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Experimental Study on Precast Buton Asphalt Pavement Panel Strengthened with Geogrid

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ABSTRACT

Precast *buton* asphalt panels having the same characteristics with the characteristics of the massive asphalt can be used as an alternative method for the use of the asphalt pavement as an effort to simplify and reduce of implementation errors, so that it can increase the attractiveness of the use of buton asphalt. The experimental programs were conducted at the Civil Engineering Laboratory, Hasanuddin University. Testing of materials namely asphalt, coarse and fine aggregate were conducted to obtain the characteristics of each material. The next phase of the tests was carried out on various mixtures of the mix asphalt concrete (AC-WC) to obtain the optimum bitumen content to be used for determining the panels. Testing on panels with the size of 40 x 30 cm with a varying thickness was conducted at the final stage. The experimental results show that the use of *geogrid* is able to raise the buton asphalt panel's ability to withstand a static load and increase the flexibility of the panel. The most effective panel was found for a panel with a thickness of 5 cm. It can not only increase the maximum static load bearing capability but also increase in the maximum deflection before collapse

Keyword: Buton Aspal, Precast, Panel, Geogrid

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1. Introduction

Buton asphalt or called Asbuton, is a natural asphalt of Buton Island with the largest deposits in the world when compared to other natural bitumen deposits, is also one of Indonesia's natural resources potential as an ingredient mix asphalt pavement. Utilization of Asbuton on the pavement has long been encouraged by the Government of Indonesia for both asbuton deposits in Kabungka (Asbuton of deposits in the District Kabungka) or Asbuton Lawele derived from Lawele District of Buton. However, the use of asbuton has not been very good as previously expected because of failure in the implementation due to several factors such inconsistency or uniformity quality, equipment factors, accuracy of mix design, as well as quality control in the field. Due to the poor quality of the asbuton pavement, sometime the pavement has to be removed or destroyed before reaching the designed age. With so many failures the implementation of the field and price competition compared with asphalt oil when the price of crude oil in normal conditions is almost equal, then make Asbuton less desirable for use as road pavement material.

Hot asphalt mixture is hot asphalt, which partly replaced by hard asphalt bitumen Asbuton, When used Buton Bitumen from Kabungka the mineral Asbuton besides replacing some asphalt also serve as fine aggregate and increase the percentage of filler. However, when used Buton Asphalt asbutonLawele then functions only as a substitute for oil asphalt. Asbuton used is asbuton with a maximum grain size of 2.36 mm (escape sieve no. 8).

Asbuton as natural asphalt when used for hot mix asphalt must have been conditioned so they can go in and mixed well with the aggregate and asphalt oil, to be used as ingredients added before processing should be done first. MadiHermadi (2008), states that based on studies in laboratory Specifications Hot Asphalt Mixture AsbutonLawele to note are as follows:

a. Aggregate nature and properties of the mixture referring to the requirements of Hot Asphalt Mixture in general.
b. AsbutonLawele used for Hot Asphalt Mixture is AsbutonLawele that are processed or conditioned in such a way (fabrication) that AsbutonLawele have homogeneous properties and meet specific requirements.
c. LaweleAsbuton requirements should be such as to accommodate the processing of simple ways that inexpensive yet quality AsbutonLawele ensuring compliance with the desired quality of pavement that has a shape that is easy to apply and produces a mixture with good characteristics.
d. At Asbuton processing Lawele light oil is not removed entirely but rather only until a bitumen with a penetration of 60-79 dmm value. Thus, processing is simpler than having to spend the whole light oil. In addition, because it has a value of 60-79 dmm penetration bitumen, or is equivalent to the value of the penetration of petroleum asphalt for pavement pen 60, then the views of the value of penetration in principle bitumen asphalt AsbutonLawele could substitute oil to 100%.
e. To anticipate dryness bitumen AsbutonLawele due to the evaporation of light oil remains, both upon heating in Unit Mixing Asphalt (AMP) as well as during isntalled until the service will be limited bitumen AsbutonLawele after weight loss with Thin Film Oven Test (TFOT), which means after the light oil is lost, should have a penetration that is still decent value for pavement that is the minimum penetration 40. This limitation refers to the requirements of Natural Asphalt Modified Asphalt with the limit values and the penetration of 40-55 dmm Pure Asbuton requirements to limit the penetration of 40-60 dmm value. If the value is not achieved or the penetration bitumen AsbutonLawele after TFOT lower than 40 dmm, it will be added to asphalt to meet the requirement and also become the benchmark levels LaweleAsbuton maximum. While AsbutonLawele

optimum levels will be determined after reviewing the donations also mineral AsbutonLawele into the mix gradation.

f. To facilitate the implementation of the mix design with Marshall procedure and to safeguard the fulfillment of the criteria of filler to bituminous ratio, AsbutonLawele will be pegged at certain levels (according to the results of the study of the properties of bitumen and grading) while to get the binder content in total optimum, which varied are the levels of tar oil added.

g. In order not to complicate the implementation of the field, which is used LaweleAsbuton products required to be in the form of grains so easily supplied into Pugmill in AMP through the silo filler or through a special bin. The maximum grain size should also be certain that mixing times faster than AsbutonLawele form large clumps.

In general, the road pavement can be classified into three major categories, namely: flexible pavement, rigid pavement, composite pavement. For rigid pavement systems is currently not only used on site or treated in the workplace, also used the system off site called precast. The advantage of the use of this method are: saving time implementation, manufacturing precast panels will ensure the consistency of the mix and raise the level of quality control, economic benefits obtained, and the road can be immediately used by the public. Besides, it also saves maintenance costs and other extra costs during the construction process.

With the various advantages of using precast concrete for pavement, then it certainly can be applied also to the asphalt pavement. Buton asphalt with a panel that made ofoff site, the expected gains in the use of precast concrete also occurs in models of panel precast asphalt used as road pavement. Moreover, it can encourage the use of Buton asphalt for road pavement.

Geogrid is one type of geosynthetic materials that have woven a large hole and stiffness better than Geotextile. Geogrid base material arePolyphropylene, Polyethylene, Polyesther, or other polymer material. Geogrid can serve reinforcement in pavement layers. With the " woven hole' relatively large (1-4 cm), Geogrid can lock the aggregate between "hole" which can increase the rigidity of the aggregate layer. The main function of the geogrid reinforcement is to strengthen the aggregate layer to provide a high tensile strength values at low strain value and to limit the aggregate layer so it will not move in the lateral direction so as to reduce the magnitude of the radial strain on the asphalt layer. This condition will certainly extend the service life of the pavement structure.

Ability geogrids provide tensile strength to the layer of asphalt concrete can also be done by testing the asphalt concrete beams were given concentrated static load continuously until the collapse of the asphalt concrete beam. The use of static load in this test to simulate the load of a vehicle that was stopped. At the time of receiving the asphalt concrete beams concentrated load, the lower beam section will receive a tensile stress. Tensile stress that occurs will be retained by the geogrid is installed at the bottom of asphalt concrete beam section. Geogrid tensile strength and shear strength between the geogrid and asphalt concrete will serve withstand tensile stress occurs in the lower beam section. Difference maximum load at the time of the collapse of the asphalt concrete reinforced with geogrid with asphalt concrete without reinforcement geogrid is the ability to withstand tensile stresses that occur at the bottom of asphalt concrete face. This test can also be used to determine the maximum deflection which can occur in asphalt concrete before the collapse due to vertical load.

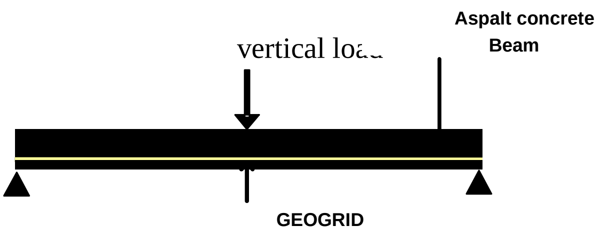

Figure 1. Scheme of Testing Capabilities Asphalt Pavement Materials

On previous testing by Moussa 2003 in Sri Widodo, et al (2012) have examined the asphalt concrete reinforcement using geotextile. The test object is asphalt concrete beam consisting of two layers of asphalt mix each 4 cm binder course and 4cm surface course. Asphalt concrete beam size is 60 x 8 x 8 cm. The test object is made of 4 models, each of which is as follows:

Model 1: without reinforcement
Model 2: with geotextile lining amid the binder course,
Model 3: between the binder course and surface course,
Model 4: in the middle of the surface layer of course.

Tests carried out at a temperature of 20 ° C. The three-point bending test system tests the static load speed of 12.7 mm / min comes amid landscapes with Geotextile Marshall tool that is used as a reinforcement of the type without the characteristic webbing with weight of 350 grams / m2, 4 mm thick, aperture of 0.106 mm, and a tensile strength of between 850-1500 N / m.

The results showed that the use of geotextiles as reinforcement provide maximum load greater when compared with that without reinforcement geotextile. Location of geotextile at the bottom who are in the middle layer of binder course provide the most substantial strengthening, so the location of the geotextile can be said to be the most optimum.

Traffic load will cause the layer of asphalt concrete pavement flexible. By the time the bottom sagged at the bottom of the road pavement structure will occur tensile and compressive stress on the top of the pavement. Layer of pavement will be back again to its original position after moving vehicle wheel load. Giving tensile strength can be done with the installation of geogrid at the bottom of the asphalt concrete pavement that will provide resistance to tensile stresses that occur on pavement while receiving traffic load. The resistance provided by the geogrid will reduce bending at the pavement when receiving the load wheel so as to increase the strength of the static load and the load receiving moving.

Vertical pressure caused by the load wheels of the vehicle will cause geogrid which sagged under the wheels of the vehicle. Tensile stress geogridgeogrid position will restore to its original position, resulting in resistance to shear force generated by the load wheels of the vehicle. Tensile modulus geogrid will greatly affect the ability to maintain the pavement ruts vehicle (Widodo, Sri, 2012).

Based on the above-mentioned to think about ways of implementing flexible pavement Buton asphalt is simple and does not require much equipment, as well as implementing the expert, but still ensuring compliance with the quality of the desired quality of the pavement and has a shape that is easy to apply. Furthermore Asphalt pavement is also utilized as a mixture Buton additional efforts to increase its use in flexible pavement.

For this purpose need experimental studies of a model of Buton asphalt pavement type precast panel with geogrid reinforcement as efforts to develop new innovations in the construction of the road surface with a material layer Asbuton.

2. Research Method

The research was a purely experimental research in the form of laboratory studies. Research was conducted in the laboratory of Transport Engineering Department of Civil Engineering, Faculty of Engineering, University of Hasanuddin Makassar. The materials used in this study include:

Coarse aggregate, derived from rocks Ex. Bili-Bili Gowa. from the stone crusher owned by PT Cipta Pratama Garungga South Sulawesi.

Fine aggregate using river sand from Jeneberang Gowa in South Sulawesi.

Stone dust from Batu Ex. Bili-Bili Gowa. from the stone crusher owned by PT Cipta Pratama Garungga South Sulawesi

Lawele Granular Asphalt (LGA) used as a mixture is produced from PT. Buton Asphalt Indonesia (PT BAI) Lawele Asphalt from Buton Buton in Southeast Sulawesi.

Bitumen Pertamina asphalt with penetration 60/70.

Biaxial geogrid produced by E'Grid of Geoforce Indonesia (www.geoforce-indonesia.com).

Use hot asphalt mixing system Asphalt Concrete - Wearing Course (AC-WC) with a guide The Asphalt Institute (1997) Superpave Series No. 1 (SP-1) which is the basis of the construction of highways and widely used by DGH. Whereas testing standards used in part using a standard issued by the Asphalt Institute (1997) Superpave Series No. 1 (SP-1) but most adopt of methods validated or standardized by ISO Highways form. Most of bitumen can be substitution of asphalt in the asphalt mix concrete.

In the tests carried out in stages, consisting of initial testing to determine the optimum bitumen content in order to obtain a mixture of asphalt mix design. From this initial test was obtained the optimum bitumen content of 6.5% by laweleButon asphalt content of 10%. Furthermore, the composition of the mixture is made model of panel size 40 x 30 cm and compacted / pressed to obtain optimum density according to initial testing. The model consists of two types, reinforced with geogrid and are not reinforced with geogrid. Furthermore, both types of test specimens were tested to determine the static load deflection and strain that occurs.

A. Equipment

Equipment used for testing precast panel consists of: Panel Molding Apparatuswith compacting equipment; Universal Testing Machine (UTM) is a testing machine to test the tensile and compressive strength of the material; Linear Variable Differential Transformers (LVDT), used 6 pieces LVDT to measure the deflection. Theequipmentsare connected to a computer so that it can be read directly load and deflection value; TDS 7130, is aequipment for recording the measurement data LVDT connected directly to the computer.

B. Testing Material

The model measuring 40 cm X 30 cm, with varying thickness is 4 cm, 5 cm and 6 cm. Consisting of panel without reinforcement geogrid, and a panel with geogrid reinforcement. In this study, for panels with reinforcement geogrid material geosynthetic is placed in the bottom panel of the idealization of conditions in the field as well as with reference to the experiment Moussa (2003) that the location of the geotextile at the bottom who are in the middle layer of binder course provide reinforcement greatest.

C. Testing Procedure

Testing of materials, including, asphalt Buton, Coarse and Fine Aggregate to obtain the characteristics of each material. The next test for various mixtures of the mix asphalt concrete (AC-WC) to obtain the optimum bitumen content as a guideline in the create of test specimens of asphalt panel; Creating a sample model of panel size 40 x 30 cm with a thickness varying; Putting the sample in the position that has been set mileage; Installing a TDS LVDT connect with tools that have been associated with computer; Using software TDS 7130, then the contents of commands that should be included in it, as required; Run UTM instrument to do the reading on TDS software to stop providing UTM appliance load.

3. TEST RESULT

Before the main testing, initial testing has been performed which showed that the aggregate to be used as a mixture of asphalt complies with SNI. The characteristics tested included examination of density, gradation, flakiness, material hardness, water absorption. The overall characteristics of the material complied with the standard. Optimum Asphalt levels gained 6.5% with the content of Buton Asphalt Lawele 10%. based on asphalt mix designs created panel size 40 cm x30 cm with and without reinforcement geogrid.

Testing of panels carried out for several conditions: without geogrid, and with geogrid with the panel thickness of 4cm, 5cm and 6cm, respectively. The result of testing can be seen in Table 1 which shows that additional reinforcement can increase the ability to withstand loads. For panel 4 cm, the increase was 122.22%; 5 cm thick panels increased 133.71%; and 6 cm thick panels increased 109%. When compared to the three of thickness, 5 cm thick panels have a higher increase than the panel with a thickness of 4 cm and 6 cm.

Similarly, when viewed from panel's deflection with a thickness of 5 cm then the panel without reinforcement and panels with geogrid has a greater deviation than the other two samples. That shows the effectiveness of geogrid to increase the ability of asphalt deflection due to static load on the sample panel 5 cm thick were higher compared with the sample thickness of 4 cm and 6 cm.

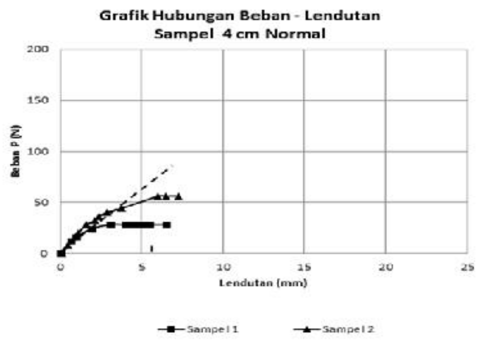

Fig.2. Load-Deflection Relationship Graph

Figure 2 shows the relationship between load (P) and deflection (δ) for a panel of 4 cm without reinforced with geogrid position at the mid span. It appears that up to 32 N load to the deflection 0-5 mm in a linear relationship. At this point the relationship obtained stiffness with load and deflection. After loading 32 N or 57,14% of the maximum load seen values rise deflection becomes insignificant.

Figure 3 shows the relationship load (P) and deflection (δ) at mid span. It appears that up to 110 N loads with a deflection of 5 mm linear relationship. At this point the relationship obtained stiffness with load and deflection. After loading 110 N or 59.78% of the maximum load seen values rise deflection becomes insignificant.

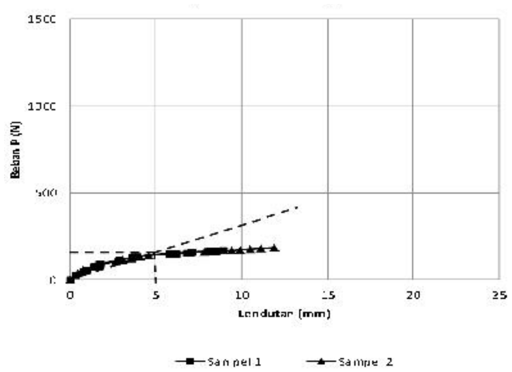

Fig.3. Load-Deflection Relationship Graph Panel 4 cm With Geogrid

From the graph it can be seen panels 4 cm thick asphalt when reinforced with geogrid at the elastic position will increase the strength to withstand a static load of 32 N to 110 N, up 243.75%. While the deflection on the position of the elastic material is 5 mm maximum.after passing the elastic phase has no effect then adding progressively load against deflection and samples already showing cracks.

Figure 4 shows the relationship load (P) and deflection (δ) at midspan. Look that up with a load of 310 N 0 -5 mm deflection linear relationship. At this point the relationship obtained stiffness with load and deflection.

After loading 310N or 70.77% of the maximum load seen values rise deflection becomes insignificant as well as samples of collapse.

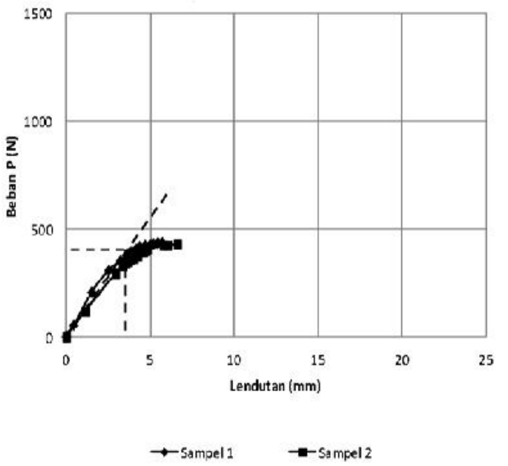

Fig.4. Load-Deflection Relationship Graph Panel 5 cm Without Geogrid

Figure 5 show the relationship load (P) and deflection (δ) at midspan. Look that up with a load of 519.2 N 5-10 mm deflection linear relationship. At this point the relationship obtained stiffness with load and deflection. After the imposition of 519.2 N or 60.02% of the maximum load seen values rise deflection becomes insignificant as well as samples of collapse.

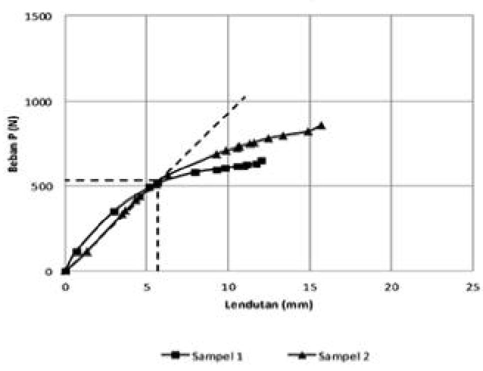

Figure 5. Load-Deflection Relationship GraphPanel 5 cm Without Geogrid

Five cm thick panel testing showed that the panel without geogrid reinforced with the result that for the linear relationship and the magnitude of the deflection static load is 310 N while the panel reinforced with geogrid be 519.2 N or an increase of about 67.5%. That matter shows that the elastic limit of the panel asphalt is 310 N and up 67% limit until the elastic load of 519.2 N. However, for samples reinforced with geogrid able to increase the strength of the material until the load 936.40 N before the sample is damaged. Furthermore, despite the added expense but the deflection is not linear anymore and samples are already visible cracks and the maximum load a sample ofcollapse.

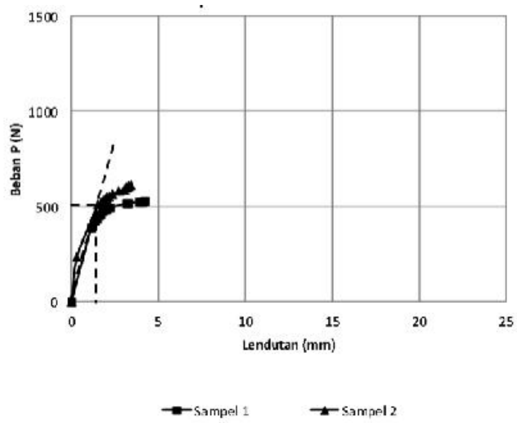

Figure 5. Load-Deflection Relationship Graph Panel 6 cm Without Geogrid

midspan to 6 cm panels without geogrid reinforced as shown in Figure 5 that up to a load of 500 N with a deflection of 0-5 mm in a linear relationship. At this point the relationship obtained stiffness with load and deflection. After loading 500N or 94.16% of the maximum load seen values rise deflection becomes insignificant.

Figure 6 shows the relationship load (P) and deflection (δ) at midspan. Look that up with a load of 976 N 5 -10 mm deflection linear relationship. At this point the relationship obtained stiffness with load and deflection. After loading 976N or 96.82% of the maximum load seen values rise deflection becomes insignificant.

When compared from the two samples in a linear relationship, the visible improvement of the capability for deflection to sample panels reinforced with geogrid. Without reinforcement deflection occurs is 500 N, while the geogrid 976 N, an increase of

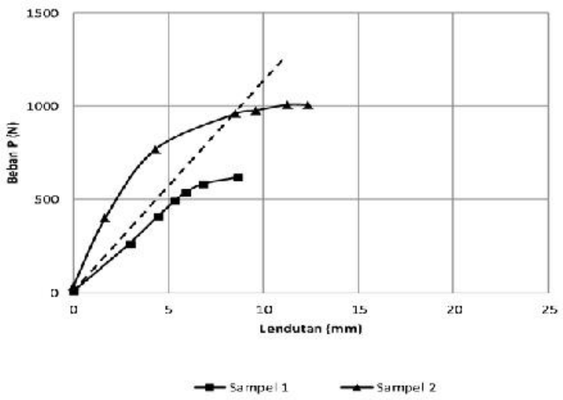

Figure 6. Load-Deflection Relationship GraphPanel 6 cm With Geogrid

95.2%.

Of the overall test results show that a thickness of the asphalt affect the load bearing capability. The thicker of asphaltlayer, the greater the load that can be accepted by the asphalt layer. It can be seen from the data that is generated on a deflection test table where averageof value P max sample with a sample thickness of 4 cm, 5 cm and 6 cm queried sequence is equal to 84 N, 400.67 and 554.67 N N.

The test result also showed that addition of geogrid in asphalt layers can improve the ability to accept larger loads, because the flexibilityof geogridcan maintain the position of the layer when it receives load. The percentage increase between the samples of 4 cm compared 4 cm + Geogrid amounted to 122.22%, while the percentage increase between the samples of 5 cm compared 5 cm + Geogrid amounted to 133.71%, and the percentage increase between the sample 6 cm compared 6 cm + geogrid is equal to 109.63%.

4. CONCLUSION.

With the results of experimental test of the model of precast panels Buton Asphalt pavement, it can be concluded that further increase of the layer thickness will decrease the deflection, because the level of flexibility of a aspalt layer decreases with the increase of the thickness of a layer.

Geogrid is able to increase the Buton asphalt panel's ability to withstand a static load. This will be very beneficial when associated with the real conditions in the field where the pavement if often loaded with static load from wheels' load of vehicles that are parked or load of the panel itself while in the process of transporting and stacking.

The most effective geogrid is installed on a panel with a thickness of 5 cm. It shows an increase in the maximum of static load bearing capabilities as well as an increase in the amount of deflection before the collapse.

Table.1. Results of Static Load Testing and Deflection

No	Sample	P Max	Deviation	Deflection Max	Deflection Max	Deflection Max
		N	%	Left Span	Middle Span	Right Span
1	4 Normal	84,00	122,22%	3,90	5,90	3,35
2	4 + G	186,67		6,49	10,97	7,90
Deviation				66,36%	85,85%	135,93%
3	5 Normal	400,67	133,71%	4,00	5,66	3,46
4	5 + G	936,40		11,25	16,51	10,84
Deviation				181,59%	191,58%	213,80%
5	6 Normal	554,67	109,63%	3,58	4,67	3,66
6	6 + G	1162,77		8,62	13,28	9,35
Deviation				140,67%	184,59%	155,36%

Normal = Panel Without Geogrid Reinforcement; G = Panel Reinforced with Geogrid

Buton asphalt panels with the same characteristics as the characteristics of a massive expanse of asphalt can be used as an alternative method of implementation of the asphalt pavement as an effort to reduce error in the field implementation and can increase the attractiveness of Buton aspalt use.

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