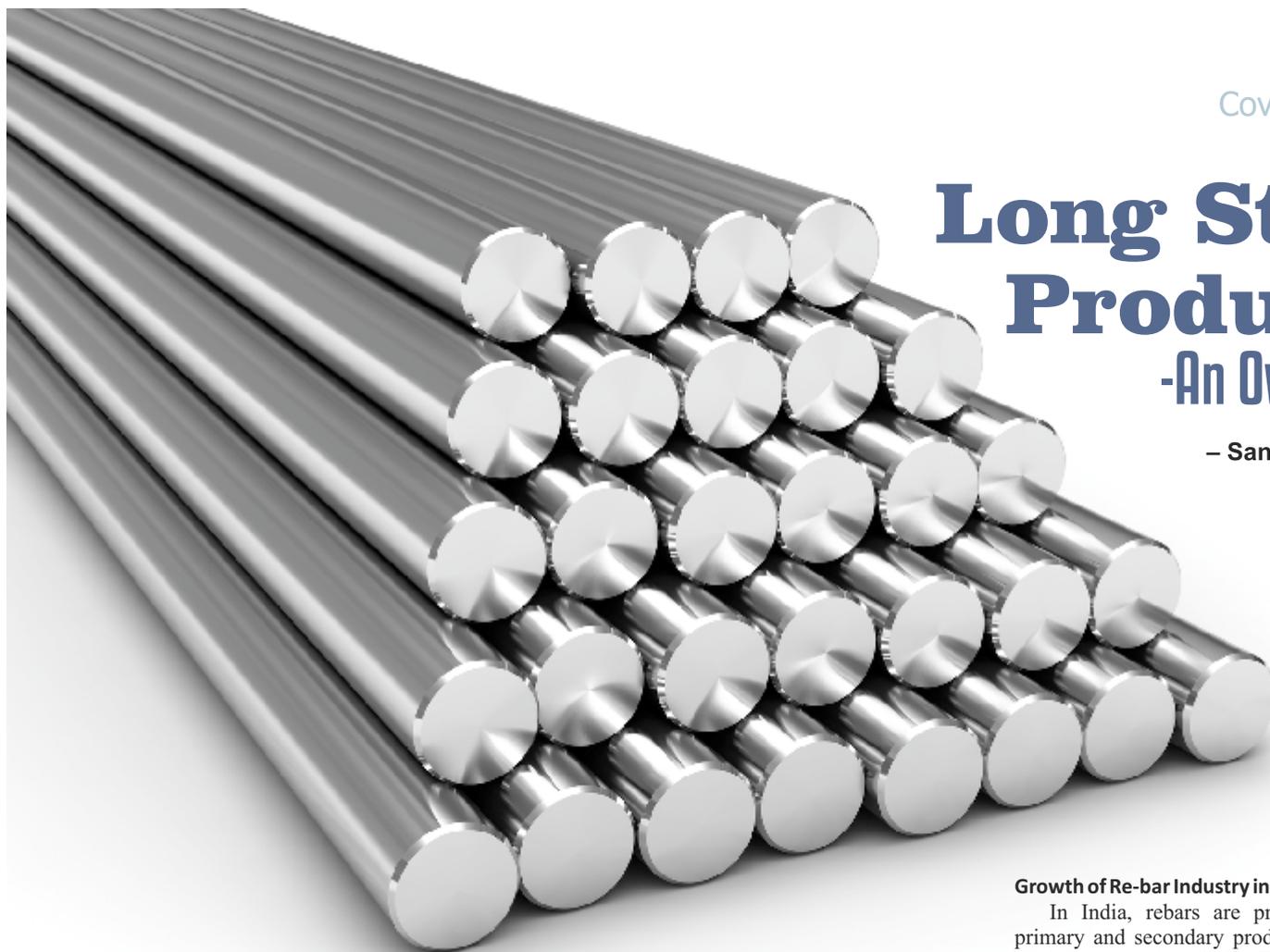


# Long Steel Products -An Overview

– Sanjay Sengupta



**S**teel is a versatile material. Presently it is the most widely used metal. It has become essential material for modern civilization. Steel has the unique property that it can be recycled indefinitely. Every new steel product contains recycled steel. Steel is more eco friendly than metals like copper and aluminium. Steel products have a wide range of applications from the manufacture of a small pin to building of automobiles, railway system, aircrafts, ship building, big construction and infrastructure projects, nuclear projects and building of space satellites. Though, steel products are prone to corrosion and have relatively high strength to weight ratio, yet alternative materials have not been able to make a significant dent on its volume of consumption.

## Categories Of Finished Steel Products

Finished steel products are usually divided into two groups viz. Non- Flat or Long products and Flat Products. Non- Flat or Long Products are broadly categorized as Bars & Rods, Structural and Railway Materials. These products comprise of many sub-products which are mentioned below:

- Bars & Rods include Rounds, Bars, Reinforced Bars (Re- bars), Wire Rod sets.
- Structural include Joints / Beams, Angles, Channels, Z- Sections, MS Arch etc.
- Railway Materials include Rails, Wheels, Axles, Sleepers, Grain Rails etc.

## Some Major Long Products

### Reinforced Steel Bars (Re-bars)

Re-bars are long steel products that find application pre-dominantly in construction and infrastructure sectors. The usage of Reinforced Cement Concrete (RCC) has become the accepted standard for the construction of residential and commercial buildings, flyovers, bridges, water retaining structures, industrial buildings, power plants etc. Re-bars had a share of about 65% in the total consumption of long products in India in 2013-14 and the product accounts for about 25 per cent of the total material cost for civil construction.

## Growth of Re-bar Industry in India

In India, rebars are produced by both primary and secondary producers. Integrated steel producers like SAIL, Tata Steel, RINL's Vizag Steel Plant, JSPL, JSW Steel etc. produce re-bars from pure iron and had a share of about 30 per cent in its total production in 2013-14 while the balance was produced by the secondary producers.

In the early seventies of the CTD Bars were being used in the construction sector in India. The engineers at that time did not bother about checking the vital parameters like yield strength (YS), ultimate tensile strength (UTS), Elongation capability of these bars while using them in RCC. The industrially developed countries had stopped the use of CTD bars at the start of 1970's.

Subsequently, the use of Thermo-Mechanically Tested (TMT) bars started. However, these so-called TMT bars available in the market were often found on testing to have yield strength of 350-390 N/mm<sup>2</sup> as against the yield strength of 485 N/mm<sup>2</sup> as specified and Fe-415 in IS:1786/1985. Later, due to a global demand of low cost high quality rebars that had a yield strength of 500 N/mm<sup>2</sup> based on Thermax and Tempcore technologies were developed.

## Thermax & Tempcore Technologies

Both the Thermax and Tempcore technologies were developed in the mid-1980s to produce re-bars that had a yield strength of 500 N/mm<sup>2</sup> combined with high ductility so that adequate safety was ensured when using

these re-bars in seismic (earthquake prone) zones and to effect a saving in steel consumption. These quenched and self-tempered bars were found to be more superior by civil engineers to the CTD and TMT bars which were being used earlier.

**● Thermax Process**

The bar, as it leaves the final mill stand, is guided by specially designed Thermax Pipes when the surface temperature of 900-1000 degree centigrade is drastically brought in a short period of time by intense and uniform cooling. The temperature of the bar-core remains largely unaffected. The name 'Thermax' has been derived from thermal exchange and this exchange is the key to the process.

The drastic and pre-determined cooling of the bar periphery transforms the peripheral structure to martensitic and needs to be annealed to render the bar useful. The annealing is achieved by the heat available at the core. Temperatures finally equalize at about 600 degree centigrade and the resultant bar structure is of tempered martensite at the periphery and of fine grained ferrite-pearlite at the core. Thermax bars save steel consumption by about 20 per cent as compared to the CTD bars. Presently, Thermax quenched and self-tempered (GST) bars with high strength and ductility is being produced by over 140 units in India and its output has gone over 15 Mtpy. Thermax producers have introduced world's latest quenching technology under the brandname 'TEGUM'.

**● Tempcore Process**

In Tempcore Process, the first stage of 'quenching' begins when the hot-rolled bar leaves the final mill stand and is instantly quenched by a special water spray system. This converts the surface layer of the bar to a hardened structure called 'Martensite' while the core remains austenitic. The second stage of 'Self Tempering' begins when the bar leaves the quenching box with a temperature gradient through its cross section, with the temperature of the core being higher than that of the surface. At this stage, heat flows from the core to the surface, giving it a structure called 'Tempered Martensite'. The core still remains austenitic. The third stage of 'Atmospheric Cooling' takes place on the cooling bed where the austenitic core is converted to a ductile ferrite-pearlite core. Thus, the grain structure martensite and a

ductile core of ferrite-pearlite. The special package offered by the Tempcore process is a unique blend of properties-an excellent combination of strength and ductility. Tempcore saves about 16 percent in steel consumption as compared to CTD bars.

**Application of Thermax and Tempcore Process in India**

Major products of re-bars have introduced Thermax and Tempcore technologies in their production process.

SAIL's Durgapur Steel Plant and Bhilai Steel Plant were pioneers in installing the Thermax process in India. These plants produce long products like plain rounds, bright bars and rebars like TMT, TMT HCR, TMT Roof Bolts, TMT EQR etc.

RINL's Vizag steel Plant and Tata steel were pioneers in India in installing Tempcore technology.

Vizag steel's Tempcore re-bars attain higher strength and achieve excellent ductility, outstanding bendability and super weldability because of lesser carbon content in the steel rolled. The quality of these rebars is further enhanced due to the low temperature rolling by way of higher strength.

Tata steel produces TISCON TMT and TISCON CRS branded quality rebars based on Tempcore technology.

TISCON TMT bars, because of their unique process of manufacturers possess a combination of strength and ductility that is far excess of the minimum limits of physical properties as specified in IS:1786/85. These bars reduces consumption of steel in the structures yet ensure safe construction.

TISCO CRS re-bars are subjected to rigorous corrosion susceptibility tests including Alternate Immersion Test, Salt Spray Test, Potentio-dynamic Test, Sulphur Dioxide Chamber Test, Hot Pack Environment Test, Atmospheric Exposure Test among others.

TISCON CRS is suitable for use in marine environment, in areas of industrial pollution, heavy rainfall, high humidity, saline sub-sail etc. Fatigue tests show that these bars can be used as reinforcement material in seismic (earthquake prone) zones.

**The Revised IS: 1786-2008 specification**

**The IS is 1786/85 grade has been revised to IS:1786/2008.**



**Wire Rods**

Steel wire rods are important members in the long steel products family. They play a very significant role both in the industrial and construction sector and helps in the development of a country's economy.

In the industrial sector, wire rods have significant use in atomic reactor vessels, auto and cycle tyers, armouring of submarine cables, hardware and fasteners industry, components and ancillaries of the automotive industry etc.

In the construction sector, wire rods are used for house buildings, construction of hospitals, educational institutions, hotels, commercial complexes, shopping malls, sports stadia, stayware bridges, roads, bridges, flyovers etc.

**Leading Producers of Wire Rods in India.**

● SAIL's Bhilai Steel Plant has a Wire Rod Mill of 400,000 tpy capacity. Its wire rods are used in structural construction, arc welding electrodes, cable armouring, in the fastener industry made from Cold Heading Quality (CHQ) wire rods.

● Tata steel has a Wire Rod Mill of 300,000 tpy capacity. Its wire rods are used for electrodes, fabrication and construction, pre-stressed concrete wires for railway sleepers, springs, auto cable wires, high tensile fasteners made from CHQ wire rods, tyer bead wires and mild steel wire rods etc.

● RINL's Vizag Steel Plant has Wire Rod Mill of 850,000 tpy capacity. It produces mild steel wire rods, bright bar quality, micro-

**The revised mechanical properties are as follows:**

Yield strength N/mm <sup>2</sup> (min)	Fe-415 415	Fe-415D 415	Fe-500 500	Fe-500D 500	Fe-550 550	Fe-550D 550	Fe-600 600
Tensile strength N/mm <sup>2</sup> (min)	485	500	545	565	585	600	660
Elongation % (min)	14.5	18	12	16	10	14.5	10

Accordingly, the construction sector are adopting new grades like Fe-500, Fe-550D, Fe-500D. On the application side, the rebar use is moving towards high value added products like corrosion resistant rebars, Epoxy coated rebars, earthquake resistant rebars, galvanised re-bars etc.

alloyed and electrode quality wire rods etc.

- Jindal Steel & Power (JSPL) has installed a modern Wire Rod Mill at Patratu in Jharkhand which is equipped with latest technology. It produces CHQ, Tyre-bead, Electrode and other superior quality wire rods.

- Mukand Ltd's Wire Rod Mill at Kalwe in Maharashtra, produces CHQ wire rods in carbon, alloy and boron grades. It also produces stainless steel, leaded and free cutting, low alloy and bright bar quality wire rods.

- Usha Martin Industries based in Jharkhand has a Wire Rod Mill that produces ball bearing, boron, CHQ, bright bar, free cutting, electrode and alloy steel quality wire rods.

- Rathi Udyog of Gaziabad, U.P. has a Wire Rod Mill which is capable of producing CHQ, bright bar, low alloy, low carbon, high carbon and electrode quality wire rods.

Other producers like Ishar Alloy, Bangalore, Viraj Alloys, Bharuch, Gujarat and many others in the secondary sector produce CHQ, bright bar, lead and sulphur being free cutting, electrode, ACSR etc. quality wire rods. Secondary producers have a share of about 70 per cent in India's total production of wire rods.

Type of structural	Beams/Joists	Channels	Angles
Heavy	Above 200x100mm	Above 200x75/76mm	150x150mm above
Medium	Above 125x70mm	From 125x65 to 200x75/76 mm	From 100x100 to 130x130mm
Light	125x75mm & below	Below 125x65mm	Below 100x100mm

Besides, the above, universal beams, H-beams, parallel beams are being produced by RINL's Vizag Steel Plant and JSPL.



infrastructure projects. Structurals are grouped by sectional weight into heavy, medium and light structural categories. Conventionally, these structurals cover the following size ranges of Beams/ Joists, channels and angles.

#### Producers of Structurals in India

- **Bhilai Steel Plant (SAIL)**

Bhilai's Rail and Structural Mill, is being predominantly used as a rail mill. The mill produced about 800,000 tonnes rail in 2013-14. The product range of the mill includes beams (600x250mm), channels (250x400mm) and angles (150x200mm). The mill has produced rail track of 260 metre length. Bhilai Steel Plant (BSP) is the sole supplier of rails to the Indian Railways.

Bhilai's Merchant Mill produces channels (75 x 140 mm) and angles (50 x 90 mm). In 2010, three conventional stands of the mill were replaced by housing less stands. BSP has placed an order with SMS Meer for installation of a 1.2 Mtpy capacity Universal Mill which will produce rails up to 75 Kg/m and up to 130 m length, welded panel up to 260 m (520 m in future), asymmetrical and head hardened rails. The mill will have 2- Hi reversing stand with a compact three-stand Universal Tandem Groups (UR-E-UF) using X = H(R) rolling method patented by SMS Meer of Germany.

SAIL's Durgapur Steel Plant (DSP) has a medium Section Mill Which produces Beams (175 x 200 mm), channels (125 x 200 mm) and Angles (100 x 150 mm). DSP has placed an order with Siemen VAI for installing a one million tonner per year capacity Medium Structural Mill that will produce Parallel Flanged Beams up to 270 mm as well as channels and angles.

Under the modernisation and expansion program SAIL'S IISCO Steel Plant at Burnpur, West Bengal has planned to install a heavy Universal Mill of 0. 85 Mtpy capacity to be supplied by SMS Meer consortium. It will produce Parallel Flanged Beams up to 750 mm



#### Wires drawn from various grades of Wire Rods and their end uses are shown below:

Wire Products	Uses
Bright Bar Wires	Components, spares, ancillaries of automobiles
Flat Cable Armoured Wire	Cables and conductors in Power sector
Round Cable Armoured Wire	Power Sector, armouring of submarine cables
Electrode Quality Wire	Electrode manufacture
Galvanised Wire	For barbing and fencing, telephone sector
Galvanised steel wire ropes	Telephone sector, Railway signals, haulage
Wires for industrial chains	Industrial chains for engineering industry
Pre-stressed concrete wires and strands	Construction of bridges, Silos, Atomic Reactor vessels, Airport Hangers, Railways
Tyre Bead Wire	Auto and cycle tyres
Cold Heading Quality Wires	High tensile bolts, screws, low tensile bolts, rivets, nails etc.
Wires For Spring Industry	Manufacture of springs in general, Tiller springs, Galvanised springs and springs for the auto Sector
<b>ACSR Wires</b>	
(a) Single Stranded Wire	Overhead power transmission lines
(b) Detonator Wire	Explosives for mining industry

Wire Drawing units, Bright Bar units and Fastener units together consume about 2.5 Mt of wire rods per year.

#### Structurals

Structural steel plays a very important role in a country's economic development by providing essential items for the infrastructural and industrial development. Structurals have major application in engineering fabrication,

bridge girders, transmission line towers, building columns, off shore construction, high rise buildings, wagon and railway coach building, ship building, construction of large factory sheds, fabrication of lock gates in irrigation projects, supporting columns in coal mines, underground rails and in many other

Specifications and Uses of structural steel	
Specification/Grade	Uses
IS2062/2008	Industrial and multi-storey buildings, Road Bridge composite construction, Utility building, Car park, Ports and harbour: jetties, warehouses, sheds, transmission line towers, technological structures, bridges, off-shore drilling rigs etc.
IS 8550/91	Desks and platforms, railway wagons and coaches, structurals for electrification and underground railways, Material handling system, conveyor gallery, supporting girders and towers etc.
IS 3039	Structural steel for ship building

**Performance of Long Steel Products Industry in India** - Performance of the long Steel products industry in India between 2009-10 and 2013-14 is shown below:

**A. Production for Sale** - Production for sale is arrived at after deducting Inter-Plant Transfers (ITP) and producer's own consumption from gross production. Production for sale of long products between 2009-10 and 2013-14 are shown in Table-1.

Table-1: Production of long Products: 2009-10 to 2013-14 ('000 tonnes)						
Year	Bars & Rods	Structurals	Rly Materials	Total	% change	% Share in Total Finished Steel
2009 - 10	21770	4141	1041	26952	-	47.21
2010 - 11	25912	4554	925	31391	16.47	48.86
2011 - 12	28102	4939	909	33950	8.15	48.02
2012 - 13	28795	5932	938	35665	5.05	46.81
2013-14 (P)	30019	6632	883	37534	5.24	47.25

Source : JPC (P) = Provisional

**B. Imports** - Imports of long products by India between 2009-10 and 2013-14 are shown in Table-2.

Table-2 Imports of long products by India: 2009-10 and 2013-14 ('000 Tonnes)						
Year	Bars & Rods	Structurals	Rly Materials	Total	% change	% Share in Total Finished Steel
2009 - 10	590	91	12	693	-	10.93
2010 - 11	438	82	12	532	(-) 23.23	9.13
2011 - 12	425	63	12	500	(-) 6.02	9.19
2012 - 13	514	91	19	624	124.80	9.98
2013-14 (P)	293	43	4	340	(-) 45.51	7.92

Data Source : JPC (P) = Provisional

**C. Exports** - Exports of long products by India between 2013-14 are shown in Table-3.

Table-3 Exports of long products by India: 2009-10 to 2013-14 ('000 Tonnes)						
Year	Bars & Rods	Structurals	Rly Materials	Total	% change	% Share in Total Finished Steel
2009 - 10	212	55	0	267	-	8.67
2010 - 11	136	37	6	179	(-) 32.96	5.57
2011 - 12	225	44	42	311	73.74	7.40
2012 - 13	413	61	3	477	53.38	9.82
2013-14(P) (P)	585	65	1	651	36.48	12.72

Data Source : JPC (P) = Provisional

India was a net exporter of long steel products in 2013-14.

**D. Consumption** - In India between 2009-10 and 2013-14 is shown in Table-4.

Table-4 Consumption of long products in India: 2009-10 to 2013-14 ('000 Tonnes)						
Year	Bars & Rods	Structurals	Rly Materials	Total	% change	% Share in Total Finished Steel
2009 - 10	21616	4199	986	26801	-	47.79
2010 - 11	26444	4619	970	32033	19.52	50.90
2011 - 12	28048	4950	869	33867	5.73	51.29
2012 - 13	29445	5987	946	36378	7.41	53.80
2013-14 (P)	30067	6616	870	37553	3.23	54.18

Data Source : JPC (P) = Provisional

and universal angles and channels. The technology will be the same as the Universal Mill that is being installed by SMS Meer at Bhilai Steel Plant.

RINL'S Vizag Steel Plant has a Medium Merchant and Structural Mill of 0.85 Mtpy capacity. This is a high speed Universal mill with computer control. It produces Universal Beams (both parallel and wide flanged) as well as channels and angles.

Jindal Steel & Power Ltd. (JSPL) has a Rail and Universal Mill of 100,000 tpy capacity. This was a used mill that was upgraded and revamped by the SMS Group of Germany. The mill now has a Reheating Furnace, primary and secondary sealers, one 2-Hi reversible stand, three stand Universal Mill (UR-E-UF), cooling bed, ultrasonic and eddy current facilities for rails and welding of to produce 480 meter long rails. The mill is predominantly being used as a structural Mill and produces parallel beams (200X100 mm to 730X300 mm) and universal columns up to 400x400 mm.

There are other producers/re-rollers and small capacity producers who have a share of over 85 percent in the total production of structurals but most of their products are unsuitable for high-end applications.

#### ● Railway Materials

Railway materials comprises of rails, crane rails, wheels, axles, wheel sets, sleeper bars, fish plates etc.

#### Producers of Railway Materials in India

SAIL's Bhilai Steel Plant produces rail tracks of 13 and 26 meter length as well as long rail panels of 260 meter length. It produces prime quality rails to IRST-12/2009, vanadium and corrosion resistant grades. It also produces 110 UTS quality rails. BSP's rails are one of the cleanest globally available with Hydrogen content of 1.6 ppm (max) and Aluminium-0.15% (max). BSP is the sole supplier of rail to the Indian Railways.

SAIL's IISCO steel plant produces crane Rail used for charging cars, coke cars, coal guide track and cold tub tram cars in collieries. It is also used for slow speed railways, light posts etc.

Jindal Steel & Power Ltd. (JSPL) has a Rail and Universal Mill that has online ultrasonic and eddy current facilities for rails along with welding of rails to produce 480 meter long rails. Though JSPL's Rail and Universal Mill has produced 120 meter long rails, it is predominantly being used as a structural Mill.

**Note :** All figures in Table-1 to Table-4 relates to carbon finished steel only.

Growth in consumption of long steel products has come down to 3.23 percent in 2013-14. The growth in the consumption of total finished steel (Non-Flat + Flat) during 2013-14 was low at 2.5 percent.

**Conclusion**

Long steel products are mainly consumed by construction / infrastructure sectors and plays a vital role in the economic development of a country.

The core sector representing the eight infrastructure industries, having a share of about 40 percent in India's Index of Industrial Production (IIP) grew by 2.6 percent in 2013-14. In the first seven months (April to October) of 2014-15, this growth reached about 2.9 percent over the same period of the previous year.

During April to September 2014, the construction sector has posted a growth of 4.7 percent over 2.75 percent recorded in the same period of the preceding year.

Due to the better performance of core sector and construction sector, India's consumption of long products at 15.85 Mt has recorded a healthy growth of 9 percent during April to August, 2014-15 over the same period of the previous year.

The Indian Prime Minister has opined that the accelerated infrastructure development was the Government's top



priority and stressed the need for creating world class infrastructure in India. It is expected that the consumption of long

products in India will record higher growth in future.



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