CHAPTER II

LITERATURE REVIEW

2.1. Literature Review

Indonesia is a huge nation, ranging from Sabang on the west to Merauke on the east, Miangas Island on the north to Rote Island on the south, and with total land area of 1,913,579 km^2, Indonesia is the greatest archipelago nation (Badan Pusat Statistik, 2017). Indonesia ranked on the fourth in world most populated country, and it is a home to approximately 237 million people (Badan Pusat Statistik, 2010). Nowadays Indonesia is still considered as a developing country, and Indonesian government realize that in order to be able to compete with other developing and developed country it is necessary to boost nation's infrastructures.

Infrastructures are mainly built on the soil, whereas in Indonesia there are so many type of soil. Problem arouses when infrastructures are built on top of problematic soils. Losses due to infrastructure's maintenance caused by problematic soils in USA are surprisingly higher than all-natural hazards that occurs in a year combined (Jones and Holtz, 1973). In order to avoid such huge losses and ensure Indonesia's economic growth several engineering applications needed to be taken.

Problematic soils are the soil that causes additional problems from the engineering point of view as a result of the circumstances of its

composition or a change in environmental conditions, and it needed to be treated in order to be functional (Saad, n.d.). It includes soft clays, soft clay categorized as a fine-grained soil which its volume will undergo changes when deformation and consolidation occurs. Clay also defined as a disturbed cohesive soil (Koa, 2016). Soft clay soil also defined as saturated clay soils that have low values of shear strength, coefficient of textures, high compressibility, high secondary compression value, and creep behaviour.

Clay with expansive content will undergo large changes in its volume depends on the amount of water contained in the soil voids, such soil will experience cracking when dried season came and will expand dramatically when in contact with the water. Due to that characteristic of the soils, it is highly unlikely to construct a structure on top of it (Karatai et al., 2017). According to Karatai et al. (2017), clays especially clay which has expansive material commonly characterized as high compressibility, low shear strength, and high swelling potential. In order to overcome those problem, soil improvement is needed for the clays.

Soil improvement is one of many engineering applications to improve clays strength. Soil improvement or soil stabilization is the process of blending and mixing materials with a soil in order to improve the soil's strength and durability. The process may include blending soils to achieve a desired gradation or mixing commercially available additives that may alter the gradation, change the strength and durability, or act as a binder to cement the soil (Department of the Army, 2001).

Nowadays soil improvements are yet to be considered as an effective solution toward the problematic soil that encountered in project site's. Due to the scarcity of raw materials or additives that are common used in soil stabilization, many researchers carried out their soil stabilization with waste material, commonly industrial by-products (Moon et al., 2009; Khandaker, 2011). According to Horpibulsuk et al., (2013) "in order to improve economic and environmental impacts, waste with rich $Ca(OH)_2$ or SiO_2 content could be mixed with waste with pozzolanic materials, such as fly ash, biomass ash, and rice husk ash to develop cement-like material". Nowadays soil improvement with waste materials are quite popular topics among geotechnical engineers. Soil improvement will only effective both environmentally and economically if the waste material could be obtained locally and nearby the project area.

Rice husk ash (RHA) is the by-product from brick's factory combustion, rice husk is easily found in D.I. Yogyakarta area due to. According to Saepudin (1996), "rice husk ash is an abundant waste product and it has the potential to improve the strength of the original material, in this case it could be soil or concrete". Although rice husk ash has a rich SiO_2 and act as a pozzolanic material, it can't be used independently.

CKD is a by-product from cement industries, since CKD is considered as a waste material and the amount of CKD is stockpiled abundantly. On the other hand, CKD has self-cementing characteristics that allows CKD to react with soil in a manner similar to Portland cement

(Khandaker et al., 2011). Khandaker et al., (2011) also reported RHA-CKD stabilized soil exhibit enhanced mechanical properties. Chang and Cho (2012) stated that usage of cement as a soil stabilizer will lead to another economical problem for particular country since the resource for cement are limited and will cost more than CKD. For that reason, cement kiln dust (CKD) will act as a binder and replacement for cement.