Industrial Training at Jaipur Tuffen Glass Industries Pvt. Ltd.

PREPARED BY

Ronak Singh (2018BTECHME004)

FACULTY GUIDE

Dr. Rajlakshmi Nayak



Department of Mechanical Engineering

Institute of Engineering and Technology (IET)

JK Lakshmipat University, Jaipur

May 2022

Industrial Training at Jaipur Tuffen Glass Industries Pvt. Ltd.

Practice School-2

Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology in Mechanical Engineering

By:

Ronak Singh (2018BTECHME004)

Faculty Guide:

Dr. Rajlakshmi Nayak



Department of Electrical and Electronics Engineering

Institute of Engineering and Technology (IET)

JK Lakshmipat University, Jaipur

May 2022

CERTIFICATE

This is to certify that the Practice School-2 project work entitled "**Industrial Training at Jaipur Tuffen Glass Industries Pvt. Ltd.**" submitted by **Anirudh Pareek (2018BTECHME005)**, **Ronak Singh(2018BTECHME004)** towards the partial fulfillment of the requirements for the degree of **Bachelor of Technology in Mechanical Engineering** of JK Lakshmipat University, Jaipur is the record of work carried out by them under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for Practice School-II examination.

Dr. Rajlakshmi Nayak
Associate Professor,
Department of Mechanical Engineering
Institute of Engineering & Technology (IET)
JK Lakshmipat University, Jaipur

Dr. Ravi Shankar Prasad
Associate Professor & Cordinator,
Department of Mechanical Engineering
Institute of Engineering & Technology (IET)
JK Lakshmipat University, Jaipur

Date of Submission: May 27, 2022

(PS2 Coordinator)

Prof. Dr. – Sanjay Goel
Director,
Institute of Engineering & Technology
JK Lakshmipat University, Jaipur

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We would also like to extent our sincere gratitude to faculty supervisor, Dr Rajlakshmi Nayak, for guiding us throughout our practice school-2 process and keeping us on track with everything.

Sincerely yours,

Ronak Singh (2018BtechME004)

ABSTRACT

Glass is used in almost every part of our daily life from automobile to architecture in its original annealed form or in tempered form. The Jaipur Tuff industry is the only glass processor of North India equipped fully automatic European machinery. Initially Jaipur Tuff was a retailer and trader of different types of architectural glass but since 2000 the journey of glass trading converted into the glass processing. They import annealed glass from reputed companies like Gujrat-Guardian (Modiguard), Sisecam and Saint-Gobain. During this Practice School-2 we as mechanical engineers got a golden opportunity to learn and work with experience industry people. During this internship we learned about the working process of a glass processing industry, technical parameters and maintenance of the following machines: CNC cutting machine, Tempering machine, Lamination line and Double glazed unit (DGU) line which plays a major role in the glass processing industry. Through-out this internship program we have learned and gained experience on how to work ethically and preciously in a glass industry.

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List of Acronyms

- SGU- Single Glazed Unit.
- DGU- Double Glazed Unit.
- VLT%- Visible Light Transmission.
- Ext. Ref%- External Reflection.
- Int. Ref%- Internal Reflection.
- CRI- Colour Rendering Index.
- CSD- Customer Satisfaction Department
- PI- Product Information.
- RG- Rough Grinding.
- PG- Polished Grinding.
- PVB- Poly Vinyl Butyral
- SGP- Sentry Glass Plus
- EVA- Ethylene Vinyl Acetate

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Chapter-1: About the Company

1.1 Company Name and Logo

Jaipur Tuffen Industries Pvt Ltd

JAIPUR TUFF
Glass! Changing the Perception

Figure 1 Company Logo

1.2 Company Journey & Working

Jaipur Tuffen Glass Industries Private Limited is a Private industry incorporated on 23 November 2013. It is classified as Non-government Company and is registered at Registrar of Companies, Jaipur. Its authorized share capital is Rs. 50,000,000 and its paid up capital is Rs. 46,550,000. It is involved in manufacture of glass and glass products. The annual turnover of the company is around 10 crores.

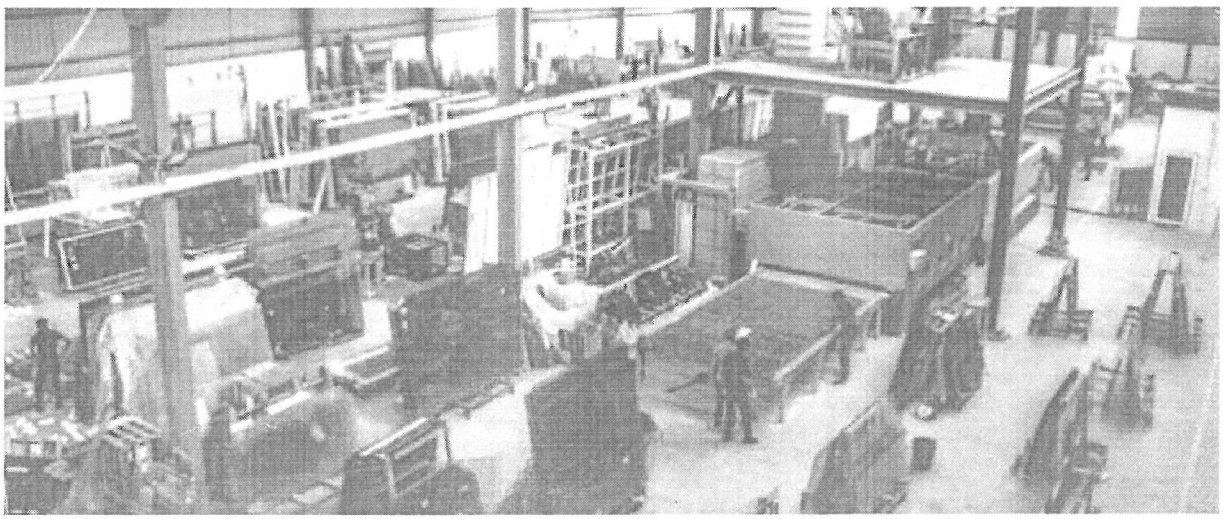


Figure 2 Jaipur Tuff Factory

Experience spanning of 4 decades, **JAIPUR TUFF** is well recognized for its excellence in the Architectural Glass Industry and meeting the demands of the modern construction. The

integrated team work, the best of engineering practices and the technological advancements have helped to develop a wide range of superior glasses that energize growing customers. They strongly believe that serving the best quality product which consistently exceeds customer's expectations is the only guaranteed methodology to deliver continued growth.

Their journey began in 1974. Back then they were a retailer and trader of different types of architectural glass of that time. In 2000 the journey of glass trading converted into the glass processing and setup first unit with Beveling and molding machines. Being with time they have started adding machines in their unit.

2003: Bending Machine (Became first bend glass manufacturer in Jaipur)

2007: Fully Automatic Beveling Machine.

2008: Fully Automatic Edge Polishing Machine.

2011: Installed Toughened Furnace and CNC Glass Cutting Machine.



Figure 3 Workers at Jaipur Tuff washing line

The biggest step of the journey was in 2017, company replaced the complete unit with the world's best technology and machinery. Today, **JAIPUR TUFF** is the only processor of North India with fully automatic European machinery having brands like Lisec, Glaston, and Intermac. Now, they are privileged to serve thousands of customers in India and abroad every year with exceptional products like Smart Glass (Switchable Glass), Smart Insulating glass and a verity of very high-performance nano-material coated reflective glass.

1.3 Company Projects

Jaipur Tuff industry has completed a numerous recognizable projects in all Government, Commercial & Residential sectors in India and also have ongoing Mega projects in pan India.

1.3.1 Government Projects



Figure 4 Bhamashah Technohub

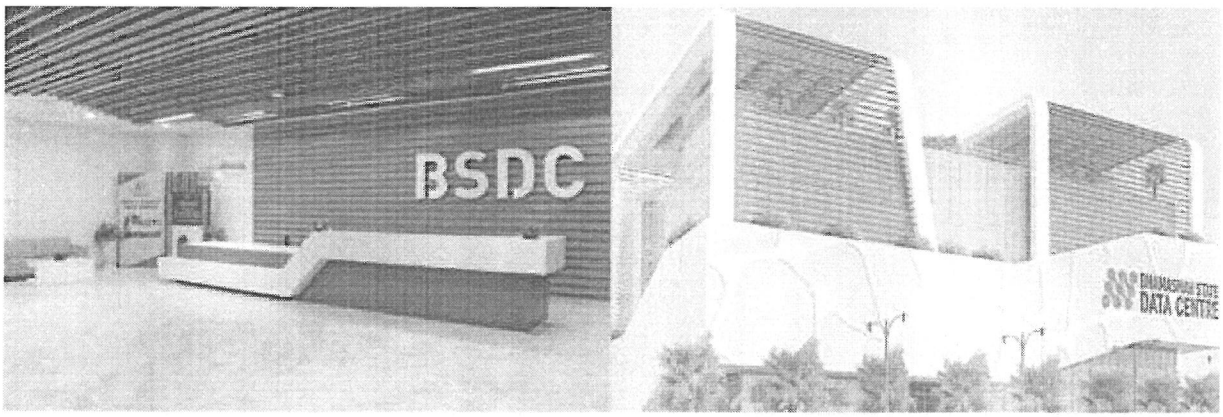


Figure 5 Bhamashah State Data Centre

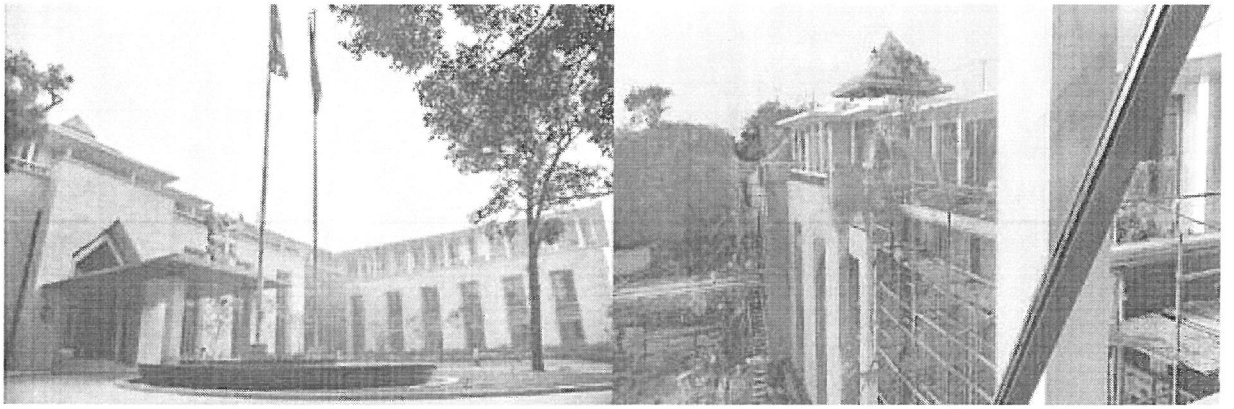


Figure 6 Royal Thai Embassy

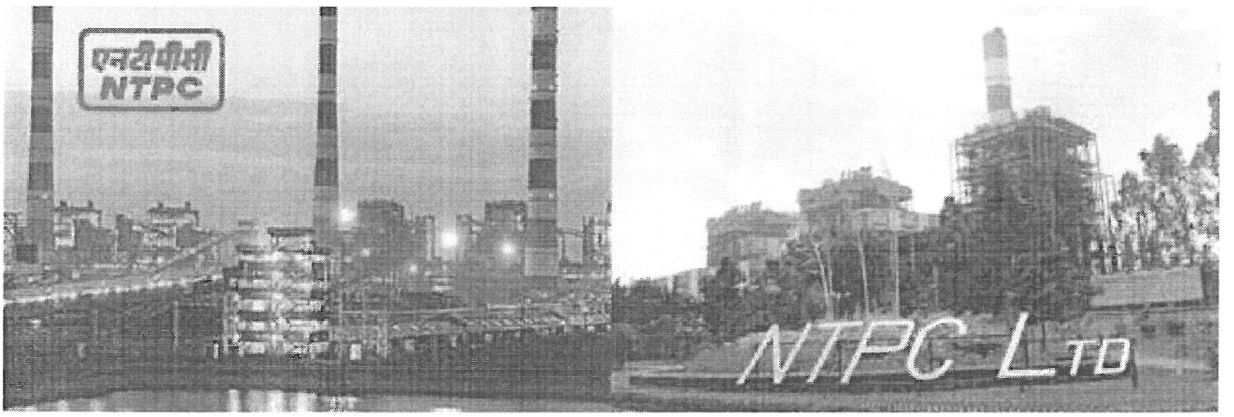


Figure 7 NTPC Ltd.

1.3.2 Commercial Projects

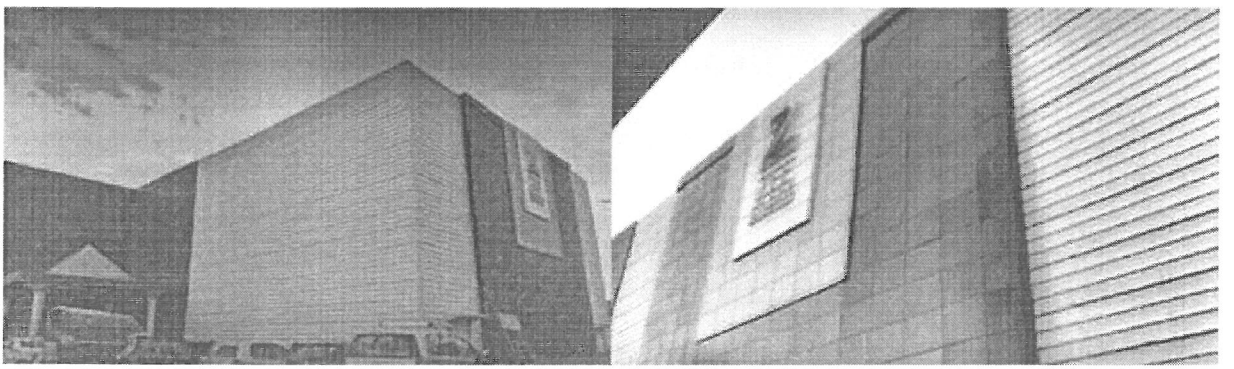


Figure 8 Zee Studio

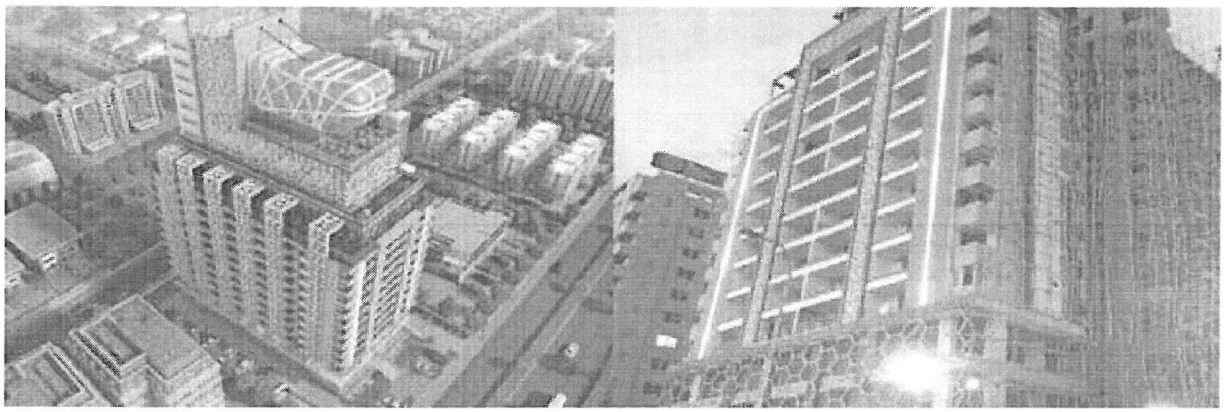


Figure 9 The Rise by Sankalp, Jaipur

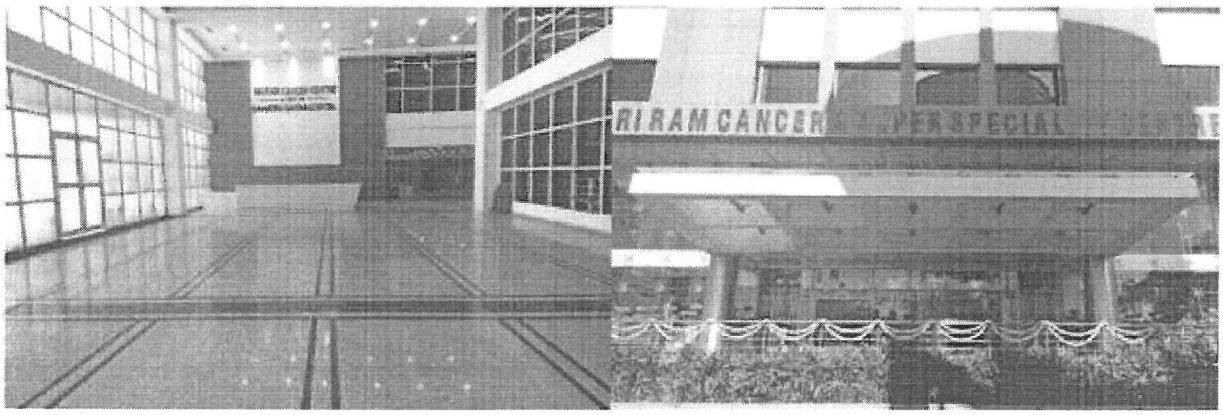


Figure 10 Shri Ram Cancer and Super Specialty Centre

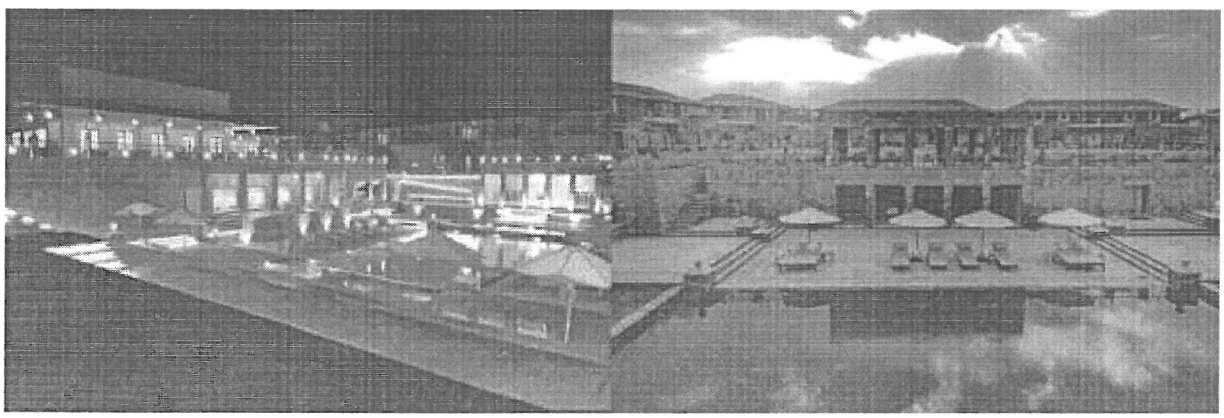


Figure 11 Sawai Vilas, Ranthambore

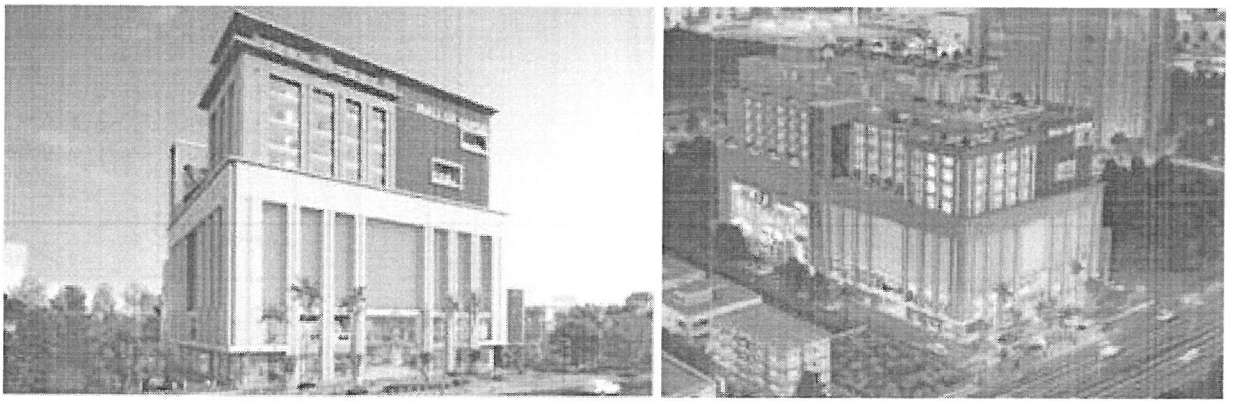


Figure 12 Mall of Jaipur

1.3.3 Residential Projects

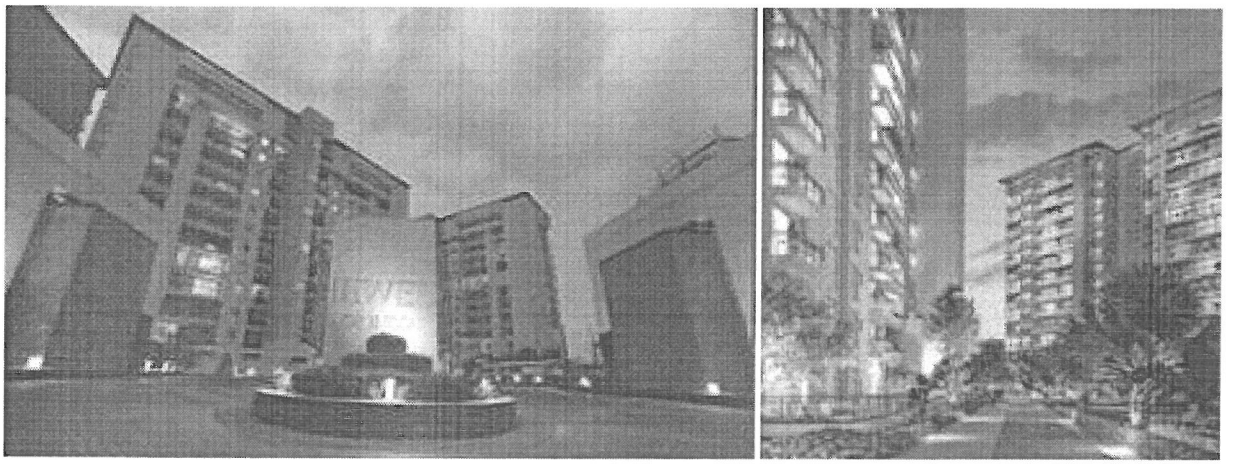


Figure 13 Jewel of India, Jaipur

1.3.4 Ongoing Projects

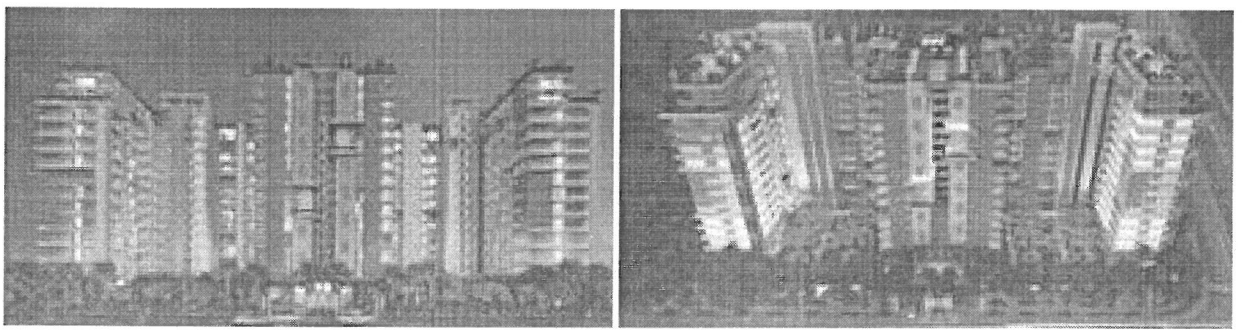


Figure 14 The Crest, Jaipur



Figure 15 World Trade Center, New Delhi

Chapter-2: About Training

2.1 Training Objective

The main objective of this training is to understand the working process, technical parameters and maintenance of the following machines:

- CNC cutting machine
- Tempering machine
- Lamination line
- Double glazed unit (DGU) line.

2.2 Training Timeline

The training is divided into 4-time slots of 26 days as follows:

- In the first slot we have to understand basic properties of glass, material handling, working of CNC machines and various robots, and submit a complete report including the general working procedure of the machines along with Standard Operating Procedure (SOP).
- In the second slot we will be train for a specific task that will depend upon the company's requirement or our field of interest.
- In the third and fourth slot, a mainstream work will be assigned to us along with a project, based on our second slot training.
- Date of final viva voce and report submission - Tuesday, 24 May 2022.

Our training will be accomplished under the supervision of operators of various machines and the final assessment will be done by the chief engineer of the company.

2.3 Expected Output & Learning from Training

Throughout this training session we will understand the working process, technical parameters, maintenance of the following machines:
CNC Cutting Machine.
Lamination Line.
Tempering Machine.
Double Glazed Unit (DGU) Line.
Additionally we will also learn about the types of glasses, testing of the glasses and quality inspection techniques. Also about how an industry is operated, managed and deals with all internal and external affecting factors.

Chapter-3: Basics of Glass

3.1 What is Glass?

Glass is an amorphous solid and transparent material that is used in numerous applications in our daily lives. Glass is made from natural and abundant raw materials (sand, soda ash and limestone) that are melted at very high temperature.

Glass is made up of...

The primary raw materials in glass are sand, soda, limestone, clarifying agents, coloring and glistening glass. Glass sand is about ¾th of the entire glass composition.

(72% Silica sand, 13% Soda Ash, 12% Limestone)

- Silica (sand) – is the major ingredient in glass.
- Soda Ash – acts as a flux and is added to help melting.
- Limestone – makes the glass durable & insoluble.

3.2 Annealed/Float Glass

Annealed glass is ordinary glass, "Float glass" (also called "flat" glass) that has not been heat-strengthened or tempered. Annealing float glass is the process of controlled cooling to prevent residual stress in the glass and is an inherent operation of the float glass manufacturing process. During the float glass manufacturing process, the hot glass is gently cooled in the annealing lehr, which releases any internal stresses from the glass to enable the cutting and further processing of the glass post manufacture. Annealed glass can be cut, machined, drilled, edged and polished. Annealed glass when broken gives large fragments with sharp edges and so is not usually classifiable as a "safety" glass.

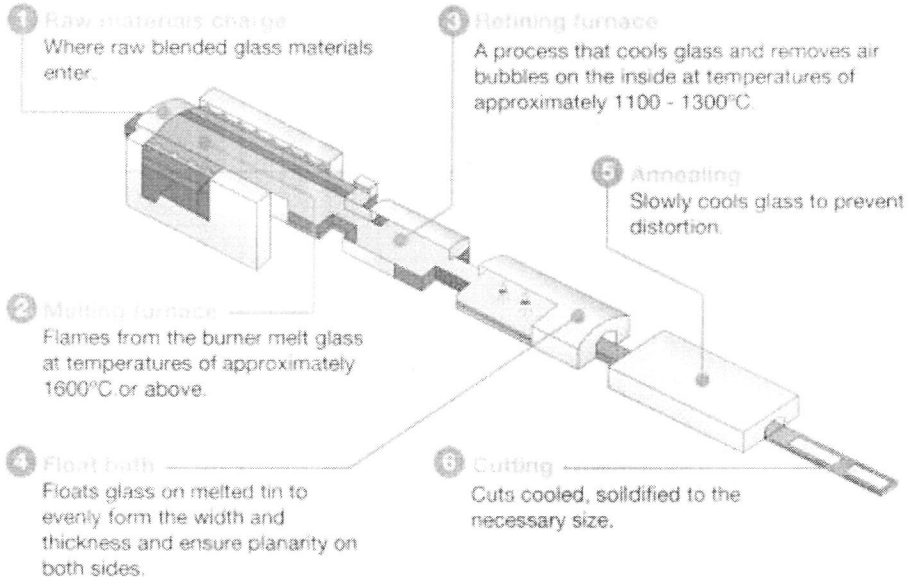


Figure 16 Float glass manufacturing process

3.3 Annealed Glass Manufacturers

Some known Annealed glass manufacturers in INDIA:

- Saint-Gobain India Pvt. Ltd.
- Asahi India Glass Ltd.
- Sisecam (HNG glass) Pvt. Ltd.
- Gujarat Guardian (Modiguard) Pvt. Ltd.

3.4 Annealed Glass Types

Annealed glass comes in a series based on the coating, quality, reflection and performance.

Annealed glass series offered by Gujarat Guardian Pvt. Ltd. Are:

- Clear
- Solar plus
- High performance
- Double silver
- HD colors

Clear Glass:

Clear Glass is a glass manufactured in the float line without any tint, allowing it to be transparent in nature. This transparent and clear finish ensures clarity of vision with true colors of the objects.

Solar plus Glass:

Solar control glass is a hi-tech product developed by the glass industry to allow sunlight to pass through a window or façade while radiating and reflecting away a large degree of the sun's heat. The indoor space stays bright and much cooler than would be the case if normal glass were used.

Solar plus glasses are colour coated glass which comes with variety of coatings as follows:

Blue 27

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	27	12	4	93
DGU	24	13	12	91

Grey 27

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	27	11	4	94
DGU	24	11	11	92

Neutral 27

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	27	14	9	95
DGU	24	15	15	94

Green 27

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	27	13	4	88
DGU	24	14	12	86

High performance Glass:

High performance glazing is one which can contribute to optimizing energy efficiency and at the same time enhance light penetration. High performance glazing has low U-value, low Shading

Coefficient and High VLT (Visual Light Transmittance) and is the ideal choice for today's energy stressed buildings.

HD Glass:

High-definition (HD) glasses are made with a modern manufacturing technique that involves scanning the eye to produce a pair of lenses ideal for the user. Created with a level or precision and customization not previously possible, HD glasses are usually at least marginally better than conventional lenses.

HD glasses are colour coated glass which comes with variety of coatings as follows:

HD Blue

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	27	19	25	99
DGU	24	20	28	97

HD Green

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	35	27	12	95
DGU	31	28	18	94

HD Bronze

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	23	13	2	95
DGU	20	13	10	95

HD Grey

	VLT%	Ext. Ref.%	Int. Ref.%	CRI (Ra)
SGU	19	11	7	96
DGU	17	11	13	97

Note: Colour coated glasses are formed by spraying metal oxides in form of thin coatings (0.01μm to 0.8μm).

4.1 Order Placing

Before proceeding towards the Glass processing there come the CSD work. First the order is received from the customer via mail and according to the customer requirement the PI is generated and once PI is made a copy of it is send to the customer for cross-checking and after confirmation the PI, glass size requirement and rough sketch for any hole cutting or other fabrication changes (if any) the information is forwarded to Production Planner.

Production planner work is to design the sheet as per requirement and to optimize the wastage which comes from cutting large sheets. Once work is to also remember the extra pre-cut sheet parts which can be used in any other project. The current software used for optimization of sheet is "Edit-way 6.5". It shows the different-different sheets arrangements from which we can select the best optimized sheet cut-out with least total wastage.

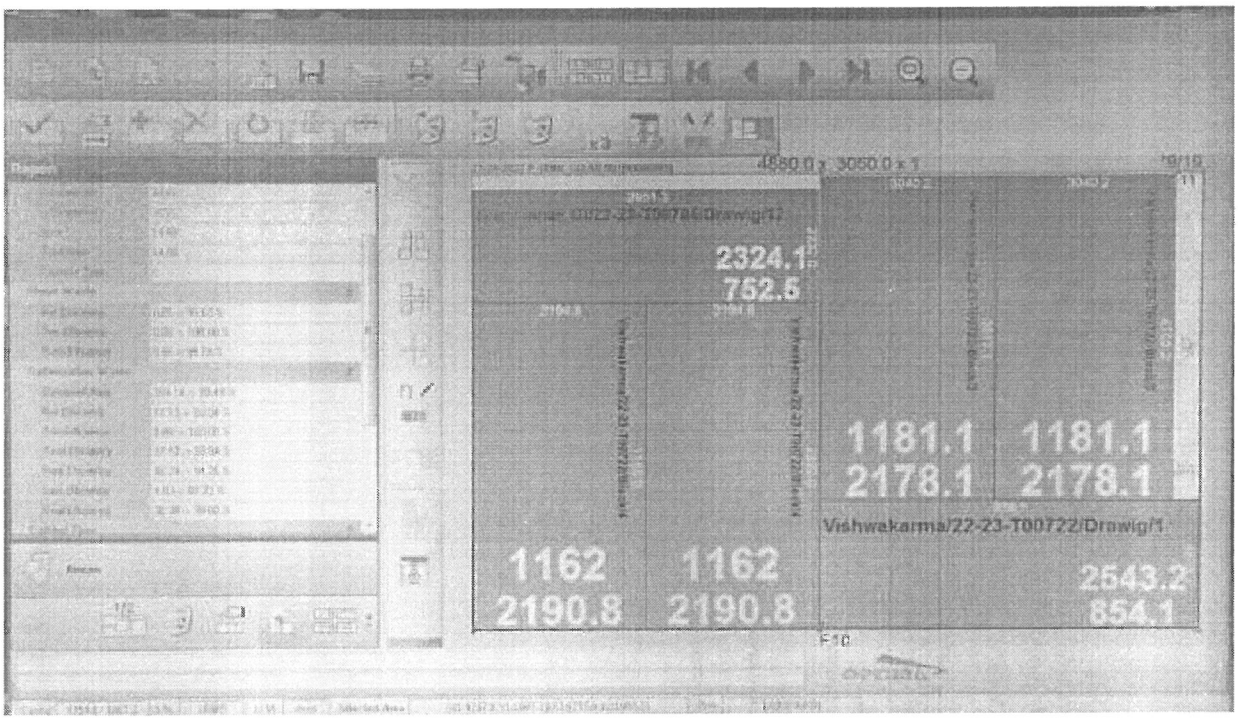


Figure 17 Sheet optimized for least glass wastage

The clear float glass comes in form of large sheets of various thickness and sizes which are as follows:

Sr. No.	Item Description	Size (mm)
1	4 MM Clear	2440*1830
		3210*2250
		3050*2140
		2440*3660
2	5 MM Clear	2440*1830
		3210*2250
		3050*2140
		2440*3660
3	6 MM Clear	3660*2440
		2250*3210
		3050*2550
		3050*2140
		2250*3660
4	8 MM Clear	4880*3050
		4270*3050
		2440*3660
		2800*3050
		2770*3660
		2800*3050
5	10 MM Clear	4880*3050
		4270*3050
		2440*3660
		2250*3210
6	12 MM Clear	4880*3050
		3660*2770
		3660*2600
		3660*2440

The colour float glass comes in form of large sheets of various thickness and sizes which are as follows:

Sr. No.	Item Description	Sizes (mm)
1	5 MM HD BLACK	2440*3660
2	5 MM HD BLUE	2440*3660
3	5 MM HD GREEN	2440*3660
4	5 MM NEUTRAL 67	2440*3660
5	5 MM SOLAR SILVER 20	2440*3660
6	5 MM SOLAR AQUA MARINE	2440*3660
7	5 MM ROYAL BLUE 20	2440*3660
8	6 MM HD BLUE	2440*3660
9	6 MM HD BRONZE	2440*3660

10	6 MM DS BLUE 50	
11	6 MM DS GREEN 40	2440*3660
12	6 MM DS NEUTRAL 40	2440*3660
13	6 MM NEUTRAL 50	2440*3660
		2400*3210
		2440*3050
14	6 MM NEUTRAL 34	2440*3210
15	6 MM NEUTRAL 40	
16	6 MM NEUTRAL 67	2440*3660
17	6 MM HP NEUTRAL 70	2000*3660
18	6 MM SOLAR GREEN 30	
19	6 MM SOLAR SILVER 20	2440*3660
20	6 MM SOLAR GREY 33	2440*3660
21	6 MM SOLAR PLUS GREEN 27	2440*3660
22	6 MM GREEN 20	2250*3210
23	6 MM ROYAL BLUE 40	2400*3660
24	6 MM ROYAL BLUE 20	2440*3660
25	6 MM HP NEUTRAL 40	
26	8 MM HD BRONZE	2000*3050
		2440*3050
27	8 MM HP NEUTRAL 70	2000*3050
		2440*3050
28	8 MM NEUTRAL PLUS 70	
29	8 MM NEUTRAL PLUS 50	3050*2440
30	8 MM SOLAR GREY 33	2440*3660
31	8 MM SOLAR GREY 32	2440*3660
32	10 MM HP NEUTRAL 70	2250*3660
33	10 MM SOLAR PLUS NEUTRAL 27	
34	12 MM NEUTRAL 67	2440*3660
35	5 MM HD BRONZE	2440*3660
36	6 MM NEUTRAL PLUS 27	2440*3660

4.2 CNC Cutting

Once the annealed glass is received it is assembled on the 6-stations as per the size and thickness difference and then they are lifted by an automated tray with suction cups and conveyor roller attached to it; this tray can move up-to these dedicated 6-stations to select and collect the glass for CNC cutting. As the glass is loaded on the CNC machine it is cut using the diamond tip tool as per the pre-feed instruction from the operator.



Figure 18 Glass stations and conveyor tray with hydraulics & suction cup

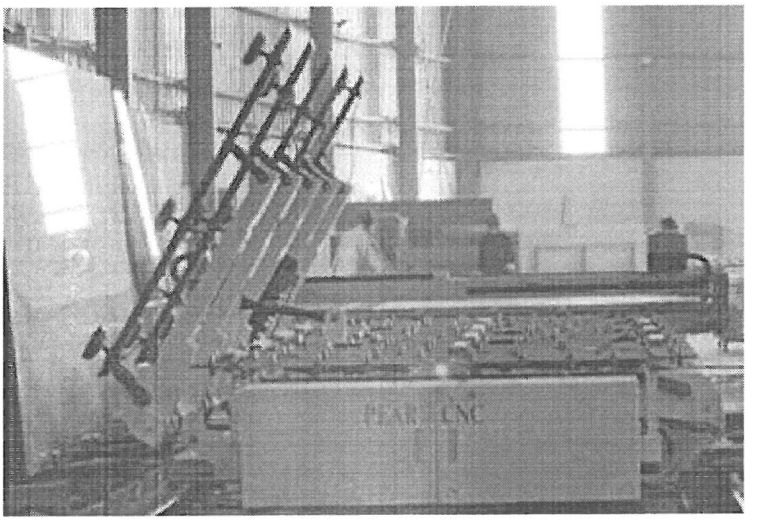


Figure 19 Float glass lifted from a station using suction cup tray

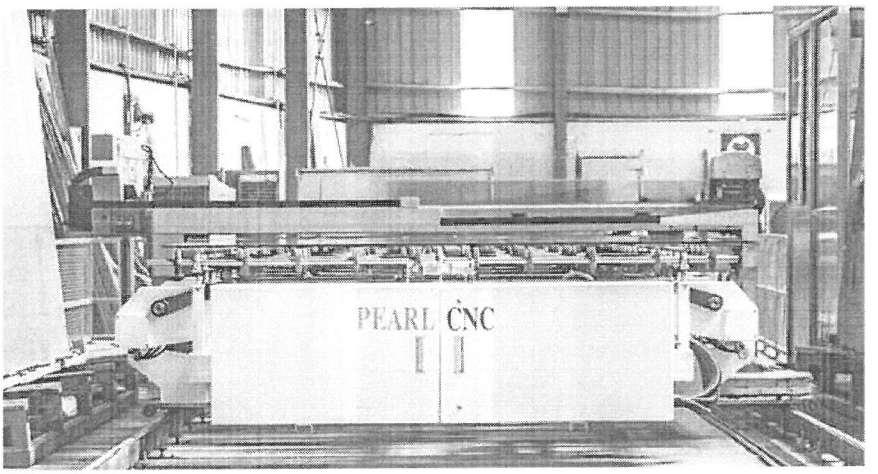


Figure 20 Loading Float glass on CNC cutting table

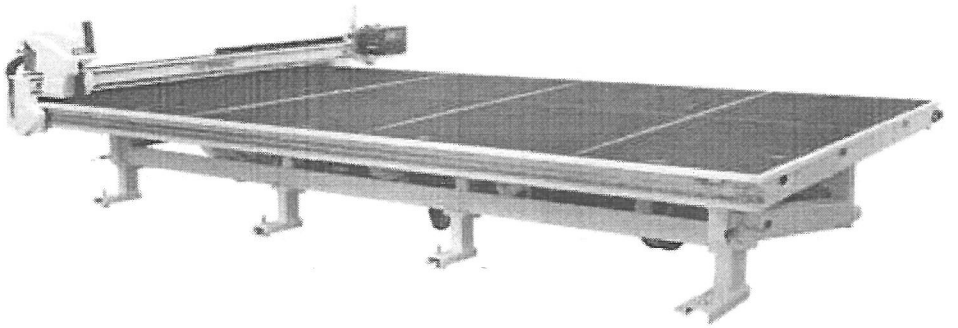


Figure 21 Intermac Genius 61 CT-RED

The CNC machine currently used in the plant is "Intermac accuracy genius 61 ct-red" with:

- Acceleration 10 m/sec².
- Speed 200 m/min.
- Precision ± 0.15 mm.

The base of the machine is made from a rigid, rectangular structure onto which ground wood panels are attached, ensuring maximum planarity of the working area, essential for optimal glass grooving and break-out operations.

The 6-position automatic tool magazine is an Intermac-patented technology that can be used to make different cuts on a single sheet, greatly improving the quality of the end result. The roller-holder cones allow the cutting tools to be changed automatically.

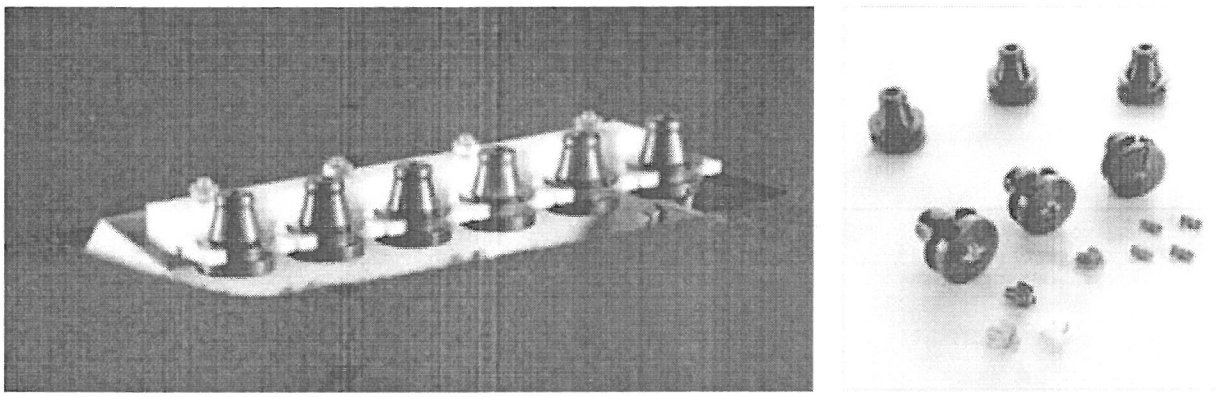


Figure 22 Cutting tips

Cutting Lubrication: The delivery of lubricant oil is managed electronically, and occurs in line with the speed of execution of the shape and the specific straight cutting requirements, eliminating waste and simultaneously improving machining results. Precise oil stream dosing with no "drop" effect is used while cutting the float glass. Pressurized oil lubrication is also available as per the requirement. Cutting lubricant has same refractive index as of the glass (1.46 or lower).

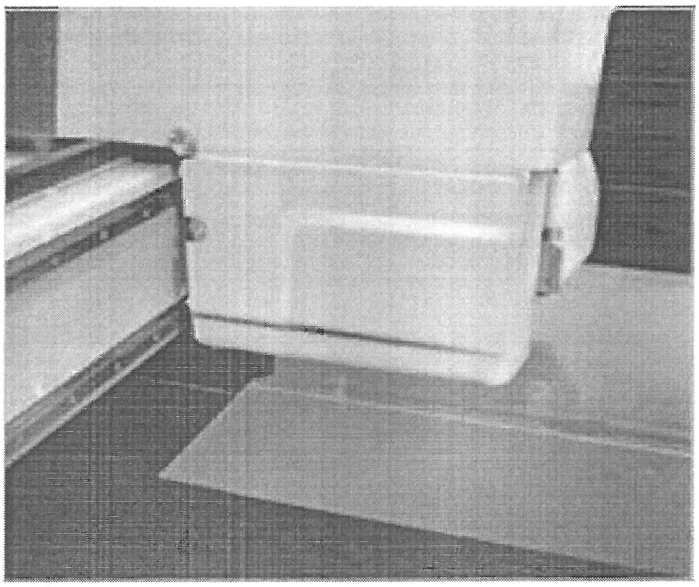


Figure 23 Lubrication while cutting

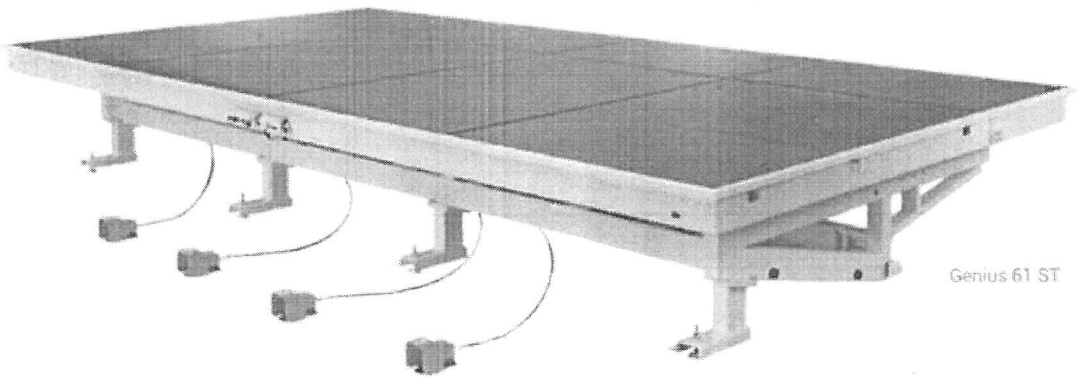


Figure 24 Cutting benches

Break-out Bars: The transverse and longitudinal pneumatic bars enable break-out operations to be performed on glass.

The Intermac CNC machine operates on the PC WNC-based numerical control system (IWNC - Intermac Windows Numerical Control)

- Ideal both for those using CNC machines for the first time and operator who already have programming experience.
- Management of the working parameters of the machine.
- Creation and modification of cutting patterns and/or of geometric or non-geometric shapes.
- Modules for production report management.

Optimizer for straight and shaped cuts, enabling the following advantages to be achieved:

- Minimizes waste.
- Meets the production requirements of glassworks companies.
- Enhances the performance of the machine.

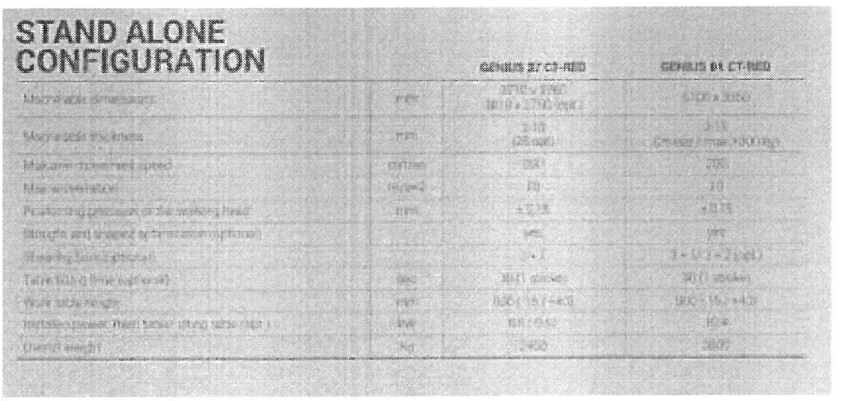


Figure 25 Intermac Genius 61 CT-RED configurations

4.3 Fabrication

After the cutting of glass as per requirement it is now sent for the fabrication processes which are as follows:

4.3.1 Single edge

Single edging is a PG process. In the Single edge machining the glass sides are grinded by 1mm from a particular side of the glass at a particular time. In this the glass is manually turned or settled for the side which has to be grinded. This process is beneficial for small glass pieces and particular edges finishing.

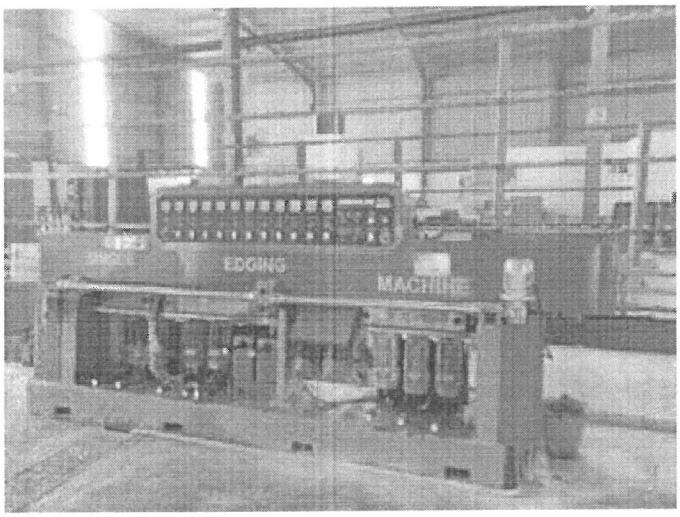


Figure 26 Single Edging Machine

4.3.2 Four edge

Four edging is a PG process. In the Four edging machine the glass edges are grinded by 1mm from all four sides to give a very smooth finish and shape to the glass from edges. This machines grind two edges at a time. But in this process the material wastage is there and hence it costs more as compared to RG process. This process is mostly done where the glass edges are clearly visible and are in direct touch with bare hands like glass doors, table tops, glass partitions, etc.

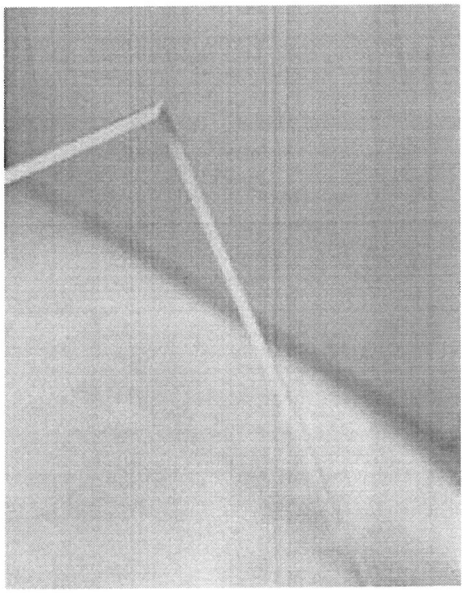


Figure 27 Four edged glass

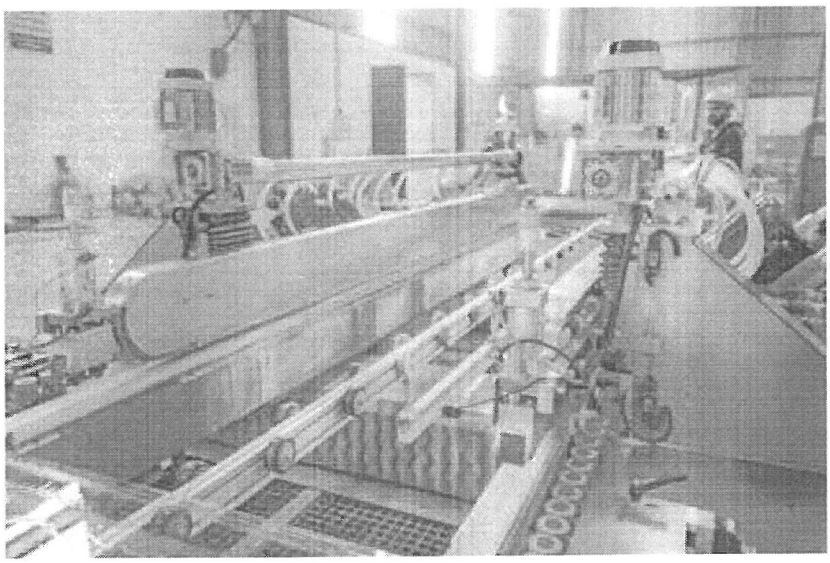


Figure 28 Four Edger machine

4.3.3 Rough Grinding

It is the RG process which can be done both manually and automatically also. In this process there is no size loss like a PG process because in rough grinding it only smooth the edges very slightly so it does not hurt when you touch the glass from edges. Irregularities from edges can be seen easily in this process but it a very cost-friendly process and it is mostly done on those type of glass panels which goes inside the aluminum frames or place where glass edges are covered and can't be seen or directly touched.

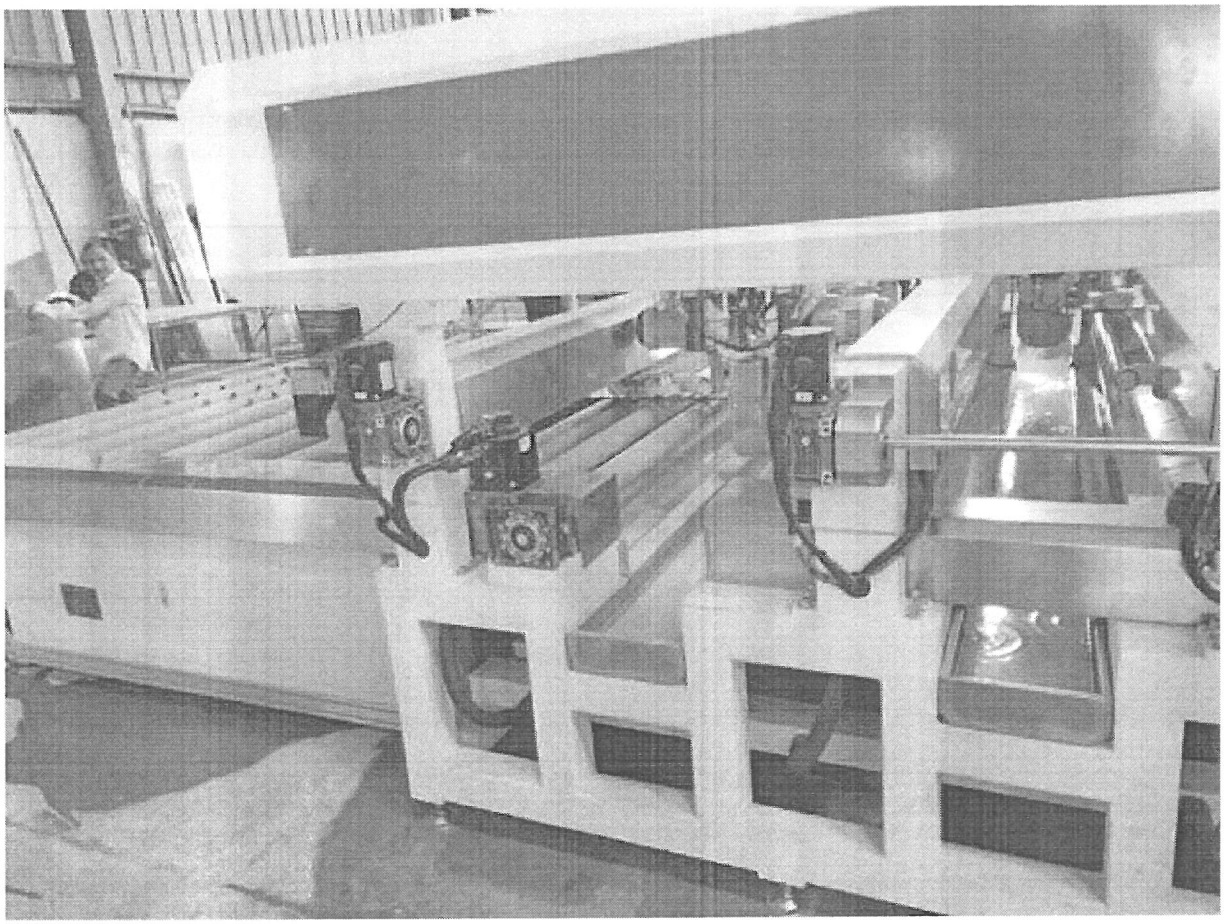


Figure 29 Automatic Rough Grinding Machine

4.3.4 Bevelling

Bevelling process lies under the PG processing. It is performed as per the customer requirements. In the Bevelling process the edges of the glass are given a slight slop from all side which increases the glass edge smoothness and gives an attractive finish. Beveled glass also gives alluring colour patterns due to the prism effect from the processing.

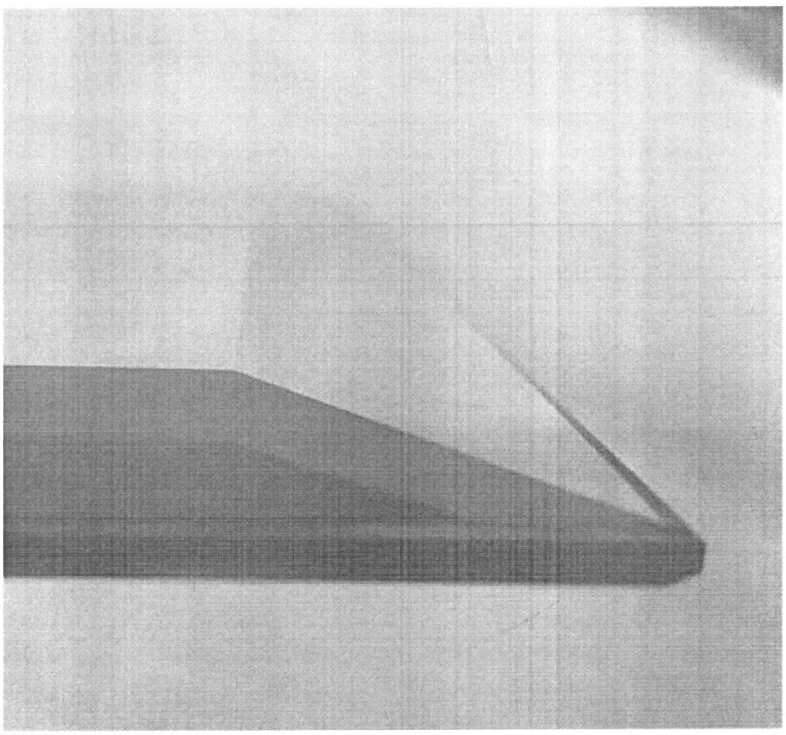


Figure 30 Beveled Glass

4.3.5 Drilling & Cutting

Other step in fabrication is of cross-byte and drilling machine but it depends upon the usage of glass and order needs like door fitting cuttings or cutting holes in glass for air passage or for sales-counter use. While drilling process an equal supporting pressure is applied around the surrounding of the hole area that had to be cut-out so that the glass does not break during cutting.

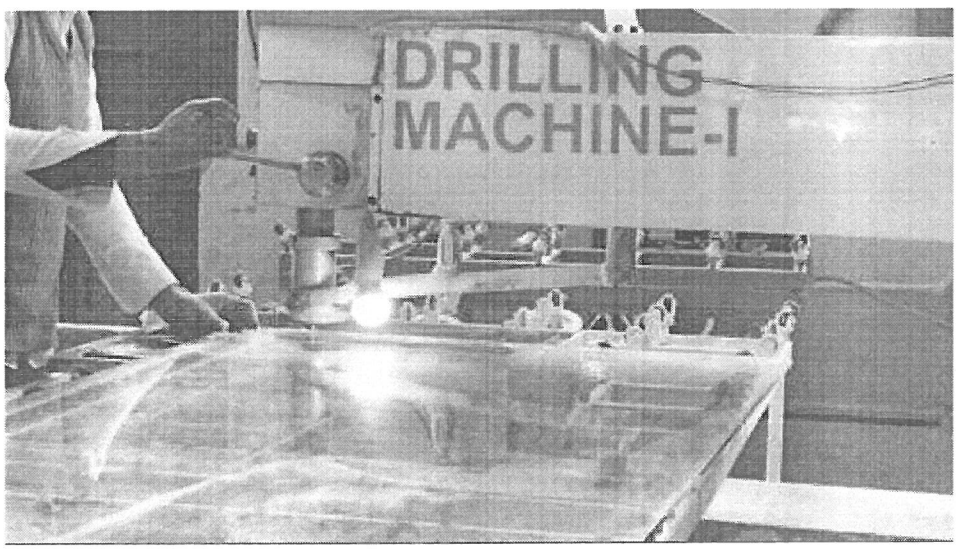


Figure 31 Drilling process.

4.4 Toughening

Toughened glass also known as tempered glass is tough in nature. When the glass breaks, it forms small granular chunks like square fragments which are hazardous and can cause injuries. It is commonly used in facades, glass-doors, windows and fire-resistant doors.

Tempered glass can be made from annealed glass via a thermal tempering process. The glass is placed onto a roller table, taking it through a furnace that heats it well above its transition temperature in general of 564 °C (1,047 °F) to around 620 °C (1,148 °F). The glass is then rapidly cooled with forced air drafts while the inner portion remains free to flow for a short time.

Tempered glass is about four times stronger than annealed glass. The greater contraction of the inner layer during manufacturing induces compressive stresses in the surface of the glass balanced by tensile stresses in the body of the glass. Fully tempered 6-mm thick glass must have either a minimum surface compression of 69 MPa (10 000 psi) or an edge compression of not less than 67 MPa (9 700 psi). For it to be considered safety glass, the surface compressive stress should exceed 100 megapascals (15,000 psi). As a result of the increased surface stress, when broken the glass breaks into small rounded chunks as opposed to sharp jagged shards.

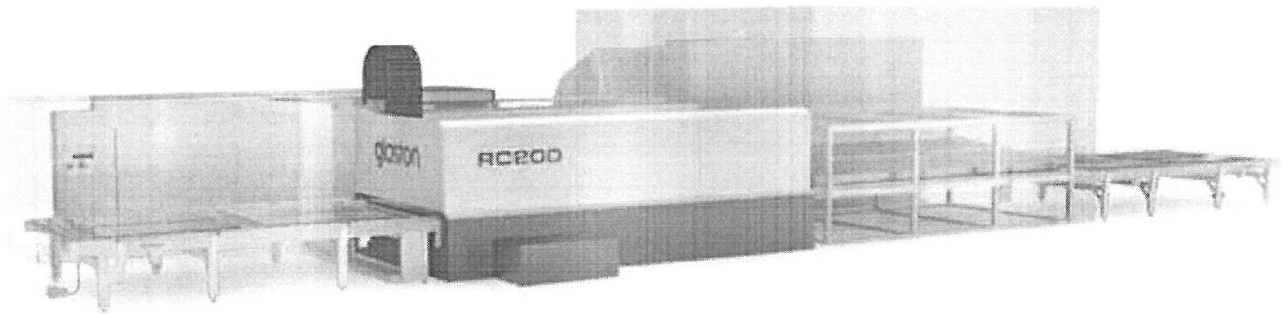


Figure 32 Glaston RC 200



Figure 33 Glass ready for toughening process

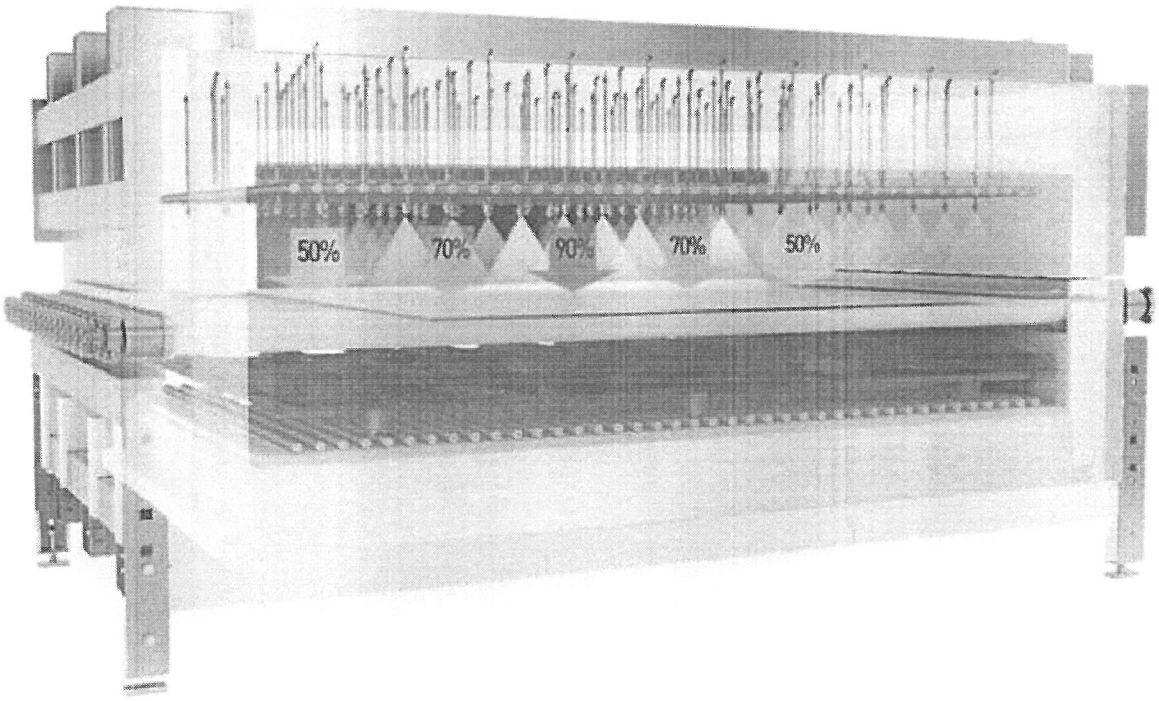


Figure 34 Glass heating inside the machine from both sides

Any cutting or grinding must be done prior to tempering. Cutting, grinding, and sharp impacts after tempering will cause the glass to fracture.

The strain pattern resulting from tempering can be observed by viewing through an optical polarizer, such as a pair of polarizing sunglasses.

Tempered glass is used when strength, thermal resistance, and safety are important considerations. Passenger vehicles, for example, have all three requirements. Since they are stored outdoors, they are subject to constant heating and cooling as well as dramatic temperature changes throughout the year.

Each glass requires different heating time and temperature as per the thickness and properties; for example coated glass needs more heating time as compared to clear glass. (Note: Coated side should always remains up and reflective side downwards while toughening process since the bottom temperature is always greater than above temperature).

Following table shows the heating time and temperature for the different-different glass types:

S. No.	Glass Type	Heating Time (in sec.)	Heating Temp. Top (in °C)	Heating Temp. Bottom (in °C)
1	5 MM Clear	212	678	690
2	6 MM Clear	274	672	690
3	8 MM Clear	382	672	690
4	12 MM Clear	661	672	678

(Note: Cooling pressure remains same for all types ranging between 1000Pa to 2250Pa.)

Technical capabilities of the Glaston RC200™

GLASTON RC200™	Capacity (loads / h) per glass thickness, clear float									Installed power (kW)			Average process power
Type	3[#] mm	4 mm	5 mm	6 mm	8 mm	10 mm	12 mm	15 mm	19 mm	Heating and drives	Blowers[¤]	Total	kW[¤]
1530 - Vortex™		18	14	12	9	7	6	5	4	321	200	521	208
1530 - Vortex Plus™	25	20	16	13	10	8	6	5	4	321	200	521	230
2136 - Vortex™	-	18	14	12	9	7	6	5	4	421	250	671	263
2136 - Vortex Plus™	25	20	16	13	10	8	6	5	4	421	250	671	290
2448 - Vortex™	-	18	14	12	9	7	6	5	4	704	315	1019	430
2448 - Vortex Plus™	25	20	16	13	10	8	6	5	4	704	315	1019	484

Note: All capacities during one hour of operation at constant production. Capacities shown above are based on 65% loading efficiency and with glass size 865 x 1930 mm according to EN 12150 and ANSI Z97.1 standards. Final capacity depends on glass size, shape and edgework quality. Capacities for double chamber furnaces to be given separately.

[#] 3 mm capacity depends on the blower/compressor combination.

[¤] Blower powers are based on 3.8 mm tempering capability according to ANSI Z97.1-2009, GB 15763.2-2005 and EN 12150-1:2000 standards. 5 mm or 6 mm blower configuration will decrease the installed power and average process power.

Figure 35 Glaston RC200 configurations

4.5 Lamination line

In the lamination process the toughened glass is placed on the conveyor bed and after that PVB material sheet layers are applied on it as per the order requirement and then another glass is placed over it and send into the furnace for slight heating which makes the PVB sheet to get glued to the glasses. After that the laminated glass is sent into the Auto Clave machine for pressure heating (Pressure boiling) where it is kept for around 4 hours at 130°C temperature which makes the laminated glass transparent and increases its holding strength by absorbing all the moisture present in it and pressurize heating also sticks the PVB sheet with glass permanently.

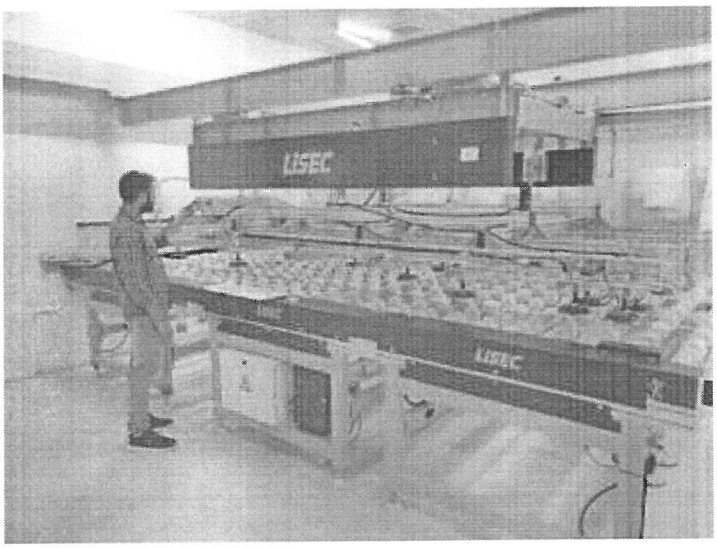


Figure 36 Lamination machine by LiSEC

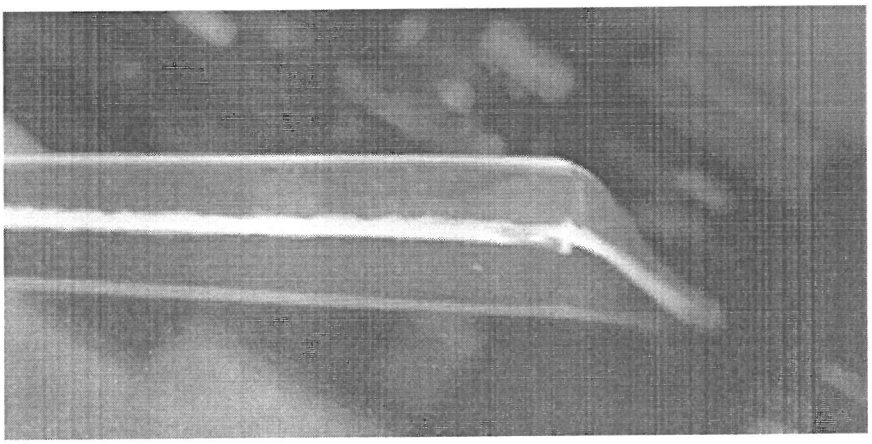


Figure 37 Laminated glass (5mm+PVB+5mm Clear glass)

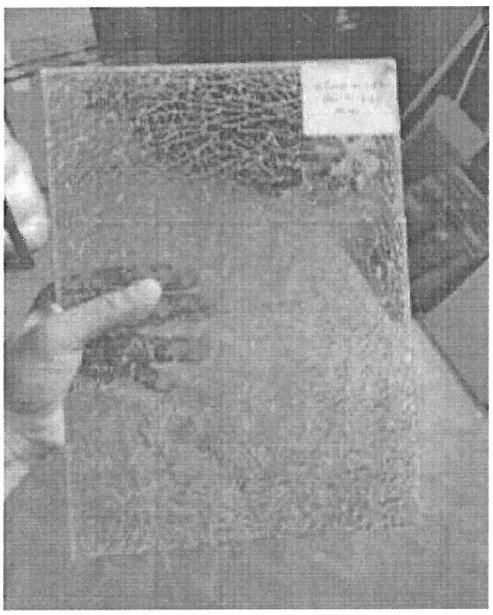


Figure 38 Glass sticked to PVB even after breaking

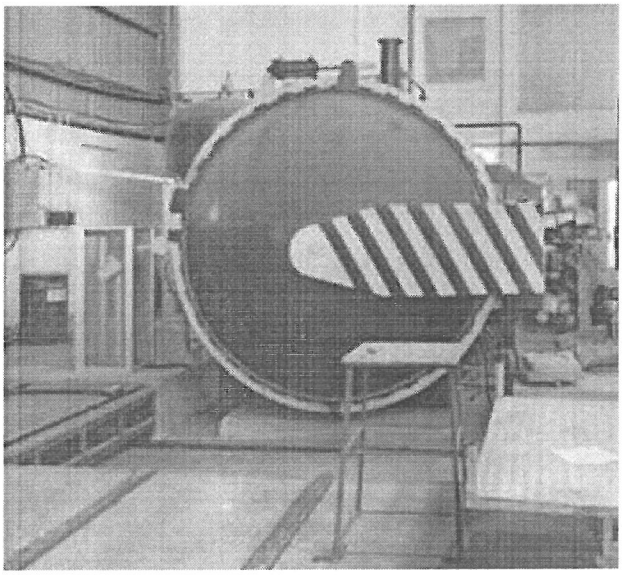


Figure 39 Auto Clave Machine

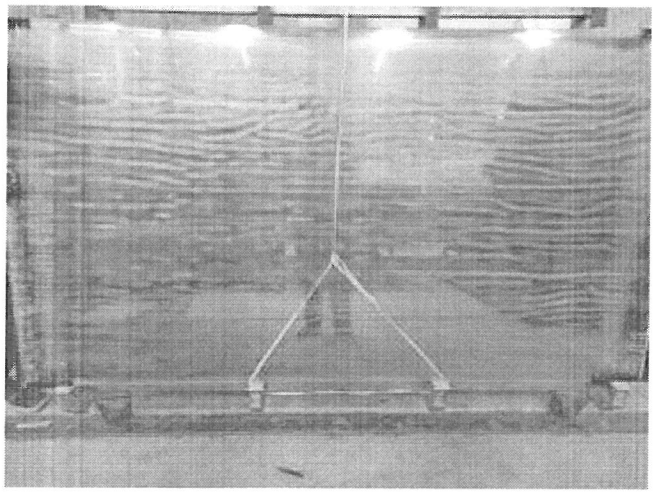


Figure 40 Lami glass before Auto Clave process



Figure 41 Lami glass after Auto Clave process

For the Laminating process there are basically three type of sheets used which are as follows:

S. No.	Laminating Sheets Type	Usage and Benefits
1	PVB (Poly Vinyl Butyral)	Mostly used material in industry for Lamination, cost effective.
2	SGP (Sentry Glass Plus)	Very good quality lamination, more strength than PVB, harder than PVB and costly.
3	EVA (Ethylene Vinyl Acetate)	Used for smart glasses, very costly.

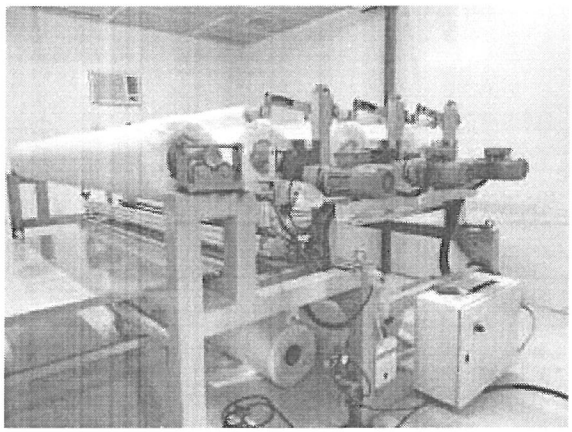


Figure 44 PVB & SGP material rolls

Small glass sizes of the Lamination process are first kept in vacuum bag and then they goes for Auto Clave process because its not possible to put pressure on small glass sizes that easily.

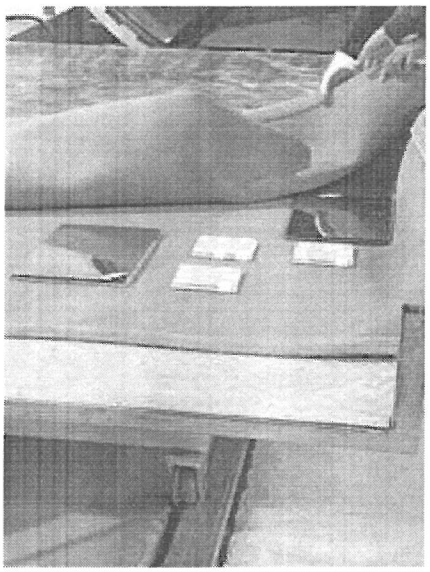


Figure 45 Small glasses kept in Vacuum bag

4.6 DGU (Double Glazed Unit) line

The DGU (Double Glazed Unit) process is a process in which an aluminum spacer is put between two glass and sealed using Butyl adhesive. After that the empty space between the glasses is filled with noble gases like argon, krypton for making the glass sound-proof and also provides a thermal break (This is done as per the customer requirement else normal air is trapped in it). Also the aluminum frame is filled with Molecular Sieves which absorbs heat to an extent. After this the glass is pressed using the pressing machine, so that both the glasses get attached to the aluminum spacer perfectly.

The outer space between the glasses is filled using silicon gel which is silicon and hardener mixture (in 10:1 ratio). With 10 liter of silicon 1 liter of hardener is mixed for an ideal solution. This silicon must settle down within time-period of 20-40 minutes after applied on the glass.

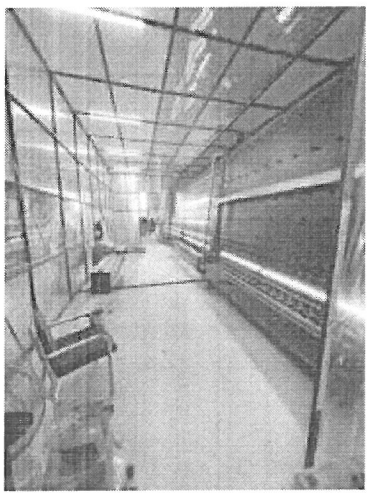


Figure 46 DGU Line-up

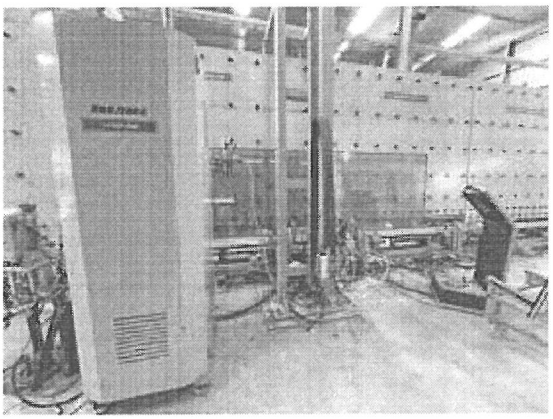


Figure 47 Automatic sealing machine

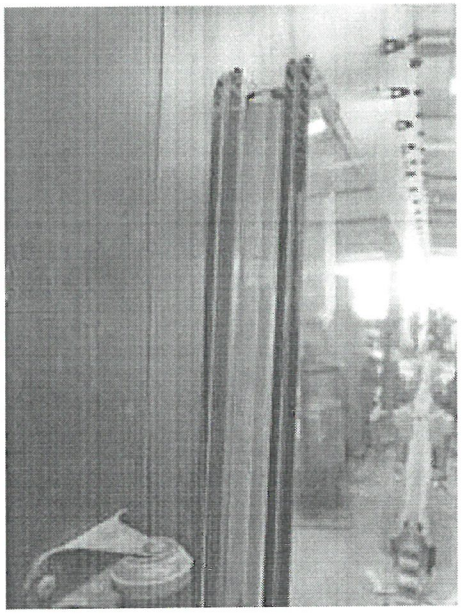


Figure 48 DGU Glass before sealing



Figure 49 DGU Glass after sealing applied

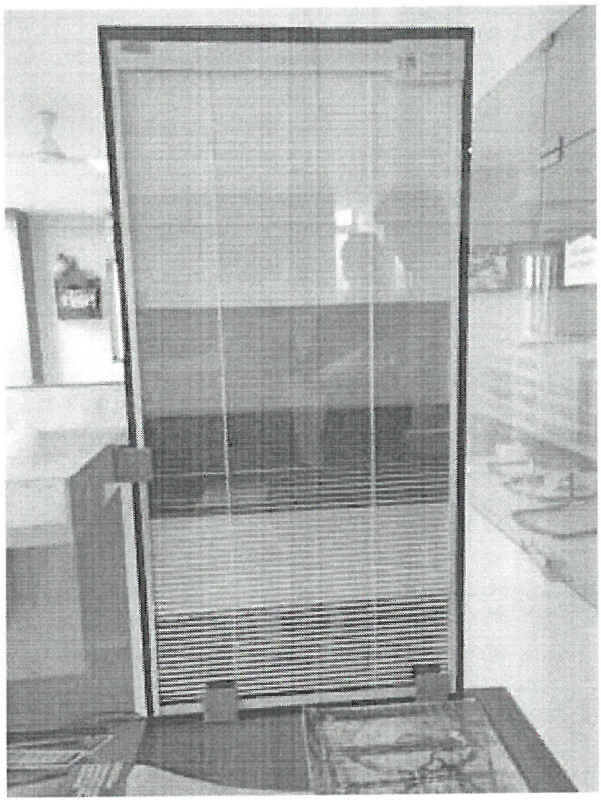


Figure 50 Smart DGU glass Window pane

Smart DGU glasses are also made with Window pane in between which can be electrically controlled using a remote controller and also LED light are placed between glass with aluminum spacer as per the purposes.

4.7 Frosting

Frosting process is in which the glass is covered with green tape at place where we don't want it to be getting frosted and in this process the uncovered part get translucent frosted effect after passing through the frosting machine in which silica sand particles are rubbed against the glass surface to provide the frosted effect and roughness on glass uncovered surface. Frosted glasses are kept dipped in acid for around 1 hr. after frosting process to get smooth touch and finish on the frosted part. No taping is required if whole glass is to be frosted.

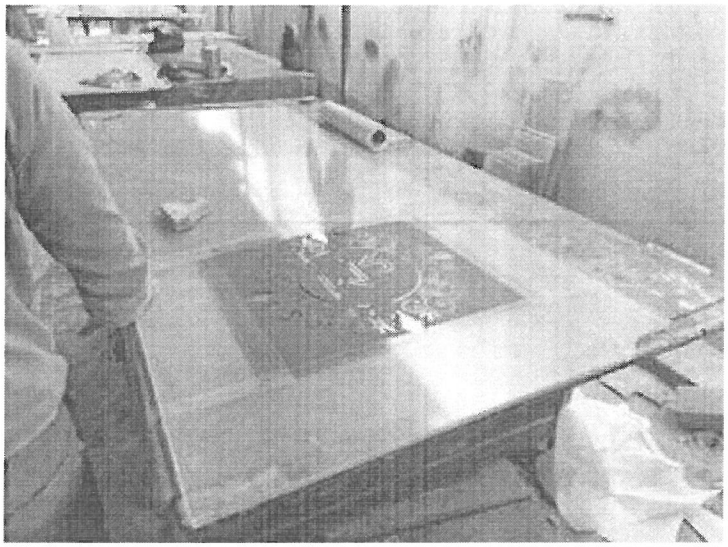


Figure 51 Taping process on glass before frosting

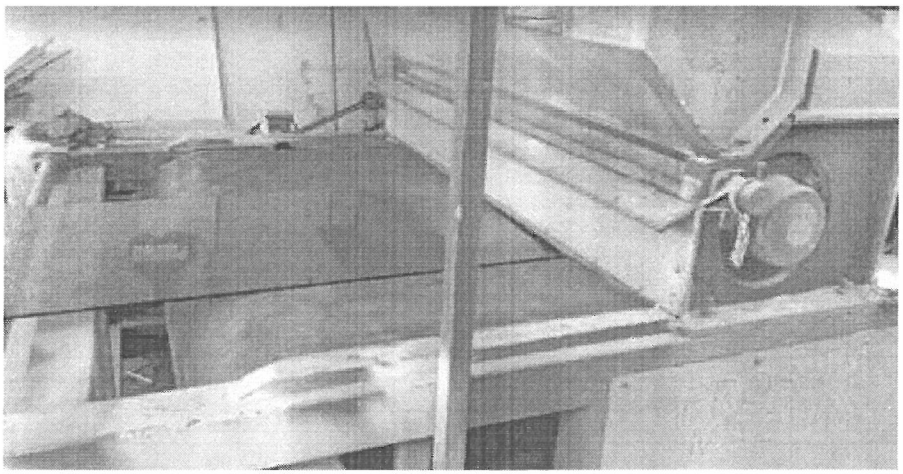


Figure 52 Frosting Machine

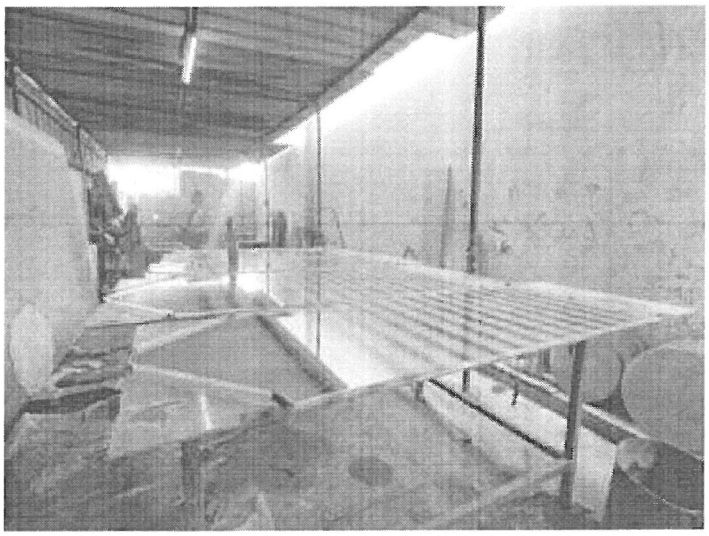


Figure 53 Frosted glass with taping kept in acid for frosting to get smooth

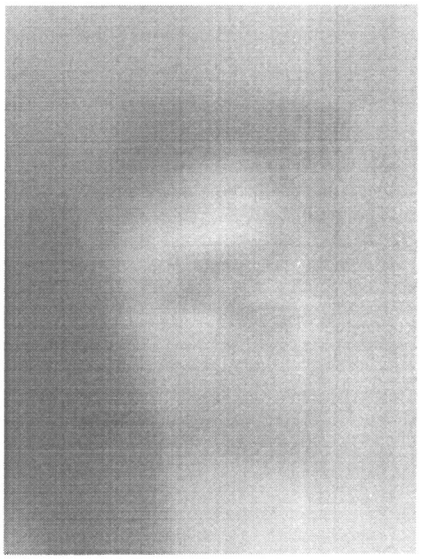


Figure 54 Frosted Glass

4.8 Glass Bending

The Glass Bending process is in which the annealed glass is kept on the wire frame structure of the required bend shape and heated up to 600°C to 642°C temperature while keeping on the frame and remain to it to get gradually cool at room-temperature and during this process of cooling it acquires the shape of the frame it is kept on.

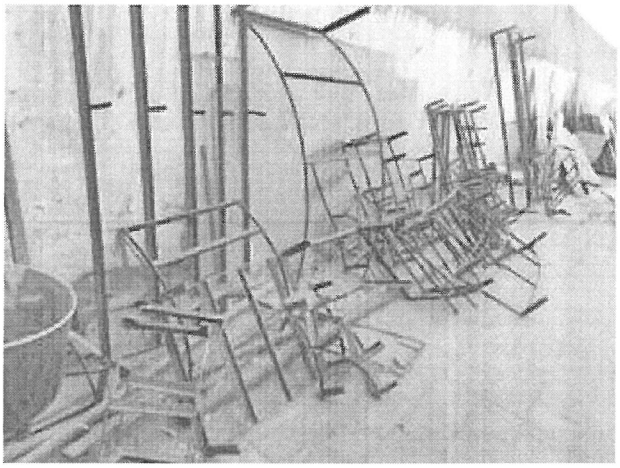


Figure 55 Frames for glass bending

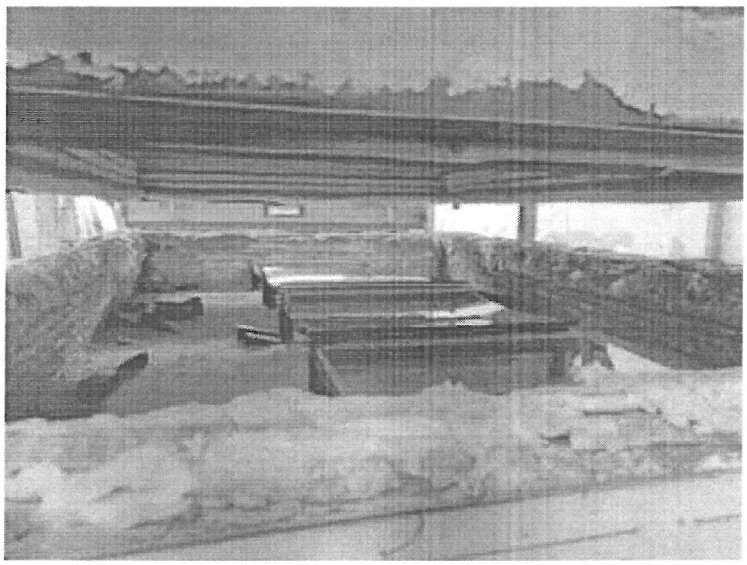


Figure 56 Glass after heating process in glass bending machine

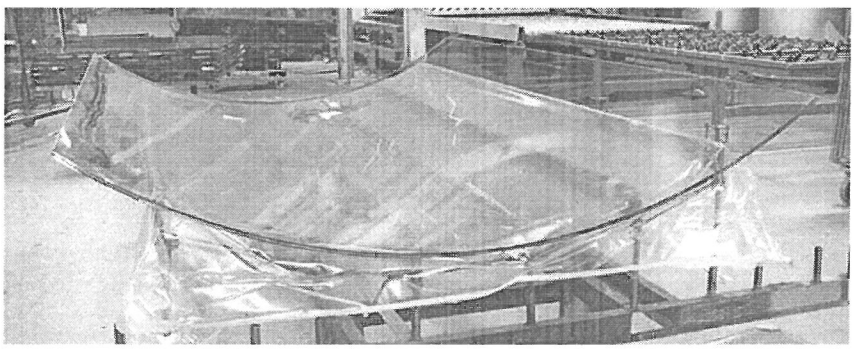


Figure 57 Bended glass

4.9 Heat Soak Machine

In the Heat Soak process the toughened glasses are kept and rapidly heated and cooled from temperature between 400 °C to 110 °C for 8 Hours continuously to strengthen the glass and the glass which passes this process are very least prone to environmental damage and this process increases the life of glass for about 5-10 years. This process is very costly and sometimes full lot gets broken in the mid-process. This Process has a major drawback that there is no test available in present that can check and justify that the glass is Heat soaked or not.

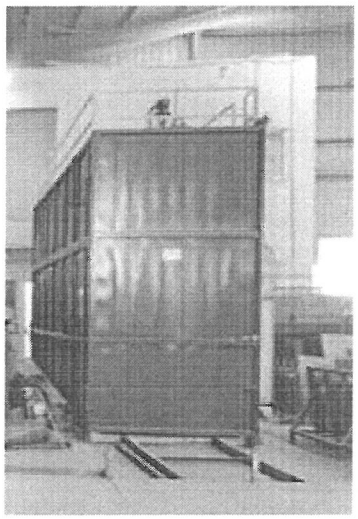


Figure 58 Heat Soak Machine



Figure 59 Heat Soak glass racks

Chapter-5: Project Work

5.1 Project work-1

The project assigned to us was to setup the new automatic rough grinding machine and attached to it the new washing unit. The Rough grinding machine was partially knocked down but the washing was a complete knocked down setup for which we have to first locate a perfect place to set the whole machine unit and then arrange both the machine unit and conveyor units in same plane and level. After arranging the machines we have to connect all the conveyor gears with each other and setting the basic wiring of motors and heat coils of the washing system with the control panel under the instructions of the company maintenance engineering head. Once the whole machine was set-up a new three phase wiring was laid and connected to the main panel box to start the whole machinery. All these set-up took us among a week time from bringing machine into the plant to the very end when the machine functions properly without any fault.

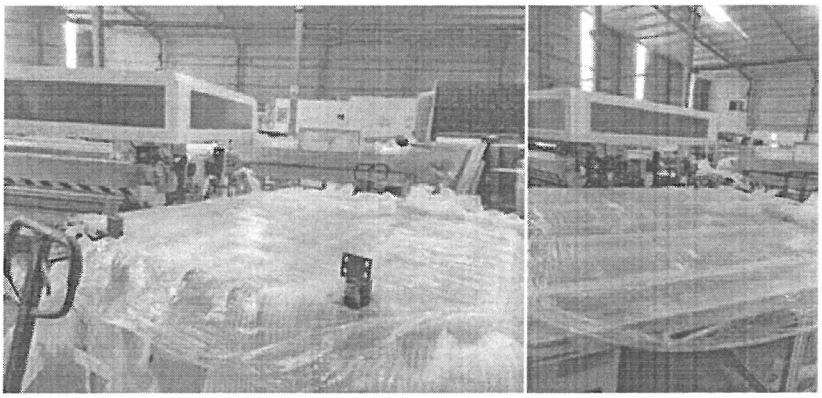


Figure 60 New machine in packed condition

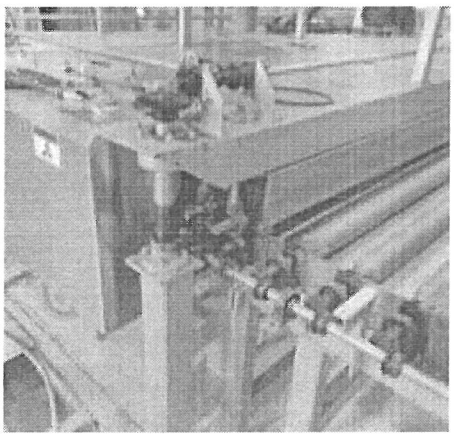


Figure 61 Arranging and leveling the machines with each other

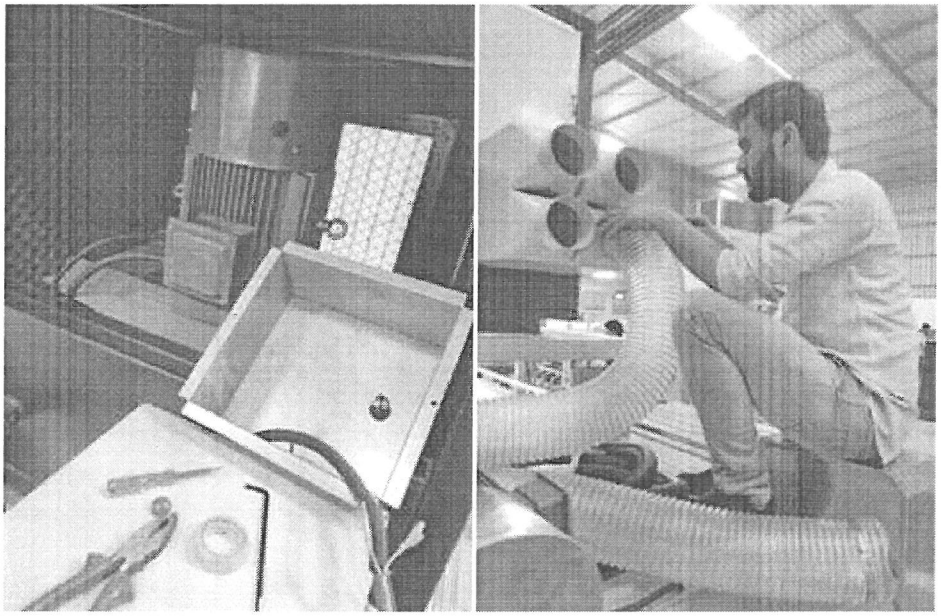


Figure 62 Air blower connection and pipe set-up

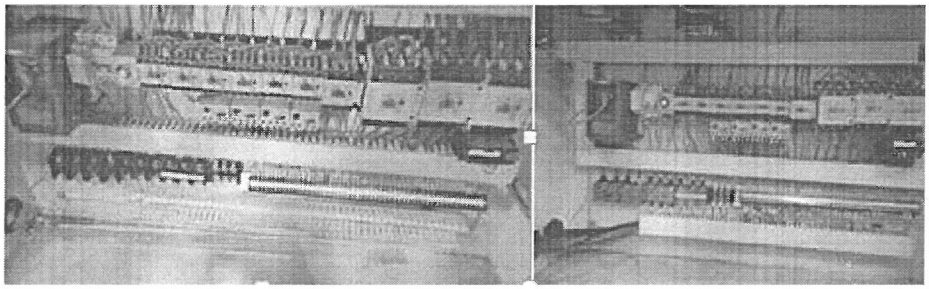


Figure 63 Machine control panel wiring

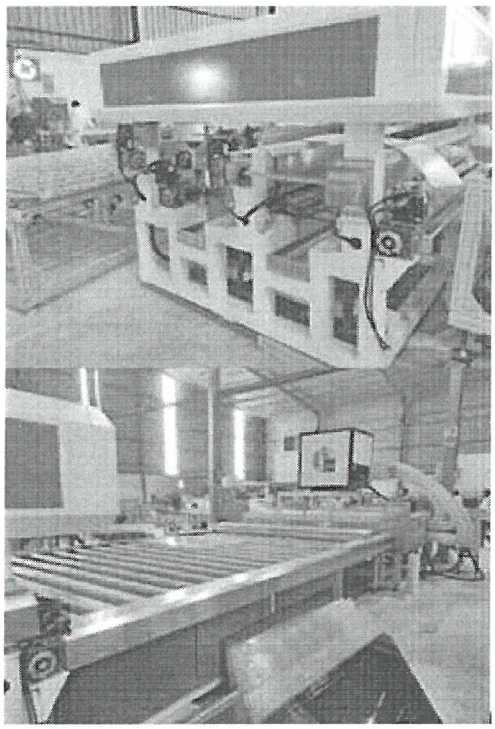


Figure 64 Machine perfectly installed and running successfully

5.2 Project work-2

Recently we were assigned with one more project work which was to quality check the whole lot/batch of the glass going to dispatch for the ongoing World Trade Centre project. In this project our goal was to randomly collect the glass sample from the different-different machining process and test them as per standards.

The first lot from the toughened was having a less strength value as compare to the required value but after that the test results were forwarded to the toughening department and the issue was solved with immediate effect. Also some of the glasses were having a little bending issue due to not giving enough time to get cool down which measure was also get taken care of afterwards.

We also performed other test related to silicon hardening time and Molecular Sieves quality which results were up to mark.

Chapter-6: Packaging & Wastage

6.1 Packaging and dispatch

Large glasses are covered in a wooden rack with plastic wrap and that wooden frame is supported on the truck and knotted with ropes. Small glasses and glasses which are locally transported are supported by wooden rack and thermocol distances and tied up with pick-up body no other measures are taken.

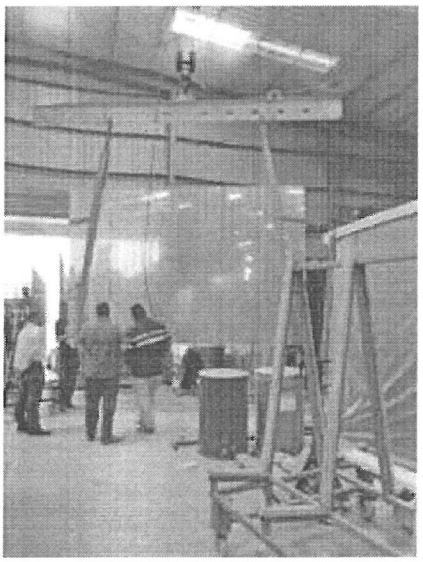


Figure 65 Material Loading on the truck

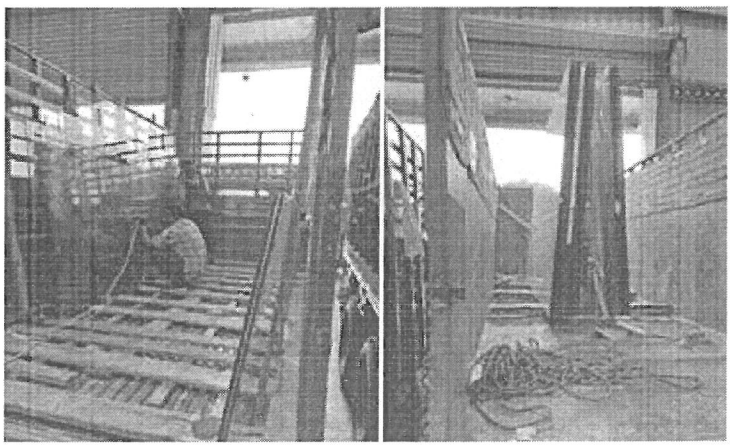


Figure 66 Large and Small glasses loaded and packed on the trucks

6.2 Wastage

There are different-different types of material wastages occurred at the industry:

1. Extra total wasted glass from CNC cutting.
2. Glasses with scratch and water marks.
3. Bended glasses with uneven bending.
4. Toughened glass breaks while processing.
5. Glass breaking while packaging & dispatch time.
6. Glass breaking and wastage while putting from one assembly to another due to human error.

The approximate total daily glass wastage is of 1 ton which is 10% of the total daily production. The waste glass is sold for approx Rs. 8-10 for 1 kg. These waste glasses goes for the recycling process.

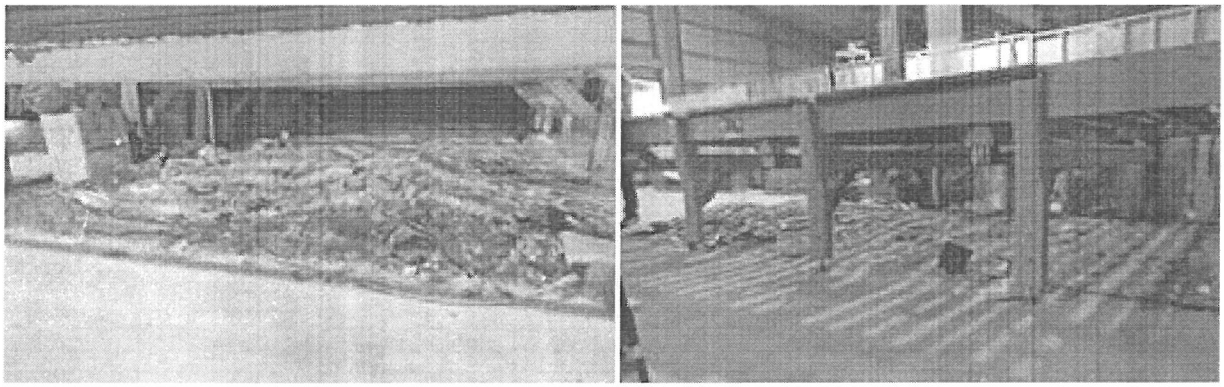


Figure 67 Glass wastage at industry

Chapter-7: Quality Check

7.1 Quality check tests

There are around 9 tests for testing the quality of the glass and other bits used in the process which are as follows:

1. Ball Drop Test
2. Fragmentation Test
3. Stress Measure Test
4. Bend Checking Test
5. Pot Snap Time Test
6. Butterfly Test
7. Hardness Test for Sealent
8. Boil Test
9. Desiccant Test

7.1.1 Ball Drop Test:

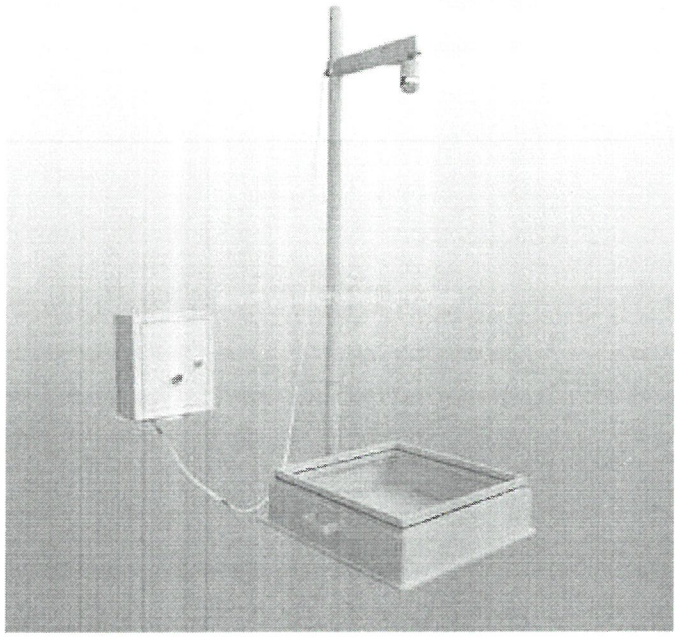


Figure 68 Ball drop test

Procedure:

- Take 5 nos. of Tempered samples of size 610 x 610 mm.
- Place the Steel ball of 1040+2 gm. Weight & Diameter of 63.5 mm in holder placed at a height of 1 meter.
- Clean the frame first for any dust or glass particles & place the sample on Frame as shown in figure.
- Drop the Ball on the sample. (Use hand gloves while doing the Tests)
- The number of Impact per Test Specimen shall be limited to ONE Time and the Test should be carried out at ordinary Temperature.
- Repeat the steps until all the 5 samples of one lot are Tested.
- Finally out of 5 samples interpret the Result as follows:
  a) The Test is PASS, If One sample is Broken out of 5 samples.
  b) The Test is FAIL, If 3 samples or more samples are broken out of 5 samples.
  c) If 2 samples are Broken, Then another 5 samples to be taken for Testing.

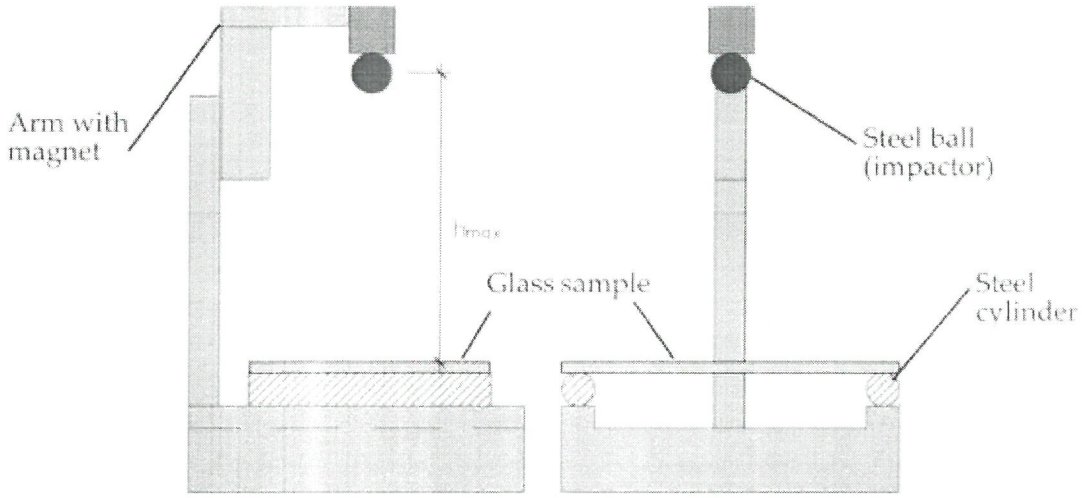


Figure 69 Test setup

Key Points:

- Ensure the Glass and Spacer surface is cleaned from Dust and Dirt particles.
- Ensure that at least 50.0 mm of the Sealant should be applied over the Polyethene sheet.
- Ensure that the curing is done in Normal Room Temperature.
- This same Test can be done Online on the Insulated Glass at the site or in Factory premises also, But insure that the peeled out area must be Repaired again properly (i.e. Resealing the cut part).

7.1.2 Fragmentation Test:

Procedure:

- Take the sample glass of size 360 x 1100 mm without holes & Notches & cut outs.
- Wrap the test sample in white cotton cloth or mask the glass at the edges with masking tape & punch it at a position 13 mm from the longest edge of the specimen at the midpoint of that edge until breakage occurs using a pointed steel tool/Hammer.
- The particle count shall be made within 3 minutes after the breakage of the glass.
- First count the fragments that lie across the marked area & divide it by 2 & then those fragments that are completely inside the marked area. Add both the numbers. Example: Fragment count that lie across the marked area = 30 pieces. Fragment that lie inside the marked area = 50 pieces.
  Therefore total fragment count is = (30/2) +50= 65 pieces (Refer figure 3 for minimum particle count)
- Repeat the 5 & 6 for counting the maximum count.

- The longest particle shall be chosen from the body of the test sample & it shall not be excluded area. In order to classify the glass thermally toughened soda lime silicate safety glass, the length of the longest particle shall not exceed 100 mm length.
- Fill the result in check sheet. If the result is not satisfactory then inform the production in charge & identify the lot.

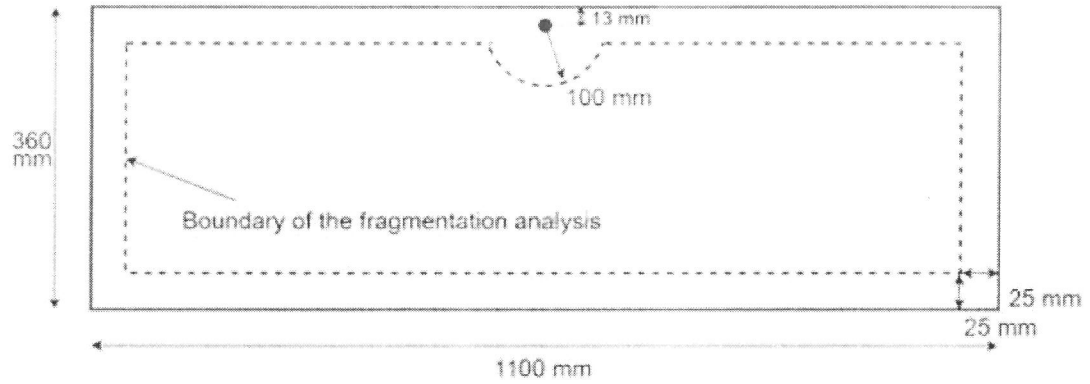


Figure 70 Markings for the fragmentation test on sample glass

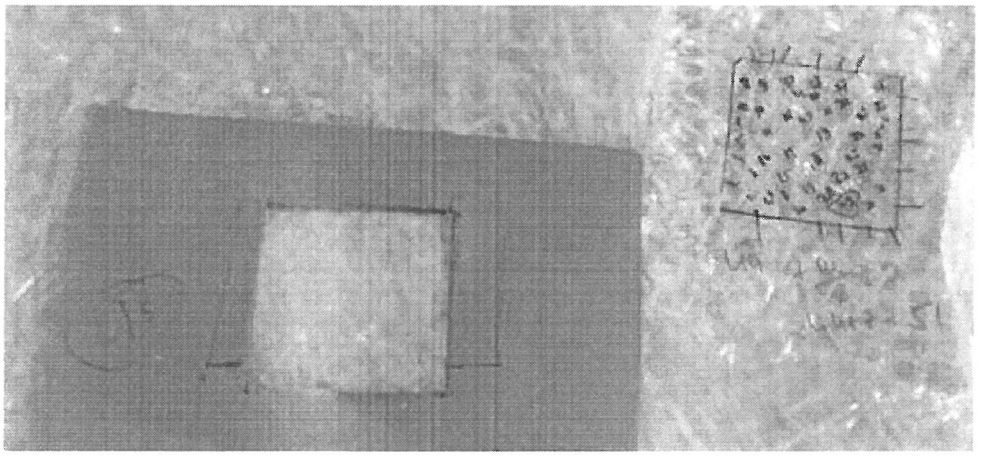


Figure 71 5x5cm slit for counting fragmented pieces

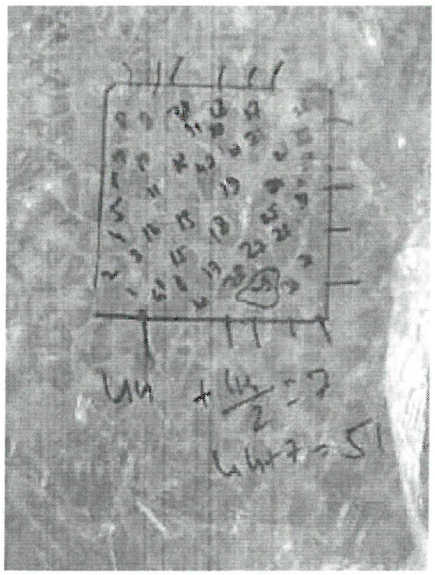


Figure 72 Fragmented pieces counted

Key Points:

- Samples of all thickness and tint produced in shifts needs to be covered in test.
- Test sample should be tightly wrapped with cloth. If cloth is used, Hammer details 75 gms mass, Radius of the curvature of the center punch / striking point approx 0.2mm
- Note: The Fragmentation characteristics of glass are unaffected by temperatures between -50 degree Celsius to +100degree Celsius.
- The particle count and measuring the dimensions of largest particles shall be made within 4 to 5 minutes after the fracture. The particle count shall be made by placing the 50 mm x 50 mm template on the coarsest fracture.

7.1.3 Stress Measure Test:

Procedure:

- Take the 5 no. of samples glass of size 360mm x 1100 mm without holes& notches.
- Mark the 5 points as shown in figure 1 on the selected sample.
- Apply a drop of fluid provided along with the meter, Place the Stress meter on the tin side surface of the glass on the fluid surface
- Stress pattern as shown in fig. Will be seen & adjust the master black lines parallel to the stress pattern lines.
- Check the stress in vertical & horizontal position at each point, such that 10 observations are made.
- Then check the pointer position on the graduated round scale. Record the angle, from the angle to stress conversion chart, calculate the stress and judge the glass whether it is tempered heat strengthen.

- Calculate the average of 10 readings & it must be within the limits.

Key Points:

- Ensure the Glass and Spacer surface is cleaned from Dust and Dirt particles
- Ensure that the curing is done in Normal Room Temperature.
- Surface using for stress measurement should be plane.

7.1.4 Bend Checking Test:

Procedure:

- Select the glass to check the warp/ bend in the glass.
- keep the glass vertically on stand such thatit rest at 2 point edges (Refer figure 1 for resting points) Hold a ruler scale or a string at the edges of the glass leaving about 50 mm from the top edge. As shown in figure 2
- Tighten the string & measure the maximum gap at the center of arc as shown in figure 2 & record it.
- Interpret the Result as follows.
  Calculate the percentage ratio of bend as follows:
  Height of the chord x 100 /Height of the arc
- The percentage ratio must exceed 0.5 % of the arc ie a bend of 5 mm is permitted for a length of 1 meter glass.

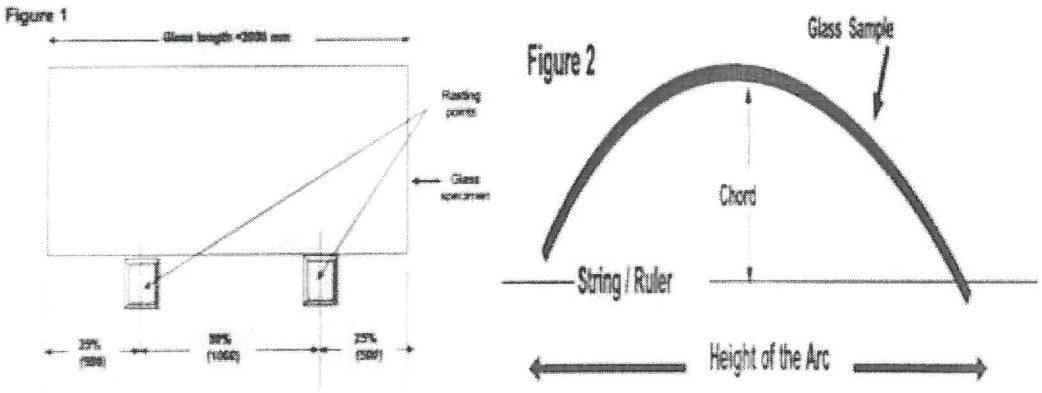


Figure 73 Bend checking diagram

Key Points:

- Always keep the Equipment in "ON" Condition.

- Always keep the equipment clean and do not allow the dust to accumulate on the lens.

7.1.5 Pot Snap Time Test:

Provedure:

- Take a small container and fill it half with the Sealant which is to be tested.
- Place a Stick, Pencil in to the Sealant as shown in Figure.1 and Note the Time in Record book.
- Every 5 10 minutes, Pull on the Stick as shown in the Figure.2.
- If the Sealant does not tear itself (Cohesively) when the stick is pulled out, the Sealant has Not Snapped. The Time at which the sealant Tears Cohesively when the stick is pulled out, the Sealant is Snap and this termed known as "The SNAP Time" (Figure 3).
- The Snap Time will vary Depending upon Atmospheric condition, Temperature, Humidity and the Individual doing Test.
- A Snap Time varying more than 45 minutes from what is Expected may Indicate an Equipment or Sealant Problem.



Figure 1 Figure 2 Figure 3

Figure 74 Pot snap test set-up

Key Points:

- Ensure that this Test is Performed on Daily basis. It relates to the Base to Catalyst Mixing Ratio to the Cure rate of the Sealant.
- Do not stir the sealant or incorporate air into the mixed sealant.
- Note down the Time of snap in record book.

7.1.6 Butterfly Test:

Procedure:

- Take a Test format paper fold it as shown in Figure.1.
- Apply a minimum 150.0 mm bead of sealant to the Crease of the folded paper as shown in Figure.2.
- Press the paper together, smearing the sealant bead to a thin film.
- Next pull the paper apart and Visually inspect the sealant smear formed. As in Figure.3
- Asses the correctness of the test as follows:
- Properly mixed sealant should have no white steaks (refer figure 4) of unmixed base. If steaks are present then more material must be pumped through the line to improve the mixing quality
- If Sealant smear is a consistent black color (refer figure3), the sealant is properly mixed and is ready to use.

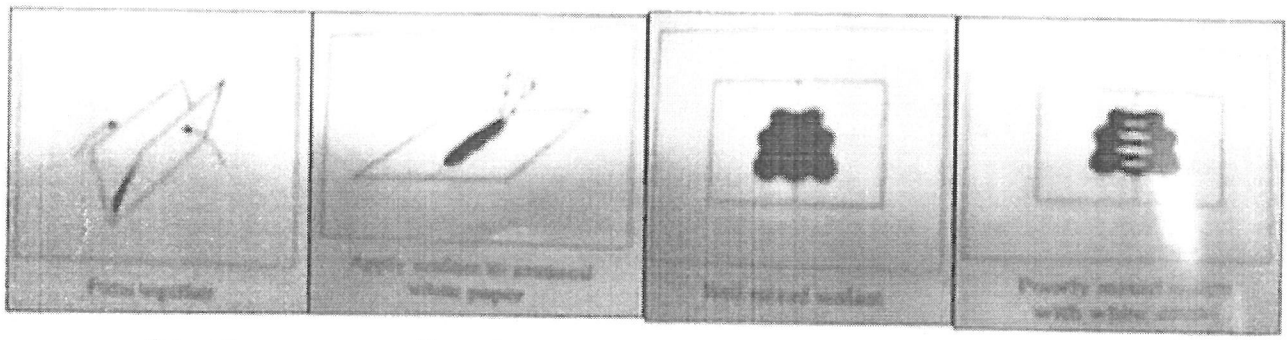


Figure 1 Figure 2 Figure 3 Figure 4

Figure 75 Butterfly Test

Key Points:

- Ensure that the test is performed every time the pump is started.
- If Grey or White streaks continue, Equipment maintanance may be needed. Cleaning or Changing the mixing system, Dispensing the hose, Dispensing Gun or Ratio system ball check valve can often correct this Problem.

7.1.7 Hardness test for Sealent:

Procedure:

- Take the hardness master sample & check the correctness by taking readings of 25 Shore A master block.
- Take the hardness master sample & check the correctness by taking readings of 50 Shore A master block.

- Take the hardness master sample & check the correctness by taking readings of 75 Shore A master block.
- Check the correctness & confirm the same.
- Next Put the Hardness Meter on the dried sealant area or on the dried sealant of the glass & press it as shown in figure.
- Take the reading & Asses the correctness of the Test as follows:
- The cured Sealant must have the hardness between (35 to 60 Shore A Hardness For Silicon)

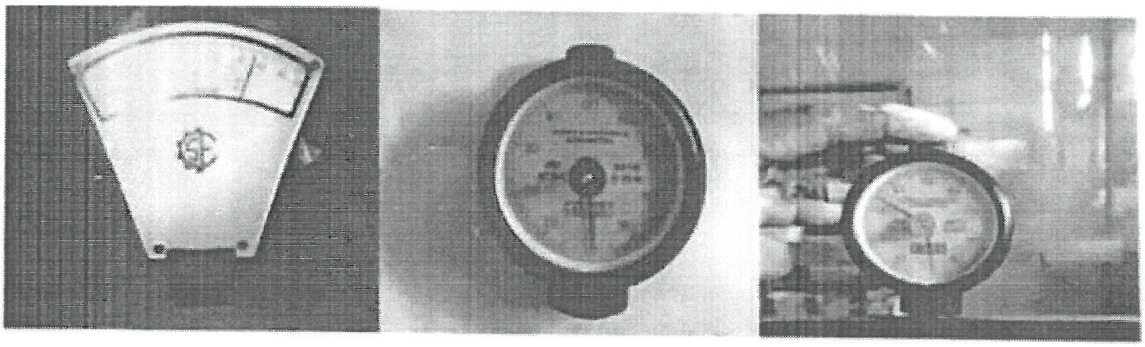


Figure 1 Figure 2 Figure 3

Figure 76 Hardness Test Set-up

Key Points:

- Ensure the meter edge do not rests on the glass surfaces during inspection, the pointer must completely touch the rubber part
- Same Test can be done Online on the Insulated Glass at the site or in Factory premises also.

7.1.8 Boil Test:

Procedure:

- Cut the 3 nos laminate samples of size 300 x 300 MM.
- Put samples vertically into the test camber conatining water heated to a tempertaure of 100c
- Maintain this temperature for a period of 2 hours, then allow the test specimen s to c0ol to the room tenmperature.
- Identify the samples for work order number, combination of laminate.
- After the 2 hours remove the samples and interpert the result as follows.
- Inspect the test sample at a distance of 30 cm & 50 cm infromt of a white back ground. Record the number and extent of all the faults occuring in the interlayer such as bubbles,

delamination & cloudiness. While inspection exclude all the faluts with in 15 mm from uncut edge. 25 mm from cut edge and samples showing cracks will be disregarded and another test sample shall be tested

- Test procedure as per standard, type/ combination of laminated glass, type of edge, number of 8u8bles and size of bubbles, delamination & cloudiness occuring.
- In case of abnormality indentify the lot and report to the production.

Key Points:

- The samples size must not be less than 300 mm x 100 MM.
- To avoid the extreme thermal stresses leading to the crack formation the samples should be heated up in two steps by first immersing it into a water bath of about 60 °c fors minutes (or gradually increase the temperature up to 100°c.
- Ensure that before placing the samples in to the envinronment chamber write the order number, combination of the glass on the glass surface with marker pen
- Use safety cotton hand gloves

7.1.9 Desiccant Test:

Procedure:

- Take 100ml water & 100gm desiccant in a test tube/ beaker
- Insert a thermometer ranging from 0" to 100" Centigrade in to the test tube / beaker
- Take 100 ml of water in a separate Test Tube/ Beaker & add this water in to the desiccant
- Check the initial water temperature & note down in deg. Centigrade.
- Add the water in desiccant & note the water temperature of water.
- Measure the temperature difference of intial reading & risen temperature reading , the difference must be not less than 32°c.
- If the Temperature rise is less ,then inform the QA in charge & materials in charge for the abnormality.

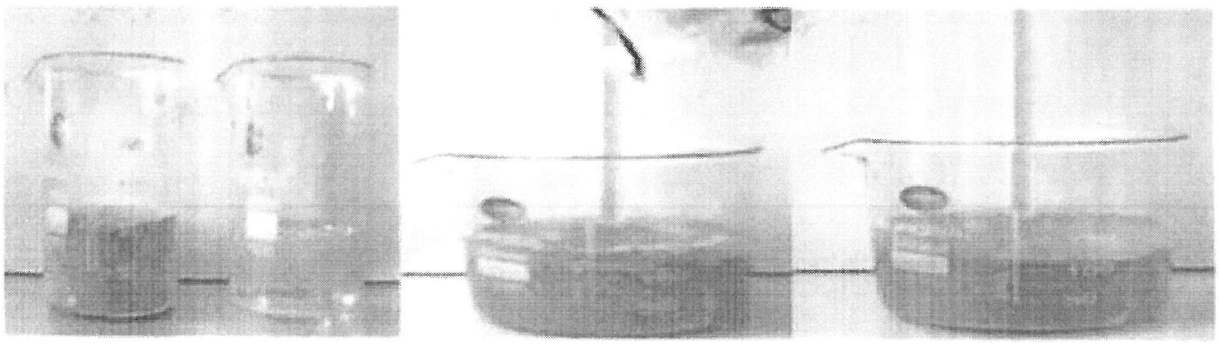


Figure 1 Figure 2 Figure 3

Figure 77 Desiccant test set-up

Key Points:

- Note down the supplier name, date of receipt of desiccant lot, Diameter of granules before each test.
- Keep record copy of the test certificate received from supplier for each lot.
- Ensure Secondary sealant is applied after confirming the correctness of Butterfly test only
- Keep a check whether the drum of desiccant is properly sealed all the time during production.

Chapter-8: Learning & References

8.1 Learning Outcomes

Throughout this training session we learned about the working process, technical parameters, maintenance of the following machines:

- CNC Cutting Machine.
- Lamination Line.
- Tempering Machine.
- Double Glazed Unit (DGU) Line.
- Rough Grinding.
- Frosting Machine.

Additionally we also learn about the types of glasses, testing of the glasses and quality inspection techniques. Also about how an industry is operated, managed and deals with all internal and external affecting factors. In this whole internship period of 4 months we as an mechanical engineer have learned and experienced all the important bits about an industry in depth which experience will help us in our future journey in the core field.

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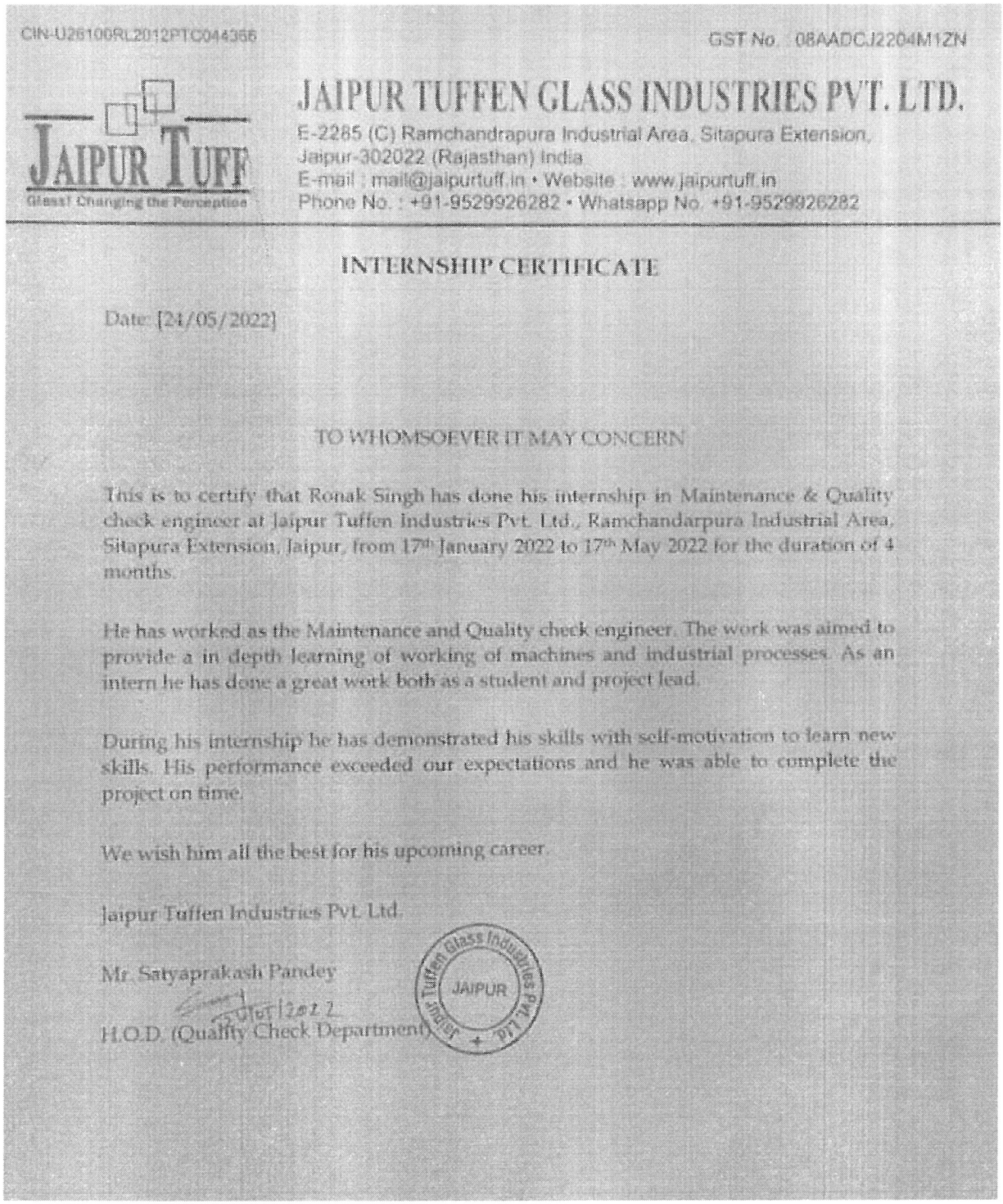
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Chapter-9: PS-2 Certificate

9.1 Ronak Singh (2018BtechME004)



CIN-U26100RJ2012PTC044366 GST No. : 08AADCJ2204M1ZN

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Phone No. : +91-9529926282 • Whatsapp No. +91-9529926282

INTERNSHIP CERTIFICATE

Date: [24/05/2022]

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Ronak Singh has done his internship in Maintenance & Quality check engineer at Jaipur Tuffen Industries Pvt. Ltd., Ramchandarpura Industrial Area, Sitapura Extension, Jaipur, from 17th January 2022 to 17th May 2022 for the duration of 4 months.

He has worked as the Maintenance and Quality check engineer. The work was aimed to provide a in depth learning of working of machines and industrial processes. As an intern he has done a great work both as a student and project lead.

During his internship he has demonstrated his skills with self-motivation to learn new skills. His performance exceeded our expectations and he was able to complete the project on time.

We wish him all the best for his upcoming career.

Jaipur Tuffen Industries Pvt. Ltd.

Mr. Satyaprakash Pandey

H.O.D. (Quality Check Department)

Jaipur Tuffen Glass Industries Pvt. Ltd. JAIPUR