



ORIGINAL ARTICLE

The roof is on fire! A dendrochronological reconstruction of the restoration of the Basilica of Our Lady in Tongeren (Belgium)



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ABSTRACT

A dendrochronological study of the roofs of the Basilica of Our Lady in Tongeren (Belgium) showed that the current roofs date to the period right after the deliberate burning of the church in 1677. High resolution dendrochronological dates – based on wood-anatomical observations of the outermost tree-ring – combined with detailed archival sources, allow us to trace the progress of reconstruction of the various roofs throughout the years following the fire at an intra-annual resolution. This provides an exceptionally detailed timeline of both the temporal and spatial progress of the reconstruction of the roofs of the Basilica of Our Lady. As such, this case-study can serve as a very detailed reference for the study of post-medieval roofs and the workflow during their construction.

1. Introduction

The Basilica of Our Lady in Tongeren (Belgium, Fig. 1) has a long and turbulent history. The construction of the current church started in the 13th century, following the local, Brabantine interpretation of the Gothic style (Fig. 2a and b). From 1999 onwards the church has been under restoration and archaeological research was done within the building (Van den Hove et al., 2002). These archaeological excavations in and around the church have demonstrated that the history of the Basilica dates back to the foundation of the town of Tongeren – the oldest town in Flanders – in 10 BC (Ervynck et al., 2014). In the 4th century AD, Roman houses were replaced by a Roman basilica (meeting house), that at some point, was possibly used as a pre-Christian church. During the following centuries several churches were erected, expanded and rebuilt on this site.

The current Basilica of Our Lady officially became a protected historical monument in 1936, and was designated by UNESCO as a World Heritage Site (1999)² within the list of Belfries of Belgium and France.

It is known from historical sources that on August the 28th and 29th 1677 Tongeren was purposely set on fire at the command of the French military authority in order to weaken its strategical value during the Franco-Dutch War (1672–1679). The Church of Our Lady suffered heavily from the fire and its roofs and tower were destroyed, leaving only the walls upright (Driesen, 1854; Geukens, 1990; Scheepers,

2009). Shortly after the fire, a damage report was written and plans were made for the restoration of the church, but the presence of French troops prevented work from starting.

The current roof construction is considered to be the result of the restoration campaign that followed after the demolishing fire. In order to verify whether the current roof indeed dates back to the end of the 17th century and if so, to further document the restoration efforts undertaken at that time, a dendrochronological survey was performed on the roofs of the Basilica of Our Lady.

2. Materials and method

2.1. The roof constructions

The roof construction of the Basilica of Our Lady consists of several distinct parts: the choir, transept, nave and two roofs over the aisles. The roof over the choir is composed of 5 trusses, numbered from east to west from 1 to 5 (Fig. 2c). On the first two trusses Roman carpenter marks are inscribed, whilst on the others Arabic numerals were used. Each truss is composed of two inclined trusses with roof plates and a ridge truss with central posts supporting the ridge purlin. Additionally, on both sides, purlins are present half way up the rafters of the low-ermost inclined truss (Fig. 3).

The roof above the nave of the church and transept has a completely

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² UNESCO entry 943bis [online: <http://whc.unesco.org/en/list/943>].



Fig. 1. Location of Tongeren in Belgium.

different structure. It is considered a purlin roof with trusses composed of inclined trusses on tiebeams and a ridge truss. The nave roof consists of eight trusses, with an identical truss connecting the nave with the transept (Fig. 4). The ridge purlin and superimposed tiebeams of the inclined trusses are supported by central posts with braces. The posts of the inclined trusses are flanked by rafters. Both are connected by short intermediary pieces, placed a little below the lowermost purlins. The inclined posts of the ridge trusses double as rafters. They are supported by braces, connected to the central posts of the ridge trusses and the superimposed tiebeams of the inclined trusses. Purlins are connected to the rafters by mortise-and-tenon joints.

The carpenter marks of the nave are less consistent compared to the choir. Again, both Roman-inspired numerals (II and V) and Arabic numbers (7, 6, 5, 3 and 10) are present on the timbers. They are located on the upward braches of the king posts, but are not sequential. Carpenter marks in the roof of the transept are Arabic numerals in ascending order from north to south (Fig. 5).

Both aisles have a roof that is constructed with semi-trusses (Fig. 6). It is clear that numerous repairs and alterations have been made over the years; a number of horizontal beams seem to have been replaced, a secondary collar has been added to a number of collars and some parts are fitted with metal nails instead of mortise-and-tenon joints with wooden pegs. The carpenter marks are sequential, but in reversed order compared to the other aisle.

2.2. Tree-ring analysis

Samples for dendrochronological analysis were first taken in November 2008 (van Daalen, 2009). In total 29 core samples were collected by using a dry wood borer with an outer diameter of ca. 21 mm (Fig. 7). Similar dry wood borers with smaller diameter (e.g. the teredo-type bores) proved to be unfit for the hard oak timbers. Shortly afterwards, a follow-up sampling campaign by the Flanders Heritage Agency increased the sample count to 47 to fully cover all roof constructions and building phases within the roofs. This approach was chosen to allow a more detailed interpretation of potential successive building phases for the different roofs.

The samples were taken from five different roof constructions: the roof over the choir (5), the transept (10), the nave (17) and both aisles (7 + 8). A rough estimate of the number of tree-rings was made based on the grain, size and orientation of the timber. Only timbers with an estimated number of 70 or more tree rings were considered for

sampling.

For the most precise dating results, suitable timbers with sapwood, bark or waney edge were selected. For timbers that retain at least part of the sapwood, a felling interval can be calculated based on statistical estimates of the number of missing sapwood rings (e.g. Haneca and Debonne, 2012). When samples with bark or waney edge can be dated by dendrochronology, the felling season can be determined. Timbers with obvious signs of re-use or a later addition were avoided, as these cannot provide more detailed information on the restauration process. The first can be recognized as timbers with open, non-functional joints, the latter by inconsistent dimensions, tool traces or fitting. However, only few such timbers were observed throughout the examined roof constructions.

All samples were glued onto wooden holders and pared with a scalpel or polished with sandpaper with increasing finer grits (P80 up to P800). Ring widths were measured to the nearest 0.01 mm using a stereo microscope and a measuring table. The presence of sapwood, waney edge or bark was recorded for each sample.

All recorded tree-ring series were then compared to absolutely dated reference chronologies, built with tree-ring series originating from archaeological contexts, historical buildings and living trees from Germany, the Netherlands, and the Meuse valley and Ardennes in Southern Belgium. The resemblance between the measurements and the reference chronologies was expressed by t_{BP} -values and the percentage of parallel variation (%PV). The t_{BP} -values are considered to be statistically significant above 3.5 (Baillie and Pilcher, 1973), but when cross-dating tree-ring series against long master chronologies it is commonly accepted that values should exceed 5.0 in order to support a reliable date and to avoid statistical Type I errors (false positive). The %PV provides a measure for the synchronous in- or decrease of ring width values for the reference chronology and the tree-ring series (Eckstein and Bauch, 1969).

2.3. Archival and historical research

Shortly after the dendrochronological analysis, a thorough examination of archival sources in Tongeren was published (Scheepers, 2009). An eye witness report was found in the archives of the Chapter of Our Lady, written by an anonymous priest who describes the events and actions undertaken near the Church of Our Lady in Tongeren between 1672 and 1680. The events following the fire in 1677 were also meticulously described in this diary. This historical document, in combination with accounts, correspondence and activities recorded by the Chapter, now allows a detailed reconstruction of the order of events that took place after the devastating fire. Especially the successive phases in the restoration of the roofs from the Church of Our Lady can now be confronted with the dendrochronological data.

3. Results

The roof construction of the choir (Fig. 3) clearly differs in typology from the roofs of the transepts and central nave (Fig. 4), which are purling roofs. Over the aisles, semi-trusses are present (Fig. 6), of which many elements have been replaced or added afterwards. All elements are made out of European oak wood, including the wooden nails. European oak covers two botanical species: pedunculate oak (*Quercus robur*) and sessile oak (*Quercus petraea*). These species cannot be differentiated based solely on their anatomical characteristics. Although certain differences in wood anatomy exist (Feuillat et al., 1997), these are very subtle and, in general, do not allow to determine the exact oak species.

The length of the tree-ring series, measured on the core samples taken from the oak timbers, varies between 38 and 122 rings (Table 1). Out of 47 only 10 tree-ring series (21.3%) display a clear agreement with the available reference chronologies: i.e. t_{BP} and %PV values above 5.0 and 65.0% respectively. These matches occurred against a variety of

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