Marine Construction and Welding

Prof. Dr. N. R. Mandal

Department of Ocean Engineering and Naval Architecture

Indian Institute of Technology, Kharagpur

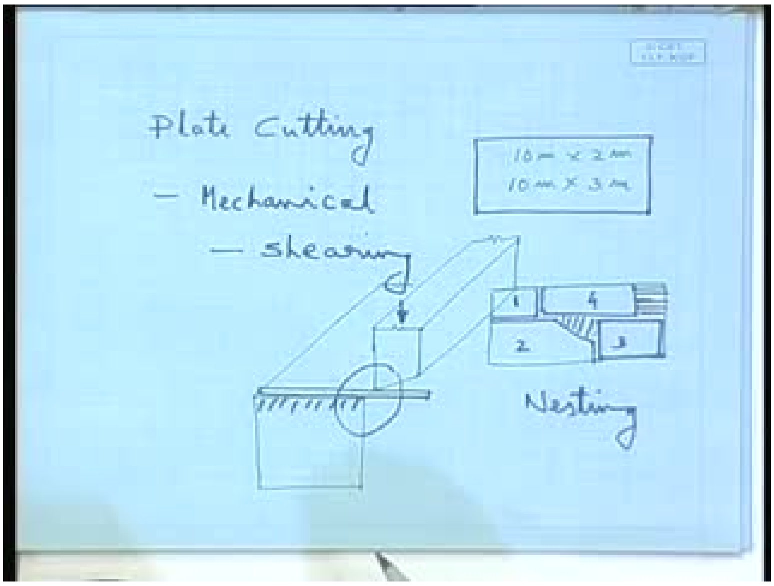
Module No. # 01

Lecture No. # 21

Plate Cutting

We will take up with the plate cutting processes, because as we have seen, in the entire ship construction or ship building sequence of activities, after your plate preparations, then you have to cut the plates to the required size.

(Refer Slide Time: 00:47)



The plates come in standard sizes, we have talked about it. Just repeating it once again that generally of this size; that means, 10 meter by 2 meter or 10 meter by 3 meters - the standard dimensions, standard sizes. There are rolling mills that also produce 10 meter by 2.5 meter that is also there, but most popularly 10 by 2 or 10 by 3. In different thicknesses they are available - various thicknesses, the thickness variation could be at 0.5 millimeter interval to a certain thickness, then could be 1 millimeter interval, then could be 2, 5, different. So, you have plates of say 4 millimeter, as well as you have plates of 80 millimeter – different, depending on your requirement you can get your plates. So, you get them flat – straight, I mean flat of this standard size. Depending on your requirement, you will have to cut it. That cut plate can be anything that means with in this you have the plate.

So, in fact the operation needed is that once the sizes, and dimensions and the shape of the cut plates are established, then you will have to put those things with in this standard size of plates. That means, you will have to mark them, do the necessary marking or you will have to draw it, whatever.

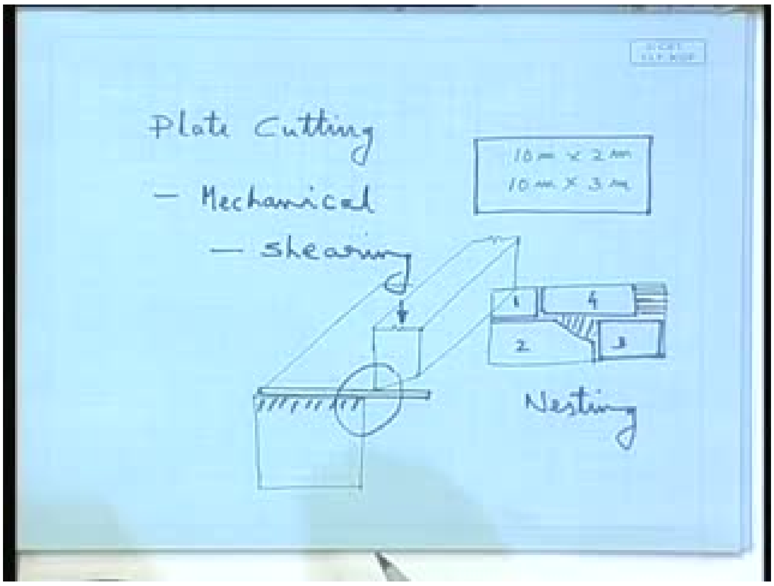
Suppose your requirement is say 1, 2, 3, 4, there are four typical shapes are needed, just arbitrary example I am giving. So, once you have that - once you know this size and the shape of this 1, 2, 3, 4 - the flat two dimensional shape, then they are need to be fitted on standard size of plates. I said fitted means, if I put them in a different fashion, I will say - I may say that I can only fit three of them, not all four. Again, I change that sort of orientations and then, I may find I am fitting not only four plus also, I am having some plate where I can fit in some fifth component also.

That means there is some optimum way of fitting them. This particular aspect is referred to as nesting. This process of fitting the different shapes, which needs to be cut out from a two dimensional plate right, is called nesting. Now, with the help of your computer and available software's, these operations have become very easy.

You know the shape of all these, this you know from once you have the design done and the structural design also done, so you know what all kinds of pieces are needed. You have seen in our structural arrangement, various sizes of brackets, various type of floors, shell plates, everything is needed. So, once we have that then you can do this so called nesting, such that you can make a utilization of the plate as much as possible. Because, you know, the way I have drawn here, this part will remain as a so called scrape, isn't it? This shaded part what we are putting it.

This is becoming scrape, means will not be used for anything, it will be thrown out. But objective should be to minimize this scrape, because there is wastage. Anyway, so that is what is nesting. Now, what happens once the nesting is done? You need not now physically draw this on a plate, because we can have a cutting machine which is numerically controlled. Once this diagram is known and then the computer can drive the cutting tool - the cutting tool as per this diagram. So, automatically your plate cutting is done, so you need not make any drawing as such, but if you do not have a numerical control cutting machine, then obviously there is no other option other than you will have to draw this physically, make punch mark and then cut by whatever means.

(Refer Slide Time: 00:47)

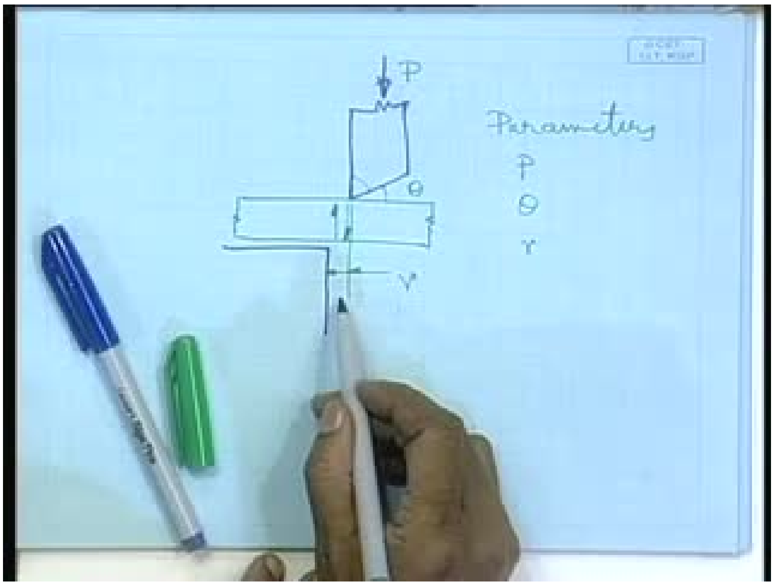


Once that is ready, then it comes to the cutting bay. I mean - that is ready means well this is a part of a design job essentially - that nesting business - once those information are ready, so you take the plate to the cutting bay that digital information is there, it drives the numerical control cutting machine and it cuts it.

So, now we come to what are the cutting processes. First thing what I have mentioned here is a mechanical process; in mechanical process, what we do is, essentially shearing. The cutting is done by shearing, schematically it can be shown in this fashion; that means you have a stationary block, over which you keep the plate. This is the cutting blade which moves vertically; this cutting blade moves vertically, so you can imagine a as if I am cutting sectional like this.

So, it is a cutting bed; that means you have the bed; this is the bottom block over which you keep the plate. This is your vertically blade which moves, it is like guillotine. Something like guillotine you have heard, in olden days people used to cut something else, but here it is also referred to as guillotine shear; it cuts by shearing - shearing action.

(Refer Slide Time: 08:01)



So, you can see this particular location where the shearing action will take place; that means, if I just draw it in a little enlarged fashion, you have the plate kept here, the blade - this is putting the force. So what happens along this section, a shearing action will take place, a shearing stress will be developed. So, you apply enough force such that shearing force what is developed exceeds the limiting shearing stress and the plate get sheared, essentially cut. So that is a simple technique.

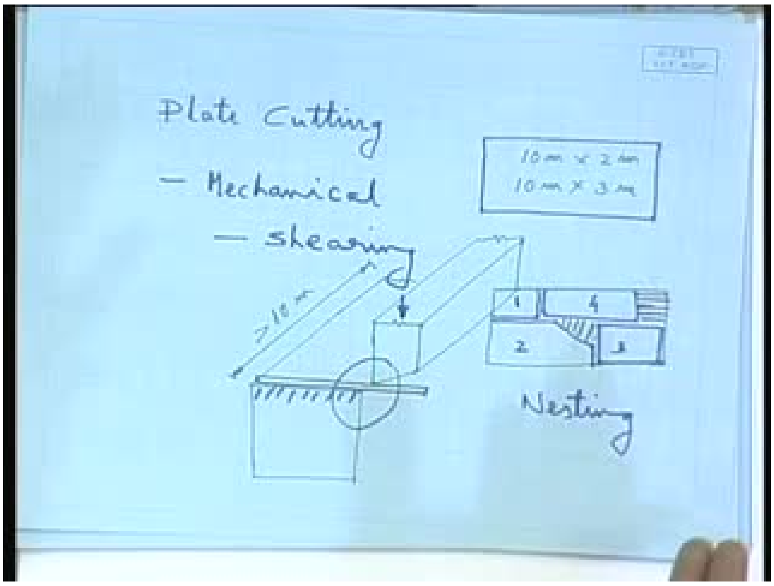
In this, what are the parameters involved, I mean, which will control this cutting operation? Obviously, one is this force, the force which it can apply. For example, the shearing machines they are essentially powered by - will be generally hydraulic machines and powering is in the order of 100s of tons; that kind of force it should have. That means this force - the higher the force it can apply, thicker the plate it can cut, because then only it can generate the required shearing stress.

What else? Another thing is this particular angle, this particular angle, either this angle or the angle here, so one and the same, either of them, this angle that is another important thing and another thing is this gap.

This particular gap says r, the gap between the two - sorts of 2 blades. If I take this bottom one - is as a blade, so gap between that because depending on the thickness of the plate, you will have to increase or decrease that gap. That r - that gap r has to be either increased or decreased with a thicker plate, you will have to increase it; thinner plate, you will have to decrease it.

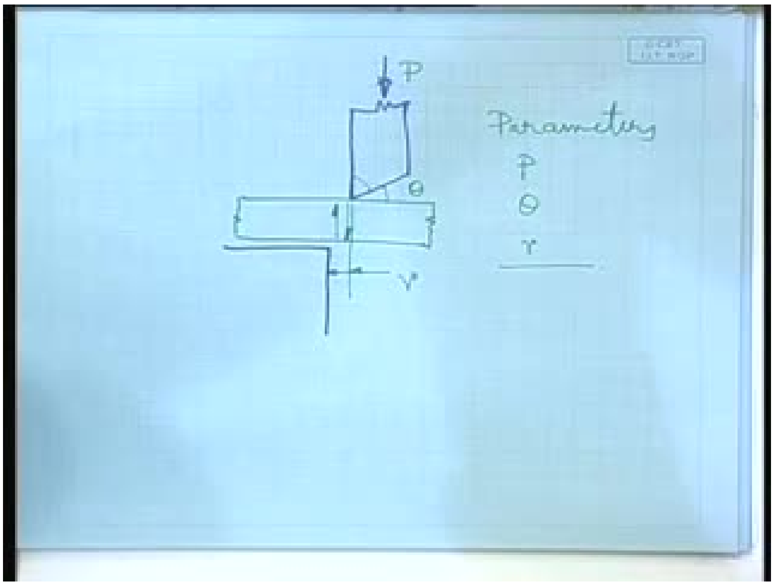
So, these are the basic parameters which need to be controlled right - which needs to be controlled for getting a shearing - proper shearing action. Now, so that what we see is that this process is very efficient as such, because by one stroke it can cut the whole length of the plate - by one stroke.

(Refer Slide Time: 11:08)



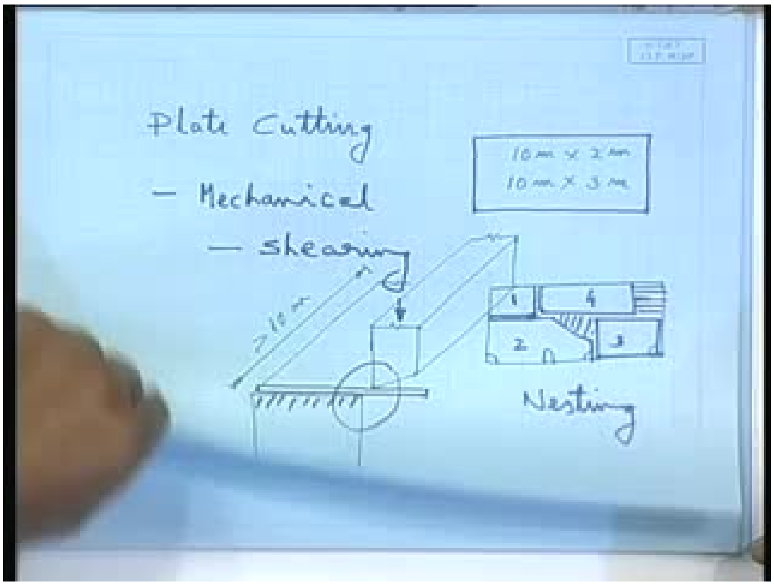
As we have drawn here, say this is my isometric view, so if the length of this blade is more than say 10 meters - just more than 10 meter that means, the whole 10 meter; that means, the whole 10 meter plate I can put one stroke, you get it cut.

(Refer Slide Time: 11:32)



It is not, which means the cutting operation is very fast - that is one big advantage. What are the other advantages? That is the cutting edge - you get a very high quality cut edge, because when you are cutting by shearing, you get a smooth cut surface. That is important, because that cut surface will be further align to some other plate, for further fabrication could be. Maybe you will have to weld and all that, so if the cut surface is more, then you get a better joint, you get a better weld

(Refer Slide Time: 12:09)



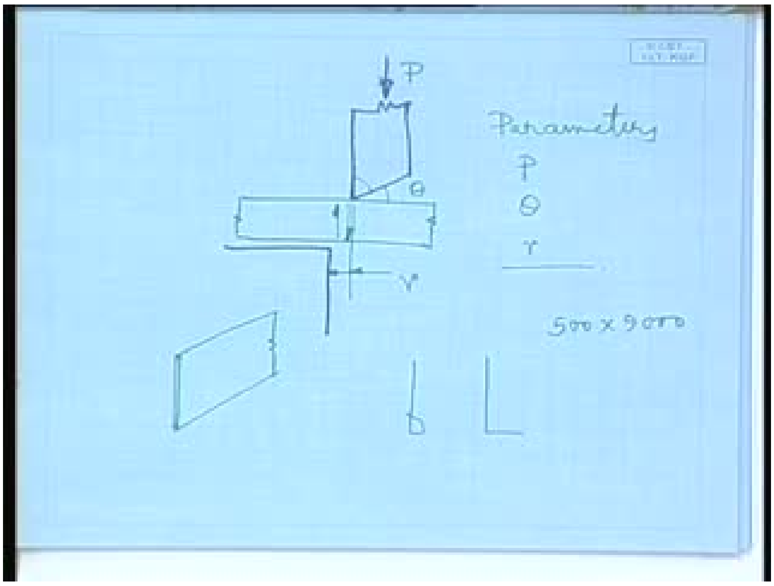
If the surface is very rough – uneven, then obviously your welding will not be also good, so that is another advantage that you will get, a very good cut surface - a smooth surface. Third advantage is that being a so called cold process - cold process means no external heat is applied, so there is no thermal effect taking place on the plate - there is no thermal effect. What could be the thermal effects? That is thermal ill effects, like it could add to distortion, it can distort the plate, it could change the metallurgical parameters because of the thermal action, it can change the micro structure there by your property at the cut edge will change.

All right, so those things are not there, so there is no thermal effect, because there is number of heat involved in this, so that way this is much advantage, quite efficient method, but it has a great drawback.

The great drawback; the great drawback is say this simple example what we have drawn, a very simple shapes, which we are cutting in fact 1, 4 and 3, all are rectangles, 2 is also a rectangle, only 1 is slight. Even this simple shape you would not be able to cut in this machine, because here, only for this part 1, I only need to cut this much.

Part 4 is little lesser in width than part 1, so I cannot continue it; again I will do cut here, so and so forth. Not only that in many of this cut pieces, you will need to have some such thing also cut already in the machine - those scallops. If there is a angle, all those scallops or stiffeners are to be fitted, all kinds of scallops, various kinds of curve cut shapes are needed, so that is not possible here. So that way this mechanical cutting machine though very efficient gives you a very good quality cut and do not effects thermally - adversely affect. There is no adverse thermal effect, but still its use is limited - limited to what?

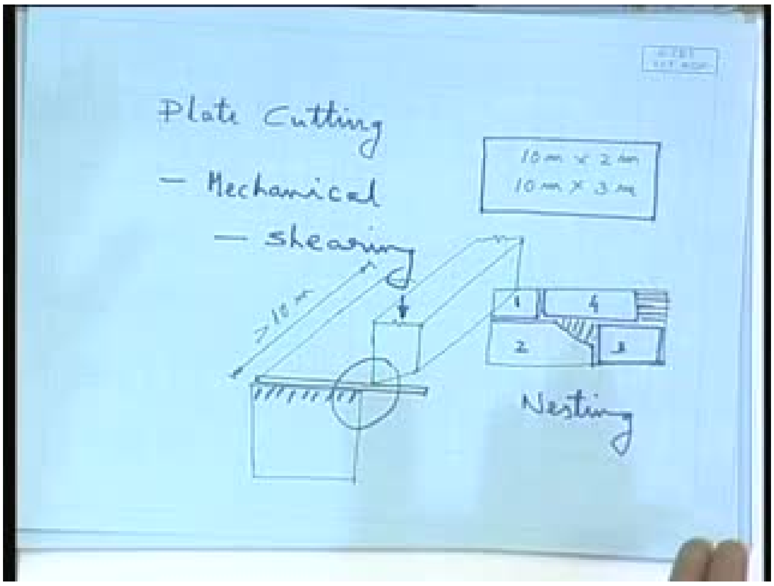
(Refer Slide Time: 15:03)



Limited to cutting straight edges, because in the construction you may also need or you generally required various rectangular pieces of various dimensions. Now, as we have already - I have told you that you’re stiffening members - one of the stiffening members is flat bar, isn’t it.

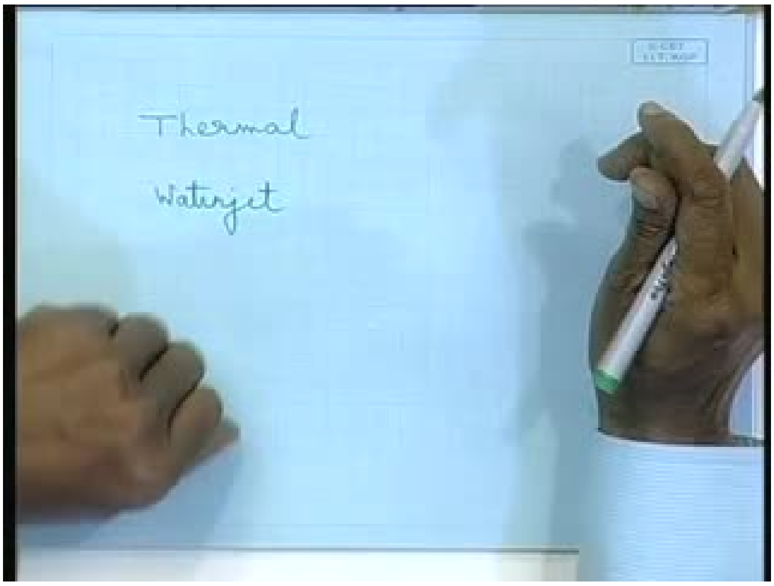
One of the stiffening members is flat bar. Now, these flat bars, if it is a standard dimension, then they are available. Available means like your so called bulb section or angle section, as they are some of them are available - the standard sections, but if it is a non-standard, some flat is needed, then this shearing machine is idle. Suppose some 500 by 9000 millimeter such a rectangular strip is needed, so you put a plate, get this 500 measured, one stroke you have that plate; that is how. So, these shearing machines, I mean mechanical cutting, though it has limitations, but still we will find the usage in shipyards, because they are our requirements for flats straight areas, which needs to be cut, so they are preferable to cut in this shearing machines.

(Refer Slide Time: 12:09)



You will have fixtures such that with the help of a crane, you put the plate on the bed - on the cutting bed, adjusts it and with a stroke you get it cut. So that is how you see that mechanical cutting it is quite a convenient methods, easy and fast method. But, only disadvantage is that it can cut only straight edges, not what you call curved or any other shapes; so, it is only limited to that. Now, for cutting curved shapes what is to be done? That means, you will have to have a mechanism by which the cutting tool can be moved anywhere in any shape, it can trace out any shape, because here my cutting tool is rigid, it is a straight blade, so such cutting tool will not work, you will have to have a cutting tool which can move around.

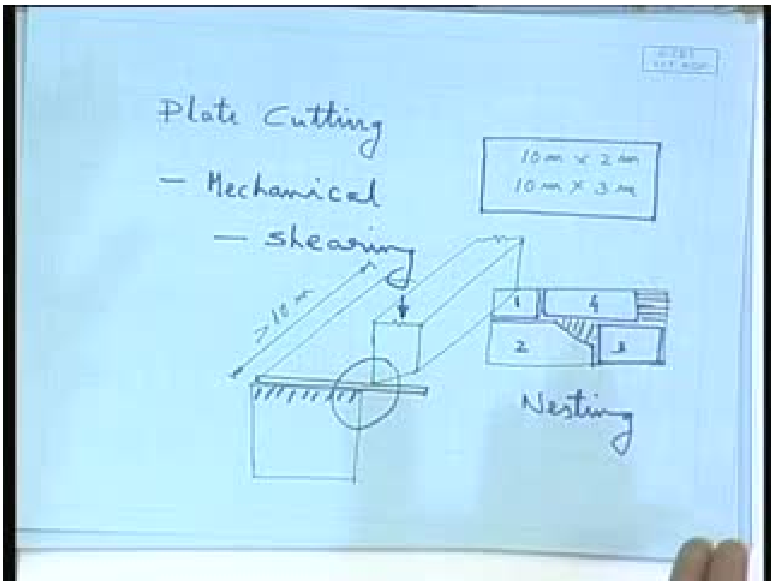
(Refer Slide Time: 17:39)



So, there comes the cutting by means of thermal effects; one is thermal and another is, well again a kind of mechanical cutting only that is water jet. For all practical purpose or if you really look at it, this water jet cutting also a mechanical cutting, only thing here the cutting tool we have replace the rigid straight tool by a powerful jet of water. So, when I am impinging the plate with a powerful jet of water, in fact I am generating that level of shearing stress locally, I am plastifying the material locally, it is going in the fully plastic state and blowing it off; basically that is what is happening.

To assist that cutting process, this water may have with its some abrasion material - abrasive material. That means, hard solid powders of say silicon carbide similar such, which helps in abrasion, because it is a kind of abrasion cutting, so that is what water jet cutting. We will not go in much detail of that; only thing, just the idea of it that here again since it is a jet, so I can move the jet in any direction, so there by I cut any shape. That means, if my nesting is like this, or any complicated nesting it can be cut with water jet anyway.

(Refer Slide Time: 12:09)



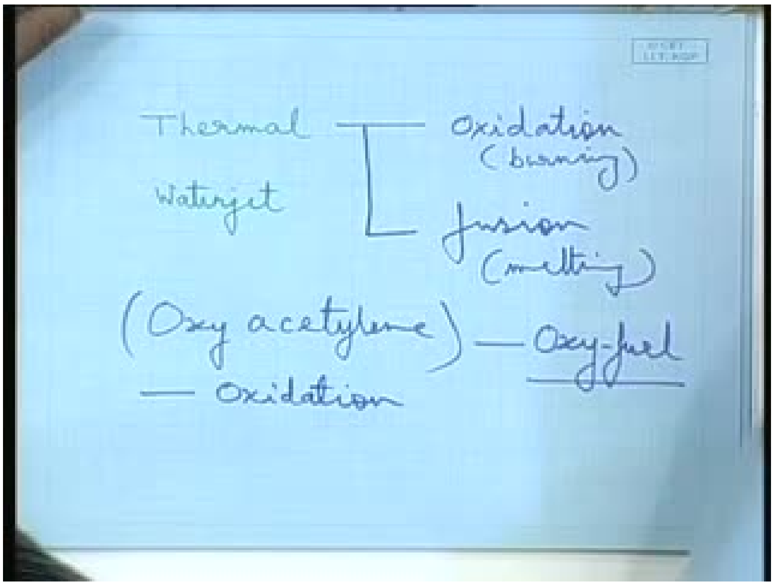
No, here what is happening? Yes, what you’re saying is correct. Work hardening means, what I said is, it is a cold work, thereby I do not have the ill effect of hot work; that means there is no heat involve in it. But, since it is in fact by cold working only its cutting depends; that means it is at the room temperature, we are applying a force and it is attending the required level of stress - shear stress, which is exceeding the critical stress and thereby it is affecting the cut. In the process, the cut edge is obviously subjected to a stress level much beyond the elastic limit - much beyond the elastic limit, so the cut edge may have a harder, I mean it will have tensile strength more than the rest of the plate.

That means that part will be harder, that is there, that work hardening will take place. Because, there if we see that stress tend curve, it will be quite above the yield point stress, so that cut edge will be work hardened truly, but what is happening that edge is work hardened and now that edge will get fully fused, because all these cut edges invariably will be welded to something.

None of this cut edge will remain free, there will be some free like the lightening whole in case of a floor and cutting it, so those edges are free. Let it be free and that is not also subjected to heavy stress levels, whatever work hardening is taking place because of such cutting that is also not of that level that it can cause any eventual - I mean loss of ductility taking place. Such that the crack will form, those chances are very less, because of the location where it is happening.

Also here if you see, this in mechanical shearing cutting, there all strategies we are cutting, so in 99 percent cases, all these edges which have been cut will be subsequently welded to something for fabrication of some structural component. So, once they are welded, so whatever change it took place, work hardening took place, because of welding that effect is nullified, so that way that problem is not there as such, I mean that is not of concern.

(Refer Slide Time: 22:41)



We can say like in case of shot blasting, it was a matter of a concern, but here it is not so. Anyway that is how we see that one of the most widely used process, is thermal process of cutting. Now, in the thermal process of cutting, we have primarily two types of cutting; one is through so called oxidation and another is through fusion.

In both the process of the mechanical cutting, it was purely mechanical by applying force, such that you exceed the shearing stress. In thermal cutting what I am doing? I am putting heat, by which, I am burning it off that is oxidation, it is basically burning and it is not combustion, ignition; that is essentially process of oxidation. So, either through burning the plate or through melting the plate; fusion means, essentially I am melting it. So, tell me what methods are used for thermal cutting, you may have - you may know, you may have done some first year experiments, what?

Oxy acetylene, we will come to oxide lungs cutting later, it is what oxy acetylene. So, what is this oxy acetylene basically? It is basically a - more general name would be what? More general name of oxy acetylene oxy fuel isn't it; a more general name would be - it is a typical case of oxy fuel cutting - oxy fuel isn't it. Because, this acetylene I can replace it with our L P G - liquid petroleum gas, I can replace it with hydrogen, replace with it propane, butane; all these are fuel.

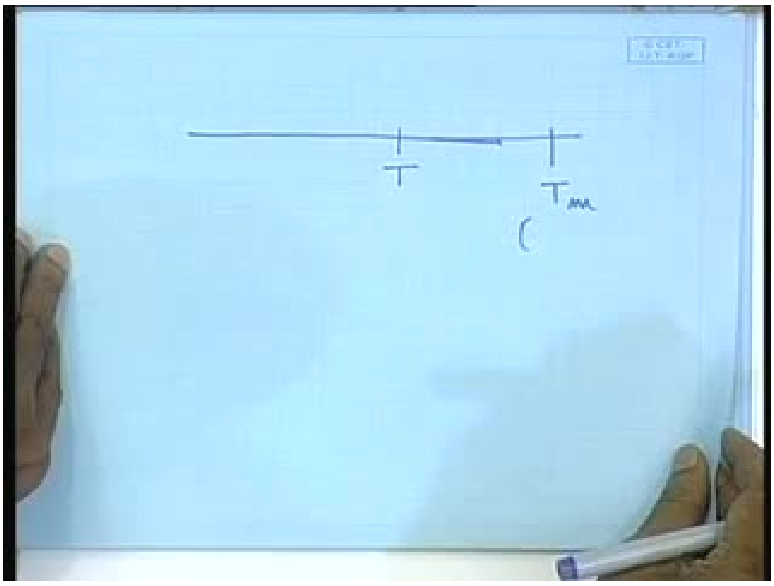
In oxy acetylene - acetylene is the fuel gas that burns - acetylene burns, oxygen does not burned isn't it. So, you may recall when you ignite the oxidation in torch, you first open the acetylene knob, ignite that and then adjust the oxygen knob. So, essentially it is a process - this oxy fuel. Here, the most popularly used fuel for cutting steel is acetylene, so it is oxyacetylene flame, is used for cutting the steel plates. So, what is done there? That falls in which category? It is a category of oxidation cutting or fusion cutting - that means it is cut by so called burning or it is cut by melting; it is burning.

So, this is a case of oxidation cutting; that means, what happens in the process? Metal is converted to oxide, there by the molten oxide is thrown off; that is how you achieve a cut edge. So, you will find in the process, what is done is, first you will have to heat up the plate and then you put in excess oxygen - extra oxygen. Once if you recall, if you have cut in the first year work shop practice, you will find that with the oxy acetylene flame you heat the plate, from where you want to cut.

After few seconds, then you press another levered in the cutting torch, thereby you may have observed the sound changes, means more oxygen by placing another lever. In fact, you are injecting additional oxygen in the flame that is being used to burn the plate - to oxidize the plate -oxidize the material there that hot material.

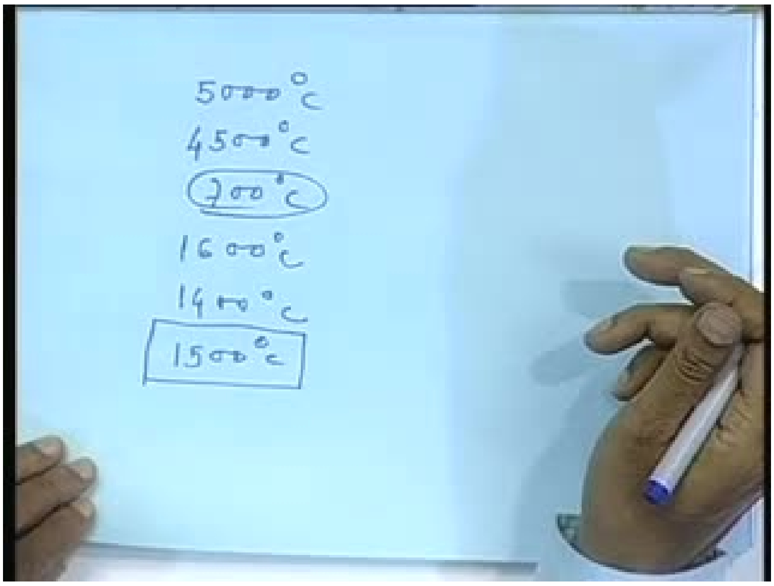
Then, you keep on moving it at a certain speed, which is suitable for that thickness etcetera, so you keep moving it. In the process what happens? That is the exothermic reaction, so additional heat is generated, plate is getting heated up coming to the necessary temperature - relevant temperature, where in with that additional oxygen it burns, means gets oxidized.

(Refer Slide Time: 28:01)



You will find a spray of things coming down, that is nothing but molten oxide is thrown off. So, metal is not melted, its molten oxide is thrown off, so there we will see - if you see in a temperature scale, it is something like this. Say this is my melting temperature of steel - how much melting temperature approximately?

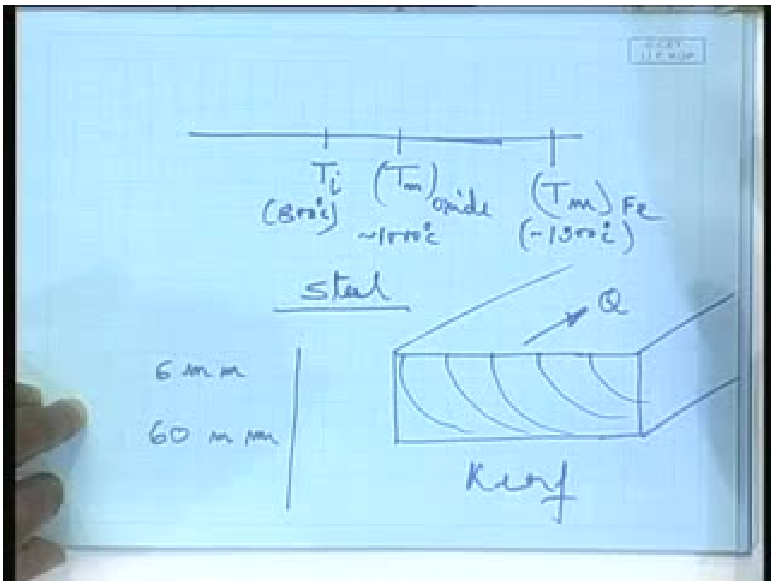
(Refer Slide Time: 28:32)



Let me see, one says 5000 degree centigrade, another says very precise 4500 700, tremendous variation. Something more, 1600 - what finite? Degree centigrade - let us write 1400, anything else, guess. No, definitely you would not take average; this is also another important thing. Suppose you are doing some experiment, you get such data, at one point you are getting 5000, another point you are getting 1400, again you are getting 700, what you do with these data? If you have such, you scrap the experiment and do it again basically.

While doing it, now if you have many more 5000s, 4800, 4700, 5200, then what you do? Scrap these data 700, 600, 1400. For some reason they came wrong, take all those and take average of that. Anyway, anymore guess 1500; that is the temperature as such.

(Refer Slide Time: 30:27)



Approximate temperature is 1500, 1490 also - 1500 degree centigrade. 700 is for aluminum, it is rather 600. Anyway, so this is about 1500 degree centigrade, this is the melting temperature of the metal off steel. This is here, its melting temperature of the oxide that is around 1000 degree centigrade, so that is what it is. That means, when you heat up the material, the ignition temperature is somewhere here around – well, ignition I write that is around 800 degree centigrade.

By ignition, I mean, at the point where I am injecting more oxygen. So, when the plate attends that around 800 degree centigrade, I press that lever to put more oxygen. How do you know that it has attended 800 degree centigrade? It turns red hot - reddish color - red hot, because steel has a peculiar property, I mean by seeing the color you can make out what temperature it is, at different temperature it exhibits different color. So, it becomes red hot that is around 800 plus, so you put in more oxygen and it starts cutting.

Basically then the temperature is gone up to 1000, around 1000 the molten oxide is been thrown off, so metal is not melted at all. Its melting temperature is much above 1500, so that is how steel is cut that is pure oxy acetylene cutting. Now, say I want to cut a 6 millimeter plate and then I want to cut a 60 millimeter plate, what would be the difference? The fundamental difference would be in cutting speed to start with. More basic could be, whether at all 60 millimeter I will be able to cut or not; that question may come.

Let me assume for the time being that we can cut a 60 millimeter plate. Obviously the speed of cutting here in 60 millimeter much less compared to 6, so productivity would be less that is understood. What else could be the effect?

Now, here what happens, like in mechanical cutting, we had – yes, all those things will come, immediate effect would be the quality of the cut edge. In case of mechanical cutting, we had a very good quality of cut edge; in gas cutting, oxide clean cutting, your quality of cut edge will depend much on the speed of cutting. If you have to cut at a slower speed, your edge becomes rougher; that means, if you look at the cut edge, it will have - some such marking it will come.

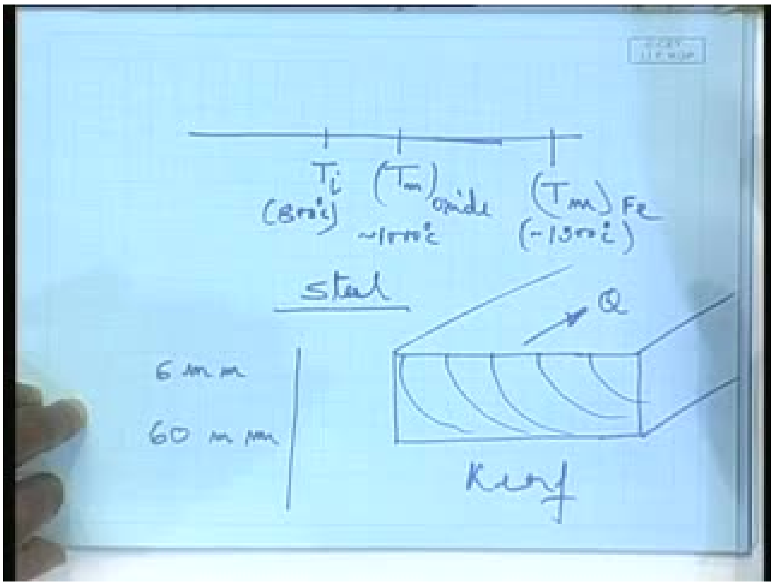
By this I wanted to show thicker plate, you need slower speed of cutting, because you will have to attain this temperature levels. You will have to give more time for the heat to flow. In the process at one location, you will have to keep the torch for a longer period. In other words, your speed of moment should be slow, once the speed of movement is slow - it is moving, it gets it forms those, it is moving this way, so it will form like this, those they are called kerf - this cut edge is called kerf.

You will have a not a very smooth kerf cut edge, as the thickness increases cut edge will not be good. What is the solution to that? Solution is only how to increase the speed of cutting, because that is needed not only from having higher productivity, but also higher product quality. I want to have the cut edge better, also at the same time, if the cutting speed is less, then more part of the plate gets heated up. That means, more heat flows in the plate direction, more part of the plate gets heated up, more it gets heated up means there is a more probability of thermal deformation.

Well, so one of the solution is – no, that we cannot do, that you increase the heat content of the gas of the gas mixture. Now, I can cut it faster, provided I can attain these temperatures – 800, 1000 degree centigrade. If I can attain them faster, so I can move the torch faster, I can cut faster space. That means, I will have to use a heat source which will have more heat content, because oxy acetylene in that mixture it is how much heat will generate, it is fixed by the by process of your chemical thermo dynamics.

You cannot increase that you can only increase if you add some additional substance. So that is one of the method is oxygen lance cutting. What is that oxygen lance cutting?

(Refer Slide Time: 30:27)

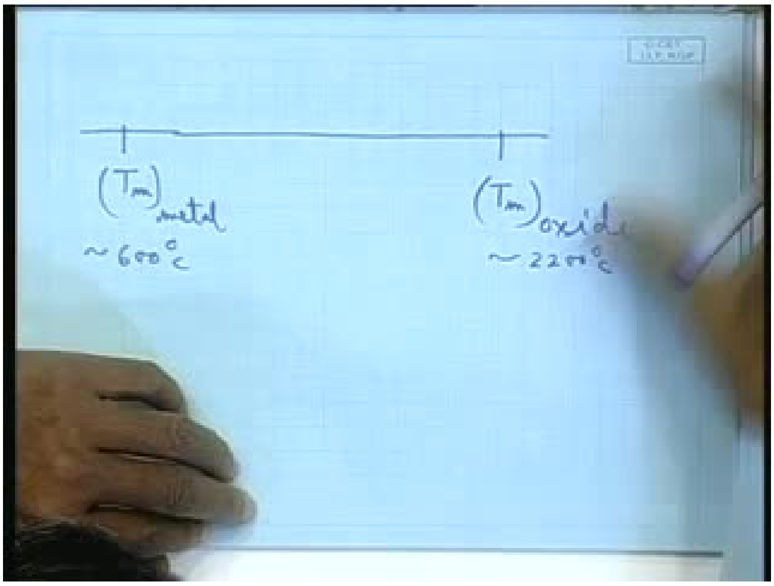


You have heard about that isn't it? I also do not know much. Do not worry, anyhow oxygen lance cutting that is, essentially you put in iron pipe powder in the gas mixture, you have a mechanism of putting in iron powder; iron powder burns exothermic process that generates sufficient heat. When you go beyond a certain thickness of steel plate, you use oxygen lance cutting that is what is called oxygen lance cutting.

Using iron powder in that so there by increase the heat output of the flame. Anyway, but for all practical purpose in ship building - in ship building industries where you are cutting, when you are encountering such very thick plates, either you go for oxygen lance cutting or go for some other technique - some other means laser cutting or plasma cutting that way.

Otherwise, for all practical purpose, it is purely oxy acetylene cutting. So, in oxy acetylene cutting this is what the principle is. That means, you burn the plate and throw of the molten oxide. Well, so tell me - this is a case of steel, now if it is aluminum what you will do?

(Refer Slide Time: 38:13)



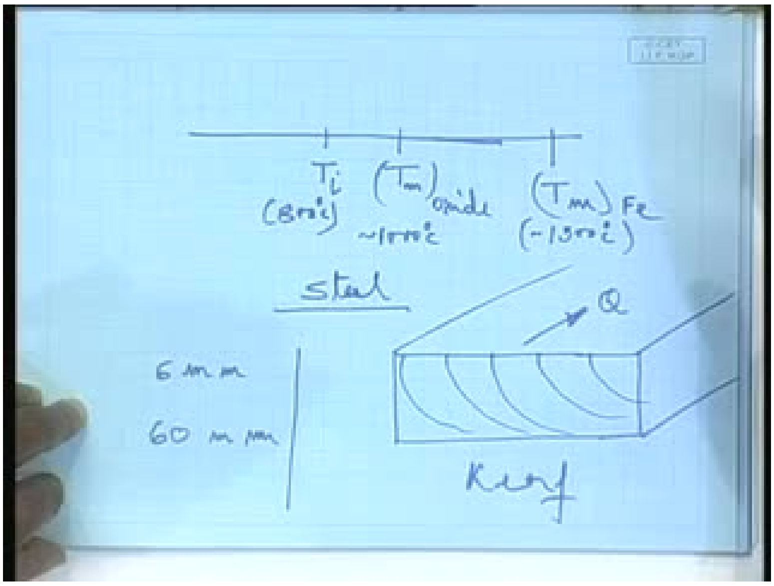
Because, there is aluminum fabrication also, isn't it. So, can we cut aluminum with oxy acetylene flame? Obviously, in mechanical both aluminum and steel can be cut without any difficulty. Now, we are going for thermal cutting, because we have that advantage of now guiding the torch, the heat source we are using, so we can cut anything. You have much better productivity also, aluminum what do we do? Why?

In aluminum, what is happening is you see in the same scale, if I see, somewhere here it will be the melting temperature of the oxide, somewhere here it will be the melting temperature of the metal and the difference is what the melting temperature oxide. Any idea, it is of the order of say 2200 degree centigrade - above 2000 degree centigrade, whereas the melting temperature is hardly 600 degree centigrade. So, what happens is, if you try to cut immediately, as you know, aluminum exposed surface is nothing but oxide alumina Al 2 O 3 that Al 2 O 3 gives its that corrosion resistance, protects it from further so called corrosion, because Al 2 O 3 is quite inert in nature.

So, if I want cut it by gas what will happen? That layer will thick enough, only further Al 2 O 3 will form. As you can see before, you could reach 2200 degree centigrade, much of the plate will attain more than 600 degree centigrade, so you will have a molten method inside, the outside will be solid - thick crest sort of aluminum. Inside metal will be in molten state or in others what will happen to the plate, plate will just crumple. You have the plate, you move the torch, the plate will just crumple, I mean it will sag and it will get totally deformed, right. Why it is deforming? Because, it is losing all its strength, inside the metal is flowing, it is in liquid state.

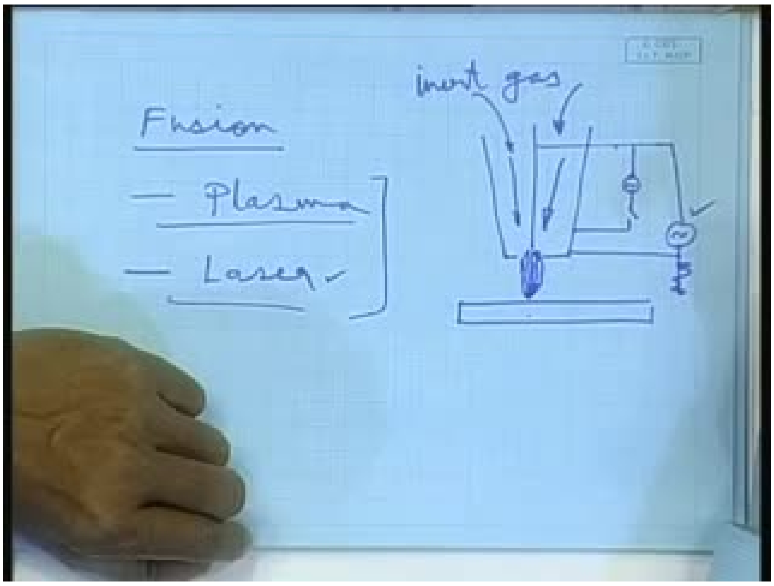
So, aluminum it cannot cut by oxyacetylene gas. How do you then build the super structure of aluminum? Because, you will have to cut it, aluminum also it comes not in 10 meter by 2 meter, but in a much smaller size. I do not recall exactly how much, but in much smaller size that is there. Whatever, it also comes in flat rectangular plates of different thicknesses, so how do you cut it then? But, you need to cut huge amount, I mean that way it is not effective. Also again the same thing, if have to cut a curved shape, all kinds, then how do you cut? Well, one is mechanical cut, obviously it is possible, but for curved shapes how do we cut? There we go for cutting by melting.

(Refer Slide Time: 30:27)



Because, there we will have to – well, I mean, the question of here in case of steel, we could ignite the steel, we could burn it and the melting temperature of the oxide was much less. Whereas, here the melting temperature of oxide is much high, so I cannot afford to cut it by so called process of burning oxidation. I will have to go by melting process, means I will not care whether the metal is melting or not, my objective is to melt the oxide straight away, in aluminum. I need to have a much higher heat source, because as you can see, for steel I will have to attended minimum 1500 degree centigrade, for aluminum I will have to attend 2000 plus degree centigrade.

(Refer Slide Time: 42:57)



That is what is cutting by fusion, the method applied is - one of the methods is plasma, by using there is a plasma cutting or it can be laser cutting. That means, use plasma as the heat source or a laser beam as the heat source, it can be cut. The whole point is, in both of them they are very high heat input process that means, moment you can attain a very high temperature - very high temperature locally. That means, very concentrated heat source, so what happens is, you can attain the required temperature immediately and that plasma jet or the laser beam will have enough force to through of the molten metal, so, the metal gets melted and keeps moving. See if I can momentarily generate say 3000 degree centigrade, so alumina will immediately cut. I am not allowing the heat to remain in position for long time such that its get conducted and the plate - the adjacent plate gets melted.

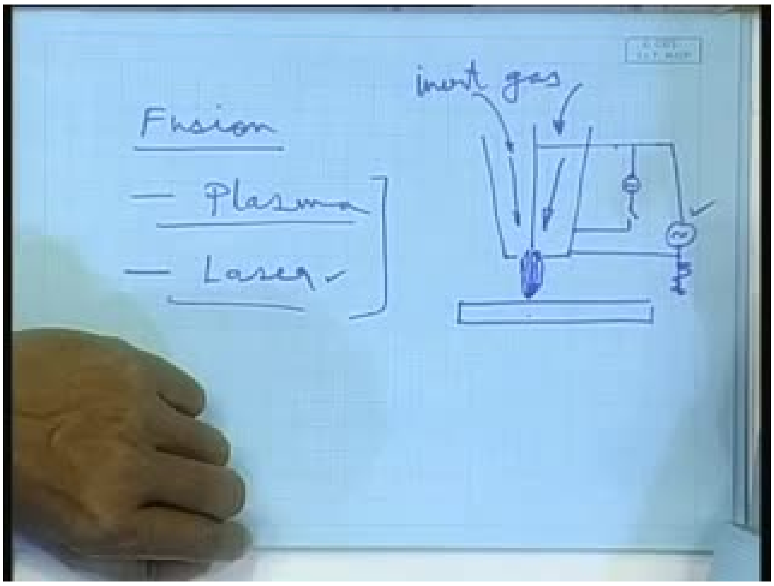
So, that is how aluminum can be cut either by a plasma source or a laser source. Now, what is this plasma source? Well, what is that essentially? It is essentially, it is a - well, let us see schematically. Say this is a nozzle, here you have an electrode and you have a power source - power source connected to this. Just schematically it is - so here you put in an inert gas, if you know a tig tungsten inert gas welding process, it has some similarity in that. Here, what you will have is some similar kind of a nozzle, obviously not exactly that of tig, but similar thing. There also given an inert gas for shielding the welding material, so here I am giving inert gas, you have an electrode in - on consumable electrode and a power source. Here, I have drawn two power sources; here is one, here is another. What is the purpose of this smaller one is here I have shown with a switch, means it is only used to ignite the so called flame. Means, it is a high frequency generator, which initiate the arc arcing between the electrode and the nozzle body. In that arc this inert gas will get ionized.

The moment the ionization takes place, this is that high frequency source is switched off; the normal source is switched on. So, thereby I attain a continuous plasma column as if plasma flame as if a gas flame. In gas burner, you have a gas flame; in a plasma torch, I have a plasma column of plasma. So that means it again behaves same as that of a gas burner, as a gas torch, only difference is here, the heat is generated by this column of plasma.

It has a very high intense heat - very intense heat, so that is how this when applied to the plate - I mean, this plate subjected to or expose to this plasma column, immediately it will attain the required temperature and start cutting it. Here, the gas is inert gas, is flown in at a certain rate, it passes through the nozzle, nozzle is so designed that it constricts the arc to the required sort of dimensions.

Means, the Arc is not spread out - the plasma column is not spread out, rather focused. So, what happens, it heats more in a confined area, even confined more than gas torch. So, in plasma cutting I can attain a very good cut edge, the quality of the cut edge can be achieved is very high quality, near equal quality that of mechanical cutting. Since, here the power - how much power it will have or how much heat it can generate depends on the power? That power can be varied with increase in the power of power source (Refer Slide Time: 48:50).

(Refer Slide Time: 42:57)



So, effectively it can cut any thickness of plate; that means much higher thickness of plate also, with plasma torch you will be able to cut. So, thereby whether it is steel or aluminum or titanium or stainless steel anything can be cut; both ferrous and non-ferrous materials of virtually any thickness can be cut with plasma torch. So, these days in better equip shipyards, you will have plasma cutting workstations. Means, well obviously this is more expensive than your gas cutting, because here the raw material used would be inert gas, it could be generally argon, so that is a costly thing plus the whole setup and the equipment is much costlier compared to oxyacetylene, which is much more cheaper.

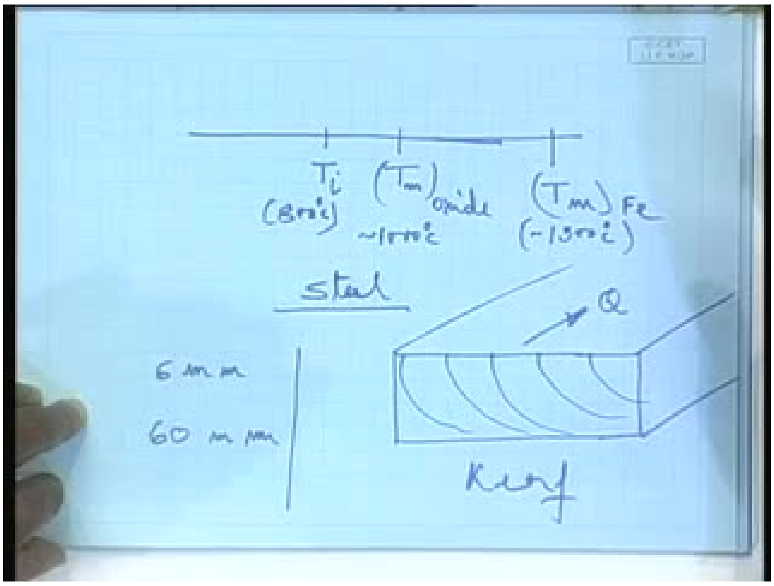
So, thereby, one will have to well with plasma cutting, you will have very high productivity; because of the high intense source of heat you can use a very high speed cutting. Now, well if your downstream activities are not that high speed, then investing in this and having a very high productivity cutting process would not make much sense. That is a different issue, but otherwise, it will give you very high productivity, as well as here, the advantage of cutting not only steel, but also of aluminum, anything can be cut.

In simple words that is the way of plasma cutting has done. The advantage is of this, but still oxyacetylene cutting is still - it is used heavily for the simple reason that cost is much less. At the same time, as I said that the productivity needed that depends on - one you will have to work out productivity of each work station depending on the overall productivity. Means, at one place, I have a very high efficiency work, the very next place, I have a very low efficiency and then in fact I am in trouble.

Because, here I will produce more and that will get stock piled. You know that is what is called bottle necking, you will form a kind of bottle neck. Especially, this particular section we are talking about plate cutting, so what will happen, lot of plates will be cut and will get dumped. So, the plate you need will lie right at the bottom, because that is the one you have to cut first and you go on cutting, it is dumped.

So, you cannot take it out physically, there are this kind of problem. So that way you are doing this entire cutting process - in this case, what is happening? As I said, you are basically melting the plate. Similarly, you replace this plasma torch by a laser torch, it is laser cutting. Now well, this principle is different, generating the laser beam, so we are not going in that. Neither we are going in the details of how the plasma and how to construct the arc etcetera. Basic principle is this; that means, we as an end user, same cutting station where we are using an oxyacetylene torch, the torch can be replaced by a plasma torch, again which can be replaced by a laser torch, only thing you are powering devices will be different. In case of oxy acetylene, you will have gas pipes coming in from the central supply; in case of plasma, you will have the cables coming in.

(Refer Slide Time: 53:46)



In case of laser also, kind of cable will come in, so that is the only difference. That means here in plasma or laser you have high heat source. In some shipyards, people have started using laser, but that is very limited, because with laser you can still have higher productivity, even higher thicknesses can be cut, but the cost exponentially increases, very high cost. Well, so we will stop here, next we will see little bit about this steel cutting. Once again will go back to that regarding what are the difficulties one faces in these cutting processes.