The Right Rollers for the Right Project

HAMM

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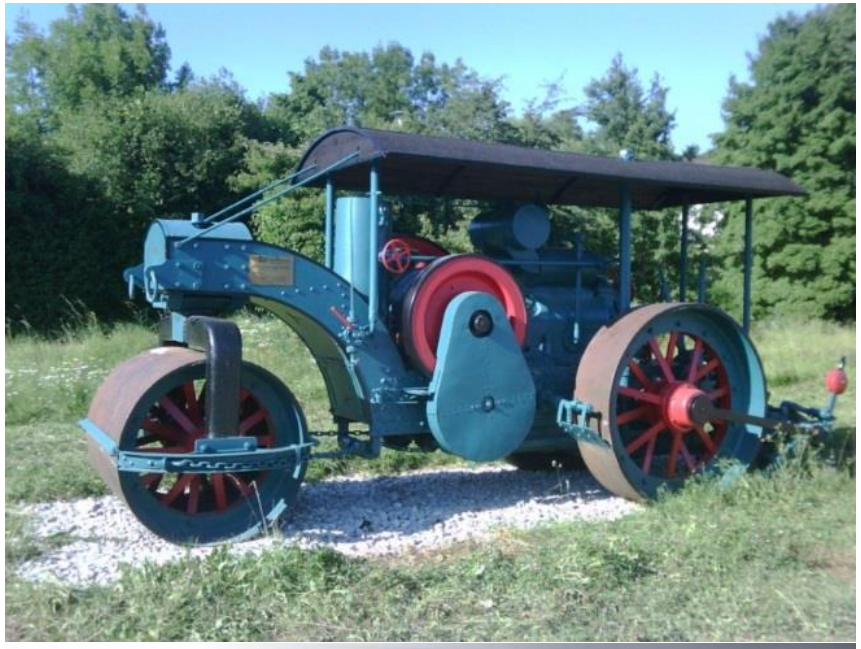
Outline

- Roller types
  - Soil
    - Small to large
    - Smooth or Padfoot
    - Compacting for stability
  - Asphalt
    - Compact to large
      - Static, pneumatic, vibration, combination, oscillation
- 4 Elements of compaction
- Roller design specs affecting compaction
- External factors affecting compaction
- Summary



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PRODUCTS

Rollers

Rollers for every application

- Soil Compactors
- Tandem Asphalt Rollers
- Pneumatic tire rollers

Variety of Different Rollers

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Over 198 different models

High regulated markets

TIER 4

EU Stage VI/
EPA Tier 4

GRW 280i

H CompactLine

Trench

HD CompactLine

GRW 180i

DV+

HD+

H

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SOIL ROLLERS

Earth Work

Trench Rollers

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- **Small for getting into trench's**
  - **22" to 38"**
- **Remote controlled**
- **Around 1.5 ton**

Compact Soil Rollers

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- **Small & Compact**
  - **54” – 66” drums**
  - **Smooth or padfoot**
  - **Blade (optional)**
  - **Compaction meter (optional)**
- **Easily maneuverable**
- **Great visibility (Cab or ROPS)**
- **Around 5-7 ton**

Compact Soil Rollers

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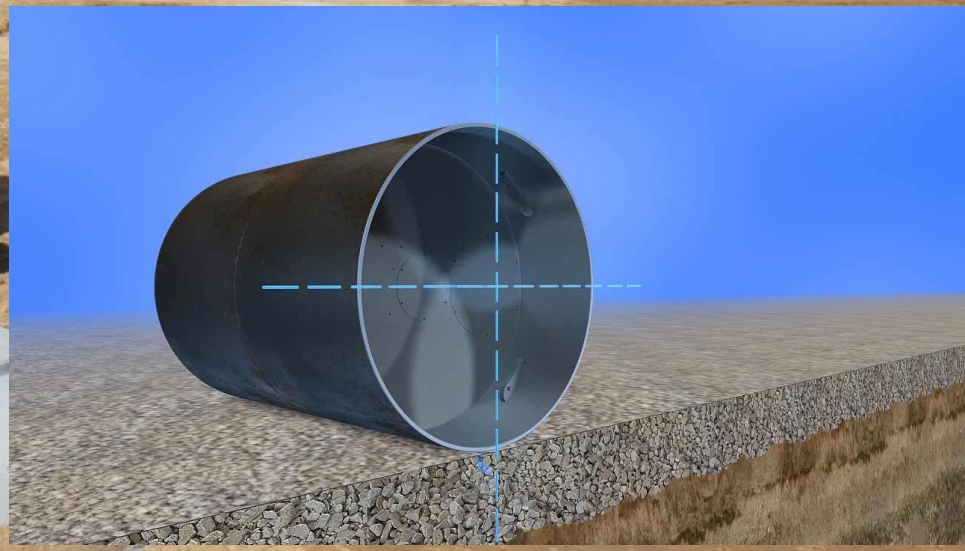
- **Some with special features**
  - **VIO drum**
- **Great in sensitive areas**



Large Soil Rollers

- **Range from 10 – 25 ton**
- **Smooth Drum or Padfoot**
  - **84” – 87”**
  - **Shell kit for smooth drums**
- **Options**
  - **IC (Intelligent Compaction)**
  - **Cab or ROPS**
  - **Dozer Blade**
  - **Remote Control**

Large Soil Rollers (climbability)

Large Soil Rollers & attachments

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Large Soil Rollers & attachments

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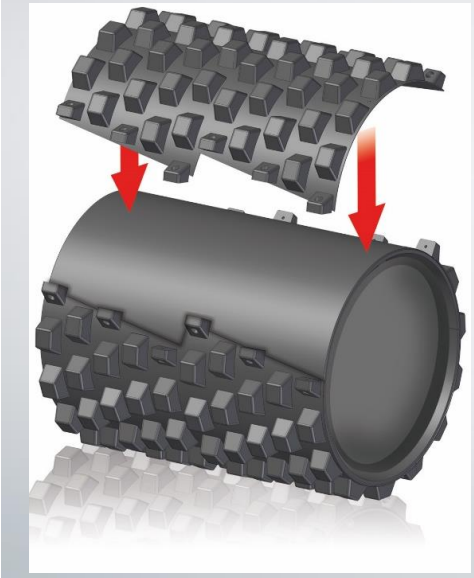

Sakai Smooth Shell Kit

Specialty Rollers

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Specialty Rollers

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Specialty Rollers

Rock crushing and compacting

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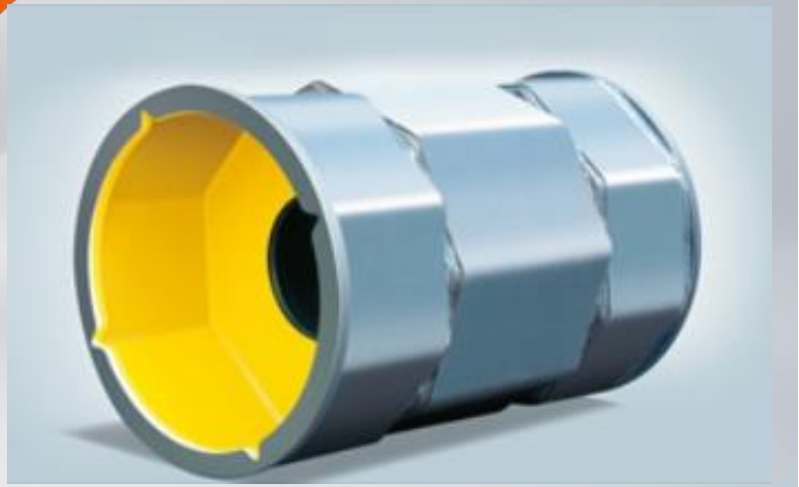

Bomag Polygonal Drum

Earth work

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Earth Work

Earthworks include all construction projects necessary for the erection of earth structures or for shaping the earth's surface (loosening, loading, conveying, installation and compacting).

Typical earthworks:

- Road substructure
- Sound barriers
- Dam construction
- Landfill construction
- Sealing layers
- Pipeline and culvert construction

Soil Material

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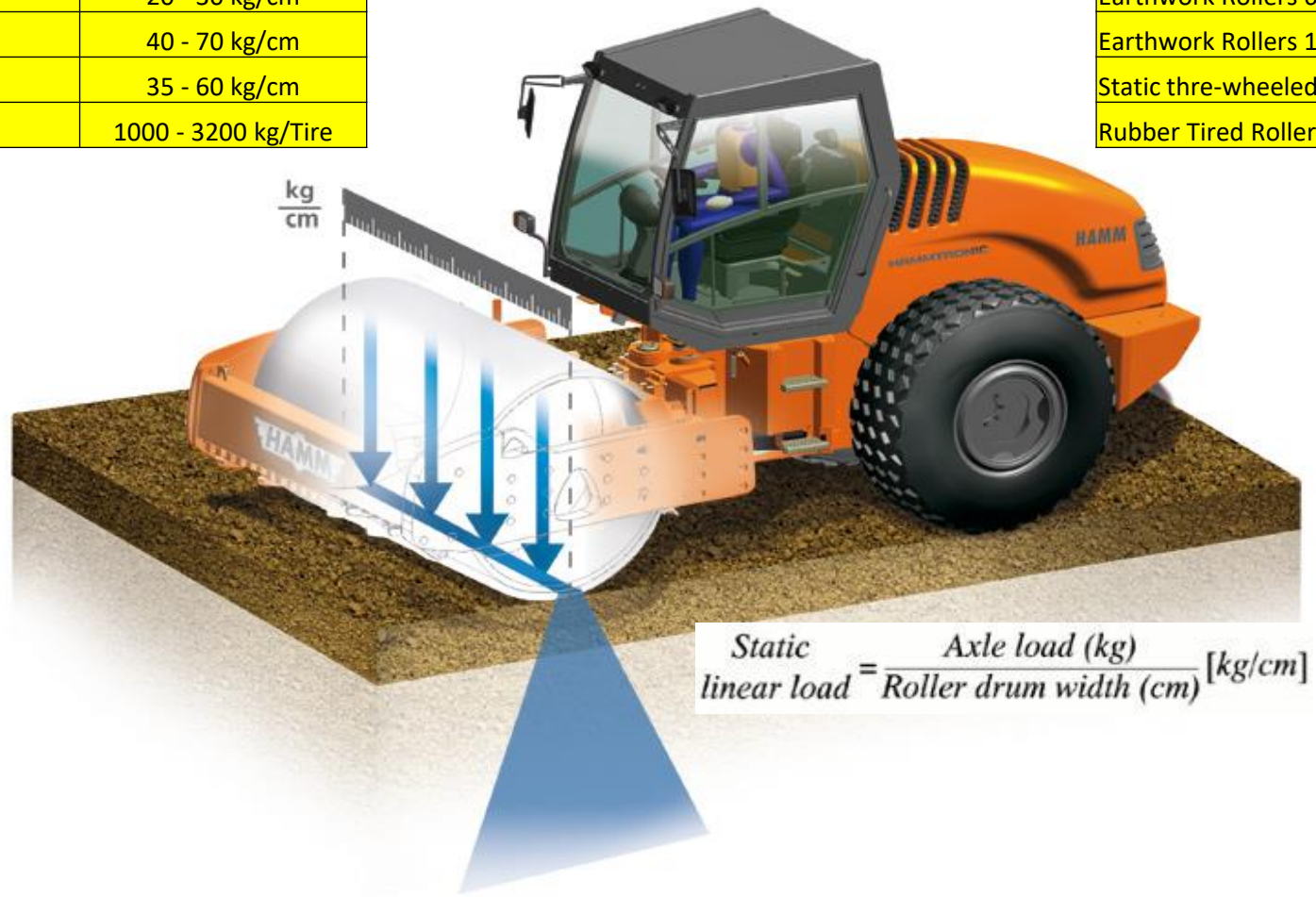
Most important parameters are:

- **Soil type (cohesive / non-cohesive)**
- **Water content**
- **Particle size distribution curve**
- **Particle shape (round / angular)**
- **Course thickness**

Static Linear Load

Type (metric)	Static Linear Load
Compact Line 1.5 - 4 t	8 - 15 kg/cm
Tandem Rollers 7 - 13 t	25 - 30 kg/cm
Earthwork Rollers 5 - 12 t	20 - 30 kg/cm
Earthwork Rollers 12 - 25 t	40 - 70 kg/cm
Static thre-wheeled Rollers	35 - 60 kg/cm
Rubber Tired Rollers	1000 - 3200 kg/Tire

Type (English)	Static Linear Load
Compact Line 2 - 5 t	17 - 33 lb/in
Tandem Rollers 9 - 16 t	55 - 66 lb/in
Earthwork Rollers 6 - 15 t	44 - 66 lb/in
Earthwork Rollers 15 - 31 t	88 - 154 lb/in
Static thre-wheeled Rollers	77 - 132 lb/in
Rubber Tired Rollers	2200 - 7055 lb/Tire



$$\text{Static linear load} = \frac{\text{Axle load (kg)}}{\text{Roller drum width (cm)}} \text{ [kg/cm]}$$

Smooth Drums

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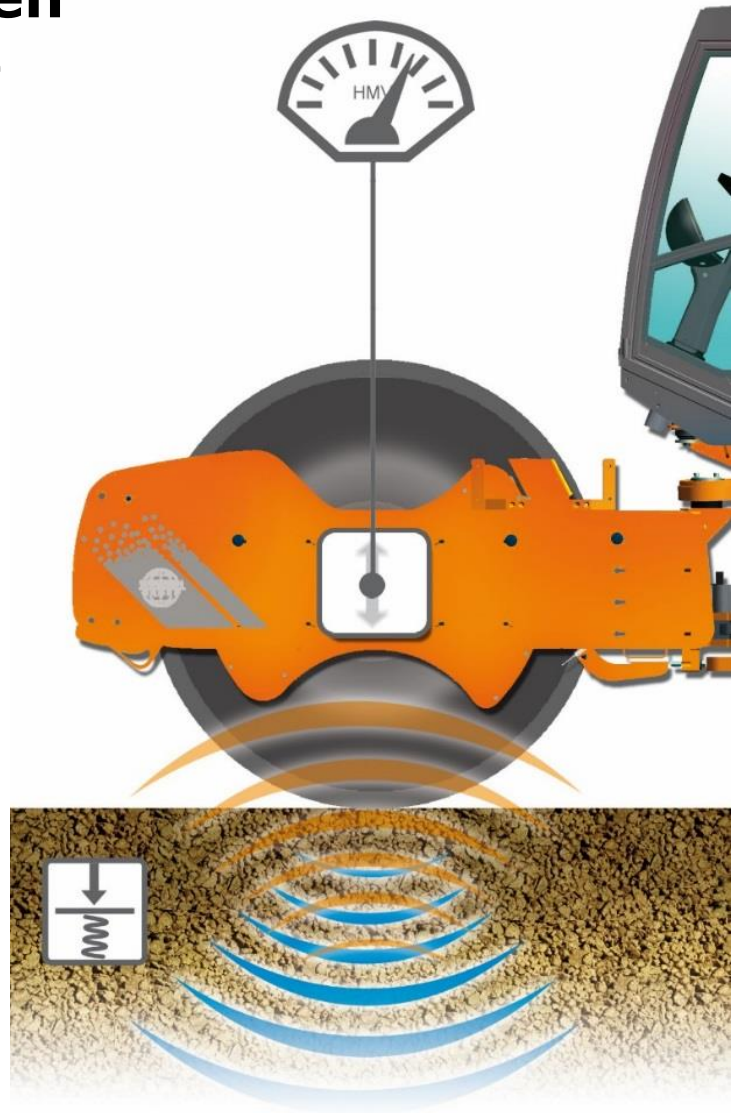
- **Smooth drums are mainly used when an even, uniform surface should be produced**
- **Used on larger stoned material or less cohesive materials**



Padfoot Drums

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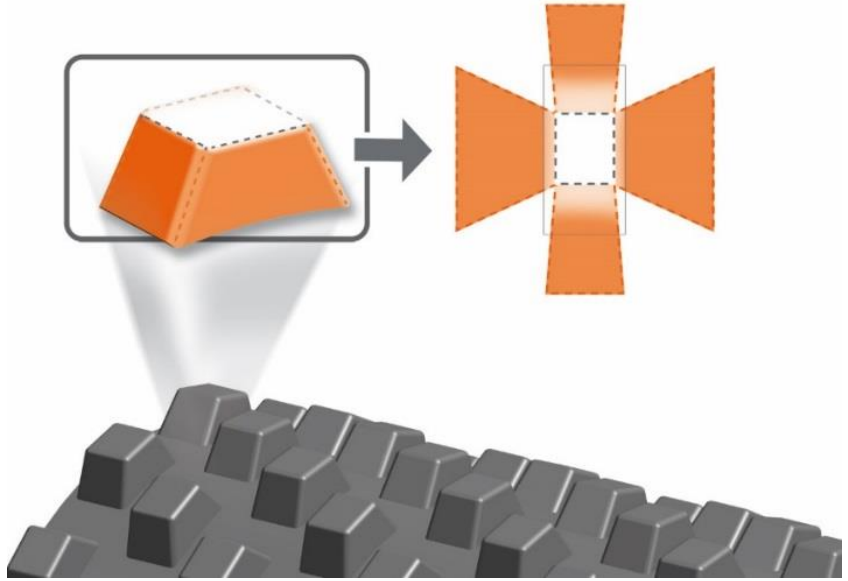
- **Padfoot drums only used in earthwork and cold recycling. They knead and roughen up the soil**
- **3 reasons for pad shape**
  - 1. The padfoot increase the surface area so that moist soils can dry out faster
  - 2. The angled shape compacts more as it goes deeper
  - 3. Reduces the material from loosening up as the pad comes out of the roll.

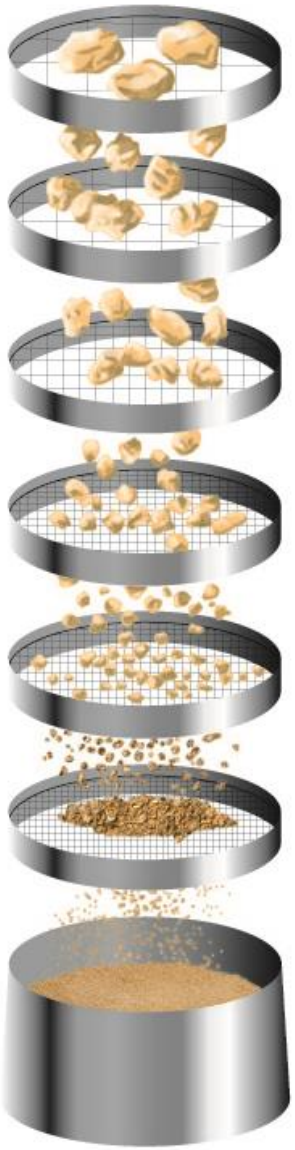


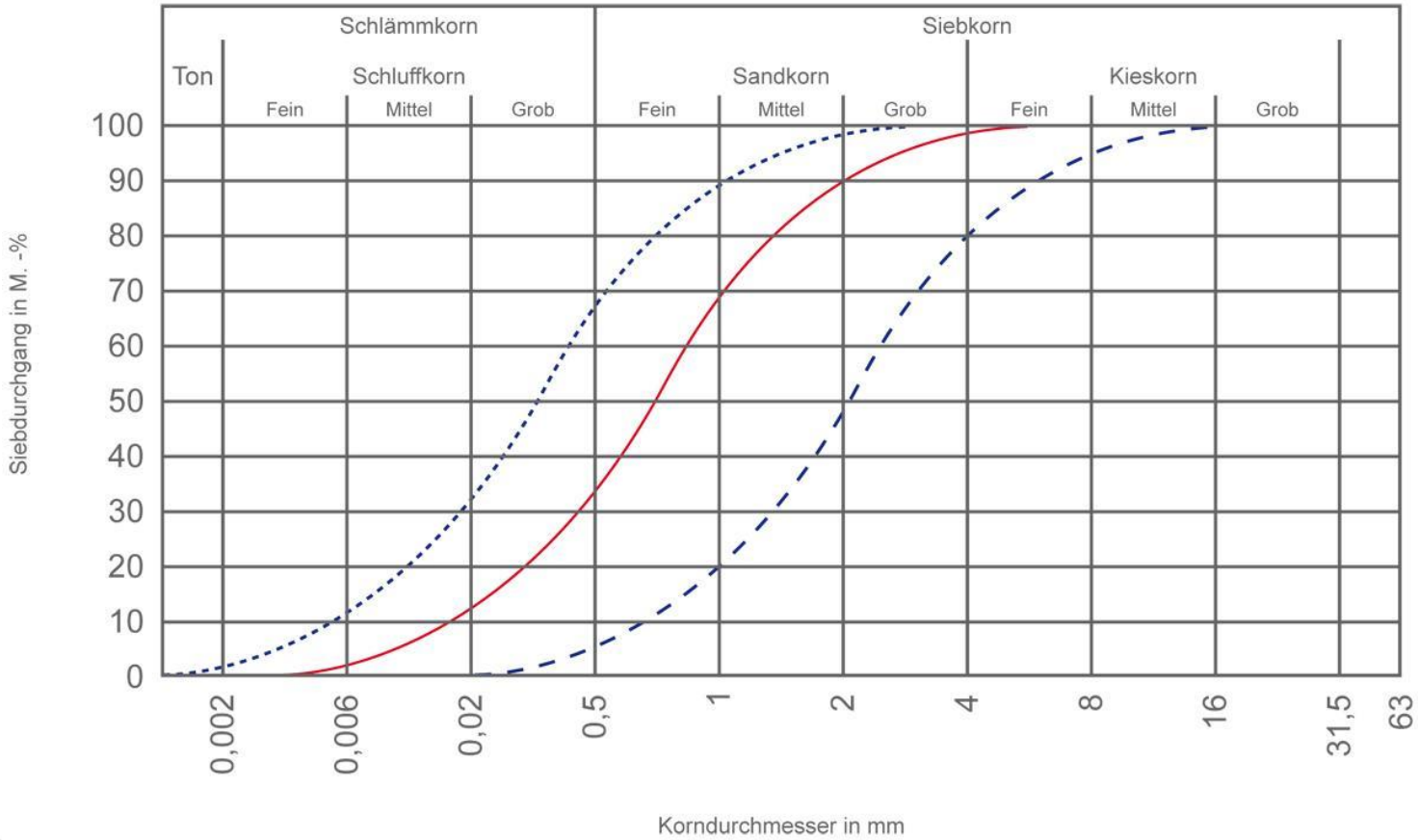
Other Soil Compactors

Shown:

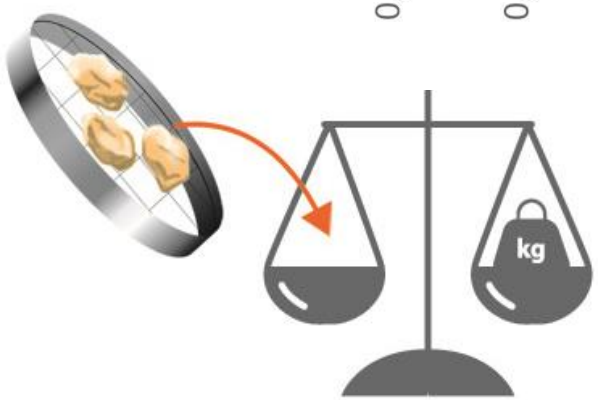
- **Sheep's foot**
- **Padfoot**
- **Smooth Drum**
- **Grid Roller**

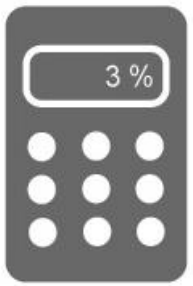
Grading curve - Earthworks





Particle size distribution according to DIN 18123





Typical structure of a sieve analysis.
The dried minerals pass through sieves with standardized mesh sizes. The contents of each sieve are then weighed individually and the percentage calculated.

Proctor Test

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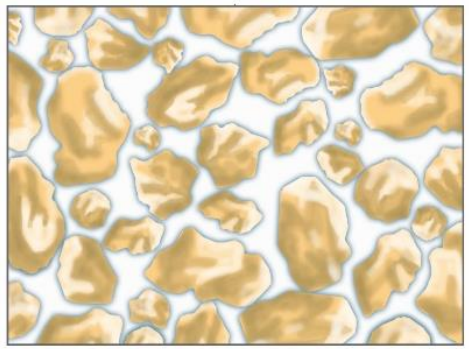
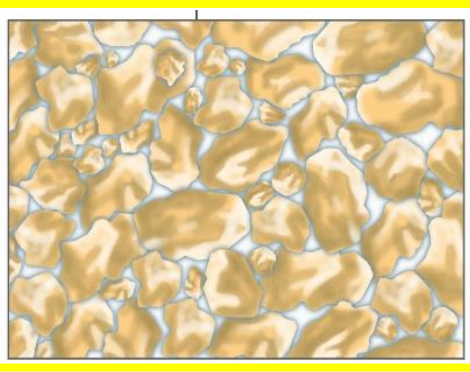
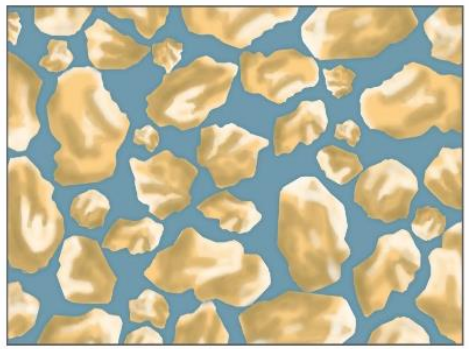
The water content of a soil has a decisive influence on its compactibility.
The water contained acts as a "**lubricant**".



Water content too low



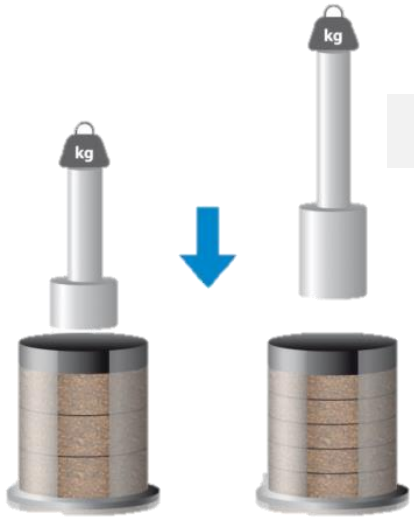
Optimum water content



Water content too high

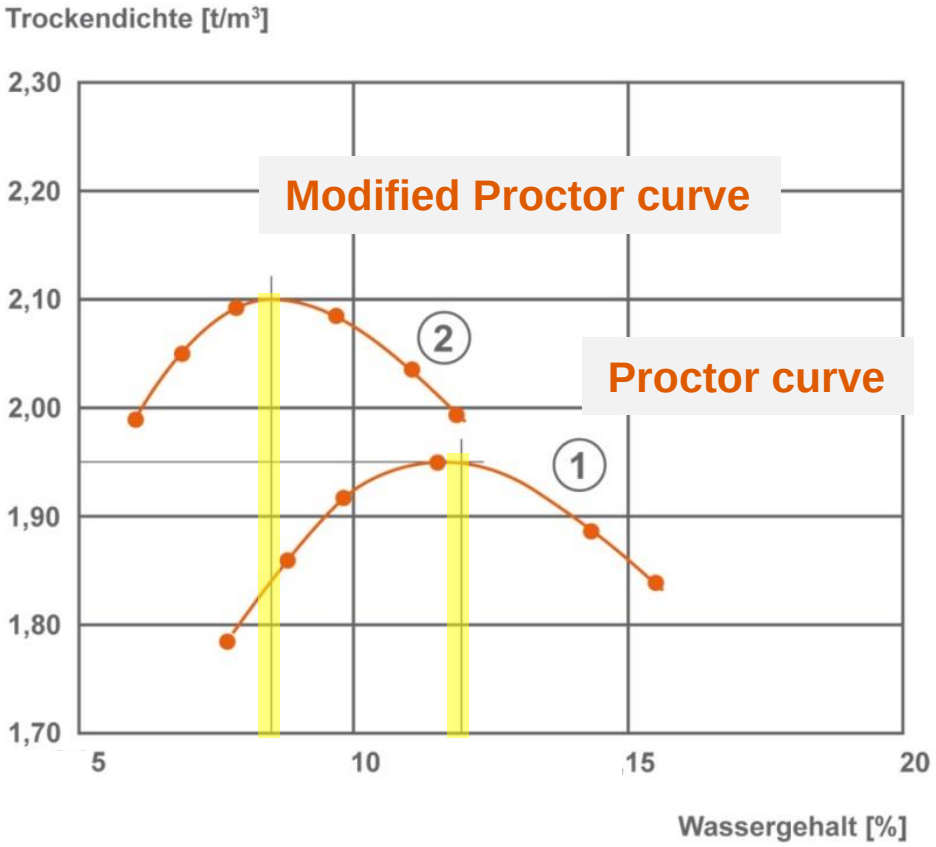
Proctor test

3 layers
Smaller mass and drop height of the drop weight



Modified Proctor test

5 layers
Greater mass and drop height of the drop weight



Working depths

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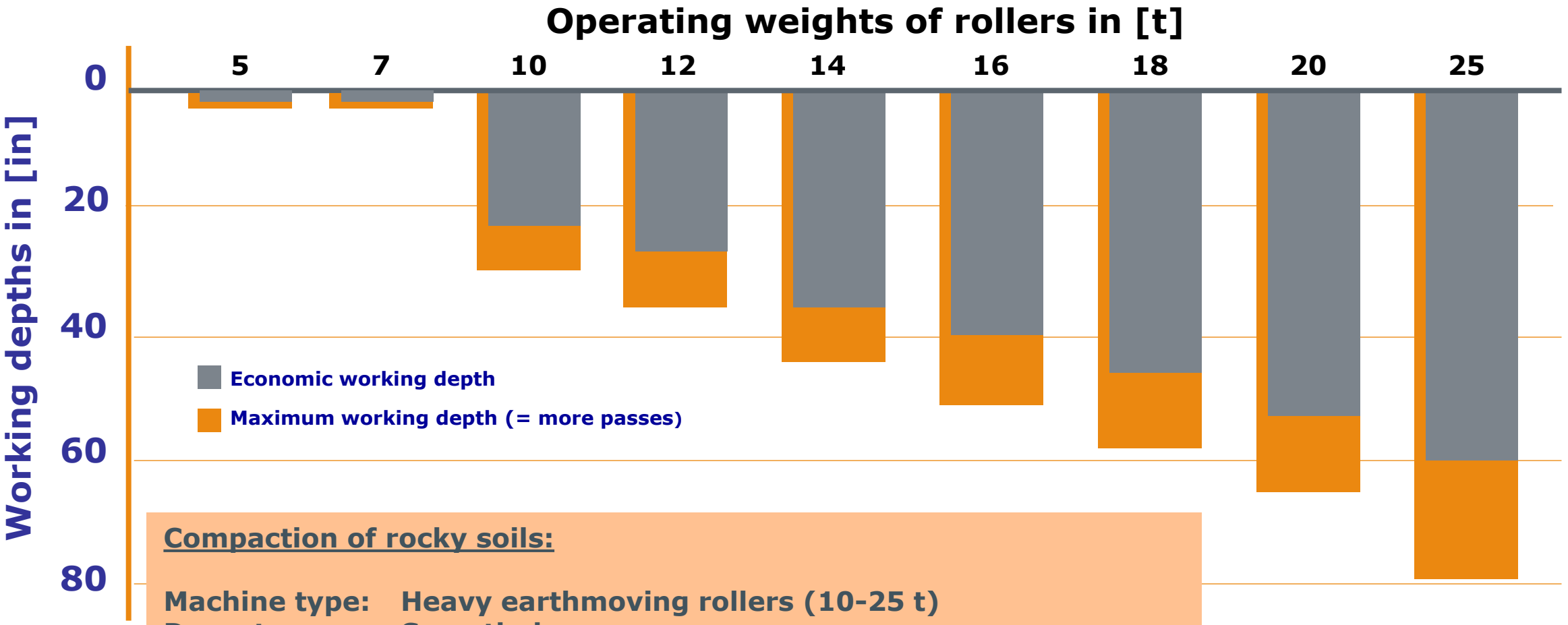
Working depths in rocky soils



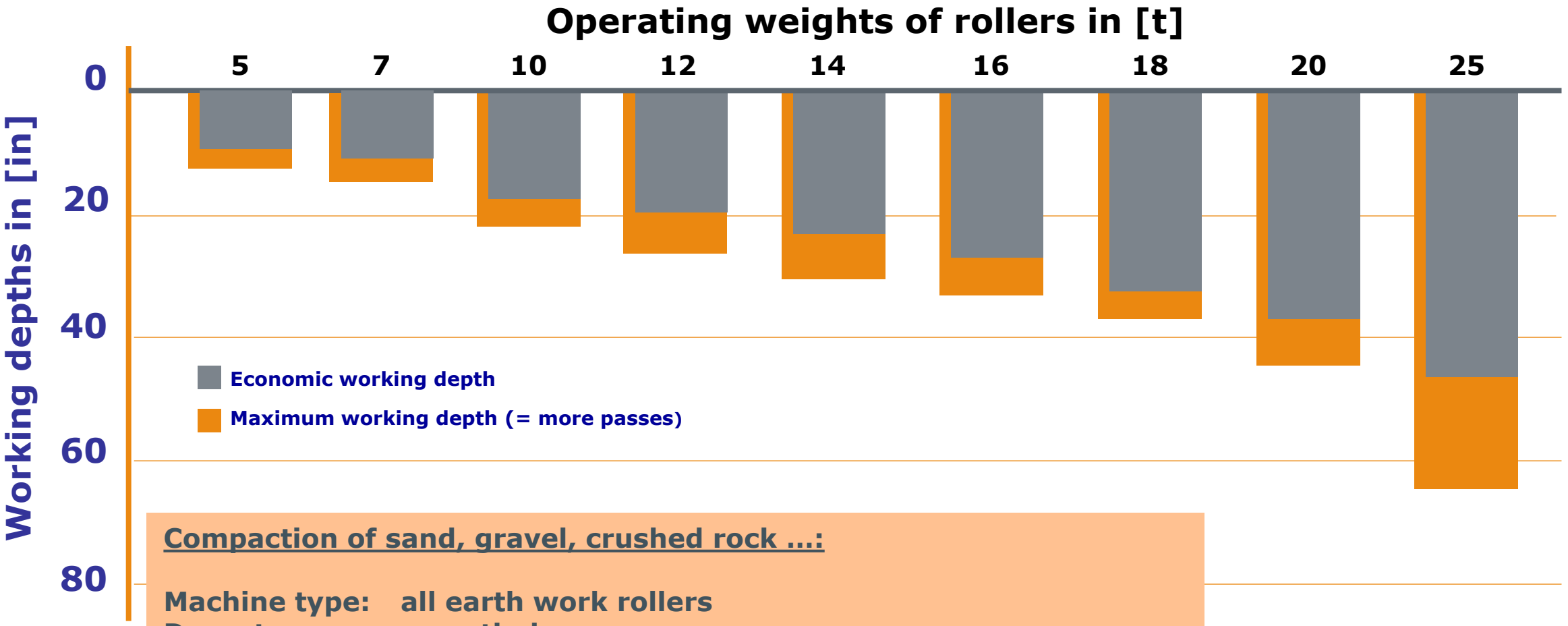
Compaction of rocky soils:

Machine type: Heavy earthmoving rollers (10-25 t)
Drum type: Smooth drum
Amplitude: First large amplitude (possibly small amplitude)

Average data, which can vary greatly due to different soil conditions.

Working depths

Working depths for non-cohesive, coarse-grained soils



Compaction of sand, gravel, crushed rock ...:

Machine type: all earth work rollers
Drum type: smooth drum
Amplitude: first large amplitude, then small amplitude

Average data, which can vary greatly due to different soil conditions.

Working depths

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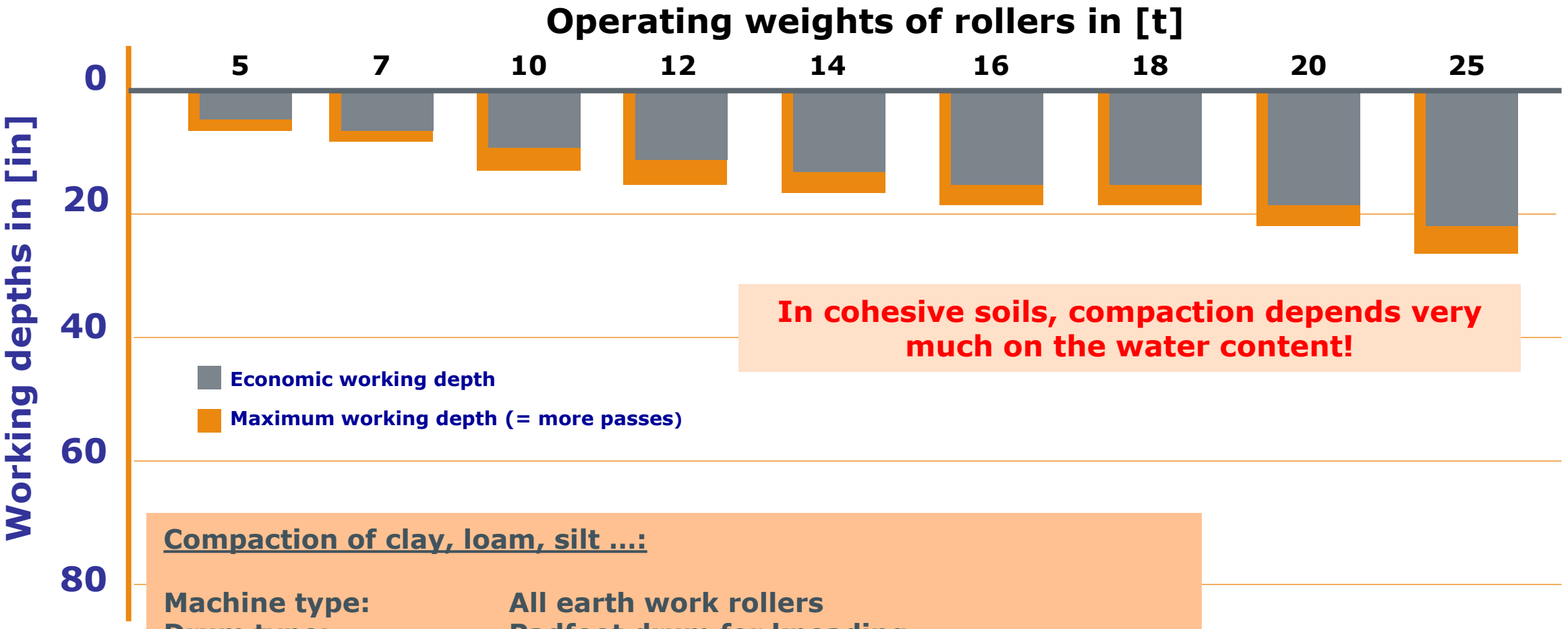
Working depths for cohesive, fine-grained soils



In cohesive soils, compaction depends very much on the water content!

Compaction of clay, loam, silt ...:

Machine type:	**All earth work rollers**
Drum type:	**Padfoot drum for kneading**
	Smooth drum for post-smoothing
Amplitude:	**first large amplitude, then small amplitude**

Average data, which can vary greatly due to different soil conditions.

Carrying capacity

Proper compaction starts from the base up, not the top down.

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ASPHALT ROLLERS

Compact

- **Small & Compact**
  - **31” – 54” drums**
  - **Compaction meter (optional)**
  - **Temperature Sensors (optional)**
- **Easily maneuverable**
- **Great visibility (Cab or ROPS)**
- **Double vibration**
- **Combination (Steel & rubber tire)**
- **Around 1.5-5 ton**

Compact

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Commercial

Compact

Large Tandem Asphalt

- **Large Tandem Asphalt**
  - **59” – 84” drums**
  - **Compaction meter (optional)**
  - **Temperature Sensors (optional)**
  - **IC (Intelligent Compaction)**
  - **Edge press**
  - **Chip Spreader**
- **Great visibility (Cab or ROPS)**
- **Double vibration**
- **Combination (Steel & rubber tire)**
- **Around 7-16 ton**

Compaction - Variety

Vibration

Oscillation

Rubber wheels

Compaction – Vibration / Oscillation

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Compaction – Drum Offset

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Track offset up to 6.7”

- Enables precise edge finishing

Compaction – Split Drum

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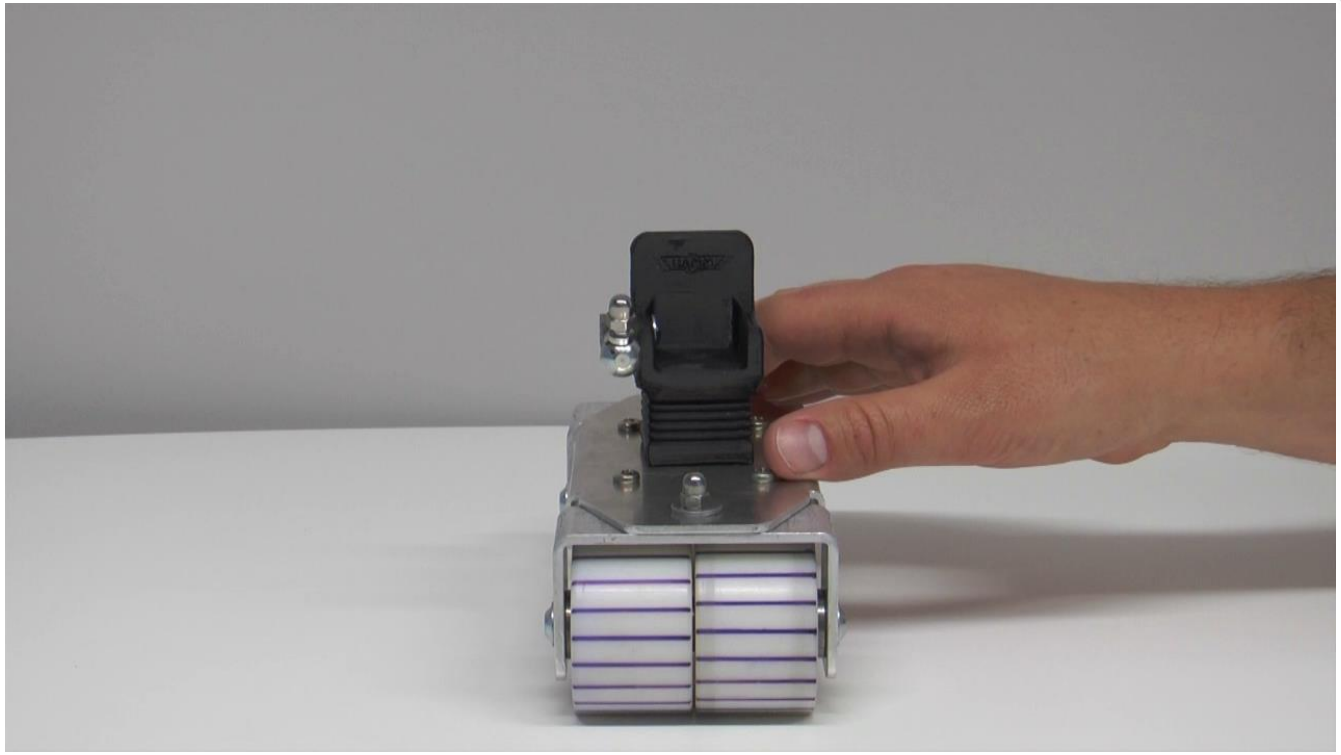
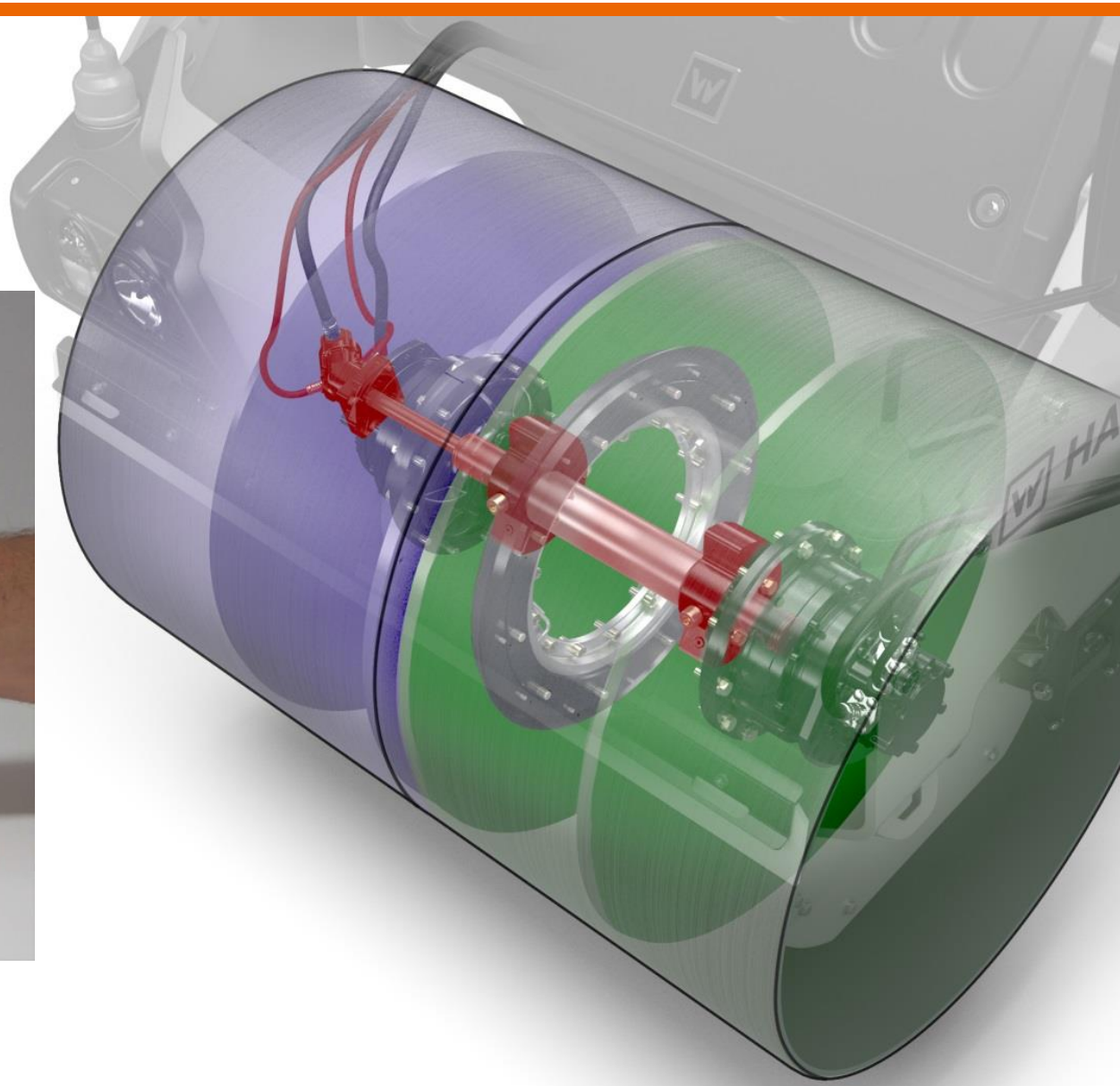
Split drum/s





Options – Chip Spreader

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Options – Edge Press

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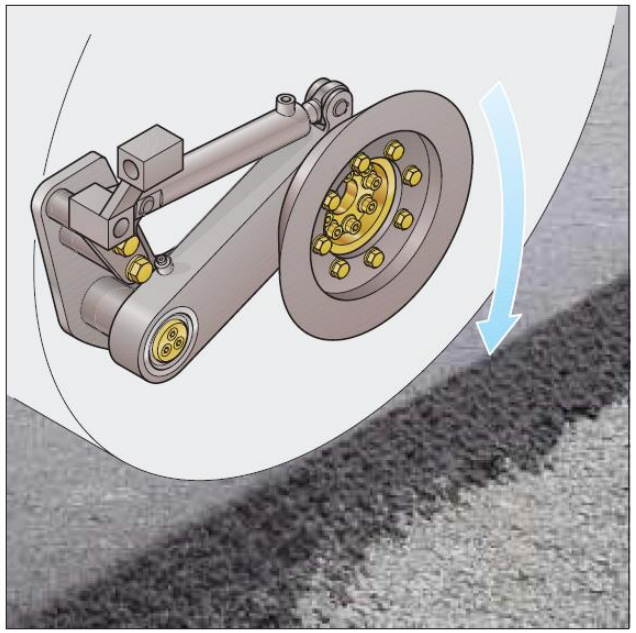
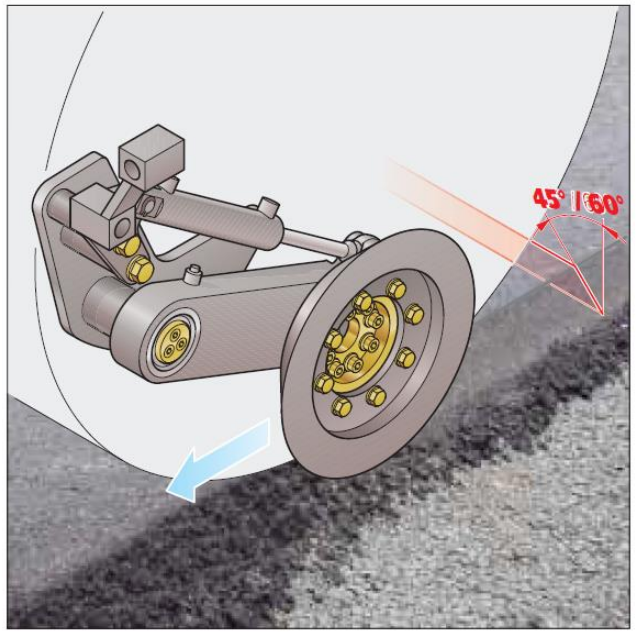
EDGE-PRESSING
AND CUTTING EQUIPMENT





Options – Intelligent Compaction (IC)

- IC Systems

Amplitude Setting Chart

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Amplitude Selection for HAMM Asphalt Rollers

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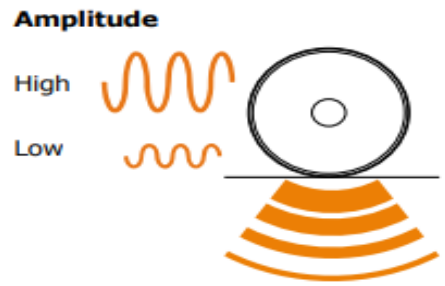
Amplitude Selection

Amplitude Setting (General set up)					
Mat Thickness	**0 - 1 inches**	**1 - 2 inches**	**2 - 3 inches**	**3 - 4 inches**	**+ 4 inches**
Recommended Amplitude Setting	Low	Low	Low / High	High	High

Note:
- HD 8 - HD 12 have a fixed amplitude setting and two frequency settings.
- HD 13 - HD 14 have two amplitude settings and two frequency settings.
- HD+ 70 - HD+ 140 have two amplitude settings and variable frequency settings.

Amplitude



Static Linear Load

Pounds Per Linear Inch											
Roller model	**HD 8**	**HD 10**	**HD 12**	**HD 13**	**HD 14**	**HD+ 70**	**HD+ 80**	**HD+ 90**	**HD+ 110**	**HD+ 120**	**HD+ 140**
Drum width	31.5"	39"	47"	51"	54"	59"	66"	66"	66"	78"	84"
Static Pressure	57.1 lbs/in	73.9 lbs/in	66.1 lbs/in	91.3 lbs/in	92.4 lbs/in	140.0 lbs/in	131.0 lbs/in	157.4 lbs/in	177.5 lbs/in	181.4 lbs/in	174.2 lbs/in
Mat Thickness	**Amplitude Selection for HAMM Asphalt Rollers**										
0 - 1 inches	Static / Fixed	Static / Fixed	Static / Fixed	Static / Low	Static / Low	Static / Low	Static / Low	Static / Low	Static / Low	Static / Low	Static / Low
1 - 2 inches	Fixed	Fixed	Fixed	Low	Low	Low	Low	Low	Low	Low	Low
2 - 3 inches	Fixed	Fixed	Fixed	High	High	Low / High	Low / High	Low / High	Low / High	Low / High	Low / High
3 - 4 inches				High	High	High	High	High	High	High	High
+ 4 inches				High	High	High	High	High	High	High	High

Note:
- Frequency settings are to be in conjunction with the speed of the roller to establish proper impacts per foot spacing.
- A test strip will need to be done for each setting of the roller to establish the correct roller pattern.

Note:
- Oscillation style compaction is not influced by impacts per foot spacing due to no vertical impact compaction.

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Creator-specific information:

created at: 26.06.2018
created by: HAMM AG
Name of Document: 2660795_00

Rigit Frame Rollers

- **Rigid Frame Asphalt Rollers**
  - **59” & 66” drums**
  - **Compaction meter (optional)**
  - **Temperature Sensors (optional)**
  - **IC (Intelligent Compaction)**
  - **Edge press**
  - **Chip Spreader**
- **Great visibility (Cab or ROPS)**
- **Double vibration**
- **Combination (Steel & rubber tire)**
- **Around 7 & 9 ton**

Compaction - Variety

Vibration

Oscillation

Pneumatic tyres

Drive

High steering precision due to 2x hydraulic cylinders per drum & swing bearing central above drum

Hugh coverage by drum off set

- **DV+ 70i** max. 2.770 m (109 in) – 59” drum (54%)
- **DV+ 90i** max. 3.050 m (120 in) – 66” drum (55%)

Rigit Frame Rollers

Pneumatic Tire Rollers

Pneumatic Tire Rollers

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Various Applications

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Pneumatic Tire Rollers

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Compaction

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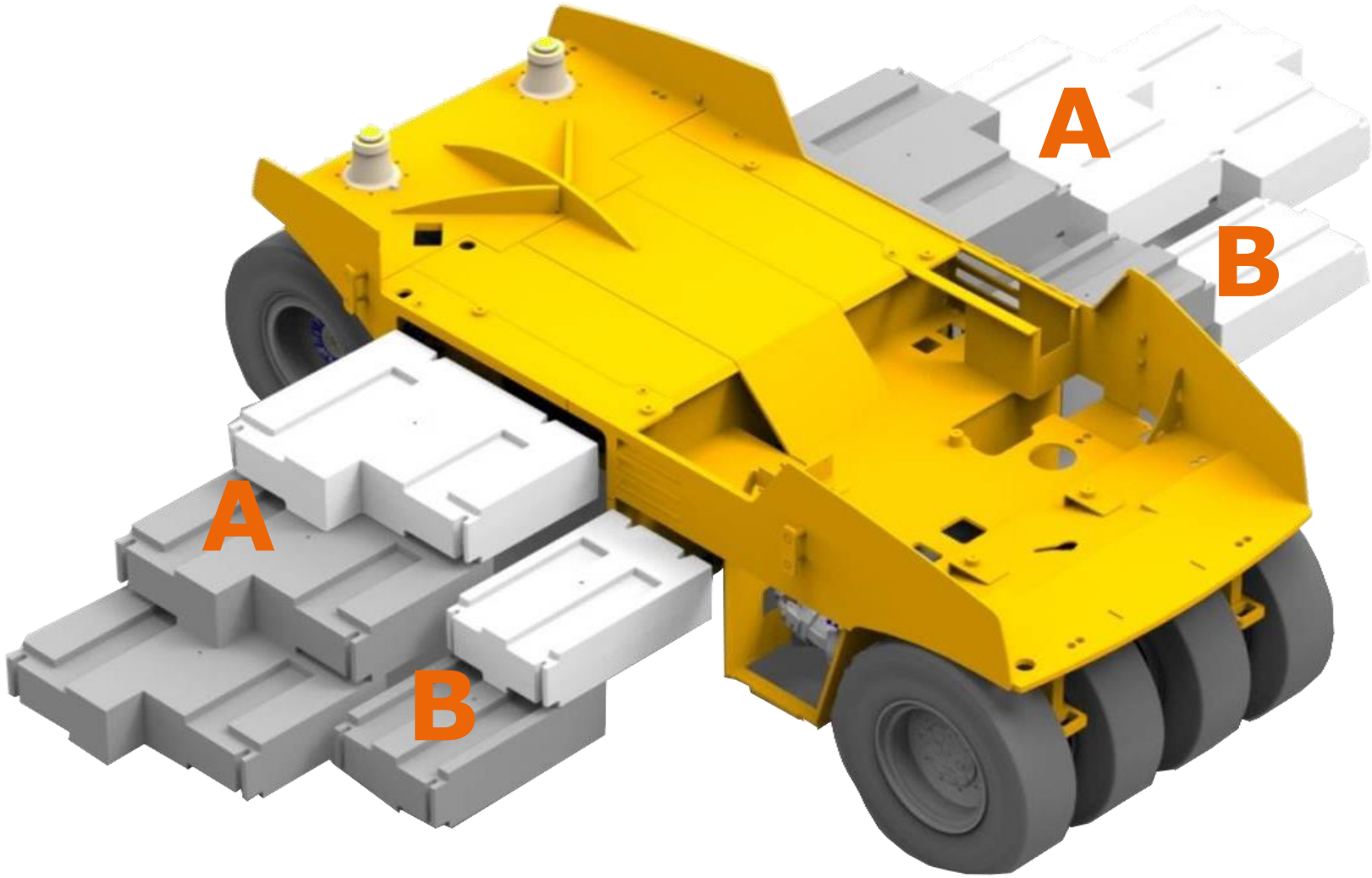
Flexible ballasting

Space	Material	lbs/ Plate
A	Steel	4630
	Magnetite	2425
	Concrete	1411
B	Steel	2315
	Magnetite	1212



Edge Press or Cutter

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Edge Formation

- Cutting edge required on FAA projects
- Different angles can be used for compacting edges or just for a safety edge
- Available for small rollers, large rollers and pneumatic rollers

Air on the Fly

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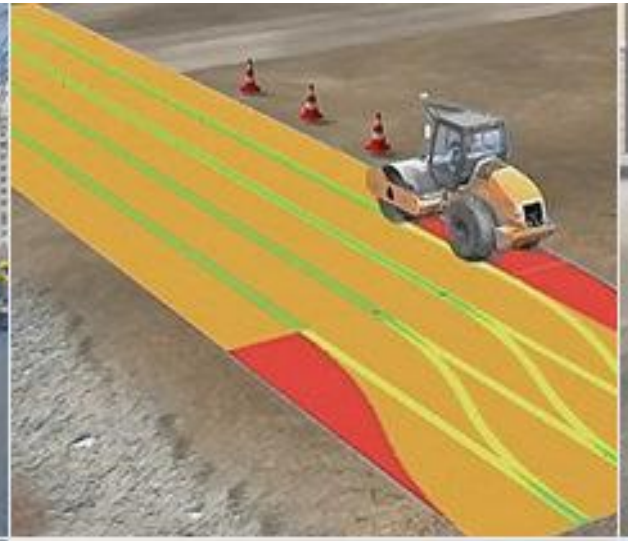
COMPACTION FUNDAMENTALS

Compaction Fundamentals



Fundamental Rules for Compacting Asphalt

- # of rollers needed
- # of passes required
- Roller speed
- Compaction temp
- Roller weight
- Vibration / Oscillation or static

Rollers Needed

# of Rollers Needed

- Installation width and installation speed
- Required # of passes
- Roller speed
- Available time for compaction

Roller Size

Roller Weight

- Asphalt rollers range from 1.5 – 16 ton

- Roller classification
  - Light rollers
    - 1.5 – 5 ton
  - Medium rollers
    - 5 – 11 ton
  - Heavy rollers
    - 11 – 16 ton

4 ELEMENTS TO ACHIEVE COMPACTION

Four Elements?

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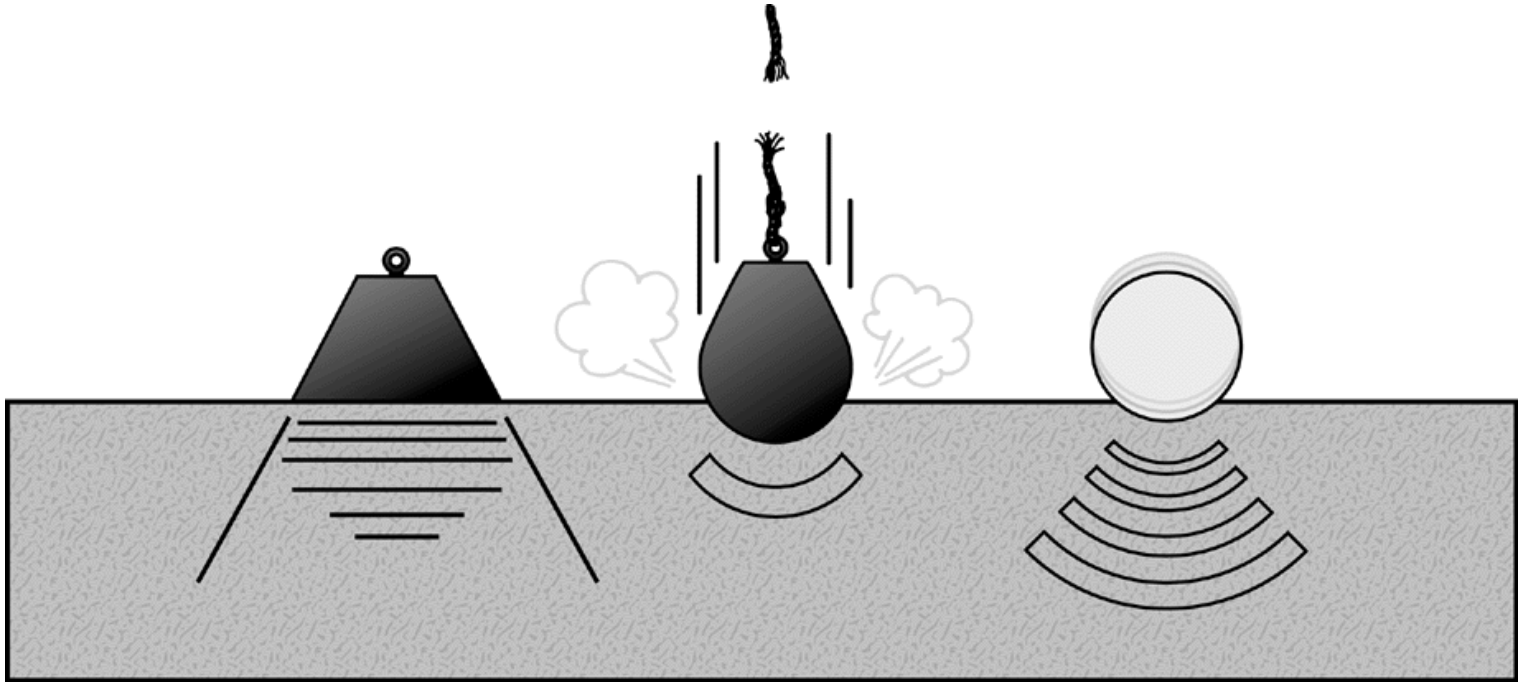
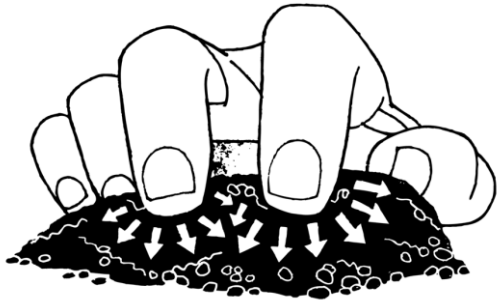
The Four Elements can be Summarized as …





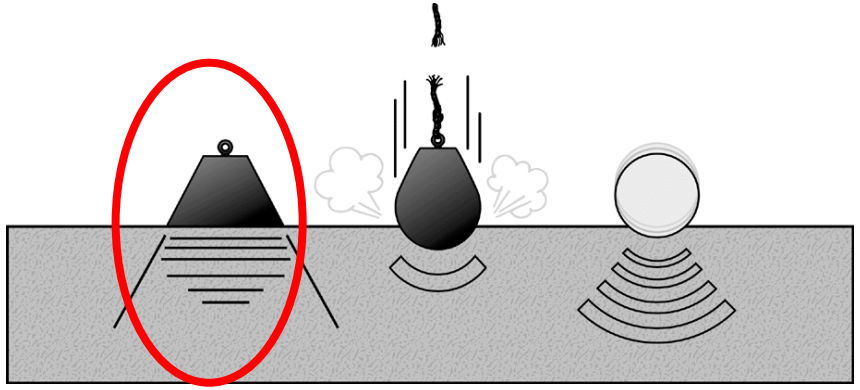
Static
Weight

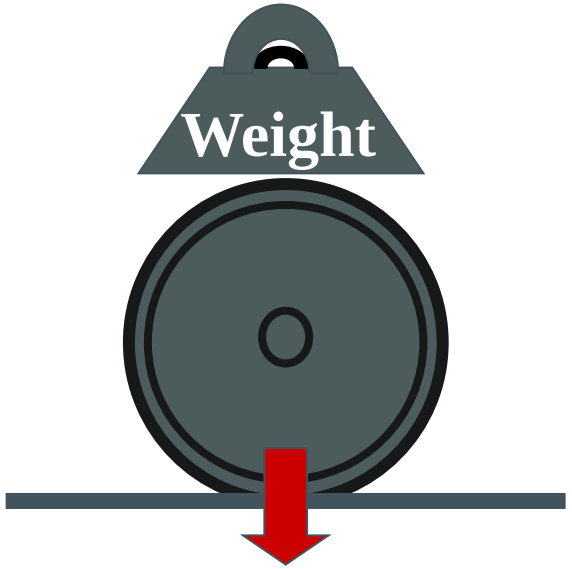
Impacts

Dynamics
(Vibration)
(Oscillation)

Kneading
(Oscillation)

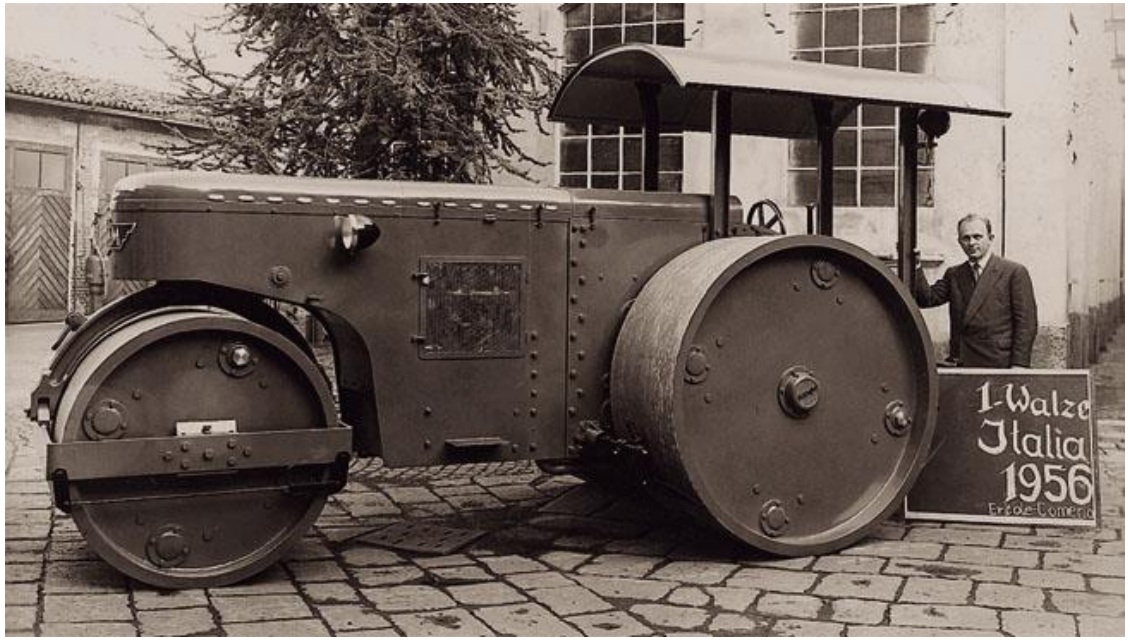
Four Elements?





Static

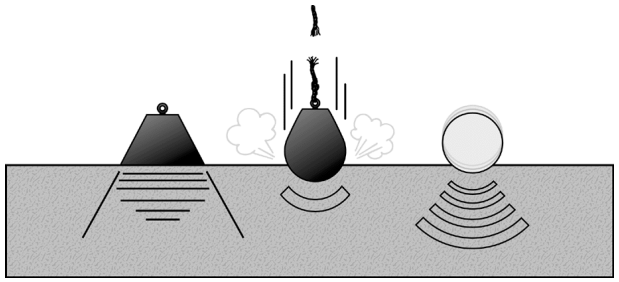
Weight



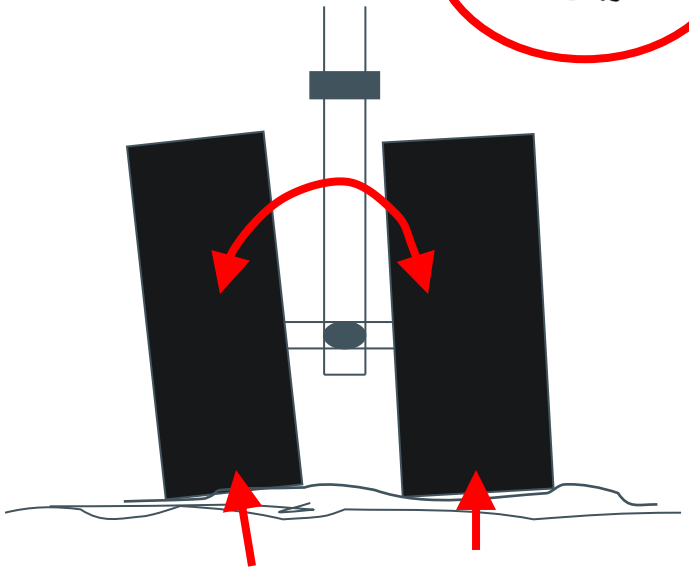
Applies a static pressure from <u>TOP</u> to <u>BOTTOM</u>

(Surface compaction)

Four Elements?



Kneading

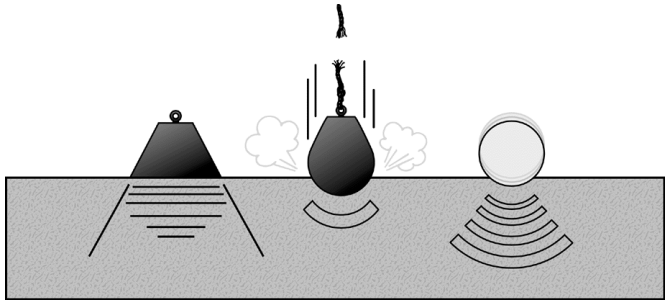


<u>Kneading effect</u>

Matches contours of an uneven surface

Minimizes bridging and helps to eliminate 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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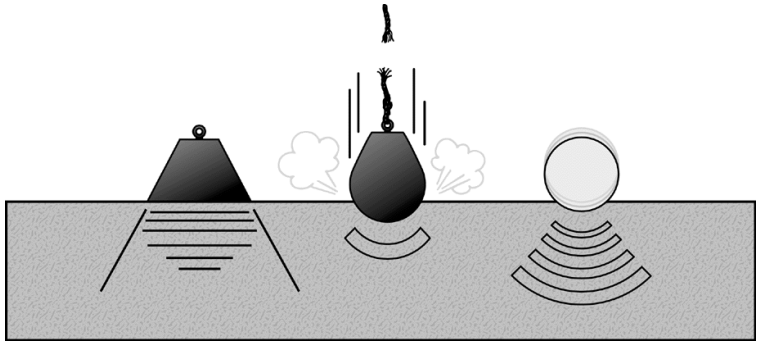
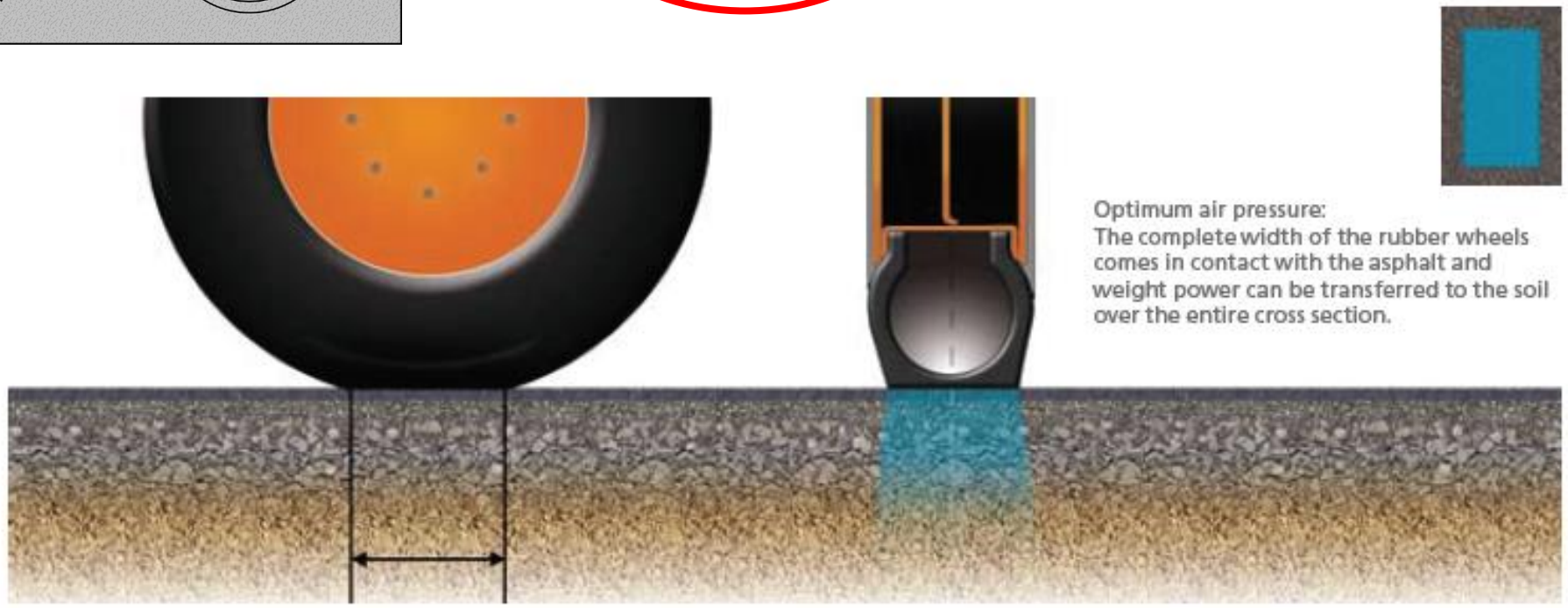
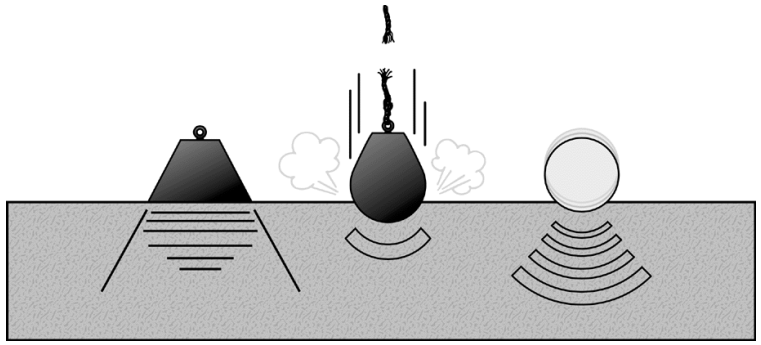


Kneading

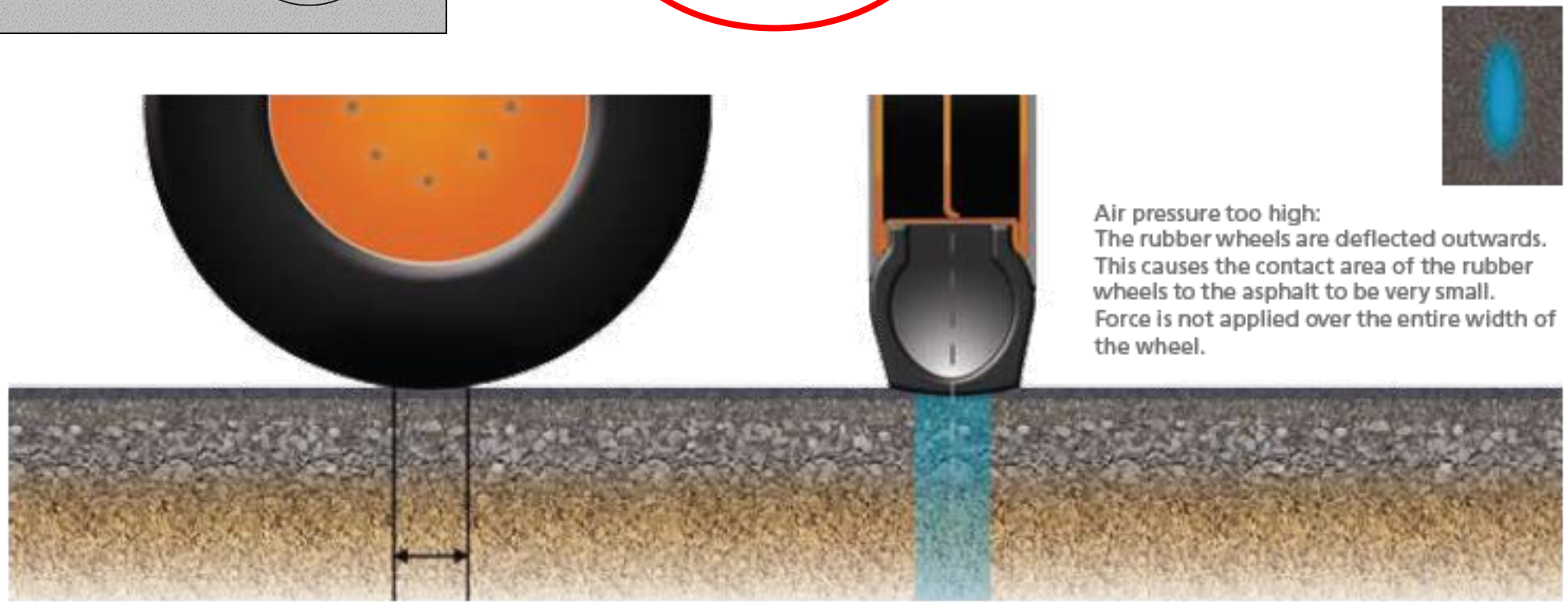


Ideal tire pressure is dependent upon ballasted weight of the machine

Four Elements?



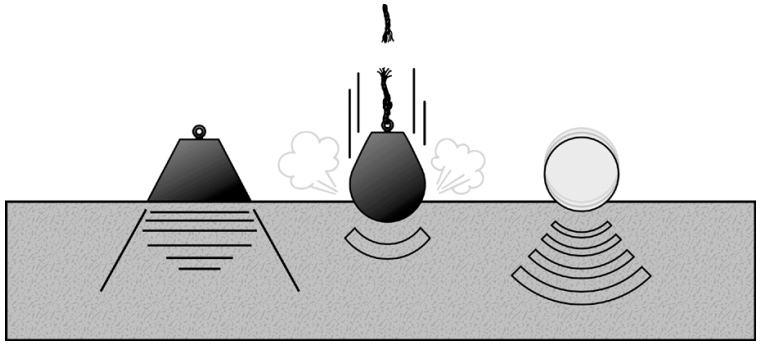
Kneading



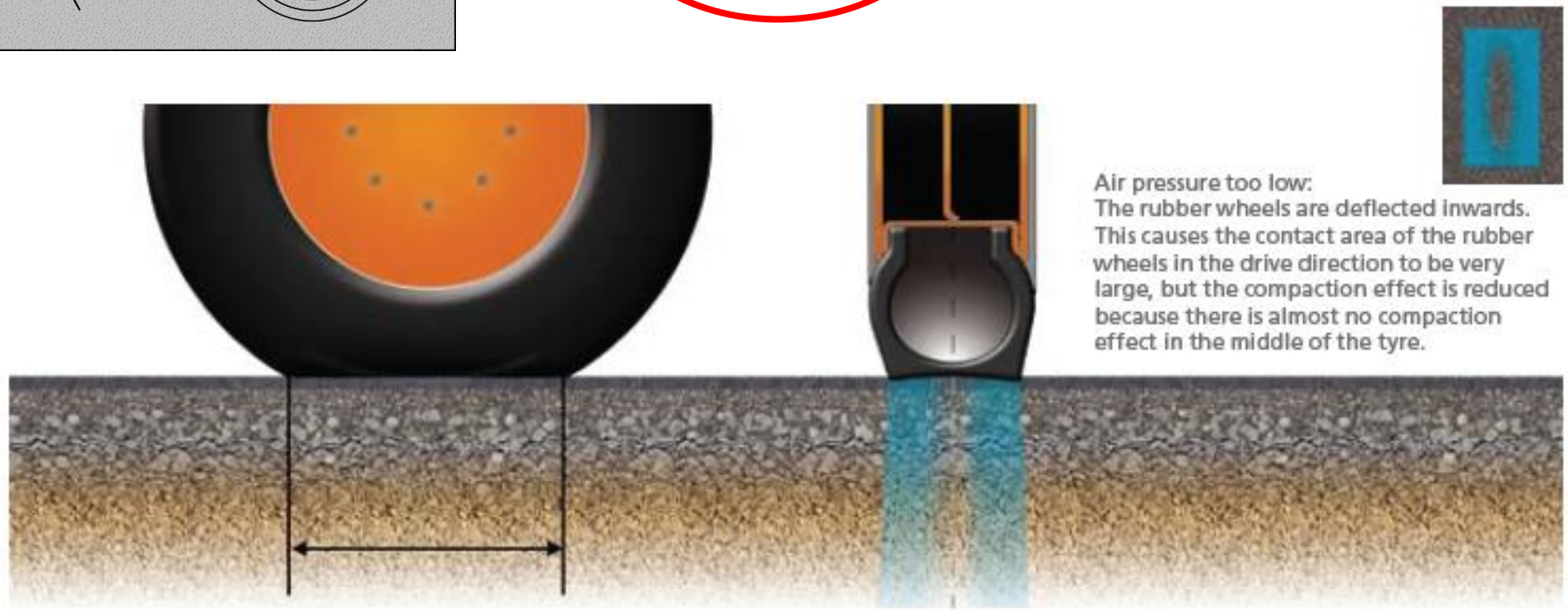
Tire pressure too high

Four Elements?

HAMM



Kneading

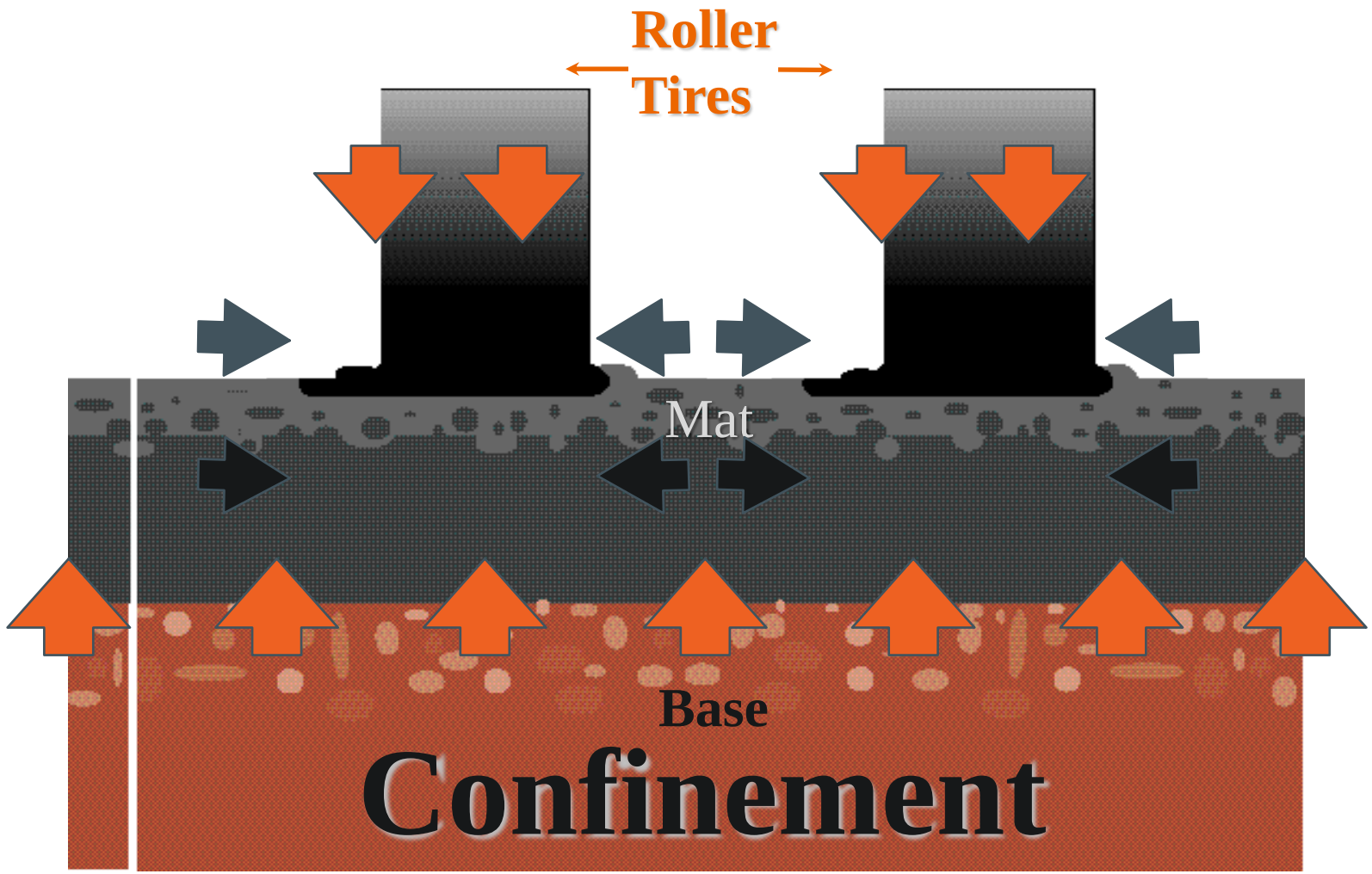


Tire pressure too low

Four Elements?

HAMM

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**

HAMM

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?

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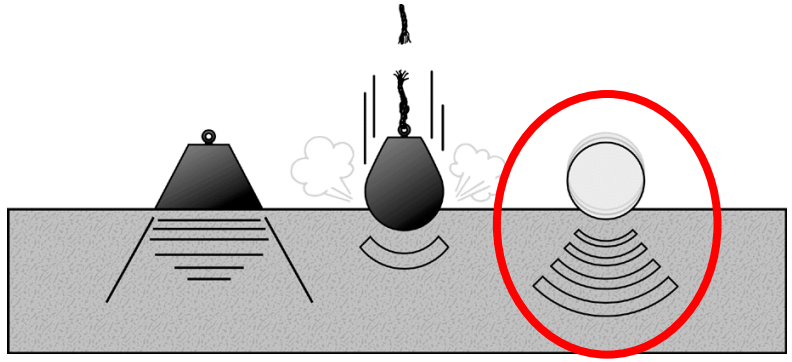
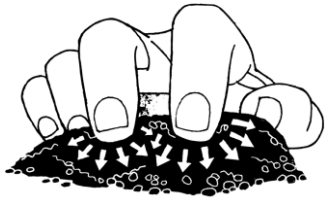
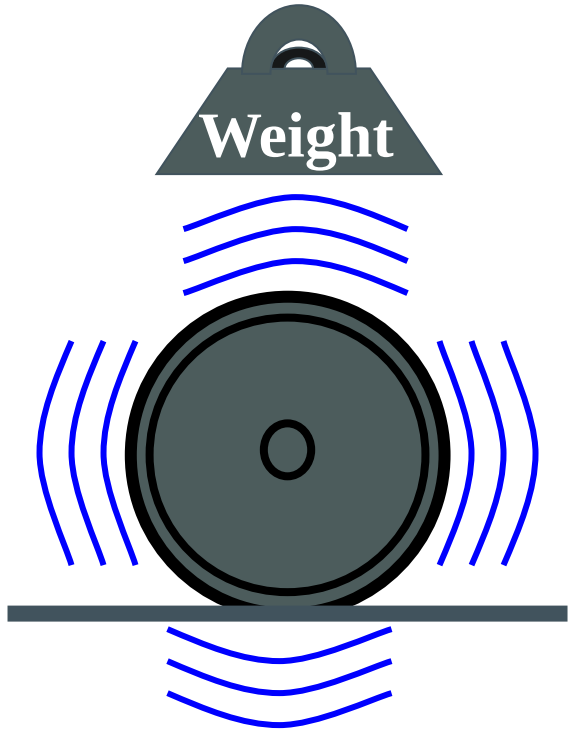




Dynamics
(Vibration)
(Oscillation)



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

Four Elements?

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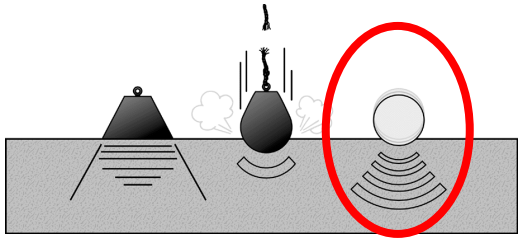
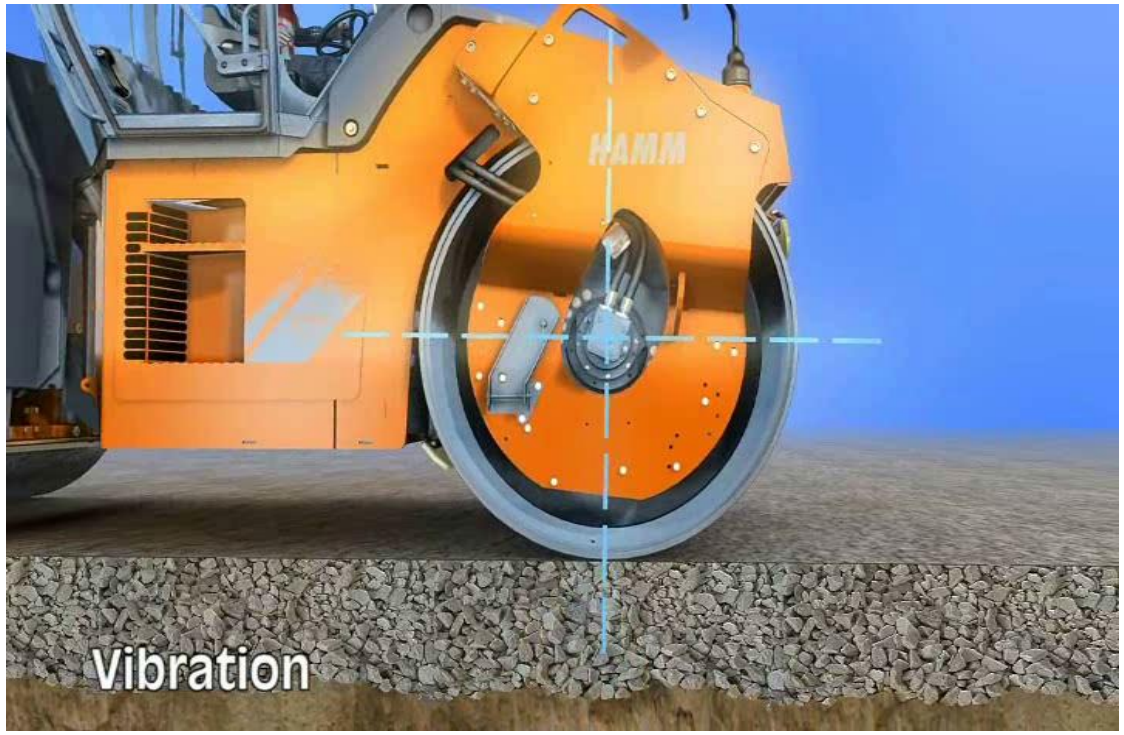


Dynamics
(Vibration)
(Oscillation)



Oscillation
(Drum has 100% ground contact)

"Non-Aggressive compaction"

Vibration
(Drum is 50% in the air)

"Aggressive compaction"

Compaction system

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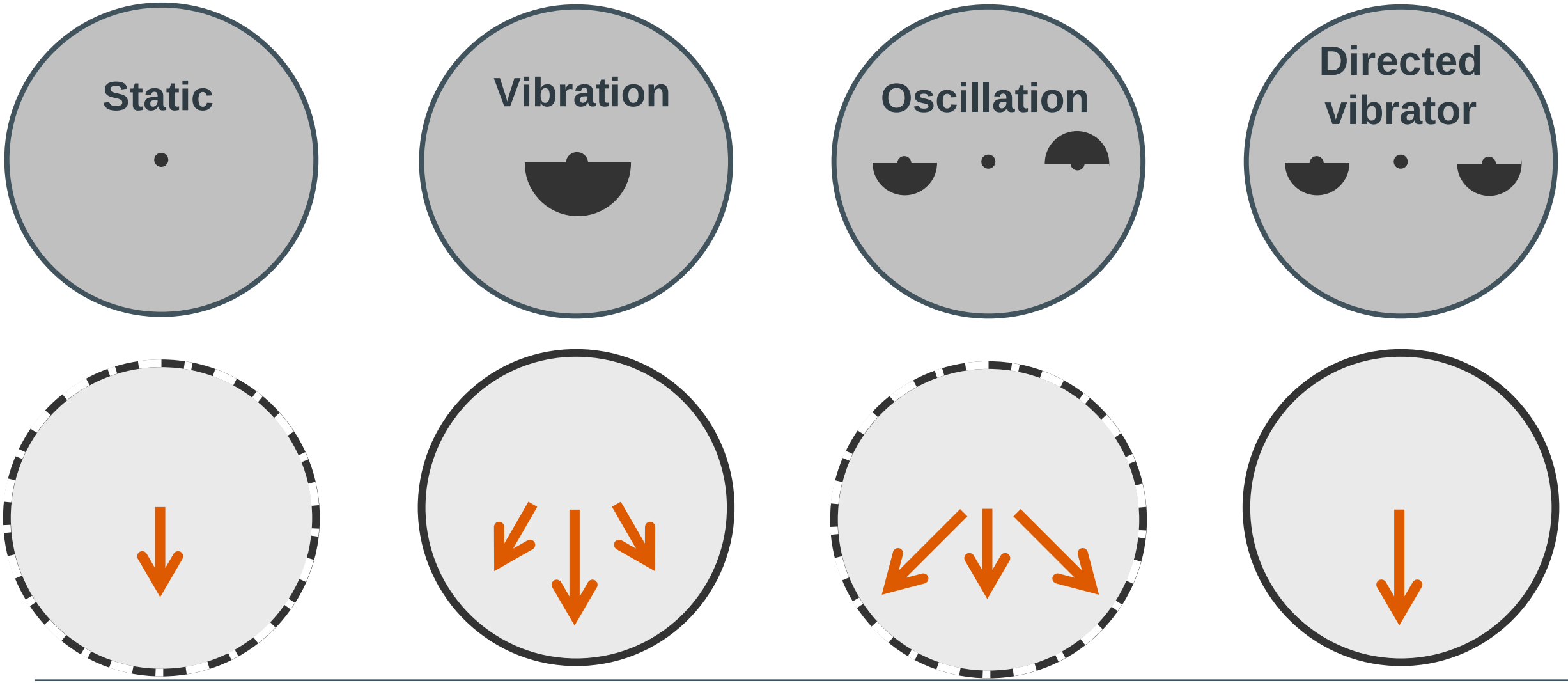

Four Elements?

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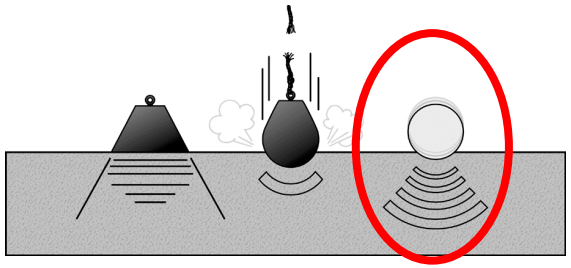
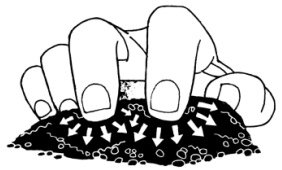
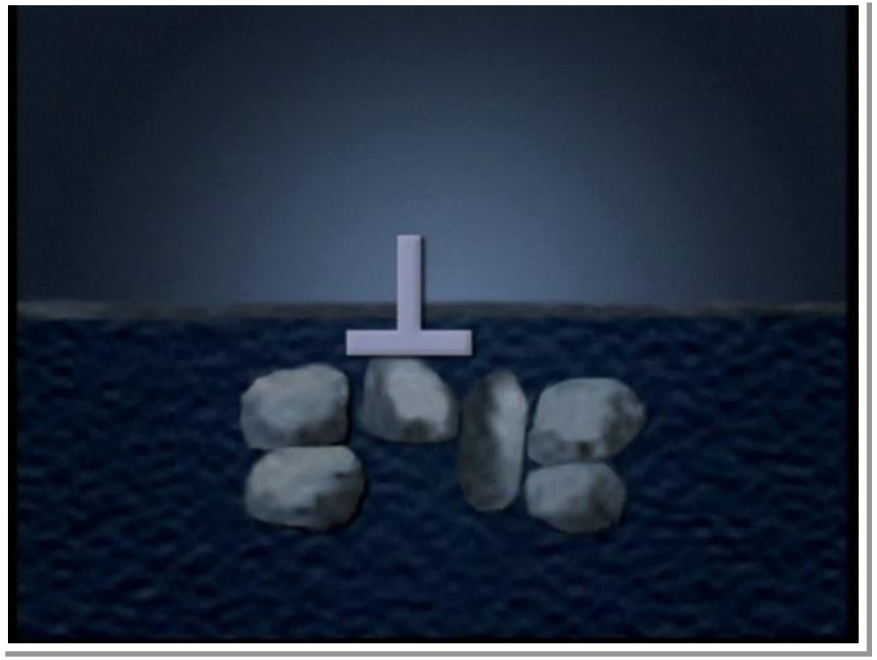


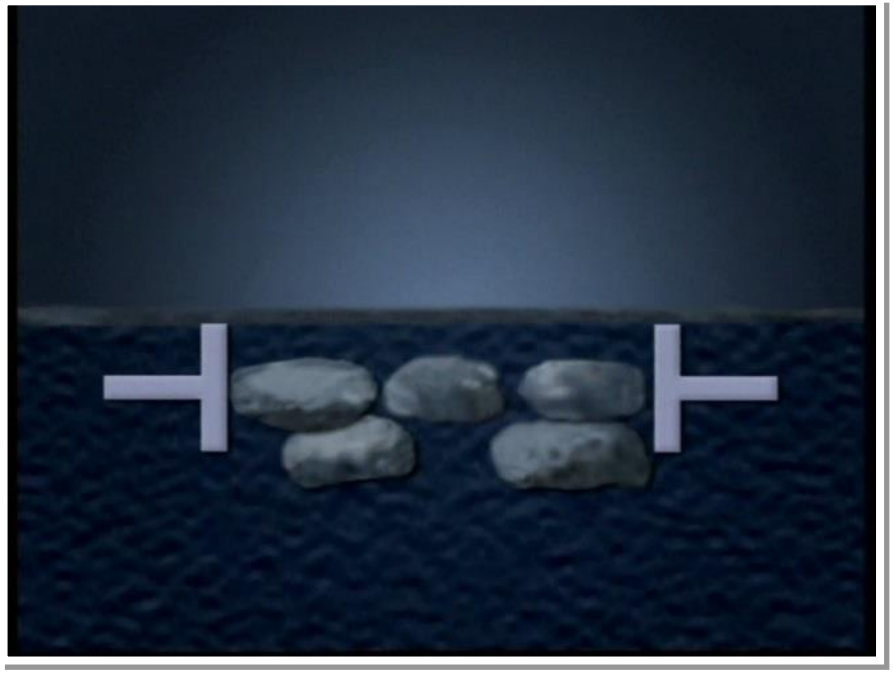


Dynamics
(Vibration)
(Oscillation)



Vibration

Vertical aggregate positioning



Oscillation

Horizontal aggregate positioning

SUMMARY OF ROLLER TYPES

Roller Types?

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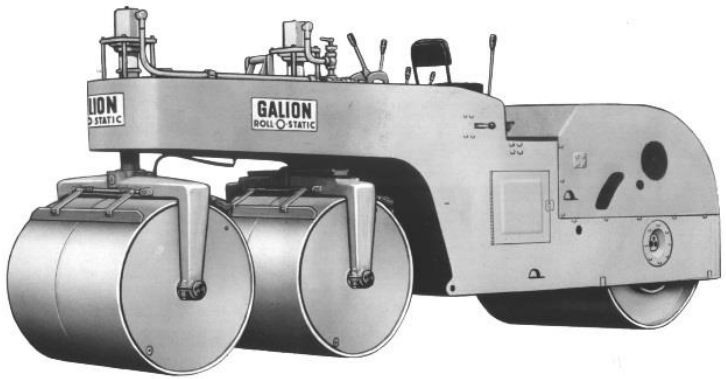
Static steel wheel



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

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

Roller Types?

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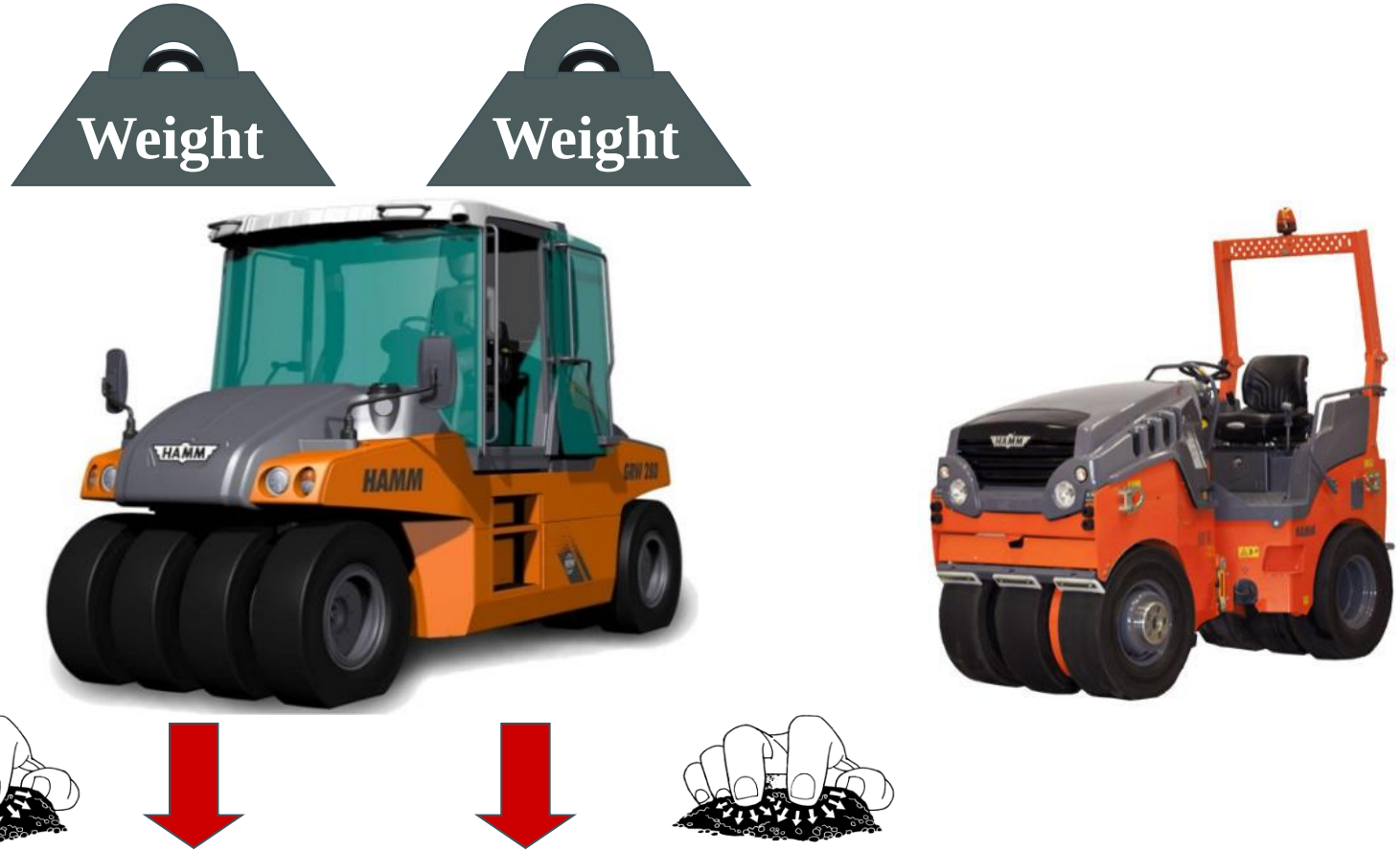
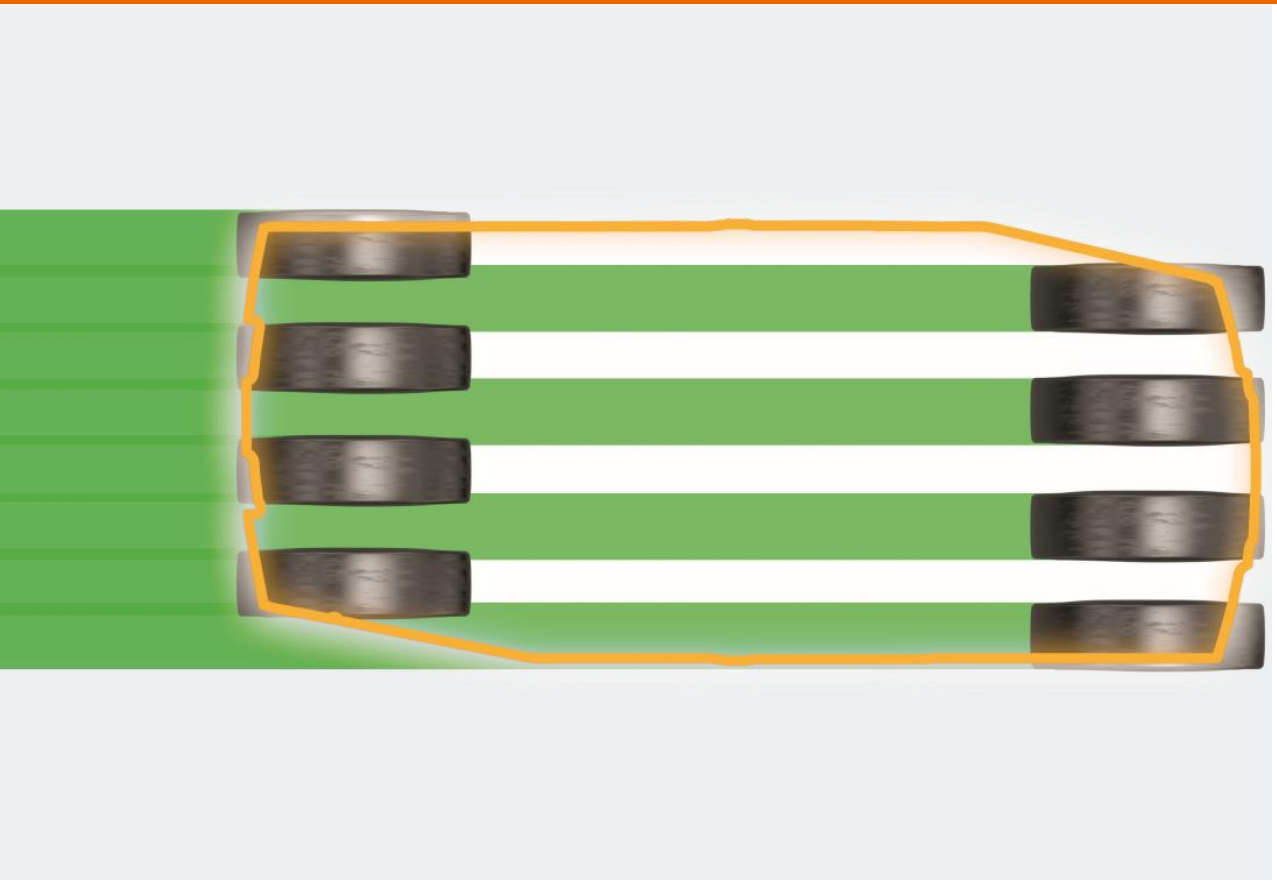
Pneumatic (rubber tires)



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

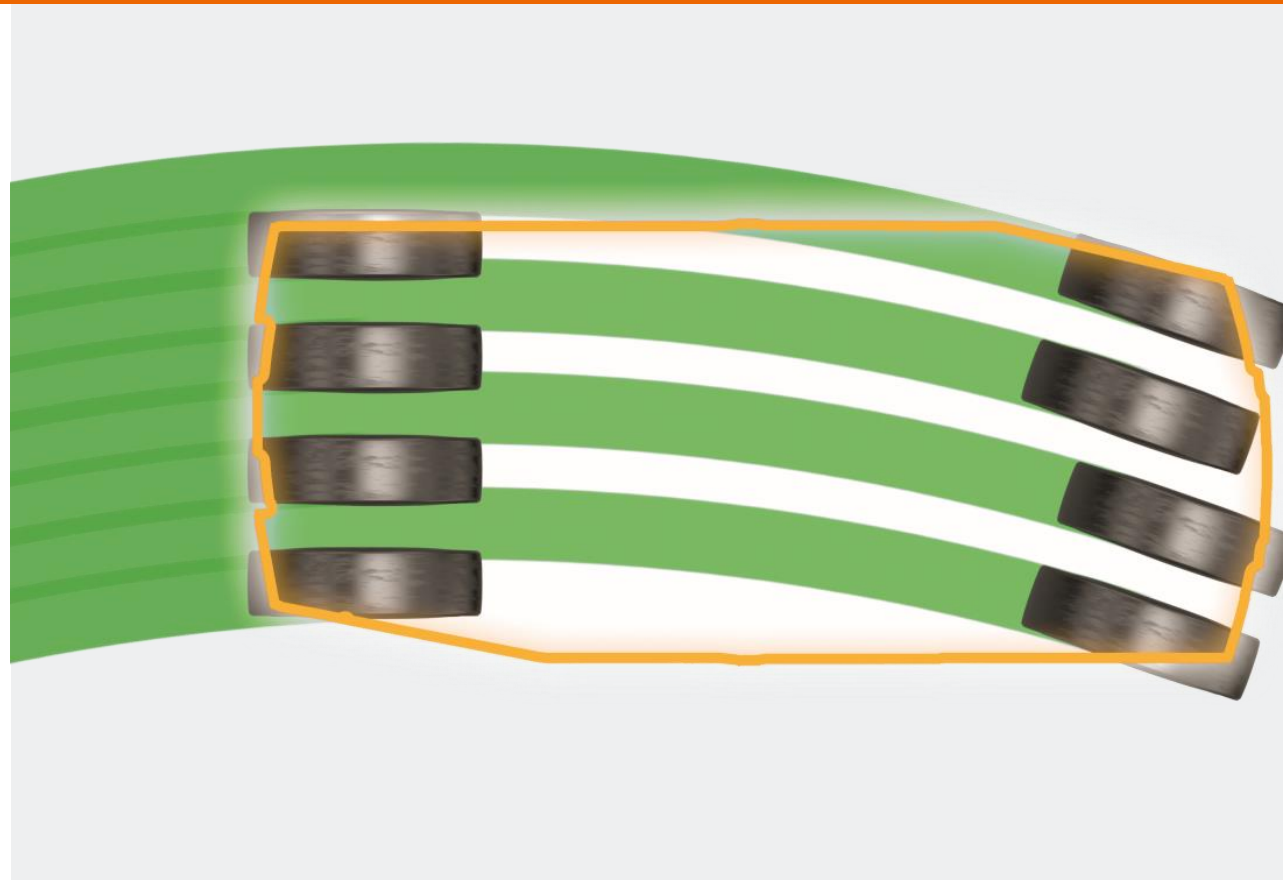
Application(s): **Seal mat surface (All)**

Track overlapping



Front and rear axle offset

Track overlapping



The track overlap is also guaranteed when cornering

Separating compound for rubber wheels

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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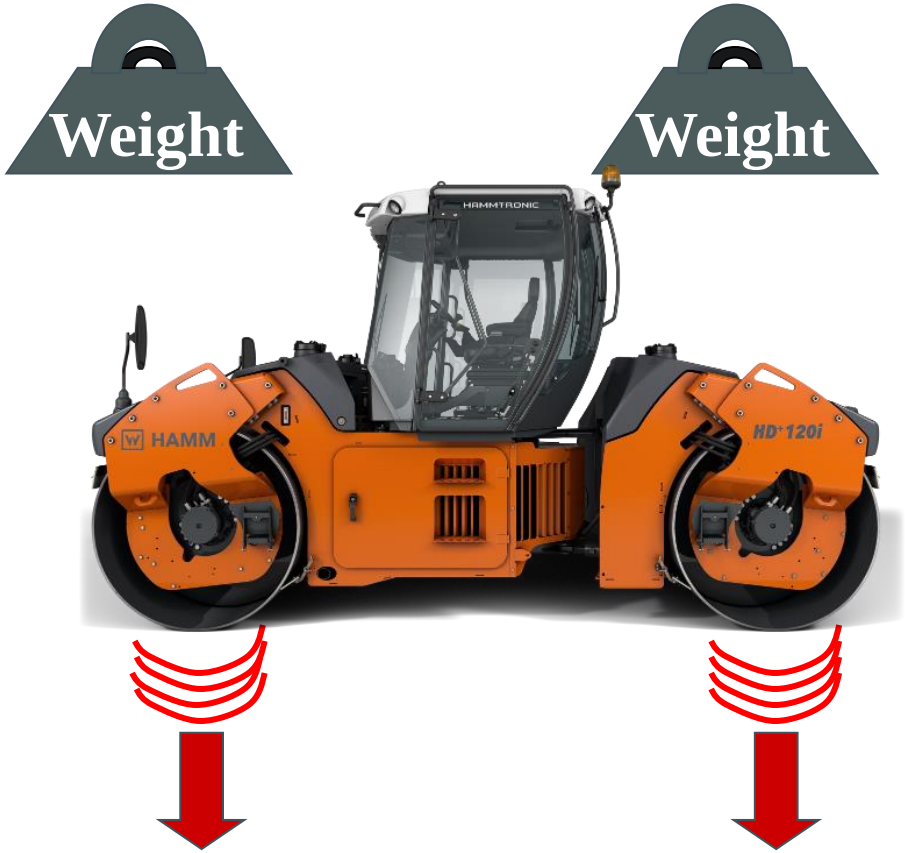
Tandem steel drums (vibration)



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

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

Roller Types?

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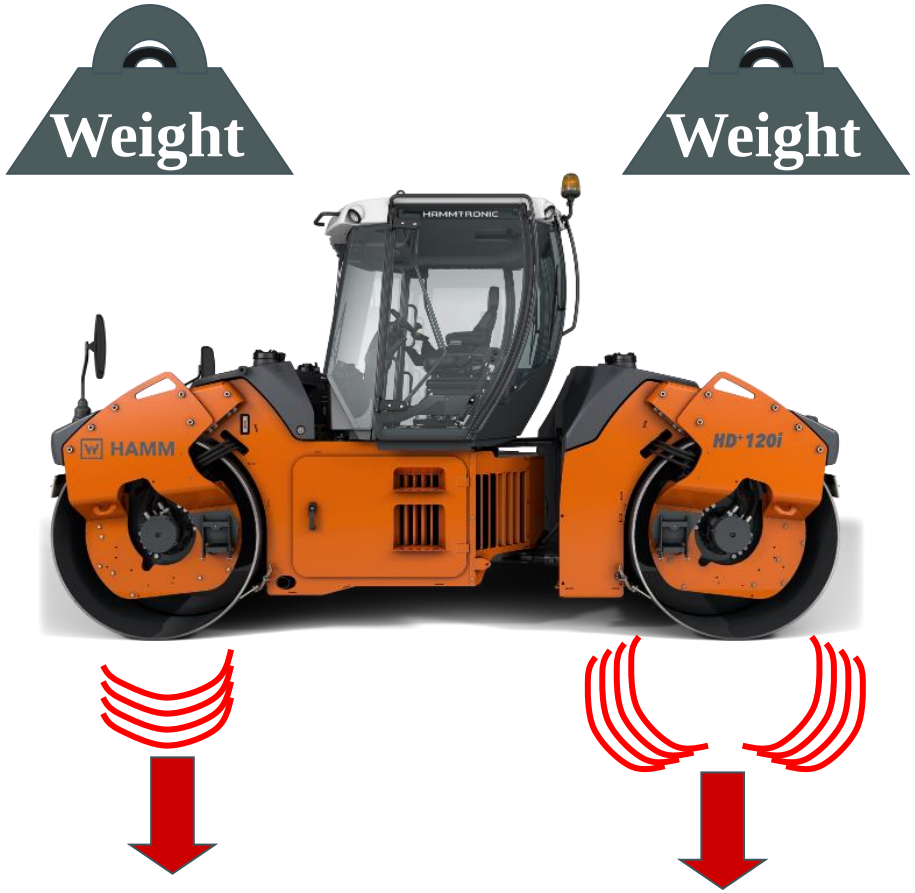
Tandem steel drums (OZZY)



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

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

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ROLLER DESIGN SPECIFICATIONS AFFECTING COMPACTION

Design Specifications

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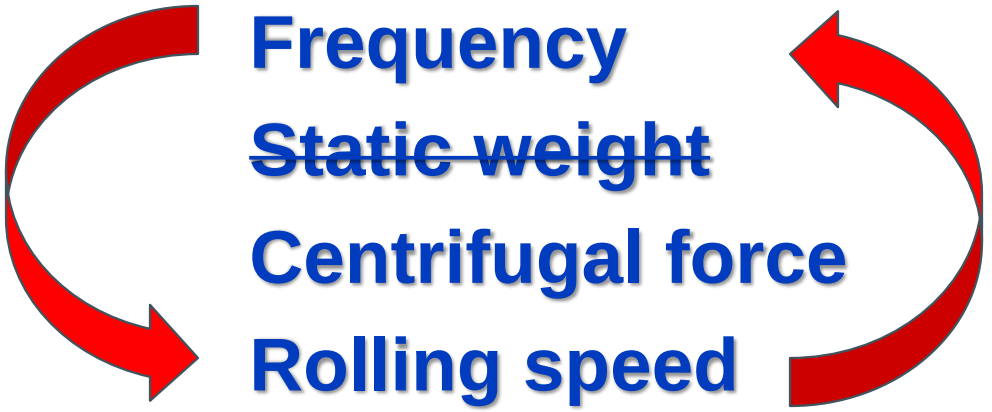
Key roller design specifications affecting compaction



Amplitude

Frequency

~~**Static weight**~~

Centrifugal force

Rolling speed

~~**Drum diameter**~~

~~**Drum activation controls**~~

~~**Drum water & scrapers**~~

~~**Drum offset**~~

Amplitude

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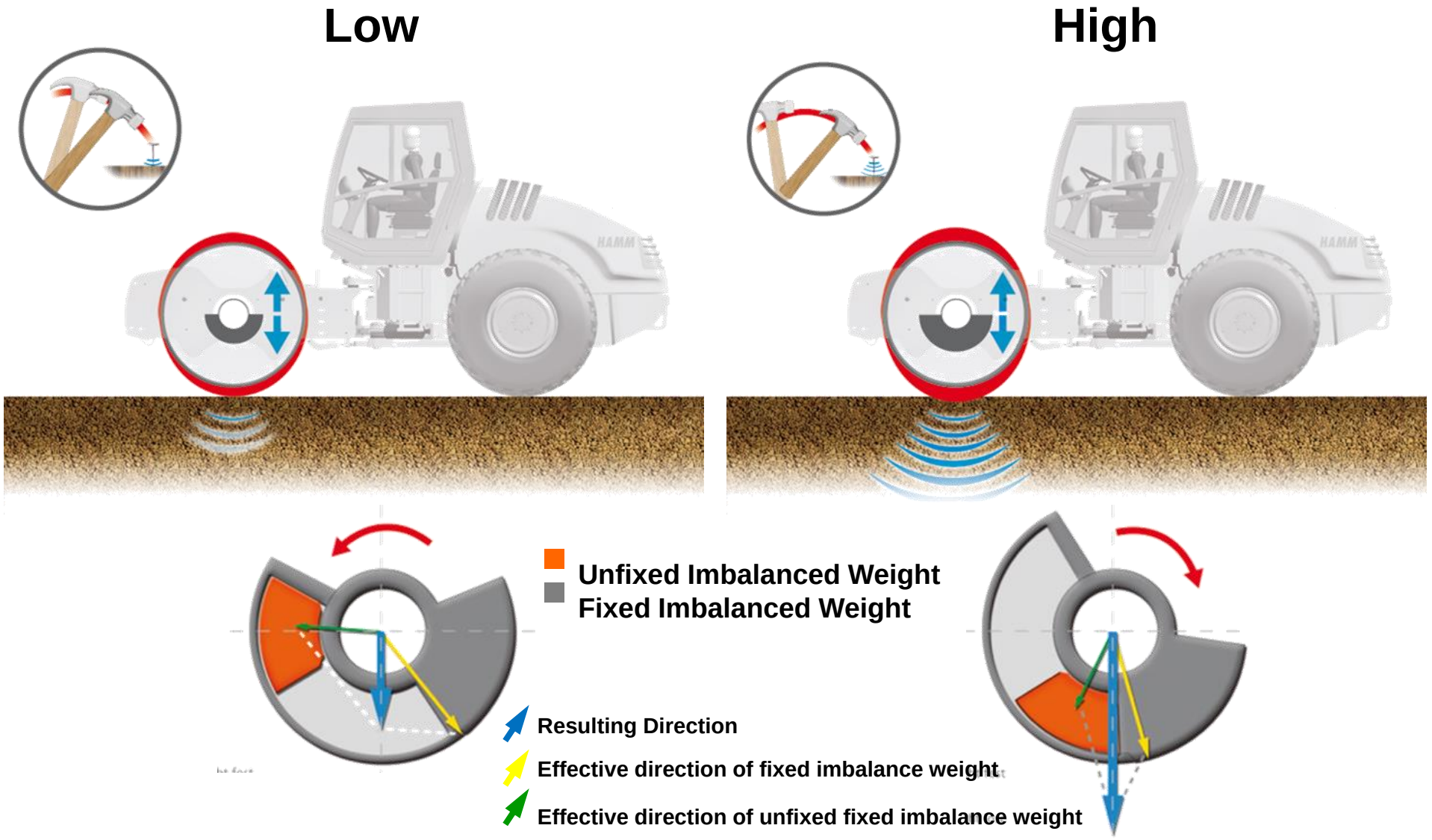

Frequency vs. Speed

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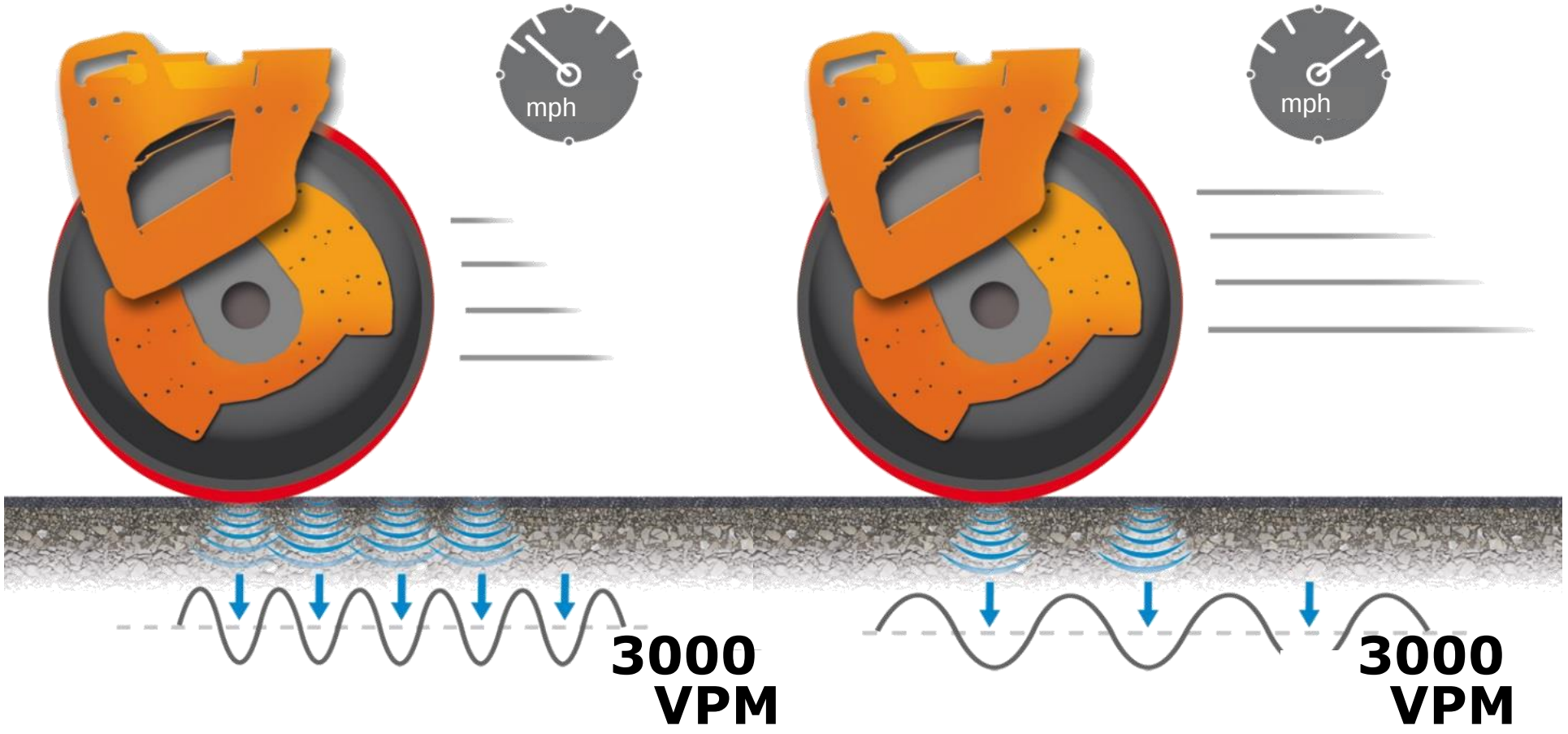
Speed can kill



Centrifugal Force

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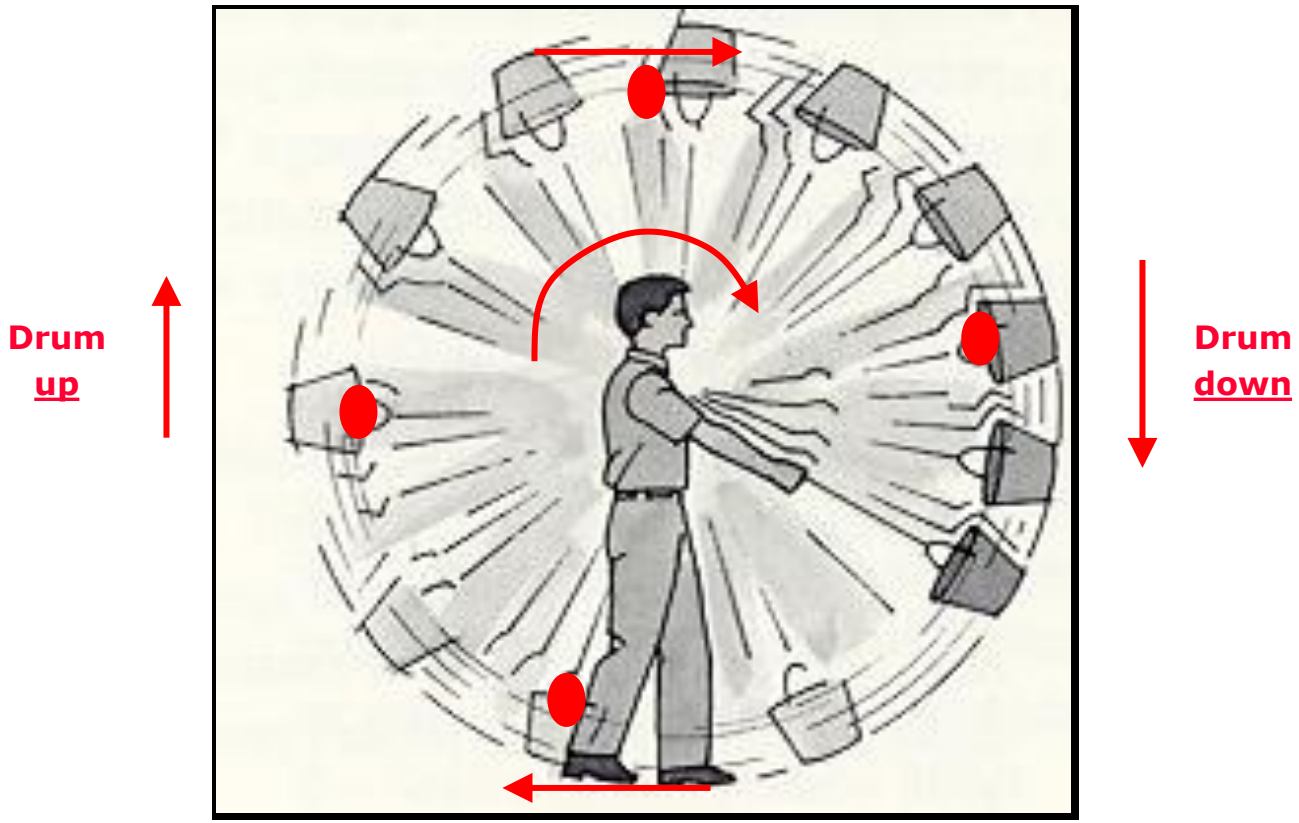
Centrifugal force principle

Centrifugal forces are generated by eccentrics in rotation

Heavier the eccentric weight – greater the generated force

Faster the eccentric rotation – greater the generated force



Frequency & Rolling Speed

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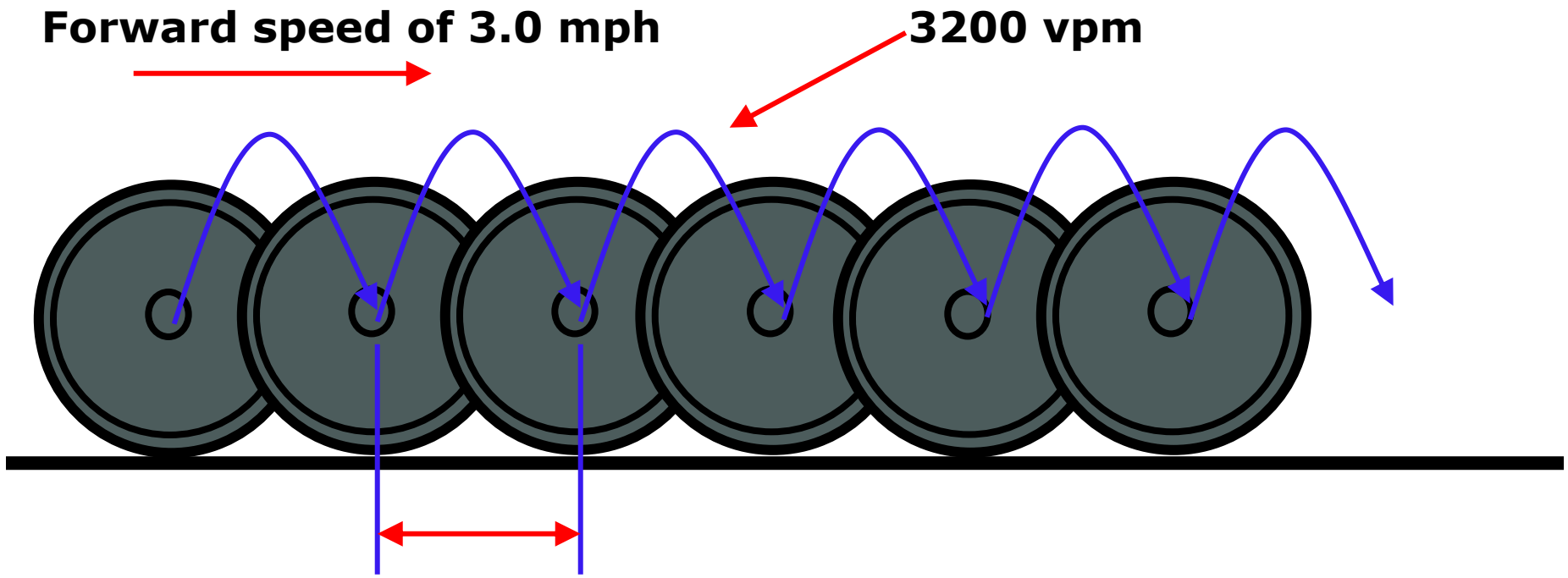
Frequency + forward speed = (impact spacing)

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



Frequency & Rolling Speed

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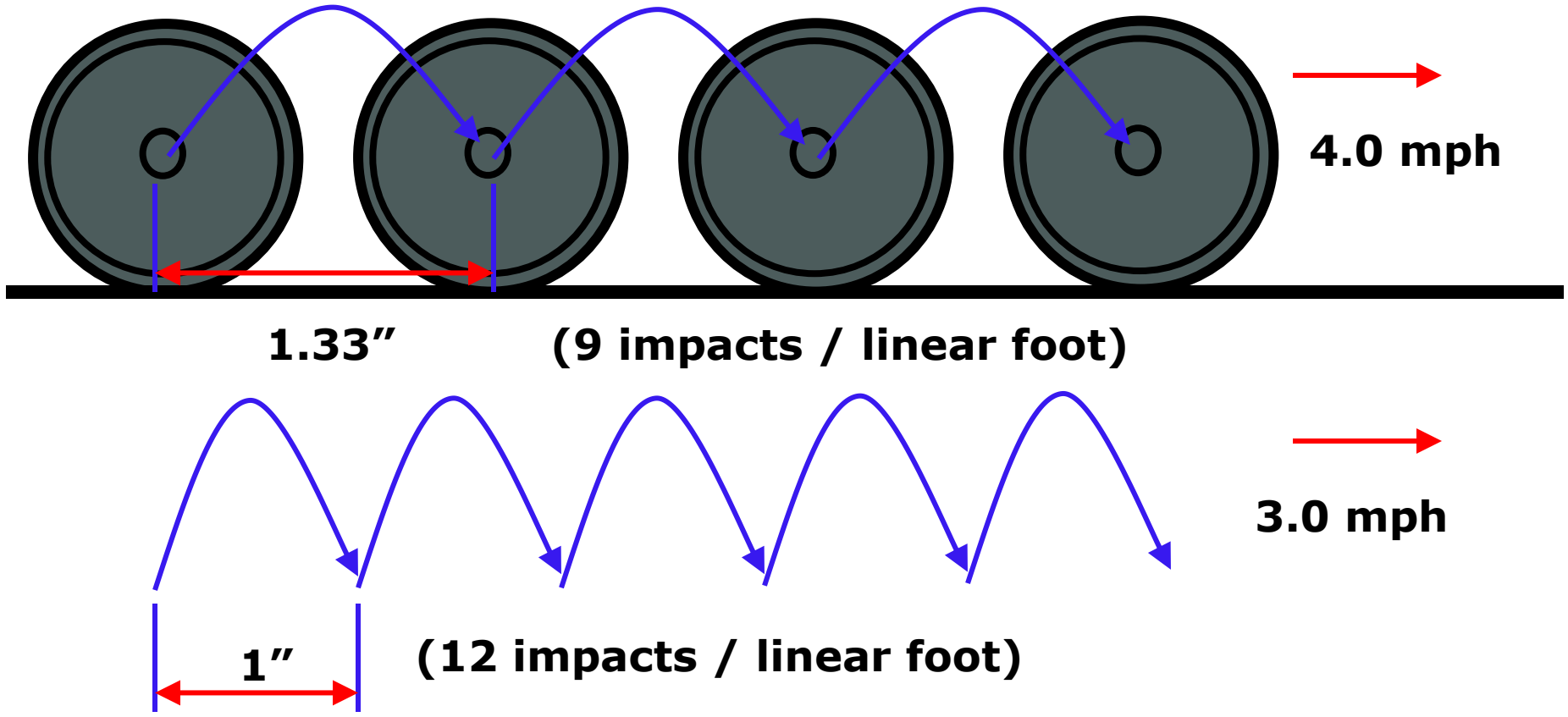
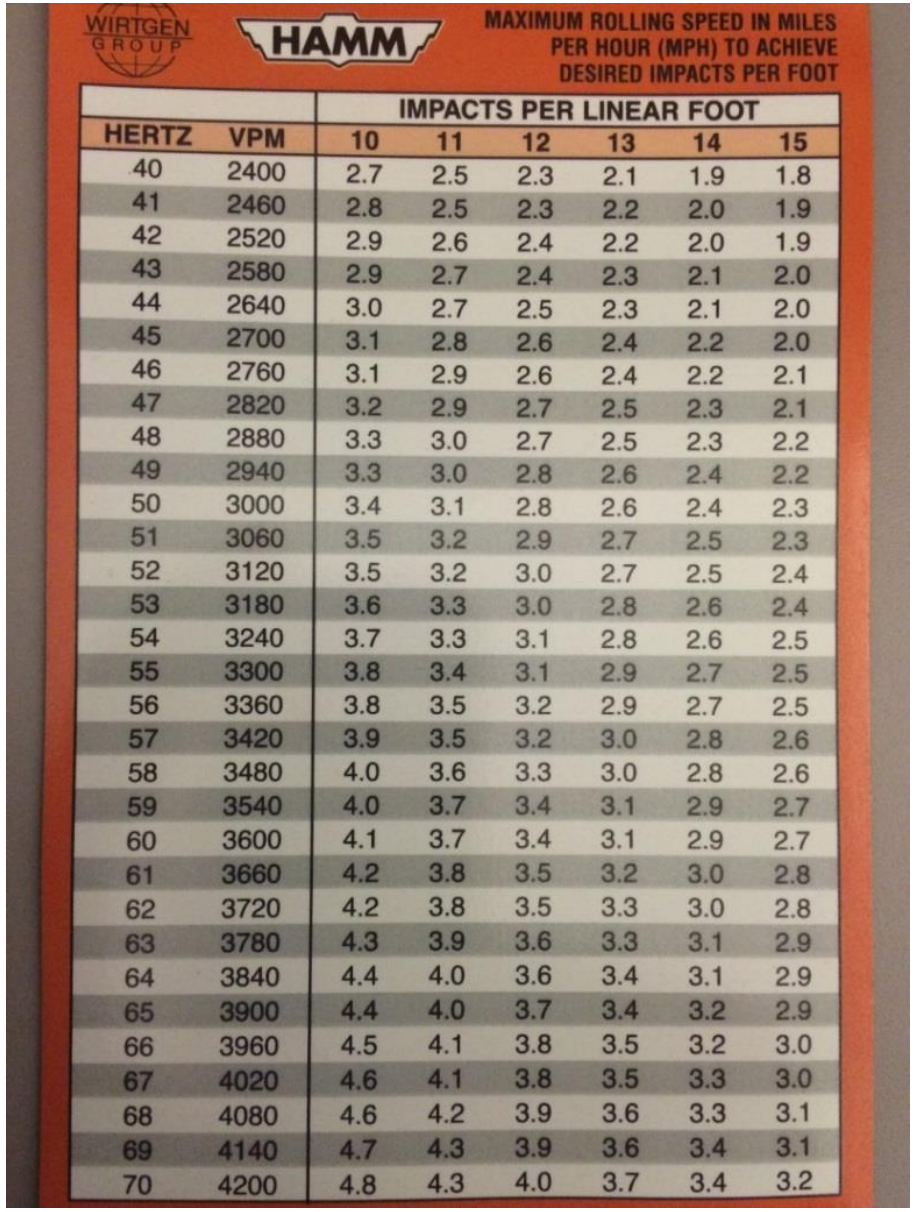
For the SAME eccentric rotation of 3200 vpm, if I ACCELERATE to 4.0mph the IMPACT SPACING will now INCREASE to …



Frequency & Rolling Speed

HAMM



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

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"WARNING"

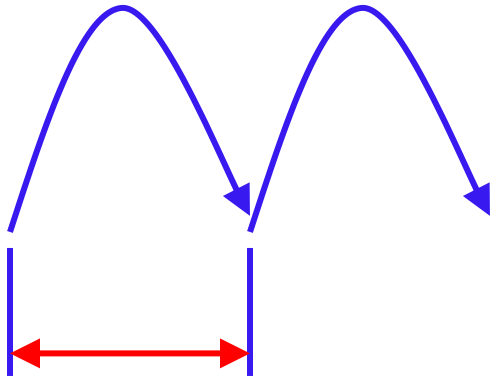
Best practices

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)

Bump Removal

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EXTERNAL FACTORS AFFECTING COMPACTION

External Factors?

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Don't go blaming the roller…

Fact is, it's rarely the rollers fault!

External Factors?

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External Factors Affecting Compaction:

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

Asphalt

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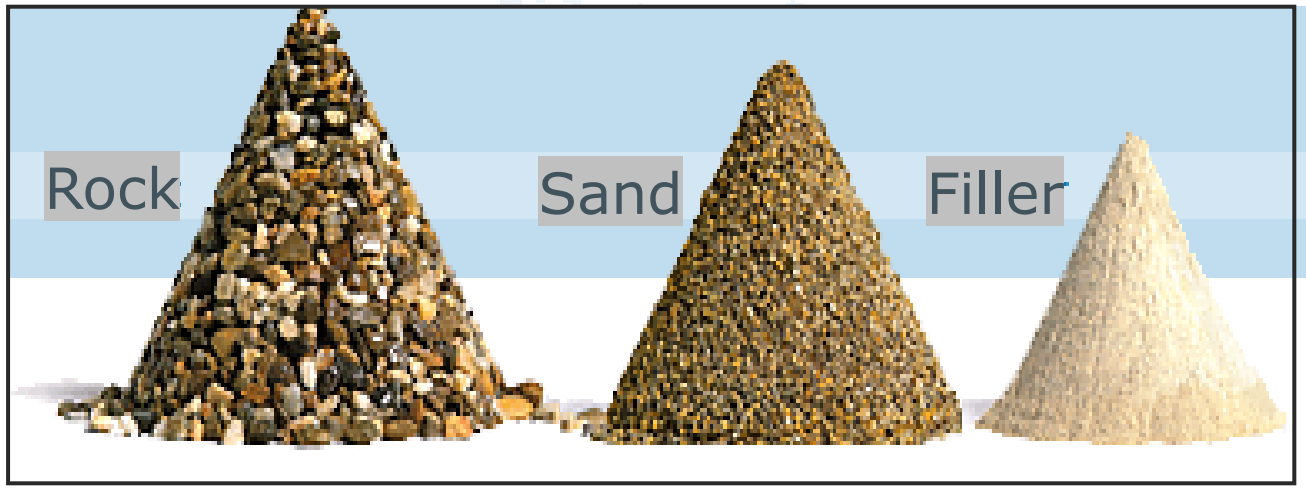
What is asphalt?

Bitumen
+
Aggregates



Mix Design

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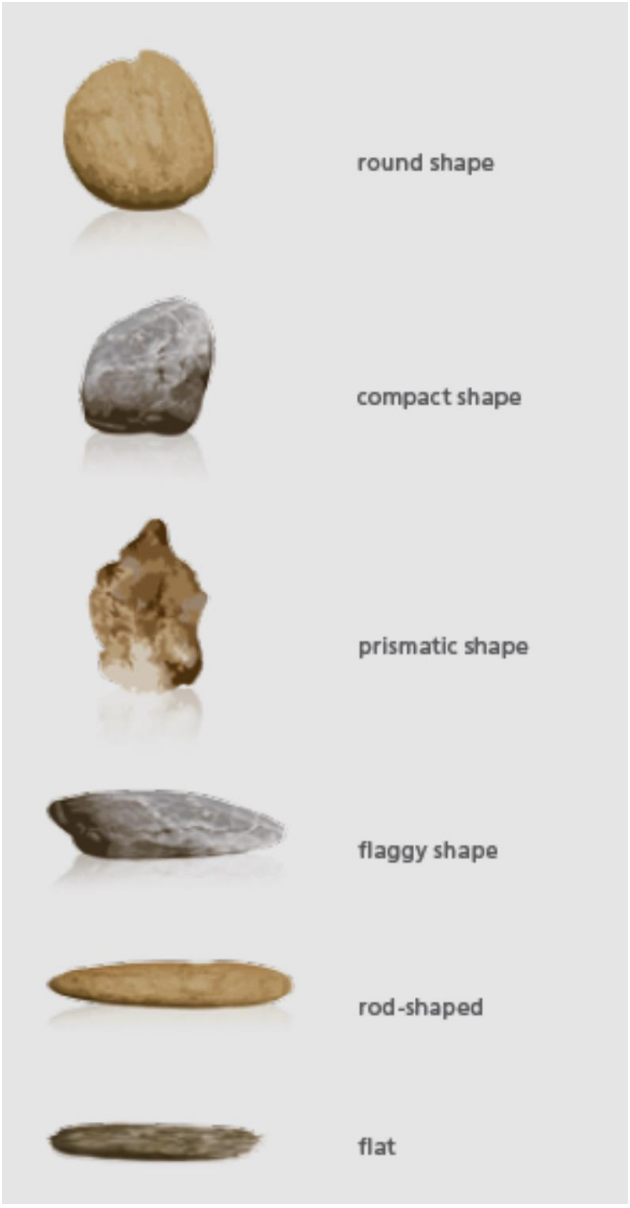
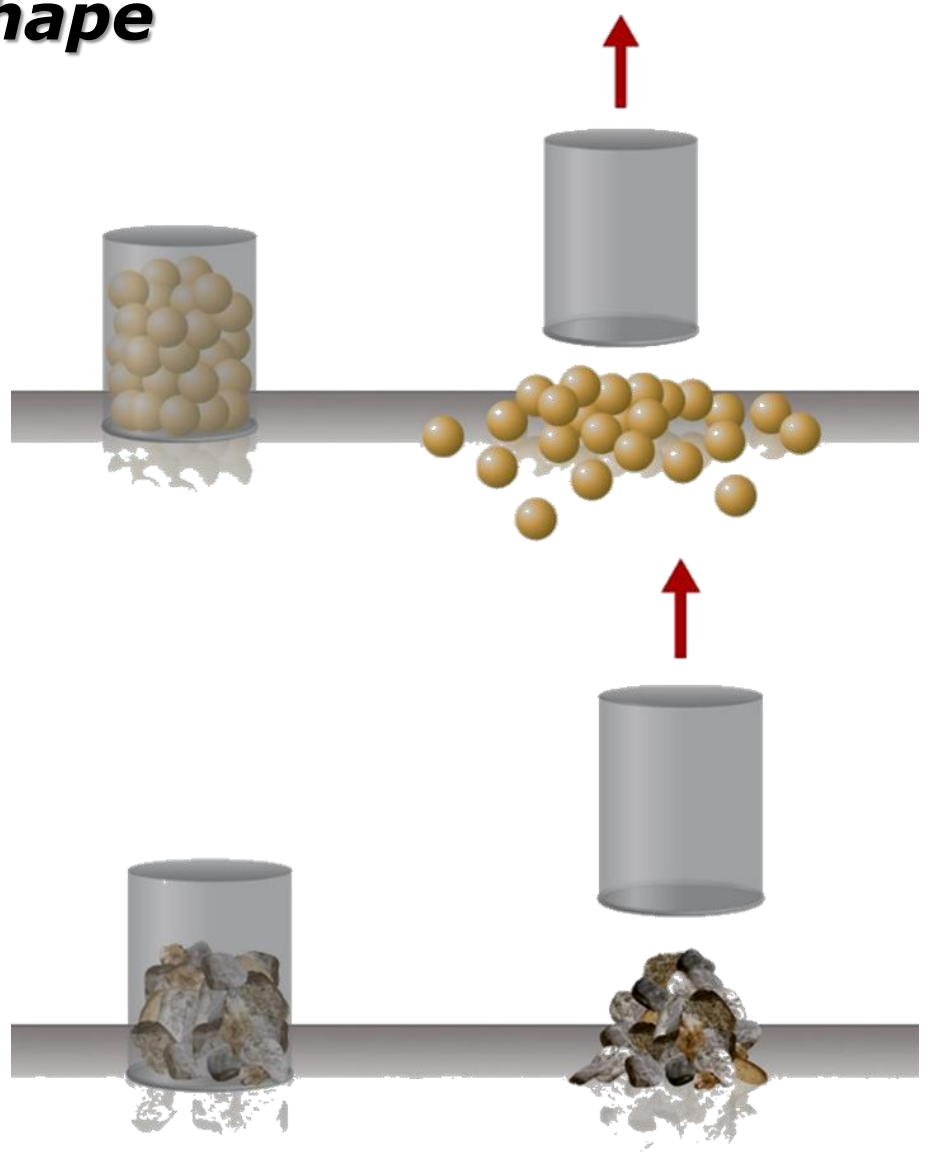


Particle shape



Mix Type & Design

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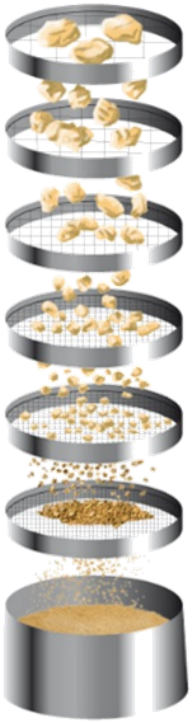
A science of its own

The main components can be summarized as follows:



Gradation of stones & fines

Bitumen

<u>Modifiers</u>

(Polymers, rubber, liquid anti-strip)

<u>Stabilizers</u>

(Fibers, crumb rubber, sulfur, hydrated lime)

Temperature (Proper Machine)

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Temperature

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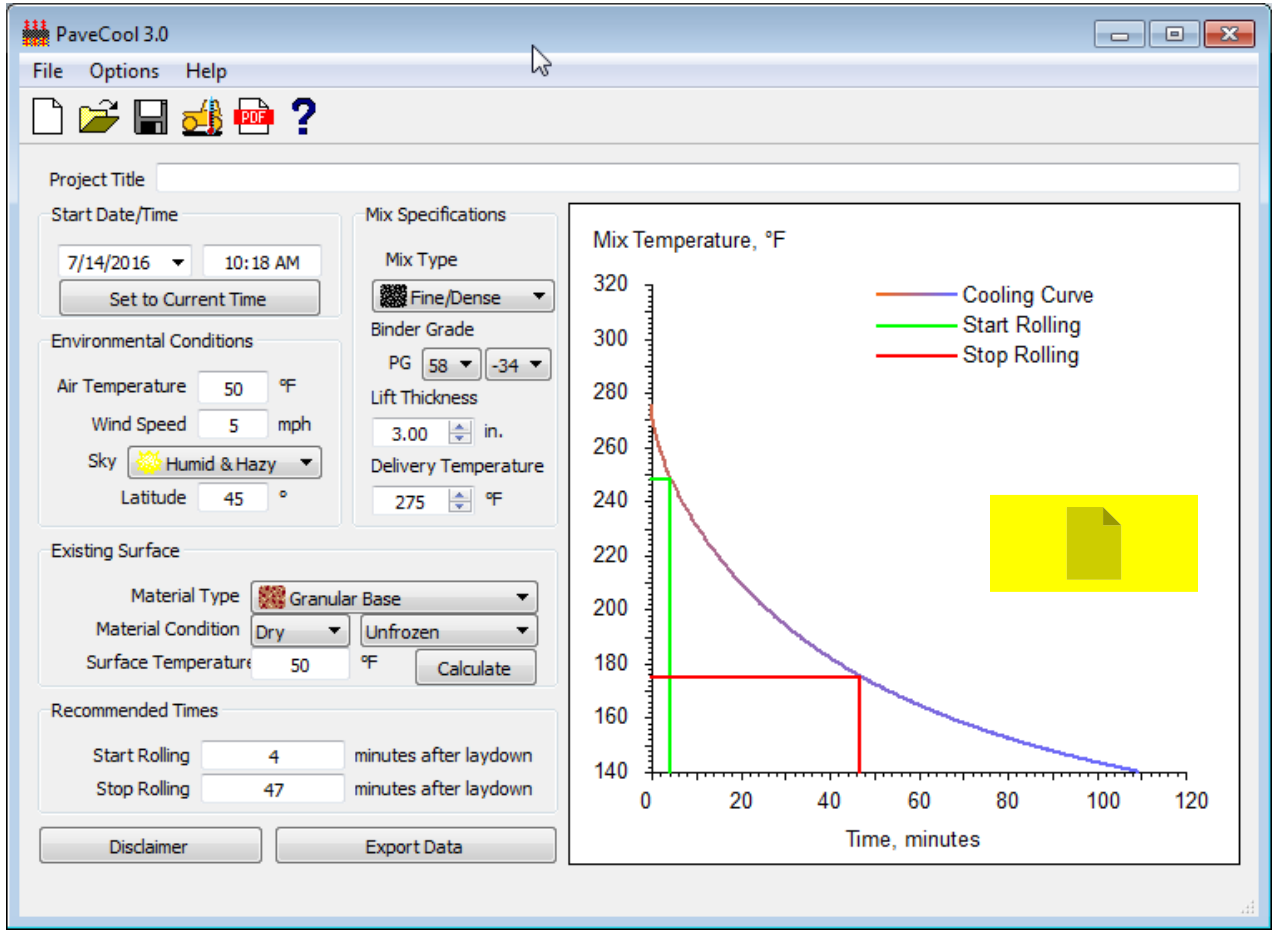
Cooling rate = rolling time



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

OR

Temperature

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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

Summary

HAMM

- **Compact for longer life**
- **Various ways to get compaction**
  - **Static, kneading, vibration, Oscillation**
- **Types of rollers**
  - **Right roller for right project**
  - **Not one roller works for everything**
  - **Several options & Attachments**
- **Roller Design Specs**
  - **Speed can kill**
  - **Impact spacing is key**
- **External Factors**
  - **Not all mixes compact the same**
  - **Base conditions are critical**

- **Being Consistent**

Thank You

HAMM

Back