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DESIGN AND ANALYSIS OF A BORE WELL GRIPPER SYSTEM FOR RESCUE

Sridhar K. P.[1] and Hema C. R.[2]
[1]Department of Electronics and Communication Engineering, Karpagam University, Coimbatore, India
[2]Faculty of Engineering, Karpagam University, Coimbatore, India
E-Mail: capsridhar@gmail.com

ABSTRACT

Modeling and analysis of gripper arm system for bore well rescue operations and a humanoid model is designed to test the various parameters inside the well at various stages of time and places (humidity, temperature, pressure, oxygen, atmospheric air supply, speech ability, carbon dioxide, carbon level) and the rescue device is tested for its holding capacity.

Keywords: bore well, gripper arm system, rescue.

1. INTRODUCTION

Today's major problem faced by human society is water scarcity, which leads to a large number of bore wells being sunk. These bore wells in turn have started to take many innocent lives. Bores which yielded water and subsequently got depleted are left uncovered [18]. Small children without noticing the hole dug for the bore well slip in and get trapped. Human search of water finally has ended in disaster. Since the holes are dug too deep it is quite impossible to save life. The fire force and medical team find it difficult to rescue children due to unknown levels of humidity; temperature and oxygen in the depths of the bore well.

Rescue work can be a long drawn affair lasting close to thirty hours. The time taken is long enough to kill a precious life. Even if rescued, the child may die due to injuries sustained. This has created an open challenge to the field of medicine, rescue and the whole human society. Apart from a seven year old who died in this manner in Dindigul district [18], all other cases involve smaller children below five years. We have documentary proof of such deaths, which were widely published. All of these children were alive and died just before their rescue is an important point. The question remains how many missing children met their ends in this gruesome manner and were not reported. To aid in such rescue we have proposed a system.

Methods to keep a child alive in a bore should take in to consideration the lack of oxygen, increased temperatures and humidity, which produces hyperthermia. These problems are addressed with fresh air delivery with or without delivery of oxygen. A hand-powered equipment to deliver fresh air inside bore is being designed. This method brings down temperature and delivers fresh air. Though we have separate electric vacuum machineries [18], these are kept as stand by as sites may not have electrical point nearby. Visualizing the child is made possible with infrared waterproof CCD cameras and a portable high resolution TV Monitor.

The camera is suspended in a 200 feet cable. The equipment is designed to operate off the 12-volt battery of the rescue vehicle. We have totally avoided 220 volts to prevent electrocution. Pulling up the child is made possible by special graspers, which can lock on shoulder area – wrist or ankle of the child. These have been specially designed and fabricated to provide open close control at one end and facility to extend it by adding additional pipe lengths. Currently we have equipments to work up to 100 feet. Stabilizing the ground around the bore and spreading the weight of equipment have been considered and a platform to achieve this is also made. We can be able to see the trapped child inside the bore well,

a) Test model

This model will test all the parameters like (humidity, temperature, pressure, oxygen, atmospheric air supply, speech recorder ,transmit audio inside the well , carbon dioxide, carbon level) inside the bore well and transfer the data to the analysis to match the data for the various test. This model is designed especially for the purpose of bore well testing and to test the mechanisms used in the rescue device for the bore well rescue operation.

2. MODELING & ANALYSIS OF GRIPPER ARM

a) Modeling

In computer-aided design, geometric modeling Figure-1 is concerned with the computer compatible mathematical description of the geometry of an object. The mathematical description allows the model of the object to be displayed and manipulated on a graphics terminal through signals from the CPU of the CAD system. The software that provides geometric modeling capabilities must be designed for efficient use both by the computer and the human designer. Here the modeling of gripper arm is done with the help of SOLIDWORKS2012.

Table-1. Geometric properties of Gripper Arm.

Material	MS (Mild Steel)
Dimension	300 x 25.4 x 8 mm
Holes	M6 x 1.0

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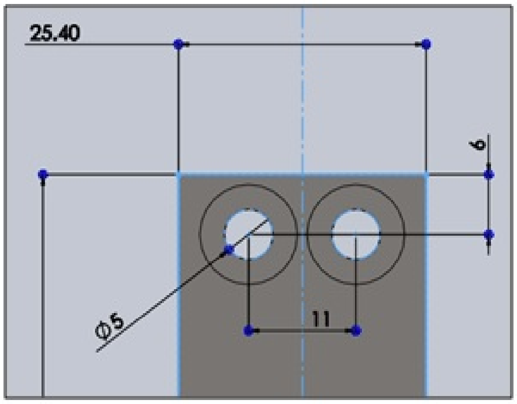

Figure-1. Computer-aided design, geometric modeling.

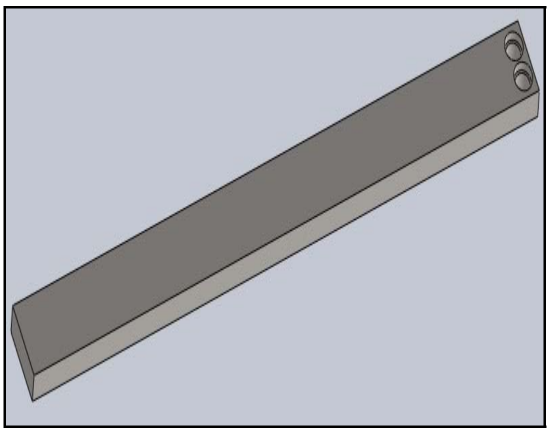

Figure-2. Overview of Gripper Arm design.

b) Structural analysis

An FEA-based design begins with the selection of the element type, how the model should be constructed, how accurate the results should be, The most accurate FEA results can be obtained by creating 3-D model of a gripper arm and followed by meshing the model with a 3-D solid element. Finer meshing with higher-order elements will produce more accurate results. However, with a higher number of elements could take hours to run by increasing computational time. While the accuracy of the result is important, the computational time must be reasonable to incorporate FEA into a gripper arm design Figure-2.

3. ELEMENT TYPE AND MESH CONVERGENCE CRITERIA

Meshing involves division of the entire of model into small pieces called elements. This is done by meshing. It is convenient to select the tri mesh because of high accuracy in result. ANSYS 13.0 WORKBENCH is the software used for the pre and post processing; meshing of arm is shown in Figure-3.

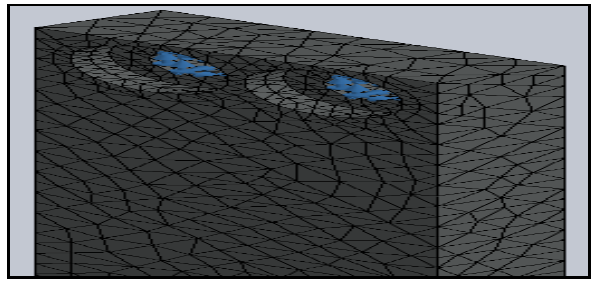

Figure-3. Meshing of Arm.

4. LOADS APPLIED

The victim (children) may weight around 15 to 20 Kg (150 to 200 N); age range around 3 to 5 years. Hence the force of 50kg (500N) by considering factor of safety is applied (Figure-5) at the end of a arm as shown in figure while the bolt holes are fixed it shown in Figure-4 and Figure-6.

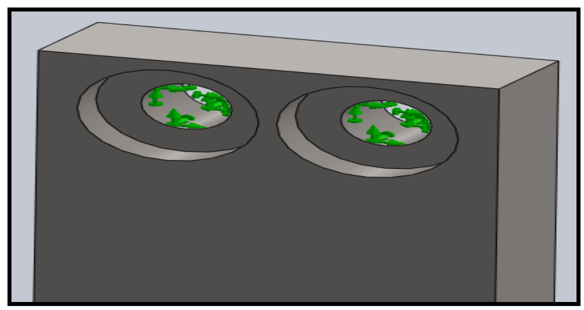

Figure-4. Fixed holes.

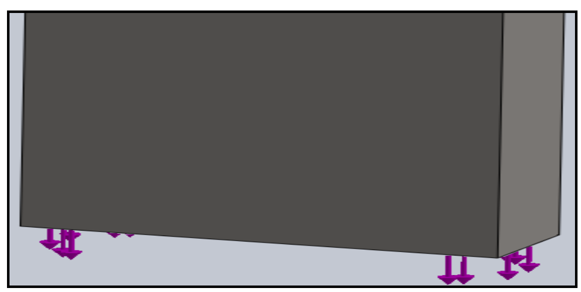

Figure-5. Loading, 500 N force acting downwards.

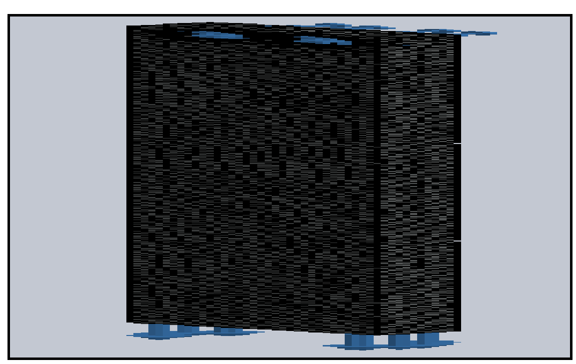

Figure-6. Fixed with bolt holes.

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Material discussion

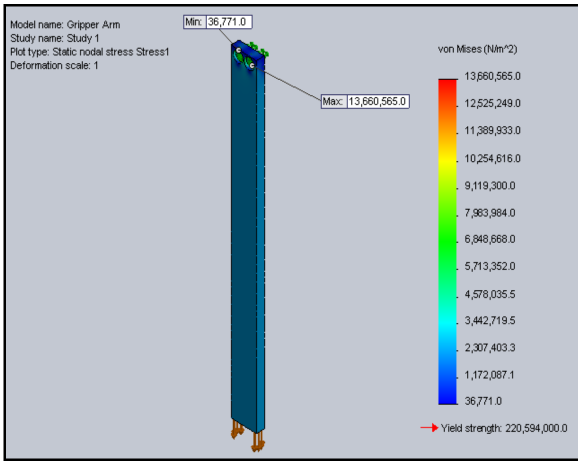

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Figure-7. Static nodel test stress.

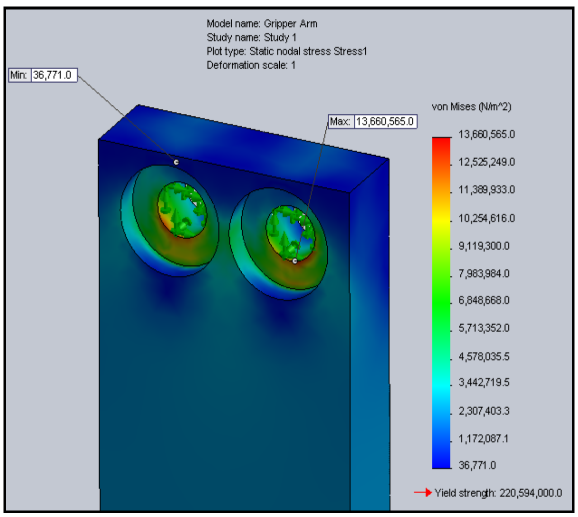

Figure-8. Maximum induced stress.

The above Figure-8 indicates that the maximum induced stress in the arm is 13 N/mm^2 when compare to the yield of the material 200 N/mm^2. At a closer look to the stress plot shows that the bolt holes experiences maximum stress level.

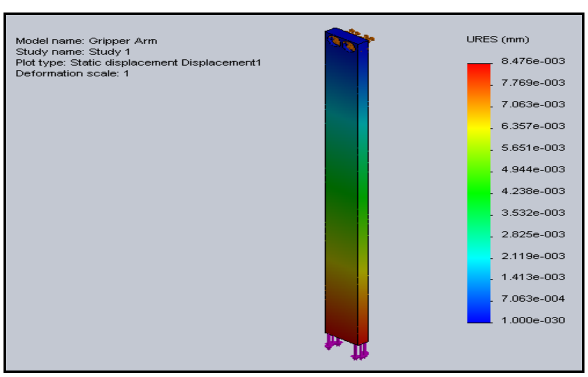

Figure-9. Displacement plot.

The above Figure-9 shows the displacement plot (The amount of movement from its original place). The maximum value is 0.008476 mm only. The following plot shows the reaction force created in the gripper. The reaction force is max. At fixed ends (Bolt holes). The maximum value is 3.094 N, at bolt holes.

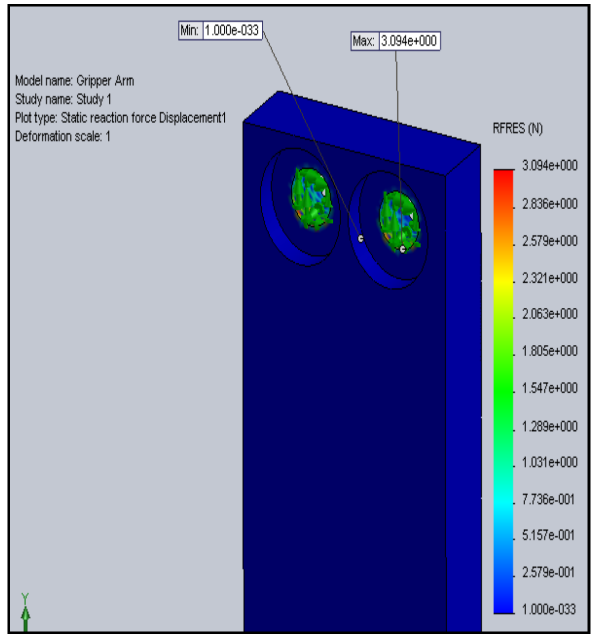

Figure-10. Safety distribution Min FOS=16.

5. FACTOR OF SAFETY

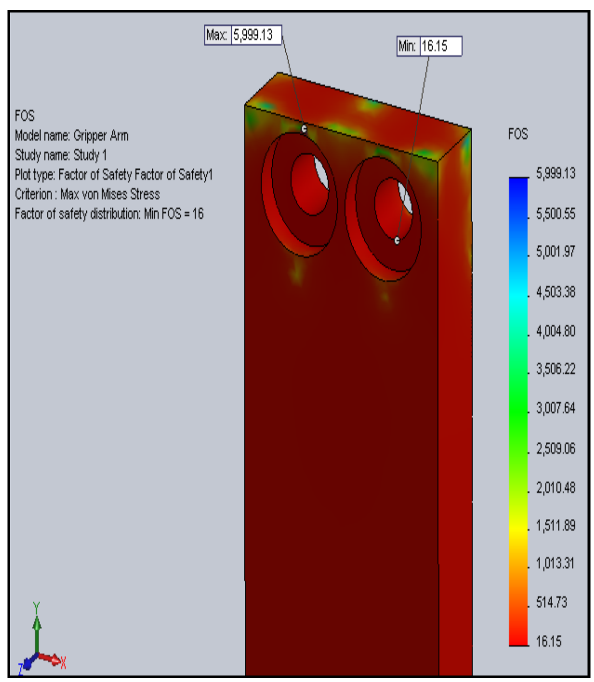

Figure-11. Safety distribution.

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The above plot Figure-10 and Figure-11 shows that minimum FOS is 16.15 which is very much above the requirement (2) for the given static load.

a) Temperature variation in deep wellls for various feet

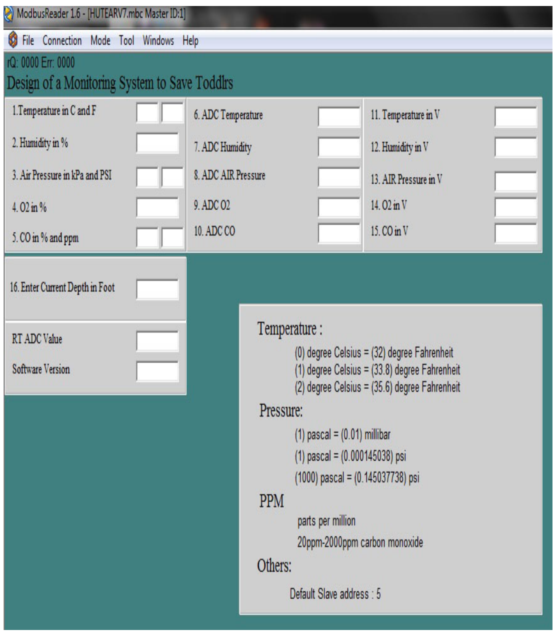

Figure-12. GUI.

From the above results we can be able to predict the medical condition of the child [6] .We are able to see the variation of the data's which is taken from the well and it is processed .From the variation of data, we can predict that the child cannot withstand in such condition of the well .if there is high temperature then the respiration will effect due to the giddiness happening to the child and lack of natural air and oxygen that makes the child for dehydration level that may seriously affect the child because of the varying atmospheric condition inside the well. In such cases medical team will find risk to overcome such problem as we have designed and fabricated a humanoid model to test the various operation of machine and to provide paramedical support by the same device. These results may vary from place to place and the types of land in that case in Tamil Nadu. In India, we have six different types of land structure so the prediction database that may help the rescue team for the better operation in the field.

The data taken from the geographical area
Center: 11, 353747-77055600
Span: 0.006311-0.005148
Place: Kovilmedu, Sirumugai, Coimbatore District, Tamil Nadu, India

These types of recorded for all types of land and that will be taken in to account for the rescue operation and to make the rescue operation team comfortable As we have taken survey with few doctors, the results obtained from the doctors says that if the child is in such condition for a long time the child will be psychologically affected due to the pressure and the fear that occurs while doing rescue operation. The child may be affected due to poor atmospheric condition inside the well that may lead to dehydration in few minutes and that may lead the child's health condition very bad. To analyze such situation the model designed may help the paramedical team to give treatment after rescue.

6. CIRCUIT DETAILS

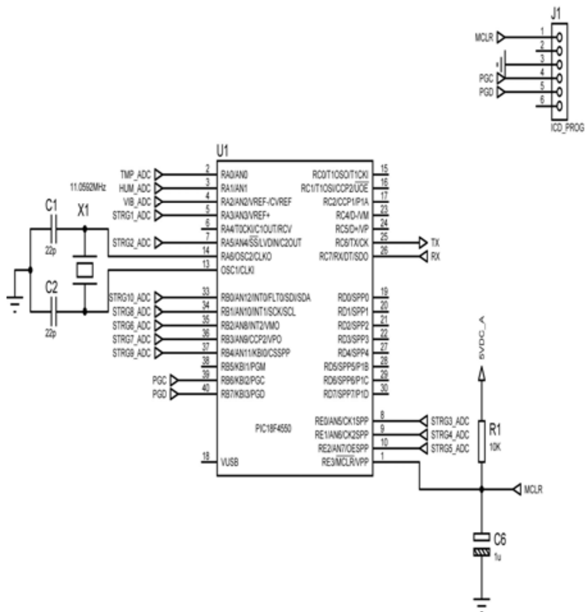

Figure-13. The above shown fig that shows the circuit diagram for the child model the processor PIC8F4550 is used to take the details from the model and that will be connected to the system for GUI for user friendly purpose.

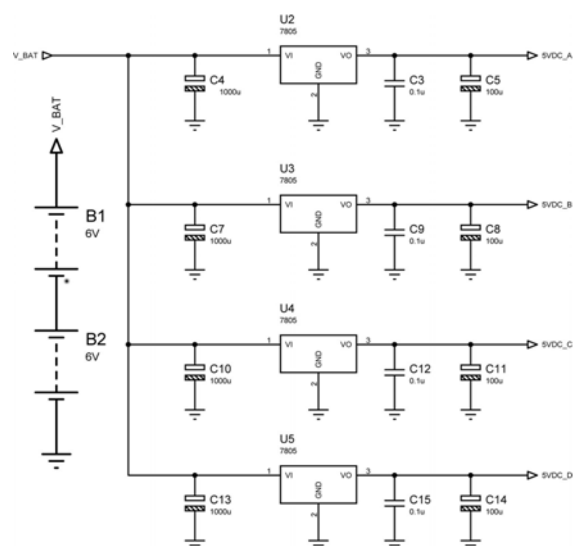

Figure-14. Individual sensor connections.

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The above circuit Figure-13 and Figure-14 shows that the sensor connections with the processor. All the sensors connected in the skeleton has molded for the special purpose in a better manner for the acquisition of the data. In that case it is possible to test the model that will give good prediction because the skeleton has been designed like a human so the data that will say the actual replication of the live child.

7. RESULTS AND DISCUSSIONS

a) Temperature humidity and pressure data accusation

Data's has been taken from the model designed and that has been tabulated as required for the tests.

Table-2.

Time	Temperature in C	Current Temperature in F	Humidity in %	Air Pressure in PSI	Current Depth in Foot	CO in %
11:11:48	36.6	97.9	24.7	0	0	97
11:11:56	36.1	97	24.9	0	0	97
11:12:54	35.6	96.2	26.6	0	1	71
11:13:08	35.6	96.2	27.1	0	1	71
11:13:52	36.1	97	30.3	0	2	71
11:14:06	36.1	97	31.6	0	2	61
11:14:48	35.1	95.3	33.2	0	3	61
11:15:01	35.1	95.3	33.9	0	3	61
11:15:46	34.6	94.4	36.1	0	4	60
11:15:59	34.6	94.4	36.9	0	4	60
11:16:52	35.6	96.2	39.6	0	5	56
11:17:05	34.1	93.5	39.2	0	5	56
11:18:22	34.1	93.5	41.5	0	6	53
11:18:36	34.1	93.5	41.7	0	6	53
11:19:28	35.1	95.3	44.4	0	7	52
11:20:39	34.6	94.4	46.1	0	8	52
11:20:54	33.7	92.6	44.6	0	8	52
11:21:31	33.2	91.7	46.1	0	9	52
11:21:45	34.1	93.5	48	0	9	52
11:22:32	33.2	91.7	47.5	0	10	57
11:22:47	33.2	91.7	47.8	0	10	57
11:23:45	33.2	91.7	48.4	0	11	57
11:23:58	33.2	91.7	48.7	0	11	57
11:24:34	33.7	92.6	50.4	0	12	57
11:27:36	32.7	90.8	52.1	0	12	44
11:29:12	32.2	89.9	53.2	0	13	46
11:29:25	32.2	89.9	53.4	0	13	46
11:30:13	32.2	89.9	53.6	0	14	41
11:30:25	32.2	89.9	53.8	0	14	41
11:30:41	32.2	89.9	53.8	0	15	41
11:30:52	32.2	89.9	53.9	0	15	41
11:31:28	35.6	96.2	57.8	0	16	46
11:31:38	32.2	89.9	54	0	16	46
11:32:27	35.1	95.3	58.2	0	17	46
11:32:38	34.6	94.4	57.6	0	17	46
11:34:05	32.7	90.8	56.1	0	18	56
11:34:16	32.2	89.9	55.3	0	18	56
11:35:28	34.1	93.5	58.6	0	19	44
11:35:40	32.2	89.9	55.7	0	19	44
11:36:25	33.7	92.6	58.4	0	20	44
11:36:35	34.6	94.4	58.6	0	20	44
11:37:21	32.2	89.9	56.1	0	21	24
11:37:31	32.2	89.9	56.1	0	21	24
11:38:49	32.2	89.9	56.2	0	22	60
11:39:00	32.2	89.9	56.4	0	22	60
11:40:21	32.2	89.9	56.5	0	23	45
11:40:31	32.7	90.8	57.4	0	23	45
11:42:24	32.2	89.9	56.8	0	24	35
11:42:31	32.2	89.9	56.7	0	24	35
11:44:35	32.7	90.8	58.5	0	25	37
11:44:45	34.1	93.5	60.1	0	25	24
11:45:09	31.7	89	56.9	0	26	24
11:45:16	31.7	89	56.9	0	26	24
11:46:03	32.7	90.8	57.6	0	27	42
11:46:12	31.7	89	57.1	0	27	40
11:47:36	31.7	89	57.1	0	28	28
11:47:44	31.7	89	57.1	0	28	28
11:48:12	31.7	89	57.1	0	29	28
11:48:20	31.7	89	57.1	0	29	28
11:50:23	31.7	89	57.4	0	30	33
11:50:31	31.7	89	57.4	0	30	33
11:51:27	32.2	89.9	58.9	0	32	33
11:51:37	31.7	89	57.4	0	32	33
11:52:09	31.7	89	57.4	0	34	33
11:52:17	31.7	89	57.4	0	34	33
11:53:17	31.7	89	57.4	0	36	32
11:53:25	31.7	89	57.4	0	36	32
11:54:14	31.7	89	57.4	0	39	30
11:54:23	31.7	89	57.5	0	39	30
11:55:31	32.7	90.8	59.4	0	42	30
11:55:40	31.7	89	57.5	0	42	30
11:56:56	31.7	89	57.5	0	45	36
11:57:06	31.7	89	57.6	0	45	36
11:57:54	32.7	90.8	59.5	0	48	36
11:58:02	32.2	89.9	59.4	0	48	41
11:58:42	31.7	89	57.6	0	51	36

b) Graphical representation of the readings acquired

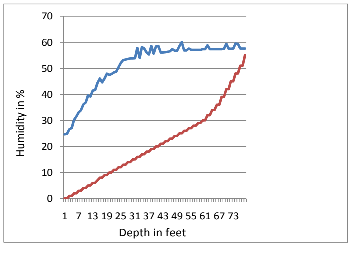

Figure-15. The humidity variation in the deep well.

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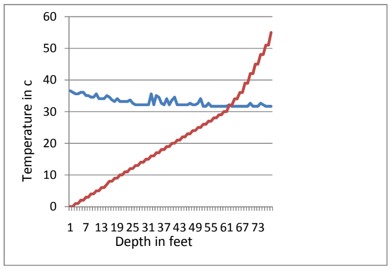

Figure-16. Temperature variation in deep wellls for various feet.

From the above graph (Figure-15 and Figure-16) and the readings acquired from Table-1 we can come to a conclusion that due to the temperature variation in the well that may affect the child and make the child to dehydrate very fast.

8. CONCLUSIONS

By predicting the condition of the infant the paramedical team and the rescue team can take a decision in that critical situation for the betterment of the child

Due to heavy humidity child tissues may got soften in that case gripping of that child that may cause injury to avoid the sensitive gripping this results will help in the live rescue

As medical team face a very big problem due to the atmospheric variation inside the well they may feel difficult to give treatment .in case if high humidity if the child is provided with liquid glucose then the child may get heavy chillness and that may lead to serious condition for the child. In such cases we can take the data's and predict the condition of the child for the paramedical operation

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