



**Automation of Manual Material Handling System for  
Centerless Grinding Machine**

at

**Ambica Steels, Unit-2**

**Plot no. 32, Site-2, Loni Road Industrial Area,**

**Mohan Nagar, Gaziabad**

by

**Research and Development Team**

**Department of Mechanical Engineering**

**Maharaja Agrasen Institute of Technology**

**Rohini Sector-22, Delhi-110086**

## **Introduction**

Ambica Steels supplies its materials to both Indian and International markets, and commands a leading position in specialty stainless steel materials. Ambica Steels is inevitably expanding and increasing its market share worldwide, while maintaining its focus on the Indian market where it is serving customers since 1970.

Ambica Steels is exporting stainless steel to countries like USA, Germany, Russia, Australia, Italy and other European countries. They have an office and local representative in Germany. They are one of the leading exporters, suppliers and manufacturers of stainless steel products from India.

Ambica Steels Limited (Ambica) is India's largest 'Specialty Stainless Steel' long-products producer. Ambica, a family business for 3 generations possesses a rich steel making experience of over 44 years, and specializes into the production of Stainless Steel Long products. Ambica is India's First AS-9100C Aerospace Certified Stainless Steel mill.

Since 1970, Ambica is constantly exceeding expectations of stainless steel long products customers in over 55 countries worldwide, and has been setting new benchmarks into the Stainless Steel Industry. Headquartered in New Delhi, Ambica's two production units are located in Sahibabad Industrial area. Ambica produces around 80,000 Tons of "Specialty" Stainless Steels in more than 150 grades like Duplex & Super Duplex Steels (F-51, F-53, F-60), 17-4ph, XM-19, XM-25, 420B, 420C, 409Ti, 403, 410, 416, 420F, 430F, 430LNB, 431, F6NM, 316Ti, 316Mo, 316LN, 304N, 347H, Nitronic 60, 1.4122, 1.4923, 1.3952, 1.4313, 1.4511, 1.4821, 1.4828 etc.

Ambica is also the leading producer of Precipitation Hardening Steels (17-4, 630, 1.4542) conforming to AMS specifications for the Aerospace Industry and Oil & Gas Industry. Being a fully integrated plant, Ambica is well equipped with most-updated stainless steel melting and rolling facilities starting from the Steel Melt Shop, AOD Converter, Continuous Billet Caster (with EMS), Ingot Casting Pit, Hot Rolling Mills, Heat Treatment facilities and ultra-modern Cold Finishing Facilities. Ambica's product range includes Precision Bars (PSQ,

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BSQ), Bright Bars, Cold drawn Hexagons and Squares, HRAP Flat Bars including Billets and Forging Ingots. Ambica is a truly customer-focused company and continuously aims to satisfy its valuable customers.

Ambica is one of the most updated Stainless Steel mill in the world, employing a wide range of ultramodern steel making technology. Melting data is monitored precisely by a strong production control system that ensures tight adherence to specified material properties such as purity levels, Chemical and Mechanical values.

Ambica Steels Limited has following mentions workshop units for the quality production of stainless steel bars.

**Melting and Casting Shop**

- Electric Melting Furnaces – 20 ton capacity
- Argon Oxygen Decarburization (A.O.D) Converter – 30 ton capacity
- Billet Continuous Casting Machine, with Electro Magnetic Stirrer (M-EMS)
- Ingot Casting (Bottom Pouring) – upto 22 ton/ Ingot weight

**Hot Rolling Mills**

- 18 inch, Hot Rolling Mill with 4 stands (460 mm)
- 13 inch, Hot Rolling Mill with 6 stands (330 mm)

**Heat Treatment**

- Solution Annealing and Annealing
- Quenching (Oil) and Tempering (Q.T)
- Hardening and Tempering (H.T)

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- Double Tempering / Double Ageing Cold Finishing
  
- Bright Bar Peeling and Cold Drawing Lines
  
- Centerless Grinding Machines
  
- Flat Bars cold finishing set-up
  
- Cold Drawing Machines for Hexagons and Square Bars
  
- Double end fully automatic Chamfering Machine.

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**Products**

There is a large variety of products which Ambica Steel Produces. The main products manufactured by ambica steels are:

- Bright Round Bars
- Precision Round Bars
- Hexagon and Square Bars
- Hrap Flat Bars
- Duplex Steels
- Precipitation Hardening Steels

The specifications of each product which Ambica Steel produces is given below:

- **Bright Round Bars**



Figure 1: Manufactured bright round bars

Table 1: Technical specifications of bright round bars

Size range	4 mm to 100 mm (3/16 inch to 4 inch)
Size Tolerances	h8, h9, h10, h11, h12, k12, k13, A-484, EN-10060, DIN-1013 etc.
Length	2 meters to 8 meters (8 feet to 26 feet)
Chamfering	Available in 30°, 45° & 60° through fully automatic, both-end chamfering machine
Crack Test	Magnetic Particle Inspection (MPI)
Ultrasonic Test	100% tested through Digital Ultrasonic Flaw Detector, , as per ASTM A-388, EN 10308 (class 1 to 4),API 6A/ISO 10423:2003-PSL 3, SEP 1920:1984 (class A, B, C), MIL STD 2154
Length Tolerance	Bright Bars available in special cuts with tolerance limits ranging between -0 to +0.5 inch (or 0 to +10mm)
Surface Finish	Centreless Ground & Belt Polished, up to Ra value = 0.2 um (12 RMS) , and Grit Polished of up to 180 to 600
Heat Treatment	<ul style="list-style-type: none"> <li>• Solution Annealing</li> <li>• Annealing</li> <li>• Hardening &amp; Tempering (QT)</li> </ul>

	<ul style="list-style-type: none"> <li>• Aging/Double Aging</li> </ul>
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- **Precision Round Bars**

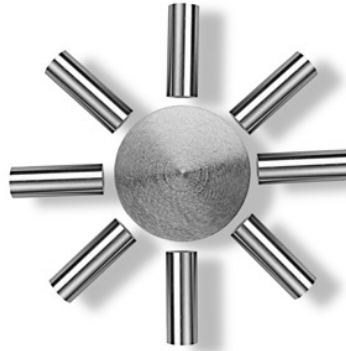


Figure 2: Precision round bars

Table 2: Technical specifications of Precision round bars

Size Range	6mm-100mm(1/4-4 inch)
Size Tolerances	f8,h8,h9 and A484
Length	2 meters – 7.5 meters ( 8 feet to 24 feet)
Ovality	Half of diameter tolerance Max.
Heat Treatment	Annealed, Solution Annealed, Quenched and Tempered (QT),Hardened and Tempered ( HT),Quenched and Double Tempered.
Straightness	0.25 mm per meter max (0.0015 per feet)
Chamfering	Available in 30,45 and 60 degree thru fully automatic both-end chamfering machine
Crack Test	Magnetic Particle Inspection (MPI).
Ultrasonic Test	100% tested thru Digital Ultrasonic Flaw Detector, as per ASTM A-388 , EN 10308 (class 1to4),API 6A/ISO 10423:2003-PSL3,SEP 1920:1984 ( class A,B,C), MIL STD 2154
Length Tolerance	Available in special-cut-to-length bars in tolerance of -0 to +10 mm (or -0+0.5 inch)
Grades	AISI: 303, 304L, 316L, 316Ti, 321, 403, 410, 416, 420, 420B, 420C, 430F, 431, 17-4ph, Duplex F51(2205), Duplex xF60 DIN: 1.4305, 1.4307, 1.4404, 1.4571, 1.4541, 1.4006, 1.4005, 1.4021, 1.4028, 1.4034, 1.4104, 1.4057, 1.4542, 1.4462, 32205, 1.4122, 1.4435
Packaging	Packing is mainly done using a variety of protective materials as well as distance rings, which are subsequently placed in a strong plywood in order to ensure a complete safety of the material during transportation

- Hexagon and Square Bars

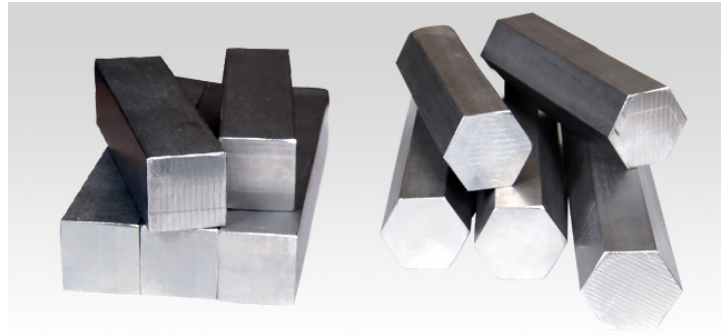


Figure 3: Hexagon and Square Bars

Table 3: Technical specifications of Hexagon and Square Bars

Hexagon Sizes	12 mm – 45 mm (1/2''- 1 3/4'')
Square Sizes	12 mm – 40 mm (1/2''-1 1/2'')
Size Tolerances	h11
Length	2 – 6 meters (8 to 20 feet)
Chamfering	Available in 30, 45 & 60 degree thru fully automatic both-end chamfering machine
Ultrasonic Test	100% tested thru Digital Ultrasonic Flaw Detector, as per ASTM A-388, EN 10308 (class 1 to 4), API 6A/ISO 10423:2003-PSL 3, SEP 1920:1984, MIL STD 2154
Length Tolerance	Available in special cut to length bars in tolerance – 0/+10mm (-0 +0.5 inch)
Surface Finish	Cold drawn condition and Belt polished condition
Heat Treatment	Annealed and Solution Annealed
Grades	AISI: 303, 304L, 316L, 316Ti, 321, 409, 410, 416, 420, 430F DIN: 1.4305, 1.4307, 1.4404, 1.4571, 1.4541, 1.4512, 1.4006, 1.4005, 1.4021, 1.4104

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- **Harp Flat Bars**



Figure 4: Harp Flat Bars

Table 4: Technical Specifications of Harp Flat Bars

Size Range	38x10 mm to 150x25 mm
Size Tolerances	EN 10058 and ASTM A 484
Length	2 meters - 7 meters ( 8 feet to 24 feet)
Length Tolerance	Available in special cut to length bars in tolerance -0/+10 mm (-0+0.5 inch)
Surface Finish	Hot Rolled Annealed & Pickled (HRAP) Condition
Heat Treatment	Annealed, Solution Annealed
Grades	AISI: 303, 304L, 316L, 316Ti, 321,410, 416, 420, 630/17-4ph DIN: 1.4305, 1.4307, 1.4404, 1.4571, 1.4541, 1.4006, 1.4005, 1.4021, 1.4542, 1.4122, 1.4435, 1.3952, 1.4923

- **Hot Rolled Bars**

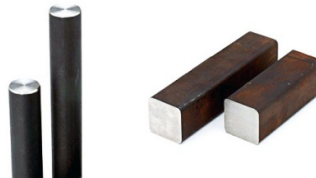


Figure 5: Hot Rolled Bars

Table 5: Technical Specifications of Hot Rolled Bars

Hot Rolled Bar Sizes	16, 17, 18, 19, 20, 21, 22, 23.5, 25, 27, 28, 30, 30.5, 32, 34, 36, 38,40, 42, 45, 47, 50, 53, 56, 58, 60, 63, 65, 68, 70, 73, 80, 83, 85, 90, 95, 100, 105, 110, 120, 125 mm
RCS Sizes	50,55,60,63,70,75,80,90,100 mm
Surface finish	Hot Rolled (Black surface) in spot ground condition. Free of surface defects/cracks.
Size	EN 10060,ASTM A 484

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Tolerances	
Length	2 meters -8 meters ( 8 feet to 26 feet)
Ultrasonic Test	100% tested thru Digital Ultrasonic Flaw Detector, as per ASTM-A 388, EN 10308 ( Class 1 to 4 ),API 6A/ISO 10423:2003- PSL 3,SEP 1920 : 1984, MIL STD 2154
Heat Treatment	Annealed, Solution Annealed, Quenched and Tempered ( QT),Hardened and Tempered (HT),Quenched and Double Tempered

- **Duplex Steels**



**Figure 6: A Product made from duplex steels**

Duplex stainless steel products are principally characterized by the following key features:

- 100% pure and premium stainless steel
- Stress and Corrosion Resistant Alloys (Austenitic and Ferritic)
- Extremely high mechanical strength
- Excellent weldability
- Superior Reliability
- Low thermal expansion
- Manufacturing process carried out in state-of-the-art facility
- High tolerance to match exact client requirements
- Ultra-inspection guidelines followed to attain extraordinary accuracy
- Improved tensile strength
- Melting/ Heating/ Reshaping of steel is carried out in a controlled environment
- ISO certified organization

Ambica Steels produces all materials in the duplex grade – Bright Round Bars, PSQ / BSQ Bars, HRAP Squares / Hexagons, HRAP Flat Bars, HR Bars & RCS, Concast Billets, Ingots. Due to its two-phase microstructure, Duplex steels are extremely tough to produce. It took Ambica Steels many years of constant trials & errors, before gaining a complete control over this steel. The dual phase structure demands a perfect balance in the chemistry of these steels. Duplex steels also show an irregular behavior when undergoing various hot working processes. Duplex Stainless Steel long products are the family of steels that have a mixed micro-structure of 50% ferrite and 50% austenite. They are known to offer exceptional strength and astounding aesthetic qualities along with better resistance against corrosion and high temperature, superior hygienic surface finishing, and improved steel recyclability.

- **Precipitation Hardening Steels**

Ambica Steels produces 17-4 steels (also known as 1.4542 Bar and AISI 630) steels. This is a precipitation hardening martensitic stainless steel with Cu and Nb/Cb additions. The grade combines a very high strength, hardness (up to 572°F / 300°C), and corrosion resistance.

Very high yield strength up to 1100-1300 MPa (160-190 ksi) can be achieved. Ambica Steels offers various heat treatments in this grade like – Solution Annealed, H900, H925, H1025, H1075, H1150, H1150D, H1150M, P800, P930, P960, P1070 etc with both Air & Oil quenching,

- **Forging Quality Ingots and Continuous Cast Billets**

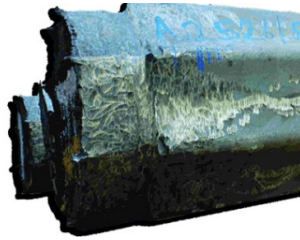


Figure 7: Stainless steel ingot

Ambica Steels is the largest producer of stainless steel ingots for various industrial applications. Ambica's steel manufacturing plant is capable of producing the Special Steel for Aerospace, R&D Labs, Tool & Die Steel and Forging quality ingots of all international/national specifications in stainless steel category. The product is used for direct upsetting forging open die forging and other engineering cases.

Continuous Casting is the process whereby molten steel is solidified into a "semi-finished" billet, bloom, or slab for subsequent rolling in the finishing mills. Prior to the introduction of Continuous Casting in the 1950s, steel was poured into stationary molds to form "ingots". Since then, "continuous casting" has evolved to achieve improved yield, quality, productivity and cost efficiency. Ambica steels also produces these continuous castings of superior quality.

**Objectives:**

- (1) To automate the centerless grinding system of the Ambica Steels unit-2 for better productivity and quality.
  
- (2) To reduce the overall involvement of labour in the material handling system.

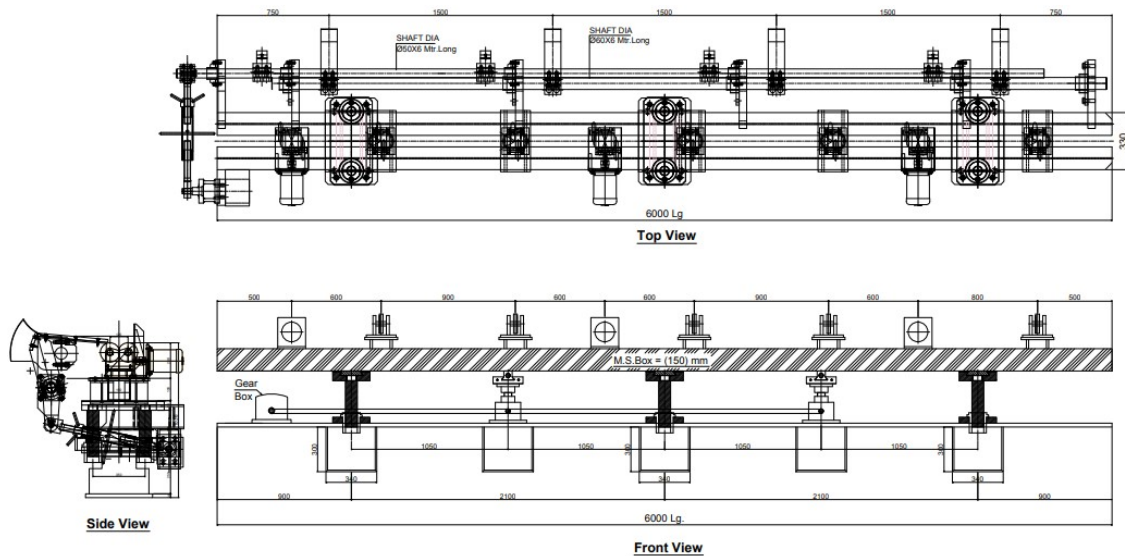
**Description of Objectives:**

The unit 2 of the Ambica Steel involves the heating the raw material in the furnaces to a temperature in the range of 900 °C- 1100 °C. After that the heated billet is passed through the number of different rolling units as per the required dimension.

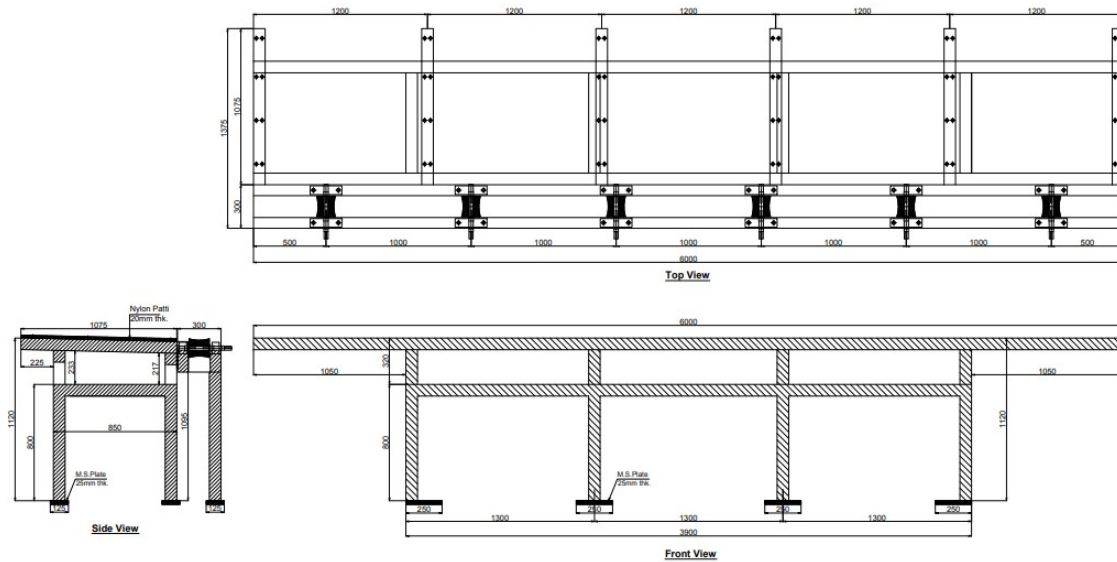
To achieve the better quality, Ambica Steels Limited has installed the centerless grinding machine. In this centerless grinding, the handling of the rolled bars is done by the labour. This handling of the bar from the entry end to the exit end of the centerless grinding machine is done by labour. This work of handling the bars takes a lot time during the production and often hinders the productivity of the Ambica Steel. So the prime objective of this consultancy work is to automate this manual material handling system, so that the time wastage can be minimized with increased productivity and requiring less number of workers for this work.

The automatic handling system also helps in preventing any injuries which may occur during the handling of the bars.

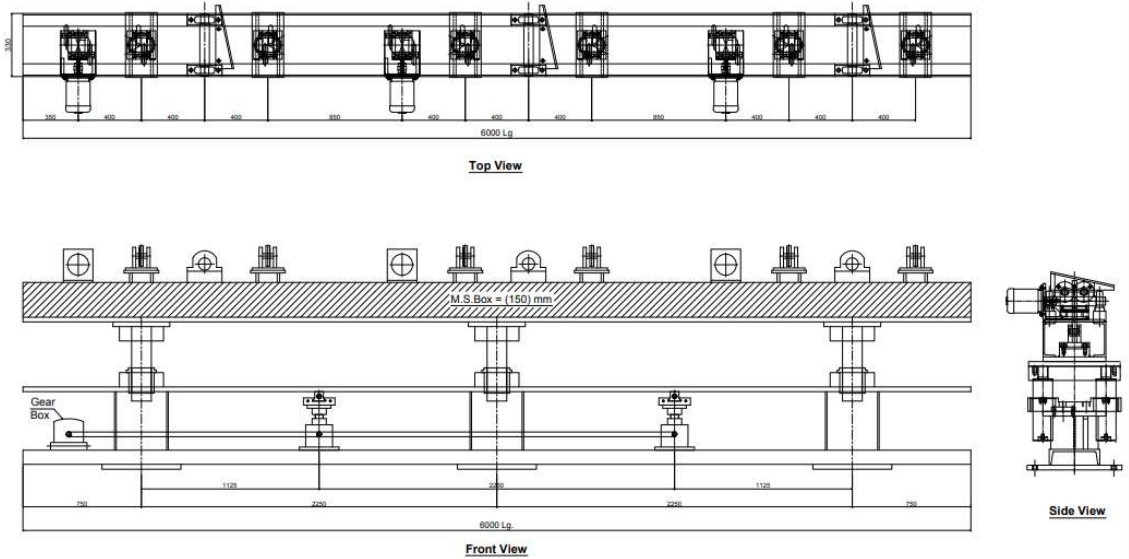




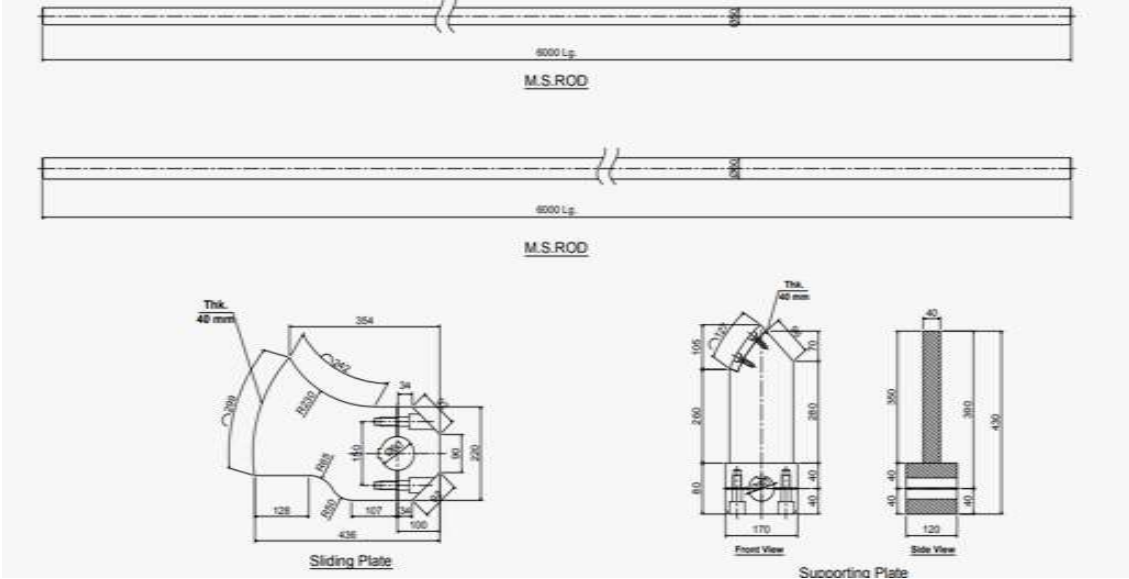
**Fig:Entry Conveyor(Material :MS) to the Centerless Grinding Machine**



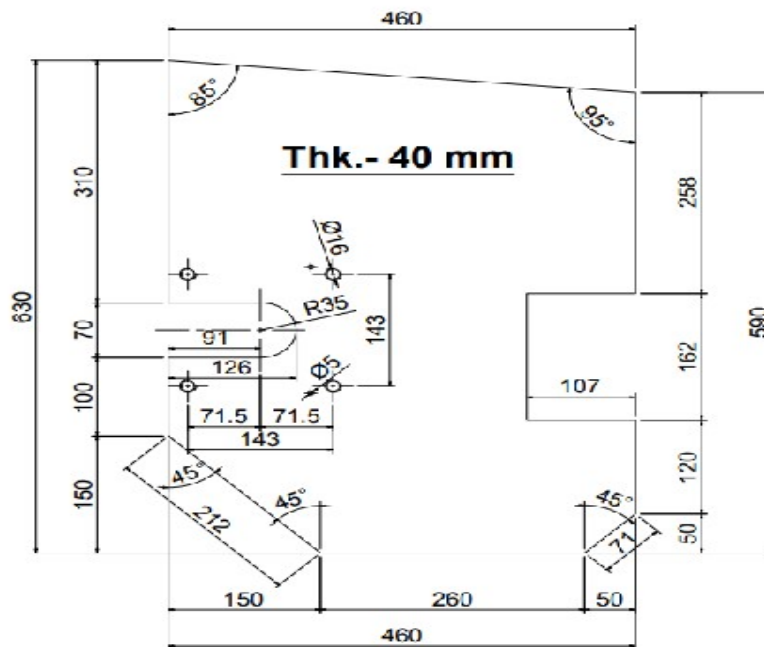
**Fig:Exit stand (Material :MS) to the Centerless Grinding Machine**



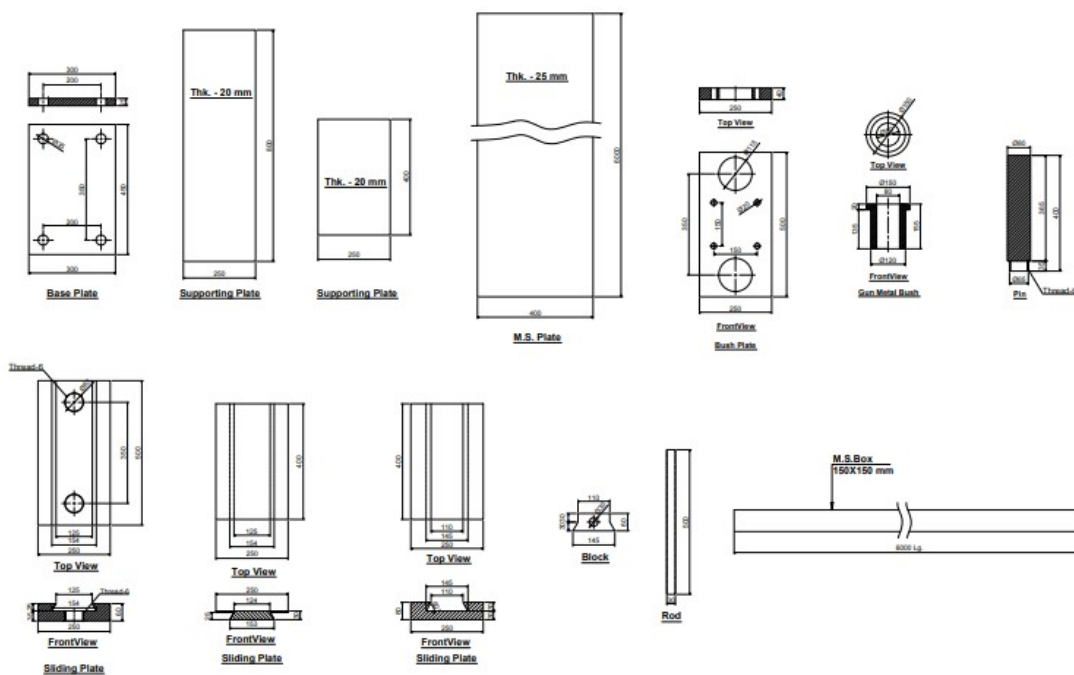
**Fig:ExitConveyor(Material :MS) to the Centerless Grinding Machine**



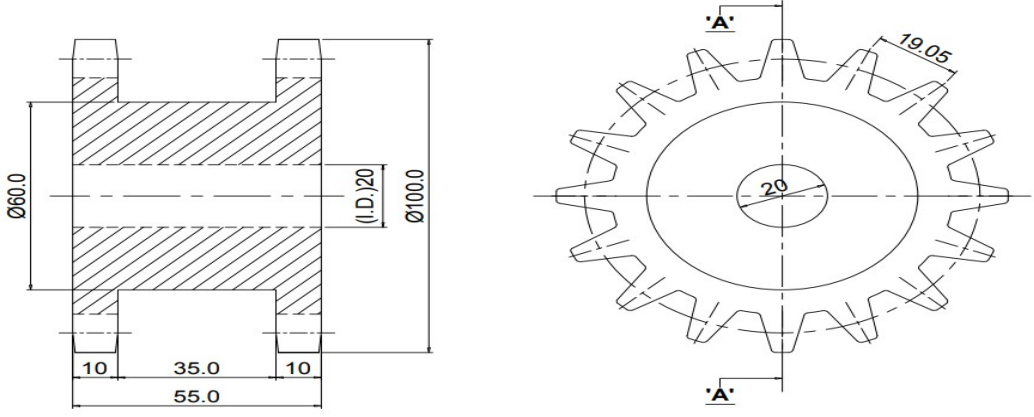
**Fig: Spare of Entry stand to the Centerless Grinding Machine**



**Fig: Spare of Entry stand to the Centerless Grinding Machine**

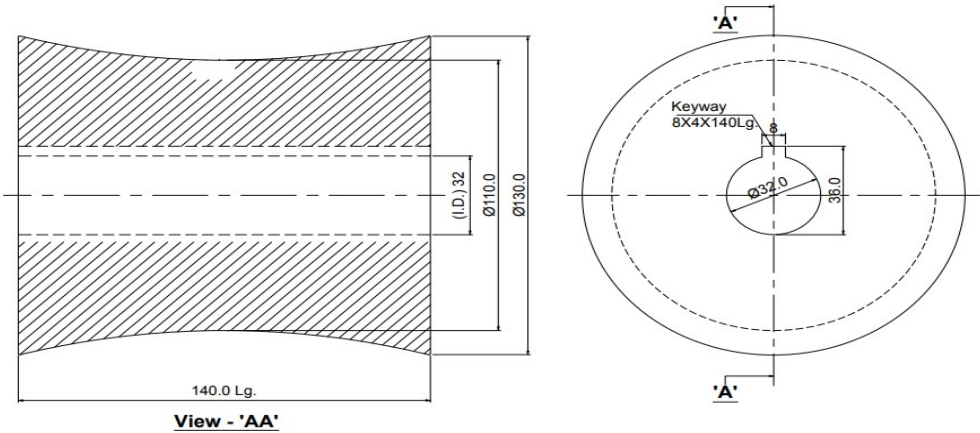


**Fig: Spare of Entry stand to the Centerless Grinding Machine**



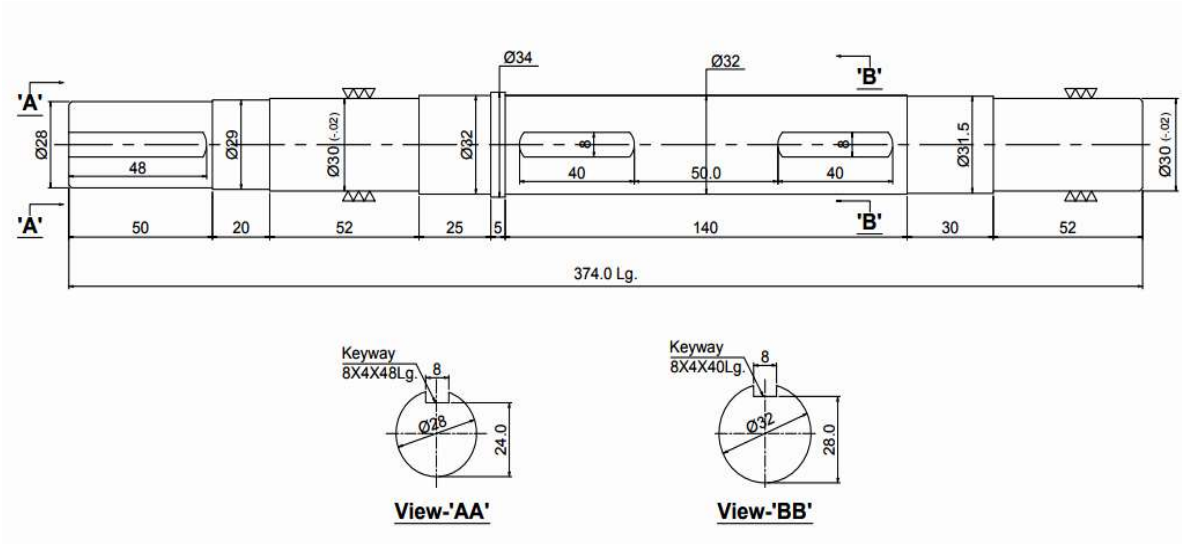
**Fig: Conveyor Chain Sprocket at section A-A**

**Note :** All sizes are finished  
**Material - EN 9**  
**No.of teeth - 16 nos.**  
**Sprocket - 3/4" Pitch**



**Fig :Conveyer Nylon Roller atCenterless Grinding Machine**

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**Fig: Conveyer Shaft (Material EN8) at Centerless Grinding Machine**

**Cost analysis of Material Handling Automation at Centerless Grinding Machine :**

CG Automation costing approximatly

<b>S.No.</b>	<b>Part Description</b>	<b>Cost of Part</b>
1	Electrical controll panal & operational penal	125000
2	Hydraulic Power Pack	105000
3	Gear Boxes	100000
4	Electrical Motors	40000
5	Hydraulic Cylinders	70000
6	Screwjacks	20000
7	Sliding Unit	100000
8	Ms Chanel, Plate, Angle and Rounds	120000
9	Plimber block Bearings	10000
10	CI bushes and Nylon patty	10000
11	Electrical Cable	20000
12	Sensors	6000
	Total	7,26,000/-

The total cost to Ambica steels Ltd. for whole automation of Centerless Grinding Machine will be Rs. 7.25 – 7.50 lacs approximately.

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**Field Trials:**

**Total Expected Time Frame for material handling automation project:           6 months**

First Trial :    After Procurement of all material and assemblies as per design specifications and drawings.

Second Trial : During installation of Entry and Exit stands and conveyors.

Third Trial :   After assembly of all components (as prescribed in cost sheet).

Final Trial :   Inspection of automation trial of loading and unloading of bars on the entry and exit strands of CG machine.

**Conclusion:**

Ambica Steels Ltd. is the niche supplier of a wide variety of stainless steel products to both Indian and International markets. The company commands a leading position in specialty stainless steel materials and is increasingly expanding & increasing its market share worldwide, while maintaining its focus on the Indian market where it is serving customers since 1970. In order to meet this increasing demand, the company needed to automate its material handling processes at its plants, where a lot of time was wasted in manual handling of in process parts.

The management of the company undertook the automation of loading unloading process of in the process handling of material and hired our consultancy for the commissioning and installation of automation of the entry and exit of the rods to centerless grinding machine. After the submission of proposed consultancy report, the company successfully installed the proposed automation plan at a cost of Rs. 7.40 lacs.