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DEFORMATION ANALYSIS OF RIGID PAVEMENT WITH SUBGRADE OF DREDGED SEDIMENT STABILISED BY CEMENT

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ABSTRACT

This study aims to determine the elastic deformation of rigid pavement using dredging sediment sub grade stabilized with cement. This research was conducted in the laboratory and in the field using dredging sediment samples from the Intake of Bili - Bili Dam, sediment samples were taken from twelve dredging points with respective distance from the dam's weir about 100-200 m. The test and analysis of sediment characteristics of cement stabilization adopted standard methods, namely, ASTM. While the test and analysis of deformation models adopted the loading test method.

The result of previous studies showed that dredging sediment of Bili - Bili Dam is classified as a fine-grained soil (silt - clay), include in the category of moderate to poor soil. By adding different variations of cement portion (cement stabilization), an increase was showed in the strength capacity/ bearing capacity and meet the condition as a road sub grade as seen from the CBR (capacity bearing ratio) field tests with the addition of cement portion of 5%, 10%, and 20%. Based on those results, loading test was conducted for the rigid pavement using dredging sediment sub grade with cement stabilization. From the test results, elastic deformation was obtained with the variation centric loading up to 9 tons. Furthermore, numeric validation was employed, where its results are in a good agreement with the results of the loading test.

Keywords: stabilization, sub grade, deformation, rigid pavement.

INTRODUCTION

Native soil is rarely found in the earth directly under conditions that capable of supporting recurring load of vehicle traffic without experiencing large deformation. Land requirement for roads continues to grow, new construction had to be carried out on land that does not meet the above conditions, including to the soft ground. This is because the good soil for filling purpose has been diminished, expensive , or difficult to obtain economically. So the existing soil (the poor) had to be stabilized first, and then can be used as a qualified soil material for filling purpose (Piratheepan, J., C. T. Gnanendran, 2010) .

In addition to the above basic land issues, assessment of sediment dredging Bili - Bili Dam needs to be done , because the volume of Bili - Bili Dam sediment showed a significant increase from year to year, especially after the caldera of Mount Bawakaraeng collapsed in 2004. According to (Haeruddin, 2011), dredging sediment deposition does not take a smooth sediment overall, but only to ensure the continuity of the function of the intake at least five years later, because to dredge the entire sediment that exist around the intake is very hard to conduct because of the considerable amount of sediment , i.e. ± 80 million cubic meters, and there is no dumping area for the dredging sediment.

According to (Samang, L.,2010) the dredging sedimentl material is planned to be placed on the left side of the field back under the Bili - Bili Dam spillway. Constraints faced are the limited storage capacity of the land, while the lands that available are only for temporary because the land will be developed for another purpose.

It means there will be a build up of sediment material; the problem on the one hand is the difficulty and the limited native land that can support the traffic load directly, while on the other hand there is an accumulation of sediments around the dam (dumping material). This becomes a major issue that is required for review in the form of a comprehensive study on the potency of the dredging sediments soil material (Chrysochoou, M., 2010); (Grubb, D. G., 2010). The research was conducted by using the dredging sediment of Bili - Bili Dam as road subgrade on rigid pavement. The purpose of this study was to determine the deformation magnitude that occurs in rigid pavement with subgrade of dredging sediment material stabilized with cement.

Sediment materials

Sedimentation problems have resulted in siltation and the malfunction of the reservoir. It can be anticipated by dredging activity. The dredging sediment material is generally disposed to the sea, but some studies have shown that sediment dredged material that has been processed and analyzed may give a very favorable advantages from the sustainable economic and environmental aspects as an alternative to sediment disposal to the ocean [Sheehan,C., 2010).

Soil stabilization

Stabilization is a quality improvement activity for pavement material or to improve the strength of the material to a particular level in order to increase the function and the performance better than the original material. Soil stabilization has been widely used to improve the performance of the subgrade layer in the

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pavement structure. In this case there is an increase in the strength, the stiffness, and the bearing capacity with different stabilization agents (Solanki, 2009; Piratheepan, 2010; Ghosh, A. 2010 ; Inoue,H., 2004; Mochtar,I.B., 2000; Gnanendran C., 2010).

METHODOLOGY

The research method used is an experimental method that conducted many times in the laboratory and in the field. The research procedures are: based on the characteristics of the soil test results obtained for the dredging sediment where from the test of basic characteristics and properties of sediment material, the dredging sediment gradation and plasticity index of soil sediment dredging are determined (ASTM. 2005). Then it may proceed to the test of soil stabilization for the dredging sediment stabilized with cement as the sub grade in rigid pavement. In this study, the additive for stabilization used is Portland Cement Type 1 or the so-called soil - cement stabilization, the addition of cement varies in the portion of 5 %, 10 %, and 20 %. The test is to determine the CBR value for the increment of each percentage (Saloua., 2010).

Further, deformation model test with loading test which consists of two parts, namely the test of sub grade deformation for sediment stabilized with cement at each value of CBR and the elastic deformation test for rigid pavement (Suryawan, Ari. 2009) that used the dredging sediment with cement stabilization as sub grade, also on each additional percentage of cement. The next phase is numerical validation which is done by using the SAP2000 (Wahana Komputer, 2010) code for comparing the value obtained from the loading test.

Material characteristics of dredging sediment

Results Analysis of Dredging Sediment Material characteristics obtained are summarized in Table-1 below:

Table-1. Characteristics results of dredging sediment material.

Parameters results	Unit	Test
Grain size distribution		
Sand	%	2,56 – 3,69
Silt	%	95,93 – 96,47
Clay	%	0,97 – 1,31
Liquid limit (LL)	%	47,19-48,40
Plastic limit (PL)	%	30,13-30,62
Plasticity index (PI)	%	17,06-17,78

Laboratory CBR test results of dredging sediments with cement stabilization obtained by penetration of 0.1 "and 0.2" are summarized in Table-2 below:

Table-2. Test results of CBR Laboratory.

Cement	Value of CBR (%)	
(%)	0,1”	0,2”
0	2,21	2,24
5	21,07	25,67
10	40,74	52,82
20	88,93	101,47

CBR field test

Field CBR testing in this study used dredging sediment material with cement stabilization i.e. with cement percentage increments of 5%, respectively referred to as CBR1, 10% as CBR2, and 20% as CBR3. Field CBR test results for dredging sediment stabilized with cement can be seen in Table-3 below:

Table-3. Analysis Results of field CBR for dredging sediment material stabilized with cement.

Cement	Value of CBR (%)	
(%)	0,1”	0,2”
5	8,80	9,95
10	11,27	12,23
20	18,73	22,12

Deformation of rigid pavement that used dredging sediment stabilized with cement as sub grade

Deformation model test methodology for rigid pavement with the stabilization sediment cement sub grade of 5%, 10%, and 20% is done by using the test load (loading test). This test is conducted to look the deformation model occurs in rigid pavement with cement sub grade stabilization with the variation of CBR. The results of the analysis are made in the form of relationship graphs between deformation based on dial reading and dial placement distances with successive loading of 0.5 tons, 4.5 tons, and 9 tons that can be seen in Figure-1, Figure-2, and Figure-3.

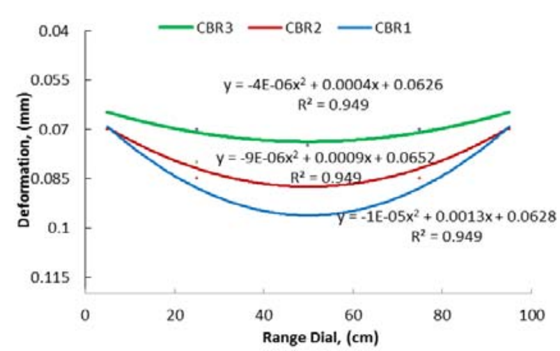

Figure-1. Deformation of rigid pavement with different value of CBR for 0.5 ton of load.

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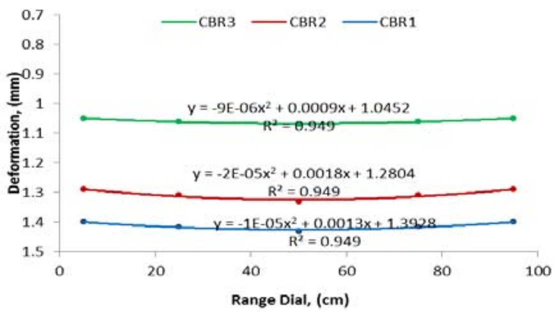

Figure-2. Deformation of rigid pavement with different value of CBR for 4.5 ton of load.

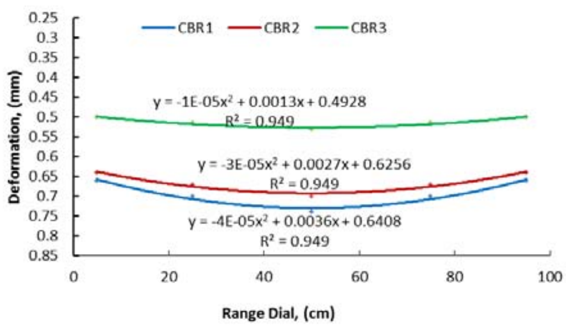

Figure-3. Deformation of rigid pavement with different value of CBR for 9 ton of load.

The analysis results of the rigid pavement deformation that used dredging sediment stabilized with cement with the variation of the CBR and load variations as shown in the graph above can be shown in Table-4 below:

Table-4. Deformation analysis results with variation of CBR and load.

	Deformation (mm)		
Load (ton)	**CBR1** (5%)	**CBR2** (10%)	**CBR3** (20%)
0,5	0,10	0,09	0,075
4,5	0,74	0,70	0,53
9,0	1,43	1.33	1,07

The validity of the rigid pavement deformation and cement stabilization sub grade

To determine the accuracy of the model of the elastic deformation of rigid pavement used sub grade of dredging sediment stabilized with cement stabilization using load test, then the data validation of rigid pavement deformation models are conducted using SAP2000 program as a comparison.

Elastic deformation results obtained by using the program SAP2000 version 14 for 9 tons load with the variation of CBR can be seen in the following graph (Figure-4):

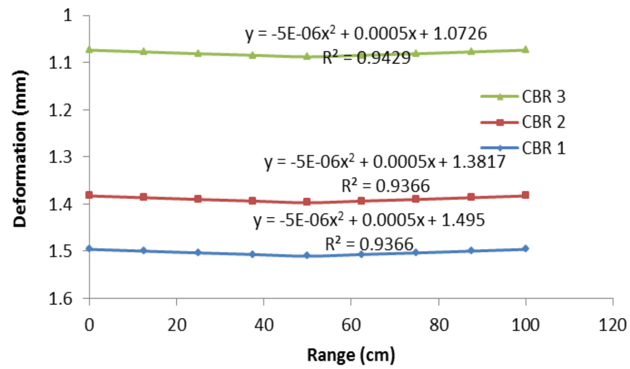

Figure-4. Elastic deformation of rigid pavement with the variation of CBR for central load of 9 tons using SAP 2000 code.

As a comparison between the value of the load test with SAP2000 on 9 tons of loading at each CBR value can be seen in the chart Figure-5 to Figure-10 below:

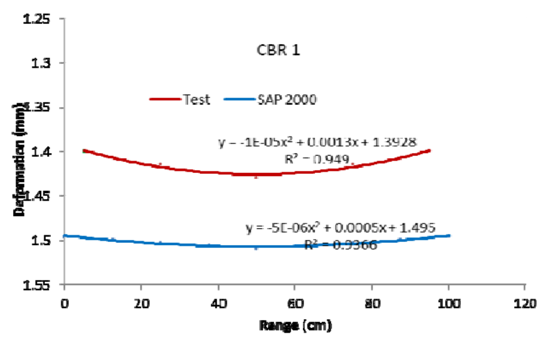

Figure-5. Deformation model of rigid pavement with loading test and SAP 2000 at CBR1 for the load of 9 tons.

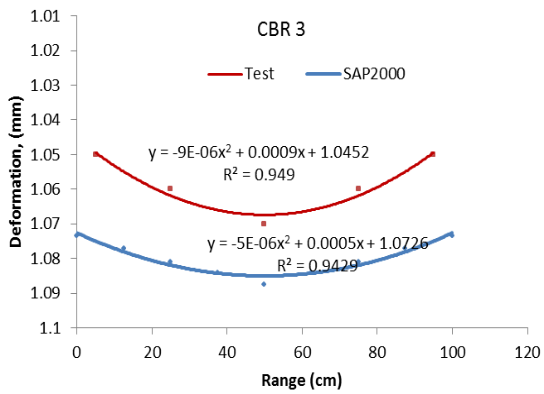

Figure-6. Deformation model of rigid pavement with loading test and SAP 2000 at CBR 2 for the load of 9 tons.

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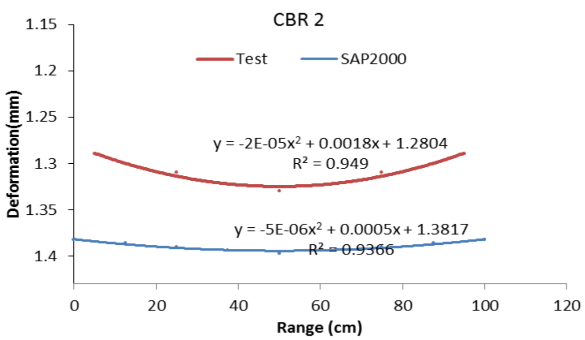

Figure-7. Deformation model of rigid pavement with loading test and SAP 2000 at CBR3 for the load of 9 tons.

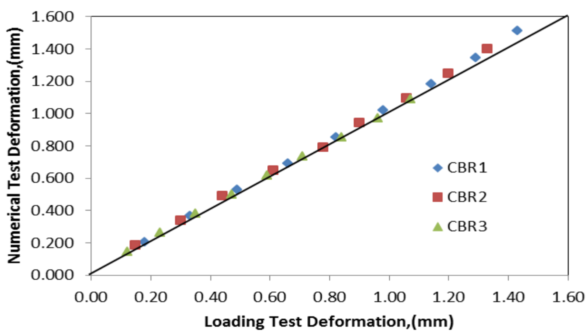

Figure-8. Deformation relationship of loading test results with numerical model deformation of SAP 2000 at each CBR values.

Table-5. The deformation comparison of loading test results with SAP 2000 for central loading of 9 tons on CBR variation.

Variation of CBR	**Maximum deformation** (mm)		
	Loading test	**SAP2000**	**deviation**
CBR 1	1,43	1,51	0,08
CBR 2	1,33	1,39	0,06
CBR 3	1,07	1.08	0,01

CONCLUSIONS

Regarding the test results and analysis of the elastic deformation model of rigid pavement with the sub grade of dredging sediment stabilized with cement, Table-5 shows that the deformation at the 9 tons of load located in the middle of span is different for each value of CBR, the maximum deformation occurs on the mid of span due to the loading that is, for CBR 1 is 1,43 mm, for CBR2 = 1.33 mm, and 1.07 mm for CBR. Regarding these results, the maximum deformation obtained from SAP2000 is slightly larger, for CBR 1 gives the maximum deformation value of 1.51 mm where 0.08 mm of difference occurs, then in CBR 2 the deformation value is 1.39 mm and the deviation is 0.06 mm, next in CBR 3, the value obtained is 1.08 mm with 0.01 mm of deviation. Based on these values, it can be concluded that the analysis results of the elastic deformation, both models based on the analysis of loading tests, and deformation results of the analysis of SAP 2000 are not considerably different and meet the requirements of deflection (L/240) = 4.16 m.

Differences on deformation occur due to the increasing percentage of cement (deformation decreases with the increasing percentage of cement) as well as for 4.5 tons and 0.5 tons of loading showed a similar trend to the deformation pattern yielded from 9 tons of loading, in other words that by increasing the percentage of cement to the dredging sediment soil will increase the bearing capacity of the sediment itself. With the cement stabilization method, the bearing capacity of the dredging sediment stabilized with cement that used as the sub grade in the rigid pavement can be increased.

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