POTENTIAL USES OF DRY AND WET WASTEWATER SLUDGE AND INFLUENCE ON PHYSICAL AND MECHANICAL PROPORTIES OF CONCRETE MIX

By
Ghada Mourtada Rabie

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In

Civil Engineering -Public works

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2017

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Title of Thesis: Influence of using wastewater sludge in concrete mix on its physical and mechanical properties

Key Words: Sewage Sludge, non-reinforced Concrete mix, Sludge Management, Egypt, Compressive Strength.

Summary:

Wastewater sludge quantity quickly developed due to urban development, as many countries search for a new disposal way to get rid of these wastes, as a good alternative solution is using the sludge in concrete mix, so this study is using (dry and wet) sludge in concrete mix and study its effect on main properties of concrete mix as it concluded that 5% of dry and wet sludge can be used as a replacement material for interlock used for road pavements and sidewalks repairing and reduce the cost of concrete mix and within accepted ranges for reuse Wastewater sludge, according to (CEHA) and we recommend more researchers are need to study the effect of sludge on reinforce concrete and the durability.

Acknowledgements

All praise be to ALLAH Subhanahu WA ta'ala for bestowing me with health, opportunity,
Patience and knowledge to complete this work.
I wish to sincerely thank my supervisor Prof.Dr./Hisham Abd El-Halim and Dr. /Ehab Helmy for their supports and guidance's throughout my research time, which has enabled me to complete this study on time, and I greatly appreciate their commitments.
Thanks to everyone at WWTPs who helped me by many ways to finish my research conscientiously, Special thanks go to my parents and my husband as they support me always during the master's time to achieve my goal at the end.

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Abbreviation and Notation

WWTP: Wastewater Treatment Plant
BOD: Biological oxygen demand
COD: Chemical oxygen demand
TOC: Total organic carbon
TSS: Total suspended solids
TDS: Total dissolved solids
EC: Electrical conductivity
CEHA: world health organization
AASHTO : American Association of State Highway and Transportation Officials

Abstract

Wastewater sludge quantity has been quickly developed due to urban development in which, almost of Wastewater sludge is get rid of by spreading in agriculture land, but due to increasing the environmental awareness and the scarcity of landfill site many countries search for new disposal way to get rid of this wastes.

The aim of this study is to discuss a new route for discarding the large amount of wastewater sludge for example, in Egypt the quantity of sludge results every year is around "4 Million ton ", as it considered a series issue facing Egypt today.

Many Countries are studying using the sludge results from different stages in concrete mix as a good alternative solution for discarding the sludge in a safe manner; and study the idea from sanitary and environmental point of view.

Thus, the recent researches are trying to explore the most suitable way for discarding the huge amount of sludge produced from wastewater treatment plants. One track of these solutions is to use sewage sludge in construction field such as "concrete mixtures and in manufacturing interlock brick samples''.

According to results findings, slight effect on reducing strength of concrete after replacing a portion of concrete percentage by dry or wet sludge by different% (5, 10 and 15%) of cement weight, but 20% of cement weight decrease the strength by 61.6% for dry sludge after 28-days and by 68.5% for wet sludge.

The results emphasize that the wet sludge decrease the strength and has more adverse effect on compressive strength than the dry sludge for the same % as the loss of strength after 28-days for wet percentages about13.76% and for dry sludge about7.73% this for sludge results from El-badrashin WWTP and for sludge results from HAWAMDIA WWTP the average strength loss after 28-days for wet percentages about17.8% and for dry sludge about13.65%,Also, results show that sludge results from HAWAMDIA WWTP has negative effect on compressive strength of concrete mix than sludge results from El-badrashin WWTP for the same percentage.

Finally, the study concluded that the dry and wet sludge can be used in as an additive to concrete mixtures till 5% these mixes will be used as a replacement material for interlock used for road pavements and sidewalks repairing a. As the study illustrate that 5% of wet and dry sludge reduce the cost of concrete mix and within accepted ranges for reuse Wastewater sludge, according to (CEHA).also we recommend more researchers are need to study the effect of sludge on reinforce concrete and the durability of sludge concrete.

Key Words: Sewage Sludge, non-reinforced Concrete mix, Sludge Management, Egypt, Compressive Strength.

Chapter 1: Introduction

1.1.Background

The huge amount of sludge produced every year make huge problems for many countries all over the world, as the disposal and treatment ways for wastewater sewage sludge are very expansive and there are many environmental constraints on theses ways, so many countries try to find another cheap and more save disposal ways due to the restrictions of the environmental regulations and public pressures, as the recycling ways are preferable than incineration ways or land spreading (Hall.J, 2001).

For example, Egypt country population tripled during the last decade about 1.5 million every year as it reach to 100 million on 2017 in which this rapidly increasing of population and development in this country will affect the wastewater production which it expected to increase in the next few years, also the infra-structure sanitation of Egypt country facing many difficulties in managing wastewater sludge results from WWTPs and funding problems , although the Egyptian governments invest over the last 20-years about 24 billion $ for developing the wastewater and also water services all over the governorate of Egypt and it's also planned to invest about 20 billion $ in the next 10-years to strengthen the wastewater sector (Hall.J, 2001).

Sludge is a very risky material which contain many danger components which it may cause contamination to surface or ground waters in which worldwide sludge may dispose by many different ways but the most used methods for sludge disposal on landfill , as it contain many components are very valuable to the agriculture which it include organic matter, phosphorus and nitrogen and other many components although, it contain heavy metals , micro-organisms and pathogens which it cause pollution too(Hall.J,2001).

Researchers focuses on the growing of civilization and industrial development for many countries and how this affect the sludge production as it's on a sever growth under the strict environmental regulations and quality requirements with economic pressure require low-cost solutions for this wastewater sludge disposal problems(Hall.J, 2001).

Consequently effluent and sludge needs to be managed and treated very well to mitigate the adverse effect on the human-being and environmental effects, as Many Countries, Prohibits using the sludge in the agriculture like in the Netherlands since 1991 and Flanders since 1999 according to the environmental regulations in these two countries (Hall.J, 2001).

Many countries urgently tried to find new ways to get rid from the large quantities of wastewater sludge without harm the humankind or harm the environment, due to

environmental laws and environmental side effects which caused due to the traditional sludge disposal ways one of this new methods is Using the dry sludge in the construction materials like (concrete mix for non-reinforced concrete, in making the bricks, and Glass too).

The sludge volume which results from the wastewater treatment it represent about 1 to 2 % of the wastewater treated volume but it cost about from 20 to 60 % from the total operational cost of the WWTPs as, the sludge treatment in many countries is a very substantial and dangerous problem due to the high cost of this operation and rigid environmental regulation as it may cause danger for the humankind (Matar, 2008).

For example in Egypt the methods and technologies used for treat the sludge results from WWTPs are very limited as it focus on only the procedures of dewatering the sludge by the natural drying beds as it expose to the sun without taking into consideration the sludge quality or main components, recently the government of Egypt try to enhance and develop a new techniques and ways for wastewater sludge treatments.

Egypt annual production of wastewater sludge is about 12-15kg/ inhabitant in which this sludge results from sewage treatment different process so, it may contain organic and in-organic materials which it depend on the sewage water treatment and drainage system as it may be about 1 to 3 % from swage water volume and increase to 4 to 10 % after the mechanical thickeners (German, G. T. Z., & Consult, I. P. P., 2002)

For the cities which located near the Nile River the large quantities of sludge results from WWTPs will be disposed into the Nile and the cities located far from the Nile the sludge produced will be disposed by land spreading beside WWTPs in which, This sludge contains at least 96 % water, which causes certain environmental problems and health hazards in the future. There's a world trend concerning sludge management are talking about converting the produced Sludge into useful materials not harmful to the human being(German, G. T. Z., & Consult, I. P. P., 2002).

Consequently, problems concerning the environmental impact of the traditional sludge disposal ways which are used in the developing countries can be mitigated by searching for a new and easy disposal options with the low cost other than disposal the sludge on land or disposal it into the sea or using it as a fertilizer for agriculture (German, G. T. Z., & Consult, I. P. P., 2002).

1.2. Objectives

This work was directed towards scrutinizing the applicability of utilizing of sewage sludge (dry and wet) resulting from (WWTPs)by different % for non-reinforcement concrete mix and how it will affect the main characteristics of the concrete mix like