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The Tower of Babel: Testing the Possibilities

The story of the Tower of Babel has fascinated scholars for centuries. The goal of the builders was to reach the heavens. An ancient document called the Book of Jubilees mentions the tower's height as being 5433 cubits and 2 palms, which is almost 2.5 kilometers (about 1.55 miles). That is certainly higher than any man-made structure today, but is that possible? The building materials of the time were simply bricks of mud and straw. So just how tall could the tower have been?

Instron had the opportunity recently to meet with Professor Linn Hobbs of the Department of Materials Science and Engineering at Massachusetts Institute of Technology (MIT). Dr. Hobbs along with two colleagues teaches the course "Materials in the Human Environment" that investigates the development of materials and technologies through human history. As evidenced by the name, the range of class teachings and projects is wide and our discussions included research into brick and mortar construction, natural-fiber rope bridges in the Andes, and whether the Egyptian pyramid blocks were cast in place rather than quarried and then lifted into place. The well-appointed MIT laboratories have several Instron test instruments that enable the students to evaluate the capabilities of the materials that they produce during the class.

To estimate the possible theoretical height of a brick-built tower, Dr. Hobbs has his students manufacture bricks using clay, sand, and straw folded together. Some bricks are sun-dried while others are fired in a furnace, as they would have been as building technology advanced. A series of empirical compressive tests on the bricks using an Instron electromechanical testing system evaluates their individual strength and from these values they can calculate the possibilities.

The sun-dried bricks withstand compressive loads up to 4000 lb/sq in. A pyramidal structure built with these bricks and with a wide base to spread the weight of the structure could reach around 1500 ft., or around a quarter of a mile. However, a new technology had developed that imparted much greater strength to the bricks; they were baked in wood-fired furnaces. When baked bricks are compressed, they can withstand 20,000 lb/sq in., which equates to a possible height for the tower of 10,500 ft or almost two miles high. That's around four times as high as the world's tallest building, the Burj Khalifa in Dubai. It's also high enough to have given altitude sickness to any Mesopotamians strong enough to reach the top!

The aim of this fascinating inter-disciplinary course is to teach innovative thinking to our future materials scientists, civil and construction engineers, archeologists, architects, and so on, through an understanding of how materials and their uses and physical properties have developed over time. It doesn't hurt that building walls, pyramids, and plant-fiber bridges is great fun as well.

Multi-Purpose Grip Shields

The new Instron pneumatic side-acting grips are supplied with adjustable jaw-face shields on either side of the grip. You can adjust the position of the shields so that you can insert a specimen between the jaw faces, but the shields help to prevent you from inadvertently placing a finger between the jaws.

Many people don't realize that the shields also provide useful guidance for specimen centering. There are two centering guides on the shields, one for round specimens and the other for flat specimens.

A notch in the shield arms is aligned with the center of the grip jaws. This notch is useful when mounting a round or a thin specimen such as wire or thread. When the shields are correctly installed and aligned for the specimen size, you insert the specimen between the shields and hold it against the notch while you close the grip jaws. You are then assured that the specimen is centered.

For flat specimens, there are marks engraved at intervals on the shield arms equidistant from the center. When inserting a flat specimen, you use the marks as a guide to accurately locating the specimen in the center of the grip jaws.

Q. Can I trust my strain figures when they are derived from crosshead position rather than from an extensometer?

A. Crosshead movement is measured using a high-resolution encoder. When you move the crosshead with no specimen installed, the reported measurement of that movement is often more accurate than for many extensometers.

However, when you install a specimen and apply a tensile or compressive load, the accuracy of the measurement of crosshead movement becomes dependent upon the "system compliance."

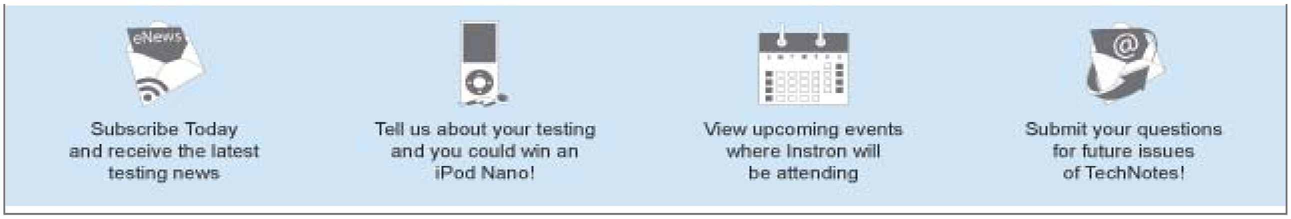
Compliance refers to the tendency of the various components of a test system to deflect under load. Consider every component in a test system as equivalent to a very stiff spring. When you apply a load to that component, even a major item such as a crosshead, it will deflect, either bending, stretching, or compressing. If it is a very stiff spring the deflection is tiny, but still measurable. Compliance is the inverse of stiffness; the more stiff, the less compliant.

There are three sources of compliance in a system: the load frame, the load string components, and the specimen itself.

- The load frame is designed with a very high stiffness. Instron measures the stiffness at a particular load and publishes that figure as part of the specifications of the load frame.
- Load string compliance is usually not known. There may be few or many components in a load string; grips or fixtures, couplings, one or more load cells, and so on. Many components do not have published stiffness values.
- The specimen compliance is usually what you are trying to measure.

As a rule of thumb, if the compliance of your specimen is around 100 times greater than the compliance of the load frame and the load string components, you can assume that the reported crosshead movement is equivalent to the deflection experienced by the specimen. However, if you are testing a very stiff specimen, you should always use an extensometer to measure specimen deflection.

If using an extensometer is not possible, then you should evaluate the system compliance before the test. Either install an extremely stiff specimen and apply a tensile force, or install compression platens and apply a compressive force with the platens touching each other. The resulting deflection measurement gives a close indication of the system compliance. When you test the specimen, you can remove this value from the result.



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