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Materials such as HSS (High Strength Steel) and UHSS (Ultra High Strength Steel) have developed considerably in recent years, in particular in the car manufacturing industry: "Lamiera" gives you an inspiring example of innovation and applied research

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High strength steel in the automotive sector

With the introduction on the market of hot moulded metal sheets, obtained from HSS (High Strength Steel) and UHSS (Ultra High Strength Steel), the manufacturing of vehicle bodyworks underwent considerable changes in recent years. The use of these materials has in fact enabled manufacturers to considerably reduce the weight of vehicles (resulting in reduced fuel costs), considerably improve their resistance to knocks (thanks to higher strength metal sheets), reduce problems due to atmospheric corrosion, optimise geometric accuracy of the vehicles (thanks to less elastic returns during the moulding processes), as well as reduce bodywork parts (due to better moulding based on higher strength of this steel more complex parts can be manufactured). It is obvious that, due to the effect of these huge advantages both for the manufacturer and the user, these HSS and UHSS materials would obviously have widespread use in the manufacturing of bodywork structures. The first manufacturer to have heavily used this steel was VolksWagen Group: in fact, we saw many parts of these vehicles (in particular the Golf and Passat models) manufactured in various European plants (how can we forget over 20 Rapido laser systems installed to trim these parts in the German Wilco Wilken Lasertechnik GmbH sub-supplier centre in Padenborn, near one of the biggest Benteler moulding centres). These manufacturing developments must also be considered within Fiat Group: after careful comparative analysis of production costs and the operational advantages of introducing use of these new materials and having witnessed a slow, yet constant increase in their percentage use on the total weight of a vehicle (using outsourced parts), in October 2007 the Group management decided to build a new hot moulding centre in their Cassino (FR) plant. This division became operative in just 12 months and, at present, is the only one of its kind in the entire Group. In this article we will try to describe what we have seen during our long visit, the first in a Fiat plant (having visited the manufacturing units of the most important European and international competitors over the years).

FIG|01| Entrance of the division in the Fiat plant in Cassino specialising in hot moulding; on the left, a mechanical presses line to trim and perforate moulded parts.

FIG|02| One of 5 sheet heating furnace lines with, on the right, the previously blanked components hot moulding press.

THE MOULDING PROCESS

We are about to enter the big plant in Lazio dedicated to Hot Moulding. We were extremely surprised from the very start: an 18,000 m2 spotless structure (certainly not for our visit), with a resin floor (that looks like it's just been cleaned) with precisely indicated corridors. Not one sheet is out of place. It's all so tidy: the central corridor is on the right where we can see furnaces and hot moulding presses (behind them, but not visible from the entrance, there is a line of blanking machines, starting with coils, for the flat contouring of the parts to mould); in the background we can see four aligned lasers to trim the moulded parts; on the right there are two big mechanical presses, automatically robot powered, for trimming and perforation of the mould and, next to the entrance, we have the moulds maintenance area. We are surprised because we have never seen such a big manufacturing unit for bodywork parts this tidy or clean. Considering the fact that this relatively new centre has been operational for over a year, it is normal to see over this time a lack of initial cleanliness, replaced by dust and sheets just about everywhere. It is not the case in this new hot moulding division.

To tell the truth, during the long route that took us by service car from the entrance to this industrial building (on the opposite side, in an area previously used to collect sheet waste) we already witnessed extreme tidiness and even the night shift workers entered the building in an orderly fashion. Having overcome our amazement (since we couldn't take photos ourselves for obvious confidentially reasons, we asked for a photo of the overall system, to try to give readers a sense of our surprise), our interlocutors showed us the process logics and the origins of the division. *«Fiat Group»*, we are told, *«for years have been studying ways of introducing increasingly higher strength sheets into the bodywork of its vehicles. This need became urgent following the issuing of increasingly specific international safety standards for vehicles in relation to front and side crashes. To fully meet these standards, we would have had to increase the thickness of the cold moulded sheets which at the time would have impacted on all the materials used. Many of the parts on the front of vehicles would have required use of up to 3 mm thicknesses and we would have to increase the engine power which also meant higher fuel consumption. The Group then began collaborating, in technical terms, with one of the biggest metal sheet manufacturers worldwide, the first to have developed and patented high strength aluminised sheets to avoid oxidation and many other corrosive effects (other vehicle manufacturers instead started using HHS and UHSS standard sheets)».*

«Further collaboration that our Group began», continue *our guides,* «was with a German group with hot moulding experience and after which we began manufacturing hot moulded parts, starting with the Bravo model. These parts in the front structure enabled these cars to achieve 5 stars in the Euro NCAP Crash Test. Such collaboration has allowed us to learn new ways of hot mould processing and directly witness its advantages. The process we have set up in this new division includes blanking of flat sheets (between 1.0 and 1.8 mm thick depending on the bodywork part) entering (via 2 robots per line) 5 long furnaces (one parallel to the other) and coming back out at a temperature of circa 930 °C and then quickly placed in pairs (to simultaneously create the right and left of

FIG|03| Blanked components inside a furnace that brings them to a temperature of 930 °C.

the vehicle) in a moulding press where all the moulded parts (composed of "blades" together) are cooled with water at 10 °C, with a constant gradient of circa 50 °C/s. We must consider that each line is controlled and if, for example, the temperature of the parts entering the presses is lower than 720 °C, the press won't work because it cannot obtain complete martensitic transformation of the parts. With the process complete, the moulded parts have a martensitic metallurgic structure, with hardness between 45 and 60 HRC. Due to the nature of the process, hot moulding is slower than similar cold moulding, however the advantages in terms of weight, number of parts and geometry must be measured based on the overall bodywork. Currently here in Cassino we are hot moulding components for Mi.To, the new Delta and new Giulietta cars, aligning manufacturing in terms of bodywork weight, with the best competition».

We conclude this interesting topic by asking what approach was taken with staff when operations began in this new division. They replied: *«The division operators all have diplomas and, pursuant to Word Class Manufacturing logic, have taken specific training courses over various months, some even abroad. We must add that since they've returned these people have contributed, in some cases significantly, to improving our production which is still in its early stages».* We noted that staff involvement from the start was really an obvious means of ensuring this new structure works well: an ordinary observation, however it's not always seen.

THE TRIMMING AND PERFORATION PROCESS

We left the right and left moulded parts in an orderly manner (as we mentioned in the introduction, order is an essential requisite in this division) in two distinct containers. At this point our interlocutor intervenes: *«Naturally, the moulded parts must be trimmed and perforated. Both these processes can be more or less complex depending on the presence or not of local intricate profiles or a large number of various, close perforations. In general, two routes are taken to conduct these processes: laser technology and mechanical blanking. When technically feasible, the parts are trimmed mechanically using moulds composed of noble and high strength steel (they must cut sheets with an ultimate tensile stress of 1500 N/mm2); if this is not possible because the geometry of the parts does not permit it (for example: when radii are too reduced, perforations with a diameter of less than 6 mm, etc.) the laser process is used».* We interrupt this discussion to take a look at two different trimming units for hot moulded parts.

We begin with the 4 last generation Rapido laser units, equipped with CO2 CP4000 and 4 kW. We ask the supplier of

FIG|04| Mechanical presses line for automatic trimming and perforation of hot moulded parts.

FIG|05| Four Rapido laser systems to trim hot moulded parts. Each unit is powered by a CO2 source with 4 kW power.

these units why such high power to trim sheets less than 2 mm thick. *«As we heard before, productivity was one of the penalising conditions of the laser cut, compared to metal blanking. The choice of source power was made to try and improve these part cutting conditions which are fused, supported by high pressure nitrogen. The various units, with a working range of 4000 x 1500 x 700 mm, are equipped with advanced dynamics both in relation to speed (175 m/min as per TCP), and, in particular, accelerations (14 m/s2 as per TCP). This enables high performance cutting even around intricate contours, which is what Fiat required. The systems are equipped with a two-station turntable to facilitate part loading/unloading operations when running while the units are active on another station».* As we take a look at the systems we can see the various stations are equipped with specifically manufactured 3D support structures. The parts are loaded by hand on these structures and they are then automatically blocked by a series of locks that close as soon as the sensors (placed on the structures) signal correct presence. Great care was taken to correctly manage waste in these blanking presses and these systems were prepared with an accurate ejection service: these, having been cut by the laser beam in small parts, fall onto a conveyor belt that automatically takes them out where they fall into specific containers. We ask what parts can be cut by these Rapido units. *«At present the following parts are mostly cut using the laser: reinforcement bars, windscreen beams, lower joints on the side framework.*

Generally, each unit works on a specific part type. Naturally, we expect an increase in the immediate future of these parts, given laser technology was promptly integrated into our production».

Naturally, each of the two blanking lines is fairly complex. Each line is equipped with 4 presses that operate in stages and, as aforementioned, from one workstation to another. They move automatically via robot. We immediately notice how operations on the two lines take place with extraordinary order, with the parts picked on entry from the two symmetrically placed containers. The new moulds are noted on the sides of each press which, placed on tracks, equip the various presses taking subsequent turns to process the new parts.

Lastly, we are informed: *«One of our priorities is the precision with which the hot moulded sheet parts are manufactured. Trimmed parts are picked at regular intervals and we check them with a CMM measurement unit. Furthermore, each mould is checked after each batch by assembling and cleaning the blades. We note these operations are conducted by specialist staff in an area located near the entrance».*

FIG|06| Each Rapido unit has a two station turntable with automatic locking devices for the parts to trim.

FIG|07| Examples of windscreen upright bars before (a, b) and after (c, d) laser trimming using the Rapido systems in the Cassino plant dedicated to bodywork, hot moulded parts

CONCLUSIONS

We were really surprised by the high quality processes conducted in this new division. This is certainly another significant sign of immense determination in the new management of the Group. ■