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Study, Analysis and Implementation of Quality Management Practices in Bituminous Road Construction

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***Abstract*: The development throughout the world is going at a very fast speed. An efficient transport system is a pre-requisite for the sustainable development of a country. Which plays a very important role in the speedy and economic growth of a country. The high growth of vehicles has further increased the demand of safe, wide and good quality of roads. Consistency in the quality has gain importance. Presently there is no proper system for monitoring the quality and quantity in the construction of the roads. Still the age old quality control measures are being adopted which do not match with the present speed of construction. To keep pace with the high speed of construction, the age old quality control methods need to be reviewed and substituted with modern methods of quality control. The overall purpose of the studies is to investigate how the concept of quality management is being adopted in the road construction process and the impact it is having. The basic objective of this work is to discover the application of supervisory control and data acquisition (SCADA) system for quality control in order to improve the quality of road construction.**

***Keywords*: Quality, Monitoring Technology, SCADA System, Implementation.**

I. INTRODUCTION

A. General Information

In India, huge investments are being made to expand the existing road infrastructure and also to develop new roads for better connectivity as well as to serve the economic activity. Road construction is dependent on several challenges right from selection of the terrain, soil condition, materials, methods, type and designs of construction to supervision and assurance of quality in construction of new Road.

The QA/QC program is a process of continuous improvement which requires input from everyone in our organization. A study of the literature and Surveys conducted in Maharashtra indicates that management commitment to quality and continuous quality improvement is very important. In order to improve the Quality of work Automation is necessary in road construction work.

B. Aim and Objectives of Study

The aim of this research work is to understand the need of implementing the automated monitoring system, creating awareness and interest about learning and implementing the rapid developing monitoring system in the construction road project. The main thrust of this research is to provide insights about quality control practices. Implementation of SCADA as a quality Management tool and their impact on the performance of bituminous road construction.

C. Methodology:

1. Interviews with various practitioners in the industry on various aspects of the Road construction work.
2. Field visits to road works to obtain better understanding of the whole operations. Supervision of road works to identify construction related Factors that affects pavement quality performance.
3. Collection of information about current quality control practices adopted at Worksite.
4. Guidance from companies supplying SCADA system to understand the technology of SCADA. Actual implementation of SCADA System in road Construction work Site.

II. QUALITY CONTROL PRACTICES USING SCADA

SCADA (supervisory control and data acquisition):- Systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. System refers to the combination of telemetry and data acquisition.

Telemetry:- Telemetry usually associated with the SCADA system, it is a technique used in transmitting and receiving the data over a medium. The information can be measurements, such as voltage, speed or flow. These data are transmitted to another location through a medium such as cable, telephone or radio.

Data Acquisition:- Data acquisition refers to the method used to access and control information or data from the equipment being controlled and monitored.

A. Fundamentals of SCADA System SCADA system is that one which collects the data from field using different devices such as sensors, computers, servers, switches, PLCs etc. It offers a lot of features such as sensing, monitoring, communication, control, maintenance reports and scheduling times.

The RTUs are monitored and controlled by MS which contains the main display units and software. The connection between MS and RTUs is done through a communication link. It may be wired or wireless links.

B. Components of SCADA System

1. Remote Terminal Unit (RTU)

2. Communication Network

3. Central Monitoring Station (CMS)

4. Field Instrumentation (FI)

5. Human Machine Interface (HMI)

1. Remote Terminal Unit (RTU) –

Field instrumentation connected to the plant or equipment being monitored It is also used to gather the data from equipment and transfer them to the central SCADA system.

2. Communication Network-

The communication network refers to the communication equipment needed to transfer data to and from different sites. The medium used either be cable, telephones. An online operation can also be implemented on the radio system.

3. Central Monitoring Station (CMS)–

The central monitoring station is the master unit of the SCADA system. It is in charge of collecting information gathered by the remote stations and of generating necessary action for any event detected.

4. Field Instrumentation (FI)-

Field instrumentation refers to the devices that are connected to the equipments or machines being controlled and monitored by the SCADA system. These are the sensors for monitoring certain parameters for controlling certain modules of the system.

5. Human Machine Interface (HMI)–

A graphical representation of a process. Usually a software application on a PC at CMS to let the operator interface with the control system.

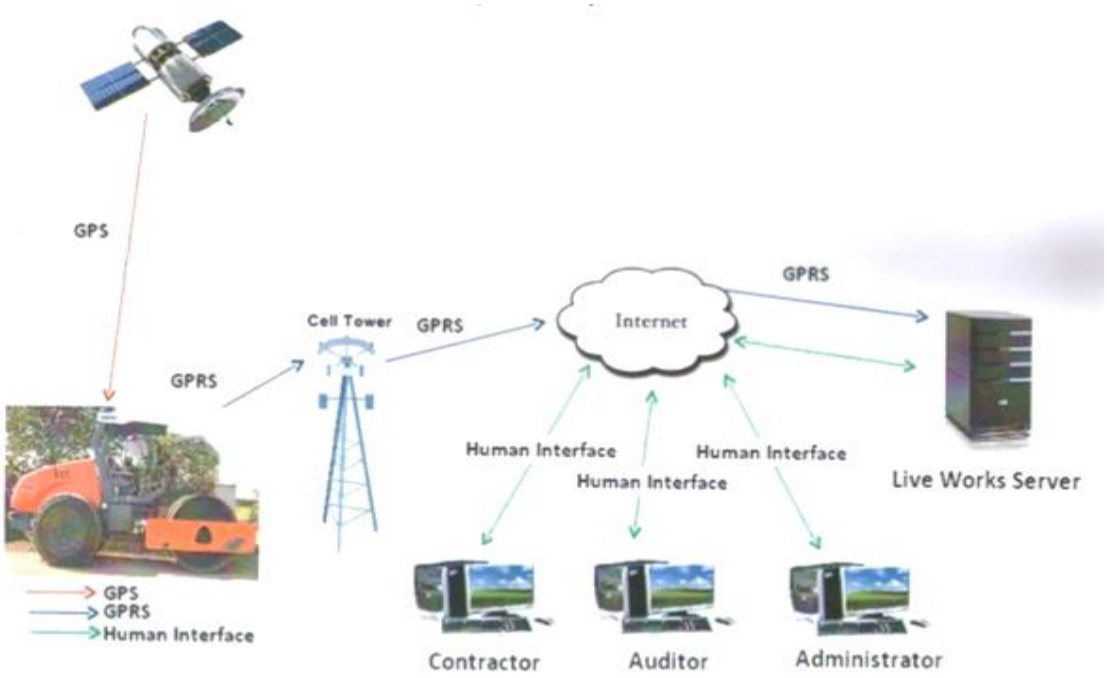

Fig.1 System Representation of Remote Data Capture and Operation

III. SCADA IN ROAD CONSTRUCTION

A. Batching Plant:

Mix- The aggregate and bitumen heated and mixed in the container coated completely. Mix temperature should be 120 - 140^0. The quality of mix is key quality parameter in bitumen roads. Temperature of materials plays important role in quality and with the help of SCADA sensors the temperature is maintained within respective limits.

The SCADA system (sensor based technique) used in Batching Plant gives the details shown in the Figure2, 3, 4.

SCADA PLANT LOADWISE REPORT

Plant Id- **Plant Name-**
Work Id - **Division Name-**
Work Name -
From Date - **To Date –**

Load No	Start time	End time	Vehicle no	Avg. before mix(Deg.)	Avg. bitumen before mix(Deg.)	Avg. mix material(Deg.)

Control Engineer **Site Quality Manager** **Confirmation of Project Manager**

Fig.2 Sample SCADA Plant Loadwise Report

DRUM MIX REPORT

Plant Id- **Plant Name-**
Work Id - **Division Name-**
Work Name -
From Date - **To Date –**

Sr. No	Date & Time	Material Type	Vehicle No	Temp Of Material Before Mix (Deg.)	Temp Of Bitumen Before Mix (Deg.)	Temp Of Mix Material (Deg.)
1						
2						
3						

Control Engineer **Quality Manager** **Confirmation of Project Manager**

Fig.3 Sample Drum Mix Report

MIX TRANSPORTATION REPORT

Plant Id- **Plant Name-**
Work Id - **Division Name-**
Work Name -
From Date - **To Date –**

Sr. No	Date & Time	Vehicle No	Distance Travelled (M)	Total Distance Travelled (M)	Speed (Km/Hr)	Latitude	Longitude

Control Engineer **Site Quality Manager** **Confirmation of Project Manager**

Fig.4 Sample Mix Transportation Report

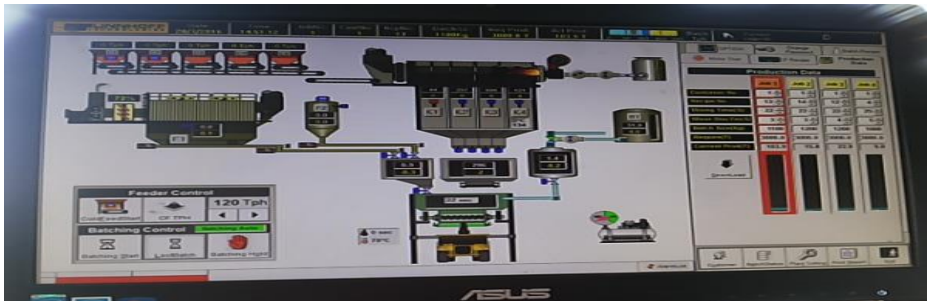

Fig.5 Display screen of SCADA control panel (Actual photograph at site)

B. Intelligent Sprayer:

For applying an asphalt prime, tack or seal coat, a specially designed "Intelligent Asphalt Distributor" is required to produce uniform application. Intelligent Asphalt distributor consists of asphalt tank, asphalt pump and spray system, heating system, power system, control system, hydraulic system.

The Intelligent Asphalt Distributor is equipped with Global Positioning System (GPS) measurement and a documentation system that continuously records the sprayer location, quantity of bitumen sprayed on surface area.

Fig.6 Intelligent Sprayer (Actual photograph at site)

C. Mechanical Paver Finisher:

The task of the paver is to lay the asphalt on the ground. The pavers have a powerful and environment friendly engine. The automatic system helps to produce smooth pavement surface without irregularities. By using slope sensors crown and super elevation slopes are controlled. The position zone sensors are also placed to track the exact location of the paver by using GPS antennas. SCADA used in paver gives the following details shown in Figure 5.

PAVER REPORT

Plant Id- **Plant Name-**
Work Id - **Division Name-**
Work Name -
From Date - **To Date –**

Sr. No	Date & Time	Temperature (Deg)	Distance Travelled (M)	Total Distances (M)	Speed (Km/Hr)	Latitude	Longitude

Control Engineer **Site Quality Manager** **Confirmation of Project Manager**

Fig.7 Sample Paver Report

D. Intelligent Compactors:

The performance of a road is highly dependent on the quality assurance and control of field compaction of each pavement structure. Intelligent compaction involves the use of compaction equipment that is equipped with a global positioning system (GPS), machine-integrated measuring sensors and control systems. The integrated GPS provides a complete geographic information system-based record of the construction site.

Fig.8 Intelligent Compactor System

It consists of sensors that measure the location and vibrations of the drum, an infrared sensor to monitor the asphalt mat temperature, and display to provide an operator the estimated pavement density in real time. These measurements show the quality of the compaction and give indications whether the compactor should move faster or slower. Important requirement is the temperature of the asphalt mix.

Table 1. Ranges of Temperatures during Compaction

Sr. no	Breakdown	Tender Zone	Finish
1	160 -121˚C	121-88˚C	82- 40 ˚C

The better the compaction is the better durability and resistance to wearing, plastic deformation as well as the effects from rain. Goal of Compacting an asphalt pavement is to achieve an optimum air void content, to provide smooth riding surface and to increase the load bearing capacity of material under construction. Compactors by using SCADA system gives following details shown in Figure 7.

COMPACTOR REPORT

Plant Id- **Plant Name-**

Work Id - **Division Name-**

Work Name -

From Date - **To Date –**

Sr. No	Date & Time	Temp (Deg)	Forward (M)	Reverse (M)	Total (M)	Speed (Km/Hr)	Latitude	Longitude

Control Engineer **Site Quality Manager** **Confirmation of Project Manager**

Fig.9 Sample Compactor Report

V. OBSERVATIONS

1. Implementation of SCADA in road construction improves the Quality of Roads from supervision and quality monitoring point of view.
2. All operations can be controlled from single CMS. Site engineer or quality Control manager has control over all the processes at centralized location.
3. SCADA removes the difficulties due to temperature variation during transportation of Hot Mix Asphalt from plant to site.
4. As it is automated system, improves the Quality of work. It is not a full control system but rather focuses on the supervisory level.
5. The automation technique involving the automatic control of all the processes which includes the monitoring and inspection.

VI. CONCLUSION

Nowadays, speed of construction is high to meet that speed age old quality control methods need to be substituted with modern methods of quality control such as SCADA.

Road construction involves various parameters to be controlled, so requires constant monitoring. The implementation of SCADA in road construction is a key to improve the quality of roads. There is wider scope for automation in road construction sector and utilization of automation is growing rapidly since last decade.

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