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Vibrations of an active rocker – bogie suspension under motion in rough terrain

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Abstract: Mobile platforms are used in many aspects of our everyday life, mostly by military, rescue teams, miners or scientists. In most of them installed suspension units have constant dimensions what limits area of operating range. Presented in this paper active rocker – bogie suspension can change length of each suspension section in order to self – level base platform what will lead to increase in stability by means of control of location of centre of gravity and application area by change in space required during work and transportation. The main scope of this study is to investigate and influence of different length of suspension members on vibration frequency as well as vibration modes. On the basis of the results one will find optimum solutions for creating a prototype.

Keywords: frequency analysis, suspension, rover, mobile platform, rocker - boogie

1. Introduction

Mobile platforms often use six or more wheels or even track drive sets [1]. Due to fact that their frames contain manipulators, radars, scanners and other fragile items one requires great stability during operations in rough and uneven terrain. This gives great challenge to the engineers during the design and test phases. In construction available on the market one can find ones that use multi-link suspension system [2] which has simple design and does not immobilize platform at failure of one suspension unit. Another type of used suspension is rocker – bogie type [3] which can be found in Opportunity and Curiosity rovers. This construction is characterized by the fact that left and right side wheels are connected by a differential bar which ensures ground contact for all wheels. Moreover rocker – bogie suspension does not have springs and it ensures overcome an obstacle equal to the length of the wheelbase. Simplified version of rocker – bogie suspension is boogie type [4] which has two swingarms on each side instead of combined one and does not have differential bar. Regardless to installed suspension system, stability in rough terrain is limited by the location of the center of gravity. In the active rocker – boogie suspension [5] studied in this paper one can control its location what greatly increases platform terrain application area. The main scope of performed studies is to check an influence of different length of suspension members on vibration modes and vibration frequency of the mobile platform. In future, one will also consider different material types such as Aluminum 6060 T66, Steel S235 or Titanium grade 1. The obtained results will allow finding the best material for prototype production.

2. Model presentation and results of numerical simulations

In figure 1 one presents investigated mobile platform, which can change wheelbase what results in control of location of centre of gravity. The markings are as follows: 1,2 – suspension arms; 3,4,5 – wheels with electric motors; 6 – main frame; 7 – differential bar; 8 – electric motors for suspension control.

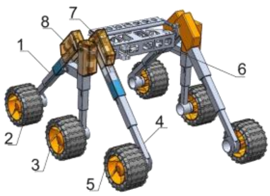

Fig. 1. Investigated suspension system

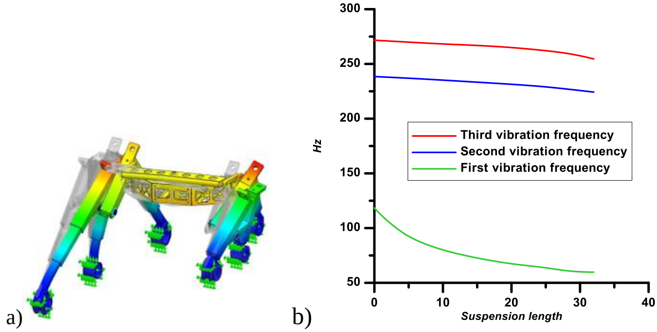

Fig. 2. a) 1st vibration mode- Al. 6060, b) change in vibration frequency

Figure 2a shows a sample of results from vibration mode investigations while figure 2b describes the change in vibration frequency magnitude at different suspension length. The frequency studies were done at different length of one side (the change in length was equal to all three wheels on one side) while the other remained fully extended. This simulates a motion of a platform on terrain with different elevation in relation to the longitudinal axis of symmetry. In the presented case the change in suspension length has the greatest influence on first vibration frequency which is being reduced significantly between min. and max. positions. The second and third vibration frequencies are much less vulnerable to change in suspension length and their reduction is more linear in relation to the first one.

3. Conclusions

As presented in section 2 the behaviour of the investigated mobile platform is very complex in relation to different lengths of suspension members. Detailed studies on vibration frequency – suspension length and vibration modes must be done before prototype production.

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