

The towers of San Gimignano. Architectural diagnostic for knowledge and conservation

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1. The research methodology

As part of the RISEM project (Seismic Risk in Monumental Buildings), funded by the Regione Toscana, a study is being done on the vulnerability of the San Gimignano towers¹. It addresses the problem in several ways, from geological and geotechnical aspects, to architectural and structural modelling.

The subject of the direct investigation and the survey of the towers presented rather complex operational problems, due to the fragmentation of ownerships that usually characterises them and the difficulties of connecting the different parts of each tower. It is probably due to these problems that, despite the interest aroused by these structures, there is no existing reliable survey of the consistency of the towers.

Two complementary survey methods were designed. The interior rooms had to be surveyed using traditional manual techniques, while the exterior shape using advanced tools such as a laser scanner². By this process, complete longitudinal and transversal sections and plans (sometimes even ten different levels) were obtained and drawn for almost all the towers.

The survey results allowed us identify the original structure of the towers and their transformation over the years. This transformation was sometimes very incisive beyond the outward appearance of these massive structures, which can be appreciated by strolling through the streets of San Gimignano.

The study provided for the first time detailed information regards the towers, a total of sixteen (figg.1 and 2), highlighting their peculiar characteristics, transformations over time and the relationships with the relative context.

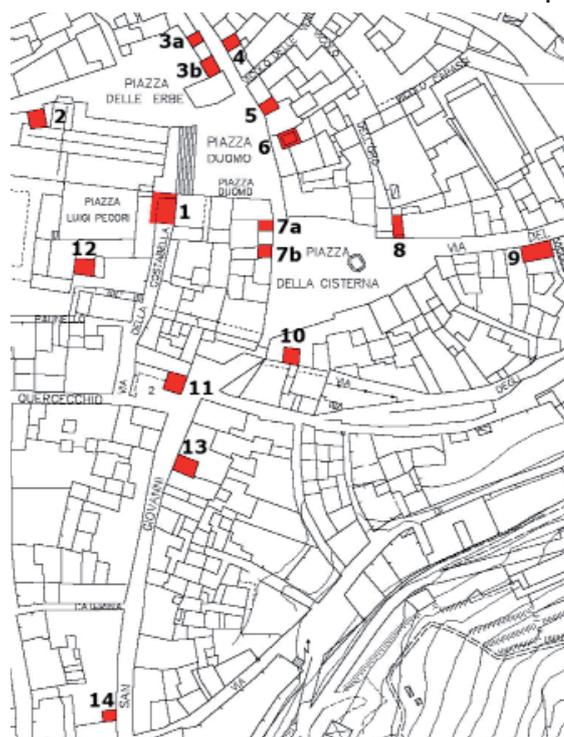


Fig.1 - The towers of San Gimignano:

1. Torre Grossa
2. Campanile
- 3a. Salvucci (North)
- 3b. Salvucci (South)
4. Pettini
5. Chigi
6. Rognosa
- 7a. Ardinghelli (North)
- 7b. Ardinghelli (South)
8. del Diavolo
9. Moronti
10. Becci
11. Cuganesi
12. Propositura
13. Campetelli-Coppi
14. Cantagalli



Fig.2 - View of San Gimignano; Fig.3 - The Salvucci Towers towards Piazza delle Erbe

Some preliminary results of this study are here presented, comparing towers largely intact with others deeply transformed.

2. The Towers

2.1. *The Salvucci towers*

A small building divides the two towers, both facing via San Matteo and Piazza delle Erbe (fig.3), and the Piazza is located at a level about 5 m higher than Via San Matteo.

The towers are built with stone ashlar of similar characteristics both in the internal and external parts.

The northern tower has a rectangular plan, at the base wide about 5,00 m and long 6,00 m, while at the top it is 4,80 x 5,90 m.

The thickness of the walls, at the level of Piazza delle Erbe, is 205 cm. The small inner room of this tower measures 180x100 cm, and its overall height, on the side of via San Matteo, is about 41.30 m; it should be added that such a cramped room was combined to the absence of windows, except for the door on Piazza delle Erbe. The longitudinal and cross sections (fig. 4), as well as the plans surveyed at six different levels (fig.5), show the existence of inner wall setbacks of 8 and 10 cm, and these increase slightly the size of the inner room. This tower, in order to get space used for commercial activities, has been subject to a significant reduction in wall mass at the level of via San Matteo, where an entrance door was obtained and the side walls were demolished to a thickness of 60 cm on one side, and 75 cm on the other. Similar masonry reductions exist at the level of Piazza delle Erbe, where we noticed also the dismantling of the wall in correspondence of the door entrance. The major demolitions are recorded at a level enclosed by housing parts (on the third floor from Piazza delle Erbe): here the wall mass was reduced by 44%

to obtain a small kitchen with an opening. Also at the examined lower levels the percentage of reduction of the wall mass is not negligible: equivalent to 33% to the level of Piazza delle Erbe and 37% at the shop level. At the top, a sidewall was reduced of about 65 cm to insert an inner spiral staircase.

At various levels stone corbels have been found once supporting the sleepers carrying the wooden floors, most likely connected by ladders. All these floors were eliminated when in the interior room the current lift was inserted to connect all the levels of this tower: the entrance from the Piazza, the intermediate housing up to the base of the terrace at the top of the tower.

The south tower has a square base with the outer side of about 7.00 m, wall thickness of 235 cm (only one side is 215 cm), the side of the square interior room is 242 cm, and the height on Via San Matteo is 42.85 m. Even in this case, the original tower was equipped with a single window on Piazza delle Erbe.



Fig.4 - Longitudinal section of the Salvucci Towers (the North tower is on the left); Fig.5 - Cross-section of the North Salvucci Tower and plans at the six levels marked in the section

The longitudinal and cross sections, and the fourteen plans performed at all levels have revealed that the interior square, with progressive and limited wall offsets, reaches on the top a side of 275 cm.

Moreover, at the top the external side of the tower is reduced to about 6.55 m with no visible offsets. There is then a slight narrowing in the elevation of the outer walls of the tower (similar to the northern one) with a slight inclination due to the lack of offsets. In other words, the interior walls are vertical while the outer ones are slightly inclined towards the inside of the tower. This is a singularity, also found in other towers of San Gimignano, which seems to demonstrate a constructive technique, on which further studies are required. The reduction in the wall structure has affected the level of Via San Matteo, where there are now shops, and two upper levels where the tower room was included in the flanking houses. At one level the intervention was limited to create two passages, as the tower is used as a link between residential rooms that flank it; in the other case the tower has been more integrated with the apartment, with wider openings in order to obtain inside the tower a bedroom and on its exterior an opening flanked by niches. In this case, the demolition of the perimeter walls is relevant, up to 18% of the wall surface, while at ground level the reduction of the walls is equal to 32%.

2.2. The Ardinghelli Towers

The Ardinghelli towers have only one face entirely visible on Piazza della Cisterna (fig.6), while the three remaining sides are incorporated into the building of the San Gimignano Town Hall; northwards the loggia of Piazza Duomo abuts against the tower.

On the ground floor the north tower has side walls 1.50 m thick, which exceed the width of the interior room, limited to 120 cm. At the third level, covered by a barrel vault, the walls of the sides were partially demolished (on the north side of 55 cm and the other of 35 cm) to obtain a space of greater amplitude: at the level of the vault springer the wall has maintained its original internal thickness (fig. 7).

Above the 12.69 m level the inner ashlar of the wall have been scraped, making the masonry core visible, a mix of lime and stone performed with a mortar of great quality. These ashlars were then used to raise the tower, therefore obtaining the result of using similar material as the exterior of the existing tower. The inner and outer faces had originally been carried out with the same constructive technique.

The section and the plan (figg.7, 8) highlight that the part built on, which makes the tower 27,55 m high, is characterised by a thickness of 50 cm, much thinner than the underlying walls.

Nevertheless, it can be noted that the surface of the scraped inner wall was not enough to build the reconstructed part, therefore it was necessary to obtain other material to get the additional ashlar.

At the second level, as shown in the section, the north wall of the tower has some peculiarities. In the middle portion the original internal facing is visible. This part of the wall is flanked, towards the square by a perfect ashlar facing with no decay; on the opposite side by plastered masonry. The characteristi-

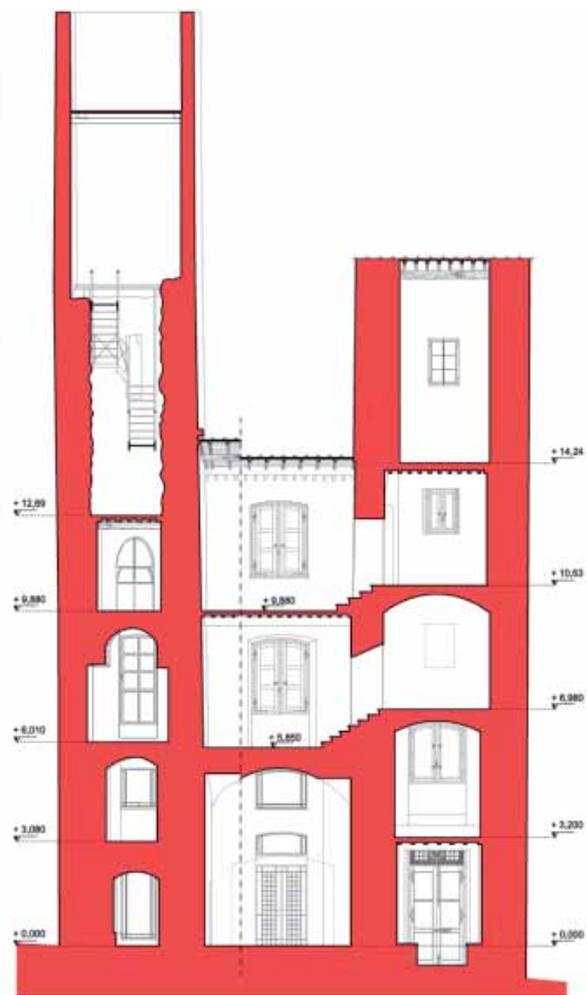


Fig.6 - The front of the Ardinghelli Towers facing Piazza della Cisterna (the north tower is on the right); Fig.7-Section of the Ardinghelli Towers. The thin wall on the top of the north tower is a raising extension made in the XXth century

cs of the walls that flank the inner original wall seem to testify that the side openings have been performed in breach. The irregularities of the demolished masonry, in one case have been disguised by plastering, in the other by a new ashlar which clearly differs from the stone masonry of the internal and external facing of the tower.

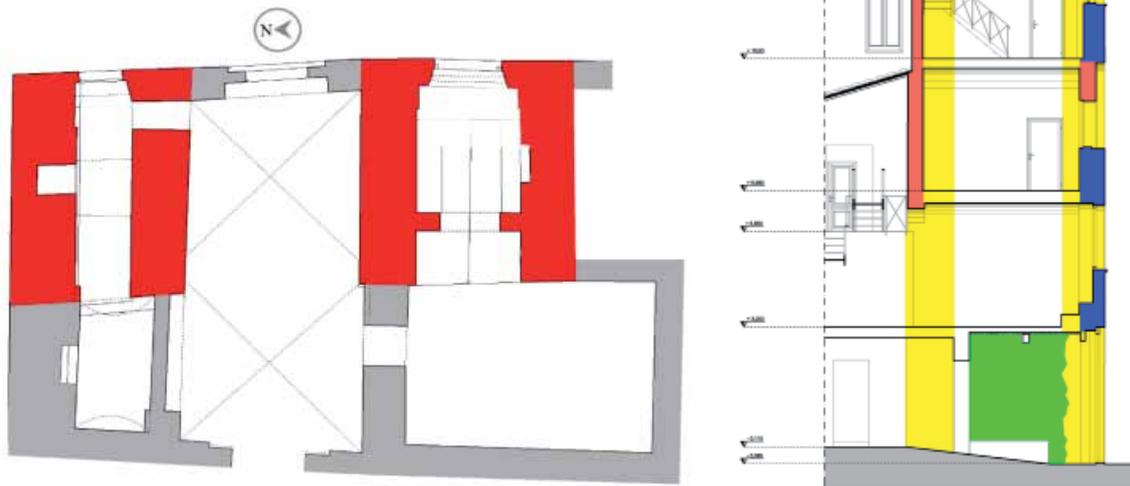
It is also possible that some of the stones used in raising the Ardinghelli north tower may come from the south tower, built with the same material and affected by extensive demolitions in the north side of the third and fourth floor and in the front and rear walls for its entire height.

This latter tower (fig. 9) has an internal room 3,24 m wide and 4,33 m long (at the fifth level), with sides walls 130 cm thick. The facade wall and the opposite one appear completely transformed. The façade has large openings most likely created by a restoration and a residual thickness of about 70 cm, at the last level reduced only to 40 cm.

The opposite wall was completely demolished and replaced by a brick wall, in the lower part by one and half bricks' thickness, and in the higher part by only one bricks'.

The Ardinghelli south tower, on the ground floor and on the roofing level, has sides with ashlar in sight, except for the corners where the wall was plastered to hide the irregularities due to the demolition of the original front and rear walls³. This tower has been deeply transformed to connect its internal rooms with the adjacent ones and perhaps also to recover the facing stone material. Originally the tower had a perimeter wall 130 cm thick and an internal room

Fig.8 - Plan of the Ardinghelli towers at ground floor level. The towers are marked in red; Fig.9 - Cross section of the south Ardinghelli tower. Are marked: the original ashlars (green), the original demolished walls (yellow); the reconstructed ashlars (blue) and brickwork (red) of the front and rear facades



roughly 2,50 m wide and 2,82 m long.

Today only its side walls survive and it is likely that, over time, also its height has been significantly decreased.

The Ardinghelli towers clearly tilt on opposite sides. The north tower up to the level of the raising point tilts northward about 30 cm. From this point onwards the rising point tilts only 3 cm. The raising was built plumb on the existing tower and later there was only a slight further increase in the inclination. The south tower has a tilt of 11 cm in total.

Despite the wide opposite leaning of the towers, which reaches 41 cm, the wall between does not show any cracks. This seems to indicate that these towers were originally isolated in the urban fabric and only later joined to the built-up area: the walls abutting the towers have probably contributed to stabilise them. It should be emphasised that, in the side of Piazza Duomo, the north tower leaned against a building demolished to make the current loggia, but that does not seem to have subsequently caused any further tilting phenomena on this side.

An ancient photo (fig.10) shows the Ardinghelli north tower before its raising and the building later demolished to build the loggia. In the south tower it is evident that recent works had already totally transformed the central part of the wall, realising the present openings in the facade.

Also the building interposed between the towers appear to have been affected by recent works; there are clear similarities with the openings of the left tower. In the north tower, changes to the openings under the single-lancet window and partial renovation of wall corners in its highest part are visible. The new housing functions of the towers are revealed in particular by the large arched



Fig.10 - The ancient photo of the front of the Ardinghelli towers before the raising of the north tower

openings made in the south tower, filled with brickwork and windows similar to those of common dwellings. Equally, on the ground floor large openings were realised necessary to carry out commercial activities.

Notes

¹ The research, coordinated by prof. Gianni Bartoli, involved:

- The following Departments of the University of Florence:
 - DICeA-Department of Civil and Environmental Engineering;
 - DINFO-Department of Information Engineering;
 - DIDA-Department of Architecture;

- The Department of Physical Sciences, Earth and Environment of the University of Siena;

- The Municipality of San Gimignano.

² The surveys have been carried out with the collaboration of the architects Francesca Venturini and Francesca Zanetti, who have cooperated to the surveys of the inner rooms of the towers and their sections, while the laser-scanner surveys were performed by the architect Alessia Nobile, of the Geomatics Laboratory for Conservation directed by prof. Grazia Tucci. We acknowledge ISTI - CNR in Pisa for providing part of the laser scanner measurements made as part of the ST@RT, Science and Technology for the Artistic, Archaeological and Architectural Tuscan Heritage.

³ On the ground floor of the Ardinghelli south tower, in the area between the sides and demolished walls, partial reconstructions of the wall with brick inserts were performed.