Norwegian Safety Investigation Authority

# INFORMATION DOCUMENT NO 2: PRELIMINARY INVESTIGATION OF THE BRIDGE COLLAPSE AT TRETTEN ON 15 AUGUST 2022

*This information document is a preliminary presentation of the NSIA's investigations relating to the bridge collapse and does not provide a full picture. The report may contain errors and inaccuracies. The final report will constitute the NSIA's official document relating to the accident and the investigation.*[1]

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| Date and time: | 15 August 2022 at 07:33 |
| Place: | Tretten bridge, Fv 254, Øyer municipality, Innlandet county |
| Type of accident: | Bridge collapse |
| Vehicles involved: | Heavy goods vehicle (lorry with trailer) and passenger car |
| Road users involved: | HGV driver and passenger car driver |

*All times given in this report are local times (UTC + 2 hours) unless otherwise stated.*

## Introduction

This information document is published to allow interested parties to familiarise themselves with some of the information that has so far been collected through our investigation. Its purpose is to provide a brief update on developments in the technical examinations and the findings made so far. The information document is based on factual information obtained and traces and parts secured from the bridge, and it contains no conclusions or safety recommendations.

## Sequence of events

On the morning of 15 August 2022, at 07:33, Tretten bridge collapsed and fell into the Gudbrandsdalslågen river and onto the E6 road. One passenger car and one lorry with a trailer carrying lime were on the bridge when it collapsed. The driver of the passenger car evacuated herself from the vehicle and climbed to safety on the west bank of the river, while the lorry driver was evacuated by helicopter. Neither of the road users involved were seriously injured in the incident.

## Organisation

The Norwegian Safety Investigation Authority (NSIA) arrived at Tretten on 15 August 2022 and began its preliminary investigation into the bridge collapse. Based on the preliminary investigation, the NSIA decided to initiate a full safety investigation of the incident.

The NSIA took over responsibility for the external expert group originally established by the Norwegian Public Roads Administration (NPRA) and Innlandet county authority in connection with the bridge collapse. The expert group consists of experts from building and construction consultancy company Aas-Jacobsen, the Norwegian University of Science and Technology (NTNU), SINTEF and engineering and architecture consultancy company SWECO. The expert group is led by the NSIA.

The investigation will seek to determine how and why the bridge collapsed, identify safety problems and map the incident's underlying causal factors. Based on the results, the NSIA will consider areas for improving safety.

[1] The object of the NSIA's investigations is to clarify the sequence of events and causal factors, elucidate matters deemed to be important to the prevention of accidents and serious incidents, and to issue safety recommendations if relevant. It is not the NSIA's task to apportion blame or liability under criminal or civil law.

**Preliminary investigations**

The NSIA, together with the external expert group, has carried out technical investigations in connection with the collapse of the Tretten bridge. In this context, among other things, relevant technical material, videos and pictures of bridal parts, as well as witness observations, have been reviewed. Static analysis of the bridge have also been carried out. Relevant inputs to technical causative factors, which the NSIA has received input on and become aware of during the investigation, have also been reviewed.

Uncovering the technical causal factors for the collapse of the Tretten bridge has been challenging. The expert group has worked its way through several hypotheses to be able to exclude non-relevant fracture mechanisms, by connecting findings to computational analyses. There was significant consequential damage to the bridge structure, both from the collapse itself, the impact with the ground and the salvage work, and it has been challenging to separate these from each other.

The technical investigations substantiate that the initial cause of damage to the collapse of the Tretten bridge was a break in one of the diagonals in the main span towards the western river foundation (axis 2).

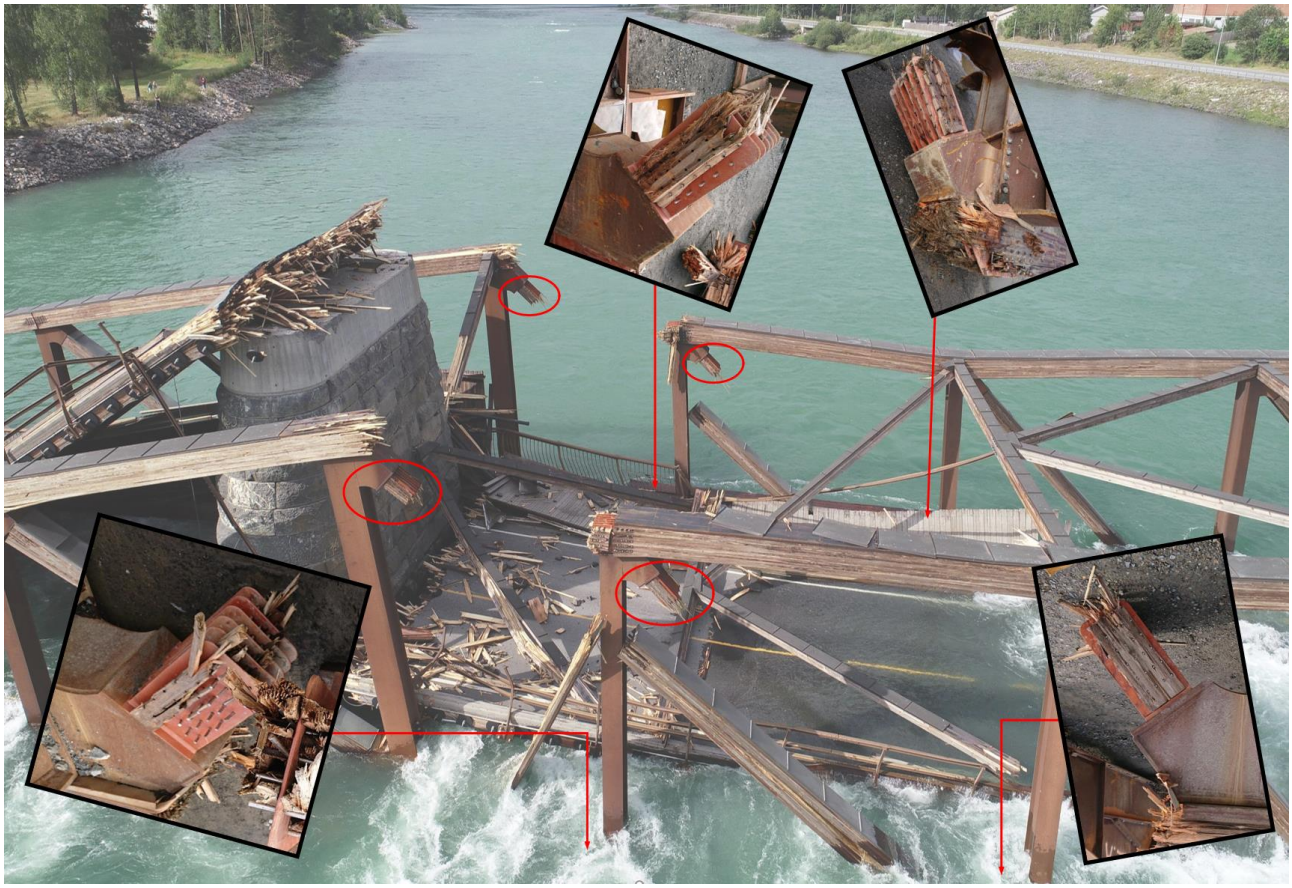

*Figure 1: Red rings around the upper connections, and images of the connections that was under water, and attached to the diagonals in the main span towards the western river foundation (axis 2). Illustration: NSIA*

The fracture form is identified as block shear failure between the wooden part and steel/dowels at the junction. This is a momentary form of failure that can cause overloading of other elements in the truss upon subsequent loading, and then with the collapse of the bridge as a result. The fracture form is supported both by technical examinations of fracture parts, photographic material and witness observations, as well as carried out structural analysis and calculations.

The cause of the fracture form has so far been assessed to be a significant overload in relation to the bridge's load impact and bearing capacity, with regard to block shear failure in the connections to the said diagonals. Checked according to the recommended calculation methods in today's current regulations for the design of wooden structures, the degree of utilization in the connections on the relevant diagonals was around 200%[2]. That is to say, the capacity of these connections was half of what they should have been

[2] *NS-EN 1995-1-1:2004+A1:2008+NA:2010, «Tillegg A (informativt): Brudd som følge av skjær langs periferien av en gruppe dybler i stål-mot-tre-forbindelser».*

when calculating the bridge's failure limit state, where safety factors for both loads and strength of materials were taken into account.

Whether the capacity has been reduced as a result of repeated loads or fatigue will be sought to be clarified in the future. Block shear failure was not a control that was specified in NS 3470 (Norwegian design standard), which Tretten bru was designed according to.

Technical investigations have not revealed any signs of a reduction in the bridge's load-bearing capacity as a result of rot or corrosion.

The NSIA emphasizes that this information letter is a preliminary and not a complete presentation of the technical investigations that have been carried out in connection with the bridge collapse. The final report will contain more detailed information about the technical investigations carried out, results and conclusions.

**Further investigations**

The main areas for The NSIA's further safety investigation are as follows (the list is not exhaustive):

- The NSIA, together with the professional group, will continue the work of carrying out technical investigations into the collapse of the Tretten bridge, and as far as is practically possible, try to uncover the underlying mechanisms for block shear failure as a form of failure.

- Regulations for the design of wooden structures, bridge management and follow-up of the Tretten bridge after the collapse of the Perkolo bridge in 2016, will constitute three main areas in the further investigation of the underlying causal factors for the bridge collapse. In this context, The NSIA is well underway in obtaining relevant information and documentation, and meetings and interviews with relevant actors are being held on an ongoing basis.

- Further investigations will also aim to try to uncover how Tretten Bru could have been in operation for around ten years before it collapsed. In this context, the investigation will try to uncover whether there have been other causal factors, beyond low capacity against block erosion, which may have contributed to a gradual weakening of the bridge over time.

The NSIA feels that the cooperation with the actors involved is very good, and that all parties want to contribute relevant information and documentation to the investigation.

The scope and complexity of the investigation means that The NSIA cannot estimate a date for publication of the final report. The investigation will continue with a high level of activity.

**Concluding remarks**

The safety investigation is well under way, and this information letter only informs about some of the investigations that have been initiated. The information letter is not exhaustive for the survey as a whole.

Norwegian Safety Investigation Authority

Lillestrøm, 2 December 2022