**Gasic M.**
E-mail: gasic.m@mfkv.kg.ac.rs
**Savkovic M.**
**Markovic G.**
**Zdravkovic N.**
**Faculty of Mechanical and Civil Engineering in Kraljevo, Serbia**

## Advanced solution of freight trailer hydraulic loading ramp for heavy machines

**Abstract**
In article the loading/unloading problem to heavy machinery on a cargo trailer – a rupture of rear pneumatics a trailer, which causes damages to the construction machine and the trailer. For increase of safety of loading/unloading to heavy machinery by specialists of Faculty of Mechanical and Civil Engineering in Kraljevo propose the new solution based on such requirements as: easy and fast raising and lowering of loading ramp, hydraulic drive of mechanism for raising and lowering the ramp, rear wheels free from additional loadings while loading and unloading, operation done by a single command.
**Keywords:** loading, unloading, trailer, pneumatics, hydraulic drive.

### Introduction

Considering their big weights and low speeds, moving of construction machines from one construction site to another has to be carried out by freight trailers. Moreover, the caterpillars could damage the driveway, especially knowing that their weight can exceed 50 tons. The critical phase of transportation task is the loading-unloading operation. For this purpose, freight trailer is usually equipped with the loading ramp as a steep plane, in order to set these machines onto the carrying platform. However, due to elasticity of trailer pneumatics, it often happens that machine slips off the carrying platform during loading/unloading operation (Fig. 1), which causes damages to the construction machine and the trailer. Also, due to excessive and unequal load, the rear pneumatics, as a rule, used to burst, which additionally influenced the unsafe loading.

Fig.1 Construction machine slips off the trailer

### Schemes of some existing solutions

Loading/unloading of low-weight (up to 2t) construction and military machines on to the freight trailer is not a great problem. By using the devices in a form of articulated steep planes, it is possible with great certainty to carry out the loading. By its self-drive, the machine gets onto the carrying platform of freight trailer (Fig. 2). Raising and lowering of loading ramp can be done manually because its weight is small (up to 100 kg). In such cases, the loading on rear pneumatics is not big, so there is no possibility of tire bursting.

The weight of loading ramp increases with the increase of weight of machine being loaded, whereby it is almost impossible to raise and lower the loading ramp manually. By installing the torsion springs in the ramp hinges, the potential energy of the ramp is accumulated in the springs as the ramp lowers. In this way, accumulated energy in the springs enables manual raising of the device into the

transportation position (Fig. 3). As the amount of accumulated energy in torsion springs is limited, this solution is not applicable for bigger machine weights because the ramp weight is also considerably bigger. By modifying the torsion spring devices, applying the hydraulic cylinder with thrust lever, it is possible to raise and lower the ramp of considerably bigger weights (Fig. 4).

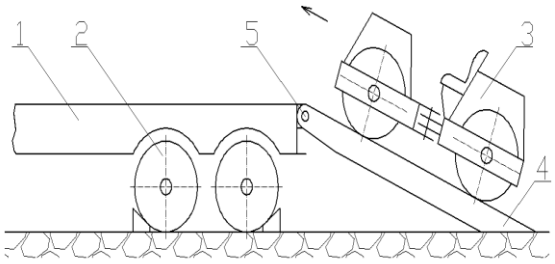


Fig.2 Simple loading ramp
for lightweight machines
1-trailer platform; 2-pneumatics;
3-machine; 4-loading ramp; 5-hinges.

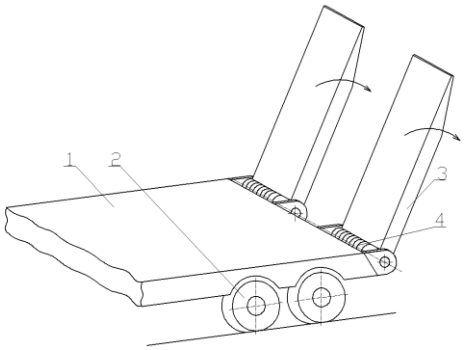


Fig.3 Loading ramp with torsion springs
1-trailer platform; 2-pneumatics;
3-loading ramp; 4-torsion spring.

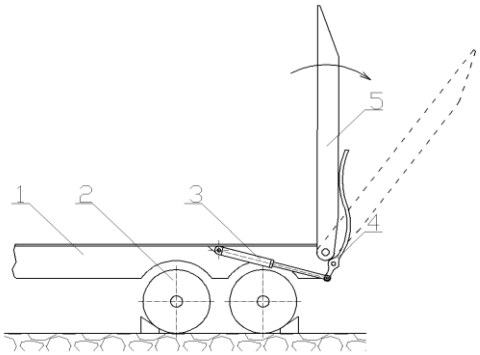


Fig.4 The solution with hydro-cylinder and thrust lever
1-trailer platform; 2-pneumatics;
3-hydraulic cylinder;
4-thrust lever; 5-loading ramp.

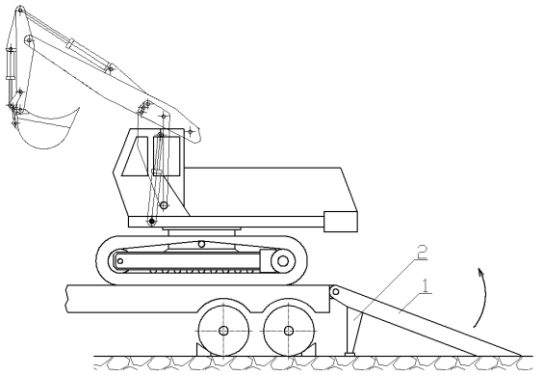


Fig.5 Loading ramp with stiff
support near hinges
1-loading ramp; 2-stiff support.

Previous solutions do not exclude the possibility of rear pneumatics overload. While loading the machine, the trailer platform lowers towards the road surface for 10 or more centimeters, bringing in additional loadings that can cause burst of pneumatics, so the trailer platform becomes unlevelled and the transported machine used to slip off very often and damage. To eliminate this occurrence, the solution with stiff support near the hinges came out (Fig. 5). Added stiff support prevented the lowering of trailer platform towards the road surface and also excluded the occurrence of additional load of rear pneumatics. This solution has two main disadvantages. Firstly, after loading operation is finished, the reaction force of stiff support can make it difficult or even impossible to put the ramp in transportation position. Also, during lowering the ramp within unloading operation, it is possible that the free end of the ramp cannot reach the ground (Fig. 6).

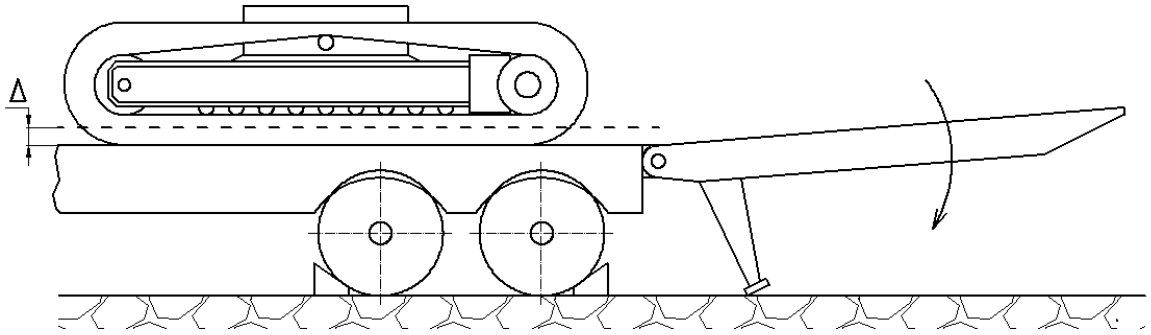


Fig.6 Negative effect of stiff support while lowering the ramp

This problem can be partly addressed by installation of hydraulic cylinder for lowering and raising the ramp or fully solved by changing the length of stiff support (for example by installing the threaded rod).

It is clear that managing such mechanisms becomes more complex because it has to be done by two independent actions: activating the hydraulic cylinder and adjusting the length of threaded rod at the stiff support. Loading of big construction and military machines with weights over 50 tons is almost impossible or hardly feasible by previously mentioned solutions.

**New solution of freight trailer hydraulic loading ramp**

Researches and development of new generation of devices for loading the heavy machines onto the freight trailers, carried out at the Faculty of Mechanical and Civil Engineering in Kraljevo are based on the following demands:

- easy and fast raising and lowering of loading ramp,
- hydraulic drive of mechanism for raising and lowering the ramp,
- rear wheels free from additional loadings while loading and unloading,
- operation done by a single command.

These objectives are fully accomplished by the new solution presented in Fig.7. The ramp body (1) and auxiliary rotary end (2), double-hinged by link (3), form the loading ramp which is connected by hinges (4) to the trailer chassis (5). Hydro cylinder (6) is supported by welded bracket (7), while its piston rod is eyed with the supporting leg (8), which leans on the ground via hinged shoe (9). Simultaneously, the supporting leg (8) is hinged with thrust lever (10) and together with specially designed clevis assembly equipped by guide slots (11) and pin assembly welded to the ramp body (1) form complex linkage which raises and lowers the loading ramp. In this way, at the same time, the rear end of the trailer gets its support on the ground, while the loading ramp is lowered at working position. The slots enable slightly lifting of the rear end of the trailer, which completely relieves the pneumatics.

Fig. 8 presents working (loading/unloading), transport and intermediate position of developed solution, while Fig. 9 gives the scheme of the hydraulic system.

**Conclusion**

Loading/unloading of heavy machine on the freight trailer is a critical phase of a transportation task. The objective is to make the loading and unloading safe, easy and as simple as possible. Thus, all the possibilities that could provoke the incidental damages would be removed. The paper presented a new solution that fulfills all these demands. It has been in use for few years already and turned to be very reliable and easy to manage.

**Acknowledgements**

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Project TR35038).

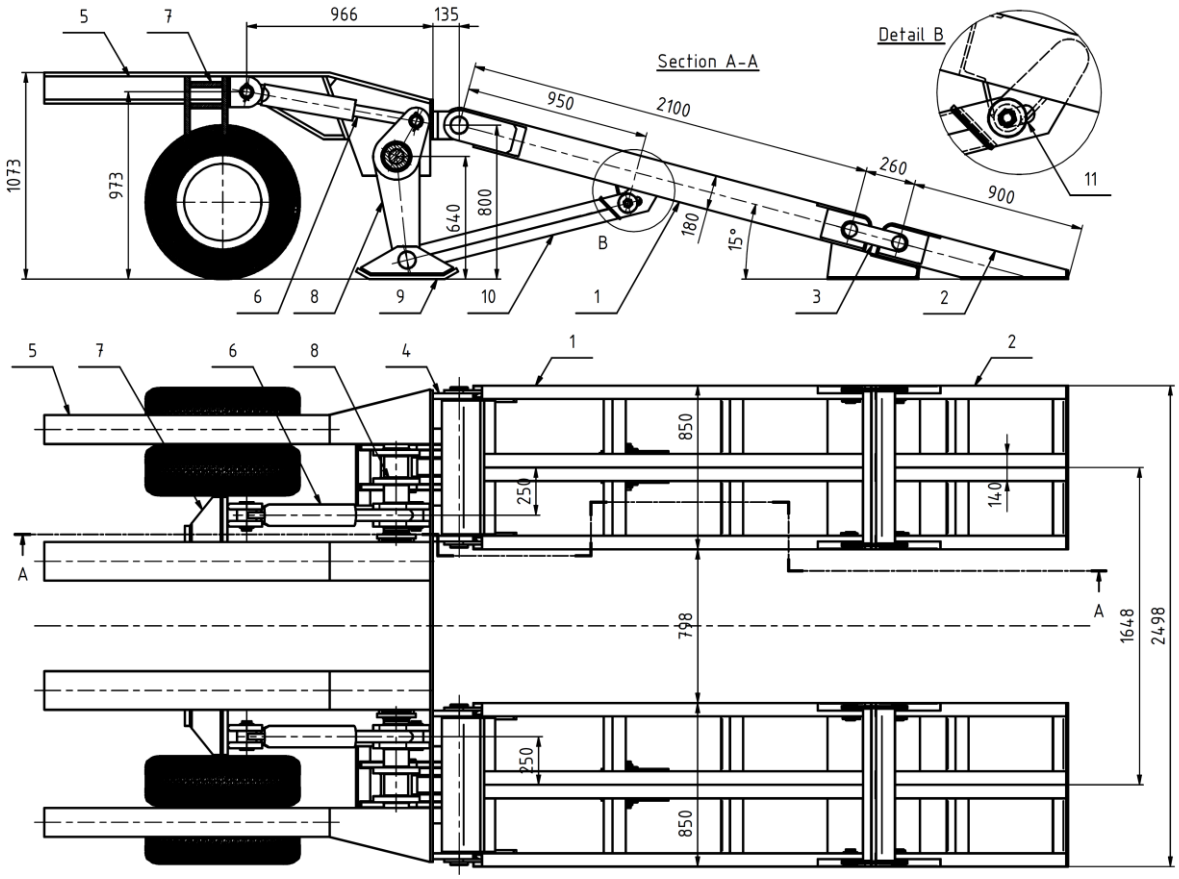


Fig.7 Advanced solution of freight trailer hydraulic loading ramp for heavy machines

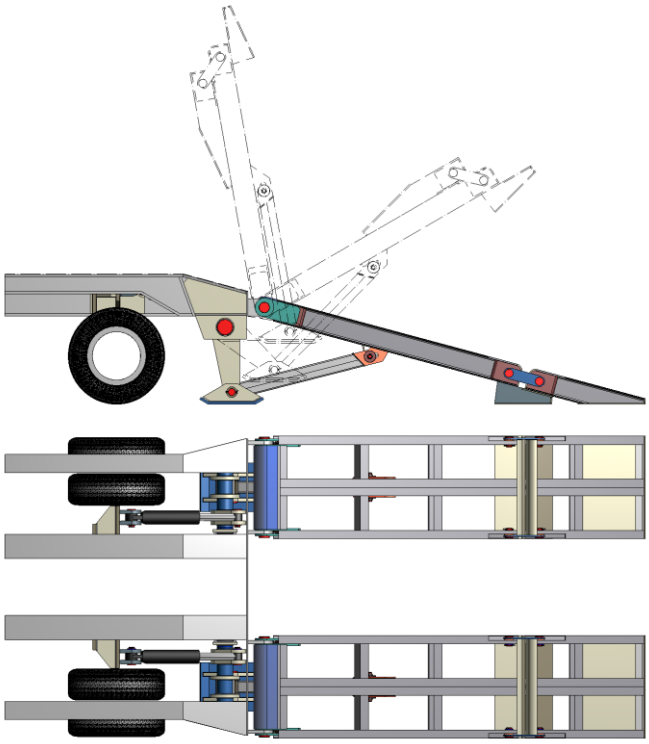

Fig.8 Positional presentation of mechanism

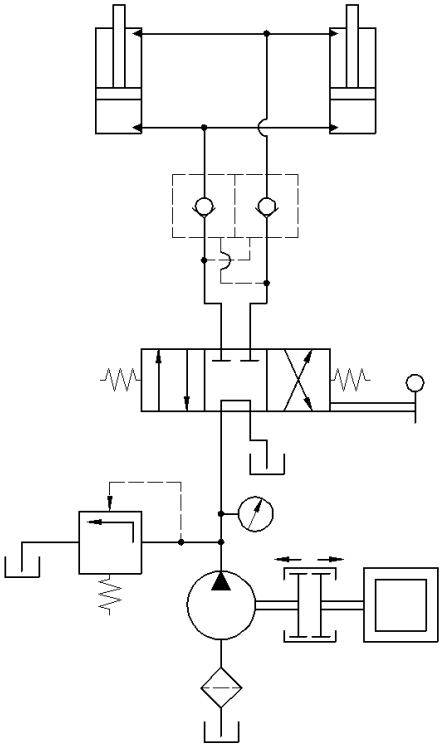

Fig.9 Hydraulic system scheme

**Reference list**

1. Zdravkoviж, N.,Gaљiж, M., Savkoviж, M., Petroviж D. Research of the force values dependences in hydro cylinders of the mobile elevating work platform articulated boom on the work position and load weight, The 7th International conference research and development of mechanical elements and system IRMES 2011, p.p. 271-278, isbn 978-86-6055-012-7, 2011.

2. Gaљiж, M., Savkoviж, M., Markoviж G.,Zdravkoviж N. Research and development of carrying structure of radial-axial bearing of construction and transport mechanization machines, The 6th International Symposium about forming and design in mechanical engineering -KOD 2010, p.p. 41-48, isbn 978-86-7892-278-7, 2010.