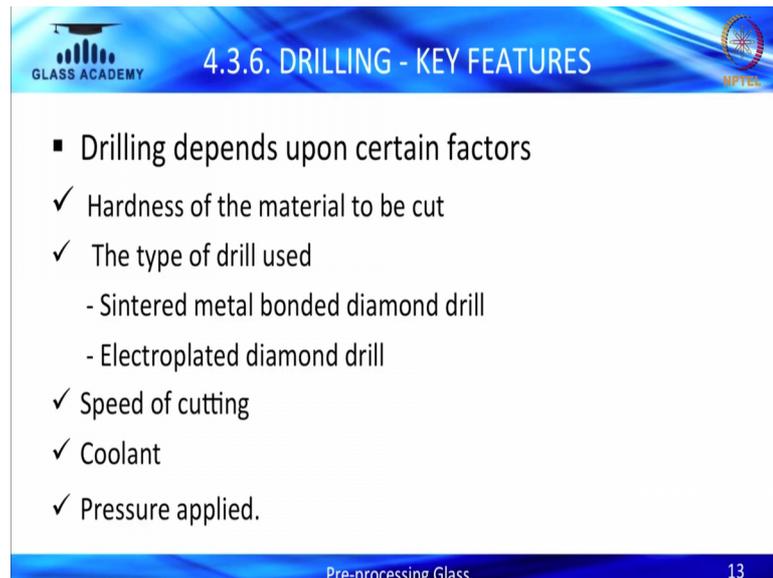


**Glass Processing Technology**  
**Prof. Mr. Gurpreet Singh**  
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**Lecture – 21**  
**Pre-Processing – Drilling**

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**4.3.6. DRILLING - KEY FEATURES**

- Drilling depends upon certain factors
  - ✓ Hardness of the material to be cut
  - ✓ The type of drill used
    - Sintered metal bonded diamond drill
    - Electroplated diamond drill
  - ✓ Speed of cutting
  - ✓ Coolant
  - ✓ Pressure applied.

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So drilling depends upon certain factors, hardness of the material to be cut the type of drill used, sintered metal bonded diamond drill, electroplated diamond drill, speed of cutting coolant and pressure applied. Obviously, what happened when you doing the drilling, there are various factors are depend what is your speed even the speed of the cutting, what is the coolant what is coolant that I have already explained the coolant is a very very important while you doing the drilling, which coolant you are using in the processing industry. So, generally they are using the water and how much pressure you are applied while drilling.

So, there are two types of drill that is a already explained you that the sintered metal bonded diamond drill and the electroplated diamond drill. So, what is the different and what is a centered and what is a electroplated, that I will explain in my next slide.

(Refer Slide Time: 01:16)

GLASS ACADEMY 4.3.8. DRILLING - TYPES OF DRILLS NPTEL

- There are two types of drill used - sintered metal bonded diamond drill and electroplated diamond drill.

Sintered Metal Bonded Diamond Drill	Electroplated Diamond Drill
Multiple layers of diamond	Single layer of diamond
Stands up well under aggressive conditions	Cannot be dressed (in most cases)
Super smooth finish	Least expensive
Long lasting blade so longer life	Limitation on the size being processed
Very universal	Cannot be used on a number of materials

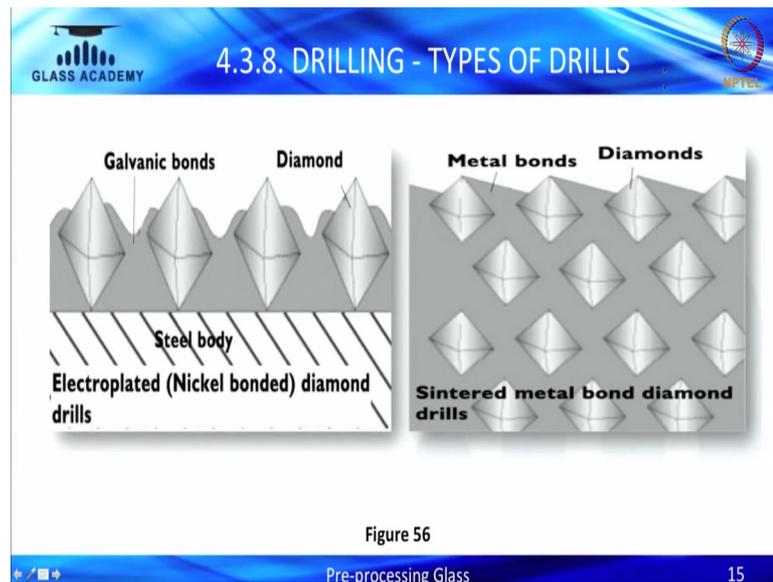
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So, let us discuss upon the sintered metal bonded drill and electroplated diamond drill, sintered metal bonded drill is a multilayer of diamond. Electroplated diamond is single layer of diamond, I will show you the images also how it is multi related and a how it is a single layer.

Stand up again the sintered metal bonded drilling stand up well under a aggressive condition cannot be dress in most cases electroplated, super smooth finish in the electroplated it will be less expensive, sintered metal bonded you will see loss long lasting blade so, longer life limitation on the science being processed. So, in the electroplated and process and the any limitation of the size, sintered metal it is a very universal cannot be used on the number of material. So, these are the different between their type of drills.

What is the sintered metal and the electroplated, I will show you in the photos in my next slide.

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So, if you see the first these are the electroplated nickel bonded diamond drills and, this is a sintered metal bonded diamonds, if you see what is I have explain you multiple layers of diamond. So, if you see in this right side image there are multiple layers of diamonds are there, these are the metal bonds these are the galvanic bonds. But if you in seen the electroplated these are the single layer of the diamond.

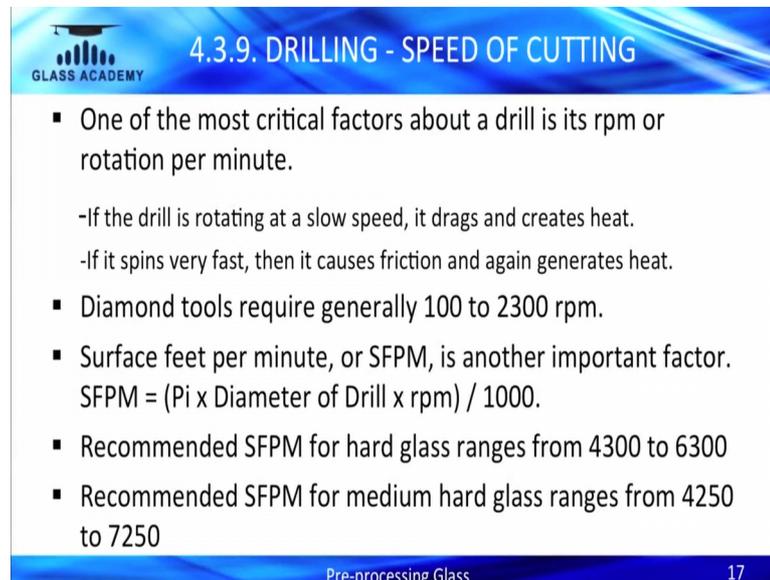
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So, these are the actual picture of a electroplated diamond drill and metal bonded diamond drill. If you see the electroplated coating on the diamond coating is very less in

this picture and, in a metal bonded it is very the density of the diamond it is very high in this. So, this pictures will give you the more idea about what is a actually electroplated diamond drill and metal bonded diamond drill. So, let us go to the next slide.

(Refer Slide Time: 03:09)



**GLASS ACADEMY** 4.3.9. DRILLING - SPEED OF CUTTING

- One of the most critical factors about a drill is its rpm or rotation per minute.
  - If the drill is rotating at a slow speed, it drags and creates heat.
  - If it spins very fast, then it causes friction and again generates heat.
- Diamond tools require generally 100 to 2300 rpm.
- Surface feet per minute, or SFPM, is another important factor.  
 $SFPM = (\text{Pi} \times \text{Diameter of Drill} \times \text{rpm}) / 1000.$
- Recommended SFPM for hard glass ranges from 4300 to 6300
- Recommended SFPM for medium hard glass ranges from 4250 to 7250

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So, again which way I have explain you in the my last slide that depend upon the speed of cutting; obviously, if you apply the proper speed, then it might be chance that you all glass will not be having any issue, but if you not applying proper speed the rpm of the speed rpm will be high and a rpm will be less create the friction in the glass, damage your drill bits or as well as your glass.

So, one of the most critical part of a drill is rpm rotation per minute. If the drill is rotating at a lower speed it drags a create heat, if the spin it if it is a less speed when causes the friction again generates the heat. So, when the heat will be generate, then again it will be create the problem with proper lubrication will not be there, you have to be use proper speed while making the drills. So, diamond drill require at speed of 100 to 2300 rpm. Surface feet per minute is a another important factor SFPM its formula is pi into diameter of drill, pi is equal to 3.81 and diameter of drill into rpm into divided by 1000.

You can convert into the rpm as well as so, rpm the SFPM it equal to 1000 and you can convert into the easily in a rpm, recommended SFPM is a harder range from 4300 to 63000, recommended SFPM for medium hard glass ranges from 4250 to 7250 rpm. So, if

the if you see the hard glass range, this hard glass range the speed is varying and from medium it is the speed is varying. So, is it depend it depend upon the glass hardness also.

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GLASS ACADEMY

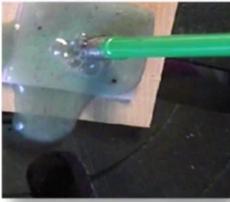
### 4.3.10. DRILLING - COOLANT

**■ Coolant**

- ✓ Diamond tools require coolant to be flooded at the point of contact of the tool with the material that has to be cut.
- ✓ Best option- have the coolant flood the point of contact of the blade or down the center of the drill, by the drill head assembly or a water swivel adapter.
- ✓ Water can be used as coolant for glass drilling.

**■ Water Swivel adapters**

- ✓ Water swivel adapters provide coolant through the centre of the diamond core drill.
- ✓ They help cool both the diamond core drill and the material in the zone of drilling.
- ✓ They have a valve for adjusting the flow of the water



DRILLING WITH COOLANT



WATER SWIVEL ADAPTER

Pre-processing Glass 18

So, as I explain you from my previous slides also coolant is very very important while you making the drills. So, diamond tools require cool to be flooded at the point of contact of the tool when the material has to be cut, when you doing the drill it should be flow at your drill bits as well as on the glass. The best option have the coolant flood on the point of contact of the blade, or bond the center of the drill by the drill head or assembly way water swivel adapter.

Water can be used as a coolant for glass drill, which I have already explained you that water is can be used for the coolant for the glass drilling. The water swivel adapter, if your right side if you see these are the adapter from where the water get come from the; from outside and it will be flow from this directions. So, water swivel adaptor provide a coolant to a center of the diamond core drill, they help cool both the diamond core drill at the and the material on the zone of drilling, they have a valve for adjusting the flow of water as well as.

So, according to your flow of the water is the if the water flow will be very high, you can easily can control with the help of this valve. So, that your flow will be get reduced, if you want the more flow then easily you can control with the help of this right side, if you see the red color this with the help of this valve.

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GLASS ACADEMY 4.3.12. DRILLING - TYPES OF DRILL HEADS NPTEL

- Drilling quality depends on the type of drill head.
- There are 3 types of drill heads.
  - Off centric diamond drill
  - Non coring diamond drill
  - Slotted diamond drill.
- OFF centric diamond drill
  - Designed with a half moon shaped ID.
  - Allows the core drill to move material and coolant at the same time as it drills the hole.
  - ID of Diamond drill/bit is made larger (off center)
  - OD is made smaller to accomplish this.

Non coring /disintegrating diamond drill



Off centric diamond drill Slotted diamond drill

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So, let us discuss about right now about the types of drill heads drilling quality depend upon the type of drill head.

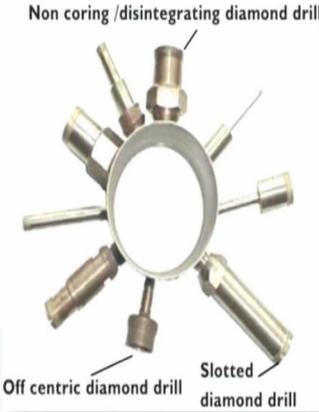
If you see the right side there are non coring disintegrated diamond drills, off centric diamonds drills and slotted diamond drill. So, there are three type of diamond drills, off centric diamond drill, non coring diamond drill, slotted diamond drill. If you see the image I have shown you this is a non coring, this is the non coring disintegrated this one is a off centric and this is the slotted what is this so, I will explain you in my next slide. Let us discuss about the off center diamond drill, designed with a half moon shaped ID.

If you see this is a half shape central diamond drill, design with a half moon shaped ID, allow the core drill to move material and the coolant in the same tray as the drill the hole. ID of diamond drill bit is larger of the center hoe OD is outer diameter is a made smaller do accomplish this. So, this is the off centric diamond drill.

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GLASS ACADEMY 4.3.12. DRILLING - TYPES OF DRILL HEADS NPTEL

- **Non coring or disintegrating ID diamond drill**
  - Considered a diamond core drill because it has a slot on the side for coolant to pass through the centre of the diamond drill.
  - Inside diameter of this diamond drill is offset.
  - Leaves no core behind as its destroy core when drilling,because its ID is offset



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So, remaining non coring and the slotted we will explain, in the next slide this is the non-core of disintegrated ID diamond drill. If you see in the top this is a non core disintegrated diamond drill. So, consider that diamond grow drill because its slot on the inside of the coolant to pass through the center of the diamond drill, inside the diameter of drill is offset, leave no core behind as it is destroy core, when drilling because its ID is offset let us discuss about the next.

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GLASS ACADEMY 4.3.12. DRILLING - TYPES OF DRILL HEADS NPTEL

- **Slots in the diamond drill design**
  - Tip allow it to drill hard materials faster.
  - Help reduce heat generation,
  - Help in propelling the coolant through the drilling zone.
  - ✓ Width of the slot depends on the hardness of the material.
  - ✓ Diamond drills manufactured for drilling harder materials require a larger number of slots than those made for softer materials.
  - ✓ Slots are recommended for thick wall diamond drills, as this helps increase drilling speed and efficiency.



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Slot in that diamond drill, third one it is a slot if you see in the right side this is the slotted diamond drill. Tip allowed to drill hard material faster, help reduced heat generation, help in the propelling the coolant through the drilling zone.

Width of the slot depend upon the hardness of the material, diamond drill manufacture of drilling harder material require a larger number of slotted those made for a softer material. Slots are recommended for the thick wall diamond drill as helped to increase drill speed and efficiency, these are the actual what is I have explained you for the non coring disintegrated and the off centric and the slotted diamond drill.

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**4.3.12. DRILLING - TYPES OF DRILL HEADS**

- Diamond core drills**
  - ✓ Have a hollow tip
  - ✓ Used for drilling through material.
  - ✓ A "core" or "plug" is obtained in the process, from the middle of the hole. Diamond core drills drill much faster than blind hole drills.
- Blind hole drills**
  - ✓ Have a solid tip
  - ✓ Make a small size hole in material.
  - ✓ Limited to how deep you can drill and the size of hole
  - ✓ Need to make a large blind hole, a bottoming tool will have to be used

Bottoming tool with water swivel adapter

Blind drill

Pre-processing Glass 22

So, type of drill heads diamond core drills, if you see in the right side have a hollow tip use a drilling through a material, a core or plug obtain in the process from the middle of the whole diamond produce much faster than the blind hole drills. This is a actual the purpose of the diamond core drill and, blind hole drill it is have a solid tips if you see this is the various solid tips these are the solid trips. Make a small size hole in the drill material, limited to how to deep you can drill and size of the hole, it is a depend upon what kind of so, a whole you want to make in the glass, you can get a in the market easily available all it kind of the drill bits.

But diamond drill bit is very much so, whenever you going to the market you should purchase the diamond directly. So, that whatever drilling you are doing it should be very smooth and having a no problem in while making the holes. So, let us discuss a blind

hole drills, limited to how deep you can drill a size of the hole, need to make a large blind hole and bottoming tool will be have to be used next slide.

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**SPECIFICATIONS OF CUTOUTS**

- **Cutouts**
  - ✓ Holes that are drilled in the glass.
  - ✓ Have to be made as per specific dimensions.
- **Minimum Glass width**
  - ✓ A glass with holes have a minimum width(W) is 8x glass thickness (d)
- **Position of the holes**
  - ✓  $a > 1 \frac{1}{2} \times d$  ( $d=3$  to  $6\text{mm}$ )
  - ✓  $a > 2 \times d$  ( $d=6$  to  $19\text{mm}$ )
  - ✓  $a > \text{hole diameter}/2$  (between two holes)
  - ✓ where 'a' is distance from glass edge and hole edge or between two holes
- ✓  $d = \text{thickness of glass}$

The slide includes three diagrams: 1. 'Specification of cutouts Minimum of glass width' showing a vertical dimension 'W' across a glass section with a hole. 2. 'Position of holes' showing two holes with diameter 'D' and distance 'a' from the edge. 3. 'Hole diameters' showing two holes with diameters 'D min' and 'D max'.

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So, this is very again we have learn about the machines, we have learn about the drill bits we have a learn about the tools, we have learn about the problems we are facing in the while making the drill bits, the issue we have faced in a while making the holes. So, again it is a very very important specification of cutouts, even if you go with the European standards 1 2 1 5 1 2 1 5 0 the toughened glass and EM 1 1 at 6 3 HS glass, it is mention about the cutouts what will be the hole distance from the adjust what is a distance from hole to hole. So, I have already I have presented in I have presenting in my just PPT so, please concentrate on this specification of cutouts.

So, holes that are drilled in the glass, if you see the right side these are the width the specification of cutout minimum glass width. So, these are the holes let us assume this is a holes have to be made as per specific dimension so, minimum glass width is W it is mention a glass, with the holes have a minimum weights this eight into glass thickness. So, whenever you making the glass so, you have to be note this point the minimum width W is 8 into the glass thickness that is d, that is small d. The position of the holes like see in the right side to this difference, this to this distance a should be greater than one and a half into d, d is equal to again thickness so, thickness which is equal to 3 to 6 mm.

So, if it if your glass thickness is 3 to 6 mm so, that your distance of the whole should be more than one and a half into thickness so, suppose if it is 6 mm multiply by 1 and a half. The distance of the hole should be there and, if your hole position should be the glass thickness should be 6 to 19 mm then a, a mean the distance the d distance should be equal and greater than equal to 2 into thickness. Suppose if it is d is equal to 6 mm so, 6 multiply by 2 it is a 12 mm.

So, 12 mm distance is a must remain the holes to holes the a is equal to or equal to and greater than diameter and divided by 2 between the two holes, that I have already explained you. The hole diameter a should be greater than and equal to hole diameter and by 2 between the two holes, the distance between this two holes, where a is the distance from the glass edge and a hole edge are between two holes, d is equal to thickness of the glass which I have already explained in this drawing.

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GLASS ACADEMY 4.3.13. DRILLING - SPECIFICATIONS OF CUTOUTS

- That is, for a 10 mm thick glass, the minimum drill diameter is 10 mm, and for an 8 mm glass, it is 8 mm.
- The diameter of the drill must also not exceed one third of the minimum width of the glass.
- That is, if the size of glass is 600 mm x 1000 mm, the maximum drill diameter can be 600 by 3, which is 200 mm.

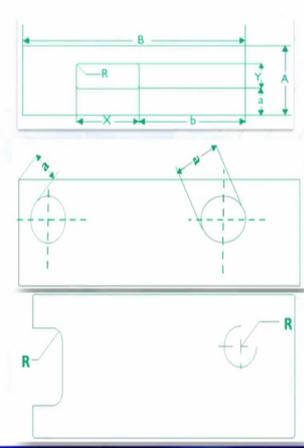
Pre-processing Glass 24

There are some example I have given here in my slide, that is if your 10 mm thickness glass is there, the minimum drill bit diameter should be 10 mm or and for 8 mm it might must be 8 mm. The diameter of drill must be not exceed one third of the minimum width of the glass. So, let us take the example if the size of the glass is 600 mm by 1 meter that is thousand mm. The maximum can be 600 by 300 which will be 200 mm. So, we have seen in the a last slide that the holes. So, let us discuss about the square holes.

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**GLASS ACADEMY** 4.3.13. DRILLING  
- SPECIFICATIONS OF CUTOUTS

- **Square holes**
  - ✓  $a \geq 1/2 \times Y$ , a is distance between hole & glass
  - ✓  $b \geq 1/2 \times Y$ , b is distance between hole & glass edge.
  - ✓  $Y \geq 1/3 \times A$ , A is glass height
  - ✓  $X \geq 1/3 \times B$ , B is glass width
- **Holes in corner**
  - ✓  $a \geq 4 \times d$ , where a is distance between holes that are in corner from corner tip of glass
- **Rounding**
  - ✓ Rounding radius (R) must be big as, or bigger than glass thickness (d)
  - ✓  $R \geq d$



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So, if you see the right side there are some images, I have given to you a is equal to a is a distance between a hole and the glass, a is greater than equal to half into y, Y it is a distance between a hole and a glass b, b it is given here b is a greater than or equal to half into y, b is a distance between a hole and the glass edge, Y is equal to one third into a, a is a glass this height X is greater than equal to one third into b which is it is given X it is given here and d is a glass this, this glass width hole in the corners

If sometime it is there the holes are coming on the corners also. So, what do we needs to do what we needs to take care a is equal to 4 into d, meaning the thickness into multiply by 4 or equal to greater than 4 or equal to 4, where a is a distance between this corners to this hole distance. The corner is for corner tip of the glass again this radius is a also important the card image it is radius must be big or bigger than the thickness of thickness of the glass.

So, R should be more than or equal to d, d is equal to glass thickness. So, why we are taking care of this much precautions while take you putting the holes, because if you are not take care of this distance or if you are doing the holes and putting the holes without knowing all this thing, it will be create the problem when you putting the glass in the furnace, what happen when the glass will enter in the furnace, while the heating it will be get break. If your holes distance on holes not as per the specification, or as you are not taken care of this things definitely it will be create the problem in the furnace.

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**GLASS ACADEMY**

### 4.3.14. SAFETY MEASURES

- The following precautions must be taken for a safe working environment.
- The use of goggles should be strictly implemented as broken glass chips can fly around during the drilling process, causing damage or injury to the eyes.



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So, again if it you not gives a proper method, this will leads to the breakdown. So, again what we are explaining again and again the safety measures. So, it is very very must when you taking care of not in the drilling, when you entering the processing industries you using cutting machine as well as drilling grinding we should always wear the safety helmets gloves shoes. So, that you can without any hesitate you can work in your area without any issue, use of goggle should be very strictly implemented as broken glass chips can fly around during of the glass process, causes the damage or injury to the eyes. Anything which is related the processing, I am again requesting you to put all the safety measure the photos have already shown you, the gloves the helmet you should wear while using your work.

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GLASS ACADEMY

### 4.3.14. SAFETY MEASURES

NPTEL

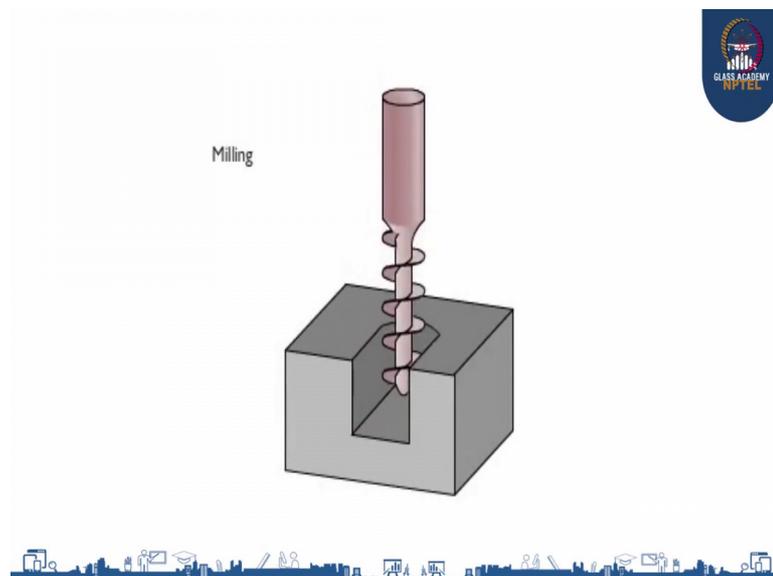
- Arm guard is mandatory as the bigger glass shards may cut and injure the forearm.
- Leg guards also are a must, as glass can damage the ankles while moving glass.
- The use of safety shoes is also mandatory for all shop floor personnel.

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Arm guard is mandatory as a bigger glass shards may cut and injure the forearms obviously, when you not put the proper the safety all the equipments, it will be create the problem and it will be create the issue and injured your body.

Leg guard also are must and glass can damage the ankle with moving glass, the use of safety shoes also a mandatory for all shop person not for using I am again telling you this is not mandatory that you should use in drilling purpose, you have whenever you entering the process industry, you should wear all the safety gadgets very well.

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So, this is our fabrication area, where we will be doing glass holes and cut outs with a help of this drilling machine. Now, you can see now they are drilling making a hole on to the glass in the mean time you see here.

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Now, they are mark they are doing marking on the glass, we have made a template that is known as Mickey Mouse cut out. Now, they are going to cut this particular area.

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The in this particular section they are going to do marking, as per the drawing this is the drawing.



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So, the through this drill bit I will be able to make 16 mm dia, this is a dia if I use this one I will able to do 10 mm dia, if I use this I will be able to do 8 mm hole. So, these are all different drill bits and, this is a specialized drill bit known as CSK countersunk hole. Generally if you see any hole you can able to feel the hole whereas, when you do this CSK, the hole will be inherent within the glass thickness, I will show you come. Now, now he is going to make a hole at that particular area for breaking.

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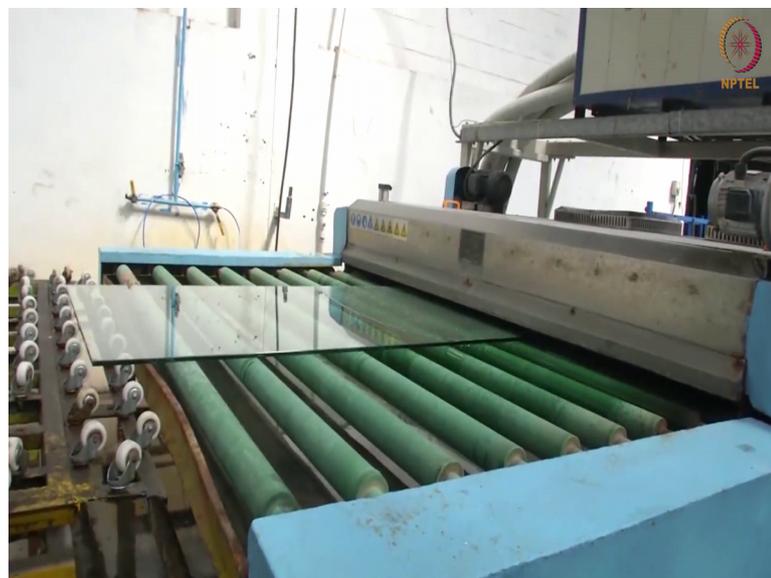
From bottom and top he is going to apply the drill bit, and now he is going to do puncturing with the water. Now, still apply water on to the glass and gradually he do drilling. Now, we seeing in the drill bit water and drop bit drill bit, now he is removing the clan in the drill bit. Now, you can see the hole at this particular glass.

Now, you see he is changing the other another drill bit, he is ensuring that both the drill bits are aligned with each other. And there is no mismatch. Now, as per the marking he is going to do drilling now, hello no Ashok sir said he will directly take, Ashok sir is saying he will directly take, hello hello hello, yes sir tell me huh tell me no he now he said he said that now he will directly take.

So, you see now this cut we have done, this is a half circle, you can see the dia 45 mm dia. so, this is less half of 45 mm you see here.

Once the drilling is done once the drilling is done it goes into the washing section again. So, wherever the glass is operated every section, you can find out the glass is going inside the washing machine.

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Now, this is going into washing, here we need to understand few things, where we can give the holes number of holes in a particular glass edge to hole edge to

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Yeah here we need to understand few things before making drilling, that is number of holes in a glass from edge to hole what is the distance from hole to hole what is a distance, what is the dia are more applicable on the glass, all these parameters we need to consider before making a drilling so, that on the later on stages that is in temperature, where glasses did not break.

Now, this glass is going for a working, now you can see a dry clean glass after watering the glass is having two holes here and a cut out there ok.

Next we go to lamination sorry ready yeah ok, now the purpose of this department is to bring safety to the glass, it is now this is a lamination section, where you are going to get safety to the glass, if at all any glass breaks unlike a single grazing unit. If at all a laminate glass breaks the PVB will adhere the broken pieces and broken pieces will not fall down. So, thereby it gives safety to the glass.

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Now, this is the loading point in order to make a laminated glass it should have minimum two lights of glass, the pair of glasses can be either annealed hs has or toughened.

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Or and we cannot have a annealed with hs hs with toughened either, we cannot have because we need to superimpose the roller wave of each glasses, you have a flat surface level and PVB to adhere properly. Now, the glass is going into the washing first we will be doing loading, next it goes to washing section, water tester [FL] water tester.

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This is the water tester for lamination especially we need to maintain the PH TDS and conducted the value, to have a good adhering to the glass and the PVB. So, first we will take the water conductivity, we will take a glass this water. So, now, I am measuring TDS

it is coming very high note like you take PH, this you take ta td is 8.5 conductivity is also very high, water when changed.

[FL]

This is a fan which will help to clean all the dust on the fall on the at whichever if person is going inside the layup room, you can feel air. So, it is a cleaning procedure cleaning entry procedure.

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Now, this is a lamination layup room or we can say assembly room.

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Or we can say clean room, where we are going to join two glasses with the help of one inter layer, known as PVB this is the PVB material. [FL]

[FL] Milky PVB clear PVB coconut PVB. [FL]

[FL]

Huh 0.76 or 1.52. [FL]

[FL]

Yeah if you see first they have taken the bottom glass, and on the top of it they are placing 1.52 thickness of PVB layer and.

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First is they have taken the first glass on top it they have kept 1.52 that is 0.762 layers of PVB. And next they have placed another glass and, there will be may making sure that the holes are matching and the edges are matching. Now, they are going to do trimming that is PVB trimming by leaving 2 mm excess edge excess PVB.

We need to make sure that RH and temperature that is relative humidity and temperature are maintained.

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In the lab.

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You can see here you can see here.

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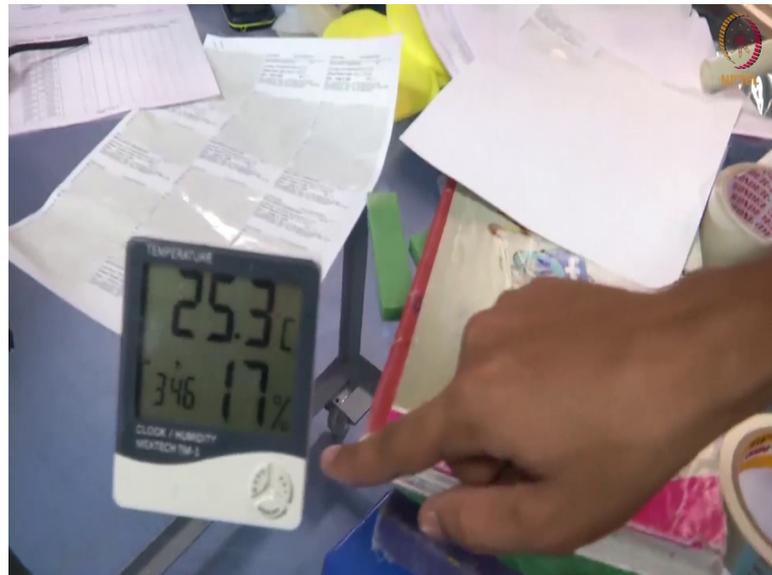
The temperature is 25 degrees and the RH is 17 percentage.

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It should be below 25 for a good warning between the glass and the PVB.

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Now, it is going for pressing ok, you show me [FL] clear PVB, milky PVB, coconut PVB. Now, they are going to stick this production sticker on the glass wait, they are going to stick this production sticker for identification. And now it is going for pressing. [FL]

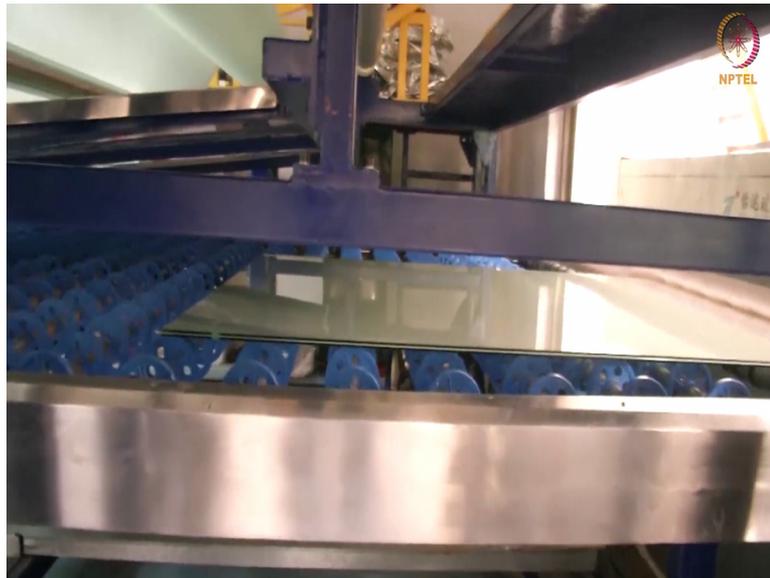
[FL]

Coconut.

(Refer Time: 31:12) finish this (Refer Time: 31:13).

Hum coconut (Refer Time: 31:15).

(Refer Slide Time: 31:29)



[FL]

[FL]

Coconut. [FL]

And next [FL] centering.

(Refer Time: 31:29) centering.

[FL]

(Refer Time: 31:30).

[FL]

0.76

(Refer Time: 31:33).

Ok come [FL]

(Refer Time: 31:48).

Come in PVB we have basically two varieties, one is known as a normal PVB which will give sound insulation whereas, another layer is known as centric glass PVB. The centric glass PVB is known for its stiffness and, it will give additional structural strength, strength to the glass. So, you cannot fold it is very stiffer compare to the normal PVB this is 0.76 SGP centric glass PVB.

And if you see a normal PVB we have basically three types of PVBs one is known as clear PVB where the transference is there, next one is a translucent PVB means like, this is a milky PVB. If I keep my hand here you will not be able to see full features and, one more is known as coconut PVB that will give opaqueness to the glass.

(Refer Slide Time: 33:06)

### Summary:

By the end of this video, you have learnt about the:

- Types of drills
  - Sintered metal bonded diamond drill
  - Electroplated diamond drill
- Speed of cutting
- Coolants
- Types of drill heads
  - Off centric diamond drill
  - Non coring diamond drill
  - Slotted diamond drill
- Specifications of cutouts
- Safety measures

