

CABLEWAYS AND RAILWAYS – ECOLOGICAL ASPECTS

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***Abstract** – The great external influences of traffic and transport (pollution of water, air, soil, visual intrusion, congestion, etc.) coming from commercial modes of transport, have led to a growing interest in environmentally friendly modes, such as railways and cableways. The goal of their implementation in the daily transport of goods and passengers is to reduce the impact on the environment, health and quality of life of people. The attention of the designers of modern means of transport, in addition to speed, comfort and safety, is directed towards the rationalization of consumption, development and application of systems that ensure the return of part of the invested energy. The concept of sustainable development, which is based on the principles of economic development, environmental protection and the social factor, aims to protect the living resources that we are depleting, which are necessary for future generations. The aim of this paper is to present in more detail the positive impacts of cableways and rail transport as well as the concept of sustainable development.*

Keywords - cableways, railways, sustainable development, environment

1. INTRODUCTION

Preservation of the environment and its protection from further degradation has become a priority, especially since the last decade of the 20th century. The fast development of a number of new technologies has significantly affected the degradation of the environment. On the other hand, transport has become part of the everyday needs of modern man and the phenomenon of mobility has been transformed into a life style [1]. However, since transport more or less damages the environment, the processes of integration of the traffic flows together with changed in the economy and society followed by growing scientific and technological development require a completely new business philosophy and strategy for development of environmentally friendly modes of transport such as railway and special subsystem of passenger transport which includes cableways. The aim of this paper is to represent positive impacts of rail transport and cableways from the point of view of preservation of the environment, as well as a concept of their sustainable development.

2. TRANSPORT AND CONCEPT OF SUSTAINABLE DEVELOPMENT

Nowadays the concept of sustainable development

is associated with different activities both in production and provision of services and in the way of life. The concept of sustainable development considers and links economic justification, social factor and environment-friendliness.

Transport that is accessible to all, environmentally friendly and that positively contributes to local, national and international development and sustainable transport. All transport modes pollute the land, water and air to a certain extent. The dominance of road transport as the key land transport mode has shown a number of weaknesses, primarily due to the pollution of air and noise it produces, as well as traffic congestion in cities [1].

The concept of sustainability or sustainable development represents one of the basic concepts of economics of natural resources and the environment. It implies the need to balance various social values and the real pace of development of the society and thus provide a long-term perspective of the survival and progress of humanity. Therefore, sustainability means harmonization of the economic growth and development of the society with mandatory protection of the environment. Indicators for monitoring of the sustainability concept are based on modern environmental laws which aim to reveal the causal links between economic policy and policy of

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protection and improvement of the environment. [1]

Indicators of sustainable development indicate where the causal links between the economy, environment and society are becoming weak and show a way to solve these problems. A reliably indicator warns about a problem before it becomes serious and helps us understand what should be done in order to solve that problem. Indicators are as various as the types of systems they monitor, but there are some characteristics that are common to all efficient indicators. They are relevant, easy to understand, reliable and based on available data. One of the biggest problems in developing indicators of sustainable development is that often the most needed indicators are those for which there are no data, while indicators for which data are available are the least suitable for measuring sustainability. Therefore there are several advantages of traditional indicators:

- Data are easily accessible and can be used for comparisons at the national and international level;
- They help to define difficult areas;
- They can be combined in order to develop indicators of sustainable development [2].

Some indicators of sustainable development have acquired the same level of support as traditional economic indicators and thus proved to be a useful tool for improvement of sustainable development. So far, no method for determining qualitative indicators of sustainable development has gained a level of general acceptance. Therefore, states, professional and scientific institutions in different areas are making huge efforts to develop indicators of sustainable development [2]. The foundations on which sustainable future of modern society should be based consist of three dimensions: economic, environmental and social sustainability.

A fourth dimension is accepted in literature – cultural sustainability [3].

3. CABLEWAYS AND ELEMENTS OF SUSTAINABLE DEVELOPMENT OF CABLEWAYS

Population mobility has always been important in the context of socio-economic and technical-technological point of view. However, there is a growing importance of the environmental aspect of sustainable development. The main case of technical-technological aspects can be seen in motorized vehicles, where, thanks to emission standards, the damage of exhaust gasses in the environment and harmful impact on the health of the population is reduced. Buses, tramways, trolleybuses, cars and recently electric cars are already widely used in cities. However, the problem of today's mobility in the city is that it takes place mostly at ground level and as a

result streets and city roads are very busy, which leads to more frequent and increasing congestions. Cableways could have an important role in solving of this problem [4].

Cableways represent a subsystem of public transport of passengers where transport of passengers is realized by fixed routes on which cabins fixed on one or more cables are moving, while the power system during the whole period of functioning uses the electric energy [5]. At the moment cableways are mostly used for touristic purposes, the most often in ski centres and much less in urban centres. In urban areas they are mostly used for transport of passengers to locations that are at higher altitudes and at short distances. Suspended cableways have a great potential for use in urban areas. Their work can greatly contribute to relieving the traffic in cities, but the problem is that they do not have the necessary capacity to transport passengers, since their maximum capacity is 4.000 passengers / h. Therefore, they are not competitive with other subsystems for passenger transport in urban centres. However, in some cities such as Medeljin, New York, London, Portland, Caracas, Rio de Janeiro and La Paz, they are widely used as a subsystem of public transport of passengers and they have greatly contributed to relieve the city roads [4]. Figure 1 shows a cableway in London called: "Emirates Air Line" which transports passengers across the river Thames to the sports hall O2. At the highest point, the passengers are at about 90 meters above the surface of the Thames and the total distance crossed by each of the gondolas is 1.100 meters. The journey takes five to ten minutes and sometimes even longer so that the tourists can enjoy the view of London from the gondolas. Besides being a real decoration, the gondolas gliding at about 50 meters from the water are also a key transport across the river Thames to East London and one of the attempts to renew the local economy [6].



Fig. 1. Cableway in London [5]

Cableways as a subsystem of public transport of passengers have a number of advantages from the aspect of preservation of the environment comparing to other modes of transport: use of electric energy which can be obtained from renewable natural sources, no emission of CO₂ and exhaust gases, much less emission of noise, etc.

Thanks to the above mentioned advantages, transport of passengers by cableways can become competitive with other modes of transport in urban areas. In order to achieve that, it is necessary for cableways to increase their capacity, i.e. to transport a larger number of passengers per hour. One of the possibilities is to reduce the intervals and distances between cabins, which can be achieved by additional platforms and thus increase the capacity [6].

When we talk about the elements of sustainable development of cableways, we observe specific environmental, economic and social parameters characteristic for cableways.

Environmental parameters of cableways are observed through the consumption of resources of water for making artificial snow, then through erosion of the ground due to the use of ski centres, parameters of destruction of certain species of birds and plants in the area where a cableway is used, as well as one of the most important parameters – impact of the construction of cableway on the environment.

Economic parameters are the duration of the ski season, number of skiers, number of passengers using the city cableway and earnings, where the objective is to achieve the maximum values of these parameters.

The social parameter is the fact that spending time in nature has a positive impact on people's health, socializing, playing sports and that as a final result we have a healthy and satisfied user.

From all the above we see that it is complicated to harmonize all these parameters because an increase of one parameter results in a decrease of another.

4. ENVIRONMENTAL ASPECT OF RAILWAY TRANSPORT

The quality of railway traffic and transport can be seen as a level of user satisfaction, increased protection of the environment and safety in transport. If we take into account energy efficiency and quality, railways meet the criteria of the most convenient transporter. The ecological risk caused by railway traffic is the most often manifested in three forms, namely: impact on the environment, safety of transport of poisonous, inflammable and explosive goods, impact on employees and passengers [7]. Thanks to the growth of environmental awareness and implementation of environmental laws, the railway system, as the system with the highest capacity, the least air and water pollution and the least use of land, represents an important competitor to other modes of transport. In 2011, the European Union presented a number of objectives for establishment of a competitive and efficient transport system, which should be realized by 2050. The main goal is to reduce the emission of gases, which contribute to the creation of the greenhouse effect. Moreover, the plan envisages the development and application of new

sustainable drive systems and fuels [8].

The railway system has a very important role in reduction of negative impacts of traffic on the environment through management of energy-related emission and ensuring a continuous supply. A positive impact comes also from efficient use of available resources. Railways play an important role in minimizing the environmental effect of transport. As mentioned, the railways use electricity as a fuel with a great work performance (it transports passengers and goods). In order for the numerous environmental advantages of railways to be visible, it is necessary to manage the railway traffic well and efficiently. Otherwise, the quality of the environment may be significantly deteriorated [7]. The advantages of railways comparing to other modes are:

- Little emission of CO₂: they take about 1,5% of the total emissions from transport in the EU, from 1990 to 2016 they were reduced for 43%;
- Efficient use of land: comparing to roads, tracks use 40 times less land;
- Low energy consumption: it represents 1,8% of transport emissions in the EU and it was reduced for 20% from 1990 to 2016, while transport emission in the same period were increased for 29%;
- In urban areas, it is easier to develop railway stations than airports [9].

Many environmental benefits of railways may be diminished by poor organisation of transport and inefficient management of railway traffic. In this way, the quality of the environment can be deteriorated. The research in the USA (Engl. United States of America – USA), has shown that railway transport is on average for 63% more energy efficient than road transport. This is mostly due to the fact that the greatest part of railway infrastructure has been electrified, which largely contributes to lower emission of dangerous gases [7]. Figure 2, shows a comparison of the emissions of CO₂ in grams per passenger km, for different transport modes, where it has been confirmed that railways have several times lower emissions of CO₂ comparing to passenger cars and airplanes [10].

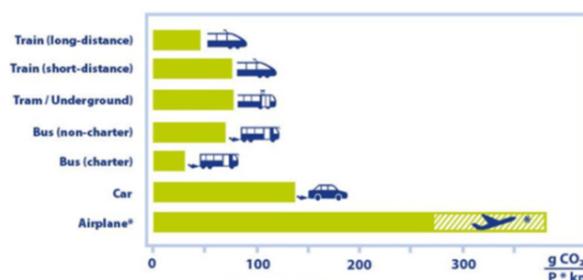


Fig. 2. Comparison of emission of CO₂ in grams per passenger km [10]

Noise and vibrations are considered to be the

biggest environmental deficiencies of railways. The main sources of noise in railway traffic are the propulsion of vehicle in the area of low speeds, the rolling of wheels on the rail and resistance of the environment, i.e. aerodynamics of vehicles in the area of high speeds. In the area of conventional speeds, the biggest problem is the noise created at the contact between the wheel and rail. This means that in the phase of track operation the level of noise from railway traffic depends primarily on the condition of surfaces at the contact between the wheel and rail, i.e. the causes of noise are roughness of contact surfaces of the wheel and/or rail, irregular geometric shapes of wheels and/or rails in the zone of their contact, then uneven rigidity along the track with discrete rail support, rail assemblies (mechanical with joints, insulated, welded), as well as tracks in curves [8]. Figure 3, presents the creation of noise at the contact between the wheel and rail.

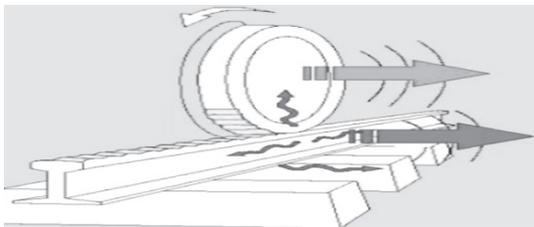


Fig. 3. Principle of generation of noise at the contact of wheel and rail [8]

Control of emission of noise and vibrations from railway traffic, from the aspect of railway infrastructure, is realised in the area of planning, design, construction and maintenance of railway lines [8]. Besides noise and vibrations, a great disadvantage of the railway from the point of view of economic parameters of sustainable development is the small market share, primarily in Europe. In Europe, freight railway transport represents about 16% and passenger transport about 6% out of the total flows of freight and passengers, which is a very small share. In order to increase these percentages, it is necessary to take the measures related to: maintenance and further development of environmentally friendly vehicles and infrastructure, increasing of attractiveness for transport of passengers and goods, reduction of operational costs, efficient use of new technologies through digitalisation, use of new materials, storage of energy etc. and development of the railway sector through education, trainings and improvement of the processes and tools for design, production and work [7].

5. CONCLUSION

Modern urban development imposes the need to introduce better quality, more economic and above all, more environmentally friendly systems for mass public transport of passengers. Given the environmental benefits of railways and cableways, especially in terms

of pollution of the environment and land occupation, their revitalisation in urban and suburban transport of big cities represents an imperative of their development. Implementation of new technologies and prescription of standard in the production of means of transport in these modes of transport in terms of tolerable emission of harmful effects ensures a high level of safety, energy savings, lower pollution and harmful effects on the human environment. In the fight against climate changes, drastic and rapid reductions of the emission of CO₂ are necessary in all sectors, including traffic depending on fossil fuels which is responsible for over 20% of the emissions of CO₂ from energy combustion.

In the future, environmental benefits of cableways could make cableway transport competitive with other modes of transport in urban areas. In order to achieve that, cableways should increase their capacity, i.e. they should transport a larger number of passengers per hour. One of the possibilities is to reduce the intervals and distances between the cabins, which can be achieved by additional platforms and thus increase the capacity [6].

Also, railway transport with its environmental advantages over other modes of transport, by taking the measures mentioned in this paper would become more competitive in the market and more represented mode of transport, which would lead to reduction of pollution of the environment.

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