

# Frost Protection of roads and railways: laboratory research

Elena Kuznetsova  
Benoit Loranger  
Karlis Rieksts



# Outline

- Introduction to the FROST project
- Laboratory research: topic 1
- Laboratory research: topic 2

## Project «FROST: Frost protection of roads and railways»

- **Funded** by the Research Council of Norway (RCN), Norwegian Public Road Administration (NPRA), Norwegian Railway Administration (Bane NOR), Leca and Glasopor
- **Duration:** 4 years (2015-2019)
- **Total budget:** NOK 10.5 mln
- 2 PhDs and 2 master students



# Project team

## University Laval, Canada



Jean Cote  
• Professor



Guy Dore  
• Professor

## Statens Vegvesen



Jostein Aksnes  
(PhD)  
• Advisory board



Kjell Arne (PhD)  
• Advisory board

## NTNU



Inge Hoff  
• Professor



Elena Kuznetsova  
• Postdoc

## NTNU



Karlis Rieksts  
• PhD student



Benoit Loranger  
• PhD student

## Jernbaneverket



Juan Barerra  
• Advisory board

# Supervision

University Laval, Canada



Jean Cote

• Professor



Guy Dore

• Professor  
• University Laval

NTNU



Inge Hoff

• Professor NTNU



Elena Kuznetsova

• Postdoc NTNU



Karlis Rieksts

• PhD student



Benoit Loranger

• PhD student

## Scientific Advisory board

Statens Vegvesen

Bane NOR

Glasopor

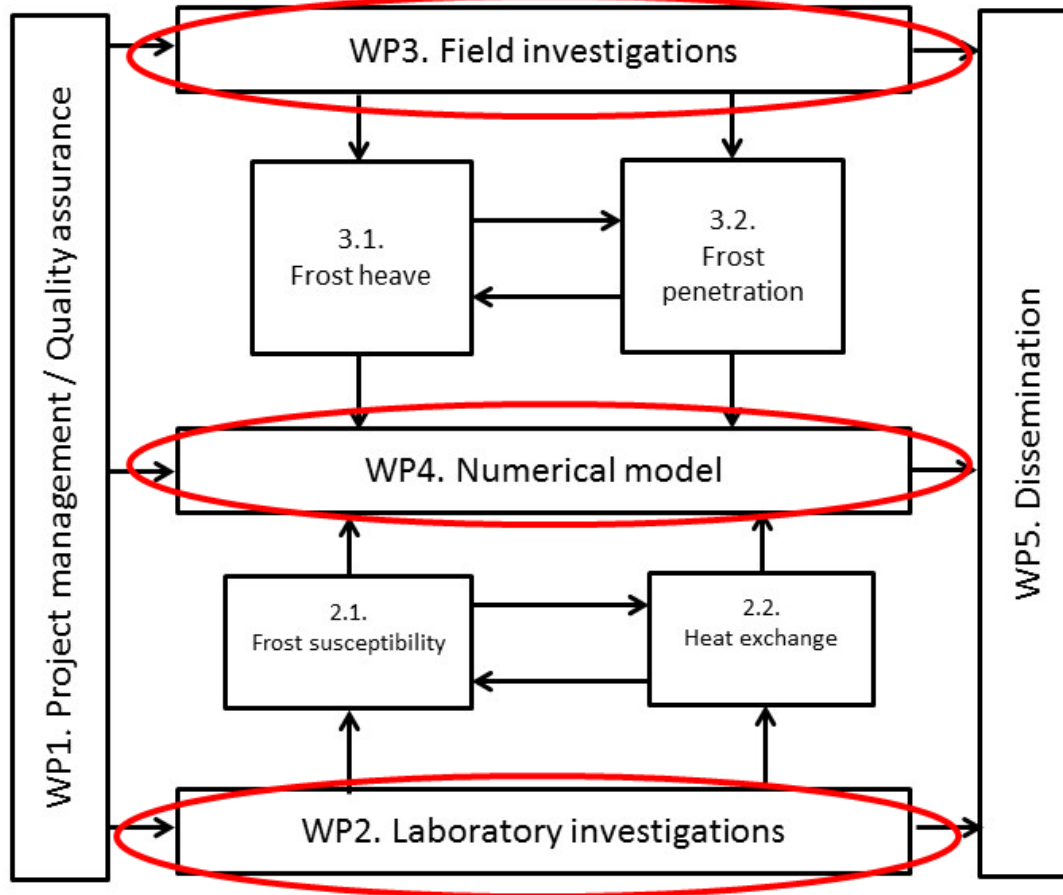
Leca

FORSET GRUS

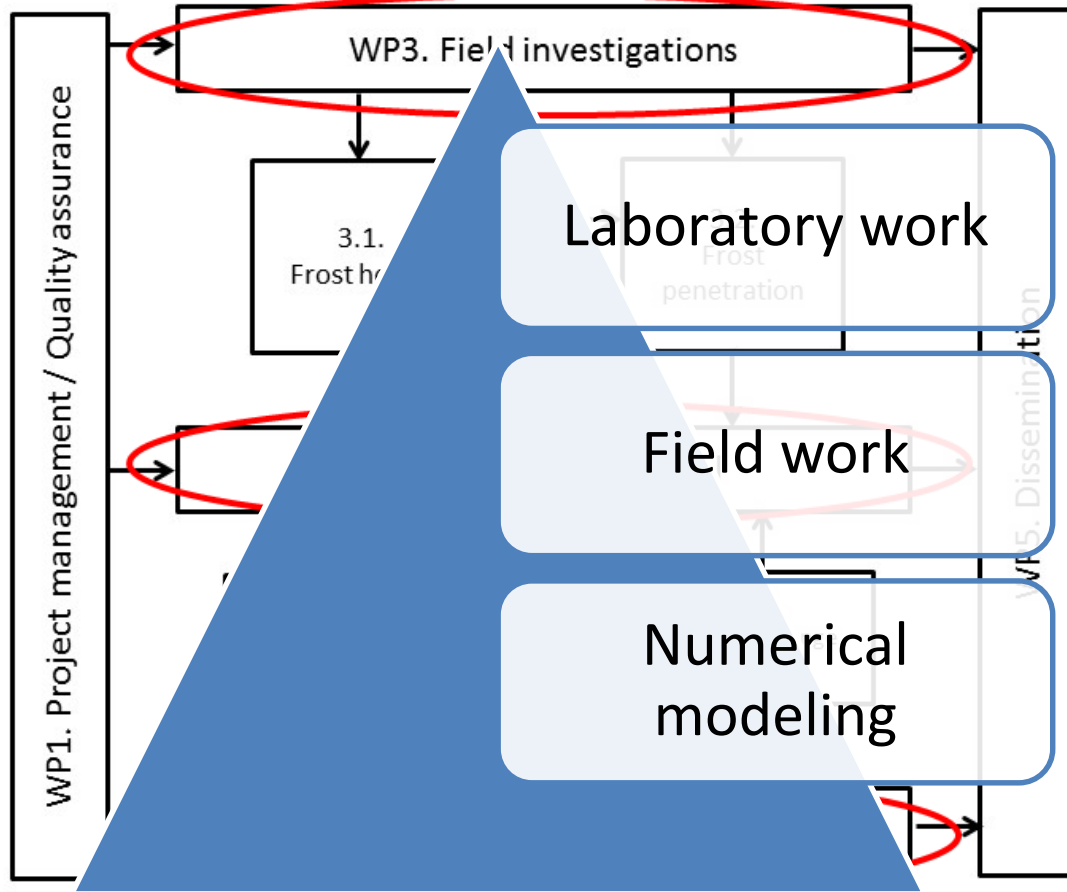


Jostein Aksnes (PhD)

• Advisory board  
• NPRRA



3 pillars:



3 pillars:

# Two main topics:

## Frost heave problems

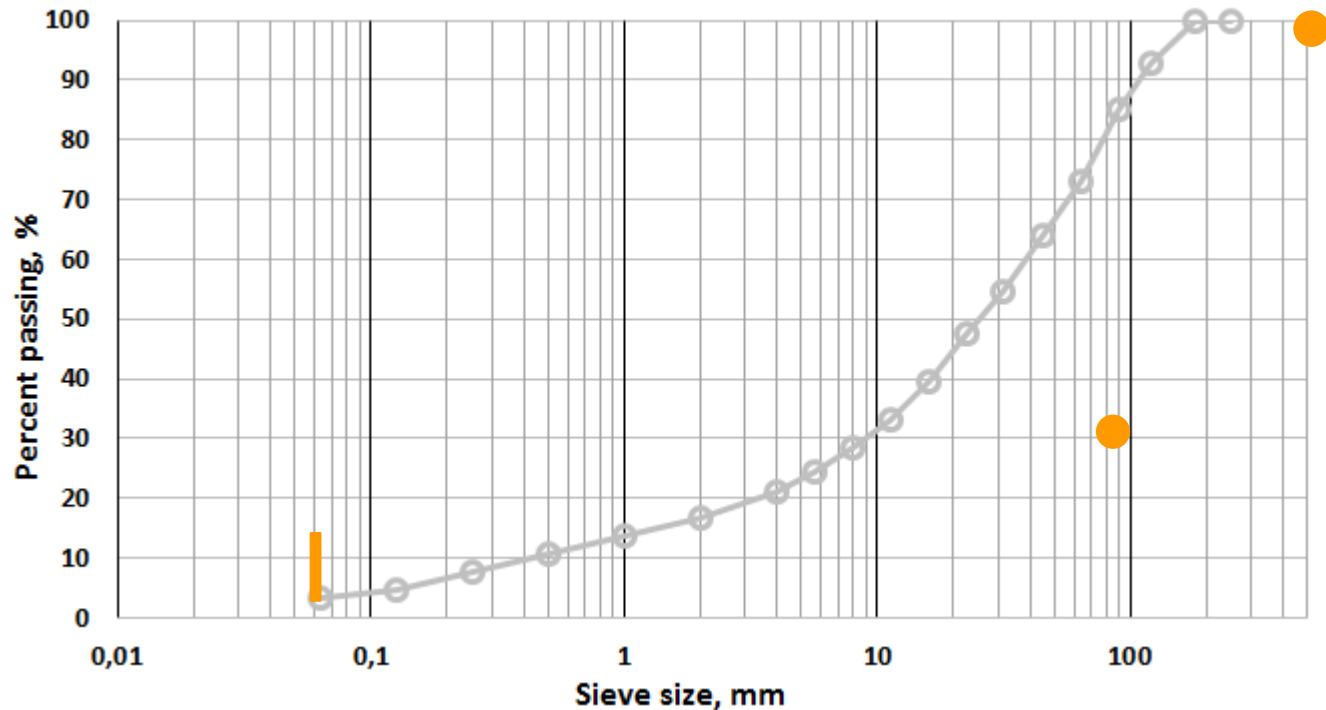
- Segregation potential theory
- Freezing cell

## Heat transfer characteristics

- Small scale (thermal conductivity)
- Large scale (convection, conduction, radiation)



# Frostsikringslag

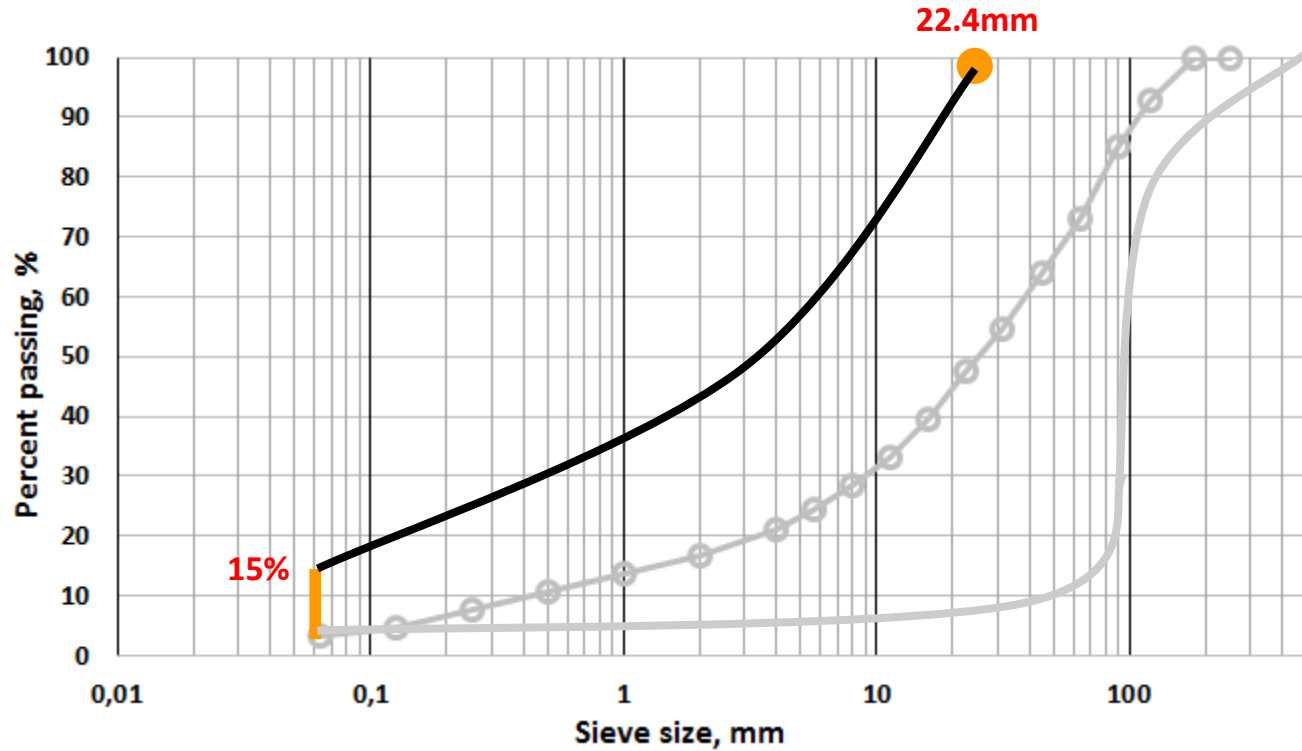


Maximum stone size  $D_{max}$  500 mm or  $\frac{1}{2}$  layer thickness

Minimum 30 % material  $\leq 90$  mm

Fines content: 2-15 % (i.e material  $< 0.063$  mm calculated from material  $< 22.4$  mm)

# Frostsikringslag



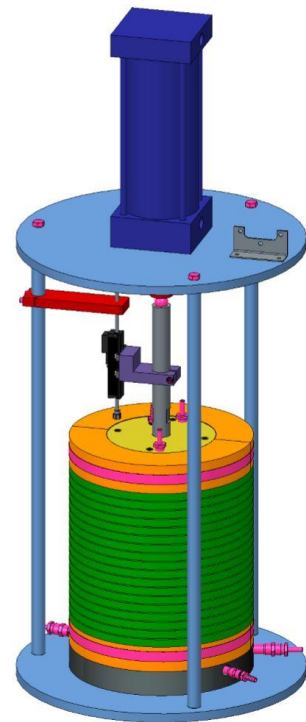
# Topic N1

- Benoit Loranger is looking to the effect of the increasing of fines and their mineralogy on frost action related problems during freezing and thawing seasons

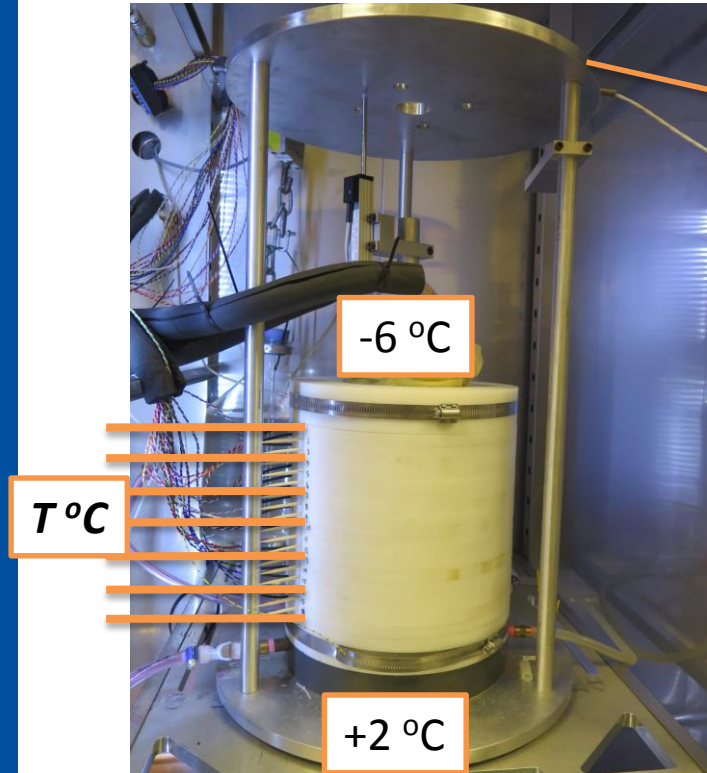


# Frost susceptibility (segregation potential)

- Frost heave test
  - Measurement of frost heave rate or total frost heave resulting from a thermal gradient induced in a soil sample placed in a freezing cell

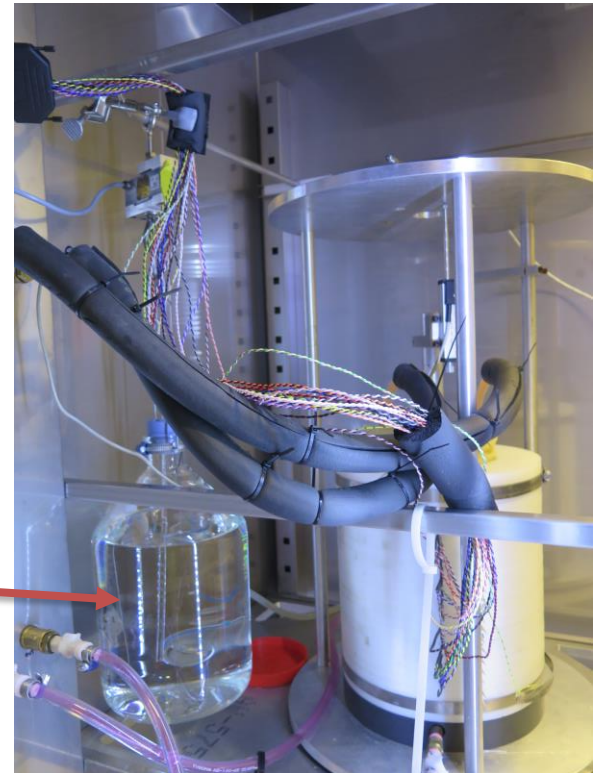


# Freezing cell



Pressure

Water supply



# Topic N2

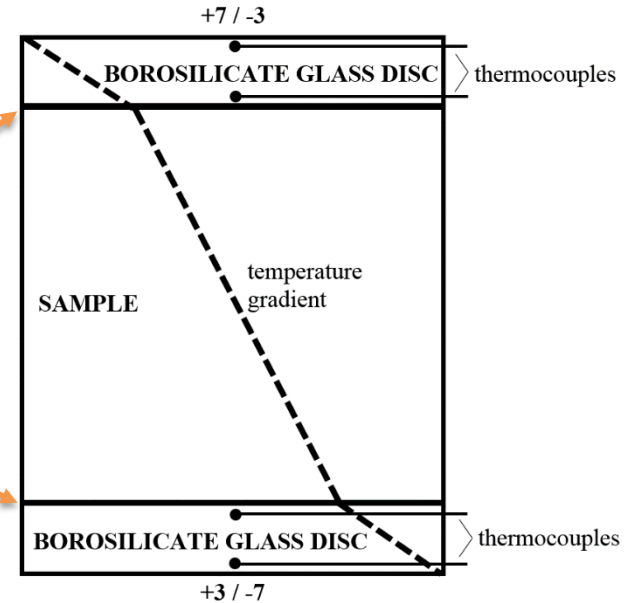
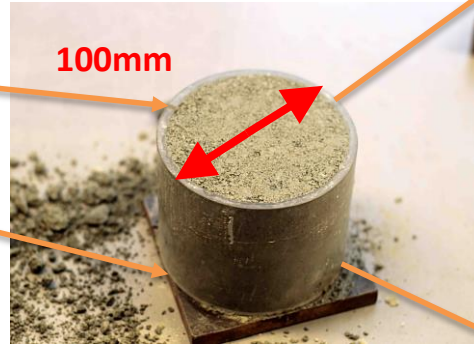
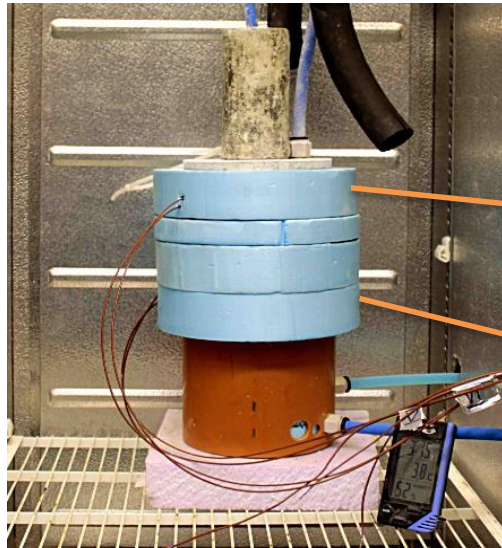


- Karlis Rieksts is investigating how the grading and mineralogy of the crushed rock material affects the heat transfer characteristics in road's granular layers and consequently, the frost penetration depth





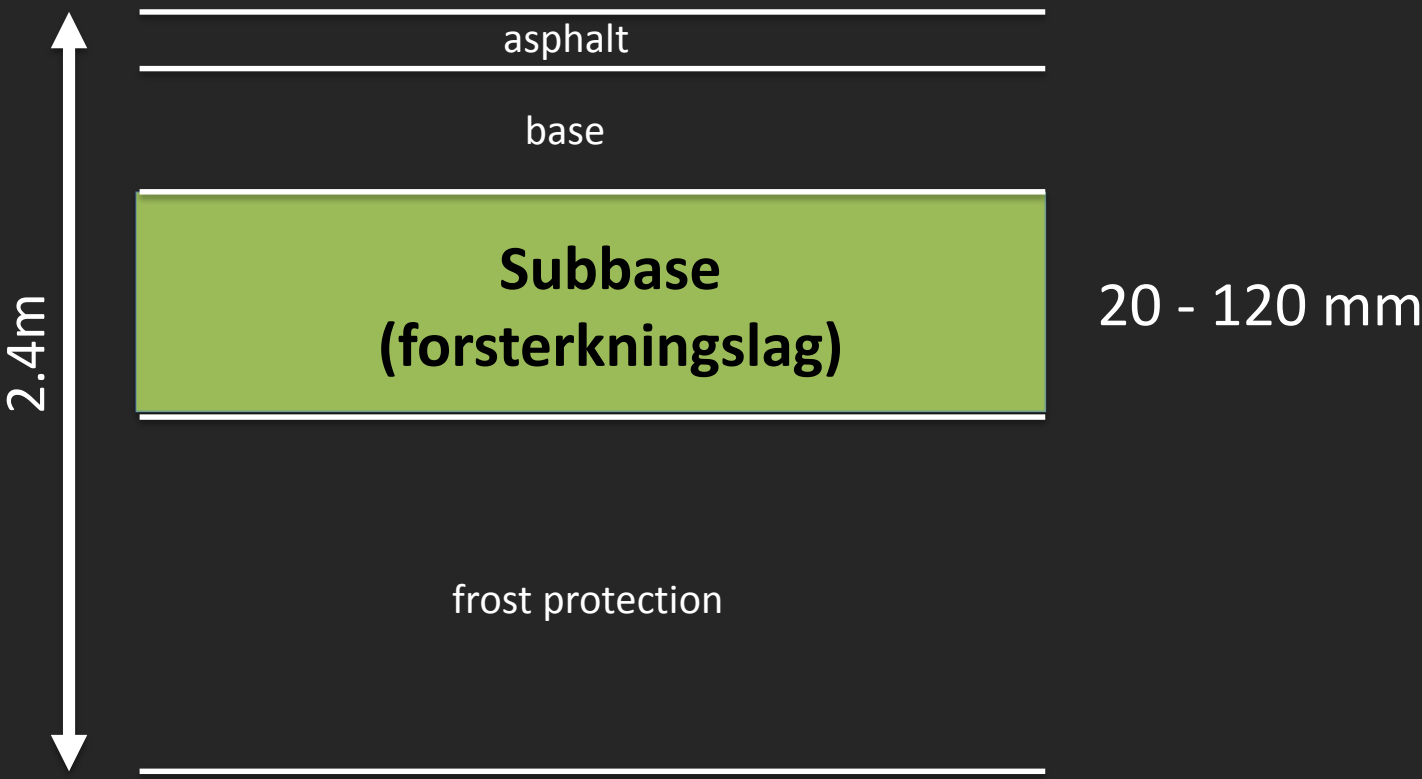
# Small scale: thermal conductivity

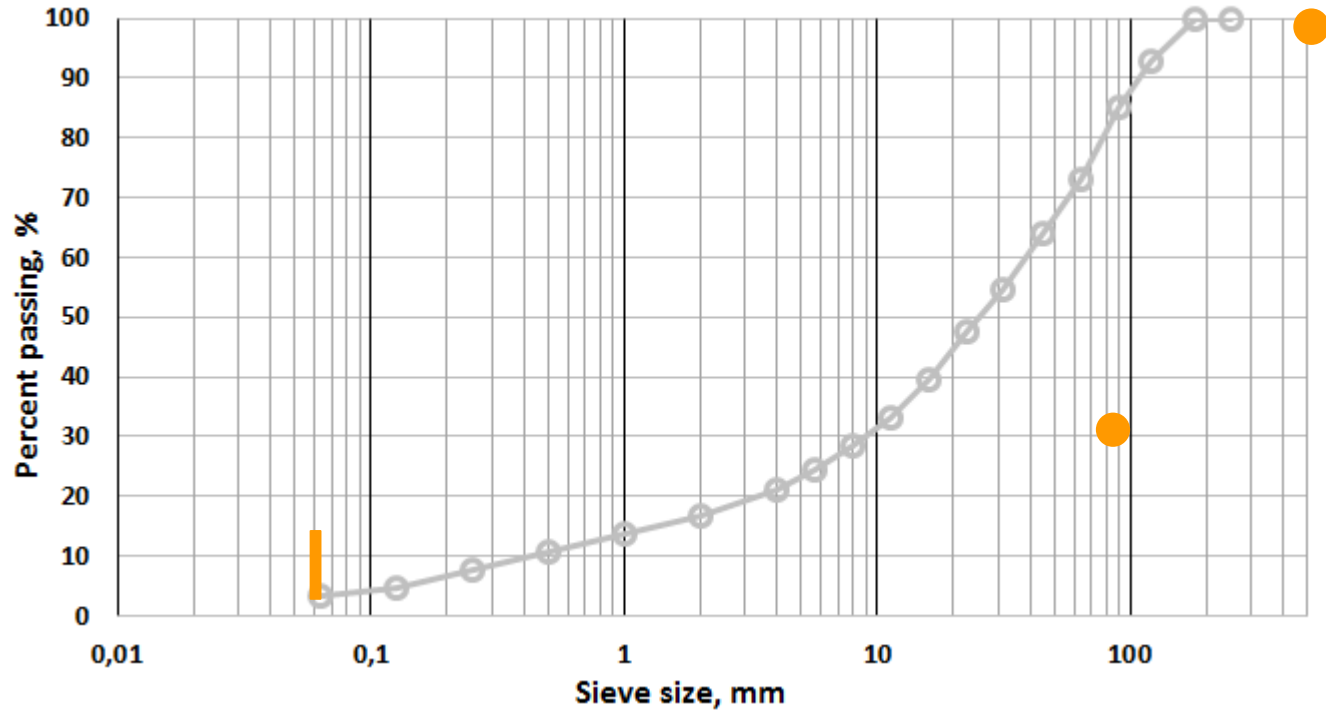


Read more: Rieksts et al. 2017 «Laboratory investigations of thermal properties of crushed rock materials»





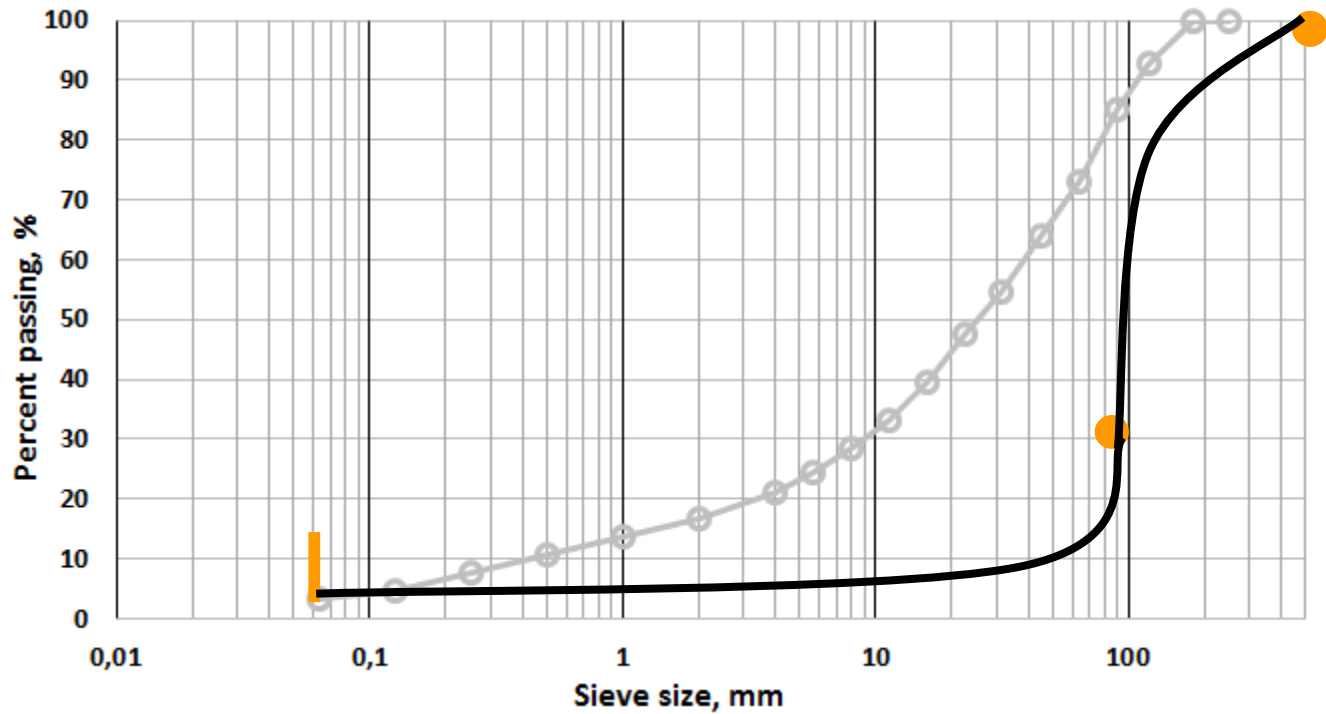




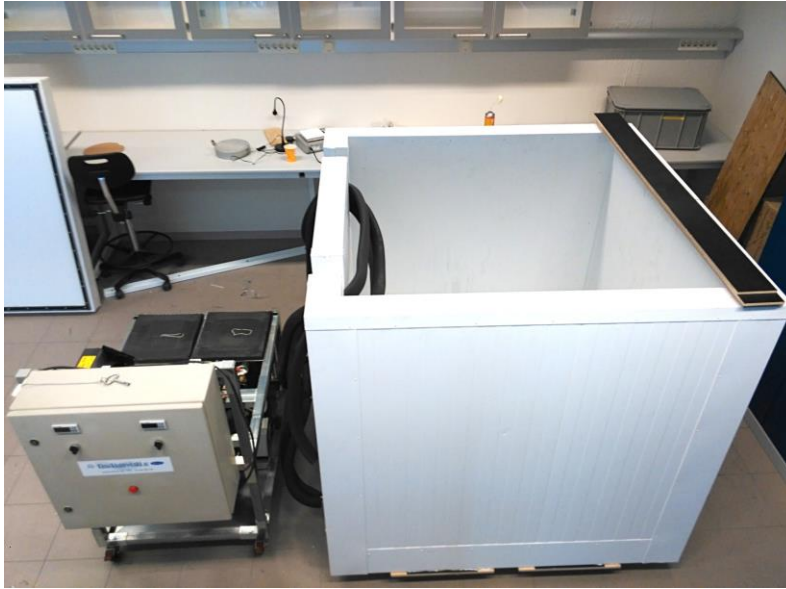
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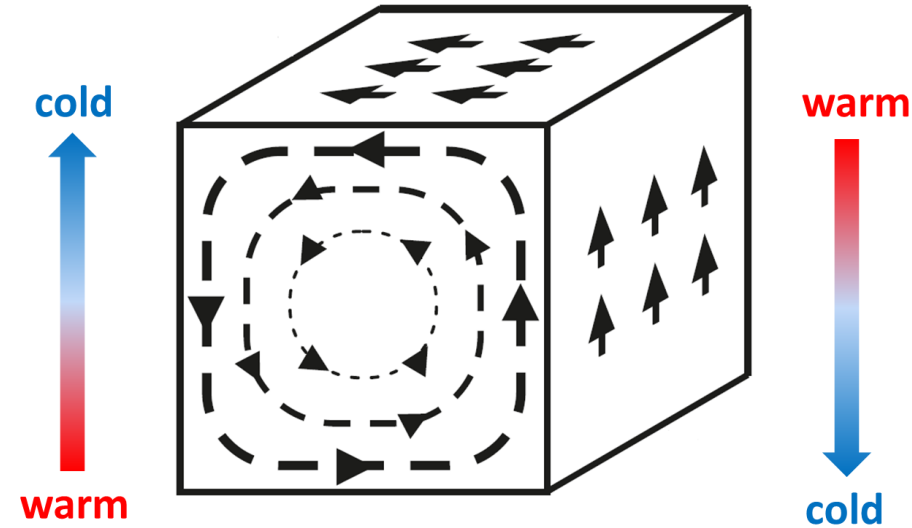


# Large scale



materials: 0 - 200 mm

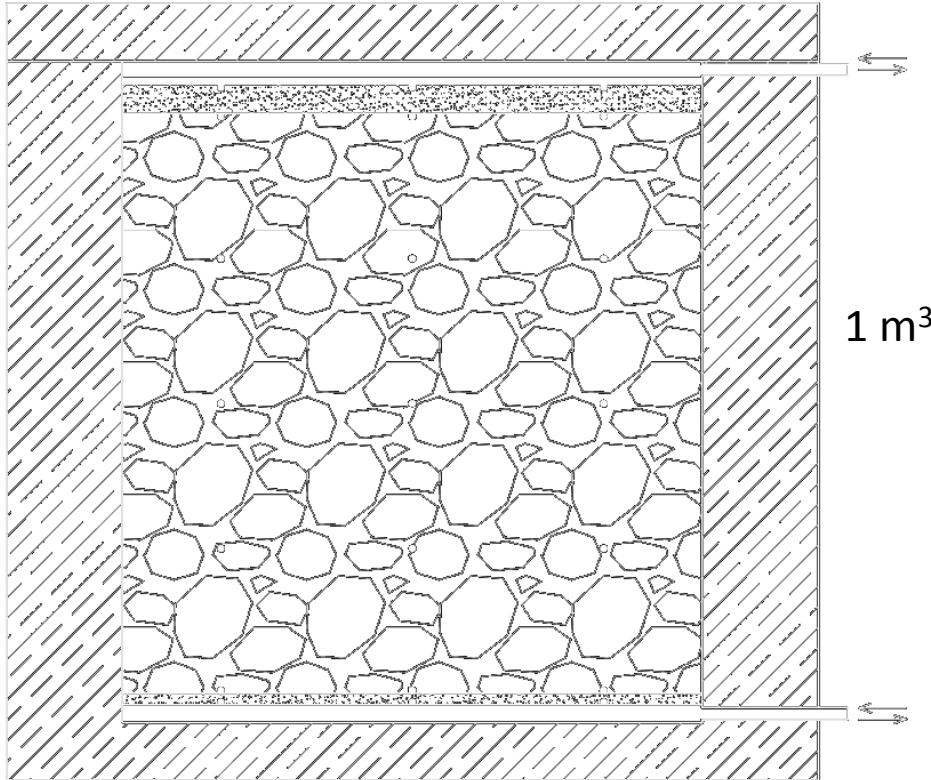
- Crushed rock (subbase and FPL)
- LWA Leca and Glasopor



Heat transfer mechanisms:

- Convection
- Conduction
- Radiation

# Large scale



1 m<sup>3</sup>



Read more: Rieksts et al. 2017 «Laboratory investigations of heat transfer of coarse crushed rock material»

- Filling of heat transfer box with cobbles
- Filling of heat transfer box with LECA
- Filling of heat transfer box with dry crushed material 20/120



**THANK YOU  
FOR YOUR  
ATTENTION**

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