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# Design And Fabrication of Manual Forklift

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**ABSTRACT**

***Manual forklifts, commonly known as hand pallet trucks, are essential tools in material handling and logistics, designed for the efficient transportation and lifting of palletized goods. This paper explores the design, functionality, and operational principles of manual forklifts, emphasizing their hydraulic lifting mechanism, structural components, and ergonomic benefits. By analyzing their role in warehouse environments, the study highlights the advantages of manual forklifts in enhancing productivity, reducing physical strain on workers, and promoting safety during load handling. Furthermore, the paper discusses best practices for operation and maintenance, ensuring longevity and efficiency. The findings underscore the importance of manual forklifts in optimizing supply chain processes while minimizing workplace hazards. A forklift is a machine designed to lift heavy loads that would be difficult or impossible for a person to move manually. While it resembles a regular vehicle, its distinctive feature is the addition of two forks used for lifting. With the press of a button, the operator can effortlessly raise and transport heavy materials.***

***Keyword - Manual forklifts, heavy weights, hydraulic lifting, load handling, Fork.***

## 1 INTRODUCTION

In today's manufacturing industries, automation has become essential due to the rapidly increasing consumption of manufactured goods. The demand for high-quality products within a short time frame has made the adoption of advanced technology and automated machinery crucial. To simplify tasks and enhance productivity, modern systems built with the latest innovations are required. Electric Hand Stackers are commonly used in manufacturing processes to handle and position products of various sizes and volumes. These machines are not typically available as standard models; instead, they are custom-designed to meet specific customer requirements. Often referred to as forklift machines, [1]Electric Hand Stackers play a vital role in material handling. This project focuses on the study and development of a machine that not only replicates human effort but also efficiently lifts and transports heavy items, thereby improving operational efficiency.

## 2. PROJECT OBJECTIVE

The primary objective of a manual forklift is to assist workers in lifting heavy loads, such as boxes or pallets, which are otherwise difficult to handle manually. It significantly simplifies the movement of goods, especially in environments like warehouses, retail stores, or storage facilities.[2] By reducing the physical effort and time required to transport heavy items, a manual forklift increases efficiency and minimizes worker fatigue. One of the key advantages of a manual forklift is its ability to operate effectively in confined or crowded spaces where larger machinery cannot access—such as narrow aisles or compact storage areas. Its user-friendly design allows workers to operate it with minimal training, making it suitable for a wide range of users. Furthermore, as it operates without the need for electricity or fuel, it is highly versatile and can be used in locations lacking power sources. In addition to operational benefits, manual forklifts also enhance workplace safety by minimizing the risk of injuries associated with manual lifting, such as back strain or muscle fatigue.

## 3. MAIN COMPONENTS

### 3.1 Fork

**Fig-1 Fork**

The fork is an essential part of a forklift, specifically designed to lift and move heavy loads with both efficiency and stability. It comprises two long, robust metal prongs located at the front of the forklift, which are designed to slide beneath pallets or load-bearing platforms. Typically constructed from high-strength steel, forklift forks are capable of withstanding substantial weight without bending or failure. The tips of the forks are usually tapered, allowing for easier insertion beneath pallets, while many forklift models feature adjustable fork widths to accommodate varying load dimensions. During operation, the forks support the full weight of the load through the lifting, transportation, and placement processes. Given this essential function, the fork plays a vital role in material handling activities across warehouses, manufacturing units, and logistics facilities.

### 3.2 Wheels

**Fig-2 Wheels**

The wheels of a forklift are fundamental to its mobility, enabling smooth and safe movement across different surfaces. A standard manual forklift is typically equipped with four wheels: two smaller caster wheels positioned at the front and two larger wheels at the rear. The front caster wheels are designed to support the load and facilitate turning and maneuverability, while the larger rear wheels provide stability and allow the operator to steer the forklift using the handle. These wheels are engineered to endure the combined weight of the forklift and its load, and are commonly made from high-durability materials such as solid rubber or polyurethane. Their construction ensures smooth navigation, even in confined areas such as narrow warehouse aisles. Moreover, the wheels play a vital role in maintaining the forklift's balance during lifting operations. Regular maintenance of the wheels is essential to ensure safe, reliable, and efficient forklift performance.

### 3.3 Steel Cable

**Fig-3 Cable**

The steel cable, commonly referred to as a wire rope, is a crucial element of the forklift's lifting mechanism, particularly in manual or winch-operated models. Constructed from multiple strands of high-tensile steel wires twisted together, the cable is designed to offer exceptional strength, flexibility, and durability. It serves as the link between the hand-operated winch and the fork carriage or lifting assembly. When the winch is engaged, the steel cable either winds or unwinds, enabling the forks to be raised or lowered accordingly. Its robust construction allows it to withstand substantial loads without snapping or excessive stretching, ensuring safe and dependable lifting operations. Additionally, the cable's resistance to abrasion and wear makes it well-suited for repeated use in demanding industrial environments.

### 3.4 Hand Winch

The hand winch is a manually operated lifting mechanism commonly found in hand-operated or manual forklift models. It comprises a crank handle connected to a gear system that winds or unwinds a steel cable. As the operator turns the handle, the cable either tightens or loosens, thereby raising or lowering the forks accordingly. This mechanism provides precise control over the lifting process without the need for electrical power or hydraulic systems, making it particularly valuable in small-scale operations or in environments where powered forklifts are impractical. Engineered for strength and reliability, the hand winch is built to endure the demands of frequent lifting tasks while offering the operator complete control over load movement, ensuring safe and efficient operation.

**Fig-4 Hand Winch**

### 3.5 Spur Gears

The spur gear is a critical element in the hand winch system of a manual forklift, playing a central role in transmitting and amplifying the operator's input force. It is characterized by a circular design with straight teeth aligned parallel to the gear's axis. When the winch handle is rotated, the spur gear meshes with a mating gear—either larger or smaller depending on the configuration—to turn the drum that holds the steel cable. This gear interaction creates a mechanical advantage, enabling the operator to lift heavy loads with significantly reduced effort. Spur gears are particularly suited for this application due to their simplicity, high efficiency, and ability to transmit substantial torque at low speeds. Moreover, they operate with minimal slippage and are relatively easy to manufacture and maintain, making them an ideal choice for manual lifting mechanisms in hand-operated forklifts.

**Fig- 5 Spur Gears**

### 4. CONSTRUCTION & WORKING

#### 4.1 CONSTRUCTION

4.1.1Frame Structure:

The main frame is made using rectangular mild steel sections.
It provides the vertical support needed for lifting and holds the pulleys and winch in place.
The base is wide and strong to ensure balance and stability during lifting operations.

4.1.2Forks

Two horizontal steel forks are attached to a vertical moving carriage.
These forks are designed to slide under pallets or small loads and are capable of lifting them vertically.

The forks move up and down guided by vertical rods or channels.

4.1.3Lifting Mechanism:

The lifting system uses a steel cable and pulley mechanism.
A manual hand winch is used to wind or unwind the cable.
When the winch is rotated, the cable pulls the fork assembly upward or releases it downward.
Pulleys at the top of the frame guide the cable for smooth operation.

5.1.1 Hand Winch

A hand-operated winch is mounted on the frame and used to manually lift or lower the forks.
It provides mechanical advantage to lift heavy loads without power assistance.

5.1.2 Steel Cable

A durable steel cable connects the winch to the lifting platform.
It runs through the pulleys and is responsible for transmitting the lifting force

5.1.3 Wheels

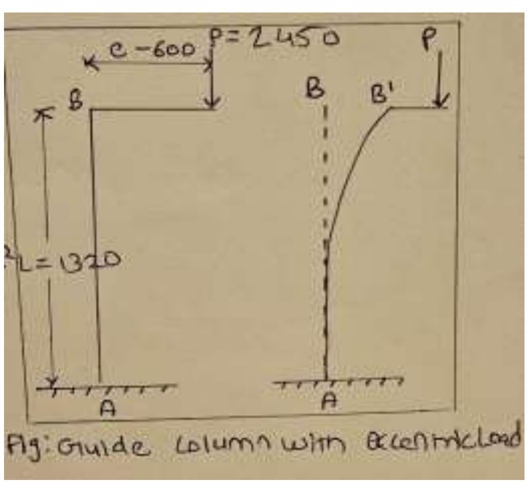
The forklift has four identical swivel caster wheels, allowing movement in any direction.
Only the rear two wheels are equipped with brakes, providing control and stability during lifting operations.

**4.2Working**

A manual forklift operates through a straightforward mechanical lifting system controlled by a hand-operated winch. To begin the lifting process, the operator positions the forklift so that the two horizontal forks are properly aligned and inserted beneath the load—typically a pallet or box. [4] Once in position, the operator turns the winch handle, which activates a steel cable routed over pulleys mounted at the top of the frame. As the winch rotates, the cable winds onto the drum, pulling the fork carriage upward along the vertical guide rails and lifting the load off the ground. The lifting height can be precisely controlled by stopping the winch at the desired level. To lower the load, the winch is turned in the opposite direction, allowing the cable to unwind gradually and the forks to descend smoothly. For added safety, the forklift's rear wheels are equipped with brakes, which the operator engages during lifting or lowering to prevent any unintentional movement. This manual system offers a controlled, efficient, and electricity-free method for lifting and transporting smaller loads over short distances, particularly in compact or power-restricted environments.

**Calculations**

Buckling consideration in C-Section column –
Column with Eccentric Load
Outer face height (D) = 75mm
Outer face width (B) = 40mm
Thickness (t) = 5mm
Material = Hot rolled steel ( Sut= 440N / mm²,



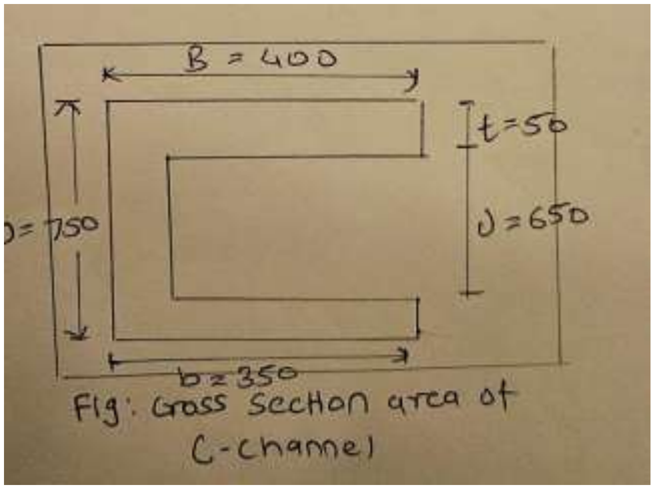



**Fig 6 Line Diagram**

$E = 210 \times 10^3\ N/mm^2$

1. Cross section area (A)
   $A = [D \times B]-[d \times b]$
   $=[750 \times 400]-[650 \times 350]$
   $A = 72500mm$
2. Moment of Inertia (I)=
   $I = [(BxD^3)/12]-[(bxd^3)/12]$
   $= [400 \times (750)^3/12]-[350 \times (650)^2]/12]$
   $I = 6052604167\ mm^4$
3. Find y`
   $Y` = t + d / 2$
   $= 50+ 650/2$
   $Y` = 375mm$
4. Section modulus (z) =
   $Z = l/y`$

   $= (6052604167 / 370$
   $Z = 16140277.78\ mm^3$
5. Equivalent length (L_e) –
   $L\_e = L / \sqrt{2}$
   $= 1320 / \sqrt{2}$
   $L\_e = 933.38mm$
6. Maximum B.M. –

$M\_max = P \times e \times \sec[L\_e/2 \sqrt{(P/EI)}]$
$=2450 \times 600x\sec[933.38/2\sqrt{(2450/(210\ \ x10^3 \times 6052604167)}$
$M\_max = 1.47 \times 10^6\ Nmm$

FSWR (FLEXIBLE STEEL WIRE ROPE) CALCULATION

To calculate the SWL in kilograms of FSWR square the rope diameter (D) in millimetres (mm) and multiply by 8.

$SWL = D^2 \times 8$

UNIT: SWL (kgs) kilograms D(mm) millimeters

Diameter of rope = 3mm

$SWL = (3mm)^2 \times 8$

$= 72$ k

Design of Fork

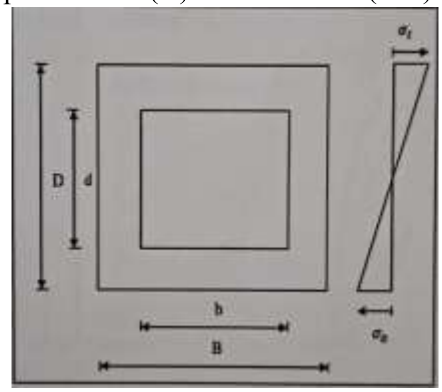



**Fig. 7 Line Diagram**

Solution =Given data:-

outer face height (D) = 50.8 mm

outer face width (B) = 50.8mm

Inner Face width (b) = 44.8mm

Inner Face height (d) = 44.8mm

Length of Fork (L) =600 mm

mass carrying (m) = 25 kg

$E = 210 \times 10^3$ N/mm²

Total load in Newton:-

1. Total load (w) = mass (m) x Acceleration due to gravity (g)
   = 25 x 9.81 W = 245 N
2. moment of Inertia of Fork (I)

$I = 1/12[BD^3-bd^3]$ $I=1/12[6659702.81-4028209.56]$

$I = 219291.10$ mm⁴

Case I :- Consider Two forks with point Load

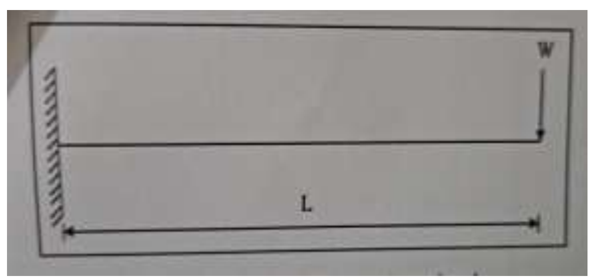



**Fig 8 Line Diagram**

1) moment of inertia for two forks (I) :-

$I = I1 + I2$

$= 219291.10 + 219291.10$

$I = 438582.2$ mm⁴

2) Bending moment(MA)

$MA = W \times L$

$= -245 \times 600$

$MA = -147000$ Nmm

3) Deflection (y-max)

$y\text{-}max = (WL^3)/ 3EI$

$=(245 \times 600)^3/3 \times 210 \times 10^3 \times 438582.2$

y-max=0.191mm

Case2:- Consider two fork with uniform distributed load

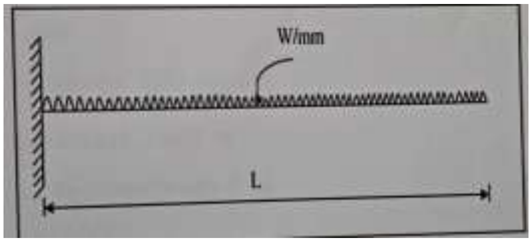



**Fig 9 Line Diagram**

1. moment of Inertia for two forks (I)

$I = I1 + I2$

$= 219291.10 + 219291.10$

$I = 438582.2\ mm^4$

2. Find w/mm

$w/mm = w/L$

$= 245/600$

$w/mm = 0.408\ N/mm$

3. Bending moment (MA):-

$MA = (w \times L^2)/2$

$= (-\ 0.408 \times 600^2)/2$

$MA = -\ 73440\ Nmm$

4. Deflection (y-max)

$y - max = (wL^4)/(8EI)$

$= (0.408x600^4) / 8 \times 210 \times 10^3 \times 438582.2$

$Y\ max = 0.0717mm$

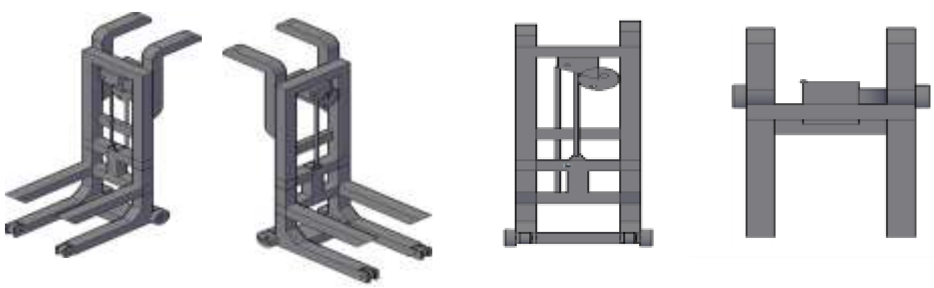


**Fig 10 CAD Design**

## 7.CONCLUSION

The project developed by our team marks a significant advancement in the domain of production and manufacturing industries by introducing an efficient and cost-effective scrap collecting forklift. This innovation eliminates the need for complex and potentially hazardous parking maneuvers, streamlining the scrap collection process while reducing associated operational costs. Designed for speed and reliability, the system ensures timely and effective task completion. Our manual forklift model demonstrates excellent applicability across various institutions, warehouses, and small-scale industries. It significantly enhances material handling by enabling users to load, unload, and transport items with greater efficiency compared to traditional manual methods. This directly contributes to reducing physical strain on workers—particularly minimizing the risk of spinal injuries caused by repetitive heavy lifting. As a mechatronics-based solution, the forklift integrates mechanical design with electronic control systems, offering user-friendly operation and improved performance. Capable of lifting loads up to 80 kg to a height of 1.8 meters, it proves its versatility and practical value in diverse working environments. The incorporation of simple electronic circuits further enhances its ease of use, making it accessible even to non-specialized operators. Additionally, the forklift operates smoothly on various surfaces, including concrete floors and roadways, and offers a low-cost alternative to commercially available models. In summary, our project presents a practical, economical, and highly functional forklift system that not only improves the efficiency of material handling operations but also contributes to safer, more ergonomic workplace practices. Its performance and features position it as a valuable tool in modern industrial logistics.

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**BIOGRAPHIES**

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