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# Design and Fabrication of Hydraulic and Mechanical Crane Lift

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***Abstract*- A Simple hydraulic mechanical Movable crane is necessary mobile equipment for lifting and moving heavy loads used in small scale manufacturing and production industries. Due to the growing of small scale industry based on the current policy of the Government, the demand of load lifting equipments has increased. To deal with such a challenge, we have come up with the brilliant concept of designing and manufacturing a simple and affordable mobile floor crane which we hope will solve the problem of lifting equipments and minimizing manufacturing costs by reducing manpower. The idea of designing and manufacturing a hydraulic-mechanical movable floor crane was best concept among the three major concepts that were initially generated. The manufacturing of the product will involve fabrication works by using hollow section steel materials. Some other parts like tires, hydraulic Jack and motors fitted in the hollow section structure.**

**Keywords- Mechanical Movable crane, lifting equipments, etc.**

## I. INTRODUCTION

The current National policy of industrialization has brought about the rise of industrial production in the Small and Medium Scale Enterprises (SME). This aspect has made the SME community suffer much in carrying, loading and unloading of goods. Currently, the movement of goods from one place to another within the factories is mostly done by employing a good number of casual labor and floor cranes. The existing Floor crane have not been completely capable to solve the problems of loading and unloading of goods due to various drawbacks such as high equipment cost, slow operation and large labor requirement.

Invention of the Simple Hydraulic Mechanical floor crane is intended to manufacture a crane which is small in size, automatic hydraulic lifting and chain driven in order to overcome the existing crane drawbacks of equipment cost, slow operation and a number of operators respectively. Hence, SME will be capable of purchasing and using the crane that is faster with little number of operators and thus, achieve productivity at reasonable costs.

### 1. Background

The first crane was invented by the ancient Greeks in the last sixteenth century and was powered by men's or beast of burden such as donkey. These cranes were made from wooden structure and were used for construction of tall buildings. Later, larger cranes were developed and these newly innovated cranes were employed to use human tread wheels and thus permitting the lifting of heavier weight. While cranes remained hand-powered for centuries, hydraulics had been steadily improving. In the 15th century French mathematician Blaise Pascal studied fluid hydrodynamics and hydrostatics and came up with a new understanding of hydraulic principles like fluid density, pressure, and incompressibility which are the fore sight idea towards the development of hydraulic cranes.

Much later in the 19th century, the rise of ironworks and industrialization meant that crane finally was made out of iron. The first cast iron crane using wire rope was invented and constructed in 1834. And in 1851, hand-powered cranes finally began running on steam power of I.C engine that provide a greater lifting capability. This was the first step toward a truly hydraulic crane. Now days several kind of cranes were developed and that include mobile cranes which are constructed by steel trusses or boom which are mounted on a mobile platform that may be railed or wheeled. The boom is hinged and it can be raised or lowered by hydraulic cylinder, the hook is suspended from top to bottom by wire ropes which are operated by prime mover. hbrown.com/cranes...cranes/history-crane

### 2. Problem Statement

The maximum performance has not been achieved with the existing floor cranes because they have some problems that will affect the efficiency and operating time. So the invention of simple hydraulic-mechanical floor mobile crane will overcome the problem facing the existing floor crane, such as manual hydraulic jacking operation which will consume time during lifting of the load. The efficiency of the floor crane will increase after the newly invented crane with extra attachments like D.C

motors have been mounted so as to eliminate the manual jacking operation and movement of the crane in existing ones and thus lifting speed will be independent of the load.

**3. Objective of Study**

This project dealing with fabrication of simple hydraulic floor mobile crane, which will serves the simplicity of lifting, lowering and transporting loads into other places and for that case instead of using physical means of load lifting, the newly innovated floor crane is designed to use hydraulic fluid power mechanism to lift up the loads up to 150kg.

**Specific Objective**

- To study the operation of the existing floor crane
- To design the floor mobile crane.
- To fabricate the model/prototype of the floor mobile crane

**Importance of The Study**

The use of floor crane will provide the simplicity to load lifting and thus less force will be applicable and hence manpower requirement will be reduced. Also, because of the low maintenance cost, cheap and requires less skills in operation, the design become affordable and thus even small entrepreneurs can accommodate.

## II. EVALUATION OF DESIGN CRITERION

The evaluation of criteria for newly innovated crane was based on the shortcomings of the existing floor crane as indicated in the table 1 below.

Table 1 Evaluation Criteria

| Design Criteria | Description | | Shortcoming Of The Existing Crane |
|---|---|---|---|
| | Existing Crane | Newly Invented Crane | |
| Load Carrying Capacity | 1 Ton | 0.15 Ton (150Kg) | Most Of Loads Lifted By Floor Crane In SME's Shops Floor Ranges Between 50-150kg |
| Size | L X W X H = 1.2mx0.7mx.2m | L X W X H=1mx0.5mx1.5m | Existing Crane Occupy Larger Space |
| Cost | TZS 1,000,000.00 | TZS 500,000.00 | The Existing Crane Is Costly And Hence Not Affordable By The SME |
| Safety | Extensive Human Involvement To Pull Or Push The Crane | Less Interaction Between The Crane And Operator | More Energy Is Incorporated In Operating The Crane And Thus Results To Healthier Problem To The Operator. |
| Operation | Has More Manual Operations | Has Less Manual Operations | More Time Is Consumed During Operation |

## III.LAWS GOVERNING THE DESIGN OF HYDRAULIC FLOOR CRANE

**1. Law of conservation of energy**

the energy can neither be created nor destroyed, although it can change forms

**2. Pascal's principle**

pressure applies in a confined fluid at rest is transmitted undiminished in all directions and act with equal force on equal area at right angle to them.

## IV. DESIGN METHODOLOGY

**1. Literature Review**

Through review of different journals and published data concerning the floor crane, data can be obtained about the available design, problem facing the available design and to encounter those problems like manual hydraulic jacking and also will provide brilliant concept for designing a hydraulic system

**2. Questionnaire & interview**

To conduct a face to face interview and questionnaire with professionals and end user operators from various industries and workshops so to obtain the general information regarding the performance and problems with the existing load lifting equipments

**3. Soft ware to be used.**

Design drawings for a floor crane is important for facilitating the manufacturing process and thus the detailed drawing as well as assembly drawing will be drawn by using software such as autocad and solid works. for the purpose of designing a crane that will provide the best and friendly service to the end users, the designer has to make an intensive study in the proceeding literature review chapter in order to know the drawbacks of existing mobile floor cranes.

**4. Research approach**

Several previous publications uploaded in google website http://www.lkgoodwin.com titled davit crane, have noted that most of the existing mobile floor crane are equipped with the hydraulic lifting facility which is manually operated. However the existing cranes movement from one place to another is done manually by using human power. thus the design becomes tedious and time consuming and thus it limit efficiency and production time. in contrast to our design, this research have therefore looked at the best method that will eliminate most of the existing manually operation and minimizing human power by providing electrical driving facility to speed up the operation and save time.

The most critical factors considered in this research and the existing drawbacks in each factor was identified and taken care of factors to be considered for the floor crane design performance the overall performance of the existing floor crane is limited due to use of manual operations whereas the designed crane is intended to minimize the use of manual operations by employing four bar jacking mechanism and chain drive system.

**5. Product cost**

The manufacturing cost of the existing floor crane having capacity of lifting up to 150kg is estimated to be usd 270

while the newly invented crane manufacturing cost is estimated to be usd 190.

**6. Weight**

Weight of the existing floor cranes is estimated to be 90kg while the invented one is estimated to be 50kg

**7. Maintenances**

Mostly of the existing floor crane are difficult to maintain because parts are not easily accessible while in the newly invented floor crane the parts to be lubricated are easily accessible and no special tools are used in maintenance.

**8. Ergonomics**

Existing floor crane reduces the operator efficiency because it took more time in the operation, but in the newly invented floor crane the controls are mounted in an accessible position relative to the operator for easy operation.

**9. Aesthetics**

The invented floor crane is intended to be attractive to improve the perception within the market and due to the high pleasing appearance it can compete with the existing floor crane within the market.

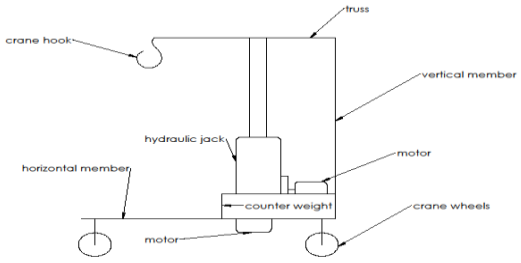
**10. Customers**

The crane is designed to be used in small scale industries, workshops and warehouses. The owners of these places have a reasonable purchasing power provided that the product is useful to them compared to the existing floor cranes which are created for heavy duty works and with high purchasing cost.

## V.METHODOLOGY

On the speculation of various details concerning the existing mobile floor crane design, the technical information and data have been obtained and knowledge of on how to innovate the mobile floor crane as well. Through literature review of published documents and the face to face interview with the end users of the existing floor crane together provide the brilliant information about the performance, durability, maintenance cost, failures of the existing floor crane, and based on those criteria the design of the newly invented crane will provide the solution towards the problem facing the existing mobile floor crane. Here are the aspects that assist the accomplishment of the entire area of study of the mobile floor crane.

- Data collection through questionnaire was prepared and distributed to various search areas so that users and professionals provided the answers toward the questions regarding information of the existing floor mobile crane.
- Data collection through Face to face interview as a means of administering questionnaire was conducted and various data and basic information concerning the performance of the floor crane were obtained.
- Also by analyzing the information collected from various search areas, the criteria for the intended design was set in order to overcome the drawbacks and problems of the existing floor crane
- At the end, a sketch of the design for the intended crane was made to facilitate demonstration of the study as it is shown in the figure below.




DESIGN SKETCH OF HYDRAULIC-MECHANICAL FLOOR MOBILE CRANE

Fig. 1 Details of the data collected are elaborated in the next chapter.

## VI. DATA COLLECTION

Data for the existing floor crane were collected by using four methods; through questionnaire, face to face interview, General conversations and internet Reading

**1. Information collected through questionnaire and face to face interview**

- Types of floor cranes
- Size of existing floor crane with 150 kg carrying capacity
- Challenges encountered on the existing floor cranes
- Drive mechanism used in existing floor cranes
- Possible failures that occurs in floor cranes
- Maintenance of the floor crane
- Durability of the existing floor crane

**2. Information collected through internet**

- Available standards of various parts of the existing floor cranes
- Material used to make up the parts of the floor cranes
- Determination of forces and stresses of the members
- Reactions acting on the wheels of the crane

**3. Evaluation of Hydraulic Floor Crane Design For Selection of The Best Concepts For Development**

Different ideas or concepts of hydraulic floor crane were generated and the following concepts Were considered for evaluation:

**3.1Manually operated hydraulic floor crane (C1)**

Lifting operation is by means of Hydraulic Jack while other operations such as pushing, pulling and cornering are to be done manually

**3.2 Mechanical jack operated floor crane (C2)**

Lifting operation is by means of rack and pinion gear mechanism

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### 3.3 Simple hydraulic-mechanical floor mobile crane (C3)

The movement of the crane is enhanced by motor coupled to a chain drive while the jacking operation is done by means of motor coupled to a four bar linkage mechanism. The floor crane proposed concepts above were evaluated to get the best concepts for development by the method of rating and weighting matrix as shown in table 2 below.

In order to select the best concept the concepts were evaluated against set criteria obtained from design specifications.

## 4. Selection matrix

- The Numerate Decision Matrix method of concept evaluation was used to evaluate the concepts. The following procedures were followed:
- The criteria were weighed according to their importance, where the importance was determined by judgment.
- Next, a rating scale was prepared on which the judgment of the concepts was made from. The scale consists of numbers ranges from 0-5 whereby the meaning of each value is as shown in the table below

Table2 Rating Scale Selection and Its Meaning.

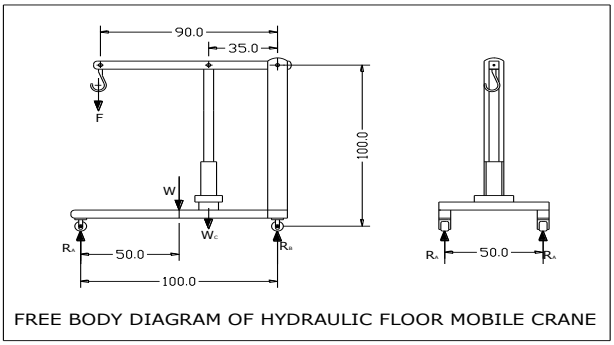
| Marks | Meaning |
|---|---|
| 0 | Useless |
| 1 | Poor |
| 2 | Satisfactory |
| 3 | Good |
| 4 | Very Good |
| 5 | Excellent |

- Then, all concepts were rated according to the criteria and assigned values from the scale.
- Next, the weight of the criterion was multiplied by its rating from the scale to obtain the points scored by a given concept on a given criterion.
- Then, summation of the marks scored by a concept for each criterion was made to obtain the total marks scored by each concept.
- Lastly, the concept with higher marks was selected as shown on table 3.

Table 3 Rating and Weighting Matrix For Evaluation of Concepts

| S.No | Criteries | Weight Factor | Rating | | | Weight Factor X Rating | | |
|---|---|---|---|---|---|---|---|---|
| | | | C1 | C2 | C3 | C1 | C2 | C3 |
| 1. | Performance | 5 | 3 | 3 | 4 | 15 | 15 | 20 |
| 2. | Material | 4 | 4 | 3 | 4 | 16 | 12 | 16 |
| 3. | Cost | 4 | 3 | 3 | 4 | 12 | 12 | 16 |
| 4. | Weight | 4 | 2 | 1 | 3 | 8 | 4 | 12 |
| 5 | Size | 3 | 3 | 2 | 3 | 9 | 6 | 9 |
| 6. | Ergonomics | 4 | 4 | 3 | 4 | 16 | 12 | 16 |
| 7. | Maintenance | 4 | 4 | 2 | 4 | 16 | 8 | 16 |
| 8. | Safety | 5 | 4 | 2 | 4 | 20 | 10 | 20 |
| 9. | Life Span | 4 | 3 | 3 | 3 | 12 | 12 | 12 |
| 10. | Aesthetics | 2 | 2 | 1 | 2 | 4 | 2 | 4 |
| 11. | Competition | 4 | 4 | 2 | 4 | 16 | 8 | 16 |
| Total Score | | | | | | 144 | 101 | 157 |

Free Body Diagram, Material Selection And Stregth Analysis To Indicate The Working Sizes Of The Components.



FREE BODY DIAGRAM OF HYDRAULIC FLOOR MOBILE CRANE

Material Selected: Mild Steel Factor Of Safety: 1.75 –3.0
Selected Factor of safety in the calculation: 3.0
Yield stress for steel: 248N/mm$^2$
Allowable stress

$$\delta_{all} = \frac{\delta y}{s.f}$$

$$\delta_{all} = \frac{248 N/mm^2}{3}$$

$$\delta_{all} = 82.67 \text{ N/mm}^2$$

For no failure

$$\delta_w \leq \delta_{all}$$

Maximum working stress

$\delta_w = \delta_{all}$ .

**Bending Moment Equation**

$F_1xL_1+\frac{3}{8}W_1L_1+\frac{1}{2}W_3L_3+\frac{1}{2}W_3L_3+(Wc+Wj)\frac{L}{4}=2R_AL_3+F_L[L1/4]$

**Reaction at "a" and "b"**

$2R_A + 2R_B = 2W_3+W_C+W_J+F_1+W_1$

**From the design;**

$L_1$=0.9m, $L_2$=1m, $L_3$=1m
FROM THE CHART
Mass of hollow section steel of 50x50mm and 2mm thickness M=3.01kg/m
Therefore W=Mg
W=3.01x9.81 = 29.53N/m

**For truss**

$W1=wL_1$=29.53x0.9 =26.577N

**For mast**

$W2=wL_2$= 29.53x1= 29.53N

**For horizontal members**

$W3=wL_3$= 29.53x1= 29.53N

$(150x9.81x0.9)+\frac{1}{2}(26.577x0.9)+(29.53x1)+(5+2)\frac{0.35}{4}=2R_Ax1+(150x9.81x0.35)$

$R_A$=423.72N

$2(423.72)+2R_B=2(29.53)+7+(150x9.81)+26.577$

$R_B$ =570.2N

## VII.CONCLUSION

The invented crane mobile floor crane was made with extra attachments like D.C motors which provide the driving mechanism to the crane as well as the lifting of the load by jacking. By doing so the operating time of the crane is reduced and also the crane operator's interaction is minimized and thus increases the performance

## REFERENCE

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