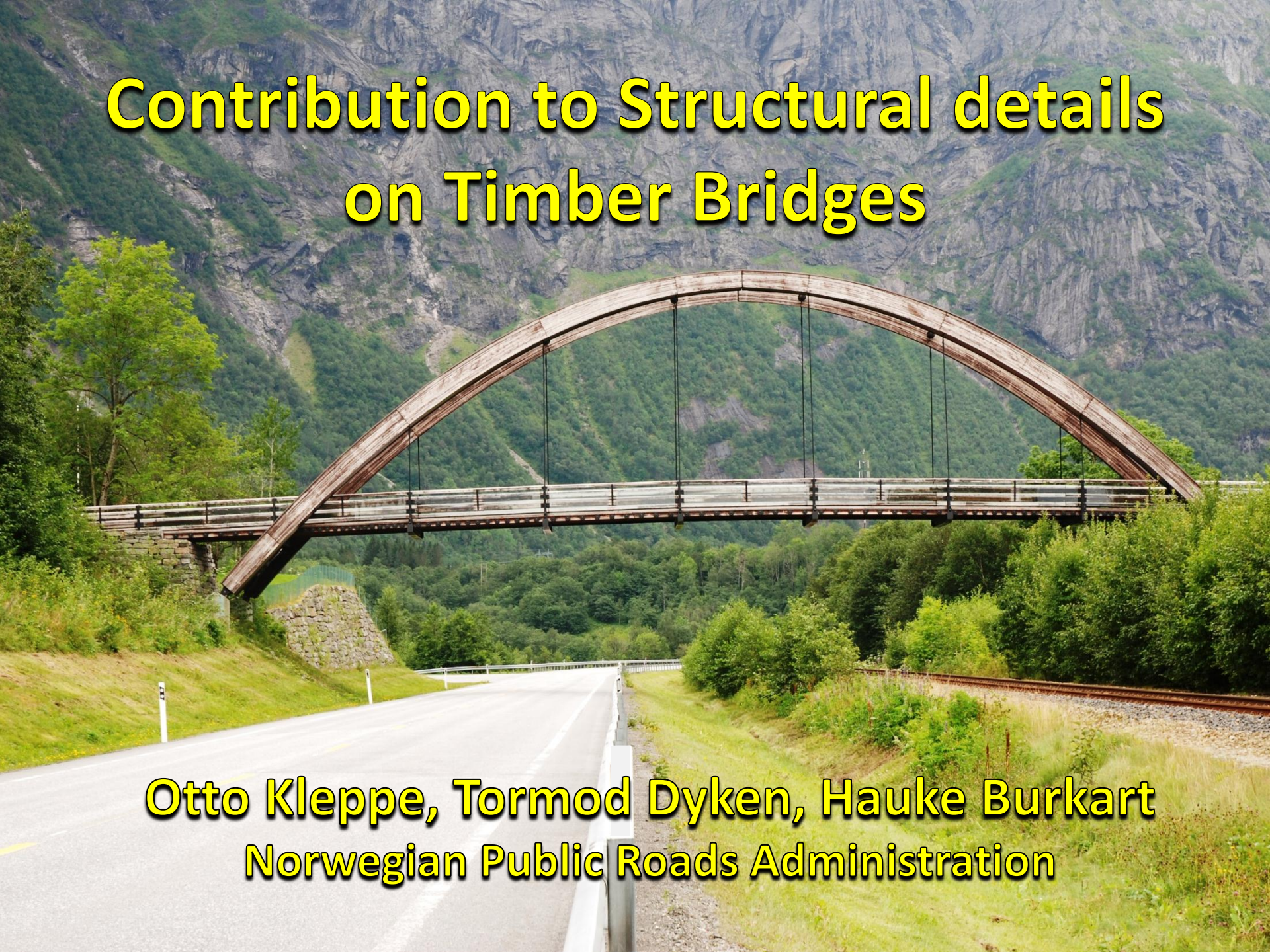
Contribution to Structural details on Timber Bridges



Otto Kleppe, Tormod Dyken, Hauke Burkart
Norwegian Public Roads Administration

Overview – Timber bridges in Norway

Statens vegvesen
Norwegian Public Roads Administration

- **The number of bridges**
  - In total there are nearly 200 timber bridges in Norway, 80 road and 110 pedestrian bridges. This includes about 25 municipality bridges.
  - On the national road network we have approximately 60 timber bridges
  - On the county road network there are approximately 70 timber bridges

Experience from Timber constructions

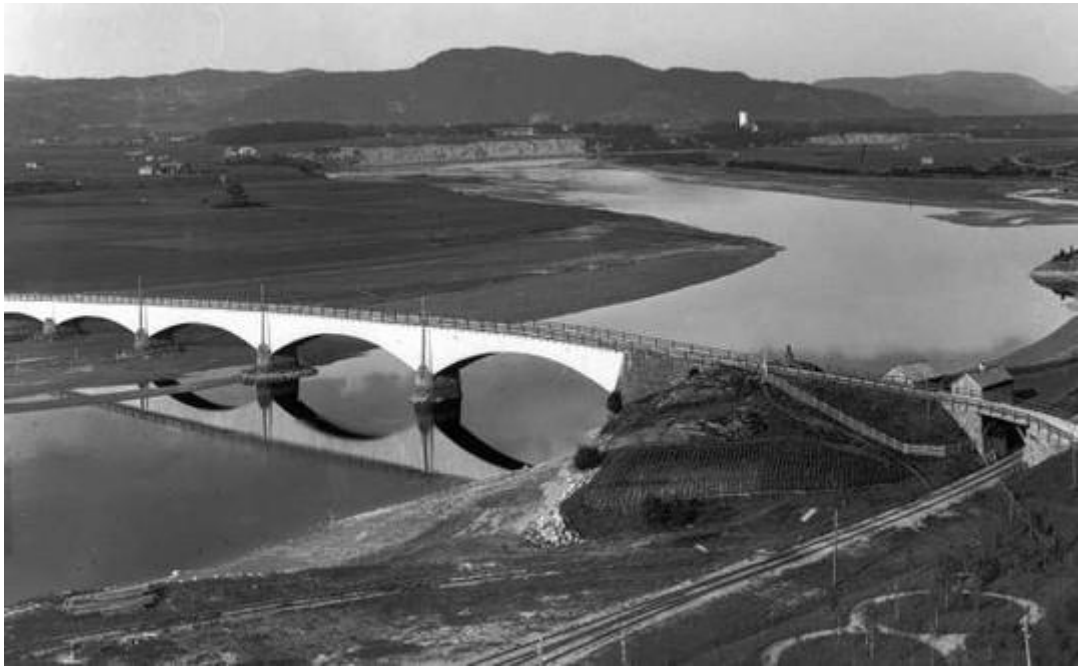
Statens vegvesen
Norwegian Public Roads Administration

- Traditional houses and churches (up to 800 year)
- Electric power supply poles (up to 70 year)
- High voltage power masts (up to 50 year)
- Cross bar on power masts (up to 60 year)

Experience from older timber bridges

Bridge over Stjørdals River at Sandfærhus – Hell Bridge

Statens vegvesen
Norwegian Public Roads Administration



- This bridge was constructed in 1856
- and demolished in 1964
- The bridge type was bolt laminated arch
- The vast bulk of the timber was reused by the building of near by houses
- The long service life is due to structural and chemical protection

The picture is taken in approximately 1890.
© Stjørdal Local History Society

The timber bridges build in Norway today

Statens vegvesen
Norwegian Public Roads Administration

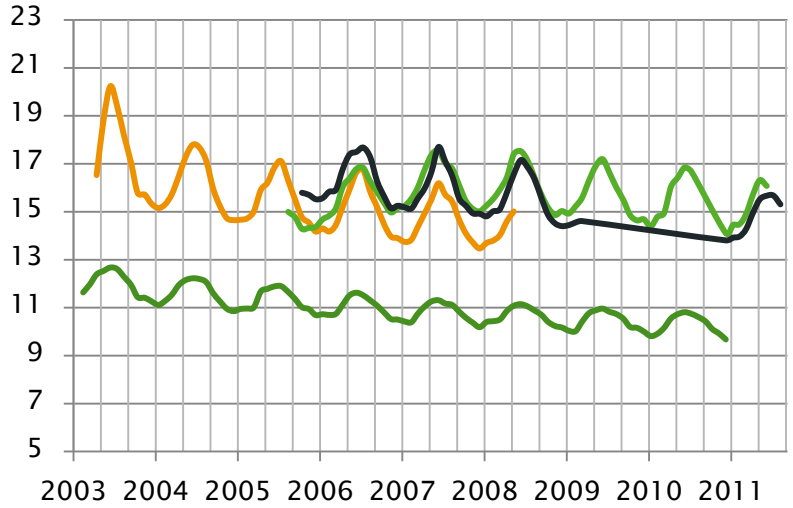
- We restarted designing Timber bridges in 1991 with a trip to USA
- The we have a requirement of100 year service life without heavy maintenance
- The traffic load requirement is the same heavy loading for all bridges
- We use structural and chemical protection, and all bridges are planned to last without comprehensive maintenance

Evenstad Bridge 5 span, 180 m long, constructed in 1995

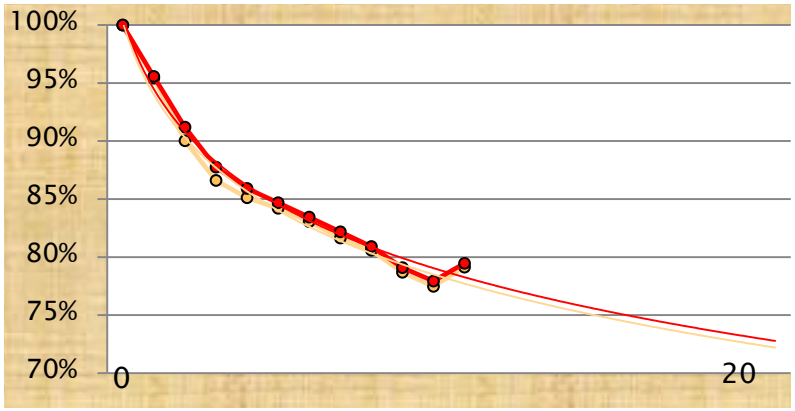
The monitoring program

Statens vegvesen
Norwegian Public Roads Administration

- The moisture content in timber bridges – 5 bridges
- The loss of prestressing force in stress laminated bridge decks



The moisture content
The average daily value



The force in the tendon bar
The average yearly value in two bars

Water at the wrong location

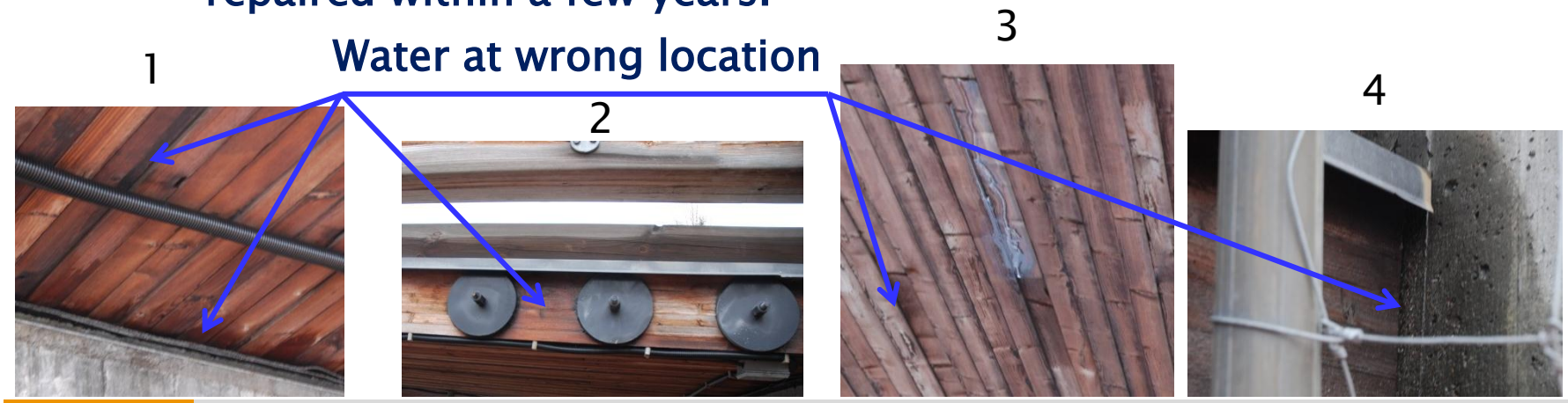
In some few occasions

Statens vegvesen
Norwegian Public Roads Administration

- Leaking membrane
- Missing or defective drip moulding (throating). The water overruns the edge of the deck and down the side face
- The water run on the support shelf or beam. Consequently the water will be absorbed by the sill, and also by the slab when the sill is made of timber

Possible consequences

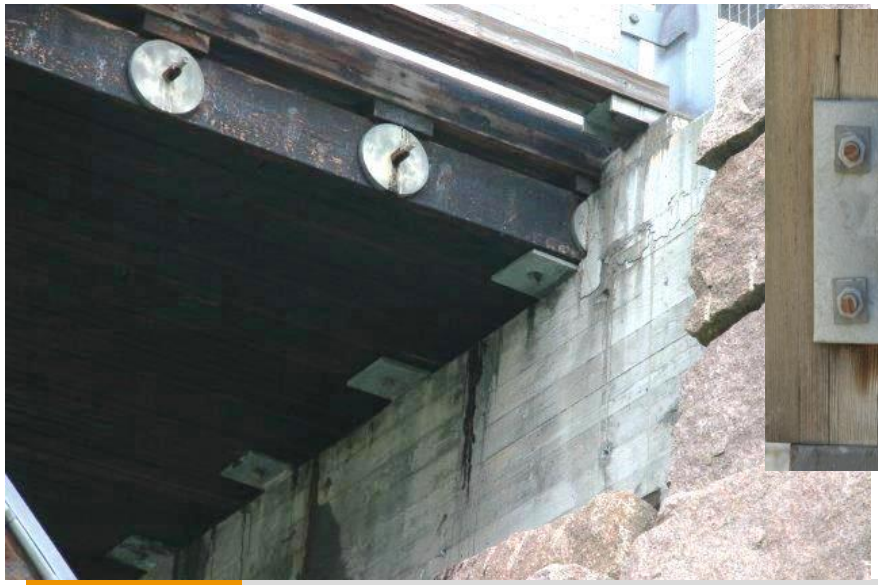
- This water at the wrong place is very unfortunate and have to be repaired within a few years.



Moisture/water absorbed in the end-grain

Statens vegvesen
Norwegian Public Roads Administration

- Water/moisture may be accumulated in different ways, enclosed and consequently absorbed in the end-grain.
- Here are three examples



Prestressing bar

Statens vegvesen
Norwegian Public Roads Administration

- In some very few cases
  - Failure of the prestressing bar – one case
  - The protruding end of the prestressing bar is sometimes far too short to allow re-tensioning of the bar
- All stress laminated decks
  - Important to find the correct point of time for re-tensioning the tendons

Corrosion on the tendon

All tendons are thermal zinc sprayed

Statens vegvesen
Norwegian Public Roads Administration

Serious challenges:

- Corrosion on the prestressing bar – The cause is so far not completely known
- A reason for the corrosion is most likely water penetration into the location of the bar
- The design of the membrane termination at the edge of the deck and the drop moulding should probably be improved

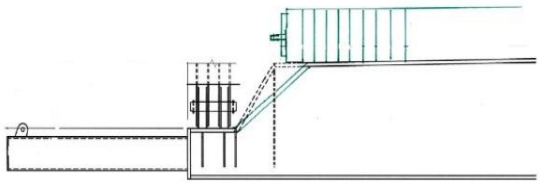
Influence from the vegetation and gravel/debris

Statens vegvesen
Norwegian Public Roads Administration

- Vegetation close to (touching) the bridge
- Gravel/debris touching or surrounding parts of the timber bridge

1

2



5

3

4

Connecting point for parapet

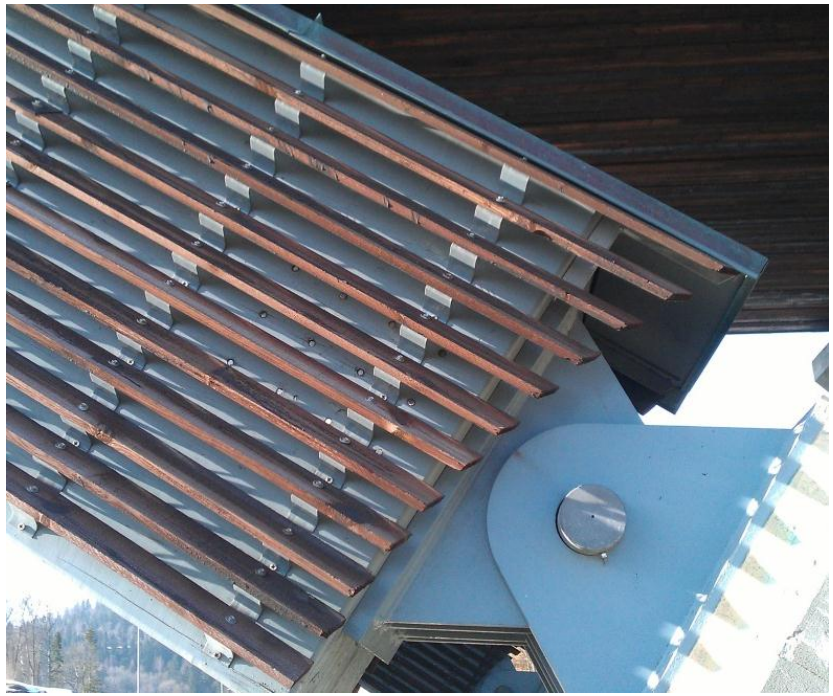
Statens vegvesen
Norwegian Public Roads Administration

- Water follows the steel structure and reaches the timber in concentrated amount
- Precipitation running off from one member to the one below

Top and side face structural protection

Statens vegvesen
Norwegian Public Roads Administration

- All members have structural protection on the top face
- Panels formed by slices of the arch on the side face
- Louvre on the side face



Water penetrating into cracks

Statens vegvesen
Norwegian Public Roads Administration

- Gloeophyllum sepiarium (Rusty gilled polypore)on timber bridges
- Water following the surface without structural protection and penetrating cracks. The water will dry out very slowly and cause wood decay fungus attack

Moving dowels

Statens vegvesen
Norwegian Public Roads Administration

- Dowels moving out of the timber as a result of traffic loading
- Today we use dowels with thread and nuts where moving could happen

Maintenance of timber bridges

So far very little maintenance has been required

As per today the timber bridge maintenance has consisted of

- Upgrading of the timber bridges because of new knowledge
  - Structural cover on all upper faces
  - Moving dowels
  - Water on timber
- Bad workmanship
  - Leaking membranes
- Bad design
- Recently discovered mistakes
  - Corrosion on the tendons
- Normal maintenance
  - Re-tensioning of the tendon
- We should have required
  - Collecting of bleeding creosote

Thank you for your attention