

The Ancient Walls of L'Aquila, from the Earthquake Destruction to New Reuse Possibilities: A Case of Study on Porta Leone

ALESSIA PANELLA, Department of Architecture (DiDA), Florence University
ANDREA INNOCENZO VOLPE, Department of Architecture (DiDA), Florence University

L'Aquila is an important town in central Italy: in time it has been a significant crossover of passages and the place to manage and control a large and complex sector of country. Besides, since ever, it was subject to strong and destructive earthquakes that often caused the reshaping of the urban pattern. The last one that happened in 2009, caused large destruction on both contemporary and ancient buildings.

This study exploits the earthquake as an opportunity to free the area of the city walls around "Porta Leone" (Lion Gate), which has been saturated in the late fifties by buildings of social housing, precluding the community from enjoying this place.

Nowadays these buildings, heavily damaged by the earthquake, are in ruins and abandoned and their full demolition is foreseen in a quite short time.

In this situation, it's possible to rethink the relationship between the town and the ancient walls.

The area was scanned using the digital survey (operated by 3D Laser Scanner and IUAV photography/video) to produce a series of models that allow to understand this part of the urban asset, rereading the town shape and developing simulations for a new settlement, less invasive than the previous one.

This study tries to give a new significance to the system walls, valorising their historical value and giving opportunity of better comprehension of the development of this city, interpreting the historical phases of evolution and defining specific solutions thanks to the use of the 3D model, going beyond a simple juxtaposition of buildings, towards a clear interpretation of the ancient evidences.

Key words:

Digital survey, earthquake, city walls, L'Aquila, Italy.

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INTRODUCTION

The intervention area is placed in the ancient city center, narrowly situated between two important pre-existing structures: on the east side the urban wall and Porta Leone, and on the west side the Church of St. Bernardino and its convent. (Fig. 1)

In the past the site was left empty to have a respect band close to the walls and after, it hosted the gardens of the nearby convent.

In the sixties this empty space was filled by various blocks of social housing, which are now heavily damaged by the earthquake, in ruins and abandoned and their full demolition is foreseen in the near future.



Fig.1. Aerial photo of the entire interest area.

THE DIGITAL SURVAY

We mainly carried out the survey phase by indirect survey with 3D laser scanner, in particular with a Zoller & Fröhlich Z+F 5006h Phase-shift model [Verdiani 2012] (Fig. 2). With this tool we were able to acquire data related to three-dimensional objects, returning them in the form of a point cloud. In particular, the position of the points in space is measured on the basis of a known reference system thanks to a coded light emitter which detects the distances between the laser and the surfaces it encounters on its path. The object detected is divided into a large number of points that make up the cloud, which could be described as an intermediate model between the infinite real points and the simplification given by force of things from the representation. Each single point is described by spatial coordinates referring to a Cartesian tern that originates (point 0,0,0) at the head of the instrument. Moreover, the points differ from one another according to the reflectance, given by the material of which the scanned object is made, in such a way that the cloud is chromatically mapped and consequently more easily readable.



Fig.2. Scanner Laser Zoller & Fröhlich Z+F 5006h.

First, we planned the survey project, aimed at establishing the optimal position of all the stations in which to place the laser scanner, to ensure a total coverage of the area, optimizing the times and detecting the greatest number of points possible, avoiding, for example, grey areas, which would result in data loss. We ideally divided the area into three portions, based on the altitude and on the possibility of being taken in a consequential way, in order to facilitate the subsequent phase of merging the point clouds.

Then we proceeded by placing spherical targets at strategic points, in order to have references to help us reconnect the various scans in the data processing phase.

We detected the area of interest over two days, a relatively short time considering the extent of the area that was about 2000 square meters. It was possible thanks to the site's morphology, free from occlusion situations. This gave us the possibility to easily detect both the block of the ATER social housing and the walls, moving the laser scanner for a total of 74 stations. (Fig. 3)

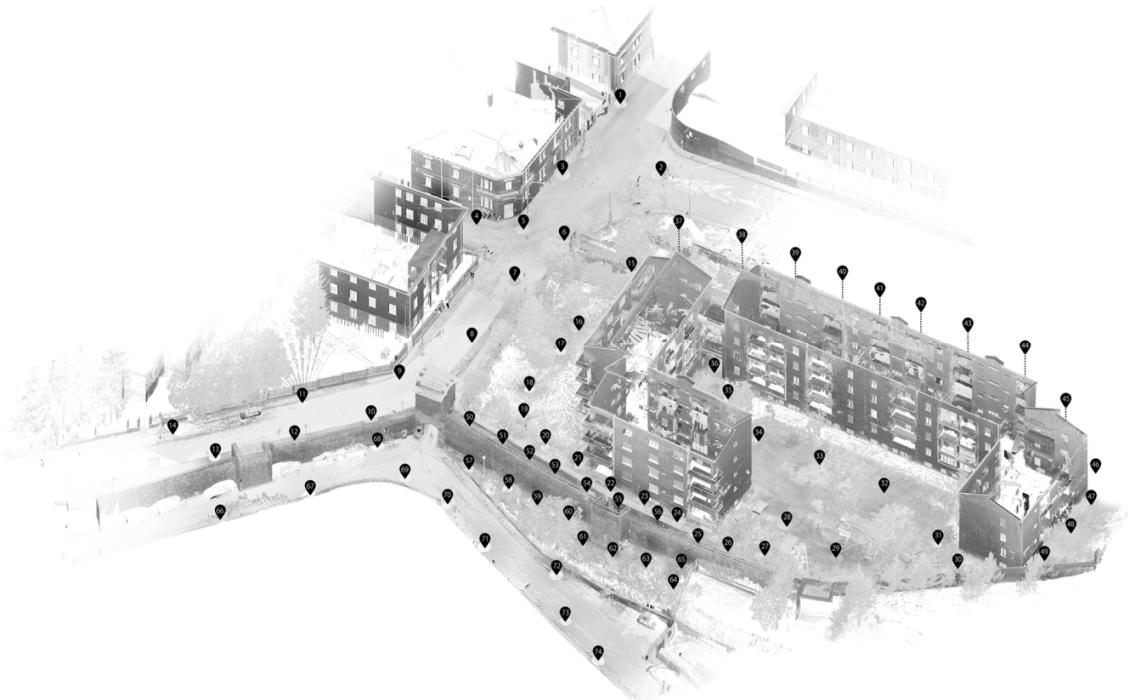


Fig. 3. Merged point cloud with all the stations indicated.

In the most difficult points to detect, it is possible to notice a stations' thickening, determined by the impossibility of placing the instrument at a greater distance in order to detect larger portions of the building. Furthermore, the scans were carried out in high and medium definition, varying the accuracy according to the different lighting conditions or the type of object to be detected. In high definition mode the scanner can record a maximum of 80 million points (40 million in medium definition), but of course these are reduced in the presence of occlusions or openings.

In this case an unfavorable situation for this type of survey was determined by the presence of vegetation, both near the wall and in the perimeter surrounding the building, due to its total state of abandon.

We have therefore proceeded to a substantial thinning of the vegetation, where possible, especially infesting plants to obtain a point cloud as complete as possible and readable without interference. Finally, the data obtained with the 3D laser scanner was also supplemented by photographs taken during the days of survey and by drone shots taken ex post, useful for understanding the portions of the cloud in which the data was more rarefied (or not detected, as in the case of roof) as well as necessary for the subsequent production of orthophotos, planned to provide a more detailed and realistic rendering of the state of the walls. The result of this first phase is a three-dimensional discontinuous model, consisting of a single point cloud for each acquisition station, which preserves the real scale of the scanned asset, allowing it to be extrapolated through the use of dedicated software [Guidi 2010]. The first program used for the post processing of this dataset was Autodesk ReCap 360 professional; as a first step, the scans of the digital survey were recorded and thanks to the particular precautions taken during the scanning phases it was possible to align most of the scans automatically, obtaining in total three macro groups, then these groups were manually aligned, using for reference a set of spherical polystyrene targets placed at strategic points at the time of the survey. The manual alignment operation consists in joining the point clouds by pairs on the basis of three known points and by following automatic geometric comparison. These points, called

vertex, in addition to being common to the two scans must be at a certain distance from each other, allowing a proper alignment of point clouds. The point cloud obtained, thus containing the relative data in a single file to the entire area, it was then exported in .PTX format, converted later through the Bentley Pointools POD Creator software into a .POD file. Then the importation of the .POD file in the Bentley Pointools Edit Pro software with saving in .PTL format was passed. At this point it was possible to use, inspect and edit the point cloud, sectioning it with the specific box for the production of plants, sections and elevations. The limit-box tool in fact allows cutting the model isolating only the interested part, thus making the file lighter and the navigation operations inside easier. By means of various alignment commands it is then possible to set the various views conforming to the orientation and the boundary points of the limit box and saving the used room. From the settings of the point cloud it is also possible to set different ways of displaying the color, starting from grey scale up to the "hue" color scale; through the plane shaders it is possible to define a repetition range of this chromatic scale and select its direction along an axis of the Cartesian reference system or alternatively align the chromatic variation to a certain view, so as to have clear depth and distance between the various elements.

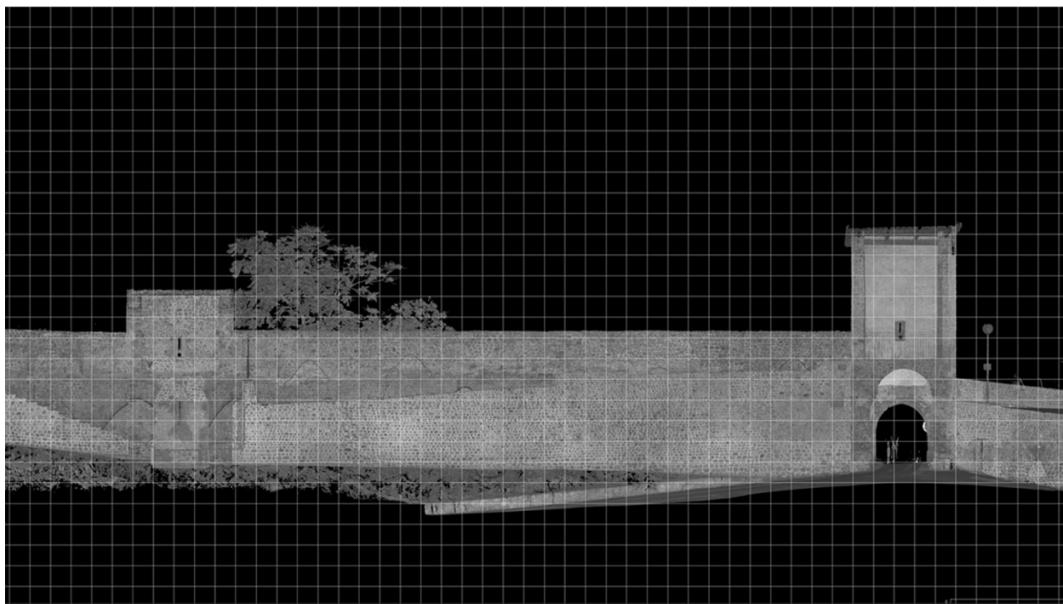


Fig. 4. Example of Bentley Pointools snapshot.

Once these parameters had been set, we proceeded to create snapshots (Fig. 4): the first step was to switch from perspective to spelling, and then set the resolution (300 dpi in this case) from the output window of the program, the scale, the export format (TIFF) and the area to be framed. It was also possible to activate the "grid" option which allows the snapshot to have a square mesh reference metric grid, necessary in the following phase to scale the obtained raster images on AutoCAD. In fact, once exported, the snapshots were imported on AutoCAD 2016 and rebutted as wires in two-dimensional elements, thus obtaining the basis for the creation of photo-planes, obtained by the treatment of photographic shots with Photoshop CC.

The restitution focused mainly on the yield of environmental sections on a scale of 1: 100, a scale sufficient to give an overall representation of the site's morphology. These were obtained by aligning the limit box according to three different orientations that follow the course of the wall curtain. The façade inside the walls was created by cutting the stone staircase that leads to a lower level in correspondence with a sighting tower, as evidence of the original portion of the walls, which before being reinforced in

the fifteenth century with the embankment that we still see today, are grafted to the same height that we can measure from the outside of the curtain (less than 4.5 meters compared to the current floor level). The external façade presents itself as a continuous, homogeneous curtain, characterized by a great thickness of mortar and without basement slipping. (Fig. 5)

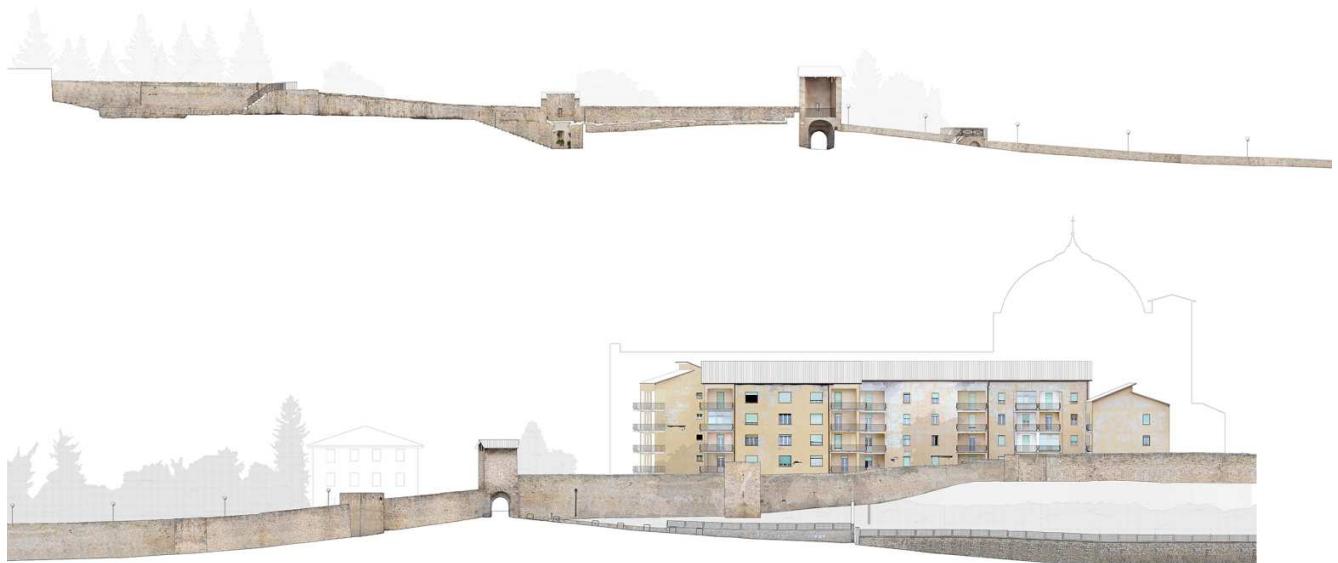


Fig. 5. Internal and external view of the ATER building and the city wall.

This uniform aspect is probably also due to the various restoration interventions to which it has been subjected over time, in 1969 the most consistent and in 1999 the most recent. [Di Stefano, 2004: 105-116]

From the point cloud we extrapolated detailed drawings of Lion's Door (Fig. 6) that show the different views and construction features: starting from the presence of the triple arch, which testifies the historical evolution, up to the coverage wooden trapezoidal shape, which follows the irregular plan of the door, probably deriving from its original function as a flanking tower. In these works, inserting also the attack of the door with the adjacent curtains, it was possible to effectively show the various changes in altitude that the door itself connects, cutting off the road surface and the various containment walls placed to delimit it.



Fig. 6. View of the Door's façades.

From the analysis of the elevations and from the study of historical images and documents it was also possible to derive a reconstructive hypothesis of the various historical and morphological phases that characterized the building: starting from the original form of sighting tower, passing through the long closing periods up to the formal changes given by the requirements of the various historical periods. Among these the most important are: the opening of the various arches, which allow us to go back to the exact period of intervention thanks to intrinsic construction characteristics typical of particular historical phases; the walls cut into the upper part, testifying to the greater height that the door had in the past, which was then reduced in 1469 [Martella and Medin 1979] to make it less vulnerable to artillery attacks; the stone ledges with holes created specifically to allow the rotation of the hinges of the studded portal which in the past (starting from 1332) protected the door [Martella and Medin 1979]; the partially buried ground: a first elevation of the decking surface dates back to 1349, the year of the earthquake after which Lion's Door was closed by the rubble of the nearby Church of St. Francesco; the process then continued in the fifteenth century with the creation of an embankment reinforcement of the city walls to finally end in recent times, during which there was a further rise of about 20 cm with the application of the road surface.

THE PROJECT

The digital survey has served as a base for a wider, more complex, view of the area and to start the definition of an intervention project for the revitalization of this area.

At a first sight the lot may look quite essential; the massive presence of the abandoned houses tends to simplify the perception of the area, hiding the terrain and the relationship with the ancient walls. The accurate survey allowed to put in evidence all the specific relationships between the housing and the walls of the city. In certain parts the ancient and the abandoned are very close each other, the almost casual position show clearly how minimal was the interest about studying a correct solution at the time of the housing intervention. The digital survey, creating a complete 3D model of the whole group of artefacts allows to read very well the balance between the parts, the presence of different levels from the wall structures, connected by ramps, staircases, secondary passages and secondary lines of walls. Especially the set of scans from 20 to 30 and from 49 to 56 documents very well the articulation and juxtaposition of the late buildings in front of the walls, the two structures never collide, nor parts of the ancient walls were sacrificed for the new building needs (luckily), thus the old and new construction just coexist in a logic of extreme exploitation of the space, without any dialogue. If this can be perceived in place, maybe with some emphasis caused by the abandon, the digital model clear states the condition, showing without possibility of interpretation the narrow spaces and the ugly relationship between the two different structures. The idea about removing the heavily damaged housing looks preferable here, the articulation and readability of the walls will only benefit from a new asset of the lot. The buildings are not suitable for recovering, their next demolition will empty the lot. A set of pictures and the digital documentation operated by this activity will keep a memory of this unlucky phase for this part of the town. Moving from the state of the lot and its possible future, the digital model coming from the 3D laser scanner survey allows to drive a better comprehension of the state of the soil inside the lot. A first step is simple: removing the abandoned housing, cutting them away from the point cloud is a first "cleaning" that allows to see the condition of the area without its actual main habitant. This removal left just the trace of the plan projection as large rectangular holes on the ground. The attention payed to reducing to the minimum the occlusion spaces towards the old walls at the time of the survey campaign gives back the possibility to have a well readable description of all its parts, and this is obviously easy to appreciate when the abandoned buildings are removed. This edited version allows some consideration: the housing interventions have moved the terrain, flattening it to allow a better exploitation and use of the surface. In this way, the walls are partially covered, creating an improper condition in front of the original state. This is clearly readable in the sections and in the 3D view of the point cloud, the very practical, thus altered condition of the area needs some rethinking to enhance the way the walls are presented to visitors and

user of the place. The high level of detail of the point cloud allows to read and interpreter all the elements of the walls, so while at work on it, it is always possible to recognize not only the architectural elements, but also the masonry texture and most of the smaller elements on it. The visualization of this apparently simple (but in real very complex) architecture in the 3D space is quite helpful in the construction of ideas about the recovery, changing points of view and passing from perspective to orthographic view continuously, checking what a visitor may see from a certain position and then passing to a section or plan view to verify a geometrical grid or the size and proportion of the proposed solution. In a certain way the point cloud enter in the process of sketching and drafting like a versatile element, creating the occasion to define any shape and proposal with a clear verification of results. Most of all the results remain at a level of ideas but define more certain conditions and helps the growing of the new project.

The intervention proposal provides for the creation of a cultural center; the choice of this project theme stems from the need to create a new meeting place for the community of L'Aquila, which has been left without such spaces since the night of 6 April 2009. In part it is an intervention planned by the municipal administration that involves the redevelopment of the entire district, called Santa Maria di Farfa (Fig. 7), already full of polarity in cultural and social terms.

It is in this context that the project is inserted, exploiting the opportunity given by the earthquake to free a space overlooking the city walls, which, returning it to its original form: in fact, in the past, the area was left empty first for military purposes and then destined to the gardens of the nearby convent. It was only saturated in the 50s with social housing's blocks that were strongly damaged by the earthquake of 2009 and will soon be demolished. Once the lot has been freed from this pre-existence and returned to the community, the intent is to create a new cultural center in this neuralgic zone, close between strong historical pre-existences, a nodal point that stands on one side as the last scenic backdrop that closes the city to the east, on the other hand as access to the historical center, also favored by the presence of Lion's Door, which, opening on the edge of the curtain wall, connects the *intra* and *extra moenia*.



Fig.7. Project master plan.

The initial phase of the study was based on the analysis of pre-existence, signs and geometries of the ancient city: the building is located on the way of the *decumanus* [Colapietra 2009] that gave rise to the city and ideally incorporates the characters of L'Aquila's historic buildings, with the intent to rebuild an ideal block, one of the many who have been missing with the earthquake that hit the city in the 2009.

The building therefore develops along the major side of the project area, reconstituting an ideal urban front facing the various openings and the main access, determining the subsequent closure of the smaller sides; in the past, in fact, this system made it possible to easily add single modular units, becoming the basic matrix of the historic subdivision process.

The presence of many openings on the ground floor, as well as resume the morphology of the historical facades, also solves a more pragmatic question as it offers the possibility of having close emergency exits, necessary for the evacuation of the building in case of a new earthquake. The aim is also to re-propose in the new building the typical duality of ancient palatial construction, which has closed external fronts and opened internal courtyards, delimited by loggias on one or more levels: in the same way the project is

configured as a more tightened volume on the side of the road, more open instead on the opposite side, towards the walls.

The two aims of the project are basically, that is to preserve the memory of the place and revive the sense of community, re-educating the people to the meeting: for this purpose, one of the points of the project is to recreate a square, overlooking the walls and lowered, to show the original quote of the walls, which can be accessed directly from the road front through a stairway or from inside the building. At the side of the square the remaining space (at quote zero) is occupied by a green *promenade*, which recalls the ancient function that characterized this place, that is urban vegetable garden, also going to integrate and implement the vegetation already here with more valuable species, creating a green space usable by the community.

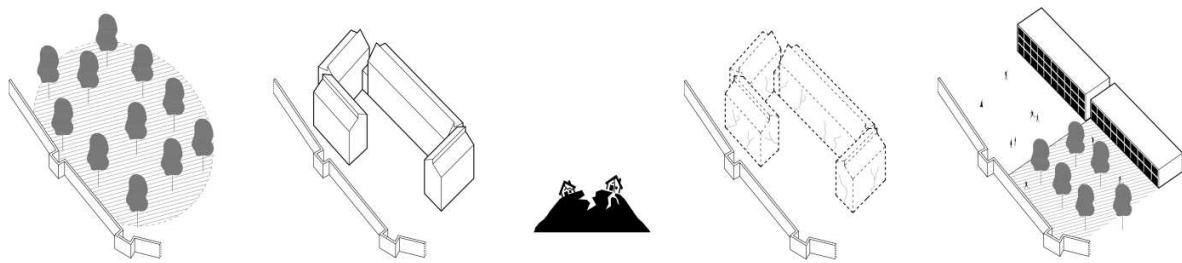


Fig. 8. Project concept.

Consequently to the different quotes of the ground, the building is developed at different levels and is configured as a union of two separate volumes: the façade follows the morphology of the typical block, but is broken in two by a cut; this break becomes a metaphor of the trauma, of the cracks given by the earthquake but at the same time it also becomes an element of access to the building. (Fig. 8)

From here starts a distribution corridor that runs along the entire length of the building, which on one side allows access to the various rooms, on the other opens into a large loggia that is repeated for all three levels, allowing enjoy the building having a constant view of the walls and a continuous visual relationship with it.

In the basement, the southernmost building houses a literary café and an exhibition space, both functions that allow to enjoy the square, while the northernmost block houses a large archive, which allows to bring back in the historic center more than one hundred thousand volumes that have been located elsewhere after the earthquake. The entire northern block houses study-related functions, a library and a large reading room, while the southernmost block houses more playful functions, designed to make this space alive even in the evening: literary café, exhibition hall, conference hall and multifunctional halls. (Fig. 9)

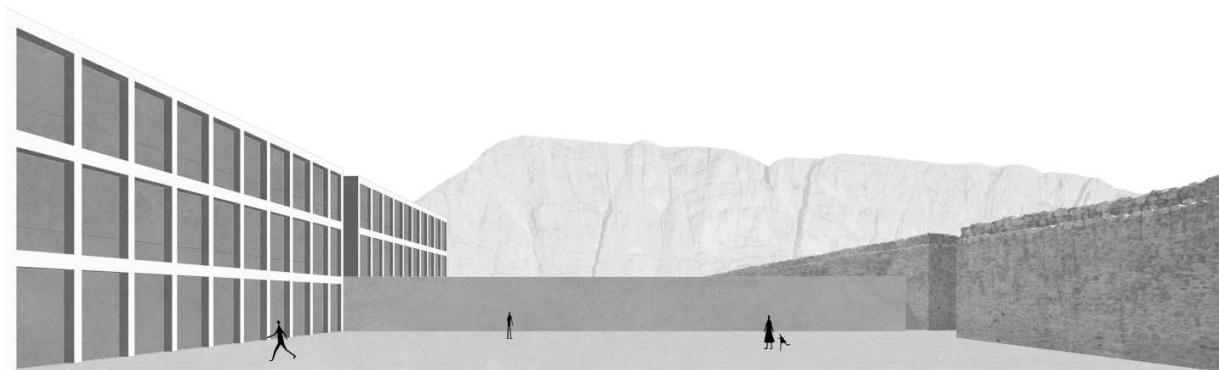


Fig. 9. Project external view.

From a structural point of view the building has been designed following the basic criteria of seismic design, above all structural simplicity; many of these criteria can also be found in the characteristics of historic buildings: the horizontal trend of buildings, which never reach heights higher than three floors or the presence of a substantial wall mass. It is from all these elements that the project derives its being, with the desire to recover contact with the place, the identity of a city that seems to have lost its way on the night of April the 6th. An architecture that aims to represent a contribution to the rebirth of L'Aquila, exploiting a tragic event such as the earthquake as an opportunity to regain possession of an identifying place in the city. An architecture that can be summarized in the definition of "urban fact", though not in its singularity, but in close relationship with the city and the context, which rejoins the walls, giving back to the community an important meeting place.

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