Welding Engineering

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Module - 6
Design of weld joints
Lecture - 3
Edge preparation

So, dear students this is the third lecture on the design of the weld joints. And in this lecture we will be mainly focusing on the different types of the edge preparations, which are used for developing the sound weld joints, so that the full penetration weld joints can be produced. In the previous lecture based on this topic we have talked about the different kind of different types of the weld joints, and the different types of the welds which are commonly used for developing the weld joints.

We know that that for developing the full penetration weld joints it is necessary that whatever, heat is applied from the top that should be in position to cause the through thickness melting. So, that the full penetration weld can be produced, but in case of the thick sheets, when thick plates are to be welded application of the heat from the top does not help in melting the edges of the plates through the thickness, and that is why it does not help in getting the full penetration weld.

So, for those situations it becomes mandatory to prepare the edges of the plate so that proper axis to the heat source can be provided. So, that melting of the faying surfaces of the base metal up to the root can be ensured, and that is why it becomes necessary to prepare the edges of the plates to be welded. In this presentation we will be talking about the various aspects related with the edge preparation and their selection. So, first of all we will be talking about the technological aspects.

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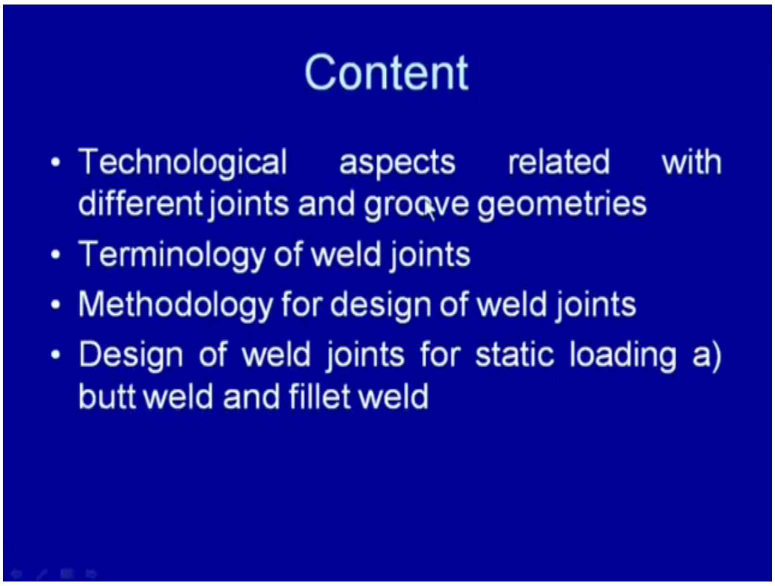

Related with the different joints, how they do the effect the mechanical performance of the weld joints, if they selected like the butt weld joint, the fillet weld joint and how the groove geometry affects the performance of the weld joints. For example, we have a square groove, V groove, U groove, J groove are then the and the double U, V, J groove geometries. So, each type of the groove geometry offers its own advantages and disadvantages each, and accordingly each type of the groove geometry in respect of the technological aspects related with them will be discussed one by one.

Thereafter, we will see what how we can define the different terms related with the weld joints like the width of the weld bead be it reinforcement, penetration. And the different parameters which are used for defining the weld bead geometry and the different parts of the weld. Thereafter, we will see that what methodology we can use for designing the weld joint and then we will take of finally, the design of the weld joint for static loading for and that will being taking up for two types of welds that is spot weld, and the fillet weld.

We know that the that various types of the edge preparations are carried out to ensure that through thickness melting takes place for developing, the full penetration weld joint. And these preparations may be of the square groove or single U, single V, single J, bevel double U, double V and double J joints. And accordingly these groove geometries can be seen from this diagram.

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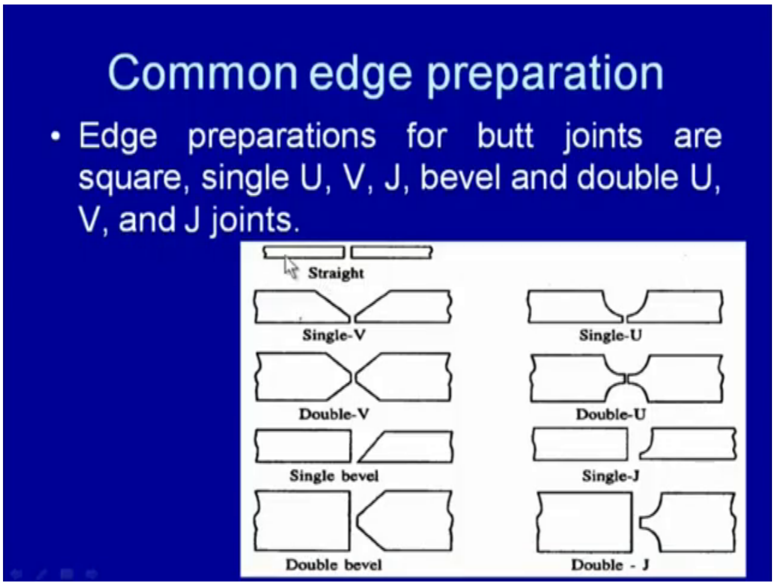

When the two plates are prepared just to have a square edges, and brought together with certain space it forms the square groove geometry. And when the both edges of the plates are beveled to form the single V, and when the V kind of the geometry is obtained on both the sides of the plates then it forms the double V. And beveling is done when the one only one side of the plate and other side of the plate, or edge kept square then it forms the single bevel. And when beveling is done in both the sides of one plate while one another plate is kept square, then it forms the double bevel, double bevel.

And when the half U shape is produced in one side of the plate, and another half U is prepared in another edge of the plate. Then when the two plates are with these kind of geometries are brought close to each other it forms the single U and the similarly, when the plates are both upper, and the lower surfaces at the edges are prepared for having the single U, in one side and means one U in one side and another U in the bottom side. Then it forms the double U groove geometry and then the J when one side of the edge of one side of the plate is prepared to have the J kind of geometry, while another kept as a straight and a square then it forms the single J.

Similarly, we can have the preparation of the one plate for having the J kind of geometry, in both the sides of one plate, then it forms the double J each type of the groove geometry offers the specific features in respect of the amount of the weld metal, which is required to develop the weld joint residual stress and distortion tendency, welding speed and the amount of heat which is required for melting, the faying surfaces.

And access to the root of the grooves, these are the factors that are affected by the selection of these groove geometries. So, the different groove geometries will be critically assessed from these characteristics point of view, and we will find that each type of the grove geometry will have certain advantages in respect of certain characteristics, while disadvantages on in respect of some other characteristics. So, we will be starting with the single grove geometries single groove geometries.

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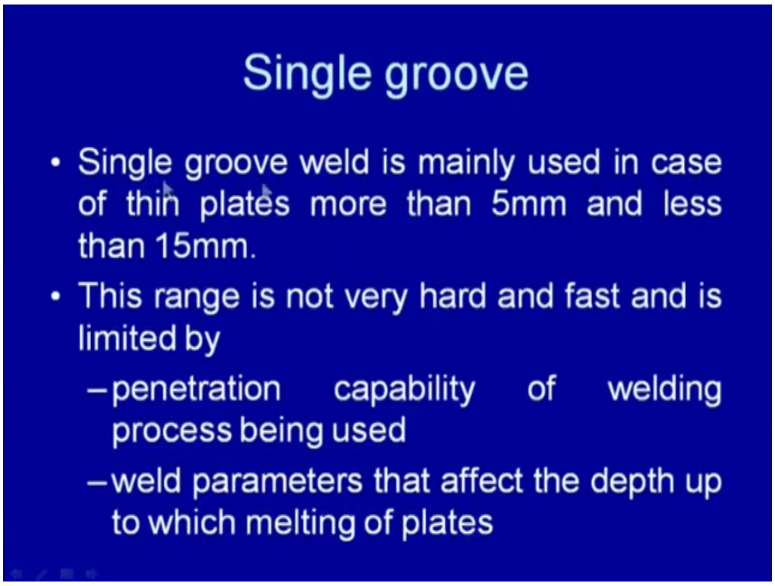

We will have the single groove weld which is mainly used in case of the thin plate, where the groove is made in just one side means only upper side of the plate. And this may be in the form of the single V, single U or the single J and this kind of the geometry is mainly used for the plates of thickness greater than 5 mm, and less than 15 mm. However, this range is not found to be very hard and fast because it is governed by the kind of penetration, which will be possibly using a particular process which is to be used.

So, the factors that predominantly govern this range up to which the single groove geometry can be used is determined, or limited by the penetration capability of the welding process being used, and the kind of parameters which are being used for development of the weld joints, because the range of parameters which will be used for developing the weld joints will directly be affecting, the depth of penetration. And in general the welding current in case of arc welding processes becomes, the main parameter that affect the penetration capability.

So, for a given if we are using the high heat input process like SAW with the high current carrying capacity. For example, 1000 ampere or 15 ampere then it will offer the higher penetration capabilities and in that case, we can work even with the single groove geometries up to the 15 to 20 or even up to the 25 mm thickness, with the full penetration weld. So, depending upon the penetration capability we can use the single groove weld for the different thicknesses. However, it is common to use the single groove geometries in range of 5 to 15 mm thickness for the thicknesses lesser than the 5 mm normally, the square groove geometry is preferred.

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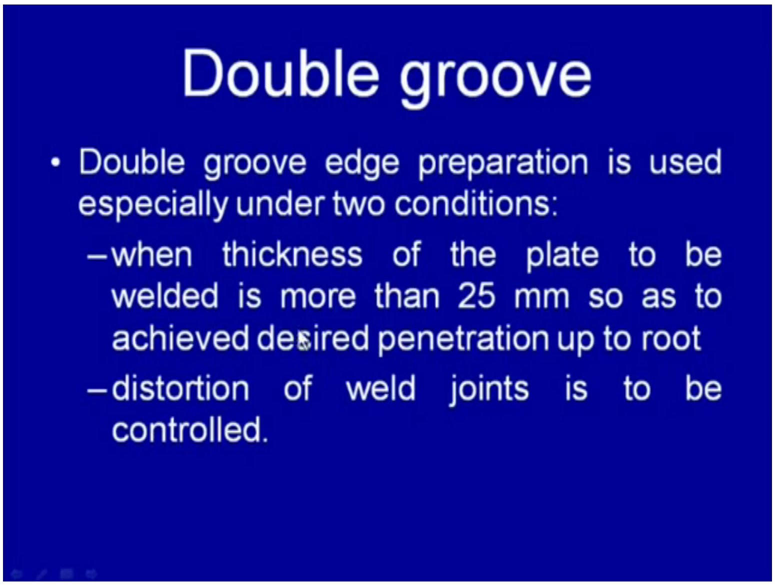

The double groove geometry like double V, double J, double V groove geometries are used under the two conditions. When the thickness of the plate is generally, greater than 25 mm so that the required penetration up to the root can be achieved from both the sides, and the distortion of the weld joint is to be minimized. So, for those situations where the application of the weld metal just from one side, has the tendency to distort the plate out of the position.

So, for those situations the double groove geometries are used where weld metal is deposited in sequence one by one from first on the upper side then on the lower side. And this kind of sequence is maintained until the whole of the weld, weld groove is completed. So, mainly for those situations where distortion is to be controlled double V groove, double groove geometries are used. And another situation where the plate thickness is greater than the 25 mm, then in order to ensure the penetration up to the root the double groove geometries are used. So, these are the basically two situations where double grove geometries are preferred.

Further advantage related with the double groove geometries is that the volume of the weld metal, which is to be deposited for developing the weld joint of the greater thicknesses becomes lesser as compared to the single groove geometries. So, these other aspects related with the advantages and disadvantage of the single groove, and double groove geometries we will be talking up in the coming slides.

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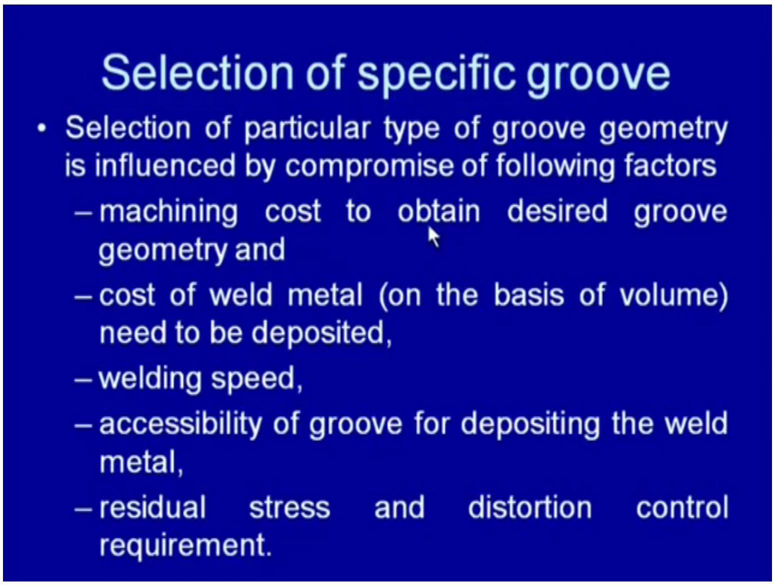

Now, the selection behind the specific kind of the groove geometry, for edge preparation is governed by the many important factors that affect the total economics of the edge preparation. And the factors that affect the cost of developing a weld using a particular kind of the groove geometry is governed by the machining cost, which is required for developing a groove geometry, it is commonly found that the single sorry V groove geometries can be developed easily at low cost, while difficulties are encountered, while developing the J and the U groove geometries.

So, the machining cost increases for those cases and the U square groove geometries are found to be of the minimum cost means, they can be developed at minimum cost. Then another important aspect is the cost of the weld metal, which is to be deposited and it is directly related with the volume that should be deposited for developing a weld joint. So, all those geometries that help in reducing the volume of the weld metal to be deposited they will be beneficial in respect of the cost of weld metal to be deposited. And in this aspect if we see then a single J, single U, groove geometries will be beneficial as compared to that of the single V geometries, especially in case of the thicker welds.

So, the cost of the weld metal will be affected by the kind of the groove geometry, which is being used. And similarly, weld speed weld speed is found to be higher for those groove geometries where weld metal to be deposited is lesser. Then the other groove geometries and because of this U and the J groove geometries, offer the higher welding speed because they reduce the volume of the metal to be deposited, for developing the weld joint, for a given plate thickness. Another important aspect that effect the selection of the specific groove is the accessibility of the groove for depositing the weld metal.

Sometimes it becomes difficult to apply the weld metal in the desired location especially, in case of the complex groove geometries like U and J. And because of this there may be possibility that due to the lack of accessibility of the groove up to the root some un fused portion can be left, where the proper melting cannot take place and that can lead to the either un welded portion, or the portion with the lot of stress risers which can decrease the strength of the weld significantly. So, for there are certain groove geometries like the U and the J they adversely affect their accessibility.

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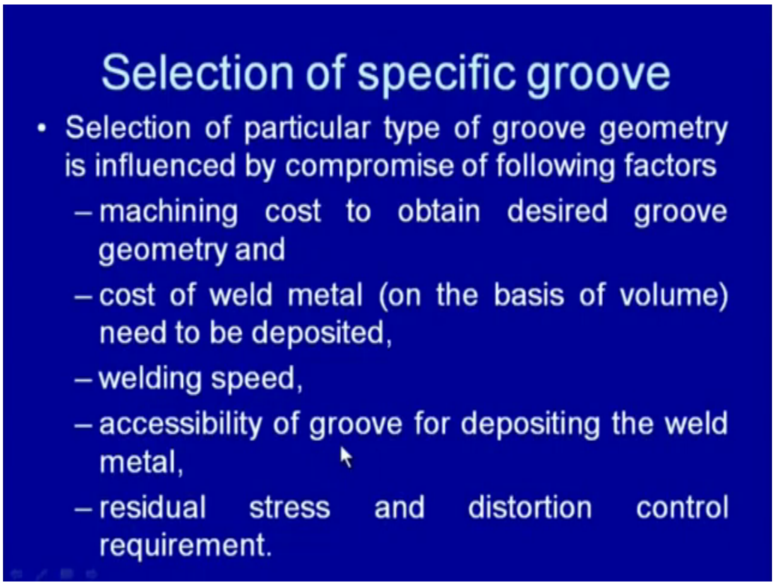

Of the accessibility of the root of the groove, for depositing the weld metal while the V groove geometry offers the better accessibility for up to the root of that groove, for depositing the weld metal and to bring that to the molten state. Then the residual stress and the distortion control requirements, we know that the single V groove geometry will be single V groove geometries require greater amount of the weld metal to be deposited. And because of the larger volume of the weld metal requirement, the greater expansion and contraction is experienced by the weld metal and the heat effected zone, and that in turn results in the greater residual stresses, and the distortion tendencies in the distortion tendencies of the weld joint.

So, those were weld those groove geometries which help in help in reducing the volume of the weld metal to be deposited, or they will be reducing the residual stress and the distortion related problems. Further the distortion related problems are more encountered in case of the single groove geometries like single V and the single J. So, for those situations it is preferred to go for the double V, double U and double J groove geometries. So, we can see that the selection of the specific groove geometry will be dictated by the machining cost, which is associated with the particular groove geometry.

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The cost of the weld metal that is to be deposited when particular kind of groove geometry is used the welding speed, which is obtained that in turn affects the productivity and the accessibility of the groove for depositing the weld metal, and to bring that up to the molten state. Especially, in case of the root of the groove and how the residual stress, and distortion related problems are associated with the particular kind of the group geometry. So, these factors significantly affect the selection of the specific groove geometry. Now, we will be taking up the one by one the each type of the groove geometry with the positive and negative sides we know that the application of the U.

And the J groove geometries are found better than the V, and the bevel groove geometries because the, these U and J groove geometries offer many advantages, over the V and the bevel group geometries. And that those benefits are especially, obtained in respect of the low volume of the weld metal to be deposited with the U, and J groove geometries as compared to the V and bevel grooves.

Similarly, the distortion residual stress problems are less because the less volume of the weld metal is to be deposited, in case of the U and J groove geometries. And similarly, the welding speed is found high as the less volume of the weld metal is to be deposited for developing the weld Joint of a given thickness, but there are many other bad sides related to the with these groove geometries and these are like difficulty.

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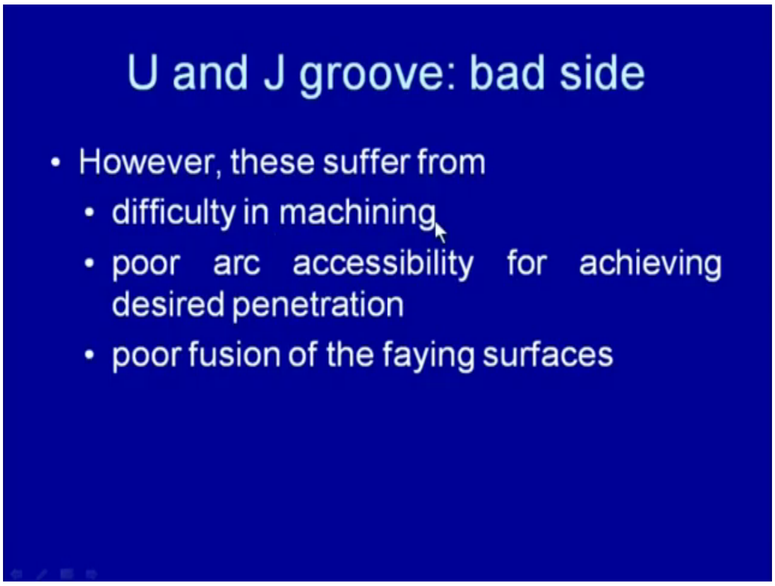

In machining it is found difficult to achieve the U and the J groove geometries on the edges of the plates that are being prepared for, and developing these groove geometries further accessibility of arc up to the root of, and the groove becomes difficult for these U and J groove geometries, and because of the poor accessibility fusion of the faying surfaces especially, at the root becomes difficult when these groove geometries are used.

So, but many times due to the very good advantages related with the U and J groove geometries these preferred. Especially, for especially when the residual stress problems are more and the higher welding speed is to be achieved, but they are apart from those disadvantages related with the V, and the bevel groove geometries there are many good sides related with these geometries. And the positives of the bevel and the V groove geometries include the easier edge preparation either by machining or the flame cutting, because very straight cut is made for developing the bevel, and the V groove geometries and that can be done very easily by machining and the flame cut machining, or the flame cutting. So, the cost of developing the groove geometries the these V and bevel groove geometries become slower as compared to the J, and the V grove J and the U groove geometries and further.

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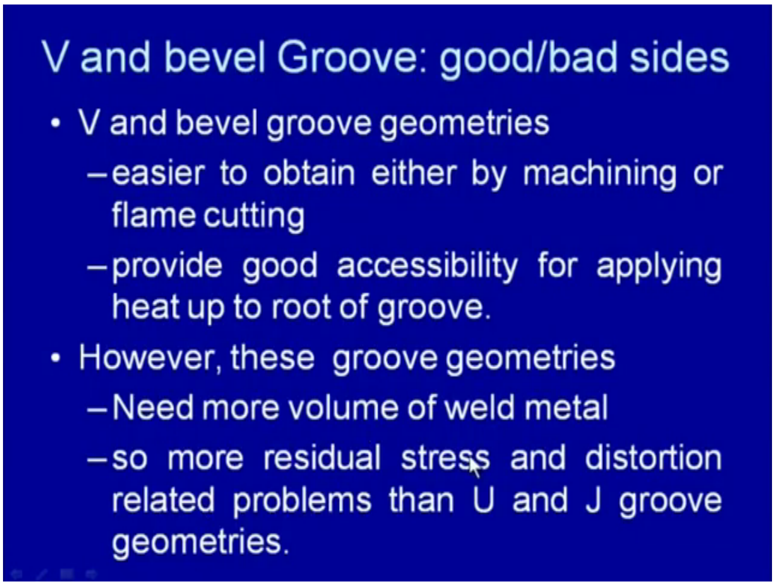

Because of the wider opening from the top accessibility of the arc, and the heat source becomes good up to the root of the groove. And so the chances related with the lack of fusion and the deposition of the weld metal up to the root related problems are reduced with the bevel and the V groove geometries, so as far as positives are concerned easier to obtain by machining and the flame cutting, and the good accessibility of applying the heat up to the root of grooves. In order to ensure them they are melting up to the bottom so as to obtain the full penetration weld joint easily, but these groove geometries suffer with the many undesirable aspects, like the volume of the weld metal to be deposited with these groove geometries is more.

So, the there will be more problems related with the residual stresses distortion as compared to the case of J and the U groove geometries. So, because of these two undesirable effects especially, in case of the thick plates the especially in case of the thick plates the U and the J, J groove geometries are preferred. Another important thing due to the requirement of the large volume of the weld metal to be to be deposited for developing the weld for developing the weld joint.

Especially, in case of thick plates the welded welding speed is reduced, and which in turn with the V and bevel groove geometries the productivity is reduced. So, the undesirable aspects related with these groove geometries include, the large volume of the weld metal to be deposited, for developing the weld joint, and the more residual stress and distortion related problems. Then the V groove geometry, square groove geometry is one of the most preferred kinds of the geometry especially, in case of the thin sheets, which are lesser than the 10 mm.

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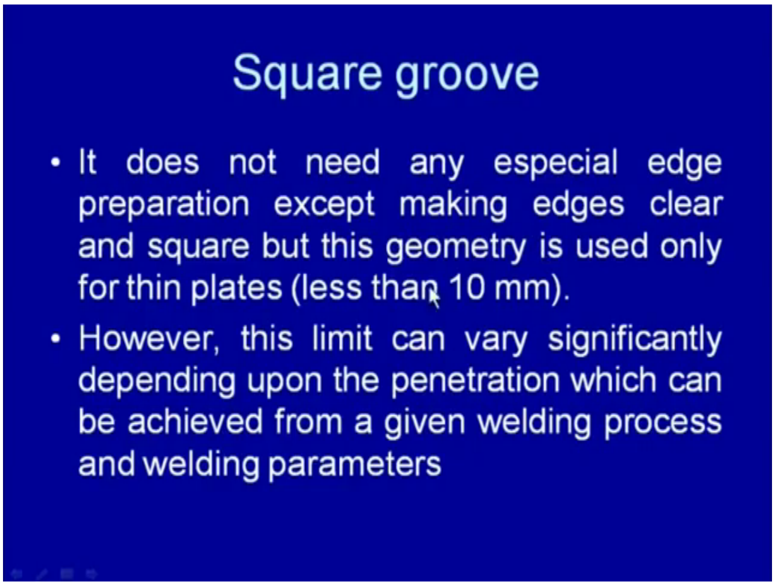

However, this limit of the 10 mm can vary significantly depending upon the penetration, which can be achieved from a given process using a given set of the welding parameters. The most preferred, this geometry is preferred because the cost of the edge preparation with this kind of the groove geometry is minimum. And the volume of the weld metal to be deposited with this kind of the geometry is also minimum, but the penetration is the only factor that limits the thickness up to which the square groove geometry can be used. So, those welding processes with the high penetration capability, and which can use the higher current they can work with the square groove geometry, even with the thicker plates.

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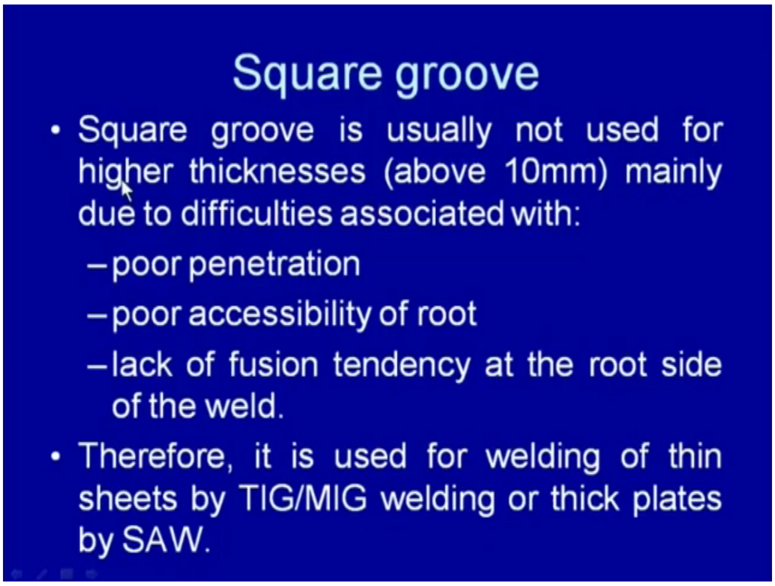

So, a square groove geometry is usually not used for the higher thicknesses above 10 mm mainly due to the difficulties associated with the poor penetration. So, due to the limited penetration capability with the above the 10 mm this a square groove geometry is usually not used this. So, this is one reason that the use of the square groove above 10 mm is not preferred because it reduces the penetration, or the poor penetration is achieved. Further the accessibility poor accessibility of the root means, the melting up to the root and becomes difficult. And we cannot means it becomes difficult to apply the weld metal right up to the root of the plate, which is being welded.

And the lack of fusion tendency at the root of the weld makes the weld joint weaker because these unwelded and unfused portion, on the root side acts as a stress region which significantly, reduces the mechanical performance of the weld. And therefore, the square groove geometry is mainly, used for welding of the thin sheets by the processes like the that is the tungsten inert gas, or the metal inert gas welding process, or the thick plates only by the submerged arc welding, which is the high penetration welding process and uses very high level of current which can be as high as 2000 amperes.

So, why groove welds are proffered as compared to the other the fillet welds, that is what will be seen like. So, this will be indicating the effect of the groove geometries and the type of the joint which is being selected for development of weld joints on the mechanical performance. So, we know that the groove, groove butt welds are mainly used for the general purpose and for the critical applications, where that tensile and the fatigue load can take place during the surveys.

So, it is common to use the butt groove weld joints because this kind of the geometry means, this kind of joint results in the better tensile and the fatigue loading performance as compared to the fillet weld joint. These groove geometries result in the minimum stress concentration and stress is stresses are uniformly, distributed across the section of the weld joint. And because of this reason the crack nucleation, and its propagation tendency is found minimum. Especially, under the tensile and the fatigue load conditions and that is why.

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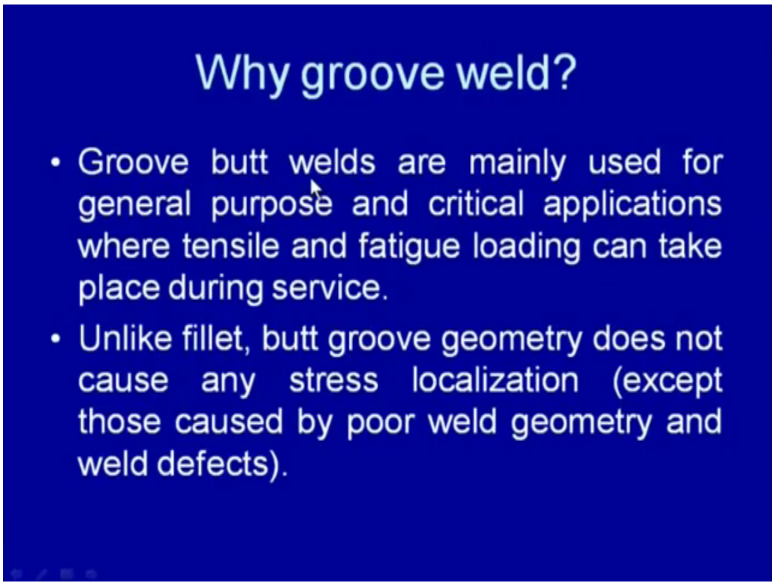

The groove butt welds are mainly used for the critical applications, where the tensile and the fatigue load can take place during the surveys. Unlike the fillet the butt groove geometry does not cause any stress localization, accept those caused by the poor weld bead geometry and the weld defect. So, if the weld is sound and weld bead profile is perfect then inherently, the butt groove geometry does not cause any stress localization which can help in the easy nucleation, and growth of crack and because of this a very good side of the butt groove geometries. The tensile and fatigue loading performance of the butt groove geometries is found much better as compared to the fillet welds.

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Therefore, stresses caused by the external loading with the butt groove geometries stresses caused by the external loading largely becomes uniform, across the section in the groove weld. Hence, the fatigue crack nucleation and subsequent propagation tendency is significantly lowered in the butt weld butt groove weld, as compared to the fillet weld and other types of the weld.

And because of this unique feature associated, associated with the butt groove welds. These are preferred for those services where, the loading can be dynamic in nature and high tensile load can act during the service, because this kind of geometry, offers the advantage of having uniform stress distribution across the cross section. And it discourages any kind of localization of these stresses, which can nucleate the crack and cause the easy fracture. So, and because of this the butt groove geometries offer the better tensile and the fatigue load performance as compared to the fillet, and other types of the weld. While the fillet welds are used for producing the lap joint, edge joint and the T joint especially, in case of the non-critical applications.

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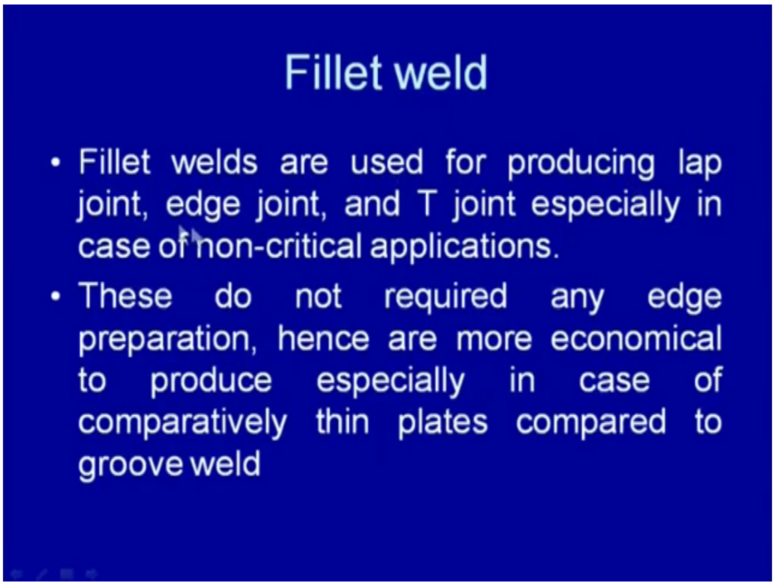

These fillet welds do not require any edge preparation and hence, found more economical to produce. Especially, in case of the comparatively thin plates as compared to the V groove welds. So, the advantage side of the fillet weld is that they do not require special edge preparation to deposit the weld metal, and just the edges of the plates and the surfaces are made a square. And the weld metal is deposited by melting the surface of the base metal directly without any edge preparation, and because of this advantage.

And these are found economical as, but these kinds of the weld are specially used for joining the thin plates, and if the critical joints are to be made for very special applications of the thin plates. Then the groove welds are used because the fillet welds have the inherent, the stress riser feature which easily, nucleates and nucleates the crack and facilitate their easy growth, under the dynamic loading conditions. And that is why for critical applications the fillet welds are not used. So, because of the advantage of no requirement of the edge preparation these are found to be economical, especially for developing the joints of the thin plates. So, if we compare the thin fillet welds and the groove welds, as far as the weld volume is concerned.

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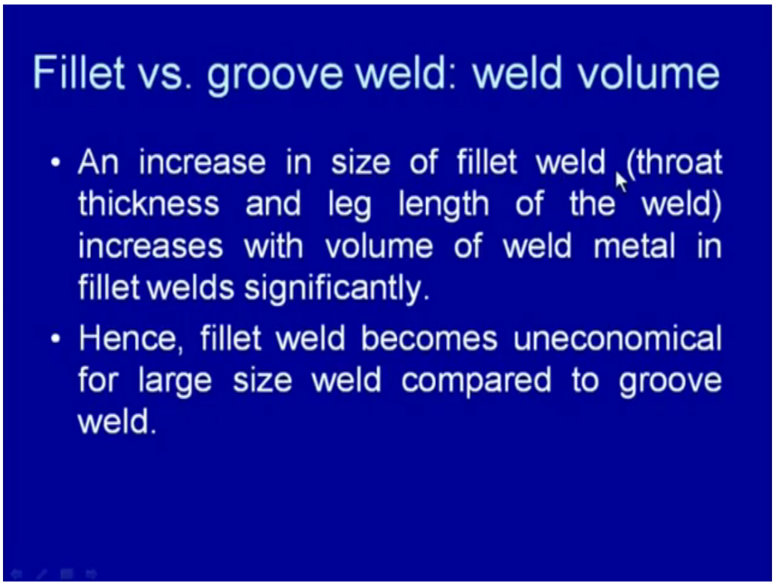

An increase in size of the fillet weld increases the volume of the weld metal significantly, but with the increase in the thickness of the plate, the volume of the weld metal does not increase in case of the groove weld that much. So, for the small size weld the volume of the weld metal deposited in case of the fillet weld is found to be less, but if the weld if the large size fillet is to be made, then the volume of the weld metal to be deposited for the fillet welds increases significantly. Hence, the fillet welds becomes uneconomical for the large size weld as compared to the groove weld. So, for understanding this we will be using one diagram here we can see if the fillet.

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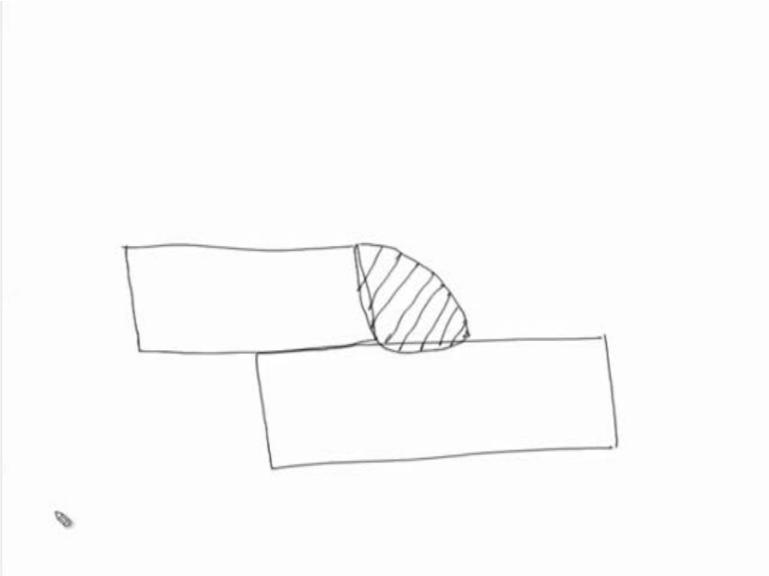

If the these are the two plates to be welded, for developing overlapped joint using the fillet weld. Then the fillet weld will be made like this by depositing the weld metal. So, the volume of the weld metal for depositing the thick plates, this becomes significantly greater if the thickness of these two plates is more as compared to the case.

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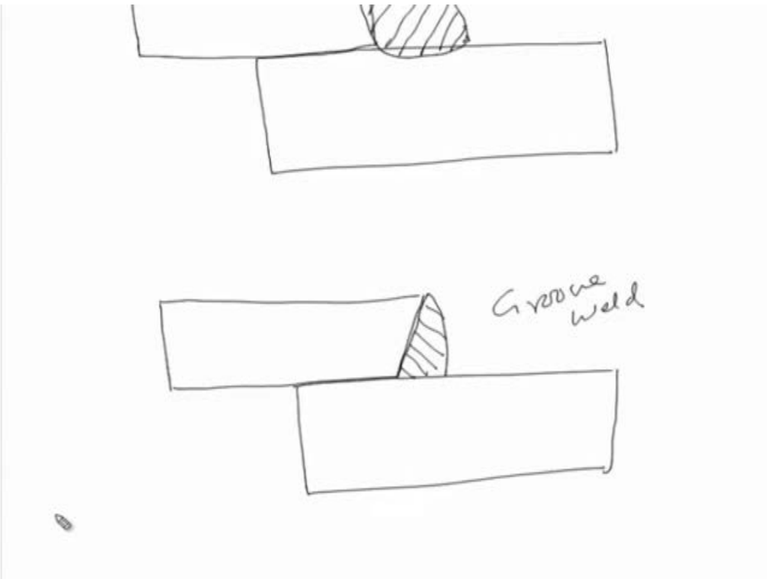

We can prepare the edges of the plates in bevel we can give slightly beveling to the edges of the plate, and then the same lap joint for the same thickness and the weld metal can be deposited like this for developing the weld. So, this is the kind of the lap joint being made using the groove weld, and this is the lap joint being made using the fillet weld. So, in case of fillet weld we do not require any edge preparation only the surface and the edges are made square.

While in case of the groove weld the say for this bevel groove weld the one edge will be beveled slightly, and then weld metal will be deposited. So, in this case when the so what we want to say that if the size of the fillet weld is increased significantly, then it requires the large volume of the weld metal, but with the groove welds increase in size does not increases the volume of the weld metal to be deposited appreciably. So, this is the advantage related with the groove weld as far as the weld volume of the weld metal to be deposited for thick sheets.

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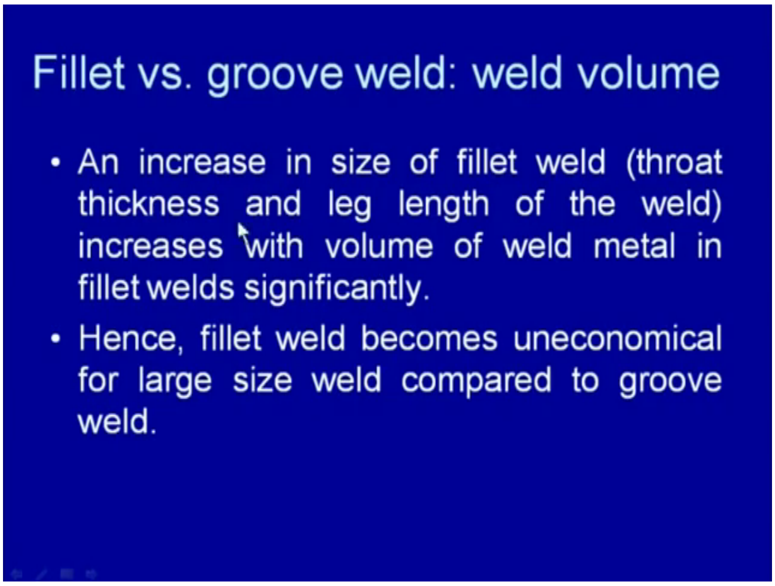

So, see an increase in size of the fillet weld in terms of the throat thickness, and the leg length of the weld in this the size of. So, increase in size of the fillet weld increases the volume of the weld metal deposited volume of the weld metal in the fillet weld increases significantly. And hence, the fillet weld becomes uneconomical for large size weld as compared to the groove weld, for large size welds. The groove weld does not increase the volume of the weld metal to be deposited significantly, and that is why it becomes economical, but the there will be associated edge preparation cost with the groove welds.

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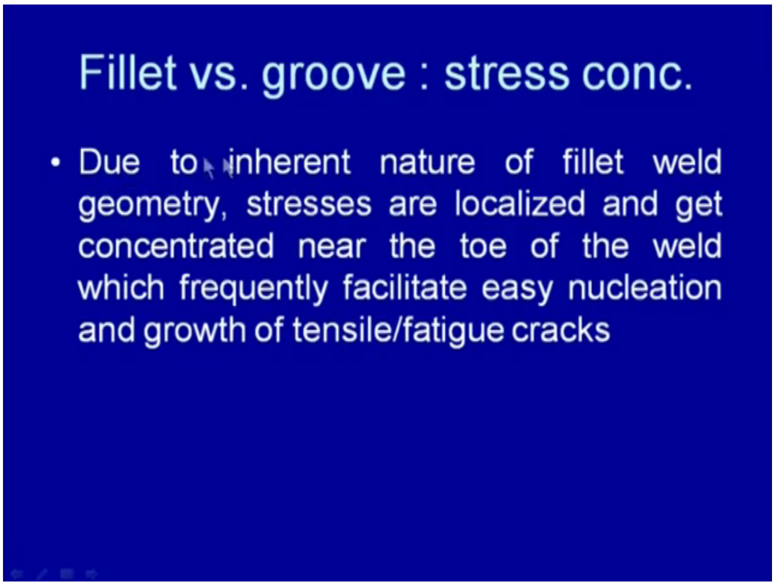

So, due to the inherent nature of the fillet weld if we try to compare the fillet weld, and the groove weld in respect of the stress concentration possibility. Then due to the inherent nature of the fillet weld, geometry their stresses are localized and get concentrated near the toe of the weld which frequently, facilitates the easy nucleation and the growth of crack especially under the tensile and the fatigue load conditions. Means, if we if we see this diagram.

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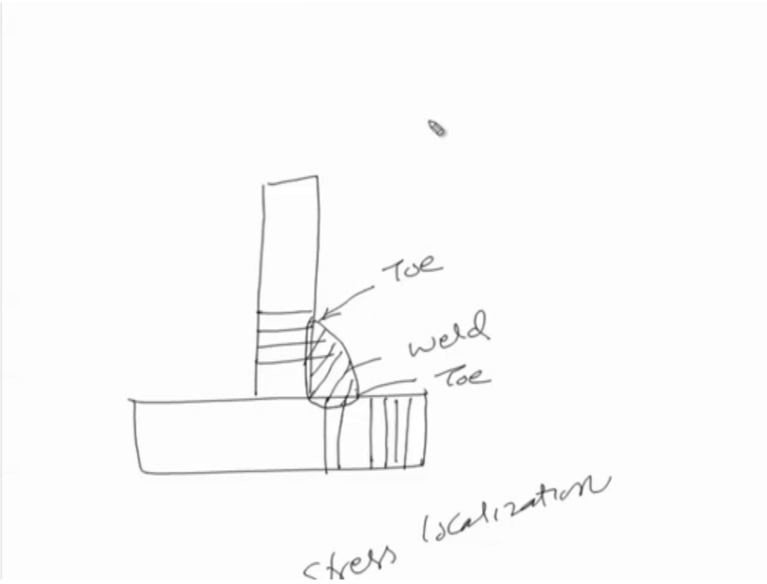

Fillet weld being made between the 2 plates in form of the T joint, when it is made normally by little melting of the base material on both the sides. So, this is the weld and the junction of the weld with the base material is called the toe of the weld. So, this toe of the weld we have abrupt change in cross section of the load resisting cross sectional area. Say in this case here there is a sudden increase in cross section here, we as soon as we come across the weld and similarly, there is a sudden increase in cross section here in both the sides.

So, if we see as soon as we come across the weld there will be sudden increase in cross sectional area, as soon as we come closer to the toe of the weld and before that the distribution of stresses will be uniform. So, because of this inherent feature related with the fillet weld at the toe stress localization invariably stress localization, or stress concentration invariably takes place. And when the external loading is done which is of the dynamic in nature, then crack cracks tends to nucleate easily at the location of this toe, while in case of the groove weld.

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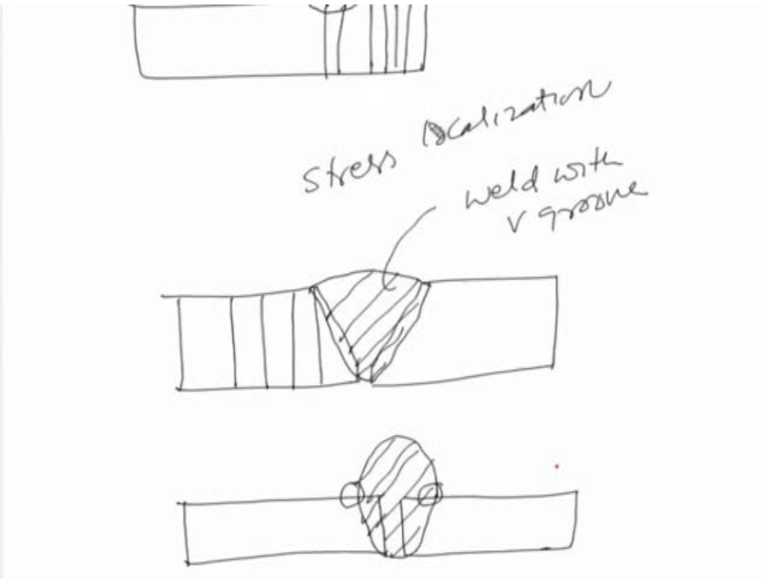

Where edges are prepared for developing the weld joint, and then by melting the faying surfaces, the weld is made say this V groove geometry, so by melting these faying surfaces when the groove is made like this. So, this is the weld V groove geometry. So, for this kind of the V groove, or U groove or J groove geometry the transition means, the change in cross section of the load resisting cross sectional area of the base metal to the weld metal is very gradual. And because of this gradual transition in the load resisting cross sectional area from the base metal to the weld metal, the stress localization does not take place easily unless the weld bead profile is extremely bad.

Weld bead profile can be bead especially, in case say this is the V groove geometry being used for developing the weld and the weld has been developed very badly using this kind of reinforcement, and melting of the faying surfaces. So, if this is the kind of weld bead geometry obtained even with the help of the groove, square groove geometry then there will be sudden change in load resisting cross sectional area at the toe of the weld. And this will be acting as a stress concentration source of the stress concentration, and will facilitate the crack nucleation and its growth under the fatigue load conditions.

So, if the weld bead geometry is extremely poor then it will increase the stress localization at the toe of the weld, even in the case of the square groove geometries, but the stress localization is found more severe, in case of the fillet weld as compared to the square as compared to the groove welds. So, and now why this kind of stress concentration takes place in the fillet weld.

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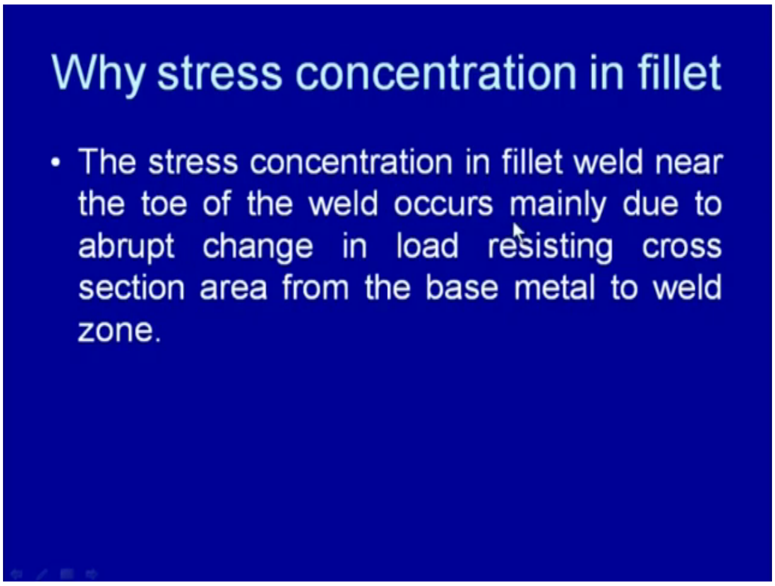

The stress concentration in fillet weld near the toe of the weld occurs, mainly due to the cross abrupt change in the load resisting cross sectional area from the base metal to the weld metal. And because of this abrupt change at the toe of the weld stress localization takes place, wherefrom the cracks tend to nucleate and grow easily.

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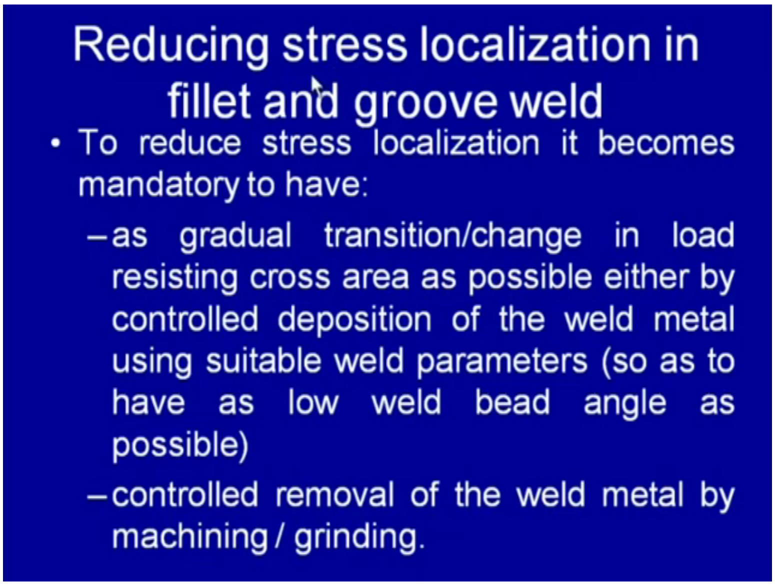

So, what can be done for reducing these kind of stress localization in case of the fillet and the groove welds. Especially, near the toe of the weld where sudden change in cross sectional area is low resisting cross sectional area of the weld is encountered. So, one major thing which is done is to have very gradual change in the low resisting, in low resisting cross sectional area, in case of the fillet and the groove weld and for this purpose efforts are made.

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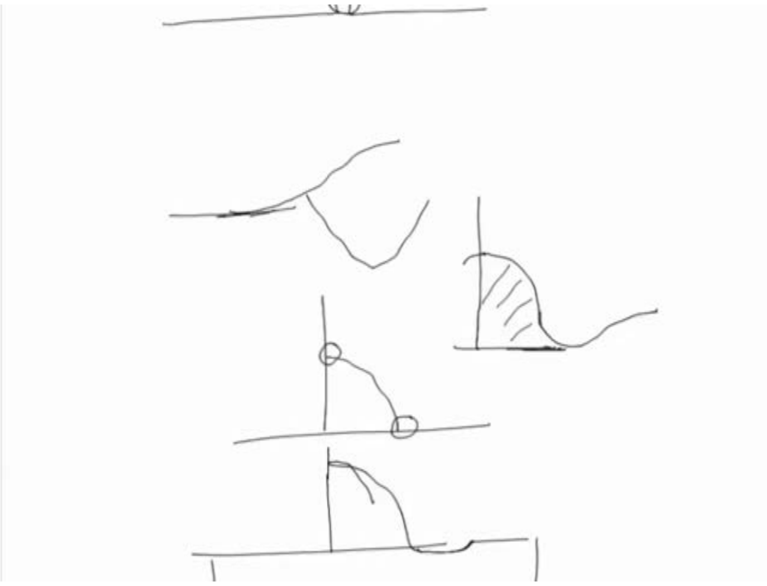

For developing the weld joints in such a way that the weld groove, the weld is made using by developing the by depositing the weld metal, in such a way that the transition from the base metal to the weld metal is very gradual like this. So, the bead angle is very low and the weld metal is deposited. So, those so the weld metal is deposited, deposited in such a way that the base metal to the weld metal transition is very gradual. So, say for this kind of transition is achieved, so that the stresses are not localized at one particular location. And so this is one way that the weld bead profile is controlled in order to have the gradual transition from the base metal to the weld region.

And another effort which is a specially made in case of the fillet weld, if this is the fillet weld which has been developed then this location there will be very sharp transition. As far as the load resisting cross sectional area is concerned. So, in order to avoid this kind of the sharp transition and normally, then the sum the machining or grinding is done. So, that so that the weld metal is deposited and some amount of the metal is removed from the toe area means, tow the area where the weld metal is connecting to the base material.

So, important thing is that some sort of machining is done say this is the fillet, and then some sort of machining is done like this so that transition is gradual from the base metal to the weld metal. So, this kind of machining is done this is weld metal and some sort of machining, or grinding is done to have the gradual transition from the weld to the base metal. So, this is the approach for facilitating for reducing the stress localization in the fillet and the weld groove.

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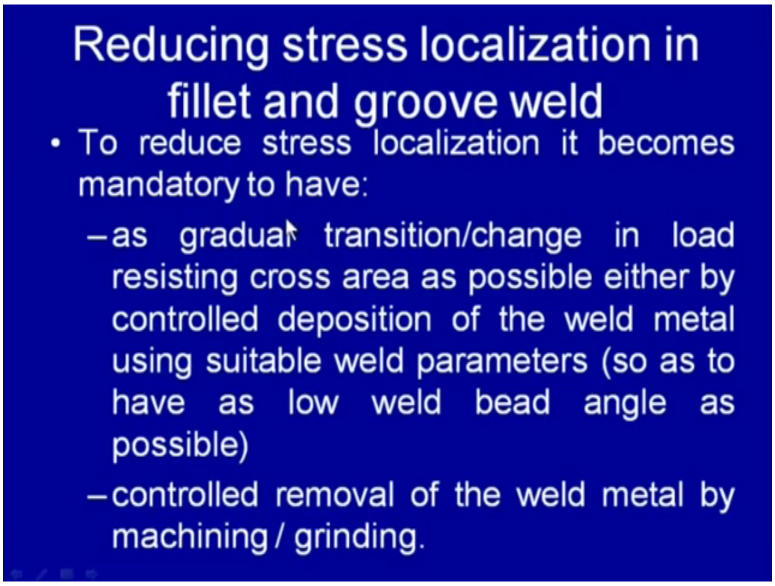

So, for this purpose as you as we said to reduce this stress localization it becomes mandatory to have as gradual transition in the load resisting cross sectional area, as possible either by controlled deposition of the weld metal using the suitable welding parameters. So, that the weld bead angle is as low as possible. So, efforts are made for achieving the situation where weld bead angle is as low as possible so that the transition from the base metal to the weld metal is very gradual.

And the second is that material is removed in very controlled way from the weld metal, and the base metal in such a way that the transition from the base metal to the weld metal becomes very gradual, and the uniform. So, that the stress localization tendency is reduced. We have seen that there are certain advantages related with the fillet weld and the groove weld, and to take the advantages of the both kind of the welds. Sometimes the both are involved for developing, or both are used for developing the weld joint say the development of the T joint is one typical case as being given in this figure, where in one side directly the fillet weld has been made.

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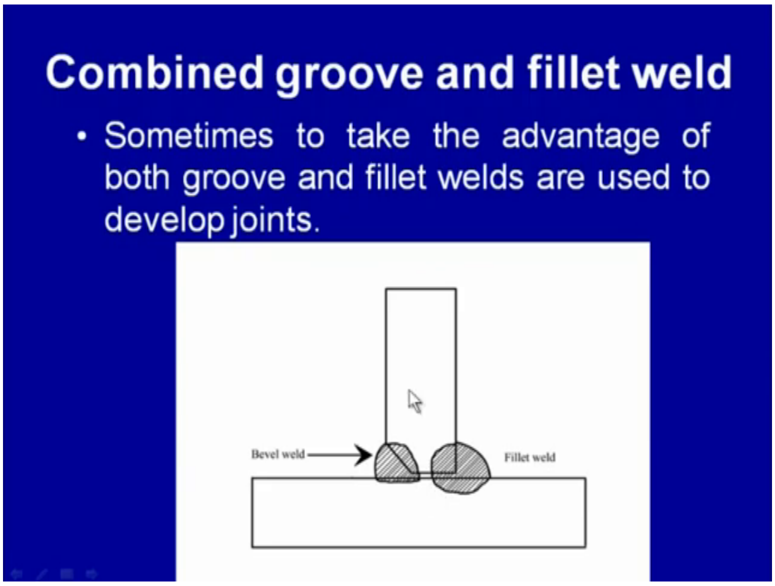

While in other side the edge of the plate was prepared, and then weld metal was deposited to have the groove weld. So, the weld, this kind of the combination many times help in reducing the cost of the development of the weld joint, through reducing the by reducing the cost of edge preparation. At the same time development of the edge in one side helps in achieving the proper penetration through the thickness of the plate, which is being welded. So, that desired full penetration weld can be obtained and fracture tendency of the weld joint can be reduced.

So, to take the advantage of the both groove and the fillet welds sometimes the combined groove, and fillet welds are used for developing the weld joint. Now, we will be talking about the certain the important terms, which are used in case of the welding and the weld joints, in order to understand them that how these should be controlled properly and what should be controlled. So, for each purpose very specific kind of terms are used. So, those will be covered now.

Now, we know that the deposition of the weld metal for developing the sound weld joint, with optimum groove design must be controlled properly to get the optimum combination of the various features of the weld bead. And but these features affect because these features affect the load carrying capability of the joint. So, the features that should be controlled properly for developing the optimum weld bead geometry, it is necessary to look into that.

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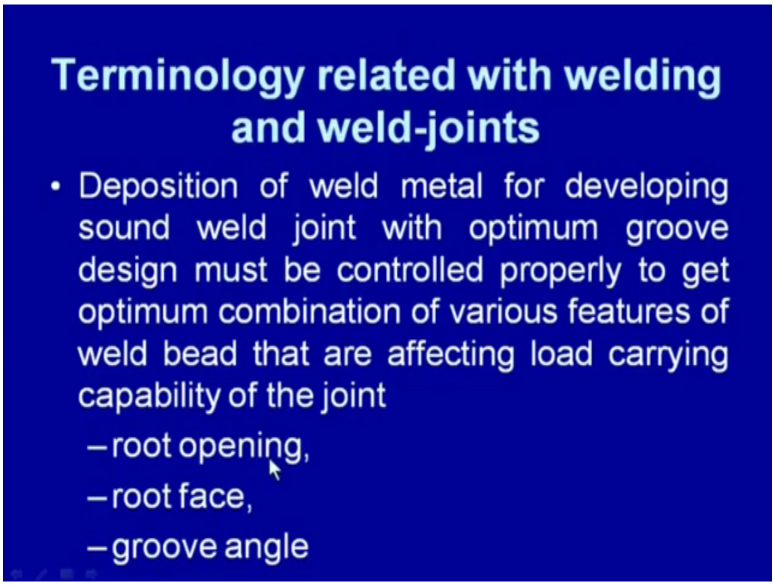

The proper root opening is obtained the proper root face is there, and the proper root groove angle is developed for depositing the weld, weld metal. So, to see this we will we will make up another diagram say.

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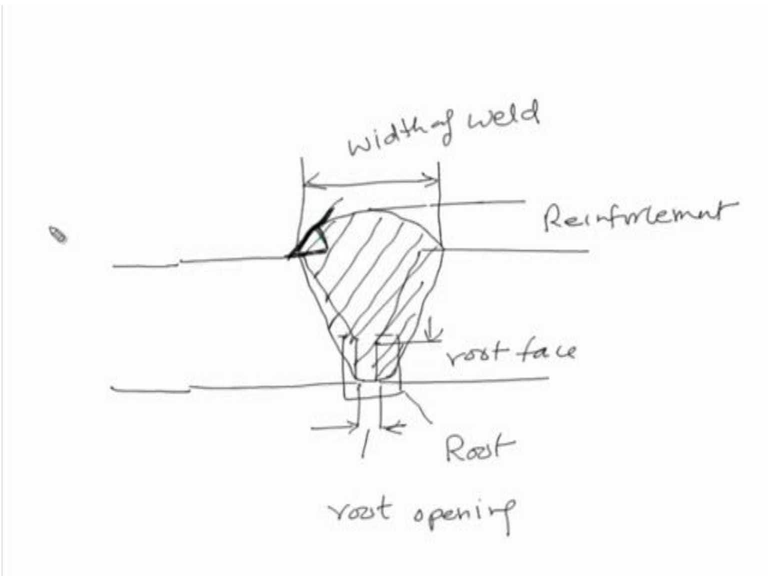

In case of the V grooves so the groove is made in one side and then one flat straight region is there, and then this is one side say the edges has been prepared in the plate in the one side. Similarly, edges have been prepared in the plate in another side, and the plates with the prepared edges are brought close to each other. So, the so this portion of the plate is called this entire portion is called root, of the groove. And the space between the plates at the root side is called the root opening.

It is always desired to have the proper root opening so that the weld metal can reach there up to the bottom and unnecessary falling down all of the weld metal is also avoided. So, too wide root opening is not good because weld metal will have tendency to fall down through this gap. So, it is good to have an optimum range of the root opening then. Then there is a root face, so this the straight portion below the beveled edge of the plate is called root face.

Root face sometimes it is kept 0, or some width is given. So, this portion of the root phase will be melting with the application of the heat during the welding, and it will avoid unnecessary falling of the weld metal through this the root opening. Then weld metal is deposited by melting the faying surfaces of both the plates, and the weld metal is deposited like this.

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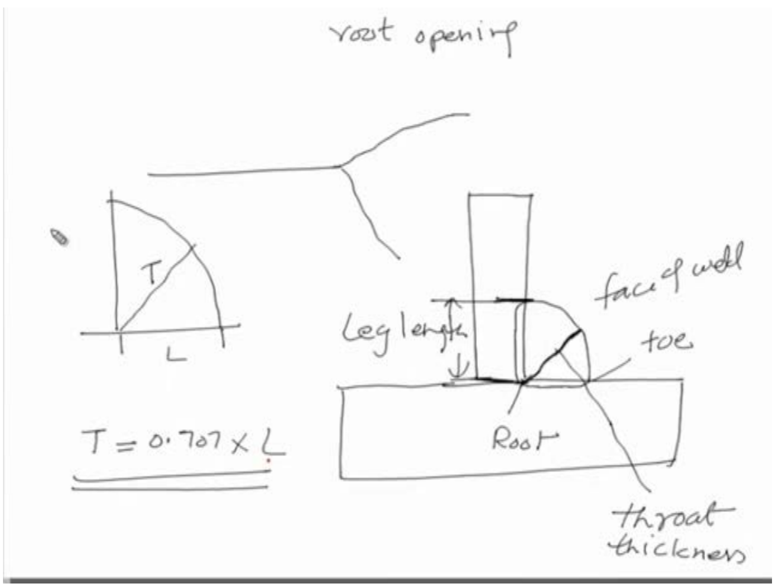

So, say if by melting all these edges and faying surfaces of the base metal weld metal has been developed, then this width is called width of the weld bead width of weld. And the height of the weld above the surface of the plate is called reinforcement. It is always preferred that the reinforcement to the width ratio is maintained below certain limits. So, that the proper bead angle is obtained. So, angle of the weld bead with respect to the surface of the base metal this one is controlled. So, this one we can say as bead angle.

Efforts are always made to have this bead angle as low as possible so that the transition from the weld metal to the base metal to the weld metal is very gradual, and it is very slow. So, that any localization of the stresses at the toe of the weld can be minimized. This portion is called the toe of the weld, where the weld beat connects with the base metal.

Well in case of the fillet welds, this is the say that some T joint is to be made this is surface of this is the lower plate, and this is upper plate and the fillet weld is to be made like this by melting the base metal surfaces. So, this is the root and this is the toe of the weld, this is the face of weld and the line straight line of the shortest length passing through the face of the weld is called throat. This throat length of this the this throat decides the load resisting cross sectional area, and this length and the length of the weld means, this length from the toe to the root of the weld, this length is called leg length, leg length of the weld. Basically for determining the load resisting cross sectional area, throat thickness is used for calculation purpose to determine the load resisting cross sectional area of the weld.

Since, we cannot measure this distance directly. So, for this purpose leg length is used, and there is a direct relationship which is obtained say in this fillet, if this is the weld and this is the throat thickness to determine the throat thickness. Basically, we measure this leg length which is measurable using the metrological instruments, say leg length is L then throat thickness is obtained using the 0.707 times of the leg length, this is how it is determined practically. And this throat thickness is directly, used for calculation of the load resisting cross sectional area of the fillet welds.

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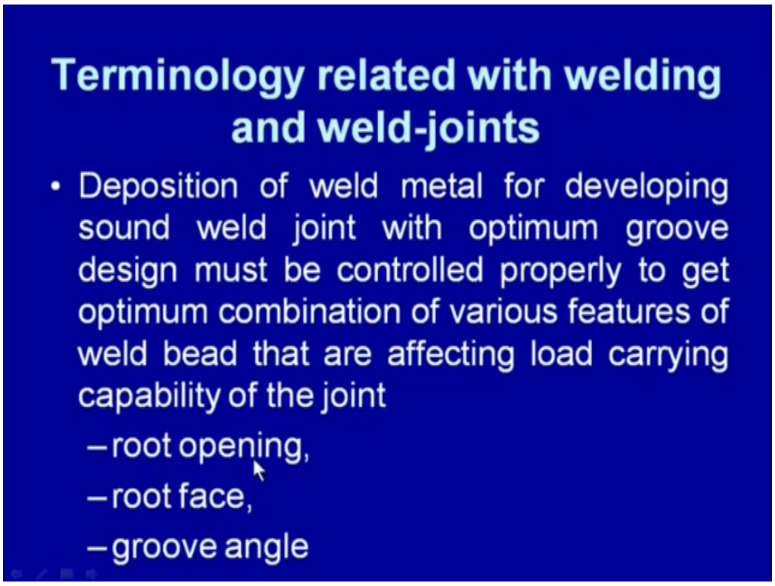

So, as far as terms are concerned we will be talking about the different terms, which are used in the welds joints like the root opening, the root face and the groove angle. Now, these common features schematically has been shown in these two diagrams.

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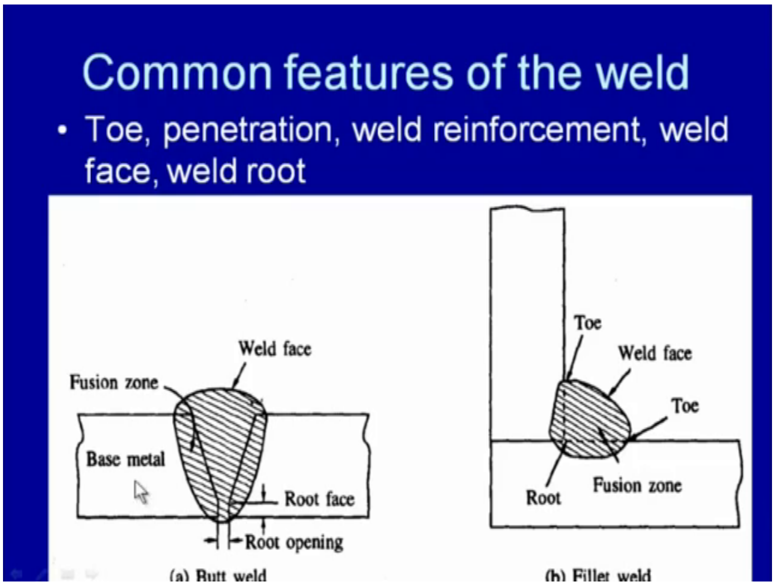

This you can this is the butt weld, and this is the fillet weld, this is the toe of the weld, this is weld face toe of the weld, this is the fusion zone, and this is the root of the weld. And in case of the groove welds this is the toe of the weld, this is weld face and weld metal this is root face and this is the root opening. So, these are the important terms related to the fillet weld and the butt weld.

Now, in the next slide means in the coming presentation we will be talking about the methodologies, which are used for the design of the weld joints under the static loading conditions. So, I will try to summarize this presentation in this presentation, we have seen the various kinds of the groove geometries, which are commonly used for developing the weld joints. The various technological aspects related with each kind of the groove geometry in terms of the weld metal to be deposited, the stress concentration related with the each kind of geometry.

The specific areas where these kinds of the geometries can be used effectively for developing the weld joint. We have in the last we have also tried to see the different the terms related with the weld joints, which are developed either using the fillet weld or the butt weld. So, in the coming presentation we will try to see this step by steps of the methods step by step methods, which are used for designing the weld joints for the static loading as well as the dynamic loading.

Thank you for your attention.