Transport technology with a use of the super-light rail vehicles

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Abstract

The paper presents the concept of transport technology with a use of the super-light rail vehicles. Mechanical and service parameters of these vehicles are determined. In the structure of the vehicles many typical road car elements are used. Firstly, in 1995, the model of the vehicle as an adaptation of two typical road microbuses were developed. In the second step the prototype of the super-light vehicle has been established. This vehicle is passenger and environment friendly. Energy consumption is two-time less than in the typical tram. Due to weight the degradation of the rail infrastructure is decreased. Non-conventional control system, as well as traffic safety problems, have been analysed.

1 Introduction

In Poland and other south and east European countries the railway traffic decreases significantly. Traffic density on many regional and suburban lines is very small. Also on the certain tramway lines passenger streams are very small. Detail analysis shows that – in many cases – application of the typical light vehicles is ineffective and need a high financial support. There are two solutions: a) closing the line; b) non-conventional use of the existing line.

If a non-conventional solution is also ineffective, than closing the line is argumented. In special cases (historical, military reason) very ineffective transportation systems are in service. These unique cases will be not considered.
In general this problem is connected with effective use of existing infrastructure. In the paper [4] two basic possibilities have been analysed: use of the so-called Karlsruhe model (see also [5]) and use of railway microbuses. The possibilities of application of special rail bicycles as tourist attraction have been also taken into account. This model was piloted also in Sweden. Integrated railway-tramway transport (Karlsruhe model) was intensively studied in Poland. Basic feasibility study in Kraków has been carried out in 1999 (comp. [2]). The model was considered also in Wroclaw, Warsaw, Poznań and other Polish cities.

Basic analysis on the possibility of a use of adapted road microbuses for passenger transport on the lines with small stream was carried out during 1993 and 1994 [3]. In 1995 vehicle called „MITOR-01” (two typical Polish microbuses, connected by special coupling elements, equipped with special wheels – Fig. 1) was tested on the tracks in the Kraków region and on the line Kraków-Zakopane. This line should be considered as a sub-mountain: maximum gradient – 30 per mille, minimum radius of horizontal curvature – about 200 m.

The test showed, that the MITOR-01 may move with maximum speed 80-100 km/h (safety is warranted), but more than one axle should be driven.

Use of ultra light rail vehicles – as a solution for city transport in the future – has been also analysed in the Great Britain [1].

The paper presents a transport technology with a use of the super-light vehicles as a possible tomorrow’s solution in cities and suburban areas.
Figure 1b

Figure 1: MITOR-01:
   a) one adapted road micro-bus,
   b) two coupled buses.

2 General concept of the proposed transport technology

The concept is based on the following observations:

1. Typical rail transport system in city and suburban area, including tramways, is effective, if passenger streams are on the minimum level of a few thousands passengers per day;
2. If a rail line exists and passenger stream significantly decreases (closing the line) than restoration of the traffic, using conventional method (attractive conventional rolling stock is very expensive, what is very important in Poland and other European country conditions), should be considered as risky;
3. Only significant reduction of the investment and service cost, including energy consumption, are reasonable from the point of view of probability of the failure;
4. If the restoration of the traffic on the rail line will be effective than external costs of the transport in city will reduced (in typical situation - more passengers from road to rail) and development of the city will be more sustainable.

From the above observations it follows that use of super-light vehicles gives the possibility to reduce the energy consumption in relation to the typical light
rolling stock and reduce track degradation. If non-conventional control and management system is also applied, with staff-less protection on the level crossing and one dispatching centre, than we obtain low level of the service costs. This condition is very important in Poland and other countries, where a road transport (microbuses and cars) develops rapidly (too much rapidly) and where is the lack of a capital for the rail transport improvement.

As it can be seen for application a new attractive rolling stock we may have many important barriers – the basic one is the lack of a capital. Because road vehicles are produced in big series (relatively low costs in relation to the rail vehicles, produced in short series), therefore use of the road vehicle elements (in the large scale) for building super-light rail vehicles is reasonable. Therefore the first model, MITOR-01, was based on the adapted road microbuses.

The basic restriction in the introducing the super-light vehicles is lack of the possibility to obtain sufficient longitudinal resistance in the case of collision. Therefore these vehicles may be used only on the lines with no conventional trains; there are many of such lines in Poland, and not only in Poland.

3 General concept of the super-light vehicle prototype MITOR-02

Fig. 2 shows the prototype of the super-light vehicle, called MITOR-02. There are two typical road trucks (traction units) with a middle part for passengers. For the passenger body part of a typical road bus has been used. The body is support on the trucks by joint elements. According to the Polish requirements for typical tramways, three doors are necessary for any side of the vehicle and minimum one should be adapted to the needs of disable passengers. Therefore, middle part of the passenger body is design as a low floor. The truck is equipped with special elastic wheels and – as tramways – in electro-magnetic braking system (additional braking system). The basic service and mechanical parameters of the MITOR-02 are as follows:

1. Capacity: 60-80 passengers (22 sitting)
2. Maximum weight (with passengers): 16 Tons
3. Maximum speed: 100 km/h
4. Driven axles: 4
5. Total length – 11,8 m
6. Width: 2,5 m

Figure 2: General view of a prototype of superlight rail vehicle MITOR-02.
4 Control and management system

It is assumed than only one dispatching centre should be sufficient for effective management of the traffic. For the communication between drivers and dispatcher the radio trucking signal system will be used (voice and data). The traffic will be carried out in general as for tramways with voice communication between drivers. The level crossing in the suburban area will be protected by light signals induced by vehicles (without wires).

5 Transport system with super-light vehicles MITOR-02 as an element of sustainable development of the cities and suburban area

Analysis of the effectiveness of the use of MITOR-02 has been carried out on the railway line Tarnów-Szczucin [3]. The traffic was suspended in the beginning of 2000. Before suspension for passenger transport diesel locomotive with 2 wagons were used. Transportation analysis shows that about 1400 persons per day and in both directions declare an interest in using rail for transport now. About 70% from these potential passenger use buses and microbuses now and 30% use cars. More than 60% of the trips are connected with transport to schools and work places in Tarnów (about 150 thousands inhabitants). It means that back on the rail may influence the reduction of environmental impact in Tarnów.

Detail analysis of the use of transport technology with super-light vehicles MITOR-02 on the line Tarnów-Szczucin gives the following results:

1. For the total investment cost only 1,8 million Euro (vehicles and infrastructure), income from the tickets practically covers all service costs, including vehicle, staff and infrastructure;
2. Back to rail gives total benefit (change of transportation process, decreasing of external costs, i.e. accidents, noise, air pollution, etc.) on the level 0,4 million Euro per year. In contrast, use of typical rail buses, with weight about 60 Tons is ineffective – this solution gives minus benefit (independently on the cost of typical rail buses) lack of benefits which might cover the infrastructure investment costs;
3. Effectiveness of the implementation of the proposed rail transport system should be described by the following values:
   - internal return ratio IRR = 15,5%;
   - benefit/cost ratio B/C = 1,77;
   - period of the return of capital PP = 10 years.
6 Summary and conclusions

The paper describes general concept of the transport technology with a use of the super-light rail vehicles. The prototype of this vehicle, called MITOR-02, has been presented. Basic elements of the detail analysis which has been carried out for the model implementation on the line Tamów-Szczucin are shortly pointed out. Implementation of the model on this line clearly indicates that use of MITOR-02 is effective and – at the same time – use of typical rail buses is ineffective. It means that there are situations in which only use of super-light rail vehicles should be considered as an element of the sustainable development of the cities and suburban area. It means also that slogan ”back on track” must be treated prudently – not any “back on track”, but “back on track” with the effective solution.

References