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Repair analysis of Pinang Bridge oprit subsidence with mortar form using LISA FEA

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Abstract

Mortar foam is one of the best alternatives to embankment soil, with a smaller load and very fast work, the use of this technology has been applied in several locations with small soil bearing capacity and requires time and cost efficient repairs, foam mortar has been used under construction of a road in Central Kalimantan and is still in good condition. This research was carried out to make improvements with the help of the Finite element method software using LISA FEA V.8. It may offer great information in calculating the stress levels that happen in the elements examined linearly and nonlinearly when examining the behavior of elements. For the selection of a very good oprit material, it tends to use mortar foam material because the material has contributed significantly to the carrying capacity of the oprit where from the deformation analysis and also the stresses that occur, the mortar foam material provides a fairly small deformation.

Keywords: *Deformation, FEM, LISA, Mortar foam, Stress.*

Abstrak

Mortar foam merupakan salah satu alternatif terbaik untuk tanah timbunan, dengan beban yang lebih kecil dan kerja yang sangat cepat, penggunaan teknologi ini telah diterapkan di beberapa lokasi dengan daya dukung tanah yang kecil dan membutuhkan perbaikan yang hemat waktu dan biaya, telah digunakan mortar foam sedang dalam pembangunan jalan di Kalimantan Tengah dan masih dalam kondisi baik. Penelitian ini dilakukan untuk melakukan perbaikan dengan bantuan software metode elemen hingga menggunakan LISA FEA V.8. Ini mungkin menawarkan informasi yang bagus dalam menghitung tingkat stres yang terjadi pada elemen yang diperiksa secara linier dan nonlinier ketika memeriksa perilaku elemen. Untuk pemilihan material oprit yang sangat baik cenderung menggunakan material mortar foam karena material tersebut memberikan kontribusi yang cukup besar terhadap daya dukung oprit dimana dari analisis deformasi dan juga tegangan yang terjadi, material mortar foam memberikan daya dukung yang cukup kecil. deformasi.

Kata kunci: Deformasi, FEM, LISA, Mortar busa, Stres.

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1. Introduction

Mortar foam is one of the best alternatives to embankment soil, with a smaller load and very fast work, the use of this technology has been applied in several locations with small soil bearing capacity and requires time and cost efficient repairs, foam mortar has been used under construction of a road in Central Kalimantan and is still in good condition.

One of the current trends in the building industry is to utilize mortar foam as a great substitute for the top layer of foundation. Mortar foam is commonly used in construction applications because of its low thickness and considerable effectiveness [1].

the occurrence of floods that hit Sangatta District, East Kutai Regency which resulted in a subsidence on the Pinang bridge oprit which became the only access between cities and provinces in East Kalimantan. The occurrence of this subsidence resulted in the inaccessibility of the bridge to be crossed due to a very deep subsidence of about 3 meters.

After conducting a detailed examination at the scene and identifying the problems that occurred, this study was carried out to make improvements with the help of the Finite element method software using LISA FEA V.8.

The use of FEM software to facilitate modeling and is also more time and cost efficient in conducting analysis, but requires detailed and basic parameters in the modeling carried out.

LISA FEA V.8 may offer great information in calculating the stress levels that happen in the elements examined linearly and nonlinearly when examining the behavior of elements [2]. In addition to model validation, numerical investigations have showed how this model is used in engineering practice to address issues such vehicle-induced vibrations from continuous welding rail (CWR) [3].

Figure 1. The sinkhole that occurred on the oprit bridge.

This research was conducted to get a description of the behavior that occurs in the selected embankment replacement material into mortar foam material, in the modeling using finite element method software LISA FEA V.8, the use of this software is so that researchers can develop several possibilities that can be seen when each parameter of the model is made different according to with applicable standards.

2. Research Method

The research was conducted by visually identifying problems that occur in the field, collecting field data, and modeling problems in the finite element method software LISA FEA V.8 with material parameters from the results of field identification references and also several previous studies.

2.1. Mortar Foam

Concrete with a heavy aggregate volume equilibrium density of between 1140 and 1840 kg/m3 is known as mortar foam. The benefits of concrete include its ability to withstand compressive forces well, its properties that are resistant to corrosion and decay by environmental conditions, the ease with which fresh concrete can be molded to a desired shape, the mold's ability to be reused multiple times to reduce costs, the ability to spray fresh concrete on the cracked surface of old concrete or to fill in the cracks during the repair process, and the ability to pump fresh concrete so that it can be poured into places. A composite material made of cement, foaming agent (liquid foam), and other materials[4], [5].

Samples made using a local cleaner had a 28-day compressive strength range of 4.07 to 4.82 MPa. It is clear that every detergent mix design presented in this exploratory study produced a compressive strength that was significantly higher than the minimum requirement of 1.38 MPa outlined by ASTM Specifications C796-04 and C 869-91. Examples placed with local detergent modified in set thickness from 865 to 960 kg/m3 [6].

Compressive strength based on (ASTM C39/C39M).

Table 1 Compressive strength and splitting tensile strength requirements

Calculated equilibrium density maks, kg/m^3 (lb/ft^3)	**Average 28-days splitting tensile strength min, MPa(psi)**	**Average 28-days compressive strength min, MPa(psi)**
All lightweight aggregate		
1 760 (110)	2.2 (319.083)	28 (4061.06)
1 680 (105)	2.1 (304.579)	21 (3045.79)
1 600 (100)	2.0 (290.075)	17 (2465.64)
Combination of normal weight and lightweight aggregates		
1 840 (115)	2.3 (333.587)	28 (4061.06)
1 760 (110)	2.1 (304.579)	21 (3045.79)
1 680 (105)	2.1 (304.579)	17 (2465.64)

Source: SNI 2461:2014.

2.2. Finite Element Method

A mathematical strategy for handling complex examination concerns is the finite element method (FEM). The restricted component approach combines a few numerical concepts to establish the parameters of a linear or nonlinear framework. The number of conditions generated is often very high, exceeding 20,000 conditions. Therefore, unless a good PC is used, this method is of little practical value.

The finite element method uses a utilizes a component discretization way to deal with tackle the issue of tracking down relocations of vertices/associations/grids and primary powers. The lattice approach for primary examination is linked to discrete component circumstances, and the results obtained are identical to those of conventional structural study. With one-layered components (line components), two-layered components (plane components), or three-layered components (volume/continuum components), discretization ought to be achievable. This method makes use of a continuum component to select a more accurate result [3], [7, p. 8], [8].

2.3. LISA FEA V.8

Three different types of intensity exchangers were each subjected to a temperature rise measurement using finite element method software LISA FEA V.8, a well-known restricted component assessment program. The line component model, the shell model, and the strong model are the three different types of models, in order of how basic and easy they are to construct.

Since we cannot prevent convection from accumulating the baseplate surface with the face determination device, the convection coefficient of the baseplate surface is not fixed as a percentage of the value used elsewhere for line component models alone. It's only a matter of being mindful.

By avoiding that area, we can easily prevent convection on the mounting surface for the other two models. For each case, an internal intensity generator is used, and the volume of the entire floor piece is considered the intensity source. Applying limit conditions to a line component model should be done with caution [9]–[15].

3. Results and Discussion

3.1. Visual identification

Based on the results of the study by visual identification, the chronological subsidence on the Pinang bridge oprit on the Bontang- Sangatta road section was the occurrence of subsidence on the Pinang bridge oprit on the Bontang side with a width of 7 meters with a fracture length of 3 meters. In the oprit subsidence, a collapsed and broken concrete slab was found with dimensions of 7 meters wide and 2 meters long and 15 cm thick. There was no tread plate holder found on the bridge abutment building, seen in figure 2.

Figure 2. Subsidence that occurred in Oprit.

There is a hole/gap behind the abutment on the left side of Bontang- Sangatta and at the time of subsidence a puddle of water was found in the hole but the condition was static with a small volume of inundation, seen in figure 3.

Figure 3. Gap behind the bridge abutment.

The identification of heavy currents and the occurrence of whirlpools at the bottom of the bridge abutments. The dominant flood tidal inundation area widened towards Bontang or parallel to the collapsed bridge oprit (on the 4th day of flooding) seen in figure 4 and 5.

Figure 4. The heavy current that occurs under the bridge abutment.

Figure 5. Flood inundation area.

3.2. Material Properties

In this study, researchers compared the stresses that arise when reinforcing oprit using granular material with foam mortar material. with material parameters as in table 2.

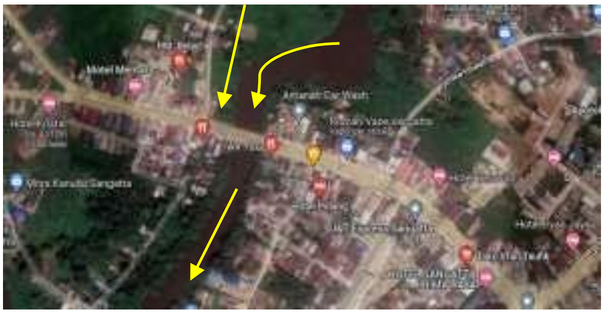
Table 2. Material Properties

No.	Material	Young Modulus (N/mm²)	Density (N/mm3)	Poison Ratio
1	Steel	210,000.00	0.00007850	0.30
2	Concrete fc' 30 MPa (Slab)	25,742.9602	0.00002400	0.20
3	Granular	150	0.00002000	0.35
4	Clay	75	0.00001800	0.25
5	Mortar Foam 2000 kPa	2.00	0.00001000	0.19
6	Mortar Foam 800 kPa	0.80	0.00000800	0.19

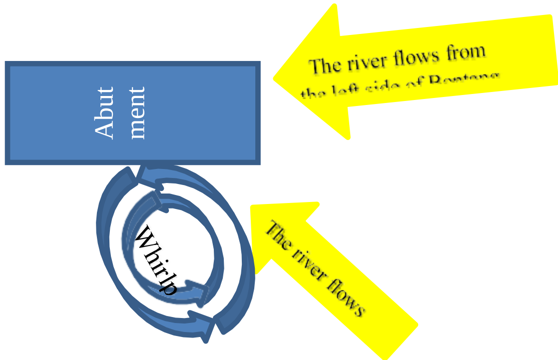
Source: Research 2022.

3.3. Problem Identification:

At the bottom of the two abutments there is no abutment safety structure which causes the formation of a whirlpool to erode the pile at the back of the abutment and an indication that the tread plate is not in its actual position, resulting in the subsidence that is currently happening.

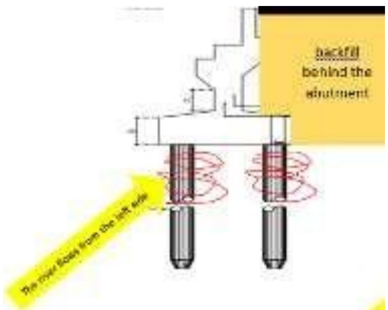


(a)

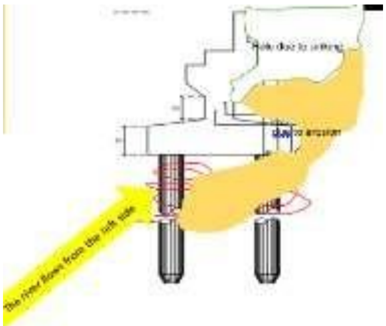


(b)

Figure 6. (a) river flow (b) whirlpool behavior.



(a)



(b)

Figure 7. (a) initial condition (b) condition after subsidence.

Shown in figure 7(a) is the normal condition of the backfill behind the abutment in figure 7(b) a sinkhole is formed due to the pile behind the abutment being eroded due to bulking under the abutment because there is no abutment building.

3.4. Modeling

In this study, the modeling of the results of visual identification and collection of material parameters was carried out using the finite element method software LISA FEA V.8.

The treatment is to restore the oprit condition of the bridge, and to strengthen the problems that occur by installing a 15 cm thick concrete slab above the abutment poerplate with the support of a 20x20 mini pile 6 meters deep and the embankment filled with granular material or foam mortar after which it is covered again with a surface layer. rigid pavement.

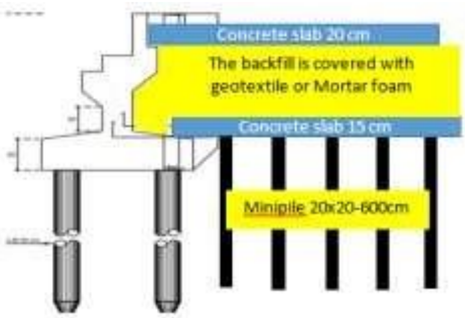


Figure 8. Bridge oprit repair plan.

The modeling was made with the help of the finite element method software LISA FEA V.8 (licence) with a modeling scale of 1:1 in accordance with the recommendations given for the bridge oprit repair step as shown in Figure 8.

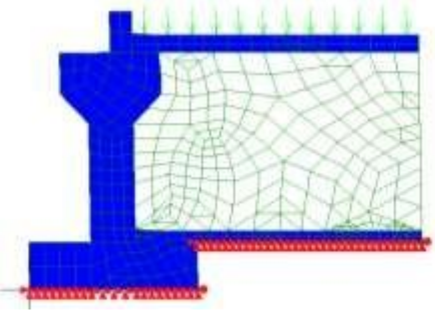
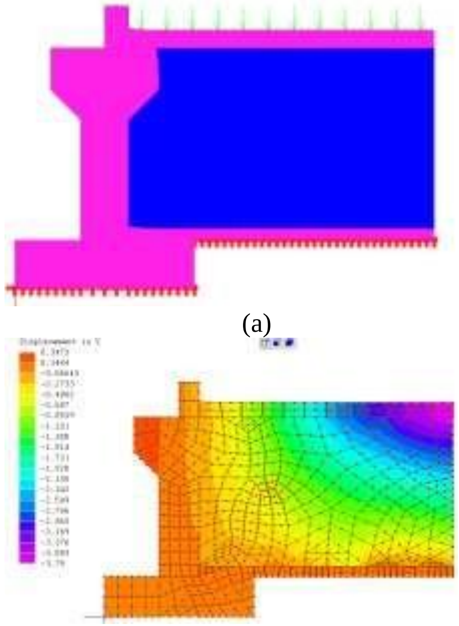


Figure 9. Bridge oprit modeling in LISA FEA V.8.

Figure 9 shows the model that has been made on LISA FEA V.8 with the type of material using embankment soil material with the parameters as shown in Table 2.

3.4.1. Behavior that occurs with embankment material



(a)

(b)

Figure 10. (a) initial modeling (b) deformation that occurs in the bridge oprit with embankment material.

Figure 10 shows the settlement value that occurs ranging from 0.3473 to 3.79 mm and the soil stress that occurs is as shown in Figure 11 which is 0.00287 to 3.894 MPa which dominantly occurs in the area of the concrete slab on the surface or the bridge slab and on the abutment wall.

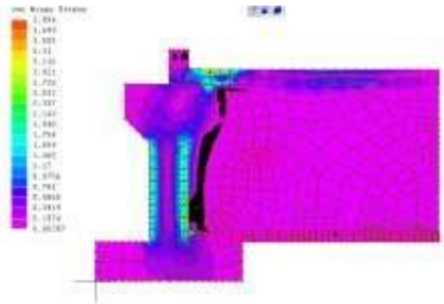


Figure 11. Stress behavior that occurs in embankment soil.

3.4.2. Behavior that occurs with granular material

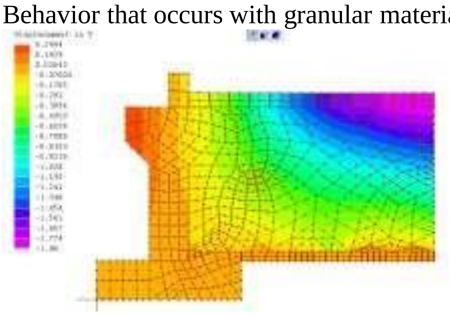


Figure 12. Deformation that occurs in the bridge oprit with granular material.

Figure 12 shows the settlement value that occurs ranging from 0.2494 to 1.88 mm and the soil stress that occurs is as shown in Figure 13 which is 0.002434 to 2.081 MPa which dominantly occurs in the area of the concrete slab on the surface or the bridge slab and on the abutment wall.

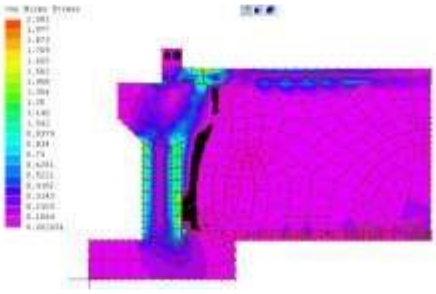


Figure 13. Stress behavior that occurs in granular material.

3.4.3. Behavior that occurs with mortar foam

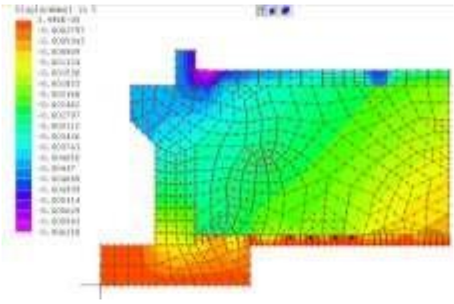


Figure 14. Deformation that occurs in the bridge oprit with mortar foam.

Figure 14 shows the settlement value that occurs ranging from 0.0000349 to 0.006 mm and the soil stress that occurs is as shown in Figure 15 which is 0.0002547 to 0.3668 MPa which dominantly occurs in the area of the concrete slab on the surface or the bridge slab and on the abutment wall.

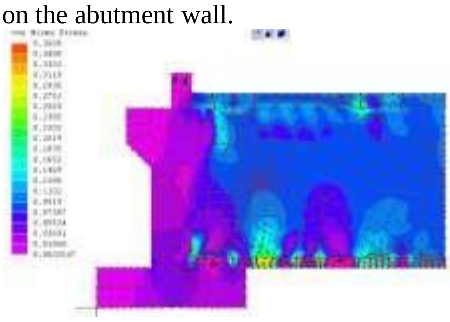


Figure 15. Stress behavior that occurs in mortar foam.

Figure 16 describes the graph of the subsidence behavior that occurs in the 3 materials where the pattern of settlement of granular material and embankment seems dynamic, almost the same as the pattern of settlement and different from the mortar foam material, which is almost linearly significant.

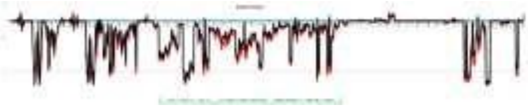


Figure 16. Deformation chart.

4. Conclusion

From the results of the research above, for the selection of a very good oprit material, it tends to use mortar foam material because the material has contributed significantly to the carrying capacity of the oprit where from the deformation analysis and also the stresses that occur, the mortar foam material provides a fairly small deformation. so that in the future it does not require maintenance that is quite expensive, while granular material and embankment have almost the same pattern of settlement that occurs, even so granular material can also be an option for bridge oprite reinforcement, where the settlement and stress that occurs is quite small.

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