NEW CONTINUOUS CASTING MACHINE FOR ARCELORMITTAL TEMIRTAU (KAZAKHSTAN)[1]

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Abstract
Today, investors worldwide are looking and waiting for new signals from steel market to understand where to direct and dedicate their money, energy and resources for possible alternative business. Because of uncertainty in the market, steelmakers are looking for more flexible operation to catch the changing market demands. The scope of this paper is to explain the complicated project for a new 6-strands Continuous Casting Machine designed, supplied and commissioned by CVS Technologies for the integrated steel plant of Arcelor-Mittal Temirtau located in the city of Temirtau, Kazakhstan. Besides, the paper describes the not easy development of the CCM design due to the very tight and congested plant layout with respect to the specific end-user requirements in term of production, flexibility and maintenance. The paper also illustrates the achievements of this particular billet CCM for what concern high casting speeds, wide production flexibility and low environmental impact, as well as the applications of the latest engineering developments in the continuous casting fields.
Key Words: Continuous casting machine.

[1] *Technical contribution to the 44nd Steelmaking Seminar, May, 26th-29th, 2013, Araxá, MG, Brazil.*
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1 INTRODUCTION

Arcelor-Mittal Temirtau (formerly part of Kazakh Karmet Steel Works integrated in 1995 into the Ispat conglomerate later Arcelor-Mittal) is the largest enterprise in mining and metallurgical sector of Kazakhstan and of Central Asia. The annual steel capacity of the largest single-site integrated steelplants in the world is of approx. 5,7 millions of tons including flat products, long products and pipes.
Previously Arcelor-Mittal Termirtau (AMT) used to purchase billets form Ukraine and Russia to feed its rolling mills for long products and pipes. However, the supply of billets from abroad was not easy to be managed in terms of quality, quantity and economical figures and finally AMT decided to become a self-producer of billets by using the huge internal availability of hot metal.
After a long and detailed analysis of all the project conditions and of the various proposals, AMT has selected the Turkish steel-plant supplier CVS Technologies for the design, supply and installation of its first billet continuous caster for long steel production.
The construction of the new continuous caster as well as the repair and upgrades of blast furnaces planned for 2010-2011 was part of AMT's plan to increase its production capacity to six million ton per year, with the eventual aim of reaching ten million ton annual capacity in the future by commissioning new production facilities.
This project represents one of the most modern, competitive and flexible CCM for production of billets, with a designed production capacity of 1,48 million tpy of commercial quality, low carbon steel and medium carbon steel.
The contract has been signed in August 2010 and the start-up of new CCM was performed on November 21st, 2011 with the participation of Mr. Nursultan Nazarbayev, the President of Kazakhstan, and Mr. Lakshmi Mittal, Arcelor-Mittal Group Chairman and Chief Executive Officer. In less than 15 months one of the most difficult project for CCM in terms of very complicated layout, harsh environmental conditions, tough local rules/standards and high plant flexibility have been successful realized by the joint cooperation of AMT and CVS teams.

2 PLANT CONCEPT

The scope of the project is the production of steel billets through the installation of a new CCM fitted with six (6) casting strands. The CCM plant has been designed according to the latest technology in the field of steel-plant machinery and equipment and the scope of works of CVS include the following main activities:

- Full engineering development, including basic design, detail design, production and metallurgical manuals, O&M manuals and as-built drawings
- Manufacturing of all mechanical and technological equipment, realized in totality in the modern workshops of CVS in Turkey
- Manufacturing of the electrical and automation equipment, through a technological partner of CVS licensees of Siemens
- Supply and delivery of all mechanical and electrical/automation equipment to site
- Supervision service for erection and supervision to start-up and commissioning
- Training of AMT's personnel.

All above activities have been fully executed always keeping in mind that the equipment and the systems making up the new CCM plant have to respect high

production flexibility, produce in quality, limited investment costs, reduced running costs and low environmental impact.
At the same time the project for the installation of this new CCM has to overcome some specific targets, mechanical and metallurgical, namely:

- Lay-out configuration
- Ladle turret sizing and design
- Caster working times
- Caster flexibility.

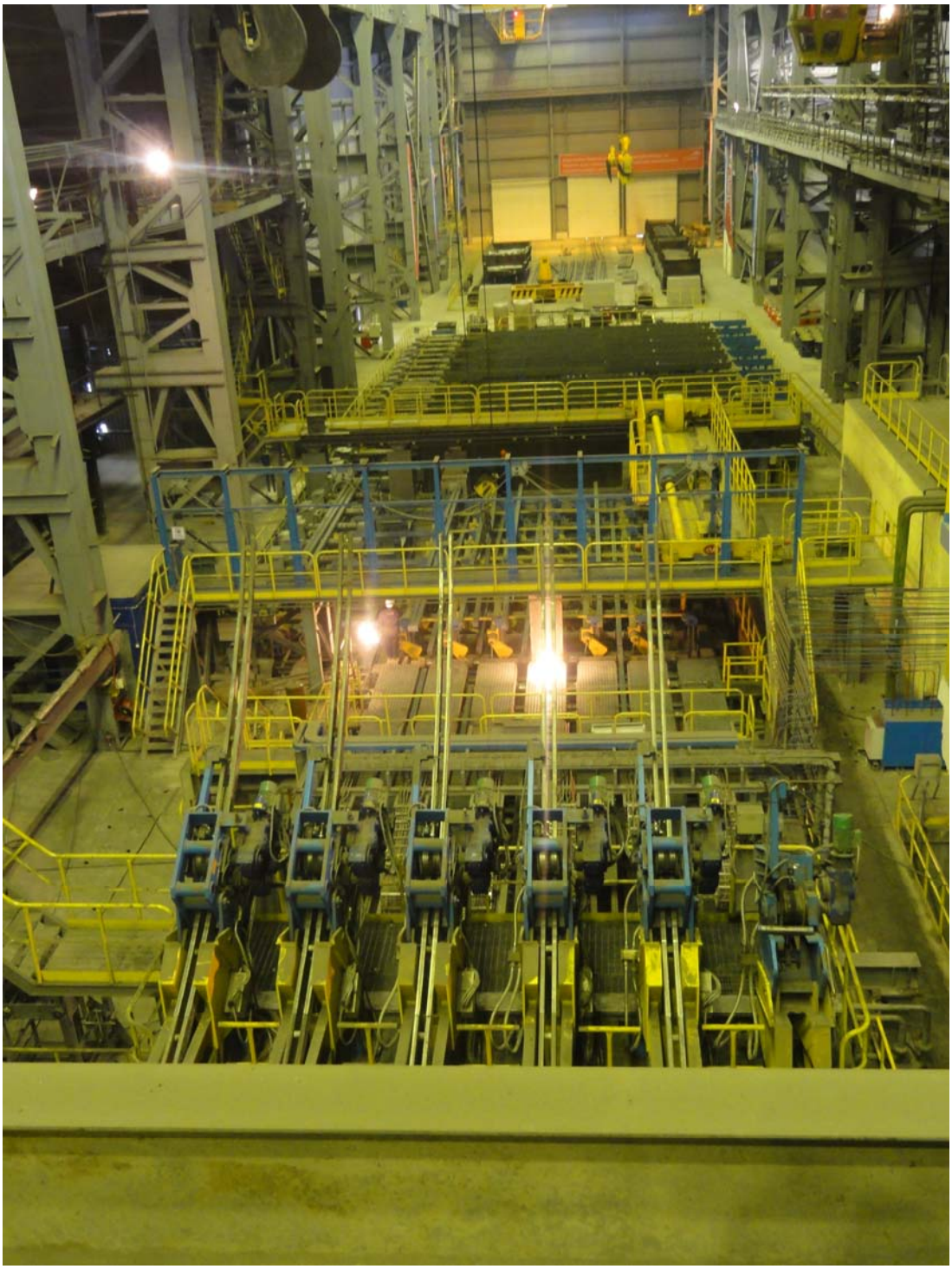


Figure 1. View from casting platform.

3 CCM CHARACTERISTICS

The new CCM has the purpose to produce square billets in sections 130x130 mm and 150x150 mm, in an initial phase in open stream conditions for construction grades and later in protected stream conditions for quality grades with the provision of electromagnetic stirrer in mould and tundish cars fitted with hydraulic lifting system. Besides, the CCM is completely automatized by Level 1 and Level 2 automation system.

Table 1 – CCM main characteristics

DESCRIPTION	UNIT	DATA
Machine type	—	CVS-CC-6/9
Number of strands	Nr.	6
Machine radius	m	9
Unbending points	Nr.	2 at 9 & 17 m
Strand distance	mm	1.200
Metallurgical length	m	25
Casting size range	mm	100x100 ÷ 160x160
Selected casting sections	mm	Square 130 & 150
Liquid steel weight (ladle)	ton	280
Full ladle weight	ton	402
Ladle support	-	Ladle turret
Ladle lifting	-	Independent lifting on each arm
Ladle lifting stroke	mm	3.400
Tundish capacity	ton	36,5 (39,2 overflow)
Tundish steel level	mm	750 (800 overflow)
Tundish support	-	Overhead tundish car
Tundish lifting	-	On tundish car by hydraulic

Table 1 – CCM main characteristics

DESCRIPTION	UNIT	DATA
Tundish stream control	-	Calibrated nozzle & snorkel
Liquid steel level control	-	load cells of both turret & tundish cars
Mould design	-	Curved mould cartridge type
Mould copper tube length	mm	1.000
Mould copper tube design	-	Multi-taper
Mould lubrication	-	Automatic oil feeding (powder future)
Mould level control	-	Radioactive with Cs 137
Oscillating unit	-	Electromechanical type
Oscillating parameters	-	25 ÷ 250 opm & 0 ÷ 16 mm
Primary cooling max flow	m3/h	140
Primary cooling pressure drop	bar	5,5
Secondary cooling parameters	-	3 zones, foot-rolls, 1st segment & 2nd segment (split into two sub-circuits)
Secondary cooling max flow	m3/h	70
Secondary cooling IN pressure	bar	10
Withdrawal & straightening unit	-	5-rolls module, 3 motorized + 2 idle
W&S unit speed range	m/min	0,2 ÷ 6,0
Billet max cutting length	m	12
Billet cutting system	-	Oxy-gas torches
Dummy bar design	-	Rigid for automatic operation
Billet removal system	-	Discharge roller tables + lifters + side transfer car
Billet final cooling	-	Double walking beam cooling beds + final collecting tables
Billet tracking	-	via 2 marking machines

4 LAY-OUT CONFIGURATION

The area dedicated to the new CCM presents very narrow sizes due to existing buildings and to existing devices that forced the CVS designers to study for a very compact and unusual layout solution, while leaving enough space on the casting floor and the evacuation area to permit easy plant operation and maintenance.
The existing building bay has a width of only 24 meters and this force to extend the casting floor only on one side (i.e. the right side) to recover a sufficient space to be able to handle the tundish on both tundish cars. For the same reason and to guarantee sufficient billet cooling, two walking beam cooling beds are provided and both are not installed perpendicular to the casting direction (as usual) but parallel and successive to it.
All these constrains while keeping into consideration a wide strand distance of 1.200 mm in order to allow the easy installation of the mould electromagnetic stirring system and sufficient space for placing the tundish maintenance area, the control room, the crop-ends removal system, the mould maintenance area and the hydraulic room.
As show in the following two sketches (Fig. 2 and 3) the CCM is heavily “tailor-made” in order to suit into the existing building within the production area of the steel-plant.

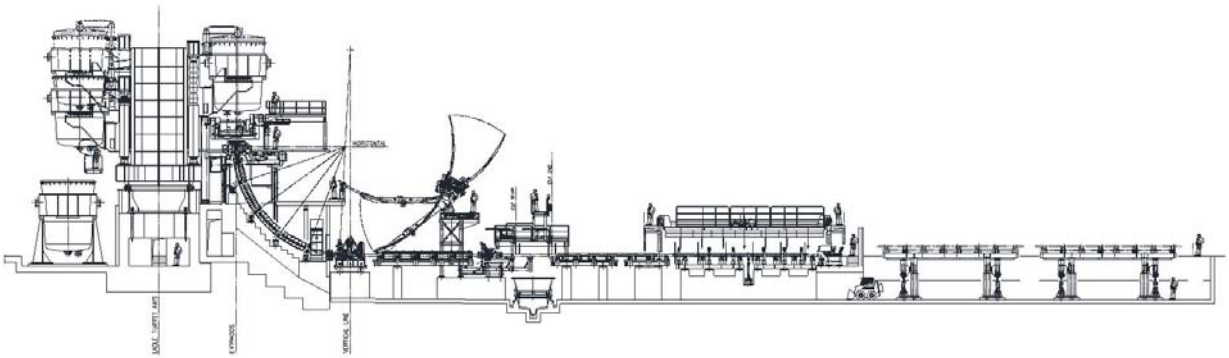


Figure 2 - CCM section.

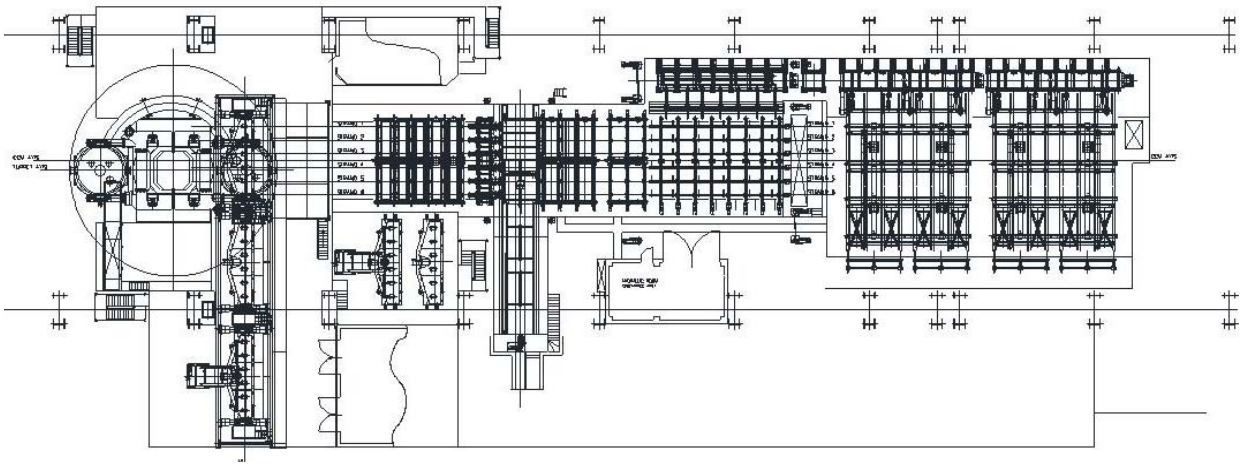


Figure 3 - CCM plan view.

5 LADLE TURRET SIZING & DESIGN

In consideration of the existing building configuration, the existing ladle handling crane with limited lifting height and the large ladle dimensions, the ladle turret provided for this project is probably the largest size ladle turret in operation on a CCM world-wide.
The studies and the engineering work of this special ladle turret has required expert engineers for structural dimensioning due to the big dimensions of the ladle and the high elevation to perform considering first of all safe conditions for operators.
The most determining data for the sizing of the ladle turret are the very long lifting movement of the ladle reaching 3.400 mm and the total ladle load of 402 ton.
The main parameters of this ladle turret are listed in the below table:

Table 2 – Ladle Turret main characteristics

DESCRIPTION	UNIT	DATA
Liquid steel quantity	ton	280
Total ladle weight	Ton	402
Turret radius	m	6,5
Overall dimensions (HxW)	m	15,3 x 18,4
Ladle lifting stroke	mm	**3.400**
Ladle lifting	-	Independent on each arm
Liquid steel weight control	-	Load cells on each arm
Rotating system	-	AC gearmotor 90 kW VVVF
Emergency rotating system	-	By hydraulic motor
Thrust bearing external diameter	mm	5.350
Ladle turret weight	ton	**600**

In the following Fig. 4 and 5 are shown the ladle turret side and top views, while in the successive Fig. 6 are shown the FEM simulations for turret stress analysis.

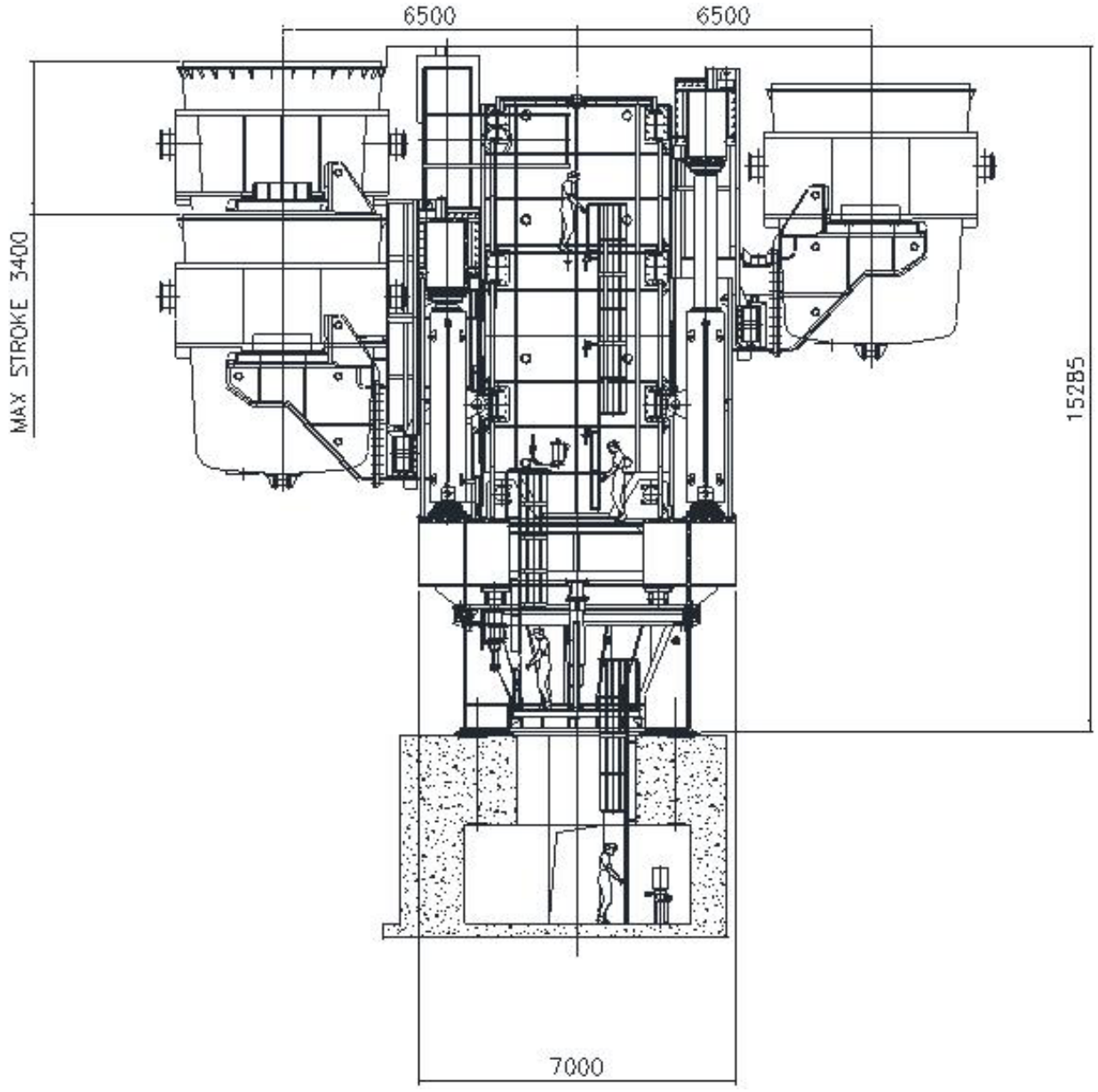


Figure 4 - Ladle turret side view.

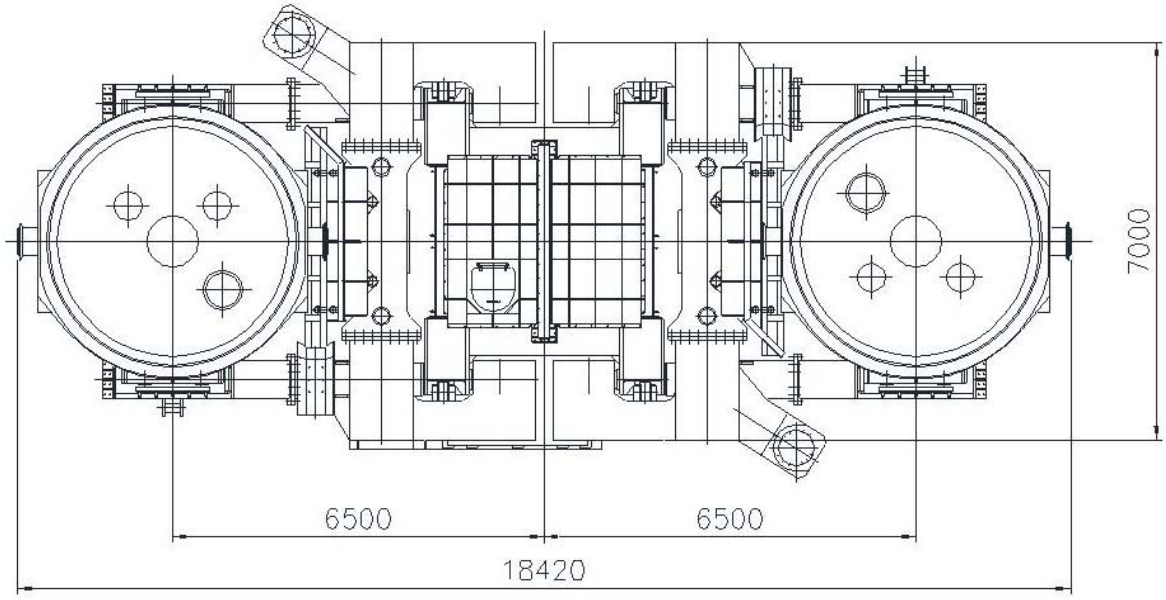


Figure 5 - Ladle turret plant view.

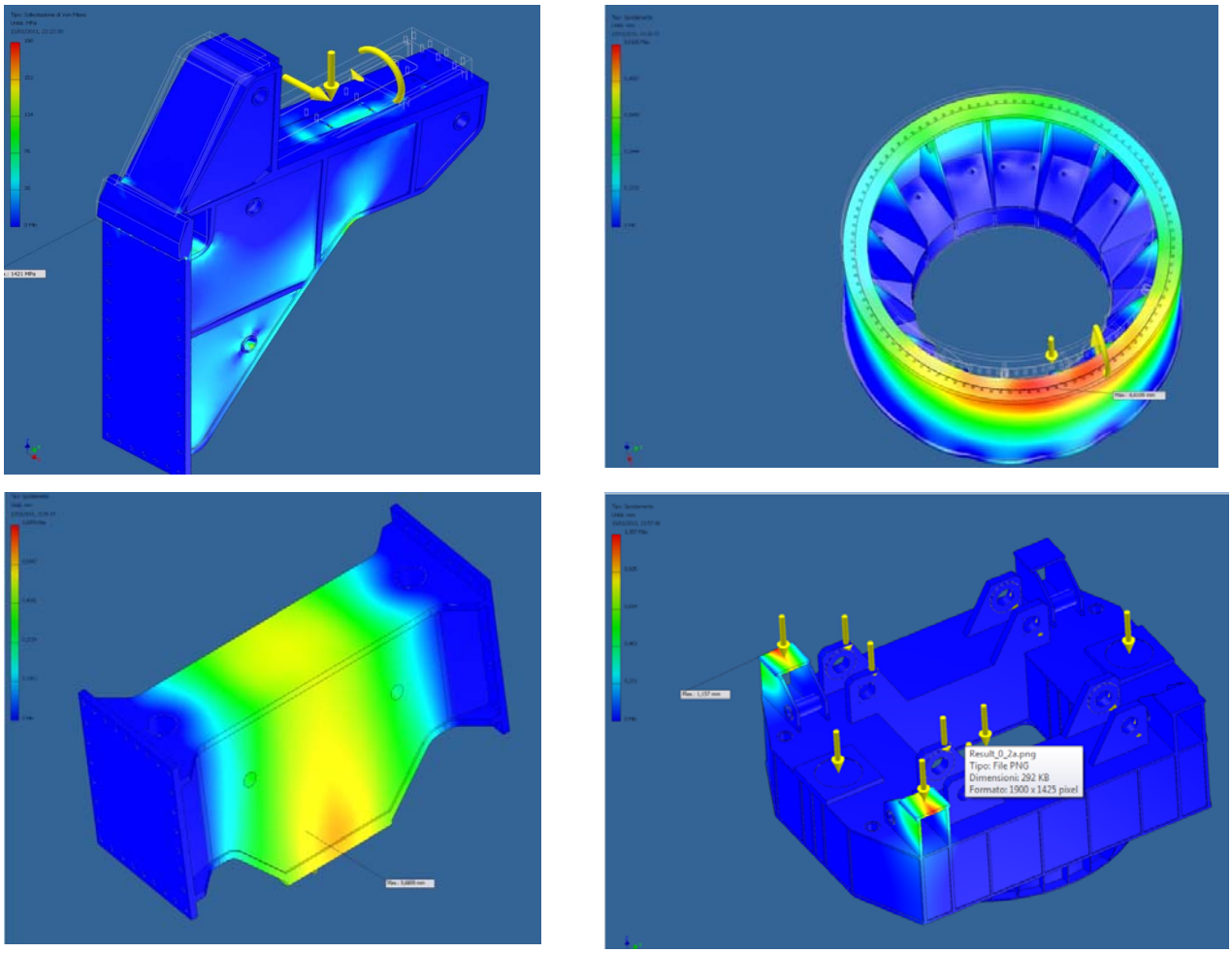


Figure 6 - FEM simulation for ladle turret stresses and strains.

6 CCM WORKING TIME

The CCM has to work in an existing production reality with casting in defined period. A huge amount of liquid steel has to be solidified in restricted times to avoid long ladle permanence on the turret with consequent temperature drop and possible steel freezing in tundish. To avoid such negative circumstances, the CCM has been designed to perform high casting speeds and relatively short ladle emptying time. Here below the casting speeds and corresponding ladle emptying times are reported. The following tables show the casting speed range out of which the CCM can perform in quality.

Table 3 – Casting speed (m/min)

SECTION	STEEL GRADE 1		STEEL GRADE 2	
	MAX	MIN	MAX	MIN
130 x 130 mm	4.5 m/min	3.2 m/min	4.2 m/min	2.9 m/min
150 x 150 mm	3.2 m/min	2.2 m/min	3.0 m/min	2.1 m/min

Table 4 – Productivity & ladle emptying time (with ladle capacity 280 ton)

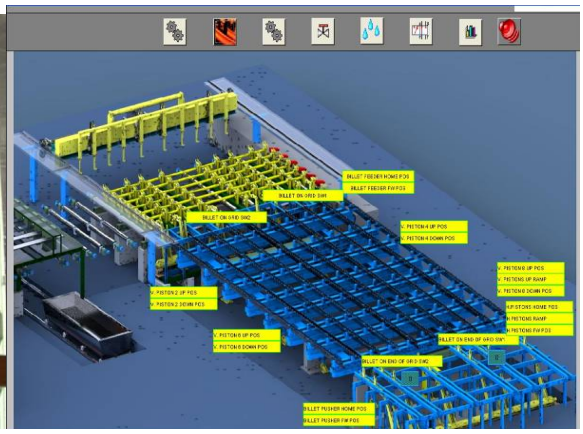
SECTION	CASTING SPEED	PRODUCTIVITY	EMPTYING TIME
130 x 130 mm	4.5 m/min	209 t/h	80.4 min
130 x 130 mm	4.2 m/min	195 t/h	86.1 min
150 x 150 mm	3.2 m/min	196.8 t/h	85.3 min
150 x 150 mm	3.0 m/min	186 t/h	80.4 min

7 CCM FLEXIBILITY

In such type of integrated plants, optimal conditions to produce quality grades, especially for automotive industry, can be performed. For that reason AMT was looking for to cover with billet production also this more profitable market.
For this reason a key-point of the project was the CCM flexibility in term of quick and easy switch of the operative practices from open stream casting to submerged casting and vice-versa. Consequently, the CCM has been designed since the begging considering the further implementations to perform high quality steel grades with special casting techniques such as mould electromagnetic stirring (M-EMS), automatic control of liquid steel level in ladle-tundish-mould, submerged nozzle casting practice facilitated by ladle and tundish lifting devices. With simple adaptations the CCM can pass from casting rebar grades to quality grades and vice-versa quickly and without limitation in order to satisfy immediate market demand.

8 AUTOMATION & PROCESS CONTROL

The new CCM at AMT operates in a flexible mode also thanks to the supplied automation system, which allow to select on the HMI (human machine interface) or on the level 2 PC's the grade and the section to be casted.
The target is to provide automation solutions, which are integrated parts of the CVS steel-making vision for innovative equipment and flexible plant solutions based on the process knowledge resulting from the efforts made by our engineering department and our high-valuable solution partners. The experience of CVS and its solutions partners in providing effective automation solutions comes from many years of design, manufacturing and commissioning of process and production control systems for the steel-making environment carried out in Turkey and other foreign countries.
For this CCM project at AMT, CVS has provided Level 1 automation based on the programmable controllers (PLC, Siemens S7-400) and Human Machine Interfaces (HMI) computers (WinCC) as well as Level 2 automation as second level of machine and process control above the Level 1.



9 CONCLUSIONS

By installing the new 6-strands multi-bending 9/17 m radius billet caster, Arcelor-Mittal has developed a new production line in the integrated steelplant of Temirtau. Besides, AMT has achieved its plan to satisfy the internal demand for long steel as well as to allow Kazakhstan to reduce the import of these important products for the construction industry.
The new 6-strands CCM, with the particular features like lay-out configuration, ladle turret sizing & design, CCM working time and CCM flexibility, allows AMT to have a flexible tool to satisfy steel market for construction and quality industries, while increasing the production capacity and keeping the product quality under control. Furthermore, the availability of higher quality of cast products has allowed AMT also to increase the finished product range by producing other quality long products such as angles, channels, rounds, strips, etc.
CVS Technologies has been able to satisfy all those requirements in a very short time, i.e. only 15 months from signing of the contract to CCM start-up.

Acknowledgments

We would like to thank Arcelor-Mittal Temirtau and all Arcelor-Mittal Group for the thrust placed in CVS Technologies as the solution partner for this very challenging project for a new 6-strands continuous casting machine to produce 1,48 million t/year of square billets at the site of Temirtau in Karaganda Region, Kazakhstan.