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Contribution of small capacity buses to level of road accidents and air polluting in the large cities

V. N. Fedotov, A. A. Bazhenov, J. N. Katcuba

Department of Vehicles and Technological Transport Complexes, St-Petersburg Mining University, Russia

Abstract

The market economy of Russia expanded the transport mobility of the population of the large cities. Therefore for many cities wide use of small capacity buses (as passenger fixed-route taxis) became characteristic. In the report results of an estimation of negative influence of fixed-route taxis in comparison with other categories of the cars are been. The researchers showed that the intensive traffic of fixed-route taxis in transport stream raises risk of road accident and becomes ecologically unsafe.

Keywords: small capacity buses, fixed-route taxis, a transport stream, risk of road accident, emissions of the pollutions

1. Introduction

The confident development of market economy of the country expanded need for movement of the population of large cities, with simultaneous reduction of number of people in groups with the identical purposes. In the large cities such as Moscow, St. Petersburg, Nizhny Novgorod, Volgograd, Yekaterinburg, etc. (12 cities at census of 2010) lives more than 1 million population.

In the location of the shopping centers, stations, educational establishments, offices and other objects greater passenger streams are forming. When the significant part of citizens has no personal vehicles wide use of small capacity buses (SCB) as fixed-route taxis for service of passengers in these cities of Russia was becoming characteristic.

As fixed-route taxis (routing taxi) the vehicles of categories M2 or M3/1 are used. The SCB of the models IVECO Daily, VW Crafter, Ford Transit, GAZelle 32213, PAZ 32053 for the transportation not more 22 passengers in addition to driver are used more often. According to classes R. No 52 ECE UN such buses are vehicles of small capacity [1].

Growth of number of vehicles is increasing the intensity of movement and in street system of city leads to the transport delays, the expending of fuel and the accelerated wear process of parts of vehicles. The urban population participating in traffic is subject of influence of the toxic gases of engines, microscopic particles of wear of the tires and brake parts of machines.

At the certain intensity of movement of SCB on separate sites of city highways the transport stream is changing quality of an environment, raises risk of accidents and becomes ecologically unsafe.

2. The features of conveyances by SCB as fixed-routes taxis (routing taxis) in the large cities

SCB as fixed-routes taxis provide a rational combination of the peculiar taxi convenience with low-cost trip in bus service. Simultaneous service of small group of people does the trip more comfortable (in a minibus is seated persons) and allows to fulfill "the stop on demand" that promotes reduction of time of approaches of passengers on foot to stops and to the purpose of a trip. The movement of the fixed-route taxis has rather high periodicity. It is reduces the waiting time of a vehicle at a stop. A circuit of the various routes covering even the most remote items and ways allows choosing to the passengers most for it a convenient route that reduces time of a trip and excludes the necessity to change of vehicle.

Unlike public transport fixed-route taxis carry out transportation on a commercial basis. Therefore the greatest interest for commercial motor transport are representing the highway running through zones with greater number of cultural and community places, shopping centers and administrative establishments (public zones). The volume of passenger traffic in such areas is remaining constant within day.

In a total amount of park of land vehicles in the large cities (the population of 1 million and more) SCB are 8...12 %. Ratios of categories of vehicles are given in fig. 1 on the example of the cities of Moscow, Yekaterinburg and Volgograd. Scientists of leading Russian universities investigate problems of transportation of the passengers by land vehicles in large cities [2, 3]. Been executed in Volgograd the complex the researches of features of transport streams, rates of movement of the vehicles, durability of details of tires and brakes of the SCB, their influences on the safety of traffic is interesting.

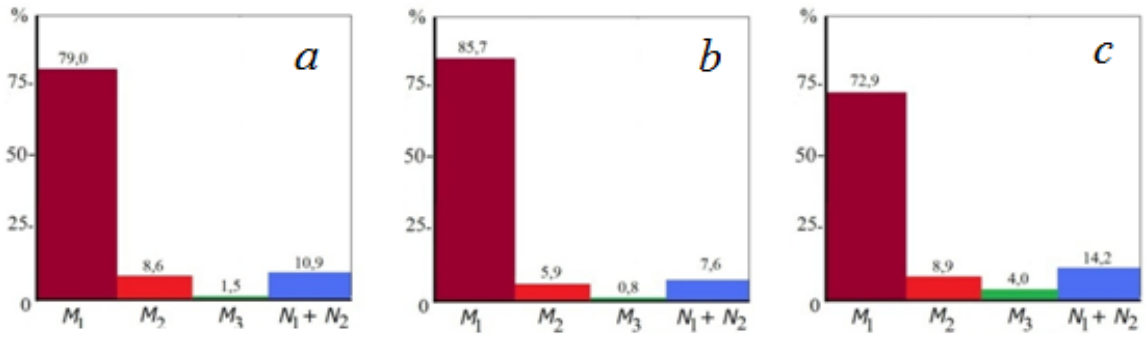

Figure1. Ratios of categories of vehicles (trucks of the category N_3 weighing over 12 t and trailers aren't shown): *a* – Volgograd; *b* – Moscow; *c* - Yekaterinburg

Researches were executed on sites of the city roads providing transportation of big masses of the population to the purposes of movement. On-site investigations revealed that such zone of bigger passenger traffic and how a result, of the intensity of the transport streams in the center of Volgograd - Lenin Street (on the length of 2.5 km). Through this part of the road, the buses of three routes, the trolleybuses of five routes and the fixed-route taxis of 46 routes are moving. Traffic of the routing taxis on 32 routes are transit. Also motor transport of the category M_1 participates in transportation of passengers. The road has three lines of movement in each direction which is divided by the trees and a bush up to 30 m wide.

Results of long-term researches showed, in 2002-2004 in this part of the road in one of the directions of movement, the intensity of cars in the afternoon, didn't exceed 790 auto/h, minibuses of 320 auto/h, trolleybuses of 56 auto/h, buses of 5 auto/h. The stream of land

transport had the maximum intensity to 14 h and gradually decreased to 18 h by 1.5 times and to 21 h by 4 times [4].

In 2004 year and next year, at preservation of the general picture of movement, the intensity of cars has been up to 890 auto/h in the afternoon, SCV up to 380-420 auto/h, intensity of public passenger transport has not changed. At 2006-2008 the growth of intensity of movement has proceeded: the intensity of vehicles streams has reached 1250, routing taxi - 600 auto/h.

Similar growth of intensity of movement on city roads happened and in other large cities. In St. Petersburg in 2008 year on sites of prospectuses of the Strikes, of the Obuhovsky and of the Nevsky the intensity of a transport stream began to reach the throughput of a highway. In such days the decrease of intensity of movement of trolleybuses less 50-52 auto/h are noted.

In the afternoon for the roads with movement on three lines the high density of a transport stream (80 - 100 auto/km) is characteristic, the maneuvers of cars are been complicated because a plenty of crossroads and pedestrian crossings (quantity of stops of public transport 4-6, routing taxi 8-11; an average waiting time 20-30 with; average speed of the message of vehicles does not exceed 16-20 km/h, and a trolleybuses of 10-14 km/h.).

At the same time, as have shown carried out researches, the character of movement of cars in a transport stream has difference, table 1. More maneuverable vehicles the cars category M_1 and SCB, which are moving at all width of the road, "reduce" transportation ability of a public transport line at simultaneous increase in risk of road accidents.

Table 1: Modes of movement of cars in a transport stream, %

Vehicles	Speeding	Braking	Constant speed	Idling
SCB (routing taxi)	31.1	26.2	17.5	25.2
Transport category M_1	22.8	15.9	31.3	30.0
Buses, trolleybuses (large passenger vehicles)	18.5	12.8	29.2	39.5

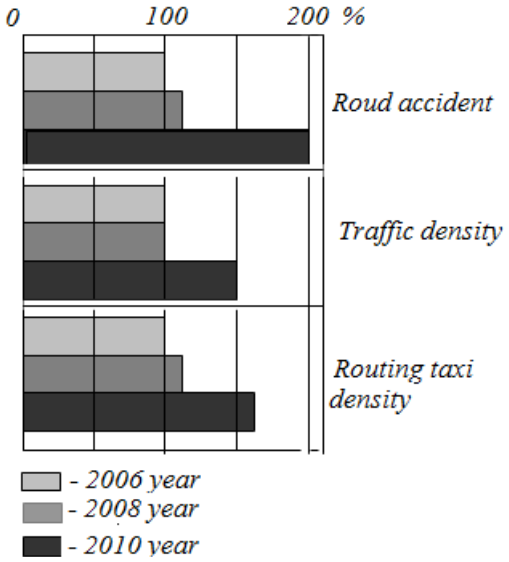

Figure 2. Comparative charts of relative number of road incidents, the general traffic density and density of routing taxis in years (on the example of Volgograd)

With the increase on the market of transport services the quantities of demands to the routes taxis, the autocarriers are being forced to employ unskilled drivers. In the conditions of growth of density of a transport stream the number of road incidents increased in the large cities. The greatest part of road incidents is connected with the wrong actions of drivers of routes taxis. Comparative charts of relative number of road incidents, the general traffic density and density of routing taxis in years (on the example of Volgograd) are given in fig. 2. To 2012 the fulfillment of the Federal target program of safety of traffic had reduced number of road accidents by 20-25%.

The variable character of movement, are frequent stops and the congestions at the crossroads by cars are the reasons of the high air pollution by the products of incomplete combustion of fuel at the public zones. Results of the calculations executed by authors on the ecologically unsafe sites of city road (Lenin av. on the length 2.5 km) have shown: if the intensity of movement are 420-600 auto/h on the one line of road, the emission of the toxic components of the exhaust gases - CO, C_nH_m, NO_x on highways with 2-3 strips in each direction can be accordingly: 2.7-4.8 kg/km*h; 0.23-0.35 kg/km*h; 0.18-0.27 kg/km*h. The assessment of mass of emissions was executed according to the methodical instructions [5], for the cars meeting standards of EURO-2. If relative quantity in a transport stream of SCB of 30-40%, the emission of their exhaust gases are 50% of total volume. Control measurements the concentrations of the carbon monoxide CO at edge of a highway at height from 0.5 to 4 m (during the summer period of year, at the days time, speed of a wind of 2-5 km/s) have shown, that in conditions, when buildings are being 7-12 floors; their building density of 70-80 %; there are the trees and the bushes the air pollution of CO are accordingly 8.7-2.6 mg/m^3. The intensity of movement on roads of St. Petersburg (for 2006 year) was higher - 4230 auto/h (the Moscovsky av.) and 4110 auto/h (the Nevsky av.). The exceed of the cars the categories of M_1, M_2 at the streams of transport were characteristic for large city. In similar conditions of measurements as at Volgograd the concentrations of CO had been 18.7 - 3.8 mg/m^3. Control measurements of concentration of particles at edge of a highway at height of 0.5-2.0 m (for the same conditions of traffic) showed: the general concentration of firm particles 0.24-1.41 mg/m^3, concentration of particles in the sizes less than 10 microns of 0.14-0.48 mg/m^3.

Prevalence of the transitive modes in movement of routing taxi on the durability of details of the vehicle influences considerably. It is more evident at the small service life of the details, which are working in the conditions of wearing out, for example: the brakes, the tires.

Wear of the brake pads (at braking) and also wiping tires and surface of the road because of the coupling of tires of cars with road creates the cloud of a dust from autotransport streams (together with emissions of the toxic gases).

According to information of the drivers of a fixed-route the tires and the brake shoes of front wheels are most intensively wearing. For an assessment of weight of particles of wear of a frictional layer of brake shoes and a working surface of tires (surface is contacting with the road) the researches at 10 buses of small capacity (a taxi of a motionless route) were conducted. Measurements of height of the working surface of tires was being carried out the regularly every 6,000-8,000 km. On replaced pads of brakes the residual thickness of a frictional layer was being measured. At this case the mileage of observed vehicles was being noted.

The analysis of researches has shown that replacements of the braking pads in front brake mechanisms of fixed-route taxis (irrespective of the manufacturer) were at the mileages from 10,000 to 16,000 km. The average mileage had been 13,200 km. According to the Operation manual on cars the brakes must has the check on every appointed mileage and, if necessary, pads must be replaced up if thickness of a frictional layer less 3 mm. Brakes of fixed-route taxi owing to decrease in efficiency of braking was being checked often and the pads were replaced on mileages, which are not stipulated by the manufacturer of a vehicle at manual for the brakes.

Wear height of a working surface of tires was measured for tires with the mileages from day of their mounting at interval 15-90 thousand km. Measurements of a working surface have not revealed catastrophic rate of reduction of height. That has allowed assuming, that the process of wear (in the above interval of mileage) is in a zone of the normal wear and can be approximated by linear dependence. By the processing of statistical data were determined the speeds of wear of the working surface of front tires of 0.08-0.10 mm on 1000 km for fixed-route taxis. The average mileage of tires up to the minimally admissible level of the height of working surface (2 mm for buses according to the national standard - GOST R 51709-2002) had been 92.6 thousand km.

The basic volume in the mass of a dust of autotransport streams - particles of a surface layer up of the asphalt road which can be wearing at more than 1 mm a year at intensive traffic of vehicles [6]. Particles 50 - 100 microns and more in size practically drop out at once on a surface of the road and are cleaned by road cars. Particles the sizes 2.5 - 10.0 microns are the most dangerous. The time of natural coagulation and sediment of the particles with these sizes are the tens of hours and can being equal to the time of stay of gaseous components in air are being [7].

Approached the account of a mass of the autotransport dust (without taking into account the wear of the brake pads and the tires pats of back wheels) for above of movement of cars and the sizes of a road has shown, that the dust of the tires and brake pads is up to 20 % of total amount of dust (tires dust of 0.098-0.112 kg/km*h, particles of brake pads of 0.038-0.044 kg/km*h. This dust is including more 60 % of the microscopic and ultramicroscopic particles of 10.0-2.5 microns and less. Calculations of intensity of wear process were spent under the formulas recommended in [8] and [9].

4. Conclusions

Thus, at all advantage of the SCB use as the routing taxi, their intensive movement in a zone of the greatest passenger traffic without controlling reduces efficiency of transport system, promotes growth of risk of road accident and aggravates ecology. Municipal formations, promoting expansion of volume of commercial transport services of new quality, for decrease in probability of the risks menacing to safety and health, should operate technological process of these services. Organizing the traffic process of cars across roads, which parallel to the main highway, for decrease in intensity of movement of cars on ecologically unsafe sites of city highways, controlling number of vehicles on a commercial route and improving system of training of drivers of routing taxis it is possible to create the transport system which will be combining high efficiency of motor transport with the minimum impact on environment.

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