



# Unconsolidated Undrained Behavior of stabilized clayey soil with lime and industrial sludges

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## Abstract

Industrial waste generating has reached up to millions of tons yearly. One way to solve the problem of this large accumulating amount of waste could be to return back to soil. Thus, finding a way for use industrial waste could be a quest for soil improvement studies. Steel and copper sludge are from the main wastes in metal industrials. Industrial sludge in certain pozzolanic react with soil and water possess cementitious properties compounds. A pozzolan is a siliceous or siliceous and aluminous material which, in itself, possesses little or no cementitious value but which will, in finely divided form and in the presence of water, react chemically with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. This study illustrates the utilization of lime, steel and copper sludge in stabilization of high plasticity clayey soil. Various replacement ratio of lime and sludge are tested in various curing time. The results gained unconsolidated undrained triaxial test show enormous changes in soil mechanical behavior of soil.

**Keyword:** clayey soil, pozzolan, sludge, steel, copper, unconsolidated undrained triaxial.

## 1. INTRODUCTION

In recent year, to solve the environmental problem of industrial wastes, several studies have been carried out[7]. The accumulation of these wastes presents considerable environmental and economical problem, especially considering the limited available landfill facilities [6]. Based on the geotechnical engineering viewpoint, some industrial wastes are useful as geo-material in construction [7]. Using industrial wastes such as cement, kiln dust, limestone dust, fly ash and metal sludges, as additives to civil engineering construction materials help arrest their hazardous effects on the environmental and reduce construction costs [11]. In fact these materials can be used as stabilizer in improvement of soils. Important factor should be considered in choosing the stabilization agents such as abundance, cost and easiness to obtain. Sludge is abundant in huge quantities and is likely to be more available in near future [5]. Soil stabilization technique are frequently used to improve the engineering properties of soil [1]. One of the most widely used method is cementation stabilization which consist of mixing cementitious additives such as cement, lime, fly ash, metal sludge and so on [4]. Chemical stabilizer (lime, cement, fly ash and so on) are commonly used to improve the performance of high plasticity soils, soil with volumetric change and low strength soil [6]. Several study have been conducted in the past to use waste pozzolanic material from industries (metal sludges, fly ash, cement kiln dust, limestone dust and so on ) to reduce the input of cement and lime. Pozzolanic material generally consist of silica, alumina, ferric oxide etc. These compounds will form a cementitious material when combined with cement or lime in the presence of water[8]. Pozzolanic stabilizers can bind soil particles together and reduce water absorption by clay particles. Several studies have been conducted in the past to evaluate the mechanical properties of cementitiously stabilized soil. For example Masashi and Supakij (1990) used cement and stainless-steel sludge to develop strength of seabed Hedoro. They reported that the addition