CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The experimental findings can be summarized into two sections as given below.

6.1.1 Unconfined Compressive Strength

Compressive strength of stabilized waste samples was enhanced if cement replacement material such as PFA was added. UCS was found to increase with each increment of C/S_d ratios. The higher cement utilization certainly will present a greater compressive strength for cement-sludge paste, but too high utilization of cementitious materials will make it uneconomical and too conservative. The results for pure model study indicated that the presence of inorganic metals would produce a lower compressive strength. The compressive strength for all the stabilized waste satisfies the UK regulatory limit for solidified specimen with a value of 0.34 N/mm^2. This meant that the waste sludge treated by the process of solidification and stabilization with OPC and additional of PFA would give better and more suitable waste materials to be easily disposed off and easily transported. Hence, solidified waste samples can be used for backfill, foundation support such as pile and roadbed support or pavement.

6.1.2 Crushed Block Leaching

It was found that after the cement-based solidification and stabilization treatment, the leaching of heavy metals for all samples were substantially reduced. The three metals concentration in the TCLP extracts were much less than their concentration present in the initial untreated sludge. Thus, every stabilized waste sample passed the USEPA

Toxicity Regulatory Discharge Limits and were not considered hazardous waste any more. Heavy metals and other contaminants present in the sludge were immobilized by the process of stabilization and solidification, and this immobilization by salts, hydroxides and cement compounds helped the stabilization process.

Generally, the amount of toxic metals released from the stabilized waste samples were not totally related to the amount of sludge added in the cement-sludge paste. Iron concentration was reported not directly related to the ratios of cement-sludge proposed. This metal concentration in the leachates was non-uniform and inconsistent while varying the C/S_d ratio in cement-sludge paste. Zinc released in the TCLP extraction was inversely proportional to the amount of sludge added and this behaviour was different from other toxic metals. However, copper released was directly related to the amount of sludge added to the stabilized waste samples.

CRM play an important role in the leachability of toxic metals from the stabilized waste samples. By adding more PFA in the cement-sludge paste, the concentration of copper released in TCLP extraction was reduced. But, the concentration of iron and zinc released increased with the increasing of PFA addition. For pure model study, it showed that the metals released in cement paste are much lower compared to metals-containing samples.

6.2 RECOMMENDATIONS

1. The leaching tests using United Kingdom (UK) or Japanese Institute of Standard (JIS) procedure should be carried out for the stabilized/solidified wastes in order to compare with the results obtained in this experiment by TCLP method.
2. Further leaching and compressive strength studies could be carried out for wastes stabilized/solidified with other cement replacement materials.
3. The leaching tests of other metals contaminants such as arsenic and mercury should be evaluated.
4. Work is required to characterize the porosity and permeability parameter and its variation with time.
5. In order to achieve a better understanding of the rate at which contaminants leach, a kinetic experiment must be carried out.
6. A theoretical or mathematical model can be formulated to simulate short and long term leaching patterns for organic and inorganic wastes.
7. Treatment attempts for other types of industrial waste like textile waste by solidification and stabilization with OPC and other CRM might also be carried out.
8. Large size mould might be used to reduce cement utilization by adding coarse sand and aggregate when compared to the initial mould used in this experiment. This will simulate the actual treatment of hazardous waste and may also increase the strength of the mixture.