Design and Development of Mechanical Forklift

Lobo Allwyn M[1], Khebude Karan N[2], Adsul Ganesh B[3], Bhosale Prathamesh G[4],

Khade Omkar S[5], Naik Abhijeet N[6]

[1,2,3,4,5]Student, Sanjeevan Engineering & Technology Institute, Panhala, MH, India
[6] Professor, Dept. of Mechanical Engineering, Sanjeevan Engineering & Technology Institute, Panhala, MH, India

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Abstract - *Material handling process is the process of movement of raw material, semi-finished goods, finished goods through various stages of production and warehousing. It has been seen that forklift equipment is widely used in many industries for different applications such as lifting, safe delivery of material such as huge boxes, Raw materials, Cylindrical sections etc. are widely used Forklift equipment. It consist of Lead screw & Nut arrangement. The forklift equipment is compact in size can be alternative for the manual lifting. Small scale industries can't afford the huge & costly material handling equipment so we are designing and manufacturing Forklift equipment for small scale industries.*

Key Words: **Forklift, Lead screw, Nut, Motor, Gearbox, Battery, Bearing, Fork**

1. INTRODUCTION

The forklift can be defined as a tool of lifting hundreds of kilogram of weight. A forklift vehicle similar to a small truck that has two metal forks on the front used to lift cargo. The forklift operator drives the forklift forward until the forks push under the cargo, and can then lift the cargo several feet in the air by operating the forks.[3]

The forklift works on Electric D.C. Motor. Electric forklift are great for warehouse use because they do not give off noxious fumes like Gas powered forklift do. Gas powered forklift are stronger than electric forklift, but they are more difficult to maintain and fuel are costly.

1.1 Market Survey

The market survey lets the firm to understand and realize the real demand and potential for the product under consideration. First and foremost, it is necessary to establish that the proposed product will fulfill a demand in the market or not, what is supposed to do, and the service it can offer to the consumers.

So, we take the survey for our prototype in 'SAFAL INDUSTRIES', Shiroli M.I.D.C. Kolhapur. There requirement of miniature forklift that can list the component up to 500 Kg economically.

After we surveyed in our institute we can found that the educational engineering apparatus up to 200 Kg is not easy to move from one place to another place. So the miniature forklift is required to design that can utilized for lifting load up to 200Kg

1.2 Field of Use

The forklift are used to transfer material from one place to another place. These are used in commercial areas like Industrial Workshops, warehouses, Car servicing station, Institutes, Material handling and construction applications.

1.3 Literature Survey

From the reference of actual Industrial forklift we have designed our miniature and cost effective forklift. The structure is constructed by using C-channels, Metal frames, lead screw, Nut etc. These materials are easily available into market. From literature survey we got important information regarding manufacturing of Forklift. It provides information related to design consideration.

Fig- 1: Forklift

Fig- 2: Motor & Gearbox Arrangement

2. WORKING

The Mechanical forklift works on Semi-Electric techniques. In this transfer the power from one form into another form using mechanical as well as electric components. The project works on technique of Transfer rotational motion into Linear motion. For this purpose D.C. motor (12V, 2.5A) are used. The motor are constructed with Gearbox with Gear ratio 5:1. The chain drive is coupled from gearbox to Lead screw using sprocket. Therefore motion is transfer to Lead screw. The lead screw is mounted on the Guide column. The Nut are fastened into the Lead screw and Roller are bolted to the Nut. And Forks are attached to the Roller. By using roller the rotational motion of Lead screw is converted into Linear motion.

3. COMPONENTS

3.1 Lead screw and Nut –

Lead screw and nut act as main component of our forklift. It is main lifting mechanism. We use square form thread for power screw because it is used to lift heavy load & it has high efficiency than other screw forms. The material selected for screw is Mild steel and Nut is Cast iron.

3.2 Guide Column-

The dimension of guide column is L=1370mm, A=75x40x5mm, the guide column is used to support the load, wheels etc. and to enclose whole assembly of screw and nut.

3.3 D.C. Motor-

The D.C. motor is act as prime mover which drive the screw to raise the load. We select 12V, 2.5A, 100rpm, 100Kgcm motor

3.4 Supporting legs-

The dimensions of supporting legs is L=640, A=75x40x5mm. It is used to avoid to fork from tilt when it is loaded. These legs are at either side of whole assembly.

3.5 Wheels-

The wheels rolls and moves the forklift from one place to another place. We use four wheels two at front side attached at bottom at support legs and two are at rear side. At front side Caster wheels and at rear side Rubber wheels are used.

3.6 Battery-

The battery act as power source for driving of motor. We use battery capacity of 12V, 7.2 Ah

3.7 Lifting Forks-

The dimensions of lifting fork L600, A=40x40x3mm. The lifting fork that directly lift the load from its position.

3.8 Gearbox-

We cannot directly couple motor to screw as we required gearing arrangement, because motor has low torque and high speed. So, to convert motor torque and speed into required torque and speed. We use spur gear and pinion. The motor shaft is directly couple to pinion and bull gear is connected to screw.

3.9 Bearings-

Bearings are used to support shaft of gearbox & Lead screw. Two types of bearings are used. Deep groove ball bearing (D.G.B.B.) are used to support gearbox shaft & flange bearing are used to support Lead screw.

4. DESIGN

The design of mechanical forklift is derived as follows. Determine maximum load capacity, lifting height, forces acting on component. The material selected for forklift is Mild Steel due to its properties like malleability, ductility, strong and low cost.

4.1 Design of Lead Screw –

- Mass carrying (m) = 250 Kg
- Length of screw = 1220 mm
- Factor of safety (FS)= 3
- Material = Mild steel {S_yt= 400N/ 〖mm〗 ^2, E= 210 × 〖10〗 ^3 N/ 〖mm〗 ^2}

1. Total load in Newton –

Total Load (W) = Mass (m) × Acceleration due to gravity (g)

$= 250 \times 9.81$

$= 2450$ N

2. Permissible compressive stress (σ_c)-

$\sigma_c = S_{yt}/FS$

$= 400/3$

$= 133.33\ N/mm^2$

3. Core diameter of screw (d_c) –

$\sigma_c = W/[\pi/4 \times d_c^2]$

$133.33 = 2450/(\pi/4 \times d_c^2)$

$d_c = 4.836$ mm

Table- 1: Properties of square thread

Nominal Diameter d (mm)	Pitch, p (mm)
22,24,26,28	5
30,32,36	6
40,44	7
48,50,52	8

There are additional stresses due to torsional and bending moments. The diameter should be increased to account for these stresses. As a square threaded screw with 22 mm nominal diameter and 5 mm pitch is selected.

We know, d= 22 mm, p= 5 mm

4. Core diameter of screw (d_c) –

$d_c = d - p$

$= 22 - 5$

$= 17$ mm

5. Mean diameter of screw (d_m) –

$d_m = d - 0.5p$

$= 22 - 0.5(5)$

$= 19.5$ mm

It is assumed that the screw has single start threads.

$l = p = 5$ mm

6. Helix angle (α) –

$\tan\alpha = l/(\pi d_m)$

$= 5/(\pi(19.5))$

$\alpha = 4.666^\circ$

7. Friction angle ($\emptyset$) –

The possible value of the coefficient of friction between screw and nut is 0.35

$\tan\emptyset = \mu$

$= 0.35$

$\emptyset = 19.29^\circ$

Since $\emptyset > \alpha$ the screw is self- locking.

8. Torque required to lift & lower the load –

$M_t = (Wd_m)/2 \times \tan(\emptyset \pm \alpha)$

For Lifting –

$M_t = (2450 \times 19.5)/2 \times \tan(19.29 + 4.666)$

$M_t = 10613.43$ Nmm

For lowering –

$M_t = (2450 \times 19.5)/2 \times \tan(19.29 - 4.666)$

$M_t = 6232.91$ Nmm

9. Check for shear & compressive stress failure –

1. $\tau = (16M_t)/(d_c^3) = (16(10613.43))/(\pi (17)^3)$
   $= 11\ N/mm^2$

2. $\sigma_c = W/[\pi/4 \times d_c^2] = 2450/(\pi/4 \times 17^2) = 10.79\ N/mm^2$

10. Checking for buckling failure –

1. Moment of Inertia (I) –

$I = \pi/64 \times d_c^4$

$= \pi/64 \times (17)^4$

$= 4099.82\ mm^4$

2. Cross sectional area (A) –

$A = \pi/4 \times d_c^2$

$= \pi/4 \times 17^2$

$= 226.98\ mm^2$

3. Radius of gyration (K) –

$K = \sqrt{(I/A)}$

$= \sqrt{(4099.82/226.98)}$

= 4.249 mm

4. Slenderness ratio (l/K) –

$l/K = 1220/4.249$

= 287.12

5. Critical slenderness ratio –

End fixity coefficient (n) = 0.25

$S_{yt}/2 = (n\pi^2 E)/(l/K)^2$

$400/2 = (0.25\pi^2 \times 210 \times 10^3)/(l/K)^2$

$l/K = 50.89$

6. Critical load on buckling (P_{cr}) –

$P_{cr} = S_{yt} A[1 - S_{yt}/4n\pi E \, (l/K)^2]$

$P_{cr} = 400 \times 226.98 [1 - 400/(4 \times 0.25 \times \pi^2 \times 210 \times 10^3) (50.89)^2]$

$P_{cr} = 45413.15$ N

7. Factor of safety for buckling Failure –

$FS = P_{cr}/W$

= 45413.15/2450

= 18.53

So the design is safe against buckling failure.

4.2 Design of Nut –

- Permissible bearing pressure (S_b) = 13 N/mm^2
- Material = Cast Iron {S_{ut} = 200 N/mm^2}

1. No. of threads in contact with screw (Z) –

$Z = 4W/(\pi S_b (d^2 - d_c^2))$

$Z = (4 \times 2450)/(\pi \times 10 (22^2 - 17^2))$

$Z = 1.23 \sim 2$

2. Axial length of Nut (H) –

$H = Z \times P$

$H = 2 \times 5$

H = 10 mm

3. Check for crushing failure of nut –

$\sigma_c = W/(\pi/4 [d^2 - d_c^2] \times Z)$

$\sigma_c = 2450/(\pi/4 [22^2 - 17^2] \times 2)$

$\sigma_c = 7.99$ N/mm^2

4. Factor of safety for crushing failure –

$FS = (0.5 S_{ut})/\sigma_c = (0.5 \times 200)/7.99 = 12.51$

So design is safe against crushing failure.

4.3 Revolving Speed of screw –

- Pitch (p) = 5 mm
- Speed of raise = 1Feet/min

Raise speed = 1 feet/min

= 12 inch/min

= 12 × 25.4 mm/min

Raise speed = 304.8 mm/min

N = 304.8/Pitch

N = 304.8/5

N = 60 rpm

4.4 Selection of Motor –

- Required torque of motor (M_t) = 10613.42 Nmm
- Required speed of motor (N) = 60 rpm
- Type of supply to motor = 12 Volt D.C.

Torque required to raise maximum load in Kg-cm = $(M_{tRAISE})/(9.81 \times 10)$

$= 10613.42/(9.81 \times 10)$

= 108.1 kg-cm

Required speed of motor shaft in rpm = 60 rpm

We have to search market carefully then we find no motor available with this specification so we choose a motor with 100 rpm 100 Kg-cm torque motor.

Table- 2: Specification of motor

Parameter	Motor Specifications
Type of motor	D.C. Car Window Motor

Speed of motor	100 rpm
Output torque of motor	100 Kgcm
Input voltage and current	12 V 0.7A- at No load 2.5 A- at maximum Load

4.5 Selection of Gear –

The selection of Gears for Power Transmission

Gearbox for Power Transmission –

- Changed Motor torque $(M_t)_m = 100$ Kgcm $= 10 \times 10^3$ Nmm
- Changed Motor Speed (N)= 100 rpm
- Starting Torque = 150% Rated Torque
- Factor of safety (FS)= 1.5
- Material = Plain Carbon Steel $\{S_{ut} = 600 N/mm^2\}$
- Assume Pitch line velocity (v) = 5 m/s
- (b/m) = 10

1. Gear ratio (G) –

We assuming ratio G = 5, & motor speed = 100 rpm and Torque 100 Kg-cm but with help of gearing arrangement, we getting of 500 Kg-cm torque & speed 20 rpm.

Gear ratio (G) $= T_g/T_p$

$= 5/1$

$G = 5:1$

2. Estimation of Module Based on Beam strength (m) –

2.1 Minimum No. of teeths (z) –

The minimum no. of teeths for 20° pressure angle is 18. Therefore,

$z_p = 18$

$z_g = Gz = 5(18) = 90$

The Lewis form factor (Y) is 0.308 for 18 teeth.

2.2 Power Rating (KW) –

$$KW = \frac{(M_t) 2\pi N}{60 \times 10^6}$$

KW= 0.104

2.3 Service factor (C_s)-

C_s = (Starting Torque)/(Rated Torque)

$C_s = 1.5$

2.4 Bending stress (σ_b)-

$\sigma_b = S_{ut}/3$

$\sigma_b = 200 N/mm^2$

2.5 Velocity factor (C_v) –

$C_v = 3/(3+v)$

$C_v = 0.375$

2.6 Find module (m)-

$$m = \left[\frac{60 \times 10^6}{\pi} \left\{\frac{(KW) C_s (FS)}{z_p N C_v (b/m)(S_{ut}/3) Y}\right\}\right]^{1/3}$$

m= 2.5 mm

2.7 Selection of module –

For m= 2.5 mm

$d_p' = mz_p = 45mm$

$d_g' = mz_g = 225mm$

b= 10m= 25mm

2.8 Tangential Force (P_t) –

$$P_t = \frac{2 (M)_t}{d_p'}$$

$P_t = 444.44$ N

2.9 Pitch Velocity (v)-

$$v = \frac{\pi d_p' N}{60 \times 10^3}$$

v= 0.235 m/s

2.10 velocity factor (C_v) –

$C_v = 3/(3+v)$

$C_v = 0.927$

2.11 Effective Load (P_{eff})-

$P_{eff} = C_s/C_v \times P_t$

$P_{eff} = 719.15$ N

2.12 Beam strength (S_b) –

$S_b = mb\sigma_b Y$

$S_b=3850N$

2.13 Factor of safety (FS)-

$FS = S_b/P_{eff}$

FS = 5.35

Therefore design is safe. After mounting Gearbox for Power transmission we have to get following speed & torque:

Speed (N) = 20 rpm & Torque (M_t) = 500kg-cm

4.6 Selection of Battery –

From battery available range in market we assume battery capacity 12V, 7.2 Ah

Required battery capacity = V × I

= 12 × 7.2

= 84.4 Watt

But Consider deep cycle of battery is 80% of total capacity of battery

Running capacity of battery = 0.80 × required battery capacity

= 70 Watt

We consider following working time –

Load raise time = 5 min

Load lower time = 5 min

Travel time = 15 min

Total time of one operation cycle = 25 min

So, total time of 25 min battery requires 10 min and in 1 hour we use 3 times battery when fully charged.

4.7 Selection of bearing –

- Bearing life = 12000-20000 Hrs
- Radial load (P) = 2450 N
- Speed (n) = 50 rpm
- Assume L_{10h} = 12000 Hrs

1. **Bearing life (L_{10}) –**

$L_{10}= (60 \times n \times L_{10h})/ 10^6$

$L_{10}=(60 \times 50 \times 12000)/ 10^6$

L_{10} = 36 million rev.

2. **Load capacity (C) –**

$C = P (L_{10})^{1/3}$

$C = 2450 (36)^{1/3}$

C = 8089.72 N

Using standard table of bearing selection,

C = 9950 N

C_0 = 4150 N

d = 12mm, D = 37mm, B = 12mm

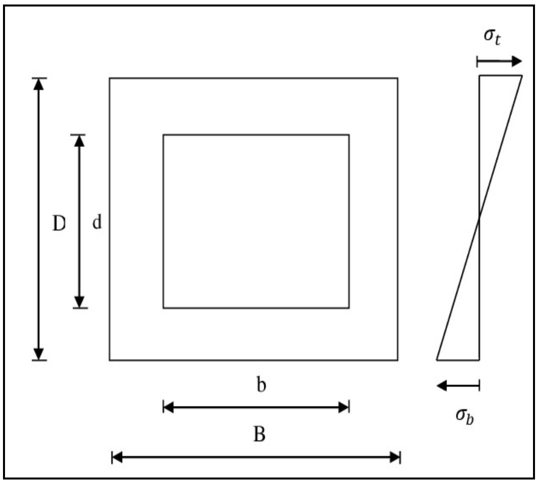
But, from available bearing range in market, we are assuming suitable bearing –

d = 12mm, D = 28mm, B = 8mm

Designation – DGBB 60012 Z

4.8 Design of Fork –

- Outer face height (D) = 50.8 mm
- Outer face width (B) = 50.8 mm
- Inner ace height (d) = 44.8 mm
- Inner face width (b) = 44.8 mm
- Length of fork (L) = 600 mm



Fig– 3: Hollow Section of Bar

Moment of Inertia of fork (I) -

$I= 1/12 [BD^3-bd^3]$

= 1/12 [6659702.81-4028209.56]

$I = 219291.10 \ mm^4$

Case I] Consider Two Fork with Point Load –

Fig- 4: Deflection of fork at Point Load

1. Moment of Inertia for two fork (I) –

$I = I_1+I_2$

$= 219291.10 + 219291.10$

$I = 438582.2\ mm^4$

2. Bending Moment (M_A) -

$M_A = -W \times L$

$= -2450 \times 600$

$M_A = -1470000$ Nmm

3. Deflection (y_{max}) -

$y_{max} = (WL^3)/3EI$

$= (2450\times 600^3)/(3\times 210\times 10^3\times 438582.2)$

$y_{max} = 1.91$ mm

Case II] Consider Two Fork with Uniform Distributed Load –

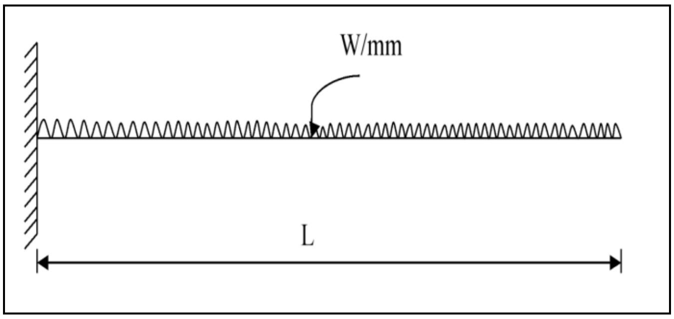


Fig – 5: Deflection of fork at uniform distributed load

1. Moment of Inertia for two fork (I) –

$I = I_1+I_2$

$= 219291.10 + 219291.10$

$I = 438582.2\ mm^4$

2. Find W/mm –

W/mm = W/L

= 2450/600

W/mm = 4.08 N/mm

3. Bending Moment (M_A) -

$M_A = (-W\times L^2)/2$

$= (-4.08\times 600^2)/2$

$M_A = -734400$ Nmm

4. Deflection (y_{max}) –

$y_{max} = (WL^4)/8EI$

$= (4.08\times 600^4)/(8\times 210\times 10^3\times 438582.2)$

$y_{max} = 0.71$ mm

4.9 Buckling consideration in C-Section column –

Column with Eccentric Load –

- Outer face height (D) = 75mm
- Outer face width (B) = 40mm
- Thickness (t) = 5 mm
- Material = Hot rolled steel {$S_{ut}=440\ N/mm^2$, $E = 210\times 10^3\ N/mm^2$}

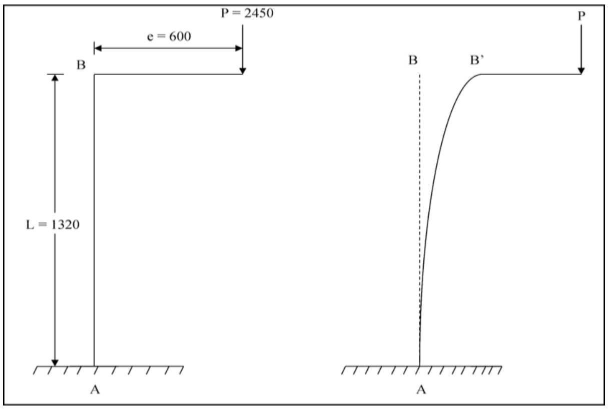


Fig- 6: Guide column with eccentric load

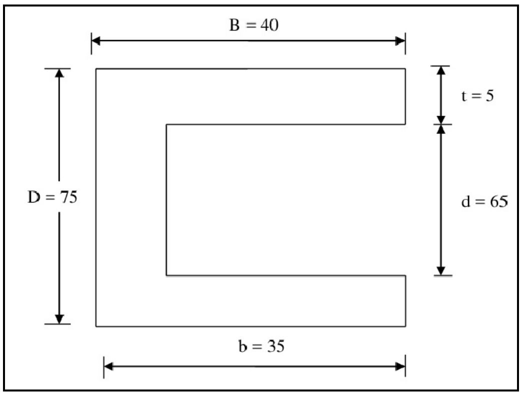


Fig- 7: Cross section area of C channel

1. Cross section area (A) –

$A = [D \times B] - [d \times b]$

$= [75 \times 40] - [65 \times 35]$

$A = 725$ mm

2. Moment of Inertia (I) –

$I = [(B \times D^3)/12] - [(b \times d^3)/12]$

$= [(40 \times 75^3)/12] - [(35 \times 65^3)/12]$

$I = 605.26 \times 10^3\ mm^4$

3. Find $\bar{y}$ -

$\bar{y} = t + d/2$

$= 5 + 65/2$

$\bar{y} = 37.5$ mm

4. Section modulus (z) –

$z = I/\bar{y}$

$= (605.26 \times 10^3)/37.5$

$z = 16140.26\ mm^3$

5. Equivalent length (L_e) –

$L_e = L/\sqrt{2}$

$= 1320/\sqrt{2}$

$L_e = 933.38$ mm

6. Maximum B.M. –

$M_{max} = P \times e \times \sec[L_e/2\sqrt{(P/EI)}]$

$=2450 \times 600 \times \sec[933.38/2\sqrt{(2450/(210 \times 10^3 \times 605.26 \times 10^3))}]$

$M_{max} = 1.47 \times 10^6$ Nmm

4.9 Design for ergonomics-

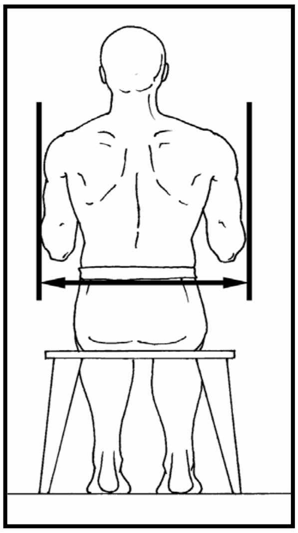


Fig-8: Elbow rest height standing

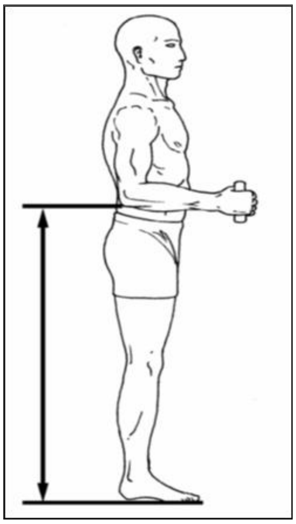


Fig-9: Width of elbow

1. Determine Height of Handle from Base-

Female -

- 997.9mm Mean
- 1185.0mm Maximum
- 856.0mm Minimum

Male-

- 1072.5 mm Mean
- 1261.0 mm Maximum
- 888.0 mm Minimum

1.1 Taking average of male & female mean-

(997.9+1072.5)/2=1035.2 mm

As we know in workplaces workers always wears shoes or any kind of footwear so the thickness of footwear is also to be taken into account. So considering normal shoe sole is approximately 25.4mm.

1.2 Adding this extra height in average-

1035.2 + 25.4 = 1060.6mm

So the height of handle from base is 1060mm.

2. Determine Width of Handle –

Female-

- 468.5 mm Mean

- 609.0 mm Maximum
- 373.0 mm Minimum

Male-

- 546.1 mm Mean
- 725.2 mm Maximum
- 399.0 mm Minimum

2.1Taking average of male female mean

(468.5+546.1)/2=507.3mm

We have to provide extra length as allowance

So providing allowance of 45mm

2.2 Adding extra length of allowance-

507.3 + 45 = 560 mm

So total length of handle bar is 560 mm

5. COMPONENT SPECIFICATIONS

Table- 3: Component Specifications-

No.	Part Name	Parameters	Material	QTY.
1.	Square Lead Screw	dc=17mm, p=5mm, d=22mm	Mild Steel	1
2.	Square Nut	L=60mm, p=5mm, B=48mm	Cast iron	1
3.	C-Channel Column	L= 1370mm, A=75×40×5mm	Hot Rolled Steel	2
4.	C-Channel Leg	L=640mm, A=75×40×5mm	Hot Rolled Steel	2
5.	Square Tube Fork	L=600mm, A=40×40×3mm	Mild Steel	1
6.	Roller Box	L=150mm, A=50×95×3mm	Mild Steel	1
7.	Roller	ID= 28 mm	Mild Steel	4
9.	Flange Bearing	UCF 204, L=86mm, ID= 20mm	Gun Metal	2
10.	Roller Bearing	DGBB 60012 Z	Gun Metal	8
11.	Rubber Wheel	ID=25.4mm, 8×2”	Rubber	2
12.	Castor Wheel	D= 50mm	Cast Iron	2
13.	Chain	Roller chain 08B, p=12.7mm, Links= 19	Mild Steel	1
14.	Sprocket	dp=45mm, d=22mm, N=8n	Mild Steel	2
15.	Gear & Pinion	m=2mm, R=5:1	P.C.S.	1
16.	D.C Window Motor	V=12volt, N=100RPM, I=2.5A	-	1
17.	Battery	Lead-acid, V=12volt, 7Am-h	-	1
18.	Key	L=25mm, B=5mm, H=8mm	Mild Steel	1
19.	Grub Screw	M6, L=5mm	Mild steel	4
20.	Plate	Square	Mild Steel	1
21.	Switch	On-off type	Plastic	1
22.	Wire	D.C. Wire, L=2m	Copper	1
23	Handle Bar	d=30mm, L=560mm	Mild Steel	1
24.	Rubber Gripper	d=30mm, L=125mm	Rubber	2
25.	Nut & Bolt	Type=Hex, M8, L=18mm	Alloy steel	12
27.	Flat Tray	560×350mm, t=2mm	Aluminium	1
28.	V-Tray	L=560mm, ∅=120°, t=2mm	Aluminium	1
29	Wheel Shaft	ID= 25.4 mm,	Mild Steel	2
30.	Washer	d= 30mm, ID= 10mm	Mild Steel	2
31.	Quarter Pin	-	Mild Steel	2

6. COST ESTIMATION

6.1 Cost of Material-

Table- 4: Cost of Material

No.	Components	QTY	Cost
1.	Lead screw And Nut	1	1600
2.	DGBB Bearing 6001 ZZ	8	240

3.	DGBB Bearing 6203 ZZ	4	200
4.	Flange Bearing UCF 204	2	500
5.	Bar for Roller ø= 42mm, L= 9”	1	
6.	Bar for Roller shaft ø= 16mm, L= 9”	1	310
7.	C-Channel for Guide column & Base 75×40×5mm, L= 20 feet	1	1600
8.	Square pipe for Roller box	1	50
9.	Sprocket, Bore= 22mm, No. of Teeth= 12	1	100
10.	Sprocket, Bore= 17 mm, No. of Teeth= 12	1	100
11.	Bar for rubber wheel shaft ø= 25, L= 15”	1	100
12.	Pinion ID= 19mm, No. of teeth= 25, m=1.5	1	75
13.	Bull Gear ID= 19 mm, No. of teeth= 127, m=1.5	1	381
14.	Bar for Gearbox shaft ø= 20mm, L= 20mm	1	50
15.	Rubber wheels 8×2”, ID= 1”	2	450
16.	Caster Wheels OD= 50mm	4	650
17.	Base plate for Guide Support 195×195×4mm	1	320
18.	Bearing Cap for Gearbox	4	250
19.	Handle Pipe L= 44” (Rs 60/8kg)	1	100
20.	Roller chain L= 15” (Rs 120/ft)	1	160
21.	Fork attachment And Plate cutting	1	380
22.	Guide column and Handle bar support	1	150
23.	Front wheel support plate	1	10
24.	Black paint 1 Ltr	1	
25.	Thinner 1 Ltr	1	125
26.	Square pipe for Fork 62” (Rs 4.50/Inch)	1	280
27.	Sheet Metal	2	490
28.	Cutting wheel	1	30
29.	Grinding wheel	2	60
30.	Welding rods (1/2 Pack)	-	150
31.	Car Window Motor 12V, 2.5A, 100 rpm	1	1600
32.	Lead Acid Battery 12V, 7 Ah	1	800
33.	Adapter 12V, 2A	1	180
34.	Charge Indicator	1	500
35.	Electric Connector switch	1	40
36.	2 Pin Plug	1	10
37.	AC Wire L= 3m	1	30
38.	DC Wire L= 10m	1	25

Total Cost of Material = 12,096 /-

6.2 Cost of Labour-

Table- 5: Cost of Labour

No.	Operations	QTY	Cost
1.	Roller machining	4	
2.	Roller shaft	2	
3.	Roller Box Drilling	1	
4.	Bearing Cap Machining	4	
5.	Pinion Boring	1	
6.	Gearbox shaft machining	2	
7.	Rubber wheel shaft machining	1	
8.	Quarter pin drilling	1	1870
9.	Rib cutting & Base plate cutting	1	40
10.	Key slots (Rs 25/slot)	4	100
11.	Motor shaft machining, surfacing	1	90
12.	Sheet metal Bending	2	490
13.	Welding	-	
14.	Grinding	-	
15.	Cutting	-	1100
16.	Motor wiring & Soldering	-	100

Total cost of Labour = 3,790/-

6.3 Total cost of Project -

Total cost of Project = Total Cost of Material + Total cost of Labour

= 12,096 + 3,790

= 15,886 /-

Fig- 10: Flat Pallet Attachment

Fig- 11: V Pallet Attachment

7. CONCLUSION

The development of Mechanical forklift assures the ergonomically comfort to the operator or worker and to reduces time required for manual lifting and handling. It lifts the maximum load of 200 Kg at maximum height 1250mm. This increases efficiency of productivity & it provide safety of operator while handling of the material.

8. FUTURE SCOPE

The current system can be made automatic by powering to wheel. And more heavy weight can be lift using bulky lead screw & high power motor. Provide foldable design for transporting in vans and trucks.

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