SELECT THE RIGHT SOLUTION FOR YOUR SCENERY

Riccardo De Guio and Emanuel Bombasaro, Bedeschi SpA, Italy, provide a detailed case study outlining the challenges associated with delivering turnkey projects in inaccessible areas.

In 2020, the evolution of markets is being driven by increased globalisation and the continuous implementation of new technologies. During the last decade, wide investments have required projects to be completed in a well-defined timeframe and with respect to the highest standards of quality and safety; creating a market for general contractors and, subsequently, intense competition for such roles.

Generally speaking, in order to reach targets in tight timeframes, the engineering, procurement, and construction (EPC) project phases need to coincide with consistent increases in the complexity of the management and co-ordination involved; this is typical of EPC projects. Indeed, there is a growing trend of major clients increasing the requirements of turnkey contracts in order to assign a single contractor full responsibility for a whole facility. However, sometimes proper planning, effective site management, and common good practices are simply not enough to achieve challenging targets – unique characteristics presented by some projects can require specifically tailored solutions.

This article aims to analyse the technical and operative solutions considered by Bedeschi SpA in order to address the challenges presented by a specific turnkey project in a hostile environment: the EPC of a 4.8 km long belt conveyor in a mountainous area which required guaranteed high standards of safety and quality during the operations. The difficulty of the environment and the specific challenges of the project led Bedeschi to implement 'smart solutions' in the engineering and the construction phases.

The project: long-distance belt conveyor in Agadir, Morocco

The project awarded by LafargeHolcim Maroc to Bedeschi SpA is part of a wide development programme which includes the construction of a new cement plant, with a clinker capacity of 3500 tpd, in the rural area of Agadir, in the south of Morocco. The project included the design, procurement, and construction of a new belt conveyor to facilitate the transport of crushed limestone to the cement plant from the quarry – located on a mountain 470 m above and approximately 4.8 km away from the plant. The belt conveyor, the sole feeding line, has a significant strategic impact on the reliability of the entire plant.

Figure 1. Lafarge long-distance belt conveyor during erection.

Figure 2. 3D model of the belt conveyor.

The project was awarded on a turnkey basis, and Bedeschi was appointed as the major EPC contractor to lead the whole process. The project's timeframe for completion was set at only 20 months, inclusive of the topographic survey, engineering design and procurement of structures and equipment, civil works, and mechanical erection.

New technologies for the engineering phase: combining different requirements

The design of the belt conveyor was developed with great attention paid to the morphology of the area. 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.

Optimisation of the engineering, in order to adhere to the project budget, was a driving force throughout the project. With this in mind, a certain economy of scale degree for the structure with regular spans and trestles, in order to allow quick and easy production, was achieved by identifying typical trusses and standard trestles. The 4.8 km conveyor was subdivided in 259 trusses of 18 m and 15 m spans, 21 standard access towers, and a special 30 m truss girder designed to assist in the crossing of a gorge.

On the other side, the design needed to be tailored as much as possible to the natural conditions of the area and adhere to the slopes. Indeed, maintaining adequate height with regards to the trestles was considered a requirement, in order to allow different methodologies of erection. This decision allowed the client and the contractor a certain level of freedom to evaluate the construction techniques being used and to remain open to various solutions, even while the single elements were under production.

Based on these premises, the project became quite complex during the engineering phase. However, by implementing new technologies, such as Tekla Structures and Trimble Connect, it was possible to increase the control of the quantities and the reliability of the production process. The combination of these two technologies also helped to improve the quality and timeframe of the design. Indeed, Trimble Connect was essential to the sharing of models between the different agents driving the project. This allowed a deep and continuous control of interfaces and a high degree of flexibility from the design desk to the site.

Erection of heavy trusses in inaccessible areas

From the construction point of view, the critical part of the project was identified as the first 1.5 km, where the conveyor was designed to pass through the mountains – a difficult to access area, especially for the equipment.

In this area, the execution of civil works was aided by the construction of a temporary road along the conveyor axis, with a consequent limitation of the impact on the local environment. This trodden track followed the natural slopes, with dedicated access ramps enabling crawler equipment and light vehicles to reach the foundations. This allowed the civil team to successfully complete the civil works.

In terms of the mechanical and structural erection, the key consideration to reducing the timeframe and allowing fluent site operations was identified as the preassembling of all the trestles and trusses at ground level. The second factor considered was the assurance of adequate safety standards during the whole construction stage.

The common procedure to erect the conveyor by using cranes and manlifts had been duly analysed as a first option; however, several site surveys failed to identify adequate spaces to safely position the lifting equipment. Moreover, the creation of temporary carriage roads and platforms for such equipment would have required a large amount of earth works, consequently increasing the impact of the project on the local environment, extending the timeframe, and creating uncontrollable cost risks. On the other hand, the difficulty of transporting preassembled trusses in the mountain area had the potential to limit the benefits of preassembly, with significant consequences for the construction schedule. Having taken these factors into account, the common procedure was not considered as feasible for the project.

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

Within these premises, the idea to use a cableway to transport the material in the mountainous area was identified as a 'smart system' to avoid 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 at ground level with all accessories mounted. This option had the potential to help the team to complete the work in a tight schedule, avoiding problems relating to access and guaranteeing high degrees of safety during the operations. This option quickly became the front runner solution, and eventually the final choice.

Figure 3. Cableway of Lafarge conveyor.

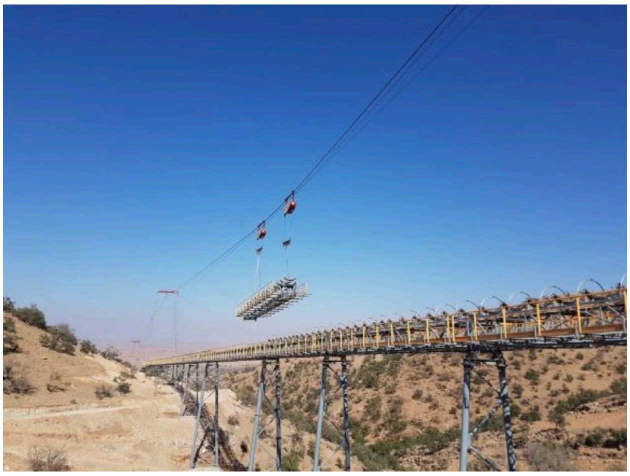

Figure 4. View of the cableway.

Cableway for material handling, a smart solution

Once the availability of referenced suppliers of cableways was verified, the reliability of the technology proposed was certified, and the feasibility of the operations was checked with some experts in the sector, Bedeschi decided to adopt the solution and thus installed a cableway to erect the conveyor in the mountain area.

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

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

The implementation of this solution was a technical challenge, especially to have it operational in time to start construction. For the upper cableway foundation, a back anchored solution was adopted; this required multiple 18 m 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, standing at an average height of 30 m, and the average distance between the conveyor and the main rope during the lifting operations was established at a minimum of 8 m.

The erection phase was organised in clearly defined steps. At the beginning of the operation, the trusses were fully preassembled at ground level, including rollers, gratings and handrails, each with a total average weight of 5 t. This phase of the 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, assuring continuity to the operations whilst maintaining a high standard of safety.

As a result of this smart solution the site team reached impressive productivity rates, with two teams erecting a total of 100 m of trusses in a single day. Indeed, the whole conveyor in the mountainous area was completed in two months. The use of the cableway led to full satisfaction of the client and the subcontractor in terms of the high standards of safety.

New challenges, solutions, and continuous improvement

The project discussed in this article reveals how difficult constraints must be studied in great detail in order for a smart solution to be found, and how generally challenging projects need to be taken on properly by contractors to succeed.

In this case, the Bedeschi team carefully evaluated the constrains of the project, considered all the possible options, and finally decided to proceed with an innovative solution to overcome specific difficulties. The main driver for the team in all evaluations and decisions was compliance with client expectations by ensuring a high degree of quality and safety; this was considered essential to achieving the final success of the project.

Innovation nearly always involves a certain degree of uncertainty and risk. It is up to ground-breaking companies, who are willing to take calculated risks, to improve industry processes and innovate advanced technologies. DB