MANAGEMENT PRACTICES OF WATER TREATMENT SLUDGE IN SRI LANKA

AND

RE-USE POTENTIAL OF SLUDGE AS A CONSTRUCTION MATERIAL

Kumuthini Anjithan

Degree of Master of Science in Environmental Engineering & Management

Department of Civil Engineering

University of Moratuwa

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Kumuthini Anjithan

118752E

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Department of Civil Engineering

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DECLARATION

"I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University or other institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text"

Signature: Date

"I have supervised and accepted this thesis for the award of the degree"

Name : Dr. (Mrs.) B.C.L.Athapattu,
Senior Lecturer,
Department of Civil Engineering,
The Open University of Sri Lanka

Signature: Date:

"I have supervised and accepted this thesis for the award of the degree"

Name : Prof. (Mrs.) N.Ratnayake,
Senior Professor,
Department of Civil Engineering,
University of Moratuwa

Signature: Date:

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ABSTRACT

Sludge remaining at water treatment plants is an inescapable byproduct of the water treatment process. The nature of sludge depends on suspended solids of raw water, coagulant type and chemicals that are used in the treatment process. Direct discharge of sludge into water bodies result in the risk of contamination of surface and ground water that affects water quality and aquatic biota. According to existing legislation, water treatment sludge is classified under industrial waste. Therefore, it is anticipated that the water treatment process would be legislated as a licensable activity in the near future. The National Water Supply and Drainage Board (NWSDB) which is the main potable water supplier in Sri Lanka, has paid attention to identify disposal routes, sustainable practices, and potential applications of water treatment sludge. The objective of this research was to recognize disposal practices and cost effective methods that conform to environmental regulations. To fulfill the objectives, a questionnaire survey was conducted pertaining to chemical usage, sludge production, sludge handling and disposal methods. To introduce sustainable practices, a series of experiments were conducted by adding sludge into production of burnt clay brick, replacing cement by sludge as an adhesive fine material in cement mortar and replacing sand by sludge as fine aggregate in Concrete Paving Blocks (CPB). The questionnaire survey revealed that 50% of selected treatment plants that are operated by NWSDB directly discharge the sludge into inland surface waters with no treatment or dispose to bare lands. Experimental results showed that the required compressive strength of burnt brick could be achieved by adding sludge up to 10% for load bearing walls of single storey buildings. Further, replacement of cement by sludge up to 30% in cement mortar, achieved the required flow of 105% to 115% with the water cement ratio between 0.7 and 1.1. Required compressive strength of cement mortar could be achieved with the addition of 10% sludge with the water cement ratios of 0.7, 0.9 & 1.1, 20% sludge with the water cement ratios of 0.7 & 0.9 and 30% of sludge with the water cement ratio of 0.7. The suitability of a CPB depends on its compliance to the compressive strength requirements. The results showed, the addition of 10% sludge as fine aggregate and 10% bottom ash and sludge as fine aggregate satisfies the requirement specified in the SLS standards for class 1. Hence Concrete Paving Blocks can be successfully produced using 10% of water treatment plant sludge as supplement for sand.Sludge production is an inevitable outcome of potable water treatmentand hence sustainable reuse techniques and disposal methods need to be introduced as a policy for protecting the environment.

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LIST OF ABBREVIATIONS

Abbreviation	Description
Alum	Aluminum Sulfate
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BOD5	Biochemical Oxygen Demand
BS	British Standards
BS EN	British Standard European Norm
COD	Chemical Oxygen Demand
CPB	Concrete Paving Blocks
DAF	Dissolved Air Flotation
DBH	Diameter at Breast Height
DMP	Donan Membrane Process
EPA	Environmental Protection Agency
ESS	Egyptian Standard Specification
ICTAD	Institute of Construction Training and Development
LIE	Liquid Iron Exchange
LOI	Loss on Ignition
NWSDB	National Water Supply and Drainage Board
OMC	Optimum Moisture Content
OPC	Ordinary Portland Cement
PAC	Powdered activated Carbon
PACl	Poly Aluminum Chloride
RDA	Road Development Authority

RHA	Rice Husk Ash
SF	Silica Fume
SLS	Sri Lankan Standard
SS	Suspended Solids
TDS	Total Dissolved Solid
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
USRV	Unpolished Slip Resistance Value
VOC	Volatile Organic Content
WTP	Water Treatment Plant
WTS	Water Treatment Sludge

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