

## STRUCTURAL PROBLEMS OF THE REFECTORY OF S. MARIA DELLE GRAZIE IN MILAN

*Marginal Notes on the 'Last Supper' of Leonardo da Vinci*

By *Gisberto Martelli*

Alarming notices which have recently appeared, more or less to the point, in the press of the whole world about alleged damage to the masterpiece of Leonardo da Vinci demand some precision which will serve to bring the argument within its real limits: that is, to affirm that dangers exist but that the situation is under control. The time has come to recognize that alongside the problems which directly concern the conservation of the famous painting, regarded as a painted plaster surface—problems which everyone knows and which consist of defence against pollution from the atmosphere, from dust and from sudden changes of temperature and humidity as the necessary preliminary to the cleaning of the surface, to the fixing of the colour, to the complete recovery of the surviving handiwork of Leonardo, and so on—there exist in addition many sources of anxiety, not less serious, which have their basis in a dramatic situation, until now for a great part hidden, in the structural conditions of the whole wall structure of the Refectory.

It is not only a question of the simple, natural state of decay due to the five hundred years that the structures have existed, with consequential physical decline in stability; for these causes of old age are additional to other and more complex negative factors, the punctilious re-examination of which since the closing months of 1978<sup>1</sup> allowed me to outline with sufficient accuracy some of the actual dangers and to foresee the necessary remedies even though only as indications.

The long hall of the Refectory, in plan having the proportion 1 : 4, is covered by a barrel vault with lunettes, the two ends being umbrella-shaped—an echo of the apsidal terminations on an octagonal base proper to the architecture of Gothic churches—and is oriented north-south; on the short southern wall Donato Montorfano painted in fresco in 1495 the great 'Crucifixion'; on the corresponding wall to the north between 1495 and 1497 Leonardo painted in tempera the famous 'Last Supper'. On the two long walls were found the openings for light corresponding to the lunettes, which according to the original composition were wisely planned from a lofty entablature painted by the same Montorfano within the general guide lines of a supervision which is recognized as that of Donato Bramante; with successive modifications of the western lights, which appear to have been desired by Leonardo himself.

The wall of the 'Supper' is by far the least favoured; the exposure to the north makes its surface the coldest of the whole envelope of the space, so that the moisture in the atmosphere has

continued throughout the centuries to condense on the painting executed in tempera; but a further most serious defect of the same wall has been discovered only in the past months when— by reason of more careful measurements and local checking— it has been possible to establish the exact thickness as being barely 46

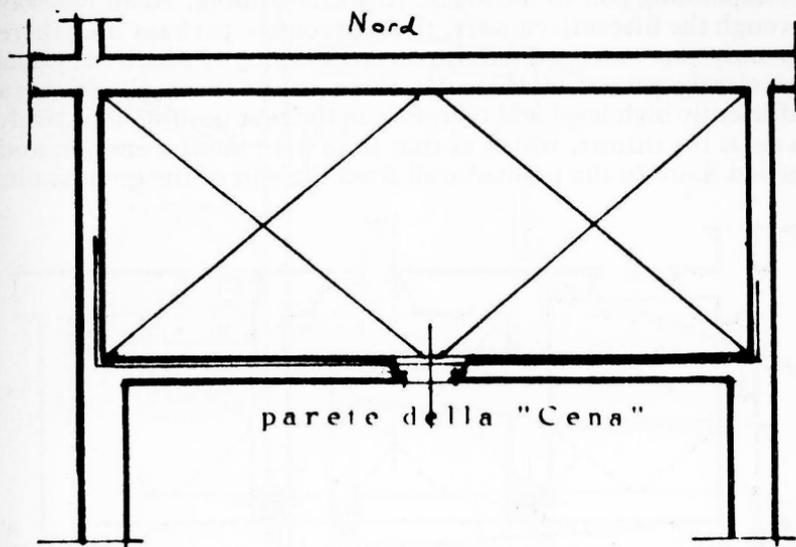


Fig. 1: Room behind the "Last Supper" showing original vaulting. (15th century)

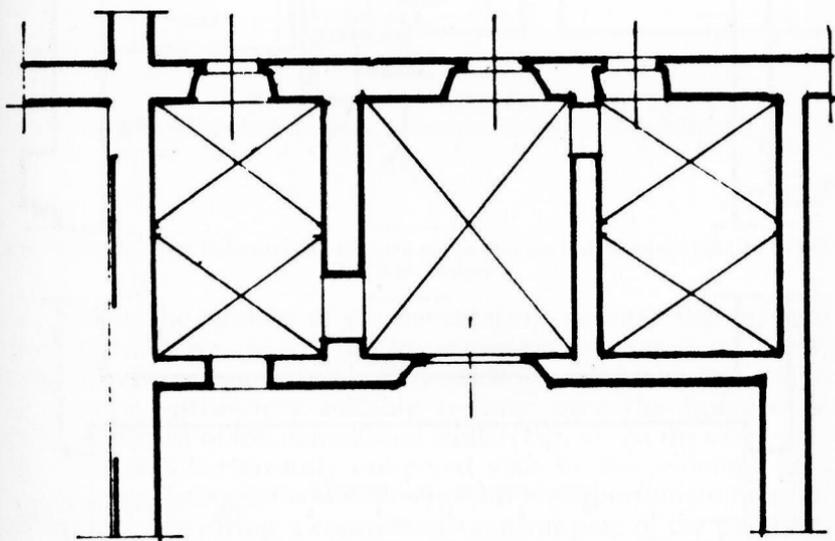


Fig. 2: Room behind the "Last Supper" showing vaulting as altered in the 17th century.

centimetres, against 70–75 centimetres for the other walls of the perimeter.

The painted wall has suffered the effects of a series of grave tamperings increasingly affecting the two small rooms to the north superimposed one on the other and analogous to the corresponding pair to the south. At the beginning, about halfway through the fifteenth century, the rear room – perhaps then there was only one – was covered by two cross vaults, of which the joints are clearly preserved (Fig. 1); these vaults were placed at a sufficiently high level and therefore in the best position effectively to resist the thrusts, which at that time were modest enough and carried down to the painted wall from the end of the great vault.

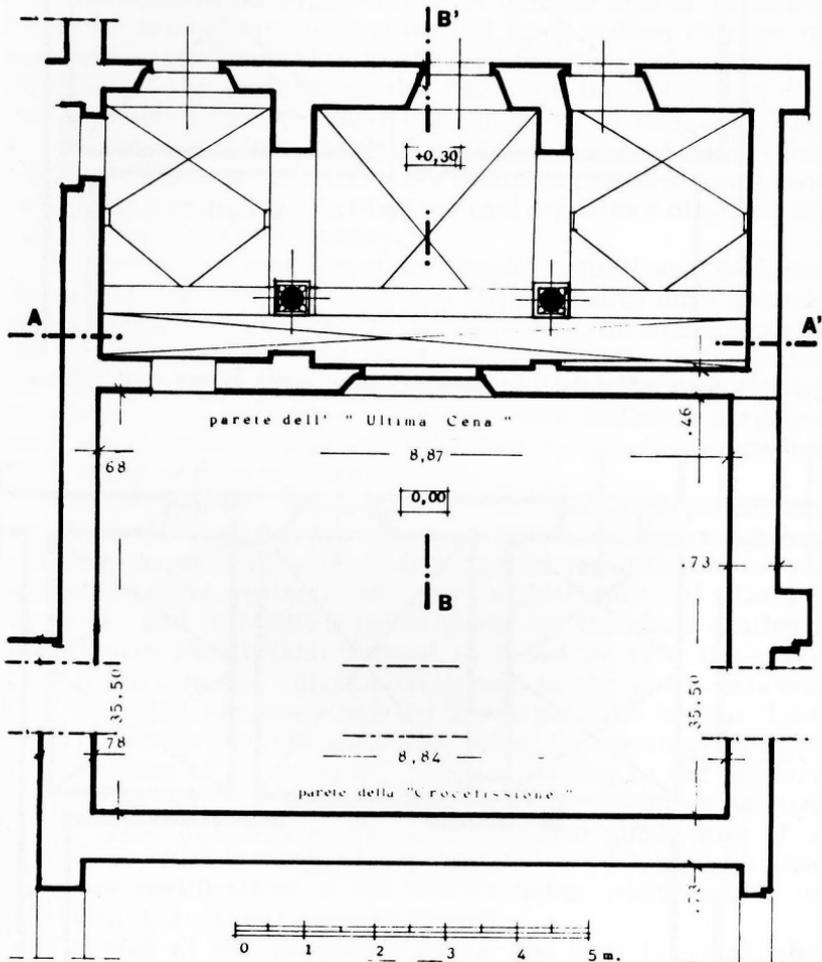


Fig. 3: Refectory plan showing partial destruction of vaulting behind the "Last Supper". (1924–25)

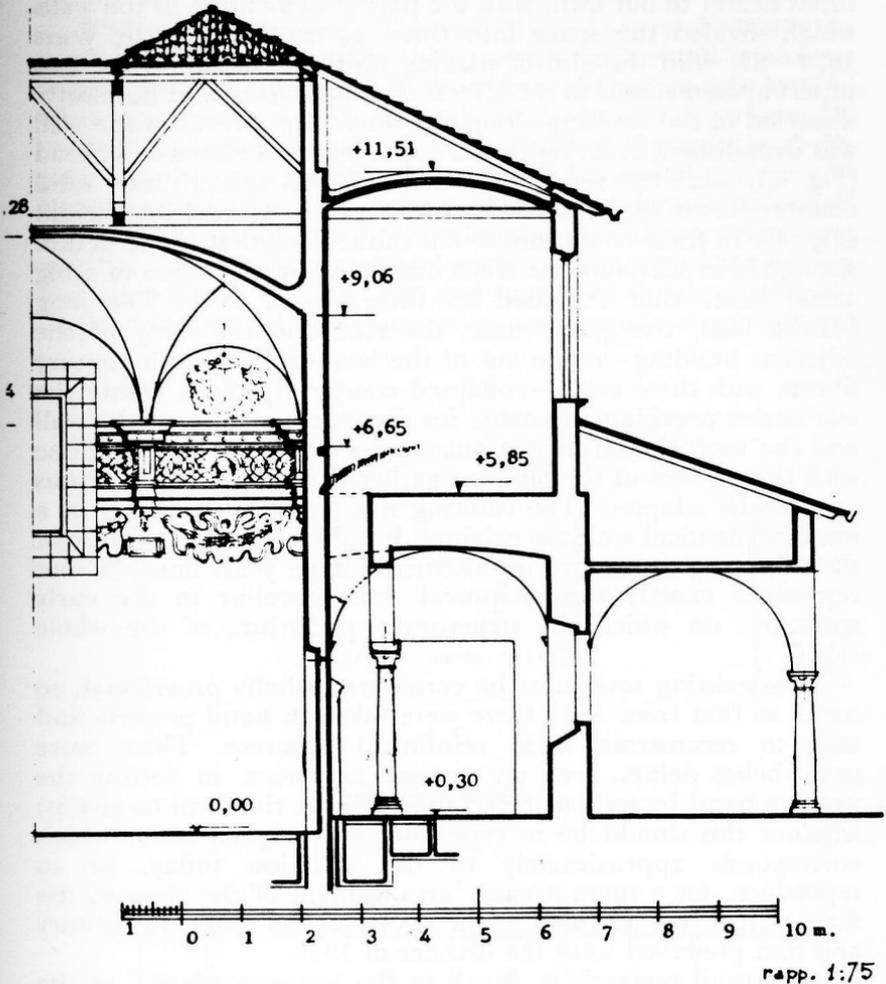


Fig. 4: North end of Refectory and adjacent rooms showing lack of support for the wall of the "Last Supper".

About the middle of the seventeenth century this original arrangement was upset: the two cross vaults were demolished, and there were constructed other vaults placed lower, but still in a position sufficiently suitable to take over the function of counter-thrust of the demolished vaults (Fig. 2). At the same time the wall was barbarously tampered with by the widening of a small pre-existing central doorway with a proportionate increase in height, destroying a conspicuous central part of the painting; another doorway towards the west was made near by, perhaps in the same years. The new vaults underwent ruinous treatment in

times nearer to our own, with the partial demolition of the walls which divided the space into three parts; then, in the years 1924—25, with the aim of making uniform the air in the two superimposed rooms to the effects of temperature and humidity, a section of the vaulting along the whole support on to the wall was demolished, creating thus a gap about 70 centimetres broad (Fig. 3); with the result that the wall was left without valid counter thrust throughout the whole of its considerable height (Fig. 4). In these conditions it was miraculous that the structure succeeded in surviving the tremendous test of the effects of a big aerial bomb that exploded on 16th August 1943. The long eastern wall, the great vault, the roof and the body of the adjacent building—made out of the beautiful fifteenth century library with three aisles—collapsed completely. Even before the war ended provision was made for the reconstruction of the wall and the roof; the latter was put together as could best be done with the timbers of the old roof gathered from among the ruins and hastily adapted. The vaulting was reconstructed later in a manner identical with the original: but the body of the fabric of the adjoining monastery reconstructed some years later did not reproduce exactly the reciprocal links peculiar to the early structure, on which the structural equilibrium of the whole relied.

The existing roof must be considered wholly provisional, so much so that from 1947 there were taken in hand projects and tests to reconstruct it in reinforced concrete. There were nevertheless delays, even up to these last years, in putting the work in hand by serious uncertainties about the form to give it; whether this should be to reproduce the original state, which corresponds approximately to the situation today, or to reproduce, for a more organic arrangement of the cloister, the form that it had assumed in the course of the sixteenth century and had preserved until the disaster of 1943.

A careful research in depth in the 'correspondence' of the Inspectorate of Monuments from 1891 to our days has allowed me to run over the vicissitudes of the monument in the past ninety years; and to give ample scientific justification to the substantial work of restoration carried out in the Refectory by Luca Beltrami in the last ten years of the past century.<sup>2</sup>

This research has had further and very important consequences since, by collating the notices collected, it has been possible to give an explanation of a state of affairs which has been widespread and concealed in the structural disorder, an explanation already summarily made public at the end of 1978, and finally developed and fully set out in these last days, though still always in an approximate manner.<sup>3</sup>

Under the main headings the state of the structures in danger

may be described as follows:

**Wall of the 'Supper':** The web of cracks very obvious in its north face shows, alongside things which can remind one of an adjustment now completed to the effects of the war-time attack, other phenomena which are without doubt still in process. A horizontal section of the wall at the level of the corbels of the great vault—with two different scales for horizontal and vertical measurements (Fig. 5)—shows evidence of deformations which are of the order of about 7 centimetres, exactly corresponding with the two corbels: the vertical section agrees, signifying equally and more clearly the direction and sources of the thrust (Fig. 6). The curvatures of the two faces of the wall fortunately correspond

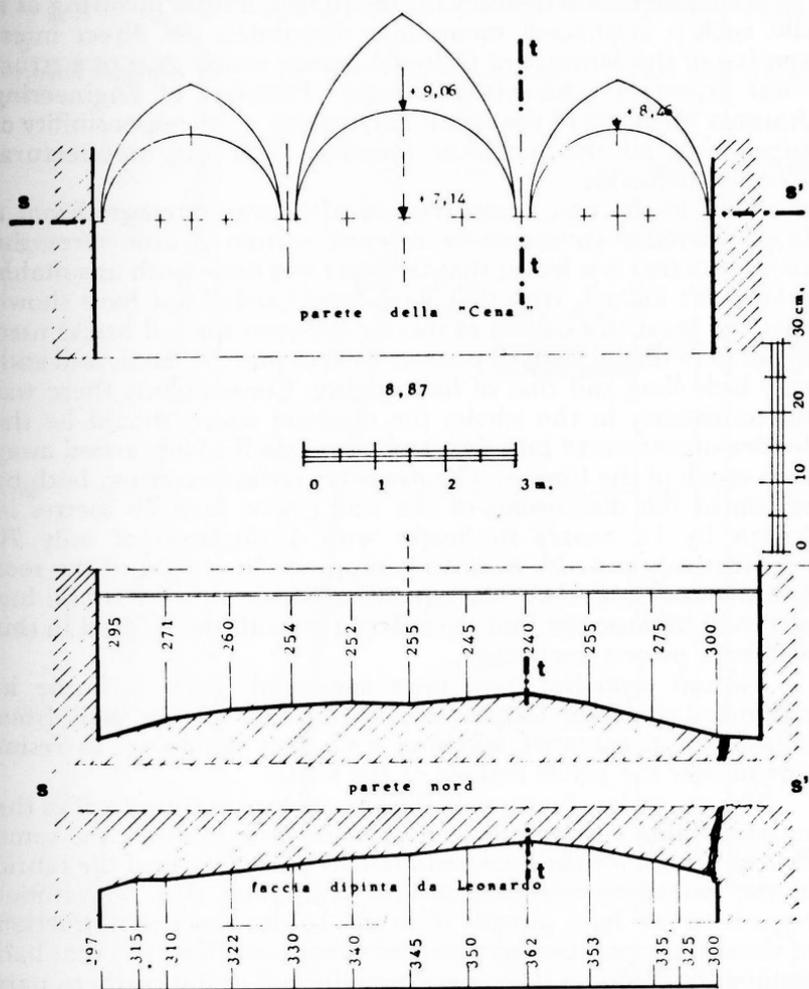


Fig. 5: Horizontal section of the wall of the "Last Supper" showing deformations.

sufficiently, excluding the possibility that empty spaces between the bricks were produced internally; but it is beyond doubt that to the tensions of the north face which cause the cracks there correspond in the south face compressions which could also compromise the stability of the painted plaster, leading to bulging and local collapse.

When in June 1980 it came about that one of the small glass 'tell-tales' placed astride a crack broke, it appeared very clearly that we were confronted by a warning of progressive deformations; it was then decided to put in hand with all urgency a special metallic structure designed by the Chief Architect of the Fabric of Milan Cathedral, Engineer Carlo Ferrari da Passano.<sup>4</sup>

The exceptional delicacy of the whole question involving as it did such a celebrated monument demanded the direct intervention of the Ministry of Cultural Assets, which gave to a structural expert of acknowledged fame—Professor of Engineering Antonio Migliacci of the Milan Polytechnic—the responsibility of supervising all the technical measures that the architectural complex demands.

**Wall to the east reconstructed after war damage:** From a brief reference contained in a letter written a little after the reconstruction it is learnt that the work was done 'with unsuitable materials': indeed, tests that have been carried out have shown that the great thicknesses of mortar between the old bricks used again were made of sifted plaster, used in place of sand, and with very little lime and that of bad quality. Consequently there was no consistency in the whole; the material which should be the binder turns instead into dust and allows itself to be carried away by a touch of the fingers. The discovery is disconcerting, both by reason of the dimensions of the wall (more than 36 metres in length by 11 metres in height with a thickness of only 70 centimetres), and also because it supports the weight of the roof and the vault with their corresponding thrust on solid bricks; but above all because the four tie-rods of the vault should find in this walling a proper anchorage.

Various remedies have been suggested, from a frame in reinforced concrete lodged in the thickness of the wall from outside to an extensive stitching with steel clamps set in resins spread over the whole surface of the wall.

The exceptional nature of the circumstances fully justifies the reconstruction carried out in a hasty manner in 1943; the same cannot be said for the reconstruction of several parts of the fabric of the monastery executed several years later (Fig. 7) without regard—as we have already noticed—to the exact reproduction of those reciprocal ties between the structures; those ties that had assured for centuries the general equilibrium of the northern part of the Refectory.

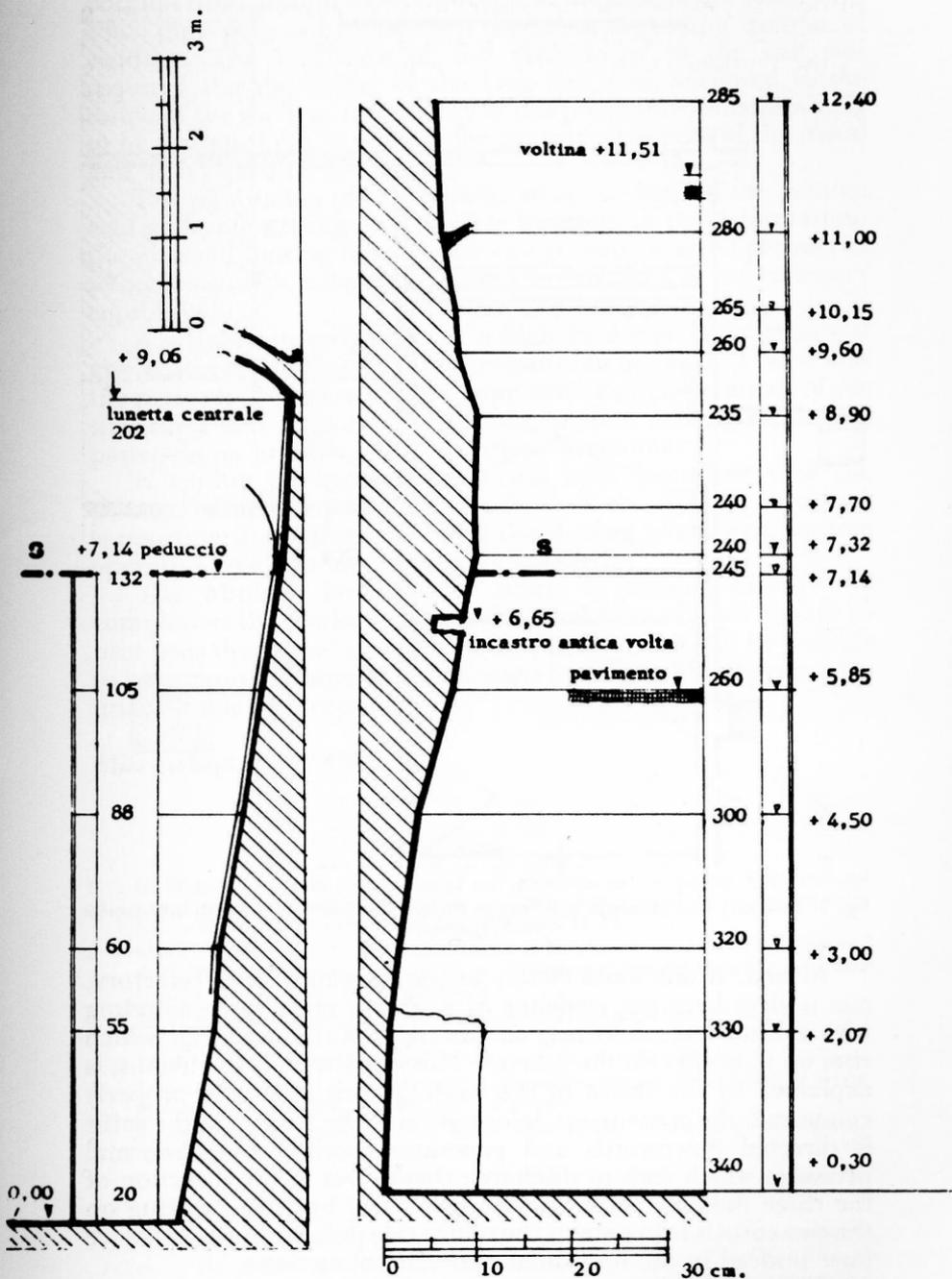


Fig. 6: Vertical section of the wall of the "Last Supper" showing deformations.

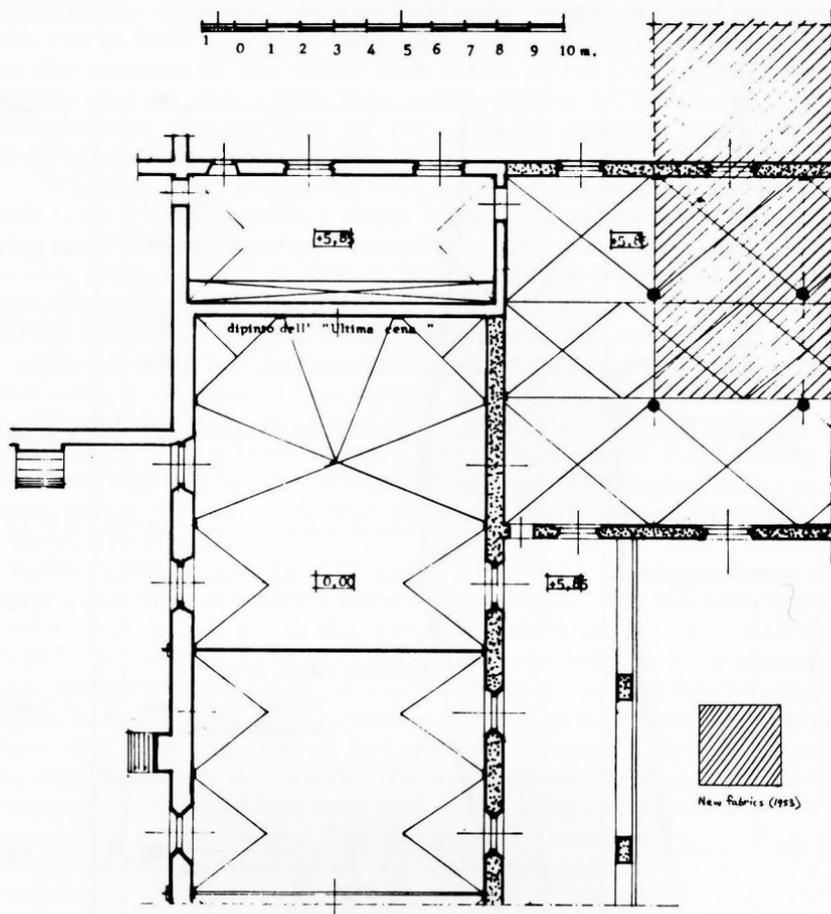


Fig. 7: Refectory and monastic buildings to the east (ancient library) with new fabrics (1953) hatched.

Indeed, if one looks closely at the interior of the Refectory, one notices here the evidence of a serious crack corresponding with the north-east corner, to the right of the painting, which rises up to border on the lunette. This impairment, so obvious, is explained by the thrust of the vault, at this point not properly countered; the consequent deformation of the surface of the soffit is directed downwards and generates considerable abnormal pressures which seek to discharge themselves in the direction of the three lunettes above the 'Supper', and by concentrating on the two corbels bring about the noticeable deformations which we have noticed in the horizontal and vertical sections.

**Tie-rods of the vault:** There are four, made of iron with a rectangular section 5 x 3 centimetres, and they were placed in

position from around 1480; however, at the time of the collapse in 1943 they were subjected to a severe strain to the margin of yielding. The severance of the attachment to the east has required the shortening of the long ties, now anchored to the inside of the walling; the validity of this procedure remains wholly to be proved, both as regards the present properties of the metal and as regards the anchorage.

The positioning of the metallic structure behind the painted wall guarantees us against possible increases in the deformation: the external shoring towards the east recently erected permits us to confront with a degree of calm the problems of the necessary consolidations.

A series of investigations at a high level now in progress will give the exact direction for the measures to be taken: I hope that the pessimistic picture derived from summary observations of the structures and from the punctilious, patient reading of the old papers in an archive will be somehow overcome.

It cannot be known what could have happened with the passage of time: but the relief felt when the metallic structure supporting the painted wall and the shoring to the east became operative seems to me thoroughly justified!

The Ministry for Cultural Assets is pledged to carry to completion the works necessary for a solution of both groups of problems that have been singled out, as soon as it will be possible to plan a programme of action, step by step, with allowance for unavoidable interruptions.

Milan, September 1980

#### Notes

1. G. Martelli, *Ricerche e precisazioni sull' ambiente del "Cenacolo Vinciano" nel complesso monumentale milanese di S. Maria delle Grazie*, in "Notiziario della Banca Popolare di Sondrio", no. 18 (1978), pp. 31-49.
2. Idem, *Il Refettorio di S. Maria delle Grazie in Milano e il restauro di Luca Beltrami dell' ultimo decennio dell' Ottocento*, in "Bollettino d'Arte del Ministero per i Beni Culturali", (NS) 1980, no. 8, pp. 55-72.
3. Idem, *Il Refettorio di S. Maria delle Grazie—Vicende degli ultimi novanta anni con particolare riguardo alla individuazione dei dissesti statici*, in "Atti del Convegno I.S.A.L. 1980 (Milano-Varenna)", in the press, in "Arte Lombarda".
4. L. Constanza-Fattori, *Il Refettorio di S. Maria delle Grazie. Rimedi studiati per far fronte ai dissesti statici*, in "Atti, etc." as above.
5. A. Migliacci, *Il Refettorio di S. Maria delle Grazie. Opere di consolidamento statico—1st part*, in "Atti, etc." as above.

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