



Demonstrating building material safety

Materials used in buildings and bridges need to withstand extremely large loads, whilst being subject to design and cost constraints. This relies on demonstrating that materials meet anticipated in-service loading within a required safety margin. Testing conducted at high loads confirms this, but improved accuracy with robust links to SI units and methods for monitoring that loads have been reliably transferred to test samples are needed to underpin public safety.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

The safety and stability of buildings, bridges, and wind turbines relies on having confidence in the strength of the construction materials used. At the same time, materials are subject to cost and design constraints, which introduce the need for performance testing using similar loads to those likely to be experienced in-service. Demonstrating material strength and stability under these conditions relies on testing machines capable of applying extremely high loads. These large non-transportable test machines are permanently installed in industrial laboratories but require robust links to the SI units. Consequently, there is a need for a 'transfer device' able to relay SI unit links from calibration facilities at National Measurement Institutes to industrial users of installed and non-transportable high load testing machines.

Transfer devices based on several transducers – devices which convert force to an electrical signal – require individual calibration up to their maximum operating load. However, when used together in transfer devices they may operate beyond this range. Therefore, a good understanding of their performance when loading limits are exceeded is needed. In addition, NMI calibration conditions are tightly controlled unlike operational conditions in industry, where greater temperature and humidity fluctuations can occur and affect transducer accuracy.

Solution

The EMRP project *Force traceability within the meganewton range* investigated how transducer performance is affected by varying environmental conditions, such as ambient humidity and temperature. Using these results, the project generated statistical models to predict transducer behaviour. Software was also developed to allow transducer users to apply environmental corrections to measurements. In gaining a better understanding of transducer performance, the project was able to develop better high-load transfer device calibrations and to establish best practice for their use.

To further improve high-load testing for construction materials, the project also investigated different transducer designs to understand how these affect performance and load-limit. This led to the discovery that the most accurate transducers are compact in both size and shape.

Impact

GTM Testing and Metrology GmbH, a company that manufactures transducers for a range of engineering and testing industries, have used developments from the project to improve their transducer designs, reducing their diameter and weight to make them more suitable for use in high load measurement systems. GTM were also able to integrate project knowhow into the transfer devices they manufacture for customers requiring high load testing. As a consequence, GTM customers can have increased confidence in reliably monitoring the performance of their high load testing systems with improved links to SI units.

The project results are helping to improve construction material testing and strengthen industry confidence that materials will perform as expected in service. This will support improved building stability and integrity during extreme loading events, such as high winds. By providing a better understanding of the load carrying capability of materials, this project is also enabling industries to improve designs and reduce costs without compromising on safety standards.

Improving accuracy for high load measurements for industry

Large-scale structures, from high-rise buildings to wind turbines, must often withstand considerable loads, with EU directives on structural integrity and construction material testing designed to ensure safety under all conditions. Large material testing machines use "build-up systems" for calibration at the highest loads. Extension to the operating range and performance investigation for transducers used in these transfer standards is needed to ensure accuracy at the meganewton loads used.

The EMRP project *Force traceability in the meganewton range* investigated various build-up systems – including a novel hexapod design – and their component transducers, enabling the introduction of calibration improvements and extending the loading range to 50 meganewtons. For industries subject to EU Directives on construction materials, users of high load material testing machines can now benefit from greater measurement accuracy when required to demonstrate compliance for safety.



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