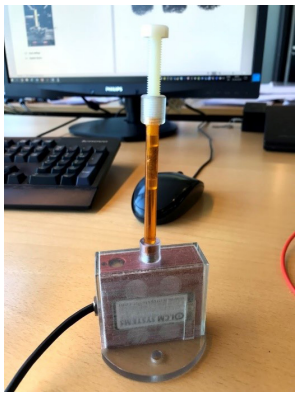
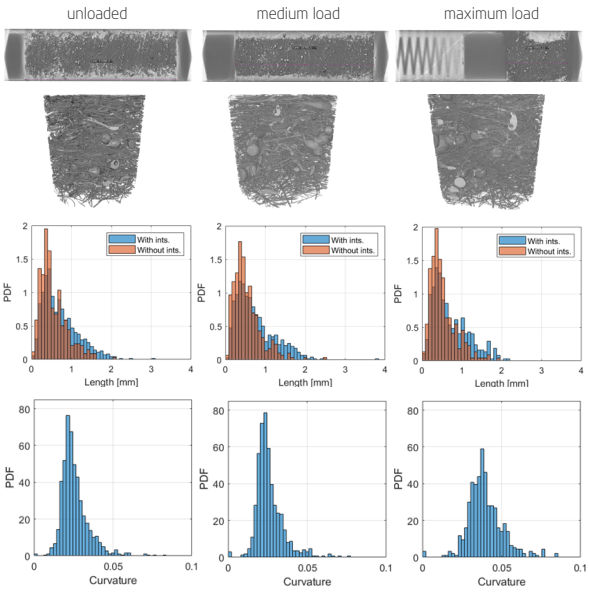
Imaging the compression of stone wool fibres

ROCKWOOL International A/S is part of the ROCKWOOL Group which is the world´s leading supplier of innovative products and systems based on stone wool. ROCKWOOL entered a collaboration with the 3D Imaging Centre at DTU to analyse the microstructure of stone wool fibres during compression. X-ray micro computed tomography (CT) was used to image the material in 3D and image analysis provided statistical information about the fibres. The aim was to study how the fibres react to compression and a subsequent release of the load on a microscopic level, as macroscopic compression test reveal a reversible behaviour at lower compression degrees, but deformation at a high degree of compression. On a microscopic level, this might e.g. be explained by fibre breakage or fibre rearrangements, which was to be studied in this collaboration.



Photograph of the in situ cell. The white screw on top compresses the sample which is kept in the orange tube. The compression cell to measure the load is placed beneath the tube.



Line 1 and 2: 3D Images obtained by X-ray CT showing the overview and zoom scans for different loadings. Line3: Length distributions of fibres with (blue) and without (orange) taking intersecting fibres into account. Line 4: Curvature of the fibres.

Challenge

To analyse the microstructure of stone wool during compression using X-ray CT, an *in situ* compression cell was built. A cylindrical piece of stone wool was placed in a tube and compressed using a screw, which during tightening transfered the load to the sample. The force on the sample was recorded by a compression cell. By imaging the full sample and its length, the strain could be calculated. In order to study the microstructure, higher resolved images of a smaller part of the sample were recorded and image analysis was applied to obtain statistical information about the fibres.

Collaboration

The compression cell was developed in collaboration between the 3D Imaging Centre at DTU and ROCKWOOL, who also provided two samples. The X-ray CT measurements were performed in house using a ZEISS Versa 410, and subsequently analysed. This collaboration was part of the LINX project in which researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques.

Results

When the stone wool was in its original state or only slightly compressed, hardly any microscopic changes could be observed. Both the fibre orientations and the fibre length distributions did not change significantly, indicating that neither a breakage of fibres, nor a signigicant rearrangement take place. However, when a high degree of compression was applied, the curvature of the fibres changed, as shown on the left. When the load was released, the curvature returned to its original state. This finding indicates that a reversible bending of fibres is the predominant reaction of the fibres to compression.

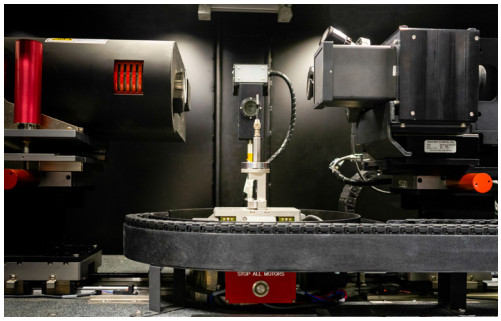
Perspectives

During the transport of stone wool products, they are placed in layers, which might cause compression in the lower layers. Knowing how much a product may be compressed without causing irreversible microstructural changes, therefore helps ROCKWOOL in optimising the transport processes such that the products can keep their properties.

Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Centre at DTU and assists companies in using and implementing 3D Imaging in research, development and production. The portal offers research-based 3D Imaging services and provides companies with the latest equipment and the most advanced knowledge within 3D Imaging and data analysis. The Imaging Industry Portal works as a gateway to ESS and MAX IV, as well as other large scale facilities.

www.imaging.dtu.dk/Industry-Portal



DTU 3D Imaging Centre