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New unconventional versatile large size intermodal transport units and their transportation

Intermodal transport unit, large size ITU, container, swap body, semi-trailer

Nowadays new unconventional intermodal transport units which are characterized by dimensions larger than standardized ones or new ways of manipulation are being developed. This should bring higher utility value of such units. On the other hand this leads to many problems which should be solved, including problems with their transportation on roads and railways, respectively water. The paper presents basic information related to the project TelliBox and Innofreight containers – requirements, development, design, benefits as well as critical points

NOVÉ NEKONVENČNÉ UNIVERZÁLNE VEĽKOROZMERNÉ JEDNOTKY INTERMODÁLNEJ DOPRAVY A ICH PREPRAVA

V súčasnosti sa vyvíjajú nové nekonvenčné prepravné jednotky intermodálnej dopravy, ktoré sa vyznačujú väčšími rozmermi ako majú klasické, ako aj vyvíjajú nové spôsoby manipulácie. Toto by malo priniesť ich vyššiu úžitkovú hodnotu. Na druhej strane to však prináša mnohé problémy, ktoré je potrebné riešiť, ako sú problémy s ich dopravou po ceste, železnici a vode. Príspevok prináša základné informácie o projekte TelliBox a kontajneroch Innofreight – požiadavky, vývoj, konštrukciu, výhody ako aj kritické miesta.

1. INTRODUCTIOM

Logistic system for goods transportation is in the centre of interest of broad spectrum of stakeholders. They all want the transport goods quickly, safe and with minimum costs, certainly with respect to the environmental impact of the transport. The system consists basically from "software", i.e. organisation and control of good transportation, and "hardware", i.e. all technical means necessary to transport the goods.

An important means of a logistic system is the intermodal transport that has potential to increase, quality of freight transport in one and the same loading unit from a sender to recipient in one continuous chain, while in large extent it transfers transport from road to railway or water thus contributing to reduction of negative effects of transport on the environment. With regards to different density of railway, water and road transport, in most of cases the latter one remains the starting and terminal in a logistic chain.

A fundamental element of the intermodal transport is the Intermodal Loading Unit – ILU (in French: Unité de Transport Intermodal – UTI), mostly container and swap body, in some cases also road semi-trailer. For transportation of the UTIs means of transport (railway wagon, road vehicle, ships) and handling equipment for loading operations are necessary.

Efforts in searching for new solutions leading to increased effectiveness of intermodal transport can be observed for longer time. This is evident in all components of logistic chain. New methods for loading and unloading and shortening time of these operations (e.g. by opening side wall, liftable roof, etc.), speeding-up transhipment when changing one transport mode to another one are just some of them. Permanent efforts for increasing cargo volume up to 100 cubic metres and even more are still of top interest for shipment companies. Another temptation is to combine advantages of containers (in particular stackability, but also solid walls creating persistence against damage of goods or pilferage) with swap bodies (larger cargo volume and pallet wide).

One results of such efforts for development of new advanced UTI was project TelliBox that was solved by consortium within 7th EU research framework programme. The project succesufuly finished in March 2011 with presentation for public of new intermodal loading unit called MegaSwapBox (but familiarly TelliBox) that combines advantages of containers and swap bodies.

During solution process many obstacles, limitations given by limit dimensions for transportation on rail, road and water. The trade-off between required parameters from the new MegaSwapBox (TelliBox) and physically possible solutions was really challenging for searching unconventional solutions and the finding compromises was very difficult. Staring from analysis of current situation in intermodal transport in Europe and Asia and demand for a new large size ILU, continuing through alternative solutions and finally building-up and testing the prototype in real traffic was the process that consortium did within three years of project duration.

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2. LARGE SIZE ILU

2.1 Reasons for large size ILU

To have intermodal loading unit with dimensions as large as possible is absolutely natural (possibility to transport higher cargo volume), but these dimensions are limited by maximum allowed dimensions by regulations, especially on road, but also railway and water transport create obstacles, similarly handling operations and storage.

Sometimes few centimetres make problems, which is evident from comparison of classic large size ISO 1 container and a swap body. Advantage of swap body is in ties size that enables better utilisation of internal space, in particular when loading with EURO pallets. This is documented in figure 1, where in container it is not possible to place 2 pallets side by side longitudinally (2 x 1200 mm), or three per width (3 x 800 mm) but it is possible to do so into a swap body. But maximum permissible width on road is 2550 mm, there is a little space left for thickness of wall structure (moreover some free space should be allowed between pallets).

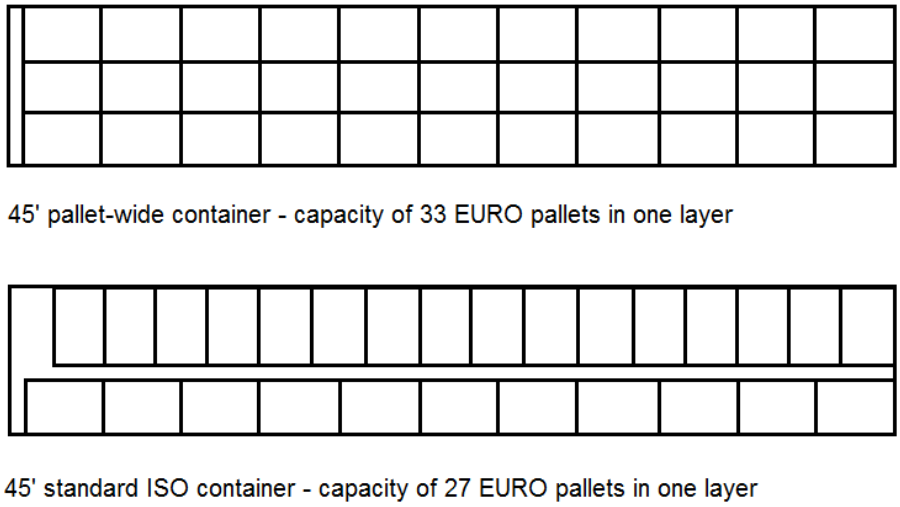

Fig. 1. Stowage of euro pallets in standard and in palletwide 45’ container)

To other of advantages of swap bodies belongs their smaller weight resulting from design not requiring stackability. This is at the same time their disadvantage (with exception of stackable swap bodies) as they need large storing areas and similar problem occurs on water transport. From this reason swap bodies are mostly used in road transport.

Solution of this problem is being searched in increased width of containers to the width of swap bodied (2,5 – 2,55 m). These are so called HighCube containers, which mostly have extended height (e.g. up to 10’6½”) comparing to standard ISO 1 container with maximum height of 9’6”. Together with the maximum standard length of 45 internal space (cargo volume) is near 100 m^3.

In Europe for longer time is initiative towards so called Eurocontainers (EILU – European Intermodal Loading Unit) with dimensions adapted to EURO pallets [1]. Internal bottom area dimensions should be 2400 x 13 200 mm, plus free space for handling, and external height 2900 mm. Stackability is expected up to 4 layers. So far the final solution is out of sight.

There are numerous solutions at present. For instance there are 45’ containers 2500 mm width, which solve problems of placing pallets side by side, but they are openable only from the front wall. This solution is simple from the strength, stiffness and weight point of view, but enables loading and unloading only through this front door. This drawback leads to container designs with openable side walls. But this requires structure with much thicker bottom frame to ensure strength and especially acceptable deformation, which is strictly limited for stackable containers. That is why these containers are either shorter or have great thickness (height) of bottom frame (in case of 45’ container it is about 430 mm). By this the internal height of a container is reduced and weight is increased [2].

2.2 MegaSwapBox – results of TelliBox project

As mentioned before, one of the answers to the challenge to combine advantages of swap bodies and containers into a new design with was the project TelliBox that was solved within the 7th Framework programme EU. Consortium was headed and coordinated by IMA RWTH Aachen, other members were manufacturers (firms WECON and WESOB – swap bodies, HRD – chassis), freight transport companies (ECC, Wincanton and CTL Logistic), supported by EIA (European Intermodal Association) and University of Žilina, Slovakia, Department of transport and handling machines as a coordinator for University of Žilina, and departments of railway transport and material engineering. This consortium was occasionally supplemented by other consultant companies for specialised tasks, e.g. final element analysis. Consortium regularly organised meetings where solutions were searched.

Benefits for such new ILU design were supported by results of analysis where potential users appreciated most of the new properties.

The basic parameters / requirements of the TelliBox system are as follows:

- Tri-modality (road, railway, water),
- Stackability,
- Handling by standard handling equipment during transhipment on individual transport modes (top corner fittings, grooves for grab lifting appliances),
- Compatible for existing low floor wagons for rail transport,
- Adaptable chassis for road transport,
- Cargo volume 100 m^3 and internal height 3 m,
- External length of 45´, width 2,55 m, height 3,2 m,
- Accessible from three sides for loading purposes (front and both side walls),
- Liftable roof for better loading and unloading accessibility,
- Ensured sufficient safety features against pilfering and damage of goods,
- Follow all relevant EU regulations on road and rail transport.

One of the predecessors and inspiration for the project was a swap body series A 100 (figure 2) made by ECC, which fulfils some of the above given parameters – transport on road and railway (figure 3). Cargo volume 100 m^3, openable side wall and liftable roof, bur does not fulfil other, in particular properties of containers (stackability, solid walls, upper corner fittings) [3].

Fig. 2. Swap body A 100 and a special chassis for its transport

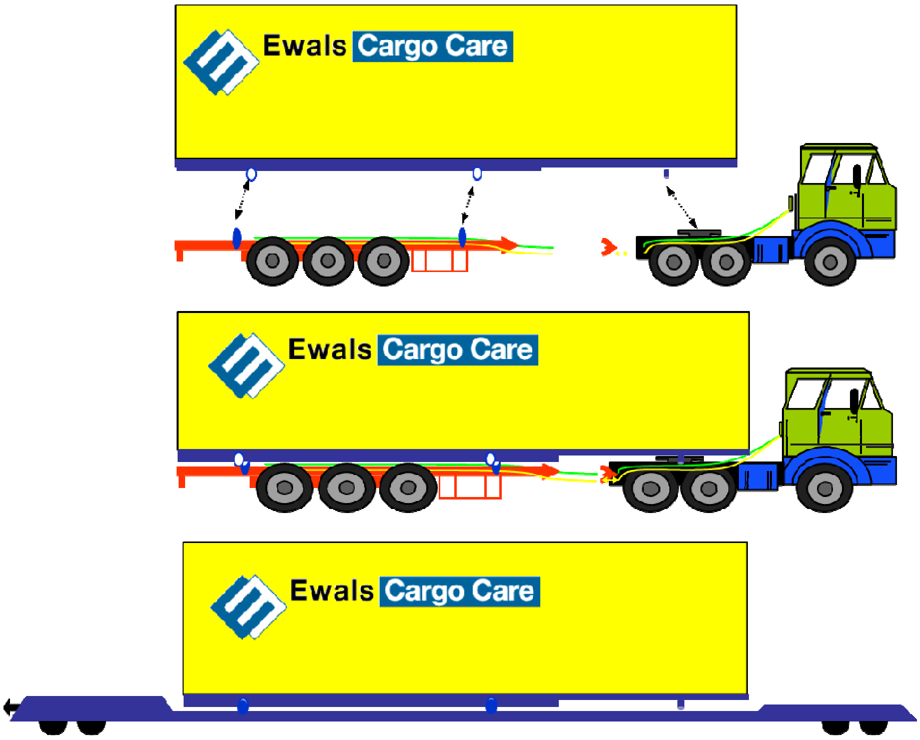

Fig. 3.Swap body A 100 and its transportation on road and railway

3. REQUIREMENTS LIMITING DESIGN

Solution procedure of MegaSwapBox (MSB) design was in sequential steps, where in the beginning basic requirements and solution space were defined. The worst problems were caused by maximum external height of 3,2 m (resulting from maximum height on the road 4 m and maximum height of fifth wheel on truck, which is currently attainable in the level of 850 mm) in close relation to the required internal height of 3 m, Then it was requirement of completely openable side walls and liftable roof. When considering length of about 13,7 m this brings extraordinary requirements on ensuring strength and especially stiffness of the container structure.

3.1 Requirements from road transport

As the analysis proved, the main problems are dimensions given by road transport. EEC directive EN 96/53 from 25 July 1996 determines maximum dimensions and weights for vehicles categories M2, M3, N2 and N3 and their trailers categories O3 and O4.

Basic dimensions are:

Maximum length:	Motor vehicle	12,00 m
	Trailer	12,00 m
	Semi-trailer set	16,50 m
Maximum width:	All vehicles	2.55 m
	Thermal insulated vehicles	2.60 m
Maximum height (All vehicles)		4.00 m
Maximum total mass of vehicle:		
	Two-axle trailer	18 t
	Three-axle trailer	24 t

Standard height of fifth wheel currently manufactured semi-trailers is 1150 mm and there are also trucks with height of the fifth wheel only 950mm. To fulfil requirement of 3000 mm internal height and to keep overall maximum height of 4000 mm it is necessary to have the height as low as possible and a special chassis is necessary. During the project solution a special truck DAF with the height of the fifth wheel only 850 mm was developed, but still the total height remained few centimetres over the permissible height of 4000 mm.

As the length of MSB concerns, the limit is given by geometry of semi-trailer, as is shown in the figure 4. Therefore ends of 45’ containers and swab bodies are cut-off.

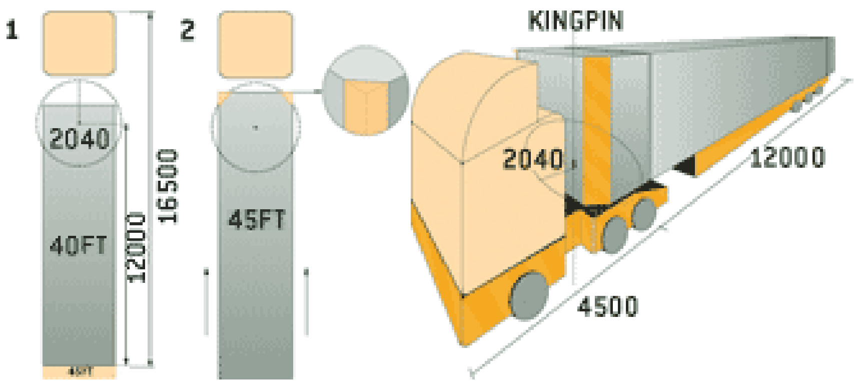

Fig. 4. Dimension limits for 45’ loading units on road semi-trailers

3.2 Requirements from railway transport

Railways for intermodal transport are defined in AGTC. For the possibilities to transport MSB on railway the most important is the loading gauge of a concrete railway line. The most important railway gauges are shown in the figure 5.

All railway lines are categorised and have number of category (codification). For containers and swap bodies the number stars with letter “C” and for trailers with letter “P”. For example most of the German lines has category C379, C400 and C410, in Slovakia C377 and C400 [4]. For external width up to 2550 mm the category has two digit code, over 2550 mm 3 digit code (e.g. C45 corresponds to C375).

Railway category determines maximum loading dimension, that is for given dimensions of ILU (or in this case MSB) maximum height of loading platform of railway wagon.

E.g. at normal height of loading platform 1175 mm for track category C45 the height of container or swap body will be maximum 2900 mm, on C75 it can be 3200 mm, on C80 it can be up to 3250 mm. Respectively, the lower loading platform of a wagon is the lower requirements on track category are.

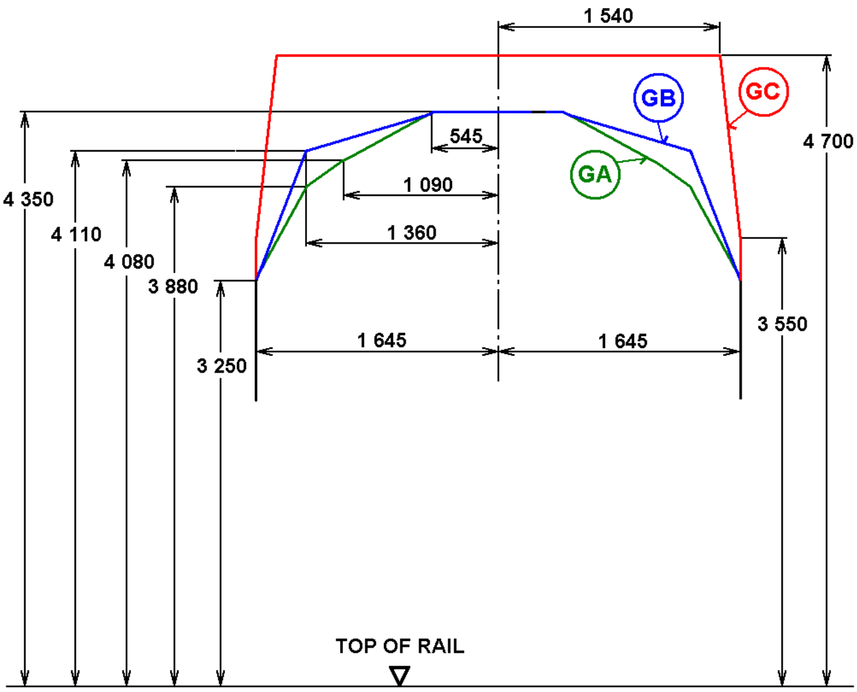

Fig. 5. Dimensions of the most important railway loading gauges

3.3 Means of transprot for large size ILUs

There are many types of freight wagons for intermodal transport of containers and swap bodies. Most of them has loading platform height about 1 175 mm above top of rail (TOR), what is too much for transportation of MSB on standard railway lines. Only few types of wagons have lowered loading platform and there is limited number of them in operation.

Only two types of flat wagons are defined in Appendix II RIV 2000. These are Sfgmmnss (loading platform height 475 mm above TOR) and Sffggmrrss (loading platform height 825 mm above TOR). Besides these two types, there are only several more with similar parameters. Maximum speed of such wagons for intermodal transport is 120 km/h.

Tab. 1: Comparison of basic technical parameters of intermodal wagons

	loading height (mm)	loading length (mm)	max. speed (km/h)	tare (t)	pay-load (t)	usable for MegaSwapBox
Sfgmmnss	475	12 200	120	23.5	61.0	No
Sffggmrrss	825	2 x 16 115	120	39.0	89.0	Yes
Sgkkms	845	15 890	120	18.0	46.0	Yes
Sgnss	1 240	18 250	120	19.8	60.2	Usable with exceeded loading gauge

Container pocket wagon Sfgmmnss is determined for transportation of ISO containers and its width of recess is only 2 464 mm and loading length only 12 200 mm. From this reason this wagon is not suitable for MegaSwapBoxes.

Container wagon Sffggmrrss – Megafret was produced by IRS Group and is used by Trenitalia. Two wagons are coupled to unit according to UIC 572. Code of the unit according to UIC 596-6 is C + 35. The wagon was designed in accordance to UIC 571-4, can negotiate a ferry ramp angle of 1°30´ with rail curve radius of 120 m and should not be humped or fly shunted when loaded. The wagon is able to operate in the UK. This wagon is suitable for MegaSwapBox. (figure 6 and 7)

Container wagon Sgkkms 698 was produced by GRAAFF Transportsysteme GmbH. The 4-axle bogie wagon with low loading height was specially developed for the transportation of large volume interchangeable containers and ISO containers up to overall loading weight of 34.0 t. The loading height was reduced to 845 mm over TOR. Code of the wagon according to UIC 596-6 is C + 33. This wagon is suitable for MegaSwapBox. (figure 8)

Flat wagon for intermodal transport Sgnss is only used for transportation of ISO containers and swap bodies. It is equipped with locks for fixation of containers and swap bodies. These locks are foldable. This wagon is suitable for MegaSwapBox only with exceeded loading gauge on selected lines.

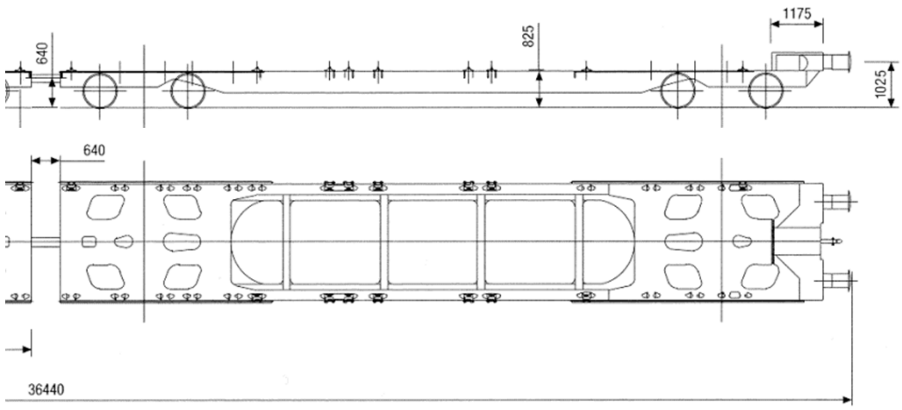

Fig. 6. Container wagon Sffggmrrss – Megafret

Fig. 7. Container wagon Sffggmrrss – Megafret with "TelliBox"

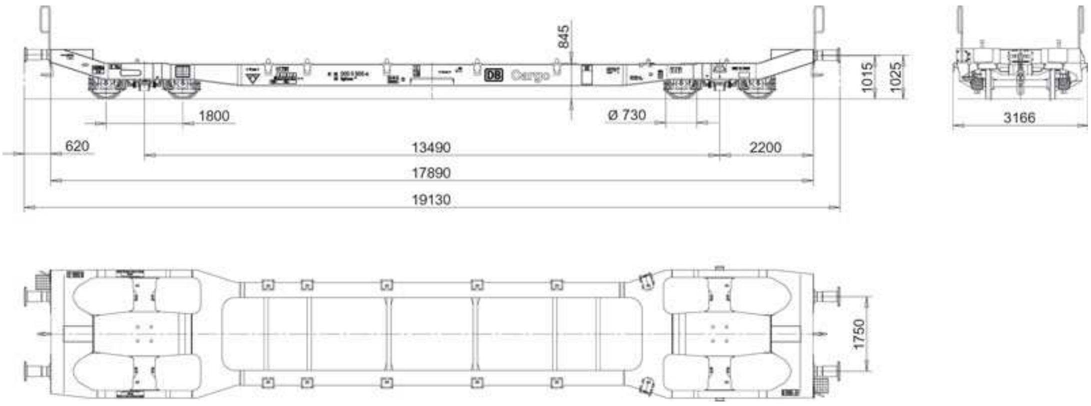

Fig. 8. Container wagon Sgkkms 698

Although there is relatively small number of railway freight wagons suitable for large size units (MSB in our case), their transportation is possible already now and railway is not limiting factor.

Worse situation is on the road, where in spite of specially developed truck DAF with low height of fifth wheel still some centimetres are over permissible 4000 mm (figure 9). Perhaps further design will decrease the height (smaller wheels cause problem with loading capacity of tyres), or the oversize will be tolerable, or only roads without this limit will be used for transport. Effort to go beyond permissible limits could be seen also in length (e.g. new semitrailer Kögel).

Water transport creates also problem for MSB. Ships are equipped with cells adapted for standard ISO containers, but dimensions of MSB are larger (broader). If MSBs are placed free on board then only modification of loading surfaces is necessary. Certainly, height of stacked units has to be considered during navigation under bridges. It should be noted that MSBs can be used only for inland water or short sea navigation.

Fig. 9. Truck DAF with chassis HRD and TelliBox

Fig. 10. MSB „TelliBox“ during presentation in intermodal terminal Duisburg

4. INNO FREIGHT

Innofreight Speditions, a small Austrian company, developed special types of containers which can be emptying by simple rotation by forklift with a rotator. There are several variants of these containers, for example WoodTainer XXL, WoodTainer XC, WoodTainer XL, WoodTainer XXL with hard top, AgroTainer XXXL, RockTainer etc. [5, 6].

The most of containers have 20 ft length, open top, standard arrangement of corner fitting, but width is 2 900 mm and height is mainly 2 900 mm as well (Fig. 11). Width of 2 900 mm causes problems in transport on the roads, where maximum permissible width of load is only 2 550 mm. Therefore these containers are predetermined only for railway transport.

Fig. 11. Innofreight´s container WoodTainer XXL

The typical representative of this kind of containers is WoodTainer XXL. Container volume is 46 m^3, total maximum weight of container is 23 t and tare 2.9 t. These containers are determined for transportation of light bulk products (woodchips, biomass etc.). The containers are characterized by reinforced fork lift pockets and very fast unloading by rotation. The special fork lift trucks are necessary for manipulate in such way (Fig. 12). Unloading cycle is very short, takes only about 40 sec.

The AgroTainer XXXL was developed to carry bulk material, in particular agricultural products. Its length is 30 ft but width only 2 550 mm and height 2 695. Loading volume is 54 m^3, maximum payload 31.9 t and tare 4.1 t. The width of 2 550 mm enables its transportation on roads without any difficulties. The AgroTainer XXXL is box type container without fork lift pockets. Loading of loose material can be realized though four covered hatches in the top and unloading can be achieved by gravity via a bulk flap in one of the end walls. The AgroTainer XXXL also has large side doors, covering entire length of container.

Fig. 12. Emptying of container by rotation by fork lift truck

5. CONLUSSIONS

The New MegaSwapBox (TelliBox) was introduced to public in Terminal Duisburg on 19 March, 2011. This was after test run on road, railway and water through Germany, Poland, Netherlands and United Kingdom.

Not always is the output of project in functional prototype as in this case. Expected properties of the new MSB should find sufficient usage on the intermodal logistic market. But number of problems remains for further solutions. Some design properties will require special handling procedures (because of openable doors which in closed position compose a bearing structural element, the MSB should be laid on a solid and straight surface, or chassis or wagon, when the doors are open for loading/unloading). There is risk of blocking door mechanisms under excessive deformation, etc. Wight of the MSB is remarkably higher against standard containers with solid side walls; similarly price will be much higher because of complex structure. Only practice will show whether new above standard properties will balance the higher weight and price. The involved parties of the consortium managed overcome virtually insolvable problems in the design of the prototype, so there is a chance that they will ménage to improve it into usable form in real intermodal freight transport, primarily on Europe - Asia corridors.

The TelliBox project is not the only one in efforts for searching for new solutions in intermodal trassport leading to higher efficiency of the logistic chain. This provides solid base for conclusion that many projects bring many new ideas that will turn into feasible solution.

6. REFERENCES

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