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Design and Analysis of Hydraulic Forklift Using Foot Operated

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ABSTRACT
The project focused on design and analysis of hydraulic forklift using foot operated. The calculated design and mass properties of parts and subassemblies according to the material selection (mild stell) to ensure the stability of th forklift , which is capable of lifting the fork upto 300 kg and lift up to an height of 250 mm . Then the stress analysis done on the important pats and subassemblies using finite element analysis method (FEA). Results show that the new design is safe to use under working conditions

Keywords: Permissible stress Bending moment Bulking Hardness

Nomenclature
The nomenclature should be in alphabetical order with Greek symbol, also in alphabetical order. Subscripts and superscripts should follow Greek symbols and should be identified with separate headings. Nomenclature entries should have the units identified. For example:

Q	Flow rate
A, A0	Area, maximum area of the exit cross section
g	Gravitational acceleration
H	Head behind the valve
He	Head drop before the minimum height section
Zc	Height for the minimum section
Cd	Discharge coefficient
H_{max}, H_{normal}, H_{min}	Maximum, normal and minimum head
K	Turbulent kinetic energy
ε	Turbulent dissipation energy

I. INTRODUCTION

Hydraulics are used in forklifts to lift the load- bearing prongs up off the ground and hold the load in the air while the forklift moves. The hydraulic system in a forklift has been described as the heart of the vehicle, and the hydraulic lifting system does most of the work and without it, the vehicle won't be able to move pallets

In general the forklift can be defined as a tool capable of lifting hundreds of kilograms. A forkliftis a 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.

The forks, also known as blades or tines, are usually made out of steel and can lift up to a few tons. Forklifts are either powered by gasoline, propane, or electricity. Electric forklifts relay on batteries to operate. Gasoline or propane forklifts are sometimes stronger or faster than electric forklifts, but they are moredifficult to maintain, and fuel can be costly. Electric forklifts and hydraulic forklift are great for warehouse use because they do not give off noxious fumes like gas powered machines do.

A forklift is a one type of power industrial truck that comes in different shapes, sizes and forms. A forklift can be called a pallet truck, rider truck, fork truck or lift truck. Yet, the ultimate purpose of forklift is the same to safely allow one person to lift and moves largeheavy loads with little effort. Hydraulic forklift also known as hydraulic hand pallet isa tool used to lift and transport heavy load forlong distances with the help of pallet.

Pallet jacks are the most compact and modern form of forklift and are intended to move heavy and light weight material within a warehouses. For the purpose of training, aforklift is a small or large industrial truck withpower operated platform. Like other forms of forklift hydraulic forklift doesn't require any kind of electric power source or diesel and gasoline because hydraulic forklift works on principle of hydrostatic force transmission.

Lifting of heavy loads is accomplished with the help of hydraulic cylinder in the forklift. Cylinder is generally fitted at lower parts of fork. Forklifts are most often used in warehouses, but some are meant to be used outdoors. The vast

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majority of rough terrain forklifts operate on gasoline, but some usediesel or natural gas. Rough terrain forklifts have the highest lifting capacity of all forklifts and heavy duty tires (like those found on trucks), making it possible to drive them on uneven surfaces outdoors. Forklifts have revolutionized warehouse work. They made it possible for one person to move thousands of pounds at once. Well-maintained and safely operated forklifts make lifting and transportingcargo strength

II. MATERIALS AND METHOD

Due to its excellent properties, mild steel has become an in-demand material in various industries. It has unparalleled weld ability and machinability, which has led to an exponential increase in itsusage. In this article, we will discuss the importance of mild steel, its uses and how it's made. **Mild steel is a type of low carbon steel**. Carbon steels are metals that contain a small percentage of carbon (max 2.1%) which enhances the properties of pure iron. The carbon content varies depending on the requirements for the steel. Low carbon steels **contain carbon in the range of 0.05 to 0.25 percent.**

Table 1. Physical properties of mild steel

Properties	Carbon Steels	Alloy Steels	Stainless Steels	Tool Steels
Density (1000 kg/m3)	7.85	7.85	7.75-8.1	7.72-8.0
Elastic Modulus (GPa)	190-210	190-210	190-210	190-210
Poisson's Ratio	0.27-0.3	0.27-0.3	0.27-0.3	0.27-0.3
Thermal Expansion (10-6/K)	11-16.6	9.0-15	9.0-20.7	9.4-15.1
Melting Point (°C)			1371-1454	
Thermal Conductivity (W/m-K)	24.3-65.2	26-48.6	11.2-36.7	19.9-48.3
Specific Heat (J/kg-K)	450-2081	452-1499	420-500	
Electrical Resistivity (10-9W-m)	130-1250	210-1251	75.7-1030	
Tensile Strength (MPa)	276-1882	758-1882	515-827	640-2000
Yield Strength (MPa)	186-758	366-1793	207-552	380-440
Percent Elongation (%)	10-32	4-31	12-40	5-25
Hardness (Brinell 3000kg)	86-388	149-627	137-595	210-620

The above considerations are validated for further proceedings and from the Table 2. There are different gradesof mild steel. But they all have carbon content within the above- mentioned limits. Other elements are added to improve usefulproperties like corrosion resistance, wear resistance and tensile strength

Table 1. Chemical composition of mild stell

CHEMICAL COMPOSTION (%)				
Fe	**M n**	**S**	**P**	**C**
98.81-99.26	**0.6-0.9**	**0.05**	**0.04**	**0.14-0.2**

PHYSICAL PROPERTIES					
YIELD STRENGTH	**TENSILE STRENGTH**	**THERM AL CONDUCTIVITY**	**MELTING POINT**	**HARDNESS**	**SPECIFIC HEAT CAPACITY**
275	**475**	**51.9**	**1523**	**143**	**0.472**

Design Of Fork Design Of Weld (FORK)

1) F.O.S = 4.7
2) MS Yield Point Stress (σy) = 300N/mm2
3) Load Applied = 300KG =2943N
4) b=5d (standard material ratio)

(a) Allowable (or) Permissible Stress σb (or) σt = σy/F.O.S (n)
=300/4.7
=63.82
=64N/m^2

(b) Maximum Bending Moment Mt Mb =-(300×600)
=-180×10^{3}N-mm

(c)Z =Mb/σ
=180×10^3/64
Z =22812.5

(d)Z =bd^2/6 [b=5d]
2812.5 =5d×d/6
2812.5 =5d^3/6
2812.5 =0.83d^3
3388.5 =d^3 (3388.5)$^{1/3}$ =dd =15.02

(e)b =5d b =5db =5×15.02
b =75.10

Maximum Load with the Plate
P=Area ×stress
Area =Breath ×Thickness

$=B \times T \times \sigma t$
$= 75 \times 15 \times 64$
$= 72 \times 10^3$
Maximum Load $=72 \times 10^3$

Case (i)

Uniform Distribution Load
(1) Moment Of Inertia $I_1=I_2=bd^3/12$
$=75 \times 15^3/12$
$=21093.75mm^4$

(2) Find W/mm3000/600
5N/mm

(3) Bending Moment (M.A)M.A $= (-w \times l^2)/2$
$= -5 \times 600^2/2$
$=-900 \times 10^3$N-mm.
(4) Deflection (ymax) $= W \times L^4/8EI$
$= 5 \times 600^4/8 \times 200 \times 10^3 \times 21093.75$
Ymax = 19.2mm

To The Length Of Weld
=140+74+140
=214mm

1) Direct shear load per unit length of weld. Pd=p/l
=2943/214
=13.75N/mm
2) Load due to bending per unit length of weld. Pn=p*e/Zw.e=800.
Zwtop = (Zbd+d^2)/3.
= (2*140*74+74^2)/3
= 8732mm2.
Zwbottom = (d^2*(2b+d))/3(b+d).
= (74^2(2*140+74))/3*(140+75).
= 3019.47N/mm^2.

Select the smaller value as the permissible value Zw=3019.47N/mm^2.
Pn=(p*e)/Zw.
=(2943*800)/3019.4
Pn=780N/mm.

3) Resultant LoadPr=$\sqrt{(Pd^2+Pn^2)}$
$= \sqrt{(13.75^2+780^2)}$
=780N/mm.

4.) Size of Weld.
Allowable stress= (P*r)/0.707wl3677
=780/ (.0707*w*1)
W=3mm

Design of Buckling Consideration in C section frame(Guide column) with eccentric load.

- Outer face height (D)=76mm
- Outer face Width (B)=40mm.
- Thickness (t) =5mm.
- Length of C frame =100cm=1000mm.
- Material =Mild Steel
- E for MS=200G

Pa=200*10^3N/mm^2.

1) Cross Section Area (A).A= (D*B)-(d*b)
= (76*40)–(66*35)A=730mm.

2) Moment of Inertia (I).
I = ((B*D^3)/12)–(b*d^3)/12))
= ((40*76^3)/12–(35*66^3/12))
= (1499834.667–838530)I=661.304*10^3mm^4.

3) Find $\bar{y}$.
Thickness of C frame (t) =5mm.
$\bar{y}$=t+ (d/2)
= 5+d/2.
$\bar{y}$=38mm.

4) Section Modulus (Z).Z=I/$\bar{y}$
= (661.304*10^3)/38.
Z=17402.73mm^3.

5.) Equivalent Length (Le) Length of C frame=1000mm.
Le=L/$\sqrt{2}$.
=1000/$\sqrt{2}$.
Le=707.106mm.

6.) Maximum B.M. Mmax=P*e*sec (Le/2) $\sqrt{}$ (P/EI)).
=3000*600*sec ((707.106/2) $\sqrt{}$ (3000/200*10^3*661.304*10^3))
Mmax=2.731*10^6N/mm.

III. RESULTS AND DISCUSSION

- The existing forklift design has its limitation in lifting a fork using lever which is connected to pump but we have made some modification in which it can be byfoot operated.
- The pedal operated forklift which have been design to load capacity of3000 N
- The weight reduction of the structure reduced to 30 percent

FROM DESIGN CALCULATION:

- Permissible Stress for fork is 63.82 =64N/m2

- Maximum Load with the Plate is Maximum Load =72 ×103 N.

IN CASE OF UNIFORM DISTRIBUTELOAD:
Deflection is Y max = 19.2mm **Consideration in C section frame (Guide column)**

- Cross Section Area is 730mm.
- Equivalent Length (Le) is =707.106mm.
- Maximum B.M is =2.731*10^6N/mm.

- So by comparing the Design calculations values in above points is equal to the values of the Ansys report while Appling the same material.

IV. CONCLUSION

We conclude that, this project will helpful for small scale industries as it is easy to operate withless cost and indirectly it will save the labor cost.
Savings resulting from the use of this machine will make it pay for itself with in short period of time and it can be a great companion in any field dealing with rusted and unused metals.
It is mechanical device, does not required electricity as well as any external source ofbattery.
The development of mechanical forklift assures the ergonomically comfort to the operator or worker andto reduces time required for manual lifting and handling.
This increases efficiency of productivity and it provide safety of operator while handling of the material. It lifts maximum load up to 400 kg at maximum height of 300 mm.

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