

Analysis of the Need for a Standardized Involuntary Anti-Decoupling Device for Sliding Suspension Trailers

Rafael Duzzioni Uliano¹, Vilson Menegon Bristot²

¹Curso de Pós Graduação em Engenharia de Segurança do Trabalho / Universidade do Extremo Sul Catarinense - UNESC, Brasil

²Departamento de Engenharia de Produção – Núcleo de Estudos em Engenharia de Produção - NEEP / Universidade do Extremo Sul Catarinense - UNESC, Brasil

ABSTRACT: *With the diversity of enterprises, technology progress, increased consumption and manufacturing, the road transport continues to be a main outflow artery of products. In this way, the road trailers customizations grow up more and more, to rise the efficient when load and unload products according with each application. The trailers development will can spoil the norms, through obsolescence or lack of coverage. The lack of regulations for the manufacture of safety items leads to an increase in accidents and potentially fatal victims. The aim of this study is to analyze the need to create a locking device that becomes the standard for the Bitrem Slide, regulamented to manufacturers of road implements in brazil first and in other countries after, like USA in the called Sliding Suspension. In order to avoid accidents like those that have already happened in Brazil and no one was held responsible.*

Keywords -Safety. Norms. Trailers. Suspension Sliding.

Date of Submission: 09-10-2020

Date of acceptance: 24-10-2020

I. INTRODUCTION

The use of the sliding bitrem without a standardized safety device, brings insecurity to the user and his environment. The purpose of this analysis is to instigate the specific regulation for this equipment, since there is no information available and easily accessible.

The article was structured in five sections. The first, the introduction, presents the universe of the study. The second section highlights the types of road implements, characteristics of the sliding bitrem and the American system and the accidents and coupling problems. Then there are the methodological procedures that characterize the typology of the research carried out, followed by the presentation and discussion of the research results, completing the third and fourth sections. Finally, the final considerations and bibliographic references are highlighted.

The main means of cargo transportation used in Brazil is the road system. According to data from the Ministry of Energy Mines, 52% of the total volume of cargo transported in Brazil is done by road, that is, half of all transport in the country is by truck. (NATIONAL TRANSPORT POLICY SECRETARIAT, 2012).

It should be noted that about 58% of the fleet consists of simple trucks with bodywork. Tractor trucks and their trailers and semi-trailers make up 34% of the fleet. The remaining 8% is made up of trucks and other support vehicles.

A complete truck is a combination of products supplied by two industrial sectors. The first is responsible for the production of the automotive vehicle, consisting of cabin, chassis and engine and traction system, and the second is responsible for the manufacture of accessory and complementary products to the truck (trailers, semi-trailers, buckets and bodies), the so-called road implements, which allow the vehicle to effectively fulfill its cargo transport function. (GOLDENSTEIN, Marcelo; et al, 2006)

Each implement - whether body, trailer or semi-trailer - is designed for specific use of a given load. The aim is to optimize the volume loaded and streamline the loading and unloading processes. Thus, the most diverse models are manufactured, such as bulk carrier, container holder, tank, chest or van, dry cargo, refrigerator and sugar cane. (GOLDENSTEIN, Marcelo; et al, 2006).

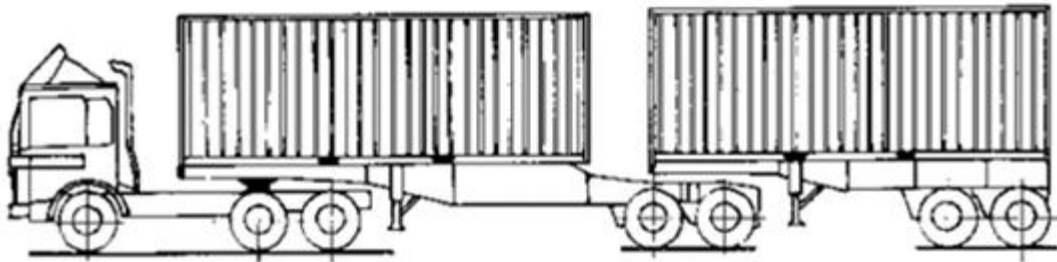
A few years ago, the Brazilian industry developed a vehicle called a bitrem, a configuration in which, with just one tractor truck, two semi-trailers are pulled. This equipment enabled a significant increase in the load

capacity per vehicle. Currently, according to the estimates of NTC & Logística (National Association of Cargo Transport and Logistics.) About 70% of the tractor trucks are sold to form a bitrem configuration. (GOLDENSTEIN, Marcelo; et al, 2006).

Road implements of the Bitrem type are produced on a large scale due to the fact that the carrier is able to take his cargo in the least possible journeys, becoming competitive in such a disputed market. Among the types of Bitrem, as the focus of this study, there is the Sliding Bitrem. This implement has in its specialty, sliding the chassis of the undercarriage (suspension, axles and tires), to facilitate the loading or unloading of the load when there is a need to use loading and unloading docks.

Figure 1, illustrates a complete Bitrem assembly (rear wagon coupled to the front wagon) coupled to the tractor vehicle (mechanical horse).

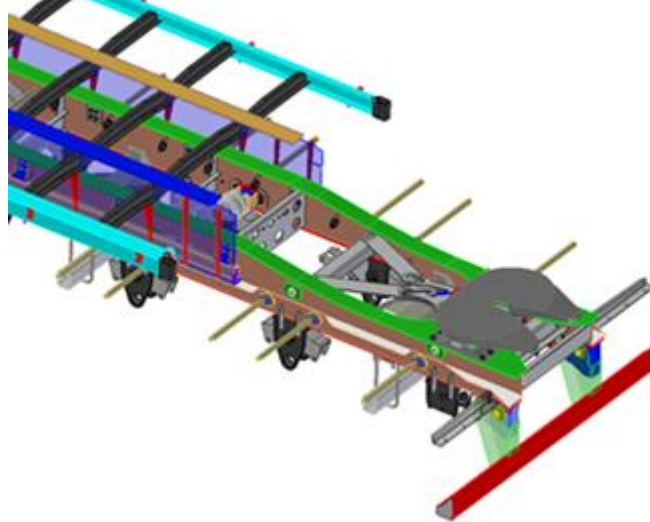
Figure 1 - Multiple heavy articulated vehicle



Source: ABNT NBR 9762, Road cargo vehicle - Terminology (2006)

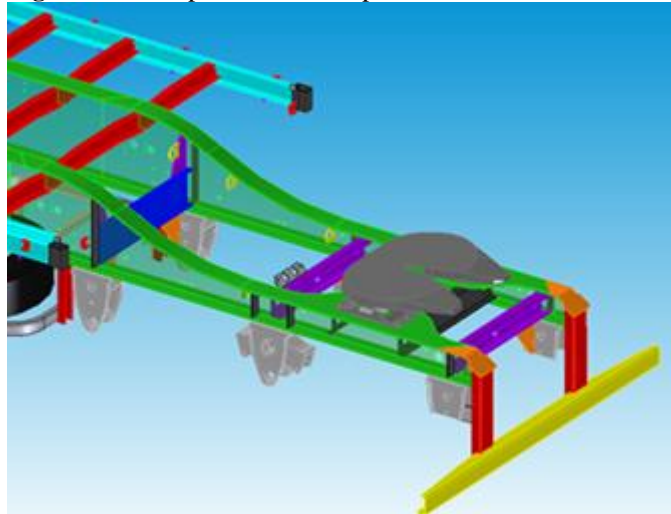
Figure 2 shows the design of a front Bitrem with sliding suspension. It can be seen that in the detail in green color (mobile chassis), the rotating assembly slides into the fixed chassis / cargo box.

Figure 2 -Front Bitrem Chassis Sliding Suspension.



Source: Computer programmed for three-dimensional drawings, Author (2019)

In Figure 3 it shows a standard Bitrem with fixed suspension, where the homogeneity of the fixed chassis (single piece) without articulation was verified.

Figure 3 - Example of Fixed Suspension Front Bitrem Chassis

Source: Computer programmed for three-dimensional drawings, Author (2019)

Because the sliding bitrem, literally sliding, there is a risk of unintentionally uncoupling, putting several people at risk in addition to the operators themselves (drivers, helpers, caretakers, etc.), not only on the roads but on private properties.

In Figures 4 and 5, it is possible to scale the problem, because it is real evidence, with photos of two accidents of involuntary decoupling, on highways in the state of Rio Grande Sul.

Figure 4 - Loss due to involuntary decoupling of the Sider slide assembly

Source: Authors (2019)

Figure 5 – Sinistro por desacoplamento involuntário do conjunto deslizante Porta-Container

Source: Authors (2020)

Currently, the implementers that manufacture these products develop their projects with their own locking systems, each with its quality and safety, as there is no standardized standard for this locking system. Just as there are several safety rules for manufacturing the other items of an implement, as an example, the Fifth Wheel (Type B coupling), King Pin, Spherical Coupling, Container Coupling, among others, as listed below:

- Quinta Roda has regulations approved by Directive Directive 94/20 / EC and ordinance 238/08 INMETRO.

- Pino Rei, requirements established in NBR NM -ISO 337: 2001, NBR NM-ISO 4086: 2006 and NBR NM-ISO 8716: 2001.

- Spherical coupling, the ABNT NBR 11410: 2016 Standard establishes the minimum requirements for the dimensioning, tests and installation of the automatic coupling and spherical coupling system to be used in trucks, trailers and semi-trailers.

- Container coupling, meets NBR 7475 standards.

- Bumpers, CONTRAN Resolution No. 593 OF 05/24/2016 establishes the technical specifications for the manufacture and installation of rear bumpers in vehicles manufactured domestically or imported in categories N2, N3, O3 and O4.

- Side guard, CONTRAN Resolution 323 2009, the side guard is a mandatory safety item for all large trucks manufactured from January 2011.

Cargo mooring hooks, CONTRAN Resolution No. 552, setting minimum safety requirements.

There are several reasons to change or redo a product design. Design flaws may be found, or customers may change to include other requirements. Product designs can be redone to improve quality, reduce costs, increase product life, or reduce environmental impacts (CELIK et al, 2013).

As there is no standard and regulation, the project is in charge of each engineering, that is, competition. Soon the information is confidential and used as a sales pitch. As it is about security, this barrier must be broken and regulation is the fundamental step.

According to information in the (TRC Guide, 2019), the sliding bitrem is a combination of cargo vehicle (CVC), usually with 9 axles, having two articulations (tractor truck fifth wheel and the sliding front semi-trailer fifth wheel) , which allows the transportation of a combined total gross weight (PBTC) of 74 tonnes.

This CVC differs from a fixed standard bitrem in that it is able to retract its structure from the front wagon in excess of the cargo box, to approach docks and / or platforms for loading and unloading materials.

Below, figure 6 illustrates the functionality of the 9-axle bitrem set with suspension / sliding chassis. Bearing in mind that it is only in the front car that the chassis slips and collapses and the suspension assembly occurs, precisely because of the articulation and coupling point of the rear car.

Figure 6 – SlidingBitremfunctionality



Source: Authors (2020)

Looking at figure 6, the applicability of the project is seen. With the suspension retracted, it is possible to lean the two wagons on the loading and unloading platform, making logistics much easier and safer, as it avoids the various improvisations in these operations.

The so-called North American Sliding Suspension, have a similar design concept to the Brazilian sliding bitrem. Since it is applied to the single wagon semi-trailer, with the sole purpose of correcting the load distribution applied to the ground and not to facilitate the loading and unloading of loads.

The correct load distribution of the CVC in addition to avoiding fines for excess weight by axles, provides better driveability to the driver, conservation of the highways, useful life of the truck components and semi-trailer and conditioning of the transported cargo.

Figure 7 – Functioning of the Sliding Suspension System



Source: Authors (2020)

Figures 4 and 5 illustrate the final result of the sequence of errors applied to the sliding suspension bitrem, involuntary decoupling. It is a heavy vehicle with its own tare, when loaded its cargo box, it tends to triple its weight. And something of this magnitude running on the highways, alongside light passenger vehicles, buses, families, the potential risk skyrockets to a critical level.

The problem with this equipment is in the locking system of its sliding part and not in the coupling of the rear car. Therefore, in these cases mentioned above, in addition to half the chassis and axles, the loaded rear wagon that is attached to this piece of the chassis is also loose on the highway.

As it is already a renowned equipment in the road implements market and hundreds of units are produced every year, the likelihood of more accidents like these increases. Even more because they are equipment that perpetuates on the roads for an average of 8 years, undergoing increasingly precarious restorations and passed on to less cautious owners with maintenance and care of the equipment over the years, usually for economic reasons.

There are several factors that can cause this accident, examples: operational failure of the driver: The operator does not correctly lock the moving part of the chassis and continues traveling; inspection, maintenance and lubrication status; flaws in the project: inefficient design, undersizing of locks and pins, material out of specification, lack of alerts, signaling and indication of locking operation, calculation of useful life, disregard of climatic factors, rain, mud, winds, erosion, corrosion and surface treatments.

The lack of a standard device, with the minimum security requirements is a relevant factor, since with a regulated device it would decrease and limit the risks without affecting the commercial margin of the implementers, because they will all need to use the same system.

This lack of regulation of a standard device makes all implementers do it in the most cost-effective way possible, of course thinking about security, however without any legal basis protecting them and protecting everyone's security.

On both sides there is the problem, the side of those who manufacture the equipment and the side of those who purchased and used it. Because those who manufacture it are not interested in their product crashing on a highway and causing fatal victims, at the same time not being able to have extra costs that exponentially increase the equipment to make it safer and still giving the operator a lot of work to use. Unfortunately the customer will run away from this implementer, since the other manufacturer does not have so much cost.

The summary of the problem is the market, it is business, the economy that moves everyone who works. Competition in the means of transport is fierce due to the high added value in the equipment.

There is also a great deal of pressure on road cargo transporters to improve their results, whether in terms of economics or in terms of safety, respect for the environment or better use of the energy resources employed. (GOLDENSTEIN, Marcelo; et al, 2006).

This competitiveness makes safety second, which should not happen at all, safety first.

Manufacturers are carrying out projects of similar concepts for the locking system of these sliding bitrem, which characterizes that all brands of road implements are at risk.

The system itself is usually made up of robust steel pins for locking the chassis, driven by the pneumatic system, derived from the braking and / or suspension system.

All this is left to the designers of the equipment and the operation in the field by the driver who is the most affected.

II. METHODOLOGICAL PROCEDURES

As for the methodological procedures, the technique adopted was the qualitative one, because, according to Michel (2015), this method is responsible for trying to understand and describe in detail a problem, identify the individuals that relate to it and clarify the influence that a variable has on the other.

As for the purposes of investigation, the present research was characterized as descriptive, because according to Rudio (2014, p.4), the descriptive research "[...] is interested in discovering and observing phenomena, trying to describe them, classifies them and interpret them".

As for the means of investigation, the study used bibliographic and documentary techniques. Vergara (2009) states that bibliographic research has as a pillar of research materials already published in print or electronic form, through books, magazines, newspapers and electronic networks. Documentary research, in turn, is carried out through documents, provided by public and private agencies or by people.

The study area focused on the sliding bitrem type truck, which is statistically highly commercialized and the device studied is the only one that does not have safety regulations.

According to Machado and Da Silva (2007), this stage of the methodology directs the researcher's focus and identifies the individuals who will be contextualized in the realization of the study. This note facilitates the planning and use of data collection techniques, providing greater consistency and reliability to the results obtained.

Regarding the planning and execution of data collection, secondary sources and the indirect observation technique were used. Justifying this framework, Lakatos and Marconi (2010) affirm that the secondary sources comprise the entire bibliographic archive that has already been made public and their objective is to make it possible for the researcher to approach the topic in a different way and reach innovative conclusions.

As for the technique by indirect observation, the data are not extracted directly by the individual who performs the research, but through indexes, written reports and documentary analyzes capable of assisting the perception and analysis of the problem (MICHEL, 2015).

After conducting the research and, through this, obtaining the necessary data, the researcher proceeds to the analysis and interpretation of the data, after all, the information, in its raw form, does not represent such relevance until it provides answers investigations (LAKATOS; MARCONI, 2010). As the study presented a descriptive historical analysis, since it sought to analyze the locking mechanisms of the bitrem, it was considered, then, as an essentially qualitative analysis.

III. RESULTS

The concept of the locking system among implementers today is similar, which converges to standard thinking, making it easier for manufacturers to accept it.

A standard of manufacture and assembly, a regulation, always seems bureaucratic and expensive, however an accident with fatal victims these days takes any company to the end of its journey.

Prevention is in the details, what never happened can happen, so the importance of anticipating the resolution of a potential problem. Research and development must be focused on security too, profit and security should not be competitors, but allies for evolution.

Like all safety equipment regulations, mainly on the road, the competent committee will list the minimum requirements necessary for the safety of manufacturing, maintenance, assembly, testing, material, etc., used for a system like this. This important step that must be taken so that the entire chain rotates minimizing risks.

Once a standard locking system is regulated, the implementers will execute it, followed by the inspection and vehicle inspection bodies that will involve it, restricting and minimizing more and more risks.

IV. CONCLUSION

The emergence of the need for this article is due precisely to the lack of related published information, therefore, due to the lack of importance given to the subject. In order to prepare this study, it was necessary to carry out an inspection work on the products of the manufacturers of road implements. Claim data was collected using photos taken from local internet sites.

With all this information, it is proposed to Organs regulatory agencies of the segment, the inclusion of an exclusive standard for the manufacture of road products with sliding suspension system, aiming at the standardization and safety of the system to avoid involuntary decoupling.

In order to fill the gap in the legislation on specific road equipment, which will emerge over time ensured by generic standards, sometimes superficial and / or vague, the competent authorities should pay attention to this case of the sliding suspension truck.

The purpose of this article is to further provide safety on highways and roads, not just in our country. Its initiative is to show the reality in this main modal of Brazil, where the risk goes hitchhiking with the road transporter.

In short, it is expected to mobilize regulatory bodies to consider the need to regulate as a plea for road safety, making the device a mandatory safety item in Sliding Bitrem and other derivations of the project, such as an extendable semi-trailer, Sliding Suspension and among others.

It is suggested as themes for future work the development of a locking system that meets the future standards and carry out a new research, with the objective of verifying the progress of the legislation of the Countries in the coming years.

REFERENCES

- [1]. AGÊNCIA NACIONAL DE TRANSPORTES TERRESTRES. Transporte Terrestre – Números do Setor, 5 de julho de 2006 (disponível em: <<http://www.antt.gov.br>>. Acesso em: 06 novembro 2019.
- [2]. AGÊNCIA NACIONAL DE TRANSPORTES TERRESTRES. Legislação. Resoluções, Deliberações e Portarias. Pesquisa Eletrônica. Disponível em: <<http://www.antt.gov.br>>. Acesso em 01 julho 2019.
- [3]. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 9500: Implementos rodoviários – Veículo porta-contêiner (VPC) - Requisitos. Rio de Janeiro, 2010. 22p.
- [4]. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 9762: Veículo rodoviário de carga - Terminologia. Rio de Janeiro, 2012. 32p.
- [5]. ASSOCIAÇÃO NACIONAL DOS FABRICANTES DE IMPLEMENTOS RODOVIÁRIOS. Comunicação. Pesquisa Eletrônica. Disponível em: <<http://www.anfir.org.br>>. Acesso em 02 julho 2019.
- [6]. CELIK, K., H et al., Product Re-Design Using Advanced Engineering Applications and Function Analysis: A case Study for Greenhouse Clips. Journal of the Brazilian Society of Mechanical Sciences and Engineering, October 2013. Disponível em: <<http://link.springer.com/article/10.1007/s40430-013-0032-z/fulltext.html>>. Acesso em 03 julho 2019.
- [7]. CONSELHO DE INFRA-ESTRUTURA CNI/SESI/SENAI/IEL. A infraestrutura no Brasil em 2005. Brasília: fev. 2005.
- [8]. DEPARTAMENTO NACIONAL DE TRÂNSITO. Legislação. Resoluções. Pesquisa Eletrônica. Disponível em: <<http://www.dnt.gov.br>>.

- www.denatran.gov.br>. Acesso em 01 julho 2019.
- [9]. GOLDENSTEIN, Marcelo; ALVES, Marcelo de Figueiredo; AZEVEDO, Rodrigo Luiz Sias de. A indústria de implementos rodoviários e sua importância para o aumento da eficiência do transporte de cargas no Brasil. BNDES Setorial, Rio de Janeiro, n. 24, p. 241-260, set. 2006. Disponível em: <<http://www.bndes.gov.br/bibliotecadigital>>. Acesso em: 06 novembro 2019.
- [10]. GUIA DO TRC. Vantagens das CVC'sx Carretas Tradicionais
Disponível em: <http://www.guiadotrc.com.br/lei/bitrem.asp>. Acesso em 05 novembro 2019.
- [11]. INSTITUTO NACIONAL DE METROLOGIA, NORMALIZAÇÃO E QUALIDADE INDUSTRIAL – INMETRO. Legislação. Disponível em: <http://www.inmetro.gov.br/legislacao>. Acesso em: 06 novembro 2019.
- [12]. LAKATOS, E.M.; MARCONI, M. A. Fundamentos de metodologia científica. 7 ed. São Paulo: Atlas, 2010.
- [13]. MICHEL, M.H. Metodologia e pesquisa científica em ciências sociais: um guia prático para acompanhamento da disciplina e elaboração de trabalhos monográficos. 3.ed. São Paulo: Atlas, 2015.
- [14]. MINISTÉRIO DO TRABALHO E EMPREGO. NR-12 – SEGURANÇA NO TRABALHO EM MÁQUINAS E EQUIPAMENTOS: Anexo XI - Máquinas e Implementos para Uso Agrícola e Florestal. Brasília, 2018. 115p.
- [15]. SECRETARIA DE POLÍTICA NACIONAL DE TRANSPORTES -SPNT/MT, Projeto de Reavaliação de Estimativas e Metas do PNLT (PLANO NACIONAL DE LOGÍSTICA E TRANSPORTE) – Relatório final, MINISTÉRIO DOS TRANSPORTES, Brasília, setembro de 2012. Disponível em: <<http://www.transportes.gov.br/public/arquivo/arq1352743917>>. Acesso em 05 novembro 2019.
- [16]. RUDIO, F.V. Introdução ao projeto de pesquisa científica, 42ª. edição, Petrópolis, Vozes, 2014.
- [17]. VERGARA, S.C. Projetos e relatórios de pesquisa em administração. São Paulo: Atlas, 2009.

Rafael Duzzioni Uliano, et. al. "Analysis of the Need for a Standardized Involuntary Anti-Decoupling Device for Sliding Suspension Trailers." *American Journal of Engineering Research (AJER)*, vol. 9(10), 2020, pp. 126-133.