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The First H-Shape Plant in Taiwan (Tung Ho Steel Miao-li Works)

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The body can be viewed from the next page.

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1 Introduction

Taiwan's first H-shape plant, comprising the processes from the electric arc furnace (EAF) to the H-shape mill, was constructed at Miao-li Works of Tung Ho Steel Enterprise Corp. with a full range of engineering support from Kawasaki Steel. Kawasaki Steel played the following roles in this project.

(1) Control and coordination of the total construction schedule
(2) Guidance for the test run, rating up, and operation
(3) Training
(4) Design of guides and calibers (for the 10 sizes of H-shape steel shown in **Table 1**)

Table 1 H-shape size availability assisted by Kawasaki Steel

Material	Products(mm)
Bloom	200 × 200, 250 × 125, 300 × 150
Beam blank	350 × 175, 350 × 350, 400 × 300, 450 × 200 500 × 200, 500 × 300, 600 × 300

(5) Design of civil works and building for steelmaking shop
(6) Design of civil works for rolling mill
(7) Supply of CLECIM-type DC arc furnace
(8) Supply of water treatment plant on full turnkey base
(9) Supply of rolls, guides, roll chocks, and bearings
(10) Supply of analytic equipment
(11) Installation of all equipment, including wiring and piping

The following describes the engineering services provided by Kawasaki Steel in the construction of the new Tung Ho plant.

2 Main Specifications and Layout of Equipment

The main specifications of the equipment and the general layout of the plant are shown in **Table 2** and **Fig. 1**, respectively. The rolling operation, as seen from the delivery side of the H-shape mill, is shown in **Photo 1**. The equipment has a capacity of 600 000 t/y, which is to be expanded to 1 million t/y in the future.

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Table 2 Main specifications of Miao-li Works of Tung Ho Steel

No.	Item	Quantity	Specification	Maker
1	Capacity of production		600 000 t/y 1 000 000 t/y (in future)	
2	Electric arc furnace	1 set	DC Arc furnace (110 t/charge) Transformer capacity 100 MVA Upper electrode 710 ϕ × 1 Bottom electrode 3 pieces (water cooled type)	Clecim
3	Dust collecting system	1 set	20 000 m^3/min at 50℃	DANECO
4	Continuous casting machine	1 set	Bloom and beam blank, 3 strands, 100 t/h	Sumitomo H.I.
5	Reheating furnace	1 set	Capacity 120 t/h Walking beam type	Chugai Ro
6	Break down mill	1 set	2 - Hi reversible mill	Hitachi
7	Vertical edger mill	1 set	For flat bar rolling	M.D.S.
8	U1 mill	1 set	Universal reversible mill	M.D.S.
9	Horizontal edger mill	1 set	2 - Hi reversible mill	M.D.S.
10	UF mill	1 set	Universal reversible mill	M.D.S.
11	Cooling bed	1 set	36 m Width × 35 m Length	China Steel
12	Inspection bed	1 set	24 m Width × 32 m Length	Kawasaki H.I.
13	Piling bed	2 sets	18 (24) m Width × 26 m Length	Kawasaki H.I.

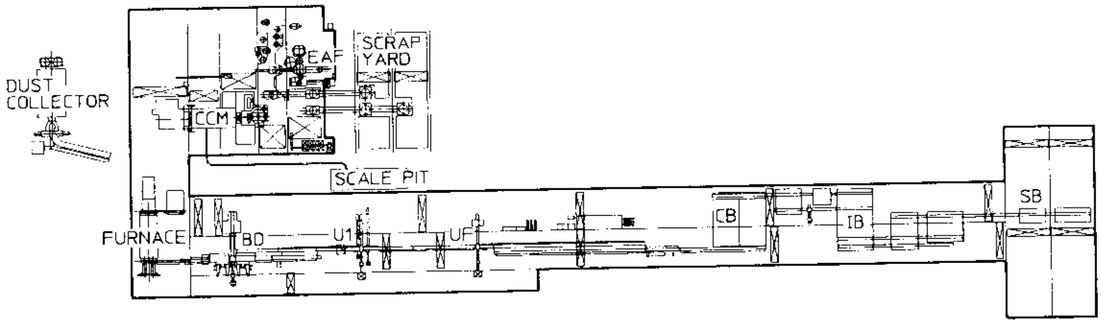

Fig. 1 Layout of Miaoli Works of Tung-Ho Steel

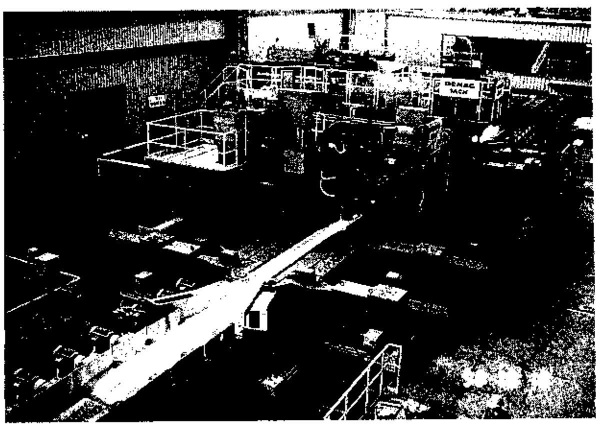

Photo 1 Universal Mill

The layout was prepared considering the following points, based on Kawasaki Steel's experience in the construction of equipment similar to that at Tung Ho at the steelmaking shop and medium flange beam mill at Daiwa Steel Corp., which is an affiliate of Kawasaki Steel, and at Kawasaki Steel's wide flange beam mill.

(1) Incorporation of future expansion plans for the EAF, continuous casting equipment, reheating furnace, cooling bed, etc.
(2) Minimization of the initial investment cost
(3) Smooth flow of materials
(4) Minimization of manpower requirements

The features of the layout are as follows:

(1) Future expansions are considered at the EAF yard, ladle yard, and continuous casting yard.
(2) The submaterial supply equipment is designed for common use by the EAF which was constructed in this project and an EAF planned for construction in the future.
(3) The scrap yard is housed in roofed buildings which are independent of the EAF yard.
(4) The scale pit is used in common by the EAF, continuous caster, and rolling mill to reduce the investment cost.
(5) The bloom yard allows the possibility of expansion in the future.
(6) Consideration is given to expansion space for the

reheating furnace, cooling bed, and U2 mill (additional universal mill).

(7) The roll exchange method was adopted in the original design of U1 and UF, but the foundation structure of these mills will allow adoption of stand exchange in the future.

3 Basic Engineering of Equipment

Although Tung Ho did not possess experience in the construction and operation of the processes from the EAF to H-shape rolling, as this project was the first plant of its kind in Taiwan, Kawasaki Steel had abundant experience in all these fields, gained at the steelmaking shop and medium flange beam mill of Daiwa Steel Corp. (a Kawasaki Steel subsidiary), Kawasaki Steel's own wide flange beam mill, and other plants. It was therefore Kawasaki Steel's aim to use its experience to construct a plant of the highest current level by total engineering of the equipment (hardware aspect) and of the training and technical assistance (software aspect). Automation and other features which support stable operation were fully incorporated in the equipment design, and consideration was given to the requirements of future expansion plans and revamping.[1]

3.1 Electric Arc Furnace

To reduce the running cost of the EAF, a DC furnace manufactured by CLECIM was abopted. Kawasaki Steel's affiliate, Daiwa Steel Corp., also has a successful record of operation with this type of furnace, which was a consideration in the selection of equipment.

The CLECIM furnace is equipped with three bottom electrodes which are cooled by copper water-cooled jackets. It is possible to control the position of the arc by adjusting the current at these 3 bottom electrodes, and thereby eliminate hot spots in the furnace. A bottom changing device was also installed to facilitate bottom electrode changes.

3.2 EAF Auxiliary Equipment

3.2.1 Submaterial supply equipment

Submaterials transported to the plant by dump truck are accumulated in storage hoppers and loaded into the charging hopper after automatic weighing. In adopting this system, consideration was given to the following points.

(1) Space was provided for future storage hoppers.

(2) Based on simulation results, the conveyor line constructed in this project will used in common for the supply of materials to the current EAF and an EAF planned for the future.

(3) For more effective use of buildings, the storage hoppers and conveyor were located in the dead space under the crane.

3.2.2 Slag handling

The slag pot is placed under the EAF, then carried to an outdoor slag yard by a slag transporter. The slag transporter is also used to carry slag from the continuous caster. Carrying the slag outside for treatment in this manner has improved the environment in the EAF operation yard.

3.2.3 Automated equipment for EAF

The following automated equipment was introduced under the guidance of Kawasaki Steel to improve work efficiency.

(1) Oxygen and carbon blowing equipment (water-cooled lance, consumable-type lance)

(2) Swing-type furnace repairing equipment with automatic refractory gunning

(3) Temperature measurement device for molten steel in the ladle at the tapping position

3.3 Scrap Yard

The scrap yard is a pit type effective storage in a limited space and easier delivery by dump trucks. The yard has a three day storage capacity, and comprises two scrap yard buildings and two scrap cars, making it possible to supply scrap in a short cycle. The scrap cars are self-propelled and equipped with scales, and the results of weight measurements are displayed in the operation room.

3.4 Ladle Yard

The ladle yard was designed for smooth handling and ladle repair, and at present is equipped with one ladle crane. A simulation showed that the addition of one small-capacity crane to handle only empty ladles will be sufficient when No. 2 EAF is installed. To reduce investment and operating costs, a ladle furnace was not installed at the present stage, but space has been provided for installation. Space for a repair area was also secured to allow a change of the ladle lining method to castable material in the future.

3.5 Continuous Casting Yard

3.5.1 Tundish repair yard

The required number of tundishes and tundish stands was decided based on the actual time spent in tundish refractory relining work in steelmaking shops at Kawasaki Steel. Considering future reductions in manning, space was also provided for automatic gunning equipment for the tundish lining.

3.5.2 Continuous casting machine

The cast house is designed for continuous-continuous casting. Repair stands for molds and segments are provided in the continuous casting maintenance yard. However, the repair stands for No. 1 and 2 segments of the mold are located in the continuous casting yard to support smooth operation during size changes and emergency situations.

3.6 Rolling Yard

The rolling line machine makers were designated by Tung Ho Steel Enterprise Corp., and included a broad range of companies, namely, Chugai Ro Co., Ltd., Hitachi, Ltd., Mannesmann Demag AG, Kawasaki Heavy Industries, Ltd., and China Steel Corp. Various problems arose because the scopes of the respective makers were not clearly defined when the companies were selected, and the drawings provided by the machine makers contained inadequacies. However, with coordination and corrections by Kawasaki Steel, a well-planned line was completed. The main points, considering plans to expand production to 1 000 000 t/y in the future, were as follows.

(1) Outdoor space was secured for expansion of No. 2 reheating furnace. For this purpose, the exhaust flues, stack, and yard piping of No.1 reheating furnace were modified.

(2) At the universal mill, preparations were made for the planned production increase by constructing the foundation for a future U2 mill. Initially, the roll exchange method will be used at U1 and UF, but a foundation structure was adopted which will allow stand exchanges in the future.

(3) The cooling bed was designed to accommodate a second line in the future.

The following improvements were also made in consideration of ease-of-work and work safety.

(1) The cooling bed was designed to enable H-shape piling and I-shape piling in both lines.

(2) The product yard crane uses a lifting magnet, but as a safety measure, a revolving stopper was installed to prevent material from falling.

(3) To shorten the time required for stand changes, reliable automatic power supply equipment (auto coupler) was recommended and installed at the universal mill and edger.

4 Environmental Measures

4.1 Dust Collector for EAF

This equipment includes direct suction for the EAF and dust collection for the EAF yard, and covers for the submaterial supply equipment and future ladle furnace. The following points were considered.

(1) The dust collector wind capacity was designed based on a combination of computer analysis results and actual results at other electric furnace shops.

(2) Operating methods were adopted which minimize the operating cost of all dust collectors.

(3) Based on the results of a comparison with the suction-type, a pressure-type bag house was adopted.

(4) A fluid coupling was adopted for the booster fan and main fan as an energy-saving measure.

(5) Considering the return on investment and environmental problems, a scrap preheater was not adopted.

(6) The design of the canopy hood complies with regulations in Taiwan.

(7) Considering economy and durability, steel sheets with a zinc coating containing 5% Al were selected as the building roofing material from among various types of corrosion-resistant steel sheets.

(8) The receiving positions of the submaterial supply equipment and conveyor joints were all provided with dust collectors.

4.2 Noise Pollution Measures

The noise level at the plant perimeter was analyzed by computer when the buildings were designed, and the following countermeasures were taken.

(1) The buildings are surrounded by walls wherever possible.

(2) Automatic opening/closing was adopted for gates with a high frequency of use.

(3) Consideration was given to allow the installation of a cover for the electric furnace and clean house which protects personnel from arc noise in the future.

It should be noted that the measured values of noise at the plant perimeter are virtually in agreement with the calculated results, and satisfy environmental standards.

5 Training

Training was conducted at Kawasaki Steel's Mizushima Works and Kawasaki Steel affiliates (mainly at Daiwa Steel Corp.'s Mizushima Works). Because the DC electric arc furnace, beam blank continuous caster, and H-shape rolling mill were all the first of their kind in Taiwan, the curriculum shown in **Table 3** was adopted after a careful study of the training items. Mornings were devoted mainly to introductory lectures, including the theory of steelmaking and rolling, and afternoons to training centered on tours of Kawasaki Steel and Daiwa Steel Corp. plants. For personnel with maintenance responsibilities, lectures on equipment control and TPM were given, and plant tours were conducted on scheduled maintenance days. Question and answer sessions conducted each day for about one hour after the plant tour were particularly well received.

6 Test Run, Rating up, and Operational Guidance

Together with participating in the preparation of plans from the start of the test run until completion of the performance test, personnel on the Kawasaki Steel side also provided technical guidance and advice on equipment and operating methods during this period. In this operational guidance, engineers and foremen were dispatched

Table 3 Curriculum of training

	Object	Curriculum	Training days
Steelmaking (First)	Manager, Engineer, Worker 23 persons	A Gr. : Lecture of E.A.F., System, Safety, Organization, Factory tour, Question and answer B Gr. : Lecture of C.C.M., System, Safety, Organization, Factory tour, Question and answer C Gr. : Lecture of refractries of E.A.F. and C.C.M. Factory tour, Queation and answer	For E.A.F. and Refractories 10 days For C.C.M. 19 days
Steelmaking (Second)	Manager, Engineer, Worker 33 persons	A Gr. : Lecture of E.A.F., System, Safety, Organization, Factory tour, Question and answer B Gr. : Lecture of C.C.M., System, Safety, Organization, Factory tour, Question and answer C Gr. : Lecture of Maintenance, Factory tour, Question and answer	For E.A.F. 10 days For C.C.M. 19 days For maintenance 18 days
Rolling	Manager,. Engineer, Worker 26 persons	A.M.(lecture) Heating, Rolling, Finishing, System, Safety, Organization P.M. Lecture of maintenance, Factory tour, Question and answer	20 days
Production control, Quality control	Manager, Engineer, Clerk 17 persons	A.M.(lecture) Production control, Quality Assurance, Order entry, Inspection, etc. P.M. Factory tour, Question and answer	10 days

from Kawsaki Steel or its affiliate Daiwa Steel Corp. to transfer the most advanced technology and skills. The scope of guidance was comprehensive, ranging from operating methods, inspection methods, and methods of correcting shape and dimensions, etc. to methods of improving yield and productivity, concepts of equipment improvement, and work safety. Several concrete examples of guidance are presented below. It can also be said that this kind of detailed, problem-oriented guidance by Kawasaki Steel engineers contributed substantially to the stable production of high quality shape steel and laid a firm foundation for problem-solving by local personnel in the future.

Examples of guidance in steelmaking:

(1) During rating up, a blow hole problem occurred, but was solved by adjusting the deoxidizer.

(2) After five months of operation, Tung Ho set a record of electrode consumption of 1.3 kg/steel-t (operation without a ladle furnace, average value for four days) and a Pon-Tap time of 51 min (time from power on to start of tapping). Considering the fact that these values were achieved following several heats after an interruption in the operation, further improvement should be expected after continuous 24 hour-a-day operation.

Examples of guidance in rolling:

(1) Because this plant was the first H-shape mill in Taiwan, personnel were inexperienced in operation, and various problems occurred, such as drops in the rolling temperature. Moreover, rolling did not proceed smoothly due to characteristic tendencies of the equipment, resulting in problems such an nonconforming dimensions, bends, wrinkles, and camber. The pass schedule and caliber were changed to solve these problems. As personnel became more familiar with the operation, additional corrections were made to achieve more proper results.

(2) Abnormal roll wear and burning and seizing of bearings occurred. The former problem was solved by improving the method of supplying cooling water, and the latter, by increasing the supply of grease before rolling, improving the method of setting the bearings, etc.

7 Construction Schedule

The construction schedule is shown in **Table 4**. The work was completed in a short period of 24 months from the start of foundation construction until the hot run at the steelmaking shop. The principal measures taken to minimize the schedule were as follows.

(1) Basic data such as the load plan, anchor bolt plan,

Table 4 Construction schedule

Items	Timing
Contract	July, 1991
Start of foundation construction	August, 1991
Start of building construction of rolling	May, 1992
Start of building construction of steelmaking	June, 1992
Start of installation	November, 1992
Hot run of steelmaking	August, 1993
Hot run of rolling	October, 1993

and others necessary for designing foundations and structures could not be received for some equipment before the makers were decided. These parts of the work were estimated from Kawasaki Steel's experience in the construction of similar equipment, making it possible to start the construction of foundations approximately one month after the contract was concluded.

(2) The design and fabrication of buildings were delayed and the delivery of the crane was late, but the finishing line equipment downstream from the cooling bed was installed using a mobile crane, which avoided a delay in the overall schedule.

(3) Adequate date for the rolling line piping and wiring work could not be obtained from the equipment makers, but drawings were prepared to the extent possible in Japan, and the remainder of the drawings were completed while examining the equipment at the site, and the construction work was executed.

8 Rating up

An orderly increase in production was achieved, as shown in **Fig. 2**.

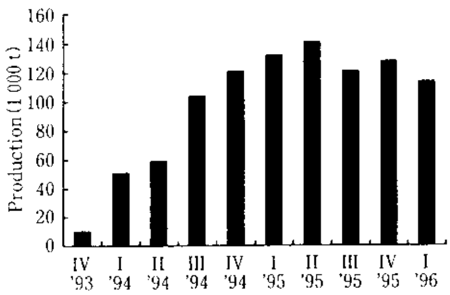

Fig. 2 Production volume (H-beam and flat bar)

9 Conclusion

The first DC electric furnace, continuous caster for beam blanks, and H-shape rolling mill in Taiwan were completed at Tung Ho's Miao-li Works with cooperation from Kawasaki Steel in all aspects of the project. The features of the construction are as follows.

(1) Smooth construction and startup were achieved in a short period.

(2) With the electric furnace, satisfactory values have been obtained for both electrode unit consumption and Pon-Tap time.

(3) The continuous caster is producing beam blanks and blooms with no major problems.

(4) The rolling operation was rated up smoothly.

(5) Enviromental standards for dust and noise have been met.

10 Acknowledgements

Kawasaki Steel is deeply indebted to the owner of the new plant, Tung Ho Steel Enterprise Corp., for its generous guidance, cooperation, and unfailing enthusiasm, without which the construction, rating up, and operation would not have been possible. The authors would also like to express their appreciation to all those concerned, including each of the equipment makers, for their cooperation.

References

1) A. Nagashima, T. Chino, H. Koide, and M. Shima: "Erection of 110 ton DC EAF Beam Blank Melt Shop", Preprint of 38 Philippine Conf., SEAISI (1994)