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Design of Lifter Flyover Segment with a Structure of Lifting Beam can Escape Pairs

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ABSTRACT

The flyover development today is very much at all to do because it is one solution as degrading congestion and lifter segment flyover is one important tool in the construction of flyovers. This research offers an example of the calculation and planning lifter segment fly over the beam structure for lifting can be separated pairs which can later be changed in accordance with the specification segment flyover to be lifted. This design uses Pahl and Beitz method, quality function deployment and rudenko. the results of the research are specifications lifter segment fly over with beam structure for lifting to be loose tide is Lifting Equipment; Wire rope with two types of options on each drum are strands left and right torsion. Mechanism trolley; Can move on the path along the 3,019 mm, diameter the wheel trolley 381 mm, Trolley the wheel shaft diameter: 12 cm or 120 mm with material JIS S45C. Struktur *lifter*; Beam lifting using a beam with a weight per unit length of 1.97 N / mm with JIS G3101 SS540 material along the 4900 mm and a surface area of retaining cylindrical pedestal A of 5024 mm2 with material JIS G3101 SS540. The mechanism of motion lifter can move on the path along the 4000 mm. Wheel lifter diameter 533.4 mm. Hydraulic of lifters driver using a double acting hydraulic with a maximum.

Keywords: Lifter, Fly Over, Pahl And Beitz, Beam, Lifting

INTRODUCTION

Along with the rapid increase in the number of transportation, we must include also with an infrastructure that support, one of them is flying over. Fly over or overpasses is a solution to facilitate traffic. In making fly over or overpass often causes traffic congestion because the use of mobile cranes to lift a segment fly over that can interfere with the smooth traffic flow. Therefore the need of a lifter segment fly over to reduce traffic congestion in the construction of fly over, because of their position lifter is not in the traffic lane.

The lifter is available at this time do not have the structure of a removable plug so it cannot perform the surgery if there is a change in the specification segment flyover, and therefore required structure for lifting lifter with removable plug.

Research related to planning the flyover has been done before, which is planning the flyover using precast concert U type (PC-U) girder [1],[2], and continuous barge unloader design [3]. Six PCU girders were used and the PCU height was 2.3 meters. Where the length of the span under review is 52 meters but analyzed is only 50.8 meters long. This is because the spans being reviewed are those that do not stick to the bridge abutments. The flyover width is 17.7 meters with the road width is 14 meters for 2 lanes, 4 lanes and 2 directions. The specifications for the tendons and anchors used are in accordance with the VSL Multi strand System. Analysis on the bridge structure was carried out by 2 methods, namely manually which was in accordance with the Indonesian National Standard (SNI) 1725: 2016 concerning Loading Standards for Bridges and RSNI-T-12- 2004 concerning Concrete Bridge Structure Planning. The design of the flyover structural components refers to the Design of Factored Loads and Strengths (PBKT). In addition to manual methods, analysis methods are also used using the Structure Analysis Program (SAP) 2000 to calculate or analyze flyover data [2].

Continuous barge unloader design offers an example of the calculation and planning of loading and unloading equipment Continuous Barge Unloader capacity of 800 tons / hour for barges loaded with coal which is normally used in the industry, especially coal handling plant. The final project is expected to be the solution for the lack of productivity of the loading and unloading of coal and one of the reference design tool manufacture Continuous Barge Unloader. This design uses Pahl and Beitz method and the results of this research in the form of structural design tools, the selection of the main component unloader (driving, lifting, belt conveyor, bucket conveyor, and electric motors for lifting and driving) [2].

Other research related to design flyover structure that is by using a segmental precast system with prestressing tendons to produce a design that is in accordance with the requirements used [4]. Then innovative system of precast segmental span-by-span construction for span lengths of above 100 m [5],[6]. Karramal conducts a pre-stressed box girder design for the upper structure of the fly over. The results obtained from the pre-stressed box girder planning are used segmental precast box girder with each segment length of 3 meters with a box height of 3 meters and a width of 9 meters [7].

The aim of this research is weeks to design and analyze the manufacturing segment lifter fly over the beam structure for lifting may be detachable so that a safe lifting beam can be adjusted to the specifications on segment fly over.

RESEARCH METHODS

The research methodology used is a method Pahl and Beitz [8],[9] with Quality Function Deployment (QFD) [6], argued that a design is a creative process, but if it is not directed systematically the possibility to issue the results of the design through the creative process will be limited [10].

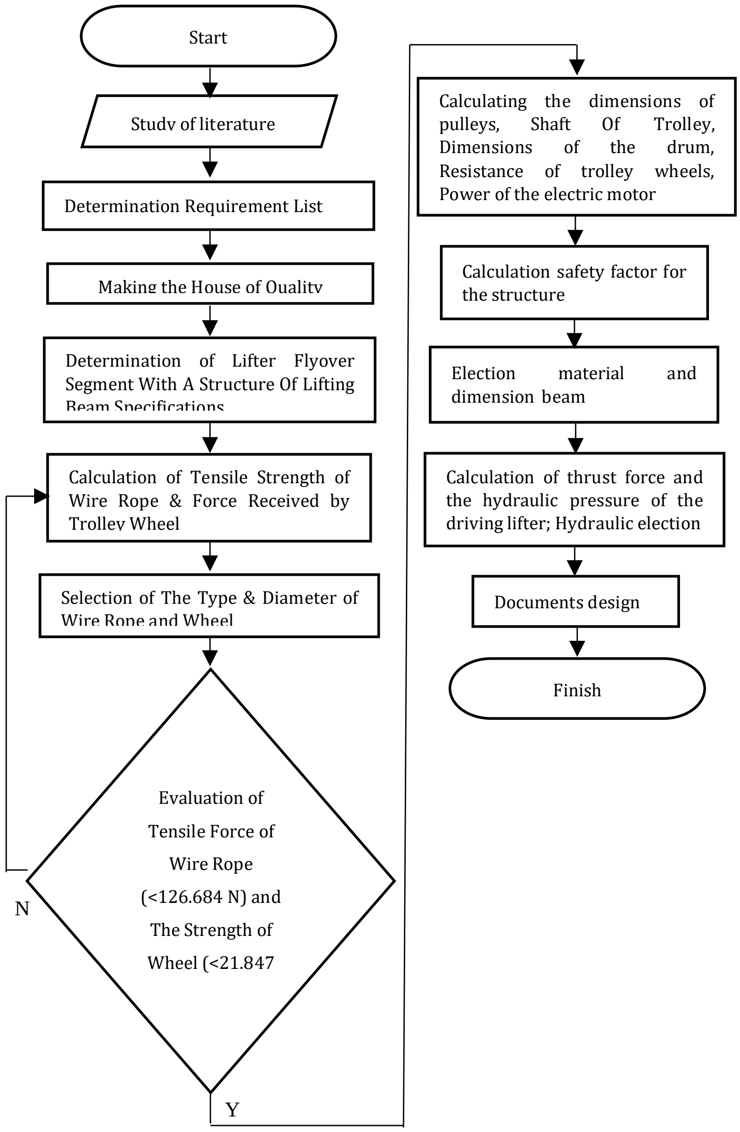


Figure 1. Flowchart of research

RESULTS AND DISCUSSION

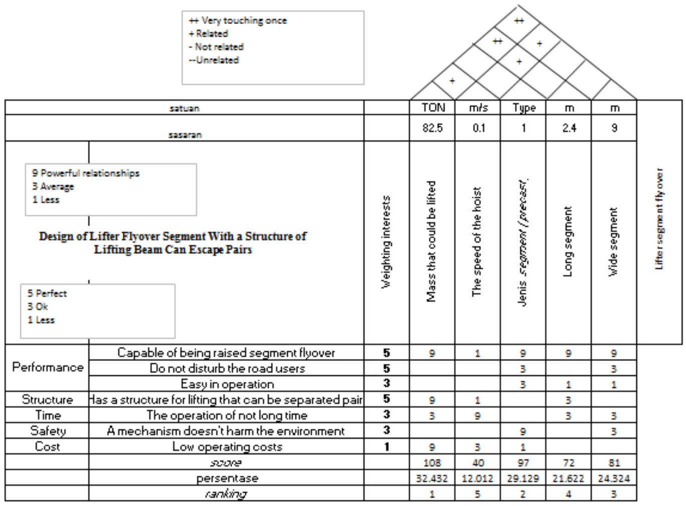
In this phase, we will clarify what needs to design of lifter flyover segment with a structure of lifting beam can escape pairs. Based on a predefined task, then prepared a technical specification of the product contained in the list of requirements. List of Requirement is used as a guideline to design of lifter flyover segment with a structure of lifting beam can escape pairs. Besides, the list of requirements drawn up based on the needs of the completion of the task, so some requirements such as the calculation of the manufacturing cost cannot be calculated or determined.

This stage describes and defines the task in a manner that task outlines into the requirements list, contains restrictions that must be met (demands) and restrictions are expected to be fulfilled (wishes). Here, in table 1 of the requirements outlined in the design of lifter flyover segment with a structure of lifting beam can escape pairs by Pahl and Beitz method.

Table 1. Requiment list

Requiment list	**Description**	**W = Wishes D=Demands**
Structure	Has a structure for lifting that can be separated pairs	D
Performance	Capable of being raised segment flyover equaling to 50 tons	D
	Do not disturb the road users	D
	Easy in operation	W
Time	The operation of not long time	D
Safety	A mechanism doesn't harm the environment	D
Cost	Low operating costs	W

To determine the importance of a design takes a structured overview. With a lifting capacity of 82.5 Ton been due to fly over a small segment estimated to have weighed 40 Ton and 80 Ton for a large, lift speed of 0.1 m/s that is faster than existing ones is 0.03 m/s, and the type, width, length segment corresponding survey data, the following is a figure of house of quality [10].



		Weighting interests	Mass that could be lifted	The speed of the hoist	Jenis *segment / precast*	Long segment	Wide segment
satuan			TON	m/s	Type	m	m
sasaran			82.5	0.1	1	2.4	9
Performance	Capable of being raised segment flyover	**5**	9	1	9	9	9
	Do not disturb the road users	**5**			3		3
	Easy in operation	**3**			3	1	1
Structure	Has a structure for lifting that can be separated pair	**5**	9	1		3	
Time	The operation of not long time	**3**	3	9		3	3
Safety	A mechanism doesn't harm the environment	**3**			9		3
Cost	Low operating costs	**1**	9	3	1		
	score		108	40	97	72	81
	persentase		32.432	12.012	29.129	21.622	24.324
	ranking		1	5	2	4	3

Figure 2. Design of house of quality

Determining the Best Variant

In the design, some components have variants which have drawbacks and advantages, to obtain the right design for lifter flyover segment with a structure of lifting beam can escape pairs, it will be elaborated several variants of the components used as well as several variants formed.

Table 2. Solutions and sub-functions

Principle/ Solutions	A	B
Structure	The structure for lifting can be separated pairs	
The position of the tool	Contained in the structure (pier)	Tool are below the flyover (*mobile*)
Media lifter	*wire rope*	hydraulic
Motion Mechanism	can move (migrate)	remain in one position

There are several combinations of solutions and sub-function in determining the type of lifter segment fly over, so that the output produced completely in accordance with the choice of several alternative options. The following table shows some solutions/sub-functions are taken for the election of a combination of the best variant for designing.

There are several combinations a solution and sub-functions in the determination of the type lifter segment fly over, so that output resulted really fit by choice from a number of alternative choice. The following table showed a number of solutions / sub-functions that is taken for the election of combination variant best to design.

Table 3. Variant shape

Variant	Description
1A-2A-3A-4A	Lifter with lifting structure to be detachable mounted on the structure (pier) by using media such as wire rope lifting, and can move or move to another place by using a specific mechanism
1A-2A-3B-4A	Lifter with lifting structure to be detachable mounted on the structure (pier) by using media such as wire rope lifting, and cannot move or move to another place
1A-2B-3A-4A	Lifter with a lifting structure to be detachable mounted on the structure (pier) by using media such as hydraulic lifter and can move from one place to another by using a specific mechanism
1A-2B-3B-4A	Lifter with lifting structure to be detachable mounted on the structure (pier) by using media such as hydraulic lifter and cannot move or move to another place
1B-2B-3A-4A	Lifter with lifting structure to be separated pairs are on the road or under flyovers by using media such as hydraulic lifters and can move or move from one place to another with certain mechanisms
1B-2A-3A-4A	Lifter with a structure for lifting can be separated pairs are on the road or under flyovers by using media such as wire rope and lifting can move or move from one place to another with certain mechanisms
1B-2B-3B-4A	Lifter with lifting structure to be separated pairs are on the road or under flyovers by using media such as hydraulic lifters and remain in one position or cannot move or move from one place to another
1B-2A-3B-4A	Lifter with lifting structure to be separated pairs are on the road or under flyovers using lifter media in the form of wire rope and fixed in one position or cannot move or move from one place to another.

From 8 variants listed in the table above, there are 6 variants are possible for the designed variant 1 up to 6 variants being the variants 7 and 8 are not allowed to be designed.

Table 4. Selection variants

TABLE SELECTION OF VARIAN									
	Procurement criteria : + yes - no ? Information is incomplete ! Review the information							Criteria Decision : + selected - rejected ? Complete back information ! What specifications may be changed	
variant	can perform its functions properly	An operating speed	Security mechanisms of the environment	Humility operating costs	Eligible capacity	The comfort of road users against the operation	Ease of operation	Reason for rejection	Decision
variant 1	+	+	+	+	+	+	+		+
variant 2	+	+	+	-	+	+	-	Operational cost is quite high and difficult to operate	-
variant 3	+	-	+	-	+	+	-	A long time in operational and operational costs is quite high	-
variant 4	+	-	+	-	+	+	-	A long time in operational and operational costs is quite high	-
variant 5	+	-	-	+	+	-	+	Disrupt road users and a long time operation	-
variant 6	+	+	-	+	+	-	+	Disrupt road users and a long time operation	-

Selected variants are variants 1 (1A-2A-3A-4A) with the explanation contained in table 3.

Design of Wire rope

Tensile strength on each rope [11]:

$$S = \frac{Q}{\text{jumlah tali penggantung}} = \frac{84785}{8} =$$

10598.125kgf,

Actual rope breaking strength:

P = S . K = 10598.125 kgf . 5.5 = 58289.687 kgf,

Sectional area of steel ropes:

$$F = \frac{10598{,}125}{\frac{20000}{5{,}5} - (\frac{1}{37{,}5} \cdot 3628874)} = 3.97 \text{ cm}^2$$

, and the steel rope tension is $\sigma t = \frac{S}{F} = \frac{10598{,}125}{3{,}97} =$ 2669.55 kgf/cm^2 = 26.66955 kgf/mm^2

Then selected types of steel ropes 6x36 core fiber with a diameter of 31.75 mm.

Design of pulley

To use the formula of pressure in the field of pulleys p = $\frac{Q}{l.d}$, where l (long bus or nap Puli) is 1.8. d (pulley diameter) and a p-value of 75 kg / cm^2 by comparison with the speed of the lift, pulley diameter is

$75 = \frac{84785}{1.8\,.\,d\,.\,d}$; $d2 = \frac{84785}{1.8\,.\,75}$ = 628 = 25.06 cm

Then length of nap is. l = 1,8 . d = 1,8 . 25.06 cm = 45.108 cm.

Design of Drum

Diameter of the drum;

D > e1 . e2 . d > 25 . 0.9 . 31.75 > 714,375 mm

D = 715 mm

number of coils;

$Z = \frac{Hi}{\pi D} + 2 = \frac{20000\,.\,2}{\pi\,.715} + 2$ = 19.82 = 20

The total length of the drum;

$L = [\frac{2H}{\pi D} + 12]\, s + l$

$L = [\frac{2.20000}{\pi\,.715} + 12]\ 35{,}04 + 420{,}48$

= 1465,25 mm

Thickness of walls of the drum;

ω = 0.02D + (0.6 up to 1.0) cm = 0.02 (715) + 10 mm ω = 24.3 mm = 2.43 cm

The maximum stress on the surface of the drum;

$\sigma = \frac{S}{\omega\,.s} = \frac{10598{,}125}{2{,}43\ (3{,}504)}$ = 1244.68 kgf/cm2

Then use cast steel material by Rudenko 9 [11] σ are allowed to cast steel up to 1600 kgf / cm^2.

Design of motor Lifting

Used motor power can be calculated by;

$N = \frac{Qv}{75\eta} = \frac{84785\ kg\ (0{,}1)}{75\,.0{,}8}$ = 141.3 Hp = 105.37 kW

With a power requirement of 105.37 kW, then have an electric motor with a power of 110 kW with a rotational speed of 3000 rpm.

Design of Rail and wheel trolley

The maximum force acting on the trolley is

$P_{max} = \frac{Q+Go}{4} = \frac{84785+2515}{4}$ = 21825 kgf or 48115.89 lbf

The radius of the steel wheels;

$$r = \left(\frac{600}{\sigma}\sqrt{\frac{P\,.\,k}{b}}\right)^2$$

$$r = \left(\frac{600}{23759}\sqrt{\frac{21825\,.\,0{,}5}{6{,}985}}\right)^2 = 6.84 \text{ cm}$$

Then wheel diameter is:

D = 2r = 2 . 6.84 = 13.69 cm = 5.39 inch

Then selected steel wheels with 15 inch radius and the maximum working load of 48.550 lb.

Design of Shaft on trolley wheels

Diameter shaft on a wheel trolley

$$dw = \sqrt[3]{\frac{10{,}2\,.\,Pmax\,.\,L}{\sigma b}}$$

(Source:[12])

$$dw = \sqrt[3]{\frac{10{,}2\,.\,21825\,.\,25}{3000}} = 12.29 \text{ cm}$$

selected 12 cm or 120 mm

Design of resistance motion trolley

Resistance due to motion trolley wheels

$W_1 = (Q + q + Go)\,\beta\,\frac{\mu\,.\,d+2\,.\,k}{D}$

$W_1 = (84785 + 2515)\ 1{,}8\ \frac{0{,}01\,.\,120+2\,.\,0{,}05}{381}$

W_1 = 536.17 kg

Resistance on the rope pulley wheel lifter

W2 = Son – Soff = 10917,11 kgf – 10287,44 kgf = 629.67 kgf

Resistance total

W total = W1 + W2= 536.17 + 629.67 = 1165.84 kgf.

Design of a motor drive trolley

The required power is

$N_{mot} = \frac{W.v}{75.\eta}$ hp $= \frac{1165,84 \ . \ 0,5}{75 \ .0,8} = 9,715 \ hp$

With a power requirement of 9.715 HP, then have an electric motor with a power of 10 HP with a motor rotation speed of 3,600 rpm and moment of inertia of 0.0077 kg.m^2.

The moment of static resistance referred to the motor shaft ;

$M_{st}= 71620 \ \frac{Nmot}{nmot} kg.cm = 198,94 \ kg.cm$

Shear shaft;

$\tau = 0,18 \ . \ \sigma u = 0,18 \ . \ 5600 = 1008$ kg/cm^2

Torque shaft;

$T = \frac{P.60}{2.\pi.N} = \frac{7,457 \ kW \ .60}{2.\pi.3600} = 0,019$ N.m atau 1,9 N.cm

The diameter of the shaft [13];

$d = \sqrt[3]{\frac{T \ . \ 16}{\pi \ . \ \tau}} = \sqrt[3]{\frac{1,9 \ . \ 16}{\pi \ . \ 1008}} = 0,21$cm atau 2,18 mm

By using a flexible coupling type jm 20c then selected shaft diameter of 4 mm.

The moment of gyration;

The moment of gyration clutch;

$GD_2 = I \ . \ 4g = 1,96 \ . \ 10\text{-}5$ kg.m2

The moment of gyration the motor;

$GD_2 = I \ . \ 4g = 0,308$ kg.m2

Moment of gyration greater for components mounted on the motor shaft

$(GD_2)r.r = \delta \ . \ GD_2 = 0.339$ kg.m^2

The moment of the dynamic force at start;

$M_{dyn} = \frac{\delta(GD^2)r.r \ n}{375.ts} + \frac{0,975G\prime v^2}{nts\eta} = 2.19$ kg.m

The moment the full force generated when the motor acceleration

$M_{mot} = M_{st} + M_{dyn} = 1.9894$ kg.m + 2.19 kg.m

$M_{mot} = 4.1794$ kg.m

Design of brake

The moment of dynamic forces during the slowdown;

$M'_{dyn} = \frac{\delta(GD^2)r.rn}{375.tbr} + \frac{0,975G\prime v^2\eta}{ntbr}{}_{dy} = 8.3$ kg.m

Moment of force is required for braking;

$M_{br} = M_{st} + M'_{dyn} = 10.2894$ kg.m

With a dynamic style moments during braking of 10.9894 kg m and planned of brake wheel diameter of 200 mm shoes, then selected Electro Hydraulic Thruster Brakes with specifications: Diameter drum (200 mm), Capacity Thruster (18 kg), Step Thruster (52 mm), moment of braking (20 kg m).

The safety factor for structure

$FS = FS_{material} \ x \ FS_{stress} \ x \ FS_{geometry} \ x \ FS_{failure \ analysis} \ x \ FS_{reliability}$ [3]

FS = 1,1 x 1,2 x 1,0 x 1,3 x 1,4 = 2,4

Structure

Beam 1;

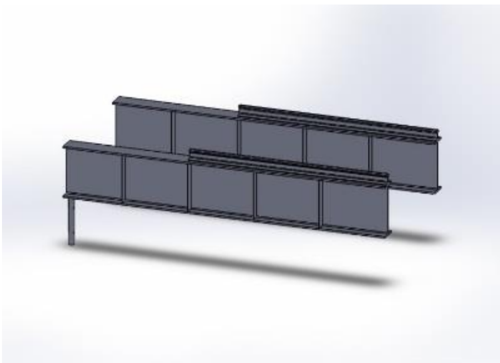


Figure 3. Beam 1 atau lifting

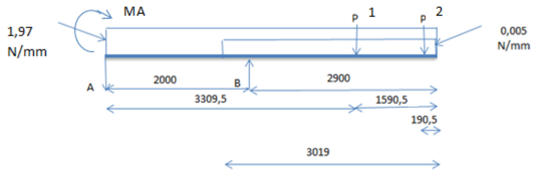


Figure 4. Free Body Diagram (FBD) beam 1

The deflection at the end of the first beam is equal - 6.670086436 mm. Can be declared safe because it is smaller than $\frac{1}{700}L$ that $-\frac{1}{700}4900\ mm$ = -7 mm.

From Free Body Diagram (FBD) beam 1 then obtained RB = 1,107,794.287 N, N RA = 661,626.192, MA = 441,740,794.4 N. And the method of sections obtained at the point of maximum bending moment is -885 451 625 2000 mm N.mm. By using the formula σ = My / I, then the bending stress is - 136.042 N/mm². By using JIS G3101 SS540 material, it can be declared safe for $\sigma_{work} < \sigma_{permission}$ = 136.042 N/mm² <166.67 N/mm².

Beam 2;

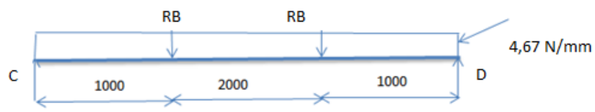


Figure 4. Free Body Diagram (FBD) beam 2

From Free Body Diagram (FBD) beam 2 then obtained RC = 1,117,134.287 N, RD = 1,117,134.287 N. And the method of sections obtained at the point of maximum bending moment is 1000 mm 1114799287 N.mm. By using the formula σ = My / I [14][15], then the bending stress is 132.9818 N / mm2. By using JIS G3101 SS540 material, it can be declared safe for $\sigma_{work} < \sigma_{permission}$ = 132.9818 N / mm² < 162.5 N / mm².

Beam 3;

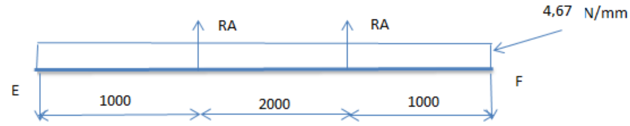


Fig. 5. Free Body Diagram (FBD) beam 3

From Free Body Diagram (FBD) beam 3 then obtained RE = 652,286.192 N, RF = 652,286.192 N. And the method of sections obtained at the point of maximum bending moment is 1000 mm is – 654,621,192 N.mm. By using the formula σ = My / I, then the bending stress is -78.08823 N/mm². By using JIS G3101 SS540 material, it can be declared safe for $\sigma_{work} < \sigma_{permission}$ = 78.08823 N/mm² < 162.5 N / mm².

Weld joint between the beam 3 with a hollow cylinder. The type of connection used is a parallel double fillet that is to be welded between the outer side of the cylinder with the beam 3 and T joint on the top of the beam 3. Using Covered Electrode type AWS E7048 / JIS D4316 for structural members. For parallel connection type double fillet weld between the outer side of the cylinder with a thick weld beam 3 is

P = 2 . 0,707 . s . l . τ

$$s = \frac{P}{2\,.\,0{,}707\,.\ l\,.\,\tau}$$

$$s = \frac{661626{,}192}{1{,}414\ X\ 580{,}4\ X\ 220}$$

s = 3.66 mm

Weld joint between the beam 3 with a hollow cylinder. The type of connection used is a parallel double fillet that is to be welded between the outer side of the cylinder with the beam 3 and T joint on the top of the beam 3. Using Covered Electrode type AWS E7048 / JIS D4316 for structural members. For parallel connection type double fillet weld between the outer side of the cylinder with a thick weld beam 3 is

$$P = 0.707 . s . l . \sigma_t$$

$$s = \frac{P}{0{,}707\ .\ l\ .\ \sigma t}$$

$$s = \frac{661626{,}192}{0{,}707\ .\ 502{,}4\ .\ 550}$$

s = 3.39 mm

Truss;

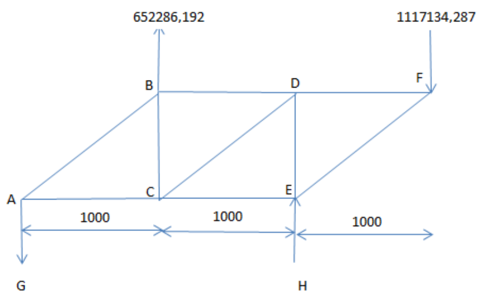


Figure 6. Free Body Diagram (FBD) truss

From Free Body Diagram (FBD) truss then obtained RG = 884,710.2395 N, RH = 884,710.2395 N. By analyzing each point and voltage of each bar with the formula σ = F / A, the selected material JIS G3101 SS540, it can be declared safe for $\sigma_{work} < \sigma_{permission}$.

Beam 4;

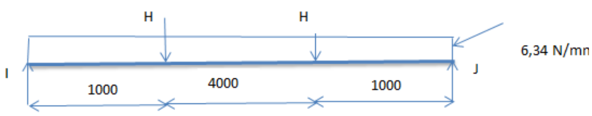


Figure 7. Free Body Diagram (FBD) beam 4

From Free Body Diagram (FBD) beam 4 then obtained RI = 1,368,578.335 N, RJ= 1,368,578.335 N. And the method of sections obtained at the point of maximum bending moment is 5000 mm is 1,365,408,335 N.mm. By using the formula σ = My / I, then the bending stress is -78.08823 N/mm^2. By using JIS G3101 SS540 material, it can be declared safe for $\sigma_{work} < \sigma_{permission}$ = 117.8888 N/mm^2< 162.5 N / mm^2.

Beam 5;

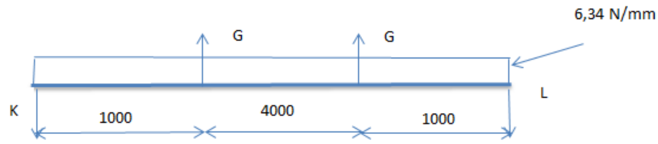


Figure 8. Free Body Diagram (FBD) beam 5

From Free Body Diagram (FBD) beam 5 then obtained RK = 865,690.2395 N, RL= 865,690.2395 N. And the method of sections obtained at the point of maximum bending moment is 5000 mm is -868,860,240 N.mm. By using the formula σ = My / I, then the bending stress is 75.017 N/mm^2. By using JIS G3101 SS540 material, it can be declared safe for $\sigma_{work} < \sigma_{permission}$ = 75.017 N/mm^2 < 162.5 N / mm^2.

Design of screw

Screw to connect the cylinder to the beam 1 and the hollow cylinder on the beam 3.

The Major diameter screw is

$$d = \sqrt{\frac{4\ .\ Ps}{\pi\ .\ \tau\ .\ n}}. = \sqrt{\frac{4\ .\ 661626{,}192}{\pi\ .\ 450\ .\ 2}} = 30{,}6 \text{ mm}$$

Thus the standard table selected metric coarse threaded M33 series and with material F10T JIS B1186.

Design of Rail and wheel lifter

The maximum force that works against the wheel lifter amounted 865,690.2395 N (reaction to the pedestal K and L on the beam 5) or equal to 86569.02395 kg to g = 10 m / s2 or equal to 190,852.0159 lb. Because there are 4 wheels then 190852,0159 /2 = 9426,00795 lb

Based on the book found that the crane rail with a load acting on the wheel of 9426.00795 lb then selected diameter steel wheels with 21 inch diameter and maximum working load of 113 350 lb and 175 lb.

Design of Hydraulic Lifter

Diameter shaft on lifter;

$$dw = \sqrt[3]{\frac{10,2\ .\ Pmax\ .\ L}{\sigma b}}$$

$$dw = \sqrt[3]{\frac{10,2\ .\ 865690,2395\ .\ 25}{3000}}$$

dw = 41,9 cm

Selected 42 cm or 420 mm

Resistivity due to friction on the wheels Lifter;

$$W = (\ Q + Go\ )\ \beta\ \frac{\mu\ .\ d + 2\ .\ k}{D}$$

$$W1 = (\ 865690,2395\ )\ 1,8\ \frac{0,01\ .\ 420 + 2\ .\ 0,05}{533,4}$$

W = 12561,76 N

Hydraulic pressure;

By using the hydraulic double acting hydraulic pressure is

P = F/ A = 12561,76 N / 3830 ,03 mm^2 = 3,27 N/ mm^2 or 474,2734 psi

Hydraulic pressure Indicated secure because 474,2734 psi < 2000 psi.

CONCLUSIONS

Specifications lifter segment fly over with beam structure for lifting to be loose tide is

1. Lifting Equipment; Wire rope with two types of options on each drum are strands left and right torsion. speed of lift 0.1 m/s, maximum lift height 20,000 mm, maximum lift capacity 82,5 Ton or 82500 kg, diameter wire rope 31.75 mm, type wire rope 6 X 36 *Fibre corre* XIPS, diameter pulleys 250.6 mm, The length of puli 451.08 mm, diameter drum 715 mm, Number of roping on drums 20 coil, The total length of the drum 1465.25 mm, Thickness of walls of the drum 24.3 mm, Lifting motor power 110 kW with motor rotation speed of 3,000 rpm.
2. Mechanism trolley; Can move on the path along the 3,019 mm, diameter the wheel trolley 381 mm, Trolley the wheel shaft diameter: 12 cm or 120 mm with material JIS S45C, motor driver of trolley 7.457 kW with motor rotation speed of 3,600 rpm. The brakes on the wheels of trolley; Diameter drum 200 mm, Capacity of the Thruster 18 kg, Measures Thruster: 52 mm, braking Moment: 20 kg.m
3. Struktur *lifter*; Beam lifting using a beam with a weight per unit length of 1.97 N / mm with JIS G3101 SS540 material along the 4900 mm and a surface area of retaining cylindrical pedestal A of 5024 mm2 with material JIS G3101 SS540. Beam 2 using a beam with a weight per unit

length of 4.67 N / mm with JIS G3101 SS540 material throughout 4,000 mm. Beam 3 using a beam with a weight per unit length of 4.67 N / mm with JIS G3101 SS540 material along a surface area of 4,000 mm and a hollow cylindrical beam anchoring lifting of 15 072 mm^2 with JIS G3101 SS540 material parallel double fillet welded on the outside of the cylinder with beam 3 with a thickness of 3.66 mm welded and butt welded T-joint with weld thickness 3.39 mm. Truss using a beam with a weight per unit length of 0.85 N / mm with material JIS G3101 SS540. Beam 4 and 5 using the beam with a weight per unit length of 6.34 N / mm with JIS G3101 SS540 material throughout 6000 mm. Threaded connection between the cylinder on the lifting beam with beam 3 using M33 bolts with steel material F10T amounted to 4 bolts along with the nut.

4. The mechanism of motion lifter can move on the path along the 4000 mm. Wheel lifter diameter 533.4 mm Hydraulic of lifters driver using a double acting hydraulic with a maximum pressure of 2,000 psi.

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