Paper 11
Disposal of Water Treatment Plant Waste Sludge: Trials in Brick Manufacture

Eng. W. K. Illangasinghe[1], Dr. D.R.I.B. Werellagama[2], Eng. S. Antony[1]
[1]National Water Supply & Drainage Board, [2]Wellington Institute of Technology, New Zealand.

THEME 3

INTRODUCTION

The Meewatura water treatment plant of the National Water Supply and Drainage Board is situated near the University of Peradeniya WTP. It has a production capacity of 32,000m^3/ day. Raw water is extracted from Mahaweli River. The water treatment process involves Bar Screens, Grit Chamber, Aerator, Pulsator unit and Rapid Sand Filters for removal of suspended and dissolved solids in the raw water. Sludge is generated in the treatment process due to particles in the raw water as well as due to the chemicals used as coagulants and for pH corrections.

New water treatment plant at Meewatura constructed by the Kandy South Water Supply Project has a comprehensive sludge treatment facility which meets the Central Environmental Authority requirements. It was stipulated that no discharge is sent back to the river. The sludge treatment system consists of a settling tank and a gravity thickener. Supernatant water from these two units is directed back to the aerator allowing full recirculation of water. The sludge settled at the thickener unit is pumped to the sludge lagoons for air drying.

The dried solids of the sludge lagoons have to be disposed in the environment. The CEA requirements for disposal of such solids can be met by making sure no chemicals are released in to the environment. In the vicinity of Meewatura treatment plant at Hondiyandeniya, Geli Oya there are a number of brick manufacturers. Non availability of clay suitable for manufacturing bricks in the locality is a problem faced by these small scale manufacturers who have domestic level businesses.

Considering the scarcity of appropriate clay for local brick manufacturers; this study was carried out to find the suitability of water treatment sludge as a raw material for local brick manufacturing industry. Objective of this paper is to present the outcome of the initial experiments done in order to assess the suitability of using the dried sludge in local brick manufacture.

HIGHLIGHTS

- Sludge generated at Meewatura water treatment plant at pulsator and filter units are treated through a sludge treatment system consisting of settling tank, gravity thickener and sludge lagoons.
- The dried sludge in the lagoons were used in brick manufacture
- Bricks were prepared using; sludge : manufacturers clay combinations in volume of 25%:75%, 50%:50% and a control sample using manufacturers clay.
- All three samples were tested for dimensions, Compressive strength, water absorption, and efflorescence
- Dimensions of all samples were out of the tolerance limits specified except two occasions, Compressive strength of all the bricks were less than the specifications, Water absorption of the control sample is within the specified limits, whereas the bricks made with sludge exceeded specified water absorption, all three sample sets show slight efflorescence, indicating less water-soluble salts in

the soil and water used for manufacture of bricks.

METHODOLOGY

On Site Brick Manufacturing

A local brick manufacturer was selected to minimise the transport distances of the water plant sludge. The brick kiln was located about 8km away from the Meewatura treatment plant.The kiln is adjacent to the motorable road. The kiln can produce about 5000 bricks at a time.

The clay for brick construction is obtained from the manufacturer's own paddy field adjacent to the kiln. Depending on the clay content of the paddy field, imported earth is mixed. The amount of imported earth is decided based on the manufacturer's past experience. After thoroughly mixing clay, imported earth and water, bricks were formed using a steel mould of standard size. (As per the SLS 39: 1978, the standard size of the bricks is: length 220mm, width 105mm and height 65mm). Formed bricks are then stacked in the field for air drying. With good weather conditions; three days of air drying is sufficient before burning. Maximum of five days air drying is needed depending on the weather.

Brick loaded to the kiln are burnt with wood fire for twelve hours. Burnt brick is allowed to cool for twenty four hours.

Experimental Set Up

Three sets of test samples were planned as follows;

1. Manufacturer's original brick as a control sample
2. Samples prepared with mixing 25% of sludge with 75% of manufacturers clay by volume
3. Samples prepared with mixing 50% sludge with 50% of manufacturers clay by volume

Each set of samples contained 36 individual bricks. Burnt bricks were transported to the Materials Testing Laboratory at University of Peradeniya, for testing the following parameters.

1. Dimensions
2. Compressive strength
3. Water absorption
4. Efflorescence

The sampling and testing of bricks were carried out according to SLS standard 39:1978.

Test samples

Air dried sludge at Meewatura sludge lagoons were collected to gunny (burlap) bags and transported to the brick manufacturing site. The sludge was mixed with clay in the proportions 25%: 75% and 50%:50% by volume. At the same time manufacturer's batch production of bricks also were under preparation. 36 bricks were prepared from each category. The bricks prepared by mixture of sludge and clay were kept for air drying for three days, together with the regular batch of normal bricks and then loaded to the kiln for burning. After cooling, the bricks were transported (to University of Peradeniya) for testing.

Testing methods (BS 39:1978)

Four parameters were tested in order to assess the quality of bricks; dimensions, compressive strength, water absorption and efflorescence.

The dimensions were measured by stacking 24 units of each set. Total length, width and height were measured and checked for compliance. Ten bricks were tested for compressive strength. Five bricks

were tested for water absorption and efflorescence. All the tests were conducted in accordance with SLS 39:1978.

RESULTS

Dimensions

24 bricks from each set are tested individually for dimensions. Table 1 gives the summary of outcome of the test.

Table 1: Dimensions

	Description	Sludge: Clay 25%:75%	Sludge: Clay 50%:50%	Clay 100%
1	Average length mm	225	222.5	229
2	Average width mm	108	100	107
3	Average height mm	62	60	62
	mm	**Length**	**Width**	**Height**
4	**Standard for all types and grade**	**220**	**105**	**65**
5	**Requirement for 24 bricks**	**5280± 75**	**2520± 40**	**1560±40**
6	25%-75% set 1	5399	2597	1484
7	50%-50% set 2	5342	2417	1444
8	100%Clay set 3	5494	2575	1497

Length of all the bricks were larger than the average. Width of more than 50% of the bricks were less than the average and height of all the bricks were less than the standard except 1. The standard measurements were outside the tolerance limits.

Compressive strength

Ten bricks from each set were subjected to crushing and the load at failure recorded. The compressive strength of each brick is calculated. Table 2 gives the results.

Table 2: Compressive strength

	Description	Sludge: Clay 25%:75%	Sludge: Clay 50%:50%	Clay 100%
1	Average compressive strength N/mm^2	0.53	0.49	1.82
2	Standard Deviation	0.11	0.15	0.36
3	Percentage of data within 95% confidence limit	90%	100%	100%

The characteristic compressive strength requirement for Type 2, Grade II bricks is $2.8N/mm^2$.

Water absorption

Five bricks from each set were immersed in water for 24 hours. The amount of water absorbed is calculated as a percentage. Table 3 gives the percentage water absorption.

Table 3: Water absorption percentage (for five bricks tested)

	Sludge: Clay 25%:75%	**Sludge: Clay 50%:50%**	**Clay 100%**
1	30	36	22
2	29	28	19
3	31	35	20
4	31	36	21
5	30	35	19
Average	**30.2**	**34**	**20.2**

The requirement specified for water absorption of Type 2, Grade II brick is not more than 28%.

Efflorescence

Five samples from each set were tested for efflorescence. All brick samples show slight efflorescence.

CONCLUSION

The study attempted to use a waste material (water plant sludge) available in large quantities for a useful purpose, keeping all constituent chemicals captured in bricks, for a long time.

The results show that the dimensions of all the three sets of bricks were out of the tolerance limits specified except two occasions. The length of bricks of 50%:50% sample and normal clay brick sample was within the given tolerance limits.

Compressive strength of the normal clay bricks produced by the manufacturer is also less than the specifications for Type 2 Grade II bricks 2.8N/mm^2. The strength of bricks prepared using sludge is much less than the standard.

Specification for water absorption of Type 2 Grade II bricks is 28%. As per the test results, both brick samples using sludge exceeds specified water absorption. The clay brick produced by the manufacturer meets the specified water absorption requirements.

The efflorescence requirement for Type 2 Grade II bricks is "Moderate". However all three sample sets show slight efflorescence, indicating less water-soluble salts in the soil and water used for manufacture of bricks.

Considering the test results it is concluded that the use of dried sludge in combination with manufacturers clay (in this batch) could not produce bricks with expected compressive strength. It will be useful to carry out further studies with lesser sludge ratios (say 10% sludge to 90% soil; for which a larger burrow site should be acquired). Also attempts can be made to determine the suitability of mixing the locally available waste materials like coir, waste jute fibre, waste clothe fibre or crushed bone from abattoirs, in order to improve the properties of the bricks. Also improving the process of manufacture (method of mixing of clay) and burning the bricks under more controlled conditions are avenues to be explored, as the water plant sludge is accumulating day by day.