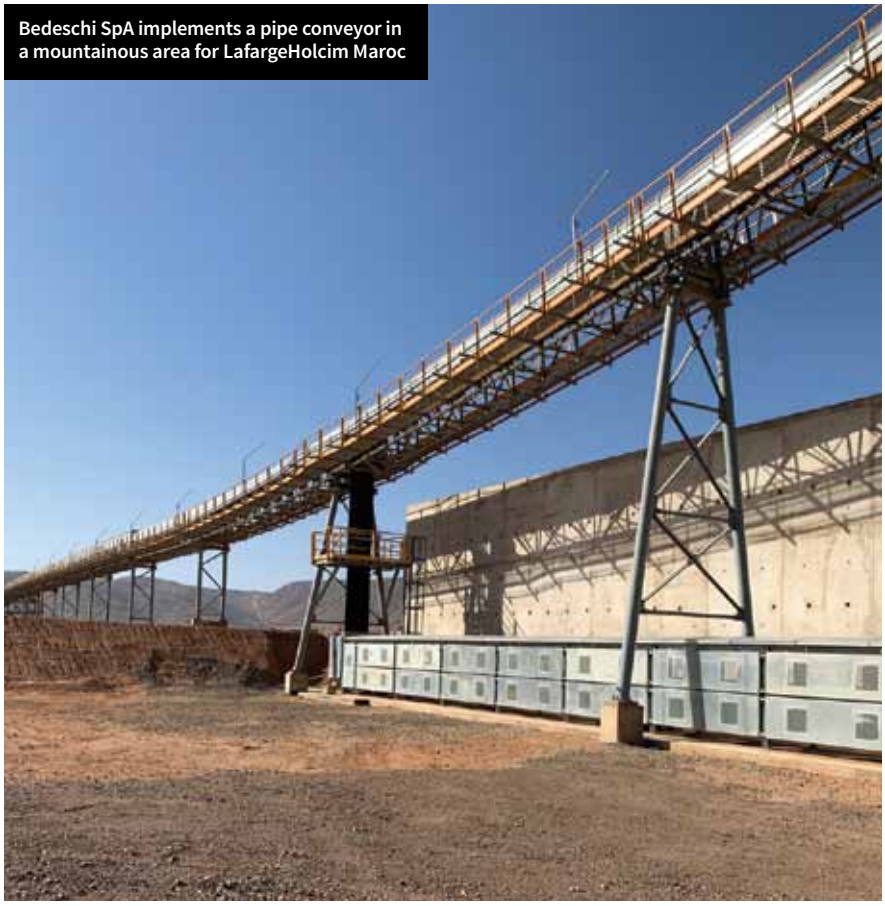
Access all areas

For LafargeHolcim Maroc's new cement plant in Agadir, EPC contractor Bedeschi SpA has implemented a 4.8km overland belt conveyor to transport limestone to the works. Given the mountainous location and altitude of the quarry, project implementation required innovative, smart solutions to overcome constraints, adhere to the construction timeline and meet the highest safety standards.

■ *by **Riccardo De Guio and Emanuel Bombasaro**, Bedeschi SpA, Italy*

As part of a wide development programme implemented by LafargeHolcim Maroc, the company selected Bedeschi SpA as the major EPC contractor for the construction of a new cement plant with a clinker capacity of 3500tpd. The project, situated in the rural area of Souss, Agadir (southern Morocco), included the design, procurement and construction of a new belt conveyor to assure the transportation of crushed limestone from the quarry to the cement plant. The quarry is situated on a mountain, 470m higher than the plant and approximately 4.8km from the cement works. The sole feeding line to the plant, the belt conveyor has a strategic impact on reliability of operations. The project had to be completed in just 20 months, including the topographic survey, engineering design, procurement of structures and equipment, civil works and mechanical erection.



Bedeschi SpA implements a pipe conveyor in a mountainous area for LafargeHolcim Maroc

New technologies for the engineering phase

"Long-distance belt conveyors are fascinating structures to design. They request attention to all details in the context of overall project constraints. The implementation of the modular structural system into Tekla structures allowed us optimise and adapt the structures to the new constraints as they became apparent," notes Emanuel Bombasaro, project engineer at Bedeschi SpA.

Given the hard environment, a detailed topographic survey was conducted to allow the engineering team to identify slopes, natural deviations and possible obstacles for the construction of the conveyor.

The optimisation of engineering to adhere to the client's budget was the driving factor. The importance of achieving a certain economy of scale for the structure with regular spans and trestles to allow quick and easy production was enabled by identifying typical trusses and standard trestles. The conveyor was finally subdivided into 259 trusses of 18m and 15m spans, 21 standard access towers and a special 30m truss girder designed to cross a gorge.

The design was tailored to the natural conditions of the area and adhered to the slopes as much as possible. Different erection methodologies were allowed to maintain the adequate height of trestles. This allowed the client and contractor certain freedom to evaluate construction techniques and keep various constructions solutions open, even while single elements were being produced.

Based on these premises, the project had already become quite complex during the engineering phase. However, by implementing new technologies such as those by Tekla Structures and Trimble Connect, it was possible to increase the control of quantities and reliability of the production process.

The combination of these two technologies also improved the quality and timeframe of the design. Indeed, Trimble Connect was essential in sharing models between the different agents driving the project. This allowed the deep and continuous control of interfaces and a high degree of flexibility from design desk to project site.

View of the mountainous area towards the cement plant

"The erection of assembled trusses in the mountain area has been an impressive challenge for our team.... Only with a smart solution, as the cableway is, has it been possible to reach such tight targets."

Riccardo De Guio, project manager, Bedeschi SpA

Erection of heavy trusses in inaccessible areas

For the construction of the heavy trusses the first 1500m were the most critical. Bedeschi's team had to imagine the best solution for delivering the equipment given the difficulties of the environment.

"The erection of assembled trusses in the mountain area has been an impressive challenge for our team. Our priority is the satisfaction of our client in full respect of safety standards. Only with a smart solution, as the cableway is, has it been possible to reach such tight targets," notes Riccardo De Guio, project manager, Bedeschi SpA.

Therefore, the team built a temporary road along the conveyor axis to limit impact on the territory. Indeed, this trodden track followed the natural slopes with dedicated ramps and access to enable crawler equipment and light vehicles to reach the foundations. This allowed the civil team to successfully complete the civil works for the project.

In terms of mechanical and structural erection, to meet the key considerations of reducing time and enabling fluid site operations the preassembly of all trestles and trusses took place on the ground. The other driving factor for the project was the assurance of adequate safety standards during the whole construction stage.

The first option analysed was the common procedure of erecting the conveyor using cranes and manlifts. However, several site surveys failed to identify adequate spaces to locate the lifting equipment. Moreover, the creation of temporary carriage roads and platforms would have required a huge amount of earthworks, resulting in an increased impact on the local environment, extended timeframe and uncontrolled cost risks. In addition, the difficulty of transporting the preassembled trusses in the mountainous area could have limited the degree of preassembly, with significant impact on the construction schedule. For these reasons often-used procedures were deemed unfeasible for this project.

The project team also studied the use of temporary movable structures such as a "launch girder" to shift the trusses one by one from the top of the conveyor up to their final position. These "gantry beams" would have to have been specifically designed to be sustained by the conveyor's trestles. The weight impact on the trestles and girder structure was estimated to be unreasonable and, therefore, this solution was rejected.

Taking these factors into account, the idea of using a cableway to transport the material in the mountainous area was identified as a "smart system" that would overcome any constraints. Furthermore, Bedeschi's team considered the possibility of building a tailored cableway designed exclusively to allow the erection of the trusses fully preassembled on the ground with all accessories mounted. It was envisaged that this option would facilitate the team to complete the work in a tight schedule, avoid access problems and guarantee a high degree of safety during operations. These factors were the key drivers behind the final choice.

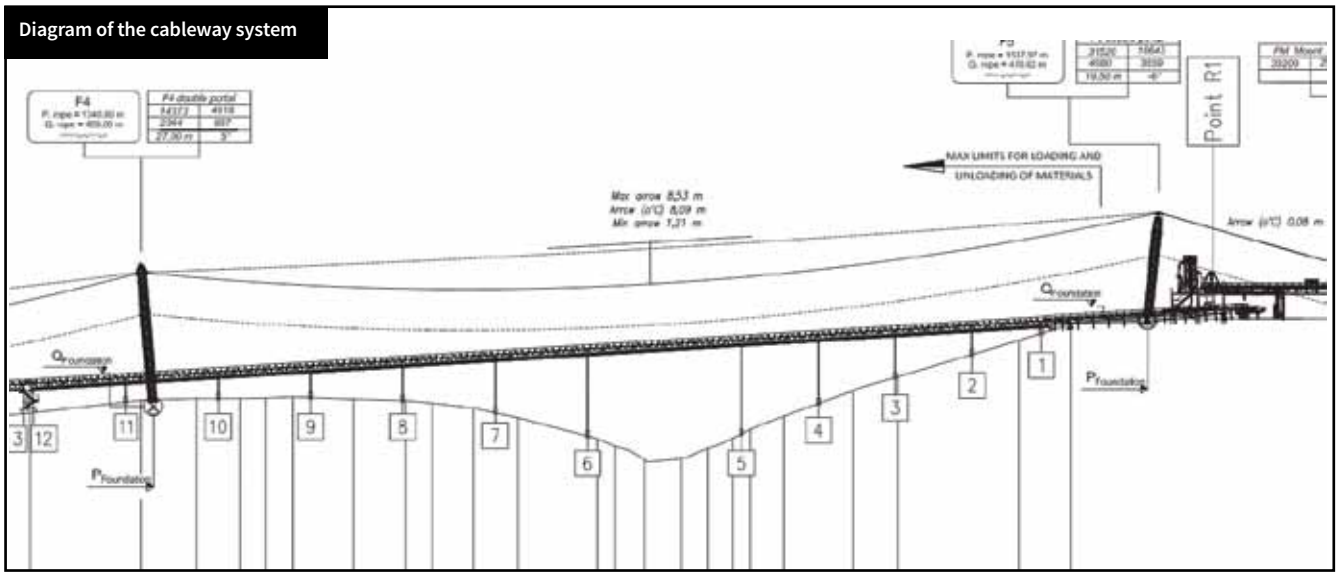
Cableway for material handling

Once referenced cableways suppliers had certified the reliability of the proposed technology and sector experts had confirmed the feasibility of operations, Bedeschi decided to adopt the cableway solution to erect the conveyor in the mountainous area.

The cableway system was designed and produced exclusively for Bedeschi by SEIK srl, a referenced company specialising in the design, installation and commissioning of cableways for material handling. The process took months of investigation and study to adapt the cableway design to the specific requirements of the project. Together, Bedeschi and SEIK teams analysed the existing mountainous area and tailored the design to allow easy operations with a high level of safety.

The system is based on two running trolleys along a single rope line suspended on five towers centred above the conveyor. The longitudinal motion of the system is operated by an electrical motor. Each trolley was able to lift and lower with an independent diesel motor. The total service load was equal to approximately 6t. Each trolley is equipped with a hook and both trolleys were designed to be placed at a distance of 12m to safely handle the

Diagram of the cableway system



conveyor structures. The lifting system is remote controlled and operated by a trained team.

Implementing this solution and making it operational in time to start erection proved to be a technical challenge. For the upper cableway foundation, a back-anchored solution was adopted. This required multiple 18m long rock anchors to be driven into the ground. The valley foundation was designed as a massive concrete block to sustain the rope tensioning force. The cableway was supported by five towers with an average height of 30m. The average distance between the conveyor and the main rope during lifting operations was granted to be a minimum of 8m.

Erection phase

The erection phase was organised in steps. At the beginning the trusses were fully preassembled on the ground, including rollers, gratings and handrails with a total average weight of 5t each. This operation took approximately three months. Once the cableway had been installed and certified, the trusses were lifted one by one using the cableway into their final position. This operation was carried out with a minimum number of personnel which assured operational continuity whilst maintaining high safety standards.

Thanks to this smart solution the site team was able to achieve an impressive productivity rate. With two teams a total of 100m of trusses was erected in a single day. The whole conveyor in the mountainous area was completed in two months. The use of a cableway lead to the full satisfaction of Bedeschi's client and subcontractor in terms of the high safety requirements.

"Our site team performed an outstanding work to manage and coordinate the operations with this innovative solution. Many unknown variables were playing important roles during the erection. Only thanks to a skilled team we achieved a resounding success," comments Mr Martari, site manager, Bedeschi SpA.

The whole conveyor was completed in two months

View of the cableway

New challenges, innovative solutions and continuous improvement

The example of the LafargeHolcim Maroc project presented in this article shows how difficult constraints must be studied in-depth to find smart solutions and how challenging projects need to be taken on properly by contractors to succeed.

In this case, the Bedeschi team carefully evaluated the constraints of the project, considered all the possible options and finally decided to proceed with an innovative solution to overcome difficulties. The main driving factors for the team during all the evaluations and choices were compliance with client expectations to assure a high degree of quality and safety. This was essential to achieving the final success of the project.

As Mr De Guio concludes: "Generally, innovation involves a certain degree of uncertainty, but it is up to groundbreaking companies to take risks to improve their experience. The only way to learn new things and improve experience, is to approach challenges with innovative ideas." ■