Considerations when designing a frameless glass hinged door

Hinged frameless glass doors rely on a minimum of two hinges

The hinges need to be firmly attached to the door & the supporting structure, this can be a wall or even another piece of glass

Hinges need to deal with two forces

Downward force

Horizontal force

The downward force is quite straight forward as it is the weight of the door & is taken as acting through the centre of the width of the door perpendicular to the floor

Horizontal force is created because the door is only secured along one edge therefore creating a horizontal force as the door would rotate around one of the hinges if it were to be released

This horizontal force must be considered when deciding the placement of the hinges.

For glass doors the hinges are only able to resist these forces using friction

The glass is only secured in the hinge with friction provided by the clamping force applied, friction depends on the ability to grip

This means the heavier the door or the wider the door the friction needs to be greater

In a couple of examples, we will try to explain what is happening and demonstrate how hinge placement is important to secure the glass

Example 1

A 10mm thick glass door 2000mm tall by 800mm wide is to be secured using two hinges, the door will weigh 40kg (glass weighs 2.5kg per mm glass thickness per M²)

So, we can see 2M X .8M X 2.5 X 10 =40kg

If the hinges are placed equally 200mm in from top & bottom the distance between the hinges will be 1600mm the door is 800mm wide, so the centre of its weight is 400mm across the door

Because the door will always weigh the same the hinges will be carrying a vertical load of 40kg between them and if everything is perfect they will share the weight i.e. 20kg each, however the horizontal forces are opposite to each other. The top hinge

needs to prevent the door from falling away from the hinge side and the bottom hinge needs to resist being buried in to the wall or glass panel holding it.

So, we have to provide a resistance to this from happening

The top hinge is therefore carrying 20kg vertically and 10kg horizontally

The only thing helping us resist these forces is friction

That is the friction between the clamping element on the hinge and the glass

That's 30kg of force simply by friction

Consider picking up a heavy shiny dinner plate on its outer edge with grippy gloves, it would not need a huge gripping force to provide enough friction to lift it

Now try picking up that same plate with wet soapy fingers, you will need to apply a lot more pressure to obtain the same amount of friction in order to stop it slipping and falling

That is exactly what the clamping plates are doing to stop the door from slipping

Example 2

A 10mm thick glass door 2000mm tall by 800mm wide is to be secured using two hinges, the door will weigh 40kg

If the hinges are placed equally 300mm in from top & bottom the distance between the hinges will be 1400mm the door is 800mm wide so the centre of its weight is 400mm across the door

Because the door will always weigh the same the hinges will be carrying a vertical load of 40kg between them and if everything is perfect they will share the weight i.e. 20kg each, however the horizontal forces are opposite to each other. The top hinge needs to prevent the door from falling away from the hinge side and the bottom hinge needs to resist being buried in to the wall or glass panel holding it.

So, we have to provide a resistance to this from happening

The top hinge is therefore carrying 20kg vertically and 11.4kg horizontally

That is now 31.4kg of force to deal with

Example 3

A 10mm thick glass door 2000mm tall by 900mm wide is to be secured using two hinges, the door will weigh 45kg

If the hinges are placed equally 200mm in from top & bottom the distance between the hinges will be 1600mm the door is 900mm wide, so the centre of its weight is 450mm across the door

Because the door will always weigh the same the hinges will be carrying a vertical load of 45kg between them and if everything is perfect they will share the weight i.e. 22.5kg each, however the horizontal forces are opposite to each other. The top hinge needs to prevent the door from falling away from the hinge side and the bottom hinge needs to resist being buried in to the wall or glass panel holding it.

So we have to provide a resistance to this from happening

The top hinge is therefore carrying 22.5kg vertically and 12.66kg horizontally

That is now 35.21kg of force to deal with that's a 17.25% increase for a 12.5% increase in weight

Example 4

A 10mm thick glass door 1700mm tall by 900mm wide is to be secured using two hinges, the door will weigh 38.25kg

If the hinges are placed equally 200mm in from top & bottom the distance between the hinges will be 1300mm the door is 900mm wide, so the centre of its weight is 450mm across the door

Because the door will always weigh the same the hinges will be carrying a vertical load of 38.25kg between them and if everything is perfect they will share the weight i.e. 19.125kg each, however the horizontal forces are opposite to each other. The top hinge needs to prevent the door from falling away from the hinge side and the bottom hinge needs to resist being buried in to the wall or glass panel holding it.

So, we have to provide a resistance to this from happening

The top hinge is therefore carrying 19.25kg vertically and 13.24kg horizontally

That is now 32.36kg to deal with.

It can be seen that just knowing the weight of the door is not the only thing to consider when initiating a design, the variables are many between width of door, height of door, placement of hinges & number of hinges.

Adding a centre hinge for example will only help carry the vertical load and also on tall doors assist with preventing deflection.

Rules

The distance between the hinges must always be at least double the width of the door or greater
The door must not exceed 900mm in width

Before attaching the hinges make absolutely 100% certain the glass is clean & completely free of any surface coatings or polishes for example anti lime scale coatings as this will resist friction & the glass can slip after installation even though the screws are tightened correctly

Also make certain the clamping screws are tightened to the correct torque, in most instances this is an M6 countersunk screw that needs to tightened to 8nm to 10nm

Also the screws will need to be tightened at least 3 times to achieve this as the gaskets compress during tightening, it will be noticed by alternating between the screws as they are tightened.

Summary

If you increase the height of the door (and/or the distance between hinges) & keep the width the same, it has a **positive** effect on the load capacity of the hinges;

If you increase in the width of the door keeping the height the same it has a **negative** effect on the load capacity of the hinges;

It is not true that mounting 3 hinges gives you a 50% increase in load capacity or that installing 4 hinges doubles the capacity

So How many hinges carry the load of the door?

If we agree that two hinges carry 40 kg, can we assume that 4 hinges will carry 80 Kg. **NO**

Hinges that carry the weight of a door and which are affected by the greatest efforts are always the Top & Bottom:

the top hinge resists Horizontal Tension forces

the bottom hinge resists Horizontal compressive forces

both hinges resist vertical forces, i.e. the force of gravity (g).

Why is my door dropping?

The door is too heavy or wide for the designed limits of the hinges selected

The hinge clamp plate screws have not been tightened to the correct torque

The glass or gaskets were not clean during installation