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PNEUMATIC AIR SPRINGS FOR RAILWAY VEHICLES

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Abstract: *The pneumatic springs are used in different applications in order to eliminate vibrations and shocks (suspension vehicles and equipment) as actuators machinery, producing shocks and vibrations (presses, pneumatic hammers, looms, etc.). The pneumatic spring consists of a pliable rubber-reinforced metal elements fixed on or within the composite which is air which normally acts as a damping spring. In the generally the upper and lower steel elements are attached to the frame, so that not replaced. Besides comfort, has the advantage of allowing the vehicle to change the height depending on the dynamic stresses to which the material is subjected rolling stock. Diaphragm pneumatic actuators springs are easy to install and secure, thanks to their elasticity and flexibility, which allows a large vertical displacement. The metal plate fixation can be of two types: conical or crimped. When fixing the conical top plate is embedded in the membrane pressure; replacement of the latter can be reused. Attaching crimped arc prevents breakage from extreme stress; the upper plate is fixed through crimping on the edges of the membrane. The main advantages of Pneumatic springs are allowing internal pressure variation to provide a high level of comfort while driving. It also allows the vehicle height control box to the path, or keeping constant load variation or change it automatically by dynamic loads occurring during the movement. Thanks to the special conformation of the pneumatic spring type circumvolut (Figure 5) and the structure characteristic of the pneumatic spring with a reduced height to obtain a high run. Maintaining the operating conditions, reducing wear, achieving long operating period of the suspension system is determined by the operating conditions and the quality of the components which are included in the railway vehicle suspension.*

Key words: *circumvolut, wear, stress tension, air suspension*

1. Introduction

A railway vehicle will travel easily loaded with a reduced air pressure in the Pneumatic springs (Fig. 1), while a heavy loaded vehicle will require a high pressure. Changing Pneumatic pressure springs from a low level at high one is automatic through special valve sensors. They are made of natural rubber or neoprene, with temperatures between - 40 and + 65 ° C, Pneumatic springs can function as actuators, at a pressure of max. 7 bar, racing with up to 225 mm, as well as vibration isolators.

Another detail concerns the stationary

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periods, lower or higher depending on planned activities that negatively affect the suspension characteristics of the rolling stock (engine traction motor or trailer).

The suspension characteristics and proper functioning of this system can affect other parts of the railway vehicle reliability. A suspension spring, with good cushioning and shock and vibration attenuation significantly reduce tire wear and fatigue fracture decreases the number of parts of locomotives and wagons subassemblies.

It is necessary to make a comparative analysis of classical solutions and solutions to improve, on the one hand in terms of static behavior by studying the effects of loading on stress and strain states to establish the critical phenomena using finite element analysis and dynamic behavior by development of functional models. At the same time, the essence of stress analysis by finite element deformable body is the replacement or actual content through an articulated structure whose subregions are called finite elements which are actually parts of that body.

The direction application of force is the vertical value -6000 N on both surfaces. The same boundary conditions were applied to other constructive solutions analyzed. The analysis results are presented as 3D charts the colors represent the quantities studied. The quantities studied for structural analysis stresses (*Tresca* and *von Mises* criteria), displacements and deformations. In practice it is found that fracture critical areas correspond to those found in the analysis.

The trend of improvement in equipment that participate in the running is to increase traffic speed in maximum safety conditions, particularly the economic motivations as this will lead to more customers who want to move or to transport goods quickly and safely and long distance. On the other side, by increasing the speed of movement of railway vehicles is a change of regime vibrations due to different speed bumps going through the same, that is a change of excitation in the contact wheel - rail, which is manifested by regime increase her level of vibration that favor such transfer of load between the two wheels of the same axle, thus amplifying the vibration of the vehicle emphasizing the negative safe running.

According to the *Nadal's* relationship guide relationship between force and axle load must not be shorter than certain values not permissible according to traffic data in the tread or more switches, values derived from measurements made in within the Committees ORE B 55 and B 136.

In order to reduce level of these vibrations at high speeds of movement, it is necessary to adopt appropriate constructive technical solutions to be able to maintain the acceptable limits of safety and comfort parameters in accordance with international standards mentioned above.

2. The pneumatic springs

The air suspension springs (Fig. 3) are used with force and energy absorber role due to thermodynamic transformations in air suspension air but also have a role to maintain the vehicle at a height desired box especially on the platform. The springs are also used rubber that rely on rubber hysteretic nature, thus having also an energy absorber. As a leading technology in countries with tradition in terms of railways have developed several variants based on the heating pad that uses electromagnetic characteristics of components running the MAGLEV solution, thus eliminating contact between the fixed and the mobile part of the dynamic system which was responsible for

generating vibration during runs.

During the driving movement, the vehicle is subjected to the action of vibrating pulses, with adverse effects on the quality of work. The vehicle responds to impulses generated in the process of running through the suspension, which is intended to mitigate the effect of acceptable values. A source of vibration in rail vehicles is the irregularity of the track vertical and transverse discontinuities and the joints (Fig. 2). By the fixing ride of both two wheels on the same axle and inverted taper of tread cause hunting of the axle movement that sprung mass of the vehicle forward. Wheel defects that eccentricity and flatness of the running surfaces are also important sources of vibration.

For provide the passenger comfort vibration and integrity of goods transported and vehicle construction depends crucially on the quality of the vehicle suspension. With the suspension depends on the ability to isolate the vehicle from disturbing impulses arising in the axle rolling about, in the vertical direction and transverse. The suspension of the railway vehicle must ensure a stable and dynamic behavior going straight and stable dynamics behavior with little guiding force when passing through curves.

The suspension should help to decrease the mutual forces between the vehicle and the path, keeping them within the limits determined by the traffic safety and the need to ensure protection of both the rolling and tread. Walking in curved centrifugal forces cleared box moving vehicle and bowed transverse spring suspension, there is a danger leaving the overall. On vehicles that do not have special devices cant deficiency compensation path, this function is performed by the vehicle suspension. This compensation is also required for limiting the transverse acceleration so as to ensure comfort when running in curves, and the changes in wheel load.

The traction vehicles, axle load variations due to wheel vibration and mode of transmission of traction force and thus influence adhesion weight of vehicle traction performance. The suspension should help reduce these load variations through appropriate design solution, but that does not jeopardize the quality of the vehicle running. In addition to the suspension to dampen shocks and vibrations have longitudinal velocity variation caused by walking, to start braking and maneuvering.

3. The functional modeling constructive suspensions. Comparative analysis of conventional rolling stock suspension

This model allows the simulation of the effects of elasticity and damping change oppress finding values for these quantities. It is also possible to test the system response to certain unevenness of the road surface. For this model was introduced for calculating block fuction force generated by a pneumatic cylinder used to the role of shock absorber.

The first measurement practice bench suspension incurred for the design of sheet springs and brackets, the second measurement was performed for the design of air springs. The last measurement was performed dynamic, bench suspended for the design classic.

On the vehicles with variable load suspension must provide an arrow in the task buffer height limits. However, if the suspension is not progressive type, then change the static arrow leads to diminishing opportunities for vibration isolation and thus worsening the quality of work. The suspension is made up of elastic elements and damping elements connected.

These elements are mounted, according to the construction of the vehicle, between

within bogie and the running gear, between the running gear and the vehicle box, between within bogie and the railway vehicle box.

The elastic suspension elements are metal (steel), rubber or pneumatic (Fig.4).

These are designed to accumulate some energy vibration and then play it in time, thereby reducing dynamic loads acting on the sprung mass and unsprung vehicle. The connecting elements consist of clocks, rings or straps carts, tee, etc. Links pendulum swing form, like rings or straps connecting the leaf springs with spring supports the stringers bogie or vehicle box, fulfill the role of elastic elements, taking transverse and longitudinal shocks. The longitudinal balancer arches or transverse suspensions are widely used in the construction of locomotives.

The conjugation of the springs by balancer arches makes load springs to maintain a constant ratio, and their result to be permanent at the same point, called fictitious point suspension. In the suspension study, the group of the tee joint springs may be replaced by an equivalent spring placed in the notional point of suspension. Suspended weight of the vehicle is considered supported by actual suspension points without rocking, and the points fictional suspension. The damper vibrations, the resistant forces that create, dissipates vibration energy and contribute to their depreciation. Rail vehicles used in general hydraulic and friction dampers.

Leaf springs, rubber and pneumatic fulfill his role of damping elements. The number of combinations of elastic elements working in series (stage suspension), suspension can be single, double, triple or even quadruple.

4. Conclusions

It was found that no matter how well-chosen dimensions, weight and other features of the vehicle, can not completely remove the shocks. Thus, to protect passengers and cargo from shocks required several aspects to ensure smooth movement of rolling stock. Moreover, another aspect of which must be taken into account is the fact that the oscillations caused by the railway vehicle, both the longitudinal and angular would be even greater, should be as small wheelbase.

Therefore, a longer wheelbase the springs reactions will be equal if the masses are distributed evenly.

It was also found that the length of the wheelbase of the vehicle does not result in smooth movement of the rail without the existence of an appropriate suspension and the suspension is best ensured by one of the following types of springs that sheet, coil, torsion bar (provided that the diameter of the wire that runs bow section rods, sheets the correct length, proper placement of the front wheel the springs and suspension joints to rolling stock). The property also have very soft springs is mainly related to their length and small cross section of the arch elements, deoarce bow should bend, to stretch, to compress, to twist due to shocks transmitted wheel and thus absorb some of the shock energy, sending him weak body or not to transmit at all.

The features and suspension parameters largely determine the proper functioning of the systems and vehicle aggregates composition. Decrease its functional parameters can lead to vibration, oscillations in operation and could thus jeopardize road safety, busy about. Note is the fact that none of the types of suspension spring slats sheet, coil, air cushion can not simultaneously meet all the technical requirements. The air suspension provides a better stability of the vehicle on the road by changing pressure cushions by charging status. If the suspension is mixed is that besides

suspension leaf springs, a vehicle equipped with a second suspension system with air springs, the payload is intended to supplement, but chose to go into action when original suspension is damaged seriously, allowing the vehicle in question to continue operating smoothly track and road safety.

5. Tables

The material properties of arc Table 1

Nr.crt.	Denumire	Valoare
1	Criteriile de rupere	von Mises
2	Limita de curgere	2.75e+008 N/m^2
3	Rezistența la rupere	6.70826e+008 N/m^2
4	Modulul de elasticitate	2.1e+011 N/m^2
5	Coeficientul lui Poison	0.28
6	Densitate masică	7800 kg/m^3
7	Modulul de forfecare	7.9e+010 N/m^2

The reaction forces of the pneumatic spring experimentally determined Table 2.

F_X	F_Y	F_Z	R_Y
-0.627205	12000	0.183746	12000

6. Figures

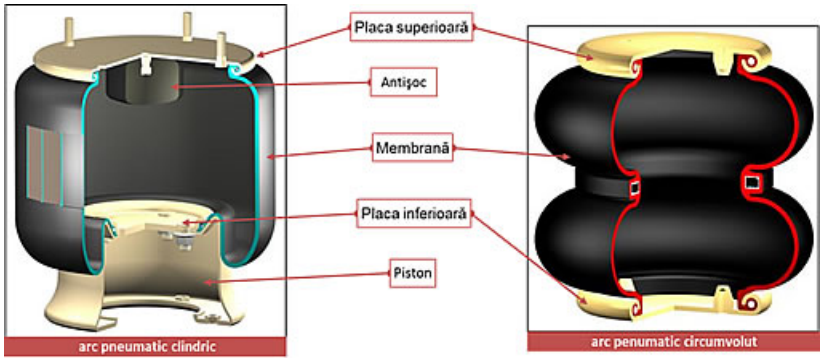

Fig. 1. *The structure of the pneumatic spring*

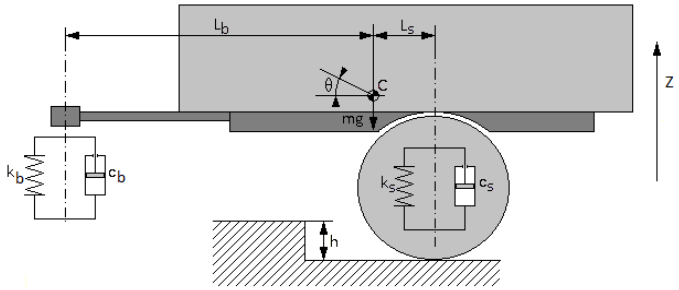

Fig. 2. *The schematic representation the classic railway vehicle suspension*

Fig. 3. *The air springs without membrane*

Fig. 4. *The pneumatic spring diaphragm with metal plate*

Fig. 5. *The circumvolute air springs*

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