

*The Notre-Dame
Translation Project*

II. Roofs & Spires

Edited by Lindsay S. Cook and Kathleen Hart

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On the Roof Framework of Notre-Dame of Paris

Written by G.-N. Lambert, P. Hoffsummer, V. Bernard, and V. Chevrier
([source](#))

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State of the science in dendrochronology

Dendrochronologists Vincent Bernard (Rennes, UMR 6566 CReAAH), Patrick Hoffsummer (Université de Liège), and Georges-Noël Lambert (CNRS / Université de Liège) collected roughly 70 samples between 1991 and 1994.

The average cambial age of the trees used was around 100 years, at most 120 years. Forty-nine of the oak samples dated from the late 11th century (the earliest date of felling was 1156, cambium intact) to the 18th century. The majority of [Notre-Dame's] wooden roof dated to the 13th century (before 1226), with the exception of:

- Viollet-le-Duc's spire
- the reused 12th-century wood, clustered near the western frontispiece
- a part reworked in the 14th century, around the year 1360
- a repair made in the 18th century, around the year 1725

The roof of the choir of Notre-Dame of Paris was not the original roof. It incorporated reused beams, dating to 1160 or 1170, which may have come from the first phase of construction.

These results, as well as a survey of carpenters' marks, were presented in Virginie Chevrier's DEA thesis.

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The Right Course of Action after the Catastrophe

Written by G.-N. Lambert, P. Hoffsummer, V. Bernard, and V. Chevrier
([source](#))

Translated by Emmeline Vickers Batzdorf | Edited by Kathleen Hart



The dendrochronological data collected from 1991 to 1996 are in the process of being updated and were sent to several dendrochronologists to ensure their preservation. As a matter of fact, with respect to all of the Francophone research labs, without an adequate mechanism for pooling dendrochronological data, the risk of losing decades of work in the short term is very high.

The day after the catastrophe, the charred wood among the wreckage has great scientific potential, especially for developing further dendrochronological research. We should be glad that the campaign of 1991-1996, linked to an academic research project, enabled researchers to collect 70 samples, whereas a mere “service” campaign would have collected fewer. The potential of such edifices, in terms of the complex development of a medieval building site, the history of ancient forests, and climate history, is even higher. Recent campaigns at Beauvais and Bourges collected between 150 and 300 wood samples. Under “normal” circumstances, at Notre-Dame we would be satisfied with the first 70 samples, counting on the possibility of returning to the site for more in-depth study. That is the case of all roofs, which represent a precious scientific reserve. The recent catastrophe drastically changed everything. Without throwing up our hands, we should systematically take samples from the material found in the rubble after the fire. We must take urgent action.

Materials for Roof Frameworks: Cast Iron and Concrete

Written by Arnaud Timbert ([source](#))
Translated & Edited by Lindsay S. Cook

The concrete roof framework of Noyon Cathedral

On April 1, 1918, under French artillery fire, the roof of Noyon Cathedral caught fire. In 1936, bolstered by the experience of the architects Deneux at Reims (cathedral) and Brunet at Soissons (cathedral) and Saint-Quentin (collegiate church), the architect Collin decided to construct a concrete roof. His decision was motivated by: 1) the relative lack of timber in northeastern France; 2) the possibility of producing a structure that was lighter than the original oak roof and thus relieving the masonry weakened by the fire; 3) construction that was not only faster, but also less costly in terms of both materials and labor. It was, therefore, the common sense and adaptability of the architect to the economic, structural, and ecological context that informed his decision.

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The cast iron roof framework of Chartres Cathedral

On June 4, 1836, embers from the brazier of a worker performing repairs on the lead roof fell down into the attic of Chartres Cathedral. The whole roof was destroyed within a few hours. Following the emotional responses and multiple discussions, virtually identical to the ones surrounding Notre-Dame with which we are familiar today—down to the pathos of the prayers—it was decided, for economic reasons, in particular, not to construct a timber roof framework, but rather to privilege modern industrial materials. From 1837, the project by the architect Martin and the iron manufacturer Mignon was selected with the support of Vitet: it incorporated both cast iron and steel, following in the footsteps of the first experiments in this domain (including the iron roof framework of the abbey church of Saint-Denis in 1844-1845) and copper for the

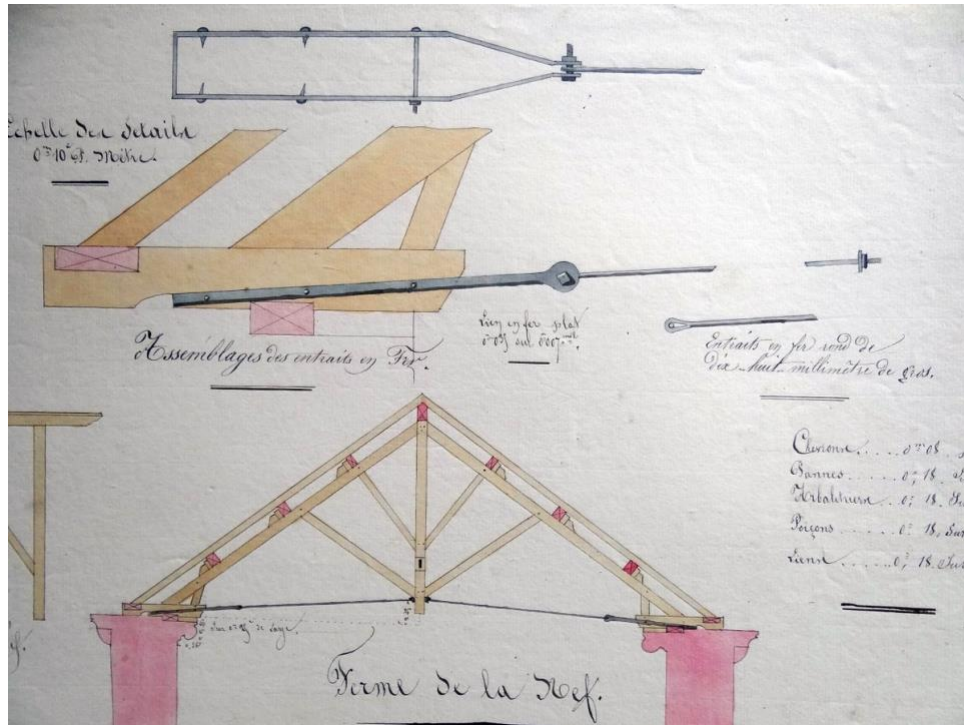
roof covering. In both cases, the economic and physical concerns (that is, the apparently fireproof nature of the materials) motivated the choice.

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Roof Frameworks Made of Wood or Metal?

Written by Arnaud Timbert ([source](#))
Translated & Edited by Lindsay S. Cook



Viollet-le-Duc often criticized the lack of knowledge about wood, especially among architects: “Mother Nature has, I imagine, paid very little attention to whether oak or fir suits our purposes; and if the human intellect knows how to derive benefits from materials that grow before our eyes, it is after having identified and confirmed their properties by experiment. Unfortunately, it would seem that the results of this experiment have not tended to increase, and, judging by the way wood is usually used nowadays, we seem to be less knowledgeable than our predecessors, or else we have lost the habit of observing with which they were familiar.” Moreover, by inviting “scholars” (archaeologists and historians) to meet practitioners (carpenters and joiners) and by suggesting to practitioners that they abandon their old habits by reinvigorating their knowledge by paying attention to “scholars,” Viollet-le-Duc played for wood a role perhaps more important than for any other material; and yet, he was particularly reluctant to use it, especially in its use, especially for roof construction.

In this area, Viollet-le-Duc most frequently relied on a hybrid timber-and-iron system (known as the Polonceau roof truss) at Vézelay, Sens, and Beaune. In this regard, he differed from his contemporaries, who built iron roofs for the church of the Madeleine in Paris (1820-1830), the basilica of Saint-Denis (1844-1845), and the church of Sainte-Clotilde in Paris (1857), while cast iron and copper were used to roof Chartres Cathedral after 1837. At that point, Viollet-le-Duc seemed reluctant to use metal, even if he decided, with Lassus, to roof the aisles of the gallery of the Notre-Dame choir with the assistance of metal ties, with the help of metal ties, he nevertheless opted to reconstruct the roofs of the transept arms and adjacent bays in wood. That said, the roof framework the two architects realized was neither a reproduction of the original structures built for the transept arms, nor of those designed for the nave or chevet, but rather a new design that synthesized technical innovations made in the field between the second half of the 13th century and the end of the 15th century. If they made any improvements or innovations, they were for the sake of harmony. Later, during his final restoration project, at Lausanne Cathedral, Viollet-le-Duc chose a timber roof in favor of an innovative experiment.

The same reluctance can be seen among the edifices he built: for churches in Aillant-sur-Tholon (Yonne) and Saint-Denis-de-l'Estrée (Seine-Saint-Denis), in 1866 and 1867, he went with a roof featuring Polonceau trusses, where wood dominated, despite having opted with Lassus, in 1848, for a metal roof framework for the Notre-Dame sacristy. Viollet-le-Duc, a product of his time, was thus apparently torn between tradition and technological innovation, which occasionally led him, as if to escape from this internal conflict, to audacious proposals, such as the brick trusses and metal beams of the roof of Clermont-Ferrand Cathedral (1872), or the zinc roof (project) for the Madeleine of Vézelay (1840). The castle of Pierrefonds sums up the overall trajectory, with the transition from entirely timber construction (1857-1863) to entirely iron construction, beginning in 1864.

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Choice of Materials and Woodworking

Written by Arnaud Timbert ([source](#))

Translated by Charlotte Gong | Edited by Kathleen Hart

For the castle of Pierrefonds, as with Viollet-le-Duc's other projects, little information has come down to us about the choice of materials, their provenance, or the tools used to shape the wood. At most, we know what Viollet-le-Duc did not want, especially for the roof: "under no circumstances should you use timber from Villers-Cotterêts, but rather that from Champagne," without justifying the reasons for this choice, which had already been carried out for the spire of Notre-Dame of Paris. For the rest, the evidence, especially at Pierrefonds and Vézelay, suggests the material was commonly used.

The scaffolding was made of a mixture of pine, poplar, and wood "of the administration," whereas some pieces were made with the help of "old wood" reused from various structures. The lead sheets of the gutters, ridge crests, and ties, including those at Notre-Dame, were affixed to "rough-sawn" oak, whereas the battens were sometimes made of raw fir or red fir (known as "rouge du Nord"), and at other times poplar. The tools used were rarely mentioned; analysis of the roof timbers from the Hector and Godefroi Towers, as well as the walls of Pierrefonds, reveals the general use of a saw and plane. The same can be said of the roof frameworks of Saint-Denis-de-L'Estrée, the castle of Pupetières, and the church of Aillant-sur-Tholon. The mechanization of saws, the delivery of calibrated and cut wood--or even entirely prefabricated roofs--reveals in this field a structure already very far removed from medieval methods.

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The Durand Brothers and Notre-Dame's 19th-century Decorative Metalwork

Written by Arnaud Timbert and Stéphanie-Diane Daussy ([source](#))
Translated by Samuel O'Keefe | Edited by Kathleen Hart

In 1844, architects Lassus and Viollet-le-Duc proposed to restore the spire that had adorned the crossing until 1792. They drafted a project on the basis of a drawing by Garneray. Lassus, at first favorable to the plan, was dubious, however, of the archaeological value of the document. Viollet-le-Duc set out to realize the project in 1859, two years after the death of his colleague. To that end, he called upon, in addition to Geoffroy-Dechaume for the sculpture and Auguste Bellu for the carpentry, Jacques Durand for the metalwork.

To revive the decorative leadwork and supply his buildings with high-quality parts—gutters, finials, and ridge crests—Viollet-le-Duc “[...] was assisted by a man who was intelligent and, rarer still, willing to set aside routines, M. Durand, [the first to have] returned to this industry some of its splendor.” Louis-Jacques Durand (1818-1860) and his brother, Antoine-Jérôme (1820-1870), inherited the plumbing and water supply business their father had founded at 29, rue Saint-Nicolas-d’Antin in Paris. Beginning in 1854, Louis-Jacques, who was in charge of the business, expanded his area of expertise to include decorative metalwork. In the decade that followed, he oversaw various important restoration projects, including the spire of Amiens Cathedral (under Viollet-le-Duc), those of the collegiate church of Notre-Dame-en-Vaux in Châlons-en-Champagne, as well as the spire of the basilica of Saint-Nicolas in Nantes (under Lassus). He was also involved in the realization of the spire of the cathedral of Sainte-Croix in Orléans (under Boeswillwald) and the restorations of the castle of Blois from 1857, where he served as a “decorative leadworker” (under Duban). Finally, he particularly distinguished himself at the Sainte-Chapelle, as well as at Notre-Dame of Paris, where he executed the ridge crest and the leadwork of the spire, as well as the roof and the decoration of the sacristy. It was with some of these creations, especially the lead statues and decorations of the Sainte-Chapelle and his work on the chapel dedicated to St. Theudosie in the chevet of Amiens Cathedral that Durand received a first-class medal at the Paris World’s Fair of 1855. As Emile Amé wrote, with whom he worked on the creation of the spire of Saint-Martin in Chablis, Durand tirelessly “pursued all aspects of the art of leadwork with love, and he positively revived it.” In addition, the renown of the contractor may be gleaned by reading the work of a worldly memorialist like

Horace de Vieil-Castel, who mentioned the artisan's rise to the rank of knight in the French Legion of Honor (1857) as part of a discussion paying lip service to the architects of his day. Viollet-le-Duc would not have solicited another artisan for Notre-Dame; he called on Durand for the roofing and leadwork before the latter was replaced by Monduit.