ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

December 2021
Volume 27
Number 4
4 th Series

RoJAE

Romanian Journal of Automotive Engineering

The Journal of the Society of Automotive Engineers of Romania
www.siar.ro
www.ro-jae.ro

RoJAE
Romanian
Journal of Automotive Engineering

Societatea Inginerilor de Automobile din România
Society of Automotive Engineers of Romania
www.siar.ro

SIAR – The Society of Automotive Engineers of Romania is the professional organization of automotive engineers, an independent legal entity, non-profit, active member of FISITA (Fédération Internationale des Sociétés d'Ingénieurs des Techniques de l'Automobile - International Federation of Automotive Engineering Societies) and EAEC (European Cooperation Automotive Engineers).

Founded in January 1990 as a professional association, non-governmental, SIAR's main objectives are: development and increase the exchange of professional information, promoting Romanian scientific research results, new technologies specific to automotive industry, international cooperation.

Shortly after its constitution, SIAR was affiliated to FISITA - International Federation of Automotive Engineers and EAEC - European Conference of Automotive Engineers, thus ensuring full involvement in specific activities undertaken globally.

In order to help promoting the science and technology in the automotive industry, SIAR is issuing 4 times a year rIA - Journal of Automotive Engineers (on paper in Romanian and electronically in Romanian and English).

The organization of national and international scientific meetings with a large participation of experts from universities and research institutes and economic environment is an important part of SIAR's. In this direction, SIAR holds an annual scientific event with a wide international participation. The SIAR annual congress is hosted successively by large universities that have ongoing programs of study in automotive engineering.

Developing relationships with the economic environment is a constant concern. The presence in Romania of OEMs and their suppliers enables continuous communication between industry and academia.

A constant priority in SIAR's activity is to ensure optimal framework for collaboration between universities and research, industry and business specialists.

SIAR – Society of Automotive Engineers of Romania is member of:

FISITA - International Federation of Automotive Engineers Societies
www.fisita.com
EAEC - European Automotive Engineers Cooperation

RoJAE
Romanian
Journal of Automotive Engineering

CONTENTS

Volume 27, Issue No. 4 **December 2021**

The RoJAE's articles are included in the *„Ingineria automobilului"* magazine (*ISSN 1842 – 4074*), published by SIAR in Romanian.

The articles published in *„Ingineria automobilului"* magazine are indexed by Web of Science in the „*Emerging Source Citation Index (ESCI)*" Section.

Web of Science

Clarivate Analytics

RoJAE 27(4) 135 – 162 (2021)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

*The journals of SIAR are available at the website **www.ro-jae.ro.***

RoJAE
Romanian
Journal of Automotive Engineering

SIAR

The Journal of the Society of Automotive Engineers of Romania
www.ro-jae.ro
www.siar.ro

Production office:
The Society of Automotive Engineers of Romania (Societatea Inginerilor de Automobile din România)
Facultatea de Transporturi, Splaiul Independentei Nr. 313
060042 Bucharest ROMANIA Tel.: +4.0753.081.851 Fax: +4.021.316.96.08 E-mail: siar@siar.ro
Staff: Professor Minu MITREA, General Secretary of SIAR
Subscriptions: Published quarterly. Individual subscription should be ordered to the Production office.
Annual subscription rate can be found at SIAR website ***http://www.siar.ro***

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

DEVELOPING A PNEUMATIC MODEL FOR ACTUATING A TRAP DOOR WHILE OPENING-CLOSING A MILITARY PERSONNEL COMPARTMENT

Daniela VOICU, Radu VILAU, Ramona-Monica STOICA[1], Ion LESPEZEANU

Military Technical Academy „FERDINAND I", Department of Military Automotive and Transportation, Bdul George Coşbuc, Nr. 39-49, 050141 BUCHAREST, Romania

(Received 19 July 2021; Revised 28 September 2021; Accepted 02 October 2021)

Abstract: *Present paper presents the development, in a specialized modelling-simulation software, of a pneumatic model which can be used to actuate the trap door while opening-closing a vehicle compartment for military personnel transportation. While developing the pneumatic model, there will be considered the characteristic parameters of an air compressor (the source of compressed air) which is driven by an internal combustion engine. In addition to the air compressor, there will be used pneumatic directional valves, OR logic valves (for an alternating actuation of the trap door, from both the driving seat and the area for the embarking and disembarking of military personnel), throttle valve to adjust the speed while opening and closing the trap door, a set of pneumatic double check valves to maintain the trap door in a certain position, as well as a double acting cylinder. The pneumatic model developed during the research will constitute the basis for producing an experimental technological demonstrator, as an alternative to hydraulic systems, in order to decrease the number of actuating systems which equips a mobile platform*

Keywords: *Compressed air source, OR logic valve, pressure, pneumatic cylinder*

1. INTRODUCTION

Some military vehicles (Amphibious Armoured Personnel Carrier, wheeled armoured personnel carrier or infantry fighting vehicle) are equipped with a trap door at the back side, allowing a fast embarking and disembarking of troops.
Therefore, the present paper describes a type of model, which can be used to pneumatically actuate the trap door (it is considered a medium or lightweight trap door of 200 kg). În real circumstances, the system has to additionally be equipped with anti-freezing elements, considering that the system works in a temperature range between -32/-25°C and up to 50/60°C.

2. EXPERIMENTAL RESEARCH

In order to simulate the actuation of the trap door which equips a military vehicle, a model was created in a specialized software, named FluidSim [5]. The pneumatic model is presented in figure 1 and it comprises of [1][2][3][4]:

- compressed air source (air compressor), represented by the vehicle's compressor, actuated by the internal combustion engine;
- air preparation unit, consisting of a manual air purge filter, a pressure regulator and a pressure gauge;
- compressed air tank (normally, the working pressure is between 7 – 7.5 bar);
- directional valves:
    - 1.1 and 3.1 as 3/2 way valves, which are actuated by a lever and they return to their default position by a spring force (they return to their default position during power loss);
    - 2.2 and 2.3 as 3/2 way valves, which are actuated by a push button and they return to their default position by a spring force (they do not retain position during power loss);
    - 2.1 as 3/2 way valve which are actuated by a lever and they return to their default position by a spring force (they retain position when not actuated);
- OR logic valves, 1.2 and 2.5 respectively, for an alternating actuation of the trap door, from both the driving seat and the personnel area;

[1]*Corresponding author e-mail: ramona.stoica@mta.ro*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

- throttle valve 2.7 for speed adjustment (upper limitation of speed) in case of opening the trap door;
- a set of pneumatic double check valves, 1.4 and 2.9, to maintain the trap door in a certain position;
- pneumatic motors (double acting cylinders), 1.0 and 2.0.

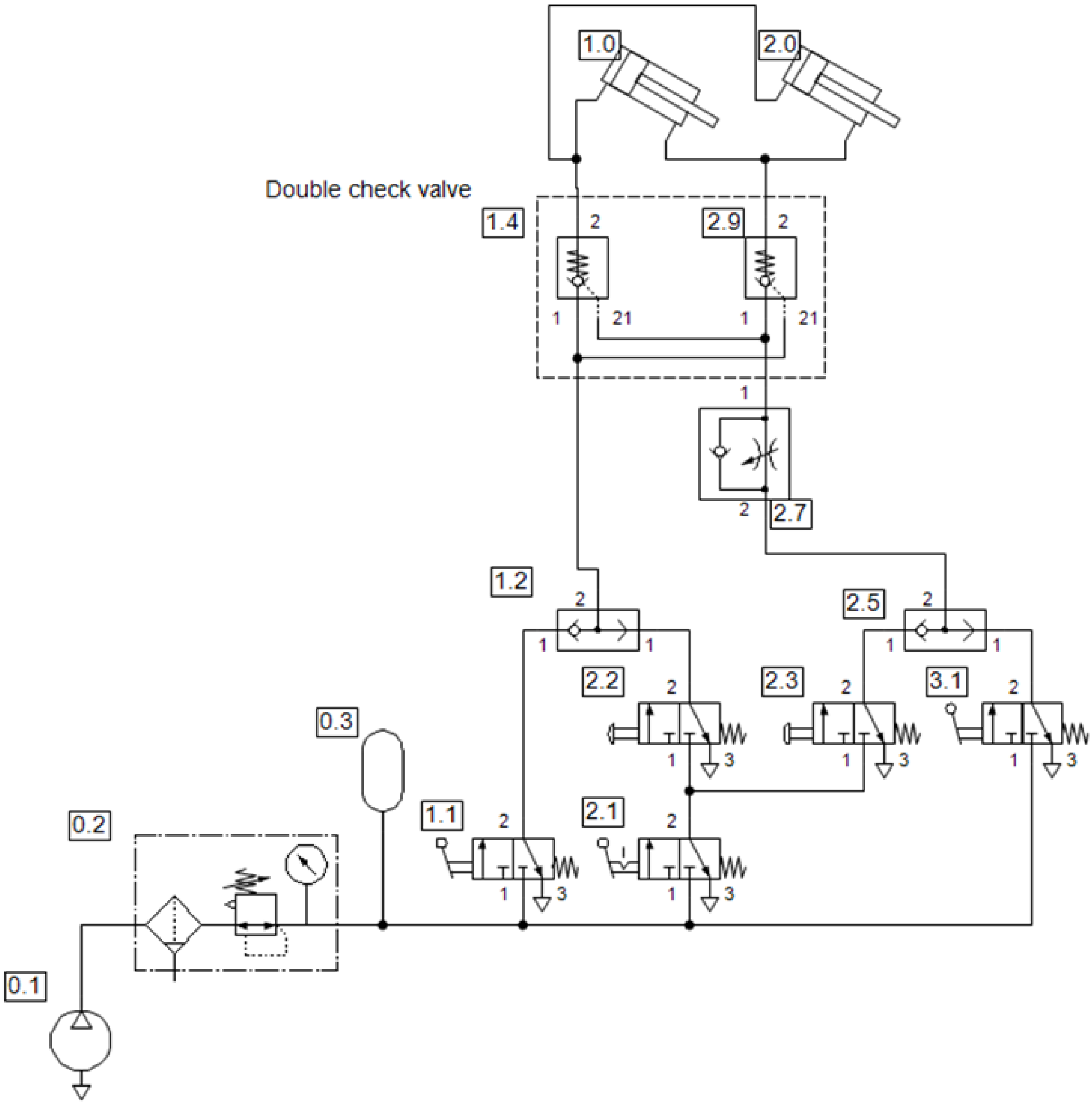


Figure 1. Constituents of the pneumatic model

Establishing values of working parameters:
- the working pressure for the air compressor: 7.5 bar, similar to the vehicle characteristic values;
- the air tank was set to 10 liters capacity;
- the double acting cylinders are mounted in floating position (initial mounting angle was 330 degrees) with specific parameters set as depicted in figure 3 [5].

<u>Working principle:</u> when the internal combustion engines starts, the air compressor 0.1 is actuated and compressed air is sent through the air preparation unit 0.2 (at this point, the air is filtered, the condensation water and oil particles from the compressor are separated and the pressure is adjusted according to the values of the pressure regulator valve) [4].

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

Pos. No.	Identification	Target ID to	Description
1	3.1	Directional valve to close the trap door (driver side)	3/n - Way Directional Valve
2	2.9	Double check valve to control the closing traveled distance	Double check valve
3	2.7	Throttle check valve to suppress the opening	Throttle check valve
4	2.5	OR logic valve to actuate the alternative closing	OR logic valve
5	2.3	Directional valve to close the trap door (personnel compartment)	3/n - Way Directional Valve
6	2.2	Directional valve to open the trap door (personnel compartment)	3/n - Way Directional Valve
7	2.1	Directional valve to block the actuation of the trap door (driver side)	3/n - Way Directional Valve
8	2.0	Double acting cylinder	Double acting cylinder
9	1.4	Double check valve to control the opening traveled distance	Double check valve
10	1.2	OR logic valve for alternative open	OR logic valve
11	1.1	Directional valve to open the trap door	3/n - Way Directional Valve
12	1.0		Double acting cylinder
13	0.3	Vehicle tank	Compressed air tank
14	0.2		Air preparation unit
15	0.1	Actuated by the termal engine	Compressor

Figure 2. Description of constituents for the pneumatic model

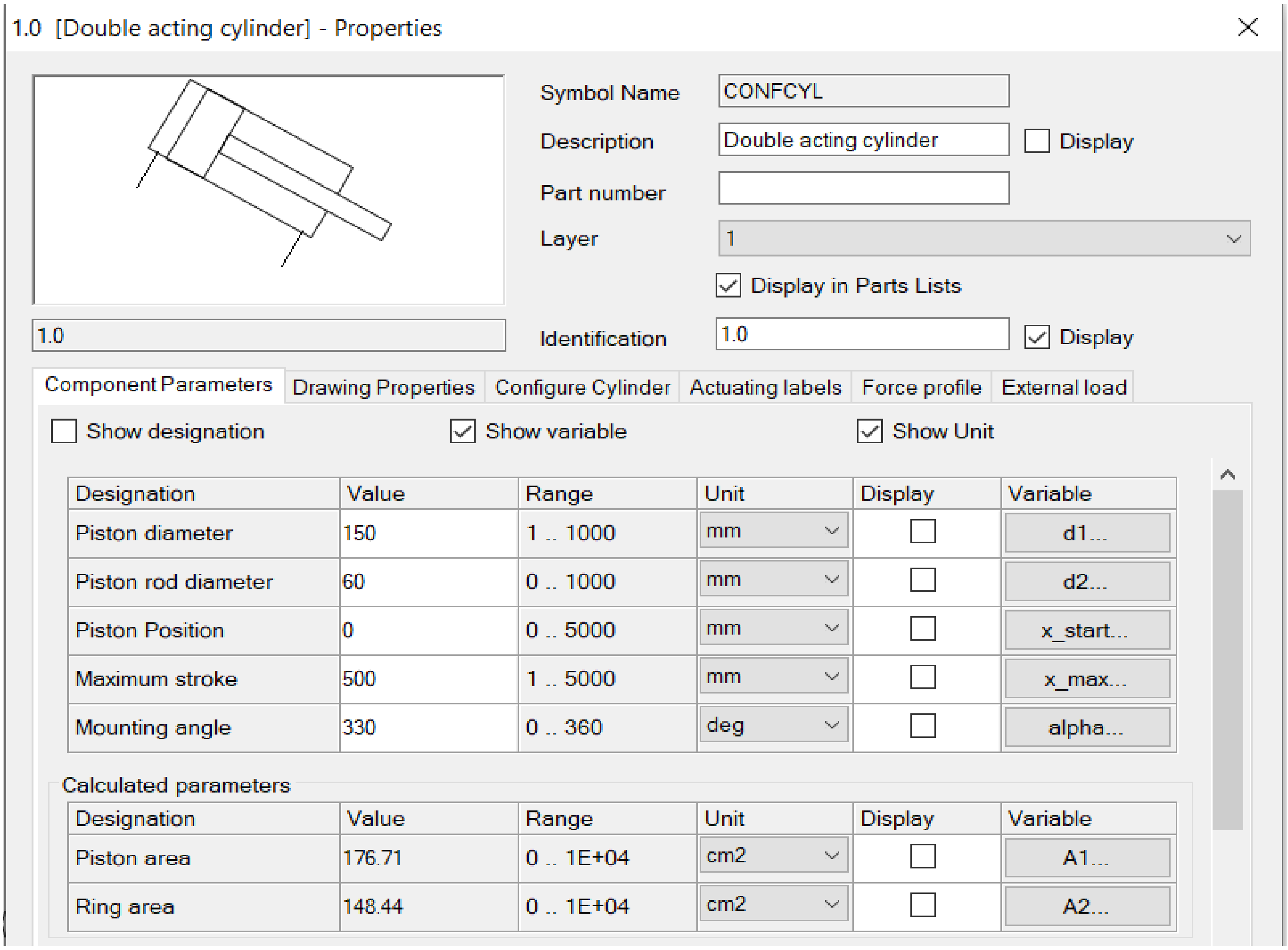


Figure 3. Set-up of working parameters

Then, the air is sent to the air reservoir 0.3 (to whom it was set a volume of 10 liters), so that the 1.1, 2.1 and 3.1 valves get to be supplied with compressed air (the flow of air is coloured in dark blue on the model from figure 4). The circuit coloured in dark blue is characteristic to the compressed air circuit, when the pneumatic directional valves are not actuated. In this situation, tank 0.3 contains compressed air. The pneumatic circuit sent to the atmosphere is coloured in blue, and the compressed air circuit, after a partial actuation, is coloured in pink (in this situation, the pressure has low values and the outtake circuit is blocked by the double check valves).

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

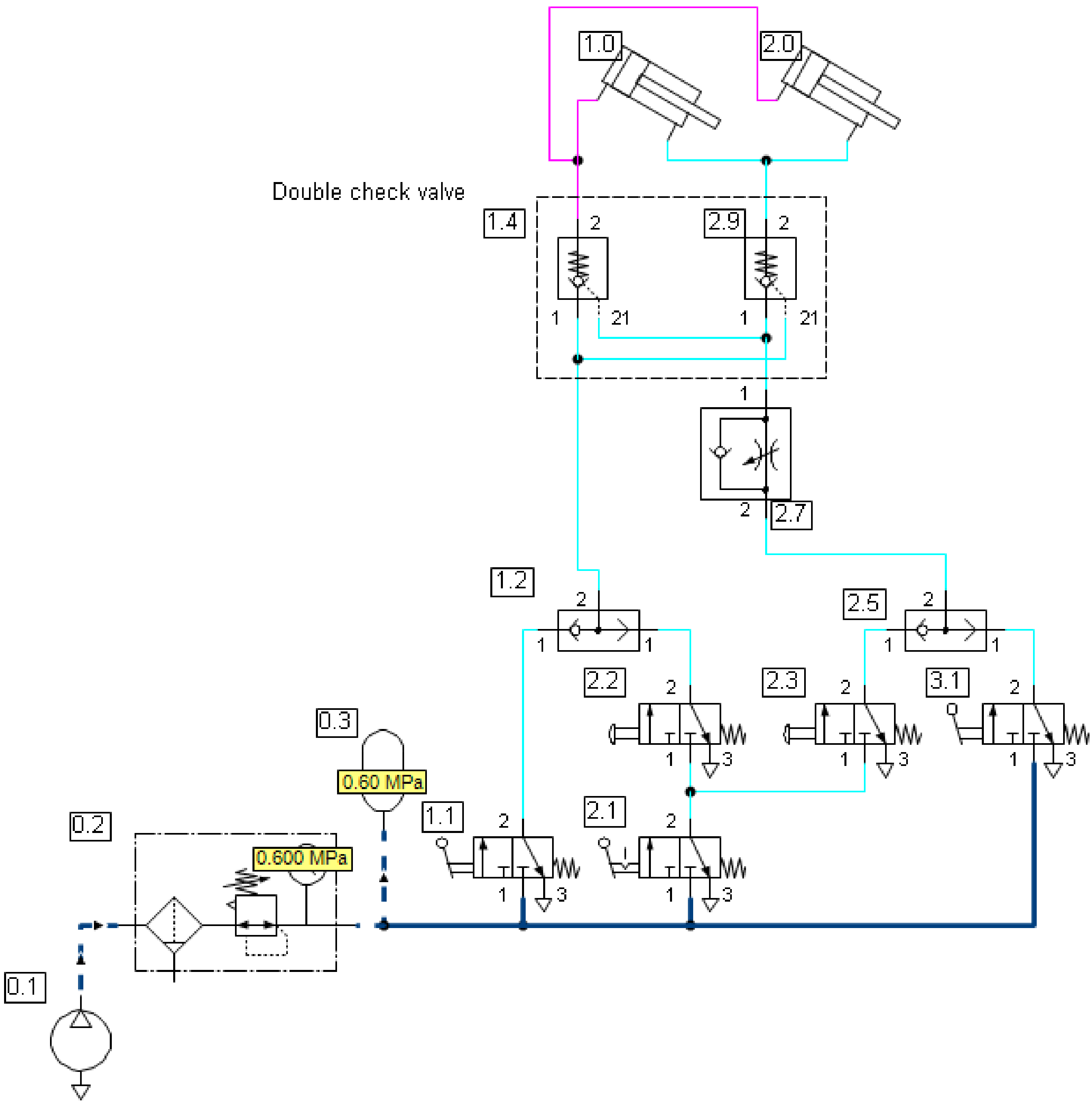


Figure 4. The flow of air when actuating the model

To close and open the trap door, it can actuate either the 1.1 directional valve from the driver or the 2.2 directional valve from the military personnel compartment, by actuating the 1.2 OR logic valve. The military personnel can operate the trap door, whether to open or close it, by actuating the 2.1 directional valve (which unlocks the control from the military personnel compartment).

This control is necessary in case of breakdown (technical failure of the pneumatic system, when the situation is not critical), so that the driver will have an extra pneumatic energy for critical actuations such as pneumatic start of engine, emergency braking etc.

The air supplied by valve 1.2 goes through the double check valve and supplies 1.0 and 2.0 motors, resulting in an increase of traveled distance (the trap door closes). The movement of the trap door is possible because the 2.9 check valve is actuated by the pressure within the 1.4 valve circuit. The set of double check valves (1.4 and 2.9) is used to prevent the trap door from closing or opening due to air losses which can occur around the sealing elements. This solution is used when the load (trap door weight) becomes an active force.

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

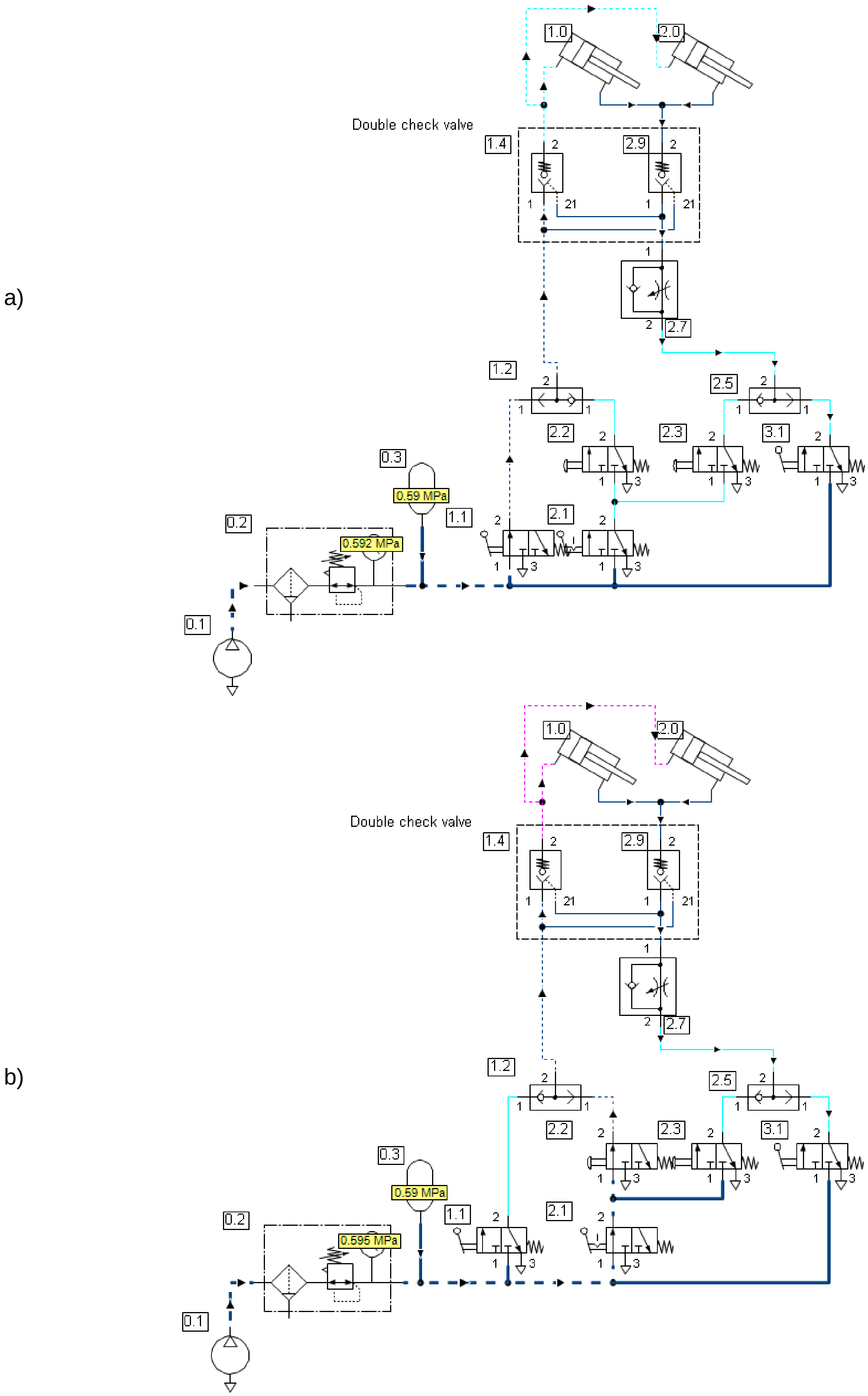


Figure 5. Functional diagrams used to represent the actuation from the driver seat (a) and the military personnel compartment (b)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

As long as there is no pressure downstream the 1.4 check valve, the 2.9 valve is blocked, avoiding an accidental descending of the trap door (hence, the use of mechanical blocking systems is avoided). Because the trap door, while descending, can cause shocks at the end of stroke, there are used throttle valves like the one numbered 2.7, which will ensure the necessary braking.
The throttle valve parameters are depicted in figure 6.

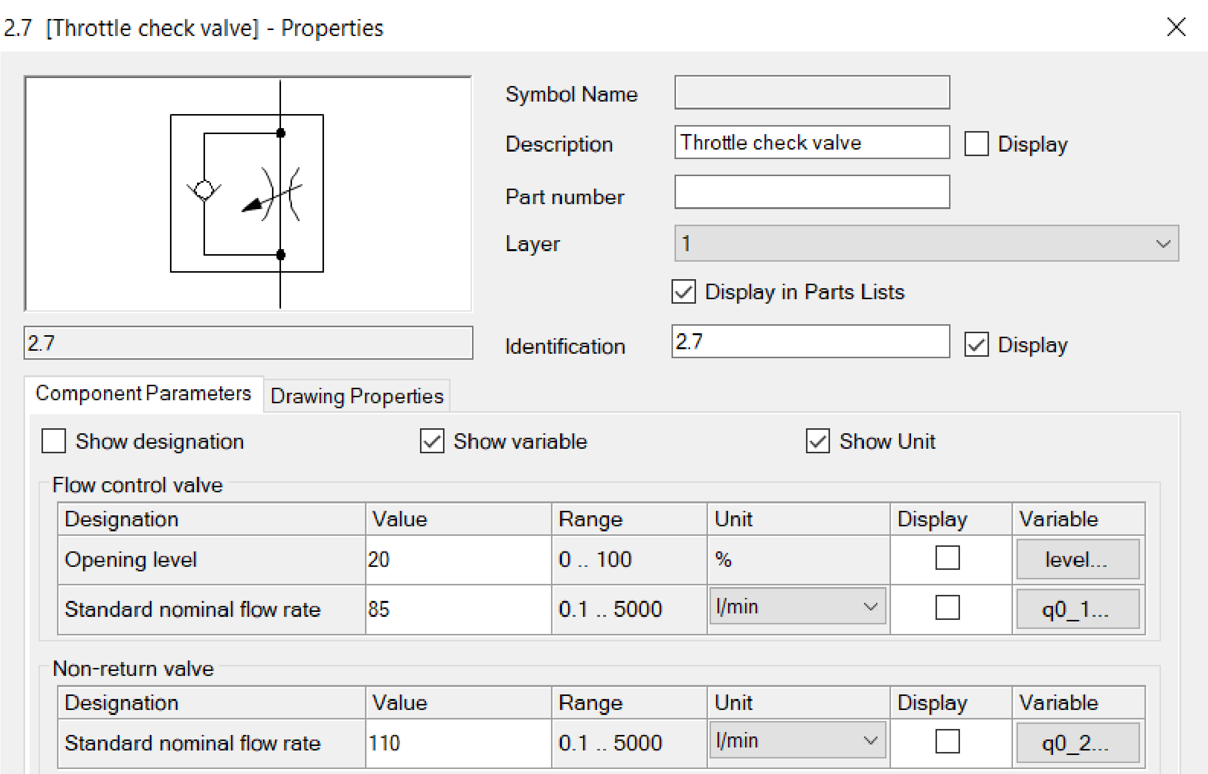
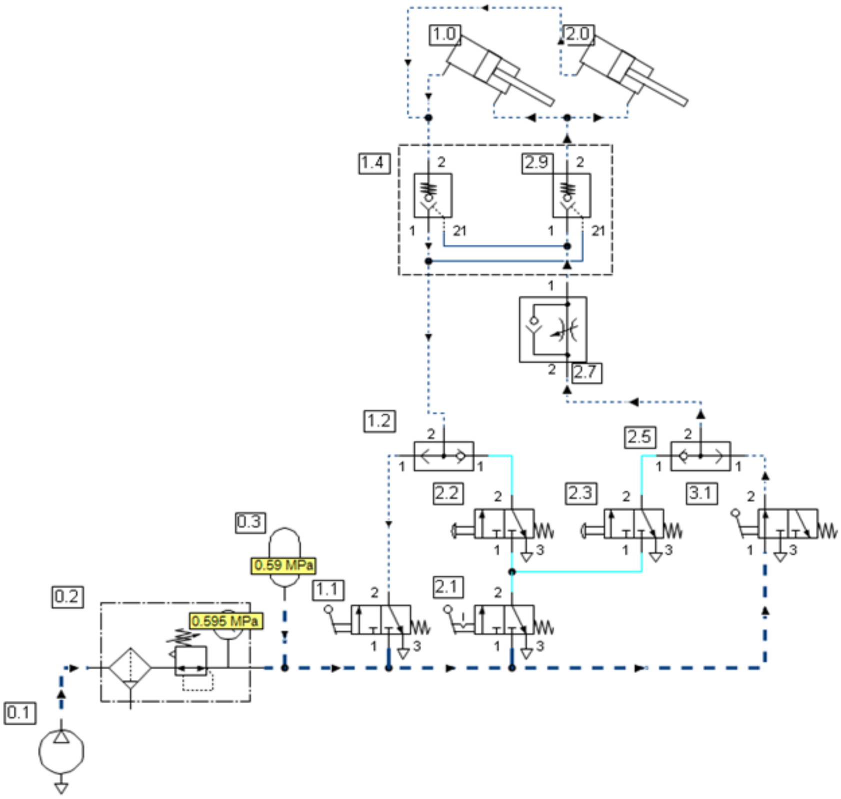


Figure 6. Throttle valve parameters

a)



b)

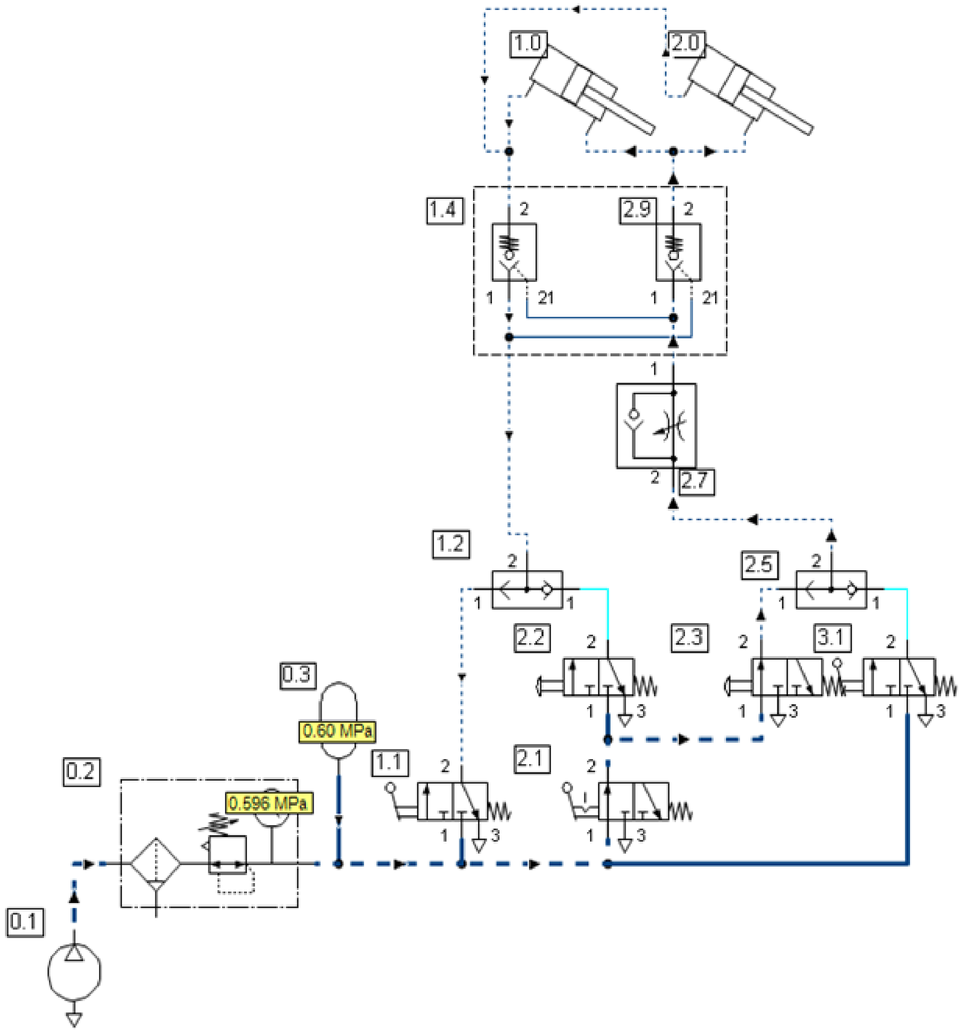


Figure 7. Functional diagrams for opening the trap door from the driver seat (a) and the military personnel compartment (b)

The compressed air is evacuated from the throttle valve by means of the 2.5 OR logic valve and the 2.3 and 3.1 directional valves, respectively. Hence, the air is sent to the atmosphere.
To open the trap door, one can actuate either the 3.1 directional valve (by the driver), or the 2.3 directional valve (from the military personnel compartment). To this end, the 2.1 directional valve unblocks the command from the driver.
Follow-up, the compressed air passes through the 2.5 OR logic valve, the 2.7 throttle air bypass valve, the 2.9 check valve and actuates motors 1.0 and 2.0, which execute the withdrawal stroke. The outtake of air towards the atmosphere, from the two pneumatic cylinders, is executed through the 1.4 check valve, which is actuated by the pressure within the fuel line for the 2.9 check valve, following the 1.2 OR logic valve and the 1.1 or 2.2 directional valve (figure 7).
The opening and closing process of the trap door allows intermediate positions.

5. CONCLUSION

In case of personnel carrier vehicles, the safe and quick embarking and disembarking of military personnel is performed through the trap doors placed at the rear part of the vehicle. Many of the systems that equips such vehicles, are hydraulically or pneumatically actuated. The hydraulic ones are used in case force is needed, such as most actuation at the front part of the vehicle (breakwater plate, full power steering, hydraulic circuit of the braking system, coupling/decoupling of gears).

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

Such a design solution can be complicated.
As a result, the solution detailed within the present paper is more flexible, easier to configure with pneumatic hoses, and less emission pollutant than the hydraulic one.
On the other hand, there are also other pneumatic consumers, on both lateral sides and at the rear part of the chassis.
Also, the simulation set-up can be implemented on an experimental technological demonstrator.

ACKNOWLEDGEMENT

This work is supported by the project ANTREPRENORDOC, in the framework of Human Resources Development Operational Programme 2014-2020, financed from the European Social Fund under the contract number 36355/23.05.2019 HRD OP /380/6/13 – SMIS Code: 123847.

REFERENCES

[1] Costache, Dragos, *Transmisii hidraulice pentru autovehicule*, Editura Academiei Tehnice Militare, 2002, Bucuresti
[2] Costache, Dragos, *Acționări hidraulice și pneumatice la autovehicule*, Editura Academia Militară, 1985, Bucuresti
[3] Voicu, Daniela, Vilău, Radu, Stoica, Ramona-Monica, *Experimental plotting of static characteristics of rotary hydraulic pumps*, The 16th edition of the international conference-European integration realities and perspectives. Proceedings, 2021, pg. 371-378, ISSN: 2067 - 9211
[4] Vilău, Radu, *Acționări hidraulice și pneumatice. Suport de curs, 2014*
[5] FluidSim 5 software documentation

DESIGNING AND TESTING CRASH TEST SLED RIG USING CAD SOFTWARE

Alexandru-Ionuț RADU*, Bogdan-Ioan NIȚULEASA

Transilvania University of Brașov, Automotive and Transport Department,
Str. Politehnicii Nr. 1, 500024 BRASOV, Romania

(Received 11 August 2021; Revised 28 October 2021; Accepted 02 November 2021)

Abstract: *This paper presents the 3d model of a crash test rig designed using CAD software and tested using a kinematic simulation to obtain results regarding the performance of the rig. The rig consists of a vehicle cockpit mounted on a carriage that rolls on a curved sled. At the end of the sled are two rubber bushings to stop the carriage and simulate a crash test. The crash test rig relies on an inclined sled and the velocity is obtained through the gravitational acceleration. Also, the stopping deceleration of the sled was obtained from the simulation. Simulation results show that the cockpit can reach a velocity of about 14 km/h and can generate a deceleration on impact of 33 g's or 330 m/s^2 with a kinetic energy of 1400 joules.*

Keywords: *Crash test, CAD model, CAD, Simulation, Sled, Kinematic simulation, 3D model*

NOMENCLATURE

m: carriage assembly mass, kg
g: gravitational acceleration, m/s^2
G: gravity, N
a: sled angle, degrees
F_n: impact force, N
k: stiffness, N/m
c_{max}: maximum damping, N/(m/s)
d_{max}: penetration value, m
g_p: penetration of one body into another, m
dg_p/dt: penetration velocity at point of contact, m/s

1. INTRODUCTION

Since the development of automotive industry, there was a need for crash testing [1]. Crash tests are used to improve vehicle safety and it is performed in a controlled environment, inside a building or in a field [2]. In a building, crash tests are performed using special rigs designed to simulate real accidents [3]. Nowadays, we can design virtual models using various CAD software to create prototypes that can be analyzed in a virtual environment to assure a correct functionality before constructing it in reality [4]. SolidWorks has a function that allows of dynamic simulations of models based on input parameters and that it can output results.
The CAD model could be simulated using ADAMS. This is a multibody numerical simulation software that uses elastic or rigid bodies connected together with kinematic joints or elastic connections such as springs. The most important parameter of this software is the solver that is a mathematical model that takes the input parameters and calculates the output parameters based on constraints and material contacts [5][6][7].
A crash test rig used for the impact of a human head with a plate at various angles was designed and simulated using this software [8]. Using the mentioned software, we designed a crash test rig that simulates a frontal collision between a vehicle and a solid object.
The model was created in the CAD software and dynamically simulated using ADAMS.

* *Corresponding author e-mail: alexandru.radu@unitbv.ro*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

2. CAD DESIGN

The rig was design in a CAD environment using part modeling.
The design of the rig is based on the force of gravity acting upon a mass that slides on two rails.
In figure 1 the basic principle of the rig is presented.

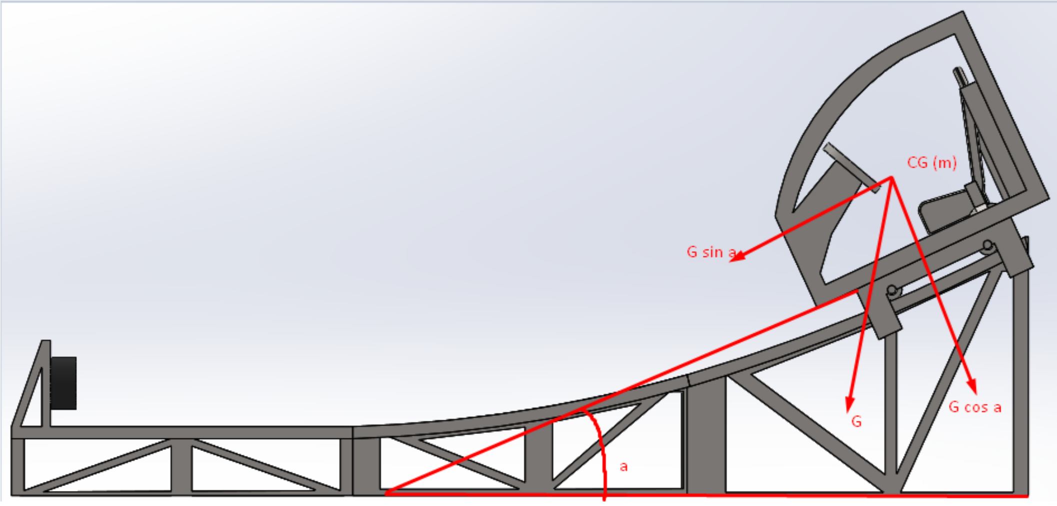


Figure 1. Rig principle

The vehicle compartment is mounted on a rolling sled, at an angle (*a*) to give it enough inertia. This uses the force of gravity (*G*) that relies on the gravitational acceleration (*g*) and the mass of the carriage assembly (*m*). Because it is at an angle, the force of gravity is divided along 2 axes (we have *G sin a* along the horizontal axis of the sled and *G cos a* along the normal axis of the sled).

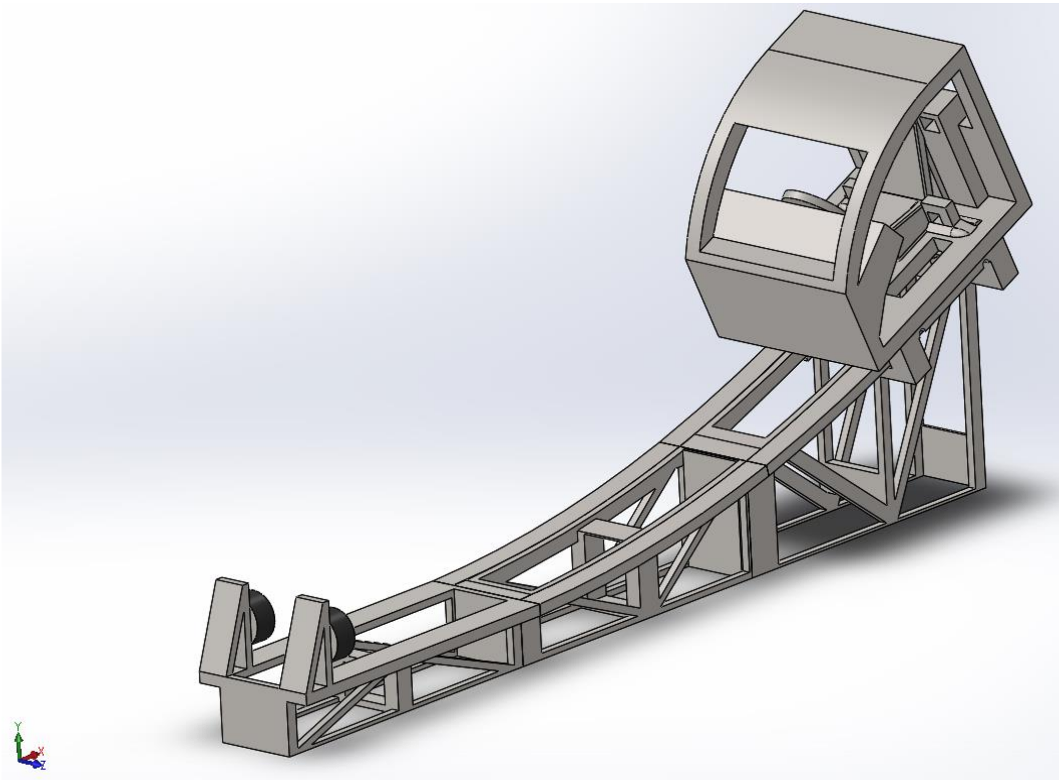


Figure 2. Rig design

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

At the end of the sled, there are two rubber stoppers mounted on a rigid frame to stop the moving sled thus granting a deceleration similar to that of a vehicle crash.
The assembly of the rig had several components.
The rigid frame is made up of 3 parts, the carriage is 1 part where the 4 rollers are mounted, and the cockpit is one single part.
It was designing this way to simplify the dynamic simulation of the moving carriage assembly.
The exploded view of the rig is presented in figure 3.

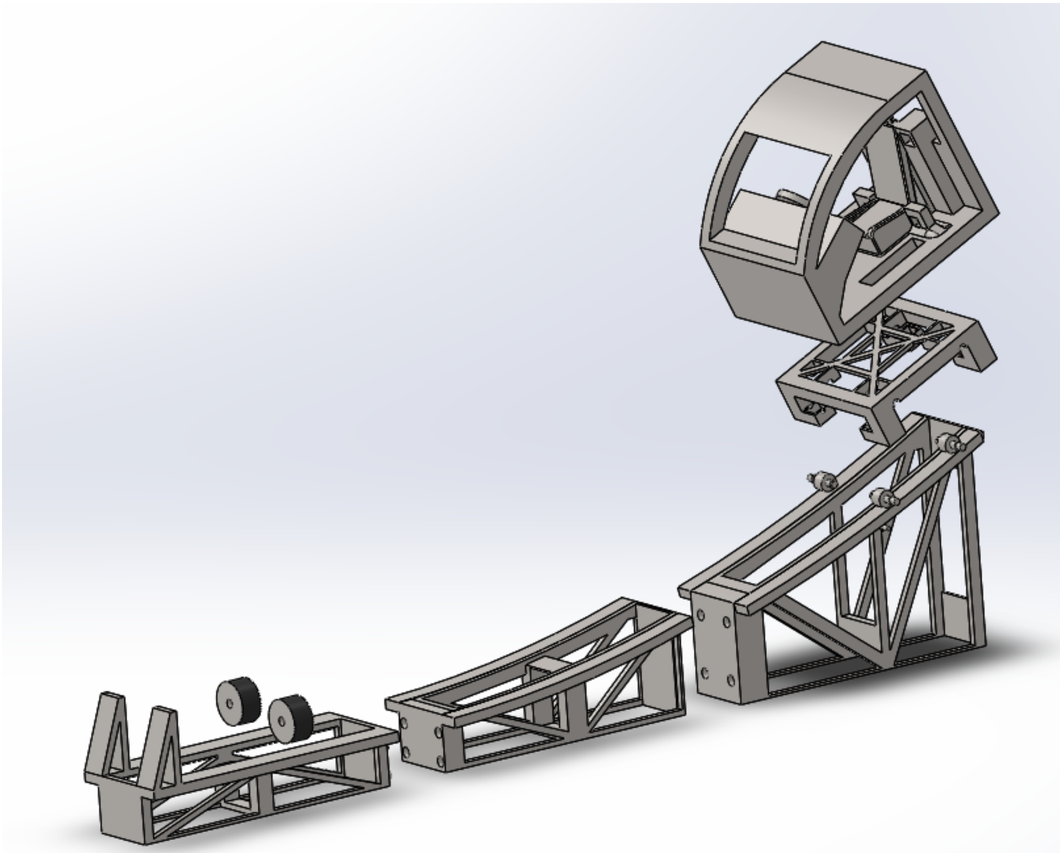


Figure 3. Exploded view of rig components

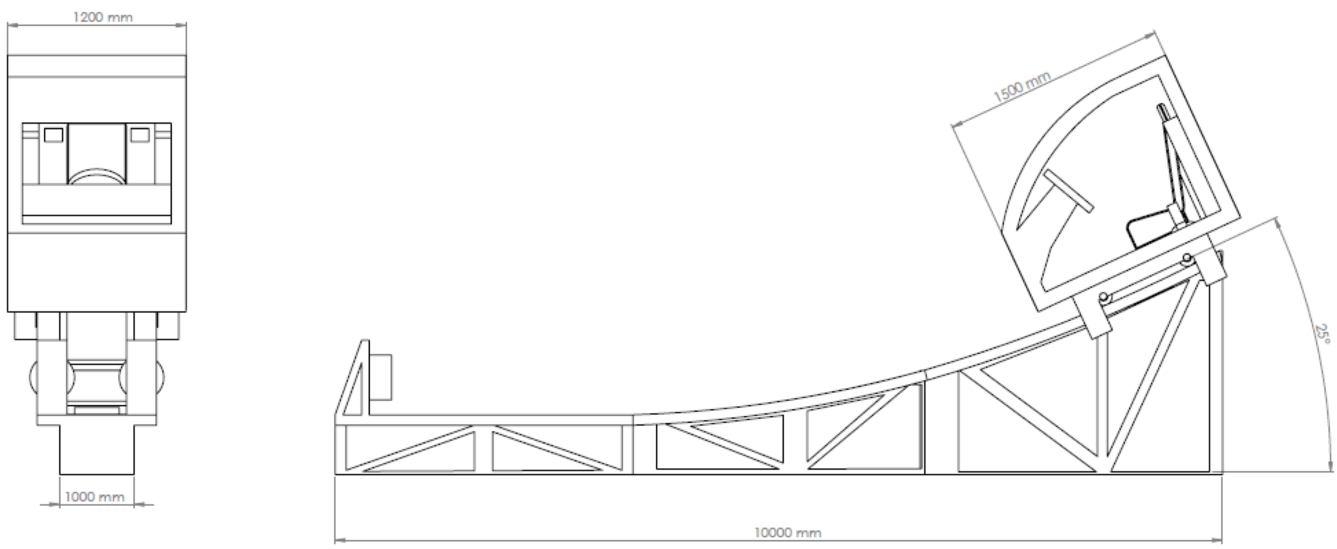


Figure 4. Rig primary dimensions

The main dimensions of the rig are presented in figure 4.
The length of the sled is 10 meters with an inclined slope angle of 25 degrees.
The width is 1 meter. Cockpit dimensions are similar to those of a passenger vehicle.
To simulate the dynamic properties of the assembly, input parameters for the mass and contact between bodies were established.
The mass parameters for the simulation are presented in table 1.

Table 1.
Model mass parameters

Part	Mass	Units
Sled assembly	650	kg
Cockpit	250	Kg
Carriage	70	kg
Rollers	5	kg

There are contacts between the parts of the assembly that will ensure a correct modelling of the dynamic behaviour of the sled. These parameters are presented in table 2.

Table 2.
Model contact parameters

Body contact part	Type of material	Stiffness value [N/m]	Max damping [N/(m/s)]
Cockpit - Stoppers	Steel - Rubber	600000	40000
Rollers - Sled	Steel - Steel	100000	50000
Rollers - Carriage	Steel - Steel	100000	50000

The material stiffness values are preconfigured in the simulation software based on the type of material used. The preferred material for the assembly was steel and only the stopper is from rubber.
To calculate the impact between two bodies, the software relies on the following formula:

$$F_n = k \cdot g_p{}^e + Step(g_p, 0, 0, d_{\max}, c_{\max}) \cdot \frac{dg_p}{dt} \quad (1)$$

Where F_n is the impact force, g_p is the penetration geometry into another body, c_{max} is the maximum damping, d_{max} is the penetration value, *k* si the stiffness and dg_p/dt is the penetration velocity at the point of contact.

3. DYNAMIC SIMULATION AND RESULTS

Dynamic simulation of the assembly can be utilized to evaluate the physical response of the model in regard to the real-world situations.
The simulations of the sled were possible by using the motion analysis model in the CAD application.
In figure 5 the simulation si presented in 3-time intervals, at 0 ms, 100 ms and 210 ms.
These intervals represent the simulation stages of the model.
At time 0 is the start of the simulation, 100 ms is the middle and at 210 ms we have the impact between the sled and stoppers.
The output results of the model are presented as diagrams of key parameters in regard to the simulation time. The first result is the sled velocity, and it is presented in figure 6.

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

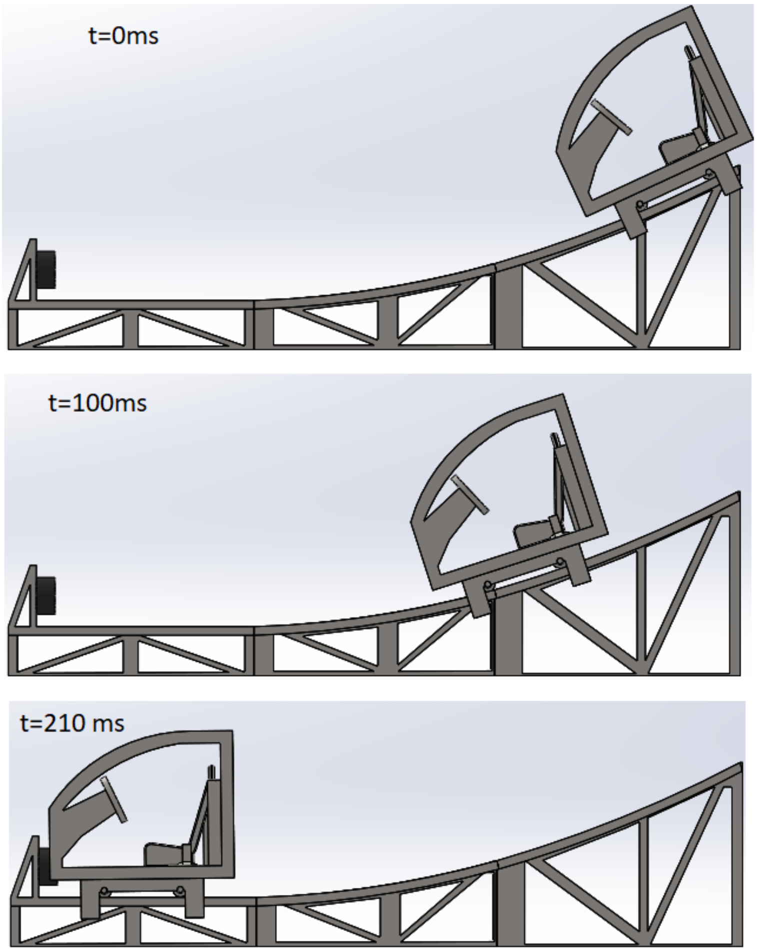


Figure 5. Simulation results

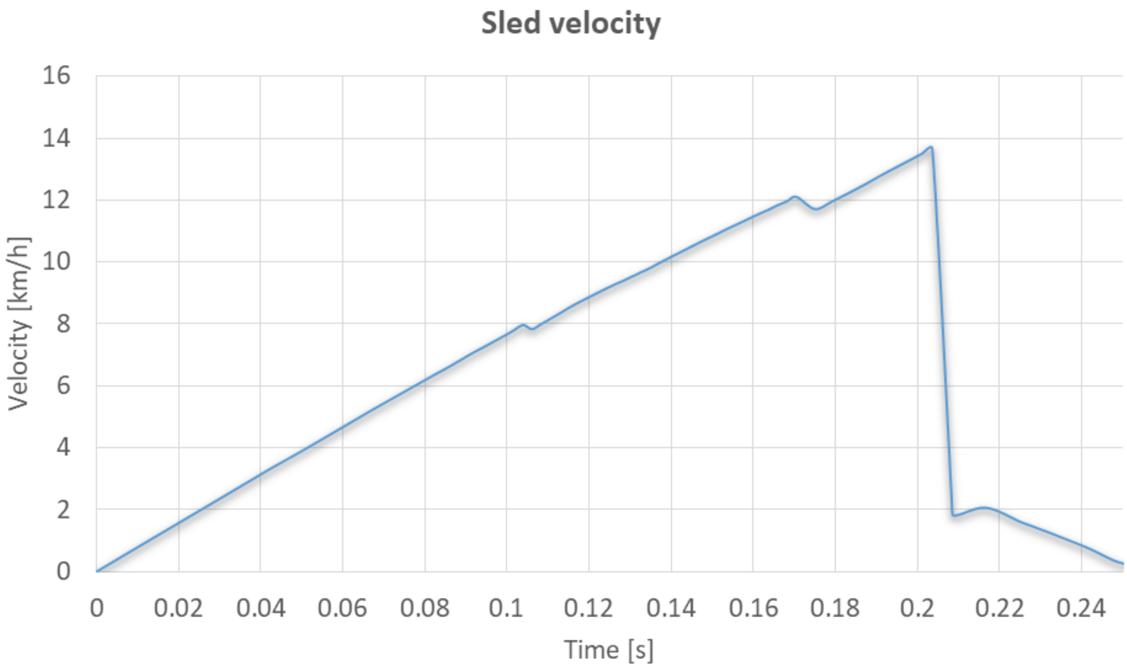


Figure 6. Sled velocity

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

The maximum velocity obtain prior to collision was 13.9 km/h.
The steps observed at 110 ms and 170 ms were caused by the contact joint of the rollers with the sled. Another result of interest was the sled deceleration that is presented in figure 7.

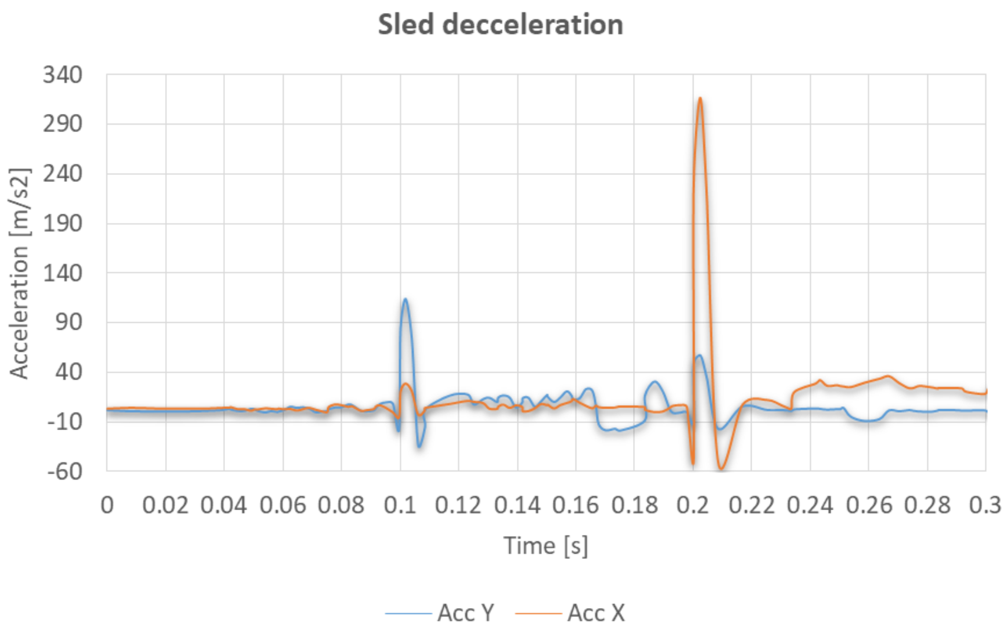


Figure 7. Sled deceleration

I can be observed that the maximum deceleration at impact was 310 m/s^2 on the X axis. We can also note the 110 ms deceleration peak on Y axis of 100 m/s^2 caused by the contact model of the rollers with the sled. Due to the way the motion analysis works, we can negate this peak.
We can also observe the kinetic energy of the sled in figure 8.

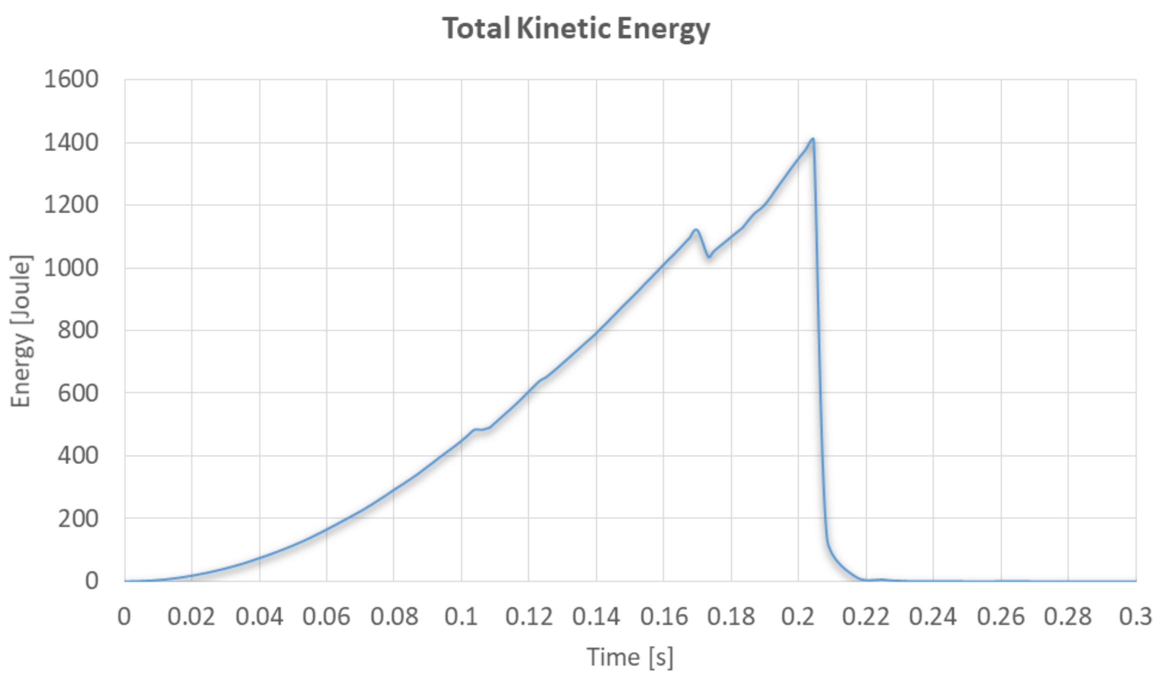


Figure 8. Sled kinetic energy

During the simulation, a maximum value of 1400 joules was obtained for the maximum kinetic energy of the assembly. The last result is the potential energy delta variation, presented in figure 9.

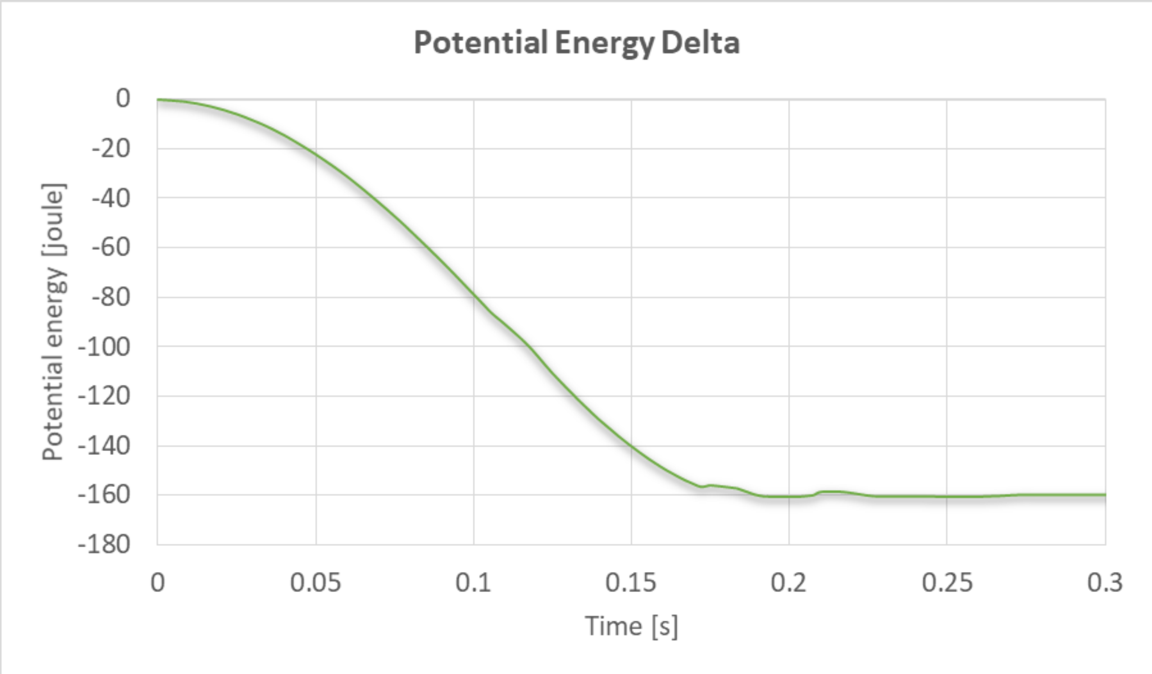


Figure 9. Sled potential energy delta

The maximum variation of the potential energy was 160 joules between the start of the simulation and the final position. This difference is the result of the displacement of the sled with cockpit from the starting position to the final position.

5. CONCLUSION

We can conclude that the designed model of a crash test rig is functional, and the simulation results show that if the model was built, it could have good performance when using it to simulate vehicle crashes. Even thou the maximum velocity obtained from the simulation was only 13.9 km/h, and it can be stated that this velocity is low, the sled can be used to study vehicle low velocity crashes with passengers inside the cockpit. Due to the non-deformable nature of the model, the maximum deceleration of the sled was a bit high with 310 m/s^2.

REFERENCES

[1] Tolea, B., Trusca, D., Antonya, C. and Beles, H *The influence of the frontal profile design of a vehicle upon the pedestrian safety at low velocity*, 26th Annals of DAAAM and Proceedings, 2015
[2] Shaw, G., Crandall, J. and Butcher, J. 2000 September. Biofidelity evaluation of the THOR advanced frontal crash test dummy. In IRCOBI Conference on the Biomechanics of Impact.
[3] Bliven, E., Rouhier, A., Tsai, S., Willinger, R., Bourdet, N., Deck, C., Madey, S.M. and Bottlang, M. 2019 Evaluation of a novel bicycle helmet concept in oblique impact testing. Accident Analysis & Prevention, 124, pp.58-65.
[4] Kurowski, P. *Engineering Analysis with SolidWorks Simulation 2013*, SDC publications, 2013
[5] Kurowski, P.M. *Engineering analysis with solidworks simulation*, Mission: SDC Publications, 2015
[6] Ryan, R.R. *ADAMS—Multibody system analysis software*, In Multibody systems handbook, Springer, Berlin, Heidelberg, pag. 361-402, 1990
[7] Bowling, M. and Veloso, M. *An analysis of stochastic game theory for multiagent reinforcement learning*, (No. CMU-CS-00-165), Carnegie-Mellon Univ Pittsburgh Pa School of Computer Science, 2000

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

[8] Radu, A. I., D. D. Trusca, G. R. Toganel, and B. C. Benea *Designing and testing a stand used to simulate the dummy head impact with different surfaces using CAD software*, In IOP Conference Series: Materials Science and Engineering, vol. 997, no. 1, pag. 012058, IOP Publishing, 2020

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

STUDY ON THE CONSEQUENCES OF THE IMPACT OF THE WHEEL OF THE VEHICLE WITH A FIXED OBSTACLE

Paul Mihai VRABIE*, Claudiu NEDELESCU, Ionuț - Alexandru RADU, Daniel -Dragoș TRUȘCĂ

Transilvania University of Brașov, Automotive and Transport Department,
Str. Politehnicii Nr. 1, 500024 BRASOV, Romania

(Received 11 August 2021; Revised 28 October 2021; Accepted 02 November 2021)

Abstract: *The paper presents the case study of the interaction between the tyre and the bumps in the tread, addressing the issue of parameters that influence the appearance of tyre depressurization. The main cause of road accidents caused by rolling system failures is related to the structural failure of the tyres, which is largely related to both their maintenance and their interaction with the imperfections of the tyres. The main objectives were to determine the influence of velocity in direct connection with the degree of deformation of the tyre in a scenario in which the depth of the unevenness varies from 50 to 100 mm. The results of the analysis showed that, even at a relatively low speed of the vehicle, structural damage to the vehicle wheel can occur.*

Keywords: *Tyre, fixed obstacle, tyre deformation, tyre analysis, road accidents*

NOMENCLATURE

dz = obstacle depth
Va = vehicle velocity
Vr = wheel velocity
Acc a = vehicle acceleration
Acc r = wheel acceleration
def rp = tire and rim deformation
tire acc def = wheel deformation acceleration

1. INTRODUCTION

According to statistics, the car remains the most unsafe means of transport, due to the number of road accident victims being among the most common causes of death in the world [3][9].

A study based on data from the Deutscher Verkehrssicherheitsrat e.V. ("DVR") "Gesellschaft für Technische Überwachung mbH" (GTÜ), in 2000, on inspections carried out on the tyres of more than 2 million vehicles, it was found that approximately 11% of all inspected tires were defective, the main causes being very worn tires, well below the allowable threshold and very aged tyres [1][9].

In addition, experts found that 25% of the tires checked did not have the inflation pressure according to the provisions recommended by the manufacturers, and for another 7%, the tire size did not match according to the licenses approved for vehicle functionality [2][4].

The effect that can be considered the most common cause of an accident is the structural damage of a tyre, normally resulting in the driver's loss of control over the vehicle [3][7].

In addition to the statistical figures on accidents caused by structurally damaged tires, there are a number of unknown cases of road users indirectly affected by such incidents [6].

A depressurized tire can be considered a deliberate or negligent abuse and a proper failure of maintenance by the driver, which is considered a major reason for damage to the structure of the tire [5][8].

* *Corresponding author e-mail: paul.vrabie@unitbv.ro*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

2. OBJECTIVES

The objectives of the paper focus on determining the influence of the geometric parameters of the slope and the dynamic parameters of the vehicle on the deformations of the tire and the rim.
The main objective of this experimental work is to dispose of the damage suffered by the vehicle when the wheel passes through a pothole. The main objectives are: Carrying out a set of vehicle-obstacle wheel type impacts; Determining the velocities; Determining the accelerations; Determining the velocities of the vehicle's wheel depending on the size and depth of the obstacle after analyzing the data obtained from the GPS receiver and the video samples; Recording the acceleration parameters when passing through potholes at different velocities using the Pic Daq DSD device.

3. METHODOLOGY

The methodology used for this work consists in simulating the impact of the vehicle's wheel with a difference in level at different velocities. There were two occupants in the car in the front seat, one being responsible for driving the vehicle and one for direct monitoring of data acquisitions.
In order to carry out the experimental tests, a vehicle from the passenger hatchback range equipped with tires of size 145/80 / R13 was used, which ran with a velocity regime between 25-26km / h, when passing through a negative unevenness with H = 100mm, L = 1000mm and l = 400mm respectively H = 50mm, L = 1000mm and l = 400mm

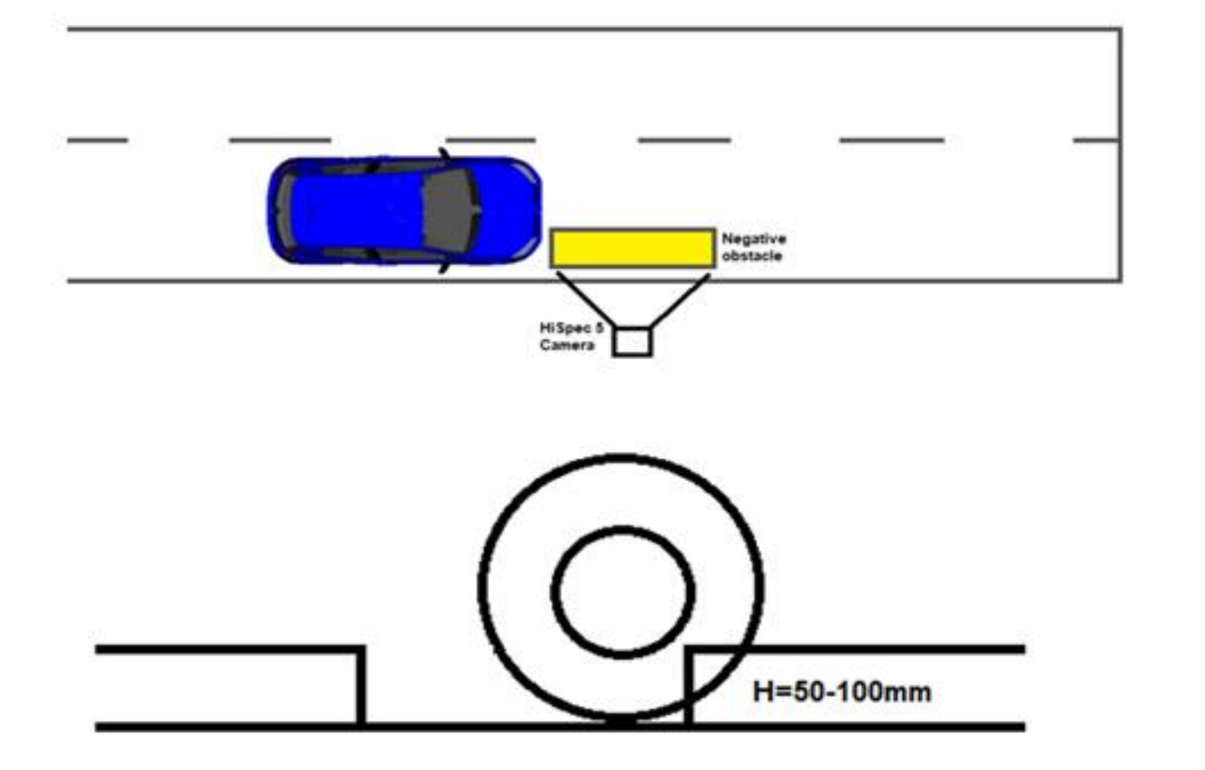


Figure 1 Test methodology and wheel position relative to the negative obstacle.

Figure 2 Marking and sizing the obstacle

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

The following devices were used for the experimental measurements:

- An acceleration recording device: PIC DAQ DSD;
- A GPS device DS-5 18x-5Hz.

4. RESULTS

From the results obtained after several experimental tests we compared two of them, the first test performed at a velocity of 25.5 km/h with an obstacle depth of 50mm, the second test performed at a velocity of 26 km/h with a 100mm obstacle depth.
The data presented below are from the analyses of test number 2.

Figure 3 Pictures obtained from the video analysis of test number 2

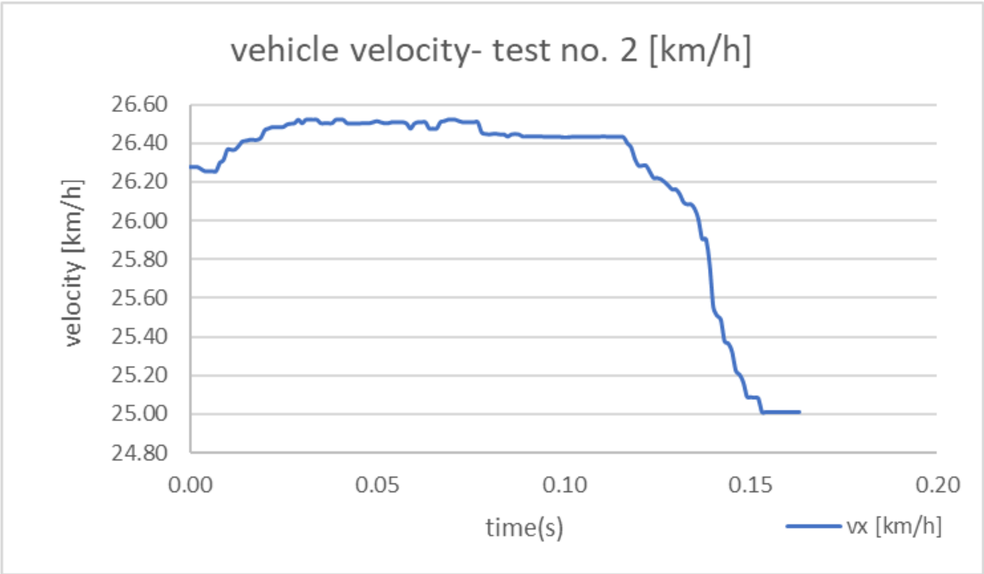


Figure 4. Vehicle velocity resulting from video data analysis and processing

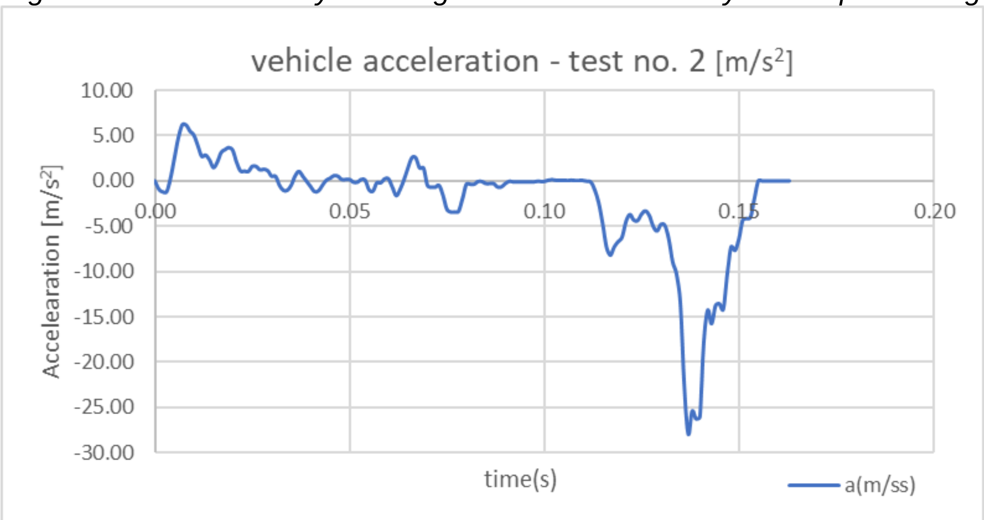


Figure 5. Vehicle acceleration resulting from video data analysis and processing

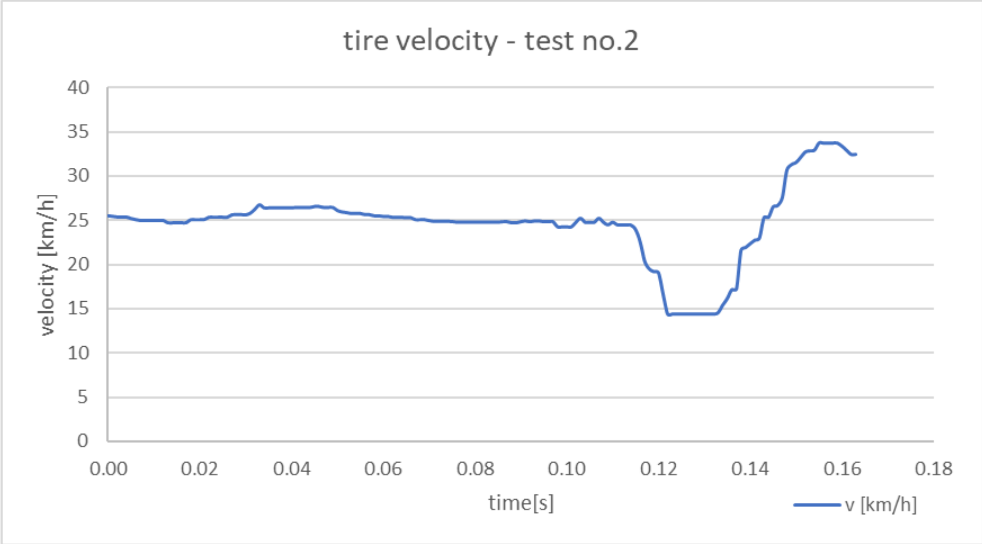


Figure 6. Wheel velocity resulting from video data analysis and processing

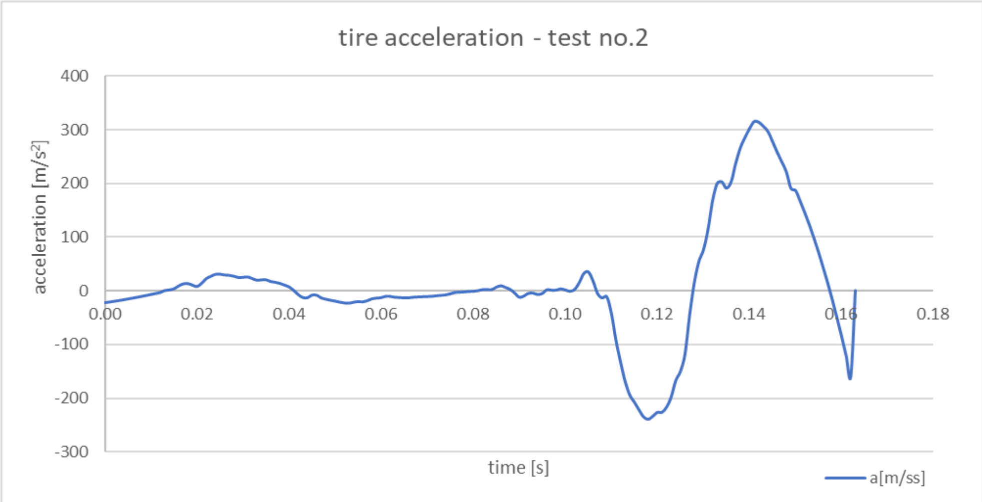


Figure 7. Wheel acceleration resulting from video data analysis and processing

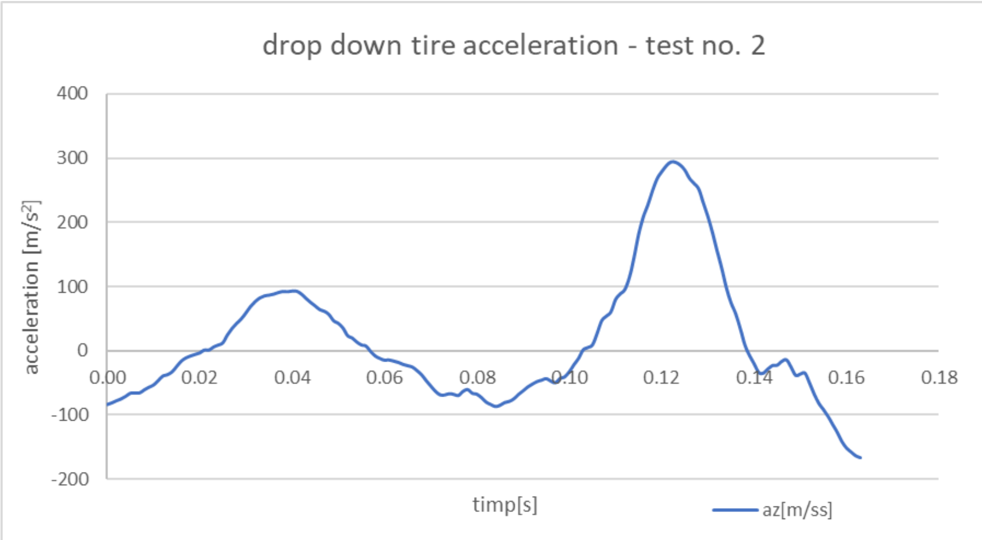


Figure 8. Wheel acceleration resulting from video data analysis and processing

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

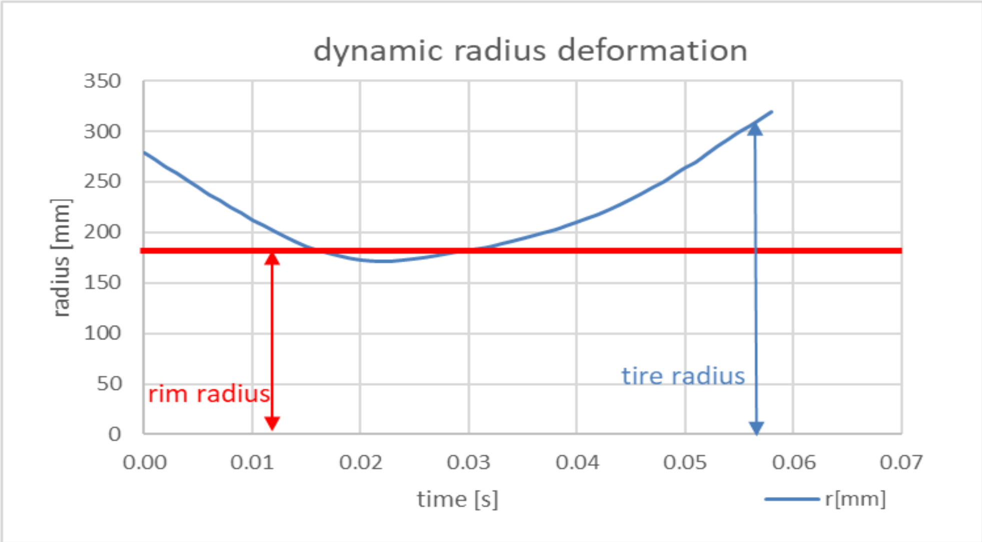


Figure 9. The variation of tire dynamic deformation at the moment of impact, resulting from video data analysis and processing

*Figure **10** Tyre deformation as following test number 2*

Table 2.
Tire deformation

Test no.	dz [mm]	Va [km/h]	Vr [km/h]	Acc a[m/s^2]	Acc r [m/s^2]	def rp [mm]	tire acc def	Rim radius [mm]
Test 1	50	25,5	25,5	95	95	191	217	180
Test 2	100	26	26	28	300	170	618	

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

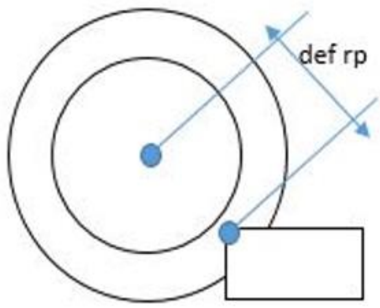


Figure 11. Tire deformation

5. CONCLUSIONS

As seen in the graphs presented above, in test number 2 (the depth of the pothole being 100 mm on a length of 1000 mm), we obtained maximum damage and deformation. Therefore, it was decided to analyze and detail the variation of the accelerations obtained during this test.
Because the structure of the tire is particularly complex and the variables that must be considered during the design are very different, it is difficult to verify it experimentally, requiring numerous tests. Considering the costs of the experiments, computer simulation virtual design is an effective aid in tire design; for this reason, tire design is done using increasingly high-performance computers and increasingly complex software packages, which are considered fundamental to save time, money, and human resources. The study of the interaction between the tire and the tread, of the tangential tensions that arise in the contact spot, because of the action of external forces and moments, is of particular importance, because it brings new elements to the design and construction of the tire to improve its dynamic qualities of adhesion. As a connecting element between the vehicle and the road, the tire decisively influences the performance, with a direct orientation on the dynamic behavior and, respectively, the economy of the vehicle. Following the tests performed, it was found at velocities higher than 25 km / h with a depth of 100 mm the damage suffered by the tire is maximum. Reaching the maximum compression of the suspension system, as well as the deformation limit of the tire, without consuming the full impact force, it was possible to observe the intrusion / impression of the wall when leaving the concave unevenness on the right front wheel rim. A rim deformation depth of approximately 27 mm was measured. Even if the depth of the unevenness is 50 mm in this case, there is a danger of damage. Carrying out experimental tests considering the parameters and factors mentioned above will provide data and information that will help to solve and correctly analyze the case of an impact between a tire and a bump in the ground.

REFERENCES

[1] K. S. Tan, S. V. Wong, R. S. Radin Umar, A. M. S. Hamouda, N. K. Gupta, *An experimental study of deformation behavior of motorcycle front wheel-tyre assembly under frontal impact loading,* 2-4, 2006
[2] Walter Reithmaier, Thomas Salzinger, *Motor Vehicle Tyres and Related Aspects,* 2003
[3] Gheorghe Ciolan, Daniel Trusca, Adrian Soica, Ovidiu Campian, Elemente de dinamică a autovehiculelor, Brasov, 2014
[4] M. Untaru, V. Campian. Dinamica autovehiculelor, Unv. Universitatea din Brasov, 1988
[5] Heinz Dieter Kutzbach, Alexander Burger, Stefan Bottinger. Rolling radii and moment arm of wheel load for pneumatics tyres, 1-5, 2018
[6] Vaclovas Kurkauskas, Algirdas Janulevicius, Gediminas Pupinis, Vidas Damanauskas. Interaction between driving wheel and road surface of all wheeled driven tractor, 1-4, 2013
[7] Zhihao Liu, Qinhe Gao. Development of a flexible belt on an elastic multi-stiffness foundation tire model for a heavy load radial tire with a large section ratio,1-3, 2018
[8] Hans B. Pacejka. Tyre and Vehicle Dynamics, 2002
[9] VACO (Wheel-tyre suppliers organisation of The Netherlands), "Onderzoek Rolling Wheel Nederland 2014

RoJAE
Romanian
Journal of **A**utomotive **E**ngineering

AIMS AND SCOPE

The Romanian Journal of Automotive Engineering has as its main objective the publication and dissemination of original research in all fields of „Automotive Technology, Science and Engineering”. It fosters thus the exchange of ideas among researchers in different parts of the world and also among researchers who emphasize different aspects regarding the basis and applications of the field.

Standing as it does at the cross-roads of Physics, Chemistry, Mechanics, Engineering Design and Materials Sciences, automotive engineering is experiencing considerable growth as a result of recent technological advances. The Romanian Journal of Automotive Engineering, by providing an international medium of communication, is encouraging this growth and is encompassing all aspects of the field from thermal engineering, flow analysis, structural analysis, modal analysis, control, vehicular electronics, mechatronics, electro-mechanical engineering, optimum design methods, ITS, and recycling. Interest extends from the basic science to technology applications with analytical, experimental and numerical studies.

The emphasis is placed on contribution that appears to be of permanent interest to research workers and engineers in the field. If furthering knowledge in the area of principal concern of the Journal, papers of primary interest to the innovative disciplines of „Automotive Technology, Science and Engineering” may be published.
No length limitations for contributions are set, but only concisely written papers are published. Brief articles are considered on the basis of technical merit. Discussions of previously published papers are welcome.

Notes for contributors
Authors should submit an electronic file of their contribution to the ***Production office:*** www. siar.ro. All the papers will be reviewed and assessed by a series of independent referees.

The Journal of the Society of Automotive Engineers of Romania
www.ro-jae.ro www.siar.ro
ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

RoJAE
Romanian
Journal of Automotive Engineering

The Scientific Journal of SIAR
A Short History

The engineering of vehicles represents the engine of the global development of the economy.
SIAR tracks the progress of the automotive engineering in Romania by: the development of automotive engineering, the development of technologies, and road transport services; supporting the work of the haulers, supporting the technical inspection and of the garage; encouraging young people to have a career in the automotive engineering and road haulage; stimulation and coordination of activities that promote an environment that is suitable for continuous education and improving of knowledge of the engineers; active exchange of ideas and experience, in particular for students, master students, PhD students, and young engineers, and dissemination of knowledge in the field of automotive engineering; cooperation with other technical and scientific organizations, employers' and socio-professional associations through organization of joint actions, of mutual interest.
By the accession to FISITA (International Federation of Automotive Engineering Societies) since its establishment, SIAR has been involved in achieving an overall professional community that is homogeneous in competence and performance, interactive, dynamic, and competitive at the same time, oriented towards a balanced and friendly relationship between people and the environment; this action will be constituted as a challenge worthy of effort and recognition.
The insurance of a favorable framework for the initiation and the development of cooperation of the specialists in this field of activity allows for an efficient and easy exchange of information, specific knowledge and experience; it supports the cooperation between universities and between research centers and industry; it speeds up the process of implementing the new technologies, it simplifies the identification of training and specialization needs of the personnel involved in the engineering of motor vehicles, transport, and road safety.
In order to succeed, ever since its founding, SIAR has considered that the stress should be put on the production and distribution, at national and international level, of a publication of scientific quality.

Under these circumstances, the development of the scientific magazine of SIAR had the following evolution:

1. RIA – Revista inginerilor de automobile (in English: ***Journal of Automotive Engineers***)
ISSN 1222 – 5142
Period of publication: 1990 – 2000 Format: print, Romanian
Frequency: Quarterly Electronic publication on: www.ro-jae.ro
Total number of issues: 30 Type: Open Access
The above constitutes series nr. 1 of SIAR scientific magazine.

2. Ingineria automobilului (in English: ***Automotive Engineering***)
ISSN 1842 – 4074
Period of publication: as of 2006 Format: print and online, Romanian
Frequency: Quarterly Electronic publication on: www.ingineria-automobilului.ro
Total number of issues: 61 Type: Open Access
(Including December 2021 issue)
The above constitutes series nr. 2 of SIAR scientific magazine (Romanian version).

3. Ingineria automobilului (in English: ***Automotive Engineering***)
ISSN 2284 – 5690
Period of publication: 2011 – 2014 Format: online, English
Frequency: Quarterly Electronic publication on: www.ingineria-automobilului.ro
Total number of issues: 16 Type: Open Access
(Including December 2014 issue)
The above constitutes series nr. 3 of SIAR scientific magazine (English version).

4. *Romanian Journal of Automotive Engineering*
ISSN 2457 – 5275
Period of publication: from 2015 Format: online, English
Frequency: Quarterly Electronic publication on: www.ro-jae.ro
Total number of issues: 28 (December 2021) Type: Open Access
The above constitutes series nr. 4 of SIAR scientific magazine (English version).

Summary

Total of series:	*4*
Total years of publication:	*27 (11: 1990 – 2000; 16: 2006 – 2021)*
Publication frequency:	*Quarterly*
Total issues published:	*91 (Romanian), out of which, the last 44 were also published in English*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

December 2021
Volume 27
Number 4
4th Series

RoJAE

Romanian Journal of Automotive Engineering

SIAR
The Journal of the Society of Automotive Engineers of Romania
www.siar.ro
www.ro-jae.ro

RoJAE
Romanian
Journal of Automotive Engineering

Societatea Inginerilor de Automobile din România
Society of Automotive Engineers of Romania
www.siar.ro

SIAR – The Society of Automotive Engineers of Romania is the professional organization of automotive engineers, an independent legal entity, non-profit, active member of FISITA (Fédération Internationale des Sociétés d'Ingénieurs des Techniques de l'Automobile - International Federation of Automotive Engineering Societies) and EAEC (European Cooperation Automotive Engineers).

Founded in January 1990 as a professional association, non-governmental, SIAR's main objectives are: development and increase the exchange of professional information, promoting Romanian scientific research results, new technologies specific to automotive industry, international cooperation.

Shortly after its constitution, SIAR was affiliated to FISITA - International Federation of Automotive Engineers and EAEC - European Conference of Automotive Engineers, thus ensuring full involvement in specific activities undertaken globally.

In order to help promoting the science and technology in the automotive industry, SIAR is issuing 4 times a year rIA - Journal of Automotive Engineers (on paper in Romanian and electronically in Romanian and English).

The organization of national and international scientific meetings with a large participation of experts from universities and research institutes and economic environment is an important part of SIAR's. In this direction, SIAR holds an annual scientific event with a wide international participation. The SIAR annual congress is hosted successively by large universities that have ongoing programs of study in automotive engineering.

Developing relationships with the economic environment is a constant concern. The presence in Romania of OEMs and their suppliers enables continuous communication between industry and academia.

A constant priority in SIAR's activity is to ensure optimal framework for collaboration between universities and research, industry and business specialists.

SIAR – Society of Automotive Engineers of Romania is member of:

FISITA - International Federation of Automotive Engineers Societies
www.fisita.com

EAEC - European Automotive Engineers Cooperation

RoJAE
Romanian
Journal of Automotive Engineering

CONTENTS

Volume 27, Issue No. 4 **December 2021**

The RoJAE's articles are included in the *„Ingineria automobilului"* magazine (*ISSN 1842 – 4074*), published by SIAR in Romanian.

The articles published in *„Ingineria automobilului"* magazine are indexed by Web of Science in the „*Emerging Source Citation Index (ESCI)*" Section.

Web of Science

Clarivate Analytics

RoJAE 27(4) 135 – 162 (2021)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

The journals of SIAR are available at the website ***www.ro-jae.ro.***

RoJAE
Romanian Journal of Automotive Engineering

SIAR

The Journal of the Society of Automotive Engineers of Romania
www.ro-jae.ro
www.siar.ro

Production office:
The Society of Automotive Engineers of Romania (Societatea Inginerilor de Automobile din România)
Facultatea de Transporturi, Splaiul Independentei Nr. 313
060042 Bucharest ROMANIA Tel.: +4.0753.081.851 Fax: +4.021.316.96.08 E-mail: siar@siar.ro
Staff: Professor Minu MITREA, General Secretary of SIAR
Subscriptions: Published quarterly. Individual subscription should be ordered to the Production office.
Annual subscription rate can be found at SIAR website ***http://www.siar.ro***

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

DEVELOPING A PNEUMATIC MODEL FOR ACTUATING A TRAP DOOR WHILE OPENING-CLOSING A MILITARY PERSONNEL COMPARTMENT

Daniela VOICU, Radu VILAU, Ramona-Monica STOICA[1], Ion LESPEZEANU

Military Technical Academy „FERDINAND I", Department of Military Automotive and Transportation, Bdul George Coşbuc, Nr. 39-49, 050141 BUCHAREST, Romania

(Received 19 July 2021; Revised 28 September 2021; Accepted 02 October 2021)

Abstract: *Present paper presents the development, in a specialized modelling-simulation software, of a pneumatic model which can be used to actuate the trap door while opening-closing a vehicle compartment for military personnel transportation. While developing the pneumatic model, there will be considered the characteristic parameters of an air compressor (the source of compressed air) which is driven by an internal combustion engine. In addition to the air compressor, there will be used pneumatic directional valves, OR logic valves (for an alternating actuation of the trap door, from both the driving seat and the area for the embarking and disembarking of military personnel), throttle valve to adjust the speed while opening and closing the trap door, a set of pneumatic double check valves to maintain the trap door in a certain position, as well as a double acting cylinder. The pneumatic model developed during the research will constitute the basis for producing an experimental technological demonstrator, as an alternative to hydraulic systems, in order to decrease the number of actuating systems which equips a mobile platform*

Keywords: *Compressed air source, OR logic valve, pressure, pneumatic cylinder*

1. INTRODUCTION

Some military vehicles (Amphibious Armoured Personnel Carrier, wheeled armoured personnel carrier or infantry fighting vehicle) are equipped with a trap door at the back side, allowing a fast embarking and disembarking of troops.
Therefore, the present paper describes a type of model, which can be used to pneumatically actuate the trap door (it is considered a medium or lightweight trap door of 200 kg). În real circumstances, the system has to additionally be equipped with anti-freezing elements, considering that the system works in a temperature range between -32/-25°C and up to 50/60°C.

2. EXPERIMENTAL RESEARCH

In order to simulate the actuation of the trap door which equips a military vehicle, a model was created in a specialized software, named FluidSim [5]. The pneumatic model is presented in figure 1 and it comprises of [1][2][3][4]:

- compressed air source (air compressor), represented by the vehicle's compressor, actuated by the internal combustion engine;
- air preparation unit, consisting of a manual air purge filter, a pressure regulator and a pressure gauge;
- compressed air tank (normally, the working pressure is between 7 – 7.5 bar);
- directional valves:
    - 1.1 and 3.1 as 3/2 way valves, which are actuated by a lever and they return to their default position by a spring force (they return to their default position during power loss);
    - 2.2 and 2.3 as 3/2 way valves, which are actuated by a push button and they return to their default position by a spring force (they do not retain position during power loss);
    - 2.1 as 3/2 way valve which are actuated by a lever and they return to their default position by a spring force (they retain position when not actuated);
- OR logic valves, 1.2 and 2.5 respectively, for an alternating actuation of the trap door, from both the driving seat and the personnel area;

[1]*Corresponding author e-mail: ramona.stoica@mta.ro*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

- throttle valve 2.7 for speed adjustment (upper limitation of speed) in case of opening the trap door;
- a set of pneumatic double check valves, 1.4 and 2.9, to maintain the trap door in a certain position;
- pneumatic motors (double acting cylinders), 1.0 and 2.0.

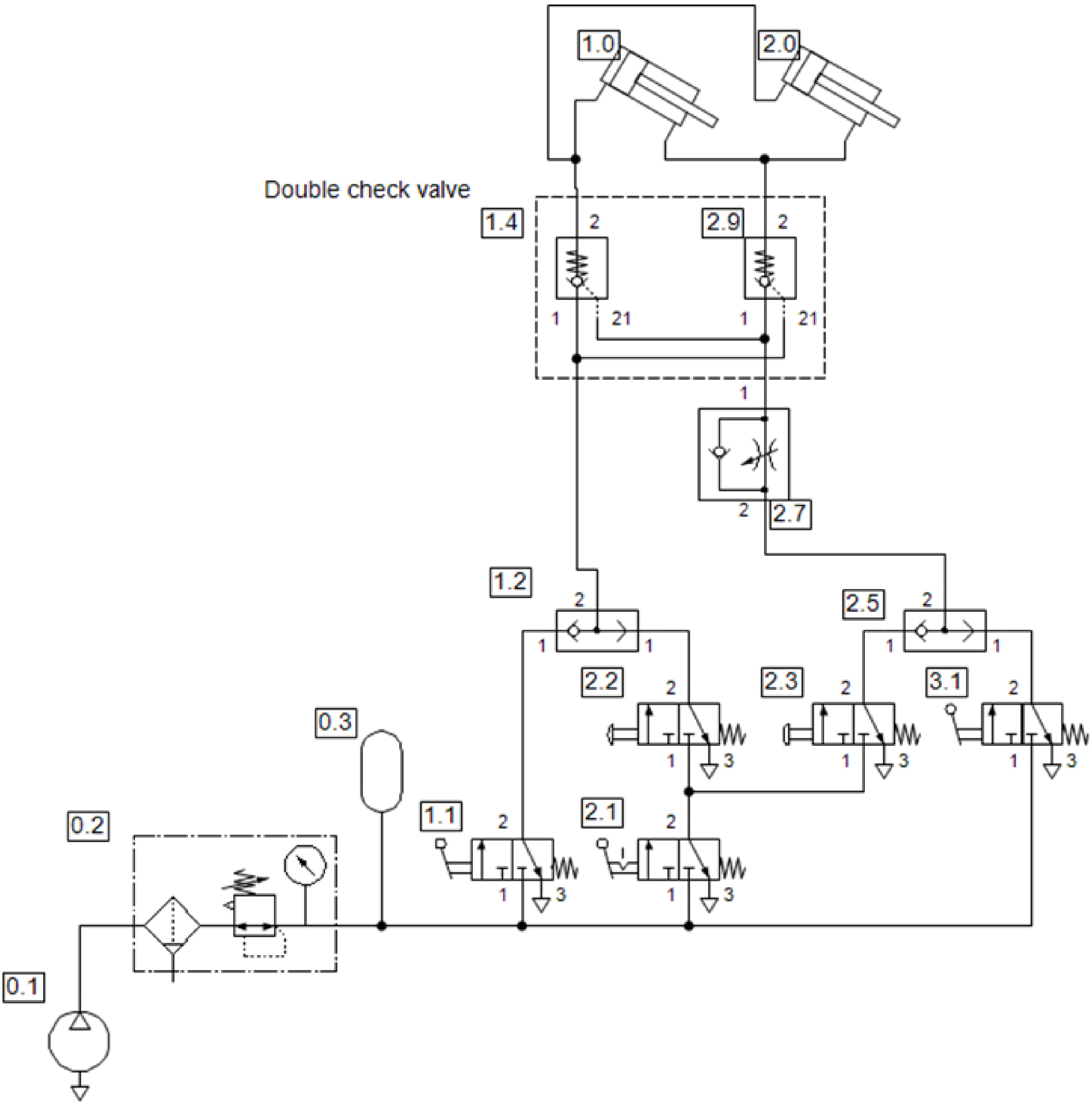


Figure 1. Constituents of the pneumatic model

Establishing values of working parameters:
- the working pressure for the air compressor: 7.5 bar, similar to the vehicle characteristic values;
- the air tank was set to 10 liters capacity;
- the double acting cylinders are mounted in floating position (initial mounting angle was 330 degrees) with specific parameters set as depicted in figure 3 [5].

<u>Working principle:</u> when the internal combustion engines starts, the air compressor 0.1 is actuated and compressed air is sent through the air preparation unit 0.2 (at this point, the air is filtered, the condensation water and oil particles from the compressor are separated and the pressure is adjusted according to the values of the pressure regulator valve) [4].

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

Pos. No.	Identification	Target ID to	Description
1	3.1	Directional valve to close the trap door (driver side)	3/n - Way Directional Valve
2	2.9	Double check valve to control the closing traveled distance	Double check valve
3	2.7	Throttle check valve to suppress the opening	Throttle check valve
4	2.5	OR logic valve to actuate the alternative closing	OR logic valve
5	2.3	Directional valve to close the trap door (personnel compartment)	3/n - Way Directional Valve
6	2.2	Directional valve to open the trap door (personnel compartment)	3/n - Way Directional Valve
7	2.1	Directional valve to block the actuation of the trap door (driver side)	3/n - Way Directional Valve
8	2.0	Double acting cylinder	Double acting cylinder
9	1.4	Double check valve to control the opening traveled distance	Double check valve
10	1.2	OR logic valve for alternative open	OR logic valve
11	1.1	Directional valve to open the trap door	3/n - Way Directional Valve
12	1.0		Double acting cylinder
13	0.3	Vehicle tank	Compressed air tank
14	0.2		Air preparation unit
15	0.1	Actuated by the termal engine	Compressor

Figure 2. Description of constituents for the pneumatic model

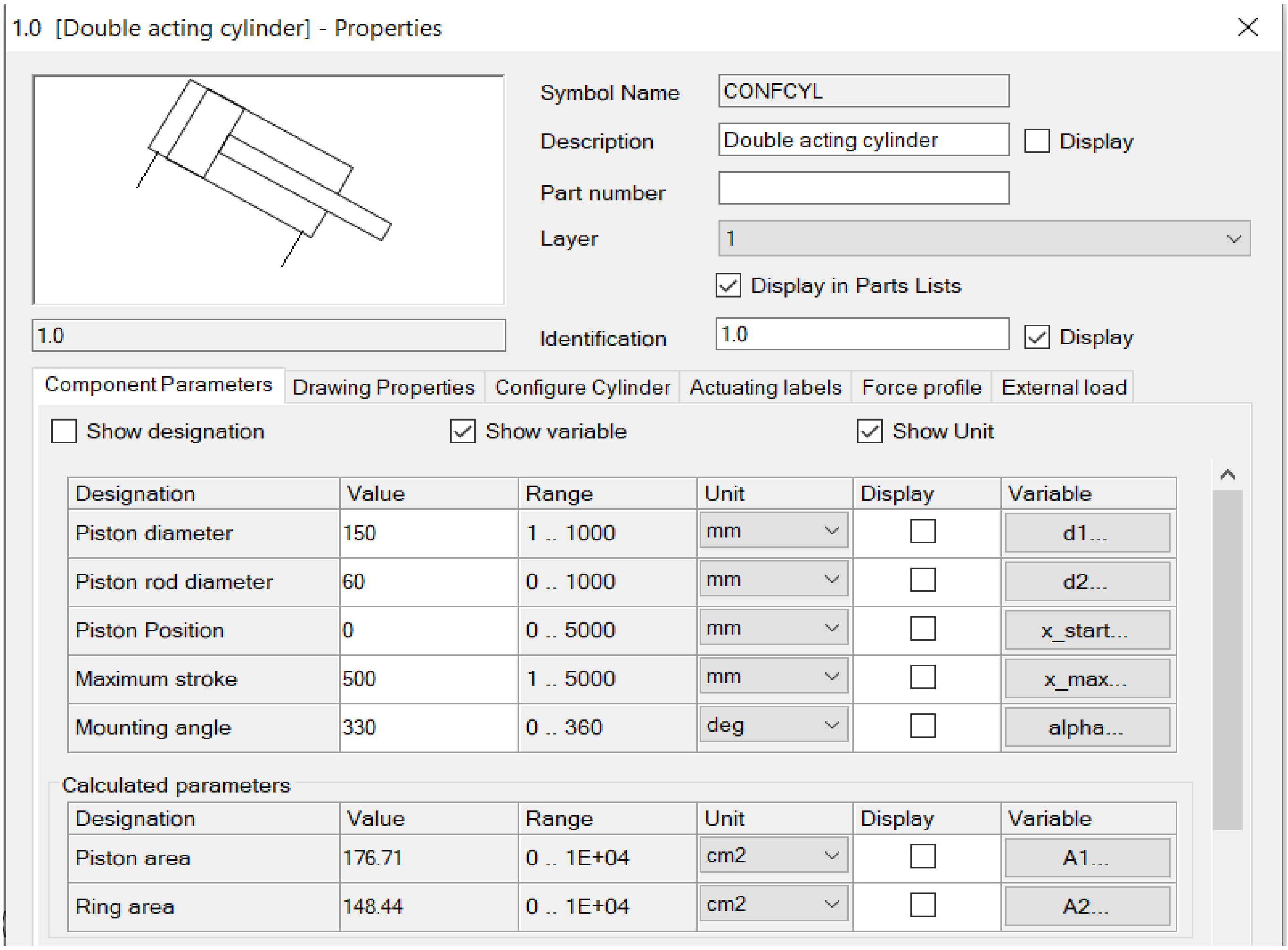


Figure 3. Set-up of working parameters

Then, the air is sent to the air reservoir 0.3 (to whom it was set a volume of 10 liters), so that the 1.1, 2.1 and 3.1 valves get to be supplied with compressed air (the flow of air is coloured in dark blue on the model from figure 4). The circuit coloured in dark blue is characteristic to the compressed air circuit, when the pneumatic directional valves are not actuated. In this situation, tank 0.3 contains compressed air. The pneumatic circuit sent to the atmosphere is coloured in blue, and the compressed air circuit, after a partial actuation, is coloured in pink (in this situation, the pressure has low values and the outtake circuit is blocked by the double check valves).

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

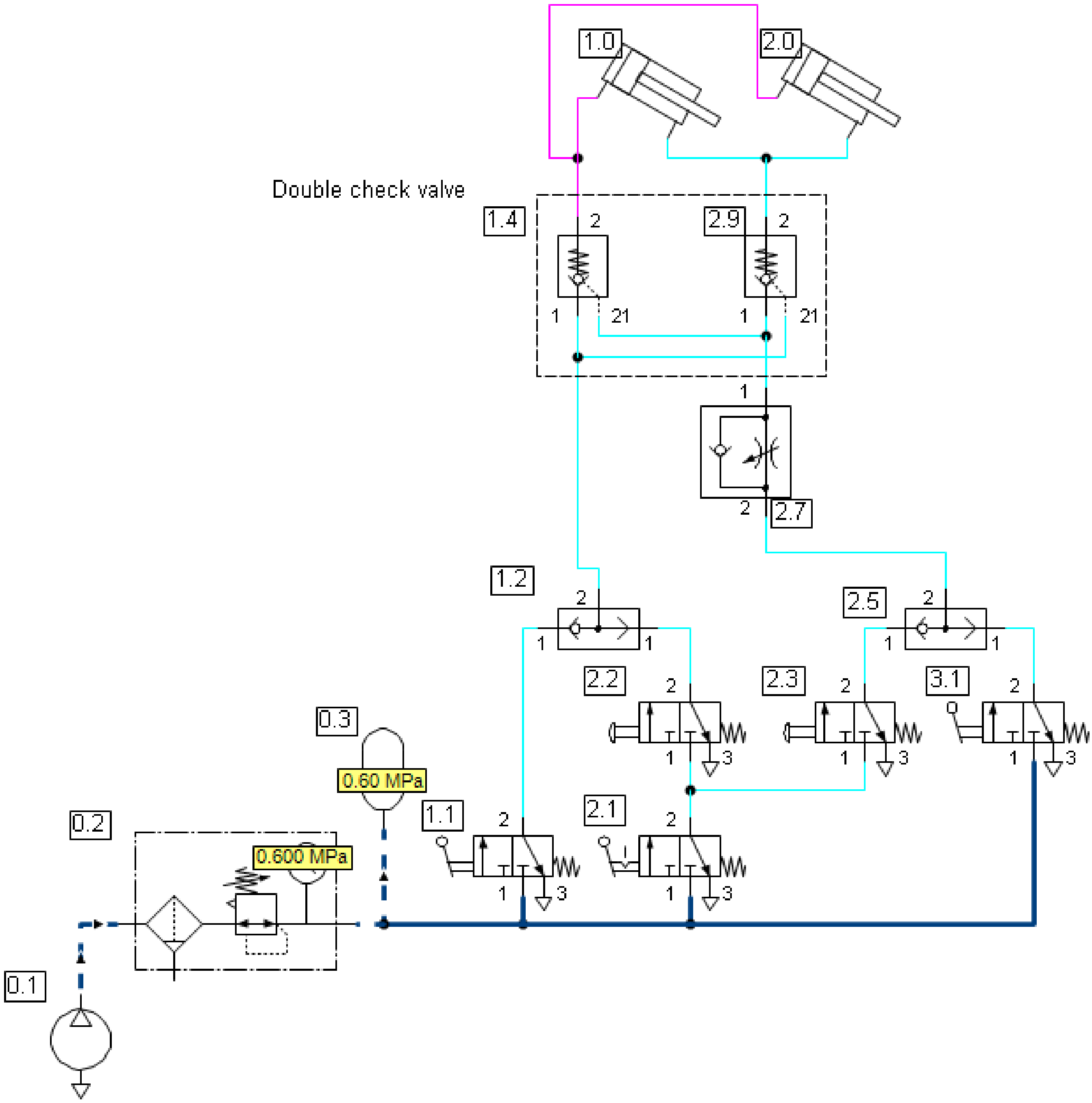


Figure 4. The flow of air when actuating the model

To close and open the trap door, it can actuate either the 1.1 directional valve from the driver or the 2.2 directional valve from the military personnel compartment, by actuating the 1.2 OR logic valve. The military personnel can operate the trap door, whether to open or close it, by actuating the 2.1 directional valve (which unlocks the control from the military personnel compartment).

This control is necessary in case of breakdown (technical failure of the pneumatic system, when the situation is not critical), so that the driver will have an extra pneumatic energy for critical actuations such as pneumatic start of engine, emergency braking etc.

The air supplied by valve 1.2 goes through the double check valve and supplies 1.0 and 2.0 motors, resulting in an increase of traveled distance (the trap door closes). The movement of the trap door is possible because the 2.9 check valve is actuated by the pressure within the 1.4 valve circuit. The set of double check valves (1.4 and 2.9) is used to prevent the trap door from closing or opening due to air losses which can occur around the sealing elements. This solution is used when the load (trap door weight) becomes an active force.

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

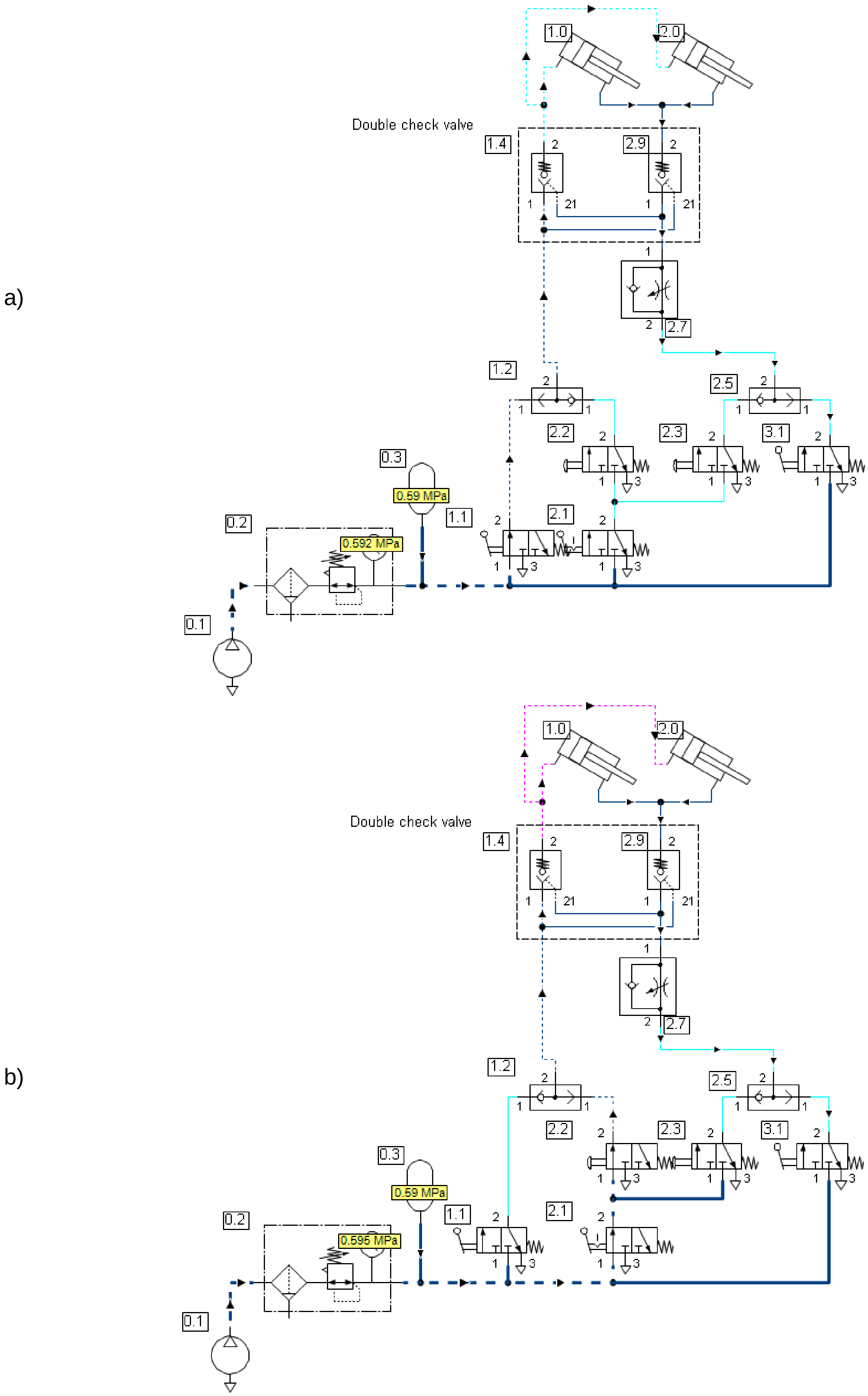


Figure 5. Functional diagrams used to represent the actuation from the driver seat (a) and the military personnel compartment (b)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

As long as there is no pressure downstream the 1.4 check valve, the 2.9 valve is blocked, avoiding an accidental descending of the trap door (hence, the use of mechanical blocking systems is avoided).
Because the trap door, while descending, can cause shocks at the end of stroke, there are used throttle valves like the one numbered 2.7, which will ensure the necessary braking.
The throttle valve parameters are depicted in figure 6.

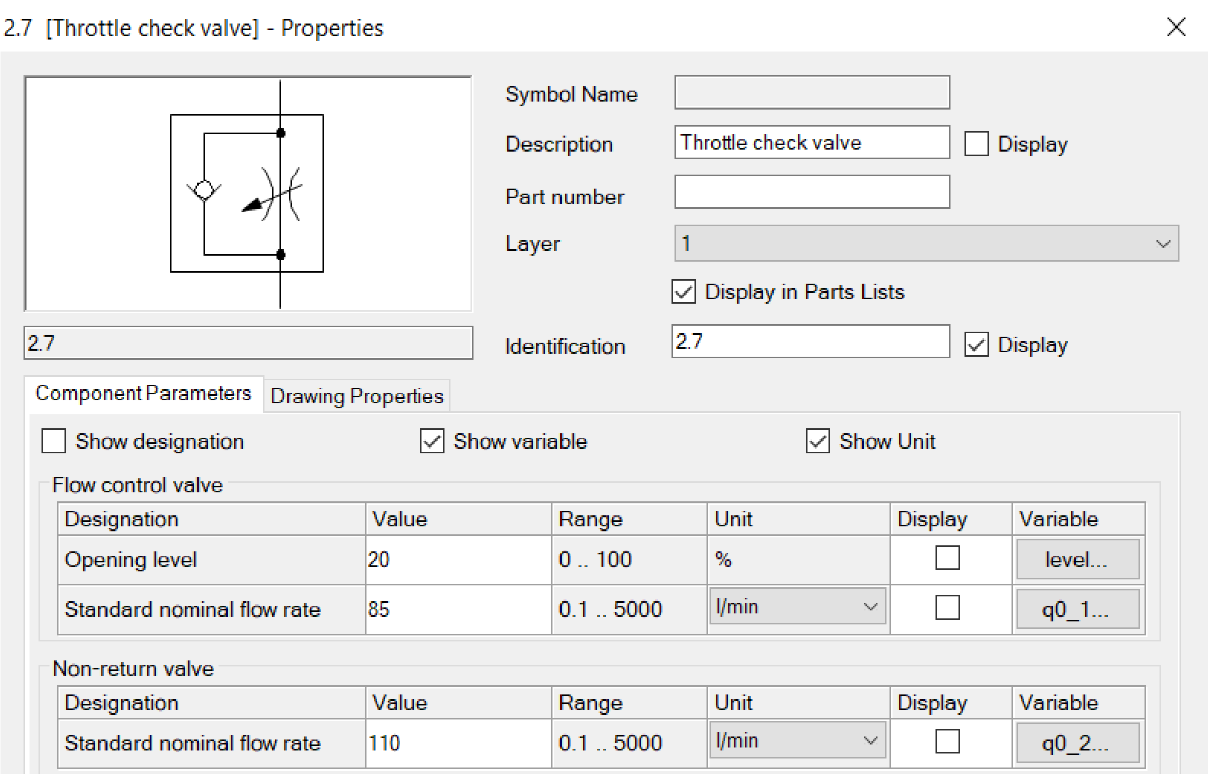
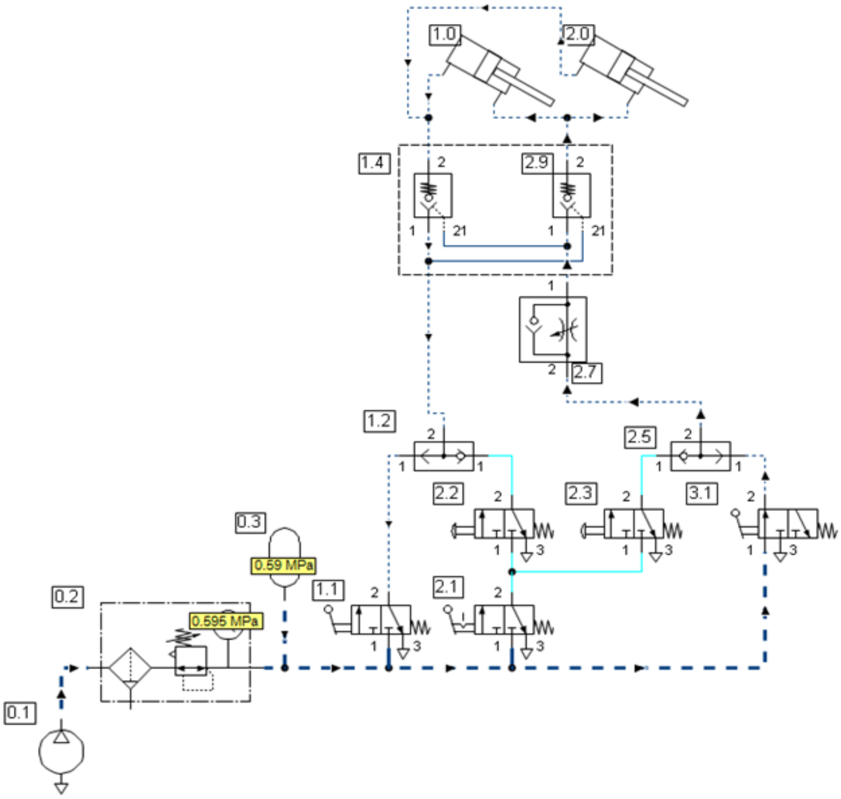


Figure 6. Throttle valve parameters

a)



ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

b)

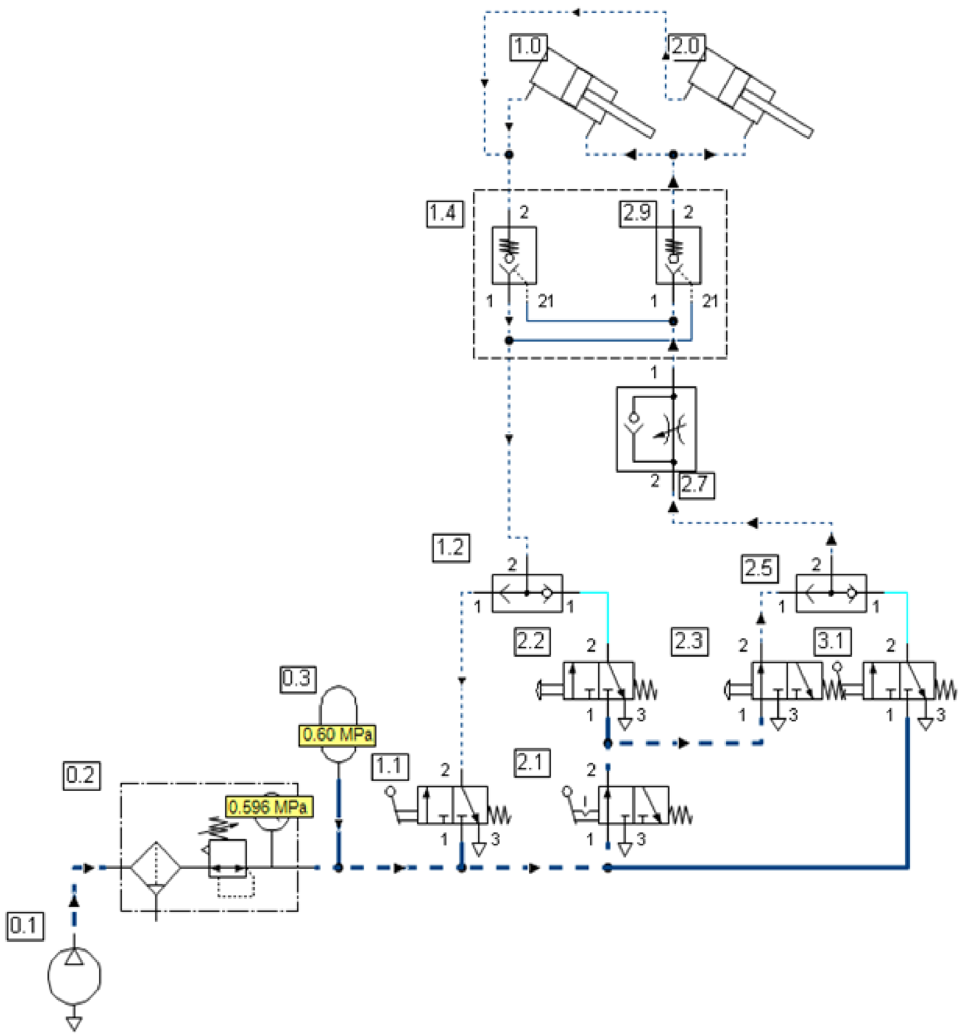


Figure 7. Functional diagrams for opening the trap door from the driver seat (a) and the military personnel compartment (b)

The compressed air is evacuated from the throttle valve by means of the 2.5 OR logic valve and the 2.3 and 3.1 directional valves, respectively. Hence, the air is sent to the atmosphere.
To open the trap door, one can actuate either the 3.1 directional valve (by the driver), or the 2.3 directional valve (from the military personnel compartment). To this end, the 2.1 directional valve unblocks the command from the driver.
Follow-up, the compressed air passes through the 2.5 OR logic valve, the 2.7 throttle air bypass valve, the 2.9 check valve and actuates motors 1.0 and 2.0, which execute the withdrawal stroke. The outtake of air towards the atmosphere, from the two pneumatic cylinders, is executed through the 1.4 check valve, which is actuated by the pressure within the fuel line for the 2.9 check valve, following the 1.2 OR logic valve and the 1.1 or 2.2 directional valve (figure 7).
The opening and closing process of the trap door allows intermediate positions.

5. CONCLUSION

In case of personnel carrier vehicles, the safe and quick embarking and disembarking of military personnel is performed through the trap doors placed at the rear part of the vehicle. Many of the systems that equips such vehicles, are hydraulically or pneumatically actuated. The hydraulic ones are used in case force is needed, such as most actuation at the front part of the vehicle (breakwater plate, full power steering, hydraulic circuit of the braking system, coupling/decoupling of gears).

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

Such a design solution can be complicated.
As a result, the solution detailed within the present paper is more flexible, easier to configure with pneumatic hoses, and less emission pollutant than the hydraulic one.
On the other hand, there are also other pneumatic consumers, on both lateral sides and at the rear part of the chassis.
Also, the simulation set-up can be implemented on an experimental technological demonstrator.

ACKNOWLEDGEMENT

This work is supported by the project ANTREPRENORDOC, in the framework of Human Resources Development Operational Programme 2014-2020, financed from the European Social Fund under the contract number 36355/23.05.2019 HRD OP /380/6/13 – SMIS Code: 123847.

REFERENCES

[1] Costache, Dragos, *Transmisii hidraulice pentru autovehicule*, Editura Academiei Tehnice Militare, 2002, Bucuresti
[2] Costache, Dragos, *Acționări hidraulice și pneumatice la autovehicule*, Editura Academia Militară, 1985, Bucuresti
[3] Voicu, Daniela, Vilău, Radu, Stoica, Ramona-Monica, *Experimental plotting of static characteristics of rotary hydraulic pumps*, The 16th edition of the international conference-European integration realities and perspectives. Proceedings, 2021, pg. 371-378, ISSN: 2067 - 9211
[4] Vilău, Radu, *Acționări hidraulice și pneumatice. Suport de curs, 2014*
[5] FluidSim 5 software documentation

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

DESIGNING AND TESTING CRASH TEST SLED RIG USING CAD SOFTWARE

Alexandru-Ionuț RADU*, Bogdan-Ioan NIȚULEASA

Transilvania University of Brașov, Automotive and Transport Department,
Str. Politehnicii Nr. 1, 500024 BRASOV, Romania

(Received 11 August 2021; Revised 28 October 2021; Accepted 02 November 2021)

Abstract: *This paper presents the 3d model of a crash test rig designed using CAD software and tested using a kinematic simulation to obtain results regarding the performance of the rig. The rig consists of a vehicle cockpit mounted on a carriage that rolls on a curved sled. At the end of the sled are two rubber bushings to stop the carriage and simulate a crash test. The crash test rig relies on an inclined sled and the velocity is obtained through the gravitational acceleration. Also, the stopping deceleration of the sled was obtained from the simulation. Simulation results show that the cockpit can reach a velocity of about 14 km/h and can generate a deceleration on impact of 33 g's or 330 m/s^2 with a kinetic energy of 1400 joules.*

Keywords: *Crash test, CAD model, CAD, Simulation, Sled, Kinematic simulation, 3D model*

NOMENCLATURE

m: carriage assembly mass, kg
g: gravitational acceleration, m/s^2
G: gravity, N
a: sled angle, degrees
F_n: impact force, N
k: stiffness, N/m
c_{max}: maximum damping, N/(m/s)
d_{max}: penetration value, m
g_p: penetration of one body into another, m
dg_p/dt: penetration velocity at point of contact, m/s

1. INTRODUCTION

Since the development of automotive industry, there was a need for crash testing [1]. Crash tests are used to improve vehicle safety and it is performed in a controlled environment, inside a building or in a field [2]. In a building, crash tests are performed using special rigs designed to simulate real accidents [3]. Nowadays, we can design virtual models using various CAD software to create prototypes that can be analyzed in a virtual environment to assure a correct functionality before constructing it in reality [4]. SolidWorks has a function that allows of dynamic simulations of models based on input parameters and that it can output results.

The CAD model could be simulated using ADAMS. This is a multibody numerical simulation software that uses elastic or rigid bodies connected together with kinematic joints or elastic connections such as springs. The most important parameter of this software is the solver that is a mathematical model that takes the input parameters and calculates the output parameters based on constraints and material contacts [5][6][7].

A crash test rig used for the impact of a human head with a plate at various angles was designed and simulated using this software [8]. Using the mentioned software, we designed a crash test rig that simulates a frontal collision between a vehicle and a solid object.

The model was created in the CAD software and dynamically simulated using ADAMS.

* *Corresponding author e-mail:* alexandru.radu@unitbv.ro

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

2. CAD DESIGN

The rig was design in a CAD environment using part modeling.
The design of the rig is based on the force of gravity acting upon a mass that slides on two rails.
In figure 1 the basic principle of the rig is presented.

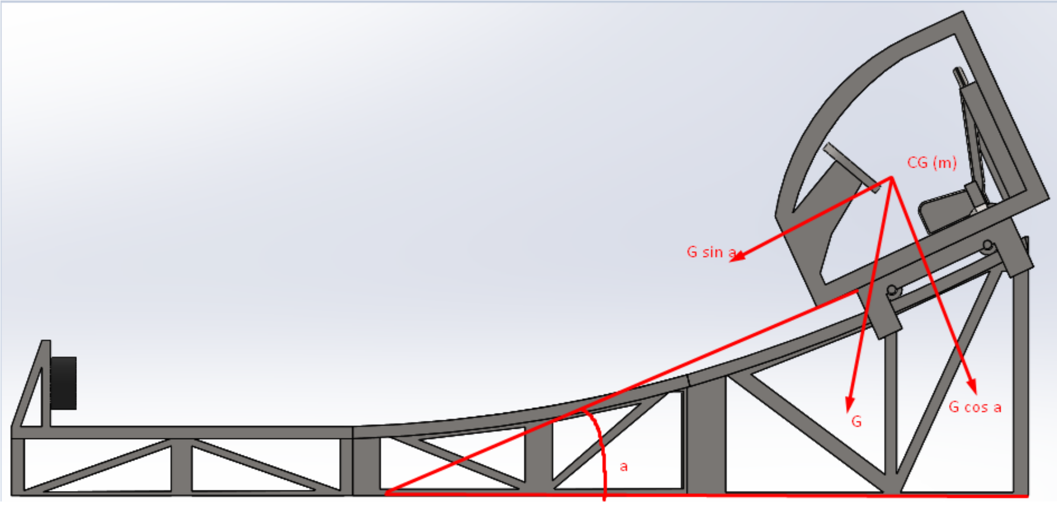


Figure 1. Rig principle

The vehicle compartment is mounted on a rolling sled, at an angle (*a*) to give it enough inertia. This uses the force of gravity (*G*) that relies on the gravitational acceleration (*g*) and the mass of the carriage assembly (*m*). Because it is at an angle, the force of gravity is divided along 2 axes (we have *G sin a* along the horizontal axis of the sled and *G cos a* along the normal axis of the sled).

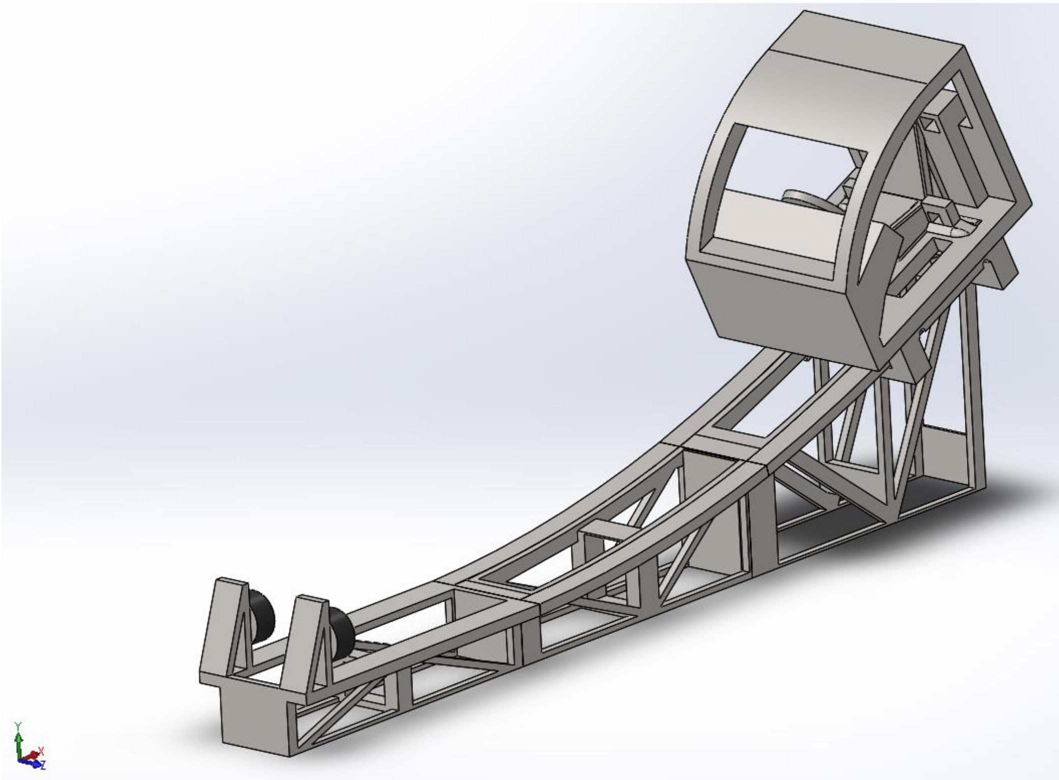


Figure 2. Rig design

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

At the end of the sled, there are two rubber stoppers mounted on a rigid frame to stop the moving sled thus granting a deceleration similar to that of a vehicle crash.
The assembly of the rig had several components.
The rigid frame is made up of 3 parts, the carriage is 1 part where the 4 rollers are mounted, and the cockpit is one single part.
It was designing this way to simplify the dynamic simulation of the moving carriage assembly.
The exploded view of the rig is presented in figure 3.

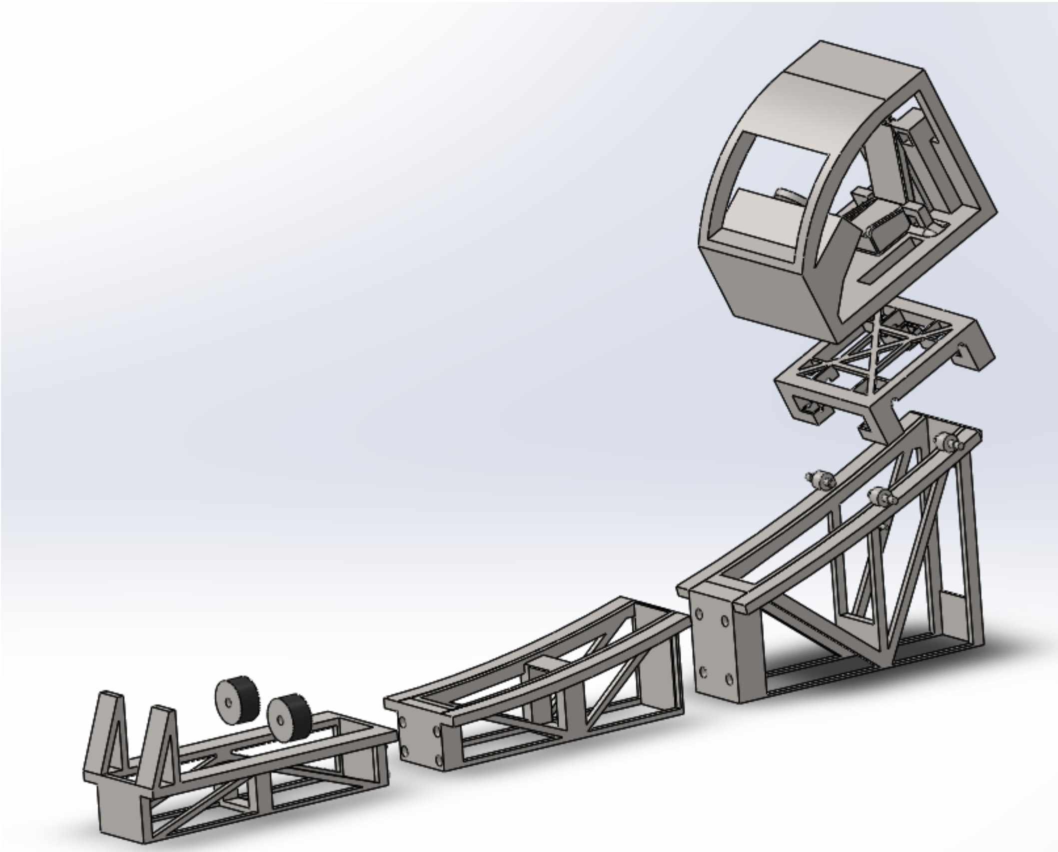


Figure 3. Exploded view of rig components

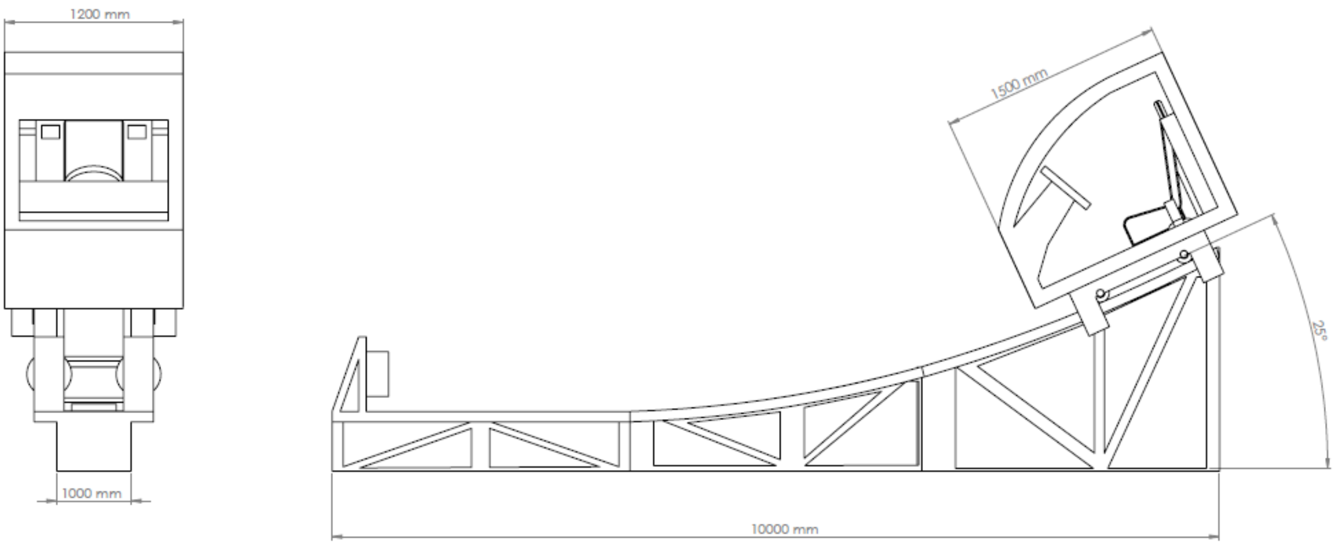


Figure 4. Rig primary dimensions

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

The main dimensions of the rig are presented in figure 4.
The length of the sled is 10 meters with an inclined slope angle of 25 degrees.
The width is 1 meter. Cockpit dimensions are similar to those of a passenger vehicle.
To simulate the dynamic properties of the assembly, input parameters for the mass and contact between bodies were established.
The mass parameters for the simulation are presented in table 1.

Table 1.
Model mass parameters

Part	Mass	Units
Sled assembly	650	kg
Cockpit	250	Kg
Carriage	70	kg
Rollers	5	kg

There are contacts between the parts of the assembly that will ensure a correct modelling of the dynamic behaviour of the sled. These parameters are presented in table 2.

Table 2.
Model contact parameters

Body contact part	Type of material	Stiffness value [N/m]	Max damping [N/(m/s)]
Cockpit - Stoppers	Steel - Rubber	600000	40000
Rollers - Sled	Steel - Steel	100000	50000
Rollers - Carriage	Steel - Steel	100000	50000

The material stiffness values are preconfigured in the simulation software based on the type of material used. The preferred material for the assembly was steel and only the stopper is from rubber.
To calculate the impact between two bodies, the software relies on the following formula:

$$F_n = k \cdot g_p{}^e + Step(g_p, 0, 0, d_{max}, c_{max}) \cdot \frac{dg_p}{dt} \qquad (1)$$

Where F_n is the impact force, g_p is the penetration geometry into another body, c_{max} is the maximum damping, d_{max} is the penetration value, *k* si the stiffness and dg_p/dt is the penetration velocity at the point of contact.

3. DYNAMIC SIMULATION AND RESULTS

Dynamic simulation of the assembly can be utilized to evaluate the physical response of the model in regard to the real-world situations.
The simulations of the sled were possible by using the motion analysis model in the CAD application.
In figure 5 the simulation si presented in 3-time intervals, at 0 ms, 100 ms and 210 ms.
These intervals represent the simulation stages of the model.
At time 0 is the start of the simulation, 100 ms is the middle and at 210 ms we have the impact between the sled and stoppers.
The output results of the model are presented as diagrams of key parameters in regard to the simulation time. The first result is the sled velocity, and it is presented in figure 6.

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

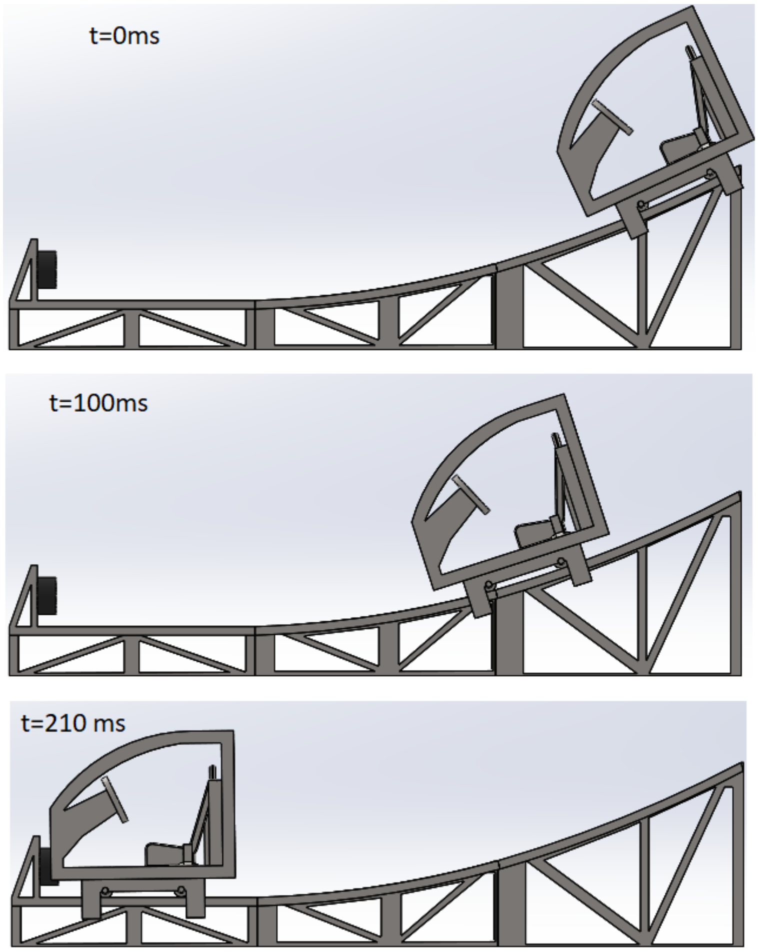


Figure 5. Simulation results

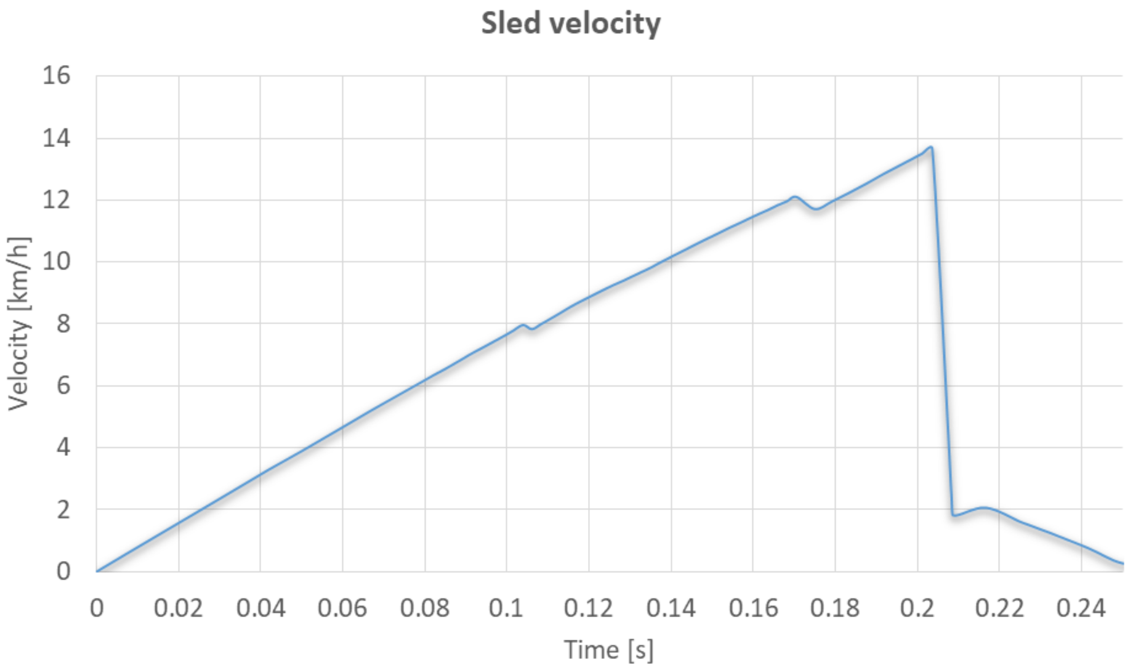


Figure 6. Sled velocity

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

The maximum velocity obtain prior to collision was 13.9 km/h.
The steps observed at 110 ms and 170 ms were caused by the contact joint of the rollers with the sled. Another result of interest was the sled deceleration that is presented in figure 7.

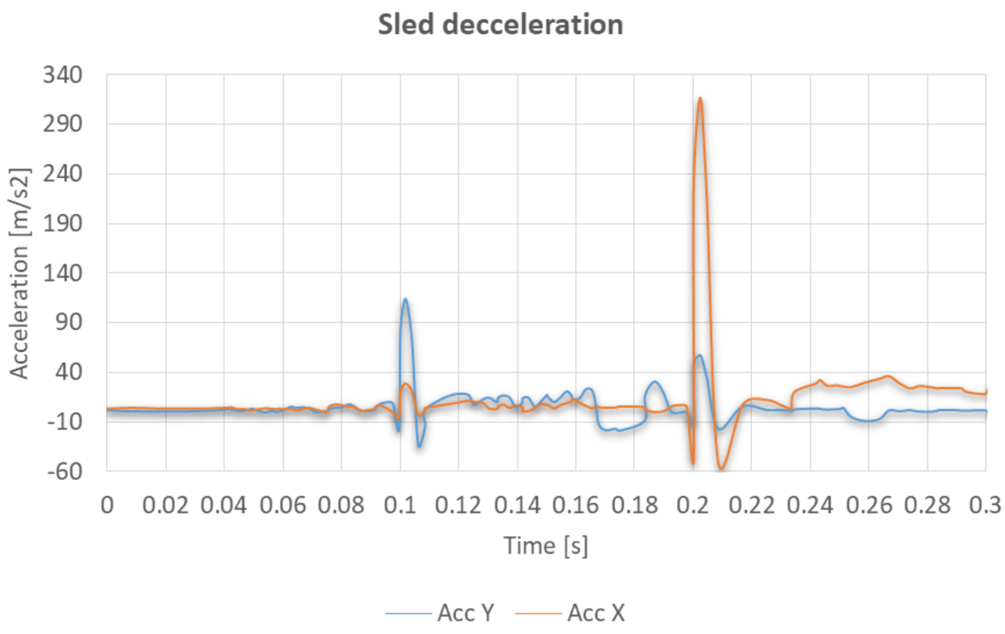


Figure 7. Sled deceleration

I can be observed that the maximum deceleration at impact was 310 m/s^2 on the X axis. We can also note the 110 ms deceleration peak on Y axis of 100 m/s^2 caused by the contact model of the rollers with the sled. Due to the way the motion analysis works, we can negate this peak.
We can also observe the kinetic energy of the sled in figure 8.

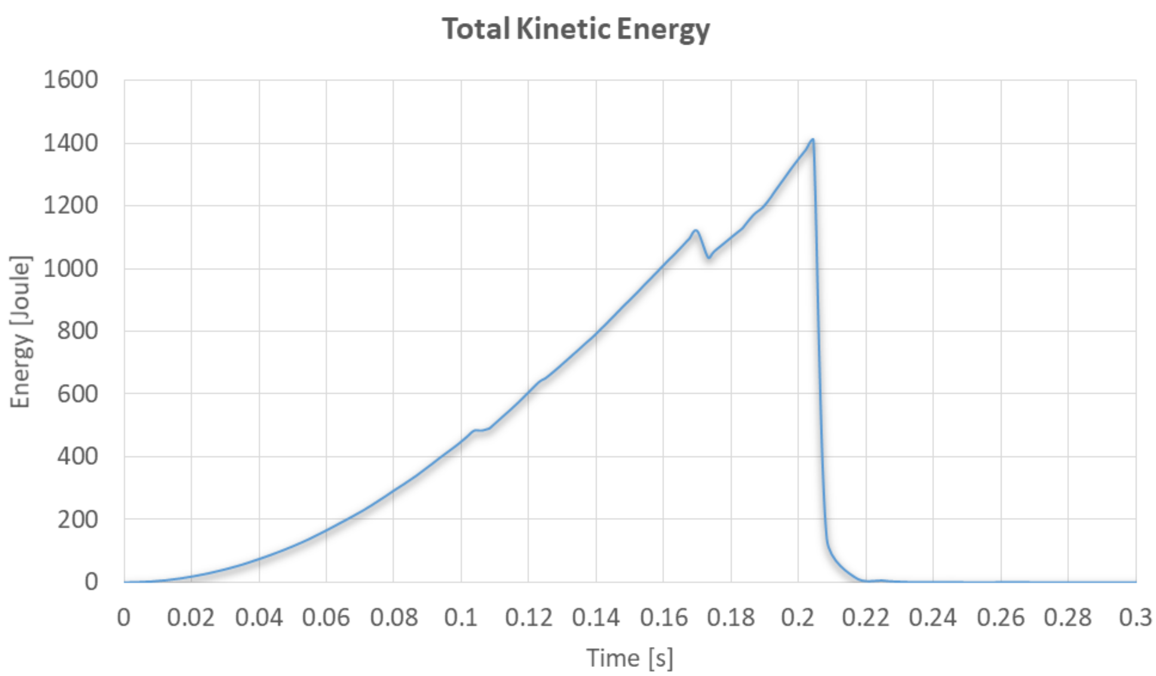


Figure 8. Sled kinetic energy

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

During the simulation, a maximum value of 1400 joules was obtained for the maximum kinetic energy of the assembly. The last result is the potential energy delta variation, presented in figure 9.

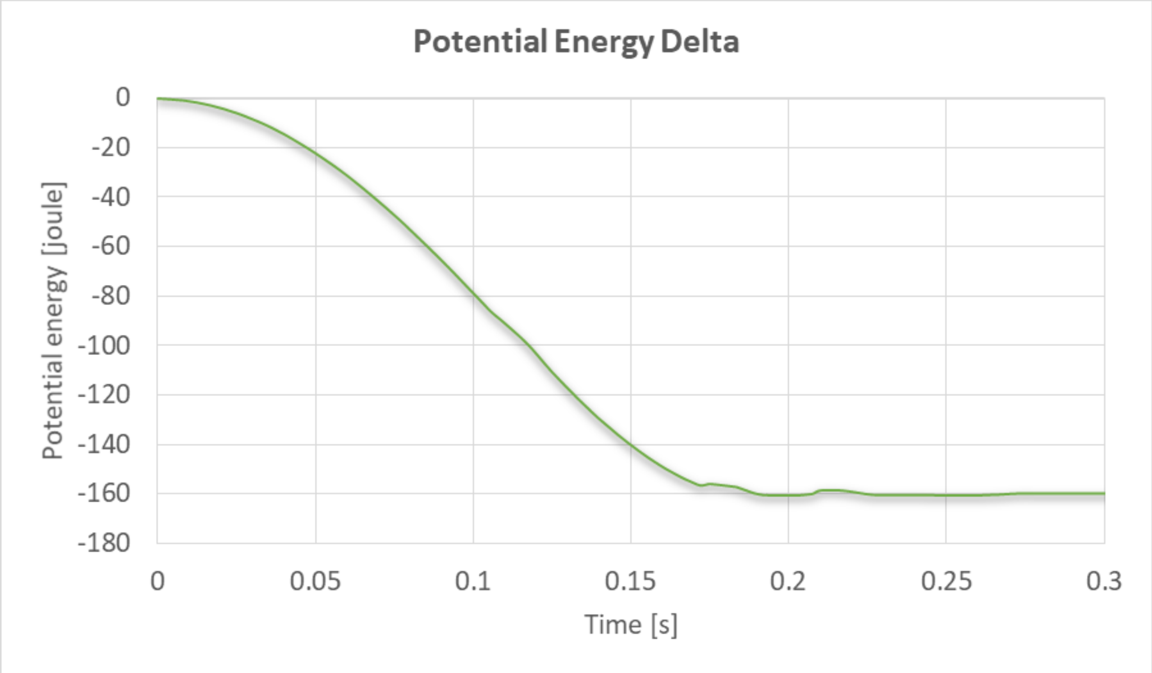


Figure 9. Sled potential energy delta

The maximum variation of the potential energy was 160 joules between the start of the simulation and the final position. This difference is the result of the displacement of the sled with cockpit from the starting position to the final position.

5. CONCLUSION

We can conclude that the designed model of a crash test rig is functional, and the simulation results show that if the model was built, it could have good performance when using it to simulate vehicle crashes. Even thou the maximum velocity obtained from the simulation was only 13.9 km/h, and it can be stated that this velocity is low, the sled can be used to study vehicle low velocity crashes with passengers inside the cockpit. Due to the non-deformable nature of the model, the maximum deceleration of the sled was a bit high with 310 m/s^2.

REFERENCES

[1] Tolea, B., Trusca, D., Antonya, C. and Beles, H *The influence of the frontal profile design of a vehicle upon the pedestrian safety at low velocity*, 26th Annals of DAAAM and Proceedings, 2015
[2] Shaw, G., Crandall, J. and Butcher, J. 2000 September. Biofidelity evaluation of the THOR advanced frontal crash test dummy. In IRCOBI Conference on the Biomechanics of Impact.
[3] Bliven, E., Rouhier, A., Tsai, S., Willinger, R., Bourdet, N., Deck, C., Madey, S.M. and Bottlang, M. 2019 Evaluation of a novel bicycle helmet concept in oblique impact testing. Accident Analysis & Prevention, 124, pp.58-65.
[4] Kurowski, P. *Engineering Analysis with SolidWorks Simulation 2013*, SDC publications, 2013
[5] Kurowski, P.M. *Engineering analysis with solidworks simulation*, Mission: SDC Publications, 2015
[6] Ryan, R.R. *ADAMS—Multibody system analysis software*, In Multibody systems handbook, Springer, Berlin, Heidelberg, pag. 361-402, 1990
[7] Bowling, M. and Veloso, M. *An analysis of stochastic game theory for multiagent reinforcement learning*, (No. CMU-CS-00-165), Carnegie-Mellon Univ Pittsburgh Pa School of Computer Science, 2000

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

[8] Radu, A. I., D. D. Trusca, G. R. Toganel, and B. C. Benea *Designing and testing a stand used to simulate the dummy head impact with different surfaces using CAD software*, In IOP Conference Series: Materials Science and Engineering, vol. 997, no. 1, pag. 012058, IOP Publishing, 2020

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

STUDY ON THE CONSEQUENCES OF THE IMPACT OF THE WHEEL OF THE VEHICLE WITH A FIXED OBSTACLE

Paul Mihai VRABIE*, Claudiu NEDELESCU, Ionuț - Alexandru RADU, Daniel -Dragoș TRUȘCĂ

Transilvania University of Brașov, Automotive and Transport Department,
Str. Politehnicii Nr. 1, 500024 BRASOV, Romania

(Received 11 August 2021; Revised 28 October 2021; Accepted 02 November 2021)

Abstract: *The paper presents the case study of the interaction between the tyre and the bumps in the tread, addressing the issue of parameters that influence the appearance of tyre depressurization. The main cause of road accidents caused by rolling system failures is related to the structural failure of the tyres, which is largely related to both their maintenance and their interaction with the imperfections of the tyres. The main objectives were to determine the influence of velocity in direct connection with the degree of deformation of the tyre in a scenario in which the depth of the unevenness varies from 50 to 100 mm. The results of the analysis showed that, even at a relatively low speed of the vehicle, structural damage to the vehicle wheel can occur.*

Keywords: *Tyre, fixed obstacle, tyre deformation, tyre analysis, road accidents*

NOMENCLATURE

dz = obstacle depth
Va = vehicle velocity
Vr = wheel velocity
Acc a = vehicle acceleration
Acc r = wheel acceleration
def rp = tire and rim deformation
tire acc def = wheel deformation acceleration

1. INTRODUCTION

According to statistics, the car remains the most unsafe means of transport, due to the number of road accident victims being among the most common causes of death in the world [3][9].
A study based on data from the Deutscher Verkehrssicherheitsrat e.V. ("DVR") "Gesellschaft für Technische Überwachung mbH" (GTÜ), in 2000, on inspections carried out on the tyres of more than 2 million vehicles, it was found that approximately 11% of all inspected tires were defective, the main causes being very worn tires, well below the allowable threshold and very aged tyres [1][9].
In addition, experts found that 25% of the tires checked did not have the inflation pressure according to the provisions recommended by the manufacturers, and for another 7%, the tire size did not match according to the licenses approved for vehicle functionality [2][4].
The effect that can be considered the most common cause of an accident is the structural damage of a tyre, normally resulting in the driver's loss of control over the vehicle [3][7].
In addition to the statistical figures on accidents caused by structurally damaged tires, there are a number of unknown cases of road users indirectly affected by such incidents [6].
A depressurized tire can be considered a deliberate or negligent abuse and a proper failure of maintenance by the driver, which is considered a major reason for damage to the structure of the tire [5][8].

* *Corresponding author e-mail: paul.vrabie@unitbv.ro*

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

2. OBJECTIVES

The objectives of the paper focus on determining the influence of the geometric parameters of the slope and the dynamic parameters of the vehicle on the deformations of the tire and the rim.
The main objective of this experimental work is to dispose of the damage suffered by the vehicle when the wheel passes through a pothole. The main objectives are: Carrying out a set of vehicle-obstacle wheel type impacts; Determining the velocities; Determining the accelerations; Determining the velocities of the vehicle's wheel depending on the size and depth of the obstacle after analyzing the data obtained from the GPS receiver and the video samples; Recording the acceleration parameters when passing through potholes at different velocities using the Pic Daq DSD device.

3. METHODOLOGY

The methodology used for this work consists in simulating the impact of the vehicle's wheel with a difference in level at different velocities. There were two occupants in the car in the front seat, one being responsible for driving the vehicle and one for direct monitoring of data acquisitions.
In order to carry out the experimental tests, a vehicle from the passenger hatchback range equipped with tires of size 145/80 / R13 was used, which ran with a velocity regime between 25-26km / h, when passing through a negative unevenness with H = 100mm, L = 1000mm and l = 400mm respectively H = 50mm, L = 1000mm and l = 400mm

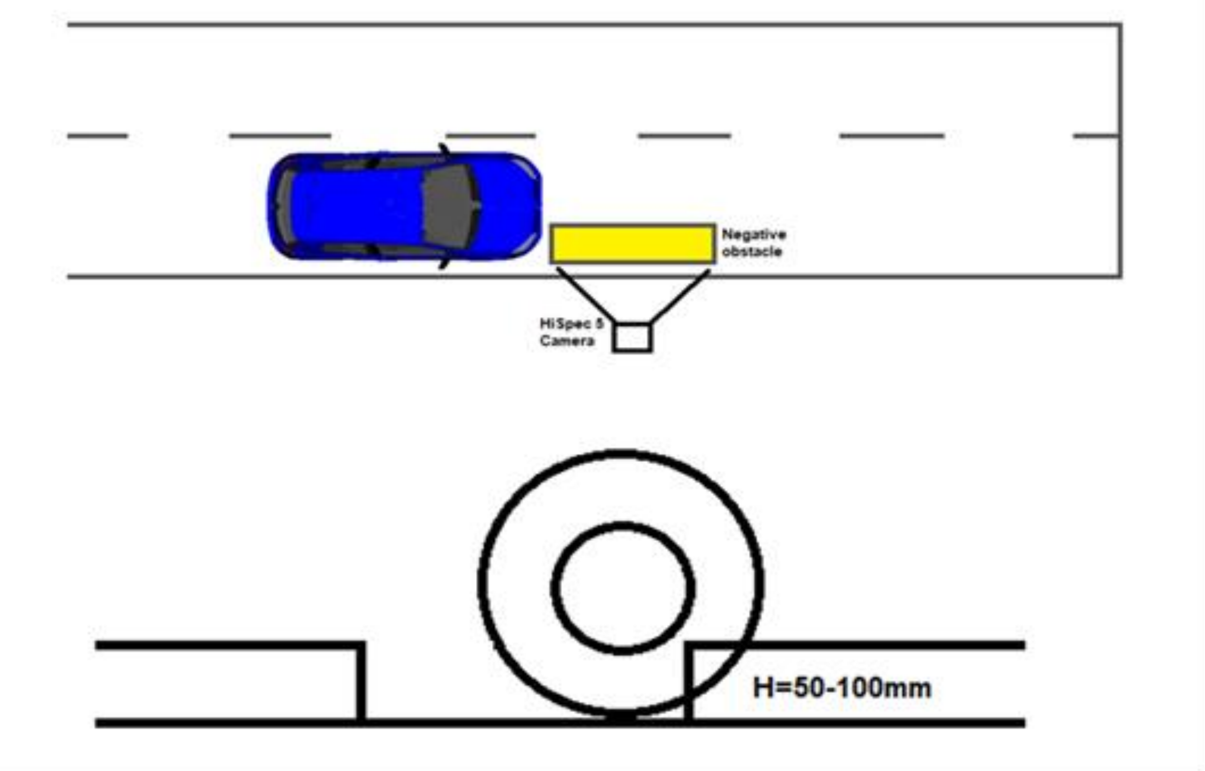


Figure 1 Test methodology and wheel position relative to the negative obstacle.

Figure 2 Marking and sizing the obstacle

The following devices were used for the experimental measurements:

- An acceleration recording device: PIC DAQ DSD;
- A GPS device DS-5 18x-5Hz.

4. RESULTS

From the results obtained after several experimental tests we compared two of them, the first test performed at a velocity of 25.5 km/h with an obstacle depth of 50mm, the second test performed at a velocity of 26 km/h with a 100mm obstacle depth.
The data presented below are from the analyses of test number 2.

Figure 3 Pictures obtained from the video analysis of test number 2

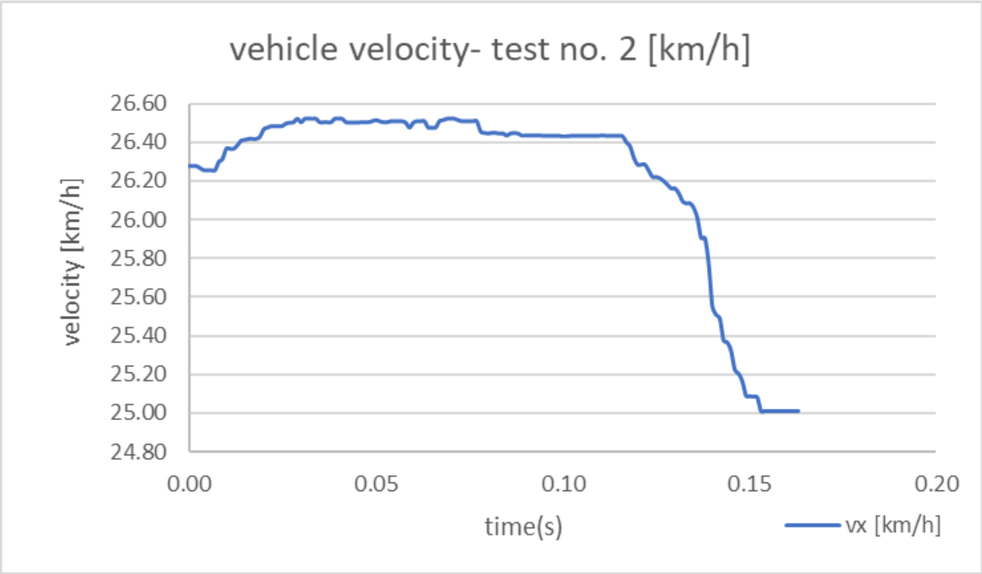


Figure 4. Vehicle velocity resulting from video data analysis and processing

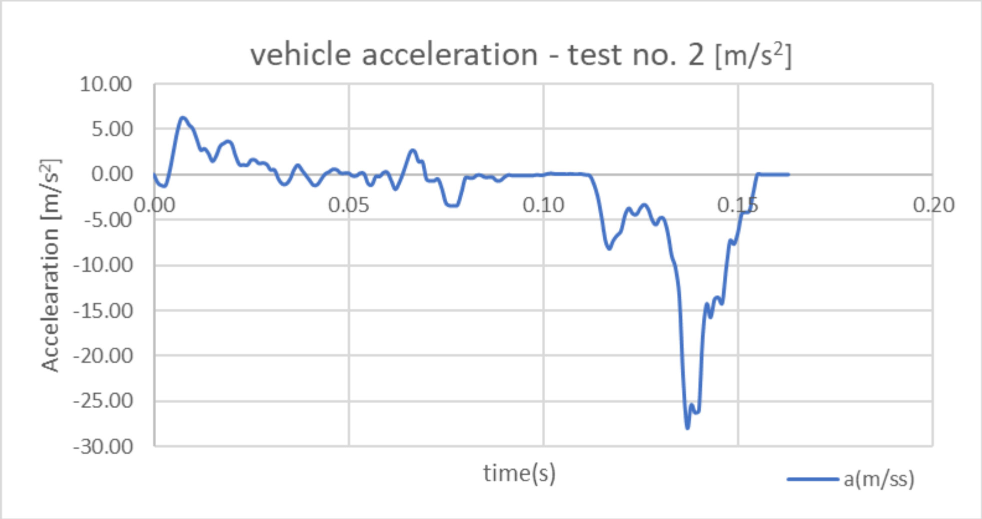


Figure 5. Vehicle acceleration resulting from video data analysis and processing

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

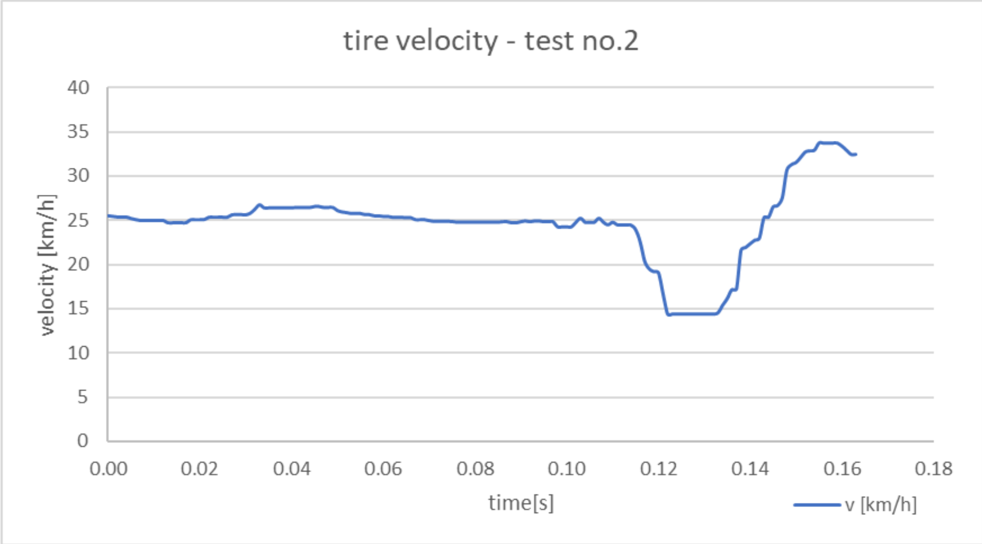


Figure 6. Wheel velocity resulting from video data analysis and processing

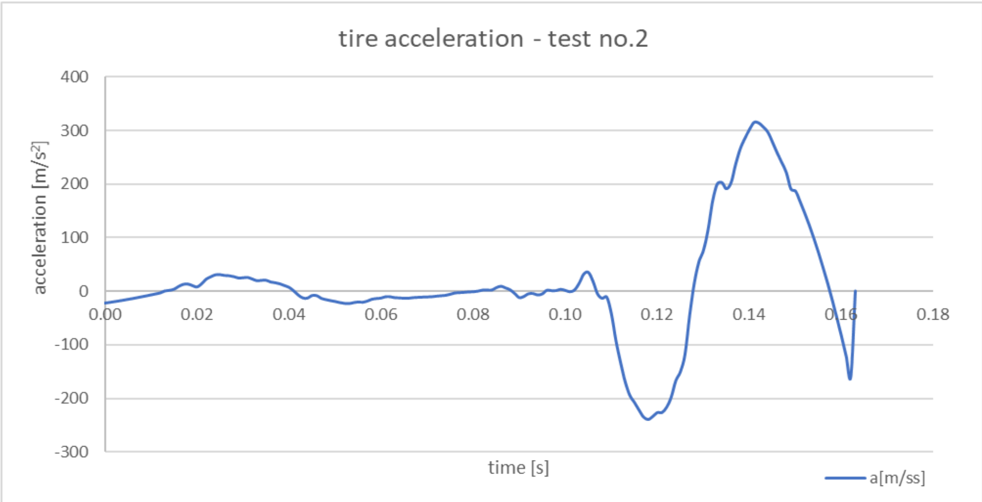


Figure 7. Wheel acceleration resulting from video data analysis and processing

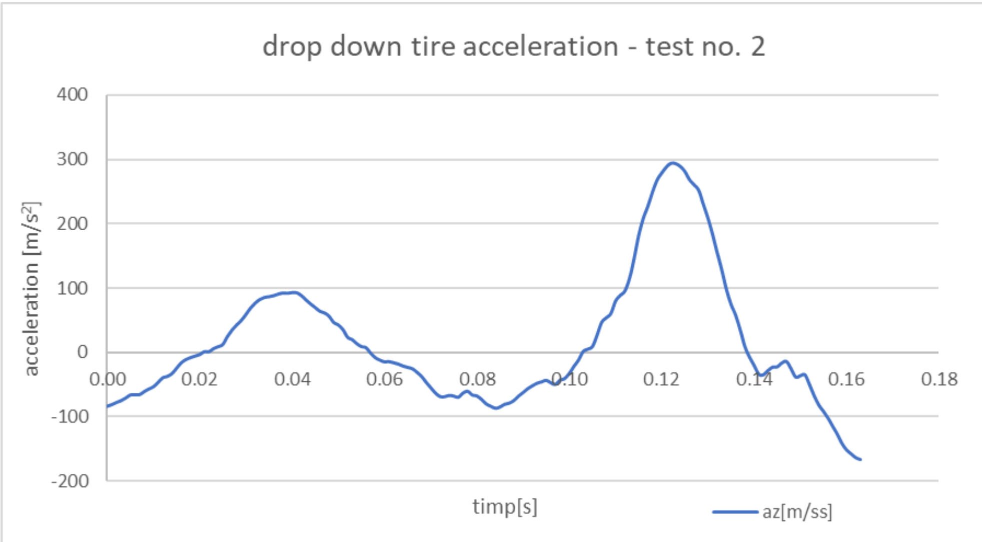


Figure 8. Wheel acceleration resulting from video data analysis and processing

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

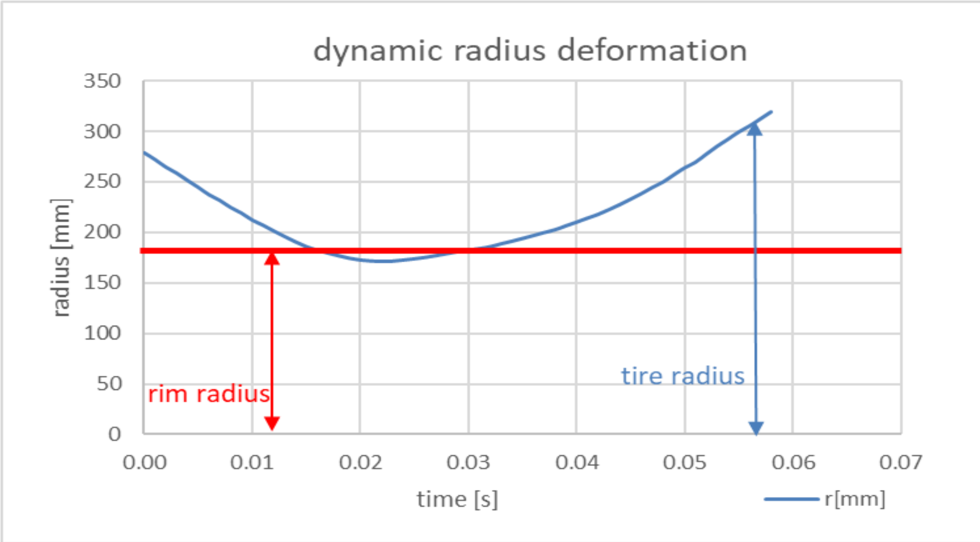


Figure 9. The variation of tire dynamic deformation at the moment of impact, resulting from video data analysis and processing

*Figure **10** Tyre deformation as following test number 2*

Table 2.
Tire deformation

Test no.	dz [mm]	Va [km/h]	Vr [km/h]	Acc a[m/s^2]	Acc r [m/s^2]	def rp [mm]	tire acc def	Rim radius [mm]
Test 1	50	25,5	25,5	95	95	191	217	180
Test 2	100	26	26	28	300	170	618	

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

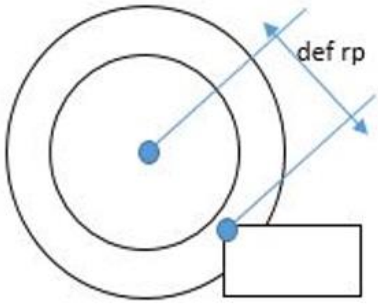


Figure 11. Tire deformation

5. CONCLUSIONS

As seen in the graphs presented above, in test number 2 (the depth of the pothole being 100 mm on a length of 1000 mm), we obtained maximum damage and deformation. Therefore, it was decided to analyze and detail the variation of the accelerations obtained during this test.

Because the structure of the tire is particularly complex and the variables that must be considered during the design are very different, it is difficult to verify it experimentally, requiring numerous tests. Considering the costs of the experiments, computer simulation virtual design is an effective aid in tire design; for this reason, tire design is done using increasingly high-performance computers and increasingly complex software packages, which are considered fundamental to save time, money, and human resources. The study of the interaction between the tire and the tread, of the tangential tensions that arise in the contact spot, because of the action of external forces and moments, is of particular importance, because it brings new elements to the design and construction of the tire to improve its dynamic qualities of adhesion. As a connecting element between the vehicle and the road, the tire decisively influences the performance, with a direct orientation on the dynamic behavior and, respectively, the economy of the vehicle. Following the tests performed, it was found at velocities higher than 25 km / h with a depth of 100 mm the damage suffered by the tire is maximum. Reaching the maximum compression of the suspension system, as well as the deformation limit of the tire, without consuming the full impact force, it was possible to observe the intrusion / impression of the wall when leaving the concave unevenness on the right front wheel rim. A rim deformation depth of approximately 27 mm was measured. Even if the depth of the unevenness is 50 mm in this case, there is a danger of damage. Carrying out experimental tests considering the parameters and factors mentioned above will provide data and information that will help to solve and correctly analyze the case of an impact between a tire and a bump in the ground.

REFERENCES

[1] K. S. Tan, S. V. Wong, R. S. Radin Umar, A. M. S. Hamouda, N. K. Gupta, *An experimental study of deformation behavior of motorcycle front wheel-tyre assembly under frontal impact loading,* 2-4, 2006

[2] Walter Reithmaier, Thomas Salzinger, *Motor Vehicle Tyres and Related Aspects,* 2003

[3] Gheorghe Ciolan, Daniel Trusca, Adrian Soica, Ovidiu Campian, Elemente de dinamică a autovehiculelor, Brasov, 2014

[4] M. Untaru, V. Campian. Dinamica autovehiculelor, Unv. Universitatea din Brasov, 1988

[5] Heinz Dieter Kutzbach, Alexander Burger, Stefan Bottinger. Rolling radii and moment arm of wheel load for pneumatics tyres, 1-5, 2018

[6] Vaclovas Kurkauskas, Algirdas Janulevicius, Gediminas Pupinis, Vidas Damanauskas. Interaction between driving wheel and road surface of all wheeled driven tractor, 1-4, 2013

[7] Zhihao Liu, Qinhe Gao. Development of a flexible belt on an elastic multi-stiffness foundation tire model for a heavy load radial tire with a large section ratio,1-3, 2018

[8] Hans B. Pacejka. Tyre and Vehicle Dynamics, 2002

[9] VACO (Wheel-tyre suppliers organisation of The Netherlands), "Onderzoek Rolling Wheel Nederland 2014

RoJAE
Romanian
Journal of Automotive Engineering

AIMS AND SCOPE

The Romanian Journal of Automotive Engineering has as its main objective the publication and dissemination of original research in all fields of „Automotive Technology, Science and Engineering”. It fosters thus the exchange of ideas among researchers in different parts of the world and also among researchers who emphasize different aspects regarding the basis and applications of the field.

Standing as it does at the cross-roads of Physics, Chemistry, Mechanics, Engineering Design and Materials Sciences, automotive engineering is experiencing considerable growth as a result of recent technological advances. The Romanian Journal of Automotive Engineering, by providing an international medium of communication, is encouraging this growth and is encompassing all aspects of the field from thermal engineering, flow analysis, structural analysis, modal analysis, control, vehicular electronics, mechatronics, electro-mechanical engineering, optimum design methods, ITS, and recycling. Interest extends from the basic science to technology applications with analytical, experimental and numerical studies.

The emphasis is placed on contribution that appears to be of permanent interest to research workers and engineers in the field. If furthering knowledge in the area of principal concern of the Journal, papers of primary interest to the innovative disciplines of „Automotive Technology, Science and Engineering” may be published.
No length limitations for contributions are set, but only concisely written papers are published. Brief articles are considered on the basis of technical merit. Discussions of previously published papers are welcome.

Notes for contributors
Authors should submit an electronic file of their contribution to the ***Production office:*** www. siar.ro. All the papers will be reviewed and assessed by a series of independent referees.

SIAR

The Journal of the Society of Automotive Engineers of Romania
www.ro-jae.ro www.siar.ro
ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

ISSN 2457 – 5275 (Online, English)
ISSN 1842 – 4074 (Print, Online, Romanian)

RoJAE
Romanian
Journal of Automotive Engineering

The Scientific Journal of SIAR
A Short History

The engineering of vehicles represents the engine of the global development of the economy.
SIAR tracks the progress of the automotive engineering in Romania by: the development of automotive engineering, the development of technologies, and road transport services; supporting the work of the haulers, supporting the technical inspection and of the garage; encouraging young people to have a career in the automotive engineering and road haulage; stimulation and coordination of activities that promote an environment that is suitable for continuous education and improving of knowledge of the engineers; active exchange of ideas and experience, in particular for students, master students, PhD students, and young engineers, and dissemination of knowledge in the field of automotive engineering; cooperation with other technical and scientific organizations, employers' and socio-professional associations through organization of joint actions, of mutual interest.
By the accession to FISITA (International Federation of Automotive Engineering Societies) since its establishment, SIAR has been involved in achieving an overall professional community that is homogeneous in competence and performance, interactive, dynamic, and competitive at the same time, oriented towards a balanced and friendly relationship between people and the environment; this action will be constituted as a challenge worthy of effort and recognition.

The insurance of a favorable framework for the initiation and the development of cooperation of the specialists in this field of activity allows for an efficient and easy exchange of information, specific knowledge and experience; it supports the cooperation between universities and between research centers and industry; it speeds up the process of implementing the new technologies, it simplifies the identification of training and specialization needs of the personnel involved in the engineering of motor vehicles, transport, and road safety.
In order to succeed, ever since its founding, SIAR has considered that the stress should be put on the production and distribution, at national and international level, of a publication of scientific quality.

Under these circumstances, the development of the scientific magazine of SIAR had the following evolution:

1. RIA – Revista inginerilor de automobile (in English: ***Journal of Automotive Engineers***)
ISSN 1222 – 5142
Period of publication: 1990 – 2000 | Format: print, Romanian
Frequency: Quarterly | Electronic publication on: www.ro-jae.ro
Total number of issues: 30 | Type: Open Access
The above constitutes series nr. 1 of SIAR scientific magazine.

2. Ingineria automobilului (in English: ***Automotive Engineering***)
ISSN 1842 – 4074
Period of publication: as of 2006 | Format: print and online, Romanian
Frequency: Quarterly | Electronic publication on: www.ingineria-automobilului.ro
Total number of issues: 61 | Type: Open Access
(Including December 2021 issue)
The above constitutes series nr. 2 of SIAR scientific magazine (Romanian version).

3. Ingineria automobilului (in English: ***Automotive Engineering***)
ISSN 2284 – 5690
Period of publication: 2011 – 2014 | Format: online, English
Frequency: Quarterly | Electronic publication on: www.ingineria-automobilului.ro
Total number of issues: 16 | Type: Open Access
(Including December 2014 issue)
The above constitutes series nr. 3 of SIAR scientific magazine (English version).

4. *Romanian Journal of Automotive Engineering*
ISSN 2457 – 5275
Period of publication: from 2015 | Format: online, English
Frequency: Quarterly | Electronic publication on: www.ro-jae.ro
Total number of issues: 28 (December 2021) | Type: Open Access
The above constitutes series nr. 4 of SIAR scientific magazine (English version).

Summary

Total of series:	*4*
Total years of publication:	*27 (11: 1990 – 2000; 16: 2006 – 2021)*
Publication frequency:	*Quarterly*
Total issues published:	*91 (Romanian), out of which, the last 44 were also published in English*

Societatea Inginerilor de Automobile din România
Society of Automotive Engineers of Romania
www.siar.ro
www.ro-jae.ro