Enclosure Design of Electronics Equipment
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Lecture - 23
Issues in bending and folding

So coming back to my drawing here again you have seen that something called set is given, when the main set it means it is a punch and die system.

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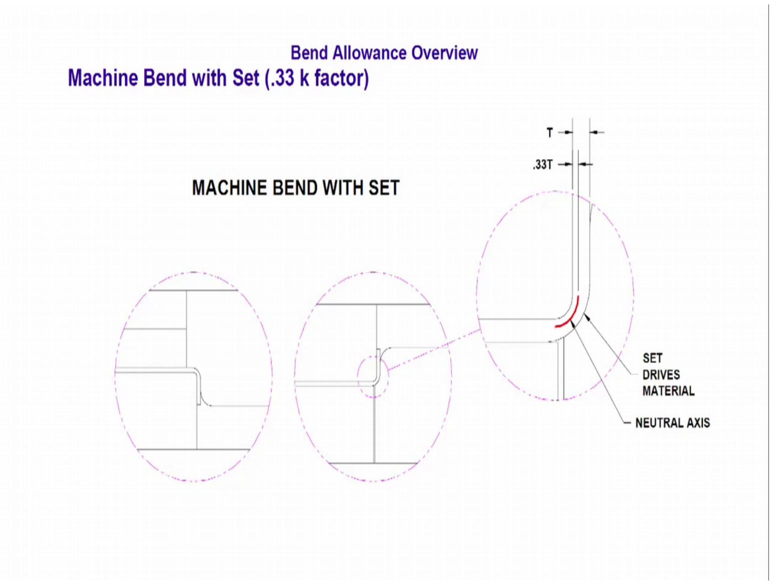

So, you have one part of it is the bottom which is here another part of it is in the top. So, here this is upwards here this is downwards here, set drives material and you will end up with any of these operations.

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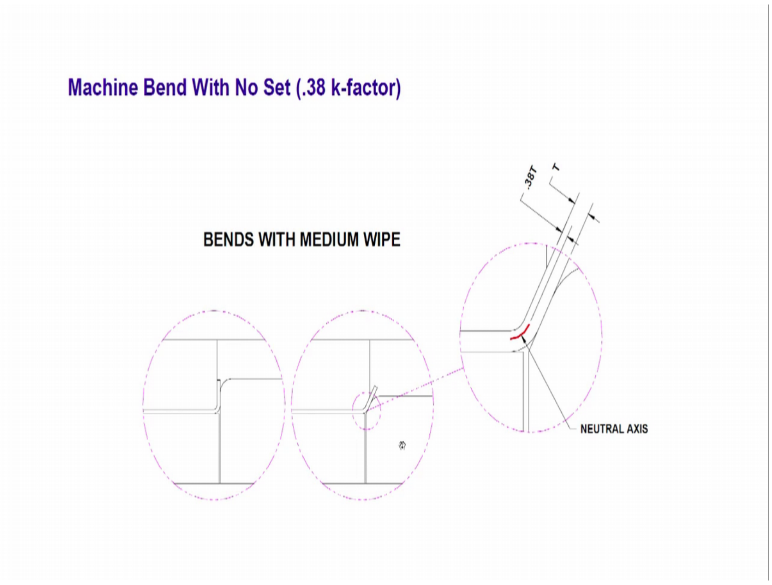

You see here bends with a medium wipe and you see here there is a smooth radius here in this corner, one of these limbs has a smooth radius so as we bend it with the this operation know will be slightly different from if it were directly done with the sharp radius and in this case you see here it could be something which is made at a different angle. So, there is a 135 mm angle here, this is 90 degrees, this is 135 mm. So, we have k factor which gives modifying all the time.

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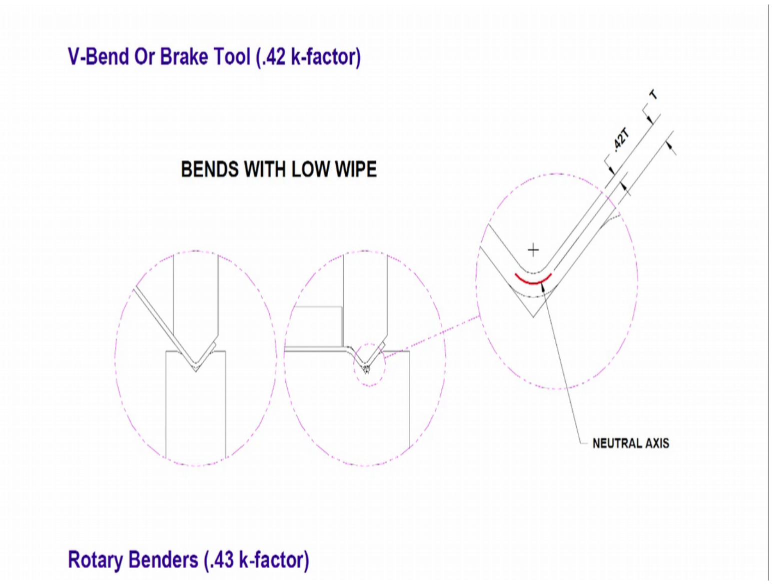

In the video we check if you have seen the previous lecture I have shown you a folding machine where we have a finger holding it and after that the bottom of bottomed I moves up bottom moves up and then we have a neat folding machine. This end, one of the things towards end I showed you was the v break.

So, we have a punch on top then we have a die at the bottom and then you see how these, how the bend takes place here. Here also three types are there one is if you have a gap we call it a air bending if both sides are you know pushed in then we hit both of them together it is called coining and then we have normal bending which has other operations.

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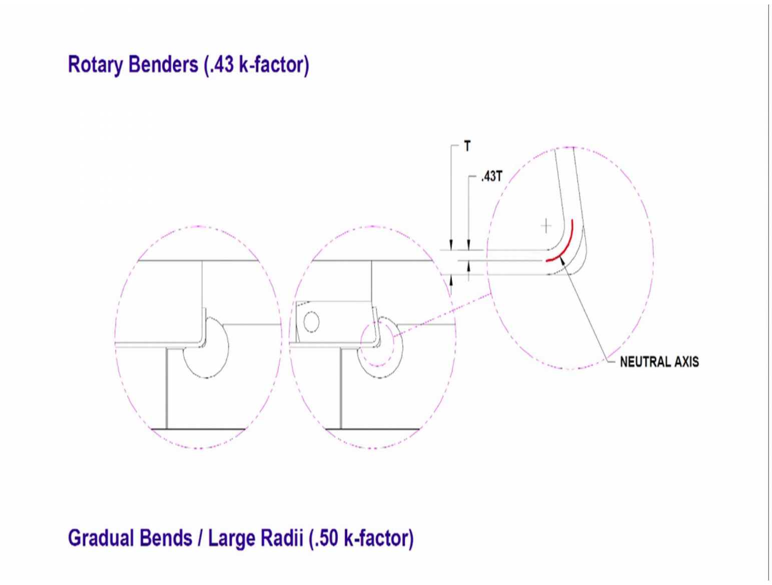

See here they have shown a moveable rotary bender here what this rotary bender now, this inside part also moves here and then gives you whatever the natural this thing here have you seen here instead of that being a rigid thing where you are it is forced to slide this part of it moves and bends with it you see this look thing here, is vertical part know you see here then you see how it bends over here. But these are all more details on the shop floor and depending on for large part production, in the case of small production is very unlikely that we will have this.

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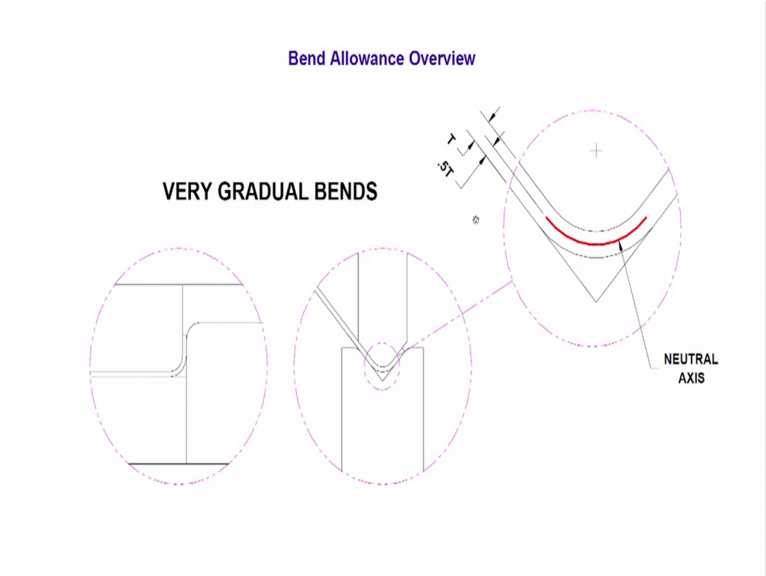

So, you have made things which have a very large gap here a gradual bend neutral axis is exactly 0.5.

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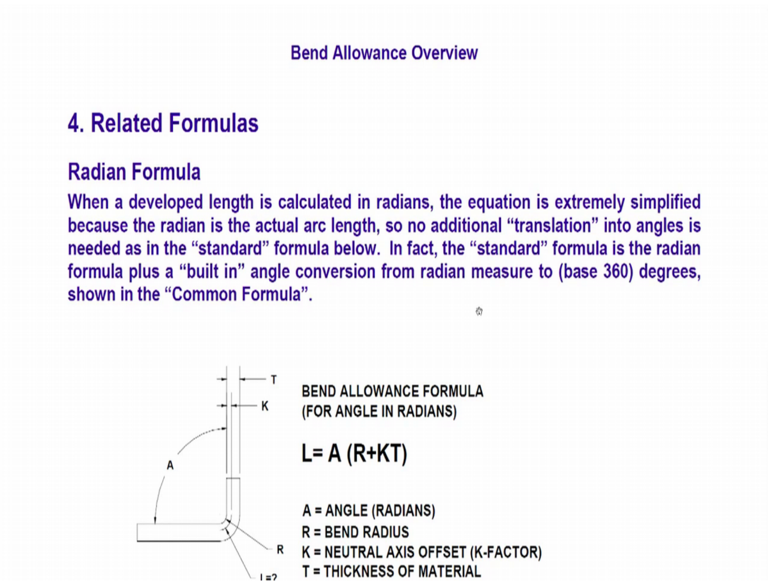

So, when you go down they try to come to the, can we have a formula when a develop length is calculated in radians. So, equation extremely simplified because radian is an arc length. So, no additional translation into angles is needed as the standard formula below. In fact, the standard formula is the radian formula plus a built in angle conversion from radian measure to base 360.

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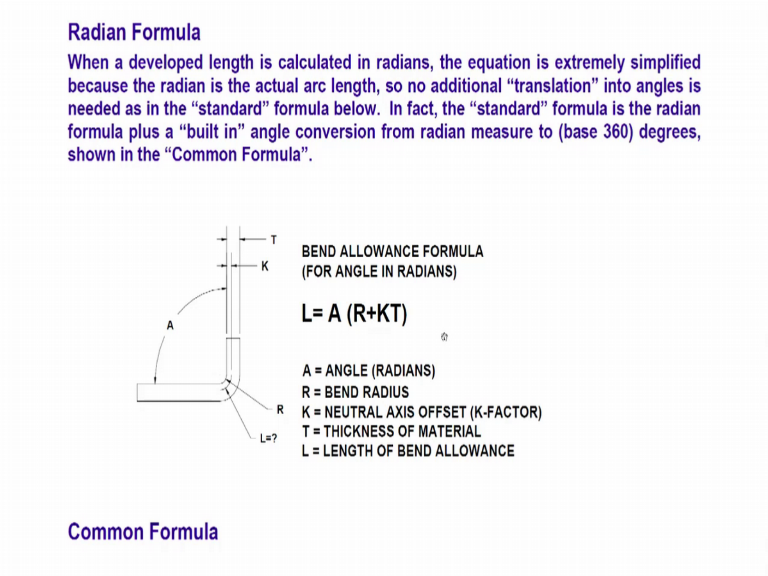

While this is nice for us probably from a physics point of view the reality is that we need to mark them in decimal millimeters. So, we have a height gage where the height gage somebody has to put the sheet that needs to be formed against a vertical surface and then do that in that case taking about things in radians for angles in know it does not makes in, but here it is about a is the angle in radians and then how to come back to making things understandable.

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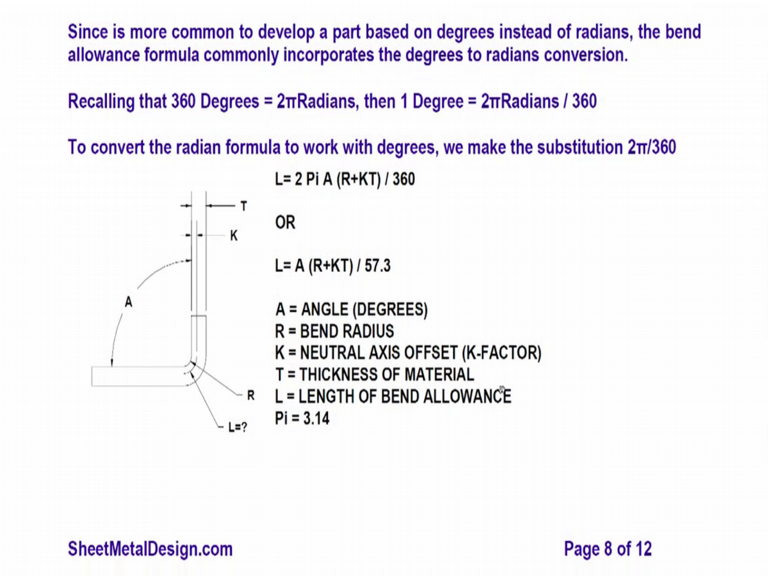

So, in this part of it now I will cover in one of the other lectures. So, what is done normally is depending on the practice in the work shop you usually have a table in the case of the place what I have shown you for all our 1.6 and 1.5 mm aluminum materials and allowance of 0.65 millimeters is added to the internal dimensions. So, you have a simple L I have a limb A I have limb B, I was this is 40 mm and this is 40 mm I take the two internal dimension straight away. Mind you I am not talking about the clamping position I am just talking about the flat length when it is laid out how much flat it will come.

So, this is what I try to show you that is so I have a flat internal plus internal plus a little bit of bending elements. So, in our case third point five mm radians and all that we come with 0.65 millimeters. So, we try to include that in various development calculations, but if you come here very elaborate things saying for all other angles where A is in radians elaborate calculations are given here.

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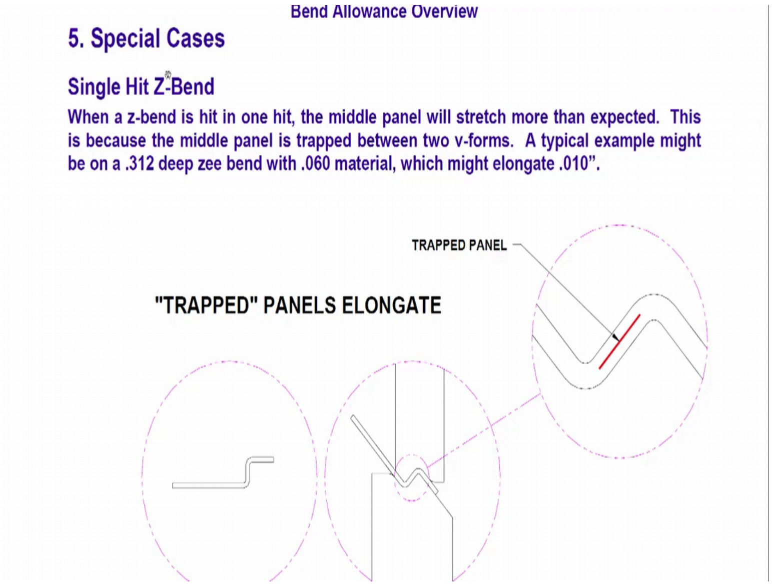

We have single hit z-bend are when a z-bend is hit in one hit the middle panel will stretch more than expected. This is because the middle panel is strapped bit into v forms typical example might be a 0.312 bend with 0.60 material which might elongate by 0.01 these are inches. I think correspondingly you may have to calculate the lens that is there. This relation to the bending machine we have in which I have shown in the video in the bending machine which we have, which we have fingers that part which is under the fingers that part the clamp part under the fingers does not change in length and then to accommodate where the internal radius we also mark 0.5 mm inside.

So, if you want the internal dimension let us say internal dimension you want around 12 millimeters we mark 11 and half millimeters here and clamp it like this. Advantage is now eventually internal dimension of twelve millimeters you get thicknesses extra.

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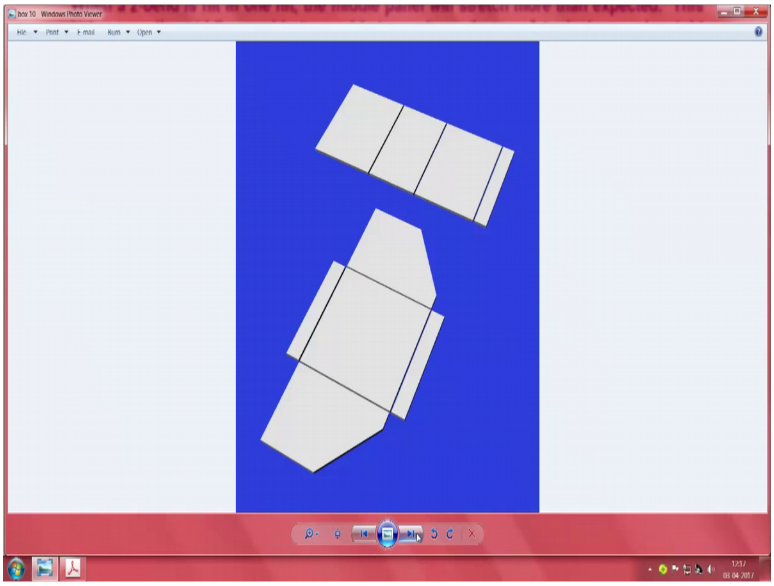

Now if you come back to the; see here this is the developed portion of the that same box which I showed you here; however, still to avoid confusion you see here we have little confusion here actually this width cannot be this much it needs to a little smaller or it needs to a bigger. In case it is overlapping this it needs to be two thicknesses wide compact to this in case it is coming inside you need to have probably to thicknesses smaller otherwise you end up with a corner just not filled the corner will not be filled. So, I can see a edges of both the sheets in the corner.

This is in one short if you trying to make any of these z angles where to be have these things wherever you seen where a thin sheet is there in it requires a little bit of strength as you would see a parlon or I do not know how to pronounce it to make sheet stiff inside they spot well items like this here. And if you see the proportions of it typically the total step what we get is about 4 to 5 times thickness of the material.

So, without occupying too much space we can make sheet stiffer by putting this z per lines inside the sheet fabric get it once again we end of with these things and then generally it is very rare to see any part making a single function that will be an over designing. So, instead this may be also used as a catch or as one of the closures of the cover or a panel which slides or something to compensate for a thickness. So, you see here imagine something like this is there this something like this is here imagine one more sheet can come here.

So, this can form a one more will comes here this can form an edge of the thing this could be the bottom point this could be the top portion and it between these two the thickness can probably be covered by a gasket which ensures the there one be any leakage between the two panels. So, if this are to be the top they can be a bottom here for example, a chassis can come here this could be at the top cover and in the bottom chassis, if I pack the inside surface with the suitable elastomer which is probably struck on onside then I add a gasket grease and then push it and top of it I can avoid and make it splash proof.

So, if normally what are to what to enter here it will not get, it will not try to go inside. So, you see here for, if we can combine the features of something that does this end that is it adds a little bit of strength stiffness plus it helps in the overlap of the materials it takes us on the way to our product design.

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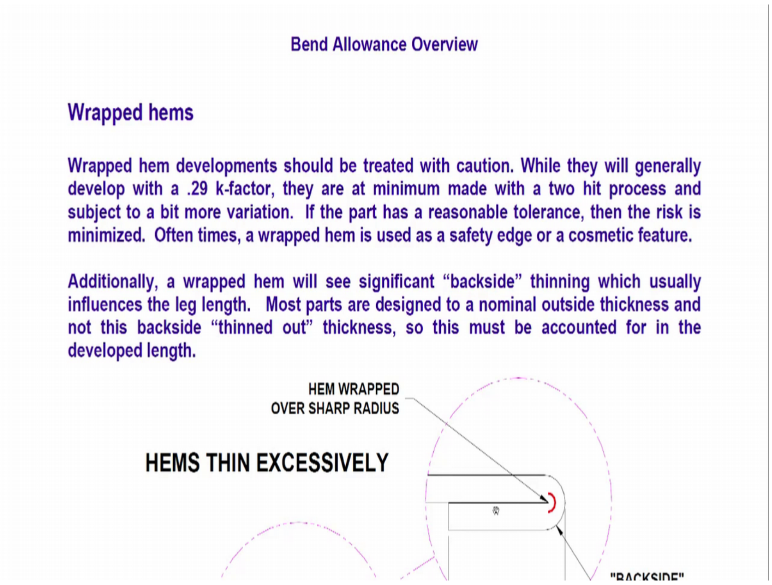

So, if you have completely closed wrapped hem developments should be treated with caution while they will generally develop with some 0.3 k factor they are at a minimum made with a two hit process and subject to a bit more variation. The part has reasonable tolerance then the risk is minimized.

Wrapped hem is used as safety edge are a cosmetic feature. So, this is where I would like to saying just saying it is a cosmetic feature to something which will ensure that you do not have sharp edges plus it also adds a little element of interest and as it goes and design if you cannot hide something that try to highlight it. So, we get things like this. A wrapped hem will see significant backside thinning which is usually influences the leg length. You see fully something is close like this, is something is fully close like this.

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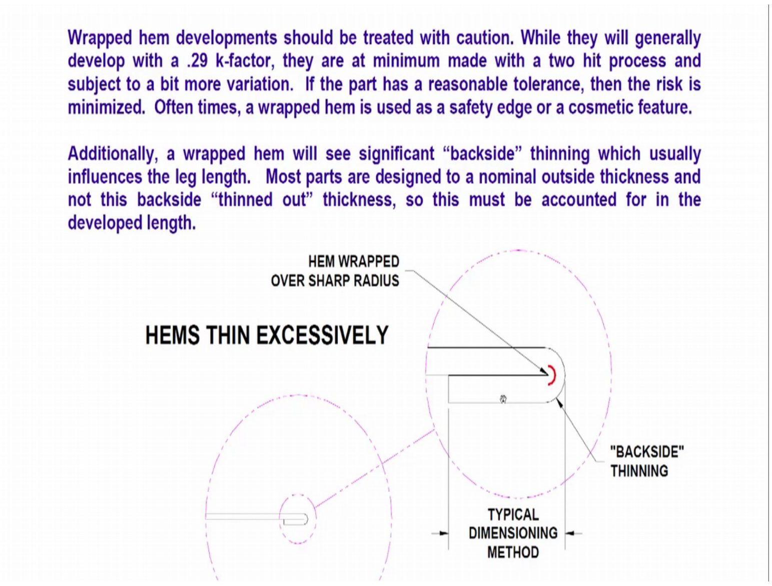

So, even the details about how much of the this extra length is required for a given and developed length it is not just about one more time not taking the inside lengths and then calculating a average of the spherical I am sorry of the circular length and then expect the total thing to come normal. When you fold something like this automatically you cannot expect all these know to behave perfectly like this, you have a circular portion which is also deformed. So, in this case now we need to take care of all these things.

Is it important and why is it that I am talking about it, yes it is important because whenever this features are added you may not have any space inside your basic equipment it is not interfere with something. So, next time we get a chance and you open a cover and see that whenever such things are done usually additional reliefs are also given. So, that is some cable may have to enter or a cable grommet needs to be placed, while a cable grommet is designed for one thickness and this place where the that folded over one eighty degree bending is there, there will an additional thickness which one need to leaking.

So, probably one fourth or one fifth ark of a material is removed there, remaining bent over and then the grommet can sit comfortably in that. In the grommet can be if you have to closures like this in between thing. So, you have a little offset here, I cannot do it and then in this portion you probably need a cut here and one more cut here to make sure that a grommet can be inserted here, in the power supply which I showed you first time it was there.

So, materials are often tried materials are often tried and specified also saying can you make a 180 degree bend at this point it will become obvious to you that if the grain structure of it that is if the this is the rolling direction of it obviously, bends easily, but the rolling direction where this or the raw material chances are little break here. So, we are in trouble. Now imagine you want it a little stronger probably would like to have one more limb this side. So, is it all right can be make it with this that point know is where the designer will take a decision, probably they will put in L shaped length here inside separately have this and join them together or have a dimple or something which once it is formed it stays stiff which will take me to the last but one what you call page saying in case you have a simple thing there, there was a large difference in the offset you understood know, almost like this it was something was here like this and something was here.

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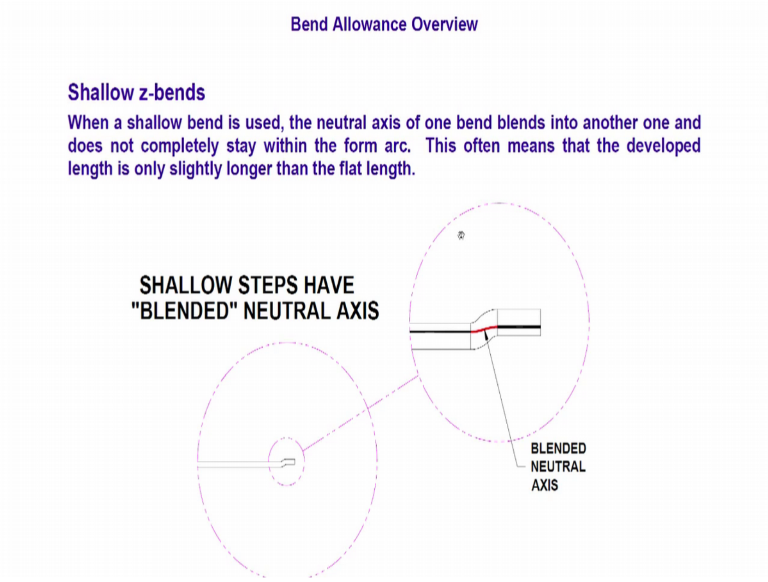

Here typically this is much less seen that know suppose is only one thickness offset. In this case the neutral axis is likely to not have too much of additional affect. So, here length is only slightly longer, when that talk about slightly longer it is probably not even measurable it should be the order of 0.05 or 0.1 millimeter long and then it does not matter because the limbs themselves know are the alter of limbs are so small.

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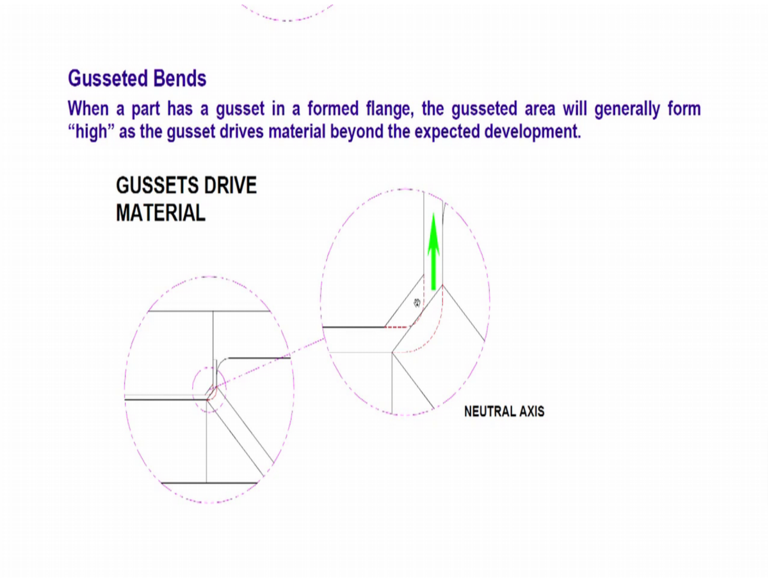

So, as you go down when a part has a gusset in a formed flange the gusset area will form high. What exactly is a gusset? So, whenever we have a L angle like this is stiffen this angle in one of the corners suppose this is a, they make a depression which goes inside this is the one makes the part stiff. So, next time you open any hardware around your house, typically opening fans or if you are a hobby is to likes to check things in a washer a dish washer or a washing machine you will notice that though the material itself is probably a good 1.6 are 2 mm steel thought it set a right angle the usually make a dimple on one side. So, that it comes in and then over a length like this let us say our lengthier 100 millimeter every 20 or 30 millimeters you have those dimple. If you have three of them say 25 mm point, it will make it very very strong.

Now slowly what was the simple bend an L bend is getting complicated because that gusset part of it that small dimple what you give in the corner will now add to all these calculations and this is not done on ordinary machine. Probably the die part of it has a relief, but the punch of part of it has been built separately. So, if you see that v bend what I have talking to about when we have that v forming. So, lot of detail is added here to see that the required bends and all take place.

So, as we come to the end of it this is where I thought I suggest you read this, go to the so old it is probably we practically 15 years old.

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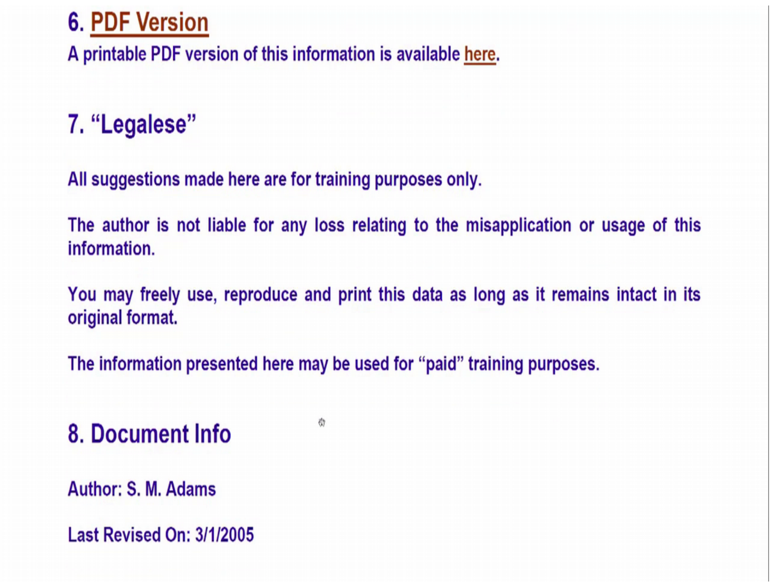
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Now, I will try to go to the; this is taken from again what you call an agency which carries out these operations.

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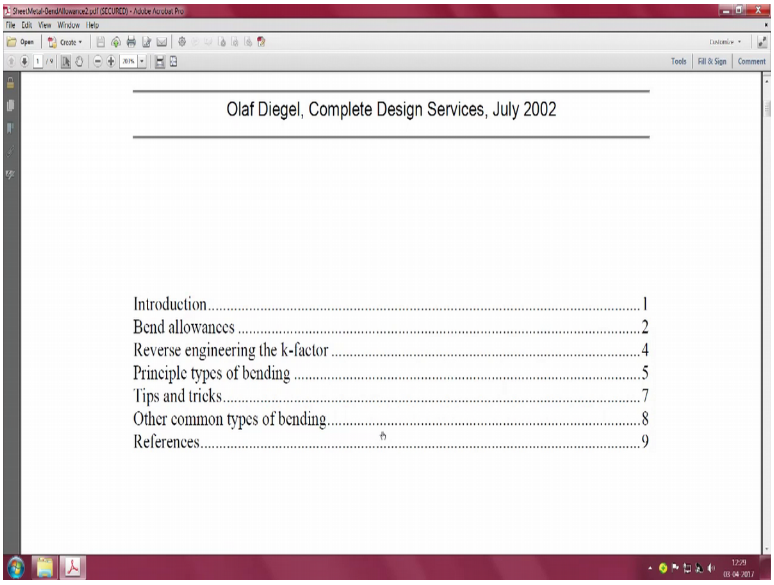

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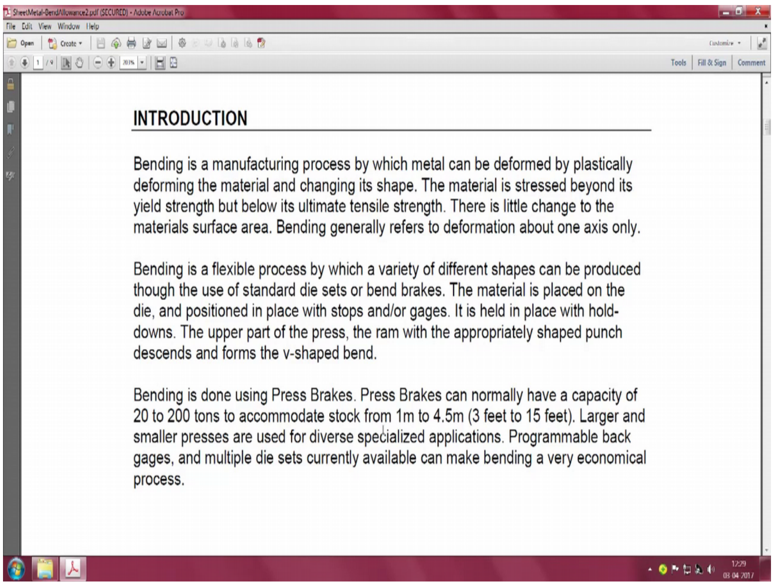

I just need to allow you to probably read what is written here. I will just the difference there is all about the k factor saying how do you determine the k factor and the word know something called scientific and the what trail and error are used.

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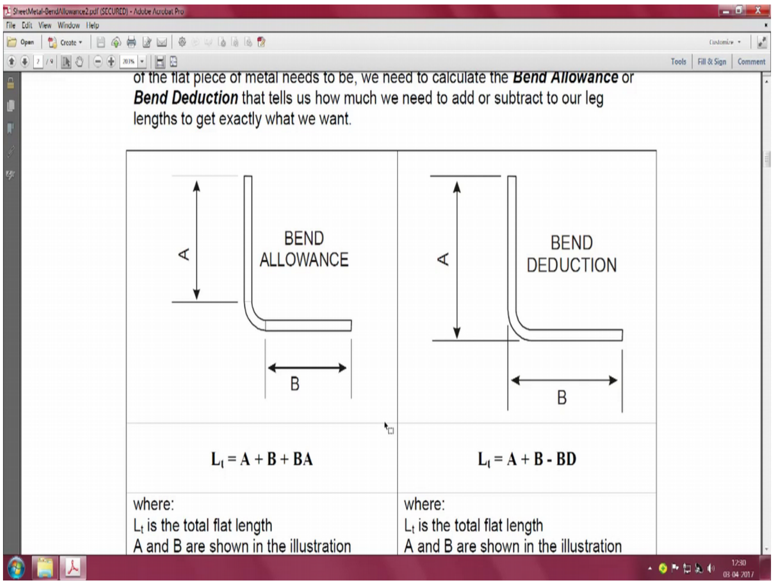

Instead here this is more related to if you take the internal dimensions minus the bending radius how do add a bending allowance where in the case you want take the external dimensions add the external dimensions and then you remove the internal dimensions.

So, we once again I will available to read this first part of it, just read it - is a manufacturing process metal can be deformed by plastically deform the material and changing it shape. Material is stressed beyond its yield strength, but below its ultimate tensile strength that is where know it contains so little ductile, ultimate tensile strength will make it fail it will break which will happen in the case of 180 degree bends. Sometimes if you do not allow it to form itself at a given rate if you do it, it is also rate phenomena. Yield strength is where the bending takes place and then if you remember our curve, stress strain curve you will see there is a small kink and then there is a residual permanent string which occurs. We use the residual permanent strain before it fails completely an then the yield strength.

There is little change to the surface area bending refers to deformation about one axis only. Here again know is very very important, we were talking about only one axis. So, if you take our plane as the xy plane the one away from front to back know is the one. Alternatively we are in the horizontal surface x is in the horizontal the y direction only, if you have an axis between the origin and the y axis and if you bend things over this is what about one axis. Bending is a process by which variety of different shapes can be produced the use of standard die sets or bending bricks.

So, if you, so read my or if you read this notes very important things are there, see this one of them it says is I will try to highlight it by going a little closure standard die sets or bending brakes. So, bending brake is what I showed you already then what is a standard die sets things like joggling and several other operations including lugging and those things use standard die sets. Meaning the design uses standard it is not as if you know the whole thing is not, just whole thing is not a standard material is placed on the die positioned in place with stops and or gages, very important, very very important things saying everywhere we have a back stop.

If you want 10 millimeters is not every time we do the marking, it is not real in the case of mass production its not to earth while marking every sheet. So, instead one sheet is marked and at the back a stopper is put the stopper it will ensure that next time you need not mark it again. So, may be a 100 pieces can be done you just feed it into the area of operations and keep doing or other is about gages instead of a stopper which is fixed it is possible for you to have a gage in the front where you can read what you need, you can have the gage in the front or the back you have a scale and then you unlock the that stopper in move it and necessary thing and then you are operation is done.

Coming back here it is held in place with hold downs upper part of the press the ram with the appropriately shaped punch descends and forms the v shaped bend its nothing, but what I have already shown you. Again coming back may be when I get a chance after we finish is little bit of reading we will go back to the work shop and see if we can make things little more clearer.

Bending is done using press brakes, press brakes normally have a capacity of 20 to 200 tons to stock from 1 meter to 4 and half meters larger and smaller presses used for diverse specialized applications. Programmable back gages multiple die sets currently can make bending a very economical process.

I think I will stop here for today and we will continue in the next lecture. I will once again start with this after I finish three of this things to read. So, I have just if you remember I have just lowered you into this small thing about a bend alleviation and bend deduction contemplate on this, alternatively if you can locate another resource read it.

So, thank you, I will stop here.