International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 08 | Aug 2023 www.irjet.net p-ISSN: 2395-0072

Steel Plant Layout: Civil Engineering perspective

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Abstract - *Steel is used in most of the infrastructure projects, bridges, dams, transmission lines, pipe lines, machine tools, automobiles, defense, commercial and residential buildings. Any country industrialization depends on metal consumption. Nation economic success depends on steel industry. India stands second position in world steel production. Steel is being used in civil engineering as major material all structural and civil infrastructure projects. The properties of steel such as light weight in nature, easy for fabrication, shipping, erection, high durability draws attention of engineers to design various structures and which saves times in completion of projects.*

Key Words: **Steel Plant Layout, Major Packages, Construction Schedule, Major Item Quantities**

1.INTRODUCTION

In Global scenario the world crude steel production for the year 2021 was 1911 million tons (mt). China had produced crude steel at 1032 mt and India produced 126 mt in the year 2022.

In India, there about 3647 units of steel production units ranging from small mini steel plants with smaller blast furnaces, sponge iron units, induction units and rolling mills.

The upcoming steel projects and their various details of capacities, project costs and land details are listed below. Some companies are taken over by MNC players in steel industry.

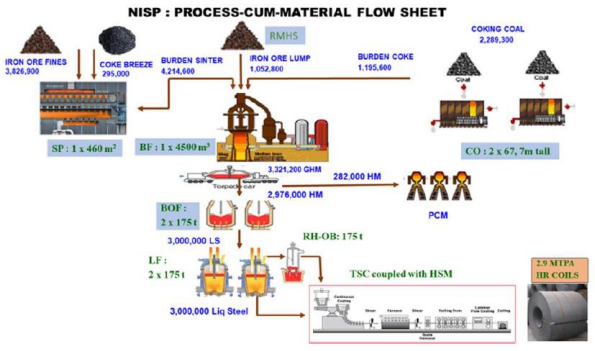
1. NMDC 3MTPA Iron and steel plant with an investment of Rs 15525cr initial project cost with land of 1934 acres.
2. Tata Steel, Capacity 6.0 MTPA Green Field Project, Orissa with project cost of 6500 Cr in 3040 acres.
3. Tata Steel Capacity 12MTPA Jharkhand,
4. ESSAR Projects in Orissa in Paradeep, Capacity 3.2MTPA in Chhattisgarh, Essar Steels, Bellary- These projects are under new company Arcellor Mittal Nippon Steel
5. JSPL, Angul, Orissa, Capacity 6MTPA expansion with an investment of Rs 23000 cr in 4332 acres
6. JSPL, Jharkhand, Greenfield Project of 5MTPA with an investment of 20000Cr
7. Ispat Industries, Capacity 2.8MTPA, Jharkhand with an investment of 10000Cr
8. Electrosteel, Jharkhand, Capacity 2.2MTPA with an investment of 7300Cr
9. Visa Steel, Kalinganagar, Jajpur, Orissa, Capacity 1.5MTPA, with an investment of Rs 2808Cr in 1200 Acres
10. Visa Steel, plans for setting up 2.5MTPA, in Raigarh Chhattisgarh
11. Visa Steel, plans for setting up 1.5MTPA, in Madhya Pradesh
12. JSW Steel, Vijayanagar, Karnataka with an expansion, 16 MTPA to 18MTPA, with an investment of Rs. 15000 Cr
13. POSCO Steel, Orissa, 12MTPA, with an investment of 51000Cr in 4000 Acres and POSCO has cold rold plants in Maharashtra.
14. JSW Utkal Steel Plant, 13.2 MTPA green field project with an investment of Rs 65000Cr
15. JSW plans to setup pellet plant in Jagatsinghpur, Orissa with an investment of Rs9000Cr

The private steel companies playing major role in crude steel production as well as sponge iron. The percentage of contribution by private players is 89% in overall production.

2. Steel Processing Methodology

Steel processing technology involves removing impurities from iron ore and alloying other elements to produce different grades of steel.

Modern steel industries use recycled material as well as traditional raw materials iron ore, coal and limestone. Two process methodology generally used in making steel such as basic oxygen steel making and electric arc furnace.



Brief about installed facilities and their capacities are as follows:

Figure 1 Steel Process and Material Flow Chart

Table 1 Installed Capacities of 3MTPA Steel Plant

S.No	Description of facility	Installed capacity
1	Raw Material Handling plant	12 MTPA capacity
2	Coke Oven & CDCP	2x67 Ovens, 7-meter-tall battery
3	Sinter Plant	1x460 m2
4	Blast furnace	1x4500 m3
5	Pig Casting Machine	3x1700 tpd
6	Steel Melting Shop	2 x175 T BOF Converters
7	Thin Slab Caster + HSM	2 Strand CC and HSM 2RM+4FM+2 Down Coiler
8	Oxygen Plant	2X1250 TPD
9	Calcination plants ❖ Lime Plant ❖ Dolomite plant	 2X500 TPD 1X300 TPD
10	Waste Energy Recovery / Power Generation	2X40 MW Turbines 3X160 TPH Boilers 18 MW TRT

2.1 Steel Plant Layout

In this paper steel plant layout has been presented based on process technology and some site specific projects listed with available prefeasibility studies.

There are several methods used for design of plant layout (i) SLP systematic layout plan (ii) Algorithm (iii) Arena simulation method. The SLP method is widely used for steel plant layouts. The overall layout of steel plant based on material inflow and outflow of manufactured products by Satyendra, Ispatguru considered.

The principles considered in designing layout of iron and steel plant is (a) minimum travel time (b) sequence of flow of materials or flow of materials (c) usage of materials (d) compactness of plant (e) consideration safety and satisfaction (f) flexibility (g) interdependencies (h) minimum investments and recoveries (j) environmental aspects

Although plant layout is often studied by metallurgical, mechanical streams, it is essential to understand basic layout and material inflow and outflow of finished products in layout design point of view by civil engineering.

Figure 2 Plant Layout of 3MTPA YSR Steel Plant, Kadapa, AP, India (source Mecon DPR)

The major and important facilities considered in plant layout are raw material shed, covered shed for coke storage, wagon tippler, by-product plant, sinter plant, fuel and flux screening, lime calcining system, blast furnace, steel melting shop, primary gas and secondary gas cleaning plant, thin slab caster, rolling mill, compressed air station, water reservoir, treated water supply, BF slag storage, air separation, main receiving sub- station, plant oxygen system, propane storage, power plant, sewage treatment plant, central stores and electrical shops, area shop buildings, railway network and weigh bridges, road network and weigh bridges, administration office, time office, material dispatch system, fire brigade, telephone exchange, medical health system and labs.

2.2 Coke oven

Size of coke oven

For 1 MTPA Steel plant need 50 to 100 coke ovens of each length 15 to 20m width 0.4 to 0.5 mt and height 4 to 6 m. In Coke Oven plant consists of gas treatment units (b) absorption tower (c) cooling and condensation units (d) gas scrubber and (e) pumps and compressors and fans.

The size of coke oven complex is approximately 600 mt x 200 mt and height of 30 m for 3 MTPA plan with a construction period of 36 months

2.3 By-product plant

Byproduct plant plays important role in steel process. It removes toxic gases and various residues generated during process of coke oven and these will be sent to byproduct.

The residues will be reused and some residues have commercial values. As per capacities of steel plant, the approximate area required for 1MTPA 1000 to 2000 sqm, for 2MTPA 1500 to 3000sqm and 3MTPA 2000 to 4000 sqm.

2.4 Steel Melting Shop

The process in SMS is briefed as after treatment in ladle furnace, liquid steel will be sent to turret of thin slab caster. The liquid steel will be cast through two thin slab casters with hot strip mill. The shop will be equipped with continuous casting machines and auxiliary facilities for production of 2million tonne HR coils in 3MTPA plants.

Gases generated during steel melting in the convertor shall undergo collection and cleaning. The cleaned convertor gas stores for use as fuel.

The size of plant depends on production process – electrical arc furnace(EOF) or basic oxygen furnace(BOF). The approximate area for 1MTPA 2000-4000 sqm for EOF,3000 to 5000 sqm for BOF, 2MTPA 4000-8000 sqm for EOF,6000 to 10000 for BOF and 3MTPA 6000-10000 sqm for EOF,8000 to 15000 for BOF.

2.5 Thin Slab Caster and Rolling Mills

The rolling mill equipment in 3MPTA has two numbers of tunnel type temperature equalizing cum holding furnaces, one pendulum type slab and cable shear, one high pressure de-scaling station, coil cooling system. Floor coil system and coil storage system and dispatching through railway lines.

The size of plant depends on production process –size of Thin slab caster for 1MTPA 3000 to 5000 sqm and mills 10000 to 15000 sqm, size of thin slab caster for 2MTPA 5000 to 8000 sqm and mills 15000 to 20000 sqm, and size of thin slab caster for 3MTPA 8000 to 12000 sqm and mills 20000 to 25000 sqm.

2.6 Oxygen Plant

Oxygen plant is required in any steel plant for oxygen enrichment in the blast furnace, blowing in BOF, heating of BOF lining, secondary refining in RH – OB and general purpose use in various units of the steel plant.

2.7 waste heat and Energy Recovery

The excess blast furnace BF gas, CO gas and BOF gas available from various units will be utilized in mixed gas fired boiler to generate HP high pressure steam. The steam generated from the gas fired boilers in addition with HP steam coming from CDCP (Coke oven) will be utilized in steam turbines of turbo blowers and steal turbines to generate power, in case of 3MTPA 2x40MW power can be generated.

Other units are not covered above are given in individual structure wise quantities in section 3.

Figure 3 Raw material junction houses

Figure 4 Coke Oven Batteries

Figure 5 Blast Furnace

3. Major civil items in a Steel Plant

The major quantities of 1Mtpa steel are excavation quantity 10,00,000cum, Concrete quantity is 10,00,000 cum, structural steel is about 100,000 tons and cladding 500000 sqm. The quantities may vary based on site specific and other factors and conditions.

Individual package wise quantities of civil and structural steel are given as follows

1. Raw material handling system concrete 170000cum, structural steel 70000MT,

2. Coke oven concrete 86000cum, structural steel 20000MT; Byproduct concrete 45000 cum, structural steel 5000MT;
3. Sinter plant concrete 51000 cum, structural steel 15000MT
4. Blast furnace concrete 113000cum, structural steel 31000MT
5. Steel melting shop concrete 152000cum, structural steel 31000MT
6. Thin slab caster and mills concrete 260000cum, structural steel 35000MT
7. Turbo blower concrete 1700 cum, structural steel 1500MT
8. Compressed air station concrete 3500 cum, structural steel 275MT
9. Piping system concrete 7900cum, structural steel 3800MT
10. Central fire and tele network concrete 2700cum,
11. Power supply other structures concrete 33000cum
12. MRS concrete 6700 cum

The other important items cabling, pipe supply and electricals are not covered, they are beyond scope present paper.

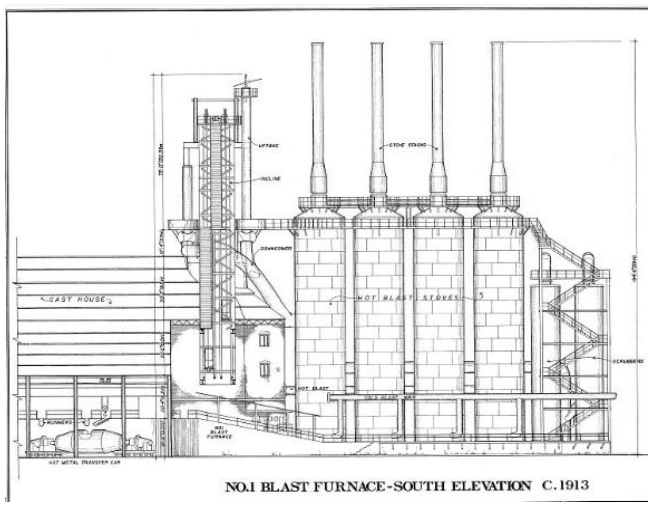


Figure 6 Elevation of Blast Furnace source Pittsburgh steel Co.

4. Construction Period of a Steel Plant

There various important points to be considered in setting up greenfield iron and steel plant. The total construction period of steel plant depends on several facto such as availability of resources, regulatory approvals, weather conditions. The points which influence in greenfield project is summarized below

a) Prefeasibility study – (8 to 12 months) study the feasibility of project considering geographical features, availability of ores and connectivity, environmental impact studies. This phase can take several months to a year. This phase also known as pre construction phase. Pre-construction phase – finalize project plans, obtain land clearances and environment impact studies procure equipment and materials

b) Design Engineering – (1 to 2 years) designing layout facilities, process flow diagrams, structural and mechanical design, electrical and instrumentation plans, This phase may take 1 to 2 years.

c) Procurement of equipment and materials (1 year) – acquiring all machinery and equipment, understanding supply procedures.

d) Site preparation – (4 months to 1 year) -area clearance, establishing temporary construction facilities and access roads. It can take several months to year

e) Construction Phase (2 years to 5 years)- construction of various civil works of essential components of steel plants. Structural construction works which is a part of main construction work. The structural work consists of fabrication and structural components of raw material handling, coke oven, byproduct structures, blast furnace, sinter plant, steel melting shop, mill structures, piping, lime calcining units, junction towers and galleries and their erection, it can take 8 months to 2 years.

f) Installation and commissioning (8months to 1 year) – This phase covers installation of various equipment of individual packages and commissioning. It can take several months to a year.

g) Trail runs and fine tuning (4 to 8 months) – Before full scale production. It is essential to run trial runs and fine tuning. This phase takes few months.

h) Full scale production – Once full operational, production phase commences.

The total construction period ranges from 3 to 7 years. The total construction period depends on continuous monitoring, financial cash flows, obtaining regulatory approvals and miscellaneous factors.

Figure 7 Sinter Plant Source JSSL

Figure 8 Typical Steel Bar Mills

Figure 9 Blast Furnace

5. Conclusion

In this paper an attempt has been made to present points to be considered in designing layout of steel point and construction aspects of various capacities of plant. Integrated steel point is a seamless integration of various branches of engineering and with careful investments. The existence of steel plant will improve socio economic improvement of any region. The paper covers few points only as it considered civil engineering perspective view and construction methodology. The schedules of the project are crucial in nature as there is lot of interferences of different technical aspects. The effective plant layout depends on material inflow and outflow of downstream plants, such as end products of steel plants, flat steels, rolled sections and wires etc.

ACKNOWLEDGEMENT

Author would like to submit the technical information presented in this paper is for information purpose only. Author submit acknowledgements to library congress and various steel producing companies in India. The technological process and feasibility studies are available in print and electronic media.

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