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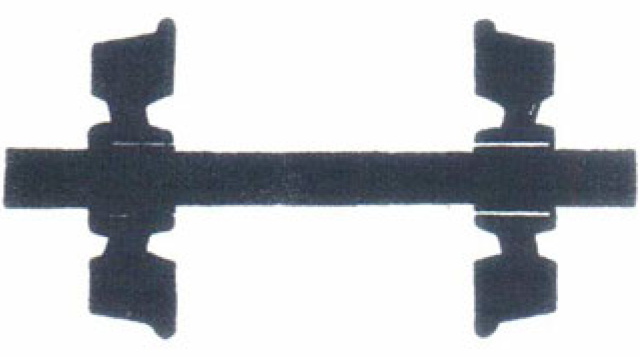

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DEVELOPMENT OF PROSPECTIVE PROFILES OF WHEEL AND TYRE ROLL SURFACE AND EXPERIENCE OF THEIR SERVICE ON MAIN-LINE AND INDUSTRIAL TRANSPORT IN THE USSR

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The problem of enhancing longevity of wheels and tyres is related to the provision of wear resistance of work surfaces of them. The wheel wear is accompanied by structure modifications that take place in the thin surface layer. These changes are connected with the development of plastic displacements due to the action of exterior loads, temperature deformations when applying brakes as well as to the formation of "white layers" when the thin surface layer is heated up to the austenite zone by the braking heat and sharp cooling at the brake switching off.

One of the ways to reduce wear of ridges and plastic deformation of work surfaces in the zone of roll circle is to upgrade the tyre profile design. When developing, one of the premises was to examine the worn out wheel surfaces by taking profilegrams of the wheel surfaces of the rolling stock that served under different conditions of main-line and industrial transport. Besides, the developed profiles were to provide traffic safety condition, i.e. passing curves, the switches, etc...

The decisive factor in the developing new profiles was to reduce contact stress level in contact interaction of the wheel-rail pair. For this purpose there has been developed a new procedure of estimating contact stresses in wheels and rails of real surface geometry. This supposed to consider the track profile, track gauge and wheel pair. For different parts of the track in the curve (for generality) there were determined possible positions of the wheel pair in relation to the rail track from the underframe inscribing condition and found initial points of contact of the wheel and rail in any conditions (both for the inner wheel pair and the outer one). In the vicinity of the found point there was carried out the contact surfaces profile interpolation, local curvatures determined, and with the help of G.Herze theory were calculated the parameters of contact zones and values of contact stresses. In case with more than one contact zone, e.g. so to say a two-point contact, the local curvatures were determined for each one of the possible zones, and then were iterationally calculated total forces acting in each zone and corresponding to them values of contact stresses.

Modelling of contact interaction of wheels and rails of various work surface profiles has been carried out. The studies resulted in the development of new profiles having patent purity. It was established that the given profiles have a substantially lower level of contact stresses at the interaction with the available in the USSR rail track. This especially concerns the zone dislocated at the bossing of the ridge, which is responsible for the shouldering of the ridge and side wear of the rails.

The quasi-dynamic forces acting on the wheel in the process of the pair wobbling have also been studied. In the developed profiles when the wheel runs upon the rail they grow significantly more smoothly than in the similar standard ones.

The developed profiles have been introduced to manufacture new wheels and repair turning of wheels in service. For these purposes was developed a copying, machining and inspection tool for facing the car and locomotive wheels. Large-scale service trials of new wheel profiles on main-line and industrial transport have shown their high reliability and performance. For example, the eight-axle tank stock rolling in the East polygon of the USSR railway system has been transfered to the Dnepropetrovsk Metallurgical Institute profile. This has resulted in reducing the wear rate wheel pair ridges by 1.5-1.8 times. On the industrial transport, i.e. Mikhailovsky mine of the Kursk magnetic anomaly, the result is still higher - wear rate is reduced by 2 - 2,5 times.

For the wheels with developed work surface profile and for the standard ones that had undergone comparative service trials were carried out metallographic studies. The steel analysis was practically the same of both wheels. The wheel microstructure in the viscinity of the roll surface was characterised by the presence of a zone of deformed grains and areas of "white layer". The appearance of deformed grains is connected to the metal bearing stress at the contact with the rail. The plastic displacements in the thin surface layer had taken place under relatively high cyclic changes of pressure and temperature. The microstructure pattern proves the discontinuous flow of plastic deformation along the section of the standard wheel rim. The grain deformation rate and the depth of the deformed grains zone along the rim width is not the same. The plastic deformation has extended most deeply at the point of the ridge bearing in the shoulder zone at the rim edge. In the bearing zone the steel deformation rate values attain 65-75%, in the middle of roll surface they decrease down to 22-25%, and significantly increase in the shoulder zone (up to 50%). The character of dislocations density and steel microhardness modification is similar. Comparative analysis of the wheel microstructure of standard and developed surface profiles has shown that the structural changes are qualitatively similar, but the zone parameters of these changes are different. Notwithstanding the fact that the plastic displacements zone patterns seem to be similar, it has been established that the level of plastic deformations and the zone depth, where it takes place are lower in the wheel with developed profile. The plastic displacements in the rim of the given wheel were developing in a smoother regime due to smaller values of contact stresses and correspondence of the developed profile to the wear pattern of wheels when in service. There is practically no shoulder on the wheel of developed profile as there is no metal build-up on the exterior lateral face of the rim leading the standard wheel profile to change. In the case of the new profile the steel flow in the surface layer was found to be of smoother character than in the standard wheel, where there were zones that manifested obvious vortex ("turbulent") steel flow at the macrolevel.

It should be also noted that the developed profiles are adaptable to manufacture, there is little chip waste when turning down on a lathe to restore true shape. The abovestated allows to conclude that it is expedient to introduce the developments in the USSR and abroad, where it may necessitate some additional developments of the profile in conformity with the available standards of rail track according to the developed procedure.