

## **CHAPTER II**

### **LITERATURE REVIEW**

Research about the soil stabilization already be common interest and developed. Various trial, analysis, and test have been done to get the most effective results. Santoni et al. (2005) found that polymers have the best potential to increase the strength of silty sand soils under wet and dry conditions. They reported that the examined polymers maintained good strength in both wet and dry conditions.

Al-Khanbasi and El-Gamal (2003) conducted an experiment to determine the effect of stabilizing sand soils with the combination of waterborne polymer emulsion system. The system was found to increase the mechanical properties, modulus of elasticity, and reduce the hydraulic conductivity of sand by incorporating small percentages of polymer.

Jan Bodi et al. (2012) has explained that grouting with polyurethane resins represent an effective method of improvement of mechanical and sealing properties of soil and rock environment and constructions. The principle of grouting technologies is injection of liquid grouting material into the rock environment or construction under pressure. During the grouting process, fissures and pores are filled with the grouting materials, which subsequently hardens and connects the disintegrated parts of the rock mass or grains of loose material.

Scucka and Soucek (2007) found that penetration of the grouting media trough the inhomogeneous environment, and thus also the resulting properties of

the formed geocomposite, is influenced by many factors. In case of geocomposites of polyurethane resin with rock soil and polyurethane resin with building materials, the following factors have primary effect :

a) Properties of the unpolymerized grouting media

Viscosity of the media as a function of temperature and rheology hardening, velocity of injection, grouting pressure, the right stoichiometric ratio of input components and sufficient time and intensity of their mixing.

b) Properties of the grouted environment

The composition of rock as building material, shape and size of soil particles and rock blocks, humidity, effective porosity or voids, type and orientation of discontinuities, temperature of the environment, permeability, adhesion of grouting media to the rock surface, composition of water, and pore pressure.

Mark Popik et al. (2010) has evaluated the potential of insitu stabilization using a proprietary two component high density expanding thermoset polyurethane resin system (URETEK Deep Injection System<sup>TM</sup> Process ). While not definitive, the results of this study indicate the URETEK Deep Injection System<sup>TM</sup> Process has potential for improving weak compressible organic soils to encapsulation.

Ben Arndt et al. (2008) has investigated about injecting polyurethane resin (PUR) product into a rock mass with open fractures apertures larger than approximately 2mm (1/8 in). The PUR product migrated into fractures and fractures orientations that were interconnected and resin flowed from one set of

fractures into adjacent fractured set. Until PUR is more fully evaluated for the mitigation of unstable rock slopes, PUR is not recommended to replace tensioned and non-tensioned rock bolting. However, PUR can be effectively used to optimize required bolting, and may mitigate the need for other types of surface treatments (for example, plates, straps, and mesh). If only a small percentage of PUR is successfully injected into a fracture plane, it will substantially increase the cohesion between the opposing side of the fracture. For example, it can be shown that an increase in 1 kPa will dramatically increase the overall factor of safety of the joint set.

Diana Che Lat et al. (2014) has recommended that injection of polyurethane helps to eliminate excessive settlement by filling the void between the soil particles. Therefore providing the rigid foundation with insignificant weight imposed to the underlying soil. In terms of construction, installation of polyurethane is very fast without much disturbance existing structure as the installation is only using small diameter tube i.e. about 30mm. In terms of cost, PU is slightly higher compared to other conventional methods.