

# Danieli Universal Endless – DUE® – technology and latest installation in P R China

*Over the past 25 years the thin slab casting and rolling process has been gaining a major market share in the production of hot rolled strip, progressively eroding the areas previously the exclusive domain of conventional mills. Danieli has progressively developed a new generation of thin slab casting and rolling plant, marking a new phase in the evolution of this process. What makes this new concept – Danieli Universal Endless DUE®) – different to the previous generation is the ability to perform coil-to-coil, semi-endless and endless rolling modes within one single plant, making this plant a major technology innovation.*

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Danieli Wean United and Danieli Centro Met

Over the past 25 years the thin slab casting and rolling process has been gaining a greater share of the global market in the production of hot rolled strip. This has been mainly thanks to the competitiveness of the process over conventional routes and to the growing ability of this technology to cover the majority of all market requirements, not only the commodity sector.

Over these years Danieli has progressively developed, together with its customers, a new generation of thin slab casting and rolling layouts, marking a new phase in the evolution of this process and now, for the first time, coil-to-coil and endless, thermo-mechanical and multi-phase, ultra-thin and thick products are now all possible in a single production line, making both high value-added niche products and the mass production commodities segment.

The layout and the optimised, effective combination of different energy sources, make the DUE® a truly 'green' plant, while also significantly reducing the OpEx compared to the current thin slab-based benchmark plants. What makes the DUE® different is the fact that, now, within one single plant, it is possible to perform endless and coil-to-coil rolling modes, making this 'dual use' process a major technology innovation compared to the previous generation of plants. This new concept in thin slab casting and rolling plant is able to unify in a single production line all the winning features that up to now have been achieved using either endless or coil-to-coil rolling modes in separate production lines, while eliminating the limiting factors of each one of them.

Hence, this new plant will be the first thin slab casting and rolling plant in the world able to reach all the production niches of the flat products market, by applying the process that is best suited to each steel grade and

product, namely:

- **Coil-to-Coil rolling mode**, where caster and mill operate independently with different mass flow and the slab is cut to length by the pendulum shear at the caster exit (one slab for each coil)
- **Endless rolling mode**, where caster and mill operate with the same mass flow in order to ensure an uninterrupted process and the coils are generated by the high-speed shear before the down coiler.

Since the beginning of the 1990s, Danieli has been the first company to develop and then utilise in an industrial way, dynamic soft reduction as basic tool in all its thin slab casters which, in conjunction with the vertical curved design, provides the best control of internal and surface slab quality in any casting conditions.

Additionally, the ability to provide the mill with a thicker slab, compared to the traditional thin slab approach, is reflected in a remarkable increment in the reduction ratio from slab to strip, which in turn allows the production of a wider product mix. This includes low, medium and high carbon, high strength low alloyed, peritectic, silicon, pipeline and advanced high strength steel (AHSS) grades.

This caster is the logical development of Danieli's already consolidated vertical curved design, taking full advantage of the operational experience acquired over more than 25 years, as well as the considerable experience gained in high-speed casting.

The DUE® line is very compact compared to traditional thin slab rolling plants, resulting in an overall footprint of approximately 290m x 90m from caster turret centreline to second-down coiler axis.

The mill itself features the already successfully proven configuration with separation of the mill stands into high ▶

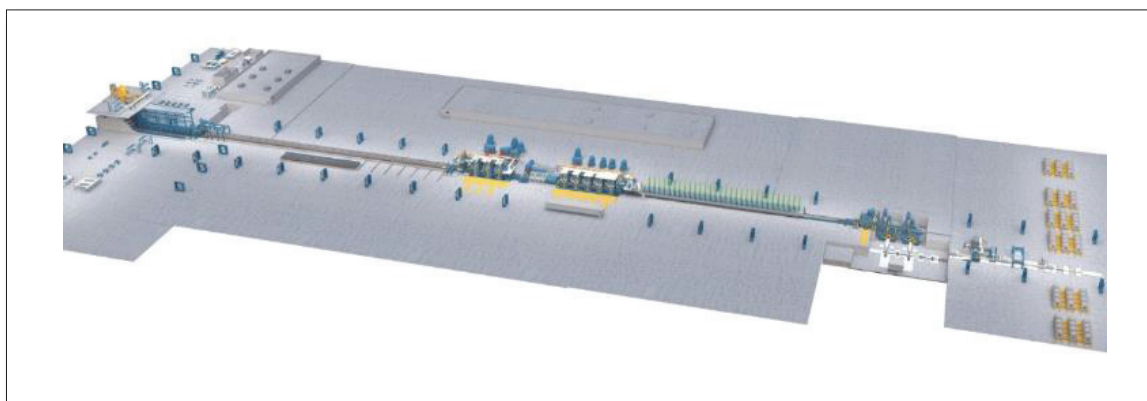


Fig 1 DUE® 3D view

reduction units and finishing units, in order to perform the dual step rolling.

#### LATEST INSTALLATION IN CHINA

After several years of successful co-operation, Shougang Jingtang United Iron & Steel Co. Ltd. (SGJT), P.R. China, placed another order with Danieli for a DUE® plant, for its new facility in Tangshan City. Danieli, in a consortium with the Japanese electrical company TMEIC, will supply to SGJT a DUE® plant, based on a single strand caster to produce 2.1 million t/yr of high value-added products in a wide steel grades mix and strip dimensions 0.80-12.7mm thick and 900-1,600mm wide (see *Figures 1 and 2*).

With its characteristics of low consumption, low emissions and high efficiency, the DUE® perfectly fits to the 'new normal' vision that establishes the guidelines for industrial development in China.

The new plant features an innovative layout (Danieli patented technology – US patent no. 8087449, 3 January, 2012), which Danieli has developed in a continuous effort to improve existing processes and technologies and overcome their current limitations.

**Casting** The vertical-curved caster features a 5.5m main radius, over a containment length of approximately 26m, designed to operate with a single slab thickness of 110mm after dynamic soft reduction (130mm at mould exit), with a casting speed in excess of 6m/min, depending on the steel grade.

Such an unprecedented combination of slab thickness and speed makes it possible to easily reach the mass flow conditions required by the full endless production mode, necessary for effective production of ultra-thin gauges.

**Reheating** The tunnel furnace, developed in-house by Danieli Centro Combustion, provides a fundamental

buffer function that increases plant flexibility and enables the mill work rolls to be changed as a background task, and so does not affect the operation of caster and melt shop. Additionally, it allows the plant to easily switch from endless to coil-to-coil operating mode and vice versa.

It also ensures slab temperature uniformity along thickness/width/length at mill entry and, particularly important for an effective endless rolling mode and guarantees a constant and homogenised slab temperature at furnace exit, regardless of the casting speed.

The overall furnace length is limited to ~80m (first to last roll), including a shuttle furnace for slab or bar rejection from the rolling line in case of emergency. Notwithstanding the reduced length, this still allows the production of full coil weight in coil-to-coil mode, ensuring at the same time uniform temperature distribution along the slab width and length.

**Bar transfer** The transfer bar area illustrated in *Figure 3* includes:

- A crop shear used to cut the transfer bar head and/or tail end, particularly for coil-to-coil rolling mode, in order to have smoother threading into the finishing mill as well as reducing tail chew-up. It also provides the bar chopping function, in case an emergency occurs.
- A dedicated high-pressure descaling unit at finishing mill entry (in addition to the one at high reduction stand entry), to eliminate imprinting scale phenomena on the final strip, thus significantly improving the relevant surface quality.
- An intensive cooling system, incorporated into the descaler box at finishing mill entry, used for thermo-mechanical rolling (TMR) when producing AHSS and API grades in order to guarantee the correct bar temperature profile and proper control of grain growth that are essential features of the true TMR process.
- An induction heating system, designed and

manufactured in-house by Danieli Automation, for consistent production of thin and ultra-thin gauges in endless mode, in which the modules can be individually retracted off-line when not in use (ie, during coil-to-coil production mode) or for maintenance purposes.

**Rolling** The mill stands, designed to guarantee excellent geometrical and mechanical properties of the final product, are equipped with all state-of-the-art features for utmost strip crown and profile control, bearing in mind that these control functions also have to be operational under load conditions as required by the endless rolling process.

**Cooling and coiling** The mill area is followed by the laminar cooling system, consisting of a combination of power and normal units for cooling strategy optimisation in accordance with the selected process mode, which in turn allows the production of a huge variety of grades, including, but not limited to, dual phase (DP) and AHSS grades.

At the same time, use of a powered cooling system allows

further grain refinement and transformation hardening on thermo-mechanical rolled products, with cost saving on alloy additions and increasing the strength of produced coils.

The line is completed by the coiling area, already fully tested and presently in operation in a pure endless rolling line in Italy, made up of a high-speed shear to cut-to-length the coil when working in endless mode, pinch rolls and down coilers.

**Automation** Danieli Automation will develop and supply the induction heating system, along with the automation of the caster and tunnel furnace area, while TMEIC will be in charge for the rolling mill automation together with online instrumentation and medium voltage/low voltage (MV/LV) drives for the whole DUE® line.

Danieli Automation, will also supply several automation packages such as Danieli Maintenance Management System (DMMS), Condition Monitoring System (CMS) and process and quality management and reports (Q3-Intelligent), all part of DIGI&MET platform for the 'Danieli Intelligent System' solution, which will coordinate the production ▶

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## STEELMAKING, CASTING AND ROLLING

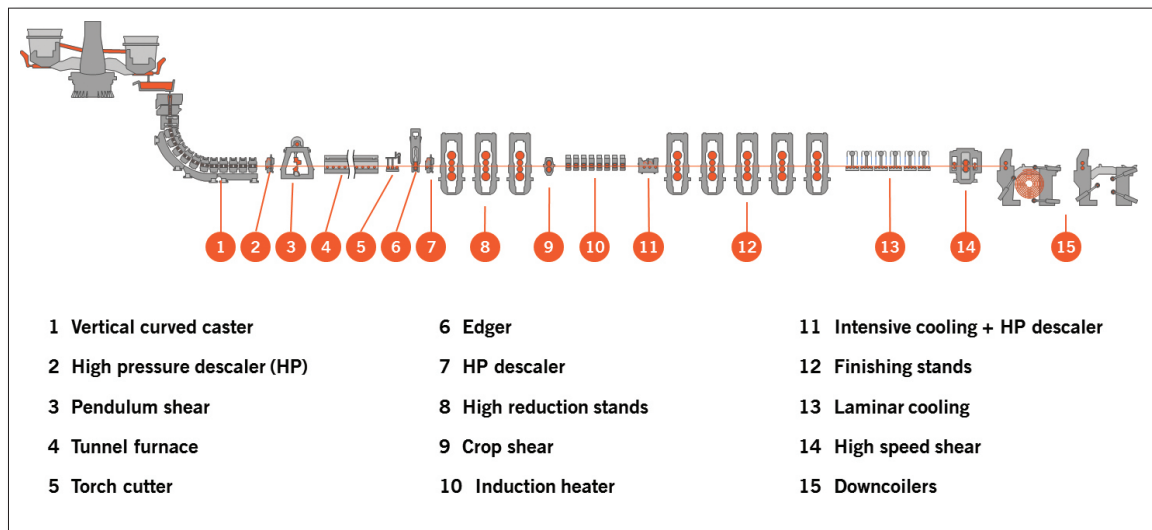


Fig 2 DUE® layout schematic

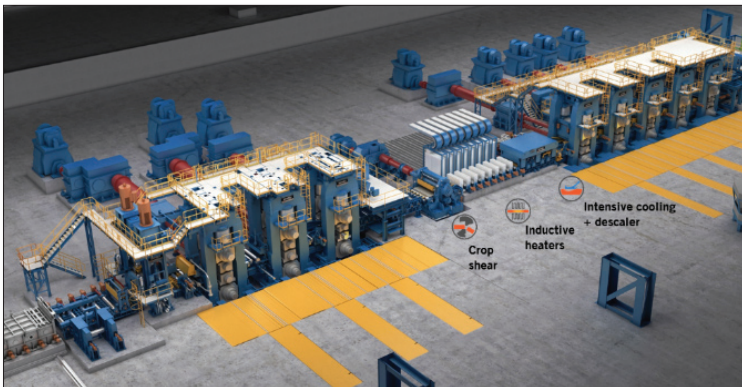


Fig 3 The DUE® mill transfer bar area

quality control along the whole production chain, from liquid steel down to finished product. The DIGI&MET platform will bring SGJT group a further step ahead in big data collection, for the use of the new DUE® line itself as well as integrated with all other plant expansion projects.

### CONCLUSIONS

Thanks to decades of research and development, comprehensive engineering and its own state-of-the-art workshops, Danieli is in a position to offer a complete package of exceptional quality to ensure optimal process performance and cutting-edge equipment.

This new approach can be seen as the natural evolution of the original Danieli concepts that marked the progress of the thin slab route, namely the application of the vertical-curved design thin slab caster and dual step rolling, which have become a source of inspiration for most of the recent innovations in the industry, confirming the advantages of Danieli's original ideas.

The DUE® layout configuration, together with an effective and optimised energy consumption, represents the most extensive application of Danieli's concept of flexibility.

With this project, which will become a benchmark in the steel industry, Danieli proves once again that it is a worldwide leader in design, manufacture and installation of advanced thin slab casting and rolling equipment. **MS**

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