Rolling mills of the main producers

Introduction

1. This paper outlines the equipment required to roll hot rolled steel sheet piling (HRSSP) and other types of section mill products. It also considers the capacity and capability of the rolling mills operated by existing EU producers of HRSSP and the potential for other steelmakers to start producing HRSSP in the EU or to start exporting HRSSP to the EU.

The rolling of HRSSP and other heavy sections

Hot rolling

2. To produce sections, bars and rods (which are jointly referred to as long products), a continuously cast semi-finished product (semi) has to be shaped by hot rolling. The equipment required in a hot rolling mill includes:

- a storage area for semis;
- a reheating furnace to bring the semis to the required rolling temperature;
- a descaler (optional);
- roughing and finishing trains of stands that each include a number of stands of various types;
- a cooling area;
- finishing facilities; and
- a dispatch area.

3. The general layout of these facilities is shown in the other background paper on our web site. The part-processed semis are moved between individual parts of the mill by means of roller tables. Specialized types of rolling mill are used to roll each main group of long products and the exact nature of the mill required depends on the size and shape of the cross-section of the particular product within the product group.

Heavy section mills

4. Products rolled on medium- and heavy-section mills include HRSSP, rails, beams, angles and channels (U-sections). Depending on the size and shape of their cross-section, they may be rolled from semis with a square cross-section (blooms), a rectangular cross-section (slabs) or a dog-bone shaped cross-section (beam blanks).

5. In all heavy section mills, the feedstock bloom or slab is first heated in a reheating furnace to around 1,250 C. It next passes through a descaler to remove scale (iron oxide) formed in the furnace by means of water pressure and is then transferred to the roughing mill. This generally comprises a 'break-down' stand and a number of intermediate stands. (In the case of Arcelor's Belval mill the breakdown stand is integrated within the first duo rolling stand—see paragraph 8.) The cross-section of the semi is reduced in steps to the required thickness and profile by several passes through one or more of the mill stands. Each pass applies pressure using appropriately shaped gaps between the rolls of the stand.

6. For HRSSP manufacture, the rolls are always grooved and may be changed to roll different products or sizes. The grooves in the opposing roll barrels of each stand combine to form the shape into which the product is forced on each pass through the stand. Unlike many other types of rolling mills, the rolls in section mill stands are often provided with more than one groove, enabling several passes to be performed in each stand. Thus the semi usually travels a number of times in alternate directions through each roughing stand. The most modern mills (unlike the mills currently rolling HRSSP in the EU) have compact cassette-type stands that facilitate rapid changes from one section size to another. Adjustments to the final shape take place in several finishing stands operating continuously in a line.

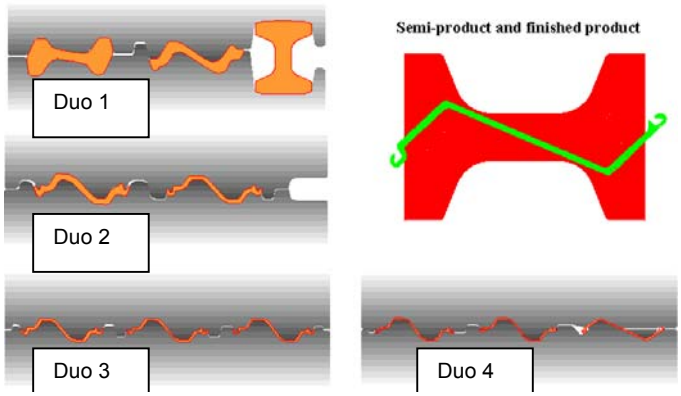
7. To limit capital costs and decrease transformation costs, the design and layout of the roughing and finishing stands are normally planned to roll only a limited range of cross-section shapes and sizes. Particular heavy section mills are thus often restricted to one or two types of sections, such as HRSSP, wide-flange beams or rails. The rolling technique used to make some types of section differs significantly from that used for rolling HRSSP.

Rolling hot rolled sheet steel piling

8. HRSSP is rolled in closed grooves on 'duo' rolling stands (that is stands with two horizontal rolls), which are often laid out side-by-side (referred to as a 'cross-country' layout). Figure 1 illustrates the rolling technique for transforming the shape of a beam blank into Z-shaped HRSSP. In this case the product passes from four to ten times through duo stand 1 (depending on size), then twice through duo stand 2, and finally three times through each of duo stands 3 and 4.

FIGURE 1

HRSSP rolling using duo rolling stands



Source: Arcelor.

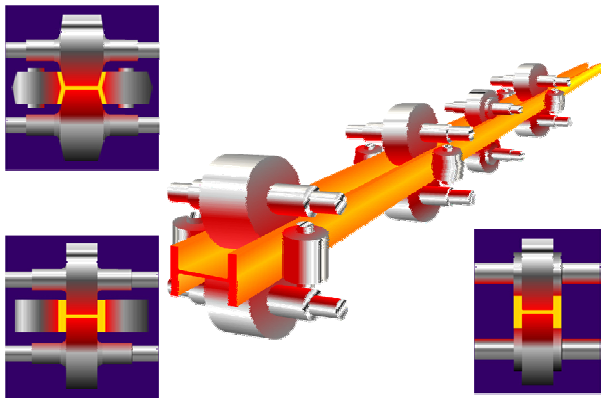
Rolling universal sections

9. By contrast, some other types of sections, such as H-beams, require rolling by both horizontal and vertical rolls. This is done in 'universal' stands with two horizontal and

two vertical rolls which are often laid out in a continuous line. In these stands the desired shape is achieved by adjusting the relative positions of the rolls at each rolling pass. Figure 2 illustrates H-beam rolling using a universal rolling mill.

FIGURE 2

H-beam rolling in a universal rolling mill



Source: Arcelor.

Switching production between different types of product

10. To roll other products, universal stands can be operated using only the two horizontal rolls and with the vertical rolls removed or disengaged. They are thus capable of producing HRSSP if the dimensions of the rolls and the power of the mill drives are sufficient. On the other hand, a section mill designed only to produce HRSSP would have duo rolling stands without vertical rolls. It would thus not be suitable for rolling universal sections at economic roll and transformation costs without further investment.

11. Whether a particular section mill could switch to producing HRSSP without substantial capital investment depends on the details of its layout and technical characteristics. The examples of Nucor Steel and Chaparral Steel, now two of the largest HRSSP producers in the USA, demonstrate that switching is sometimes possible. Both these companies have recently adapted heavy section mills to roll

HRSSP. Arcelor told us that Chaparral Steel had achieved this by adding three rolling stands to an existing mill.

12. Whether a heavy section mill is technically capable of rolling HRSSP also depends on whether the available rolls can accommodate the required rolling grooves (see Figure 1). This depends on the number of rolling stands and on the barrel length (ie width) of their rolls. The motors driving the rolls must also be powerful, as HRSSP needs more shaping than beams.

13. Arcelor told us that all section mills designed to manufacture products up to a maximum cross-section dimension less than 400 mm would be technically unsuitable for rolling HRSSP. (The minimum width of HRSSP is 400 mm and the widths of the new wide designs of HRSSP range from 600 to 750 mm.) This would eliminate most medium section mills, which generally manufacture sections between 220 and 600 mm high, from producing HRSSP. On the other hand, Ispat Polska considered that any section mill capable of rolling sections over 550 mm high could be adapted to roll HRSSP. The need for powerful motors is likely to limit the mills that could switch to HRSSP to the largest medium section mills and to most heavy section mills, which are generally capable of rolling sections with a height of over 600 mm.

14. Arcelor told us that the heaviest HRSSP rolled in Belval weighed 146.7 kg a metre compared with the weight per metre of heavy beams which normal ranged from 178 to 349 kg a metre. This comparison implies that a mill specializing in heavy sections could suffer a serious loss of productivity if it switched to rolling HRSSP.

European mills currently rolling HRSSP

15. Table 1 shows the heavy section mills that produced HRSSP in the EU in 2004, their capacities and the assessment of these mills made by Corus in two recent internal presentations.

TABLE 1 **Comparison of mill capacities and capabilities**

Mill	*Capacity for HRSSP, '000 tonnes a year*	*Assessment by Corus of costs*	*Comments by Corus in February and April 2004 internal presentation*
Corus Scunthorpe Heavy Section Mill Arcelor Esch Belval No 2 Mill Salzgitter HSP Dortmund Union Mill Ispat Polska Dąbrowa Górnicza (Huta Katowice) Heavy Section Mill Vítkovice Steel a.s.	[redacted]	[redacted]	[redacted]

Source: Arcelor, Corus and other producers.

16. Both Corus and Arcelor told us that the European producers were differentiated by the width of the Z-shaped and U-shaped piling that they could offer. Both agreed that standard widths of U piles were becoming a commodity product.

Corus

17. Before the closure of the Scunthorpe Heavy Section Mill (the HSM), Corus had three structural section mills and claimed to offer one of the most comprehensive product ranges of any producer.

18. Corus used the HSM to produce HRSSP. This mill also rolled a small quantity of sections up to 457 mm high. In recent years the HSM had been upgraded with a modern reheating furnace, improved electrical systems and mill controls and enhanced finishing. Internal assessments by Corus said that the HSM's cross-country layout (see paragraph 8) was a disadvantage and that it had high fixed costs and low productivity. The barrel width of the HSM's rolls constrained pile width below the level offered by Arcelor and Salzgitter. Corus added that very substantial investment would be required to enhance the product range and it considered that

the benefits would have been insufficient to justify this. Without this major investment Corus considered that the HSM's product range would become progressively less competitive and that the HSM would soon have to be closed.

19. Corus also has other section mills at Teesside, Scunthorpe, Workington, Hayange (in France), Skinningrove and Mannstaedt (in Germany). It told us that the Teesside Beam Mill was designed for rolling heavy section sizes up to 1,016 mm beams and had a capacity of up to 850,000 tonnes a year depending on the product mix. It had been developed over the last ten years and Corus considered it to be among the best mills of its type. The size and power of the TBM would be sufficient to roll HRSSP and Corus had considered adapting it to do so. It told us that the considerable investment needed to adapt the mill would not be economic.

20. The Scunthorpe Medium Section Mill is a continuous mill with a product size range up to 305 mm and a capacity of up to 600,000 tonnes a year. It is not thus capable of rolling HRSSP.

21. The mills at Workington and Hayange are rail mills and the mills at Skinningrove and Mannstaedt produce special sections. These mills cover specialized product ranges of rails and designed-to-order sections respectively and are not suitable for producing HRSSP.

Arcelor

22. Arcelor rolls HRSSP and medium sections on its Number 2 Mill at the Esch-Belval works. It told us that this product mix was inefficient. Arcelor had therefore decided to transfer the mill's medium section production to a new rolling mill currently being built next to the existing mill. This is expected to start operating at the end of 2004 or early in 2005. The existing Belval mill will then specialise solely in HRSSP. Arcelor

said that the capacity of [✂] tonnes a year for the mill declared to the European Coal and Steel Community (the ECSC) had been based on producing both beams and HRSSP. When the mill started to produce only HRSSP, its finishing capacity for HRSSP would limit annual production to [✂] tonnes.

23. Arcelor manufactures sections at ten other sites. Two are in Luxembourg (at Differdange and Rodange), one in Germany (at Thüringen), one in France (at Longwy), one in Italy (at Pallazeno, formerly known as Duferdofin) and five in Spain (at Gijon (rails), Olaberria and Madrid (beams), Bergara and Zaragoza (merchant bars and/or light beams). Arcelor told us that, for technical reasons, it would not be appropriate for any of the mills, other than the Belval mill, to produce HRSSP. It did not believe that it could adapt any of its existing section rolling mills at a reasonable cost to produce HRSSP and it had no intention of doing so.

Salzgitter

24. Salzgitter told us that its rolling mill capacity for piling products was about [✂] tonnes. It produces these products on two rolling mills. The Dortmund Union Mill has been modernized during the last five years to extend its product and size range to compete with those of Arcelor. Its production facilities are focused on HRSSP and it now produces the complete range of U-shaped and Z-shaped HRSSP and straight web piling sections. In 2003, HRSSP accounted for [✂] per cent of the mill's total output. The rest of the Dortmund mill's output consists of mining sections and bulb flat sections for shipbuilding. Corus's internal assessment of the Dortmund mill was that, before the recent investment, its productivity and conversion costs [✂].

25. The heavy section mill at Peine produces bearing pile sections, rather than HRSSP. In 2003 the Peine mill produced [✂] tonnes of these products, which accounted for [✂] per cent of its total output. The Peine mill also produces beams.

26. Salzgitter told us that it had no intention of switching mills from other products to HRSSP. If demand for bearing piles increased, Salzgitter could produce more of them at the Peine mill.

Ispat Polska

27. Ispat Polska told us that its heavy section mill at Huta Katowice (now renamed Dąbrowa Górnicza) in Poland had an annual capacity of [✂] tonnes. About [✂] tonnes of this capacity was available for producing U-shaped HRSSP up to a width of 600 mm. The mill also produced angles, beams, channels, rails and mining supports. [✂] considered that, this mill's productivity for these products could be similar to that of other producers. [✂] added that increasing the mill's capacity and producing wider HRSSP would probably require more powerful mill drives and an extra larger stand. A new straightening machine might be needed for wider products. The total investment needed could amount to [✂] million.

Vítkovice Steel

28. The Vítkovice heavy section mill at Ostrava in the Czech Republic produces U-shaped HRSSP up to a width of 600 mm and is expected to be privatized within the next year. The mill also rolls bars, beams, channels, crane rails and special sections. It has a capacity [✂] tonnes a year and HRSSP production typically amounts to about [✂] of its output. [✂] considered that the rolling mill was old, had not been modernized and was in an ineffective state. It added that the Vítkovice mill needed an investment of at least [✂] million to improve its stands, its roller tables and its straightening machine. [✂]. A number of potential buyers have been mentioned in press reports, including Ispat, Severstal and Industrial Union of Donbass.

29. Corus commented that Ispat Polska and Vítkovice were competing 'at the bottom end of the range'. Arcelor believed that they both could produce HRSSP competitively. It

expected Huta Katowice to become a more effective competitor following its acquisition by Ispat and added that beam production there had already improved significantly.

Steelmakers producing HRSSP elsewhere in the world

30. Some imports of HRSSP come into Europe from various companies based mainly in Japan, South Korea, Thailand and the USA. Arcelor considered that such imports were mainly limited by prices in the EU being lower than those in the USA and Asia and could increase if this price differential changed.

31. Annex 1 shows the producers elsewhere in the world listed in Iron and Steel Works of the World[1] (ISWW) as claiming to offer HRSSP. Corus's internal assessments of non-EU producers commented that the Nucor and Chaparral ranges in the USA fully covered the range of HRSSP previously produced by Bethlehem Steel and that Steel Dynamics Inc was a new entrant. As for the rest of the world, Corus said that local suppliers in Korea had developed product ranges and that Japanese producers were concentrating on their domestic market. It identified Maanshan in China and Jindal in India as new entrants.

The potential for other steelmakers to start producing HRSSP

32. Arcelor estimated that the construction of a new HRSSP mill would require an investment probably exceeding £100 million. Together with the discussion in paragraphs 10 to 14, this implies that the steelmakers most likely to start producing HRSSP are those that already have a heavy section mill—particularly those whose heavy section mills have spare capacity.

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[1] *Iron and Steel Works of the World 15th Edition*, 2002, Metal Bulletin Directories Ltd.

Other EU section mills

33. Salzgitter told us that it knew of no additional steelmakers with heavy section mills in Europe that could easily start producing HRSSP without installing a new rolling mill. It told us that the cost of investing in a new or modernized heavy section mill would be very high. The cost of adapting existing mills would depend on the extent of the work required and any technical changes needed to produce the full range of HRSSP. The fact that the total capacity of the existing mills was above market demand would discourage further investment in HRSSP. Salzgitter thought that it was unlikely that any further company would start supplying HRSSP in the next three years.

34. Data reported under the former ECSC regime enabled us to identify the total capacity and output of heavy section mills in each of the then 15 EU countries (the EU15) in 2002 (but does not identify output by individual mills). Table 2 shows the tonnage of heavy section mill products rolled in each of the EU15 countries in 2002 (the last year for which such data is available under the ECSC regime). No analysis of production of HRSSP (or of other detailed product categories) by country is available.

TABLE 2 **EC15 heavy section mill production in 2002**

'000 tonnes

Country	*Heavy sections**	*Rail track material*	*Total heavy section mill products*	*Percentage of heavy sections, excluding rails*	*Percentage of heavy sections, including rails*
Austria	0	376	376	0.0	3.4
Belgium	123	0	123	1.3	1.1
Finland	0	1	1	0.0	0.0
France	383	330	713	4.2	6.5
Germany	2,403	319	2,722	26.1	24.8
Italy	1,258	318	1,576	13.7	14.4
Luxembourg	1,361	41	1,402	14.8	12.8
Spain	2,256	192	2,448	24.5	22.3
Sweden	23	0	23	0.2	0.2
UK	1,402	195	1,597	15.2	14.5
Total	9,209	1,772	10,981	100.0	100.0

Source: Eurostat 2002 Table 3.15.

*Includes wide-flanged beams, sheet piling, sections for mining frames and other heavy sections >80mm.
Note: No production in Denmark, Greece, the Irish Republic, the Netherlands or Portugal in 2002.

35. Table 3 shows a breakdown of this production by type of heavy section mill product. (Minor inconsistencies between the tables are caused by rounding differences.) This table demonstrates that HRSSP production was a small proportion of total heavy section mill output in 2002 and that the highest volume categories of heavy section mill products were H-sections and 'other' heavy sections.

Breakdown of total EU production in 2002	*'000 tonnes*	*Percentage*
H-sections (wide flanged beams)	3,841	35.0
Other heavy sections	4,579	41.7
HRSSP	791	7.2
Rails	1,693	15.4
Rail accessories	78	0.7
Total	10,982	100.0

Source: Eurostat 2002 Table 3.12.

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36. Table 4 shows the actual and forecast maximum production potential (MPP) of heavy-section mills operated by producers in each of the member countries of the EU reported to the European Commission in 2003. (The MPP is a measure of mill capacity that takes account of the upstream constraints of the production processes normally used to supply each mill.) Tables 2 and 4 demonstrate that the largest proportions of EU15 heavy section mill capacity are in Germany, Spain, Italy, the UK and Luxembourg.

TABLE 4 **EU15 maximum production potential* of heavy-section mills**

Million tonnes a year

Country	*Actual*			*Forecast*					
	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*Utilization rate in 2002, %*	*Percentage of EU15 capacity in 2002*
Austria	0.5	0.5	0.5	0.5	0.5	0.5	0.5	75.2	3.2
Belgium	0.1	0.1	0.2	0.2	0.2	0.2	0.2	72.9	1.3
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NA	0.0
France	1.3	0.9	0.9	0.9	0.9	0.5	0.5	76.1	5.8
Germany	3.8	3.8	3.8	3.7	3.7	3.7	3.7	73.6	24.5
Irish Republic	0.5	0.5	0.0	0.0	0.0	0.0	0.0	NA	0.0
Italy	2.4	2.4	2.5	2.4	2.5	2.5	2.5	65.2	16.1
Luxembourg	2.0	2.0	2.0	2.0	2.0	2.7	2.7	70.2	12.9
Spain	3.0	3.2	3.3	3.3	3.3	3.3	3.3	72.5	21.3
Sweden	0.5	0.2	0.0	0.0	0.0	0.0	0.0	NA	0.0
UK	2.8	2.4	2.3	2.4	2.4	2.4	2.4	68.5	14.8
Total EU15	16.9	16.0	15.5	15.4	15.5	15.8	15.8	71.0	100.0

Source: EUSC Investment Survey 2003 Tables 17 and 31.

*Maximum production potential is the maximum production that is possible under normal working conditions. It allows for constraints caused by upstream bottlenecks.

Notes:

1. No production in Denmark, Greece, the Irish Republic, the Netherlands or Portugal in 2002.
2. N/A = not applicable.

37. The national analysis of investment data reported to the ECSC in 2002 showed that only medium- and heavy-section mills in Germany, Italy, Luxembourg, and Spain have received or are expected to receive investment of over €90 million over the seven-year period from 1999 to 2004.

38. As the ECSC data did not enable us to identify production or investment at individual mills, we examined other sources. Apart from the mills already discussed, we identified a further six heavy section mills in the 25 member countries of the EC that are listed in ISWW. (Arcelor commented that this information was no longer up-to-date and not totally reliable; in particular it omitted a number of mills.)

39. Determining which of these mills could start producing HRSSP would require a detailed assessment of the facilities and layout of each mill. General cost estimates by Arcelor and Salzgitter, and estimates by Corus of the cost of adapting the TBM to roll HRSSP, suggest that the capital cost required would be substantial. The investment would probably not be justified unless either the price of HRSSP increased drastically relative to other heavy section mill products or the mill had considerable spare capacity and potential sales of HRSSP could be readily identified. We asked Arcelor, Corus and Salzgitter whether any other EU heavy section mill might start rolling HRSSP. None of them considered that this was likely.

Companies claiming to offer HRSSP

Country	*Company*	*Comments*
EU		
Austria	Voestalpine AG	Austria only features in ECSC heavy section returns as a rail producer. Probably cold-formed piling.
Czech Republic	Vítkovice Steel a.s.	
Germany	Salzgitter AG	
Luxembourg	Arcelor SA	
Poland	Huta Katowice SA	
Sweden	Fundia AB	Low Swedish output in ECSC return probably consists of welded sections. Zero Swedish MPP declared to ECSC.
UK	Corus Group plc	
Other Europe		
Russia	OJSC Nizhniy Tagil Iron & Steel (Integrated Works) (OAO NTMK)	Owned by Evraz. Full range of heavy sections.
Switzerland	Forming AG	Probably cold-formed piling.
Ukraine	OPSC Dneprovsky Iron & Steel Integrated Works named after FE Dzerzhinsky (OPSC DMKD)	Owned by Industrial Union of Donbass. U piles and full range of heavy sections.
North America		
USA	TXI Chaparral Steel Co	New efficient heavy section mill. Full range of US HRSSP.
USA	Nucor Corp	Full range of heavy sections
USA	Nucor-Yamato Steel Co	Joint venture. US Z piles and full range of heavy sections.
USA	Steel Dynamics Inc	US HRSSP and full range of heavy sections.
Asia		
China	Maanshan Iron & Steel Co Ltd	Full range of heavy sections.
China	Tai Feng Qiao Metal Products Co Ltd	Probably cold formed piling.
Japan	Kawasaki Steel Corp (now JFE Holdings)	Full range of HRSSP and heavy sections.
Japan	Nippon Steel Corp	Full range of HRSSP and heavy sections.
Japan	NKK Corp (now JFE Holdings)	U piles and full range of heavy sections.
Japan	Sumitomo Metal Industries Ltd	U piles.
Japan	Tokyo Steel Manufacturing Co Ltd	U piles and full range of heavy sections.
Japan	Yamato Kogyo Co Ltd	Full range of heavy sections.
South Korea	Dongkuk Steel Mill Ltd	U piles and beams.
South Korea	INIsteel	U piles and full range of heavy sections.
South Korea	Kangwon Industries	U piles, rails and beams.
Thailand	Siam Yamoto Steel Co Ltd	Joint venture. U piles and full range of heavy sections.

Source: Iron and Steel Works of the World 2002, Coyne et Bellier.