Fundamentals of Automotive Systems
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Module No # 12
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Tyres Part - II

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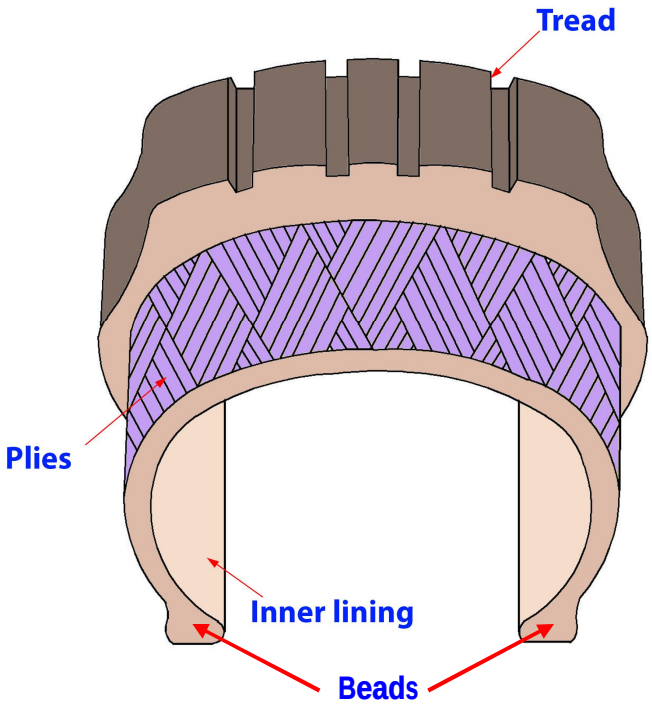
So now based on the arrangement of these plies in this substructure right so, we have two common types of pneumatic tyres that we would have encounter. The first one is what is called as a diagonal or cross or bias ply tyres so what are these? Ok. And the second class based on the arrangements of the plies is what is called as a radial tyre, right. So what is the, what are the characteristics of both and what are the different. So let us look at them.



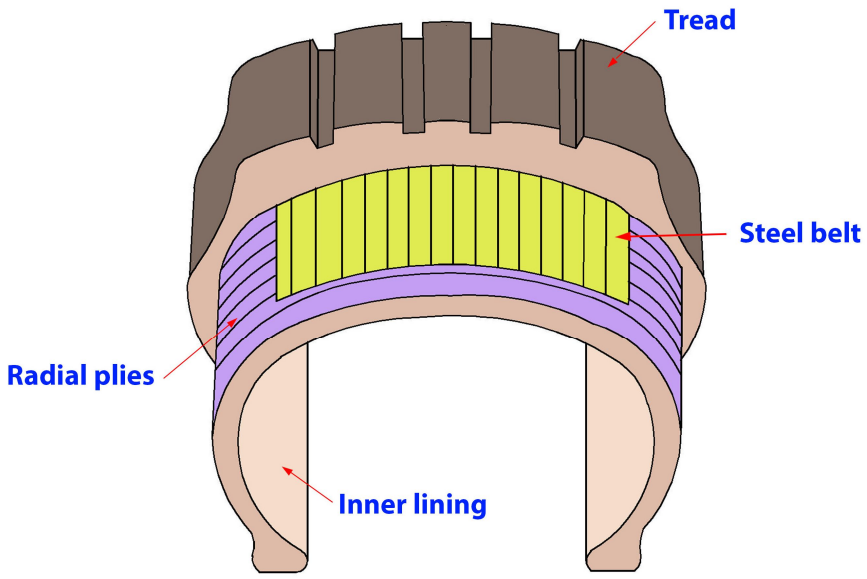
So let us look at first the diagonal ply. So what is a diagonal ply tyre you know this is the simple schematic which shows the cross section of this diagonal ply tyre. So we can observe that these are the ends ok. So we have essentially cut a pneumatic tyre, right basically we taken a chunk of the tyre right and these ends are the beads are constitute the bead assembly, ok. We are shown not of details here but the plies are nothing but as we learned they are essentially layers of fabrics and cords which run from one end to the other right along the profile of the tyre.

So in a diagonal or cross or bias ply tyre we can see that all these plies are running in a criss cross fashion, right. Layers of plies, you know one layer ply you know like is having cords which are at this angle and you can see that another layer of plies which are wound near it are having another direct the cords oriented in another direction, ok. So for this reason they are called as diagonal or cross or bias ply tyre, ok.

And typically if you look at the angle made by these cords with the axis of this in this direction it is typically around 20 to 40 degrees. You know like that is the typical range what is called as a bias angle ok. So that is essentially a diagonal or bias ply tyre ok. So the plies are run criss crossed diagonally from one beat to another, ok. The cords or the fibers of the plies have a bias angle of around 20 degrees to 40 degrees with the central plane of the tyre, ok. And of course these plies are wrapped around the bead core right at the bottom ok and that is how these plies run ok.

So today if we look at most automobiles the design which is very popular and which is commonly used is what is called as a radial tyre, right or the term radial tyre is essentially commonly used to denote a radial ply tyre, ok. So what is the

radial ply? Okay so as the name indicates in this design or in this construction, the plies run or the cords of the fabrics of the plies run radially, ok.



RADIAL PLY TYRES

So you can see that each cord they are not now criss crossed to each other. But then they run from one beat to another along the radius ok of the tyre, ok. So that is why this is what is called as a radial ply tyre. And typically in radial tyre what we have are these belts which are present below the tread to provide stiffness particularly, stiffness along the circumferential direction. Because the cords of the fibers in the radial tyre go along the radial direction, right.

So here if you want go along the circumference and then like a have some stiffness along that direction we provide these what to say belts which are typically having the steel fibers ok. So, these are commonly called as what are called as steel radial tyre. So if you encounter a term steel radial tyres they are nothing but radial tyres with these steels belts for additional support ok. So that is the radial ply tyre.

So the cords or the fiber on the plies run radially across the tyre from one bead to another, ok. So that is why it is called as a radial tyre. And a belt of cords typically made of steels ok is situated below the tread for providing the necessary stiffness particularly along the circumferential direction ok. So that is why when steel is used as a material for these belts, these are what are called as steel radial tyres.
So what are the advantages of these radial tyres over bias ply because today you know like radial tyres are the preferred choice right have become the preferred choice. So what are the advantages that they give? So typically they result in higher mileage that, mean the better life, right. And then like they have higher load capacity at lower tyre weight so that is an attractive feature, because we want to decrease the mass of the tyre also, right. So we have higher load carrying capacity at lower tyre weight.

So and radial tyres have a lower rolling resistance and then like they also give better wet breaking behavior, ok. So they have flexible sidewalls which implies softer ride, better ride, ok and. So these advantages are made them quite popular ok over bias ply tyres, ok, over the as a preferred choice you know like for most automotive applications, ok. So there are the bias and radial ply tyres.

So there is another parameter which is very important for characterizing a tyre which is what is called as a tyre aspect ratio. So what is this tyre aspect ratio? The tyre aspect ratio is the ratio of the height of the tyre's cross section to it is width, ok. So that is what is called as a tyre aspect ratio. So you look at the height of the tyre so if we go back to this schematic. So broadly you know like the height of the tyre will be this, right.

So the width of the tyre will be this. So the aspect ratio will be the ratio of the height of the tyre to the width of the tyre, ok. So that is what is the; aspect ratio so if we have a higher aspect ratio ok this implies narrower tyres, right because if the aspect ratio is higher that means the height divided by width in large right. So, that we are going to have smaller width resulting in narrower tyres and larger sidewall height.

So the sidewalls are going to be much larger in size relatively we are talking relatively right. So we are going to have larger sidewall height, ok. So typically it has been found that this helps in better ride comfort but compromises on handling ok. So that is the limitation with a higher aspect ratio, ok.

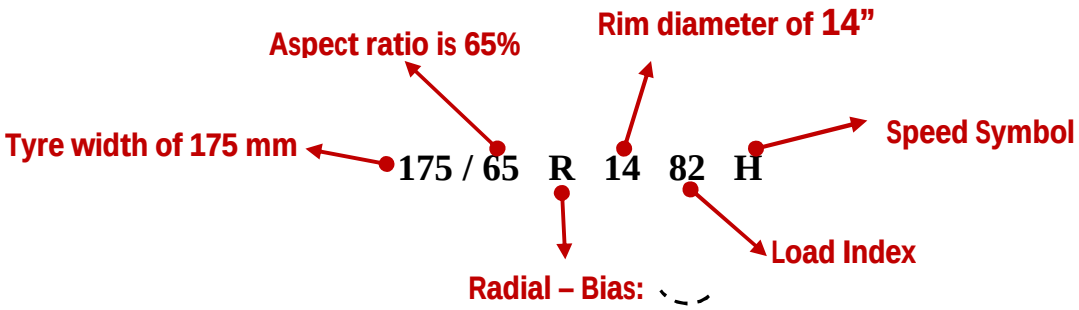
Conversely if we have a lower aspect ratio that implies that we have wider tyres, ok relatively, the tyre width is going to be high and of course the tyre height is going to be smaller, so we are going to have shorter sidewalls, ok, relatively. So what will this result in? This results in better cornering performance, we get better grip so better cornering performance ok. And can result in a larger wheel rim, ok. That can accommodate a larger break. Because please note that the break assembly is also included inside the wheel assembly.

So the sidewall height is small right and essentially we have a fixed outer radius then the rim radius will be higher, right. So then we will have more space to accommodate a larger brake and that leads to higher breaking capacity, right. So that is an advantage with having. However with lower aspect ratio, there is a trade off in ride comfort, ok. Ride comfort becomes poor and obviously vibrations are passed on to the vehicle body. That is the trade off, ok with having a lower aspect ratio.

So one needs is to balance the aspect ratio you know as per the requirements, you know like the conditions under which the vehicle is operated.

So based on this we typically specify tyres in a certain way, ok. So if you look at a pneumatic tyre you know like you will see its specifications is marked on its external surface so let us see what those typical specifications are and how to interpret them right based on what we have discussed. So typically the specification indicated on a tyre are first thing is the tyre width in mm, the aspect ratio in percentage and then we have information on whether it is radial or diagonal ply ok.

Then we have rim diameter in inches. Then we have load index so what is this load index, this indicates the maximum load carrying capacity of the tyre, ok. So that is what is called as a load index of the tyre. Then we have what is called as the speed index, speed symbol essentially indicates the maximum speed upto which the tyre can be used safely of course right. So that is the, those are typical information that is one could gather you know like by looking at the tyre specification indicated on a typical pneumatic tyre. So let us taken an example and then identify ok so let us say you know like in some tyre.



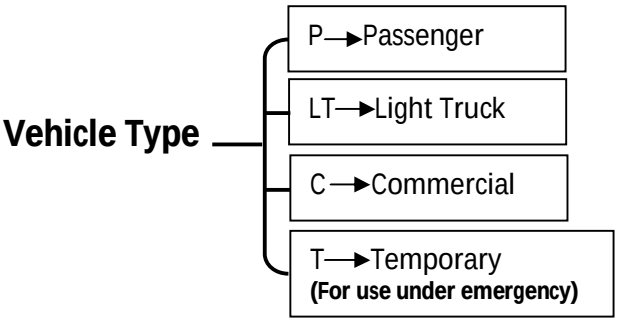
TYRE SPECIFICATION

So we have the marking as let us say 175 slash 65 and then R, I am just giving space so that I can write the explanation, typically it is bunch together ok. Let us say 82 and then H ok. So let us say that these are the markings which are found. So what do they mean? So what happens is this? This is 175 number is indicative of the tyre width so this indicates this tyre has a width of 175mm. So 65 means its aspect ratio is 65% ok R indicates it is a radial tyre, ok.

So typically for bias ply or diagonal, people use a hyphen right a dash to essentially indicate that it is a bias ply design you know like in some cases you know like one also uses the what to say uses marking B or D ok to essentially indicate a bias ply or diagonal tyre ok. So this 14 indicate a rim diameter of 14 inches, 82 indicates the a load index. So this helps us in figuring out that of course there is a standard table which tells us what will be the corresponding maximum supported load and kilogram as a function of the inflation pressure, ok.

So one could essentially figure it out from this load index and this is the speed symbol. So H it is a character which essentially representative of speed symbol as an example, right. So in this case, the character H is typically used to specify a maximum allowable speed of upto 210 kilometers per hour, ok. That is what this H corresponds to. So once again we have a rating right in terms of some indicators, right. So these are typical information which we will get.

$$Tyre\ radius: (175mm + 0.65mm) + \frac{14 * 25.4mm}{2} = 291.55mm$$



So there are other markings which are found in addition to this so to indicate the vehicle type and the usage type you know like in of course there are additional markings which can be observed the character P essentially indicates a passenger tyre you know like the character P is put ahead. And then LT indicates the light truck okay and C indicates the commercial vehicle and T indicates a temporary usage.

So for example, you know like we use the spare tyre under emergency you know those will be mark with the symbol T, ok. So these are supposed to be used only under emergency and then it be replaced with the service tyre you know like as soon as the repairs are carried out ok. So those are some additional markings that we will . So now if we want from this specification if we want to calculate the tyre radius, how would we do this?

So from this specification please note that the tyre width is 175mm, right, so 175mm times 0.65 will be the tyre height, right, from beat to the tread. So then to get an first get, approximate value, right, then we have the rim diameter as 14 inches. So what will be the rim radius in mm? It will be 14 inches times 25.4mm and then divided by 2 right that will give the rim radius. So if you want to get a nominal tyre radius from the tyre specification you can get it ok.

So I think if you do the calculations are correctly I hope I am correct. In this case we get around like 291.55mm, ok. So that is what we will get, right ok. So this is the very brief introduction to tyres of course tyres are very important as far as the transmission of forces is concerned between the road and the vehicle. And the field of tyre mechanics is a huge area which essentially deals with this phenomenon, right. How are the forces and torques are transmitted between the vehicle and the road ok.

So the object of this lecture is to essentially provide a broad overview of tyre what are the different components and some information related to the pneumatic tyre ok so I will stop here thank you.