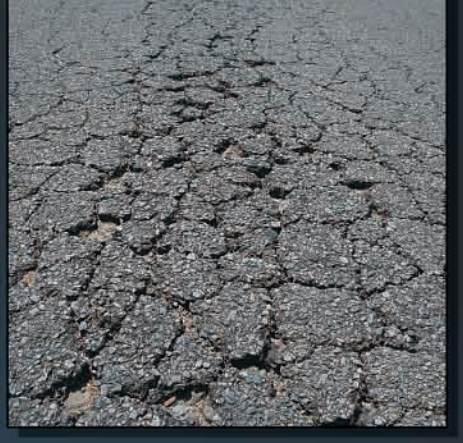
CSA II
Asphalt Rheometer

...A robust
reliable DSR for
Characterization of
Asphalt Binders



TA Instruments
Thermal Analysis & Rheology
A Subsidiary of Waters Corporation

Characterization of Asphalt Binders

Historically, asphalt characterization was based on measurements of penetration, capillary viscosity and ductility. While these measurements were repeatable, they could not be easily correlated to end-use performance characteristics such as rutting or cracking. An exhaustive multi-year study (SHRP) by the Federal Highway Administration (FHWA) resulted in the adoption of alternative measurements which solve this correlation problem. These measurements provide a set of standard criteria for selecting asphalt binders and aggregate mixes to meet specific end-use conditions.

The Dynamic Shear Rheometer, or DSR, was identified as one of the techniques of choice for performance evaluation of asphalt binders over a broad temperature range. Specifically, DSR measurements include:

- **AASHTO† TP5** (method which specifies the general conditions for determining the complex modulus (G*) and phase angle (δ) for an asphalt binder)
- **AASHTO PP6** (method for grading an asphalt binder)
- **AASHTO MP1** (method for verifying the performance grade of an asphalt binder)

Laboratories involved with formulating and supplying asphalt for use on federal and state highways must routinely perform these measurements to verify the grade and quality of their materials, making the Dynamic Shear Rheometer a necessary part of their laboratory instrumentation.

† American Association of State Highway and Transportation Officials

CSA II Asphalt Rheometer‡

The TA Instruments CSA II Asphalt Rheometer is a dedicated Dynamic Shear Rheometer specifically designed and built to satisfy the latest FHWA requirements. The instrument is based on a proven design whose key components reflect over 20 years of technical leadership. The CSA II and associated software are easy to use, enabling operators with no prior knowledge or experience in rheology to successfully and reliably evaluate asphalt binders to FHWA specifications.

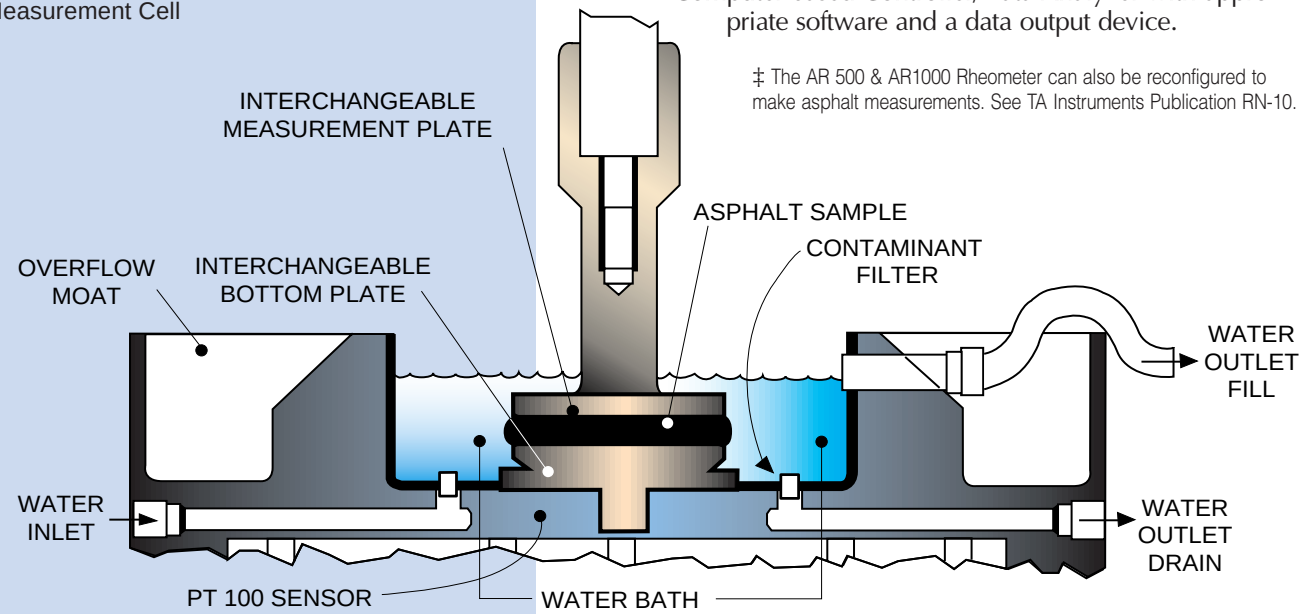
The asphalt sample [original binder, Rolling Thin Film Oven (RTFO) residue, or Pressure Aging Vessel (PAV) residue] is placed between two stainless steel parallel plates of known dimension (either 8mm or 25mm diameter) and oscillated at a frequency of 10 radians/second. Precise (±0.1°C) temperature control is provided by immersing the sample and plates in a temperature controlled water bath which includes a built-in overflow moat and drain to protect the instrument in the event of an overflow (Figure 1). A disposable filter prevents small particles from plugging the outlet water line. This filter is white for easy inspection of contamination.

The CSA II's removable, raised test fixture design facilitates sample trimming before evaluation, as well as rapid cleanup between tests. Data is collected and automatically converted to a plot (satisfies PP6 test requirement) or a single value (satisfies MP1 test requirement) which allow the operator to rapidly grade the asphalt binder or to verify that the material supplied is the correct grade for a specific geographic application.

The complete CSA II system consists of the CSA II Rheometer, a Computer-Controlled Circulator (Temperature Control), a Computer-based Controller/Data Analyzer with appropriate software and a data output device.

‡ The AR 500 & AR1000 Rheometer can also be reconfigured to make asphalt measurements. See TA Instruments Publication RN-10.

Figure 1
CSA II Measurement Cell



Temperature Control

Excellent temperature control

Rheological properties of asphalt binders can change significantly with minor changes in temperature, so precise temperature control is required in order to obtain accurate, reproducible results. The CSA II temperature control system includes:

- a water immersion measurement cell which surrounds the plates and sample
- a Pt 100 temperature probe in close proximity to the sample which forms a closed-loop control circuit with the external circulator
- temperature calibration with a thermistor or other reference temperature probe as required in AASHTO specifications
- calibration offset values to automatically control the cell to the calibrated temperature
- a multi-point temperature calibration routine
- an automatic flow rate and fluid level control without operator adjustment

The result is temperature control to within ± 0.1°C, providing accurate reproducible results.

Rapid Temperature Change

The ability to rapidly change and stabilize temperature, both in heating and cooling is critical to achieve reduced test times, and increased productivity. The CSA II is able to perform a typical 6°C jump (as per AASHTO specifications) in less that 6 minutes, and cool from 56 to 30°C in less than 10 minutes. The standard temperature range of the CSA II is 5 - 85°C (as per AASHTO specifications).

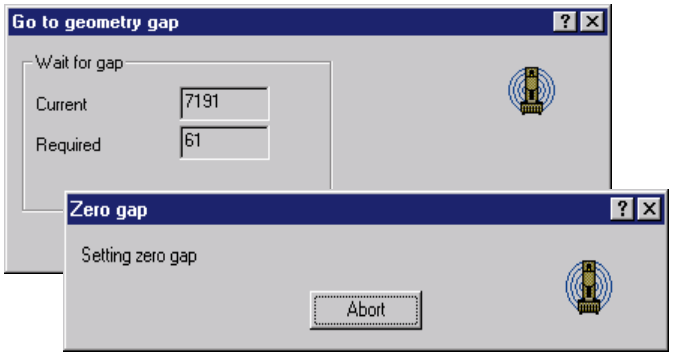


Figure 2
Automatic gap set

Automation

Automatic gap set

Provides unattended adjustment of the sample measurement gap before the experiment begins. Software specifically written for asphalt evaluation automatically adjusts the rheometer head to initially zero the gap, close the gap to a specified trimming gap (50 microns greater than the final gap), and then to set a final gap for measurement as specified in TP5 (e.g., 1mm for the 25mm parallel plate). In addition, as the gap changes with temperature due to expansion/contraction, the system automatically provides thermal compensation to maintain a constant gap. Together, these capabilities guarantee reproducible results free of operator-to-operator variation.

Figure 3
Automated scripts instruct the operator

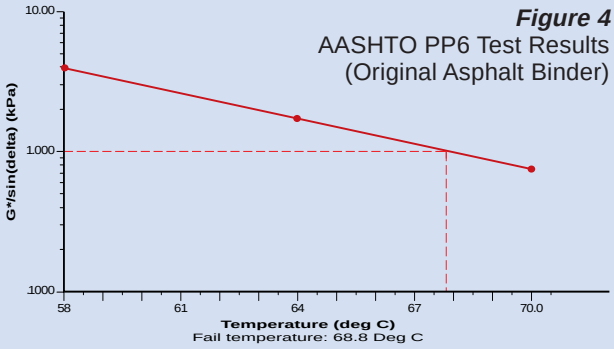
Ease of Operation

The CSA II is operated through a series of automated test procedures called scripts. The operator simply selects the appropriate script from a menu, starting the test sequence with single mouse click. The script then steps the operator through the test, giving on-screen prompts when action is required (i.e. attach plates, load sample, trim sample, etc.). After the sample has been loaded and trimmed, no further operator involvement is needed. The system automatically completes the test and prints out the test report.

The report for an AASHTO PP6 test includes:

- a plot of G*/sin(delta) vs. Temperature for Original Binder or RTFO Residue (see figure 4) or G*. sin(delta) vs. Temperature for PAV Residue
- a table of values complete with pass/fail indication for each test temperature (see figure 4)
- the exact fail temperature calculated from a regression line through the data, which provides resolution performance beyond the normal grading system

Figure 4
AASHTO PP6 Test Results
(Original Asphalt Binder)



G*/sin(delta) (kPa)	Temp (°C)		Analyzed file and step
3.948	58.0	pass	Tank3.010-Time sweep
1.815	64.0	pass	Tank3.020-Time sweep
0.8688	70.0	fail	Tank3.030-Time sweep

If the material does not fail the PP6 test, the user has the option to continue incrementing the temperature until a fail temperature is achieved. Additionally, the PG grading of an Original Binder can be validated by performing a strain sweep. (Note: this validation of the PG grading is expected to be added to the AASHTO specifications.)

Positioned for the Future

With five times the torque of current AASHTO requirements, the CSA II is well positioned to accommodate changing requirements. Additionally, TA Instruments is committed to developing new automated test procedures (scripts) as test requirements change and evolve.

The CSA II can be upgraded to a research rheometer, with capability for Oscillation (strain sweep, frequency sweep, time sweep, stress sweep), Flow and Creep testing. Fully integrated Time Temperature Superposition (TTS) software is available for Master Curve generation.

Asphalt Users List

The CSA II and its predecessors, the CSA 100 and CSA 500, are used by the U.S. Federal Highway Administration and numerous State Department of Transportations. In addition, our instruments are currently being used at more than 100 asphalt testing facilities worldwide. Contact your local TA Instruments representative for a list of specific referrals.

TA Instruments Commitment

The CSA II is designed and engineered to assure easy, reliable, trouble-free operation. It is supported by a full range of services, including an applications laboratory, publications, training courses, seminars, applications CD's, internet website, and a telephone Hotline for customer consultation. Highly qualified service personnel specializing in thermal analyzer/rheometer maintenance and service are available throughout the world. All of these items reflect TA Instruments commitment to providing innovative thermal analysis & rheology products and related services that deliver the maximum value for your investment.

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