THE UTILIZATION OF DRILL CUTTING WASTE FOR BRICK MANUFACTURING

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Abstract— Chevron Geothermal Salak, Ltd (CGS) as one of the Geothermal Power Plants, to increase geothermal reserves, CGS conducts drilling and as is well known this activity produces a lot of drill cutting waste material so that it can quickly fill the temporary storage area. To overcome this, efforts should be made to reduce and / or utilize the waste. The effort is to use the material as a mixture of brick manufacturing. The purpose of this study is to be able to know the use of drill cutting waste as a raw material for brick manufacturing, to know the properties or characteristics and quality of drill cutting waste, and to be able to know the composition of the drill cutting waste mixture for brick manufacturing. The compositions used is drill cutting waste, soil stabilizer, and cement. In this study the compressive strength test was carried out at a maximum age of 28 days. It aims to find out the best mixture composition in the brick manufacturing, so that it gets high quality and can be used in the field. The results of this study can be concluded that by utilizing drill cutting waste as a material for making concrete blocks, it has achieved a compressive strength of 21.74 MPa that meets the quality requirements of concrete bricks in the quality level category IV. The brick products produced from the use of drill cutting can be used for drainage channels, trash container, pond walls, and retaining wall.

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KEYWORDS
drill cutting waste, brick manufacturing, soil stabilizer.

1. Introduction

Geothermal exploitation is currently being carried out by drilling geothermal wells in conjunction with the increasing demand for energy sources, so that it has the potential to produce quite a lot of waste [1] [2]. Drilling geothermal wells generates various kinds of waste. One of the waste that is generated in large quantities is drill shale in the form of sandy mud which contains certain chemicals that can pollute the environment if not handled properly [3] [4]. From the results of the study, it is shown that various drill shale can be used as raw material in the manufacture of a mixture of building material components such as hollow concrete bricks, solid concrete bricks, paving blocks, concrete tiles, and concrete panels [5] [6].

Drilling mud can be defined as all types of fluids (foaming liquids, pressurized gas) that are used to assist drilling operations by cleaning the bottom of the hole from the drill bits and lifting it to the surface, so that the drilling can run smoothly [7] [8]. The drilling mud used today originated from the development of the use of water to lift drill cuttings. Then with the development of drilling technology, drilling mud began to be used. Apart from drilling mud, gas or air is also used as a drilling fluid [9]. The composition of the drilling mud is composed of various chemicals, each of which has an individual function, and it is expected to work synergistically with each other to obtain the expected mud properties [10] [11]. The chemicals making up the mud are not only single function but can function multiple. The first function is called the primary function while the second function is called the secondary function. The most widely used drilling mud is water base mud, where water is a continuous liquid phase and as a solvent or retaining material in the mud. [12]

Incorporation of waste materials in the manufacture of masonry bricks Incorporation of waste materials in the manufacture of masonry bricks: An update review , This study presents the latest research updates on utilizing waste materials in bricks manufacturing. The study categorized into two groups based on manufacturing method: fired and unfired methods. The review of literature exhibited an obvious potential of the waste materials as partial or total replacement of conventional raw materials where the produced bricks fulfilled the standards requirements. Additional research work is required, not just in the properties and economical parts but also on educating and aware the public about the advantages of utilizing waste materials in bricks manufacturing as well as on developing codes of practices and standards.[13]

Development of eco friendly brick using water treatment plant sludge and processed tea waste This paper aims to study the effect of the addition of water treatment plant sludge (WTPS) and processed tea waste (PTW) on the properties of burnt clay bricks. The reuse of WTP sludge as a raw material for brick production is a long-term approach, to sludge disposal, for economic and environmental sustainability. Sludge have been added at 10, 20, 30 and 40% and processed tea waste at 5% (by weight) in replacement of clay for brick manufacturing. Each batch of hand-moulded bricks was fired in a heat controlled furnace at a temperature of 990°C. The compressive strength has been found to increase with the sludge content, however, a slight decrease in compressive strength was observed with tea waste addition. Further, PTW addition has improved the thermal insulation of bricks as compared to controlled bricks. The study shows that 40% WTPS, 5% PTW and 55% natural clayey soil can be considered as an optimum mix for bricks with good compressive strength as well as improved thermal insulation property. Design/methodology/approach: Four different mixing ratios of sludge at 10, 20, 30 and 40% of the total weight of sludge-clay mixtures were used to make bricks. Similarly, PTW was investigated as a substitute of natural clayey soil in brick manufacturing. Each batch of hand-moulded bricks was fired in a heat controlled furnace at a temperature of 990°C. The physical, mechanical and engineering properties of the produced WTPS bricks and PTW bricks were determined and evaluated according to various Indian Standard Codes of Specification for burnt clay bricks and certain reference books. Findings: The results exhibited that WTP sludge and PTW can be used to produce good quality brick for various engineering applications in construction and building. Increasing the sludge content increases the compressive strength. Moreover, thermal insulation of PTW bricks depicted an upward trend when compared to controlled bricks. Hence, an optimum mixture of 40% WTPS, 5% PTW and 55% natural clayey soil was found, at which bricks showed good compressive strength as well as improved thermal insulation property of the building material. Research limitations/implications: The present work provides a sustainable solution for disposal of WTP sludge and tea waste. Utilization of these waste materials in brick manufacturing is viable and economic solution. Practical implications: Bricks with 40% WTP sludge and 5% processed tea waste proved to be economic, technically sound for construction purposes with added thermal insulation properties. Social implications: Bulk amount of waste such as WTP sludge is a threat to society owing to its environmental implications of disposal. Authors propose to use WTP sludge and tea waste for brick manufacturing and provide a solution to its disposal. Originality/value: Water treatment plant sludge along with tea waste have not been tried for brick manufacturing so far. Hence, the composition is new in itself and also have resulted into good performance.[14]

The reuse of waste glass for enhancement of heavy metals immobilization during the introduction of galvanized sludge in brick manufacturing ,The mixing of galvanized sludge in fired clay brick manufacturing has been regarded as an alternative approach for the consumption of galvanized sludge. Decreasing the surface area and porosity of fired brick definitely lowers the risk of heavy metal release. In this study, a novel method is proposed to reduce the surface area and porosity of bricks and promote heavy metal immobilization by adding waste glass. The introduction of waste glass enhanced the physical and mechanical performances of fired clay bricks and resulted in an increase in bulk density and compressive strength and a decrease in water absorption. Microstructure analysis showed that the texture of the bricks turned from porous to smooth and homogeneous due to the introduction of waste glass. Porosity analysis showed that surface area and pore volume of fired brick were substantially reduced. When the added waste glass amount exceeded 15 wt%, the heavy metal concentrations that leached from bricks containing 10 wt% galvanized sludge fired at 950 °C met the regulatory requirement. These results demonstrate that waste glass can be reused to enhance the stabilization/solidification of heavy metals, during the mixing of hazardous waste in bricks and ceramics manufacturing process.[15]

Recycling of construction wastes for manufacturing sustainable bricks The purpose of this study was to manufacture sustainable bricks, based on three types of wastes generated in the building industry: wood-cutting residues, wastes from the excavation process and recycled aggregates (RA). Water was added as the kneading material, and Opuntia ficus-indica extract (mucilage) was supplemented as a natural additive to improve the workability of the mixtures. The conventional firing process was substituted by drying in a solar drying chamber. Nine mixtures were prepared using 62% excavation wastes, 5% wood-cutting residues and 33% RA. These mixtures were classified into two groups depending on their granulometries: the first one denominated cementitious RA only having granulometries from 3/8 inch (0·95 cm) and 1/4 inch (0·63 cm) to fines and the second group denominated all-in-one RA having granulometries from 1/4 inch to fines. The quality of the sustainable bricks was evaluated according to compressive strength and water absorption parameters. The results showed that the ecological bricks manufactured with the mixture of cementing RA only of 3/8 and 1/4 inch to fines meet the standard requirements, providing compressive strength values of up to 8 MPa; moreover, the use of O. ficus-indica extract as a natural additive notably improved the workability of the mixture.[16]

Utilization of solid waste from brick industry and hydrated lime in self-compacting cement pastes The huge quantity of solid waste from the brick production industry can be used as a cement replacement. However, replacement exceeding 10% causes a discount in power because of the slowing of the pozzolanic response. Therefore, in this examine, the pozzolanic potential of brick waste is more suitable using ultrafine brick powder with hydrated lime (HL). A total of six self-com-pacting paste mixes had been studied. HL 2.5% by weight of binder turned into introduced in two formulations: 10% and 20% of waste burnt brick powder (WBBP), to prompt the pozzolanic reaction. An boom inside the water call for and putting time become found by means of growing the replacement percent of WBBP. It became discovered that the mechanical houses of mixes containing five% and 10% WBBP consistent with-formed better than the control mix, while the mechanical properties of the mixes containing 20% WBBP were observed to be almost identical to the manage blend at ninety days. The addition of HL greater the early-age electricity. Furthermore, WBBP formulations encouraged improvements in both sturdiness and rheological homes, complemented through decreased early-age shrinkage. Overall, it was determined that brick waste in ultrafine length has a completely high degree of pozzolanic capacity and may be efficaciously utilized as a supplementary cementitious material. [17]

Incorporation of industrial wastes as raw materials in brick's formulation This article presents a case study conducted as an experiment with the incorporation of different types of industrial waste in brick manufacturing process in laboratory scale. The main objective of this work is to incorporate large amounts of different types of waste as raw material in brick's formulation. Three types of wastes were mixed with clay: automotive industry waste sludge containing heavy metal concentrations; glass waste, from a galvanic plant, mainly consisting of glass microspheres; and wood ash, from the ceramic burning furnace. The formulation's materials were analyzed by X-ray diffraction, X-ray fluorescence and electronic microscopy. The dried samples were milled separately and then dry mixed. Water was added to the mixture in order to contribute to the compaction process. The samples were dried and then burned at temperatures similar to those used for brick firing furnace. The obtained ceramics were analyzed for their retraction and then submitted to flexural strength testing. Samples obtained value above 4 MPa were approved. Among the samples tested, the formulation that showed higher flexural strength was chosen. It was prepared sufficient sample to perform the solubilization and leaching tests. For tests, the samples were reduced to dust. The results of such analyzes did not identify the presence of elements described in the initial samples' formulation. Morphological analysis was performed using scanning electron microscopy. Tested sample showed glassy characteristic of material that has been sintered during the firing process. This effect is also a proof that the waste identified in initial sample's formulation were inerted. Obtained results characterizes that the tested formulation can be considered as an alternative for bricks manufacturing with incorporation of industrial waste and an activity non-hazardous to the environment.[18]

Application of lean manufacturing tools and techniques for waste reduction in Nigerian bricks production process Engineering The study focused on the various wastes in Nigerian BPP. It also focused on the various lean tools/techniques that can be adopted to reduce the wastes. Aspects such as the percentage of the wastes and their cost implication on the factory were not covered during the study and could be further investigated by prospective researchers. Practical implications: The study provides knowledge on how lean thinking can be adopted to reduce wastes in BPP. Such knowledge may be beneficial to the present and prospective bricks producers. This implies that the proposed framework in the study allows producers of bricks to identify gaps in their implementation efforts, focus attention on areas that may require improvements, and access the benefits of lean approach in their factory products. The proposed framework may also be beneficial to the academics. Originality/value: This paper first gain originality in the study context to propose for a lean framework that can be adopted to reduce wastes in BPP. Furthermore, the paper has not been previously published and all the information obtained from other sources are duly referenced.[19]

A Study of Manufacturing Bricks Using Plastic Wastes Plastic waste which is increasing day by day becomes eyesore and in turn pollutes the environment, especially in high mountain villages where no garbage collection system exists. A large amount of plastic is being brought into the tourist trekking regions are discarded or burned which leads to the contamination of environment and air. Hence, these waste plastics are to be effectively utilized. Low-density polyethylene bags are cleaned and added with sand at particular percentages to obtain high strength bricks that possess thermal and sound insulation properties to control pollution and to reduce the overall cost of construction; this is one of the best ways to avoid the accumulation of plastic waste which is an on-degradable pollutant. This alternatively saves the quantity of sand/clay that has to be taken away from the precious river beds/mines. The plastic waste is naturally available in surplus quantity and hence the cost factor comes down. Also coloring agents can be added to the mixture to attain desired shades. Hence in this thesis, an attempt is made to study regard the properties of the brick which is manufactured using plastic wastes. The present work deals with the manufacturing and analysis of bricks made with waste plastic (LDPE) and fine aggregates. The bricks produced are light weight, have smooth surface and fine edges, do not have cracks and have high crushing strength and very low water absorption. The bricks are manufactured by heating waste plastic to temperature range of 120 to 150 degree centigrade and mixing sand to the molten plastic.[20]

Usage of the sludge from water treatment plant in brick-making industry The aim of this work is to study the possibility of utilizing the water-plant sludge waste for brick manufacturing using some mineral nanopowders as additives. Batches were prepared from the sludge, one of these contains no additives (blank) while the others contain a constant (5 mass %) additive of either MgO, Cr_2O_3, Al_2O_3, or Fe_2O_3. The bricks were shaped into cylindrical bodies through a hydraulic pressing. After drying, the bricks were subjected to different firing temperature 900°C, 1000°C, 1100°C, and 1200°C. The mineral compositions of the fired samples were determined using XRD technique. The microstructure of the samples fired at 1200°C was depicted using SEM technique. The sintering parameters and mechanical properties of the fired bricks were tested according to the International Standard Specifications. The results indicated that the sample containing nanopowder additives especially Cr_2O_3 exhibit a pronounced improvement in sintering and mechanical properties compared with the blank one. So, usage of sludge in brick manufacturing is an option for basic sustainable development, providing environmental and economic benefit.[21]

A review on utilization of plastic waste materials in bricks manufacturing process This study summarises the work done by authors to use plastic as construction material in bricks. The recyclable properties of plastic waste can be utilized to recycle this waste and produce a new product having lesser negative impact on the environment. One of the options to recycle plastic waste is to form bricks of plastic by mixing plastics with sand which can be used to replace traditional bricks. Various authors performed comparative study with brick made up of other materials by using various testing method such as scratch test, apparent porosity, water absorption, apparent porosity test, soundness test, efflorescence test and analysed that the further research on this field can enrich the strength, quality and durability of these masonry bricks. These bricks absorb very less water as compared to conventional bricks that is also very significant with the view of environmental sustainability.[22]

Manufacturing of sustainable clay bricks: Utilization of waste sugarcane bagasse and rice husk ashes Burnt clay brick is one of the major and widely used building unit in masonry construction around the globe. The manufacturing of burnt clay bricks using waste materials can minimize the environmental overburden caused by waste deposition on open landfills and would also improve the brick performance at low production cost leading to more sustainable construction. This study aims to evaluate the effect of the waste addition produced from two major crops: sugarcane and rice in clay bricks manufacturing. In this study, sugarcane bagasse ash (SBA) and rice husk ash (RHA) were collected locally from a sugar mill and bull's trench kiln, respectively. Brick specimens were manufactured at an industrial brick kiln plant using various dosages (5%, 10% and 15% by clay weight) of SBA and RHA. Mechanical and durability properties of these bricks were studied. It was observed that clay bricks incorporating SBA and RHA exhibited lower compressive strength compared to that of clay bricks without SBA and RHA. However, compressive strength of bricks with 5% of SBA and RHA satisfied the Pakistan Building Code requirements (i.e. >5 MPa). Scanning electron microscopy (SEM) analysis confirms the porous microstructure of the brick specimens incorporating SBA and RHA, which resulted into lesser unit weight leading to lighter and economical structures. Furthermore, resistance against efflorescence was improved in all the tested bricks incorporating SBA and RHA. Based on this study, it can be concluded that the brick specimens incorporating lower dosage of SBA and RHA (i.e. 5% by clay weight) will not only relieve the environmental burden but also result into a more sustainable and economical construction.[23]

Manufacturing of clayey bricks by synergistic use of waste brick and ceramic powders as partial replacement of clay Clay bricks are extensively used as building material worldwide. Natural soil deposits are in constant reduction due to the frequent use of clay to manufacture bricks. About 1600 billion bricks are produced annually by the consumption of millions of tons of natural resources. The prime focus of this study is to assess the feasibility of using a composite mixture of waste brick powder (WBP) and waste ceramic powder (WCP) as a replacement for depleting natural resource "clay" in brick manufacturing. Based upon the previous studies, the replacement levels were kept as (4 + 5)%, (8 + 10)%, and (12 + 15)% of WCP and WBP, respectively. The brick specimens were evaluated in terms of compressive strength, modulus of rupture, density, water absorption, efflorescence, apparent porosity, resistance to chemical attack and sulfate attack, and freeze-thaw resistance. The study reveals that about 27% of clay can be replaced with ceramic waste powder and waste brick powder, which can preserve a massive amount of natural clay without compromising the quality of the bricks.[24]

Sustainable unfired bricks manufacturing from construction and demolition wastes The management of construction and demolition wastes is a huge challenge for most Governments. The greatest component of such wastes is concrete and masonry fragments or remains. Among the most common approaches to valorization of such wastes is to convert them to recycled aggregates, however this may be hampered by low quality of some recycled aggregates compared to natural aggregates. This paper presents the results of experimental investigation where concrete and ceramic remains were used to partially substitute clay soil in producing unfired bricks. The bricks were then tested for mechanical strength, water absorption freeze-thaw resistance. Additionally the environmental impact of the bricks was assessed based on Life Cycle Analysis (LCA). It was established that concrete waste could be used to substitute up to 50% of the clay whereas ceramic wastes could only substitute a maximum of 30% of the clay. Blended bricks made from clay and concrete waste mixes had a lower mechanical strength than those made from clay and ceramic waste. As regards water absorption, there was no marked difference between the two blends of brick however reduction in water resistance was slightly greater in bricks containing concrete waste that in those containing ceramic wastes. Also, tests showed that freeze-thaw resistance was greater in bricks blended with concrete wastes than in those incorporating ceramic wastes. Life Cycle analyses demonstrated that it is the binder content in the mix that largely determines the environmental impact of the blended bricks. Lastly, it was demonstrated that the most desirable technical and environmental credentials of brick material mixes resulted from using the binder combination: CL-90-S+GGBS 2/8.[25]

In this research, studied how to deal with drill shale so as not to have an impact on the environment and not be polluted. Then it is suggested solutions and their use if they make a positive contribution, namely cost savings, efficiency, and benefits. With alternative use, namely the manufacture of building material components or used as a mixture in making brick. It seems that this utilization is more

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profitable and seen from the safety factor is a good recommendation. Because the environment is not disturbed or safe. Based on the description above, in order to deal with these problems, it is necessary to conduct research on drilling bits of geothermal well drilling waste to be utilized in the optimal amount as a raw material in a mixture of brick making that meets special requirements.

2. Method

The approach pattern of utilizing drill shale as a mixture in brick making is principally by taking a technical, economic, and environmental approach. This research was conducted in the laboratory of the Bandung Residential Research and Development Centre. The stages of the research carried out are as follows on fig 1:

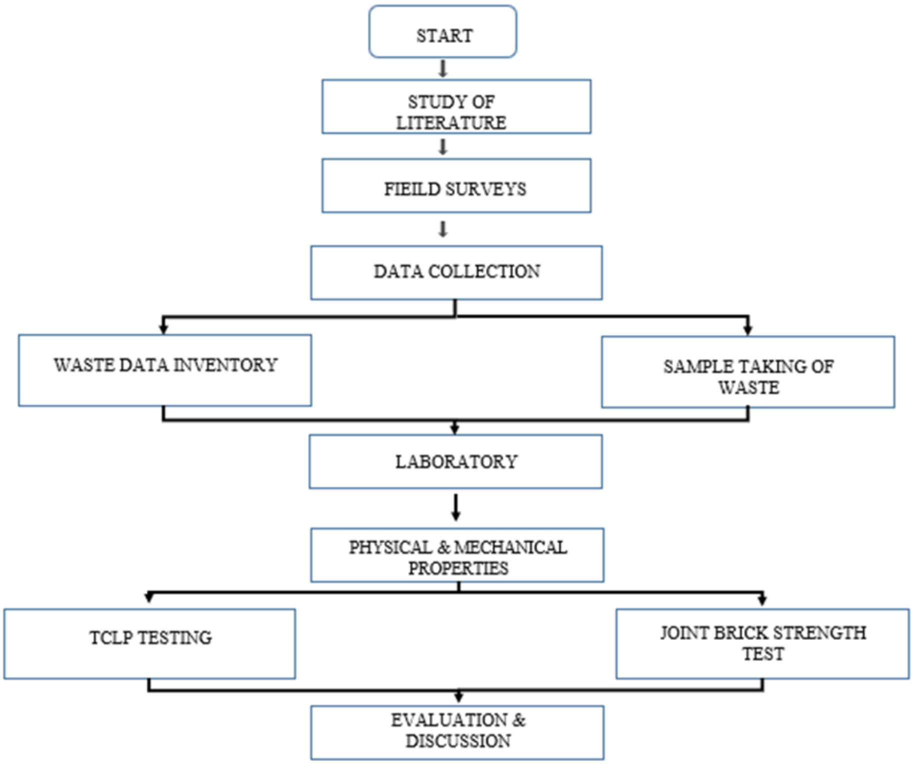

Fig. 1. Research Flowchart

2.1 Tools and Materials

The material used is in principle the same as in the making of brickwork, only for this study using a mixture of drill cutting waste. The materials needed include:

- Drill cutting waste
- Soil stabilizer
- Cement

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Fig. 2. Drill Cutting Waste

Likewise, the equipment used is exactly the same as the usual brick making equipment. So, the equipment used is as follows:

- Solid brick moulding tools
- Mixer
- Shovel
- Bucket

2.2 Making Process

- **Mixing** the ingredients using a mixer and the solid brick compaction process in the mold

Fig. 3. Mixing and Compacting Process

- Smooth the solid brick shape on the mold, step on the lever to release the mold

Fig. 4. Tidying Process

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- Solid brick is loosened from the mould and removed from the mould

Fig. 5. Detachment Process from Mould

- Drying with ambient air and solid brick ready for use

Fig. 6. Drying Process

3. Results and Discussion

3.1. TCLP Analysist

Based on Government Regulation no. 18 of 1999 concerning Hazardous and Toxic Waste, the sludge from the drilling process is categorized as B3 waste. As for the sludge from drilling, it is included in the category of B3 waste because in the drilling mud there is an element of Ba (Barium) so that in its management it must be proven whether the waste contains B3 or not. The laboratory test results show that the content of hazardous materials in the drilling flakes is far below the quality standard threshold listed in attachment II of Government Regulation No. 85 of 1999 and Regulation of the Minister of Energy and Mineral Resources No. 045 year 2006. TCLP test results for concrete brick samples, can be seen in full in Table 1 below.

Table 1. Table 1. TCLP Analysist Result.

Parameter	Analysist Result (mg/L)	Quality Standard
	PPB-L01	
1. Arsenic	0,006	5,0
2. Barium	<0,5	100,0
3. Boron	<10	500,0
4. Cadmium	<0,01	1,0
5. Chromium	0,051	5,0
6. Copper	<0,01	10,0
7. Lead	<0,01	5,0
8. Mercury	<0,005	0,2
9. Selenium	<0,005	1,0
10. Zinc	8,01	50,0

3.2. Strength Stress Analysist

Batako consists of solid bricks, namely bricks that are not perforated with a size of 40 x 20 x 10 cm3 and hollow bricks with a small size of 40 x 20 x 20 cm3. Solid brick is stronger than hollow brick, grade II for solid brick has the same strength as quality I for hollow brick. Based on SNI 03-0348-1989, the following is the quality and method of testing for solid concrete:

Table 2. Solid Brick Classification

No	Physical Requirements	Quality Level of Solid Concrete Brick			
		I	II	III	IV
1	Minimum average gross compressive strength * (kg/cm2)	100	70	40	25
2	Minimum gross compressive strength of each (kg / cm2)	90	65	35	21
3	Maximum average water absorption (%)	25	35	-	-

The following is an explanation of the physical requirements of the brick:

- Quality IV: Brick is used in construction that does not bear the load installed in a place protected from outside weather and given a protective layer.
- Quality III: Brick is used in construction that does not carry loads, installed in a place that is protected from outside weather but not given a protective layer.
- Quality II: Bricks used in load-bearing construction are installed in a place that is protected from outside weather.

- Quality I: Bricks are used in load-bearing construction, installed in a place that is not protected from outside weather.

The following are the results of the compressive strength test for solid bricks carried out in the PU laboratory, which can be seen in Table 3 below:

Table 3. Compressive Strength Test Results

No	Age (Days)	Size (cm)			Large (cm2)	Weight (kg)	Load (kg)	Compressive strength (kg/cm2)	
		P	L	T				Each	Average
1	28	40,20	9,80	19,20	393,96	13.310	7.000,00	17,77	21,74
2	28	40,20	10,00	19,30	402,00	13.490	9.000,00	22,39	
3	28	40,20	10,00	19,20	402,00	13.530	8.100,00	20,15	
4	28	40,20	9,80	19,20	393,96	13.290	8.240,00	22,28	
5	28	40,20	10,00	19,20	402,00	13.120	10.500,00	26,12	

Based on 5 samples of solid bricks sent to the PU laboratory for compressive strength tests, the test results showed that the solid brick samples were included in the category IV quality level with the composition of solid bricks, namely 1 m3 of drill flakes, 0.18 stabilizer soil, and 5 zacks cement.

4. Conclusion

Based on the research results, the conclusions drawn are as follows:

After the TCLP (Toxicity Characteristic Leaching Procedure) analysis test is carried out, the sludge from the drilling process has a relatively small potential for pollution to the environment.

The TCLP test results for solid brick samples from the 28-day-old field trial showed that the number was below the quality standard.

The compressive strength value of solid bricks based on the test results obtained an average value of 21.74 kg / cm3, included in the category IV quality level with the composition of solid bricks, namely 1 m3 of drill chips, 0.18 m3 of soil stabilizer, and 5 zaks cement.

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

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