



Asociación Mexicana
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PAVIMENTANDO
EL CAMINO
HACIA UN
FUTURO
SOSTENIBLE



**SEMINARIO INTERNACIONAL DEL
ASFALTO**

9 al 11 de Octubre, 2024, Monterrey, N.L.

Intelligent Compaction

Jan Frománek



Asociación Mexicana
del Asfalto, A. C.



SEMINARIO INTERNACIONAL DEL ASFALTO

Jan Formánek

Commercial & Product management

AMMANN

Jan.formanek@ammann.com



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Intelligent Compaction

CCC – Continuous Compaction Control



- The highly demanding situation in the construction industry is increasing the needs for Quality → Quality means Control → and Control means Measurement
- The answer is Intelligent Compaction.





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Intelligent Compaction

Basic systems versus Advance systems



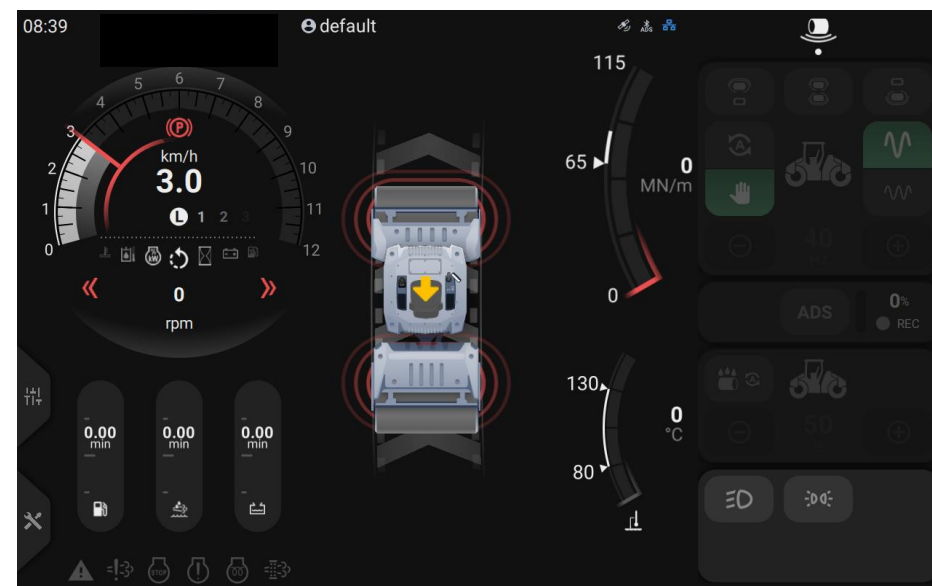
• Basic CCC Systems

- **Relative measurement (%)**
- System consists of:
 - Compacted material Stiffness measurement



• Advanced CCC Systems

- **Absolute value measurement (MN/m)**
- System is combination of:
 - Compacted material Stiffness measurement
 - Operators Guidance
 - or Automatic Vibration Regulation





Intelligent Compaction

Absolut value versus relative measurement



- Where to use **Relative vs. Absolute** measurement:

Pass	Jobsite with Relative measurement	Measured value %	Jobsite with Absolute measurement	Measured value kB
1.	SDR 7t with Relative measurement	60%	SDR 7t with Relative measurement	70 MN/m
2.	SDR 7t with Relative measurement	70%	SDR 7t with Absolute measurement	80 MN/m
3.	SDR 7t with Relative measurement	75%	SDR 7t with Absolute measurement	85 MN/m
4.	SDR 7t with Relative measurement	78%	SDR 7t with Absolute measurement	88 MN/m
5.	SDR 7t with Relative measurement	79%	SDR 7t with Absolute measurement	89 MN/m
6.	SDR 7t with Relative measurement	78%	SDR 7t with Absolute measurement	89 MN/m
7.	SDR 11t with Relative measurement	40%	SDR 11t with Absolute measurement	95 MN/m
8.	SDR 11t with Relative measurement	50%	SDR 7t with Absolute measurement	105 MN/m
9.	SDR 11t with Relative measurement	58%	SDR 7t with Absolute measurement	110 MN/m
10.	SDR 11t with Relative measurement	62%	SDR 7t with Absolute measurement	113 MN/m
11.	SDR 11t with Relative measurement	65%	SDR 7t with Absolute measurement	115 MN/m
12.	SDR 11t with Relative measurement	65%	SDR 7t with Absolute measurement	115 MN/m

Relative measurement is good for Progress check, but how do you set Compaction target to be achieved by the operator independently from machine Type/Size?



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Basic systems benefits



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- **Affordable Compaction progress indication**
- **Easy Quality control with no additional System setting**
- **Jobsite efficiency improvement:**
 - Time & Fuel economy
 - CO₂ reduction
 - Re-work costs reduction
 - Machine and Jobsite Lifespan extension
- **Over compaction warning**





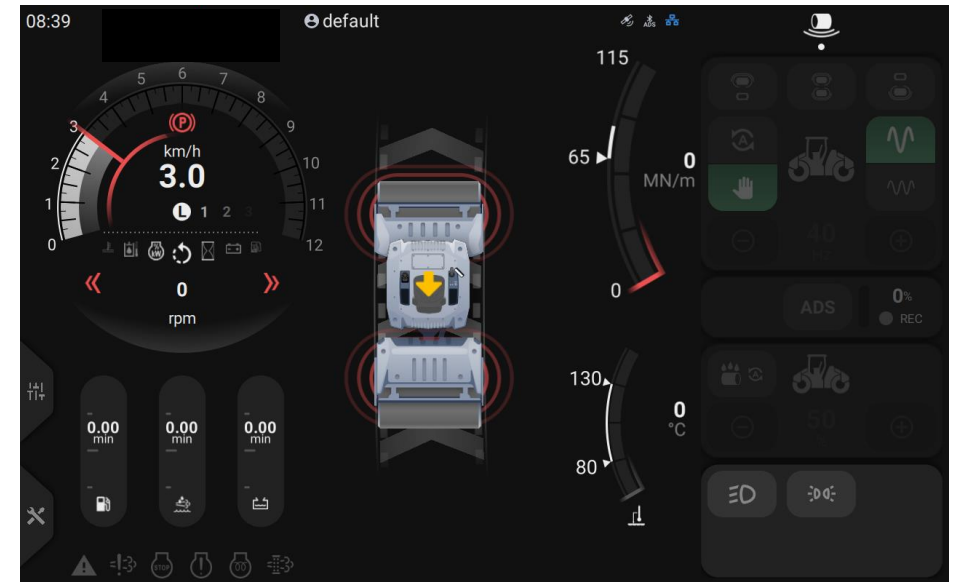
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Advanced systems benefits



- **Advanced system with compaction target setting and laboratory tests correlation**
- **Intuitive system setting via machine display**
- **Machine control of:**
 - Autonomous Vibration setting – Amplitude and Frequency
 - Machine speed Guiding
 - Temperature range Control
- **Jobsite efficiency improvement:**
 - Time & Fuel economy
 - CO2 reduction
 - Re-work costs reduction
 - Machine and Jobsite Lifespan extension
 - Less Laboratory visits on jobsite
- **Double jump warning preventing Machine and Surface damage**





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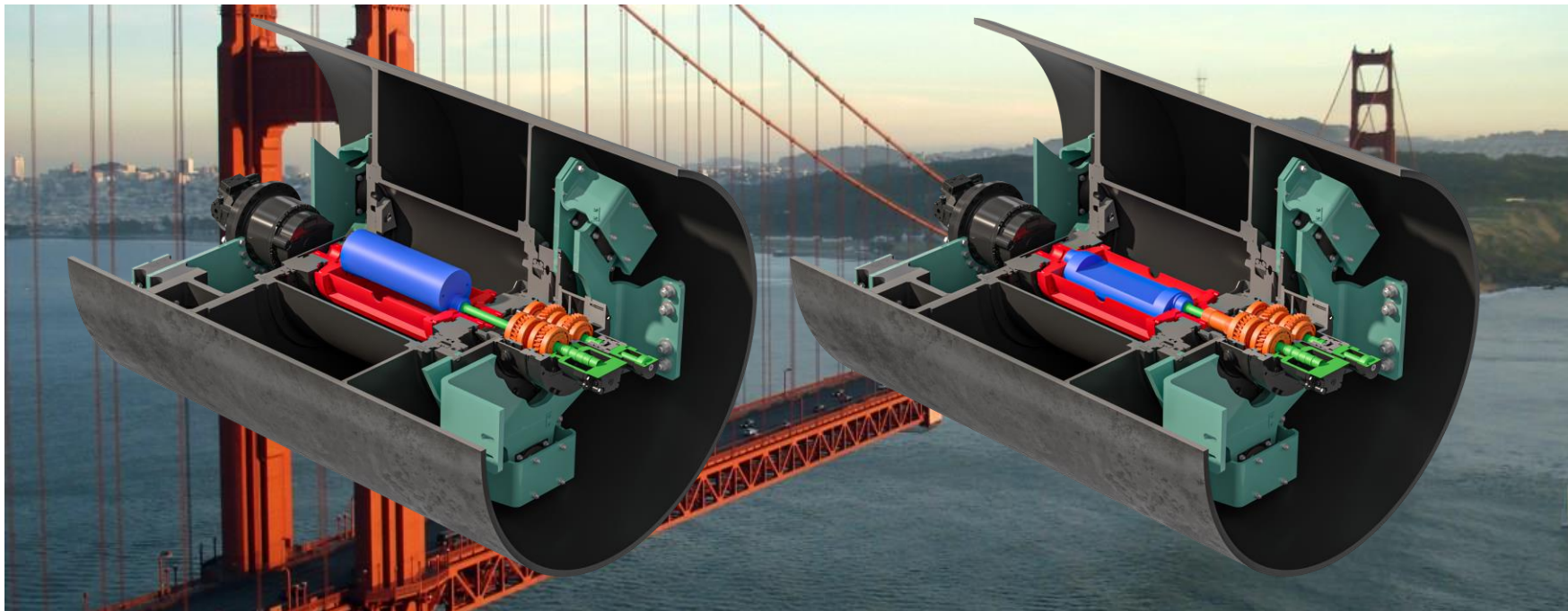
Advanced systems benefits



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- **Bridge compaction**

1. Exciter starts rotation with 0% eccentricity and reach 50Hz (passing of dangerous resonance frequency ~17Hz at **Zero Amplitude**)
2. Only then Increases eccentricity up to 100% and generate Vibration





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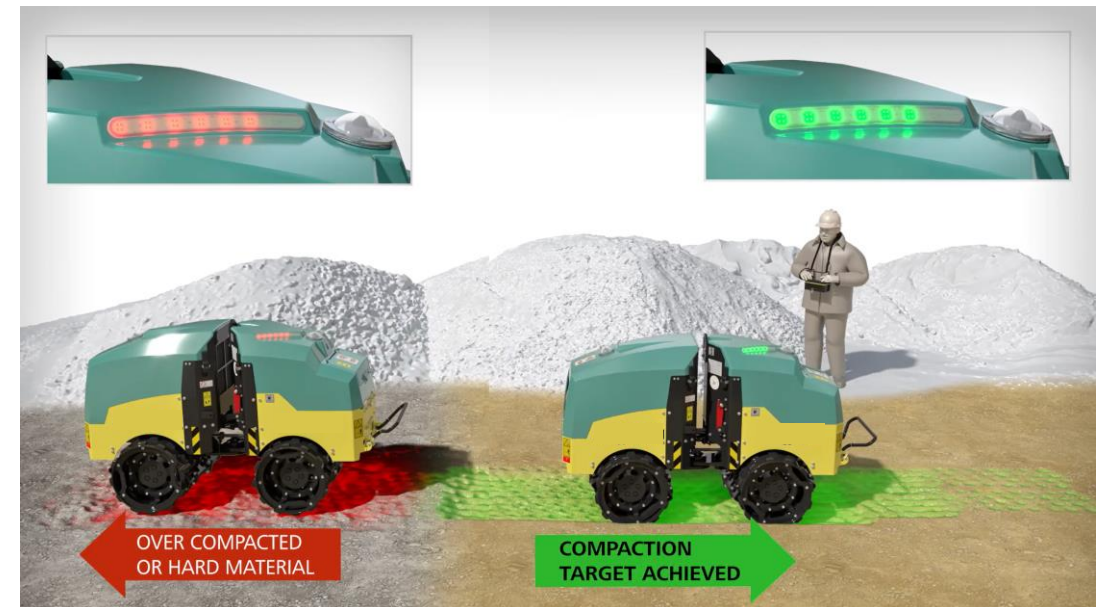
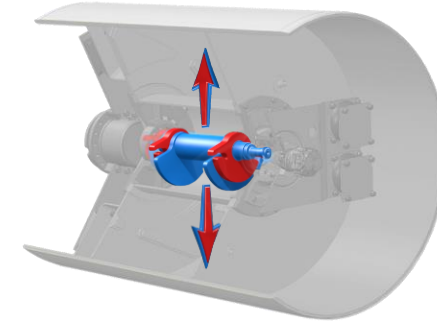
How does it work





- **Relative value**
- **Relative** system measures Value of height of Drum´s jump and via Fourier´s analyze displays the „% **value**“ (non-dimensional value)
- Sufficient for Compaction progress indication, **but not** for quality laboratory correlation
- Measurement process:
 - Drum Acceleration sensor
 - CPU with Display unit

A - acceleration

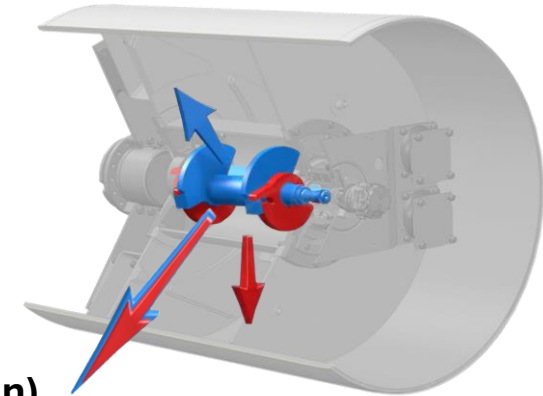
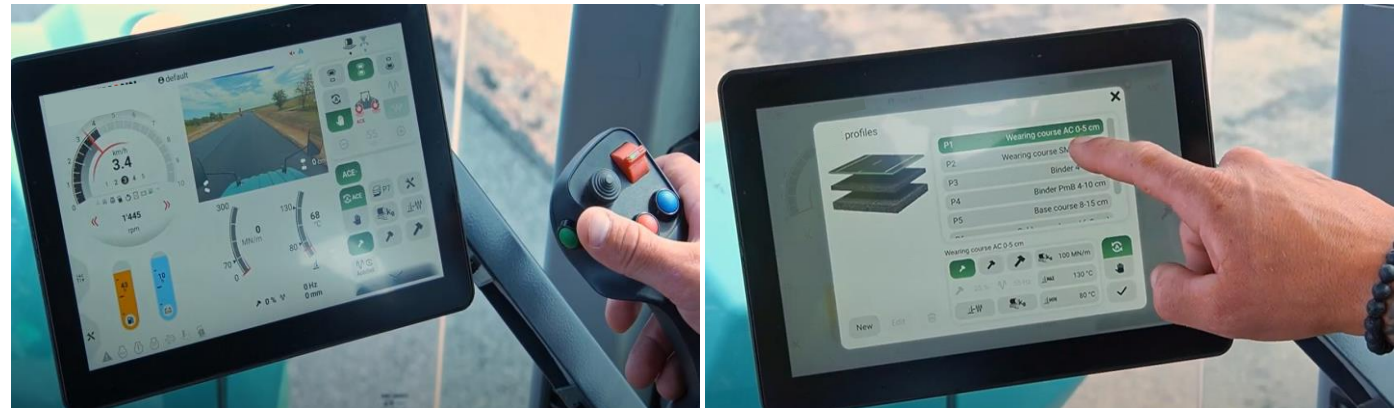




- **Absolute value**
- **Absolute** compaction measurement works according to the plate bearing test (Gyratory test) by evaluating the calculated transmitted compaction energy versus the vibratory drum's acceleration – result is MN/m

- Measurement process:

- Drum Acceleration sensor
- Sensor of Position of eccentric mass
- Frequency sensor
- Machine Speed sensor
- CPU with Display unit

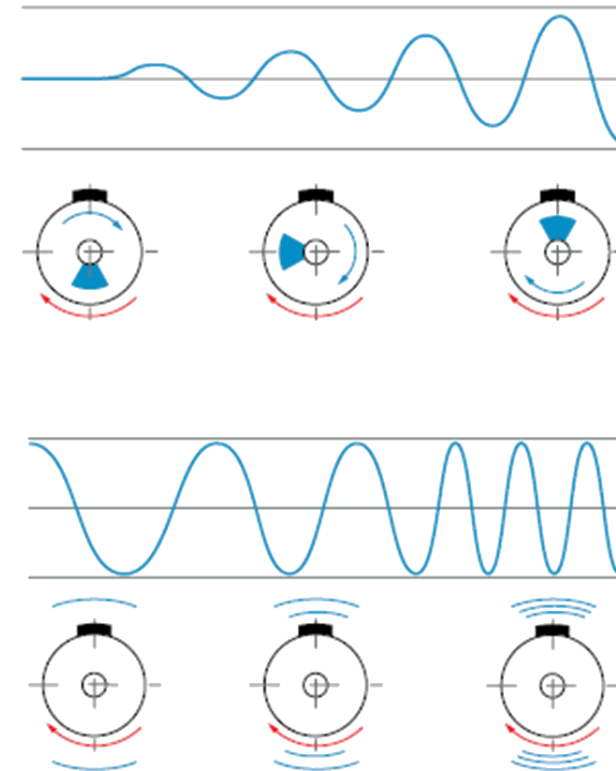


A - acceleration

V - vector (size & direction)



- **Amplitude control**
- Sensor of eccentric force setup (Gearbox) needed
 - the effective Amplitude is automatically reduced or increased by step less positioning of Eccentric weights in the vibration unit of the drum
- **Frequency control**
- Frequency sensor & Machine Speed sensor needed
 - the Frequency is automatically adjusted by varying the RPMs of the vibratory shaft.

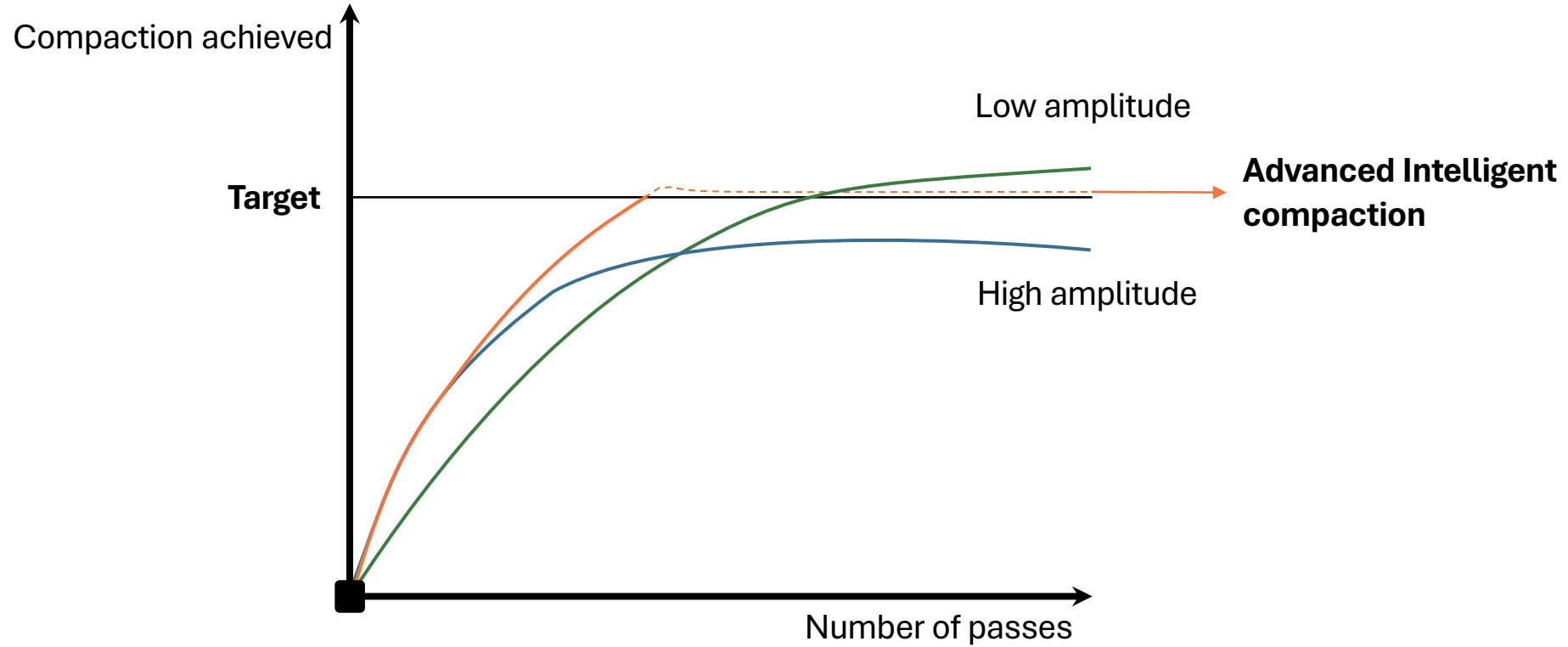




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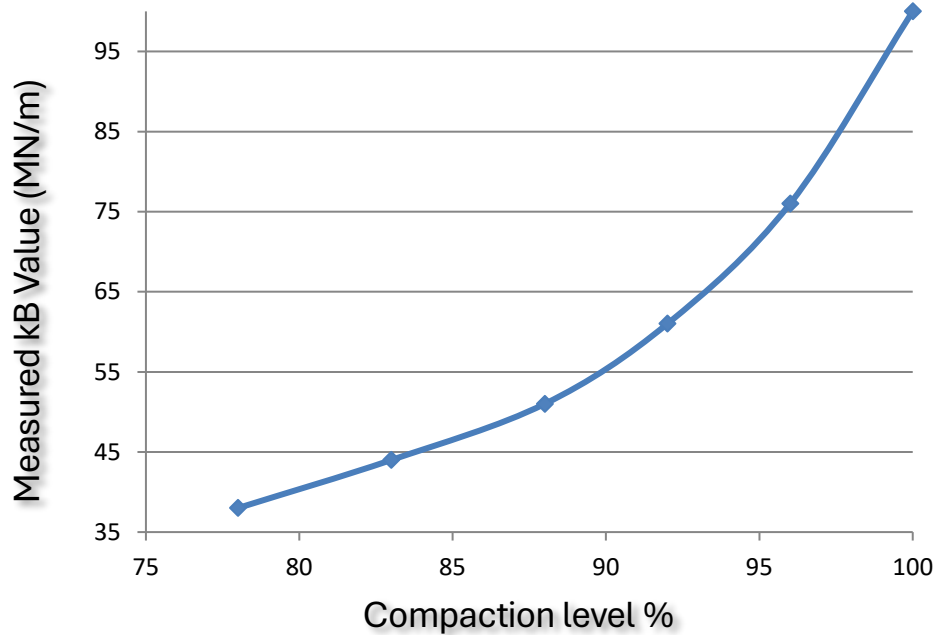
Advanced systems



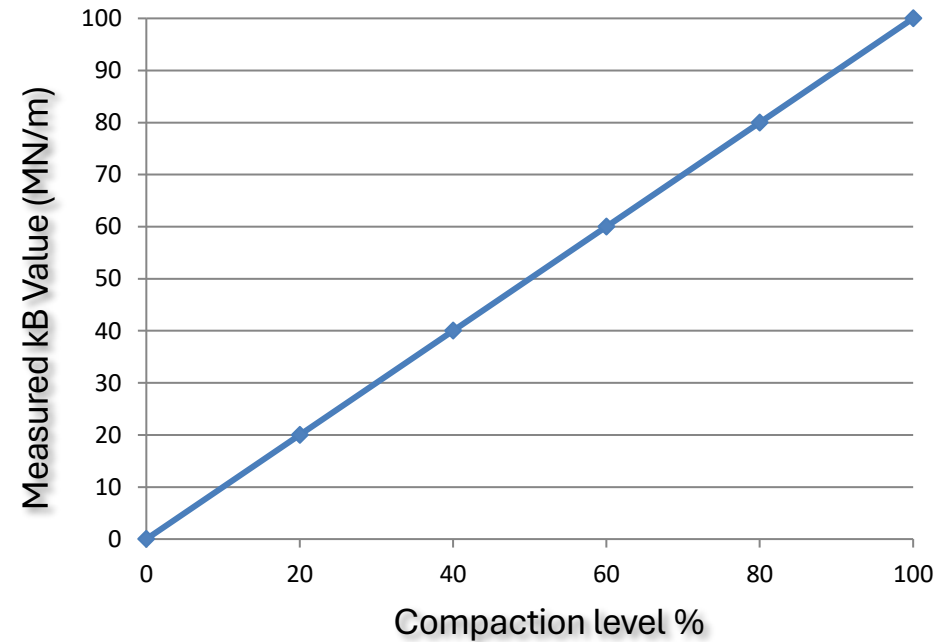


- Value in MN/m corresponds with the static and dynamic plate loading test (defined force/load; defined loading area) and correlates to the Proctor evaluation
- Correlation examples:

Asphalt Correlation (Cohesive material)
 Test vs. Ground Bearing Capacity
 Asphalt Mix – Binder 0/22, PMB65



Soil Correlation (Non-cohesive material)
 Test vs. Ground Bearing Capacity
 Soil Mix – Sand-Gravel





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Intelligent Compaction

Basic Documentation / Reporting systems



- **Basic**
- Job-site documentation of compaction results measured by **basic** systems can be also combined with GPS position for precise localization
- **Possible Functions/Features:**
 - Recording jobsite machine passes and compaction progress with GPS position
 - Jobsite visualization on Maps
 - Compaction statistics downloadable with for example bluetooth connection to the mobile app.
 - Report customization available, CSV data available for further analyses.





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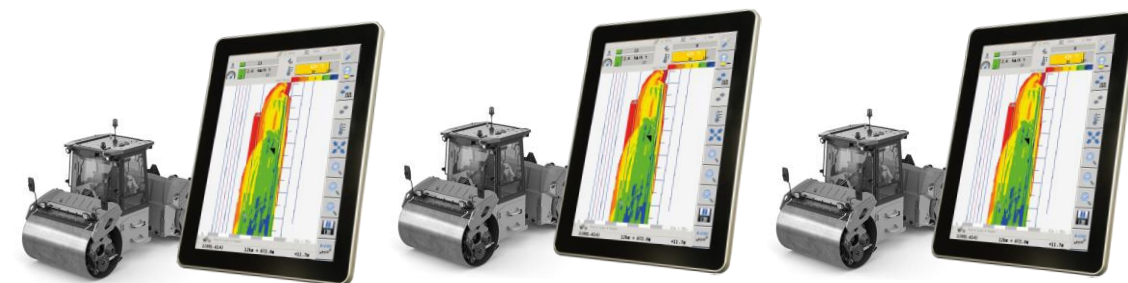
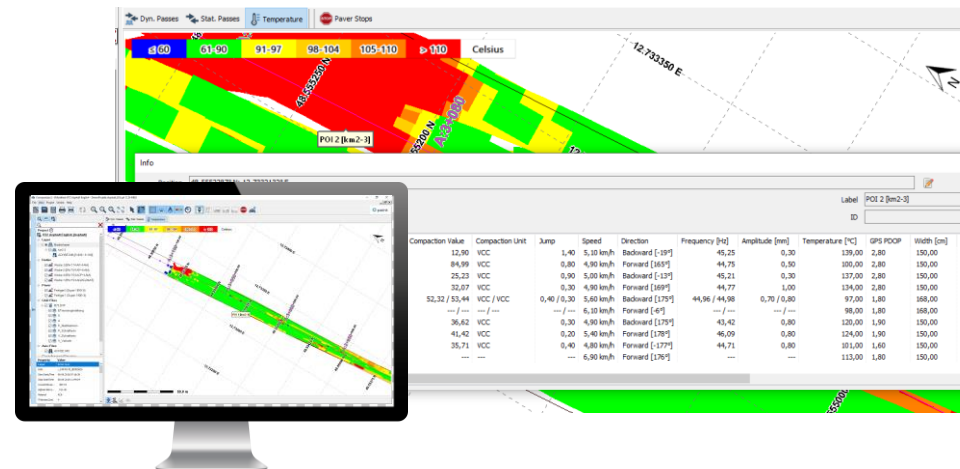
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Advanced Documentation / Reporting systems



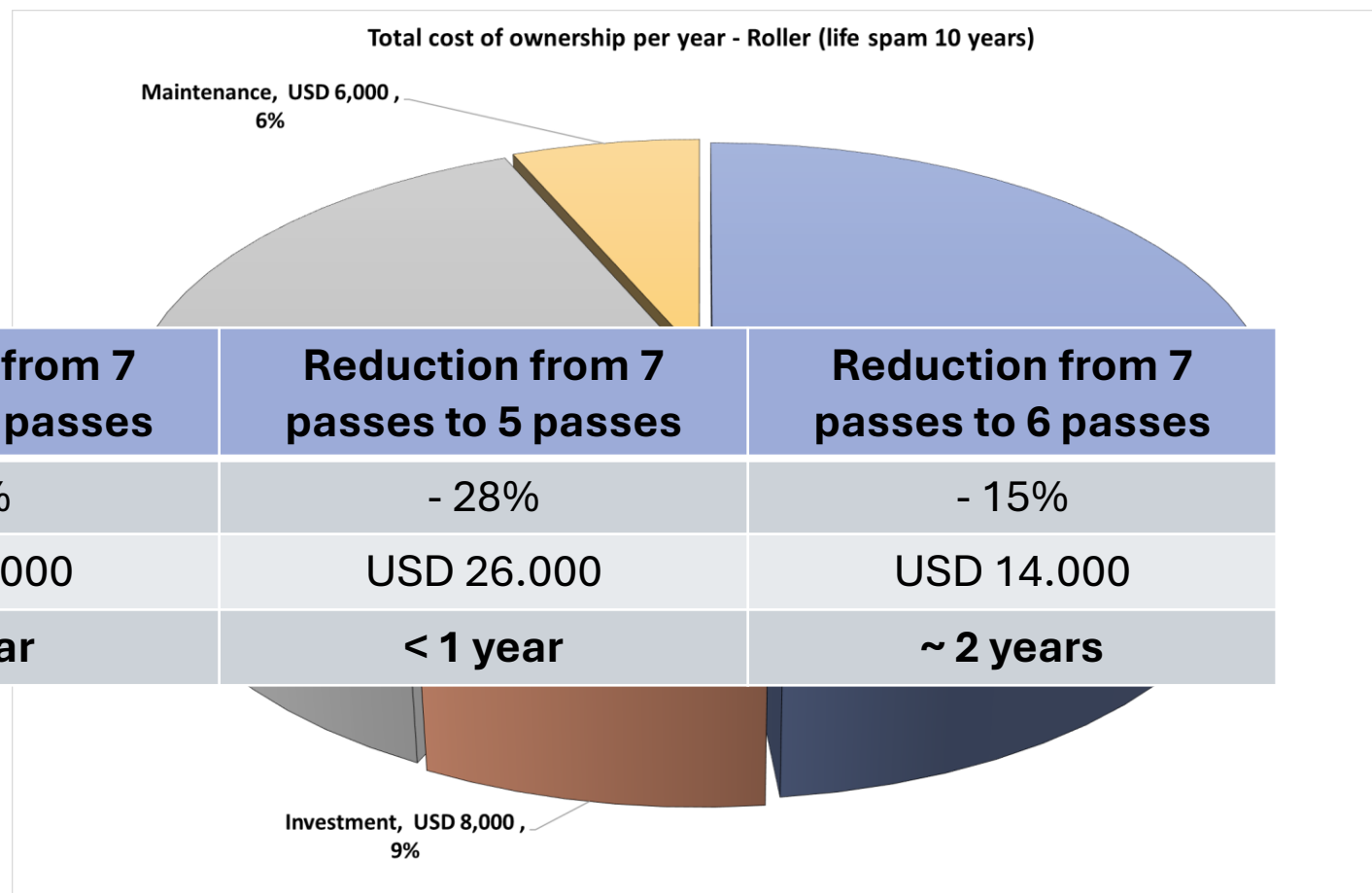
• Advanced GPS & cloud solutions

- Live update
- Multiple machines cooperation / Asphalt mixing plant / Truck / Paver / Roller
- Advanced reporting
- in-time comparison with the project assignment
- Independent on machine type
- Merged visualization of compaction process (Operator can see Compaction results of all Machines in process)





- TCO / year USD 93.000
- ~ 90% of the costs are influenced by machine usage
- Considering Investment to full advanced intelligent Compaction USD 20 000



	Reduction from 7 passes to 4 passes	Reduction from 7 passes to 5 passes	Reduction from 7 passes to 6 passes
Reduction of time/costs	- 42%	- 28%	- 15%
Saving per year	USD 39.000	USD 26.000	USD 14.000
Return on investment	< 1 year	< 1 year	~ 2 years



¡Muchas gracias!

Jan Formánek

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Jan.formanek@ammann.com