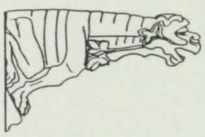
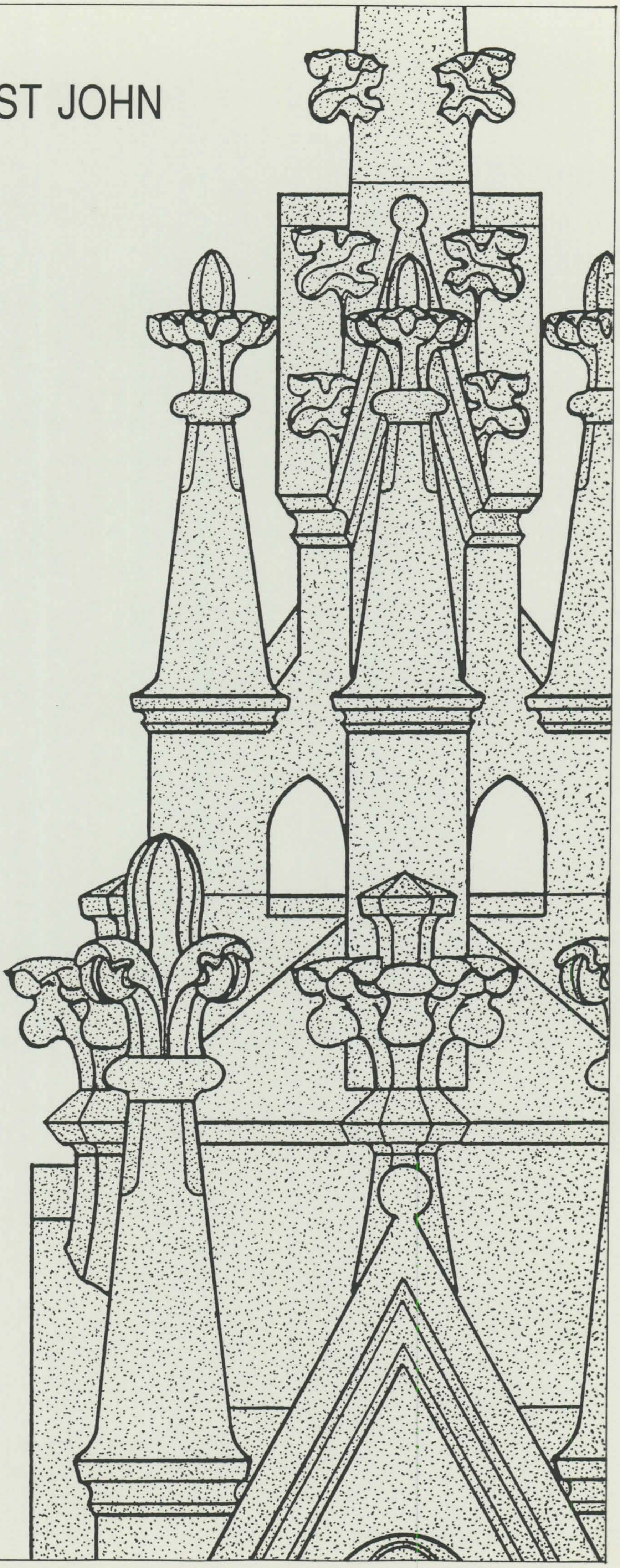
JOHANNEKSEN KIRKKO

THE CHURCH OF ST JOHN

Helsinki, Finland

The Restoration of
the Cast Cement Ornamentation
of the Façades
1990 - 1991





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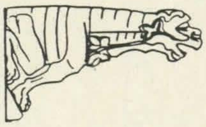

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PREFACE

In December 1892, a year after the Church of St. John in Helsinki (Fi. Johanneksen kirkko) had been completed, the technological journal Teknikern devoted two issues to its construction, presenting the main stages of the work, the problems that were encountered, and the solutions that were found to them.

Information contained in that article was of invaluable help for renovations and repairs a century later, since the original specifications had disappeared, and only a small number of the original plans and designs had survived.

Over the decades, alterations and additions had been made to the façades and other structures of the church, but their documentation had been random and haphazard. Missing information posed problems in planning and carrying out repairs and renovations in 1990 and 1991. What had been done? When? Why and how?

Relying on thorough preliminary studies, sound expertise and collaboration, the restorers were able to begin work in the summer of 1990, and the project was completed by the centenary of the church in December 1991. Owing to the nature of the restoration work, all aspects of technique could not be planned in detail beforehand, and it was even necessary to alter plans during the work itself. In particular, the façades presented situations where detailed work and the extent of restoration *measures often had to be decided upon while working on the scaffolding.*

After the work was completed, the client prepared documentation of the main repairs and renovations for the benefit of those who will be responsible for the church and its maintenance in the future.

This publication is based on the collected documentation, and it describes replacements and repairs to the concrete ornamentation of the façades mainly from a technical perspective.

No detailed drawings or elevations of the façades were available when work began, and it was only during the actual restoration that the façades could be studied in detail and measured. In addition to photographs and other drawings, these results also appear in the illustrations to this publication. Video techniques were also used in studying specific problems and recording various stages of the work.

I have compiled this publication in my capacity as supervisor of the restoration project, and I wish to extend my thanks to the sponsors of this booklet: Asiantuntijamestarit Oy, Entisöinti Pulla Oy, Fescon Oy and Rakennus Oy Leo Heinänen.

Warm thanks are also due to the Group of Parishes in Helsinki for providing documents and printing services.

I hope that this publication will prove to be useful in future restoration projects of a similar nature.

Helsinki, March 20th 1993

Heikki Pyykkö
Architect

1. THE ORIGINAL SITUATION

1.0. Background

The Church of St. John in Helsinki, or the New Church as it was originally called, was designed by the Swedish architect Adolf Emil Melander. He received the commission for the church project in 1879 on the basis of an architectural competition.

At the time, Melander's design with its features imitating French Gothic cathedrals raised a great deal of debate and even opposition among Finnish architects. It appeared for some time that church would not be built. After several stages involving studies, alterations and adjustments the designs were finally approved, after a period of preparation that had lasted eight years.

Bricklaying was begun in the spring of 1888, and work progressed quickly with the help of technical aids, including a small-gauge railway running into the actual church building and a steam-powered lift.

In August 1890 the scaffolding was torn down in a storm, but the church remained undamaged.

The new church was inaugurated in December 1891. It still has the greatest number of seats of all the churches in Helsinki.

The concrete ornamentation for the façade of the Church of St. John was already included in early designs for the church by A.E. Melander. At that time, however, the term 'cement casting' was used instead of 'concrete'. The ornamental elements or units were made by a casting firm owned by the Helsinki businessman Julius Tallberg *and apparently established for work on the Church of St. John.*

1.1. Articulation of the façade

The vertical articulation dominating the façades of the church was achieved with bricklaying techniques. Parts cast in cement were used to accentuate details of the façades, and cement was used in the most prominent and visible ornamental parts.

The complex porches of the six entrances, with their archings and embrasures were all assembled from units or elements cast in cement. Similar elements were also used for framing the rose windows and the parapet. Elements were also used in accentuating the buttresses, the lancet windows of the high bell chambers and the gables. Horizontal mouldings of elements encircled the whole outer surface of the church. The pinnacles - and in some early designs even the upper parts of the main spires - were assembled from cast pieces laid on top of each other. All the sculptural details (the finials, the crockets of the porch gables, and the water-spouts, the gargoyles) were made of cast cement. Only the narrower decorative mouldings running at the level of the eaves, and other minor details, were faced with cement.

1.2. Preparing the ornamentation

No information or instructions have survived concerning the methods by which the cast cement ornamentation was made. Nor do we know if the models were first made of wood or plaster, or what was the original material of the moulds. An analysis of the original concrete revealed a considerable amount of cement mixed with sand. No other materials were observed. In the process, a relatively dry fine-grained preparation of fresh cement was beaten down on the bottom of the mould (Sw. stampad och gjuten cement), forming an outer layer 30-40 mm thick. This was followed by a considerably coarser mix containing rubble. The inner material remained very porous. There was no reinforcement of the modern type. Pieces of scrap iron were placed here and there in the elements. In renewing the finials of the pinnacles it was observed that heavy pieces of round steel bars were placed in their centres. If the elements had contained more reinforcing irons, their damage would have been much more extensive than at present.

The cast cement parts for the façade were installed during the bricklaying and cemented in place with a thin grout.

It was not necessary to ascertain the original number of ornamental elements in connection with the repairs on the church. An early contracting bid suggests, however, that some 400-500 different types of prefabricated cement-cast elements were used in the façades, totalling approximately 4,000 elements. (During the restoration work, a study was undertaken by the Department of Art History at the University of Jyväskylä concerning the ornamentation of the church).

Surviving information on the costs of the church indicate that the casting and installation of the elements amounted to c. 10 % of total costs, and slightly over a third of the costs of the bricklaying. The extent of cement work is indicated by the fact that 70 persons are shown in a photograph of the workers of the Helsingfors Cementgjuteriet casting works, who were engaged for the work on the church.

The largest cast pieces, the three ring-crosses surmounting the gables located at a height of over 30 metres each weighed approximately 800 kg. The porch ornamentation which was shielded from rain has very smooth surfaces, indicating that these parts were ground and smoothed after being cast. There is no information *on how the surfaces were treated; they appear to have been left unpainted. The original plan of assembling the spires from prefabricated elements was never realized.*

2. LATER ALTERATIONS

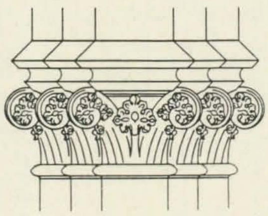
The first problems with the cement ornamentation appeared when the horizontal cement mouldings encircling the brick spires began to disintegrate. We do not know if the mouldings were made of elements or rendered in situ. In any case they were removed and replaced with wooden mouldings in the spring of 1910. The signature E. Hämäläinen 20.4.1910, which was found on the spire, may date from this stage. In the following summer the present copper-plate roofing was installed on the spires.

In 1934 work again had to be undertaken on the façade. This involved the eight corner pinnacles of the main towers. According to inspection reports, the finials and the crockets were in such poor condition that they were a risk to pedestrians. The ornamentation was removed and the pinnacles were covered with copper plate. The only pinnacles still bearing the crockets were those flanking the main porch. The removal of a total of 160 cement ornaments that were originally seen against the skyline decidedly changed overall appearance of the church.

In 1939 central heating was installed in the church. The chimney required by the heating system was located at the junction of the north transept and the choir, where half of a pilaster-like pinnacle, originally adjoining the wall, had to be dismantled.

In the early 1950s, building inspectors observed that the remaining pinnacles were in poor condition. The solution this time was not to face the pinnacles with sheet metal but to cover them with a five-centimetre layer of reinforced concrete. This was done to all 28 pinnacles and only the above-mentioned ones, adjoining the main porch remained in their original state.

The ornamental elements of the church façade continued to weather and disintegrate. Repairs were begun in 1975 and extended in 1977-78. This work was originally based on the sole use of polyester resin. The idea was to cast new ornamental elements from a mixture of very fine-grained quartz sand and polyester resin, which was also to be used for repairs. It was also planned to treat the seams of different parts with diluted resin, which was also to be used to fill cracks in the concrete surfaces and even protect the reinforcement parts that emerged from the cracks. It was apparently believed that this would stop corrosion. The proposed extensive use of polyester resin was based on information on its suitability for repairing sculpted ornamentation elsewhere in Europe. There were no studies on the weathering properties of the resin. Fortunately, this stage of repairs did not last long. Some 20 finials were, however, completely re-cast.



3. RESTORATION WORK 1990-1991

3.0 The main tasks

Since the planning stage of repairs, the cast cement ornamentation of the façades was a special subject of interest. The main tasks prior to beginning repairs were to survey damages, to develop methods and to find a repair medium suited to the task at hand. It was clear from the beginning that the main emphasis of work on the façade would be on the concrete parts.

3.1. Damages to the cast ornaments

Only some ten years had passed since the previous repairs of the façade, but it could already be seen that, despite expectations, the repairs of the 1970s had not proven to be long-lived. The polyester-resin based repair medium used in the exterior ornaments of the choir part had not survived major changes in temperature. The rendered repairs to other parts of the façade had also suffered damages. These, however, could not always be seen from ground-level. It was only when the client had a special video film of the exterior taken from a sky lift that the gravity of the situation became apparent: damages had increased. By now, it had become so common for the ornamental elements to disintegrate and fall off that it was dangerous to move anywhere beneath them. The video film had a decisive effect on undertaking repairs in sufficient extent.

In most cases it was observed that the dangerous cracking was caused by the rusting of the irons originally placed in the cast elements. In places on the smooth cast surfaces were networks of hairline fractures that were clearly not caused by the reinforcing metal parts. In addition, the exposed surfaces had become disintegrated and weather-worn, and the resin applied in the previous repairs had fallen out. The new concrete *finials cast in the 1970s were, however, in satisfactory condition.*

A closer study of the hairline fractures revealed that the 20 to 40-mm-deep fractures often turned parallel to the surface at the seam between the hard exterior surface of the element and its coarser and more porous fill. Some of the edges of the decorative mouldings had fallen off in precisely this manner. Cross-sections of the fractures indicated that impurities in the air had entered the interior parts through the cracks.

Analyses of samples also showed that the cement surface had hardened and darkened as a result of carbonation, i.e. carbon dioxide being introduced from the atmosphere into the structure of the part concerned. This phenomenon hardens the surface but ultimately leads to the corrosion of the reinforcing metal. The calcium hydroxide of the hardened cement, which protects the metal from corrosion, becomes calcium carbonate, gradually losing its protective alkalinity and permitting corrosion to begin. The products of the corrosion process expand the metal, inevitably forcing off the protective concrete layer. According to studies, carbonation is, however, a slow process which appears to end at a depth of approximately 25 mm. From this it could be deduced that those metal parts that were placed too close to the surface had 'revealed themselves' over the span of a century. The deeper reinforcing metal parts could still be assumed to be protected.

The locations of reinforcing metal parts were first investigated with an ordinary metal detector, which showed that metal reinforcements were in most cases rare and they were not placed in the elements in any systematic manner. Steel bars c. 5 mm in diameter were the most common reinforcing parts. It was later observed that scrap metal was also used, but fortunately in small quantities. When the scaffolding was erected it was also *attempted to locate reinforcing metal parts with a special detector developed for modern concrete structures, which would also indicate the depth and size of the metal parts. It was soon discovered, however, that the detector was very slow in this process, as it had been developed for detecting reinforcing iron laid according to present standards. The most reliable method was to tap the suspected parts of the elements with a small steel hammer, in which connection damages were revealed by the sound of the concrete.*

The pinnacles which had been coated with cement in 1959 posed a separate problem. In places, the reinforcement had remained too close to the surface, especially at the corners of the pinnacles, where the corrosion of the metal had led to cracks. The cement mortar used in these repairs was coarser than the material generally used in the façade elements, and the thickening had made the pinnacles lose their original slender shape. Solutions concerning these pinnacles were left to the actual on-site work.

3.2. Developing working methods

In the late summer of 1989 the choir porch was chosen as a testing ground for methods for repairing the façade elements. This work was undertaken by Entisöinti Pulla Oy, a specialist firm of restorers with previous experience of repairs to the Church of St. John.

Experiments were carried in a number of methods, including the cleaning of cast cement surfaces with a mixture of sand and water and by grinding. Also studied were the installing of elements, local repairs, and the casting of new parts, for example in replacing some of the crockets of the porch.

Both pinnacles flanking the porch, which had been re-coated in earlier repairs were removed for a closer study. The pinnacles were later re-cast (with the exception of the finials) in a single process to the level of the brick pillars, and their original slender shape was restored. Concrete developed by the Fescon Oy firm was used in the experimental casting.

It was also attempted to impregnate the surfaces with waterglass to repair the cracks, but experiments proved this process to be ineffective.

Also investigated was the possibility of sheeting the concrete surfaces with copper plate. A study of the Church of St. John in Stockholm in the autumn of 1989 showed that this method would spoil the appearance of the church.

As result of experiments and studies, the following methods were selected for repairs:

- Concrete surfaces that were intact but weathered were to be carefully cleaned by water-sand blasting or grinders using special blades and discs.
- The damaged parts of mouldings and larger elements were to be removed as far as the intact surface, laid with acid-resistant steel reinforcements and re-cast in situ.
- The elements that had suffered the worst damage were to be completely re-cast in a workshop in the church cellar. The metal reinforcements were to be made according to the structural designs. Separate decisions were to be made concerning re-casting in each case.

At this stage, no decisions were made concerning repairs to the hairline fractures. Suggestions included injection with a thin epoxy medium, filling with thin grout, or leaving the fractures untreated.

3.3 The concrete

In the initial planning stage all experts agreed that a cement casting process, as in the original ornamentation, was to be used in repairing the façade elements and in making the replacements. This required fresh concrete with technical properties and a colour suited to the old elements.

Finland's two leading concrete manufacturers analysed samples of the elements, and offered their own standard products for the purpose. In view of the poor results of previous repairs, the client felt it necessary to invest in developing a suitable repair material. This task was given to Fescon Oy, which was known as an expert firm willing to take on the challenges of this project.

As there were no specifications available concerning the original working methods, developing the repair medium had to begin with the façades. Cylindrical samples were taken of the elements, revealing the hardened cement surface and also material from the fill and the grout down to the brick surface. The samples were analysed at the concrete laboratory of the Imatran Voima Oy firm.

The results of analysis show that in addition to the aggregates (gravel and sand) only cement was used in the casting process. The mixture was not especially hard and carbonation had proceeded to varying depths. These results were then applied in developing a suitable type of concrete for repairing and replacing the ornamental elements. At Fescon Oy this work was headed by Ms. Aino Heikkinen. The client's expert, Ms. Thorborg von Konow, undertook a critical evaluation of the results.

The requirements placed on the new concrete were as follows:

- colour and form corresponding to the original concrete
- non-shrinkable

- *resistance to rain-water and atmospheric impurities*
- *frost-resistance*
- *low susceptibility to carbonation*
- *good workability and homogeneous consistency.*

In the spring of 1990 several alternatives were studied in laboratory conditions before a concrete for repairs and replacements was found that satisfied all requirements. A grout that was of finer granularity than the above was developed for fixing the elements in place.

The new fresh concrete that was now developed was based on microproportioning techniques where the particle size distribution could be planned and controlled up to a particle size of 0.020 mm (diam.).

The client was especially pleased with the properties of the selected concrete in low-temperature tests. It was discovered that the strength of the concrete had even improved after several stages of freezing and thawing.

3.4. The working process

It was already noted in the planning stage that the amount of work required on the façade ornaments could not be reliably evaluated from ground level. It was not until scaffolding was erected around the south tower in August 1990 that the total extent of the work could be seen. The aim now was that repairs to the south tower would permit a reliable estimate of the costs and schedule of the façade repairs as a whole.

Because it was not possible to assess the number of elements requiring repairs or replacement, work on the concrete parts of the façade was organized on a special contracting basis, the costs and schedules of which were closely monitored by the client.

In the late winter of 1991 scaffolding was erected on the west front, the north tower, and the north wall of the church, from where work progressed through the north transept and the choir to the south face.

There was less work on the façades in the winter months as casting was not possible in sub-zero conditions. The ornaments that were to be preserved and the intact surfaces were smoothed and ground when weather conditions permitted. During the winter, new ornaments for the façade were cast in the cellar of the church. The guiding principle in this work was that all elements that were to be replaced were made, reinforced and finished beforehand to be installed at a later stage. Casting repairs to damaged elements and the grinding of surfaces was carried out on the scaffolding.

The number of workers involved was larger than initially estimated. Entisöinti Pulla Oy employed an average of 20 to 25 workers on the scaffolding and about half this number during the winter months. The work on the façade was completed on schedule in November 1991.

3.5. Casting the ornamental elements

The largest individual cast cement ornaments of the façade had been in place for a century, most of them at a height of several dozen metres. These parts could not be treated adequately with surface repairs.

Of the large individual parts, only the canopy above the main entrance had survived under the arching of the porch. Almost all the other ornaments had to be renewed.

The largest ornaments were the three ring-crosses surmounting the roof ridges at the gable ends, each weighing approximately 800 kg. The finial of the south transept was lowered first in October 1990, and it *disintegrated under its own weight upon being placed on the ground.*

Slightly lighter than the above parts were the c. 120 cm-high flower-shaped finials surmounting the four pinnacles at the corners of the transepts. (The 150 cm-high corner pinnacles of the main towers had been sheeted with copper plate in the 1930s). A large number of smaller ornaments were cast in the cellar workshop: finials for the pinnacles, crockets of different size, porch ornaments etc.

The new concrete ornaments were cast with traditional methods, but using partly new materials. In the process, a relatively well-preserved ornament was first removed and the original shape and form were restored with plaster additions, making the piece correspond as much as possible to the original. This 'original' was then used to make a mould of vinamold, a rubbery plastic, but it first had to be varnished and oiled to prevent it from sticking to the mould. When the concrete was cast, the vinamold mould had to be encased in a plaster support. The metal reinforcements of the largest ornaments were laid according to the instructions of the structural designer. Acid-resistant corrugated steel bars and stainless wire was used throughout. The casting material was the new 'church concrete' prepared according to instruction from Fescon Oy by adding four litres of water to each 20 kg bag. The cast parts were kept moist for several days, and the smallest ornaments were completely immersed in water.

The largest ring-crosses were cast in a two-stage process, in which the completed half was laid on top of another mould, with the reinforcing steel bars already in place. The vinamold moulds could be used several times. The moulds for a number of smaller ornaments were stored in the church cellar for possible future use. After casting, all the concrete ornaments were carefully *smoothed and ground, after which they matched the smoothed original pieces in both colour and texture.*

Work was speeded by establishing the ornament workshop in the church cellar, and this arrangement also made it possible to concentrate on different tasks according to weather conditions (casting in the cellar / installation, casting and grinding on the scaffolding).

During the work it was also necessary to erect a large tent outside the church for the grinding and smoothing of the ornaments.

The ring-crosses were individually lifted into place after their bases had been cleaned and new holes for the steel bars had been drilled around the original stem bar, which had been cut off. A thin mixture of grout was poured into the holes; the element was lowered into place with a sky lift to rest on small metal wedges; and was temporarily supported. Fastenings for lightning conductors were left on the 'dorsal' side of the ornaments.

The four large flower-shaped finials of the pinnacles at the corners of the transepts were cast and finished in the winter of 1991. Each of these finials was designed to be assembled in three parts: a flat base, a body part, and the cap. The parts were cast to permit assembly on top of each other. The steel bars of both the spire and the cap passed through the body of the ornament. Installing these parts had to await the decision to renew the corner pinnacles.

Some of the smaller concrete finials were replaced, while the remaining ones were smoothed and re-installed.

The new separate ornaments, already smoothed, were installed with their steel bars and concreted in place with a thin grout. Over 200 separately cast ornamental *elements or their parts were installed in the façades of the church.*

For technical reasons, it was not always practical to renew the damaged cement elements along the original seams. When the church was built, the ornamental elements had been joined to the walls as part of the brickwork, and accordingly they were deeply lodged in the walls in several places. Where only the visible, protruding part of the element was damaged, it was cut off and the replacement was bolted and grouted in place. Replacing a whole element would have required the dismantling of the intact inner parts and the brickwork.

Because the elements lodged in the brickwork were not completely replaced, their shape within the wall structure remained unknown. During the restoration, however, it could be observed that the ornaments largely corresponded to the element designs in the original tenders.

3.6. The pinnacles

In its original state, the Church of St. John was adorned with 42 pinnacles made of cast cement. Most of these were freely standing parts, while four of them were joined in a pilaster-type construction to the brickwork of the transepts.

When repairs were begun, only the two pinnacles flanking the main entrance were in their original state. The ornaments of the corner pinnacles of the main towers had been removed in the 1930s when they were also covered with copper plate. In the late 1950s a pilaster pinnacle had been dismantled to make room for the central heating chimney, and the remaining pinnacles had been coated with concrete. In these parts, the reinforcing metal had begun to corrode, displacing the concrete shell to such *a degree that it was decided to carry out thorough repairs on the row of pinnacles encircling the aisles and the choir. The concrete shell had to be removed before further action could be decided on.*

This stage of the work was begun on the south side of the church. In some cases, the concrete shell was easily removed, revealing the original shape of the pinnacle. The conical body was assembled of three hollow elements with horizontal groove-and-tongue seams. The walls of the elements were c. 50 mm thick. The inside was filled with brickwork, and in the upper parts was a mixture of thin grout and brick fragments without reinforcing pieces of metal. In 1978 new finials had been installed with reinforcing steel bars in the top parts of the pinnacles.

It was observed that all the pinnacles on the south side could be repaired. The uppermost element with its finial was lifted onto the scaffolding erected around the pinnacles. The finial was removed and the parts were rejoined with a new rust-free reinforcing steel bar. The repaired part was then lifted back and cemented in place, after which the whole pinnacle was repaired by removing the damaged parts, where a new surface layer was cast. This process was followed in the repairs to all eight pinnacles on the north and south sides. Finally, all the surfaces were smoothed and the finials were sheeted with lead plate, as also the backs of the gargoyles.

In the choir part it was observed that all ten pinnacles had suffered so much damage that repairs could not be considered. The pinnacles had cracked and disintegrated, and some of them were broken in places. It was decided to dismantle the pinnacles and to replace them with single cast pieces instead of the original three overlaying elements. Shallow grooves were cut into the *surface of the new pinnacles to mark the original element seams.*

The finials were first removed to be ground and smoothed on the scaffolding. The old reinforcing metal bars were cut off and a new acid-resistant upright steel bar was placed in each ornament. The three main parts of the pinnacles were dismantled, the bases were smoothed and the reinforcing bars for the new pinnacle, extending into the brickwork, were cemented in holes drilled in the smoothed base.

The new pinnacles were cast in situ according to the original measurements in shell-like form, with a hole in the solid upper part for affixing the finial and another hole at the side for the fill. The cast pinnacle parts were individually lifted in place and filled with concrete. After this, the finials were installed and the finishing touches were made to the pinnacles. The replacements of the pinnacles of the choir were the last items of repair work and were carried out in November 1991.

The concrete coating was also removed from the corresponding pinnacles at the entrances to the transepts, which were either replaced or repaired. The well preserved pinnacles flanking the main porch were smoothed.

As described above, the heavy, flower-shaped finials of the almost five-metre-high corner pinnacles of the transepts were cast in the winter of 1991. In these parts, the concrete shell was thicker than in the smaller pinnacles, and the metal reinforcements had not damaged the surface as much as in the smaller pinnacles.

Part of the later concrete shell was removed from the top of the south-west corner pinnacle, revealing the badly damaged original top of the pinnacle, with remains *of paint on the surface. Inspection of the inside revealed that here, too, the original cement element had been filled pieces of brick and an extremely fine-grained cement grout resembling clay, which in the highest part had completely disintegrated into horizontal slabs. It even appeared as if the cement with its high water content had frozen, possibly in the first winter. Inspection of the lower parts revealed serious damage to the pinnacle, which was held together only by the new concrete shell. Because the new concrete shells of the pinnacles were the parts in the façade in which large amounts of the corroding reinforcing metal was close to the surface, it was decided to dismantle and reconstruct all four pinnacles at the corners of the transepts. Repairs to the original octagonal pinnacles could not even be considered.*

When the pinnacles were dismantled it was discovered that their stems were originally made of two shell elements laid on top of each other and joined at the seam with eight vertically laid hooks made of steel bars installed close to the outer surface of the element. In the wider lower part, the inside was filled with carefully laid brickwork. A few vertical pieces of iron were laid in the brickwork of the base to reinforce the joint of the lower element with the bricks.

The small triangular faces of the lower parts of the pinnacles were originally reinforced with metal parts, whose corrosion had greatly damaged the structure. Removing the metal parts would have destroyed the whole structure, and it was consequently decided to replace the triangular faces. It was not, however, possible to break off the pinnacles at the original element seams, as this would have led to 24 small surfaces at the juncture. The pinnacles were cut off horizontally; the brickwork core was dismantled; the new cut-off surface was laid with reinforcements, smoothed, and the necessary vertical steel bars were installed. The *remaining ornamental surface below this part could still be repaired in situ.*

It was decided at this stage that the restorers prepare the eight triangular ornamental elements of the lower part of each pinnacle, install the finials, and carry out the finishing work. The main contractor (the Rakennus Oy Leo Heinänen firm) was responsible for casting the stem of the pinnacle in two parts with the seam in the original location. The plans and drawings for the elements and their metal reinforcements were prepared by the structural designer.

For technical reasons, the seams of the triangular elements were given a less complex configuration than in the original. A plaster model was first made of a single element. It was discovered that the elements of the north-west and north-east corner pinnacles were somewhat too large and they had to be reduced in size. The elements were first assembled by welding together the steel bars so that their upper and lower surfaces corresponded to the shapes of the joints. The octagonal ring formed by these elements was then raised and fitted into place onto the pinnacle base. Minor discrepancies of measurements were corrected by grinding the surfaces. The element ring was then filled with concrete.

The two conically octagonal ring elements of the upper parts of the pinnacles were cast on site with the 'church concrete' developed for the project. Casting the large pieces first presented a number of problems before the right amount of water and the best method of vibration were found. Too much water prevented the upper part of the elements from drying and left it more fragile. This made it necessary to re-cast two of the elements. There was also a tendency for bubbles to remain in the outer surface, which were not discovered until the elements were treated with a steel brush. It was possible to fill and smooth the surface with a thin *grout. The smoothed elements were lifted on top of each other and welded together on the inside. The interior was then filled with concrete, the seams were finished, the surfaces were ground and smoothed, and the finials were installed. The corner pinnacles were completed in early November 1991. Of the 41 surviving pinnacles, 33 were restored to their original form during repairs. The only ones that were not restored were the eight corner pinnacles of the spires which had been stripped of ornaments and sheeted with metal in the 1930s.*

3.7. The gargoyles

The most exotic ornaments of the façades are the animal figures or gargoyles. There is a total of twenty such figures protruding from the walls; the twelve lower ones encircle the towers below the level of the balcony, and eight others are located higher up at the corners of the spires.

The lower gargoyles may have been originally intended as water-spouts, which is suggested by their location. In any case, they are only ornaments, extending some 120 cm from the brick wall. Had they served as water-spouts, they would have speeded the weathering of the façade in conditions of alternating frost and thaw. Water from the passage behind the parapet was led to the tin roof. The lower gargoyles were each cast in a single piece and sunk deep into the brickwork.

When scaffolding was being installed on the south tower in late July 1990, the head of one of these gargoyles on the south face was dislodged by only a slight bump, almost causing a serious accident. A quick inspection showed, however, that nothing similar was to be expected with the other gargoyles of the south tower.

It was discovered in repairs to two lower gargoyles that their metal reinforcements did not include a transverse iron ring at the neck. The corrosion of this part had caused the head of the above-mentioned figure to fall off. The remaining lower gargoyles were inspected by tapping, and no dangerous cracks were observed. Most of the gargoyle figures required only the cleaning and grinding of the surface.

The upper gargoyle figures, which are larger than the above, are water-spouts for the corners of the towers. There is channel passing through the corner pinnacle from which the water runs along a groove in the back of the gargoyle, dripping down from its forehead, which explains why the heads of the upper gargoyles were completely disintegrated. Large pieces which were on the verge of falling down could be dislodged simply by tapping.

The upper gargoyles consisted of two parts symmetrical along the lengthwise axis. The intervening spaces were filled with cement grout. The bases were lodged deep in the brickwork. The element was held in place by the weight of the corner pinnacle above it.

In the repairs to the lower gargoyles, the beheaded figure was removed almost completely and only the rear part, firmly lodged in the wall, was left in place. Inside the body of the figure were two rods of steel c. 15 mm square laid lengthwise. The steel had not corroded. A vinamold mould was made of this figure for the casting of a new gargoyle reinforced and held in place with stainless-steel bars. This work was done in situ on the scaffolding. The reinforcing steel bars were drilled through the remaining part into the brick wall, and the reinforcements of forward part were assembled onto them. The vinamold mould, supported with a plaster shell was put in place and secured with iron bands and screw clamps. The fresh concrete was poured through *holes left in the upper part. In the autumn, when the nights began to chill, the cast gargoyles were covered for several days with a tarpaulin and heated from underneath with a hot-air fan. The cast figures were kept moist to ensure proper setting.*

For reasons mentioned above, the head-parts of the upper gargoyles were mostly damaged. There was only one exception, which only required the grinding and smoothing of the surface. The head of this figure was used to make casting mould.

It was necessary to remove the head-parts of the seven other larger gargoyles and re-cast them. It was observed that the metal reinforcements had not been made in any uniform way. The size, shape and number of metal parts varied. The casting of the forward parts was carried out in situ according to the structural designs and following the procedure described above. After casting the gargoyles were carefully smoothed.

The upper gargoyles were left to function as water-spouts. To ensure durability, the dorsal sides of these and also the lower gargoyles were sheathed with lead plate secured with lead rivets. The lead plate was affixed and sealed around the edges with Sikaflex II FC filler.

3.8. Repairs to the ornaments from the scaffolding

Most of the concrete elements were originally laid into the brick wall, just like their prototypes, the pieces of limestone in the walls of medieval European churches. Because the damages to the elements were mainly the cracking and weathering of surfaces, they could be repaired without removing them from the wall. The damaged parts were marked and cut off with a grinder as far as the intact material. Threaded acid-resistant *steel bars were cemented in place in holes drilled into the remaining surface and nuts were screwed onto them. Larger areas requiring repairs were reinforced more thoroughly.*

For the repairs of the element mouldings, disposable plaster moulds were made in the workshop, and the varnished and oiled moulds were affixed to the sections requiring repairs. They were filled with concrete which was made to spread evenly by knocking and tapping on the outside. The repaired sections were kept moist for a few days, after which the moulds were removed and the cast parts were ground and smoothed flush with the adjacent surface.

Protruding element parts, such as consoles, floral and leaf ornaments, parts of capitals etc., were repaired by removing the damaged parts and replacing them with bolted and cemented elements cast and smoothed in the workshop.

Repairs to smooth element surfaces with cracks did not require plaster moulds, as mould veneer could be used.

The elements which covered the gable of the west front and extended past the level of the ridge were cracked in most places, and large sections of them had to be re-cast. The surfaces were strengthened with armouring to a greater degree than other parts.

The parapet of the passage connecting the towers was in very poor condition in places. The railing beam had weathered and disintegrated. The parapet wall, consisting of thin-edged elements, was broken in several places, and the corners of the railing at the south-west and north-west ends were almost in a state of collapse. Here, however, it was not intended to replace the whole parapet. Following the suggestion of the structural designer, it was decided to recast only the beam, the *main part of this structure. The old beam was cut off, and the replacement was reinforced and cast leaving expansion joints between it and the adjacent supporting pillars. The new railing beam was then covered with copper plate. This precautionary measure was approved, since the sheeting could not be seen from below.*

The ornamental wall-part of the parapet was inspected in detail. The worn and weathered parts were removed and repaired by casting in situ.

Mouldings running across the façade at the levels of both eaves posed problems. In earlier designs by the architect Melander it was suggested that also these mouldings were to be made of cement elements.

It appears that when the church was under construction, costs were saved by making the mouldings of protruding brickwork which was then plastered. At the eaves, this traditional method was suitable, because the mouldings are straight. But problems arose in places where the mouldings encircled pinnacles and buttresses; the brickwork could not be extended at the same level in two directions from the corners. This problem had been solved by supporting one of the corner bricks by a piece of steel plate lodged in the wall. When the mouldings were later faced with cement, the steel plate was in many places only 10 millimetres from the surface. Over the period of a hundred years the carbonation of the surfaces had extended to the steel, causing corrosion. In many places, the corners of the mouldings had fallen off or were disintegrating: 90 % of approximately 100 corner mouldings were replaced. The rusted steel plates were cut off as deeply as possible within the brickwork. This original savings in costs had led to systematic structural damage, requiring costly repairs. Further damage to the mouldings was caused by their later sheathing with copper plate in the 1950s, in which connection the rivets had split the edges.

The smooth plaster surface of the tympanum above the main entrance, which may originally have been meant for a relief, also required repairs. Painting was first considered, but experiments did not lead to satisfactory results. It was finally decided to treat the surface with a coating of thin cement grout coloured with an admixture of soot, as in the old working methods. It was not necessary to do any additional work on the lesser wall surfaces that had been faced with cement.

3.9. The smoothing and sand-water blasting of the concrete surfaces

The original cement surfaces were very smooth, as shown by the porch ornaments which had been shielded from the weather. However, the other surfaces which had been exposed were badly weathered and had disintegrated. One of the aims of the work at hand was to restore the original smooth surfaces.

After casting, it was necessary to remove by grinding the cement glue from the new ornamental elements to bring out the right texture and colour of the material. Also the cast repairs made on the scaffolding were ground and smoothed.

The most laborious tasks in restoring the façade were grinding and smoothing the original cement surfaces which were intact but had weathered on the surface. This was done by discs on grinders or special drill-bits. The work was slow, dusty, and required a great deal of patience. It also revealed cracks and fissures which would otherwise have remained undetected.

After the initial stages of this work it was seen that some of the better-preserved areas, such as the porches, could be cleaned by a mixture of sand and water sprayed with compressed air at low pressure instead of with *grinders. This was also less costly than the use of hand-held grinders.*

Sand and water, however, caused problems for other work in progress. In spite of precautions, the fine dusty sand found its way into the church, although taping the entrances helped somewhat. It was realized only later that the situation could have been alleviated by pressurizing the interior of the church with the new ventilation system. Work on the south façade revealed that sand and water had in places entered the attic from under the eaves and above the brickwork. From here, the mixture of sand and water flowed along the walls and into the church. The streaks, however, were easily cleaned.

3.10. Hairline fractures and injection tests

Fractures in the concrete surfaces were a cause of concern in the early stages of the restoration project. A main question was what fractures were dangerous. The sloping element surfaces of the buttresses contained networks of cracks and fractures for which repairs appear to have been attempted even before the 'resin repairs' in 1978. Investigations revealed that these fractures were caused by the shrinking of the concrete and that they followed changes in temperature. Consequently, they were not regarded as especially dangerous. On the other hand, fractures which could be attributed to the corrosion of the reinforcing irons were studied in close detail, and casting repairs were made where necessary.

Injections of thin cement grout into the fractures were also considered, but it was soon noticed that even a thin solution of grout could not penetrate the minute fissures.

In a limited area of the south tower, experiments were carried out with pressurized resin injections into hairline fractures. The results of these experiments will be monitored over the following years.

In the injection tests, small holes were drilled into the hairline fractures, into which the resin medium was injected under pressure. The experiments were not continued, because there is still insufficient experience of injections into old concrete structures.

The smallest hairline fractures were left untreated, while the larger fissures were opened and filled with a thin grout.

4. THE MAINTENANCE AND INSPECTION OF CONCRETE ELEMENTS

In the future, special attention must be paid to the relatively few original ornaments of the façades, which are hoped to survive as long as possible.

It was not possible to survey and document in detail the repairs of concrete surfaces that were carried out on the scaffolding. The repaired parts are visible at close range, but seen from a distance they blend with the original concrete surface. Further attention must be paid to the seams of repaired sections.

The injected surfaces of the south tower must also be monitored.

We recommend inspections of the façade ornaments from a sky lift at ten-year intervals, in which connections the concrete surfaces should be cleaned with pressurized water.

SUMMARY

In the late 1980s, when the centenary celebration of the Church of St. John was approaching, it was observed that the cast cement ornamentation of the façades of the church was in poor condition and even dangerous, despite previous attempts at repairs. A video film recorded at close range from a sky lift revealed the gravity of the situation, and it was decided to carry out repairs to the façades in connection with other restoration and alterations to the church.

Some of the ornamental elements were completely damaged, some had cracked, and the cement surfaces of all of them had badly weathered. It was not possible to carry out an extensive survey of damages from ground level. Furthermore, the original drawings and plans had disappeared.

The first stage of the work was to study the scant archive sources that were available and to identify the original techniques and working methods.

A small experimental work site was established at the chancel end of the church for testing various methods. It was observed that only small amounts of reinforcing iron had been used in the original ornaments, but their wrong method of installation had often led to cracks and fissures.

Samples were drilled of the cast parts for analysis. The original concrete was observed to be dense on the surface, but more porous on the inside. After repeated studies, experiments and deliberation it was possible to develop suitable concrete and grout for the work at hand, with technical properties and colour closely corresponding to the original.

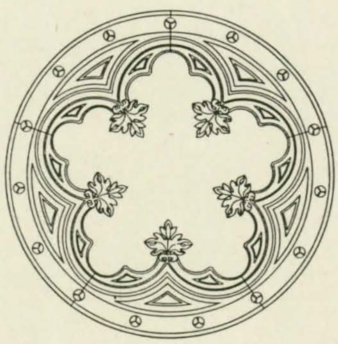
Work began at the south tower, from where the extent of damage was surveyed for an estimate of costs. A cement-casting workshop was set up in the church cellar for making replacement parts. A number of ornaments could be repaired on the scaffolding by re-casting the damaged parts. All the cast concrete surfaces, both replacements and the original, intact, but weather-worn, ornaments were ground and smoothed by hand.

Almost all the pinnacles which had been coated with concrete in the 1950s, had begun to suffer damages, and the concrete shells were removed during the restoration. It was possible to repair some of the original pinnacles, while some had to be completely re-cast according to the original shape.

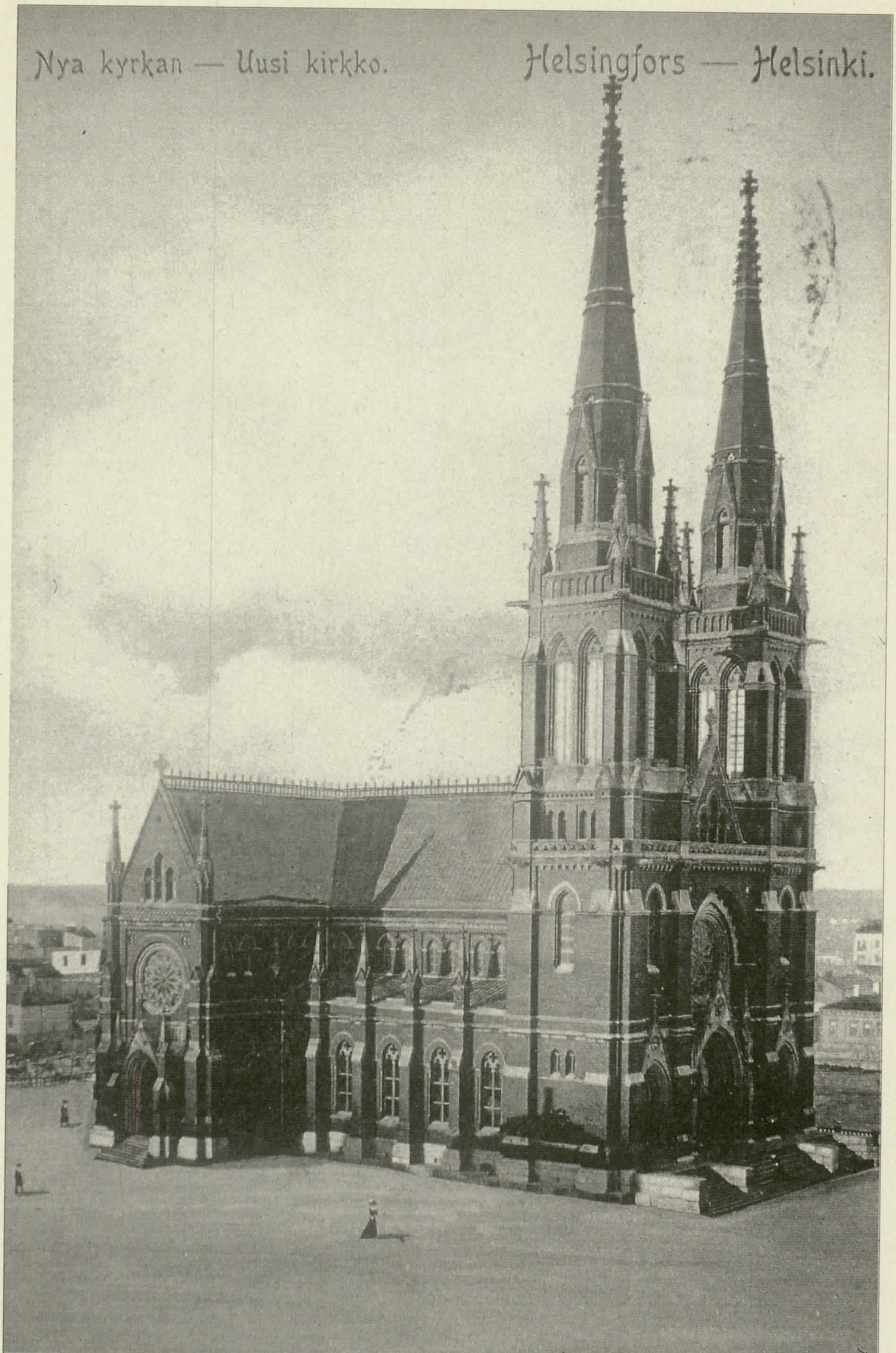
It was decided not to reconstruct the eight corner pinnacles of the main towers. These parts had been sheeted with copper plate in the 1930s.

Work on the façades lasted approximately 15 months, and was carried out alongside other restoration work. An average of 20 to 25 persons were employed in repairing the ornaments throughout the process. During the winter season most of the work concerned the making of replacements (repairs to the façades cost a total c. FIM 6 000 000).

The work on the façades was carried out in close collaboration with the National Board of Antiquities, and was completed well before the centenary celebration.



APPENDICES



THE CHURCH OF ST JOHN / OLD POST CARD PROBABLY FROM THE YEAR 1892. (THE OLD HOUSES AND SHACKS ON THE FOREGROUND HAVE RETOUCHED!)

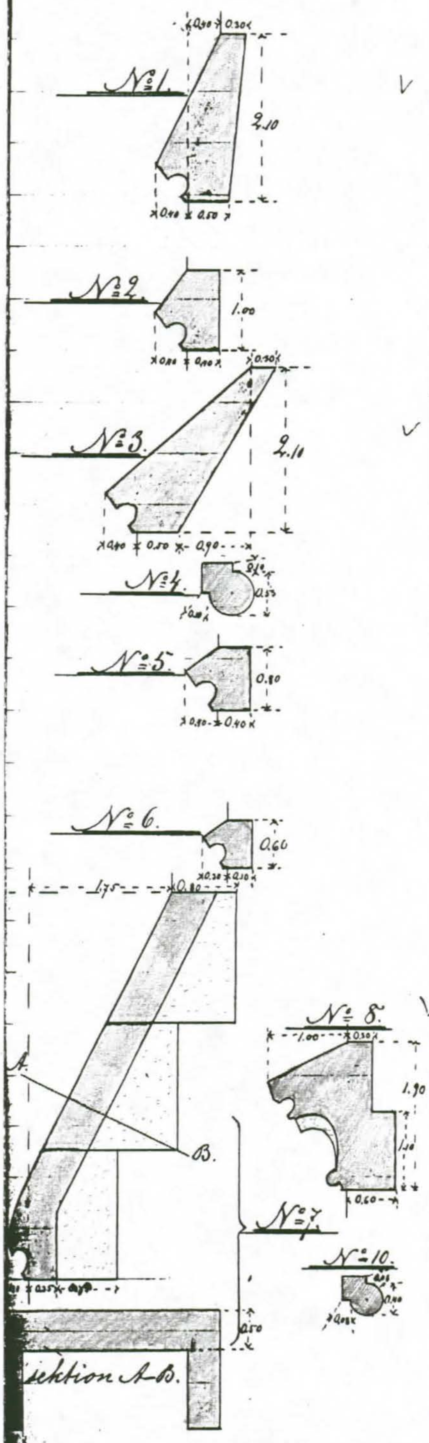
Förteckning

Komiténs exempl.

Erbjudande

till Herrar Kommitterade för ny luthersk kyrka i Helsingfors.

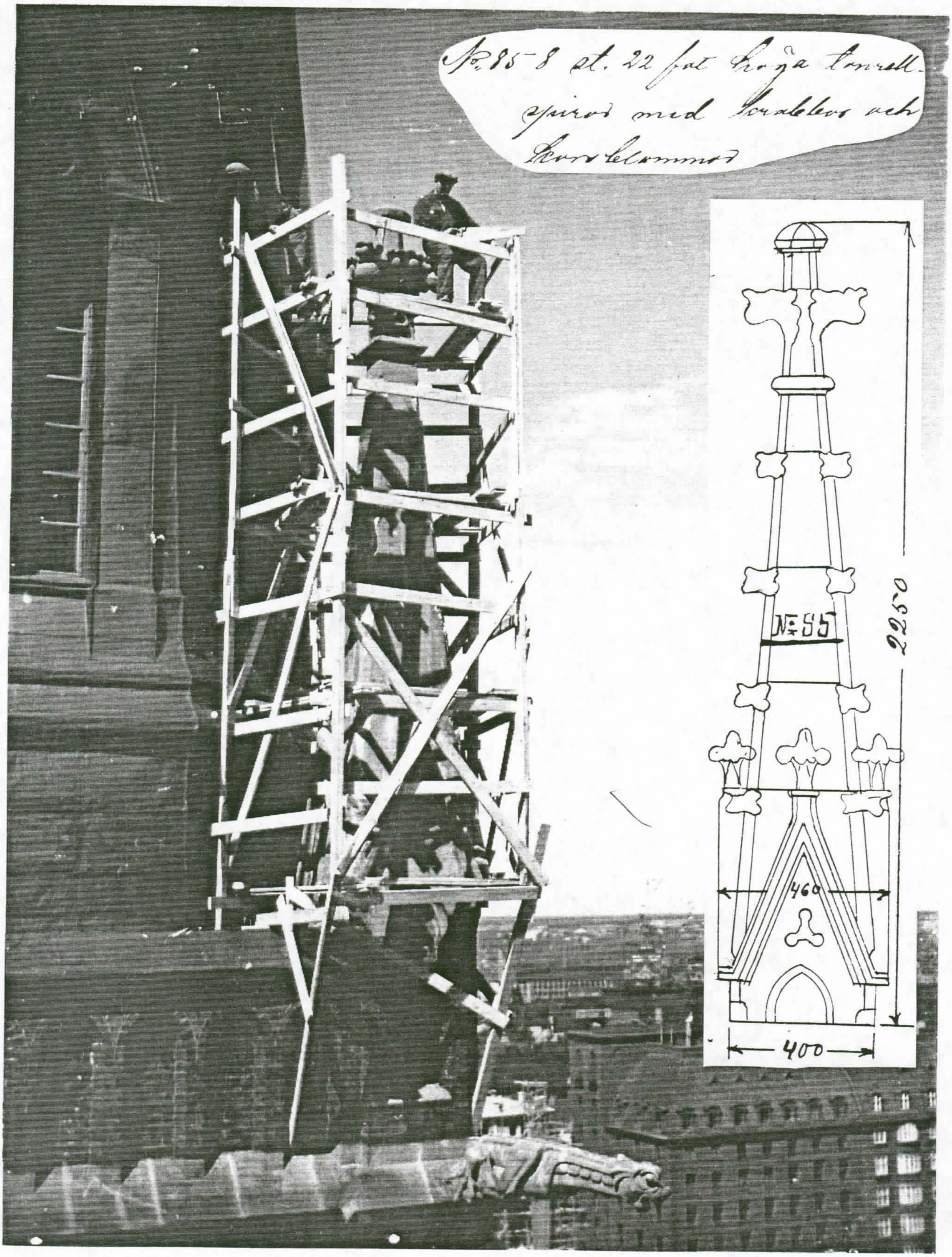
Till Helsingfors nya kyrka erbjuda vi oss att utföra följande cementarbeten på nedan angifna bestämmelser



	Kronor	öre
I. Till sidoskepp och nedre chor		
№ 1. 236 löpfot list å sträfpelarne vid fönsterbottnarnes höjd	850	.
№ 2. 115 löpfot list mellan sträfpelarne vid fönsterbottnarnes höjd	230	.
№ 3. 20 st. 5.50 fot långa fönsterbottnar	450	
№ 4. 40 st. 11 fot höga fönsterkolonetter	520	.
№ 5. 136 löpfot bandlist vid contrefortfallens höjd	260	.
№ 6. 360 löpfot omfattningslist öfver fönsterna	440	
№ 7. 20 st. 4.90 fot höga contrefortfall	680	.
№ 8. 390 l.f. nedre taklist	2220	.
№ 9. Öfre taklist putsas		
№ 10. 80 st. 3.40 fot höga kolonnetter under sträfpelarlisterna	240	.
Transport	5990	.

A PAGE FROM AN EARLY CONTRACT BID ON CAST ELEMENTS / 1887

WORKERS OF "HELSINGFORS CEMENTGJUTERIET" CASTING WORKS WITH CAST CEMENT ORNAMENTS FOR THE CHURCH OF ST JOHN.



DISMANTLING THE ORNAMENTS OF THE TOWER PINNACLES 1934 AND A TEXCT AND DRAWING FROM AN EARLY CONTRACT BID.
(MEASURES IN FEET)

THE FINIAL ABOVE THE MAIN PORCH IS MISSING. OTHERWISE THE DAMAGES CANNOT BE USUALLY SEEN FROM GROUND LEVEL.

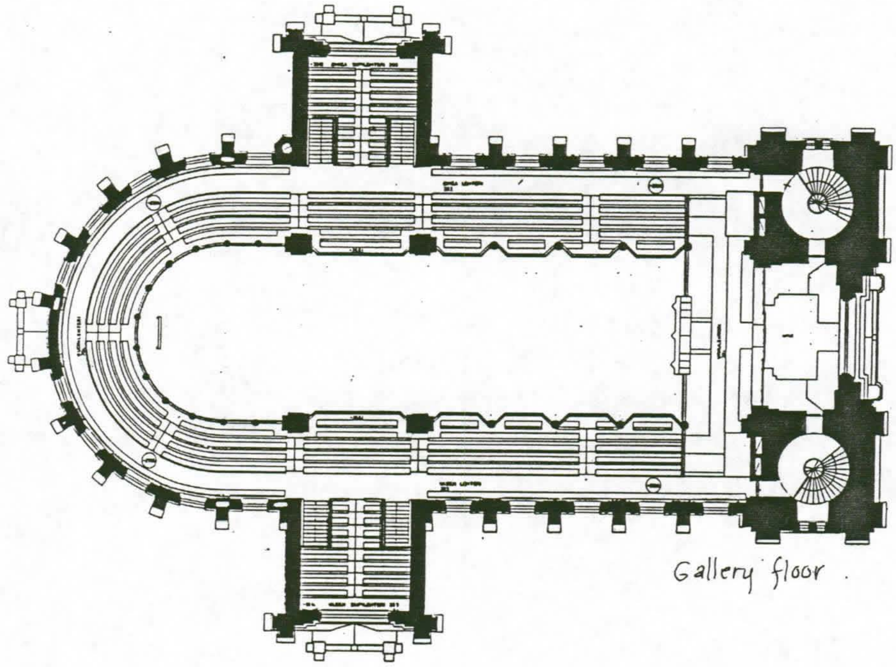
The starting point

WEST FRONT BEFORE THE RESTORATION
SPRING 1990

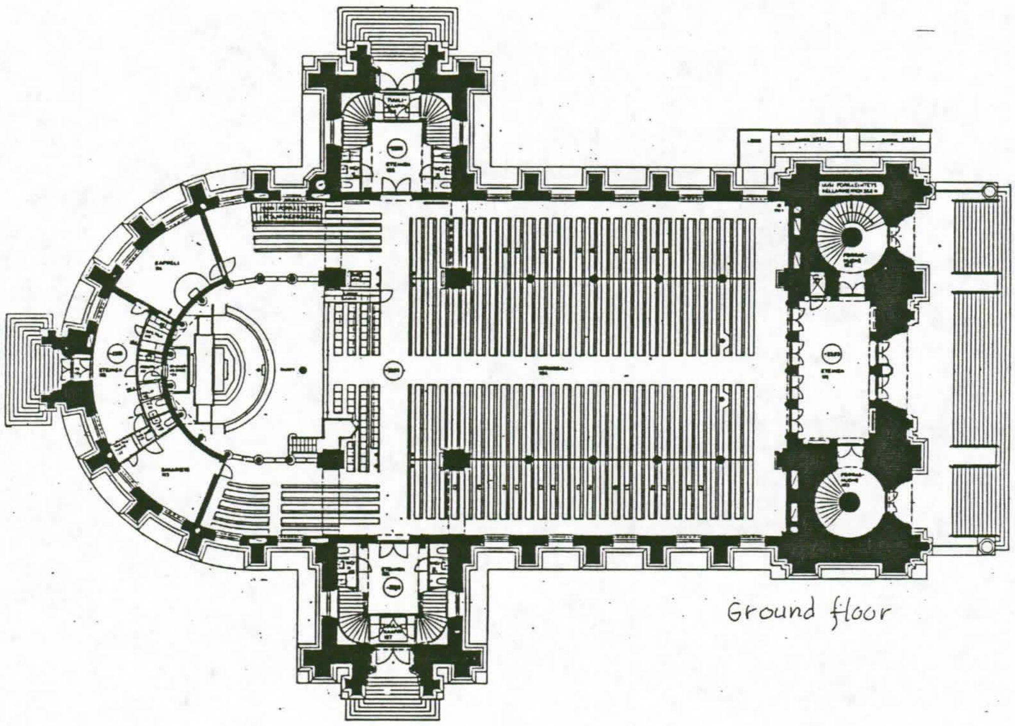
EVERY PINNACLE STILL HAS ITS NEW CONCRETE SHELL FROM THE 1950'S WHIS HAS STARTED TO DISINTEGRATE.

The starting point

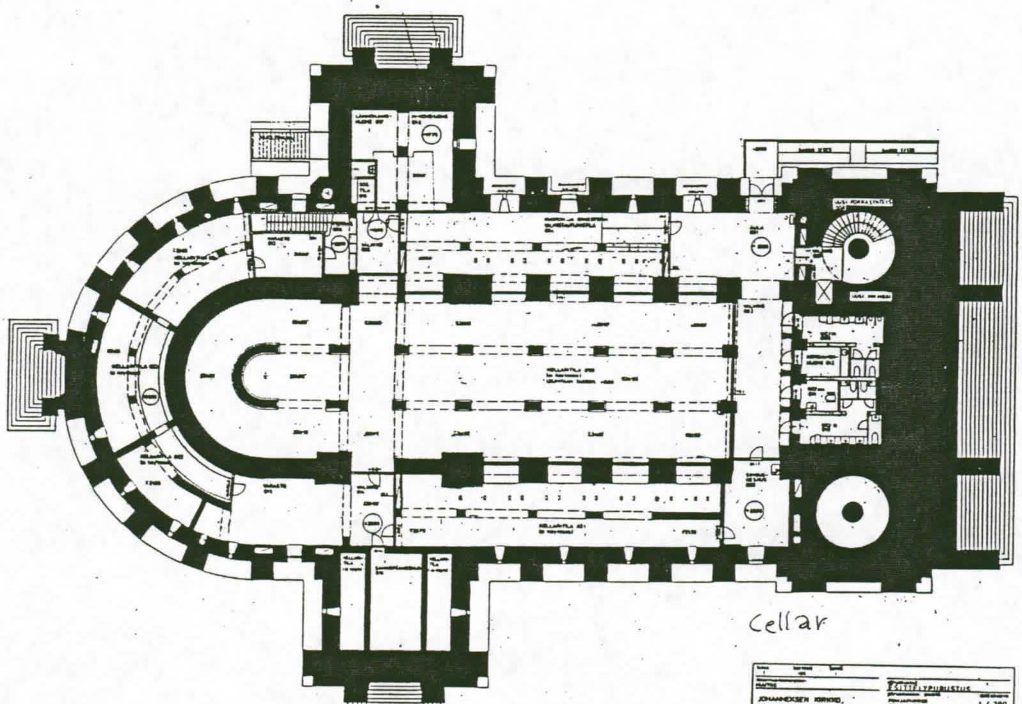
THE CHOIR BEFORE THE RESTORATION
SPRING 1990



Gallery floor



Ground floor



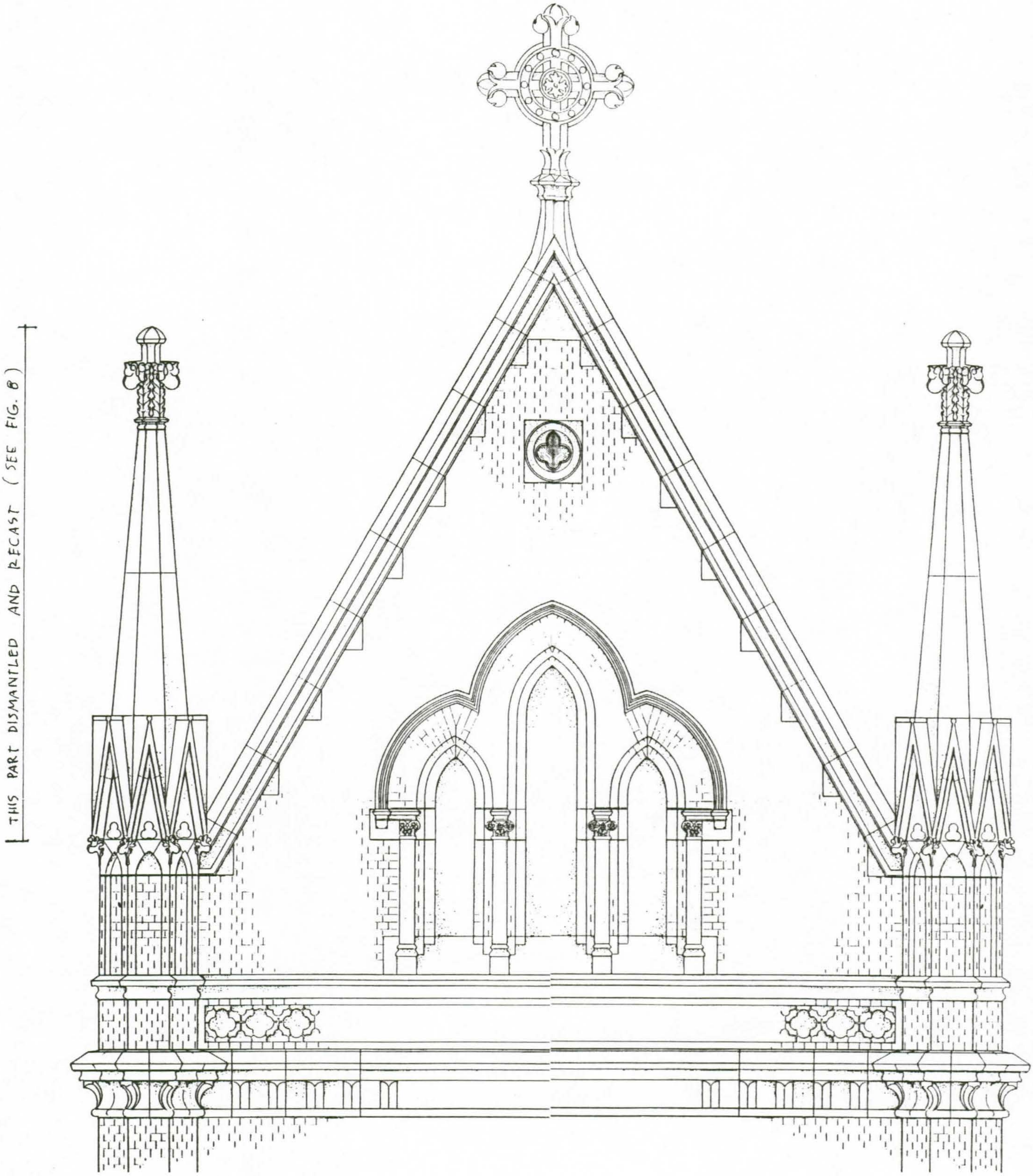
Cellar

JOHANNEKSEN KIRKKO,
PERUSKORJAUSTYÖ

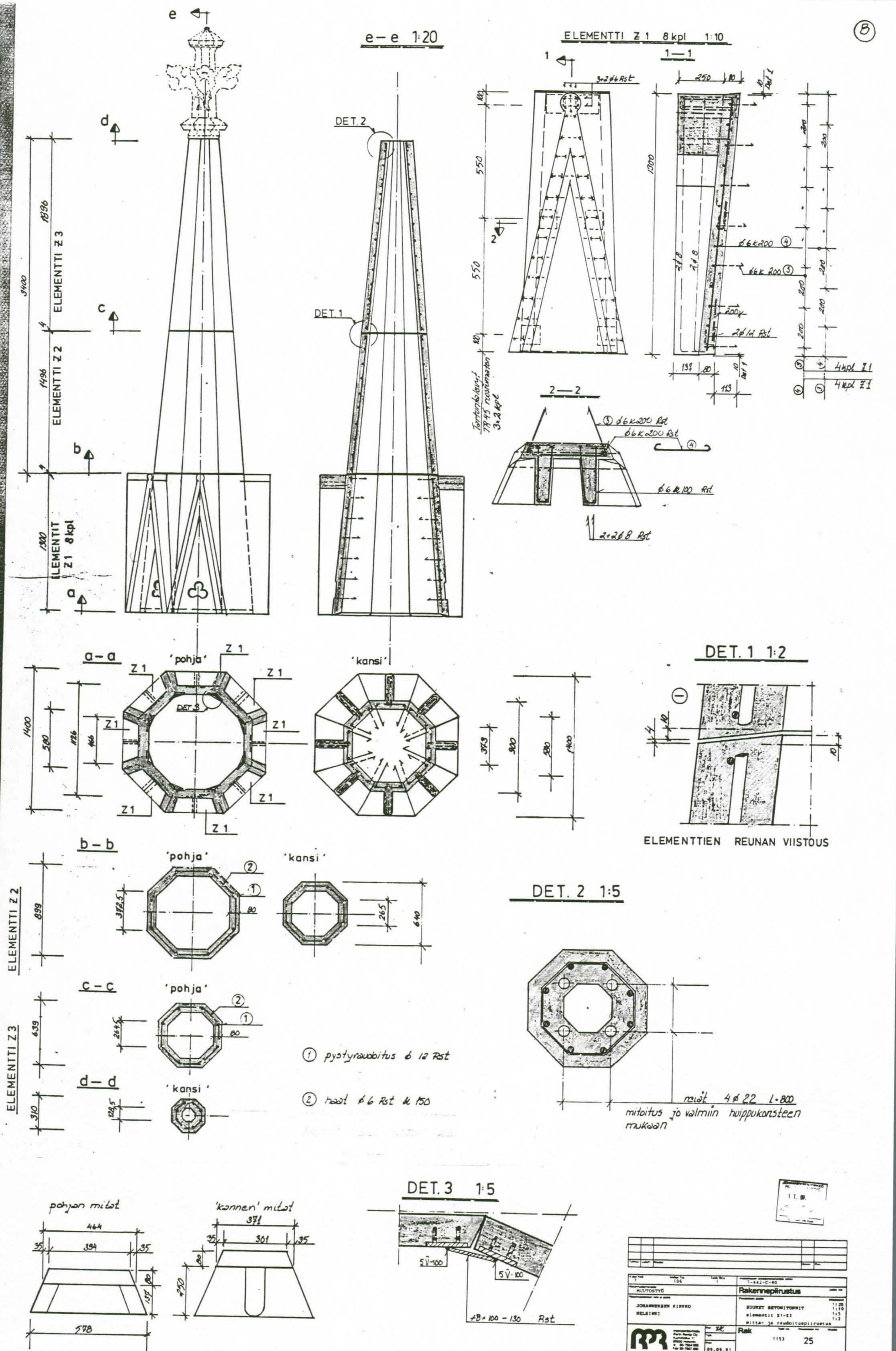
1 / 200

PLANS

1:400

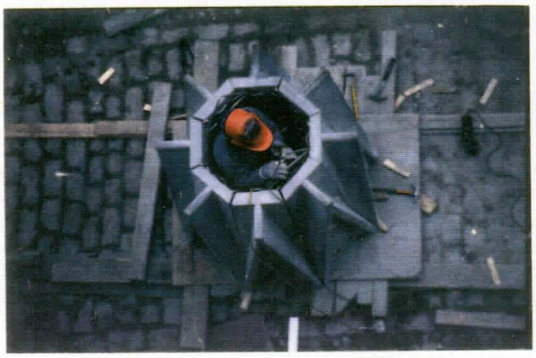


THE TRANSEPT GABLE WITH RING-CROSS AND PINNACLES

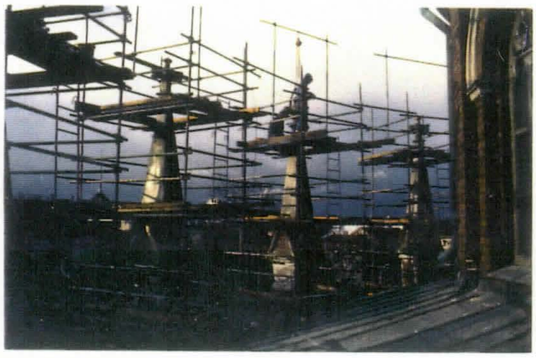


CONSTRUCTION DRAWINGS FOR NEW TRANSEPT PINNACLES

CASTING THE NEW PINNACLES ON WORKING SITE. THE "CHURCH CONCRETE" DEVELOPED BY FESCON OY FIRM WAS USED.



ASSEMBLING THE PRE-CAST UNITS OF THE CORNER PINNACLES OF THE TRANSEPTS TO BE LIFTED UP.



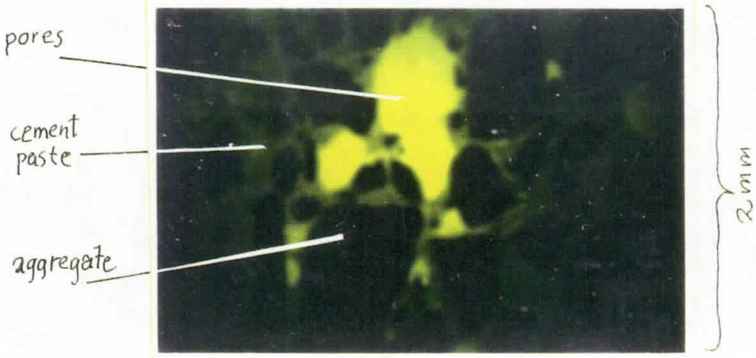
REPAIRING AND RENEWING THE PINNACLES OF THE CHOIR.

READJUSTING A FINIAL OF A SMALL PINNACLE.

A VINAMOLD MOULD HAS BEEN MADE ACCORDING TO THE FORMS OF AN OLD FINIAL WHOSE FORMS HAS BEEN RESTORED BY PLASTER.

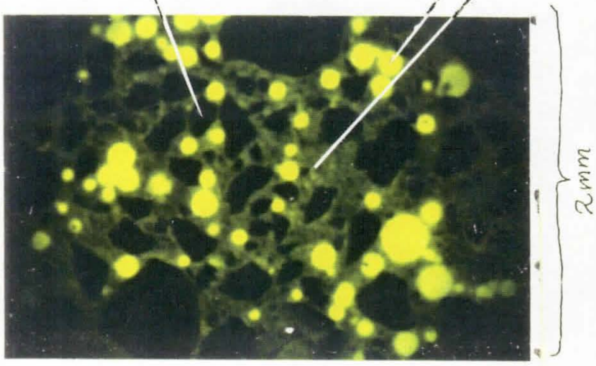
NEW PARTS OF THE FINIALS OF THE TRANSEPT PINNACLES.

(PHOTOGRAPHED THROUGH A POLARISATION MICROSCOPE)



Concrete S. 100 ("normal" CONCRETE)

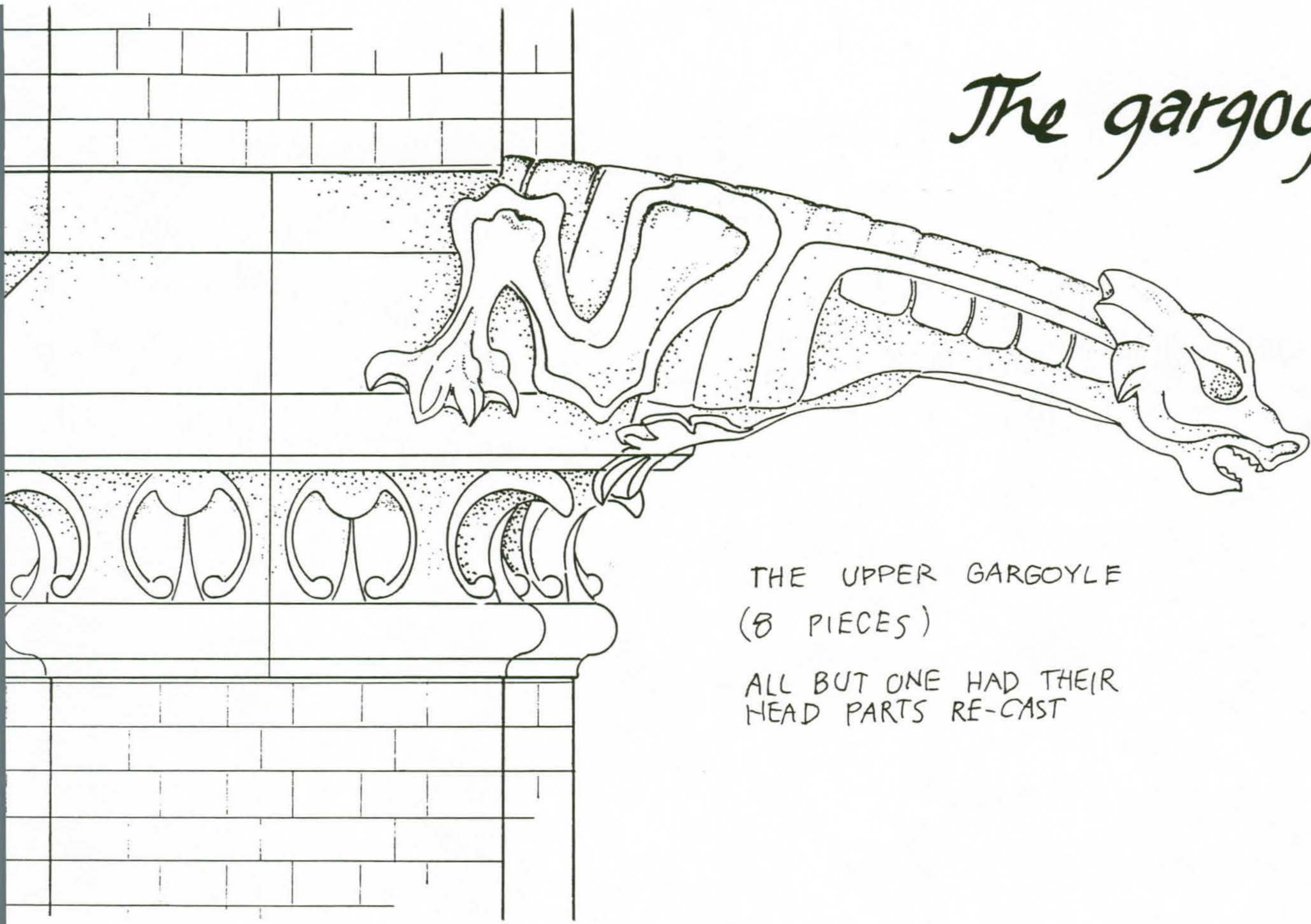
The bad workability (työstettävyys) of the fresh concrete had led to inhomogenity in the pore distribution. Some of the pores are also too large. The concrete is not dense enough and its frost-resistance is uncertain.



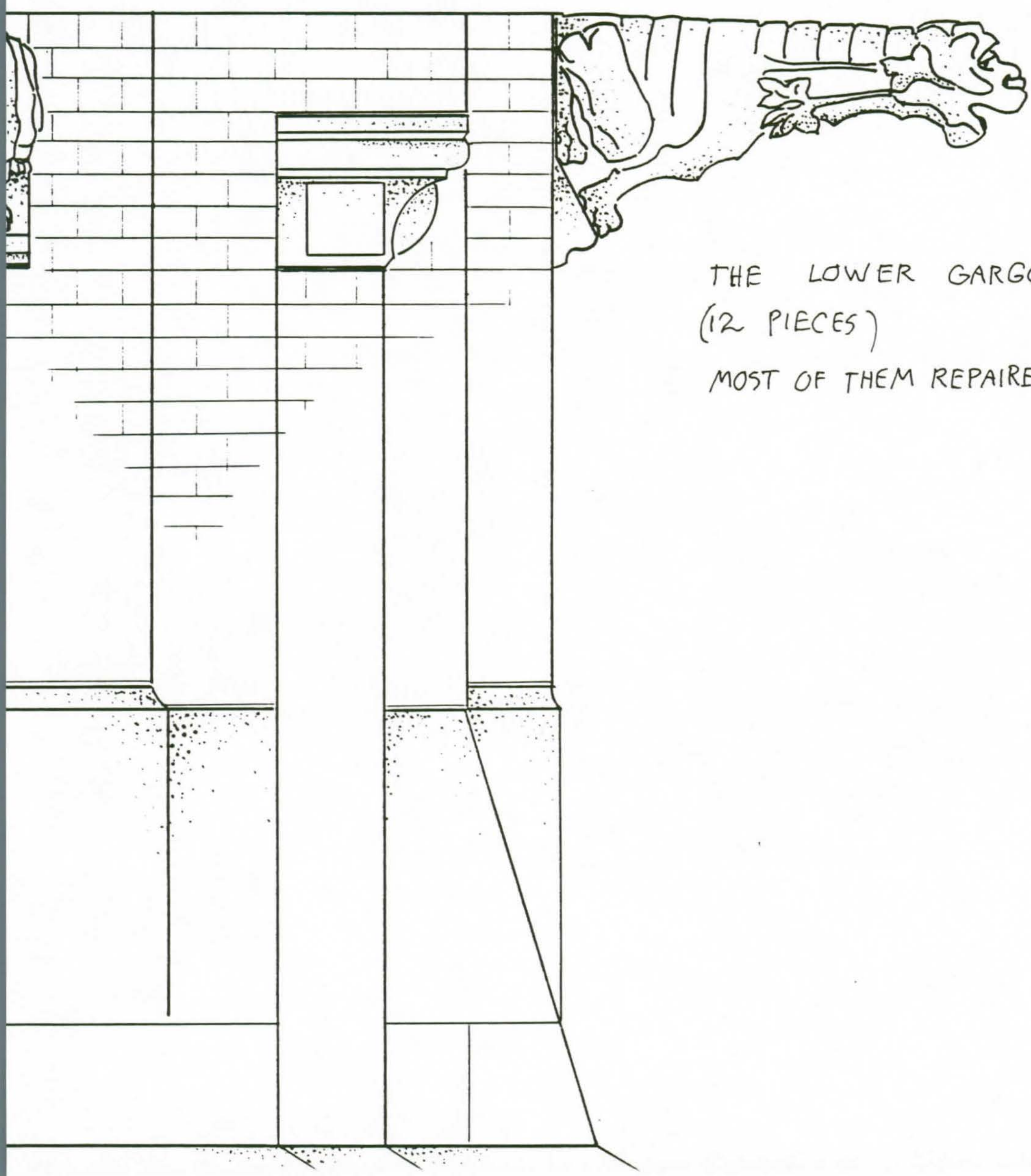
"The church concrete" (FESCON OY)

Because of good microproportioning, the distribution of the fine aggregate and the pores in the concrete is homogeneous. Since the pores are small they act as protecting pores. The cement paste itself is dense without any cracks. Such microportioned concrete has a good durability.

The gargoyles

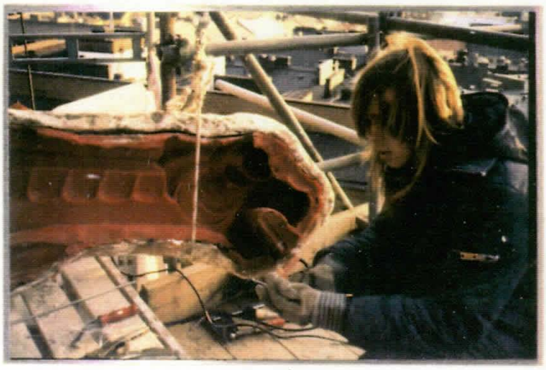


THE UPPER GARGOYLE
(8 PIECES)
ALL BUT ONE HAD THEIR HEAD PARTS RE-CAST



THE LOWER GARGOYLE
(12 PIECES)
MOST OF THEM REPAIRED

BEFORE THE INVESTIGATIONS: THE LOWER GARGOYLES ARE SEEMINGLY INTACT...



ADJUSTING THE MOULD FOR ONE OF THE LOWER GARGOYLES.

UNTIL ONE OF THE HEADS WAS DIS-LODGED BY A SLIGHT BUMP! A RUSTED IRON RING HAD CAUSED CRACKING. THE DEEP CARBONATION CAN BE OBSERVED.

THE RESTORER, THE MOULD AND THE NEW-BORN GARGOYLE.

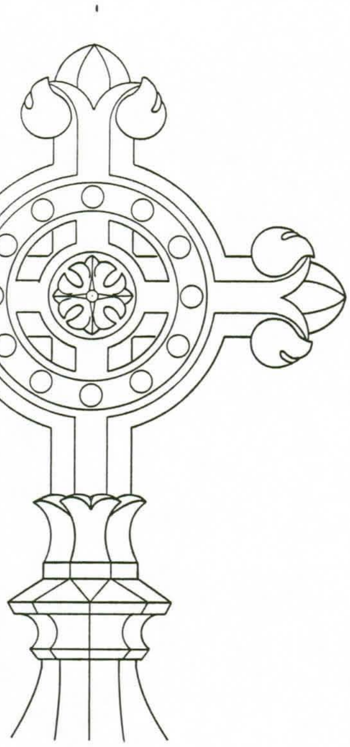
10 KGS

FINISHING THE GRINDING BY HAND.

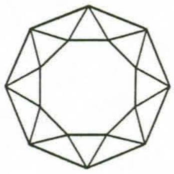
CASTIN THE HEAD PART TO ONE OF THE UPPER GARGOYLES. THE MOULD IS SUPPORT-ED WITH A GLASS-FIBRE CASE AND SECURED WITH IRON BANDS AND SCREW CLAMPS.

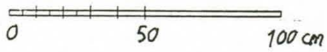
THE CLAWS OF ONE OF THE UPPER GARGOYLES.

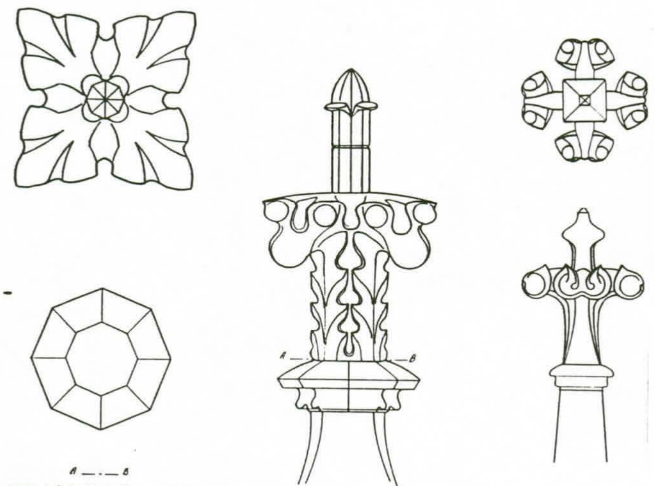
Ring-crosses and finials



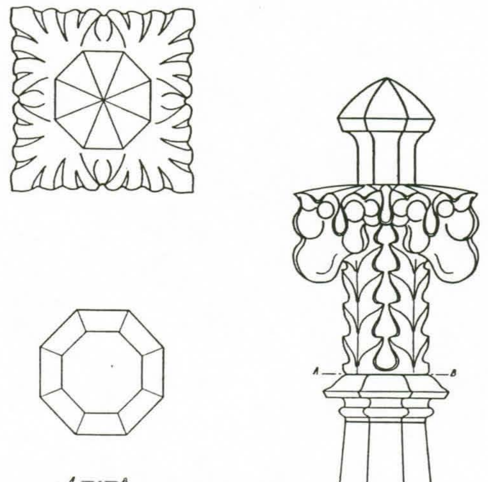
RING-CROSS
WEST FRONT AND TRANSEPTS
3 PIECES



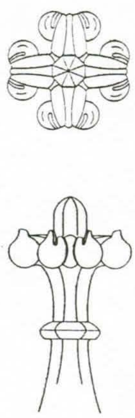




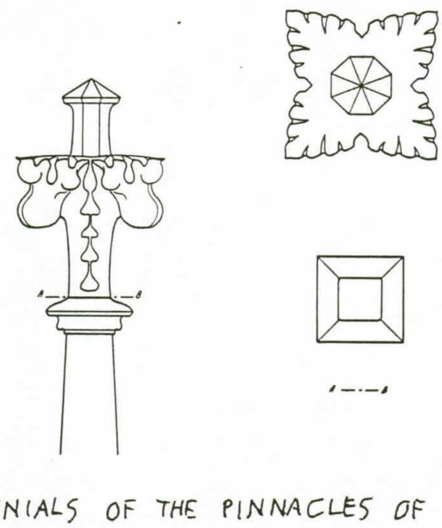
FINIALS OF THE TRANSEPT AND CHOIR PORCHES
3 + 6 PIECES



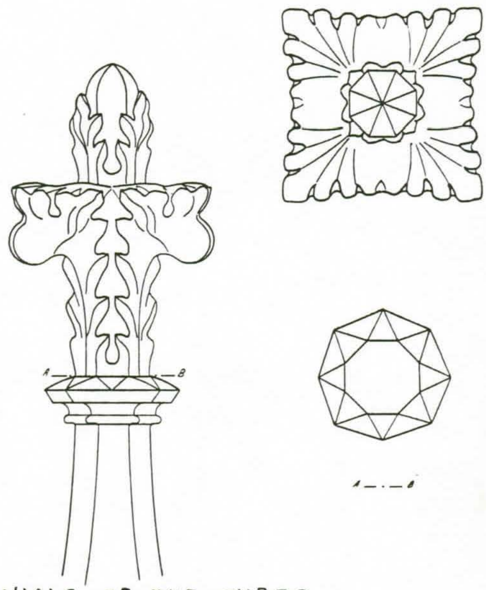
FINIALS OF THE PINNACLES OF THE TRANSEPTS
4 PIECES



SMALL FINIALS OF THE TOWERS
16 PIECES



FINIALS OF THE PINNACLES OF THE AISLES AND CHOIR
18 PIECES



FINIALS OF THE THREE PORCHES OF WEST FRONT
3 PIECES

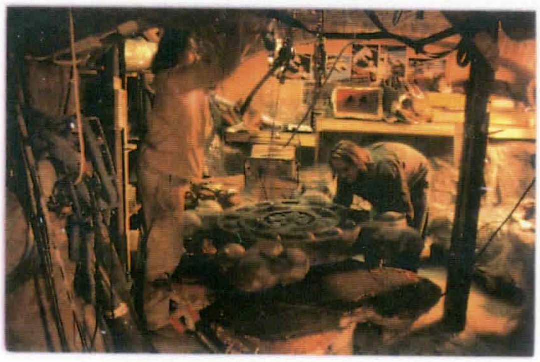
The pinnacle

(THE AISLES AND CHOIR)

TAKING DOWN A RING-CROSS. THE UPPER PART, WHERE AN IRON RING HAD BEEN USED AS REINFORCEMENT, IS BADLY DAMAGED.

VIBRATION OF FRESH CONCRETE IN THE MOULD. A READY MADE HALF OF THE RING CROSS IS HANGING ABOVE.

THE CENTRAL STEEL BAR AND THE CAST CEMENT MATERIAL OF THE LOWER PART WERE IN PERFECT CONDITION.



LOWERING AND ADJUSTING THE OTHER HALF ON THE MOULD.

THE ORIGINAL SHAPE AND FORM OF THE RING CROSS WERE RESTORED WITH PLASTER ADDITIONS.

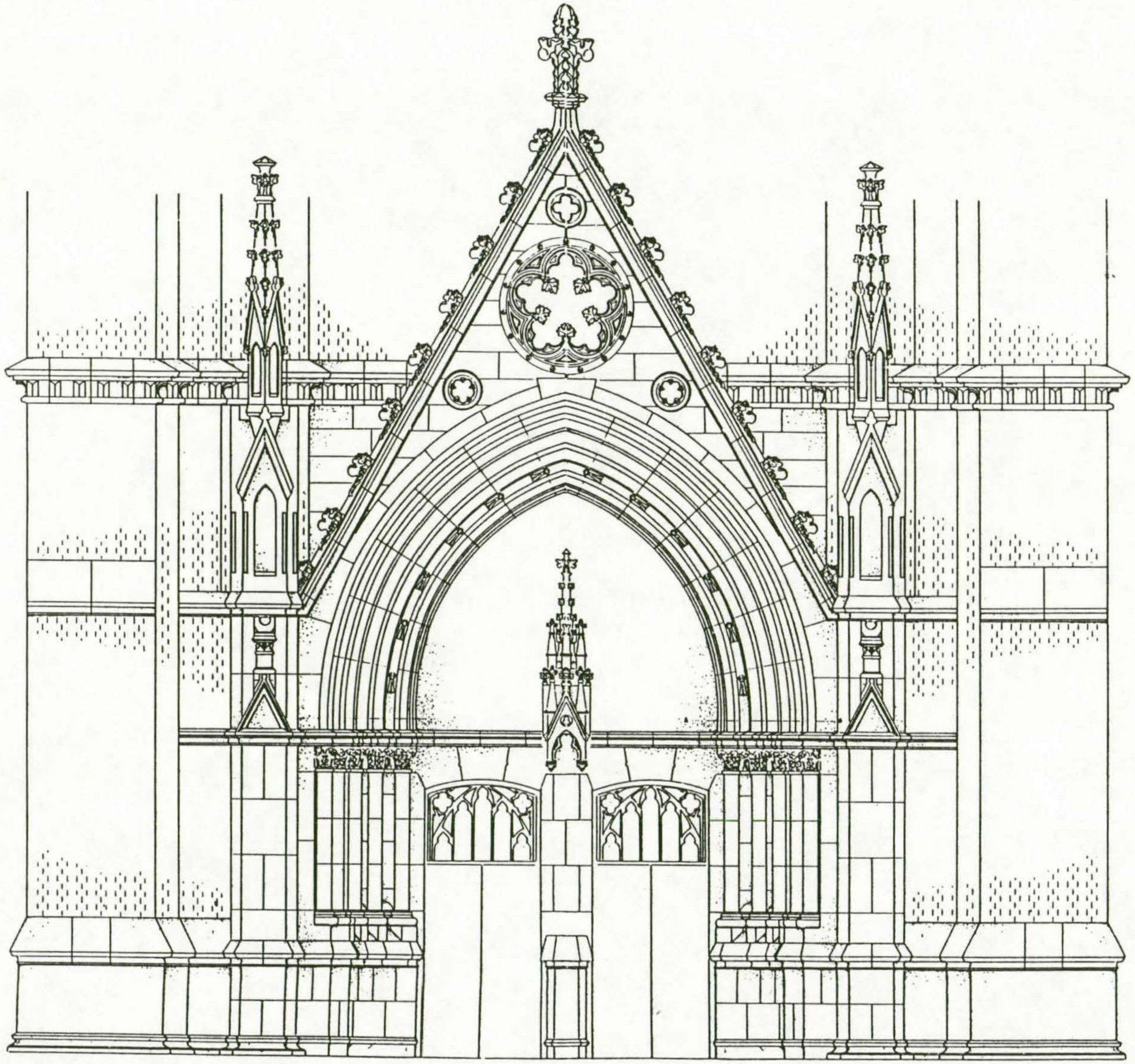
THE WORK IS OVER ! THE RING CROSS IS READY TO BE LIFTED UP.

A VINAMOLD MOULD SUPPORTED BY A PLASTER CASE WITH ACID-RESISTANT STEEL REINFORCEMENT.

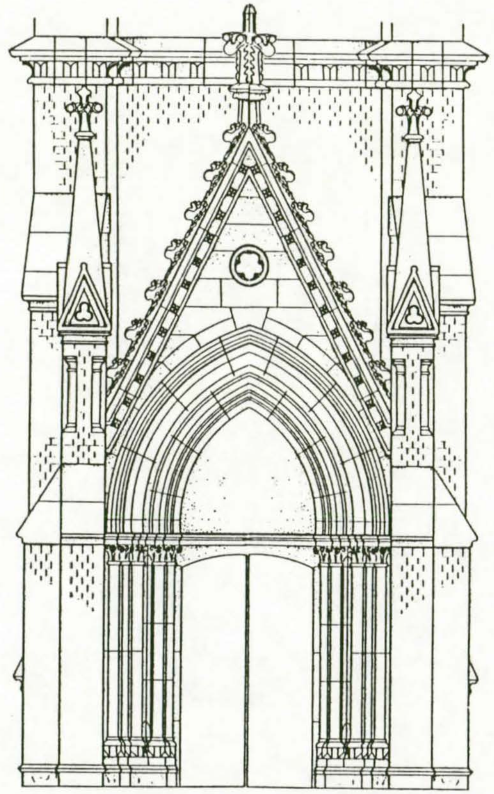
THE SMOOTHED DETAILS OF THE CROSS.

Porches

SCALE : ~ 1:100



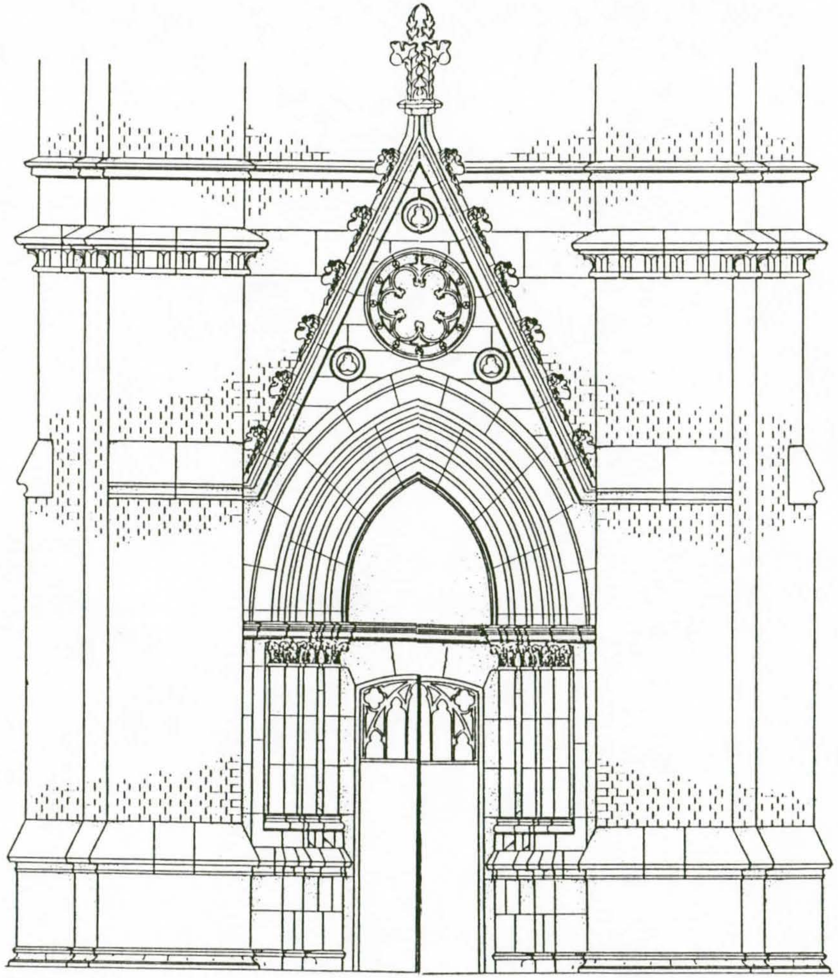
MAIN PORCH



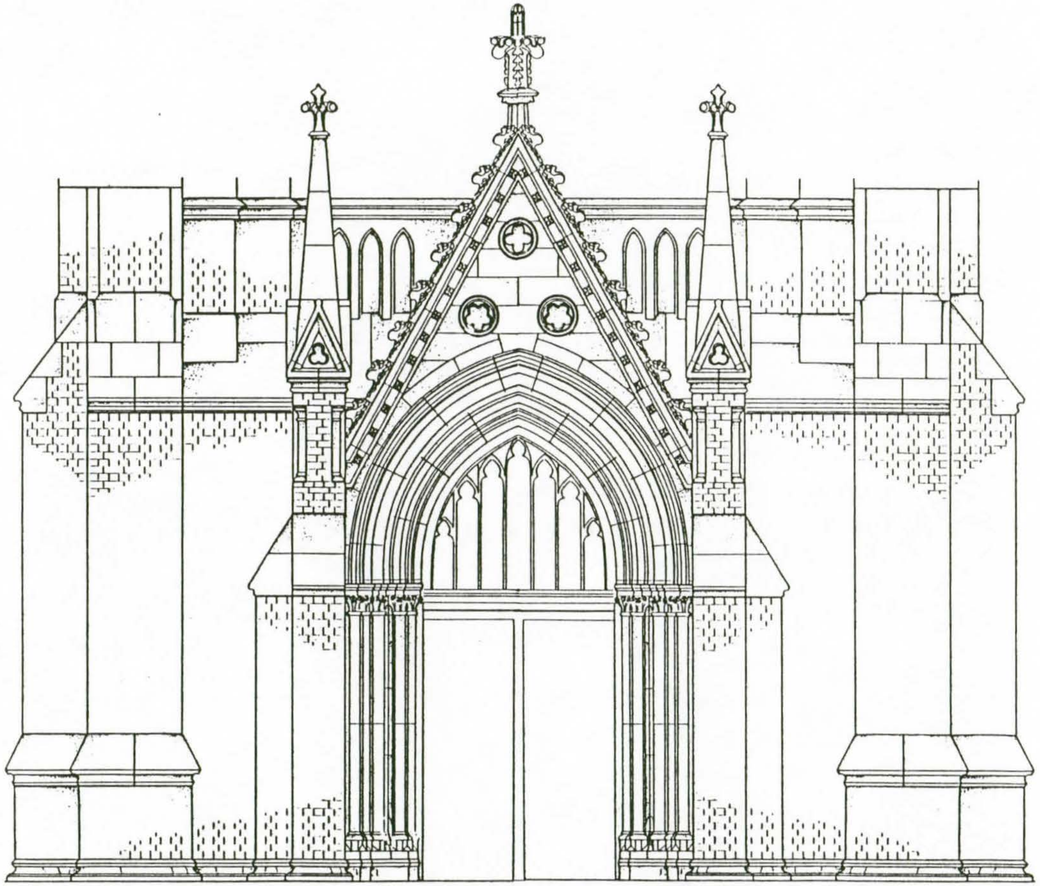
CHOIR PORCH

Porches

SCALE : ~ 1:100



WEST FRONT, SIDE PORCH



TRANSEPT PORCH

WHAT IS THE CONDITION OF THE FAÇADES ?

DREAMS ...

... AND REALITY

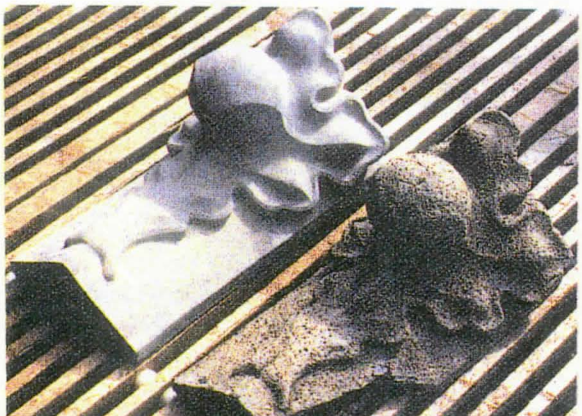
A RUSTED PIECE OF REINFORCING IRON HAS BROKEN THE CORNER OF A MOULDING. THE CORNER HAS BEEN CUT OFF.

REPAIR OF (ANOTHER) CORNER. A DISPENSABLE MOLD IS USED.

FINISHING A FINIAL BY GRINDING

FLUSHING THE WALL WITH CLEAN WATER. THE REPAIRED SUFFACES ARE VISIBLE.

ADJUSTING A DISPENSABLE PLASTER MOULD AND REIN-FORCEMEN TO A CORNER



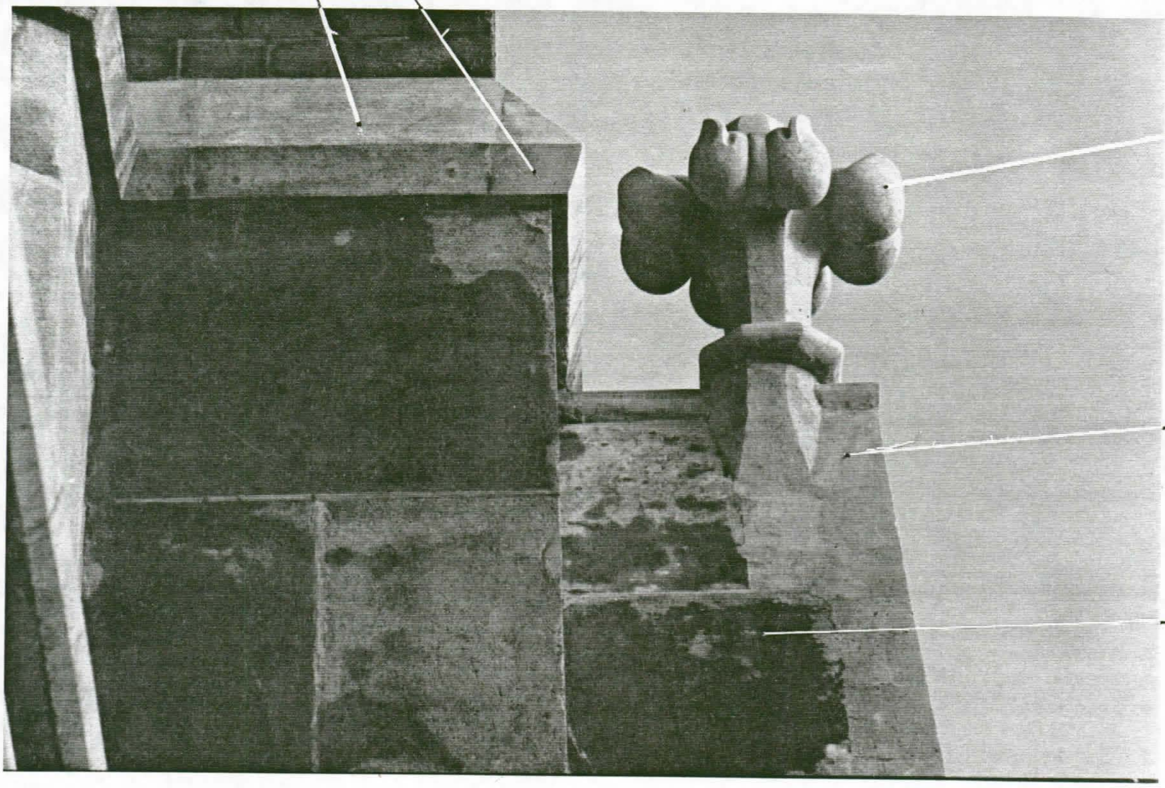
A NEW CROCKET AND A DETERIORATED ONE

Observations

MARCH 1993

ORIGINAL SURFACE SMOOTHED AND GROUND / DRY

NEW CORNER



RE-CAST FINIAL IN GOOD CONDITION

NEW SURFACE: DRY

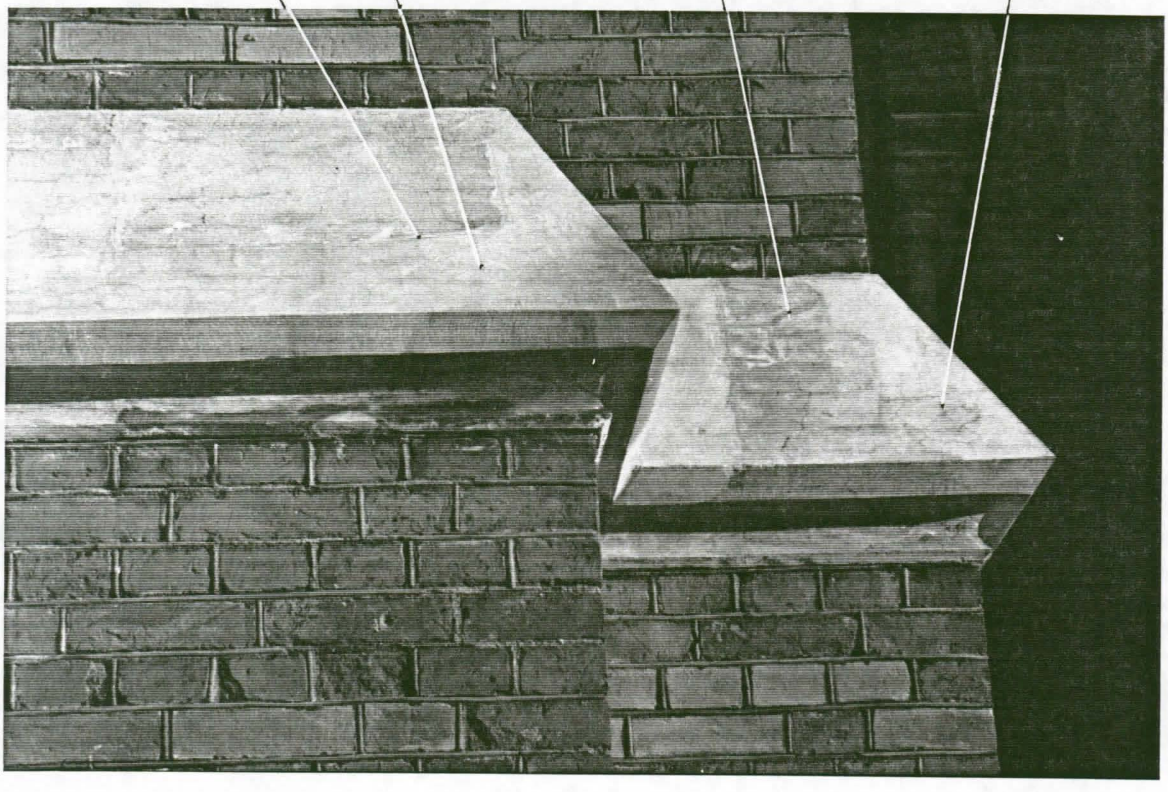
ORIGINAL SURFACE: IN PLACES WET

NEW CORNER

HAIRLINE FRACTURES OPENED AND FILLED WITH GROUT: NO CRACKS

HAIRLINE FRACTURES BOTH IN OLD AND NEW SURFACES

SEAM VISIBLE BUT WITHOUT CRACKS



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