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IO4 Guide for Professionals

Erasmus+ UP4GREEN CONCRETE UPskill Professionals FOR sustainable renovation plans of CONCRETE buildings Ref.: 2020-1FR01-KA202-079810	
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Context

The climate crisis demands an urgent intervention towards energy transition. We must deeply renovate and fully decarbonise the buildings in which we work and live every day.

In particular, the deteriorating state of existing concrete buildings urgently demands for an effective approach to rehabilitate the old structures. These buildings are extremely inefficient from an energy and thermal insulation point of view, and often characterised by a low living comfort.

Renovation offers a unique opportunity to rethink, redesign and modernise our buildings to make them fit for a greener society and sustain economic recovery. Making the construction sector more sustainable is a crucial issue for achieving the goals the European Commission objectives. The Climate Target Plan 2030 aims to cut net greenhouse gas emissions in the EU by at least 55% by 2030 compared to 1990. Therefore, there is a strong need for a deep renovation and new construction of a social and climate-friendly built environment.

Aim of the Guide for Professionals

This guide tries to propose a global approach to help professionals to renovate a concrete building. A global approach is needed not only to improve the energy efficiency of buildings and thus save energy but also, a better air quality and therefore a better quality of life and a decrease in the health risks.

Training professionals and future professionals in these issues is one of the solutions so that they adopt new approaches when consulted to renovate such buildings.

This guide has therefore been put together to share and provide practical advice and tools and equip professionals and future professionals in the sector to respond appropriately to the emerging climate, environmental and social challenges.

Description of the methodology

The UP4C partners have worked together to an innovative methodology to help professionals in the analysis of the concrete buildings that need to be rehabilitated.

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Two main tools have been designed to the purpose:

1. the UPC mobile APP that will guide the professionals in the different sections of the building and help them identify the weaknesses and needs of the building;
2. the case study materials which provide examples of the diagnosis process

The two tools have been designed following the results obtained from the mapping of competences therefore they are consistent in their structure and they can be used both independently and together.

Mobile APP

The UP4C mobile APP has been designed to help professionals identify the best practices of construction, particularly referring to the rehabilitation of concrete buildings.

The application focuses on the following topics, which users will be able to select:

- Energy efficiency and savings
- Health-related risks and construction quality
- Comfort of use
- Lifestyle-related factors and layouts

The application comprises various construction topics, so as to enable construction professionals to thoroughly analyse concrete buildings, detect their pathologies and seek solutions that will minimise the health risks and maximise a building's efficiency.
Users will thus have access to some sort of checklist including the following insights:

- Points of vigilance
- The aforementioned topics of focus to choose from
- Proposed solutions to each problem

In a nutshell, it will provide users with a detailed and accurate analysis of each building prior to undertaking any kind of construction work, so as to achieve optimised results and energy efficiency in the shortest time span possible, while prioritising the users' health and safety.

Here attached, the full guide for users on how to use the APP is provided.

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Case studies

The renovation of concrete building is not a usual technique for craftsmen and professionals. Our mapping of competences describes the knowledge and competences necessary to adopt a global analysis of the building and suggest a rehabilitation proposal that will take into account all the topics and points of vigilance identified.

Four Learning Units have been identified, conceived as a synthesis between improvement of the individual's competencies and increase of awareness towards a sustainable renovation:

1. Analysis of concrete building typologies to be regenerated/retrofitted
2. Analysis and pathologies of concrete buildings
3. Techniques for renovation and energy regeneration of concrete buildings
4. Energy regeneration: different heating systems and ventilation

The template for the development of case studies is consistent with the contents of the UP4C Learning Units identified. Case studies are the application of the theory gained during the training to real situations. Therefore, they are based on "real" buildings.

Local authorities such as municipalities, regions but also private property owners should be contacted to have their permission to analyse their buildings which represents a good example of case study.

The template provides the structure and the requirements to be followed to perform the **diagnosis** of the building through:

1. Analysis of concrete building
2. Analysis of the pathologies of the concrete buildings

and then propose a **renovation** plan, including the

3. Techniques for renovation and energy regeneration of concrete buildings
4. Energy regeneration techniques: different heating systems and ventilation

Precise indications on the expected length of the answers are provided.

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The case study methodology has been chosen as it promotes active and experiential learning and develops the critical thinking skills that are necessary to formulate a proposal for a renovation plan.

This is pro-active approach is a good mean for the professionals to take ownership of the process to be followed as a methodology for the analysis and diagnosis of the building.

Six case studies have been developed following the template and based on real building in Europe. They can be used as teaching materials. For each of them, a general presentation of the building with technical information is provided. The main pathologies of the building are identified, analysed and put into perspective with health related issues as well as comfort standards. This cross-cutting analysis leads to a rehabilitation proposal. The images and photos are very effective to illustrate the diagnosis performed.

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ANNEXES

Mobile APP User Guide

UP4C Case studies

Template for the case study

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MOBILE APPLICATION USER GUIDE

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Introduction

The Up4Green Concrete mobile application is anticipated to define the best practices of construction, while supporting current and future professionals in regards with the practical use of concrete.

The application focuses on the following topics, which users will be able to select:

- Energy efficiency and savings
- Health-related risks and construction quality
- Comfort of use
- Lifestyle-related factors and layouts

The application comprises various construction topics, so as to enable construction professionals to thoroughly analyse concrete buildings, detect their pathogenies, and seek solutions that will minimise the health risks and maximise a building's efficiency.

Users will thus have access to some sort of checklist, one that contains the following insights:

- Points of vigilance
- The aforementioned topics of focus to choose from
- Proposed solutions to each problem

In a nutshell, it will provide users with a detailed and accurate analysis of each building prior to undertaking any kind of construction work, so as to achieve optimised results and energy efficiency in the shortest time span possible, while prioritising the users' health and safety.

Compatibility

The Up4Green Concrete mobile application is compatible with the following:

- Apple iPhones
- Android mobile phones

Installation

For Apple devices:

1. Open the Apple Store
2. Search for 'Up4Green Concrete'
3. Tap on the 'Get' button and wait for the download to finish

For Android devices

1. Open the Google Play Store
2. Search for 'Up4Green Concrete'
3. Tap on the 'Install' button and wait for the download to finish

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Home

Through the application's Home screen, users may choose to navigate among its three units of interest as presented in Image 1.1.

Users may also choose to browse within the application's Info section, at the bottom left of the Home screen.

At the Home screen's bottom centre, users are able to view the application's Disclaimer.

Finally, users are able to switch between different languages, by tapping on the Language button, which is located at the bottom right of the application's Home screen.

Image 1.1

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Area

As mentioned above, users are able to select between the application's different units, thus tapping either of the following three:

1. Analysis of the types of concrete buildings to be regenerated / renovated (Image 1.1)
2. Analysis and pathologies of concrete buildings (masonry building) (disorders, including humidity and materials) (Image 1.2)
3. Energy regeneration: different heating systems and ventilation (Image 1.3)

Each of the aforementioned shall lead user towards the following screens:

Image 2.1

Image 2.2

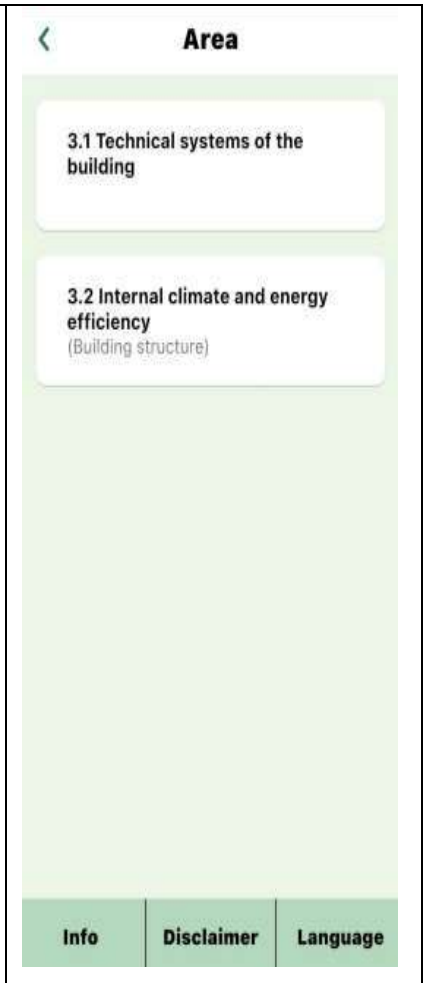

Image 2.3

Having selected one of the units, user are thus able to scroll down and navigate between a variety of topics, either related to a part of the building that users might be interested in (e.g. 1.3. Electrical system) or connected to a common area of concern in the field of construction (e.g. 2.3. Infrastructure construction process: Foundation methods).

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Area | Further navigation (1/2)

A paradigm of how the Up4Green Concrete app can be used is the following.

Image 3.1

Assuming that a user is interested in the '3. Energy regeneration: different heating systems and ventilation' unit as per Image 1.1, tapping onto that button will lead that same user to the screen displayed in Image 2.2, which contains two options:

3.1 Technical systems of the building
3.2 Internal climate and energy efficiency (Building structure)

Further assuming that the user is interested in the first option (3.1), tapping that same button shall lead to the screen of Image 3.1, which has the following three options:

3.1.1. Heating System – building related
3.1.2. Heating System – system related
3.1.3 Ventilation system

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Having established the user's interest in the section 3.1 Technical systems of the building, let us further assume that the same user is interested in the third option, 3.1.3. Ventilation systems. Tapping that button will redirect them to the screen displayed in Image 4.1, which shall allow the user to further define the nature of their building-related issue. Specifically, 3.3.1. Ventilation systems included the following specified options for the user to choose from:

3.1.3.a Mold and Fungi
3.1.3.b Noise
3.1.3.c Allergy
3.1.3.d Heat Loss

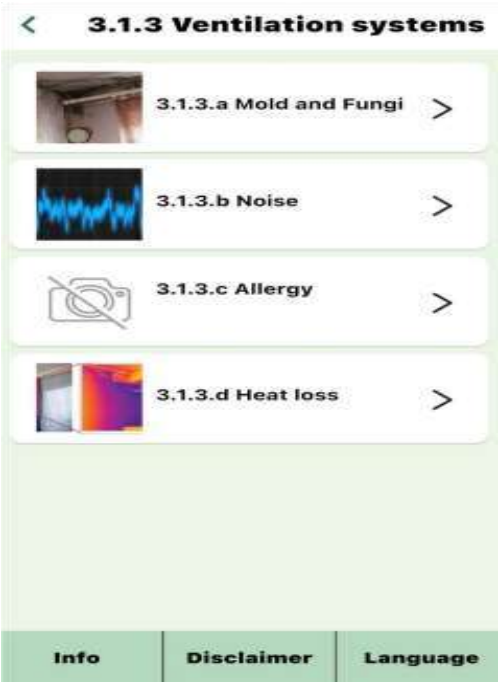

Image 4.1

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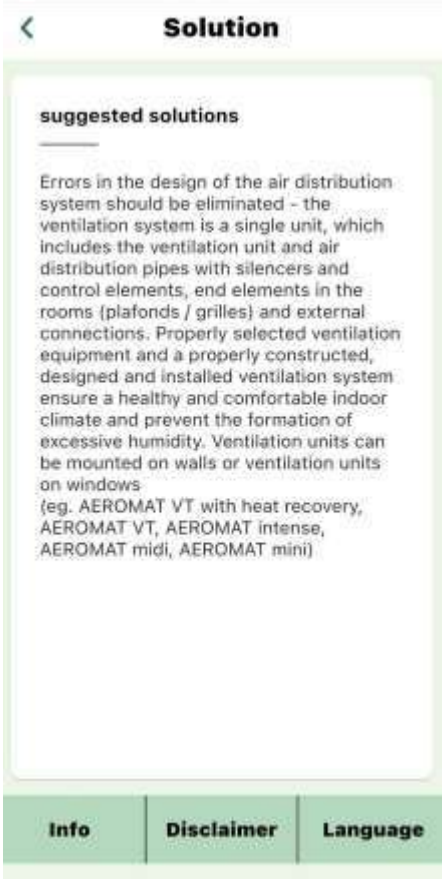
Area | Further navigation (2/2)

Assuming that the user is interested in the first option of Image 4.1, which is 3.1.3.a Mold and Fungi, selecting that option shall lead user to the screen displayed in Image 5.1 below.

The image includes a suggested solution for each issue that may occur.

Image 5.1

.



The exact same logic applies to any area that users may choose from; picking an area, which is further analysed to better reflect each user's specific needs, in order to finally provide them with an accurate and elaborate solution that shall help them.

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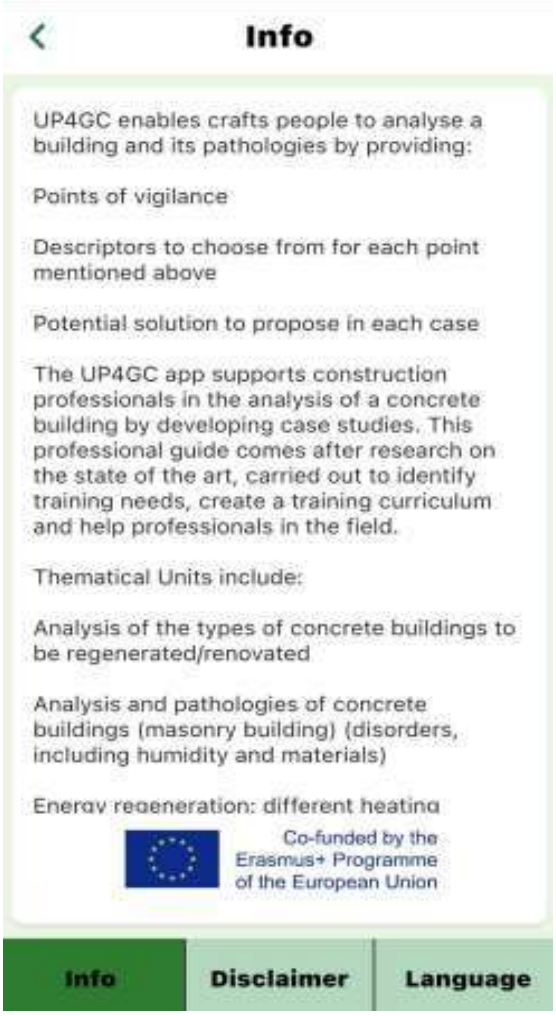

Image 6.1

INFO

The Info section can be accessed by any screen, including the ones mentioned in the above instructions.

Essentially, the Info section is designed to provide current or prospective users with a detailed analysis of the application's objective and goals, as much as some information on the application's background and funding.

Users are able to view the Info section as per Image 6.1, and scroll down the entire text.

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Disclaimer

Similarly, with the Info section, the application's Disclaimer section is also accessible through any screen.

As a project that is co-funded by the European Commission, it is important to state that co-funding does not signify the European Commission's endorsement of the Up4Green Concrete mobile application's content, and, coincidentally the European Commission shall not be held responsible for any misuse related to the application.

The disclaimer is available in all languages used within the European Union, as per Image 7.1. Users are able to scroll down the Disclaimer section

Image 7.1

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Language

While using the Up4Green Concrete mobile application, users are able to view its content and navigate in the following languages:

- English
- Estonian
- French
- Greek
- Italian
- Polish

As per Image 8.1, which showcases an example of the Language section as accessed from Home, users are able to switch languages within the application, at any given point.

Just like the Info and Disclaimer sections, Language can be accessed from any screen.

Image 8.1

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UP4C CASE STUDIES

Public housing in Piacenza Italy

Municipality owned building, Pärnu County, Estonia

Private house: Koeru, Järvamaa

Technical educational building - Le havre

Dwelling house Le havre

Building in Lodz for residential use

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CASE STUDY

Public housing in Piacenza Italy

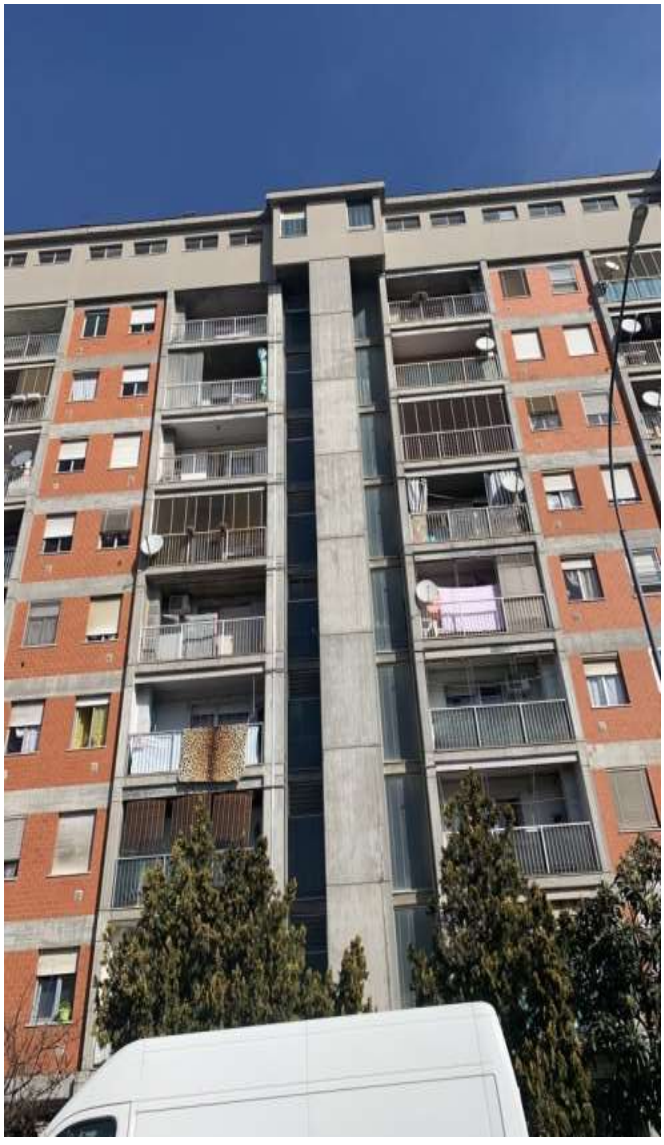

Image 1: building in Piacenza for residential use

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- **Age:** 1970
- **Location**: Piacenza, Italy
- **Present conditions**: the 10-floor residential building is in poor condition especially on the pillar structures and reinforced concrete beams; the preliminary diagnosis phase highlights water infiltrations, exposed and exploded irons, inadequate use of concrete mix
- **Use**: public housing

b. Technical information: overview of

- **load-bearing and cladding structures**: the load-bearing structures are in reinforced concrete pillars and beams, the cladding is made of masonry, some coatings are in face brick, others in metal
- **construction materials used in their construction and installation**: cement, concrete, perforated and double UNI bricks, solid bricks, metal
- **technical systems for the use of the building to ensure the indoor climate and the operational safety of the building:** each flat has a gas boiler that produces domestic hot water, there are no cooling methods, and only a few flats have their own air conditioner, in general there is a lack of safety in the whole building.

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2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element:

- **Risk categor:** in relation to the table below, the building analyzed is in the *R2 risk category: disorder on the evolving load-bearing elements (1-2 years)*

Risk level		Description	Intervention
R1		Poor state of conservation: Risk for the people and the objects	12 months
R2		Disorder on the evolving load-bearing elements	1- 2 years
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

- **analysis of pathologies in:**
  - masonry: the infill walls are old and in a poor state of preservation

Image2: Technological cavity accommodation masonry showing the state of deterioration of the masonry

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- concrete**:** the concrete presents several cracks, in several parts of the buiding bars are exposed, the mix of cement used is of low-quality and shows gravel nests and air bubbles
-

Image3:
The pillar and the corresponding beam show cracking due to compressive stress on an unsuitable concrete mix

Image4:
The beam shows a lack of cover and bare irons
The pillar shows a substandard concrete mix, the reason for obvious cracks

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Image5:
The pillar shows detachments due to a too thin cover which is the cause of the iron bursting

- isolation**:** practically non-existent

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- **Pathologies are due to:**

  - humidity: rising and weathering humidity is present

Image 6:
Humidity due to weathering

  - Hygrometry: there is no hygrometric well-being, seepage into the flats is evident

Image5:
Moisture attacks load-bearing structures, creating thermal bridges where there is a change of material/structure, leading to hygrometric consequences in flats

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- cracking evolution: many in the load-beraing elements, cracked beams and pillars are observed

Image 6:
The pillar shows evidence of concrete detachments due to wear and tear, in the internal area, most subjected to load, you can see gravel nests due to an inadequate mixture

Image 7:
The pillar shows evidence of concrete detachments due to an inadequate cover thickness, resulting in the explosion of the irons, in the internal part you can see gravel nests due to an inadequate mixture

Image 8:
Beams come loose from terrace coverings due to thermal bridging

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- heating efficiency: there is no energy efficiency due both to lack of insulation and use of boilers that are often outdated

- ventilation efficiency: no ventilation equipment present

b. Repair works needed:

- **steel repair, reinforced concrete and surface coating:**
  - Steel shirts or collars reinforced
  - Concrete walls reinforced
  - Reinforcement of the knots with Fiber reinforced Polymers
  - Steel braces to increase overall ductility and dissipative capacity
  - Resin injection Bandage with FRP Fiber reinforced Polymers

- **repair of masonry joints:**
  - Filling of stabilized cracks
  - Resin injection
  - Reinforcement with Fiber reinforced Polymers

- **change of insulation according to the situation (interior or exterior):**
  - Need of external coats after the renovatiion of structures and load-bearing walls
  - Plan an energy efficiency system with condensation boilers or heat pumps

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

Suggestion of the most suitable technologies for energy recovery and the elimination of pathologies identified

As described above: a renovation project is needed, and it should include:

- the cleaning of metal and masonry structures and elements
- the reinforcement of structures with resin injections, steel collars, reinforcing cement
- walls
- the application of energy-efficient coats possibly made of natural materials (lime and hemp, wood)
- roof insulation with green roofs
- the renovation of the heating/cooling and hot water system

a. list the recovery techniques for reinforced concrete buildings :

- resin injections
- reinforced concrete liners with thermal insulation materials
- partial bandage with Fiber Reinforced Polymers
- reinforcement of the knots with Fiber Reinforced Polymers
- reinforced concrete walls
- steel braces
- insertion of wall panels
- external buttresses

b. list the techniques for insulation:

- insulating panels inserted directly into the reinforcement or glued later, in order to reduce thermal bridges
- insufflations
- cavity with insulated masonry
- thermal coat with different materials

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4. Energy regeneration: different heating systems and ventilation

Suggestions for replacing heating systems with newer technologies, providing a higher energy efficiency

a. list the techniques for improving heating systems and ventilation:

- **To thermically insulate technical installations for higher energy efficiency:**
  - Exterior wall insulation and green roof renovation

- **To improve the building's heating, ventilation, cooling and residual heating systems co-efficiency**:
  - Install heat pumps or condensing boilers
  - For the cooling, use a system with cavity wall with vents in the flats

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CASE STUDY

Municipality owned building, Pärnu County, Estonia

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- **Age**: built approximately in 1960
- **Location** Pärnu-Jaagupi, Pärnu County, Estonia
- **Present conditions**
  - load-bearing walls: despite the cracks, the condition of the reinforced concrete met the load-bearing requirements, i.e. it was not in danger of collapsing. Therefore, it is possible to renovate without additional reinforcement. The concrete surfaces required repair of cracks and other damage before the insulation works could be started
  - condition of the roof: eternitic (asbestos cement) roofing at the end of its lifetime, which had to be replaced with steel roofing. The timber structures had little damage and required minimal restoration. The insulation of the end-ceiling was inadequate and had to be replaced in whole.
  - The heating system pipework was in good condition, the ductwork required insulation, incoming knots required replacement, bushings (passage) and radiators were replaced with thermoregulated ones.
  - The ventilation systems needed to be fully modernised, i.e. replaced in accordance with the current normative documents.
- **Use:** public school

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b. Technical information: overview of

- **load-bearing and cladding structures:** load-bearing walls: reinforced concrete elements (poles, panels)
- **fillings and boundaries of buildings:** openings are made of wood, which are obsolete, sparse (not heat-retaining)
- **construction materials used in their construction and installation:** roof is made of asbestos cement and is at the end of its life, insufficient insulation under the roof.
- **technical systems for the use of the building to ensure the indoor climate and the operational safety of the building:** the external insulation was insufficient, the facade covered with cement plaster. Panel joints insulated. Ventilation capacity too low, no heat recovery, mechanisms too energy intensive. Central heating systems generally meet the requirements, but re-insulation of the ducts / bushings (passages) is needed.

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2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element (only R3 and R4):

Risk categor: in relation to the table below, the building analyzed is in the *R3-R4 risk category*

Risk level		Description	Intervention
R1		*Poor state of conservation: Risk for the people and the objects*	*12 months*
R2		*Disorder on the evolving load-bearing elements*	*1 to 2 years*
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

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· **Analysis of pathologies in**:

° masonry

condition of the walls: panels generally in good condition, cracks and fractures at the joints. No risk of structural collapse. Insufficient insulation, waterproofing.

° concrete

foundation: monolithic reinforced concrete. There are cracks, not yet dangerous to the structure. Hydro-insulation has degraded (deteriorated) over time, insufficient insulation.

° Wood

Openings: windows/doors are thin, with rot in places. Roof structures are generally in good condition; masonry slats have some superficial moisture damage in places.

° metal structures

Joining plates of panels, posts and the welds are in a good shape, no additional work required.

° isolation

Both hydro and thermal insulation is inadequate, do not comply with modern standards, and lead to excessive energy consumption.

· **Pathologies are due to**:

° Humidity

waterproofing is outdated throughout the building, insufficient. Moisture damage was found in the interior of the basement of the building: at the joints of the foundation and at the joints of the floor, ceiling and foundation. The moisture damage had to be

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removed, the outer foundations waterproofed and insulated in accordance with current building regulations.

° Cracking evolution

Cracks and fractures are present at the joints.

° Heating efficiency

The building has a central heating system. There is an accumulation of rust in the pipework (ductwork), there are not enough thermostats in the rooms, the insulation of the bushings (ducts, passage) is insufficient.

° Ventilation efficiency

Ventilation (flow) capacity too low, no heat recovery, mechanisms are too energy intensive.

b. Repair works needed:

· **steel repair, reinforced concrete and surface coating**

facade, roofing needs to be replaced in full

· **repair of masonry joints**. Filling of stabilized cracks.

Renovation of joints is necessary in some places.

· **rust passivation of metal structure**

is needed in some knots

· **wood structure graft repair**

complete replacement of openings, occasional repairs to roof structures are sufficient.

· **change of insulation according to the situation (interior or exterior)**

Both the hydro and thermal insulation needs to be renewed throughout the building.

· **any other**

the ventilation system needs to be replaced throughout the building, the heating system needs occasional repairs and the installation of thermostats.

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

Suggestion of the most suitable technologies for energy recovery and the elimination of pathologies

a) list the recovery techniques for reinforced concrete buildings :

- resin injections - *Not necessary*
- reinforced concrete liners with thermal insulation materials - *necessary in full*
- partial bandage with Fiber Reinforced Polymers and reinforcement of the knots with Fiber Reinforced Polymers - *required in some knots, in Estonia, SILS is widely used as a solution to this problem* https://www.caparol.ee/caparol_pim_import/caparol_ee/broschueren/pdfs/178252_SILS_Paigaldusjuhend.pdf
- reinforced concrete walls - *cracks need to be repaired*
- steel braces *Not necessary*
- insertion of wall panels - *Not necessary*
- external buttresses - *Not necessary*

b) list the techniques for insulation:

- insulating panels inserted directly into the reinforcement or glued later, in order to reduce thermal bridges – it is *necessary to do it throughout the building*
- insufflations - *occasionally necessary*
- cavity with insulated masonry - *occasionally necessary*
- thermal coat with different materials - *necessary in full, throughout the building*

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4. Energy regeneration: different heating systems and ventilation

Suggestions for replacing heating systems with newer technologies, providing a higher energy efficiency

a. list the techniques for improving heating systems and ventilation:

- **To thermally insulate technical installations for higher energy efficiency -** *needed in pipes and ducts.*
  http://katused24.ee/web/ckfinder/userfiles/pdf/Labiviigudlamekatustest.pdf

- It is needed to improve the building's heating, ventilation, cooling and residual heating systems co-efficiency throughout the building, including replacing the entire ventilation system.

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CASE STUDY

Private house: Koeru, Järvamaa

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- **Age:** 1975
- **Location**: Koeru, Järvamaa
- **Present conditions**:

– load-bearing walls: load-bearing capacity guaranteed, many cracks, waterproofing on concrete foundation inadequate, no insulation, no through cracks, only superficial;
– roof: covering material is eternite (asbestos cement), which is practically unusable, wooden structures with rot damage;
– heating: local central water heating, system outdated, ventilation by chimney with low pressure (ventilation from a reduced pressure chimney), not adequate

- **Use**: private house

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b. Technical information: overview of

- **load-bearing and cladding structures**: bubble concrete panels or reinforced concrete hollow core slabs / planks (ET: mull betoonpaneelid) & cement plaster, silicate brick, wood cladding; Foundation: concrete blocks, walls: mull concrete panels & cement plaster
- **filling and boundaries of buildings**: wooden openings (windows, doors), obsolete, not heat-retaining
- **construction materials used in their construction and installation**: roof: Asbestos cement
- **technical systems for the use of the building to ensure the indoor climate and the operational safety of the building:** local central water heating, ventilation by chimney with low pressure

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2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element:

- **Risk categor:** in relation to the table below, the building analyzed is in the *R3 and R4 risk category*

Risk level		Description	Intervention
R1		Poor state of conservation: Risk for the people and the objects	12 months
R2		Disorder on the evolving load-bearing elements	1- 2 years
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

- **analysis of pathologies in:**

  - masonry: - bubble concrete panels or reinforced concrete hollow core slabs / planks, damage to the exterior, deteriorations (cracks) that have not weakened the load-bearing functions. Joints hermetically sealed, plastered, but it is cracked in places. Sealant in need of partial renewal. Minimal moisture damage at joints of the floor and wall

  - concrete**:** concrete block foundation. Hydro-insulation (waterproofing) of the foundation completely damaged, insulation poor. Joints partially deteriorated on the outside. Partial moisture damage

  - isolation**:** concrete hollow core slabs, clearly inadequate, does not meet modern building standards. The installation of a SILS (thermal insulation jointing system) is necessary to achieve energy efficiency

  - Wood: openings (windows & doors) and roof structure – deteriorated/ obsolete, Metal structures - missing in significant form

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- **Pathologies are due to:**

  - humidity: hydro-insulation deteriorated over time over the whole area, needs to be renewed completely and systemically, i.e. from the repair of the substrate to the surrounding filterable backfill

  - Hygrometry: the wooden structure surrounding the building foundation does not have the necessary filtering capacity

  - cracking evolution: joints partially collapsed, blocks and panels substantially intact

  - heating efficiency - wood heating with electric heating (this part is energy intensive!). There is a problem of moisture accumulation at wall and floor junctions

  - ventilation efficiency – insufficient, requires additional investment, because full insulation creates the so-called thermos effect, i.e. the air intake through e.g. openings can be obstructed to achieve energy savings. Additional ventilation is therefore necessary to ensure an oxygen-rich indoor climate

b. Repair works needed:

- **steel repair, reinforced concrete and surface coating:** joint repair. Work required: remove all loose and crumbled material from the surface and cracks, replace the sealant, impregnate with a tack (adhesive) dispersion and coat with a repair mortar

- **repair of masonry joints:** repair of cracks in part of the structure, the repair technique is similar to filling concrete cracks

- **wood structure graft repair** - Roof structure leaking, rotting in places, in need of complete replacement. The openings are deteriorated, need full replacement.

- **change of insulation according to the situation (interior or exterior):** both hydro and thermal insulation needs to be re-installed throughout the building. It

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is definitely necessary to use so-called systematic techniques, i.e. from the impregnation of the substrate to the finishing, it is recommended to use materials developed by one manufacturer and follow their installation instructions. This ensures the quality of the interaction/durability of the different layers. For hydro-insulation, adhesive bitumen materials could be used - the application is easier than in the case of liquid bitumen materials.
https://www.ceresit.ee/et/products/hudroisolatsioon/bituminous-membranes/bitumen-sam/ceresit-bt-21.html

- **SILS, i.e. thermal insulation joint systems** for plinth and façade insulation:
  https://www.caparol.ee/tooted/soojustamine/sils
  If a wooden façade system is planned for a private house, e.g. the instructions are here: https://www.isover.ee/infomaterjalide-otsing?f%5B0%5D=field_document_tr_category%3A96
  There are several manufacturers, these links to their instructions are just one of many!

- **Any other** Upgrading the ventilation system, adding forced ventilation parts with heat recovery/distribution/exchange.

- Replace the heating system with a geothermal heat pump based heating system

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

Suggestion of the most suitable technologies for energy recovery and the elimination of pathologies identified

a. list the recovery techniques for reinforced concrete buildings :

- resin injections *not necessary*
- reinforced concrete liners with thermal insulation materials *necessary in full*
- partial bandage with Fiber Reinforced Polymers *required in some nodes/ knots*
- reinforcement of the knots with Fiber Reinforced Polymers *required in some nodes/ knots*
- reinforced concrete walls *cracks need to be repaired - renew joint sealing and hydro-insulation on the foundation*
- steel braces *Not necessary*
- insertion of wall panels - *renew joint sealing*
- external buttresses *Not necessary*

b. list the techniques for insulation:

- insulating panels inserted directly into the reinforcement or glued later, in order to reduce thermal bridges *necessary in full*
- insufflations *occasionally partially necessary*
- cavity with insulated masonry *missing*
- thermal coat with different materials *necessary in full, throughout the building, insulate the entire building - foundation, walls, ceilings, roof - in accordance with current standards.*

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4. Energy regeneration: different heating systems and ventilation

Suggestions for replacing heating systems with newer technologies, providing a higher energy efficiency

a. list the techniques for improving heating systems and ventilation:

- **To thermically insulate technical installations for higher energy efficiency**
- **To improve the building's heating, ventilation, cooling and residual heating systems co-efficiency**:
  - Necessary technical installations: upgrading parts of the ventilation system and switching from an electric heating system to a geothermal heat pump based system.

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CASE STUDY

Technical educational building - Le havre

Image 1 : Technical education building / LE HAVRE

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

Images 2 et 3: Explanations of possible pathologies on the civil engineering technical platform

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a. Description of the building:

- **Age:** from 10 to 15 years
- **Location**: Le Havre
- **Present conditions:** In functional condition despite numerous cracks in the floors and walls, which themselves have numerous problems with capillary rise
- **Use**: public building

b. Technical information: overview of

- **load-bearing and cladding structures:** Reinforced concrete column and beam structure
- **infills and building boundaries:** Precast concrete or traditional masonry infill panels
- **construction materials used in their construction and installation:** concrete, bricks, manufactured concrete blocks (MCB**)**
- **technical systems for the use of the building to ensure the indoor climate and the operational safety of the building:** Individual town gas heating supplied by a central boiler, ventilation and extraction system on the technical platforms

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2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element:

- **Risk categor:** in relation to the table below, the building analyzed is in the *R3 risk category: Average state of conservation: Risk for the objects*

Risk level		Description	Intervention
R1		Poor state of conservation: Risk for the people and the objects	12 months
R2		Disorder on the evolving load-bearing elements	1- 2 years
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

- **analysis of pathologies in:**
  - masonry: Numerous aesthetic cracks but also deep cracks. Many of the reinforcements are exposed and oxidised due to poor coating and due to the masonry reacting to the ambient salt, being at the seaside

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- concrete**:** Numerous aesthetic but also deep cracks starting from many structural elements such as foundations, slabs and columns

- isolation**:** Insulation is very poor or non-existent. When it exists, it is in poor condition and in contact with many outside elements due to waterproofing problems

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- **Pathologies are due to:**

  - humidity: Many moisture problems due to capillary rise or waterproofing problems

  - Hygrometry: Numerous patches of mould and saltpetre on the ceilings and at the joints of the joinery

  - cracking evolution: Despite temporary repairs, many cracks have widened and led to further cracks. Many fittings are becoming apparent

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- heating efficiency: Insufficient heating system due to numerous problems in the hot water circuits (sludge). Boiler in poor condition and reaching the end of its life

- ventilation efficiency: Lack of natural ventilation and no mechanical ventilation in many parts of the building

b. Repair works needed:

- **steel repair, reinforced concrete and surface coating:**
  - Application of a protective product on exposed reinforcement and repair mortar on concrete. (Example of a product = « Sikagard 706 Thixo »)

- **repair of masonry joints:**

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- Filling of stabilised cracks
- Fibre-reinforced repair mortar in stabilised cracks with previously applied bonding agent (« Sikalatex »)

- **rust passivation metal structure**

- Application of curing compound, resin injection or repair mortar; protective fibre membrane

- **change of insulation according to the situation (interior or exterior):**
- Thermal insulation from the outside (cladding or rendering finish) to prevent the cold from entering the building and to maintain the full surface area of the classrooms

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

The best thing would be to insulate from the outside.

There are 3 methods of installing an ETI:

1) By rendering system: Whether it is a mineral or a hydraulic coating, the finishing render is the cheapest technique and offers a wide range of finishing options. Whether glued, fixed to profiles or pegged, it is up to the customer, with the advice of the builder, to choose the desired method.

2) By coating system: This technique requires only one application on the facade and consists of two insulating elements. It enlivens a house by offering an incredible range of decorations and excellent exterior insulation.

3) By cladding system: The added benefit of character for a house without any charm, cladding is a solution for aesthetic insulation. Cladding is easy to install. Wood, metal or tile, it also offers a wide range of choices and foolproof insulation.

This solution is the most suitable for keeping heat in, reducing thermal bridges and regulating humidity.
Cracks repairs and application of the protective product to the frames is done beforehand and would be protected by the cladding.

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4. Energy regeneration: different heating systems and ventilation

a. list the techniques for improving heating systems and ventilation:

- **Install solar panels on all roof terraces and solar water heaters and paint roof terraces white to prevent heat accumulation in summer**.

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CASE STUDY

Dwelling house Le havre

Image 1: Dwelling house / LE HAVRE

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- **Age:** from 60 to 70 years
- **Location**: Le Havre
- **Present conditions**: In functional condition despite numerous cracks in the floors and walls, which themselves have numerous problems with capillary rise
- **Use**: private building

b. Technical information: overview of

- **load-bearing and cladding structures**: Structure made of manufactured concrete blocks covered with façade rendering and wood cladding on one part
- **Infills and building boundaries :** Precast concrete or traditional masonry infill panels
- **construction materials used in their construction and installation**: Concrete, bricks, manufactured concrete blocks (MCB)
- **technical systems for the use of the building to ensure the indoor climate and the operational safety of the building:** Individual town gas heating supplied by a boiler, controlled mechanical ventilation system in the water rooms

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2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element:

- **Risk categor:** in relation to the table below, the building analyzed is in the *R3 and 4 risk category*

Risk level		Description	Intervention
R1		Poor state of conservation: Risk for the people and the objects	12 months
R2		Disorder on the evolving load-bearing elements	1- 2 years
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

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- **analysis of pathologies in:**

  - masonry: Numerous aesthetic cracks but also deep cracks in particular due to masonry reacting to the ambient salt, being on the seafront and due to ground movements, or even foundations that are certainly inappropriate

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◦ concrete: Numerous aesthetic but also deep cracks starting from many structural elements such as foundations, slabs and lintels**.**

◦ isolation: Insulation is very poor or non-existent. When it exists, it is in poor condition, and in contact with many outside elements due to waterproofing problems

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- **Pathologies are due to:**

  - moisture: many moisture problems due to capillary rise or waterproofing problems

  - Hygrometry: Numerous patches of mould and saltpetre on the ceilings and at the joints of the joinery

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- cracking evolution: Despite temporary repairs, many cracks have widened and led to further cracks

- heating efficiency: Insufficient heating system due to numerous problems with a boiler in poor condition and reaching the end of its life, as well as poor insulation which makes the building a “thermal sieve”.
- ventilation efficiency: Mechanical ventilation problems in many parts of the building

b. Repair works needed:

- **steel repair, reinforced concrete and surface coating:**
  - Application of a protective product on exposed reinforcements and facade restoration with waterproofing rendering.

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- **repair of masonry joints:**
  - Filling of stabilized cracks with fibre-repair mortar or sealant
- **Rust passivation metal structure**
  - Application of curing agent, resin injection or repair mortar; protective fibre membrane.
- **change of insulation according to the situation (interior or exterior):**
  - Thermal insulation from the outside (cladding or rendering finish) to prevent the cold from entering the building and to maintain the full surface area of the rooms

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

The best thing would be, after repairing the structural elements, to insulate from the outside;

There are 3 methods of installing an ETI:

1) **By rendering system**: Whether it is a mineral or a hydraulic coating, the finishing render is the cheapest technique and offers a wide range of finishing options. Whether glued, fixed to profiles or pegged, it is up to the customer, with the advice of the builder, to choose the desired method.
2) **By coating system**: This technique requires only one application on the facade and consists of two insulating elements. It enlivens a house by offering an incredible range of decorations and excellent exterior insulation.
3) **By cladding system**: The added benefit of character for a house without any charm, cladding is a solution for aesthetic insulation. Cladding is easy to install. Wood, metal or tile, it also offers a wide range of choices and foolproof insulation.

This solution is the most suitable for keeping heat in, reducing thermal bridges and regulating humidity.
Cracks repairs and application of the protective product to the frames is done beforehand and would be protected by the cladding.

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4. Energy regeneration: different heating systems and ventilation

a. list the techniques for improving heating systems and ventilation:

Change the boiler for a condensing or low temperature gas boiler and review the entire ventilation system to control the humidity of the building

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CASE STUDY (PL)

Building in Lodz for residential use

Photo 1. Building in Lodz for residential use, with a public health institution on the ground floor.

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DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- **Age:** 1961
- **Location**: Lodz, Poland
- **Present conditions**: The building is in poor overall condition on the outside. There are no signs of damage to the load-bearing structure of the walls and floors, which are made of precast large reinforced concrete slabs. Preliminary inspection revealed problems with balcony structures, degradation of basement windows, water infiltrations, exposed and exploded irons, wild vegetation causing damage and humidity to foundations and walls
- **Use**: residential, detached, multi-family, 5-storey, with basement, 3-bay; a public health institution on the ground floor

b. Technical information: overview of

- **Load-bearing and cladding structures**: Large block construction. Structural elements of the building e.g. foundations - cast reinforced concrete footings, basement walls - precast reinforced concrete, load-bearing and external walls - precast large reinforced concrete slabs, partition walls - perforated and solid bricks, metal.
- **Construction materials used in the construction and installation**: cement, concrete, perforated bricks, solid bricks, metal.
- **Technical systems for the use of the building to ensure the indoor climate and the operational safety of the building**: The building is connected to the municipal heating network (hot water), which supplies all flats with domestic hot water and heating in the winter season. Other installations supplied to the building: electricity, gas, cold water, sewerage. Air exchange in the building is ensured by a gravity ventilation system, brought to each flat and the basement. There is no central air conditioning system and only a few flats have their own

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air condition devices installed (see photos). The building lacks some vital operational security installations e.g. a network of fire sprinklers.

Photo 2. Individual air condition device (split type).

2. Analysis of the pathologies of the concrete buildings (masonry building)

a. Identify disorders according to the level of risk for each supporting element:

The building analysed is in the **R2 risk category**: *Disorder on the evolving load-bearing elements (1-2 years)*.

Risk level		Description	Intervention
R1		Poor state of conservation: Risk for the people and the objects	12 months
R2		Disorder on the evolving load-bearing elements	1- 2 years
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

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- **analysis of pathologies in:**
  - masonry: degradation of basement windows structure and deterioration of exterior walls plaster

Photo 3. Degradation of basement windows structure due to water infiltration and mechanical force

Photo 4. Exterior walls showing the state of deterioration of the plaster due to thin layer and humidity

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◦ concrete**:** although the concrete load bearing structure of the building shows no signs of damage, the concrete foundation walls and external walls show visible signs of water infiltration; all balconies and entrance platform to the ground floor public health institution present cracks and detachments as well as exposed and rusted reinforcement iron

Photo 5. Entrance platform showing detachments as well as exposed and rusted reinforcement iron.

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Photo 6. Balconies showing cracks and detachments as well as exposed and rusted reinforcement iron.

Photo 7. The concrete foundation wall shows visible signs of rising humidity presence

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○ Insulation: lack of exterior insulation as well as damages to sheet flashings, resulting in exterior and interior humidity issues as well as poor heating efficiency.

Photo 8. Lack of exterior insulation and damages to sheet metal flashings, resulting in humidity issues inside and outside of the Building

○ Joinery: windows and doors joinery as well as window sills are old and severely damaged, resulting in poor heating efficiency and providing unsatisfactory living comfort

Photo 9. An old window in extremely poor condition, with peeling paint and damages to metal flashings, all due to the lack of regular and proper maintenance

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- Gutters, downpipes and drains: damages resulting in water infiltration

Photos 10-11. Damage to a drain pipe due to frost or mechanical force, resulting in the increased water penetration of the foundation walls and in turn – increased humidity.

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- **Pathologies are due to:**

○ Humidity and weather conditions: rising and weathering humidity is present, leading to hygrometric consequences in flats; frost in winter.

Photo 12. Humidity due to weather and damages to roof flashings.

○ Wild vegetation: causing damage and humidity to foundations and walls

Photo 13. Self-seeded trees and bushes destroying brick basement windows structures and allowing for water penetration into the walls.

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- Cracking: cracks and detachments as well as exposed and rusted reinforcement iron are present in balconies and one entrance platform.

Photo 14. The balcony shows evidence of concrete detachments due to wear and tear and damaged metal flashings, mostly subjected to water infiltration; gravel nests due to the inadequate mixture.

- Ventilation inefficiency: the ventilation system is old, inefficient and causing humidity increase inside the building.

Photo 15. The ventilation system is outdated and requires audit and replacement.

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○ Heating inefficiency: the energy and heating efficiency in the building and its flats is extremely poor due to both lack of proper insulation as well as degraded condition of windows and doors joinery as well as window sills.

a. Repair works needed:

- **steel repair, reinforced concrete and surface coating:**
  - Steel shirts or collars reinforced
  - Concrete walls reinforced
  - Reinforcement of the knots with Fiber reinforced Polymers
  - Steel braces to increase overall ductility and dissipative capacity
  - Resin injection Bandage with FRP Fiber reinforced Polymers

- **repair of masonry joints:**
  - Filling of stabilized cracks
  - Resin injection
  - Reinforcement with Fiber reinforced Polymers

- **change of insulation according to the situation (interior or exterior):**
  - Need of external coats after the renovatiion of structures and load-bearing walls
  - Plan an energy efficiency system with condensation boilers or heat pumps

a. Repair works needed:

- **Humidity on the foundation walls of the building:**
  - removal of wild vegetation growing into the building elements and growing in the immediate vicinity of the building;
  - repairing and unblocking the drainage around the building;
  - creation of a drainage and sealing band made of concrete slabs;
  - replacement of vertical and horizontal insulation with new insulation.

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- **Repair of basement windows structures:**
  - re-bricking and plastering of basement windows with high quality concrete render;
  - replacement of all grates with new ones.
- **Humidity on external walls:**
  - replacement of roof flashings and at each storey level.
- **Gutters, downpipes and drains:**
  - replacement of the old and damaged pipes with new ones, including metal flashings (installation of gutter and over-gutter strips).
- **Repair of balconies:**
  - execution of an expert's assessment of the technical condition of the balconies and their possible repairs;
  - repair or replacement of damaged balcony slabs with new ones (depending on the expert's opinion) or decision to remove balconies.
- **Windows and doors joinery:**
  - replacement of the old windows and doors with the new ones providing high thermal and acoustic parameters, e.g. passive, triple-glazed windows;
  - installation of new window sills;
  - masonry work after replacing windows and doors (smooth sanding without filling).
- **Thermo-modernisation of the building:**
  - *prior to the commencement of thermo-modernisation, the following works should be carried out:*
  - insulation of foundation walls;
  - dismantling of flashings, window sills, balcony railings, lightning protection installation;
  - repair of balcony slabs, installation of new balcony railings;
  - insulation of foundation walls below freezing point, i.e. 1.2 m below ground level with 12 cm thick extruded polystyrene XPS panels with a thermal conductivity;
  - insulation of the external walls of the ground floor with a 12 cm thick layer of extruded polystyrene XPS 12 cm thick;
  - insulation of external walls (including balcony recesses) with a layer of 14 cm thick self-snuffing polystyrene;

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- insulation of window and door recesses with a layer of self-extinguishing foamed polystyrene 5 cm thick;
- the surface of the walls to be finished with 1.5 mm thick silicone plaster;
- the surface of the plinths will be finished with mosaic plaster;
- thermal insulation of the roof with mineral wool granulate 22 cm thick using the blowing method;
- thermal insulation of basement ceiling with 11 cm thick mineral wool;
- finishing works – due to the increase of the insulation layer, it will be necessary to replace the existing flashings and window sills with new ones as well as carry out a comprehensive renovation of the balconies. Also, a new lightning protection system should be introduced and construction of concrete blocks around the building.

RENOVATION PLAN

2. Techniques for renovation and energy regeneration of concrete buildings.

Suggestion of the most suitable technologies for energy recovery and the elimination of pathologies identified.

As described in the section above, a renovation plan is needed, and it should include:

- thermo-modernisation of the building;
- removal of wild vegetation growing into the building elements and growing in the immediate vicinity of the building;
- repairing and unblocking the drainage around the building;
- creation of a drainage and sealing band made of concrete slabs;
- replacement of vertical and horizontal insulation with new insulation
- the cleaning of metal and masonry structures and elements
- re-bricking and plastering of basement windows with high quality concrete render;

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- replacement of all grates with new ones
- replacement of roof flashings and at each storey level
- replacement of the old and damaged pipes with new ones, including metal flashings (installation of gutter and over-gutter strips)
- repair or replacement of damaged balcony slabs with new ones or decision to remove balconies
- replacement of the old windows and doors with the new ones

a. List the recovery techniques for reinforced concrete buildings:

- reinforced concrete liners with thermal insulation materials;
- partial bandage with Fiber Reinforced Polymers;
- reinforcement of the knots with Fiber Reinforced Polymers;
- reinforced concrete walls;
- steel braces;
- insertion of wall panels;
- external buttresses.

b. List the techniques for insulation:

- thermo-modernisation with polystyrene, wool or PUR foam;
- insufflations;
- cavity with insulated masonry;
- thermal coat with different materials.

3. Energy regeneration: different ventilation system.

Suggestions for replacing ventilation systems with newer technologies

a. List the techniques for improving ventilation:

- to thermically insulate technical installations for higher efficiency:

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TEMPLATE FOR CASE STUDY

DIAGNOSIS PHASE

1. Analysis of concrete building typologies to be regenerated/retrofitted

a. Description of the building:

- Age (*please indicate the approximate year of construction)*
- Location (*town and country*)
- Present conditions (*3/4 lines of a general overview of the building, it appears in good /bad conditions, there are cracks in the concrete surface, suspect of infiltration)*
- Use (*public, private?)*

b. Technical information: overview of

- load-bearing and cladding structures,
- fillings and boundaries of buildings,
- construction materials used in their construction and installation
- technical systems for the use of the building to ensure the indoor climate and the operational safety of the building

(this is just an overview, each of the above mentioned points will be explained further on, therefore be concise, max 3/4 lines each point)

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2. Analysis of the pathologies of the concrete buildings (masonry building) (disorders, included humidity and materials)

a. Identify disorders according to the level of risk for each supporting element (only R3 and R4):

Risk level		Description	Intervention
R1		*Poor state of conservation: Risk for the people and the objects*	*12 months*
R2		*Disorder on the evolving load-bearing elements*	*1 to 2 years*
R3		Average state of conservation: Risk for the objects	5 years
R4		Non-impacting defect, other than aesthetic	10 years

- Analysis of pathologies in: *(please give a comprehensive analysis of pathologies following the points listed below – if any of them is not relevant, omit it – suggested length 15 lines per point – photos are highly recommended)*
  - masonry
  - concrete
  - isolation

- Due to: *(please give a comprehensive analysis of the points listed below – if any of them is not relevant, omit it – suggested length 10 lines per point - photos are highly recommended)*
  - humidity
  - hygrometry
  - cracking evolution
  - heating efficiency
  - ventilation efficiency

b. Repair works needed: *(please describe the repair works needed following the list below – if any of them is not relevant, omit it – suggested length 5 lines per point)*

- steel repair, reinforced concrete and surface coating
- repair of masonry joints. Filling of stabilized cracks.
- rust passivation metal structure
- wood structure graft repair
- change of insulation according to the situation (interior or exterior)
- Any other

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RENOVATION PLAN

3. Techniques for renovation and energy regeneration of concrete buildings

Suggestion of the most suitable technologies for energy recovery and the elimination of pathologies identified (referring to the last point of the section above – Repair works needed, please choose from the list below the techniques you would use and explain why – free length)

a. list the recovery techniques for reinforced concrete buildings :

- resin injections
- reinforced concrete liners with thermal insulation materials
- partial bandage with Fiber Reinforced Polymers
- reinforcement of the knots with Fiber Reinforced Polymers
- reinforced concrete walls
- steel braces
- insertion of wall panels
- external buttresses

b. list the techniques for insulation:

- insulating panels inserted directly into the reinforcement or glued later, in order to reduce thermal bridges
- insufflations
- cavity with insulated masonry
- thermal coat with different materials

4. Energy regeneration: different heating systems and ventilation

Suggestions for replacing heating systems with newer technologies, providing a higher energy efficiency (please choose from the list below the techniques you would use for improving the heating system and explain why - free length)

a. list the techniques for improving heating systems and ventilation:

- To thermically insulate technical installations for higher energy efficiency
- To improve the building's heating, ventilation, cooling and residual heating systems co-efficiency

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