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A NEW DESIGN OF A 5,4MN BUILD-UP SYSTEM

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Abstract: The main purpose of the build-up system is the use in verification measurements of force standard machines up to 5MN or even higher capacity. The special design of the described build-up system allows the use of nine force transfer standards either individually, in groups of three transducers or all transducers together in three groups of three. A 9- channel digital measuring amplifier (GTM VN-Digitizer 3.0) enables the user to get the readout of all transducers simultaneously.

Keywords: build-up, force-transducer, calibration

1. INTRODUCTION

The most accurate machines for force generation are deadweight machines. Machines of this type are mostly limited to capacities of 1000kN or less, the number of machine exceeding this capacity is small. Higher ranges for force measurement are realized by other types of force machines such as for example hydraulic machines. Such machines do not generate the force directly with deadweights and therefore have to be calibrated with other methods. A build-up system enables a traceable calibration for these machines.

2. DESIGN OF THE BUILD-UP SYSTEM

The 9 x 600 kN build-up-system (Fig. 1.) has been developed specially for verification measurements of force standard machines up to 5,4 MN capacity. The primary reference is from a 1000 kN force standard machine.

The design is modular, which means that the force transfer standard load cells (Pos. 20) used in its construction can be used either individually, or in groups of three, or in three groups of three each loaded together.

The complete system includes a 9-channel digital measuring amplifier (GTM VN-Digitizer 3.0), in order to allow truly synchronous readout of all load cells and to simplify numerical correction and addition.

In order to achieve the highest possible repeatability, GTM force transfer standards of the type KTN-D are used for the 9 individual sensors. These bending ring transfer standards have been developed specially for machine intercomparison measurements and offer the lowest measuring uncertainty available at present. Their use in comparison measurements has been well documented. They are of stainless steel construction, hermetically sealed, and specially compensated to achieve extremely low eccentricity error and temperature effects. The force introduction into the load cells is designed as a pendulum strut (Pos. 10, 17, 9, 11, 18). This offers statically determined conditions even in multiple cell arrangements and further reduces the influence of lateral forces and misalignment.

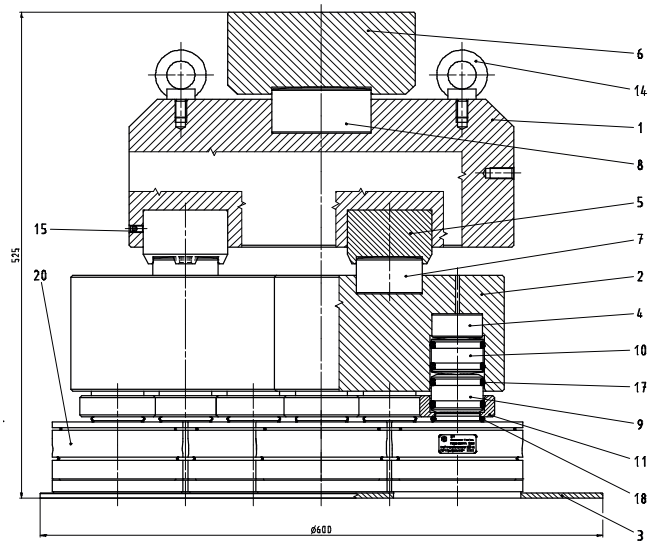

Fig. 1. Build-Up System 5,4MN

All 9 force transfer standards and pendulum assemblies are machined to practically the same hight, in order to minimise alignment problems.

Three of the 600 kN force transfer standards can be arranged such that they form a 1800 kN build-up-system. This is achieved by using a spacer disk which positions the sensors accordingly, and an interconnection plate (Pos. 2) which links the three pendulums together and has a spherical top interface (Pos. 7).

Due to the characteristics of the single load cell design, these plates and the whole assembly are still very compact and light. Thereby, the assembly is essentially similar to a single 1800 kN transfer standard.

As with the individual load cells, it is possible to arrange three of the 1800 kN build-up systems into a group, and joining them at the top interface with an additional plate (Pos. 1). This yields essentially the same advantages as outlined above.

In order to reduce height and weight, whilst making the handling easier, no extra bottom plate is required. A light-weight spacer disk (Pos. 3) keeps all three sub-assemblies at their relevant positions.

The top disk again links the 1800 kN build-up systems to a single domed top, using a hardened load spacer (Pos. 6 + 8).

The VN-Digitizer 3.0 (Fig. 2.) uses five PC-based high-precision force transducer interface cards (GTM PC-DMS) for the amplification and data acquisition of all nine individual transfer standards. Each card has two channels, there is one channel not used for the build-up-system. All channels are completely synchronized and each channel is assigned to a certain transducer. A 3rd order polynomial stored for each transducer linearize its output signal across the measuring range.

The VN-Digitizer 3.0 user surface is especially designed for the usage of the build-up-system. All nine channels are indicated together with the calculated average of the three groups as well as the average of all nine transducers.

Fig. 2. VN-DIGITIZER 3.0

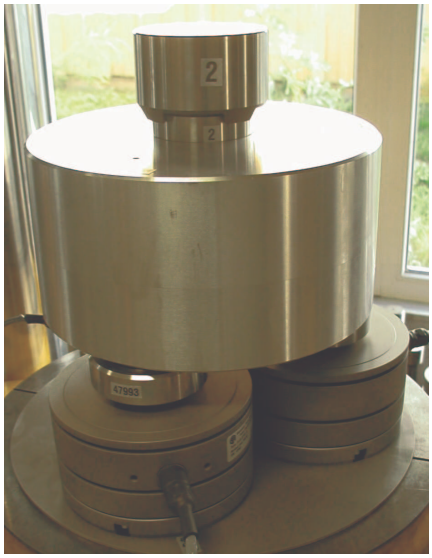

Fig. 3. COMPLETED BUILD-UP SYSTEM 1800kN

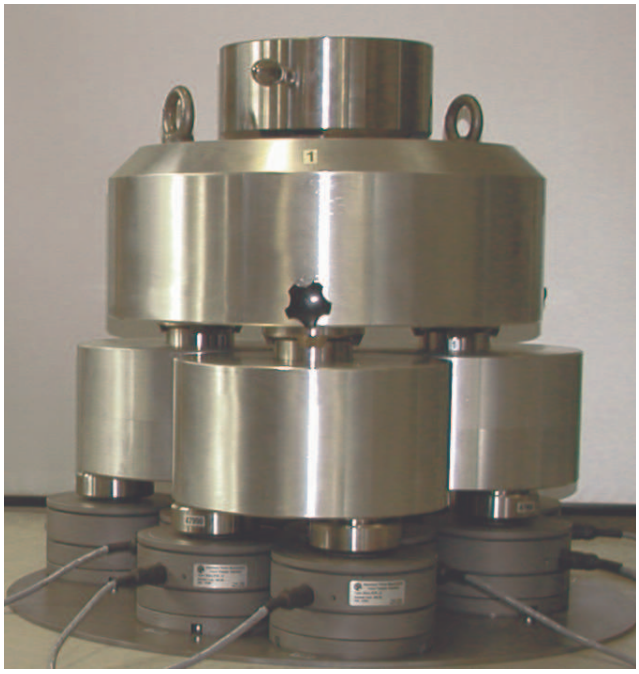

Fig. 4. COMPLETED BUILD-UP SYTEM 5400kN

Fig. 5. BUILD-UP SYSTEM 5400kN (PRINCIPLE)

3. CONCLUSION

A new easily manageable and flexible build-up system using 9 calibrated GTM force transfer standards can be used to calibrate force standard machines with high capacities. The modular design of the new 5,4MN build-up system enables calibrations in three ranges:

100kN – 600kN with a single 600kN transducer
300kN – 1800kN with the 1800 build-up system (Fig. 3.)
900kN –5400kN with the 5400kN build-up system (Fig. 4.)

REFERENCES

[1] L. J. B. Maybank, A. J. Knott, "Uncertainty of Force Measurement in Build-Up Procedures," Proceedings of the XV IMEKO World Congress, Osaka, 1999.