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Smart Bore Well Child Excavator

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Abstract

In recent years, there has been an increase in resource damage when children fall into open pits. This project aims to design a system that can rescue a child easily and without causing disruption such as scratching the walls of the well. The system is a simple, integrated arrangement with 4 arms to which a Claw gripper & Drill bit are attached, which is used to remove the loose mud covered on the sides of trapped child. The system is controlled by a rotating cable drum, cable, and gripper. The design of the system that fits to the diameter that varies from 4 inches to 12 inches. The Depth of a Child is assessed on camera using a live detector. This project aims to reduce the time taken to rescue and the risks involved in this work with the additional usage of Servo motor. The project is geared towards the recovery process, which is strategically focused. Depth of a bore well plays a major role in the rescue operation, detected by the Camera connected to a live detector. Uninterrupted supply of oxygen is provided to eliminate any respiratory problems. In the determination of the child position inside the bore well, the claw gripper location to hold the child is changed as in Shoulders or in Wrists. When the hands are in upright position, the gripper holds the wrists and when the hand is attached to the hip region, shoulder are gripped. Using the Gripper, the child's body is tightly locked and tied between the Gripper. The entire sandwich system is gradually expanded to ensure a secure lift. The Gripper used in the system can carry 15 Kilograms. Lifting and dropping is done by Rotating Rope Drum, operated by Motor. The replaceable arms are used to conserve space in the well.

Keywords: Gripper, Pulley and Belt Mechanism, Chain Drive, DC Motor, Drill Bits, IR Camera, Arms.

1. Introduction

Resources are being mined to supply the ever-increasing need for industrial, agricultural, and commercial water. Groundwater is not available everywhere due to the massive rise in population. The number of boreholes in the groundwater table grows as a result of this. The majority of the water sources designed to pump clean water are located in places where people live, and some of them do not have access to groundwater. These wells are regularly kept open, despite the fact that they are recognised to be hazardous to human health.

Since September 2001, 45 children's deaths have been reported in the country. Only nineteen are demonstrated by the newspaper with proof. Their deaths are the result of dry bore wells that have been left exposed. Even a six-inch diameter became wider when the casing pipes, which cost about Rs.2000- 3000/-, were removed, trapping an innocent child. Only one child, Sandhya of Bellary, and Prince of Haryana, have been saved alive from a bore well in the country's recent history. Deivaraj, a six-year-old kid, was recovered from the bore well on June 8, 2004, but died in the hospital owing to injuries sustained during the rescue attempt and a lack of medical attention.

The Rescue team's standard procedure is to use a rope to determine the child's depth in the bore well. After

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determining the depth, earthmoving vehicles are used to dig a parallel pit. This method of rescue has the following drawbacks. The parallel pit can take up to 30 hours to dig, by which time the infant would have died. Inside the bore well, there is a lack of oxygen. During the rescue mission, a lack of imagery is a big stumbling block. There is no specific equipment available to save the child who is trapped inside the bore well.

These buildings' mouths are just covered with polythene bags or brittle cement blocks, which are insufficient to close a potentially deadly hole in the ground. Young children frequently fall into these open wells and become trapped. The (Fig.1) shows the number of bore well accidents that occurred across the country in a single year.

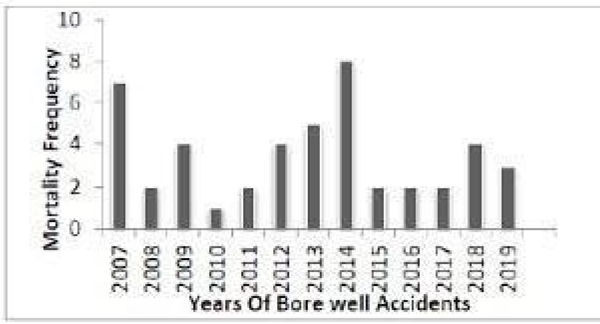

Fig.1 Years of Bore well Accidents

For everyone involved in the effort, rescuing these trapped children is difficult and dangerous. A child's life can be consumed by even a minor delay in rescue. Furthermore, removing a child from the spotlight is a difficult undertaking. Victims have often been scarred since the fall, whether as a result of being imprisoned in a small space for more than a few hours or as a result of running out of oxygen, which can lead to death.

2. Literature Reviews

Sumathy et al. Describes that the Temperature sensor (LM35), gas sensor (mq4), oxygen tube, web camera, and clipper think up the Smart and Safe Child Rescue System. The sensors are mounted to the clipper and are controlled by an Atmel microcontroller. The DC motor is now in control of the clipper. The clipper's hands are tied together with a 90cm rope and manually put into the hole. A Web camera (5MP) is mounted on the arm facing the ground, which we can monitor on a PC and learn about the child's condition inside the well. Since it is not a night vision camera an LED fixed with it. Once inserted, the temperature sensor detects the temperature difference and displays the result on the LCD (Liquid crystal Display), followed by the gas sensor, which detects the gas and displays the result on the LCD within a second. Through the camera, the clipper picks up the child with the help of the remote controller, and the clipper holding the child is manually pulled up to the land[1].

Arthika et al. (2018) Describes that the system detects temperature and gas leaks in a specified location using a temperature and gas sensor. An LCD monitor shows the child's surroundings (liquid crystal display). We're employing an infrared transmitter and receiver to calculate the rope's length. By selecting the operations to do, the keypad is used to deliver inputs to the microcontroller. In order to move the roper up and down or compress and expand the ARM, the controller will provide a high signal to the relay driver circuit based on the input. The air filler is used to give oxygen when there is a lack of it. In this case, the controller is a PIC microcontroller with an integrated ADC. It's a form of erasable memory that's programmed and saved in the computer's internal memory[2].

Kaur et al. Describes that the 12V power source, switch pad, and gear motors are the first components of this robot. Three micro switches are wired to the microcontroller I/O pins on the switch pad. In this system, the PIC 16F877A microcontroller is used. This microcontroller is based on RISC (Reduced Instruction Set Computing) and has analogue input channels, analogue comparators, and additional timer circuits. The microcontroller saves and displays the data collected by the robot. The robotic action is also carried out by five gear motors. Three motors are used to control the robot up and down, one for the clock, and one for the gripper contracting and extending. The robot then enters the bore hole, adjusting its legs in accord with the dimensions. The switch pad is used by the operator to control it. The video camera attached on it provides an in- depth view of the child's position and location. This video will be watched on a computer. The temperature that the robot senses is first saved in the microcontroller and then displayed on the LCD. The robot then grasps the child by compressing or expanding its gripper as needed. The robot secures the child and carefully removes it from the bore well[3].

Agarwal et al. (2019) Describes that the two round plates are the most important components of our suggested system. The upper plate will be connected to a mechanical system that will try to release two linear actuation units that will keep the system set up by pushing the bore-well wall. The lower plate will be connected to a mechanical gear system that will rotate in order to position it in plane with the child. Two arms will be joined to the lower plate. Two high-resolution cameras will be mounted to the arm at the lower plate. The high-resolution cameras will provide a view of the surrounding environment, which will be very useful in communicating between the two arms. For the system's operation, we will supply lighting conditions. Two additional cameras will be installed on the pneumatic arms, one for each arm, to broadcast the view of the arms. A chest mount strap will be included in the equipment, which will be essential in rescuing the child from the bore hole. The systemic arms will be used effectively to secure the victim's harness straps. The work will become more difficult if the child refuses to cooperate or gets unreasonable. The victim would be ready to be picked up after the system had attached the harness to him. Given the variety of harnesses available today, we chose the chest harness to simplify the task[4].

Prakash et al. Describes that there are five motors in their project. Four motors drive the wheels, and one controls the robotic arm's compression and relaxation. Relays are employed when a low-power signal is required to control a circuit (with perfect electrical isolation between the control and controlled circuits), or when several circuits must be controlled by a single signal that is also used to drive motors. Sensors are used to detect the child's inside environment. The light within the dig is provided by an LDR sensor, which detects light intensity and lights the light using a high-power LED driver. The temperature inside the bore well is detected using the LM35 temperature sensor. For the rescue, this project employs ZIGBEE technology embedded systems and a mechanical unit. The child is lifted from the bore-well using special graspers. Two dc motors are controlled by a microcontroller. The LED is controlled by a microcontroller. The child status is recorded by the wireless camera and communicated back to the controller unit through the ZIGBEE Transceiver. The whole system will be tested by using a child in a dry bore well[5].

Kumar et al. (2019) Describes that is possible by properly designing the bot and monitoring system to work in bore well operations. The temperature inside the bore well is measured using a potential high-sensitivity temperature sensor. The gas sensor included in the model can identify any harmful gases present inside the bore well. The system also includes a Passive Infrared Sensor (PIR), which will assist in detecting the child inside the bore well. The Water Sensor will detect the presence of water inside the bore well if there is any. The bot is equipped with a specialised device that allows it to communicate with the child. The particular light sensor can detect the level of illumination inside the bore. Three different analogue pins connect all of the sensors to the PIC. The laptop is connected via USB connection, and the COM5 port is used for the operation. The board connects the SMPS, TTL logic, and PIC controller. The board has four different switches attached to it for (upward, downward) and (forward and reverse). Switches can be used to control the rotation of the motor. Gripper is used to take the child from the bore well by opening and closing through switches. Led light are attached with top portion of the gripper to enhance the visibility[6].

Garg et al. (2019) Describes the system comprises of two DC motors, one for controlling the pulley system and the other for controlling the robot arm, both of which are controlled by a motor driver. The robot arm is equipped with a camera that provides an internal view of the bore well as well as the child's position. The Arduino Uno communicates with the computer using ZigBee wireless communication. Giving comments from the PC controls the moment of the pulley to and fro. The PC is also used to control the opening and holding of the robot arm. Because the bore well becomes darker as we go deeper, an LED is added to the system to give sufficient lighting. The temperature sensor is used to monitor the temperature within the bore well, which can vary as we move down. A gas sensor is used to determine whether any dangerous gases are present inside the bore well, and if so, what steps should be taken to remove them and replace them with oxygen. With the help of an oxygen pipe attached on the robot arm, oxygen is provided within the bore well. The UDM sensor is used to determine the distance between the victim and the robot arm, allowing the pulley to be modified to reach the victim and release the robot arm. We also utilise a PIR sensor to track the movement of the child inside the bore well to see if he or she is alive or dead[7].

Ravikumar et al. (2019) Describes that the rescue system is set up near the bore hole, where the victim is felt inside and the gripper is checked for correct insertion into the bore well with no distractions. The winch drum's dc motor is initially set to rotate counterclockwise, allowing the rope wound on the drum to be released according to the rotation experienced on the drum. Due to the gravitational pull, the gripper attached to the rope extends and travels into the bore well, causing the gripper arrangement to reach the victim. The winch drum motor is turned off at that point, and the motor that powers the gripper is turned on to revolve clockwise, grabbing the victim. Once the victim is gripped tightly, the gripper motor is stopped, and the winch drum motor is engaged in a clockwise motion again. The rope is wound on the winch drum, which causes the gripper containing the victim to move up. The motor is switched off after the victim reaches ground level, and the gripper motor is actuated in an anticlockwise motion to release the victim[8].

Madhankumar & Manonmani, Describes that due to the rotation of shaft by motor the nut will move down that pulls the upper disc to move down thereby it makes the fixing pad to expand. The fixing pad will be able to attach to the bore well wall as a result of this extension. We placed the pressure sensor on the outside of the fixing pad to see if it attached to the wall. It determines how much pressure the pad applies on the wall. After the fixing process is completed, a Direction Control Valve is used to actuate a piston cylinder for gripping. Now that the piston has been retracted, the child should be grasped with extreme care. A pressure sensor on the grabbing pad measures the force acting on the child, and a cushion system is also installed in the gripping pad to prevent harm to the child. Now that the grabbing action is complete, the fixing pad must be withdrawn from the wall, which requires the motor to rotate in the opposite direction. The nut will move up, pushing the upper disc up with it. As a result, the fixing pads will compress, and it will be released from the wall. The rope is lifted above the ground surface by the motor, and the child is securely retrieved by expanding the hands[9].

Suji et al., (2018) Describes that the Motor Driver (L293D) is employed to drive two DC motors. The DC motor is powered by a step down transformer that converts 230V AC to 5V AC, with the output being a transformer bridge rectifier that converts AC to DC. Arduino is then provided the 5V signal. A second step down transformer transforms 230V AC to 12V AC, which is fed to the motor driver to power two DC motors. The vertical and horizontal movement of the entire setup is controlled by DC motor 1, while the open and close movement of the rescue unit is controlled by DC motor 2. Initially, an ultrasonic sensor is employed to determine the child's location and display it on the LCD display. The distance is measured in cm and m by the ultrasonic sensor. The HC - SRO4 is a low- cost altitude sensor with excellent accuracy. The HC - SR04 ultrasonic ranging module has a non-contact measurement range of 2 to 400 cm with a ranging accuracy of 3 mm. The ultrasonic transmitters, receiver, and control circuit are all included in the modules. The rescue unit is a robotic arm equipped with an ultrasonic sensor, an LED display, and a web camera. The purpose of an LED display is to allow for night time visualisation[10].

Keote et al. (2020) Describes that the LPC2148 Microcontroller, load sensor, GSM driver, Buzzer, IR sensors, LCD display, DC motor, and motor plate are all part of the system . Outside the bore well, a joystick is used to control all of the system's components. With the help of a pulley and rope, the system is placed inside the bore well and used to reach up to the child by using a high-powered proximity IR sensor. The live position of the child can be captured using a camera, and communication with the child can be done using a microphone and an operational amplifier 7805. The load sensor is used to determine the total load of the system. The two-arm system's harness is extremely soft, ensuring that the child is not injured while gripping. According to the child's position, the system rotates using a DC motor. The child is grabbed in a proper position, and the system is then pulled out of the bore well by the rope[11].

Kavianand et al. (2016) Describes that the Smart Child Rescue System is made up of PIR sensors that can detect only humans regardless of the weather. These sensors will be installed at the top of the bore well pipeline, helping them to detect a human if he or she falls into it. The Raspberry-pi controller will receive these signals from the sensor. This raspberry-pi controller recognises this and closes the automatic horizontal closure in the bore well pipeline, which is set at approximately 10 feet depth. The horizontal closure's top surface has been softened for children's safe landing. Using the GSM Module interfaced with the Raspberry Pi Controller, the Raspberry Pi controller sends an alarm message containing the location to the nearest fire department as well as the Technician in charge at the same time. It also produces an alarm sound to inform the surrounding areas. In addition to these characteristics, an LED light casing is installed at the Horizontal Closure that goes on automatically to help children overcome nyctophobia (fear of the dark)[12].

William Raj et al. (2020) Describes that surviving inside the bore well, a temperature sensor LM35 is used to measure temperature. Toxic gases such as NH3, Methane, CO2, and Benzene are detected with the MQ135 air quality sensor. The Arduino receives the sensor output and processes it before displaying it on the LCD. There are 14 digital I/O pins on the Arduino. The working voltage is 5 volts. The Arduino is operated by a voltage of (7-12)V. It has a 32- kilobyte flash memory. The total performance is controlled by the ATMEGA 328. For picking and positioning, a robotic arm has a motor attached to it. The position of the servo motor (arm position) can be modified by altering the values of the potentiometer. The wireless camera will show the child's position information on the screen in real time. The arm will save the child with the help of the camera[13].

3. Summary of Literature Reviews

A major problem faced by the human society was water scarcity. More bore wells are being drilled on the surface of the earth as a result of drought and the depletion of underground water. Bore wells are drilled and left exposed in many regions without being properly covered. These bore wells quickly turned into death traps, claiming the lives of many people, particularly small children. Children's falls into bore wells are on the rise these days as a result of their carelessness and playful behaviours. The bore wells were drilled to a depth of around 700 feet. In these circumstances, rescuing a child from such a deep bore well is quite difficult. Bore well robot can move around inside the bore well, and its operation will be determined by the arm design. This robot is controlled by a PC using wireless technology and a wireless camera that sends both audio and video information to the television. In the pipe, where the light intensity is low, the robot's high-power LED works as a light source. It is a low-cost human-controlled robot that monitors and provides an insight view of how to safely rescue the child. Because the bore well's diameter is too small for an adult to get through and the light within dims, the rescue mission is difficult. The robotic apparatus that will use pneumatic arms to pick up the infant and attach a harness on them. The robot is also equipped with a teleconferencing device for communicating with the child.

4. Proposed System

The proposed idea using various items like drill bits, base, segments to rescue the child quickly and without any damages. The proposed idea are.

Installation of a DC Servo Motor to increase the rescue time. Using 4 segments for diameter adjustment. This segments are connected with base. The slotted pulley which connected the base and segments. For adapting the system to the various diameter of the bore well. There are two ways of motion is possible for the slotted pulley they are expansion and contraction. In expansion the maximum size of the diameter that the system can expand is 13 inch (Fig.2). In contraction the minimum size of the diameter that the system can contract is 9 inch (Fig.3). Usage of 4 arms for the effective holding of child. Two arms are fixed & other two are replaceable with Drill Bits. Two fixed arms are used to hold the Child’s Shoulders or wrists. The usage of drill bits is to remove the mud Stacked upon the child. After that drill bits are replaced with two arms to hold the chest and spinal Region of child. Now, the entire

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force is distributed upon the child’s body, so the chances of injuries are less. Along with this IR Camera & oxygen supply is given. IR Camera is used to locate the child’s position in the dark with IR Radiation.

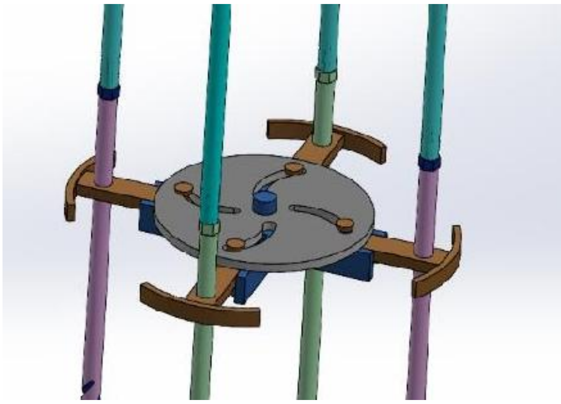

Fig.2 Expansion

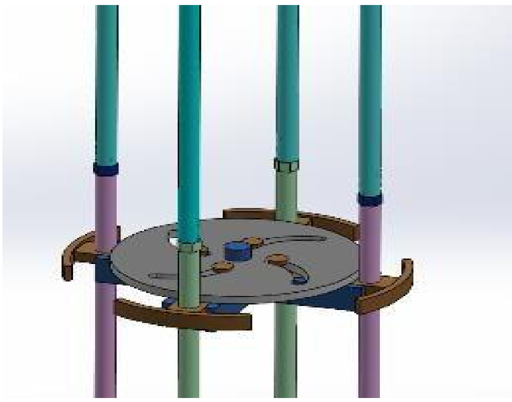

Fig.3 Contraction

4.1. Advantages over existing methodology

- The child's location, distance, temperature, and oxygen level will be Monitor.
- To save time and reduce risk by employing this device to keep the child secure within the bore well.
- While performing this operation, human effort will be reduced.
- The child will be Excavate from the bore well in a shorter period of time and ensure that the child will be taken alive.

5. Major Components

5.1 Segment

Here we are using 4 segments (Fig. 4) for 4 arm operation. Which plays a major role for diameter adjustment in our project. There is a threatted hole in the segment where the 4 arms are inserted. These segments get operated by giving rotary motion as input. By arresting all Degrees of Freedoms except linear Sliding motion along X and Z axis. Which help us to make sliding on the base. These segments are attached with base link.

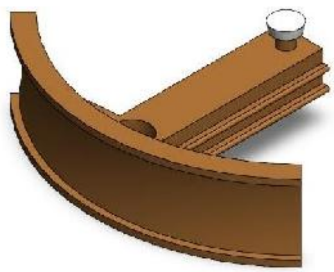

Fig. 4 segment

5.2 Base

Base (Fig.5) is main part which holds the 4 segments. There is groove like projection in base where the segments are placed it and provide a smooth sliding movement. There is a cylindrical projection where the slotted Pulley is placed. Here we arrested all DOFs hence the base link is in stable manner.

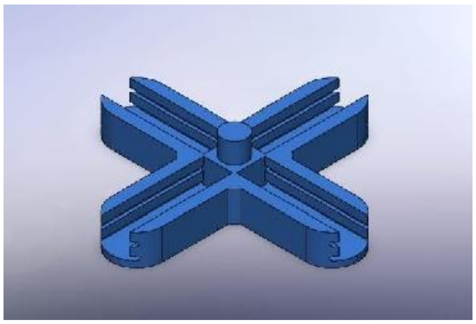

Fig. 5 base

5.3 Slotted pulley

These slotted pulley (Fig.6) has been mounted on cylindrical surface of the base. These four segments are controlled by this slotted pulley. All Degree of Freedom are arrested, except rotation X-plane motion only allowed. By using this gear we Adopt to bore well diameter.

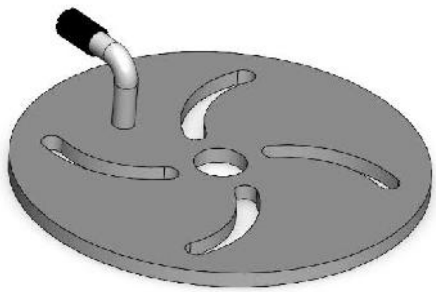

Fig. 6 slotted pulley

5.4 Fixed Arm and Connecting Rod

This fixed arm and connecting Rod (Fig.7) are attached to the segments in the base. By using connecting rod griper is fixed with arm. At the end of the fixed arm gripper is attached for the grasp action. Length of the fixed arm is 2 feet.

Fig. 7 Fixed Arm and Connecting Rod

5.5 Replaceable Drill Bit Arm

This replaceable drill bit arm (Fig.8) are attached to the segments in the base. These replaceable drill bit arm are used to clear mud stacks in deep inside. At the end of the drill bit we provide 60 degree helix angle that provide to clear the sensible amount of mud stack. These replaceable drill bit arm has get the input from dc motor.

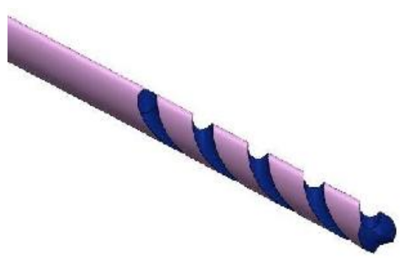

Fig. 8 Replaceable Drill Bit Arm

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5.6 Gripper

There are two gripper (Fig. 9) attached with fixed arm and connecting Rod. By using gear mechanism gripper open and close is take place to hold a arms. There is no damage occurring in grasping the hand because of its cylindrical structure.

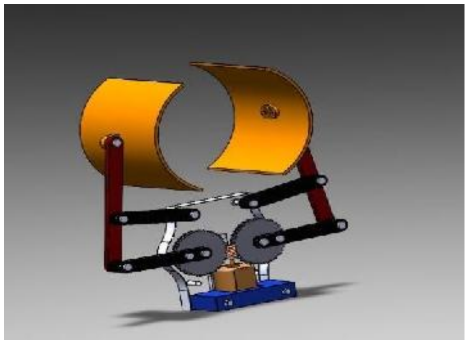


Fig. 9 Gripper

6. Working

First the diameter of the bore well is calculated and the total equipment is set based upon the diameter of the bore well. The slotted pulley is used to set the diameter depending upon the borewell diameter. The mechanism is that, the segment in the equipment gets adjusted based upon the rotation in the slotted pulley. The size of the equipment can be controlled from 6 inches to 12 inches based on contraction and expansion. Two arms in the segment are fixed which are connected with the gripper to hold the child safely and the other two are placed with drill bits that are directly connected to the shaft of the motor, in order to provide vibration to the mud area. The entire setup is sent inside the bore well with the help of a chain drive that is connected to a stepper motor, outside the well. The location of the child is identified with the help of an IR camera and Temperature sensor. After the location of the child, firstly, the child's hand is held with the gripper based upon location of child in the line diagram (Fig. 10, 11). Secondly, drill bits are operated with the help of the motors that are connected to the bits with a low rpm initially, depending upon the depth of the mud covered the rpm of the drills will be increased. After the removal of mud around the child with the help of the drill, the child is safely excavated from the well with the help of the stepper motor.

Fig. 10 Hands on Upright position

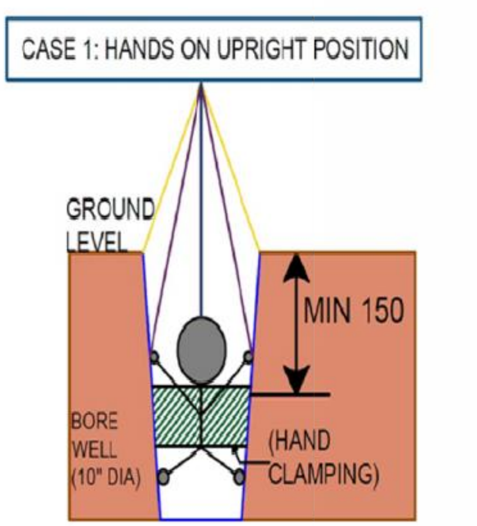
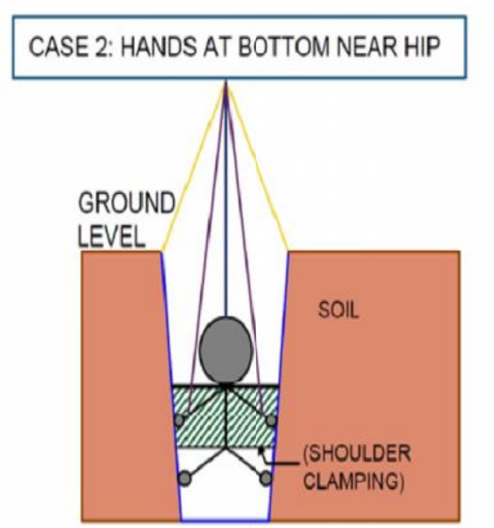


Fig. 11 Hands at Bottom Near Hip



7. Calculation

Let diameter of arm = 10 ,
Assume Weight of child = 7 ,
Factor of safety = 3,
Weight of child with FOS = $7 \times 3 = 21$
Weight of per arm = 2kg
Overall weight or load acting at end of the arm =$21 + 2 = 23$

$$=\frac{}{}$$

Let the arm is a circular cross-section so,

$$= \frac{\ ^2}{4}$$

$$= \frac{(10)^2}{4}$$

$$= 78.5398 \quad ^2$$

$$= \frac{23}{78.5398 \quad ^2}$$

$$= 0.292845 \quad / \quad ^2$$

In terms of SI unit,

$$= 0.292845$$

$$= 0.292845 \quad 9.81$$

$$= 2.87281 \quad / \quad ^2$$

This is for stress act at arm.
Here we use 4 arms so the load is evenly distributed.

$$= \frac{0.292845 \quad ^2}{.}$$

$$= \frac{0.292845 \quad ^2}{4}$$

$$= 0.073211 \quad / \quad ^2$$

In terms of SI units,

$$= 0.073211$$

$$= 0.073211 \quad 9.81$$

$$= 0.71820 \quad / \quad ^2$$

We can choose Steel or Aluminium alloy it has greater efficiency to withstand this load.

8. Conclusion

We implemented the mechanism like expandable Pulley along with sliding segment, worm & spur and pulley & belt. In existing model they use belt drives and chain drives for excavation but it is not efficient to save the life of the child. By using motor, arms and mechanism in our project can be excavate easily. We done trail and error method for excavating the child from bore well, we also succeed in excavation process. The proposed system can retain the lives of many children who fall into the bore well in future.

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