EFFECT OF TEST SPEED ON VERIFICATION OF MATERIAL TESTING MACHINE

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ABSTRACT

In order to verify material testing machine, constant test speed is necessary for satisfactory results. According to EN 10002-2 or EN ISO 7500-1 standards, all the verifications shall be carried out with a slowly increasing force. This means that test speed should be low as much as possible. But it is not specified in the standards. If the machine is capable to hold the selected force in quasi-static conditions, in this case selected forces are applied step by step during verification. In some cases, material testing machine cannot capable to hold quasi-static force. In this case, it causes the error due to difficulty of reading and getting the data. Sometimes, machine cannot adjust the slow test speed; in this case results are doubtful. In this study, measurements were realized in tension testing machine using force-proving instruments, which comply with the requirements specified in EN ISO 376 and EN 10002-3. The class of the instrument is 00 as well. Similar measurements were repeated during different test speed conditions to compare results and determine the effect of test speed on the verification results. At the same time, step-by-step and continuously increasing forces during identical test speed condition are compared to determine the effect of loading conditions. Measurement results show that different test speed and loading conditions during verification of material testing machine effect the verification results. In this study these results are discussed and findings are presented.

1. INTRODUCTION

Most of the verifications are carried out in according to EN 10002-2 or EN ISO 7500-1 standards in the European Community for verification of material testing machines [1-2]. Constant test speed is necessary for satisfactory results. All the verifications shall be carried out with a slowly increasing force according to standards. This means that test speed should be low as much as possible. But it is not specified in the standards. If the machine is capable to hold the selected force in quasi-static conditions, in this case selected forces are applied step by step during verification. In some cases, material testing machine cannot capable to hold quasi-static force. In this case, it causes the error due to difficulty of reading and getting the data. Sometimes, machine cannot adjust the slow test speed; in this case results are doubtful.

In this study, computer controlled material testing machine having 250 kN capacity were verified in different crosshead speed of the machine. 10 kN, 100 kN and 250 kN capacities Class 00 force transducers were used during measurements. These reference transducers are traceable to national standards, which were calibrated by EN ISO 376 in UME (Ulusal Metroloji Enstitusu - National Metrology Institute). Verification was performed according to EN ISO 7500-1 procedure. In order to determine effect of test speed three different crosshead speeds which are 0.05 mm/min., 0.2 mm/min and 1 mm/min was selected. These speeds are applied continuously and step-by-step. Results show that higher speed over the 0.05 mm/min influence the repeatability of the results and cause the changing of the verification results. This study and determined results are presented in detail.

2. EXPERIMENTAL STUDY

Three Class 00 (by EN ISO 376) reference tension type force transducers shown in Table 1 have been used during measurements and verification [3]. Indicating instrument of the force transducers is VN Digitizer produced by GTM (Fig. 1).

Table 1: The Force Transducers and Measurement Ranges

Force Capacity	Transducer Type	Class	Producer
10 kN	Tension	00	INTERFACE
100 kN	Tension	00	INTERFACE
250 kN	Tension	00	INTERFACE

All measurements have been performed in Zwick / Roell BZ250/SN5A type computer controlled material testing (Class 0.5) machine (Fig. 1). Test speeds are adjustable by the computer to allow making experiments of this study.

Laboratory conditions are controlled at 21±1 °C and 45±5 % RH continuously.

Measurement procedure to determine crosshead speed of the machine on the accuracy and repeatability of the results are explained in below.

Three different speeds, which are 0.05 mm/min., 0.2 mm/min and 1 mm/min, were applied on the reference transducers in continuous and step by step loading conditions. Data was taken in three increasing series in which ten steps. In continuous loading conditions, after reaching the specified force value, 10 seconds were waited before taking the data.

Figure 1. Material Testing Machine and Calibration System (indicator + load cell)

3. MEASUREMENT RESULTS

In this study accuracy values (q) were compared to see effect of speed on the results. As it known that "q" values are most important parameters for the accuracy class of the material testing machines. At the same time accuracy directly related to repeatability of the measurements. In this case only, accuracy of the verified machine were compared and evaluated at the end of measurements. Accuracy of the measurement results of 10 kN, 100 kN and 250 kN reference transducers are given in the Table 1, Table 2 and Table 3.

Table 2. Accuracy change of 10 kN ref. transducer in different speeds and loading conditions

10 kN Transducer Force steps	**Crosshead Speeds of The Machine**					
	0.05 mm/min		**0.2 mm/min**		**1 mm/min**	
	Continuous Loading	**Step by Step Loading**	**Continuous Loading**	**Step by Step Loading**	**Continuous Loading**	**Step by Step Loading**
kN	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**
1	0.186	0.147	0.551	0.117	1.505	0.121
2	0.163	0.142	0.541	0.097	1.186	0.087
3	0.170	0.151	0.522	0.125	0.917	0.118
4	0.148	0.133	0.494	0.112	0.696	0.109
5	0.180	0.128	0.457	0.120	0.524	0.087
6	0.164	0.128	0.411	0.119	0.399	0.118
7	0.146	0.122	0.356	0.119	0.321	0.113
8	0.146	0.125	0.292	0.125	0.290	0.095
9	0.108	0.124	0.219	0.124	0.306	0.115
10	0.100	0.122	0.137	0.129	0.369	0.116

Table 3. Accuracy change of 100 kN ref. transducer in different speeds and loading conditions

100 kN Transducer Force steps	**Crosshead Speeds of The Machine**					
	0.05 mm/min		**0.2 mm/min**		**1 mm/min**	
	Continuous Loading	**Step by Step Loading**	**Continuous Loading**	**Step by Step Loading**	**Continuous Loading**	**Step by Step Loading**
kN	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**	**Accuracy (q) %**
10	0.034	0.092	0.252	0.058	0.991	0.029
20	0.046	0.094	0.221	0.066	0.813	0.036
30	0.057	0.096	0.194	0.072	0.659	0.043
40	0.066	0.098	0.172	0.078	0.530	0.051
50	0.074	0.101	0.154	0.084	0.425	0.059
60	0.080	0.103	0.140	0.089	0.343	0.067
70	0.084	0.106	0.131	0.094	0.285	0.075
80	0.087	0.109	0.126	0.097	0.250	0.084
90	0.089	0.112	0.126	0.101	0.239	0.092
100	0.088	0.115	0.130	0.104	0.251	0.101

Table 4. Accuracy change of 250 kN ref. transducer in different speeds and loading conditions

250 kN Transducer Force steps	Crosshead Speeds of The Machine					
	0.05 mm/min		0.2 mm/min		1 mm/min	
	Continuous Loading	Step by Step Loading	Continuous Loading	Step by Step Loading	Continuous Loading	Step by Step Loading
KN	Accuracy (q) %	Accuracy (q) %	Accuracy (q) %	Accuracy (q) %	Accuracy (q) %	Accuracy (q) %
25	-0.007	-0.082	0.080	-0.056	0.435	-0.053
50	-0.001	-0.050	0.071	-0.024	0.367	-0.022
75	0.005	-0.022	0.064	0.005	0.306	0.005
100	0.012	0.004	0.060	0.030	0.255	0.029
125	0.020	0.026	0.058	0.053	0.212	0.051
150	0.027	0.045	0.058	0.072	0.178	0.069
175	0.035	0.062	0.060	0.088	0.153	0.084
200	0.044	0.075	0.064	0.100	0.136	0.097
225	0.052	0.085	0.071	0.110	0.127	0.106
250	0.062	0.092	0.080	0.116	0.128	0.112

In order to see the results in graphical representation, Fig. 2. Fig. 3 and Fig. 4 were presented.

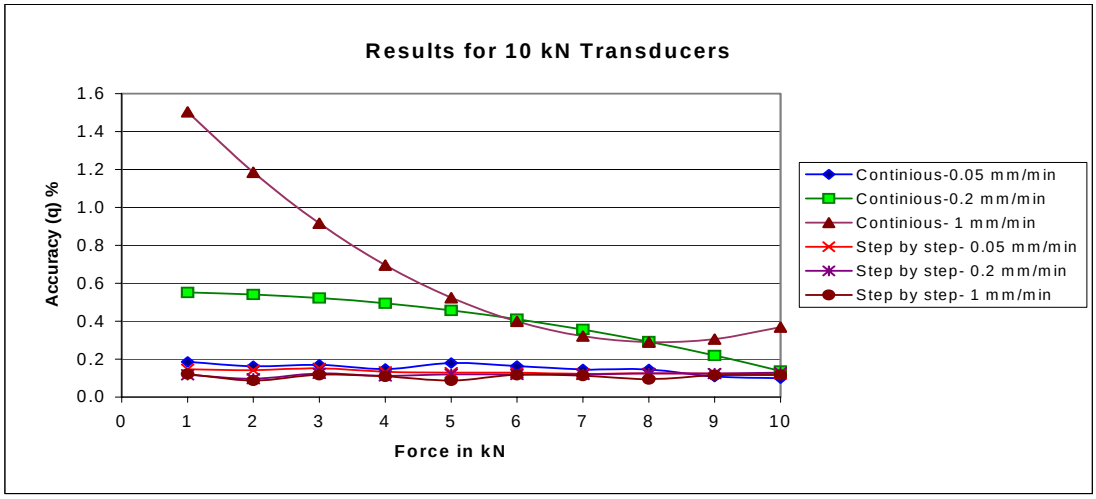

Figure 2. Effect of crosshead speeds on the accuracy of the machine in 10 kN ref. transducer measurements

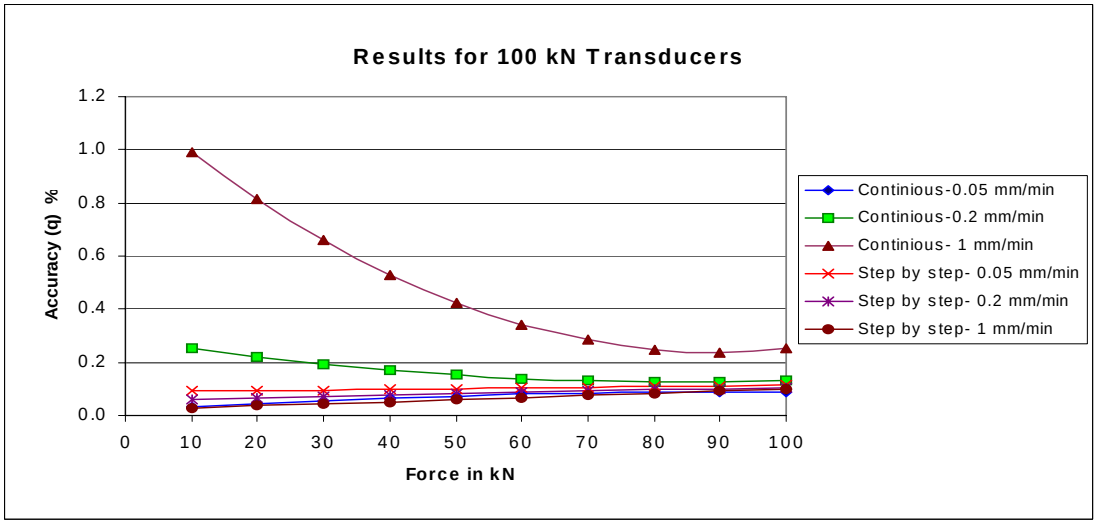

Figure 3. Effect of crosshead speeds on the accuracy of the machine in 100 kN ref. transducer measurements

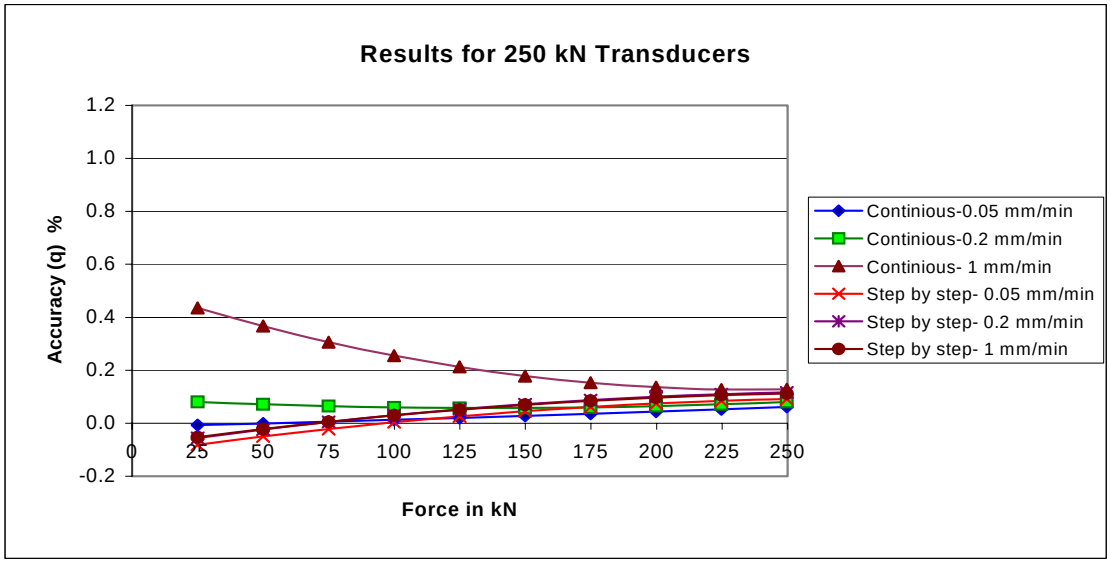

Figure 4. Effect of crosshead speeds on the accuracy of the machine in 250 kN ref. transducer measurements

As it shown in the graphics that in the increasing speed have more effects on the accuracy. Increasing speed of the crosshead of the machine influence the accuracy of the machine over the 0.2 mm/min speeds. In this case it is advised to make measurements below than 0.2 mm/min speeds. Otherwise, accuracy class of the machine can be changed due to speed of crosshead. It is better to verify material testing machine in step by step loading conditions instead of continuous loading if possible. Its advantage can be seen in Fig. 2 and Fig. 3 easily.

4. CONCLUSIONS

As it shown in the results that three is no difference in the accuracy values in the low speed below 0.2 mm/min. In this case, it is advised to make measurements in below than 0.2 mm/min speeds. Increasing speed cause the decrease of accuracy of the material testing machine. The best loading condition is step by step loading during verification. Because, data is taken quite difficult during continuous loading and this cause the errors during measurements. Although step by step loading is applicable both slow and high speed, continuous loading is allowable only slow speed conditions.

REFERENCES

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