



# RUMOR

A(BouT) Building Technology

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**Kengo Kuma,**  
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Dominique Gauzin-Müller,  
ecoLogicStudio, V8 Architects,  
Biobabes, Redhouse Studio,  
Kathryn Larsen, Selena İşildar

79. Bio-Based



Fig. 1: Load bearing straw-bales walls  
© Ville de Rosny-sous-Bois

## WOOD, STRAW, HEMP & CO. Materials for the ecological and societal transition

Dominique Gauzin-Müller

The Paris Climate Agreement signed in 2015 by 196 countries calls for a significant reduction in the environmental footprint of existing and future buildings. The use of materials based on fast-growing plants, often in combination with wood, earth and stone, meets this requirement. Numerous examples, such as these three French TERRAFIBRA Award finalist buildings, highlight the great diversity of techniques. They demonstrate that it is possible to enrich the architectural project by using local resources and drawing inspiration from vernacular building cultures.

### Sustainable materials

Facing the worrying climate change, the construction sector must quickly offer an alternative to the hegemony of cement and reinforced concrete, which are responsible for approximately 8% of CO<sub>2</sub> emissions. The use of bio-based materials (wood, straw, hemp, etc.), in combination with earth with its high inertia, offers virtuous technical solutions. Some have been tried and tested for centuries, others are being invented today. The potential of these construction methods is highlighted in the travelling exhibition and the book presenting the 40 finalists of the TERRAFIBRA Award<sup>1</sup>, the world's leading prize for contemporary architecture in earth and plant fibers. These inspiring projects show the pioneering role of France in the use of straw and hemp in construction. They are part of the movement initiated in January 2018 by the "Manifesto for a happy and creative frugality in architecture and territorial management"<sup>2</sup>, which has already received more than 13,500 signatures from 80 countries.

### The multiple benefits of biobased materials

The finalists of the TERRAFIBRA Award combine the use of local resources, bioclimatic measures and contemporary design. They symbolize a frugal modernity, which pays tribute to ancestral know-how without refusing robust and efficient technical innovations. They show that the biobased sector also represents an important potential for economic activities and job creation, while respecting the material and immaterial wealth of the territories. Biobased materials contribute to the energy performance of new constructions and renovated buildings. Not only do they not emit CO<sub>2</sub>, but they store carbon and therefore present a huge opportunity to fight global warming. The use of fast-growing plants also limits the waste of non-renewable resources. One of the great qualities of walls made of biobased materials is their perspiration, which allows the migration of water vapor while ensuring air tightness. Experience has shown that hygroscopic capacity improves the theoretical thermal performance of a straw or hemp lime wall.

<sup>1</sup> This prize is supported by amàco and the Grands Ateliers ([www.terrafibraaward.com](http://www.terrafibraaward.com)).

<sup>2</sup> This manifesto was launched by the engineer Alain Bornarel, the architect and urban planner Philippe and the architect-researcher Dominique Gauzin-Müller ([www.frugalite.org](http://www.frugalite.org)).

### The French straw building network

France is a pioneer in straw construction with around 5,500 buildings insulated with this agricultural co-product, including several hundred public facilities and social housing. This success is due to a well-organized sector based around the French Straw Construction Network<sup>3</sup>, which has been able to provide the means for success: wide dissemination of good practices, numerous training courses, participatory work sites, etc. In 2012, fire tests at the CSTB and the publication of professional rules helped convince insurers and technical inspectors. Several implementations coexist: filling in a framework or prefabricated wooden boxes, or even load-bearing walls made of superimposed straw bales.

### Leisure center in Rosny-sous-Bois

The town of Rosny-sous-Bois, near Paris, is a pioneer in frugal architecture using biobased and geobased materials. The leisure center it opened in 2020 marks a new step towards the objective of reducing the environmental footprint of its building stock. The building can accommodate 180 children after school and during the holidays. Its two-story northern façade is made of load-bearing straw bales, with lime-sand finish on the outside



Fig. 2: Curved Facade © Ville de Rosny-sous-Bois

and earth-plaster on the inside. Slightly curved, this bioclimatic construction is compact to reduce heat loss and naturally ventilated thanks to five wind towers. Its southern façade is largely glazed to capture a maximum of solar gain; the others, more opaque, protect the building from rain and prevailing winds. The innovative technical choices were discussed in advance with the control office in order to eliminate any possible blockages. They also gave rise to numerous exchanges within the town hall's departments to optimize the operation of the leisure center.

### Building with large, load-bearing straw bales

The large organic straw bales used for the Rosny-sous-Bois leisure center travelled 50 to 100 km from agroforestry

farms in the Eure-et-Loir and Yvelines regions. They have the same cross-section (47 x 80 cm), but three different lengths (125, 165 or 200 cm), which makes it possible to combine them to reduce cutting on the site. The bales have a very high density (over 140 kg/m<sup>3</sup>). They are laid flat, cross-jointed in corners and on long walls. The bundles are planted on 3 cm diameter chestnut stakes embedded in the bottom rail in order to limit the risk of buckling of the walls and cracking of the plaster at the junction between two bales. The straps passed under the stringers of the bottom beam are used for tightening during the compression phase. The work was carried out by the APIJ BAT cooperative, a company that takes in people on social reintegration and which also built La Ferme du Rail, located to the north-east of Paris, a few kilometers from Rosny-sous-Bois.



Fig. 3: Floorplan with its straw-bale wall ring © Ville de Rosny-sous-Bois

<sup>3</sup> Réseau français de la construction paille ([www.rfcp.fr](http://www.rfcp.fr))



Fig. 4: Centre de loisirs under construction © Ville de Rosny-sous-Bois

#### An urban market gardening project based on solidarity

La Ferme du Rail is a place for living and training in urban market gardening, dedicated to the integration of people in precarious situations. This militant operation was the first to be carried out under the Réinventer Paris call for projects, launched in 2014 by the City of Paris. Initiated by residents and associations of the 19th arrondissement, it proves that another way of life is possible, even in a major European capital. Its sustainable and supportive economic model, based on short circuits, generates agricultural activity that creates jobs. The two buildings are wood-framed with straw bale insulation. To the west of the vegetable garden, the residence houses fifteen people on integration programs and five horticulture students. To the north, the farm building includes a large greenhouse, workshops, a mushroom farm and the restaurant "Le Passage à Niveau". Here, customers can taste the fruit and vegetables produced on the site and those of partner farmers. The Ferme du Rail is also a neighborhood facility that provides several services: collection and treatment of organic waste, maintenance service for green spaces, organization of workshops and events, etc.



Fig. 5: Cross Section of La ferme du rail © Grand Huit



Fig. 6: Front View © Clara Simay

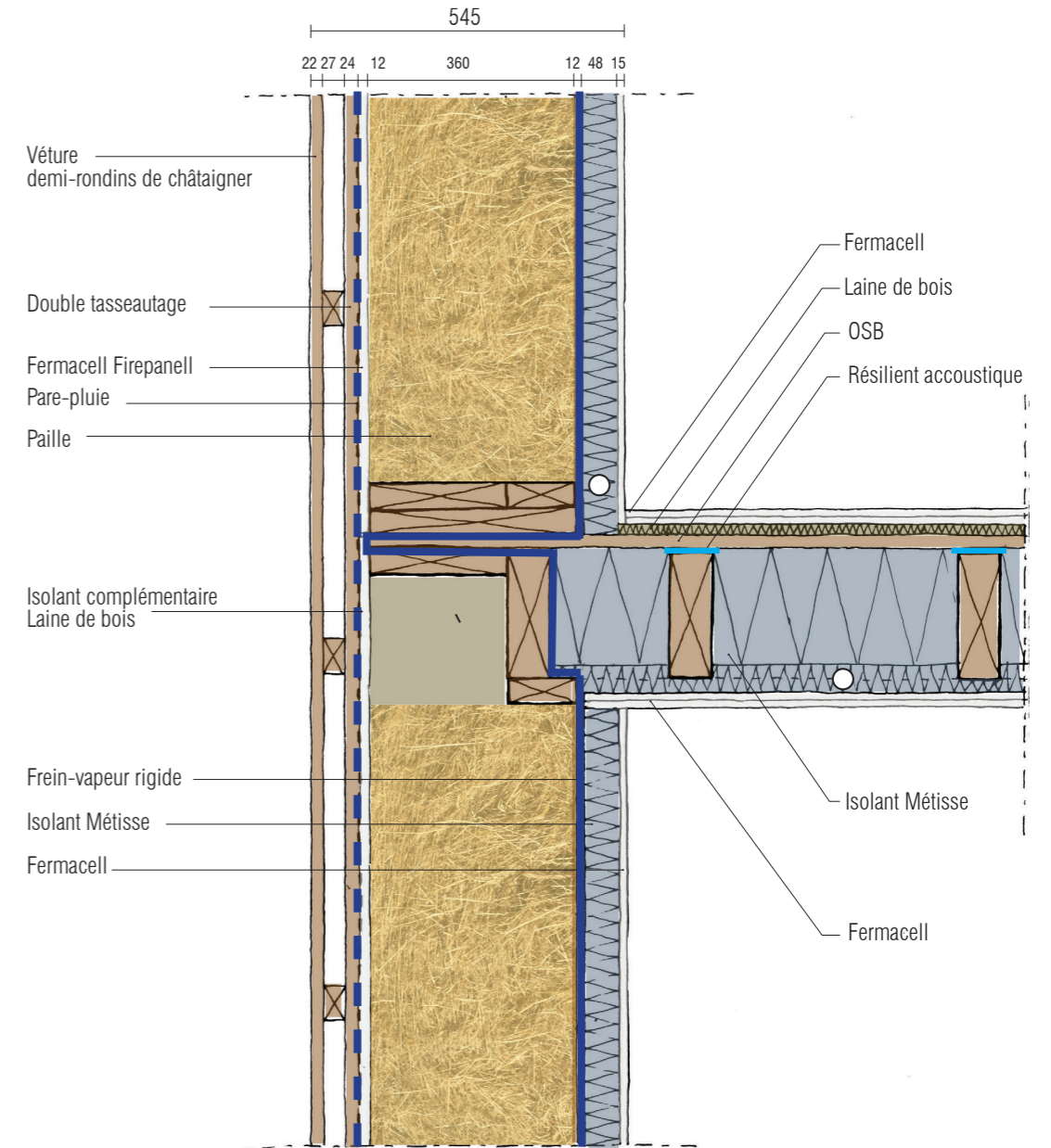


Fig. 7: Constructive Detail © Grand Huit



Fig. 8: Side View © Clara Simay

### Building and renovating with hemp

Hemp construction is another emerging sector in France. The resource is available: the country is the leading European producer, with 50% of the surface area planted. Produced in a short circuit, hemp contributes to the development of sustainable agriculture, promoting crop rotation and soil regeneration. Since the publication of professional rules in 2014, the use of hemp is developing for new construction and renovation, especially in the Paris region thanks to a few committed architects, engineers and

craftsmen. A distributed insulation made of hempcrete has shown its efficiency for the "low carbon" rehabilitation of old Haussmannian buildings. But the hemp-lime mixture is also very effective in new residential buildings, such as that of the architectural office North by Northwest in Boulogne-Billancourt.

### Building of fifteen dwellings in hempcrete

The Silly-Gallieni neighborhood is one of the most dynamic in this Parisian suburb. Public facilities, services

and shops stand alongside two- to ten-story residential buildings with good public transport links. As part of the densification of the urban fabric, a house built on a 241m<sup>2</sup> plot was replaced by this 15-unit residence. The primary structure consists of reinforced concrete partition walls and slabs. The hempcrete is sprayed from the outside into the prefabricated wooden boxes of the street and garden facades. The mixing of hemp shives and lime mortar is done in the end of the lance using a technique that allows a good yield on the building site. The reinforced concrete skeleton is filled with 22 cm of hempcrete composed of 100 kg of hemp shives and 180 kg of lime for 1 m<sup>2</sup> mixture. The finish is a lime plaster.

This nine-story building made of hempcrete is a first in France, and even in Europe. Its facades are five times lighter than concrete walls with added insulation. This lightness, the ease of implementation and the speed of execution presented several advantages on this difficult site, with a fragile subsoil and a very small plot of land for an nine-story building. The hemp-lime mixture contributes to the hydrothermal comfort of the inhabitants. The gas/liquid phase change phenomenon releases or absorbs energy, reducing the difference between the ambient and the external wall temperature and eliminating the cold wall effect.



Fig. 9: Pouring Hempcrete at construction © CecileSeptet



Fig. 10: Facade view from the street © Cécile Septet

### Towards frugal and creative architecture

All of these projects demonstrate the commitment of pioneering teams of architects, engineers, builders and clients. They prove that it is possible to build differently, using local resources and know-how without giving up innovation. Anchored in their territory, these frugal and creative architectures open up new horizons for construction and renovation.



Fig. 11: Facade units © North by Northwest Architectes

## INFORMATION ABOUT THE PROJECTS

### Jacques-Chirac leisure center made of load-bearing straw bales

Location: Rosny-sous-Bois, France

Completion: 2020

Client: City of Rosny-sous-Bois

Design: City of Rosny-sous-Bois, Research and Territorial Innovation Department

### La Ferme du Rail in timber frame and straw infill

Location: Paris, France

Completion: 2019

Owner: Réhabail, associations Atoll 75, Travail et vie and Bail pour tous

Design: Grand Huit/Julia Turpin and Clara Simay (architecture); Mélanie Devret, Scoping, Toreana Habitat, Albert & Co, Pouget Consultants, BTP Consultants (engineering offices)

### Residence of 15 dwellings in hempcrete

Location: Boulogne-Billancourt, Île-de-France, France

Completion: 2021

Owner: Groupe 3 F

Design: North by Northwest Architects (architecture), LM Ingénieur (engineering office)



Dominique Gauzin-Müller

Dominique Gauzin-Müller, a French architect living in Stuttgart (Germany), is honorary professor of the UNESCO Chair "Earthen Architecture, Constructive Cultures and Sustainable Development", and lectures in several universities around the world. Author of 21 books and curator of several exhibitions on sustainable architecture and urban planning, she collaborates with many international reviews. She initiated and coordinated the TERRA Award 2016, first world prize for contemporary earth architecture, and the FIBRA Award 2019, first world prize for contemporary biobased architecture. Those two awards have been combined to create the TERRAFIBRA Award 2021. The finalists of each prize are highlighted in a book and a travelling exhibition. Dominique is also co-author of the "Manifesto for a happy and creative frugality".