

GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

▶ **APT-100E**
Asphalt Pavement Tester



- **Economical solution for advanced asphalt pavement testing**
- **Dynamic complex modulus, flow number, flow time, indirect tension, beam flexural fatigue, resilient modulus tests and direct tension tests**
- **Precise, accurate, quiet and compact**
- **Intuitive by design**
- **Unsurpassed performance at the best price**
- **Meets the newest AASHTO, ASTM, and European standards**
- **Frequencies up to 70 Hz**
- **Temperatures from -10 °C to 60 °C.**
- **gTest iOS app for remote monitoring**
- **Complete “turn-key” systems**

DESCRIPTION

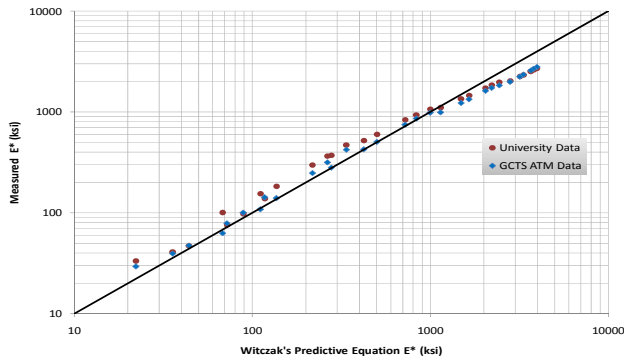
The APT-100E is the most affordable system in the market today offering a complete assortment of dynamic testing procedures (fixtures) for asphalt concrete. The equipment is offered in a modular fashion allowing the user to select only the required testing modes (Dynamic Modulus, Resilient Modulus, Fatigue, Direct Tension, etc.). Additional fixtures for other HMA testing modes can be added at a later time. The APT-100E incorporates state-of-the-art technologies that allow GCTS to provide high precision equipment at very economical prices. The APT-100E includes a specially designed dynamic actuator for frequencies up to 70 Hz with minimal friction design for improved accuracy. The design of APT-100E also incorporates space saving features that not only allow our customers to optimize lab space but also save on shipping cost. The complete system is integrated into a single unit that includes all of the necessary components (environmental chamber, A/C compressor, hydraulic pump, electronics, etc).

The GCTS environmental chamber features a large sized front window. 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

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reached the desired temperature throughout. A temperature sensor that can be embedded inside a dummy sample is also provided.

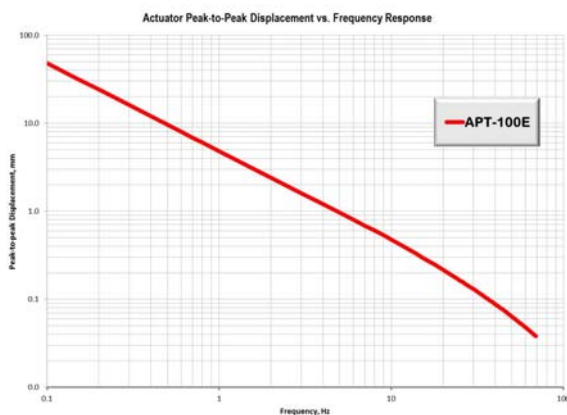
GCTS has conducted extensive verification of these systems, comparing the results for the full temperature range against Witzcak's predictive model as well as test data on multiple replicates obtained at a leading research university.



Comparison Study

At the core of the APT-100E 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.



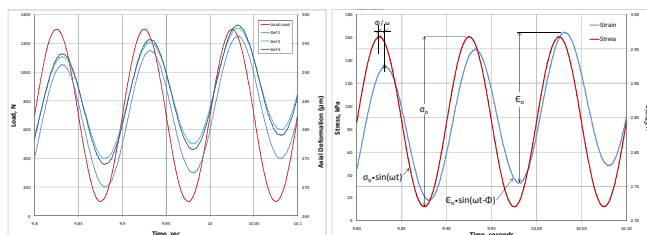
APT-100E Frequency Response Curve

Behind GCTS CATS software is the SCON-1400 wireless servo controller that can accommodate up to 8 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, which can communicate with the SCON controller via a WiFi network. Integration and wireless communication eliminate the need for any external cables or hoses.

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 APT-100E system. 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 all into a single component. The GCTS SCON can directly interface with load cells, pressure transducers, LVDTs, strain gages, thermocouples, etc. The user is free to connect sensors from any manufacturer without requiring the purchase of expensive normalizing electronics. This universal digital signal conditioning includes 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.

The SCON controller features wireless WiFi communication, along with standard TCP/IP, and serial connection. This allows the user to remotely control the system, program and monitor the test progress from anywhere. The APT-100E only requires a single cable for power connection, so there are no messy wires and cables around the equipment. The APT operates on 220 V, 1 phase, 50-60 Hz.



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.

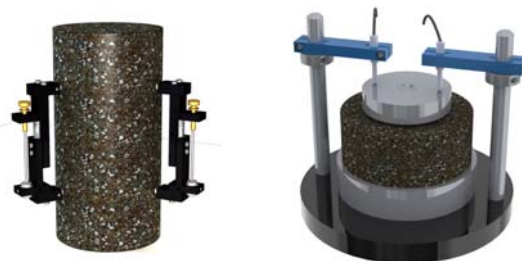
The base system offers all of the above generic functions and specific solutions are offered as options allowing the user to configure the system with only the required fixtures. Each one of the test fixtures includes solution software modules that are pre-programmed to automatically perform the required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

SCON controller also works with our gTest iOS app. gTest is a remote monitoring app which displays test status in real time. Current test information can be displayed digitally or graphically from any location.

DYNAMIC MODULUS

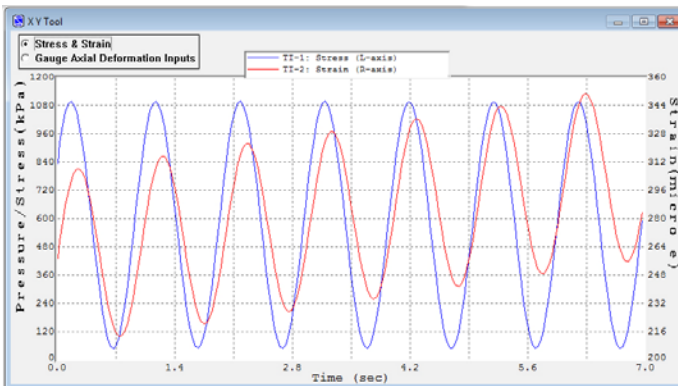
The Dynamic Complex Modulus is an important property of HMA mixtures. It is used to determine both the linear viscoelastic and elastic properties of pavement materials. The dynamic modulus $[E^*]$, the absolute value of the complex modulus, is used to predict the permanent deformation (rutting) potential 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



AASHTO TP-62 & EN-12697-25 Fixtures

The GCTS WIN-UDMA Software for obtaining the Dynamic Modulus of Asphalt Materials includes automated test control and report generation to perform AASHTO TP 62-07, ASTM D3497-2003, and EN 12697-25 specifications as well as user definable test procedures.



Dynamic Modulus (E^*) Test Software

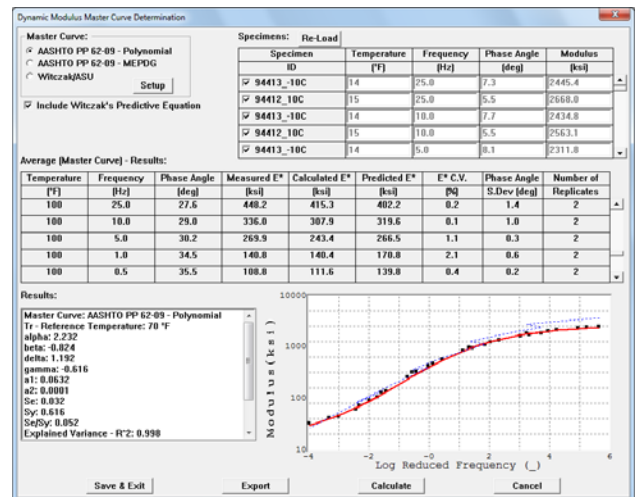
The apparatus includes small range deformation sensors that can be configured for multiple ranges to achieve the precision required by the specifications. The axial deformation device is mounted to the specimen on pre-glued gauge points with predetermined gauge length. The GCTS GPF-100 Automatic Positioning 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.



Automatic Positioning Fixture & Pin Holder

The pin holder front face includes a recess to avoid squeezing the epoxy out while 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

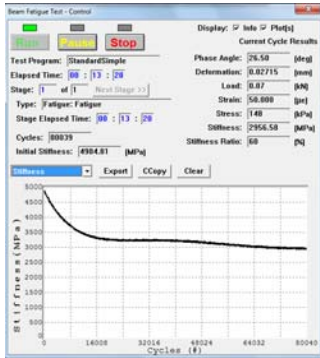
In this case the gauge lengths are fixed by locking the device in one of several preset positions during installation and releasing it prior to testing. Asphalt specimens can be placed on the platens with membranes and axial deformation mounting points outside the cell while another test is running inside 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.



Master Curve Solver

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 or as a fixture for the APT Asphalt Pavement Tester.

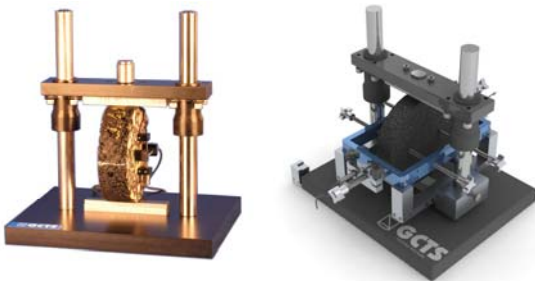


Beam Flexural Fatigue

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

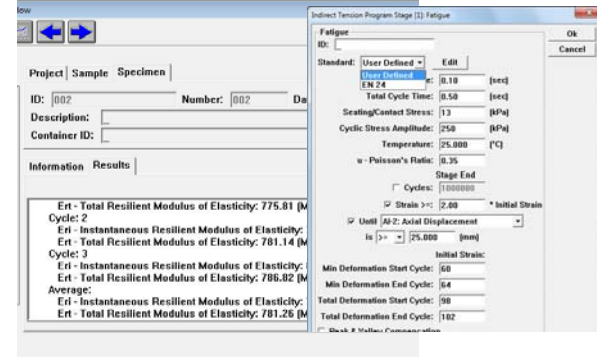
The tensile strength of the HMA is a major predictor of the serviceable life of the pavement. The cracking potential of the HMA is directly related to its tensile strength. The higher the tensile force or tensile strain at failure, the longer the life of the pavement will be. In combination with the APT Asphalt Pavement Tester, 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 AASHTO T322, 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 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.