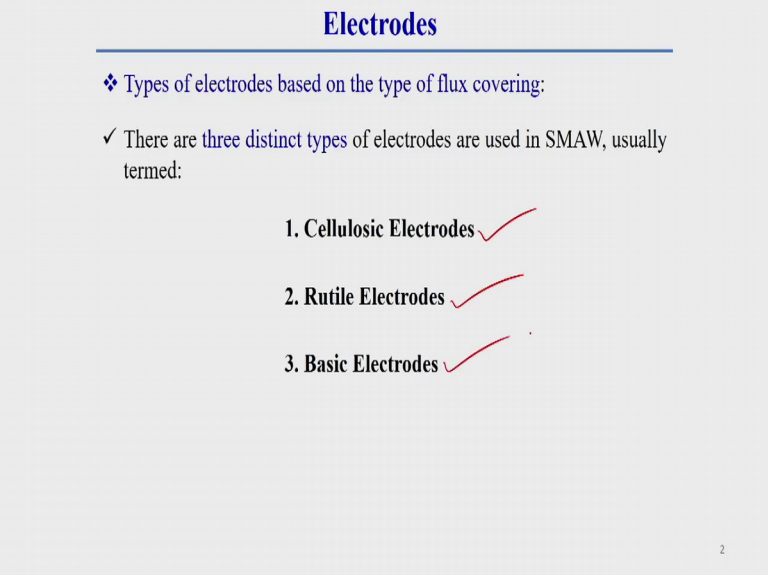
Fundamental of Welding Science and Technology

Dr. Pankaj Biswas
Department of Mechanical Engineering
Indian Institute of Technology, Guwahati

Lecture - 20
Shielded Metal Arc Welding

In last lecture, I was discussing first about the oxy acetylene or oxy fuel gas welding techniques. At the end of last lecture I was started about the SMAW process and I have completed till the classification of different flux copper electrode used in a SMAW process in details. There I completed 2 different categories of flux coated electrode, one is called cellulosic electrode and another one is called rutile electrode. And another categories of electrode also I will discuss in today's lecture. Apart from that I will completed rest of the things related to SMAW process that means, Shielded Metal Arc Welding or shielded manual metal arc welding process.

(Refer Slide Time: 01:22)



So, last lecture I was discussing about cellulosic like categories of different electrode used in SMAW process one is called Cellulosic electrodes another one is called rutile electrodes and third one is called Basic electrode. So, I have completed this 2 cellulosic electrode, rutile electrode. What we observe generally, rutile electrode is a general purpose electrode, it have what is the application, what is the basic feature of their things? I have discussed in details in last lecture.

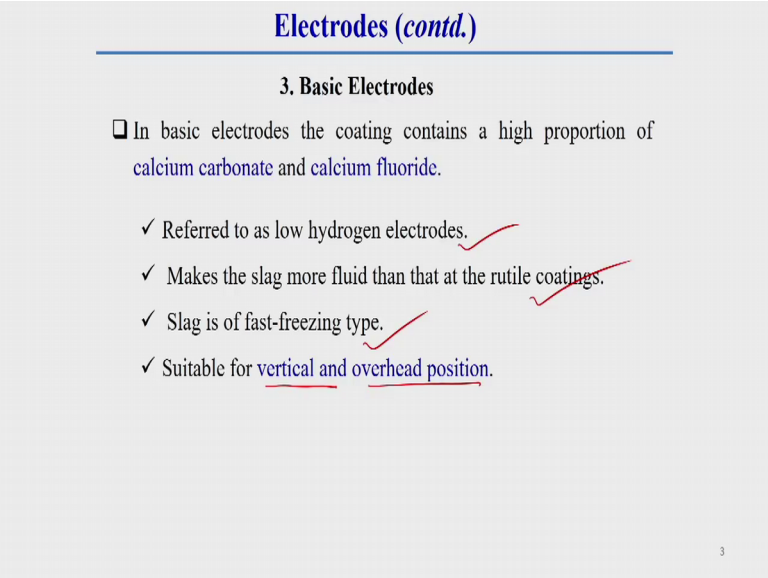
And the I was also discussing about cellulosic electrode in last lecture that there what we observe that is a very good electrode, but it has some drawback also because it has a mechanical property which is good in nature compare to this rutile electrode. And thus in cellulosic electrode what we observe that it has some drawbacks; that means, when its burn in it produce generally hydrogen gases. So, these hydrogen gases high temperatures what we observe that in high temperature it is converted to hydrogen ion. Generally, hydrogen ion at high temperature its volume comparatively lesser than hydrogen molecules.

So, at room temperature when this hydrogen ion converted to hydrogen gases then its volume increase. So, then this draft intermolecular draft hydrogen ions once is converted to hydrogen molecules. Then its volume increase due to that can be occurs embrittlement brittlement or embrittlement of the what is called microstructure of that material. And due to that embrittlement of this microstructure there can be chances of a crack propagation or cracking of welded heat affected zone. That we observed in last class that is the main drawback of cellulosic types of electrode.

So, actually what we observe that you may think so why do these 3 different electrode is require? Because 3 different electrode is required or why these electrode is gradually developing and developing that types of things you can think. The think of this because what happens it has seen that all the electrode the 1 electrode cannot do all the purpose actually so that is how what happens wherever there will be some requirement there will be some research and there will be some new development. That is why this new types of electrode is coming into picture.

Nowadays also you can see that there is different types of electrode is a electrode oriented research or it is going on for different purpose and new different types of electrode is also developing. Now that is why these the different types of electrode, but these are electrode which are widely used electrode in a case of SMAW process that is I am discussing here. So, the third categories of electrode because what we have to we observe that cellulosic and rutile electrode have some drawbacks and which I have drawbacks or we can say some set of which is required for some other welding purpose that we are not getting, that is a another electrode is developed. So, what happens one of the electrode is like basic electrode.

(Refer Slide Time: 04:31)



In basic electrodes there also these electrodes generally do not provide actually what happens, in this electrode generally contain calcium carbonate and calcium fluoride these 2 component present with this flux constituents. So, due to this 2 components present in flux your constituents this have some very good properties which I will discuss subsequently. This electrode do not have hydrogen generation. Actually that is why it is referred to as low hydrogen electrode. This is the main characteristic of this electrode.

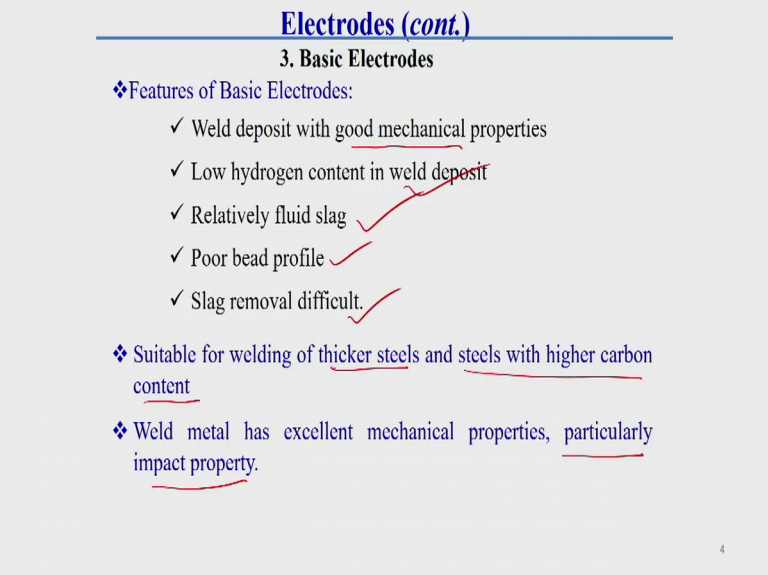
This electrode generally makes the slag more fluid than that of rutile coating. Because you see we have observed generally rutile have fluid types of a slag composition that means, viscous types of slag its produce and its bead shape also depends on this viscous property of slag there we observe that its bead shape also quite good in case of what it what it is called rutile types of bead appearance is good in case of rutile types of slag.

But here it is more fluid than the rutile coating. And here one things you should keep it in mind here slag is first freezing type. That means, it is immediately it is solidifying actually. It is solidifying read is very fast compared to rutile types of due to this solidifying or you can say fast freezing characteristic of this types of electrode is suitable for vertical and overhead position you see you have observed than the other other electrode also able to do positional welding like what it is called cellulosic we observe that it can use in vertical down and properly. But here is that will not be suitable for overhead welding process where as we observe the rutile is suitable for horizontal as

well as vertical position welding, as well as vertical position welding. But what it is called that is not also suitable for overhead position. But due to this fast freezing characteristic of these types of flux and it is solidifying immediately and its viscous characteristics that means, more fluids than that rutile electrode and fast freezing characteristics this you can successively use in overhead position.

This overhead position means due to this fast freezing type fast freezing characteristics of slag here it is solidifies rapidly that is how what happens chances of falling down of molten metal from overhead is less. So, you can successfully use this what it is called electrode in overhead position also. So, you see there is some extra types of advantages than other welding electrodes.

(Refer Slide Time: 07:15)

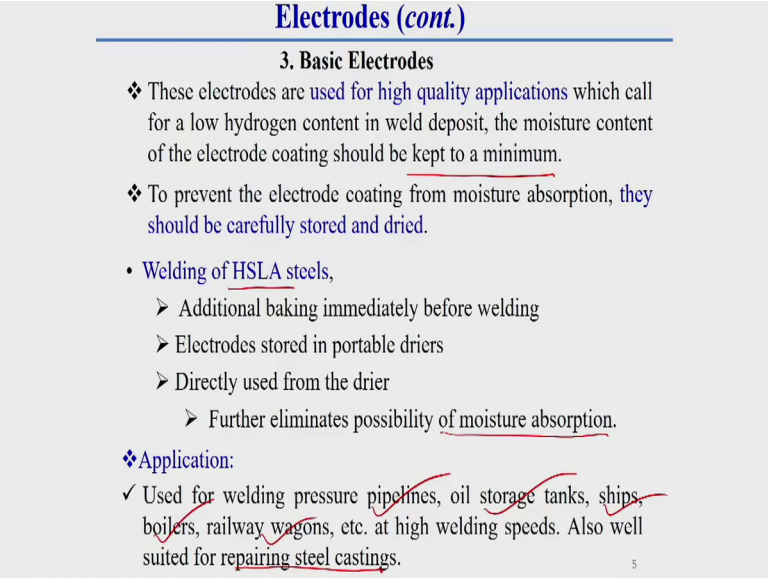


Now, here this is the basic feature of this that means, feature of basic electrodes generally have weld deposit with good mechanical property. What we observe? Though this what it is called rutile electrode is also viscous and liquid property is there, but its mechanical property moderate in nature, but here generally mechanical property is good. Here it is at low hydrogen content in weld deposit as there is no hydrogen content or generally here compared to cellulosic also, it is it has what it is called low hydrogen content in weld deposit. That is how you generally this has very good quality application this types of electrode is used.

That I will tell subsequently. Here it is relatively fluid slag. Here a generally as it is fast freezing type due to this rapid solidification of slag here generally bead profile is comparatively poorer later poorer; that means, poor bead profile there you we get and here another thing due to this fast freezing characteristic and poor bead profile here is slag removal is little, little bit difficult than other electrodes.

Here this electrode is very suitable for thicker steel steels with higher carbon content also and another things we should keep it in mind is generally weld metal has excellent material property especially impact property once you do welding by using this electrode was a impact property is very good. That is how here it is particularly impact property once you do the using this welding electrode then your welding has excellent impact property.

(Refer Slide Time: 08:56)



Now, this basically electrode generally are useful for what I have already told you that for high quality application. Who call for low hydrogen content because as it has very low hydrogen content or you can say here hydrogen is almost is not available that is why what happens it has generally very high quality application it is used. The moisture content of the electrode coating should be kept to a minimum. This you should keep it in mind here once we do the welding by using this electrode moisture content should be minimum as minimum as possible. Then you your weld quality will be good.

Here one things you keep it in mind that is once a electrode exposed in open weather then what happened this flux have a tendency to absorb moisture from atmosphere. So, what happens here to avoid this thing generally once you go for using any electrode or these types of electrode basic electrode you should dry it before doing welding. That is why what happens because these type of flux have a tendency to absorb moisture once there will be moisture in the flux hence during welding it is generally burn and it can produce hydrogen. That hydrogen again can do that embrittlement effect and cracking effect in weld joint. That is why whenever you go for doing welding of welding by using this types of electrode you should dry it properly.

So, that moisture should remove and it should be as minimum as possible. That is why welding of HSLA steel. HSLA is a very sophisticated types of material it is full form is high strength low alloy steel it has it is strength is high, but in this material there is different alloying components are there. Alloying means different very small amount different material is added. In this steel actual this is a type of steel high strength low alloy steel generally. H is for high, S for strength, L for low, A for alloy. So, this has wide application in different industry like shipbuilding industry and other industrial also it has different application.

A thermal power plant or not only thermal generally in shipbuilding industry it has wide application, apart from this it has also application in different power plant application also it has there. Once you go for a doing this HSLA steel welding generally basic types of electrode is best suitable for this. And once electrode is suitable and so when we go for using this basic electrode for doing these types of steel welding material then what happens here generally additional baking generally is used.

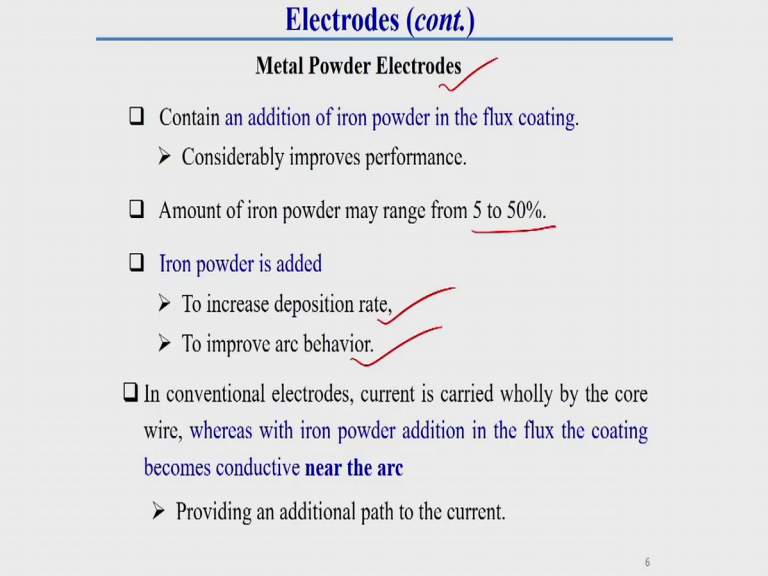
See additional baking immediately before welding generally. What is baking? Baking is a process actually we can say, baking is a process by which electrode is dried. That means, electrode is dried by baking operation. Here what happens there is a drier there which is either some sort of electrical types of furnace or some sort of other means also that their drier can be it is a small container here continuously heating up mechanism is there. So, what happens once you keep the electrode over there, then what about the moisture and other things will be there that will be heat up and that will be remove. That is why once you go for using HSLA these types of drying operation is immediately before welding is done. So, that what happens here the moisture absorption will be

removed and the weld quality will be very good. That is why directly there the that is why this HSLA in this case electrode used directly from drier and generality as it is directly from drier and it is use for welding as for that reason further eliminates possibility of moisture absorption.

That means that moisture content will be eliminates more or less fully. So, that is why this types of baking operation is used immediately before welding in case of HSLA to remove moisture content and remove this possibilities of hydrogen embrittlement.

Application of this types of electrode generally it is used for pressure pipelines, oil storage tanks, shipbuilding industry, ships that is ships boilers, railway wagon and this you can use at very high welding speed also. Also this is well suited for repairing of steel casting part. That means, this is also used for repairing it has this is a practical application of this types of electrode that I telling here.

(Refer Slide Time: 13:33)

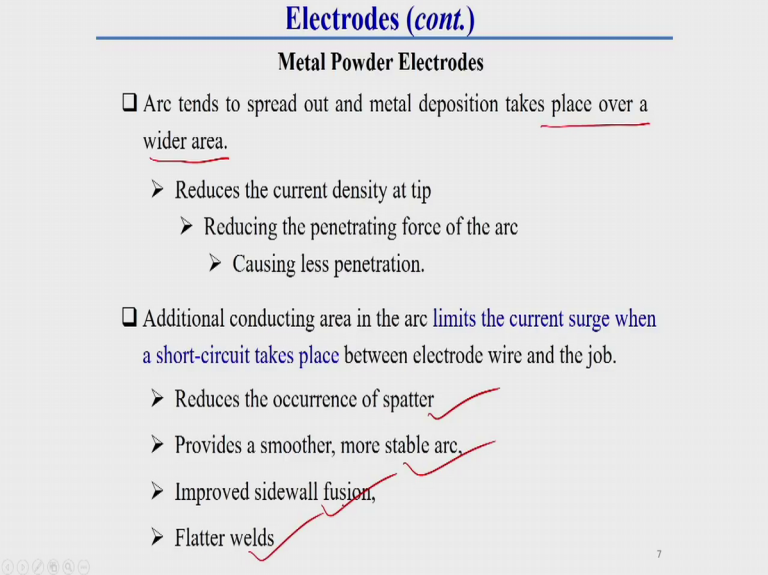


Another types of electrode is also you can see once you will be in industry that is called Metal Powder Electrode. Here generally metal powder is a constituents of the flux. So, I here generally it is contain an additional iron powder in the flux coating. Due to this excess amount of iron powder containing flux coating, it considerably improve the performance of the welding operation. How it is that I will discuss subsequently. Here this amount of iron powder in flux composition can varies from 5 to 50 percent. Generally iron powder is added generally to increase deposition rate and to improve arc

behavior. This you keep in mind. How it is increase deposition rate and how its improve the arc behavior that I will discuss.

In conventional welding electrode whatever the electrode I told you already discuss 3 different their current is carried wholly by the core wire whereas, with iron powder addition in flux the coating become conductive near the arc. So, here this flux cover as it is contain some iron powder, it is also provide some conducting path. So, as it is providing additional path of current. So, that is why generally here arc tend to spread out and metal deposition takes place over a wider area. Here these things you keep it in mind. Because here the conducting area is increases due to this arc tends to spread out.

(Refer Slide Time: 14:52)

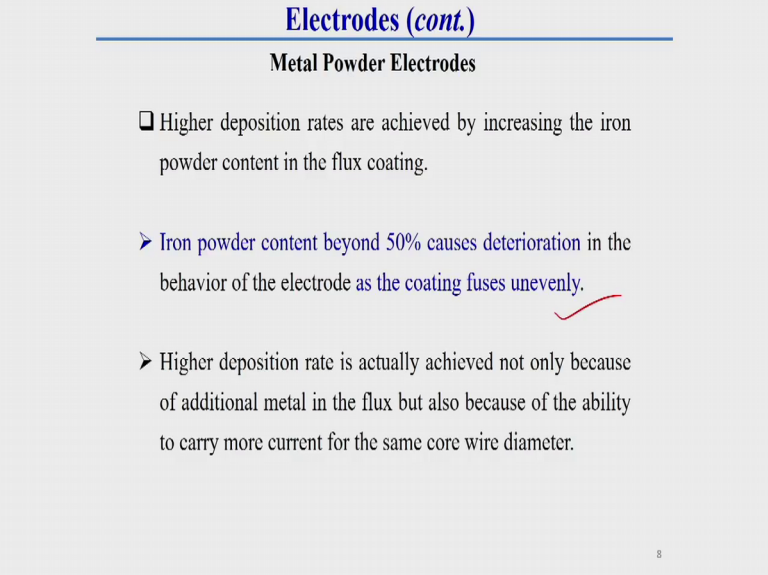


So, what happens as the arc is spread out. So, what happens there is a chances of metal deposition area will be wider. So, as the arc area increases we know because due to this extra conducting path or extra current flow through the flux coating. So, here definitely your current density will be because arc cross sectional area is increasing where you know then arc current density generally ampere per millimeter square; that means, ampere per area that is called current density what I have already discussed. So, generally it as the area is increasing so current density will decrease. So, once current density will decrease then penetrating force will decrease. So, once penetrating force will decrease then what happened here, less penetration is occur due to this excess flow of current through flux bubble.

Now, additional conducting area in this arc generally limit the current surge when a short-circuiting types of take place here. One things you keep in mind, as the current is flowing through this flux coating so, what happens? Once the short circuiting will be taken place then what happens there is a chance of less current surge; that means, current rise will be slow or less generally due to this higher conduction of current through flux square. That is why general what happens? so during short circuiting types of metal transfer this types of flux coating is one way we can say good because due to this less surge of current occurs in case of short circuiting types of metal transfer.

Due to this things what happens for this reason extra conduction of current through flux cover what happens here, reduce the occurrence of spatter, provide a smoother and or more stable arc, improve sidewall fusion and flatter welds. Why this things occur that you understand. That because what happens it generally increase the wider the bead area or you can say wider the arc so, bead area. So, that is why a sidewall fusion also will be good. And what happens due to this wider arc area here bead becomes flatter.

(Refer Slide Time: 17:24).

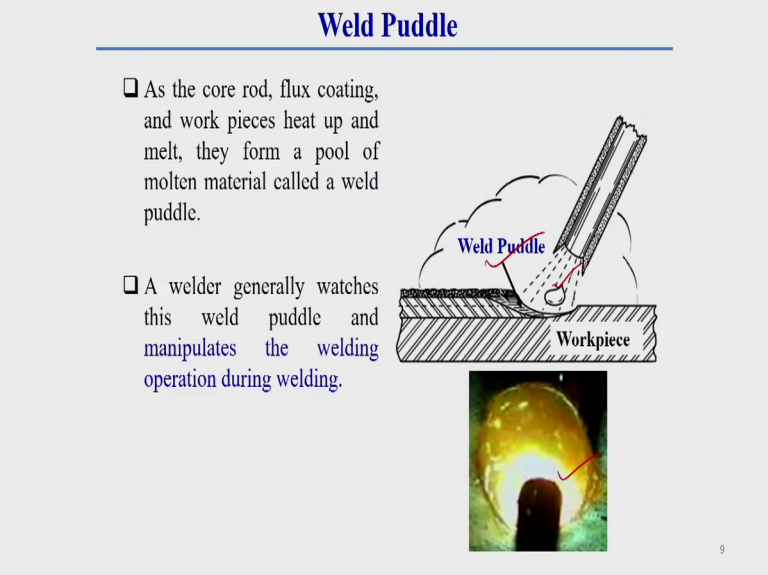


Now, here generally higher deposition rate in this metal powder electrode higher deposition rate are achieved by increasing the iron powder content into the flux coating. But one things you should keep it in mind, that in first slide itself about this flux coating I told you here generally this range of means this metal powder should not exceed 50 percent. Because what happens? If we use more than 50 percent flux over these then

generally these electrode behavior deteriorates. Because, why this deterioration occur? Because due to this high content of what it is called metal powder in flux there can be a high flow of current and due to this high flow of current there can be chances of high resistance, due to this high resistance there can be what happens, there can be coating fuse unevenly. So, due to this what happens? This can clear that this electrode behavior deteriorates if it is go beyond 50 percent what it is called metal powder content. That is why generally it is better to keep the metal powder below 50 percent ok.

Here another things you should keep it in mind, higher the position rate is actually achieved not only because of additional metal flux but also as it is contain additional metal flux in flux coating it has a chance to carry more current. Because due to this more current and additional metal in flux coating. So, deposition rate increases that you should keep it in mind.

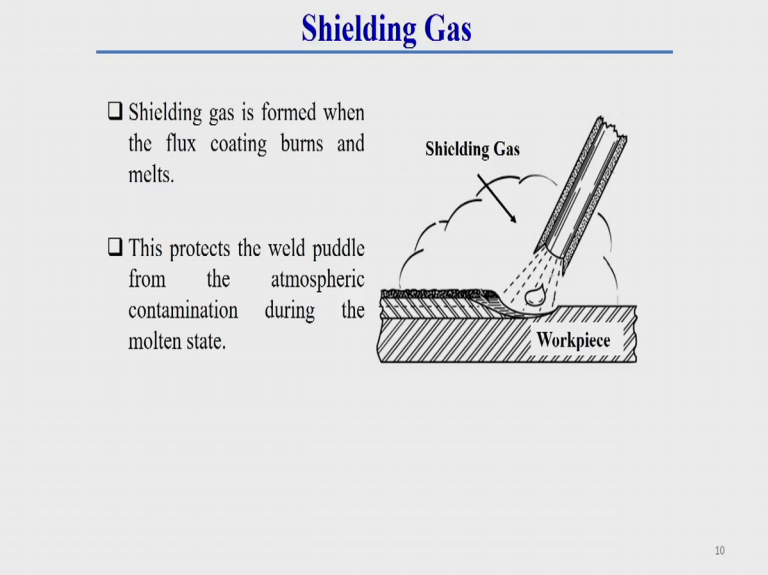
(Refer Slide Time: 18:58)



Now, we will go for other constituents of what are that because we are discussing about different constituents of SMAW process. There we observed that one constituency is electrode another one is Weld Puddle. Weld puddle actually it is representing here itself generally weld puddle is a molten pool. Molten pool of what? Molten pool of base material these electrode material and that flux. So, once this flux burn or may melt on this metal melt, base metal melt and the electrode melt generally this form a molten pool. These molten pool is called a weld pool. Generally these you have always keep it in

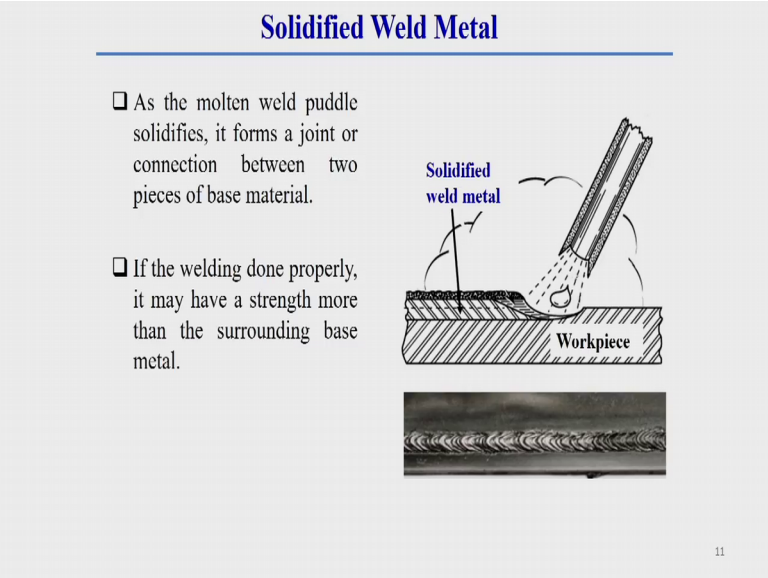
mind welder manipulate the welding operation to see this well puddle. It is weld visible to welder or generally which weld visible this weld puddle. So, what happens to see this and manipulate the welding operation during welding? This is generally shown the picture of a weld puddle.

(Refer Slide Time: 20:00)



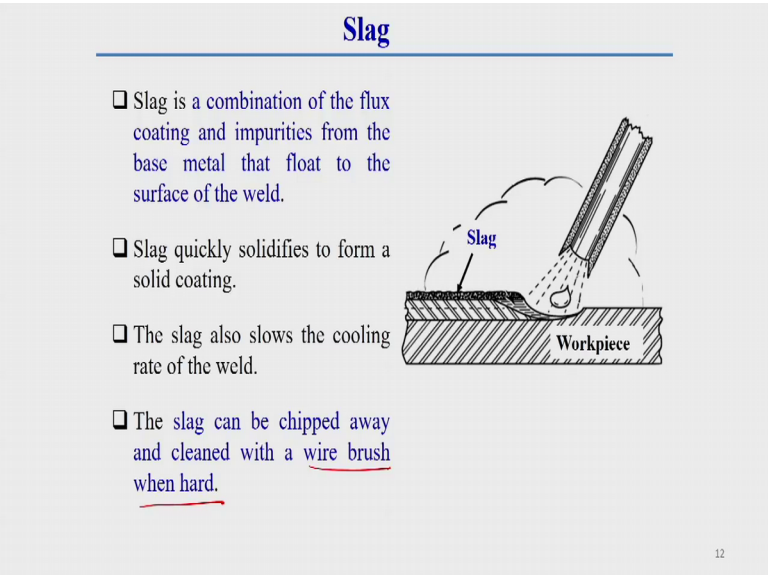
Now, the other constituents is shielding gas. What I have already told you shielding gas is generated due to the burning of the flux cover. That means, once this flux cover burned, generally it produced some gases. This gases generally protect the molten pool or we can say molten puddle from atmospheric contamination. So, that is why its act as a shielding medium that is shielding gas actually.

(Refer Slide Time: 20:26)



Now, this solidified weld metal and another constituent that also I have discussing. Solidified weld material means, when these electrode material or weld material and base material solidifies it form a joint or connection between 2 piece of base material. So, here if the weld form a joint or connection between 2 piece of base metal. You see this is generally represent solidified weld metal or here a practical real view a real picture of this solidified metal. Generally here one things you keep it in mind if the welding is done properly this solidified metal can have more strength than the base material.

(Refer Slide Time: 21:09)



Now, we will go for slag. That what I have already discussed that means, when the flux burn generally then it is converted to slag, then it is generally call slag. Here one thing you keep it in mind, slag is a combination of flux coating and impurities from the base metal that float to the surface of the weld. Its float the surface of the weld why because its volume comparatively much lesser than molten metal volume. That is why what happen its float over the surface of the molten pool so and it is solidify it is also solidify very faster than molten material.

So, due to this what happen it is provide a solid cover over the surface of the molten pool? Due to this solid cover it is also I have already told you it is also reduce the cooling rate. So, here due to this a solid cover have generally slow cooling is occur due to this slow cooling what happens here there are a weld metal ductility also increased. So, here one things you should keep in mind this slag can be chipped away and clean with a wire brush when hard. Generally this is required at the end of the welding you generally this slag removed from the welded portion by using a wire brush that wire brush used to clean this slag.

(Refer Slide Time: 22:31)

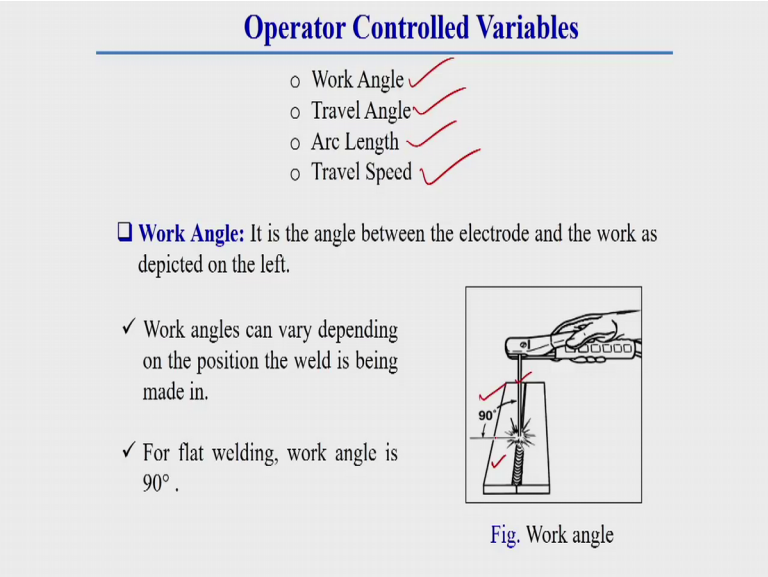


Fig. Work angle

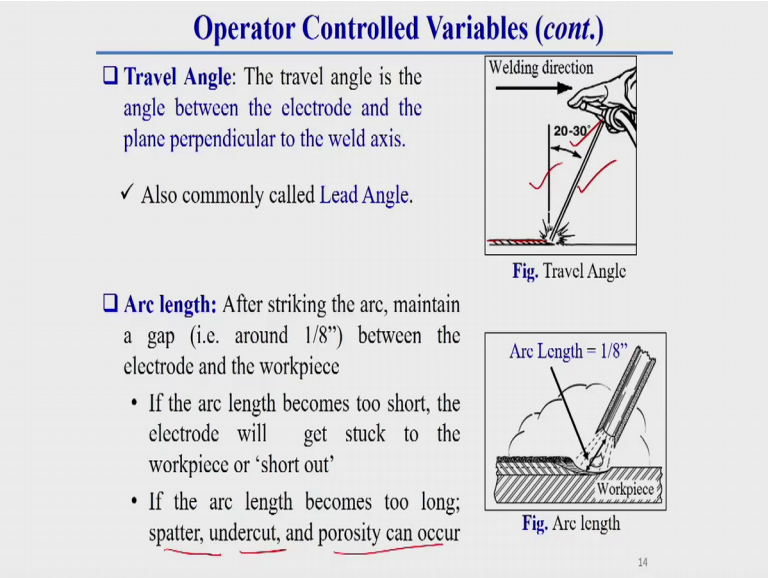
Now, here generally so these all about the different constituents of welding process. So, now we will go for what are the operator controlled variable. What are the different types of variable which can be controlled by a operator here? Actually I am not discussing about what are different operating variable of different welding process because what

happens, what I have already discuss in at the end of the physics of welding topics there are different types of operating by that is current voltage, speed everything that what I have already discuss in details over there. It has same function here also. So, in every welding process that I will not discuss. Here I will discuss some extra we can say extra signifidoes not aspect, extra significant parameters if it is used for this types of if separate seperate welding process that I will discuss for a particular types of welding process. Here like this operator controlled variable here it is very important variable for these types of welding process.

One is called Work Angle, another one is called Travel Angle; another one is Arc Length and Travel Speed. So, these generally can be control be operator by this welding process because it is a manual welding process. So, this is controlled by operator only. So, generally this I will just discuss subsequently until what is this thing in details here I will discuss.

So, first of all work angle. Here you see work angle is the angle between the electrode and the work depicted on the left. You see this is the work which depicted on the left it is the angle between this electrode and this work. If the work at the here you see for different types of position welding this angle is different. But for a flat types of welding operation its angle generally you within the range of 90 degree that means, its angle is 90 degree in case of flat types of welding operation. Here you see this is the angle 90 degree this is the work angle for flat types of welding operation.

(Refer Slide Time: 24:39)

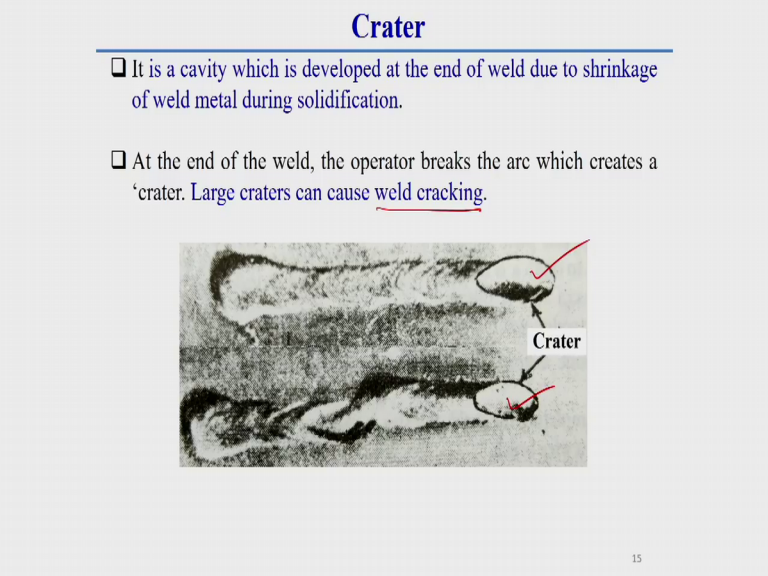


Now, travel angle. Travel angle it is the angle between the electrode you see this is the electrode and the plane perpendicular to the work axis or we can say perpendicular to the weld axis. So, if the angle between the electrode and the plane perpendicular to the weld axis you see this is the weld axis. So, here generally a perpendicular you see a perpendicular plane once you provide between this perpendicular plane or we can say perpendicular plane and electrode whatever the angle is there that is called travel angle. This is also known as lead angle. Travel angle or you should know also what should be the range of this travel angle. Travel angle generally varies within a range of 20 to 30 degree, that here it is showing for this types of welding operation.

Then arc length arc related thing I have already discuss in physics of welding in details, but here also what is the range of arc length are there that you should know. Here arc length is we have within a range of 1/8 inch were within a range of around three millimeter or you can say within a range of around diameter of the electrode. So, here what is this arc length? Generally arc length is the distance between base material and electrode tip whatever the distance or gas if there that is generally called arc length. Too short arc length is not good or too high arc length also is not good what I have already discuss in detail because if the arc length become too short the electrode will get stuck to the workpiece or that can be short out ok.

So, if the arc length become too long there is a also chance of a spatter, undercut, porosity can occur that I have already discuss. So, here I will not discuss in detail about, but here just these are the thing generally welder can operate or control. These are the operating variable can control that is why I am telling here. Another one is travel speed what I have already discuss travel speed means, the speed at which this electrode moves through the welding per unit time that where that what I have already discuss. Generally through the welding line; that means, the how much length is depositing per unit time that is generally called travel speed. Here generally too high travel speed also is not good too low travel speed is also not is not good that as I have already discuss in physics of welding. So, it has also similar effect here.

(Refer Slide Time: 27:07)



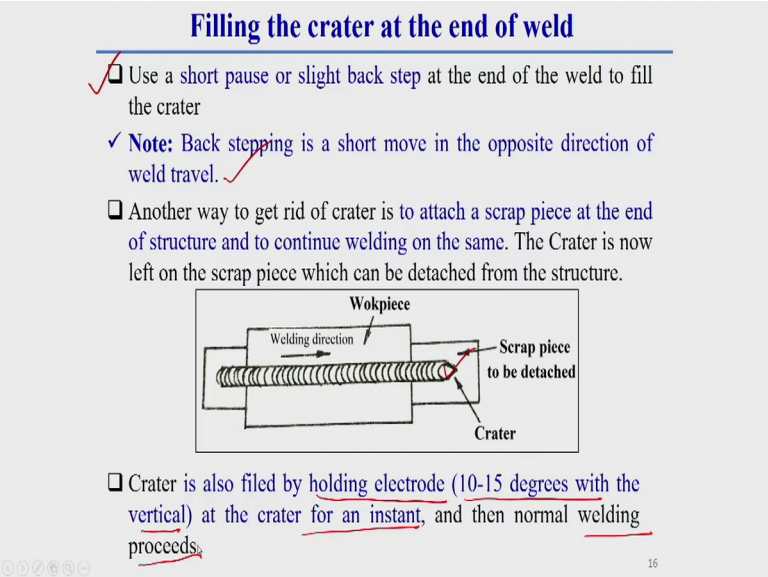
So, you see then we will go some what are the another different types of aspect or important aspect generally we found in this types of welding that I will discuss one by one. So, first of all in this welding operation most of the welding operation this thing happened, but in this welding operation this has significant effect and this is very frequently workout this types of phenomena, that is called crater. Crater generally it is a cavity which develop at the end of weld due to shrinkage of weld metal during solidification.

So, what is crater? It is a cavity it is a generally you see at the end of the welding operation you will see there is a depression or a due to shrinkage or there is a cavity type

shape which shape is like this you see this is the end of the welding position as you see, here generally cavity types of shape is generally developed or depression of or concave types of cavity generally is there at the end. Why this is occur? Due to solidification and shrinkage effect of weld material this types of things generally occur. So, at the end of the weld why this is occur the operator break the arc due to this breaking of the arc here this crater is generated.

Here one things you keep it in mind this crater is a place where there is a chance of develop crack. So, always you should keep it in mind, you should eliminate or remove the crater during welding operation. Otherwise there will generate crack or other thing, because due to the depression and other things there is a chances of crack generation. So, that is why larger crater can cause weld cracking. Here it is telling actually. Larger crack can cause weld cracking also. Now we will discuss how to fill this crack, how to eliminate this crack that is I will discuss in subsequent slide

(Refer Slide Time: 29:04)



So, first of all filling the crater at the end of the weld how we can do this thing? Because in this welding operation generally this is a very vital aspects or you can say vital types of aspects we find in this types of welding operation. So, how to fill this crater that we should know. This we can fill by different types of way or this you can eliminate by different types of way. One is call back stepping method. Here use a short pause slight back step at the end of the weld to fill the crater.

What is back stepping? Back stepping means a short move in the opposite direction of weld travel that means, wherever there will be some crater you have to just move your electrode back and fill that things and do the welding operation again. So, back stepping this method is generally called back step a short move in the opposite direction of weld travel and fill the crater. This is one way. Another way can be use a separate scrap material at the end of the weld and continue the welding operation till scrap material and then crater is left on the scrap piece which can be generally detected detached which can be detached from the structure.

So, here generally crater is left on the scrap piece here it is crater scrap piece which can be detached after welding operation from this structure. Sorry which types of things you can see once you will be in the industry actually there generally these types of different procedures generally is used. Here we have to make the welding continuous and at the beginning at the end also there is 2 scrap material generally use is; that means, a start welding start from a scrap material continue to main material work piece and after that also it continue to another scrap material after that it tend remove this 2 scrap material we can remove and you can get a very good weld quality you can say continuous types of weld quality. So, this types of this is; so, this is another method to eliminate what it is called crater. in case of SMAW process.

And crater is also filled by holding electrode you see, that holding angle of the electrode is around 10 to 50 degree with vertical this holding the electrode at the crater for instant, and then normal welding proceed. That means, wherever there is a crater hold the electrode for a particular instant, or for a particular time and then normal weld welding proceeds this way also you can eliminate the crater.

(Refer Slide Time: 31:52)

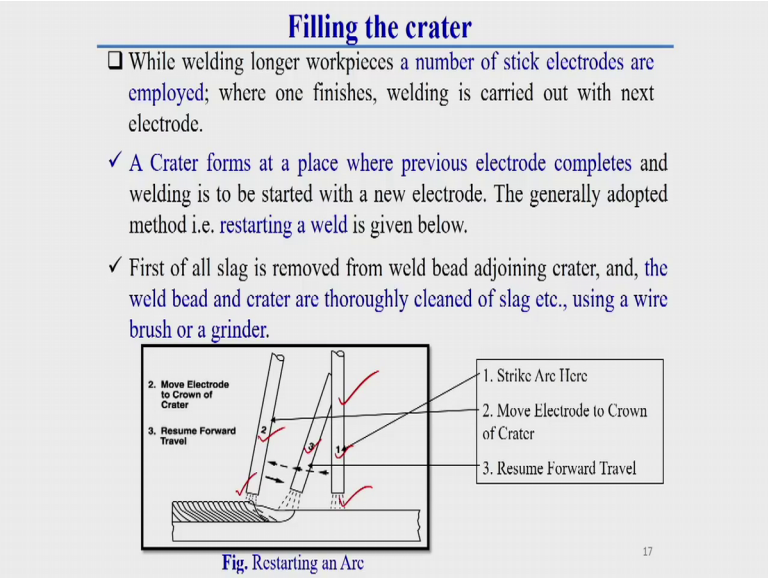


Fig. Restarting an Arc

You will see this crater effect is very frequent on the workpiece is very long because why this crater effect is very high. Because here generally while welding with long workpiece a number of stick electrode are employed. So, when one finishes then generally then, welding is carried out with the help of other electrode. So, here there is a number of start and stop of welding operation was there. Due to this number of a start and stop of holding operation a at the end of one electrode get a crater. So, what happens then we should eliminate this crater. How we can eliminate this crater for this long run welding operation that I will just did. So, here used a technique that is call restarting of the arc. So, this by using this restarting of arc we can eliminate what it is called crater effect in case of long run of SMAW process. There what happens very good technique that is called restarting of arc.

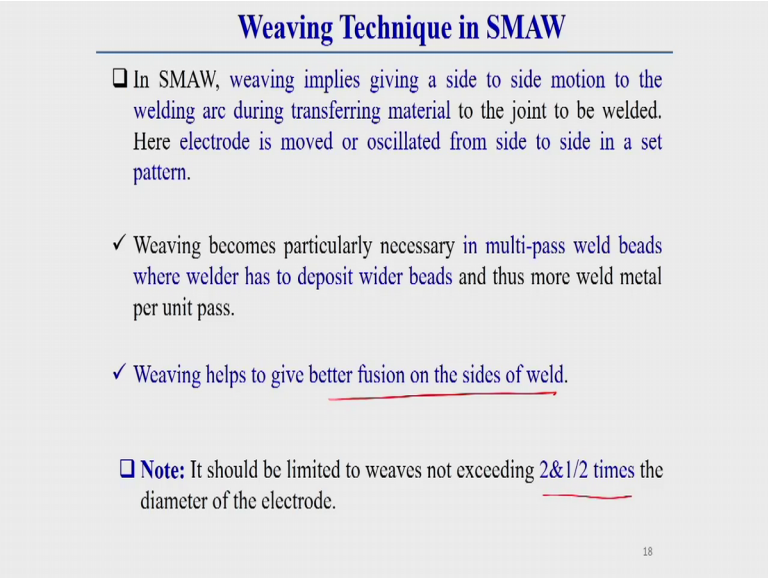
Here generally restarting of arc have some sequences, that I will just explain. Once you use that types of restarting sequence then you can eliminate the what it is called crater effect in case of long run types of welding operation. So, a crater generally formed at a place where previous electrode complete and welding is to be started with a new electrode that what I have told you. Generally here what is done first of all before restarting what happens, slag is removed from the weld bead adjoining crater and the weld bead and crater are thoroughly cleaned of the slag etcetera. How slag we have to removed near the crater region, then we have to clean it is properly by using wire brush or grinding by using grinding operation also you can do that things. After that you have

to do what it is called restarting because if it will not be clean properly then there is a chance of slag inclusion inside the weld metal that is also a defect. So, we should clean it properly.

Then this sequence of restarting procedure is required to do what is the sequence or restarting of weld are there? Here generally you have to generally tap the electrode away from the weld region after that you see, so here after the tapping you have to start the arc here immediately at the second step move the electrode to the crown of crater after that this third step you see this is first step, this is second step and resume then after that resume the forward travel and do the welding operations.

So, you see. So, first of all you have to start the weld away from the welding region by tapping method, after that immediately you have to move the electrode to the crown of the crater and resume the welding operation by forward travel. Like this is step 3. So, if you do the restarting of the electrode by this way then what happens this crater will be eliminated? So, these are the different process by which you can eliminate crater from welded joint. This is very important aspect of SMAW process you should keep it in mind.

(Refer Slide Time: 34:53)

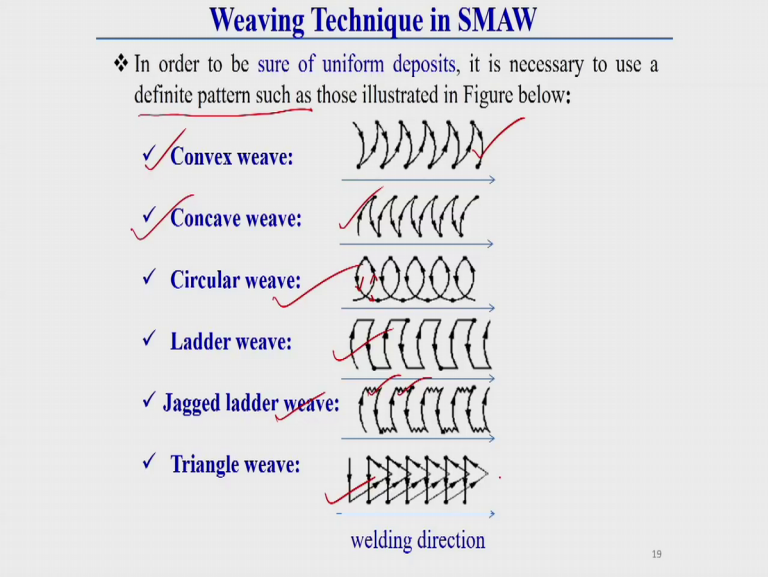


Now, we will go for weaving technique in SMAW. This is a very interesting and important aspects which is used in SMAW process generally weaving generally is implies giving a side to side motion to the welding arc during transferring material to the

joint to be welded. Here generally electrode is moved or oscillated from side to side in a set of pattern. So, generally this weaving operation is required to do where more material is required to deposit and weld bead shape require is wider, this types of weaving operation is required to do.

Especially for multi pass where more material and wider bead shape is required or thicker section this types of what it is called? Weaving operation or weaving technique generally used, weaving helps to give better fusion on the side of the weld. This also not only wide in the weld bead it is also gives better fusion at the side of the weld bead also here one things you should keep in mind this whatever the weaving width should be in a welding operation that should not exceed 2 and half times more than the what it is called electrode diameter that you keep it in mind.

(Refer Slide Time: 36:11)

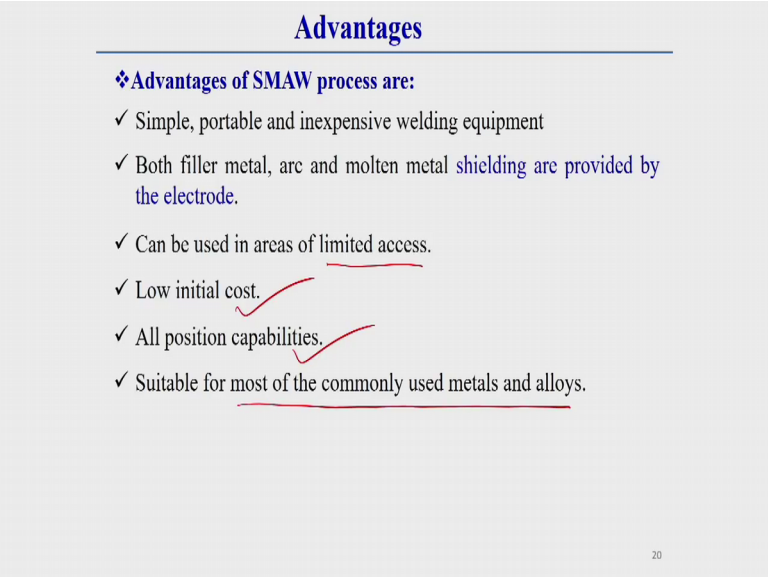


Now, we will see to there are different types of what it is called weaving operation are there. So, in order to be sure of uniform deposit it is necessary to use definite pattern of weaving operation. So, too sure of uniform deposit definite pattern generally, it is not do arbitrarily that is different very definite pattern are there that we should follow. Generally the for doing weaving operation. Here like this can be here I am just showing these 6 different weaving operation which generally widely used for during weaving operation. That is one is call convex weaving here you see how the movement these arrows represent the movement of the electrode.

How this movement should be movement of electrode should be there it is this is call convex of weaving. This can be concave weave also or you can say concave weaving operation. So, convex concave weaving operation here it is generally opposite to this convex weaving operation. This can be circular types, how the circular types you see this arrows representing as you see how it is generally continuously moving and how the circular shape is coming. So, this is called circular weave.

Then another can be ladder weave how this ladder weave is done? This is the ladder weave operation. This can be jagged ladder weave you see this horizontal position generally there is a some zig zag motion. So, that is why it is called a called jagged ladder weave as jagged ladder weave weaving operation. It can be triangular shape how this triangular shape is there that is also given; that means, this arrow represent what should be the moving direction how it is it is makes a shape of triangular in nature. So, this is generally call triangular types of weaving operation. So, different pattern of what it is called a weaving operation over there. So, once we follow this pattern of welding operation or weaving operation then we can get a uniform weld bead deposit.

(Refer Slide Time: 38:15)



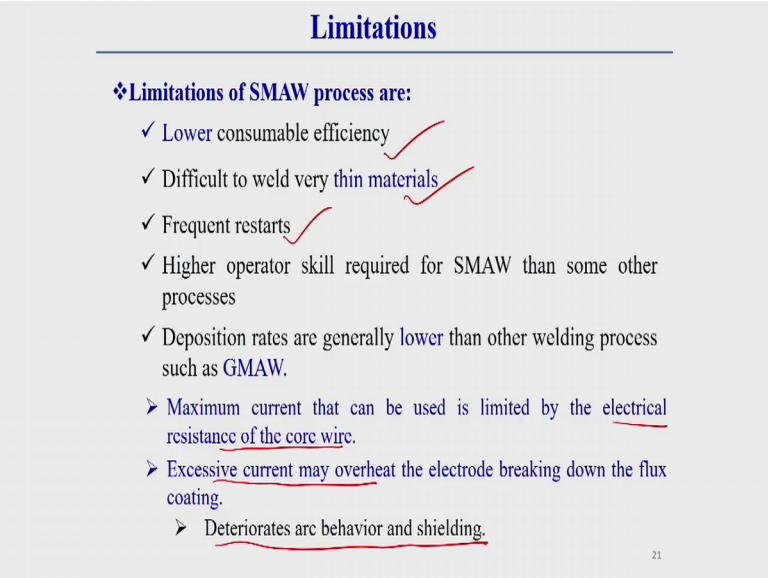
Now, we will discuss that what is the advantage of this welding operation? What is the drawback of this welding operation? Then what is the application of this welding operation in details. Here you see this welding generally have different advantages these are the following advantages we can observe in this welding operation like first of all this

welding is simple, portable, well and expensive welding equipment of there. So, here generally simple portable and inexpensive welding equipment is used. Here the another thing both filler material arc molten metal shielding generally are provided by electrodes.

So, whatever the shielding here we are providing every shielding of molten material electrode arc everything is shielding by how by electrode only because it is providing shielding gas as well as flux or slag cover due to this generally it is shielded the molten pool as well as arc as well as what it is called a filler material. This can be used in the area of limited access; that means, where a small special limited area access is there also you can do the welding by this welding methods.

So, limited access position in limited access position also you can use this welding operation. It has very low initial cost compared to other welding techniques it has also all position capability because I have already told you why this welding operation you can do horizontal, vertical, overhead welding policy welding process that it means, all position capabilities of welding operation you can do by this welding method. And this is a welding method which we which you can use most of the commonly use metal and alloys. So, you see. So, many advantage of this welding techniques are there.

(Refer Slide Time: 40:13)



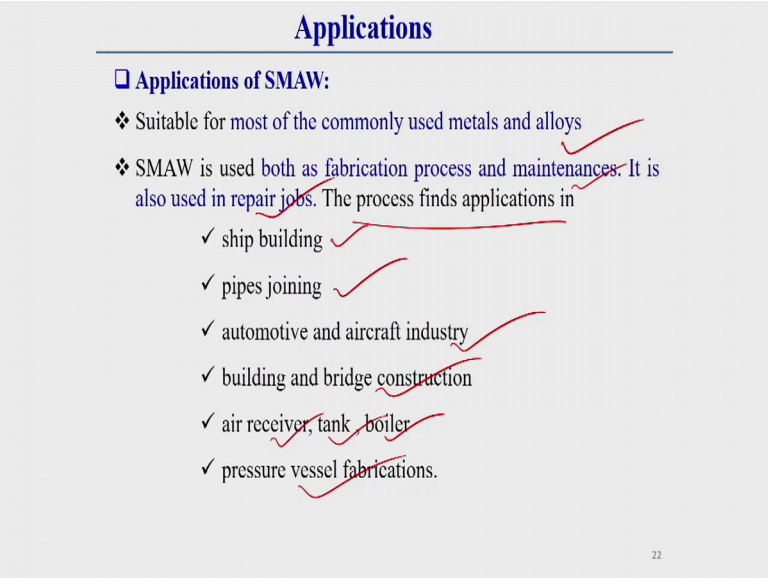
Now, we will see what is the limitation of this welding process. because you we see here there is a advantage there is some drawbacks also, but a what is this drawback? Generally lower consumable efficiency here whatever the consumable we are providing

it is efficiency is lower difficult to weld very thin material. What I have told you it is a stick welding generally what happens during starting of the arc itself there is a chance of what happens melt through of that thin material is there. That is why it is difficult to weld very thin material because there can be melt throughout that thing that is why it is difficult this is a drawback of this welding process. This another thing here stick is use. So, very frequent restart will be there.

If the welding length is higher side then very frequent restarts also are there and here one things you should keep it in mind here generally operator skill should be comparatively better than other welding process. So, higher operator skill is required in SMAW process then other welding process. Because here so, many technique so, many things is required to control what I have already told you. Here another things you should keep in mind deposition rates are lower than other welding process like GMAW, like GMAW that is dash metal arc welding or mig welding technique, why that you should know. Because here one things we should keep it in mind we cannot increase the current through the electrode as much as possible. Why? Because what happens this electrode have a resistance due to this electrode if the current flow will be more through this electrode there is a chances of overheating of this electrode is there. Due to this overheating means there is a chances of deterioration of the flux cover is there.

So, what happens? So, we cannot deterioration of flux cover and there can be uneven breaking of flux cover is there. So, if there will be uneven breaking of flux cover then that create some defeat that is not that will not provide good quality welding. That is why what happens here is a limit of current flow through the core wire are there. So, we cannot increase current as we want ok. That is why maximum current that can be used is limited by the electrical resistance of the core wire. This we can keep it in mind. Because excessive current may overheat the electrode braking down the flux coating, due to this overheating of this what it is called core wire there can be electrode breaking down. So, what happens is we will that deteriorate the arc behavior and shielding then we are whole quality will be defective.

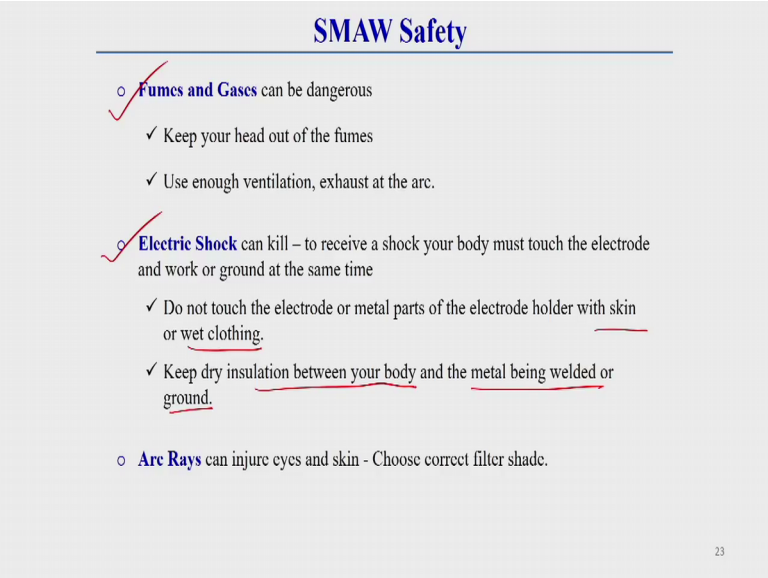
(Refer Slide Time: 42:55)



Then we will go for application you see this welding techniques have lot of application. Lot of application in the sense it is generally suitable for most of the commonly used metal and alloy this shielded metal arc welding is used both as fabrication process and maintenance it is also used in repair job. The process find the application in the following industry or you can say in following industry lot like in shipbuilding industry, piping joints, pipe join, automotive and aircraft industry, building and bridge construction, air receiver, tank, boiler, pressure vessels fabrication. So, it has different application of this SMAW process.

So, you say these are well about this welding process. Generally you know is every welding process generally this will be a sequence of pattern of discussion. Like first of all in the there will be introduction of that welding process then there will be set up of this welding process. Then there will be principal of this welding process. Then there will be different important aspect of this welding process and at the end there will be advantage disadvantage and application of this welding process. And if there is any safety precaution that also we will discuss.

(Refer Slide Time: 44:18)



So, here also in this welding operation there is some safety precaution in this that you should keep it in mind. Generally in this welding of process you observe there generate fumes and gases this fumes whatever the fumes and gases are there that can be harmful to welder or whatever whoever do the welding that can be harmful that is why always keep it in mind keep your head out of the fumes used in a ventilation and exhaust at the arc. Nowadays, for doing this welding operation in shop generally there is use some extraction system, which extract that fume and other things so, what happened there is a chances of less effect to weld or there. Then another so this is one safety precaution is there. That means keep your head away from the fumes or gases ok.

Then second one electric shock. Here there can be chances of electric shock because what happens, if there their bodies touch the electrode and work piece at a time then there is a sudden shock can be there and which can be dangerous to the welder also can be there. So, that is why do not touch the electrode or metal part of the electrode holder with skin or wet clothing. This you should keep it in mind. Keep dry insulation between your body and metal being welded or ground. So, dry insulation should be there is there is the generally for doing the welding operation there is generally use some gloves types or things also there. And there is some separate types of clothes and other thing used for during this welding operation.

So, this always keep it in mind you should not touch the workpiece and electrode simultaneously at a time and we should keep dry insulation between your body and metal being welded or ground. Then another thing also in this welding operation are generated that is generally ray at the night times you can see or generally where this types of welding operation is done there you can see there is a thunder light, thunder types of light coming out somewhere at the night if that type is sparking types of thing.

So, if this is a very a very dangerous types of ray you can say. This is generated due to this arc or a spark between this electrode and workpiece. This arc ray can injure your eye and skin. So, that is for the for that reason always we should keep in mind you should wear correct filter shade of goggles during this welding operation otherwise your eye can be damage. So, these are the different generally safety precaution of this welding operation.

Now in next lecture I will discuss about another arc welding process and that is called GTAW; that means, gas metal arc welding process. In this gas metal arc welding process or you can say sorry GTAW; that means, gas tungsten arc welding process so, in next lecture I will discuss about another arc welding or electric arc welding process that is called GTAW process. GTAW means gas tungsten arc welding process or simply that is call teague welding process there also I will discuss the similar way that mean there also will be introduction of GTAW, there also will be setup of GTAW, there also will be what it is call principle of GTAW, then if there is any special aspect of that welding operation is there or not after that at the end I will discuss about advantage, drawbacks or disadvantage and limitation and if there is any safety precaution is required that I will discuss. So, in this way next lecture also I will discuss about another arc welding process.