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INVESTIGATION OF THE MEASUREMENT CAPABILITY OF ROLL BRAKE TESTER BY THE TEST TRAIL

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Abstract – The investigation of the roll brake testers used testing for trucks has been made during year 2002. There have been developed a test trail [1], reported in TC-3 Congress Celle 2002. The aim of this investigation was to get information about real measurement capability of the roll brake testers used in inspection of the trucks for Finnish authority (The Finnish Vehicle Administration AKE). The usually way to calibrate roll brake tester has been to generate the reference force direct against of the force measurement transducer. This calibration does neither take in to account the mechanical construction of the rollers nor the diameters of them or the dynamic behaviour of the measurement. The investigation gives the information over practical uncertainty of the roll brake tester. The used comparing method has been static with the reference transducer as well quasistatic by the test trail, which makes the control of roll brake testers with the speed of normal use of a roll brake tester, about 3 km/h.

Keywords: torque, brake test, measurement uncertainty.

1. CONSRUCTION OF THE ROLL BRAKE TESTERS

The roll brake tester has hast two rollers for each wheel of the axle. The rollers are connected together by a chain with electrical motor, which rotates this systems and the wheel on the rollers. The driving motor is supported on the bearings, which makes possible in principal the free rotation of the motor. This free movement is used to measure the counterforce to rotate the wheel and as well the braking force. Fixing the motor by on force transducer prohibits the free rotation and the force transducer gives the information of the measured force. Figure 1 gives the principal information of the construction.

The measured value of the braking force is indicated on the analogue scale, giving rough information of that. Additional the measured signal of the force is as input for the PC, where the calculation of the theoretical braking force up to 50 kN …60 kN is made. There is a calculation program on PC, which calculates the extrapolation of the braking force from 2 bar braking pressure up to 6 bar. In praxis the measurement is possible only with a braking force 15 kN …25 kN due the insufficient friction between wheel and rolls. This value corresponds approximately with the value of 2 bar by braking pressure. The maximum braking pressure is 6 bar and the braking force for this value is in interest by inspection of trucks.

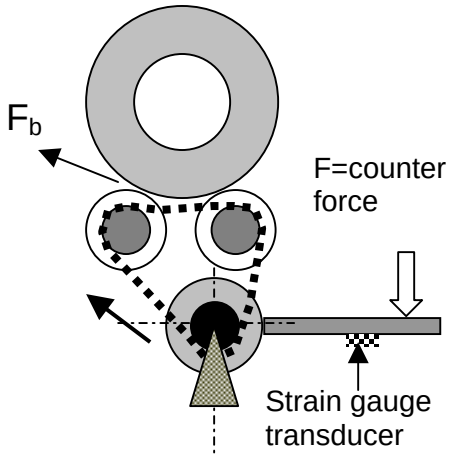

Figure 1. Principle of the roll brake tester.

2. STATE OF THE ART TO CALIBRATE THE ROLL BRAKE TESTERS

Actual measured quantity, which should be calibrated, is the tangential braking force on the surface of the roll. However the used method for calibration of the roll brake tester is to compare the capability of the force transducers against reference force. This reference force is built in most cases by a beam and weights or in few cases by a reference transducer. This calibration method did not take care of the chain or bearing of the rollers or of the motor. These components in the measurement uncertainty can

be low relative to needed accuracy. More important is that it does not take care of the diameter of the rolls. The theoretical value for force is calculated for new roll and the diameter varies normally by different manufacturer from 200 mm up to 350 mm. The measured diameter have had a value during the wear and tear up to 10 mm less than original, which means for diameter 200 mm an error 5 %. The calibration of the transducers did not take in to account as well the error of the length by supporting beam of electro motor. Figure 2 gives examples of the calibration methods.

The results of the measurement indicate on analogue indicators, which are more informative. Unfortunately in most cases the calibration is made only for analogue indication, not for signal used in the calculation by PC, which is the determinant element for measurement. The manufacturer of the roll brake testers equipments are giving the measurement uncertainty for measured braking force about 1 % …3 % of full range.

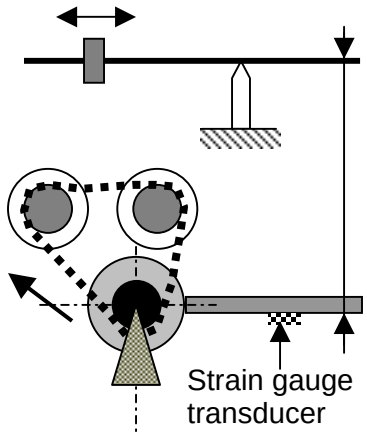

Figure 2. Calibration principle by a beam and weigth.

At least in Finland the calibration devices do not have any kind of calibration certificate from accredited laboratory and as well not calibration certificate with an uncertainty calculation.

3. USED METHODS TO CHECK THE CALIBRATION OF ROLL BRAKE TESTERS

The investigation has been made in two phases. The first step was to check statically the indication of analogue devices as well the indication on PC. For this task has been used a beam fixed direct on the roll of test device. The beam had a length of 1000 mm and a hydraulic jack loaded the system. Between the loading jack and beam was connected a force transducer to measure the loading force.

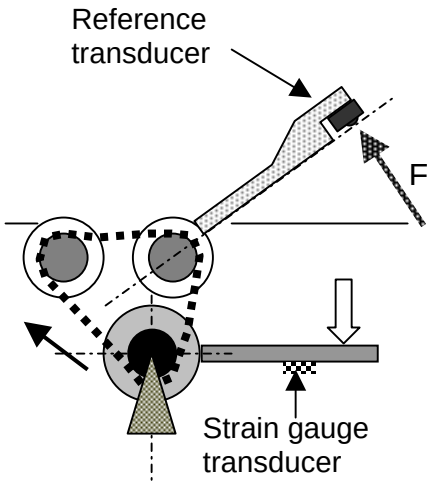

Figure 3. The scheme shows the principle of the static calibration with reference transducer.

Unfortunately it was not possible to measure all type of roll brake testers by this method because used system needed the locking of the gearing box and for some type of devices it was not possible to lock it. Figure 3 gives the illumination of the system. The calculated uncertainty for the reference value is 0,5 % from measured value.

The table 1 shows the results with different devices. If possible, the indication was read always from PC-input. But in some cases it was possible to take the readings only from analogue indication. The first column of the table indicates the way to take the readings of measured force. The second column test station, where the work has been done. Second and third column indicates the manufacturers, which can be different for test device and for PC-program. Fifth column has the maximum measured force by the device. On the sixth column are the differences for zero point and for extrapolated force by 25 kN. Seventh column indicates the measured wheel of the axle and last column gives the difference of the measured force in percent.

Table 1. The result of the measurements with reference transducer.

Measured value read from	Test station	Manuf. of the tester	Manuf. of the evaluation program	Maximum of the measured force by test station	Differen ce of the measure d values		End of the axle	Difference at 25 kN in %
					0 kN	Extrapolation to 25 kN		
PC-indication	8	A1	F	15,0	0,101	0,779	Right	3,1 %
PC-indication			F		-0,014	0,884	Left	3,5 %
PC-indication			B		0,141	-0,403	Right	-1,6 %
PC-indication			B		-0,015	-0,038	Left	-0,2 %
PC-indication	16	D1	F	15,0	-0,115	-0,253	Right	-1,0 %
PC-indication			F		-0,346	0,015	Left	0,1 %
Analogue indication			D		-0,040	1,109	Right	4,4 %
Analogue indication			D		-0,006	1,050	Left	4,2 %
Analogue indication	9	D1	D	15,0	0,544	8,813	Right	35,3 %
Analogue indication			D		0,250	7,943	Left	31,8 %
Analogue indication	15	D1	D	20,0	0,104	6,635	Right	26,5 %
Analogue indication			D		0,146	5,243	Left	21,0 %
PC-indication	6	D1	B	15,0	0,122	0,857	Right	3,4 %
PC-indication			B		0,067	1,510	Left	6,0 %
Analogue indication			D		0,122	0,857	Right	3,4 %
Analogue indication			D		0,067	1,510	Left	6,0 %
Analogue indication	10	D2	D	15,0	-0,077	1,300	Right	5,2 %
Analogue indication			D		-0,018	2,496	Left	10,0 %
Analogue indication	13	D2	D	15,0	0,127	1,431	Right	5,7 %
Analogue indication			D		0,287	2,127	Left	8,5 %
PC-indication	11	E	E	15	0,360	-1,010	Right	-4,00 %
PC-indication			E		0,120	-0,750	Left	-3,00 %
Analogue indication			E		0,080	-1,350	Right	-5,40 %
Analogue indication			E		-0,134	-0,825	Left	-3,30 %
PC-indication	12	A2	F	13	0,090	1,360	Right	5,40 %
Analogue indication			A		-0,050	0,850	Right	3,40 %
PC-indication	3	A2	B	11	-0,127	-0,610	Right	-2,40 %
Analogue indication			A		-0,065	-0,357	Right	-1,40 %

The number of measurements, which have had deviation to reference value more than 3 %, has been 22 from total 28 measurements. 12 measurements had an error higher than 5 %. Standard deviation has been about 10 %.

Second phase of the investigation was to use the test car [1] to check the calibration. This check is made dynamically and the results can be compared very easily direct on the report of roll brake tester. The uncertainty of the reference value by the test car is less than 1 % of measured value over values 2 kN of braking forces, below this value the uncertainty can increase up to 2 %. The test car simulates the normally three-axle truck and by this way the measurement has been repeated three times.

The true measurement uncertainty depend more of the practical maintenance of the tester. The investigation has shown, that the device can have a deviation from 5 % to 10 % to the true value and in some cases even more. The statistic over measurements shows:

Number of measurements	Deviation
7	< 5 %
6	5 % …10 %
6	> 10 %

There are in some cases different errors than by calibration with reference transducer. One station has been calibrated between the measurements but the deviation had increased by the calibration.

Table 2. Results of the calibrations by the test trail.

Test station	Type by the manufacturer	Prog-ram	Diff %	Date of the calibration	Date of the check	Time from calibr.	Remarks
1	A1	B	0,6 %	6.11.2002	12.11.2002	6 days	
2	B	B	-1,0 %	26.2.2002	6.11.2002	8,5 months	
3	A2	B	-1,0 %	13.5.2002	8.11.2002	ca. 6 months	With rf-sender for air
4	C	B	-1,3 %	30.10.2002	7.11.2002	ca. 1 week	
5	D1	B	1,4 %	6.6.2002	6.11.2002	5 months	
6	D1	B	-2,3 %	1.11.2002	11.11.2002	10 days	
3	A2	B	-2,6 %	13.5.2002	8.11.2002	ca. 6 months	Normal transd. for air
7	D2	B	4,0 %	5.3.2002	6.11.2002	8 months	
8	A1	F	6,1 %	24.10.2002	11.11.2002	2,5 weeks	
9	D1	D	8,3 %	22.11.2001	11.11.2002	all most 1 year	
10	D2	B	8,5 %	7.11.2001	5.11.2002	1 year	Before calibration
11	E	E	8,7 %	18.5.2002	11.11.2002	ca. 6 months	
12	A2	F	8,9 %	16.10.2002	8.11.2002	ca. 3 weeks	
8	A1	B	-9,0 %	24.10.2002	11.11.2002	2,5 weeks	
11	E	B	-11,8 %	18.5.2002	11.11.2002	ca. 6 months	
13	D2	D	12,1 %	8.10.2002	12.11.2002	ca. 1 months	
10	D2	B	12,4 %	5.11.2002	14.11.2002	9 days	After calibration
14	D1	F	14,4 %	12.12.2001	12.11.2002	11 months	
15	D1	D	17,1 %	27.11.2001	8.11.2002	11,5 months	
16	D1	F	21,9 %	11.6.2002	7.11.2002	ca. 5 months	

The test trail was used only to check the calibration, not to do the calibration. The test has been made on autumn, which has given various environmental especially with temperature. The uncertainty of the measurement is very important due the fact, that normally inspections are made in most cases by empty car and the brake force is maximal about 15 – 20 kN. To evaluate the value for maximum brake force and to get the approval, the maximum brake force is to extrapolate from measured value. The total brake force is approximately three times the measured value and to have the uncertainty of the final value below 10 %, the true measured value must have at least measurement uncertainty less than 3 %. This requirement is not realized according to results of this investigation.

2. CONCLUSION

The results have indicated, that the static calibration method used to day does not give guaranty for needed measurement uncertainty and in most of cases the measurement uncertainty will neither be calculated nor indicated. This investigation was the first step of a series of measurements. The planned program is build to have three stages. In the first stage measurement of the testers, about 30 pieces (without advance notice) and which has been done with results reported here; the second stage, recalibration of the testers by user; third stage, checking the change of the measurement capability due the recalibration. The results of the study will bee used to develop the static calibration method to answer the requirements for this kind of test devices. The test car is very suitable method for checking the measurement capability of roll brake tester, but it is not practical tool for daily work due the high cost. It will probably used only at intervals, maybe once in two year.

REFERENCES

[1] A.Pusa, “Traceability of the Calibration of Test Car for Roll Brake Tester”, IMEKO, TC3/TC5/TC20, Celle, 2002.

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