FALLSTUDIEN FS22
FINAL REPORT

Zollhusbrücke, Eschikofen (TG)

Amélie Chiffelle, Céline Bourban, Claire Debons & Manon Amsler

Location and history of the bridge

Zollhusbrücke Tüüffelschanze is a wooden bridge situated in Eschikofen, a municipality of the canton of Thurgau. It bridges the two shores of the river Thur and is considered the oldest road network structure in the canton of Thurgau[1].
The history of the bridge is highly related to the flooding of the river. This is reflected not only in the way the bridge is integrated in the landscape but also in its construction. The bridges' capacity to resist to the changing levels of the river has been improved throughout history.

A new road connecting the villages of Frauenfeld and Weinfelden made it necessary to build this bridge. Thus, in 1835 the council of Thurgau started the initiative to build the bridge. Financing the bridge wasn't complicated. Due to its geographical position, a private investor payed 23 900 "florins" (local money at the time) for the construction and could then gather interests on custom fees[2].

For many years, custom duties were levied by the investors, hence the name of the bridge «the house of customs». When these taxes were abolished, the canton of Thurgau took back the ownership of the construction[3].
The bridge was completed in 1837 by the carpenter Müller from Hüttlingen. It was put to the test on 1 May 1839, when the road between Frauenfeld and Weinfelden started being regularly used by vehicles[4].
Gradually throughout time, steel elements (bolts, cables etc.) were added in order to reinforce it. After 150 years of service for vehicles, in 1954, the bridge was cleared of traffic[5]. Nowadays, the bridge is still open to all soft mobility (horses, pedestrians and cyclists are regularly seen on it). It is now considered a monument, a masterpiece of craftsmanship.

[1] Etter Alfred, *Brücken und Fähren im Thurgau* (Weinfelden, 1982).

[2] «Zollhusbrücke Tüüfelschanze», *Swiss Timber Bridges*.

[3] Etter Alfred, *Brücken und Fähren im Thurgau* (Weinfelden, 1982).

[4] Etter Alfred, *Brücken und Fähren im Thurgau* (Weinfelden, 1982).

[5] «Zollhusbrücke Tüüfelschanze», *Swiss Timber Bridges*.

Description of the bridge existing today

A) Construction time and possible later modifications of the existing bridge

After finishing the construction of the bridge, steel elements were added to reinforce the main structure[1]. One of the most important of these interventions was the adding of steel tie rods to relieve the queen posts (Hängesäule) of part of the tensile loads. They also added horizontal tie rods just above the tie-beam (Streckbalken), at the foot of the diagonal truss beams (Sprengswerkstrebe). These help alleviate the forces in the main structural frames and the beam underneath it (Sprengswerkstrebe-Spannriegel).

In 1896, an iron truss bridge connected the main road to the wooden bridge[1]. This iron bridge was renovated in 2020-2021 because the iron sleepers and stringers were no longer in good condition (due to chloride water infiltration)[2].
In 2007, Zollhusbrücke was renovated because floods had damaged the condition of the wood.
In 2020 and 2021, it underwent a major renovation on the pillars and the north side (steel addition)[3].

B) Main specifications: total length, clear width and height, number of openings, clear width of all openings

The bridge measures a total of 91 metres. It consists of 5 repeating bays, each 18 metres long. Its clear width is 5.30 metres; its total height is 7.70 metres while its clear height is 4.20 metres.
The bridge has 8 windows: 5 are on the east side and 3 are on the west. The windows on the east side are 1.26 metres wide while those on the west side are 0.96 metres wide[4].

[1] Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

[2] Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

[3] Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

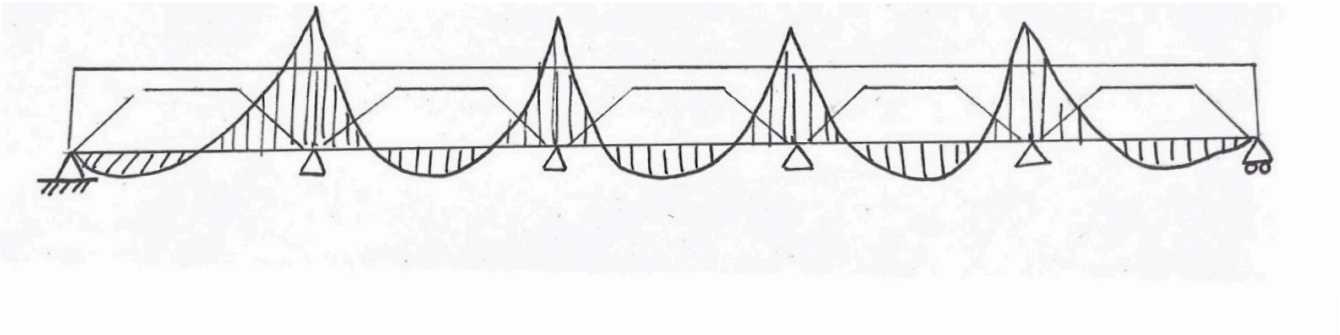
[4] «Zollhusbrücke Tüüfelschanze», *Swiss Timber Bridges*.

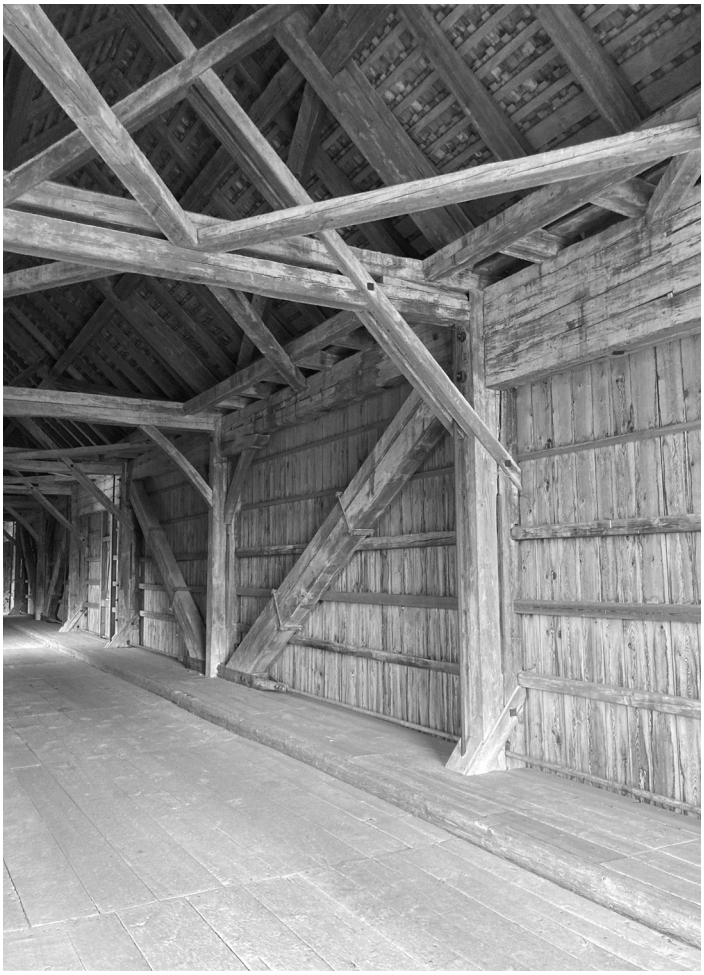
C) Description of the main support system of the bridge

The bridge is considered a continuous beam. As a result of flooding, the original wooden supports were deteriorated and therefore replaced by 4 intermediate iron ones to ensure its stability. It currently has 6 supports (2 extremities, 4 intermediate). These iron additions are riveted and not bolted, which proves that they are relatively old.

Zollhusbrücke Tüüffelschanze consists of five bays, each divided into three spans. These spans are divided by queen post trusses (zweifaches Hängewerk). There are two main tie beams (Streckbalken): the upper one supports the roof structure and the lower one carries the loads of the deck. The upper tie beam (Streckbalken) is in compression whereas the vertical elements (Hängesaule) are in tension.
The queen post (Hängesäule) connects the truss brace (Hängewerkstrebe) to the lower tie beam. It acts as a central element, which is under tension and holds the main horizontal structure (Zerrbalken + Fahrbahnplatte). The importance of this element can be seen in the fact that it is doubled and strengthened by an iron tie rod running through the entire height of the bridge.
The individual parts of the bridge are interwoven into complex constructional nodes and create a force path leading to the supports.

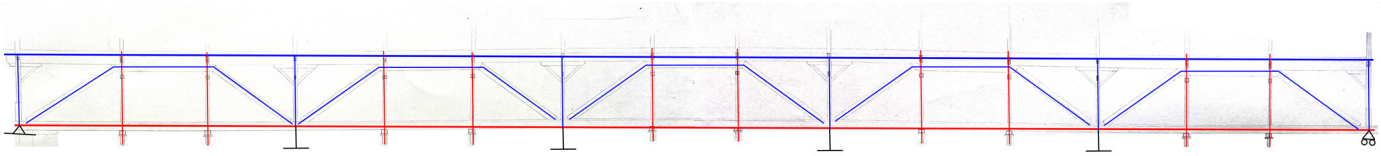
The queen posts (Hängesäule) are attached to the two main tie beams. These relieve the upper tie beam of compression forces and the lower tie beam of tensile forces.
The structure under the bridge is a composition of overlapped beams (Balken). The hierarchie works as follows, from top to bottom: there are the main beams that support the longitudinale charges throughout the bridge, bringing them to the transversale beams (Strekbalken). The transversale beams are braced and held by the queen posts (Hängesäule). Finally, the charges are passed on to the tie beam (Streckbalken) that is also held by the queen posts. The lower tie beam (Streckbalken) is divided in 2 pieces forming a *verzahnter Balken*, it therefore mainly carries the loads of the deck which are then punctually guided to the supports.





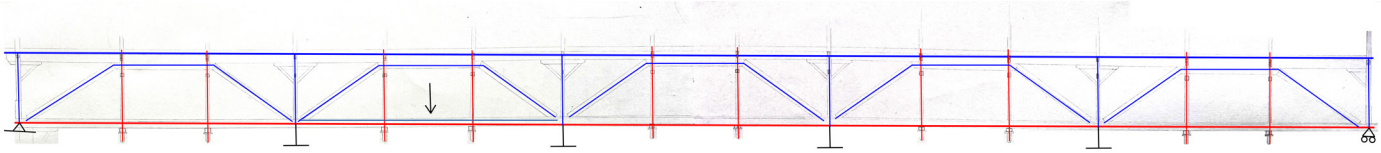
D) System drawing of a yoke of the bridge longitudinal framework (one line per beam) with entry of the load state «compres- sion» or «tension» in the load case dead weight/full load.

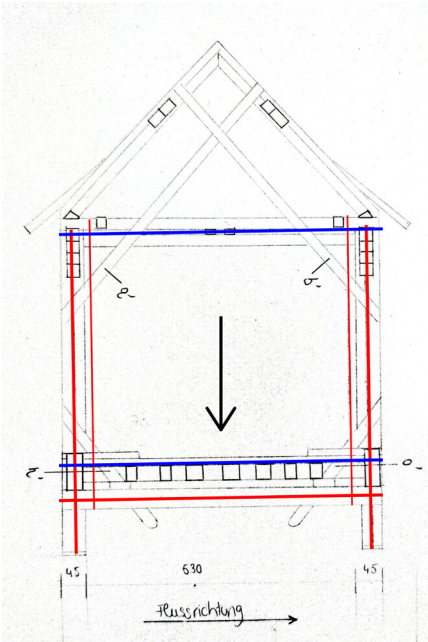
In the longeron (Streckbalken) that supports the floor of the bridge there is tension. Whereas the tie-beam (Zerrbalken) supporting the roof structure is under compression. The frame trusses (zweifaches Hängewerk) that build the lattice of the bridge consist of two diagonal beams (Sprengswerkstrebe) and one horizontal (Rähm + Spannriegel = verzahnter Balken). These frames are like arcs under compression. They are supported by two queen posts each that then act as connectors between the floor and the upper tie beam (Streckbalken from the roof). The queen posts that sit on supports are therefore under compression.

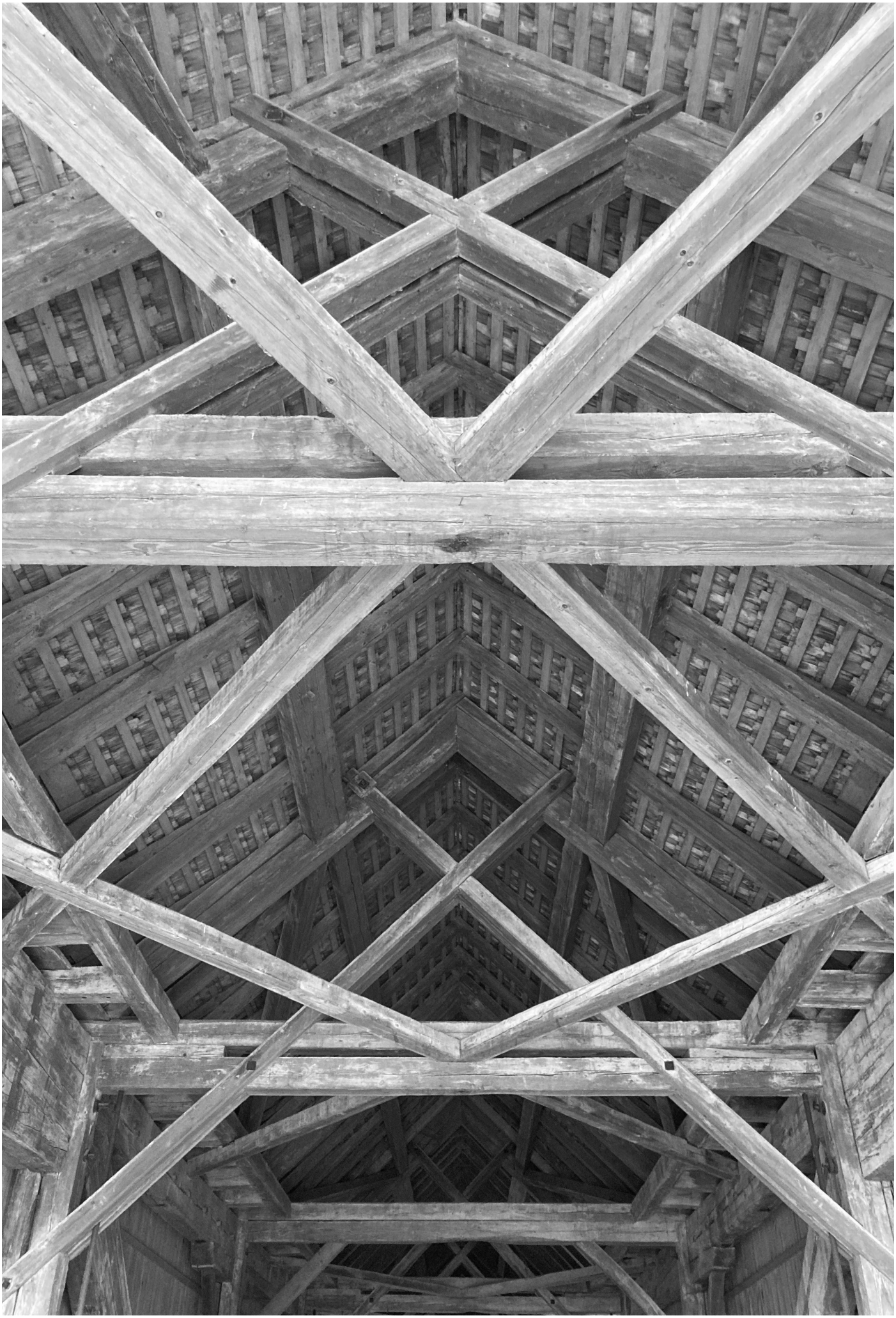


E) Explanation (with system sketch of the bridge's transverse structure) of how the load of a vehicle standing in the middle of the roadway is entered into the main longitudinal structure

When the bridge receives the punctual load of a vehicle it changes the forces in one bay. If the load is directly above a support, it doesn't change the distribution of forces within the wooden structure. Nevertheless, if the load is not situated on a support the structural functioning of the elements varies. The upper part of the deck remains under tension and the lower part of the deck is no longer under tension but is in compression.







F) Explanation of the system of carpenter's marks

The carpenter's marks were developed from the south to the north, so the south is the assembly face (Bundseite).

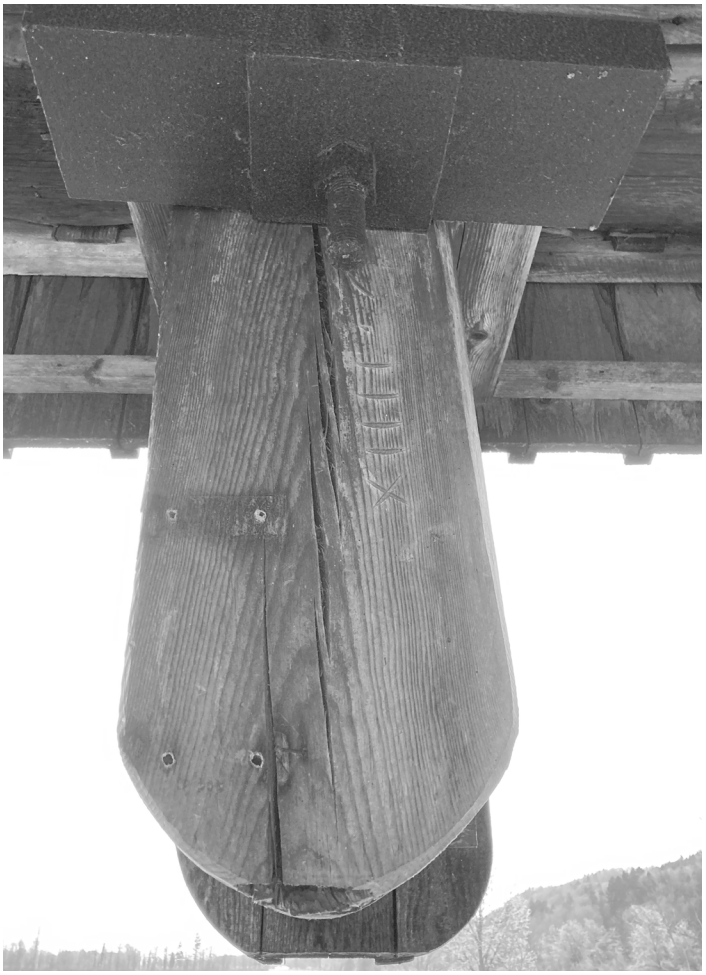
The carpenter marked each element of the bridge according to two logics: he thought the bridge (roof and tie-beam) in bays, 5 bays each consisting of 3 spans. Whereas for the queen-posts he counted from 1 to 15.

Main marking system:
His numbering goes from 1 to 5, a peak-shaped notch for bay I, 2 notches for bay II and so on.
These notches are accompanied by a horizontal line from 1 to 4 to indicate their order of assembly (a scissor brace (Kreuzstrebe) with 3 «teeth» and 1 line will be placed before a scissor brace (Kreuzstrebe) with 3 «teeth» and 4 lines, always with the help of the assembly face.

To distinguish whether the element is mounted on the left or the right, he represented this by vertical lines, 1 line for the right, 2 lines for the left.

In the case of some doubled elements, it was necessary to engrave assembly marks looking from the north.

Queen posts:
They are written in Roman numerals, unlike the other carpenters' marks that are notches.



G) Appreciation of the bridge in the sense of explaining those characteristics of the bridge which make it a monument worthy of preservation

Even if the bridge is not used as much as it used to be, it remains a monument of high historical and social value.
Once, it was one of the most important links in the canton of Thurgau, but now it is restricted to pedestrians and no longer serves as a major connection, except for the access to the circus and a path to cross the river[1].

However, it's the history of the bridge that makes it worth having a closer look at. Since its construction, it has withstood many floods[2]. It is a relatively important piece of history. This monument bears the traces of its many renovations and developments. It can be compared to a palimpsest of the last 185 years. Although, it had to be reinforced, most elements are still preserved today and show evidence of the the art of wooden bridge building of the 19th century.
The construction comprises also a metallic structure which was completely renovated in 2020[3]. The contrast between these two parts is very interesting and not common in the Swiss landscape. Indeed, the bridge has been adapted over the years in order to last.

Finally, the structure has a strong social and historical connotation for the canton of Thurgau. Its evolution reflects the development of traffic and society. The redundancy of wooden bridges along the river shows the importance that was attached to the passage from one side of the river to the other. It is therefore a key element of the city, as well as of the canton.

[1] Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

[2] Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

[3] «Die Brücke beim Zollhaus Eschikofen erhält ein Buch zur «Wiederauferstehung in Rot», *tg.ch*, December 8, 2021, https://www.tg.ch/news.html/485/news/55444/l/de.

Sources and literature

Bundesamt für Strassen, Inventar historischer Verkehrswege der Schweiz, 12.03.2020, Historische Verkehrswege im Kanton Thurgau, ASTRA, Bern.

Clementine Hegner-van Rooden, «Substanz konserviert, Thurbrücke Eschikofen» *espazium.ch*, September 9, 2020, https://www.espazium.ch/fr/node/25765.

«Die Brücke beim Zollhaus Eschikofen erhält ein Buch zur «Wiederauferstehung in Rot», *tg.ch*, December 8, 2021, https://www.tg.ch/news.html/485/news/55444/l/de.

Etter Alfred, *Brücken und Fähren im Thurgau* (Weinfelden, 1982).

Stefan Holzer, «Glossar: Bauforschung und Konstruktionsgeschichte», September 17, 2020.

«Thurgau: Historische Vorlandbrücken bei Eschikofen werden saniert» *baublatt*, February 25, 2020, https://www.baublatt.ch/bauprojekte/thurgau-historische-bruecke-bei-eschikofen-wird-saniert-29268.

«Zollhusbrücke Tüüfelschanze», *Swiss Timber Bridges*.