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RAIL VEHICLE WHEELS COMMON FAULTS CHARACTERISIC

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S u m m a r y . The article focuses on the issue of rail vehicle common faults characteristic with the purpose of choosing optimal method of their diagnosis in service.
K e y w o r d s . Wheelsets, undercarriage, wheelset faults, rim, profile, flange.

INTRODUCTION

At the present stage of railway transport development it is necessary to pay special attention to the issue of passenger and goods transportation safety.

Wheelsets are the major element of undercarriage because traffic safety depends on their condition in the first place. They receive the weight of the body and wagons with all the equipment (sprung mass) as well as their own weight with details that are mounted directly on the wheelsets (unsprung weight) and convey it to the rails. In addition, the wheelset transmitts the torque of the traction motor; tractive and braking forces are realized at the place of wheels and rails contact. As the locomotive moves each wheelset takes hits from the track irregularity and guiding forces, and in turn, strongly affects the upper track structure and assembly of articulated wheelsets with a cart itself. Therefore, monitoring the wheelset assembly state is an actual task.

There is an analysis of wheelset details faults in works [1, 2, 4, 10, 11, 13]. However, each author considers faults that are specific to the individual assemblies of the wheelset.

OBJECTS AND PROBLEMS

Wheelset construction has not changed since the emergence of rail transport, and is mainly determined by the way of torque transfer from the traction motor, traction motor suspension method and the type of wheel centers.

Wheelset consists of an axle and two wheels. In order to transfer torque one or two tooth gears should be pressed on the axle, or there could be mounted the hollow shaft which is attached to the wheels with the help of elastic fingers. Traction gears are in their turn pressed on the shaft [12, 13, 16, 20].

Most domestic locomotives are operated with the axle load of up to 225 kN and can have wheelsets with wheels of 870-1050 mm in diameter. Wheels on new passenger locomotives DEL70 (diesel-electric locomotive) and DEL75 have a diameter of 1220 mm; wheel diameter of 1250 mm is accepted for freight locomotives with the load of axle on the rails up to 245 kN. [4, 5, 6].

Figure 1 shows profile of standard diesel wheelset rim according to State Standard 11018-87 [6]. The outer surface (roll surface) has a special profile which consists of the flange (ledge), main surface with the conical shape of 1:10 and lateral surface with the conical shape of 1:3,5. Flange directs the movement of the wheel on the rail track and prevents the wheelset of derailment. The main conical surface allows centering wheel pair in fixed tracks and facilitates the passage curves sections of track without slipping and excessive wear. The main conical surface allows centering of the wheelset in tracks and facilitates the passage of the curved sections of track without slipping and excessive wear. The lateral conical surface and chamfer facilitate the passage of switches [17-19].

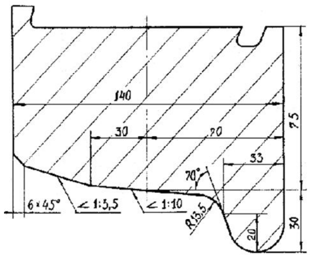

Fig. 1. Flange profile according to State Standard 11018-87

Flange is the most wearing part of the wheelset. Wear in the time of rolling circle is called clearance under flange; wear of the flange's lateral side is called flange worn sharp. Wheelsets in proportion to their wear come to tyre returning at which their original profile is restored. Marginal rate of wear and flange thickness are set according to the rules for technical operation.

In the operation of wheelsets there happen their natural wear and damage [5, 9].

The analysis of the wheelsets classification shows that the main faults of wheelset axles are the following [3, 6, 7, 8]:

- cracks in the wheel seat (on the inside of the wheel hub and rarely in the centre piece).
- scuff marks of the wheelset axle in the centre piece.
- weakening and shift of the wheel on the axle.
- modification of the axle journal (which occurred because of roller bearings usage in car boxes).

Possible causes of wheelset axles faults emergence and faults themselves are shown in table 1.

Wheels in turn can have the following faults[4,10, 14, 15, 17 - 19]:

- cracks;
- splitting of rim, disc and hub of solid-rolled wheels;
- fractures;
- uneven wheel rolling;
- even rim rolling;
- flange wear;
- flange undercut;
- sliders (dents);
- chips (local depressions on the surface of the wheel rim of wheelset, appearing due to peeling or chipping of metal);
- blisters in the wheels.

- In addition to the above-mentioned faults of the wheels, there are often found circular gallings on the roll surface (fig. 2), metal displacement and sharp worn in the area where the undercut part of flange joins its top (fig. 3).

Table 1 Wheelset axles faults

Fault	Possible causes of their emergence	Geometrical characteristics of the faults
Cracks in the wheel seat	Strikes experienced by wheelset under the condition of the poor quality of wheelset formation, while loading and unloading of wheelsets	Hidden defects and transverse cracks of≤2-4 mm in depth, inclined cracks of≤ 2 - 8 mm.
Scuff marks of the wheelset axle in the centre piece	It is caused by incorrect assembly and adjustment of the brake linkage	The depth of scuff is 2 -2,5 mm.
Scuff marks in the before-hub part	Friction of the walls of box with the axle because of incorrect assembly of axle unit and other reasons	No more than 2 mm.
Weakening and shift of the wheel on the axle	Among the signs of attachment hub weakening there is appearance of rust or oil at the hub of the wheel on the inside, crack of paint around the perimeter of the connection to the hub	The deviation from the nominal size according to State Standard 30237-96
Modification of the axle journal	The use of roller bearings in the car box	Conicity is ≤ 0,1 mm, ellipticity is ≤ 0,05 mm, waviness is ≤ 0,02 мм.

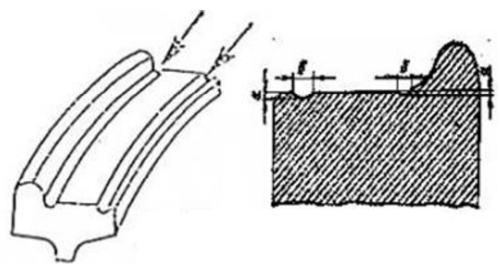

Fig. 2. Circular gallings on the roll surface

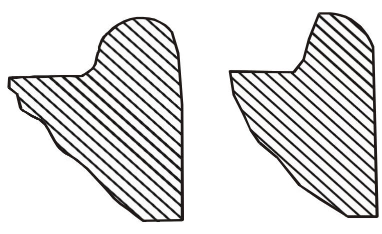

Fig. 3. Example of flange worn sharp

Circular galling is allowed at the base of flange with the depth of no more than 1mm and at the inclination of 1:7 it should be 2 mm at most or no more than 15 мм broad. Metal displacement (gain) may be at a height of wheelsets of passenger cars no more than 0,5 mm.

Possible causes of wheel faults emergence and faults themselves are shown in table 2.

Circular crack in the drive wheels can appear due to the tight fitting of drive axle. Wheelsets with cracks in the rim and solid-rolled wheels drives are not allowed to operate.

All of these defects of wheelset parts lead to quick wheelset breakdown, and also serve as the source of additional dynamic loads that cause vibrations in the frequency range close to resonance.

Taking into account the results of this study, in order to ensure reliable operation of the rolling stock it is necessary to create a system for wheelsets defects identifying. The basis of this system is the detection of wheelset defects by methods and techniques of vibro-acoustic signal.

Table 2. Wheel faults

Fault	Possible causes of their emergence	Geometrical characteristics of the faults
Cracks; splitting of rim, disc and hub of solid-rolled wheels; fractures	Shock interaction of wheel and rail	It is not allowed to operate wheel sets if they have a surface spalling on the outer rim edge, including local split circular roll, with depth (radial tires) exceeding 10 mm, or if the width of the remainder of the rim in spalling is less than 120 mm, or in a damaged place, regardless of the size of spalling, there is a crack extending into the metal
Uneven wheel rolling	It occurs mainly due to the stiffness of the way, high speed, and formation of defects of the brake origin on the roll surface	Uneven wheel rolling is standardized only for passenger cars: ≤ 2 mm (for wheelset with gear from the front axle it is ≤ 1 mm)
Even rim rolling	Its friction on the rails	≤ 4 mm for wheelsets with gear drive from the end of the axle and ≤ 5 mm for other wheelsets of passenger cars with speed from 121 to 160 km/h; ≤ 7 mm for long-distance passenger with speed up to km/h; ≤ 8 mm for cars of local and commuter passenger train; more than 9 mm for freight and refrigerator cars used in the trains at speed up to 120 km/h; for empty cars, used for loading or included to deadhead routes the wheel rolling of ≤ 8,5 mm is not allowed
Flange wear	Contact with the rail due to the winding movement of wheelset on straight way and car passing on curves	At speed of ≤ 120 km/h the flange thickness is more than 33 mm or less than 28 mm at the locomotive when measured at a distance of 20 mm from the top of the flange at a height of 30 mm, while the rolling stock with flange height of 28 mm measured at a distance of 18 mm from top of the flange
Flange undercut (especially often appears in eight-wheel cars)	Larger difference of lateral bogie frames bases; large difference between the diameters of wheels mounted on a single axle; and if there is a large gap between the axle boxes and jaws, as well as the warp of a bogie frame; wheels which were forced on the axle irregularly	It is not allowed to use cars, which have wheelsets with vertical undercut of the flange on a height of more than 18 mm from wheel rolling circle or flange worn sharp
Sliders (dents)	They are formed on the roll surface when sliding on rails in case of jamming of wheelsets	Having roller bearing axle boxes with depth of ≤ 1 mm; plain bearings with depth of ≤ 2 mm.
Chips	Flaking or pitting of the metal. They occur most often in the place of sliders and are located symmetrically on one line of both wheels	Depth is ≤ 10 mm, length is ≤ 25 mm for passenger cars, thickness of the wheel rim in the place of chip is: ≤ 31 mm. for passenger trains with speed of up to 120km/h; it is ≤34 mm., if speed is up to 140 km/h; and it is ≤ 40 mm. if speed is up to 160 km/h
Blisters in the wheels	Non-metallic inclusions in the metal, which are found on the roll surface after its abrasion or peeling	Not standardized
Circular gallings on the roll surface	Interaction with the surface of the pad, large axial and lateral loads	Depth at the base of flange is ≤ 1 mm, at the inclination 1:7 is ≤ 2 mm, width is ≤15 mm, metal displacement (gain) is ≤ 0,5 mm
Circumferential crack in the disk of wheel	Tight fitting of drive axle	≤ 2 - 4 mm

CONCLUSIONS

Proposed classification is of great importance for the analysis of defects causes and development of their elimination measures. It establishes link between the characteristics of wear, wheelset damage and operating conditions.

Therefore, for safety movement of rolling stock it is necessary:

- to develop a systematic approach when predicting running gear faults;
- to implement monitoring and diagnostics based on methods of vibroacoustics natural frequencies vibroacoustics, acoustic emission, electromagnetic acoustics, multi-angle acoustogalographics;
- to develop a new generation of diagnostic systems, which give three-dimensional image of defects with predictable operation life;
- to introduce fixed and on-board diagnostic of the rolling stock state assessment.

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ХАРАКТЕРИСТИКА РАСПРОСТРАНЕННЫХ НЕИСПРАВНОСТЕЙ КОЛЕС РЕЛЬСОВЫХ ЭКИПАЖЕЙ

Надежда Махортова, Юрий Вивденко

Аннотация. Статья посвящена вопросу характеристики распространенных неисправностей колес рельсовых экипажей для выбора оптимального метода их диагностирования в процессе эксплуатации.

Ключевые слова. Колесные пары, экипажная часть, неисправности колесной пары, бандаж, профиль, гребень