# Humidification of house foundation soil affected by the clays shrinkage-swelling phenomenon


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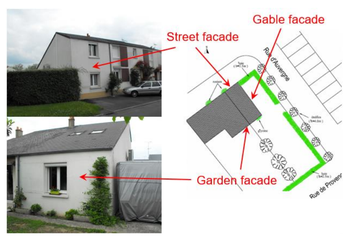
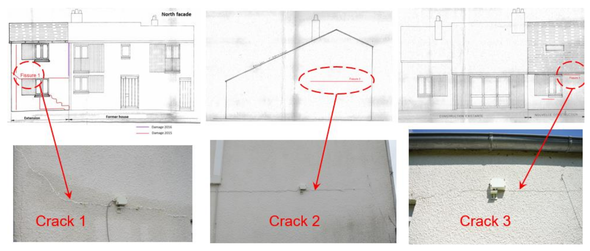
Damages induced by shrinkage-swelling phenomenon of clayey soils are well known as major natural disaster in France and more generally in the world. Affecting an individual house, soil shrinkage-swelling causes important and expensive structural damages. For this case, Cerema has tested an innovative and environmental solution on one damaged-house localized at center region in France. It is based on stocking rainwater into two tanks of 800 liters volume capacity of each one and the principle is to humidify the foundation soil during high drying period.


## 1- Description and initial investigations

➢ House localization and description


➢ Cracking state since 2015



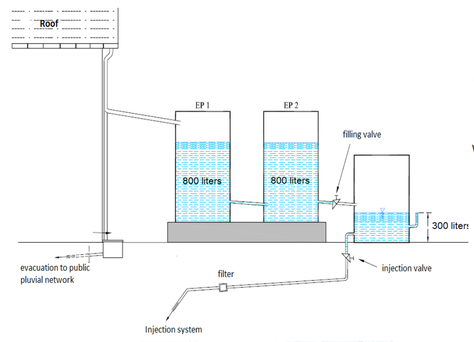

➢ Geotechnical investigations

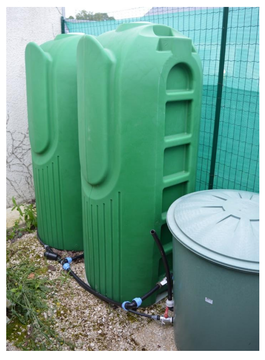
➢ Soil physical properties

| | localization | Particle size distribution | | | | Plasticity | |
|---|---|---|---|---|---|---|---|
| | | Sieve passing (%) | | | Dmax (mm) | VBS (g/100 g of dry soil) | Plasticity Index PI (%) |
| | | 2 µm | 80 µm | 2 mm | | | |
| Decalcification clay | Excavator drilling | 57 | 97 | 99 | 10 | / | 37 |
| | SP1 (1.5 m) | / | 98 | 99 | 5 | 5.5 | 39 |
| | SP2 (1 m) | / | 98 | 100 | 5 | 6.4 | / |
| | SP2 (2 m) | / | 89 | 98 | 10 | 6.0 | / |
| Beauce limestone | SP1 (5 m) | / | 58 | 84 | 20 | 1.4 | / |

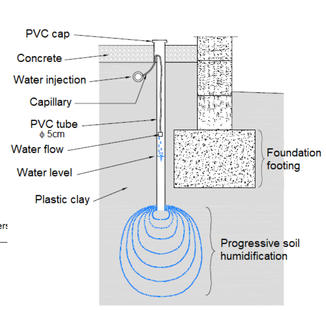
## 2- Rainwater storage and injection process

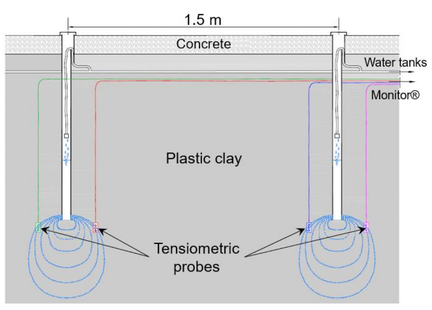
➢ Rainwater collection and storage



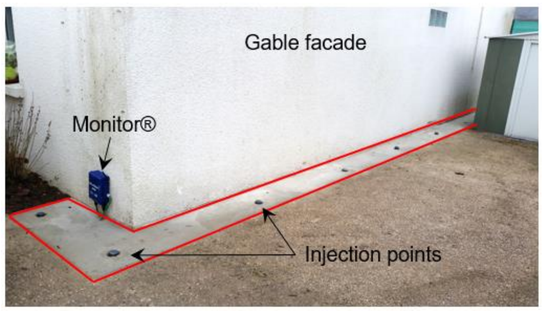



➢ Injection device and monitoring



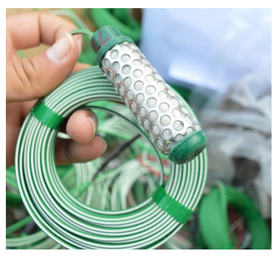




➢ Injection points location



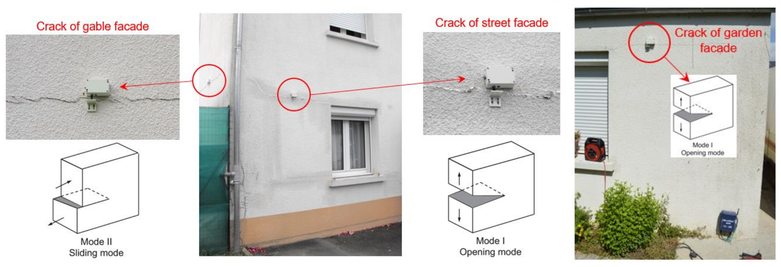

## 3- Tensiometric, crack and hygrometric monitoring

➢ Tensiometric probe

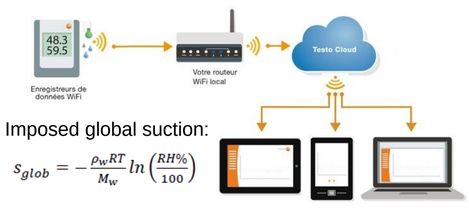


➢ Monitor®

➢ Monitoring of house existing cracks




➢ Air temperature and humidity measurement

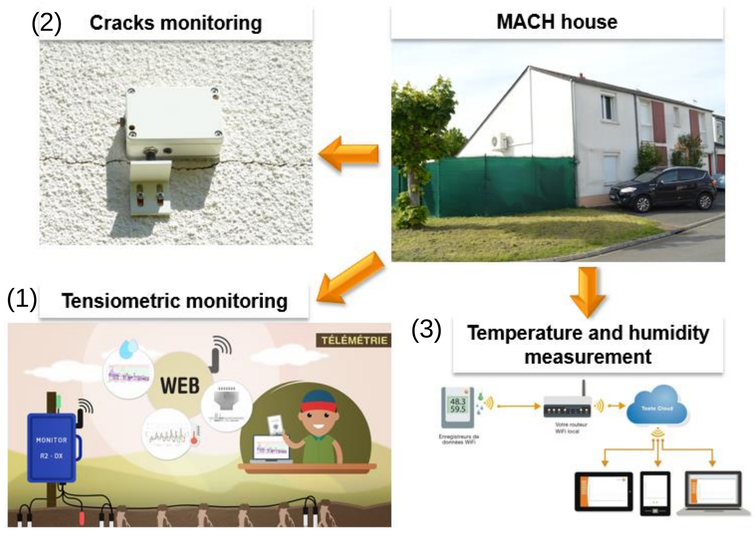



Imposed global suction:

$$s_{glob} = -\frac{\rho_w RT}{M_w} ln\left(\frac{RH\%}{100}\right)$$

## 4- MACH follow-up operations

➢ Principal operations to follow-up during the MACH process:




(1) Soil suction monitoring: this operation allows recording the soil suctions related to water content conditions, and can reach a maximum suction of 239 kPa which represents the limit of tensiometric probes.

(2) Cracking monitoring: it consists of measuring the opening or the closing of the existing cracks.

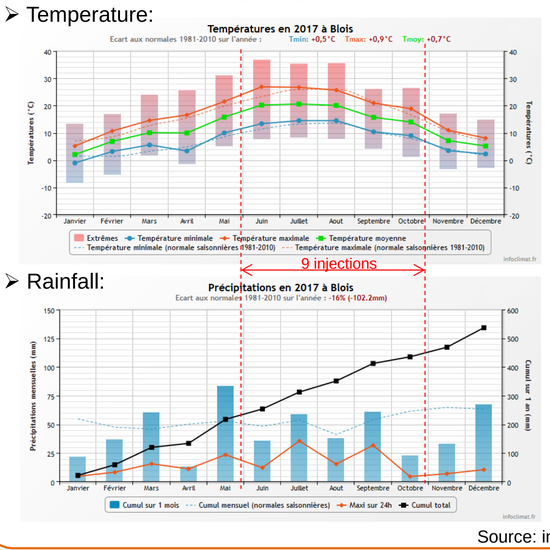
(3) Since the end of 2018, a connected device has been installed in the house to measure in real time and continuously relative humidity and temperature of the outside atmosphere.

## 5- Experimental results: comparison between 2017 and 2018

➢ Rainfall and temperature data from meteorogical Blois station (41)

Year 2017 | Year 2018

➢ Temperature:

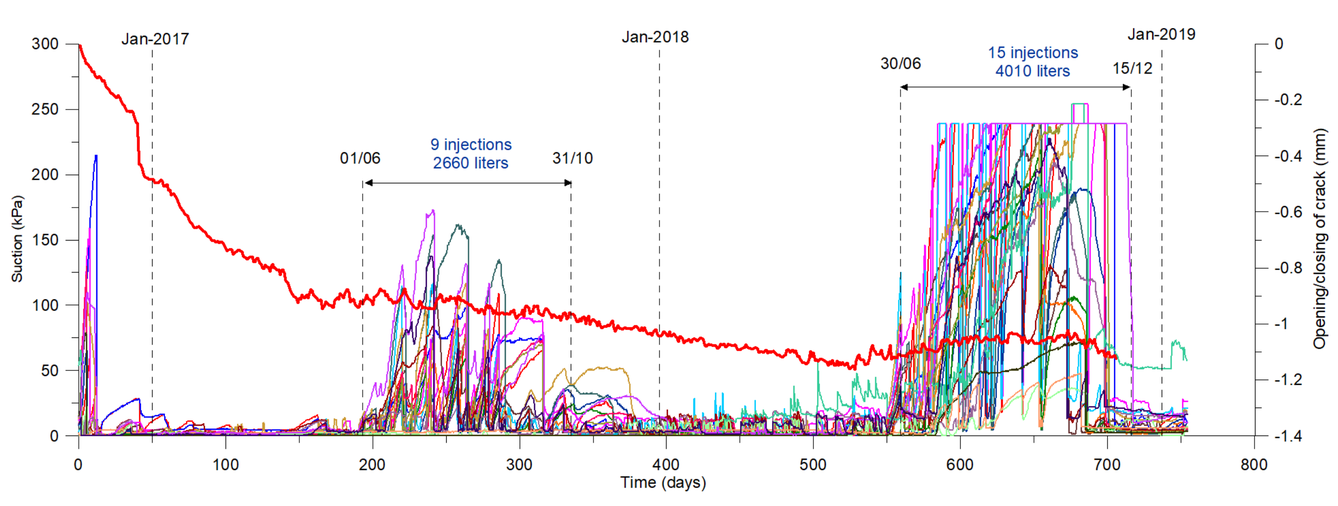



➢ Rainfall:




Source: infoclimat.fr

➢ Soil suction curves of the corresponding probes and evolution of the street facade crack (red curve)




## 6- Conclusions

➢ This study summarizes the MACH monitoring operations during 2018 and a comparison is made with 2017's results.

➢ Summer of 2018 was considered as one of the hottest and comparable to that of 2003, resulting in a particularly severe drought. This made it possible to test the MACH process under extreme demands of rainwater and strong suctions in the soil.

➢ The results obtained confirm the effectiveness of the MACH process for the stabilization of cracks during the period of high temperatures and very low rainfall.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