Timber as a Pavement Construction Material: Design and Application

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Abstract. Roads are one of the most important infrastructure to increase economic growth, accelerate the flow of goods and communication between regions. Therefore, in building road infrastructure it is necessary to pay attention to using materials which appropriate the specifications. Limited pavement materials in an area or region is one of the problems faced by government. It is causes that very important to looking for replacement material that can be used to overcome the problem of material limitations. This study use Bus timber as a substitute material for aggregate in subbase course. It is considerate that Bus timber is often used in timber bridge construction. Bus timber will be made as a raft foundation. At the end of this study, the expected result is that bus timber can be used as pavement material especially for subbase course.

1. Introduction

The development of transportation infrastructure, especially roads, is an important part of national development. Because the availability of road infrastructure can significantly increase productivity and economic growth, absorb labor and create new jobs so that it can help reduce poverty. In addition, access to remote areas can be reach so it can provide opportunities for local communities to the business world. However, road infrastructure development cannot be separated from various challenges, such as geographical conditions and climate change, as well as material limitations [1]. The existence of extreme climate change greatly affects the conditions of the pavement. Each region has a different rainfall. High rainfall that falls on the pavement can damage the pavement layer and make short the pavement service life. Delays in handling road damage can causes high maintenance costs and investment costs.

The construction of new roads especially flexible pavement, takes a large amount of both asphalt and aggregate materials. However, the limited material for road pavement, in this case the aggregate, becomes a separate problem because of the material must be imported from other places or outside the region, thus resulting in expensive material costs [2]. Moreover, the price of concrete work is very expensive [3]. Several studies that using geosynthetics as a road pavement material have been carried out. Many experimental have been performed to evaluate the benefits of using geosynthetics. Using geogrids can extend the service life of pavement [4]–[7]. It is also can reduce permanent deformation [6], [8]–[12], and reduce the thickness of base course [13], [14], and also geogrid can decrease the rutting [15]–[17]. However, these materials are fabricated and expensive material. So it is necessary to
find another materials as an alternative substitute especially for subbase course. Timber is known as a renewable material which it available in large quantities in nature. It has different values for strength and durability. It can be used as a pavement material. This research aim to used timber as a substitution material for subbase aggregate in flexible pavement.

2. Methodology

This research is an experimental study that is divided into two parts, in the laboratory and in the field. Some of the tests that will be carried out in the laboratory include aggregate testing, asphalt testing, soil characterization, and compressive strength testing and flexural test for timber. In this paper, it discusses field testing consisting of making a model of the timber bus raft structure. The part of the pavement structure model was built in the field with dimensions of 14 mx 3.5 m 0.06 m, with a length of 7 meters for pavement with a timber raft foundation and 7 meters without a timber raft.

In this study, the design of the bus timber raft construction model that will be used as the subbase on the flexible pavement can be seen in Figure 1. The raft will be placed on subgrade layer as shown in Figure 2.

![Top view](image1.png)

![Front view](image2.png)

![Side view](image3.png)

**Figure 1.** Design of timber raft construction
3. Result and Discussion

Timber can be used as a road pavement material, where the wood is made into raft construction. The application of timber raft construction on flexible pavement is presented in Figure 3 and Figure 4. The mechanism before the bus timber raft is installed / placed on the subgrade, first subgrade to be used must be compacted using a soil compaction machine, such as a stamper machine, then digging ± 15 cm deep on the right and left side as a place to enter the timber raft poles. Then, the bus logs are assembled into a raft construction and the gap between the timber assemblies is covered with soil to cover a layer of timber 2 cm thick which functions to level the surface before being given a mixture of soil cement on it. Bus timber is arranged layer by layer to three layers, and becomes a timber raft. The timber raft construction that is placed on the top of the subgrade serves as a subbase as shown in Figure 3. The selection of timber that is installed must have no curves so that the bus timber raft installation process is arranged tightly and solidly with the ground so that when it is compacted on the top layer surface it will be more sturdy and stable.

Figure 3. (a) compacted subgrade; (b) first layer of raft timber; (c) raft timber with three layer; (d) raft timber construction
Furthermore, the soil is placed on a 20 cm thick raft construction and mixed with Portland cement, then compacted using a vibrator roller as shown in Figures 4 (a) and 4 (b). If the cement soil layer has been installed, then proceed with the prime coat work of the asphalt on the main layer before the bearing course (Figure 4c). Then the penetration layer work uses an aggregate of 3-5 cm and 2-3 cm in size which has been mixed and then doused with hot asphalt and sprinkled 1-2 cm of aggregate and compacted using a tandem roller. The top layer is poured with hot asphalt with a sprinkling of 0.6 cm of aggregate and rock ash with a more complete compaction (Figure 4 d). The flexible pavement with the design of foundation layer using the timber bus raft construction as subbase has been used by the community in the Musamus University, Merauke.

4. Conclusion
This paper proposed a new concept for a flexible pavement structure using timber as subbase layer. The timber is made as raft foundation and placed on the subgrade. This concept can minimize the use of aggregate and cement in large quantities, overcome material limitations, and minimize road pavement construction costs. It is also can increase the use of local materials. It is expected that the construction of timber raft can improve the performance of pavement flexible structures.

Acknowledgment
I would like to say thanks to everybody who provides support, therefore the research could be finished. Special thanks for the facilities provided by Rector of Musamus University, Merauke. And
also thanks to Dean of faculty of engineering and Rector of Diponegoro University, Semarang – Indonesia.

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