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Vibration Level of Pillering Using Diesel Hammer

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ABSTRACT: The use of Diesel Hammer at the time of pile driving causes vibrations and has the potential to damage buildings and disturb the comfort of the surrounding community. The factors that affect the magnitude of the level of vibration due to driving are the method of driving, the distance from the location of the pile, the condition and type of soil at the location of the pile driving. In this study, the vibrations caused by pile driving were measured using a vibration level meter capable of measuring from a frequency of 0.01Hz to 10,000Hz, while the vibration variables measured were vibration speed (v) and vibration deviation (A). The measurement of the vibration level was carried out in the village of Kalidengen at a distance of 10m, 50m and 70m from the piling location. The maximum vibration speed occurs at a frequency of 5Hz with a speed of 20.69 mm/s at a distance of 10 m from the piling location. The lowest speed is at a frequency of 63 Hz at 0.004mm/s at a distance of 50m. The maximum vibration deviation occurs at a frequency of 4Hz with a deviation of 689.22 m at a distance of 10 m from the piling location. While the minimum vibration deviation at a frequency of 63 Hz is 0.011 m at a distance of 50m.

KEYWORDS: Pile Drive, Diesel Hammer, Vibration Rate, Vibration Speed (v), Amplitudo (A)

I. INTRODUCTION

To facilitate access in and out of goods and people at the New Yogyakarta International Airport (NYIA), the government built a 5.4 km railway from Kedundang Baru Station to NYIA airport, with details of 4.9 km of the railway being above ground level (elevated) and 500m at ground level (at grade). The construction of the elevated railway was preceded by pile driving as a support for the railroad, using a diesel hammer. The use of diesel hammer during pile erection causes vibrations and has the potential to damage buildings and disturb the comfort of the surrounding community. The factors that affect the magnitude of the level of vibration due to driving are the method of driving, the distance from the location of the pile, the condition and type of soil at the location of the pile driving. The magnitude of the impact of vibration on the environment caused by pile driving activities is regulated in a government regulation in the Decree of the Minister of the Environment Number Kep-49/MENLH/11/1996 concerning vibration. In the regulation, it is emphasized that there are two effects of vibration that occur, namely to humans and to buildings/structures, therefore the purpose of this study is to analyze the vibration parameters, namely the amplitude of vibration and the speed of vibration at several frequencies, while the criteria for the impact on human comfort and damage to buildings are analyzed using the Decree of the Minister of the Environment of Indonesia Number Kep-49/MENLH/11/1996.

Class The railroad that was built from Kedundang Station to NYIA Airport along 5.4 km is 1st class with a rail width of 1.067mm so that trains can pass at a speed of 120 km/hour. The elevated building was chosen because it is located along the Kedundang station to the NYIA airport, which crosses many roads and waterways. The construction of the railway from the kedundang station to the NYIA airport with elevated construction, was preceded by pile driving using a diesel hammer. Piling using a diesel hammer has an impact on the surrounding area in the form of vibrations and soil pressure due to the penetration of the pile into the ground. Vibration occurs due to mechanical energy from the hammer dropped on the pile, according to M. Ridwan, 2008 pile driving has an impact up to a distance of 200m both on human comfort and on building damage, but the impact of vibration due to pile driving at each location is very empirical, that is, it only applies at that location.

The location for measuring field data is in the village of Kalidengen, Special Region of

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Yogyakarta, Indonesia. Data retrieval is done by placing the Vibration Level Meter at a distance of 10m, 50m and 70m. The data measured are the Amplitude (A) and the Vibration Velocity (v) data at the time of pile driving work. Calculation of vibration acceleration (a) and Amplitude(A) using the equation:

$a = (2\pi f)^2 \times A$

$v = 2\pi f \times A$

with
A:Amplitude(Micron)
a : Acceleration (mm/s2)
v : Speed (mm/s)
f : Frequency (Hz)

[4]. The impact of vibration for comfort is obtained by measuring the vibrations at frequencies of 4 Hz, 5 Hz, 6.3 Hz, 8 Hz, 10 Hz, 12.5 Hz, 16 Hz, 20 Hz, 25 Hz, 31.5 Hz, 40 Hz, 50 Hz and 63 Hz which is then displayed on the graph and analyzed to obtain impact criteria. For the impact of mechanical vibrations measured are the speed of vibration at frequencies of 4 Hz, 5 Hz, 6.3 Hz, 8 Hz, 10 Hz, 12.5 Hz, 16 Hz, 20 Hz, 25 Hz, 31.5 Hz, 40 Hz and 50 Hz which are then presented on a graph. and analyzed to obtain impact categories.

II. VIBRATION IMPACT

Figure 1. Measurement Of The Level Of Vibration At A Distance Of 10m And 70m

According to the Decree of the Ministry of Environment, the vibration level and speed of vibration at various frequencies in the environment are detailed as shown in tables 1 and 2.

In general, there are two effects of vibration, namely on humans and on buildings/structures. For humans, vibration has an impact on the level of comfort, while in buildings, vibration has an impact on damage.

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Table 1. Vibration Rate ValueTable 2. Peak Movement Limit

No	frequency (Hz)	Vibration Rate Value (10^{-6} m)			
		Not disturb	disturb	Uncomfort able	Hurtful
1	4	<100	100-500	>500-1000	>1000
2	5	<80	80-350	>350-1000	>1000
3	6,3	<70	70-275	>275-1000	>1000
4	8	<50	50-160	>160-500	>500
5	10	<37	37-120	>120-300	>300
6	12,5	<32	32-90	>90-220	>220
7	16	<25	25-60	>60-120	>120
8	20	<20	20-40	>40-85	>85
9	25	<17	17-30	>30-50	>50
10	31,5	<12	12-20	>20-30	>30
11	40	<9	9-15	>15-20	>20
12	50	<8	8-12	>12-15	>15
13	63	<6	6-9	>9-12	>12

No	frequency (Hz)	Peak Movement Limit (mm/s)			
		Category A	Category B	Category C	Category D
1	4	<2	2-2,7	>27-40	>140
2	5	<7,5	<7,5-25	>24-130	>130
3	6,3	<7	<7-21	>21-110	>110
4	8	<6	<6-19	>19-100	>100
5	10	<5,2	<5,2-16	>16-90	>90
6	12,5	<4,8	<4,8-15	>15-80	>80
7	16	<4	<4-14	>14-70	>70
8	20	<3,8	<3,8-12	>12-67	>67
9	25	<3,2	<3,2-10	>10-60	>60
10	31,5	<3	<3-9	>9-53	>53
11	40	<2	<2-8	>8-50	>50
11	50	<1	<1-7	>7-42	>42

III. EXPERIMENTATION

According to M. Ridwan, the intensity of the vibration of the pile driving activity at a location depends on several factors such as: the condition of the soil as a medium for wave propagation, the intensity of the vibration source and the distance from the vibration source, therefore, the impact of the piling activity on the surrounding environment will also vary. , depending on the type of pile dimensions, the type of machine used, the method used, the type of soil where the piling is located and the condition of the buildings around the piling site. Pile piling activity is carried out using Diesel Hammer, the working principle is that diesel engine power is used to lift the hammer and then released it following gravity (M.Ridwan, 2008), while vibration is measured at the closest location to the piling activity, namely in the village of Kalidengen.

3.1.Vibration Speed

Installation of piles in the village of Kalidengen using a Diesel Hammer (Diesel Hammer). To determine the level of vibration during pile erection, it is carried out by directly measuring the level of vibration in the closest settlements to the project site at three points with a distance variation of 10m (7°53'25.01" 110° 5'19.21"), 50m (7°53'30.08 " 110° 5'18.78") and 70m (7°53'49.85" 110° 4'55.90") from the current location of pile driving.

The results of the vibration speed measurement (v) show that the vibration speed at point 1 which is 10m from the vibration source at frequencies of 6.3 Hz 10 Hz 12.5 Hz and 16 Hz has exceeded the maximum threshold for vibration speed according to the Decree of the Minister of the Environment Number Kep-49/MENLH/ 11/1996. For the vibration speed point 2 and point 3 are still below the maximum threshold. This shows that the distance of the vibration source greatly affects the speed of the vibration at a point. The vibration speed at various measurement points is shown in Figure 2.

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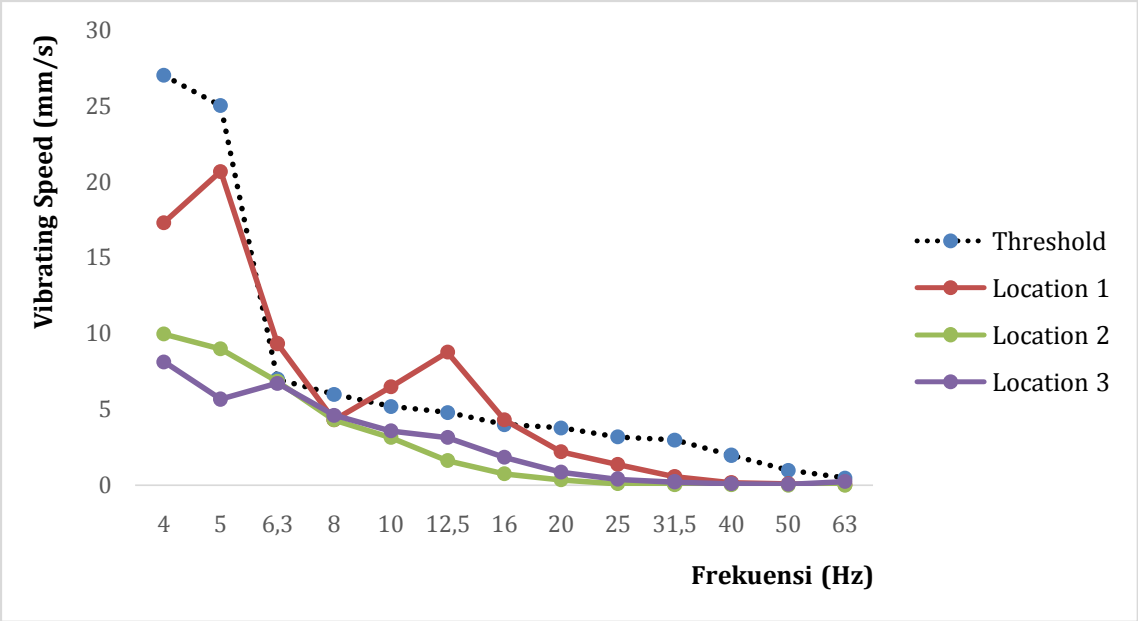

Figure 2. Graph Of Vibration Speed Against Frequency At Various Distances

5.2.Amplitude (A)

As in the measurement of the speed of vibration, the amplitude measurements were carried out at frequencies of 4 Hz, 5 Hz, 6.3 Hz, 8 Hz, 10 Hz, 12.5 Hz, 16 Hz, 20 Hz, 25 Hz, 31.5 Hz, 40 Hz, 50 Hz and 63 Hz. The results of the amplitude measurement (A) show that the amplitude at location 1 which is 10m from the vibration source at a frequency of 4Hz 5Hz 12.5Hz and 16Hz has exceeded the maximum amplitude threshold according to the Decree of the Minister of the Environment Number Kep-49/MENLH/11/1996. For location 2 and location 3, the amplitude is still below the maximum threshold. This shows that the distance of the vibration source greatly affects the amplitude at a point. The graph of the amplitude against the frequency at various distances is shown in Figure 3.

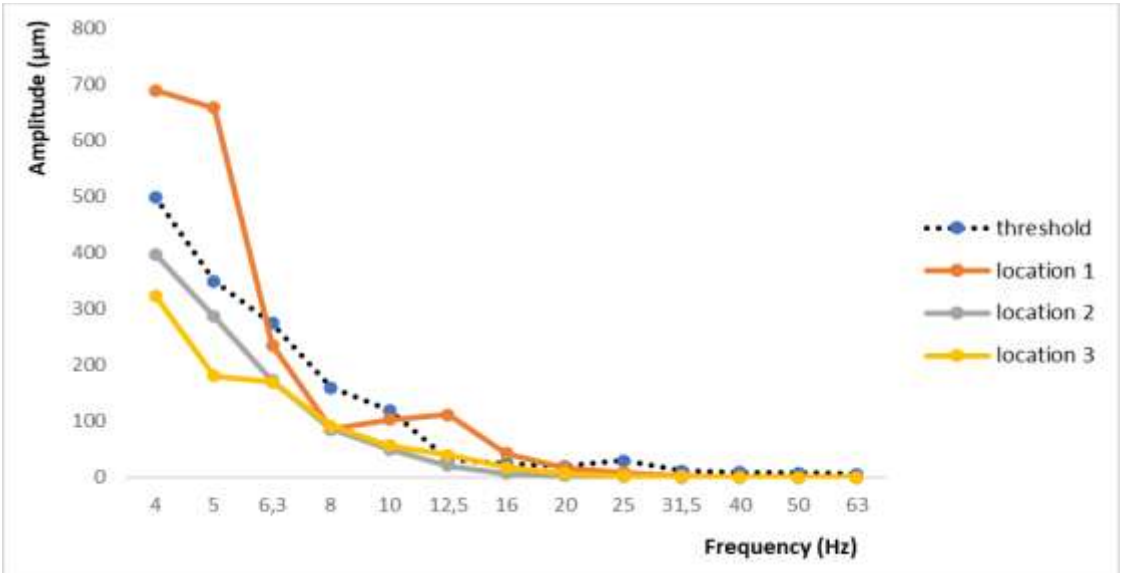

Figure 3. Graph Of Amplitude Against Frequency At Various Distances

The results showed that the level of vibration during pile driving activities in Kalidengen village was included in the criteria for disturbing the comfort and health of residents. This is also shown in the results of the vibration level measurement in Figure 1. which shows that the vibrations at the frequencies of 4 Hz, 5 Hz, 6.3 Hz, 8 Hz, 10 Hz and 12.5 Hz have been included in the disturbing category based on the decree of the Minister of the Environment Decree No. 49/MENLH/11/1996. Meanwhile, from the graph of the measurement results in Figure 2, the vibration level does not cause damage, but from the results of the measurement of the speed of vibration at a frequency of 4Hz at 8.14 mm/second so that the speed of vibration at that frequency has been included in the category of allowing damage to the plastering of the walls of the building. Based on the analysis of pile driving vibrations and geological studies which state that the soil types are relatively the same between Kedundang station and NYIA airport, it is necessary to pay attention to the magnitude of the vibration level in pile driving work throughout the area. Installation of piles using a Diesel Hammer (Diesel Hammer) in the area can still be done at a safe distance, especially from settlements. There are several ways to reduce the vibration level of pile driving work, among others, by changing the driving method using pre boring, bore pile or Hydraulic Static Pile Driver (HSPD).

IV. CONCLUSION

Some things that can be concluded in this study are: Maximum vibration speed occurs at a frequency of 5Hz with a speed of 20.69 mm/s at a distance of 10 m from the location of the pile. The lowest speed is at a frequency of 63 Hz at 0.004mm/s at a distance of 50m.

The maximum vibration deviation occurs at a frequency of 4Hz with a deviation of 689.22 m at a distance of 10 m from the piling location. While the minimum vibration deviation at a frequency of 63 Hz is 0.011 m at a distance of 50m.

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