# Design and Fabrication of Compact Borewell Pipe Lifting Machine

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**ABSTRACT: Nowadays bore well is a major water source in India for domestic as well as agriculture field. It is a deep narrow well consists of pipe kept inside the hole and the submersible pump is at its bottom. Conventionally the bore well pipe and pump are lifted out of the bore well using rope and pulley block mechanism driven by robust vehicles and the initial setup and installation is done manually. Especially the pipe lifting takes more time as it is very long. A new, compact and low cost borewell pipe lifting machine is mainly developed to overcome the problem. This machine is developed using the rollers and belt drive mechanism coupled to AC motor which is mainly used to reduce human effort, time and cost. The presence of spur gears with levers is to adjust the required portion of frame connected to lead screw, at the initial stage. The electric energy of motor is converted into rotational energy which produces torque, so we can lift high weight where only minimum horse power motor is required. The bore well pipe lifter machine gives a desired transfer rate with less effort which makes the removal and replacement of the pipe in bore wells very fast and easy.**

**Keywords: AC motor, Belt drive, Borewell, Lead screw, Pipes, Rollers, Spur gears, Transfer rate.**

**Abbreviations: T, torque; AC, alternating current; HDPE, high density poly ethylene; P, power; RPM, revolutions per minute; CCTV, closed circuit television.**

## I. INTRODUCTION

One of the important commodities which is indispensable for all living beings is water. So it is necessary to store the water in dams, ponds and borewell for future use. Borewell is a deep well where a pump is kept at its bottom to raise water from the deep soil. For development of borewell, a borewell drilling machine is used to dig the hole of about diameter 4½ to 12 inches. and it also requires replacement of pipes and pump at some times. There will be shortage of laborers in future, because of which the wages given to laborers and workers will raise if the work is much laborious and time consuming such as borewell pipe and pump removal and replacement. It is usually done using robust machines which contains rope and pulley block mechanism. In which the pipe lifting is a much time-consuming task. Nowadays the advancement in these machines is slowly developing, but the initial and operating cost is too high. Even though the work is done mostly by such machines, the workers have to always ensure and notice its working continuously especially during the initial and final stages of pipe removal. So our primary aim of our project is to develop a compact, low cost semi-automatic machine which helps for to reduce the human efforts, time requirement during lifting and replacement and requirement of skillful labors etc. In our machine it is easy to operate and adjust whole mechanism.

S. Prithiviraj and S. Ravikumar [1] designed a SPR hook to lift the broken bore pipes from borewell holes. SPR hook which derives its mechanism by modifying the traditional hook mechanism. This SPR hook lifting process is employed only to lift HDPE pipe. [2] Guidelines of Construction & Maintenance of Bore wells and Tube wells researches and standards are discussed. Akshay M. Bajbalkar et al. [3] have done a comprehensive review and modelling of Borewell pipe lifting and transportation machine which had feed roller and pressure roller, pinion and

gear drive mechanism to transfer motion and motor for initial torque. The pipe is removed from well by the rotation of fixed roller and pipe moves between the rollers. Gajanan Patil et al. [4] designed a borewell pipe lifter by implementing automation. It consists of set of two feed rollers and a set of two pressure rollers. In each set rollers are kept one below the other with pressure adjuster between them. The power source is a 12 V DC geared motor with internal worm gear box (1:55 gear ratio) connected to pinion coupled to shaft of feed roller. This mechanism is expected to give better results. Still it is not yet manufactured. Choure Bhagvanta et al. [5] have done a comprehensive review on Bore Well Pipe Lifting and Transportation Machine. It consists of Motor coupled to generator by chain pulley mechanism and a long shaft is protruded out of generator supported by bearings. The rope is tied over the shaft and another motor is kept at another end of rope which is made to fix to borewell pipe. Suraj M. Namde et al. [6] developed a pump lifting machine consisting of spur gears, one having larger teeth is coupled to shaft mounted on bearings and on with less teeth is coupled with handle. It runs manually and no motor is required. A. Bergaley and A. Purohit [7] developed the bore well pipe lifter and transportation machine which process the mounting and dismounting of the submersible pump in bore wells fast and easy process. The machine consists of shaft, motor and gear pair, pressure roller sub assembly, pressure adjuster mechanism comprises of screw and nut, frame. K. Mohankumar and D. Venkatesan [8] discussed about the paper modelling of such mechanism and its parts. It is made up of the elements such as load pipe, pressure roller and feed roller, pressure adjuster and shaft. This automation in the installation of pipes using borewell motor pump used in time reduction. C.N. Sakhale et al. [9] fabricated a borewell rescue vehicle in which machine assembly was supported by a gripped tyre and rope pulley drive, a stand and all necessary accessories. The energy source was a 12V battery and it will rescue the victim safer. R. Shah Vrunda et al. [10] aim to rescue trapped child in the bore well by continuous monitoring & supply of necessary items to survive using technical method. The components used in the machine are wireless infrared camera, oxygen, water and food supply system, DS temp sensor, ultrasonic sensor and 12v rechargeable battery is used. From the above literatures we can take what are all the advantages of those machines and implement those in our project so as to have a compact, low cost and effective one.

## II. MATERIALS AND METHODS

From the literatures two power transmission ways are suggested, one is chain pulley transmission and another is V pulley- V belt transmission. Pulley belt mechanism may be implemented as pulley-belt transmission is suitable for. Some of the most commonly used materials for fabrication of frame is to select mild steel square rod or circular pipes because only those materials are easily weldable.

Selection of materials is one of the important tasks of the project work after the literatures collection. So the each material should be selected in such a way that it ensures proper functioning and provides a better outcome and should be taken references from literatures. Another important step is the methodology. For fabrication, say development of rigid frame the process, bottom up approach is suitable (Starting from basement).

### *2.1 Materials and Specifications*

Components to be selected are discussed in Table. 1.

**Table 1 : Components and specifications**

| Component Description | Material | No. of pieces | Specs |
|---|---|---|---|
| AC motor | Cast iron | 1 | Power=0.25 HP,Speed= 1200 rpm |
| Spur gears | Nylon plastic | 3 | Teeth 60 |
| Square rod for frame | Mild steel | As required | Square rod 4×4 cm |
| Shaft | Mild steel | As required | Diameter=12 mm |
| Ball Bearings | Stainless steel | As required | Inner dia=12mm, Outer dia= 36mm |
| Rollers | Mild steel | 2 | Diameter=60 mm |
| Hand lever | Mild steel | 1 | - |
| Lead screw | Mild steel | 2 | Length=1m, Dia=12mm, |
| Belt | Rubber | 1 | V belt, length 60 inch |
| Pulley | Mild steel | 2 | V type,1 slot 1)Dia=30m m 2)Dia=6mm |

*2.2 Methodology*

The methodology of this research work has been depicted in Fig.1.

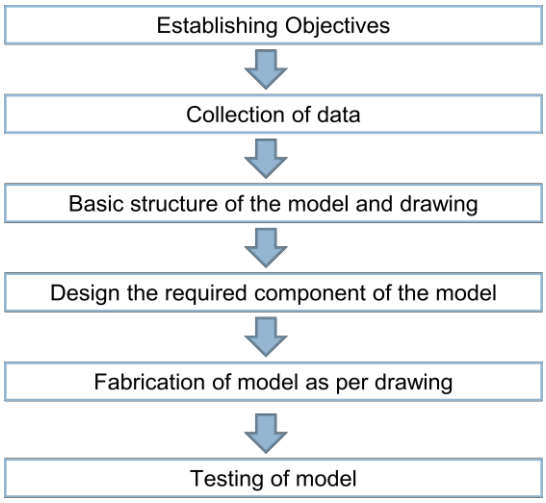

Fig. 1. Methodology flowchart

*2.3 Design Calculation***.**

Fig. 2 represents the proposed design of the project. With the help of the design calculation, design and fabrication are done.

1. Torque of AC motor used, Where,

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

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

P = 0.25 HP=186.425W, N=1200rpm

T = 1.48 N-m

2. Pulley rpm,

Driver rpm1=1200

Dia. of driver(D1) = 60 mm

Dia. of driven(D2) = 300 mm

$$\text{Driven rpm2} = \frac{D2}{D1} = \frac{rpm1}{rpm2}$$

=240 rpm

Speed of the driven pulley= 240rpm. Since the roller is coupled with driven (larger) pulley, the roller speed is also 240rpm.

3. Centre distance between pulleys

distance between pulleys

Length of the V belt (L) = 60 inch = 1524 mm

Dia. of driver(D1) = 60 mm

Dia. of driven(D2) = 300 mm

$$L = 2C + \frac{\pi}{2}(D2 + D1) + \frac{=}{4C}(D2 - = D1)^2$$

$$C = \frac{L - 1.57(D2 + D1)}{4} + \sqrt{\left\{\frac{L - 1.57(D2 + D1)}{4}\right\}^2 - \frac{(D2 - D1)^2}{8}}$$

C = 239.7+224.179

C = 463.88 mm

We have to ensure that centre distance between the pulleys should be around 464 mm so that belt would function properly without runoff.

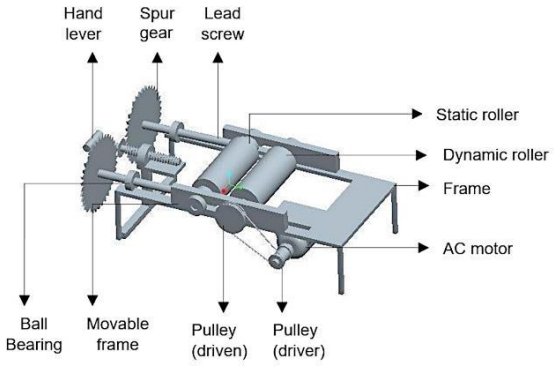


Fig. 2. Design of borewell pipe lifter (Top view)

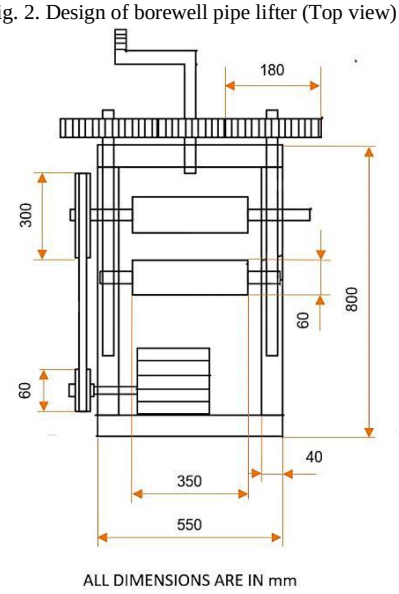


Fig. 3. 3D model of pipe lifting machine

*2.4 Design.*

The Fig. 2 represents the design with the proper dimensions in milli meters. Fig. 3 represents the 3-D model of the machine done in Solidworks with names of each components.

*2.5 Proposed System.*

Fig.4. Fabricated machine (side View)

The base frame which acts a rigid support of machine is fabricated with the help of square tubes and channels by metal cutting and metal joining process known as welding. The static roller which is supported by bearing at its ends is mounted to the base frame and one end of roller shaft is coupled with larger pulley which is connected with AC motor

with the help of V-belt. Another roller (dynamic) is mounted parallel to the static roller and get connected to the height adjustment mechanism. The height adjustment mechanism consists of pair of lead screw which is supported by bearing ends, its one end is mounted with two large diameter spur gear and these two gears get meshed with single pinion gear which get attached with hand lever. The nut meshed with lead screw is attached with movable frame where dynamic roller is fixed such that the rotation of lead screw tends to adjust the position of roller. For the selection of shaft in this process, it is assumed that the stress at any location of the shaft should not exceed the material yield stress. Twisting moment on the shafts is neglected.

*2.6 Working.*

Fig.5. Fabricated Machine (Front View)

Initially the roller is adjusted by rotating the hand lever either by clock wise or counter clock wise, this rotation tends to rotate the pinion gear and causes the lead screw to rotate with the help of interconnected spur gears. The rotation of lead screw makes the frame with dynamic roller to move linearly towards forward or backward as per the rotation experienced. Once the required gap is achieved, then one end of submerged pipe is placed firmly between the rollers and AC motor is turned on, it tends to rotate the static roller which is connected with the help of belt drive. This rotation pulls the loaded pipe and make it to raise up, by continuing the process submerged pipe is completely removed.

## III. RESULTS AND DISCUSSION

The machine we fabricated, is tested at a suitable condition. For domestic purpose, the borewell pipe with diameter 4½ inch and 6 inch HDPE pipes are selected. The transfer rate (speed) of the pipe can also be calculated but it is not constant for the given diameter of the pipes. The factors affecting the transfer rate of pipes are depth of the pipe, nature of the soil, weight of the pipe, effect of gravity. Even though these factors involved, the machine gives good transfer rate of around 6 - 7 metres/min for both 4 ½ inch and 6 inch pipes (calculated using stop watch). Much human effort is also not needed.

## IV. CONCLUSION

The project is made provides flexibility in operation. Thus, the borewell pipe lifter has been fabricated and tested. The product we fabricated is fully operational and gives desired results. This innovation has made the bore well pipe repair operations more desirable and economical. This project is developed with the hope that it is very much economical and helpful to households and some commercial areas giving plethora of advantages like compact size, simple to operate, low noise, easy to install, low maintenance cost and also does not required skilled labor. The cost would be around ₹12,000

## V. FUTURE SCOPE

In the current design the machine is operated manually and only used to mount and dismount the pipe. Further it can be modified by operating automatically and make it to do various process such as rescuing the child or any other objects that fall into the borewell. It can be modified with by fitting a sensor it the machine to detect the object in hole, it will help the lifter not to dash in the object. The machine is operated through a personal computer according to observations made by using the CCTV camera, oxygen suppliers are also fixed and the machine is also capable performing operations according to the user commands. As a whole if we produce this product in mass production, it can be very useful as it can be used for both pipe removal and rescue operations.

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