Technical elements for minimising of vibration effects in special vehicles

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Abstract. The paper presents chosen solutions and technical elements for minimising of vibration effects in special vehicles. Due to volume and scope of the impact, forces and load generated in special vehicle during operating these elements are extremely important for isolation and absorbing of vibration affecting human or load. As the example of such solutions frame, suspension of car-body and cabin adopt in high mobility wheeled platform were described.

Keywords: minimizing of vibration, special vehicle, high mobility wheeled platform.

1. Introduction

Vibration can be considered in many terms, as effects of different generators and linear or nonlinear functions of propagation [1]. Vibrations perceived as internal phenomena reduce the efficiency of transport processes as well as transport safety and comfort [2].

Modern military vehicles must meet a number of different requirements in terms of technology, constructions, ergonomics and configuration options giving many possibilities of their use in the armed forces. One such solution is the innovative High Mobility Wheeled Platform (KPWM), which is a special purpose truck. The modular construction of KPWM allows easy platform for performing modifications and modernization, extremely important in the life cycle of devices and military equipment. Project process of the proper chassis is one of the most important issues of the process of building special vehicles. Also the chassis and frame can be part of the base for all sorts of platforms, so it has been adapted for driving on rough terrain and off-road. Thus the technical elements for minimizing of vibration are very important.

2. Technical elements for minimizing of vibration effects in special vehicles

Generally the suspension system is used to connect the wheels to the vehicle frame. Its main task is vibration insulation of the vehicle-body, i.e. damping of vibrations generated at the wheels by moving over uneven surfaces, the wheel adhesion to the road surface, as well as keeping the wheels to ensure maximum transfer of the driving forces and braking. The technical elements of the suspension system are divided into:

– steering – define the geometry of the movement of the wheels relative to the vehicle (e.g. Wishbones, arms);

– springs – stored vibration energy, oscillating motion (e.g. spring, coil spring);

– damping – energy dissipating vibration motion (e.g. shock-absorbers).

These suspension elements transfer the forces generated at the space between the wheels and the surface on the rest of the vehicle. Due to the comfort of passengers and minimization of forces acting on the vehicle load suspension should have a big vertical jump. Large movements in the vertical direction the wheels also provide good off-road properties. The suspensions should also be characterized by a degree of flexibility longitudinal and little flexibility in the transverse. Strong transverse rigidity allows for precise guidance of the vehicle. Thus it can be defined that vehicle suspension system, which consists of damping, springing and steering elements, are responsible to a considerable extent for damping of vibrations generated by road roughness. Parameters of

those elements have nonlinear characteristics which determine system response as vehicle vibrations from road roughness.

Some examples of spring elements have been depicted in Fig. 1. Coil springs are resilient elements formed of spring steel wire formed as a helix where the pitch of turns of the springs can be fixed or variable. An example of coil spring modelled for simulation research on vibration properties of vehicle and its characteristic have been depicted in Fig. 2.

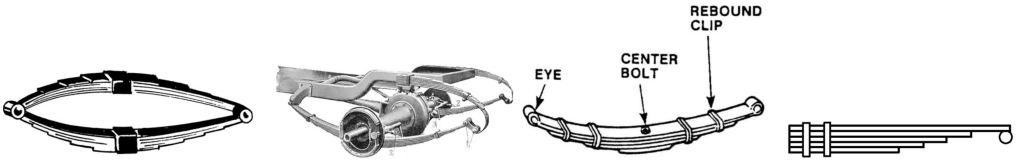


Fig. 1. Examples of spring elements: a) elliptical, b) ¾ elliptical, c) half-elliptical, d) quarter-elliptical [3]

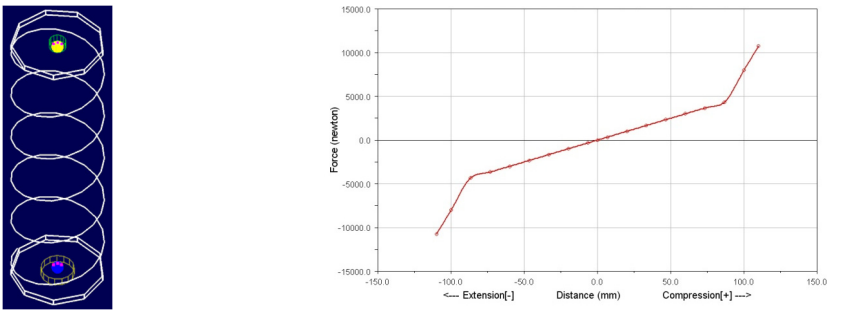


Fig. 2. Model of coil spring element and its characteristic [4]

The most important element for minimizing of vibration effects is shock absorber. The purpose of every shock absorbing system and element is to minimise the impact exerted by vibrations on other systems as well as on the persons inside the vehicle. Passive shock absorbers has nonlinear and nonsymmetrical characteristics of damping (asymmetric damping characteristics in compression and rebound are used in order to achieve a better compromise between ride, road-holding, handling and control performance of the vehicle - the dampers provide significantly higher damping force in rebound). An example of passive shock absorber modelled for simulation research on vibration properties of vehicle and its characteristic have been depicted in Fig. 3.

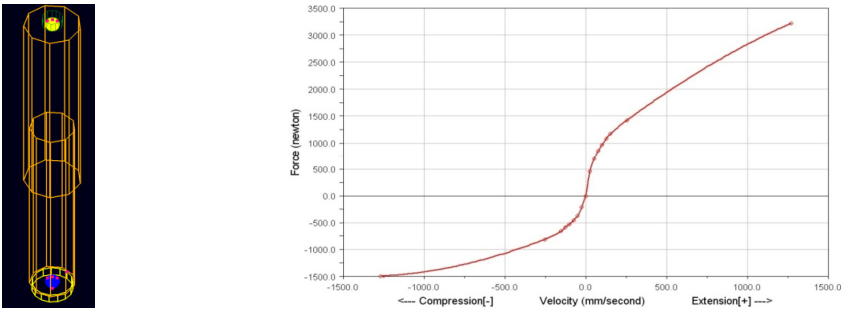


Fig. 3. Model of shock absorber element and its characteristic [4]

For the heavy vehicles it is often used hydro-pneumatic suspension. The main component of this suspension is hydro-pneumatic strut. The role of springing and damping elements are replaced by hydropneumatic cylinder. It can be attached to the upper or lower arm of suspension, or to the support frame of the vehicle. The big advantage compared to helical springs is less than the

diameter of the element, no additional components damping adjustable suspension height of the vehicle and adjust when a load of the vehicle. With the adjustable elements in real time can be individually controlled for the wheel suspension stiffness, the use of hydropneumatic elements stabilizer (substitutions suspension stiffness for the outer and inner wheels during driving of the arc), and the function to repair the damaged without lifting the wheels of the vehicle. The example of hydro-pneumatic suspension has been presented in Fig. 4.

Fig. 4. Frame and hydro-pneumatic suspension of special vehicle – KTO Rosomak [5]

3. Construction of suspension system of special vehicle

The issues of minimising of vibration effects, vehicle dynamics and stability in terrain become big factors for developing project and new constructions. Especially for special vehicles operated in different environment and on irregular ground surface. These types of vehicles have large scope of loads, from general cargo to concrete. It can be designed, developed, produced and installed truck bodies and trailers for any kind of use according to special and individual requirements [6-8]. Due to the forces and the reactions occurring between the sprung and unsprung masses of the vehicles an important element become connecting the wheels and axles of the vehicle, the frame and body. In trucks, mass ratios of these elements necessitate consideration of dynamic phenomena in another scope. In the case of special vehicles, where there is the need to adapt its body weight can significantly increase depending on the required equipment.

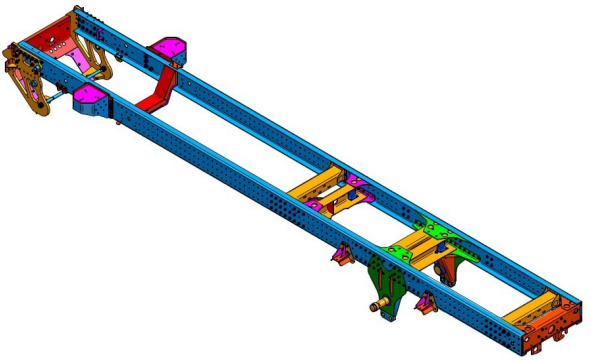
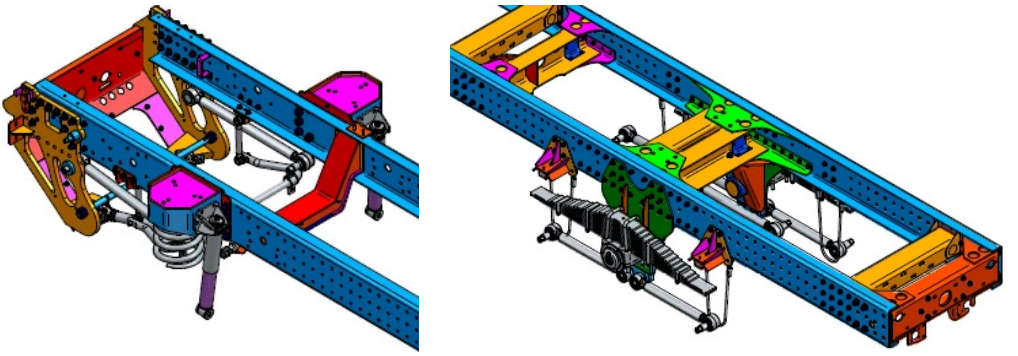


Fig. 5. Example of frame of special vehicle (KPWW) [9]

The analysis of construction of suspension, frame and cabin in term of vibration isolation has been conducted based on High Mobility Wheeled Platform (KPWM). The main frame (Fig. 5) of KPWM is the backbone of the entire vehicle, which supports all elements. Should meet the strength requirements set up to carry the burden of rough roads, and the load from the body and its parts and cargo that will be transported. The material used for making the frame is resistant to

static loads and dynamic and resistant to the conditions occurring during operation of the vehicle. The frame consist of steel forming a flat grid: stringers and cross beams that connect them in accordance with the design.

For the suspension system was adopt and build-in elastic elements such as reinforced parabolic leaf springs in front suspension (Fig. 6(a)) and semi-elliptical leaf springs in rear suspension (Fig. 6(b)). Also the shock absorbers and a stabilizer, designed were used to reduce lateral body roll during cornering. Parabolic or half-elliptical spring suspension is suited to large masses of the total and heaviest operating conditions. Springs should carry the vertical forces, longitudinal and transverse torsion of feathers made of alloyed steel. During the spring leaf movements move relative to each other – gives the effect of damping of vibration.



a) b)

Fig. 6. a) Front and b) rear suspension elements build-in frame of special vehicle (KPWW) [9]

For the perception of vibration of special vehicle driver there is also one more important vehicle system. It is cabin, which can absorb vibration transferred from frame. Cabin should be safe and provide comfort and isolation from noise and vibration caused by the operation of the engine and suspension. Therefore, cabin suspension is equipped with shock absorbers and silent. In addition to vibration isolation, the driver's seat is suspended pneumatically. The cabin suspension has been depicted in Fig. 7.

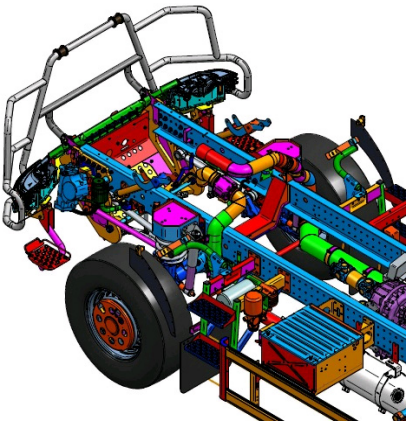


Fig. 7. Cabin suspension of special vehicle (KPWW) [9]

4. Conclusions

Special vehicles are operating in different environment and on irregular ground surface. These type of vehicles have large scope of loads, from general cargo to concrete. Thus technical elements for minimising of vibration effects are very important. For such vehicles this phenomena has to

be considered starting from frame, suspension elements and suspension of the cabin. The paper presents chosen technical solutions and working characteristics combined with one suspension system. The paper presents review of chosen solutions which are or can be implement for the special vehicles based on example of on High Mobility Wheeled Platform.

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