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Design, Fabrication and Installation of Mechanically Operated Lift for Floor wise Transportation of Stationary

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***Abstract* - This project describes the design as well as fabrication and installation of a material handling unit which works by mechanical means. The design was developed keeping in mind that the lift can be operated by mechanical means so that the overall cost of the lift is reduced and also human efforts are reduced to transfer materials. Also such design can make the lift more compact and much suitable for medium scale work. Conventionally an electric lift is used to lift the material and transfer it to different floor or material is lifted by the human efforts. But in this case along with lifting a material, efforts are used to move the material up to a certain height by incorporating power transmission mechanism. Though project is designed to transfer load only up to a certain height but it will be capable enough to transfer the load up to three floors in near future. Thus a lifting mechanism is customized which is affordable, occupies less space, requires less maintenance and its design simpler than the electric lift.**

I. INTRODUCTION

Lift is a simple mechanical device used to raise element or object from ground level to a certain height to perform a specific work with maximum load and minimum efforts.

1.1 Similar Work

Nowadays there are hydraulic and pneumatic lift but in accidental cases or any technical problem it is difficult to carry these systems as they are bulky and also need lot of maintenance but this mechanism is portable and requires less maintenance as compared to pneumatic and hydraulic systems.

In this project, main focus is on power transmission mechanism. A material which is to be transferred to the different floor will be transported using a Pulley and a power transmission mechanism operating mechanically with the help of pedal driven mechanism.

1.2 Expected Outcome

To make a few efforts in driving the mechanism and the stationary can be transported. It should work any time. It should help reducing the problems related to power consumption, maintenance etc. Its main benefit should be reduction in unnecessary cost, reduce the over design and design should be up to the mark.

This project illustrates many mechanical aspects like designing of the components such as casing, pulleys, chain drive, modelling and analysis. Other aspects are design finalisation, fabrication and installation.

Following are the objectives expected to be fulfilled by the project:-

- ✓ To design and analyse a material carrying cage for handling stationary.
- ✓ To design and fabricate a power transmission mechanism and raise objects from ground floor to certain height.
- ✓ To fabricate and assemble all the major components.
- ✓ To install the entire set up in the proposed location and carry the test run.

II.LITERATURE REVIEW

2.1 Pedal driven Mechanism

Pedal driven mechanism helps to obtain less effort and give more power output. The person can pedal and produce more outcomes in less effort.

2.2 Pulley mechanism

Pulley is a simple mechanism that is used to lift heavy objects. Pulleys are usually used to sets designed to make the amount of force needed to lift something.

2.3 Chain Drive

Various chain arrangements are used for different types of machines or vehicles. It transmits more power than belts and no slip takes place during the operation.

2.4 Power transmission mechanism

Various power transmissions modes are available which are used for different applications. But chain drive is the cheapest mechanism which reduces the total cost of the transmission mechanism.

III. DESIGN DESCRIPTION

Some components were designed using standard design calculations, some using FEA tool and some using the standard selection criteria. Below is the tabular form of the nature according to which the components are selected. The components are categorized into below 3 categories.

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Table3.1:- Selection Criteria for components

Analysed using FEA Tool	Using design calculations	Standard selection
Cage	Rope	Winch
-	Chain Drive	Pulley

3.1 FEA Simulation

FEA Simulation was done for the selection of the cage.

3.1.1 Steps Performed

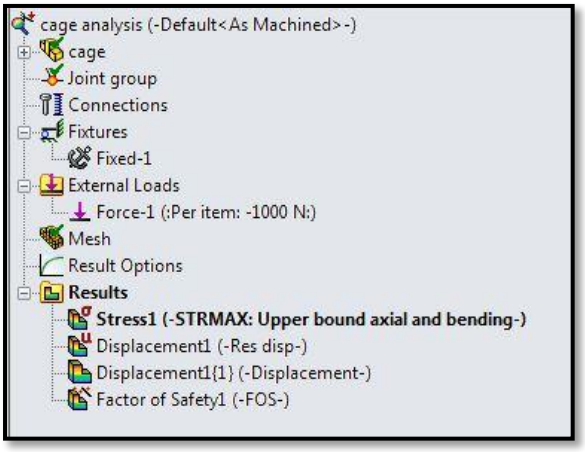

Figure 3.1:- Detailed Analysis Performed

A detailed analysis was performed for the analysis of the cage. 1000N force was applied in the negative Y-Axis. By following appropriate steps from the solid-works its analysis was done. The values for Stresses, Displacement and Factor of Safety were obtained.

3.1.2 Material Selection

ASTM A36 Steel was selected and applied for the analysis of the cage. This material was chosen because it satisfies the requirements of the cage. Moreover it also possesses the essential properties of Mild Steel. It has high tensile strength of 400000000 N/m^2 which is sufficient to lift the given amount of load.

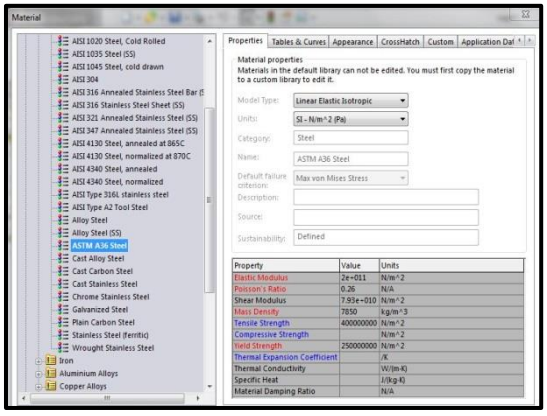

Figure 3.2:- Material Applied

3.1.3 Meshing

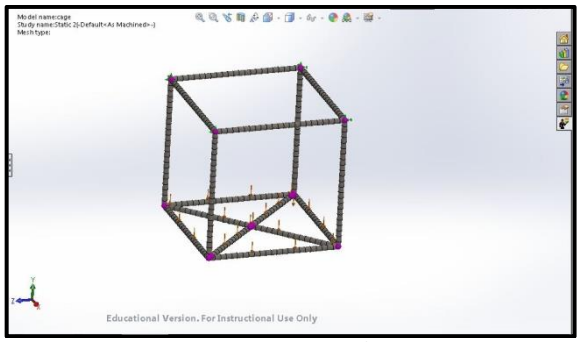

Figure 3.3:- Meshing of Cage

Meshing was done to sub divide the CAD model into smaller domains in order to increase accuracy of the solution obtained.

3.1.4 Boundary Conditions

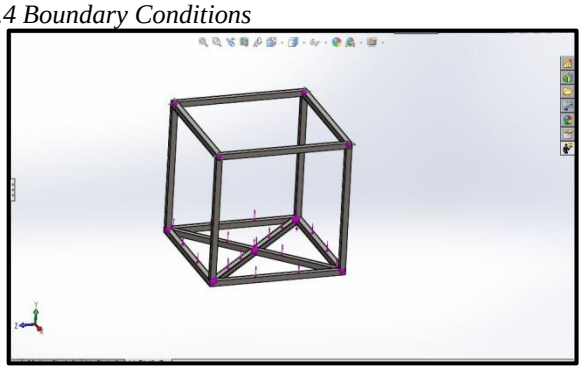

Figure 3.4:- Boundary Conditions for Cage

Various boundary conditions were applied to the cage in order to get a solution for it. The upper four vertices of the cage were given fixed support. The lower four members of the cage were subjected to negative Y-Directional force equivalent to the load to be lifted by the cage.

3.2 Standard Design Calculations

3.2.1 Rope

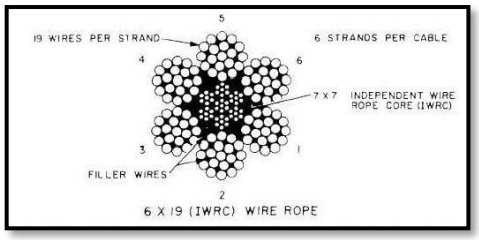

Figure 3.5:- Steel wire rope of group 6*19

The rope is wound around the pulley to transmit force. Steel wire rope of group 6×19 was selected depending upon its load carrying capacity. The dimension of the rope was found out using design procedure and considering design load which was found out by formula

Design Load = 2.5 × Load to be lifted × Assumed FOS

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By considering this design load Effective load (W_{ea}) was found out. Then actual and considered FOS were compared and the working FOS was found out be greater than considered FOS which made the design safe and the diameter obtained which is 6mm was accepted.

3.2.2 Chain Drive

Chain drive, which is the crucial part of the Power transmission mechanism, was designed using standard design procedure.

By considering the transmission ratio and the number of teeth required, the chain was selected and checked for the parameters like breaking and bearing strength and the length of the chain was found out.

3.3 Standard components selection

3.3.1 Pulley

A standard 3 sheave pulley was selected based on the standard selection and catalogue provided by the manufacturer. This pulley was incorporated in order to reduce the amount of weight to be lifted by one person.

3.3.2 Winch

Winch is selected based on the standard catalogue of the manufacturer. It is provided with a locking and anti-locking mechanism to hold or stop the winch whenever required.

IV. DESIGN ANALYSIS

Since cage is selected by FEA tool, it was analysed in the solid-works software.

Analysis was done for the parameters like:-

4.1 Factor of Safety

4.2 Stress

4.3 Y-directional Deformation

4.1 Factor of safety

The experimental procedure for the cage was carried out using solid-works software.

Optimization for the modified design of cage was done. The load carrying cage was analysed on solid-works software. After analysis, the Factor of safety was found to be 5.7 which is below a certain specified limit. Thus, it was considered safe for design of cage. Since the design is safe, the cage is strong enough to lift or move the desired load.

4.2 Stress

Analysis of cage was done for calculations of the stresses on it using solid-works. The upper vertices of the members were subjected to fixed support. Forces were applied on the lower end of the base member and accordingly analysis was done. The maximum stress was found to be 109MPA. So cage was considered deformation free and design was safe.

4.3 Y-Directional Deformation

Analysis for Y-Directional deformation was done using solid-works software. After analysis the directional deformation was found beyond a certain specified limit which was 1. Thus it was negligible and was found to be safe.

The components were selected in such a manner that its FOS is higher, adequate strength, feasibility of the components, mechanical properties, satisfies the ergonomic requirements, easy to operated, less complexity of design. The components are found to be safe even after its design calculations. Due to all these factors the chosen design components are safe in every aspect.

V. EXPERIMENTAL SETUP

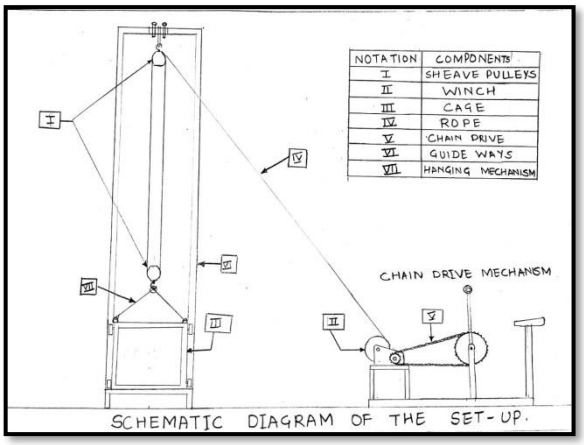

Figure 5.1:- Schematic Diagram of the setup

Figure 5.2:- Assembly of the entire set-up

A load carrying cage which is capable to withstand a load up to 100 to 150kg would be lifted with the help of Steel wire ropes. The ropes are able to lift the cage through the hooks attached on it. A pulley is then incorporated to reduce the amount of force needed to lift the cage. The pulley holds the steel wire rope and the rope is able to slide over it easily. Chain drive mechanism with pedalling system is incorporated which is the main driving mechanism. Winch is integrated to wind and unwind the rope over drum. As we pedal, the force is applied and the power is transmitted to the rope which lifts the load carrying cage and the stationary is shifted to the desired location, meanwhile the rope winds itself around the winch. Once the work is done, the cage goes back to its

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original position and the rope unwinds it from the drum mechanically. This assembly is to be installed in the concrete technology lab and drawing hall.

Table5.1:- Observation Table

Sr. No.	Parameter	Value
1	Time required to lift load up to 14ft.	98 sec
2	Number of revolutions required to raise cage up to one foot	6

5.1 Details of Parts

5.1.1 Pulley

Figure 5.3:- Groove sheave pulley

A rope and Pulley system is incorporated.
A 3 groove sheave pulley is used and two such 3 groove sheave pulleys are used which will be attached to the beam on the ceiling of the floor. The material selected is GCI FG 200. Dimensions of the pulley are 6 inches. The cost of each pulley is ₹900 per pulley.
Each groove in the sheave pulley reduces half of the actual weight. 3 such grooves on the single pulley reduce weight up to 3 times. As 2 sheave pulleys with 3 grooves on each are used, the weight is reduced 6 times to its original weight.

5.1.2 Rope
The rope is threaded over the pulley to transmit the tension force around one or more pulleys to lift or to move a load. It connects the cage to the winch through pulley and slides over the pulley. Steel wire rope of group 6×19 with wire diameter 6mm was selected. It consists of several strands of metal wire laid into a helix. These ropes are best suitable to transmit force. These steel wire ropes have very high strength of the rope wires which enables it to support large tensile forces and to run over sheave with relatively smaller diameter. Cost of the rope is ₹35 per meter.

5.1.3 Cage
A load carrying cage is used to withstand the required amount of load. The cage is rectangular in shape and is capable of carrying a load of 100 to 150kg. The cage is attached to the rope through hanging mechanism. Cross members are incorporated in the cage to distribute the load equally. The material selected for the cage is Mild Steel because no special techniques are needed to weld the material that is welding of the material is quite simpler and it is affordable. It is also recyclable.

5.1.4 Winch

Figure 5.4:- Winch

The function of winch here is to wind and unwind the rope around it. The winch is attached to the shaft of the sprocket of the chain drive mechanism through gas welding. Dimensions of the winch are 549mm and diameter is 540mm. When the drum rotates it causes the rope to wind and unwind mechanically. Cost of the winch is Rs. 1800.

5.1.5 Shaft

Figure 5.5:- Shaft

The shaft is linked horizontally from the centre to the chain drive mechanism and the other extreme end to end to the winch. The shaft is pushed inside both the Pedestrial bearings. This pedestrial shaft assembly is bolted to the entire frame. The shaft end is welded to the winch. As being the Driving member it rotates and causes the drum to rotate. It transmits its power to the drum which causes the drum to rotate.

5.1.6 Chain drive

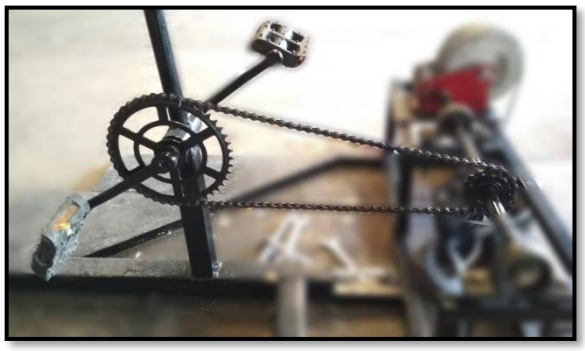

Figure5.6:- Chain drive

Calculations were done so as to select the power transmission mechanism. To the chain and sprocket assembly a seat and pedal is attached for the operator to sit over it and pedal the sprocket. The fact that selection chain drive over belt drive is

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that drive belts can slip off easily unless have teeth which mean that output side may not rotate at a precise speed and some work gets lost to the friction of the belt as it bends around the pulleys. Moreover, angular velocity ratio in case of belt drives is not constant because of slipping in belts.

VI. CONCLUSION

In the First Iteration of the project, a load carrying cage which is the main part which acts as a transportation unit was designed, analysed and fabricated with high factor of safety.

In the second iteration, power transmission mechanism was designed with consideration of load to be lifted. It is the main driving mechanism and made in such a manner that it could withstand the desired load and operate fully mechanically.

All the major as well as minor components were selected and fabricated like pulley, winch, Guide-way, base, sackle, fasteners etc.

All the components and sub-assemblies were assembled together and installed at the proposed location.

The test run was carried out to check the functionality and operation of the whole setup and it was found that the system operates properly with expected outcomes that the cage carried 50kgs weight up to a height of 14 feet in 98 seconds.

Thus a successful test run was conducted to raise the weight from ground floor upto certain height.

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