**ATM-025/ATM-100**

Asphalt Mix Performance Tester

- Advanced testing for Hot Mix Asphalt (HMA)
- Dynamic complex modulus, flow number, flow time, indirect tension, beam flexural fatigue, and resilient modulus tests
- Electro-Hydraulic Digital Servo Control
- 25 kN (ATM-025) or 100 kN (ATM-100) dynamic load capacity
- Frequencies up to 70 Hz
- Modular design with accurate and easy to use software and electronics
- Meets the newest AASHTO (Superpave), ASTM, and European (EN-12697-24,25,26) standards
- Complete “turn-key” systems

**DESCRIPTION**

The GCTS ATM-025/ATM-100 Equipment is a modular system that can be configured to test asphalt in a variety of modes. Two standard models are offered with the only difference being the load capacity. The ATM-025 is limited to 25 kN dynamic loads and offers an excellent dynamic accuracy for testing softer specimens (i.e. HMA at elevated temperatures) while the ATM-100 is also able to perform strength tests as required by AASHTO-322 Creep Compliance and Strength where 100 kN capacity is specified. GCTS also offers a combination system with a dual actuators (25 kN & 100 kN) for improved dynamic performance at low dynamic loads and fully capable of performing tests to specimen failure.

Both systems can be supplied with an environmental chamber which houses the optional accessories required to perform dynamic complex modulus, flow number, flow time, indirect tension, beam flexural fatigue, and resilient modulus tests. The GCTS environmental chamber is a high quality stainless steel.
chamber with a full size front window and a dual temperature PID control loops of both heating and cooling. Chamber temperature is directly controlled through GCTS application software providing efficient and precise temperature control typically better than 0.2 °C. This system can either control the chamber air temperature or the internal temperature of any instrumented dummy sample to ensure that test specimens have reached the desired temperature throughout. A temperature sensor that can be embedded inside a dummy sample is also provided. The ATM-025/ATM-100 includes a sliding drawer to easily remove/install test specimens minimizing the time the environmental door is open.

GCTS has conducted extensive verification of these systems, comparing the results for the full temperature range against Witczak’s predictive model as well as test data on multiple replicates obtained at a leading research university.

\[ \text{Comparison Study} \]

At the core of the GCTS ATM-025/ATM-100 is our application software. GCTS has developed the most advanced software for performing dynamic modulus, indirect tension, fatigue, resilient modulus and several other tests for HMA. Our software offers advice to the user on how to conduct each test and in some cases even provides real time comparisons of tests results with published predicted values.

Every aspect of the test is software controlled, from turning on the hydraulic pump and monitoring the oil level and temperature to executing the test with a simple mouse click. All standard test procedures are pre-programmed, but the CATS software is flexible and powerful enough to allow custom test procedures as well.

\[ \text{ATM-025 / ATM-100 Frequency Response Curve} \]

Behind GCTS CATS software is the SCON-1500 digital servo controller that can be configured with up to 8 universal sensor input channels, two dedicated temperature inputs and 3 control output channels (28 inputs and 8 control outputs with optional SCON-2000). All signal conditioning, as well as high speed data acquisition and control functions are done by the GCTS SCON unit and controlled by the user through CATS, the GCTS windows-based servo control software running on a standard PC.

The fully integrated Digital Servo Controller has an embedded microprocessor capable of performing all test functions even if the Windows computer is turned off. It provides automatic dynamic control mode switching between any connected transducer or calculated parameter. This controller also conditions all transducers used in the ATM-025 system. This digital controller is capable of updating the control loop at up to 6 kHz as is required for high frequency dynamic tests. The GCTS controller has several adaptive compensation techniques to improve the control precision without user intervention. Adaptive control allows the system to precisely match the desired cyclic stress amplitudes throughout the tests.

Unlike other systems, the GCTS SCON is fully integrated with the sensor signal conditioning, servo controller and test software into a single component. At the same time, the SCON offers a modular approach with easy to install expansion boards to accommodate future needs. The GCTS SCON can directly interface with load cells, pressure transducers, LVDTs, strain gages, thermocouples, etc. The user is free to connect sensors to any universal input channel from any manufacturer without requiring the purchase of expensive normalizing electronics. This universal digital signal conditioning includes automatic sensor recognition and software management of excitation, offset, gain, and linearization settings reducing the possibility of accidentally or inadvertently changing or using the wrong sensor calibration. Linearization of each sensor is performed in real-time using high order polynomials automatically calculated for every input range. These are essential time and money saving features for asphalt testing systems to accommodate the different sensor configuration and ranges specified for each different test mode.

\[ \text{Raw Data & Real-Time calculated data output} \]

The GCTS software has simplified the operation of our instruments allowing the user to directly program test calculated parameters in the units of interest (stress, strain, etc.) based on the specimen geometry and size. These parameters are calculated in real time and are available for display, graph and/or control in any desired unit system. In addition, dynamic parameters such as stress and strain amplitude as well as phase shift are also calculated at the end of each cycle. These parameters are calculated using sophisticated regression analysis including all data points within each cycle. Curve fitting of waveform regression is the most accurate technique as systems that only use the maximum and minimum waveform values may introduce significant errors for small amplitudes where the signal-to-noise ratio is also significant. Using the mathematical functions to calculate phase shift is the only way of ensuring
accurate results. This is especially important when testing at colder temperatures where the cyclic deformations could be very small and the sensor variability may introduce a significant error in the calculation of the cycle amplitude and phase shift.

The base system offers all of the above generic functions and specific solutions are offered as options allowing the user to configure the system with only the required fixtures. Each one of the test fixtures includes solution software modules that are pre-programmed to automatically perform the required test and reduce the data according to the listed specifications. This makes the GCTS ATM-025/ATM-100 a complete custom-made solution for the customer.

**DYNAMIC MODULUS**

The Dynamic Complex Modulus is an important property of HMA mixtures. It is used to determine both the linear viscoelastic and elastic properties of pavement materials. The dynamic modulus ($E'$), the absolute value of the complex modulus, is used to predict the permanent deformation (rutting) potential of HMA. The GCTS systems can perform this test with ease, in both unconfined and confined condition, and automatically obtain the master curve.

GCTS Dynamic Complex Modulus ($E'$) software allows for automatic test execution for one or multiple tests. Each individual test can be programmed for different temperatures and frequencies as well as number of replicates at each temperature and frequency pair. This program includes a function solver to obtain the Master Curve from test data according to AASHTO or Witczak functions.


The apparatus includes small range deformation sensors that can be configured for multiple ranges to achieve the precision required by the specifications. The axial deformation device is mounted to the specimen on pre-glued gauge points with predetermined gauge length. The GCTS GPF-100 Automatic Positioning Fixture was designed for easy and accurate extensometer holder positioning on the cylindrical asphalt specimens used in Dynamic Modulus tests. Alignment and secure fastening of the extensometers is essential in running a successful test. With the GPF-100 along with the specially designed extensometer holding pins the need for labor intensive effort is eliminated and the preparation time is reduced to a fraction of the time required otherwise.

The pin holder front face includes a recess to avoid squeezing the epoxy out while it pressed against the sample. A rigid support is essential to eliminate errors from sensor friction or spring resistance at both low and high temperatures. These pins together with the GPF-100 fixture provides the most accurate method of affixing the axial strain measurement sensors for Dynamic Testing

In this case the gauge lengths are fixed by locking the device in one of several preset positions during installation and releasing it prior to testing. Asphalt specimens can be placed on the platens with membranes and axial deformation mounting points outside the cell while another test is running inside the cell. When the test is complete, the first specimen is removed from the cell and the deformation device transferred to the new specimen, which is simply set into position inside the cell.

**BEAM FLEXURAL FATIGUE**

Fatigue or alligator cracking is one of the principal modes of Hot Mix
Asphalt (HMA) pavement failure. Fatigue life of the HMA layer is determined by lower stresses than in the other modes of failure, meaning that in many cases the fatigue properties of the HMA determine how long the pavement will be functional. The GCTS Beam Flexural Fatigue apparatus is designed to perform flexural tests on the HMA beam specimen, in a controlled environment, in order to determine their fatigue properties and estimate the pavement life. GCTS offers the Beam Flexural Fatigue as a stand-alone unit and as a fixture for the ATM Asphalt Testing Systems.

**Beam Flexural Fatigue**

GCTS Beam Flexural Fatigue software allows for automatic execution and control of a long term fatigue test with relative ease and flexibility. The fatigue test on the asphalt beam can be conducted in two modes: constant strain/deflection or constant stress/load. GCTS WIN-FBA includes automated test control and report generation to perform AASHTO T 321-07, SHRP M009, EN 12697-24 and EN 12697-26 specifications as well as user definable test procedures.

**INDIRECT TENSION**

The tensile strength of the HMA is a major predictor of the serviceable life of the pavement. The cracking potential of the HMA is directly related to its tensile strength. The higher the tensile force or tensile strain at failure, the longer the life of the pavement will be. In combination with the ATM Asphalt Testing Systems, the Indirect Tension Test module can be used to conduct tests at different temperature conditions.

**Indirect Tension Fixtures**

The Indirect Tension software module allows the user to perform Creep Compliance, Fatigue, Resilient (Stiffness) Modulus and Tensile Strength using the Indirect Tension apparatus (either American or European standard/apparatus). While the user can configure/setup the test to be done according to one standard the software will also calculate and display the results of the other available standards of the Modulus Test.

**Indirect Tension Software**

GCTS WIN-IDT-MR Software includes automated test control and report generation to perform SHRP-P07, ASTM D4123-95, EN12697-24, EN12697-26 and NCHRP 1-28 specifications as well as user definable test procedures.

**RESILIENT MODULUS**

The Resilient Modulus is an indicator of the stiffness of the soil and the aggregate materials that are found in the subgrade and base layers. The structural integrity of a pavement depends on this parameter. The GCTS Resilient Modulus Testing System is specifically designed for this test; however all of the ATM Asphalt Testing Systems can perform this test with the optional triaxial cell.

**Resilient Modulus for Unbound Material**

GCTS Resilient Modulus software allows the user to either select from one of the standard resilient modulus test programs, or allows the user to setup a user defined test program (up to 30 sequences) with selections for cell pressure, cyclic stress and contact stress for each sequence. The user has complete control over how many cycles are applied in pre-conditioning and normal loading stages. GCTS WIN-TRX-MR Software includes automated test control and report generation according to AASHTO T-274, AASHTO T 307, SHRP P46, and NCHRP 1-28, EN 13286-7 as well as user definable test procedures.