Nye løsninger til fremtidens infrastrukturer

Monitoreringsbehov på eksisterende konstruktioner

Vejdirektoratet

Bridge Inspections with Drones

Advantages / Challenges
Use of Artificial Intelligence
Conclusions of pilot projects

Traditional bridge inspection (2014)

Traditional bridge inspection (2014)

Traditional bridge inspection (2014)

Traditional bridge inspection (2014)

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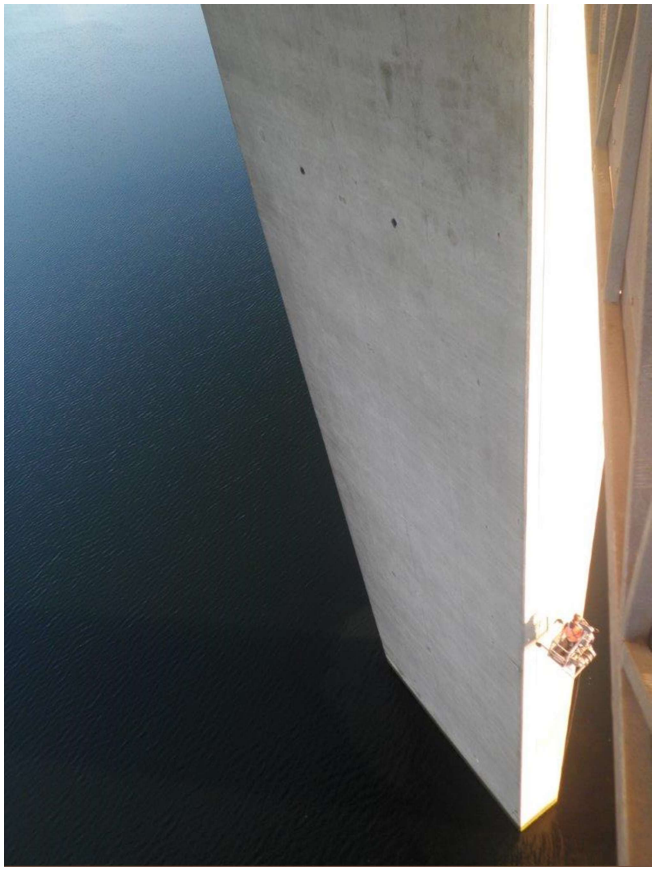
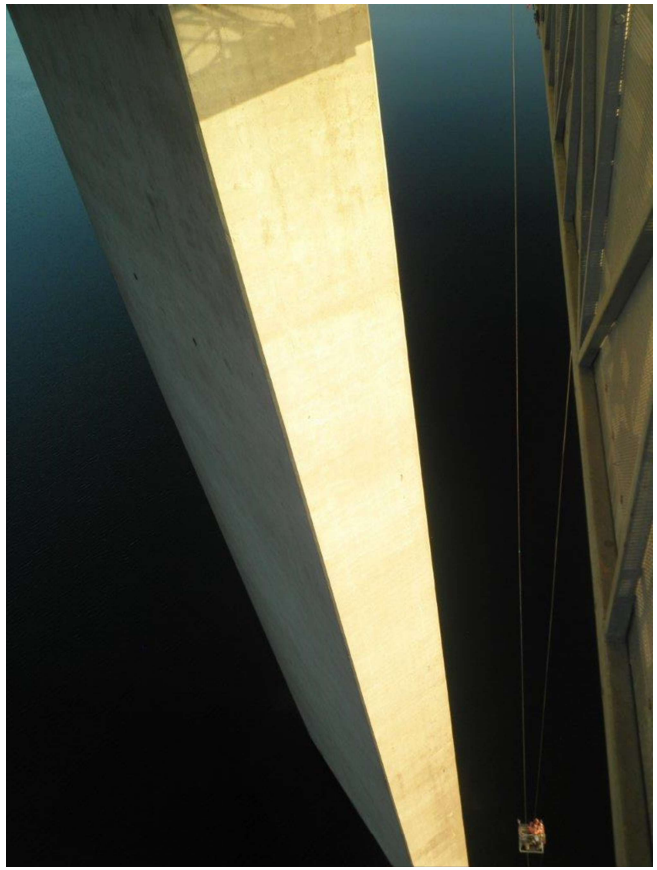
Traditional bridge inspection (2014)

Traditional bridge inspection (2014)





Advantages

Drone inspections of bridge structures provide a wide range of benefits

The main points include:

- Drone inspections on bridges provides more valuable **information and data** than the traditional approach.
- Easy access to **areas difficult to inspect** e.g. tall bridges and bridges above water.
- Access to areas that pose **safety risk** both to the bridge inspectors and the traffic.
- Can be performed by drone operators without domain knowledge.
- Can be cost effective.

Bridge Inspections with Drones

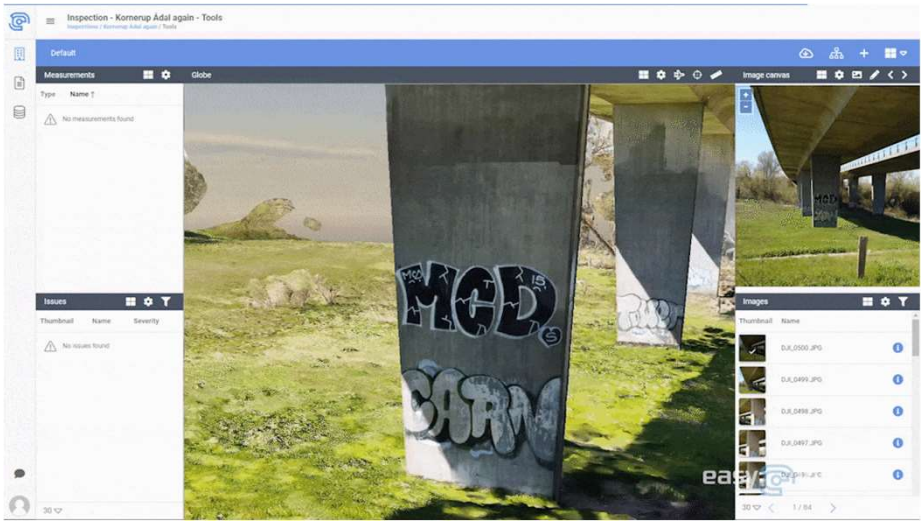
Advantages

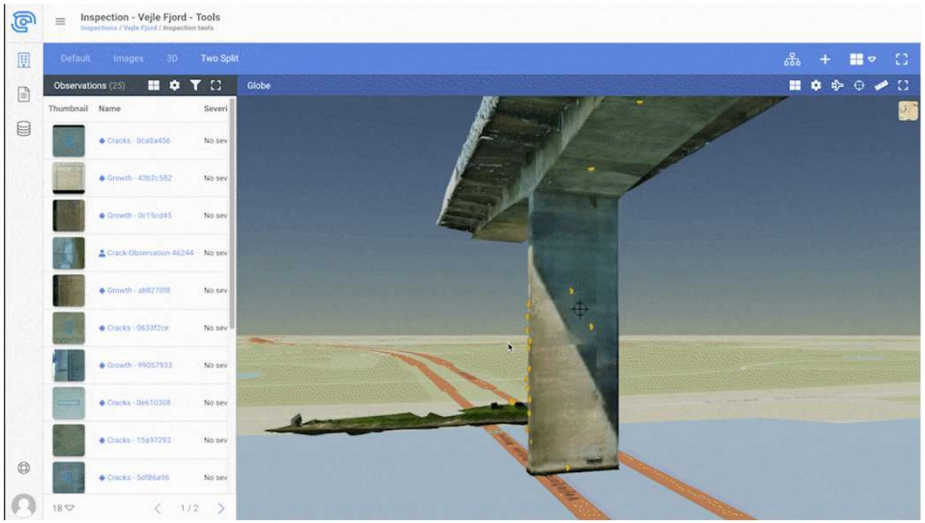
3D BIM model

An exact representation of the existing structure that you'll be renovating.

Information on the detected damages visibly marked in the 3D model.

The 3D BIM model helps making informed decisions based on complete visibility.





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Challenges

Data quality

To collect data with a satisfactory quality, it requires a good camera on the drone, which also must has the opportunity to photograph upwards to cover upwards surfaces.

Lack of experience with the drone operator

Drone inspections of bridges is a complex task and require some experience with the drone operator, in order to collect data of a satisfactory quality.

Here and now the challenge can be solved by training.

In the future, the drone operator will be redundant as the drones will fly autonomously around the structure.

Challenges

Missing GPS Signal and GPS Data

Bridges may be in the way of GPS coverage when the drone flies under the bridge, which may result in missing GPS Signal and GPS Data.

The solution is to use a drone with RTK module.

At the same time, data can be corrected with GCP (Ground Control Point).

Other external conditions

Weather: A wind force of maximum 6-8 m / s is recommended, no rain at the time of inspection, preferably cloudy.

Dense vegetation around the bridge structure is a significant obstacle for the drone.

Bridge Inspections with Drones

Use of Artificial Intelligence (AI)

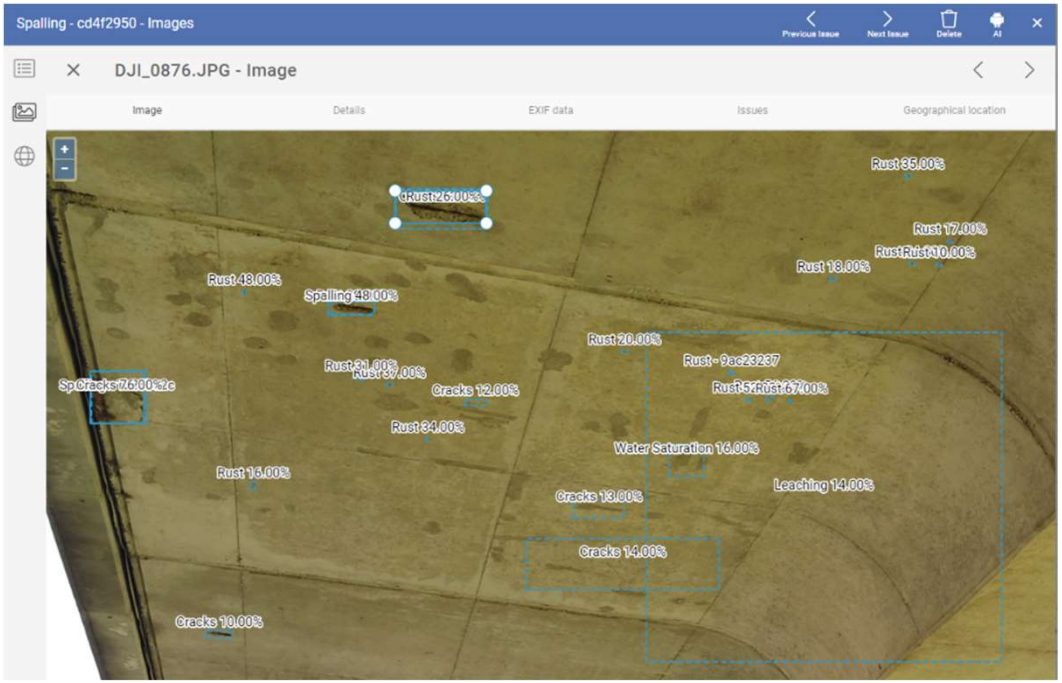
Examine photos

Removes the need for manually to go through thousands of photos.

Damage detection

Artificial intelligence can be used to automatically detect damages in the bridge construction.

- Cracks
- Growth
- Spalling
- Leaching
- Rust
- Water Saturation



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Bridge Inspections with Drones

Use of Artificial Intelligence (AI)

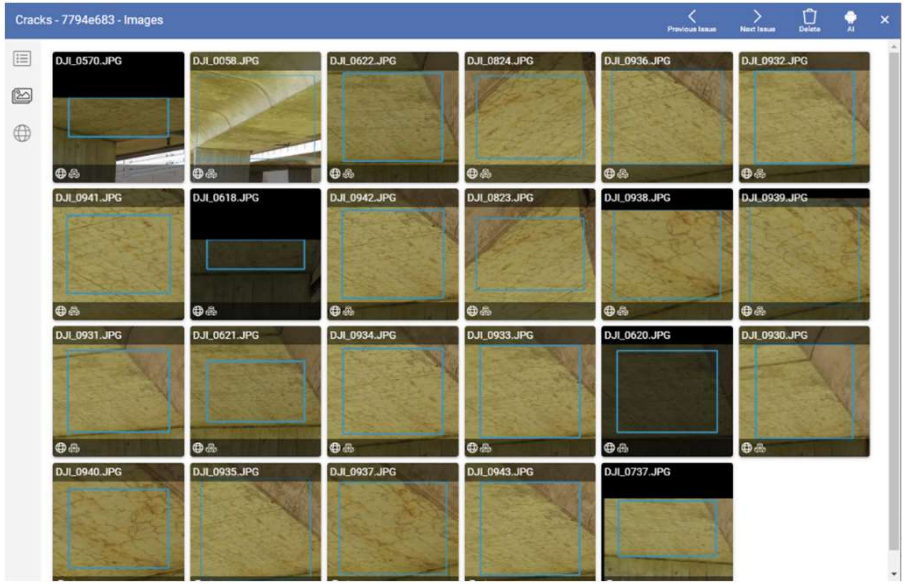
Can't stand alone (yet)

Artificial intelligence can still only point out damage, but cannot tell how critical it is.

Therefore, a person must still assess the detected damages on the bridge.

Final inspection report

An inspection report is produced, based on the analysis of the data, and the information is divided into severity and priority according to the seriousness of the damage.



Conclusions of pilot projects

Drone Technology will be a useful tool for future inspections of bridges

It is **not expected to be able to completely replace** traditional bridge inspections.

Critical or damaged areas of the bridge requires a more in-depth assessment.

A quick overview of a bridge as a whole

Identify the areas to be further inspected by the engineer.

Potential for savings and efficiency improvements

The area that has the greatest potential for savings and efficiency improvements in drone inspections in the short run is at the large bridges, and especially the bridges that are above water.

Bridge Inspections with Drones

Conclusions of pilot projects

The Road Directorate expects to minimize risks and costs

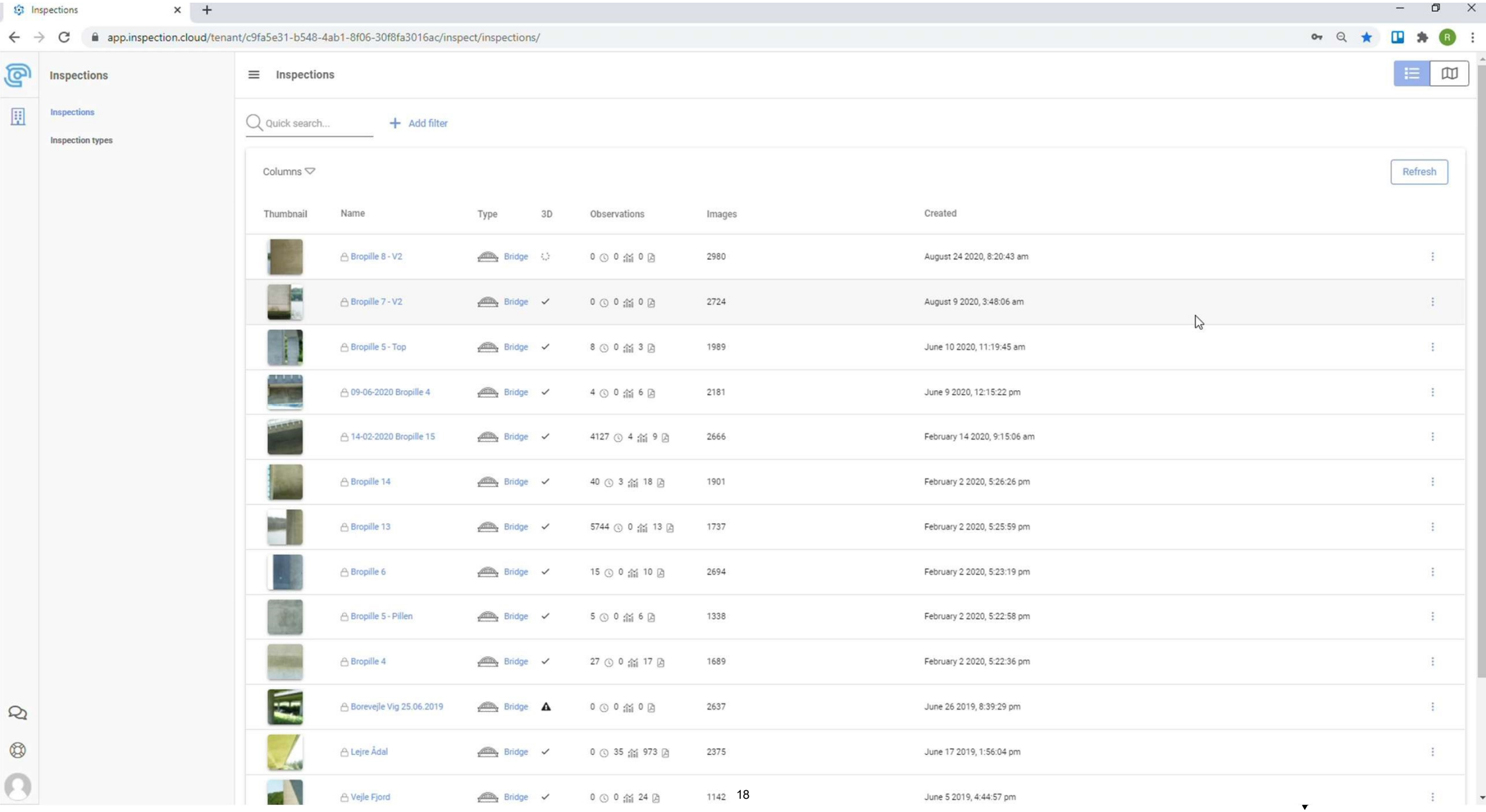
The risk at work and the risk in traffic.

The number of working hours and other costs associated with the traditional inspection methods that require special equipment and high level of expertise.

A new Asset Management Information System

In the future, a new Asset Management Information System will become a central tool for handling the large amounts of data and information.

Drone data, together with other data from other high-tech measurement systems, will be able to provide valuable information on the state of the Danish Road Directorate's bridges.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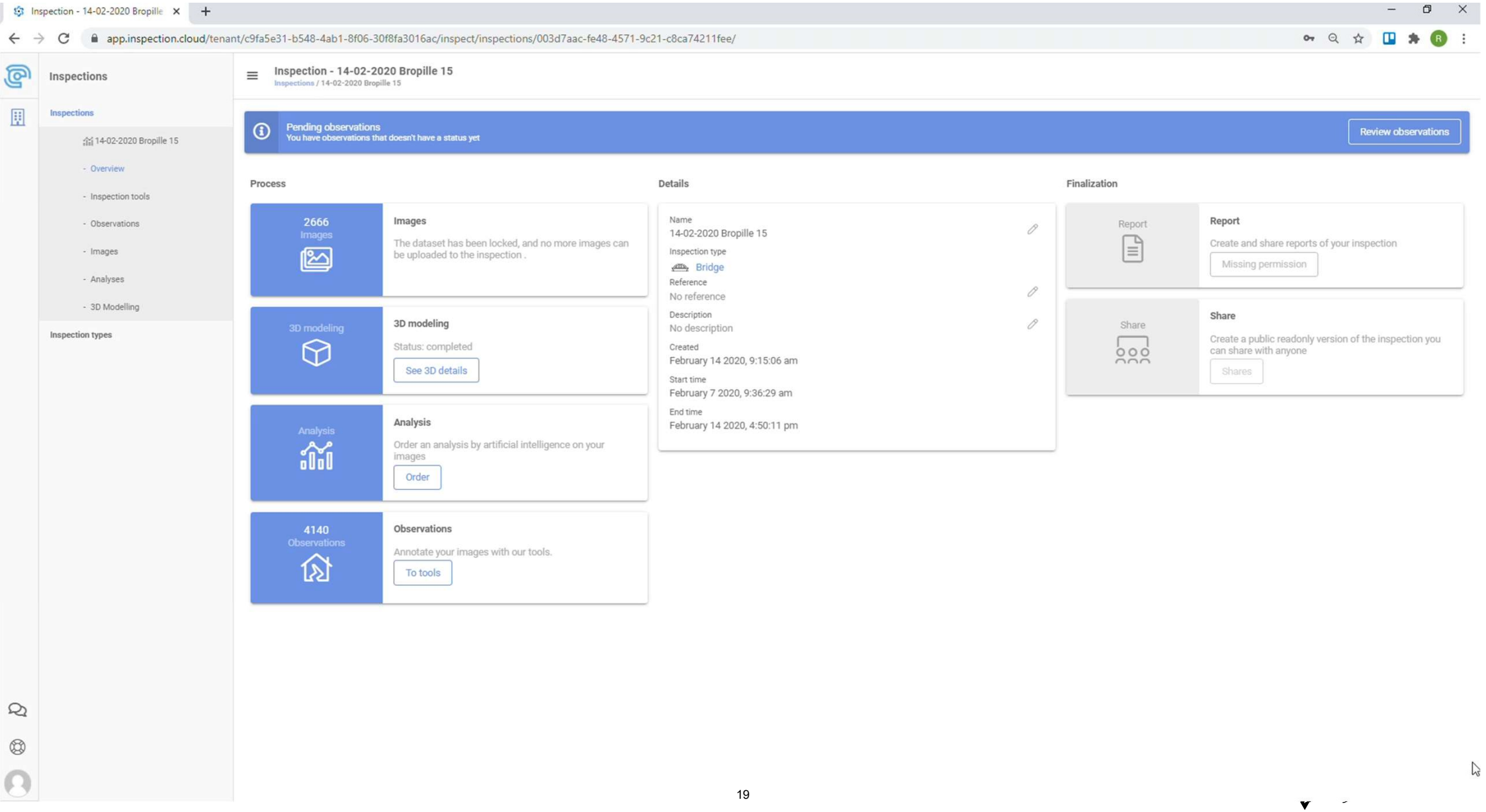
Inspections
Inspection types
Inspections
Quick search...
Add filter
Columns
Refresh
Thumbnail
Name
Type
3D
Observations
Images
Created
Bropille 8 - V2 Bridge 0 0 0 2980 August 24 2020, 8:20:43 am
Bropille 7 - V2 Bridge 0 0 0 2724 August 9 2020, 3:48:06 am
Bropille 5 - Top Bridge 8 0 3 1989 June 10 2020, 11:19:45 am
09-06-2020 Bropille 4 Bridge 4 0 6 2181 June 9 2020, 12:15:22 pm
14-02-2020 Bropille 15 Bridge 4127 4 9 2666 February 14 2020, 9:15:06 am
Bropille 14 Bridge 40 3 18 1901 February 2 2020, 5:26:26 pm
Bropille 13 Bridge 5744 0 13 1737 February 2 2020, 5:25:59 pm
Bropille 6 Bridge 15 0 10 2694 February 2 2020, 5:23:19 pm
Bropille 5 - Pillen Bridge 5 0 6 1338 February 2 2020, 5:22:58 pm
Bropille 4 Bridge 27 0 17 1689 February 2 2020, 5:22:36 pm
Borevejle Vig 25.06.2019 Bridge 0 0 0 2637 June 26 2019, 8:39:29 pm
Lejre Ådal Bridge 0 35 973 2375 June 17 2019, 1:56:04 pm
Vejle Fjord Bridge 0 0 24 1142 June 5 2019, 4:44:57 pm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Inspections
14-02-2020 Bropille 15
- Overview
- Inspection tools
- Observations
- Images
- Analyses
- 3D Modelling
Inspection types
Inspection - 14-02-2020 Bropille 15
Inspections / 14-02-2020 Bropille 15
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You have observations that doesn't have a status yet
Review observations
Process
2666
Images
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3D modeling
3D modeling
Status: completed
See 3D details
Analysis
Analysis
Order an analysis by artificial intelligence on your images
Order
4140
Observations
Observations
Annotate your images with our tools.
To tools
Details
Name
14-02-2020 Bropille 15
Inspection type
Bridge
Reference
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Description
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Created
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Start time
February 7 2020, 9:36:29 am
End time
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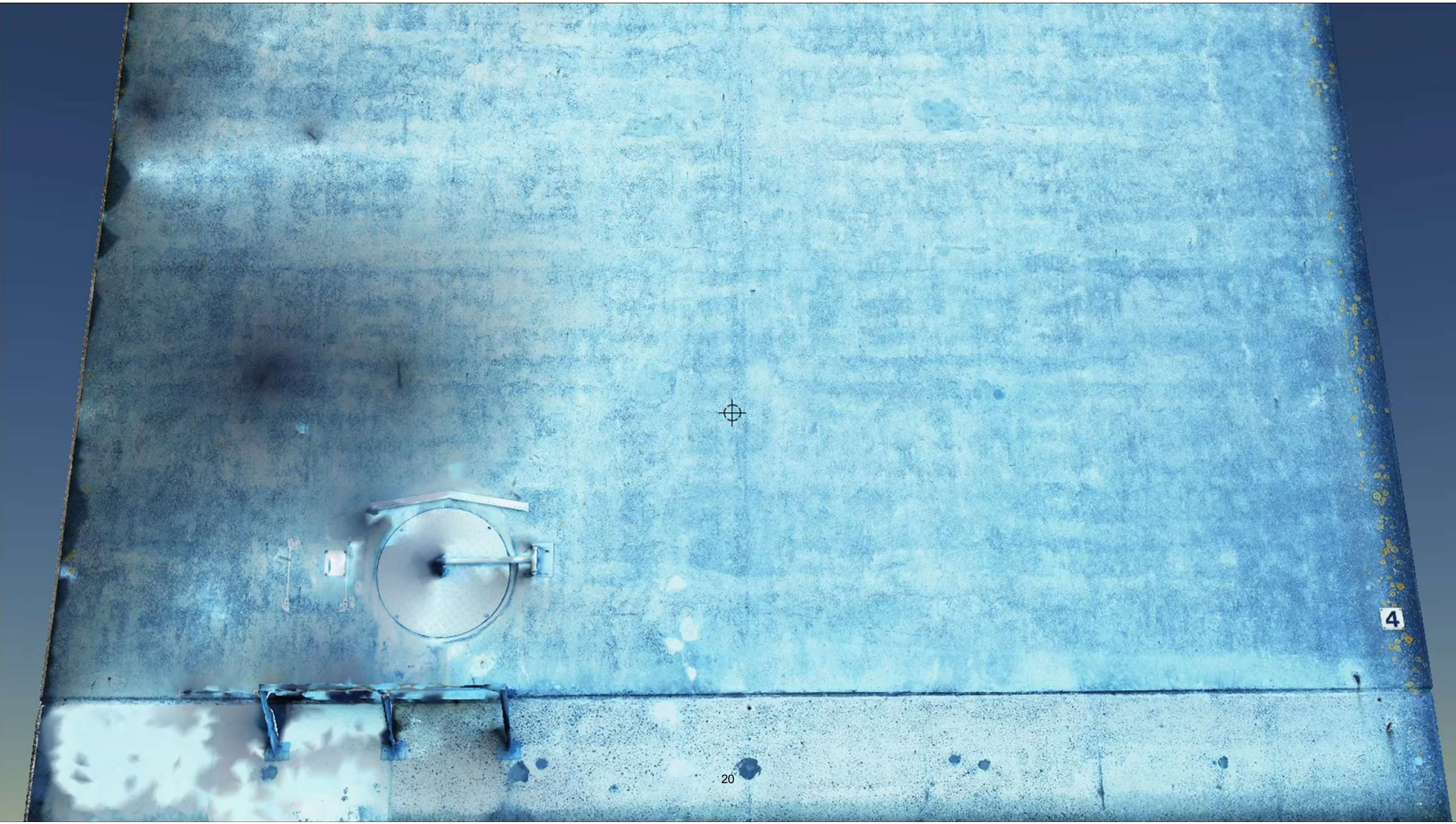
Create and share reports of your inspection
Missing permission
Share
Share
Create a public readonly version of the inspection you can share with anyone
Shares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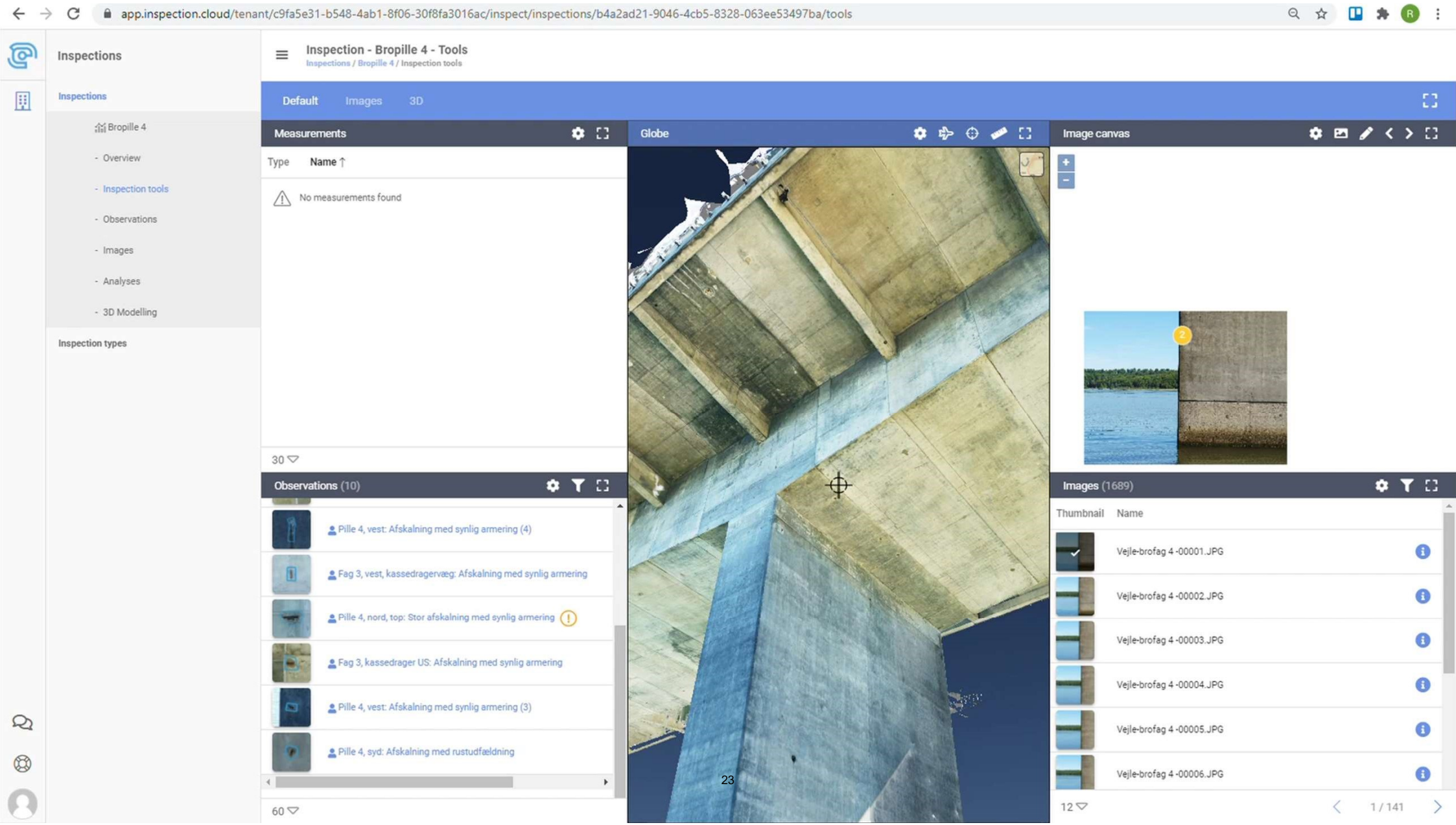
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Inspections
Bropille 4
- Overview
- Inspection tools
- Observations
- Images
- Analyses
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Inspection types
Inspection - Bropille 4 - Tools
Inspections / Bropille 4 / Inspection tools
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Images
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Globe
Image canvas
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Pille 4, vest: Afskalning med synlig armering (4)
Fag 3, vest, kassedragervæg: Afskalning med synlig armering
Pille 4, nord, top: Stor afskalning med synlig armering
Fag 3, kassedrager US: Afskalning med synlig armering
Pille 4, vest: Afskalning med synlig armering (3)
Pille 4, syd: Afskalning med rustudfældning
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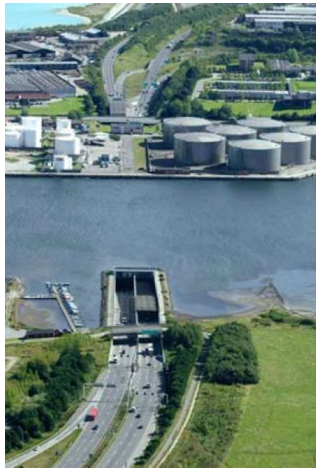
Globe

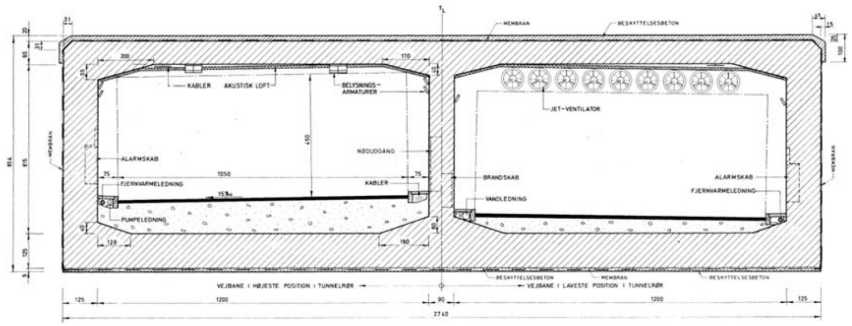
Limfjord Tunnel

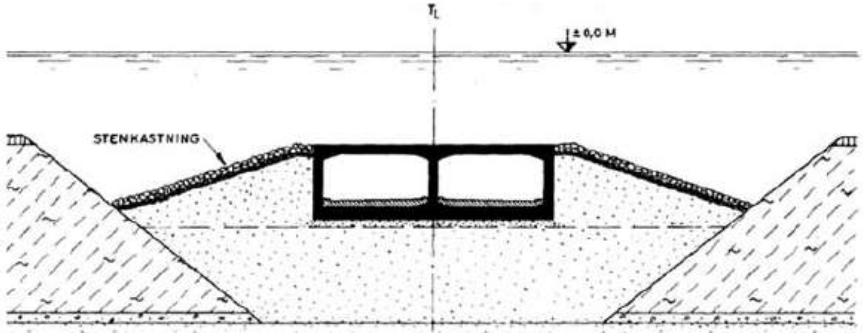
Assessment and retrofitting

Limfjord Tunnel

Assessment and retrofitting







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Limfjord Tunnel

Assessment and retrofitting

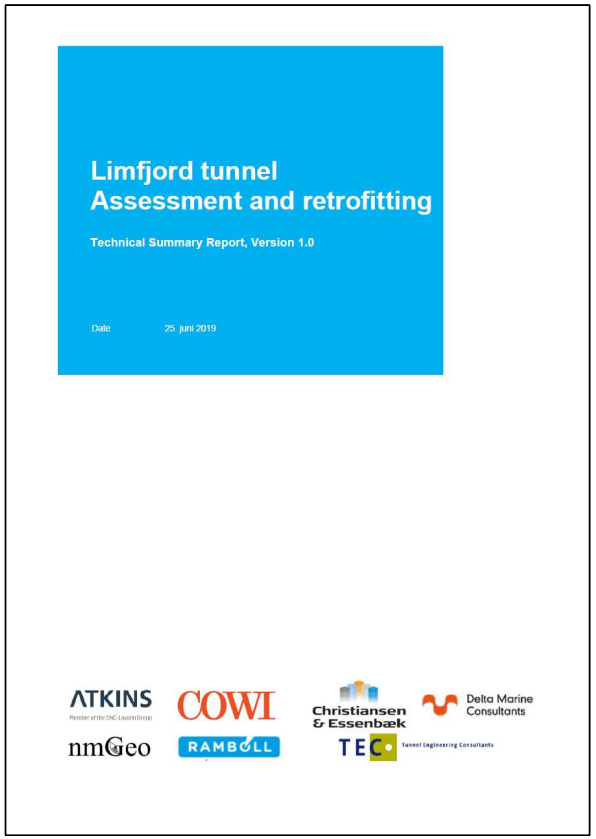
Background

The Limfjord Tunnel completed in 1969.

- Water-proofing membrane.
- Cracks in the tunnel roof and outer walls.
- Settlements of the tunnel.
- Corrosion of the reinforcement.
- Post-tensioning cables installed in 1993-94.
- Reinforcement and concrete repair late 1990´s.
- Anchors repair due to delamination in 2010.

Limfjord Tunnel

Structural Expert Group 2018-2019



Objective

The objective of the work carried out by the Structural Expert Group and summarized in this report has been to provide the Danish Road Directorate with suitable and practical guidance to maintain, repair and correct (where relevant) the structures of the Limfjord Tunnel for the remaining lifetime of the tunnel until the year 2069.

Limfjord Tunnel

Structural Expert Group 2018-2019

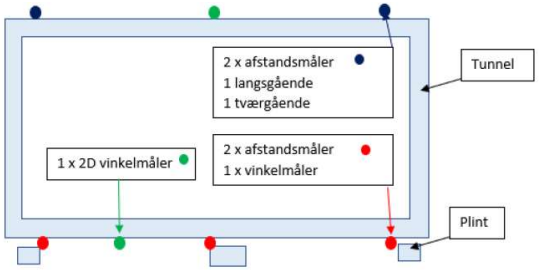
Condition Assessment

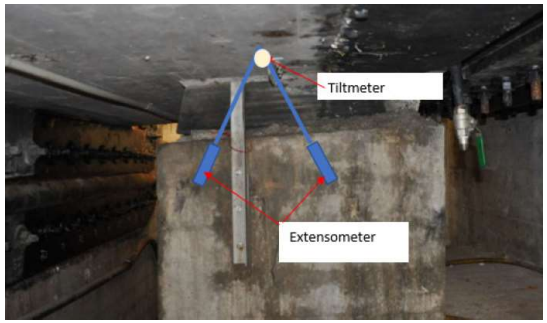
A comprehensive physical condition assessment of the tunnel structure has been carried out.
The main conclusions are summarised below:

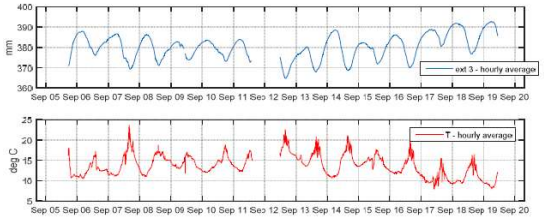
- The characteristic compressive strength of the concrete has been determined to be a minimum of 40 MPa compared to the original requirement of 25 MPa.
- The outer waterproofing membrane is found to have limited function and is unable to prevent water ingress into the concrete structures.
- Numerous cases of leaking water have been observed in core holes and break outs indicating that the tunnel structures are heavily exposed to water ingress.
- High chloride contents have been found in several samples. In other samples very low chloride contents have been determined.
- No signs of significant corrosion of reinforcement have been observed during inspections. Hence, it is considered that the reinforcement is generally in good condition.
- The quality of the interface between the repair and the original concrete in the roof is assessed to be adequate to effectively transfer the shear forces although delamination is seen in some areas.
- **It is strongly recommended to keep the tunnel under increased observation by comprehensive monitoring and inspection activities due to the high exposure to water ingress and significant chloride contents seen in some areas of the tunnel.**

Limfjord Tunnel

Basic maintenance and repair strategy







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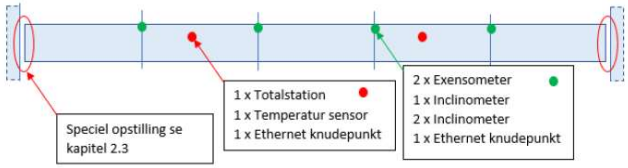

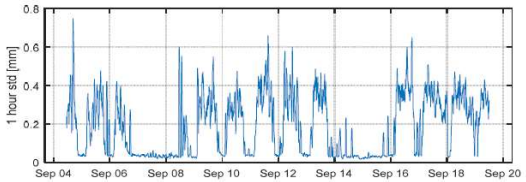

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Thank you

for your attention

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