

Theory of Production Processes
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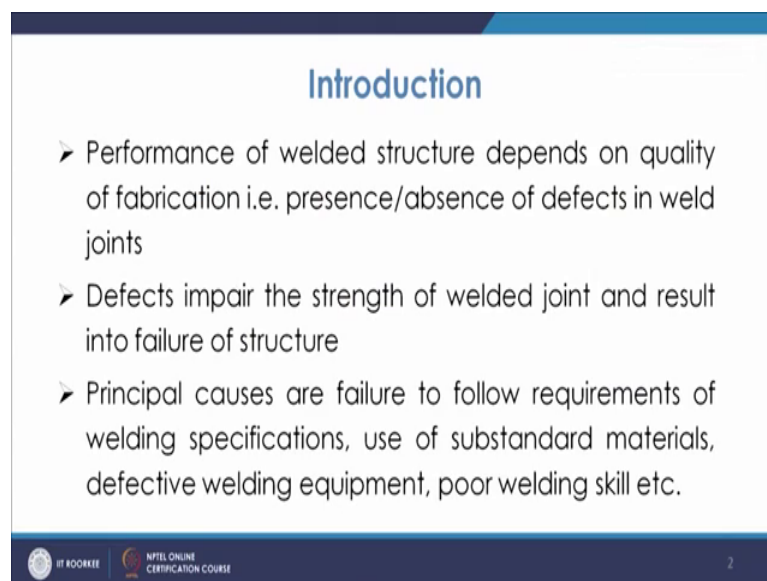
Lecture - 60
Welding Defects

Welcome to the lecture on welding defects. So, far we discussed about various kind of welding processes and as we know that ultimate aim is to have a defect free weld component. Now, as we know that there are chances of errors on many accounts just like there may be problems related to the machines, there will be problem related to the labour who is working on it. So, basically the defects are likely to occur in the case of welding.

Now, when there will be. So, what is the welding defect now the quality which we expect, if we do not get that quality then we tell that there is a defect. Like if we do not get the proper weld surface or proper weld contour or there are cracks developed or even the formation of stresses are there inclusions are there these are all the kinds of different type of types of defects which occur in the case of welded components.

So, basically we also turn like you know like imperfections or even the discontinued, discontinuities.

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Introduction

- Performance of welded structure depends on quality of fabrication i.e. presence/absence of defects in weld joints
- Defects impair the strength of welded joint and result into failure of structure
- Principal causes are failure to follow requirements of welding specifications, use of substandard materials, defective welding equipment, poor welding skill etc.

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So, this way the welding defects crop up and basically why weld in defect is important to be studied because ultimately if the defects will be many a times if the defects are, I mean number of defects are moved or the severity of the defect is on a larger scale, then the component is likely to be rejected. So, basically the quality will be depending upon how many defects are there or what is the order of the defect whether defect is not there that is the ideal option.

So, because the defect if it is there, it will be trying to impair the strength of the welded joint and if the strength of the welded joint is affected then that may lead into the premature failure of the structure, many a times the catastrophic failure may occur. So, that is why the study of the welding defects what are the reasons of these welding defects, what are the different types of welding defects which occur and how can we see that we can minimize these defects, now that study is important for a welder.

So, principal causes are which occur in the welding or which results into the formation of welding defects are the failure to follow requirements of welding specifications. So, many a times you have certain procedures which are to be followed and if you are not following that that may result into the formation of a different type of welding you know defects. Like use of substandard materials, if you are have to use the electrode of certain quality certain composition and if you are not using that of basically the proper composition or with proper quality or it is not a you know a maintained in a good state. Like many times with the you know stick electrodes or coat electrodes, we need the coating to be in a you know dry state.

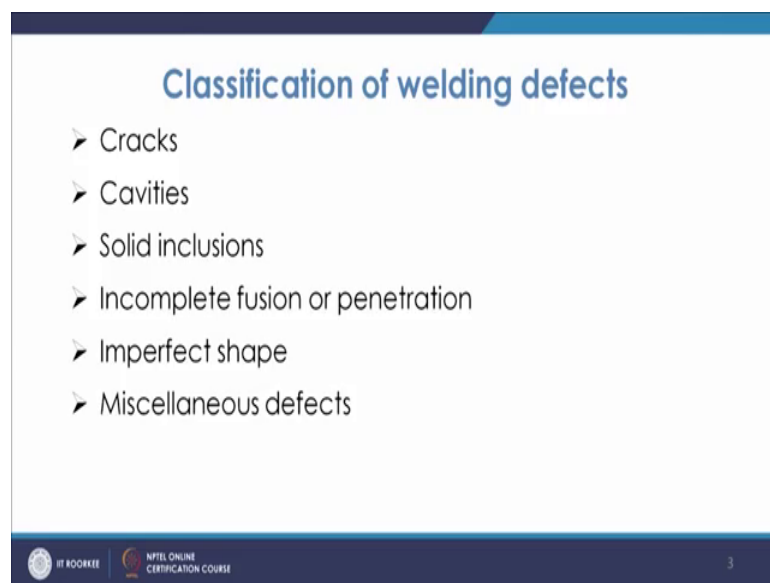
So, if it is not kept in a proper a you know place, in a proper shape that case that may lead to the welding defects similarly defective welding equipment. So, many a times the equipment itself may be defective. You know like if you are having a welding torch the torch may be worn out or the you know the torch diameter is not appropriate or the valve which is opened. So, that there is adequate or required amount of gases have to flow and it is ignited further that is not working properly.

So, this way that may result in too defective defects just like in arc welding, if the arc creation is not proper, those cases the holders are not properly, you know they are not properly holding the electrodes or the current flow is not proper, those things also lead to

defects poor welding skills. So, workmanship may be poor the labour who is working on this he may not be the skilled one, he may not have the adequate skill to do the working.

So, even if the machines are quite all right you have other conditions quite favourable, but if the person who is doing the welding if he is not having good workmanship in that case also the defects occur. So, this way the defects are likely to occur in the case of a welding process, now we are going to discuss about the different types of welding defects.

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So, when we talk about the a welding defects then the classification may be broadly under these categories.

So, like you have cracks. So, cracks develop at different positions and they are like a hot cracks or cooled cracks you have different cracks in the different you know at different in the directions of the weld or in the transverse direction. So, based on that you have longitudinal or transverse crack, similarly crack on certain places like you have 2 crack then you have the crack on the crater, so that is crater crack. So, this way different types of cracks develop because of basically the that is stresses value which reach or because of uneven cooling or so that way cracks develop.

Similarly, you have the defects in terms of cavities, now the cavities may be like you have blow holes. So, blow holes are there because of the gases. So, cavities means you

have the space which is unfilled, where the gases occupied the space. So, you have blow hole is there or porosity is there where I mean this is all because of the gaseous problems defects due to gas.

So, you have blow holes then you have porosities that is a similarly, you have shrinkages. So, they are in the form of cavities and that's why these blow holes are the pinhole porosity or shrinkages they come under this category of cavities, next is the solid inclusions. So, many times the solid inclusions go into the weld pool and they form the welding defects.

Now, in that you may have the slag entrapment, you may have the flux entrapment. So, this way you may have the metallic oxides formation which is their entrapped. So, these are basically in the form of you know solid which are as inclusions like sometimes that tungsten is also trapped. So, turns to an oxide is there so that also trapped. So, these are the kind of defects known under the category of solid inclusions, then you have the incomplete fusion or penetration. So, in the case of incomplete fusion or penetration you have the lack of fusion going on like many times you have the weld bead is there and with the parent metal you have must have proper you know fusion to take place.

So, if there is a lack of fusion that is basically a defect because there the structure will become quite weak. So, the failure may occur at that place, you have lack of penetration. So, because of the improper design or because of many times improper heat input or so the improper penetration also is caused. So, that is coming under this incomplete fusion or penetration, then you have imperfect shape. So, many a times the contour which tried to have that is not the one which we get.

So, in that case that the shape must be the perfect shape. So, the imperfect shape contours they are basically you know a type of defects, you have basically the different types of defects coming under this category like you have the dimensional deviation because you had to have the bead of certain width and that is not there. So, then that is the one, next is your undercut many times you get like undercut. So, in the bottom part you have cut portion so that is undercut or under fill is there.

So, under fill comes under this imperfect shape of the defects you have also the cases of excessive penetration. So, excessive penetration also comes under this category of imperfect shape type of defect, then you have weld bead shape. So, that shape may be

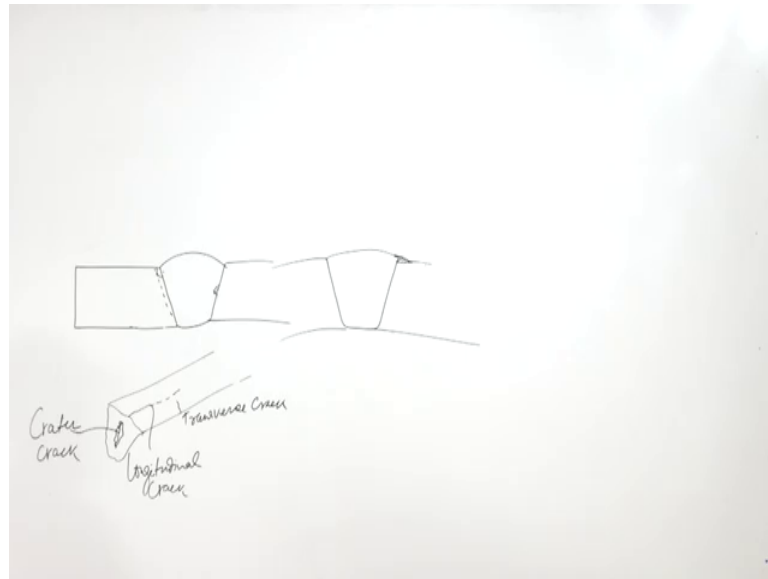
may have you may have the convex type of structure or different improper shape of the weld bead that is also a defect and which comes under this category of imperfect shape. You have also the miscellaneous defects that includes like strike or excessive spatter then you have creation of rough surfaces. So, these are the defects which are coming under this you know miscellaneous defects, then you have also uneven ripples also sometimes generated.

So, these are the defects which are coming under these miscellaneous defects, further the defects can also be categorized under those defects which are visual or which are at the surface and the defects may be the ones which are not visual. So, they are hidden or you can say that they are the subsurface type of weld defects. So, defects which we see at the surface which is which you can by looking at the surface itself you can find whether what type of defect is there or else there will be some surface defects which are inside, like inclusions or so which are there inside you cannot see them.

So, that way you have either the visible defects or you have the invisible defects or the hidden defects, a in the case of visible defects as we have seen we have different defects like you have surface cracks which are there on the surface they are divisible defect. Then you have distortion which you see that is a kind of a visible defect. You have incorrect bead profile, if the bead profile is not correct that is also a kind of visible defect you have you know overlaps that is. So, as you see that if you see that that they are overlapping the weld bead. So, that is a kind of visibility fact under fill then you have unfilled craters.

So, you have this way whatever you see is on surface on the surface you have different marks uneven a surface mark surface roughness these are the visible defects, if you go to invisible defects or our hidden defects in that you have come like there may be cracks which is hidden. So, that is some surface cracks or hidden cracks, then you may have been that you have lack of fusion withdrew which you do not see that the proper fusion has not taken place at the appropriate place. So, that will be the situation of lack of fusion.

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So, suppose you have so in these cases. So, if there is no proper fusion something like you do not see them, you cannot see this improper fusion if it is here than in that way you do not see. So, that is a kind of hidden type of defect then you have the improper penetration lack of penetration is there which you do not see which is not visible from outside. So, that is also an example of hidden type of defect, you have shrinkages blow holes then you have you know micro structural changes which has occurred inside if there has been course a structure because of the temperature.

So, all these things are a coming under the category of a you know invisible you know, I mean a hidden type of defects which we do not see. Now, as we have discussed that there are the different sources which are responsible for having the defect is the improper you know a selection of a process. That is if you have you know deep penetrating source maybe there where you do not require that or you have you know narrow v angle is there.

So, in those cases there may be the cracks in the root portion. So, this is under the improper selection of process category, similarly you have the you have the application of the process welding process itself incorrectly. So, you have not you are not doing the process correctly like you are not putting the improper current, you are putting the improper. Current, current has to be more stored more deposition are the you are not putting the adequate current.

So, in that case the defects which may come because of these improper welding process, many times we have excess metal deposition also. Sometimes we have the inadequate metal deposition and we may have the excess metal deposition also, then a many a times the defect come because of the interaction of the a weld metal with the part which is already present. So, that if there are you know impurities that may you know be interacting with the weld metal. So, if the impurities are left on the surface is not properly cleaned.

So, this is because of the improper cleaning or there are impure substances which react with them and then they form the undesirable you know and they give the undesirable properties. So, it is because of the interaction of the weld metal with the impurities or with the base metal or you may have sometimes the formation of oxides or silicates or so then the another source may be because of the undesirable structure. So, metallurgical structure may be undesirable you could have, you wanted to have a fine grain, but you are getting the coarse grain.

So, that may be because of the undesirable metallurgical structure then may be that many a times you have the formation of certain phases and they are going and depositing at the grain boundaries creating the brittleness in the well bent. So, that is because of that type of reactions which take place or because of the metallurgical you know, lack of methodological you know control of the structure then you have undesirable shape of the weld bead due to over feel or because of the poor profile and poor supervision.

So, already we have discussed about all these different types of you know problems which may come in the case of welding. Now, coming to the different types of welding defects we will discuss one by one about these defects. So, if you talk about a particular type of you know, defect like cracks. So, the cracks basically are most of the mostly dangerous type of defects in the welding and what happens that you have different types of cracks which are defined, like if you have the this weld pool and which is going like this.

So, the cracks you know may develop a. So, you have the this is the weld metal zone and if the cracks are developing likes this. So, this is known as the longitudinal crack and if the cracks are developing like this. So, this will be your longitudinal crack, then this is known as transverse crack, then a crack may also develop in this zone. So, that is known

as the crater crack, now these cracks these cracks are developed, you know if the crack is basically present in the weld metal or in the adjacent z. Then what happens that this is because crack is developing because at that point it is assumed that the stress value has reached to a very high level and that is why the cracks are developed.

So, many most of the time once you have the development of crack then it is the job is not acceptable, if it is on the surface and if the customer will see the crack then certainly they will not be accepting it. Now, the main reason for the crack is that the concentration of a stress at any certain place is becoming more. So, that is how these cracks are getting developed, then you have poor fit up and incorrect welding procedure that also leads to the information of the cracks and a many times you have the age quality improper in those cases, these cracks also a develops.

Now, crater cracks, discussing about the crater cracks the crater cracks are basically caused whenever the welding operation is interrupted. So, once you are doing the welding operation and if you are interrupting in between many a times you have the formation in here basically the crack comes and that basically further aggravates as the welding cools. So, what we do is many a times we are filling these you know a cracks. So, that this crack does not propagate in the case of crater cracks and normally what is seen is that these crater cracks when you are doing the welding and you are stopping sometime, then basically you must have a convex type of you know deposit, you deposit the metal in a convex form.

So, that the crater form cracks are not formed at this place. So, this way you can minimize the chances of formation of a crater cracks and crater cracks are normally formed in the material with high thermal expansion coefficients like you have the austenitic stainless steel. So, in those cases the formation chances of formation of these crater racks are more, then we have the other type of defects also. So, next type of defect is basically suppose you take the distortion. So, we have already discussed about the distortion and in the case of distortion as we see that if you have the improper you know fitting or if you have not ever been residual stresses are going to a larger level. In those cases that may lead to the distortion, for is distortion basically you need to have the proper post weld heat treatment.

So, that you can you know get rid of this distortion. So, post weld you will have to maintain a slow cooling rate so that distortion can be a minimized. Many a times we get the incorrect weld profile and that also has a large amount of I mean remarkable effect on the weld quality. So, because you know now mainly it happens that when you give the first pass and then that pass is not improper in those cases these a weld profiles may be improper. So, the first pass is you know very much important in the case of when you are doing the welding.

So, first many a times what is seen is that when you are giving the first pass that should be by experienced welder and then later on that can be done by a semi skilled type of labour weld first pass has to be basically filled with the very you know a experience type of welders. So, that way you can have the perfect shape of the weld profile, you have other defects like you have undercuts so that is also an important defect. So, as we see in the undercut. So, these undercuts are basically the groups which are melted into the apparent metal. So, the parent metal which is there in that basically there will be some melting and that is normally adjacent to the 2 of the weld.

So, that way like if you have this and here if there is something. So, here that is known as undercut in the case of this you know, but type of weld and normally they are caused because of the excessive current. So, that is your undercut, similarly you have overlap which is occurring. So, in the case of overlap what happens that now in the case this goes in this side. So, that will be some overlap so this way this is known as overlap.

Now, in this case that is known as overlap and they are basically the producers on the weld metal itself you will see that there is this weld bead which is should have this as the correct shape it has gone from here and like this. So, that is known as overlap. So, that basically you know is obvious by looking at the weld bead itself and normally it is caused because of the again excessive electrical current. You have other defects like you have cavities, in the cavities normally what happens that when you are doing the welding and if you have moisture left in those cases also there are chances of you know gaseous pockets which are normally trapped in.

So, that may lead to the cavities formation inside you may have the shrinkages also shrinkage of the metal which is a taking place and further from that also shrinkages cavities may be generated. Solid inclusions as we have already discussed that if it is not

properly cleaned or so in that case the solid inclusions may come up in complete fusion or penetration is may be because of the improper joint or may be because of the improper selection of the welding parameters like welding current or. So, imperfect shape already we have discussed certain types where mainly the you know welding current improper selection that is one of the you know parameter in the case of overlaps.

Then you have the miscellaneous kind of defects where we have males better is there sometimes many times while doing the welding you have the spattering taking place that results into the rough surface of the weld metal. So, you can have basically the reasons to be known first of all once you know that what has been the reason. Then accordingly the you know remedies can be you know taken like if your current is improper then that case the current has to be maintained. Similarly, if you have the you know proper joint is not there being made or fixing is not made in that case you have to have the fixing proper fixing of the structure.

So, all that way you can get rid of these defects and then once you have the defects a you know checked because you have to see that these defects do not appear finally. So, you have the different type of you know tests or non destructive testing methods to see that how these, how can you see that these defects are not visible. Like you are there if they are not there then with that machine if you do the n d t testing and if you get their satisfactory results and you know that tells.

So, depending upon the different types of you know defects, a you can have basically once you know the cause and the remedies of these defects then accordingly you can go for selection of the different you know a parameter selection and then you have you can finally, get a good weld which will be good for the you know customers for the company or so. So, in this way we are now at the end of the lectures.

We have discussed about the different types of also you know defects and then the other you know aspects of welding processes, you can refers the standard books to study because this you must have studied in the case of. You know earlier courses where there must be certain information about the different types of welding defects and basically after getting certain you know knowledge about other welding processes or so or parameters you can have the link. You can make a link between the defect different defects and the different type of you know welding parameters like mainly what you see

is the selection of proper welding parameters, proper preheat or post heat proper you know preparation of the joints.

So, these are the main things on which you have to work and then you can see that all of most of the like that if the stresses generated are less than the chances of cracks will be less, proper practice has to be followed. Similarly, if the proper heat is you know accumulated proper heat is going as input then certainly the chances of cavities I know like improper penetration or improper profile may not come.

So, like that so this way we are we are at the end I hope that you have basically got some beneficial you know knowledge about the course you have developed some interest while studying this course and you will be able to basically you know match this knowledge with the knowledge of the books. You can supplement this knowledge with the by reading more about these things in the books and you can practice even wherever you have the numerical problems you can solve more and more problems especially that comes in the case of casting and forming and then you can have more understanding. and if need arises you can even have basically study of the particular type of process even in detail.

So, I hope you have enjoyed the course, thank you very much for your a kind attention to this course. I wish you a good luck towards the preparation of the exams which will be going on later on and.

Thank you very much.