New Technology to control coupler height by using Axel Box

Hyung-Suk Mun, Sung-Kyou Choi
Korea Railway Research Institute
374-1, Woulam-Dong,
Uiwang-City, Kyonggi-Do, KOREA

Keyword : Couplers, Height, Adjust, Block, Axel, Box, Maintenance, Cost

SUMMARY

In order to reduce the railway maintenance cost, KRRI (Korea Railway Research Institute) has provided new solution to KNR (Korea National Railway, Operator) in 2000.

In the railway workshop, there were a few checkpoints to replace wheel such as surface damage level and diminution level of wheel diameter. As we know, the main reason of difference of couplers height is caused by different wheel diameter from difference vehicle. Every maintenance period, the repairman in workshop carefully investigates wheel condition and makes final decision to change wheel or not. If the difference of couplers height two connected vehicles does not meet basic requirement of maintenance guide of workshop. The repairman has to replace wheels. Even though the wheels can be used more and more.

Since KRRI took this research project from KNR, KRRI had approached various ways to solve the problem. In the beginning of project, KRRI had a plan to design and manufacture a height adjustable coupler but it takes a lot of time or budget to buy patented technology from abroad. So, KRRI decided to invent new instrument to control couplers height.

This technology was applied for patent by KRRI (Patented Number, KR-10-2000-66011). It will provide very effective and economical solution to railway operator.

The new axel box is divided in the AB(Axel Box) and the ABH(Axel Box Holder). The height of couplers can be controlled by the HAB(Height Adjust Block). This is basic idea of the technology.

Problem definition based on old solution

The maintenance guide in the workshop restricts couplers height to 860 mm (empty car, fright vehicle) from top of rail.

<table>
<thead>
<tr>
<th>Wheel Diameter</th>
<th>Coupler Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>860 (origin of wheel)</td>
<td>880</td>
</tr>
<tr>
<td>840</td>
<td>870</td>
</tr>
<tr>
<td>820</td>
<td>860</td>
</tr>
<tr>
<td>800</td>
<td>850</td>
</tr>
<tr>
<td>780</td>
<td>840</td>
</tr>
</tbody>
</table>
Table 1 Comparison of interrelation between wheel diameter and coupler height (mm)

<table>
<thead>
<tr>
<th>Coupler Height Standard</th>
<th>Empty Car</th>
<th>Load Car</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum 880</td>
<td>Minimum 830</td>
</tr>
</tbody>
</table>

Table 2 the Standard of Coupler Height of KNR (mm)

As we see the table 2, the standard of couplers height of KNR restricts the coupler height between 880 and 830. But in practice in the railway workshop, if the couplers height was not over 860mm repairman replaces wheel or puts a solid material (coupler height adjustable material) under the primary spring or secondary spring in order to the control couplers height based on the maintenance guide of workshop. Even though the couplers height is under the 860mm and the wheel can be used more, the coupler height is controlled over the 860mm. For this reason, actually, two standards of coupler height are in existence in Korea. One is for the standard of KNR and another one is for the maintenance guide of KNR. The old maintenance way did not provide a perfect solution to KNR. It is just temporary maintenance way. The suspension systems of all kinds of vehicles are designed based on its dynamic design parameters such as maximum allowed load and maximum speed of vehicle. If the repairman puts too high material under the spring or suspension system the dynamics system of vehicle will be come out unstable. There is a certain limitation to adjust coupler height by using the traditional maintenance way.

The International standard of couplers height

The following countries in Table 3 might had same problem with couplers height as the KNR did. As shown table 3, they have their standards. The beginning of this study, all of the different standard from the foreign countries was considered very important research material by KRRI. But KRRI didn’t get any solution or clue to solve problem from it. Because each of standard is decided based on foreign countries maintenance technology or experience.

<table>
<thead>
<tr>
<th></th>
<th>Empty car</th>
<th>Load car</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>Maximum (1,045)</td>
<td>Minimum (950)</td>
<td>UIC (Automatic Coupler)</td>
</tr>
<tr>
<td>U.S.A</td>
<td>Maximum (876.3)</td>
<td>Maximum (850.9)</td>
<td>AAR</td>
</tr>
<tr>
<td></td>
<td>Minimum (825.5)</td>
<td>Minimum (800.1)</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>Maximum (890)</td>
<td>Minimum (790)</td>
<td>Japanese standard</td>
</tr>
<tr>
<td></td>
<td>Minimum (855)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 the International Standard of Couplers Height
The calculation of maximum difference of coupler height between two vehicles in an extreme situation

The maximum difference of couplers height between two connected vehicles in the extreme situation can be calculated following steps.
1. The deflection of spring
   First of all, the deflection of spring is measured as following table

   ![Figure 1 the Deflection of spring](image)

<table>
<thead>
<tr>
<th>Factor</th>
<th>The type Of Load</th>
<th>Load (kg) On the spring</th>
<th>Deflection Of Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard of KNR (maximum allowable coupler height)</td>
<td>-</td>
<td>-</td>
<td>75 mm</td>
</tr>
<tr>
<td>Empty Car</td>
<td>Static load</td>
<td>401.5 kg</td>
<td>10.4 mm</td>
</tr>
<tr>
<td>Empty Car</td>
<td>Dynamics load</td>
<td>521.95 kg</td>
<td>13.52 mm</td>
</tr>
<tr>
<td>Load Car</td>
<td>Static load</td>
<td>1,779 kg</td>
<td>46.1 mm</td>
</tr>
<tr>
<td>Load Car</td>
<td>Dynamics load</td>
<td>2,312 kg</td>
<td>59.92 mm</td>
</tr>
</tbody>
</table>

   Table 4 the Deflection of spring

2. The difference of couplers height in an extreme situation
   The maximum difference of couplers height can be happened between empty car with new wheel and load car with maximum used wheel. Actually, such kind of case is usually happened in the railway operator.

3. The calculation of the maximum difference of couplers height
   Maximum difference of couplers height can be expressed as follow. Maximum allowable couplers height – Minimum allowable couplers height – deflection of spring (Empty car)
   \[880 – 815 – 10.4 = 54.6 \text{ mm}\]
The maximum different of coupler height in the extreme situation is 54.6 mm (The calculation based upon the standard of KNR, See Table 2 and Table 4)

Figure 2 Maximum difference of the couplers height in the extreme situation

Main function and Organization of the height adjustable axel box

In following a general view on the organization and the operating instructions related to the height adjustable axel box.

First of all, this invention mainly consists of the AB(Axel Box), the ABH(Axel Box Holder) and the HAB(Height Adjustable Block).

As shown figure-3 and 4, there is one pair of grooves(31) under the ABH to fix the axel box and the HAB. The main function of the ABH(10) is to connect the AB(20) and a primary spring. It also supports whole load from a vehicle under a primary spring. The axel box can be assembled to the ABH through grooves(31). In this invention, main function of the AB(20) is to hold a wheel axel(40) and to support the ABH(10). Consequently, the ABH(10) and a wheel axel are connected by the AB(20).

We can use the HAB(30) to control coupler height. The HAB can be different in its height.

The main idea of this invention is to the control couplers height by using the HAB(30). Depends on the situation, the repair man uses the suitable the HAB(30) and puts it under the ABH(10).
Conclusion

1. In order to improve the maintenance efficiency as well as to reduce the maintenance cost of KNR, the project is performed.
2. The capacity of height adjustable axel box can be expressed in the following. The Bogie of left side has a brand new wheel and right side of bogie has a used wheel. Due to the abrasion of wheel diameter in service condition, the used wheel has smaller diameter than the left side wheel (h = the difference of wheels height). But as we see the following picture (Figure 5), we can’t find out any difference of bogie frames height, even though two size of wheels are applied two different bogies. Consequently, the HAB(30) under the ABH(10) compensates difference of couplers height. The HAB(30) can make equal the two bogie frames height.
3. The foreign country’s regulation of couplers height is investigated.
4. The maximum difference of couplers height in service condition is calculated.
5. This paper only introduces the idea to control couplers height. And all the figures presented in this paper are not scaled.
6. Before we apply this technology to the real freight vehicle, the operation and safety of the mechanism have to be verified by the testing.
7. We might control couplers height by using following new type mechanism (rack and pinion). But it has problem with its structurally complicated because it is easy to break and hard to do its maintenance.

8. Influenced by the difference of couplers height, The life time of coupler parts can be studied in the further project.
Figure 7 The FEM (Finite Element Method) modeling of coupler part

BIBLIOGRAPHY