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INTERCOMPARISON OF 3 MN HYDRAULIC TYPE BUILD-UP AND 1.1 MN LEVER AMPLIFICATION FORCE STANDARD MACHINE BETWEEN UME AND PTB

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Abstract : The 1.1 MN lever amplification dead weight force standard machine (FSM) and a new 3 MN hydraulic type build up FSM were installed at UME in 1995 and 2002 respectively. Both machines were regularly intercompared to each other and to PTB to maintain the performances. After making a new cooperation contract, a new intercomparison measurment were organised to see the existing performances of the both machines. The measurement results show that relative measurement uncertainty of the machines are better than 1×10^{-4} for 1.1 MN machine and better than 4×10^{-4} for 3 MN build-up machine of UME.

Keywords: Lever amplification machine, Built-up force standard machine, intecomparison results

1. BASIC INFORMATION

The 110 kN/1.1 MN lever amplification dead weight force standard machine was constructed by GTM have been installed into UME Force Measurement Laboratory in 1995. After installation of this machine three intercomparison measurements between UME and PTB Force Standard Machines was realized using with PTB force transfer standards in 1995 and 1997 and 2000. These are reported in different IMEKO TC3 conferences [1-3]

Fig.1. shows the general view of the 110 kN/1.1 MN lever amplification machine of UME.

The dead weight side of the machine can be used as an independent force standard machine to generate forces of 2 kN up to 110 kN with force ranges 20 kN, 50 kN and 100 kN. The dead weight side has one stack of 25 weights, which is produced by chemically nickel-plated mild steel discs.

The lever amplification is realized with a single lever and a transmission ratio of 1:10. With lever multiplication, the forces are generated from 20 kN up to 1.1 MN with force ranges 200 kN, 500 kN and 1 MN. Each force ranges in both side of this machine have 10 steps with 10% increment. At the same time, loading of 10 % additional force is possible for overloading test of force proving instrument in each force ranges. A compression and tension space are provided on both the dead weight side and lever side.

The 3 MN hydraulic built-up UME machine is fully computer controlled and a pressure transducer assembled directly to main piston-cylinder gets continuous feed-back signal to protect the whole system at any time. The hydraulic system is produced as to be closed system. This system has been developed as to operate the machine for calibration both automatically and manually. This means calibration can be performed according to predetermined procedure by software and full data can be recorded and calibration certificate generated by the help of software programme. In the manual mode, forces are selected and applied on the transducers and data are recorded by manual operation functions

A general view of the machines is shown in Figure 1 and Figure 2.

Fig.1 110kN / 1.1MN lever amplification dead weight force standard machine

Hydraulic type build up force standard machine uses a 3 MN build-up force transducers in which a group of three 1 MN capacity transducers are placed in parallel for reference force values and signals. Build-up method is quite efficient and it substitutes with great advantages and economy of resources the force standardization machines of high capacity. The biggest advantage of using 3 MN build-up system shown in Figure 3 is the supplement of traceability over 1 MN UME force standard machine for calibration of each individual 1 MN reference transducers [4].

Fig. 2 3 MN Hydraulic built-up force standard machine

2. COMPARISON MEASUREMENTS

Transfer force transducers with capacities of 500 kN, 1 MN and 3 MN which are manufactured by GTM are used in this intercomparison measurements. The transducer list and used force steps given in Table 1. The measurement procedure is based on the comparison of the measurement results obtained in PTB and UME Force Measurement Laboratories. The measurements were made to determine the relative deviations among the various forces realized by PTB and UME. First measurements of 500 kN, 1 MN and 3 MN transfer force transducers were performed in 1.1 MN UME lever amplification machine and 3 MN UME hydraulic built-up machine. Then, they were measured in 1 MN and 2 MN PTB dead weight machines and 16.5 MN PTB hydraulic amplification machine. Then last measurements were repeated at UME. Avarage force values were compared to each other according to international comparison measurement evaluation procedure [1]. Evaluation results calculated from equation (1) as relative deviation (RD) betwen PTB and UME machines and all the results are given in Figure 3 and Figure 4.

$$RD = \frac{X_{UME} - X_{PTB}}{X_{PTB}} \quad (1)$$

TABLE I. Transfer force transducer used in comparison test

Force transducer	Force steps (kN)
500 kN	100, 200, 250, 300, 350, 400, 500
1 MN	200, 400, 500, 600, 800, 900, 1000
3 MN	300, 600, 900, 1200, 1800, 2400, 3000

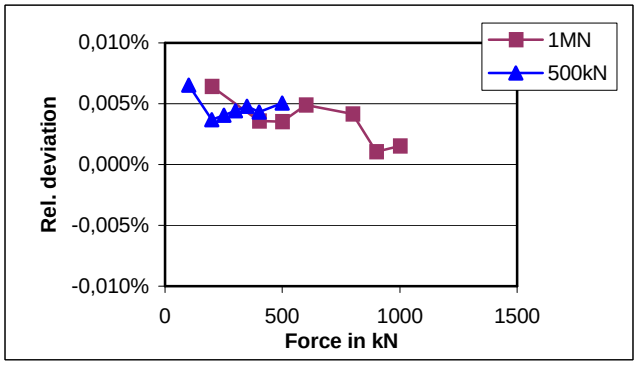

Fig. 3. Comparison results of 1.1 MN UME Built-up machine

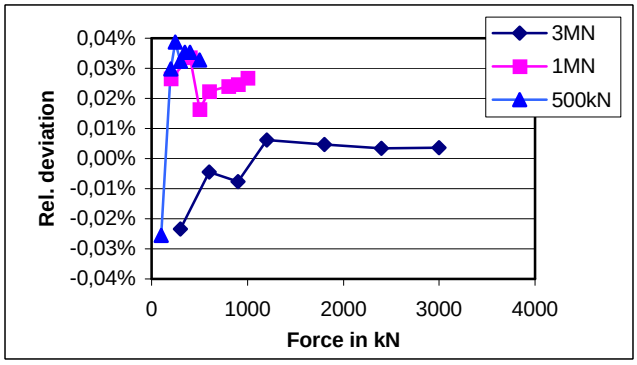

Fig. 4. Comparison results of 3 MN UME Built-up machine

3.CONCLUSIONS

The performance test results show that relative measurement uncertainty of 1.1 MN machine is better than 1×10^{-1} and a 3 MN build-up machine of UME is better than 4×10^{-4} .

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