EXCELLENCIA
INTERNATIONAL MULTI-DISCIPLINARY JOURNAL OF EDUCATION

Volume 02, Issue 04, 2024 ISSN (E): 2994-9521

Calculation of the Force Generated in Pairs of Wheels in Wagon Sorting Sections

D. A. Axmedova [1], U. A. Ziyamukhamedova [2], G. B. Miradullayeva [3], J. H. Nafasov [4]

[1, 2, 3, 4] Tashkent State Transport University

Abstract:

This article presents a mathematical description of the friction of a pair of wagon wheels and rails on sections with stops of a sorting hill, using the theorem on the change of kinetic energy for a non-free body in the final state. Such an approach helps to solve the problem of deriving the formula for the braking distance of the car in the sections of parking spaces on sorting hills.

Keywords: sorting sections, wheel, rail, slip, braking sections, slope.

Introduction.

When designing sorting hills, choosing its optimal parameters, the precise values of the kinematic parameters of the movement of wagons and trains in all sections are important. The analysis of existing methods for calculating sorting peaks has shown that there are some inaccuracies in the used formulas and the absence of expressions for determining some important kinematic quantities[1-4].

Sorting provides an opportunity to determine the speed of the wagon and/or wagon train in the uneven rotation of the hill, based on the calculation and creation of a simplified mathematical model of the movement of the wagon, especially in sections with a stop on the downhill part of the hill. This helps to rationally choose the geometric parameters of the hill [5-6]. It is the results of such researches that form the initial theoretical condition in regulatory and technical documents in the study of the dynamics of rolling wagons from the slope of the hill [7-9].

It is worth noting separately that the relative resistance to movement of various resistances in the braking zones of parking lots $|w_{Ti}|$ in practice, it is a non-constant quantity ($|w_{Ti}| \neq \text{const}$), and its growth occurs when the speed of the car decreases [10]. Calculating and reducing the forces generated in wheel pairs at wagon sorting sections ensures the lifetime of the wheel pair.

Methods and research.

According to the Dalamber principle, parallel to the rail line, *Ox'y'z'* to the projection of the inertial calculation system *Ox'* axis (Fig. 1) for the absolute motion of the solid body in the braking zones of the sections of the sorting hill, based on the mathematical description of the wagon movement in the equally decelerated movement of the wagon acceleration has a negative sign

$$|a_{\text{к}\text{т}i}| = \frac{|\Delta F_{\text{т}i}|}{M_{\text{пр}0}} 10^3, \qquad (1)$$

where $|\Delta F_{\text{т}i}|$ – is the resultant force, due to which slippage of wagon wheel pairs along the rolling surface of the track and on the brake tires of the wagon retarder in the braking zones of sections with a parking place occurs, kN:

$$|\Delta F_{\text{т}i}| = F_{xi} + |F_{ci}|; \qquad (2)$$

$|a_{\text{кт}i}| = a_{\text{кт}i} \cdot \text{sgn}\Delta F_{1\text{т}i}$ – with the modulus function if $|\Delta F_{1\text{т}i}| < 0$ if $|a_{\text{кт}i}| = -a_{\text{кт}i}$, will be.

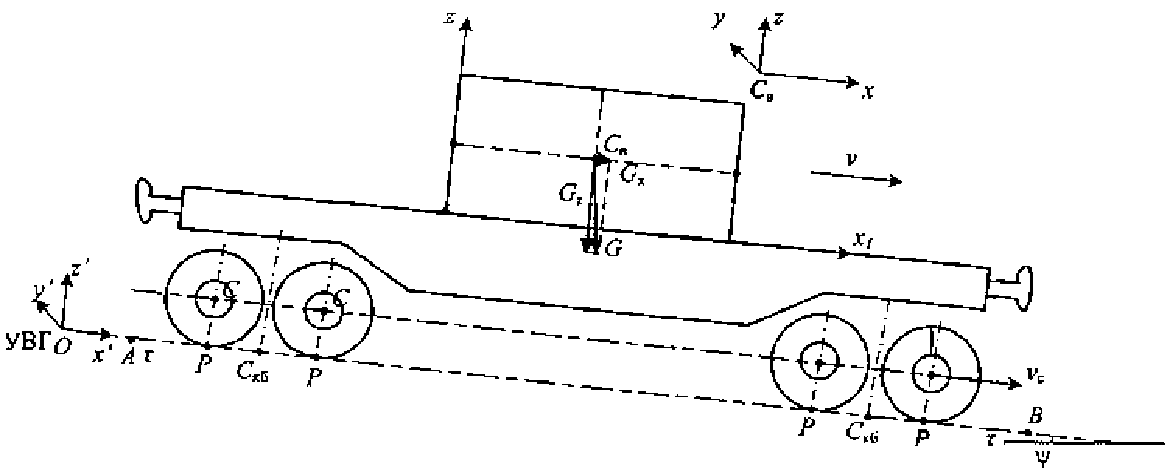

Figure 1. Scheme of movement of the wagon on the railway tracks.

From expression (1), $|\Delta F_{\text{т}i}| < 0$ or $|F_{ci}| > F_{xi}$ when the condition fxi is observed, the acceleration of the car in the braking zones of the sections with a stop at the initial speed $v_{\text{нт}i} > 0$ will be equally slowed down to the moment v = 0.

According to the existing methods of calculating sorting peaks, we express formulas (1) and (2) in conventional concepts and generally accepted notations.

It is possible to present the force Fxi due to the entry of the wagon into the braking zones of the parking lot, the force of the non-rotating parts (carriage, wagon body) and the weight of the wagon G_1 in shares:

$$F_{xi} = k_{x0i} G_1, \qquad (3)$$

where, i – is the number of profile sections of the sorting hill (i = 1, … 9); k_{x0i} – The coefficient describing the force F_{xi} taking into account the force $F_{\text{в}x}$ of the projection of the longitudinal wind force in the share of G_1, i.e. in the following form:

$k_{x0i} = i_{xi} + k_{\text{в}x} \approx 0{,}014 + 0{,}004 = 0{,}018.$

We note that the value of $F_{\text{в}x}$ is not taken into account because it is too small: $F_{\text{в}x} << G_1$ (for example, 3.2 << 794 kN [10].

Power of various resistances $|F_{ci}|$ due to its components, the speed of entry of the wagon into the braking zone $v_{вх.т i}$, the adhesion force of the wagon wheel to the brake pad of the wagon retarder $F_{торм}$, the sliding friction force of the wheel pair relative to the brake tires (main wear) $F_{тр.ск i}$ or F_{oi} ni, the environment, The resistance force $F_{сн}$ from snow and ice can be determined as a percentage of the weight G_1 of the non-rotating parts (carriage, wagon body) and the weight of the freight wagon, as well as the F_{xi} force.

The result is the power of various resistances $|F_{ci}|$ can be represented as:

$$|F_{ci}| = (k_{торм} + k_{oi} + k_{св} + k_{сн})G_1 \qquad (4)$$

According to the final result, we can write formulas (1) and (2) in the following form in the generally accepted notation:

$$|a_{кт i}| = a_{т}(i_{т0xi} - |w_{т i}|), \qquad (5)$$

where, $a_{т}$ = const is the conditional determination of its linear acceleration in the uniformly decelerated motion of the car in the braking zones of the parking lot, m/s^2:

$$a_{т} = \frac{G_1}{M_{пр0}} 10^3. \qquad (6)$$

For example, G_1 = 794 kN and in $M_{пр0}$ = 8,269·10^4 kg: $a_{т}$ = 8,953 m/s^2;

$i_{т0xi}$ – According to the formula (3), the dimensionless quantity that conditionally describes the profile slope of the hill in the parking areas, taking into account the effect of the longitudinal wind projection force $F_{вx}$:

$$i_{т0xi} = i_{тxi} + k_{вx} \qquad (7)$$

$k_{вx}$ – Dimensionless quantity that takes into account the effect of small longitudinal wind projection $F_{вx}$ on the Ox axis, contributing to the accelerated movement of the wagon in proportion to G_1. If the force $F_{вx}$ is not taken into account, then $k_{вx} = 0$;

$|w_{т i}|$ – dimensionless quantity and/or difference conditionally describing the relative resistance of different resistances to movement in the braking zones of the parking lot sections taking into account the effect of longitudinal wind, $|w_{т i}|$ has a dimension that is not in the system of units of measurement.

$$w_{т i} = k_{торм} + k_{oi} + k_{св} + k_{сн} \qquad (8)$$

Where, $k_{торм} = F_{торм}/G_1$, $k_{0i} = F_{трxi}/G_1$ ёки $k_{0i} = F_{oi}/G_1$, $k_{св} = F_{св}/G_1$, $k_{сн} = F_{сн}/G_1$ – Coefficients taking into account the forces F_{torm} in the braking of the car retarder, the non-rotating parts of the car and the weight of the car G_1, the forces $F_{трx} = F_{oi}$ from the main resistances, the forces $F_{св}$ from the environment and wind, and the forces $F_{сн}$ from snow and snow.

It is worth noting separately that the relative resistance to movement of various resistances in the braking zones of parking lots $|w_{т i}|$ in practice, it is a non-constant quantity ($|w_{т i}| \neq$ const), and its increase occurs when the speed of the car decreases.

The resultant force due to the occurrence of car braking in the parking areas is $|\Delta F_{т i}|$ we can write as follows:

$$|F_{т i}| = \left(k_{x0i} + |(k_{торм} + k_{oi} + k_{св} + k_{сн})|\right)G_1 \qquad (9)$$

Conclusion.

Longitudinal and transverse forces acting on the wagons at the sorting stations significantly affect the value of the force between the wheel-rail pair.

For the first time, the formula for determining the acceleration of movement in the braking zones of the sections of the sorting hills with a parking place in the calculation of the sorting hills according to the existing methods, in the usual concepts and generally accepted designations was presented.

References.

1. Железнодорожные станции и узлы (задачи, примеры, расчёты): Учебное пособие для вузов ж. – д. трансп. / Н.В. Правдин, В.Г. Шубко, Е.В. Архангельский и др.; Под ред. Н.В. Правдина и В.Г. Шубко. – М: Маршрут, 2005. – 502 с.
2. Правдин Н.В. Определение уклонов скоростных участков и тормозных позиций на спускной части сортировочной горки / Н.В. Правдин, С.А. Бессоненко // Транспорт: наука, техника, управление, 2008, № 9. – С. 6– 10.
3. Бессоненко С.А. Оптимизация параметров сортировочной горки по времени расформирования составов / С.А. Бессоненко // Транспорт: наука, техника, управление, 2007, № 9. – С. 30 – 34.
4. Бессоненко С.А. Теория расчета сортировочных горок для различных климатических зон. Автореф. дисс. на соиск. уч. степени д–ра техн. наук. – МИИТ, 2011. – 37 с.
5. Правдин Н.В. Перспективы применения закрытых горок в Сибири и на Дальнем Востоке / Н.В. Правдин, С.А. Бессоненко // Транспорт: Наука, техника и управление, 2004, № 7. – С. 14 – 16.
6. Федотов Н.И. Проектирование механизированных и автоматизированных сортировочных горок: пособие / Н.И.Федотов, А.М. Карпов. – Новосибирск: НИИЖТ, 1960. – 123 с.
7. Савченко И.Е. Железнодорожные станции и узлы: учеб. для вузов ж. – д. трансп. / И.Е. Савченко, С.В. Земблинов, И.И. Страковский. – М: Транспорт, 1967. – 466 с.
8. Рудановский В.М. Об определении удельных сопротивлений движению вагонов на путях с переменным уклоном / В.М. Рудановский // Вестник Всесоюзного научно-исследовательского ин-та ж.-д. транспорта, 1969, № 1, с. 46 – 50. ISSN 2223-9731.
9. Старшов И.П. Определение воздушного сопротивления движению вагонов на сортировочных горках / И.П. Старшов // Вестник Всесоюзного научно-исследовательского ин-та ж.-д. транспорта, 1970, № 6, с. 16 – 20. ISSN 2223-9731.
10. Журавель В.В. Проблеми регулювання швидкости скочування відчепів на сортувальних гірках / В.В. Журавель // Восточно-Европейский журнал передовых технологии. Выпуск №8 / 2014. – С. 45 – 50.