

## Design of Machine Elements – I

Prof. B. Maiti

Department of Mechanical Engineering

IIT Kharagpur

Lecture No - 31

Belt Drives

good day today we continue our {les} ((00:00:47 min)) discussions on the belt drives  
this is lecture number thirty-one  
(Refer Slide Time: 00:00:54 min)



now in the last class uh we started with the belt drives so just to recapitulate it very quickly we started with uh belt material

now normally for the belt drives uh leather rubber plastic and fabric are the materials which are most commonly used for the manufacturing of the belts

now in the leather belt material you are having you can see the oak tanned and chrome tanned type of leathers are available

in the rubber basically what happens the canvas or cotton duck impregnated with rubber this is the constructions of the rubber belts

plastic belts as it was told it consist of a thin plastic sheet with a rubber layer and which could be ah having more number of plies what is a number of plies means the number of layers of such plastic belts if we put it in the one after the other then we call this as the ply

and last one we consider as the canvas or the woven cotton ducks

so these are called the fabric belts which are normally used for ah very temporary and short period belt operations

so this was the ah place where we stopped in the last class

so if we continue the first thing is that typical belt drive specifications

what we understand by typical belt drive specifications

now normally what happens that whenever you are designing an belt then the most important part is the material

the decision of the material you are using for a belt depends of course onto the surface

so depending upon the different services a different types of materials are being used

then you can see the point number of ply

(Refer Slide Time: 00:03:13 min)



so what is a number of ply

as i told you the what is the total number of ply that with which the belt is made of

so that the cross sectional thickness will depend upon the number of ply you are using in a belt

maximum belt stress per unit width

so what this means this means that the belt is always in tension as you know

so what is a capability of belt to withstand a tensile stress is what a maximum belt stress per unit width

why per unit width because from the earlier three points one has already taken a decision roughly that we should use for this particular purpose these type of thickness although the final thickness will come into picture later on

but some or other ah it is as because all design procedures are little ((iterative ))((00:04:15 min)) in nature now one has to think at the initial or starting point

so ah only thing that depending upon the total tensile strength which will be calculated depending upon the design situation depending on that particular tensile strength one has to select for the thickness because the stress if you know multiplied by area gives you the total tension

so out of that if we fix the thickness at the beginning then width becomes a variable so normally it is recommended that the belt stresses are been given as per width but this situation also may change

sometimes what happens you know that ah instead of such specification per width one also can find out in design data book the stresses coming onto the belt are just given in terms of ((power)) (00:05:16 min) means Newton per meter square

so as i told you in the design it will be normally given as NPA that means it will be Newton's per milli meter square

so if you directly get the stress value then if you just multiply it by the cross sectional area then you get the total stress

so in both the ways a belt strength is specified

so next comes that the density of the belt material and coefficient of friction for a given belt material

now once again just i will give ah ah discussion at at different speeds and for a specific specified speed okay

uh what this means this particular situation means that depending upon the belt speed the tensile strengths also vary

so what happens that the chart normally provided for design gives you the strengths at varied speeds or it can give the strength at a given speed and you have to incorporate what are the factors ah you have to incorporate the actual strength through a factor

so that's a design at different speeds and for a specified speed are the two terminologies normally used

so ah now i suppose that you understand that this could be the chart for the stresses either for this situation at different speeds so you do not have to do any corrections or incorporate any corrections

for a specified speed means you have to incorporate a correction

density of the belt material is very much required and in this particular case i would like to say

the density of the belt material are normally provided per unit length per unit cross section

that means for a given cross section for an one meter of belt length in SI units what is the weight of the belt material

that way the density of the belt material is normally specified the density of the belt material

specification is required because you have to compute in the basic equation the centrifugal force arising due to the rotation of the total belt

coefficient of friction as you know will be again required in the basic equation and this

coefficient of friction obviously depends on two situations one is a belt material another is a pulley material

say the pulley material is cast iron and the belt material is leather

so there will be an coefficient of friction stated for leather and cast iron

and similar the situations will be varying whenever materials of the pulley or the belt will change

next we come down

(Refer Slide Time: 00:08:39 min)

Indian Institute of Technology, Kharagpur

### Modification of belt tension

- When maximum belt stress/unit width is given for a specified speed
  - A correction factor ( $C_{spd}$ ) is required to modify belt tension when operating at a speed other than specified one
- When angle of wrap is less than  $180^\circ$ 
  - The belt stress to be reduced by 3% for each  $1^\circ$  lesser angle of wrap or as specified in handbook as a factor say,  $C_w$

to the same ideas what i have just discussed

the modification of belt tension when maximum belt stress per unit width is given for a specific or specified speed then what happens in that case you require to go for a correction factor which is ah we have defined as  $C_{spd}$  to modify the belt tension and when it operating at other than the specified one

so just which one i just told you is been given over here in written

another important factor is that what we call is angle of wrap is less than one eighty

see normally for a belt if we look to the situation that is this is a pulley and if we're having an belt like this this is your one eighty this alpha value you know this from here to here this we called as an alpha angle of wrap

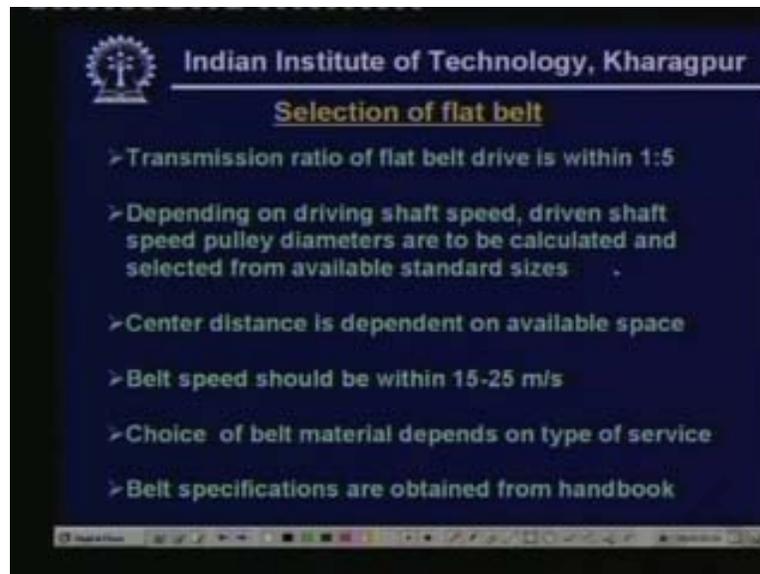
so this is normally all the design values given in the design hand book and based on one eighty degree

however this one eighty degree will be maintained when the both the driven and the driving pulleys are the same in diameter

however if one is larger than the other then obviously you have seen in the earlier figures what we discussed that the angle of wrap onto the smaller one or the smaller pulley will be less than one eighty

so if it is less than one eighty then you understand that the contact area between the belt and the pulley decreases thereby the power transmission capacity will be changing will be decreasing accordingly depend from what we get at one eighty degree angle of wrap

so thereby what happens that a reduction in the belt strength is to be considered now a very rough guideline although you might be getting the exact values for this ah this reduction but normally as in thumb rule one can think of that the belt stress to be reduced by three percent for each lesser angle of wrap or specified in handbook as by factor  $C_w$  ah is i think ah this is what it was covering for each you know for each ten degree okay [Vocalized-noise] that means if it is three percent less for each {tingree}((00:11:47 min)) ten degree so if it is one seventy degree then how much you get you reduce the strength by three percent if it is hundred sixty degree then you reduce the strength by six percent and so and so forth you can get this particular angle of angle of wrap factor which we are considering over here as  $C_w$  so ah what we have learnt in these two slides that the specifications how it is given in a design data book that means one has to know the material one has to know the belt stress per unit width or what i told you that in certain cases the things becomes very simple that directly considering all this aspects of you know one degree wrap angle or different speeds a gross value of the belt stress may be considered say for example a gross value of belt stress for a leather material can be taken as two MPa two mega Pascal's means i just write down so that is something like two MPa so this is something an average type of situations you can take so same thing if you are considering for leather belt then the value will be coming out to be something around one point five or so okay so this are also well utilized in design ah to consider the belt stress so other situations ah requirements for belt drive design is the ah you know the belt density and the belt and the pulley between the belt and the pulley what is the coefficient of friction (Refer Slide Time: 00:13:54 min)



now selection of flat belt

how we consider the selection of flat belt will be discussed in this particular slide

now normally what happens that belt drive transmission ratio or the transmission ratio of the flat belt drives is normally limited to around one is to five

next thing is that although it is uh it is there i instead of this number point number two i go down to the point number three

the center distance is dependent on available space

well this is true that center distance is dependent on available space

so you have to compromise over the space availability but one important thing you should

remember normally for the flat belt drive ah practically there is not much of a limitations of the center distance

however that does not say that you put an infinite center distances okay a normally ah it depends relatively on the experience but uh somehow there an situation like that that center distance

something around twice the sum of the two pulley diameters is all right okay

it could be little higher ah normally it should not be lower than that and that factor two can also vary

well all this statements suggest that's i am not giving you a definite value

the reason is that the first statement what i made you the really there is no limit for the center distance

but you know if you are having a very large belt and the belt flattening and due to the weight of the belt the centrifugal forces

so that those are certain aspects that unnecessarily one should not go for a very very large center distances

again at the same time if you are making the center distances too small then what is happening the flexing of the belts will take place very rapidly

thereby some amount of belt life will be lost

so some compromise depending on the experience space availability is a guideline for selecting the center distance but you should remember that normally for a starting point this  $d_1 + d_2$  plus  $d_1$  into two that means the twice the sum of two pulley diameters little over that is quite good but the situation will change of course for other type of belt drive

you will come down to those points

now the choice of belt material depends on type of service that I have already told

belt specifications are obtained from handbooks

so what you get from the handbook I have already dealt up in the earlier slide

so depending upon the different kinds of hand books all hand books won't give you in the similar manner there will be some changes

however what I mean to say those basic parameters are more or less specified in all the handbooks of design handbook of design and uh from which you will get the initial guideline as far as the belt stresses are concerned because our primary design objective is what the primary design objective although we'll be seeing after some time still I'm just telling you is the uh belt should not fail in operation okay

so that thereby the stress value is very important and other situations like belt length which is also very important

one of the vital factors I think I have told you in the last class is the this flat belt are not endless means it has to be joint

so a proper care should be taken while joining these two belts at their interfaces

well coming down to the second point in the slide what you see that depending on driving shaft speed driven shaft speed pulley diameters are to be calculated and selected from available standard sizes

this means that all the pulley drives what you are going to design have a specific idea means what happening that what is a ((prim mover))((00:18:54 min))

suppose it is a electrical machines so electrical machines will be uh operating at a certain speed say ah standard three phase induction motor speed will be around fourteen forty rpm fourteen fifty rpm like that

so that will be your ah this driving pulley shaft speed

however the other one the driven one will be the actual one which will be running a machine element something say a pump or ah a machinery it will be running ((not necessarily)) ((00:19:27 min)) machinery it will run

say a pump or a some grinding flour grinding means uh you you find it in standard shops okay or a rock crusher whatever may be so it has got another speed

so what happens that you have to design the pulley diameters accordingly so that the speed of the driving and the driven uh shaft are as per your requirement

now that you know will be uh can be conveniently found out from the relations of the speed ratio or the velocity ratios etcetera

now here i would like to say that normally all the pulley i mean the uh belt drives will have a certain amount of slip present in this case

what is a amount of slip you have seen that amount of slip will be roughly around three percent however ah if the value of slip is not given which is normally the fact that in all designs you do not the slip {a priorly}((00:20:41 min))

in that particular case what happens that as because the slip amount is not going to change your pulley dimensions to that extents ah people may ignore the slip at the beginning

well ah why this statement i'm making because you can see that after you calculate a dimension then what happens that that dimension calculated dimension as a matter of fact may not be as per the standard size

okay so it will be always economical that you choose the pulley from the standard ah size or the stock of standard sizes available in the market

otherwise economically it won't be viable i mean the it will be more costly if you try to manufacture each and every time the pulley as per your need

so once you find out the standard sizes you will be always finding out the exact speed ratio that what you want it to confirm to may be differing slightly

well so that is a thing that slight difference ah in the speed ratios or the velocity ratios could take care of your slips situations okay

if it is given fine but otherwise you can just simply ignore the slip the reason is that it is not a very great amount

so and it will be taken care of during this adjustments of the dimensions and other things okay so the coming down to this particular idea once again i read it that depending on driving shaft speed driven shaft speed pulley diameters are to be calculated and selected from available standard sizes

this point is clear to you

now i come down to the fourth point that the belt speed should be within fifteen to twenty-five meters per second

this is from that experience and that that some calculations that it has been found out that for a flat belt drive ah good speed is something which should be lying between fifteen to twenty-five meters per second say twenty meters per second okay we we just taken some average value so that what is the idea

that you consider designing the designing means sorry computing the diameters of the pulley taking a velocity in your mind say twenty meters per second

then you calculate the pulley diameters and then adjust the pulley diameters to the standard sizes again we calculate what is the new belt speed because this belt speeds is an important parameter which will be useful for what you understand useful for finding out the belt stresses as i noted a point little earlier

and depending upon the belt speeds as a matter of fact the stresses in the belts will be changing now last two points are already clear ah to you the choice of belt material depends on type of service and belt specifications are obtained from handbooks

(Refer Slide Time: 00:24:21 min)

Indian Institute of Technology, Kharagpur

**Selection of flat belt**

> Design power ( $P_{des}$ ) = service factor ( $C_{sv}$ )  
 x required power ( $P$ )

$C_{sv} = 1.1$  to  $1.8$ , for light to heavy shock

> From the basic equations, design power is given as,

$$P_{des} = bt(\sigma' - \rho v^2)\left(1 - \frac{1}{e^{\mu\theta}}\right)v$$

$$\sigma' = \sigma C_{spd} C_w$$

now we come down to the this particular concept of selection of flat belt  
 now first of all you are going to design the flat the belt drive depending upon a design power  
 what is that one  
 you are to transmit certain amount of power through the belt drive that is your objective  
 now what happens that depending upon the service conditions what are the service conditions  
 means a machinery may run for only two hours a day  
 a machinery can run only for twenty-four hours a day a machinery can run ah in a very clean  
 environment a machinery can run in a very rough environment  
 so depending upon all those all these situations what happens the affect comes on to the belt  
 stress and thereby the belt live  
 so certain service factors are always given in the design handbooks roughly it is classified as a  
 light shock medium light duty medium duty and an heavy duty  
 and one could be like that a continuous operation one could be a shock operation like that  
 so uh under this categories you will be finding out that different types of service factors are  
 recommended  
 now from the given handbook ah you can find out that what could be the appropriate service  
 factor for your use  
 as a matter of fact the space ah and the time do not permit here to reproduce all the service  
 factors that are listed in the design handbook  
 however a rough guideline could be something like that

you just see it is given in blue color that is it is the service factor is normally one point one to one point eight for light to heavy shock loads

well this is an guideline okay so if you want to be very conservative you can just straight away take one point eight but that will be ah actually ah actually it won't be economic for you in that particular case because conservative designs are always too costly okay

so design power  $P_{\text{design}}$  is given as service factor multiplied by required power required power means the power which you intend to transmit

now from basic equations design power is given as  $P_{\text{design}}$  equals to  $b$  into  $t$  into etcetera etcetera what it is given over here

now i think ah for this expression i will give you a brief idea so that uh you can understand the genesis of this equation

this equation is simply from two fundamental equations what we have derived in the last class well ah what you can see is that you know what will be the power

(Refer Slide Time: 00:28:09 min)

The image shows a whiteboard with handwritten mathematical derivations for belt power. The main equation is:

$$P_{\text{des}} = (T_1 - T_2)V$$

where  $\frac{N \cdot m}{s} = \text{Watt}$ . The derivation continues as:

$$= [T_1 - f(T_1 \dots)]V$$

$$= T_1 (\dots)$$

Below this, a term  $\sigma_a \times b \times t$  is circled. To the right, the relationship  $T = mV^2$  is shown, with  $T_2 = \frac{mV^2}{e}$  and  $e = \dots$ . At the bottom, a unit derivation is shown:  $\frac{m^2}{b \times t} \times \frac{kg}{m^3} \times \frac{m^2}{s^2} = N$ . There is also a note "2.5.1" at the bottom left.

power  $P$  will be given as  $T_1$  minus  $T_2$  into  $V$  what is  $V$

$V$  is belt speed and  $T_1$  and  $T_2$  are the belt tensions

so unit Newton into meter per second so Newton meter per second so this is effectively is the watt or power

so once you get this  $T_1$  minus  $T_2$  into  $V$  is the power so here why what we have used this power is actually your design power okay that you understand by multiplying by service factor

now out of this if we can replace  $T_1$  by means some means then our problem is solved  
 you know very well  $T_1 - mv^2$  by  $T_2 - mv^2$  equals to  $e^{\mu\alpha}$

what is this one  $\mu$  is the coefficient of friction as you know and  $\alpha$  is the angle of wrap okay  
 now which  $\alpha$  you should take for the larger pulley or for the smaller pulley

now you understand if the pulley material and the belt material of course the same belt is running  
 if the pulley materials are the same then what will happen that the product of  $\mu$  into  $\alpha$  will  
 be lower for which one for the smaller pulley

so normally for all situations smaller pulley is the guiding pulley that means all the designs are  
 based on the smaller pulley because the power transmission capacity on the smaller pulley will  
 be smaller than what you will be obtaining if you have considered the larger pulley

so you understand that the guiding feature will be  $e^{\mu\alpha}$  for the smaller pulley  
 and the value of  $\mu\alpha$  should be expressed in radians that you should be keeping in your  
 mind

well so from this equation ah you can get [Noise] the value of  $T$  okay now ah what is happening i  
 think i have mentioned about this  $m$

see this  $m$  is basically what

it is the weight of the belt material per unit length per unit cross section

so if we look into this particular equation then what is  $v^2$  the  $v^2$  we know the it will  
 be coming out be meter square per second square

so we multiply it by Kg per meter cube and we multiply into meter square

what is meter square

the meter square stands as  $b$  into  $t$  what is  $b$  into  $t$  the width into thickness

so meter square gets you this ah this particular meter cube and this cancels okay

so you are having Kg meter per second square or this is equivalent to your unit Newton

so once you substitute this particular one in this value so this is this is very important just to look  
 into the ah what you call the unit point unit part

so ah once you are satisfied with the unit this is coming out with the same unit so we will be  
 putting these values accordingly

so what we'll be putting we'll be putting  $bt$  and Kg multiplied per (( )) ((00:32:31 min)) by row  
 okay this is the expression for this one

so once you are substituting T two then entire expression comes out to be what T one minus a function of T one and other parameters

so you can and sorry i put this bracket and multiplied by V

so once you get this one you take this T one common

so what is coming out to be T one multiplied by all these things which is coming over here

now this T one is basically is what the maximum belt stress

now this maximum belt stress is an allowable stress in the belt multiplied by its cross sectional area isn't it

so we replace T one by this particular value an ((allowable)) (00:33:27 min) stress into b into t

how you take the allowable stress either a simple way either you take ah something around two or something around one point five or one point six as i told you

or you can consider this particular sigma a from the design data book per unit ah well per unit length and unit cross section these values will be given

any way you can you were in a position to know this particular value

so if w come down this particular expression if we put it in the proper manner well i have given you this ideas then what we get

(Refer Slide Time: 00:34:17 min)

Indian Institute of Technology, Kharagpur

Selection of flat belt

> Design power ( $P_{des}$ ) = service factor ( $C_{sv}$ )  
x required power ( $P$ )

$C_{sv} = 1.1$  to  $1.8$ , for light to heavy shock

> From the basic equations, design power is given as,

$$P_{des} = bt(\sigma' - \rho v^2)\left(1 - \frac{1}{e^{\mu\theta}}\right)v$$

$\sigma' = \sigma C_{spd} C_w$  → value directly

we get ah okay we get this equation P design equals to bt that you can see bt we have taken it out so in these case when we have taken this bt taken we have out then this sigma dash p row v square into this v

now you can see once again ah we have used this sigma dash  
this sigma dash parameter as i told is actually specified value modified by a speed factor and  
modified by the angle of wrap factor  
in certain cases you require this equation or you can get a value [Noise] directly  
so if you get this one then obviously ah is much more better that no other corrections are required  
for that matter  
so this is the design equation  
so what you get from this design equation  
you see you know this value from the design data book you know this value from the design data  
book this is your choice of the speed  
what should be the choice of your speed say roughly twenty meters per second  
and this thing you are getting one from the material property and alpha this alpha from the  
geometrical property  
so all these things are known to you  
so what is unknown you do not know the value of  $b t$   
so once you can set this particular value of  $b t$  from this equation then what you get you get the  
cross sectional area  
now once the cross sectional area if we have obtained then a choice of what should be the typical  
width and thickness could be different combinations  
and you see that from the standard availability in the market what should be the width and what  
should be the thickness  
a compromise between ah it should not be very thin or very wide because the more you make the  
wide then what will be happening you know uh the pulley has to be the {mart}((00:36:46 min))  
the pulley materials will be more because you have to make make an larger pulley width okay  
similarly too large of a thickness ah in that direction might be keeping a per unit cross sectional  
length and weight of a belt  
so a compromise between these two can be very easily made from your experience and the  
availability okay  
so from where you can set these two values  
so this gives you a very ah good way of designing or a selection so this is an mixture of how you  
do the design means ah as a matter of fact and the selection

so here design parties not very much it's a selection basically okay

so once you find out the typical cross section of the belts etcetera that is all right

i think one part ah i i just ah wanted to tell you that in this particular expression uh while you

have been deriving the value of alpha you have already chosen the center distance isn't it

so once you have chosen the center distance and which is fixed the pulley diameters already you have calculated

now it will be very easy for you to calculate what should be the total length of the belt because in the very first lecture uh already you have seen the formula for the total belt length requirement is given over there

so uh in this particular case what is happening that uh we have assumed the belt drive to be an open one isn't it because we have taken a smaller pulley diameter and a large pulley diameter like that

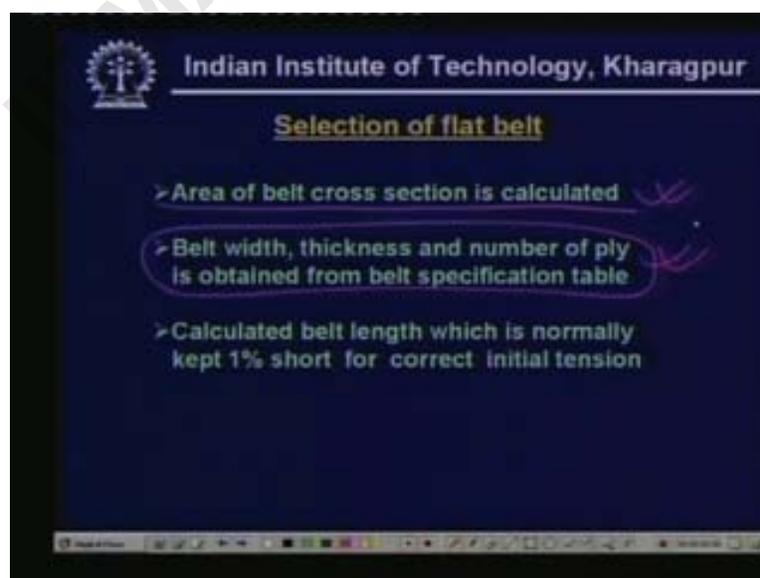
had it been an cross belt drive then of course those beta parameters or alpha parameters would have been the same basically we require the alpha parameter

anyway that is not preventing you ah or that do not make any change in the design procedure

whichever the type of belt drive you choose it is both suitable ah for either a cross belt drive or a open belt drive

now this is the idea by which you consider the design of the uh designed selection of the flat belts

(Refer Slide Time: 00:39:22 min)



[Vocalized-Noise] so this is a the next slide which again is a repetition of what i have already told you that means what you understand is this one that already we have computed the area of belt cross section that is already over okay

i have just told you belt width thickness and number of ply is obtained from belt specification table

so that is where one should (( ))((00:39:54 min)) okay that which could be an best combination to suit a situation

now the last one what requires little bit of ah ah this discussion which we have not done yet is that calculated belt length which is normally kept one percent short for correct initial tension now in this particular case what is happening that you know the role of initial tension in power transmission that we have already discussed

so you can go on increasing the initial tension till a limit what happens that  $T_1$  one could be maximum and  $T_2$  coming out may be coming out to be zero

however that is not done in that ah in that in that manner but anyway uh this is an possibility also that means you has to one has to introduce a good amount of initial tension

again just to repeat that initial tension will dictate that what should be the bearing loads onto the shaft and thereby the bearing designs and other things are also ah dependent on this particular initial tension

now normally ah what should be the optimum {init}((00:41:05 min)) initial tension instead of calculating in actual practice what is been done the {ex}((00:41:11)) exactly belt length you have taken up and calculated and selected

then what you do from your calculated value of the belt length make the belt length roughly it's a just an guideline that you make it one percent short all right

now this one percent short is not always to it depends depending upon number of ply's also well what i'm giving you are just an indicative value

and if you make it one percent short and then make it the joint where you should take care once again i'm telling you the joint should be very carefully taken care of otherwise noise will come and belt might snap uh without giving you any notice

then ah coming back to the thing what i was just telling that this one percent shorter belt length will automatically create an initial tension which for all practical purpose ways has been found to be quite quite uh you know ah quite optimum in nature

so this is the idea you design everything is over cut a belt length but while cutting you take some amount small

what is that small amount small roughly around one percent length you take smaller and just join it and put it onto the drive

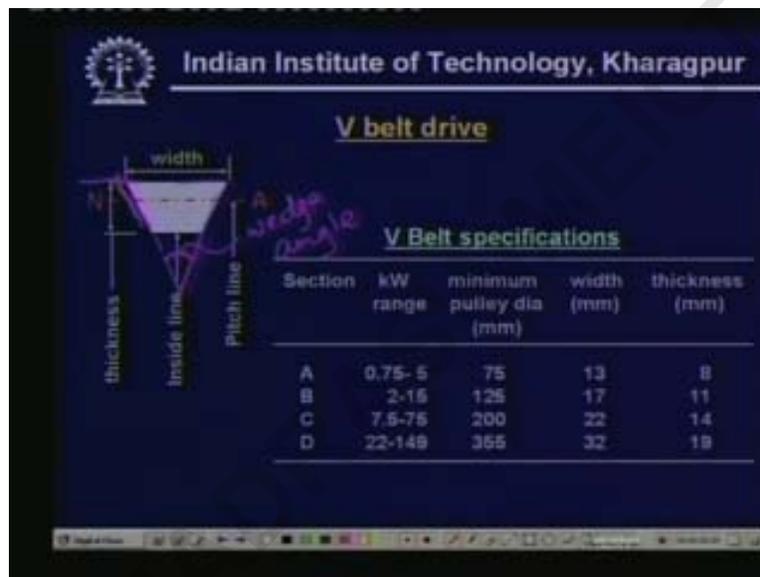
so that solves your problem

so this is the idea by which one can go for the selection of the belt

now you know that uh another very very important and widely used belt drive is a V belt drive

now we will going to discuss about some aspects of the V belt drive

(Refer Slide Time: 00:43:22 min)



now you can see this slide on the V belt drive

here you please uh look to this figure this is actually what is shown here a V belt drive means you know the look is something like an V had we completed the entire situation okay

now this is the wedge angle okay and of course you understand the pulley should be something like this to confirm the V belt

here i think i give you an idea that the pulley the belt should not go in entirely inside the pulley but it will be something like this

this is a best way of designing some portions will be like this again

so with within the pulley the particular V belt is situated

now here the nomenclature of the V belt stands like this as it is given it is thickness this is the top width and you do have a neutral axis what is a neutral axis that means when you are bending the belt

where the bending of the belt will take place because the bending of the belt will take place whenever it is just passing over a pulley

so in that case a zone will come which we were defining here as a neutral axis where there will be no stress

and other sides one side it will be compressive stress and other side it will be tensile stress

now this particular distance what we call as a pitch line

this is a pitch line okay which is going passing through the neutral axis is pitch line

and this obviously will be the inside line

so that means if you are having an belt drive through which a V belt i'm just giving an exaggerated view alright

V belt is going so we have something like this as a pitch line and this one is an inside line okay so this is an inside line and this is the pitch line

so this two parameters are very important because of the fact that while calculating or or while using the equations of belt drive then ah whatever the diameters or the

i mean i mean to say the pulley diameter or the belt length  $L$  all what we compute are best on these pitch line means what is the values you are getting or using are all pitch line values

so if you want to come down to the uh inside line then appropriately you have to do some subtractions some value subtractions to come down to the inside line okay

so this is the cross section of a pulley

i i am sorry V belt cross section as it is given in this figure and next what we we'll see that normally these are the V belt specifications

what are the V belt specifications we understand

now here i would like to say one thing that these particular cross sections are normally available in the terms of A B C D and a little higher side also E that i have not included over here

so let us consider as the situation to be A B C and D of course we do have something like E section also

now A section means of course ah of course thinner cross section i mean a ah smaller cross section that you can understand thirteen is the width and eight is the thickness in milli meter

and D on the other hand you can see thirty-two is the width and nineteen is the thickness so obviously uh the given the material of the belts being same the D section has got a larger power transmission capacity this D section has a larger compared i mean power transmission capacity compared to an A section belts

so that's a reason you can see the kilo watt range

so if you are going to transmit anything within five you go for A section

if you are going to transmit something ah within this C zone say ah ten or fifteen or twenty then you go for this C section

now if you are going to transmit something around uh this particular value you can see although you can go for two over here but sometimes the two means it is going towards the this side of the A section belts

so normally people can go means these are the overlapping zones either you can choose A or you can choose B

so some amount of overlapping zones will be always there

however one should concentrate in this way that somewhere in the loop zone or like that is a better way because you can see ah for a given power transmission of very large uh can we not do with an belt A

of course you can do with a belt A suppose you require just an example you require two sections of D belt two two numbers of D belt D section belt then what will be the number of A section belts

it will be two it will be it may be ten it may be twelve or something like that without calculation it is very difficult to say but something around this way looking at the horse power i mean kilo watt capacity range one can understand that if you are using an A section belts then you have to use more number of belts compared to a D or C ah belt cross sections okay

in this case what will happen

the situation is that you require a pulley with more number of groups thereby the pulley becomes heavy and it becomes costly it becomes it it actually creating an more load onto the the ((self weight))(00:50:23 min)) of the pulley itself will cause a more load onto the shafts okay

so thereby uh the choice of the belt section whether it should be A B C or D depends ah on the ah on the situations of power transmissions

however a brief guideline is as given in this particular slide

so once again if we look into this one then you find that in the belt specification some other things are also mentioned

that is the minimum pulley diameter is seventy-five mm one twenty-five two hundred and three hundred fifty-five

means what is happening basically you know that uh when it is passing over a pulley it has to bend a lot isn't it

now this V belts or or this V belts having an different thicknesses

so if it is going for a very small pulley this ninety mm thickness then the belts are to be bended belts are to be bent in a very great extent

okay so thereby it will cause a huge amount of stress in these areas okay the bending stresses will be more

so obviously depending upon the situation one has to look for what one has to look for that what should be this minimum pulley diameter this pulley is becomes an guiding factor

as because A section belt has got a lesser thickness its minimum pulley diameter is seventy-five and in the same logic the D can be going to as high as three hundred fifty mm pulley diameter so ah in in this particular case one is (( warned))((00:52:21 min)) of the situation uh that use of minimum pulley diameter is always recommended while going for V belt drive designs okay so in this one or the belt specification stable i think everything is quite clear

that means you know how that what are the type of belt sections A B C and D how it is designated depending upon the power transmission capacity

and we do have a belt section E also but it's not been specified over here because those are for the very high capacity

and another important factor is that looking at the flexing of the belt this word is used very much flexing means how much you are bending okay

so how much the flexural strength is getting changing means that is the flexural strength you have learnt earlier that means it is plus minus plus minus okay

so this repeated stress situations also are taken care of okay ah while considering the belt design in terms of certain factors that we will be looking very shortly

(Refer Slide Time: 00:53:46 min)

Indian Institute of Technology, Kharagpur

**Designation of V belt**

B section belt with nominal inside length of 1016 mm

**B 1016/40**  
(mm) (in)

Inside length + X = pitch length

	A	B	C	D
X(mm)	36	43	56	79

The slide also includes a diagram of a V-belt cross-section with labels for Pitch Line (PL) and Inside Line (IL).

so this is another important thing that means how you designate a V belt that means the belt or the V belt we always talked about the pitch line this is the pitch line and this is inside line okay so obviously this belts when we are considering so it will have a pitch line length and it will have a inside length which is shortened obviously the inside length is shortened now while just drawing this figure one important thing came into my mind is that this V belts do not have any joints these are continuous belts and uh what is happening that ah this particular belts are manufactured without joints so that means what is happening that certain standard lengths of the belts are only available ah you cannot have the belts of length of your choice you have to you have to just select which ever the belt is very close to your situation so ah while designating a belt the interesting fact is that it is never designated with respect to pitch length but it is designated with respect to nominal inside length suppose after calculation you see have selected a B section belt depending upon the power transmission and you computed that the belt length is one zero one six mm then what something else and in the catalog you find that one zero one six mm is a closest to your calculated length then you have to choose this one zero one six mm belt and you have to designate this B one zero one six oblique forty

this is in mille meter in the same data book you will be finding out the another value is given in inch also

so this is the designation of a V belt B one zero one six by forty

now what we find out the relationship between inside length plus X will give you the pitch length

so what is that one that if you have as just just referred to this figure so this inside length plus some length will give you pitch length

so this X what is the value of X in mille meter if it is A section thirty-six B section forty-three C section fifty-six and D section seventy-nine

well ah with this ah designation of V belt i think we uh stop here for today we'll continue our lecture in the next class

thank you

Transcriber's Name: Ashwini Acharya

Design of Machine Elements - 1

Prof. B. Maiti

Department of Mechanical Engineering

Indian Institute of Technology Kharagpur

Lecture No. # 32

Belt Drives

good day we continue our discussion on the belt drives

so today's lecture is lecture number thirty-two and

(Refer Slide Time: 00:57:28 min)

Indian Institute of Technology, Kharagpur

### V belt drive



#### V Belt specifications

Section	kW range	minimum pulley dia (mm)	width (mm)	thickness (mm)
A	0.75- 5	75	13	8
B	2-15	125	17	11
C	7.5-75	200	22	14
D	22-149	355	32	19

you see just a quick recapitulation what we have done in the last class so this is for the V belt drive and you know that the V belt specifications are as given over here so there are four type of sections mainly also also i told you that there was an E section present so depending upon the kilo watt range one has to select the typical ah belt for the use (Refer Slide Time: 00:58:04 min)

Indian Institute of Technology, Kharagpur

### Designation of V belt

B section belt with nominal inside length of 1016 mm:

**B 1016/40**  
(mm) (in)

Inside length  $\times$  X = pitch length

	A	B	C	D
X(mm)	36	43	56	79



next one that we just talked about that the designation of V belt how we ah considered this so ah what happens that if we have a belt length something like this then we we know that this is the inside length and this is the pitch length so by the formula etcetera what we have learnt earlier we can determine the pitch length where by use of this chart we have to find out this inside length

and this inside length whatever has been computed should be chosen as a nearest that is available

IITMADRASINMEICT