

IFSTTAR/ GERS/ SRO (Marne la Vallée near Paris)  
February/march to june/september 2020 (5-6 months)

**Subject : Raw earth material for construction:  
test of surfactant additives to decrease the water sensitivity of clays**

After the monopoly position of hydraulic binder (Portland cement) during several decades, traditional construction modes come back on center stage. In this context, raw earth material offers several opportunities to architects and builders in term of environmental benefits. Indeed, they are composed by only water and usually local mineral resources such as soil composed by sand, silt and a fraction of clay. However, clays in earthen materials used to build walls may shrink a lot during the stage of drying at the end of the manufacturing inducing damaging cracks, in the same way as the dry/wet cycles imposed to the material when relative humidity in neighbouring environment changes during its life.

If lime is a traditional additive in raw earth material that induces a stabilization of volume variation under hydric or hygric variation, new additives may be considered, notably chemical swelling inhibitors met as for example in drilling mud or petroleum extraction domains. Among such organic molecules, the use of surfactants such as polyethyleneimine or PEI (a cation exchanger coupled to a non polar carbon chain) or lawsone (non charged surfactant) will be tested during this internship. Surfactant properties (such as critical micelle concentration or CMC) will be measured using a tensiometer (newly acquired by the lab) and their effect on clay (in this case a montmorillonitic clay from ABM society) will be shown via the modification of surface tension  $\gamma$  (the Washburn's equation applied on a powder will be used to determine the surface tension of the clay with and without modified surface by adsorbed surfactant). The measurement will require a methodological development to prevent water molecule in atmosphere to interfere with surface tension measurement Results will come to complete tests obtained during a IFSTTAR/LRMH PhD thesis in course.

Such superficial characteristics play a great role on wettability, that's to say the water adsorption measurable by Dynamic Vapor Sorption or DVS, as well as on the capillary phenomenon in porous medium.

Using the pore description via the measurement by mercury intrusion porosimetry applied on a small piece of compacted raw earth material composed by a 30/70 mixture of montmorillonite and sand, the aim is to demonstrate that surfactants impact also at macro scale the suction measurement met in unsaturated soil domain Suction or negative pressure or water potential in pore will be measured using a chilled mirror method (included in the WP4 apparatus).

Finally, suction may be seen as a force occurring during the drying and responsible of the shrinkage and the soil deformation at macro scale. The final goal of the internship should be to link surfactant properties applied to clay (microscopic properties) and its effect on swelling and shrinkage of raw earth specimen at macroscale.

**Profile :**

Master 2 students in the domain of materials, unsaturated soil with a interest for physico-chemistry, (mineral) chemistry, clays, surface and interface properties...

**Competences:**

Main skills: material sciences (knowledge in geomaterials or materials for civil engineering will be a plus), basis in experimental techniques cited previously, multi-scale approach, chemical reactivity at interfaces...

Kow-how: Autonomy, sense of initiative, curiosity, rigor, taste for experimental work and materials.

**Contacts:**

Candidatures (CV+ detailed motivation letter explaining the adequacy of the student profile to the subject, its personal motivations and projects after Master 2) should be sent by email to [myriam.duc@ifsttar.fr](mailto:myriam.duc@ifsttar.fr) - Phone. 0033 (0)1 81 66 82 53

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