Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 15 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
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PhD information	
Title	Investigation of higher-strength geopolymers for civil engineering applications
Main topics regards to CSC list (3 topics at maximum)	Geopolymer; Civil engineering Materials; Mechanical properties

Required skills in science and engineering	Civil engineering; Mechanical; Computational tools

Subject description (two pages maximum)

Global warming becomes a critical issue nowadays and the released CO_2 due to cement production is considered to be responsible for approximately 7% of all greenhouse gases released worldwide. It is estimated that about a ton of cement is being produced for every human being per year and the manufacture of each ton of cement produces about 650–920 kg of CO_2. Besides, we assist nowdays to various catastrophic fires in France causing hundreds of casualties in public buildings. Therefore, reserach on novel structural and non-flammable building materials are required to be used instead of Ordinary Portland Cement (OPC) concrete.

To date, geopolymer as an alternative binder, have potential to lower the carbon footprint of OPC concrete in a significant amount. It is also an environmentally friendly inorganic-amorphous binder which exhibit ceramic like property in fire or at elevated temperatures. Extensive researches have been conducted to study various mechanical and durability properties of geopolymer [1-4]. In general, they possess many excellent mechanical properties such as high early strength gain, low creepand shrinkage, and good resistance in acid and sulphate attacks. Therefore, geopolymer provides cementless material having competent performance with the conventional cement based material.

Developing a Higher-strength geopolymer material will offers a lot of advantages over conventional OPC, such as higher mechanical strengths, lower shrinkage and superior durability with environmental sustainability. The promising way to develop the new generation of high strenth geopolymer concrete is the incorporation of nanomaterials which minimizes the air gaps content in the nanostructure. The denser structure positively affects the physical and mechanical properties of the whole nano-composite.

The proposed project will focus mainly on the study of metakaolin and fly ash based geopolymers nano-reinforced with oxides materials. Although some experimental studies have been conducted, the molecular nano-structure and the relationship between chemical composition, the kinetics reaction and the durability of nano-geopolymers (nano-GP) is necessary. It is still difficult to tailor the properties of nano-oxides geopolymers since they are influenced by multiple synthesis factors, such as the properties of raw materials, chemical composition (e.g. Si/Al and Na/Al ratios), nano-oxides density and dispersion, water content, curing temperature and humidity. Therefore, the characteristics of nano-oxides geopolymer microstructure from the nano to macro scale play important roles in governing the macro-mechanical properties and have to be well understood to achieve desired properties.

We aim to understand the link between geopolymer and microstructure with macroscopic mechanical properties. Using various scale modeling, our objective is to analyze the effects of:

- the oxides size, morphology, concentration and dispersion
- the atmosphere humidity and heating,
- the response to external (mechanical) loading.