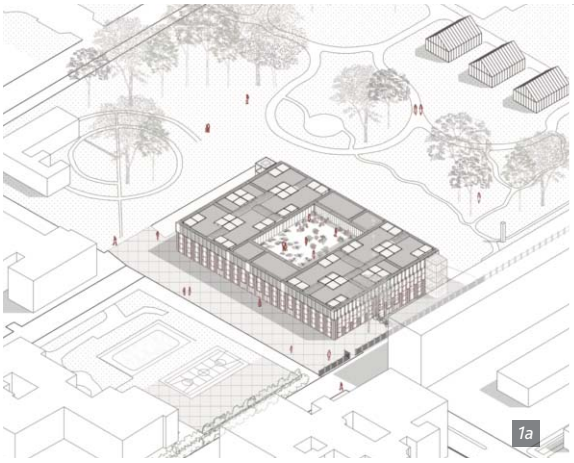
MASTER THESIS PROJECT

grINdoor

A college on the roof.
The light house for students and plants!

The master thesis "grINdoor" has been conceived as a lightweight experimental supra-elevation within the Politecnico di Milano Leonardo Campus. Due to the structural conditions of the existing building underneath and to the inherent properties of a supra-elevating residential green roof, it has been designed for being the most lightweight possible, balancing the materials used for the vertical and the horizontal elevation structures and taking advantage of an ETFE roof coverage.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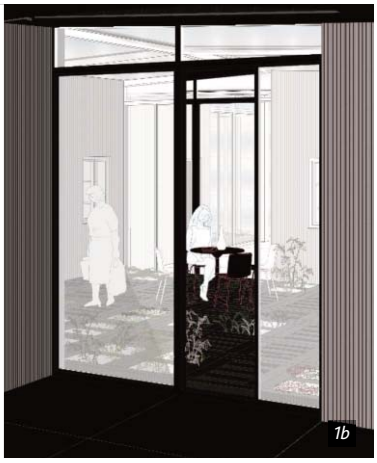
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Project concept

The project aims at combining a green roof with an additional residential level, in order to increase the green into the city of Milan, as well as to provide a bigger offer of beds for students.
The idea of supra-elevating an existing building derives from the necessity to increase the number of accommodations offered within the city of Milan, whose population is steadily increasing, while at the same time from the will to turn the existing roofs into green ones, in order to contribute to the absorption of Co2 emitted by our cities. The city of Milan aspires indeed to increase its green coverage of the 625% within the next 10 years: turning existing roofs into green ones seems to be a great option for doing so, although, into the process, it is necessary to consider the additional weight that green roofs will carry to the existing structure. Therefore, it becomes fundamental to plan a light-weight supra elevation.

Project description

The project considers all the aspects, from a structural point of view, a compositional one and a bio-climatic one. It establishes an interconnection between the residential modules and the green roof through the presence of green courtyards covered by sliding ETFE cushions that would work as bioclimatic greenhouses.
The whole supra-elevation area of almost 3300m² has been subdivided into four symmetric districts with a central courtyard completely opened hosting the real green roof. Each section is characterised by the presence of 2 units of bedrooms attached two by two and linked together by a central courtyard. Each bedroom faces an openable and closable courtyard covered with square sliding ETFE cushions of 3,35m side length: the whole system would allow the light penetration for illumination reasons guaranteeing, as well, the adequate ventilation for the bedrooms. Additionally, the presence of the ETFE cushions for the roof would allow the courtyards to work as greenhouses, mitigating the internal conditions of the bedroom throughout the whole year.

Technical description

In order to make the whole supra-elevation the most lightweight possible each element has been balanced, obtaining prefabricated residential boxes whose weight has been minimised in toto, looking for a solution that reduces the total weight of almost 100kg per m². In the whole study, the use of the ETFE for


2a


2b

covering the courtyards, instead of glass panels, contributes to diminishing the total weight of the system of 15kg per m², letting the whole supra-elevation floor to reach a final weight of 105kg per m², instead of 120kg per m² if only glass panels would have been used for covering the courtyards.

ETFE cushions have been used not only for covering the openable and closable courtyards, but also for covering the corridors. They have therefore differently studied according to their use.
A system of sliding ETFE cushions has been used for the courtyards: cushions have been slightly sloped through a rail system towards the residential boxes, in order to automatically slide, thanks to the gravitational force, on top of the opaque roof covering the residential boxes and leaving the courtyards exposed to the natural conditions; a mechanical motor would later govern a rope system that, turning, would mechanically put back on place the ETFE cushions, covering again the courtyards. The whole system has been studied in order to allow the courtyards for being easily opened and closed according to the external atmospheric conditions and the internal necessities.
The corridors of the residential college instead have been conceived for being covered by fixed ETFE cushion with integrated photovoltaics. As already experimented in the AWM carport in Munich (Germany), PV cells have been fixed in a removable way onto the middle layer of the 3-layers cushions. Being enclosed by transparent ETFE-films, the PV modules are kept safe from external exposures, although the whole system will affect the overall solar radiation gain of a 10%. With a total area of around 850m², the fixed ETFE cushions with integrated photovoltaic of amorphous silicon solar cells will produce around 59500kWh, that would correspond to the 113% of the needed energy by the 48 students living into the residential college.
In addition, the pattern generated by the integrated photovoltaic into the ETFE cushions will determine specific shadows that, besides creating a game of lights and shadow, will reduce the thermal impact in summer into the corridors below.

Conclusion

In conclusion, the master thesis focusing on the design of a light-weight supra-elevation floor, hosting both a college for students and a house for plants, aspires to be an experiment in regards to the need of transforming the existing roofs into green ones and to increase the number of accommodations into nowadays cities taking advantage of the existing structures. It explores new technologies and design methods for adapting these solutions even to existing buildings that presents critical conditions for supporting additional weights. The thesis discloses how a well-balanced design would open up several possibilities and how ETFE membranes can be used for multiple solutions, satisfying different needs.

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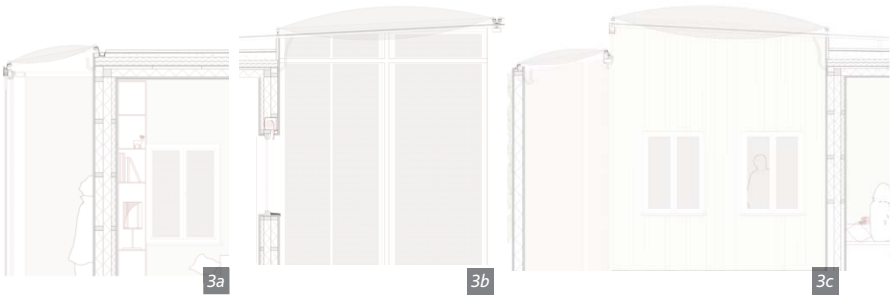
Name of the project:	grINdoor. A college on the roof. The light house for students and plants
Location address:	Via Camillo Golgi 20, 20133, Milano MI
Client (investor):	Politecnico di Milano
Function of building:	Residential college
Type of application of the membrane:	Roof coverage
Year of construction:	Architectural Master thesis
Author:	Giulia Procaccini
Technical consultant:	ing. Giorgio Piantato
Supporter:	TextilesHub DABC
Material:	ETFE cushions
Covered surface (roofed area):	1500m²


4a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4b

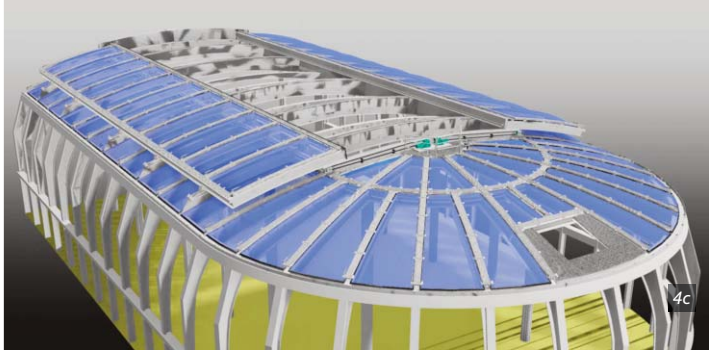
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Figure 1.Visualisation of the building in its context (a) and towards the courtyard (b) © Giulia Procaccini.

Figure 2. Plan view of the whole building (a) and roof view of one section (b) © Giulia Procaccini.

Figure 3. Details of the fixed opaque ETFE cushion (a), the sliding ETFE cushion (b) and combined fixed – sliding ETFE cushion (c) © Giulia Procaccini.

Figure 4. Reference projects of existing ETFE cushions: AVW Munich as a reference for the fixed ETFE with integrated photovoltaic into the middle layer of a three layers cushions (a) © Michael Fischbacher; Beyazit Library courtyard covered with ETFE, subdivided into four cushions (b) © Emre Dörter and AIDA Deck: sliding ETFE cushions covering the pool. The sliding method is similar to the one I conceived for this project (c) © Seele Holding GmbH.