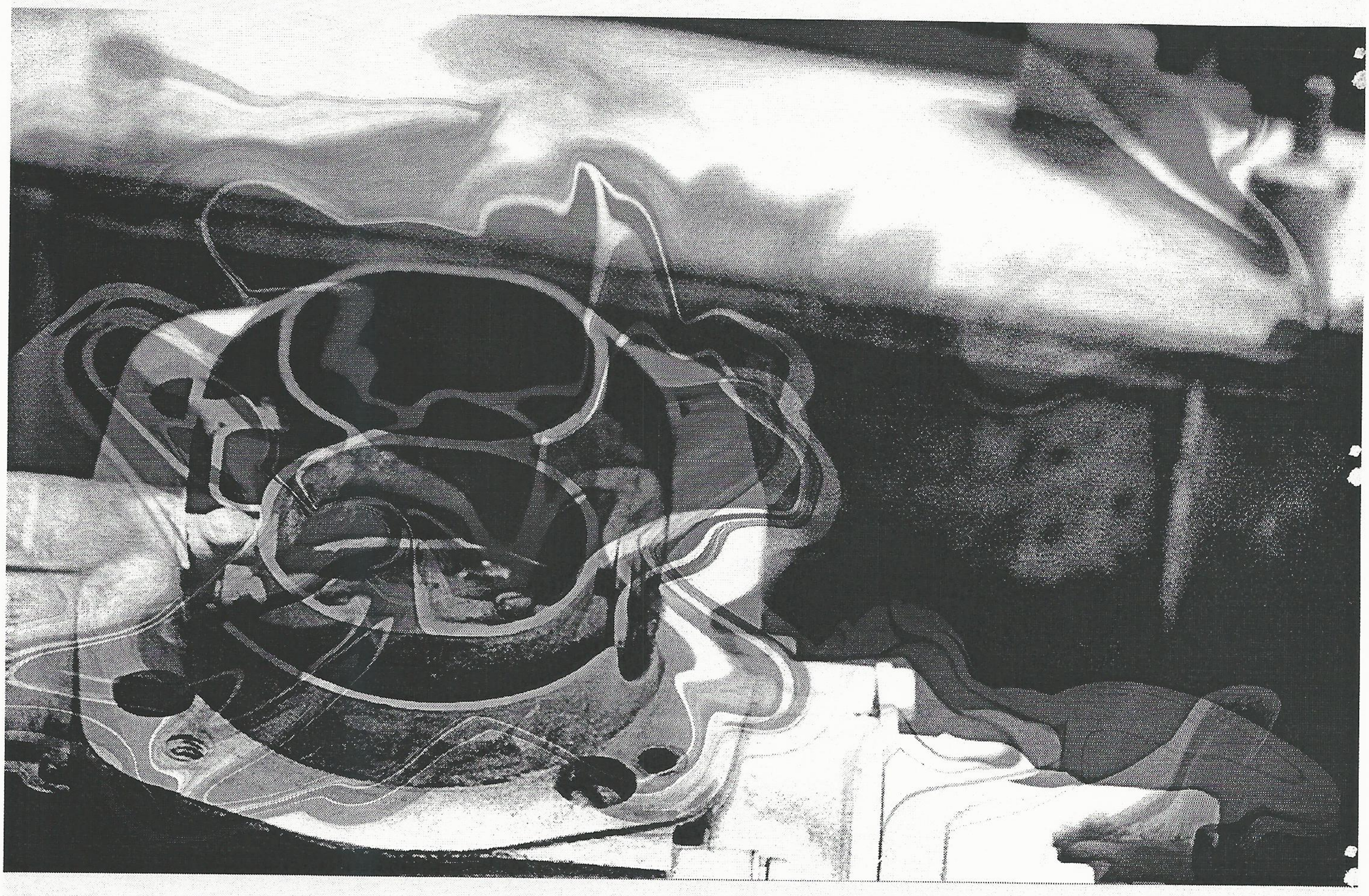
International Congress Motor Vehicles & Motors 2016

VEHICLE AS A KEY FACTOR IN TRANSPORTATION

Proceedings



Ministry of Education, Science and Technological Development

October 6th - 7th, 2016
Kragujevac, Serbia

International Congress
Motor Vehicles & Motors 2016

VEHICLE AS A KEY FACTOR IN TRANSPORTATION

PROCEEDINGS

October 6th - 7th, 2016
Kragujevac, Serbia

Publisher:	Faculty of Engineering, University of Kragujevac Serbia, 34000 Kragujevac, Street Sestre Janjić 6
For Publisher:	Dr Dobrica Milovanović, prof. - Dean
Editors:	Dr Jovanka Lukić, prof. Dr Dragan Taranović, assist. prof.
Technical preparation:	Dr Dragan Taranović, assist. prof.
Picture on the cover:	Nemanja Lazarević
Print CD:	Faculty of Engineering, University of Kragujevac, Kragujevac
	ISBN 978-86-6335-037-3
Year of publication:	2016.
Number of copies printed:	200

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

629.3(082)(0.034.2)
621.43(082)(0.034.2)

INTERNATIONAL Congress Motor Vehicles & Motors (6 ; 2016 ; Kragujevac)
Vehicle as a Key Factor in Transportation [Elektronski izvor] : proceedings / International Congress Motor Vehicles & Motors 2016, [6th], October 6th - 7th, 2016 Kragujevac ; [editors Jovanka Lukić, Dragan Taranović]. - Kragujevac : Faculty of Engineering, 2016 (Kragujevac : Faculty of Engineering). - 1 elektronski optički disk (DVD) ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Tiraž 200. - Nasl. sa naslovne strane dokumenta. - Bibliografija uz svaki rad.

ISBN 978-86-6335-037-3

a) Моторна возила - Зборници b) Моторни са унутрашњим сагоревањем - Зборници
COBISS.SR-ID 226303756
--

Publishing of this book is supported by:

Ministry of Education, Science and Technological Development of the Republic of Serbia

SCIENTIFIC BOARD

ORGANIZATIONAL BOARD

President: Assist. prof. Dr Dragan Taranović, Ph.D., FE Kragujevac, Serbia

Secretaries: Assist. prof. Danijela Miloradović, Ph.D., UniKg, FE, Serbia
Assist. prof. Jasna Glišović, Ph.D., UniKg, FE, Serbia

CONGRESS ORGANIZERS

- University of Kragujevac, Faculty of Engineering
- Department for Motor Vehicles and Motors, FE in Kragujevac
- International Journal "Mobility & Vehicle Mechanics"

CONGRESS PATRONS

- Government of the Republic of Serbia, Ministry of Education, Science and Technological Development,
- University of Kragujevac, Faculty of Engineering
- Road Traffic Safety Agency of the Republic of Serbia
- Centre for technical proper function of vehicles, FME Kragujevac

CONTENT

INTRODUCTORY LECTURES

SECTION A
Power Train Technology

SECTION B
Vehicle Design and Manufacturing

SECTION C
Vehicle Dynamics and Intelligent Control Systems

SECTION D
Driver/Vehicle Interface, Information and Assistance Systems

SECTION E
Transport Challenges in Emerging Economies

International Congress Motor Vehicles &Motors 2016

Kragujevac, October 6th-8th, 2016

MVM2016-003

S. Mačužić[1]
D. Miloradović[2]
J. Glišović[3]
J. Lukić[4]

FEM MODELLING OF MCPHERSON SUSPENSION SYSTEM

ABSTRACT: The modern method construction of a system and its components involves the use of a specific software package. Application of the software packages for modeling and numerical analysis of the McPherson suspension system is presented in this paper. The advantage of using these packages is that the end results can be obtained directly and the influence of individual geometrical parameters can be analyzed. In addition, another advantage is that any change of external parameters resulting in a automatic change of model. Suspension system ensures stability, safety and comfort during cornering and on uneven surfaces. Its role is to provide a flexible connection between the vehicle structure and the axle with wheels.

KEYWORDS: McPherson suspension system, vehicle, shock absorber, numerical simulation

INTRODUCTION

The modern concept of development of motor vehicles is reflected primarily in an increase in traffic safety in all modes of travel. For this reason it is essential continuous improvement of steering system construction, braking and suspension, as well as the compliance of the functional characteristics for each car model. The suspension system has the primary task to transfer all the reactive forces and moments that occur in the contact point of the tire and the ground to the body with as much damping shock loads [1]. Also, it should provide the necessary stability of the vehicle especially when braking and cornering movement. Suspension system realizes flexible connection between the basic structure of a motor vehicle with wheels and axles. There are six degrees of freedom of the elements (rotation around each of the three axes and moving along all three axes).

McPherson suspension system is used in many vehicles because of its light weight and compatibility. This type of system is more prevalent on the front axle of the vehicle but is also used on the rear wheels of the vehicle. The required performance of the suspension system is to adequately support the weight of the vehicle, to ensure the efficiency of driving quality, and to maintain the stability of the vehicle. In addition, the use of McPherson suspension system allows better movement of the vehicle when cornering and better passengers comfort. Contemporary literature shows interest of researchers for this type of system in order to increase the vehicle's performance.

[1]*Slavica Mačužić, Ph.D., student, University of Kragujevac, Faculty of Engineering,University of Kragujevac, Sestre Janjić 6, 34000 Kragujevac, Serbia, slavicamacuzic89@gmail.com*
[2] *Danijela Miloradović, Ph.D., assist. prof., University of Kragujevac, Faculty of Engineering University of Kragujevac, Sestre Janjić 6, 34000 Kragujevac,Serbia, neja@kg.ac.rs*
[3] *Jasna Glišović, Ph.D., assist. prof., University of Kragujevac, Faculty of Engineering University of Kragujevac,Sestre Janjić 6, 34000 Kragujevac, Serbia, jaca@kg.ac.rs*
[4] *Jovanka Lukić, Ph.D., prof., University of Kragujevac, Faculty of Engineering University of Kragujevac,Sestre Janjić 6, 34000 Kragujevac, Serbia, lukicj@kg.ac.rs*

MODELING MCPHERSON SUSPENSION SYSTEM

Modeling McPherson suspension system (Figure 1) was done in the softvare package CATIA V5R17. This software is a powerful tool for modeling of individual parts of a machine, and complete mechanical systems. We have used the Part design module to create the geometry of all parts of the system. After that, we used Assembly module in order to connect all the parts into one functional system. Figure 1 shows the main parts of the suspension system.

The most important parts of this system are the shock absorber and spring. The lower mounting point attaches to a lower control arm, and it is this connection that dictates both the longitudinal and lateral orientation of the wheel assembly. The upper mounting point of the hub is attached to an assembly that contains a coil spring and a shock absorber. The other main defining factor in a McPherson strut suspension is the way that the axis of the strut itself also serves as the upper steering pivot (the lower pivot is the mounting point between the knuckle and control or track arm.) This upper pivot point is attached to a tie rod end that, in turn, is attached to the steering gear.

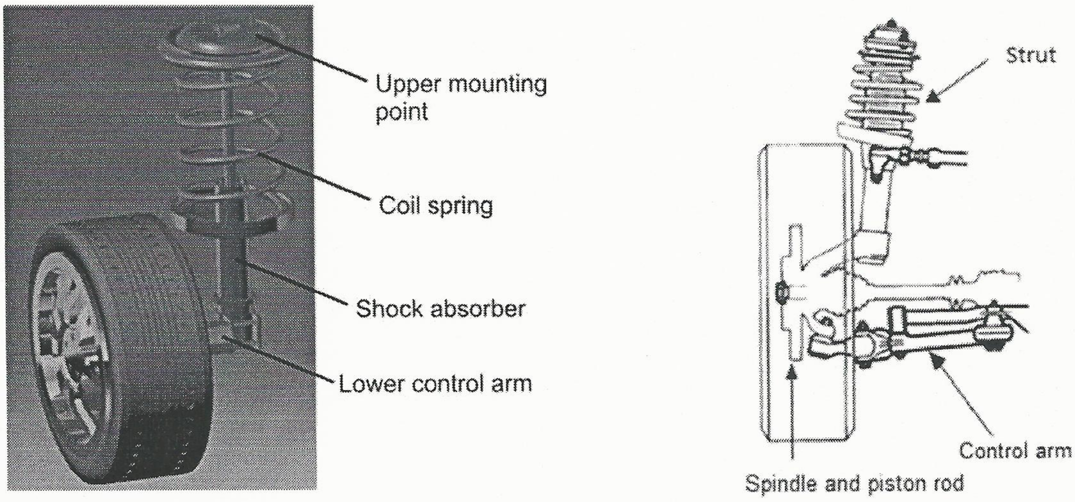
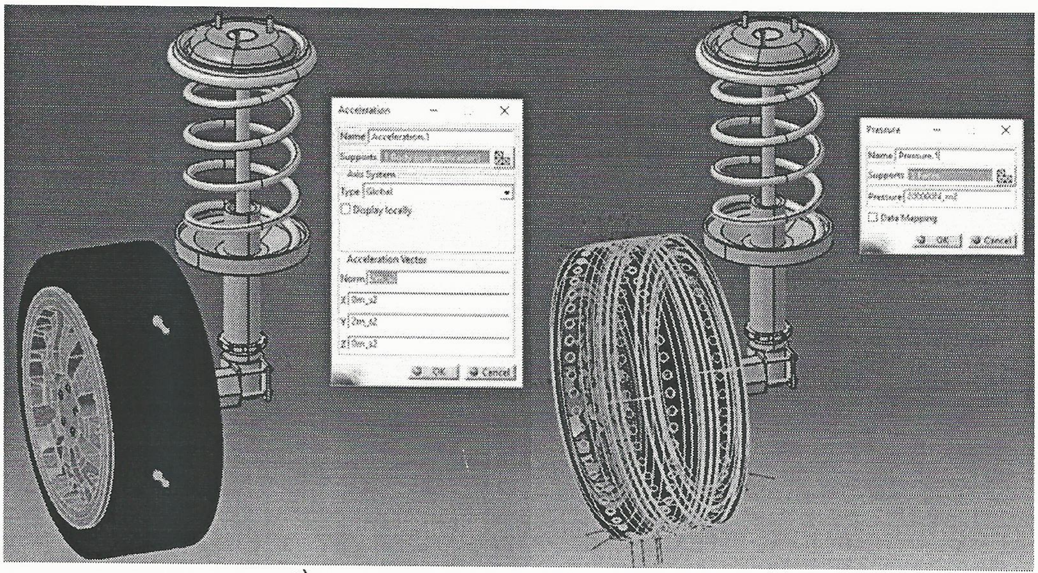


Figure 1 *3D model and shematics of the McPherson strut suspension [12]*

NUMERICAL SIMULATION OF THE MCPHERSON SUSPENSION SYSTEM

The mechanic system of levers that binds the wheel recesses for the bodywork is made of rigid connection with the joints [7-9]. Using Catia v5R17 software package we designed the existing vehicle parts which are used in series production and are used in almost all vehicles depending on the purpose and functionality of the system. This is covered by a complete set of shock absorbers and springs to point in one unit where they did not take into account the additional stabilization elements in this analysis because the criteria are placed on the most critical parts of suspension [10]. The influence of other elements does not affect too much on the analysis so that they will not be considered. Analysis includes the following parts: spring, shock absorber, piston shock absorber, protective rubber shock absorber, a cup shock absorber, strut bearing, tire and rim. Using static analysis, we checked the distribution of pressure for different acceleration and different pressures in the wheel. We used linear tetrahedron as the final element. Finite element mesh consists of 41781 of nodes and 79224 elements. Regarding the boundary conditions, clamp is plased at the junction of the bodywork at the top of the shock absorber. Boundary conditions are input value, while the simulation results are output. Material of tire is isotropic material - rubber, the value of Young module $2 \cdot 10^6$ MPa, poisson coefficient of 0.49 and density of 910 kg/cm^3. Spring steel was used as coil spring material (Young module $2.02 \cdot 10^5$ MPa, poisson coefficient 0.29 and density of 7820 kg/cm^3). All other parts of the suspension are modeled as structural steel (Young module $2 \cdot 10^5$ MPa, poisson coefficient 0.3 and density of 7850 kg/cm^3).

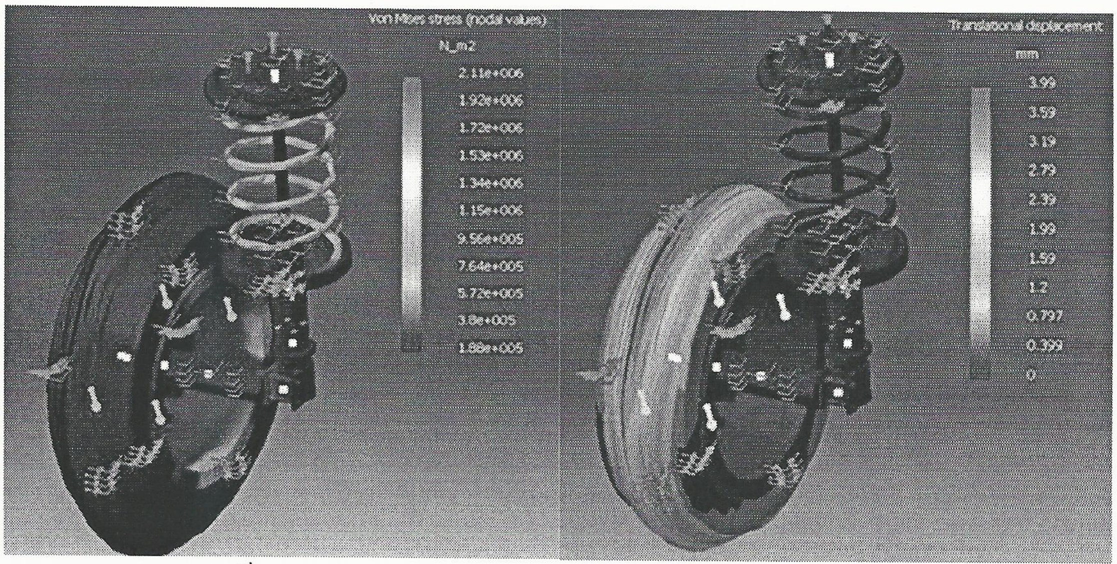
A slower acceleration rate means that the car is weaker and will take longer to respond to the driver's controls. Acceleration is necessary when avoiding a crash. In this study we wanted to examine the behavior of a system of suspension for three different acceleration [11]. Acceleration and pressure are set according to Figure 2.



a) b)

Figure 2 *Setting boundary conditions; a) sets the acceleration values, b) placing pressure values*

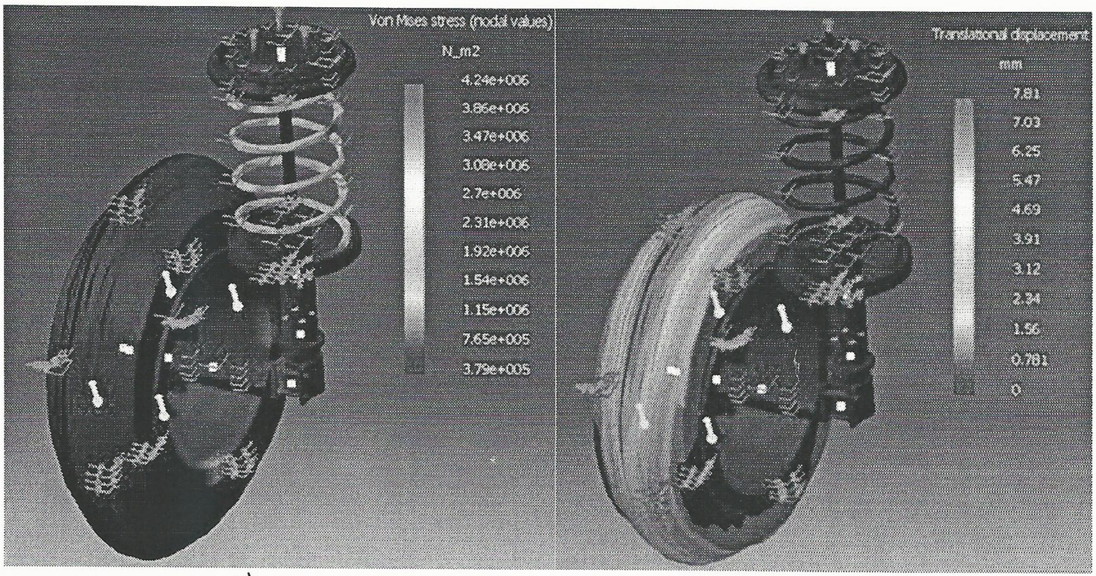
The value of the acceleration is 2 m/s^2 and this value acting on the center point of the rim of the wheel hub. Tyre pressure is 2 bar. After determining an entrapment and set value for acceleration and tire pressure changes, we running simulation.



a) b)

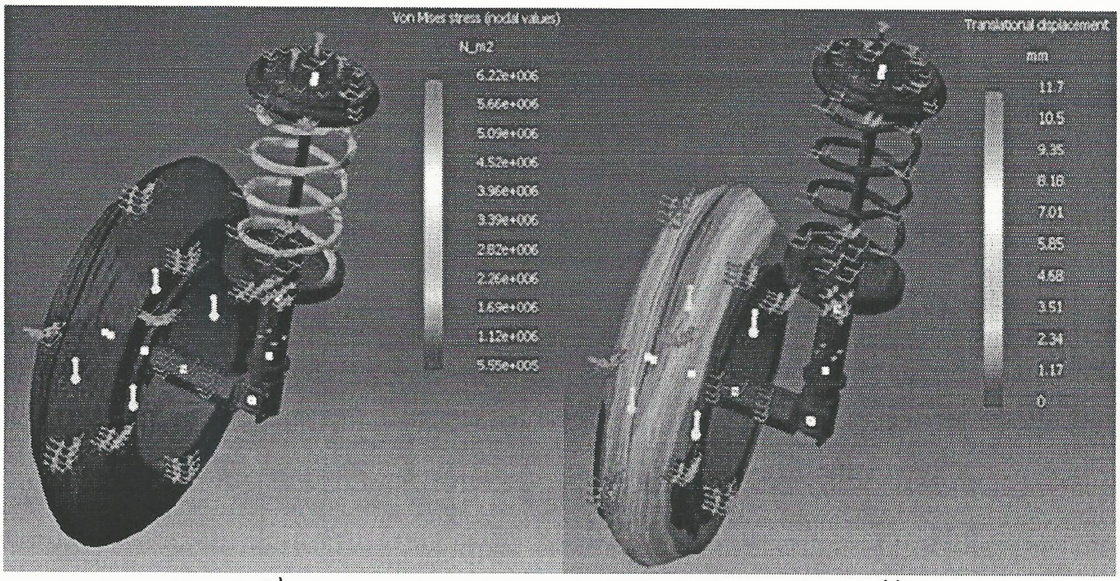
Figure 3 *The simulation results for the acceleration of 2 m/s2 and the tire pressure of 2 bar; a) stress distribution, b) dispacement field*

The maximum value of the Von Mises stress is approximately 2.1 MPa on the upper parts of the spring, for the first case of acceleration. Spring is the most exposed to the highest stress (shown in red). Its role is to mitigate sudden shocks hence the greatest load in this part of the suspension system. At the junction on the bodywork (the place with clamp) as a connection between the upper shock absorber and body, the stress has a small value. The maximum value of the displacement field on the tire in the vertical direction is marked in red, due to the nonlinear behavior of the material. Other displacements are relatively small. The simulation is also performed with acceleration values of 4 and 6 m/s^2. The following figures shows the stress distribution and displacement field for a set of acceleration values and tire pressure of 2 bar.



a) b)

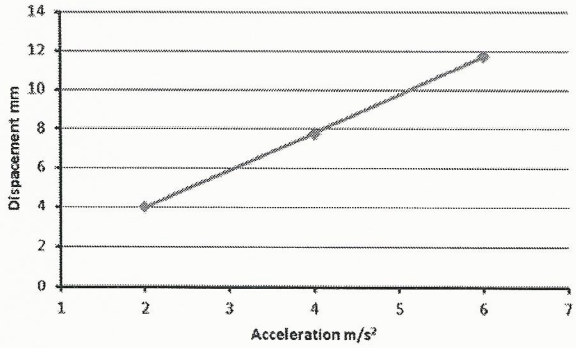
Figure 4 *The simulation results for the acceleration of 4 m/s2 and the tire pressure of 2 bar; a) stress distribution, b) dispacement field*

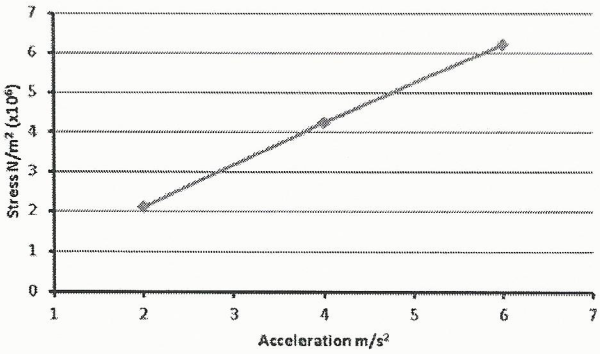


a) b)

Figure 5 *The simulation results for the acceleration of 6 m/s2 and the tire pressure of 2 bar; a) stress distribution, b) dispacement field*

Previous figures shows that with increasing acceleration comes to major deformation of the tire in case the same pressure on them.In the first case, when the acceleration was 2 m/s^2, were observed on the tire displacement of 3.99 mm, while the highest Von Mises stressof the spring was 2.1 MPa.With the rise in the value of acceleration to 4 m/s^2, the displacement of the tire reaches 7.81 mm, and the stress on the spring 4.24 MPa. The last case, an acceleration of 6m/s^2, causing maximum displacement of the tire, whose values are going up to 11.7 mm, and the Von Mises stress at the upper parts of the spring to 6.22 MPa.Figure 6 is a diagrammatic representation almost linear dependence of displacement field of the tire and the Von Mises stress on the spring with increasing acceleration.





a) b)

Figure 6 *Change of displacement of the tire and Von Mises stress on the spring as a result of different acceleration values, respectively*

CONCLUSIONS

Simulation covers the most vital parts of suspension type McPherson. This work shows the greatest load zone system that has been modeled, during the movement of vehicles on the road. The importance of these simulations is that before installation of certain parts of the car we can see their loads and behavior. To make the system much more realistic, we modeled all important parts that influence the behavior and stability of vehicles in motion. Future development of this work could be done in the direction of determining the behavior of the system when the car meets the road with holes, and see how they behave certain parts of the McPherson system.

ACKNOWLEDGMENTS

This research supported by the Ministry of Education, Science and Technological Development of Republic of Serbia through Grant TR35041.

REFERENCES

[1] Simić, D.:"The dynamics of motor vehicles fluctuations and suspension car", 1975, Faculty of Mechanical Engineering, Kragujevac,
[2] Colombo, D., Gobbi, M., Mastinu, G., Pennati, M.: "Analysis of an unusual McPherson suspension failure", Engineering Failure Analysis 16, 2009, Page 1000–1010,
[3] Gadhia Utsav, D., Sumant Patel, P.: "Design and Problem Identification of Wagon-R car's rear suspension", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, Volume 2, Issue 7, July, 2012, Page 111-113,
[4] Pathmasharma, S., Suresh, J. K., Viswanathan, P. and Subramanian, R.:"Analysis of Passenger Car Suspension System Using Adams", International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, No. 5, May, 2013, Page 1186-1193,
[5] Dodiya, D. V., Patel, P. H., Chauhan, M. J.:"Dynamic Analysis Of Leading Arm Suspensions System With Horizontal Spring Damper Assembly", International Journal of Advance Engineering and Research Development (IJAERD), Volume 1, Issue 2, March, 2014, Page 1-6,
[6] Purushotham, A.:"Comparative Simulation studies on Mcpherson Suspension System", International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue 3, May-June, 2013, Page 1377-1381
[7] Den Hartog, J.P.:"Vibrations in mechanical engineering", construction books, 1972, Belgrade,
[8] Vukojević, D., Ekinović, E.:"Theory of oscillations", Faculty of Mechanical Engineering in Zenica, 2004, Zenica,
[9] Stojić, B.:"The theory of the movement of road vehicles", Department of Motor Vehicles, 2012, Novi Sad,
[10] Filipović, I.:"Motorcycles and motor vehicles", Faculty of Mechanical Engineering, University of Tuzla, 2006, Page 190-210.
[11] http://hypertextbook.com/facts/2001/MeredithBarricella.shtml, Accessed 25.06.2016
[12] Fallah M. S., Bhat R., Xie W. F.: "New model and simulation of Macpherson suspension system for ride control applications", Vehicle System Dynamics: International Journal of Vehicle Mechanics and Mobility, Vol. 47, No. 2, 2009, pp. 195-220.

ISBN 978-86-6335-037-3