Make Sure the UTM Fits the Application

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With so many universal testing machine options available in a competitive global environment, a buyer should optimize the evaluation process to ensure that the system meets all his application requirements before purchasing.

Purchasing a piece of equipment or services is a difficult task. Selecting an electromechanical static universal testing machine (UTM) is no exception. For example, there are more than 60 UTM manufacturers worldwide, and there is a considerably large number of equipment options available. As with purchasing anything, typically, the higher the price tag, the more carefully you should study the pros and cons of certain features and specifications. The fact that each different supplier highlights its own advantages makes the job that much more difficult. A UTM should comply with the major and applicable standards, but additional, special features will increase the purchase price for things that might be unnecessary for a particular application. Some of the most relevant features to consider when selecting a UTM test system are discussed below.

Load-frame capacity and dimensions

The selection of load frame capacity is based on the maximum force required to cause the material being tested to fracture. Specifications for UTM load frame capacity and dimensions are vital to the equipment-selection process.

Dimensional specifications must take into consideration clearances between columns and vertical clearance to adequately handle the products being tested. Some materials, such as elastomers and soft polymers will elongate substantially, and sufficient vertical travel must be available to allow the material to stretch as far as necessary without running out of travel space. Also, consideration should be given to any special grips, fixtures and environmental chambers that could require additional space in both directions.

Frame stiffness

In some instances, frame stiffness is a feature that can be overrated. The stiffness of the test frame could be an important factor where only crosshead motion is being used instead of a separate extensometer or deflection-measuring device. Most applications that comply with international tensile-testing standards call for the use of an extensometer or deflection-measuring devices.

There are many machine components that can affect the frame stiffness including screw diameter, ball-nut fit, crosshead stiffness, screw-bearing fit and frame stiffness (Fig. 1). In addition, compliance of the specimen itself, pull rods and the specimen-gripping devices also contribute to errors. Thus, using the load frame as a deflection-measuring device produces a complicated dilemma. There are only a few applications where crosshead displacement is used to measure deflection, so the equipment purchaser should carefully weigh the reasons to incur the expense of a machine that has high frame stiffness if frame stiffness will not be a factor in the testing process.

Some manufacturers of UTM equipment that have lower frame stiffness offer as standard equipment a data channel and program for the direct measurement of strain or deflection. This provides a correction factor to use if the load frame needs to be used for deflection measurement. This constitutes a more economical solution for those few applications that require the use of crosshead displacement to measure deflection.

Drive-system specifications

These important specifications ensure that the system complies with the relevant international standards. Lateral motion is important and is addressed in

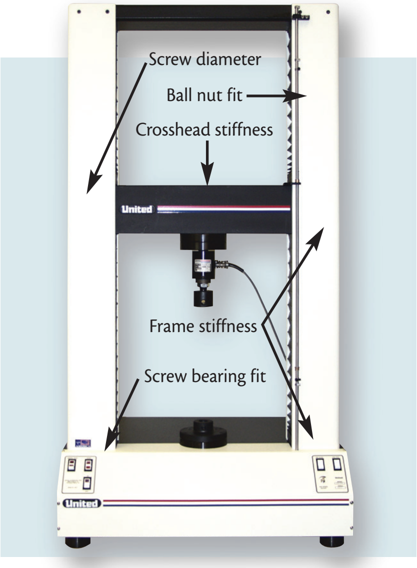

Fig 1 UTM components that can be a source of test errors include screw diameter, ball-nut fit, crosshead stiffness, screw-bearing fit and frame stiffness.

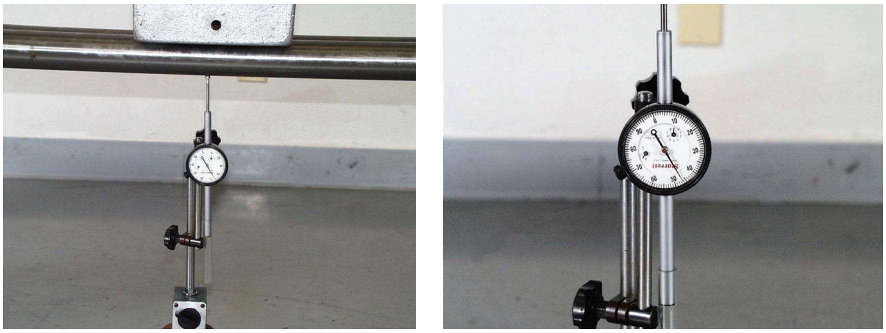

Fig 2 Deflection of bars under a 200 lb (90 kg) load (two bars are used to keep the weight steady). Controlling the lateral motion of a machine using round bars can be a source of errors in test results because the bars do not have the required stiffness.

more detail below. Speed accuracy, position resolution, position accuracy and repeatability all constitute important specifications for consideration.

Lateral motion

Lateral motion possibly is even more important than frame stiffness. Lateral motion of the crosshead can be a serious source of errors because it introduces bending motion into the test specimen. Mixing bending into a tensile test will cause the specimen to fail at lower stress than normal.

Round bars are used for crosshead guidance to control the lateral motion in many UTMs. These round bars lack the stiffness to prevent lateral motion, which can create the problems mentioned above (Fig. 2). Other UTMs use a stiff two-column frame with crosshead guidance roller bearings to minimize lateral motion of the crosshead (Fig. 3). This crosshead guidance system also prevents the crosshead from twisting in the front to back direction. Using a two-column frame construction in the form of two large steel channels can increase the stiffness to more than ten times the stiffness of ball screws or typical round bar columns used in many testing machine frames. This is illustrated in Figs. 2 and 3, which show a column deflection of 0.007 in. (0.2 mm) under a 200 lb (91 kg) load, compared with 0.046 in. (1 mm) deflection with two 2-in. (50 mm) diameter round bars under the same load.

Maximum speed at full load

Maximum speed at full load also is an important specification. Many UTMs are claimed to be capable of operating at full speed and at full force. However, it is questionable whether this is desirable, particularly using high-capacity machines (e.g., 100 kN, or 22,500 lbf and over). Most steel tensile-testing standards call for testing at load speeds less than 2 in./min (50 mm/min). Polymer material-testing speeds can vary (depending on the type of polymer) from 0.08 to 2 in./min (2 to 50 mm/min). Elastomers do require high speeds, but they very seldom demand full load at those speeds.

There are a few testing applications that require full speed at full load, such as testing steel springs and urethane polymers, but these materials typically work at low capacities (100 kN and lower). Therefore, the maximum speed at full load could have limited practical value in the test lab.

Testing-control electronics

Designing testing equipment many times presents a dilemma of trying to design something as completely and comprehensively as possible, but to do so without making the hardware so sophisticated that it becomes very difficult to repair and/or too expensive. For example, some UTM equipment might include a control console, a computer, interface boards and signal conditioners, depending on the accessories to be used. In an optimized design, on the other hand, the fewer components a system incorporates, the fewer the parts that can fail and the fewer the chances are of something going wrong.

A machine with a console should be considered if basic testing without data acquisition is to be performed. However, a control console is not necessary for applications requiring data acquisition, statistical analysis, report

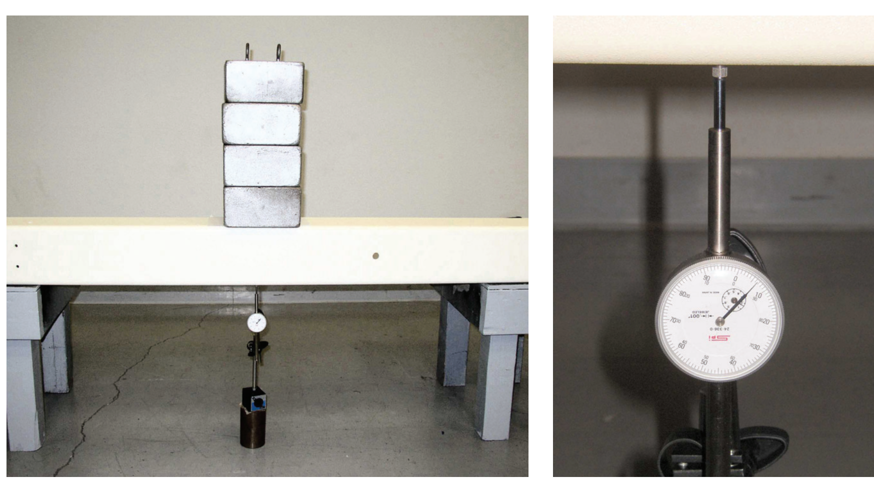

Fig 3 Deflection of steel channel column under 200 lb (90 kg) load. Steel channels used to control lateral motion provide good resistance to deflection, and, thus, less source of error in test results.

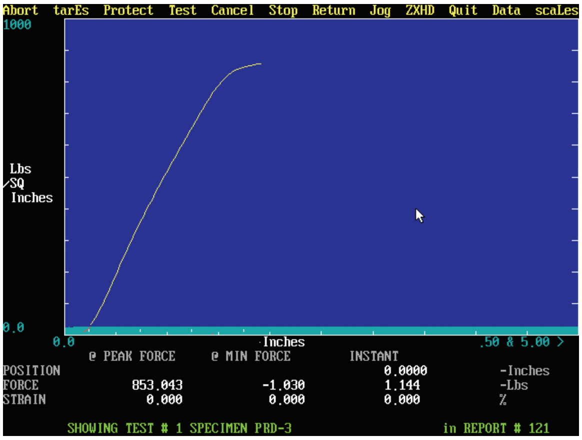

***Fig 4** Real-time plotting of test data*

generation, etc. It is much easier and inexpensive to repair and/or replace a PC than to repair/replace an expensive specialized console with associated long delivery lead times. A console is redundant if a PC is part of the system.

Data-recording speeds and bandwidth

Some manufacturers suggest recording 5,000 data readings per second during a test. Such a data-acquisition rate would produce 50,000 data points for a test duration of ten seconds, which would be the equivalent of a table more than 80 printed pages.

How many testing data points need to be recorded to get all of the important information from a test? ASTM E 1856-97, Appendix X2 (Standard Guide for Evaluating Computerized Data Acquisition Systems Used to Acquire Data from Universal Testing Machines) specifies a maximum bandwidth requirement of 20/(event duration in seconds), and a sampling rate of 31 times the required bandwidth. Therefore, for a test that lasts 10 seconds, you need a bandwidth of 2 Hz and a sample rate of 62 samples per second. If the test is run very fast so the sample breaks in 1 second, then you need 20 Hz of bandwidth and a sample rate of 620 samples per second.

Some computerized testing systems have a bandwidth of 20 Hz, which is sufficient to capture a test one second long with acceptable accuracy, but below the frequency of the power system to exclude noise from that source. If analog-to-digital converters are synchronous, there is no time skew between channels. With a data-sampling rate adjustable from 1 per second to 1,000 per second, this allows collection of data at a rate appropriate to the test being performed. One reasons that some machines offer fast sampling rates of up to 5 kHz (even though much of the data collected is not used) is that available dynamic UTM technology is applied to the static UTMs, even though there may be very little practical value.

SELECTING A UTM CAN MEAN DIGGING THROUGH MYRIAD EQUIPMENT OPTIONS OF THE MORE THAN 60 UTM MANUFACTURERS WORLDWIDE.

Force-measurement system

This system calls for accuracy and repeatability. An accuracy of ±0.5% of reading to 1% of capacity, and a repeatability of 0.25% of reading covers 95% of the applications. Self-identifying load cells can be convenient when multiple load cells are to be used on one system.

Automatic Calibration

A push-button automatic calibration function is really a single point check of the readout system. The definition of calibration states that the device being calibrated is to be compared with a traceable standard source of the quantity being measured. Traceable standards can be weights, calibration rings and load cells.

The process of auto calibration means, in effect, that a control in the readout device is provided to allow adjustment. This can create a risky situation where that control can be accidentally adjusted while using the machine. This could potentially result in erroneous data.

An alternative philosophy is to make the system very stable and allow no adjustments except by a qualified calibration technician using proper standards for comparison. The more buttons there are to push, the more chances there are of something going wrong.

Strain-measurement system

Most international standards, such as ISO, ASTM, JIS, DIN, BS, etc., contain similar specifications for strain measurement. Accuracy should be 0.5 μm, repeatability 0.25 μm and resolution 0.0004% of range. In selecting a strain-measurement system, it should be verified that the specifications meet the corresponding standards.

Conclusion

Trying to weed through the large amount of information about equipment features, characteristics and specifications to decide which are useful and pertinent to the particular application can be a daunting task. It is important not to pay more for the equipment than necessary, but also not to purchase on price alone, where you could lose money in the long run due to quality, reliability, service and production-downtime factors. **IH**

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