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WATER USAGE MINIMIZATION USING AUTOMATED CURING TECHNIQUE

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Abstract

Curing is the process of regulating the rate and extent of moisture loss from concrete to ensure an uninterrupted hydration of Portland cement after concrete has been placed and compacted in its final position. Curing also ensures to maintain an adequate temperature of concrete in its early ages, as it directly affects the rate of hydration of cement and eventually the strength gain of concrete. Thus proper and efficient curing of concrete structures are important in achieving strength of the concrete. However, proper curing practices are not always followed in most of the cases leading to a weak concrete. Main difficulty is when it comes to curing of vertical walls improper curing and wastage of water are the major concerns. An automated curing machine can be employed to overcome this problem of efficient curing and water wastage during the curing process. This water wastage may not be a major concern for water abundant regions, but there are many places within our country where water is a scarce resource. Thus automated curing machine can be widely utilized in construction site with a shortage of water resources for curing. Automation has reduced human involvement and has made it easier for production and management. Automation in Civil Engineering is increasing along with implementation of different sensor systems for monitoring and controlling different functions. Proper water management is possible with the proposed automated curing system thus wastage of water can be minimized. The main objectives of the machine are:

1. Reduced water consumption and labour requirements for curing of walls after plastering.
2. Ensures efficient curing with equal and uniform distribution of water.
3. Helps in water conservation within construction sites.
4. Helps to reduce materials cost as well as labour costs.

The automated curing machine is provided with a number of components as shown in Fig 1. The components provided in the machine include

1. Storage tank**:** The machine is provided with a storage tank for storing the water required for the curing process. Water for the water resources in the construction site is filled in this storage tank.
2. Pump: The water that is stored in the water storage is pumped vertically using a pump. The pump is connected to a height adjustable pipe which will be carrying the water vertically.
3. Height adjustable pipe: A height adjustable pipe will be carrying the water that is pumped vertically. The pipe is provided such that water can reach varying heights of structures within a building. The height adjustable pipe is connected to the water distributor which will be delivering the water to the structures for curing.

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4. Water distributor: The water pumped is delivered to the water distributor which is provided with small slots or openings for discharging the water uniformly on the surface of the structures.
5. Water collector: The excess water flowing down along the surface of the structure will be collected by the water collector. The collector provided is made of steel plates. This water that is collected will be delivered to the storage tank after filtering it through a mesh provided. The collector is also provided with a sensor system which will be stopping the working of machine once the water touches the collector plates.

The machine is an automated model in which the water stored will be distributed uniformly on the surface of the vertical walls of massive structures. Water from the water resources in the construction sites will be filled into the storage tank through the pipe can be fixed in various heights and thus helps in carrying water to different heights within the building. The pipe will be delivering water to the water distributor which will be discharging water to the surface of the structures. The distributor is a pipe provided with small slots emitting water jets at high velocity which then flow through the wall. The water flowing through these walls will be absorbed by the surface materials and the excess water will be flowing down. The excess water which is flowing down the surfaces will be collected by the water collector made of steel plates. These collectors will be carrying the water to the water storage after filtering the excess water through the mesh provided. The machine will be working in two cycles to achieve efficient curing. A cycle is completed once water from the water storage which is pumped up is discharged through the surfaces and the excess water reaches the water collector and then the pump stops for a while to ensure absorption of water. After five seconds the second cycle takes place in a similar manner and now when water reaches the water collector after flowing through the walls the pump stops working. These cylces of watering are achieved by providing a sensor system within the collector plates. The machine is also provided with a wheel system for easy handling and movement of the machine within the construction site. Three-dimensional model of the machine is shown in Fig 2.

The electric circuit shown in Fig 3 consist of an arduino UNO board which is a microcontroller board and it consists 14 digital input /output pins, 6 analog outputs, a USB connection, a power jack, an ICSP header and a rest button. It can be simply connected to a computer with a USB cable or can be powered using AC-To-DC adapter or a battery .This arduino board is programmed in order to control the working of the ultrasonic sensor, moisture sensor, water pump and the relay module connected to it. Ultrasonic sensor can be used to measure point-to-point distance by transmitting and receiving discrete signals of ultrasound between the sensors. So here it is used to measure the distance between the machine and the adjacent wall. Moisture sensors used in order to detect the water content on the water collector for starting and stopping of each cycles of curing. Once the sensor detect water on the collector the machine stops pumping water upwards and resume with the second cycle of curing after a duration of 5 seconds. When the sensor detect water for the second time at a respective position the pump stops and the machine move sidewards for curing the next section**.** Relay module is an electrical switch that is operated by an electromagnet which is activated by a separate low-power signal from a micro controller here we use an arduino UNO board. A 4 channel relay module is opted for the automated curing machine

Results and inference:

1. Large reduction in water wastage for curing of plastered walls.
2. Reduction in material cost and labour cost.
3. Main attraction is the ease of operation of the machine.

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4. Cost of manufacture comes around Rs 8000 which is very low when compared to its benefits during long term use.
5. Even if the initial cost to purchase the machine is a little high, it is cost efficient in the long run.

Keywords: Micro controller, Analog output, ICSP header

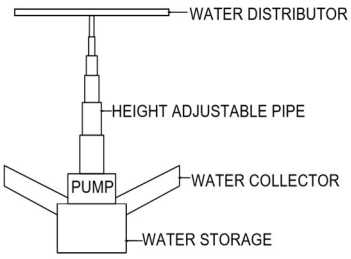

Fig 1: Components of automated curing machine

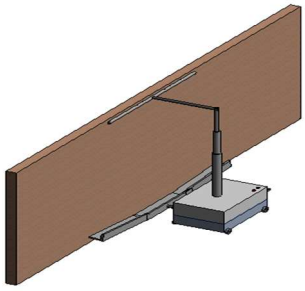

Fig 2: Three-dimensional view of automated curing machine

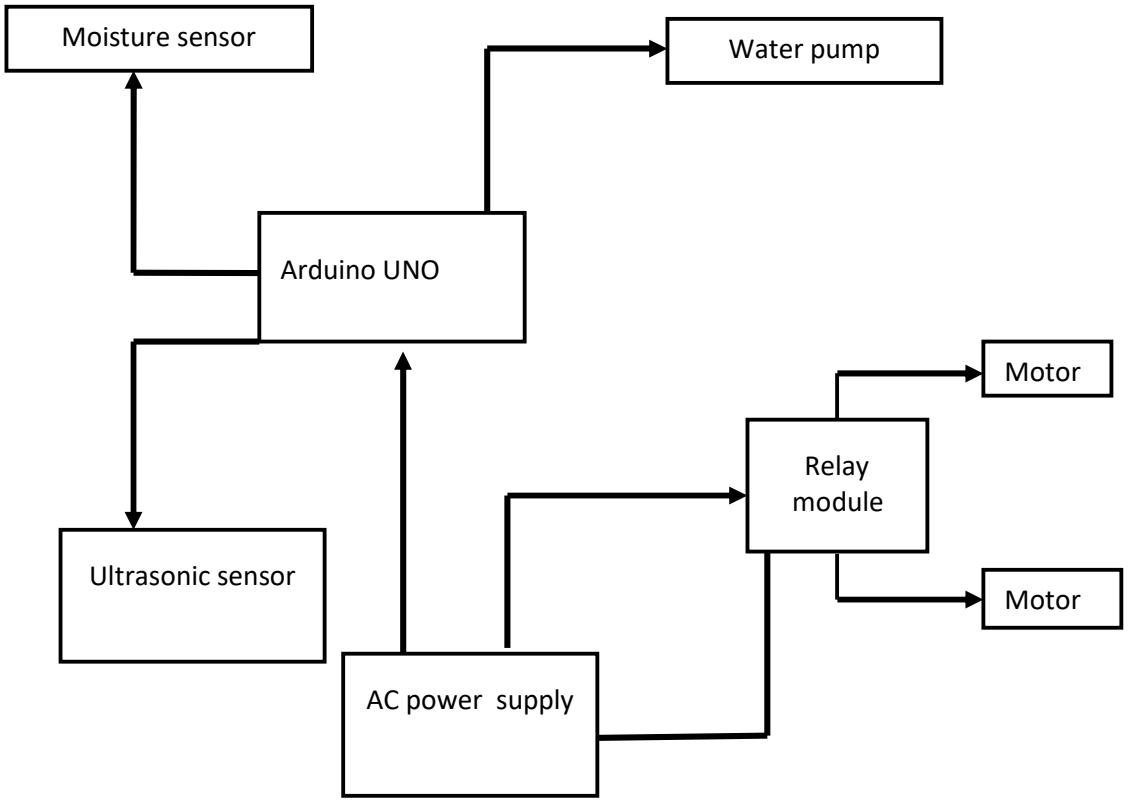

Fig 3: Electric circuit

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