Joining Technologies of Commercial Importance

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Lecture – 20
Flash Butt Welding

Hello, I welcome you all in this presentation. This presentation is based on the flash butt welding process and this presentation is also related with the subject joining technologies for the metals you know. That this process falls in category of the resistance welding process and we can say largely the joint is formed in a solid state by forging the joints together, forging the components to be joined together.

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So, we will see that how this process works in and in which way the joint is formed what kind of components are commonly joined so the process or butt welding. So basically, this process is resistance welding process, where primarily the heat for preheating purpose is produced through the I square RT heating principle, but the total heat required for development of the joint is a combination of the resistance heat plus the arcing or flashing heat the heat which is generated due to the flashes.

So, both these are used for increasing the temperature of the work piece to the required forging temperature, say 1250 degree centigrade for steel. So basically, we need not to have the fusion State for development of the joint, but it is mainly the heating to the forging temperature, as per the metal system say 1250 for the steel.

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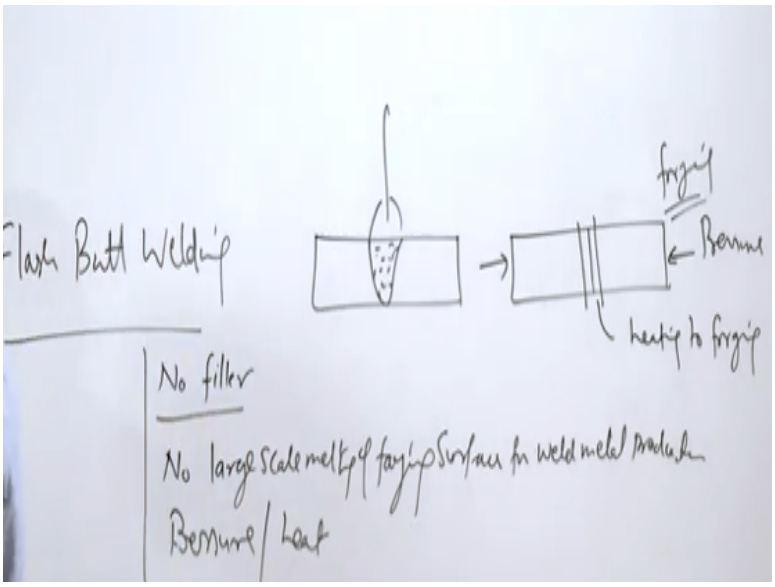

The kind of temperature which is needed for this purpose with each like preheating through I square RT heating and the heat generation due to the arcing both these have their own specific role for a development of the joint like since this process is a one variant of the solid state process also. So as the joint is not formed in DES by melting the faying surfaces of the base metal, but joint is forging the components to be joined together.

So, this process uses no gainsay filler metal. There is no filler metal and no you can say no large scale melting of faying surfaces for weld metal production. Whatever melting takes place, that is primarily for the cleaning purpose and so that the metal to metal contact can be established when the things are forced together. So, no large-scale melting of the faying surfaces for producing the very metal production.

At the same time this process relies heavily on the pressure for forging and for heat to reach the recrystallization. So, like in any other welding process mainly rely on the heat so that the faying surfaces can be brought to the molten state like this application of the heat through arc or through the gas flame. So that molten state is achieved and under the gravity conditions the solidification is achieved.

So that metallic continuity can be obtained, but in this case heat is used for increasing the temperature of the fin surfaces to the holding temperature and pressure is used for the forging purpose. So, heating to the forging temperature and pressure for pressure application for forging the members to be joined, so that metallic continuity can be obtained.

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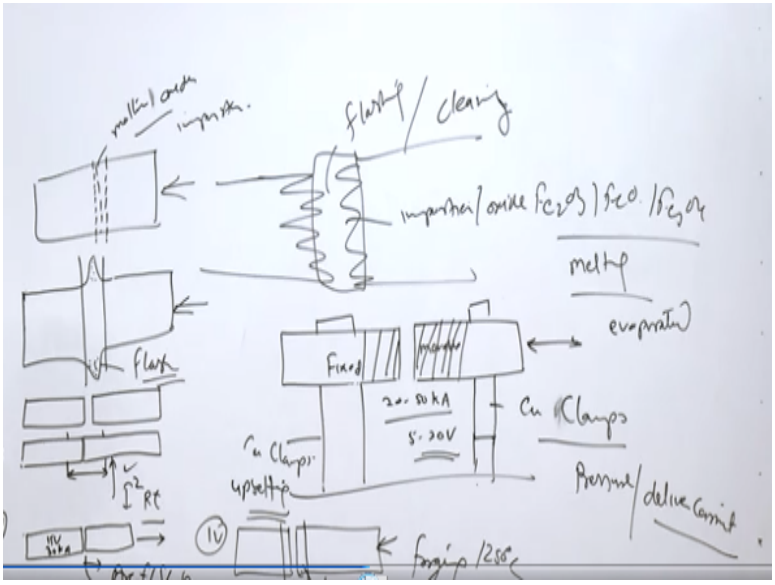

So, this is what is there in the basics of the process. As a whole how does it work in that is what and now we will let you know in detail. So, this process in this process one work piece for the members to be joined. Say one piece is kept fixed like seaweed, be helped off the copper supported clamps copper clamps and another end is kept a moveable, say this is a movable part or another work piece to be joined, which is kept moveable.

And this is also clamped with the copper shoes, so this can move back and forth and both are supported on the suitable structure. So here initially, so this one is fixed, and another is can be moved towards the work piece and away front towards the fixed component and away from so this is also of the copper clamp. Since the it is of the copper so because this copper clamps apply pressure as well as deliver current to the work pieces for the flashing or for the flash butt welding process.

So how does it a start initially, the members are kept away like this in stage one they are separated then in very controlled way the movable part is brought close to the fixed one, so that there is a connection between the metallic connect contact between the two and in this stage, when the two are in contact the contact will be through the peaks and valleys present at the interfaces both the sides.

And at this stage, the current is fed so when the current is fed the flow of current of course will be taking place from the clamps the two ends and between these two so the flow of heavy current I square RT heating takes place. So, during this heating what we will see during this

heating this causes the preheating of the ice being joined. This is one thing at the same time since the contact is very localized.

So, what we will see contact is very localized. So, excessive heating at very localized points can take place for which can cause the partial melting of the peaks. So initially when there is a contact, preheating of the ends of the work piece takes place and this heating becomes complete means this entire section of the entire end of the work piece will be preheated in the pre heating stage when they are brought together.

So, this is what happens in the stage one and thereafter the moveable is brought apart in addition to this. The flow of the current is very high here, the current which is allowed to flow. Maybe say like say 20 to 50,000 ampere and the voltage is quite low maybe 5 to 20 volts. So, the very low current and high, a very low voltage and high current is allowed to flow through the work pieces and the section size is large.

So, the resistance will be limited to have enough heat generation. The current has to be too high and then it is allowed to flow for some time. So, though I square R heating, preheating can take place and then moveable component is moved apart. So, what we will see after this preheating, you will see that in the stage two, they were brought in contact in stage 3 in a very controlled way. The members are moved away from.

So, whatever whenever there was contact, so these members are moved apart, so as soon as since there was a voltage of say 15 volt and flow of current was of safe 30,000 amperes. As soon as the movable component starts moving away, from will see that heavy arcing or flashing arcing or flashing starts this arcing and the flashing causes so many things. Like if this is the end of the work piece.

And here between the two heavy flashing is taking place, then all these impurities oxides like in case of the iron Fe2O3 or Fe o or Fe304 for what our oxides are there. They will be melting, so all the impurities oxides under the influence of heat so they will be either evaporated melted and thus they will be removed. So, this flashing will be basically cleaning these surfaces of the component to be joined.

And once this flashing is the over, so once the flashing is over, in the fourth stage, the component of which the component once the flashing is over. So, during this period, there will be rise in temperature of the due to the flashing and arcing for a short while. There will be heat generation due to which impurities oxides etc. will be evaporated, melted. At the same time the ends will also be heated.

And this will continue until we will see that the rise in temperature emissions which to be forging temperature, say in case of the steel cities 15 1250 degree centigrade. Once this temperature reaches, the ends are brought together, means with the pressure, the ends are brought together or in closed form contact. So, this is what we say upsetting stage. In the upsetting stage the ends are forced together, with heavy pressure.

So, the form metal to metal contact, between the two is established. Say this is what is heated portion with the all molten oxide and impurities. All these when the forging takes place, all these are removed and as the softened and tends to take altogether different shifts. So, we will see that the impurities are getting pushed away in form of the flash towards the outer edge and this is the kind of.

So here we will see that oxides and impurities are localized at the edge and here at the perfect metallic continuity is obtained, so this increase in a, localized increase in diameter is termed as the flash now which will be coming out or this is object region. And the impurities will be localized in this region and thereafter once the joint is formed and this upsetting basically happens under the forging conditions.

The metal near the ends becomes soft, so under the force conditions, it gets upset and while the remaining sections remaining the well the locations away from the interface they remain at lower temperatures. With Rudd road they get upset or they do not experience the change in their dimensions are upsetting. So, this is how the joint is formed. Impurities will automatically be localized here, under the optimal set of the pressure and temperature conditions.

And this, the flash is subsequently removed through the post treatment or a post machining operation, for developing the proper now for achieving the, required size and shape.

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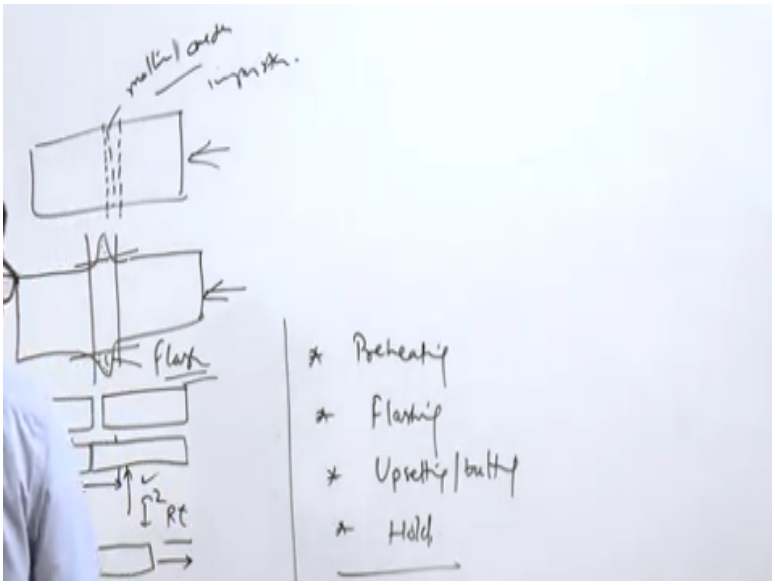

So now we will see, so this is, these are the basic steps, and this is what happens in case of the flash butt welding for developing the joints between the members. So, there are four stages one is preheating, second is like a flashing, fourth is the offset authorities upsetting or butting under pressure, and then hold in the whole stage the two components after upsetting they are kept together under pressure for certain time so that the joint can be formed and thereafter the things are taking off, so this is these are the four steps related with the flash butt welding.

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Now, we will see that in which way the things happen one by one, like say in this is time and we may have like pressure and current so like this. This is what also we can explain using this diagram.

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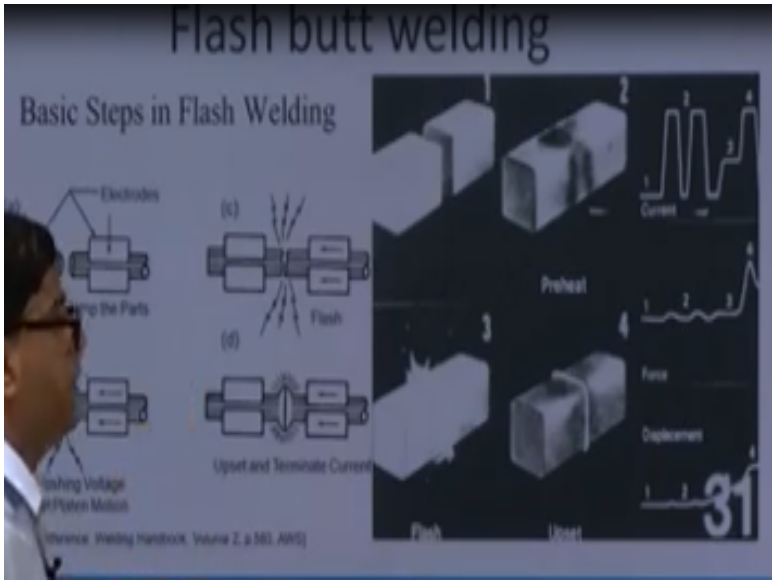

So here we can use this also schematically the four stages have been shown here. Initially in the initial stage, the parts to be joined are kept on the two clamps of the copper shoes, with the proper position. So, in the initial stage this is the position when they are brought together. Initially like say initially, we may have may have pre heating or may not have so in case of preheating entire the ends of the work piece are heated well.

In case of the flashing only the interface joint is heated so the flashes are their flashes will be melting the impurities removing the oxides and other impurities. Once the required marry Chris required folding temperature is attained. The ends are the components, movable components is brought towards the fixed component, so that all the impurities are expelled out from the interface and then upsetting happens.

Whenever upsetting happens we will see that localized increase in the dimensions. So, these three are all these histories have been shown near like a stage one. There is no flow of current in this stage. Two, the two components are brought in contact with each other flow of current, is trucks. So, this will be resulting in the preheating of the ends of the work pieces and thereafter, as soon as the component starts moving.

Flashing starts and in case of the flashing, so here 1 2 3 this is the stage of the preheating and in a stage 4 once the flashing is over the forging is done so that there is the in case of the forging the two components will be coming close together. All the impurities will be expelled from the interface and upsetting will happen. So, this is what we can see. As per the displacement is concerned there is continuous; in the initial stages there is no major displacements 1,2,3.

But in the upsetting stage there is significant displacement happens. So as far as the force and the displacement is concerned, this is the kind of variation.

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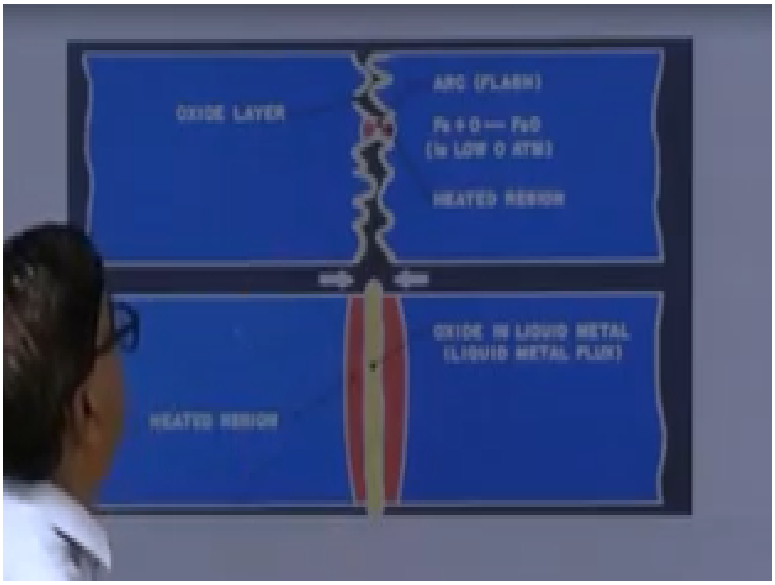

And we will see this is the what happens actually at the interface. In the initial stages when there is a contact through the peaks and valleys, so there is a heavy flow of current. The peaks and valleys causes very localized heating. And the oxide layer will be getting heated and when this happens means the arcing and sparking continuous for long it results in the layer of the molten metal wherein having the oxides.

And other impurities at the same time nearby the heated region is also formed. So once this is achieved, the things are forced together. So, all these impurities and the liquid metal is taken off or expelled from the interface. And the softened zone will be subjected to the upsetting to have the direct metal to, metal connection.

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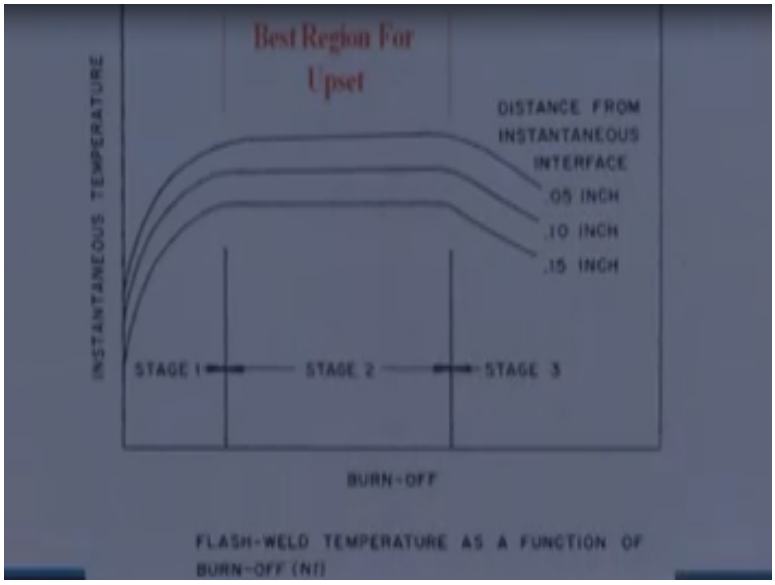

So, this what will see that the different stages which are being shown. In the initial pre heating stage, in this stage one, there is a flow of current. In the pre heating stage, there is a continuous rise in temperature. And then temperature remains constant in the stage two. And once the flashing is over upsetting starts. The temperature starts coming down. As the function of the time or this is also the burn off period.

And as a function of distance if you see from the interface.

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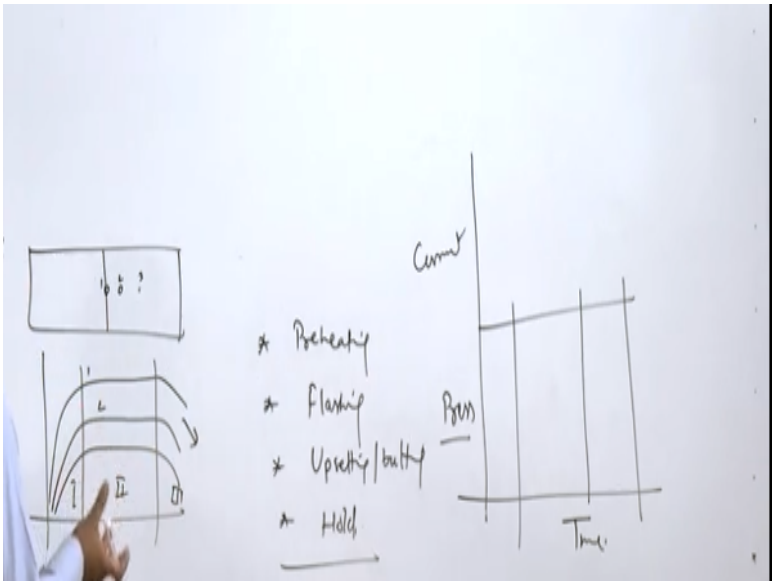

So, the interface like this. If this is the interface, point 1, point 2 and point 3. So, the kind of variation in temperature, the temperature will be higher. At 1, the temperature will be somewhat lower, at 2 and at 3 like this. So, in the stage 1, stage 2 and stage 3. This is the upsetting stage,

once the heat generation all that is over. This is the flashing stage and pre heating stage. So, this is the kind of variation, which takes place?

And these variation, this is the period when the flashing is required. At this time only efforts are made, so that the upsetting can be done in very proper way.

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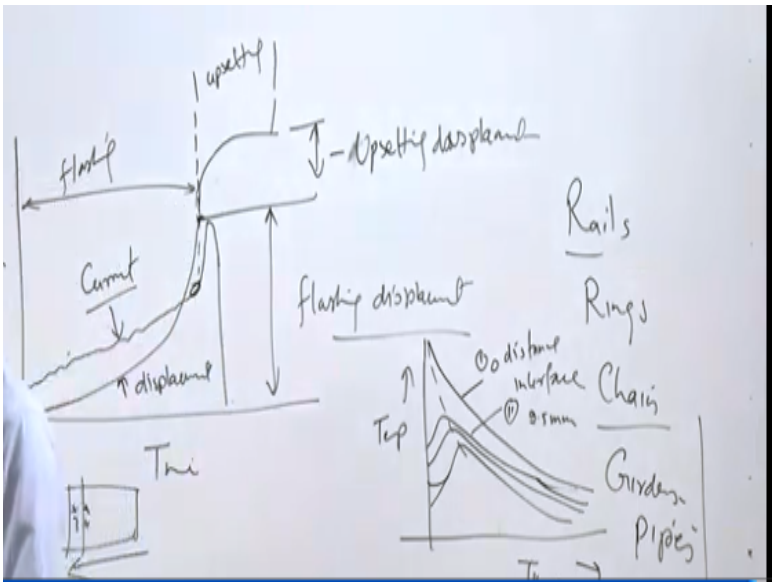

Now we will see the kind of variations which takes place during the welding in respect of the time and the pressure. Time and the pressure, so. Here this will be showing displacement. Displacement is about kind of movement here work piece and this is the another work piece. So how the movable and moves towards the; movable work piece moves towards the fixed end so that the magnitude keeps on increasing.

So, this is what will be showing here, so this displacement is found to be like this. So, this is the upsetting stage, and this is the flashing stage. Flashing stage and the upsetting stage. So, in case of the flashing will see this is the flashing current. Current variation goes like this. On both this will be going together almost, Yeah like this. So, this is the current variation. Or you can say this is; this one is displacement, and this is the current variation during the welding.

So here if we see once the; here this is the period when our flashing will be occurring, there will be continuous rise in temperature of the ends of the work piece. And then the offsetting force is applied, there is upsetting force there is rapid displacement. So, what we will see that the burn off period and upset. So, this is the magnitude now which will be indicating the displacement corresponding to the offsetting displacement.

And this is corresponding to the here, the displacement, yeah so, this one; this is corresponding to the flashing displacement. Enough scope is kept for the additional lines corresponding to the flashing as well as the upsetting displacement. And if we see the kind of variations which take place in the temperature right at the interface or increasing distance away from the interface. Then typically the world thermal cycle, or thermal cycles which are experienced at the interface will see the continuous decrease in temperature as a function of the time.

Y axis here temperature and in the X axis the time. And then will see the point 1, 2, 3, 4; say at each interval of the 2.5mm. So, the 1 and 0 distance that is at the interface experiences direct cooling. But the points which are away from, they will be experiencing thermal cycle like this, like a point 1; this is point 1 and point 2 at 2.5mm distance. And then point 3 taking somewhat longer period. Point 4 for the taking longer period.

So, the peak temperature and the time to reach the peak temperature they are also longer. So, our time actually comes like this time to reach the peak temperature. So here depending upon the kind of metal systems the heat affected zone may be difference of the different sizes. So, this is what we can obtain, we can see from the now, well thermal cycles. Now will see what are the typical applications for this process.

The typical applications of this process includes like most commonly is used for the joining of the rails. And it is also used for the joining of the rings of the large diameter. At the same time, it is used for the joining of the chains and the girders. And in addition to that these are also used for joining of the pipes of the large diameter. So here now I will conclude this presentation. In this presentation, we have talked about one of the welding processes that is the flash butt welding.

This process is mainly used for the joining of the symmetrical section components. This process works on the principle of the electrical resistance heating plus the flashing or arcing for increasing the temperature of the ends of the work pieces to be joined to the forging temperature and there after upsetting results in the development of the joint. This typical kind of the temperature for a steel is 1250 degree centigrade and upsetting is done using the temperature, using say, a 90 or 100 MPA pressure.

So that the joint is formed and optimum combination of the current, time and the displacement results in the clean weld. And this process effectively be used for the joining of the, like rails, rings, chains, girders, pipes etc. Now, thank you for your attention.