Gear and Gear Unit Design: Theory and Practice
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Lecture - 22
Development (Layout) of Output Shaft and 2nd. Stage (Output) Gear

We are continuing with design of general purpose industrial helical gear reduction unit, and this is part 3 and week 5, and this is lecture number 22. And in this lecture I will show how the output shaft drawing can be developed and also the second stage; that is the last stage, output stage gear also.

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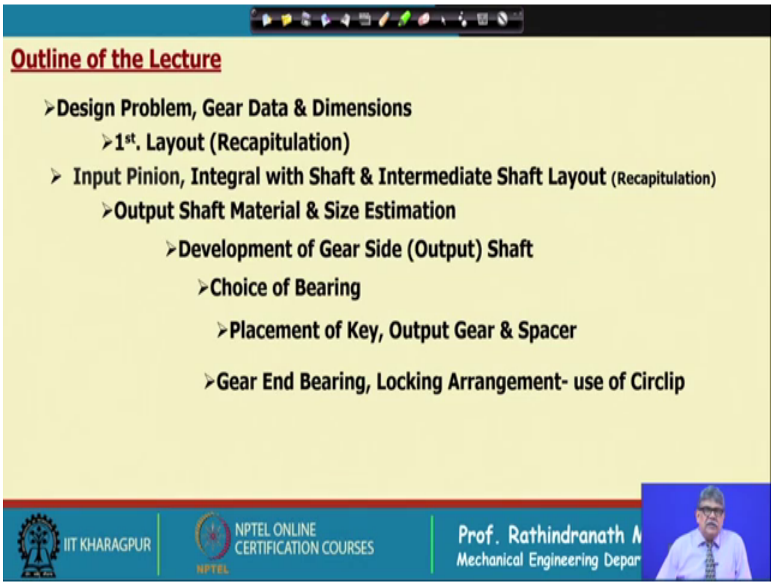

Now, in this lecture I shall cover again, we will first show the design problem gear data and dimensions and then say first layout, this will recapitulate and then input pinion integral with shaft intermediates, shaft layout and then output shaft material and size estimation, then development of gear side output shaft, choice of bearing placement of key; output gear and spacer gear, end bearing, locking arrangement, use of circlip.

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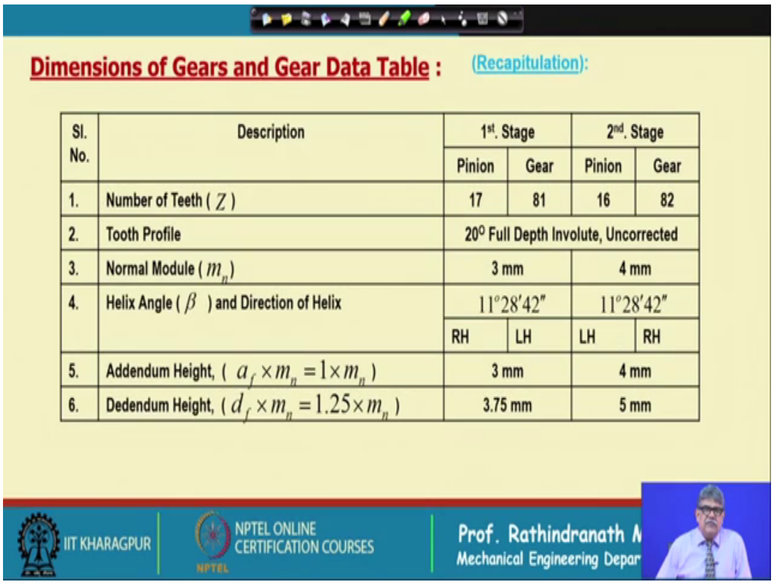

And that again this is the problem, just to mention that it is of around 24 4.24.5. The reduction ratio second stage around 5.2 and first is the rest of the part 4.0 something in the first stage, and in this stage, the last stage we have module is 4 millimetre and the gear dimensions already we have discussed many times.

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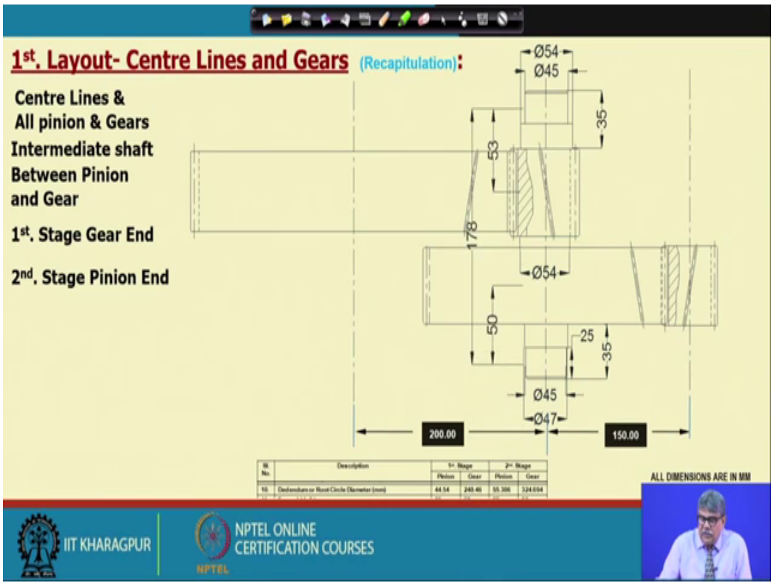

Then first we will, I will show the layout what we have already developed earlier that in that we placed only the centre distances and the gears and pinions

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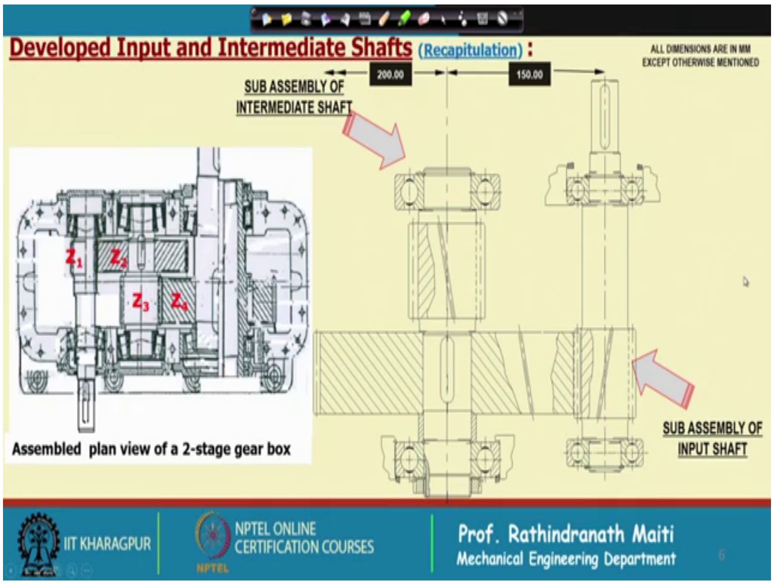

And this is the intermediate shaft which we have already developed. And then here I have shown that the developed intermediate shaft. Why we have developed the intermediate shaft fast? Because that give the idea of both side; input side and output side. So, first we have developed the intermediate shaft with bearings gears, everything locking arrangement, everything we have shown here, we have made as much as detail possible of the shaft. We have also shown that possible arrangement of locking with the gearbox housing.

Then we have the same way I have shown, also the input shaft arrangement with the bearing locking arrangement. Now we shall. So, this means that if you look into this gearbox, this is intermediate shaft and the input shaft is already developed and so on and the centre distance 150 to 200 that will what we have done. This is the sub assembly of intermediate shaft that we have done early.

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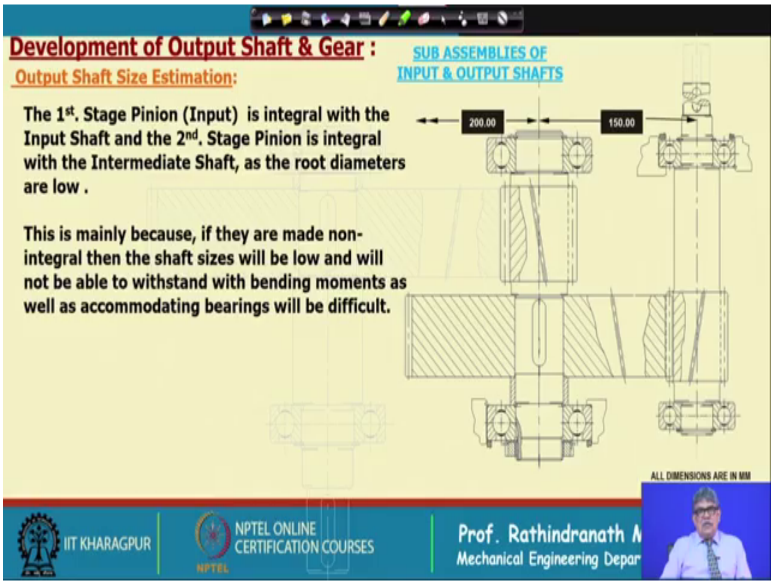

And then the sub assembly of input shaft right inside. Now we shall first discuss that what might be the size of the output shaft. First thing that the output gear is large size and it may not be required, why may not be. It is not required to make this gear integral with the shaft which was required for the input shaft and the intermediate shaft, and in those two shafts if the this pinion are made separate; that is separate from the shafts, then shaft side will be so less that it may not be able to withstand with the bending moment there or even talk there.

So, that is why it is essential, we have to make this two pinions input and intermediate minions integral or other words first stage pinion, and first second stage pinion integral with the respective set. This means that there the shaft material is the pinion materials and which is having high strength, but in this case, as the shaft is being made of other material, as well as if there is a space for making the shafts large we can go for some other material and what might be the possible size of the shaft. Then we will think of that in the intermediate shaft pinion. We have taken 45 millimetres.

So, in the case, in this case output shaft, definitely the bearing size will be higher than that. So, first possibility is that at the bearing end at the step for bearings we can keep the diameter is around 50. Why around 50? It is 50; that means, we can consider the 6, 3, 10 bearing. Then with that assumptions and considering that bearing material will be median carbon steels.

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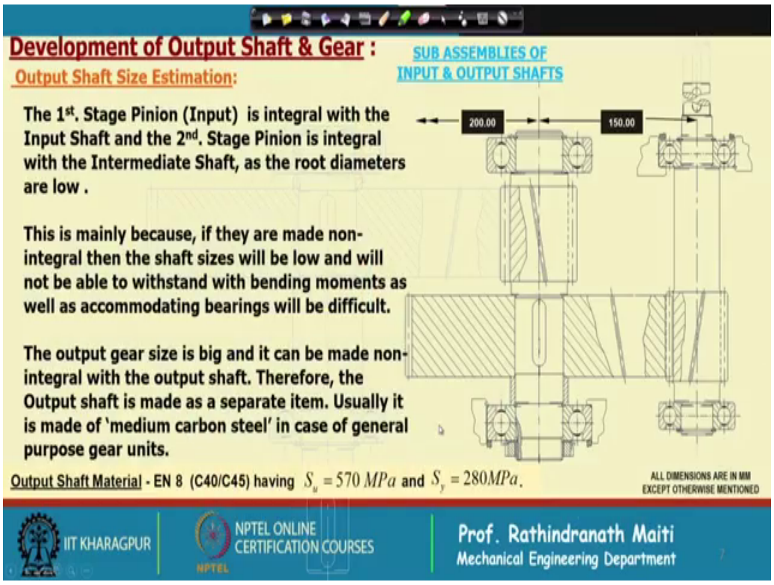

Where which are widely used for that purpose, and for which say EN 8 C 40 or C 45, having the ultimate strength of 570 mega Pascal's and it is strength of 280 mega Pascal's.

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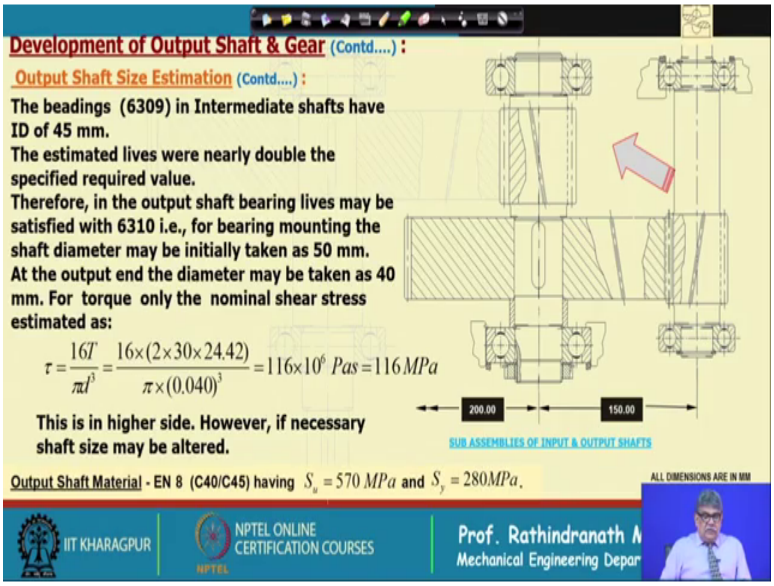

We can assume that shafts diameter will be on the bearing will be 50 millimetre and the bearing number is 6 3 1 0, and the output end after putting the bearing in the output side of the shaft again, will require one step for sealing and then the next step for coupling that coupling step or which is output end, we can be taken 40 millimetre. So, we will check there is also pure torque, assuming that I will check whether what will be the shear stress there

Now, in this case suppose we have multiplied the nominal input torque by twice, because it is a, there is a heavy shocking load. So, with that what we find the shear stress is coming 116 mega Pascal's and the material is medium carbon steel and this is in higher side. However, if necessary shaft side may be altered also but still what we can consider that with the nominal torque, the stresses will be half of that; that means, around 58 mega Pascal's and the yield strength is 280 mega Pascal's, and probably there will be no harm if you use the same diameter and the same material for the output set

Now, with this first preliminary selection of the shaft material, and what might be the size, then we start developing the output shaft. Now this centre distance from the intermediate shaft, it is 200 millimetre, and we have again introduced the centre line and then we are developing the output gear inside.

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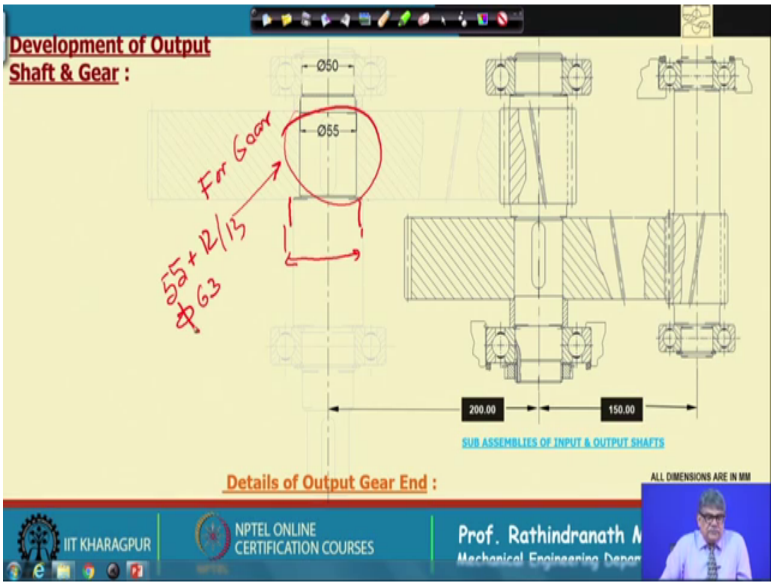

There we find that if we keep the bearing diameter 50 then to reduce the overall size of the shaft. Probably we can go for the sub diameter about 55 for the gear, and; that means, where the gear will sit and then for bearing we are keeping 50, and the shaft diameter after the gear; that means, hair after the gear. So, this is for the gear. This portion, have kept for gear ok. Next this portion which will be raised, maybe we will take 55 plus say 12 to 13 ok. So, it might be 63 gear; that means, this portion can be made 5 63. So, we can have a stock of 65 millimetre diameter and from that stock we can make this shaft with this idea we proceed.

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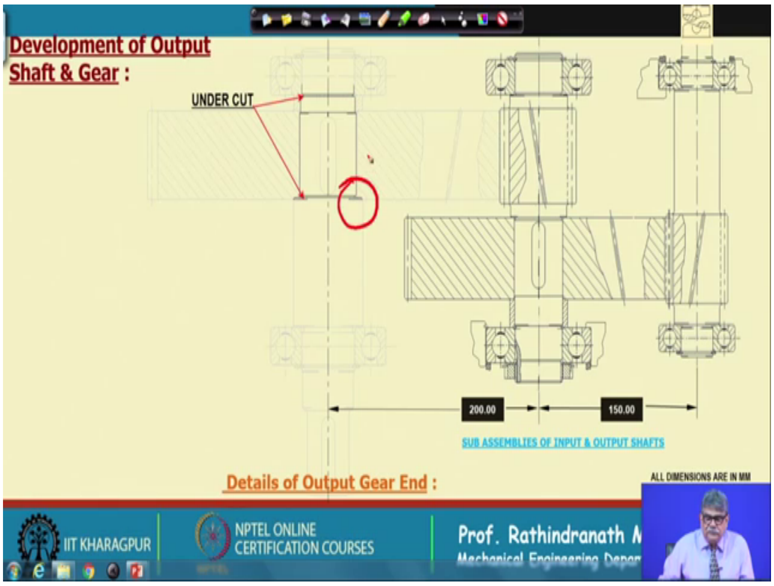

Now, we have, again we have provided two under cuts; one for sitting the bearing, another for sitting the gear. Now here I would like to mention these under cut at the, when the step of this shaft, where the gear will see it; that means, here we may not provide the under cut, it can be simply step up, but in that case we have to be ensure with the gear, that there should have good amount of chamber, but if you provide the under cut, then there the chamber may be very small, and we will have more support, solar support for the gear anyway.

We will again, I would like to say that we will see later when will make that little drawing. Now we put the key way ok. So, we have initially developed the shaft diameter here for sitting the gear and also we have considered where the bearing can sit, then we considered that the key for locking the gear with the shaft.

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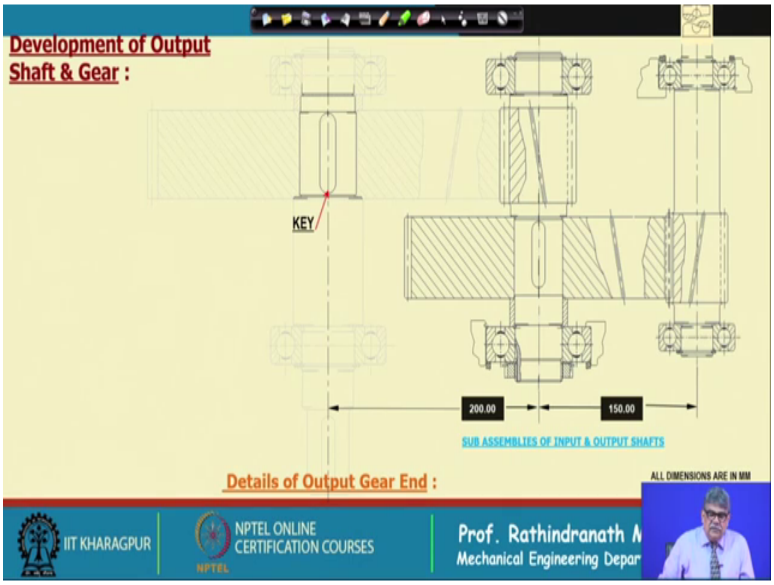

So, this is again taken from a standard key, is taken from the catalog.

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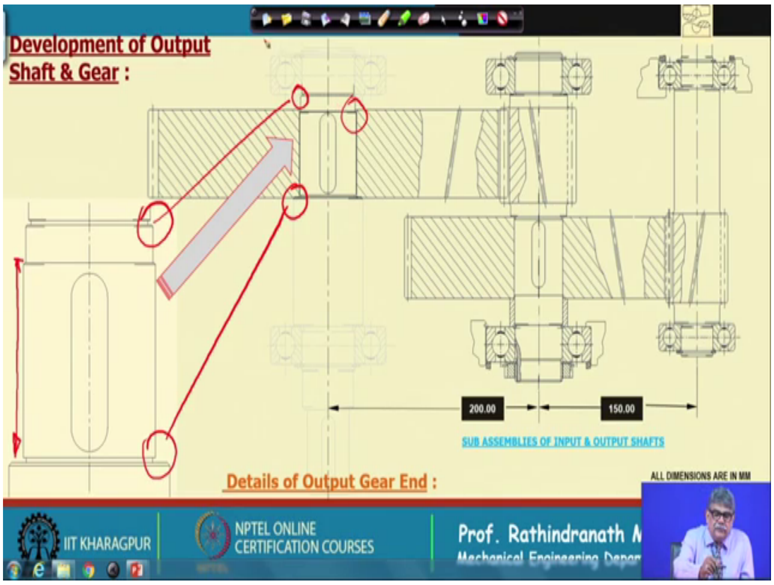

And then we have drawn it here and then we have put the gear key and gear, so this is output second stage gear. Now from the gear end towards the bearing side, the step is very small. Therefore, we need to provide a special that will look into this, but here again details of this portion is shown here. We have provided an undercut here.

This under cut is a here and another undercut we have provided this is here ok. These two under cuts are there, and here simply a step down here. We should keep in mind that the width of the gear and this length, this length will be less than the width of the gear which is shown here; otherwise when we will put the sleeve that will not touch the gear end. So, that gear must be taken while we are considering this design.

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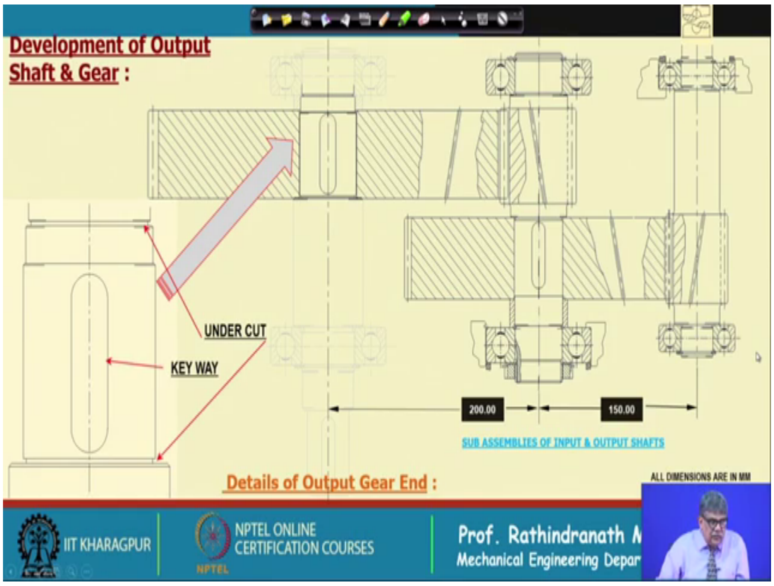

So, this is the under cut. Here it is shown that is the under cut, what I have already discussed and this is the key way

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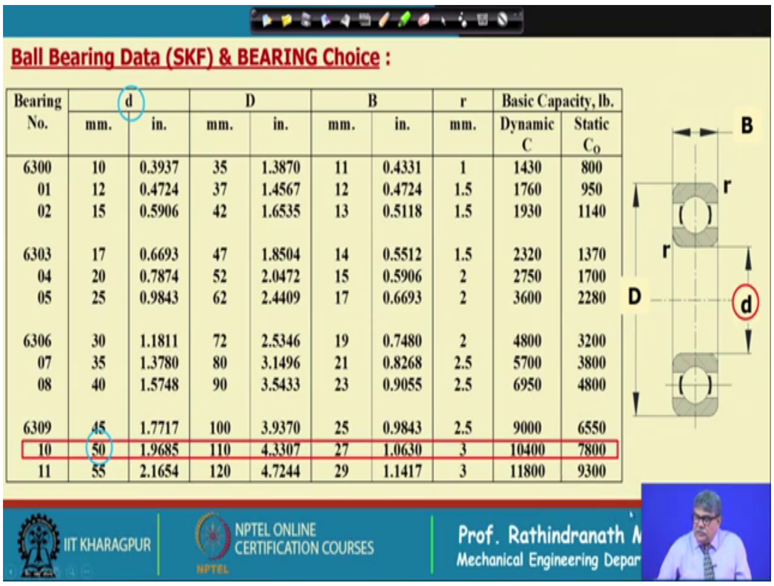

Bearing No.	d		D		B		r	Basic Capacity, lb.	
	mm.	in.	mm.	in.	mm.	in.	mm.	Dynamic C	Static C_0
6300	10	0.3937	35	1.3870	11	0.4331	1	1430	800
01	12	0.4724	37	1.4567	12	0.4724	1.5	1760	950
02	15	0.5906	42	1.6535	13	0.5118	1.5	1930	1140
6303	17	0.6693	47	1.8504	14	0.5512	1.5	2320	1370
04	20	0.7874	52	2.0472	15	0.5906	2	2750	1700
05	25	0.9843	62	2.4409	17	0.6693	2	3600	2280
6306	30	1.1811	72	2.5346	19	0.7480	2	4800	3200
07	35	1.3780	80	3.1496	21	0.8268	2.5	5700	3800
08	40	1.5748	90	3.5433	23	0.9055	2.5	6950	4800
6309	45	1.7717	100	3.9370	25	0.9843	2.5	9000	6550
10	50	1.9685	110	4.3307	27	1.0630	3	10400	7800
11	55	2.1654	120	4.7244	29	1.1417	3	11800	9300

Now, the treasure bearing; now we will think of the bearing. Now as the intermediates shaft bearing what we have selected 6 3 0 9 or 45 millimetre diameter. So, that it will have almost a double the expected life. So, we can perhaps go for the bearing 6 3 10; that is the 50 dia bearing for the output shaft; otherwise we have to go for one size higher, but this again we may need to redesign after verifying the bearing life and the shaft design.

So, at the present moment we shall proceed with shaft diameter is 50, diameter is 50 and here the dynamic load capacity is will be around 4500 Newton and will check later as I have mentioned. So, we; however, will push it with that bearing. So, first of all we put a sleeve here and then see sleeve, it is also called pressure. Now, this pressure is used to transmit the axial load from the inner race of the bearing to the gear and vice versa ok.

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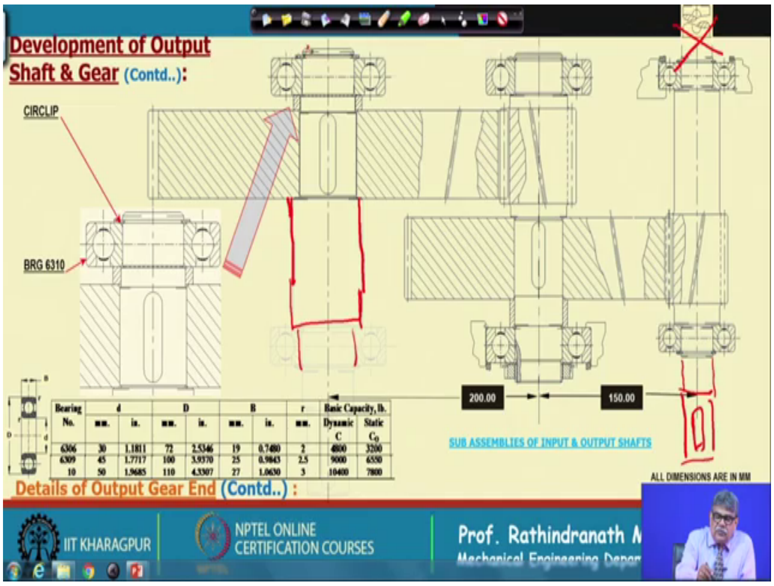

So, now we will put. Now we will consider the bearing and we will put the bearing. You see this is bearing, each touching here the sleeve and sleeve is touching the gear surface. So, any load is coming on this bearing that will be transmitted. And finally, if we lock this bearing with his circlip then this side, the bearing is fully locked in both ways, it cannot move any way, and if we can now lock with this wearing with the housing. So, that end can take the load; otherwise we will give that free. We lock the other side bearing.

Now the next pressure, this is the circlip and this is the detail of the sport set what we have developed. Now circlip, the bearing is 6 3 1 0, and we have. So, far we have developed up to the end of this shaft bearing here, this side. We will now developed in the other side of the bearing which we shall continue next, but before that I just want to give you some hints that this site we have, we have considered that shaft it may come like this

and the other side we will put the bearing here. So, we will developed in that way and then we shall consider for the bearing. Now in choosing this output shaft, the one question will arise, whether why we are putting the input and output side in the reverse directions. This is one reason is that the size of the machine and the size of the prime over, may be such that we cannot put the input and output in one side.

So, it will be in the other side. The next question will arise that, is it possible that we can reverse this? This means that can we put the input end this side and this side we can put it off similarly, whether we can put the output in this side. The answer is yes we can definitely put it. We can put the other side also that instead of making that the bottom, we can put the outside the topic.

Anyway, we shall continue this in the next lecture.