Vancouver International Airport Asphalt Cracking Analysis

Numerical Simulation in Abaqus CAE

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Background

Twy. Hotel (L-D) is a heavily used taxiway around Apron VI and main taxiing corridor running North-South

Prior to 2019 issues:

- Highly distressed
- Accelerated maintenance needs (reactive than proactive)
- Poor rideability for the users
- High risk of FOD

Constraints:

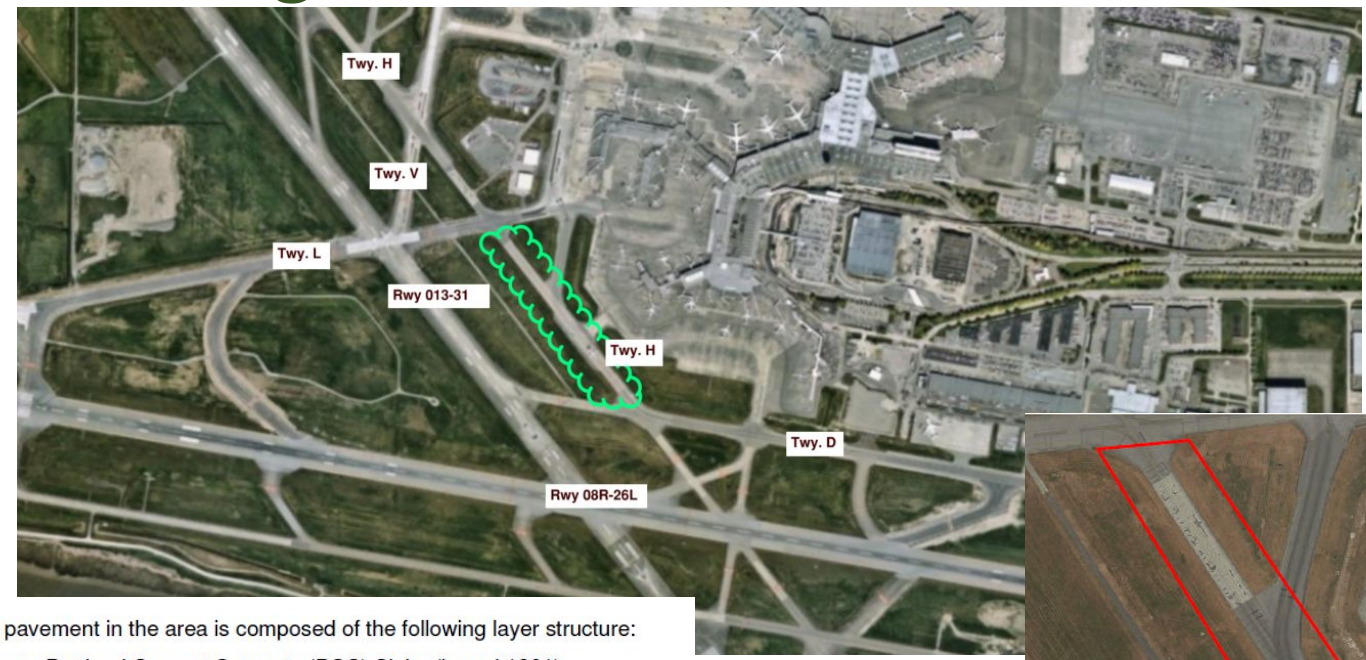
- One of the hardest section to close on the airfield

Treatment Strategy:

- 100mm HMAC In-Lay with and withc ACE fibre

Observations:

- Distress manifestation after 6months



The pavement in the area is composed of the following layer structure:

360 mm Portland Cement Concrete (PCC) Slabs (keyed 1961)

150 mm Granular Base

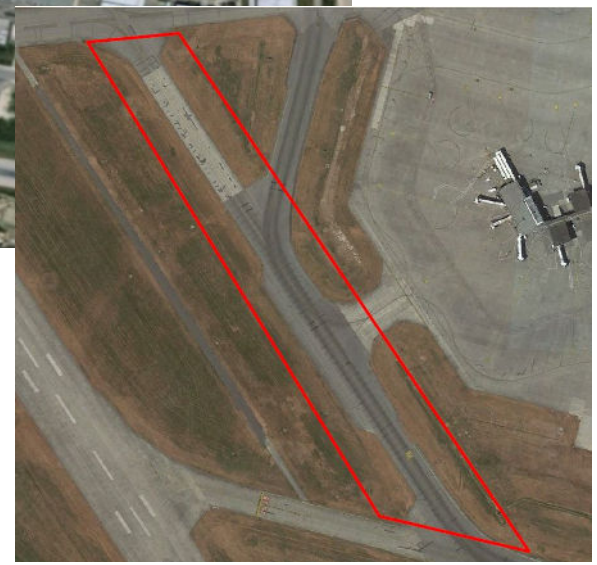
460 mm Granular Sub-base

150 mm Hot Mix Asphalt Concrete (HMAC 1996 inlay)

210 mm PCC (1961)

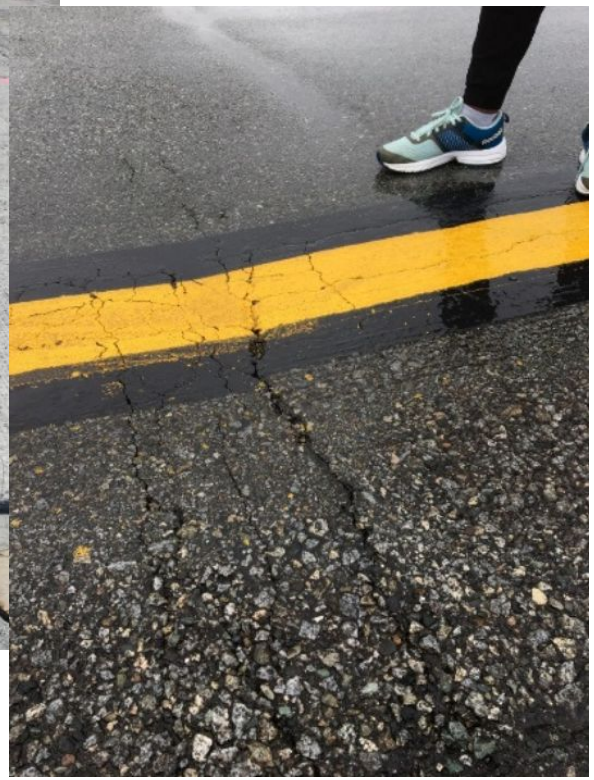
150 mm Granular Base

460 mm Granular Sub-Base

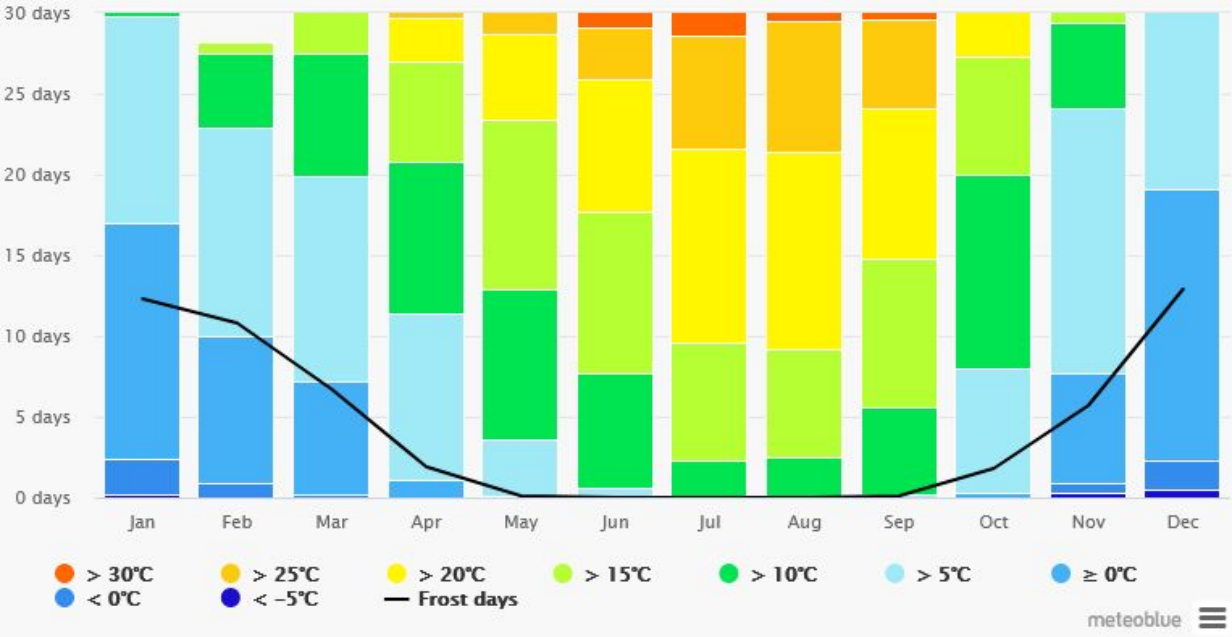


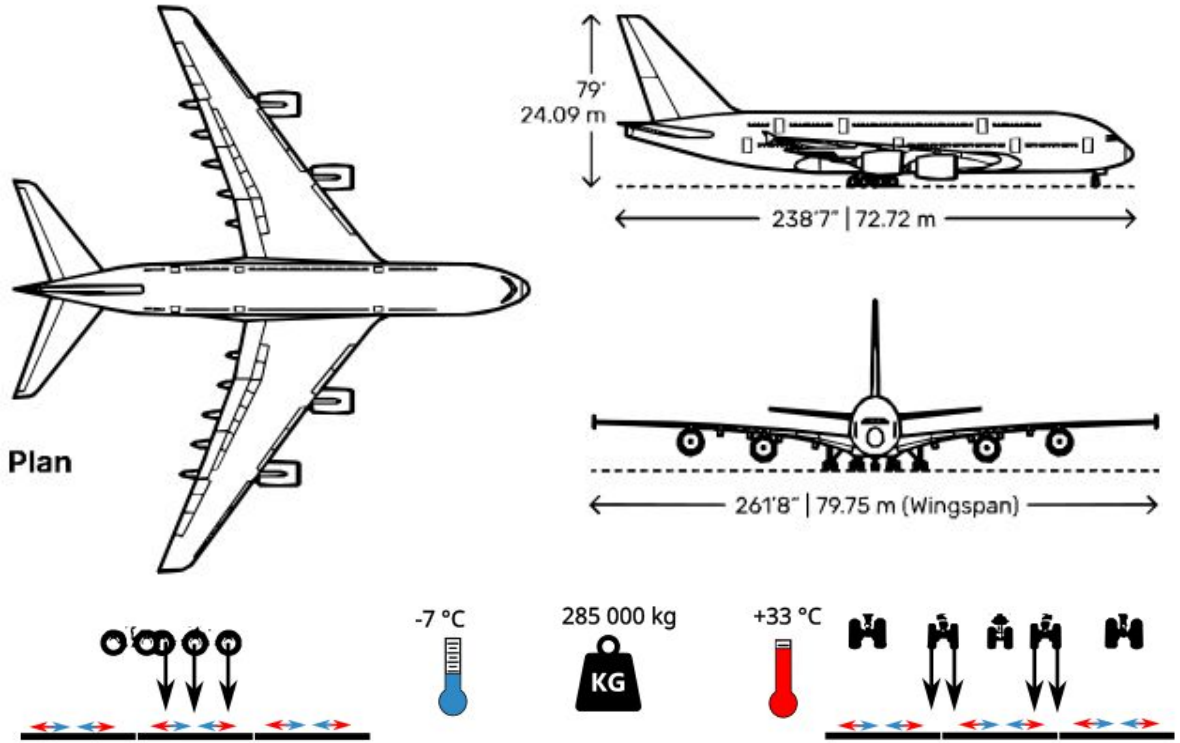
Motivation, Description, Goals

- Concrete of the runway/taxiway is cracking
- There are two likely causes:
  a) Traffic
  b) Temperature
- Is It possible to solve it by asphalt overlay and increasing the thickness of the asphalt layer?
- Is it possible to solve it by adding fibers into the asphalt mixture?
- **What is the influence of each cause and solution?**



Inputs - temperature and traffic

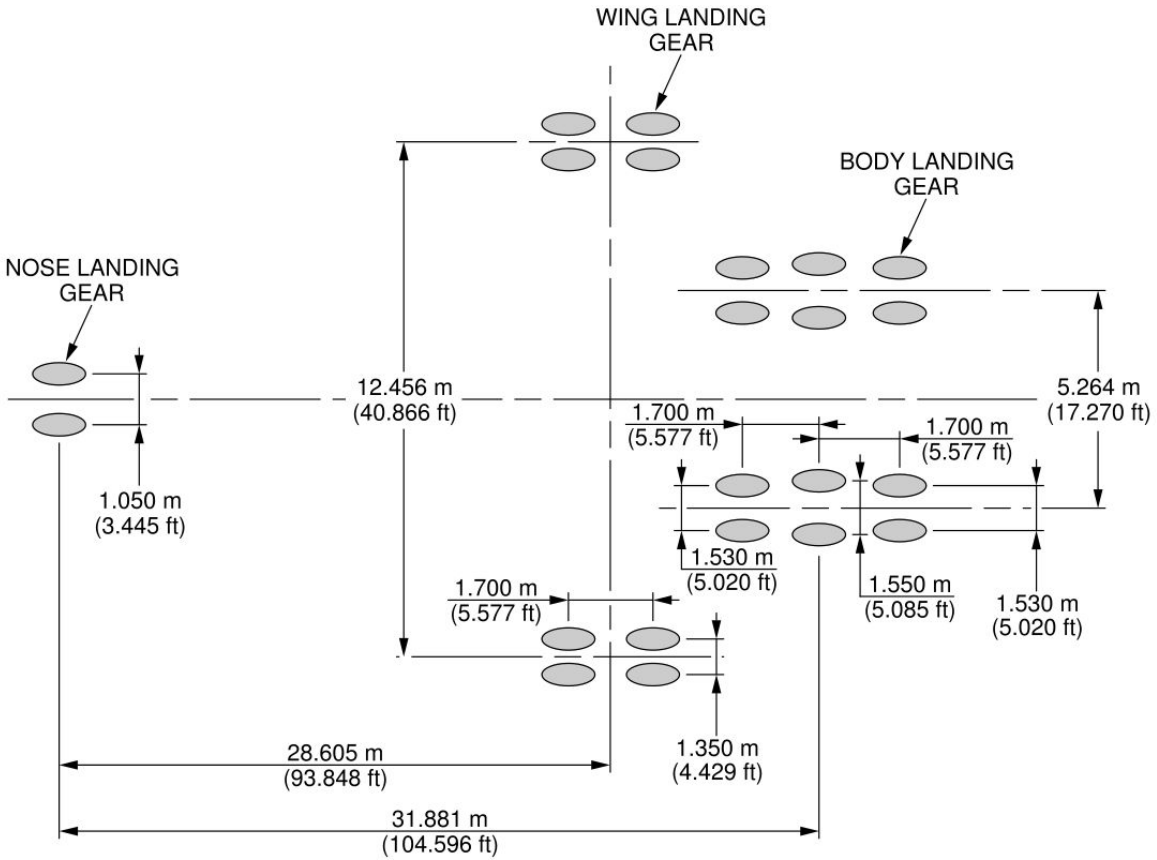




Sources:
https://www.meteoblue.com/
https://www.dimensions.com/

Footprint – Airbus A380

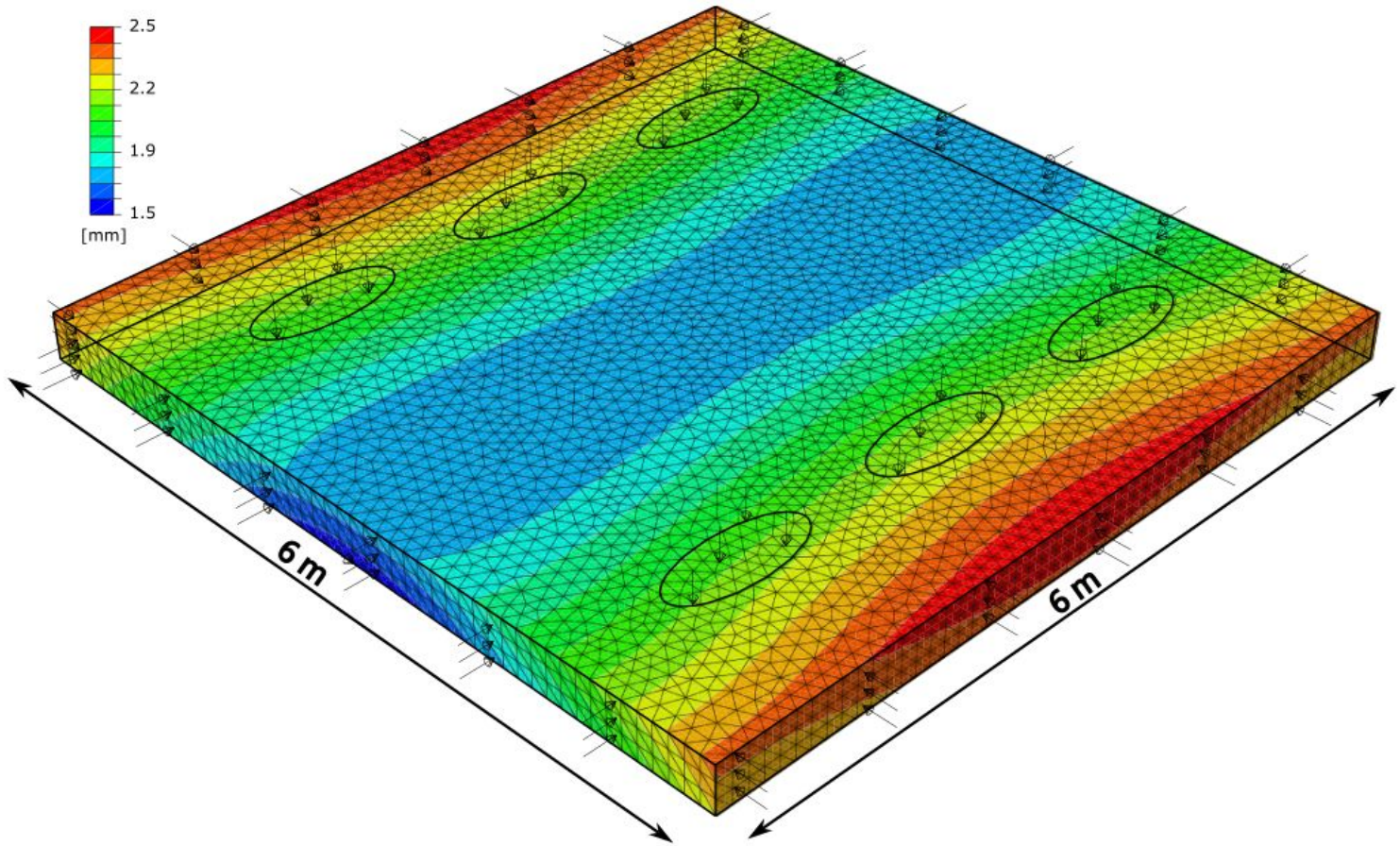
- Dimensions of Airbus A380 are 72.72 m x 79.75 m x 24.09 m
- The axial distances of the body landing gears are 6.794 m x 3.4 m
- Weight of the plane is 285,000 kg
- Most of the weight is expected at body landing gears.
- If static stiffness of the subgrade is 24 MN/m^3, vertical deformation can be up to 2.5 mm.
- **This is definitely not negligible.**



Source: https://www.dimensions.com/element/airbus-a380-800

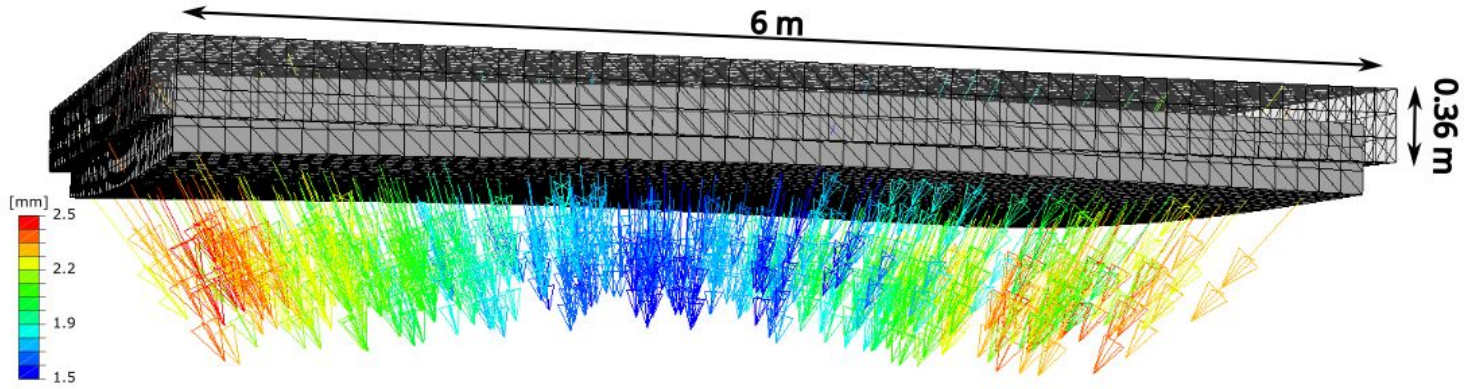
Single slab – Finite Element Model

- Useful to find critical positions of gears with respect to slab deformations.
- Can combine both thermal expansion and sag of the slab
- Limited by computational power



Single slab – Finite Element Model

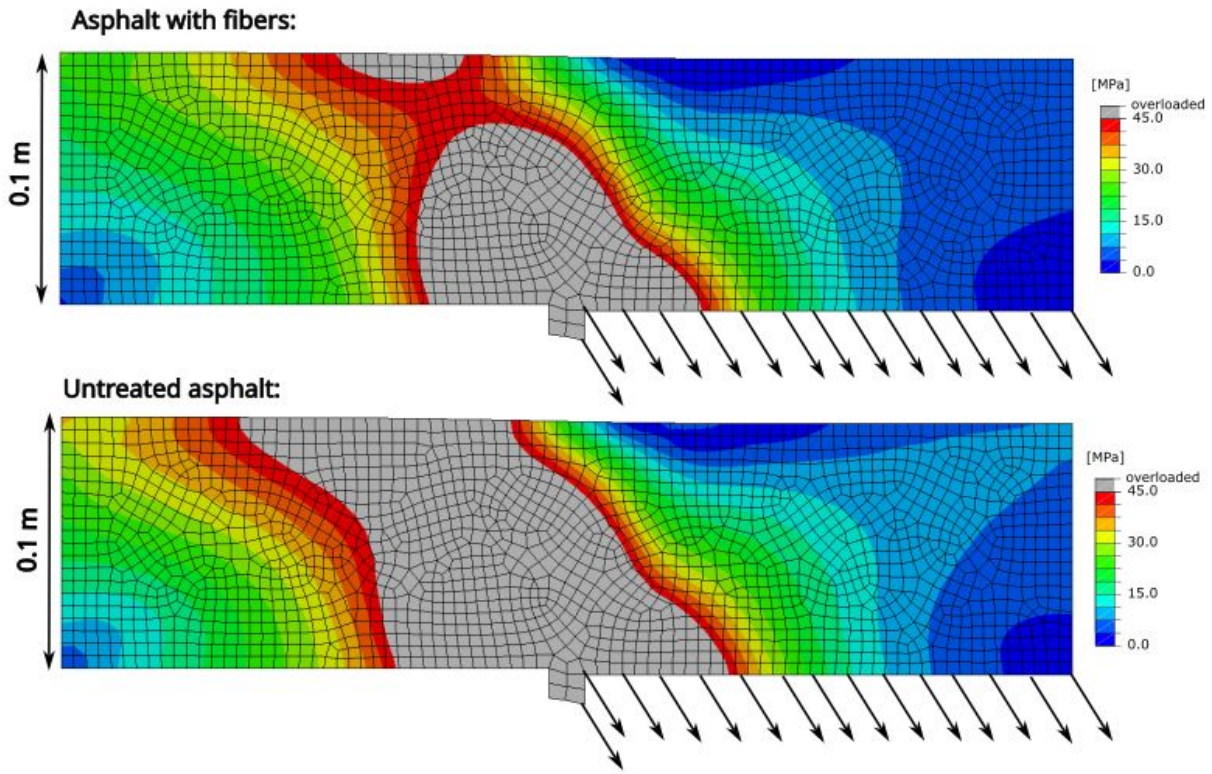
- Deformations of the concrete slab can be expressed in form of colorful arrows showing magnitude and direction of the deformation.
- **These arrows indicate that neither traffic nor temperature can be neglected. Both have significant influence on making the conditions for the development of cracks in the asphalt layer placed on the slabs.**



- The simulation outputs can be used as inputs to more detailed numerical models.

Asphalt layer above the gap between the slabs

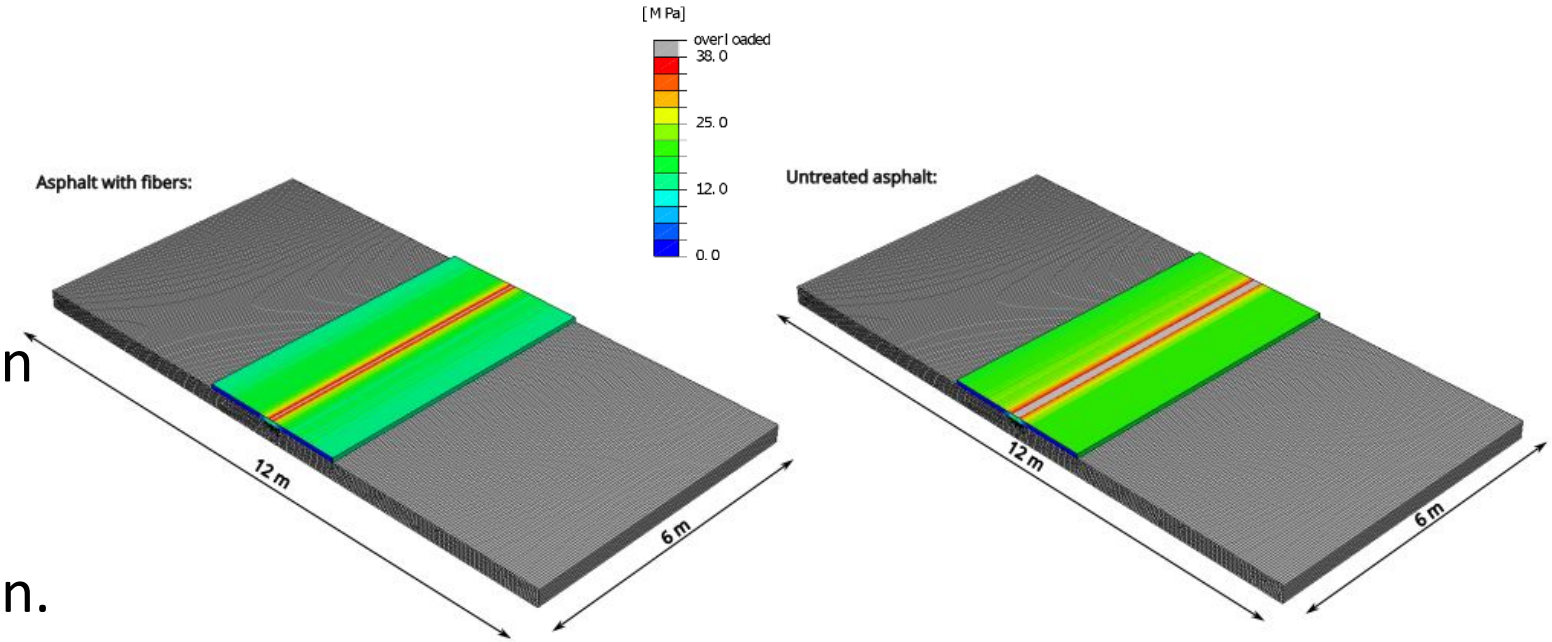
- The influence of addition of fibers to asphalt layer covering the gap between two concrete slabs on its resistance to deformations was studied in Abaqus.
- Von Misses stress in the asphalt layer with fibers is lower than in case with the untreated asphalt layer.
- **Fibers have positive effect.**



- Von Misses stress contour plot could be used to identify overloaded areas.

Two slabs and asphalt layer over the gap

- More complex numerical model can simulate the fatigue of the asphalt layer by cyclic loading.
- This model consists of two concrete slabs and a layer of asphalt covering the gap between them. Both traffic load and thermal expansion is taken into the account during the simulation.
- Technical solutions to prevent the cracking can be checked



Conclusions/Findings

- **Fibers**
  - Have the positive effect in reducing the stress in the asphalt
- **Dimensions**
  - Have the positive effect in reducing the stress in the asphalt
- **Numerical simulations**
  - Can be used to find the optimal solution to prevent the cracks.

Further development/Recommendations

- **Loading conditions**
  - More loading conditions can be studied, such as:
    - positions of traffic load
    - cyclic load by temperature
- **Fatigue and various mechanical properties**
  - More advanced material model of asphalt layer can be studied.
- **Recommendations**
  - Technical solutions to prevent cracking can be checked.

Thank you
Questions?