How to measure the loads a crane jib can withstand?

Experimental stress analysis of components

Various tests are performed to determine the safety and adequate design of components. In the process, some test parts are stressed to the point of destruction. This approach is particularly important for elements that are subject to high mechanical stress, such as commercial and construction vehicles. Strain gauges are often used to measure the forces acting on the parts. The subsequent analysis of the measured data makes it possible to check if the system meets design intent.

Measure loads to verify design

To ensure that components are optimally manufactured, they are thoroughly tested for various types of stress. The aim is to achieve the right balance between material and manufacturing costs while ensuring sufficient safety and durability. A distinction is made between measurements of the loads in real operation or at the limit, and destructive tests. One way to collect data is with experimental stress analysis using strain gauges. In destructive tests, the strain gauges are applied to the relevant points and the components are then loaded until they reach the point of material fatigue. Construction machines and their parts are tested in special test centers to enable accurate statements to be made regarding maximum overload. With the measured stress curves, the calculations of the design department can be verified to determine the ideal material design.

Many strain gauges required

Efficient execution of the required tests saves time and costs in the testing processes, so a coordinated measurement technology solution can help to simplify the workflows. At the same time, the data from many stain gauges must be acquired synchronously for the precise measurement of the mechanical stresses in the structures of the various jib sections. A data rate of at least 200 Hz per measurement channel is also necessary for the desired accuracy, as well as a high total sampling rate to synchronize the numerous measurement channels. Since short-term peaks are also to be expected, the measurement range needs to be sufficient to capture these spikes.

Thought-out process for quick and accurate results

For the investigation, the jibs of two cranes were each equipped with 48 strain gauges. Some of the strain gauges were applied as single strain gauges, while three strain gauges were glued to the center of the flanks as a rosette to measure stress curves. To compensate for temperature influences, self-compensating strain gauges were selected specifically for the material of the crane jibs and connected to **STG6 BK20** modules. The strain gauge sensor cables from CSM offer internal half-bridge completion close to the sensor. The measurement modules allow the internal conversion of the measurement signal directly into strain. Thus, the measurement channel outputs the measured variable as µm/m, since the necessary material- and sensor-specific factors can be easily entered with CSMconfig software and saved in the module. This simplifies the subsequent analysis, since no conversion is necessary after the measurement. At the same time, the data from all 48 strain gauges are acquired synchronously. All STG6 BK20 modules are networked via EtherCAT® and connected to an **XCP-Gateway** as a protocol converter. The XCP-Gateway acts as an EtherCAT® master for all measurement modules, ensures time synchronization and allows easy connection to Vector's **vMeasure** data acquisition software.

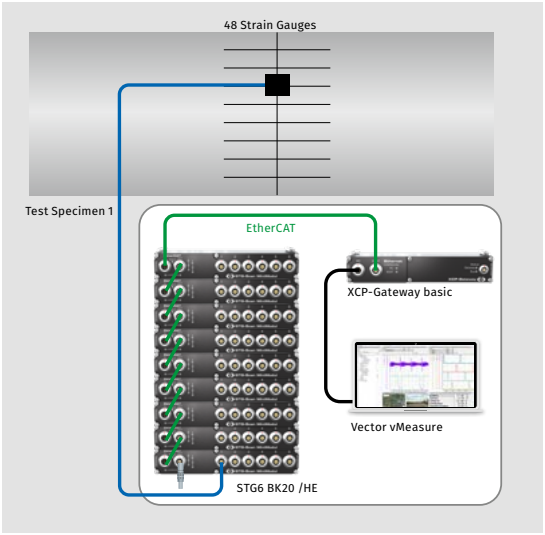

Fig. 1: CSM STG6 BK20 measurement modules synchronously collect data from 48 measurement channels. These are configured with CSMconfig.

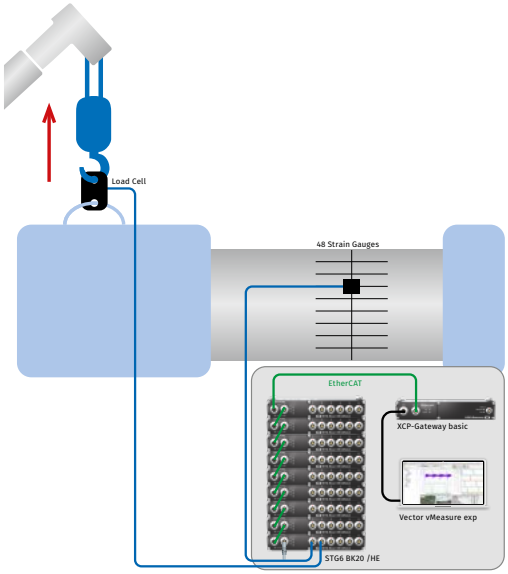

Fig. 2: The measurement modules are transported to the test area with the test specimen. Here, the test specimen is fixed on one side and the desired load is applied by lifting on the other end.

Transportation and test of the components on the test bench

The test cranes are individually equipped with the strain gauges and measurement modules and then prepared for transport to the test stand. While one jib section is undergoing the test, another one is already being prepared to ensure a seamless process. Before the measurement begins, all measurement channels are zeroed again in CSMconfig. At the test stand, the jib section is mounted on one side and fixed to the floor, while the test object is loaded via the free side. A load cell is used to measure the force applied until the jib breaks. The measurement range of the STG6 BK20 is large enough to capture a wide range of signals. At the same time, the tests are accompanied by high-speed cameras, which also help to visualize the progression of the damage.

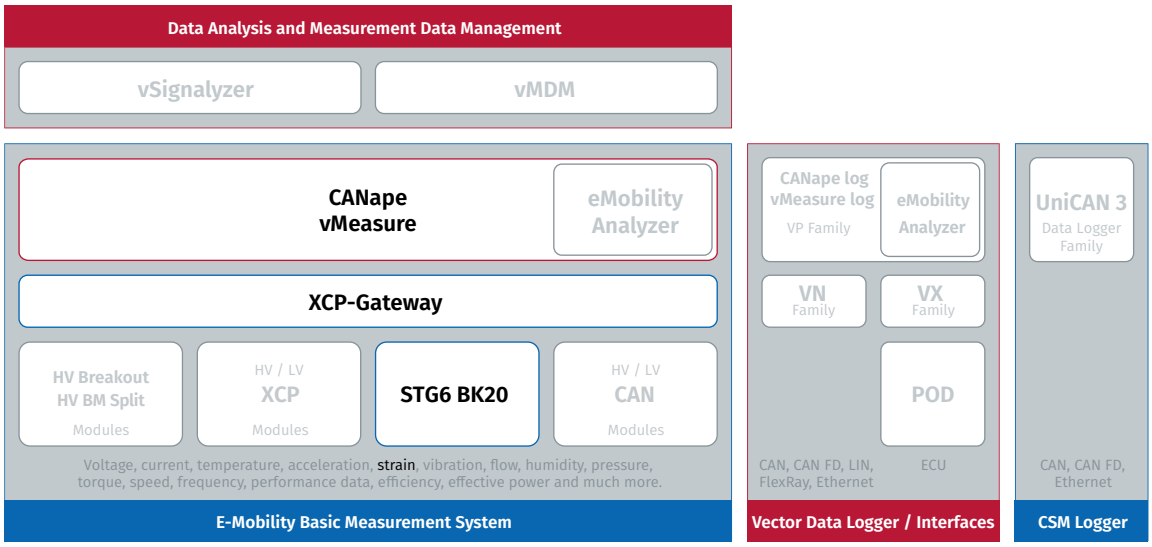

Fig. 3: The experimental stress analysis on crane booms in the systematics of the Vector CSM E-Mobility Measurement System

Robust measurement technology

The compact and weatherproof measurement technology makes it possible to work in parallel during preparation and the actual test. It can be easily transported with the test object to the respective locations. The simple cabling and configuration with **CSMconfig** also ensures efficiency. Due to the data transmission via EtherCAT®, all measurement points can be recorded synchronously. Measurements of mechanical load can be performed quickly and accurately in this way.

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