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RELIABILITY COMPARISON OF CLASSICAL BRAKE FOR FREIGHT WAGONS AND THE INTEGRATED BOGIE BRAKE TYPE IBB 10

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***Abstract** – The introduction of integrated (compact) bogie brake systems has opened a new chapter of improvements in freight wagon performance, efficiency, reliability, reduction of weight and noise, simpler installation, reduction of installation space, lower operating costs, reduced maintenance, increased reliability availability and safety. Because of all these benefits from using integrated bogie brake systems, many producers of railway brake equipment have developed their own compact brake systems. In this paper will be described a reliability comparison of classical (conventional) brake system for freight wagons and the integrated bogie brake system type IBB 10 from the railway brake equipment producer Wabtec.*

Keywords – railway, reliability, bogie, brake, freight, wagon

1. INTRODUCTION

As freight operators focus on the need for greater improvements in efficiency and safety, there is a significant need for advances in wagon brake systems. The use of integrated bogie brake systems is allowing freight operators and maintainers to benefit from higher network capacity and reduced maintenance costs. These advanced bogie brake systems that include integrated brake cylinder, slack adjusters and parking hand brake are adding to these benefits through additional capacity improvements, significant safety improvements for operators and maintainers and optimized life cycle costs [1].

The aim of this paper is to make direct comparison of classical (conventional) bogie brake and the integrated bogie brake type IBB 10 in terms of efficiency, weight difference brake shoe (block) wearing and reliability.

2. CLASSICAL BRAKE FOR FREIGHT WAGONS

The most common classical (conventional) brake system for freight wagons (excluding all of the pneumatic units), consists of one brake cylinder, one slack adjuster, pull rods, brake riggings, brake triangles, hangers, brake shoe holders and brake shoes. The description of the classical brake system is shown in fig. 1 and the schematic view of this system is shown in fig. 2

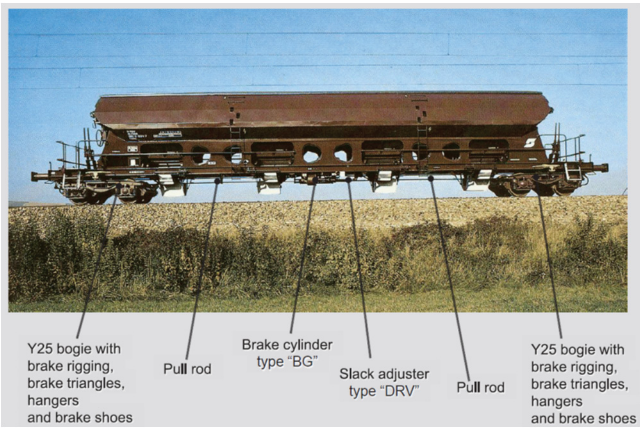

Fig.1. Description of classical brake system

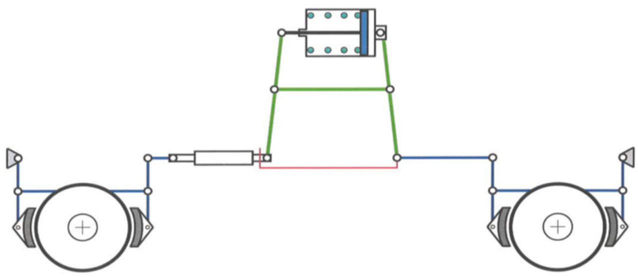

Fig.2. Schematic view of classical brake system

The simplicity of the classical brake system has

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made this brake equipment dominant in the freight market worldwide until the arrival of integrated bogie brake systems.

3. INTEGRATED BOGIE BRAKE SYSTEM TYPE IBB 10

The patented integrated bogie brake type IBB 10 was developed for freight wagon application. It is the lightest brake on the railway market so far [2].

The invention in general relates to the area of braking devices for railway vehicles, and regards especially to bogie brake devices and slack adjusters for the use with bogie brake devices. Braking devices are used for the realization of braking of railway vehicles by introducing of air under pressure into the relevant cylinder chamber. Through a system of levers and slack adjusters the created force in the brake cylinder is intensified and transferred directly onto the wheels of the bogie [3].

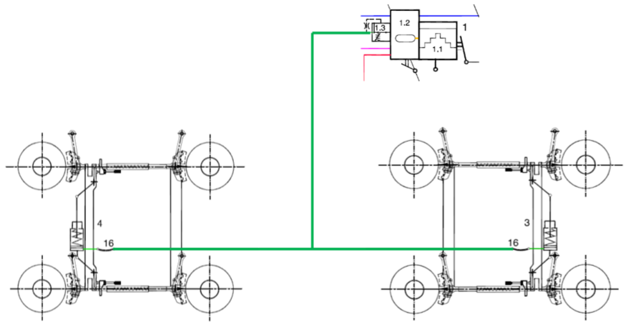

Fig.3. Schematic view of integrated bogie brake system

This design enables easy assembly and disassembly of each component separately, which is a big advantage taking into consideration overhauling and maintenance of the system. The assembly of IBB 10 is located between the bogie wheels and it fits the standard interfaces of Y25 bogie family. Its function is to provide equal braking force application simultaneously on four wheels. The design is based on the use of a brake cylinder as an executive unit with (or without) hand brake application and two double-acting slack adjusters for automatic gap regulation between all four wheels and brake shoes [2]. The air pressure in the brake cylinder creates a force which is intensified and transferred to the slack adjusters by levers, and equal force is transmitted to the primary and secondary beam from which the brake shoe holders apply the braking force on the wheels through brake shoes (blocks).

On one bogie can be assembled one IBB 10, and because the most common variant is one wagon to have two bogies, usually total of two IBB 10 are needed per wagon as a set. Because each wagon needs to have the function to be parked in stationary position when it is removed from the train composition, at least one IBB 10 needs to have a parking hand brake. Because of different types of wagons, two types of hand brake systems were developed by Wabtec MZT - platform hand brake (when the activation is done from the platform of the wagon) and side hand brake (which is assembled on the bogie and activated from lateral side of the wagon).

On fig. 4 is shown the integrated bogie brake type IBB 10 without hand brake.

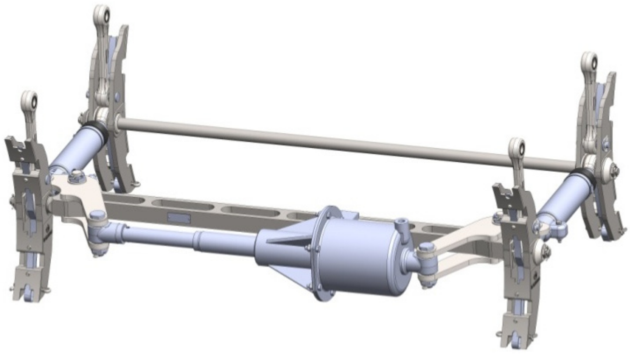

Fig.4. IBB 10 without hand brake

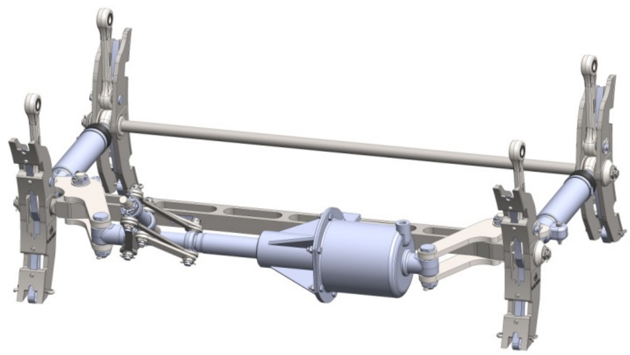

Fig.5. IBB 10 with platform hand brake

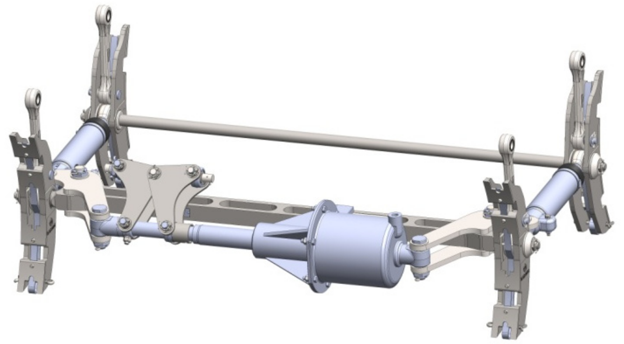

Fig.6. IBB 10 with side hand brake

On fig. 5 is shown the integrated bogie brake type IBB 10 with platform hand brake. It has the same function as IBB 10 without hand brake with addition of manual hand brake application from the platform of the wagon. The platform hand brake mechanism should be connected with telescope cardan shaft and hand wheel, which is operated from the platform of the wagon from longitudinal direction. The hand brake activation is realized by rotation of the hand wheel and this torque is transferred onto the spindle of the hand brake mechanism by the telescope cardan shaft. The hand brake mechanism consists of system of levers which activate the brake cylinder by rotation of the hand brake spindle. With the activation of the brake cylinder the braking function occurs just like in service braking.

On Fig. 6 is shown the integrated bogie brake type IBB 10 with side hand brake. It is very similar with IBB 10 with platform hand brake, with only difference that the hand brake application is realized from the ground and from the lateral sides of the bogie. Because the hand brake activation needs to be operated from each side of the wagon, a gearbox needs to be installed on the body of the bogie, which will cause the hand brake application to be realized by rotation of the hand wheel in the same direction from both sides (usually rotation in clockwise direction). The hand wheels from each side need to be connected to the gearbox and in the same time connected to the spindle of the side hand brake mechanism with telescope cardan shaft.

4. RELIABILITY COMPARISON OF CLASSICAL BRAKE AND IBB 10

One of most important benefits of the integrated bogie brake design is its higher reliability level. In order to be evaluated reliability of both brake systems and have better perceptions it is necessary both systems to be analysed through reliability block diagrams. On Fig.7 is presented reliability block diagram of conventional brake system. Cumulated reliability of the system is presented with blocks which depending of mutual interdependencies are in serial connection. Because of it calculation will be made by multiplication of their values and result will be cumulative reliability of the system.

$$R = R_{DV} \cdot R_{DVb} \cdot R_{BC} \cdot R_{SA} \cdot R_{mech} \quad (1)$$

R_{DV} – reliability of distributor valve
R_{DVb} – reliability of distributor valve bracket
R_{BC} – reliability of brake cylinder
R_{SA} – reliability of slack adjuster
R_{mech} – reliability of mechanism

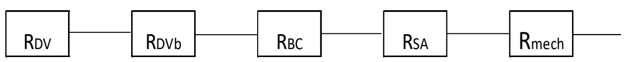

Fig.7. Reliability block diagram of conventional brake system

On the second figure (Fig. 8) is presented reliability block diagram of integrated bogie brake system. As can be seen the first two blocks are in serial connection while in the following part arises separation of two mutually independent reliability blocks. This blocks in reality are the two independent IBB10 mechanism. The equitation for calculation the reliability for blocks is shown on the figure. To get better picture it is necessary to make assumption that reliability is equally allocated to all blocks of the system and is 95% than in the first case on conventional system achieved reliability will be approximately15% lower than reliability in second case with IBB brake mechanism. That indicate that the second system has higher level of inherent reliability level due to design of the system [4],[5]. The other advantage of the integrated bogie brake design compared with classical design is that which prevent wagon to loose complete braking power if one IBB systems is in failure. This means that the other will stay in function beside the fact that wagon will lose 50% of braking power. In case with classical system if only one executive block lose function than complete system lose function and wagon loses 100% braking power.

$$R = R_{DV} \cdot R_{DVb} \cdot \big(1 - (1 - R_{IBB1}) \cdot (1 - R_{IBB2})\big)$$
$$= R_{IBB1} = R_{IBB2} = R_{BC} \cdot \big(1 - (1 - R_{SA}) \cdot (1 - R_{SA})\big) \cdot R_{mech} \quad (2)$$

R_{DV} – reliability of distributor valve
R_{DVb} – reliability of distributor valve bracket
R_{BC} – reliability of brake cylinder
R_{SA} – reliability of slack adjuster
R_{mech} – reliability of mechanism
R_{IBB} – reliability of IBB mechanism

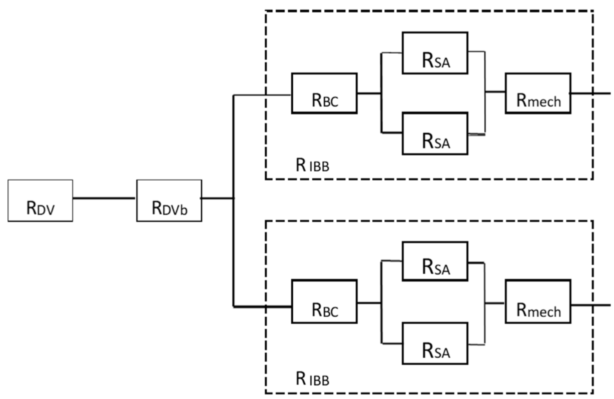

Fig.8. Reliability block diagram of integrated bogie brake system

5. CONCLUSION

From all of the above mentioned and analysis made from different viewpoints can be concluded that new design of braking systems with integrated bogie brake have a lot of advantages compared to classical braking systems. These advantages will have positive impact on wagon efficiency in terms of additional capacity of freight wagon, better maintainability, optimized life cycle costs, and better reliability availability and safety.

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