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Transportation and Environmental Geotechnics

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Abstract

The Environmental Geotechnics as well Transportation Geotechnics are getting a great attention during last few decades. It is given by new demands for Transport Infrastructure generally, as well by greater attention to the environment protection. The paper is focused on the intersection of these two main points, particularly on the possibility to use large volumes of the different waste materials or byproducts for the earth structures of transport infrastructures as railways, motorways or airfields. Therefore not only mechanical - physical properties of these materials, as is e.g. ash, slag or construction and demolition waste, will be mentioned, but also the potential impact of their leakage on the surrounding environments. Potential contamination from the vehicles leak will be discussed as well. The final conclusion is specifying the conditions under which different waste and by-products can be applied in Transport Infrastructure.

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Keywords: transportation geotechnics, environmental geotechnics, earth structures, waste utilization, impact of leachate

1. Introduction

The Environmental Geotechnics as well Transportation Geotechnics are getting a great attention during last few decades. It is given by new demands for Transport Infrastructure generally, as well by greater attention to the environment protection.

In the field of Transport Infrastructure some priorities during last years were defined, e.g. in:

- Horizon 2020 Transport Advisory Group (TAG), May 2016 [25];
- FEHRL Vision 2025 for Road Transport in Europe [26];
- ECTP reFINE (2012) [27];

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- ELGIP position paper (2016) [28].

Basically all are emphasizing three aspects: sustainability, availability and affordability.

Sustainability is putting an accent on increase resource-efficiency of infrastructure. Namely via the development of more economically and environmentally acceptable earth structures. Therefore the attention is devoted to the decrease of energy, consumption of natural aggregates and land saving, e.g. [1, 2, 3, 4, 5].

Availability is putting an accent on increase of infrastructure capacity not only for current but also for expected changes in future, e.g. from the weather change point of view. Therefore the interaction of transport infrastructure with natural hazards as e.g. landslides, rock falls, floods are studied very intensively – e.g. European project INTACT, as well by authors: [6, 7, 8].

Affordability is strongly connected with reduction of life cycle costs, for which new methods of structure conditions are measured to be able to predict the structure deterioration – ageing – as well with efficient methods of structure maintenance, e.g. [9, 10, 11, 12, 13].

Geotechnical engineering always had a very close relationship to nature. However gradually the interest in and problems associated with environment protection is acquiring a special position in the wider branch of classical geotechnics, [14].

A very significant step in this process was State of the Art Report "Environmental Geotechnics" presented by Sembenelli and Ueshita during the X^{th} International Conference SMFE in Stockholm 1981. From 1994 international congresses of Environmental Geotechnics are organized by ISSMFE (ISSMGE) - Edmonton 1994, Osaka 1996, Lisbon 1998, Rio de Janeiro 2002, Cardiff 2006, New Delhi 2010 and Melbourne 2014 [15].

With respect to the regard of the earth structures and environmental problems Sembenelli and Ueshita defined 4 main spheres: removal solids from surface, extraction of solids from underground, solids accumulated on surface and finally underground deposits. As geotechnical engineering is more connected with deposition, few aspects are mentioned. The surface deposition is mostly connected with landfills, tailing dams and spoil heaps, e.g. [16, 17]. Problem of underground deposits is very challenging from the point of view of Environmental Geotechnics, but for the general population it is very sensitive. Filling of underground spaces by large-volume waste as for example flying ash from electric power stations can limit the surface deformations on one side but on the other side this waste material is in direct contact with underground water and therefore it is necessary to prove that this interaction is not dangerous for environments. A very specific problem is associated with high level radioactive waste disposal in underground spaces, e.g. [18, 19]. It is an up to date fundamental concept of disposal of spent fuel from nuclear power plants. Principle of multi-barrier protection is applied there and a natural geological barrier is a fundamental element of this protection.

This brief specification shows how wide the problem of interaction of Environment a Transport Geotechnics is. Therefore the paper is focused only on limited aspects, mostly connected with utilization of large volume waste for earth structures of transport engineering to save natural aggregates respectively on protection of transport infrastructures ground against possible contamination.

2. Waste, recycled materials utilization

2.1. Basic principles of waste management

Human activities produce a huge amount of different waste. Therefore the main important aim is to decrease the volume of such waste. Only after that the second question is what to do with waste which is produced. Basically there are two main possibilities:

- waste deposition;
- waste utilization.

It is obvious that the second alternative is preferred. From the Transport Infrastructure point of view, waste produced in large volumes is getting top priority, as:

- Construction and demolition waste – e.g. old bricks, concrete, ceramics, gravel ballast;
- Industrial waste – e.g. ash, dross, slag;
- Mining waste – overlaying soils, waste rock, quarry waste, residues after washing china clay etc.

During last period the orientation is also on other relatively large volume materials as tyres, glass, polystyrene.

The discussion about excavated soil is still going on, whether we have to look on it as on the waste material or not, what quick and cheap methods of control of possible contamination can be used.

In the first place the producer of the waste should have the interest to find practical application for waste, as it is not only environment friendly solution but in many cases also financially attractive solution.

Practical application can have different manner of utilization:

- Without any improvement – for example old tyres can be used directly in protection barriers against rock fall, e.g. in the form of reinforced protection embankment (wall);
- With significant changes of the waste character – e.g. for above mentioned tyres, they can be crushed down and small particles can be used as additive material for new asphalt pavement;