

PAVEMENT'S LABORATORY TEST EQUIPMENT

PRESENTED BY:

MOHAMMED MOTTAGHI

TECHNICAL SALES EXECUTIVE



DTS-30
30 KN DYNAMIC TESTING SYSTEM



DTS-130
130 KN DYNAMIC TESTING SYSTEM



TSRST
MULTI-STATION THERMAL ASPHALT SYSTEM

WELCOME TO CETANZ CONFERENCE 2023



MOHAMMED MOTTAGHI

TECHNICAL SALES EXECUTIVE

Being in the test industry for up to 22 years, has helped me to obtain some experience on various aspects of material test industry, including technical sales, calibration, training and after sales services, I had the chance to cooperate with the famous brands and manufacturers of the world.



GEOTECHNICS

Founded in 1959, Geotechnics is NZ's foremost civil engineering testing company. We operate at an international level, serving the geotechnical, environmental and civil engineering industries with a suite of testing and monitoring services, conducted both onsite and in our laboratories. In addition to this, we also supply, hire, service, calibrate and repair civil engineering testing equipment. The nature of our work requires precision and clarity above all else. That's why we employ the industry's sharpest minds, most meticulous methods and state-of-the-art technology, to always produce data that you can rely upon.



MATEST[®]
INNOVATIVE. GLOBAL. MANUFACTURER.

PAVETEST[®]
WHERE TECHNOLOGY MEETS THE PAVEMENT.

tecnotest[®]
MATERIAL TESTING EQUIPMENT

STEELTEST[®]



SAMPLE PREPARATION

Methods and machinery for preparing the samples, in lab or from the field

- Mixing
- Compacting
- Coring and Cutting
- Curing (condition maintaining)



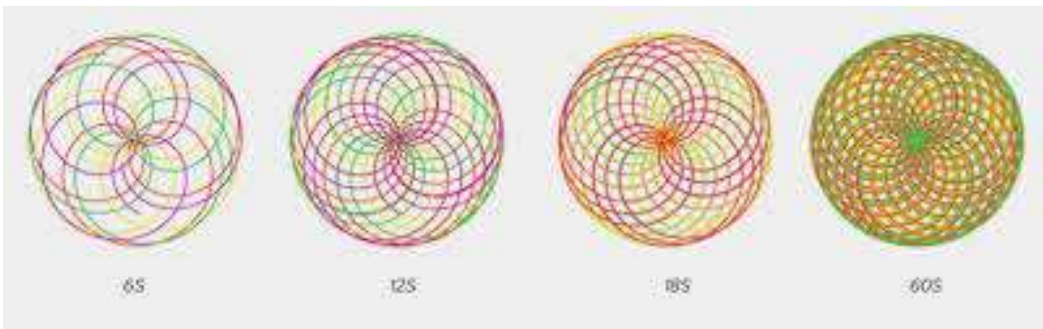
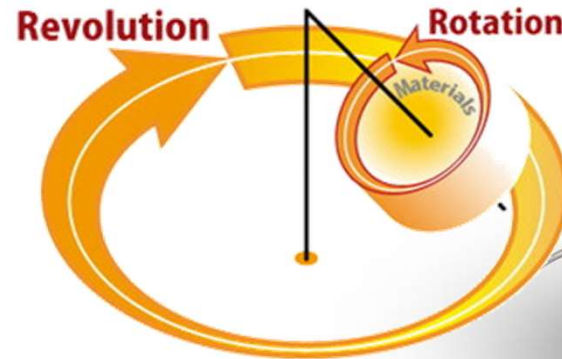
MIXING

Methods and machinery for preparing the samples, in lab or from the field



ORDINARY MIXERS

- Revolving actions
- Planetary



ORDINARY MIXERS

- Heaters



PAVEMIX - ASPHALT LABORATORY MIXER

- Automatic Mixing process
- Large 32 liters capacity
- Strict Temperature Control
- Quick/efficient mixing, avoids Mechanical aggregates degradation
- EN 12697-35, ASTM D6307
AASHTO TP53



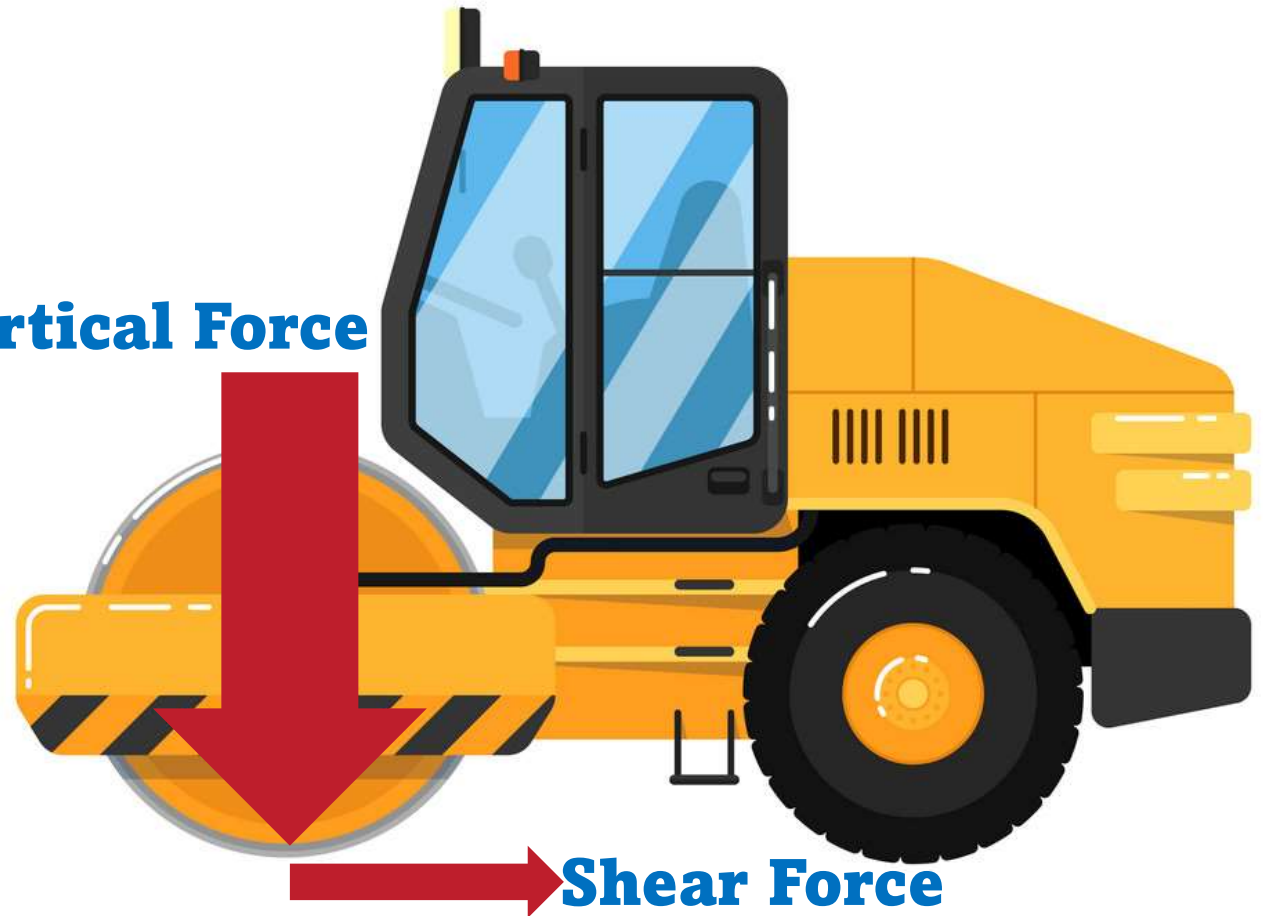
FIELD COMPACTION

We normally use a roller compactor, after paver screed.

Vertical Stress is caused by the weight of the roller to the gravity load

Horizontal Stress caused by the acceleration and /or Retardation, lifting, pulling, maximum torque and towing, steering load.(Mohamed 2005)

Vertical Force



Shear Force

LABORATORY COMPACTION

California Kneading Compactor –Hveem (James Cox & Sons 2023)

Compacts the sample by applying some pressure using a foot and then rotates



Marshal Compactor

Compacts the sample by falling of a weight from a certain height



Gyratory Compactor

Compacts sample by applying vertical force while the direction angle of the load varies during the



Roller Compactor

Applies the vertical load using a roller can resemble the road compaction



TEST PARAMETERS

California Kneading Compactor –Hveem (James Cox & Sons 2023)

Number of pushes,

Angle between tamping's



Target/Outputs:

No live density

Marshal Compactor

Number of the blowing



Target/Outputs:

No Live density

Gyratory Compactor

Vertical Force

Gyration
Angle, Speed, Number



Target/Outputs:

Height/Density

Shear/Vertical Force

Roller Compactor

Applies the vertical load using a roller can resemble the road compaction



Target/Outputs:

Height/Density

Vertical Force

HISTORY OF MIX DESIGN



1890

- **Barber Asphalt Paving Company**
- Asphalt cement 12 to 15% / Sand 70 to 83% / Pulverized carbonite of lime 5 to 15%

1905

- **Clifford Richardson, New York Testing Company**
- Surface sand mix: 100% passing No. 10, 15% passing No. 200, 9 to 14% asphalt
- Asphaltic concrete for lower layers, VMA terminology used, 2.2% more VMA than current day mixes or ~0.9% higher binder content

1920s

- **Hubbard Field Method** (Charles Hubbard and Frederick Field)
- Sand asphalt design
- 30 blow, 6" diameter **with compression test (performance)** asphaltic concrete design (Modified HF Method)

Stability

1927

- **Francis Hveem** (Caltrans)
- Surface area factors used to determine binder content; **Hveem stabilometer and cohesionmeter** used
- Air voids not used initially, mixes generally drier relative to others, fatigue cracking an issue

Stability + Durability

1943

- **Bruce Marshall**, Mississippi Highway Department
- Refined Hubbard Field method, standard compaction energy with drop hammer
- Initially, only used air voids and VFA, VMA added in 1962; **stability and flow utilized**

Stability + Durability

1993

- **Superpave**
- Level 1 (volumetric)
- Level 2 and 3 (performance based, but **never implemented**)

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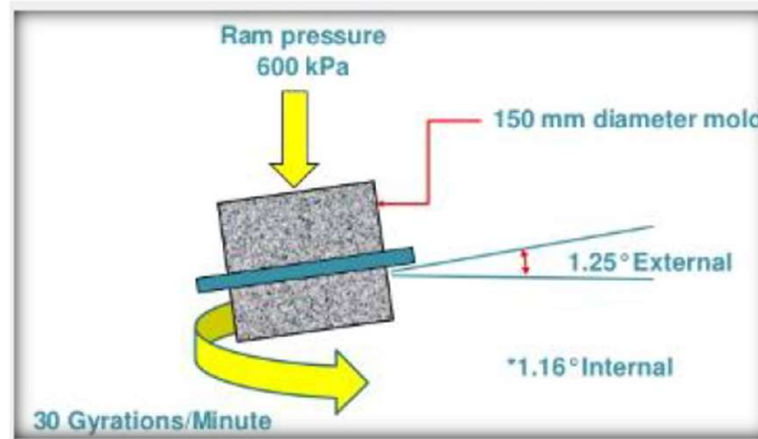
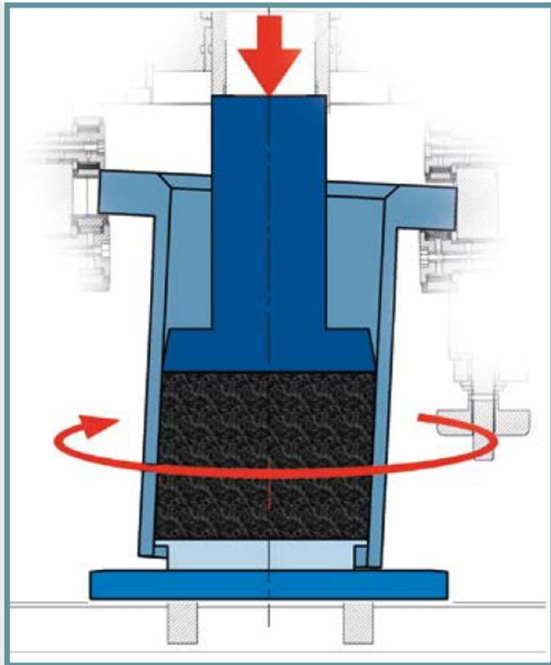
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<http://asphaltmagazine.com/history-of-asphalt-mix-design-in-north-america-part-2/>



GYRO RESEARCH - ELECTROMECHANICAL



- It maintains vertical stress
- While an unbalanced system causes gyrations to a certain angle

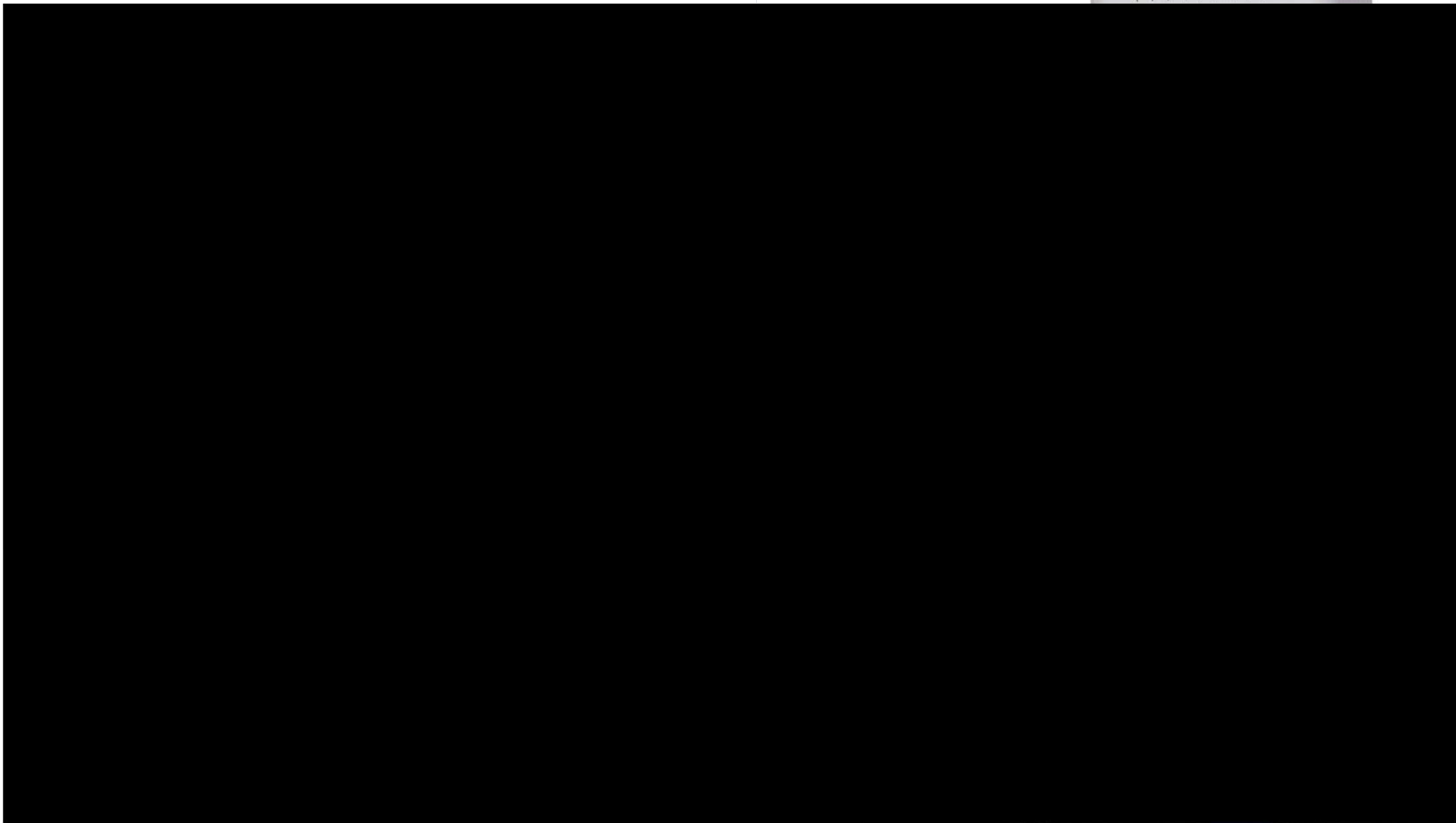


GYRO RESEARCH - ELECTROMECHANICAL

- Meets International Standards
- Meets Superpave Principals
- Shear Stress Measurement
- Comes with Balance
- Extruder Included
- Better specimen length coverage
- Fantastic Gyration Angle Accuracy
- Automatic Flattenning Cycle



GYRO RESEARCH - ELECTROMECHANICAL



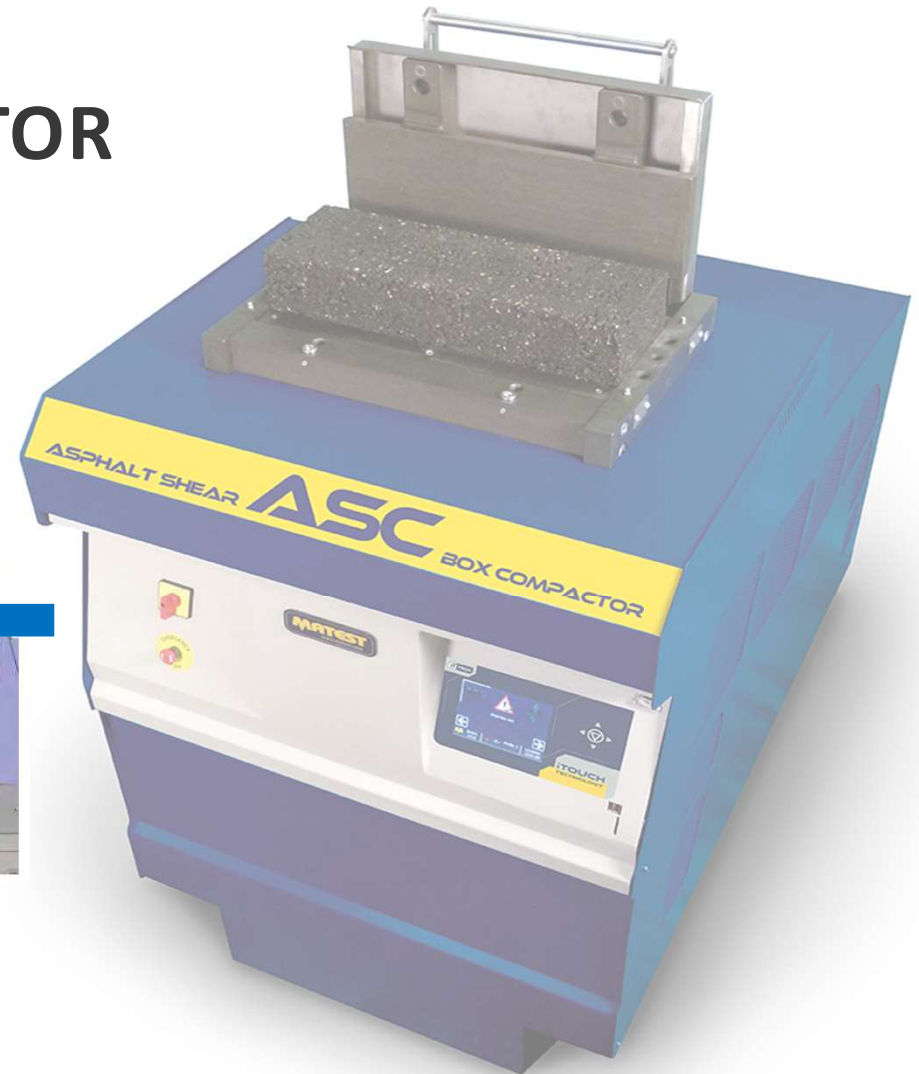
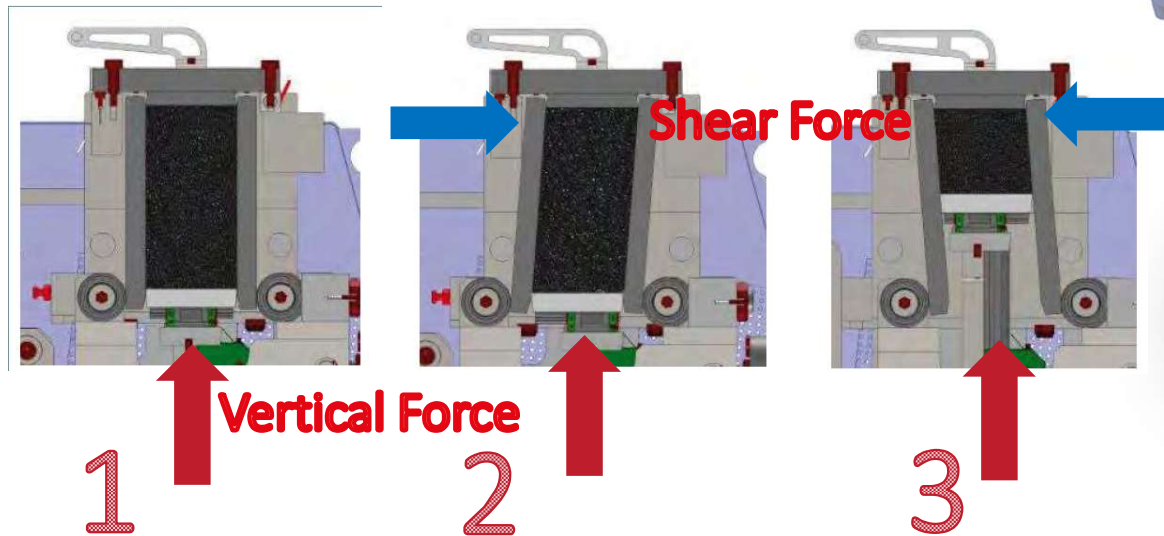
ASPHALT SHEARBOX COMPACTOR ELECTROMECHANICAL

Usually in Laboratories we try to produce samples like the field, or to make something with controlled properties for the design



ASPHALT SHEARBOX COMPACTOR ASTM D7981-15

How does it work?



ASPHALT SHEARBOX COMPACTOR

Test End Conditions:

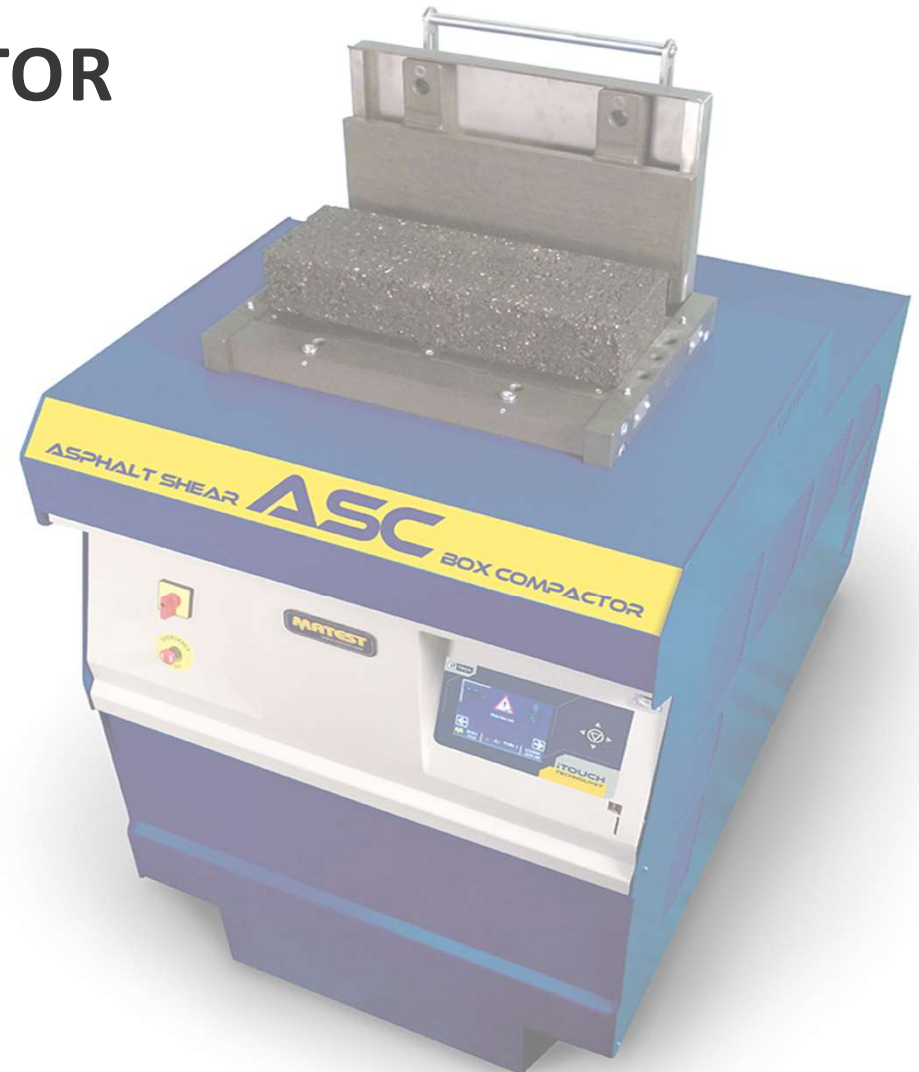
- Number of Cycles
- Height
- Density

Applies(Controls):

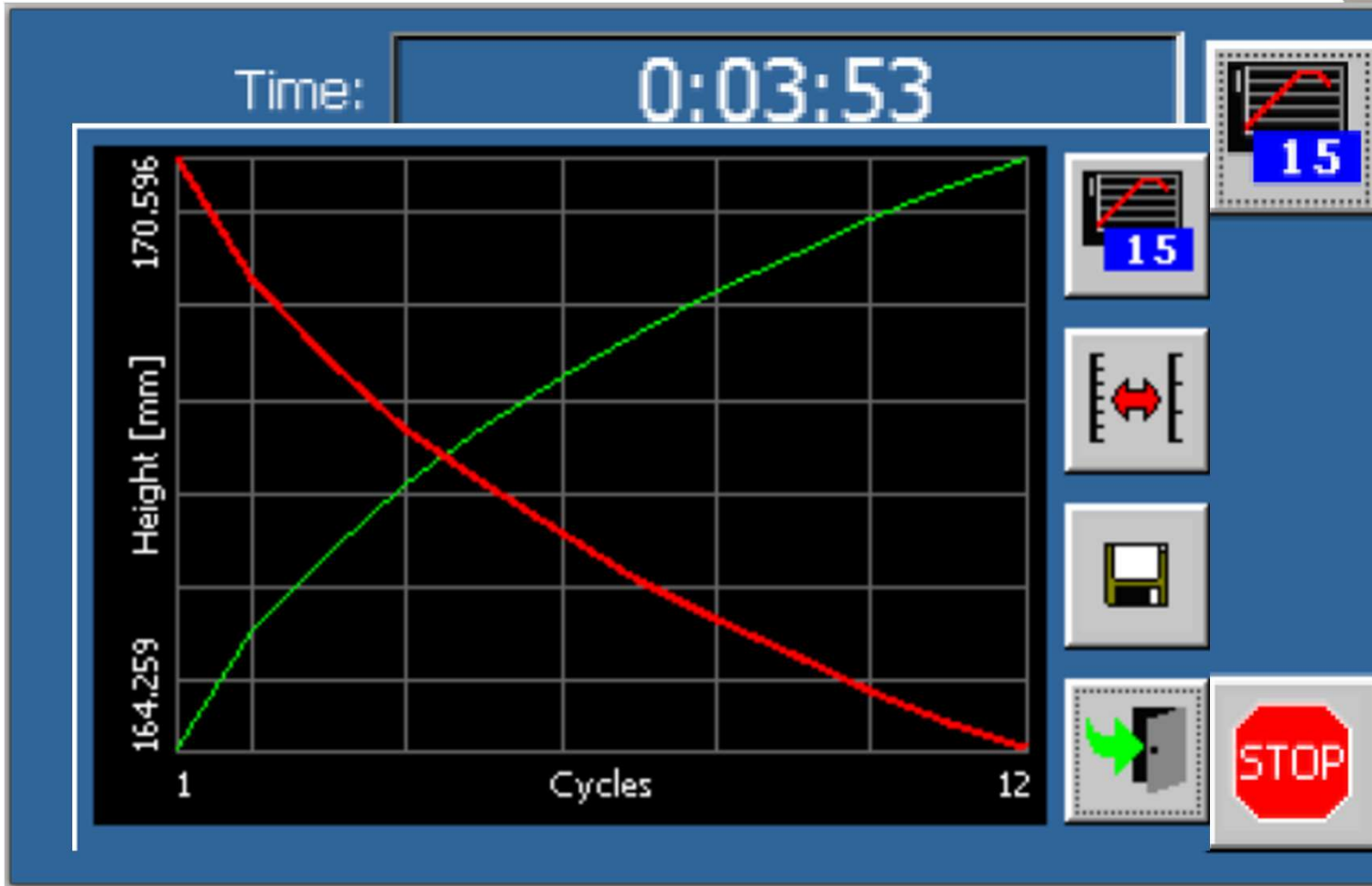
- Vertical Force & Horizontal Force
- Angles
- Temperature

Measures:

- Vertical Force (Horizontal Force Option)
- Number of Cycles
- Height
- Density



ASPHALT SHEARBOX COMPACTOR



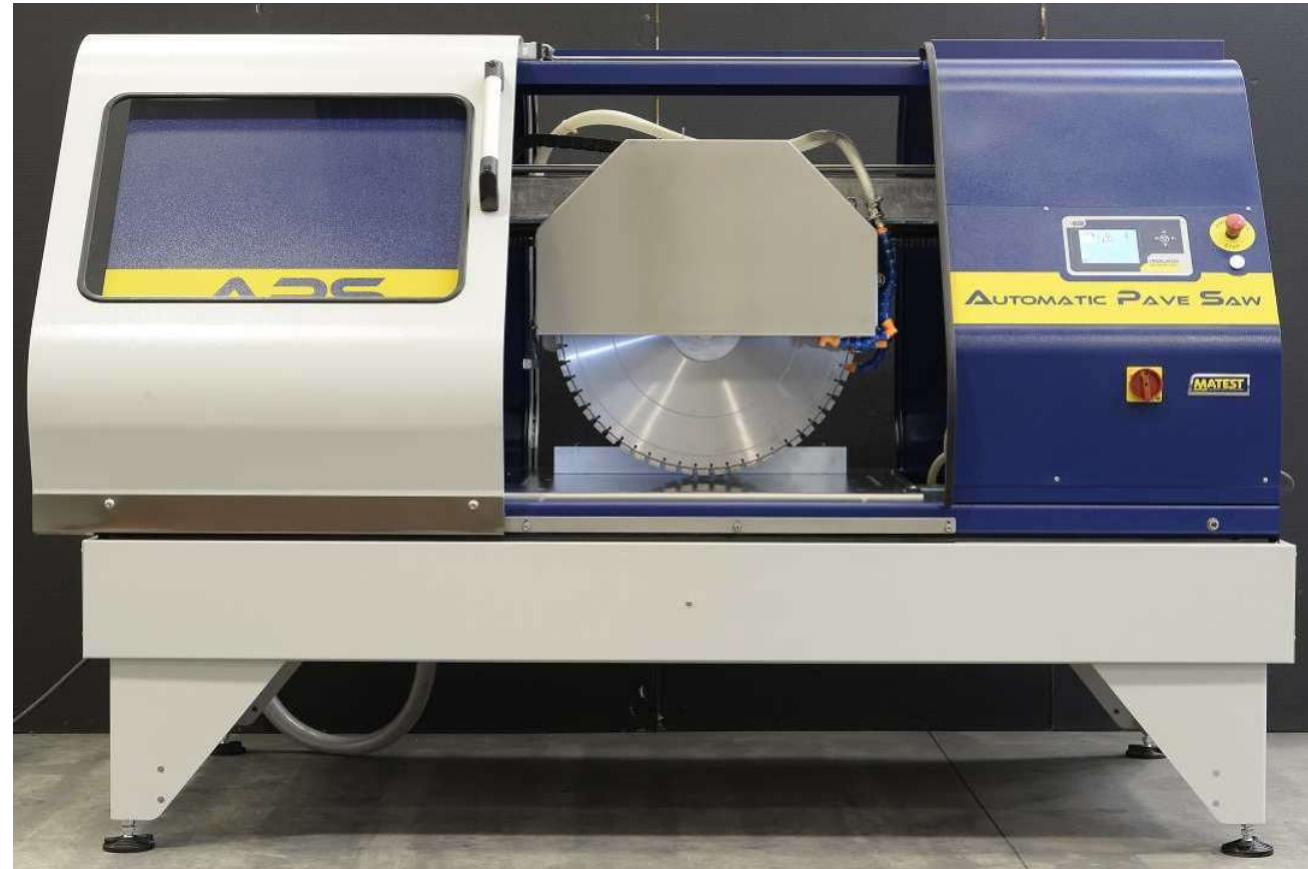
APS - AUTOMATIC PAVE SAW

- fully automated asphalt sawing system
- fast and accurate cutting
- rectangular beams
- trapezoidal prisms
- overlay test specimens
- semi-circular specimens
- trimming of cylindrical specimens



APS - AUTOMATIC PAVE SAW

- cutting prismatic specimens up to 200mm high, fast and accurate cutting
- cutting length up to 500mm trapezoidal prisms
- cylindrical specimens up to 150 mm diameter semi-circular specimens



AUTOMATED CORE DRILL (ACD)

- fast, accurate cutting of cores
- can take cores from cylinders, prisms and slabs
- Three selectable drill speeds
- Clear protective/splash
- Includes water container
- Adjustable specimen clamp



AUTOMATED CORE DRILL (ACD)

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- Adjustable specimen clamp



PAVEMENT CORE DRILLING MACHINE

- Portable
- Vertical screw feed
- Petrol Engine
- 5HP power



STS-25 STATIC TESTING SYSTEM

- Rigid two column load frame
- 25 kN electro-mechanical actuator (30 mm stroke)
- 8 channel Control and Data Acquisition System (CDAS) & TestLab software
- Temperature range:-40 to 80 °C
- Load cell (± 30 kN)
- 30 mm actuator LVDT
- accurate loading rates up to 50mm/minute
- Overlay, SCB, DCT, TSRST and DT.T.



WE NEEDED A NEW DESIGN METHOD BECAUSE

- **Problems:**

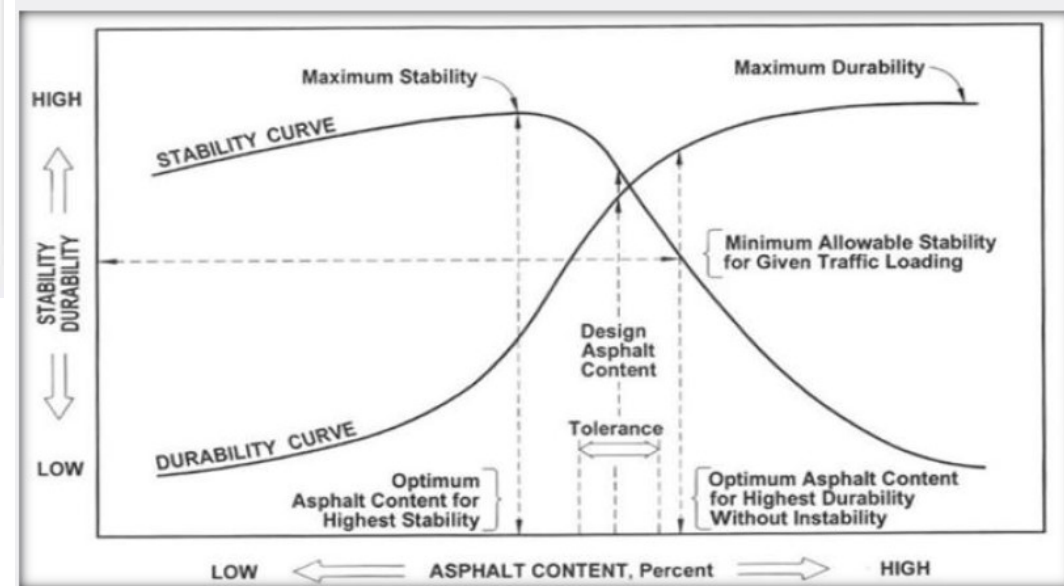
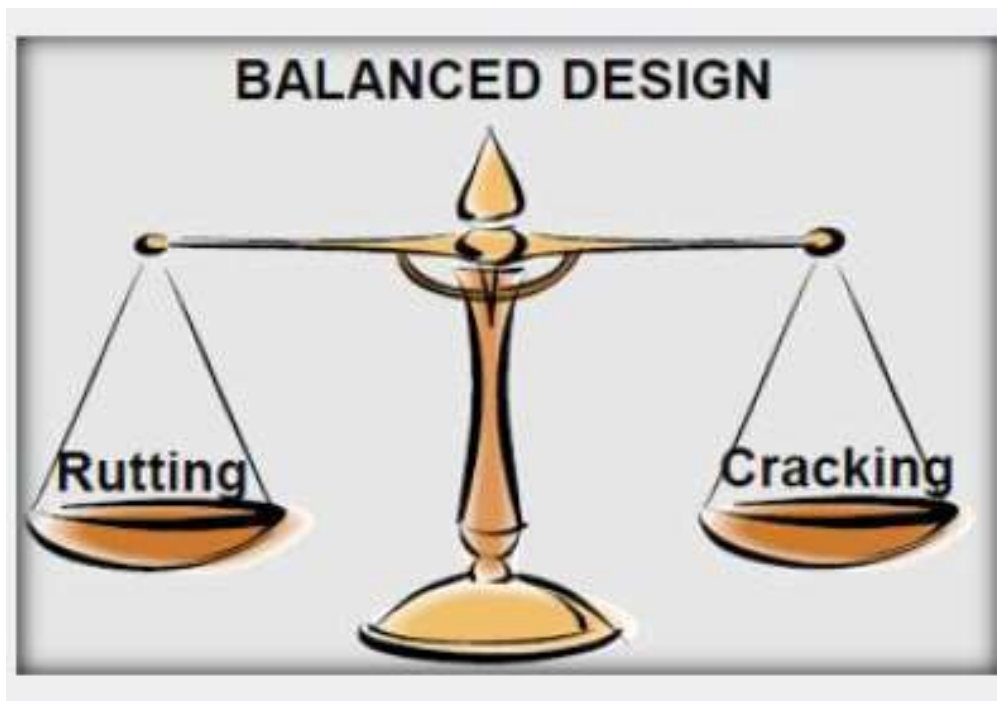
- Dry mixes exist in some areas.
- Volumetrics alone can not adequately evaluate mix variables, such as recycle, warm-mix additives, polymers, rejuvenators, and fibers.

- **Solutions:**

- **Recognize performance issues** related to dry mixes in some areas. (Note: Many performance issues are caused by factors outside the mix design.)
- **Increase understanding** of the factors which drive mix performance
- **Design for performance** and not just to “the spec”.
- **Start thinking** outside of long held “rules and constraints”
- **Innovate!**



BALANCED MIX DESIGN



MOST COMMON PERFORMANCE TESTS (RUTTING & CRACKING)

Rutting Tests

- Rutting can be evaluated with several available tests based on the user preference.



Hamburg Wheel Test (HWT)



Asphalt Pavement
Analyzer (APA)



AMPT Flow Number

MOST COMMON PERFORMANCE TESTS (RUTTING & CRACKING)

Fatigue (Bottom Up or Top Down) Related Cracking Tests

Bottom Up



Bending Beam Fatigue

Bottom Up



Texas Overlay Test

Bottom Up /
Top Down



SCB
- LTRC – Jc
- IFIT

Bottom Up



Direct Tension Cyclic
Fatigue, S-VECD

MOST COMMON PERFORMANCE TESTS (RUTTING & CRACKING)

Thermal Cracking Tests



IDT Creep
Compliance



TSRST



SCB at Low Temp



Disk Shaped Compact
Tension (DCT)

MOST COMMON PERFORMANCE TESTS (RUTTING & CRACKING)

Reflection (Reflective) Cracking Tests



Disk Shaped Compact
Tension (DCT)



Texas Overlay Test



SCB (IFIT)

PERFORMANCE BASED TESTS



DTS

DYNAMIC TESTING SYSTEM



AMPT

ASPHALT MIX PERFORMANCE TESTER



TSRTS

THERMAL STRESS RESTRAINED SPECIMEN TEST



CYCLIC TRIAXIAL TEST

FOR UNBOUND MATERIAL



CREEP TEST

FLOW TIME AND FLOW NUMBER



IDTM

INDIRECT TENSILE MODULUS



OVERLAY TEST

SUSCEPTIBILITY TO CRACKING

STAND-ALONE SERVO-PNEUMATIC FOUR POINT BENDING SYSTEM (4PB)

- Accurate loading wave shapes up to 60 Hz
- haversine or sinusoidal wave shapes
- Stress control/strain control mode
- Measures flexural stiffness and modulus
- ± 5 kN load Capacity
- 10mm max deformation range





SMARTTRACKERTM

ITS SMART DESIGN IS JUST THE BEGINNING

CONTENTS

1. Hamburg Wheel Tracker
2. Why the SMARTRACKER™ ?
3. Advantages for the end user



SmarTracker™ - Hamburg wheel tracker

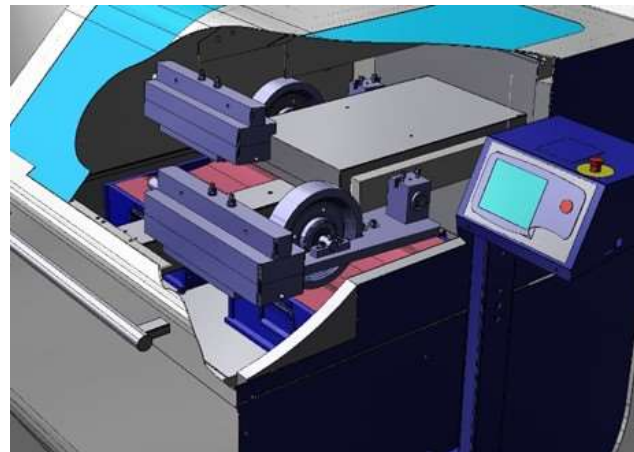
The Hamburg Wheel Tracking Device - HWTD is used to determine the rutting resistance of an asphalt mix sample. The cyclic movement of the wheels simulates the effect of traffic load on the pavement.



SMARTRACKER™ - HAMBURG WHEEL TRACKER

Tests can be carried out in water and/or air (wet/dry tests) simultaneously at a predetermined temperature.

When carried out in water, tests also determine the **moisture sensitivity** of the asphalt over time.



SMARTRACKER™ - HAMBURG WHEEL TRACKER

EN 12697-22

- Three types of machine: extra-large, large and small
- Conditioning in air or water (wet/dry tests)
- Uses samples prepared in the laboratory or taken from site
- Tests cylinders or slabs
- Rubber wheel
- Two test methods: A and B

AASHTO T324

- Conditioning in water (wet test)
- Tests cylinders and/or slabs
- Uses samples prepared in the laboratory and/or taken from site
- Steel wheel
- Two test methods: manual and automatic
- Stripping inflection point calculation



SmarTracker™ - Hamburg wheel tracker

Goals

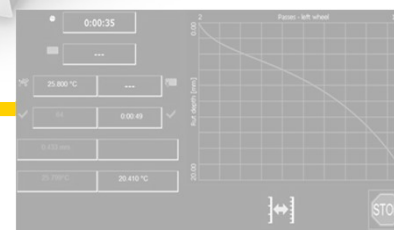
- Carrying out independent tests
- Simultaneous testing - Water and air (wet/dry)
- Comfort and ease of use
- Limited footprint



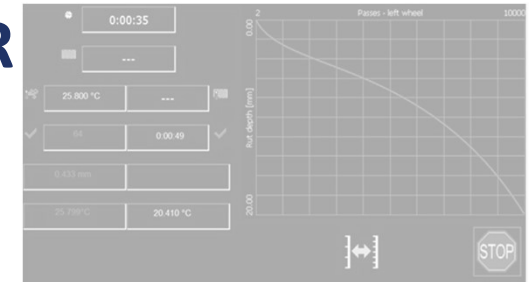
SMARTTRACKER™ - HAMBURG WHEEL TRACKER – ROLL-OFF MECHANISM



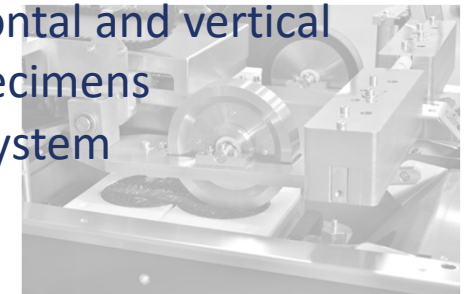
- Patented roll-off mechanism for wheel loading
- Automatic positioning in test start conditions
- Automatic retraction of wheel load mechanism at end of test back to starting position
- Possibility of adjusting the wheel speed separately
- Interchangeable Wheels EN - ASTM
- Independent wheel movement



SMARTRACKER™ - HAMBURG WHEEL TRACKER

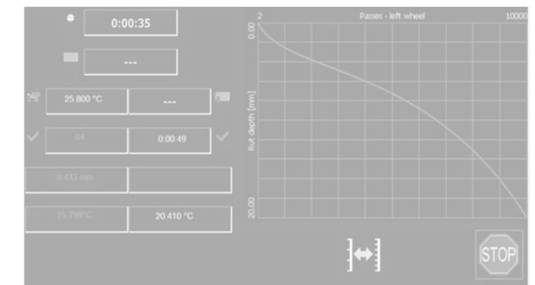


- Interchangeable moulds according to the reference standard EN - ASTM
- Variation of dimensions of the moulds through the use of horizontal and vertical adapters for different specimens
- Easy mould positioning system



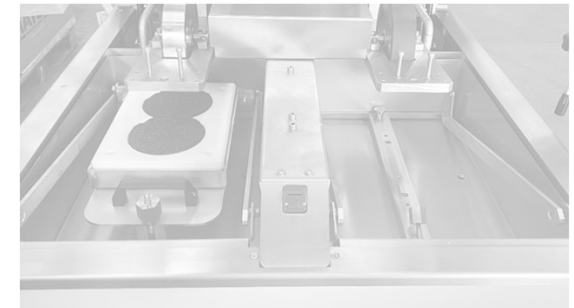
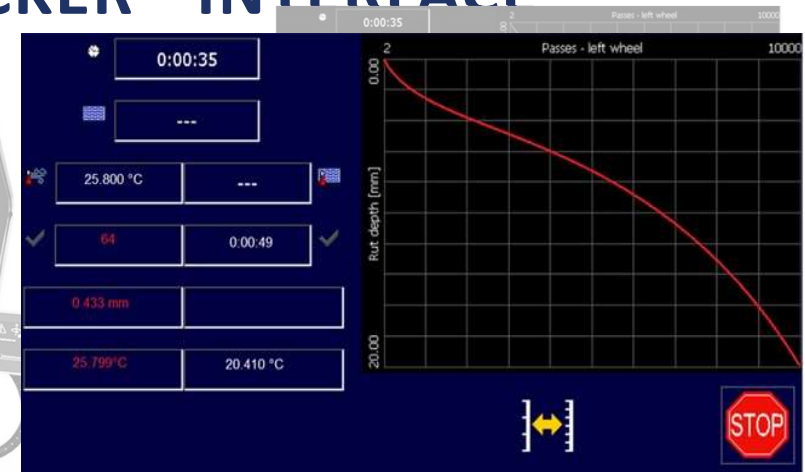
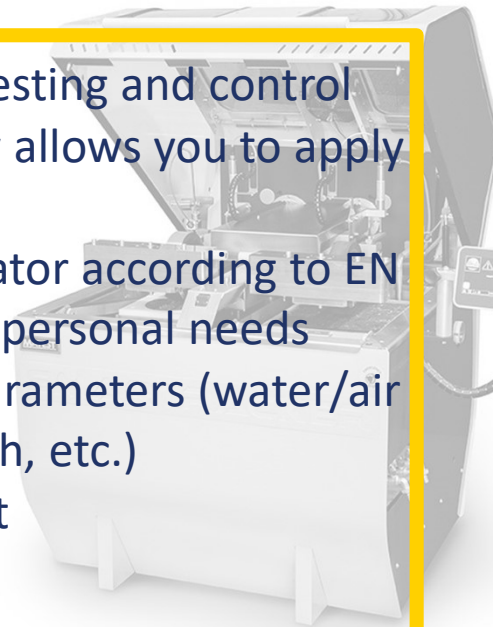
SMARTRACKER™ - HAMBURG WHEEL TRACKER - TANKS

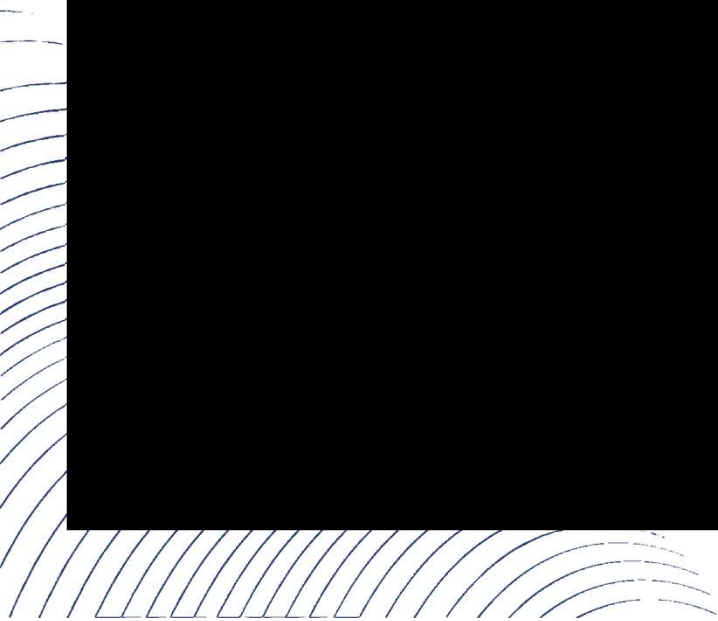
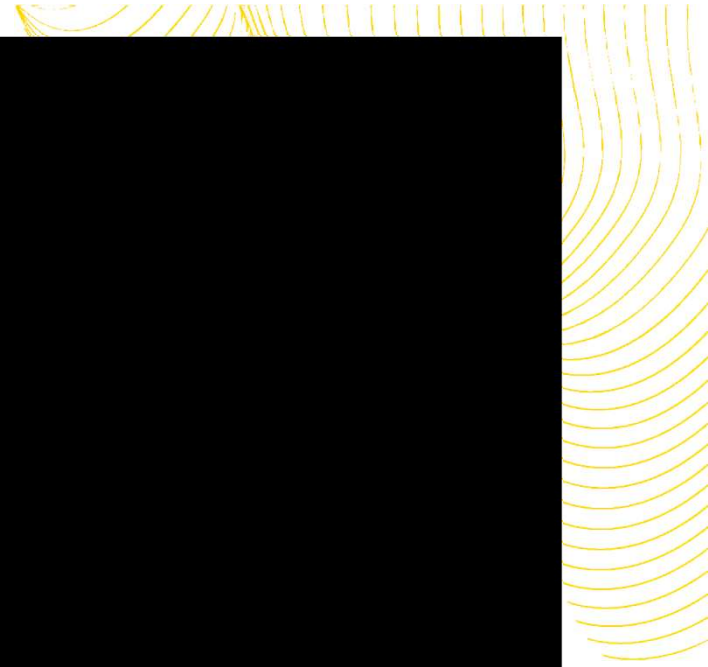
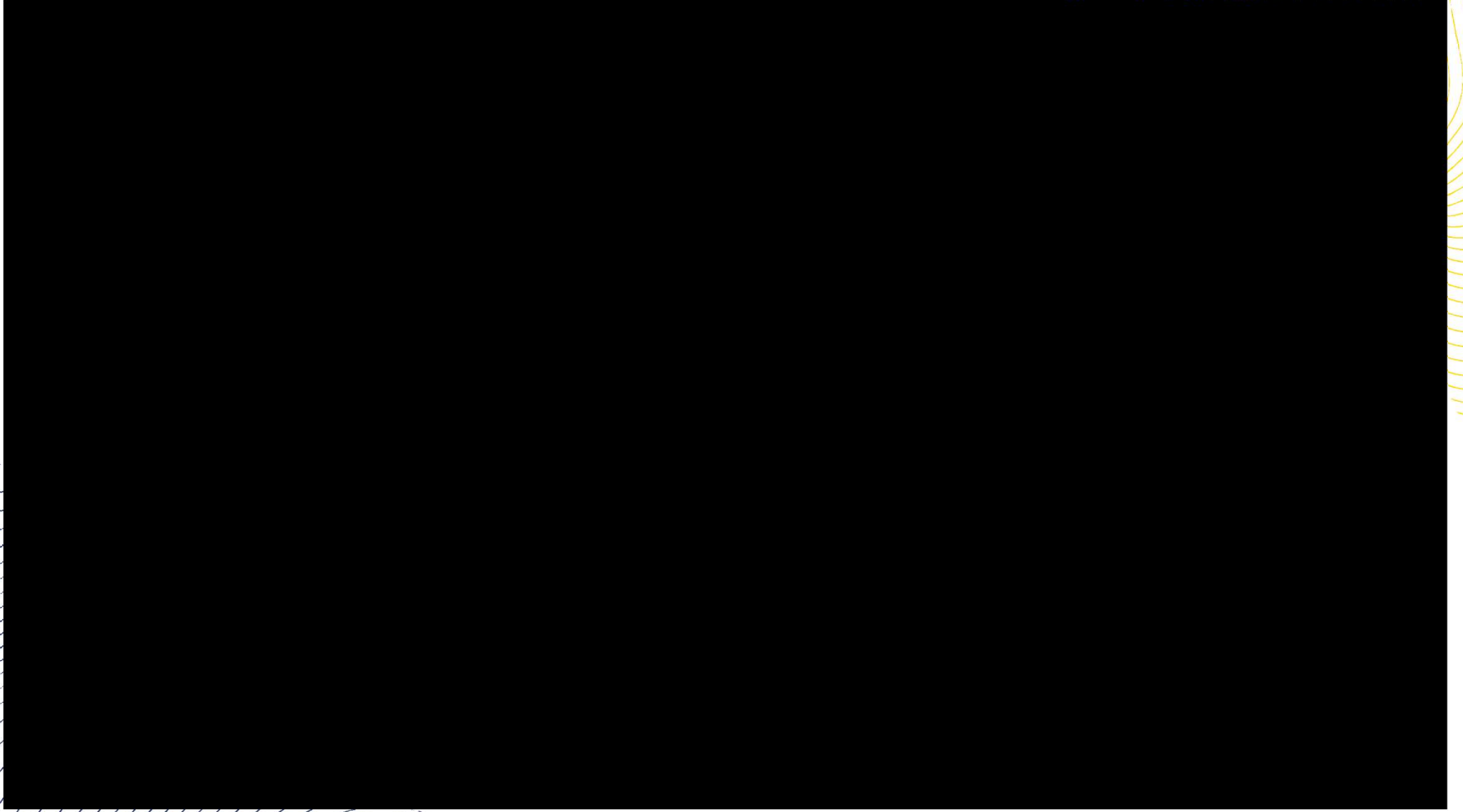
- Independent tanks for tests in water and air
- Filling of tanks with water controlled by solenoid valve
- Water recirculation system with temperature control within ± 1 °C.
- Independent water emptying system
- Air heating system, using resistors for test temperatures up to 75°C
- Water corrosion-resistant materials used
- Easy accessibility for cleaning and maintenance



SMARTTRACKER™ - HAMBURG WHEEL TRACKER - INTERFACE

- 7" touch-screen for real-time testing and control
- Cyber Plus Progress technology allows you to apply a load with a perfect sine wave
- Fully customizable by the operator according to EN and AASHTO Standards and/or personal needs
- Real-time monitoring of test parameters (water/air and specimen T°C, rutting depth, etc.)
- Transfer of results in .txt format





BINDER CONTENT



CENTRIFUGE EXTRACTOR BINDER CONTENT FURNACE

USES SOLVENT TO EXTRACT
BINDER FROM AGGS.



BURNS BITUMEN TO OBTAIN
THE %



ASPHALT MIX ANALYSER(AMA)

MULTIPLE STAGE PROCESS TO EXTRACT BINDER

1. AMA - Asphalt Mix Analyzer
2. Why AMA? - Improvements
3. End User's Advantages



AMA - ASPHALT MIX ANALYZER



Automatic bitumen extractor

Automatic, hermetic, closed circuit system



Goals

- Eliminate several test steps
- Reduce test times
- Eliminate the risks related to the use of solvent
- Give the user the option to store the test results
- Easy to use

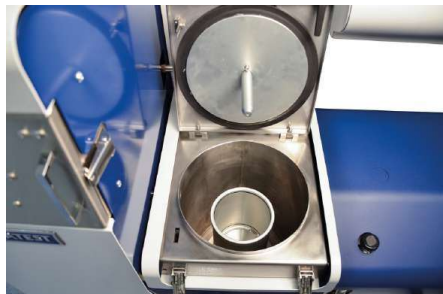
AMA - ASPHALT MIX ANALYZER



WASHING CHAMBER



INTERFACE

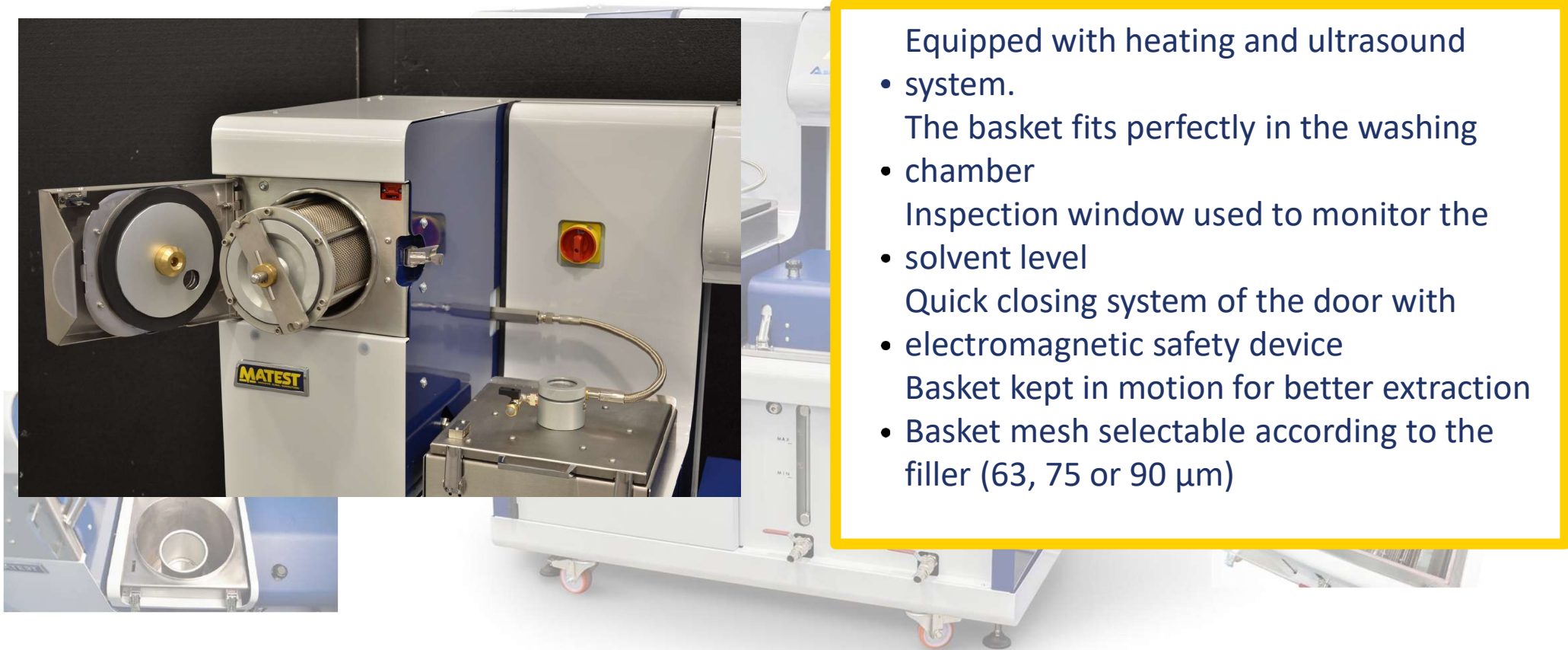


CENTRIFUGE



DISTILLER

AMA - ASPHALT MIX ANALYZER



- Equipped with heating and ultrasound system.
- The basket fits perfectly in the washing chamber
- Inspection window used to monitor the solvent level
- Quick closing system of the door with electromagnetic safety device
- Basket kept in motion for better extraction
- Basket mesh selectable according to the filler (63, 75 or 90 μm)

AMA - ASPHALT MIX ANALYZER



- High speed centrifuge action (8,000 rpm)
- Possibility of recovering up to 300g of filler
- Window on the cover to monitor the color of the solvent
- Quick closing system of the door with electromagnetic safety device

AMA - ASPHALT MIX ANALYZER

- Complete distillation of the solvent at the end of the test cycle
- 100% stainless steel to prevent corrosive phenomena
- 2 elements provided to choose the desired distillation level
- Spray nozzle for chamber cleaning
- temperature set at the factory according to the solvent used
- Heating elements with safety to prevent overheating
- Solvent level can be monitored from the outside



AMIA - ASPHALT MIX ANALYZER

- Stylized representation of machine components
- Monitoring of test parameters in real time
Possibility of modifying the parameters
- during the tests
Indication of the temperatures reached both in the washing chamber and in the
- distiller.
- Cycle phase indication
- Test time indication
Possibility to modify the heating element power during the test



AMA - ASPHALT MIX ANALYZER

Automatic bitumen extractor
EN 12697-01 - ASTM D8159

Automatic, hermetic, closed circuit system



Results:

✓ Eliminate several test steps

✓ Reduce trial times

✓ Eliminate risks associated with the use of solvent

✓ Give user the opportunity to store the results

✓ Easy to use

➔ Extraction and drying in a single machine

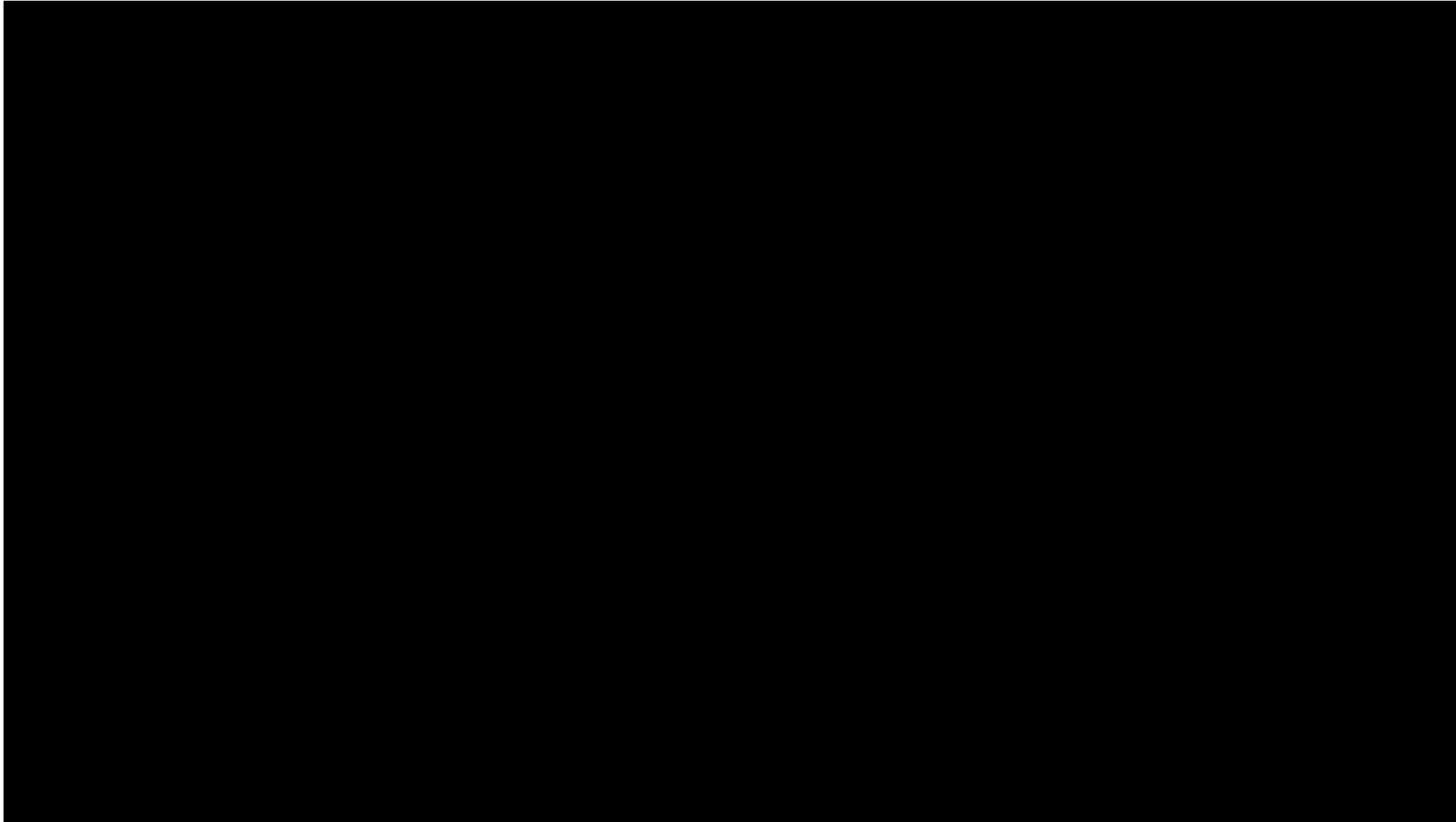
➔ Extraction and result in 1 hour (cycle function) with complete distillation of the solvent used

➔ Hermetic machine to avoid contact with the solvent

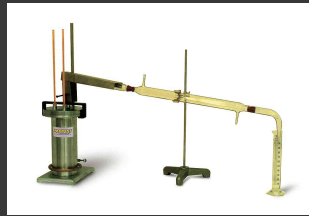
➔ Automatic calculation of bitumen content and storage of results in

➔ .txt files

User friendly



EMULSION BITUMEN TESTS



EMULSION DISTILLATION

DETERMINATION OF REMAINED BITUMEN



PARTICLE CHARGE

DETERMINE IF EMULSION IS ANIONIC OR CATHONIC



SAYBOLT VISCOSITY

MEASURING VISCOSITY OF EMULSION



BREAKING VALUE

BREAKING VALUE OF CATHONIC EMULSION



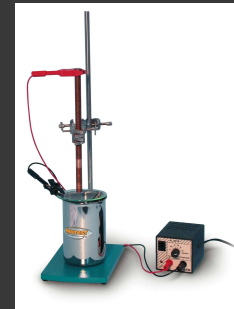
SIEVE RESIDUE

MEASURING KINEMATIC OR DYNAMIC VISCOSITY



WATER CONTENT

MEASURE AMOUNT OF WATER IN EMULSION



STORAGE STABILITY

ASSESSING STORAGE STABILITY

PG(PERFORMANCE GRADING) BITUMEN TEST SET



RTFOT OVEN TEST

ROLLING THIN FILM OVEN TEST



PAV

PRESSURE AGEING VESSEL



VDO

VACUUM DEGASSING OVEN



DSR

DYNAMIC SHEAR RHEOMETER



BBR

BENDING BEAM RHEOMETER



DTT

DIRECT TENSION TEST



RV

ROTATIONAL VISCOMETER

STANDARD TESTS BITUMEN TEST SET



PENETRATION TEST

MEASURES RESISTANCE AGAINST NEEDLE UNDER CERTAIN LOAD AT CERTAIN



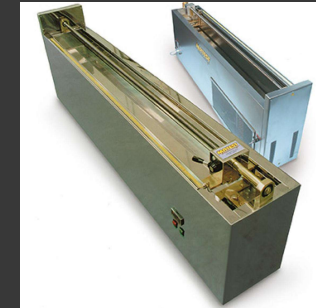
AUTO. RING AND BALL

MEASURING SOFTENING POINT OF BITUMEN



OPENCUP FLASHPOINT

MEASURING FLASH AND FIRE POINT OF BITUMEN



DUCTILOMETER

MEASURING DUCTILITY OF BITUMEN



VISCOMETER BATH

MEASURING KINEMATIC OR DYNAMIC VISCOSITY



TFOT

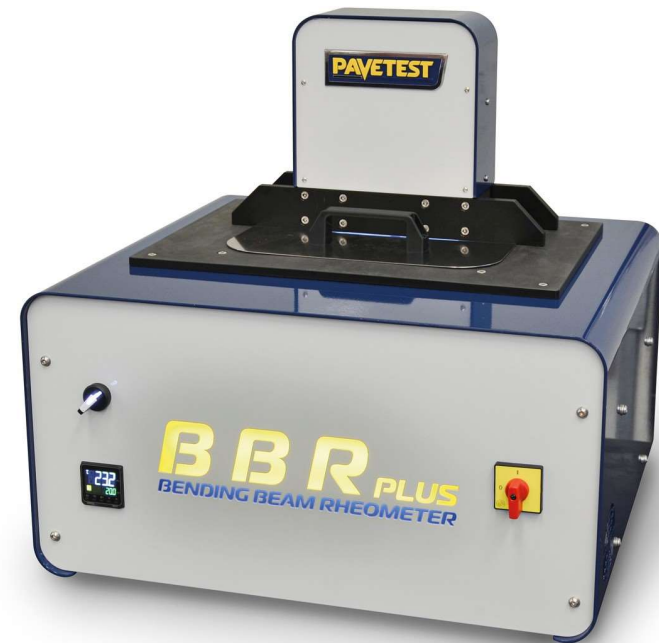
THIN FILM OVEN TEST



KINEMATIC & DYNAMIC VISCO

VISCOSITY TUBES

1. BBR Plus
2. Why BBR Plus? - Improvements
3. End User Benefits



BBR Plus – Bending Beam Rheometer

Bending Beam Rheometer

Servo-controlled system, developed for static and dynamic tests



Goals

- Eliminate the use of compressed air
- Eliminate frequent calibration
- Developing a research system also for dynamic tests
- Giving the user the possibility of generating dedicated test methods
- Easy to use in accordance with Test Standards

BBR Plus – Bending Beam Rheometer



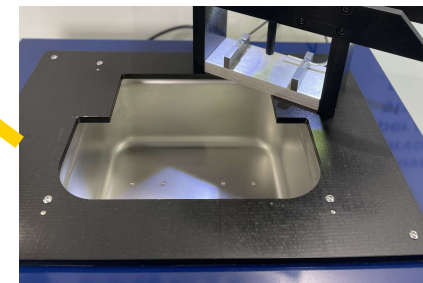
LOADING SYSTEM



CDAS-2 CONTROL UNIT

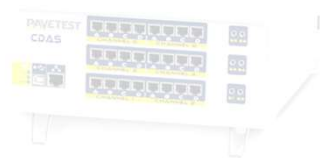


USER INTERFACE

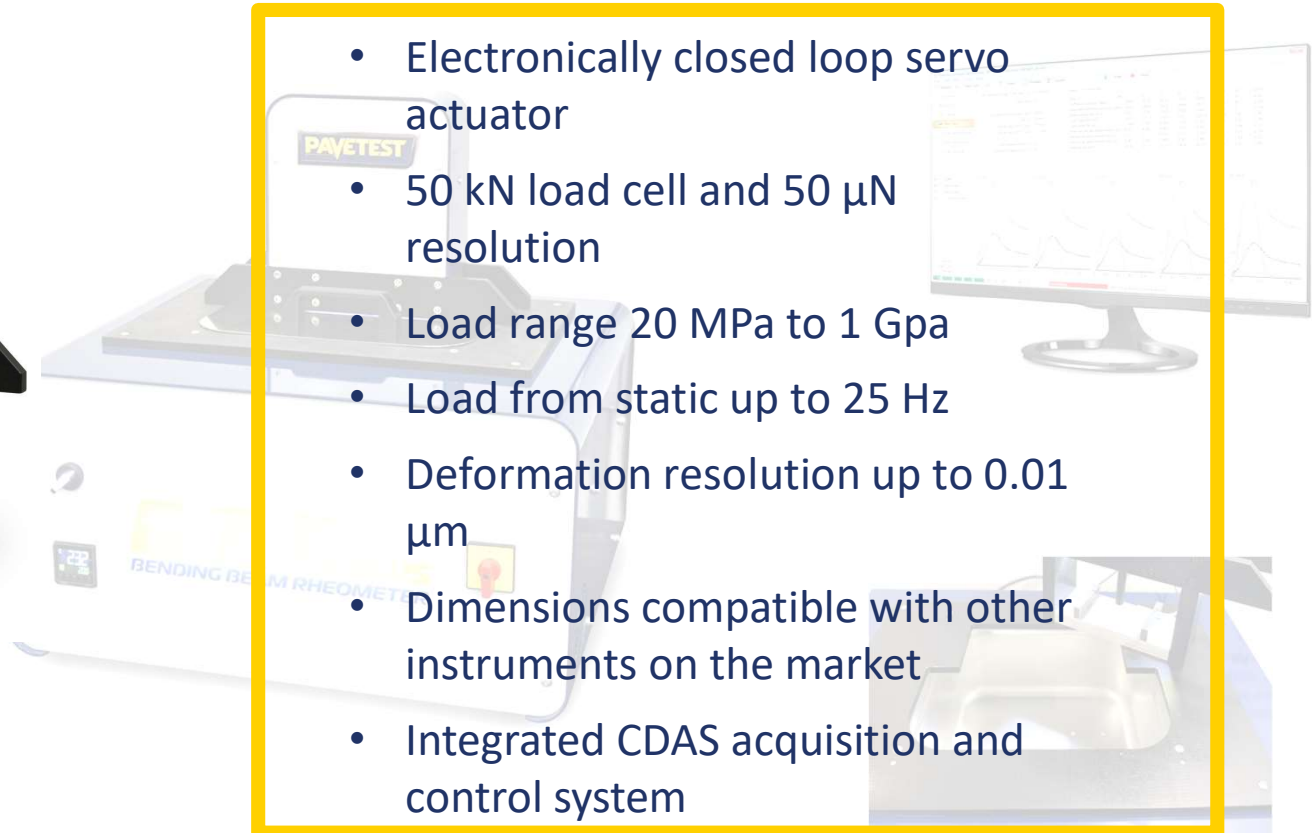


CLIMATIC CHAMBER

BBR Plus – Bending Beam Rheometer

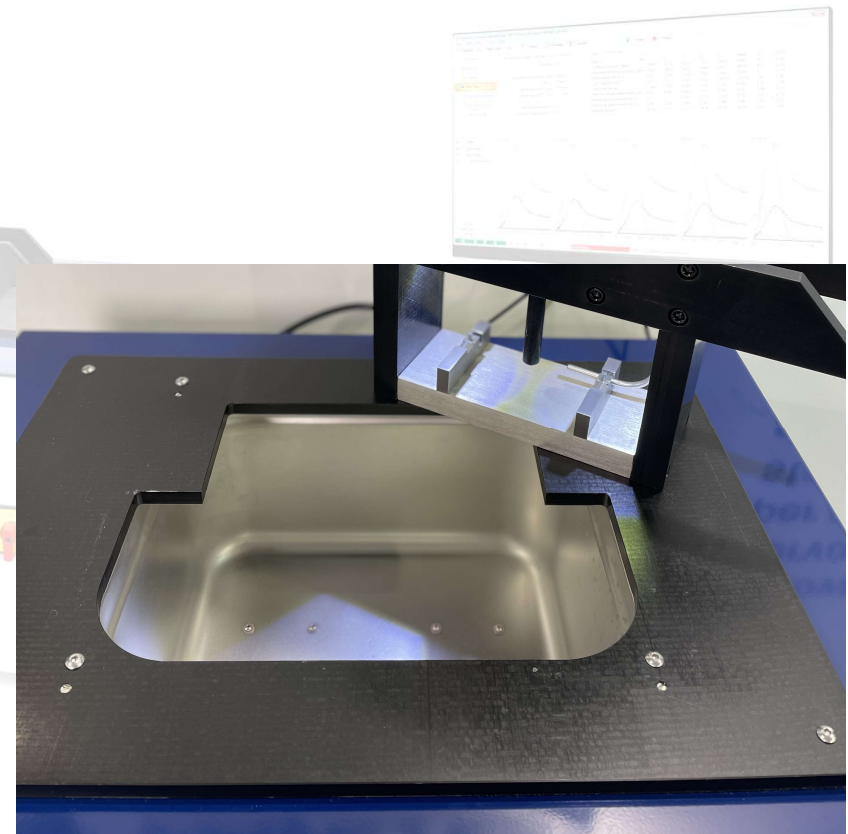


- Electronically closed loop servo actuator
- 50 kN load cell and 50 μ N resolution
- Load range 20 MPa to 1 Gpa
- Load from static up to 25 Hz
- Deformation resolution up to 0.01 μ m
- Dimensions compatible with other instruments on the market
- Integrated CDAS acquisition and control system

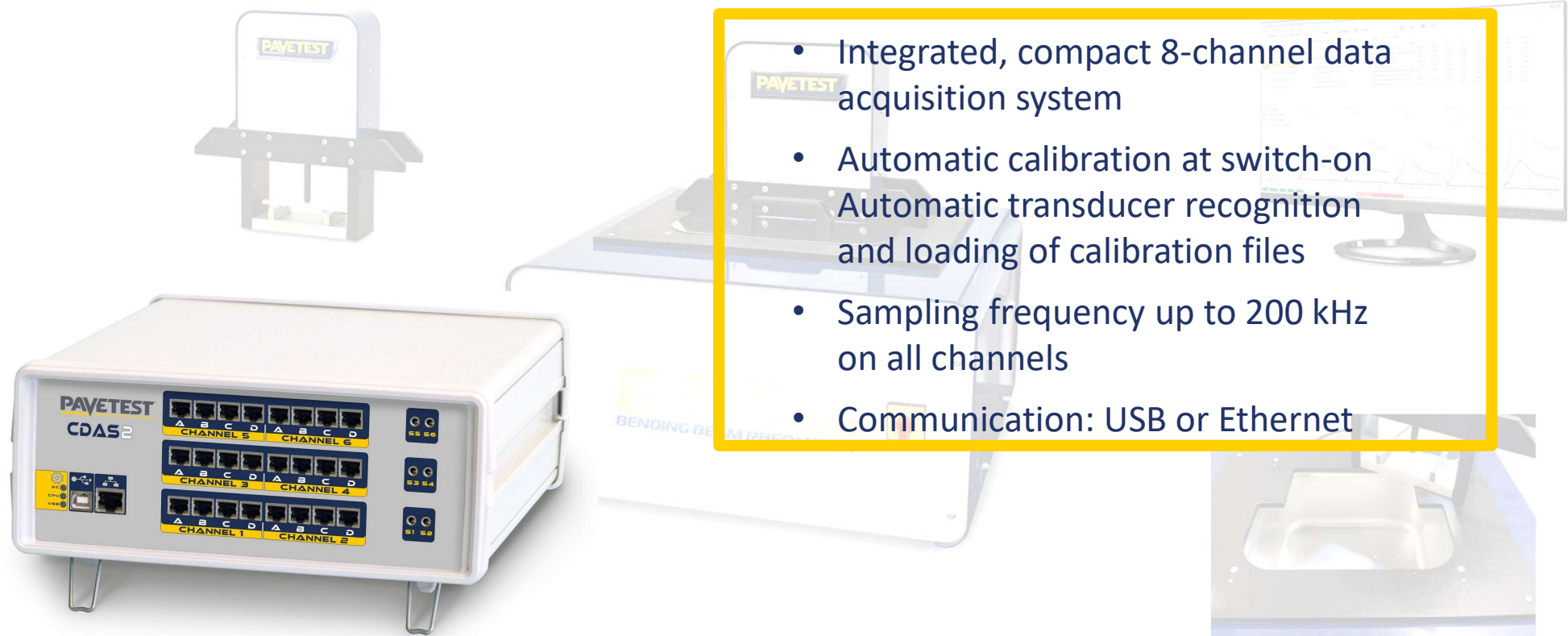


BBR Plus – Bending Beam Rheometer

- Integrated, self-contained bath allows cooling of samples using Ethanol
- Sufficient size for cooling several samples simultaneously
- Cooling system with Peltier cells
- Test temperature from ambient down to -40°C with $\pm 0.03^{\circ}\text{C}$ stability
- Temperature controlled by the bath itself or via TESTLAB software



BBR Plus – Bending Beam Rheometer



BBR Plus – Bending Beam Rheometer

- Pre-programmed 'Method files' according to EN/ASTM/AASHTO test methods
- Full access for advanced users to specify their own calculations, test results and graphs
- Ability to send raw data to Excel for processing and display of results in the software
- Setting/monitoring of bath temperature via software



BBR Plus – Bending Beam Rheometer



Results

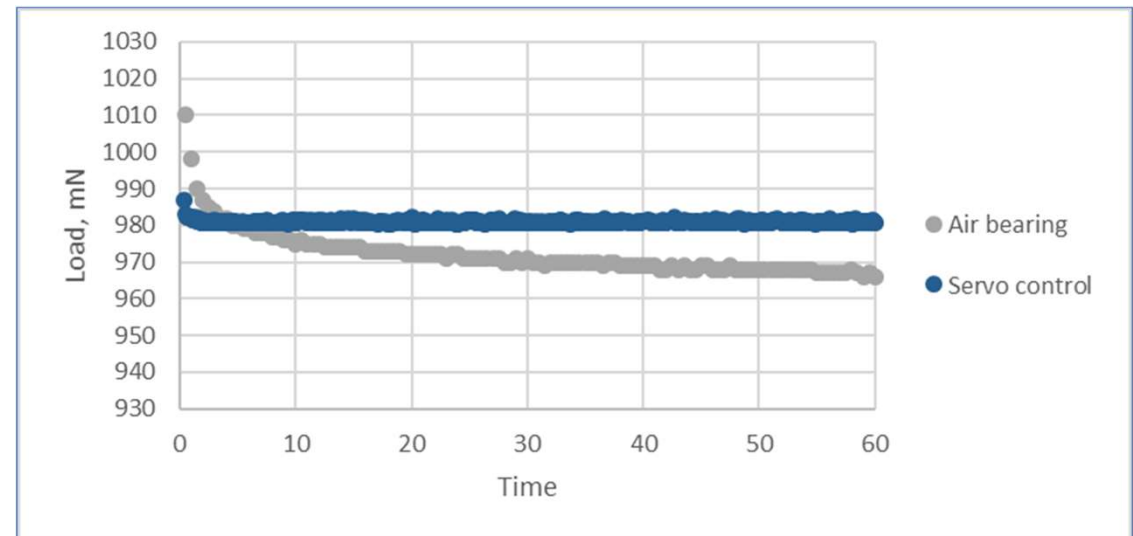
- ✓ • Eliminates the use of compressed air
 - ✓ • Eliminates frequent calibration
 - ✓ • Development of a research system also for dynamic tests
 - ✓ • Gives the user the possibility of generating dedicated test methods
 - ✓ • Easy to use in accordance with Test Standards
- Servo-controlled system
- Loading range from 20 MPa to 1 GPa, both static and dynamic, up to 25 Hz
- TESTLAB Software
- Method File complying with EN and AASHTO

Why BBR Plus?

Servo-controlled system

Stable load throughout the test, static or dynamic

- Superior stability to traditional air bearing system
- High sampling frequency and PID control for maximum accuracy
- Can be extended to dynamic tests up to a frequency of 25 Hz



Why BBR Plus?

Servo-controlled system

Always calibrated

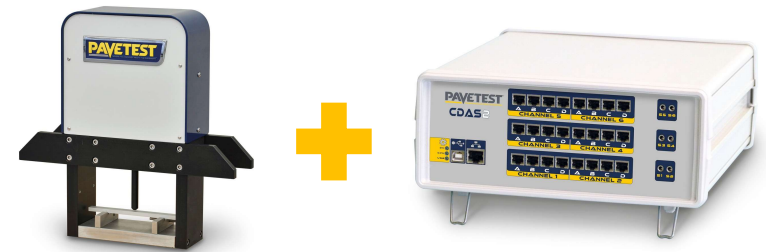
- Eliminate frequent calibration
- Automatic calibration at switch-on Automatic transducer recognition and loading of calibration files
- Calibration kit purchase option, easy to use



Why BBR Plus?

Existing instruments can be upgraded
The loading system is designed to be used in the upgrade
of existing climatic baths*

- Standardized design
- External data acquisition system can be supplied



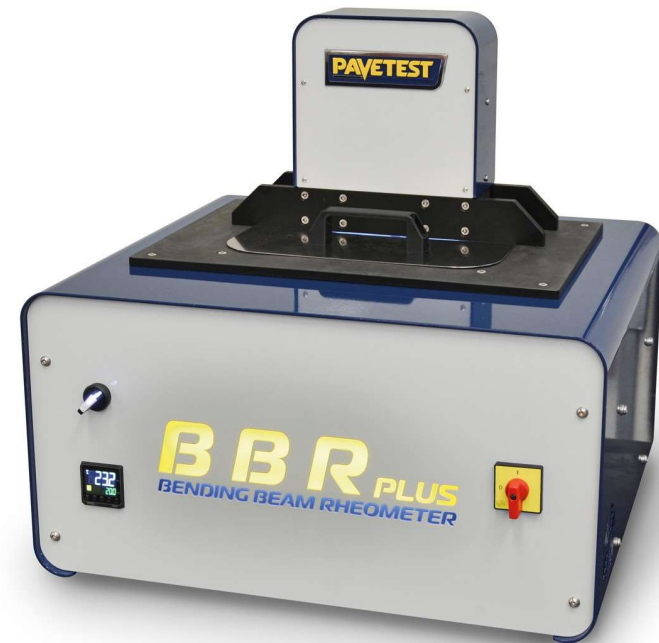
* Subject to verification with Matest technical department

Advantages

BBR Plus

Aimed at different types of laboratories

- Construction management/concessionary laboratories
- Control laboratories
- Universities



Advantages

Construction management/concessionary laboratories
Design checks and installation according to the latest regulations

- Regulatory compliance for PG Grade determination of bitumen
- Ease of use and repeatability of results
- Investigating Binder Performance Superior to Today's P.A. and Penetration Tests



Advantages

Control laboratories

Providing a better service to its customers

- Comprehensive offer also for special projects or experimental analyses
- Thorough investigation for the use of additives
- Ease of use and repeatability of results

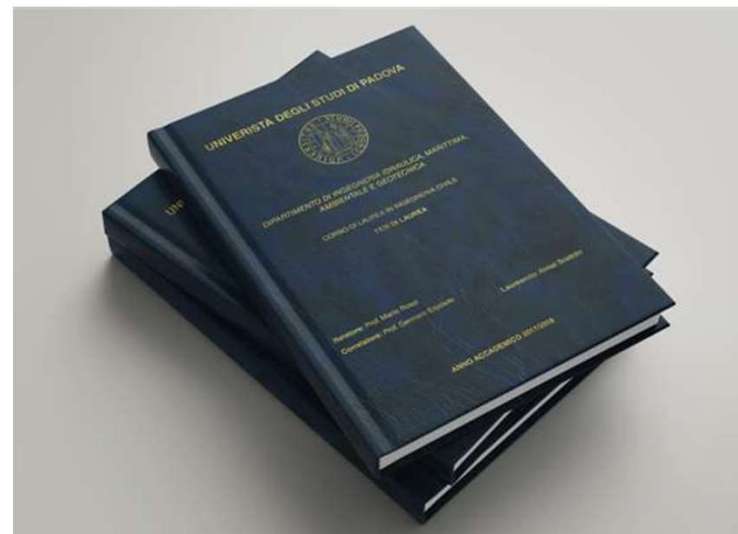


Advantages

Universities

Research and testing of new technologies for use in bitumen

- Possibility of both static and dynamic tests
- Customisation of the test
- Experimental new technologies survey
- Ease of use and repeatability of results



How does SmartLab work?



What is SmartLab?



- It is software to be installed on a computer based on the MS Windows operating system.
 - The computer on which it is installed acts as a server, if connected to the **Internet** it allows access to SmartLab via other devices connected to the Internet via a browser (e.g. other PCs, tablets)
 - It consists of a basic module (not coded in the price list because it is supplied with any test module) which serves to put computers and test machines in bidirectional communication, and of numerous application-specific test modules (individually coded in the price list)
 - The test modules provided are many, will be made available and constantly enriched over the years.
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REFERENCES

- Mohamed, A. (2005). Load Calculation and Simulation of an Asphalt Roller.
- Shane Buchanan, (2017) Oldcastle Materials, Balanced Mix Design of Future
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