WTS' silt incorporation in mortar production

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ABSTRACT

The construction industry is one of the industries that consume the most raw materials, impacting the environment both in the extraction, and in the disposal of their waste. The loss of raw materials during the work execution is significant, mainly 44% of the extracted sand sites that should be Area of Permanent Protection. On the other hand, we find the essential sanitation for public health, in the water treatment generates large amount of rich silt on metals, in particular aluminum, which requires specific purpose, to reduce the generated impacts. This research studies the incorporation silt from Águas Guariroba water treatment plant in Campo Grande - MS, replacing the sand in the mortar. It was found after the experiment that mortar ratio 1: 2: 8 (cement: lime: aggregate (sand and silt)) it was possible to replace 50% of the volume of sand by the WTS yielding a 50% increase in resistance and compression.

KEYWORDS

Silt of Water Treatment Station; Sustainable Materials; Replacement of sand; Mortar.

INTRODUCTION

Because of their size, economic strength, and profound societal importance, construction activities and processes are among the largest consumers of materials and energy and significant polluters on the global scale. For these reasons, more attention should be devoted to understanding, researching, and ultimately reducing their environmental impacts. (Horvath, 2004).

In Brazil 70% of the produced sand is extracted from riverbeds, 223 million tons of sand were consumed in 2005 and the estimated production of 545 million tons of sand for the year 2030. This extraction is done in Areas of Permanent Protection (APP): using stretches of riverbanks as a point of transfer or passage for pumping ducts, its reserves are both in riverbeds, in hills slopes or dunes. (Quaresma, 2009).

According to the chemicals used in the water treatment, the silt of WTS generates a rich silt of aluminum, this is an environmental liability caused by sanitation companies that pour this into the nearby bodies of natural water. (R. F. Ribeiro, 2012).

Studies for the manufacture of mortar with WTS' silt showed a strength of 2.68 MPa after 28 days compared to that achieved without silt, 2.80 MPa, which is not a large decrease in strength, using the ratio 1: 8 (cement: aggregate) (Sales & de Souza, 2009). With the WTS' silt of Campo Mouro the mortar ratio measured was 1: 2: 7 (cement: lime: aggregate), which also uses the aluminum polychloride, it was concluded that with the incorporation of

10% WTS' silt in the mortar the resistance showed was 2.98 Mpa higher than mortar without silt. (R. F. Ribeiro, 2012).

This paper aims to study the incorporation of WTS' silt, dry on drying bed, in mortar 1:3 ratio (cement and aggregate) and 1: 2: 8 (cement: lime: aggregate), by percentage of 10 %, 50% and 100%, evaluating its compression resistance and its drying shrinkage by analyzing the influence of the presence of lime in the mortar together with silt.

OBJECTIVE

Incorporating silt from water treatment plant in mortars to evaluate the influence of the silt in the mechanical resistance of the mortar, and the shrinkage suffered by them.

METHODOLOGY

Materials

The silt used was already dry when collected from the Guariroba water treatment station in the city of Campo Grande - MS, then packed in bags for transport and storage, the clods were broken at the laboratory to get a closer granulometry of the sand as in Figure 1.

The sand used was the most commonly found in the market of the city of Campo Grande - MS, the cement used was Portland cement CP II-E 32, of the Itaú brand, and the hydrated lime used was CH III, of the Itaú brand, both acquired in the local market.

a b c

Figure 1 - Sludge harrowing. a- Raw sludge. b- Process harrowing. c- Sludge destorroado
Source : Prepared by the authors

The sand and silt particle sizes were defined by the test of NBR 7217 (ABNT, 1987), thus traced their granulometric curves presented in Figure 2.

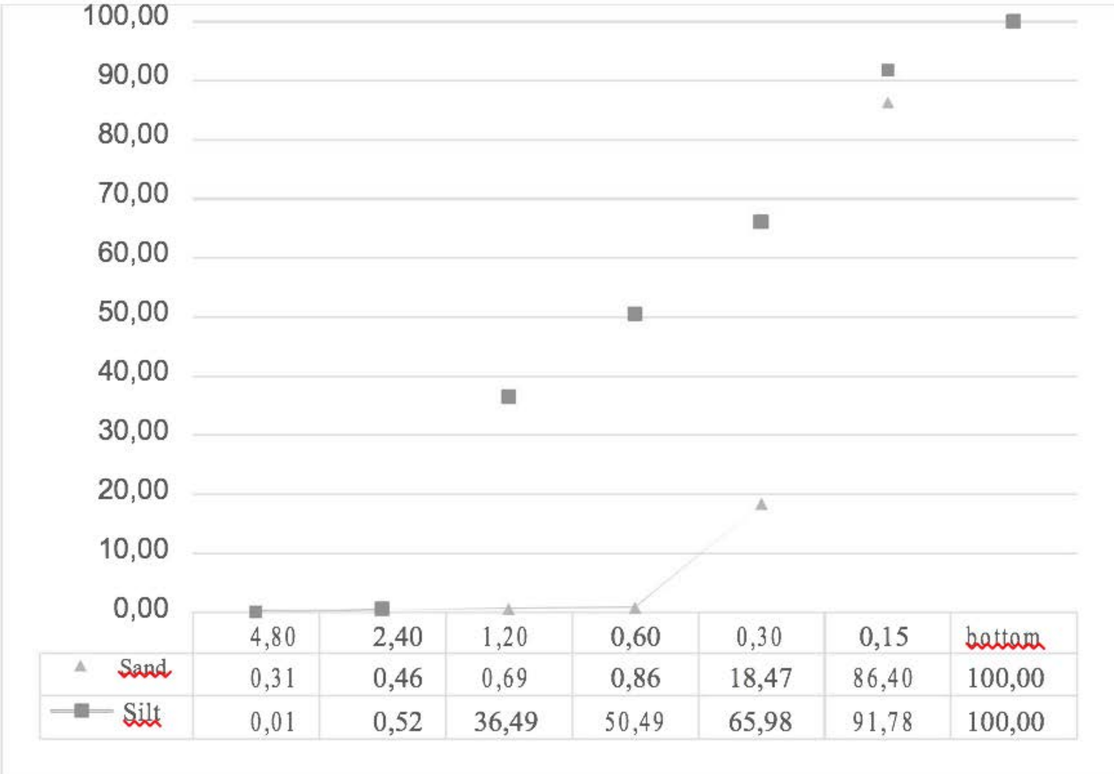

Figure 2 - Curve of sand and silt Sieve

Presently, it was defined the specific masses of each material to obtain the mass traces, with the specific sand mass defined by Chapman tube provided for the test NBR 9776 (ABNT, 1987) and silt by the assay of the pycnometer provided for in the NBR 6508 (ABNT, 1984), cement and lime had their specific mass obtained from data sheets of chemical products, as table 1.

Table 1 – Specific mass of the material

Material	Specific mass	
Cement	3,15 Kg/dm3	Attachment 1
Lime	2,3 Kg/dm3	Attachment 2
Sand	2,62 Kg/dm3	Assay
Silt	2,53 Kg/dm3	Assay
Water	1 Kg/dm3	

Ratio

First the conventional mortar line of cement and sand was selected with ratio 1: 3 (1 volume of cement: 3 sand volume), this being considered the white proportion (1-b) was then incorporated into the silt as replacement of the sand, using 10% silt and then 50% silt, generating the traits shown in table 2.

Table 2 – Traces volume of cement mortar

Ratio	Cement	Sand	Silt
1 - b	1	3	
1 - 50%	1	2,7	0,3
1 - 100%	1	1,5	1,5

To prepare these a cement mixer of the Catholic University Dom Bosco materials laboratory was used the, each piece of the material was place in the sequence proposed by Ambrozewicz (2012) placeing lime, aggregates, cement and water, water in sufficient amount to ensure optimal workability, visually verified.

After the preparation of the mortar and using each material in the right volume, the correction of traits for mass was produced, obtaining the proportion of material for one unit of cement using the equation 1, thus generating the table 3.

$$P = \frac{V \times Y}{Mc}$$ equation 1.

Table 3 – Traces corrected cement mortar

Ratio	Cement	Sand	Silt	Water
1 - b'	1	2,5		
1 - 10%'	1	2,25	0,24	
1 - 50%'	1	1,25	1,2	0,37

In the next step a mixture of mortar with cement, lime and sand, was used with the objective of studying the influence of the lime in the silt incorporation. For this step a white mortar ratio 1: 2: 8 (2-b) was used. Next silt was incorporated as a sand replacement, using 10% silt and then 50% silt and finally 100% of silt, causing the traits shown in table 4.

Table 4 – Mixed mortar traits in volume

Ratio	Cement	Lime	Sand	Silt
2 - b	1	2	8	
2 - 10%	1	2	0,2	
2 - 50%	1	2	4	4
2 - 100%	1	2		8

The manufacture and correction of mixed mortar with cement and lime traits were made in the same way of the mortar cement, thus generating the table 5.

Table 5 – Mixed mortar mass traces

Ratio	Cement	Lime	Sand	Silt	Water
2 - b'	1	1,46	6,65		0,71
2 - 10%'	1	1,46	5,99	0,64	0,91
2 - 5%'	1	1,46	3,33	3,21	
2 - 100%'	1	1,46		6,43	1,09

Resistance to Compression

The resistance to compression was obtained by testing provided for the NBR 5739 (ABNT, 2007), with cylindrical test bodies of dimensions 5cmx10cm height, molded with the fresh mortar and condensed to each third of the cylinder with a metal rod aid, then for the initial drying the samples remained in the laboratory at room temperature and humidity for 24 hours and then unmold and placed in a humid chamber for healing until the date of their break by hydraulic press, figure 3-a.

a b c

Figure 3 – Compressive strength test: a- CP in a humid chamber b- CP being broken c- CP broken

To break the test pieces were removed from the humid chamber, they had the surface sanded to remove imperfections, they were weighed on a precision scale and had their dimensions measured with a digital caliper.

Then they were broken in the hydraulic press, 3 bodies of proof for each age, so being made the simple average of the resistance to compression figure-5 a, b and c.

Retraction

Prismatic square faces test bodies with dimensions of 4cmx16cm were shaped for retraction when remained at room temperature and humidity for the initial cure for 24 hours, then they were unmolded and placed on the north facade of the Laboratory, where they were exposed to weather conditions, having the dimensions been measured on days 1, 3, 7, 21, from its molding.

RESULTS AND DISCUSSIONS

In the first stage disruptions of the mortar cement test bodies were conducted, and the result with the incorporation of 10% silt, the mortar strength at 28 days drops to 85% of white mortar strength even still in area usable mortars, reaching 5.71 MPa. Retraction analysis was disregarded, because the mortar with incorporated silt did not present compressive strength compatible with white cement mortar.

In the second stage mixed mortars were analyzed with the presence of lime in conjunction with the silt causing an increase in resistance after 28 days and had the highest initial increase of resistance acquired, a resistance almost three times that of the white mortar resistance.

The total shrinkage suffered by mortars were range of 0.07%. At the end of the tests it was found that after 1 month in a humid chamber the trait of test bodies without the presence of lime developed mold on its surface, this was not seen in the traits with the presence of lime nor in the trait that had lower silt concentration.

CONCLUSIONS

The mortar mixture of cement and lime have characteristic resistance lower than mortar using only cement as a binder, those with the silt incorporated in concentrations of 10% and 50% by sand substitution caused an increase of 80% and 50% strength respectively.

In traits, containing 50% incorporation of silt in the base trait without the presence of lime it was observed after 28 days a presence of mold resulting from organic matter present in this, for the same amount of silt in the mortar presence of lime, mold was not observed.

The retraction occurred on the traits of mortar mixed with incorporation of 10% and 50% silt, it was equal to that occurred at the mortar base.

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