

# **BEST PRACTICE FOR COMPACTING WARM AND HOT MIX ASPHALT**

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**NEAUPG**

**OCTOBER 7, 2009**







# GOALS

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## DAILY

# SAFETY-QUALITY- PRODUCTION

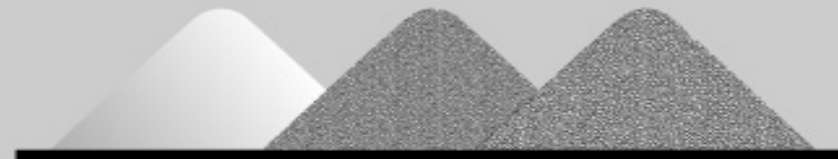
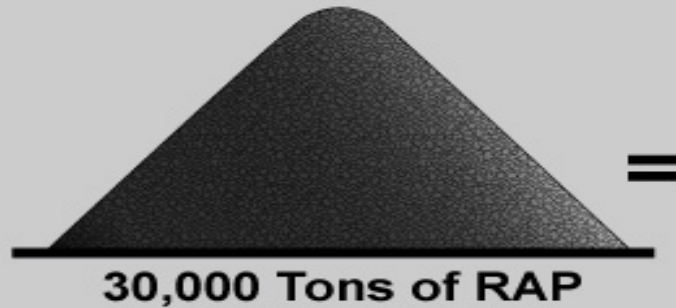
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- **EVERY PROJECT**
- **EVERY DAY**
- **EVERY TON**

# 101 COST SAVING IDEAS FROM NAPA

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- **WARM MIX ASPHALT**
- **RAP**
- **STOCKPILE PROPERLY**
- **ESTABLISH TRAINING FOR  
PAVING CO. CUSTOMERS**



**RAP is Worth the Virgin Material It Replaces**



# What is WMA?

- Process or additive that allows for the production and compaction of asphalt pavements at temperatures lower than traditional HMA
  - Reduction can range between **275 - 185°F**
  - Different mixes and technologies dictate temperature change





# WMA Technologies Used in North America

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## ■ Foaming

- Double Barrel Green
- Terex Warm Mix Asphalt System
- Gencor
- Stansteel
- LEA
- Aspha-min
- Advera WMA
- WAM Foam

## ■ Organic Additive

- Sasobit

## ■ Chemical Additive

- Evotherm
- Evotherm DAT
- REVIX
- Rediset WMX
- Cecabasa RT

# Summary of WMA Introduction to Drum Plants

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- **Foaming Devices**

- Foaming unit injects pressurized water into binder

**OR**

- Wet sand is introduced at the RAP collar

# Summary of WMA in a Drum Plant, cont.

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## ■ Additives

- Typically injected near binder line
- Terminal blending is an option for some technologies
  - Sasobit

# General Differences Between Technologies

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- Foaming using just water is less expensive but the drop in temperature is also less
  - May need an anti-strip agent
- Some of the additives alter binder properties
  - i.e. Sasobit
- Some additives act like additional fines
  - i.e. Aspha-min and Advera WMA



# Benefits of WMA

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- Energy savings
- Reduced emissions
- Extended paving season
- Increased haul distance
- Reduced issues with crack sealant
- Less oxidized binder
  - Less brittle, may endure cold better
  - Softer binder good for high RAP content mixes



# HMA vs. WMA





**HMA - 315° F**



**Aspha-Min WMA - 265° F**





Absc



# Similarities With HMA

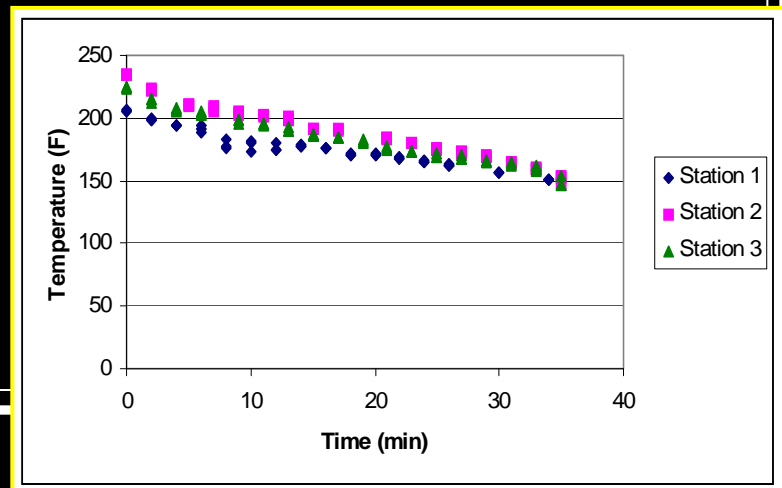
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- Same plants, just modified in many cases
- Same paving equipment
- Same rolling equipment



# Concerns About WMA

- Moisture susceptibility
- Rutting
- Affect on baghouse
- Coating
- Cooling
- Activate RAP and RAS binder
- Compatibility with polymer modified binder
- Expense



# How Are The Concerns Being Addressed?

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## ■ Moisture susceptibility

- Anti-stripping agents
- Monitoring of pavement performance
- Checking moisture content of mix
- To date no issues with moisture damage in the field

## ■ Rutting

- Binder is less oxidized but lab and early field result indicate it is not an issue
- To date no issues with rutting in the field

# How Are The Concerns Being Addressed?

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- Affect on baghouse
  - Monitoring high tonnage projects
- Coating
  - Some mixes look poorly coated prior to the silo but at the site are fine
  - Adjusting temperature
- Cooling
  - Properly tarped trucks
  - WMA does not cool at the same rate as HMA
  - Compaction window broader for WMA



# How Are The Concerns Being Addressed?

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- Activate RAP and RAS binders
  - Field and laboratory studies underway
  - Evaluating blending of virgin and RAP binder for HMA and WMA
- Compatibility with polymer modified binder
  - Test sites constructed
  - Higher temperature than neat mixes
- Expense
  - Offset by energy savings
  - Add RAP

# No Distress Apparent after One Year of Service



# Another year later...No Distress



# Good Longitudinal Joint





# Summary of Experience to Date

## ■ Concern: is WMA rut resistant?

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- Less aging of binder during production – not as stiff

## ■ WMA has been rut resistant to date

- Quick turnover to traffic
- Accelerated loading
- Industrial areas

# CAUTIONS

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- WMA is not a cure all
- Do not assume you can remove one roller
  - Mix dependent
- Properly tuned burners are a must to realize fuel savings
- The lowest temperature a technology can go is not always the best temperature for all mixes

# Future of WMA

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- Expect it to be a regular tool in your toolbox within the next 2 years
- Texas is running high tonnage projects regularly
  - 30,000 tons to 300,000 tons
  - One district only allows WMA for overlays

# COMPACTION

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- Is a mechanical process:
- \_\_\_\_\_ compresses HMA into a smaller denser volume after placement by applying one or more of the 4 forces of compaction
- Increases mixture stability:
- \_\_\_\_\_ forces asphalt coated aggregate particles closer together
- \_\_\_\_\_ achieves particle to particle contact

# *COMMUNICATION COMPACTION GOALS*

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- *DENSITY*
- *SMOOTHNESS*
- *BALANCED PRODUCTION*

# FACTORS AFFECTING COMPACTION

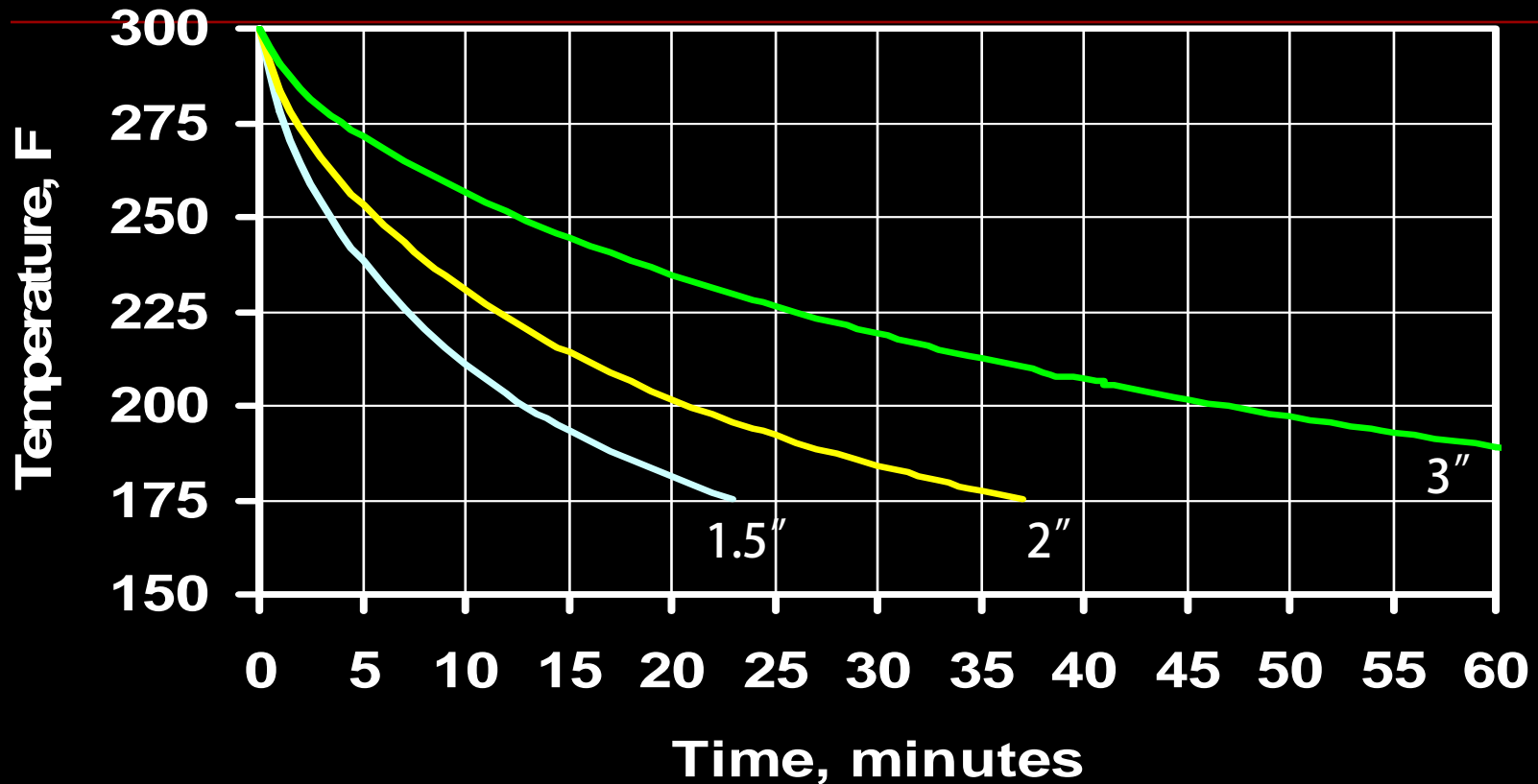
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- MIX DESIGN
- AGGREGATE AND ASPHALT CEMENT
- LAB DENSITY & FIELD DENSITY
- CLIMATIC CONDITIONS
- PAVER TYPE AND PAVING METHOD
- TEMPERATURE: MAT, BASE AMBIENT, DIRECTION OF SUN; WIND



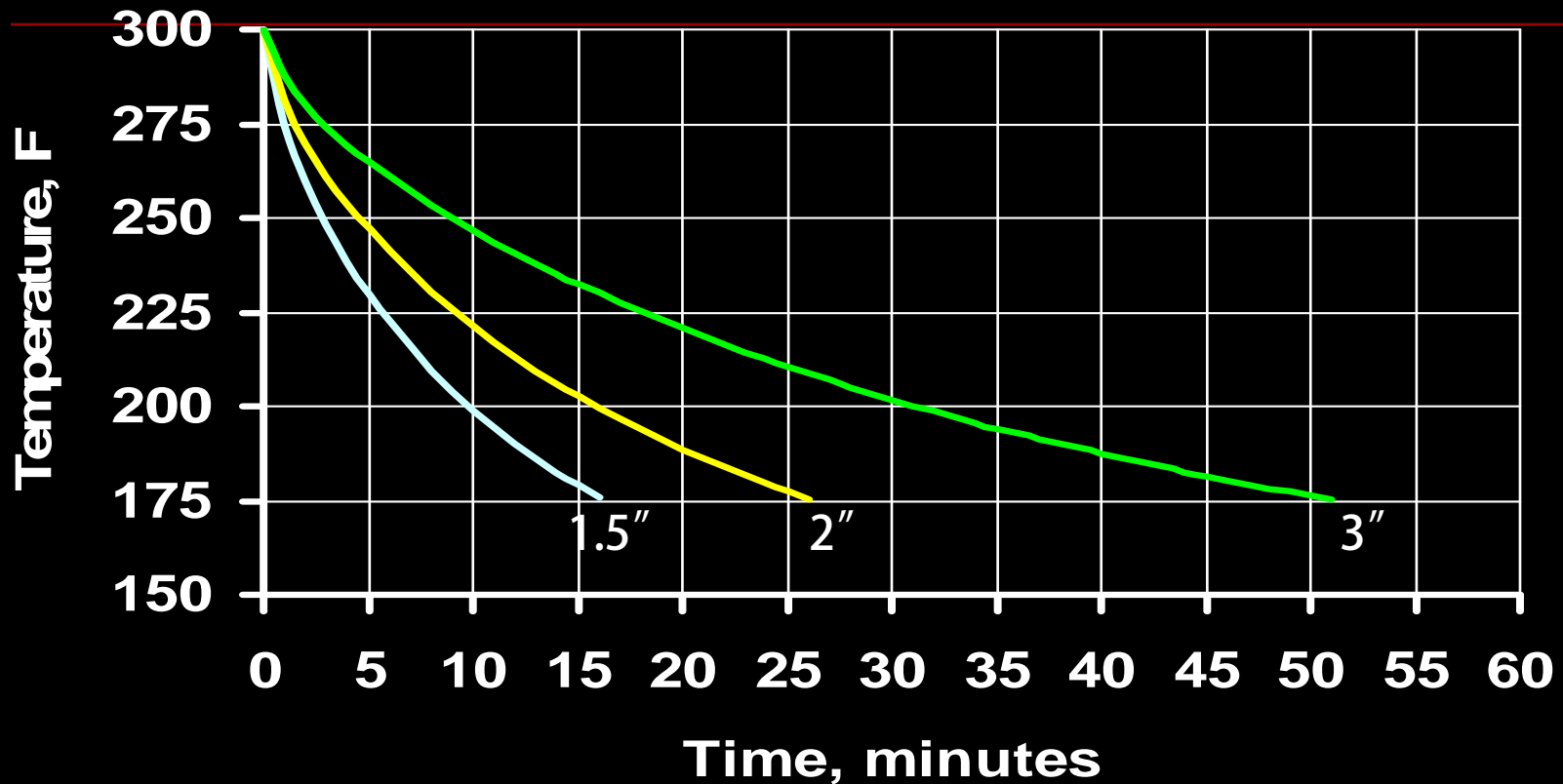
# Temperature

80°F Surface & Air Temperature, 5 mph wind



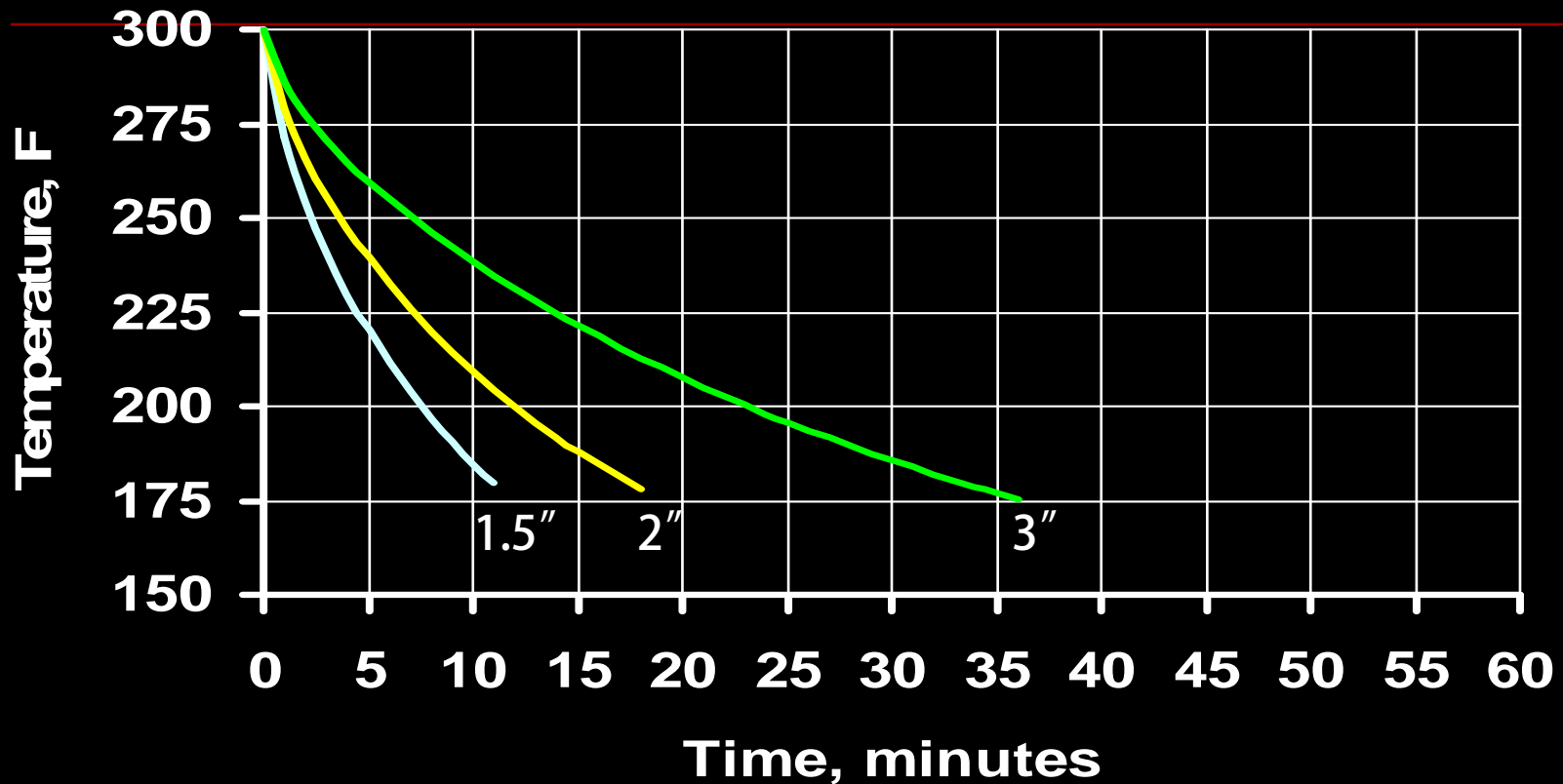
# Temperature

50°F Surface & Air Temperature, 5 mph wind



# Temperature

30°F Surface, 40°F Air Temperature, 15 mph wind



# Major Factors Affecting Rolling Time

	<del>allows MORE time</del>	<del>allows LESS time</del>
<b>Mat Thickness</b>	<b>THICK</b>	<b>THIN</b>
<b>Mix Temperature</b>	<b>HIGH</b>	<b>LOW</b>
<b>Base Temperature</b>	<b>HIGH</b>	<b>LOW</b>

# Compaction of Superpave Mixes

Compactive Force

Pressure  
Vibration

Pressure  
Manipulation

Pressure

**TENDER  
ZONE**

Temperature  
Zones

300° - 285°

240° - 200°

170° - 150°



# **WARM MIX ASPHALT COMPACTION**

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**MIX DESIGN: PG 82-22, POLYMER MODIFIED**

**WARM MIX PROCESS: SASOBIT ADDED AT  
THE PLANT**

**JOB LAYOUT: PAVING WIDTH 12', PAVING  
SPEED 25 FEET/MIN., LIFT THICKNESS 2 1/2  
INCH LOOSE**

**TEMPERATURES: MIXING TEMP. 315 F  
LAYDOWN TEMP OFF THE SCREED 287-  
305F**



# **WARM MIX JOB ROLLING PROCEDURES, TEMPERATURE ZONES, # OF PASSES, LENGTH OF ROLLING ZONES, DENSITY ACHIEVED IN EACH ZONE.**

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- **BREAKDOWN ZONE 66" DOUBLE DRUM  
VIBRATORY 3000vpm DISTANCE OF ZONE  
150' TEMPERATURE IN ZONE 287-305 F  
ROLLING PATTERN 5 PASS PATTERN  
DENSITY ACHIEVED 90%-92%**
- **INTERMEDIATE ZONE 66" DOUBLE DRUM  
VIBRATORY 3000vpm DISTANCE OF ZONE  
150' TEMPERATURE IN ZONE 200 F ROLLING  
PATTERN 5 PASS PATTERN DENSITY  
ACHIEVED 92.4%-94.3%**

# **WARM MIX ROLLING PROCEDURES**

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- **FINISH ROLLING 66" DOUBLE DRUM  
OSCILLATING DRUM ROLLER VIBRATE IN  
STATIC OUT 5 PASS PATTERN 200'  
ROLLING ZONE DENSITY ACHIEVED 94.7%-  
95.6%**



65-376

BW27 RH

POWER

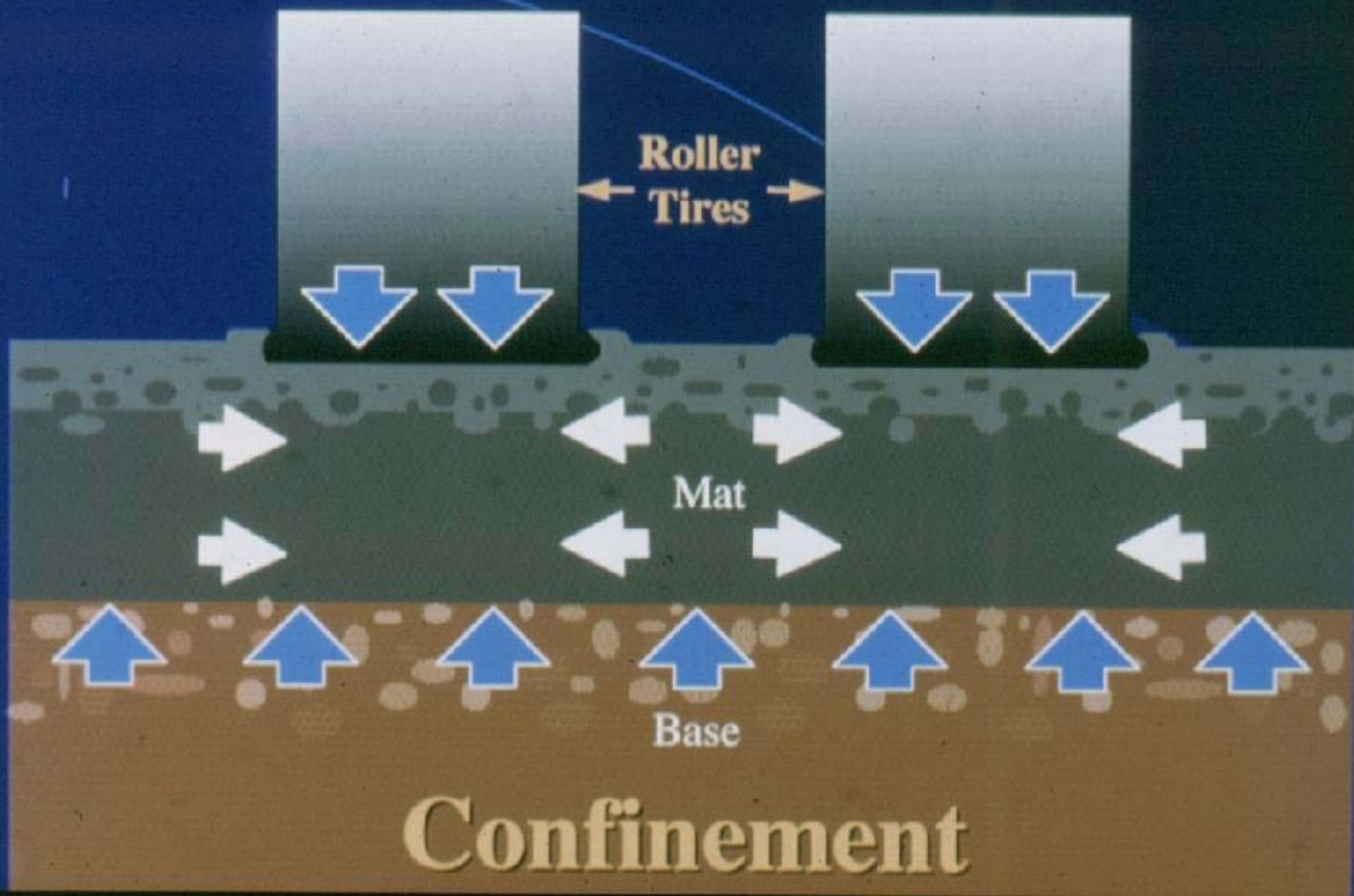


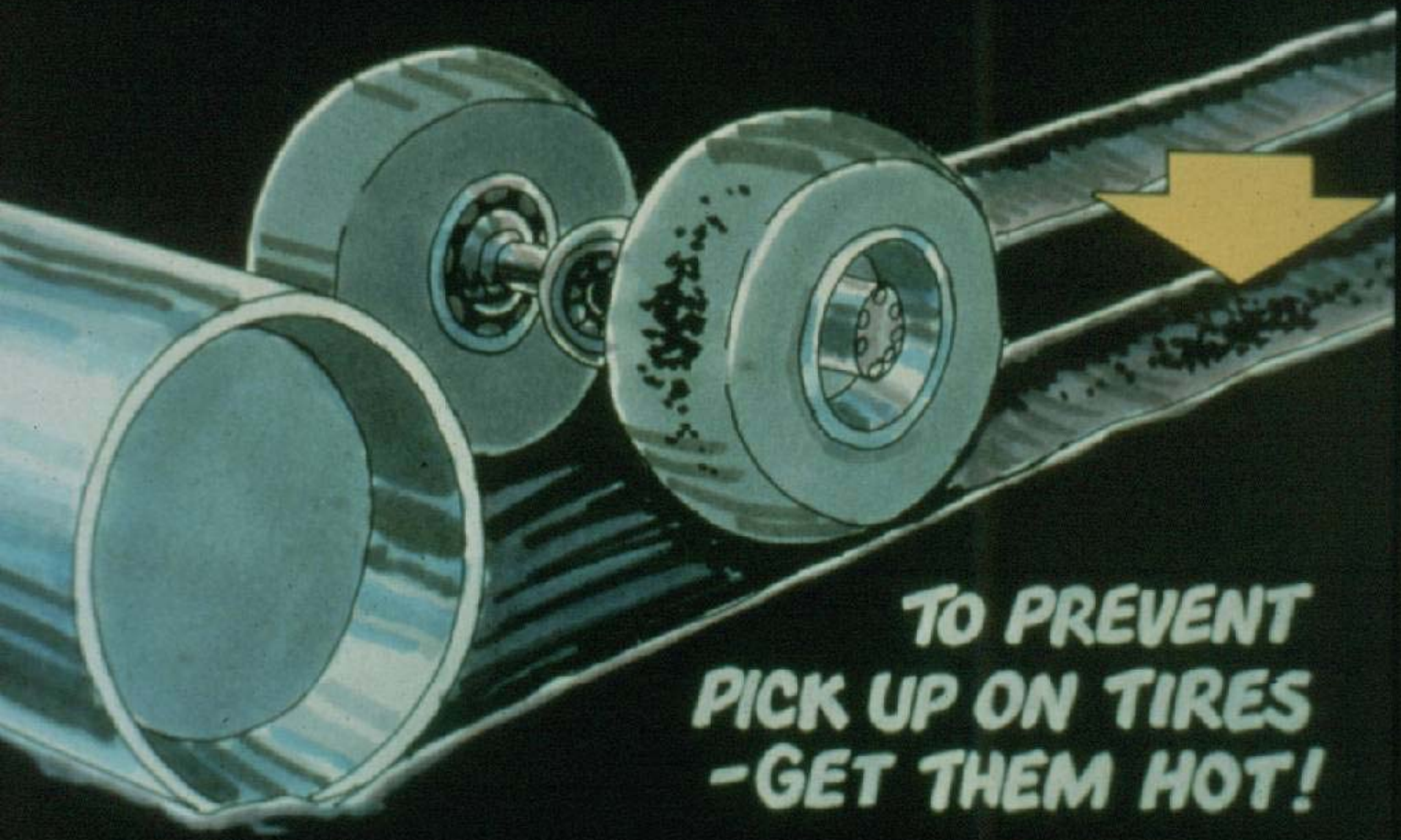
**Roller  
Tires**

Mat

Base

**Confinement**





**TO PREVENT  
PICK UP ON TIRES  
-GET THEM HOT!**



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parking  
Administration  
eiving  
urier

Stationnement  
supplémentaire  
Stationnement  
des autobus  
Administration  
Réception  
Courrier







**HYDAC**







# COMPACTION BY VIBRATION

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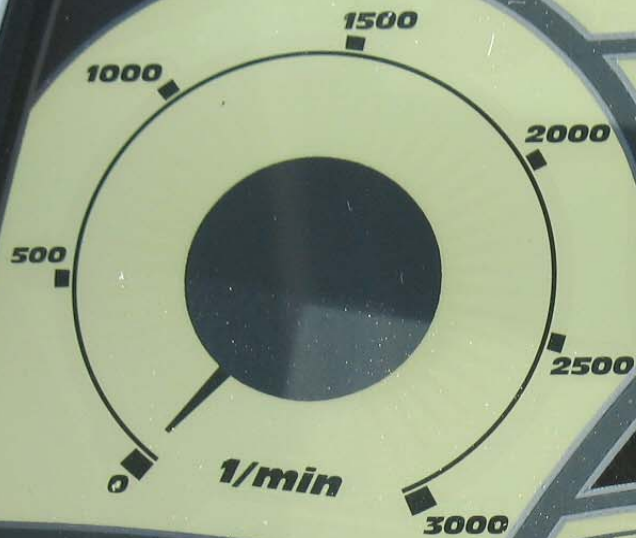
- WE REARRANGE THE AGGREGATE
- WE LOCK UP THE AGGREGATE STRUCTURE
- WE LEAVE IMPACT MARKS IN THE HMA MAT
- WE CONTROL THE SPACING OF THESE IMPACT MARKS, SO YOU WILL NOT SEE OR FEEL THEM, BY MATCHING- TRAVEL SPEED & FREQUENCY



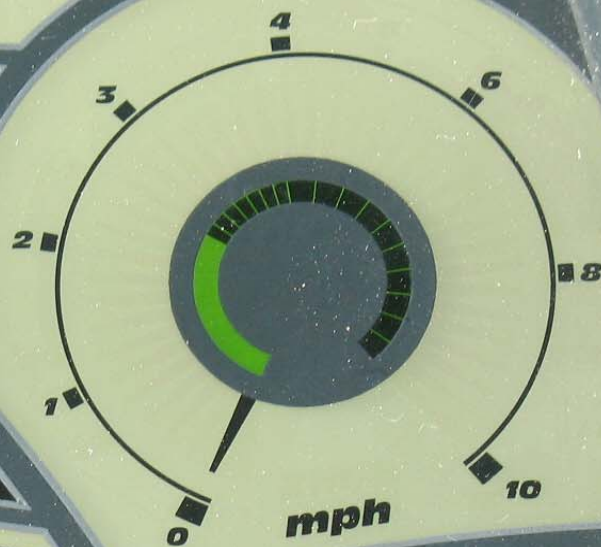
# SYSTEMS ON VIBRATORY ROLLERS

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- **AMPLITUDE: THE HEIGHT THE VIBRATING MASS MOVES FROM THE MATERIAL BEING COMPACTED-IN ONE ROTATION OF THE VIBRATING MASS.**
- **FREQUENCY: THE NUMBER OF TIMES THE VIBRATING MASS MOVES IN A MINUTE- VIBRATIONS PER MINUTE OR V.P.M.**
- **FREQUENCY AND AMPLITUDE CREATE A GIVEN AMOUNT OF CENTRIFUGAL FORCE.**



0853



gal/h



°F 32 120 180 230 290 340 390

2.5

mph

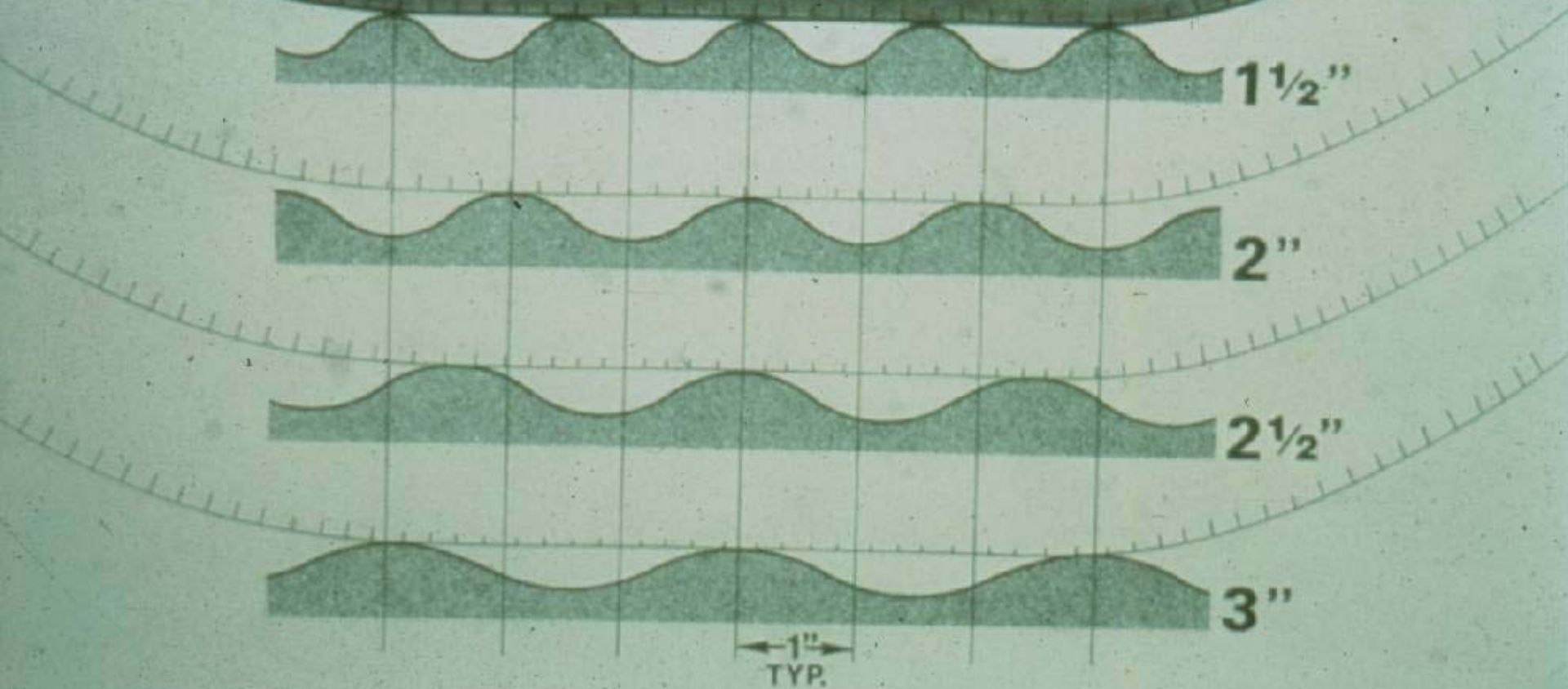


# **VIBRATORY IMPACTS PER FOOT IPF**

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**MAINTAIN BETWEEN 10-14 IPF  
IPF GIVES US DENSITY, SMOOTHNESS, AND  
BALANCED PRODUCTION**

# TIRE SURFACE CONTACT VS. VIBRATORY IMPACT SPACING

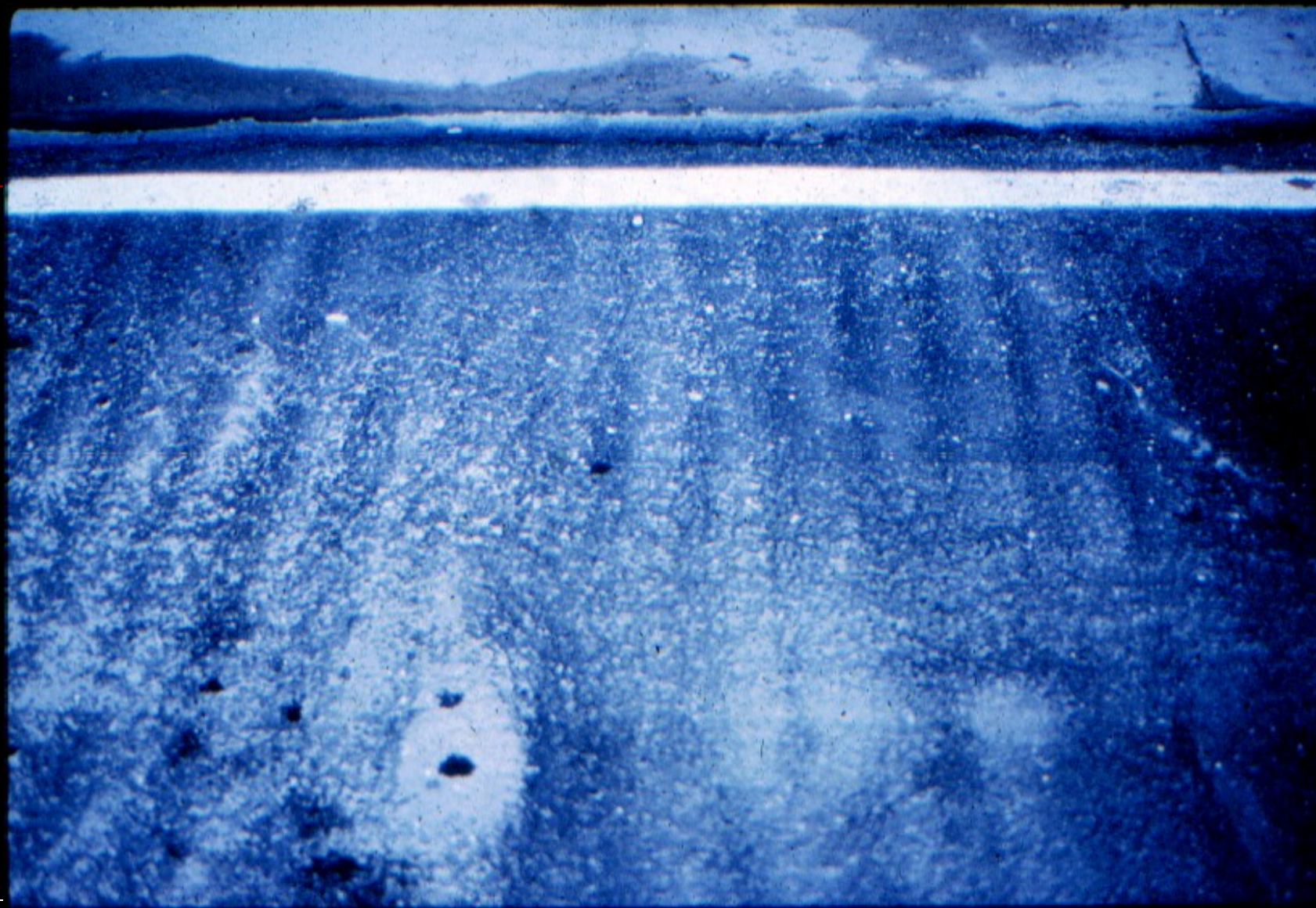




# *Impact Spacing*

Frequency	2 MPH	3 MPH	4 MPH	5 MPH
2000 vpm	1.06	1.58	2.14	2.64
2200 vpm	0.96	1.44	1.92	2.40
2400 vpm	0.88	1.32	1.76	2.20
2600 vpm	0.81	1.22	1.63	2.03
2800 vpm	0.75	1.13	1.51	1.89
3000 vpm	0.70	1.06	1.41	1.76
3200 vpm	0.66	0.99	1.33	1.65
3400 vpm	0.62	0.93	1.24	1.55
3600 vpm	0.59	0.88	1.17	1.47
3800 vpm	0.56	0.83	1.11	1.39





# **TRAVEL SPEED OF ROLLERS**

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**DOUBLE DRUM VIBRATORY 2-4 MPH**

**PNEUMATIC ROLLER 2-3 MPH**

**STATIC STEEL WHEEL ROLLER 3-5 MPH**

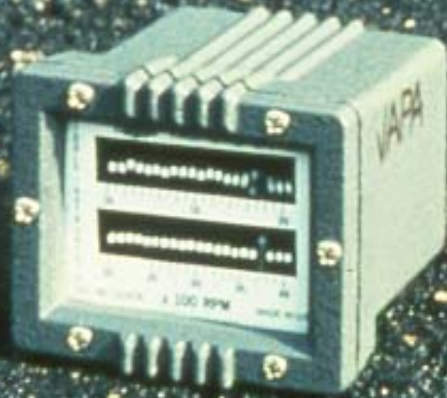
***SPEED CAN KILL***

# Drum Impacts per foot

(10/ft minimum)

Frequency	2 MPH	3 MPH	4 MPH	5 MPH
2000 vpm	11.36	7.58	5.68	4.55
2200 vpm	12.50	8.33	6.25	5.00
2400 vpm	13.64	9.09	6.82	5.45
2600 vpm	14.77	9.84	7.39	5.91
2800 vpm	15.91	10.61	7.95	6.36
3000 vpm	17.05	11.36	8.52	6.82
3200 vpm	18.18	12.12	9.09	7.27
3400 vpm	19.32	12.88	9.66	7.72
3600 vpm	20.45	13.64	10.22	8.18
3800 vpm	21.59	14.39	10.80	8.63





***Frequency***

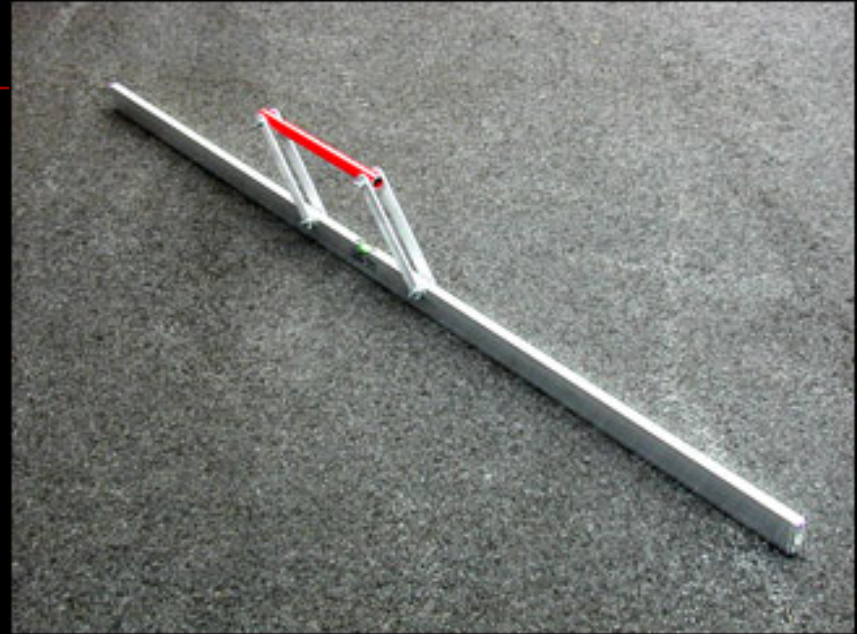




# How To Measure Roughness?

- Equipment

1. Straightedge

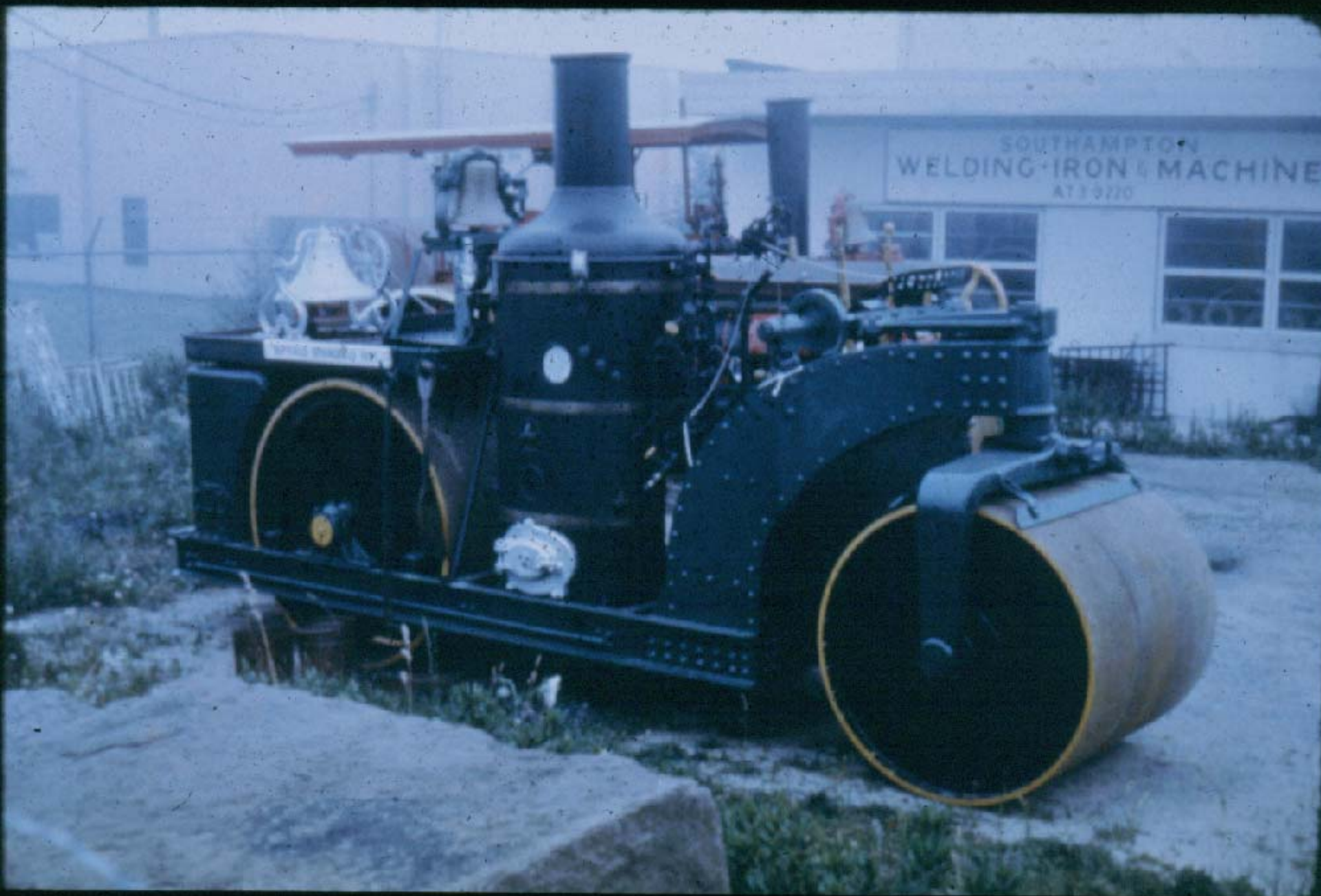


2. Inertial Profiler









# **BASIC PRINCIPLES OF GOOD COMPACTION**

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**KNOW THE VARIABLES**

**KNOW THE SPECS KNOW THE LAYOUT**

**ESTABLISH A PATTERN TO ACHIEVE:**

**COVERAGE, DENSITY, SMOOTHNESS, AND  
BALANCED PRODUCTION**

**KNOW THE BASIC OPERATION OF EACH TYPE  
OF ROLLER**

# CONCLUSIONS:

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**COMPACTION OF WARM MIX AND  
HOT MIX ASPHALT FOLLOW  
BASIC BEST PRACTICE**

**WARM MIX, DEPENDING ON MIX  
DESIGN HAS BEEN EASIER TO  
COMPACT-----AND WE HAVE  
REDUCED THE # OF ROLLERS,  
BUT THIS IS THE EXCEPTION**



