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Design and Fabrication of Loading and Unloading System (Case Study: Two Wheeler)

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***Abstract-* The following paper describes the design as well as analysis of a vehicle lift. Conventionally a scissor lift orjack is used for lifting a vehicle for various purposes, to lift the body to appreciable height, and many other applications Also such lifts can be used for various purposes like maintenance and many material handling operations. It can be of mechanical, pneumatic or hydraulic type. The design described in the paper is developed keeping in mind that the lift can be operated by mechanical means by using wire ropes with the help of electric motor. In our case our lift was needed to be designed a portable and also without any pneumatic or hydraulic means. Also such design can make the lift more compact and much suitable for medium scale work.**

***Index Terms-* Elevators ,Lifts ,Ropes ,Drive ,Sheave etc.**

I. INTRODUCTION

Lifts are generally use for loading or lifting and unloading of goods, vehicle or a person .Lift are most commonly used mode of vertical transformation in modern buildings having more than three stories.

Lifts are generally powered by electric motors that either drive traction cable and counterweight system like a hoist, or pump hydraulic fluid to raise a cylindrical piston like a jack. In agriculture and manufacturing, an lift is any type of conveyor devise used to lift materials in a continuous streams into bins or silos .several types exist, such as the chain and bucket elevator, grain auger. More than a decade ago, it was estimated that there were more than half a million passenger elevators in the United States transporting people day and night every day of the year. Many of these elevators are located in urban area in high seismic region.Most elevators are built to provide about 20 years of service, as long as service intervals specified and periodic maintenance by the manufacturer are followed.

Mobile column lift are the most cost effective heavy duty lifts, battery operated models are compact, portable an easy to use. Just set them up when they are needed, and clear them out of the bay when they are not. It's also important to choose the right accessories an adapters for a higher capacity lifts.

A lift is essentially a platform that is either pulled or push up by a mechanical means. A modern day lift consist of cab (also called a cage or car) mounted on a platform within an enclose space called a shaft or sometime a "hoist way". In the past , lift drive mechanism where powered by steam and water hydraulic piston .In a traction lift ,cars are hold up by mean of rolling steel ropes over a deeply grooved pulley, commonly called a sheave in the industry the weight of car is balanced with a counter weight sometimes to lifts always move synchronously in opposite direction , and they are each other counter weight .

The vehicle lifts are now available in the 2 post lift and 4 post lift variety. Instead of having to stand below the car in a pit, The car could be raised to various height for mechanical comfort. They were more convenient, safer ,and offered a much wider variety of servicing option than the original in ground lifts.

II. LITERATURE REVIEW

Ramteke G.S, "Design of wire rope", Journal of engineering research and technology , volume -3 ,issue 1.0,october 2014 ,pp-2278-0181

The current standard in rope drive transmission is using stainless steel rope on Aluminum sheave that are hard coated with 0.002 thick anodize. Tungsten was found to have the highest fatigue resistance. The highest power transfer efficiency is acquire when a very stiff rope is used in low tension transmission stage. This can be done with low torque, high speed stage. The mostly use sheave are made with A16061-T6511 were coated with 0.002 bar as anodize .The fiber rope have better fatigue resistance with high groove. The groove support at least 120-150 of rope circumference. The profile should be a circular shape to maximize the surface contact between the rope and the sheave. The majority of wire rope manufacture recommend that the groove be oversized 6-8%larger than the nominal rope diameter for rope less than $1/8^{th}$in diameter.

Zheng M.W, "method of radiation detection (intermediate level) , "the society of non-destructive testing and certification of Taiwan, taipae ,volume -2,issue 3 ,October- 2015 , pp-893-910

In elevator and cranes mostly the steel wire rope are applied. In an elevator for driving comfort, the value of maximum acceleration to 1/4m/s2. Boundary condition of lower rope end is defined by load mass and at upper rope end by movement of inertia of all driving mechanism component. Problem on detecting the size of steel wire rope coated with plastic material. The gamma ray approaches the steel rope , a part of gamma ray is absorb by the steel wire rope and other part passed through directly .the amount of gamma ray absorbed depend on the density, thickness and atomic number of the steel wire rope .

Velinsky S.A, "Design of wire rope", journal of mechanism , transmission ,and automation in design ,volume -3,issue-3,November-2015,pp 382-388.

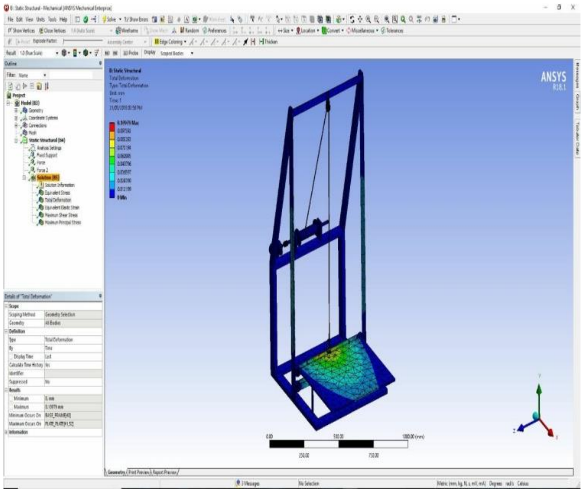
The life of the rope decrease with increasing axial load and decreases with increasing axial load and decreasing sheave bend radius. The efficiency of rope drive increase proportionally to stiffness of the tension element. For torque to be transmitted there must be a tension and velocity difference between the rope input and output from the sheave. The rope is terminated at both sheave and the contact friction is maximized to idealize a transmission. The low friction contact between the sheave and the rope minimize the crown wear. The number of outer strand in a rope determine the contact area between the rope and the sheave. By increasing this area abrasive wear between the rope and the sheave is reduced.

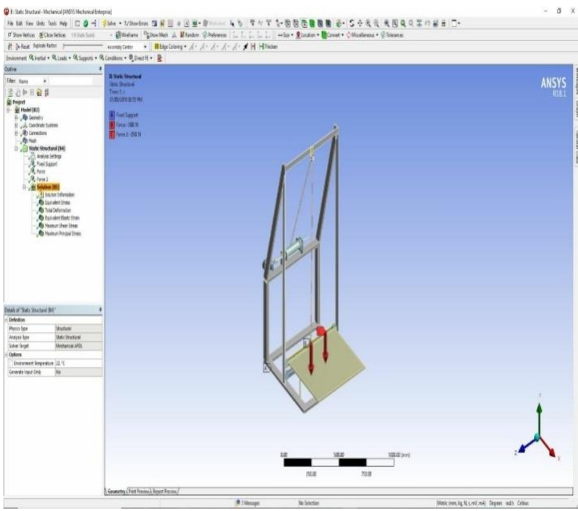
Phillips J.W, "Analysis of wire rope with inter wire rope core" , journal of applied mechanics , volume-52 , issue-3, November-2015, pp-238-251

The small wire have better fatigue life .Larger wire are less ductile for the same strength as smaller wire. The breaking strength can be increase in two ways either by increasing the wire material tensile strength or by increasing the rope fill factor. The fatigue performance of wire rope varies based on internal and external friction and rope material ability to resist abrasion and wear. Synthetic rope are stronger than wire rope of the same diameter. Lubrication makes a huge difference in rope life. It also reduce wear on sheave or drum. All high load, the steel and the tungsten rope wore into hard anodize coating. A tungsten rope with 7 strands and 19 wire per strands is best rope on the market for bending over sheaves. To increase life of sheave it should be made out of A16061-T6511 that has 0.002 thick hard cat anodize surface. This maximize wear resistance while maintain low weight.. Due to this stresses between strand and wire also reduce. Rope diameter are mostly in the Range of 25 mm to 55 mm .The effect of increase rope surface area on rope damage through the reduction of radial crushing pressure. Our standard cable fitting are made from $1/8^{th}$ steel and and stock both rounded end eyelet with either a 1/4th hole or a 5/6 the hole and square end eyelet with a 5/32 hole. The stock 1/8, 3/16, 7/32 Aluminum loop sleeve and a 1/8 Aluminum stop.

Petrikowa jana , " determination of mechanical characteristics of single –wire rope loaded by tension" , the international journal of transport and logistics ,volume -5 , Issue-6, july-2013, pp348-620

In design the design of the structure , the steel cables to be designed for the 40-50% of the tension carrying of the material .A diameter of the core is bigger than the diameter of wires in surrounding layers ..A small amount of wires with a big diameter resist to wear more and a large amount of wires with small diameter resist more to fatigue. The ropes with six triangular strands or eight round strands and an internal plastic layers are installed on drum winder. The usual tensile grade of the rope wires is in the range 1770 M pa .at present the cables are made especially from different kind of high strength steel for ex.-IPS or EIPS. The casing prevent contact between the rope and sheave. Lubrication improve the fatigue resistance and provide high level of corrosion resistance. Laser Harding the surface of wire improve fatigue resistance The fiber rope having high strength can made from natural or synthetic materials. The jacketing strand to protect them from inner strand abrasion greatly increase the fatigue life of the rope whereas the lubrication reduce the friction between fiber and strands.





3.DESIGN THEORY AND CALCULATION

Design procedure for Wire Rope Selection :

Step:1Selection of wire rope type

Select a wire rope (6 x 19) based on the type of application.

Step:2Calculation of design load

Design Load = 2.5 * Load to be lifted * Assumed factor of safety

W = 2.5 *15000* 5

W = 187500 N.

Select factor of safety from PSG Design Data Book P. No: 9.1 based on the rope application

Step:3Selection of wire rope diameter (d) :

Assuming the design load as breaking load select the wire rope diameter from PSG Design Data Book P. No: 9.4 to 9.5.

1N=(1/g)kg = 0.1019 kg,

Hence, 187.5KN = 19106.25 kg = 20 tones (APRs).

(Nominal breaking strength of rope)

For 20 tones (nominal breaking strength) ,Rope diameter d=20mm (PSG Data book , pg.9.4)

Step4:Calculation of Sheave/drum diameter (D):

D/d ratio from page 9.1 (PSG data book)

D/d=23

D=23*20 mm

D=460 mm

Step: 5Selection of Useful cross sectional area (A):

$A = \pi r^2 * 0.4$

$A = 3.14*(20/2)^2*0.4=125.66$ mm

A = 125.66 sq.mm

Step: 6 Calculation of wire diameter (d_w)

$$d_w = \frac{d}{1.5\sqrt{i}}$$

$$d_w = \frac{20}{1.5\sqrt{6*19}}$$

$$d_w = 1.24\ mm$$

$$i = \text{Number of strands} * \text{number of each strands} - 6 * 19$$

Step: 7 Selection of weight of rope (W_r):

$$\text{For } d = 20 \text{ mm approx.weight} = 1.47 \text{ kgf/m}$$

$$\text{approx. weight} = 1.47 * 9.81 = 18.05 \text{ N/m}$$

$$\text{Now, for 5m height} = 18.05 * 5 = 90.25 \text{ N}$$

$$W_r = 90.25 \text{ N}$$

Step: 8 Calculation of Effective Load (W_{ea}):

$$W_{ea} = W_d + W_b + W_a$$

$$W_d = W + W_r$$

$$= 15000 + 90.25$$

$$= 15.09\ KN$$

$$W_b = E * \frac{d_w}{D} * A$$

$$= 0.84 * 10^5 * \frac{1.24}{460} * 125.66 = 28454\ N$$

$$a = \left(\frac{v_2 + v_1}{t}\right)$$

$$= \frac{0.381 + 0}{30} = 0.0127\ m/s^2$$

$$W_a = \left(\frac{w + w_a}{g}\right)a$$

$$\left\{\frac{15000 * 90.25}{9.81}\right\} \times 0.0127 = 19.535\ N$$

$$W_{ea} = W_d + W_b + W_a$$

$$W_{ea} = 15090.25 + 28454 + 19.535$$

$$W_{ea} = 43563.785\ N$$

W_{ea} = Effective Load

W_d = Direct Load (load to be handled)

W_b = Bending Load

Wa=acceleration load

E = Take it from PSG Design Data Book P. No: 9.1

$v_1 = 0$ (Initial Velocity)

Step: 9 Calculation of factor of safety:

$$Working\ Factor\ of\ Safety = \frac{Breaking\ load\ of\ the\ selected\ Rope}{Effective\ Load}$$

$$Working\ Factor\ of\ Safety = \frac{18750}{43563.785}$$

$$= 4.305 < 5$$

The working factor of safety is not greater than the recommended factor of safety then the design is not safe.

If it's not safe calculate how many wires can be used to handle the load using the next step.

Step: 10 Calculation of number of wires:

$$Number\ of\ Ropes = \frac{Recommanded\ factor\ of\ safety}{Working\ factor\ of\ safety}$$

$$\frac{5}{4.304} = 1.16 \cong 2$$

Design of sheave:

Diameter of groove of sheave/ drum: -

for rope diameter (d) = (20-29) mm, minimum groove dia. = d+2.4

Hence, Diameter of groove of sheave/ drum =20+2.4=22.4mm

Depth of groove: t_{sg} *= 1.5 d = 30 mm*

Wall thickness of drum = 0.02D+ (0.6 to 1.0) cm = 1.72 cm = 17.2 mm.

Pitch diameter of sheave (p) = 2.065d < p < 2.18d

= 23.12<p<24.416=24mm.

Step: 11.Pulley Speed:

$$V_p = \frac{\pi.D.N}{60}$$

$$0.381 = \frac{\pi * 0.460 * N}{60}$$

Step: 12 Design Power:

$$P = force * lifting\ rate$$

$$= 15 \times 10^3 \times 0.381$$

$$= 5.715\ KW$$

$$T = \frac{60 * P}{2\pi N}$$

$$= \frac{60 * 5.715}{2\pi * 15.81}$$

$$= 3.45\ Nm$$

CALCULATION FOR STRUCTURE :

1. PALLET:-

$Dimensions : 3000\ mm \times 2500\ mm$

$Load\ of\ 187500\ N\ acting\ on\ pallet\ will\ be\ taken\ as$ "UNIFORMLY DISTRIBUTED LOAD ON CANTILEVER BEAM"

Step: 14. Design of sheave:

Step: 14 Torque

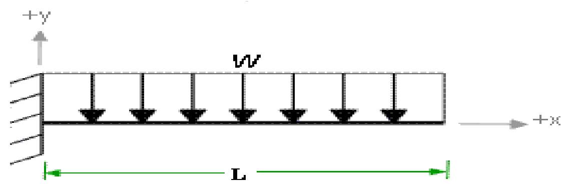
DEFLECTION ON BEAM:-

$$\delta = \frac{wl^4}{8EI}$$

$$= \frac{62.5 \times 3000^4}{8 \times 183 \times 3.8 \times 10^{12}}$$

$$= 0.909\ mm$$

To avoid much deflection we can use angle plate and will rivet it to the structure.



Design specification of Wire Rope:

Wire rope	6x19(based on type of application)
Material	Cast Steel
Design load	187500 N
Wire rope Diameter	20 mm
Cross section area	125.66 sq.mm
Drum diameter	460 mm
Wire diameter	1.24 mm
Weight of rope (Wr)	90.25 N
Effective load (Wea)	43563.785 KN
Direct load (Wd)	15.09 KN
Bending load (Wb)	28454 N
Acceleration load	19.535 N
No of rope	2

Design specification of Sheave:

Diameter of groove of sheave/drum	22.4 mm
Depth of groove	30 mm
Wall thickness of drum	17.2 mm
Pitch diameter of sheave	24 mm
Pulley speed (Vp)	0.381
Design power (P)	5.715 KW
Torque	3.45 Nm

Result:

Components	Materials	Parameters	Dimensions
Wire Rope	steel	No. of ropes	2
		Diameter	20 mm
		Wire Diameter	1.24 mm
Sheave	Carbon Steel	Diameter	22.44 mm
		Depth of groove	30 mm
		Pitch diameter	24 mm
Electric Motor		Power	5.715 KW

		Torque	3.415 Nm
Pallet	Cast Iron	Area	3000*2500 = 7.5 m sq.
		Deflection	0.909 mm

IV. CONCLUSION

The detail review of this paper will lead one to understand that essentially a new loading and unloading design was proposed to decrease the Time consuming work, fatigue during work etc. The proposed lift is an assembly unit made up of simple and easy to manufacture parts. The Machining cost will be reduced as compared with other loading, unloading lifting machines like hydraulic machines. The Existing machines were not proving stress full at providing loading at cheaper rates. The maximum stress was is very compatible according to the industrial or goods service provider taken in. The proposed lift showed high Carrying stresses and displacement as compared with the previous case this is due to the some analyzed and strengthen components of the lift like wire rope, motor, and pallet. According to the Indian industry standard of goods loading and unloading this proposed lift is considered as a fit to the rule to service it at the very cheaper rates and east to handle. Even better results are possible after precisely following the guidelines formulated for the easy flow of work for volunteers.

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