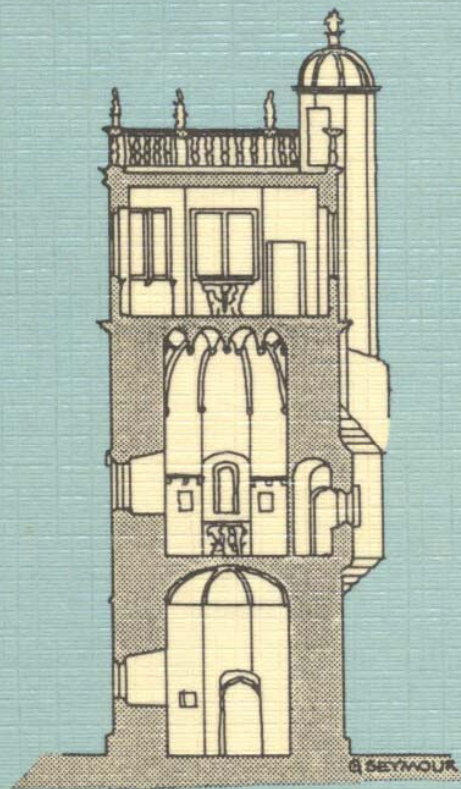


**Structural Repair and Maintenance
of Historical Buildings II**

**Vol 2: Dynamics,
Stabilisation
and Restoration**

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The Restoration of Agia Kiriaki in Grevena, Greece

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ABSTRACT

All stages necessary for the restoration of the church of Agia Kiriaki are described, starting from first inspection and observations on site. Next, the research work on site and in the office and the first conclusions for the diagnosis of the problems are presented. Finally, the restoration works are described, which include the pulling back of an outward leaning wall and its consolidation to the vertical, the consolidation of the other walls of the church and the arrangement of the direct environment.

INTRODUCTION

The church of Ag. Kiriaki is located in the village Mavronoros, county of Grevena. Mavronoros is a small village with limited facilities, at a distance of approximately 15km from the capital of the county, Grevena. The church dates from the 16th century. Unfortunately, it has been neglected in the last decades. Therefore, its problems were seriously aggravated. A program of restoration works started in 1989 for its preservation. Ministry of Culture -11th Ephory of Byzantine Monuments was in charge of this project, which was supervised by the author of this paper.

DESCRIPTION OF THE MONUMENT

The church has a rectangular form and small dimensions, namely 8,00m long and 5,00m wide (fig. 1). Its height varies from 2,5m to 4,0m, depending on the inclination of the ground. The church was covered with a timber roof with two slopes and the roofing material was slate. The walls of the church are built of rubble stone and lime mortar. The masonry is strengthened with timber tie beams.

The entrance to the interior is a low opening on the western facade. The old wooden door has been preserved in good condition. The interior was initially lighted up with one window on the south wall and two small ones, like slots, on the east wall. Later, in the first half of this century, a second window was opened on the south wall. The floor of the church is at a lower level than the ground

around the monument. It was covered with stone slabs which have been preserved in good condition.



fig. 1 The church of Ag. Kiriaki in 1989 before the restoration works. Western facade.

All the walls of the interior and the western facade were covered with mural paintings. Those on the east and the west wall have been preserved in good condition, the ones on the south wall in a fairly good condition, while the mural paintings on the north wall have been destroyed almost completely. The other three facades of the monument are simple. Traces on the south wall show that once they were plastered.

THE CONDITION OF THE MONUMENT BEFORE THE RESTORATION WORKS

In 1989 an inspection was made during which the following defects were recorded:

- The east part of the south wall had collapsed at a length of approximately 4m (fig. 2). This part of the wall had collapsed once again in the past and had been rebuilt of stone and mud mortar.
- The rest of the south wall had strongly leaned outwards (fig. 3). This inclination measured 43cm, while the height of the wall was 400cm and the depth 75cm.



fig .2 South east corner.

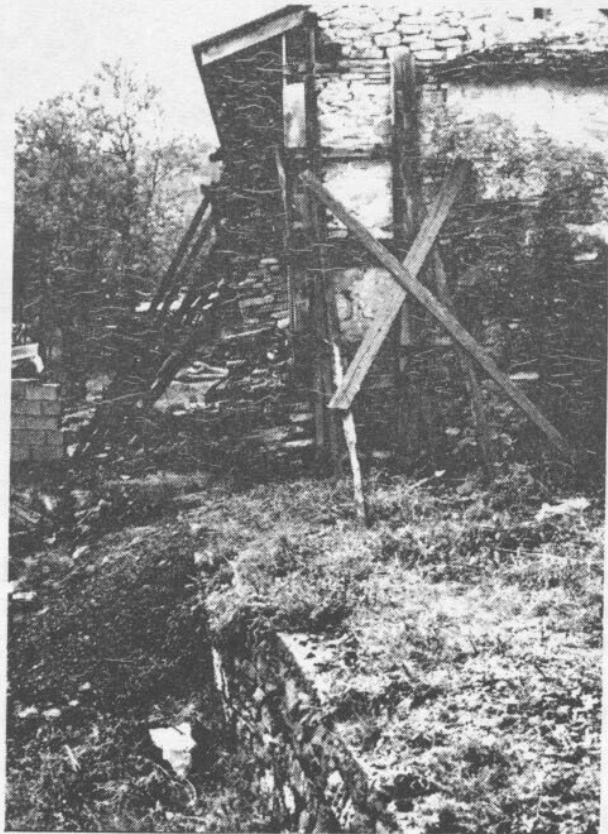


fig. 3 The outward leaning south wall

- The upper part of the north wall had leaned inwards in the middle by 15cm. It should be noted that both faces of this part were above the ground level.
- The internal face of the north wall formed a bulge in the middle of its lower part. The corresponding external face of this part was partly under the ground level.
- Serious cracks appeared on the three corners of the monument (the southeast corner had collapsed). Among them, those on the north and south wall were assessed as being in a critical condition (fig. 4).

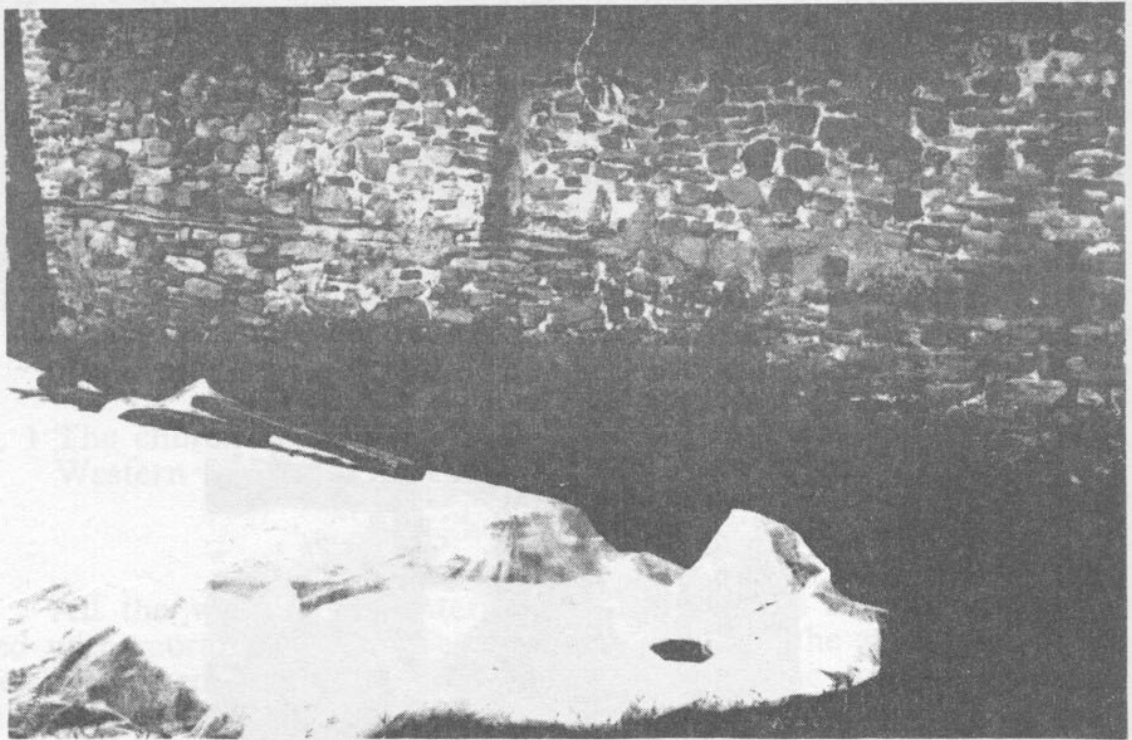


fig. 4 Northern facade. Destroyed tie beams, moisture and cracks are some of the problems.

- Timber tie beams were partly destroyed, especially at their joints.
- The mortar was in fair condition.
- Excessive moisture appeared on the lower parts of the north and east wall.

In addition to the above, the inspection of the direct environment also showed that:

- There were a number of trees at a small distance from the monument recently cut.
- There was strong inclination of the ground level.
- One of the villages roads passed by, at a distance of about 4m from the north wall.
- Finally, a telecommunication pole was located at a distance of 1m from the northeast corner of the monument.

RESULTS FROM THE ARCHIVES RESEARCH

A research was also undertaken into the archives of the 11th Ephory of Byzantine Monuments, so as the history and the problems of the monument to be further investigated. From this research, together with photographs dated from the same period (fig. 5), a fairly complete picture of the condition of the monument in the last two decades was obtained.



fig. 5 The south wall in 1981. The rebuild part of the east end can be distinguished, as well as the trees very close to the monument.

In 1968 the east part of the roof had already collapsed, while the east part of the south wall was ready to collapse (Tsioumi [1]). Indeed, ten years later the above part of the wall was found collapsed and at the same time the west part of the roof was about to.

The rest of the south wall had strongly inclined, while the other walls were in a better condition, although cracked and weathered (Vasilas [2]). In a report written in 1981, it was observed that the east and west wall were still in a sound condition. The inclination of the north and the south wall measured 15cm and 40cm respectively. These inclinations are attributed by the writer to the collapse of the roof, which pushed the two walls while it was falling. On the other hand, the collapsed part of the wall was attributed to the rainwaters which moistened it after the roof had collapsed. Among the proposals included in this report for the conservation of the monument, a reconstruction of the south wall as well as the inclined part of the north wall was proposed (Lembidas [3]).

In 1984, according to photographic records, some measures were taken aiming at slowing down the evolution of the defects, such as shoring and temporary roofing. During those works the remains of the roof were destroyed. No report was kept about the form and structure of the roof trusses and their traces and position on the top of the walls; therefore a future reconstruction of the roof may entail a number of imprecisions.

The above research showed that there was a very fast destruction of the monument in the last two decades and especially in the 1970s. Thus, among other reasons, abandonment and neglect were critical for its problems at that time. The measures taken in 1984 were proved to be very helpful because they stabilised to some extent the condition of the monument.

SITE INVESTIGATIONS

Both the information gathered from the archives and the site inspection showed that previous attempts to diagnose the problems were inadequate. Furthermore, no report had taken into account the fact that the collapsed part of the south wall had already collapsed in the past, at least once. Therefore, a program of further site investigations was set off concerning the form and the conditions of the foundations. Two sections were made on the ground, one on the south east corner and the other in the middle of the north wall (fig. 6). The position of these two sections was chosen, taking into account on the one hand the form, the position, the direction and the width of the cracks, the deformations and the destructions and on the other hand the characteristics of the direct environment (such as inclination of the ground level, high trees, etc.).

These sections revealed a number of useful features relevant to the problems of the monument. More specifically:

- The foundations were in a very short depth, namely 40cm lower than the floor of the church and as thick as the wall upon it. Moreover, at a distance of 1m onwards from the south wall, the level of the ground was lower than that where the foundation lay.

- The foundation of the collapsed part of the south wall lay partly on the ground and partly on a grave. Between the foundation and the grave there was a layer of soil, 30cm thick.

- At a distance of 1,5m from the south wall, the foundation of the south wall of an older building was found. The east wall of this building continued just under the east wall of the church. The above grave lay within the perimeter of this building. Further excavation showed that the surrounding area used to be a cemetery. Therefore, though the excavations have not yet been completed it is presumed that the older building was a church as well.



fig. 6 South east corner. The grave and the foundations of an older building.

Together with the research work on site and in the office, these inspections proved that the main reason for the collapse of the east part of the south wall was its foundation partly on the soil and partly on the grave. A further reason was the fact that the rest of this wall was founded on the ground, while the east wall on the foundation of an older building. This conclusion is supported by the fact that the collapsed part of the wall was the only one which had created serious problems in the past.

Therefore, the destruction process can be described as follows. The east part of the south wall had again collapsed in the past and was roughly rebuilt of stone and mud mortar. Consequently, the south part of the roof was seated on a wall which was partly built

of lime mortar and partly of mud mortar. Furthermore, the poor construction was founded in a different way than the other walls. These problems, together with the weathering of the timber elements of the roof, caused the collapse of its eastern part. It is possible that the movements of the roof up to its collapse pushed the north wall inwards and the south outwards. The whole condition was aggravated by the strong inclination of the ground and the trees around the monument. It should be noted that the two sections also revealed the roots of the trees under the foundations.

Furthermore, the bulging on the lower part of the north wall was mainly due to the ground damp, because the external face of this wall was partly buried and therefore absorbed a large amount of humidity. The whole condition of the monument was further aggravated by the aging of its materials and especially the timber tie beams, as well as its abandonment and neglect in the last decades.

RESTORATION WORKS

The restoration works dealt with the inclination of the north and south wall and the bulging of the north wall. In addition, they dealt with the destruction of the tie beams, the cracks, the weathered mortars and the arrangement of the direct environment of the monument.

The north wall had no stability problems and so it was restrained in the inclined position. On the contrary, the south wall was pulled back to vertical position and was held there, because of its serious stability problems, the form and history of its defects. The mural paintings were retained on this wall and were temporarily stabilized, so that no damage would be caused to them during the whole operation.

The pulling back (Macgregor [4]) concerned the full height of the wall, because its foundation was shallow and its leaning started from there to the top. In order to proceed to this work, its west end was disconnected from the west wall. The east end was already free because of its collapsed part, as described above. The window was temporarily blocked up with masonry of stones without mortar, while a hole was left so that the wire cable could pass through it.

The slabs of the floor were taken away across the internal face of the wall and a concrete foundation was inserted in short lengths under the existing foundation. At this stage this foundation reached half the width of the wall. A slot was left between the stone foundation and the concrete one, so that there was space for the wall to move towards its new position.

Both faces of the wall were fully covered with planks, which were connected together with timber beams. The two timber faces were also connected together, so as to form a non flexible structure, with the wall in it. Internally, a layer of spongy material

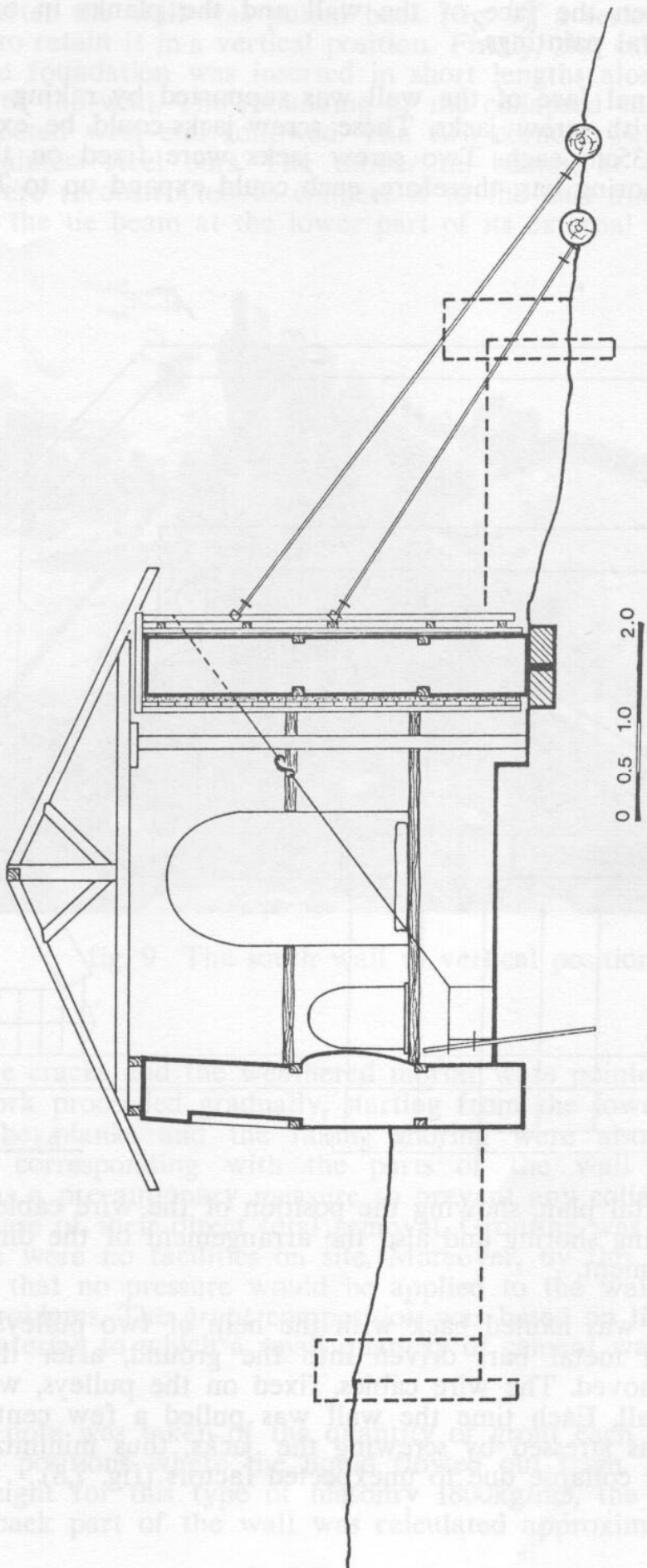


fig. 7 Section showing the south wall to the vertical, the concrete foundation, the shoring and the wire cables. The dotted line shows the arranged level and the retaining walls.

was put between the face of the wall and the planks in order to protect the mural paintings.

The external face of the wall was supported by raking shoring tightened up with screw jacks. These screw jacks could be expanded approximately 35cm each. Two screw jacks were fixed on the two ends of each shoring bar; therefore, each could expand up to 70cm.

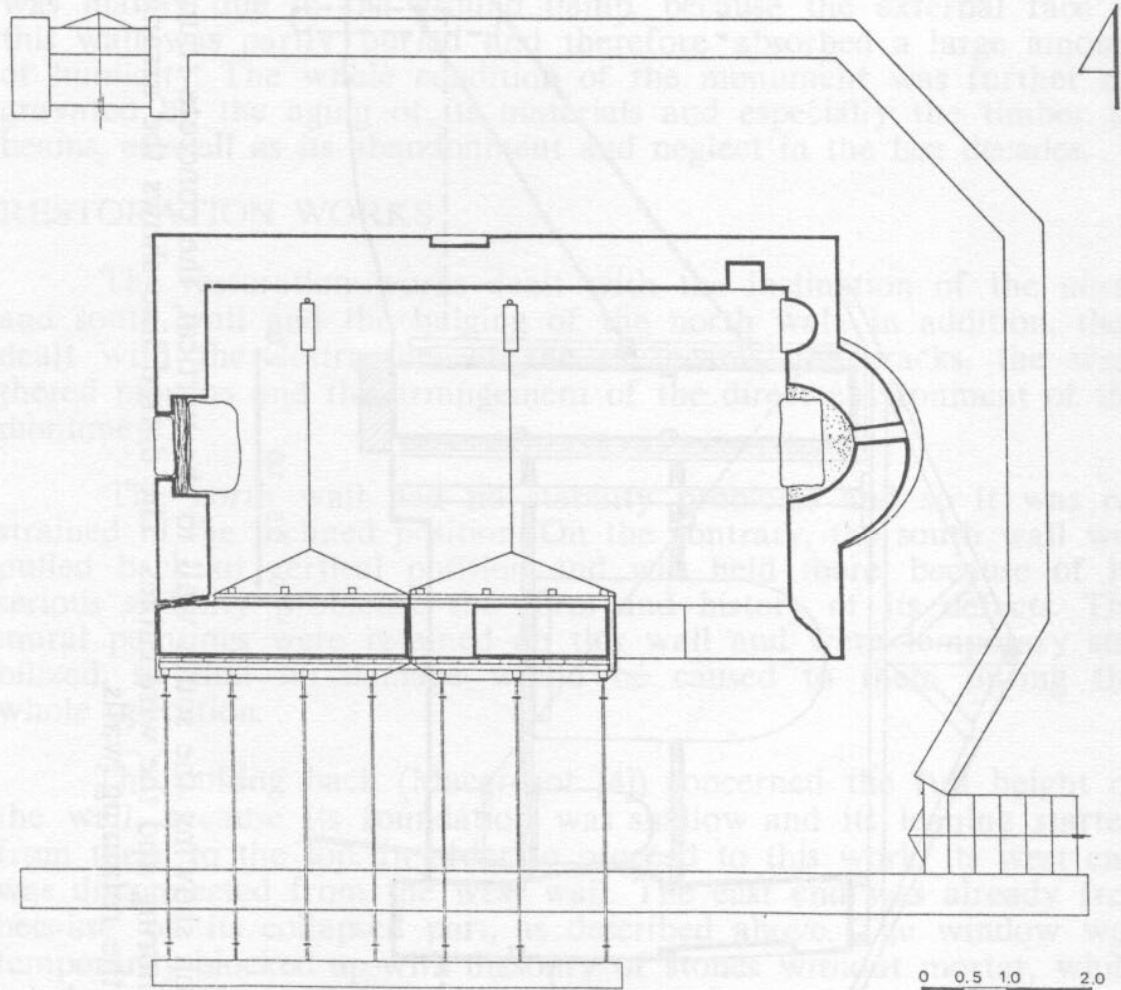


fig. 8 Horizontal plan, showing the position of the wire cables and the raking shoring and also the arrangement of the direct environment.

The wall was hauled back with the help of two pulleys, which were fixed on metal bars driven into the ground, after the floor slabs were removed. The wire cables, fixed on the pulleys, were embracing the wall. Each time the wall was pulled a few centimeters, the shoring was stressed by screwing the jacks, thus minimizing the possibilities for collapse due to unexpected factors (fig. 7,8).

After the wall was pulled back (fig. 9), a series of works followed to retain it in a vertical position. Firstly, the other half of the concrete foundation was inserted in short lengths along the external facade of the wall. The rebuilding of the collapsed east part and the disconnected west end followed. The two corners were strengthened with stainless steel bars. The timber tie beams, at the top of the wall, were reconstructed to connect it to the east and west wall, as well as the tie beam at the lower part of its external face.

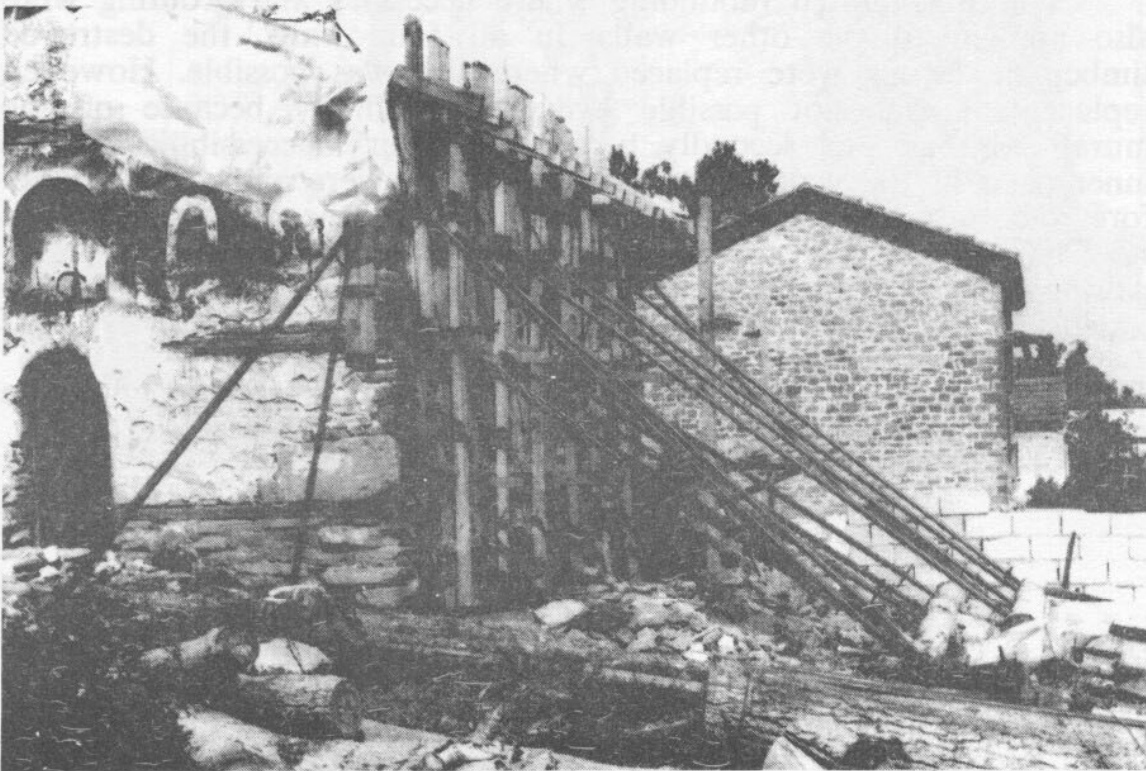


fig. 9 The south wall to vertical position.

The cracks and the weathered mortar were pointed and grouted. This work proceeded gradually, starting from the lower parts of the wall. The planks and the raking shoring were also gradually removed, corresponding with the parts of the wall to be repaired. This was a precautionary measure to prevent any collapse or damage in the case of their direct total removal. Grouting was made by hand as there were no facilities on site. Moreover, by this method it was secured that no pressure would be applied to the wall, which might cause problems. The grout composition was based on lime and pozzolonic material, to which a small quantity of cement was added (Penelis [5]).

A note was taken of the quantity of grout each point absorbed and the positions where the liquid flowed out from. Taking as specific weight for this type of masonry 1800kg/m^3 , the weight of the pulled back part of the wall was calculated approximately 22t. This

part absorbed 1.7t of grout, which is proportionate to the 7.8% of its weight.

The ground was lowered to the north in order to be kept approximately at the same level around the monument. A retaining wall was constructed by concrete around the three facades of the monument to support the soil. The top of these walls and their visible face were built of stone masonry (fig. 8).

Pointing, limited rebuilding where necessary and grouting were also applied to the other walls. In all four walls, the destroyed timber tie beams were replaced where this was possible. However, replacement was not possible everywhere, firstly because of the mural paintings and secondly because of their inaccessibility in the inner parts of the walls, where some of them were embedded. Therefore, the four corners of the walls were strengthened with stainless steel bars, positioned horizontally, at different heights. The above repairing works were applied to the north wall as well, and were assessed adequate for its consolidation (fig. 10,11).

The works have not yet been fully completed. It is planned to be continued and completed in summer 1991.

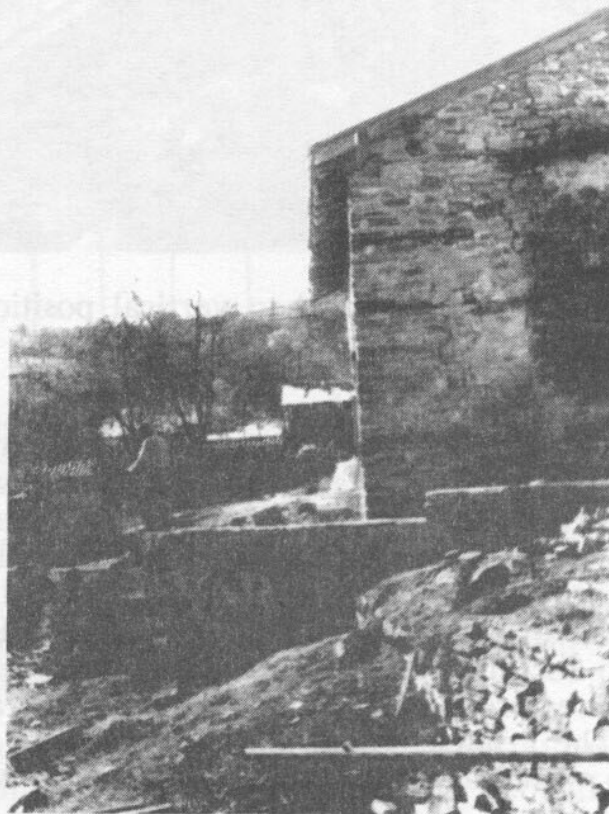


fig. 10 South east corner after the restoration works. A comparison to figure 3 shows the position of the south wall before and after the works.



fig. 11 The church after the restoration works.

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HISTORICAL NOTES

The historical notes presented in this section are taken from the book "El Puente de Rio Tinto" ("The Rio Tinto Pier") by the architect Gonzalez Vilchez [1]. This work is an extract from the same author's Doctoral Thesis (Gonzalez Vilchez, [2]) on the history of