HRVATSKO ASFALTERSKO DRUŠTVO

Poboljšanje slabo nosivog tla ispod kolnika

Improvement of weak soil below the pavement

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- **MANAGING DIRECTOR –**
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  AREA MANAGER FOR SLOVAKIA/CROATIA

STUDIES:

1997 – 2000
SLOVAK TECHNICAL UNIVERSITY
Faculty of Civil Engineering
Bc. (Architecture and Civil Engineering)

2000 – 2002
SLOVAK TECHNICAL UNIVERSITY
Faculty of Civil Engineering
Master (Economy and Building Management)

WORK:

2002-2005
UK – Various jobs and language improvement

2005 – 2014
SAT SLOVENSKO – Economist
2014 - 2018
SAT SLOVENSKO – Economist, Managing Director
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SAT SLOVENSKO+OAT – Technical, Managing Director and Area Manager for SK/HR

SAT SLOVENSKO s.r.o.

- **SLOVAKIA**
- **Subgrade replacement – substituted by improvement through soil improvement**
  (for several years now, cooperation among designers, investors and contractors)

- **CROATIA**
- **Subgrade replacement**
  (excavation of unsuitable material, disposal at a landfill, import and placement of aggregate)

SUBGRADE REPLACEMENT – APPLICATIONS

- Removal of unsuitable soil and its replacement with crushed aggregate

- **Used in cases where:**
  - the original soil is compressible, clayey, organic or unsuitable in terms of bearing capacity
  - there is a risk of uneaven settlement of the subgrade of the planned structure

SUBGRADE REPLACEMENT – PROCEDURE

- Excavation of unsuitable soil
- Transport of soil to landfill
- Compaction of the subgrade
- Import of suitable material
- Spreading and compaction of suitable material

SUBGRADE REPLACEMENT – ENVIRONMENTAL IMPACTS

- Greater environmental impact
- Material transport – higher CO

SUBGRADE REPLACEMENT – ECONOMIC IMPACTS

- Simple construction process
- Longer construction time
- Distance to and availability of quarries
- Cost of suitable material
- Cost for disposal of unsuitable soil

SUBGRADE IMPROVEMENT – APPLICATIONS

- Improvement of the mechanical and physical properties of soils
- Addition of a hydraulic binder to the original soil
- Use of existing materials directly on site

SUBGRADE IMPROVEMENT – PROCEDURE

- Determination of the type and quantity of binder
- Breaking up the soil structure
- Dosing of the binder
- Homogenization of soil and binder
- Spreading and compaction of the stabilized layer
- Curing of the stabilized layer by watering
- Maturation (curing) of the stabilized soil

SUBGRADE IMPROVEMENT – BINDERS

Commonly used binders:

- **Lime-based**
- **Mixed (composite)**
- **Cement-based**

SUBGRADE IMPROVEMENT – ENVIRONMENTAL IMPACTS

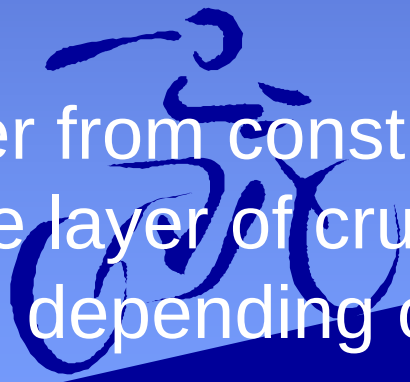
- More environmentally friendly technology
- Use of existing soil on site
- Minimizes material transport
- Shorter construction time
- Lower carbon footprint

SUBGRADE IMPROVEMENT – ECONOMIC IMPACTS

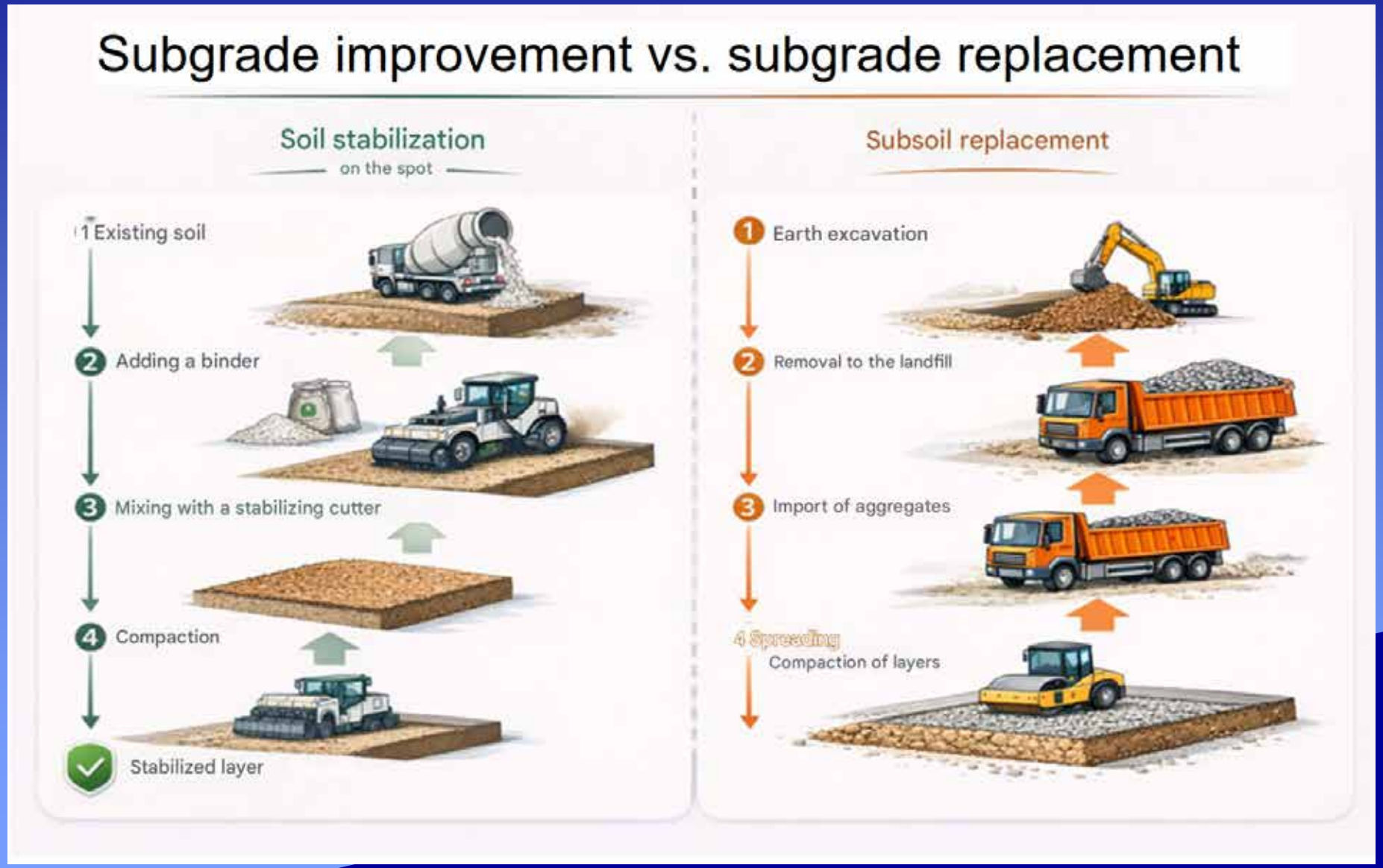
- Minimal material transport -binder
- No landfills (operation)
- Smaller volumes of earthworks
- Shorter construction time
- Minimal transport of materials

SUBGRADE IMPROVEMENT – QUALITY IMPACTS

- The minimum air temperature during execution must not fall below +5 C, and the air temperature over the previous 24 hours must not fall below +3 C
- Do not carry out works during rainy weather
- Incorporation of the binder into the mixture within a maximum of 180 minutes
- Ensure protection of the improved layer from construction traffic until it is covered with an additional protective layer of crushed aggregate after 4–7 days of curing and maturation, depending on climatic conditions



SUBGRADE IMPROVEMENT VS. SUBGRADE REPLACEMENT



TECHNOLOGY COMPARISON

- **Subgrade replacement**
  ADVANTAGES
- Reliability of the solution
- Versatility of application
- Simple construction process

- **Subgrade improvement**
  ADVANTAGES
- Lower construction costs
- Reduced volume of material transport
- Faster construction execution
- Improved soil properties

TECHNOLOGY COMPARISON

- **Subgrade replacement**
  DISADVANTAGES
- High implementation costs
- Large volume of material transport
- Greater environmental impact
- Longer construction time

- **Subgrade improvement**
  DISADVANTAGES
- Dependence on the properties of the original soil
- CO_2 emissions from binder production
- Required technological equipment

METHODS OF SOIL STABILIZATION IMPLEMENTATION

ACCORDING TO LABORATORY TESTING

- Soil sampling
- Laboratory analysis of soil
- Technical specification (TS) and mix design proposal
- Implementation according to TS

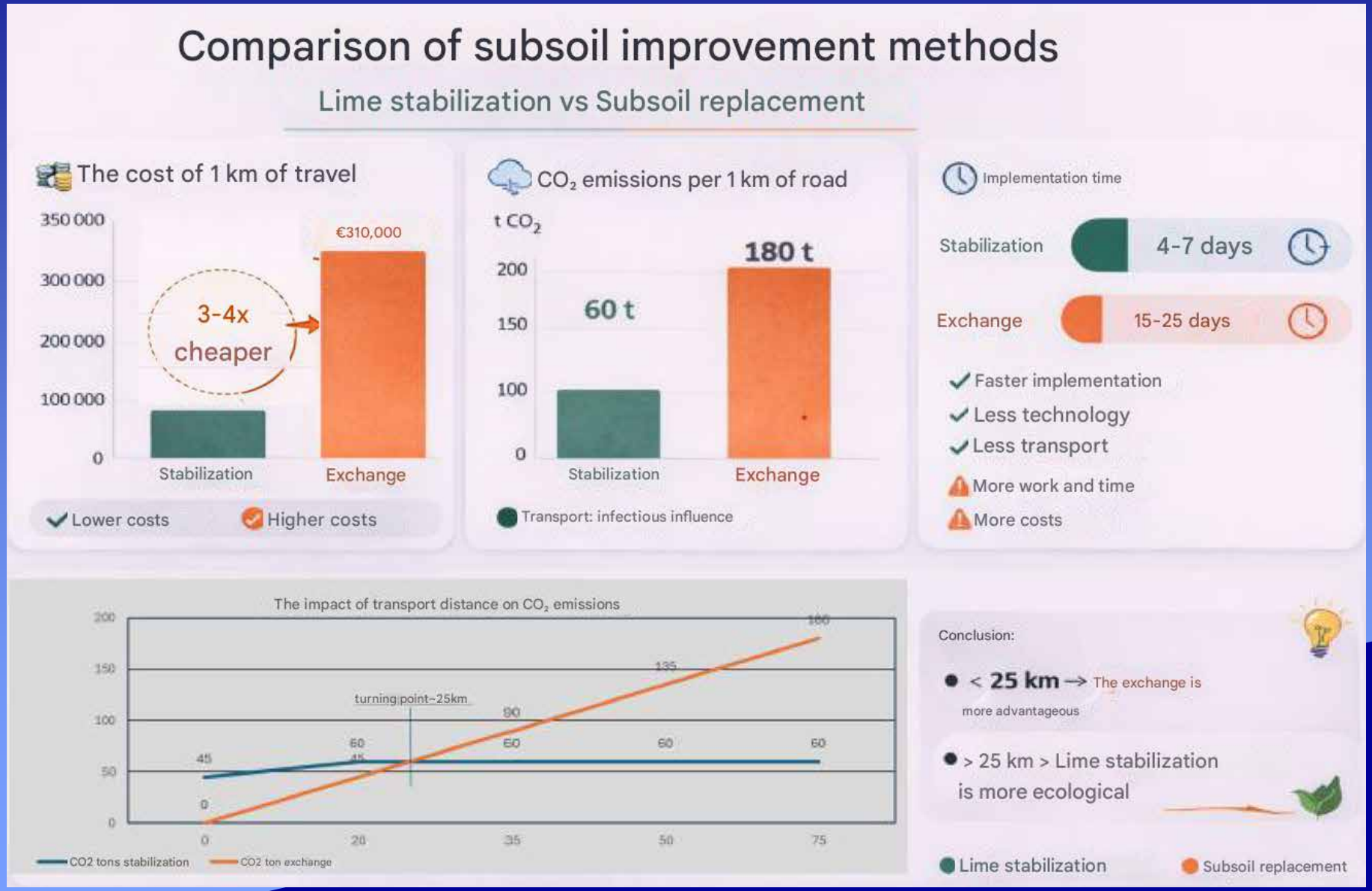
ACCORDING SAT

- Soil inspection
- Design and implementation based on SAT SLOVENSKO experience for the designed or required bearing capacity parameter (MPa)

SUBGRADE IMPROVEMENT – EQUIPMENT

- Soil stabilizer
- Binder spreader
- Grader
- Soil compactor (min. 13 tons)
- Tankers for binder transport
- Water tanker for mixing (towed)
- Water transport tanker
- Water tanker for curing

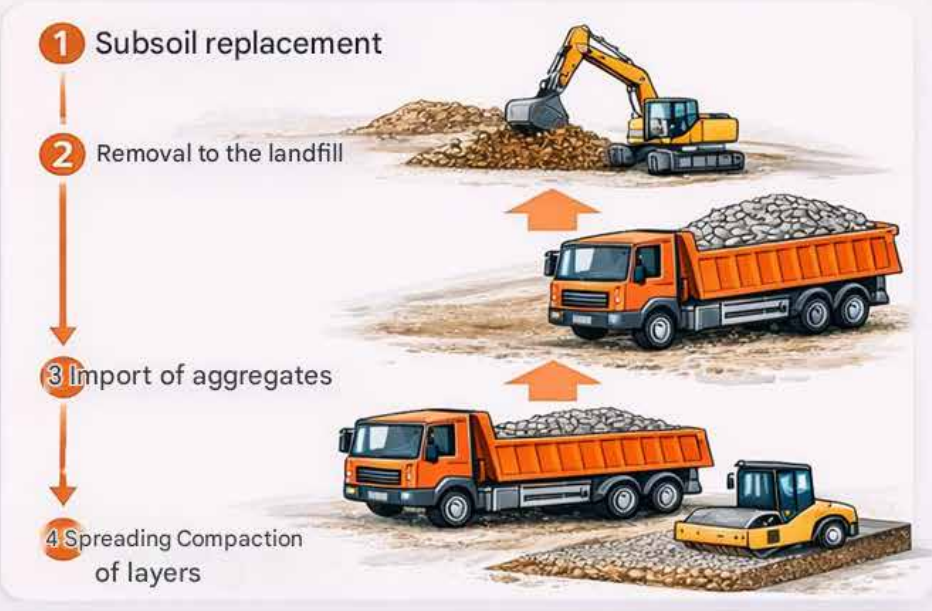
COMPARISON OF SUBGRADE IMPROVEMENT METHODS

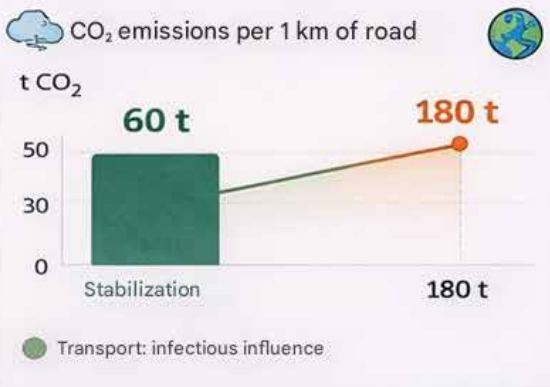


COMPARISON OF SUBGRADE IMPROVEMENT METHODS

Comparison of subsoil improvement methods

Lime stabilization vs Subsoil replacement



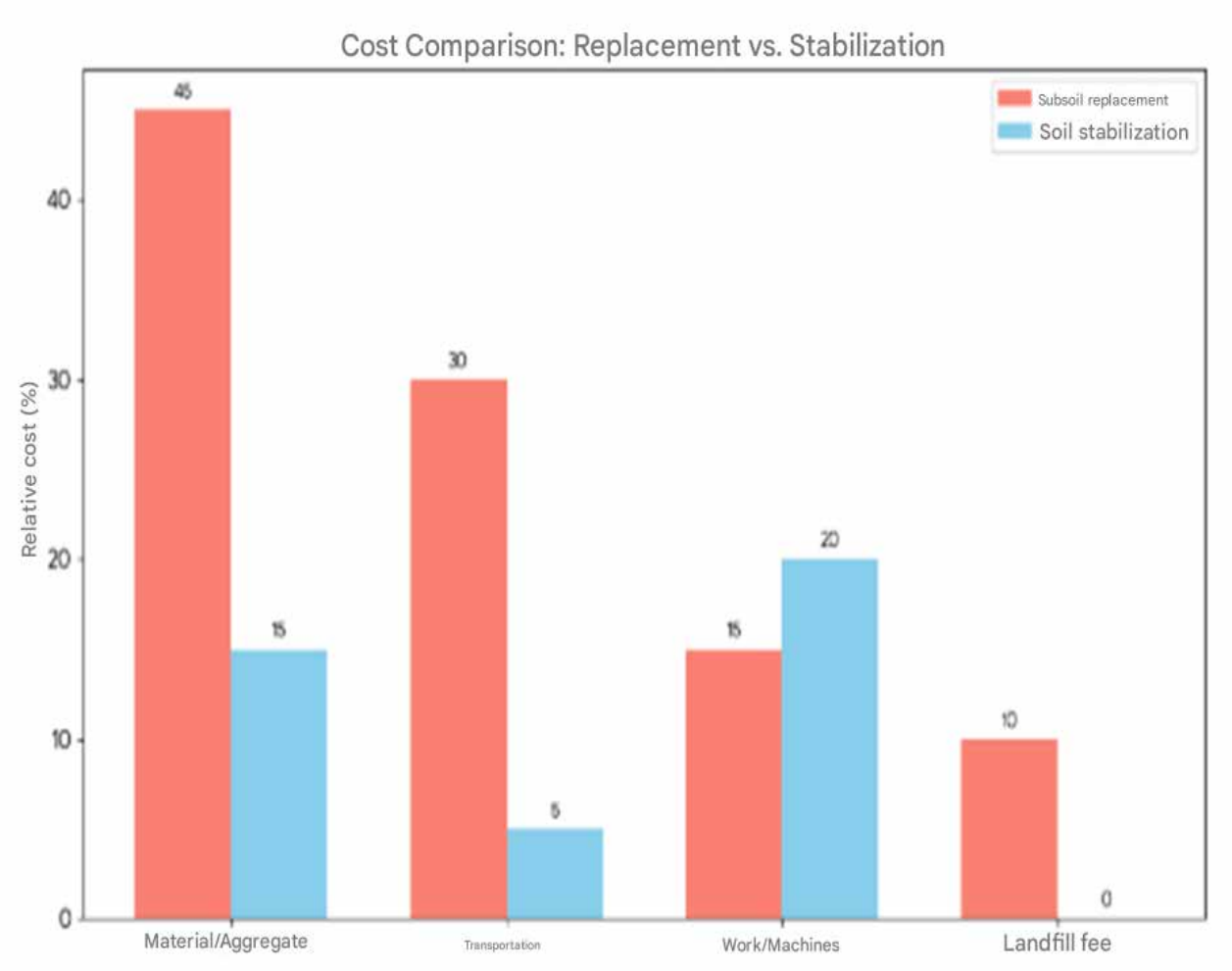


zerte criteria:	Lime stabilization	Subsoil replacement
costs	low	high
transport	tall	tall
construction time	short	longer
use of local materials	yes	no
CO_2	low	high

COST ITEM COMPARISON

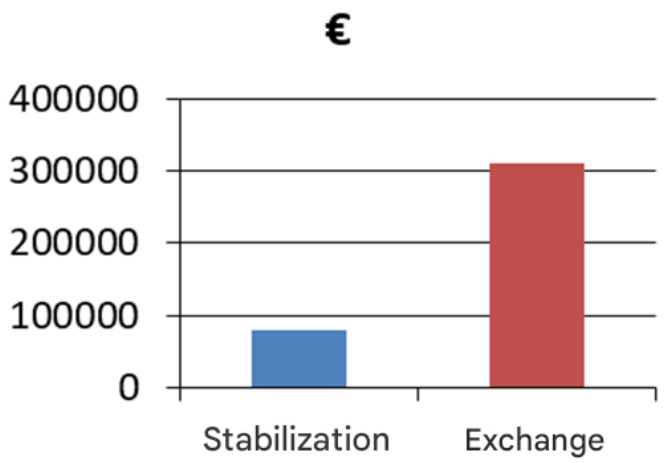
- Where does the biggest cost difference between the two methods arise?
- We find the answer in the graph

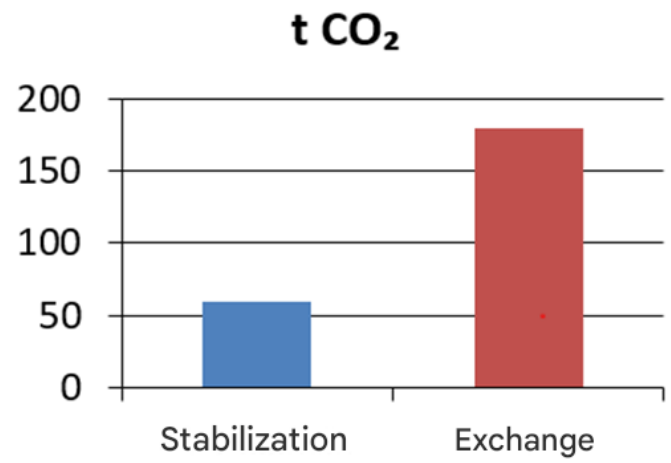
- After calculating costs, the total savings is 60%



COMPARISON OF SUBGRADE IMPROVEMENT METHODS

CONCLUSION – Comparison of stabilization and subsoil replacement





- ✓ Lime stabilization significantly reduces CO2 emissions
- ✓ Stabilization is more economically advantageous
- ✓ When transporting aggregates > 25 km, stabilization is more environmentally friendly
- ✓ Subsoil replacement is suitable for short transport and gravelly soils

PROJECTS USING SUBGRADE IMPROVEMENT METHODS

- Every year, SAT SLOVENSKO s.r.o. carries out projects using the method of improving unsuitable subgrade

- For example, one of the key projects in 2025 was the state contract “Construction of taxiways Airport”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– TAXIWAYS

- Cooperation of STRABAG group companies
- Original project – inadequate bearing capacity of subgrade replacement of unsuitable soils with aggregate to a thickness of 90cm
- Change of technology during the procurement process
- New project – replacement of subgrade exchange with soil stabilization; achieved cost savings of 50% and winning the contractor tender

– TAXIWAYS

Improvement of low-bearing-capacity subgrade using lime stabilization – procedure:

- Excavation of the top soil layer (thickness 40 cm) with temporary storage in an intermediate stockpile
- Stabilization of the lower soil layer with lime (thickness 50 cm)
- Reinstatement of the top soil layer back onto the section
- Stabilization of the top soil layer with lime (thickness 40 cm)

IMPROVEMENT OF UNSUITABLE SOILS

- **PRINCIPLE:** Mixing unsuitable or less suitable soils with a specific type and amount of hydraulic binder depending on the soil type and moisture content

- **RESULT:** Improvement of physical and mechanical properties and increased bearing capacity of the subgrade under road structures, paved areas, halls, and buildings

- **CONTROL:** Measurement of the achieved bearing capacity (plate load test – PLT) in MPa.

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- Thank you for your attention

- Ing. Radoslav Prokop