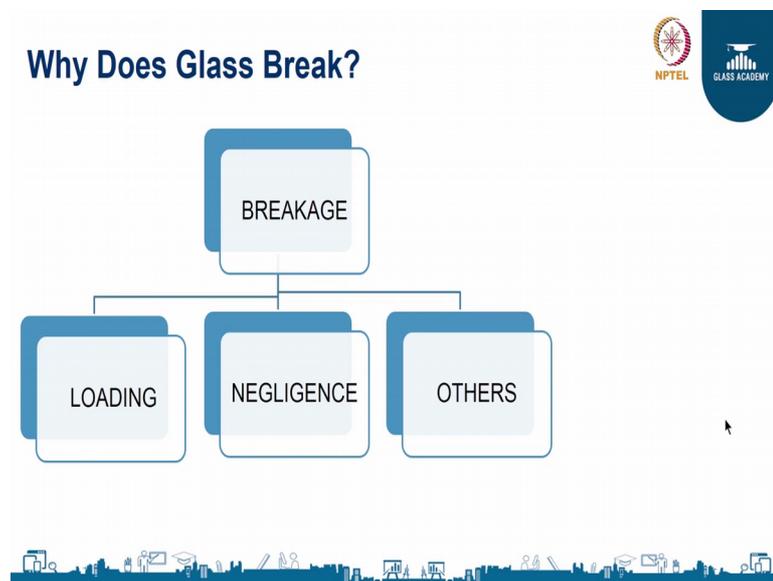


**Glass Processing Technology**  
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**Indian Institute of Technology, Madras**

**Lecture - 63**  
**Glass Breakage Reasons**

Hello friends, my name is Chiranjit Roy; I am the National Manager for Projects and Processing in (Refer Time: 00:27) Indian Private Limited.

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Today I am going to cover various reasons for Glass Breakage. Why does a glass break? Glass can break because of the loading which is may be because of impact, because of wind load, because of negligence, because of our unknown knowledge about glass application, others may be because of different other factors.

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The slide features a flowchart on the left and a speaker on the right. The flowchart starts with a box labeled 'BREAKAGE DUE TO LOADING' at the top. Two lines descend from this box to two separate boxes below: 'FAILURE DUE TO UNIFORM LOADING' on the left and 'FAILURE DUE TO IMPACT LOADING' on the right. The speaker is a man in a dark suit and light blue shirt, positioned to the right of the flowchart. In the top right corner, there are logos for NPTEL and GLASS ACADEMY. A decorative city skyline graphic is at the bottom of the slide.

First we will be discussing on breakage due to loading. So, breakage due to loading can happen because of uniform loading or may be because of the impact loading.

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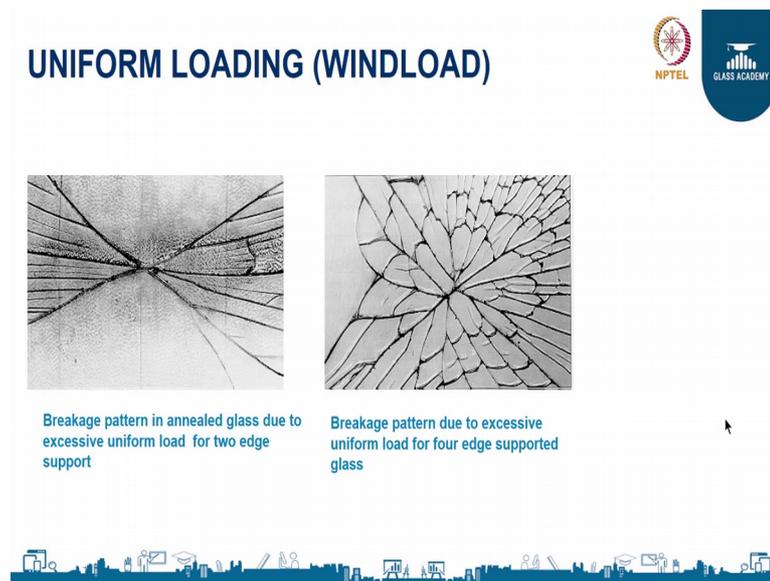
The slide is titled '1. UNIFORM LOADING (WINDLOAD)' and contains three bullet points. The speaker is the same man as in the previous slide, positioned to the right of the text. The logos for NPTEL and GLASS ACADEMY are in the top right corner. A decorative city skyline graphic is at the bottom of the slide.

- Glass thickness should be sufficient to take the uniform load- wind pressure applied over the panel.
- To ensure this, the glass thickness suggested has to be safe, compliant to the following codes:
  - ASTM E 1300/BS 6262/AS 1288 for maximum deflection/stress.
  - IS 875 Part 3 for Wind load.
- If the glass is not decided as per the norms, breakage due to insufficient thickness is more probable.

Uniform loading, what do you mean by uniform loading? May be wind load so, uniform loading is called wind load. So, the glass thickness whatever we are deciding for our building should be sufficient enough to take the uniform load or wind load pressure applied over the panel. And to ensure that the glass thickness suggested has to be safe and compliant to the following codes we have ASTM E 1300 or BS 6262 or AS 1288 for

maximum deflection or stress or IS 875 part 3 for wind load. So, if the glass is not decided as per norms, the breakage due to insufficient thickness is more probable. So, please check the thickness of glass before applying, please check the thickness of glass before putting on the frames.

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Some photographs of glass breakage due to windload. On your monitor on the left hand side, the breakage pattern of annealed glass due to excessive uniform loading for two edge support; on the right hand side, breakage pattern due to excessive uniform load for two edge support take glass system. On your monitor, you can see the glass breakage pattern for annealed glasses. The left hand side is the pattern for annealed glass due to excessive uniform load for two edge support. On the right hand side you can see the breakage pattern due to excessive uniform load for four edge supported glass. So, if the glass thickness is not selected considering the windload, glass might break.

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## WHAT IS THE RIGHT THICKNESS ??

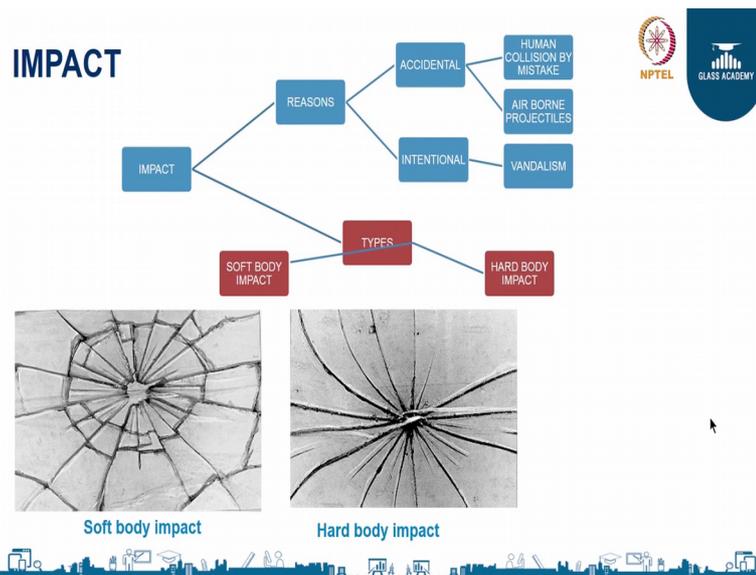


- Following details are required to calculate the right thickness
  - Glass size
  - Fixing details( 2-side/4-side support)
  - Wind load factor



So, what is the right thickness, what do you need to decide on the right thickness of glass? We need what should be the glass size, and how you are going to fix it whether it is 2-side support or a 4-side support, and what is the windload factor that is effecting on the panel. So, there are softwares available which can tell you whether the thickness we have selected is safe or not. So, I recommend you to ask the glass manufacturer for the right thickness of glass.

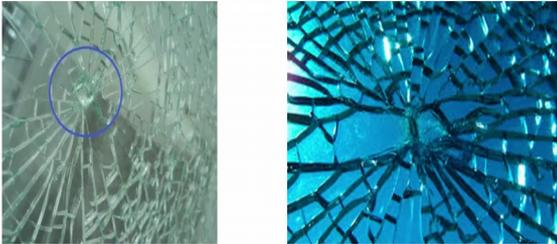
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Second impact, the reasons may be accidental or may be intentional. In accidental there might be human collision by mistake, or there might be some air borne projectiles will be there intentional people can think of vandalism. Types there might be a soft body impact or a hard body impact. You can see on the bottom line glass breakage due to soft body impact on hard body impact.

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**Hard Body Impact**



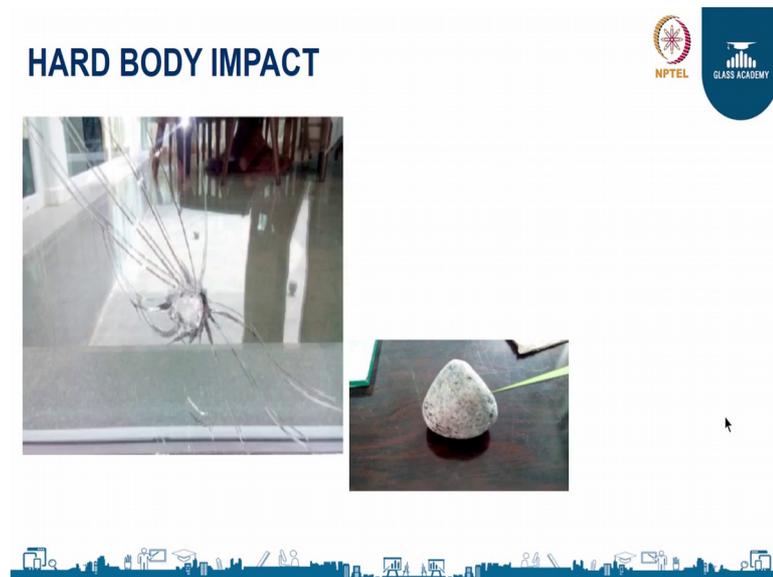
I have some more photographs to show you the different kinds of breakages.

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**HARD BODY IMPACT**

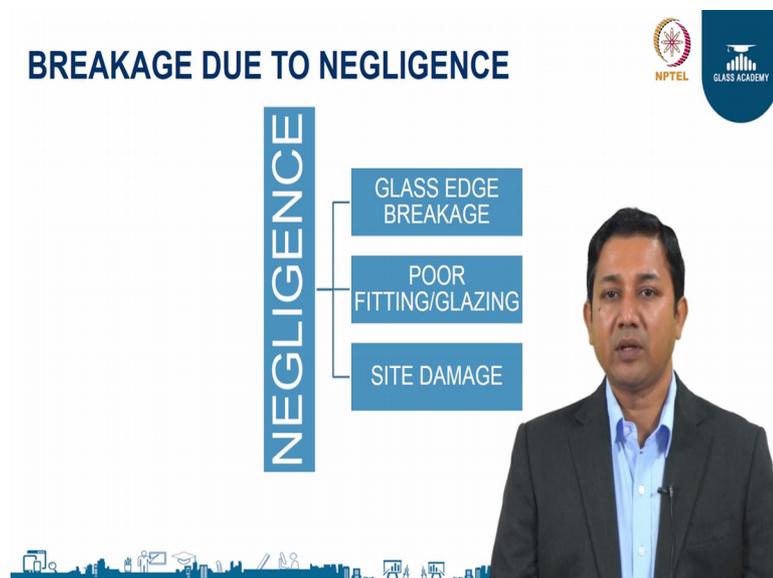


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There are two images of hard body impacts. This one also hard body impact and you can see the hard body impact and the stone which the glass was broken.

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Next comes your breakage due to negligence. This can happen because of glass edge breakage, poor fittings or glazing or site damages.

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## GLASS EDGE BREAKAGE



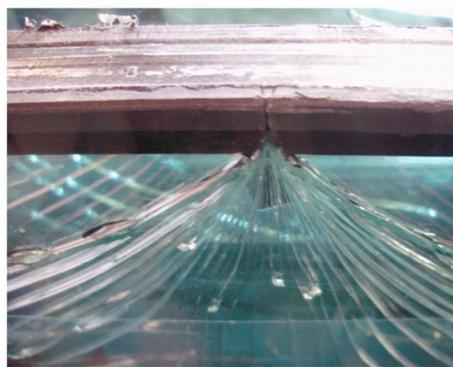
- Caused due to poor handling
- No standard available for checking this
- If glass panels have deep feathers or vents at the edge of panels, it leads to stress concentration.
- Consequently, this stress concentration leads to breakage.



Glass edge breakage it is caused due to poor handling. There are no standards available for checking this. If glass panels have deep feather or vents at the edge of the panel, it can lead to stress concentration at that point, because of this stress concentration there might be a breakage in the glass.

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## GLASS EDGE BREAKAGE



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So, some more photographs so, you can see there are multiple stress when you see there are multiple points are coming out from that; it is very sure there are some vents the glass edge, and there is a stress concentration at that point.

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Poor glazing, there might be insufficient clearance, then we need the gap between glass and the frames, so that there is an expansion and contraction movement happen. Second point is glass size mismatch with the frame; glass should be checked for max size with the frame. If the glass is not fitting, then it should not be grounded or nipped because, when you are doing it, you are creating stress on the edges of the glass and you are not giving any space for the glass for expansion or contraction. So, the glass can break, improper setting blocks, setting block breaks and rigidity must be checked it should not

never be too hard or too soft. So, we have some photographs of glass breakage due to this poor glazing.

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You can see the glass is supported with the plasters there is no clearance for the glass for expansion and contraction, so which will lead to breakage.

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And this you can see the glass is touching the metal in that photographs. So, there is no space for expansion and contraction of that glasses which will lead to breakage.

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Poor glazing you can see the glass people are moving on the edge of the glass surface, which will also lead to breakage of the glass surface in future.

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You can see glass is touching the ground on that surface and there is no space for expansion and contraction. Glass in this photograph you can see glass is directly grouted on the ground without any gasket.

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You can see in the left hand side glass in contact with the marble so, it will break eventually. See in the in the right hand side in monitor, you can see the setting block has come down and creating a pointed load at that point and the glass is broken.

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## POOR GLAZING



GLASS TOUCHING METAL



Again you can see there is no gasket there is a glass to metal contact which can lead to a breakage in this in future.

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## SITE DAMAGE



- Proper care has to be taken such that the following activities do not affect the glass:
  - Welding
  - Grinding
  - Storage
  - Plastering
- Unprepared execution of the above activities shall lead to metal intrusions or damage glass, which in due course will expand and cause crack and shatter.



The next point I am discussing is site damage so, we have to be very careful in the site. So, we have to take proper care such that while doing welding, grinding or storing or plastering process, we should not deposit on the glass surface. So, unprepared execution of the four points might lead to metal intrusions or damage the glasses which in due course will expand and will crack the crack and shatter the glass.

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You can see some photographs of the site where the cement is there on the edge of the glasses. So, in order to remove the cements normally what happens is people will use metals or some abrasive material to remove this cement from the surface which will damage the glass surface and it might create crack in future.

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Again you can see how we have people have stored glasses on this site you can see the glasses are kept on the edges. We have two photographs on the left hand side you can again see cement on the top of the glass surface and on the right hand side you can see

the glasses are kept on rods. As you know for toughened glasses edges are the weakest points. And if you keep without any cushioning material on the bottom, there might be a damage on the edges which might lead to the breakage in the glass.

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Again you can see glasses were kept floors without any cushion. So, see the floor is wet so, there it might damage the glass again on the see there is a glass to there is edge chip due to bad storage.

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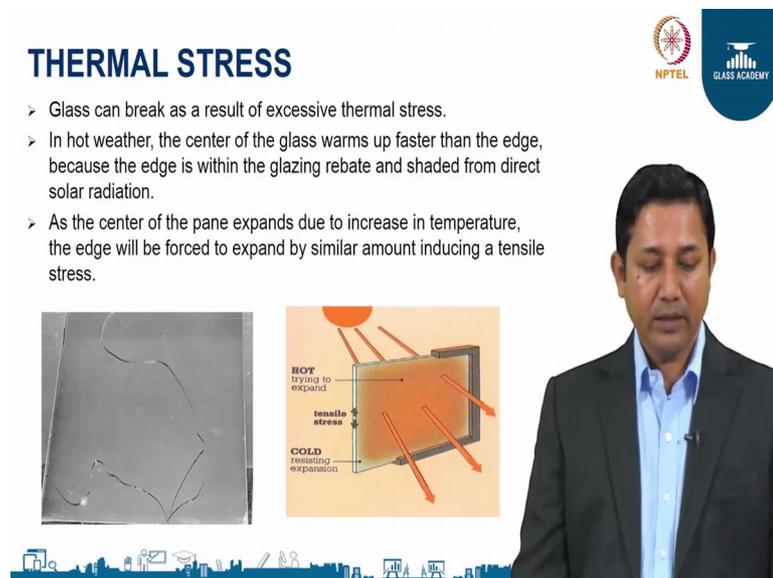


Site damage how to avoid it? So, we have mentioned some of the storage requirement at site. Glasses need to be stored in a dry well ventilated an enclosed places glasses should not be kept in open. All the glass panels need to be stored with proper interleaving cushion need to be provided at the back and at the bottom of the racks. Alkaline products may be emitted from the concrete, plasters, mortar, etcetera such materials or materials containing fluorine and acids will lead to a sustaining or matting of the surface. To prevent such occurrence all such substances must be removed from the glasses immediately. Grease oil and materials used for facilitating the installation must be removed washing tools used for cleaning and glass must be free from abrasives.

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**THERMAL STRESS**

- Glass can break as a result of excessive thermal stress.
- In hot weather, the center of the glass warms up faster than the edge, because the edge is within the glazing rebate and shaded from direct solar radiation.
- As the center of the pane expands due to increase in temperature, the edge will be forced to expand by similar amount inducing a tensile stress.

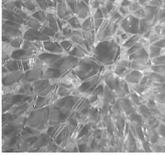


There are other reasons for glass breakage. Now, come to that glass can break as a result of excessive thermal stress. In hot weather, center of the glass becomes hot faster than the edge because your all edges are protected with the frame. As the center of the glass expands due to increase in temperature the edge will be forced to expand in a similar amount that is inducing a tensile stress on the edges and the glass might break.

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## NiS INCLUSIONS

- NiS is one of the inclusions that are inherent in the process of glass making
- These are microscopic inclusions and can't be detected practically
- NiS inclusions are harmless in annealed glass & almost nil in Heat Strengthened glass
- It is harmful in the below cases
  - If located in the tension zone in FT glasses
  - Glasses with higher Surface Compression Stresses
  - Size of NiS is greater than 50microns (0.05mm)

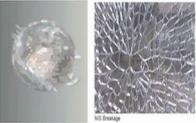


The other reason is NiS inclusions. See, NiS is one of the inclusions that are inherent to the process of glass making and these are microscopic in nature and cannot be detected practically. NiS inclusions are harmless in annealed glass almost nil in heat strengthened. It is harmful in the below cases if it is located in the tension zone in the fully toughened glasses, glasses with higher surface compressive stresses when we are inducing high stress on the glass surface, size of the nickel sulphite is greater than 50 microns.

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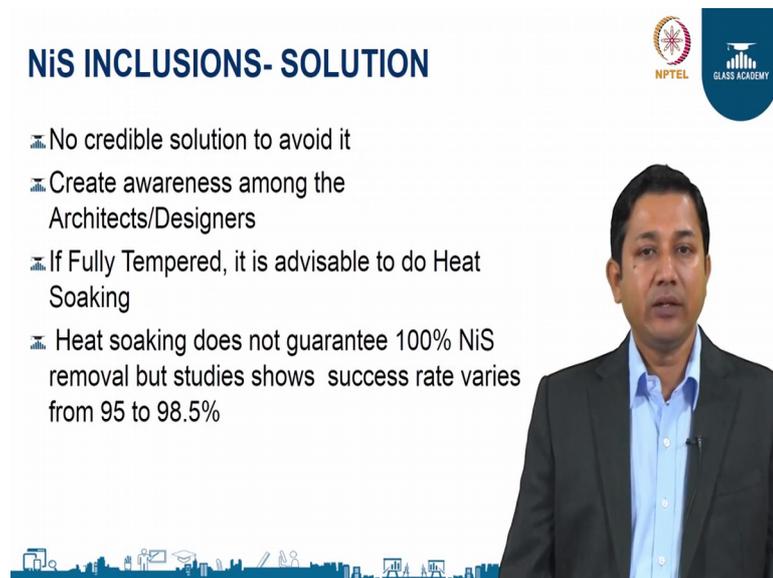
## NiS INCLUSIONS

- Breakage due to NiS inclusions is not the only cause for glass breakage as discussed in the previous slides.
- It is only one of the reasons why Glass breaks.
- Only on the basis of thorough chemical analysis we can conclude that the breakage has occurred due to NiS.
- Normally the pattern of breakage Double D or Butterfly
- The breakage pattern alone cannot decide the cause of breakage is due to NiS. This is because, even if glass breaks by small impact load, it can induce similar patterns.



Breakage due to NiS inclusion is not only the reason for glass breakage as discussed in previous slides, it is only one of the reasons why glass breaks. Only on the basis of thorough chemical analysis we can conclude that the breakage has happened due to nickel sulphite. Normally, the pattern of breakage is double D or a butterfly, you can see in the images, the please understand the breakage pattern alone cannot decide the cause of breakage due to nickel sulphite. This is because even the glass breaks by small impact load, it can induce similar patterns so, we have to be very careful.

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**NiS INCLUSIONS- SOLUTION**

- No credible solution to avoid it
- Create awareness among the Architects/Designers
- If Fully Tempered, it is advisable to do Heat Soaking
- Heat soaking does not guarantee 100% NiS removal but studies shows success rate varies from 95 to 98.5%

The slide features a speaker in a dark suit and light blue shirt on the right side. In the top right corner, there are logos for NPTEL and GLASS ACADEMY. The bottom of the slide has a decorative blue bar with white icons representing various educational and professional fields.

NiS inclusion solutions, there is no credible solution to avoid it the only way is to create awareness among the architects, designers, builders. And if it is a fully toughed glasses it is advisable to do heat soaking; all though heat soaking does not guarantee 100 percent NiS removal, but study shows the success rate varies from 95 to 98.5 percent.

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### **Summary:**

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

- Breakage due to loading  
Thickness of glass, Soft body impact, Hard body impact
- Breakage due to negligence  
Glass edge breakage, Poor Glazing, Site damages
- Other reasons for glass breakage  
Thermal Stress, NiS inclusions, Uneven heat treatment

