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Lifting Plan for Containers Weight of 20 tons

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Abstract---*Infrastructure development in Indonesia supporting economic activities has reached its highest point in 2019. The construction of elevated toll roads has become one of the solutions for the development of the Cikampek-Jakarta toll road. Based on information, there have been several accidents on the toll road project due to the failure of the lifting process using a mobile crane. Based on this, an example of planning the appointment of a 40-foot container with a load of 20 tons using a mobile crane is intended to provide lessons in transport planning, so that accidents that occur can be minimized. The method used in this plan is as follows: (1) identify the dimensions and weight of the object to be transported; (2) determine the crane data to be used (3) calculate the total load of the object to be lifted along with the lifting gear (3) find the percentage of crane conditions used (4) calculate the Safety Factor; (5) comparing lifting capacity with the allowable lifting load based on the load card. Based on the calculation results, it can be concluded that the total load is 24,676 Tons, the lifting location factor is 28,377 Tons, Load Chart 29, 88 Tons, safety factor 1,052, with a boom length issued by 17.5 m, lift angle of 39o and the length of the main host is 5.9 m.*

Keywords---*mobile crane, lifting plan, safety factor, highway.*

I. Introduction

The development of infrastructure to support economic activities in Indonesia, has reached its highest point in 2019. Along with the policies of President Joko Widodo as the President of the Republic of Indonesia, which is in the process of equitable distribution of development to all regions from Sabang to Merauke by building toll roads, sea toll roads and air expressways which aims to facilitate the flow of movement of goods and services throughout the region. To simplify the economy on an island, the government is constructing toll roads, based on information from the Ministry of Public Works and Public Housing (PUPR) of the Republic of Indonesia. At present, the total toll road that has operated around 1,600 kilometers (km), the Toll Road Regulatory Agency (BPJT) plans to end 2019 all operating toll roads exceeding 2,000 km with the operation of the Trans Sumatra Toll Road (JTTS), Balikpapan - Samarinda, and Jakarta Outer Ring Road2 [1].

Based There have been many accidents on toll roads or other infrastructure projects due to the failure of the lifting process using a mobile crane. One of them was obtained from the DKI Jakarta Regional Disaster Management Agency (BPBD) that said four people died and one other suffered minor injuries. The incident occurred on Sunday (4/2) around 05.00 WIB during the concrete lifting process (Harian Republika, February 4, 2018).

Based on the above, there are many workplace accidents related to lifting equipment and mobile cranes in several development projects in Indonesia. Therefore, on this occasion, an example of planning the appointment of a 40 feet container with a load of 20 tons using a mobile crane is presented. provide learning in conveyance planning, so that accidents that occur can be minimized.

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II. LITERATURE REVIEW

Lifting Plan Management

To eliminate the causes of accidents when operating a mobile crane, it is necessary to identify the causes of the accident. One of the activities that must be carried out is planning the appointment of activities in accordance with the conditions required in the appointment of an object. Some of us understand that the activities in lifting operations using safe lifting equipment require a high level of management commitment, professional competence of executors, and adequate resources/equipment. In order for successful lifting operations managers are responsible for directing their operators to commit to following all the steps of lifting equipment operations according to the lifting plan.

Lifting Data Used

Lifting plan is made prior to lifting or lifting work that uses heavy equipment such as TMC (Truck Mounted Crane), Mobile Crane, Tower Crane, Crawler Crane, etc. (in the case here, will take the use of a mobile crane type). Before making a lifting plan, there are some important data that we need to prepare, namely:

1. crane data
2. calculate the total load lifted: (the sum between the weight of the main load lifted + the total weight of the lifting gear used) multiplied by Dynamic Factor is taken from the table.
3. Next we need to know the percentage of crane conditions that we use from the inspection results.
4. after that we have to calculate the Safety Factor for this lifting activity by dividing the lifting capacity by Total load (total load x DAF), Safety factor = lifting capacity / total load.
5. if we get the lifting capacity <of the maximum lifting load allowed on the load chart, then the lifting process can be declared safe to do

III. METHODOLOGY

The method used in this plan is as follows: (1) identify the dimensions and weight of the object to be transported; (2) determine the crane data to be used (3) calculate the total load of the object to be lifted along with the lifting gear (3) find the percentage of crane conditions used (4) calculate the Safety Factor; (5) comparing lifting capacity with the allowable lifting load based on the load card.

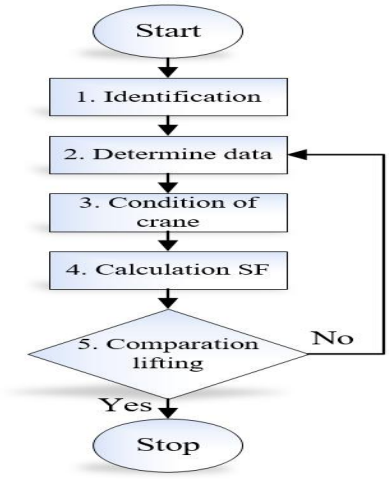


Figure-1 Flow chart Methodology

IV. RESULT AND DISCUTION

In calculating the Lifting plan it is better to do before the lifting or lifting work that uses heavy equipment as in the example here, will take the use of a mobile crane type Before making a lifting plan, as explained in the previous chapter, we must prepare some important data, namely:

1. Crane data
   a. Appointment Location Factor

   Appointment Location Factor

   Calculation data:

   Total load (24.61 Tons) x dynamic amplification factor (1.15) = 28,301 Tons Remarks: DAF selection is assumed that lifting onshore moves on land with the use of mobile cranes that are moving rather than static tower cranes and DAF values refer to the table below this:

Table 1: Dynamic Amplification Factor (DAF)

Gross weight, W (tonnes)	DAF			
	Offshore	Inshore	Onshore	
			Moving	Static
W ≤100	1.30	1.15		1.00
100 < W ≤ 1,000	1.20	1.10		1.00
1,000 < W ≤ 2,500	1.15	1.05		1.00
2,500 < W ≤ 10,000	1.10	1.05		1.00

   b. Crane Capability Based on Load Chart

   Calculation data:

   Load chart (33.2 Ton) x crane condition (90%) = 29.88 Ton

   Information :

   in this case the condition of the crane is merely an assumption not based on actual field observation values and the load chart value is determined based on the table below with the adjustment of safety factor values. In the realization of the field, of course every crane that will operate will first go through a load test, hydraulic inspection and penetrant test on the crane connection parts.

Table 2: Load Chart Crane STC1000C

Prerequisites:
① Boom operating conditions(fully extended boom length),min.length is 13.25m and max.length is 60m
② The span of outriggers is 7.6m×7.6m
③ 360°rotation is applied
④ Counterweight is 32.5T

Range (m)	Main boom														Range (m)
	13.25	17.5	17.5	17.5	21.8	21.8	21.8	26.1	26.1	26.1	30.5	30.5	30.5	34.8	34.8	
3	100	91	86	82												3
3.5	100	87	86	82												3.5
4	97	85	82	82	80.5	78.4	57.5	65	58	55.7						4
4.5	89	81	74	80	74.7	74.4	54.7	64	56	52.2						4.5
5	83	72.5	71	69	69	68	51.8	63	53.6	48.7	52	50.2	48.5	43.3	41.3	5
5.5	77.5	69.75	68	68	65.5	64.5	49.2	61.5	50.75	46.1	50.8	47.1	46.4	41.1	39.4	5.5
6	72	67	65	57	62	61	46.6	60	47.9	43.5	49.5	44	44.2	38.9	37.5	6
6.5	66.5	63.5	62	56.5	58.5	58	44.4	58.7	46.75	41.4	48.3	41.7	42.1	36.75	35.65	6.5
7	59	60	59	56	56	55	42.2	57.4	43.6	39.3	47.1	39.4	40	34.6	33.8	7
8	53	51	50	50	50.6	50	39.1	51.7	40.2	35.7	42.6	35.3	36.2	31.1	30.9	8
9	45	44	43	42	46	45.6	36.1	47	37.3	32.8	38.9	32	33.2	28.2	28.1	9
10	39	38.5	38	37	38.2	37.6	33.5	43.6	34.2	30.3	36.4	29.5	30.6	26.4	26.9	10
12		33.2	32	31	32	31	29	34.6	29.3	26.2	30.5	26.2	26.7	21.9	22.4	12
14		25.2	26.8	27.3	24	24	26.471	26.7	25.6	23.2	26.6	21.6	23.5	18.8	19.6	14
16					20	20.9	23.793	21	21.6	20.5	21.8	19.1	20.9	16.4	17.4	16
18					16.5	16.8	19.57	16.9	17.5	18.8	17.6	16.8	16.9	14.4	15.6	18
20								13.8	14.4	16.1	14.6	13.8	16	12.6	13.6	20
22								11.4	12	13.7	12.463	11.742	13.6	11.3	11.3	22
24											10.506	9.785	11.7	9.7	9.6	24
26											9.27	8.137	10.1	8.343	8.2	26
28														7.004	7.1	28
30														5.871	6.1	30
32																32

2. calculate the total load lifted calculate the total load lifted: (the sum between the weight of the main load lifted + the total weight of the lifting gear used) multiplied by Dynamic Factor is taken from the table.

Based on the case that the load will be lifted 20 tons and put into a 40 feet container, the equipment that needs to be used is 4 pieces of 1 inch size crosshackle (the selection of this size is based on the calculation of the total load), webbing sling 4 tons, L = 7.2 m, W = 4 "(4 sides) and tag line (manila rope) L = 2 m.

Table 3: Container of Table

Keterangan		20 ft	40 ft	40 HC	45 ft
Dimensi Luar	Panjang	6,058m	12,192m	12,192m	13,716m
	Lebar	2,438m	2,438m	2,438m	2,438m
	Tinggi	2,591m	2,591m	2,896m	2,896m
Dimensi Dalam	Panjang	5,898m	12,032m	12,032m	13,716m
	Lebar	2,352m	2,352m	2,352m	2,438m
	Tinggi	2,385m	2,385m	2,69m	2,896m
Bukaan Pintu	Lebar	2,343m	2,343m	2,343m	2,340m
	Tinggi	2,280m	2,280m	2,585m	2,585m
Volume		33.1m³	67.5m³	76.1m³	86.1m³
Berat Kotor		30,480kg	30,480kg	30,480kg	32,500kg
Berat Kosong		2,400kg	4,000kg	4,200kg	4,700kg
Muatan Bersih		28,080kg	26,480kg	26,280kg	27,800kg

The amount of weight of the main load lifted + the total weight of the lifting gear used multiplied by Dynamic Factor is taken from the table. Some lifting gear used in crane lift planning are: Shackle Crosby (table 4), hook (Figure 1)

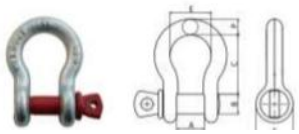


Figure 2: Shackle Crosby Table

Table 4**:** Container of Table

NOMINAL SIZE IN	WLL TON	WEIGHT KG/PC	DIMENSIONS(IN.)					
			A	B	C	P	E	F
3/16"	1/3	0.02	3/8"	1/4"	7/8"	1/16"	11/16"	9/16"
1/4"	1/2	0.05	1/2"	5/16"	1-1/8"	1/4"	25/32"	11/16"
5/16"	3/4	0.09	17/32"	3/8"	1-7/32"	5/16"	27/32"	13/16"
3/8"	1	0.14	21/32"	7/16"	1-7/16"	3/8"	1-1/32"	31/32"
7/16"	1-1/2	0.17	23/32"	1/2"	1-11/16"	7/16"	1-5/32"	1-1/16"
1/2"	2	0.29	13/16"	5/8"	1-7/8"	1/2"	1-5/16"	1-3/16"
5/8"	3-1/4	0.63	1-1/16"	1/4"	2-3/8"	5/8"	1-11/16"	1-9/16"
3/4"	4-3/4	1.02	1-1/4"	7/8"	2-13/16"	3/4"	2"	1-7/8"
7/8"	6-1/2	1.53	1-7/16"	1"	3-5/16"	7/8"	2-9/32"	2-1/8"
1"	8-1/2	2.41	1-11/16"	1-1/8"	3-3/4"	1"	2-11/16"	2-1/8"
1-1/8"	9-1/2	3.09	1-13/16"	1-1/4"	4-1/4"	1-1/8"	2-29/32"	2-5/8"
1-1/4"	12	4.31	2-1/32"	1-3/8"	4-11/16"	1-1/4"	3-1/4"	3"
1-3/8"	13-1/2	6.01	2-1/4"	1-1/2"	5-3/16"	1-3/8"	3-1/2"	3-5/16"
1-1/2"	17	8.03	2-3/8"	1-5/8"	5-3/4"	1-1/2"	3-7/8"	3-5/8"
1-3/4"	25	13.78	2-7/8"	2"	7"	1-3/4"	5"	4-5/16"
2"	35	20.41	3-1/4"	2-1/4"	7-3/4"	2"	5-3/4"	5"
2-1/2"	55	38.90	4-1/8"	2-3/4"	10-1/2"	2-1/2"	7-1/4"	6"
3"	85	65	5"	3-1/8"	13"	3"	8"	7-7/8"

After determining the equipment that has been used, the following calculations can be obtained:

a. Total Load Data calculation: Load to be lifted (20 Tons) + empty weight of the container (4 Ton) + hook weight (514 Kg) + total shackle weight (96.4 Kg) = 24.61 Tons

b. Safety Factor Data calculation:

Crane Capability Based on Load Chart (29.88 Ton) / Lift Location Factor (28,301 Ton) = 1,055 Description: Lift is said to be safe if the Safety Factor value is more than 1 (one)

3. Next we need to know the percentage of crane conditions that we use from the inspection results. if we take the percentage of crane conditions 95% because the crane inspection results are declared safe, there is no huydraulic leakage and the usage year is under 2 years, then we will correlate the calculation with the safe load in the load chart as follows: crane condition = 95% of the weight allowed according to load chart = 7.1 tons then Lifting capacity = 7.1 tons x 95% = 6,745 tons

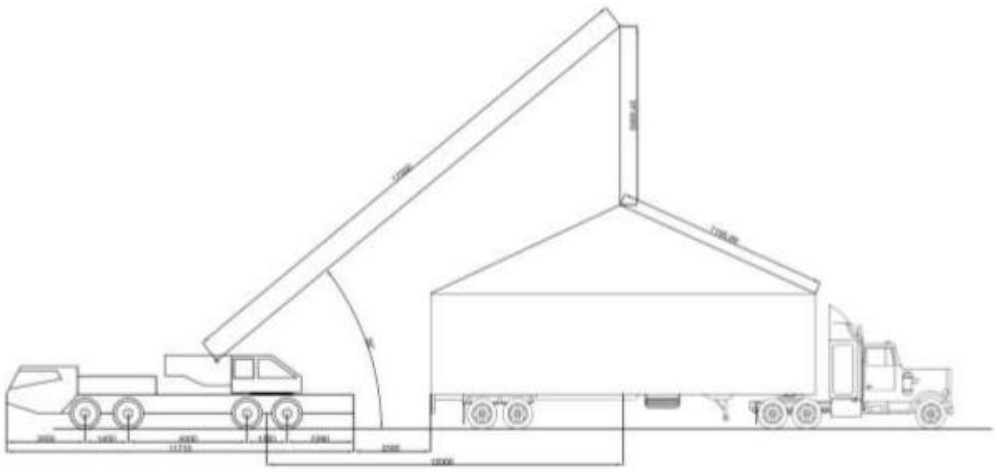
4. after that we must calculate the Safety Factor for this lifting activity by dividing the lifting capacity by the total load (total load x DAF), Safety factor = lifting capacity / total load = 6,745 tons / 6.16 tons = 1.09

5. Crane Capability Based on Load Chart (29.88 Tons) / Lift Location Factor (28,301 Tons) = 1,055 Description: Lift is said to be safe if the Safety Factor value is more than 1 (one)

6. If we get the lifting capacity <of the maximum lifting load allowed on the load chart, then the lifting process can be declared safe to doNext we need to know the percentage of crane conditions that we use from the inspection results. if we take the percentage of crane conditions 95% because the crane inspection results are declared safe, there is no huydraulic leakage and the usage year is under 2 years, then we will correlate the calculation with the safe load in the load chart as follows: crane condition = 95% of the weight allowed according to load chart = 7.1 tons then Lifting capacity = 7.1 tons x 95% = 6,745 tons

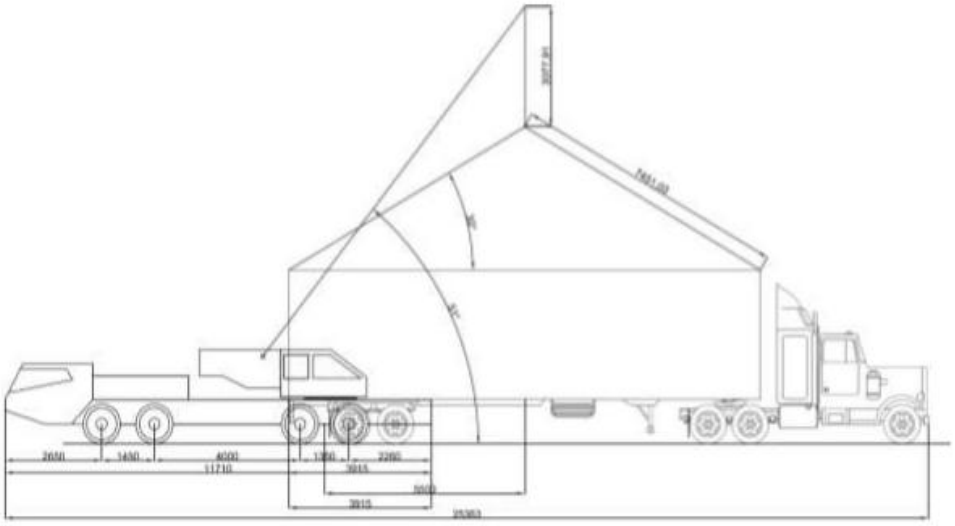
V. CONCLUTION

From the case of a load of 20 tons put into a container with a dimension of 40 feet will be lifted using a Sany STC1000C crane which is calculated based on the lifting plan operating method, the lifting activity is "Safe for Load". The reason in this paper to use the STC1000C crane is based on the following 2-dimensional comparison of the lifting process:



Gambar 6. Operasi Rencana Angkat Menggunakan Sany Crane STC1000C

Figure 3: transport lift plan using STC1000C sanny crane



Gambar 7. Operasi Rencana Angkat Menggunakan Sany Crane STC500

Figure 4: transport lift plan using STC500C sanny crane

In both images there are significant differences when using Sany Crane STC1000C (100 T) with Sany Crane STC500. In Figure 6. Distance of the front body of the crane with the rear body of the truck + 2.5m which means the crane is behind the truck while in Figure 7. the distance between the body of the front of the crane with the rear body of the truck is -3.9m so that the crane is next to the truck. In this case the consideration is the safe distance when the appointment process is carried out.

From the case of a load of 20 tons put into a container with a dimension of 40 feet will be lifted using a Sany STC1000C crane which is calculated based on the lifting plan operating method, the lifting activity is "Safe for Load". The reason in this paper to use the STC1000C crane is based on the following 2-dimensional comparison of the lifting process:

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