LOGISTICS : A key constituent for steel sector

- Steelworld Research Team

The steel making production chain starts with the mining of iron ore which is delivered into an integrated process that combines raw materials (iron ore, coke and limestone) in a blast furnace to produce molten iron which then goes into a basic oxygen furnace to create crude steel. Over 65 percent of the world's steel is produced via this traditional method. The balance of steel is produced by "mini-mills", which use high iron materials, mainly steel scrap, but also pig iron or direct reduced iron (DRI) for their raw materials. A mini-mill melts this material at very high temperatures using electric arc furnaces (EAF).

Due to technology advances, both methods can produce similar forms of finished steel products. The majority of mills now produce steel on a continuous casting line – going from furnace to finished product in one uninterrupted run. Over 1.3 billion tons of crude steel is produced throughout the world which represents nearly one trillion dollars of value. The dollar value of steel is twice the size of all other major metals industries combined and in terms of tonnes produced steel is 15 times larger than these other metal industries. In terms of importance, steel is second only to oil as an essential ingredient for economic development; there is no practical replacement for steel in most cases due to the relative high cost of alternative materials.

There exist three means of steel and its raw materials transportation like roadways, railways and waterways. Preferably trucks and trails ply between iron ore mines and steel mills while railway wagons are used for transporting these materials to distant places. Exports and imports of steel and steelmaking raw materials are always carried through ships.

Domestic steel sector

The steel sector in India has been growing at a compounded annual growth rate (CAGR) of 11.6 percent for crude steel production during 2003-08. This is above the international compounded annual growth rate (CAGR) of 6.5 percent. At a production of 55 million tons of crude steel during the calendar year 2008, India was the 5th largest steel producer in the world, behind China, Japan, USA and Russia. India accounted for about 4 per cent of the world's total production in 2008.

As per the National Steel Policy 2005 (NSP), based on a production of 38 million tons in 2004-05 and a CAGR of

7.3 percent, the production is expected to reach over 110 million tons by 2019-20. With further imports of 6 million tons and exports of 26 million tons, steel consumption in India is expected to reach 90 million tons. With steel production reaching about 55 million tons in 2007-08, at the CAGR of 7.3 percent, it would reach 73 million tons in 2011-12, and 128 million tons in 2019-20. Nonetheless, with the current rate of ongoing greenfield and brownfield projects, the Ministry of Steel has projected India's steel production capacity to touch 124 million tons even by 2011-12. In fact, based on the status of Memoranda of Understandings (MoUs) signed by the private producers with the various State Governments, India's steel production capacity could be 293 million tons by 2020. Going by an estimate of US$ 811 million investment per million tonnes of additional capacity, the sector is likely to see an investment of US$ 56.13 billion by 2012 and US$ 176.49 billion by 2020.

India is the fifth-largest consumer of steel in the world. Demand for steel is likely to grow at around 12 percent against the global average of 5-6 percent. A Credit Suisse Group study states that India's steel consumption will continue to grow by 16 percent annually till 2012, fuelled by demand for construction projects worth US$ 1 trillion. The scope for raising the total consumption of steel is huge, given that per capita steel consumption was only 46 kg in 2006 - compared to 150 kg across the world, 250 kg in China and 400 kg in developed countries. About 60% of the country's steel production is used by the construction and infrastructure sectors.

Proximity matters

Proximity plays a major role in determining steel prices. Being a bulky transportation material, iron ore supply to mines, and coking coal supply to blast furnace (BF) or EAF, and above all supply of finished steel to major consuming centres, remain a challenging task for steel mills to access potential market. Therefore, iron ore miners always prefer to set up steel mills in close proximity and vice a versa.

Iron and steel are freight dependent markets where shipping and transport play a crucial part in determining supply and demand, and therefore the ultimate price. Dependency is based on the freight cost vis-à-vis the underlying commodity cost. Freight represents a high percentage of the steel price. In this regard steel supply remains centered on regional markets, while key factors influencing price are global.

Although, steel transportation cost depends upon mutual relationship between mills and transporters, a rough estimate indicate transport comprises 2.5 to 3 per cent of the total value.

Product rages

Steel is one of the most ubiquitous of commodities yet the hardest to set specifications and price for. There is not a single global price for steel, since there are many different physical and chemical properties relating to steel. There are more than 3,500 finished steel products. This is primarily because steel is not an element on the periodic table, as is gold or copper, but an alloy of iron and carbon. Nearly all of the world's steel is a carbon based alloy, comprising greater than 90 percent iron and less than 2 percent carbon, with the balance being made up of additives for strength and finish. Finished steel products fall into one of two broad categories, either flat or long products. Flat products include hot and cold rolled coils, plate and coated sheet, while long products consist of rebar, structural, rails and wire rod. All these products are consumed as basic materials in the industrial manufacturing of buildings, automobiles, appliances, furniture, pipelines, machinery and containers.

Raw materials

The raw material requirements are of three kinds: iron ore, coking coal/coke (high value thermal coal can be used directly in certain processes), and fluxes consisting of limestone and dolomite. With best quality raw material, the requirements would be about 3 times the expected crude steel output. Iron ore would constitute 55 percent, coking coal/coke about 31 percent, and fluxes about 14 percent.

Sometimes iron ore is pre processed to sponge iron in stand alone sponge iron plants and sold as raw material to crude steel makers. While this improves the raw material quality in the traditional process, it is a requirement in many small units which

are designed to use the same. India has the largest sponge iron industry in the world. There are two types of sponge iron making: gas based and coal based. While iron ore is the primary solid raw material for gas based sponge iron, iron ore, thermal coal and fluxes constitute the solid raw material for coal based sponge iron. The iron ore requirement for a gas based plant would be about 1.6 times the output. In a coal based plant, the raw material requirement would be 3 times, of which iron ore would constitute 55 percent, coal 40 percent, and fluxes 5 percent. Other raw material improvement processes like sintering of iron ore and converting coking coal to coke, if required, are done within the premises of a steel plant. Many steel plants also have captive electricity generating units, since power is a critical input in steel making. These units require thermal coal.

All the above elements of the industry structure have implications for movement of raw material, intermediate products including sponge iron, crude steel, and pig iron, and finished steel products. Raw material requirement is estimated at 3 times the crude and pig iron production i.e 167.4 million tons. Of this, 18.3 million tons, being the total sponge iron industry output, was raw material input. Of the remaining 149.1 million tons, 55 percent was iron ore (82.0 million tons), 31 percent coal/coke (46.2 million tons), and 14 percent fluxes (20.9 million tons). Of the sponge iron output, 5.2 million tons was gas based and 13.1 million tons was coal based. The gas based production required 8.3 million tons of iron ore (being 1.6 times the output). The coal based production required 39.3 million tons of raw material. Of this, 55 percent was iron ore (21.6 million tons), 40 percent thermal coal (15.7 million tons), and 5 percent fluxes (2.0 million tons).

According to a paper presented on steel and transport scenario in India by Raghuram G, the raw material requirement can be restated commoditywise:

* Iron ore figure of 111.9 million tonnes is the total of 82.0 million tonnes for crude steel making, 8.3 million tonnes for gas based sponge iron making, and 21.6 million tonnes for coal based sponge iron making.
* Coal figure of 61.9 million tonnes is the total of 46.2 million tonnes coking coal/coke for crude steel making, and 15.7 million tonnes thermal coal for coal based sponge iron making.
* Fluxes figure of 22.9 million tonnes is the total of 20.9 million tonnes for crude steel making, and 2.0 million tonnes for coal based sponge iron making.

Transport requirement

Projecting India's crude steel production figure at 100 million tons in 2011-12, based on a lower bound of 7.3 percent CAGR (73 million tons) as per the Steel Policy and an optimistic perspective of the MoUs materializing (124 million tons). Similarly, for 2019-20, steel output is estimated at 200 million tons, based on a 9.1 percent CAGR from the 100 million tons in 2011-12. This would seem feasible, since the MoUs indicate a possible capacity of 293 million tons. Given the current industry structure, we expect the finished steel output to be almost of the same order of the crude steel output, 35 percent through inplant transfer and 65 percent through interplant movement. As per the NSP, while we expect at least 25 percent of the production (partly as crude steel and partly as finished steel) to be exported, the steel imports are planned not to exceed 5 percent. For transport assessments, while steel exports are part of the output.

At the projected finished steel production and 6 times movement requirement, the total material transport (excluding coal for power plants captive to steel plants, slag to cement plants, and cement from cement plants captive to steel plants) would be 600 million tons in 2011-12 and 1200 million tons in 2019-20.

There are difficulties in making an accurate assessment of rail share for the steel industry, due to inherent problems in Indian Railway's statistical accounting methods. Following are some assumptions with regard to railway loading in which only SAIL, RINL and Tata Steel are considered while emerging steel producers including Essar Steel, JSW and Ispat Industries are not considered in these statistics:

* Aggregate steel (finished steel, pig iron, and crude steel) figure of 27.0 million tons as per the Indian railway Year Book 2006-07.
* Iron ore figure of 77.5 million tons is

Table 1. : Transport requirements for the steel industry (million tons)

Commodity	2006-07	2011-12	2019-20
Finished steel	52.5	100	200
-Domestic	39.4	75	150
-Exports	13.1	25	50
Semi-finished and	38.1	65	130
crude steel			
Sponge iron	18.3	35	70
Raw material	196.5	400	800
Iron ore	111.9	225	450
Coking coal / coke	46.2	100	200
-Domestic	7.8	15	30
-Imports	7.9	15	30
Fluxes	22.9	45	90
-Domestic	18.3	35	70
-Imports	4.6	10	20
Total	305.6	600	1200
Port linkage	71.8 (13.1 + 58.7)	150 (25+125)	300 (50+250)
(export + import)			

the difference of 116.3 million tons (total iron ore) and 38.8 million tons (iron ore for exports) as per the IR Year Book 2006-07 and Data Book 2008-09 respectively.

* Coal figure of 50.9 million tons has been derived based on some assumptions. The movement of 25.3 million tons (55 percent of 46.2 million tons, which is the share of "main" producers) coking coal/coke to them is done entirely via rail. Of the remaining 20.9 million tons to "other" steel plants and 15.7 million tons to sponge iron plants, 70 percent (25.6 million tons) is estimated as moving via rail from mines, but possibly to intermediate merchant locations and then by road to the respective plants. The remaining 30 percent would be direct by road to plants located close to mines.

Poor infrastructure

There are many junctions at which reversals take place, causing delays to the rake movement and congestion, and consequent asset utilization inefficiency. The same would be true with respect to flyovers in terms of cross movements. For example, in the case of JSW Steel, many rakes undergo reversals, either at Toranagallu, Bellary or Madgaon stations, causing additional delays to rakes of one to four hours. Given the level of traffic at many steel plants, lack of multiple access in and out of steel plants leads to operational complexity, cross movements and consequent congestion. Due to lack of connectivity to mines, short haul movements are performed by road, resulting in IR's decreased market share in the high rated bulk commodity movement of iron ore.

While throughput has been increased by increasing the axle loading from 20.3 to 22.9 tons per axle and even up to 25 tons per axle in certain select routes, line capacity is a bottleneck in many sections. An example is the Hospet – Mormugao port single line section, which services coal imports for JSW Steel. Doubling of this section, and short of that, smaller debottlenecking works are on the amble. However, project execution is not synchronized with the needs of the steel plant. Infrastructure at terminals, especially at unloading centres (goods sheds) is quite poor. Apart from inadequate facilities and equipment, location of such goods sheds based on the 'station based goods shed' concept leads to congestion in the shed and evacuation problems.

There are certain commodities eg coking coal, pipes etc that cannot be loaded upto the carrying capacity (CC) of a wagon. In case of coking coal, the actual loadabilility is 58- 60t (depending upon the type of coal) while the CC of BOXN wagon is 65t. As a result, the commodities, which cannot be loaded upto chargeable weight, are charged for their fixed chargeable weight based on the type of wagons resulting in idle freight. (SAIL, Rourkela)

Wagons are not designed for size or handling of some special types of steel (tinplates, CRNO steel and pipes). BFNS wagons, which transport high quality value added steel like coils, are not designed for protection from atmospheric influences. Customized wagons for specific finished steel products are not available.

Table 1. : Commodity wise rail movement

Commodity	Total (million tons)	Rail (million tons)	Rail Share (%)
Finished steel	52.5	-	-
Pig iron	5.0	27.0	29.8
Cruce steel	33.1	-	-
Sponge iron	18.3	Negligible	Negligible
Raw material	-	-	-
Iron ore	111.9	77.5	69.3
Coal	61.9	50.9	82.2
Fluxes	22.9	12.7	55.7
Total (Raw Material)	196.7	141.1	71.8
Total	305.6	168.1	55.0