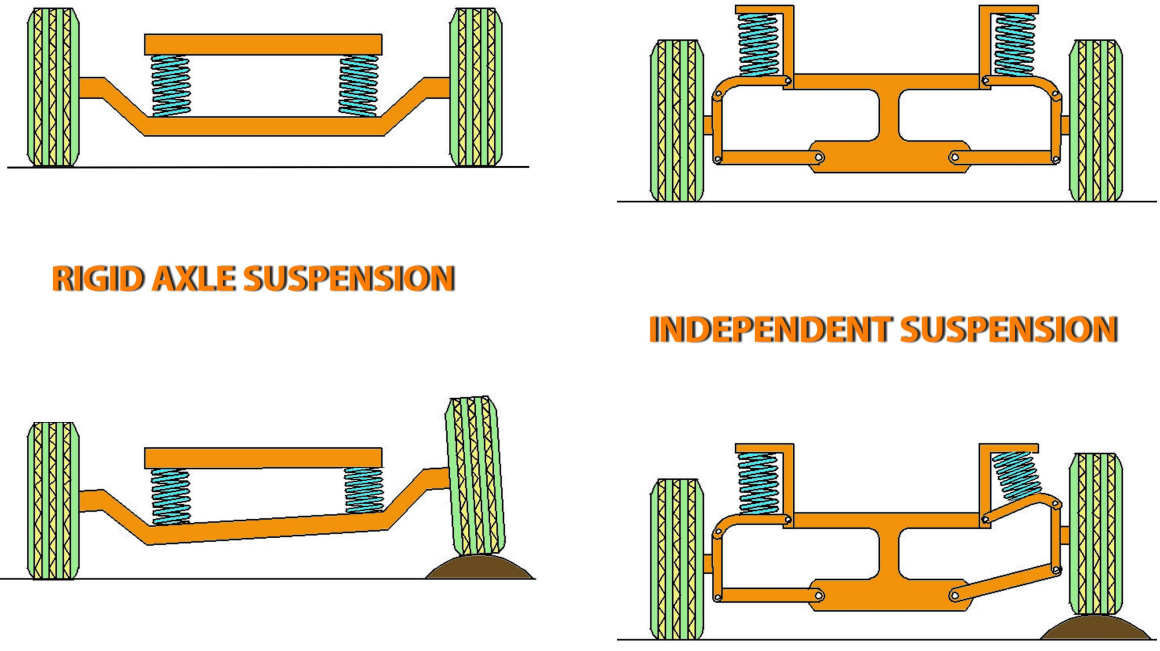
Fundamentals of Automotive Systems
Prof. C.S. Shankar Ram
Department of Engineering Design
Indian Institute of Technology - Madras

Module No # 12
Lecture No # 68
Shock Absorbers and Independent Suspension – Part 02

So another category or perspective of classifying suspension is from the perspective of the connection between the left and right wheels on the same axle right. So let us look at how we can essentially classify suspension based on this criteria. So based on this we have broadly two classes okay so what is called as a rigid axle or dependence suspension and an independent suspensions.



So this rigid axle is nothing but a what is also called as a dependent suspension. So what are these two classes of suspension so as we can see in this schematic

indicating the rigid axle or the dependent suspension we can see that the left and the right wheels okay are connected by means of a rigid axle so as a result if let us say this wheel hits a bump this wheel is going to travel up.

So what is going to happens is that the entire vehicle body will roll and this is going to be pushed off. So any perturbation which is filed by one wheel is transmitted to the other wheel in a rigid axle or dependent suspension. On the other hand in an independent suspension let us say we have the left and the right wheels what happens is that when the let us say once again the right wheel hits a perturbation right then the right wheel maybe displaced.

But then we can see that the displacement is absorbed right by the suspension linkages and consequently the maybe the disturbance which is transmitted to the other side is fairly low okay so that is the important feature of an independent suspension. So let us look at both okay so first let us look at dependent suspensions and we would then look at various realization of these dependence suspension.

So a rigid link connects the left and right wheels so of course the movement the motion of the wheel assemblies and the tyres are dependent on each other the vertical motion right. So consequently there are few limitations okay we have issues related to handling as what happens when we steer the vehicle right so and then issues related to ride comfort and role holding because the unsprung mass is more okay. So this is going to impact suspension performance including ride comfort okay those are all limitation of a dependent suspension system okay.

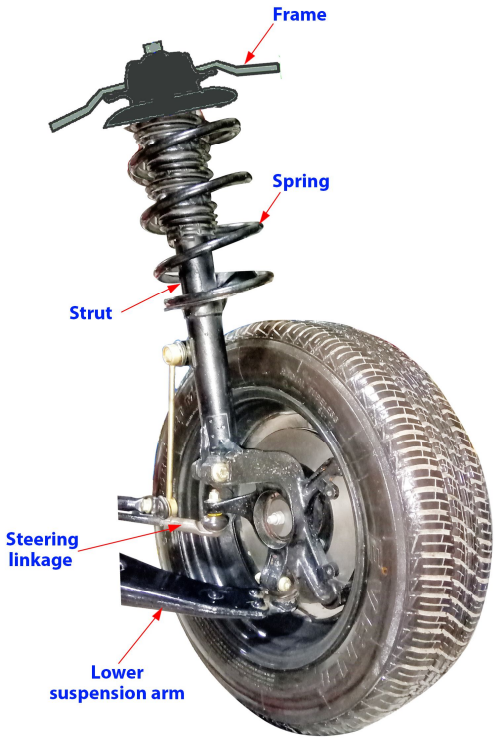
So on the other hand an independent suspension has advantages okay what are those so the two wheels can move independently as far as vertical displacements are concerned right. So then but then like what we have is that like we have a suspension elements such as control arms okay wishbones trailing arms okay.

These are all elements so because there are see it provides some relative motion between the wheels on either side but then like there should be some support also right.

So at the same time as far as the structure is concerned. So these elements link the vehicle frame and the suspension okay and transfer loads between them right. So that is what happens in an independent suspension so what are the advantages? Advantages include lower unsprung mass okay we will shortly see that we can require a smaller space requirement okay which becomes important when we want to move these suspensions on the drive axles or the driven wheels and disturbance on one wheel is not transmitted on either side's wheel is not transmitted to the other side to the greatest possible extent right. So that is the advantage of the independent suspension.

So let us look at common realizations of these suspension okay in road vehicles what are the different ways in which these independence and dependent suspensions are realized.

Let us look at a few common types and then like we will study the features so the first type of independent suspension that we will look at is what is called as a Mcpherson strut suspension okay so this is what is called as a Mcpherson strut and let me also have the control arm schematic so this is the Mcpherson strut and this is a schematic of what is called as a controller. So what is this Mcperhson strut suspension it is a very popular suspension that is used in it is a very popular independent suspension right.



Mac PHERSON STRUT SUSPENSION

It is used in small cars right so let us identify how it is constituted and what are it's features. So we have what is called as strut okay an element called as a strut that houses the spring and also inside the spring there is a shock absorber okay so the shock absorber and the coil spring are wound in parallel right. So this arrangement you know like some people will say coil over oil okay in a colloquial sense right because we have a coil spring around this oil filled shock absorber right.

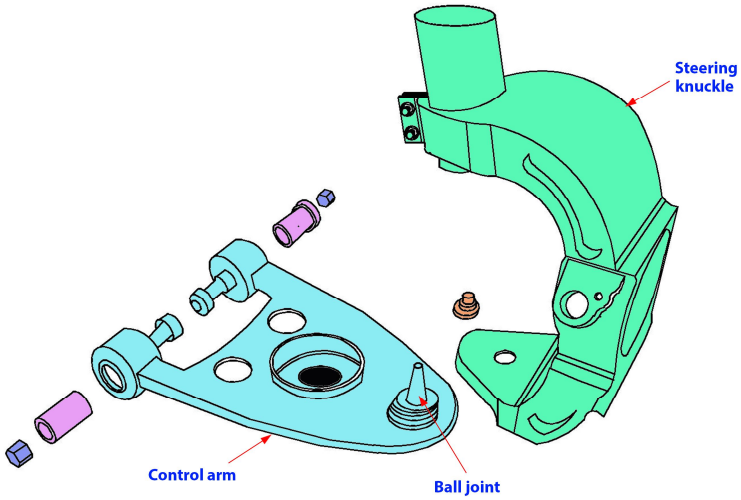
So very compact right you just have the strut it is mounted to the wheel assembly and the vehicle body goes here right this connected at the top to the vehicle body that is about it. A very nice you know like and it is very advantageous to have when we are driving the front wheels because the suspension itself only takes a very little space. So those are all pretty good advantages of the McPherson's strut simple in construction and realization.

However we can immediately see that we have to provide some other elements to support the wheel assembly in the other directions that is the longitudinal and lateral directions alright with respect to the vehicle body that is where we have what are called suspension arms or control arms. So this is the control arm which is typically connected at the bottom okay here so what is what happens is that the control arm is connected to steering knuckle through a ball joint right and this other end of the control arm is fixed to the vehicle frame or the vehicle body okay.

So that there is some support between the wheel assembly and the vehicle body right along the lateral direction. So that is the role of a controlled arm in this McPherson strut assembly okay so the McPhersons strut has typically a strut assembly and a lower controlled arm. So the strut assembly contains the spring and the shock absorber okay. So of course the top end of the strut is connected to the vehicle body the main advantage of this is it that like compact so suitable for compact cars right where space is a premium right.

So packaging everything becomes very important right and particularly where the front wheels are steered. So where we have front wheel steered cars this becomes important okay and since the strut is used as the upper suspension link so we can see that there is a control arm which is a lower suspension link okay.

Because we have the steering knuckle right which support this wheel assembly. So this strut is connected close to the top okay and then the lower control arm is connected to the bottom right. So the since the strut is used as the upper suspension link so we have more clearance for the drive shafts because if you want to drive the wheels right I need a drive shaft I need to put in a drive shaft right is not it?



CONTROL ARM

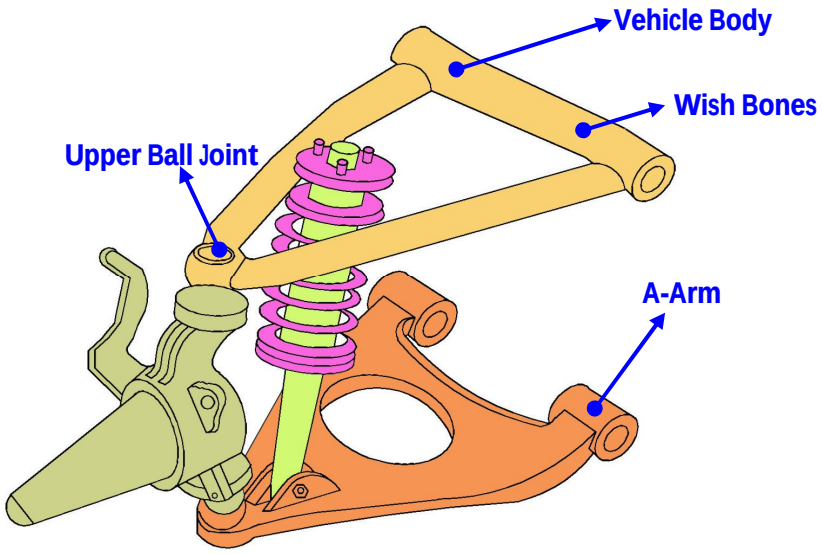
So we will have more clearance for accommodating the drive shaft in a front wheel drive vehicle right. So more clearance is available for the drive shafts in a front wheel drive vehicle okay so that is one main advantage of McPherson strut simple compact easy to mount and accommodate right so popular in compact cars but what are limitation?

Main thing is that when suppose if this wheel hits a bump right and when we corner this is going to rotate right. So what is going to happens is that the camber of the wheel is going to change okay. So the McPherson strut cannot take care of that aspect and consequently that is going to affect the handling properties so the wheel camber angle changes due to wheel movement so the McPhersons strut is not very effective in addressing this.

So this implies that the McPherson strut suspension does not provide as good a handling performance as the next choice that we are going to look at which is what

is called as a double wishbone suspension. So that is one limitation of an McPherson strut suspension okay alright okay.

So now that leads us to what is called as the double wishbone or A-arm suspension so what is this double wishbone suspension. So it is once again a very popular type of independent suspension so what are how is it realized and what are it's characteristics? So if we look at a double wishbone suspension.



DOUBLE WISHBONE (A-ARM) SUSPENSION

So we have two suspension arms or links that are shaped like a wishbone right we can immediately see that we can essentially see that there are that in the shape of an A or a wishbone right.

So that is why it is called as a double wishbone or an double A-arm suspension okay so that is the reason. So these two suspension links are shaped like a wishbones or like an A so what happens is that we can immediately see that these two wishbones are connected to the steering knuckle at the upper ball joint and the

lower ball joint okay. So there are two ball joints at which this steering these wishbones are connected.

So there is good support at both the bottom and the top and then that other ends of wishbone two wishbones are connected to the vehicle body this side on this one alright. So there is good structural support between the wheel assembly and the vehicle body more importantly we will see that if we make the arm of the upper wishbone smaller than the lower wishbone you will see that the moment the wheel hits a bump these two points will traverse of arcs of different radii okay.

Let us say the upper wishbone is smaller the arm length is smaller than the lower wishbone so this point will travel on a arc of smaller radius than the bottom arc right is not it? Then we will immediately see that it will naturally introduce a negative camber which is good for handling performance okay. So we discuss this during this wheel alignment right so why do we have negative camber because when we are cornering we want good contact at the output tyre interface right.

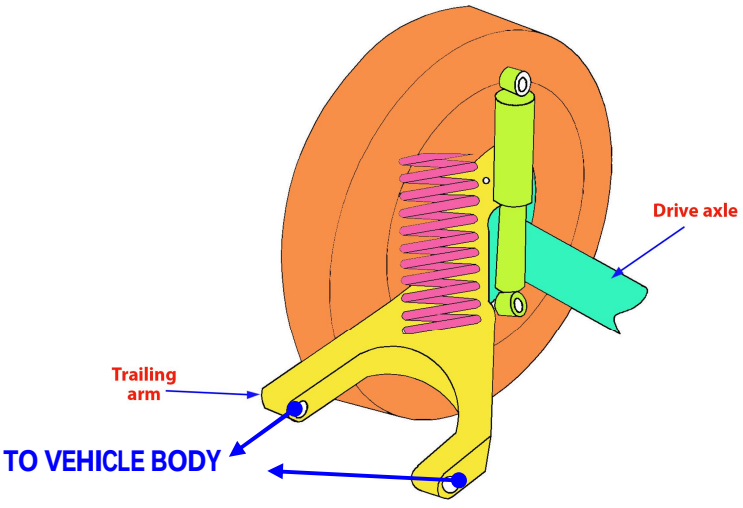
But the inner wheel tyre also we do not want to lose contact right so this double wishbone can adjust the camber right such that it tends to negative camber and there is a good and the wheel straighten up or the tyre will straighten up when we take a turn. So that the contact between the tyre and road interfaces maintain in at reasonable levels or the expected levels okay. So let us quickly write down the keys points of the double wishbone suspension so as two wishbone are what are called A-arms as the lower and upper suspension links okay.

Then compared to the previous choice the double wishbone has better ride and handling characteristics right due to the reasons that we discussed. So each

wishbone is connected to the wheel assembly and the vehicle frame at its two ends alright so that is one thing.

And then we have what is called as short long arm suspension what is abbreviated as SLA double wishbone. So as we discussed this is the suspension where the length of the upper wishbone is smaller than the lower one okay. So the upper arm is shorter in length than the lower arm so hence as a wheel hits a bump a negative camber is gained since the upper arm swings on an arc of smaller radius of course what is the tradeoff?

See if we have the upper arm swinging on an arc of different radius then the lower arm you will see that the trye will scrub side to side see now the tyre is also going to be rotated accordingly right. So the tradeoff is that side to side scrubbing of the tyres will occur with this arrangement okay so that is the that is a tradeoff right with a double wishbone suspension right. So one more type which is sometimes used as independent suspension also to reduce the space is what is called as a trailing arm suspension so what is this trailing arms suspension?



TRAILING ARM SUSPENSION

In a trailing arm suspension we can observe that so this trailing arms are also used to provides structural support in other types of suspensions but let us look at what is called as a trailing arm suspension right.

So in a trailing arm suspension we can observe that there is spring and shock absorber and there is no wishbone right the wishbone essentially projected into the vehicle along the lateral direction. The trailing arm comes along the longitudinal direction okay. So that is why it is called as a trailing arm. So if you recall the wishbone essentially went into the vehicle right as from the lateral direction.

The trailing arm goes along the longitudinal direction of the vehicle so that is why it is called as the trailing so it goes and connects to the vehicle body okay. So that is what is called as a trailing arm suspension so what is the main advantage of this trailing arm suspension you know like it basically it is pretty compact and what to say particularly if you want to use it for use in driven wheels it is a reasonably good choice okay.

But however you know like it needs what to say today these trailing arms are by and large used for providing support to the other types of suspension okay. So that is the common use of this trailing arm okay along the longitudinal direction okay so we will encounter these trailing arms when we look at other types of suspensions okay I will stop here and then we will continue in the next class thank you.