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Late 18th-century innovation: The first Mediterranean purlin roof truss in German-speaking Switzerland at Embrach ZH

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ABSTRACT: Swiss architect David Vogel (1744–1808) enjoyed a thorough theoretical training compared to his compatriots. His most important commission after his education was the transversely oriented “oval” reformed church at Embrach ZH (1779–80). Vogel’s designs show distinct Italian influences from three years of studies with Winckelmann in Rome in the 1760s. He integrated these ideas into the designs for the church at Embrach, where both the architectural layout and the construction were innovative for the German-speaking part of Switzerland, including the comparatively flat roof pitch with a Mediterranean roof truss. This paper focuses on the preserved construction, which adapts the Italian standard to local conditions. The roof structure at Embrach is pioneering since the type of roof truss employed was later generally adopted in the 19th century throughout the German-speaking world for constructions with a lower roof pitch.

1 THE ARCHITECT DAVID VOGEL

1.1 *Study visit to Rome*

The architect David Vogel was born in Zurich on 12 February 1744. He originated from a family of master builders who had been passing down the craft for many generations (Zwicky 1937). He started his education in the bricklaying business of his father, Heinrich Vogel (1717–1775), but already as a young man his main interest lay more in theory and science than in practice. He belonged to the society of artists and scholars in Zurich around Johann Caspar Füssli, Salomon Gessner and Leonhard Usteri. They recommended he study under Johann Joachim Winckelmann (1717–1768) in Rome (Gubler 1974: 281), and in 1763 the nineteen-year-old Vogel set off towards the South and first travelled on his own to Northern Italy before finally arriving in Rome at the end of the year (Usteri 1778: 127).

Vogel’s three-year study visit is documented by numerous letters to his Zurich friends Füssli and Usteri and through a bundle of large-format drawings, which are kept in the manuscript collection of the Zentralbibliothek Zurich (ZBZ). Vogel probably compiled his collection in a very conscious way to bring home a repertoire of representative architectural models for later reference. In his time, training as an architect involved not only drawing one’s own surveys of buildings but also copying existing plans (Maronnie et al. 2019: 21). Therefore, it is almost impossible to determine which buildings he surveyed himself – he signed most of his plans with “D. Vogel de Zuric”. In addition to ruins from antiquity, early Christian basilicas, baroque churches, palaces and villas, three sheets from the bundle show timber roof constructions.

To the annoyance of his teacher, even in Rome Vogel’s enthusiasm was directed more towards the study of contemporary technical literature than towards architecture (Blümner 1882: 129). His interest in scientific treatises published at that time by German, Italian, French, English and Dutch architectural theorists is attested to by the catalogue of Vogel’s own collection (cf. “Verzeichniß einer Sammlung architecton. Werke v. David Vogel gesamm. Zürich, bey Salomon Frieß 1809”, ZBZ, Rara 18.1676,8). His private collection included editions of Vitruvius, Palladio, Serlio, Vignola, Alberti, Philibert de l’Orme, Sturm and Blondel, part of which in several languages and to mention only the most famous masterpieces on architectural theory in his possession. He also owned numerous treatises on bridge building and hydraulic engineering published up to the end of the 18th century. The works by Robert Pitrou (1756), Johann Esaias Silberschlag (1772), Henri Gautier (1765), Caspar Walter (1766), Lucas Voch (1776, 1780), Carl Christian Schramm (1735), Bernard de Bélidor (1740) and Carl Friedrich Richter (1765) are worth mentioning. In the context of roof framing studies, the carpentry treatises by Jost Heimburger (1729), Matthias Mésange (1753), Johann Jacob Schübler (1731), Leonhard Christoph Sturm (1726), Caspar Walter (1769), Johann Wilhelm (1649) and Christian Gottlob Reuß (1764) are of particular interest. More than 300 books prove that the architect was well informed about contemporary construction techniques at home and abroad.

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1.2 *Works*

After returning from Rome in 1766 and passing the examination for the master craftsman's certificate, Vogel's contacts encouraged him to establish himself in Zurich. However, he did not achieve great success in practical construction work: only five projects were realized according to his plans and under his direction. In Embrach (1779–1780), Vogel built the first neo-classical church in German-speaking Switzerland, in contrast with the still prevailing late Baroque tradition (Carl 1979: 207). Shortly before, Vogel had already received his first commission: a new parsonage for the parish of Rorbas, not far away from his main job. In 1781, Vogel submitted design plans for the Helmhaus in Zurich, but these were never executed. His participation is also mentioned in the new construction of the Hirschengraben staircase to connect to the Seilergraben in Zurich around 1790 (Carl 1979: 208). In 1794, he supplied plans – implemented a short while later – for the extension of the north tower of the parish church of Winterthur. His project involved raising the church to a height that would also bring the exterior appearance into line with the baroque design of the existing south tower.

In the mid-1790s, Vogel moved to Paris for a few years and witnessed the aftermath of the revolution. This stay shaped his following works. Several of Vogel's political writings from this period are also preserved (cf. Vogel 1798). After his return to Switzerland, the committed republican became politically active and worked for the Helvetic government as head of the building department (Zwicky 1937: 41). In 1805, he took over the supervision of watercourses and dam maintenance, since his superiors deemed that "no use can be made of the architectural services offered by Mr David Vogel" (government decision of 1805, StAZH, MM 1.11 RRB 1805/0096). Presumably also in this context, Vogel was commissioned one year later by the building department to examine the competition designs for the new Rhine bridge to be built near Eglisau, for which he also submitted plans. A few years later, he died in Zurich on 10 December 1808 at the age of 64.

Vogel was known to his contemporaries as an architect "whose great theoretical knowledge combined with the meagreness of his practical experience, and the merits and shortcomings of his personal character, to produce the strangest of contrasts (...) His curiosity was immense, his narcissism not much less" (Füssli 1806: 4022).

2 THE REFORMED CHURCH AT EMBRACH

2.1 *History of the building*

The present church of Embrach, completed in 1780, replaced the Gothic predecessor which had been severely damaged by an earthquake in the winter of 1777. The bailiff of Embrach was concerned, and demanded that someone "who had experience in the art of building should take a closer look" at the dangerous situation (Thomann 1927: 83–84). Therefore, David Vogel was called to Embrach as an expert consultant. He presented a proposal for the protective measures to be carried out to the building. However, only two days after underpinning of the foundations had begun, the entire tower including the choir collapsed and damaged parts of the nave (Baer 1980: 4). As a result of this incident, the Commission decided at the end of 1778 to rebuild the entire church, and called for project proposals to be submitted (Thomann 1927: 89).

Figure 1. Exterior of the reformed church at Embrach, looking west (Schäfer 2019).

Thereupon, "architect David Vogel, master bricklayer Bluntschli and master bricklayer Hafner of Winterthur drew up plans, from which the draft of the first was selected on 24 April [1779] and the entire project was signed on 10 June" (Vogel 1845: 173). According to the decision of the commission, Vogel's design "would be the most durable building because of its configuration", although "no such building has so far been found in our country" (Thomann 1927: 90).

2.2 *Architecture*

The ground plan of the church at Embrach consists of a square that is closed off by semi-circular apses in the east and west, thereby creating the impression of an oval building. The south side is marked by a pediment which, together with the front tower, dominates the main façade and announces the transverse orientation of the interior (Figure 1). The plain interior with a width of 13.7 m and a length of 25.5 m and flat ceiling is lit by high rectangular windows. The pulpit on the north side is located opposite the main entrance. In front of it is the baptismal font. The pews of the hall and the cantilevered galleries are arranged in a U-shape around the pulpit. Neo-classical stylistic features characterize both the external appearance with its temple-like front and interior of the building. When the building was completed, "the beautiful symmetric church, one of the most graceful in the canton"

Figure 2. Main façade of an oval church building. Design plan by David Vogel around 1780 (StAZH, PLAN R 310).

was acclaimed (Erni 1820: 223). "The great taste that prevails in the whole building, both inside and out, testifies that the master builder, Mr David Vogel of Zurich, was especially educated in Rome and Naples" (Nät 1802: 219–220).

The reformed church at Embrach is the only religious building by David Vogel to be executed. However, the numerous designs for churches he produced illustrate how intensively Vogel occupied himself with the architectural requirements of Protestant liturgy. His designs recall the plans for transversal churches published in 1718 by Leonhard Christoph Sturm. In addition to trapezoidal ground plans, oval ones in particular seemed to fulfil his ideals of a reformed church building. A drawing with an elevation of a main façade which contains three variants of the tower end (Figure 2) may be considered as a draft design for the church at Embrach. The biapsidal building in early neo-classical style has a pedimented front and closely resembles the completed building.

Vogel had already paid particular attention to oval ground plans in Rome as testified by some of his architectural surveys, and the Baroque oval churches of Sant'Anna dei Palafrenieri (Giacomo da Vignola, 1583) and especially the church of Sant'Andrea al Quirinale (Giovanni Lorenzo Bernini 1670) may have contributed to inspiring the church in Embrach. Until then, the oval shape for religious buildings in Switzerland had been common only in the French-speaking West, which was influenced by Huguenot temple architecture. The reformed church buildings of Chêne-Pâquier (1667), Oron-la-Ville (1678) and Chêne-Bougeries (1756) could be mentioned here.

2.3 *Roof construction*

With a roof pitch of 33°, the construction is relatively flat in comparison to the contemporary baroque roofs of the German-speaking part of Switzerland. The construction of the roof is similar to the layout of a Mediterranean or Italian roof truss (Figure 3).

This system existed in the Mediterranean region as far back as antiquity. The purlins, which support the common rafters and the roof covering, rest on triangular principal trusses consisting of two principal rafters and a tie-beam. Depending on the span, there are variants in which the tie-beam is additionally suspended by one or more tension posts, and the construction is stiffened by rafters and a collar beam. Diagonally arranged raking braces between the king post and the principal rafters are typically used.

The roof structure of the reformed church at Embrach was designed according to this model. It consists of five principal trusses above the nave, which are arranged at an average distance of 3 m, with two secondary trusses in between each pair of principals. A continuous tie-beam, two inclined principal rafters and a king post form the principal trusses (Figure 4).

The lower ends of the principal rafters are tenoned directly into the 16 m long tie-beam. At the upper end they are attached to the king post with a small abutting joint and an additional tenon. The king post carries a ridge purlin at its upper end. At about half the height of the construction, a kind of two-part straining beam is tenoned between the king post and the principal rafters. Similar to the raking braces of a conventional purlin roof truss, this contributes to stabilizing the principal rafters. Extended by means of a nogging piece of wood, the straining beam joins the common rafter. The semi-circular hipped roof ends on both sides employ three principal half-trusses each, which are designed according to the same principle as the normal trusses.

On top of the tie-beams, a longitudinal girder runs along the central axis. It is attached to the king post with stirrup straps. In addition, rectangular purlins or collar plates connect the principal trusses in longitudinal direction. They are tenoned into the principal rafters at both ends. For this purpose, an inclined tenon is worked out at the joint, which runs parallel to the inclination of the principal rafter. The mortices also have this shape and partially pass through the full thickness of the beam cross-section.

To suspend the tie-beam, a hand-forged stirrup strap is inserted through the girder and attached to the king post with two bolts and square nuts (Figure 5). Small wedges in the girder prevent the iron from slipping. The girder runs the entire length of over 25 m; it consists of two pieces which are connected in the middle with a wedged Jupiter joint. In addition to the wedges, iron bolts secure the wooden connection.

Figure 3. Roof construction of the church (Schäfer 2019).

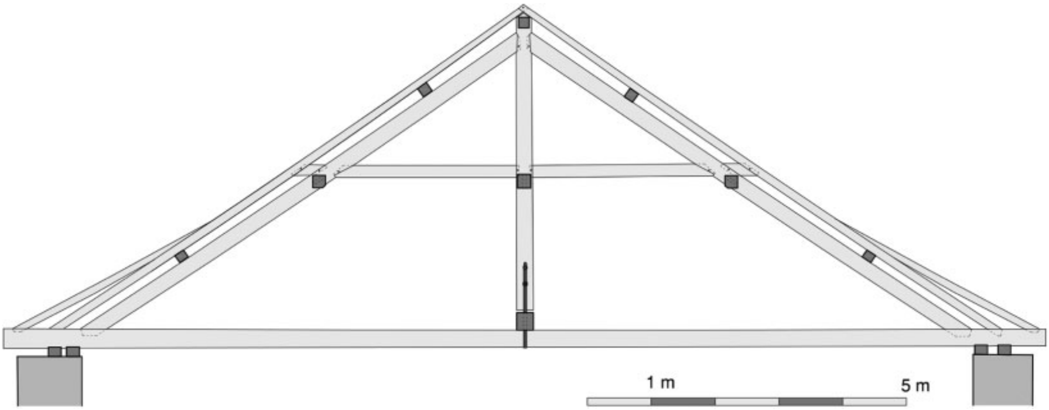

Figure 4. Total station survey of a principal truss of the reformed church at Embrach (Schäfer 2020).

Below the straining beams, a further girder runs in the longitudinal direction of the roof structure. This is tenoned in four sections, from king post to king post. The straining beams of the secondary trusses are tenoned into the girder and can therefore also be used as collar beams. Two purlins are resting on each side of the principal rafter, which are fastened with iron nails. At the ridge point the common rafters are connected with a mortice and tenon joint, and the rafter feet are tenoned into the tie-beams.

2.4 *Differences to the model*

Although the construction described has some similarities to the classic purlin roof trusses, there are considerable differences in detail compared to the Italian original. Mediterranean purlin roofs usually have no longitudinal bracing whatsoever, apart from the purlins and the roof membrane. In Embrach, however, the collar plates between the principal rafters and the girders in the central longitudinal axis are arranged to provide longitudinal wind-bracing. This additional stiffening is an improvement over the Mediterranean model and is also found in England, France and Germany (Holzer 2015: 83–84).

The horizontal straining beams between the principal rafters – instead of raking braces – are another striking change compared to the conventional solutions used in the Mediterranean area. Later, Rondelet would also notice the advantage of horizontal elements over the sloping design of the raking braces (Rondelet 1833: 132—134). In the secondary trusses, the straining beams take on the function of collar beams, as they are tenoned directly into the common rafters. This

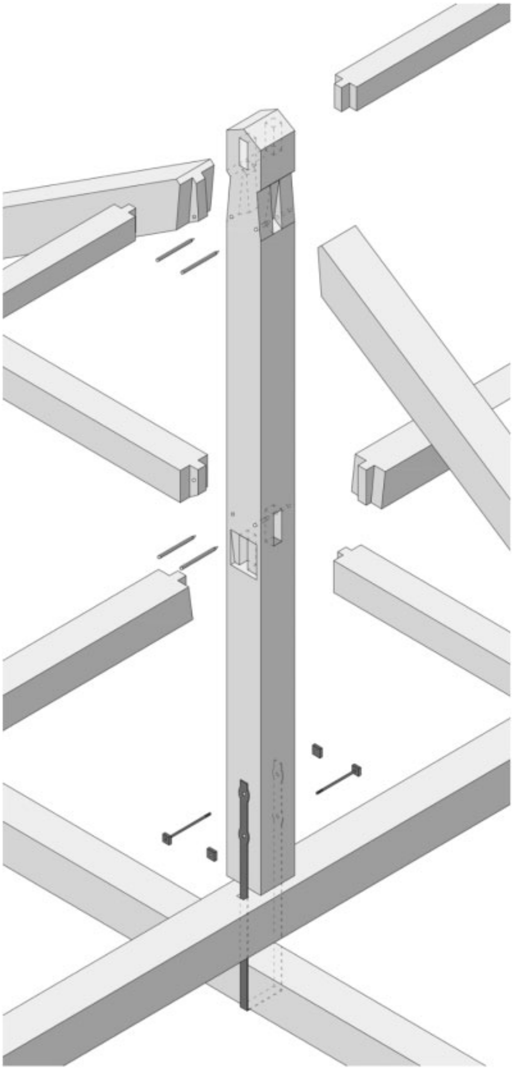

Figure 5. Explosion of the king post with the connection details (Schäfer 2020).

arrangement stiffens the secondary trusses and relieves the principal ones.

The mortise-and-tenon joint of the principal rafter in the tie-beam also strikes as a deviation from the Italian model. In Italy, there are usually abutting joints to connect the two elements, which are usually secured by iron stirrups (Valeriani 2006: 140). Almost all tenon joints are also fixed with pegs, which differs from the traditional design of the Mediterranean models.

2.5 *Context*

With the roof structure executed in Embrach, Vogel presented a construction system hitherto almost unknown to German-speaking Switzerland which he adapted to local conditions. This interpretation of the

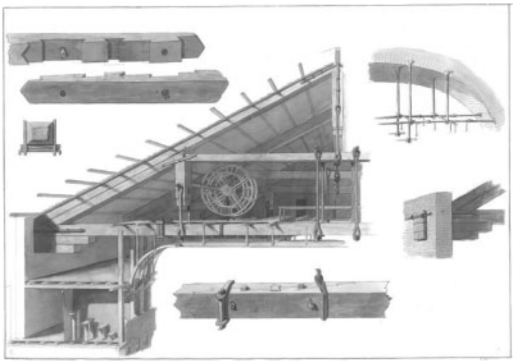

Figure 6. Construction and details of the roof truss of the Teatro Argentina in Rome by David Vogel (ZBZ, FA Escher v G 188.6, fol. 45).

Mediterranean style is characteristic of early examples of purlin roof trusses in the German-speaking world. The use of the Italian construction principle in roofing works north of the Alps spread throughout Europe at the turn of the 19th century. Apart from the visual advantages of the flatter roof pitch, the use of this principle offered further advantages in terms of functionality, load-bearing capacity and wood savings. This development could also be traced in Germany by studies of roof structures (Holzer 2015: 93–94).

In the Swiss context, the application of Embrach's Mediterranean-inspired roof system can be classified as remarkably early (secular buildings excluded). According to the current state of research, the larger churches built around 1780 in the German-speaking part of Switzerland are predominantly *liegender Stuhl* constructions with adjusted king and queen posts. A general transition to lower roof pitch took place only after 1800, but even then, baroque load-bearing systems were still used.

In this context, the building surveys by Vogel from his journey to Italy, which also show roof constructions, are worthy of interest. In a drawing of the Basilica of Saint Paul Outside the Walls in Rome, which was destroyed by fire in 1823, Vogel depicted the construction of the roof above the nave of the Basilica. There is also a drawing by Vogel of the roof structure of the Teatro Argentina in Rome, in which he illustrated in particular the details of the joints (Figure 6). The construction of the roof truss with triple king post system is shown in perspective. Two smaller detailed drawings show the scarf joint of the tie-beam, which employs a Jupiter joint and is secured by additional iron straps. A third sheet contains several roof trusses of different buildings, among them again a drawing of the roof construction of the Teatro Argentina with the corresponding dimensions of the components. Other roof trusses over a shipyard and a hall of the Toulon Arsenal are also shown, as well as the construction of the theatre of Parma.

Once again, Vogel made use of the purlin roof construction in a competition design for the reconstruction of the Rhine bridge in Eglisau ZH, destroyed in 1799.

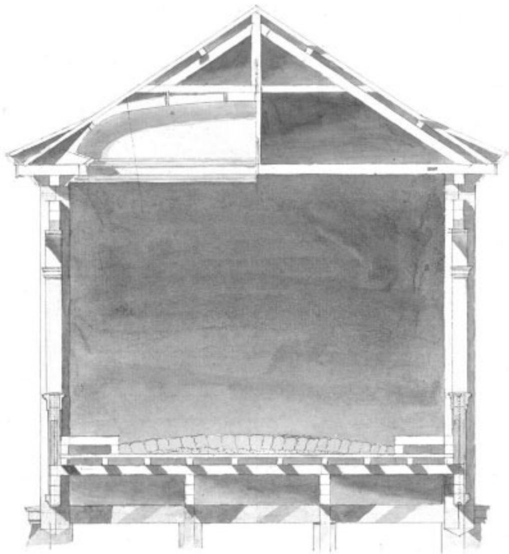

Figure 7. Section of a wooden bridge for Eglisau. Design drawing by David Vogel (StAZH, PLAN M 10).

To shelter the bridge from the weather, Vogel designed a purlin roof (Figure 7). The basic construction of a braced king post with a horizontal compression beam and purlins resting on the principal rafters is almost exactly the same as the roof structure of the reformed church at Embrach, built more than 20 years earlier. Vogel was also familiar with the traditional construction method in this country with *liegender Stuhl* constructions.

Some designs for an oval church with pedimented fronts show formal similarities to Huguenot temple architecture. It is possible that the series is part of the competition project for the church at Embrach, for which Vogel submitted several proposals according to the protocols. Vogel planned to cover the building with a flat roof construction above the transverse direction (Figure 8).

A section of the principal truss is shown, consisting of a *liegender Stuhl* construction and an adjusted quadruple queen post system. The raking struts with pentagonal lower plates and collar plates are supported against each other by a straining beam with soulaces. The tie-beam projects far beyond the outer walls in order to also cover the porches. Short braces support the tie-beam from below. Due to its length, the tie beam consists of two parts connected with a Jupiter joint. The two outer queen posts end on girders and are presumably designed as *moises*, which include the straining and collar beam and a slightly arched brace. A second brace is used to transmit force to the outer part of the tie-beam near the wall. The structure centrally supports the ridge turret, the loads of which are supported on the collar beam by double braces.

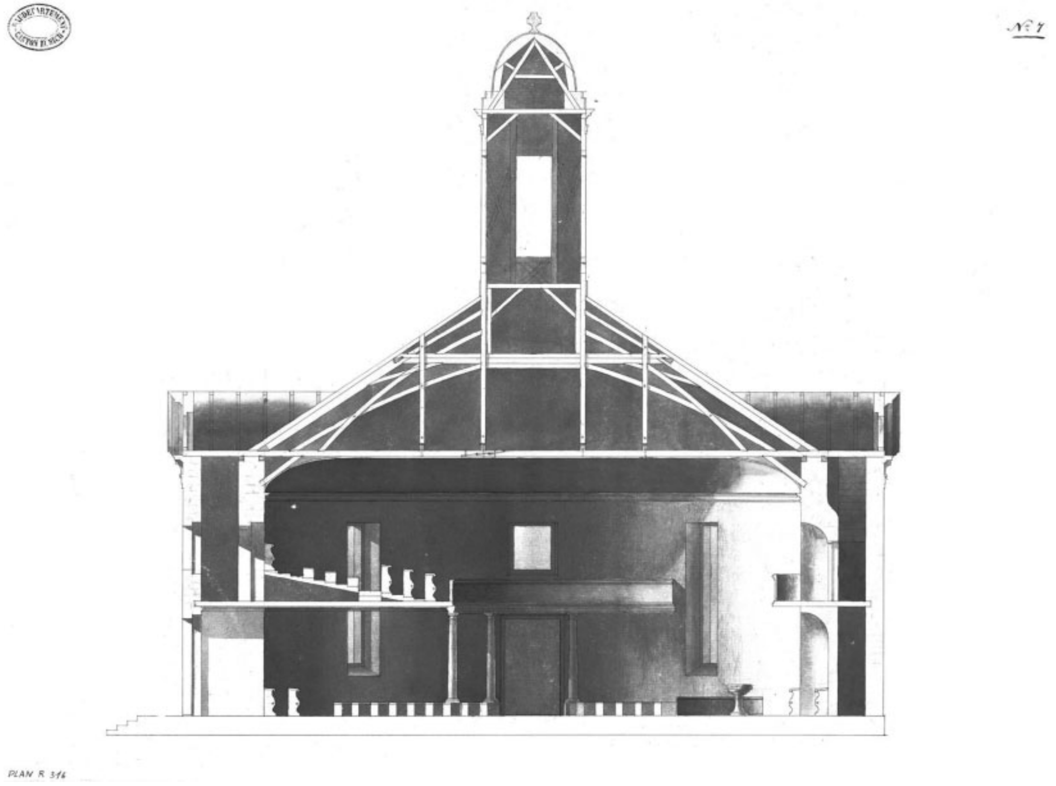

Figure 8. Cross-section through an oval church with roof construction. Design plan by David Vogel around 1805 (StAZH, PLAN R 316).

3 CONCLUSION

The richly preserved design studies and the completed church building at Embrach give an impression of how a classically trained architect thought, planned and also built in contrast to the common Swiss building practice of the late 18th century.

However, Vogel was unable to influence the local building culture with his innovative and revolutionary spirit: the purlin roof at Embrach was left without a successor in German-speaking Switzerland for many decades. Only later generations around Leonhard Zeugheer (1812–1866) were able to establish the classicist architecture and new constructive concepts. In this sense, the case of David Vogel is probably more of a curiosity that did not change the history of construction in Switzerland over the long term.

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