APPLICATION OF DIAGNOSTIC METHODS FOR THE REAR DRIVE AXLE OF THE PASSENGER CARS

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ABSTRACT

This paper introduces developing of the methods for diagnostic of the rear drive axle for the passenger cars without its demounting. Are used subjective and objective diagnostic methods. Localizing of the noise of subjective methods is done through the stethoscope and other devices for hearing the noise, while the objective methods of diagnosing the rear drive axle is done with diagnostic vibrometer device. By application of these diagnostic methods greatly would be contributed in quickly localization of the rear drive axle fault where diagnostic process of the servicer will done fastener.

Keywords: Diagnostic, Rear Drive Axle, Vibration, Objective and Subjective Methods.

1. INTRODUCTION

Determining of the vehicle condition is one of the key elements during process of vehicle maintenance. Therefore it is necessary to monitor continuously changing situation of the specific parameters which over the time lead to the weakening of the vehicle components. If not intervene in the time, then comes up fault respectively stopping of the vehicle work.

In the paper, is treated diagnostics methodology for the rear drive axle, through objective and subjective methods?

The technical diagnostic, as a part of the maintenance process determined by the condition, should be certify the technical condition of the component part of the system with a certain precision and the right moment of the time [1].

The technical diagnostics of vehicles is a new field and quite spread and uses objective diagnostic method. Through the technical diagnostics will do:
• Confirmation of the regularity of the technical condition of the rear drive axle,
• Confirmation of the working condition of the rear drive axle,
• Confirmation of functionality, and
• Research of failures (location, type and cause of failure).

The moment of the appearance fault in rear drive axle manifests with symptoms, such as: vibration, noise, shot, temperature, leak oil, etc. The causes of vibrations and noises should be required from damages of differential gears or bearings.

Measurement of the vibrations in the rear drive axle of a Mercedes Benz 190 D is achieved by vibrometer MANUAL PCE-VT 3000.

The obtained values from vibration are compared with the ISO 2372 norms for vibration [2].

Despite the progress of developing modern diagnostic tools, subjective methods are used, which are based on the experience of experts who deals with this problem. This method used diagnostic flowchart (algorithm) while as an equipment is used stethoscope.

2. SUBJECTIVE DIAGNOSIS OF THE REAR DRIVE AXLE

During the diagnosis firstly should be verified and documented drivers concern, through answers to the following questions:

• When noticing the problem for the first time,
• Did something unusual happens that would coincide with it or preceded,
• Did its appear suddenly or gradually,
• Are any condition affecting the concern such as: road speed, kind of road , the way of driving, temperature, load or unload condition,
• Condition change has continuous character or interruptions.

After completed the preliminary investigation (found answers in previous questions), continue with road vehicle testing in order to found caused problem.

The road test is necessary for any drive concern about noise or vibration, because vibration and noise are beginner symptoms of fault for the rear drive axle.

The rear axle and driveline concern symptoms are also same as the vehicle engines, transmission, rear wheel bearings, and tires. For this reason should be concluded that the symptoms comes from the rear drive axle before repairing or installing any part in rear drive axle [1].

During testing of the vehicle on the road, registered concerns that occur must be written to which speed [km/h], or the number of engine rotations [rpm] appear noise and vibration.

Therefore, diagnosis specialist should have full knowledge about the functioning of the power transmission system to detect any errors [1].

If after completion of the test vehicle on a part of road could be appear symptom in the rear drive axle (ring and pinion gears or differential case), should be made a visual inspection of the rear drive axle:

• Check if have signs of oil leakage on the case of rear drive axle, and
• Cracking and other damages.

If during the visual inspection shows no leakage and cracking, then remove bolts for draining oil from the differential and control [3]:

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• The amount of oil in the differential,
• The presence of any foreign metal particles,
• Particulate metal parts from wear of the differential, and
• The presence of burned oil (odor).

If during the inspection will detect the presence of metal particles, before the vehicle is repaired would be used the subjective diagnostics method for rear drive axle.

To identify the possibility cause, used symptoms and control procedures is introduced in Table 1. Then should be used corrective action to repair parts of the vehicle.

Symptoms or manifestations of irregular work of the rear drive axle are developed with flowchart shown in Fig 1, [4] and [5].

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Control Procedure</th>
</tr>
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<tbody>
<tr>
<td>Noise during wheel rotation</td>
<td>1</td>
</tr>
<tr>
<td>Constant noise</td>
<td>2</td>
</tr>
<tr>
<td>Gears noise during driving</td>
<td>3</td>
</tr>
<tr>
<td>Gears noise during driving of the vehicle in coasting road</td>
<td>4</td>
</tr>
<tr>
<td>Bearing noise during driving of the vehicle in coasting</td>
<td>5</td>
</tr>
<tr>
<td>Noise appeared during driving of the vehicle in curves road</td>
<td>6</td>
</tr>
<tr>
<td>Temperature in differential</td>
<td>7</td>
</tr>
<tr>
<td>Oil leak from rear drive axle</td>
<td>8</td>
</tr>
</tbody>
</table>
Figure 1: Flowchart by symptoms of the irregular work on the rear drive axle

In the Figure 2 is presented flowchart for noise during rotation of the vehicle wheels (control procedure 1 of Table 1 and Figure 1), while in literature [4] are submitted all of other flowchart data for 2, 3, 4, 5, 6, 7, and 8.
3. TECHNICAL DIAGNOSIS OF THE REAR DRIVE AXLE FOR THE PASSENGER CAR MERCEDES 190

The preparation of the passenger car Mercedes 190 D to measure vibrations velocity, vibrations displacement and vibrations acceleration of the rear drive axle is presented in Figure 3. The vehicle is raised from the ground by the crane and placed into two supports on both sides in order during rotation of the wheels do not come into contact with the surface of the earth.

The measurements were made in the fourth gear of gearbox transmission (direct transmission ratio). In this case the vehicle speed reaches 100 [kmh^{-1}], which corresponds to the number of engine rotation, respectively the input rotation of differential is 3000 rpm.
Measurements of vibrations in the rear drive axle of the passenger car Mercedes 190 D are made with vibrometer MANUAL PCE-VT 3000. After the measurement is proved that the vibrating velocity are in limits norms for vibrations which are introduced by ISO 2372 standard. The ISO 2372 serves with monitoring of the vibrations.

**Figure 3**: Preparing of the vehicle for measurement of the vibrations in the rear drive axle of the passenger vehicle Mercedes 190 D [4]

4. MEASUREMENTS RESULTS FOR REAR DRIVE AXLE OF THE PASSENGER CAR MERCEDES 190

Measurements of the vibration are done in five specific points, which are presented in Figure 4. Measuring sensor has needle shape which is used for measurements in 3 and 4 point, while the measuring sensor with electromagnet is used in other measurement points.

**Figure 4**: Measurement points in the rear drive axle:

1 - Differential housing, 2 – Bearing of the pinion gear, 3 – Right carrier bearing, 4 - Left carrier bearings, 5 - Back part of the rear drive axle [4]

In Figures 5, 6 and 7, are shown the measured values of the vibration velocity, vibration displacement, and vibration acceleration in rear drive axle for passenger car Mercedes 190 D, when the input rotation of the differential is 3000 rpm.
**Figure 4**: Graphic presentation of the vibration velocities in measuring points [4]

**Figure 5**: Graphic presentation of the vibration displacements in measuring points [4]

**Figure 6**: Graphic presentation of the vibration acceleration in measuring points [4]
Figure 7: Vibration measuring values for the vibration acceleration, vibration velocity and vibration displacement shown in measuring vibrometer display (MANUAL PCE-VT 3000) [4]

Vibration measuring values of the acceleration, velocity and displacement are compared with normative norm according ISO 2372 (10816) for vibration, Table 2.

Table 2: Maximal allowed values of the vibration velocity according ISO 2372 standard [2]

<table>
<thead>
<tr>
<th>Vibration velocity $v_{\text{max}}$ [mm/s]</th>
<th>Type of machine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class I $P_e &lt; 15$ [kW]</td>
</tr>
<tr>
<td>0.00 $\div$ 0.28</td>
<td>A</td>
</tr>
<tr>
<td>0.28 $\div$ 0.45</td>
<td></td>
</tr>
<tr>
<td>0.45 $\div$ 0.71</td>
<td></td>
</tr>
<tr>
<td>0.71 $\div$ 1.12</td>
<td>B</td>
</tr>
<tr>
<td>1.12 $\div$ 1.80</td>
<td></td>
</tr>
<tr>
<td>1.80 $\div$ 2.80</td>
<td>C</td>
</tr>
<tr>
<td>2.80 $\div$ 4.50</td>
<td></td>
</tr>
<tr>
<td>4.50 $\div$ 7.10</td>
<td></td>
</tr>
<tr>
<td>7.10 $\div$ 11.20</td>
<td></td>
</tr>
<tr>
<td>11.20 $\div$ 18.00</td>
<td></td>
</tr>
<tr>
<td>18.00 $\div$ 28.00</td>
<td></td>
</tr>
<tr>
<td>28.00 $\div$ 45.00</td>
<td></td>
</tr>
<tr>
<td>45.00</td>
<td></td>
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</tbody>
</table>

Note: Area A - Good condition of machine, Area B – Operation of machine is satisfactory, Area C - Operation of machine is unsatisfactory, and Area D – Operation of machine is unacceptable (to repair).

In Figure 8 is shown condition of component of the rear drive axle after measuring of vibration (after disassembling).
After measuring, the rear drive axle is disassembled and its components are observed carefully, where components are in good condition (haven’t shown any damage).

7. CONCLUSION

The presented paper introduces two diagnosing methods for rear drive axle of the passenger cars, by using subjective and objective diagnosis methods.

By subjective diagnosing method is achieved through symptoms to determine fault and what corrective action should be taken to repair components of the rear drive axle, introduced by developed flowchart diagram.

In the technical diagnostic are made vibration measurements of the vibration velocity, vibration displacement and vibration acceleration by vibrometer device MANUAL PCE-VT 3000, when the vehicle speed is simulated to be 100 [km/h], which corresponds with input rotation of differential 3000 [rpm].

Obtained results for the vibration velocity, vibration displacement, and vibration acceleration measuring for five points in the rear drive axle are:

- In Area A - good driving condition (according to ISO),
- Greater values of vibration velocity are appeared in the bearing carriers, (points 3 and 4 of measurement),
- Vibration velocity and acceleration have similar behavior compared with vibration displacement.

The obtained results are suitable because after disassembling, the condition of the component of the rear drive axle are good (don’t shown any damage) after measuring.

8. LITERATURE