19th Seminar of Track Management
STRAHOS 2022

Using of Recycled Materials in Substructure

Richard Svoboda, Dana Hubáčková, Jan Valehrach
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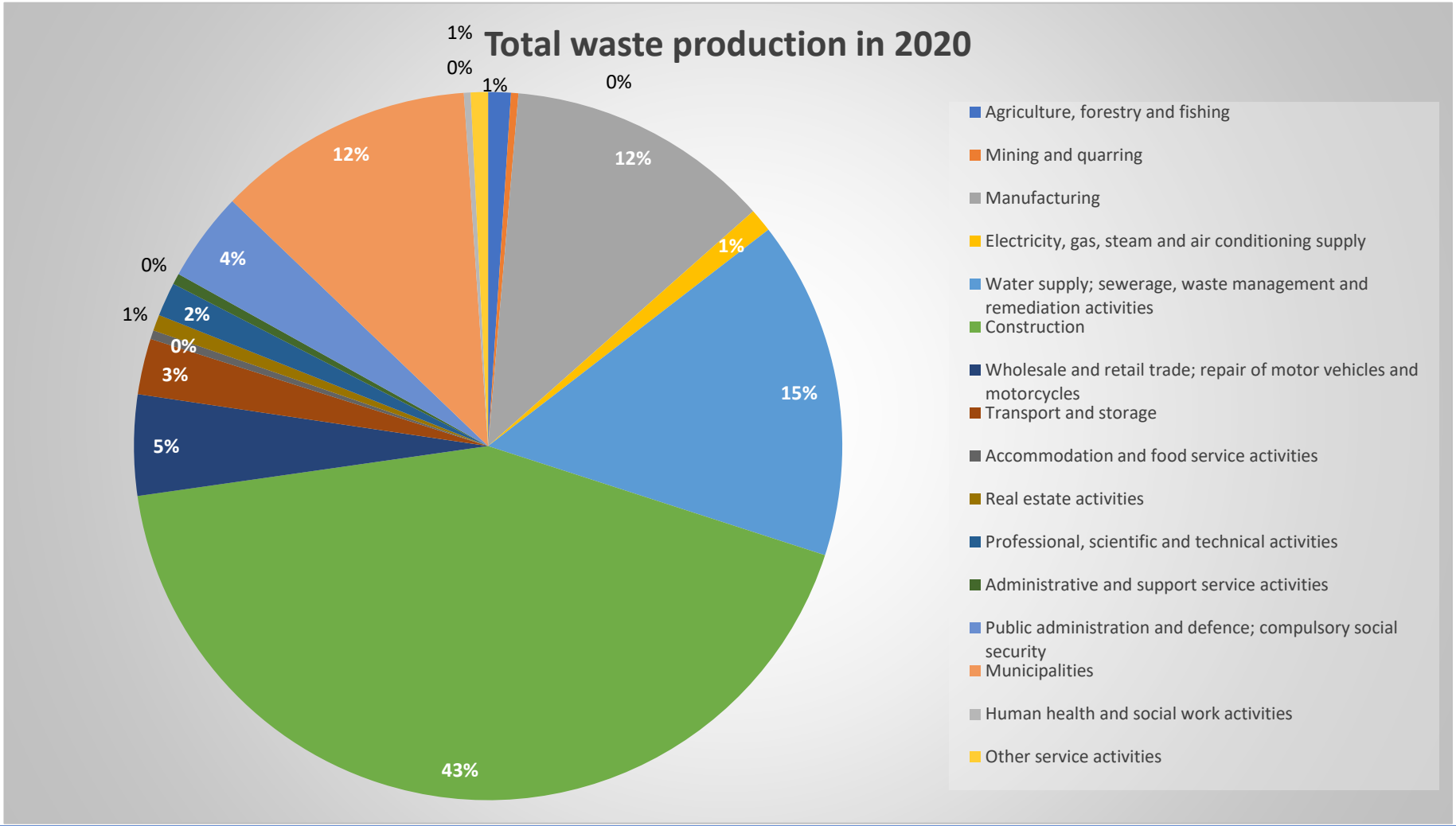
Project
'Special Session and Workshop
on Seminar of Track Management STRAHOS'
supported by
Visegrad Fund

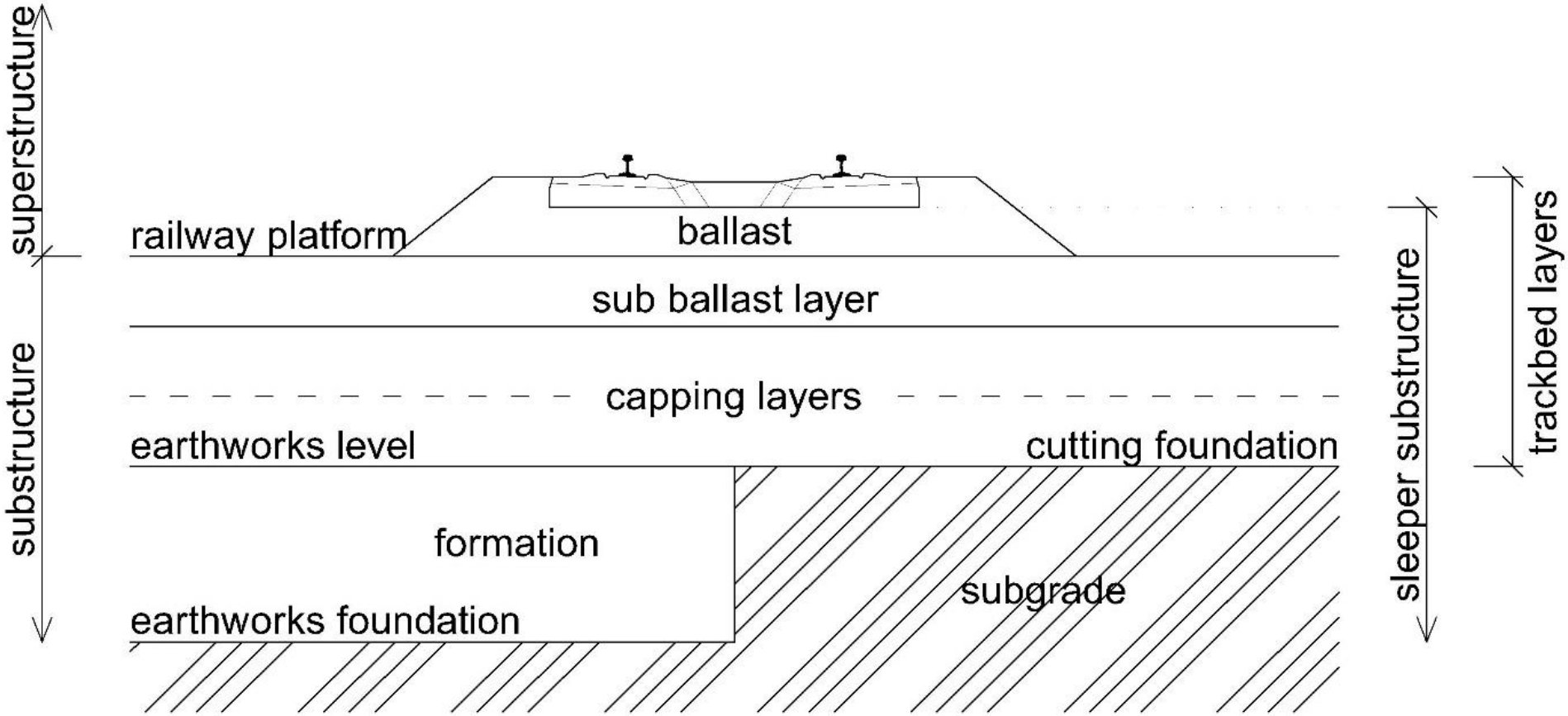
Introduction

- Project with support of Ministry of Industry and Trade Cooperation with Institute of Technology of Building Materials and Components
- Focus to the effective use of secondary raw materials
- Cooperation with Institute of Building materials and Components
- Project FV40081 - Advanced technologies for installation and restoration of the protective layers of railway substructure with the efficient use of secondary raw materials

Construction waste



Substructure



Natural aggregate

- Mineral raw material used in practically all construction sectors
- Significant decrease of deposits permitted to be mined
- Ecological burden - missing aggregates will have to be imported from more distant regions/abroad
- Price has increased significantly
- Consumption of crushed aggregate has grown significantly

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Design of subballast

- The following materials can be used for the capping layers in the Czech republic
  - Gravel
  - Crushed aggregate
  - Stabilization and improved soil
  - Geosynthetics
  - Asphalt concrete
  - Other materials with the consent of Czech railway infrastructure manager
- The actual design of the capping layers is carried out by the prescribed calculation using the DORNII method.

Design of subballast

Highest speed limit (kph)	Expected operational loads (millions gross tons/year)	Track class throughout whole lifetime	Composition of trackbed layers
≤80	<2	A – D	min. 200 crushed stone fraction 0/32 kv (min. 150 with the agreement of infrastructure manager)
	2-8	A – D	min. 250 crushed stone fraction 0/32 kv
	>8	A – D	min. 300 crushed stone fraction 0/32
81-120	<2	A – D	min. 250 crushed stone fraction 0/32 kv
	2-8	A – D	min. 300 crushed stone fraction 0/32 kv
	>8	A – D	min. 300 crushed stone fraction 0/32
121-160	<2	A – D	min. 300 crushed stone fraction 0/32 kv
	2-8	A – D	Var. I: min. 400 crushed stone fraction 0/32 kv Var. II: min. 250 crushed stone fraction 0/63 kv
	>8	A – D	Var. I: min. 400 crushed stone fraction 0/32 kv Var. II: min. 250 crushed stone fraction 0/63 kv
161-200 (incl.)	For all operational loads	A – D	Var. I: min. 400 crushed stone fraction 0/63 kv Var. II: min. 100/asphalt concrete +250 crushed stone fraction 0/63 kv

Waste for bonded layer

- Hydraulic properties
- Mixing with the soil can be used for the improvement of the capping layers
- Unstable composition appears to be problematic

Waste for bonded layer

- **High temperature fly ash**
- coal combustion at temperatures of 1200 – 1700 °C
- **Fluid fly ash**
- burning finely ground coal in fluid boilers at lower temperatures (850°C)
- **Biomass bottom ash**
- burning biomass
- **Coal slag**
- contains unburned remains of the combustible component of coal
- **Cement kiln dust**
- dust particles from the flue gas when burning cement





Waste for bonded layer

- **Waste material from ballast cleaning**
  - highly dependent on the content and origin of fine particles/pollution
  - contains clay or fine elements which can be blown from the surroundings or seep into the track bed from the subsoil or dropped from vagons.

Waste for bonded layer

- **Recycled concrete**
  - mixed concrete rubble, lesser extent also brick fragments

- **Recycled asphalt**
  - fraction 0/16, can no longer be used for roads, very low load-bearing capacity

Conclusion

- The time is coming when it will be necessary to replace natural aggregates in railway construction (as well as in other sectors).
- Waste materials appears to be a suitable alternative.
- For unbonded layers seems to be possible material from cleaning the ballast bed and concrete or asphalt recycled material.
- Recycled concrete appears to be the most suitable material, insertion into the test section is planned in the next phase of the project.

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