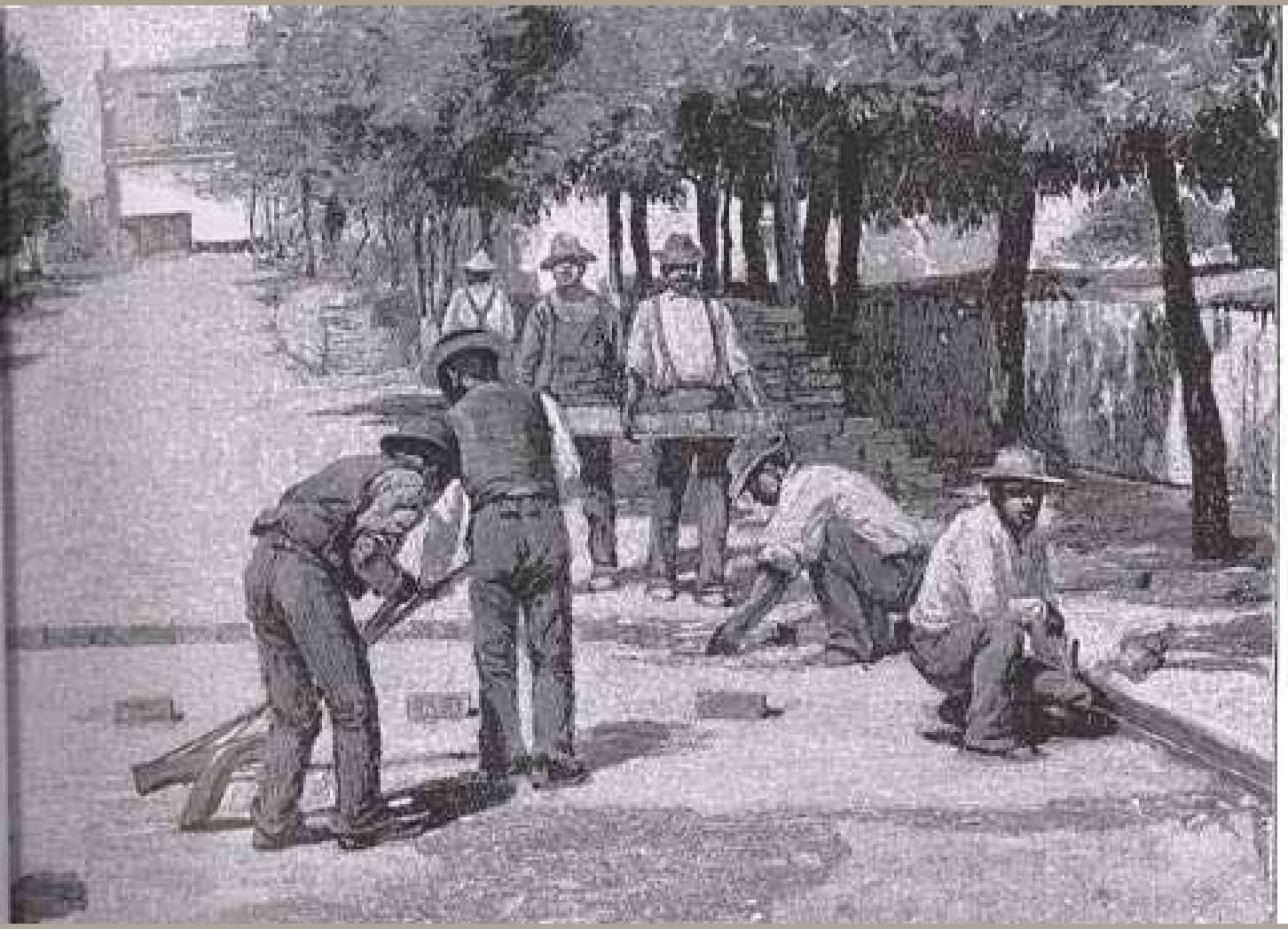
AAPA
14th International Flexible Pavements Conference
26 September 2011

# Pavement Smoothness
# The Sum Total of Best Paving Practices

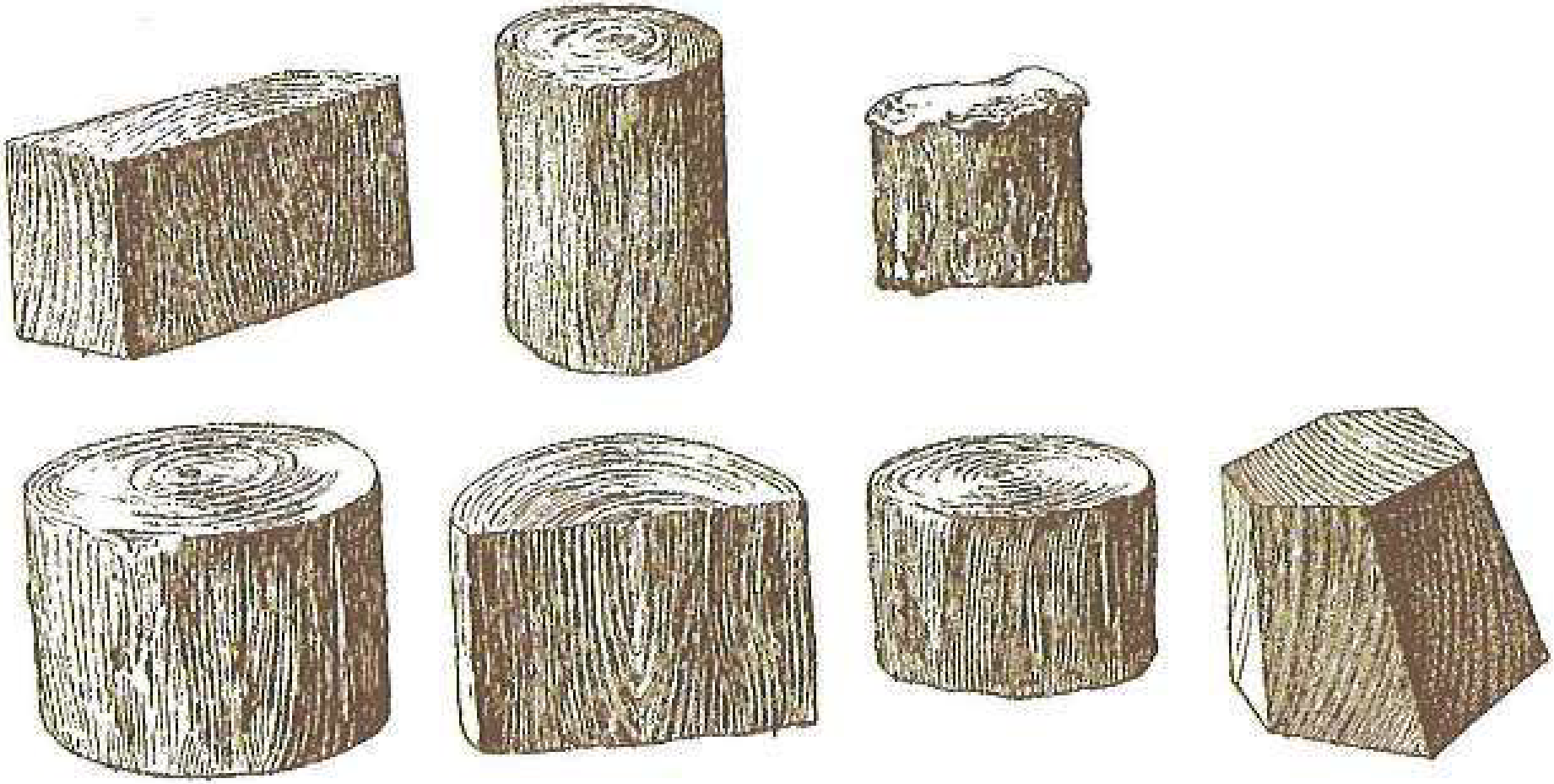
Jeff Richmond, Sr.
President - Roadtec, Inc.

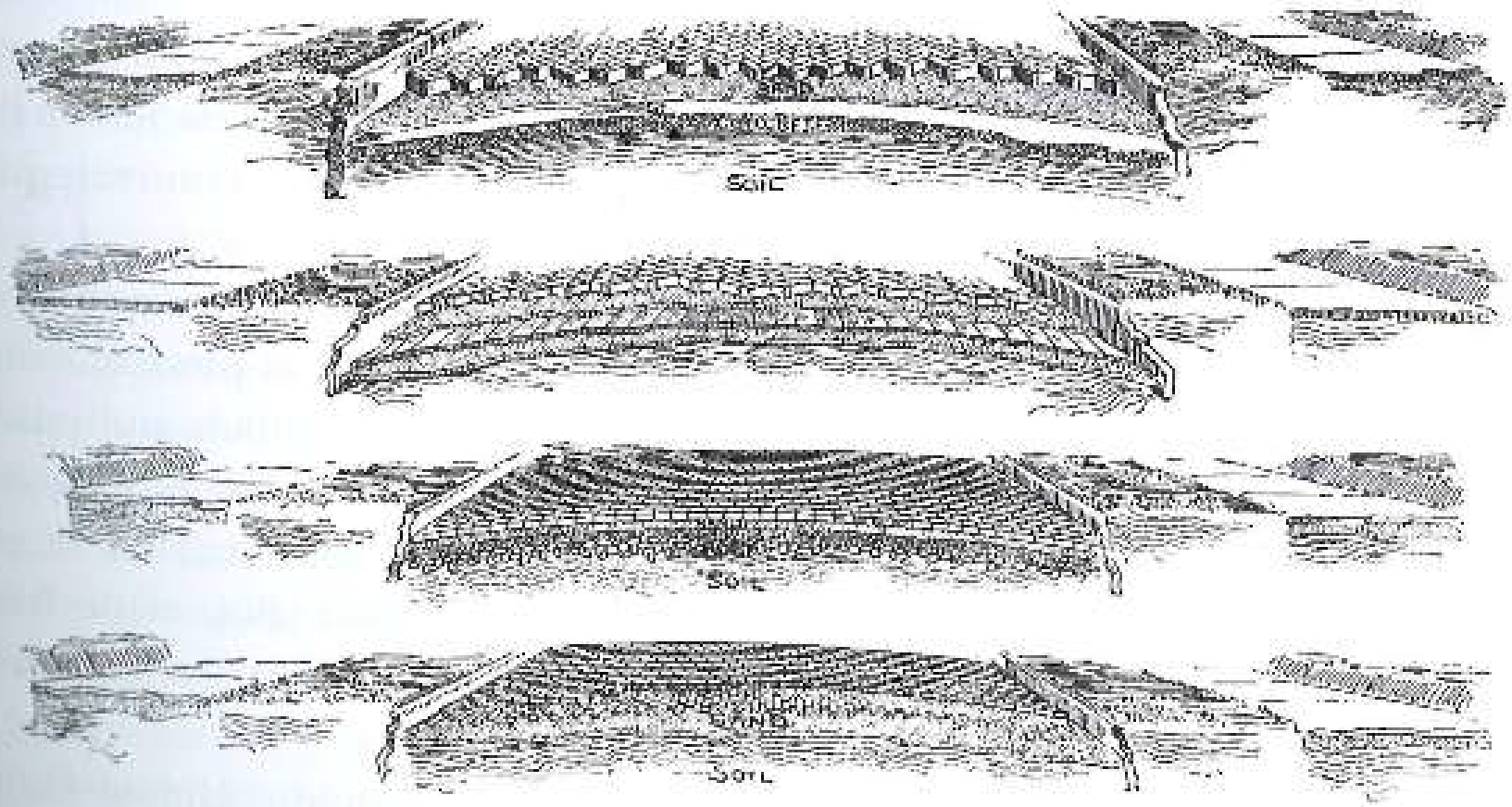

Curved surface, called a camber
Cobbles
Ditch for drainage
Small stones or broken tiles
Large stones
Ditch for drainage

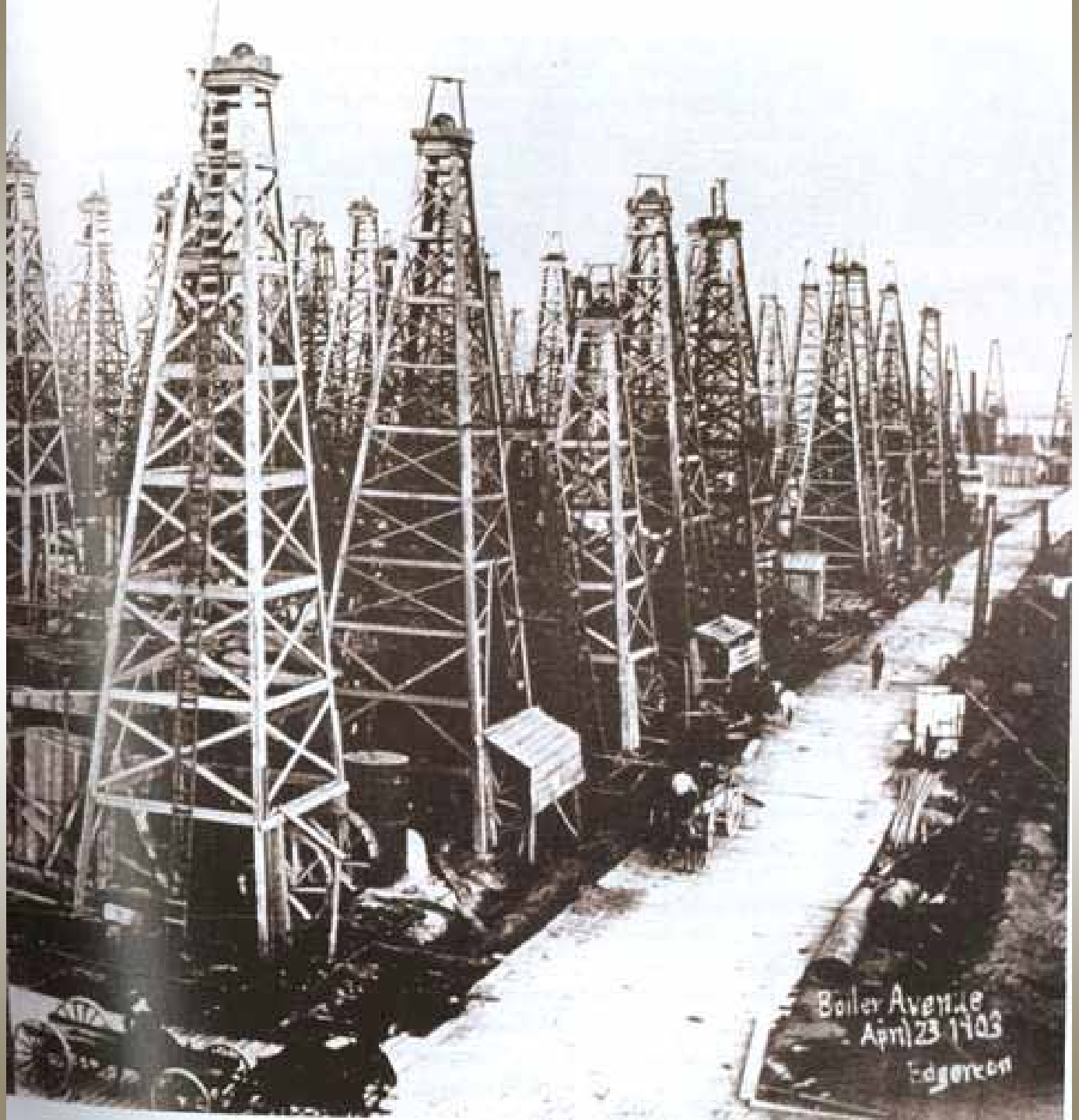

RESTAURANT
COFFINS
WOOD & COAL YARD.
WOOD YA



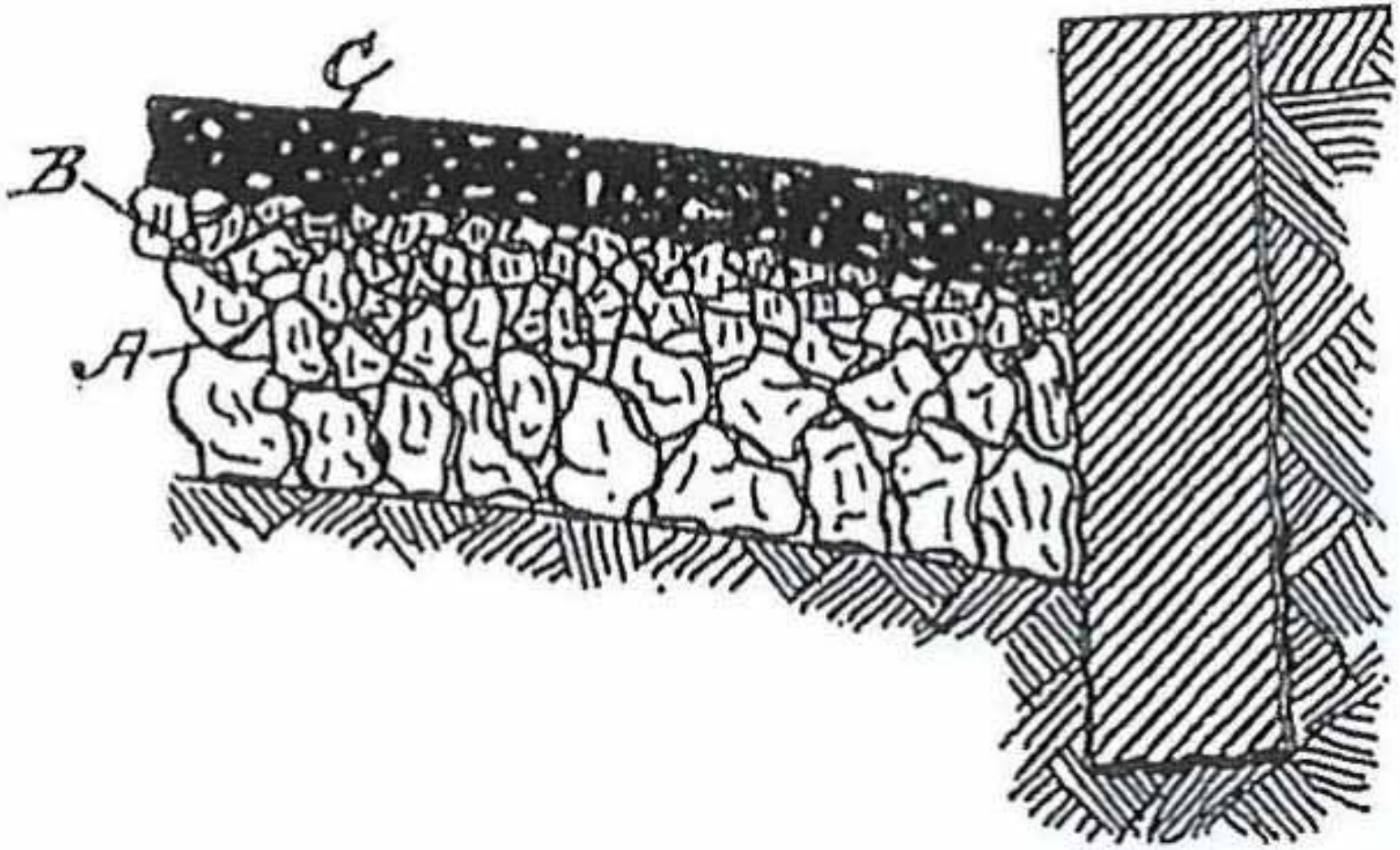
**Bricks** baked from clay were easy to lay down (left) and could be set in many patterns (lower left). But if not made to strictest standards, they could crumble or chip.

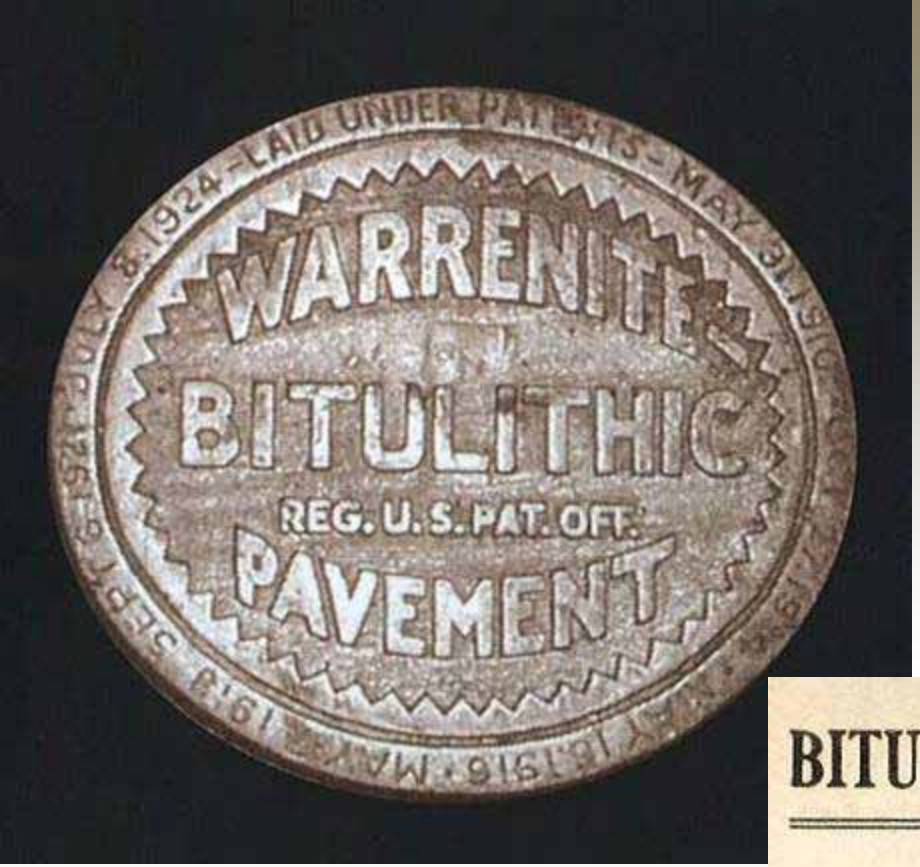



SOIL
SOIL
SAND
SOIL


Boiler Avenue
April 23 1903
Edgerton


THE BRENNAN CONSTRUCTION CO.
Engineering Contractors


C
B
A




# BITULITHIC

## THE WORLD'S MODEL STREET PAVEMENT
## ITS WONDERFUL GROWTH DUE TO MERIT ALONE

AN UNRIVALLED RECORD.

| | | | | |
|---|---|---|---|---|
| 7 | cities in | 1901 | laid | 16,400 square yards |
| 33 | " " | 1902 | " | 400,831 " " |
| 40 | " " | 1903 | " | 915,630 " " |
| 45 | " " | 1904 | " | 940,239 " " |
| 63 | " " | 1905 | " | 1,091,825 " " |
| 79 | " " | 1906 | " | 1,508,093 " " |
| 67 | " " | 1907 | to June 25, have laid or contracted for | 2,105,397 " " |

Total in six years 6,660,612 square yards, equal to 378 miles of 30-foot roadway.

## WARREN BROTHERS COMPANY

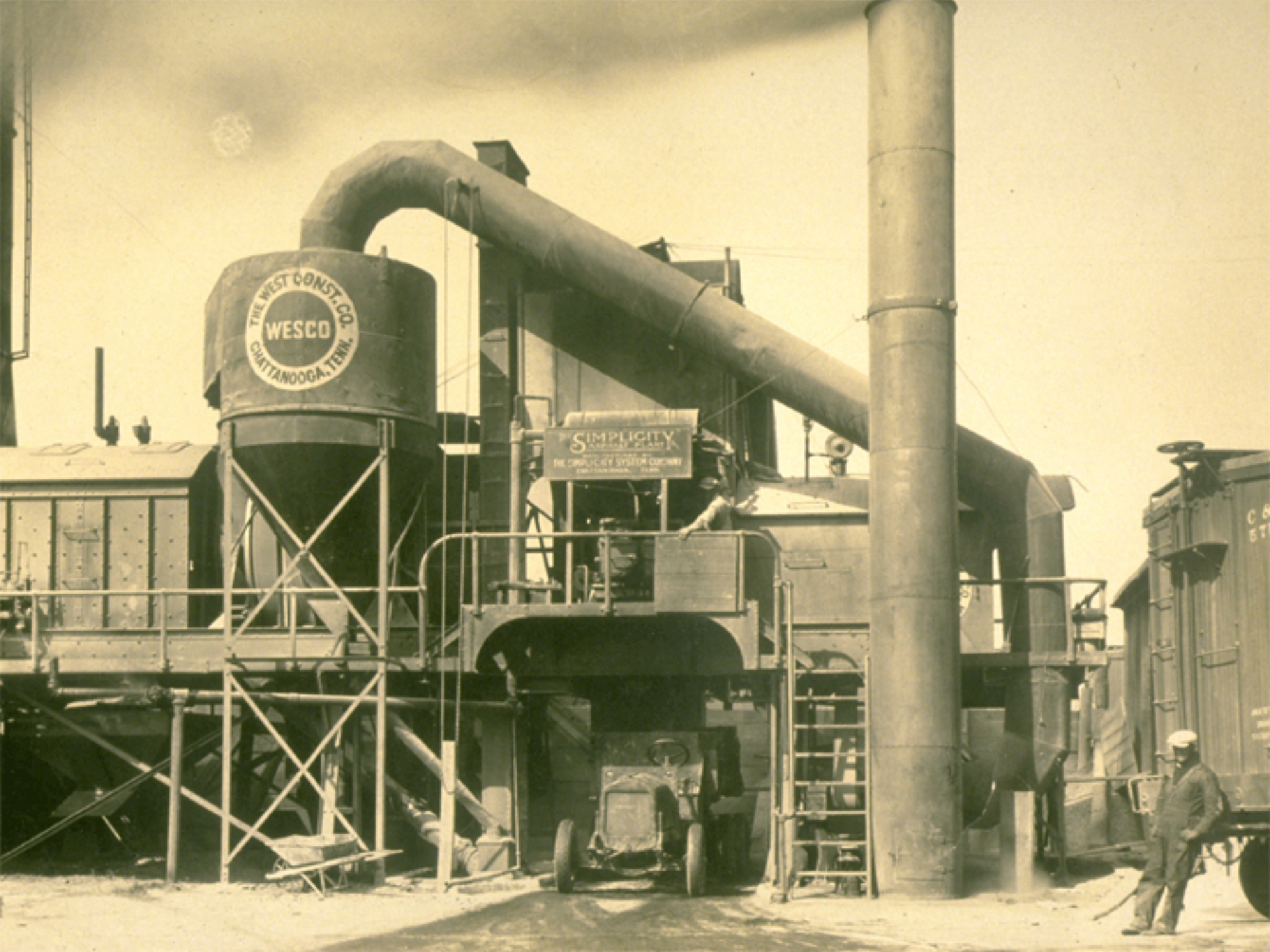
93 FEDERAL STREET - - - BOSTON, MASS.

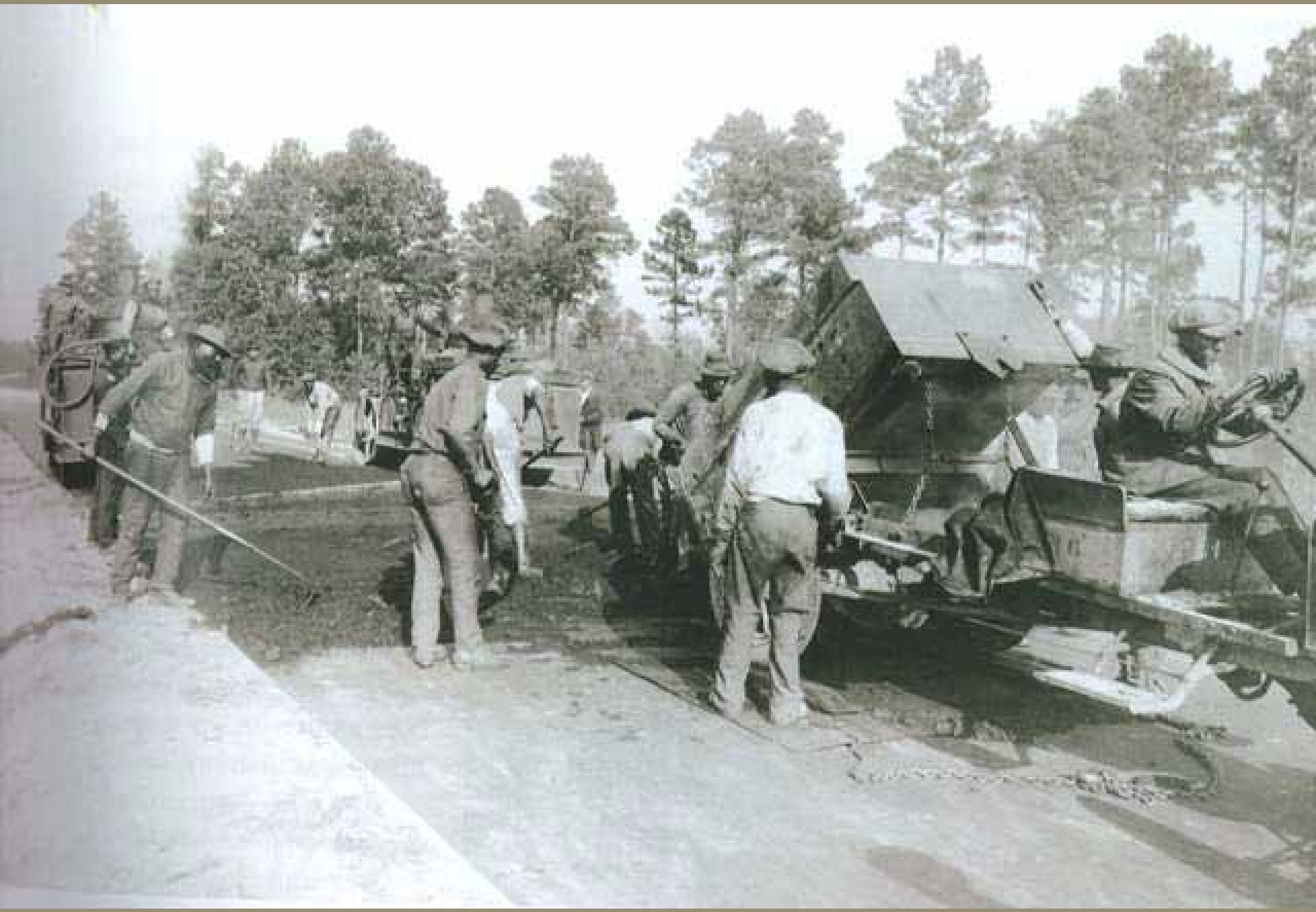
Registered Trade Marks

"BITULITHIC" "BITROCK" "PURITAN"
"BITUSTONE" "BITUMINOUS MACADAM"


View of 8 miles of Canal St New Orleans
Paved


PHOTO OF BOTHELL ROAD
TAKEN MAY 8, 1912
W B & S SEATTLE, WASH.


THE WEST CONST. CO.
WESCO
CHATTANOOGA, TENN.
SIMPLICITY




208G 1596P
43E DT212

# What the Customer's Demand

Long Life Pavement

Pavement Smoothness

No Material Segregation

No Temperature Segregation

Uniformity of Density

Speed of Construction

Minimizing Traffic Delays

Low Price


RX-800

**The rolling straightedge “tuned” to certain wavelengths of roughness in the road, while ignoring others.**

*Steven M. Karamihas; The University of Michigan*

# Profilograph

To overcome this problem the rolling concept was subsequently improved by adding an array of wheels to establish a reference plane from which to measure deviations and remains with us today memorialized as the Profilograph.

*Adapted from "Everything You Always Wanted to Know about the IRI, But Were Afraid to Ask!" by Thomas D. Gillespie, Ph.D., UMTRI*

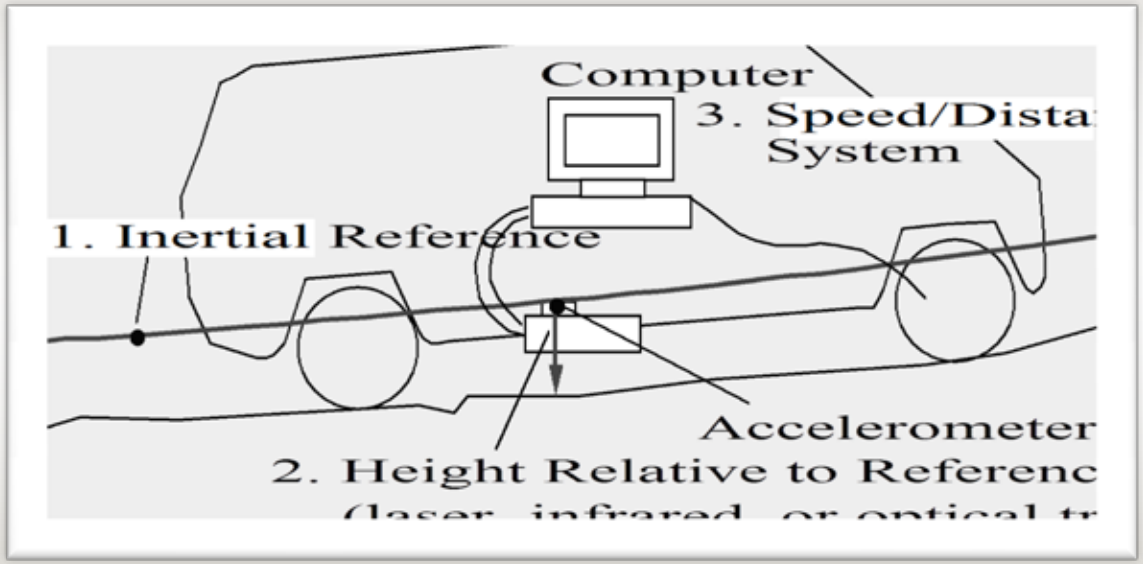
# Road Profilers

**ICC provided FHWA SHRP with 4 profilers.**

**To date, ICC has installed over 300 systems into different vehicles for high-speed data collection.**

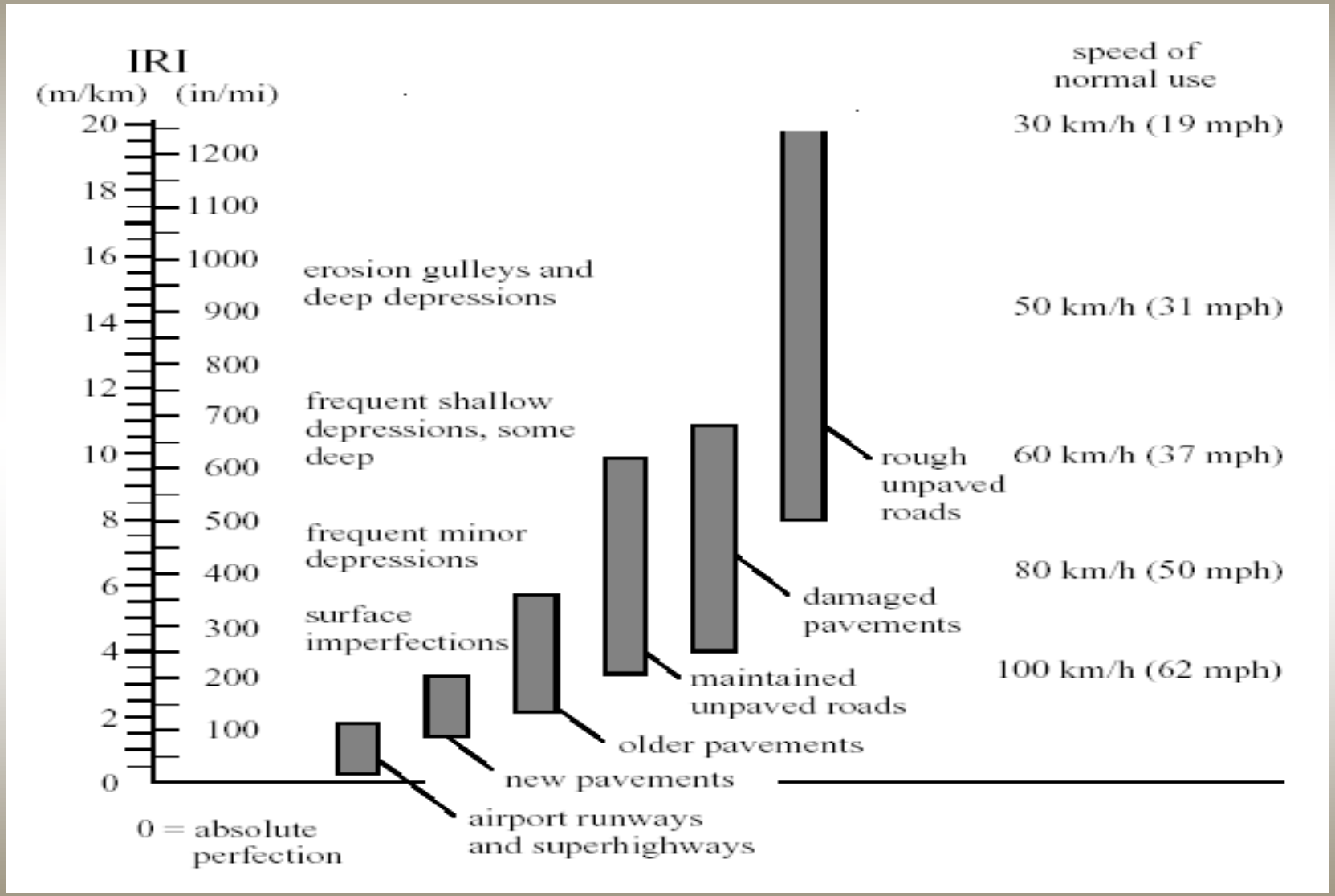
# What is a Profiler?

- A profiler is an instrument used to produce a series of numbers related in a well-defined way to a true profile.
- A profiler works by combining three ingredients:
  - A Reference Elevation
  - A Height Relative to the Reference, and
  - Longitudinal Distance




*Adapted from The Little Book of Profiling by Steven M. Karamihas and Michael W. Sayers; The University of Michigan*

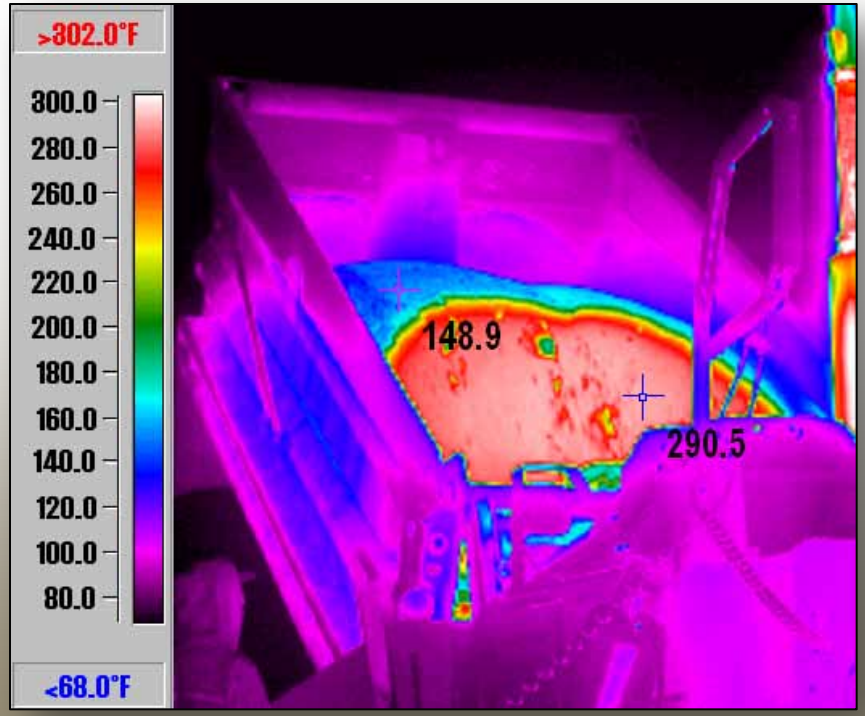
# The following figure shows IRI ranges represented by different classes of road.

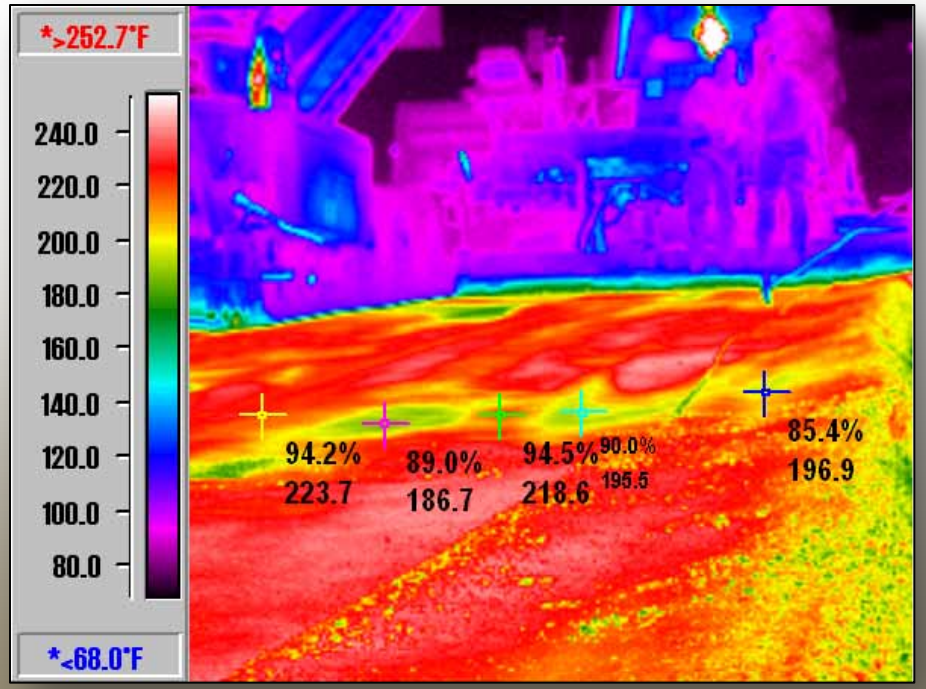


# Segregation

# End Dump/No MTV

Low density, open texture areas in HMA which permanently fail by fatigue cracking, raveling, or both, directly relate to the thermal differentials.

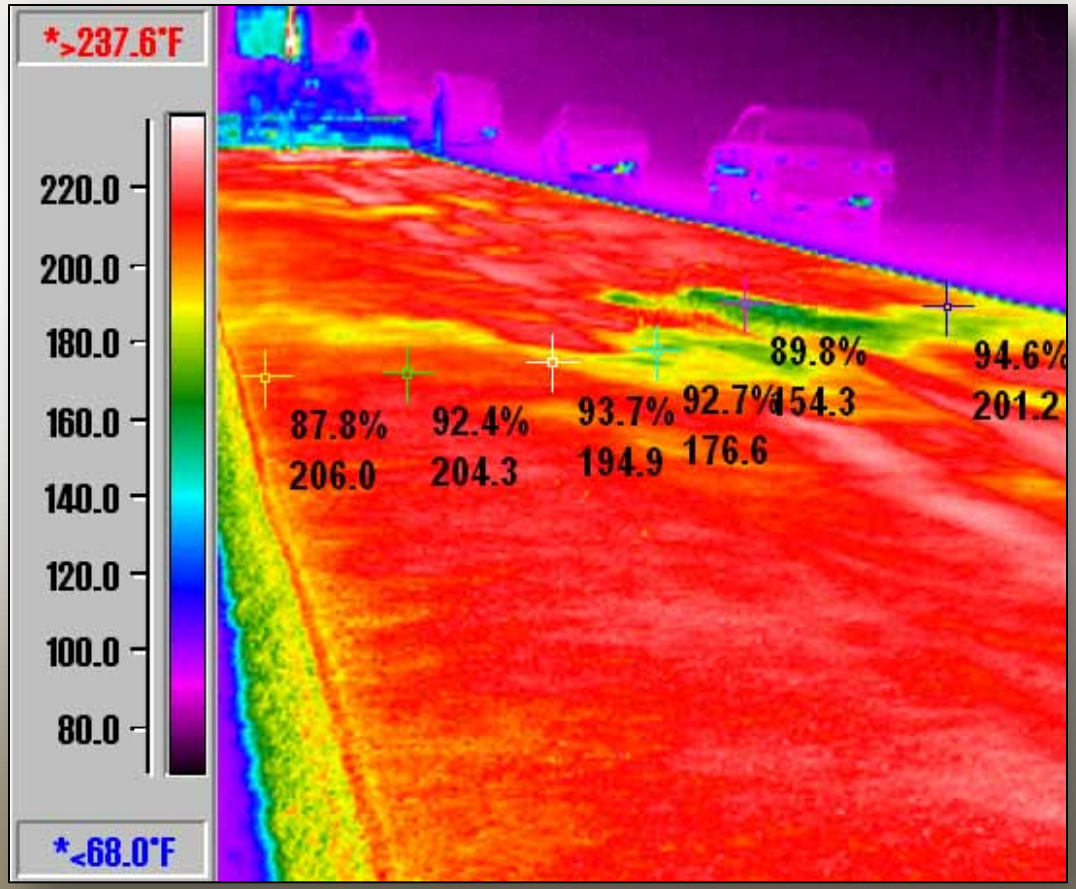


# End Dump/No MTV

The cooler HMA formed during transport is placed in concentrated areas in the Mat and tend to resist adequate compaction.

These concentrated areas of cooler material usually have higher air voids, open surface texture that are more susceptible to deterioration.

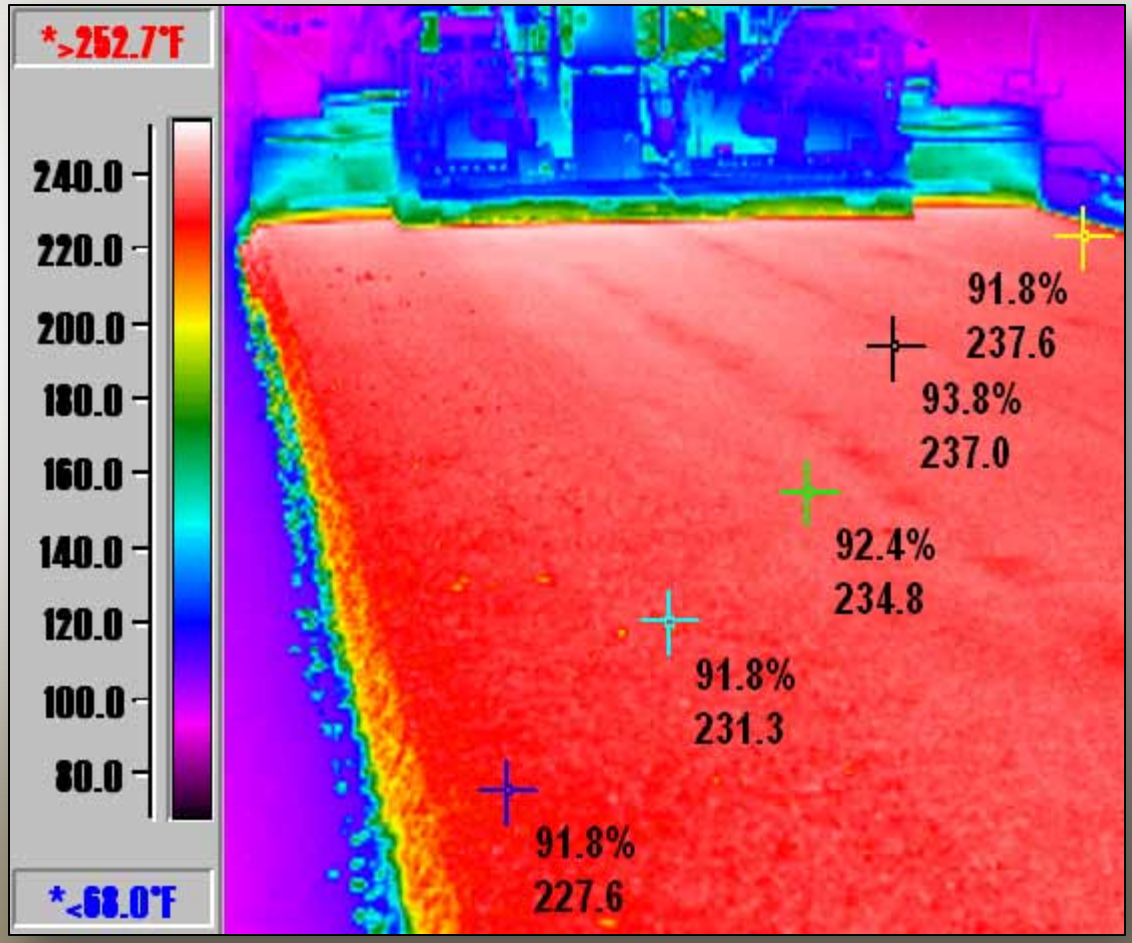


# End Dump/Roadtec Shuttle Buggy

A number of factors will influence the amount of heat loss and the amount of temperature differential within the truck.

These factors are as follows:

1) Mix temperature when loaded into truck
2) Ambient air temperature
3) Is the truck bed insulated
4) Size of truck bed in relation to tons of mix hauled
5) Length of haul
6) Speed of travel
7) Waiting time at paver
8) If the mix is covered
9) Traffic delays



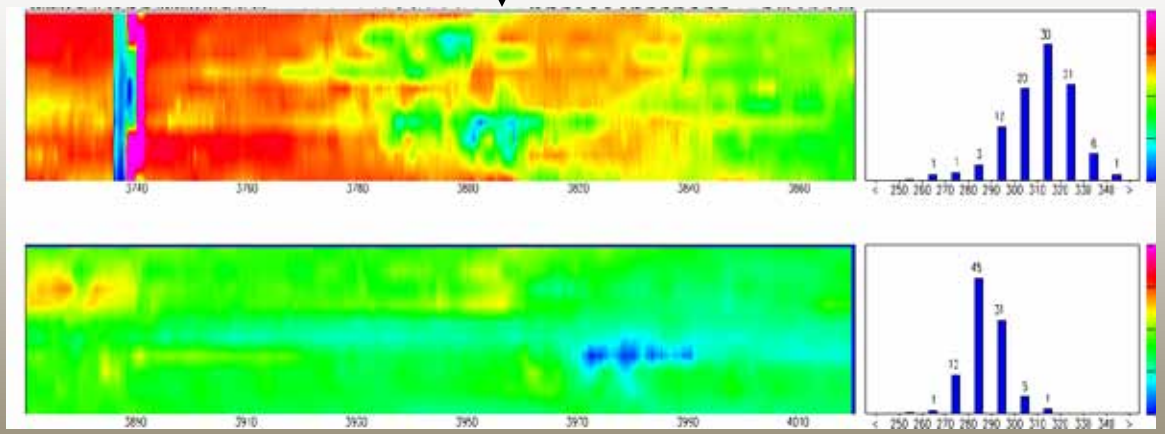
# Intermediate IR Bar Prototype

- Implemented central control box
- Transitioned to sensors permanently installed in sensor bar.

# Pave-IR – Continuous Thermal Profiling with Real Time Display

Mounts on paver – once running requires no operator

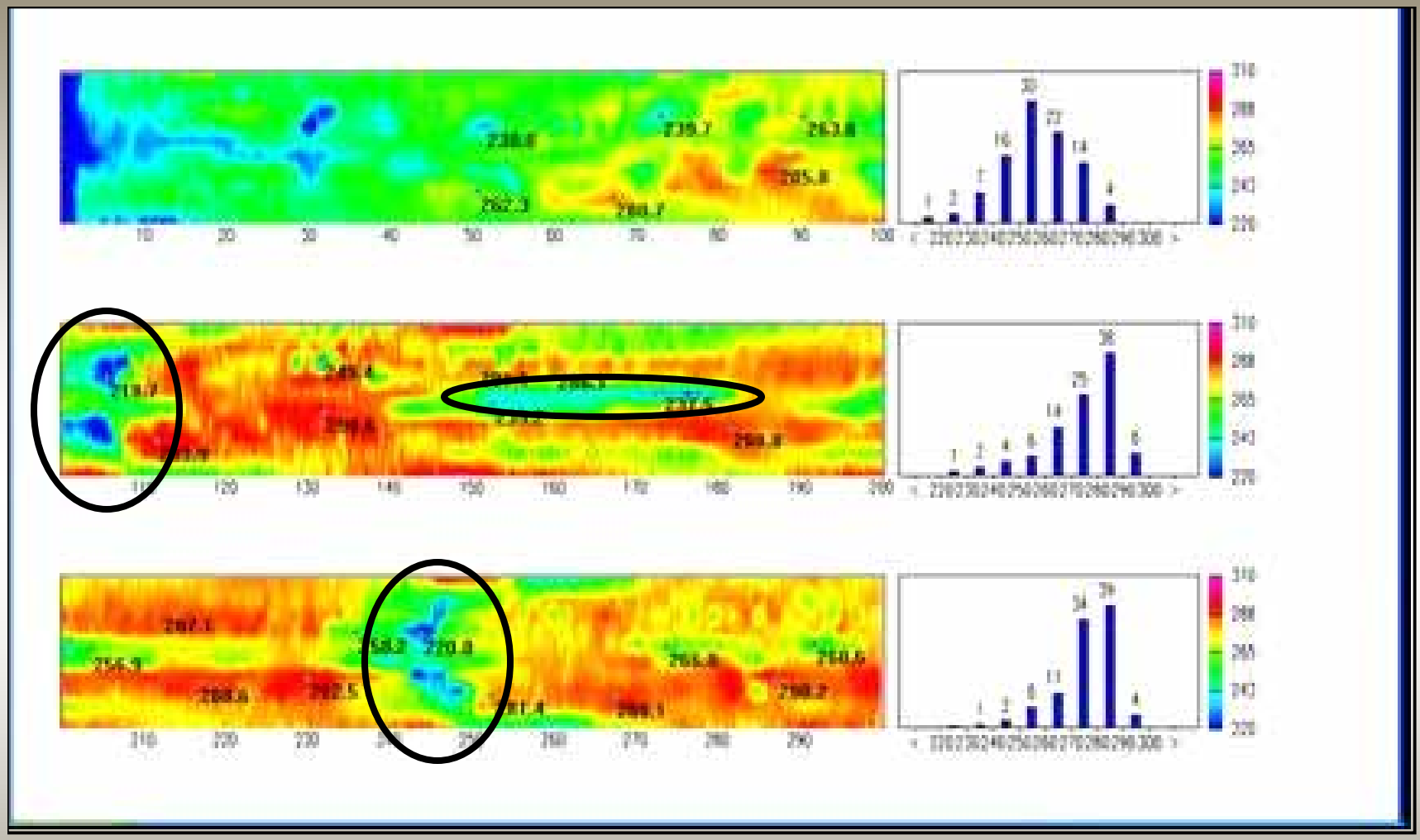
Temp plots displayed in real time along with histogram every 100 feet



Non-destructive & 100% coverage

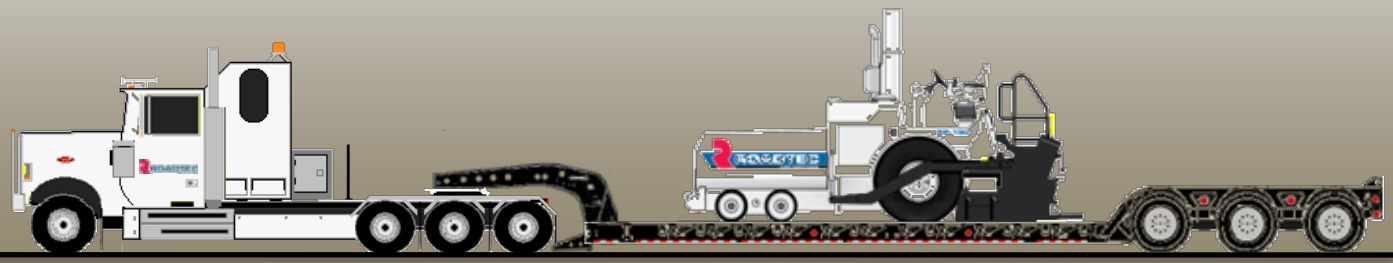
# Sensors Mount on Paver Footplate


Sensor bars on footplate – control box and computer on operator's platform



…and document locations of suspected non-compliance

# Welcome to the Paving Professionals Workshop




ROADTEC
RX700

# Differential Compaction

Surface overlay

Freshly Placed Mat-75%

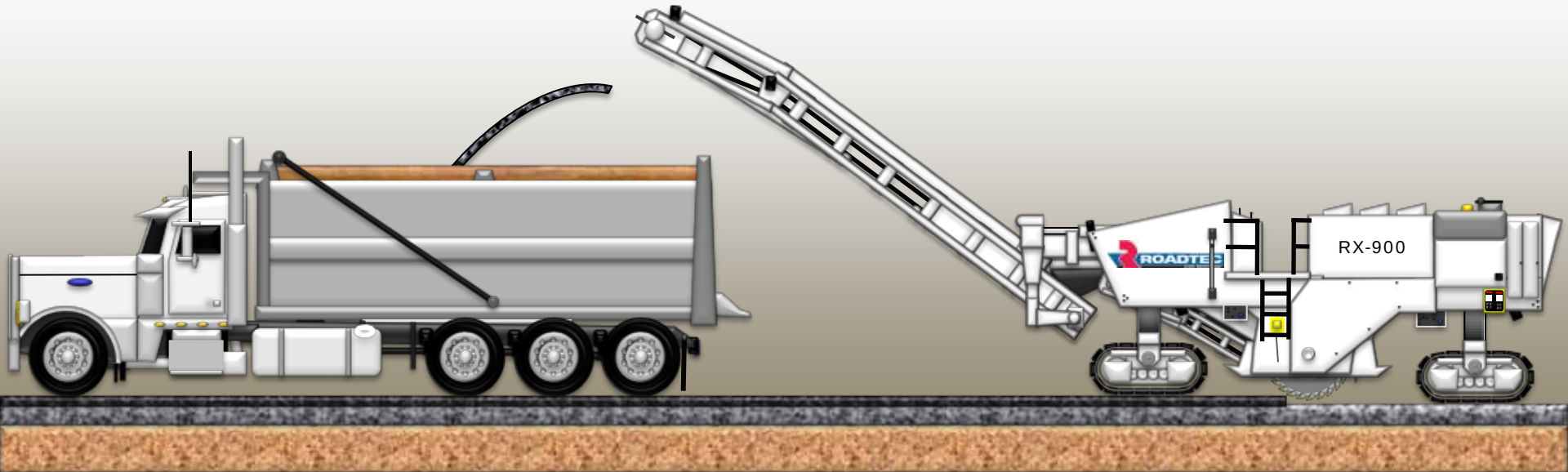
Profiled/Planed Off

Original Uneven Base

15 m (50 ft)

# Proper Machine Operation

The milling operation shall produce a pavement surface that is true to line, grade, and cross section, and of uniform texture.



# Check your teeth

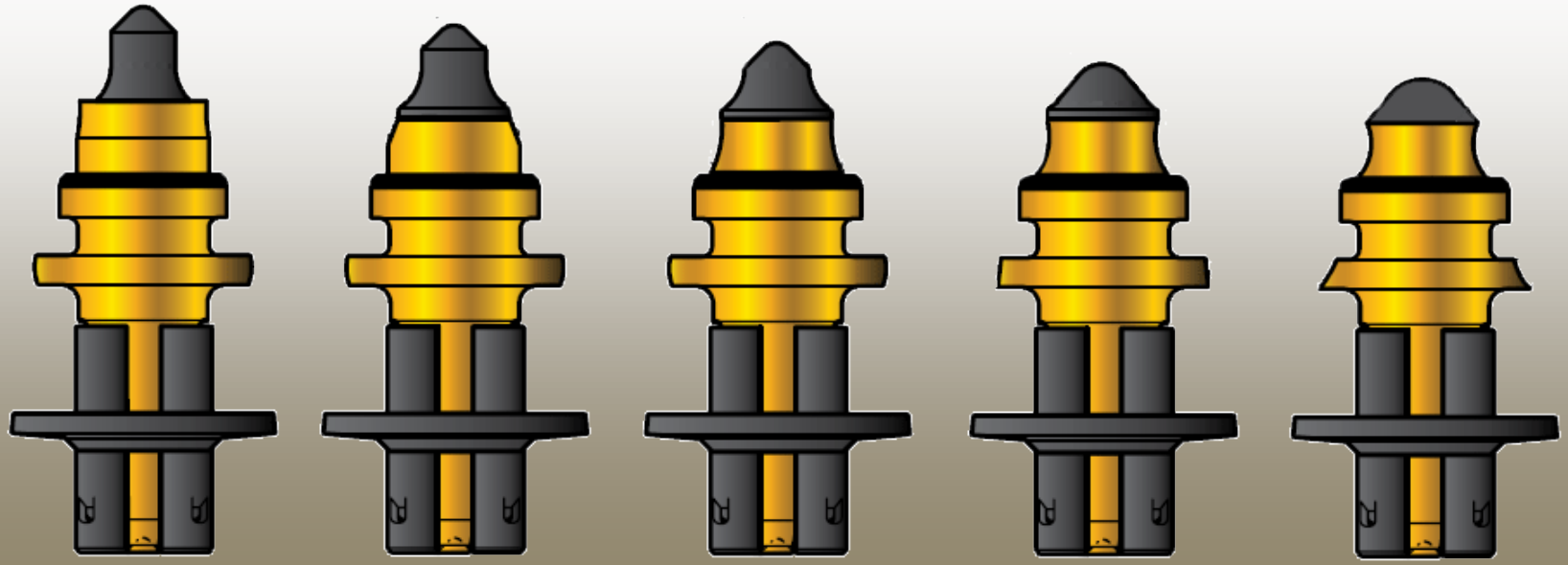
# Tooth Wear

| Depth of Cut | Speed FPM | Speed MPM | Tools Engaged | NP68 Surface Area of Tips in the Cut: New tool in.² | New tool cm.² | Stage 1 in.² | Stage 1 cm.² | Stage 2 in.² | Stage 2 cm.² | Stage 3 in.² | Stage 3 cm.² | Stage 4 in.² | Stage 4 cm.² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.15 | 1.0 | 0.15 | 1.0 | 0.15 | 1.0 | 0.32 | 2.0 | 0.43 | 2.8 * |
| 1.5" (3.8 cm) | 30 | 9.1 | 11 | 1.62 | 10.5 | 1.62 | 10.5 | 1.62 | 10.5 | 3.47 | 22.4 | 4.78 | 30.9 |
| 1.5" (3.8 cm) | 60 | 18.3 | 13 | 1.91 | 12.4 | 1.91 | 12.4 | 1.91 | 12.4 | 4.10 | 26.5 | 5.65 | 36.5 |
| 1.5" (3.8 cm) | 120 | 36.6 | 17 | 2.50 | 16.2 | 2.50 | 16.2 | 2.50 | 16.2 | 5.37 | 34.6 | 7.39 | 47.7 |
| 3" (7.6 cm) | 30 | 9.1 | 15 | 2.21 | 14.3 | 2.21 | 14.3 | 2.21 | 14.3 | 4.74 | 30.6 | 6.52 | 42.1 |
| 3" (7.6 cm) | 60 | 18.3 | 16 | 2.36 | 15.2 | 2.36 | 15.2 | 2.36 | 15.2 | 5.05 | 32.6 | 6.96 | 44.9 |
| 3" (7.6 cm) | 120 | 36.6 | 20 | 2.95 | 19.0 | 2.95 | 19.0 | 2.95 | 19.0 | 6.31 | 40.7 | 8.69 | 56.1 |
| 6" (15.2 cm) | 30 | 9.1 | 20 | 2.95 | 19.0 | 2.95 | 19.0 | 2.95 | 19.0 | 6.31 | 40.7 | 8.69 | 56.1 |
| 6" (15.2 cm) | 60 | 18.3 | 22 | 3.24 | 20.9 | 3.24 | 20.9 | 3.24 | 20.9 | 6.95 | 44.8 | 9.56 | 61.7 |
| 6" (15.2 cm) | 120 | 36.6 | 26 | 3.83 | 24.7 | 3.83 | 24.7 | 3.83 | 24.7 | 8.21 | 53.0 | 11.30 | 72.9 |
| 12" (30.5 cm) | 30 | 9.1 | 28 | 4.12 | 26.6 | 4.12 | 26.6 | 4.12 | 26.6 | 8.84 | 57.0 | 12.17 | 78.5 |
| 12" (30.5 cm) | 60 | 18.3 | 30 | 4.42 | 28.5 | 4.42 | 28.5 | 4.42 | 28.5 | 9.47 | 61.1 | 13.04 | 84.1 |

*Surface area of one tip in the cut.

Tip wear relates to the:

A. Depth of cut
B. Speed at which the machine is operating



# Truck Loading

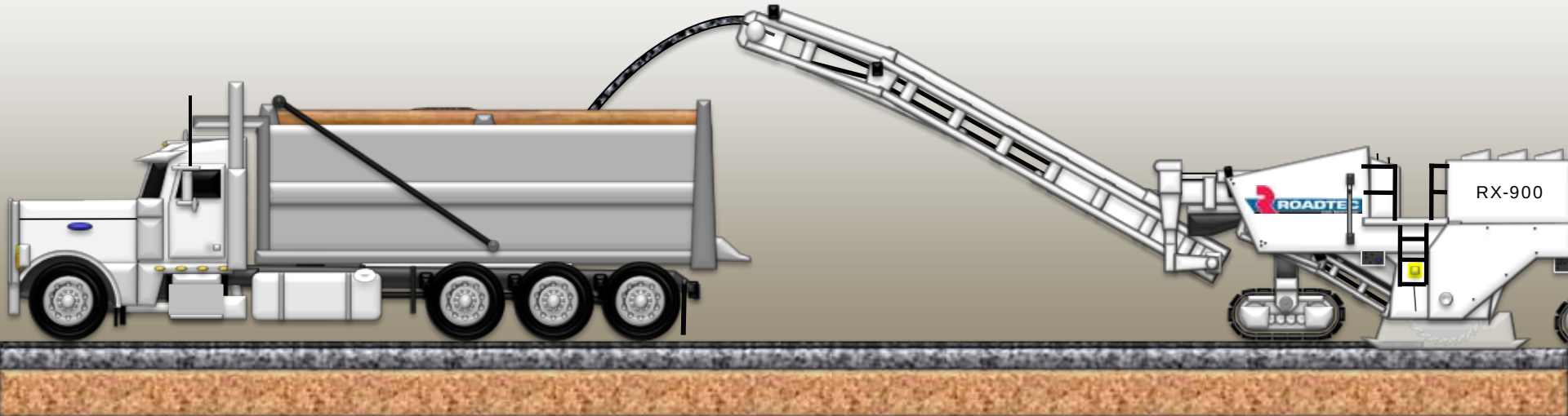
Don’t over load your truck.

Keep it consistent when you are loading.

We cannot forget that truck drivers have special needs.

Over loading trucks presents several problem:

a. Fines for truck drivers.
b. Fine for the company
c. This puts the drivers in jeopardy.
d. This also put other drivers at risk.
e. Spillage. Resulting in a poor job.

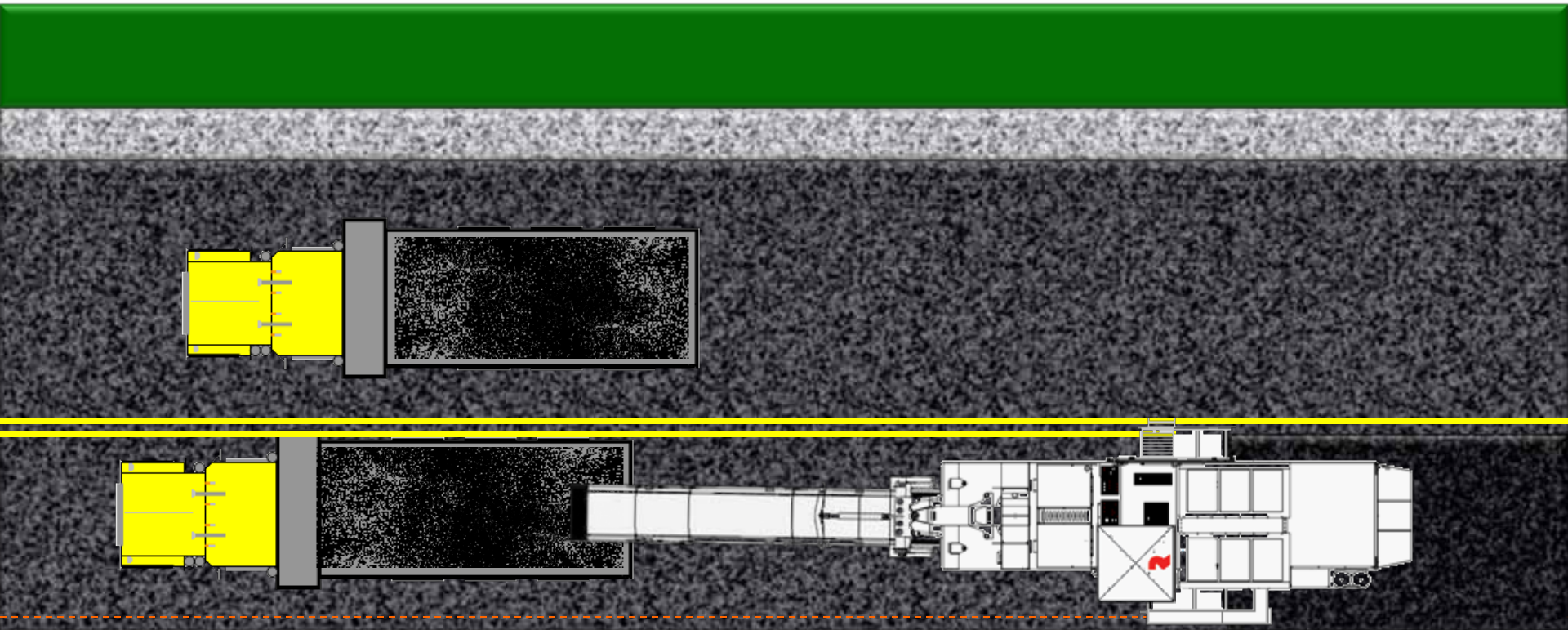


# Operator

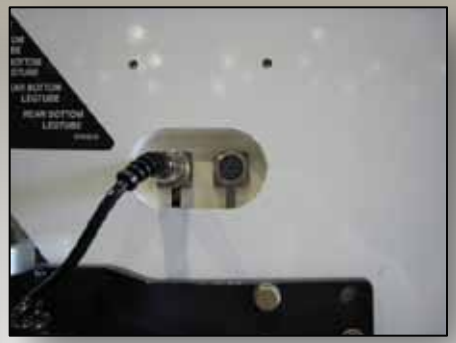
When its possible stage your trucks so that they can be loaded one after another.

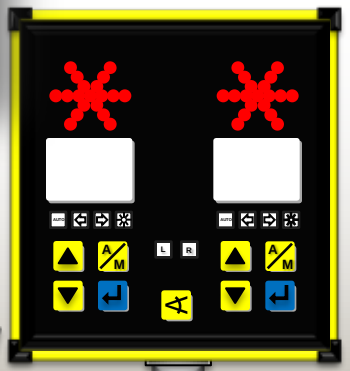
By side loading your trucks you will save time between your truck transitions.

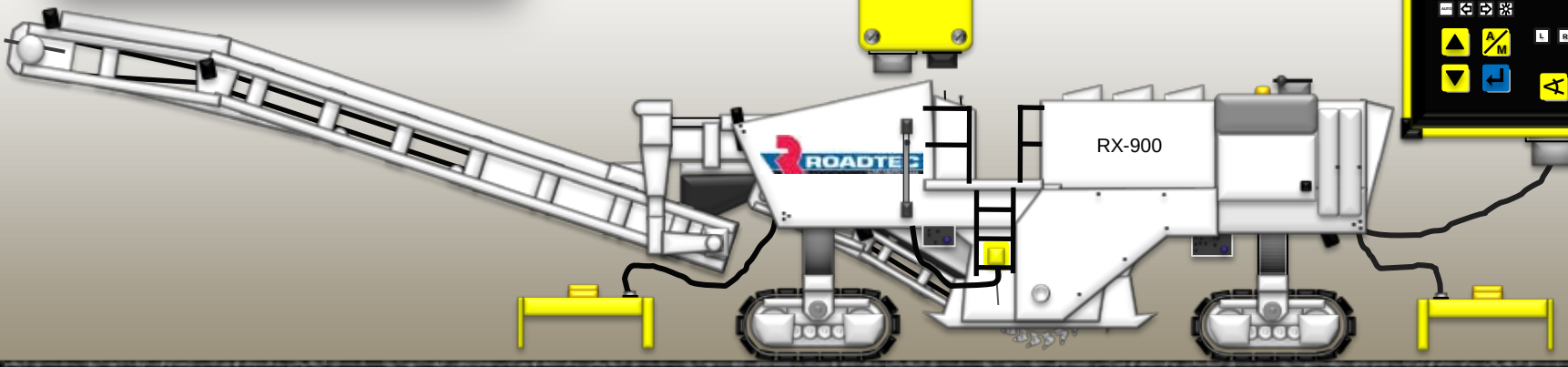
Remember that the conveyer will swing 60 degrees. Use this feature to your advantage.



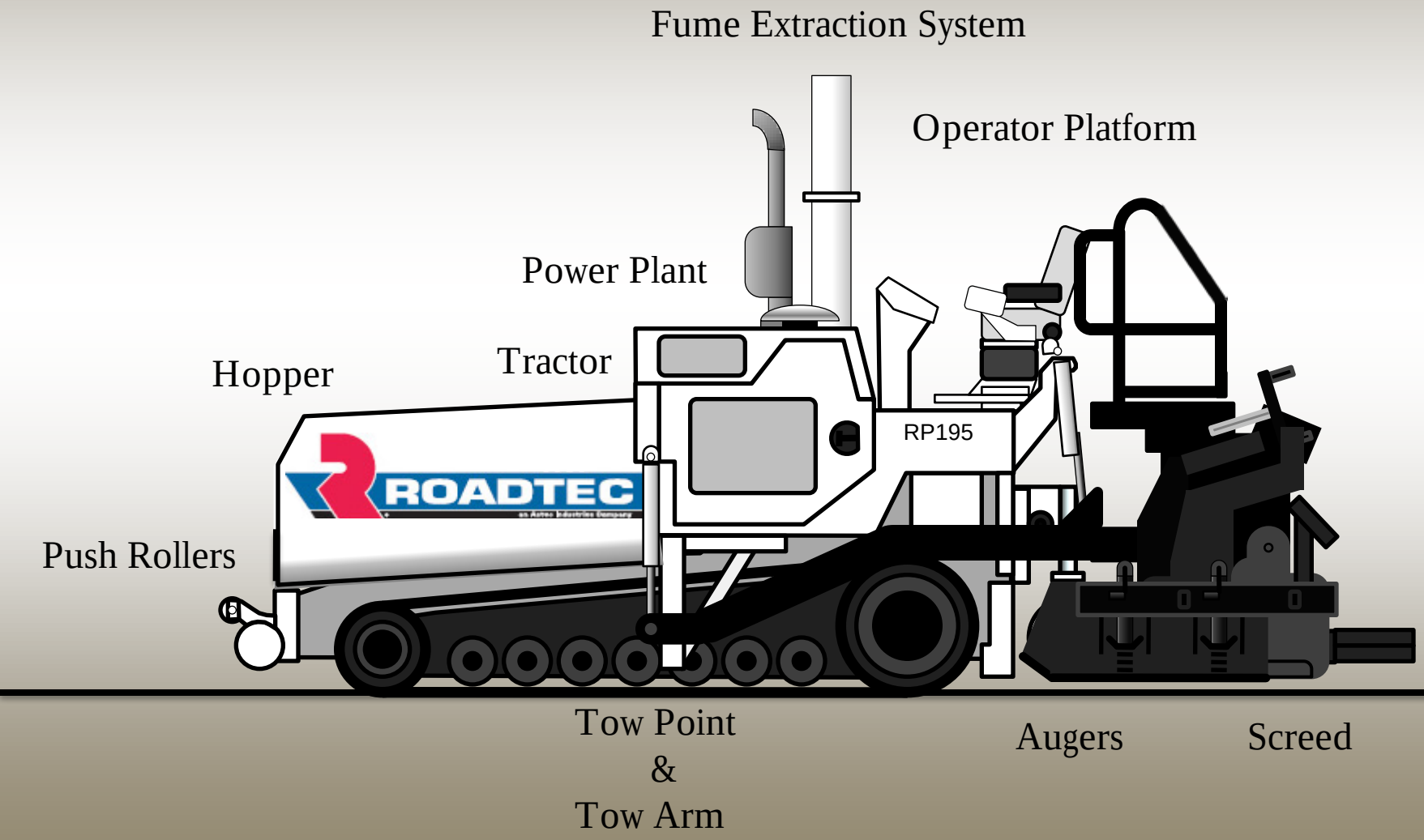
# Smooth Mill Ski



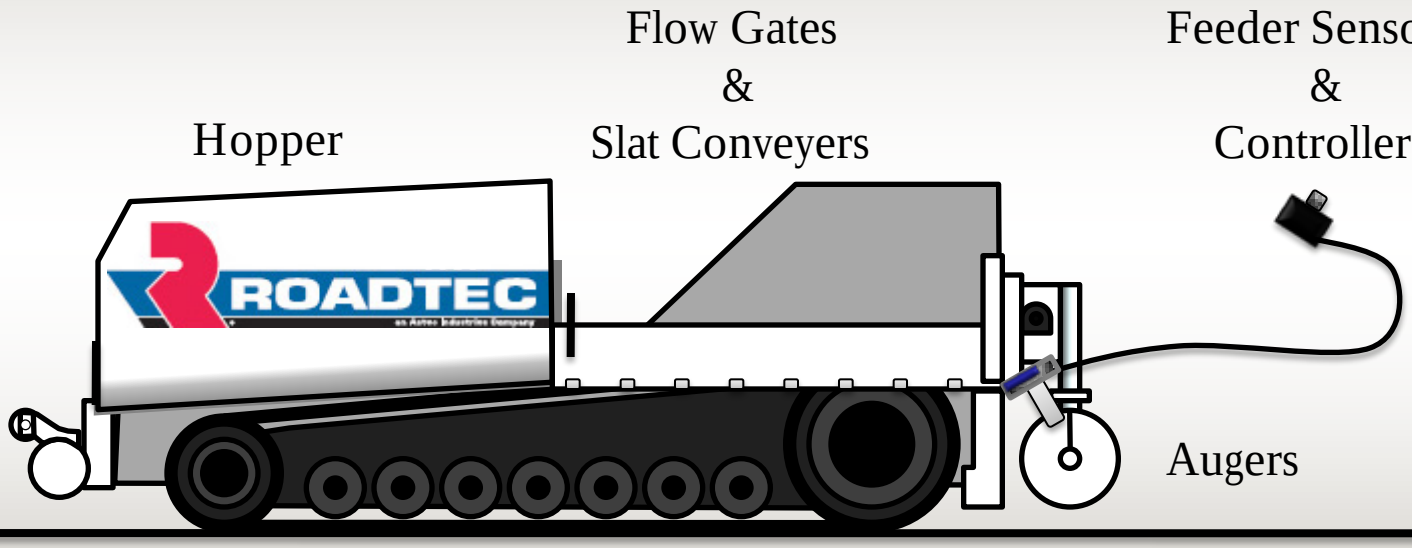




# Paver Components



# Feed System Components




The Hopper is  to receive the mix

Slate conveyors carry it through the paver tunnel

Flow gates to strike off the mix

Augers to distribute the mix in front of the screed

Sensors to control the material level at the outboard edge of the screed

# It's All Balance

To consistently build high quality, smooth riding roads, the paving speed MUST be at a constant rate.

Quality Paving Techniques:

1) Uniformed "Head of Material"

2) Proper Angle of Attack

3) Constant Speed of Paver

# Balancing production

What will I need to get the job done on time?

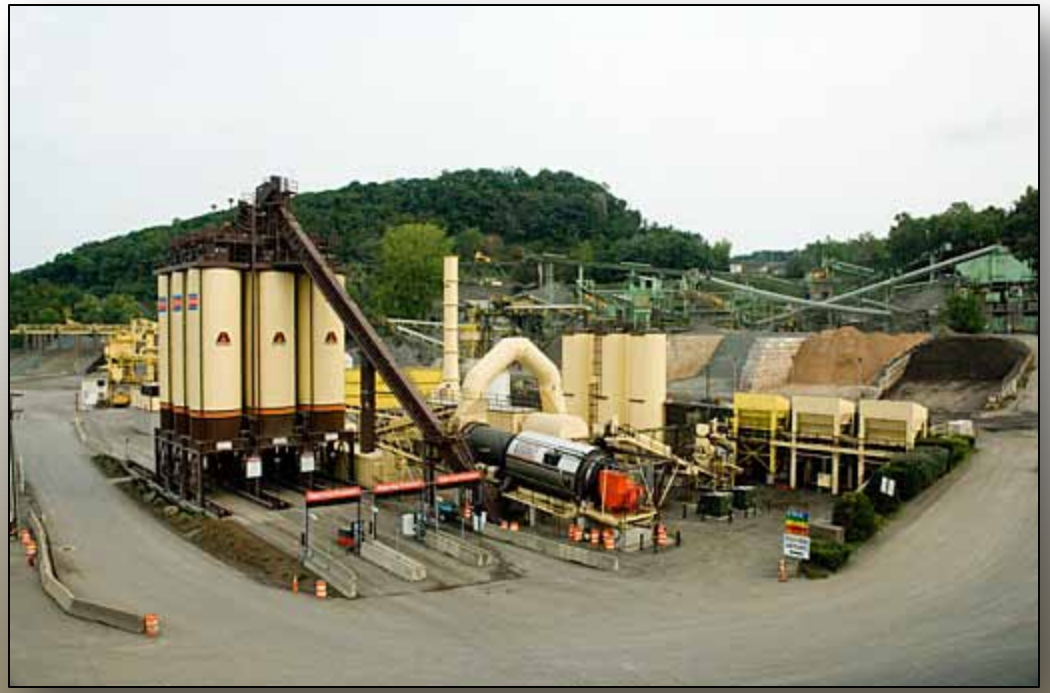
This is determined by:

Asphalt Plant Production.

Truck Capacity.

Length Of Haul.

Traffic Conditions.



# Asphalt Plant Production

We need to know how much asphalt can be produced for this job.

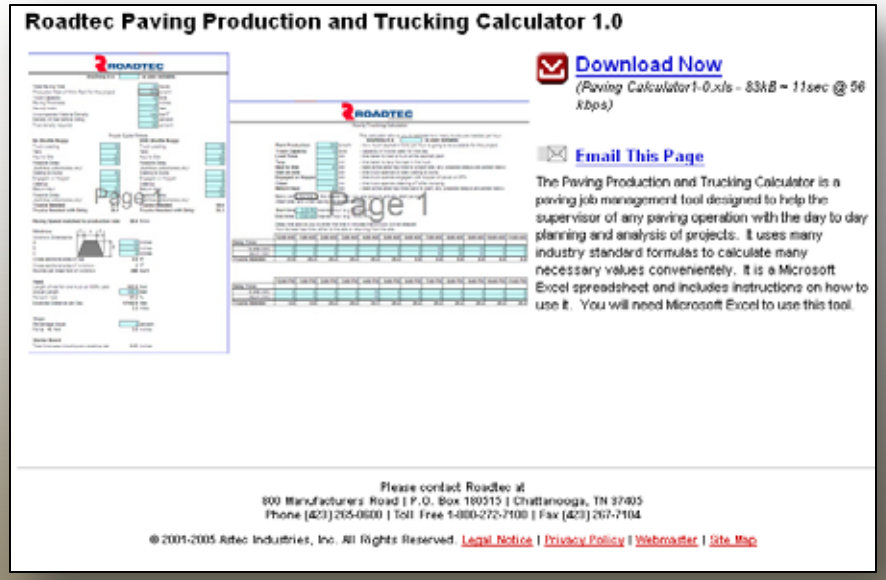
The plant may be making asphalt for jobs other than just our job.

The tonnage per hour that is available for your job is needed to calculate paver speed.

# Paving Calculator

Most foremen today use a laptop computer. This information is all available through the ROADTEC website.

This information will help us manage our jobs and balance our production. This balance will result in a better service to the customer.



**Roadtec Paving Production and Trucking Calculator 1.0**

Download Now

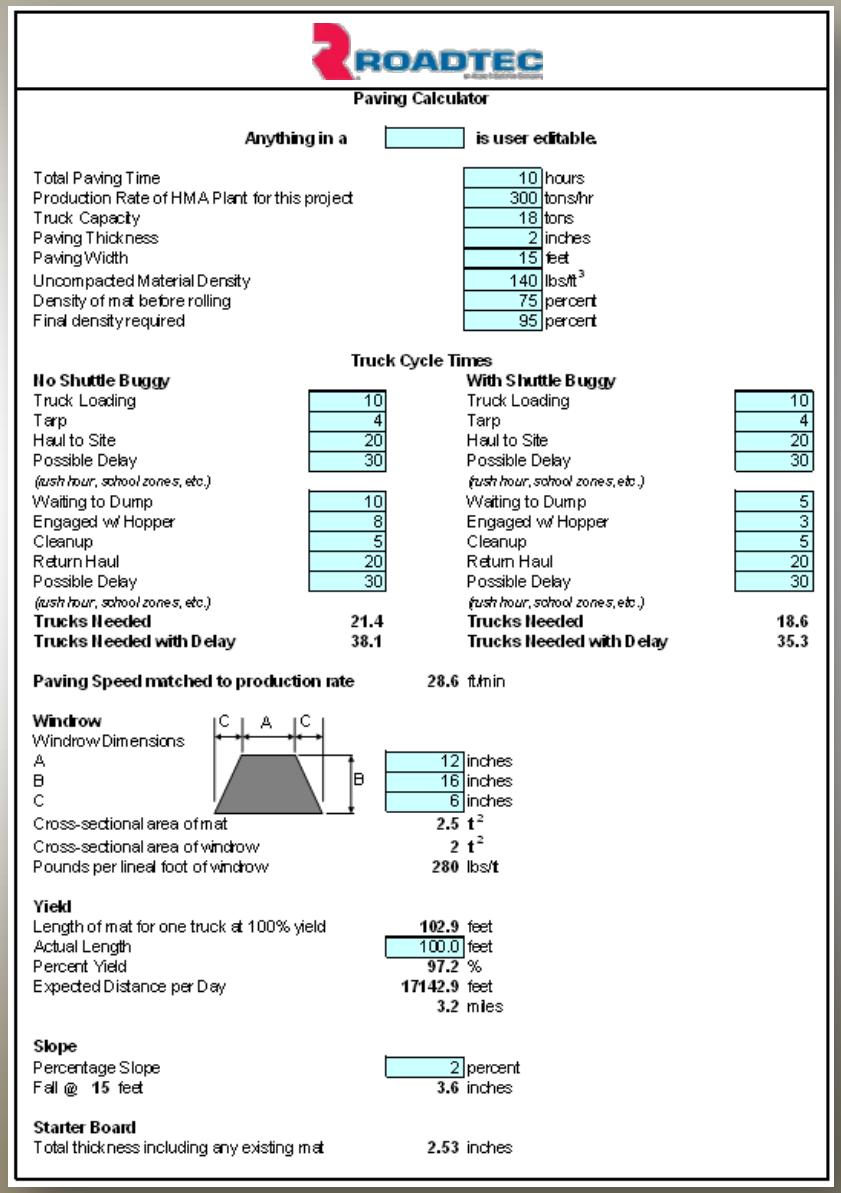
*(Paving Calculator1-0.xls - 83kB ~ 11sec @ 56 kbps)*

Email This Page

The Paving Production and Trucking Calculator is a paving job management tool designed to help the supervisor of any paving operation with the day to day planning and analysis of projects. It uses many industry standard formulas to calculate many necessary values conveniently. It is a Microsoft Excel spreadsheet and includes instructions on how to use it. You will need Microsoft Excel to use this tool.

Please contact Roadtec at
800 Manufacturers Road | P.O. Box 180313 | Chattanooga, TN 37405
Phone (423) 265-0600 | Toll Free 1-800-272-7100 | Fax (423) 267-7104





ROADTEC

**Paving Calculator**

**Anything in a** [ ] **is user editable.**

| | | |
|---|---|---|
| Total Paving Time | 10 | hours |
| Production Rate of HMA Plant for this project | 300 | tons/hr |
| Truck Capacity | 18 | tons |
| Paving Thickness | 2 | inches |
| Paving Width | 15 | feet |
| Uncompacted Material Density | 140 | lbs/ft$^3$ |
| Density of mat before rolling | 75 | percent |
| Final density required | 95 | percent |

**Truck Cycle Times**

| **No Shuttle Buggy** | | **With Shuttle Buggy** | |
|---|---|---|---|
| Truck Loading | 10 | Truck Loading | 10 |
| Tarp | 4 | Tarp | 4 |
| Haul to Site | 20 | Haul to Site | 20 |
| Possible Delay | 30 | Possible Delay | 30 |
| *(rush hour, school zones, etc.)* | | *(rush hour, school zones, etc.)* | |
| Waiting to Dump | 10 | Waiting to Dump | 5 |
| Engaged w/ Hopper | 8 | Engaged w/ Hopper | 3 |
| Cleanup | 5 | Cleanup | 5 |
| Return Haul | 20 | Return Haul | 20 |
| Possible Delay | 30 | Possible Delay | 30 |
| *(rush hour, school zones, etc.)* | | *(rush hour, school zones, etc.)* | |
| **Trucks Needed** | **21.4** | **Trucks Needed** | **18.6** |
| **Trucks Needed with Delay** | **38.1** | **Trucks Needed with Delay** | **35.3** |

**Paving Speed matched to production rate** **28.6** ft/min

**Windrow**

Windrow Dimensions




| | | |
|---|---|---|
| A | 12 | inches |
| B | 16 | inches |
| C | 6 | inches |
| Cross-sectional area of mat | **2.5** | t$^2$ |
| Cross-sectional area of windrow | **2** | t$^2$ |
| Pounds per lineal foot of windrow | **280** | lbs/t |

**Yield**

| | | |
|---|---|---|
| Length of mat for one truck at 100% yield | **102.9** | feet |
| Actual Length | 100.0 | feet |
| Percent Yield | **97.2** | % |
| Expected Distance per Day | **17142.9** | feet |
| | **3.2** | miles |

**Slope**

| | | |
|---|---|---|
| Percentage Slope | 2 | percent |
| Fall @ **15** feet | **3.6** | inches |

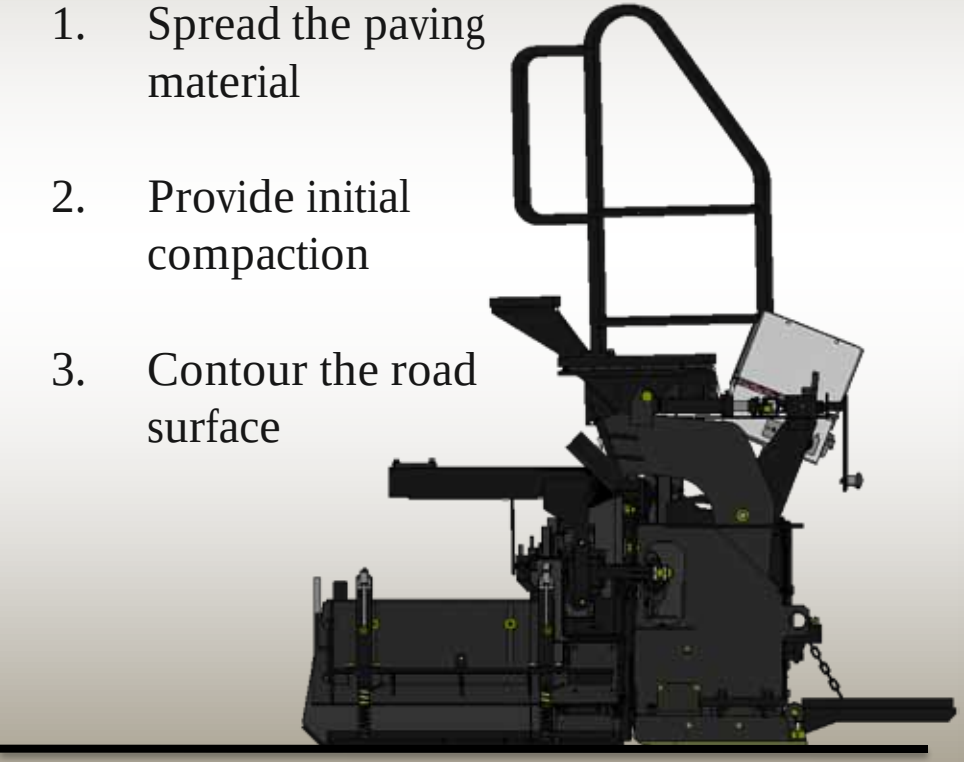
**Starter Board**

| | | |
|---|---|---|
| Total thickness including any existing mat | **2.53** | inches |

# Paving Principles

The main purpose of the screed is to:

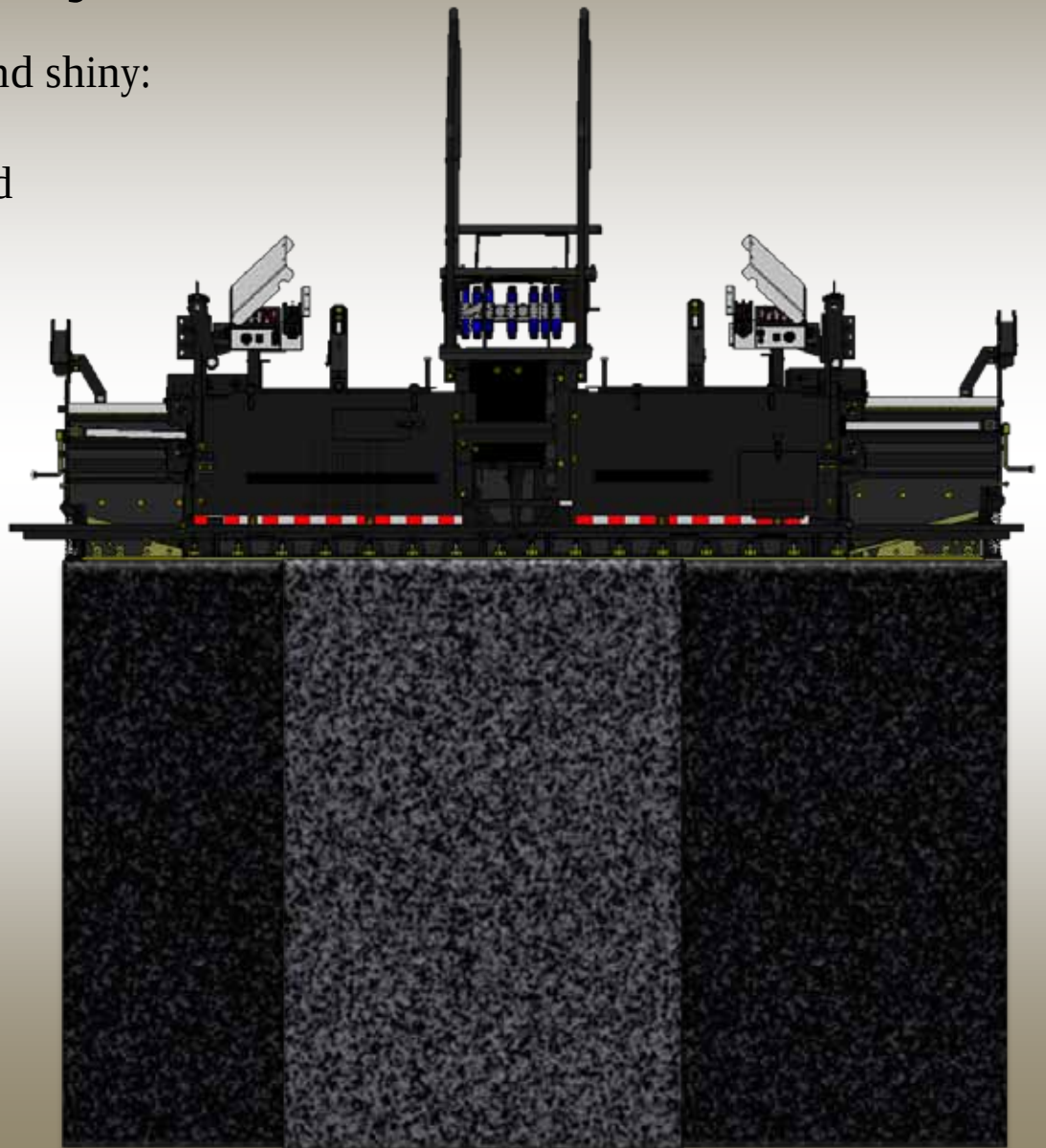
1. Spread the paving material
2. Provide initial compaction
3. Contour the road surface



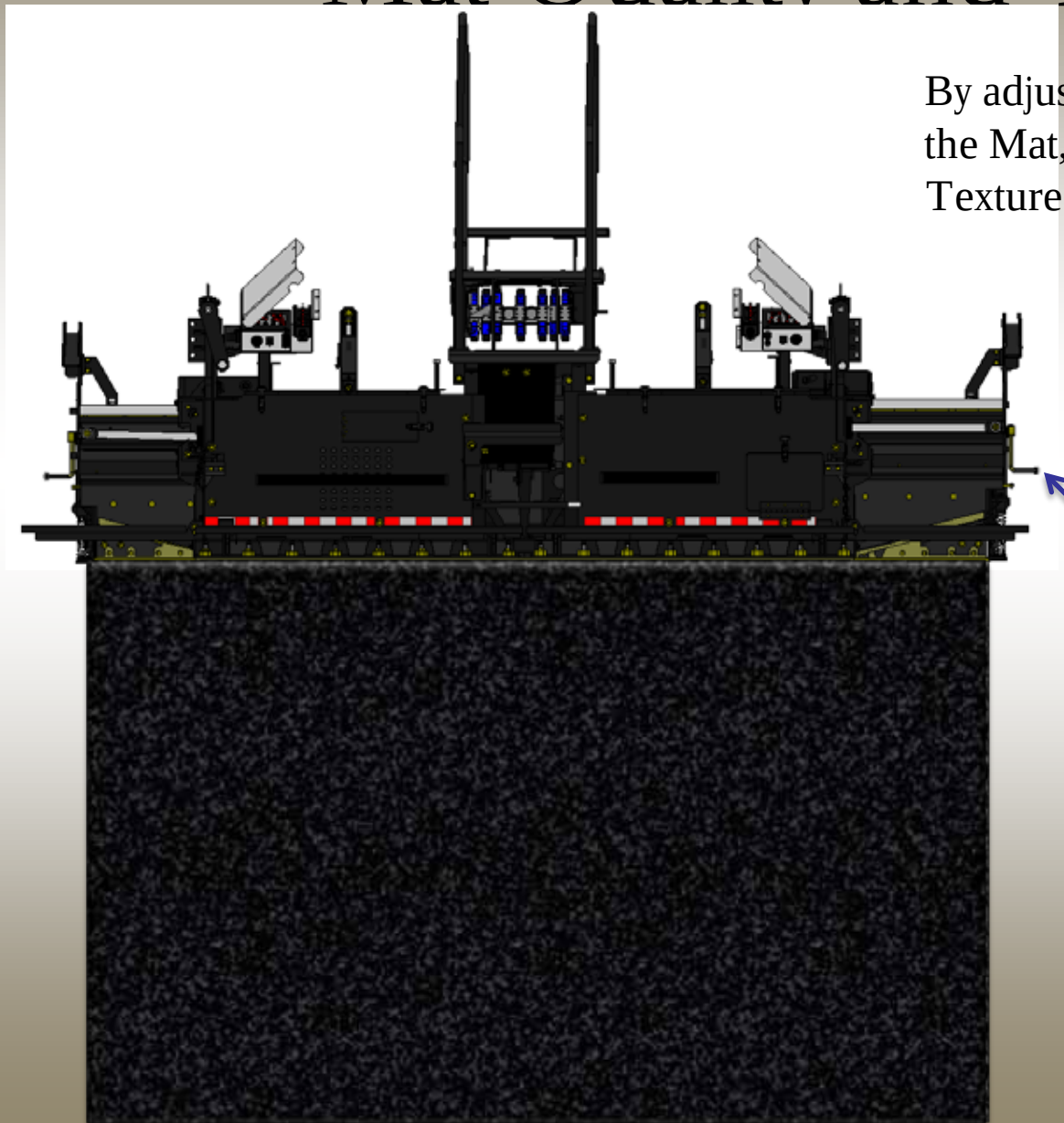
# Mat Quality and Texture

This mat (under extension) is too tight and shiny:

The angle of attack jack should be turned approximately one revolution counter clockwise to push the bull nose down to decrease mix feeding under the screed extension, thus transferring more weight to the main screed.



# Mat Quality and Texture



By adjusting the extensions to tighten the Mat, you will notice changes in the Texture.

Clockwise tightens the Mat.

Counter Clockwise loosens the Mat.

# Layout and Job Prep


# It’s ok, it will cover

Cover it, is not the answer here. It is understood that not all jobs are perfect but the customer needs to know what happens when jobs are rushed.

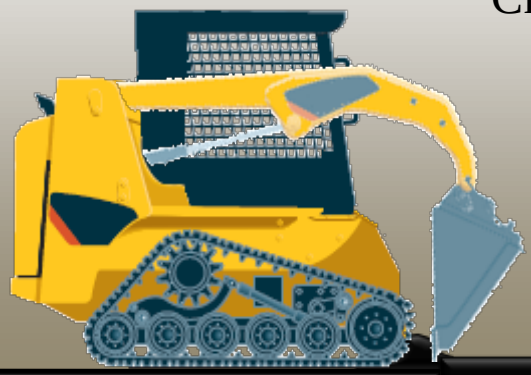
# Clean up and Joint Prep

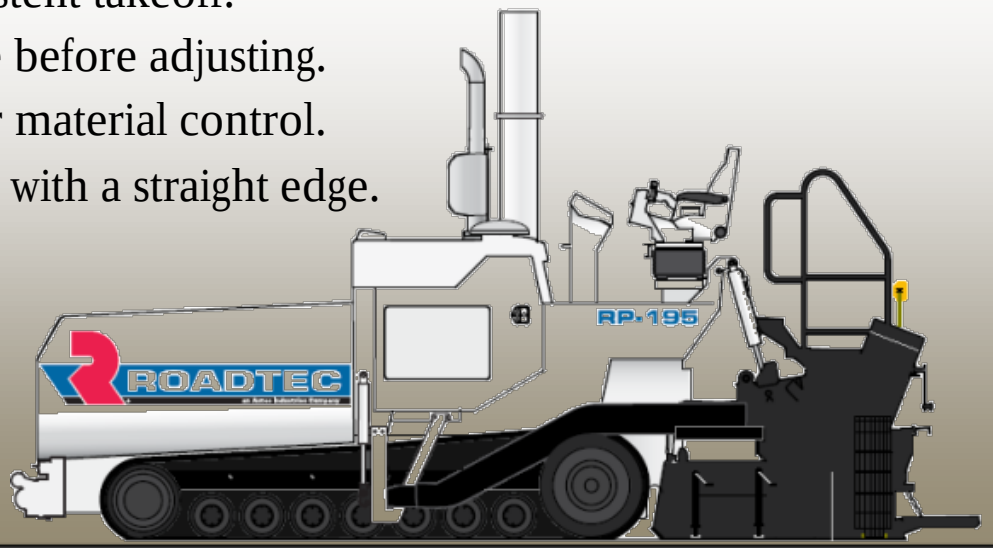
If the take off or landing weren't important, then they would let the kid in the window seat fly the plane.

If we just set down and pull off without any prep then we will go down.

Setting down and getting the following in order will give us a successful takeoff.

Allow for roll down.
Slow and consistent takeoff.
Take your time before adjusting.
Execute proper material control.
Check the joint with a straight edge.





# Anybody Know this Truck driver?


Keep control of your drivers. Slamming into the machine is a poor paving practice.

Explain to your drivers what you need and how they should approach the machine each time they unload.

# What happens here?

# Optional Equipment

We like to think we are innovators in the asphalt industry, but when do you draw the line ?

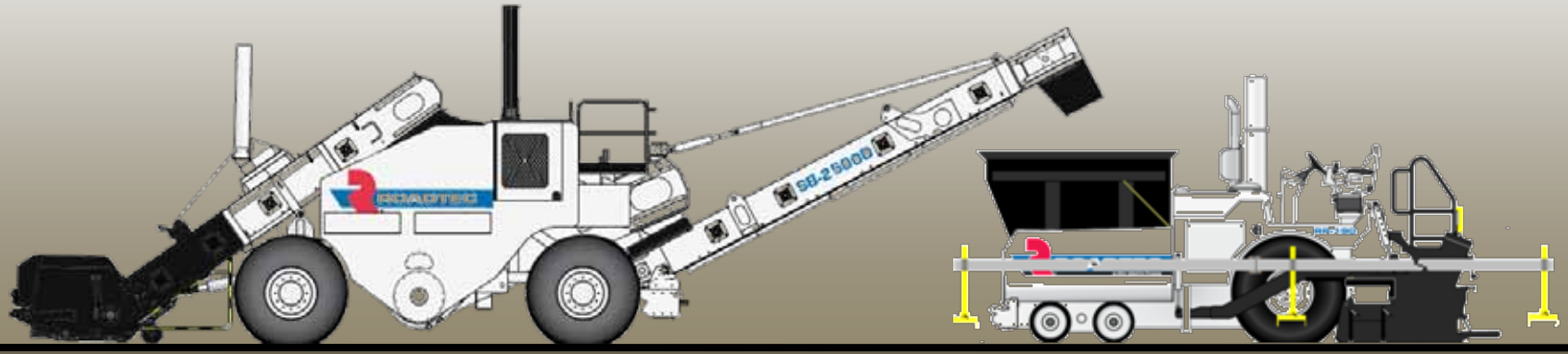
Material is made to go into the hopper by design and end up on the ground, but at the rear of the machine.


# Segregation

In summation, segregation in Hot Mix Asphalt mixtures is a common and persistent problem.

However, the problems can be controlled and even eliminated through:

- Proper mix design
- Proper maintenance
- Operation of plants
- Paving equipment



# Stabilizers Reuse All Materials

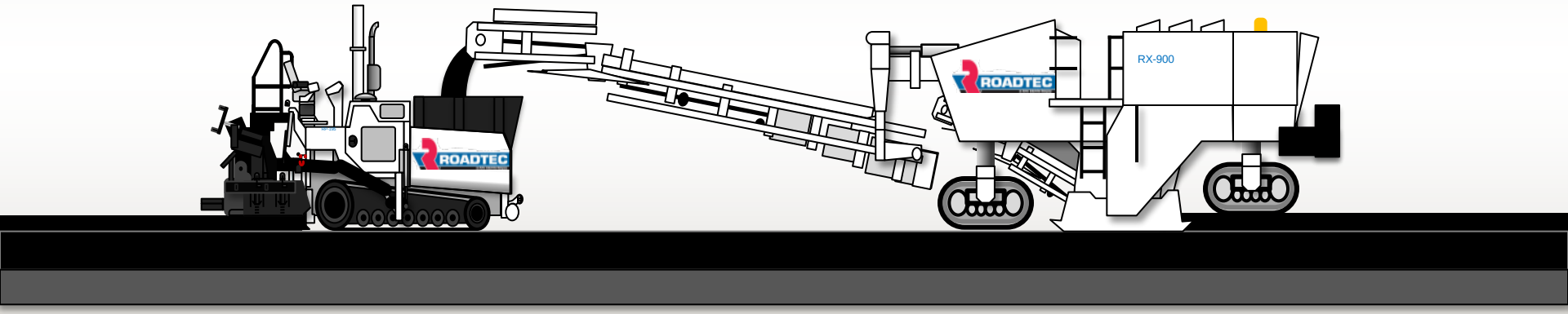
- **The use of a stabilizer can rehabilitate pavements that are almost beyond hope.**
- **Additives have been developed that will rejuvenate the lowest residual penetration grades and mix these materials into the base to create a new base**
- **100% recycling is a major goal of the stabilization industry**

# Stabilizers use cement

- **Dry Cement or fly ash can be placed on the ground and the stabilizer will mix this into the underlying materials.**

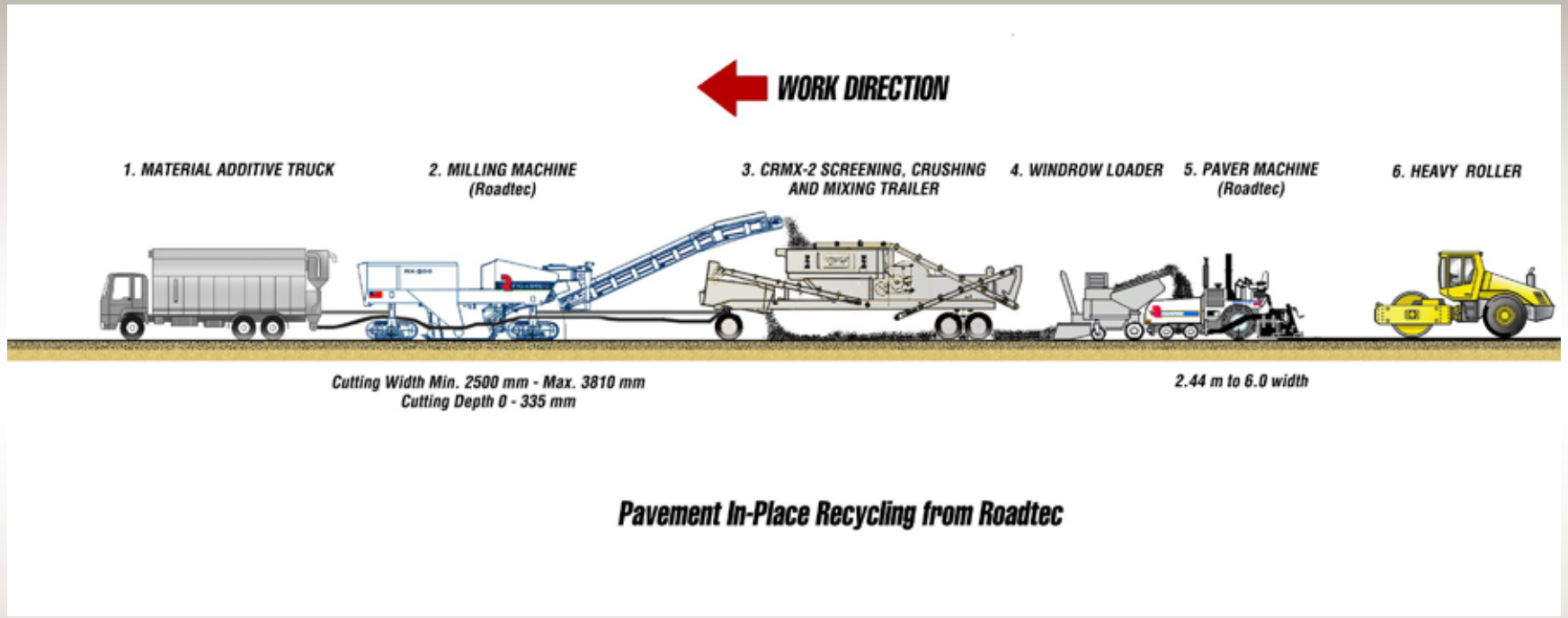
- **At the left, a wet slurry is sprayed onto the ground and the stabilizer is used to mix this into the roadway being stabilized.**

# Stabilizers use Emulsion




Direction of Travel

# The Train Machine Concept




**Used when the Engineer's design requires milled material & needs to be screened, be of a uniform size and fully mixed in a pugmill**

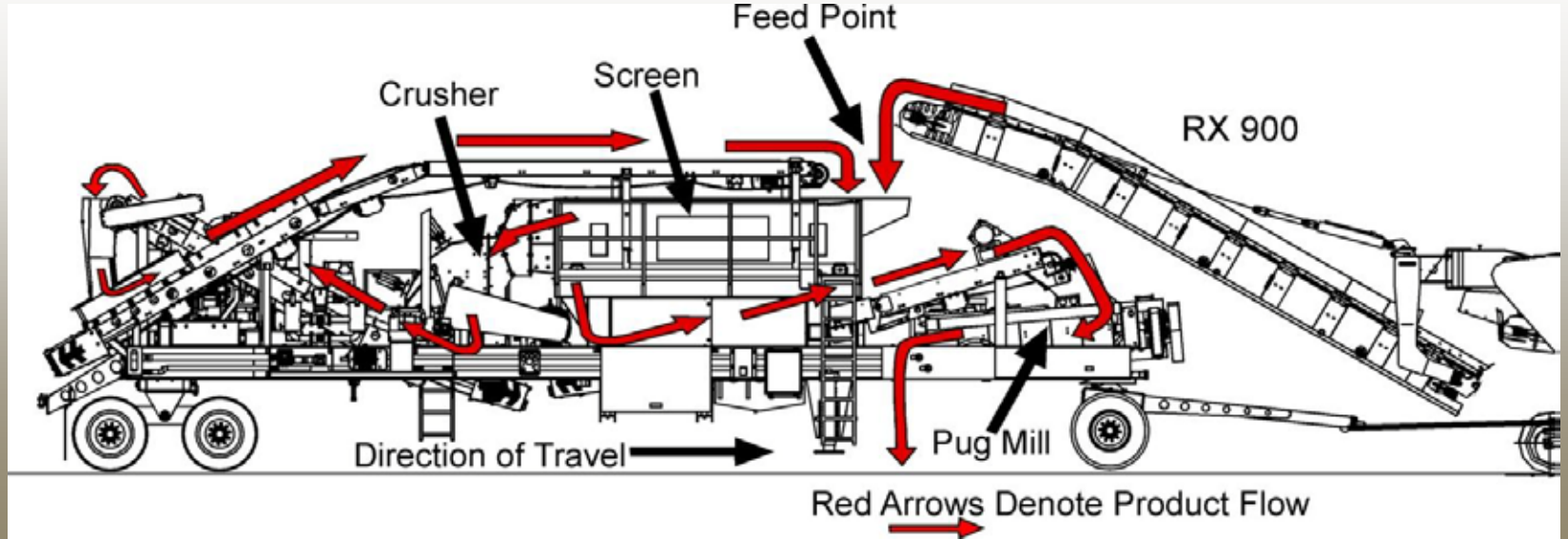
# Mix Designs

- The mix design can be as varied as the conditions require, in this instance, the emulsion was 2.5% by weight of RAP
- Water was added at 3% by weight of RAP
- Other additives such as slurrys or foamed AC can also be added
- Various materials can be added to an existing roadway to create a new layer of recycled pavement
- The Bearcat system is shown to the right.

# Full Lane Mill and Trailer Mounted Recycler

# The Recycling Mixing Trailer

- **The mill's conveyor puts milled material on the top deck of the 5142 JCI Flat Screen.**
- **If oversized, it goes through the Telsmith 3048 Horizontal Shaft Impact Cusher and back to the screen via a two conveyor return circuit.**
- **Material that passes the screen drops onto the 1.2 m (48") weight belt. This sends a signal to the blending computer which adjusts the flow of additives to the KPI Model 52 pugmill mixer.**
- **After a full mixing cycle it is discharged onto the roadway.**

# Elimination of Cracks coming to the Surface

**The new layer of recycled material will create a barrier to keep the sub-base cracking from coming to the new surface.**


Thank you!
Questions?