Welcome

HAMM

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Outline

HAMM

- Compaction Basics
  - What is compaction?
  - Why do we compact?
- 4 Elements of compaction
- Roller Train
  - Varies with specifications and location
- Roller types
- Roller design specs affecting compaction
- External factors affecting compaction
- What affects roller patterns
- Summary

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Basics of compaction

Why do we need compaction?

Why Compaction?

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To build support foundations

Hydro power dams

Building pads

Airport runways

Roads & streets

Soil Material

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The most important Characteristics of soil are:

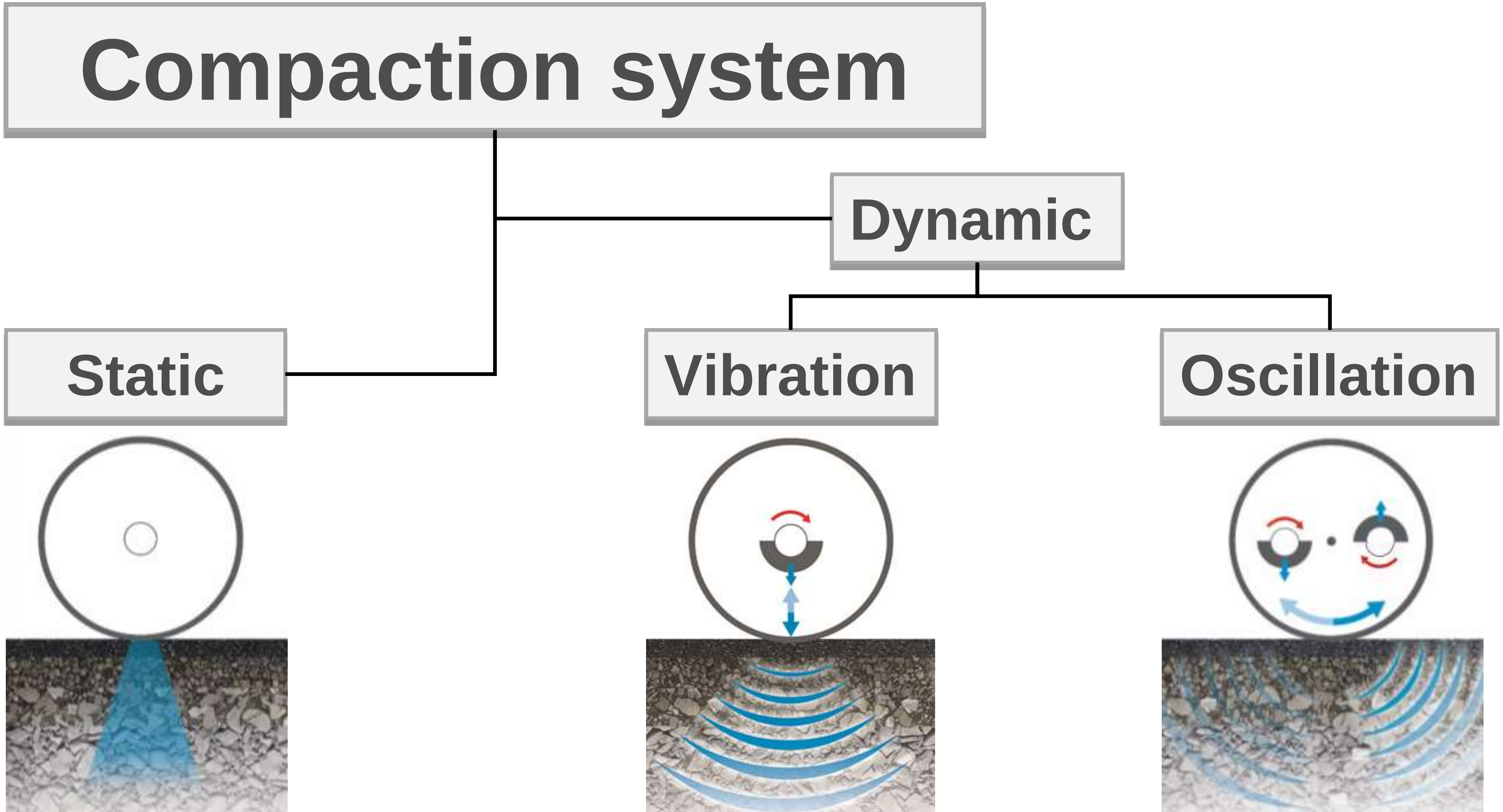
- **High load-bearing capacity**
- **Good stability**
- **Low water permeability**
- **Extremely level**
- **Grading curve**
- **Layer thickness**

Asphalt Material

<u>Most important parameters are:</u>

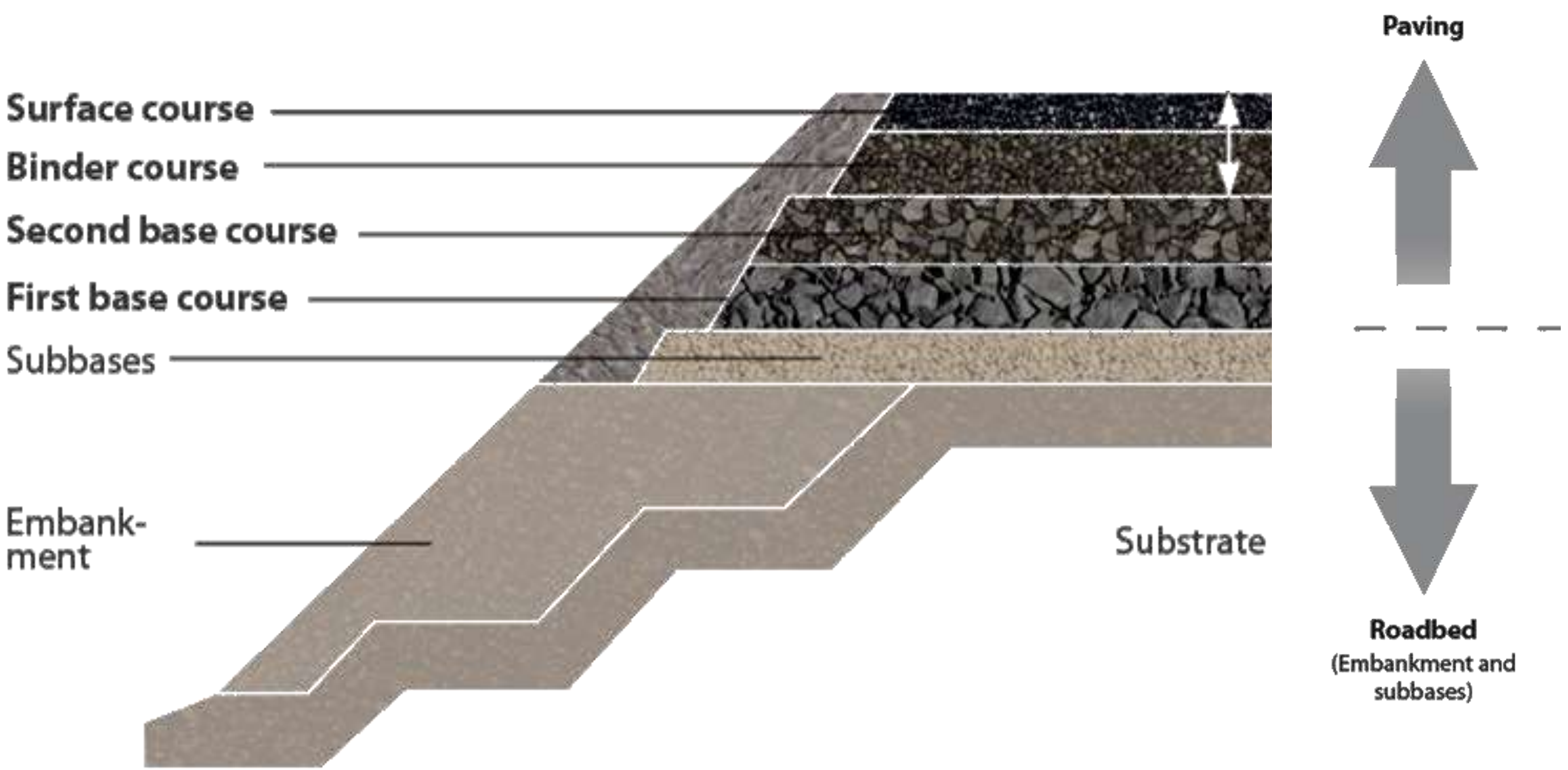
- **Mix type**
- **Particle size distribution curve**
- **Binder type and proportion**
- **Environmental conditions when paving**
  - **Temp, wind, overcast or sunny**
- **Course thickness**

Basics of Compaction



Why Compaction?

To build and rehabilitate roads



Why Compaction?

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- **Improve material stability**
- **Minimize permanent deformation / rutting**
- **Improve fatigue resistance / cracking**
- **Reduce moisture penetration & breakouts**

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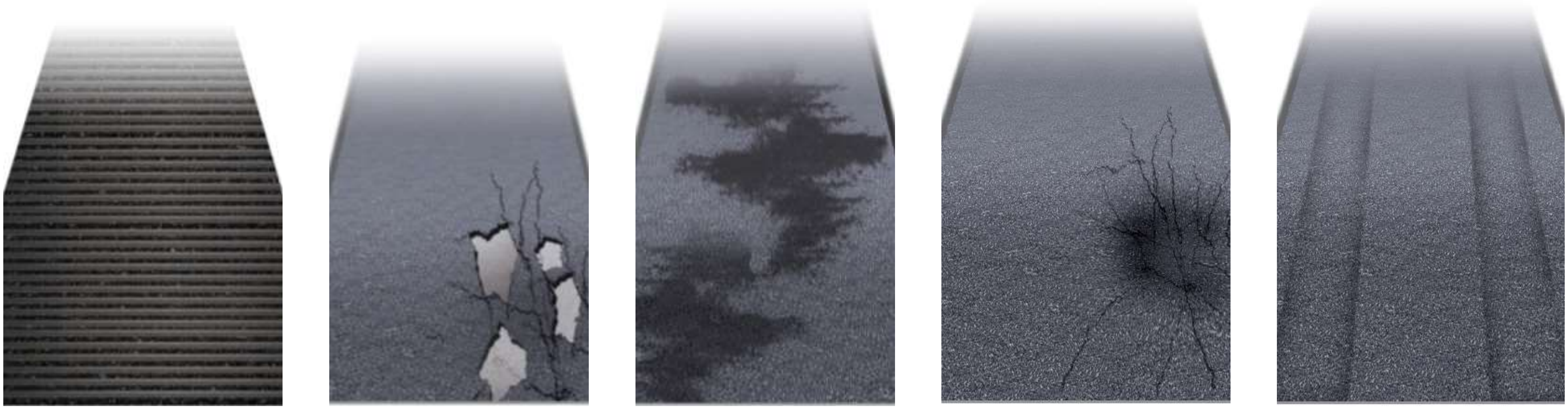
Typical damage patterns and their sources of error



Pavement Distresses

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Ruts are caused by:

- **Over-compaction** - due to insufficient voids in the compacted asphalt body, the mix cannot "contract" or "relax" due to the traffic load. This results in plastic deformation and no visco-elastic deformation.
- **Under-compaction** - there is an insufficiently interlocked grain structure! This is compressed by traffic over time.
- **Defective mix**

Pavement Distresses

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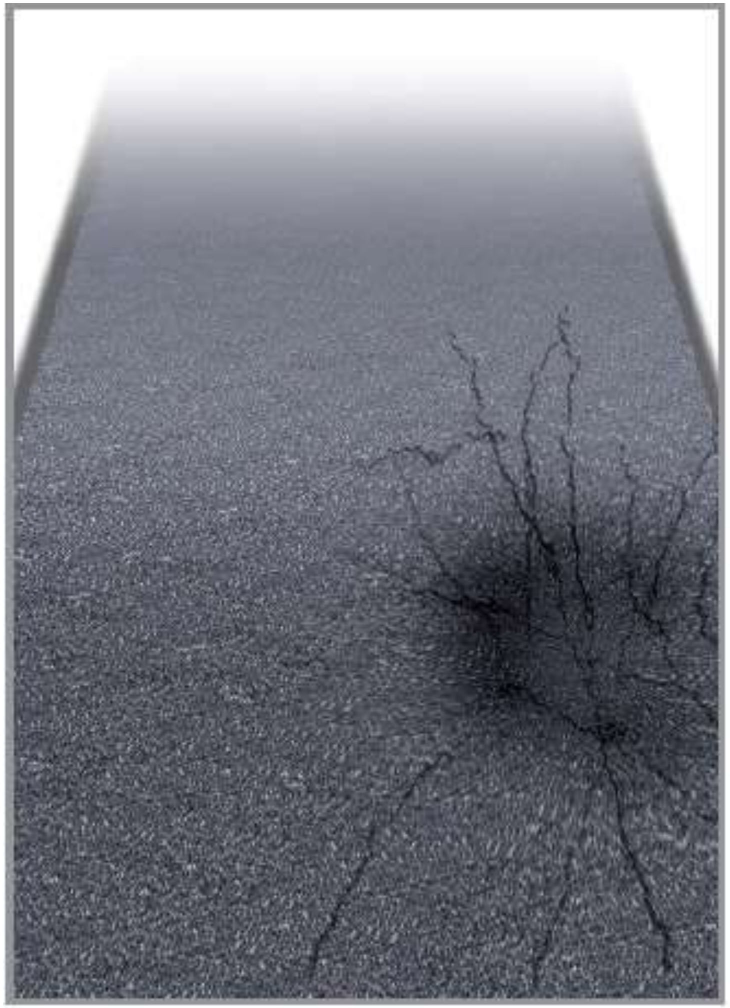
Settlements are caused by:

- **Insufficiently load-bearing soil** that is compacted locally under the traffic load (weak point in the subsoil)
- **Penetrating water (e.g. burst pipe)** that penetrates into the road body and flushes out the subgrade



Pavement Distresses

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Binder enrichment (bleeding) results from:

- **Too high binder content in asphalt mix**
- **Too much bitumen emulsion (tack)**
- **Incorrect use of the dynamic compaction** binder is pulled to the surface by vibration compaction
- **Too Intensive use of pneumatic tire rollers**
- **Over-compaction** - bitumen is drawn to the surface by "ironing"
- **Mix that is too hot**

Pavement Distresses

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Outbreaks are caused by:

- **Faulty mix formulation**- adhesive effect between the grain structure is not sufficient
- **Frost damage** - through penetrating water
- **Dynamic compaction on cold asphalt**
- **Insufficient bond between layers**

Pavement Distresses

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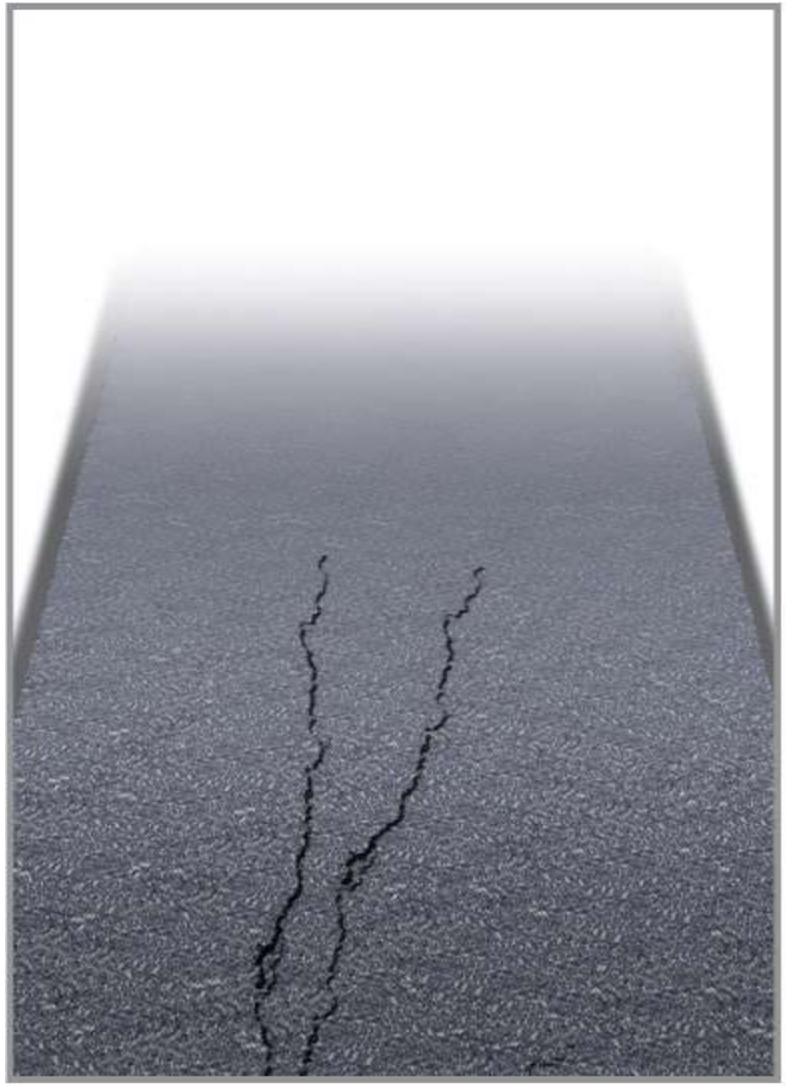
Longitudinal and transverse cracks are caused by:

- **Deformation** – settlements
- **Frost damage** - In dew periods, heavy vehicles can destroy the road surface by destroying frostbite
- **Incorrectly made seams**
- **Fatigue**
- **Low-temperature behaviour of the asphalt**
- **Error during paving:**
  - Too much dynamic compaction
  - Roller too heavy
  - Rolling start too early
  - Pan formation



Pavement Distresses

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Wave formation by the paver

- Wrong screed setting
- Mix (temperature, material flow, ratio grain size / paving thickness)
- Uneven substructure
- Wrong sensors on the paver
- Insufficient pre-compaction of the screed
- No constant speed

Wave formation through the roller

- Rolling over the bow wave (speed)
- No steering in front of the paver
- Strong steering movements on hot mix
- Wrong frequency / amplitude / speed of the roller

Who‘s Job is Compaction?

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What is Compaction?

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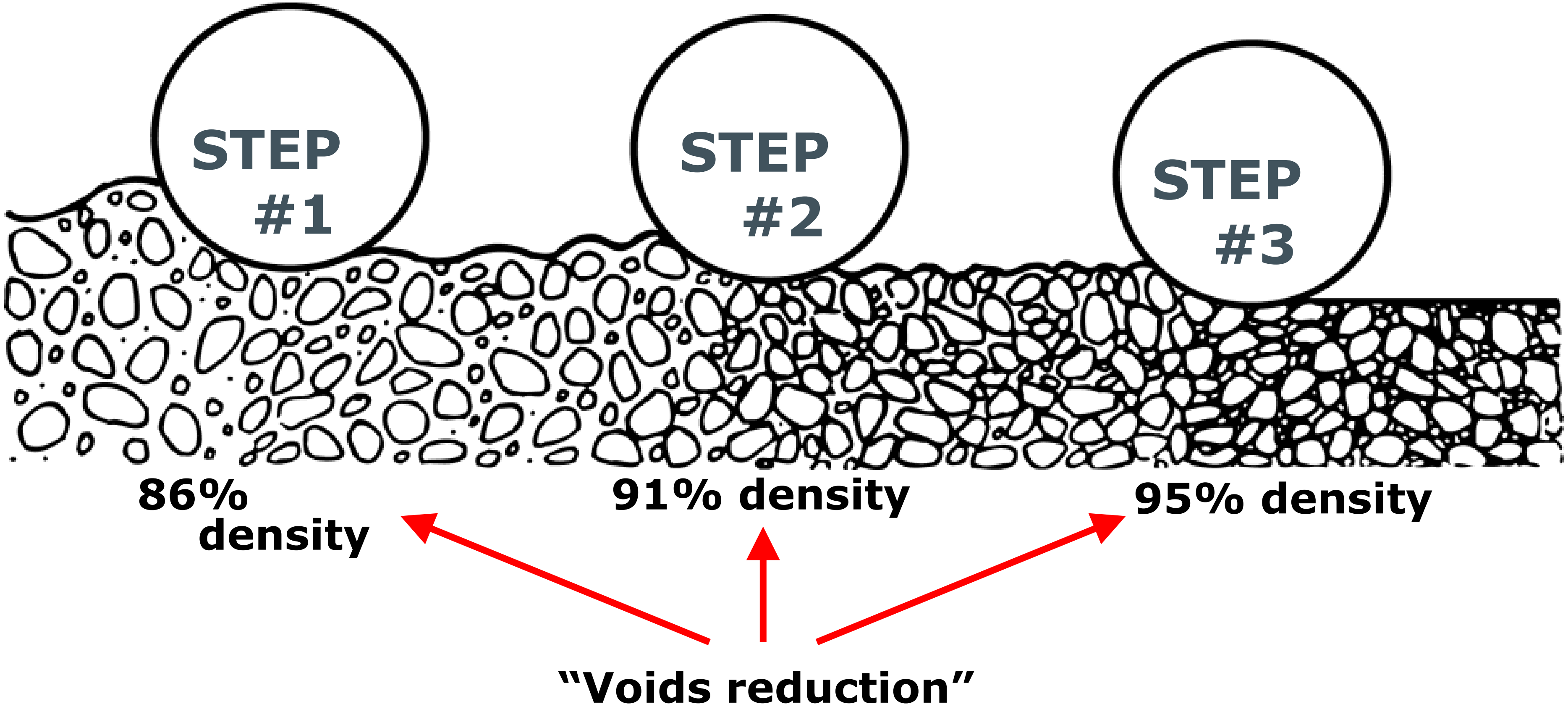
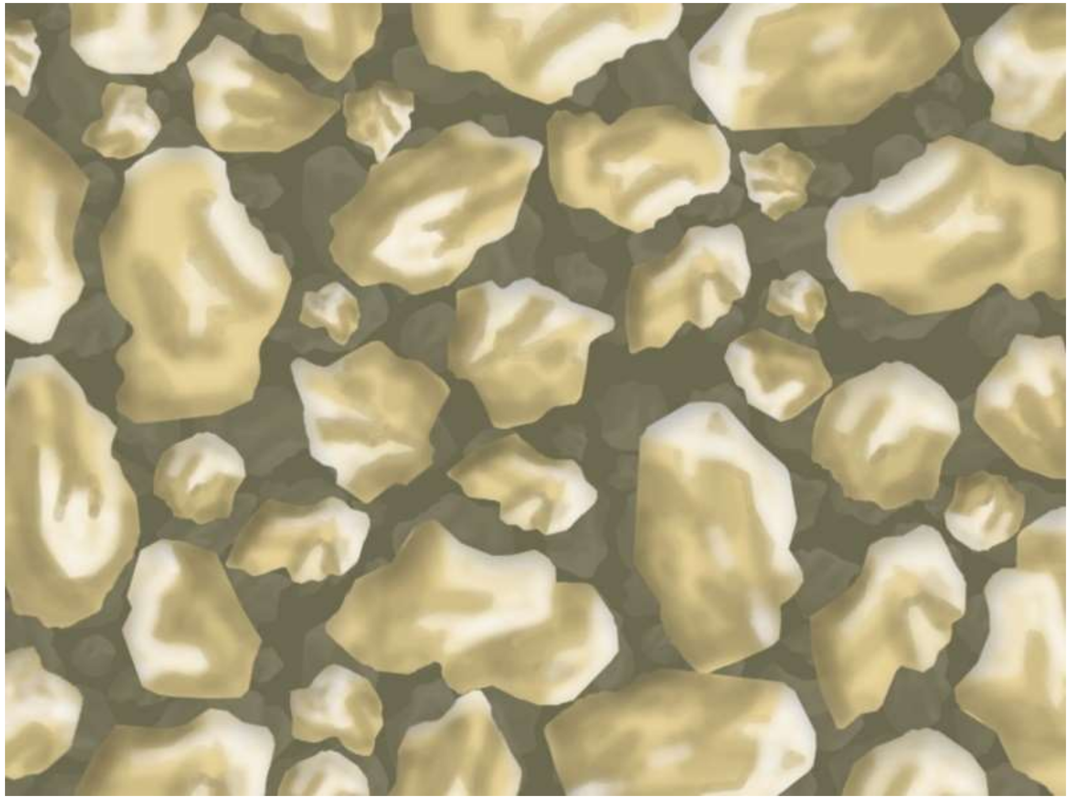
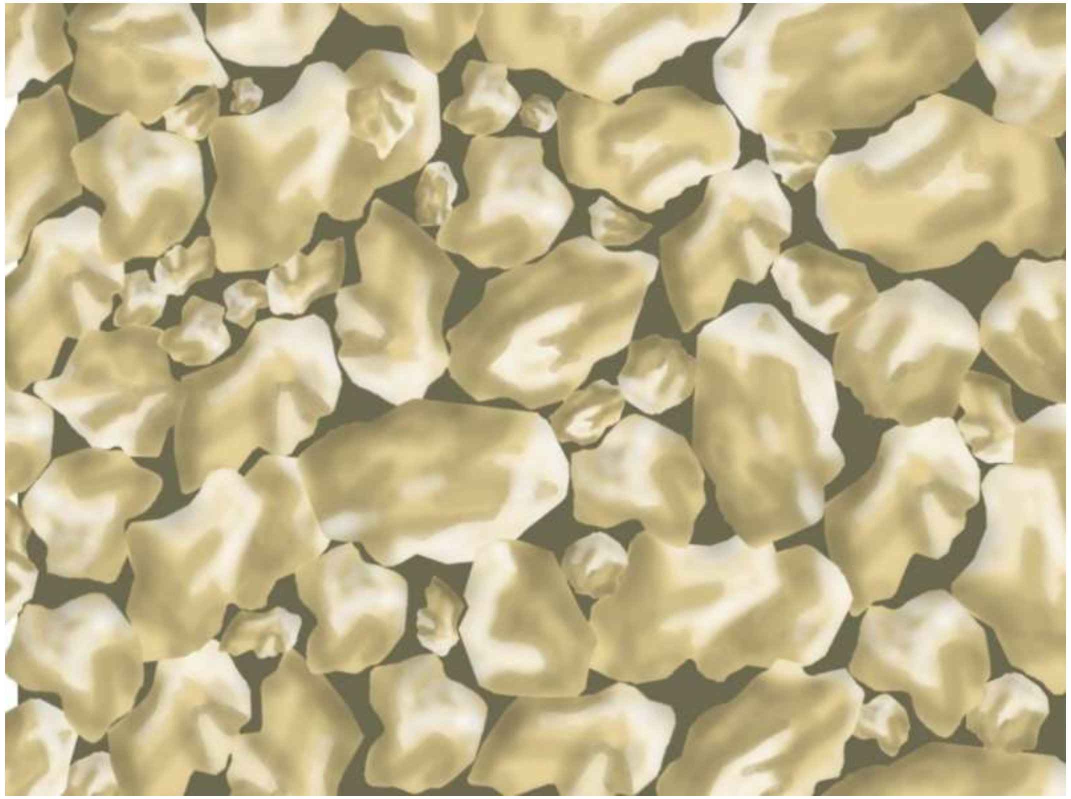
Compaction is a sequence of STEPS in order to <u>MANIPULATE</u>

aggregates & REDUCE the voids between them.



What is Compaction?





Reduces voids
Increases friction

What is Compaction?

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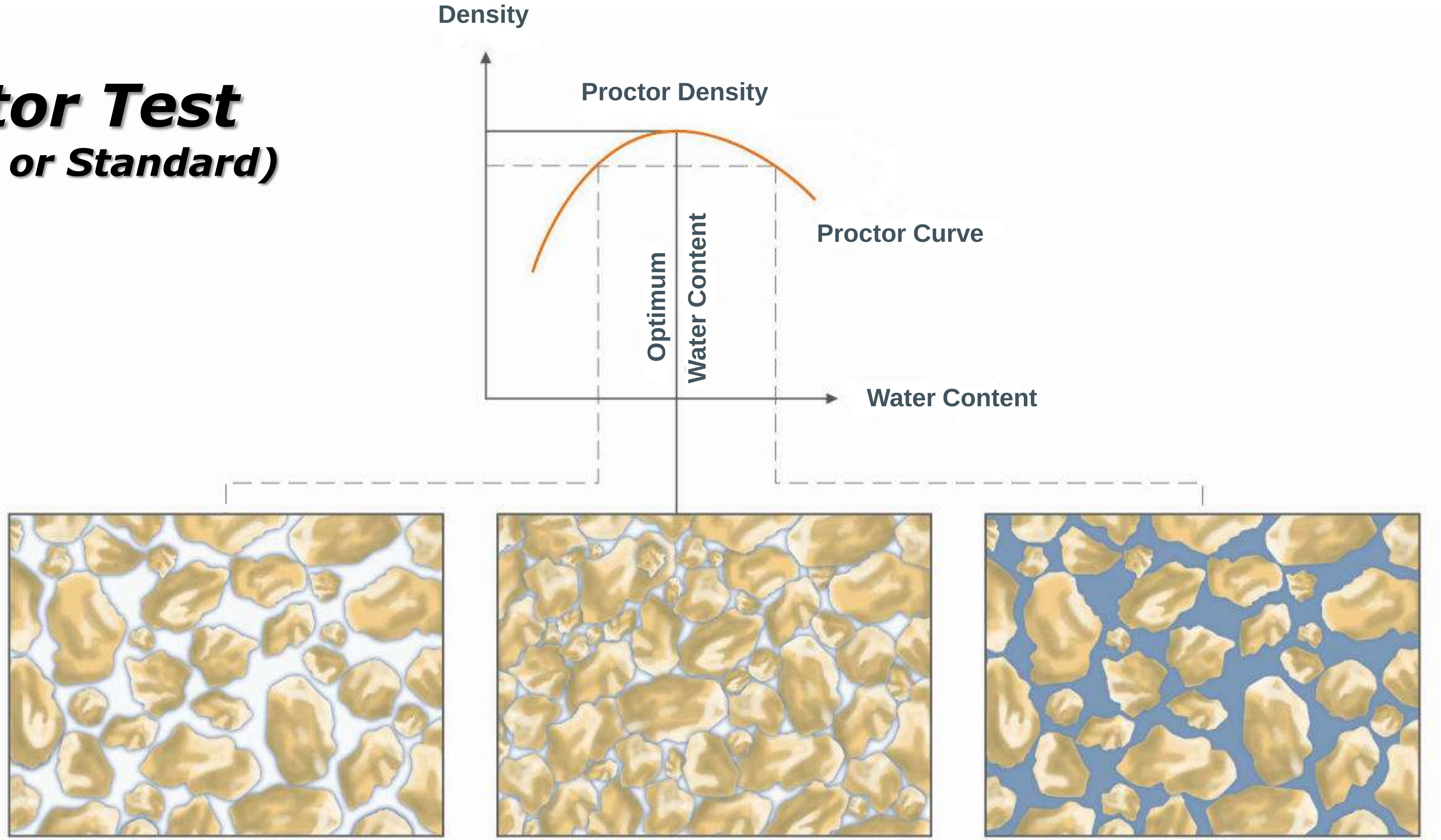
Proctor Test
(Modified or Standard)



Water content to Low | **Optimum water content** | **Water content to high**

What is Compaction?

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Sample at 95% density

95% DENSITY means that we still have 5% AIR VOIDS left in the compacted layer

Asphalt is a FLEXIBLE product.
Too much rigidity would not be desirable.

What is Compaction?

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How is compaction measured?

In the laboratory
Producing test samples of the designed mix (Gyratory or Marshall)
Measuring the forces to break the test samples in a press

Provides the maximum theoretical density level attainable of the material (100% density)

What is Compaction?

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How is compaction measured?

On Site

Portable units measure the density

These units give a good indication of density and assist the QC in establishing a rolling pattern

What is Compaction?

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How is compaction measured?

In the laboratory using core samples to analyze its quality

Provides the EXACT density
level of the compacted core sample

What Are The Four Elements to Achieve Compaction?

Four Elements?

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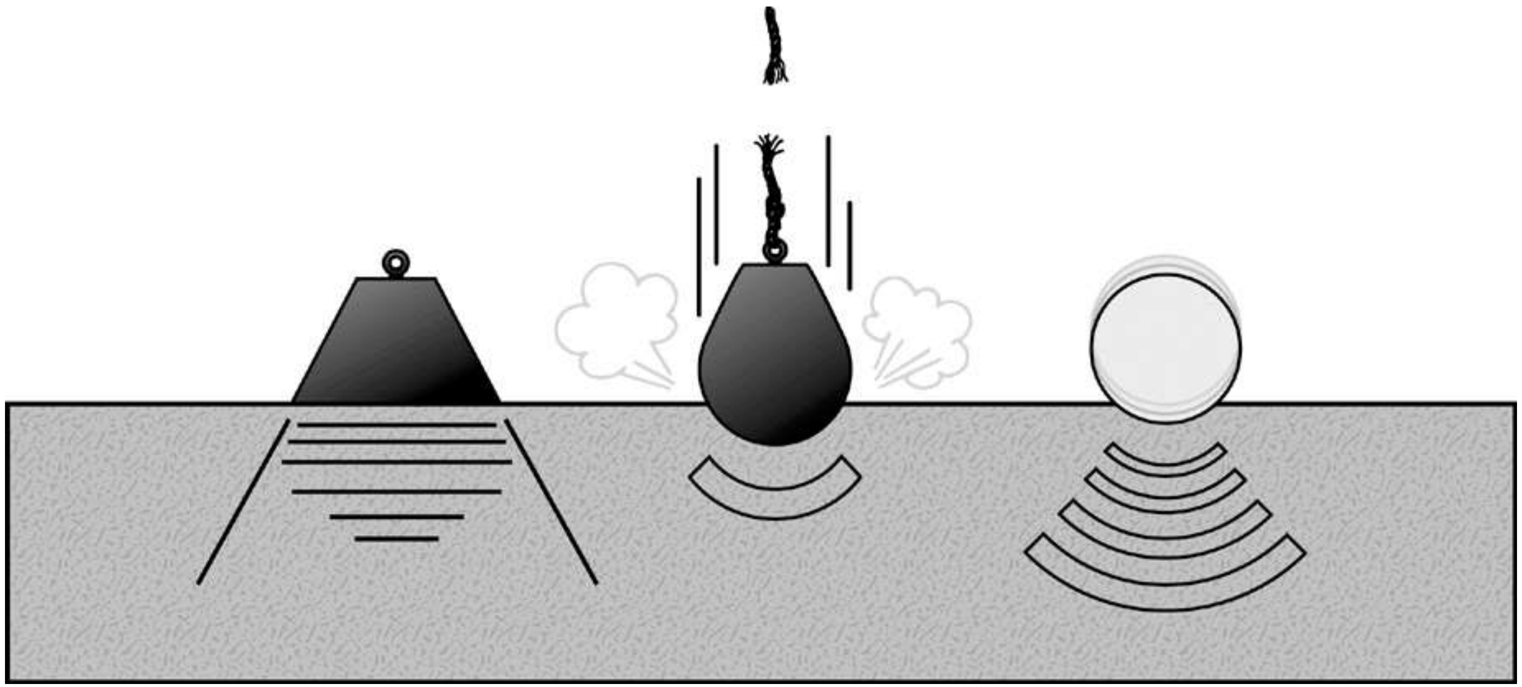
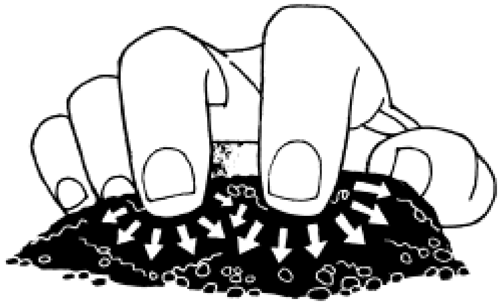
The Four Elements can be Summarized as …





Static Weight | Impacts | Dynamics *(Vibration)* *(Oscillation)* | Kneading *(Oscillation)*

Four Elements?

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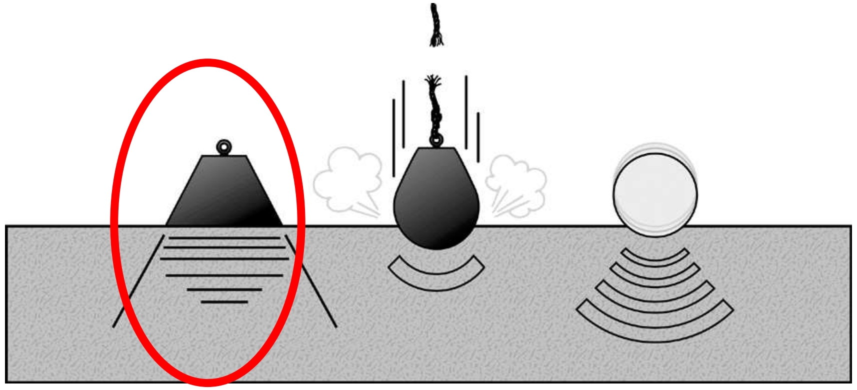
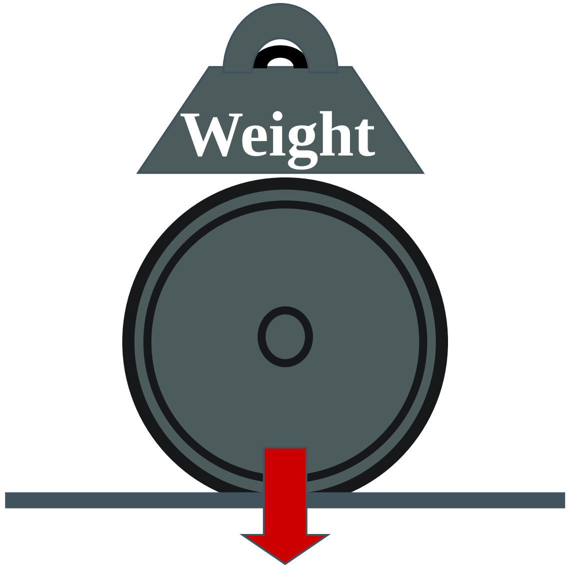
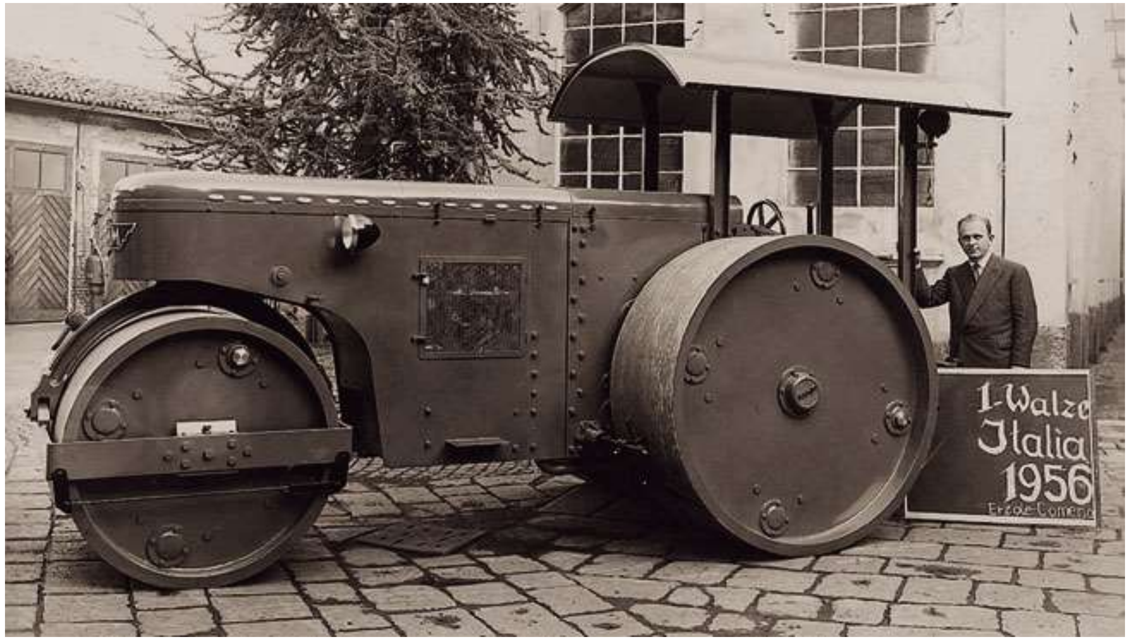




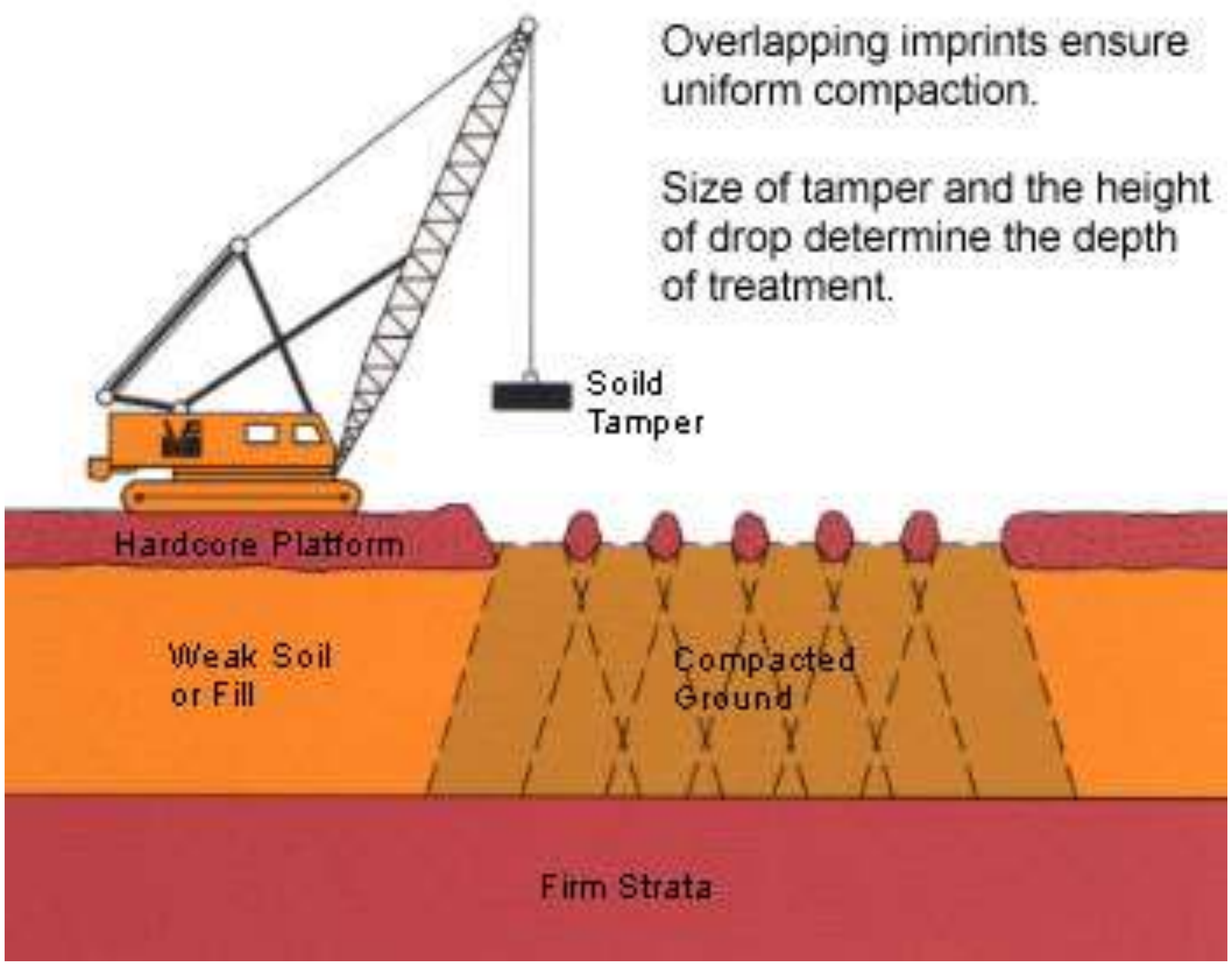
Static Weight



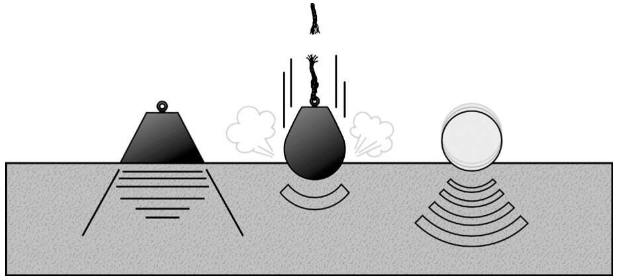
Applies a static pressure from <u>TOP</u> to <u>BOTTOM</u>

(Surface compaction)

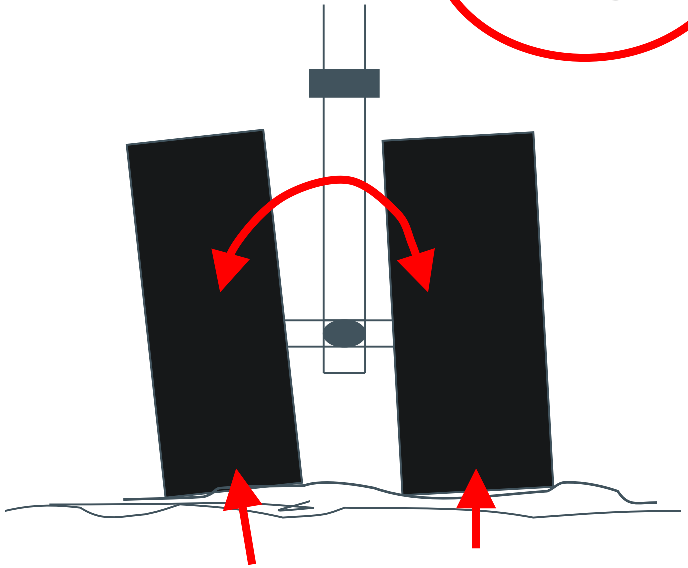
Four Elements?



Four Elements?



Kneading

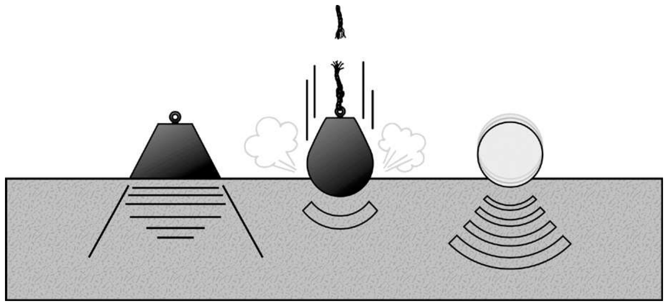


<u>Kneading effect</u>

Matches contours of an uneven surface

Minimizes bridging and helps to identify soft spots

Four Elements?



Kneading

Applies a static pressure from TOP to BOTTOM
(DEEPER surface compaction than a static drum)
Seals the mat by bringing fines to the surface.

Four Elements?

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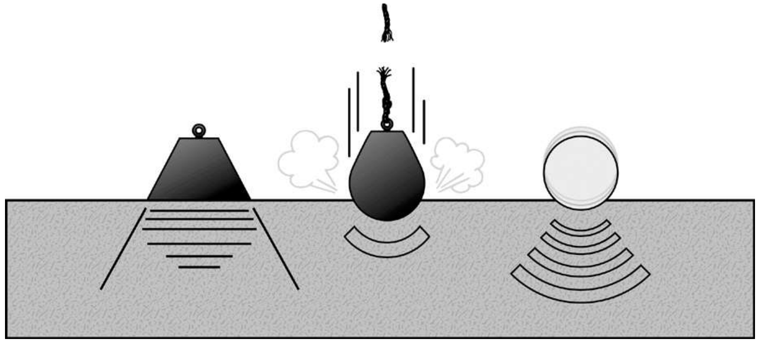
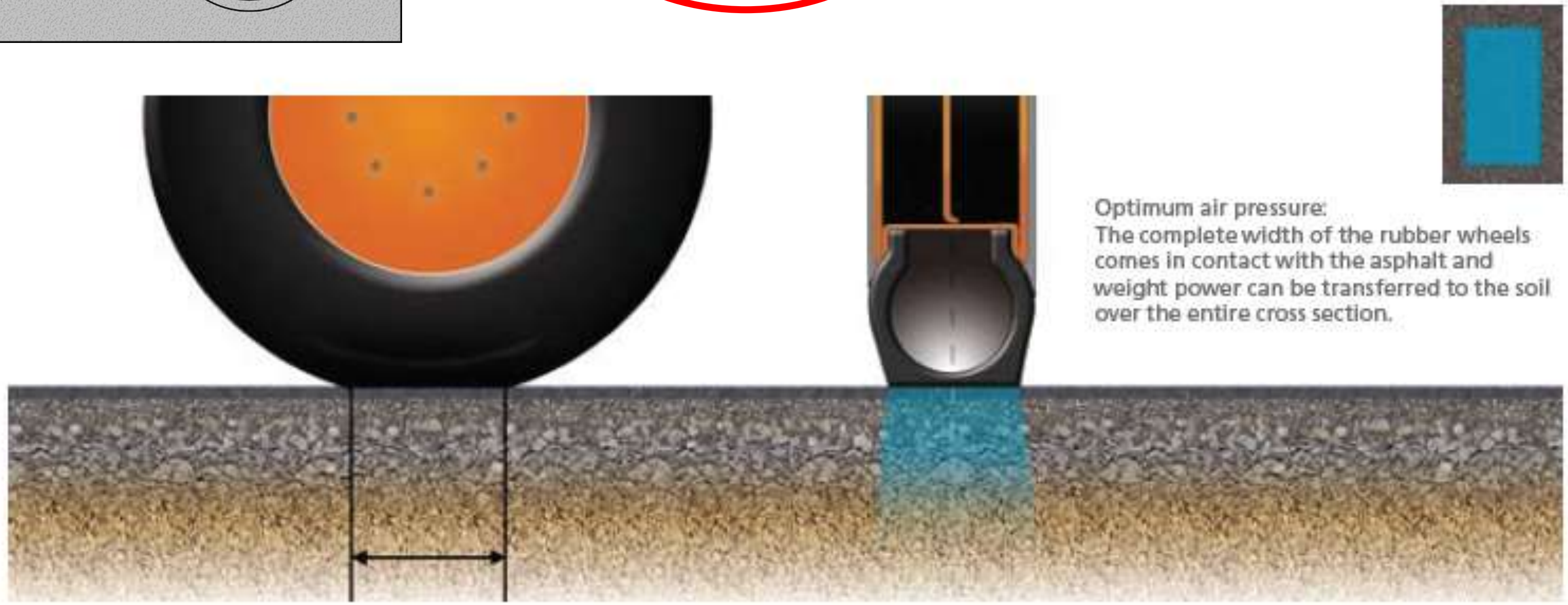


Kneading



Ideal tire pressure is dependent upon ballasted weight of the machine

Four Elements?

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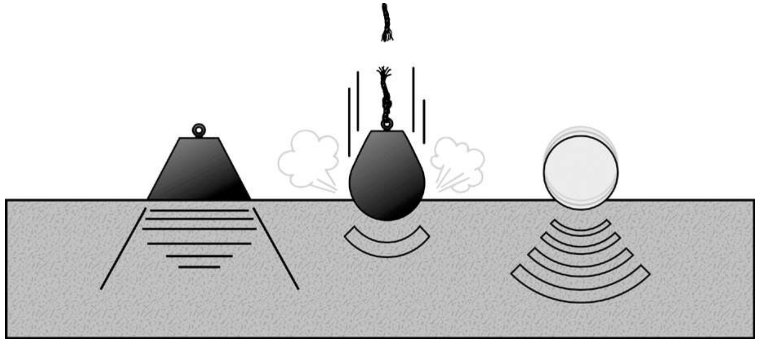
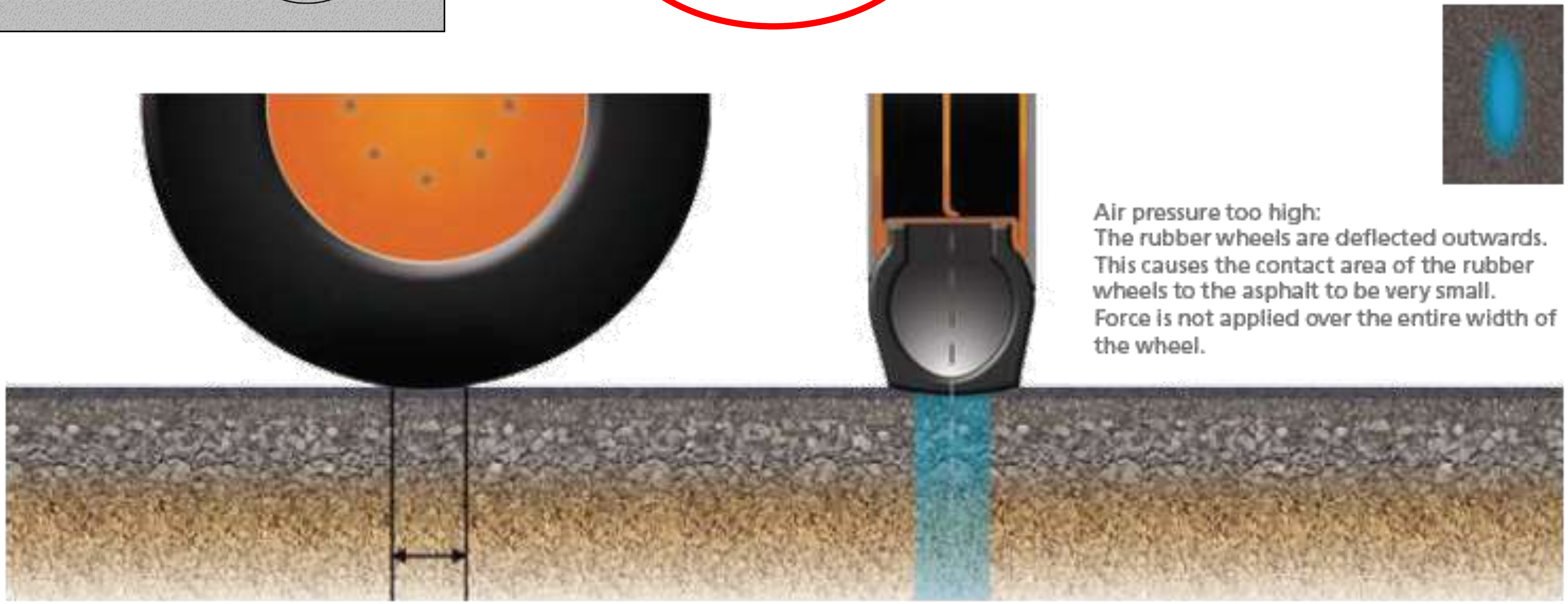
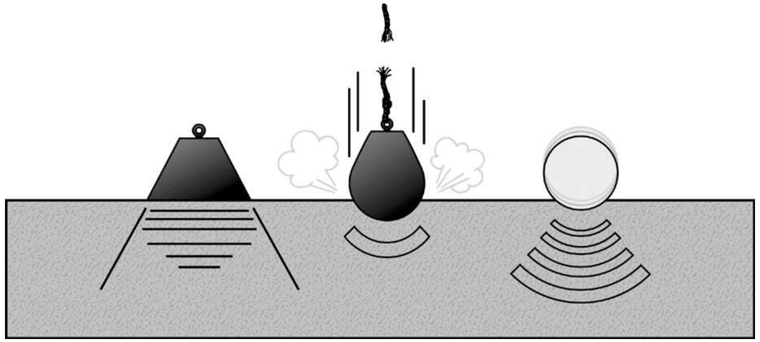


Kneading

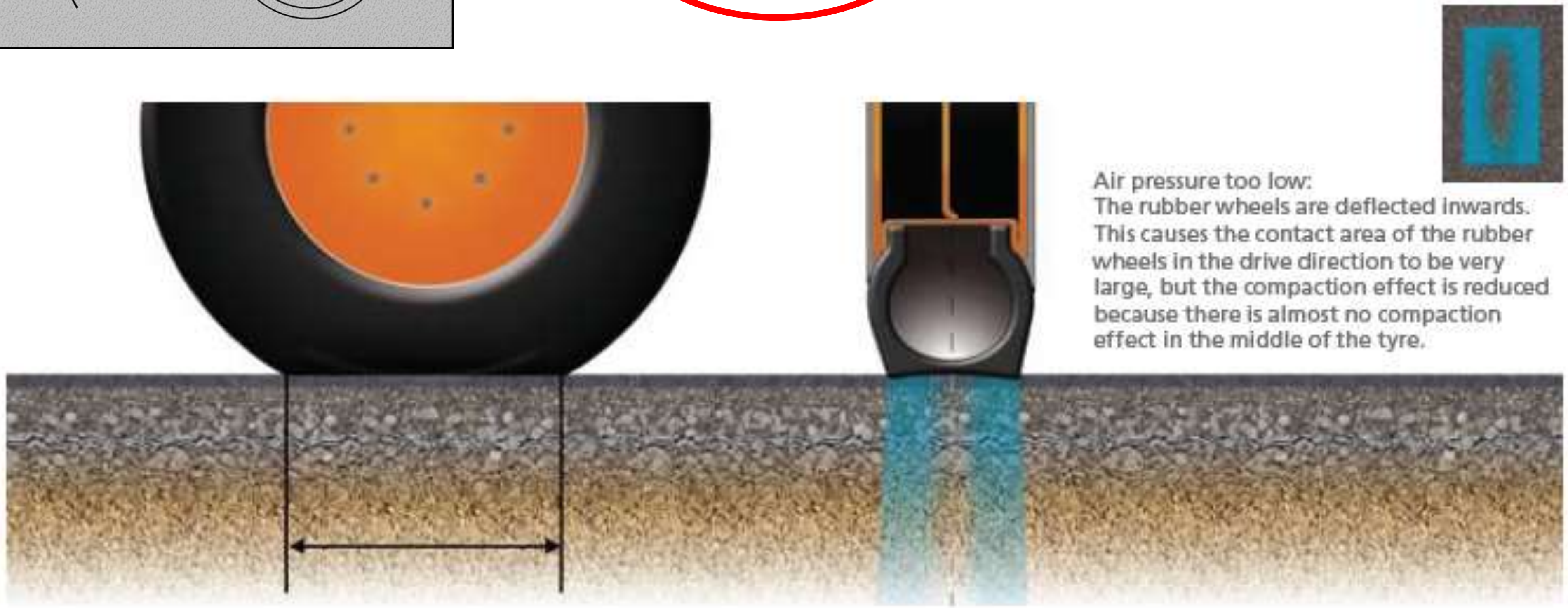


Tire pressure too high

Four Elements?



Kneading



Tire pressure too low

Four Elements?

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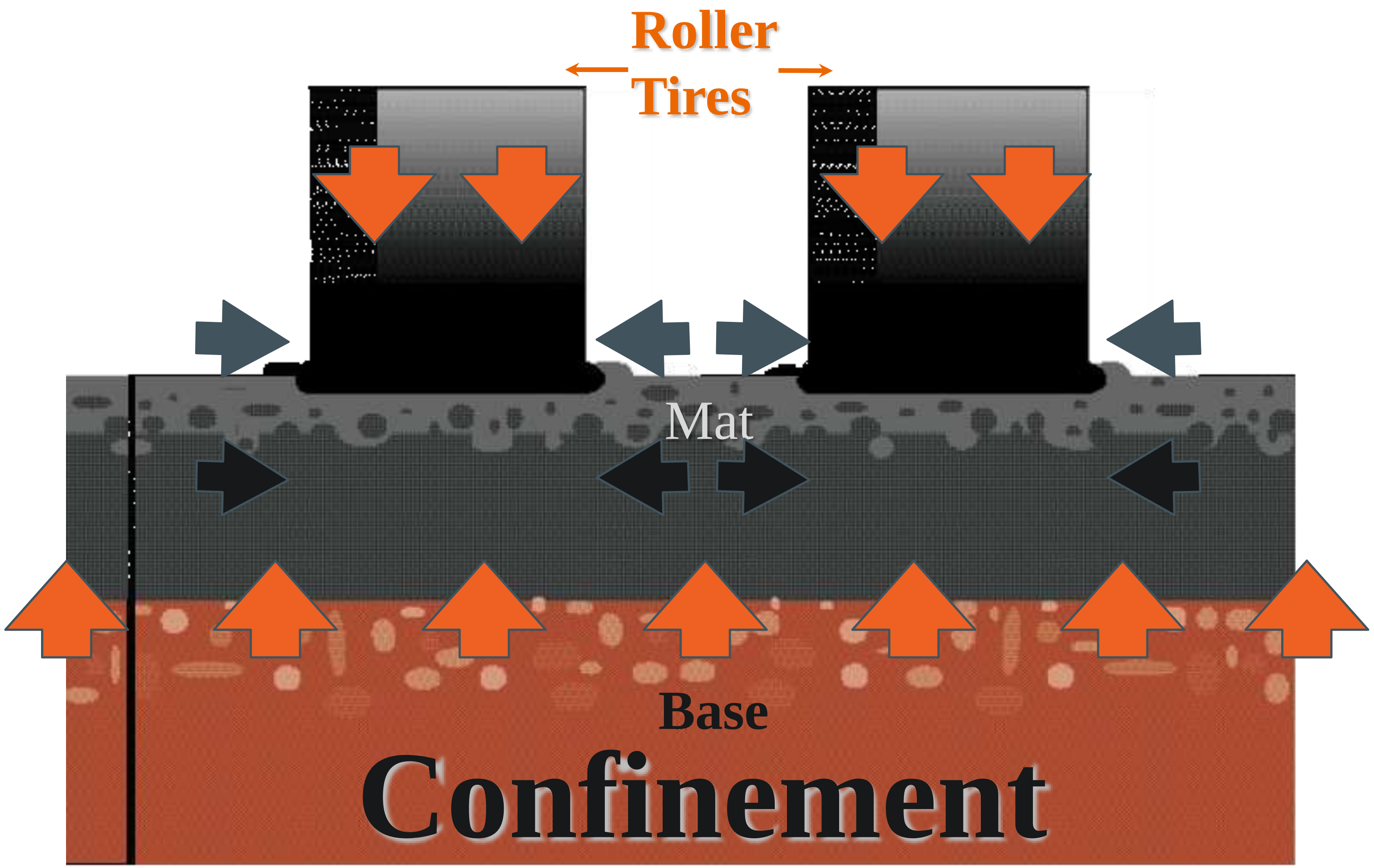
PTR´s provide a very effective form of compaction within a tender-zone on Superpave mixes



Tire Pressure Chart

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CA and GCP for **Dunlop Tires**

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Dunlop Tires 11.00 R 20

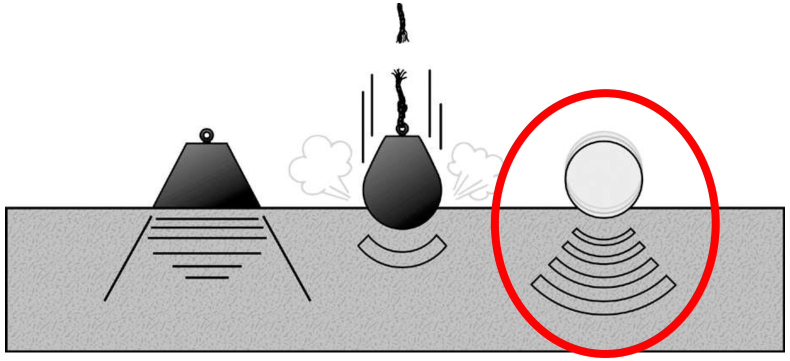
Inflation pressure [psi]		43,5	58,0	72,5	87,0	101,5	116,0
Wheel load [lbs]	Ground Contact Pressures and Contact Areas*						
2750	CA	74	62	52	46	42	39
	GCP	37	44	53	60	66	71
3300	CA	86	72	62	55	49	46
	GCP	38	46	53	60	67	72
4400	CA	109	92	81	71	64	59
	GCP	41	48	54	62	68	74
5500	CA	127	108	95	85	77	71
	GCP	43	51	58	65	72	77
6600	CA	146	124	110	99	89	83
	GCP	45	53	60	67	74	79
7700	CA	162	137	123	111	101	94
	GCP	48	56	63	70	76	82

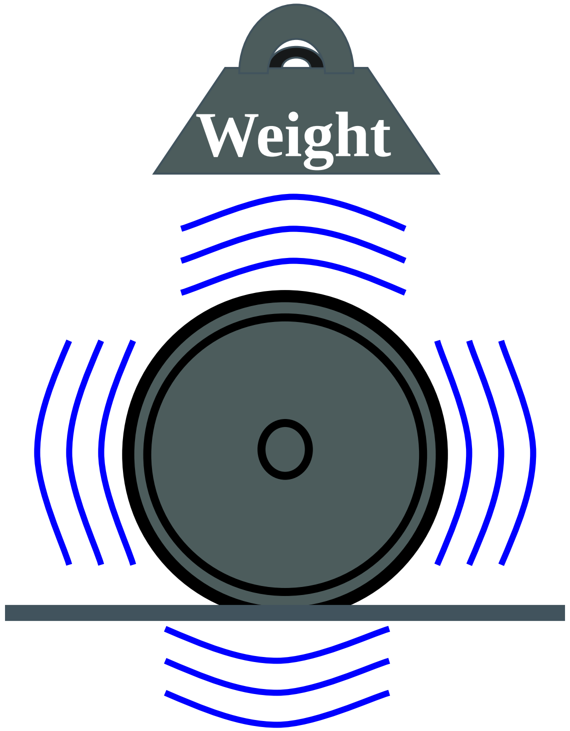
CA = Ground Contact Area [in^2]

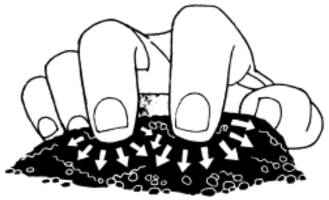
GCP = Ground Contact Pressure [lbs/in^2]

* Values are subject to change, 18.12.2016

Four Elements?







Dynamics
(Vibration)
(Oscillation)

Dynamic energy puts aggregates in motion and compacts from the BOTTOM - UP

Four Elements?

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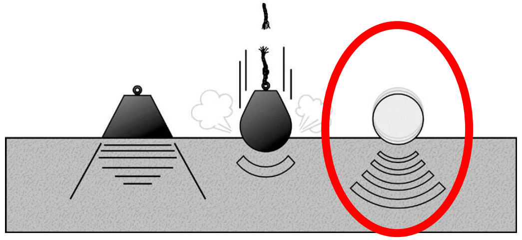

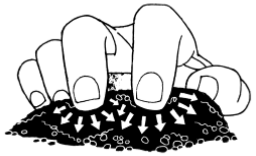

Dynamics
(Vibration)
(Oscillation)

Oscillation
(Drum has 100% ground contact)
"Non-Aggressive compaction"

Vibration
(Drum is 50% in the air)
"Aggressive compaction"

Compaction system

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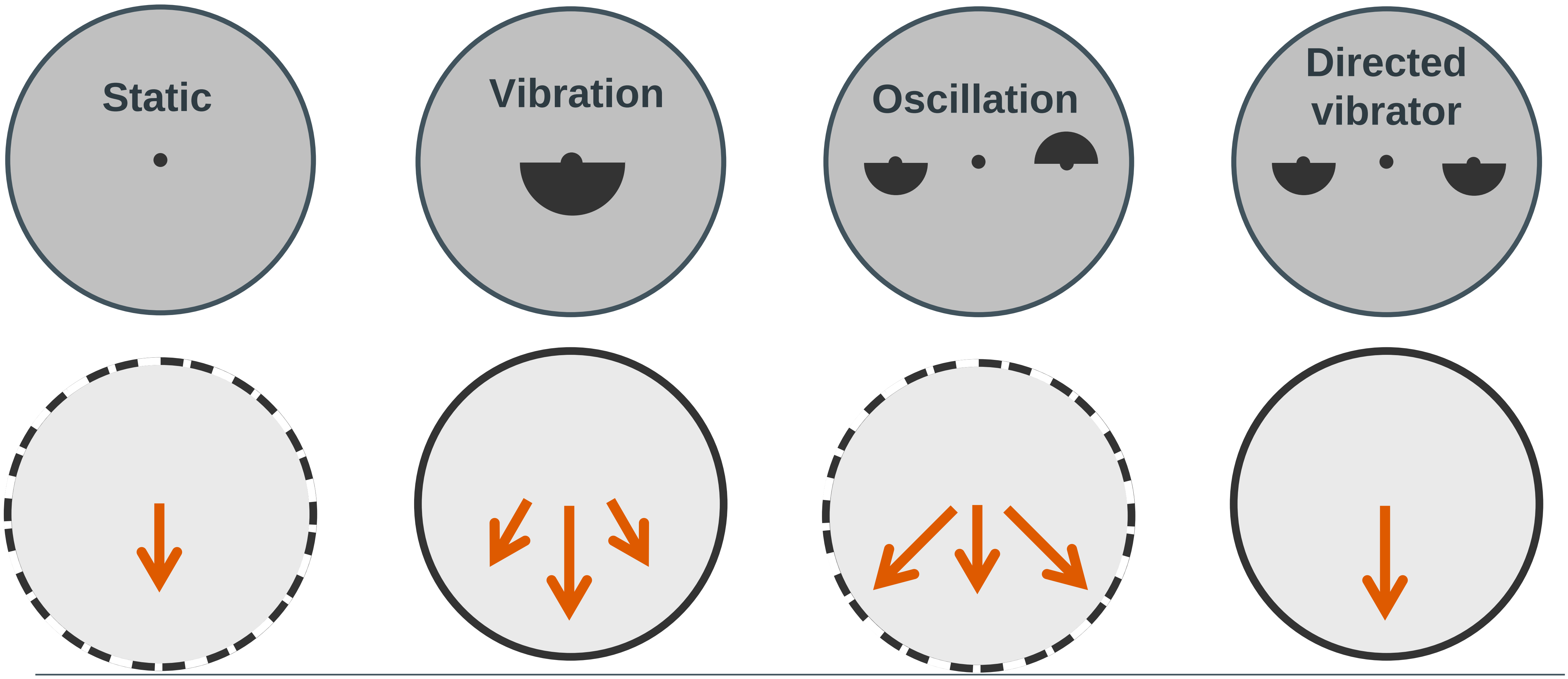

Four Elements?

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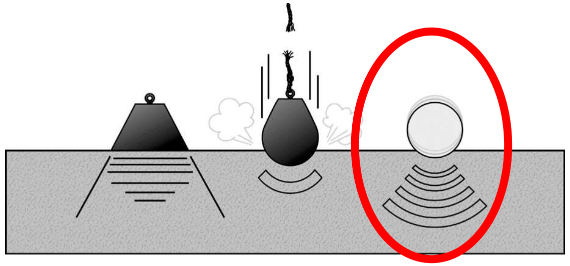
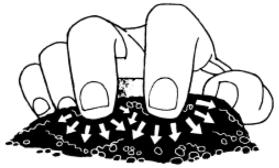
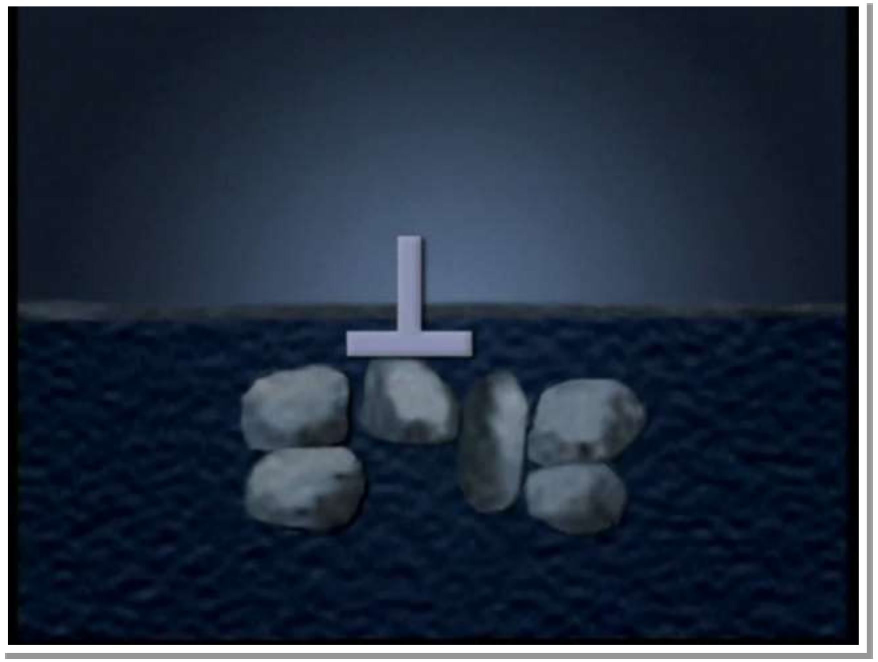
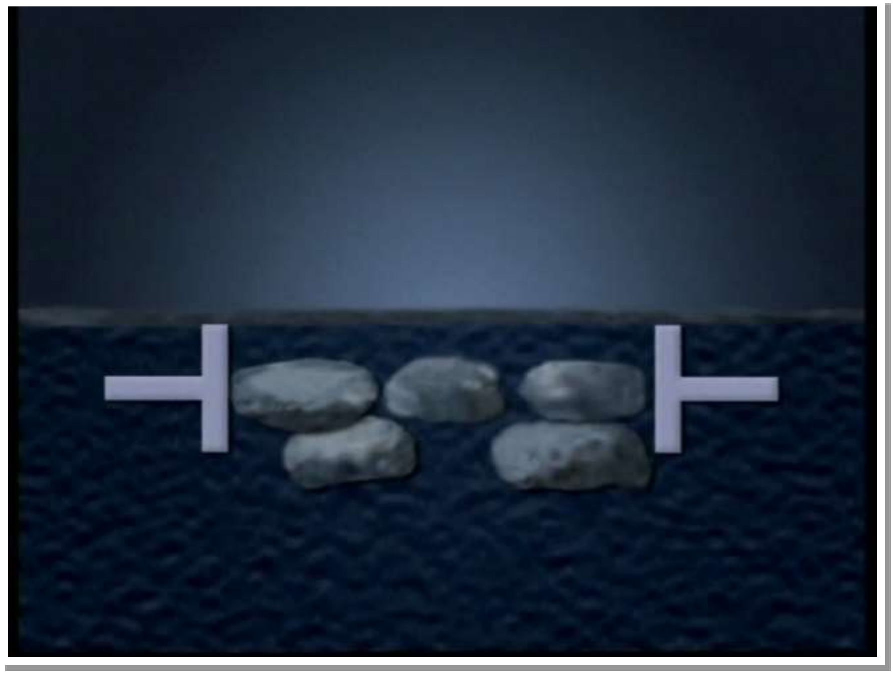




Dynamics
(Vibration)
(Oscillation)





Vibration	**Oscillation**
Vertical aggregate positioning	**Horizontal aggregate positioning**

The Roller Train

Roller Train?

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A "roller train" can be summarized as…

A sequence of rollers following the asphalt paver
Each working the mat at a fixed distance range from the paver
The objective is to achieve required density & provide a quality mat finish

	Breakdown	Intermediate	Finish
Delivered density: 75 - 80%	Approx. 90-91%	Approx. 91-93%	Approx. 93-94%
Distance	Up to 200 ft	Up to 200 ft	150 ft & more

Roller Train?

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Roller trains are flexible…

The "roller train" can be a mix of any compactor types & sizes

The main goal is to adapt to the asphalt mix design, jobsite conditions using equipment available in order to achieve required density & mat finish requirements <u>in the least number of passes</u>

	Breakdown	Intermediate	Finish
			
Approx delivered density; 83%	Approx. 90-91%	Approx. 91-93%	Approx. 93-94%
Distance	⟷ Up to 200 ft	⟷ Up to 200 ft	⟷ 150 ft & more

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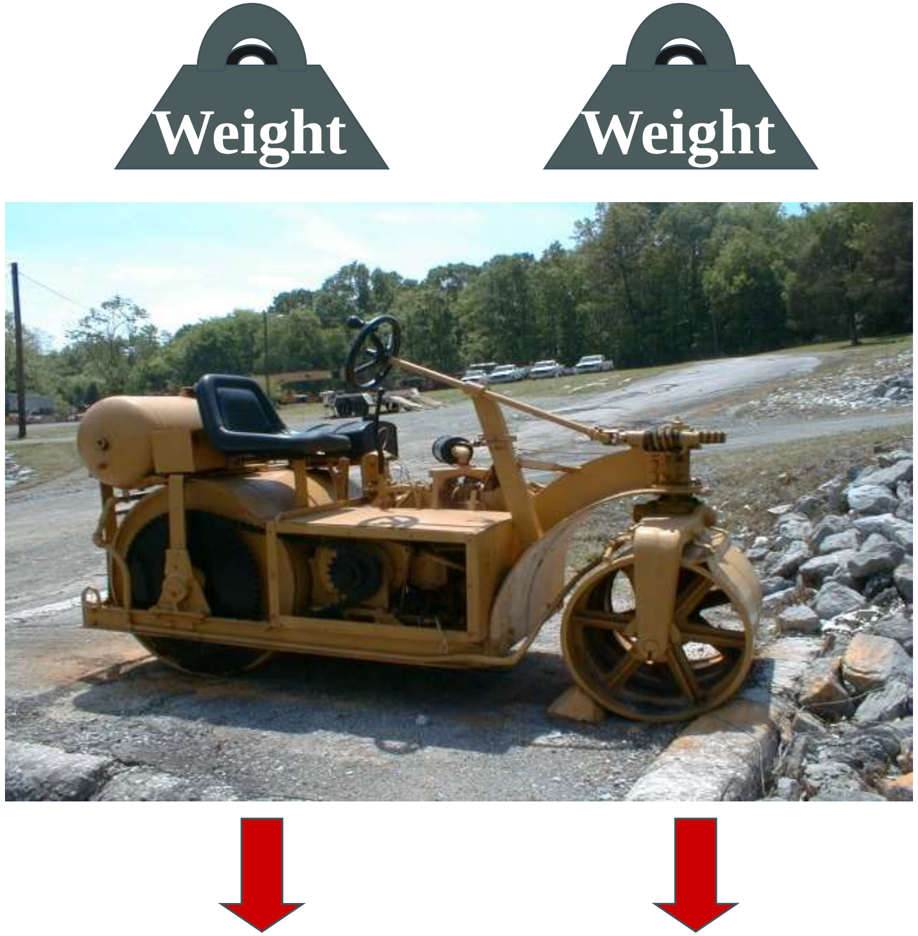
Summary Of Roller Types

Roller Types?

Static steel wheel

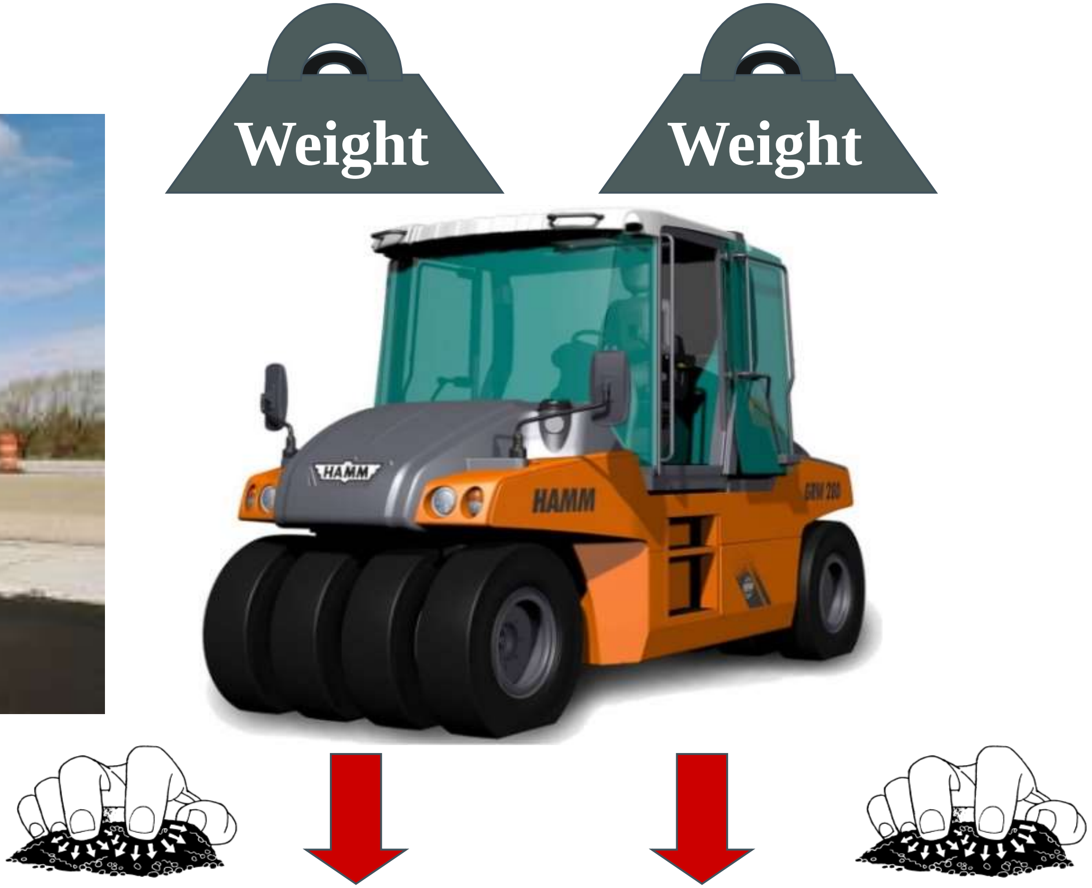


Element(s) involved: **Static weight**

Application(s): **Mat smoothness (mainly finish rolling)**
Pinching a joint

Roller Types?

Pneumatic (rubber tires)



Element(s) involved: **Static weight, kneading, proof rolling**

Application(s): **Seal mat surface (All)**

Track overlapping

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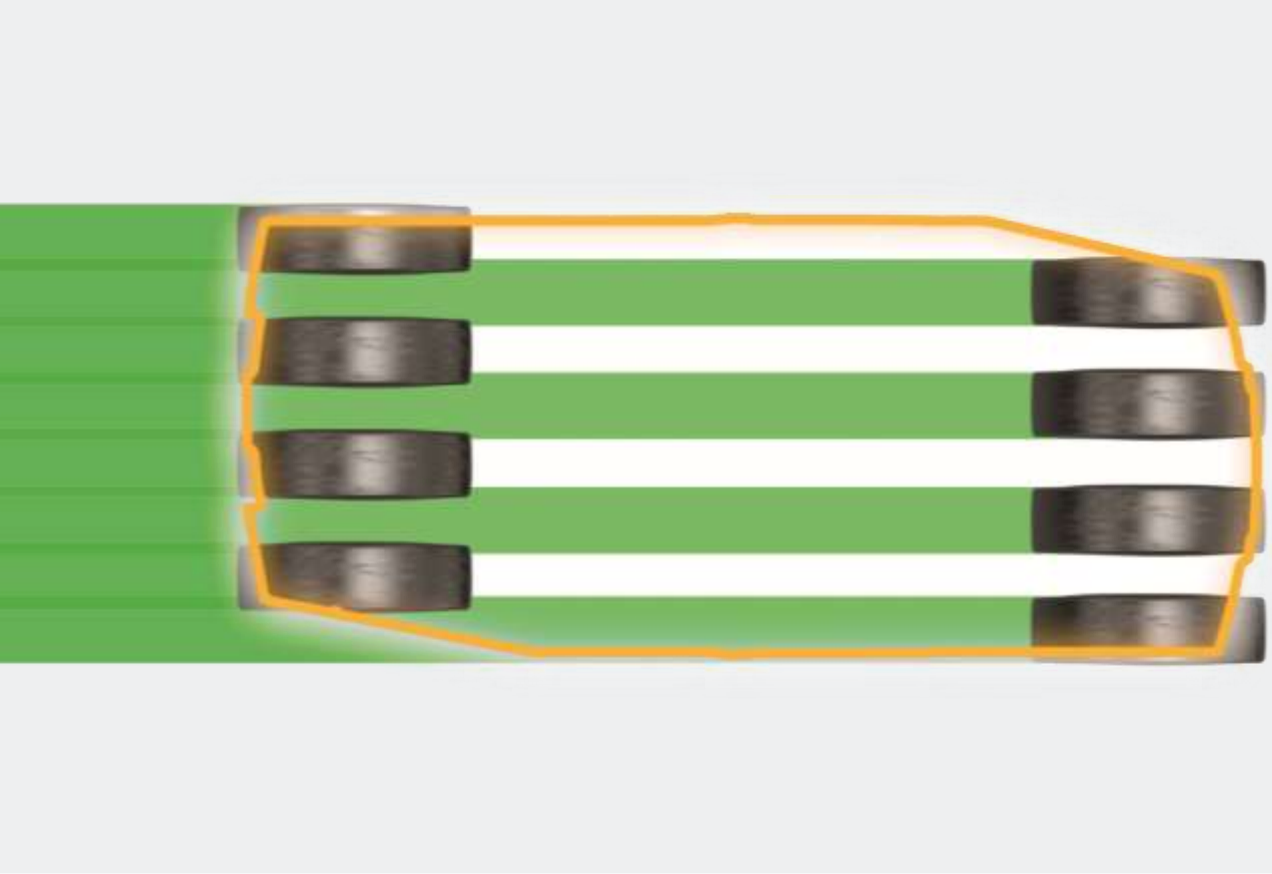
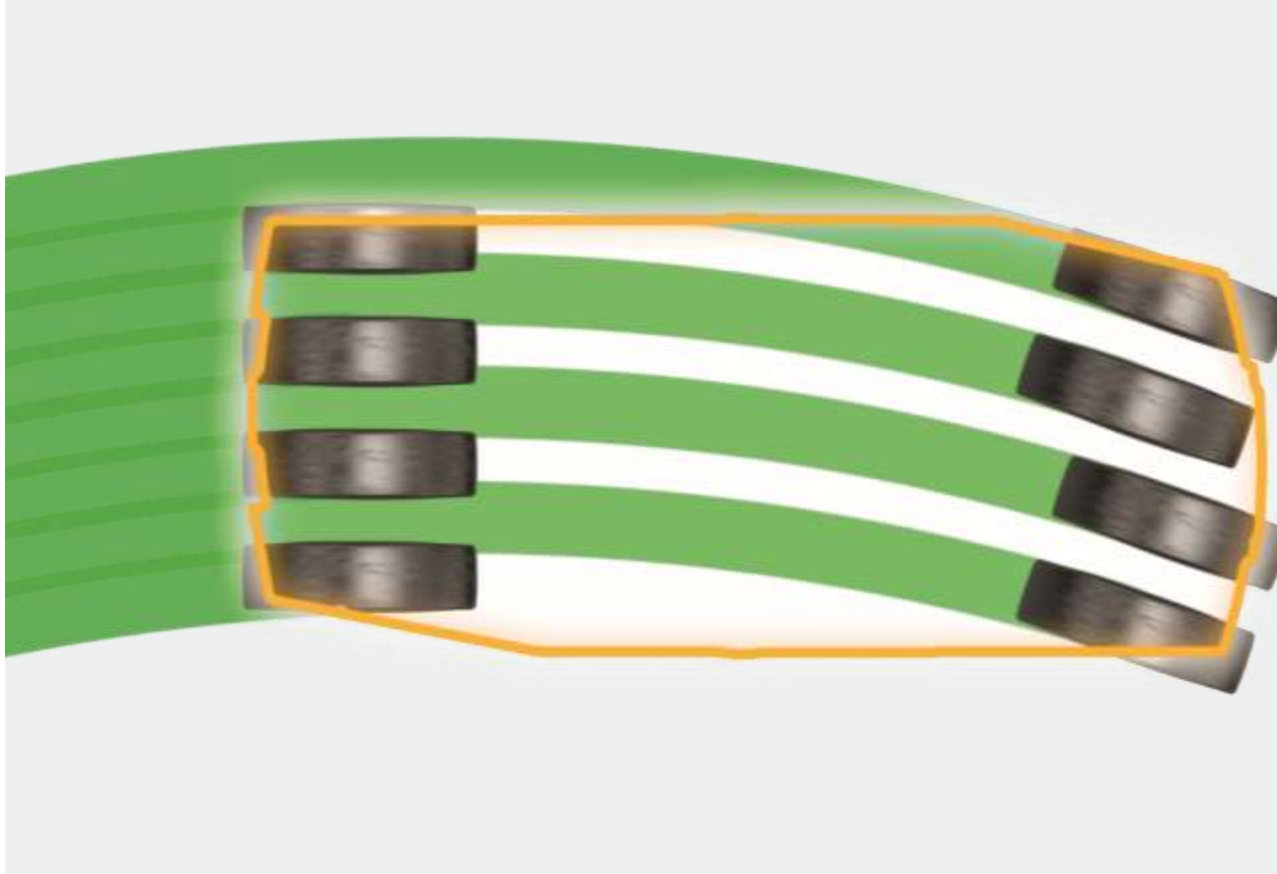


Front and rear axle offset

Track overlapping



The track overlap is also guaranteed when cornering

Separating compound for rubber wheels

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When <u>diesel</u> is used as a separating compound, the rubber becomes soft. This forces the rock into the tyre material. Therefore only use the correct separating compound!

Roller Types?

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Combination (steel drum & rubber tires)

Element(s) involved: Weight, kneading, dynamics

Application(s): Municipal jobs, steep grades, etc…
(Versatile unit for smaller jobs)

Roller Types?

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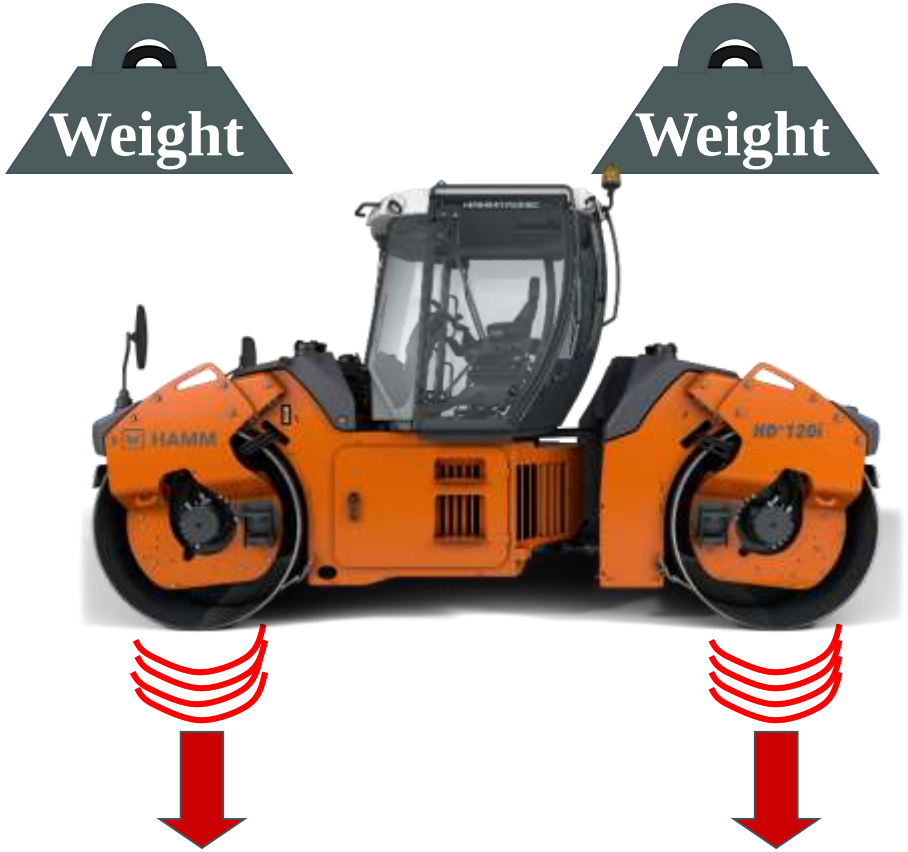
<u>Tandem steel drums (vibration)</u>

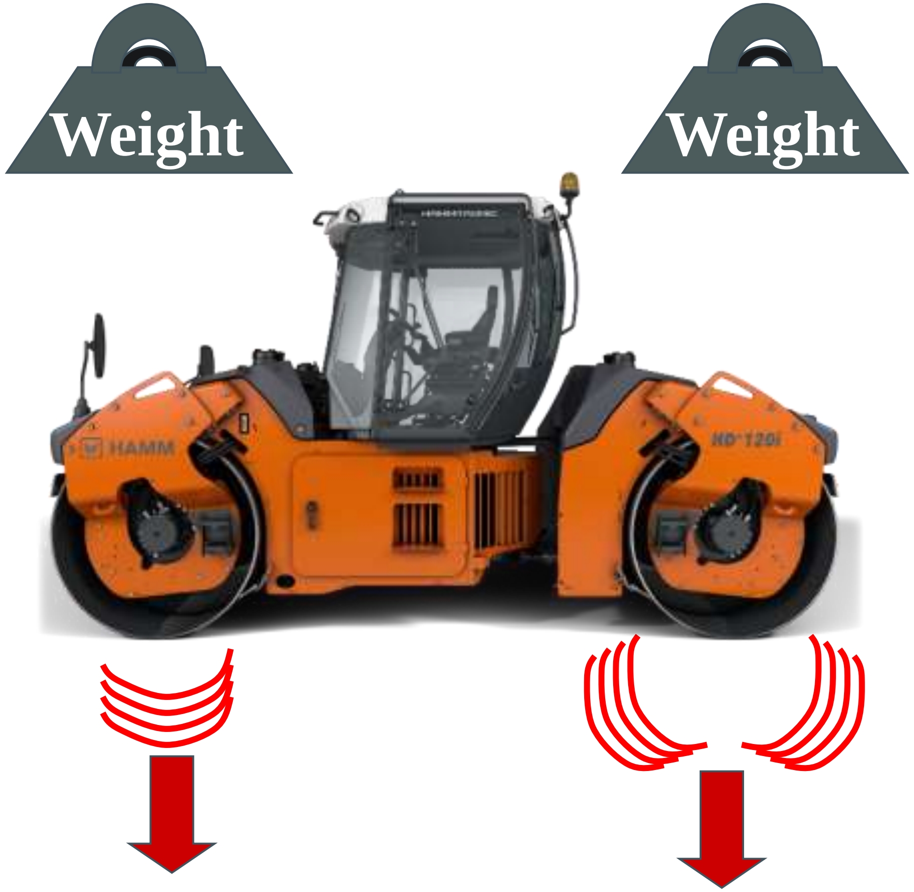


Element(s) involved: **Weight, dynamics (vibration F & R)**

Application(s): **Breakdown and Intermediate, finish in static mode**

Roller Types?

Tandem steel drums (OZZY)



Element(s) involved: **Weight, dynamics (vibration F & oscillation R)**

Application(s): **All roller train positions**
(Extended rolling time, no crushing, smoothness, joints)

Tandem rollers

(pivot-steered)

(articulated)

Steering types

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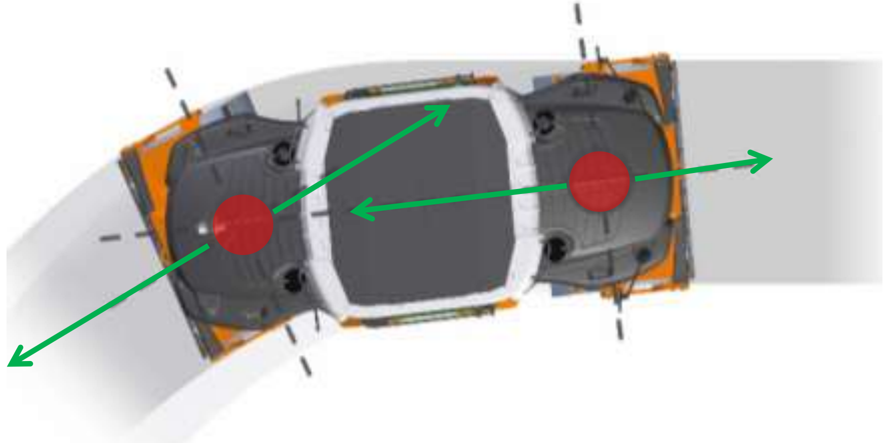
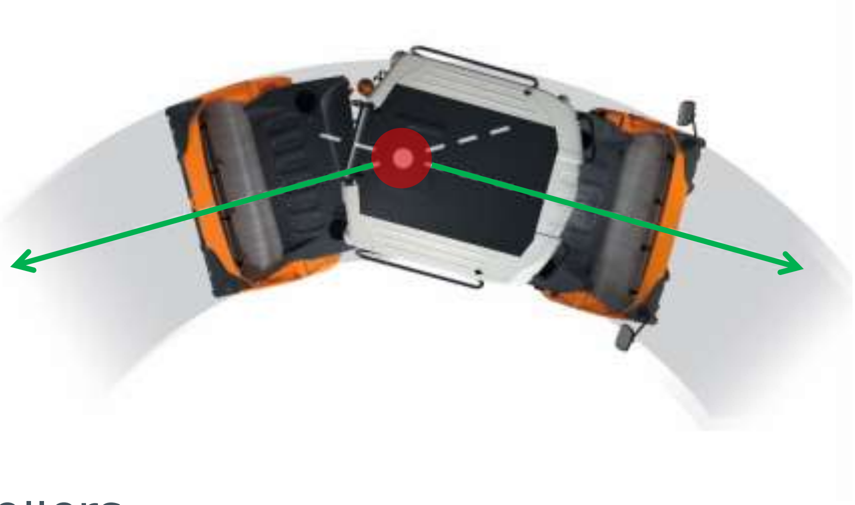


Pivot-steered drums

allow both drums to be steered separately from each other



Articulated rollers

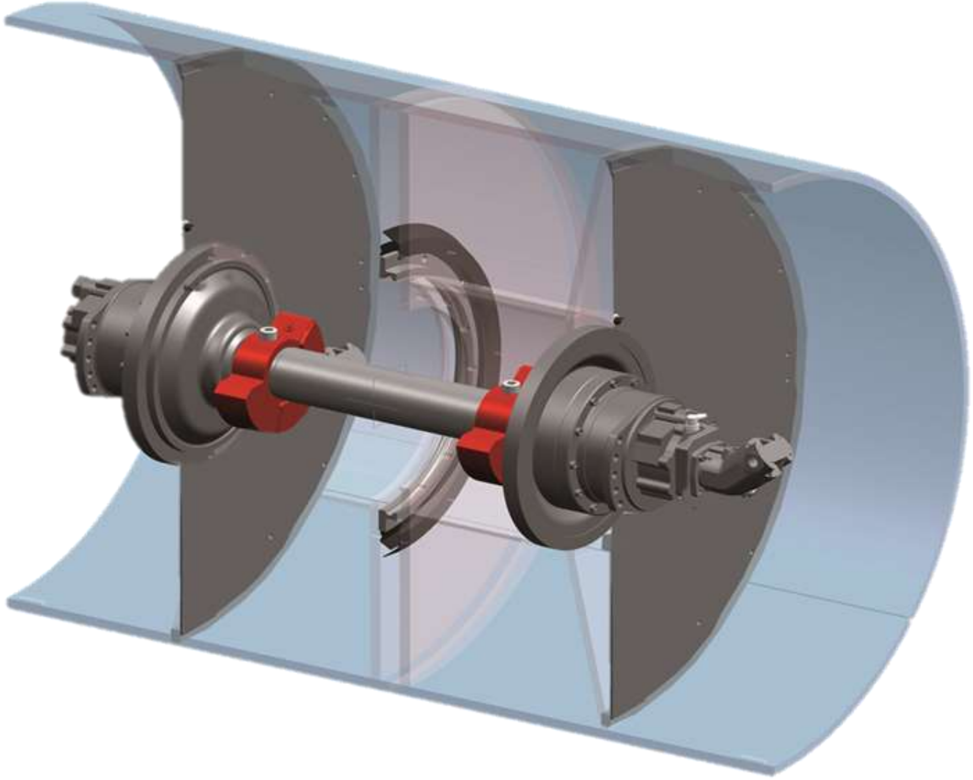
have a pivot in the middle of the frame

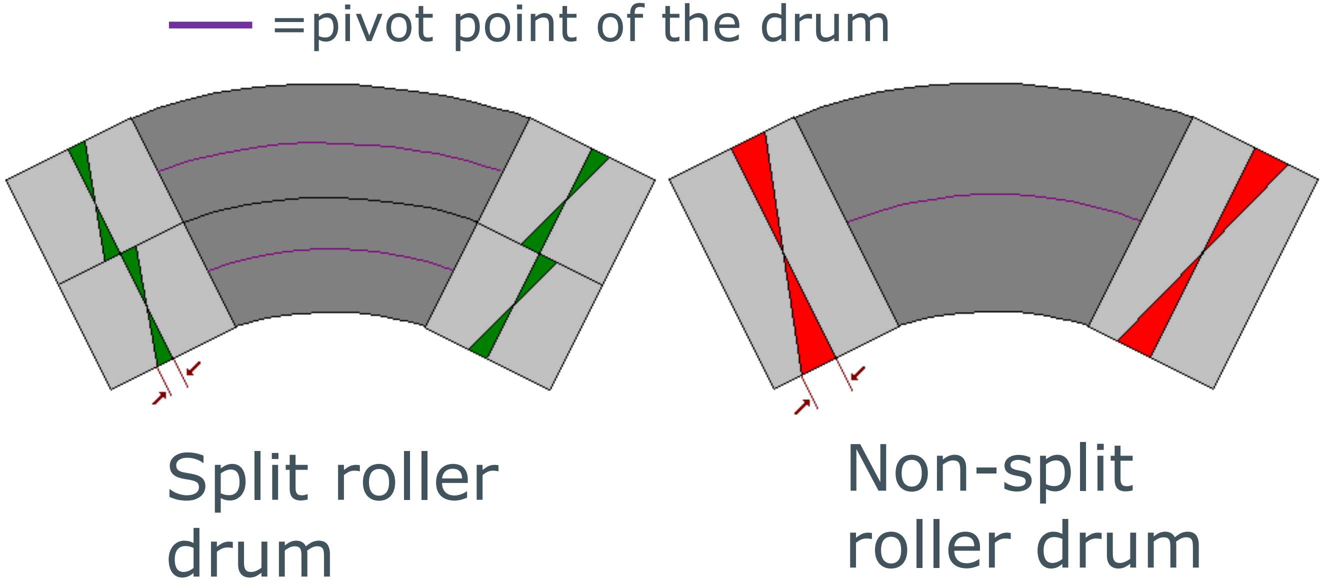
This allows the frame to "buckle"

=steering point

=rolling direction

Split roller drum





Splitting the drum can reduce the lateral sliding by half

- Same size drum halves with one drive motor each
- ASC reduces the speed of the inner drum when cornering
- Less material displacement and cracks

Key Roller Design Specifications Affecting Compaction

Design Specifications

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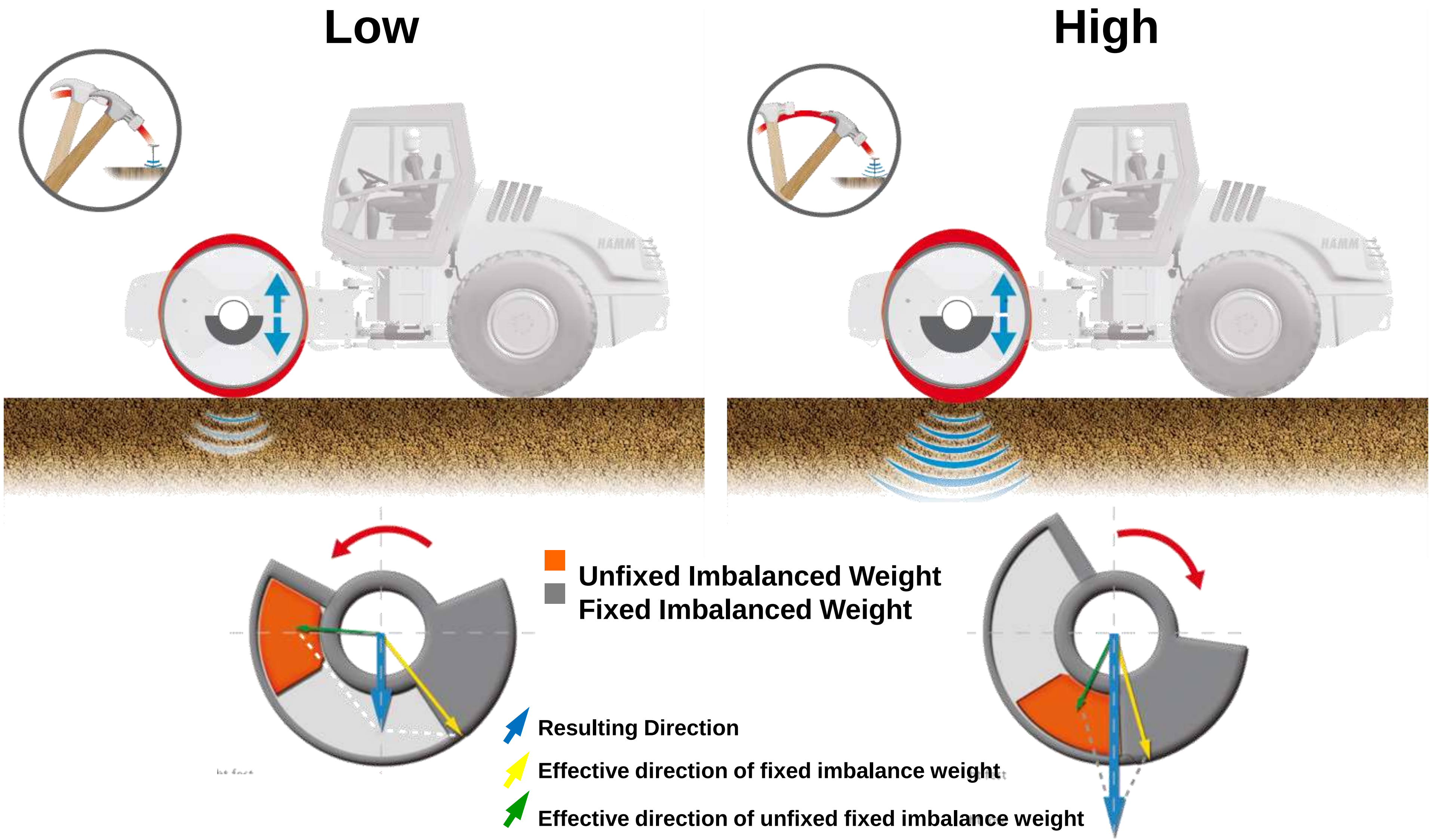
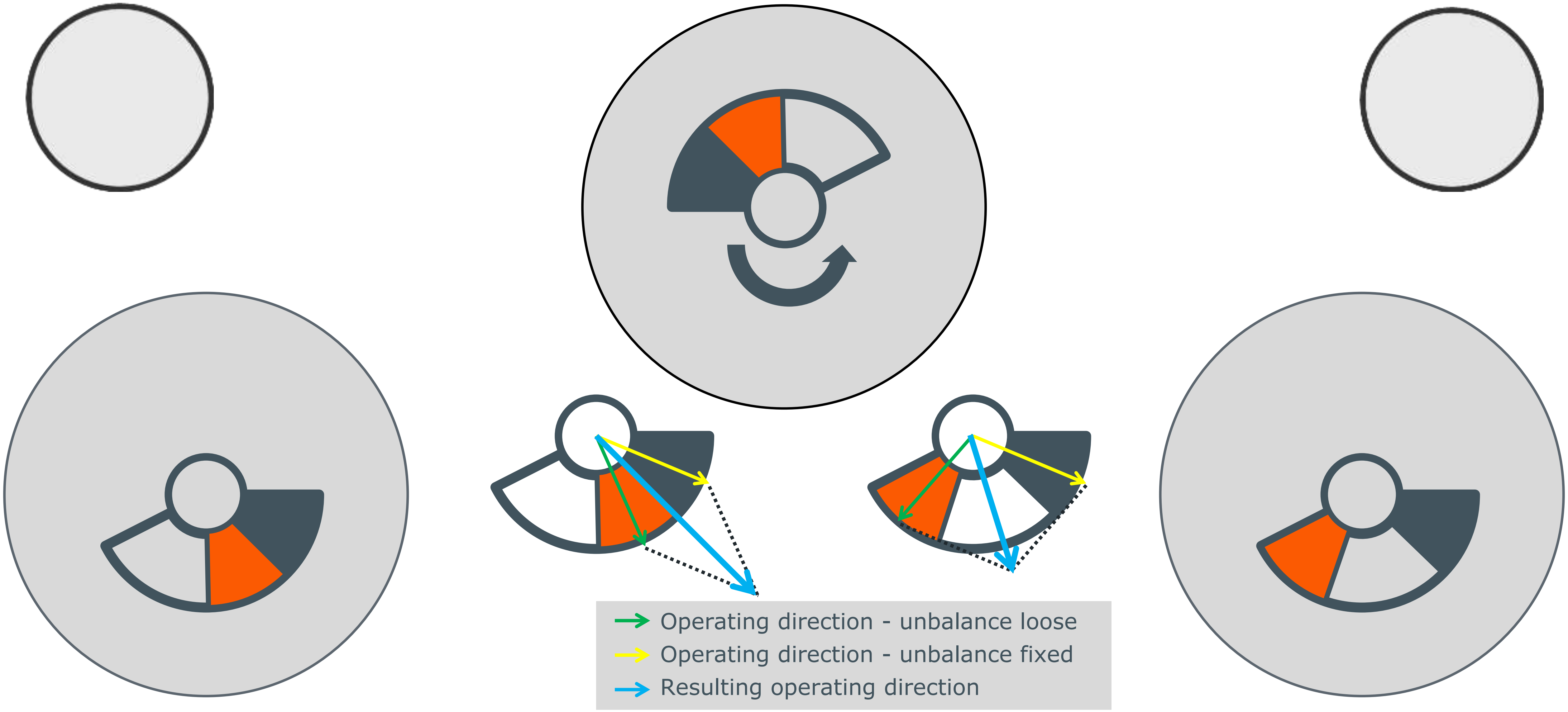
Key roller design specifications affecting compaction

Amplitude
Frequency
Static weight
Centrifugal force
Rolling speed
Drum diameter
Drum activation controls
Drum water & scrapers

Amplitude


Low
High
Unfixed Imbalanced Weight
Fixed Imbalanced Weight
Resulting Direction
Effective direction of fixed imbalance weight
Effective direction of unfixed fixed imbalance weight

Vibration - different amplitudes



Comparison of amplitudes

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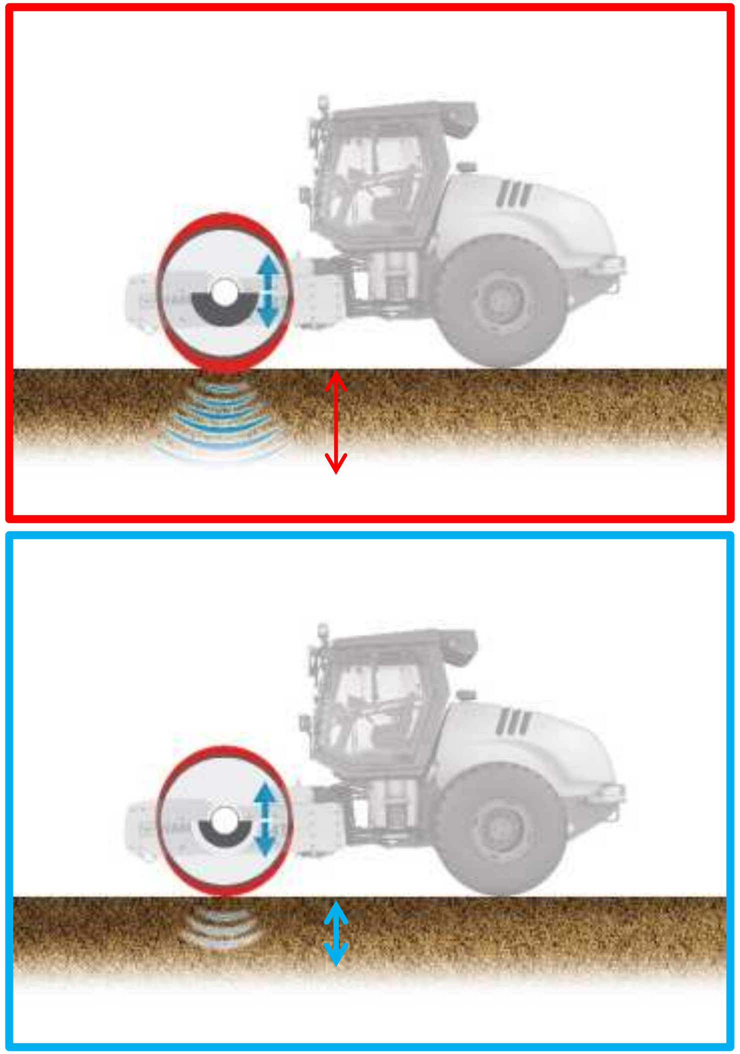
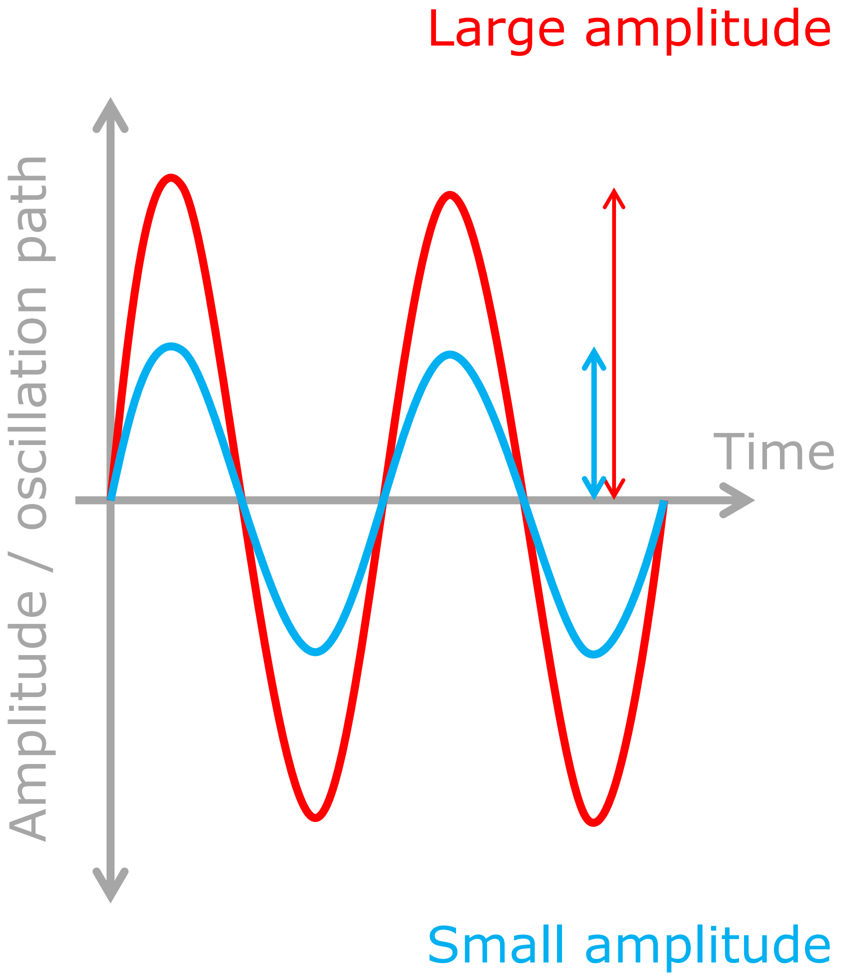
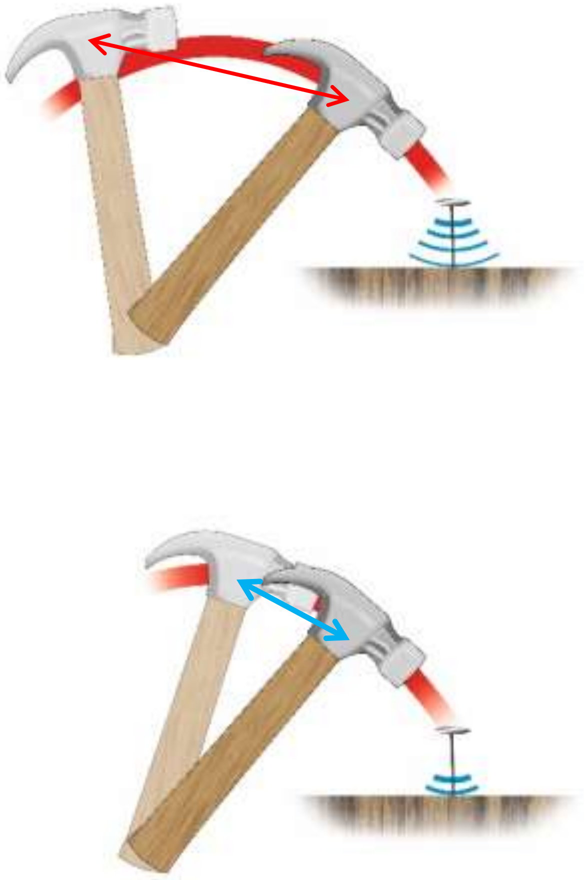


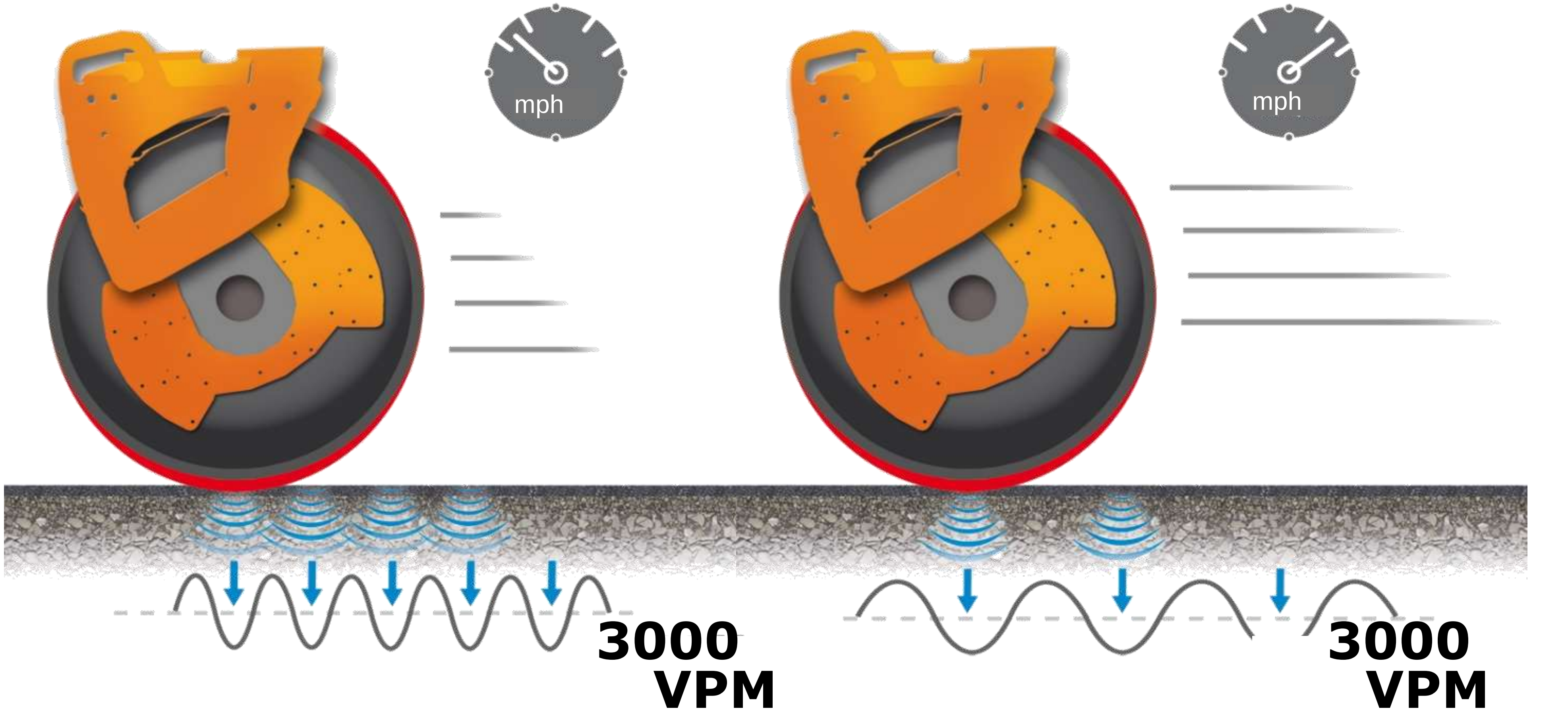




Frequency vs. Speed

HAMM

Speed can kill



Centrifugal Force

HAMM

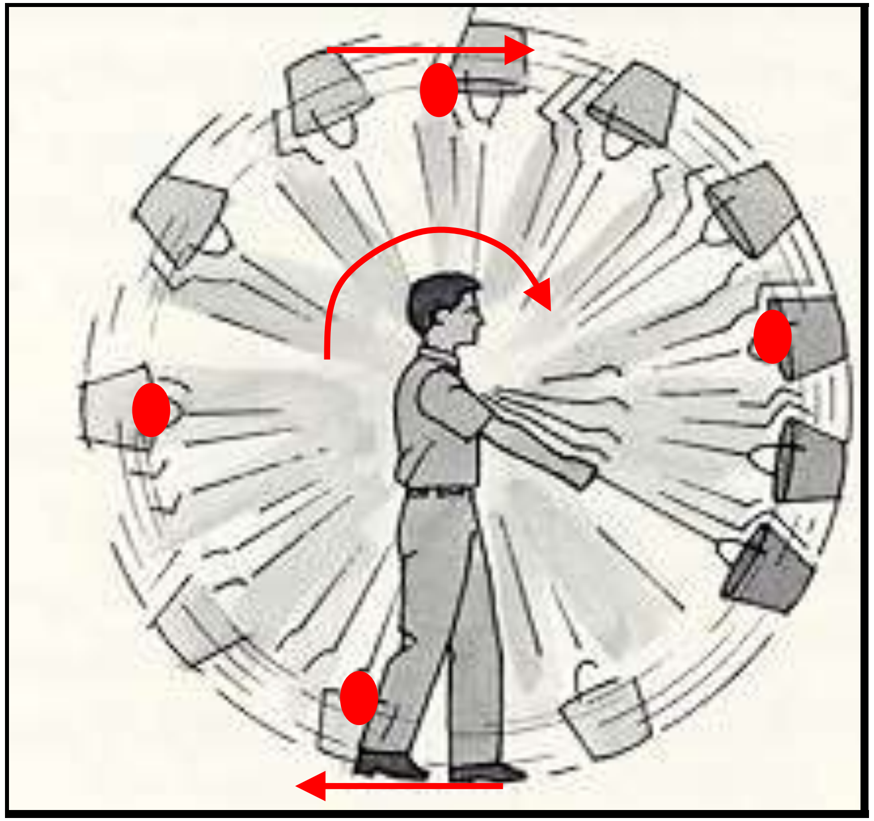
Centrifugal force principle

Centrifugal forces are generated by eccentrics in rotation

Heavier the eccentric weight – greater the generated force

Faster the eccentric rotation – greater the generated force

Drum up



Drum down

Centrifugal Force

HAMM

Centrifugal Force is Calculated by:

Multiplying the *Amplitude* times the Un-sprung *Drum Weight*, times *Frequency* squared divided by 35,198.

Makes you wonder!

Frequency & Rolling Speed

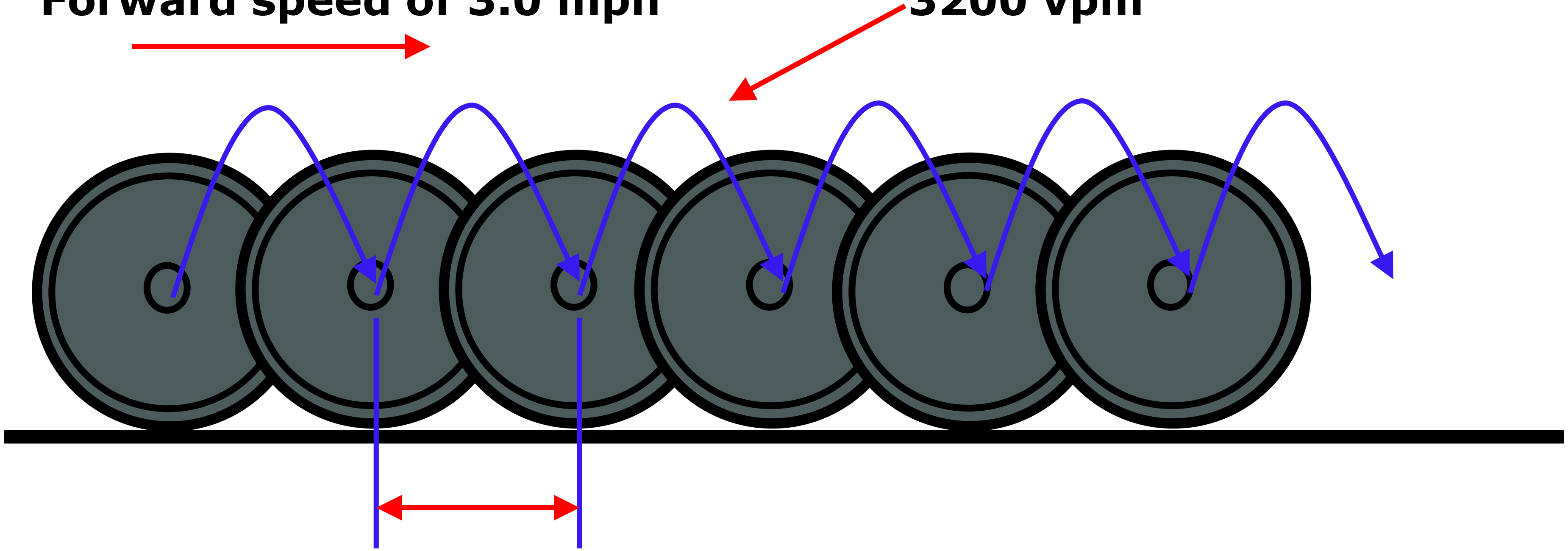
HAMM

Frequency + forward speed = (impact spacing)

The animation will show the relation between
Eccentric frequency – roller travel speed – impact spacing

Forward speed of 3.0 mph

3200 vpm

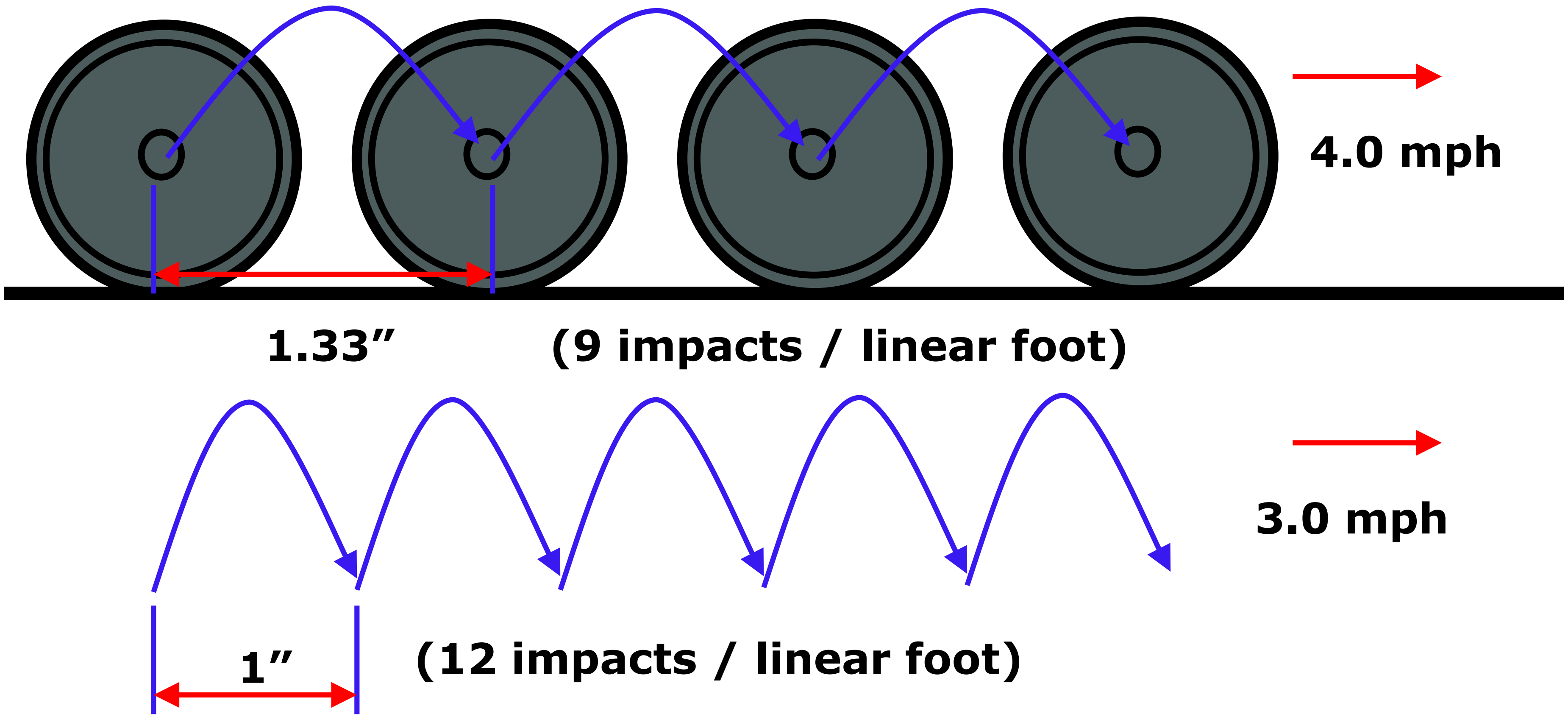


Approx. 1”
(12 impacts / linear foot)

Frequency & Rolling Speed

HAMM

For the SAME eccentric rotation of 3200 vpm, if I ACCELERATE to 4.0mph the IMPACT SPACING will now INCREASE to …



Frequency & Rolling Speed

HAMM

"WARNING"

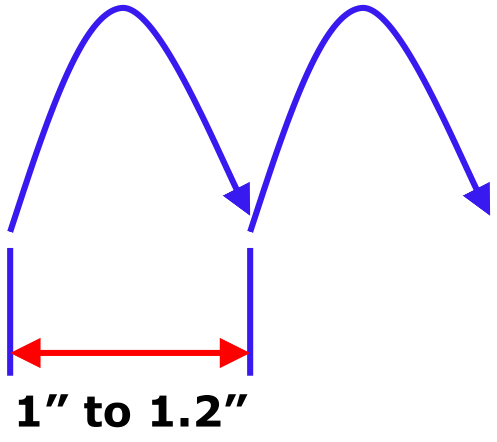
Best practices

dictate that you should REDUCE your rolling speed

NEVER TO INCREASE impact spacing over 1.2"

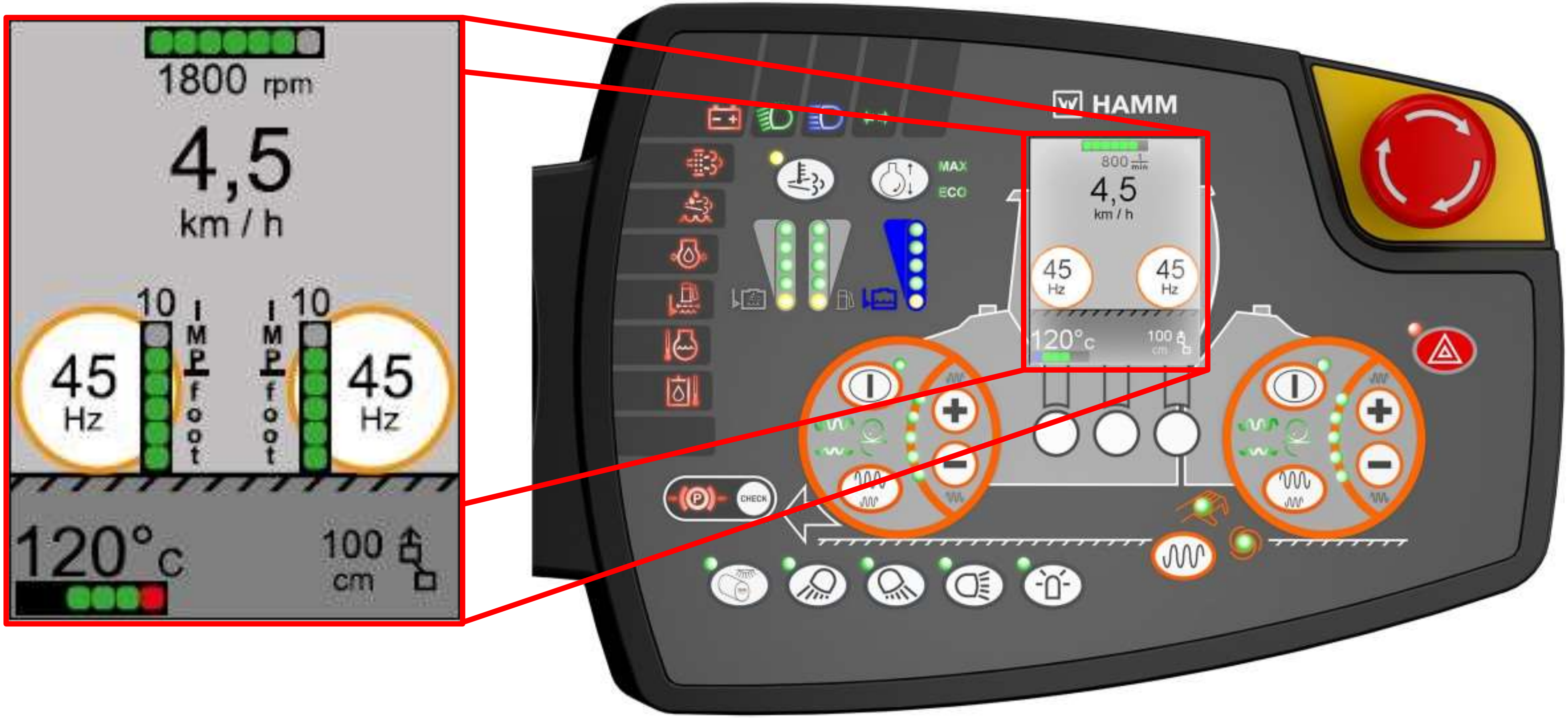
Or

NOT TO GO LOWER than 12 impacts / linear foot



Optimal
12 impacts / linear foot)

Frequency & Rolling Speed



Frequency & Rolling Speed

HAMM

Rolling Speeds

MPH / VPM	1	2	2.5	3	3.5	4	5	6
1,500	17	8.5	6.8	5.7	4.8	4.3	3.4	3.8
1,600	18.2	9.0	7.2	6.0	5.1	4.5	3.6	3.0
1,700	19.3	9.6	7.7	6.4	5.5	4.8	3.7	3.2
1,800	20.4	10.2	8.2	6.8	5.8	5.1	4.1	3.4
1,900	21.6	10.8	8.6	7.2	6.2	5.4	4.3	3.6
2,000	22.7	11.4	9.1	7.6	6.5	5.7	4.5	3.8
2,100	23.9	11.9	9.6	8.0	6.8	6.0	4.8	4.0
2,200	25.0	12.5	10.0	8.3	7.1	6.3	5.0	4.2
2,400	27.3	[illegible]	[illegible]	[illegible]	[illegible]	6.8	5.5	4.6
2,500	28.4	[illegible]	[illegible]	[illegible]	[illegible]	7.1	5.7	4.7
2,700	30.7	15.3	12.3	10.2	8.8	7.7	6.1	5.1
2,800	31.8	15.9	12.7	10.6	9.1	8.0	6.4	5.3
3,000	34.1	17.0	13.6	11.4	9.7	8.5	6.8	5.7
3,300	37.5	18.8	15.0	[illegible]	[illegible]	[illegible]	[illegible]	6.3
3,500	39.8	19.9	15.9	[illegible]	[illegible]	[illegible]	[illegible]	6.6
3,600	40.9	20.5	16.4	13.6	11.7	10.2	8.2	6.8
3,800	43.2	21.6	17.3	14.4	12.3	10.8	8.6	7.2
4,000	45.5	22.7	18.2	15.2	13.0	11.4	9.1	7.6
4,200	47.7	23.9	19.1	15.9	13.6	11.9	9.6	8.0

Standard → (3,000 VPM row)

High Freq. → (4,000 VPM row)

OK | *To Fast* (3,000 VPM)

OK | *To Fast* (4,000 VPM)

Drum Impact Spacing Chart

Frequency & Rolling Speed

WIRTGEN GROUP

HAMM

MAXIMUM ROLLING SPEED IN MILES PER HOUR (MPH) TO ACHIEVE DESIRED IMPACTS PER FOOT

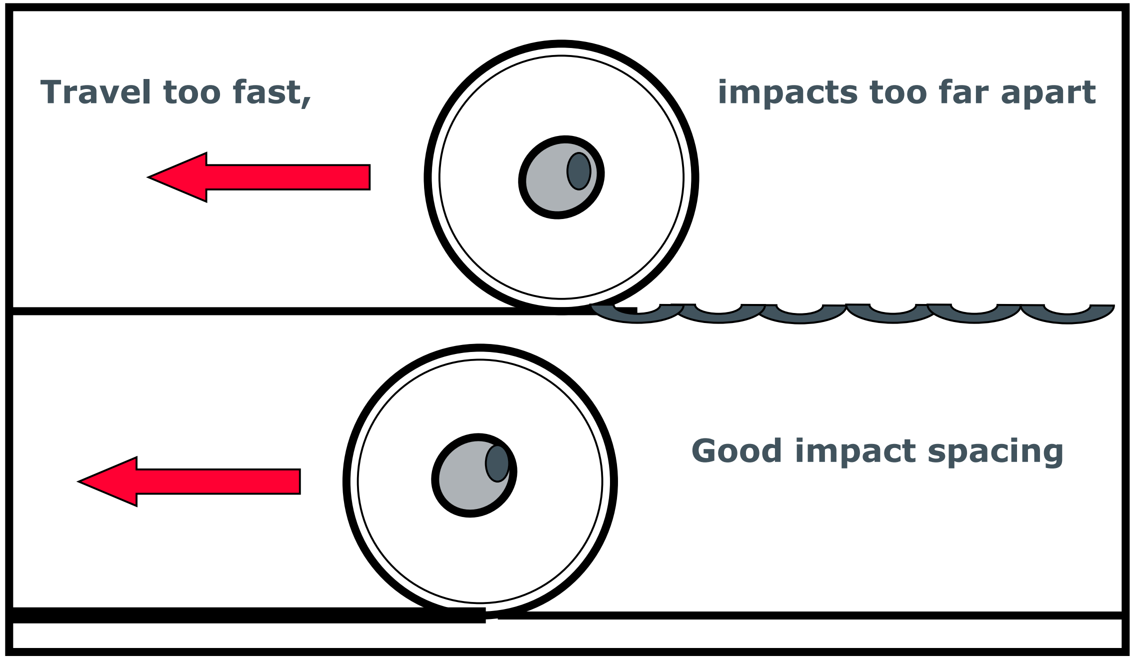
		IMPACTS PER LINEAR FOOT					
HERTZ	VPM	10	11	12	13	14	15
40	2400	2.7	2.5	2.3	2.1	1.9	1.8
41	2460	2.8	2.5	2.3	2.2	2.0	1.9
42	2520	2.9	2.6	2.4	2.2	2.0	1.9
43	2580	2.9	2.7	2.4	2.3	2.1	2.0
44	2640	3.0	2.7	2.5	2.3	2.1	2.0
45	2700	3.1	2.8	2.6	2.4	2.2	2.0
46	2760	3.1	2.9	2.6	2.4	2.2	2.1
47	2820	3.2	2.9	2.7	2.5	2.3	2.1
48	2880	3.3	3.0	2.7	2.5	2.3	2.2
49	2940	3.3	3.0	2.8	2.6	2.4	2.2
50	3000	3.4	3.1	2.8	2.6	2.4	2.3
51	3060	3.5	3.2	2.9	2.7	2.5	2.3
52	3120	3.5	3.2	3.0	2.7	2.5	2.4
53	3180	3.6	3.3	3.0	2.8	2.6	2.4
54	3240	3.7	3.3	3.1	2.8	2.6	2.5
55	3300	3.8	3.4	3.1	2.9	2.7	2.5
56	3360	3.8	3.5	3.2	2.9	2.7	2.5
57	3420	3.9	3.5	3.2	3.0	2.8	2.6
58	3480	4.0	3.6	3.3	3.0	2.8	2.6
59	3540	4.0	3.7	3.4	3.1	2.9	2.7
60	3600	4.1	3.7	3.4	3.1	2.9	2.7
61	3660	4.2	3.8	3.5	3.2	3.0	2.8
62	3720	4.2	3.8	3.5	3.3	3.0	2.8
63	3780	4.3	3.9	3.6	3.3	3.1	2.9
64	3840	4.4	4.0	3.6	3.4	3.1	2.9
65	3900	4.4	4.0	3.7	3.4	3.2	2.9
66	3960	4.5	4.1	3.8	3.5	3.2	3.0
67	4020	4.6	4.1	3.8	3.5	3.3	3.0
68	4080	4.6	4.2	3.9	3.6	3.3	3.1
69	4140	4.7	4.3	3.9	3.6	3.4	3.1
70	4200	4.8	4.3	4.0	3.7	3.4	3.2

Frequency & Rolling Speed

HAMM

"WARNING"

"RIPPLE" problems can be generated by large impact spacing…



The problem may be WORSE with THICK asphalt layers

Rolling Speed Example

HAMM

- **4 impacts per foot**
- **Creates rough ride or could even create sound issues**
- ***Watch your speed***

Frequency & Rolling Speed

HAMM

High frequency compaction rollers

POSITIVE ASPECTS

Allows for HIGHER travel SPEED

Allows for MORE roller mat COVERAGE (sq. ft / min)

Theoretically allows for MORE productivity

Good for "THIN LIFTS"

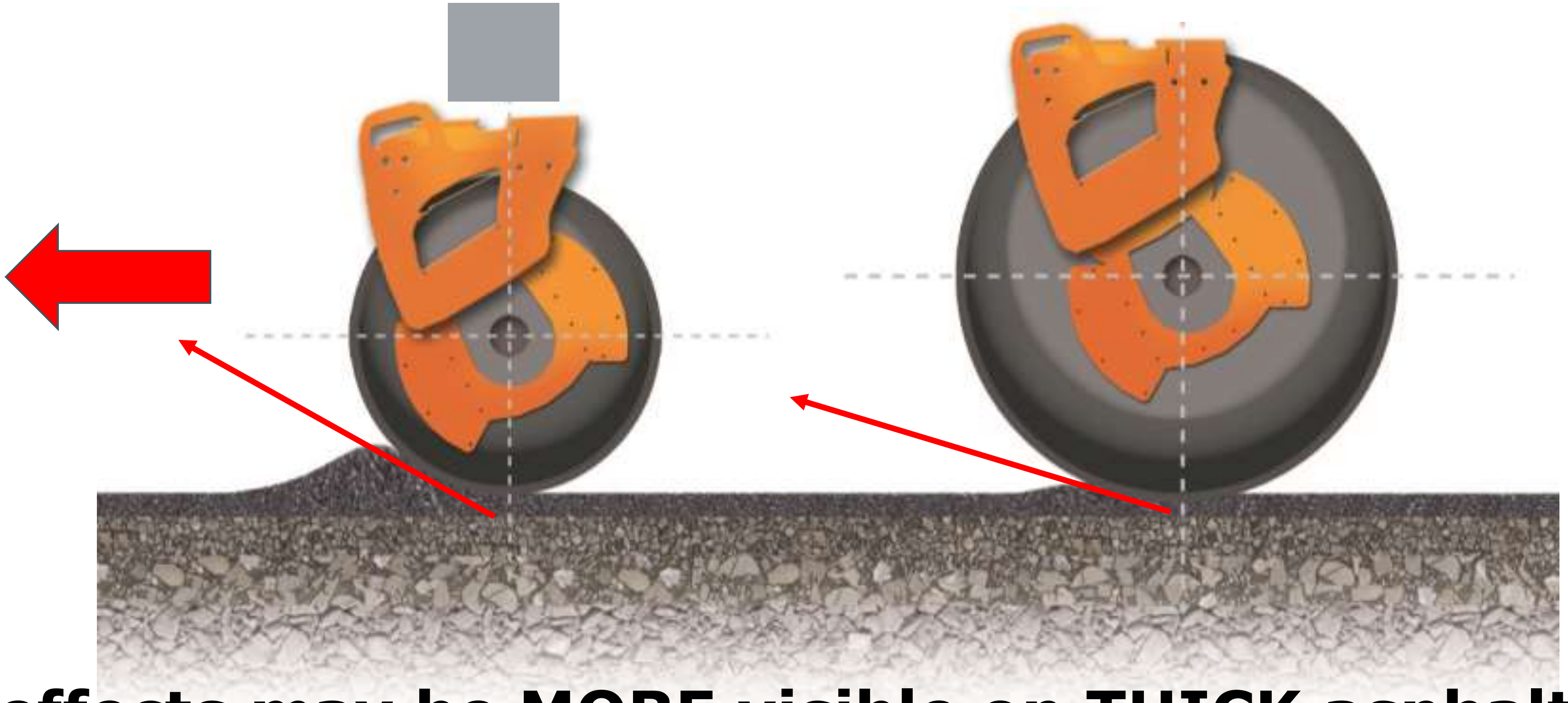
- ✓ **Quick sealing of mat surface behind paver**
- ✓ **Could increase rolling time before tender zone occurs**

Drum Diameter

HAMM

Larger drum diameters …

Provide for more UNIFORM mat contact
Are LESS prone to mat marking
Are LESS prone to bow waves



The effects may be MORE visible on THICK asphalt layers

HAMM

Pressurized water system

High pressure water system ensures full coverage to drum surface.

Drum Water & Scrapers

HAMM

Dual scrapers per drum

External Factors Affecting Compaction

External Factors?

HAMM

Don't go blaming the roller…

Fact is, it's rarely the rollers fault!

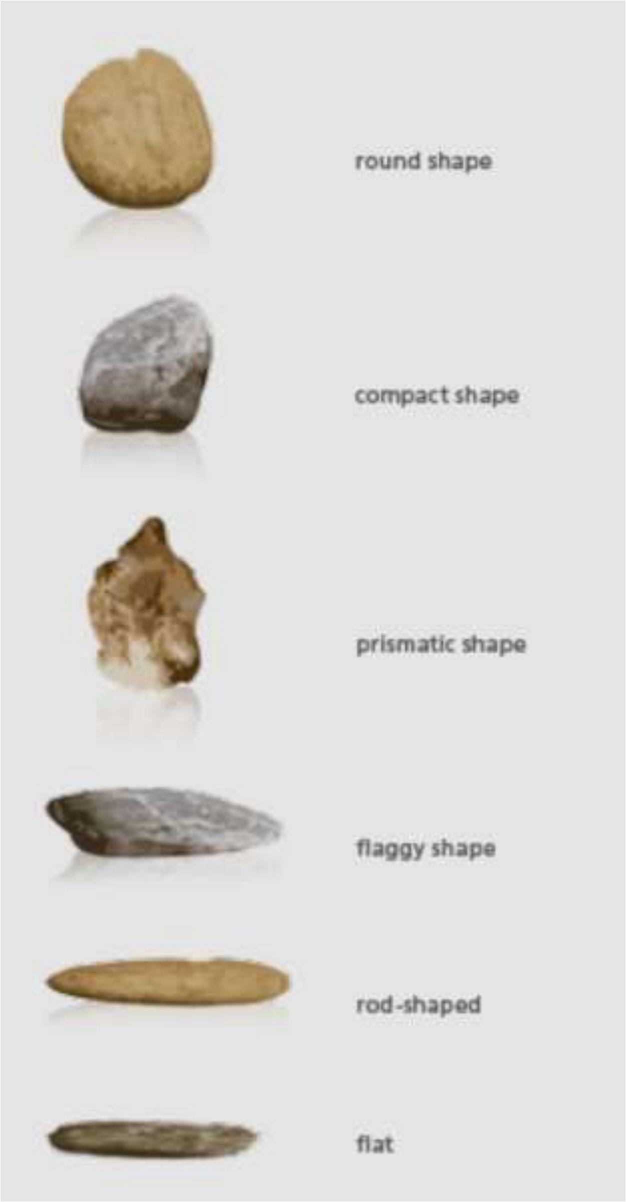
External Factors?

HAMM

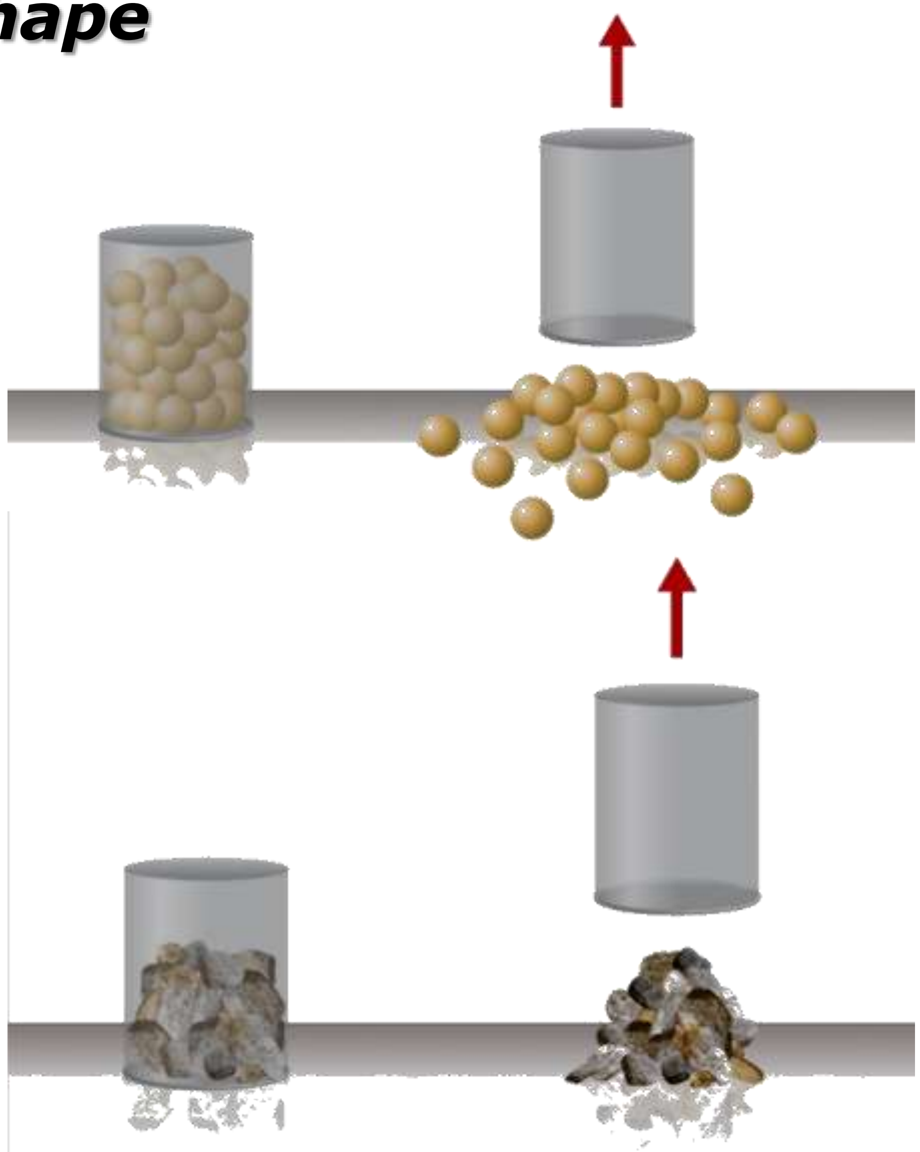
External Factors Affecting Compaction:

- **Mix design**
- **Mix temperature**
- **Paver issues**
- **Operator Issues**
- **Ambient temperature**
- **Base Conditions**

Mix Design



Particle shape



Mix Type & Design

A science of its own

The main components can be summarized as follows:

Bitumen

Gradation of stones & fines

Modifiers

(Polymers, rubber, liquid anti-strip)

Stabilizers

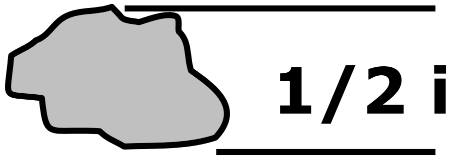
(Fibers, crumb rubber, sulfur, hydrated lime)

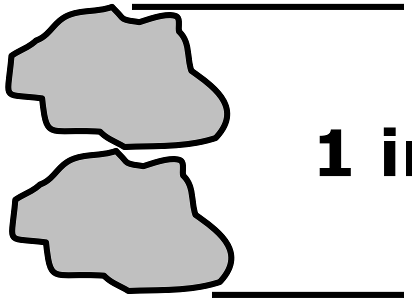
HAMM

Minimum mat thickness vs aggregate size

"CONVENTIONAL" Asphalt Mix Design

Largest aggregate size in the mix	Rule	Minimum Mat Thickness
1/2 inch	X 2	1 inch





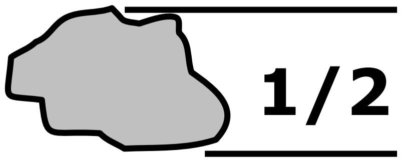
Lift Thickness

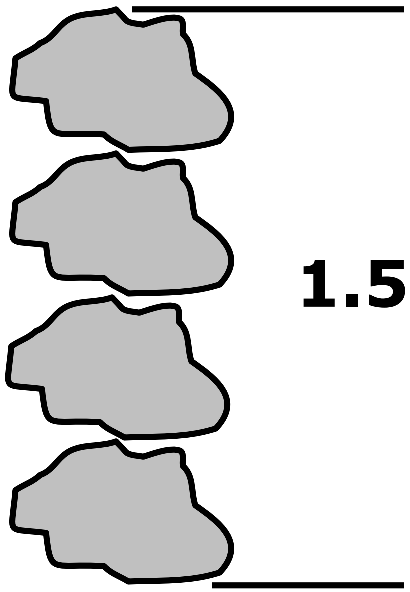
HAMM

Minimum mat thickness vs aggregate size

"SUPERPAVE" Asphalt Mix Design

Largest aggregate size in the mix	Rule	Minimum Mat Thickness
1/2 inch	X 3-4	1.5 - 2 inches



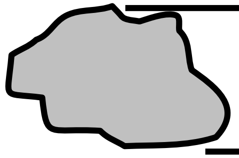


Lift Thickness

HAMM

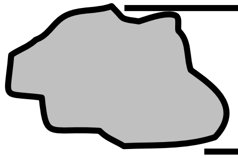
Minimum mat thickness vs aggregate size

"CONVENTIONAL"



1/2 inch X 2 min

"SUPERPAVE"

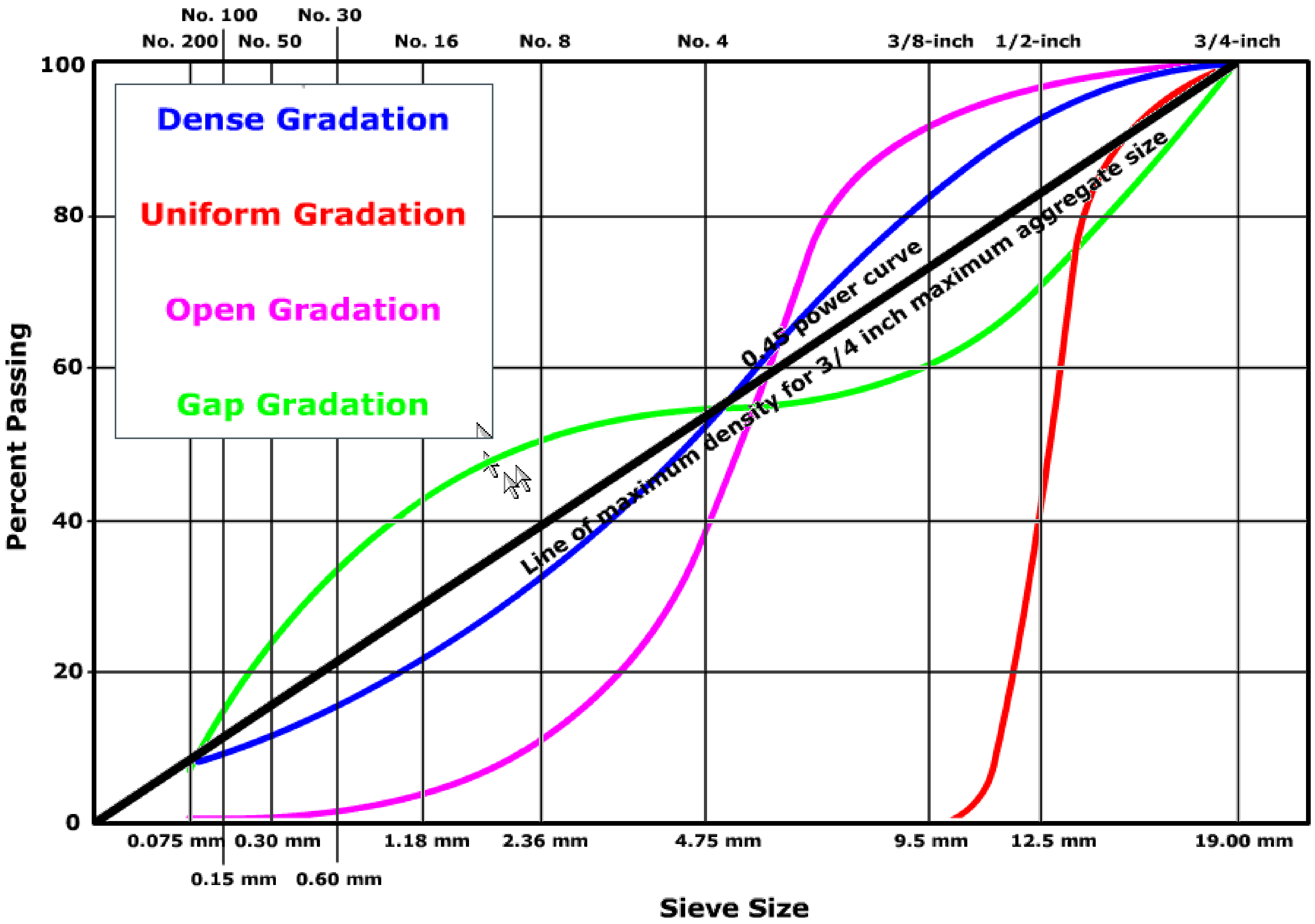


1/2 inch X 3-4 min

"Grain Crushing" may occur

"White" crushed gravel surface

Gradation Curve



HAMM

Good to keep a log

Roller operators have NO control of the mix delivered

It is therefore a good practice to;

- **Identify the mix you are working on**
- **Keep a log for future reference (see example…)**

Date	Worksite	Mix type	Mat Temp.	Weather	Rolling Pattern	Achieved Density	Target Density	Mat thickness

KNOWLEDGE & EXPERIENCE is priceless!!

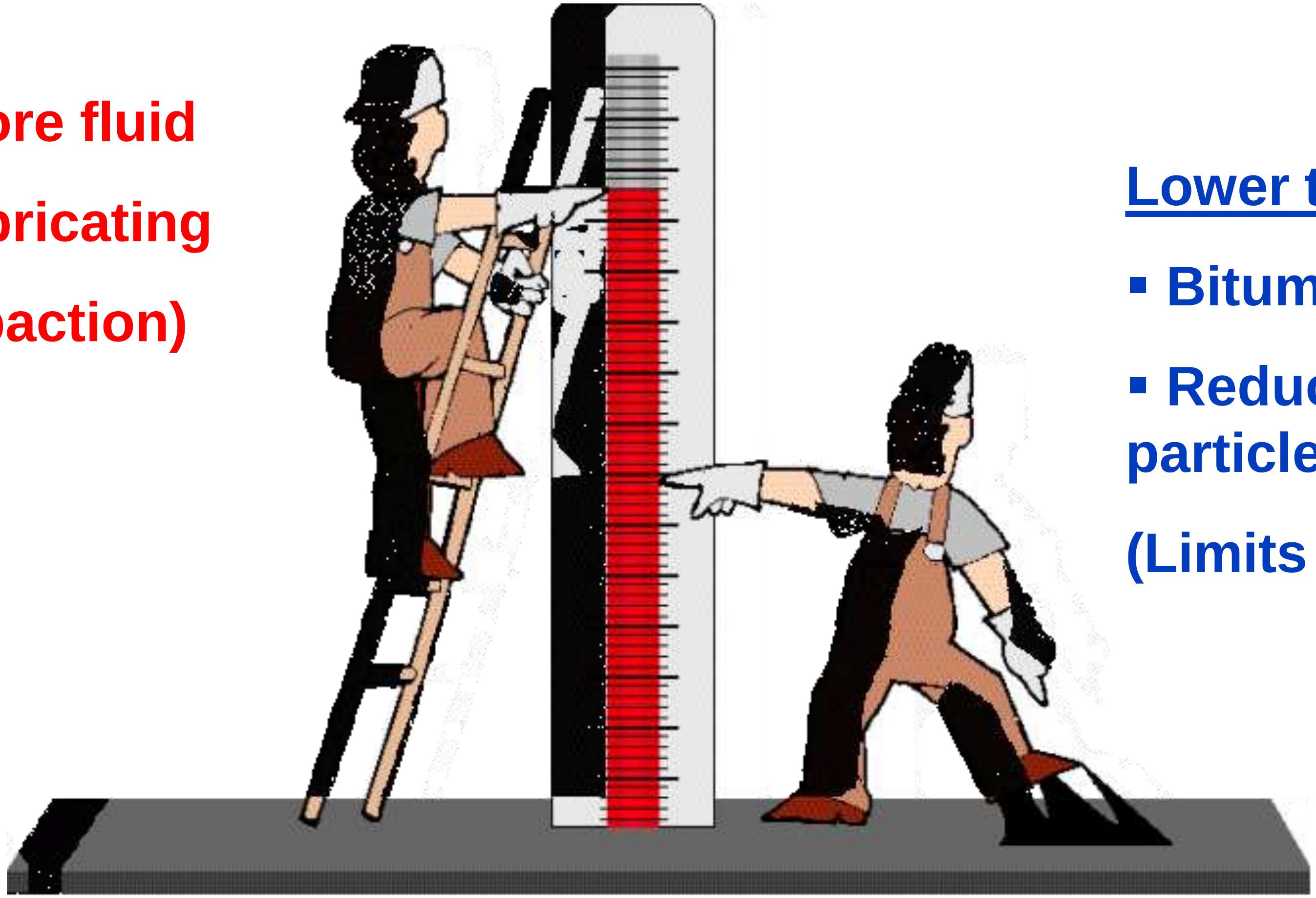
HAMM

Hot mix & ambient temperature

Higher temp.

- **Bitumen is more fluid**
- **Bitumen is lubricating**

(Good for compaction)



Lower temp.

- **Bitumen is more stiff**
- **Reduces ability to move particles**

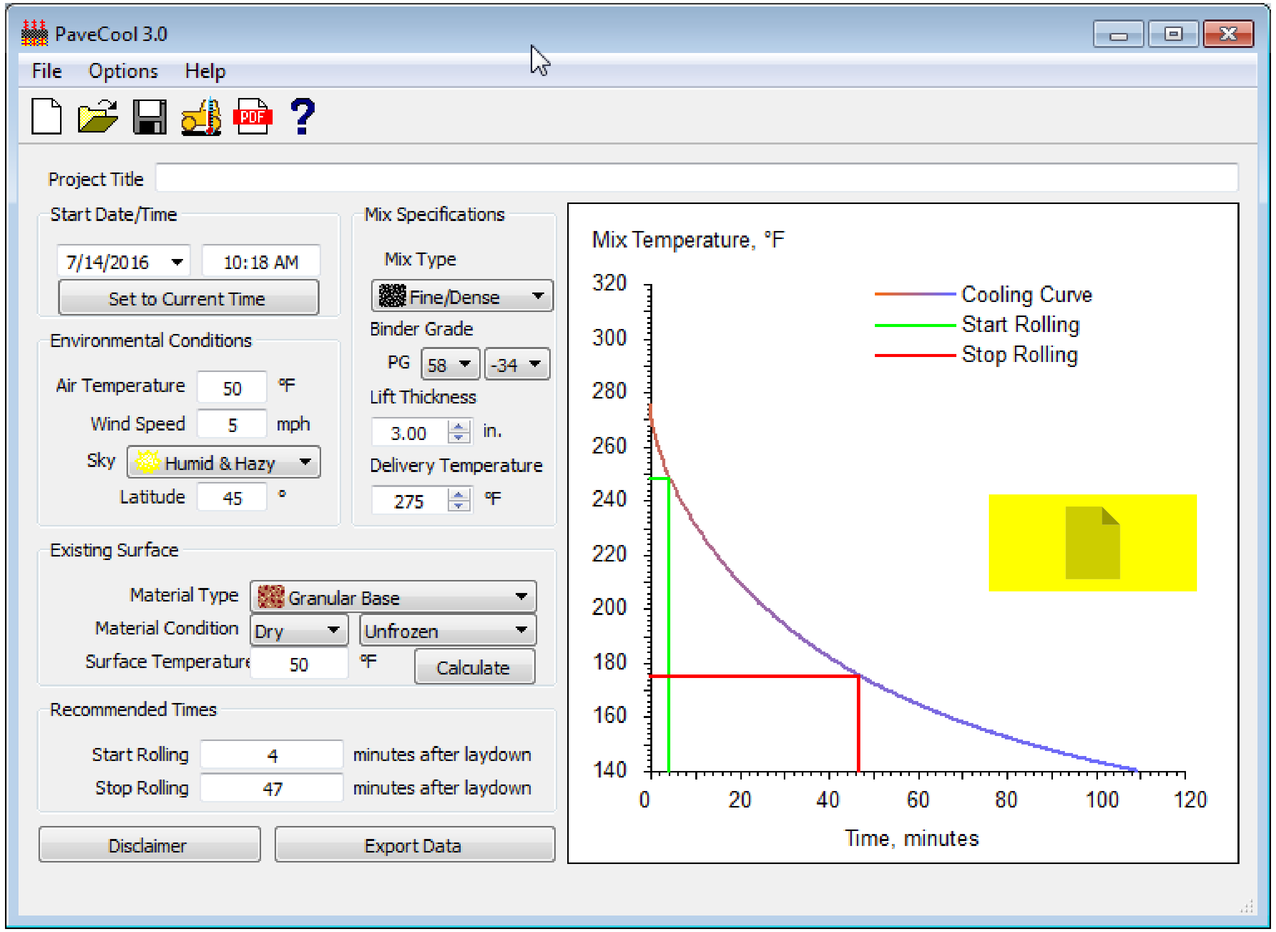
(Limits compaction)

Temperature (Proper Machine)

HAMM

Temperature

Cooling rate = rolling time



Software has been developed to estimate the temperature window for rolling time

OR

HAMM

Cooling rate = rolling time

MultiCool V2.0

Can run from Computer

Android & iPhone App

Software has been developed to estimate the temperature window for rolling time

Temperature

HAMM

Hot mix & ambient temperature

Temperature ranges can dictate the “roller train” set up

	Breakdown	Intermediate	Finish
Temp.	310 – 240 °F	240 – 200 °F	200 – 150 °F
Distance	Up to 200 ft	Up to 200 ft	150 ft & more

HAMM

Hot mix & ambient temperature

Cooling rate affected by…

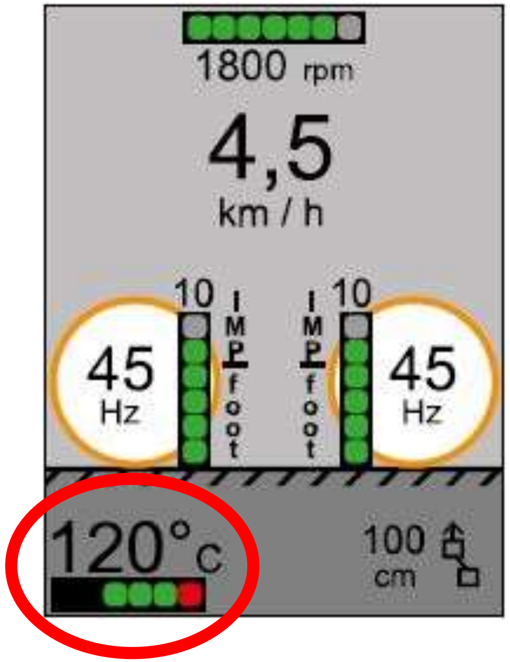
- **Mat lift thickness**
- **Ambient & base temperature**
- **Asphalt mix lay down temperature**
- **Wind velocity**

Temperature

HAMM

Monitoring system

Constant temperature readout



Display & warning controller

Infrared temperature sensor

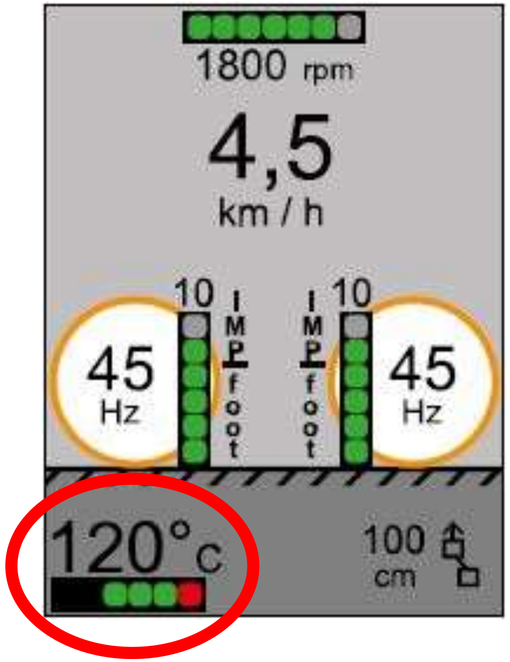
HAMM

Monitoring system

Operator can set the temperature parameters

Temp. high:

300°F



Temp. low:

240°F

Base Conditions

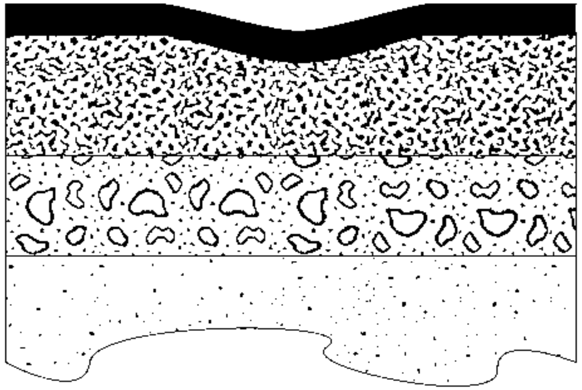
HAMM

Grading and base compaction is critical

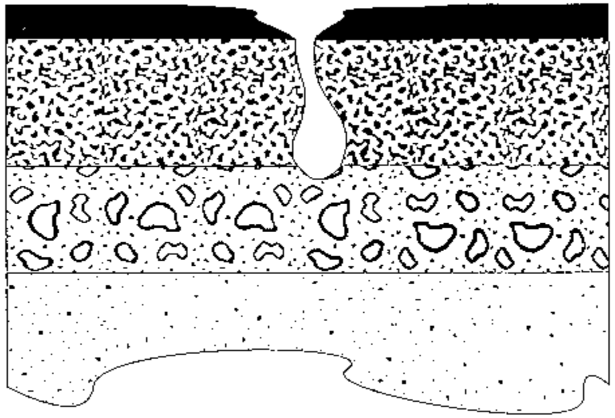
Compacted surface is only as good as its BASE

Grading and surface uniformity is critical

Base reconstruction or milling may be necessary



Deformation



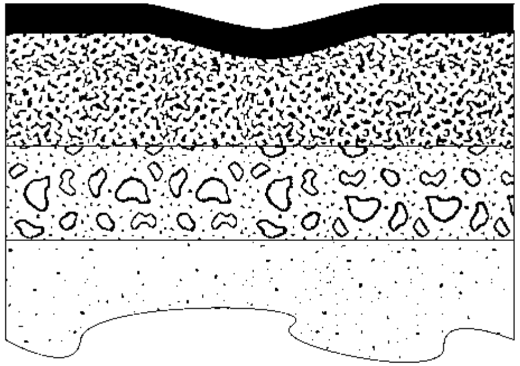
Cracking

Weak Base

Base Conditions

HAMM

Preparation is critical



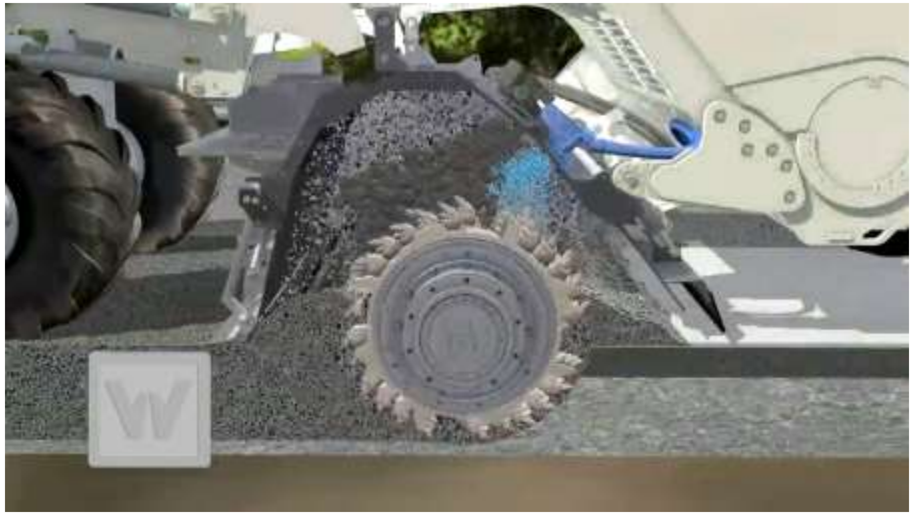
Deformation

Cracking

Base Conditions (Preparation is Critical)

HAMM

Milling



Recycling

Base Conditions (Preparation is Critical)

HAMM

“Fine milling” for near perfect re-profiling before paving

Base Conditions (Preparation is Critical)

HAMM

Preparing Your Roller for Work

HAMM

- Do a walk around, look for obstacles or anything out of the ordinary
- Check water system, clean filter
- Check function of lights, indicators and beacon
- Check fluid levels
- Check scrapers, make sure they are in the correct position
- Allow for the equipment to warm up

Know your equipment!

Using a vibratory roller

- **Deactivate vibration before reversing**
- **Choose the amplitude and frequency to match the job and the mix**
- **Compact surface course at low amplitude / high frequency**
- **Compact thick layers of more than 3” on high amplitude first, then switch to low**
- **On hills, only vibrate up hill and static down**
- **On asphalt temperatures under 175, only use static or oscillation**

10 Commandments for Roller Operators

HAMM

1) **Roll as closely as possible behind the paver**

2) **When compacting, always begin at the lower edge**

3) **Compact the seams first (if next to a hot mat)**

4) **Deactivate vibration before reversing**

5) **Always change the rolling speed gently**

6) **Move forwards and backwards in the same track**

7) **Change the roller track on the cold side**

8) **Roll in parallel tracks**

9) **Water the drums sufficiently**

10) **Never leave the roller on the hot asphalt**

And Three More...

HAMM

After Finishing

- When parking, secure roller out of the way
- Inspect drums and scrapers
- Inspect water system
- If risk of freezing, drain water tanks and sprinkler system
- Flush with anti-freeze
- Pick up and remove your trash and belongings
- Turn off battery switch (if equipped)Lock up and don’t lose the keys

Key Factors Affecting Rolling Patterns

Key factors affecting pattern

- Basic rolling techniques
- Paver speed
- Number of passes
- Number of coverage’s
- Joints & edges

Rolling Pattern

HAMM

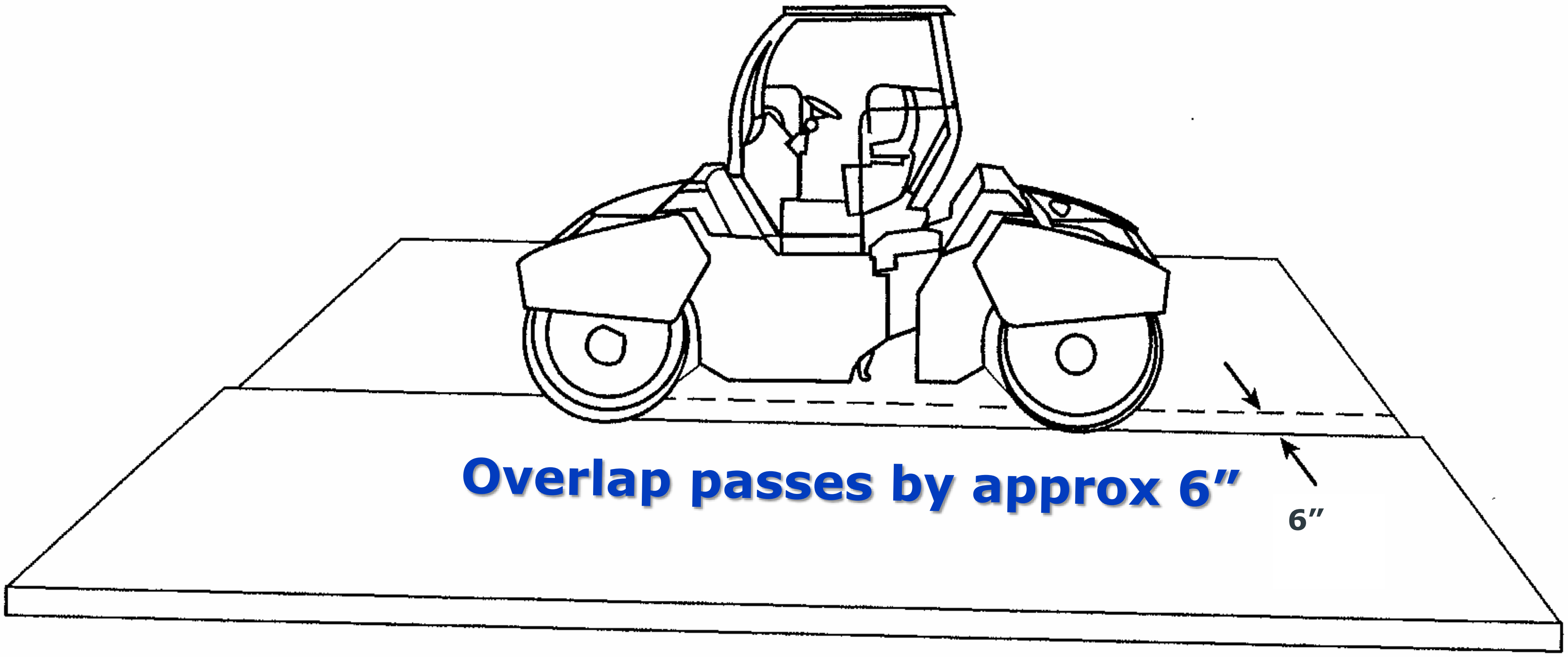
Basic rolling techniques

Never STOP on a soft mat

Never VIBRATE standing still

HAMM

Basic rolling techniques



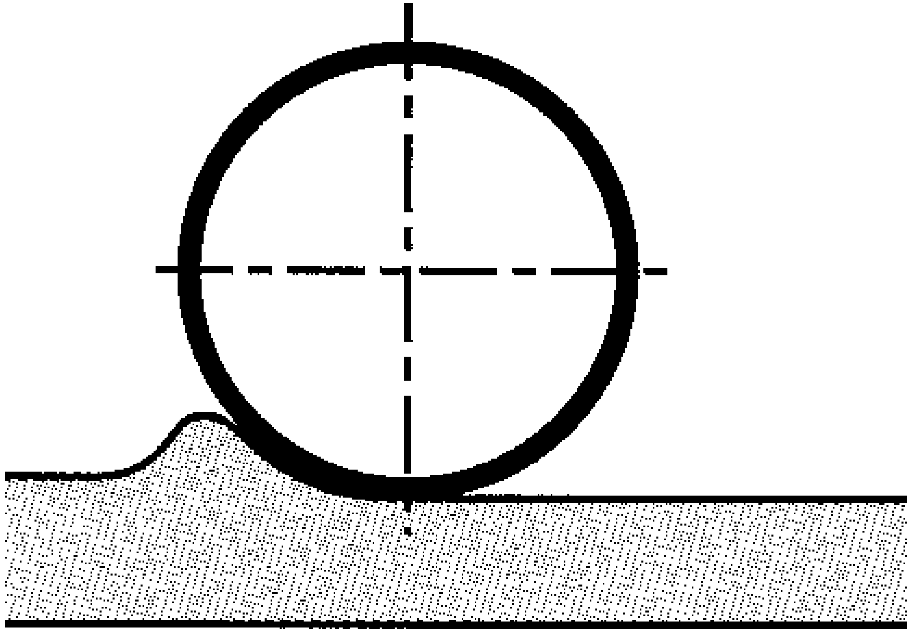
Overlap passes by approx 6"

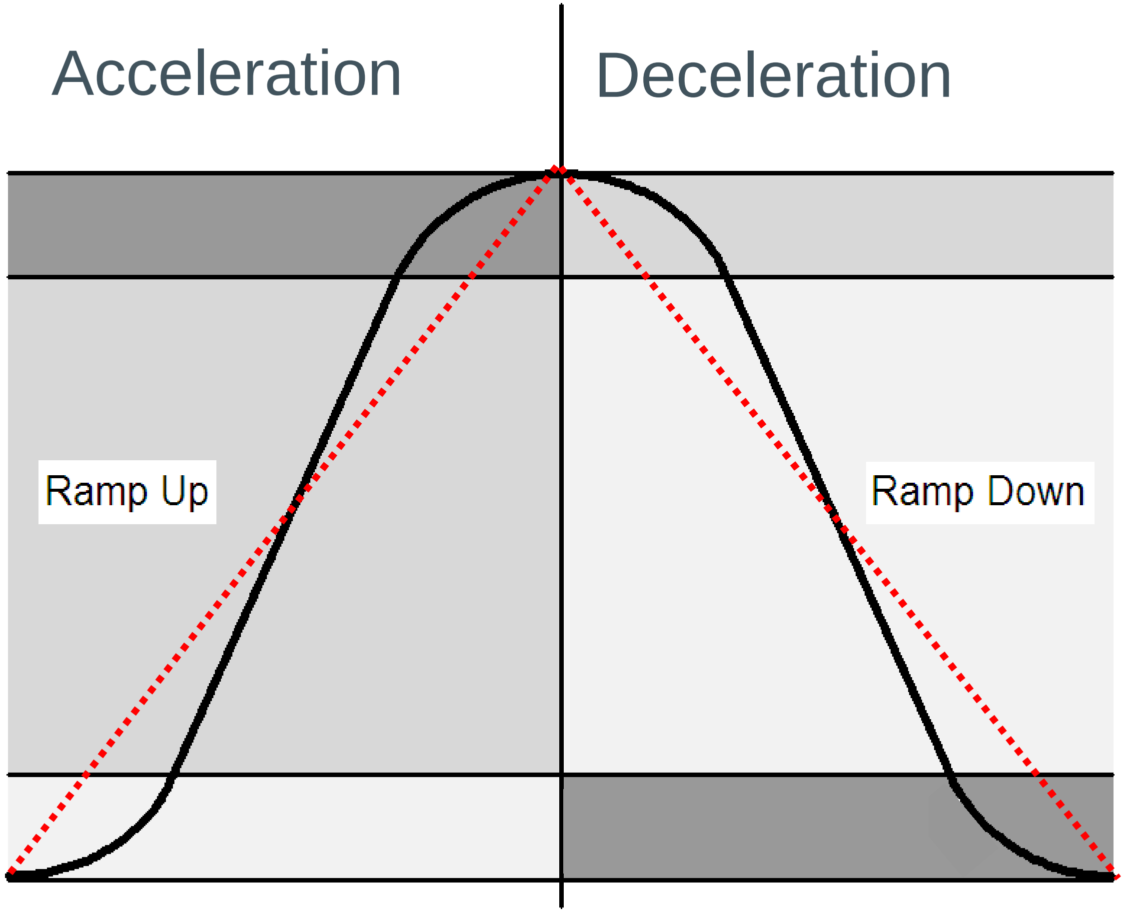
HAMM

Basic rolling techniques

Need for delicate transitions

- **Smooth start**
- **Smooth stop**



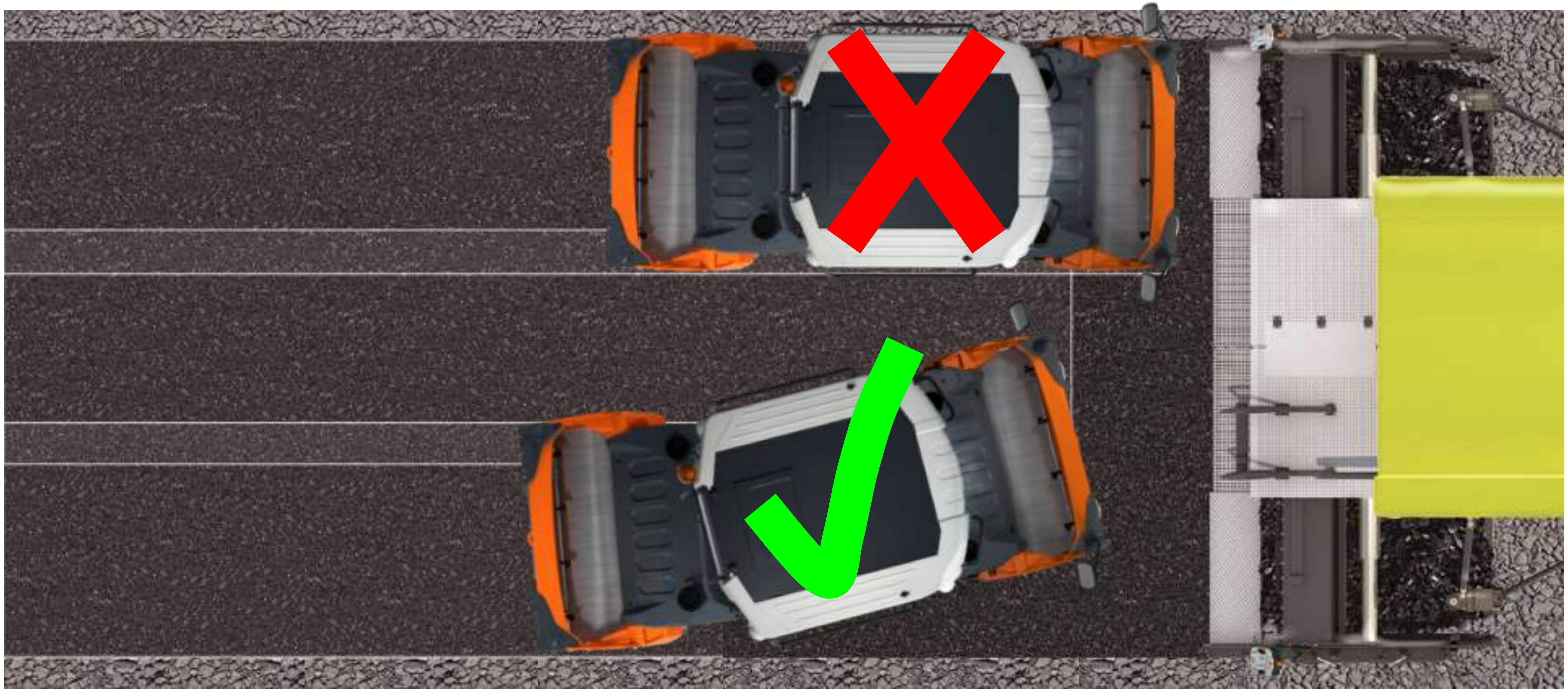


Rolling Pattern (Stopping)

HAMM

Basic rolling techniques

Always stop at an angle



Rolling Pattern

HAMM

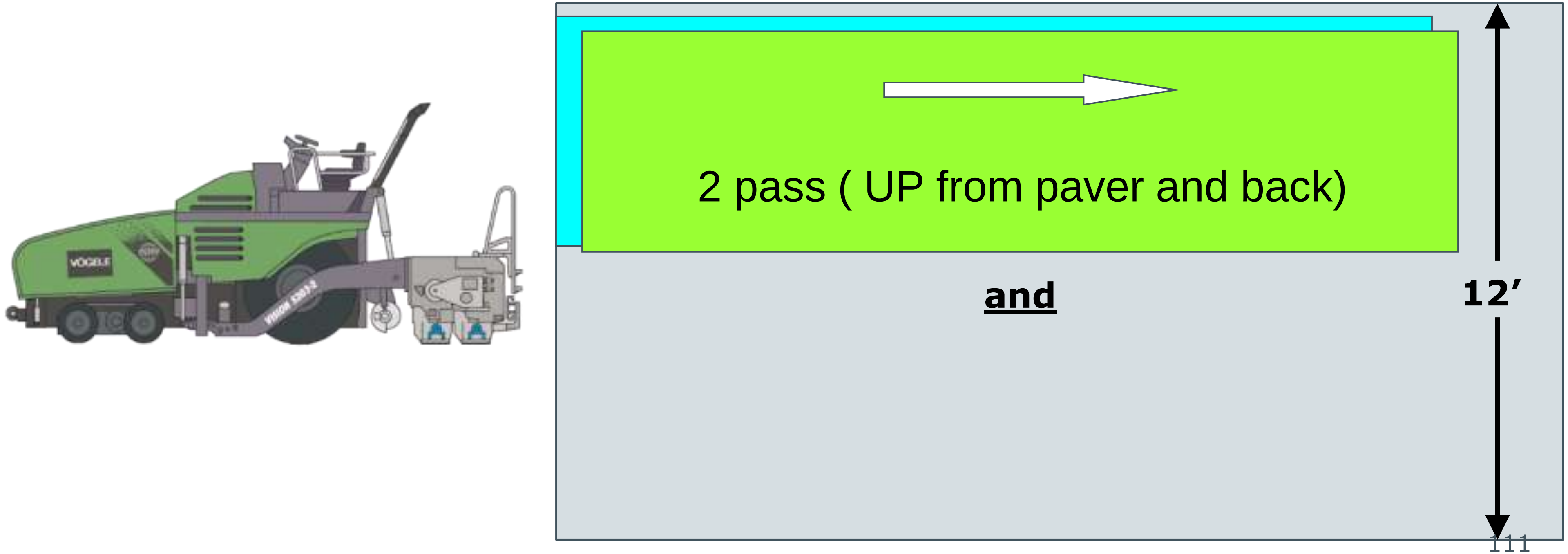
Basic rolling techniques

Always stop at an angle

Rolling Pattern (Number of Passes)

HAMM

- **1 pass = 1 way up towards the paver**
- **2 passes = 1 way up and 1 way down on the mat in the same track**
- **Patterns need to be maintained for consistency**
- **Each rolling train zone has its own pattern**
- **Number of passes will always be an odd number**



Rolling Pattern (Number of Coverage's)

Coverage = Number of passes to cover the mat once

Number of coverages needed to achieve final density

In this example 2 passes are needed to make 1 coverage

Rolling Pattern (Longitudinal Joint – Vibration)

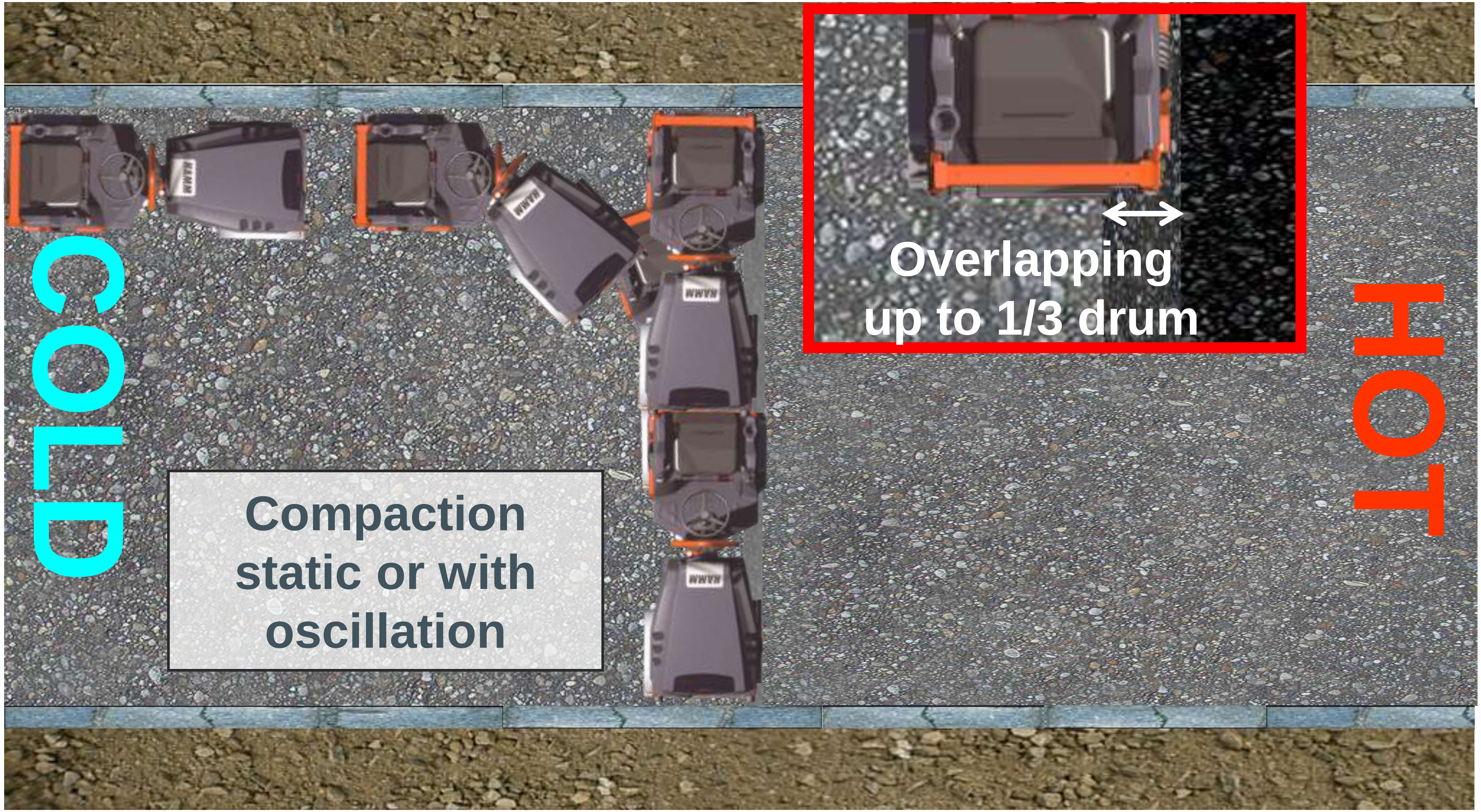
HAMM

Rolling Pattern (Longitudinal Joint – Oscillation)

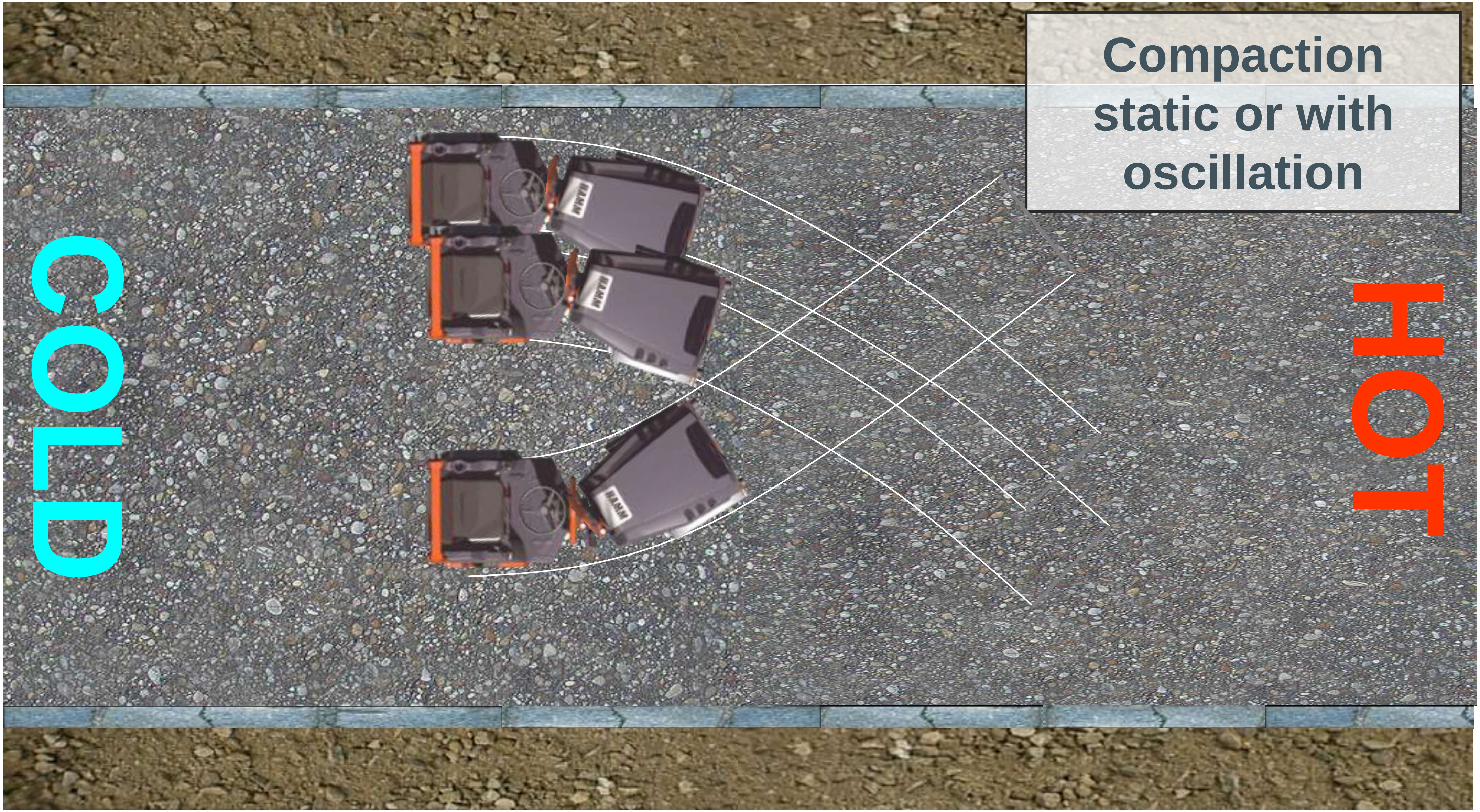
HAMM

Compacting the seam *transversely* to the road surface

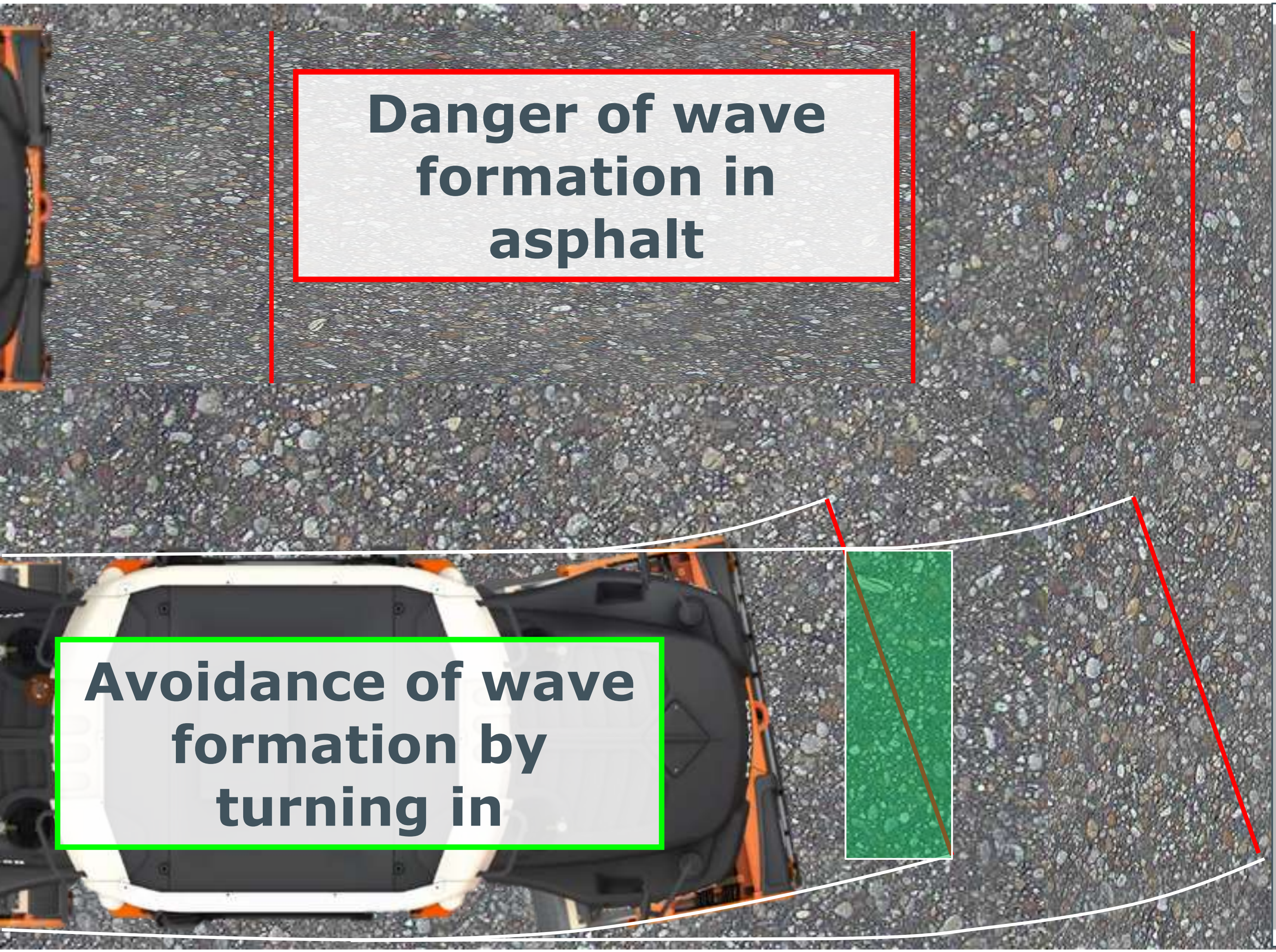
HAMM

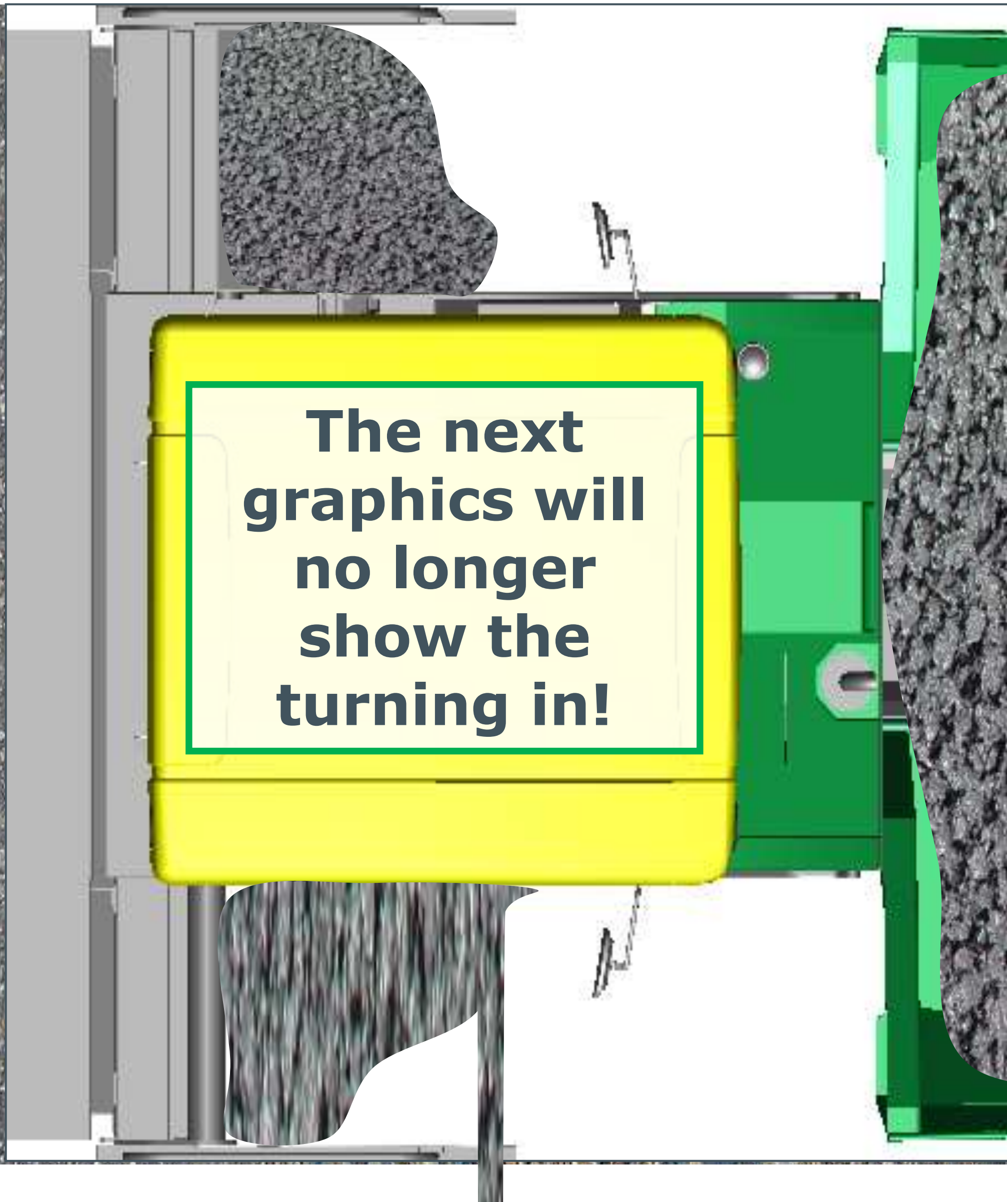


Compaction of the seam in the *fan shape*



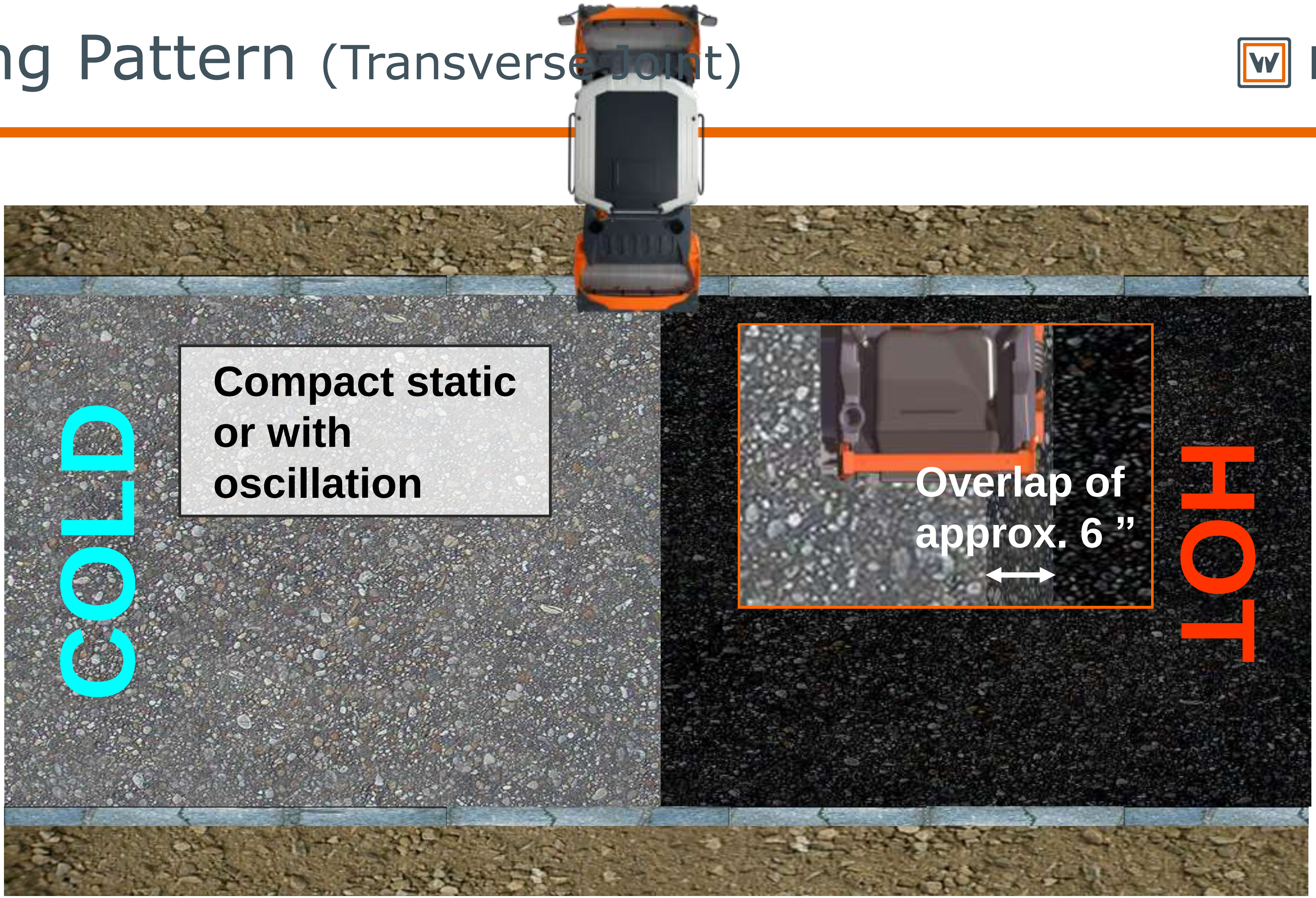
Reversing before the paver





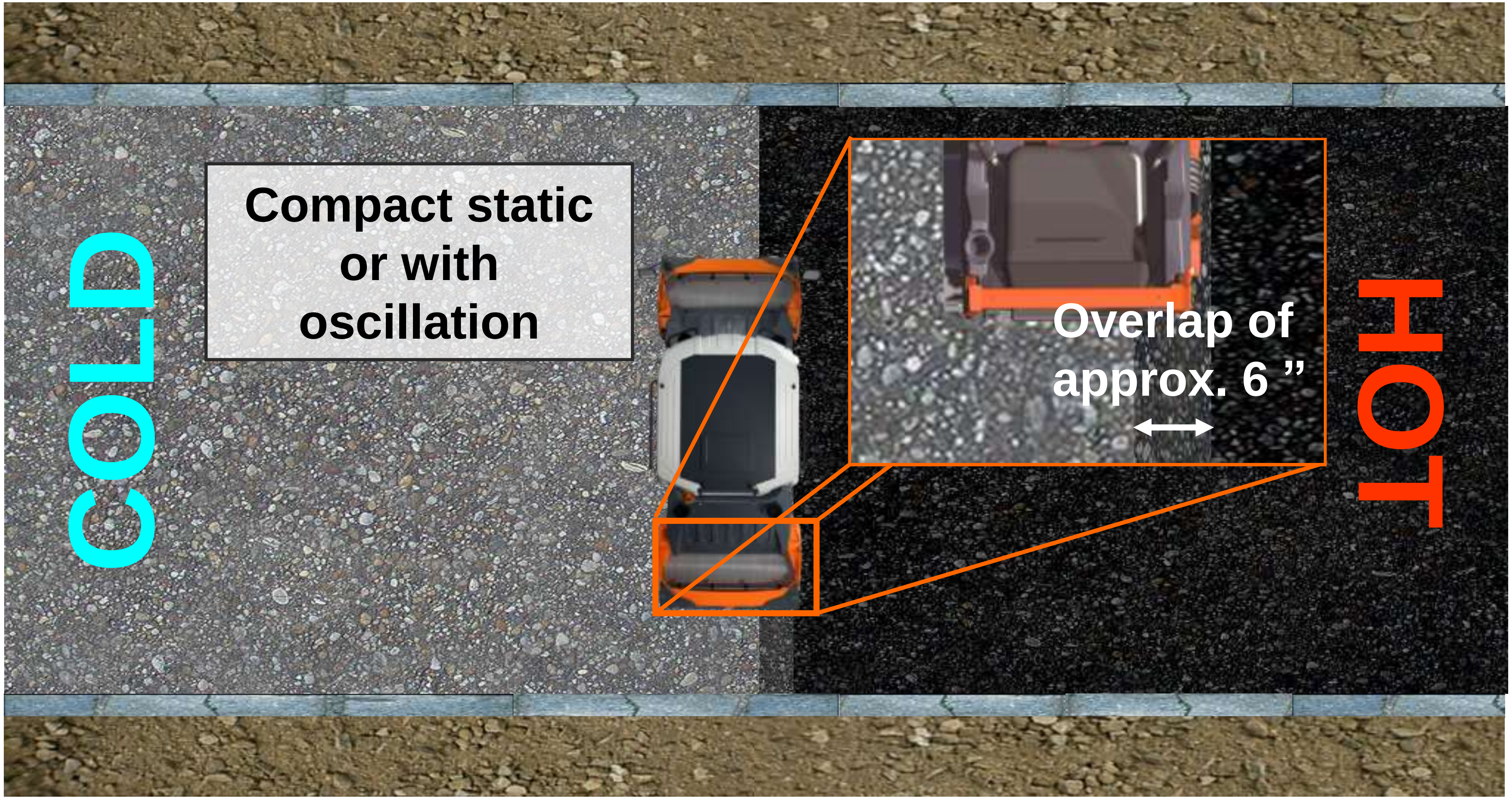
Rolling Pattern (Transverse Joint)

HAMM



Rolling Pattern (Transverse Joint)

HAMM



Summary

- **Compaction starts from the bottom up**
- **4 elements of compaction**
  - **Static weight, Impacts, Dynamics and Kneading**
- **Roller Trains**
- **Roller types**
  - **Where and when to use**
- **Roller Deign Specs**
  - **Impact spacing**
  - **Water & Scrapper system**
- **External Factors**
  - **Mix Designs (vary)**
  - **Temperature, Temperature, Temperature**
- **Rolling Techniques**
  - **Stop on angle**
  - **Smooth transitions**

Consistency

Thank You

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