

## DIAGNOSIS OF THE STATE OF THE OLD ALICANTE PROVINCIAL HOSPITAL, CURRENTLY HOUSING THE “MARQ” (ALICANTE ARCHAEOLOGICAL MUSEUM)

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### ABSTRACT

*This study deals with the old Alicante Provincial Hospital building, and aims to determine the systems and materials used in its construction, and their state of preservation. The reason behind this project was to identify the causes of damage found there prior to the intervention that converted it into the Alicante Archaeological Museum (MARQ).*

*To carry out the study, historical information on the building and copies of the original plans were gathered from the Alicante Municipal Archive, Provincial Council and the Institute of Architects. During field work, the building was visited both internally and externally and these visits were used to make graphic records of its current condition.*

*Samples were also taken of the different materials for analysis in the University of Alicante laboratories, using equipment in the Science Faculty and the Higher Polytechnic School. To be more exact, samples of the materials were prepared to undergo physical tests as per RILEM standards (calculation of real density RD And open porosity OP), X-ray diffraction analysis (hereafter XRD), thin sections (hereafter TS) for study in the petrographic microscope and preparations for study in the scanning electron microscope (SEM).*

*In accordance with the data obtained from the study, proposals were made concerning the preservation and repair options available concerning the different elements that formed part of the building and that were to be maintained in the proposed project or, where applicable, replaced.*

*The Museum was restored following the criteria described herein and is now one of Alicante's flagship buildings, where intervention has allowed an example of obsolete hospital architecture to be converted to a new use.*

### KEY WORDS

*preservation, materials, analysis*

### INTRODUCTION

Towards 1920, Alicante decided to replace the old Hospital, commissioning the well-known architect Juan Vidal Ramos to carry out the project in the Plá del Bon Repós. This was an ideal site, flat, free of industrial buildings and close to the pine forests on the northern slopes of Mount Benacantil. The first stone was laid on 4<sup>th</sup> November 1924, although Vidal did not complete the project until April 1926. Work started on 29<sup>th</sup> March 1927 and the hospital was finally opened on 7th January 1931. During the 70s, different improvements and repairs were carried out, among them the interior and roof of the chapel. The last intervention was in 1986 to repair all the roofs. The building was not used for some three years, until the start of the work that was to transform it into the Archaeological Museum.

The San Juan de Dios Hospital was designed to be a wholly independent building, something that has been respected even though later extensions to the plot and building along the streets at the end on the left-hand side have meant that the original concept has been lost. The Provincial Hospital and all its installations had a maximum capacity for 320 beds. The rectangular plot runs N-S and is perfectly defined by a perimeter wall consisting of base, stone buttresses and iron railings and which was built at the same time as the Hospital.

The main building consists of a body as the central axis with five symmetrical orthogonal wings projecting from each side. This is a very common solution nowadays, but was a very new idea in the health care world at that time, as hospitals normally consisted of separate buildings [1].

Different heights were used to emphasise the different bodies, of varying volumes according to their use or arrangement, something that allows the architecture to be easily understood and gives the building a clear and functional image. The main body and that of the religious community are built with two floors, as are the towers of the wings and the extremes of the central body, with the apse of the chapel rising above them. The wings have only one floor, although it is very high and thus achieves the right scale for such a large building.

The different uses are perfectly divided into zones, with the body acting as the axis housing Hospital management and administration and the bedrooms for those on night duty. Around the access portico we find a large foyer and the staircase, underlined by the great free height up to the skylight. We then find the specialised services: consulting rooms, radiology, laboratories, operating theatre, etc., which all open on to a series of inner patios. We finally come to the chapel and the areas for the religious community, the kitchens and laundry in a semi-basement and the conduits that run through the whole building.

The elevations are perfectly symmetrical, both with the front and rear facades and with the rhythmic nature of the sides. The wells have a notably vertical nature, underlined by the two-storey bodies that emphasise the height, highlighting the verticality with an appropriate treatment of the ledges and lintels.

The facade of the access was designed with two lateral towers to frame the central body and the access staircase. It is crowned by a prefabricated concrete handrail finished off with pinnacles and balls, as is the rest of the building. It is broken at the entrance to house an unrecognisable pediment with a small blue tiled tower containing a brightly coloured ceramic statue of Saint John. This historical decoration and the traditional language of other elements, such as the neogothical chapel, do not obscure a building that is composed in a clearly rationalist manner [2]. Seen as a whole, it is a typical example of the eclectic architecture of the period that its author Juan Vidal handled so well.

Structurally, it is a step backwards when compared with Juan Vidal's other work, as it uses load-bearing walls and metal beams – something justified by the limited number of stories and for cost reasons. The abundant use of prefabricated concrete elements and hardly any masonry is also to reduce costs but, overall, it is very well executed and was very carefully built, although two important elements are lacking: the expansion joints and the perimeter reinforcement elements that are vital for such a long building.

The old Provincial Hospital is located on land making up the Plá del Bon Repós, which had only a few low buildings when it was built and which is now the busy Plá neighbourhood. Geologically speaking, the site is a calcareous crust - the fossil remains of a significant sedimented glaciais made up of silts and sands located above the current riverbeds. Geological maps refer to it as a Q2 K unit and gauge the maximum thickness of the crust to be one metre, although it varies abruptly from one point to another.

The vertical structure consists of 45 cm. thick perimeter and vertical load-bearing walls, built from mixed San Julian sandstone masonry bound with lime mortar, stretches of perforated brickwork as small pillars embedded for main beam supports, well jambs and the termination of the wall perimeter as a cornice. Both types are perfectly connected with toothed stones. The well lintels consist of very superficial double metal profiles, meaning that the external cladding has had to be repaired on numerous occasions. The material used for the masonry was different to that used for the foundation work, as the stone from the San Julian mountains is an easily-worked biocalcarenite that allows for more regularly-shaped stones, approximately 15x15x25, that are well consolidated with lime mortar.

## EXPERIMENTAL PROCEDURE AND RESULTS

The same techniques as above were used to determine their composition and the samples were compared with others from the quarry. They are basically calcite with high dolomite content and traces of quartz. The TSs clearly show that the material is a fossiliferous limestone with abundant foraminiferals, fragments of bryozoa, molluscs, etc. The physical tests gave an RD of 2.66% and an OP of 17.3%, similar to the values obtained in previous studies of this stone [3], that show high porosity that allows water to enter it. However, in this case it is clad and thus the porosity has no effect on its behaviour.

The external base has an average height of 150 centimetres and consists of false bush-hammered Campello limestone ashlar 20 centimetres wide, 30 centimetres high and a length that varies between 30 centimetres and 100 centimetres, almost being a very thick external plate, a building technique that was very common at the time. The ashlar also vary greatly in their appearance and most of them are in good condition, although some show displacement, loss of material and arenization. This is due to the fact that the stones were not chosen carefully and we found a mixture of very crystalline limestones, marls with high clay content and even calcareous conglomerates [4].

Obviously, one of the most frequent causes of damage to the buildings is the presence of dampness due to water's ability to dissolve and transport salts because of the hydration it produces in certain minerals and because of its action as a catalyser in certain chemical reactions.

We tried to identify the degree of humidity of the whole perimeter of the building in order to locate the points with a high concentration of water, as well as its precedence. To this end, as well as ocular inspection, the "Protimeter" humidity meter was used at 107 points of the surface of the perimeter of the building, with two measurements taken at each point, at 20 cm. and 150 cm. from ground level respectively. Measurements were also taken using probes to test the interior of the walls, as surface evaporation substantially modifies the percentage of water in them with osmosis or capillary rise, whilst if the interior is dry, then the cause is condensation.

By observing the terrain and the setting, we were able to deduce that the presence of water coincides with rainfall, as we have already mentioned that the calcareous crust of the terrain is impermeable and does not retain humidity. The fact that the site is paved reinforces this impermeability, meaning that humidity arises due to rainwater gathering in puddles on the surface, both rain that falls directly on the surface and that coming from the drainpipes that pour out on to it. The inexistence of drainage channels and sack-shape of the building aggravate the problem. The terrain slopes towards the Eastern side and causes runoff that affects the walls in its way. This accounts for the higher humidity in the Westerly-oriented facings that slows water down.

Due to these facts, we were able to deduce that the humidity was temporary and punctual, although it continued even in the summer as the fabric of the wall is very permeable and there is a more impermeable stone base, meaning that water is retained inside and evaporates above the base. XRD was used to analyse samples of the blocks and others from the Campello quarry to determine whether the latter was the source of the material. This was in fact shown to be true, although the samples of the masonry are richer in quartz, probably because the best quality material was chosen or because of the highly heterogeneous nature of the rock formation. Observation of the TSs in the petrographic microscope allowed us to determine that both stones are undoubtedly sandy fossiliferous limestones, known as biomicrite according to Folk. Physical tests showed an RD of 2.57% and an OP of 5.46%, higher than the foundation materials but always with a low value for this type of rock.

The above-mentioned ultrasound equipment was used, following the method described by Facaoaru & Lugnani in 1993. When interpreting the data we bore in mind the fact that the higher values of said speed indicate a higher density and compactness of the material, while the lower values indicate a higher degree of porosity or discontinuities such as pass-through cracks [5].

The values obtained should be compared with other known values such as the 5,000 m/second for marbles and the 3,000 m/sec for sandstones and limestones. With loose stones, we obtained an average of 4,800 m/sec, allowing us to classify the material as highly compact limestone.

Significantly lower values of approximately 1,900 m/second were obtained for the masonry base, which was to be expected as it is lined with masonry and mortar joints are also present. In the stuccoed area 1.5 metres from ground level, highly variable values of between 707 and 3,135 m/second were obtained, this being an interval that shows the highly heterogeneous nature of the source. In the areas of masonry, the figure oscillated around 1,500 m/second, very much lower than that of the loose stones. The square section brick pilasters gave a figure of 1,843 m/second, quite a high figure for ceramic material.

Very low values were obtained in areas with cracks, between 300 m/second and 540 m/second. We observed that the crack in the chapel is almost pass-through as it reached 308 m/second compared with the uncracked neighbouring area.

The pointing mortar was made from dry crushed stone, very probably from remains of the stone from the terrain, as XRD analysis gave us an almost identical composition. The binding material was non-hydraulic lime, as there are no remains of the bicalcium and tricalcium silicates that are typical of Portland cements. However, a lot of repair work has been done with this type of cement and this should be avoided in any pointing work that may be necessary as, apart from the colour change, they add alkalis that can lead to salts that alter the stones [6].

One of the most interesting aspects of this building with respect to materials was the profuse use of prefabricated concrete elements, both reinforced and unreinforced, for many items on the facades. They are to be found on handrails, pinnacles with balls, cornices, parapets, small pillars and other decorative items.

Although these parts began to be manufactured industrially in 1905, they were not used very much in Spain, and were very probably moulded on-site, as it also appears that the moulds were preserved until very recently and had been used to manufacture replacement parts. They were made with a concrete base, a layer of dry cement to improve their consistency and avoid the bars inserted later from sinking in too far, and were finished off with another layer of concrete.

The parts were grey, as white cements were not yet in use and a mortar rather than concrete was used – as the dry material is very fine beach-type – then reinforcing them with 5 mm. bars. Given that the thickness of the parts varies between 3 cm and 10 cm, the coating of the reinforcement is almost always sufficient.

Values for RD = and OP = 20.81% were obtained, indicating that the material is fairly spongy and allows easy access to water, probably because of poor granulometry. The XRD analysis showed that the binding material is a Portland cement, as we found remains of silica anhydrides and aluminates, probably because they were not ground very conscientiously and the nuclei were not hydrated. The sand used is round and very fine, below 1 mm, and obviously came from a beach as it contains aragonite from small shell fragments (magnesian limestone).

Phenolphthalein was applied at different depths to identify the degree of carbonatation. This allowed us to see that the paints applied to the parts offered a high degree of protection, as portlandite is found after sanding hardly a few tenths of a millimetre from the surface, meaning that the carbonatation is very superficial. The deeper colouring near the reinforcements is possibly due to a layer of dry cement applied before fitting them, thus giving them greater protection.

Component part alterations were localised in the roof elements and the small window pillars. The former was due to paint loss due to greater exposure to the sun and rain, with the water thus penetrating the porous mortar and causing corrosion of the reinforcements.

With the small pillars, the cause was to be found in the fact that they are extremely thin and vertical and fastenings were used to avoid them turning. The chosen, almost certainly improvised, solution was to cut the parts slightly to embed a fastening that was later covered with mortar, although plaster was also applied in order to secure them. This led to the corrosion of the fastenings and the resulting expansion has broken off the mortar covering them. The remaining elements of the lower parts are still in perfect condition.

The fastening points of the pillars could be repaired by removing as much plaster as possible, applying a corrosion inhibitor, such as Ibofer or similar, to the reinforcements and a special high alkalinity mortar with high adhesive properties for patching [7].

This building had cracks and fissures over almost all its facades, these being located in the upper areas where the wall meets the roof. The elements most suffering from damage were the semi-circular bodies and the areas where the eaves contact their highest rectangular elements.

All the semi-circular bodies had almost vertical cracks, the number and thickness of which increased as they approached the join with the next element. In turn, in all the wings of the building, where they join the above-mentioned highest rectangular element, there were oblique cracks 45° to the horizontal and in the direction of the raised element. This latter part also had small pass-through cracks over the whole wall, parallel to those already mentioned running along the first floor of the building. The roof has to withstand high temperatures due to the sun and these are also transmitted to the metal structure. Said temperatures lead to major lengthwise expansions of the ties and in the same direction and, as each body has a specific tie-beam direction, there are perpendicular movements between them that caused the cracks and fissures.

The geometry of the semi-circular bodies means that the movements caused by pushing due to expansion of the structure led to numerous cracks that also underline the lack of cornice.

The 45° cracks appearing in the highest elements of the eaves were a result of turning caused by the forward stresses transmitted by the larger body to the damaged element. Any possible problems with the foundations were not found.

In conclusion, we can state that the cracks and fissures were caused by heat expansion of the structure bearing the roof.

The cracks should be sealed by the injection of epoxy resins hidden beneath lime mortar, bearing in mind that they must be protected against ultraviolet rays.

## FINAL REMARKS

The building designed for the Alicante Provincial Hospital by Juan Vidal and finished in 1930, has generally maintained its good condition.

Its transformation into an Archaeological Museum is a highly important project that, without altering the external image of the building, has led to major modifications to its structure and internal arrangement. We should highlight the creation of basements under the wings and the complete refurbishment of the roof.

The above study led us to recommend that the following actions should be taken: The characteristics of the terrain and the type of foundations meant that excavation of the basements was a very delicate operation, as it meant cutting through the supporting rock at several points. We thus advised that deeper test borings be made, as well as test drilling around the perimeter, in order to identify the type of ground at the supporting level of the new structure. For the horizontal structure we merely suggested the creation of a cornice around the perimeter, which was considerably altered in the project.

With respect to the perimeter walls, which act as both load elements and to close off the facade, we proposed preserving them by carrying out a series of specific actions such as sealing cracks with different types of mortar, according to their thickness; replacing the seriously damaged ashlars, consolidating those that were only superficially damaged, and using fungicides and herbicides in areas colonised by lichens.

The cladding mortar was to be chipped away to a height of one metre above the base and replaced with a porogenous renovation mortar to eliminate the humidity, after application of an efflorescence inhibitor. A breathable paint was used for the finish.

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**Figure 1** - Overall view of the Hospital buildings at the time they were completed



Figure 2 - Side view with the highest aspect of the building

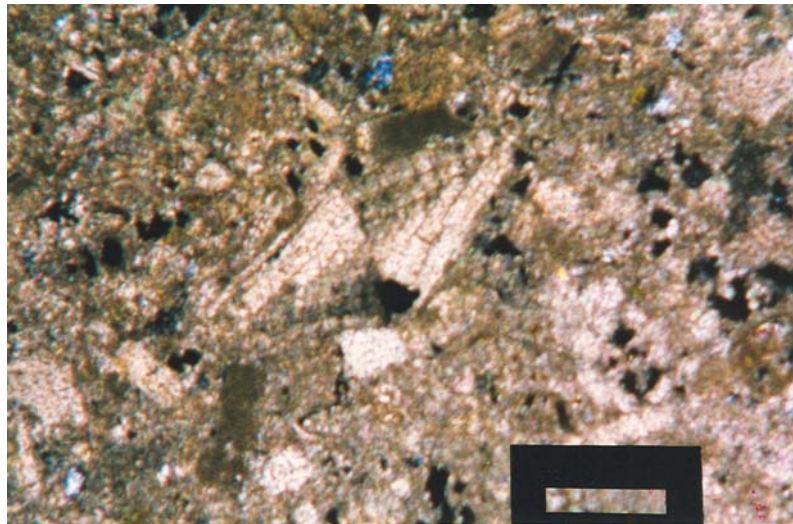


Figure 3

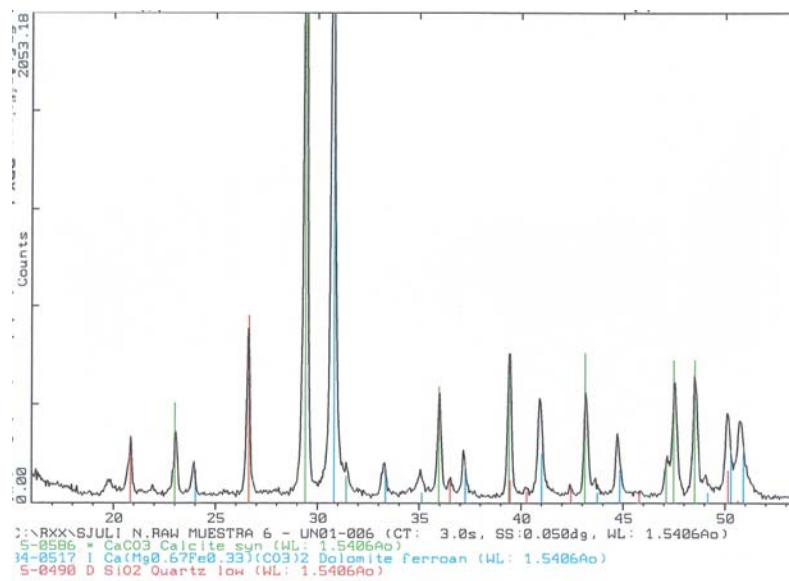


Figure 4