MARCH 2019

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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Remote Sensing & Remote Monitoring for Engineering Projects

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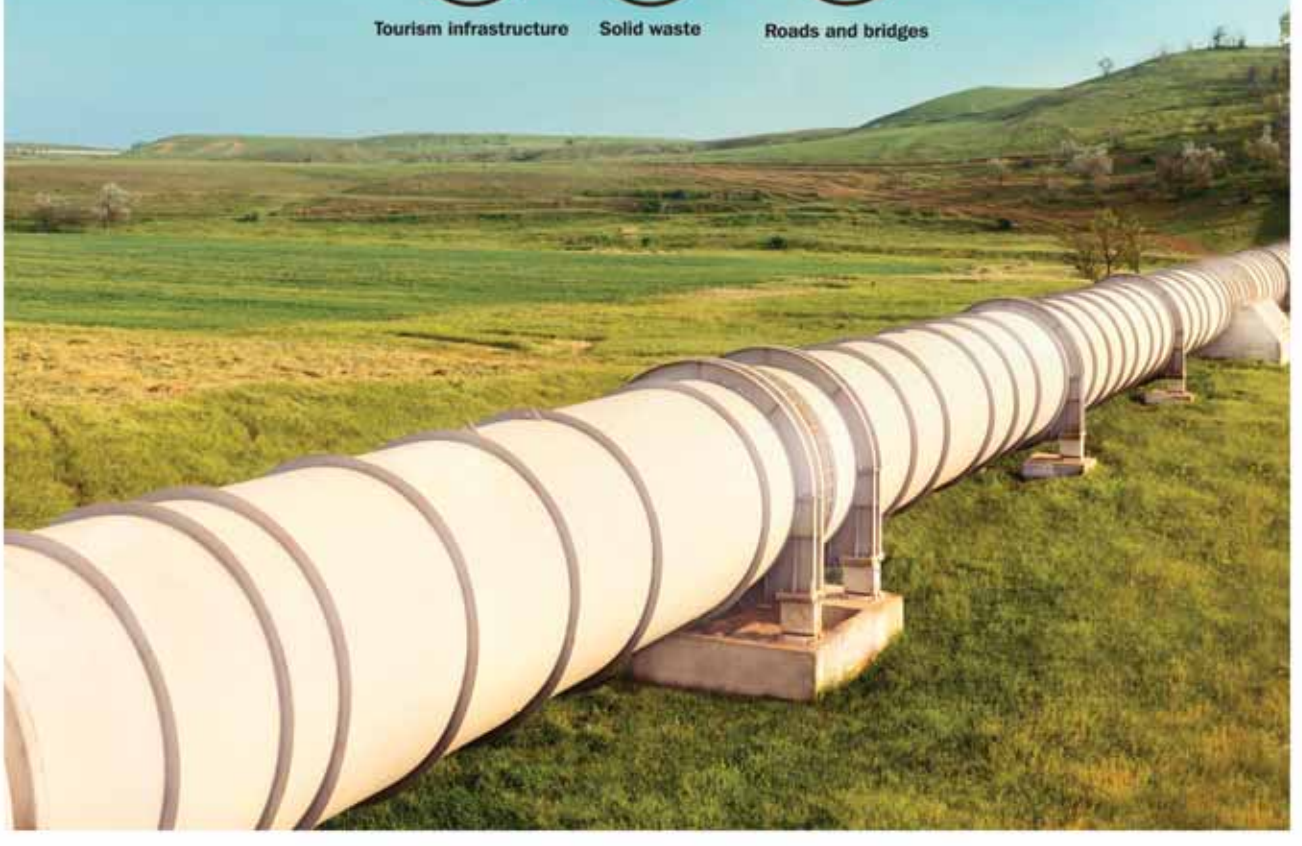

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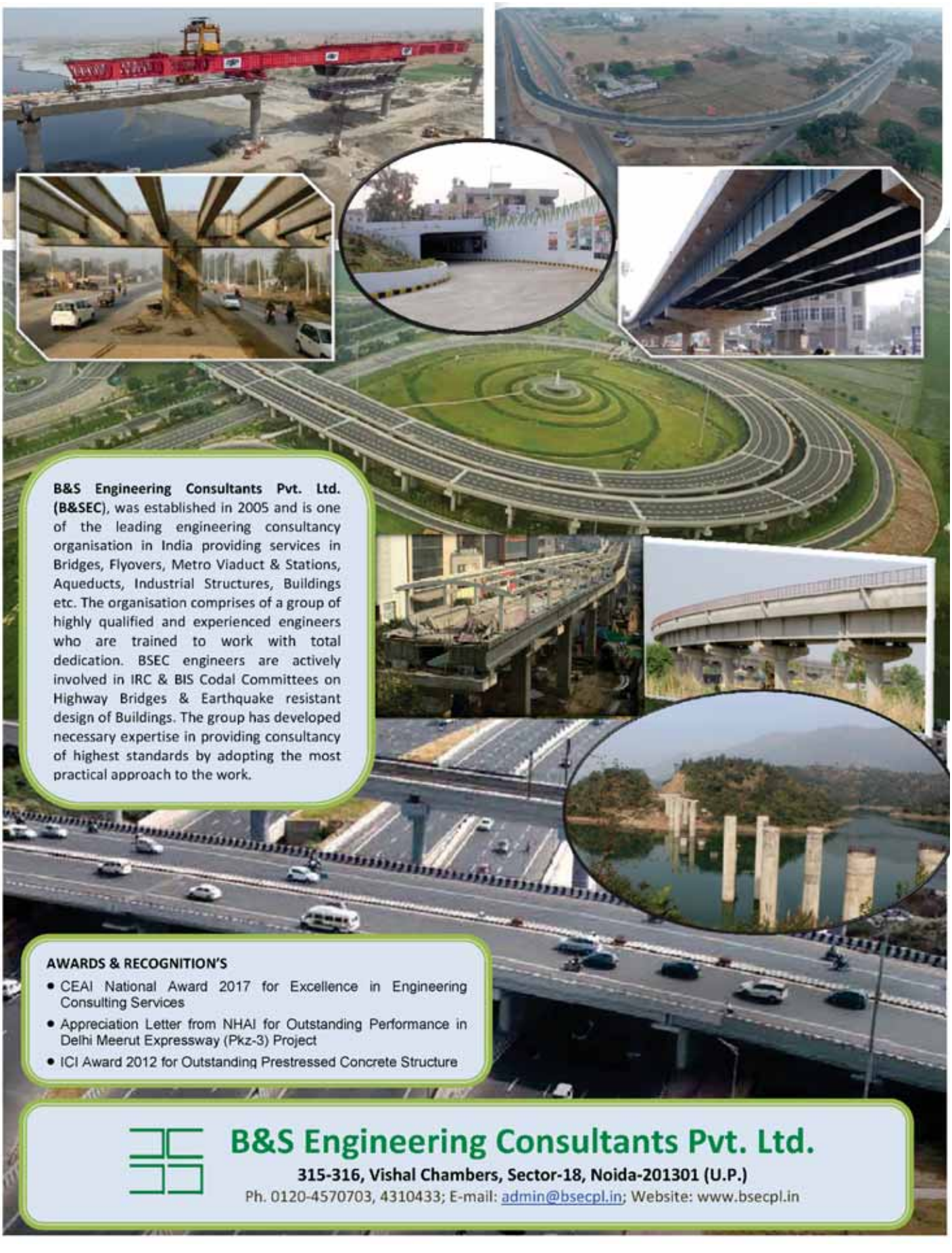

B&S Engineering Consultants Pvt. Ltd. (B&SEC), was established in 2005 and is one of the leading engineering consultancy organisation in India providing services in Bridges, Flyovers, Metro Viaduct & Stations, Aqueducts, Industrial Structures, Buildings etc. The organisation comprises of a group of highly qualified and experienced engineers who are trained to work with total dedication. BSEC engineers are actively involved in IRC & BIS Codal Committees on Highway Bridges & Earthquake resistant design of Buildings. The group has developed necessary expertise in providing consultancy of highest standards by adopting the most practical approach to the work.

AWARDS & RECOGNITION'S

- CEAI National Award 2017 for Excellence in Engineering Consulting Services
- Appreciation Letter from NHAI for Outstanding Performance in Delhi Meerut Expressway (Pkz-3) Project
- ICI Award 2012 for Outstanding Prestressed Concrete Structure

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MESSAGE FROM CHIEF EDITOR

Dear Fellow Consulting Engineers,

In the quest to be omnipresent, mankind has moved from the earth to the sky for sensing what's on earth and in the skies. What started as visual and other analogue means has over a period of time given way to digital ones. The latter have become all pervasive on account of their being micro in size and the tremendous possibilities discovered in nano materials and bio masses.

In generic terms, the smoke signals, pigeons, arrows, balloons, semaphore, telegraph, telescope, photography and aerial photography were also ways to communicate what had been visually observed at one place to another person at a remote distance. Today the terms remote sensing and remote monitoring have a much wider connotation and encompasses all walks of life with automation being introduced in all spheres. However, for the purpose of this issue is limited to engineering projects.

Earlier project progress was reported in written form, then with the advent of photography, photographs got added, later on they got supplemented by 16mm movie films, and then videos made their appearance. Space exploration and the satellites which became equipped with more powerful viewing systems (optical, thermal, infra red, etc.) started to provide not only images of the earth surface but also data of earth's resources. The satellites have been providing very valuable data which allow better planning in all sectors.

With projects becoming larger and greater in number, close monitoring has become essential and that's where remote monitoring enabled by sensing systems which can be either in situ or remote is playing a stellar role. Remote monitoring and control can be employed for all stages of a project execution at site or in a plant and later on for monitoring the health of a structure, plant, equipment or system.

Deployment of Remote Sensing and Monitoring in the structures that affect everyone day in and day out can help raise alarms about the impending distress in a structure and its consequent failure which can lead to injury and even fatalities. Such incidences project a wrong image of the engineers and the administration involved. It is therefore imperative that structures especially public structures which witness heavy usage, loading, and weathering be provided with sensors and linked to monitoring centres where audio-visual alarms based on

predetermined threshold limits can be provided to alert the persons in-charge of the structure. The same should also be applied to the high-rise buildings which are mushrooming. Had good surveillance systems been provided then perhaps the tragedies that have occurred on account of structural failures may have been avoided. Along with the remote monitoring and control, the access and exit to these should also be automated and controlled at the location as well as remotely to regulate or even stop the usage of the structure. The system can be extended in tall buildings and large areas to provide information as to where a person is at any point of time – information that would help ensure evacuation in times of emergencies – fire, post cyclone or earthquake scenario, etc.

This issue presents some Case Studies and other general papers on the theme **"Remote Monitoring And Control Of Engineering Projects".** They show how gainfully these systems can be employed to provide operationally safer and more secure structures, plants, equipment and systems. Satellites could be deployed for monitoring traffic (rail, road, air and water), and a host of other sectors.

Advancement in Technology has enabled easier and better access to data and more information being processed faster and made available for use. AI is making mundane tasks easier however one ought not to become totally dependent on technology. Human check and balance and gut feel that come from experience are the *sin qua non* for ensuring that the data and information thereof are reliable.

Reverting back to the incidences of failure with result in needless fatalities and injuries it once again raises the question of the responsibility and accountability of engineers and the administration. To resolve and regulate the practice of engineering, **Legislation for Engineers** is a dire need. AICTE had been charged with forming a Committee to draft it. Its finalization and enactment is eagerly awaited so that the profession of engineering becomes legally recognized and have a body/ bodies inter alia comprising professional engineers to regulate the practice.

Happy Reading and Learning

A P Mull

GOVERNING COUNCIL 2018-2020

The newly elected Governing Council for the term 2018-2020 held its first meeting on 14th December 2018 after the AGM, wherein Mr. Amitabha Ghoshal, Chief Advisor to the Board of Directors, STUP Consultants Pvt. Ltd. was unanimously elected as the new President of CEAI.

The Governing Council at its 2nd meeting held on 30th January 2019 unanimously elected the following members as Office Bearers of CEAI.

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IMMEDIATE PAST PRESIDENT

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TATA Consulting Engineers Ltd.

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B&S Engineering Consultants Pvt. Ltd.

Dr. Samarjit Chatterjee
S Chatterjee Associates Consultants Pvt. Ltd.

Mr. Sudhir Dhawan
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Mr. Prashant Kapila
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Consulting Engineers Group Ltd.

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Asian Development Bank

Mr. Sitaram Aggarwal
Consultant

COMMITTEES OF CEAI

The Governing Council decided to appoint the following committees, under respective chairpersons, for addressing the priority needs in order to strengthen the Association:

- **Action Plan Committee**: Dr. Ajay Pradhan
- **CEAI Image Building**: Mr. A. S. Brara
- **Ethics & Quality**: Ms. Sayona Philip
- **Finance & Institutional**: Mr. R. S. Sharma
- **Infrastructure**: Mr. K. K. Kapila
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- **Membership Committee**: Mr. Alok Bhowmick
- **Publications**: Mr. A. P. Mull
- **Strategic Plan Committee**: Mr. Mahendra Raj
- **Technical/ FIDIC Training:** Dr. Dhaval Parikh

Achieving Sustainability and Improving Water Use Efficiency through Remote Monitoring and Management: A Case Study of Narayanpur Left Bank Canal Automation Project

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Vice President,
Mechatronics Systems Pvt Ltd., Pune

Dr Ajay Pradhan
President & CEO,C2S2 Pvt. Ltd, New Delhi
Consulting Advisor to Mechatronics

***Abstract*—**Case Study of Narayanpur Dam Left Bank Canal Automation System, which comprises of several components. A State of art project where considerations of Indian economical and social conditions were taken into account to implement systems for improving yield in command area by efficiently managing and distributing water judiciously.

Keywords*—Farmer Focused Canal Automation, Irrigation Management Information System (INMIS), Geographical Information System (GIS), SCADA, Farmer Dashboard, Smart Irrigation Systems*

I. Introduction

The Government of India has launched the National Water Mission as a part of the National Action Plan for Climate Change. The main objective of the National Water Mission is "Conservation of water, minimizing wastage and ensuring its equitable and judicious distribution both across and within states through integrated water resource development and management."

The Mission will take into account the provisions of the National Water Policy and develop a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing.

As a sequel to the policy of the GOI, a Comprehensive Strategy Plan was worked out by Krishna Bhagya Jala Nigam Limited (KBJNL) to improve water use efficiency by 25% in Narayanpur Left Bank Canal System through total system improvement.

A. Naraynpur Dam and NLBC Command Area

The Narayanpur Dam is located on the Krishna River near Bachihal and Siddapur villages of Bijapur District. The reservoir caters to the irrigation needs of a very vast area of about 4.5 lakh hectares. It supplies water to the Narayanpur Left Bank Canal (NLBC), the biggest and the main artery of the canal network of about 77 Kms, designed to discharge 10,000 cusecs.

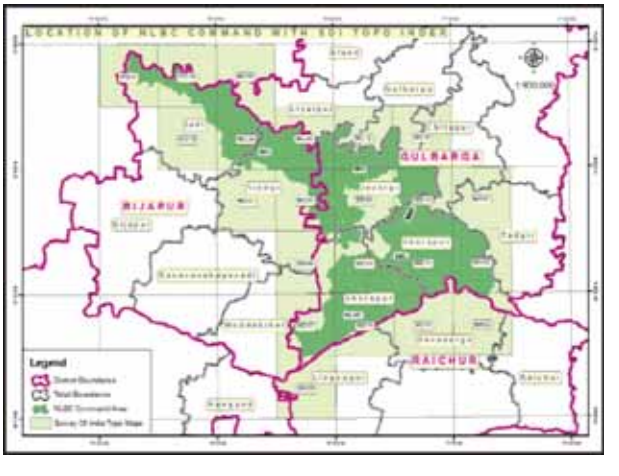

Figure 1 Command Area Map

The network includes several branch canals:

1. Hunasagi Branch Canal,
2. Indi Branch Canal,
3. Jewargi Branch Canal,
4. Mudbal Branch Canal,
5. Shahpur Branch Canal, and
6. Indi Lift Canal.

Plus there are sub systems totaling a length of 6000 kms.

B. Pre-Implementation Scenario

Before implementation of Canal automation the scenarios which existed and needed to be addressed were:

1. There were *atchkut* are as of 1,05,623 Ha. (*atchkut* is a local word implying an area which is present in the Command Area but where water is not delivered; these areas are generally at the tail end of Command Area of Canals, Distributory and other structures),
2. Water Use Efficiency (WUE) of 31.75% against Design Efficiency ofmerely 51%,
3. Violation of rotational system/ Warabandhi,
4. Absence of proper water regulatory system,
5. Inadequate manpower for canal operation,
6. Methodology as fixed flow structure,
7. Manual Control of the gates,
8. Inaccuracies, uncertainties in measurement,
9. Poor Emergency Response,
10. Wastage of water, and
11. In-equitability between upstream and tail end water users.

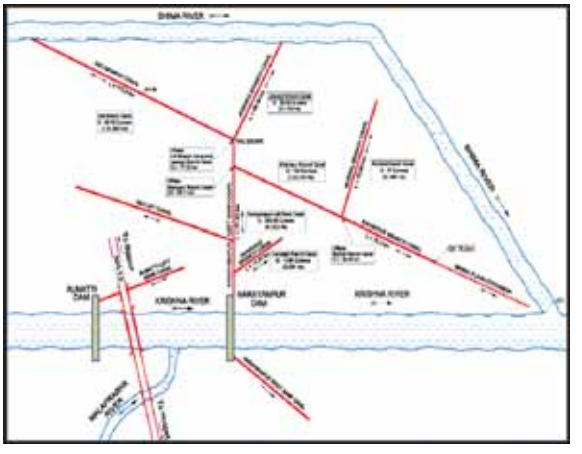

Figure 2 Canal Network Line Diagram

II. Project Objectives

- The primarily objective of the project was to increase the water use efficiency in the network, so as to not only empower the management to accurately control the flow through gate operation, but also automatically control the canal network even in the absence of operators.
- Canal Automation aims at sharing of water judiciously, equally and efficiently among the farmers/stake holders in command area and reduction of losses. By improving the efficiency of the system it increases the command area by the virtue of saving irrigation water. That in turn increases the crop productivity in the tail end regions.
- A system which would cater to water demands from the end user and manage available resources efficiently.
- A system which would map all the canal network beneficiaries to a single platform and to meet their requirement and future expansion.
- A centralized audit system was envisaged providing data on excesses, deficits and corrective measures taken in the canal network. Water accounting and auditing by establishing flow measurement devices.
- By comparison of water use in volumetric terms per hectare by the distributaries and the defined boundaries, it would ensure balanced or optimum utilization per hectare across the command area.
- The systems to be designed to react to imbalance in the canal network due to natural or human disturbances.
- Main objective of Canal Automation was, to make the canal systems more efficient, responsive, flexible, cost effective and safe.

III. The Project

A. Scope

- Providing and fixing Supervisory Control and Data Acquisition (SCADA) “Integrated Automatic Gates” at 30 distributory gates, 335 laterals and Direct Pipe Outlets (DPOs)which includes all Distributory Heads on NLBC main canal and entire Command Network of Hunasgi Branch Canal (HBC),

- SCADA software comprising of Control and Regulation,
- Irrigation Network Management Information System (INMIS), planning based on Demands and availability of water before start of the season,
- Geographical Information System (GIS), base map creation and updating every season, Crops mapping, Soil Health, Weather, Water Use, Demand, etc.,
- 210 Kiosks as part of Water Allocation Management, and as a tool for information collection and dissemination to Water User Cooperative Societies,
- Automation of existing 41 Head Regulators (HR)/ Cross Regulators(CR)/Escape gates on NLBC main Canal with Mechanical Refurbishing and electrical retrofitting,
- Establishing Wireless DATA communication network,
- Establishing Master Control Station and Training Center at Narayanpur,
- Establishing 10 Remote Monitoring Stations, and
- Operation & Maintenance for 5 years.

B. *Solution*

Solution for the project was based on the components of the canal given below.

1) Automation of existing 41Nos. Head Regulators(HR) and Cross Regulator (CR) gates

Around 41 Radial Gates were required to be automated for the canal automation. All these gates were made SCADA ready for the project. That included the Electrical & Mechanical retro fitment of all the radial gates. It was also necessary to construct CR Control Rooms near the gates to install all the Panel Instrumentation which included:

(a). Encoders for Gate Positioning,

(b). Up & Down Limit Proxy Switch,

(c). Local Control Panel for Local Mode Gate Operation,

(d). U/s & D/s Level Sensor to calculate Discharge,

(e). Gate Control Panel with Touch Screen Display, and

(f). Network Equipment for Data Transmission and Reception.

2) Solar Powered Intergrated Gate

Solar powered Integrated Gate was specially designed with stainless steel material to obviate erosion and corrosion in the field for combined flow Control and Metering application.

The Integrated Gate has inbuilt instrumentation and controls:

(a). Accurate Gate Control System,

(b). Accurate Gate Measurement,

(c). Flow measurement Device,

(d). Upstream & Downstream (U/s & D/s) Water Level Measurement,

(e). Wireless Communication System,

(f). Self Sufficient Solar Based Power Supply System, and

(g). CCTV Cameras

The Integrated Gate can be operated and monitored on field as a standalone gate or operated remotely from the Master Control Centre when connected to the SCADA network. It is a smart device and uses M2M communication to connect to any TCP IP/SCADA/Internet of Things network. The Integrated Gate controls the water discharge by gate operation based on desired set-points, or the demand. The Integrated Gates also have an Outer Vandalism proof cage and are in operation for the past 2.5 years during which there has been no theft.

As this was the first and one of its kind of project in India, various laboratory and field tests have been conducted and witnessed by many scientists of renowned institution of Government of India such as CWPRS, FCRI, WAPCOS, IISC Bangalore and KBJNL. The project has passed all the tests specified for performance in the Indian Eco-Sociological condition and the Certificate for the same has been received.

Figure 3 Typical Installation of Solar Powered Integrated Gate

3) Hybrid Wireless Data Communication Network

Considering the large area of operation the communication network was designed as a hybrid network, since the parameters and conditions of every location change on account of the geography, terrain, climatic conditions, distance, etc. and also factored future expandability.

a) Main SCADA centre

The Master VSAT transmission and receiving equipment are located at Narayanpur and are connected to all the Master Data Collection Stations by VSAT.

b) Data Concentrater Station:

The Master Data Collection Station are at the CR/HR Gate locations which poll the slave radios, through the UHF radios and concentrate the data. It will send the concentrated data to the Main SCADA Centre by VSAT.

c) Slave:

The Slave Stations are at the Integrated Gate locations which are polled by the Master Station and Data is collected at the Master Station. Some of the Stations act as Repeater, and connect the farther Station to the Master.

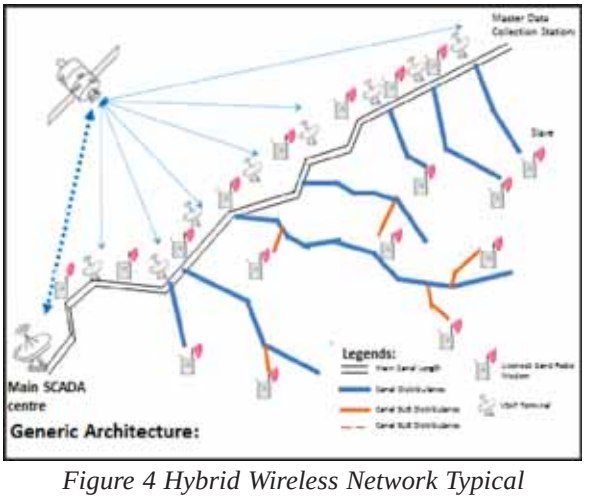

Figure 4 Hybrid Wireless Network Typical Architecture

4) Soil Collection, Testing and Preparation & Distribution of Soil Health Card

The objectives of National Mission for Sustainable Agriculture (NMSA) during the 12th Plan commission were to make agriculture more productive, sustainable and climate resilient; to conserve natural resources; to adopt comprehensive soil health management practices; and, to optimize utilization of water resources. To meet the objectives, the "Soil Health Management" (SHM) is one of the most important interventions.

2.78 lakh Soil samples were collected from the Command Area and tested in the laboratory and the Soil Health Card were made available to the farmers through Irrigation Network Management Information System (INMIS), Information Kiosk & Smart phone application which was specially developed for the project.

5) Irrigation Network Management Information System (INMIS)for Command Area

To manage the canal network in the Command Area of 5.4 lakh Hectares, whose juridical spread among 3 Zones and several other sub juridical systems it was necessary to implement a Irrigation Network Management Information System which comprised automated office process to provide information, on a single click, about all the canal details with the end beneficiaries of the system which inter alia included the following:

Figure 5 Soil Heath Card for Farmer

- User management,
- Canal Structure with all the Design Details,
- All Beneficiaries data for each section of canal,
- Water User Co-Operative Society (WUCS) implementation,
- Handling of Crop - Water Requirement collected from end user and WUCS,
- Analysis of collected water demand was sent to the SCADA software for Canal Operation
- Canal Monitored data has been incorporated for Crop - Water Billing Generation to WUCS and farmer, and, much more data.

6) Geographical Information System (GIS) for Command Area

When working with a large Command Area of 5.4 lakh Hectares it was necessary to have Geographical Information System which would facilitate providing an overall picture of the Command Area. Mapping of all the Canal Structures with respect to Revenue Maps and Cadastral Maps to the GIS provided a powerful tool to cater to the need of end user requirement. A user can search for which canal structure is available for which survey number of village, and can search for beneficiaries for the particular command area and vice a versa.

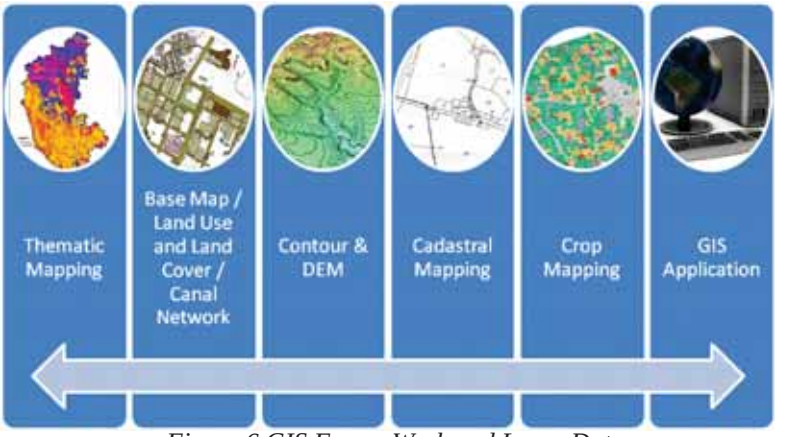

Figure 6 GIS Frame Work and Layer Data

The GIS also included preparing a base map to be useful for the day to day routine decisions. This had more than 42 information data layers such as Soil Health Layer, Land Use, Land Cover, Contours, DEM, etc., which help to take decisions. It also has exceptional capability to analyze season wise crop pattern and crop yield which enable the stakeholder to plan requirement of water use for the next season more efficiently.

7) Information Kiosk with Farmer Dashboard

The Information Kiosk with the Farmer Dashboard has become powerful tool of e-governance and one stop all information tool which farmers need for their growth. The Information Kiosk provides vital information such as:

- Farmer Details with Canal Command Jurisdiction Office Detail which is helpful for Grievances,
- Information about Irrigation Schedule so that they can plan their crop,
- Farmer can raise their water demand in the form of Crop and Area only,
- Crop - Water Billing made simple and easily accessible,
- Weather Details and Forecast in one single click,
- State wide commodity rates are accessible right from the kiosk,
- Soil Health Card viewing facility is also provided,
- All the important Central and State Governments portal links and access facility to the farmer,
- A large knowledge base and books are added to the system, and
- Last but not least the Farmer Dashboard is multilingual; it can be accessed in Kannada, Hindi and English.

Figure 7 Information Kiosk

Figure 8 Farmer Dashboard

8) SCADA System Software for Controlling and Monitoring

SCADA is meant for the monitoring and controlling of the Integrated Gates and HR/CR gates of canals through Wireless Data Communication Network.

All the water demand data is feed into the SCADA software to monitor and control all the canal regulation points and to make proper analytical reports which enable decision maker to understand the situation in Command Area.

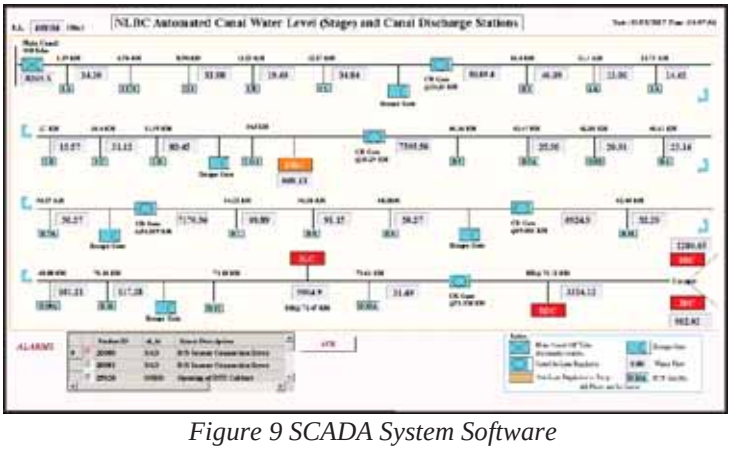

Figure 9 SCADA System Software

9) Smart Phone Application for Farmer

It's a miniature version of Information Kiosk on a smart phone which can be downloaded to Smartphone and can be used as an Information Kiosk.

10) Master Control Station

The Master Control Station is located at Narayanpur, for the Command Area related information and all controls can be done from there.

The Master Control Station is equipped with:

- SCADA Application Server,
- INMIS Application Server,
- GIS Application Server,
- Engineering Station,
- Wireless Data Communication Master Station Equipment,
- 10 Mbps Lease line for Web Connectivity, and
- UPS and Generator set for Power backup.

Figure 10 Smart Phone Application for Farmer

11) Remote Monitoring Station

The Remote Monitoring Station is meant for monitoring of the canal command area and not for any other control.

There are 10 monitoring stations established for monitoring the flow and other canal related activity at Sub-Division and Division levels.

12) Training Center

The project comprises various components and technology hence for capacity building among all the stake holders of the system i.e. from Farmers, WUCS Presidents and KBJNL office staff, it was necessary to have a Training Center which to facilitate regular training to all stake holders at Narayanpur.

The Training Center is equipped with state of art classroom where 35 persons can attend training and also can have hands on sessions for all the application software.

Figure 11 Master Control Station and Training Center

13) Operation and Maintainance for 5 Years

As per Contract condition there is 5 Years of Operation and Maintenance out of which 2.5 years have been successfully completed.

C. System Architecture

The Canal Automation System comprises various components, the System Architecture and Data flow of which is as follows:

(a). Farmer/ WUCS list their Crop and Area which they are willing to cultivate for the particular crop season. All the water demand goes to the respective office and complete Canal Command Area Water Report is generated and analyzed through INMIS and GIS.

(b). Irrigation Scheduled is prepared as per the Demand collated.

(c). Irrigation Schedule is published on the Farmer Dashboard.

(d). Analyzed and approved Irrigation Schedule is fed to Canal Control and SCADA Software.

(e). All the necessary commands and set points are generated by the software and transmitted to the HR/CR and Integrated Gates.

(f). All the feedback is taken into SCADA is also given to the INMIS and Crop - Water Use analyzed into INMIS and GIS.

(g). Water bills are generated through INMIS.

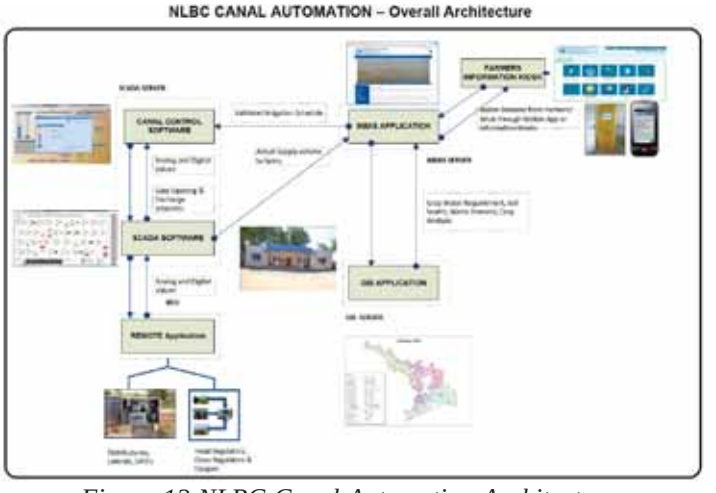

Figure 12 NLBC Canal Automation Architecture

(h). Crop Pattern and Crop Yield report is generated through Remote Sensing data for particular crop season

IV. Benefits from the Project

1. First time in the history of NLBC, water was delivered to the tail end users suffering in *atchkut* areas.
2. Increased the water use efficiency in the network.
3. Single room control for canal operation
4. Water distribution has been done judiciously, equally and efficiently among the farmers/stake holders in Command Area.
5. Reduction in water loss.
6. Increased Agriculture Produce at tail end and Command Area.
7. Increased Irrigated area.
8. Water Auditing &Accounting.
9. Online Water Demand, Water Billing & Revenue generation with reduction in cost of paperwork and process improvements.
10. Enhance collaboration and knowledge sharing within government & stake holders.
11. Optimization of water storage.
12. Instantaneous Decision making.
13. Reduction/ Elimination of man-made errors
14. Reduction in operational costs.
15. Better service to the water users.
16. Easy management of the water system.
17. Reduced maintenance requirements, and
18. Better response to emergencies.

AUTOMATION – THE WAY FORWARD FOR WATER ASSET MANAGEMENT

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Introduction

Population rise, development of new townships, industrialization and change in life style is resulting in continuous increase in water demand for Indian cities. On the other hand water scarcity is increasing due to limited availability of fresh water sources. In many cities the sources of water are located beyond 50-100 kms and thus require major capital investment to convey the water. The urban population which has expereince of life style and fcilities in developed countires have higher expectations from Indian municipalities to meet global standrads of better service. Hence judicious planning of water system is required to meet the expectations of citizens, manage the resources, operations and maintenance aspects considering delivery standards.

Asset Management refers to the practice of managing assets, be they physical or non physical, to maintain them properly so as to get better yield and performance from them. It is thus the process of monitoring and maintaining facilities or systems, with the objective of providing better services to consumers.

Water Asset Management showing Pressure Gauges

These need to be handled at planning stage itself by introducing the required measurement tools, data acquisition measures leading to predictive and regular maintenance of the structures, plant and equipment.

As the towns and cities are expanding fast, the operation and maintenance of water supply becomes a challenge for the operating agency. The water supply assets, treatment plants, tanks and pumps, operating valves are spread over larger distances, remote locations and storage, operations, distribution control become more complex. Dependency on pump and valve operators makes a supply system inefficient since the considerable time is lost in travelling from valve to valve to open or close it. All operation information does not reach the management in time.

Automation helps with the best solution for management of water assets and thus to provide better service to the community. The essential advantages are:

a) The availability of information like water level, quantity in every tank distributing water to consumers at central location,
b) The automatic control of pumps and valves based on level in a tank at local level and all the data being available at a central location,
c) If a pump has not been operated when due, alarms are generated at central location
d) Over-riding control at Central location, and
e) Consumption pattern based on data received.

It is the need of today to have a computerized Supervisory Control and Data Acquisition (SCADA) System. The automated SCADA systems helps in Centralized Monitoring and Control of the complete water supply system from water abstraction points up to the consumer end. A few cities in India are operating their water supply system with centralized monitoring and control using SCADA. An example is Jaipur, Rajasthan where automated control system had been installed under the Bisalpur Jaipur Water Supply Project.

Project Brief

The Public Health Engineering Department (PHED) Jaipur planned to enhance the water supply to Jaipur city through Japan Bank for International Cooperation (JBIC) loan assistance.

Water Supply System

The project area covered 522.10 km^2 comprising an area of 465.05 km^2 administered by Jaipur Municipal Corporation and a peripheral area of 57.05 km^2 outside the city limits around the Jaipur city.

The water supply system starts from Bisalpur Dam to the Master Balancing Reservoir (MBR) at Balawala and further distribution to various water distribution centers within the city. The transmission system from Bisalpur to Balawala was executed under ADB finance.

Being a large water supply network it was proposed to provide an automation system for better monitoring, operation and maintenance. A computerised Supervisory Control and Data Acqusition (SCADA) System was proposed to monitor the water supply system from a central Master Control Centre and generate Management Information System reports for the system.

The project under automation included the transmission system from Bisalpur to Balawala MBR and the trunk water network downstream of Balawala. The trunk network from Balawala divides into three separate mains feeding the Central, Western and Southern areas. The overall length of the transmission and the trunk water network was 258 kms.

Components of Automated System

1. Equipment and Appurtenances

For the inlet of each Clear Water Reservoir (CWR) pump discharge lines and strategic locations, electromagnetic flow meters were installed. Electronic pressure transmitters are installed on the inlet pipeline. Motorized plunger type flow control valves were provided at the inlets of CWRs for regulating the flow and butterfly valves where the inlet pressures are low.

Flow Control Arrangement

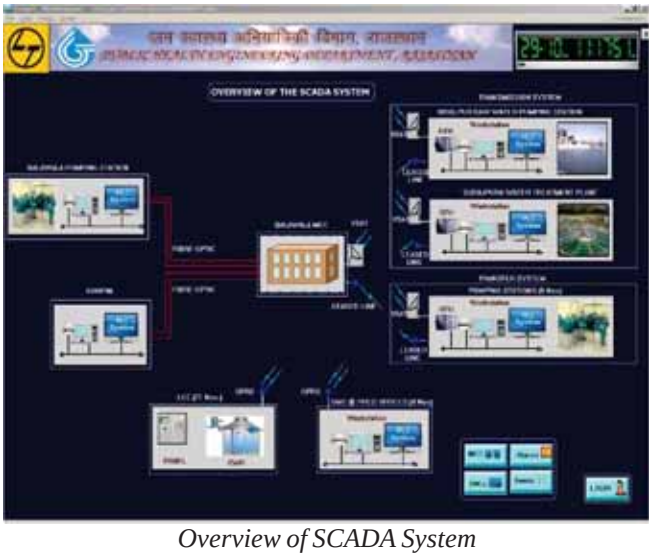
The automated system included the Master Control Centre, Subsidiary Monitoring Centres established in the control rooms of eight pumping stations and four PHED offices. In addition, 71 Local Control Centres were established at a number of reservoir sites in the city-wide distribution network.

2. Master Control Centre (MCC)

The Master Control Centre of the SCADA system provides the complete monitoring and controll on the overall

performance of the water transfer system operations. SCADA provides facilities for measurements, controls, recording, logging and alarms. The MCC of the SCADA system consists of a high end dual redundant server system, complete with 17" screen, keyboard and mouse, operating on a dual redundant high speed Ethernet bus cable system and communicating with a minimum of 4 PC based operator workstations. There is a server based large screen display system comprising two 63" TFT displays, printers for the purposes of alarm and event reporting and for the production of reports and historical trends. It is a server based telecommunications system operating with VSAT, ISDN and GPRS communications media.

MCC Building



Overview of SCADA System

3. Local Control Centre (LCC)

LCCs were located at the 71 existing distribution stations. Distribution Stations consist of 0.75 Ml to 2.0 Ml capacity storage reservoirs, local pump house to transfer water to elevated storage reservoirs. The purpose of the LCC was to automate the filling of the CWR. These reservoirs were connected with new transfer mains laid during the Bisalpur Jaipur Project, to regulate the flow rate and therefore time of filling of CWR. Two valves are installed on the pipeline viz. Isolation Valve and Flow Control Valve. To measure the flow parameters, a Flow-Meter-Transmitter was installed downstream of the valves. A Pressure-Meter-Transmitter measures the water line pressure before the water is regulated by the valves. To measure the water-level in the CWR, a Level Transmitter is installed in the CWR.

Control Room

RTU at Distribution Tank

A LCC contains a Remote Terminal Unit (RTU) whose function is to monitor the level, the suction and discharge pressures and the nactuated valve position. The RTU also monitors loss of power and calculates and stores the flow totals and average system pressures. The RTU communicates with the Master Control Centre via the GPRS.

A Touchscreen HMI (Human Machine Interface) is available on the Control Panel which is used to monitor the system variables like flow, pressure, level, status of MCBs in the Power Distribution Box. Alarms generated by the RTU are visible in the HMI which an Operator can acknowledge and take action. Historical Alarms are also displayed on the HMI. Alarm Annunciatorshows alarm statuses and an Operator can acknowledge or reset alarms. Operator can see the Flow Rates, Total Flows, Pressure, Level of CWR, percentage opening of flow control valve on the digital meters on the panel.

An Emergency Stop has been provided push button on the panel which can close the valves from the Panel Push-Buttons, RTU and HMI.A Two-way Switch is provided on the Panel for the Operator to switch from Auto to Manual mode of operation and vice versa. In Manual mode, the operator can operate the motorized valves using the push-buttons provided on the panel. The Operator can also operate the valves from HMI. The Operator must login to the HMI appropriately to be able to operate the valves.

4. Subsidiary Monitoring Centre (SMC)

SMCs are provided at 12 locations - the various pumping stations and water treatment works forming the water transmission and transfer system to provide system data on a view only basis to enable the local operators to know what is happening on the relevant portion of the water transfer system in their area. There are 8 Subsidiary Monitoring Centres at pumping stations on the transmission and transfer systems and 4 Subsidiary Monitoring Centres at the PHEDoffices within Jaipur.

The purpose of the SMC is to fetch the data/variables related to Level, Flow, Pressure, winding temperatures of motors and pumps, running status of pumps, emergency stop condition, etc. The Control Panel is installed with RTU containing redundant Central Processing Unit (CPUs) and Power supply module. It communicates with the Local Pumping Station PLC using serial communication. The Data is then transmitted to the MCC using VSAT and Leased Line. The Operator can also visualize and Monitor data in the SCADA application provided on the SMC workstation.

5. System Software

The system software facilitates centralized monitoring of Bisalpur water supply system operations by viewing real time operational data at all the water works in graphical form. The display includes status of pumps, open/ close, status of motorised valves, readings of flowmeters, pressure and level instruments and status of electrical circuit breakers, etc. The other functions include generating and recording of alarms along with time of stamping, data logging, generating trends and maintain records of all the data, printing of alarms and events, report generation and remote operations.

Conclusions

The investment requirement for creating assets for water supply is very large hence operating and maintaining them during their life cycle is the key for better service delivery. Automation of the operations helps in capturing the data leading to better monitoring, control and maintenance of service and delivery standards.

Similar remote monitoring and control systems have been implemented in major Indian cities like Bengaluru, Mumbai, Delhi and Internationally smart cities like Singapore, Barcelona, Yokohama and Cannes.

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REMOTE SENSIN G AND REMOTE MONITORING OF LIMESTONE MINE

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Introduction

Imagine the mine of the future, with sustainable environment and the least environmental foot prints, where all processes are continuous, all moving equipment are autonomous, and mine operations are controlled remotely by skilled manpower from distant locations. This would be achieved by application of "Remote Sensing", "Satellite Imagery" coupled with GPS (Global Positioning System) and GIS (Geographical Information System) techniques of multi-user relational database (such as Oracle, Microsoft SQL Server, or IBM DB2) in exploration and mining operation.

This paper illustrates the application and advantage of remote sensing and remote quarry monitoring for limestone mine. The study could affect significant achievement in identifying the limestone deposit by remote sensing in East Africa and remote quarry monitoring in South Africa.

Remote Sensing

Itis the science of obtaining physical characteristics of an area or object from a distance, typically from aircraft or satellites. The remote sensing has the advantage to examine the geological portrayal of a large area of the Earth or synoptic coverage in single scenes (or in mosaics) on a regional basis. This technique has the ability to analyze multi spectral bands, quantitatively in terms of numbers (DNs) permitting them for computer aided processing.

Remote Sensing techniques have the capability of merging different types of remote sensing products (e.g. reflectance images with radar or with thermal imagery) or combining these with topographic elevation data and with other kinds of information bases (e.g., thematic maps; geophysical measurements and chemical sampling surveys) enabling new solutions in determining interrelations among various natural properties of earth phenomena.

Identification of Limestone Deposit by Remote Sensing

Remote Sensing technique has been used in identifying carbonate rocks in remote area in an East African country. Based on the spectral bands, depicted by satellite imagery, generated by remote sensing techniques, a regional geological map, differentiating different rock units could be established. Apart from rock type differentiation, the study provided the expression and modes of origin of landforms within the area.

Remote Sensing Platforms

Three types of platforms are being used for remote sensing study viz. satellite, aircraft and ground systems. For the present study, satellites imagery was used. The satellites provide a "bird's eye" view and uses data that humans are incapable of measuring. The different types of imageries being used based on resolution requirement are:

- For coarse resolution more than 30 m spatial resolution LANDSAT and MODIS,
- For medium resolution between 5-30 m resolution IRS LISS-1V and LISS-III, ASTER, LANDSAT, and SPOT, and
- For high and very high resolution less than 5 m up to 30 cm resolution IRS Cartosat, Quickbird, World view, and Geo Eye are being used.

Methodology

The Sun is a source of energy or radiation, which provides a very convenient source of energy for remote sensing. The sun's energy is either reflected, as it is for visible wavelengths, or absorbed and then re-emitted, as it is for thermal infrared wavelengths.

For limestone, Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) is most commonly used, based on the absorptions of carbonate minerals in the spectral bands.

- ASTER spectral band 8 discriminates the carbonate rocks from others rocks due to the presence of predominantly occurring carbonate minerals.
- ASTER band 5 distinguishes the limestone and marl (more hydroxyl clay minerals) from metamorphic/ hydro-thermally altered rocks.

Findings

The study on the intensity of the total absorptions against the reflections of these rocks shows that Limestone and Marl have low intensity in absorptions and high reflection values due to the presence of carbonate minerals (calcite and dolomite) occurring in different proportions.

The study of ASTER Thermal Infrared (TIR) spectral bands distinguished that the marls have low emissivity of energy due to the presence of hydroxyl bearing alumina-silicate minerals from the other rocks such as limestone, which have high emissivity due to the absence of hydroxyl bearing alumina-silicate minerals and the presence of carbonate minerals and carbonates.

ASTER, visible near infrared (VNIR) and shortwave infrared (SWIR) spectral bands show Marl having high reflectivity and low emissivity of energy in ASTER TIR spectral bands due to the presence of hydroxyl bearing alumina-silicate minerals.

The ratio images of Landsat 8 (having 11 bands) display that the spectral contrast of specific absorption features is extensively in geologic remote sensing (Rowan, 2003). Relative absorption depth (RBD) images have an especially useful three-point ratio formulation for displaying Al-O-H, Mg-OH and $CaCO_3$ absorption intensities.

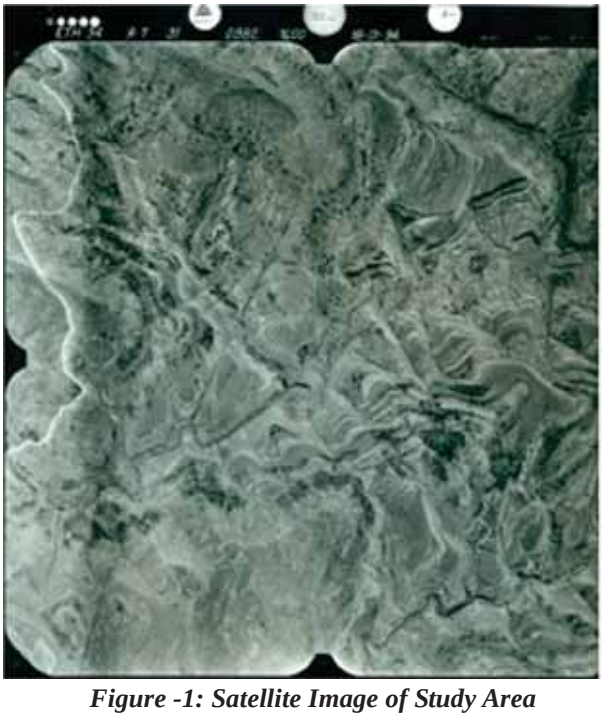

Figure -1: Satellite Image of Study Area

- The band ratio [(7 + 9) / 8] image highlights the CaCO3 and Mg-O-H absorption feature.
- The band ratio [(6 + 8) / 7)] image exhibits dolomite distribution distinguishing it from limestone. The satellite imagery of the study area is shown in Figure-.

Outcome

Based on the interpretation of satellite imagery and its analysis, a detailed geological exploration of the selected area was carried out. The geological investigation comprising of detail topographical survey of the delineated area, diamond core drilling, sampling and sample analysis was carried out. The geological investigation established substantial limestone resource/ reserves in the area for establishment of a 5000 tpd capacity cement plant. Now, the Techno-Economic Feasibility study for the project is in progress.

Figure_2: Photoplate showing part of Study Area

Remote Quarry Monitoring

With the limited availability of raw material resources, increasing mining constraints, stringent quality requirement, tighter planning schedule and stiff competition in price of end product, exploitation of raw material is becoming more cost competitive. Innovation in mining methods and technology that are in line with international mining standards and "best practices" have become vital.

Remote quarry monitoring was carried out for a limestone mine of a cement plant located in North Africa. The objective of the study was to:

- Remotely monitor mining operations on weekly basis,
- Guide and suggest optimum extraction technique on a weekly basis, and
- Provide flexibility in mining operations.

Remote Quarry Monitoring is a combination of various IT enabled tools coupled with state-of-the art mining software to optimally manage the deposit on as low as weekly basis, from a distant location (Figure-3), satisfying the long term objectives of **"Maximization of life at Minimal cost of Production"**. This provides the following advantages:

- Control and Monitoring of a mine from a remotely located platform using emerging IT tools,
- Global objectives are reflected in a short term model,
- Synergy between planning and operation with enhanced coordination and knowledge base,
- Streamlined and effective coordination by reduction of redundant management,
- Flexible and instantaneous planning from remote location with minimum efforts,
- Sharing of knowledge base at organizational level,
- Takes into account instantaneous corrective measures by timely expert intervention,
- Regular and continuous updation of deposit inventory,
- Monitoring of mining equipment uptime, and
- Savings by providing optimal layout and avoidance of expert visits.

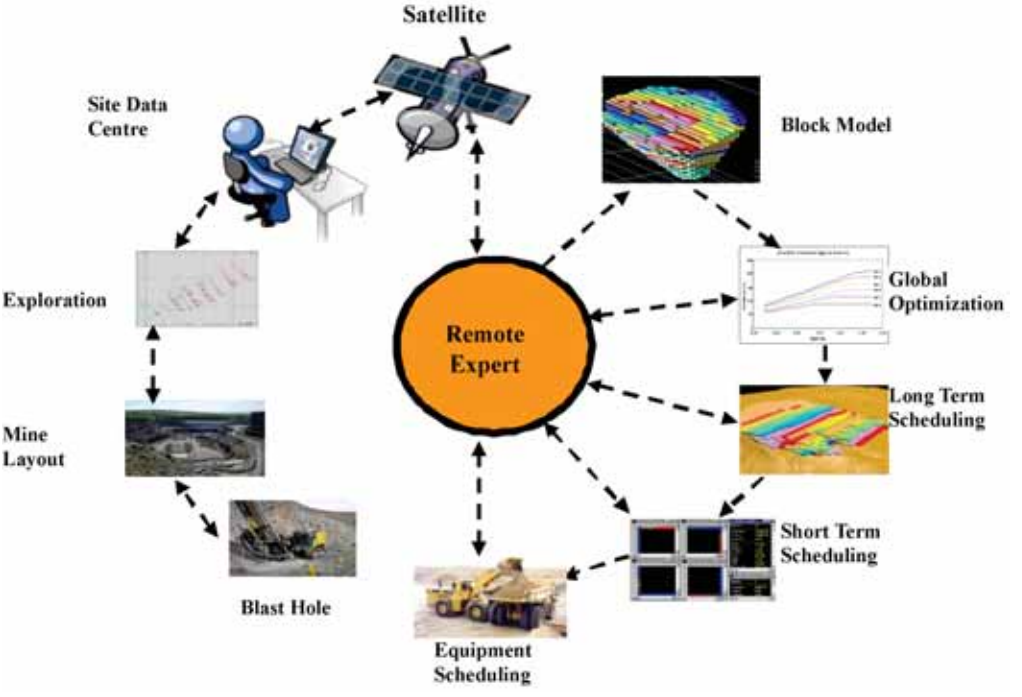

Figure-3: Flow Diagram of Remote Quarry Monitoring

Benefits

Remote Monitoring benefits a Quarry in terms of productivity, saving in cost and knowledge base at various levels in multiple ways. The potential benefits are as follows:

Level	Short Term	Long Term
Mining Engineer	▪ Quick and alternate solution ▪ Enhanced Deposit Life ▪ Timely and Detailed analysis ▪ Avoid human biasness	▪ Efficient operation management ▪ Flexibility in operation
Manager	▪ Evaluation of Multiple Scenario ▪ Elimination of dedicated manpower	▪ Optimal use of deposit ▪ Streamlined quarry layout ▪ Continuous updation of inventory ▪ Better control over deposit
Company	▪ Saving in operating cost ▪ Continuous updation of inventory	▪ Enhanced equipment life/ uptime ▪ Enhanced Deposit Life

Inputs for Remote Quarry Monitoring

To carry out remote monitoring, the following information is gathered and updated in the system:

- Exploration data (Topographic Plan, Geological Plan, Drilling Data)
- Exploitation Data (Updated Quarry Plan, Feed Back for Blast quantity, quality and location)

- Quality Control Data (viz. Blast Hole Sample results with location, Corrective data)
- Equipment Data (Equipment wise Run Hrs/ Break Down Hrs, Availability, Utilization, MTBF/MTTR, Fuel Consumption, Spares consumption, etc.)
- Plant Data (Target LSF, SR, AR, Quality parameters and Target quantity)

Methodology

The various components which contribute to remote quarry monitoring are:

- Deposit inventory by construction of Deposit Block Model,
- Quarry Scheduling and Optimisation, considering various sort of parameters viz. Mining constraints, Raw Mix design, Equipment capability, etc.,
- Preparation of Blast Hole Model for short term scheduling,
- Weekly planning considering pile parameter and alternate schedule, and
- Feedback and continuous updation of Block Model in every 5 years, based on feedback/ additional exploration.

The steps involved in Remote Quarry Monitoring are presented in a flow chart (Figure-4).

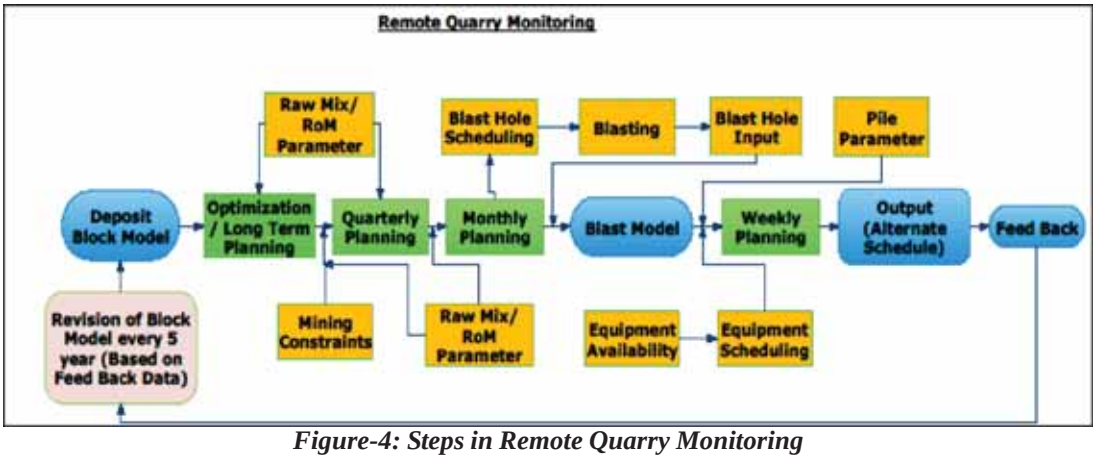

Figure-4: Steps in Remote Quarry Monitoring

The steps are broadly elaborated in the following para:

Deposit Block Model

Deposit Block Model is the digital form displaying inventory of the deposit in smaller mining units. A deposit block of smaller form of the deposit, which can be reliably estimated (both in terms of Quantity and Quality), based on the available exploration data. The block model created by SURPAC/ DATAMINE (as shown in Figure-5) provides exhaustive information about the deposit besides providing the basis for mine scheduling and offering flexibility in mining with multiple blending options.

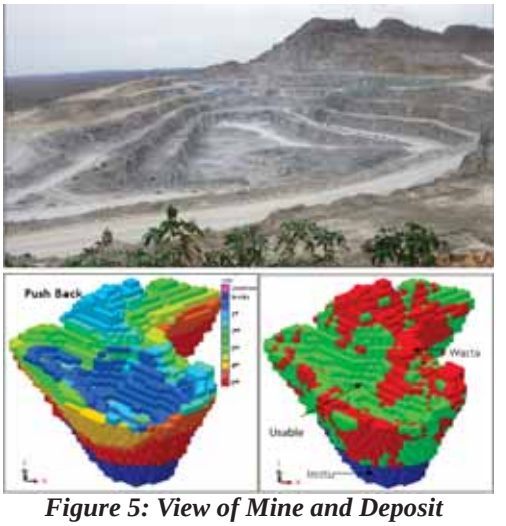

Figure 5: View of Mine and Deposit Block Model

Deposit Inventory

Grade-tonnage relation generated from block model using powerful software viz. GEOSTAT and MINRES reliably describes the deposit

inventory at various cut-off grades. While the Grade Tonnage curve displays the availability of material at various cut-off grades and helps the Mine planner to understand the soundness of the deposit.

Global Optimization/ Sensitivity Analysis

While Grade tonnage relation gives an idea of the deposit inventory, QSO (Quarry Scheduling Optimization) portrays the potentiality of the deposit, where multiple grade and mining constraints put together determines the maximum possible reserves with minimum rejection. Global optimization provides benefits of maximization of deposit life by optimization of low to marginal grade material and saving in cost by minimal rejection.

Mine Planning

Remote Quarry Monitoring uses the latest optimization technique with artificial intelligence and is beneficial to the entrepreneur by providing global objectives transferred into 5 yearly planning. It minimizes the cost of production and provides the industry the knowledge with change in plant and mining parameters.

Remote Quarry Monitoring with the help of multiple skill base and combination of software is very effective and helpful for a Mining engineer even up to weekly production level using blast hole model and is advantageous in the following ways:

- Multiple weekly/ monthly schedules with its pros and cons,
- Steady and homogeneous supply of mined product,
- Geo-coding of schedule to make it user friendly and for easy identification in the field,
- Cost optimization by reduction in corrective consumption by planning at raw mix/ pile level,
- Equipment scheduling to match the production requirement in most cost-effective ways,
- Saving by lead balancing, and
- Planning for micro mining constraints

Tools

Highly Secured web base data sharing of Remote Quarry Monitoring data from various mines/ deposits are stored on weekly basis for its analysis and reporting by expert bodies. Following tools are used at various phases of Remote Quarry Monitoring (Figure-6).

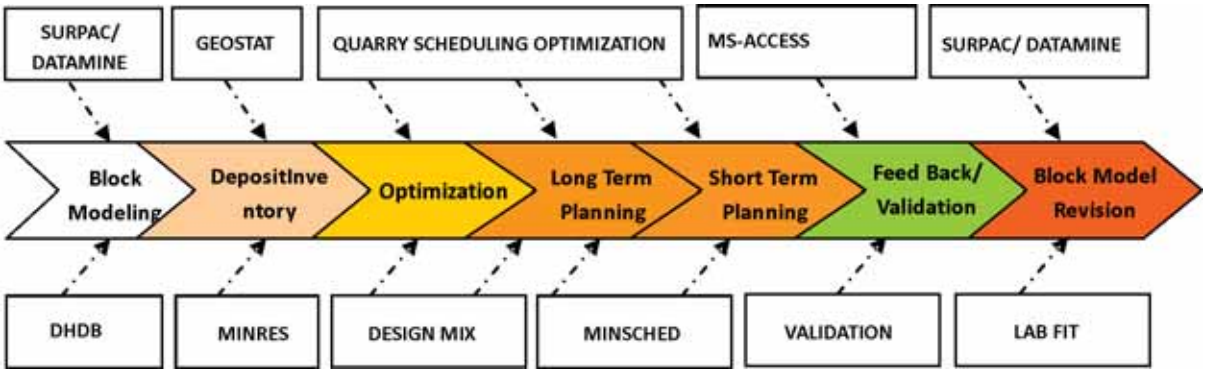

Figure-6: Tools used for Remote Quarry Monitoring

The mine under reference belongs to a Cement Company located in Zimbabwe. The rock types encountered in the area are marl, limestone, gypsum and sandstone.

Detailed geological investigation of the area comprising of topographical survey, geological mapping, diamond core drilling, sampling and sample analysis were carried out. Subsequently the deposit was evaluated by application of SURPAC software and a deposit Block Model was constructed. The deposit block model has established the availability of marginal grade quality marl and high grade limestone within the quarry area.

Blast Hole Scheduling

Weekly and monthly blast hole planning/ sequencing, Drilling Inventory, Lead Balancing and planning for micro mining constraints.

- Short Term blast modeling based on blast hole data and Geo coding of model for interactive use,
- Scheduling with alternate production plan on weekly basis meeting of Pile requirement,
- Analysis of equipment health, availability and capabilities for production,
- Equipment placement scheduling with weekly production and development need,
- Outputs in the form of production plan and geo-coded plans for implementation at site, and
- The working plan is developed as a KMZ file to view in Google Earth for real time feeling.

Measurable Benefits availed

- Enhancement in Mine Life by 16 years by gain in reserves of 48 million ton
- Optimising overburden ratio,
- Saving in terms of cost by about 0.70 USD per ton of limestone. Recurring saving over additional 16 years of Mine life,
- Benefits in terms of material handling/ dumping,
- Reduction in excessive manpower,
- Saving in drilling cost, fuel consumption in mining equipment, etc., and
- Optimized and streamlined quarry layouts while maintaining global objectives.

Conclusions

The requirements for the cement industry are the reduction in depletion of known limestone resources and to identify new potential limestone areas. Further depleting of good quality limestone resources will be inducing the cement industry to look for more flexible, cost effective and smarter business model.

The Remote Sensing technique is useful in identifying the occurrences of new limestone bearing areas by discrimination in VNIR-SWIR ASTER spectral bands 4, 5 and 8. The Relative Absorption Depth (RBD) band ratio image ((7 + 9)/ 8) and ((6 + 8)/7) is also used in identifying the potential limestone resources. The interpretations of limestone and associated rocks over the processed image are verified through field and laboratory studies and prove that the applied methods are successful.

Mining is a dynamic scenario and any change in the market would affect this industry first unless it is timely managed. “Remote Quarry Monitoring” gives a complete solution for mining, optimization, scheduling, quality control and monitoring

from remote location with expert intervention and fits most into the future business model of mine management. The application of Remote Quarry Monitoring for a cement plant in Ethiopia have shown that low grade marl occurring at the top of limestone and forming the overburden could be managed in most optimal and cost effective way.

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Holtec Consulting Private Limited (HOLTEC) has carried out a number of assignments on limestone deposit identification, geological investigations, deposit evaluations, mine designs and mine operations in India and Overseas, specifically in Middle East, Africa and South East Asia. Remote Sensing technique using Satellite Imagery was used for identification of limestone deposits in Ethiopia and Nigeria. The analysis of satellite imagery leads to identification of potential limestone deposits for establishment of large capacity cement plants. Remote Quarry Monitoring service is being provided to limestone mines located in Zimbabwe and Vietnam. Encouraged by the results of the previous work, the customer in Zimbabwe has assigned further work for continuation on Remote Quarry Monitoring, which is currently in progress.

Artificial intelligence drives project cost savings

NOVEMBER 1, 2018

PROJECT DELIVERY

Fluor uses IBM Watson to deliver predictive analytics capability for megaprojects.

In September, Fluor Corporation and IBM announced the use of artificial intelligence-based systems to predict, monitor, and measure the status of engineering, procurement, fabrication, and construction (EPC) megaprojects from inception to completion. Fluor’s extensive engineering, fabrication, construction, and deep supply chain expertise, coupled with artificial intelligence and analytic technologies from IBM Watson, forms the foundation for big data analytics and diagnostic systems that help predict critical project outcomes and provide early insights into the health of projects.

REMOTE STRUCTURAL HEALTH MONITORING OF BRIDGES IN INDIA –CASE STUDIES

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1 INTRODUCTION

To obtain and record information about a structure's condition or performance, some form of monitoring regime is necessary. Traditionally an inspection and maintenance team of the bridge owner, visits the structure at a predefined interval and to assess its condition by visual inspection and some manual measurements. In recent years automated remote health monitoring has become the choice of bridge engineers worldwide due to its consistency, accuracy, efficiency, continuity, providing real time data, and several other benefits. In an automated remote Structural Health Monitoring (SHM) continuous, 724x7x365, surveillance is possible even without visiting the structure physically. The concept has also caught up with bridge owners in India and quite a few projects have already deployed such a system and some more are on the anvil. This article illustrates the benefits of the use of automated remote SHM systems, with reference to a number of current bridge monitoring projects in India.

2 THE CAPABILITIES AND FEATURES OF MODERN SHM SYSTEMS

Automated SHM systems can provide continuous records of almost any variable in a bridge's condition, such as the position or length of any part, or the forces arising within the structure. Modern systems can also be configured to analyse the data gathered, and present the results in any desired format. The functioning and features of a typical high-end monitoring solution are described below.

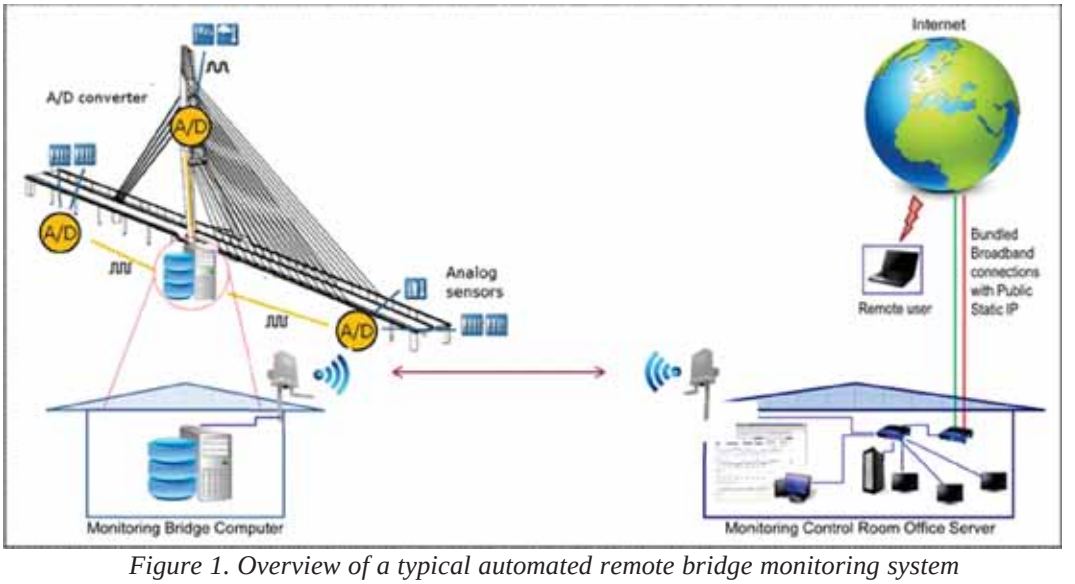

Figure 1. Overview of a typical automated remote bridge monitoring system

The automated remote health monitoring system is typically provided with a local power source and a means of transmitting data to the system's central server, where it is automatically processed and made easily accessible from anywhere in the world via the internet (Figure 1).

A view of the SHM system's Dashboard - the user interface which provides authorised users with remote access to system data, requiring only an internet connection and a password is shown in Figure 2.

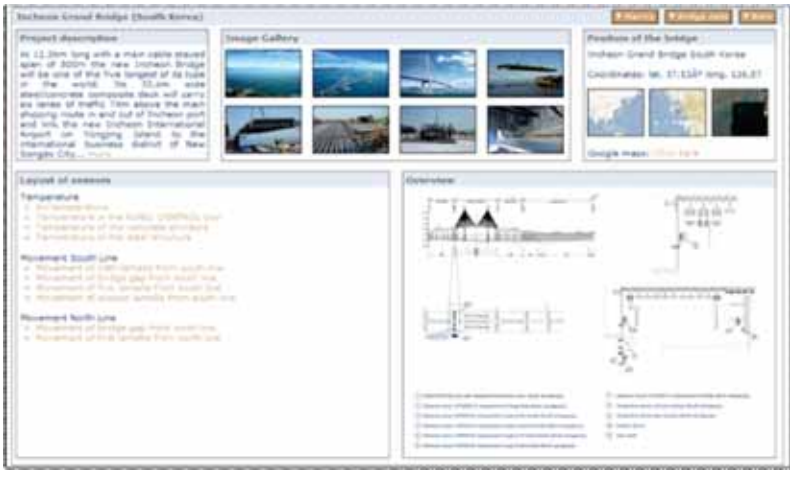

Figure 2. Monitoring system - user interface on the internet for remote access.

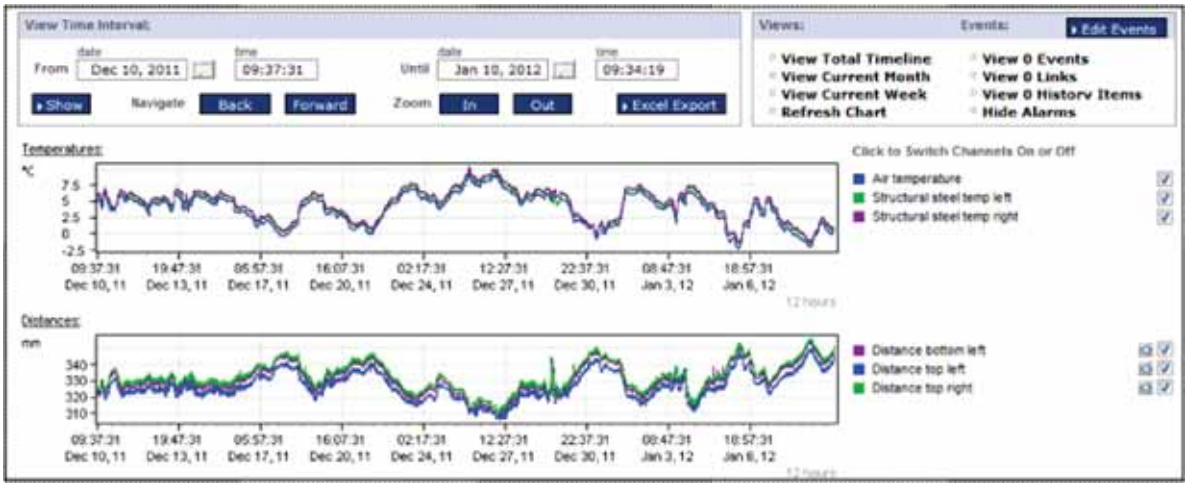

Figure 3. Presentation of measured data (graph form).

The data can be viewed in graphic form, enabling clear trends and correlations to be established as shown in Figure 3, or exported in tabular form for further analysis.

Automatic alarm notification by SMS or email can be provided when a predefined value of any of the parameter being measured. This is of particular interest to bridge owners to reinforce the confidence in their structure's regarding the continuing serviceability or safety of the structure.

Such measurement and data processing power, and user-friendly features, have much to offer for the inspection and maintenance of bridges, as illustrated by examples below.

3 CONTRIBUTION OF AUTOMATED REMOTE SHM TO PLANNING OF BRIDGE INSPECTION AND MAINTENANCE WORKS

Routine inspection and maintenance of bridge structure and its mechanical components such as bearings and expansion joints, is critical to ensure long-term safety and performance and in minimising life-cycle costs. Reliance on purely manual methods can have a number of drawbacks, including time and effort required, costs incurred, and the sporadic nature of the information provided due to the length of time that elapses between inspections. As a result, inspection work often does not get the attention it deserves, and the delay in recognising the need to address any deterioration can have a serious impact on the bridge and its users, leading to higher repair costs, greater disruption to traffic and increased risks to bridge users. The immediate alarm provided by automated monitoring systems can enable the responsible authorities to quickly take appropriate action following deterioration of the structure for any reason – for example, from unexpected events such as earthquakes, extreme weather, or ground settlement or slippage (Figure 4).

Figure 4. The ongoing condition of the Pont Nanin structure in the Swiss Alps has been monitored by an SHM system (with force monitoring at bearings as shown) since its static design was changed a decade ago (fixing at end).

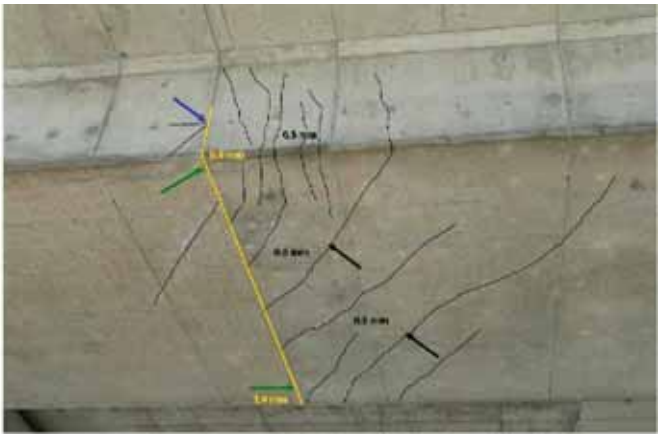

Figure 5. The significance of cracking in the deck of the Weyermannshaus Viaduct in Berne was investigated using an SHM system - saving extensive strengthening works.

4 CASE STUDIES OF AUTOMATED REMOTE SHM IN INDIAN BRIDGES

4.1 Case Study 1: Monitoring of the Signature Bridge in Wazirabad, Delhi

The cable stayed bridge across the Yamuna River in Wazirabad, Delhi (Figure 6) has a total length of 675 metres, with a main span of 251 metres. It has a steel-concrete composite deck, with a total width of 35 metres, and carries four lanes of traffic in each direction. Its dramatic inclined steel pylons are 154 metres high, enabling an elegant stay cable design, which makes it an attractive and imposing addition to the Delhi skyline. In addition to this pleasing aesthetic impact, the shape of the pylon enables it to provide, to a substantial extent, the stress balance required to support the deck. It's been named the *Signature Bridge* and was inaugurated in November 2018.

Figure 6: Wazirabad's Signature Bridge in Delhi

The bridge is being equipped with a sophisticated structural health monitoring system to monitor the structure's behaviour, performance, and condition, with three main focuses:

- structural health monitoring and damage detection;
- monitoring of weather loading (e.g. temperature, storms); and
- earthquake monitoring.

It will consist of the following:

- 104 sensors, using 171 data channels, to measure environmental, load and structural response factors (see Table 1);
- a signal acquisition solution, including signal capture from the sensors, signal verification and temperature adjustment, conversion of signal to digital format using 24 bit architecture, 1/1000 sec. signal time synchronisation, signal transport to pre-processing data acquisition unit, signal pre-processing and buffering prior to transferring to data processing;
- data processing to generate reports, prompt control actions and provide alarms (audio – visual) as required;
- data storage; and
- a user-friendly interface to enable necessary operational intervention, maintenance optimisation and support high level analysis such as finite element.

Sensor type	Sensors	Channels
Structural Temperature	20	24
Strain Gauges	20	20
3-D Wind Sensors	1	4
All-in-one Weather Sensors	1	6
3-D Accelerometers (Cables)	18	54
3-D Accelerometers (Other)	8	24
Seismic accelerometers	4	12
Displacement	4	4
Inclination, Tilt	4	8
Corrosion	3	6
DV Camera	4	
Traffic Analyser	8	
Electromagnetic (Cable Force)	9	9
Total	104	171

Table 1: Summary of sensors for Signature Bridge

The automated monitoring system will provide enormous amount of information which will enable the conditions, to which the bridge is subjected, and the structure's condition and performance, to be precisely evaluated with a minimum of effort. It is thus a good example of the type of comprehensive service which can be provided by modern SHM systems, if properly conceived, detailed, and implemented.

4.2 **Case Study 2: Monitoring of Mumbai Metro WEH Bridge**

The Mumbai Metro construction project began in 2008 and had been executed in order to meet the city's rapid population growth. The main objective of the Mumbai Metro is to provide mass rapid transit services to people within an approach distance of between 1 and 2 kilometres, and to serve the areas not connected by the existing Suburban Rail network. At the WEH junction, the Metro line passes over the highway on a cable-stayed bridge which has another concrete road bridge below to ease the road traffic at the junction, thus making it a complex intersection. (Figure 7).

Figure 7. Views of monitored cable stayed bridge of Mumbai Metro over the Western Express Highway.

The cable stayed bridge being located over the highway bridge and road is very critical for smooth flow of road and Metro traffic. Any damage would cause serious repercussions. Hence, the bridge had to be equipped with a system that would immediately react to any alarming impact and raise an alarm. The remote structural health monitoring system through the intelligent placement of various sensors installed at pertinent locations throughout the body of the structure monitor the structure's condition, behaviour and performance. They have been in operation since 2017.

The system monitors the pylon's inclination, the cable's vibration and tension, the deck's deflection as well as the concrete's deformation allowing any critical deviation to be detected and accordingly presented to the engineers in charge. The environmental data is also collected to establish correlation with the observed parameters. There are 27 different sensors (Table2) which capture data round the clock and provide a comprehensive assessment of the structure's response to the traffic and environmental loading.

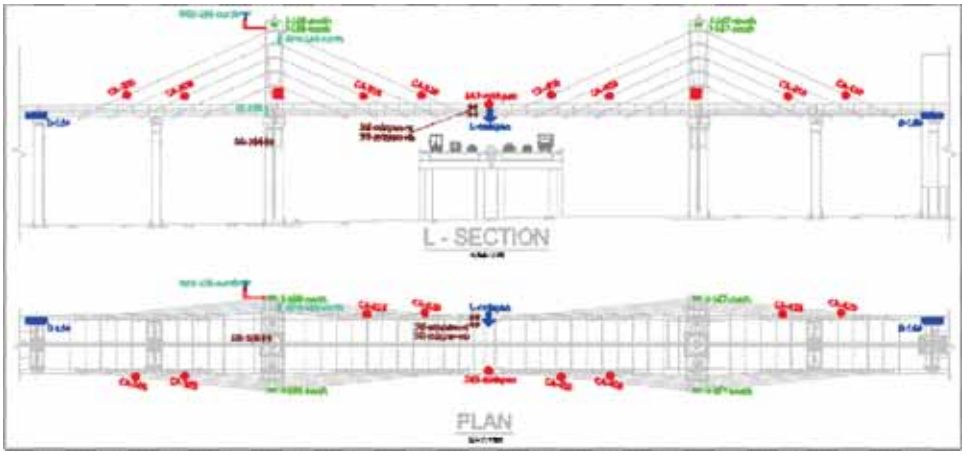

Figure 8. Location of sensors at various pertinent locations of the structure

The data that is measured and recorded are:

- Acceleration of Suspension Cables
- Wind and Meteorological Surveillance
- Vertical Deflection Measurement of Midspan
- Inclination of Pylons
- Linear Displacement at Expansion Gaps at both ends
- Strain Measurement of Deck and Pier
- Vibration of Deck

Sensor	Logo	Number of Sensors	Number of Channels
Accelerometer:			
Cable accelerometer	CA	8	8
Tri-axial structural accelerometer	SA3	1	3
Wind Sensor:			
Wind direction and intensity	WDI	2	2
Displacement Sensor:			
Wire or contactless sensor	D	2	2
Deflection Laser Sensor:			
Laser	L	1	1
Structural Temperature:			
Structure Temperature	ST	1	1
Air Temperature and Humidity:			
Air Temperature & Humidity	ATH	2	2
2D Inclinometer:			
Tiltmeter	I	4	8
Unit Deformation:			
Strain Gauges	SG	6	6
Total		27	33

Table 2: Summary of Sensors for Metro Bridge on WEH

Figure 9. Master Station at the Metro bridge (left) and Cable Accelerator (highlighted) on the suspension cables (right).

All measurements are accurately gathered in a double database and are immediately visible in the project's SHM web interface. Figure 10 shows one of the online system "cockpits" that the end-user can access day or night. The measurements on two bridges are shown: West and East structures.

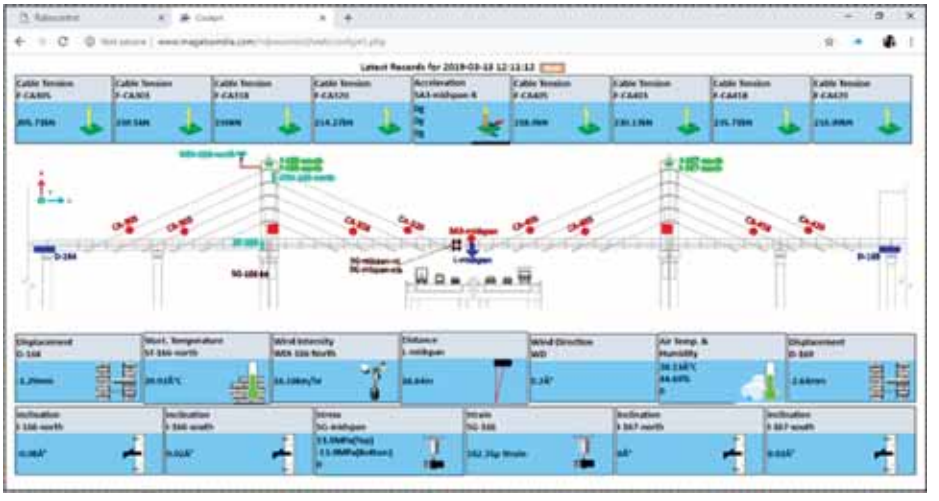

Figure 10. Web interface "cockpit" of the Mumbai Metro WEH SHM system.

The concerned engineers can check the records at any time, they can also view the entire time history of the measurements graphically (Figure 11). Any abnormal value of the measured parameters would be immediately recognisable, enabling safety precautions to be implemented. To ensure that the information is immediately recognised by the engineers, even when not in the office, the system also includes an alarm feature which will provide immediate notification of such an occurrence by email.

Figure 11. Historical Data can be viewed for any period of choice (highlighted)

4.3 . Case Study 3: Monitoring of Bardhaman ROB

Bardhaman is situated at 107 km from Howrah on the Howrah Delhi route. There is an old multi span ROB of brick masonry construction with plate girders over the Bardhaman railway yard, connecting the G.T. Road side of Bardhaman town with the Kalna-Katwa Road. Due to its old age a new ROB of cable stayed type was sanctioned over this extremely busy electric railway yard. The bridge owned by Eastern Railway was constructed by Rail Vikas Nigam Limited.

Figure 12. Cable stayed bridge constructed over Bardhaman Railway yard.

Figure 13. Sensors being placed on the cable strand before stressing

To ensure the safety of the structure, monitoring of the cables in the middle pylon had been specified. 6 longest cables are equipped with EM force sensors to measure the force on the cable directly (Figure 13).

All the sensors are connected to the Master Station which is placed inside the central pylon and connected to the internet (Figure 14). Alarm notification is enabled in the system. On the crossing of any threshold value of a force, email notification is sent to the respective authority for their necessary action.

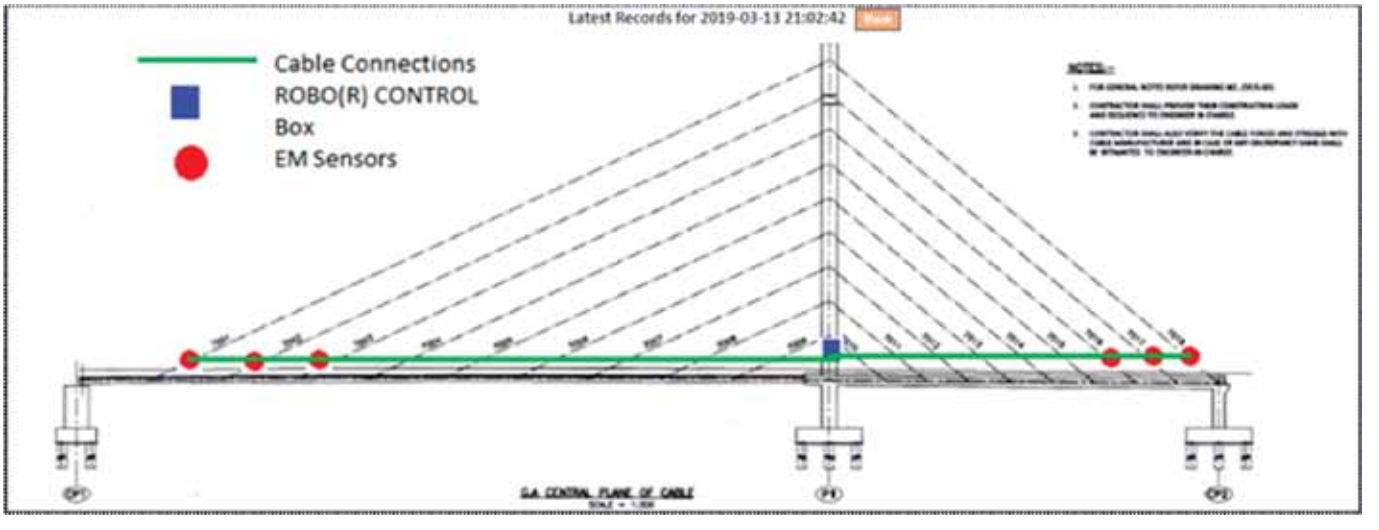

Figure 14. Web interface "cockpit" of the Bardhaman ROB

The system is running uninterruptedly for last 3 years.

5 CONCLUSIONS

Automated Structural Health Monitoring systems offer many benefits over traditional manual observation and measurement methods: they are typically much more efficient, having far lower "running costs"; they are capable of an extraordinary level of detail and accuracy, e.g. in measuring high-frequency vibrations that would scarcely be registered by human touch; and they can be set up to operate 24 hours a day, 7 days a week, for as long as required, and can thus be relied on to immediately record and report unexpected/ serious events, no matter when they might occur. Due to these benefits, such systems can be used to serve many purposes in relation to bridges and other structures, and effectiveness and efficiency dictate that the use of automated monitoring systems to support inspection and maintenance activities should be considered for all important bridges.

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Satellites Show How Major Reservoirs Are Drying Up Around the World Brian Kahn

Climate change could make drought a way of life in certain parts of the world. Though the prospect of "Day Zero" in Cape Town is being staved off, it's far from the only city to suffer through a water crisis right now.

In a new report, the World Resources Institute (WRI) highlighted four other regions dealing with shrinking reservoirs, including time lapse satellite imagery that starkly shows the water woes. The report shows how varying combinations of weather, infrastructure, management and changing land use have decimated water resources in Morocco, Spain, India, and Iraq. How policymakers deal with the changes will offer a preview of the choices other cities will be forced to make in the future.

Source: https://earther.gizmodo.com/satellites-show-how-major-reservoirs-are-drying-up-arou-1825188190

REMOTE MONITORING OF MULTIPLE BROWN FIELD CONSTRUCTION SITES IN A STEEL PLANT

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ABSTRACT

Effective management of a construction site inter alia requires continuous monitoring of the complex set of activities involved. Such monitoring is only possible through real time and correct data collection and it's processing which lead to timely action. With the increasing stress on qualified supervisory resources to execute construction jobs the reliance on technology has become the need of the hour. State of the art technologies are being used for remote monitoring of construction sites which facilitates a smaller management team to maintain control on progress, quality and safety effectively from a single location. This article describes the implementation of remote monitoring carried out for a brown field project site where new plant facilities were being put up in the vicinity of existing operating plants. The successful implementation of remote monitoring resulted in safe and incident free execution within the project schedule.

1. INTRODUCTION

A typical construction project site comprises of a heterogeneous mix of resources comprising materials, machinery and humans performing multiple inter-related activities. The diverse activities comprising excavation, demolition, construction, erection, testing and commissioning may occur at the same place or at different places at the same time. The entire gamut of activities have both spatial and temporal variation and meticulous planning of activities at various levels along with the resource planning, quality assurance plan and safety plan are prepared to successfully execute the project. While the actual physical work goes on at site, a large amount of data collection, handling and processing is done at back end offices to coordinate the activities well so as to achieve the desired results in terms of safety, quality, schedule and cost.

In order to monitor project execution for all these aspects, the practice has been, and on many projects still is, to engage a team of supervisors and foremen who are physically present at site supervising the works and collecting data manually to measure and monitor progress, quality, safety, keep watch on pilferage of materials and generally ensure that workers were performing the designated tasks correctly, the construction equipment are functioning and doing their allocated task, etc. This system has two major drawbacks. On one hand it requires a large number of supervisory staff of different specializations to be physically present at site with associated high costs and more scope for human error. On the other hand where budget constraints restrict the deployment of required numbers of trained supervisory staff, the execution of works suffer; the most common victims are safety and quality since time and cost take priority in project monitoring. Further, with most companies trying to work across various geographic locations, this old practice in the fast track modern projects is now almost failing to produce acceptable results.

Many new technologies are now available for remote monitoring of many aspects of site construction. These technologies help the Project Managers, Project Owners and other stake holders to review data from various areas of the same site or even from various sites in a command control centre. They can receive data feed on real time updates, review

and analyze the data, monitor the situation and suggest action based on the requirement of the situation. Physical on-site monitoring promotes the sense of involvement of the management in the condition and progress of the work and the wellbeing of the workers. The use of the right technology can greatly enhance this feeling with much lower direct manpower effort from the managers.

Fig.1: A PTZ camera at construction site

2. DESCRIPTION OF THE PROJECT AND CONSTRUCTION SITE

The project taken up for execution was for a steel plant. The plant owner has an integrated steel manufacturing facility with coke ovens that employ wet system for quenching of hot coke from ovens. The wet quenching systems, for two Coke Oven Batteries (COB), werebeing changed to dry quenching system to meet environmental norms and also use the waste heat for power generation. The new Coke Dry Quenching (CDQ) plants were being installed inside the existing coke oven plant and in close vicinity to many existing and operating units. Due to space and time constraint, the construction activities become very critical in terms of achieving progress with limited accessibility to the work areas, extra care required to allow unhindered operation of existing plant and complete safety of not only the project execution team but also the operation and maintenance staff in the adjoining operating plants.

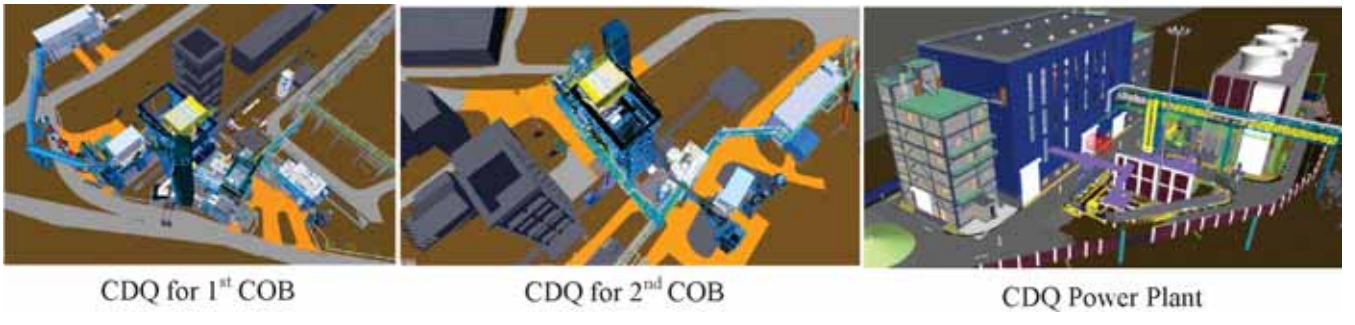

Fig.2: Coke Dry Quenching Facilities Layout

3. DESCRIPTION OF PROPOSED REMOTE MONITORING SYSTEM

The monitoring system proposed for the construction site was a CCTV surveillance system. Nine cameras were installed at various locations across the sites at the two CDQ plants and the CDQ Power Plant. There were nine fixed cameras and three Pan-Tilt-Zoom (PTZ) cameras all housed inside enclosures with IP67 rating to make them suitable for use in the dusty and humid conditions at site. The cameras were connected to a multi-channel TV unit located at the project site office through IP based wireless system. Point to point (PTP) wireless access point/ bridge capable of handling seamless video streaming from IP based cameras was used. The monitoring set used was a 32" screen. The equipment comprised a Network Video Recorder (NVR) processor unit, and STP cables for connections. Eight numbers of wireless radio communication sets were also installed with eight port switch for multichannel communication with the engineers on field. The locations of the fixed cameras across the site are shown in Figure-3.

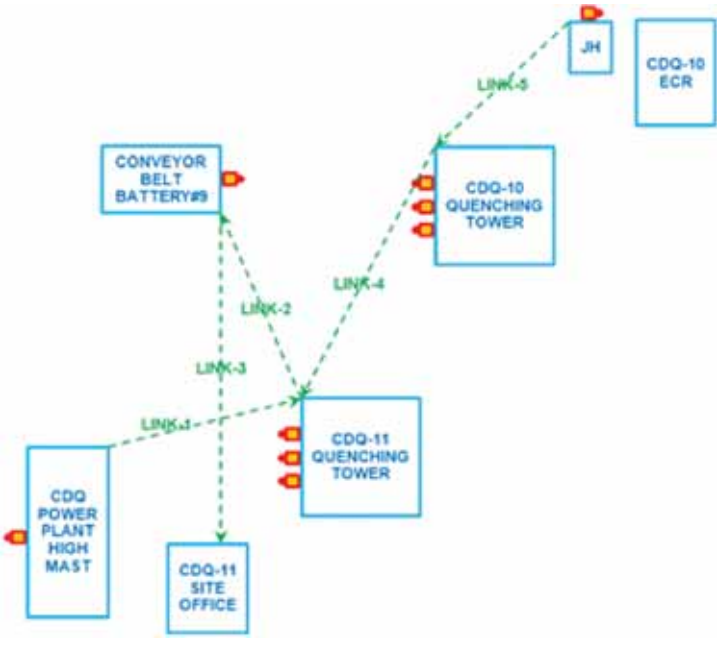

Fig.3: CCTV Camera Location at site

4. MONITORING ACTIVITIES CARRIED OUT FROM COMMAND CENTRE

The project execution area was spatially demarcated into three distinct zones as can be seen from the site layout in Fig.-2.The Command Centre was established in the 2nd CDQ area which is almost midway between the two other sites –1st CDQ and Power Plant. The site activities comprised work for demolition of old structures and their foundations, installing excavation protection system for deep excavations adjacent to existing structures and their foundations, earthwork for deep excavation, foundation construction, building construction, structure erection, mechanical and electrical equipment erection, piping and cabling works and various miscellaneous jobs. The monitoring work carried out from the command centre involved:

a) Review of vehicle movement and logistics – cranes, dumpers, excavators, and concrete millers,

b) Monitoring of cranes and other lifting equipment during structure and equipment erection,

c) Note incidences of safety violation and take corrective and preventive action, including imposition of penalties, if necessary,

d) Note incidences of attempted pilferage, misuse of materials and take corrective and penal action,

e) Review implementation of safety practices; whether being properly adopted as per site HSE policy,

f) Review work quality and detect lapses; also note good practices, appreciate and highlight such cases in mass meetings,

g) Detect hazards due to multiple activities by various agencies happening at same time and place across the three sites, and

h) Review progress of work and plan for the next activities based on real time feedback.

5. BENEFITS ACCRUED FROM THE REMOTE MONITORING

For a complex project of this nature distributed over various discrete areas of an operating plant, reliance on only human supervision would have affected all aspects of the project vis-à-vis schedule, safety and quality. The remote monitoring system facilitated achieving the following for the site works:

a) Major demolition of existing building in Power Plant site done safely.

b) Enable to ensure that the Safety Tool Box was checked on daily basis without fail.

c) Timely job commencement daily, in morning.

d) Monitor major machine/ equipment deployment which helped in getting maximum efficiency of machine/ equipment usage time.

e) Monitoring progress 24 x 7.

f) Capture safety and quality violations in any area of the site.

g) Monitor progress of work at height.

h) Check actual resources available at site and help to calculate delay due to lack of resources.

i) Ensure 100% supervision of work using lesser supervision staff.

j) Ensure safety during night work at height with few supervisors from control centre.

k) Capture real time progress with time to prepare exact current status report during review meetings.

l) Security of material during no work or holidays which helps zero incident of theft.

An interesting case study to highlight the benefit of the remote monitoring system was during an incidence of cutting of existing live power cables during the excavation work. The incident occurred at night due to negligence of the contractor who was working without a valid work permit in that area. The contractor requested for work permit after the incident occurred and tried to put the blame on the supervising staff. However, the incident was recorded on camera with actual time of occurrence and when that was compared with the time of permit, the agency at fault was correctly detected and suitably cautioned.

6. CONCLUSION

The use of the remote monitoring system proved to be invaluable in handling such a difficult project with multiple constraints. The benefit of the system was highlighted by the fact that out of the total of 9 million man hours consumed at site there were no safety incidences recorded. There was only one case of Loss Time Incident (LTI) which happened in the bar bending yard located offsite and was thus not covered under the remote monitoring system. Hence the learning is to monitor even the off-site works.

7. ACKNOWLEDGEMENT

The authors gratefully acknowledge the encouragement given by Tata Steel Limited, India during the execution of this complex brown field project and in implementing the remote monitoring system at the project site.

8. SNAPSHOTS FROM PROJECT SITE

Fig.4: Control Centre with Display Monitor and Camera Feeds

STRUCTURAL HEALTH MONITORING AND REMOTE SENSING TECHNOLOGY FOR BRIDGES

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This paper mainly how Structural Health monitoring of bridges can be done using Sensors and Remote Sensing Technology to obtain various parameters of the bridge. The paper describes the health monitoring that was done for 5 Spans of the Vishakhapatnam Port Trust Bridge.

The structure has been monitored to obtain its Deflection, Natural Frequency, Lateral and Longitudinal Displacement and Measurement of Cracks for its Static as well as Dynamic Loadings.

This paper summaries the issues with the bridge that could be detected from high resolution remote sensing imageries and based on visual interpretation as guidance for remote sensing imagery based bridge inspection, and the development of future automatic detection methods.

Introduction

Bridges have always been the most pivotal part of the civil infrastructure. Many of our bridges have exceeded their designed life which means that the cost for its repairs and maintenance will be quite significant. To ensure that the economic investment is appropriately done, the Structural Health monitoring of bridges is of prime importance. It helps the Authority to assess the Structural Integrity of the structure accurately which is not possible through visual inspection. Load, Strain, Natural Frequency and Lateral as well as Longitudinal Displacements are the important parameters which should be monitored in order to assess the structural integrity of a bridge.

Case Study - Description

The Flyover in located in Vishakhapatnam and connects the Port area and the Airport to Vishakhapatnam city and NH-5. The length of the flyover is approximately 1.2 km.

It is constructed on pile foundations and has Reinforced Concrete piers. The superstructure consists of RCC girders with composite RCC deck slab. The superstructure rests on elastomeric bearings. The bridge was constructed about 15 years ago.

Figure-1: VISHAKHAPATNAM PORT TRUST BRIDGE

Some deterioration was observed in the structural members and the bearings. All the spans had deviated longitudinally from their original positions and different gaps were found between them. The increase in gap at few locations was large and detrimental to both traffic and the health of the girders. The elastomeric bearings were also found to have deformed and were in bad shape. Inclined and vertical cracks were also found in the girders. As the condition of the bridge was not good and multiple defects were found,

it was decided to perform instrumentation and load tests to quantify the defects and distress precisely. The following tests were performed and analyses were done.

1. Static Load test,
2. Vibration Analysis,
3. Braking Load Test,
4. Crack width measurement, and
5. Measurement of movement and inclination of girders.

Visual Observations

The whole bridge was inspected visually. It was found that the condition of the expansion joints was not good. There were huge gaps between the expansion joints and the joints had even got opened despite the filler material. This had initiated a pounding action by the vehicles and led to further worsening the condition of the joints. The impact of vehicles while crossing over the gap could be easily felt at the bridge site. The gaps have been created due to random longitudinal movements of the girders.

Fig. 2 & 3: Condition of Expansion Joint

The elastomeric bearings were found to be in bad shape and conditions. Due to movement of longitudinal girders and severe vehicular impact, the bearings had got severely distorted and dislodged from their original position. The conditions of all the bearings were critical and they all need replacement. The life of elastomeric bearings is around 15 years and the existing bearings are already 13 years old.

There are cracks in the longitudinal girders mainly near the joints. There were inclined as well as vertical cracks. As the expansion joint had widened, the bearings had deteriorated and cracks had developed in the girders due to development of additional loads. The girders were tied to each other with steel plates.

Fig 4:- Steel plate Ties between Two Girders.

Structural Health Monitoring of Bridge

The Bridge was monitored to find out its Deflection, Natural Frequency, Crack Width, and Braking Load Test and also to Measure the movement along with inclination of girders for 5 spans of the Vishakhapatnam Port Trust Bridge.

Static and Dynamic Load tests were performed to know the behaviour of the girders in flexure under Live Loads. Six loaded trucks of 22 tonnes each were used to perform the Load Test. Axle load distribution and load configuration of loaded test trucks were used for static loading. They were placed behind each other in three lanes at the centre of the deck for each span.

Fig 5:- Linear Potentiometer

Deflection Measurement: The mid Span Deflections were taken by installing the LVDT's in the middle of the Girders. Draw wire type arrangement was used to connect the displacement sensors to the soffit of the girders.

Table 1 gives the Vertical Deflection at Mid of Girders for Span 63-64

Sr. No.	Location	Initial Reading	Final Reading	Vertical Deflection in mm
1	G1	18.51	22.75	4.24
2	G2	20.12	23.48	3.36
3	G4	13.56	17.14	3.58

Table-1: Vertical Deflection for one span.

Natural Frequency measurement: Natural frequencies of the RCC girders and deck were measured by installing accelerometer on the deck. The accelerometer was installed on the soffit of the girders. The specific sensitivity and the frequency range of the accelerometer used at site were 9.863 and 0.3 Hz to 18 KHz respectively. The deck was excited by getting a vehicle to pass over the deck. The response under free vibration was measured in time domain. The natural frequencies of the girders were in the range of 4.411Hz to 4.612 Hz.

Span No.	62-63	63-64	69-70	70-71	71-71
Natural frequency in Hz	4.602	4.587	4.411	4.596	4.612

Table 2: Natural Frequency Measurements.

Crack Width Measurement: - In this test, the increase in width of the existing cracks were measured. The activeness of the cracks was established by measuring the increment of the width by performing load tests. All cracks were found to be active. An omega type displacement transducer (crack width sensor) was mounted across the crack. It is a strain gauge based transducer which can measure minute displacements. Studs for each transducer were fixed at predefined locations. These transducers were wired in a full bridge configuration. Initial

Fig 6:- Omega Sensor and Vernier Caliper

readings were taken before loading of the bridge. Final readings were noted after two hours of loading to determine the increase in crack width under the load.

The increase in width was in the range of 0.6 mm to 0.9 mm during Static Load Tests.

Table 3: Crack width Measurement in Static Load Test

Spans	Girder No.	Crack width Reading		Increase in Crack Width in mm
		Before Loading	After Loading	
63-64	G2	85.8	86.7	0.9
70-71	G2	125.5	126.1	0.6

Measurement of Girder Inclination: A digital magnetic inclinometer with an accuracy of 0.05 degrees was used to study the inclination of girders before and after the Static Load Test. The Inclinometers were mounted on a metal surface which was bonded to the girder with a proper adhesive and sealing compound. Final readings were noted after two hours of loading to find out if there was any inclination of the girder. The maximum inclination observed was 0.6 Deg.

Fig 7: Placing of inclinometer

Spans	Girder No.	Reading of Inclinometer		Inclination of girders in degree
		Before Loading	After Loading	
63-64	G1	87.7	87.75	0.05
	G4	1.05	1.35	0.3
70-71	G1	1.3	1.8	0.5
	G4	0.6	1.2	0.6

Table 4: Inclination of Girders in Static Load Test

Braking Load Test:

During inspection it was found that all girders were displaced longitudinally from their original position thus creating wide gaps in expansion joints. Some gaps were so large that they could be easily noticed from top as the gaps had opened up and the filler material was out of place.

Figure 8: Placing of Linear Potentiometer

Sr. No.	Location	Initial Reading	Reading at Maximum Displacement	Maximum Displacement	Reading After Completion of Test	Net Displacement in mm
1	L1	10.3	11.26	0.96	10.74	0.44
2	L2	27.93	29.05	1.12	28.17	0.24
3	L3	32.23	33.26	1.03	32.53	0.31
4	L4	10.77	11.98	1.21	11.16	0.39
5	L5	9.38	10.03	0.65	9.96	0.07
6	L6	27.39	28.23	0.84	27.10	0.58
7	L7	25.29	26.42	1.13	25.51	0.22
8	L8	10.47	9.96	0.51	10.13	0.34

Table 5: Girder displacement resting of Spans resting on pier 70 when brake applied on span 69-70.

Observations:

1) It was found by visual inspection that the condition of the expansion joints was not good. There were large gaps between the expansion joints and the joints had opened more than the elongation capacity of the filler material.

2) That had initiated the pounding action by vehicles and that let to further worsening the condition of the joints. The impact of the vehicles while passing the gap could easily be felt at the bridge site. These gaps were created due to random longitudinal movements of the girders.

3) The maximum longitudinal and transverse displacement measured were 0.58 mm and 0.44 mm respectively. That indicates that due to longitudinal braking forces of test vehicles, the girders got displaced slightly and did not return to their original position even after the loads were removed.

4) The maximum deflection of 6 mm was recorded at mid-span of the girder at the centre of span 69-70 where Linear Potentiometers were placed.

5) The natural frequencies of the girders were in the range of 4.411 Hz to 4.612 Hz. There was very minor variation in natural frequencies which indicate that the flexural stiffness of the girders was almost similar.

6) The maximum inclination recorded was 0.6 degrees for girder G4 of span 70-71.

7) The openings at the joints were of very wide - in the range of 0.6 mm to 0.9 mm. That indicated that there were active structural cracks and they required to be repaired on priority.

8) The Expansion joints were damaged and not functioning properly and hence needed to be repaired where required.

REMOTE SENSING TECHNOLOGY FOR BRIDGES

This part addresses the potential applications of Commercial Remote Sensing (CRS) technologies for bridge monitoring. It summaries bridge issues that can be detected from high resolution remote sensing imageries based on visual interpretation as guidance for remote sensing imagery based bridge inspection.

Two CRS Technologies are mainly used for monitoring Bridge Health.

1) Scanning LiDAR system.
2) SFAP (Small Format Aerial Photography)

LiDAR scan provides high resolution 3D Optical images that than can be used to quantify bridge component conditions including those of deck collision damages, large permanent deformations, etc., while SFAP coupled with GPS provides automated imaging which allows the mapping of the wear of surface conditions.

1) SCANNING LiDAR

- These are 3D laser scanners which operate on Radio Detection and Ranging Mechanism.
- They often operate in the Ultraviolet, visible, near infrared, mid infrared and far infrared regions.
- They consist of a transmitter, receiver and a signal processing unit.
- A pulse or a series of light is emitted from the transmitter and part of the scattered energy is reflected back to the receiver after reaching the object area.
- The time the light travelled between scanner and object can be measured.
- Using this technology the damages on bridges can be easily recognised. Besides, load testing of bridges can also be performed.

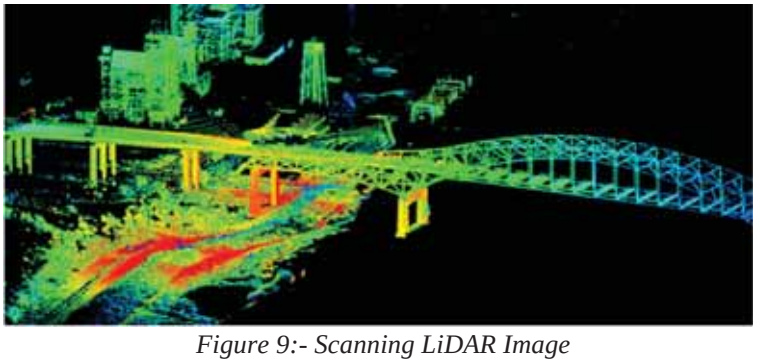

Figure 9:- Scanning LiDAR Image

2) SMALL FORMAT AERIAL PHOTOGRAPHY

- The use of geo–referenced, high resolution aerial photography and automated imaging allows the mapping of the surface wear conditions.
- Crack Detection and movements of Expansion joints can be monitored using SFAP.
- The photos in figure below were taken from a height of 500 m for higher resolution in digital format.
- A critical component in SFAP technology is the on-board GPS system which allows all aerial photos taken to be geo-referenced.
- This technology is most effective in monitoring new constructions.

Using GSI Platform, a bridge engineer/ inspector can examine multiple bridges simultaneously and perform concurrent bridge ratings and comparisons.

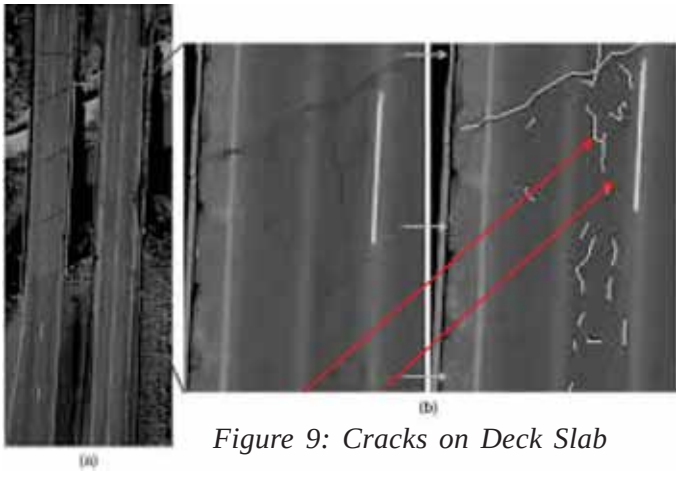

Figure 9: Cracks on Deck Slab

SUMMARY:

An overview of Bridge Inspection to find its important parameters is described with the Help of Various Sensor Technologies and Remote Sensing of Bridges with the help of new technologies in this Paper. As new technologies are developed, new monitoring techniques also sprout and will continue to do so as technology advances.

REMOTE MONITORING OF POWER PLANTS

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ABSTRACT

Remote monitoring of power plants, both plant units and fleet of plants, significantly improves the plant operation and maintenance activity by providing condition monitoring continuously which avoids downtime and improves performance. In order to improve asset life time, secure higher reliability and availability of the equipment, power plant owners are giving a very high priority to remote monitoring of plant equipment. Traditionally, data was collected manually from monitoring devices. Given the massive amount of data available, monitoring of all data is no longer feasible. Remote monitoring and automated guidance is crucial to transform data base into useful actionable data that can be presented on a customized dashboard at a fleet/ plant/ equipment level.

Remote monitoring also provides significant benefits by connecting the power plant operating staff online to the best domain experts, ensuring real time efficient operations.

INTRODUCTION

In today's scenario, justifications of plant budgets are not only based on engineering criteria associated with Operation and Maintenance (O&M), but also on Return On Assets (ROA). Asset Management reduces costs by identifying problems related to performance of equipment, improvisation in predictive maintenance, extension of asset life cycle in addition to assisting development of business plans for further investments. Remote monitoring of plant typically consists of:

a. Monitoring equipment condition and identification of their performance.

b. Improving the focus on predictive maintenance and reduce the downtime.

c. Optimize plantasset lifecycle and assessasset failure impact.

d. Access to decisions and solutions by domain experts.

e. Ensure compliance to security and safety regulations.

AVAILABILITY OF PLANT

Reducing unplanned maintenance time is key to improving both Overall Equipment Effectiveness (OEE) and ROA of a plant. Important aspects to focus are to increase equipment's performance and availability so as to minimize the assets lifecycle costs. Unplanned maintenance in a Power plant has been proven to significantly impact a plant's operating profit. Improvements in information technology and communication systems that allows transmission of sizeable volumes of data across the globe and their analysis substantially reduces unplanned maintenance in power generating plants.

Remote monitoring of plants on real time basis mitigates the risk associated with their failures. The aim of the plant managers would be to improve equipment performance and availability in addition to minimizing the asset lifecycle costs. It is important for plant managers to know the condition and performance of the plant and its equipment before any kind of optimization and control decisions are made. In addition to this, the asset lifecycle cost approach intimates the operator about the influence of his action on the future plant state. Based on this information, a decision can be taken on, e.g. whether to initiate maintenance inadvance, or to operate the plant by extending the maintenance interval.

REMOTE MONITORING STRATEGY

Remote Monitoring assists in identifying equipment performance and reliability issues through collection of data and their analysis – called fingerprints. It generates both a system benchmark and an improvised plan which can be informed either on-site or remotely, using a remote access platform. These fingerprints are the building blocks for a three-step optimization process: Diagnose, Implement, Sustain.

DIAGNOSE:

The preliminary fingerprints generate performance reports which are delivered at various frequencies depending upon requirements of system and user. For example fingerprints for Control Systems include measurement and analysis of control system performance, network communication, and controller loading, specifically: software, firmware, network parameters, cyber security settings, etc.

Implement:

On the basis of the fingerprints obtained, expert recommendations are determined and planned for implementation, to facilitate the start of optimization process. These improvements may be completed all at once or scheduled to be completed incrementally over a period of time. In either case, implementation ensures that changes can be made and maintained remotely with steady progress toward the performance goals.

Sustain:

Regular fingerprinting, implementation and sustaining of these services are recommended to achieve and continue the improvement process.

These three processes - Diagnose, Implementation of corrective action, Sustain targets, early detection of power plant equipment abnormal operating condition ensuring improvement in plant operation, availability and reliability. Numerous data acquisition tools could be used for acquiring day to day operational information from power plant equipment like steam generators, steam turbines, heat recovery boilers, gas turbines, electrical generators, and transformers.

The remote monitoring centers have advance diagnostics software to analyze data, enabling failure detection and performance anomaly with right expertise and minimum time.The state of art diagnostic software enables expert engineersto quickly identify problem areas so as to take corrective actions preventing abnormal alarm levels. The diagnostics plant engineers/ domain experts bring in the entire knowledge at one center forremote monitoring. Remote Monitoring Centers would provide prioritized notification at client sites through remote monitoring support further reducing average downtime, enhancing machine reliability and ensuring lower maintenance costs.

Earlier, Original Equipment Manufacturers (OEMs) would tend to provide "Two Pass repair", i.e., first inspection visit to identify and access parts and collect data followed by root cause analyses and suggestions for repair. Now with remote asset health monitoring andanalytics, OEMs get advance alarms and plan for zero downtime maintenance.This also enables best practice sharing across their equipment at different sites and lessons learnt from one site may be useful for avoidance of a similar problem at another site located in an entirely different geography. With the above benefits, OEM's have a huge opportunity to make maintenance a profitable business using the remote monitoring of their equipment.

REMOTE SECURITY ACCESS

The remote service platform software provide all the required connection security between the Remote Monitoring Center and the user sites. This platform enables secure, real-time remote monitoring and control of equipment installed at client sites(Figure – 1)

The plant site and the Remote Monitoring Center shall perform two-way authentication before initiating communication. To provide end-to-end security, remote service shall utilize standard secure communication protocols with encryption.Based on the security policy of the plant owner the remote service platformshall be configurable by enabling / disabling data access.

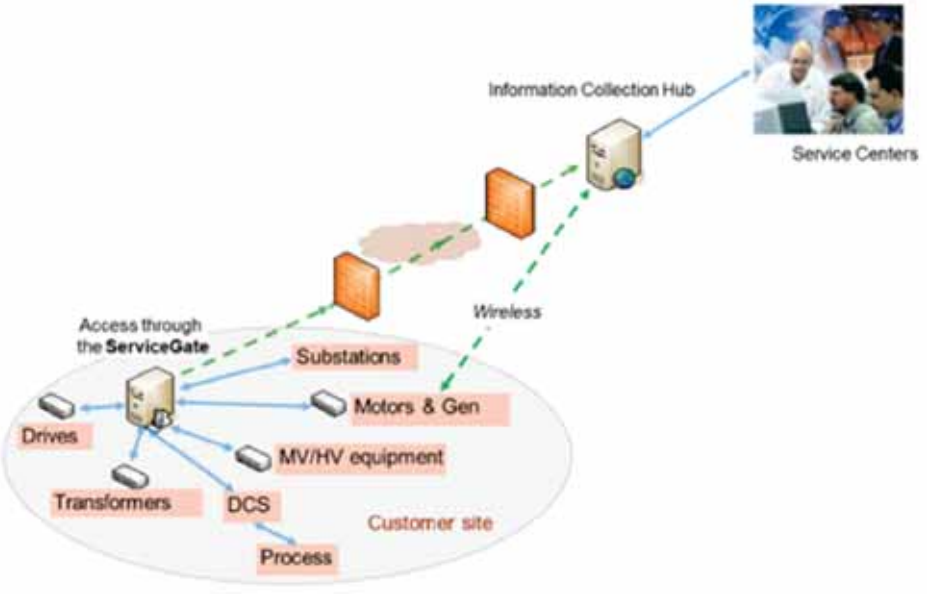

Figure -1 Remote Monitoring – Site to Expert Center

DATA ACQUISITION

Technology for remote monitoring has matured by leaps and bounds over last few years with advancement of high speed internet and cost-effective smart sensors/devices. This facilitates process engineers to look at the plant process parameters in a real time from any part of the globe. Sensors measuring the parameters required for sending data to the system can be either analog or digital signals with relevant information received from related multifunction sensors.

DATA ANALYSIS

Data Analysis is largely executed at Remote Monitoring Centers. Automated applications for analysis and diagnostic actions are a fusion of multiple software tools with human intelligence, expertise, judgment updations from process

domain engineers and specialists at different locations. This gives comfort and confidence to plant operators that the diagnosis and expertise communicated have a high level of validation.

The OEMs have the advantage of having access to wealth of knowledge of consolidated annually compounded operating data from an entire fleet.With access to the vast data, it is increasingly difficult to review and arrive at the right conclusions to obtain desired result. Hence, it is mandatory to have powerful software tool(s) tosort identical events, analyze them and revert with corrective actions. The common feature of these tools & systems is to provide plant – area- unit- specific operating characteristics providing early detection of abnormal drifts. If the plant operators face any new or unusual issues, they could easily consult one of the many specialists who add expertise in the evaluation of specific operational or hardware related issues.

DIAGNOSTIC FINDINGS AND BENEFITS

There are a number of advantages of remote monitoring shared by plant owner and respective OEMs. OEM's can reduce potential damages of plant equipment being monitored by collecting operating data from plant site and evaluating it on a daily basis.The diagnostic tools available are designed to detect small deviations of monitored parameters with respect to expectation.These changes/ deviations are meticulously analyzed to provide online operation based advice to the plant operators. Early fault detection in certain conditions would be able to mitigate consequential damage and in turn help reduction in overall repair costs considering time availability to plan all required actions upfront, like arranging spare parts and manpower at site when the plant equipment is shut down for repair.

At times, the Government imposes restrictions on generating plants in taking operating units for maintenance due to high demand for power. Under these circumstances, remote monitoring services would present the plant operator with better information to continue to operate the plant and delay the scheduled maintenance.

CONCLUSION

Remote monitoring is being widely adapted by the power generation industry. Remote Monitoring Systems have data acquisition, data storage, data analysis and reporting capabilities that are being exploited for the identification of abnormal operating conditions of power plant equipment.This information, along with associated recommendations paves the way for taking more informed corrective action regarding diagnostics concerns. Fact-based decisions can give huge financial benefits to plant owners.

Remote monitoring of plants substantially supplements the internal operators and OEM's on the site support in improving the effectiveness of the operation and maintenance works. Remote services provide expertise guidance to plant operator in a cost-effective and efficient way.

Remote monitoring of plant equipment can track and report key performance indicators of the plant, for taking proactive actions. Thus, maintenance work, dispatching and lifecycle management can be planned more efficiently. Downtimes are minimized, and recovery times after defects are reduced, thereby avoiding loss of production and possible penalties.

Remote monitoring philosophy is growing fast in energy sector. Intelligent/ smart maintenance and diagnostic programs are available today that provide data acquisition, analysis, reporting capabilities as well as early detection of impending failures. The important advantages from remote monitoring of Power plants are faster resolutions with improved efficiencies, proactive maintenance and valuable insights based on the available expertise.

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IMPORTANCE OF REMOTE SENSING & MONITORING IN ENGINEERING PROJECTS

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Master of Science in Mechanical Engineering
Master of Science in Construction Management
Ph.D. in Building and Construction Engineering

Introduction to the Building Monitoring and Control System

Building Management addresses the activities planned for design, construction, operation, and maintenance of the entire facility. It is to ensure actuation of appropriate actions within the organization in aligning with the electro-mechanical services - HVAC System, Fire Protection and Fire Alarm, Detection & Address System, Water Supply Distribution, Building Drainage, Electrical including lighting and power, Building Transportation such as elevator, walkalator and escalator, Closed Circuit Television (CCTV) and Communication as a Building System Operation for remote sensing and monitoring.

A combination of managerial talents are required for a Building System Operation and also continuous professional development - technical training, education, in addition to experience, which is gathered on field and office operations during design, construction, building operation and maintenance stages. A building could be considered as an assemblage attached to the ground and providing shelter for machines, processing equipment, human beings to perform their activities, storage, or any combination of these.

Today's large scale building complexes, towers, skyscrapers are an art and science combined based on technological design aspects to meet the intended purpose. They are legally executed by competent professionals-Town Planners, Architects, and Engineers from a number of disciplines & specialisations - Civil, Geo-technical, Structural, Public Health,,Electrical, Mechanical, Instrumentation and Control, Communications, etc. The Building Services Engineering Manager and the Building Construction Project Manager manage the project during the building design and construction stage, while the Building Facility Manager, later on, once the facilities are operational, uses the Building Management and Control Systems for positive movement and environment with highly skilled persons, labourers and craftspeople all enabled by remote sensing, monitoring, surveillance, and control. These are essential for ensuring safe and secure facilities as well as for evacuation in times of emergency.

The Building Management and Control Systems (BM&CS), are linked using the Building Information Modelling (BIM) facilities to enable building operations for precise building controls and services in time of emergency constraints apart from solving maintenance issues. They are highly complex systems which enable easier and more exhaustive visualization by Remote Sensing. Remote Monitoring of the Engineering Operation is done through creation of virtual models for the analysis and calculations, and that enables easy spatial maintenance planning and projections.

Building Remote Sensing and Monitoring Technological Design Process

The designs of Mechanical, Electrical and Public Health Systems for a building are continually evolving and progressively respond to the local market's economics, demand, social and political concerns. For a building design, multiple alternative

solutions are possible, and the system selected for one project may not be appropriate for another. It's only through analysis and an iterative process that examines the real needs of a building and its intended use, that the proposed architectural and engineering design can be evolved to provide the most appropriate solution being selected by the Building Facility Manager.

Whilst the Architects and Engineers do their part of the work it's the Instrumentation and Controls engineers who integrate all the remote sensors that provide the feedback to the Building Management and Control Centre.

Remote Sensing and Monitoring in a Building's Healthcare Facility

In building services engineering project, a critical aspect involving sophisticated controls and monitoring is in the Healthcare facility - the Isolation Room or the Operating Room. An Isolation Room has air pressure sensors that measure the differential pressures between the designed room and the adjacent reference areas which are usually the corridor and/ or the Anteroom. Figure 01 shows a typical Isolation Room Air Schematic Distribution Diagram. It shows how the controls and sensors plays a vital part in establishing and maintaining pressurization requirements eliminating leaks in the walls, ceiling and the floor, as well as keeping the doors closed unless someone or something needs to be provided access. The designed sensors and transmitters display the room pressure and adjoining area pressure on a remote panel adjunct to the Nurse Station for monitoring. The same is also interfaced with the Building Management and Control System for immediate response by the concerned building system maintenance personnel if any malfunction occurs.

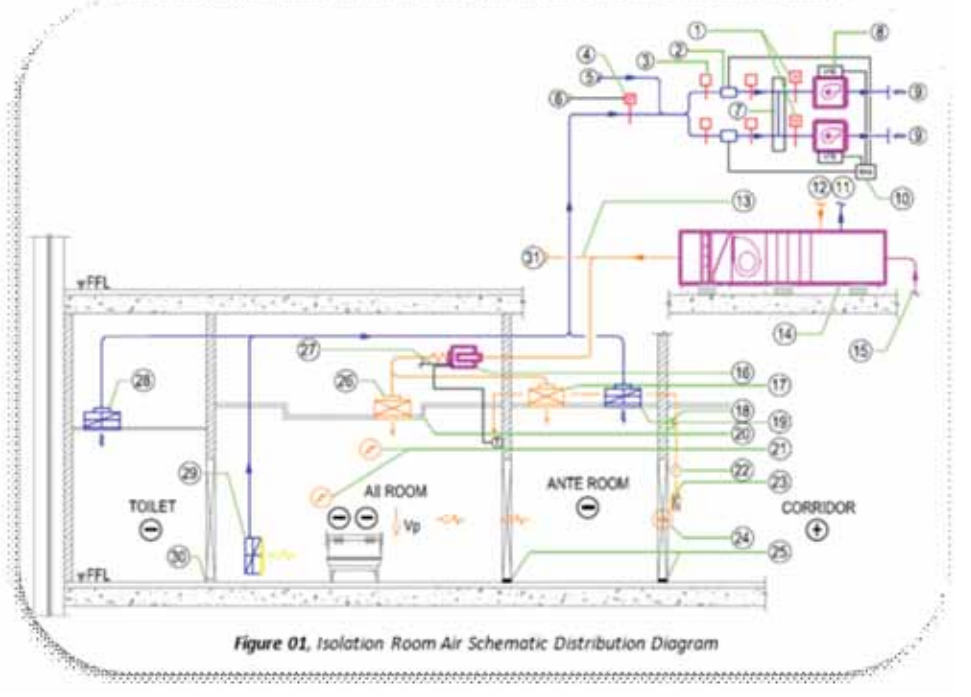

Figure 01, Isolation Room Air Schematic Distribution Diagram

Figure 01 shows the Isolation Room with an Anteroom. These critical rooms are provided with monitors to measure the air pressure and raise an alarm if the pressure differential between the two rooms is not as stipulated. The protective environment of the Isolation Room needs to have a constant volume offset with a negative pressure vis-à-vis the Anteroom. The Anteroom has to be positively pressurized vis-à-visthe Isolation Room but slightly negative vis-à-visthe adjacent corridor. Thus, the sensing devices have to be installed carefully, tested and balanced, and their display monitored in the Nurse Station as well as the Building Management and Control Centre.

Refuge Areas and Evacuation shafts for use during an emergency such as fire in a high rise, are other building facilities which need to be secureddepending on the occupant's evacuation strategy as part of the building fire protection and life safety approach. The HVAC system sensor and monitoring play a significant role in life safety and need special attention. The strategic control may be an active or passive application.

Difference between Remote Sensing and Remote Monitoring Application

For ease of understanding, sensing can be likened to our ears or nose or touch to identify something in the environment while monitoring can be our eyes sending the signal to our brain to assimilate and respond. As per Wikipedia, "Remote monitoring and control (M&C) systems are designed to control large or complex facilities such as factories, power plants, network operations centers, airports, and spacecraft, with some degree of automation. M&C systems may receive data from sensors, telemetry streams, user inputs, and pre-programmed procedures. The software may send telecommands to actuators, computer systems, or other devices. M&C systems may perform closed-loop control."

According to the US Geological Survey "Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance from the targeted area. Special cameras collect remotely sensed imagesof the Earth, which help researchers "sense" things about the Earth." It involves recording, measuring, and analyzing information about a phenomenon from a range.

Technical advancement has enabled building services operation using cloud technology, communication services via internet applications, and monitoring of devices through the electromagnetic spectrum that can be controlled without physical presence. However, these might depend on the source of energy which illuminates the object under study. Remote Sensing techniques have been classified into two types -Passive and Active Remote Sensing. Passive Remote Sensing System is defined as the naturally radiated or reflected energy from the earth's surface features which are measured by the sensors operating in different selected spectral bands on board air-borne/space-borne platforms. An example can be photography in the daytime without flash, see Figure 02.

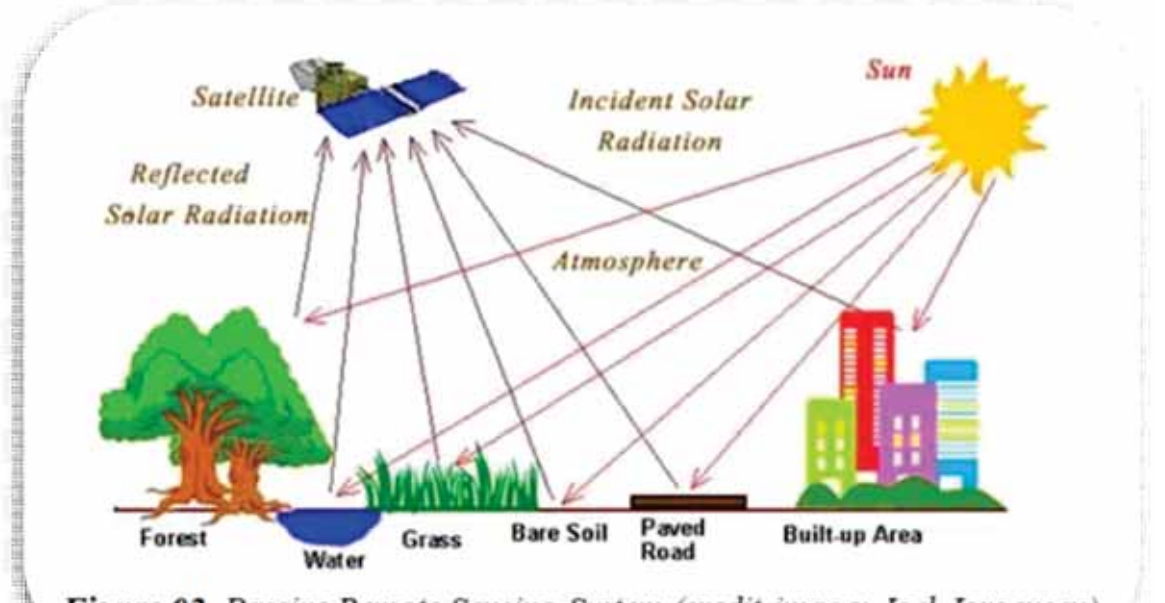

***Figure 02**, Passive Remote Sensing System (credit image: Joel Jorgensen)*

On the other hand, an Active Remote Sensing system supplies its source of energy to illuminate the objects and then measures the reflected energy which is returned to the system. Example of this can be similar to the photography that is used at night with flash, Figure 03.

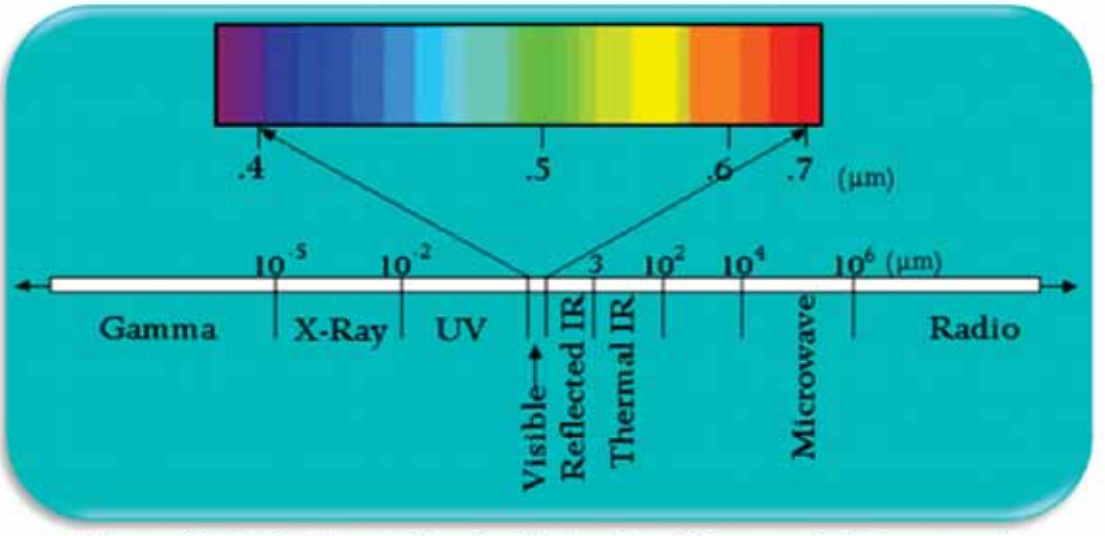

***Figure 03**, Active Remote Sensing System (credit image: Joel Jorgensen)*

The applications of remote sensing are now more advanced and are deployed in engineering projects starting with geotechnical data through satellite. That allows proper management of renewable and non-renewable resources and provides timely as well as detailed information about the Earth's surface, i.e., Google Map.

Building Lighting Control Strategies

In a building's facility, lighting management can be controlled through DALI(Digital Addressable Lighting Interface) system, a proposed international system which ensures a high level of flexibility and energy conservation in the building lighting demand. An example is the changing exhibition scenarios which are control by a programmed overall lighting system.

The lighting control system can provide local individual control of specific areas as are applied in the offices and the exhibition areas with precise scheduling all linked to the Building Management and Control System. The lighting control strategy helps minimize energy consumption.

Building Indoor Quality Monitoring Equipment

The BM&CS also controls over-supply of fresh air to the building in large spaces with the variable population. CO_2 sensors are also provided to ensure safe habitable areas. Likewise the AHUs and FCUs (Air Handling Units, Fan Coil Units) which incorporate variable speed fans are also linked to a control strategy towards energy conservation for maintaining a sustainable environment in the building. The HVAC systems have Volume Control Dampers, Sensors, Temperature Control, Humidity Control, and Variable Speed Motors to balance and optimise the systems operationsto meet sustainable building environment norms.

The buildings are also provided with sub-metering to monitor the specific uses and services (energy and water) in different areas for different uses to help identify which end-use or service (e.g., lighting, fan, pumps, etc.) is performing well or poorly and where energy may be getting wasted.

Strategic Control through the Building Physics

Thermal protection is achieved by means of the building envelope which can be strategically controlled remotely to provide high comfort level in the interior spaces plus save energy. The heat transfer for the opaque components of the building depends on their thermal conductivity; hence the heat that is generated in the building envelope can be used for the HVAC System. Remote Sensing and Remote Monitoring enable optimisation of the building envelope and its features by enabling passive energy saving gained from the building to enhance energy conversion since the building façade balances passive solar heat gains, daylight, heating, and the cooling demand as part of the building energy control strategy. Thus a high degree of thermal and daylight comfort can be achieved together with high energy efficiency.

Given the warm climate of the tropics and especially the arid/ desert region countries, the building envelope needs toreduce the heat gain and delay its transfer to the interior as much as possible so as to reduce the cooling load requirement in the building facility. A low U-value is the most desirable which can be achieved by using heat insulation materials with low thermal conductivities that are usually provided by the manufacturer for the building.

Conclusion

It is this seen that Remote Sensing and Monitoring are a key requirement for Building Management and Control Systemsand their incorporation in the building project scales up environmental sustainability. The Building Facility Manager needs to work closely and be fully familiar with the building services controls and monitoring since they play a significant role in today's green building science.

For Facility Management, an appropriate Building Services Engineering Management Plan should be made to simplify the application of the Building Management and Control Systems. The latter is prepared to comply with the specific work condition, intended purpose, laws and regulations applicable to the building.

The benefits of properly designed, executed, operated and maintained Building Management and Control Systems with remote Monitoring and Control are immense and will grow as facilities become bigger, towers rise and their numbers increase.

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MONITORING LAND AND INFRASTRUCTURE FROM SPACE
Right of way monitoring using AI and Satellite Imagery

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Attentive AI

'Man must rise above the earth to the top of the atmosphere and beyond for only thus will he fully understand the world in which he lives.'

Socrates 500 BC

Introduction

About one-fourth of the Earth's total surface area is exposed land where information is ready to be extracted for detailed earth observation. Fortunately, this can now be easily done through use of remote sensing devices mounted in high flying aircraft or earth orbiting satellites. From weather forecasting to military intelligence, remote sensing has been used successfully for specific surveillance and monitoring of remote and dangerous areas. However, till recent times this analysis was done by a team of engineers through visual inspections.

Today, many such satellites are frequently used to monitor the Earth's surface collecting data every day. It is impossible for an organisation to manually sift this large volume of data. The key for full and useful exploitation of the data lies in deploying fully automated analysis methods.

Artificial intelligence provides tools and methods to extract digital, reliable and expressive insights from raw remote sensing data.

The amalgamation of remote sensing and artificial intelligence is here to stay and has already started benefitting a wide variety of industries in monitoring land use and even other activities. Whether it be gas pipeline right of way monitoring using aerial photography[1], land and property management using drones[2], forest degradation monitoring using satellite[3] or coastal area monitoring to predict disasters[4]or monitor encroachments. Any government authority or body or organisation with widespread natural or man-made assets can monitor their right of way using either satellites, drones or helicopters or a combination of these and get real-time and unbiased alerts on encroachments, trespassing, natural hazards and other activities.

Case in point - Road Transportation Sector in India

Problem

With over 52 lakh kms of roads, India has one of the largest road networks in the world. New roads and highways are being designed and built and the existing highways are being upgraded. While the road sector has witnessed significant development in the last decade, its efficiency has been hampered by various factors like inadequate width of the highway, local traffic nearby urban areas, uncontrolled proliferation of access points to the highway, uncontrolled building activities and roadside advertisement and encroachments. These challenges need to be tackled to ensure that the momentum of growth in this sector is sustained and risk is minimised.

Solution

Using high frequency satellite imagery and AI, the progress of construction for highway projects can be monitored and new encroachments around national highways detected to minimise risks. At the core of the solution lies the process of machine learning based change detection method. These algorithms have been trained on high resolution sub 1m satellite imagery datasets to recognise road segments in different stages of development.

The status of construction progress on a project and new encroachments could be automatically calculated using AI and displayed on a central web dashboard. Different stages of construction could be flagged in the monitoring process; surface preparation, mounting, tarmac laying, connectivity of different stretches of highway and construction of flyovers. The dashboard would allow any road authority to overlay geo-tagged construction progress reports from its existing monitoring mechanisms that are based on on-ground reports or CCTV photographs or drone photographs and verify their veracity using satellite-based monitoring as an unbiased source. Unregulated structures like dhabas, parking zones, buildings, colonies and industrial units detected along highways could also be geo-tagged and the locations shared in a GIS-ready format through web-based dashboard. A Highway Authority could then select those stretches as and when it is required to carry out an eviction drive or to carry out orders of courts.

Stage 1 of Surface Preparation

Stage 2 of Mounting

Final Stage of Tarmac Laying

Conclusion

When used alongside complementary monitoring methods, remote sensing contributes towards improving safety and asset knowledge and a reduced need for physical asset inspections. With ever changing technology it is important to recognise its potential and to realise its strategic implementation for sustainable development.

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About **Attentive AI**

The capability to process remote sensing data effectively is uniquely human. With this belief **Attentive AI** was founded on the premise that only artificially intelligent systems can extract insights with human-like accuracy and at scale. Based out of Delhi, India, **Attentive AI** develops software that makes it possible to analyse petabytes of remote sensing data and convert into accurate insights with minimal human effort.

REMOTE MONITORING OF CONSTRUCTION PROJECTS - CURRENT TRENDS AND FUTURE SCOPE

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Introduction

Remote Monitoring or Virtual Supervision of Construction Projects is becoming the buzzword on account of increase in demand, scale and complexity of the projects as seen in the construction of skyscrapers, SMART cities, Airports, Water Supply, Sewerage, Rail networks, etc. Monitoring large-scale projects, by pure manual efforts has its pit falls in terms of cost, time, safety and quality. Thus project monitoring is cascading into an ever increasing usage of remote sensing and picture capturing devises. Drone usage itself has seen an annual increase of 239% (Drone Deploy, 2018), higher than any other commercial sector. In many large projects, automated remote monitoring, using either CCTV Cameras or Drones, is now being done to obtain real and accurate information. The collected data improves the accuracy and validates the workflow results as well as the product and productivity of the worker. Their ability to capture aerial view and the capacity to gather crucial data make them a reasonable and reliable instrument, offering benefits *inter alia* include safety and security surveillance in addition to virtual monitoring of the construction site.

The benefits offered by aerial monitoring such as Drone photos, videos and images empower the project monitoring authority with the capability to note the progress through comprehensive real-time updates.. With the scaling-up of projects in terms of size and complexity, drone usage will continue to be appreciated in the construction industry.

Remote Construction Site Monitoring

The Need for Remote Monitoring

"Liberda et al.(2003) identified 51 factors related to the construction productivity in Alberta, 35 of them expressly associated to poor management practices in the construction industry. Site management is majorly accountable for more than 50% of the time wasted due to poor management practices."(Lahiru P. Silva, 2015). Remote monitoring can help in improving the reduced levels of productivity in the industry, through addressing the critical factors i.e. enhancing supervision and site management factors.

Figure 1: DN-CN Integration and Remote Monitoring

Remote Monitoring systems help with improved productivity and project management by using it as a tool for the "Schedule Management" process, and cost control (tracking use of equipment and personnel) plus help in managing risks through monitoring and controlling, identify unsafe acts and conditions and prevent accidents through remote supervision.

Site Monitoring Transformation –

Through use of Wireless Cameras

Advances in the administration of Remote Systems and capabilities presented through connectivity of IP-based video systems, together have now enabled Construction Managers and other stakeholders to monitor progress of any size and number of construction projects, and managing them remotely.

Figure 2: Remote Monitoring using PTZ Camera at Pune (2012)

Using cameras or videos, remote monitoring is a proactive 24/7 operating option that captures every detail for the Site Management team and other critical stakeholders. Maintaining a fully organized large-scale site with fewer defects on an average becomes an organized and collaborated task.

Experience in using CCTV Cameras on project shave shown benefits in costs on supervision, reduction in theft problems, ease in insurance approvals, covering multiple areas simultaneously and recording of every construction operation 24/7. It also aids in identifying the Root Cause of an accident.

Through use of Drone Surveying

Drones, equipped with cameras and remote sensors, become indispensable for projects spread over large areas considering the process complexity involved in Construction, viz. monitoring, quality control, logistic planning, change identification and management of its order, etc. The UAVs can remouldthe way of working at almost every stage of the construction workflow, through aerial photography to 3D model mapping. In addition to providing access to data facilitating better communication and decision-making, drones also help savings in money and resources.

Figure 3: Site Planning using Drone Survey (2019)

Role of drone across Construction Lifecycle could be identified as follows:

Pre-Construction/ Planning	Execution	Post-Construction/ Closure
1) Design – Safety & Optimization 2) Mapping 3) Quantity Surveying 4) Estimation	1) Virtual Supervision 2) DN-CN Integration 3) Site Management – Inventory & Logistics 4) Resource Management – Productivity	1) O & M 2) Defect Identification & Rectification 3) As-Built Documentation

Application of Drones in Construction Project Management

Periodic inspection of construction sites is integral to successful accident prevention since new hazards, equipment, people and materials moving around the site are a typical feature on a typical construction project. Drones can be deployed to conduct safer and more accurate inspections instead of having the safety managers physically identify potential hazards.

"As drone maps are geo-tagged, they have potential to take basic space measurements and instantly estimate stockpile volumes for real-time decision-making. Drone information can even be overlaid with extra site information, or imported into industry-based software for a more advanced planning."(Drone Deploy, 2018)

Typical Project Issues	Drone-based Resolution
Traditional Project Management	Aerial Maps & Models
Imperfect/Partial information	HD Data Sets (Detailed View)
Conservative & Tedious Analytics	Real-time Apprehension
Multi-stakeholder Communication	Efficient Multi-party Communication

Project Management & Drones

Progress Tracking & Reporting

Periodic drone maps help in significant reduction in amount of time spent in physical monitoring of progress, construction supervision and examination of safety and quality issues.

Aerial maps facilitate to make a comprehensive visual record of a project, and a survey for easy check on the progress based on the schedule and time. It also facilitates with its in-built tools to enable commented reports for all stakeholders - internal and external.

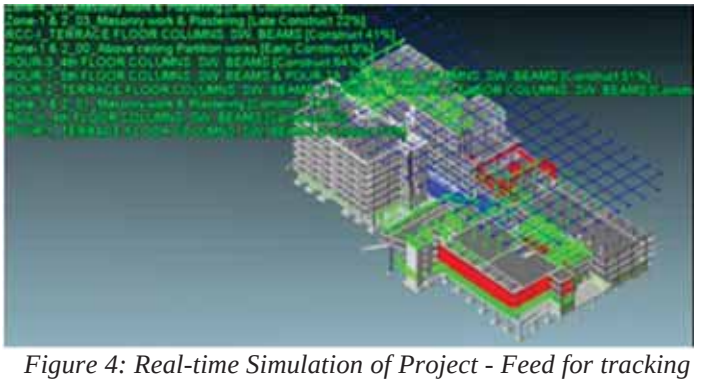

Figure 4: Real-time Simulation of Project - Feed for tracking through Virtual Supervision

Communication, Collaboration & Information Sharing

Drones support in streamlining communication and data sharing to all stakeholders. This streamlined communication channel keeps everybody aligned and abreast of with up-to-date and easily comprehensible visual information."We can share duly marked-up aerial maps between team members in real time, keep everyone updated on the progress of a project through shared links and interactive 3D models of a job site. Sharing an interactive 3D model allows customers, collaborators, and stakeholders to explore a job site remotely, thus facilitating a 360 deg perspective of the entire project."(Drone Deploy, 2018)

"Aerial surveys also enhance the decision-making process by referencing an upto-date drone map, highlighting timely changes that require to be introduced on a project." It also enables easy reference to current site issues during Project Review meetings through communicating changes and data distribution with efficiency, even across large teams.(Drone Deploy, 2018)

Site Planning

To enable better and more accurate planning, drone maps with existing site conditions such as underground utilities and/or other facilities can be superimposed with 3D/4D models and simulations. This facilitates comparison of real-time site conditions against plans (as illustrated by real-time simulation shown in *Figure 5*).

A more productive aspect is identification of conflicts at an early stage and facilitating value engineering to achieve optimum project cost. Also, the cost of value engineering would be minimum. For more advanced planning, drone maps can be exported to industry software like BIM, GIS and CAD.

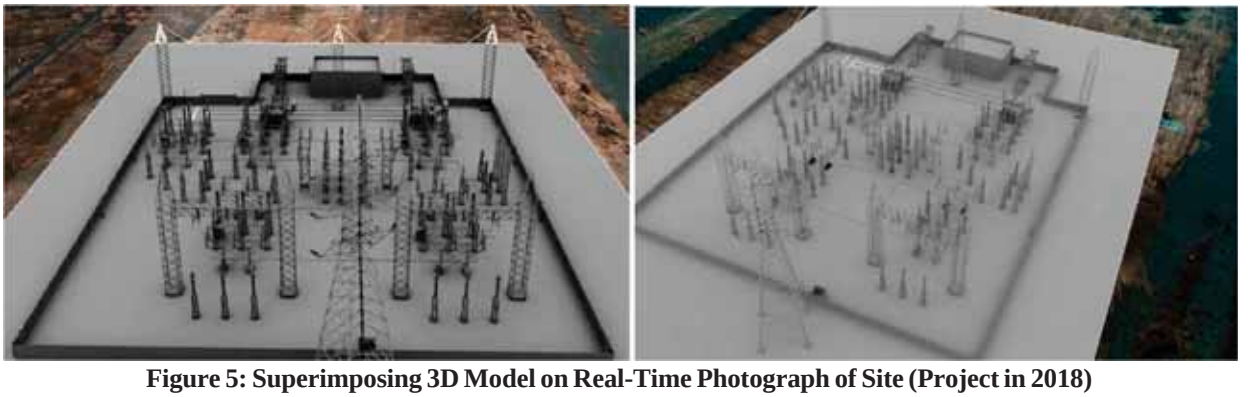

Figure 5: Superimposing 3D Model on Real-Time Photograph of Site (Project in 2018)

Construction & Personnel Safety

The industry is waking up to providing a safer work place and giving safety a due priority as the construction projects account for over 39% of worker fatalities(Zitzman, 2018). "The construction industry, which is the second largest employer of workforce in India, contributes to 24.20% of all occupational fatalities, the highest in the country annually"(British Safety Council, 2019). What is the data for India? Inspections and measurements require that construction workers move uptowering heights and navigate around, thus exposing them to unsafe conditions. Here, drones can support in mitigating such hazards, where lives are exposed, by successfully recording live videos and pictures and enabling remote monitoring of quality issues and planned rectification of the same. Drones can also be used to fly in tunnels, under-ground sewer trunks with hazardous gas identifiers and check the safety for man-movement prior to the actual movement.

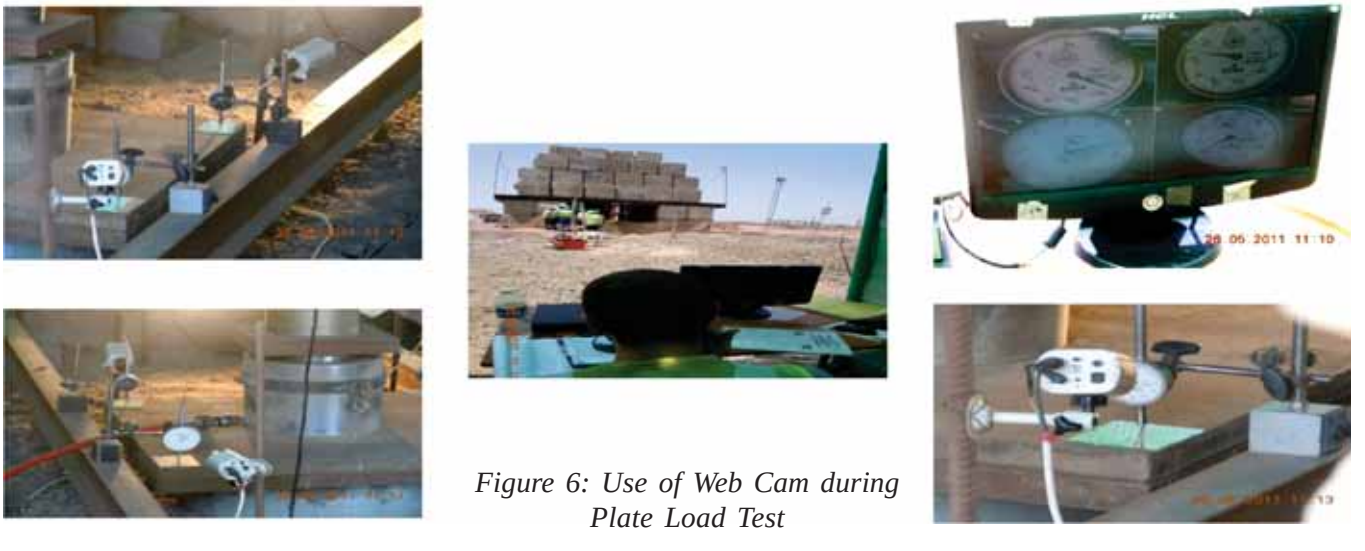

Figure 6: Use of Web Cam during Plate Load Test

Drones and CCTV cameras can be also deployed by Construction Managers for surveillance of the construction site to monitor and control safety concerns at job site. It would help them in ensuring that workers are following all the necessary safety precautions and that any suspected or temporary structures and/or equipment are safe enough to ensure no injury to construction workers.

Use of web cam was used for monitoring the readings of the settlement and rebound on the dial gauges during plate load tests, and it proved to be the "safest way", not involving any human interface.

Structure Inspection

Drones could offer crucial examination of heavy machinery and bulky staging, so as to inspect critical concerns for replacement. "A bird's eye view around structures can be captured to ascertain stability and fine details, and take high-resolution imaging for analysis. When equipped with thermal sensors, drone surveys can detect heat leaks, cold spots, and any electrical issues. This level of quality assurance helps with client relationships in the long haul."(Zitzman, 2018)

An aerial survey map can also be deployed to prepare and execute plans for maintenance works of larger-scale infrastructures such as bridges, towers, roofs, etc. From a complex and time taking task involving a whole team of expert surveyors, the job reduces to a few hours with a drone operator.

Drone Deployment at Construction Sites

Operating Drones in India

India's Director General of Civil Aviation has circulated the country's policy for drones, effective 1st Dec'2018, which define and classify drones, and also outlines the permitting process for operators and norms on flight restrictions.

The DGCA applies the term "Remotely Piloted Aircraft" (RPA) to describean Unmanned Aerial Vehicle (UAV) piloted from a remote station, thus differentiating them from model aircrafts. As per new regulation, RPAs need to be registered under a Unique Identification Number (UIN) and Unmanned Aircraft Operator Permit (UAOP) for commercial operation and follow flight rules as per norms. All drones except those categorized under "Nano" category must be registered and issued a Unique Identification Number (UIN).

CONCLUSIONS

The benefits of using hi-resolution cameras for construction management are enormous and have always exceeded their expected impacts. They also have the potential for of being used in various fields, for example in Resource Management, Safety & Quality Inspections, etc. Arriving at quantitative savings is difficult, but the qualitative results on the executed projects were eminently satisfying.

There is increasing deployment of Remote Monitoring with Drones & CCTV cameras by construction companies.

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USE OF REMOTE SENSING AND REMOTE MONITORING FOR ENGINEERING PROJECT

Pramod Jain
Vice President
Consulting Engineers Group Ltd., Jaipur

Introduction

Remote sensing (RS) is the acquisition of information about an object or phenomenon without making physical contact with the object as against observation made after making physical contact. The term now a days generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both above and below the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation). It may be split into active remote sensing (when a signal is first emitted from aircraft or satellites) or passive (e.g. sunlight) when information is merely recorded.

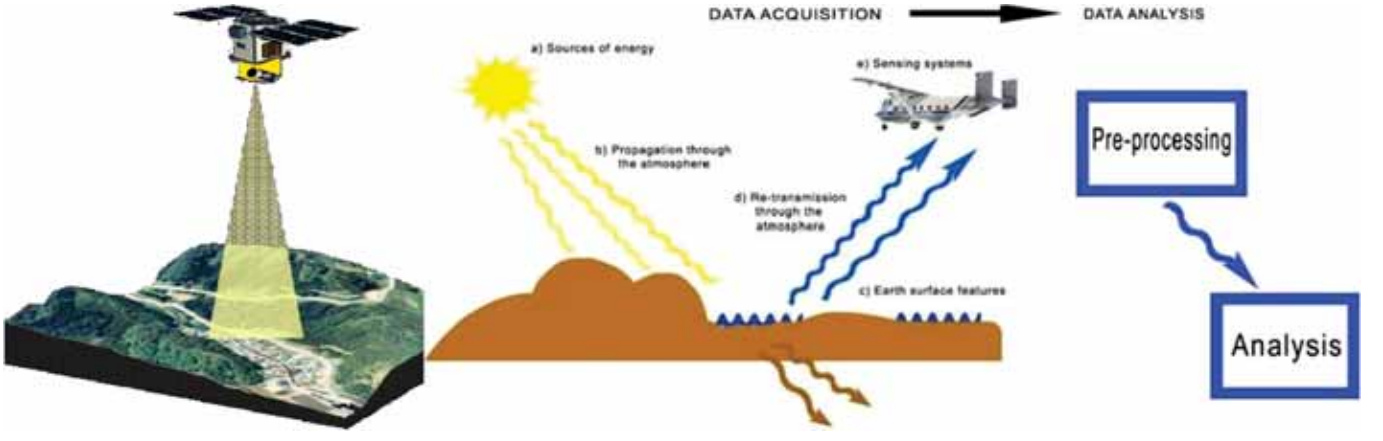

Fig-1: Remote Sensing System

Use of Remote Sensing in Engineering Projects

Remote sensing is used as a tool to extract information about the land surface structure, composition or subsurface, but is often combined with other data sources providing complementary measurements.

Geological applications of remote sensing include the following surficial deposit / bedrock mapping, lithological mapping, structural mapping, sand and gravel (aggregate) exploration/ exploitation, mineral exploration, hydrocarbon exploration, environmental geology, baseline infrastructure, sedimentation mapping and monitoring, event mapping and monitoring, geo-hazard mapping and planetary mapping.

1. Highway Engineering
2. Structural Mapping& Terrain Analysis
3. Geologic Unit Mapping
4. Geotechnical Engineering
5. Water Resources & Hydrological Engineering
6. Land Degradation
7. Mining & Mineral Exploration
8. Forestry & Environment
9. Hazard Assessment

1. Use in Highway & Traffic Engineering

(i) Topographical Survey using LIDAR (Aerial Surveying)

Topographic survey captures the essential ground features along the alignment of road though UAV (Unmanned Aerial Vehicle). The detailed field survey is carried out by high precision instruments viz. LiDAR (Light Detection & Ranging).

It provides the data in (x, y, z) format. Topo & Contour Maps are also provided by aerial survey and collects land use data including data of Bridges, Buildings, Trees and Utilities.

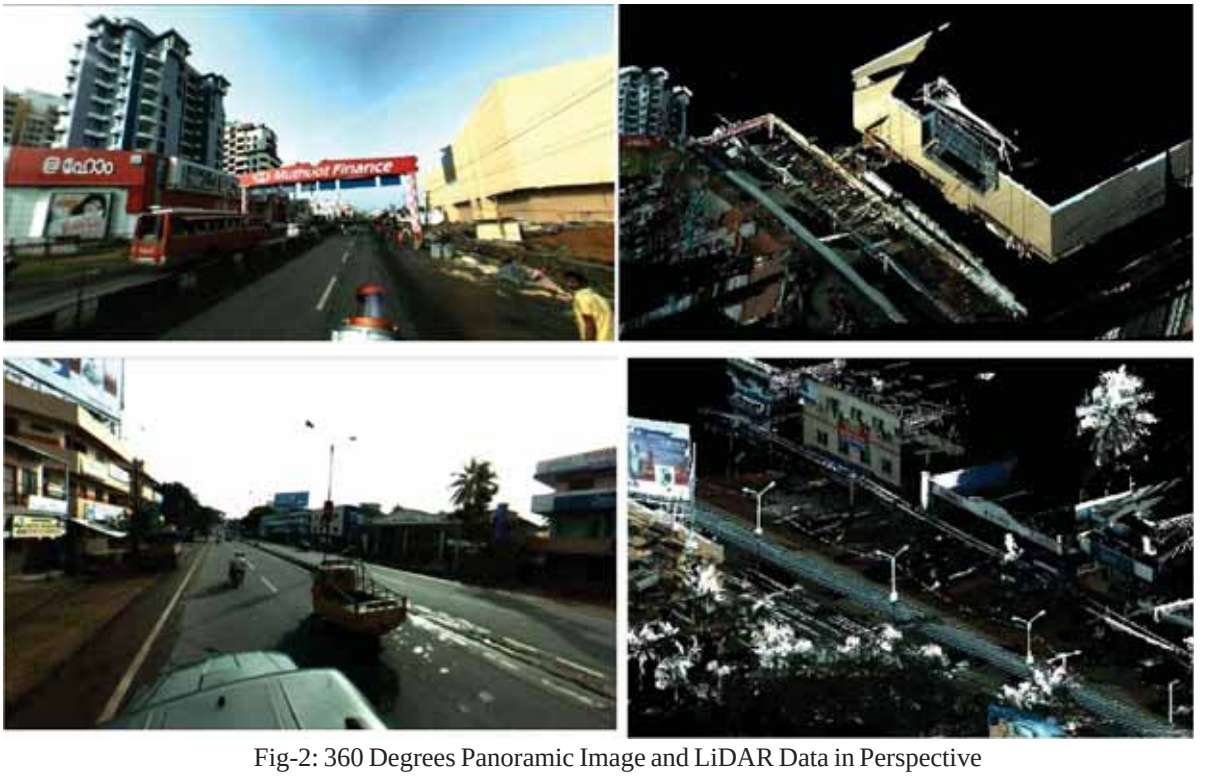

Fig-2: 360 Degrees Panoramic Image and LiDAR Data in Perspective

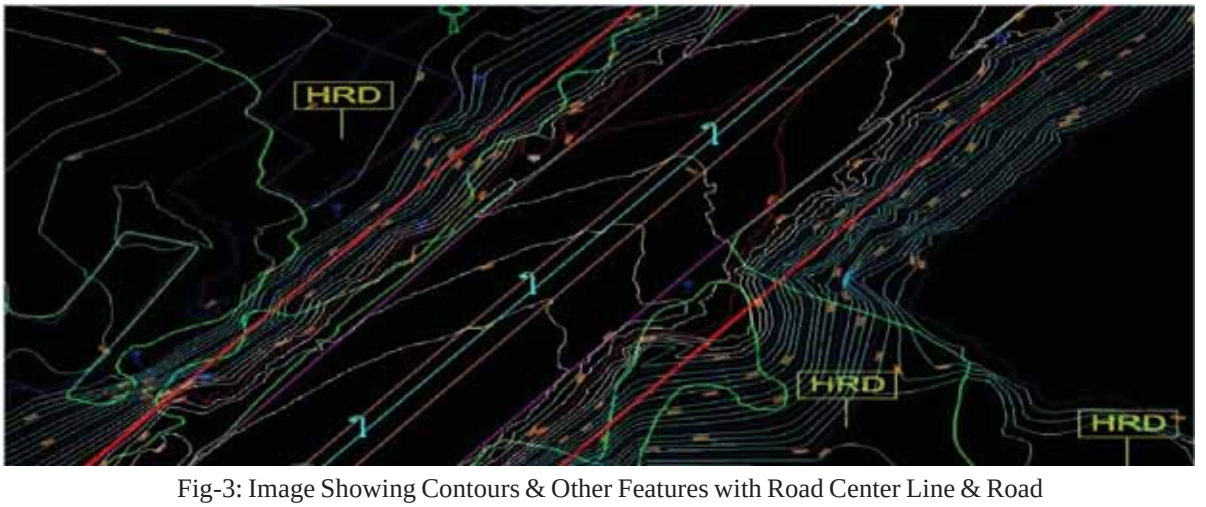

Fig-3: Image Showing Contours & Other Features with Road Center Line & Road Edge Line with Features like Trees/Lamp Post, etc. Demarcated

Type of Remote Sensing Techniques used for Highways:

LiDAR is considered an efficient way to carry out survey of the road project by leveraging the latest technology. The geographical intelligence captured by LiDAR technology helps in efficient and accurate road project planning.

LiDAR is a surveying method that measures distance to a target by illuminating that target with a laser light.

The technology is based on a scanning laser combined with both GPS and inertial technology to create a three dimensional set of 3D points i.e. 3D point cloud. Data is stored in binary format and is used in post-processing software to produce highly accurate 3D point cloud data with intensity and RGB value.

(ii) Land Acquisition Work for development of Land

Visualization of land information is the key to decision making in site selection for locating projects, acquiring land for the project and managing large estates.

Remote Sensing provides parcel level information on land attributes such as area, land type, ownership, valuation, etc.; captures and manages information on the progress of acquisition for different land categories (Government/ Private/ Forest) in the project area; facilitates query and reporting of land parameter and acquisition progress; and acts as a Decision Support Tool for efficient and effective Land Acquisition reducing Time and Cost involved in Land Acquisitions.

Fig-4: Map Showing Elevation of Terrain

2. Structural Mapping & Terrain Analysis

Remote sensing allows examination of structures for clues to crustal movement and potential hazards, such as earthquakes, landslides, and volcanic activity. Identification of fault lines can facilitate land use planning by limiting construction over potentially dangerous zones of seismic activity.

3. Geologic Unit Mapping

In terms of remote sensing, the "lithostratigraphic" units can be delineated by their spectral reflectance signatures, by the structure of the bedding planes, and by surface morphology. VIR (Visible and Infra Red) remote sensing provides the multispectral information relating to the composition of the unit, while radar can contribute textural information. Multiple data sources can also be integrated to provide a comprehensive view of the lithostratigraphy.

Fig-5: Color Code Showing Different Zones

4. Remote Sensing Applications in Geotechnical Engineering

In geotechnical engineering projects, Remote sensing techniques can become potential and indispensable tools. Various civil (geotechnical) engineering application areas include regional planning and site investigation, terrain mapping and analysis, water resources engineering, town planning and urban infrastructure development, transportation network analysis, landslide analysis, etc.

(i) Regional Planning and Site Investigations

High spatial resolution satellite data with stereo vision capability can facilitate depth perception in the above site investigations and also for regional planning of large commercial airports, harbours, industrial towns and recreational sites. Terrain information can be acquired from RS data and by generating the Digital Terrain Model (DTM). In an engineering construction like dam, the knowledge of material comprising the terrain is essential for proper planning, location, construction and maintenance of engineering facilities. For computation of hydrograph parameters like peak runoff rate, time of concentration and time to peak, the height and slope information derived from Digital Elevation Model (DEM) are useful.

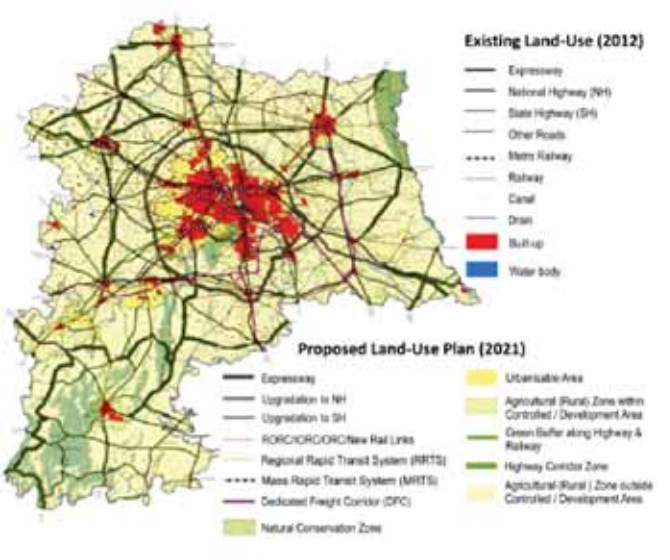

Fig-6: Land Use Plan Using Satellite Data

Remote sensing based inventory of construction material such as boulders, quarry rock, sand–clay mixtures, etc. helps in locating suitable sites of construction materials.

5. Water Resources and Hydrological Engineering

By analyzing multi-date RS data, it would be possible to monitor the effects of dam construction. Remotely sensed data of pre and post dam construction can reveal the forest and other land at different water levels. This would also help in preliminary investigation of finding suitable areas for human resettlement. Also, reservoir sites to store the surplus flows in these basins could be identified.

Such projects of large dimensions require considerations of land use/ land cover, soil and geological mapping, terrain evaluation, construction material inventory, etc. the latter are derived from satellite remote sensing data of particular resolution depending upon the scale on which such information is required.

The water storage built in through reservoirs, tanks, etc., are often reduced due to sedimentation. Remotely sensed data can be used to monitor the water bodies over time and assess the silting condition. In case of gauged reservoirs of medium to large sizes, RS data can provide an assessment of sediment volume and reduction in the capacity of sediment volume and reduction in the capacity of the reservoir.

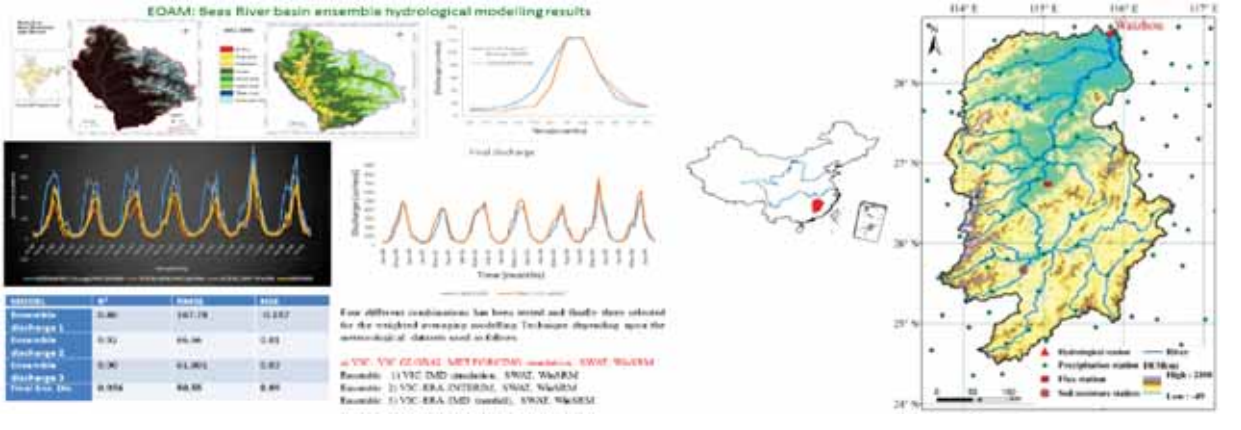

Fig-7: Figure Showing Hydrological Data Exploration & Hydrological Modeling

6. Mining and Mineral Exploration

RS data allows identification of mineral deposits in remote areas. Once a mineral deposit is identified, mining techniques are discussed. RS data gives us suitable data regarding the geological and the topographical conditions in which the mineral resource exists and this helps in planning of the mining operation particularly in tunnel engineering. Also as mentioned above minerals such as oil, limestone, etc. have important uses in manufacturing of materials for civil engineering projects and so locating their deposits is essential and RS data can help us do that economically.

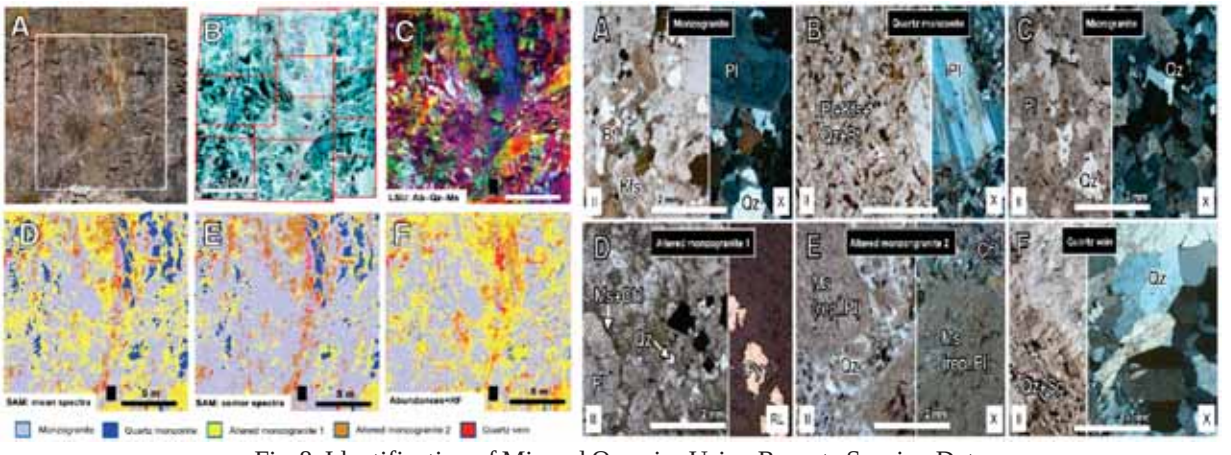

Fig-8: Identification of Mineral Quarries Using Remote Sensing Data

7. Land Degradation

Remote sensing is a useful and powerful means for monitoring and exploring land surface changes and degradation and for producing dynamic information since satellites have the ability to cover vast and inaccessible areas and provides long-term repetitive data.

Remote Sensing helps in monitoring vegetation degradation land-use, land-cover change in dry lands, drought monitoring, salinization and water logging, soil compaction and soil crusting, wind erosion, dune encouragement, water erosion, grazing and watering points, agriculture expansion and shift cultivation and human-induced desertification.

Fig-9: Land Degradation Study in India

8. Forestry & Environment

Under the GIS program, the forest maps are digitized and a forestry inventory can be updated constantly. GIS provides a way for forest agencies to manage and manipulate their databases. Landsat satellite is used to update the individual maps that need current information due to forest harvesting or forest fires.

There are many forestry applications that remote sensing can be used for. Some of these applications include terrain analysis, forest management, re-cultivation, updating of existing forest inventories, forest cover type discrimination, the delineation of burned areas, and mapping of cleared areas

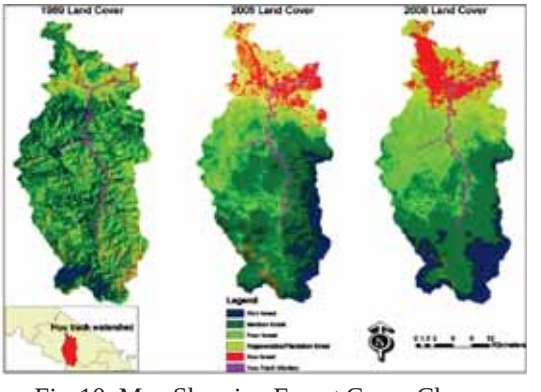

Fig-10: Map Showing Forest Cover Change

9. Hazard Management

One of the most important applications of remote sensing can be found in the case of natural disasters, where satellite imagery can be a valuable data source used in order to support rescue operations and damage estimation. With advanced studies, remote sensing can also be used to predict catastrophic events and to determine hazardous areas. It is used in classifying the type of the hazards like Flood, Volcanic Eruption, Earthquakes, and Desertification with proper formulating appropriate mitigation measures and developing response plans required for different remote sensing data sets.

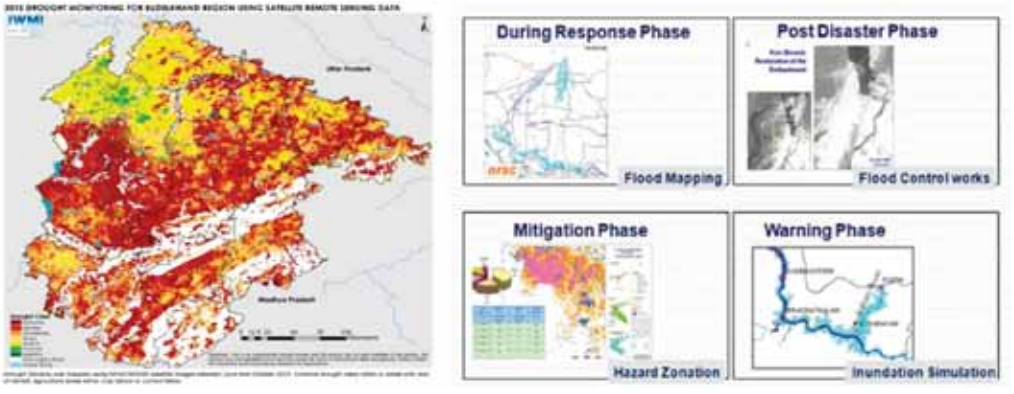

Fig-11: Drought Monitoring & Flood Mapping Using Remote Sensing Data

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Cold-atom sensors could spell end of investigative digging

The government is backing the development of new ground sensing technology that will reduce the need for investigative drilling or digging.

A UK consortium of scientific and engineering companies has come together to develop a new industry of quantum cold-atom sensors that detect and monitor objects beneath the ground better than any current technology.

The Gravity Pioneer project has been awarded £6m in research funding from UK Research & Innovation. The project is led by engineering services company RSK with 12 quantum technology partners: Teledyne e2v, Fraunhofer UK, Altran, Geomatrix Earth Science, Magnetic Shields, UniKLasers, Silicon Microgravity, Optocap, QinetiQ, the University of Birmingham and the University of Southampton.

The project aims to build and test a new gravity instrument that will have demonstrable benefits over existing technologies on the market.

Source: https://www.theconstructionindex.co.uk/news/view/cold-atom-sensors-could-spell-end-of-investigative-digging

PROCEEDINGS OF CONCREATECH 2018 – Sustain to Gain

Prof. Mainak Ghosal
Jt. Secretrary,
Coal Ash Institute of India

1.0 INTRODUCTION

There has been a positive wave of changes across the Indian Cement Industry, significantly on the front of Cement economics and sustainability. CON**CREATE**CH was Cement Manufacturers Association's endeavour to nurture a platform for discussion on a sustained basis on matters of importance across industries. CON**CREATE**CH was coined from – CONCRETE – which in Latin means to grow together. The Cement Manufacturers Association (CMA) have powered it by technology, the driving force of our times to take initiative and gave the name CON**CREATE**CH. The theme of the conference was – **Sustain to Gain** –based on the importance of infrastructure to the nation and the growing realisation towards ensuring sustainable growth. The Ministry of Environment, Forest and Climate Change, Government of India was the supporting ministry.

CONCREATECH
SUSTAIN TO GAIN

As India readies itself for the next level cusp of growth, it is more than ever looking at aligning regulatory policies with its global sustainability commitments. Whatever the drivers that are prompting change – internal necessities or external commitments – they are leading to a rethink and reorientation in business, processes and, indeed, the approach to the whole ecosystem. The quintessential need at this juncture is for an exchange of ideas and dialogue with policy makers and businesses to comprehend where the country is headed; are sustainability models really to be the order of the day, is industry in India ready to take the lead in delivering the nation's global commitments and the emergent innovative ecosystems.

Keeping that in mind, CMA chose **Sustain to Gain** as the theme for CON**CREATE**CH 2018, a platform to nurture conversations around driving business integration with developmental alternatives along with sustainability imperatives.

2.0 BRIEF DISCUSSION

CON**CREATE**CH 2018 was held on 29th November, 2018 at Hotel ITC Maurya, New Delhi. Mr. Hardeep Singh Puri, Hon'ble Minister of State (Independent Charge) for Housing & Urban Affairs, Government of India was the Chief Guest and talked about the target set by the government, the achievements so far and the planning undertaken. A Booklet for school children was released by him, in which thirty students from three different schools in Delhi participated.

Lighting of Lamp by Chief Guest, Hon'ble Minister, Mr. Hardeep Singh Puri; Ms. Aparna Dutt Sharma (extreme left), Secretary General, Cement Manufacturers Association

The 1st session on '*Building The Nation: Perspectives and Prospects*' provided a perspective on the global cement industry, the regional context and offered critical insights into the trends shaping the Indian Cement Industry, the market drivers and the medium long term outlook. The Speakers were Mr. K.K. Maheshwari, Managing Director, Ultra Tech Cements Ltd.; Dr. Pronab Sen, Country Director International Growth Centre's India Central Programme; and Mr. Thomas Armstrong, Managing Editor, International Cement Review. The session was anchored by Dr. Shubhashis Gangopadhyay, Research Director, India Development Foundation.

The 2ndsession –'*Sustain-Abilities….For A Shared Future*' deliberated on the commitment to Sustainable Development Goals (SDGs) Agenda 2030 which demand a public private partnership of a new order in India like elsewhere. The decision makers, the experts and industry for insights on the evolving scenario(both globally and in the Indian context) dwelt on how does India aim to create a Sustainability Convergence Matrix based on trusteeship and shared goals that is ecofriendly, inclusive and growth oriented. The Speakers were Mr. Hardik Shah, Indian Administrative Service, Ministry for Environment, Forest & Climate Change, Government of India; Mr. Tony Henshaw, Chief Sustainability Officer, Aditya Birla Group; Ms. Sue Zielinski. Michigan University and Harvard Institute of Design, formerly Managing Director, SMART (Sustainable Mobility & Accessibility Research Transformation); Mr. Siddharth Hande, Founder/ CEO, Kabadiwalla Connect; and Ms. Claude Lorea, Cement Director, Global Cement and Concrete Association. The session was anchored by Mr. *Dilip Yadav*, Founding *Partner of First Partners*. Mr. Sujogya Kumar Dash, Managing Director, Xcoal Energy & Resources India Pvt. Ltd., Luncheon Sponsor, presented the value prospects of Thermal coal in the Indian market.

View of Audience

The 3rd session was on '*Against All Odds: The Role of Leadership and Vision*'. It is said that persistency and resolution with abilities to anticipate, align to changing realities and navigation through deep waters sets the leaders apart from the ordinary. It is therefore fit to learn from success stories of those who turned around business fortunes and built legacies. CMA invited the stalwarts in India to yet again reimagine the future in the race to win and sustain progress. The Speakers were Mr. H M Bangur, Managing Director, Shree Cement; Dr. Shailendra Chouksey, President, Cement Manufacturers Association, India & Whole Time Director, JK Lakshmi Cement; Mr. Puneet Dalmia, Managing Director, Dalmia Bharat Group;. Prof. Dipankar Gupta, formerly associated with Jawaharlal Nehru University, Delhi School of Economics& regular columnist with The Times of India, The Hindu & serves the board of Reserve Bank of India, & the National Bank for Agricultural and Rural Development(NABARD); and Mr. Ajay Kapoor, Managing Director & Chief Executive Officer, Ambuja Cements. The session was anchored by none other than a very famous investigative journalist, Ms. Navika Kumar, Managing Editor, Times Now.

The session thereafter was on '*Driving The Cogs Of Progress*' that are critical to India's ambitious infrastructure growth plans and are its majestic supply chains, which carry its freight: Roads almost 65% of freight, Railways ~ 26%, Inland Waterways ~ 0.15%, within India and shipping almost 95% outside India. The government intent to ensure a seamless movement of goods, a right mix of inter modal transport, an integrated IT infrastructure and smooth coordination across all regulatory Ministries and stakeholders was also discussed. The panel also deliberated on the prerequisites and efficiencies for last mile connectivity across India. Ithad speakers like Mr. Alok Ranjan,

ICAS, Member Finance, Inland Waterways Authority of India, Government of India; Dr. Anjan Chatterjee, Chairman, Conmat Technologies Pvt. Ltd. & former Whole time Executive Director, ACC Ltd.; Mr. Manoj Srivastava, Executive Director, Traffic Transportation, Railway Board, Government of India; and Mr. Arun Salve, President (Logistics) Ultra Tech Cements. The session was anchored by Mr. Gaurav Choudhury, Deputy Executive Director, Moneycontrol.com.

The last session on 'Mapping the Low Carbon Footprint Journey in the Indian Cement Industry' stressed on the ambition to spread adoption of low carbon solutions. During the session it was mentioned that beyond Cement Sustainability Initiative (CSI) membership, the Cement Industry developed the Low Carbon Technology Partnerships Initiative (LCTPi) in 2015 and together with the CSI focused its efforts on scaling up its climate tools. In 2018 the CSI updated its 2009 Global Cement Technology Roadmap, which was the very first sect oral roadmap developed by any industrial sector in cooperation with the International Energy Agency (IEA) paving the way for more than 20 additional roadmaps to be developed. The CSI in India subsequently embarked on a project to review the impact of activities after the release of the Low Carbon Technology Roadmap for the Indian Cement Sector and to outline further support required on technical, policy and financial dimensions to achieve the roadmap targets from2020 onwards. '*The Low Carbon Roadmap - Status Review Report*' for the Indian Cement Sector was released during the session, to give the progress that has been achieved since the release of the 'Low Carbon Roadmap of Indian Cement Industry' in 2013,. The session Speakers were Mr. Philippe Fonta, Managing Director, Cement Sustainability Initiative, World Business Council for Sustainable Development; Mr. Mahendra Singhi, Vice President, Cement Manufacturers Association, India & Managing Director and CEO, Dalmia Cement (Bharat) Limited; Mr. Jamshed Cooper, Managing Director, Heidelberg Cement India, Limited & Zuari Cement Limited & Chair, CSI in India; Mr. Benjamin Sport on, CEO, Global Cement and Concrete Association; and Mr. Ramesh Ramanathan, Head Investments for Manufacturing, Agri-businesses & Services, South Asia, IFC. Mr. Gaurav Choudhury, Deputy Executive Director, Moneycontrol.com, anchored the session.

Launching of CMA website by Dr Shailendra Chouksey (second from left-2nd), President, Cement Manufacturers Association, India while Ms. Navika Kumar(extreme left-2nd),Managing Editor, Times Now looks on.

3.0 CONCLUSION

To foster an exchange of ideas and dialogue with policy makers and businesses to comprehend where the country is headed, CMA for the first time designed a High-Level One day Conference (CONCREATECH 2018). It had its own measures of strength and weaknesses, though the strength outnumbered the latter. In India, universities have reasonably good research facilities and can take development ideas forward. However, there must be academia-industries interface so that firms promoting research and the universities who undertake them ensure that they deliver results and make the venture a success. Currently, research and development in the country is generally confined to a narrow circle of

academicians and end in conferences or seminar or journal papers or reports with very little industrial applications since very few industries interact with the universities/ academic institutions. The main challenge of transfer of R&D from laboratories to field lies in organizing, implementing and directing the research efforts in a well-coordinated manner through appropriate collaboration [1]. Research and development must have strong linkages with industry for meeting socio-economic goals [2]. University professors and the young research scholars working under the professors comprise an enormous pool of expertise and resources which must be tapped to solve many a challenging problems faced by the society in the fast changing world with global competition.

A major problem that is faced by educational, research, consultancy and industrial institutions today is how to attract and retain qualified and meritorious persons [CEAI, 2017].A large number of such persons leave their motherland for higher education abroad for better pay and perks, congenial environment for research, freedom of work and above all due recognition of their achievements[3].CMA should outreach its arms and extend its platform to include in its panel, the academic researchers in the cement – concrete sector as well as it has done for other faculties like economics.

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MACKINAC BRIDGE SENSOR TESTBED EXPANDED

MARCH 5, 2019

MIDWESTSTRUCTURES + BUILDINGSTRANSPORTATION

St. Ignace, Mich. — The first 20 prototype infrastructure sensors installed beginning in 2016 on the Mackinac Bridge, powered solely by vibrations from traffic, have proven their durability and performed as intended. Now researchers from Michigan State University (MSU) and Washington University in St. Louis (WUSTL) are ready to roll out the next phase of testing, installing up to 2,000 of the tiny devices to both explore the logistics of a large-scale deployment and provide useful monitoring data to the Mackinac Bridge Authority (MBA).

MSU associate professor of civil and environmental engineering Nizar Lajnef gave a presentation to the MBA board today detailing those next steps.

"The successful large-scale deployment of this novel low-cost sensing technology will dramatically transform the economics of bridge preservation/management and ultimately improve the serviceability of bridges," Lajnef said. "We also will explore how the collected data could be used for improved cost-effective, condition-based maintenance of the Mackinac Bridge structural components. We are very excited that this will be the first fully instrumented bridge in the country using advanced wireless and self-powered monitoring technology."

CEAI NEWS

BRIEF REPORT ON "NATIONAL WORKSHOP ON NATIONAL BUILDING CODE OF INDIA 2016 AND REVISED SEISMIC CODES", GUWAHATI 11TH & 12TH JANUARY, 2019

– A CEAI Event

A two day ***"National workshop on National Building Code of India 2016 and Revised Seismic Codes"*** was held in IIT Guwahati, organised by **Consulting Engineers Association of India (CEAI)** together with **Bureau of Indian Standard (BIS)** and **IIT Guwahati** as knowledge partner, on 11th and 12th January, 2019. Academicians, the Civil, Structural and MEP consultants who have contributed to the revised codes were present in the workshop, and shared their domain knowledge on the recent revisions in the codes and various other aspects of design of structures.

The event was attended by delegates from not only the North Eastern states of India but also from other parts of the country including J&K, Dehradun, Karnataka, etc. Amongst them there were designers, design checkers, contractors and administrators. Out of more than 125 attendees 70 were sponsored delegates who came from the organisations like Northeast Frontier Railway (NFR), National Highway and Infrastructure Development Corporation (NHIDCL), Kailasahar Municipal Council from Tripura, National Institute of Technology from Srinagar, Public Works Department (PWD) of Arunachal Pradesh and Himachal Pradesh, Central Public Works Department (CPWD), Indian Oil Corporation, Fire & Emergency Service from Assam and many other private organisations. The workshop was also attended by post graduate students from IIT Guwahati and other Engineering Institutes from Assam.

Amongst the speakers there were Mr. Arun Kumar, Scientist (Civil Engg.), BIS, who gave an overview of the new NBC 2016; Mr. S.K. Dheri, Former CFO of Delhi Fire Service, who spoke on Fire and Life Safety; Ms. Shruti Goel, Director, Proion Consultants, who spoke on Building services like Electrical Installations; Mr. Aman Deep Garg, Creative Design Consultants and Engineers P. Ltd., who spoke on Hill Area Development – land slide

assessment and control; Professor C. V. R. Murty, Institute Chair Professor of IIT Madras, who spoke on overview of current seismic code IS-1893(Part 1): 2016; Dr. Anjan Dutta, Professor, IIT Guwahati, who spoke on Modelling of Bridges for Seismic Analysis; Mr. Sumatra Sengupta, Chief Manager (Design), STUP Consultants Pvt. Ltd., who spoke on Concept of Limit State Design and Seismic Design Principle; Dr. Kaustubh Dasgupta, Professor, IIT Guwahati, who spoke on Modelling of RC Frame Building for Seismic Analysis, Dr. Nitindra Nath Som, Rtd. Professor of Jadavpur University, who spoke on Structural Design – Soils and Foundation and Under-Ground Construction; Dr. Rupen Goswami, Professor, IIT Chennai, who spoke on Design & Detailing issues of IS-1893 (Part 1): 2016 & IS-13920:2016; Dr. Hemant B Kaushik, Associate Professor, IIT Guwahati, who spoke on Seismic Retrofitting of Unreinforced Masonry Building; Dr. Sajal Kanti Deb, Professor, IIT Guwahati, who spoke on Fundamentals of Seismic Retrofitting of RC building.

The event was inaugurated by Mr. N. K. Prasad, GM Construction of Northeast Frontier Railway. A more than half an hour questionnaire session was held at the end which turned out to be very interactive. The two day work shop was found to be a great success, both from organiser's end and from the benefits that accrued to the participants.

IIT Guwahati provided the event infrastructure and student volunteers working under Prof. Anjan Dutta that made the entire event a seamless, efficient and enjoyable one.

CEAI-IIC LECTURE SERIES

CEAI, jointly with the India International Centre, New Delhi is organising a series of six Lectures on ***'Engineer & the Society'***. The Lectures commenced in August 2018. The last lecture in the series was held on 12th January 2019.

SIXTH LECTURE

The sixth lecture in the series held on 12th January 2019 was on ***"New Energy Resources"***. The Chairperson was Mr. Abhilakh Singh, General Manager, Indian Renewable Energy Development Agency (IREDA).

The speakers were Dr. Jami Hosain, Vice President and Technical Chair, World Wind Energy Association, and Dr. Bibek Bandyopadhyay, Sr. Advisor, E&Y, Former Director Solar Energy Centre MNRE.

Dr Jami Hosain delivering his presentation

Mr. Abhilakh Singh, Chairperson addressing the participants

Dr Bibek Bandyopadhyay delivering his presentation

WEBINAR ON ENGINEERING SOLUTIONS FOR SANITATION

CEAI organised a webinar presentation on ***"Engineering Solutions for Sanitation"*** on 29th January 2019.

The presentation was by Ms Jyoti Verma, a Civil Engineer – Environmental Planner who is currently working as a Support Engineer in Tata Consulting Engineers.

CEAI AGREEMENT WITH TAYLOR & FRANCIS GROUP FOR PUBLICATION OF WORKS BY CEAI MEMBERS

Taylor & Francis Group (T&F) an INTERNATIONAL publisher of academic and scholarly books and journals under various imprints including Taylor & Francis and Routledge Internationally, is amongst the top four STEM publishers.

CRC Press is the imprint for its publishing in science, technology, engineering and mathematics.

T&F desired to expand its reach and hence approached CEAI to introduce T&F to its members who can write scientific, technical and academic works with a view to T&F potentially publishing those works.

GC formed a committee to get the views from members and potential authors and to study the benefits of the venture to CEAI, in enhancing its branding and visibility.

After due diligence and several rounds of discussions with Taylor and Francis representatives in India, the CEAI Committee signed the MOU between CEAI and T&F in December 2018.

The highlights of the MOU entered into with T&F is available at the CEAI website https://ceai.org.in/wp-content/uploads/2019/02/CRC-Press-Agreement-for-CEAI-Website.pdf

CEAI members may please intimate their willingness to write books, monographs, textbooks, short form and handbooks of interest, as per MoU.

Organisations can use this opportunity to encourage their 'Experts' to turn 'Authors'.

ADVANCED WORKSHOP ON STEEL DESIGN

CEAI in association with Institute For Steel Development & Growth (INSDAG), IIT Bombay, Centre of Excellence in Steel Technology (CoEST) at IIT Bombay and IIT Madras brings the ***Advanced Workshop on Steel Design***

which will be held on 14th & 15th June 2019 in Mumbai.

For the benefit of those who missed the earlier two, there will be a quick recap of some basic principles to refresh and bring everyone on par.

One of the main topics, in view of the numerous ***FIRE*** incidences that have occurred in urban and industrial areas, would be the design of steel structures treating fire as a design load on the structure.

The second main topic would be relating to ***SEISMIC forces***, since analysis and design to deal with those forces have become more intensive. Hence those aspects along with the joint designs will be other thrust areas.

A third topic of great interest would be ***WELDING***, which drew tremendous attention last time, and is a major connection procedure.

Presentations will be made by faculty from IITs, INSDAG and Consulting Organisations.

FIDIC NEWS

FIDIC ASPAC CONFERENCE IN 2019

CEAI is organizing an International Conference involving ASIA – PACIFIC Countries along with FIDIC, an International Association of Consulting Engineers.

The Conference theme is ***"QUALITY INFRASTRUCTURE FOR CLEAN AND SUSTAINABLE DEVELOPMENT"*** and will be held at Le-Meridien Hotel, New Delhi from 7th to 9th July 2019.

ASPAC represents the consulting engineering industry in Asia and Pacific Region as the regional grouping of FIDIC Member Associations. ASPAC has 22 member countries. The main objective is to encourage regional cooperation amongst the member associations by sharing and enhancing knowledge on the different infrastructure requirements of each country.

Many of the member associations of ASPAC are investing significantly in infrastructure development not only with their own financial resources but also with funding from MDBs. This conference will provide Member Associations (MAs) of FIDIC a platform to share and interact for mutual benefit.

Players from across the world are expected to come for exploring business opportunities and building partnerships.

The objective of the Conference is to encourage regional cooperation by sharing and enhancing knowledge on the different infrastructure requirements of each country.

For more details please visit conference website **http://www.aspacdelhi2019.com/**

ACCREDITATION OF DR. DHAVAL PARIKH AS FIDIC TRAINER

Taking note of the vast knowledge and experience of Dr. Dhaval Parikh on the FIDIC Contract Documents, FIDIC has signed an agreement with him as a FIDIC Accredited Trainer. Dr. Parikh is the first Indian to become a FIDIC Accredited Trainer.

WORLD BANK SIGNS FIVE-YEAR AGREEMENT TO USE FIDIC STANDARD CONTRACTS

International engineering federation FIDIC (the International Federation of Consulting Engineers) has secured a major agreement with the World Bank that will see the international funding organisation adopt the use of six FIDIC standard contracts for the next five years.

Under the terms of the agreement, FIDIC has granted The World Bank a non-exclusive licence to refer to the six major FIDIC contracts (see list in notes below) for projects they finance and the documents will be used as part of the Bank's standard bidding documents. The contracts mainly include the 2017 Second edition FIDIC contracts, which cover a wide range of international construction and infrastructure work, and The World Bank's move represents a major endorsement for the contracts from a major international funding organisation. FIDIC also expects to announce a similar agreement with the other multilateral development banks.

FIDIC Chief Executive, Dr. Nelson Ogunshakin said: "This is a major development for FIDIC and we are delighted that The World Bank has agreed to adopt our 2017 editions of the Rainbow suite of contracts and use them as a key part of their standard bidding documents. This will create more certainty in the market as by adopting the FIDIC contacts on major projects, The World Bank is saying that they endorse the fair and balanced approach that these documents offer to parties on major construction contracts. The familiarity that the FIDIC contracts bring, make them easier to get projects underway as many of the typical commercial risks are clearly addressed in the contracts and all the parties understand their obligations and responsibilities.

"Endorsement by The World Bank should provide additional comfort to the financial, institutional and private equity investors operating in the global market to adopt the use of FIDIC standard procurement contracts as an effective tool to mitigate the risk associated with investable infrastructure asset class. Over the coming months, we will be working with our member associations and strategic partners to ensure that the FIDIC 2017 contract editions are translated into five major languages - Arabic, Chinese, French, Portuguese and Spanish - to aid effective use across The World Bank and other multilateral development banks' operating countries."

Commenting on the signing of the agreement, Enzo De Laurentiis, Chief Procurement Officer at The World Bank, said: "We are very pleased to continue to build on our long collaboration with FIDIC by adopting the standard conditions of contracts in the 2017 suite for use in projects financed by The World Bank, as appropriate and complemented by our Conditions of Particular Application (COPA). Together, the 2017 FIDIC standard conditions and our COPA, will ensure that infrastructure contracts financed by The World Bank continue to be based on an internationally recognised standard and reflect key aspects of our policies and practice related, among others, to managing environmental, social and integrity risks."

FIDIC President Alain Bentéjac said: "This move by The World Bank represents major international market buy-in for our FIDIC 2017 Second edition contracts and one that we hope will also influence the supply chain to adopt FIDIC contracts thereby creating even more certainty in the planning and delivery of major international construction and infrastructure projects. We look forward to continuing our strong partnership with the World Bank and the other multilateral development banks (MDBs) over the coming years."

Notes

The six FIDIC contract documents covered by the FIDIC/ World Bank agreement are as follows:

- Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer ("Red book"), Second edition 2017;
- Conditions of Contract for Plant & Design-Build for Electrical & Mechanical Plant & for Building & Engineering Works Designed by the Contractor ("Yellow book"), Second edition 2017;
- Conditions of Contract for EPC Turnkey Projects ("Silver book"), Second Edition, 2017);
- Client/Consultant Model Services Agreement ("White book"), Fifth Edition 2017;
- Conditions of Contract for Design, Build and Operate Projects ("Gold book") First Edition 2008; and
- The Short Form of Contract ("Green book"), First Edition 1999.

ASPAC AWARDS 2019 – CALL FOR NOMINATIONS

ASPAC Secretariat has invited nominations for ASPAC

Awards 2019. Award documents were circulated to all members. The nominations should reach ASPAC Secretariat before 3rd May 2019. The results will be announced and presented during ASPAC Conference scheduled to be held in Delhi in July 2019.

For more details please contact CEAI Secretariat.

OTHER NEWS, VIEWS & NOTES

BRIEF REPORT ON ONE-DAY CONSULTATIVE WORKSHOP OF STAKEHOLDERS ON *"PROFESSIONAL ENGINEERS BILL"*

A meeting was called by AICTE on February 11th, 2019 at their headquarters in Delhi to hold a One-Day Consultative Workshop of Stakeholders on ***"Professional Engineers Bill".*** The persons on the dais included Prof. Surendra Prasad - Ex-Director IIT Delhi, Prof. Sandeep Sancheti – VC SRM University Chennai, Dr. M P Poonia – VCM AICTE, Prof. Rajive Kumar – Advisor AICTE. The meeting was attended by a large number of persons from professional associations and other stakeholders.

The effort of the engineering fraternity to regulate the profession through the Engineers Bill has had a long journey, and over the past decade and more it has been piloted by the Engineering Council of India (ECI), which was specifically created for the purpose. The last version of the draft Bill titled "The Indian Council of Engineers Act – 2011" when presented to the nodal ministry, the MHRD, the MHRD advised that the engineering profession could be regulated through a private initiative and did not require the enactment of a Bill at this stage. On this basis ECI started registering engineers through its member associations.

However, it was mentioned at the workshop, that the MHRD had been receiving letters from Mr. E. Sreedharan stating that there is an urgent need to regulate the profession with an Engineers Bill through the Act of Parliament. This was stated as the reason for the revival of the effort to enact the Bill and AICTE has been appointed by the MHRD to drive the initiative.

A draft document prepared by AICTE titled "Professional Engineer Bill 2019" was circulated for discussions. There were many views voiced by the members of the audience and a response was also presented by ECI that comprehensively summarises the issues, an excerpt of which is given below:

1 As the Bill is to set up a 'Council of Engineers', the composition of the Council should be given in the main Bill, and not in Annexure. Secondly, all members of Council should have same status. It is only procedural matter that some are nominated by government bodies and some are nominated by professional societies. There is no need to introduce another term 'Professional Associates'.

2 The Council should be supreme and autonomous. It should appoint or elect the Board of Governors (BOG) which should be answerable to the Council. Here the BOG has been given over-riding powers, powers to oversee the functioning of the Council and take all actions in the name of the Council.

3 The BOG is heavily weighted in favour of government and IIT/ NIT nominees. There are only 2 representatives of professional societies. There should be equal number of the representatives from these bodies. The deliberations of the BOG will be technical and professional in nature. These would require a professional head.

4 There is no clarity on division of functions between BOG and EC (Clause 7.3).

5 There are too many procedural details included in several clauses. An Act normally leaves these details to the Rules and Regulations as these may need to be amended from time to time. What will be covered by Rules (to be formulated by Government) and by Regulations (to be formulated by the Council) should be stated in the Bill.

6 The main purpose of the Act is stated 'that engineering activities are performed by qualified persons and in a manner, which facilitates sustainable development and ensures safety and welfare of the people. Thus it should ensure that the key engineering practice is undertaken only by registered PEs and other than PEs should be debarred. Such 'Practice' which only PEs can undertake, has to be defined separately. Clause 5 gives a very general definition.

The engineering practice can be divided into two parts:

(ı) Which only PEs are authorized to do - such as certification of any design, process, system, works, project, supervision of project management, etc. They will thus take the responsibility for design, works, etc.

(ıı) Which engineers other than PEs can do, such as assisting PEs, undertaking preliminary design/ project activities, not involving certification.

7 While debarring those not registered as PEs, the Act should specify the penalties if non-registered engineers undertake the 'practice' exclusively reserved for PEs. This could include monetary fines and imprisonment.

8 There should be the mention of how and by whom disciplinary action will be taken in case registered PEs do not follow code of ethics or indulge in unscrupulous activities.

9 The Council should be authorized to specify the engineering disciplines in which candidates can be registered as PEs.

10 As per Clause 8.1.5, only members of licensed members can be registered by them as PEs. This is discriminatory clause and should be removed. Any one applying for registration and meeting the criteria should be considered as per procedure.

11 In Clause 9 – The council has also been empowered to recognize support by an individual to the council, and call that individual an "Associate of the Council". The need for this clause is not understood.

References:

- Draft Professional Engineer Bill – 2019, prepared by AICTE
- Draft The Indian Council of Engineers Act – 2011, prepared by Engineering Council of India

BRIEF REPORT ON INDIA-JAPAN SEMINAR ON "ADVANTAGES OF USING STEEL STRUCTURES IN BUILDINGS AND INFRASTRUCTURE"

The Centre of Excellence in Steel Technology (CoEST) at IIT Bombay and the Indian Institute of Technology, Bombay organised a two-day India-Japan Seminar on the ***"Advantages of Using Steel Structures in Buildings and Infrastructure"*** under the India-Japan Steel Relations Program on 12th and 13th March 2019 at Mumbai.

This seminar was organised under the auspices of Ministry of Economy, Trade and Industry (METI), Japan, The Association for Overseas Technical Cooperation and Sustainable Partnerships (AOTS), Japan and Ministry of Steel, Government of India

The objective was to disseminate the need to look at steel structures as a viable alternative due to their enormous advantages over the structures lifecycle. Japan is one of the leading countries where use of steel in buildings and structures in all sectors, have increased considerably. Speakers from Japan shared the experience of Japan in promoting the use of steel in buildings and infrastructure and its advantages. Speakers from India also presented the capabilities and use of steel in India. The issues covered pertained to:

- Understanding advantages of using steel structure over life cycle
- Identifying gaps on the availability of ranges of steel sections and ranges of steel sections and products to optimize design
- Design philosophy adopted by Japan for optimizing cost and minimizing construction time
- Safety practices in steel making and fabrication
- Demand creation and increasing steel growth as envisaged in the National Steel Policy-2017
- Design for special purposes buildings like earthquake resistant buildings, marine structures, affordable housing, etc.
- Requirement of special steel and sections for optimizing cost
- Specifications and standards for steel oriented buildings
- Advanced fabrication and pre-fabrication methodology in steel buildings

Dr. Harshavardhan Subbarao, Member Governing Council and Chairman of CEAI-Western Region Centre

gave a captivating presentation on *"Steel Bridges Various Issues"*. He painted the Beauty in Steel Bridge went on to cover some aspects of Steel Bridges relevant to India. He highlighted the recent steel bridges – road and rail, built in India. They included the cable-stayed 'Signature Bridge', New Delhi; the rail-cum-road Ganga Bridge, Patna; the Bogibeel Bridge, Assam, the longest rail-cum-road bridge in India, which is also the first all welded rail bridge in India; Bridge No. 20 on Udhampur-Katra Rail Link, J&K, etc.

VIEW POINT

The next issue of the View Point will be published in ***June 2019,*** the theme for which will be ***"FUTURE OF ENGINEERING".***

Considering the experience of CEAI members and various stakeholders in the subject, CEAI would be happy to receive articles on the above theme.

Authors could share their knowledge enriched by the works executed, firsthand accounts of the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit our readers for better appreciation of the issues encountered and addressed.

The articles for June issue need to reach CEAI by 10th May 2019. Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal margin on A4 size.

Tech Quiz

1. When did Remote Sensing begin?
   a. 1800s b. 1940s
   c. 1890s d. 1920s
   e. 1840s
2. Which was India's first satellite?
   a. Aryabhata b. Chandra (AXAF)
   c. Rohini-1 d. APPLE
   e. SCROSS-C
3. Who was the first to demonstrate Remote Control?
   a. Robert Adler b. Leonardo Torres Quevedo
   c. Nikola Tesla d. Oliver Lodge
   e. Guglielmo Marconi
4. Who invented packet switching?
   a. Donald Davies b. Leonard Kleinrock
   c. Tim Berners-Lee d. Vinton Cerf
   e. Paul Baran
5. Which was India's first operational remote sensing satellite?
   a. Rohini-1 b. INSAT
   c. OcenSat-1 d. IRS-1A
   e. Bhaskara-1
6. When was the first photograph from a satellite of earth taken?
   a. 1950 b. 1959
   c. 1901 d. 1947
   e. 1899
7. What was the medium of transmission of Morse Code?
   a. Flags b. Radio waves
   c. Wires d. Flashlights
   e. Laser
8. Which was the first satellite launched?
   a. Explorer b. Vanguard
   c. Pioneer d. Sputnik
   e. Galileo
9. Who was the inventor of wireless communication?
   a. Thomas Alva Edison b. Ray Tomlinson
   c. J C Bose d. C S Tainter
   e. Alexnader Graham Bell
10. Who invented the strain gauge?
    a. Arthur Claude Ruge b. John Meier
    c. Alfred deforest d. EE Simmons
    e. Claire Bertucci

The first person who mails the correct answers to CEAI *info@ceai.org.in* will get a congratulatory mail and will be acknowledged by publishing his/ her photograph in the next issue.

Contributed by A P Mull

Answers to Tech Quiz December 2018 issue
1(c), 2(b), 3(d), 4(e), 5(a), 6(c), 7(b), 8(e), 9(d), 10(b)

Prof Mainak Ghosal, Consultant is the winner of the Tech Quiz with full/ maximum marks.

STUP Consultants Pvt. Ltd.

STUP, established in 1963, an Indo-French organization of international repute which provides design, construction engineering, technology transfer and project management services for multiple sectors.


01


02


03


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11


12

Sectors

01. Airports & Aviation
02. Environmental and Public Health Engineering
03. Energy, Telecommunication and Space Infrastructure
04. Roads, Highways, Expressways
05. Urban, Rural and Industrial Development including all Types of Buildings
06. Bridges & Flyovers
07. Railways
08. Offshore, Harbour and Coastal Engineering
09. Metros
10. Water Resources and Agricultural Development
11. Construction Engineering, Project Management and Technology Transfer
12. Rehabilitation of Structures and Heritage Buildings

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