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Mini Forklift Design with A Maximum Capacity of 5 Kg

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ABSTRACT

During the long-term development until now, industrial machinery products have shown very rapid progress, both in terms of volume and variety of products produced. The development of this product is not only marked by the fulfillment of public interest, but also leads to the ability to enter exports to increase the country's foreign exchange. In making this mini forklift, the author first understands the methods in planning in the preparation stage and in theory, namely by analyzing the design, because planning also requires the ability to analyze planning to get performance on this mini forklift. In its use in mini forklifts, the shaft is used as a transmission link from the gear motor to the elevator wire. The output power (P) is 0.012 kW. Shaft material is estimated from S30C carbon steel with tensile strength (σ B) 48 kg/mm2 and shaft rotation is n 105 rpm. With a 1 then the construction of the fork is safe. Based on the calculations and planning carried out, the conclusions are as follows (1) Planning Specifications. a. Material to be lifted: Unit load crates, pipes, iron, cardboard and plates. b. Machine capacity: 5 kg. c. Transmission system: Steel Rope and Pully.

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1. INTRODUCTION

During the long-term development until now, industrial machinery products have shown very rapid progress, both in terms of volume and variety of products produced (Miranza, 2009). The development of this product is not only marked by the fulfillment of the interests of the community (Zulpan, 2009), but also leads to the ability to enter exports to increase the country's foreign exchange (Ginting, 2009). Forklifts are often found in factories or companies with the intention of making it easier to move goods from the warehouse to the production room and vice versa from the finished production room to the warehouse for packaging (Syahputra, 2009). This has become very much needed in the factory, and with the development of the times, forklifts are getting more and more modern (Widowati & Septiawan, 2021).

Forklifts or also often referred to as lift trucks are one of the most widely used material handling materials in the logistics world (Hendriko et al., n.d.). The main purpose of using a forklift is for transportation and lifting (Lumanto & Sugondo, 2014). The history of forklifts first began in 1906. The Pennsylvania Railroad introduced a battery platform truck for moving goods (Prassetyo, 2015). Subsequent developments took place during World War I. It is said that historically, the world of logistics was greatly influenced by the existence of war (Pongtiku et al., 2016). Modern forklifts are now very different from the early history of existing forklifts (Maslihan, 2020). Modern forklifts are really focused on two main things, namely transportation and lifting (Wibowo, 2020).

Forklifts are useful as a material moving machine that has a predetermined maximum load lifting power (Puteri et al., 2022), move to lift goods that are supported on a fork with a lift system as up and down (Suganda, 2019). Forklifts that are widely used in companies and factories are forklifts using a hydraulic booster that uses 2 tubes, namely (Yanitia, 2015): (1) Booster to lift and lower the load (2) Booster to lighten the frame at 6° and 12° in the forward and backward directions. By using forklift work becomes easy, practical and efficient for various reasons (Romansyah, 2016). Seeing and reviewing the problems faced by users, the authors create a more useful and efficient equipment that makes it easier to find out which forklifts are Mini forklifts with a maximum load of 5 Kg (Slamet, 2019).

The objectives of designing a Mini Forklift machine are: (1) To design a Mini Forklift with a lifting load of 5 kg. (2) To realize a Mini Forklift that has a simple system, is inexpensive, easy to operate and maintain, and can increase the use of the tool. This final report is expected to be useful for: (1) To support the development of appropriate technology for factories and campuses. (2) For students who want and are interested in developing from this tool. (3) The author himself is to add insight into the process of making a mini forklift machine and apply the knowledge gained during lectures which is used to design a mini forklift machine tool.

2. RESEARCH METHOD

2.1 Preliminary Data

In making this mini forklift, the author first understands the methods in planning in the preparation stage as well as in theory (Ariyadi, 2010), namely by analyzing the design, because planning also requires the ability to analyze plans to get performance on this mini forklift (Astuti & Iftadi, 2016).

2.2 Mini Forklift Capacity Determination

The capacity of the mini forklift machine is planned to be able to lift a maximum of 5 kg of material to be transported using a fork.

2.3 Transmission System Planning

To move the motor rotation to the drive shaft, it is planned to use a shaft and roller transmission system and be adjusted to their needs (Bayu et al., 2021). In the planning of this mini forklift, it is planned that the final rotation is 105 rpm.

2.4 Planning Specification

Material Type: Unit load crates, pipes, iron, cardboard and plates. Capacity: maximum 5 kg. Transmission system: Shaft and roller.

3. RESULTS AND DISCUSSIONS

3.1. Shaft Strength Analysis on Motor Drive

In its use in mini forklifts, the shaft is used as a transmission link from the gear motor to the elevator wire. The output power (P) = 0.012 kW. Shaft material is estimated from S30C carbon steel with tensile strength (σ B) = 48 kg/mm2 and shaft rotation is n = 105 rpm. For planning power (Pd) is: Pd = fc.P Where: fc = power correction factor shown in table 2.1Pd = fc.P = 2 x 0.012 kW = 0.024 kW. To calculate Torque in can.

$$T = 9{,}74 \times 10^5 \times \frac{P_d}{n} \tag{1}$$
$$= 9.74x10^5 x \frac{0{,}024}{105}$$

= 22.04 kg.mm
For Permitted Shear Stress can be obtained

$$\overline{\sigma}_a = \frac{\sigma_B}{sf_1 \times sf_2} \tag{2}$$
$$= \frac{48}{6x2}$$

= 4 Kg/mm2

$$\overline{\sigma}_a = \frac{\sigma_B}{sf_1 \times sf_2} \tag{3}$$
$$= \frac{48}{6x2}$$
$$= 4 \ kg/mm^2$$

$$\tau_a = \frac{\sigma_a}{1{,}73.\alpha_0} \tag{4}$$
$$= \frac{4}{1{,}75 \ x \ 1} = 2{,}2 \ kg/mm^2$$

For the Shaft Diameter can be calculated by calculating

$$d_s \geq \left[\frac{5{,}1.T}{.\tau_a} \times Kt \times Cb.T\right]^{\frac{1}{3}} \tag{5}$$
$$d_s \geq \left[\frac{5{,}1}{.2{,}2} \times 3 \times 1{,}0 \ x \ 22{,}04\right]^{\frac{1}{3}}$$
$$d_s \geq 5{,}6 \ mm$$
$$d_s = 11{,}2 \ mm$$

where the mini forklift in the design of the shaft diameter is 11.2 mm (Appendix 9) So, the shear stress that arises on the shaft is:

$$\tau = \frac{16.T}{\pi.d_s^3} \tag{6}$$
$$= \frac{16 \ x \ 22{,}04}{\pi.(6)^3}$$
$$= 0{,}5 \ kg/mm^2$$

So it can be said that construction is safe becausea

3.2. Fork Strength Analysis (Fork)

This fork is attached to the frame with motion caused by a pulley system connected to the driving motor to go up and down, as shown in Figure 2.7. This section will calculate and analyze the weight of the fork, fork moment, shear and tensile stresses as well as deflection. what happens to the fork rod.
Wd = (1 + %) Q
Where: Wd = design load (kg)
1 = constant
% = balance taken 20%

Q = lifting capacity (kg)
Wd = (1 + 20%) 5
= 6 Kg
Wd = (1 + 20%) 5
Then: Wm = x Wd
Where : Wm = mechanical load
Wd = design load
Wm = x 6
= 3 kg

3.3. Tensile Stress In Steel Rope

The steel rope in the design of this mini forklift uses 2 mm diameter steel, which functions as a fork carrier up and down with or without load. The pulley is used as a steel rope wheel with a motor drive system wrapped around a steel rope on the motor shaft. The tensile stress on the steel rope is analyzed to find and determine the strength of the material of this steel rope which is made of coiled steel as shown in Figure 2.14.

$$\tau = \frac{M_x.C}{I_x} \qquad (7)$$

$$\tau = \frac{16\ .\ M_x}{\pi\ .\ d^3} \qquad (8)$$

Then the tension in the steel rope for the total load (L)

$$\tau = \frac{16\ .\ 1000}{\pi\ .\ 20^3}$$

$$\tau = 2\ \frac{kg}{mm^2}$$

Permissible tensile stress (σ a):

$$\overline{\sigma}_a = \frac{\sigma_b}{sf} \qquad (9)$$

$$\tau_a = \frac{\overline{\sigma}_a}{1{,}73.\alpha_0} \qquad (10)$$

With b = tensile strength of steel rope 130 kg / mm2 sf = 1 to 5 is taken = 5

$$\sigma_a = \frac{13{,}3}{5}$$

$$\sigma_a = 2{,}2\ \ kg/mm^2$$

The bending stress for the length of the arm is given a load (P) at the midpoint

$$\sigma_t = \frac{500kg}{\frac{1}{6} x\ 150\ x\ (5)^2}$$

$$\sigma_t = 0{,}8\ \ kg/mm^2$$

Permissible tensile stress (σ a):

$$\overline{\sigma}_a = \frac{\sigma_b}{sf} \qquad (11)$$

With b = 13.3 2 kg mm is taken from table 2.3, and sf = 1 to 5 is taken = 5

$$\sigma_a = \frac{13{,}3\,kg/mm^2}{5}$$

$$\sigma_a = 2{,}2\,kg/mm^2$$

Untuk beban di	σ_a	σ_t
L/2	2,26	0,8
L	2,26	1,6

With a > 1 then the construction of the fork is safe.

3.4. Transported Material

A review of the transported material needs to be carried out in the mini Forklift discussion. This review aims to obtain data regarding the characteristics of the transported material and the variables carried out in this discussion.

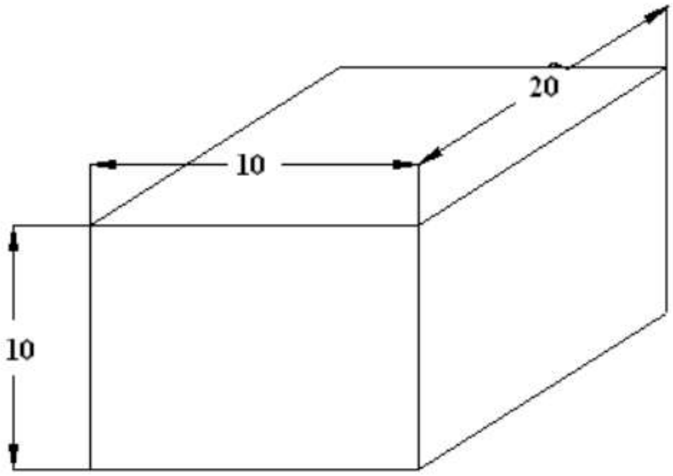

Figure 1. Dimensions of Transported Materials

Table 1. Effect of Load Variation on Motor Power

No.	Beban (Kg)	Putaran Motor (Rpm)	Kecepatan Beban (Vg) (m/s)	Daya Motor (HP)
1	1	105	0,1	0,0013
2	1,5	105	0.1	0,002
3	2	105	0.1	0,0026
4	2,5	105	0.1	0,0033
5	3	105	0.1	0,004
6	3,5	105	0.1	0,0046
7	4	105	0,1	0,0053
8	4,5	105	0.1	0,006
9	5	105	0.1	0,0066

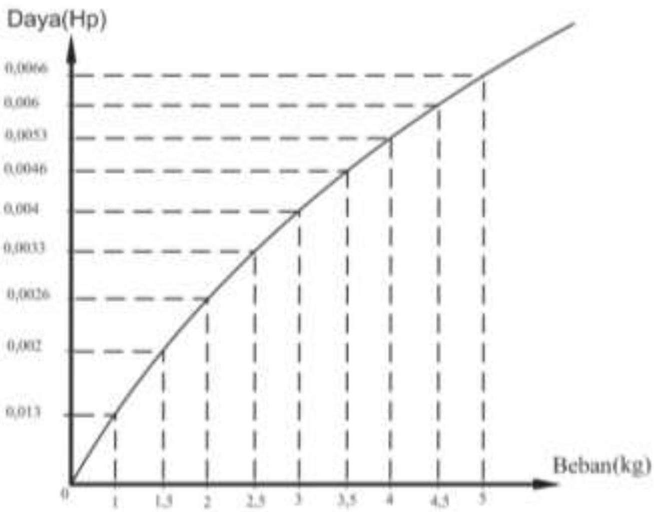

Figure 2. Drive Motor Test Analysis Graph

The graph above shows that the greater the load that is lifted, the greater the motor power needed. This happens because the power adjusts to the speed of the load. If the power applied to the motor at the time of loading is the same as the power at the time of no loading, then the motor speed will decrease according to the loading conditions.

4. CONCLUSION

Based on the calculations and planning carried out, the conclusions are as follows; (1) Planning Specifications. a. Material to be lifted: Unit load crates, pipes, iron, cardboard and plates. b. Machine capacity: 5 kg. c. Transmission system: Steel Rope and Pully. (2) Tool construction a. Drive motor power: 0.012 Kw. b. Drive motor rotation: 105 rpm. c. Wheel Speed: 105 rpm. d. Shaft size: l = 128 mm, d = 11 mm. e. Drive motor shaft material: S30C carbon steel. f. Mounting frame: 5mm Acrylic Polymer. (3) Transmission system. a. Transmission system: Steel Rope and Pulley. b. Pulley size: 10 and 30 mm. c. Steel Rope Size: Type B 2 mm. (4) Analysis of the shaft strength of the driving motor. a. shear stress arising on the shaft (τ): 0.5kg/mm 2. b. Permissible Shear Stress (a) : 2.2 kg/mm 2. c. Torque on the Shaft (T): 22.04 kg.mm. d. Shaft Diameter (d): 11 mm. (5) Tensile Stress on Fork. a. Tensile stress on arm L entirely (σ t): 1.6 2 kg mm. b. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a) : 2,2 2. (4) Analysis of shaft strength on the driving motor. a. shear stress arising on the shaft (τ): 0.5 kg/mm2. b. Permissible Shear Stress (a): 2.2 kg/mm2. c. Torque on the Shaft (T): 22.04 kg.mm. d. Shaft Diameter (d): 11 mm. (5) Tensile Stress on Fork. a. Tensile stress on arm L entirely (σ t): 1.6 2 kg mm. b. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a): 2.2 2. Allowable tensile stress (a) : 2,2 2. (4) Analysis of shaft strength on the driving motor. a. shear stress arising on the shaft (τ): 0.5 kg/mm2. b. Permissible Shear Stress (a): 2.2 kg/mm2. c. Torque on the Shaft (T): 22.04 kg.mm. d. Shaft Diameter (d): 11 mm. (5) Tensile Stress on Fork. a. Tensile stress on arm L entirely (σ t): 1.6 2 kg mm. b. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a): 2.2 2. Allowable tensile stress (a) : 2,2 2. (4) Analysis of shaft strength on the driving motor. a. shear stress arising on the shaft (τ): 0.5 kg/mm2. b. Permissible Shear Stress (a): 2.2 kg/mm2. c. Torque on the Shaft (T): 22.04 kg.mm. d. Shaft Diameter (d): 11 mm. (5) Tensile Stress on Fork. a. Tensile stress on arm L entirely (σ t): 1.6 2 kg mm. b. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a): 2.2 2. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a): 2.2 2. Tensile stress on arm L center load (σ t): 0.8 2 kg mm. c. Allowable tensile stress (a): 2.2 2.

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REFERENCES

Ariyadi, R. A. (2010). *Manajemen persediaan dan penataan gudang spare part bus di PO. Safari Eka Kapti*.

Astuti, R. D., & Iftadi, I. (2016). *Analisis dan Perancangan Sistem Kerja*. Deepublish.

Bayu, S., Dikka, H., & Rosanti, H. (2021). *MODIFIKASI MESIN PENCACAH PELEPAH SAWIT METODE "CUTTING TOOLS PRINCIPLE."* Politeknik Manufaktur Negeri Bangka Belitung.

Ginting, M. S. (2009). *Prosedur dan Pembuatan Mesin Pengupas Kulit dengan Kapasitas 40 kg/jam*.

Hendriko, D., Zuliantoni, Z., & Supardi, N. I. (n.d.). PERANCANGAN PROTO TYPE ROBOT FORKLIFT OTOMATIS. *TEKNOSIA*, *1*(11), 22–31.

Lumanto, A. A., & Sugondo, S. (2014). PERENCANAAN ALAT BANTU PENGANGKAT DAN PEMINDAH KERTAS GULUNG. *Mechanova*, *3*.

Maslihan, M. (2020). ANALISIS MATERIAL HANDLING PROSES PRODUKSI PENGOLAHAN KAYU DI SUB DEPARTEMENT PRODUKSI (WOOD CENTER) PADA PERUSAHAAN WOODWORKING MANUFACTURE DI KAWASAN INDUSTRI CIBITUNG BEKASI INDONESIA. *Strategy: Jurnal Teknologi*, *4*(2).

Miranza, N. (2009). *Analisa Hasil Pengujian Mesin Pengupas Kulit Kopi dengan Kapasitas 40 Kg/Jam*.

Pongtiku, A., Robby Kayame, S. K. M., Rerey, V. H., SKM, M. P. H., Tedjo Soeprapto, M. M., & Resubun, Y. (2016). *Metode Penelitian Kualitat If Saja*. Nulisbuku. com.

PRASSETYO, E. (2015). *Rancang Bangun Alat Pengangkat Dan Pemindah Drum (Proses Pembuatan)*. Politeknik Negeri Sriwijaya.

Puteri, M. A., Harianto, H., Saputra, T. J., Simanjuntak, M. A., Randalangi, E., Salsabila, A., & Al Farisi, A. H. V. (2022). Analisis Keselamatan Kerja Pada Sistem Pengoperasian Forklift Dan Crane Guna Mencegah Kecelakaan Kerja. *Zona Laut: Jurnal Inovasi Sains Dan Teknologi Kelautan*, 32–37.

ROMANSYAH, M. A. (2016). *Teknik Pembuatan Pakan Buatan Ikan Gurame (Osphronemus gouramy) di CV. Mentari Nusantara Desa Batokan Kecamatan Ngantru, Kabupaten Tulungagung, Propinsi Jawa Timur*.

Slamet, M. (2019). *APLIKASI REKAYASA NILAI (VALUE ENGINEERING) PEMENUHAN TARGET PRODUKSI IDLER ASSEMBLY*. President University.

Suganda, Y. (2019). *Pembuatan Konstruksi Forklift Mini Kapasitas 200 Kg Untuk Usaha Kecil Menengah (Ukm)*.

Syahputra, I. (2009). *Analisa Pengujian Performansi Mini Forklift Kapasitas Maksimum 5 Kg*.

Wibowo, A. (2020). Manajemen keuangan. *Penerbit Yayasan Prima Agus Teknik*, 1–324.

Widowati, R., & Septiawan, T. R. (2021). ADMINISTRASI PERGUDANGAN PADA CV EASTERN DEPO JAKARTA. *JAB (Jurnal Akuntansi & Bisnis)*, *7*(01).

Yanitia, A. D. S. (2015). *Perlindungan Hukum Pemegang Hak Merek Dalam Negeri Terhadap Merek Terkenal*. Untag 1945 Surabaya.

Zulpan, M. (2009). *Rancang Bangun Mini Forklift dengan Kapasitas Maksimum 5 kg*.