

PROGRESS IN RESEARCH ON MODERN ELECTRONIC BRAKE SYSTEM OF TRANSPORTATION UNITS EQUIPPED WITH GOOSENECK TRAILERS AND LIGHT TRUCKS OR FARM TRACTORS

Summary

PIMR realizes R&D project on implementation of modern transportation option, based on well known in USA light trucks and gooseneck trailers, but novelty is that they will be equipped with PIMR's new electronic brake system [PEBS] and coupling device. PEBS could be mounted in trailers instead of very dangerous inertia brakes or less effective electric brakes from USA. Gooseneck trailer could be coupled with farm tractor to take goods from fields or forest to transit point and after replacing it with light truck to transport forward to other rural localities. Slow moving farm units ought to be blamed as the one of main reason of traffic slowdown, collisions and fatal road accidents. New road units should replace outdated farm tractor-trailers units with unsafe brakes. New technology – better for drivers, more efficient and environmentally friendlier ought to have a great impact on road safety and sustainable growth of rural areas.

POSTĘP PRAC BADAWCZYCH NAD NOWOCZESNYM ELEKTRONICZNYM UKŁADEM HAMULCOWYM ZESTAWÓW TRANSPORTOWYCH ZŁOŻONYCH Z NACZEPY TYPU GĘSIA SZYJA SPRZĘŻONEJ Z SAMOCHODEM PICKUP LUB CIĄGNIKIEM ROLNICZYM

Streszczenie

Prowadzone w Przemysłowym Instytucie Maszyn Rolniczych w Poznaniu prace badawczo-rozwojowe dotyczące opracowania nowoczesnego systemu transportowego, który jest oparty na stosowanym od lat w USA zestawie pojazdów złożonym z samochodu skrzyniowego i naczepy typu gęsia szyja. Nowością zestawów proponowanych do wdrożenia w Polsce jest wyposażenie pojazdów w nowy elektroniczny układ hamulcowy PIMR-EBS (PEBS) oraz nowego typu sprzęg kulowy. PEBS powinien być montowany w przyczepach w miejsce niebezpiecznych najazdowych układów hamulcowych lub mniej skutecznych elektrycznych układów hamulcowych z USA. Naczepę samochodową typu gęsia szyja można łączyć z klasycznymi ciągnikami rolniczymi, np. by przetransportować z pola płody rolne lub w lesie – drewno przewieźć z terenu zrębu do punktu przeładunkowego, a następnie bez niepotrzebnego przeładunku naczepa ta może być sprzęgnięta z samochodem skrzyniowym, by szybciej i bezpieczniej dostarczyć ładunek do wiejskich miejscowości lub miast. Wolno poruszające się po drogach zestawy złożone z ciągnika rolniczego i przyczepy stanowią główny powód spowolnienia ruchu drogowego, co może także być pośrednią przyczyną szeregu kolizji i wypadków drogowych. W transporcie drogowym nowe zestawy pojazdów samochodowych powinny zastąpić tradycyjne zestawy złożone z ciągnika rolniczego i przyczepy – z niebezpiecznym jednoprzewodowym układem hamulców pneumatycznych. Pojazdy nowego systemu transportowego poprawiają komfort i bezpieczeństwo pracy kierowców, zapewniają efektywniejszy transport towarów i powinny przyczynić się także do poprawy bezpieczeństwa drogowego oraz powinny przyczynić się do bardziej zrównoważonego rozwoju wiejskich obszarów – nowe usługi, nowe miejsca pracy, mniejsze zużycie paliw, mniejsza emisja szkodliwych składników spalin itp.

1. Introduction

Since June 2008 PIMR realizes, supported by Polish governmental funds, R&D project on implementation of modern transportation option, based on well known in USA light trucks and gooseneck trailers, but novelty is that new gooseneck trailers will be equipped with PIMR's electronic brake system [PEBS] and PIMR's coupling device.

PEBS could be mounted also in trailers (horse trailers, camping, specialized trailers for gliders etc) instead of very dangerous inertia brakes or less effective electric brakes with electromagnets, usually imported from USA. New road units ought to replace outdated farm tractor-trailers units with unsafe one line pneumatic brakes. In Poland, slow moving farm units should be blamed as the one of main reason of traffic congestion, collisions and fatal road accidents.

Gooseneck trailer could be coupled with farm tractor to take goods from the fields or forests to transit point and there - after replacing it with light truck to transport forward to other rural places. New road units – much more comfortable for drivers, more efficient and environmentally friendlier should have great impact on road safety, development of new services and sustainable growth of rural areas.

2. Light truck's adaptation for new technology

Over decade, PIMR's R&D works were focused on light trucks and cars adaptation for towing gooseneck trailers equipped with electric brakes from USA [1], since 2004 with electronic Sens A Brake system from New Zealand [2], and finally since middle of 2009 year with PIMR's electronic brake system (PEBS). Several Polish

cars and trucks: Polonez, Lumina, Subaru Impreza Outback, Jeep Grand Cherokee, Zuk, Lublin as well as forestry fire truck - Land Rover Defender 110 and Mitsubishi L200 - were equipped with constantly modernized versions of electric brake system.

2.1. Lublin truck

Adaptation of Lublin delivery truck (Fig. 1) is a good example to show how easy is to improve versatility of regular delivery car, by taking off protective canvas with its support frame, and in short time to transform vehicle into mini-liner (Fig. 2). The gooseneck trailer was coupled with hitch ball expandable from the beneath of loading floor and light's plug and SAB (Sens a Brake) system's plug were attached to their sockets.



Fig. 1. Lublin truck



Fig. 2. Lublin with gooseneck trailer

2.2. Land Rover Defender 110

PIMR's idea was to transform LRD (Land Rover Defender) fire truck into mini forestry tractor for towing gooseneck trailer (Fig. 3, 6) [4]. LRD was equipped with special support frame of hitch ball for gooseneck trailer (Fig. 4). Height of 60 mm ball hitch over trucks floor allows easy mounting fire module. To transform fire truck into mini-tractor - fire module is unloaded then gooseneck trailer coupled on hitch ball, as well as light and SAB system's plugs connected with proper sockets (Fig. 5). Reversing procedure allows to transform forestry mini-tractor into fire truck.



Fig. 3. LDR fire truck



Fig. 4. Hitch ball frame



Fig. 5. Coupling and sockets



Fig. 6. Land Rover Defender coupled with gooseneck trailer during field tests

2.3. Mitsubishi L200 car

In September of 2008 year, Mitsubishi L200 car (Fig. 7) was bought and transformed into PIMR's research light truck's tractor (Fig. 8-13). It should be underlined that among others European firms only Mitsubishi was eager to accept planed changes in the new car without taking back its factory warranty.

L200 truck was equipped with 60 mm hitch ball - expandable from the beneath of loading floor (Fig. 8, 9). General design of support frame of hitch ball for coupling gooseneck trailers is based on PIMR's patent nr 189623 but construction details of frame's anchoring points to the frame side members, free space for spare tire, swing axle carrier (Fig. 10-12) were chalanging so much that adaptation works took over 2 months. Hitch support frame was mounted using bolts, nuts and washers of Nord-Lock bolt securing system (www.nord-lock.com). The hitch ball cover is rectangular shape and it was cut out from the plate of loading floor (Fig. 8) – it is only change that was made in the truck's body by PIMR.



Fig. 7. Mitsubishi with hard top

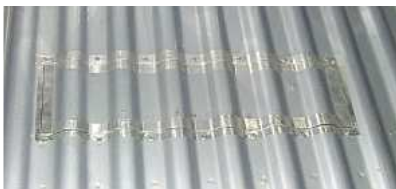


Fig. 8. Cover of hitch ball



Fig. 9. Hitch ball in working position and sockets



Fig. 10. Hitch ball frame



Fig. 11. Side view of hitch ball support frame



Fig.12. Hitch ball frame's anchoring point



Fig. 13. Mitsubishi L200 truck with gooseneck trailer and collapsible hydraulic lift for unloading containers with small trees from forestry nursery

3. Gooseneck trailers (category O2 and O3)

PIMR's research works proved that carefully modernized trucks could tow much heavier gooseneck trailers that regular trailers. For example, Lublin truck could tow only 2 t trailer but after transformation it could tow easily gooseneck trailers with GVW (gross vehicle weight) up to 4.5 tones [3]. The same is with Land Rover Defender 110 that could tow 1 t trailer on unpaved forestry ducks but after transformation into truck's tractor it could tow gooseneck trailer with GVW up to 4 tones.

In the beginning of 2009, thanks to R&D Project NR 10-0006-04/2008 funds, virtual (FEM) models of universal

chassis and body of gooseneck trailer/trailer, GVW up to 3.5t and up to 10t, were designed and also virtual models of new hitch ball couplings (Fig. 14-19). Main feature of these models is that they are based on the same universal frame of chassis and one type of coupling device. So, on one universal frame could be mounted different type of tongue: for typical trailer's or for gooseneck trailers as well as two versions of bodies: low bed - with wheels extended over floor or with wheels below loading surface - for transportation farm tractors with tools and machines (sowers, sprayers etc); for transport of forestry and agricultural products (small forestry trees, corn etc.); for transportation of animals like cattle or horses.

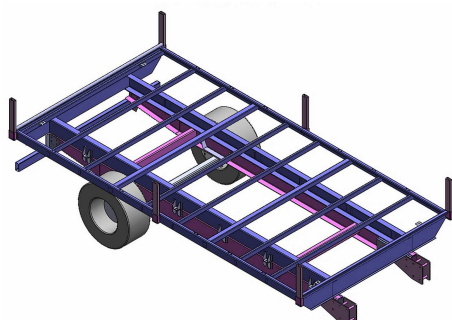


Fig. 14. Trailer frame with wheels below loading floor

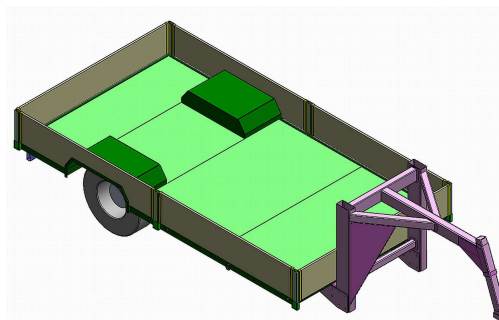


Fig. 15. Gooseneck trailer – low bed version

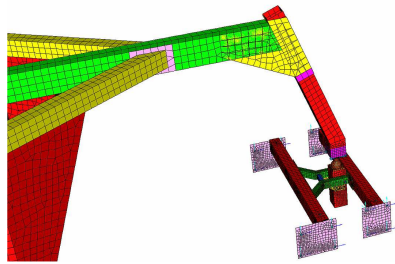


Fig. 16. FEM of gooseneck's tongue

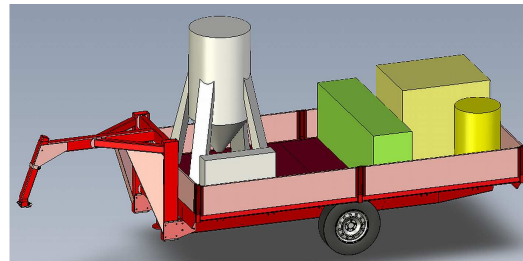


Fig. 17. Model of Mobile biodiesel refinery, mounted on gooseneck trailer (category O2)

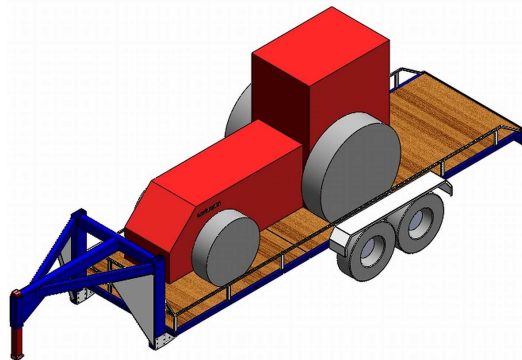


Fig. 18. Gooseneck trailer (category O3)

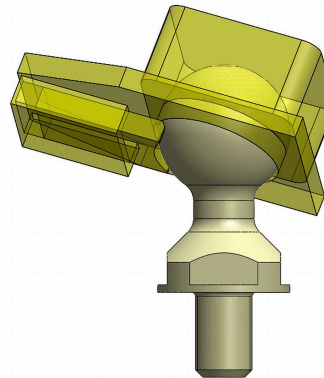


Fig. 19. Hitch ball and coupling device

In the spring of 2009 year, steel models of gooseneck trailers/trailers category O2 and O3 were built and equipped with axles from KNOTT POLAND with ABS sensors and hydraulic drum brakes, with parking feature and/or axles from DEXTER AXLE (USA) with ABS and hydraulic disk brakes. Dexter Axle axles and Kodiak disk brakes were delivered by BOOPARK B.V. from Netherlands.

In one of the tested option of forestry gooseneck trailer - a small hand operated lift was mounted on column of the trailer's tongue for unloading containers with Styrofoam cassettes and small forestry trees. After functional lab tests that lift was replaced by small collapsible (hand operated) hydraulic lift. New gooseneck trailer's unloading system is based on set of shelves containers with small trees (220 kg), mini palette cart with hand lever and hydraulic lift. Each

container should be lifted by mini palette cart and transported on loading floor toward and right under the hook of the small hydraulic lift. Then after lifting container is unloaded to the ground - forestry duck or road and unit is moving forward to the next unloading point. Designed system is cheaper, from that based on professional hydraulic lift, in addition - it should has impact on safety work improvement in transportation of small trees, plants etc in forestry and agricultural sectors.

Gooseneck trailer, thanks to special adapter (Fig. 25, 26) (patent NR195519), could be coupled with farm tractor (Fig. 27) to take goods from the field or forest to transit point and there after replacing it with light truck to transport forward to other rural places.



Fig. 20. Tests of unloading 200kg weight, behind gooseneck trailer visible forestry containers with agrotexile canvas cover (green, white, black, silver as on trucks)



Fig. 21. Gooseneck trailer loaded with 9 containers for transportation of small trees from forestry nursery



Fig. 22. Special tongue frame design allows for tight turns of gooseneck trailer



Fig. 23. Styrofoam cassettes with forestry trees transported in containers



Fig. 24. Mitsubishi L200 truck coupled with gooseneck trailer on reafforest terrain

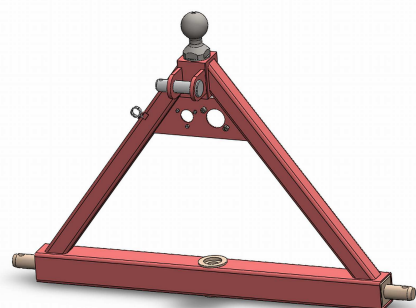


Fig. 25. Special adapter category 2 or 3 for coupling gooseneck trailers with farm or forestry tractors

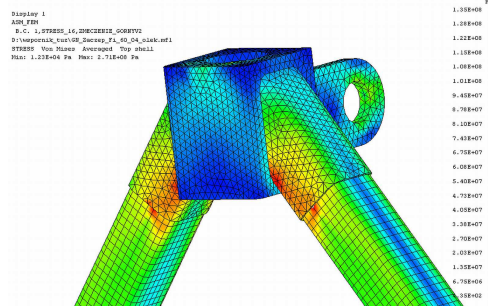


Fig. 26. FEM map of reduced stresses in top part of the special adapter



Fig. 27. Farm tractor coupled with gooseneck trailer - functional tests of unloading system

4. PEBS – PIMR’s electric brake system

In the beginning of 2009 PIMR made decision to stop R&D works on Sens A Brake system and start R&D works on own brake system - because business partner Edge International Ltd., from New Zealand went into bankruptcy process.

New model of PIMR’s electric brake system (patent disclosure WIPO ST 10/C PL390980) was built and tested in laboratory and road tests. Its modified versions were mounted in Jeep Grand Cherokee, Mitsubishi L200 and three gooseneck trailers and trailer. New electric-pneumatic-hydraulic brake system is compact construction - simply to mount in cars, trucks and gooseneck trailers and trailers (O2 and O3). Electric signal from pressure transmitter (in car/truck) is steering by wire electric-pneumatic proportional valve and through modulator EBS, pneumatic-hydraulic converter is steering hydraulic brakes of trailer. System is ready for gooseneck trailers and trailers category O2/O3 homologation approval [5]. In the cabin is located control color LEDs display that is informing driver about status of the trailer’s braking system.

During field and road test (autumn and winter 2009/10) vehicles equipped with PEBS could safely drive with speed up to 100km/h. Very short reaction time of whole system, measured from the moment of touching of the brake pedal is equal $0.3s < 0.6s$ and ABS system is working well even in worst weather and road conditions. Implementation of new brake system should have positive impact on reduction of number of road collisions and accidents.

New transportation units should replace classical farm tractor-trailers units (equipped with one line pneumatic brake system). This could have great impact on improving

safety, especially on reduction of number of fatal accidents, caused by roll over tractor - pushed by trailers with too slow working pneumatic brakes. That is because reaction time of whole brake system is over 0.6s [6].

European homologation tests of Mitsubishi L200 coupled with trailer (Knott axles: 2 x 1.8t, tires 195 R14C 106/104P) were done by Polish Branch Office of IDIADA (www.idiada.com). In April of 2010 year IDIADA sent to PIMR information that “the tested vehicle FULFILLS the prescription related to vehicle braking systems as defined in ECE Regulation 13.11” [7] and that PIMR’s brake system type P1 got Type approval number E9-13R-11.1264.

This is very important european confirmation that PIMR’s brake system is professionally designed and it could be mounted in gooseneck trailers, semi-trailers and trailers category O2. In 2010 year PIMR is going to check heavier version of gooseneck trailers and trailers (category O3) in homologation tests.

5. Conclusion

1. Universal chassis design ought to reduce manufacture time of gooseneck trailers and classical trailers.
2. Gooseneck trailer could be coupled with farm tractor to take goods from the fields or forests to transit point and there - after replacing it with light truck to transport forward to other rural places.
3. New road units – much more comfortable for drivers, more efficient and environmentally friendlier should have great impact on work safety, development of new services and sustainable growth of rural areas.



Fig. 28. Mitsubishi L200 – two hydraulic pressure transmitters mounted under special connectors on brake pump. On top visible air bleeding valves



Fig. 29. L200 - LEDs control panel, counter of work hours of air compressors, red push button – trailer’s emergency braking action

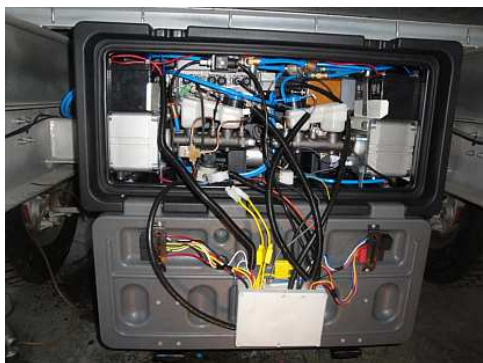


Fig. 30. PEBS is mounted behind rear axle of gooseneck trailer (category O2 or O3)



Fig. 31. L200 truck coupled with trailer - PEBS is mounted under white cover

4. Innovative PIMR's brake system should replace very dangerous inertia brakes and equally dangerous one line pneumatic brakes in outdated agricultural trailers.
5. New road units ought to improve traffic flow on Polish network road system and decrease number of road collisions and fatal accidents.

6. References

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