氏　　名	MOHIE ELDIN MOHAMED AFIFY EL.MASHAD
授与した学位	博　士
専攻分野の名称	学　術
学位授与番号	博甲第３２００号
学位授与の日付	平成１８年　３月２４日
学位授与の要件	自然科学研究科地球・環境システム科学専攻 （学位規則第４条第１項該当）
学位論文の題目	Integral studies on soil improvement in the arid land by using industrial by-products such as slag, fly ash, waste iron hydroxide mixed with dune sand in the desert, bentonite, cement and/or lime （産業副産物のスラグ、石炭灰、中和滓と砂漠の砂、ベントナイト、セメント、石灰との混合による乾燥地帯の地盤改良に関する総合研究）
論文審査委員	教授　花村　哲也　　教授　西垣　誠　　助教授　竹下　祐二

学位論文内容の要旨

This research divided to two main parts the first part also divided to parts

In the first part from the first part we have tried to use the waste materials fly ash, slag, and bentonite to develop dune sand using Japanese standard sand (JSS) as substitute for the dune sand to use as base and sub base material for the embankment road construction. We have tested these materials individually or as mixture like specific gravity for every material grain size distribution analysis for every material, plasticity properties as mixture, free swell tendency for bentonite only, compaction ability for the mixtures, California bearing ratio (CBR) for the mixtures to check the ability to use as base and sub base material. By mixing the above materials together by different ratios we got good results for the road construction base and sub base as good dry density, low moisture content and high California bearing ratio. We found that the slag is effective more than the fly ash that increases the dry density of the mixture. Also increases of the bentonite ratio increases of the plasticity and decreases of the CBR.

In the second part from the first part we have tried to use the waste iron hydroxide with or with out slag as base and sub base materials we also tested this materials with the same tests above. WIH is available in two types as a filter pressed cake type and a dried pellet type through rotary kiln. We have found that using the waste iron hydroxide material individually or with slag it gives very high California bearing ratio. Waste iron hydroxide slightly has low dry density and high moisture content using slag with waste iron hydroxide increases the dry density and decreases of the plasticity properties and also decreases the moisture content. We have found that the dried pellet type is better than the filter pressed cake.

In the second part we have tried to use fly ash, slag, bentonite, small ratio from cement or lime using and Japanese standard sand (JSS) as substitute for the dune sand to develop new type grout to use in general for the soil improvement or tail grouting especially. To check these mixtures to use for the soil improvement, we used experimental program to check the mixtures in the fresh case and after solidification case. For the fresh case we used flow ability, pressure filtration, slump, bleeding, and the setting time tests. For the solidification case we used the compressive and the permeability tests.

We have found the following

All the type of grouting except ground compaction accepts high flow ability but only the ground compactions accept low flow ability for the grouting mixtures used. The mixtures that contain small bentonite ratio, fly ash, sand, slag, and lime is very good for all the grouting types, which give high flow ability. But the mixtures contain high percent of bentonite, slag, sand, and cement it will be very good for ground compaction grouting type, which give low flow ability.

Bentonite it is the main material affecting on the stability of the mixture (Kft) where increases the bentonite ratio increases the stability of the mixture. Increasing the slag ratio slightly decreases the Kft where slightly increases the stability of the mixture. In case of cement, sand, and slag increases the cement ratio slightly decreases the Kft, but in case of mixture contain cement, slag, and bentonite increases the cement ratio increases of the Kft. Increases of the lime mixture with any mixture slightly increases the Kft where decreases the stability of the mixture. Also increases fly ash ratio in the mixture decreases the stability of the mixture where increases the Kft of the mixture.

Setting time of the mixture is mainly depends on the cement, lime, slag, and fly ash where increases of any of this materials increases the setting time of the mixture. The effect of increases of cement, lime and slag is much higher than the effect of fly ash on the mixture. Bentonite is also affecting on the setting time of the mixture. Increases the bentonite ratio decreases the setting time of this mixture. Increases the slag ratio in case of mixture contain slag, cement, and sand is more effective than the same mixture but contain lime instead of cement where the setting time of the mixture with cement is lower than the setting time of the lime ratio. Increases the slag ratio in case of bentonite, lime, and sand mixtures is more effective than the same mixture but using cement instead of lime where the setting time in case of lime is lower than the setting time in case of cement. Increases the fly ash slightly decreases of the setting time of the mixture. Also the lime is more effective in case of mixing with slag only where the setting time is less than the setting time in case of using cement instead of lime.

Compressive strength of the mixture is mainly depends on the cement, lime, slag, and fly ash where increases of any of this materials increases the compressive strength of the mixture. The effect of increases of cement, lime and slag is much higher than the effect of fly ash on the mixture. Increases the bentonite ratio decreases the compressive strength of this mixture. Increases the slag ratio in case of mixture contain slag, cement, and sand is more effective than the same mixture but contain lime instead of cement where the compressive strength of the mixture with cement is higher than the compressive strength of the lime ratio. Increases the slag ratio in case of bentonite, lime, and sand mixtures is more effective than the same mixture but using cement instead of lime where the compressive strength in case of lime is higher than the compressive strength in case of cement. Also the lime is more effective in case of mixing with slag only where the compressive strength is higher than the compressive strength in case of using cement instead of lime. Increases the fly ash slightly increase the compressive strength of the mixture.

論文審査結果の要旨

論文は、母国エジプトの砂漠における地盤改良技術の確立を目的に、砂漠の砂を改良対象地盤とし、母国で入手できる製鉄産業副産物のスラグ、一般廃棄物であるナイル川に生い茂るウォーターヒヤシンスの焼却灰や山岳地帯に存在する膨潤性粘土を用いて道路路盤材料を開発し、また、少量のセメントや石灰を加えてトンネル裏込め材としてのグラウトや一般地盤改良材を開発することが可能であることを、研究成果としてまとめたものである。さらに、ペイント材料の二酸化チタン製造過程で生成される日本の産業副産物である中和滓を用いた、経済的な路盤材料開発研究も併せて行った。

研究は実験を主体としたもので、日本で手に入る材料の砂、石炭灰やベントナイトを用いて実験を行ったが、エジプトの砂漠の砂、ウォーターヒヤシンスの焼却灰、膨潤性粘土が地盤改良材料の開発に使えることを明らかにし、それらを用いて必要なコンシステンシーと強度・支持力を持つ米国道路基準に適合する路盤材料を開発した。また、以上の材料に少量のセメント、石灰を混合し、必要な強度、止水性をもつグラウト材や地盤改良材を開発し、廉価な地盤改良材の開発技術を得た。さらに、同様の技術を用いて日本の産業副産物である中和滓を利用した路盤材料開発を行い産業副産物の再利用技術を拡げた。

本研究は、地盤材料として今まで使いにくかった乾燥地帯の砂漠の砂に、産業時廃棄物や一般廃棄物を用いて新たな地盤改良材を開発できることを示し、かつ少量の産業生成物であるセメント、石灰を加え、廉価な路盤材料や地盤改良材を作ることが可能であること証明し、乾燥地帯の地盤改良の方法を得たことや、廃棄物の再利用技術を拡大したことにあり、さらに、乾燥地帯の国における循環社会形成への手がかりを得たことである。

以上により、本研究は、学術博士の学位に値する研究として認めることが出来る。