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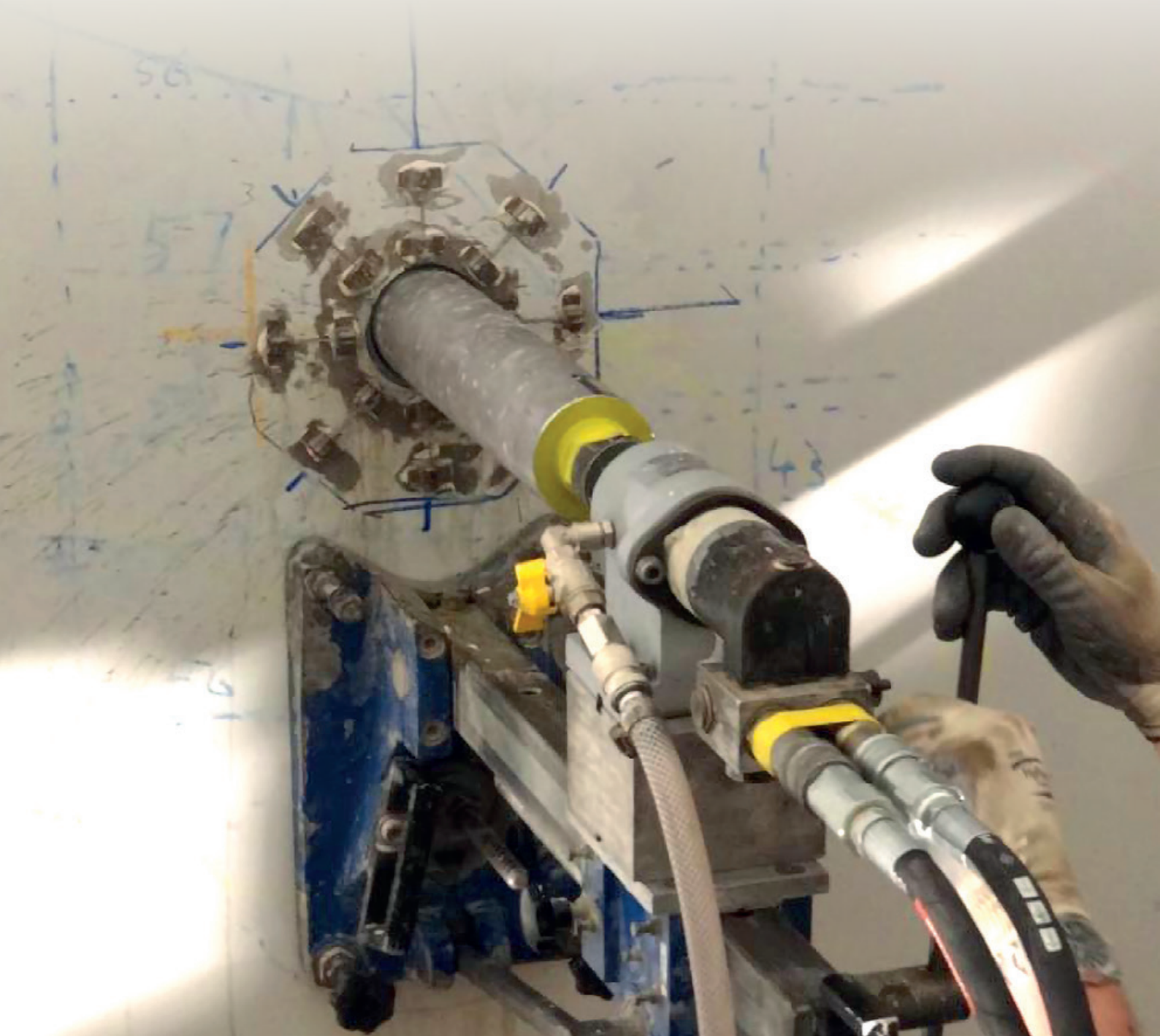
Pioneering Sustainably

James Fisher
Strainstall

In-situ stress measurement

Accurate measurement of dead load and residual stresses.



In-situ stress measurement

Accurate measurement of dead load and residual stresses.

Accurate knowledge of dead load stress is vital for understanding the structural health and capacity of infrastructure assets. With our team's extensive experience in civil engineering, James Fisher Strainstall offers a wide variety of specialist services for structures, bridges, and pipelines that enable owners and operators to increase the safety and performance of their assets.

Techniques for civil engineering structures

In-situ dead load stress testing techniques measure strain changes from the controlled and localised removal of material. This enables the stress and load experienced by an asset to be accurately calculated. In partnership with leading universities across the UK, we have modified and enhanced the approach used in mechanical engineering and aerospace sectors to deliver its benefits to the civil engineering industry.

This method helps owners and operators to gain increased assurance by mitigating the risk of structural integrity incidents. The technique also enables long-term stress monitoring to be calibrated: using absolute values rather than relative ones, providing a more accurate understanding of the load experienced by a structure over time.

When is it needed?

- If analysis indicates that a structure's capacity is insufficient for its safe operation and additional data is required to confirm results
- As part of the Supplementary Load Testing process
- As part of a bridge post-tensioned special inspection (PTSI)
- If owners or operators are concerned about the integrity of an asset and require in-depth insights into its structural health

Where is in-situ stress measurement applicable?

Concrete structures

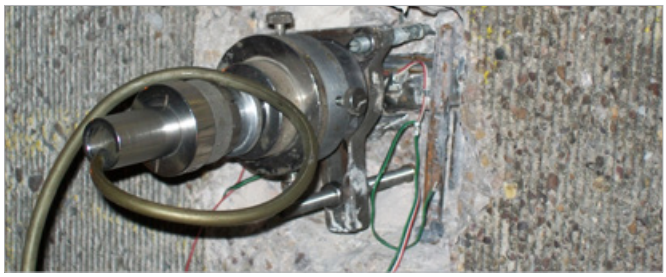
Concrete dead load stress measurement

Standard coring

Small diameter coring

Pressure compensation slotting

Post-tensioning tendons and reinforcing bars



Pre-stressing wires – centre hole method

Bars – centre hole method

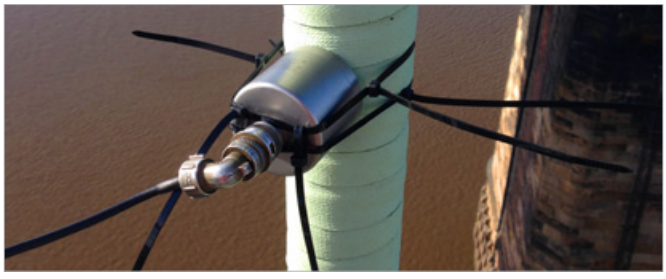
Masonry structures

Pressure compensation slotting

Steel structures

Centre hole method and through thickness drilling

Cable supported structures



Cables (wire strands)
– centre hole method or vibration method

Bars (e.g Macalloy bars)
– centre hole method or vibration method

Practical tests for civil engineering structures

Centre hole strain relief drilling method

We use the centre hole method to provide accurate data insights about your structure's dead load state. This semi-destructive technique uses strain gauge data to accurately determine residual stress. A small diameter hole is drilled in incremental steps with strain readings taken at each stage.To determine the stress regime, including principal stresses and orthogonal stresses, we use the relationship between surface strain change and drilling depth.

To meet your requirements, we offer a wide-range of services based on the centre-hole method:

Pre-stressing tendon test

With extensive calibration data, as well as a library of test configurations and material properties, asset owners and operators stand to benefit from highly accurate stress determination and tendon load calculation for tendons and bars. This test is a variant of the centre hole drilling method that uses a pair of strain gauges configured to suit the tendon wire geometry and space. For structures such as retaining walls, the same two-element technique can be used for passive reinforcing bars, to detect whether yield has been reached.

Global stress effects – coring

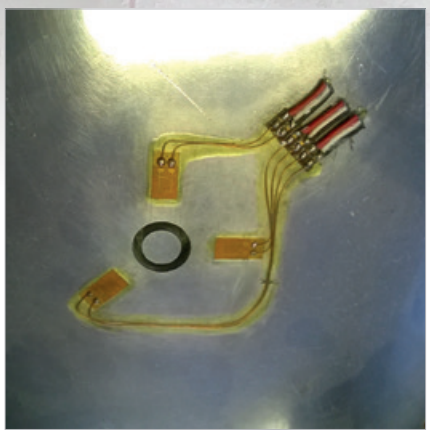
Concrete coring tests use strain gauges placed around and within a 78mm diameter core to measure strain changes throughout the coring process. The heat generated is carefully controlled through water cooling to ensure that strain readings remain unaffected. To determine stress, we identify and use Young's Modulus, which can be measured by using a jack inside the core hole, or through laboratory testing of the recovered core.

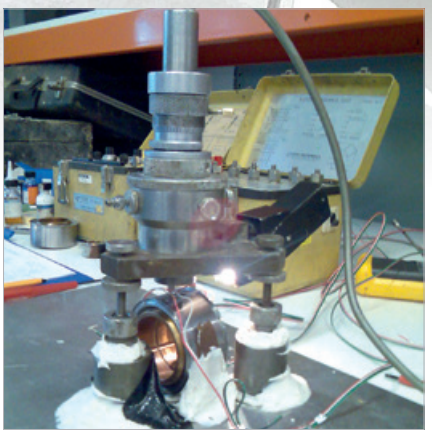
When the space between rebars or tendons is insufficient for a standard coring test, an array of smaller diameter cores of 36mm or 45mm can be used. This is typically deployed when testing pre-stressed beams.

Pressure compensation slotting

This method involves the cutting of a slot to a certain depth between two parallel bars, which have displacement sensors fitted to their ends. After readings are taken at the start of the test, the disc saw is used to produce a segment shaped slot into which a matching curved flat jack can be inserted. Following this, further readings are taken from the displacement sensors. Stress is then reapplied by using the flat jack to determine the pressure required to return the displacement sensor values to their pre-test values. Therefore, the pressure in the jack is the same as the average stress relieved by cutting the slot. This is a direct measurement of the stress in the structure once the slot deformation recovers.

Pressure compensation slotting is a highly accurate approach as it calculates stress directly from the jack pressure. It does not require a known Young's Modulus as the technique uses relative strain to determine the structure's in-situ stress.





Centre hole method for metallic structures

Although in-situ stresses in metallic structures can be measured through standard ASTM E837 tests, these methods are less accurate as they usually concentrate on surface stresses, which are primarily determined by stresses locked into the material through its manufacturing processes. JF Strainstall has a range of gauges and techniques that enable us to select the optimum hole diameter and depth to determine in-situ stresses that are isolated from the surface and related to dead load stresses. Our team is highly experienced in setting up, performing and processing tests, which are critical to delivering accurate results.

JF Strainstall also offers through-thickness stress determination to get an even more accurate understanding of the average stress across a section. With through-thickness stress determination, stress is measured from each side using drilled hole diameters that equal the section's thickness. This enables more accurate determination of dead load stress, by cancelling out the residual stresses associated with the material manufacturing processes.

Vibration method

For tie rods, bridge stay cables, suspension hangers and other tensioned bars or cables, the tensile force in each element can be estimated accurately by measuring its natural frequency of vibration.

It is an effective non-destructive technique that can be deployed quickly. Its main limitation is related to the empirical equations used to relate vibration frequency to tension – the element is modelled as a string and must be very slender

About JF Strainstall

James Fisher Strainstall (JF Strainstall) is a world leader in the development of innovative monitoring solutions to enhance the safety and performance of your assets.

Drawing on more than 50 years' experience, we develop and apply our innovative technology, including load, strain and stress measuring techniques, within a wide range of sectors including marine, offshore, civil engineering, rail and aerospace.

In 2016, JF Strainstall celebrated 50 years at the forefront of developing innovative monitoring solutions for our customers.

We specialise in the design and manufacture of standard and bespoke load cells, strain gauges and integrated systems, which are proven to perform year after year in hostile and hazardous environments.

Whether a project is large or small, we provide a range of services including hull stress monitoring, crane weighing and overload, tendon and riser tension monitoring in TLPs.

Our instrumentation and software systems capture and analyse data on parameters such as strain, displacement, inclination, temperature, vibration and water levels to provide asset owners and operators with a comprehensive and real-time overview of events to realise optimum performance.

JF Strainstall has been part of James Fisher and Sons plc since 2006. James Fisher is a leading provider of specialist services to the marine, oil and gas and other high assurance industries worldwide.

Construction and temporary works monitoring

Data services

In-situ stress measurement

Smart asset management SAMS

Straingauge

Test equiptment

Weather monitoring

Safety and control systems

Structural investigation

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