Fundamentals of Manufacturing Processes
Dr. D. K. Dwivedi
Department of Mechanical & Industrial Engineering
Indian Institute of Technology, Roorkee

Lecture – 47
Joining of Metals: Fundamentals I

Hello, I welcome you all in this presentation related with the subject fundamentals of the manufacturing processes and today we will be starting a new topic that is related with the joining of the metals and we will take a first the fundamentals of the metal joining. But before going into the fundamentals of the joining metal joining, techniques I will talk the remaining portion little bit remaining portion of the last lecture, which was left one was related with the grinding and the three aspects which were related with the wheel wear or the cutting efficiency of the grinding.

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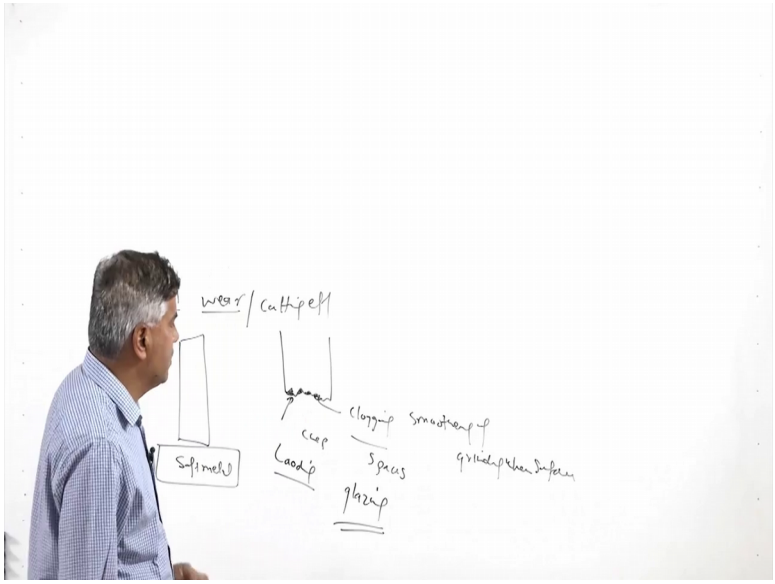

So, what we know that when the grinding wheel like this is used for grinding of the soft metals. So, during the grinding of the soft metals whatever chips come out of the after grinding they find spaces, it spaces the chips fill in the spaces between the abrasive grains. So, this is what is termed as clogging of the spaces between the abrasive grains and when it happens, the smoothening of the grinding wheel surface takes place grinding wheel surface takes place and which in turn reduces the cuttability of the grinding a wheel.

So, this process of a clogging or. So, this process in which clogging of the soft metal into the fine spaces between the abrasive grains take place is called loading of the grinding wheel and because of this when the flattening and smoothening of the grinding wheel occurs so that is termed as glazing. Glazing in an effect where in the smoothening and flattening of the grinding wheel surface takes place by filling in the spaces between the abrasive grace due to the clogging of the metal especially of the soft work-piece material. So, this glazing in turn reduces the cuttability of the grinding wheel.

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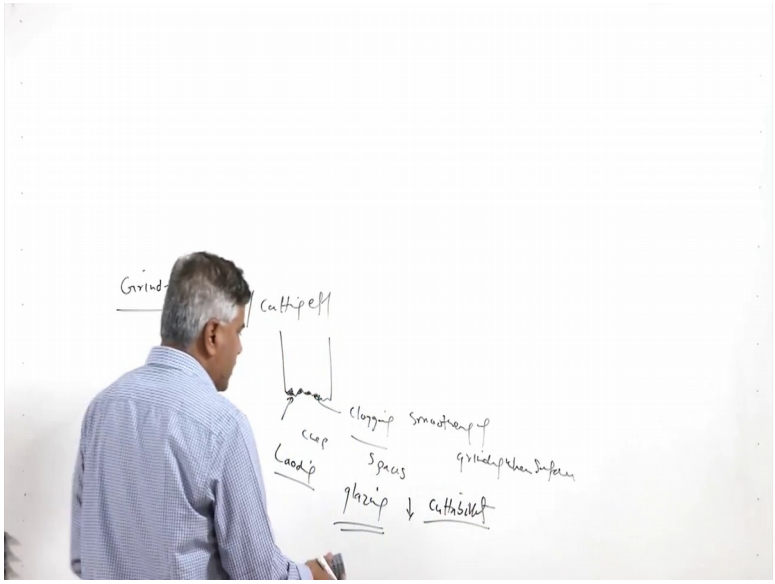

So, it is important that cutting efficiency of the grinding wheel or grinding efficiency is maintained properly, it is required that all these clogged metal is removed from the surface of the wheel.

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And for that purpose what we use, we use the operation dressing in dressing. Dressing is basically where in either another grinding wheel rotating at much higher speed or a star shaped diamond tool is used. So, that this star shaped diamond tool is pressed against the grinding wheel.

So, all these the clogged metal; the clogged metal and the glazed surface both glazed surface as well as clogged metal they are removed and the surfaces surface of the wheel is roughened so that the cuttability of the grinding wheel can be improved. So, this dressing means making the surface of the wheel rough with the help of either high speed running high speed rotating grinding wheel or a diamond shaped cutting tool which is pressed against the surface of the wheel. So, that the surface the clogged metal is removed and the fresh grains fresh cutting grains are exposed to the surface, a surface is roughened. So, that the cuttability of the grinding wheel or ability to remove the material or ground the material can be improved.

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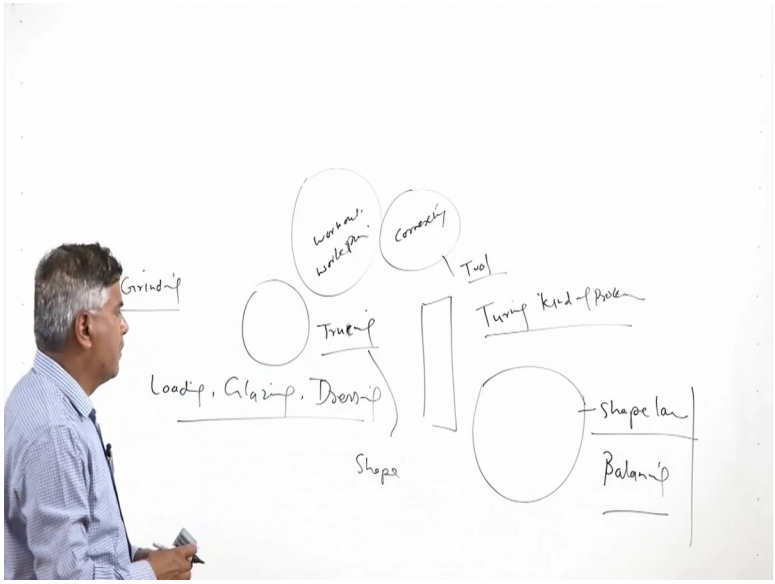

So, what we have seen basically loading then glazing and then dressing all these three are related with each other. We know that when there is a loss of the material there whenever there is a grinding wheel which is in use. So, there is a loss of material loss of material from the grinding wheel. So, if the loss of material is uniform all along the periphery then probably the shape of the wheel will remain circular and it will remain balanced.

But in the case when the removal of the material is not uniform all along the periphery, it is more at one location than other in that case there will be the loss of balance in the wheel. So, first the shape of the wheel will not remain circular, it may remain it may go out of the shape. So, out of the shape means the shape loss of the wheel will be taking place and because of the shape loss or a non uniform material loss from the circumference of the grinding wheel it will be losing its balance.

So, the balancing of the wheel due to non uniform wear as well as loss of shape both needs to be corrected and. So, for this purpose basically a turning kind of process turning kind of processes used where work-piece is rotated like this and another grinding wheel is brought firmly in is pressed firmly against the grinding wheel which is to be processed. So, this is the worn out of the grinding wheel and this is the another correcting grinding wheel which will be it is pressed against the wheel which is to be which has been worn out.

So, that, it can be used for correcting the shape. So, the this is just like turning kind of the process where the correcting grinding wheel will be used as a tool, and the worn out grinding wheel will be used as a work-piece. So, this actually in turn will be leading to the perfect circular shape of the wheel, and this process is called truing. Truing is a process where the shape of the wheel is brought back to the original shape or the circular shape when its shape goes out of the circular shape due to the non uniform wear.

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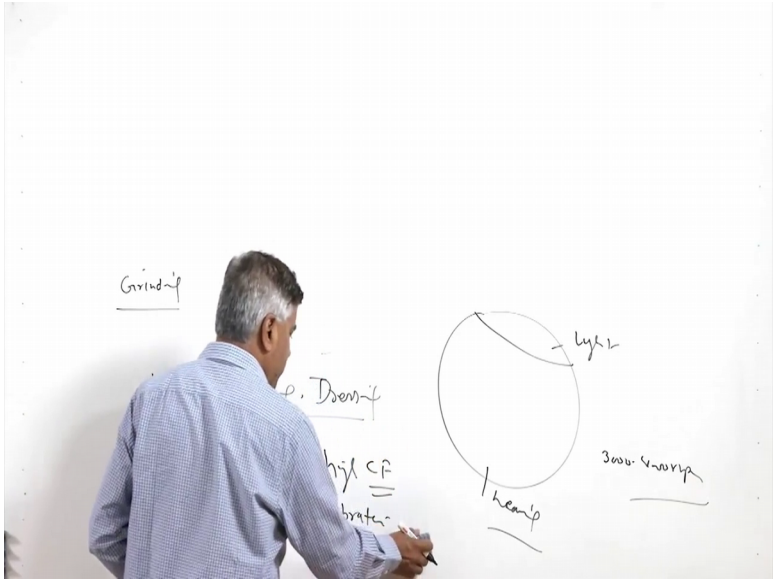

Similarly, the balancing of the wheel is important because if do to the non uniform wear of the wheel, if the material loss is unequal then it will be heavier in one side than other side and this will lead to the lot of imbalance in the grinding wheel, which is rotated say this is the lighter side of the wheel and this is the heavier side. So, during the rotation at much higher speed maybe like say 3000 to 4000 rpm under these conditions, even little bit imbalance in the grinding will be will be leading to the high centrifugal forces.

So, high centrifugal forces will be generating unstabilizing forces that will be leading to the vibrations and even it may lead to the instability of the grinding wheel machine which is being used. So, that will be leading to the unnecessary noise reduced surface, finish which can be achieved heavy vibrations due to the imbalance.

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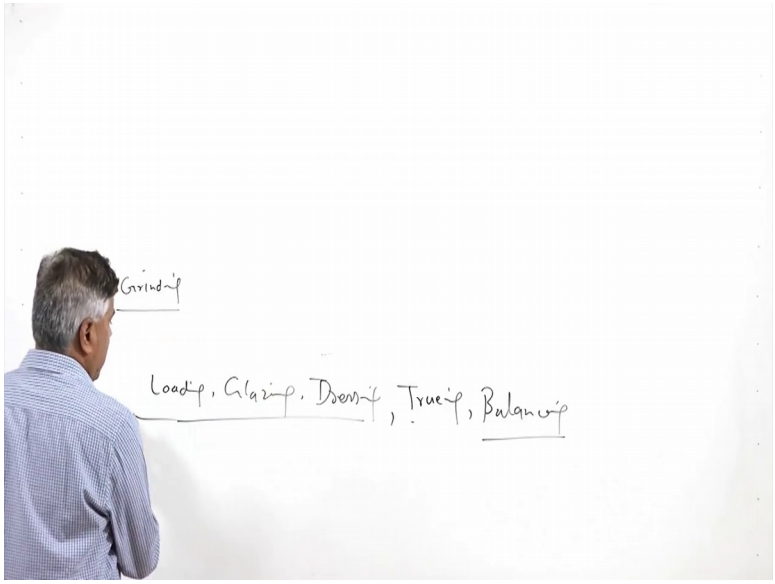

So, for this purpose; normally wherever there is a; so suitable weights are attached to the wheel by fill by drilling the holes and filling the heavy metal like lead.

So, that the wheel can be balanced further in order to avoid the adverse effects related with the imbalancing of the wheel. So, apart from the dressing the truing is another which is basically for correcting the shape and balancing is about balancing of the wheel in order to deal with the problems related with the imbalance of the wheel. So, these are the 4 of or 5 terms related with the grinding wheels which will be experienced by the grinding wheel during the service after some time.

So, loading, glazing, dressing, truing and balancing these are the four common things which are experienced and which are applied in order to get the things back into the shape properly like truing balancing and dressing of the grinding wheel.

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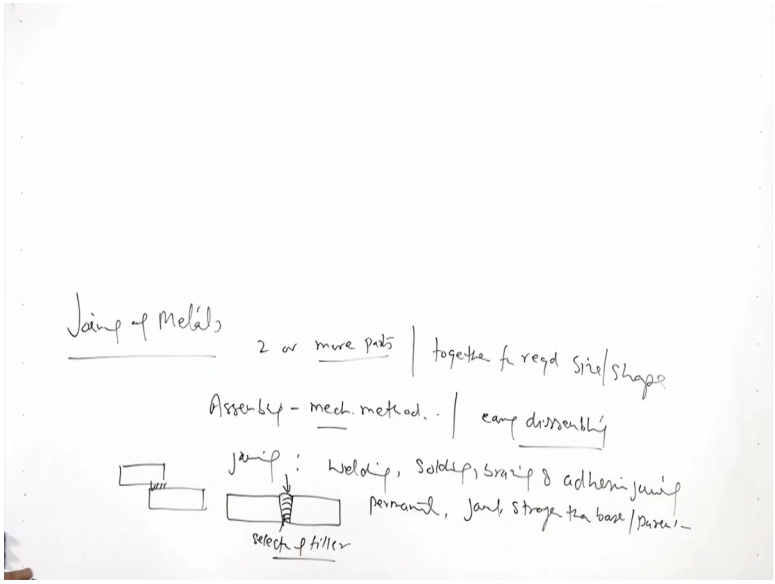

Now, we will come to the next topic that is about the joining of the metals. So, joining of the metals like the two or more parts are brought together for required for achieving the required size and shape.

Basically the simple shape components are brought together so that the desired final size which may be complex one also can be achieved. For this purpose basically the two approaches are used one is called assembly another is called joining in assembly basically the mechanical methods are used like a riveting and the nuts and bolts even press fitting is also one of them, but here most of the time most of the methods allow easy dissembling of the parts if required, on the other hand joining basically involves the processes like mostly processes like welding shouldering brazing and adhesive joining.

So, most of these joints are basically the permanent in nature, although if they are if the suppressor is needed then joints need to be broken. Another thing is that here the suitable selection or proper selection of the metal or the filler metal for the welding purpose can lead to the j joint stronger than the base or parent metals. So, for example, mostly like in processes in brazing and shouldering the weak material is used at the interface. So, these joints are weaker as compared to the base metal usually.

But if we consider another case; where fusion welding is applied; so, in that case, basically the filler metal if the thick plate is to be welded, then the application of the filler metal can lead to the joint which may be stronger than the base metal; so, the

selection of the filler metal basically to a great extent determines the strength of the joint which will be realized through such kind of the weld joint. So, not necessarily it will be weaker in case of the joining.

So, basically we will be focus we will be focusing on the joining techniques used for metal joining. So, as I have mentioned that this the joint is permanent in nature which is produced mostly in joining processes like welding, brazing, shouldering and adhesive joints adhesive bonding and a suitable selection of the filler metal can also lead to the having to have the joint which may be even stronger than the base metal and parent metal.

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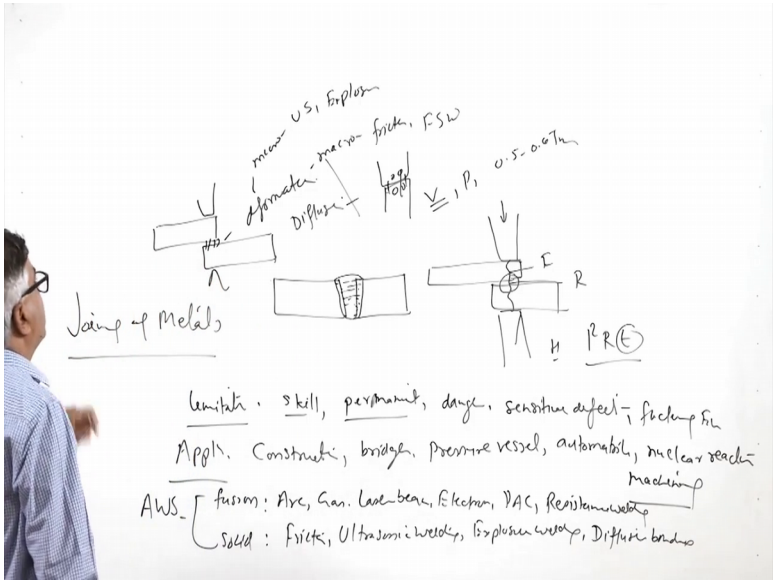

But if we talk of the limitations related with the process joining processes like the welding processes, then these requires lot of skill the skill of the worker is important in determining the success of the joint another one if the joint need to be dissembled then it is a problem because a joint is permanent in nature and there is always danger because of use of high energy or a heat or the power. So, there is a possibility for harm to the operator as well as this is also sensitive for the defects those joints which are made are sensitive for the defects.

And most of these can be made in the factory environment only. If we see the applications of the joining process mostly these are used in like say the construction industry for joining various parts and components then like the bridges then pressure

vessels like penny stocks pipelines, automobiles most of the automobile systems will be having lot of the weld joints mostly these are the spot welds and then in energy sectors like nuclear reactors will be having the joints.

And then it will also include the pressure vessels and fabrication of the machinery unlike so, many machines whatever we see all around us needs a joining of a the different kind. According to the AWS if the joining processes are classified then in simplified form what the classification is in two broad categories one is the fusion welding and another is solid state welding. In the fusion welding we have like arc welding gas welding process like a laser beam and a electron beam a plasma arc welding.

So, most of the even resistance welding also has been kept in this case under the fusion welding category, then in the solid state a solid state joining the joints are made in the solid state itself. So, under this category we have friction welding ultrasonic welding explosive welding and then a explosive welding and diffusion bonding.

So, in these cases although the approaches are different for example, in case of the fusion welding processes normally like in the fusion welding processes of faying surfaces I have brought to the faying surfaces are brought to the fusion are melted. So, that the metallic continuity is realized after the solidification in case of the fusion welding processes like here, a spot welding also has been placed where in like the overlapping plates are subjected to the application of the current flow through the copper electrodes from both the sides.

So, there is a flow of current through the interface like say the current I flows and at the interface contact resistances R. So, depending upon the I square Rt the time for which current flows, heat is generated and that causes the melting at the interface especially. So, that a fusion plus the subsequent solidification leads to the development of the joint while in other cases in solid state welding processes, the surface needs to be extremely clean like this surface must be very cleaned and the in the pressure is applied to such an extent that that the two surfaces come close to the atomic contact and so the, for firm metallic continuity exist between them.

And then either through and this firm metallic continuity is realized through the surface layer deformation as well as diffusion. So, both these places the both these approaches work significantly in case of the solid state joining processes. So, the deformation maybe

micro level deformation in case of the process like ultrasonic welding and explosive welding, explosive welding while the deformation is of the macro scale means large scale deformation takes place in the processes like friction welding, friction steer welding and in case of the diffusion bonding the firm metal to metal surface contact.

So, diffusion of atoms from one side to another is facilitated due to the concentration gradient of the alloying elements from one side to another and the metallic continuity is established at a high temperature mostly this is conducted in vacuum and under the pressure at a high temperature like 0.5 to 0.6 times of the melting point of the metals which are involved. So but in these processes like in solid state joining processes there is no fusion, but the different approaches like the macro or micro scale surface layer deformation or the diffusion is used in order to achieve the metallic continuity so, that the joint can be made.

Now some basic terms will be seeing related with the joints which are used in welding, then there is a; the welds which are used and then we will also see the positions in which welding is carried out.

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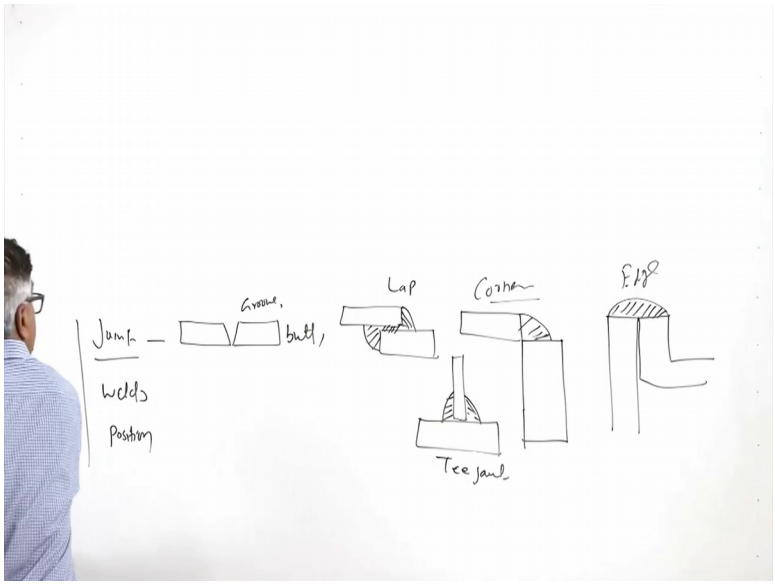

So, these are the basic aspects related with the joints, the there are different types of the joints which are used for the metallic continuity whatever is the kind of the joining process like brazing, shouldering or the welding or adhesive joining.

So, the common types of the joints are like groove joint is one where groove like this is made, it can be square v or u any kind of the joint a groove can a will be. So, the one is groove joint then there is a butt joint also the butt is one of the most common joint butt joint then we have the lap joint, where the plates to be joined are kept in overlapping positions.

So, lap joint; then we have a corner joint where in the plates to be joined like lap joint may be made like this or at the interface or like this also. So, you may be made a single fillet or double fillet or the filler metal at the interface like embracing and shouldering, then in case of the corner joint the joint is made like this where in the fillet is made at the corner. So, this is corner joint and then there is a edge joint and tee joint edge joint goes in like this where the joint is made at the edge of the component to be joined.

So, this is the edge and the weld will be made in this location for edge joint and then tee joint depending upon the orientation the plates are like this, and another plate is brought at a 90 degree on the top surface of the plate. So, here the fillet weld can be used like this for making the tee joint. So, this is the kind of a these are the four or five types of the joints butt joint, lap joint, corner joint, edge joint and the tee joint. So, the butt joint offers the very good tensile strength as well as fatigue resistance as compared to the lap joint and the tee joint means other joint configurations because of the better residual stress distribution and reduced a possibility for the stress concentration.

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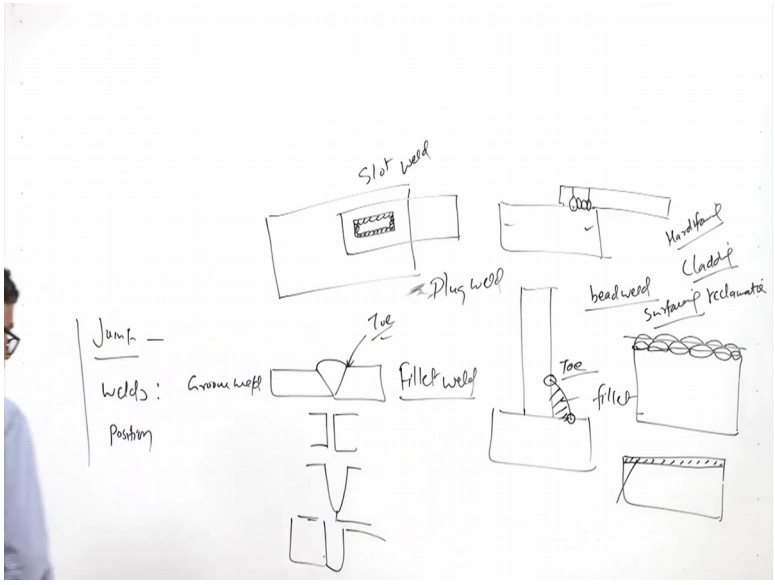

Then the there are different types of the welds which are made these welds are like groove weld where the groove is prepared like this and it is filled in. So, the this is like v groove likewise there can be square groove or there can be u groove like this, between the members to be joined there can be j groove like this. So, j configuration is made just one side likewise there can be single v, single u, a single j or double j double u or double v kind of the groove joints then there is fillet weld.

Fillet welds is are very common, but these result in very high stress concentration. So, the two of the weld leads to the higher, now a higher stress concentration and which becomes the main cause of the a point of the stress concentration. So, the weld is like this. So, here this is the toe of the weld which wear stress concentration will be high and this is the fillet weld which is made. In case of the groove weld the two of the weld is this one here also we will see the stress concentration, but not as high as that in case of the fillet welds.

Then there is another kind of the arrangement which is called like say in the top view if we see on the plate looking like this, then another plate to be joined is made like this we can make one hole on the top plate and through us and it just it touches the through hole is made in the top plate, and the plate is placed on the bottom plate and then oh one continuous weld is made in the inner surface of the upper plate. So, that the metallic connection between the top and bottom plate is achieved.

So, if we see the same thing in the front view then what we will see like this is here it will be going like this is the top plate and the hole was made like this. So, the weld will be leading to in this way all around the periphery. So, the melting of the lower plate as well as the sub portion of the top plate is also achieved all around the periphery, when this kind of arrangement is made it is called a plug weld and when the shape of the weld is a square instead of the circular sorry shape of the weld is a rectangular, shape of the slot in the top plate is a rectangular like this and then weld is made all along the a periphery of this slot then it is called no slot weld.

So, plug weld for the circular hole and the slot weld for the rectangular hole and then we have the a bead weld which is normally used for the surfacing or overlaying purpose like this is the surface of the component which has worn out or which need to be surfaced for improved properties or to regain the dimensions, then we deposit the bead over the

surface in this way and subsequently. So, likewise the number of beads can be deposited on the surface of the component and then we can machine it out in order to have the surface.

So, the surface with the weld be deposited like this will be able to help to regain the size and shape of the component as well as it may also be used to improve the surface properties of the component. So, this a 1 is called surfacing process, surfacing can be used for like a hard facing when very hard material is deposited as the weld bead or it can be used for improving the corrosion resistance, then it is called cladding and when it is used just for regaining the dimensions then it is called reclamation. So, the weld bead can be used in different ways in order to have the regaining the size and shape improving the surface properties or for the hard facing purpose.

So, now, here I will summarize this presentation; in this presentation first I try to talk about some of the important features related with the grinding a wheel like the dressing, truing and balancing of the grinding wheel and thereafter I started the fundamentals of the metal joining processes wherein what are the different ways by with the joints of the metallic materials can be made and what are the different types of the welds the different types of the joints and the different positions in which weld can be made, that this I will be talking in the next lecture.

Thank you for your attention.