IOP Conference Series: Materials Science and Engineering

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To cite this article: D T Safarov and A G Kondrashov 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **289** 012018

IOP Conf. Series: Materials Science and Engineering **289** (2018) 012018 doi:10.1088/1757-899X/289/1/012018

Stand for monitoring the operational parameters of conjugations "Ball support – body of the tie-rod end" of automotive components

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Abstract. The method of testing the conjugation "Ball support - body of the tie-rod end" is considered. The design of the test bench for simulating the working conditions of the interface is proposed. The results of testing the conjugation samples in accordance with the test procedure are given. The conformity of test results was assessed.

1. Introduction

Tie rods of various design purposes are responsible suspension components and steering systems. They largely determine the predictability of the behavior of the car when performing maneuvers. Tie rods provide the transfer of forces and provide the prescribed laws of movement between individual connecting levers.

For the performance of its functional purpose, the design of tie rods includes matings having several angular degrees of freedom. Structurally, they are made in the form of a ball bearing, and a nest with a spherical element, made in the body of the tip.

Any defect of this coupling, which manifests itself during the operation of the thrust, affects the safety of the vehicle's movement, therefore special requirements are required for the structural elements of the interface parts for controlling the geometric parameters of the parts, material properties and surface layers contacting in the interfaces. To the interface and the design of the unit as a whole, there are requirements for carrying out tests for operational reliability and resistance to atmospheric influences [1–4].

2. Theoretical part

Limiting backlash in pairing is a key functional requirement. In some cases, it can be determined from the data of measurements of conjugate parts [5, 6]. Its value is practically impossible to predict based on measurement data. Loft is manifested as a result of contact interactions in the process of functioning of the conjugate surfaces in various degrees under the axial and radially acting load.

Therefore, at the manufacturer of thrusts, the task arose to design a special stand simulating the operating conditions of the unit, up to and beyond the limits. It is not possible to manufacture the test stand completely by the forces of the enterprise. The finished stand is produced by special orders by foreign manufacturers. To reduce the total cost of the stand, the power frame of the device is manufactured at the enterprise, and the loading device - servo-hydraulic drive and electronic registration components are ordered in a foreign manufacturing enterprise specialized in manufacturing such stands.

The frame is a sturdy table with T-shaped grooves, the dimensions of which provide reliable fastening of the tested products without destroying the fasteners, with the posts and a movable cross bar into which the test head is mounted (Figure 1). Dimensions of the frame and landing nests in it provide an opportunity to install both horizontal and vertical positions of the entire range of the steering rods produced by the enterprise of different design.

Figure 1. Test bench with installed steering traction during the test.

3. Testing technique

To control the axial and radial play for the stand, a special method for carrying out the control tests has been developed. The tests for determining the magnitude of the axial displacement and the effort of pressing the finger in the tip are carried out according to the scheme shown in Figure 2.

The tip of the rod is installed with a lid on the support sleeve. A static force is applied to the end of the ball pin, aimed at "extruding" it from the tip body, smoothly increasing from zero to a force value of 2…2.5 kN. During the test, the loading diagram is recorded in the coordinates "Moving S, mm – force F, kN.

According to the diagram obtained, the axial movement is determined at a force of 1 kN and the amount of force of the pinching of the finger by the elastic element to the supporting spherical surface of the tip. In the diagram, the moment of overcoming the clamping force is observed in the form of a characteristic sharp curve inflection. In the absence of an inflection, the compression force is assumed to be zero (the liner does not press the finger against the support surface). An example of the diagram is shown in Figure 3.

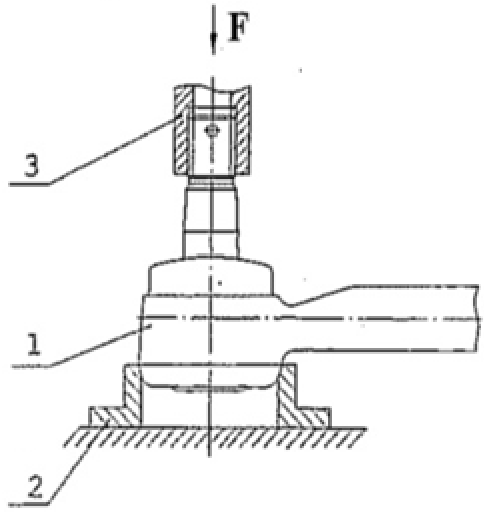

Figure 2. Scheme of fixing and loading the tip of the thrust during the test to determine the axial displacement and the compression force: 1 – test sample, 2 – basic rigging, 3 – transition element.

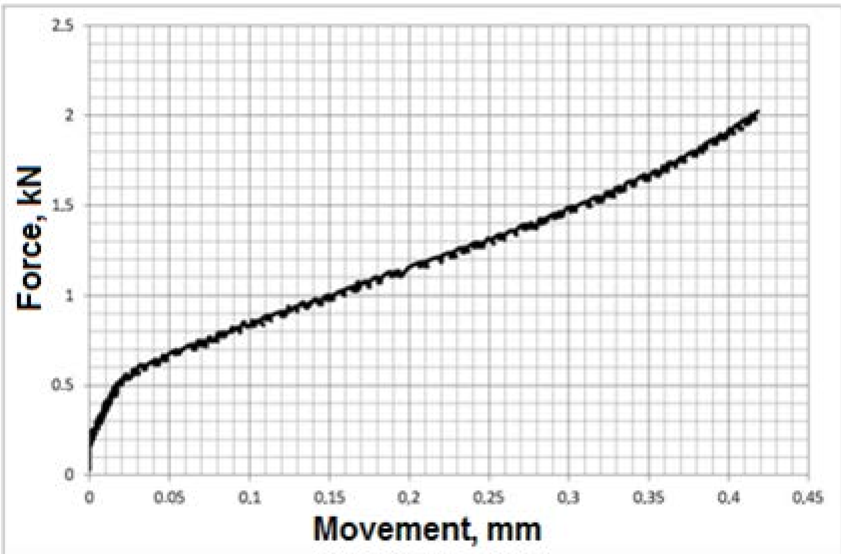

Figure 3. Example of the loading diagram in the test for determining the magnitude of the axial displacement and the force of compression.

The tests are carried out according to the scheme shown in Figure 4 to determine the radial clearance value under the action of cyclically changing forces in the friction pair "ball pin – tip body".

Thrust (or a separate tip) is attached to the ball pin on the stand, a static tension-compression force of ± 20 kN is applied to the other finger. In the course of the tests, the diagram "Movement S, mm – force F, kN is also recorded.

From the diagram obtained, determine the difference between the absolute values of the displacement at the moments of the transition of the curve in opposite directions through the zero value of the force. The value obtained in this way is considered as a gap in the friction pair "ball pin – tip body" (for traction assembly - the total for the two tips). An example of a diagram is shown in Figure 5.

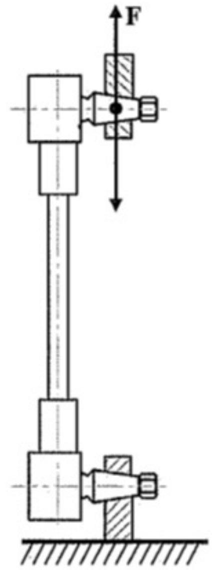

Figure 4. The scheme of fastening and loading of steering drafts in tests for determining the gap in the friction pair "Ball pin - body of the tie-rod end " with the radial cyclic action of the load.

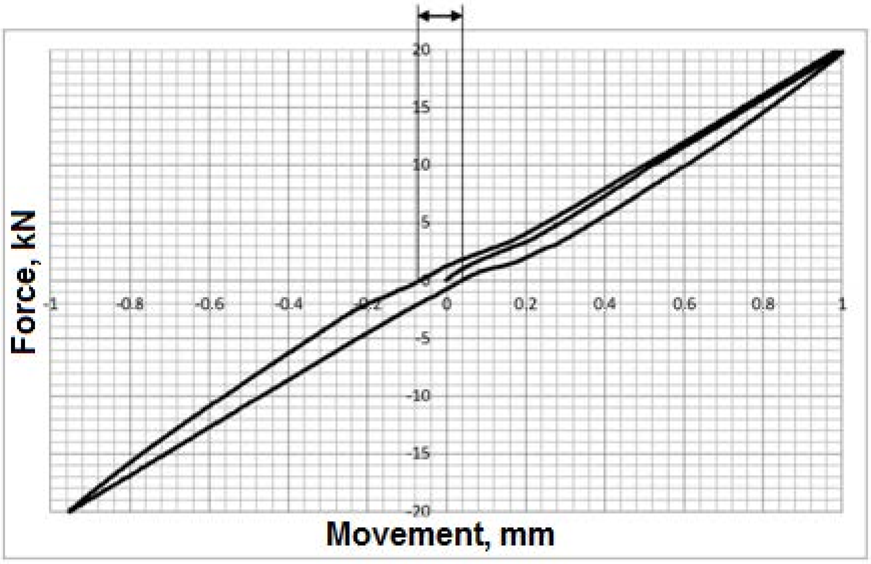

Figure 5. Example of the load diagram for the test for determining the gap in the friction pair "Ball pin – body of the tie-rod end".

In the initial period of the draft, there were no requirements for axial and radial clearance in the conjugation under load, the operation of the stand allowed determining the value of the gap under the action of the testing load.

The tie-rod ends are considered inoperative, in cases where:

- axial movement at a force of 1 kN exceeds 0.6 mm (for tie-rod end with a sphere diameter ø 45 mm);
- the compression force is zero (there is no kink in the diagram of the axial movement, an example is shown in Figure 6);
- on the gap measurement diagram there is a section coinciding with the X axis or close to it (there was a pronounced re-lay at zero force, an example is shown in Figure 7).

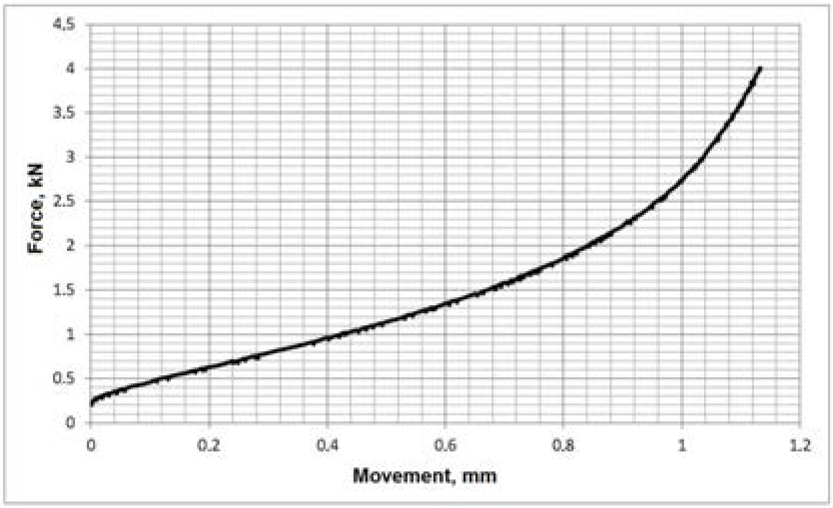

Figure 6. Example of the loading diagram in the test for determining the magnitude of the axial displacement and the force of the pinching: the elastic element is not compressed, the tie-rod end is inoperable.

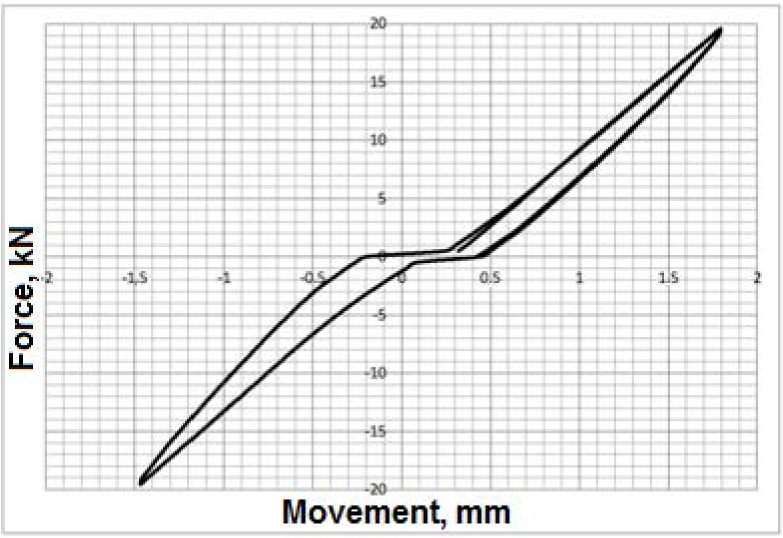

Figure 7. Example of the loading diagram for the gap test: a pronounced rearrangement has occurred, the tie-rod end is inoperable.

4. Results of tests

Let's give an example of tests of drafts of a sod by the resulted technique of a steering for a new product for a heavy dump truck KamAZ 6520, and the last run in 60 thousand in km. in conditions of constant operation at the maximum load when performing road earth during the excavation of soil (Figures 8, 9).

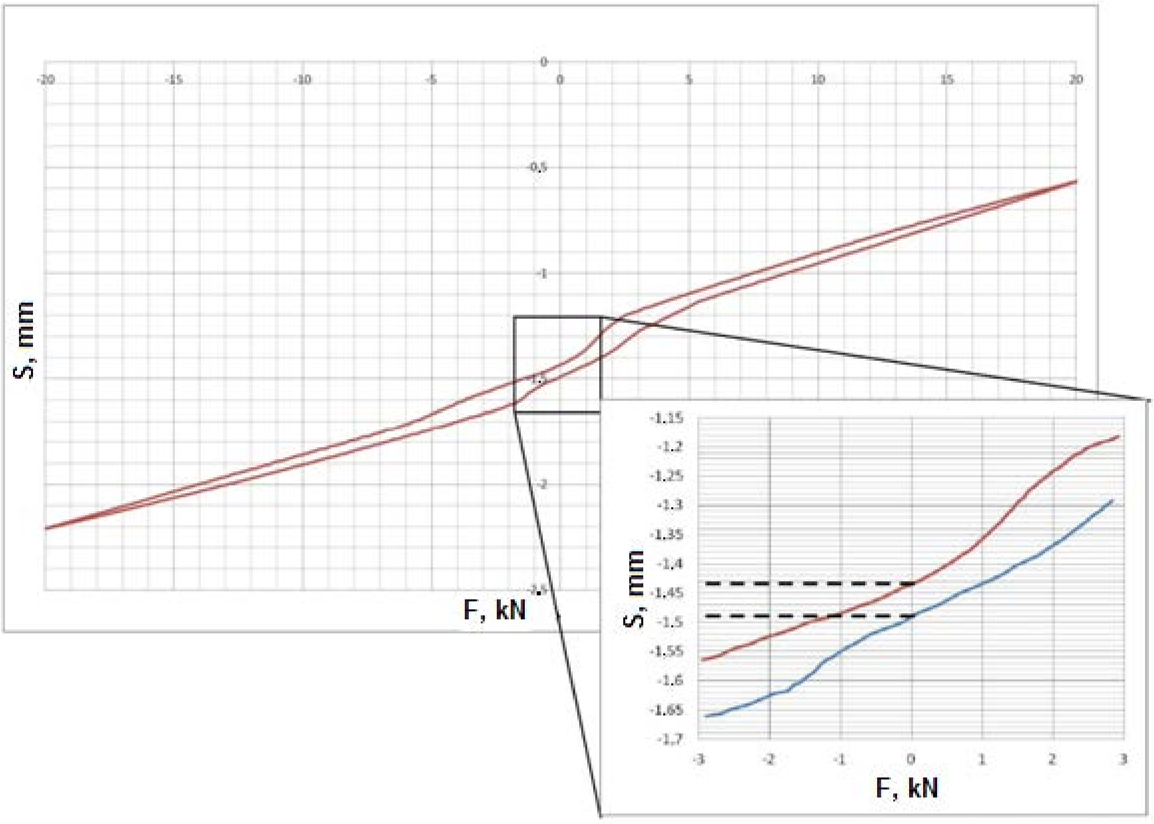

Figure 8. Diagram of tests of new steering link.

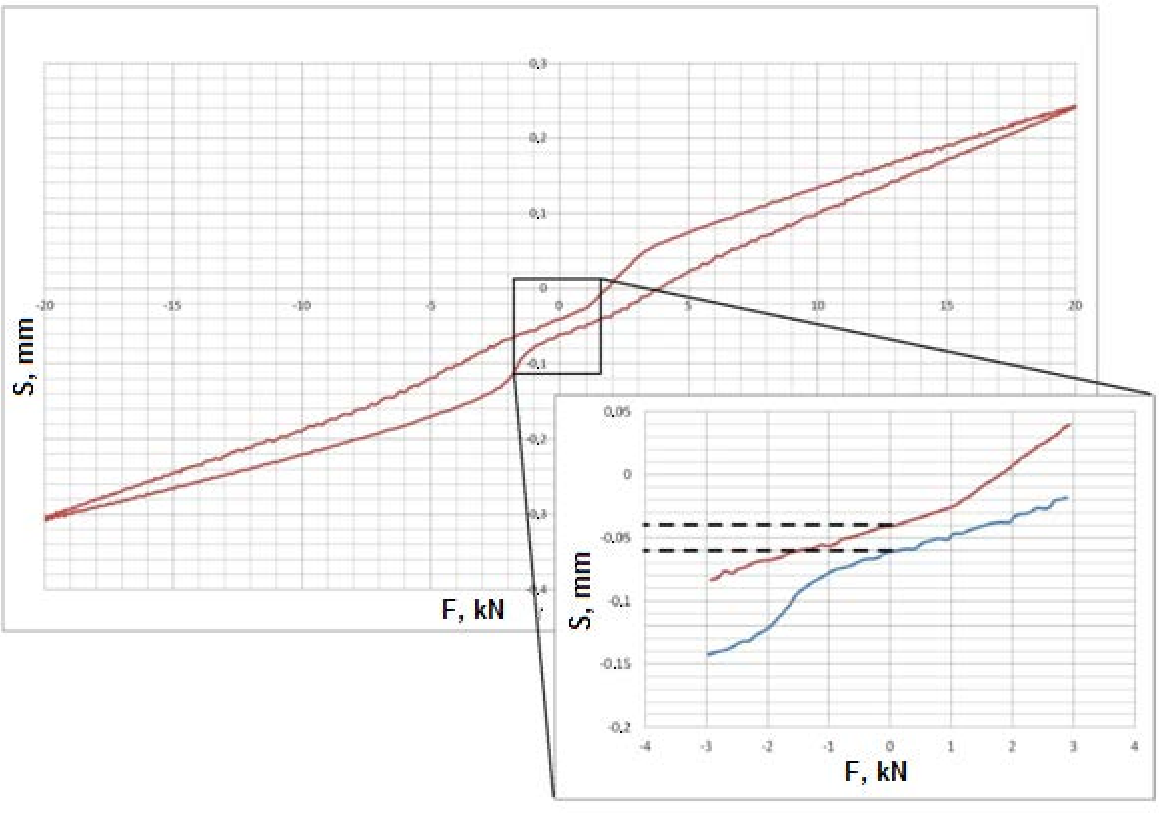

Figure 9. Test steering link at a run of 60,000 thousand km.

The results of changes in the gap in the process of operation from these diagrams are given in Table 1.

Table 1. Results of measurements of a backlash in pairs of friction of tie-rod end.

Sample name	Clearance value, mm
Thrust of bipod of steering control 6520 in assembly, new	0.05–0.055
Thrust of bipod of a steering of 6520 in gathering, run of 60 000 km	0.055–0.06

The control data show a slight change in the clearance in the ball interface, which indicates a high reliability of the interface.

5. Conclusion

Thus, the design and manufacture of the test stand allowed:

- reduce the costs of the company to conduct tests in external laboratories;
- to carry out operational improvement of the design of newly developed traction links for various models of modern trucks;
- to shorten the duration of the APQP process of preparation of production when developing models of new steering link [7].
- reduce the complexity of establishing the causes of the defects of defects without disassembling the interface.

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