DEVICE AND TECHNOLOGY OF WAGON BOGIE Y25LSD TESTING

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Abstract

Current paper focuses on design, development, study and implementation of Device and Technology of Wagon Bogie Y25Lsd Testing. Used for measuring device includes 4 specialized force sensors incorporated in rail track. Wagon Bogie is subject to loading by forces in accordance with [1]. PC controls hydraulic system which carries into effect loading forces. Loading values of each bogie wheel as well as conform to loading geometric parameters are measured and recorded by means of DAQ. The system prints out protocols as to serviceability of bogie

Keywords: wagon bogie, testing, measuring device

1 Introduction

To guarantee the train traffic safety and reliability of wagon bogie elements, it is necessary to test the latter after being manufactured. The EU standard EN 13775-4:2004 determines the technology and conditions of loading with the test of a bogie.
In the practice of wagon factories in Bulgaria, there was no device to provide wagon bogie testing according to the standards mentioned.
For that purpose a device has been designed and built. It automatically implements the necessary conditions of loading and testing. That makes possible to exclude the subjective factor and save the results in the computer records.
The device consists of a metal structure, hydraulic system to perform loading, force sensors and electronic system to measure and control the conditions of loading. The general appearance of the device is shown in Figure.1.

2 The Structure and Main Features of the Device

The main technical data of the bogie Y25Lsd1 are as follows:
- width: 2347mm;
- length: 3250mm;
- height: 905mm. /from the central bearing to the head rail /;
- track-gauge 1435mm;
- distance between the bogie wheel axles: 1800mm.

The main technical parameters of the device are as follows.

Figure 1 General form of the device

The device presents a metal structure built from standard profiles. The general diagram of the stand is shown in Figure.2. The most important data: a width of 3370 mm; a length of 7000 mm; a height of not less than 2000 mm.

The main stages of measuring:

- setting and positioning of the bogie on the device;
- successive implementations of loads ordered, measurement of the load in wheels and geometric dimensions under control;
- introduction of the geometric dimensions measured in the computer;
- printing of protocols.

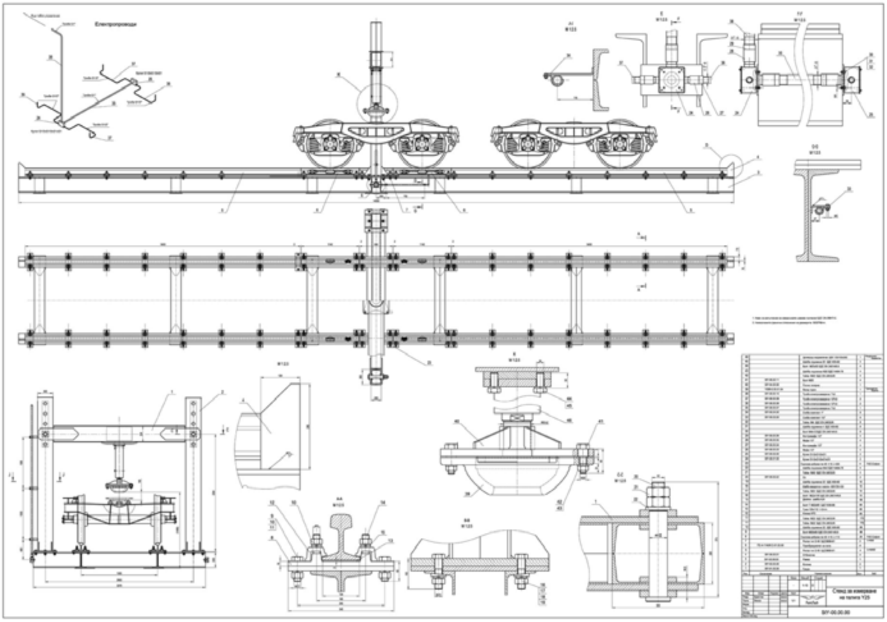

Figure 2 General form of the device draft

2.1 Strength calculations of the device for bogies

Taking into consideration the real metal structure to a maximal extent, a three-dimensional model of the device has been developed for strength calculations. The analysis has been accomplished by the Finite element method with the help of Cosmos Design Star software. The main data of the device bearing elements are shown in Table 1.
A tetrahedron is used as a finite element. The parameters of the network for analogue-to-digital conversion are: the number of elements – 104172 and the number of nodes - 206780. The device is loaded with a force of 200 kN, distributed evenly on the area of the hydraulic cylinder support. The supporting reactions are applied to the points of contact between the wheel tyres and rails.

Table 1

№	Element	Material	Mass kg	Volume m^3
1	Beam	S275JR	570.081	0.0721621
2	Column 1	S275JR	304.865	0.0385905
3	Frame	S275JR	1134.83	0.143649
4	Axle 1	S275JR	7.37112	0.000933053
5	Axle 2	S275JR	7.37112	0.000933053
6	Column 2	S275JR	304.883	0.0385928

Results: The maximal values of strains are shown in Table 2 and their visualization is in Figure 3. The maximal values of deformations are pointed at in Table 3 and their visualization is in Figure 4.

Table 2

№	Strains	Min	Zone	Max	Zone
1	Equivalent strains	0.00741227 MPa Node: 64889	(-0.005 m, -1.30625 m, 0.799354 m)	135.729 MPa Node: 190557	(0.1 m, 1.3 m, -1.84855 m)
2	SX: Normal strain along X	-55.8629 MPa Node: 75741	(0.0666667 m, -0.65 m, -2.197 m)	38.1623 MPa Node: 156322	(-0.05 m, -0.65 m, -1.897 m)
3	SY: Normal strain along Y	-85.5371 MPa Node: 17374	(0.00393733 m, -0.0857561 m, 7.72155e-015 m)	65.8077 MPa Node: 74550	(-0.1 m, -0.85 m, -2.197 m)
4	SZ: Normal strain along Z	-58.7812 MPa Node: 192956	(-0.1 m, 1.6 m, -1.84845 m)	144.306 MPa Node: 190557	(0.1 m, 1.3 m, -1.84855 m)
5	P1: Main strain 1	-18.3756 MPa Node: 31908	(-0.0231763 m, 0.0713292 m, -4.47027e-010 m)	155.05 MPa Node: 190557	(0.1 m, 1.3 m, -1.84855 m)
6	P2: Main strain 2	-34.7888 MPa Node: 17374	(0.00393733 m, -0.0857561 m, 7.72155e-015 m)	38.5932 MPa Node: 190612	(-0.1 m, 1.31667 m, -1.865 m)
7	P3: Main strain 3	-90.6219 MPa Node: 17374	(0.00393733 m, -0.0857561 m, 7.72155e-015 m)	30.7812 MPa Node: 190614	(-0.0833333 m, 1.3 m, -1.865

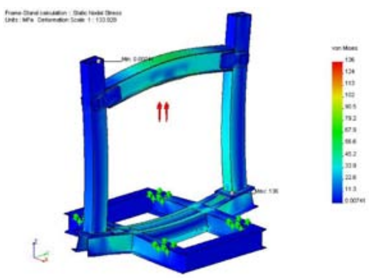

Figure 3 Maximum values of stresses

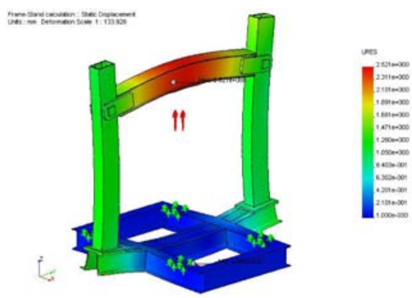

Figure 4 Maximum level of distortions

Figure 5 shows the coefficient of safety as the ratio of the boundary of yielding flow to the equivalent strain.
The maximal equivalent strains of 136 MPa are in the zone of welding of the column to the supporting plate (Figure 6) but their values are twice lower than the boundary of yielding flow of steel S275JR.
The maximal deformations of 2,5mm are in the middle of the central beam.
Based on the results obtained, it can be considered that the device metal structure is correctly dimensioned and can bear the necessary loads.

Table 3

№	Deformation	Min	Zone	Max	Zone
1	URES: Deformation	0 mm Node: 78808	(1 m, -0.65 m -1.877 m)	2.52089 mm Node: 17770	(-0.135 m, -0.0164744 m, 0.041 m)
2	UZ: Deformation along axis Z	-0.123968 mm Node: 76450	(0.2 m, 2.22045e-016 m, -1.897 m)	2.49015 mm Node: 17770	(-0.135 m, -0.0164744 m, 0.041 m)
3	UY: Deformation along axis Y	-0.352112 mm Node: 178829	(-0.1 m, 1.5 m, -1.23615 m)	1.08291 mm Node: 178365	(0.074 m, 1.45 m, 0.849 m)
4	UX: Deformation along axis X	-0.000343911 m Node: 81001	(-0.1 m, -1.66 m, -2.197 m)	0.000357516 m Node: 80952	(0.1 m, -1.675 m, -2.197 m)

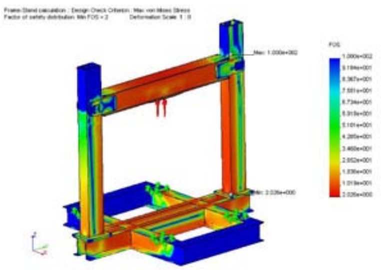

Figure 5 Safety factor

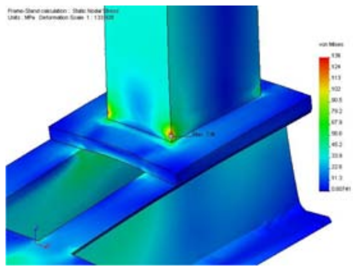

Figure 6 Maximum equivalent stress

The hydro-system is intended to supply a pressure flow of specified parameters and its scheme is shown in Figure 7.

Technical features:

- Maximal pressure – 250 bar
- Capacity
  - Fast stroke – 23.7 l/min
  - Working stroke – 3.7 l/min
- Power installed
  - Fast stroke – 3.7 kW (2.2 kW+1.5 kW)
  - Working stroke – 2.2 kW
- Supply voltage of electric engine – 380 V
- Supply voltage of distributors – 24 v DC
- Tank capacity – 100 l.

2.2 Structure and operation of the hydraulic loading system

With switching on power supply, the two electric engines at positions 3 and 10 wind up pumps at positions 2 and 9 and they draw in oil from the tank at position 1. The oil sucked by the pump at position 9 is stuffed up into the reverse valve at position 12, passes through it and enters the distributor input at position 13, the pump at position 2, stuffs up the oil sucked to the pressure filter at position 4 and from there enters the distributor input at position 13 where is summed up with the oil of the pump at position 9. In a normal state, the distributor discharges the pumps through the filter at position 16 to the tank at position 1. With supplying a voltage of 24V DC to the electric magnet “a” of the distributor, a quick run of the cylinder at position 15 begins downwards until reaching the track switch off, which switches off the electric engine at position 10 and the cylinder passes to a working stroke.

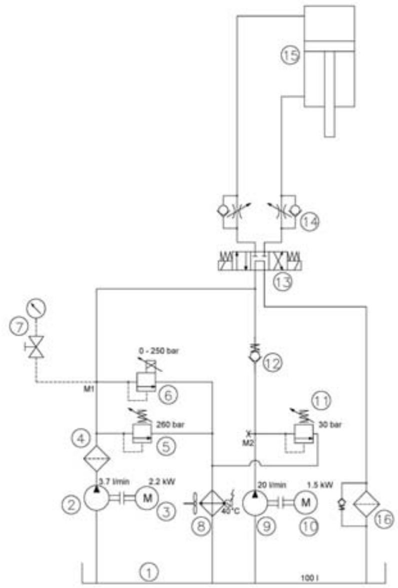

Figure 7 Scheme of hydraulic system

After reaching the bogie, the pressure can be lightly increased by the proportional safety valve at position 6 as in that way the desired load is achieved. The safety valves at positions 5 and 11 are built for maximal pressure of pump operation. The outputs of the valves at positions 5, 6 and 11 are connected with the input of the cooler and when the oil temperature reaches 40º, the cooler fan is switched on to cool it. The valve at position 14 serves to regulate the cylinder speed at position 15. The hydraulic system for implementation of loading on the device makes possible for loads to be up to 200 kN. The computer system controls the value of the force under the conditions of both bogie loading and bogie unloading. That allows accomplishing a “loading-unloading” cycle in order to determine the hysteresis of the bogie hanging down, which is due to the “dry” friction in the bogie axle boxes. The specification of the force value is accomplished through proportional control with a width-pulse modulated signal. To reduce the time of reaching the desired value of loading, a proportion-integral-differential law of regulation has been used. The block scheme of the device electronic measuring system is shown in Figure 8.

The force sensors are implemented on tensometric principle, as a piece of P49 standard rail with a length of 1140mm is used as a sensitive element [2]. The sensors are located under each bogie wheel. To achieve a minimal level of disturbances, the tensometric amplifiers are built in sensors and have a current output of 4÷20 mA.

To measure the forces of loading on sensors, a data acquisition system USB6009, a Texas Instruments make, is used for control and management.

The ensuring software has been developed in the Microsoft Dot Net environment using C#. Figure 9 shows the panel of control on the modes of bogie testing. The results of testing are saved in a file that can be used to print protocols in Bulgarian and German languages depending on the order for manufacturing wagons.

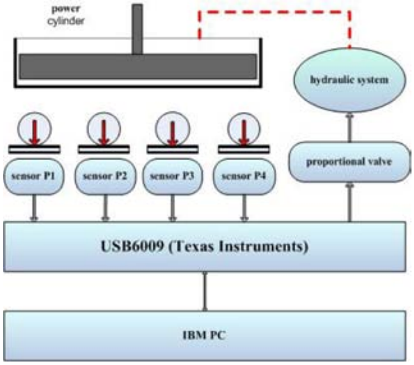

Figure 8 Block diagram

Figure 9 PC control panel

3 Conclusion

The protocols of bogie measuring are shown in Figure 10 (in German language designed for the customer of the wagons manufactured).
The device is calibrated and certified by an authorized body as the certificate issued is shown in Figure 11.
The device has been in regular operation since September 2008. More than 200 newly-manufactured bogies for the country and export were tested until the end of the last year.

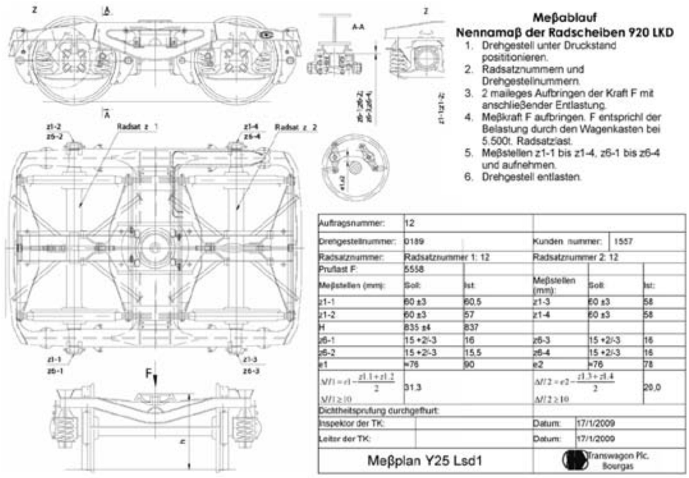

Figure 10

АКРЕДИТИРАНА ЛАБОРАТОРИЯ ЗА КАЛИБРИРАНЕ "КАЛАБСИ"
ПРИ "КАЛАБСИ" ООД
СЕРТИФИКАТ ЗА АКРЕДИТАЦИЯ
рег. № 10 ЛК / 29.04.2008 г. на ИА "БСА"
валиден до 30.04.2012 г.
1592, София, ул. "Асен Йорданов" № 12, тел./факс: 02 / 979-11-48

СВИДЕТЕЛСТВО ЗА КАЛИБРИРАНЕ
№ 1316 - С – 07 / 2008

СРЕДСТВО ЗА ИЗМЕРВАНЕ : Съоръжение за измерване натоварването в колелата на талига (система за измерване на силата)

ТИП (ОПИСАНИЕ): Y25-1
обхвати : P1, P2, P3, P4 - до 5000 kgf.

ПРОИЗВОДИТЕЛ : България
ИДЕНТИФИКАЦИОНЕН №: C15BC4

НАИМЕНОВАНИЕ И АДРЕС НА ЗАЯВИТЕЛЯ :
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Заявка вх. № 391 / 2008

ДАТА НА КАЛИБРИРАНЕ : 07.07.2008 г.
СВИДЕТЕЛСТВОТО СЪДЪРЖА: 3 страници

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Извършил калибрирането : инж. С. Стоянов
Р-л лаборатория : инж. Пл. Събев

Не се допуска използването на копия на свидетелството и на части от него, освен с писменото разрешение на лабораторията.

Figure 11 Certificate of calibration

References

[1] European standard EN 13775-4:2004

[2] N. Nenov, G. Mihov, E. Dimitrov, T. Rouzhekov, P. Piskulev, Optimization of Specialized Intelligent Force Sensor Parameters for Railway Transport, 30th International Spring Seminar on Electronics Technology, May 9-13, 2007, Cluj-Napoca, Romania