Design and Manufacturing of Monkey Mini Crane

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Abstract— Cranes are amongst of the most dangerous equipment used in both the industry and construction sites. Despite the risk awareness, incidents in crane's operations have not substantially decreased; most of them arise from wrong load handlings, poor visibility in moving loads, etc. Their dangerousness has special relevance in the chemical process industry and the intermodal transport, where accidental events could also generate the release of hazardous substances. This paper focuses on mini crane of 100 kg or 150 kg because this type of cranes is usually not available by maintaining the safety in crane operations, the main causes of accident will be identified and a statistical analysis is presented with the aim to drawn some conclusions and comment about future trends of research about this issue.

Key words: Industrial Safety, Crane Accident, Load Displacement, Human Error

I. INTRODUCTION

Cranes are widely used in the construction industry to move materials, in the transportation to load/unload cargos, in the manufacturing industry to assemble heavy equipment, etc. [6]. When installed and properly used, cranes make operations easier and safer. Nevertheless, even if the technology and risk awareness have substantially increased, safety still needs to be improved, as underlined by many crane-related accidents occurring each year worldwide.

Earlier we used lifting machine for the higher capacity which are started from 300 kg or 250 kg but if we want to use the mini crane of 100 kg or 150 kg then this type of crane is usually not available in the market. To avoid this kind of problems, we created a new safety crane which can work with range of 100 kg to 150 kg. Nowadays prices of lifting machines are very much high so there is need of design and manufacturing of an economical lifting machine. Generation of lift by using this requirement of economical and safety operation. No noise pollution.

This paper focuses on mini crane of 100 kg or 150 kg because this type of cranes is usually not available by maintaining the safety in crane operations, the main causes of accident will be identified and a statistical analysis is presented with the aim to drawn some conclusions and comment about future trends of research about this issue.

II. LITERATURE REVIEW

This project highlights previous work that has been done in the area of collision avoidance in building and industrial projects, as well as other fields like robotics and mechanical engineering, from which the project has drawn inspiration and guidance. During manufacturing We meet numbers of manufacturer and make our parts with help of them. Previous work is related to only for large construction while small construction also needed large machines and it is very much costly. So after discussing with our group guide this idea is developed and suddenly we start the work on it. Initially we go through various books like Cheng Teizer [2] and Spasojevic Brkic. [3] And then we find some ideas and applied on our project.

III. METHODOLOGY

A. Tool Used

1) Machine Design Book of V.B. Bhandari
2) Design data book (Design of springs)
3) Vernier caliper (Measurement of dimensions)

B. Experimental Procedure

1) We design various parts as per need of project and decided its dimensions after checking feasibility of model.
2) After deciding elemental parameters we move towards manufacturing of parts and its assembly.
3) This project required pit for installation of setup, so necessary of proper space selection and check the environmental conditions before installation.
4) Install the setup where performance is consistent throughout its operation.
5) Then run the setup and check the unexpected errors and modified them to improve efficiency.

C. Working

First we needed single phase electrical supply for the operation of motor. When Electrical supply is given to motor the motor starts rotating with the 1440 rpm. Due to this gear box which is connected to motor starts rotating in clockwise direction, if we forward the power switch. The electrical motor and gear box are in contact with each other by the means of coupling. The gearbox reduces the speed to 72 rpm and drum also rotate due to this the rope and drum goes downward and we stop the switch (Power switch). When the material is filled in the bucket then we reverse the switch therefore the shaft rotates in anticlockwise direction. And rope is wound around the drum the bucket and material is picked up. When the bucket is lifted at required altitude then operator required to move the machine with live help of rotating mechanism. Then Operator Switch of the machine by using power switch

Fig. 1: Monkey Mini Crane

IV. DESIGN & MANUFACTURING

A. *Motor*

We use 2 H.P. power motor with 1440 rpm of single phase

B. *Gear Box*

Worm and worm wheel gear box which transmit the power by 90 degrees. The speed Reduction ratio is 20:1.

C. *Coupling*

Muff coupling used because the shaft and motor axis is coaxial with each other.

D. *Rope*

Ropes were originally made by hand using natural fibres. Modern ropes are made by machines and utilize many newer synthetic materials to give them improved strength, lighter weight, and better resistance to rotting.
8 mm diameter and 480 cm length

V. CALCULATIONS [1 & 5]

A. *Design of EOT*

Class 2 Mechanism
Capacity = 2 KN
Lift = 10m
Voisting speed = 6m/min

1) *Design of rope* [1]

Consider 20% extra load to account weight of taken,
{Wd} = 2KN×1.2
= 2.4KN
No. of falls,
Since the load is less, therefore 4 fall multiple pulley system is used.
Force

$$F = \frac{\text{Design Load}}{\text{No of pulley} \times \text{No of falls}}$$

Where,
N pulley = 0.97 antifriction bearing [5]

$$F = \frac{2.4 \times 10000}{4 \times 0.97}$$

F= 618.55 N
= 0.61855KN
F= 61.85 kgf

2) *Selection of rope* [5]

Selecting ordinary cross lay rope at 6 × 37 of grade 180
Selection of Dmin/d
Dmin/d = 17 for 3 bends
Selecting Dmin/d = 23 for better life of rope

3) *Design of stress factor* [5]

n= n' ×duty factor
n=n' = 5.0

4) *Diameter of a rope* [5]

$$A = \frac{F}{\frac{6u}{n} - \frac{d}{Dmin} \times 36000}$$

$$A = \frac{61.85}{\frac{18000}{5} - \frac{1}{23} \times 36000}$$

18000 taken for grade,

$$A = \frac{61.85}{3600 - 1565.21}$$

A= 0.3039 cm^2
0.38 =0.3039
d=0.8942 cm
d=8.9 mm
selecting standard wire rope
d=10 mm

5) *Rope life* [5]

$$D/d = m.бC1C2C + 8$$

Where,
Б= tensile stress

$$F/A = 61.85/0.38 \times 10^2$$

= 1.62 kgf/mm^2
C = 1.02 180 grade cross
C1= 1.04
C2 = 1.1

$$23 = m \times 1.62 \times 1.02 \times 1.04 \times 1.1 + 8$$

23 = 2.82m + 8
m = 5.3
selecting Z = 30×10000
Rope life,

$$N = \frac{0.4 \times Z}{a \times \beta \times Z2}$$

a =1000
β = 0.5
Z2 = 4

$$N = \frac{0.4 \times 30 \times 10000}{1000 \times 0.5 \times 4}$$

As
N = 6 months
8hr/day is in working.

Design of hook [1 &5]

All types of hooks are made of steel and manufacturing by forging and trapezoidal in c/s.
Design load for hook
Wd = load to be lifted ×duty factor
= 2.4 ×1.2
= 2.88 KN
C = 27 for less than 0.5 tons' load.
Tread size = M14 course series.
H = 0.93 c = 25.11
r0 = ri + c = 40.5
ri = 0.5 c = 13.5
Z = 0.12 c =3.24
b0 = 1.6 Z =5.184
bi =1.2 M =19.44
M =0.6 c = 16.2

$$R = ri + \frac{h}{3} \times (\frac{bi + 2bo}{bi + bo})$$

R = 23.63 mm

$$rn = \frac{\frac{1}{2} \times (bi + bo) \times h}{\left(bi\frac{ro}{h} - bo\frac{ri}{h}\right) \times Ln \times \left(\frac{ro}{ri}\right) - (bi - bo)}$$

rn = 18.9296
e= 23.63-18.9296
e= 4.7004mm
hi= rn-ri = 18.9296-13.5
hi= 5.4296
ho = ro-rn =40.5-18.9296
ho= 21.57
Mb = Wd × R
= 2.88×10000×23.63
= 68.05*10000
a = {bi + bo} ×h/2
= {19.44 + 5.184} × 25.11/2
a = 309.15 mm^2
selecting a material,
{бt} = 150 N/mm^2
and
HTS {бt} = 200 N/mm^2
Checking for induced stress,
At section 1-1, tensile stress,
Бc = 0.84 × 68
= 57.12 N/mm^2
Бind = Wd/A
= 1.1239
Selection of pulley & design of shaft diameter
We know,
Dmin /d =23
Dmin = 23×d = 23×10 =230
D = Dmin+d =230+10=240
Do = Dmin+2h
Selecting standard. pulley proportional
For d =11
A=40
B=40
H=25
Do=230+50=280 mm
Design of shackle plate

As a rule, only the shackle plates are check for strength neglecting plate in view of relatively small thickness
Section 1-1 is weakest section
=2×diameter of large hole
=2×14 M14
B=28 mm
Assume material. C 20
t =100 N/mm
Wd/2=(B-Daxle) ×l× t
2.88×1000/2 = (28-22) ×l×100
L=2.4mm
Design of drum
L1=a+25
=65+25
L1=90mm
D=Dmin
D =230mm
Df=D+6d
=230+(6×11)
=230+66
Df=296mm flange dia.
Taking
Df=300mm
Wall thickness
W=0.02D+1
=0.02×230+1
W=5.6mm
Di=D-2W
=230-(2×5.6)
Di=218.8mm
POWER CALCULATIONS [1&5]
Motor capacity
P=Wd×v/60000×ηt
=2.82 kw
Selecting std. motor from PSG 5.124
Of capacity 3.7 KW with 1500 rpm
From no.-112m
H=112
A=190total reduction i
B=140nput
C=170
Bolt size =M10
Selection of gear box
total reduction= input speed/output speed
1500/94.24
=15.91

Single stage gear box is required with speed reduction ratio 1:20 selecting worm & worm wheel for speed reduction.
Design of worm &worm wheel [5 & 6]

System selection &find weaker element to control abrasive wear to provide continuous lubrication let select a closed system
Assuming tooth system as 200 full depth involute system
Selection of no. of starts
Z=40/i+1
=40/15+1
=2.5
Selecting no. of starts =3
No. of teeth on worm gear
Z=i×z=15×3=45
Taking worm diameter factor q=11
Angle determination,
Based on no. of starts & helix angle (load)
ϒ=β2=15015’18’’
=15.2550
Then, β=90-15.255
= 74.745
Virtual n0, of teeth for worm
Zv=Z/cos3β
=164.640
Yvw=0.4664

VI. MATERIAL SELECTION

Worm=steel
Worm wheel =bronze
This combination most commonly used because of tantalizer
Worm –c45 (b)=1350kg. /cm2
Worm wheel –bronze PSG8.45 table
b =500 kg. /cm2

Strength calculation
b) w Yvw=1350×0.4664
=629.64kg. /cm2
b) vww×Ywww=500=0.4266
=213.3kg/cm2
Here gear is weaker element hence design gear
Determination of module
A=(z/q+1) × √ 2×(Mt)
Where
Z=45
Q=11
(Mt)= mt×k×Kd
=71620 ×hp/n
Hp=2.4×1000×1.2/746
=3.86hp
Mt=71620×3.86/1500×15×0.85
=2350kg/cm2
Taking
K=kd=1
Mt= 2350kg/cm2
A= (45/11+1) × √ 2×2350
=29.52 cm
Where
A=0.5 mx (z+q+2x)
29.52=.5×mx (45+11+0)
29.52=28mx
mx=1.0522
Mx=10.52mm
m=11 in choice

VII. ADVANTAGES & DISADVANTAGES

A. *Advantages*

- The main advantage of this project is used for smaller applications.
- It is economical and No effect on environment
- There is no chance of accident with operator.
- Semiskilled operator can handle this machine
- Only one operator is needed.
- Less maintenance needed as well as Easy to handle
- Disadvantages
- There is a problem of break if the light is gone or the operator switch the machine at improper time.
- There is a more effort required to the machine when load at required altitude.

B. *Applications*

The applications of Monkey mini crane are numerous. Apart from fulfilling the primary functions for which it has been conceptualized it renders useful cervices also.

- It is economical for that constructor whose construction site is small.
- It is useful for small construction.

VIII. CONCLUSIONS

This machine is very beneficial to small constructor. Compared to the conventional machine the overall design is compact and occupies a smaller floor area. Looking at the income per month the cost of monkey crane is recovered within the two months of production. From above information we can conclude that our machine is simple in construction than conventional machines, also our machine is simple in handling.

IX. FUTURE SCOPE

The limitation of our monkey mini crane is the absent of electronic sensor for sensing the weight of the material. If we provide sensor, then it is easy to load the bucket and reduces the accidents. We can develop the suitable seating arrangement for the operator then it's very comfortable to operator.

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