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Moulding line: mixing and stripping (Photos: Gemco Engineers)

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Turn-key implementation of a foundry for railway materials

In order to respond to a growing worldwide demand for railway materials JEZ Sistemas Ferroviarios S.L. located in the Basque country in northern Spain, chose to expand its production facilities with the erection of a new to build plant on the French side of the Atlantic Pyrenees, in Arbérats, France. The choice for a location in France would allow the company to also better serve the highly potential French market. Gemco Engineers was asked to perform a concept study, followed by a foundry design and turn-key implementation of all the equipment

The new state of the art facility by the name of Matériel Ferroviaire d'Arbérats, in short MFA, specializes in the production of railway crossings with a maximum length of 6 m. The biggest challenges in this project were the automation of certain sections in the process. In order to manufacture the long and slim manganese steel railway parts of specific dimensions with the required level of automation, most of the machines needed to be specially developed to handle these products, including equipment and fittings such as pattern plates and flasks. A smart design and in-depth automation of the departments made it possible to implement the facility on a small area.

Moulding line

The moulding department is positioned next to the melting plant in an adjacent bay (**Figure 1**). This permits short transfer lines between both de-

JEZ Sistemas Ferroviarios S.L., Laudio-Llodio/Spain, is a renowned manufacturer of railway crossings and sidings. The company is located in Llodio, in the Basque country in northern Spain. The history of the company dates back to 1926 when JEZ, Talleres y Fundiciones was originally established in Bilbao as a company involved in metal construction. In 1994, a joint venture with the VAE Group resulted in the new firm JEZ Sistemas Ferroviarios S.L. The combination of a (Spanish) market-leader and a multinational key manufacturer in this particular field makes JEZ a significant player in the crossings and sidings market. The company has clients in over 35 different countries with important projects and clients such as the French railways and metro systems (SNCF, RATP), the London subways and Santiago (Chile) subways.

partments with the pouring area being relatively close to each. From the moulding line, the prepared moulds move straight in front of the melting furnaces onto the pouring line.

With the purpose of performing the pattern change within the cycle time of the moulding line, while minimizing the required surface, pattern storage space has been created in height (**Figure 2**).

A 9 m high bay storage system, to contain 42 ready to use patterns, each 7 m^2, was specially designed to optimize the floor surface. The storage contains complete patterns, already attached to the bolster plates. Handling of the patterns (sliding in/out of the 7+ m deep slots of the storage rack) is performed by an automated pattern manipulator. The pattern manipulator also lifts and lowers patterns to moulding line level and transfers the patterns to the moulding line where they are prepared for the moulding process and joined together with the flask halves.

In order to maximize efficiency, all castings are made on one moulding line that utilizes flasks with standard dimensions. In order to reduce manual handling and to keep associated labour levels to a minimum, an automated

Figure 1: Moulding line: rollover closing unit and pouring cup setting in front coating drying, inspection and core setting and transfer car behind

Figure 2: Pattern storage and manipulator

moulding and transfer system needed to be developed. The mould production is based on an automated fast loop to produce boxed moulds of 7 m x 1 m. The moulds are automatically transported though the different stations of the line: mixer/sand filling, mould hardening, stripping rollover, inspection, after curing oven, in-line flood coating, coating drying oven, core setting and inspection, automatic rollover closing unit and pouring cup setting. Processes on these stations run manual or semi-automatic, except stripping and closing, which are fully automated processes

The filling station consists of a double length roller track, a vibrating table and a continuous, single arm mixer for use with a no-bake binder system. Instead of the regular way of moving the mixer outlet over a stationary flask, the flask is now transported over a double length roller track with a variable and reversible drive speed underneath the (basically stationary) mixer outlet. An empty flask half, accurately positioned on top of the pattern and associated bolster, enters the mould filling line from the pattern preparation station and is transferred via a roller track to the filling station. At that position it stops automatically by activation of specifically located sensors and an operator starts the continuous mixer running in order to fill the flask with layers of mixed chromite or silica sand. During the filling process the flask is moved forward along the track by means of motor drives until the leading side of the flask reaches the end of the roller track. The trailing side of the flask will then be directly underneath the mixer outlet. After reaching this position the movement is reversed and the filling process is continued, permitting optimal layered sand filling in the flask plus it provides time for the moulding operative to add inserts into the mould.

Figure 3: Pouring and cooling line, front row for pouring

Figure 4: Heavy duty manipulator as operated after heat treatment and prior to grinding and welding booths

After filling, the flask complete with pattern plate carrier is automatically transferred to the next station for curing, stripping and inspection. The rollovers and stripping movements of the long and slim flasks required a special design. Special care had to be taken to avoid distortion of the flaks in process. Straightforward manipulator type handling equipment did not qualify for the reason that the length of the product makes it liable to flexion/distortion and therefore requires full length support.

Rollover type machines have been engineered instead. Especially for the flood coating station, a special rollover had to be developed, providing for sufficient support alongside the 7 m flask on one side, where on the other hand sufficient part of the rollover had to be kept open to allow space for a coating collection tray under the full length of the mould once it's tilted.

After painting, the mould travels through the coating-drying station, core setting and final inspection. Two half moulds are then coupled automatically in the auto-closer.

Pouring line

The mould is transferred to the pouring and cooling line by a transfer car that serves one side of the moulding line. This car runs in line with the pouring line directly in front of the furnaces in the adjacent bay. The mould line transfer car parks immediately next to a similar car that is used solely for the pouring and cooling line, which was designed and manufactured by Gemco. Situated on this unit is a mould support pouring-rack that runs on a set of rails that allows movement across the bay. A hydraulic cylinder pushes the rack, complete with assembled mould transversely across the bay into the semi automatic pouring and mould cooling line. This line spans the bay in front of the melting deck and is arranged in two rows.

The row in front of the furnaces is used to accommodate moulds that are ready for pouring (4 off) and moulds that are being poured with a single batch of metal (max. 4 off). The second row, immediately behind the first and further down the bay within an enclosed and covered area, is used solely for in-mould casting cooling and can also house eight moulds. Transfer cars situated at each end of both rows carry out transfer between pouring and in-mould cooling (**Figure 3**).

Tilting of flasks during pouring

The full moulds (each weighing up to 15 t) are indexed to the pouring positions. The product is very long with a very small cross section and causes the metal filling speed to be a very critical parameter that requires specific control. Practically all moulds are cast in an angled position. However, to achieve optimum casting quality some models need to be cast “uphill” while other models need to be cast from the uppermost end. To facilitate pouring in either direction, Gemco designed and equipped the 4 pouring stations with a special hydraulic tilting device that allows the complete rack and associated mould to be positioned in any angle in the required direction. In addition, and also required, it is also possible to gradually (“stepless”) adjust and vary the angle during or immediately after pouring. This device is operated by means of a switch by the casting operatives. After pouring and re-levelling the moulds are transferred into the cooling tunnel.

While a mould is transferred from the pouring line to the cooling line by a transfer car, a mould and associated casting that has undergone the necessary cooling cycle is discharged from the other end of the cooling tunnel.

The automatic discharging of the mould from the end of the cooling tunnels places it, with its rack, on the transfer car at the end of the line and in front of the shakeout unit. A complete cast mould is transported into the shakeout and placed on the shakeout deck. (This leaves an empty rack on the transfer car ready for loading to repeat the cycle on the pouring/cooling line).

Manipulator handling

After finishing the shake out process the product transfer is automated by the use of heavy duty manipulators (**Figure 4**). The casting, complete with runners and risers, is taken out with a manipulator through the sliding side doors on the long side of the shake out. The castings are removed by a hydraulically powered, operator controlled, 6-axis manipulator equipped with a pneumatic hammer. This unit runs on rails that traverse the bay at the position of the shakeout. This manipulator carries out the following operations within the cycle time of the moulding line: Removal of casting from the shakeout, removal of residual sand and lumps and placement in a temporary cooling area, collection of one of the cooled castings from the intermediate cooling area and transport to the runner and riser removal booth. There the manipulator removes the risers by knocking them off with an integral pneumatic hammer. Then it removes the runners by means of flame-cutting (manual) and transfers the de-gated castings from the runner/riser removal booth to the batch make-up area for subsequent heat treatment, which is located between the manipulator and the heat treatment furnace (**Figure 5**).

Figure 5: Heat treatment furnace with a 15 t automated manipulator for loading/unloading as well as quenching

From this position the manipulator builds up a complete heat treatment charge assembly from up to 15 castings, including the setting of spacers between the individual castings. The complete charge is picked up in a single lift by an overhead crane and placed onto the loading/unloading manipulator of the Heat Treatment (HT) furnace. The HT-manipulator loads the up to 15-t charge into the HT-furnace where it undergoes its heat treatment cycle. Once the furnace cycle is completed and the furnace doors open, the HT-manipulator re-loads the almost 1200 °C hot charge and sinks it automatically in the adjacent 200 m^3 quench bath, all within 45 s.

After heat treatment and quenching, the complete heat treated batch of 15 castings is removed from the furnace charger by overhead crane and placed immediately next to the in-feed conveyor of the shot blasting machine.

A second manipulator is employed immediately in front of the shotblaster. This manipulator runs on rails between shotblaster loading and unloading area, preliminary grinding station and transfer cars that take the preground castings to the final grinding and weld repair section of the factory.

The manipulator lifts the castings one by one onto the in-feed conveyor of the shotblast machine. The length of the casting is such that not all the part is in the blast chamber at any one time but travels through the blast chamber at a pre-determined speed. A set of conveyors lies immediately behind the blasting chamber. The cleaned casting is transferred onto the conveyors after blasting. The manipulator picks up the cleaned casting from the holding position at the out-feed of the shotblaster, rotates through 90° and brings the casting to a position in the preliminary grinding booth. The manipulator places the casting, feeder face up on a set of trestles with integrated hydraulic clamping device inside this booth. Then by means of the 75 kW grinder which can be attached to the manipulator gripper removes all the feeder and riser witnesses. The manipulator then places the casting onto the automated transfer cars that take the parts direct into one of the 4 grinding and welding booths.

From the grinding booths, the castings are placed into special transport frames holding 4 castings each for overhead crane and further automated transfer car transport through straightening, finishing and machining, butt welding, quality control and despatch.

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