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# PLC BASED AUTOMATIC DAM GATE OPENING SYSTEM

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**Abstract**

Dams are typical structure functions to drain, store and control the large amount of water for industrial as well as domestic purpose. Any disaster in the dam may lead to severe damage to both human and their belongings. In this paper, an automated process has been designed to control and maintain the water level in maximum range by opening and closing of dam gate in required time. This work mainly deals with the usage of electro –pneumatic control with the combination of programmable logic controller (PLC). In this proposed system, Allen Bradley branded PLC has implemented as the heart of system. The system processes the signals from two sensors namely pressure sensor (S1) and water level sensor (S2) to actuate and control the rotary solenoids, which is responsible for the opening and closing of the dam gate.

**Keywords:** Ladder logic, Dam Automation, PLC, and Electro-Pneumatic

## 1. INTRODUCTION

In our India, there are approximately over 500 dams have gates. Approximately these dams cover 170000 sq. km catchment area for collecting water. There is also vast range of long and complex canal network through which about 10 lakhs hectare land gets water for irrigation and drinking purpose. As we know water is gradually becoming one of the most precious natural resources. By limited water we can live and die with vast amount. If there is of any disaster over the dam area, all water gets drained and flow over the nearby residential area, which toils both life and materials. For the stated problem, this work is to develop a PLC based system which automatically controls the movement of dam gate whenever necessary by detecting the water level and pressure in dam. In India, Only one dam has partial automated dam controlling system. (Ukai dam on Tapti River at Surat). In all over India one and only canal has fully automated gates (Indira Gandhi canal or Haraikai Beraj reservoir). Automation or automatic control is the process of controlling the various operating parameters with the use of different control systems such as machinery, processes in factories, boilers and heat treating ovens. Some processes have been completely automated. Automation brings the various advantages of high accuracy and efficiency with least or no manual power.

## 2. SYSTEM DEVELOPMENT

### 2.1 Programmable Logic Controller (PLC)

PLC enrolls as heart of the proposed system, which effectively controls the entire system. PLC is a compact device equipped with input module, output module and central processing module. ABB type of PLC has maximum of 200 inputs and same number of outputs in a single rack configuration. In this work, four micro switches (or limit switch) connected with the input module and two driver circuits and alarm circuit are connected to output module of PLC. Since PLC is user friendly, anyone can

easily configure and program for a specific function very effectively. Programmer can implement either ladder logic program or relay logic program for configuring and programming. In this work, ladder logic program gets implemented.

### 2.2 Sensors

This paper mainly deals with Pressure Sensor and water level sensor. Generally sensors are the devices, which convert the available form of energy in to analogous form. The water level gets indicated to the heart of system by the hollow float accompanied with limit switches. The increased water level raises the float to energize the attached limit switch. Pressure sensor is in the form of capacitance type performs to measure the available water pressure inside the dam. The increased pressure varies the capacitance value (C) and presents the same in output voltage.

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d}$$

Both sensors drain their output to PLC for the further processing of the system.

### 2.3 Rotary solenoids

It is a type of electromagnetic actuator that converts the available electrical signals or pulses in to magnetic flus and in turn creates the mechanical rotary movement. These types of solenoids are available in the form of either clockwise direction or anticlockwise direction, sometimes bi directional. These are mainly functions to replace the available electric motor (DC or Stepper) where the small angular rotation has to achieve. The commonly available angles for rotary solenoids are 25, 35, 45 and 90 degrees. It produces the rotational movement when the coil gets energized or de-energized or change in pole of the electromagnetic field

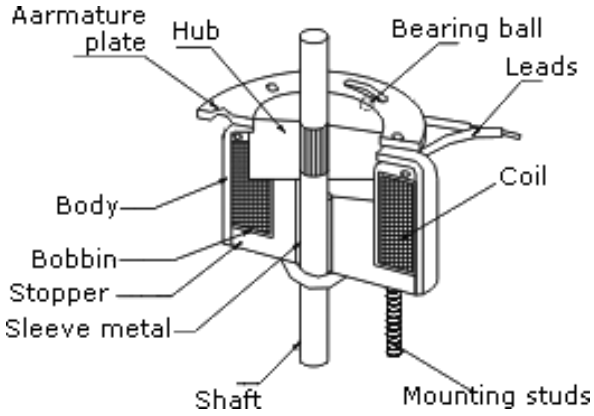



**Figure 1 Rotary solenoids**

### 2.4 Gate Control

In this work, the gate assembly has two doors D1 and D2. Both doors are controlled by two rotary solenoids. D1 gets opened, when the pressure is in controllable range but beyond expected range. D2 gets opened, when the water level reaches the maximum range (to control overflow). Both D1 and D2 gets opened when the water pressure is uncontrollable range (indicates the severe damage in dam). The closing and opening of the gate is achieved by rotary solenoids coupled with the toothed belt. Two more limit switches indicate the fully opened door to the heart of the system.

### 2.4 Alarm and power supply

There is a separate circuit for indicating the dangerous zone to the dam engineers. For this this work simply implements the buzzer to indicate. The limit switches from both sensors not only sends signal to PLC but also to the Buzzer circuit this may help to awake or grab attention towards the dam operation. Switch Mode Power Supply (SMPS) helps to rectify the available AC to required DC for the PLC and other digital devices. This SMPS functions to deliver the 12V supply to limit switches and other axillary devices.

## 3. SYSTEM DEPLOYMENT

### 3.1 Description

In this work, water level sensor and pressure sensors are provided for the operation (both closing and opening) of shutter doors in the dam even without any human interventions then and there. The available sensors perform their duty as programmed in the flood season and they provide safeguard to the dam. Hence each shutter arrangement in the dam has two separately controlled doors D1 and D2 by means of rotary solenoids. Pressure sensor S1 and water level sensor S2 provides the basic level control, which senses and indicates the available notable changes in both pressure and water level respectively. These two sensors drain their output signals to the input module of PLC, there the input signals gets processed and conditioned as for the processing element by its respective unit in PLC. PLC executes the upcoming signals periodically say 10 µs as per our dumped program in its program memory. The PLC actuates the output signals to control the rotary solenoids through their driver module. By this action only, the automation of dam shutter can be achieved. The PLC continuously monitors the signals from the limits switches L1 and L2 at the doors of the dam shutter. These signals only, indicate the completely opened or completely closed at that situation.

### 3.2 Structural Layout

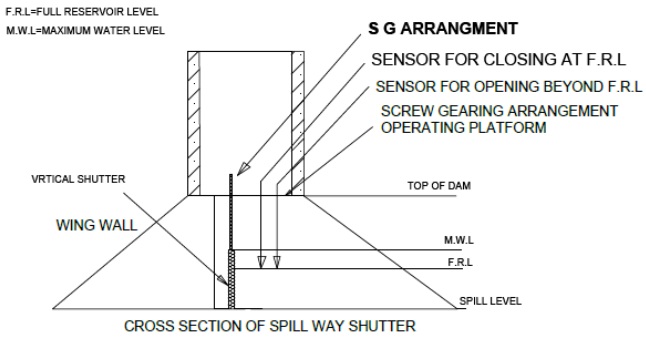



Figure 2 Cross sectional view of Dam Spillway

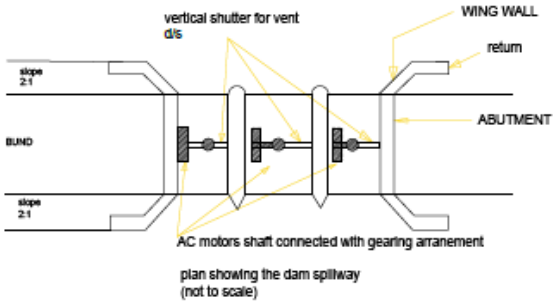
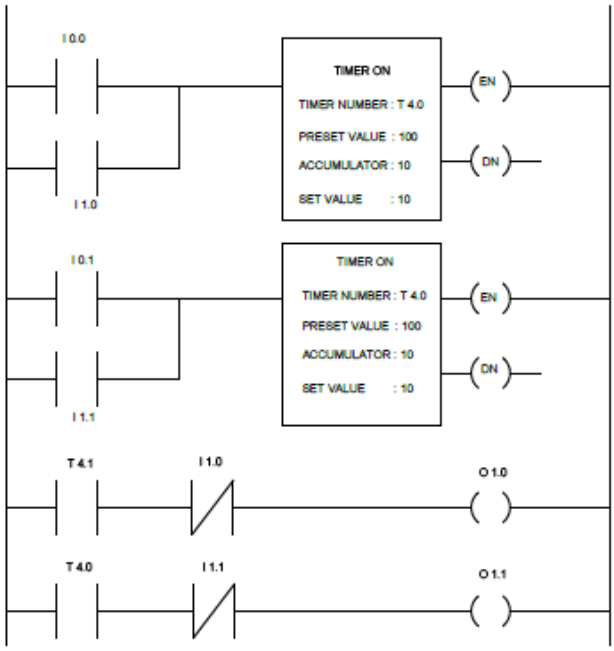



Figure 2 Plan of Dam Spillway

### 3.1 Ladder logic

Ladder programming is a well known approach to program a PLC for our required application. In this work, the PLC receives the signals from the pressure sensor (S1) as well as water level sensor (S2) through limit switches of value 12V there PLC process the input as per our programmed execution. PLC releases the signal to energize the available rotary solenoid if both sensor values cross the peak value. Since it is programmable logic controller of event based sequence, we have to schedule the available logics between the occurrence and effects. The ladder program for the work is as follows. PLC not only controls the solenoid but also continuously monitoring the status of




## 4. Conclusion

The various papers evolved to automate the dam shutter operation in the field of electronics or purely mechanical, but they have certain limitation in their application. Those limitations get eradicated by usage of combination of both electronics and mechanical. This paper represents the automatic control of dam shutters at the time of floods or any other natural calamities. We hope that our detailed work pays a way to implement the technical feasibility of automatic dam shutter. Since the used components are user friendly, we can easily installed our system to anywhere in the control area. PLC implements the event based automation with higher efficiency.

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