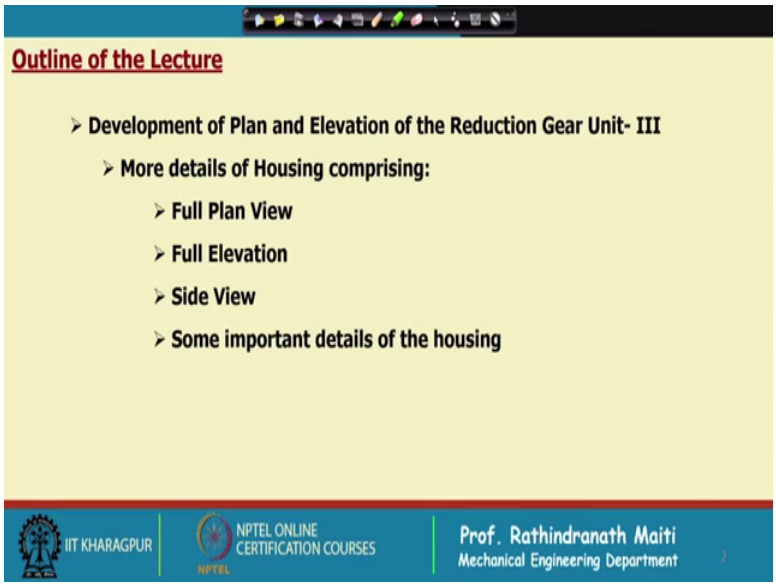
Gear and Gear Unit Design: Theory and Practice
Prof. Rathindranath Maiti
Department of Mechanical Engineering
Indian Institute of Technology, Kharagpur

Lecture - 30
Development of Plan and Elevation of Gear Reduction Unit – III

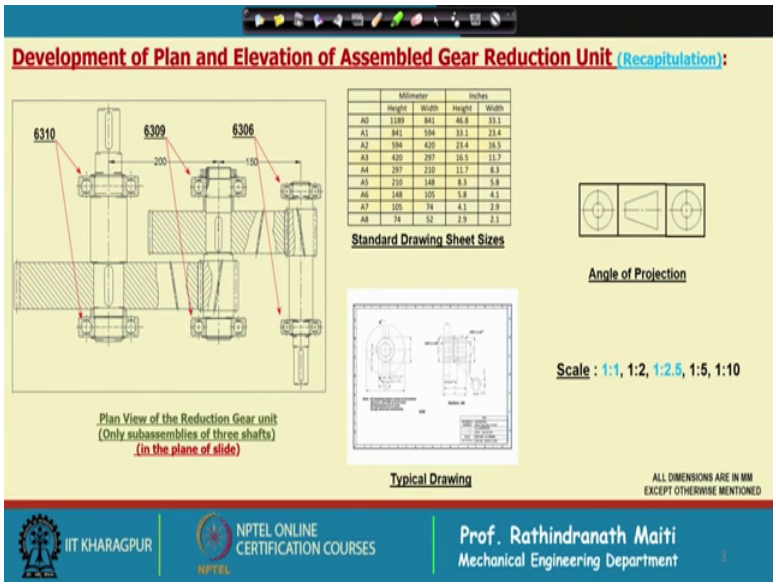
Welcome to this week 6 lecture module 6 design of general purpose industrial helical gear data reduction unit this is part 4. We are still continuing with the development of plan and elevation of the gearbox and this is the fourth lecture of this week lecture number 30, Development of Plan and Elevation of Reduction Gear Unit Part 3.

(Refer Slide Time: 00:46)



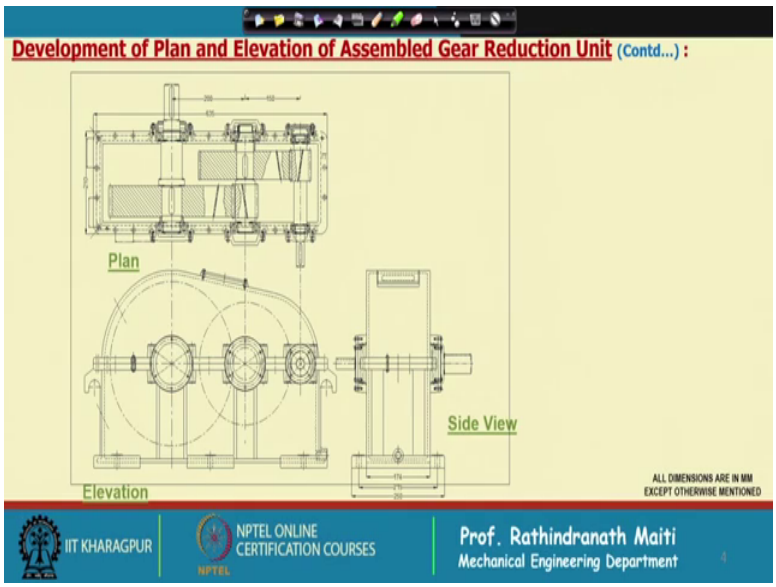
And in this lecture I shall cover the Development of Plan and Elevation of Reduction Gear Unit 3; more details of housing comprising, full plan view, full elevation, side view, some important details of the housing.

(Refer Slide Time: 01:03)



Now, this is again we have in the last lecture we have discussed that why we have taken 1 is to 1 scale. And we will accommodate everything inside that we are following the third angle projection for the viewing and this is a typical drawing view and the scale 1 is to 1 we have taken; however, we have changed the bearing to 6 to 0 5 6 to 0 8 and 6 to 0 9.

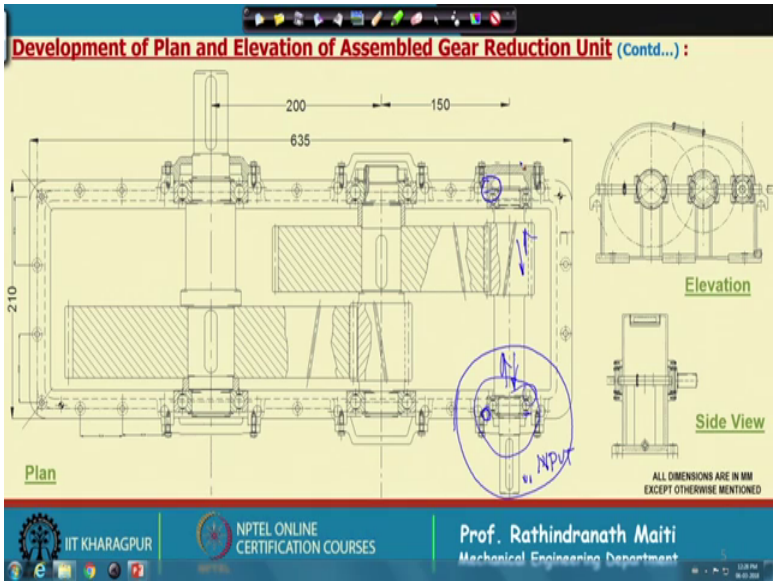
(Refer Slide Time: 01:36)



Then, if we look into this view this is just to show you that how it looks like say this is that a 0 size drawing sheet. We have left top corner we have put the plan view of the full

plan view is shown there. And below that following the third angle projections I have shown the elevation view all components are not yet put there, but you can this is to we can understand easily what we are going to do next? And then by the side of elevation right side we have drawn the side view, which is also in third angle projections this details I will discuss next.

(Refer Slide Time: 02:37)



Now, this is in this view what I have shown the, we have zoomed out that the plan view of the gearbox. Now, if you look here in this plan view first of all this is I have already shown this part, that is the input shaft this is input shaft sorry this is input shaft and in the input shaft, what we have put who we have put the cover and oil seal we have put the cover and oil seal, which is shown already shown in the previous lecture.

Now, if we think of the other side the other side you will find that the cover is there, but there is this is completely blind, because other side this shaft is not extended this is only input from one side only. So, we need not go for making any hole or oil seal is not required simply we put a cover, this construction of the cover is more or less same only at the middle there is no hole as you see there, but importantly while we are estimating the life of the bearing, what we did that the bearing at the far end of the pinion that bearing is locked.

So, that it can take the axial load irrespective of direction of rotations here we have taken the pinion of right hand pinion right hand helix pinion ok. So, directing depending on the

direction of rotations either they axial force either it will be in this directions or it will be in this directions. And whatever may be the directions this axial load will be taken by this bearing, either it will be pulled or it will be pulled.

That is why, if you look here that the cover is touching the bearing race here it is touching the bearing race and this bearing race corner is rest on the housing also. So, this outer race cannot move. And, if we look into the inner race of the bearing that is one side there is a step of the shaft it is resting on that, and other side there is a circlip. So, this bearing also cannot move on the shaft.

So, therefore, whatever axial load is coming that will be taken by this bearing and other side has been kept free. So, that if there is some misalignment in the assembly, that will be taken care of as well as if there is some elongation of the shaft or contraction of the shaft due to the heat. Then this would be taken care of, that means that can move that bearing can move axially outward or inward there.

Essentially, we should give a gap there if you observe that from the bearing end in a recent and the cover end there is a gap. If you minutely look into this there is about 1 2 millimeters gap, shaft elongation will be very small very very small. So, we need not worry about that 1 or 2 millimeter gap is there. However, these 2 components these 2 cover will definitely will be of different dimension different feature. So, they are separate component we have to while we are numbering this component part number this 2 will have separate identity, separate part numbers.

Now, if we come to the next intermediate shaft in intermediate shaft there is no shaft end it is not that shaft end is going out. So, we can use the cover blind cover both side. Now, if you look into the side, which we have where the, we have locked the bearing; that means, this end we have the locking of the bearing with the shaft by a lock nut.

Which he also manufactured by the bearing company this comes with the bearing that is having a special thread. And, we have used that locking arrangement; if we look into this this locking arrangement is there. We could have used the circlip also, but this is the better way of locking usually in intermediate shafts of the where both gear pinions etcetera there it is better to put that type of locking ok. And, if it is taper roller bearing if you go for taper roller bearing, then it is essential we cannot avoid that.

Now, if we look into the locking of that side there is also this corner that we have kept a raised portion of the housing. So, that inner race outer race can rest on there and on the shaft we have used the stiff and lock nut. And then this cover must touch the outer race if you look into this this part the cover is also touching there. And then this for making this drawing so, that the cover line cover does not touch the shaft, we have raised this portion. Unlike this say if we compare with this this is simply we have put the cover and here we have put the cover slightly projected. Now, question is that in other side whether we can put the same cover.

Now, if you look into this this design is made in such a way the same cover can be put on also in the other side right. So, the here we will give only one item number say this is 21. So, here also we can put 21 and number of will be 2 this will at least a whatever may be the small, but still in (Refer Time: 11:03) will be less for that we can use the same cover them the other sides ok. And as you if you look here the dimensions are maintain in such a way here this gap is there this gap may be a little more to adjust the all dimensions, but does not matter.

Now, another issue is there that still there is a possibility that oil will leak through this from the side of the bearing through this it can leak like this. So, usually this surface is a very thin gasket is put that looks that looks likes very thin type very thin micron level few microns are there that is if you think of this that polythene packets of transparent packets, which something look like that or like a transparent sheet simply it is cut and it is put there where it is tighten, then there will be no leakage of the while this special seal is made for that also. So, that is put in all cover. So, this is we have completed the cover of intermediate shaft.

Then if we come to the output shaft side then we find that there we have already discussed about this output part and there how the sealing and cover is put and how we have locked the bearing there that is also far end. So, we have locked that part and other end we have the bearing we have locked with the shaft using the circlip whereas, the cover is made blind. In any case these two components can be cannot be made same although the shape may be same, but there will be a hole on output side and other side it will be blind.

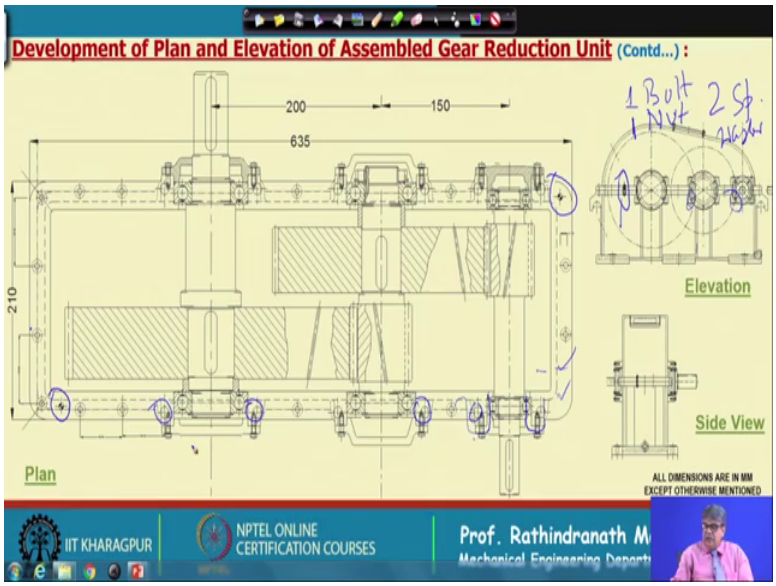
However, here we have taken; that means, this will carry separate item number we have made flat type and if you compare with this of other side it is more or less same, but size is different of course. So, in that way we complete the cover part ok.

Now, next other important factors are first of all let me discuss about this dowel pin. So, after the first planning is over by in a planning machine this surface this surface ok. For both top and bottom then this this is there are through holes are made that is to put the trough bolts, if you look into here see one bolt is shown on the elevations. So, these bolts are put like this and for that bolt you need to make a some counter on the both sides. So, that the bolt can, both can be put there with without any I mean it can touch the surface properly.

So, but I would say that we use the spring dive washer spring washer there, but still we make the surface there is a special tool like a drill and end mill cutter, that is put there and these surface are machined and as you look minutely the circle with dotted lines bigger circle with dotted lines that is for there. And here in this drawing we have used this is small gearbox we have used M 5 bolt for tightening. And so, that outside diameter of that one may be can be made 10 millimeter. So, we can use the book special tool of 10 millimeter and we can make that surface.

And this hole size diameter of hole for the 5 m 5 bolt is usually 5.2 to 5.5 this deal is available of that size and you can make the hole. So, that easily you can put the bolt through there.

(Refer Slide Time: 16:07)

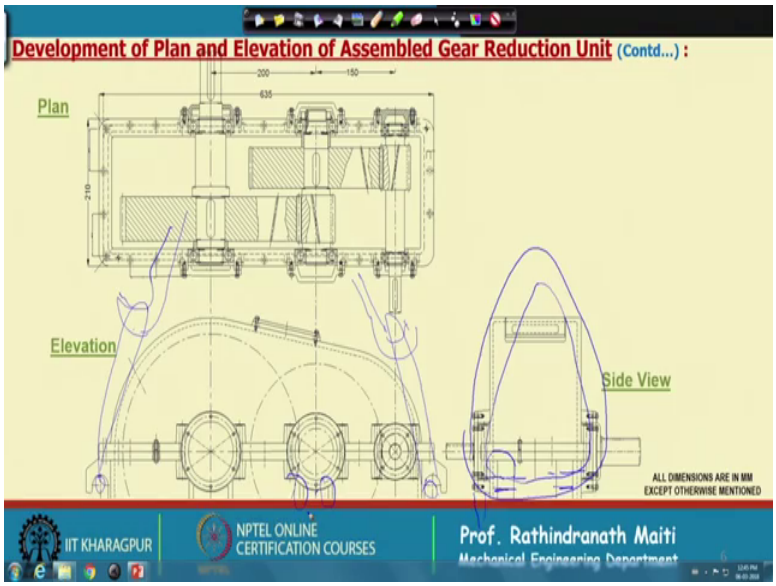


So, this means that if we look into this here there will be 1 bolt, 1 nut and 2 spring washer one at the top and one at the bottom, but sometimes we can use one side plane washer other side spring washer, but better to put with the spring washer. So, that it will not easily open due to the vibration ok.

So, that is done and as you also look into this there are bigger holes say here if you look the size this this housing portion for bearing it is a you can imagine, this we have taken this gearbox of 7 millimeter wall thickness, but here for this housing this wall thickness has been increased this is say 15 20 millimeter thickness like a rim sort of things that is touching the gear box touching the main housing and then for this bolt holes very close to bearing. So, that bearing because bearing there is a load. So, we use higher size bolt near the bearing and for that you need a it is somewhat barrel shaped rage portion is there and then we make the deal hole there.

In this case probably we have to use 100 millimeter bolt and diameter we have taken 10 millimeter m 10 bolt the 5 millimeter for this locking and here this dimension we have kept about 30 40 or 50 millimeter, this from this to this here perhaps it is more 60 millimeter. So, and we have made several holes, but near the bearing we have put the larger bolts as you see here.

(Refer Slide Time: 18:31)



Now, if I in this view what we have done I have shown the elevation not fully bottom portions just to show you that, this covers we have 6 bolt 1 2 3 4 5 6 bolt this is also we have taken m 5. Now, here this bolt is simply tightened on the bearing seat there will be scaffold. And, if we look into this view here say here this is these are the 6 holes for tightening the cover m 5 bolt and thread is made inside this housing raised portions where the bearing are settled.

Now, if we look this view apparently this bolt hole and the hole here they are interfering, but it is not that this is just to show this view of this bolt one detail view is shown here, you can enlarge you can see it there. And as you see these are not fouling with this walls these are made at the 30 degree from the meeting point of the upper and lower casing from that line 30 degree and totally angle between these are 60 degree to put 6 hole 6 bolts, but if you come to the input shaft perhaps we do not need 6 bolts there, we can use 4 bolts at 45 degree, but by no means they are not going inside the bolt here.

So, they will not foul you can we can easily put the bolt here for tightening larger bolts we can put it here. So, if you look there this hole by the side of this many large holes. So, absolutely there should not have any problem and we have developed fully, that what are the essential fixing bolts and etcetera that that are shown here?

Now, next the whole gearbox when they are assembled we need to lift those ok. Then for lifting there should have it is this is a cast body. So, we have made casting and this this in

casting body we have kept a some groove. So, that we can put some roof there this side one roof and other side another roof and then roof will make a loop here like this. And then by hook at this point or we can put usually there will be 2 hooks and then whole thing can be lifted there. So, this is for lifting purpose, but as well this is also stiffened the bottom housing the wall size is only 7 millimeter. So, we need to put some stiffener.

If, you look into this stiffener in the side view these are widen and this is the central line make maybe this due to that on line will come over here on line will come here. And, as I as I told that roof can be put like this and then this is used for lifting ok. So, this is also not only for lifting purpose, but also stiffen the housing as you see here ok.

But apart from that we also use some stiffener here these are all typically 7 millimeter thick and between this raised portion here and between the bottom portion of the housing, that I will show in the next part these ribs say, if you if you look from this side it will be around 25 millimeter wide, 7 millimeter thick and height will be from this to bottom.

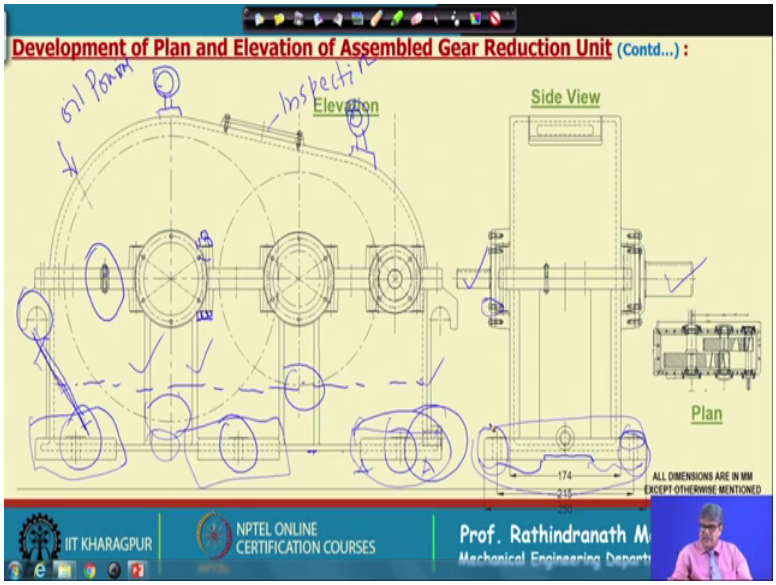
That will also it is it is some it will look like a fins and also this is having another purpose. The purpose is that we are increasing the surface of the gear box putting this stiffener. This is stiffening the body of the housing as well as the surface is also increased. So, that it can dissipate the heat easily, because this gear box are not normally in many cases it is not no pulling arrangement is there separate pulling arrangement is there.

So, and as well we can put some stiffener here also, we will put that stiffener it is not shown here, but as you find here is something is there. This is called inspection hole, through this inspection hole; we can remove this cover top cover and we can inspect. Of course, we shall keep in to keep in mind that while the gear box is running we should not open this one, only this can be open when it is not running and through this we can see inside with some light source we can see inside whether these are intact these are occasionally open and seen.

So, that is for inspection and what is not yet developed it will be maybe in the next drawing it will be shown here, we need to put a while filling either here or at the bottom also we can put a oil filling.

So, that we can part the oil inside, usually you can you can say that at least the larger large largest gear, that will touch the oil at the bottom. This will be filled may be depending on the size of the gearbox maybe 5 6 liter of oil or even more and the label is such that the bottom gear would always touch that one. And, when this gear will rotate then automatically oil will come over here, it will lubricate the pinion and due to the splashing all components will be lubricated. This is called splash lubrications that is very common in gearbox.

(Refer Slide Time: 26:40)



As well as and there is it is not in this view in other view I will show you. So, everything are discussed here, if something omitted you can ask me later I can give the answer or else in the next lecture I shall discuss.

Now, in the side view I have shown littles here for. So, as this is for lifting, they mentioned and this is for oil pouring here will be. So, this is for lifting this is for it is not a developed while pouring and here there will be a I bolt sort of things here also it will be there. So, this is just to lift the upper cover only, keeping everything intact we can leave the upper cover. So, these eyebolts are provided there that will be there.

But, we should check also the oil level. So, that is why we need to put a oil gauge here and this time to time we can open it and we can see the what is the level of oil. And, usually as you can see this oil it can be put it like this it may be both the gear or touching

the while this will be emerged in the oil and this is touching the oil. So, that proper lubrication is done.

So, this is inspection hole and these are stiffener this side also has a stiffener and here importantly here is a drain hole drain plug is not given drain hole, if you would like to drain out the oil then we can gain it out. And lastly I need to show that these 3 this side and 3 in other sides; that means, this side 3 and this side 3 that is for foundation that is foundation bolt we can on the ground or maybe on the structure we can fix this gearbox with bolt.

Now, interestingly the bottom of this gearbox, that is slightly above these surfaces which are machined ok. For this small size gearbox we can imagine that it is about say 5 inches wide and maybe totally 10 inch long this portion say this is a thicker portion of the casting that are made at 3 places here and here and this bottom is machined. So, that it can set it properly, but housing is ending here; that means, oil level will be above this point this is 7 millimeter and this is not touching the ground. However, we can make this on this this 3 that additional thick portion what we can make we can make slightly here it can be made like this optional.

So, only from this portion to this portion and this portion to this portion at 6 places that will be machined and this hole is 12 millimeter as you find at this top of that some raised portion is on casting is kept and that also by using a special cutter we can make that surface machined. So, that the bolt and washer that can be put there and it can be properly tightened and I think these all about this gear box here I have shown that how this fixing is done, we have not shown this bolt here, but usually bolts are put from the bottom side and not is put from the top for tightening purpose.

So; that means, here if I consider this portion there will be also a bolt like this and here there will be nut and this is the end of bolts a bolt from the bottom and then it will be put if we measure this it is about hundred millimeter to 112 millimeter bolt ok. It is only threaded at the top portions other portions are solid not threaded, here also up to this portion it is not threaded only upper portion is threaded we can put it there whereas, these bolt what we put here it is fully threaded because this thickness of this calf this cover is very thin.

And I think I have discussed everything if I missed anything that you can ask and I can answer to that we will put some more stiffener maybe the available nodes it will be there. This is the input shaft this is the output shaft we can put in other way also this can be put in other way this side input other side input the simply the shaft can be put in the opposite directions, as we see this intermediate shaft that can be output also in the opposite side. So, this design has been made like this.

So, this is the end of this lecture and next lecture I shall show you detail detailing of some components before that I will mention. How to number the components although drawing may not be fully complete, but which is called bill up materials we will make few items identify, we will give the number there and we will show that how they are put in the bill up materials. And, then we will have a general discussion on the design of this gearbox that is the concluding part or their repetitions that how actually we have developed this gearbox.

Thank you once again.