Study on the Effect of Brake Drum on Braking Performance in a Serious Traffic Accident

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Abstract. In this paper, the chemical composition of vehicle damage brake drum occurred in the heavy traffic accident on the highway is analyzed, and analyzed the influence on the braking performance of vehicles, pointed out that the direct cause of the accident is due to the friction surface of the drum brake has a penetrating crack.

Introduction

Because of the compact structure, reliable performance and high braking power, the brake drum is the most common brake device for trucks and large or medium buses. It is also an important guarantee for safe driving. For the large thrust of the brake friction plate on the inner surface of the brake drum, the inner surface of the brake drum is subjected to extrusion stress. At the same time, the brake drum wall can bear tensioning force. When the vehicle is broken, the vehicle moves from high speed to low speed or stop, so that the kinetic energy of the automobile is converted into heat energy. Theoretical study shows, about 90% of the thermal energy generated in the parking brake during braking drum is absorbed, working surface of the brake drum is increased with continuous braking, the brake drum surface mechanical properties and micro structural stability is relatively low, and has a greater thermal stress on the working surface. With the continuous development of automotive technology and the needs of different customers, the vehicle is constantly high speed, heavy load, frequent braking and other aspects of development. In the past, the performance of brake drum with good performance at low speed and light load is greatly reduced. Since the opening of a highway in Guangdong Province in 2014, 19 accidents have been caused by the failure of wheel brake drum. Therefore, in the technical identification of traffic accidents, it is necessary to observe and analyze the macro cracks and material of the brake drum in order to find out the cause of the traffic accident.

Accident Situation

One day in June 2015, in a highway of Guangdong Province, a fully loaded bus, suddenly rushed out of the right side of the guardrail and rollover occurred. One person died and many people were injured in this accident. After investigation, the
damages of the bus were the body severely deformed, the steering column was broken in the accident, the steering arm shaft is broken in the accident collision, steering rod broken off, the window glass have been damaged, as shown in figure 1.

Figure 1. Accident vehicle.   Figure 2. Left rear brake drum and crack.

**Macro Analysis of Left Rear Brake Drum**

After cleaning the left rear brake drum of the accident vehicle, four large cracks were found, as shown in Figure 2, one crack across the entire working surface "A" shown in Figure 3-4, three shallow cracks "B", "C" and "D". There were a lot of regularly arranged network cracks on the friction surface of the brake drum, and the hard spots of the brake belt are different in size.

Figure 3. “A” Crackle.       Figure 4. “A” Penetrating crack.

**Macroscopic and Chemical Composition Analysis of Brake Drum Sampling**

Cutting sampling in the vicinity of the brake drum "A" and "B", samples No. 1 and No. 2 were obtained, as shown in figure 5-6. These two samples were examined macroscopically, and a large number of shrinkage holes were found on the cut surface. The location and size of these holes are shown in table 1. On the cut surface of No. 2 sample, the ratio of length and corresponding thickness is up to 57%.
Table 1. Location and size of shrinkage hole.

<table>
<thead>
<tr>
<th>Project</th>
<th>No. 1 sample</th>
<th>No. 2 sample</th>
<th>“A” crack section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between shrinking edge and brake drum working surface (mm)</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Distance between shrinkage hole edge and the outer surface of brake drum (mm)</td>
<td>14</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Distance between shrinkage hole edge and dust groove of brake drum (mm)</td>
<td>19</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Ratio of shrinkage hole length to wall thickness</td>
<td>30%</td>
<td>57%</td>
<td>43%</td>
</tr>
</tbody>
</table>

No. 1 sample was cut off from the crack. Under the magnifying glass, it can be found that there are obvious defects such as shrinkage porosity, loose structure, slag inclusion etc. Taking the iron filings on the cut surface of No.1 sample for chemical analysis, results are shown in table 2. By chemical composition analysis, the specimen shall be cast iron. According to Chinese national standard (GB 9439-88), various elements should be: C, 2.7~3.8%; Si, 1.1~2.7%; Mn, 0.5~1.4%; P, <0.3%; S, <0.15%. Obviously “P” element content is high.

Table 2. Analysis for chemical composition of conventional elements.

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.29%</td>
<td>2.60%</td>
<td>0.62%</td>
<td>0.46%</td>
<td>0.076%</td>
</tr>
</tbody>
</table>

Cause Analysis of Brake Drum Cracking and Its Influence on Automobile Safety

Cracking Reason Analysis

The most fundamental reason for cracking is that the total external stress is greater than the strength of brake drum. External stress is the maximum stress applied to brake friction plate, which is the reason for large number of axial cracks. In addition, in vehicle braking and uninstalled water shower case, the relationship between inner surface of the brake drum and brake friction generated a lot of heat, the brake drum and plate temperature rise rapidly, to produce hot crack mesh easily on the working
surface. The material of this bus brake drum has serious casting defects (shrinkage, porosity, slag inclusion), and the mechanical properties of brake drum are decreased.

**Analysis for Braking Performance of Automobile**

Automobile braking performance means while driving in a short distance parking and driving direction ability to maintain stability and a certain speed on the downhill path. In addition, it also includes the ability to park for a long period of time. The evaluation indexes: 1) Braking efficiency, i.e. braking distance and braking deceleration; 2) Braking performance of the constant, that is, antirecession performance; 3) The direction of the vehicle stability when braking, that is, when the car does not brake deviation, sideslip and loss of steering performance. Because of the existence of a through crack in left rear brake drum, when braking, the brake drum brake shoe with friction surface, with brake drum crack expanding, applied to the brake shoe the pressing force will be greatly reduced, brake force will be reduced greatly, so the tire braking deceleration than the normal ones, will reduce the vehicle braking deceleration, braking distance will increase.

When this bus braking, left rear wheel brake force is less than right rear wheel. Two tyres being not locked, braking force coefficient of braking force coefficient is larger than the left rear wheel. The vertical load of the rear axle is evenly distributed. The left rear tire ground braking force is less than that of the right rear tire. This causes the braking force of the right and left of the rear axle is not equal to cause the vehicle to go to the right side. Vehicle braking direction stability will be greatly reduced, resulting in security risks.

**Conclusion**

(1) There is a penetrating crack on the left rear wheel brake drum, which results in the decrease of vehicle braking performance and the deviation.

(2) In order to find out the reasons for the brake drum failure, the chemical composition of brake drum and the mechanical properties are analyzed in the traffic accident vehicle safety performance technical appraisal work.

(3) In the two level maintenance of vehicle, it is necessary to pay attention to the maintenance of the brake drum. If there is a crack in the drum or the cracking of working face, if the penetrating crack is found, the brake drum should be replaced to eliminate the hidden danger in time.

**Reference**

