

LANDSLIDE WARNING SYSTEM USING ARDUINO

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Abstract – Arduino based sensors perform wide range of applications in the present era. The drastic changes in the climatic conditions lead to an imbalanced atmospheric conditions lead to heavy rainfall causes excess flooding. The natural ecological balance has been interrupted due to many of the activities and hence the disasters are occurring frequently. The research focuses on detection of the landslide using an Arduino sensor which depends on the slope of the area to be analysed. The Arduino Uno board is a microcontroller based on ATmega328. A low cost warning system is developed for better evacuation process.

Key Words: Arduino , detection technique, soil piping, landslide, heavyrainfall

1. INTRODUCTION

Environment has a diverse interaction among its species natural resources, weather etc. The human activities evidently made ecological imbalance and hence disasters are occurring frequently. In the nearest times flood, landslide have been occurring drastically which made a huge loss in lives, properties etc. This paper focuses on the internal soil erosion detection on earthen dams and landslide. The strength of soil is determined by the presence of water. The increase in the water content increases the plastic limit and thereby soil have a tendency to lose its shear strength.

The study has a bifold objective , a soil is selected i.e, red earth for this study and the slope corresponding is made and various rainfall conditions is stimulated . The second fold includes the programming and making of the Arduino based low cost sensors which will detect the presence of water. The Arduino Uno board , jumper wires , soil moisture sensors are mainly used. The programming of the soil moisture sensor is done and the setup can find time duration and early detection of landslide.

1.1 Objective of the study

The main objective of the study is to detect the presence of water and seepage failure , thereby early detection of landslide. The plasticity index of the soil is analysed and developing of an integrated system using Arduino for detection of landslide

1.2 Scope of study

The study mainly deals with the detection of seepage failure with the development of an integrated system using Arduino as well as soil moisture sensors.

The presently developed system has a wide scope of study. The system can be made more effective if a digital system with a wifi mode is provided in it . As the condition for landslide is being increased day by day the scope becomes more wider. When this is made on a mountain a sensor pillar can be made by using same setup and hence detection of around 10 km s can be made.

2. MATERIALS AND METHODS

Red soil is a type of soil that develops in a warm, temperate, moist climate under deciduous or mixed forest, having thin organic and organic-mineral layers overlying a yellowish-brown leached layer resting on an alluvium red layer.^[8]

Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button.^[8]

A jump wire is an electrical wire, or group of them in a cable, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.^[8]

Soil moisture sensors measure the volumetric water content in soil. Rain fall condition similar to the condition is simulated and regulated rainfall intensity is provided so that with the varying intensity the change moisture content and moisture characteristics is found out . A warning system embedded with it earns just that the slope begins to slide.

The working principle of this moisture sensor is as follows, the sensor gives a particular analogue reading to the micro controllers as and when the sensor is completely dry. As the dampness increases the sensor become more resistance to transmit these analogue readings and shows a

decrease of analogue readings. The sensor is calibrated to identify the dampness percentage in the soil based on this principal. A sensor pillar embedded into the soil will be a viable solution for detecting the problem. The sensors will be programmed such that, it will give the warning to the respective authority to stop and evacuate that area whenever a particular soil moisture level occurs and this level of critical accelerated in real world scenarios like cracks due to earthquake and dynamic loading. So as the water head increases the time required for the fully penetration of soil sample decreases. In case of addition of barriers can be helpful for the soil to withstand piping. That is why in most of the earthen dams, the core is made with impermeable fine clay and reinforced with geosynthetics. The warning signal was set of at some time after the removal of the stick for the piping to occur and exactly after 18 minutes and 20 seconds the breach of water was observed on the downstream side at around 10 cm from to bottom. Phreatic line is visible as the soil have been saturated.

various intensities of rainfall and will note down the various changes occurring in the model. After the completion of the work the model has been set still for 24 hours with a little bit of water on the upstream side to ensure there is no leakage. To predetermine the piping path a narrow stick is inserted through the core. After 24 hours, the tank is completely filled with water and the readings of the sensor is recorded with a small android based computing device. The data is collected and displayed in the displaying unit .

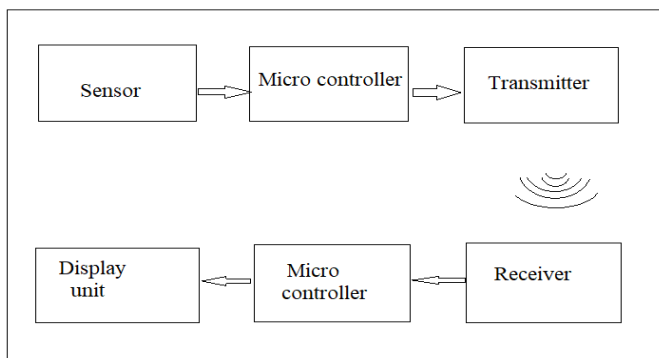


Fig -1: Working Principle^[1]

Sample of soil is collected from killimangalam, kerala, India . The soil is collected from a place where landslide is frequently occurring past two years . The soil is collected at a depth of 3 m below the ground level . The soil is collected in plastic sack . The soil is deep red in colour . The major steps involved in the experimental study includes the basic properties of the sample taken for the entire work is to be found, the index properties play a very good role in determining the piping potential of the soil

For the placement of the system in large scale or on the slopes a sensor pillar is made .It contains a sample tube of 350 mm. The principle behind the working of this sensor pillar is as given in fig 1. Basically, there will be two modules, one for transmitting the analogue signal through a micro controller and other for receiving this data and will be far away from the location of installation of the sensors.. A box is taken which may be made of plastic and the soil which is collected is thoroughly compacted and settled in it . Usually the compaction percentage for the soil that have been present in hill is about 50- 60%. The slope that here test is carried out is about 45 degree.then rainfall condition is simulated for



Fig -2: Developed prototype

3. RESULTS AND DISCUSSIONS

3.1 Plasticity index of soil

The properties of a soil is important in determining its strength and withstanding capacity. The soil chosen is red soil and its properties were tested. The properties that have taken into consideration is liquid limit and plastic limit. The liquid limit is the water content corresponding to 25 number of blows . Hence liquid limit is 35 . The plastic limit is 18.18.

Therefore,

$$\begin{aligned} \text{Plasticity index IP} &= \text{WL-WP} \\ &= 35-18.18=16.82\% \end{aligned}$$

From the experiments conducted it have been found out that the plastic limit for the soil under consideration is 18.18 and the liquid limit is 35. The plasticity index is 16.82%. The red soil have a common character of having low plasticity and high liquid limit .The soil under consideration is also having low plasticity and high liquid limit.

3.2 Experimental results

From the experiment done on the developed Aurdino based system , when the rainfall condition is simulated the soil moisture content of the slope varies .

The Arduino uno board is connected with the jumper cables as well as with soil moisture sensors and hence detection proceeds, the variation is shown in Table 1

Table -1: Experimental readings (1:1.5 scale)

Rainfall (mm/hr)	Time of recording (minutes)	Sensor Reading	Time for Warning (minutes)
1mm/hr	8 minutes	360	16 minutes
	16 minutes	102	
2 mm/hr	4 minutes	285	9 minutes
	9 minutes	112	

The various sensor readings are noted down along with increase in the moisture content and the visibility of the phreatic line is exhibited so as a warning of soil piping and of landslide . The developed system similar to this warns the landslide before 18 minutes 20 seconds of its occurrence as by the system.^[1]

4. CONCLUSIONS

The study plays an important role in present times , the climatic condition is becoming worst and the disasterous atmosphere is increasing. From this study, the results obtained was very helpful to understand about soil internal erosion even though this study focus on the internal erosion. A system is developed as a prototype and readings were taken. The seepage of water is a very interesting phenomenon and a study of such in red earth, which is a low plasticity clayey soil is conducted and the results are obtained in the present study. A landslide warning system is also possible with the technology in the present study.

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