The rehabilitation of traditional architecture in Jericho (Palestine)

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opposite page
Fig.1
View of oasis of Jericho from Jordan

next page
Fig.2
View of Herod's Palace from the south

Abstract

The unique characteristics of the Jericho area provide excellent opportunities for the proper valorisation and promotion of existing resources. The conservation project for some historical mud-brick buildings respects the principles of *eco-sustainability* and *biocompatibility*. The life-cycle of materials and renewable resources are of the utmost importance for both reflecting on the interaction between humans and the environment, and for attempting to safeguard the local cultural heritage even though it has been severely impoverished by the continuous geopolitical instability.

Jericho is located in the oasis of the Jordan Valley, in the Desert of Judah, 7 km west of the River Jordan, 10 km from the Dead Sea and 30 km from Jerusalem (Fig. 1); at 258 metres below sea level, it is the lowest city in the world. From the archaeological finds, Jericho can also be considered the oldest city in the world, with traces of urbanization dating from 8,000 years before Christ.

There are numerous testimonies to its prosperous past: from the original urban centre called Tell es-Sultan (the Sultan's Hill), to Elisha's spring, Herod's Palace, the Synagogue and Khirbat al-Mafjar (Hisham's Palace), the residence of the Umayyads. (Fig. 2)

The collaboration between the Palestinian Ministry of Public Works & Housing, the University of Birzeit, the Municipal Administration of Jericho and the Department of Architecture (DIDA) of the University of Florence, which has a long tradition of cooperating in Palestine, has generated a new way of working together (lecturers and students, from the University of Birzeit and the University of Florence — taking part in a workshop, held in Jericho), — for development which we hope will spread to other Palestinian and international institutions[1]. (Fig. 3)

The main objective of the workshop was to develop an experimental project based on the study and valorisation of traditional mud brick architecture, local materials and local building cultures that would satisfy the principles of eco-sustainability, biocompatibility, the life-cycle of materi-

[1] Taking part in the workshop in Jericho and in drawing up the final project: for the Italian part, the professors Flaviano Maria Lorusso, Saverio Mecca, Roberto Sabelli, Fabio Sciurpi and Giacomo Tempesta, the architects Ombretta Dinelli, Marco Nestucci, Andrea Salvietti and the students Italo Celiento, Leonardo Gobbini, Irene Manfredi, Benedetta Mazzieri and Jacopo Giuseppe Vitale; for the Palestinian part professor Shadi Ghabdan, engineer Ghada Abed Rabbo and the students Omar Khalil Aboudi, Rawan Majid Alfityani, Leena Mohammad Abed-Aljawad, Muath Ibrahim Abo Jheish Eh and Mosb Mohammad Zohoor.

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Jerusalem
Dead sea
Oasis of Jericho

Fig. 3
Traditional mud brick architecture

opposite page

Fig. 4
Official meeting during the workshop in Jericho

Fig. 5
Traditional mud brick architecture

als and renewable resources and to be an example of reference for further development of the existing local natural and human resources, towards a sustainable balance between the human being and his environment, in the area of Jericho and throughout Palestine.

Indeed, a high demographic density, and an endemic and instrumental lack of water, electrical energy and waste disposal areas go hand in hand with a population with a low income, and few available resources for high-quality building that is sustainable for the environment and the landscape[2].

For Jericho's ecosystem, a true oasis in the lowest point of the land, it is vitally important to draw up an awareness-raising strategy in order to value the cultural heritage and traditional local building techniques as indispensible elements to pursue the three fundamental components of sustainable development: environmental, social and economic[3]. (Fig. 4)

The sustainable development of a territory, above all if subject to a great demographic increase, cannot be separated from a conscious respect of the historic and natural resources, nor, therefore, from a correct programming and management of the territory. An awareness of the need to preserve the environment is only acquired thanks to the citizens' cultural evolution through continual training actions and correct information[4].

In order to raise awareness among the population on the importance of building with a low environmental impact — therefore greatly reducing the ecological footprint — and with higher living standards than the concrete block constructions, (Fig. 5, 6) it has therefore proven necessary to make preparatory research on the mud-brick buildings still existent in Jericho, and verify the possibility of restoring them.

An operating methodology has been drawn up which, starting from a precise knowledge of the existent buildings, aims to exalt the potentials of

[2] Jericho's economy is based on tourism and on natural resources. The distinctive features attract international agronomy study teams but also ornithologists for the recurrent migrations of birds.

[3] 'The process of enhancing cultural heritage (learning about it, safeguarding it, conserving it, managing it, and using it) contributes to local progress if it is integrated with the broader territorial system, the environment and social and productive system. This is in accordance with the following widely acknowledged principles: a) the centrality of the resources of the area involved, b) the participation of local stake-holders in the decision-making process through the mechanism of harmonization and bottom-up programming, c) the responsibility, compatibility and sustainability of the proposed measures in terms of the resources they require' (Mecca 2012, 131).

[4] See Novelli 2012, 23-24.

this building technique through a process of adaptation to more modern production, comfort and safety requirements. (Fig. 7, 8, 9)
Little knowledge of the characteristics of the traditional building techniques is indeed at the basis of the perception that a poor material like earth is unreliable, even though its use has guaranteed the survival of buildings in Jericho for thousands of years.
Through a specific survey sheet recording the traditional typological and technical-construction characteristics we have tried to understand the principles and requirements at the basis of the choice of materials and, from the analysis results, the decay present, with an assessment of the causes behind it. (Fig. 10)
There are many examples mud-brick constructions in Jericho: the walls and dwellings at Tell es-Sultan (Fig. 11), some of which date back to the eighth millennium BC[5], many historical buildings such as the elegant dwellings and accommodation facilities (hotel) built during the British Mandate in the first part of the twentieth century and the fabric of present-day urban dwellings.
Following the census, eight constructions were selected — of different types, dimensions and subject to different types of decay — all dating from the beginning of the 1900s, between the Ottoman and British Mandate periods.

[5] From the findings at the archaeological site of Tell es-Sultan it is evident that the raw clay brick was the first building material from 8300 BC and the one used for the longest (see Sala 2006, 270-277).

[6] Draft project April 2010. Architectonical design: Saverio Mecca, Flaviano Maria Lorusso, Roberto Sabelli, Ombretta Dinelli, Marco Nestucci, Ghada Abed Rabbo. Structural design: Giacomo Tempesta. Project plant: Fabio Sciurpi, Andrea Salvietti. Workgroup: Italo Celiento, Leonardo Gobbini, Jacopo Giuseppe Vitale, Benedetta Mazzieri, Irene Manfredi, Rawan Majid Alfityani, Leena Mohammad Abed-Ajawad, Mosb Mohammad Zohoor, Muath Ibrahim Abo Jheish Eh, Omar Khalil Aboudi.) Partners involved in the project: Ministry of Public Works & Housing of npa, University of Florence-Faculty of Architecture, Governorate of Jericho, Municipality of Jericho, Birzeit University, Faculty of Architecture, Jericho and the Jordan Valley (CPT).

[7] See Musso, Franco 2014, 55-56

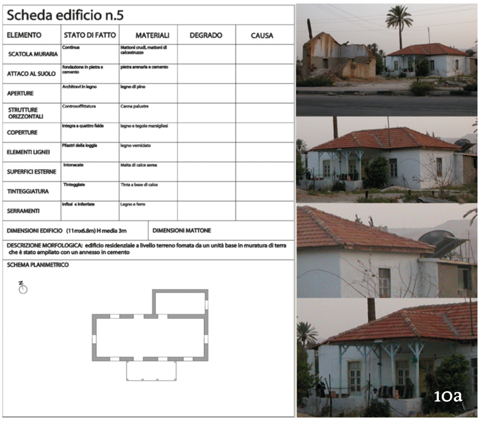
The study on the existent buildings was accompanied by a project for the construction of a new mud-brick complex, for residences and services, and a university campus, with public multipurpose areas, highly efficient modern technology standards, high environmental sustainability, good safety and low energy consumption with a high share of self-produced energy[6]. The technological innovations included in designing the new buildings were assessed for their use on historic buildings too. (Fig. 12)
This gave rise to interesting experimental solutions to improve the structures' resistance to earthquakes, achieve low energy consumption, recycle water and protect the mud brick elements.
In addition, a maintenance plan was prepared to lengthen the service life of the historical architecture[7]. Where possible, the experiments on the

opposite page
Fig. 6
New architecture in concrete blocks

Fig. 7
House in mud brick of the Ottoman period

Fig. 8
Hotel in mud brick of the Ottoman period

Fig. 9
House in mud brick of the Ottoman period



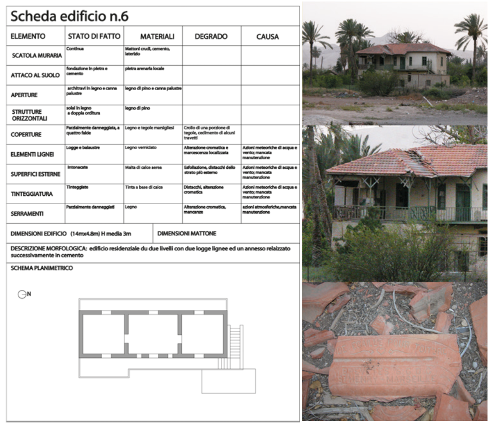
Scheda edificio n.5

ELEMENTO	STATO DI FATTO	MATERIALI	DEGRADO	CAUSA
SCATOLA MURARIA	Continua	Mattoni crudi, mattoni di calcestruzzo		
ATTACO AL SUOLO	fondazione in pietra e cemento	pietra arenaria e cemento		
APERTURE	Architravi in legno	legno di pino		
STRUTTURE ORIZZONTALI	Controsoffittatura	Canna palustre		
COPERTURE	Integra a quattro falde	legno e tegole marsigliesi		
ELEMENTI LIGNEI	Pilastri della loggia	legno verniciato		
SUPERFICI ESTERNE	Intonacate	Malta di calce aerea		
TINTEGGIATURA	Tinteggiate	Tinta a base di calce		
SERRAMENTI	Infissi e inferriate	Legno e ferro		

DIMENSIONI EDIFICIO (11mx6.8m) H media 3m | DIMENSIONI MATTONE

DESCRIZIONE MORFOLOGICA: edificio residenziale a livello terreno fomata da un unità base in muratura di terra che è stato ampliato con un annesso in cemento

SCHEMA PLANIMETRICO



Scheda edificio n.6

ELEMENTO	STATO DI FATTO	MATERIALI	DEGRADO	CAUSA
SCATOLA MURARIA	Continua	Mattoni crudi, cemento, laterizio		
ATTACO AL SUOLO	fondazione in pietra e cemento	pietra arenaria locale		
APERTURE	architravi in legno e canna palustre	legno di pino e canna palustre		
STRUTTURE ORIZZONTALI	solai in legno a doppia orditura	legno di pino		
COPERTURE	Parzialmente danneggiata, a quattro falde	Legno e tegole marsigliesi	Crollo di una porzione di tegole, cedimento di alcuni travetti	
ELEMENTI LIGNEI	Logge e balaustre	Legno verniciato	Alterazione cromatica e marcescenza localizzata	Azioni meteoriche di acqua e vento; mancata manutenzione
SUPERFICI ESTERNE	Intonacate	Malta di calce aerea	Esfoliazione, distacchi dello strato più esterno	Azioni meteoriche di acqua e vento; mancata manutenzione
TINTEGGIATURA	Tinteggiate	Tinta a base di calce	Distacchi, alterazione cromatica	Azioni meteoriche di acqua e vento; mancata manutenzione
SERRAMENTI	Parzialmente danneggiati	Legno	Alterazione cromatica, mancanze	azioni atmosferiche,mancata manutenzione

DIMENSIONI EDIFICIO (14mx4.8m) H media 3m | DIMENSIONI MATTONE

DESCRIZIONE MORFOLOGICA: edificio residenziale du due livelli con due logge lignee ed un annesso relaizzato successivamente in cemento

SCHEMA PLANIMETRICO

Fig. 10a | 10b The sheets to record the traditional constructions

Fig. 10c The samples analysed and their chemical composition

existent buildings include the integration of traditional materials (mud brick and stone) with lamellar wood to improve seismic resistance, and the adoption of advanced technology for integrated systems to produce clean energy, such as thermal and photovoltaic solar panels, and recycling for water reuse. (Fig. 13)

From a further selection of the recorded constructions, two were identified on which to prepare a final restoration project with new functions derived from technological upgrading: a beautiful private residence and a large hotel complex built in the first decades of the twentieth century in an advanced state of decay owing to abandonment.

The choice was made with the intent to highlight the possibility of having high-quality architecture in mud-brick too, both for living purposes and service activities.

Particular attention to construction and composition, together with a suitable maintenance plan, can guarantee that the mud-brick building will have a long life and low environmental impact, with the possibility of notably reducing running costs, such as the costs for possible demolition and consequent disposal.

Lastly, the research performed highlighted that above all a lack of information, or even misinformation, is the reason for the generic perception of the unreliability of the traditional construction technologies and a material that is easy to find and work such as mud.

Case study

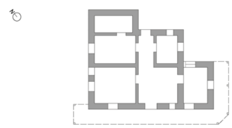
The residential building (Fig. 14), of particular significance owing to its good visibility along the main access road to Jericho from Jerusalem and the Dead Sea, is one of the examples of private architecture from the end of the Ottoman period (around 1908), followed by the British Mandate period (1915-1948), in which a western influence can nevertheless be seen, with typically French and British forms and the use of imported materials. The middle of the nineteenth century marked the beginning of a westernization phenomenon in the area of Ottoman influence, which saw the west-

[8] See Garzoli, Mastaglio, Paganelli 2010, 28, <https://www.politesi.polimi.it/bitstream/10589/12581/1/2010_12_Garzoli>

[9] Amiry-Tamari 2008; D'Ayala-Fodde 2008.

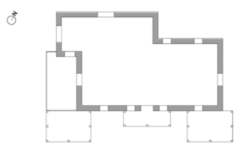
[10] The mineralogical-petrographic and physical analyses were performed at the University of Florence Materials Analysis Laboratory (LAM) and at ICVBC-CNR in Sesto Fiorentino.

Scheda edificio n.7				
ELEMENTO	STATO DI FATTO	MATERIALI	DEGRADO	CAUSA
SCATOLA MURARIA	Continua	Mattoni crudi, cemento, laterizio	Erosione alla base, fessurazioni, crolli	Azioni meteoriche, cedimenti della fondazione, mancata manutanzione
ATTACO AL SUOLO	fondazione in pietra	pietra arenaria locale	Erosione dell'attacco alla muratura	Ruscellamento delle acque, mancato allontanamento acqua piovana
APERTURE	architravi in legno	legno di pino	Erosione degli architravi e degli spigoli della muratura	Mancata manutenzione, marcescenza
STRUTTURE ORIZZONTALI	solai in legno a doppia orditura	legno	Crolli e cedimenti dei travetti ed del tavolato	Crolli e cedimenti dei travetti ed del tavolato
COPERTURE	Parzialmente danneggiata, a quattro falde	Legno e tegole marsigliesi	Mancanze, cedimenti dei travetti di supporto	Azioni meteoriche di acqua e vento, mancata manutenzione, marcescenza
ELEMENTI LIGNEI	Logge e balaustre		Alterazione cromatica, mancanze. marcescenza	Azioni meteoriche, esposizione solare; mancata manutenzione
SUPERFICI ESTERNE	Intonaco a base di terra e calce e paglia	Malta di calce aerea e terra	Erosione, distacchi di ampie superfici	Azioni meteoriche di acqua e vento; mancata manutenzione
TINTEGGIATURA	Tracce di tinteggaitura	Tinta a base di calce	mancanze, erosione, alterazione cromatica	Azioni meteoriche di acqua e vento; mancata manutenzione
SERRAMENTI	Quasi completamente mancanti	legno		
DIMENSIONI EDIFICIO (12.5mx10m) H media 6m		DIMENSIONI MATTONE (31x14x10 cm)		
DESCRIZIONE MORFOLOGICA: edificio residenziale su due livelli fomata da un unità base in muratura di terra, caratterisitizzata da copertura ed elementi lignei aggettanti di derivazione occidentale				
SCHEMA PLANIMETRICO				



10b

Scheda edificio n.8				
ELEMENTO	STATO DI FATTO	MATERIALI	DEGRADO	CAUSA
SCATOLA MURARIA	Continua	Mattoni crudi, cemento, laterizio		
ATTACO AL SUOLO	fondazione in pietra	pietra arenaria locale		
APERTURE	Architravi in legno	legno di pino		
STRUTTURE ORIZZONTALI	solai in legno a doppia orditura	legno di pino		
COPERTURE	Integra a due falde	Legno e tegole marsigliesi		
ELEMENTI LIGNEI	Logge e balaustre	Legno verniciato	Alterazione cromatica, marcescenza localizzata	Azioni meteoriche di acqua e vento; mancata manutenzione
SUPERFICI ESTERNE	Intonacate	Malta di calce aerea	Lacune, distacchi dello strato più esterno	Azioni meteoriche di acqua e vento; mancata manutenzione
TINTEGGIATURA	Tinteggiate	Tinta a base di calce	Distacchi, alterazione cromatica	Azioni meteoriche di acqua e vento; mancata manutenzione
SERRAMENTI	Integri	Legno	Alterazione cromatica	azioni atmosferiche,mancata manutenzione
DIMENSIONI EDIFICIO (16mx10m) H media 6m		DIMENSIONI MATTONE		
DESCRIZIONE MORFOLOGICA: edificio residenziale su due livelli fomato da un unità base in muratura di terra, a cui è stata successivamente addossato un annesso in cemento e laterizio per ampliarne la cubatura				
SCHEMA PLANIMETRICO				



10c

Campione	Quarzo	Calcite	Feldspati	Minerali argillosi	Altro
1 Intonaco	XX	XX	tracce	tracce	_
2 Intonaco	XX	XX	tracce	_	_
3 Malta	X	XX	X	_	dolomite, aragonite
4 Mattone	XX	XX	-	XX	_

ern European architecture as a model for new buildings in the Near East. However, due to its conservative structure, culturally the Ottoman Empire remained detached from the innovative European movement[8]. Nevertheless, it welcomed novelties introduced in Europe, especially in the production and building sphere[9]; in our case, the use of St. Henry Marseilles tiles. (Fig. 15)

The horizontal parts, interiors and exteriors of the building feature wood, as does the pyramid roof, which clearly show the inspiration taken from aspects of western construction.

The *three-brick thick* load-bearing walls are made using 31x14x10cm mudbricks. (Fig. 16)

When subjected to XRD analyses, the bricks and the mortars used for the bedding and for the plasters highlighted that the clay bricks present traces of quartz and calcite, that the bedding mortar was made with a carbonate binder and a carbonate-silicate sand (aragonite, dolomite) with the presence of fossils, and that the plaster was made with a lime binder and a silicate aggregate — quartz and traces of feldspars — nevertheless it cannot be ruled out that the aggregate included a carbonate component[10].

The hotel complex, contemporary to the first, has a two-storey rectangular

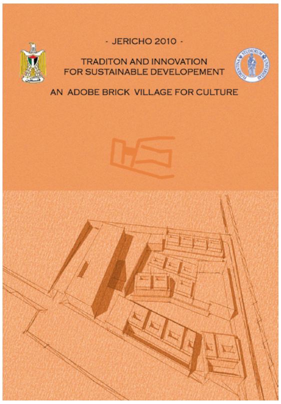


Fig. 11
Tell es-Sultan: ancient mud-brick houses

Fig. 12
New proposal for a mud brick complex

opposite page
Fig. 13
Details of the consolidation of the mud brick hotel

floor plan, with rooms set out symmetrically along a corridor that follows the longitudinal axis of the building. Alongside the first storey only there is another building, which is a bar and restaurant.
This closes the whole construction in a C-shape, thus creating an internal courtyard partially open on two sides.
The compositional characteristics of this building, albeit similar to the first in terms of materials and techniques, are of an extreme simplicity, so much so as to make this construction appear as a compact volume with windows looking onto the road. The considerable dimensions of this structure make it clear that the poorest materials can also be used in building architecture of great representative importance. Indeed, this construction was built along the main road that links the city of Jericho to the most famous and visited sites in the area: Tell es-Sultan, the monastery on the Mount of Temptation and Khirbat al-Mafjar (Hisham's Palace).
Only the details of the study and plans for the residence are shown here.

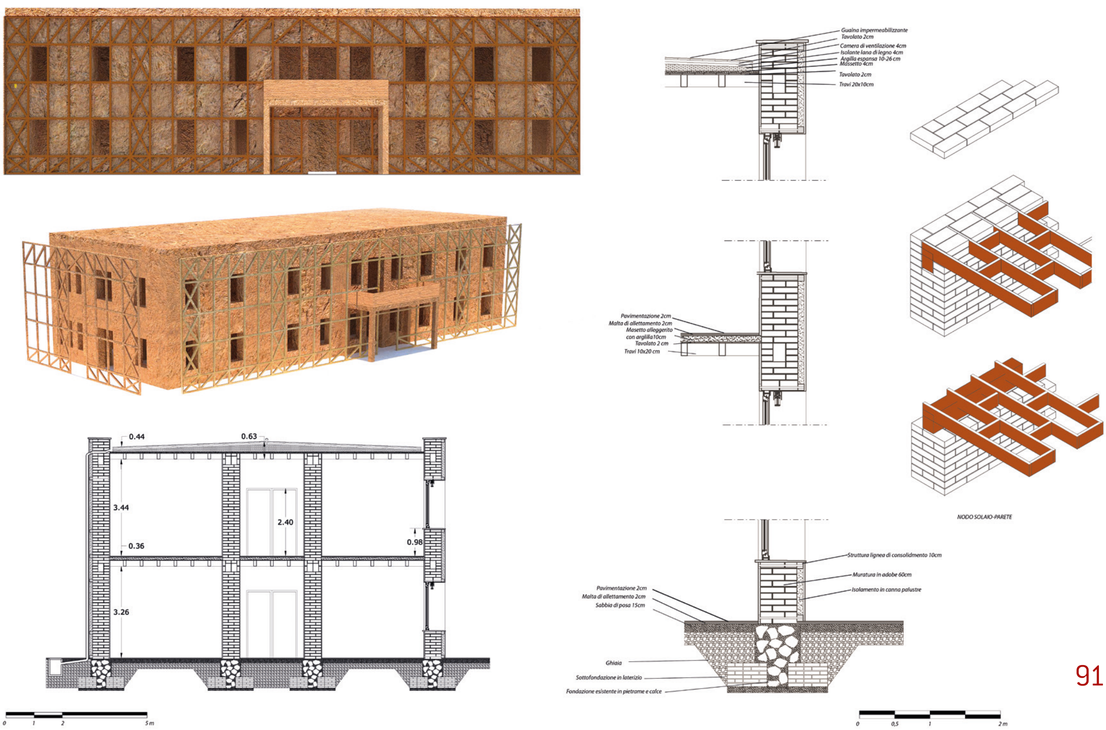
Analysis of the decay

The causes of the advanced state of decay of the building are of a physical and mechanical nature — rainwater, sun, wind, rising damp — and neglect. In particular, rain, in Jericho occasional but torrential, has caused erosion phenomena at the base of the walls especially owing to the lack of a protection strip (Fig. 17). The increase in volume caused by the water infiltrations between the layers of clay and its subsequent reduction owing to evaporation have favoured the formation of cracks of various sizes. The presence of water has also led to a notable decrease in the walls' capacity to resist compression, so much so as to compromise the stability of a large

part of the structures. The damage at the wall-beam joints is greater, where the rotting wood has caused the masonry above to cave in.
The subsidence of the foundations can be attributed to their imprecision and lack of drainage. The plaster has come off all the outside walls, except for the one under the loggia. In sum, it can be asserted that, around one century after it was built, the main cause for the general decay of the construction is a total absence of maintenance. (Fig. 18, 19).
(R.S.)

Proposal for rehabilitation

The main structure of the building consists of brickwork of around 60cm, supported by foundations made of stones mixed with lime. The base of the brickwork has eroded in the most exposed areas and its connection with the foundations is not always guaranteed.
Hence, it is necessary to extend the foundations, also to improve its seismic resistance, with 40cm high brick underpinning, slotted into the existing foundations on both sides. The excavation must be filled with gravel which gets increasingly fine towards the top to favour the natural evaporation of the damp from the soil and avoid it rising to the base of the masonry. The cracks in the walls must be filled with mud, sand and natural lime mixtures, with a good capacity to bond to the support, which is dampened beforehand, and with very little shrinking.
The particularly decayed material can be removed and integrated with small blocks of compressed mud which enable the shrinkage phenomena




GRANDE-ECAILLE POUR TOITURE
BREVETES S.G.D.G
St HENRY - MARSEILLE
ROUX FRERES

to be contained. In order to improve the seismic resistance of the building, a vertical wooden grid of small 10x10cm beams, with an inter-axis varying from 1m to 1.5m in relation to the presence of openings for doors and windows, has been envisaged. The grid of beams, slotted and glued together, will be braced on the horizontal and vertical strips; in the vertical direction there will be double braces.
In order to guarantee continuity between the two levels of the structure, a continual lamellar wood beam will be inserted in the brickwork, with toothing at the corners.
The floor will consist of a series of small parallel beams, with an inter-axis of around 40 cm, linked to the other transversal elements that are staggered to protect the beams from twisting. The seismic resistance of the walls will therefore by guaranteed by the structural continuity of the building. (Fig. 20)
In order to restore the external aspect, the thickness (10cm) of the wooden consolidation grid will be filled with reeds. Reeds, with good heat insulating properties, are breathable, favour the diffusion of vapour and perform a hygroscopic balancing action; furthermore, given the high quantities of silicon acid contained, it is fire resistant and in the event of a fire does not pollute. The plaster can consist of clay and sand for the interiors with an addition of hydraulic lime for the exteriors. Some natural additional components will also be used, such as chopped hay, which reduces the phenomenon of cracking and helps to thin out mixtures. Unlike mineral fibres, despite having inferior mechanical performances, vegetable fibres can absorb the water in the mixture and, with drying, make a single body with the mud mortar. The quantity of water can vary according to the type of mixture and the mineralogical characteristics of the clayey binder. Clay-based plasters have the capacity to regulate the humidity of the rooms, and perform an absorbing action in the presence of a lot of damp and, in the opposite case, a releasing action, thus maintaining optimal humidity levels for humans, i.e. between 50% and 70%; they have good thermal inertia and excellent soundproofing properties[11]. Clay, as a colloid, also retains the dust, gas and smells present in the air and protects from electromagnetic fields.
The jutting loggia, balustrade and its roof are made entirely of painted wood from the local area.
The most sheltered horizontal elements are better preserved while some vertical elements of the balustrades are missing, having been replaced in time to avoid collapse with different, easily identifiable elements. Instead, no traces remain of the original exterior staircase connecting the two floors of the house, built against the north-eastern and north-western sides, which will need to be totally rebuilt. The roof structure, built in pyramid style with wooden beams, is not very safe.
It is covered with Marseilles tiles and is not insulated. The structure can be rebuilt like the original with new material and the insulation can be made with wood fibre inside a ventilation chamber.
By studying the movements of the sun using special software, it was found

opposite page

Fig. 14
Case study house of the Ottoman period

Fig. 15
St. Henry tile

Fig. 16
Detail of the mud bricks

Fig. 17
Detail of decay for erosion phenomena

[11] Mecca et alii 2008, 13-22.

Load-bearing walls
The intervention for the restoration and seismic enhancement of the building envisages the consolidation of the load-bearing walls with the use of a wooden grid, braced and gripped to them, constituted by 10x10 cm components placed with an interaxle spacing that ranges from 1 to 1.5m, depending on the presence of openings. The joists of the structure are wedged and glued together, the horizontal strips are individually braced in the contrary direction based upon a central axis of symmetry for each facade, while the vertical strips are braced in both directions, so as to offer a greater resistance by the vertical components in case of the collapse of the structure.

The foundations
The existing foundations are made with stones of various dimensions bound with mortar. The intervention, aimed at enhancing the stability of the grip to the ground, envisages a 40cm deep clay-brick sub-foundation which intersects the 20cm one that is already present on both sides. The lateral excavation will be filled in with gravel in order to favour the natural evaporation of the humidity of the ground, thus reducing the problems related to the capillary movement of moisture in the walls

The structural continuity on every level of the plan is reconstructed with the use of wooden lamellar beams, appropriately placed within the walls and connected with each other at the corners and other points of intersection, with single or double sections. The wooden sections are to be doubled if the wall is internal and supports two levels with joints placed on the same direction, and single if the intervention is carried out on a perimetral wall with single level beams. The load-bearing structures of the attic are constructed with a series of small parallel wooden beams, with an interaxle spacing of 40cm and unaligned transversal connecting beams, to counteract the effects of torsion. The seismic resistance of the walls is guaranteed by the structural continuity of the construction, from the joint between the floors and perimetral walls and, in general, by the uniform horizontal and vertical distribution of the structure.

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Fig. 18
View of the interior of the house

Fig. 19
Detail of the jutting loggia and balustrade of painted wood

Fig. 20
Details of the consolidation of the house. Structural restoration

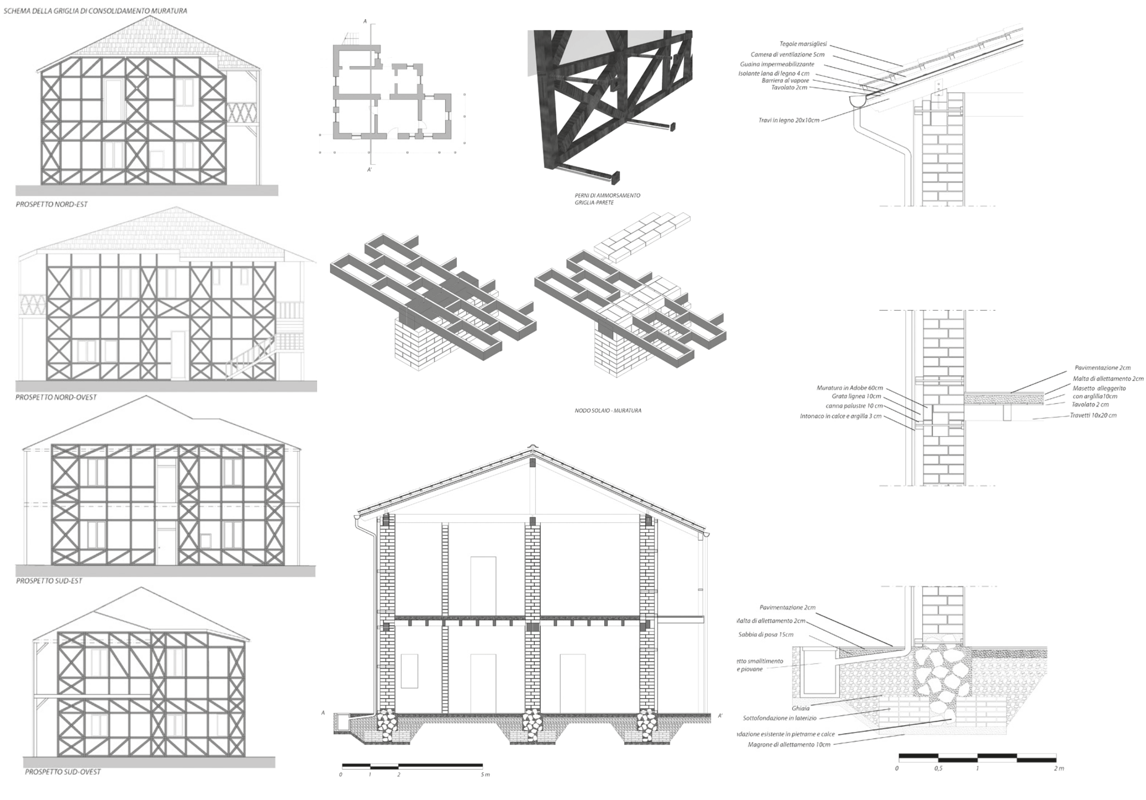

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Fig. 21
Flow diagram of the research project

that the inclination of the rays falling on the southern façade can vary from 32° in the winter months to 82° in the summer months. The most exposed sides are those facing to the south-east and south-west. The low part is protected by the jutting terrace. To increase the protection from radiation new frames can nevertheless be placed inside the wall which, thanks to its great thickness, would increase the shade during the hours of most exposure. It has been verified that no condensation forms in the interstices.

The complex should produce enough energy to be self-sufficient and to have a low environmental impact thanks to the use of the primary resource in the area: the sun. The overall concept of the engineering plant is based on the following fundamental goals: to guarantee and maintain active and passive safety for people and the environment; to guarantee and maintain hygiene and comfort within the building independently of the external climatic conditions; to favour the use and integration of passive strategies with a low energy consumption; to guarantee a low energy consumption target for the complex in terms of the energy required for air-conditioning, hot water production, mechanical ventilation and artificial lighting.

The different plant systems should all be integrated, flexible, and access and easy to maintain; their optimal management should be ensured by adopting management and regulation control systems, that make them capable of responding to climatic changes and to the variability of energy requirements in order to avoid a costly waste of energy. To exploit the solar energy needed to guarantee the residence energy autonomy an area of 60sqm of solar panels would be needed, with at least 10 sq m of which heat-photovoltaic, to obtain the production at full capacity of 6 kW of electrical energy and the hot water needed for sanitary use. Therefore, it has been proposed to exploit the slope of the surrounding ground to the south of the building. The hot sanitary water will be collected in a tank underneath the outside stairs, with a system of forced circulation so that the solar collectors can be placed at will.

The air conditioning system, seeing the great thermal inertia of the wall — out wall plus external infill — will consist of an external reverse cycle heat pump, with heat regeneration from the compressor, and it will contribute to the production of sanitary water. In the internal rooms, the heat will be regulated using fan coil units to be positioned in the false ceiling (Fig. 21). (I.C.)

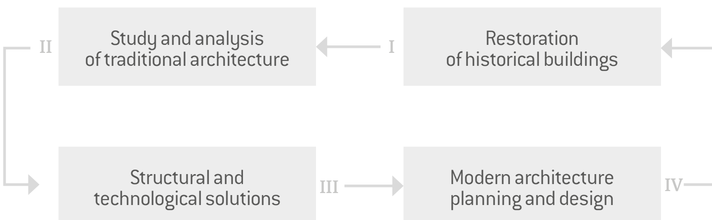
I. The project for the conservation of the two examples of abandoned adobe structures was carried out thanks to the analysis of traditional construction techniques and to the study of the possible improvements aimed at better security and comfort. Thus with the integration of systems and structural enhancement, the two historical structures may now satisfy the requirements related to security and energy performance, preserving at the same time the building traditions and the skills of the local masons.

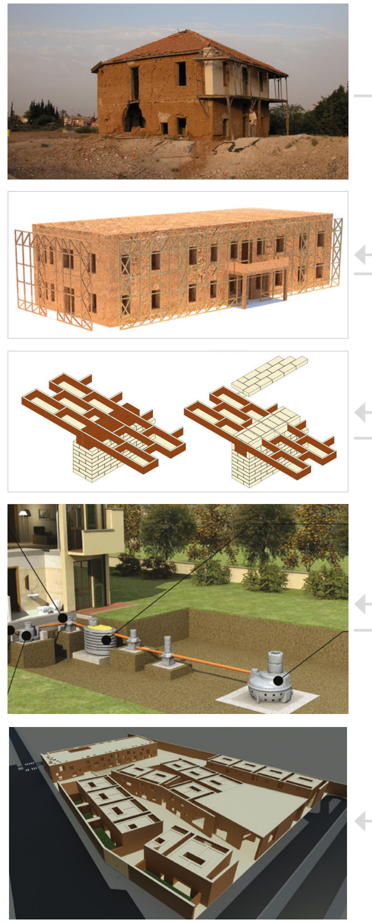
II. The structural system is designed to enhance the seismic response of the buildings and is based upon the continuity of the walls, guaranteed by lamellar wooden components that support the horizontal structures. The structure of the attics consists on small beams placed at a distance of 40cms from each other, approximately, with the inclusion of unaligned transversal elements aimed at fostering the resistance to torsion.

III. The concept of the project has the following objectives:
- maintaining active and passive security of the inhabitants of the building
- a high level of environmental comfort in all external conditions
- a low consumption of energy and its production from renewable sources,
- a limited consumption of water.

IV. Multidisciplinary work permitted the development of a project which, using traditional adobe techniques enhanced with technological improvements, may respond to the requirements of sustainable development in the region.

V. The new residential complex "for culture and research", at the entrance of centre of the city, is aimed at housing groups of students and researchers, who are attracted by the multiple resources of the region. A "production theatre", which is envisaged within the complex, represents another cultural attraction for the city and a new space for social interaction for both the population and the inhabitants of the new complex.





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