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# Salem Abbey

## Conservation of Molasse Sandstone

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Albert Kieferle

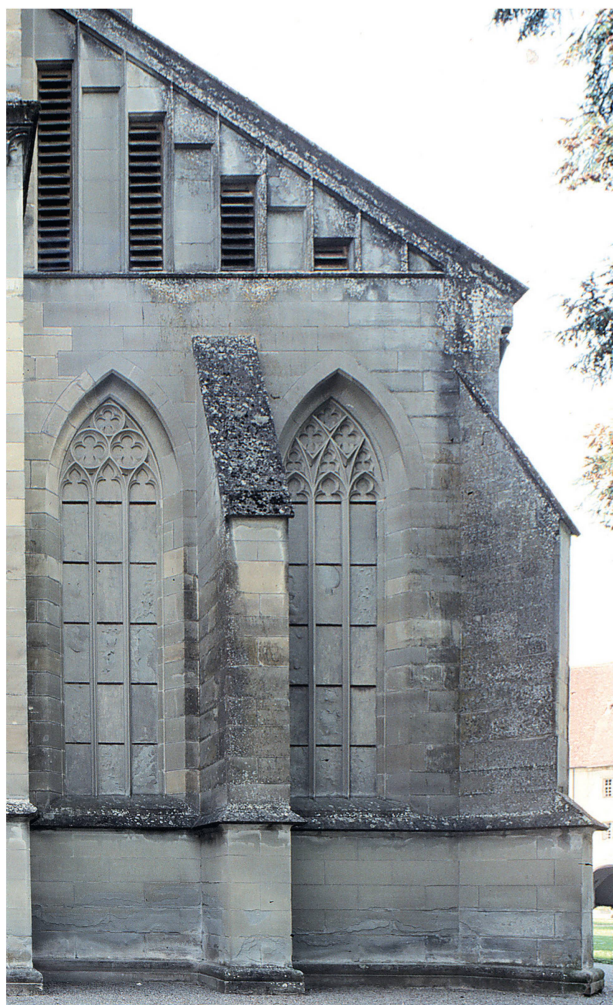
Salem Abbey was founded between 1134 and 1138 on a rather wet terrain as a Cistercian daughter of Lützel Abbey in Alsace. Only a few years later in 1142 the abbey was subordinate directly to the Kaiser and in 1178 to the Pope. In the late 12th century a first minster was built. Freed from local disturbances and rivalries the abbey became wealthy, making it possible to rebuild the church in the then modern gothic forms from 1285 to 1425. In 1697 a fire destroyed all of the monastic buildings south of the minster, to which only minor damage occurred. In the early 18th century the destroyed buildings were rebuilt in a baroque manner, partially reusing material from the un-charred remains of the previous structure. The decoration in the main rooms of the building was done in several stages in the following period. Beginning in the 1750s the minster was redecorated, leaving the outer walls and roofs untouched. The chancel was reorganized dismantling a chapel dedicated to St. Michael and a large tower was constructed on the intersection. The inner part of the church was redecorated first by Feuchtmeier and a few years later again by his former partner Johann Georg Dirr and his successor Johann Georg Wieland, leaving the unique alabaster altars and the up to now almost untouched interior decoration of the church. In the course of this work Salem became a brilliant artistic centre of the region. In 1804 the Abbey was closed down after it had been handed to the Margrave of Baden. In the first half of the 19th century only minor repairs were made. Bagnato's tower on the intersection was taken down and replaced by the ridge turret, which is still in place. At the beginning of the 1880s the church had undergone a last fundamental renovation on its exterior until the later discussed current restoration. In the course of this renovation large parts of the exterior were replaced, especially the four pediments and large parts of the base structure.

The church, like cornices, windowsills etc. of the monastic buildings were made in "molasse" (soft sandstone). In the course of time different types of molasse soft sandstones were used. In the middle ages a yellowish to greenish stone, as it can be seen at Sipplingen and Überlingen was used. Post medieval work was mostly done in dark green, almost bluish molasse sandstone. This sandstone was used by Bagnato, when he closed the windows on the east side of the chancel. Damaged covers of buttresses were also replaced using this material. Partially a greenish to grey sandstone, most likely from Rorschach was also used. From the 1880s Rorschacher sandstone was exclusively used.

At least in times the building was protected by paint. We managed to find very little remains of yellow, red and grey paint in corners. The sandstone portions and the rendering of the newly built monastic buildings still bear large amounts of untouched baroque painting.

## RESEARCH

Research on conservation of the molasse sandstone at Salem began in 1971, when Riederer from Munich made first tests on stone consolidation with silicic-acid-ester. Unfortunately, he did not document exactly where he had applied these materials therefore, they could never be located with certainty<sup>1</sup>. Later in the early to mid 1990s research was intensified first within the project "Stone Decay and Stone Conservation" (*Steinzerfall/Steinkonservierung*) of the former ministry for research and technology (BMFT), later continued within the Franco-German research project.



1 Eastern façade before restoration in 1992 (Photo A. Kieferle).

Within this broad area of partly basic research, and in other parts applied research three studies, or more precisely, study groups had a larger impact on the future conservation of the minster. Hans Ettl, Munich and Zehnder from the ETH Zürich made a first approach on surveying and mapping the damages of the minster from the ground and from a small hoisting platform. They noted zones with different degrees of damage (*Schadenssituationen*), the most significant were determined to be blistering, delamination sanding and flaking. The observed zones were:

- the base area showing large scale blistering and delamination with flaking in areas where the surface has been lost,
- areas beneath cornices with very strong sanding and flaking in the less exposed areas,
- areas beneath the roof edge,
- corners and niches of the building, both showing sanding, flaking and blistering.

They also noticed differences in the deterioration of the different types of stone<sup>2</sup>.

From a restorers point of view – a more basic part, which was never the less very important for the following works, was published by Gabriele Grassegger, summing up a large number of surveys by her colleagues:

Within this project the role of humidity was examined from various points of view, and its effects were observed. The detailed emission measurement and the meteorological data show, that the deposition of pollutants are strongly reduced in the lower parts of the building [...]. Sulphur-dioxide is the main deposition. [...] hydrological and geological research show, that the western portion is constantly in contact with ground water, the eastern portion only occasionally. For the first time moisture from the underground could be observed without damages to the building by spontaneous potential logging [...]. Microwave-reflection and transmission give us a (semi-quantified) image of the spreading of humidity. The mortar in the joints plays an important role as a water conductor. [...] All surveys show that relatively high concentrations of salts (mainly sulphate) are present in the stone, but reduced towards the interior. The chemical and mineralogical degradation of the stone material are carbonate and mineral solutions by acid, the creation of gypsum in solution pores and cracks. Especially severe damages occur in constantly moist and periodically moist areas, protected from rain (i.e. bottom sides of cornices). The different kinds of molasse sandstone have slightly different cementation and contain different types and concentrations of rock fragments, influencing the resistance against weathering<sup>3</sup>.

Finally a limited area was conserved by Egon Kaiser and examined by Hans Ettl. In course of these large research campaigns a set of conservation materials based on silicic acid and silica-sol had been developed and thoroughly tested. It proved that the main damages, especially the delamination and ruptures could be treated with these at that time advanced conservation techniques<sup>4</sup>.



## RESTORATION OF THE MINSTER

(1997-2002)

Based on these studies we started a stone-by-stone mapping of damages, stone-material, mortars, stone-cutters marks etc. We were able to mark out certain combinations of damages, damages to stone-material, damages to exposition and damages to specific constructions.

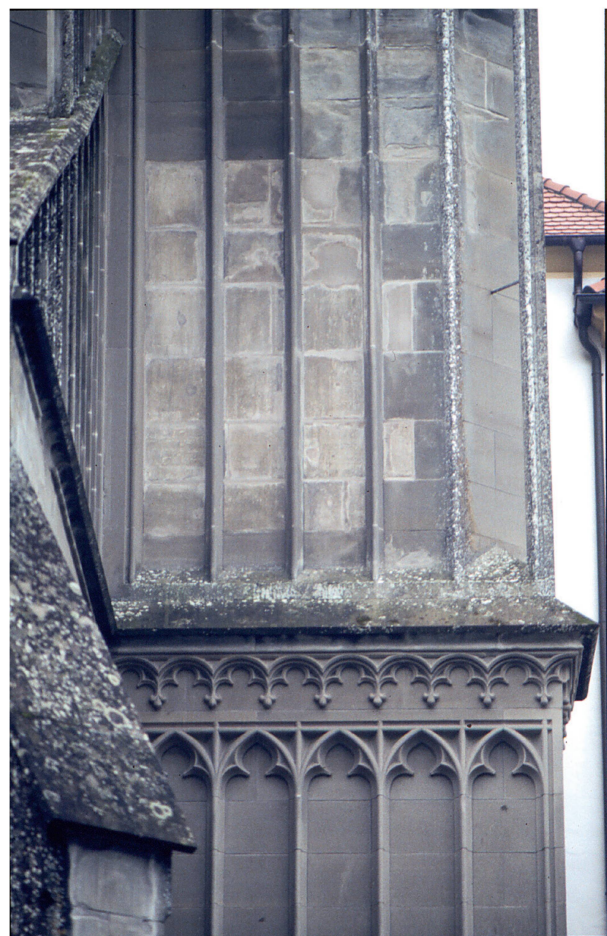
Due to the very damp climate of the region and even more, the place itself, there was a very extensive carpet of vegetation, spread on all surfaces more or less exposed to rain consisting of a biofilm of algae on which lichens and even different types of moss grew. The characteristic combinations of exposition, stone material and damages were:

### RORSCHACHER SANDSTONE

This stone type was mainly used in the 1880s restoration. In course of this restoration repairs were done in the exposed areas of the pediments with their traceries and the plinth exposed to the humidity of the surrounding soil and ground water. Both areas showed severe delamination with large portions of surface fallen off. The surfaces in these fallen off areas showed sanding and flaking with a depth of degradation of up to 5 cm. So the portion of the stone able to bear the weight of the stones on top in the traceries were reduced to a minimum; often enough leaving doubts, if it still existed. Especially parts not protected from direct weathering were frequently very severely damaged and were regarded as not being treatable by conservation techniques.

### YELLOWISH SANDSTONE

The yellowish sandstone used in the middle-ages, although molasse sandstone too, showed completely different damages. In areas strongly exposed to rain it showed a strong rounding or erosion, often reducing the parts several centimetres below the surrounding surfaces, sometimes with perforations by wasps. The surface peeled off in larger, contiguous areas, with a brown alteration of colour on top. Despite this, sometimes quite severe deterioration, parts made of this stone, were almost always considered as treatable.



2 West façade after restauration in 2000 (Photo A. Kieferle).

### WIDENED JOINTS

The rounding or erosion of the yellowish sandstone had already occurred before 1880. During the last big restoration campaign the joints, together with the damaged zones, were filled with a, at that time, highly valued cement-mortar. The completely unmatched properties of the two materials made the joints loosen and eventually fall off.

### CRACKS CROSSING JOINTS

Within areas, where much stone replacement had taken place in the late 19th century, cracks across joints could be observed. The cracks were oriented vertically and started a few centimetres within the lower stone, crossing the joint and ending a few centimetres within the upper part. The damage was not analysed, but we believed, the phenomenon to be related to the front joint being pure cement and the portion behind consisting of a lime mortar.



## COVERS OF BUTTRESSES

The cover stones of the buttresses had been replaced prior to 1880, changing the original construction, however, still preserved on one of the buttresses, from stones simply with one slanted side and horizontal joints to slabs lying on a sloped joint, stressing the supporting part at the bottom beyond limits. Several of these supports showed cracks.

In 1996 the Magrave of Baden had decided to restore the roof of the minster. Scaffolds had been set up for the first time since the late 19th century. In the course of these works it showed that the masonry of the building was severely damaged and a restoration could by no means be delayed. On the other side financial resources were only budgeted for the roofs. We were forced to design a restoration to meet the following goals:

- spend as little money as possible,
- delay a major restoration campaign for at least 10 years,
- ensure safety for visitors.

In a discussion with Otto Wölbert from the Landesdenkmalamt, the owner and the heritage authorities, we developed a restoration concept including:

- a complete conservation of all parts, considered treatable with conservation techniques developed and tested within the prior research campaigns,
- stones which were not considered successfully treatable – mainly parts showing severe delamination – were to be taken off and the remaining portions treated with conservation techniques and
- secure the covers of the buttresses.

So this means conservation was completely done, but no repair of pieces being considered not treatable could be attempted. Parts originally intended to be replaced were treated in a somewhat reduced manner, assuming their treatment would not turn out to be durable, but for limited time assuring, that no parts would fall off<sup>5</sup>.

To prevent the most hazardous damage, the slabs on top of the buttresses were the first to be secured in 1997. According to the plan by Johann Grau, the covers on the buttresses were additionally fixed using four thick fibreglass rods per slab. The rods were placed in a trass-lime mortar and covered by lead on the top, to prevent the mortar from damage. The work was done by Torkret from Freiburg.

Starting in late 1997 this securing preservation was carried out by Ulrich Bauer-Bornemann from Bamberg, starting at the west front. In the following years the chancel with the adherent clerestory and finally the transept followed. The side aisle and the naves clerestory were not touched.

The delamination and cracks were treated with great routine and a unique, but very effective way, by Bauer-Bornemann from Bamberg. Instead of placing filling pieces on top of the cracks and applying the injection mortar with more or less pressure, the company stuck little hoses onto the gaps and let the mortar settle in slowly. The results were excellent.

The edges of damages were relined using the silica-sol mortar. Areas of flaking were washed using the same basic material, strongly reducing the area exposed to weathering within these zones.

Bonds between the grains of the sandstone were re-established using silicic-acid-ester. This had worked well in the samples done by Egon Kaiser and proved successful despite the moisture expansion of the molasse sandstone.

Loosened joints, especially the widened cement-mortar joints were taken out and replaced by trass-lime mortar joints, not covering the stone with a thin layer any more. Edges showing up when the joints were taken out were relined with the silica-sol mortar instead. Joints with crossing cracks were also redone with trass-lime-mortar.

Finally, three parts of stone had to be replaced, despite the original intention: Two stones had to be replaced to bridge a gap and one had to be made to replace a water pipe in the traceries of the northern pediment, which had been a rather long term temporary solution<sup>6</sup>.

The research and the work done within this restoration campaign were finally published by the Landesdenkmalamt as *Arbeitsheft 11: Das Salemer Münster*<sup>7</sup>.

## RE-EXAMINATION

In 2009 we were lucky enough to have had the chance to re-examine the work. When the Bundesland Baden-Württemberg planned to buy large portions of the abbey from the Magrave of Baden they wanted to know quite in detail in what condition the buildings were and what it would cost to carry out restoration. AeDis, founded shortly after the restoration works at the minster had just been terminated by Peter Reiner as architect, Georg Schmid as Restorator in charge of stone, rendering and paint, as well as the author were commissioned to do this. This gave us the opportunity to revise the facades, the first of which by this time, had been restored more than 10 years before. The results were all-in-all very positive. The work done with mortar was, as expected, stable. The

areas formerly damaged by delamination were firm, except for three blocks where the surface had to be taken off for security reasons. After the surface had been taken off, we saw that they had been already fully detached before treatment and were only held by the mortar in the surrounding joints. Statistically three out of almost 2000 so treated blocks were failures.

Sanding had restarted in some regions in a form, that the upper most layer of sand could be wiped off, layers below were firm. The deep going sanding, observed before the treatment could not be seen any more. The treating of the flaking areas within the fallen off delaminations was in parts less satisfying. The lining and washing was in place, but the degradation of the sandstone below had continued, showing very fine gaps within the washing. This problem mainly occurred in areas where we had doubts, if they could be stabilized by conservation techniques and which were originally intended for replacement.

Around the same time the molasse sandstone areas were revised within the DBU-Project "Stone Monitoring" by the university of Stuttgart, all in all showing similar results. Sadly, the study did not distinguish between the parts regarded as treatable, and those areas treated temporarily<sup>8</sup>.

## PRESERVATION OF THE COURT FACADES

When the Land Baden-Württemberg had bought the Abbey of Salem, restoration on the most endangered parts began emphatically. The inner courts still had decorated lining from the 18th century, which in very large areas was untouched. The condition was very bad, so restoration would have to start here. The original lining is decorated with window framings painted in black and grey. A second layer on top shows yellow framings around the windows. The window lining and the pilasters of the portals are made of molasse sandstone, like the minster facades.

In accordance with the people in charge from the owner's side, organized in the Lenkungsausschuss and the heritage administration we planned and carried out a proof of concept for a restoration of these facades, maintaining all painted areas and areas with original lining. This once more limited replacement of partly very severely damaged stones, and their replacement could only be done within the plinth and a few sills in areas with no lining left what so ever. The rest had to be done the same way as a few years earlier, now with a more intense treatment of the flaking areas with regard to stabilization and the reduction of



3 *Façade of the eastern court (Sternenhof) after restoration 2011*  
(Photo AeDis).

flaking areas. The windowsills that were strongly damaged and are very much exposed to weathering were covered by sills made of lead.

Georg Schmid was the restorer mainly in charge of these works from our side. The concept for the plastering includes consolidation with silicic-acid-ester and silica-sol, reattaching of detached surfaces, filling of cracks with lime and rendering of lost areas with a mortar, closely resembling the original mortar. In the mean time four out of six facades have been treated by a large number of restorers. The conservation of the sandstone surfaces has been done by Bauer-Bornemann from Bamberg, who had already done this at the minster, as well as by Frank Eger from Balingen. The stone masonry was carried out by Eduard Schnell, Fridingen and by Johannes Abel from Auggen<sup>9</sup>.

## NOTES

<sup>1</sup> Eberhard WENDLER, Ludwig SATTLER, Rolf SNETHLAGE & Dietrich KLEMM, «Untersuchung zur Wirksamkeit und Dauerhaftigkeit früherer Konservierungsmaßnahmen am Münster Salem», in *Gemeinsames Erbe gemeinsam erhalten, I. Statuskolloquium des Deutsch-Französischen Forschungsprogramms für die Erhaltung von Baudenkmälern*, Karlsruhe 1993, pp. 179-184.

<sup>2</sup> Hans ETTL & Konrad ZEHNDER, «Klosterkirche Salem: Generelle Zustands- und Schadensaufnahme an den Außenfassaden», in *Gemeinsames Erbe gemeinsam erhalten, I. Statuskolloquium des Deutsch-Französischen Forschungsprogramms für die Erhaltung von Baudenkmälern*, Karlsruhe 1993, pp. 75-79; und zugehöriger unveröffentlichter Untersuchungsbericht von 1992.

<sup>3</sup> Related to surveys listed in the appendix, Gabriele GRASSEGER, «Molassesandsteine – Varietäten, Eigenschaften und Ursachen der Verwitterung», in *Das Salemer Münster 2002* (cf. note 7), pp. 47-64. This text also holds a list of further publications to research done in Salem.

<sup>4</sup> Hans ETTL, «Untersuchungen zur Hinterfüllung und Anbindung von Schalen mit kieselgelgebundenen Mörteln», in *Das Salemer Münster 2002* (cf. note 7), pp. 87-92.

<sup>5</sup> Otto WÖLBERT & Albert KIEFERLE, «Detaillierte Bestandserfassung und Maßnahmenplanung an den Fassaden», in *Das Salemer Münster 2002* (cf. note 7), pp. 97-134.

<sup>6</sup> Ulrich BAUER-BORNEMANN, «Steinrestauratorische Maßnahmen an den Fassaden. Bericht über die durchgeführten Arbeiten», in *Das Salemer Münster 2002* (cf. note 7), pp. 135-142.

<sup>7</sup> *Das Salemer Münster, Befunddokumentation und Bestandssicherung an Fassaden und Dachwerk*, Günter ECKSTEIN & Andreas STIENE (hrsg.), Stuttgart 2002 (Arbeitsheft des Landesdenkmalamtes Baden-Württemberg 11).

<sup>8</sup> Jana KRONAWITT, Stefan SCHÄDEL & Theresia GÜRTLER BERGER, «Das Nordquerhaus des Salemer Münsters nach der Musterkonservierung. Schadensanalyse im Rahmen des DBU-Projektes Monitoring Naturstein», in *Natursteinsanierung Stuttgart 2012*, Gabriel PATITZ et al. (hrsg.), Stuttgart 2012.

<sup>9</sup> Peter REINER, «Restaurierung der Fassaden in den Innenhöfen», in *Kloster und Schloss Salem, Sanierungsmaßnahmen 2009-2011*, Ministerium für Finanzen und Wirtschaft Baden-Württemberg (hrsg.), Stuttgart 2012, pp. 57-65.