ANALYSIS OF CAUSES OF WAGONS DERAILMENT

VAGONU NOBRAUKŠANAS NO SLIEDĒM ANALĪZE

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The derailment of mobile composition are attended with a considerable damage to the railways. The especially heavy consequences have tails from rails in the cases when the timeliness of delivery and safety of loads is important.

Researches showed, presence of row of factors, resulting in the tails of mobile composition from a rail, in the number of which loss of ability of wheels to self setting by reason of the dissatisfied state of surface of rolling or insufficient greasing of rails, dry center bowl of knots of light carts and superfluous inhaling of lateral supports, dry internal rails in curves, low resistibility of frames of light carts to warping and weak fixing of rails [1]. In many cases removal even one of these factors far diminishes probability of tails from rails. However to liquidate even one such factor not simply.

Some factors, for example dry rails on the inside curves, avoiding is impossible. Problems caused by the wear of wheels, deciding is difficult, because in practice it is impossible to recover a type or replace every wheel, as soon as the signs of wear are revealed. Frequent revisions of lateral supports for providing of their correct regulation also practically not feasible. It left to the researchers only one choice – to improve greasing and decrease a friction in a foot knot.

After the beginning of researches works, were the result of these efforts accumulation of large volume of information about the dynamics of foot knot and making recommendations, which, if to execute them, can considerably decrease the number of tails of mobile composition from greasing of rail without the considerable increase of charges on technical service and repair [1].

When a freight train moves in to the curve, center pivot and center bowl of light carts is subject to influence of considerable on size forces of friction, especially in the center bowl knot of front on motion light cart of carriage. Overcoming this resistance at a turn, the front light cart of carriage is warped and takes form of parallelogram. The change of form of light cart creates a situation, at which the large corners of appearing suddenly of the wheeled pair take place on rails, resulting in the origin of the large transversal loadings which, at presence of other factors, listed above, on occasion can result to in rail and to the tails of mobile composition. At the enjoined carriages this problem much is less difficult, because helps the second light cart to be inscribed in curve basket of carriage.

In the case of the joined carriages every element of carriage leans only against one light cart. This light cart always operates as front at motion of carriage in one direction or as back in opposite. When a train moves in unfavorable direction, all light carts have the high loadings and here is not retaining of rail next light carts. At presence of a few such light carts in one sequence the high transversal loadings, causing him oblique setting accumulate in a rail.

The shipwrecks can happen regardless of the personnel related to motion of trains. Some shipwrecks take place because of joint act of the factors, related to the state of train and his management, geometry of way and dynamics of carriages.

These factors in different combinations can result in the tails of carriages from rails, for example fracture of rail from tireless defects or fracture of the automatic coupling from excessive longitudinal forces in a train. These forces arising up from the wrong management by train can result in getting up of wheel, rolling into on the head of rail and knocking over of rail.

At trains, formed from different carriages, there are problems of passing the curves of small radius. In combination with large longitudinal forces of tension-compression such composition can leave the tracks from rolling into of wheel on the head of rail. Hook of empty carriages before a hook loaded in composition a train potentially can result in the tails of train from rails from the origin of excessive longitudinal forces in the automatic coupling.

Variable setting of hooks of carriages, equipped long-travel cushion by taking in vehicles, and without such vehicles requires the hooks of carriages careful management by train. A wrong management or urgent braking of such train can serve as potential reason of tails from rails.

The factors resulted not only can reasons of tails of carriages serve from rails. The large influencing is rendered by the dynamic reactions of separate freight carriages on the geometrical defects of way, such as a different height of rails is in a transversal plane, defects of vertical type, unevenness of way in a plan and uterine of track. In addition, important part is acted by types and state of surfaces of wheels and rails. It appears in that behalf, that polishing of internal verges of rails and their wrong greasing have strong influence on possibility of tails from rails from knocking over of rail [2]. As examples of dynamic there are reactions which can become reasons of tails of separate carriages from rails, it is possible to mark:

the vibrations of galloping and lateral tossing from the vertical unevenness of way can result in getting up and lowering of wheel;

the vibrations of jumping up from the unevenness of type result in getting up of wheel and center block of leaning of basket on a light cart;

at empty carriages there can be excessive vibrations wagging, resulting in rolling into of wheel on the head of rail with subsequent by his tails.

At carriages with three-piece truck the large moments of turn of light carts are possible beyond measure at an entrance in curves, that results in the defect of bogie side frame and knocking over of rails; a situation can be worsened from the wrong greasing of rails and polishing of their internal verges.

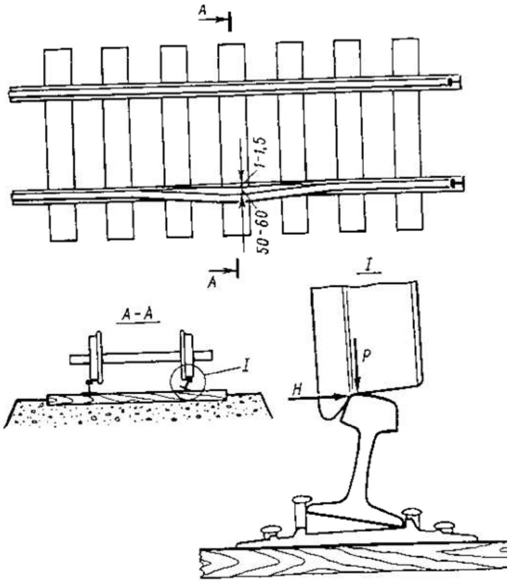

Fig. 1 Wringing out of wheel of head of rail a comb from his inclination

Derailment can be divided into the followings basic kinds:

1. Derailment from pressure of track – wringing out of one wheel of head of rail a comb due to his resilient inclination (fig. 1) and failure of the second wheel into track from other rail.

Such type of derailment of wheels in modern terms is most widespread on areas with wooden railroad ties and model crutch clamping. On areas with the railroad ties of the reinforced concretes and clamping of KB, and also on areas with wooden railroad ties and linings inclination of rail due to tearing away of internal edge of sole to linings is impossible. In the mechanism of tails of this kind it is necessary to select two moments. First – on the eve of tails, when wringing out of head of rail a comb close to critical. At this juncture the second wheel is on verge of failure and rails normal canting has under this wheel (fig. 2, *a*) [3]. Second moment, when the second wheel failed already. An at this juncture failing wheel by a backside wrings out the head of the second rail, inclining him with tearing away of internal edge of sole from linings. At this juncture both rails are inclined (fig. 2, *b*) at tails only one wheel.

2. Derailment from pressing out of crew, i.e. from rolling into the rib of wheel on a head rail or wit (fig. 3, *a*) with the subsequent failure of other wheel of the same wheeled pair into track (fig. 3, *b*). Comparison of actual types of head of rails of fully consilient types does not exist practically. Wear of every rail both on a size and in a due form individual. Such variety is determined the variety of contact of new and threadbare wheels with new and threadbare rails taking into account actual and dynamic canting, and also rises of outward rail and rate of movement.

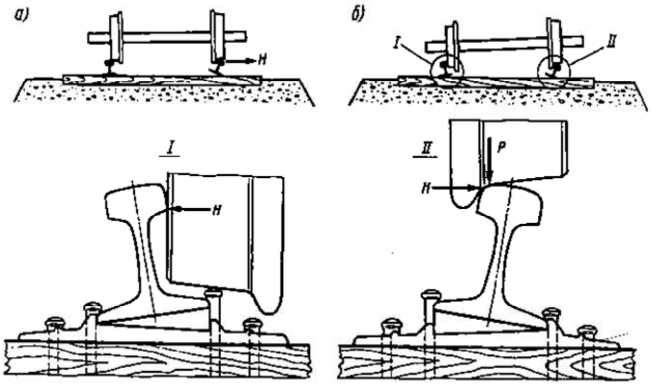

Fig. 2 Position of the wheeled pair and rails the day before (*a*) and after the failure of left wheel from hold apart of track (*b*)

3. Derailment from impermissible horizontal transversal curvature (change) of track by the wheels of light cart at braking of train or from its temperature troop landing. Thus simultaneously there is rolling of comb of one wheel through the head of the distorted rail and failure into track of other wheel of the same wheeled pair. Such type of tails is most characteristic for the cases of quick visit of locomotive in place of impermissible horizontal curvature of track because of its temperature troop landing, and also for the cases of horizontal transversal change of rails railroad tie grate of light cart of crew at braking of train.

4. Derailment take place from knocking over of rails, when comb of wheel it is enough long time is in touch with a rail and at large forces in the area of contact an internal rail deviates outside. The corner of rejection of both rails depends on the lateral wringing out of both heads of rails. The size of the lateral wringing out depends on combination of lateral and vertical forces from the wheels of carriage passing on an area.

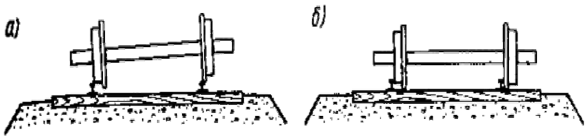

Fig. 3 Position of the wheeled pair the day before (*a*) and after tails (*b*) from pressing out of empty carriage

At an entrance on transitional area of the crooked light cart turn in relation to a basket. In relation to a basket force of friction hinder the turn of every central bearing of light cart in center bowl and lateral bearer. In addition, from the change of height of rise of outward rail in a transitional curve a light cart accomplishes winding motion and vertical loading on lateral bearer is multiplied, that results in the proper increase of moment of turn. It should be noted that the effective greasing of central bearing can have strong influence in the moment of turn. At dry central bearing the moment of turn of light cart is strongly multiplied.

At the normal passing of crooked bogie side frame and truck central bearing of model three-piece truck light cart occupy such position, when the front wheeled pair has comparatively a large corner of appearing suddenly and rib of wheel is in touch with an outward rail, while the back wheeled pair occupies almost radial position. As a result only on the front wheeled pair there are large lateral forces, extending rail track. However if moment of turn of light cart the large is enough, it is necessary to overcome resistance of defect, arising up from the friction of fan clutch wedges from the column of bogie side frame of light cart. It brings to the defect of bogie side frame relatively truck central bearing over.

The large corners of appearing suddenly of two wheeled pair result in that the combs of both wheeled pair contact with an outward rail and both they create large lateral forces extending rail track accordingly. It in same queue results in far greater attitudes of transversal forces toward vertical ones, by what at the normal conduct of light cart, when at the dry head of internal rail this the relation is measured on outward and internal rails, approached to the sizes about 0,6.

Researches showed that on propensity of light cart the strong polishing of internal corners of heads of rails or their greasing renders to the defects. Both these the factor influence on ability of light cart to offer resistance to the moment of turn.

5. Derailment from breaking over the unadjoining to the frame rail edge of wit of cut rib of light cart and creepage of rib on a frame rail and wit.

6. Derailment from the fracture of rail.

One of the greatest constituents of the lateral bending of head of rail is a turn of area of rail in relation to a rail gasket. The size of turn of rail depends on forces of influence of wheels. She can be certain by the simplified method at consideration of forces, operating on a rail. Lateral force operates on a shoulder, equal to the height of rail, creates a moment, aspiring to tip a rail over outside. At that time vertical force operates on a shoulder little less width of sole of rail and creates a moment, aspiring to pin a rail downward to the railroad tie. If an break torque moment to lateral forces exceeds a retaining moment to vertical forces, on a rail operate clean break torque moment.

If there is a clean break torque moment, he must be compensated due to torsion inflexibility of rail or clamping. In order to smuggle out of a crutch from a new railroad tie it is required to make considerable effort. However as far as the senescence of railroad tie this force considerably weakens and can not resist the action of break torque moment.

For the model area of rail in the point of contact wheel on the inside of rail maximal size of relation of transversal force to vertical for bogie side frame light cart, will make 0,6. However if a point of contact of wheel is on the middle of head of rail, the maximal size of relation diminishes to 0,4. It exceeds a maximum size 0,4 and there is a clean break torque moment of rail.

Important part in counteraction any clean break torque moment is acted by torsion inflexibility of rail. On short distance between the axes of the wheeled pair of light cart torsion inflexibility of rail is ever-higher. As a result of force to all wheels effectively operate together in combination with a tipping over a rail moment. On this account used relation of transversal and vertical forces of one not wheel, but bogie side frame of light cart.

The however conducted researches showed [2] that it is important to take into account a general break torque moment not to one light cart, but to two nearby. At ordinary carriages two light carts are relatively close one to other. It usually helps to pin a rail against railroad ties, and consequently, to hinder his knocking over. At the joined carriages the nearest nearby light carts are one to other in the distance about 15 m, therefore they are anymore subject to this type of tails from rails. In addition, a looking after presently tendency to the increase of the axial loadings multiplies an break torque moment, operating on rails. Until more durable clamping or rails is not inculcated with less attitude of height toward the width of sole, the number of tails of type will be multiplied.

Analysing the tails of freight carriages from rails in the crooked areas of way, it is possible to notice that, as a rule, one or both axes of light cart go down from rails in middle part of train. Thus a train without the decline of speed follows 1-2 and more than kilometers without the tails of subsequent carriages.

In the crooked areas of way internal rail filament shorter canting. The wheels of mobile composition are fastened on an axis hardly, i.e. can not automatically work at motion on the curves. At new wheels the surface of rolling on rail has conical shape 1/n = 1/20. At such extremity in curves with R = 1100 – 1300 m takes place trundle of wheels on rails without the longitudinal sliding of contacting surfaces. There is inevitably the longitudinal sliding of contacting surfaces of wheels and rails at other radiuses.

Mass measuring actual conical shape wheels of freight carriages in exploitation testify that conical shape 1/20 have no more than 10% wheeled pair actually. Approximately 30% wheeled pair because of wear of surface of rolling skids and head of rails have practically cylindrical surface or even negative (fig. 4) [3]. 60% wheeled pair have other surface in an interval to 1:20 to 1: ∞.

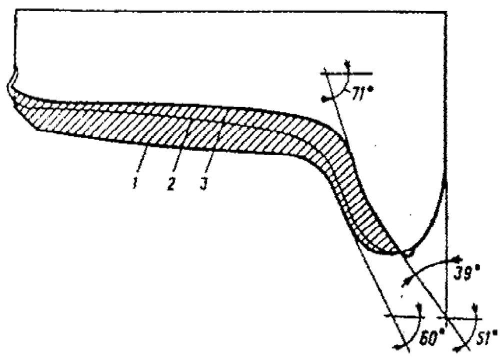

Fig. 4 Actual types of new (*1*) and threadbare (*2, 3*) wheels, entering grinding

At free trundle of the wheeled pair with threadbare (cylindrical) wheels to on by the crooked radius 300, 400 and 500 m the wheel of carriage, following on the internal rail filament of curve, is outstripped by outside accordingly on 16, 12, 10 sm, and for each 20 turns of the wheeled pair the heat of internal wheel to direction of motion makes according to 32, 24 and 20 sm. There is a defect of the wheeled pair in a plan and failure of wheel into track (fig. 5).

In a light cart two wheeled pair are bound by a truck central bearing and bogie side frame. At the backlashes in the jaws of bogie side frame and in their openings for a truck central bearing the internal wheels of light cart outstrip outside and a light cart in a plan assumes an air of parallelogram.

Because of presence of partial horizontal connection of the wheeled pair in a light cart possibility of heat of internal wheels as compared to outside is limited. Therefore inevitably there is the longitudinal sliding (skid) or outward (wheel sliding) wheels on a rail filament on which to resistance less. At the surplus rise of outward rail all wheels, followings on the outward filament of curve, slide to direction of motion. Wheels, followings on the internal filament of curves, weighted because of crossing of baskets on internal bearer. Therefore resistance sliding (skid) of internal wheels considerably anymore, what resistance the longitudinal wheel sliding of outward wheels. Producible in present tense, greasing only of outward rails of curves facilitates the indicated sliding of outward wheels even in default of surplus rise. Therefore she does not give the desired results, especially wherein for multiplying coupling of wheels with rails apply sand.

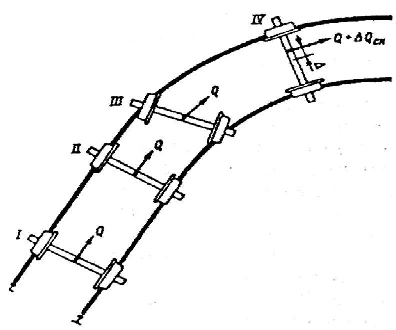

Fig. 5 Chart centred and mixed the wheeled pair

In the mode of traction motive (active) force is put to female center plates of light cart and operates under direction of motion. Forces operating from the internal wheels of light cart on rails in the area of contact and equal in every contact are reactive $P_B \cdot f_B$, where P_B is vertical loading from an internal wheel on a rail f it is coefficient of rolling friction wheel with an internal rail. Reactive also there is force of resistance to the longitudinal sliding of outward wheel for a rail, equal for every outward wheel $P_H \cdot f_H + H_Б \cdot f_Б$, where P_H is vertical loading on the outward rail of curve, $H_Б$ is lateral horizontal loading of comb on the lateral verge of head of outward rail, f_H is coefficient of rolling friction rim of wheel with astride heads of outward rail, $f_Б$ is coefficient of friction of comb with the lateral verge of head of outward rail of curve [4].

CONCLUSIONS

In the mode of braking the lateral affecting of comb of wheel of axis of light cart first on motion head of outward rail of curve is substantially multiplied. It is conditioned by absence of motive force to direction of motion, light cart attached to female center plates. Active to direction of motion there are only forces in the contact of internal wheels of light cart with the head of internal rail of curve. Therefore sharply force of pinning of comb of the first axis of light cart increases to the head of outward rail of curve. This force the more than anymore surplus of superelevation and than head of outward rail is stronger smeared. Exactly this and can be reason of tails of carriages of curves.

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Sergejevs D., Gavrilovs P. VAGONU NOBRAUKŠANAS NO SLIEDĒM ANALĪZE
Analizētas vagonu noeju galvenās ainas uz dzelzceļa. Aprakstīti cēloņi, kuri noved pie vagonu noejām. Darba beigās sniegti analīzes rezultāti un secinājumi.

Sergejevs D., Gavrilovs P. ANALYSIS OF CAUSES OF WAGONS DERAILMENT
Analysis basic types of derailment of carriages on the railway. Reasons which result in the derailment of carriages are described. At the end of work the results of analysis and conclusions are presented.

Сергеев Д., Гаврилов П. АНАЛИЗ ПРИЧИН СХОДОВ ВАГОНОВ
Проанализированы основные виды сходов вагонов на железной дороге. Описаны причины, которые приводят к сходам вагонов. В конце работы представлены результаты анализа и выводы.