Demolition and reconstruction?

After the long seismic sequence named “Amatrice-Norcia-Visso”, a large part of the Italian population realized the difficulty to obtain adequate safety levels for the diffuse building heritage. During the earthquake, characterized by a limited magnitude level (about 6.3), a large part of the building heritage, even if restored following the most recent technical codes, collapsed suddenly. The consequences for the population concerned were devastating. Several hundred people died and about 30,000 people moved to other locations by the sea without knowing if they could have returned to their native places, considering that some historical towns were completely destroyed. The particular extension of the damages with the collapse of entire urban centers has shown that the damage recorded can only be partially attributed to specific defects of some buildings or non-compliance with existing technical rules. More generally, the particular seismic sequence gave evidence of the difficulty to grant, at the same time, the preservation of the historical identity of these towns and the use of historical buildings with modern standards and adequate safety levels. As a consequence, the basic concept of the seismic codes relating to seismic with respect to intervention on the historical building heritage (improvement instead of adaptation) has been questioned and at the political as well as technical level a debate has emerged regarding the forms with which to face the emergency, envisaging the possibility of an extensive process of demolition and reconstruction.

The shock of the damage extension and the possible abandonment of entire areas of the nation, with important social and economic consequences, has once highlighted the centrality of said issues and the need to further deepen research areas such as those related to the issues of the seismic safety of the diffused building heritage to avoid the supremacy of simplified and purely...
technological (an therefore completely partial) approaches to adequately preserve the identity and the image (which is also part of the constructive culture) of these places, not only for cultural reasons but also for economic reasons, considering the touristic appeal of these places.

After this earthquake the need to give a further and significant impulse to research in this area emerged strongly, to the analysis of specific cases with the aim of finding solutions, which hardly will be general or generizable, but which will be useful to highlight useful orientations to guarantee security, adequate levels of life in the buildings that characterize the smaller centers, without losing the cultural identity that characterizes these places.

Marco D’Orazio

Editor
The recovery of the former University pediatric clinics in Cagliari: a project for the reuse, environmental redevelopment and structural and anti-seismic retrofitting of a modern building in a monumental centre

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Highlights

The main objective of the research is to examine intervention methodologies for the redevelopment of modern heritage with an interdisciplinary approach that combines the requirements of conservation with those of modification, which allow to respond with quality to the changed conditions of use.

Abstract

This paper discusses some of the issues related to the redevelopment of the modern building, with a rethink about the spaces consequent to the need to change its planned use that is structurally more burdensome and the related anti-seismic retrofitting. The case study concerns the project for the restoration and reuse of the former pediatric clinics of the University of Cagliari, according to an integrated method of intervention which, in the absence of historical documents, made it possible to reconstruct the material and structural characterisation of the building and its technical and constructional features.

Keywords

Modern recovery, Integrated project, Architecture and historic centres, Non-destructive techniques, Minimum space devices

1. INTRODUCTION

The redevelopment of modern architecture has become one of the essential priorities in the process of renewal in our cities, especially when placed in historical contexts of particular historical-monumental importance. Even in contexts where risks are almost non-existent as in Sardinia, seismic retrofitting has become an inescapable necessity which accompanies the process of rethinking the spatial, architectural, technological and performance aspects of buildings constructed in the 1900s, which are now considered to be authentic historical buildings (particularly those built up to the 1960s). Buildings that were constructed according to state-of-the-art experimental procedures for
the period in which they were conceived, suffer nowadays from their own experimental genesis which, even in the more significant cases, requires regulatory and performance improvements, and more in general, an adaptation to contemporary uses. The case study of the redevelopment project (carried out with expert advice from DICAAR) concerning the former pediatric clinics of the University of Cagliari enables us to illustrate an integrated method of intervention for rethinking space, together with a hypothesis of planned use that is structurally more burdensome with the consequent anti-seismic retrofitting.

2. THE FORMER PEDIATRIC CLINICS AND THE FIRST MODERN EXPERIENCES

The former University pediatric clinics are located in an urban area that historically represented the un-built margin between the mediaeval fortress of the Castello di Cagliari and the archaeological park of the Roman Amphitheatre. This is an intermediate position between the lower town (the historic district of Stampace) and the citadel (the Castle and the Park of Viale Buoncammino) along what is now Via Porcell, resulting from an imposing urban rethink by the neoclassical architect Gaetano Cima who, at the end of the 1800s, introduced a new connection with the fortified historic town. The city began its expansion outside the walls, through the foundation of the University’s hospital and scientific complex. The hospital part consists substantially of two buildings: one from the early 1930s and the other started immediately after the war and completed in 1958. The first Pediatric Clinic was one of the first attempts to introduce modern culture into the architecture of Cagliari. However, these experiences that could be referred to as “pioneering” did not fully implement the formal opportunities offered by the reinforced concrete frame and the consequent opportunities for open plan structures and façades. Designers and builders of the era were still unable to totally abandon the techniques and languages related to the massive aspect of traditional wall construction work, resulting from a strong influence from the Pre-modern building elements which derive from a mix of techniques in which reinforced concrete frames coexist and cooperate with stone- or brick-wall structures.

Freed from the eclectic design, which at that time had characterised other University and institutional buildings in the city (Palazzo delle Scienze, Biology Institutes, Legione dei Carabinieri, etc.), the Pediatric Clinic approached the almost proto-rationalist language, which in the Twentieth Century asserted itself as a precursor of the heroic experience of the Italian

1. INTRODUZIONE

La riqualificazione dell’architettura moderna è ormai una delle priorità irrinunciabili nei processi di rinnovamento delle nostre città, specie quando inserita in contesti storici di particolare valore storico-monumentale. L’adeguamento antismosico, anche in contesti a rischio quasi nullo come quello sardo, è una necessità includibile che si accompagna al ripensamento spaziale, architettonico, tecnolo-gico-prestazionale degli edifici costruiti nel novecento, ormai da considerarsi a pieno titolo storici (in particolare quelli costruiti sino agli anni ’60). Architetture costruite secondo spinte avanguardiste d’evangeli-sia per il momento storico in cui sono state concepite scontano oggi la loro stessa genesi sperimentale che, anche nei casi maggiormente significativi, rende necessario l’adeguamento normativo, prestazionale e più in generale d’uso contemporaneo. Il caso studio del progetto di riqualificazione, (condotto con la consulenza scientifica del DICAAR) delle ex-cliniche pediatriche dell’Università di Cagliari, consente di illustrare una metodologia di intervento integrata per il ripensamento dello spazio, associato a un’ipotesi di variazione di programma d’uso strutturalmente più gruzzolo con conseguente adeguamento antismosico.

2. LE EX-CLINICHE PEDIATRICHE E LE PRIME ESPERIENZE MODERNE

Le ex Cliniche Pediatriche universitarie sorgono in un ambito urbano che storicamente ha rappresentato il margine non costruito fra la rocca medievale del Castello di Cagliari e il parco archeologico dell’infortunato romano. Si tratta di una collocazione intermedia che, alla fine dell’800, introduceva una nuova connessione con la città storica fortificata. La città iniziava la sua espansione fuori dalle mura, attraverso la fondazione del polo ospedaliero-scientifico universitario. Il complesso delle cliniche è costituito sostanzialmente da due edifici: uno risalente ai primi anni ’30 del Novecento, l’altro iniziato nell’immediato dopoguerra e terminato nel 1958. La prima Clinica pediatrica costituisce uno dei primi tentativi di introduzione nella cultura moderna dell’architettura cagliaritana. Tuttavia, queste esperienze che si potrebbero definire “pionieristiche”, non a vevano del tutto recepito le opportunità formali del telaio in cemento armato e le conseguenti possibilità di pianta e facciata libere. I progettisti e costruttori dell’epoca ancora non riuscivano ad abbandonare del tutto le tecniche e i linguaggi legati alla dimensione massiva della costruzione muraria tradizionale, esito di una forte influenza del cantiere di matrice pre-moderna da cui discende una connessione di tecniche in cui i telai in cemento armato convivono e
Modern style. The “modern Italian approach to architecture” (Poretti, 2008) features a leading role played by thick walls both in the structural and formal conception of buildings.

Technological and constructional hybridisation is also a recurrent aspect in this particular case of the former Pediatric Clinics: on the one hand, they experimented with innovative solutions with horizontal elements in reinforced concrete and/or cement and brickwork, which enabled the reduction of their resistant sections and compressing components on the walls, and on the other hand, the elevated structure continued to be conceived according to the traditional scheme of the resistant cell with massive masonry structures. This is a mixed system which, albeit through a “spurious” conception that was still unable to fully benefit from the structural potential of reinforced concrete frame structures, led nevertheless to a substantial reduction in the size of structures towards a “structural optimisation” (Gulli. 2012) along with an improvement in the quality of space. The sections of horizontal elements and masonry were reduced compared to the recent past and the same wall structure was invariably strengthened by reinforced-concrete frame portions where the façade was prevalently characterised by openings on the front of the resistant box.

It was clearly a compromise: a cautious approach, a first contact with the new technology of reinforced concrete launched in those years in many buildings in Cagliari, while the experiments conducted primarily by Ferrobeton on buildings like the same Palazzo delle Scienze, the Legione dei Carabinieri or the Palazzina Scano al Corso were precursors to the introduction of the reinforced concrete frame, which would only become general practice in the Post-war Period.

In fact, the second Pediatric Clinic, known as the Clinica Macciotta (after its founder), was started just after the war and completed in 1958 and was also built according to the same pattern, with cement and brick slabs on walls that were almost exclusively in masonry. In this case, it is precisely the extremely interesting central hub, housing the stairwell in reinforced concrete and the front lobby and acting as a connection volume between the two mutually rotated building structures, that was built entirely using techniques that demonstrate a growing mastery of the technology and a fully framed structural system that addresses the structural union with the building which was conversely built with a masonry structure in brickwork. The role of this hub between the buildings is significant also in terms of the formal and linguistic characteristics and allows the entrance to stand out with a monumentality that is inherited from the recent past.
3. THE PROJECT FOR RESTORATION AND REUSE

The current situation provides a rather patchy picture as regards the state of conservation and general deterioration of the buildings that make up the complex.

While the former Pediatric Clinic was the subject of recent major maintenance work which completely revamped the external envelopes and partially the interior, the Clinica Macciotta building and the villa from the 1930s that completes the upper articulation of the complex, are in a substantially more significant state of disrepair: partially missing or flaking plasterwork; stone cladding on the façade in dangerously unstable conditions; inefficient and incorrectly-functioning rainwater drainage systems; antiquated doors and windows that are unable to ensure the building heat engineering performance characteristics; flat roofs with sealing properties in a highly critical condition.

Moreover, the three buildings have also been colonised by a progressive “parasitism” from external systems, mostly on the south-facing rear side, according to an episodic process of additions linked to contingent needs that have never been associated with properly-planned intervention work. As a result, the flat roofs are in some cases totally occupied by obsolete machinery and pipework, while the façades are affected by risers of various natures and sizes. In terms of distribution, the three-building complex is currently fully navigable at all levels; an integrated system of connections on the floors and vertical connection elements, located in the different buildings, allows general circulation, albeit with some passages governed solely by flights of stairs and mezzanine floors between one building and the other (often of a temporary nature) which do not actually provide full accessibility to people with disabilities. The endowment of vertical connection systems provided by staircases and lifts, especially when assessed in light of the new intended use and the number of intended users, appears totally under-sized and inefficient.

The division of spaces – the result of a system of intermediate partitions between the load-bearing masonry structures – is unsuited to the new intended use as it does not allow the rationalisation of the various functions of the rooms required by the new plans for the building and breaks up the available space excessively.

The redevelopment project for the Clinica Macciotta is the result of an integrated approach which looks initially at its intended reuse and is not limited to bringing the buildings into line with the updated structural, technological, safety, environmental and performance requirements by simply adding renewed elements, but seizes the opportunity to entertain a more
broadly encompassing idea, with the ultimate aim of giving back to the city a complex that is fully suited to a new phase of life in every respect and at every level. The plan proposes a renewed public dimension for the area, through the redefinition of a collective and easily navigable ground floor space, with study rooms for group activities, refreshment areas and the readaptation of the open spaces on the terraces overlooking the historic city. The permeability between the front and back on the ground level is an essential precondition in the new urban dimension and the roles between the part of the complex devoted to teaching, with classrooms and laboratory spaces, and the part intended for departmental activities with studies and meeting rooms are clearly defined in its longitudinal development, thus complying with the dictates regarding fire-prevention compartmentalisation, anti-seismic improvements and in terms of its functional and planned use. In general the underlying principle for the redevelopment of the Pediatric Department of the Clinica Macciotta is that of minimum compatible intervention, associated with a systematic and careful purging of the various incongruous functional layers of engineering systems in order to restore the readability of the original historic complex. The categories of intervention referred to involve the building renovation of those parts of the envelope and the exteriors and also the major maintenance work for repairs to the interior, associated with a systematic and careful purging of the various engineering systems; in particular, this involves the rehabilitation of the roofs of the historic buildings and the terraces overlooking the Fossa di San Guglielmo, with some constructional elements in compliance with structural and seismic requirements (cross-bracing walls, intermediate floor slabs, staircases and lifts), the consolidation of the horizontal elements, demolition of lightweight partitioning walls, rebuilding of a new partitioning system for the spaces between the load-bearing walls and the reconstruction of a new system of vertical connection elements (integration and reconfiguration of staircases and lifts); 1. a new layout for the distribution, accessibility and circulation network with a reconfiguration of the interior spaces that involve modifying some constructive elements in compliance with structural and seismic retrofitting (cross-bracing walls, intermediate floor slabs, staircases and lifts), the consolidation of the horizontal elements, demolition of lightweight partitioning walls, rebuilding of a new partitioning system for the spaces between the load-bearing walls and the reconstruction of a new system of vertical connection elements (integration and reconfiguration of staircases and lifts); 2. redevelopment of the base of the building and the surrounding outdoor areas by eliminating the added structures and incongruous volumes adjacent to the historic buildings and in the areas of pertinence in order to improve accessibility and permeability between the Interior and exterior of the building; 3. redevelopment of the spaces occupied by cumbersome and obsolete engineering systems; in particular, this involves the rehabilitation of the roofs of the historic buildings and the terraces overlooking the Fossa di
San Guglielmo [St. William’s Ditch], with the consequent redefinition of the engineering plant systems for the entire complex.

The readability of the historical complex is an objective which is pursued through two combined and complementary operating procedures: one involving removals and one involving additions or replacements. The outcome of this is a new coordinated image of the complex that is not limited to returning the places to their original conditions, but also involves reorganising the system and its functions to meet contemporary needs. A particularly emblematic aspect of this is the replacement of the building connecting the Clinica Macciotta with the Pediatric Clinic which had “in the past resolved the question of connecting, in an almost improvised and rather incoherent manner, the old and the new buildings”, which also includes some functional and technological improvements and was located there to coordinate the buildings of the two former clinics.

The plan for reuse of the two historical buildings involves the integration of the existing spaces through a systematic use of independent specialist units on formal terms compared to the existing autonomous units on functional and constructional terms, which enable an effective answer to be given to the themes of reuse and the relationship between “the old and the new”. As a minimum unit, the box ensures the integration of specific functions which require recognition or which cannot effectively be placed within the existing historical elements due to issues regarding performance or because it would excessively sacrifice the space in the finest areas. Each box will be able to accommodate bathroom facilities, storerooms, classrooms and all those places where one intends to perform highly specialised tasks together with their technological requirements that were more difficult to achieve in the historic building.

The boxes are defined by the relationship that is established with the existing structures, according to their related positions: In-boxes, Between-box and Top-boxes.

a) **In-boxes.** They are wholly contained within existing spaces where specialised functions are introduced by modifying the overall distribution layout of the existing structure. These are the stairwells added to the building, that is intended for teaching purposes, and the redevelopment units in the former heating plant to be used as new teaching spaces.

b) **Between-box.** This is the most complex box among the ones included in the project: it will be sandwiched between the two differently-aged buildings and will replace the old connecting structure; it will solve the issue of longitudinal connection between the buildings and between the front and the rear of the

originario dei luoghi, ma ne riarticolca l’impianto e le funzioni per rispondere alle esigenze contemporanee. Emblematico in questo senso è la sostituzione del corpo di raccordo tra l’edificio della Clinica Macciotta e quello della Pediatrica che aveva “risolto a suo tempo in modo quasi improvvisato e piuttosto incoerente il giunto vecchio-nuovo, che risentivano in sé adeguamenti funzionali, tecnologici ed è interposto a coordinare gli edifici delle due ex cliniche. Il programma di riuso dei due edifici storici prevede l’integrazione degli spazi esistenti attraverso un uso sistema di unità specialistiche indipendenti sul piano formale rispetto alle preesistenze e autonomie su quello funzionale e complessivo. La scatola come unità minima garantisce l’integrazione di funzioni specifiche per le quali sia richiesta una riconoscibilità o che non sia efficiente collocare entro la preesistenza storica per questioni prestazionali o perché ne sacrificherebbe eccessivamente lo spazio negli ambienti più pregiati. Ogni scatola potrà accogliere servizi igienici, depositi, aule e tutti quei luoghi nei quali si previsione di svolgere attività altamente specializzate a cui sono associati requisiti tecnologici più difficilmente raggiungibili nella fabbrica storica. Le scatole sono definite dalla relazione che si stabilisce con la preesistenza, secondo la loro posizione reciproca: In-box, Between-box e Top-box. a) **In-box.** Sono completamente contenute all’interno di vani esistenti in cui introducono funzioni specialistiche modificando l’assetto distributivo complessivo della preesistenza. Si tratta dei corpi scala aggiunti nell’edificio destinato alla didattica e delle unità di riqualificazione della Pediatrica che avevano un ruolo determinante per l’adeguamento stocico del complesso, eliminando l’inopportuno collegamento che aveva reso solidali i due edifici, altamente penalizzante in caso di sisma. Sul piano funzionale risolve in sé tutta la dotazione dei servizi igienici per l’intero edificio destinato alla didattica, il collegamento verticale di emergenza per l’edificio destinti agli studi, una minima dotazione aggiuntiva di spazi di lavoro e la collocazione, adeguatamente controllata sotto il profilo paesaggistico, delle macchine esterne dei nuovi impianti di climatizzazione. Nell’attacco al suolo la scatola between-box è totalmente attraversabile e mette in relazione diretta gli spazi pubblici a monte sulla via Porcelli con i terzi, adeguatamente affacciato sulla città storica. c) **Top-box.** Sono collocate sulle coperture a terrazza, in aderenza ai corpi d’atto, il cui uso era essenzialmente di servizio tecnico. Il loro obiettivo è limitato al punto 3 dei principi di intervento, poiché
system of outdoor spaces. It satisfies the principles of intervention and plays a decisive role in the seismic retrofitting of the complex, eliminating the inappropriate connecting structure that had made the two buildings united, which would be highly detrimental in the event of an earthquake. In functional
terms, it resolves by itself all the requirements for bathroom facilities for the whole building used for teaching purposes, the emergency vertical connections and the positioning of the external engineering plant for the new air conditioning systems, that are compliant in terms of landscape planning requirements. At a ground level, the between-box is fully traversable and directly connects the upstream public spaces on Via Porcell with the terraces overlooking the historic city.

c) Top-boxes. These are placed on the terrace roofs, adjacent to the roof-top structures, whose use was essentially linked to technical utilities. Their purpose is limited to point 3 of the intervention principles, because they allow the real and complete reuse of large surface areas that are freed from the intrusive hospital plant systems and increase the provision of work spaces.

The outdoor areas had up to now been ignored by the original plans and the subsequent works and were exclusively an area of space for solving engineering plant issues that have led to the current state of decay and impracticability. The project recognises the potential relational value between the upper and lower parts of the city and redefines a public plan in terms of ground levels and makes the full accessibility of the building a precondition for an overall improvement of the complex on an urban scale, through the redevelopment of the interior atria filtering devices between the inside and the outside. As regards the building itself, the permeability and the connection between the public spaces to the north on Via Porcell and those to the south on the terraces enables the natural ventilation dynamics to be enhanced and the overall heating and hygrometric well-being of users to be improved.

The intervention involves a ground project that redefines the terraces for the redevelopment of the outdoor areas, where possible reacquiring the lines of the original ground layout while maintaining the objective of maximum viability and accessibility for all. In this way, the project generates new collective spaces not intended solely for the academic community but integrated with the city as common social areas and for moving between the areas of the city.

It also offers a response to the need for water drainage coming down from the slope with a coherent system of rainwater collection and management that involves its containment, slowdown, drainage and potential reuse, associated with a general restoration of a satisfactory level of soil permeability. This last factor is particularly important in areas that are excessively “mineral” such as historic centres, because rainwater flows on the surface and causes damage and inconvenience during heavy rainfall. Improvements to the nature of ground surfaces through controlled planning and proper water management, taking
into account the particular “impluvium” style conformation of the urban area in question, represent essential objectives and requirements in order to restore a proper relationship between architecture and the environmental context.

4. FROM KNOWLEDGE TO ANTI-SEISMIC RETROFITTING: THE STRUCTURAL PLAN

**PAEDIATRIC CLINIC.** The Pediatric Clinic was built using various types of brick walls and horizontal elements. The floor slabs on the first floor are made of steel girders and small vaults, while the other floors are made of cast-in-place reinforced concrete of different types with bricks and inter-placed load-bearing elements of various sizes, but also with pre-fabricated concrete joists and hollow blocks of the same material. The horizontal elements of the basement were made with barrel vaults. The walls are also of various types and sizes: a significant part is made with “opus incertum” consisting of calcarenite from Cagliari, and others with solid brick masonry while on the top floors (fourth floor and small attic) there is masonry consisting of semi-full bricks.

In particular, along the southern façade the load-bearing walls are comparatively narrow (45-50 cm), even if these are also made from calcarenite “opus incertum”. The building has no bond-beams except in the roof floor-slab and the floor-slab between the third and fourth floors; the latter was built several years after the first three levels. The connecting stairways were all built in reinforced concrete.

**CLINICA MACCIOTTA.** Compared to the Pediatric Clinic, the walls of the Clinica Macciotta have wider foundation walls (70-90 cm on the ground floor, about 100 cm in the basement) almost entirely made of solid bricks. The building, however, has a greater height (5-7 levels). The ground plan shape consists of two wings that are mutually-rotated by about 120° with a central hub where there is a large reinforced concrete stairwell of particular architectural interest, characterised by a triangular shape. The dividing walls on the floors above the first plug in the upper floors are made from calcarenite “opus incertum” (65-80 cm thick).

The floor slabs are substantially divided in two types: a floor slab of cement and bricks cast in situ and a floor slab with prefabricated beams and hollow concrete bricks located in the North Wing. The presence of reinforced concrete bond-beams was found in all floor slabs which, in load tests showed an excellent degree of jointing.
STRUCTURAL SURVEYS. In order to proceed with the regulatory retrofitting of the building, it is necessary to identify some characteristics of fundamental importance such as the geometry of the structural elements, structural details (reinforcements, connections, etc.) and the mechanical properties of the materials. Such data can be obtained from the existing documentation, from suitable site surveys and with static tests including: destructive tests (DT) i.e. core samplings with the breakage of taken samples, partially destructive tests; (PDT) such as pull-out tests, tests with flat jacks and endoscopic tests; non-destructive tests (NDT) such as sclerometer tests, thermographic tests, cover meter tests, ultrasonic tests and load tests on floor slab structures. Assuming an LC1 knowledge level, if there is no experimental information on the resistance of the walls of the two buildings, we should use minimum resistance values and the related safety coefficients would be significantly penalising. That is why some experimental tests are necessary, such as those with flat jacks that allow us to obtain a more accurate assessment of the strength of the masonry until reaching an LC3 level of knowledge. This allows us to make more appropriate choices for the structural design of consolidation.

MODELLING AND ANALYSIS. We used two types of modelling, one for “linear” analyses (including that for non-seismic loads) and one for “non-
linear” static analyses according to the equivalent frame method. The project consisted of the demolition of the staircase, the addition of a new staircase and bathroom facilities, the addition of openings, including trimmings on certain cross-bracing walls and the reinforcement of weaker load-bearing walls. We then proceeded to perform a comparison of the behaviour of the building before and after the project works, using the linear static analysis and the dynamic modal analysis, both carried out using the finite element method (FEM). In fact, even in Sardinia (which is the least-seismic area in Italy, even among the seismic areas) a complete seismic assessment is required. Usually, in light of the expected low accelerations, this kind of assessment is no more restrictive than other horizontal actions such as, for example, the wind action.

In this case, however, there was a requirement from the Fire Department to locate the archive included in the project on the upper floors and this led to a significant seismic effect. In the assessment phase of the structural design, the inclusion of a joint between the two parts of the building (Pediatric Clinic and Macciotta) allowed the modelling to be done independently. To take advantage of the good deformability of the walls, we assessed their seismic behaviour after the project intervention through a non-linear static analysis using the equivalent frame method (push-over). Modelling the entire building which is longer than 120 m, using the non-linear static analysis, would have been rather complicated, because a number of the floor slabs of the respective buildings are not at the same level and the effective modelling of the effects of the horizontal actions of the floor slabs on the cross-bracing walls would become extremely difficult, especially on a building of this size. The analyses we performed highlighted the probable need for a reinforcement intervention on the less-thick walls made of calcarenite with “opus incertum” while the simulations on the behaviour of solid brick walls had a positive outcome, showing that their resistance should be of an acceptable level.

STRUCTURAL CHECKS. The models created with suitable software, show that the linear static assessments were not satisfied, especially for vertical loads due to the fact that the implementation of the requirements indicated in the regulations in force (N. T. C. D.M. - Italian Ministerial Decree on Construction Technical Regulations of 14/01/2008 – Circ. 02/02/2009) require the use of high safety coefficients. When performing the non-linear static assessments (push-over), the behaviour of the walls was shown to be much more satisfactory; this is because the bearing capacity of the masonry structure remains high even in the presence of significant stress, with a ductile behaviour of the whole building in the plastic range. This is also
because the Clinica Macciotta is provided with bond-beams on each floor slab structure, which improve their performance in withstanding horizontal actions. To extend certain classrooms, the project plans to join together some areas separated by cross-bracing walls by opening them and adequately strengthening them with steel frames which must be sufficiently flexible in order not to limit the flexibility of the building and not to cause stress concentrations in the masonry, if they turned out to be too rigid. The model distinguished the different stiffness of the steel-beam floor structures without bond-beams from that of the reinforced concrete floor slabs especially when provided with bond-beams. The vaults of the Paediatric Clinic were modelled in the software and were approximated to flat floor structures with adequate stiffness as regards their static behaviour. Finally, the change of use leads one to believe that is is highly likely that some consolidation works for the horizontal structural elements (floor slabs) are necessary, with an underlying grid of steel beams to ensure adequate carrying capacity and less deformation (especially on floor slabs with steel beams), as a consequence of the expected load increments. With regards to the foundations, it is necessary to know the geometry of the continuous foundations underneath the walls, as well as the geo-technical and seismic characteristics of the ground.

5. CONCLUSIONS

The redevelopment of the former pediatric clinics is part of a well-established recovery trend regarding modern heritage, that recognises the importance of the innovation used to design these buildings by considering them as authentic examples of historical heritage buildings worth safeguarding. The reuse is, as known, the most effective strategy for ensuring durability to

Figure 3. Structural modelling using the equivalent frame method after inserting the joint between the two buildings.
buildings but also involves continuous adjustments in terms of regulation, structure, technology, environment, space and performance. The presented project embraces this strategy and aims to combine the resulting different improvement aspects within a systemic vision. In this way, for example, the intervention re-develops the base of the building and its external areas, managing a natural ventilation system along the atria, and includes minimum support devices, through categories of “boxes”, capable of managing the separations between the two buildings and embracing specific functions inside them in addition to contributing to the whole structural consolidation.

The restoration and seismic retrofitting works represent the opportunity to redefine a new architecture based on the principle of minimum intervention that allows for the reading of the original characters of the historical building and translates the careful additions into recognisable devices, without altering the image of the building and without compromising the improvements to its technical and performance efficiency. The knowledge, the study of techniques, of geometries and structural details including the mechanical properties of materials, are fundamental tools needed to reconstruct a structural model capable of meeting the anti-seismic retrofitting in a modern architecture building where spatial and structural designs are integrated and give birth to a new phase of life and use of the redeveloped building.

6. REFERENCES