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Theoretical and Practical Analysis on Borewell Rescue Device Using Inspection, Holding and Supporting Mechanism

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Abstract

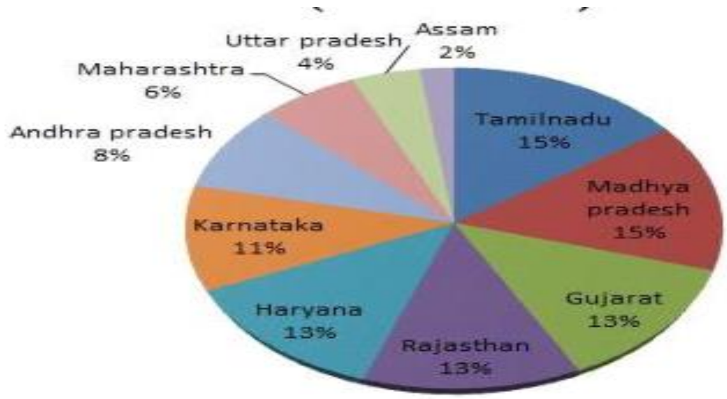
Cases of fatal bore well accidents have surged in India since 2006. This paper therefore aims to design and develop a bore well rescue system which uses, inspection, holding and supportive mechanisms to reduce bore well fall fatalities. The paper also considers children weighing 12kg, 15kg and 18kg in which the new device is based on. The new device developed in this paper is embedded with night vision cameras, oxygen cylinder, vacuum pipe and suction cap to increase its effectiveness and efficiency in rural and urban settings. To prove further effectiveness of the proposed device, the study conducts theoretical, ANSYS and experimental calculations. Regarding these aspects, the study also measures deformation, strain and stress associated with the chosen weights of children. Therefore, the proposed device would not only be effective in rescuing children but also alerting paramedics.

Keywords: Bore-well, ANSYS, Child Rescue

1. Introduction

Bore well accidents are common and the main victims are usually small kids who slip through the open wells. In most cases, the wells are empty, neglected and unprotected due to related costs of re filling them. This makes the wells a hazards to people especially children and infants who are susceptible to falling in such wells. India is one of the countries that has suffered the most from children falling into empty bore hole which has prompted us to look into the issue (refer to figure 1). As much as the falling of children is an issue, the process of rescuing them is also a challenge. Statistics show that more than 30 bore well fall fatalities occurred in consecutive years since 2006. The most disturbing thing about the statistics is that more that 92% of victims are children under 10 years. Kids play close to empty bore wells oblivious of the imminent death. Once children fall in the empty wells, they die of suffocation due to deprivation of oxygen and toxic environment in the well. In most cases, they die before rescuers arrive or before rescuers enter the bore wells. This shows that the rescue infrastructure and strategies are not only effective but also expensive. Therefore, communities require strategies that are reliable, flexible and affordable.

Figure 1. Number of Bore Well Accidents 2006-17, [2]



Several groups have embraced new and efficient methods of rescue, which ensure the survival of infants, and children who fall in bore wells. A study by Raj et al. (2014), found that some groups use rescue technique which use pneumatic arms to rescue infants. For the arms to effectively rescues a child, the arm must be connected to a harness. However, if the hole is small, attaching the child to the harness may not be possible during the pick-up procedure. To solve this problem, a study by Gopinath and Devika [4] employed the use of software to design multifunctional robotic arms to rescue children from bore well. So far, the design is yet to be implemented to demonstrate its feasibility of solving the existing problem.

In another study, Channabasavaraj et al. [5] developed a rescue device designed to rescue children stuck in bore wells. Unlike the devise designed by Gopinath and Devika to rescue children from small holes, this device was use for alternate situations where hole required further digging. The digging is done through robotic mechanism. The device also requires other components such as digital signal data, LED display, crystalloids, liquid crystals and DC monitor to function efficiently. Due to all these components, the method requires a lot of work force, electric power and high financial expense hence it is used by large-scale industries. To ensure the efficiency of the device, Sridharet al.[6] designed a wireless sensor fusion system to evaluate the internal and external environment of the bore well. The sensor is connected to a microcontroller using regulated power. The function of the sensor is to receive data from the bore well. Some of the data received and calculated are temperature, oxygen concentration, humidity and CO2. Although the procedure is effective, the challenge presented was the supply of oxygen in highly polluted land. Due to contamination the reaction between oxygen and the contaminants might produce harmful gases within the bore well which may be more hazardous to children trapped with the bore well. Sujatha et al. [7] designed and implemented the Lab View oriented child rescue robot. Other technologies invented by the same researchers were the IR technology, the rescue arm robot which is android based and the versatile prosthetic bore well scheme.

Previous studies show progress in the automation industry through the design of robots, which have lasting effects on society. Several scholars through their designs aimed at regulating the environment in which the child is trapped within the bore well. Their designs aim at informing paramedics while at the same time trying rescue the victim. Additionally, these designs detect the temperature, humidity, pressure and presence of toxic gasses within the bore well. The methods previously mentioned may seem to be expensive and labor intensive, but the paper herein deals with three possible ways and simple techniques of saving children trapped in bore well within a short time span. The project's goal is to rescue children who have become trapped in bore wells by utilizing the following modes: supportive mechanism, inspection, and holding. To that end, Raj et al. (2014) developed a method of child rescue that employs a pneumatic arm attached to a harness.

2. Methods and Materials

The processes of rescuing babies from bore well is challenging hence, the paper herein design simple and effective techniques to rescue babies.

2.1 Design

Modeling in creo 2.0 parametric

A revolve command is utilized for the cup to hold the baby.

Figure 2. Holding Mechanism Design

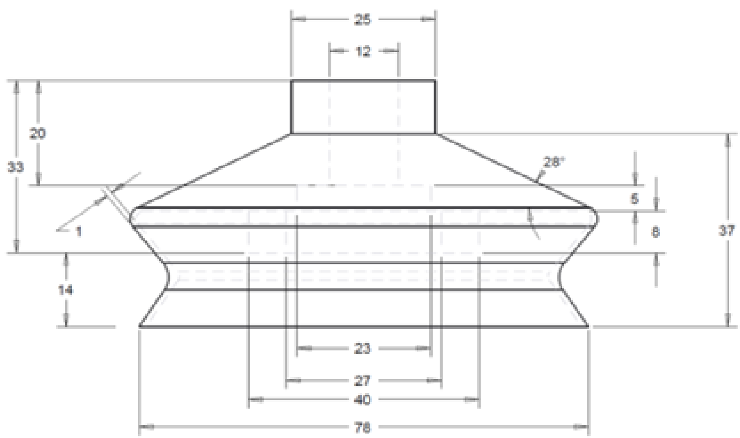
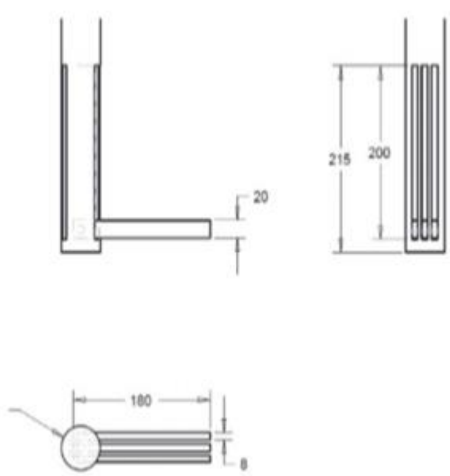


Figure 3. Supporting Mechanism Design



To develop the nut, the helical sweep and resolve operation are utilized along with a 20-foot pipe made with extrude operation. All the parts are united to form the design above.

2.2 Working Mechanism

This mechanism is comprised of other mechanisms such as holding, adjustment, supporting, inspection and pulling mechanism.

Inspection Mechanism

Some of the tools that aid in the child rescue process are night vision cameras, torch light and oxygen pipe with a cylinder. The oxygen cylinder is necessary because in deep levels of the bore well oxygen is limited and this could lead to early death of children trapped in bore wells. Before using the oxygen pipe and cylinder, the rescure must consider the position of the child in the bore well. The rescure should also consider whether there is a gap between the child and the wall of the bore well. These considerations are necessary to ensure that the child can be supplied with oxygen easily. Deep inside the bore well, there is likely be difficulty in lighting, this is where night viasion cameras ans torches become useful. The artificial lighting help locate the bagby while the oxygen pipe provide oxygen to the baby to prevent suffocation.

Holding and Adjustment Mechanism

Thes mechanisms are used to properly position the baby in the bore well. The mechanim has a vaccum pipe connected to a suction cup at the end. The cap with the help of the vaccum pipe help hold the baby in a favorable position to ensure a gap is creaated between the wall of the bore well and the baby so that other rescuing equipment can be used.

Supporting Mechanism

The mechanism is made of a main supporting rod with three other rods fixed with clothes at the end. The main rod holds the other three rods that creates a supporting platform. The supporting platform hold the baby. The cloth help protect the baby. When a baby falls into a bore well, it keeps falling deeper into the hole until the diameter of the bore well becomes smaller than the baby. Chances are high that the baby may sink deeper if they wiggle in their stuck position. In such situations, rescue machines are lowered into the bore well to hold and lift the baby out. However, this can only happen when there is a a gap between the baby and the wall of the bore well. In cases when there is no gap the suction cap and the vaccum pipe can create a space between the wall and the wall and the baby so that the supporting rod can be lowered. Once the supporting rod is below the baby and the cloth supporting it, then by pulling the supporting plate, the baby may safely be removed from the bore well.

2.3 Fabrication Details

Below are the images of the three mechanisms

Figure 4. Fabrication of Inspection, Holding & Supporting Mechanism

3. Results and Discussion

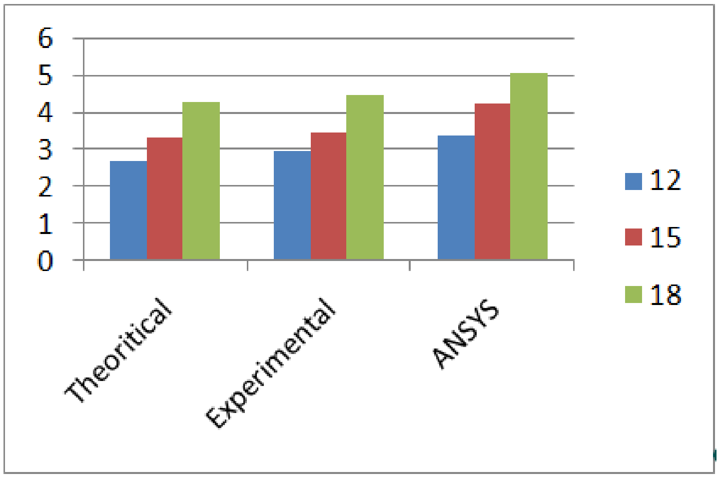
3.1 Holding Mechanisms

Table 1. Comparison of Outcome's for Holding Mechanism at Different Loads

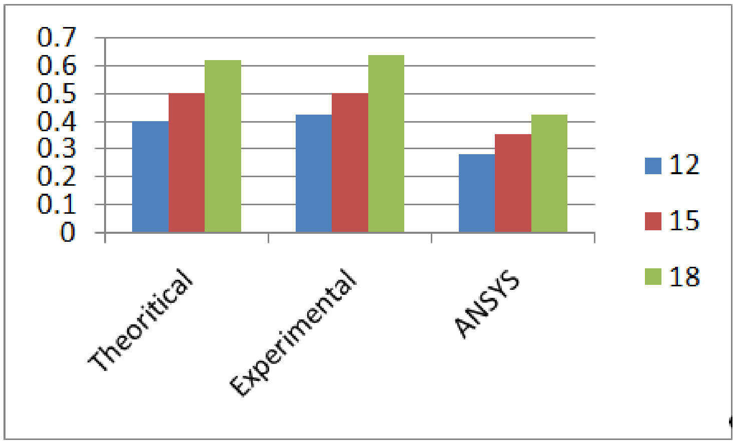
Load (kg)	Deformation (mm)			Stress (MPa)			Strain		
	Theoretical	**Experimental**	**ANSYS**	**Theoretical**	**Experimental**	**ANSYS**	**Theoretical**	**Experimental**	**ANSYS**
12	2.68	3	3.38	0.403	0.4275	0.281	0.134	0.1425	0.141
15	3.332	3.5	4.239	0.5	0.5	0.351	0.1666	0.16	0.17
18	4.284	4.5	5.086	0.62	0.6428	0.422	0.206	0.2142	0.2086

The table above shows the results of the holding mechanism technique using three different methods of calculation: theoretical, experimental, and ANSYS. The study was conducted on children weighing 12kg, 15kg, and 18kg. As a result, the study determined that the theoretical, experimental, and ANSYS deformations of a 12kg child were 2.68, 3 and 3.38 mm, respectively. The stress was also measured at 0.403, 0.4275, and 0.281 MPa in the study. The deformation was 3.332, 3.5, and 4.2 mm for the 15 kg child. The stress was measured to be 0.5, 0.5, and 0.351 Mpa, while the strain was measured to be 0.1667, 0.16, and 0.17, respectively.

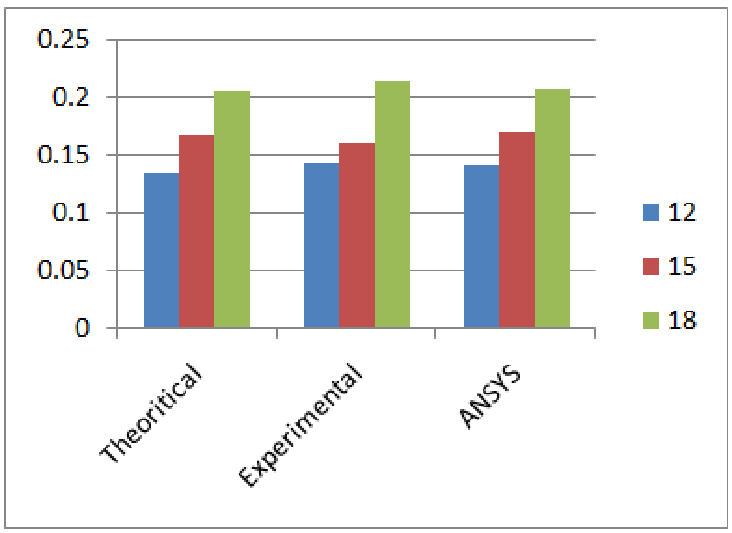
Graph 1. Deformation



Graph 2. Stress



Graph 3. Strain



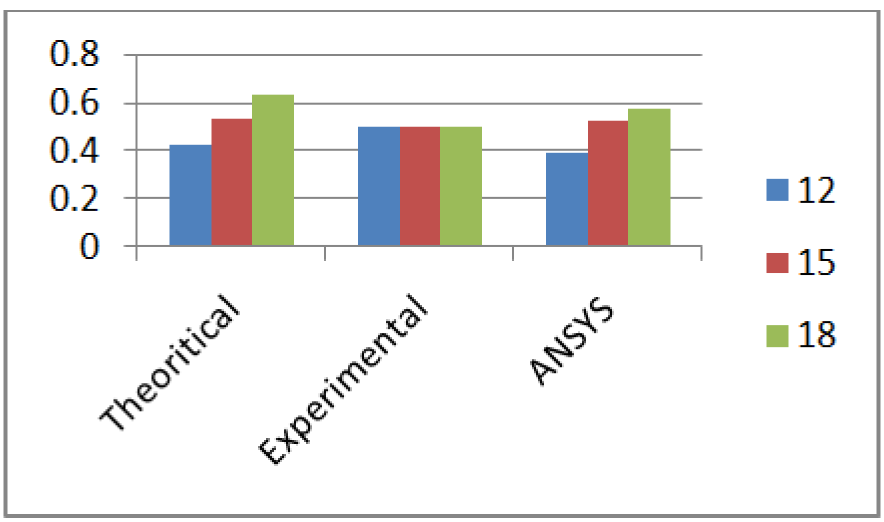
Supporting Mechanisms

Table 2. Comparison of Outcome's for Supporting Mechanism at Different Loads

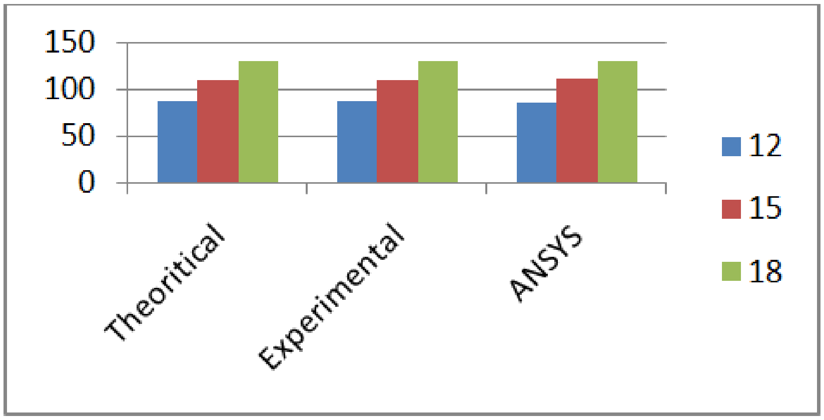
	Deformation (mm)			Stress (MPa)			Strain		
	Theoretical	**Experimental**	**Ansys**	**Theoretical**	**Experimental**	**Ansys**	**Theoretical**	**Experimental**	**Ansys**
12	0.425	0.5	0.3957	87.2	87.2	85.73	1.2×10^{-6}	1.2×10^{-6}	1.24×10^{-6}
15	0.531	0.5	0.5216	109	109	110.23	1.5×10^{-6}	1.5×10^{-6}	1.52×10^{-6}
18	0.637	0.5	0.5756	130	130	129.82	1.8×10^{-6}	1.8×10^{-6}	1.81×10^{-6}

The table above shows the results of the supporting mechanism via three ways of calculation which are theoreticajl, experimentmal and ANSYS. The analyses was done on three chldren of weights 12kg, 15kg and 18 kg. The study determined that the deformation of the 12kg child was 0.425, 0.5 and 0.3957mm while the stress was at 87.2, 87.2 and 85.73 as well aos a strain of 1.2×10^{-6} in all the three forms of calculation. The deformation of the 15kg child was as observed for theoretical, experimental and ANSYS were 0.531, 0.5 and 0.5216 while the stress values were ar 109, 109 and 110.23 MP. The strain was at 1.5×10^{-6}, 1.5×10^{-6} and 1.52×10^{-6} for the three forms of calculation. Finally, the deformation of the 18kg child base of the three forms sof calculation experimental and ANSYS were at 0.637, 0.5 and 0.5756. The stress value bagsed on the three calculations was 130, 130 and 129 MPa while the strain was at 1.8×10^{-6}, 1.8×10^{-6} and 1.81×10^{-6} also bagse on the three calculations.

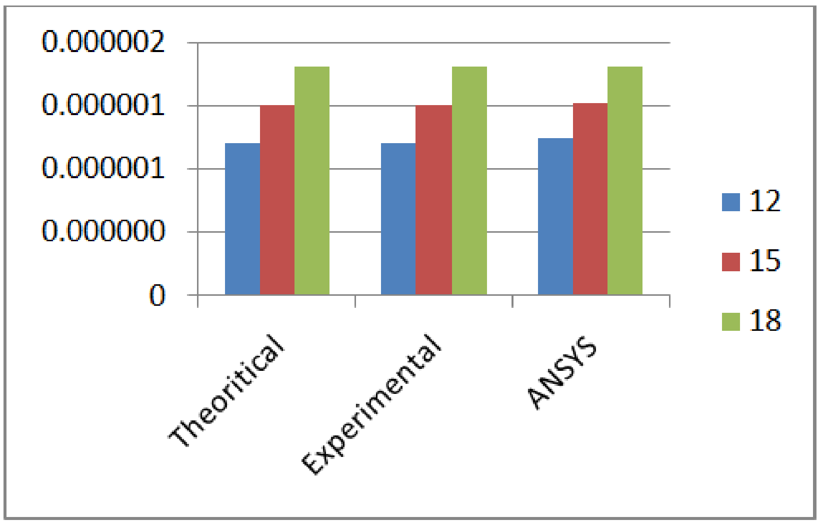
Graph 3. Deformation



Graph 5. Stress



Graph 4. Strain



4. Discussion

The major intention of this study was to design and investigate the effect of proposed bore well device base on the holding, inspection and supportive mechanism. The increasing number of bore well accidents in India compelled the study. Additionally, there are no effective techniques to save children from bore well accidents in the past decade. Although the existing techniques were effective, they were expensive. As such, it was necessary to develop a bore well infrastructure that was acceptable both in the rural and urban regions.

Based on studies by Manjari et al. [1], India began experiencing a surge in bore well accidents since 2006. Since then several techniques have been adopted to rescue children who fall in open bore wells. Some of the techniques include used are DC monitor, LED display, crystalloids, microcontroller alongside a pneumatic arm. Sujatha et al. [7] invented the robot used to rescue children. Kalavathi et al. [8] invented another rescue robot based on IR technology and Rajesh et al. [10]. Although these machines are effective they are expensive in terms of labor, electricity and financial maintenance. Hence, the present study designed a device with three mechanisms to improve on efficiency. The designed device was based on children weighing 12kg, 15kg and 18kg based on the theoretical, experimental and ANSYS calculations. During the use of the device, the study measured stress, strain and deformation. From the supportive and holding findings, the researchers designed the strain, stress and deformation based on the weight of children. Some earlier methods such the wireless fusion sensors which determine the external and internal condition of the bore well before rescuing a fall victim was invented by Sridhar et al. [6]. The device uses a regulated power sensor mounted on a micro-controller. The micro-controller collects information from bore well using various transmitters such as the RS 485 and the RS 232. The information collected are those related to temperature, humidity, CO_2, oxygen, toxic gasses and other impurities. The device design developed in this study has all the above advantages in addition to a suction pump and a cap designed based on the weight of the child. The only drawback of the whole system was the chemicals which could pollute soil once they react with oxygen they generate toxic gasses in the bore well which could be a danger to children in the bore well.

The present technique entails digging a perpendicular tunnel through the bore well the infant is stuck. Moreover, the method is labor and material intensive hence not readily accessible by anyone. The method also requires a huge space around the bore well to dig the perpendicular tunnel. The technique is dangerous as it can lead to injury of the people involved in the digging and rescue effort hence the method cannot provide a long term solution to the bore well accident problem. Additionally, the method uses hooks to secure the victim`s body and clothes, this can lead to damage to the victim`s body. However, the current design of the bore well rescue device is designed to deal with almost any rescue effort situation. Hence, the research arrives at the conclusion that the device can rescue without harming the victim.

5. Conclusion

In recent years, there has been a surge in children deaths associated with bore well accidents. To overcome this problem, several rescue techniques have been developed. One method that has gathered a lot of attention is the use of robots due to its high success rate. Despite the high success rate of robot use, it requires a lot of time and financial resources. Hence, this research uses the holding, inspection and supportive mechanism to rescue children who fall in bore holes within the shortest time possible with the help of theoretical and experimental calculations. Based on the new rescue device, this paper considers children weighing, 12kg, 15kg and 18kg. To make the new device more effective, it is embedded with night vision cameras, torchlight, oxygen cylinder and a suction cup.

Future Scope

The future prospects of the device is that it could be used to provide extra elements to the project. This is because the device is designed to withstand any weigh and can also be adjusted to a variety of bore well diameters.

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