


# MACH - House Comforted by Humidification

by [Lamine IGHIL AMEUR](#) / 2020-07-09 22:30:24 / France / 7635 / FR



**Renovation**

**Primary energy need :**

90 kWhep/m<sup>2</sup>.an

(Calculation method : Other )

**ENERGY CONSUMPTION**

Consumption Range (kWhep/m <sup>2</sup> .an)	Energy Class	Building Type
< 50	A	Economical building
51 à 90	B	Economical building
91 à 150	C	Building
151 à 230	D	Building
231 à 330	E	Building
331 à 450	F	Building
> 450	G	Energy-intensive building

**Building Type** : Isolated or semi-detached house  
**Construction Year** : 1967  
**Delivery year** : 1968  
**Address 1 - street** : 10 rue d'Auvergne 41500 MER, France  
**Climate zone** : [Cfb] Marine Mild Winter, warm summer, no dry season.

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**Net Floor Area** : 200 m<sup>2</sup> Autre type de surface nette  
**Construction/refurbishment cost** : 15 000 €  
**Cost/m2** : 75 €/m<sup>2</sup>

## General information

In a **global context of disruption and climate change**, natural phenomena are multiplying in a recurring manner with greater intensity. The year 2020 is an extraordinary year: the hottest in France since 1900 [ 1 ]. The 2020 temperature in France, consolidated with the forecasts for December 28, is 14 ° C, thus exceeding that recorded in 2018 (13.94 ° C). Thus, in 2020, we experienced the warmest winter since the beginning of the 20th century [ 2 ], the driest summer (from June 21 to September 20) since at least 1959 [ 3 ] and an exceptional episode of heat in September [ 4 ]. Even more recently, we experienced the hottest November 2020 on record worldwide [ 5 ].

In 2019, **drought was ranked 1st natural risk** in terms of costs of damage caused, estimated between € **600 and 870 million** by the Caisse Centrale de Réassurance (CCR), and a third of the French territory affected [ 6 ]. The current trend is not likely to be reversed in the future in the context of climate change, with **6,265 applications** for recognition in a state of natural disaster (Cat-Nat) drought 2019 processed, of which **47% are favorable** and **2.1 million houses in the medium-strong RGA zone** [ 7 ]. In the long term, projections illustrate this trend through an increase in the cumulative cost of drought insurance by **+ 162%** over the period **from 2014 to 2039** [ 8 ].

**Cerema**, awarded the Carnot Institute "**Clim'adapt**" label in 2020, is stepping up its efforts in favor of **adaptation to climate change** through **applied research and innovation** .

From the end of 2016 to the end of 2020, Cerema experimented with a new **remediation solution, MACH**, based on the **re-humidification of clay soils** during the drought period by making use of **rainwater**, previously collected and stored (during the wet period preceding the period of drought). drought). The **principle** of the MACH solution aims to **maintain a balanced water state** at the level of the foundation soil, despite the **phenomenon of shrinkage** and **aggravation** under the effect of **evapotranspiration** and **vegetation**, in order to stabilize the opening of **existing cracks**. in the structure and prevent the initiation of new cracks. The **results**, recorded during the last 4 years of intense droughts, are **encouraging** in terms of stabilizing the opening of existing cracks instrumented by

crackometers.

## Sustainable development approach of the project owner

The house was built on very plastic clay soils, subject to the phenomenon of **RGA** (shrinkage swelling of clay soils), with shallow foundations. With the effects of **climate change** and the **increasingly intense droughts** since the summer of 2015, **structural damage** has appeared inside and outside the house.

In fact, the differential settlements of the foundation soil due to the **phenomenon of shrinkage** during the drought period, then the **swelling** undergone during the wet period in a cyclical manner under the effects of climatic disturbance affect the mechanical properties of the soils and can induce instabilities at the level of the structure.

The objective of the **MACH** solution is to maintain a balanced water state during the drought period to limit the phenomenon of subgrade shrinkage and thus stabilize existing damage and prevent the appearance of new damage.

The advantages of the **MACH** solution are numerous, the main ones being:

- **ecological** : the only resource for the operation of the **MACH** solution is the **recovery of rainwater** previously collected and stored,
- **economical** : compared to the conventional solutions available, the cost of which is at least 50 to 70 k € HT, the cost of the **MACH** solution at around **15 k € HT** makes it **accessible to all** disaster victims,
- **light** installation: the installation of the **MACH** solution does not require the moving or rehousing of the occupants,

To summarize, our **innovative approach** makes it possible to provide a new **effective concrete response** to the growing problem of RGA while being ecological and economical.

## Architectural description

The reinforcement work provided by the MACH solution vis-à-vis the natural phenomenon of RGA does not concern the architecture of the building but the stability of its structure.

## See more details about this project

<https://www.cerema.fr/fr/actualites/stabilisation-du-phenomene-retrait-gonflement-sols-argileux>

## Photo credit

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## Stakeholders

### Contractor

Name : M et Mme Noblecourt (propriétaires de la maison MACH)

### Construction Manager

Name : Cerema

Contact : Lamine IGHIL AMEUR (lamine.ighil-ameur[a]cerema.fr)

<https://www.cerema.fr/fr>

## Energy

### Energy consumption

Primary energy need : 90,00 kWh/m<sup>2</sup>.an

Calculation method : Other

## Renewables & systems

### Systems

Heating system :

- Gas boiler

#### Hot water system :

- Individual gas boiler

#### Cooling system :

- Others

#### Ventilation system :

- Natural ventilation

#### Renewable systems :

- Other, specify

## Environment

### Urban environment

Detached house with garden.

## Products

### Product

MACH

Cerema

lamine.ighil-ameur[a]cerema.fr

<https://www.cerema.fr/fr>

#### Product category :

See the description in the "Project highlights" section in the identity card.

Moistening the foundation soil with rainwater during drought re-hydrates the shrinking clay soil and thus limits the structural vulnerabilities of the house.

## Costs

### Construction and exploitation costs

Total cost of the building : 15 000 €

#### Additional information on costs :

This is the total cost of installing the MACH solution

## Contest

### Reasons for participating in the competition(s)

Following the initial **geotechnical surveys** (G5) of the soil in place, a layer of **clay** < strong> plastic 2 m thick (sensitive to RGA) was identified at the **foundations** . It should also be noted in the initial inventory of the presence of **vegetation** (trees and hedges) near the damaged facades. The **principle** of the MACH solution is inspired by **irrigation agricultural** controlled by measuring soil suction. Thus, the operation consists in carrying out a **humidification** of the foundation soil during the drought period with **rainwater** , collected and then stored upstream. Humidification depends on the continuous **measurement** of **soil suction** and is carried out manually by opening valves. The objective is to **rehydrate the soil** plastic clay near the foundations and thus try to **control** the propagation of the existing **cracks** and prevent the initiation and the propagation of new cracks.

The **monitoring** of the experiment, carried out by the Cerema, made it possible to " record **data** for 4 years of intense drought 2017, 2018, 2019 and 2020. These data relate to **tensiometry** of the soil, **cracking** and **meteorology** . The first **results** in terms of stabilizing existing cracks during periods of drought are **encouraging** .

MACH is an **innovative** and **resilient** solution: (i) **ecological** , limiting the impact on the **water resource** using rainwater and **reducing the carbon footprint**

compared to conventional repair techniques, (ii) **economical** , with an installation cost and supply of equipment of approximately **15 k € HT** making it **accessible to all disaster victims** compensated or not via the cat-nat device and (iii) allows, with a < strong> light implementation , to **limit the vulnerabilities** of constructions exposed to the risk of drought and to the RGA phenomenon.



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