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The Use of KOBEL Brick for Repairing Soil that Subsides Due to Water Flow

Susilawati Cicilia Laurentia[1,*], Indah Wahyuning Tyas[2]

[1]Department of Civil Engineering, University of 17 August 1945 Semarang, Semarang, 50235, Central Java, Indonesia
[2]Department of Civil Engineering, Flores University, Ende Flores 86319, East Nusa Tenggara, Indonesia

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Abstract The flow of water in the sub-soil tends to transport fine soil particles to other places. This happens, especially during heavy rains, where rainwater that seeps into the ground, flows carrying fine particles into the pond, and causes the soil surface to subside in certain parts. This encourages a study to be carried out to apply KOBEL bricks to overcome this. KOBEL bricks have 2 holes with a diameter of 5 cm, when arranged, they will form a pipe that can regulate the flow of water, so it does not carry fine grains that flow or are eroded. The simple concept of providing available water flow can prevent soil erosion and minimize the negative impact on soil subsidence due to water flow in the soil. KOBEL bricks are made from soil base material that is pressed up to 62.5%, applied as soil improvement, so that the soil surface becomes stable and does not sink anymore. From the results of the application of the KOBEL brick for the subsided soil surface, it turns out that the surface is no longer sinking. It can be concluded that the use of KOBEL bricks which is very easy to do and requires very low cost can be used to overcome soil subsidence due to water flow in the soil.

Keywords Soil Improvement, Subsidence, Water Flow, KOBEL Brick, Low Cost

1. Introduction

The flow of water in fine-grained soils tends to transport the fines from the soil. This happens, especially during heavy rains, where rainwater that seeps into the ground flows carrying fine grains into a pond, and causes the soil surface to sink in certain parts. This occurs in the application of KOBEL bricks in arranging the garden around the pond of The PAUD Edelweiss. Encouraged to continue to apply the KOBEL brick system, research was carried out with the title: The Use of KOBEL Brick for Repairing Soil that Subsides due to Water Flow.

Asdak [1] defines water erosion as the process of eroding and transporting soil layers caused by water activity or movement. This erosion occurs due to the force of water or wind [2]. As a result of large rainfall intensity with a slope also causes erosion [3]. The effect of vegetation cover also has an impact on erosion [4]. Changes in land use and rainfall regimes also have an impact on erosion [5]. The studies related to erosion are widely discussed, in various ways to overcome them, including conservation techniques [6] [7] [8] [9].

In a case study of the arrangement of a natural pond that occurs due to a spring beside PAUD Edelweis, Serut Hamlet, Palbapang District by applying the KOBEL brick system, soil erosion occurs due to the flow of water from a spring that enters the pond. This was triggered by heavy rain and in the arrangement of the PAUD park the original soil was demolished so that the grains became loose and easily eroded. The phenomenon that occurs is the subsidence of the surface of the KOBEL brick layer used as a ground cover (Figure 1).

Based on the definition of water erosion described by Asdak [1], the phenomenon of subsidence of the surface of the KOBEL brick layer that occurs is caused by soil erosion

caused by the flow of water in the soil when heavy rains occur. The simple concept is to provide a flow of water in the soil, so as to avoid soil erosion that occurs and does not cause the impact of land subsidence due to the flow of water in the soil.

KOBEL bricks which have 2 holes with a diameter of 5 cm, are arranged to form a pipe that functions to regulate the flow of water through the pipe that is formed so that it does not bring along fine grains to flow or erode. The simple concept of providing an available flow of water, can prevent soil erosion that occurs so that it does not cause the impact of land subsidence due to water flow in the soil.

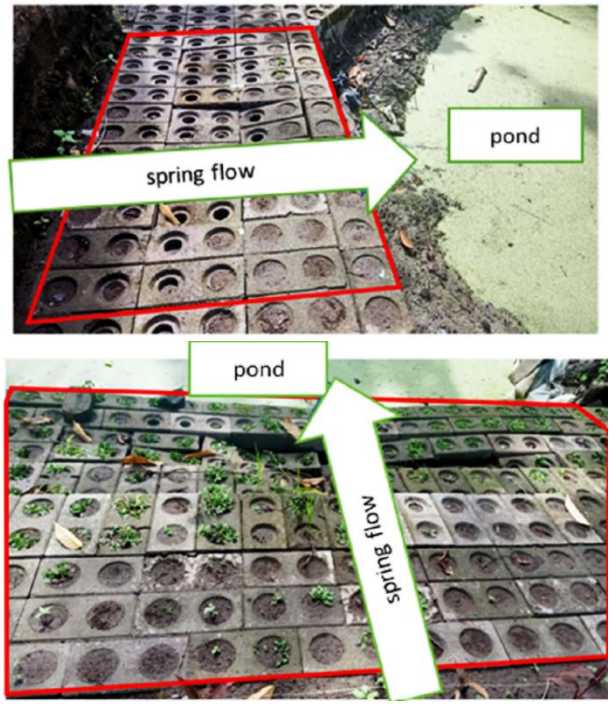

Figure 1. Subsidence of ground cover layer

2. Materials and Methods

In general, the study method carried out can be explained as in the flow chart of Figure 2 below.

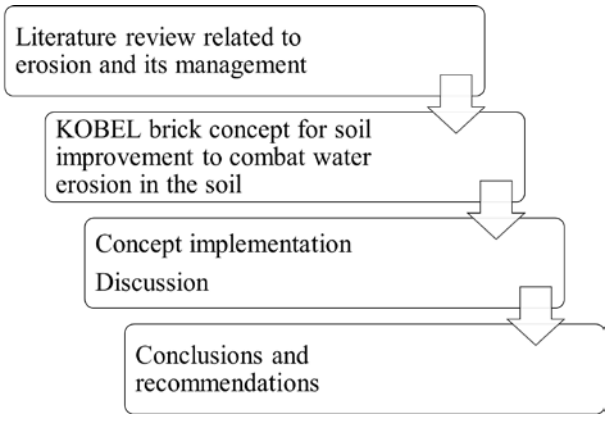

Figure 2. Study method flow chart

A literature review was conducted to find the concept of soil improvement that can overcome in the soil. Furthermore, the concept is applied in the case study problem of PAUD garden arrangement in Serut Hamlet. From the discussion carried out during the process of applying the concept as well as in the process of observation, conclusions and suggestions from this study can be written.

2.1. KOBEL brick concept for soil improvement

KOBEL brick made of soil-based material with a pressing process up to 62.5% serves as a soil improvement as well, so that the soil surface becomes stable and does not subsidence again.

Interlocked soil pressed stone is a kind of brick material made from soil; other materials are added to make it more stable when pressed (Compressed Stabilized Earth Brick – CSEB). These bricks are better known in Indonesia as bricks or lego bricks [10], do not require layers of mortar to arrange them and are interlocked with each other or interlocked.

The main factor of soil stabilization, which is a change in each soil property to improve its technical performance is influenced by soil type, cement content, compaction and mixing method [11] [12]. One of the main functions of the stabilizing medium is to reduce swelling properties of the soil, through the formation of a rigid framework with the soil mass, which will increase its strength and durability [13] [14]. Portland cement is the most widely used stabilizer for this soil stabilization. Cement has the ability to reduce the liquid limit and increase the plasticity index, thereby increasing the workability of the soil. The addition of chemical stabilizers such as cement and lime have the dual effect of accelerating flocculation and promoting chemical bonding [15]. The chemical will bind depending on the type of stabilizer used [16]. The results of the study revealed that soils with a Plasticity Index (PI) of less than 15% were suitable for cement stabilization [17]. Another observation of cement as a stabilizer explained that the cement binder content in the mixture ranged between 4% and 10% of the dry weight of the soil [18]. However, if the cement binder content is greater than 10%, it becomes uneconomical for CSEB production [19].

From the initial investigation related to the CSEB property conducted on 2 soil samples, it was concluded that the soil has characteristics suitable for cement stabilization with a plasticity index of 12.4% - 14.6%. Increased stabilization from 0% - 7.5% gives a strength between 0.35N/mm^2 – 2.84 [20] and [12]. Cement which is an expensive element, can be maintained up to a range of 3 - 10% of the mix without compromising performance. From experience in Tanzania, a ratio of 1:16 (cement: soil) can produce an average of 100 Interlocking Stabilized Soil Brick (ISSB) from one bag of 50 kg cement. This is equivalent to 0.45 m^3 of wall volume. In contrast, conventional brick (Conventional Brick-CB) with a

cement-sand ratio of usually 1:8 can only produce 20 stones per 50 kg cement bag (equivalent to 0.31 m^3 of wall volume). Therefore, ISSB produces 31% more wall volume than CB. The soil limit for stabilization that reduces the use of cement in the production of crushed stone is shown in the following graph Figure 3 [21].

The use of soil available for construction, in all economic spheres and through various stages of social and technological development, has the potential to provide sustainable appropriate technologies for the creation of the built environment [22]. Soils that have low shrinkage (high sand content) are more stable with Portland cement (PC) to be pressed using a high-power pressing machine (>4MPa), while soils that have high shrinkage (high clay content) are more stable with lime to be pressed using a low-power press machine.

2.2. KOBEL Brick to Combat Water Erosion in the Soil

KOBEL bricks, which have 2 holes with a diameter of 5 cm, are arranged obliquely, so as to form a water flow pipe, which functions to drain water so as not to carry fine particles away or erode [23]. The simple concept of providing available water flow can prevent soil erosion so that it does not cause the impact of land subsidence due to water flow in the soil (Figure 4).

Furthermore, on top the KOBEL bricks are arranged tilted and are used normally as ground cover are as shown in Figure 5.

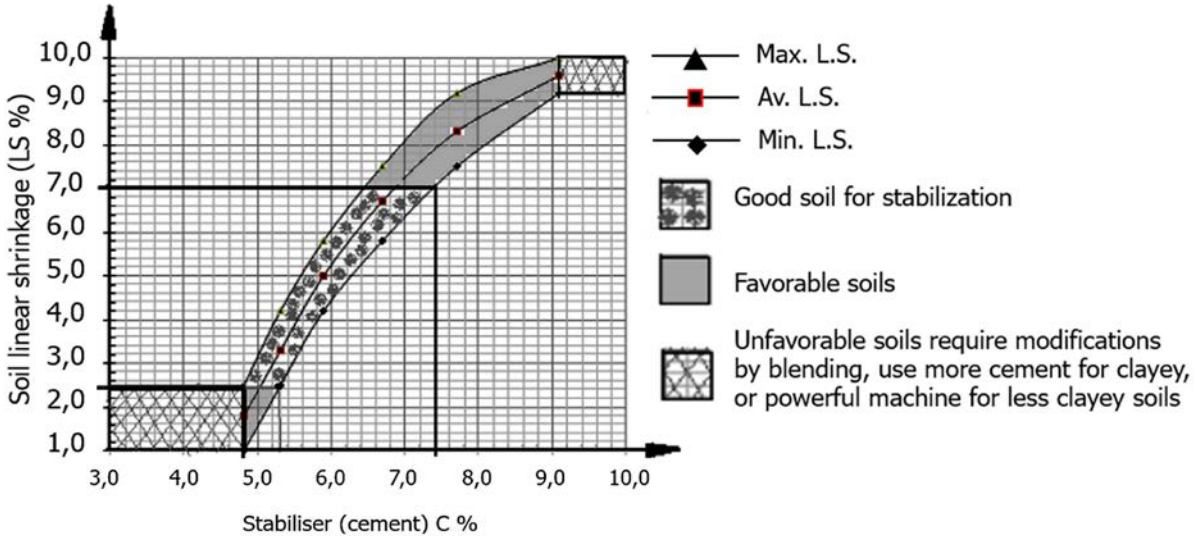

Figure 3. Soil boundary graph for stabilization that reduces cement use [21]

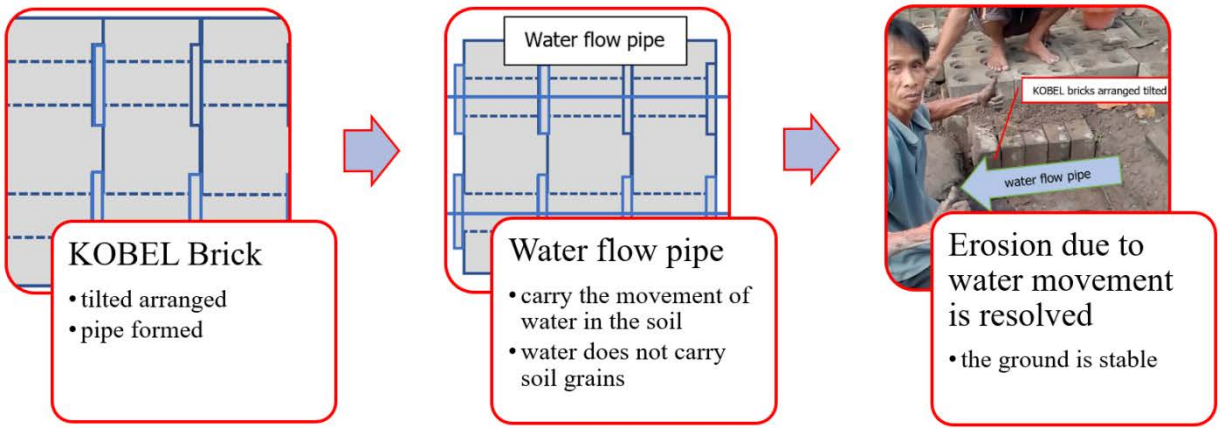

Figure 4. The use of KOBEL bricks to drain the movement of water in the soil

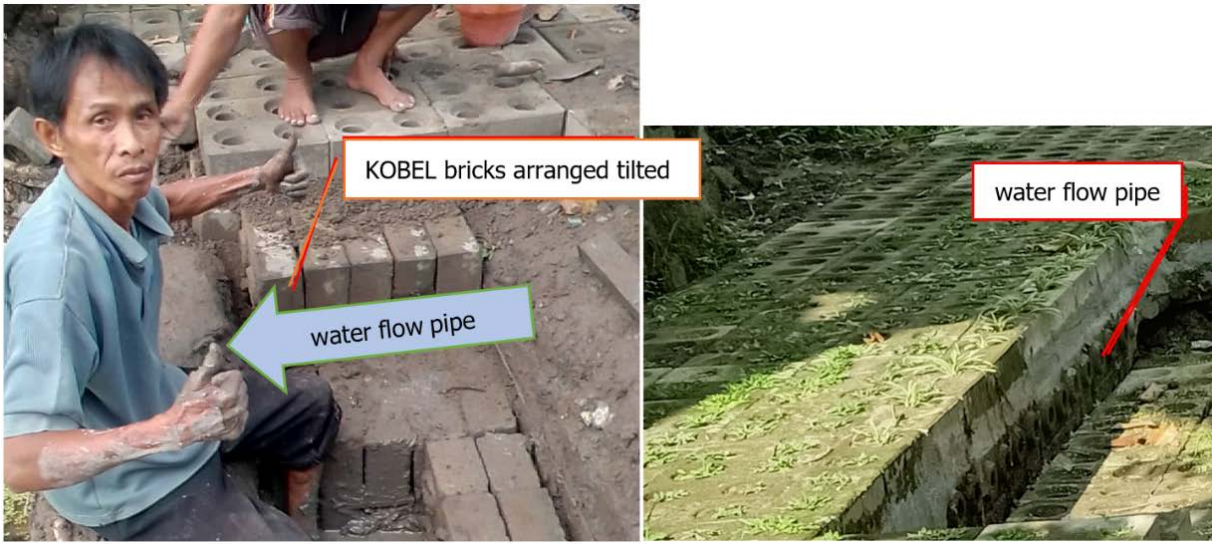

Figure 5. The use of KOBEL bricks as water flow and ground cover

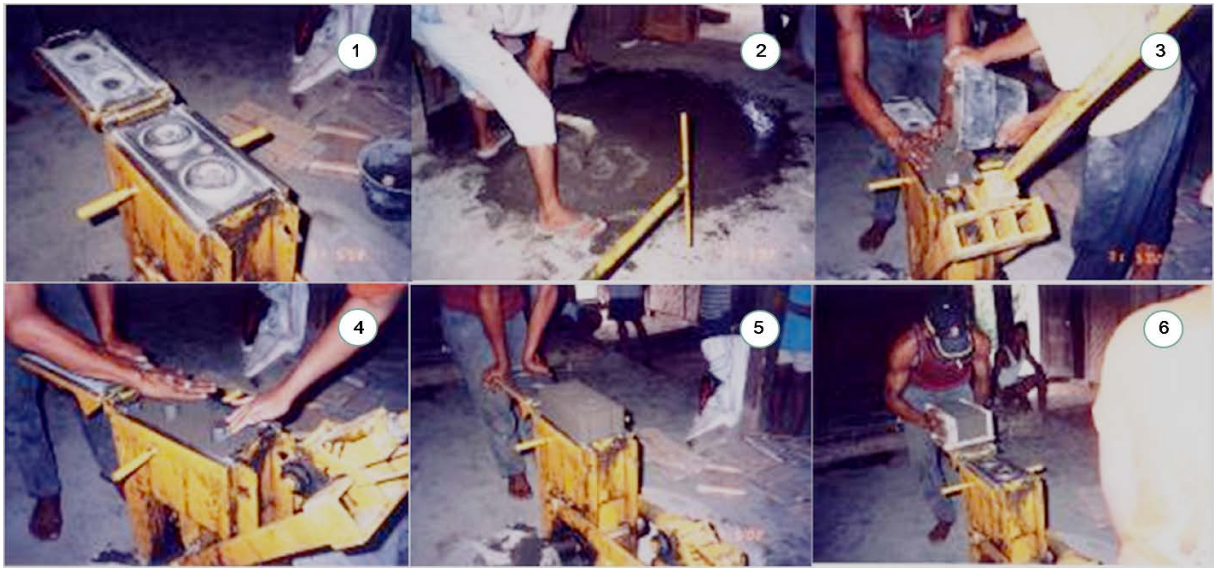

Figure 6. KOBEL brick making process

2.3. Easy and Cheap Use of KOBEL Bricks

Appropriate technology of interlocking bricks was developed to provide low-cost building materials [24]. This research related to interlocked soil pressed bricks was carried out since 1996, 1999 and 2002. Then it began to be integrated with a rainwater management system to meet low-cost materials for rainwater management building infrastructure [25]. This technology is also environmentally friendly and an ecological building material [26].

This soil pressed brick is not only used for the construction of houses, but also for the construction of civil infrastructure such as rainwater catchment ponds [27] and other civil buildings [28]. In its development, this soil pressed brick was given the name KOBEL brick [29]. This technology system has also been applied in infrastructures such as clean water distribution funded by CSR-BNI funds in community participation in the village [30]. Finally, this system was applied in the arrangement of the library garden in the Serut hamlet Palbapang [28].

KOBEL brick is an alternative building material to the common brick and is applied to the building construction. It doesn't require finishing like stucco anymore because it's already interlocked, with an instantly neat appearance. This aspect makes the use of KOBEL bricks cheaper and easier to assemble. The use of local soil with a little improvement in the base material, also makes it easier and cheaper to produce these KOBEL bricks [31]. The production process of KOBEL bricks is described as in Figure 6.

The local soil was filtered using a 5 mm sieve, then mixed with a little cement (ratio of 1 cement: 8-10 parts of soil) in dry conditions. Furthermore, the soil that has been

mixed with a little cement is moistened with water that is poured gently, to a certain moisture limit. Then this moist soil is put into the KOBEL brick mold which is ready to be pressed manually and the result is removed for slow maintenance (airing).

The KOBEL brick production process shown in Figure 6, starting from the notation of Figure 1 on the top left up to 6 is in the form of: 1. KOBEL brick press tool; 2. the process of mixing soil with cement; 3. put the soil ready to be pressed into the KOBEL brick press tool; 4. tidy the mixed soil and ready for pressing by pulling the pressing handlebar; 5. raise the pressed brick by pulling the handlebar in the opposite direction; 6. lift the resulting brick with 2 auxiliary boards so that it is not damaged to the next treatment area.

3. Conclusion

KOBEL bricks can be used to overcome the subsidence of the soil due to the movement of water in the soil, by arranging them obliquely so that they function as a flow of water movement.

KOBEL bricks made of soil-based materials that pressing up to 62.5% as soil improvements, so that the soil surface becomes stable and does not subsidence again.

The use of KOBEL bricks is also very easy to do and requires very low costs.

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