INDUCTIVE RESEARCH

From practice to research To practice again

Building site as a catalyst for reflexions.

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Introduction

In issue 187 of the magazine Plan Libre, Sébastien Martinez-Barat describes his architectural design process with the phrase *'the project is an enquiry'*. He describes the project in terms of its searching and prospective dimension rather than as a goal to be achieved. Mainly because the starting point is not the formulation of a hypothesis that remains to be verified, but rather an observation that questions and worries, an uncertainty that persists after having done, an intuition that would guide the action of searching beyond, outside the project itself. The investigation as inductive research, which proceeds by successive deductions, by a non-linear path. *'Each project opens up its own field of research. Thus, what is achieved at the completion of this process is unexpected and strange. Unexpected because it is discovered. Strange because it is foreign, outside of oneself.'* [1]

This approach is closely related to that developed by the philosopher John Dewey, who considers enquiry as a practice whose purpose is to clarify a problem in order to make it intelligible. Enquiry confronts a complex situation, involving a certain lack of understanding or a high level of uncertainty - in our case the project in all its complexity - thereby to engender a problematic. The question is clarified in an iterative way until the stabilisation of the situation. The intuitions at the start of the enquiry are suggestions that become ideas. *'Ideas are operational in that they instigate and direct further operations in observation; they are pro-*

[1] Martinez-Barat, Sébastien, October 2021, 'L'enquête', Plan libre 187.

posals and plans for acting upon existing conditions to bring new facts to light and organize all the selected facts into a coherent whole' [2]. This to the point of becoming a theoretical statement, a plan of action, a possibility. Enquiry shifts the focus from the result to be achieved to the process to be developed, while the project continues ineluctably towards its final completion. The investigation opens up possibilities for action, while the project seals the action of doing. These two distinct and complementary approaches place our practice in the field of the shareable, the common and the disciplinary.

Fig. 1 - The construction site shows fragments of the ground becoming elements of architecture.

[2] Dewey, John, 1938, Logic, The Theory of Inquiry, New York: Henry Holt.

Fig. 2 - The hempcrete is the whole envelop of the building. The insolation is the whole wall.

Therefore, the consideration of the construction site, as the starting point of our research and investigations, leads us to adopt an inductive approach as opposed to a deductive approach based on the hypothesis to be verified.

Our research method remains protean and opportunistic. Two sites (O27OBK and 047MRX) are real starting points for research projects. The construction of a massive stone building (fig. 1) led us to investigate the stone sector and the transformation of ground into architecture (066FAI). The insulated hemp-concrete (hereafter hempcrete) project (fig. 2) motivated research on the formal potential of this natural insulator (101CDC). More autonomously, the construction of an artefact for the Biennial of Architecture and Landscape allowed us to produce a statement on assemblage (086AUG). The limits of the regulatory framework of the hemp-concrete technique led us to conduct a series of normative experiments beforehand (088JOL).

Stone building (027OBK)

Between 2013 and 2017, the agency carried out studies and then the execution of a housing block in Paris made of solid load-bearing stones, wood, concrete and hempcrete. Beyond the heritage dimension and the possible formal relations with some of the Parisian traditions of the 19th century, we were interested in the potential contemporaneity and topicality of a constructive system of this type, and in the numerous environmental virtues of all the materials employed.

The preparation of the building site took place relatively early on in the studies, given our initial lack of knowledge of the different materials handled. All the suggestions inherent to the constructive systems had to be resolved or at least identified, both in order to ensure their technical and regulatory mastery, but also to fully explore their formal and architectural potential. Also, to increase our competence on the strict subject of stone, we visited numerous quarries and stone-cutting yards, met several industrialists, contractors and carvers, and progressively embraced a large part of the sector and assimilated the different trades that constitute it. These multiple conversations with all the actors, and, above all, the numerous contacts with the material, have initiated deeper reflections on the act of building today.

The two images (fig. 3 and 4) expresses the transformation of the ground. The fragments extracted are choosen for

their appearance, squared and then laid on the construction site. Building is manipulating ressources that are inevitably coming from the Earth.

Visiting a quarry engages a direct relationship with the Earth's surface and its constitutive elements. Whether open-air or underground, the landscapes observed awaken different levels of consciousness and raise the issues of construction to considerations beyond the building itself. This provokes scientific and poetic questions and stimulates both objective and subjective concerns. The vertical walls of the quarries, whose shape is the result of the extraction methods used, force a sectional observation of part of the terrestrial crust. The process by which the material is formed is revealed and gives an account of the slow phenomenon of sedimentation - an accumulation over tens of millions of years of animal and vegetable organisms compacted by phenomena that mix pressure and de-pressure, rising and falling water - and reminds us of the primarily telluric property of our planet.

Fig 3 - The blocks extracted from the quarry are waiting to be squared, and to become architectural elements ready to be laid.

Fig. 4 - The stones are being assembled on the site. They bear the traces of their belonging to the ground.

Exhibition STONE (066FAI)

The logic of stone construction is comprised of three major stages: extraction, transformation and installation. The energy involved in the displacement of the material accounts for a large part of the carbon weight of the stone. However, stone allows these three phases to be carried out in the same place. This was the objective of our solid stone project (027OBK), which could not be maintained after the tender procedure. The selected stone contractor, located 300 km from Paris, offered us a stone from its own resource basin, which met our aesthetic and mechanical requirements. In the 19th century, the architects and builders involved in the transformation of Paris had taken advantage of the immediate availability of the resource, which a century later we were no longer able to reproduce. This is where our desire to investigate the availability of the limestone resource, and the existence and vitality of the Ile-de-France stone sector, was aroused.

In 2017, simultaneously with the construction work of 027OBK, the Pavillon de l'Arsenal launched the FAIRE programme, a call for research and experimentation projects. We seized this opportunity to propose an investigation of the Ile-de-France stone sector, in partnership with the photographer, architect and Doctor in Architecture Giaime Meloni and with the scientific support of the environmental consultancy Elioth. The results of the study took the form of an exhibition for which we provided the scientific curating.

The research is envisaged here as a desire for demonstration and concreteness, with a double objective: to draw up an inventory of an already existing sector in Ile-de-France, and then to justify the environmental relevance of load-bearing stone construction. The method of investigation is cumulative and proceeds by data collection and analysis, measurements and extrapolations. The ambition of the exhibition is to communicate objective and manipulable elements, so that everyone can grasp and consider the possibility of building with stone in the Paris basin and thus maintain the link between the resource basin and construction. This results in a deepening of the territory in its metabolic capacity to produce for the city.

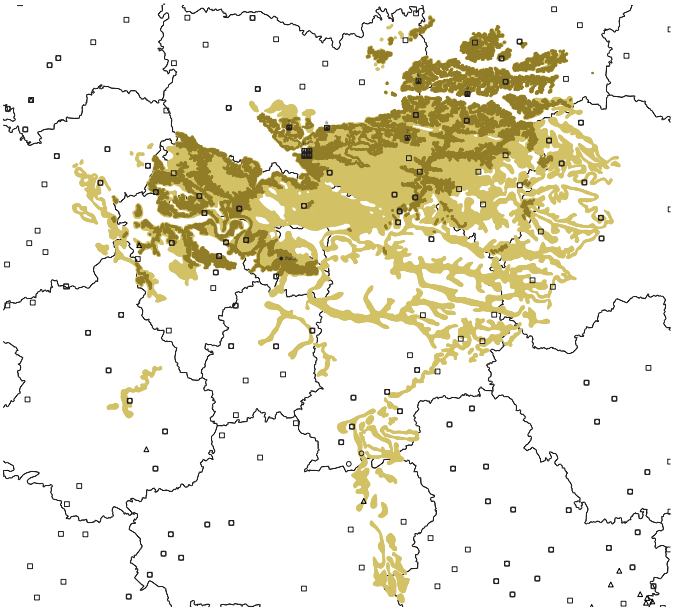


Fig. 5 - This lithostratigraphic map represents a part of the Parisian limestone basin. The light patch corresponds to the Eocene era, and the lighter patch to the Lutetian stage. The latter is the available outcrop layer just below the natural ground, on which all the quarries are located.

The studies and the exhibition were structured around three topics: the resource, energy and assemblages. The first was the subject of surveys and readings, the second of measurements and calculations led by Elioth, our technical partner, and the third offered a panorama of contemporary housing projects in solid stone. With the support of an expert geologist from BRGM, we integrated into the scenography some fundamental knowledge of geology to recall the formation of this sedimentary basin in which the Lutetian stage, belonging to the Eocene era, is the outcropping layer of limestone that we are collecting (fig. 5).

Of the many quarries in operation, nine are identified by our study as being capable of providing rock suitable for construction. We draw a statement of their available reserves and their annual extraction potential as well as the duration of exploitation. As the same limestone soil can comprise different sedimentation beds, we represent, in cross-section and axonometry, the reality of the different layers that make up each quarry, in order to enumerate exhaustively and completely all the types of available rock. The total volume of stone extraction is then aggregated for the nine quarries concerned. In relation to the quantity required per dwelling (10m3), we extrapolate the possible annual production of solid stone dwellings to about 6000, i.e., about 10% of the needs of the Ile-de-France region up to 2030. [3]

[3] SDRIF 2013: (Schéma Directeur de la Région Île-de-France) : Annual needs for the construction of 70,000 new dwellings.

Fig. 6 - Through one economical gesture, the cut, the fragment becomes element of architecture.

Measuring the energy embodied in stone and placing it in relation to two other materials, wood and concrete, was the second part of our investigation. The major quality of this material lies both in its intrinsic nature, which requires no modification, and in the simplicity of its transformation. Cutting, by sawing, the only transformational operation in its trajectory from matter to material, is incomparably energy efficient (fig. 6). The comparative analysis of the life cycles and carbon footprint of the material, conducted by our partner Elioth on an identical construction unit, reveals the low footprint of stone. It therefore represents a realistic alternative to concrete, even without reaching the environmental performance of wood. Stone construction could therefore take on a significant share of the construction industry by meeting high environmental requirements.

This study, as well as the resulting exhibition, has enabled us to draw three major conclusions that lie between the fields of architecture, construction and economics. Our first conlusion was that, by accumulating the various data acquired, we have drawn up both a panorama of the reservoir of the limestone resource near the capital, and a portrait of a very active structure of trades linked to stone construction. Without ever suggesting that questions of discipline or form are secondary, awareness of the act of building is augmented by considerations of territory, energy and movement. A ready-to-use building material is the result of a whole system of organisation; a sector, which allows the identification of a natural resource, its transformations, its displacements, and its forming into an architectural element.

The second conclusion is a fundamental concern that deals with the act of building. Any architectural material handled is initially a fragment or product of the terrestrial soil. The limestone used in the construction is the result of a long process of transformation of the material and reminds us that the Earth, which has been shaping its soils and subsoils for tens of millions of years, is telluric in nature. During the laying of the stones on our site, and throughout this study, we became aware of the architectural becoming of a terrestrial fragment. Construction, to be deeply connected to environmental issues, must integrate this awareness of the soil into its imaginary (fig. 7).

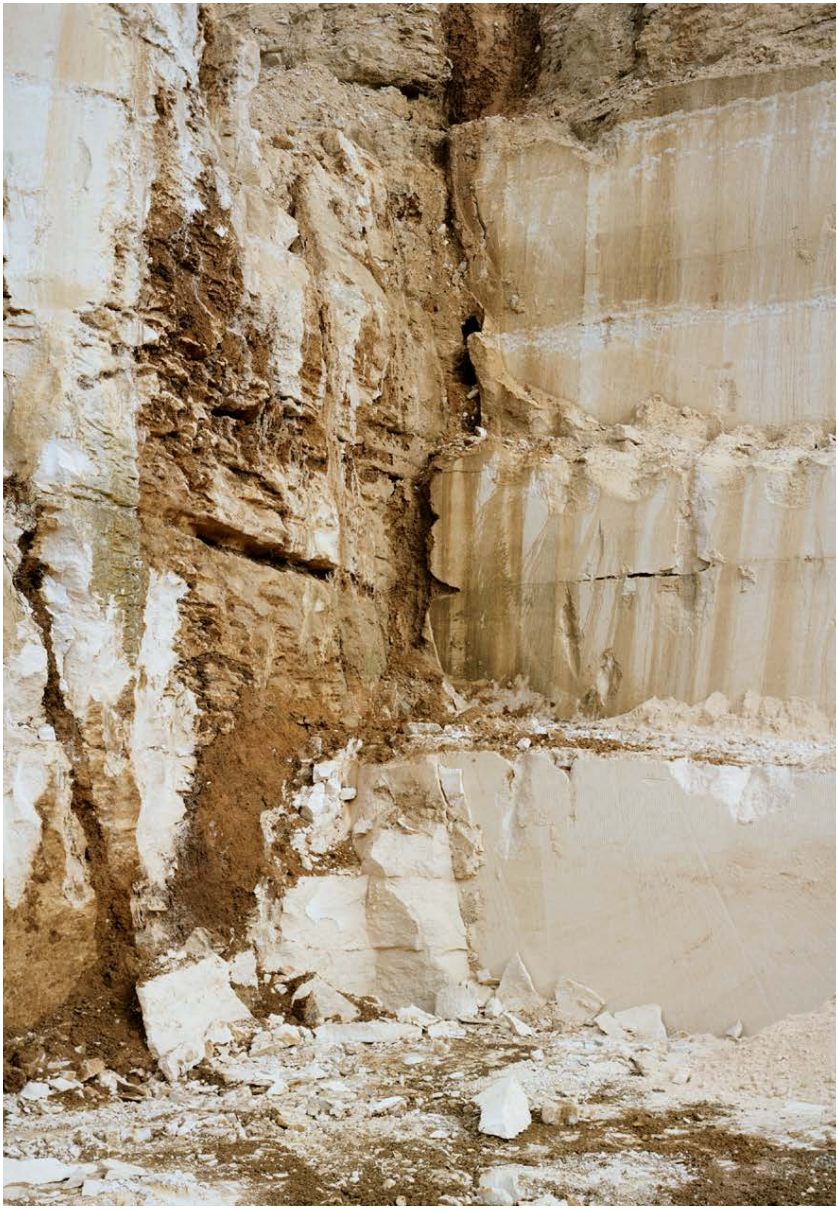


Fig. 7 - For each of the quarries visited, a photograph, produced by Giaime Meloni, is selected. Through this tool, we proceed to build a very strong relationship with the soil, which is both natural and transformed. The traces of sedimentation and the constitution of the limestone are as visible as the marks of the saws (cutters) used to extract the blocks. Nature, beyond being contemplated, is engaged in a transformation instigated by man.

The last conclusion focuses on the issue of economy. The transformation of matter requires many stages and movements, each of which involves a certain amount of energy. To initiate a profound change in our relationship with the Earth, building today requires us to limit these steps and movements and thus reduce our footprint as much as possible. These considerations allow us to go beyond the financial cost of the elements we handle, and to extend the question of economy to energy and carbon. The same process of material reduction by sawing is carried out at each stage of stone processing, from extraction by cutter, to squaring with a circular saw, to the final adjustment of the block with the saw. The transformation is thus only successive volumetric reductions without any change in the state of the material. The nature of a stone present in a building is strictly identical to that which it was in the soil. The fragment of ground becomes an architectural element immediately. And conversely, the element that has been laid down bears witness to the fact that it belongs to the soil.

Fig. 8 - The exhibition aimes to relate the fragments of the ground, the territory and the act of building today.

Fig. 9 - 29 stones are available for extraction in the resource basin. They all have distinct mechanical and thermal specificities.

Assemblages (086AUG)

In addition to the reflections carried out for the PIERRE exhibition, the project of housing in massive stone pointed to another register of questioning, linked this time to the assemblages and the necessary complementarity of the materials.

During the preparation of the PIERRE exhibition, in July 2018, the Biennale d'Architecture et de Paysage d'Ile de France (BAP!) launched a call for applications to participate in its first edition in Versailles. We propose to participate, again as a team with Giaime Meloni, in the exhibition commissioned by Djamel Klouche, AUGURES.
If the research method was cumulative during the PIERRE exhibition, it is reflexive within the framework of the BAP! The approach is similar to the design process of an architectural project, but it is even freer, as it is independent of all practical contingencies inherent to use or function. It is through form, and through the language that derives from it, that the discourse is tested, illustrated, constructed and then affirmed. It is through architecture, and through the question of assemblage, that we take a stand. Our installation is divided into two parts: an artefact MANDALA and two photographic images PRÉLÈVEMENTS. All these elements illustrate an approach that seeks to put in tension form, assemblage, displacement and transformation of resources.

The form of the artefact is directly borrowed from Sol Lewitt's Variations on Incomplete Open Cubes, produced in 1974. The object consists of three vertically and horizontally arranged rectangular parallelepipeds with square sections and identical proportions (fig. 11). Each of the parallelepipeds is made up of a stone element and a wooden element. The language of the assemblages is derived from the constructive tradition of Japanese frameworks, explored here for their interlocking qualities, which do not require any third-party elements to ensure their stability. Their size and dimensions are linked to the measures imposed by nature but are also subordinated to a formal idea that goes beyond them and unites them.

The wood was felled in a forest in the Eure-et-Loir, cut in a sawmill in Frétigny, and then transported to a workshop in Ivry-sur-Seine to be cut into smaller elements. The limestone comes from the north of Paris, near the town of Saint Maximin, and is transported to a factory in Gennevilliers to be cut, trimmed and adjusted into blocks ready to be laid. These two materials are purchased, dressed and assembled by two partner companies: Lefèvre for the stone, and Benjamin Gorridge for the wooden elements.

The two PRÉLÈVEMENTS, photographic images produced by Giaime Meloni (Fig. 12 and 13), reflect the original state of the two identified resources. From the innocence of their primary states, it is a question of initiating a mental process that allows any fragment or product of the soil looked at to become an element of architecture.

Through the co-presence of the MANDALA and the PRÉLÈVEMENTS, the spectator is endowed with a gift of ubiquity. They are simultaneously in the presence of the displaced material and in front of the place of its collection. They are invited to travel and meditate towards these places of extraction or cutting, like a hunter-gatherer in search of available resources. Architectural thinking transforms natural elements into cultural elements. The immediacy of the process is linked to their gaze on the elements that comprise nature, to their ability to make the connection between the natural environment around them and the cultural information at their disposal. Nature is no longer contemplated but *'undertaken'*, being part of a *'dialectical process'*. [4]

The MANDALA reduces architecture to an essential form and allows us to take a stand, once again, on the act of building. Construction is understood as the simultaneous manipulation of natural materials and savoir-faire from a nearby environment, and of universal disciplinary knowledge. Architecture confronts endogenous resources and exogenous knowledge. A balance is established between the abstraction of form and the belonging to resource territories.

[4] Marot, Sébastien, 2010: 'Sub-urbanisme / Sur-urbanisme, de Central Park à la Villette', Marnes 1

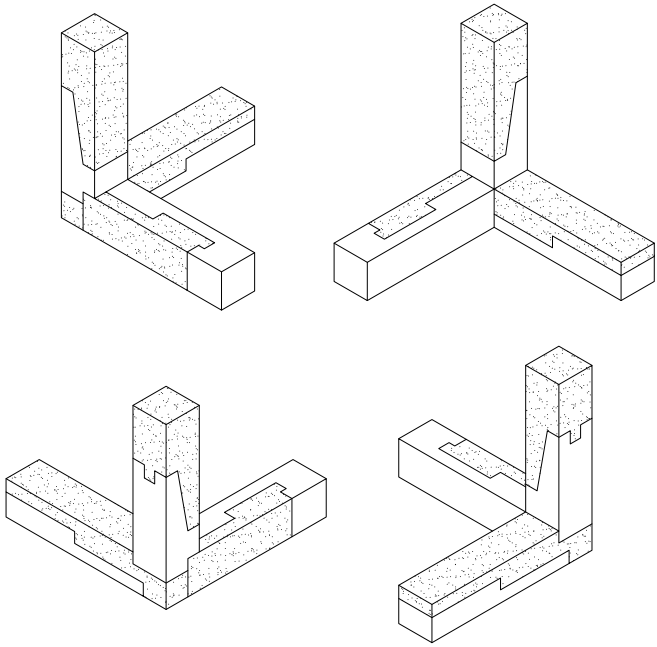


Fig. 11 - The open object of the Mandala replaces the closed space of the primitive hut and proposes an alternative to the initial scenario. The form engages another relationship with the environment and suggests sitting, resting, leaning, contemplating. It is the need to observe that replaces the need to isolate. It is the awareness of the environment that modifies the original idea of architecture.

Fig. 12 and 13 - The architect travels through the territories he transforms. His interested wanderings allow him to locate the products of the ground that are suitable for the construction of his shelters, and to take samples. The two photographs record the initial state of the two resources identified.

Fig. 14 - The two companies involved in the assembly commit their savoir-faire to the transformation of the two materials: stone and wood. Their experience and gestures allow them to adjust each of the elements of the artefact.

The approach allows us to confront local materials and Japanese assemblages, and to demonstrate the necessity, today, of not limiting architectural writing to the immediate context. This attitude demonstrates the impasse of any deliberately vernacular architecture, i.e., one that would limit reflections on form to the reproduction of a strictly local and insufficiently questioned tradition. We believe that architecture today is, by contrast, necessarily knowledgeable. All contemporary design enjoys unlimited accessibility to limitless knowledge and information. Ignoring these, whether voluntarily or involuntarily, would reduce the process to a retrograde and nostalgic posture.

Finally, highlighting the potential of hybridisation and complementarity of materials and sectors makes it possible to question the mono-material traditions, and to define the modalities of languages that are aware of their history, but which can also generate nascent forms (Fig. 14). In the case of stone, for example, it is important to consider references and reflections beyond the history of stone construction itself, to confront constructive logics that are specific to it with universes that are foreign to it. The material is originally innocent, and it is the architect, through the assemblage, who takes a stand and builds meaning.

Housing in hempcrete

In 2022, the office completed a building of 15 apartments in Paris. A search for economy of means led us to opt for a primary reinforced concrete frame and a peripheral envelope made up of a secondary wooden frame filled with hempcrete insulation. Our interest focused on the relationship between structure and insulation, their relative positions and their formal potential. These issues placed technical and constructive considerations very well ahead of our design so that they could nourish all our architectural reflections. However, several questions arose during the implementation of the hempcrete. We methodically documented these moments of the construction site, to preserve a history and a material for reflection (fig. 15, 16, 17 and 18). We can consider these revelations as a kind of dynamic that goes beyond the project in progress in order to initiate future reflections. We note them as observations of observed facts, of factual and objective realities.

The relationship between the structure and the insulation seems to be renewed by the very nature of the material used and calls for further questioning of this particular aspect of the project. The thickness of the envelope, made up almost entirely of insulating material, questions the very term ‘wall’ and the apprehension of the elements of the architecture in an autonomous and separate way. A sort of fusion takes place, creating a system of heterogeneous elements. A reversal of hierarchy occurs where the form is determined more by the insulation than by the structure.

Fig. 15, 16, 17 and 18 - Hempcrete is a compound, an assembly of hemp shives (the aggregate) and lime (the binder) which is only formed at the moment of its implementation by the operator. It does not exist prior to its instantiation on the construction site. The projection of the hempcrete into the wall, by agglomeration, reveals the conditions of the final continuity of this mass.

The final material only appears at the time of its implementation and drying. It is a fragile material and must be covered and protected afterwards. The insulator disappears and its presence is then only a transitory moment, the efficiency of an invisible material which is only revealed by its thickness.

The necessity of the full

The experience of the implementation of hempcrete led us to consider this insulator as an architectural element generating specific forms, writings and spatialities. Wishing to extend these observations, we responded to a call for research projects launched by the Caisse des dépôts et consignations 'research in architecture and landscape'. [5]

Our research project is supported by the École Nationale Supérieure d'Architecture Paris Est. It is made up of a mixed practitioner/researcher team with the collaboration of Giaime Meloni and the scientific support of Sandrine Marceau, doctor of materials science, researcher at the laboratory of Physico-Chemical Behaviour and Durability of Materials at Gustave Eiffel University.

Insulation issues are relatively recent in our discipline. The term insulation itself only gained acoustic and then thermal acceptance in the late 1920s. Until then, insulation only referred to the notion of separation. The history of insulation as a material is therefore very recent. It is mainly a continuation of the development of scientific knowledge in the field of physics and more particularly heat transfer. Modern architecture only considers the issue of insulation through the prism of the separation of two media, with-

[5] For the fifth consecutive year the Caisse des Dépôts is launching a call for applications to support research and innovation in the field of architecture and landscape in France. Caisse des Dépôts is fully committed to reducing the territorial and social fractures in our country and intends to promote research work that contributes to these objectives by taking the measure of the environmental and social challenges facing our society.

out taking into account their resistance to heat transmission: their thermal resistance. The inclusion of an air space between the glazings subsequently made it possible to reduce losses by convection and met with great success in the 1930s. This relationship between air and matter is not new since it existed in vernacular architecture through the use of 'breathing' materials with high inertia and hygrothermal regulation qualities. However, it is the integration of air in industrial materials that marks a decisive turning point. *'Thus, whether it is between the glazing of the window, the glass panel, inside the bricks and glass blocks, or between solid walls, the logic of air insulation seems to be triumphant.'* [6]

It was only later that new studies recommended the use of materials specifically dedicated to reinforcing thermal insulation. Materials that meet two fundamental rules, containing air and consisting *'of the smallest possible independent cells.'* [7]

Subsequently, synthetic insulating materials from a flourishing chemical industry were used to meet energy objectives that had become unavoidable. This led to a hyperspecialisation of the material which, through a continuous quest for performance, leads to the distancing of insulation, and the act of insulating, from architectural and aesthetic issues. Insulation is no longer approached solely

[6] Lempereur, Hubert, 'Une brève histoire de l'isolation', episode 4/10 : l'air et la matière', *D'A n°250*.

[7] Charpentier, L, 1932: 'Études techniques : Isolation thermique des bâtiments', V : 'Le pouvoir des matériaux', l'Architecture d'Aujourd'hui, April.

from a technical, industrial and performance point of view (Fig. 19). Today, the increasing use of bio-sourced materials shifts the focus from pure thermal resistance performance to a more complex balance between inertia, thermal conductivity, and mass heat. Hempcrete meets these ambitious objectives. The internal structure of the hemp fibre coupled with the lime constitutes a heterogeneous whole whose internal structure generates porosity networks at different scales. This structure gives the wall high hygrothermal properties. Our research focuses on revealing these internal, microscopic structures, which are at the origin of the performances observed. Both trapped and moving air plays a major role.

The microscopic structure of the material, at the origin of the internal dynamic phenomena of the lining, leads to the thickening of the insulator, upsetting the hierarchy between insulator and structure, to the point where the need for fullness is affirmed. This statement leads us to find architectural issues in technical problematics and thus replace the insulator in the architectural field. The fullness having as corollary the notions of surface, thickness and continuity – three key-subjects to commit some profound theorical investigations.

The intrinsic properties of the material as well as its thickness are determined by the very nature of its microscopic structure, which is by definition invisible. One of the axes of our research consists in making this dimension of the material visible, in order to reveal the nature of the cou-

ple relations between its mineral part, lime, and its vegetal part, hemp. This becomes an issue of representation, an architectural issue in essence.

The images are obtained by Scanning Electron Microscopy (SEM). They reveal the three types of porosity in this material (one visible inter-particle, the other two invisible: intragranular and microporous). The SEM offers magnification

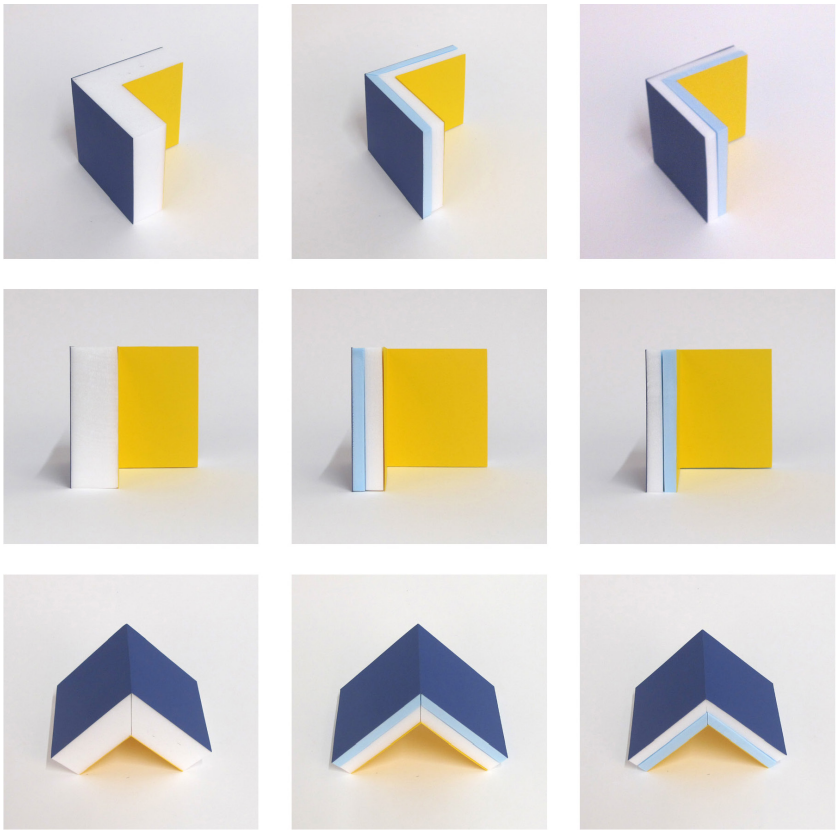
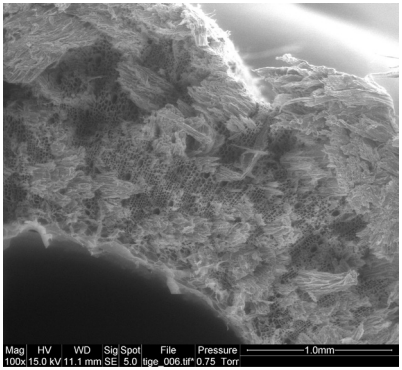
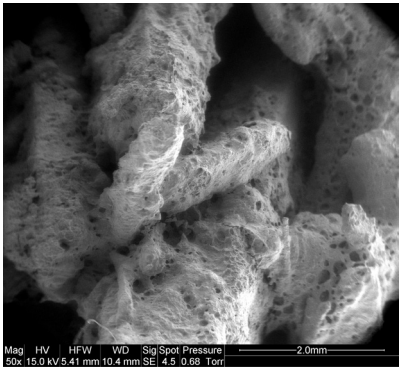
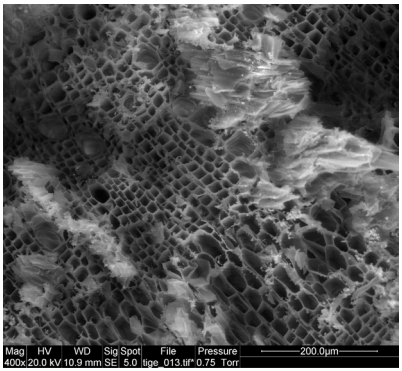
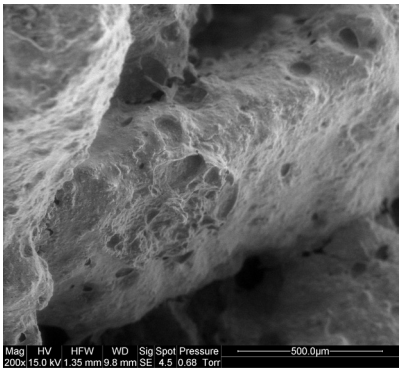


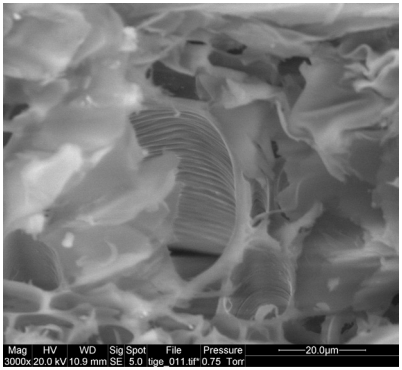
Fig. 19 - The models expresses the evolution of the composition of a wall. Hemp Insulation subverts its purpose, and suggest a homogeneous organism which doesn't separate the function of its elements.











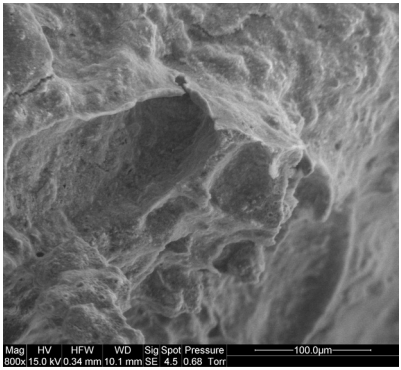


Fig. 20 - Sample of hemp shives alone.

The SEM allows us to visualise the repetitive honeycomb structures of the plant. Each cavity traps a portion of air and thus contributes to the thermal resistance of this natural material. The microscope reveals an aesthetic universe of striking abstraction.

Fig. 21 - Sample of hempcrete.

The different magnifications reveal the different types of porosity. Between coated aggregates and on the surface of the binder itself. The presence of air and its potential circulation in the material allows us to understand how the material works.

possibilities allowing the visualisation of both the covering of pieces of hemp shives by the binder (x10) and the structure of the fibre itself (x800) (Fig. 20 and 21). All these porosities are as many voids, with different shapes: closed porosities that trap air or open porosities that allow hygroscopic exchanges. The void, essential for insulation, is everywhere. This void is inseparable from the full, the fulls, which surround it. The full is therefore necessary to generate this highly complex void, a void with high thermal performance. This void cannot exist without the full (the reciprocal being possible), so we take an option on the full by affirming its architectural necessity.

The architecture of full insulation shifts the notion of architectural rationalism, in the sense of reasoned knowledge, from construction rationalism to what might be called thermal rationalism. The manipulation and consideration of the insulator, which until now has remained relatively outside the field of ideas, defines new architectural problematics and opens up new formal potentialities.

Normatives experiences

Since 2019, we have been developing a project for 100 housing units for the 2024 Olympic athletes' village. SOLIDEO, the developer of the Olympic facilities, finances innovation projects. Our proposal, selected by an innovation committee in October 2020, concerns the construction of a prefabricated, perspiring, load-bearing wall made of wood frames insulated with hempcrete. This innovation is based on the state of the art of existing technical solutions and on our experience gained from previous projects. Hempcrete construction solutions are currently validated in France not as a standard technique through the DTU (Documents Techniques Unifiés) but through professional rules in a relatively restricted application framework. This experimental stage should allow the definition of a new normative framework for the technical deployment of hemp-concrete construction. It entails an undeniably collective dimension. The test protocols set-up is defined in the framework of an ATEx procedure. [8]

Parts of the construction system are subjected to a series of extreme loadings, known as limit states. The constructive mode must prove its technical maturity, its durability and by extension its potential reproducibility.

[8] 'The Appréciation Technique d'Expérimentation (ATEx) procedure contributes to the development of innovations in the building industry by facilitating their access to experimental applications. The ATEx is an evaluation for the benefit of innovative products, processes, or techniques in construction, established by experts under the aegis of the CSTB (Centre Scientifique et Technique du Bâtiment), at the request of parties interested in obtaining a rapid technical evaluation. Specially created to facilitate experimentation in implementation, this procedure applies only to innovations that have been sufficiently studied and developed to justify such experimentation.' https://evaluation.cstb.fr/en/technical-experimentation-assessment-atex/

Through this experimentation it is also the role of architecture as a driving force for innovation that we consider interesting to question. More and more frequently, we find ourselves in a situation where the initial technical state we know is insufficiently reliable to respond to the innovative solution we are asked to develop. To solve this technical problematic there is never a sole solution, but a multitude. The choice of one technical solution over another does not therefore refer to the technique itself, but to architecture in its cultural dimension. Architecture is a laboratory of technical innovations where the reference to the technical question alone is not sufficient to solve the technical problem. Like Jean-Pierre Séris, we can consider the resolution of the technical problem as an aspiration, a desire for technique beyond technique itself: *'Technique conceives of aporia only in reprieve: technique is inseparable from a decision to seek further, except in cases of satisfied stagnation.'* [9]

This *'will to technique'* leads us towards action and opens-up a field of reflection that goes beyond the technical problem to engage architectural and cultural issues. *'To pose problems beyond what we know and can solve is to access problems of a very particular essence and status.'* Mastering this technical dimension is also a necessary condition for building, for doing. Our experiences on the building sites open-up fields of possible questioning and reflexivity, as we have created the conditions for the possibility of doing things upstream. The mastery of the technical design is always alongside the uncertainty inherent in the building site.

[9] Séris, Jean-Pierre, 1994: La technique, PUF, p.20

[10] Ibid

The documentation of these tests plays a fundamental role in the experimentation process, beyond the final result determined by its success or failure. This recording is twofold. On the one hand, a record of the values obtained, which constitute the measurements to be analysed (fig. 22 and 23), and on the other, a photographic recording of the conditions of the test and the experiment itself (fig. 22, 23 and 24). This work of scientific imagery refers to the mechanical objectivity [11] described by L. Daston and P. Galison or to the work of Berenice Abbott [12] who took scientific photographs at MIT in the 1950s. The abstract forms she then unveiled made it possible to visually represent complex mechanical concepts and physical laws that were hitherto invisible.

Uncertainty and risk are inherent to the process of experimentation. Risk represents *'an educated audacity, drawing on the lessons of the past. This is why technology is not just the quiet possession of solutions to a few problems, but the aspiration to change, the creator of problems, the provider of solutions that never prevent the question from bouncing back and persisting in another form'*. [13] It is in the unpredictability and instability of experimentation that the ferment, the potential for discovery and the unexpected, lies. As a condition increasingly necessary to the possibility of construction, experimentation plays an essential role in defin

[11] Daston, Lorraine & Galison, Peter, *2012: Objectivité*, Les Presses du réel

[12] Abbott, Berenice, *2008: Documenting Science*, Steidl Interart.

[13] Séris, Jean-Pierre. Ibid. p.44

Fig. 22 - Fire resistance test.

This is a fire resistance test of a load-bearing hempcrete wall with timber frame. The aim is to evaluate the load-bearing capacity «R», the thermal insulation «I» and the fire-resistance «E» of the wall, subjected to a thermal action according to the standardised temperature-time curve of standard NF EN 1363-1. The prototype is a wood-frame wall filled with hempcrete with a dimension of 4 x 3 m and a thickness of 40 cm. It is equipped with numerous sensors (pyrometers and thermocouples) and subjected to a compression load of 38 tonnes applied by a system of jacks.

Fig. 23 - Water resistance

6 wall prototypes were subjected to alternating humidification (8 hours) and drying (40 hours) cycles. The objective of this test will be to confirm the ageing protocol of the hempcrete prototypes (with or without lime coating), in relation to the conditions to which the wall is subjected under real loads. The resulting protocol will then be applied to the driving rain test. Both the penetration of moisture into the wall and the durability of the plaster are measured.

Fig. 24 - The photo shows the drying bench which generates a temperature of 80°C for the drying cycle.

ing the place of technique in the architectural discipline. *'Architecture is not a field of application of construction techniques, thought of as instrumental means elaborated upfront, but it is a medium of experimentation of techniques, essential to their development and their adaptation in complex situations. Architecture is also a field of critical reflection on our ways of acting and building, in which technique is in project'.* [14] These constructive experiments maintain invention in the field of architecture, at a good distance from the research laboratory or industrial prototyping: *'The awareness that no constructive system reaches maturity without a phase of experimentation in a complex project situation, is a major challenge for the exercise of the architect's profession and the definition of its scope of competence.'* [15]

[14] Berthier, Stéphane, 2017 : 'Création architecturale et industrialisation de la filière bois : l'architecture comme milieu d'expérimentation des innovations techniques', in *Architecture, aménagement de l'espace*. Université Paris Saclay, p.3

[15] Berthier, Stéphane, ibid

Conclusions

The office was founded in 2009. The first vectors of reflection and the first conversations to initiate the design of projects were directly derived from a common education between the two partners, and structured mainly around history, construction, and architectural theory. The act of building is considered a cultural process and answers a question that would have been asked before. We provide an answer that is both aware of the canons it calls upon, committed to current concerns, but also nascent. Today, these lines of thought allow us to share production ambitions with the whole team and to define a framework in which we want to include all conversations. We have constructed methods and envisaged processes through which knowledge can be defined and accumulated by all. Through research, enquiries and investigations, we identify questions and assert our positions.

In 1974, Roland Barthes published *Au séminaire*, in which he depicts the structure of exchanges between teachers and students. Research and the production of knowledge organise the relationships between the different participating individualities and allow for the establishment of a horizontal scheme that overturns any hierarchy in the exchanges. Barthes identifies three spaces: institutional, transferential and textual, and in the second, he specifies: *'I am neither a sacred (consecrated) subject nor a friend, but only a stage manager, a session operator, a regulator: one who gives rules, protocols, not laws. My role (if I have one) is to free*

up the stage where horizontal transfers will be established.' [16]

The articulation between research and project within the agency involves the collaborators in a reflexive approach, and no longer one that is only productive. The methods constantly interrogate the universal discipline to which they belong, and question without restraint the means and devices by which we act on the world. The agency is a stage on which different individualities move, seeking, sharing and pooling experience and knowledge. The working conditions and processes linked to research allow us to go beyond the opposition between those who know and those who do not and involve each actor in a role that is both responsible and non-hierarchical.

Research repositions the architect in their collective and cultural mission. It is a state of mind, an agency structure, an ambition that manipulates the uncertainties of the world in which we evolve, and that accepts doubt as a system of relations between people and for the design of projects. It transforms the posture and allows the role of the architect to evolve from being solely the one who knows to being the one who seeks.

[16] Barthes, Roland, 'Au séminaire', in *L'Arc,* N°56, 1974

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