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Friction is not a devil

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Tribology Study of Suspension and linkages in automotive

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ABSTRACT
In automotive, ball joints are important component in the suspension and linkage system. The ball joints are subjected to different range of load, rotation and frequency dependent upon driving condition. This scenario will inevitably induced wear phenomenon. Ultimately, the balls are pulled out of the socket and led to the dysfunctional of the car's system. Therefore, this paper give an overview on the tribology test of the ball joint of suspension and linkage system specialized in evaluating wear phenomenon.

1. Introduction

In automotive application, the study of friction and wear behavior of any components in the suspension and linkage system are is necessary because of the components always subjected to different range of load, rotation and frequency, results from different conditions of driving like . Thus, these components must highly capable to resist a wear and tear over longer period of time. Generally, tie rod end, Ball joint, axial rod, track control arm and stabilizer link are components that responsible for the suspension and linkage system of the car's system. One of the important component in that system is ball joint. The ball joint must be always checked once in a while to ensure the wear is under control. When the wear behavior at ball joint become worse, the clearance increases and caused less smooth driving. The worse situation is when the ball joint is pulled out from the socket because that led to the dysfunctional of the car system.

Most automotive industry (either OEM or aftermarket) will perform wear test as a justification. There is co-relationship how much wear test will indicate the mileage. This study has been proven through R&D either in DOE, field test or etc. Eventually the specification has been decided and need to comply. For example, our industry is looking into the indication of elasticity, breakaway/Rotational torque before and after wear test. The setup of elasticity and wear tests for the ball joints are presented as in Figure 1 and Figure 2, respectively.

Figure 1: Elasticity test for ball joint.

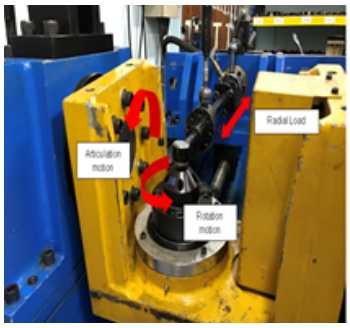

Figure 2: Setup of wear test for ball joint.

In ball joint mechanism, ball stud and bearing must be always in contact as shown in Figure 3. In the car's suspension system, the ball joint is designed to freely make a connection from chassis to the wheel, and there is a normal force exerted to the bearing. The design of ball stud and bearing must be always kept in that position in order to retard both friction and wear phenomenon. Another

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parameters that are necessary to take into consideration in ball joint are listed below:

1. Ball surface roughness (*Rz* value)
2. Material selection
3. Manufacturing parameter
4. Grease type and quantity

Usually, the best design of ball joint must meet a critical criteria of capability to resist a wear and tear for quite longer time. However, there is others requirement need to be fulfill when designing the ball joint, which are a business and commercial issues. In automotive industry, optimizing the safety and commercial are also critical subjects and necessarily to take into account.

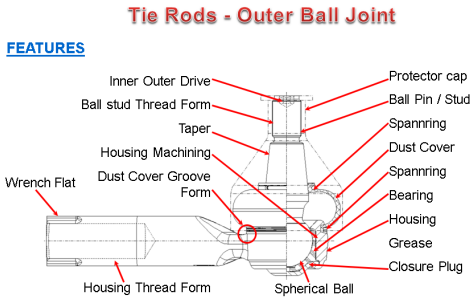

Figure 3: Mechanism of outer ball joint.

2. Experimental procedure

The test sample were validated as per below details:

a) Measurement of rotation breakaway torque, rotation steady torque and radial elasticity are conducted as elucidated in Figure 1 and Figure 4.
b) Thermal calibration is performed at certain temperature and duration as shown in Figure 5.
c) After that, measurement of rotation breakaway torque, rotation steady torque and radial elasticity is carried out.
d) Then, wear test is performed at a certain load and cycle together with the movement of rotational and articulation torque done simultaneously as presented in Figure 6.
e) Lastly, measure rotation breakaway torque, rotation steady torque and radial elasticity.

All results from the test like rotational break away torque, rotational steady state torque, radial elasticity, spring travel and elasticity are recorded and tabulated as shown in Table 1. All the tests are recorded at each stage of initial sample, after thermal calibration and lastly after the wear test, as shown in Figure 7.

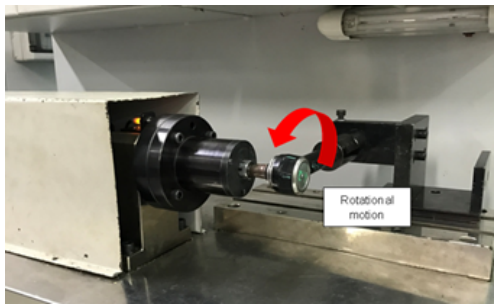

Figure 4: Rotational motion of test rig.

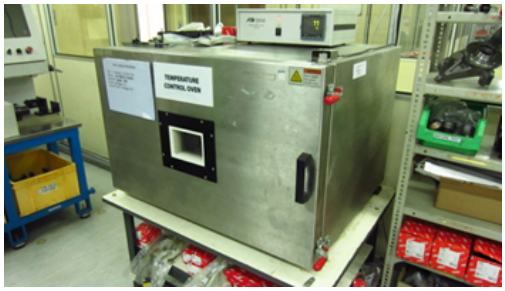

Figure 5: Thermal calibration testing unit.

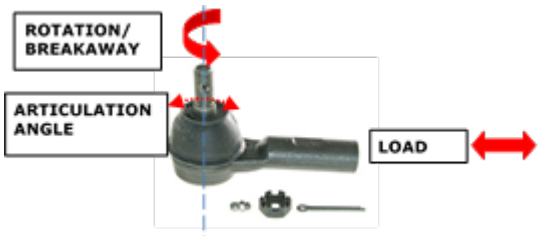

Figure 6: A cross section of the ball joint.

Table 1: List of data obtained from wear experiment of ball joint.

No.	Items	Requirement
1.	Rot. Breakaway Torque [Nm]	≤xx
2.	Rot. Steady Torque [Nm]	yy
3.	Radial Elasticity [mm]	≤zz
4.	Radial Spring Travel [mm]	-
5.	Radial Elasticity Slope	The slope in each point of radial elasticity hysteresis curve shall not fall short of ¼ of the slope of the test load.

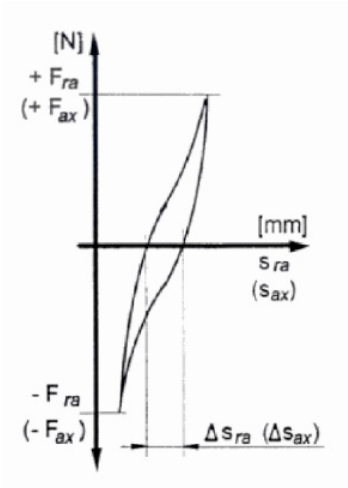

Figure 6: A result sample

3. Conclusion

From the wear test, it can be concluded that:

1. Rotational/Breakaway torque must be achieving as requirement (before wear test)
2. Radial Elasticity shall be achieving as requirement (before and after wear test). This subject is particularly notable to show that how much gap is allowed before and after wear test.