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Design and Manufacturing of 3-Axis Portable Machine with Criss-Cross Mechanism

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***Abstract*— Lift is a straightforward mechanical gadget used to raise component or item from ground level to a specific stature to play out a particular work with most extreme burden and least endeavors. This task portrays the structure just as examination of scissor lift which will be worked on DC engines. Additionally such structure can make the lift increasingly minimized and much reasonable for medium scale work. In any case, for this situation alongside lifting material we are additionally going to attempt to move the material at an equivalent stature various way. The upper base or board will be moved with the assistance of lead screw which is worked by DC engine. At long last, the investigation will be completed so as to check the similarity of the plan esteems.**

***Index terms* -** Portable, 3-Axis, Scissor Mechanism, Drilling.

I. INTRODUCTION

Wilo Mather platt is a multinational German company which manufactures pumps and pump systems in water and industrial sector. Wilo manufacture five series of pumps. All series of pumps are made up of WCB (Carbon steel) material. There are various manufacturing processes like boring, milling, drilling, facing.

All processes are carried out on 1 to 5 Series. These processes take same time for 1st to 4th series of pumps, but for the last process after the assembly, is a drilling operation for steady pin hole which takes more time for 5th series pump than the other 4 series pumps and in manufacturing process number of operation required for that pump is more and material handling of pump required special type of cranes to move pump from assembly shop to machine shop. for operation of drilling. And machine used for drilling operation is conventional lathe machine, it requires a time setup a tail stock and then operation of drilling is carried out and then pump is rotated and other side of pump drilling operation is done now it checked for steady pin.

Steady pin play measure role in proper alignment of pump during assembly and disassembly of pump. For drilling operation of steady pin required all this arrangement and it takes 11 hours for a single pump. For drilling operation of steady pin hole takes more time and cost economically as well to minimize the time, material handling and cost of operation company assigned us a project to design a drilling machine. Which would carry drilling operation without moving pump assembly to machine shop. Rather drilling machine could be brought near to the pump and drilling operation would be carryout, the machine will be versatile able to do operation on series 1st to 4th. Portable Drilling machine have following four major parts-

1. Drilling Head
2. Scissor Lift
3. lead screws
4. Supporting Elements

II. LITERATURE REVIEW

Shinde Nikhil et. al. [1] discussed about development of Indian assembling division depends to a great extent on its profitability and quality. The most ideal approach to improve the generation rate (efficiency) alongside quality is by utilization of unique reason machine. Handiness and execution of the current spiral boring machine will be expanded by structuring and advancement of twin shaft boring head connection.

A. S. Udgave et. al. [2] explained the machine has two shafts driven by a solitary engine and every one of the axles are encouraged in to the work piece at the same time. Nourishing movements are acquired either by raising the

work table or by bringing down the drills head. The inside separation between the shafts can be balanced in any situation as required by the diverse employments. For altering the inside separation between the drill shafts they are associated with the primary axle by all inclusive joints. In large scale manufacturing work drill dances are utilized for directing the drills in the work piece in order to accomplish precise outcomes.

Pravin A. Desai et. al. [3] discussed about convenience and execution of the current spiral boring machine will be expanded by planning of multi framed boring head connection. This paper manages plan and advancement of multi framed boring head for process duration streamlining of the part. The report introduced here gives point by point review of creation of the Special reason machine. This report contacts to various parts of building, which has been shrouded in the educational modules of UG and PG projects of Mechanical designing.

Ajay Kumar Singh et. al [4] discussed the present developing universe of rising innovation, the miniaturized scale machining process has requesting task in different divisions like aviation, oil, barrier, car, biomedical science and numerous businesses at smaller scale and nano dimensions of assembling and structuring. In different distinctive kinds of smaller scale machining, miniaturized scale penetrating is one of the instrument based smaller scale machining task. For the most part miniaturized scale boring is utilized to manufacture smaller scale openings in miniaturized scale items. Principle accentuation is boring rate (R.P.M) and the feed rate of the axle. In this investigation, the cutting velocity and feed rate will be taken as procedure parameters. We endeavored to expand the precision by offering feed to bore axle through lead screw rather than direct feed. Here are a few angles which are considered in the structure of all inclusive small scale spiral penetrating machine.

P. Gunasekaran et. al. [5] commented, presently multi day, machines are generally constrained by inserted framework. To address the issue of detonating populace monetary and compelling control of machines is vital. Our task even is turned to effortlessly penetrate at any heading. So work setting activity isn't muddled just as diminishes the setting time for the task. It likewise mulls over the best technique for controlling the boring machine by physically. Materials like wood, plastic and light metals can be bored with this. The work piece is fixed on the work table, which is furnished with a moving course of action. The penetrating machine is a standout amongst the most vital machine devices in a workshop. In a boring machine openings might be penetrated rapidly and requiring little to no effort.

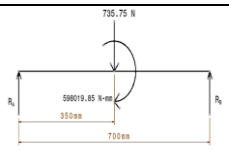
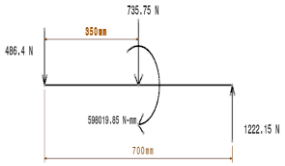
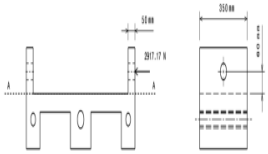
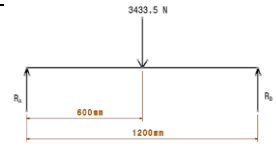
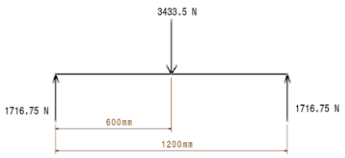
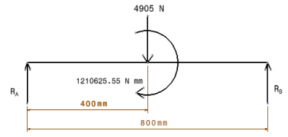
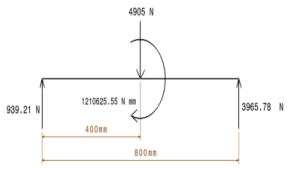
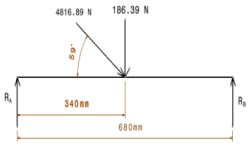
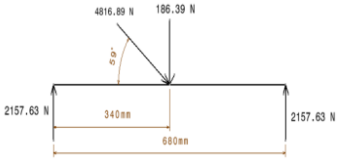
Amay Saxena et. al. [6] discussed about the scissor lifts, a staple of mechanical plan, particularly in focused apply autonomy, are a sort of linkage that can be utilized to raise a heap to some tallness, when followed up on by some power, as a rule applied by an actuator. The situation of this actuator, in any case, can influence the mechanical favorable position and speed proportion of the framework. Consequently, there should be a solid method to scientifically think about various actuator positions. In any case, all ebb and flow examination into the investigation of scissor lifts either concentrates just on the screw jack arrangement, or determines separate power articulations for various actuator positions.

III. METHODOLOGY

With an aim to design a portable drilling machine which is capable of drilling steady pin hole on one, two, three, four and five series of pump. It was essential to avoid wastage of time which require for large pump in operation like material handing with special cranes, time required for job setting on conventional lathe machine, loading and unloading of pump on machine and shifting of job from machine shop to assembly shop. Total time require is eleven to twelve hours, After studying all the operations a unique solution for this problem is to design a portable drilling machine. A machine which is portable, it is has mobility to move different shops like assembly, machine shop etc. Due to its mobility function without moving series five pumps assembly to machine shop, Drilling machine by itself could move to assembly shop to carryout drilling operation.

TABLE NO 1

IMPORTANT CALCULATION (DESIGN CALCULATION FOR SOME PARTS)

Sr. No	Part Name	Free Body Diagram	Calculation
1	Design of Lead Screws For Z Axis		$R_B = 1222.15$ N $R_A = -486.4$ N
			$M_{max} = 427779.85$ N mm $T_{max} = 598000$Nmm $S_{yt} = 370$ Mpa $\tau_{Perm} = 52.8571$ Mpa D = 42 mm
2	Design Check For Middle Block		$S_{yt} = 370$ Mpa $\sigma_{Perm} = 123.33$ Mpa $\tau_{Perm} = 61.66$ Mpa Maximum reaction = 1223 N $\tau = \frac{\text{Force}}{\text{Area}} = 0.0801\ {}^{N}/_{mm^2}$
3	Design Of Lead X Direction Lead Screw		$R_B = 1716.75$ N $R_A = 1716.75$ N
			M max=1030050 Nm T max=0 Nmm S yt=370 Mpa τ Perm=52.8571 D=48 mm
4	Top plate [c section]		W = 4905 N $R_B = 3965.78$ N $R_A = 939.21$ N
			$S_{yt} = 370$ Mpa $\sigma_{Perm} = 123.33$ Mpa $\tau_{Perm} = 61.66$ Mpa $\sigma_{bending} = 0.0109\ {}^{N}/_{mm^2}$
5	9 Design Of Lead Screws For Z Axis		$R_B = 2157.63$ N $R_A = 2157.63$ N
			M_{max}=733595.9Nmm S_{yt}=370 Mpa $\tau_{Perm} = 52.8571$ D = 42mm

A. Design of scissor link

Material used for the link = carbon steel

TABLE NO 2

VARIATION OF FORCES FROM TOP TO BOTTOM POSITION OF SCISSOR LIFT

Force	Angle	Axial force(F_A)	Normal force (F_N)
4170	29	2021.65 N	3647.16 N
4170	34	2331.83 N	3457.08 N
4170	39	2624.26 N	3240.69 N
4170	44	2896.72 N	2999.64 N
4170	49	3174.13 N	2735.76 N
4170	54	3373.60 N	2451.06 N
4170	59	3574.38 N	2147.70 N

$$S_{yt} = 410 \text{ Mpa}$$

$$\text{Factor of Safety} = 3.5$$

$$\sigma_{Perm} = \frac{\text{Syt}}{\text{factor of safety}}$$

$$\sigma_{Perm} = \frac{410}{3.5}$$

$$\sigma_{Perm} = 117.14 \ {}^{N}/_{mm^2}$$

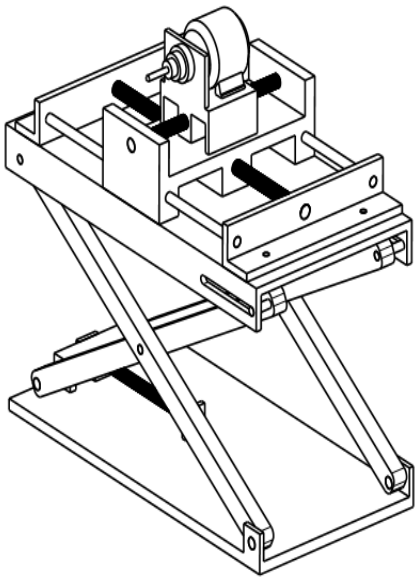


Figure 1: Industrial portable drilling machine

IV. PROBLEM STATEMENT

In Wilo Mather Platt, Pumps of series 5 having larger size so can't be drilled with help of small drilling machine. Hence pump after assembly need to shift from assembly shop to machine shop with help of special type of cranes for drilling of steady pin holes and machine setting is required to mount pump on machine it takes (10-11 hours) per pump and cost economically as well and it requires two workers extra.

TABLE NO. 3

TOTAL TIME REQUIRED FOR DRILLING OF STEADY PIN HOLE FOR SINGLE PUMP

Sr. No	Process	Time Required
1	Material handling	35 minutes
2	Cranes handling	70 minutes
3	Machine setting	15 minutes
4	Job setting	60 minutes
5	Drilling of both sides for steady pin	390 minutes
6	Unloading time	30 minutes
7	Shifting of job from machine shop to assembly shop	35 minutes

So to minimize this wastage of time and for better output it is essential to manufacture portable drilling machine which can have motions in all three directions i.e. in vertical, longitudinal and transverse.

V. OBJECTIVES

1. Reduce time required for drill steady pin hole on boring machine.
2. Avoid material handling by special purpose cranes.
3. To reduce man power.
4. Design of a versatile portable machine which can also use for drilling operation on group 1 to 5 pumps.
5. To increase productivity.
6. To form an efficient process to improve quality of pump.
7. It will reduce wear and tear of pump due to material handling.

V. CONCLUSION

With this design of an Industrial Portable Drilling Machine, the complexities in the design can be reduced. Also with such design parameters, the time required for drilling can be reduced. This design can be used for production in industries. To carry operation of drilling. The

analysis by using ANSYS software is also shown that the design is safe under Permissible limit. Also further modifications can be implemented for optimizing the design and further analysis can also be carried.

TABLE NO 4

RESULTS AFTER MANUFACTURING OF MACHINE

Sr. No	Process	Time Required (BEFORE)	Time Required (AFTER)
1	Material handling	35 minutes	N.A
2	Cranes handling	70 minutes	N.A
3	Machine setting	15 minutes	15 minutes
4	Job setting	60 minutes	30 minutes
5	Drilling of both sides for steady pin	390 minutes	120 minutes
6	Unloading time	30 minutes	30 minutes
7	Shifting of job from machine shop to assembly shop	35 minutes	N.A
Total Time Required		11-12 Hours	3-4 Hours

V. FUTURE SCOPE

1. Mass optimization of machine using light weight material that has high strength to weight ratio.
2. Control panel can be upgraded by using PLC's system.
3. Computerized Numerical version of this machine could be possible in future.
4. This machine not only used for large pump but operation on small pump can be possible

VI. REFERENCES

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