# A quarry-to-lorry solution

**by Naresh K Verma and Rajendra K Rath, ABB Ltd, India**

*A complete quarry to lorry solution was provided by ABB to Dalmia Cement Bharat Ltd facility in Kadapa, India. The solution for the cement producer included design, engineering, supply, erection, testing and commissioning of automation, instrumentation and quality control system.*

ABB was awarded the project in June 2007 for a 4500tpd cement plant located at Jammalamadugu in Kadapa district in Andhra Pradesh, India. The automation and instrumentation was commissioned in 2009 and the quality control system in 2010.

ABB offers a full range of proven power and automation solutions in cement, mining and material handling applications. ABB in India has provided solutions to major cement manufacturers, including Grasim, Holcim, Lafarge, HeidelbergCement, JP Associates etc.

In this project the company delivered a fully-automated AutoLab solution for improved and consistent quality across the cement process.

Dalmia Cements (Bharat) Ltd (DCBL), has business interests in two major segments, cement and sugar. It has cement plants in southern states of Tamil Nadu (Dalmiapuram and Ariyalur) and Andhra Pradesh (Kadapa), with a capacity of 9Mta. A leader in cement manufacturing since 1939, DCBL is a multi-spectrum cement player with double-digit market share and a pioneer in super speciality cements used for oil wells, railway sleepers and air strips.

Dalmia Cement Bharat Limited facility in Kadapa

## Dalmia plant requirements

**Plant operation:** plant operation shall be monitored and controlled in automatic mode by operators from control rooms. There are three control rooms for the cement plant. The first is located in the limestone crusher section, the second is the central control room (CCR) and the third control room is situated in the packing plant. It is possible to monitor the limestone crusher and packing plant from the CCR in the main plant.

All the departmental level controllers along with I/O (input/output) panels pertaining to respective areas are distributed throughout the plant and located adjacent to motor control centres or integrated into the MCCs and in the field as per requirement, for real-time acquisition of process parameters and plant safety and fail-safe operation.

In each control room, plant operation is monitored and controlled from a control desk comprising colour monitors, normal keyboards, mouse etc. Sequential logic controls, interlocks, alarm generation, analog signal processing, process loops and analogue monitoring is performed by department level controllers associated with these control desks.

**Process optimisation:** advanced process optimisation applications are called 'auto-pilots' for the parts of the production process which they are configured to take care of (eg kilns or mills). The best possible control strategy is implemented and continuously applied on a computer linked with the instrumentation and control system. The system monitors and controls the kiln, cooler and for the vertical roller mills of raw mill, cement mill and coal mill process to optimise the cement production.

**Quality control:** it provides user interface to the analyser for setting the parameters, calibration and checking the system station. The man-machine interface runs Gammametrics software that processes the data from the processing electronics and calculates the analytical results.

**Display:** there is display of data such as current analysis and trending. The main server is located in central lab at plant CRR and one additional console is installed at mines office/LS crusher control room for the continuous monitoring and taking corrective action at the mining end, based on results. The quality control performs the following functions:

- acquiring data from user and the analyser
- managing the database of analytical information
- displaying trend graphs, analytical results, equipment status
- alarm generation
- supports process control function (pre-blending optimisation system)
- communication with plant control system.

**Instrumentation:** instruments for the production process are installed for a safe and secure plant, as well as a stable

process operation meant for the cement plant, ie crusher, raw mill, kiln/cooler, coal mill, cement mill and packing plant for process control and monitoring, machinery and human safety are necessary for the safe, efficient operation.

**Engineering, erection and commissioning:** the solution consists of complete automation, instrumentation and quality control system engineering like I/O list preparations and assignments, CCR and laboratory layout, development of graphics, logic developments for plant controls, log/trend and report generations, software and hardware engineering for controller/I/O, MIS, LIMS, panels and laboratory equipment. Control, instrumentation and communication cable schedule and interconnection were provided by ABB. Erection and supervision of supplied and free supplied equipment/ material and commissioning were also performed.

## ABB solution

### Process control

The complete cement plant is monitored and controlled by ABB's distributed control system (DCS) Industrial$^{IT}$ 800xA improving process control and managing information effectively to maintain reliable operation, cost-effective production, producing consistent, high-quality cement, caring about environmental responsibilities which is configured at three levels.

### Level I: process control

Processor and I/O cabinets are installed in the respective sub-stations, where the intelligent motor control centres, sub control systems and DP/ PA Devices are located and connected via fieldbus.

### Level II: operator workstations

The operator stations, aspect and connectivity servers are located in the central control room, where the connectivity serves as the main connection between levels I and II. Both the plant and the control networks are redundantly connected to operator stations, servers and processors. Process control and operator interface are based on the ABB System 800xA Minerals Library. This unique object-oriented software module allows the design of process control and power applications in a modern, efficient and fully parameterised fashion. The technology significantly increases the standardisation, functionality and quality of the process control software over the complete life cycle of a factory.

Where plant operation required a local operation, a local control room was designed with an operator station and reporting printer, for example, in the lime stone crusher area and packing area.

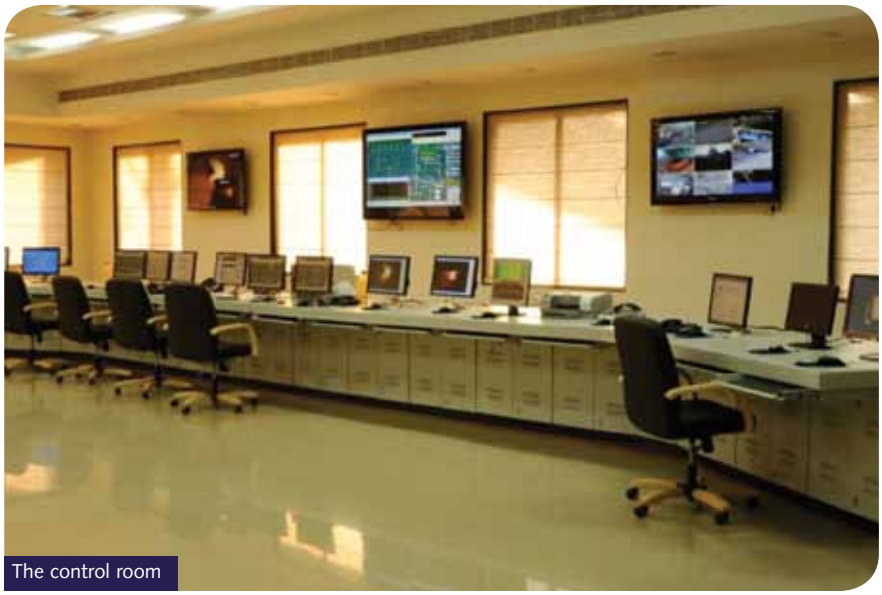
### Level III: raw material proportioning, expert optimisation and management

A raw material proportioning (RMP) system, based on ABB's Expert Optimizer system, ensures a consistent raw material quality using an online gamma ray analyser signal to calculate the required percentage of limestone and shale. Its second function is to mix the raw material components according to the required clinker/cement qualities by calculating the required additives of high-grade limestone, bauxite and iron ore to the main mix raw material. The result of laboratory analysis enabled the RMP system to calculate and control the amount of additives to be added continuously.

Optimize$^{IT}$ Expert Optimizer is a computer-based system for controlling, stabilising and optimising cement production processes. It implements automatic online set point adjustments to achieve the targets. The revised set points are calculated within the expert system server, based on the current state of the process and while using embedded process specific knowledge. For example, new calculated values for kiln feed, fuel flow and fan damper position are then sent automatically to the kiln control system. This drives the process towards the optimised kiln targets.

The site-specific information and configuration was revised, which provided the opportunity to implement a new and simplified strategy. This brought benefits in terms of a more robust strategy and made things easier for the maintenance teams and the operators.

A further installed system is the ABB Knowledge Manager system, collecting data from the whole plant including laboratory system, preparing production reports for the operators and the plant management.



The control room

## Laboratory automation

Samples are taken automatically by sending stations installed in the field at their respective station from predefined locations, at specified intervals and dispatched via pneumatic tubes to the laboratory. In the laboratory, the samples are taken over by an automatic receiving station. Thereafter, a robot takes over the sample cup and loads it into the preselected laboratory equipment, ie grinding mill, pelletising press etc. According to the type of material, the sampling method and the laboratory equipment installed, all the necessary tasks required are fulfilled within the laboratory. The operation is controlled and monitored by a separate control system in laboratory. Necessary quantities of sample material are prepared into sample cups. The system is designed for analysing 18 samples per hour (four samples each from the raw mill, kiln feed, cement mill and packing


Automatic sampling and preparation

plant sections and two from clinker cooler section).

Waste or excess material from the complete cycle within the lab is removed by way of a dedusting system and emptied into a separate container outside the laboratory. The equipment is cleaned and prepared for the next sample continuously. The results of samples, which are analysed by different equipment, are communicated/transferred via serial links to the Laboratory Information Management System (LIMS). In LIMS, the data shall be stored for analysis, quality control reports, etc. It can also be tailored for cement plant information management.

The ABB scope of supply included XRF/XRD, pelletiser, grinding mill, automatic sampling system, Laboratory Information Management software, online/offline particle size analyser and robot.

## Instrumentation

The scope of instrumentation includes field instruments, transmitters for measuring temperature, pressure, air/water flow, gas analysers, level either continuous or point type, vibration, position, speed, zero speed monitoring, temperature measurement devices, pressure, differential pressure measurement devices, flow measurement devices, level measurement devices, dust monitoring system, kiln shell scanner, general purpose CCTV system, public address system and telephone exchange system, etc.

## UPS system

UPS systems with an output of 220V AC are installed for control systems offered, MMI stations, I/O and field instruments, QCX lab systems in main plant, LS crusher, stacker/reclaimers and for packing plant separately. A further 220V AC UPS systems are installed in different e-rooms to maintain power for the control systems, as well as providing essential lighting.

## Engineering

The scope included layout and general arrangement of sub-stations, control rooms and laboratory showing equipment orientation and cable opening, interfacing of sub-control systems supplied with mechanical equipment, estimation of requirement of type and sizes of power, instrumentation, data and control cables. Cable schedule and termination details for complete process control and instrumentation including power supply cables for instruments, field bus cables, sensor cables, instrument wiring diagrams showing hooking-up details between field mounted instruments, JBs, IPDBs and control panels, general arrangement drawing of control desk, processor panel, I/O panels, UPS distribution boards, JBs, IPDBs, instrument panels and spectrometer, sample preparation equipment and accessories were part of the offering.

Schematic wiring and terminal diagrams of processor panels and I/O panels, I/O assignment list showing panel, rack and channel identification for various group level processors integrating the requirement for MCCs, motors, instruments, sub-control systems. Detailed block interlocking diagrams (BID), process function diagrams, requirement of field junction boxes/power distribution boards for instruments/field bus components, instrument installation drawings, showing mounting details connection details for impulse pipeline with manifold and mounting details of accessories.

## Erection and commissioning

Scope of work included erection and testing and commissioning and handing over of complete DCS system, UPS, field Instruments, installation materials, sub-control systems and field instruments (supplied by main machinery supplier).

The testing and commissioning of sub-control panels and special instruments supplied by main machinery were carried out by commissioning engineer of the supplier of equipment. Expertise required to interface the sub-control panels and special field instruments with plant DCS system was provided by ABB.

## Documentation

Documentation covered complete as-built documentation of detailed engineering drawings and software. All documents viz drawings, GA, block diagrams, schemes, circuit diagrams, bill of materials, write-ups, instrument list, test and calibration reports, loop diagrams, PID, interlocking diagram, field bus, control layer and MMI layer network diagram, network calculations, I/O charts, specification sheets, manuals, installation/operating instructions, catalogues, hardware/firmware/software manuals, testing/setup/configuration/calibration/tuning/commissioning/ maintenance instructions or manuals, tag list, EMS, MIS, documentation software, etc controller and MMI software listing were provided as per the comprehensive documentation.

## Conclusion

Dalmia Cement benefitted from ABB's automation, instrumentation and quality control system which have been configured in such a way that the entire plant can be monitored and controlled from the central control room, with the delivered products mostly coming from ABB. The interfaces, which are a critical element, have been brought to universally-accepted standards. ABB has delivered a fully-automated AutoLab solution for better and consistent quality across the cement process in the plant. The dedicated solution is aiding the customer to raise productivity and achieve higher levels of control, while monitoring every process.