Transportation Engineering -II
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Lecture - 22
Signals part - 1

Dear students, I welcome you back to the lecture series of course material of transportation engineering 2. In the previous lectures we have discussed about the geometrics and the different types of turnouts and the crossovers. Now, from today's lecture we will be starting another important aspect of railway engineering and that is signals. Signals constitute the controlling part of the movement of the rolling stock on a railway track which is already being designed and laid as we have seen in the case of geometrics and turnouts. Now, these signals will be looking at various types and maybe we will be discussing the signals in 2 parts. So in the today's part, that is part one, we will be looking at the signals and their objectives, the types of the signals and classifications and then out of those classifications whatever can be taken up today will be discussed.

Starting with the signals and defining what the signals are: the signals are systems or devices or the means by which the trains are operated efficiently and the tracks are used to the maximum extent maintaining the safety of the passengers, rolling stock and the staff.

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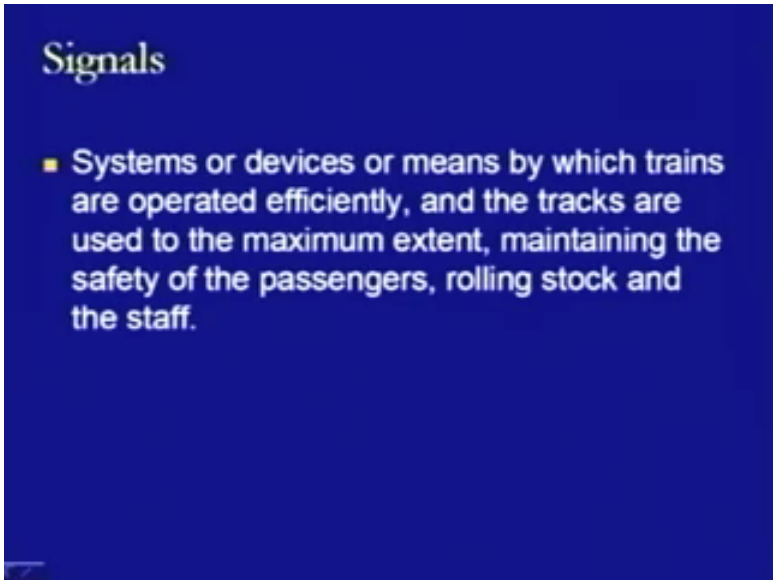

So definition itself comprises of certain things. certain objectives with which the signals are provided. What it says is that we want to have an operational efficiency and that has to be maximized. You have to maintain the safety and not only the safety of the passengers. We also have to maintain the safety of the rolling stock and the stock which is operating rolling stock. So these are the 2 important things which needs consideration; one is efficiency; another one is safety. The devices of a system which helps in attaining these things are signals.

Now, the objectives of a signal if we define a little more, then they should provide efficient movement of trains or the rolling stock. It should ensure safety of trains which are moving on crossing tracks. It should maximize the utilization of the track. The track should not remain idle for a long period of time. It should also maintain the safety during shunting operations. This is another objective because the trains have been taken to the yards or the locomotives are going to bring some more wagons or compartments or they have to be taken from the main track to another track or likewise whatever operations are there. So that safety is to be ensured along with this safety of the rolling stock which is moving on tracks or crossing different tracks. Managing train movements during maintenance and repairs, that is another aspect which is also related with safety, that is, if there is any maintenance or repair work is going on at any of the section of railway track, it should help us in managing the train movements or the movements of the rolling stock.

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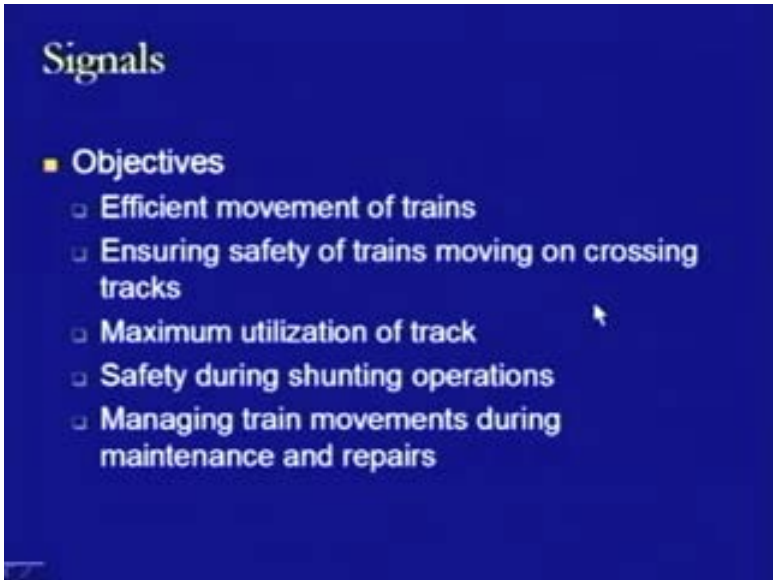

Now we come to the classification of the signals. In the classification of signals we have different type of basis by which the classifications can be done. The one is based on the operation characteristics. Another one is based on functional characteristics. Then the third is based on locational characteristics and apart from all these 3, there are some signals which have special characteristics on the basis of that they are classified in the fourth category. So we will be looking at all these 4 categories one by one and then within those categories whatever type of signals come or can be categorized or sub categorized will be looked at and discussed.

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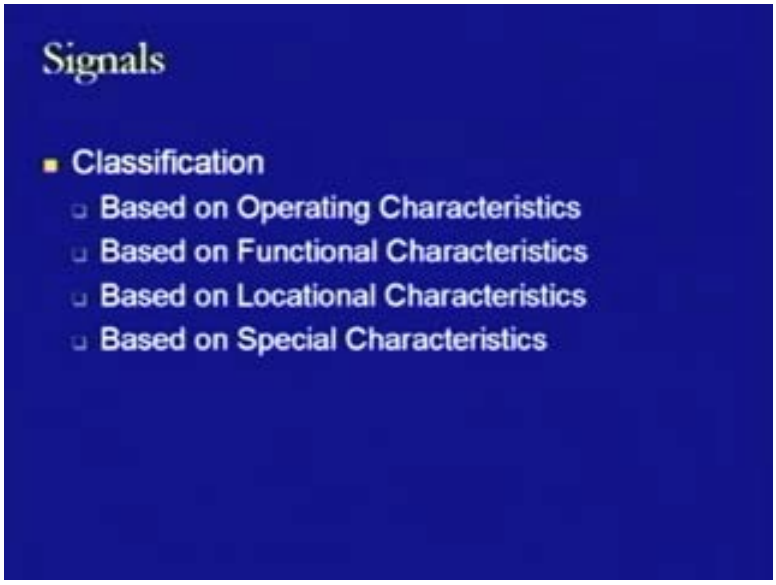

Starting with the first classification, that is, classification on the basis of operational characteristics, we found that these signals can be defined in 2 ways. One is that they are audible and another form they are visual, that is, whether we are using our eyes or we are using our ears to listen or to see those signals. In the case of visual category, again they may be hand operated or they may be fixed installations. So this is the way the signals are operated on the basis of that, this is the type of the classification which can be provided.

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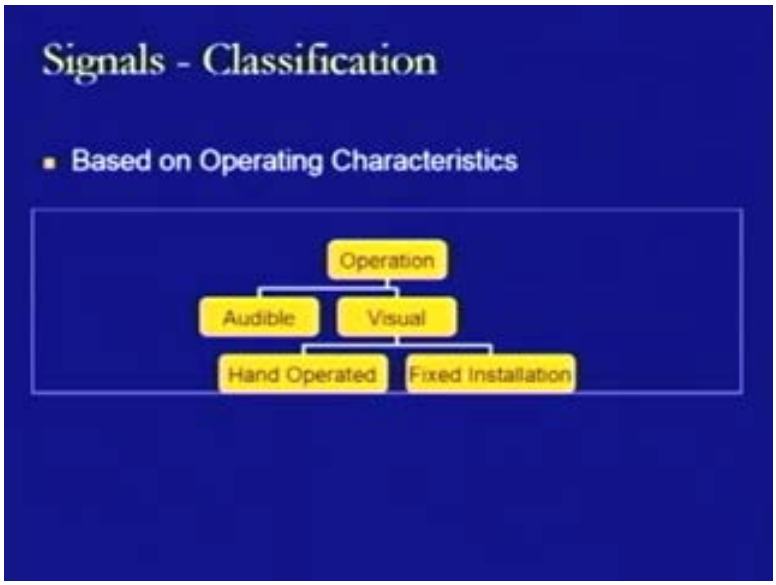

Now, if you look at this classification and we go into the details of these, then in the case of audible signals most of the time detonators are used so as to make a big noise which is audible enough to the driver so that they become cautious and understand that there is something hazardous which is available or the signals have been provided ahead of them so that they should look for them because they have come in a very close proximity of those signals.

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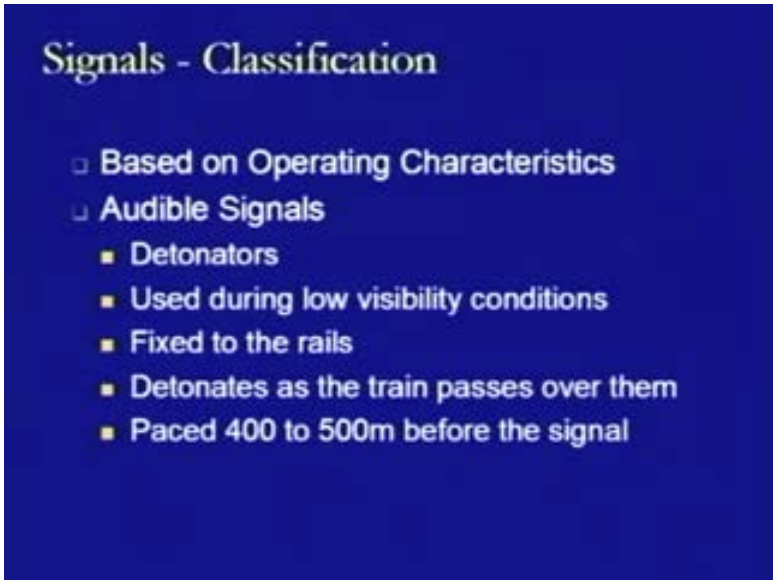

Generally they are used during the low visibility conditions where there is a mist or fog and therefore it becomes very difficult for the driver to see the signal on the track. These detonators are fixed to the rails and then as soon as the locomotive passes over that due to the force they detonates and makes a long big noise and this big noise is indicated to the driver that the signal is ahead and he should look for that signal and act accordingly. Most of the times, these detonators are placed at a distance 400 meters to 500 meters before the signals. So these types of signals being provided then they are known as audible signals. Most of the times these audible signals are provided along with the fix type of signals so as to make the driver understand that the fix signals are ahead of them. Then on the basis of the operating characteristics we have the visual signals and as we have seen these visual signals can further be divided as hand operated signals or the fixed signals.

So the visible signals are the one which can be seen easily and they are hand operated then they are just moved by using hands and that can be done in different ways. We must have seen at number of times the different types of hand operated signals. We will be looking at those closer a little further away. The fixed installation signals on the basis of operation characteristics of those which remains at one location only and most of the time they are placed at the top of post.

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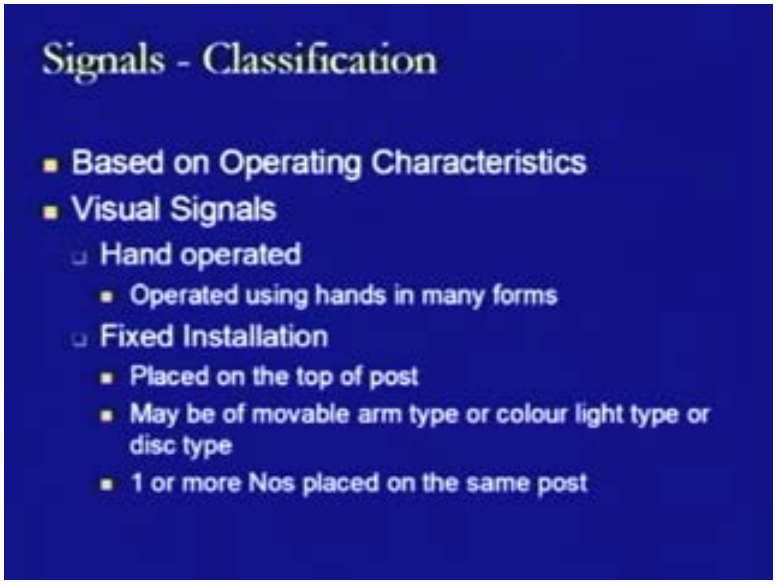

They may have the movable arms or they may have the colored lights by which the indications are given to the drivers or sometimes they are also provided in the form of a disc. There can be one or there can be more than one signal on the same post. So that type of installation if it is there, then it comes under the category of fixed installation.

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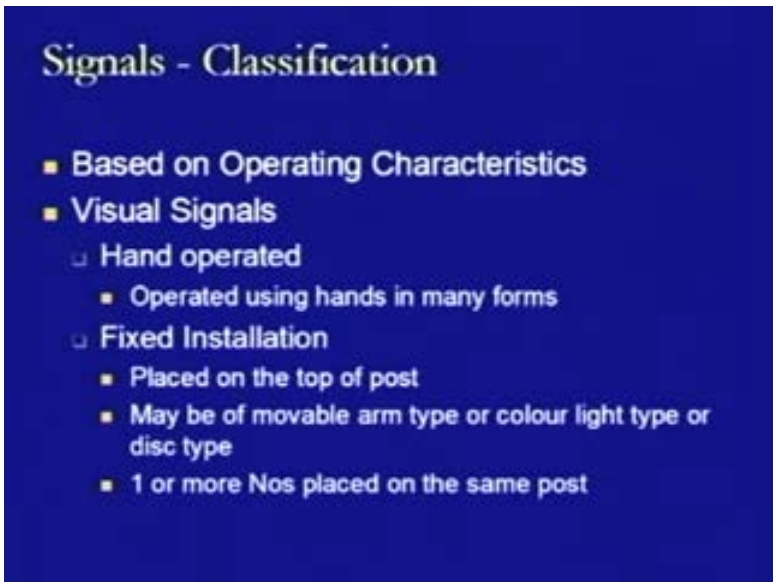

Now, in the case of another classification where we are looking at different signals, that is, on the basis of functional characteristics, we found at this categorization which we were looking at now in the last stage that is using hand or fixed that comes under the functional condition and then in this using hand we have 3 types of signals, that is, the flags lights or the hand indication whereas in the case of the fixed signal we have 2 categorizations; the Stop signals and the Warner signals.

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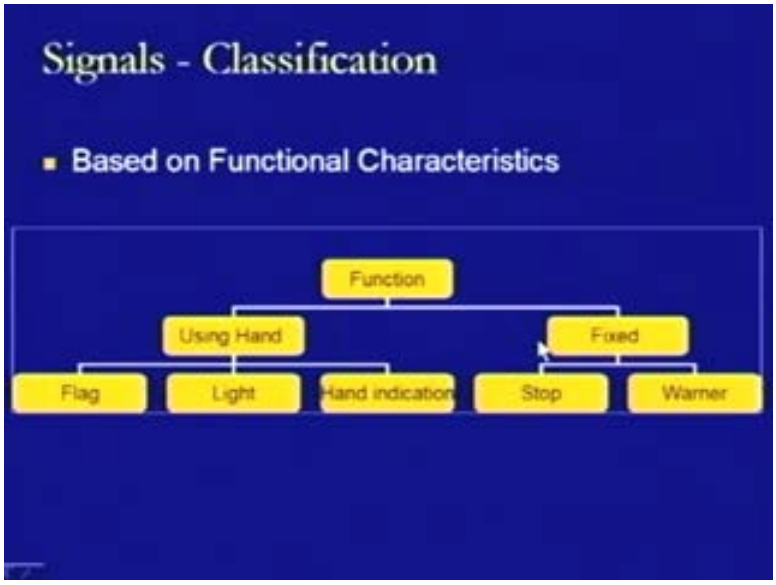

Now, in this case when we are looking at the using hand condition then here we have the flag, we have the color light and we have the hand indication.

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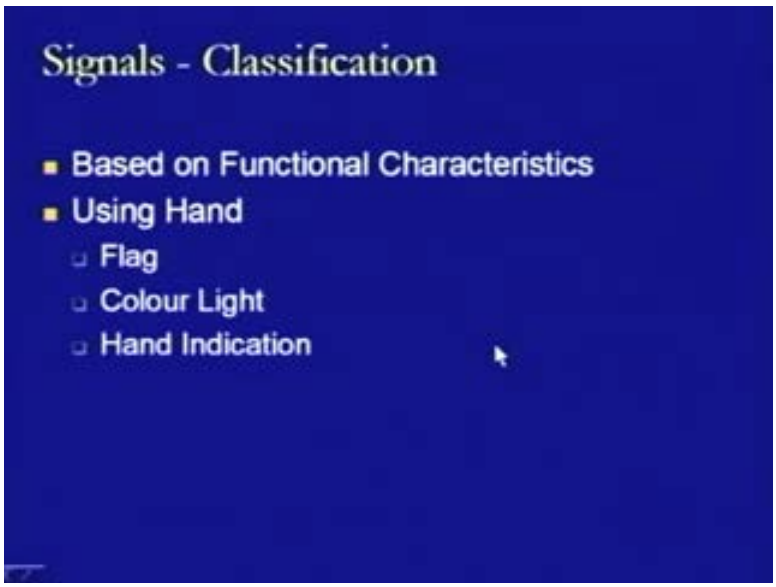

Then the flags can be you must have seen on the railway stations there are certain operating staff which are provided with 2 types of flags; one is red in color, another one is green in color.

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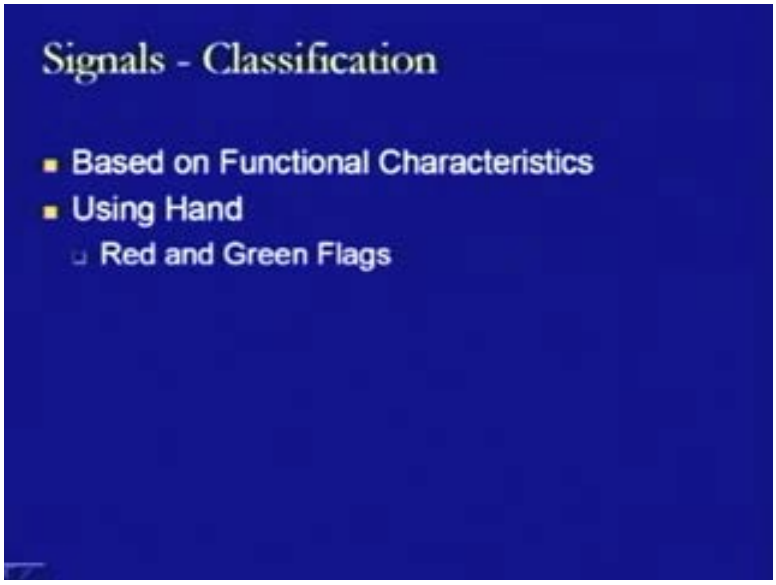

The red as usual defines the stopping condition and green again as usual defines the priority or the movement condition, that is, allowing the movement to take place on the track.

Similarly, we can have the light indicators and in the case of light indicators it may be again the 2 light indicators or a 3 type of indicators, that is, either it may be red and green or it may be red, yellow and green. The red and the green light is the same characteristics which being defined in the case of the flags.

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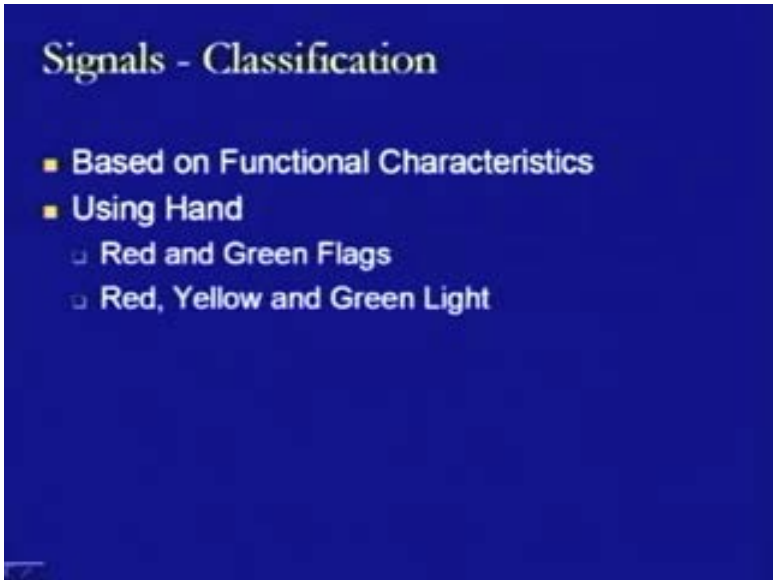

The yellow is the condition which defines the caution, that is, the speeds need to be reduced because there is something due to which the whole permission of movement is not being provided on the track and therefore the train can move at a slower speed. Sometimes, the hand indications are also used and these hand indications are mostly used when the shunting

operation is being carried out because at the time of the shunting it is very difficult for the person who is moving behind the shunting train.

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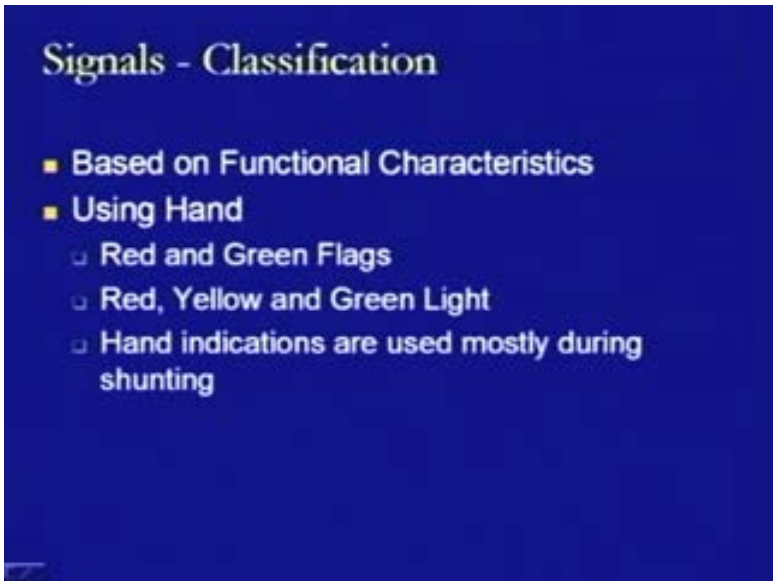

That person will not be visible to the driver or the person cannot come out and show the lights of the flag so as the things remains visible to the driver. So in that sense, the person comes on the side and shows [11.10….) indications' using his hands and that is how the driver reacts to that. So these are generally the persons who are using these type of hand operated signals, they are station masters, guards, gang man, cabin man, point man, key man and similar such persons

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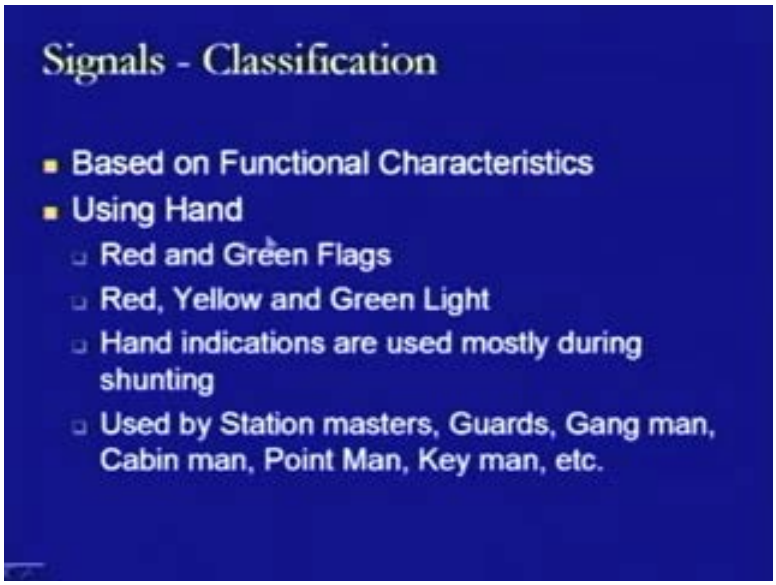

Then further, where we come to the fixed signals and in the case of fixed signals we have Stop signals and Warner signals. The stop signals are those signals which try to define that the train has to be stopped whereas Warner signal is sort of condition where the caution has

been defined. That means the train has to move at a slower speed but there is no requirement to stop at all at this particular location. So we have to look at how these works and we will be discussing these in the coming discussions or slides.

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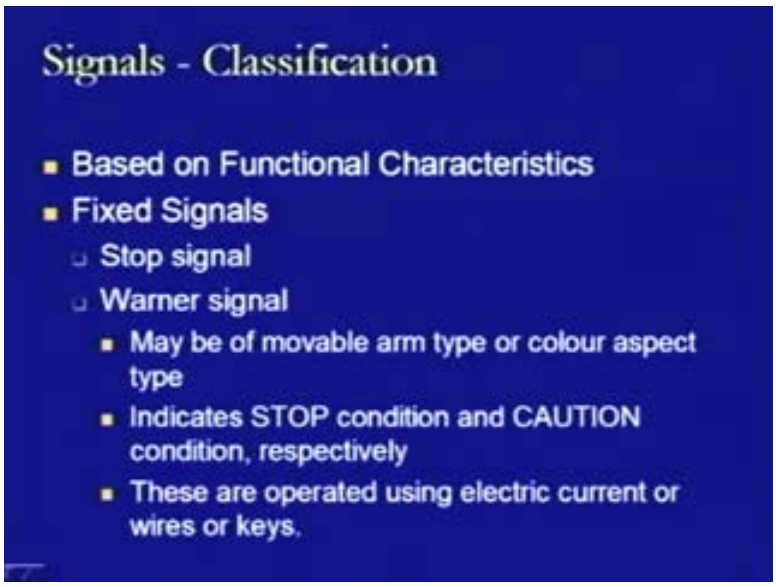

Now what happens here is that both the types of signals may be having a movable arms which moves up and down and that is how it provides the indication whether the movement is allowed on the track or not. Another condition is the color aspect, where in by using the color of the signal we define whether the movement is allowed or the movement is allowed with some caution or the movement is not at all allowed on this track. Therefore, this indicates the stop condition or the caution condition respectively as already told and these are operated using electric current or wires or keys. So these are things which are used so as to operate these 2 types of signals, may be in the movable arm condition or in the color aspect condition. So in the color aspect, then it is the electric current condition which is used where is a movable arm condition it is wires and keys which are used to move those arms.

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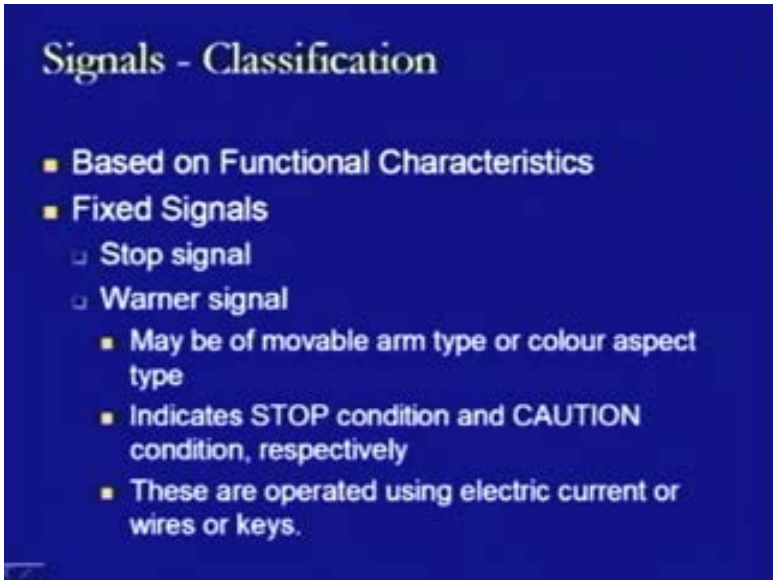

Then further when we come to the fixed signals and we are discussing both type of signals and these both signals can be provided by using either movable arm or color lights. Movable arm signals are known as semaphore signals, that is the specific means given to those signals which are provided with movable arms.

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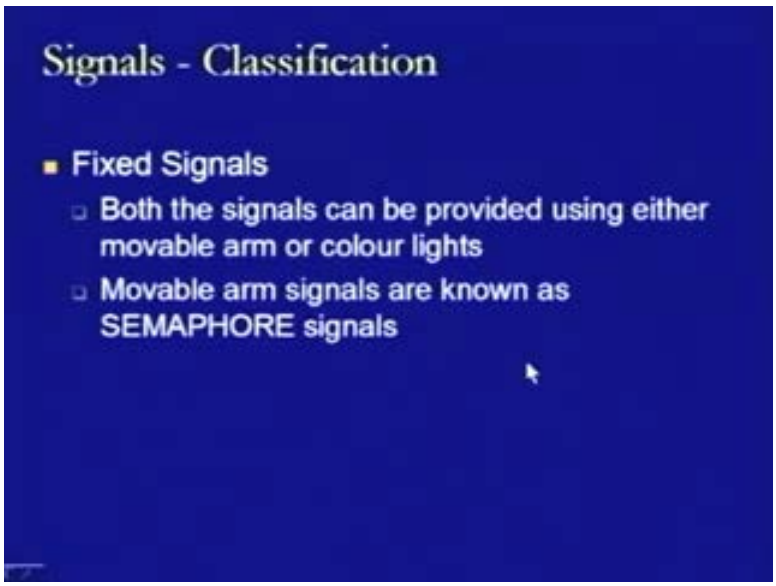

Whereas those signals which are provided with the colored lights they are termed as color aspect signals. This is the distinction between the 2 categories of signal which are using either the movable arm or the colored light.

Now we look at the semaphore stop signal. In the case of semaphore stop signal as already being defined that it is having movable arm, so what we found is there are number of things which are provided on this semaphore stop signals. It has large number of components.

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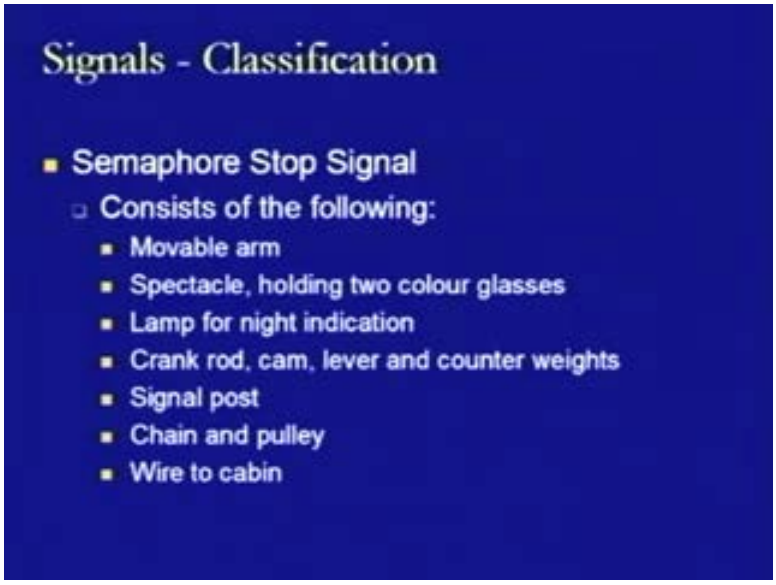

The components are the movable arm, spectacle holding 2 color glasses, lamp for night indication, crank rod, lever and counter weights working as a one complete assembly. Signal post, chains and pulleys so as to operate the movable arms and wire to the cabin from where it is operated. So these are the things which are provided in the case of a semaphore stop signal and that constitutes a signal.

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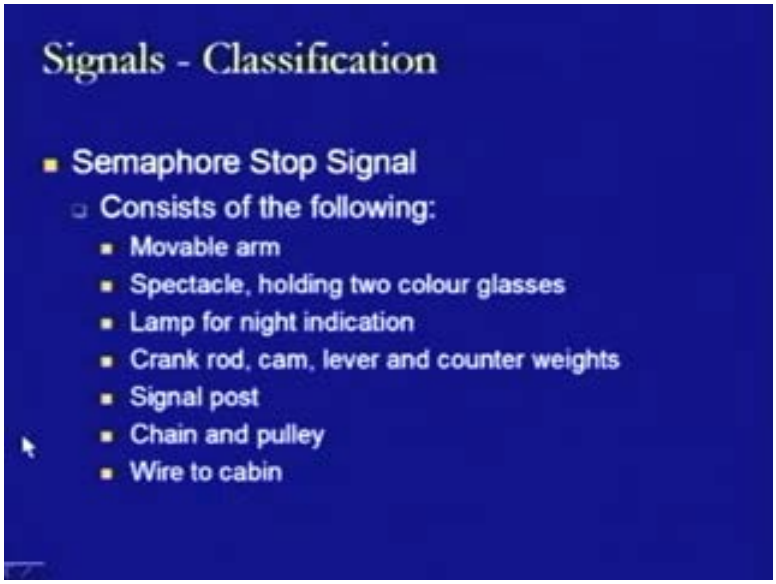

Now we look at this diagram. This diagram tries to define what is semaphore stop signal and how it looks like. In this case, what we can see is there is a big post which is located like this. This is the big post which is located at the ground level g l. At the top of this one, at some distance we have are providing this arm. This arm which is pivoted at this location, here, so we have this spindle here with respect to which it will go up or down. Now this moveable arm, this is of same rectangular size and it is 25 to 35 centimeter in this width. This movable arm is provided at a height of 7 point 5 meters from the ground level. So this is the center of

this movable arm. So the center of this movable arm is at a height of 7 point 5 meters. This movable arm is provided with a band and this band is white in color whereas the rest of the color of this movable arm is red. So therefore, there is a white band on the red background, that is, what is the color combination of this movable arm.

Then on this side of movable arm, we are providing 2 glasses and the glasses are red and green in color and these are provided within this section which is known as spectacle. At the back of this spectacle a lamp is provided. So this is the lamp which is being shown at the back of this spectacle. Now as this arm moves accordingly we will be having a red light or a green light. This spindle is connected to cam at the bottom at this location and this cam is having a total combination of levers, balancing wheels etcetera which are provided here. So we have the weight at this location, we have the balancing lever here and if it moves up and down accordingly this crank rod will move which is making the connectivity between the cam and this spindle, so we have this crank rod. This cam is connected by using a chain which passes through the pulley and it goes up to this and from here the wire goes to the cabin. So that is how the total assembly of any semaphore stop signal is being provided.

Now on the basis of whether this wire is being stretched or the tension is being given to this wire then this will operate this chain and this chain will further operate the cam and with this help it will go up and this will come down and that is how this semaphore stop signal works. So in this case of a semaphore stop signal what we observe is that the movable arm can remain in the horizontal direction as it is shown in this case or it may go down at some angle or it may go up at some angle. The angles by which it can go down or by which it can go up it may be 45 degrees or 60 degrees or in some cases it may be vertically upwards also.

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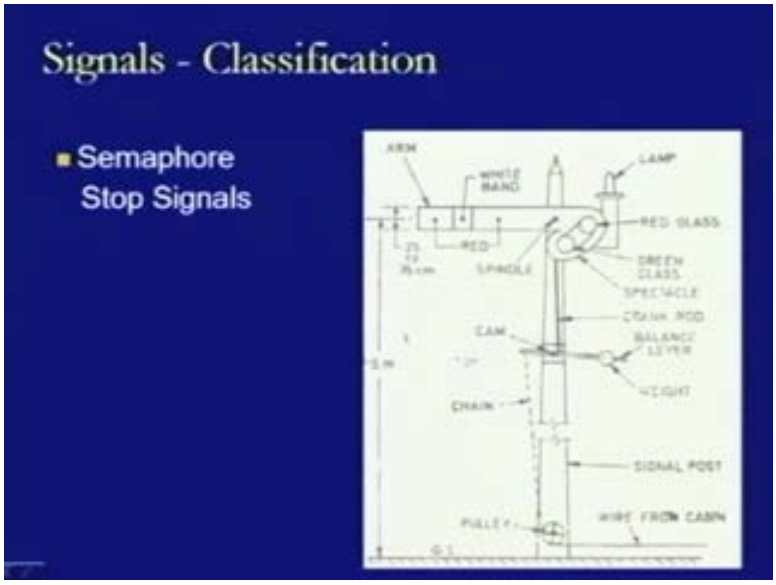

So depending on the condition which we are interested in defining this movable arm will be working. So if you look at this semaphore stop signal, this is another diagram where we are trying to show that 2 conditions. The first condition where it is being shown as a horizontal arm that signal indication shows stop and when it is stop then the lamp will be oriented behind the red light. So the red light also will be seen during the night as well as the day operation.

Now, if you look at another condition where it is proceed condition where the arm is going down. It is being specified in such way that arm goes down then in that condition the green glass will come in front of the lamp and it will get illuminated and that is how we will be seeing the green light. So that is the indication of proceed. So 2 LQ's with second low quadrants with multiple color aspect lower quadrant signal. So here what we have seen is that there is one position which is termed as on position. This is what is being defected here in the first diagram. This on position defines that the arm remains horizontal and when the arm is horizontal then it indicates a stop condition or a danger condition.

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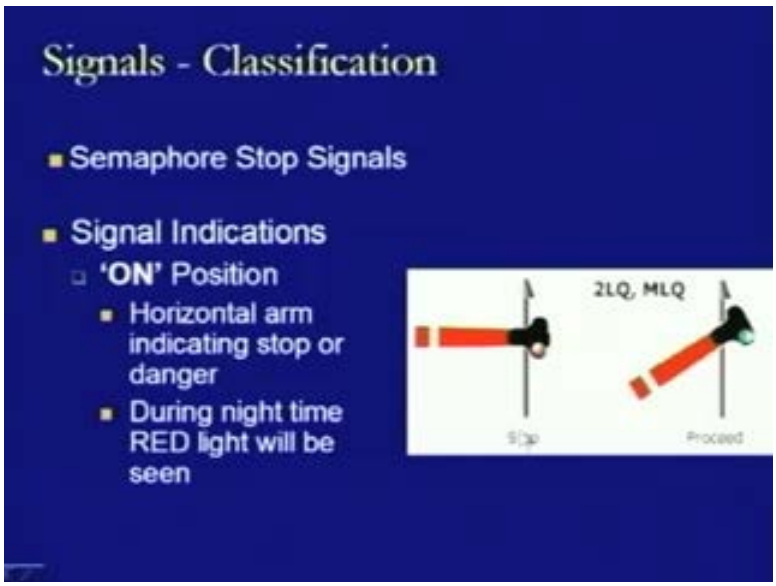

So that is the way it is defining the stopping of a vehicle and during night time the red light will be seen. So if it is not possible to see this arm then with the help of red light the driver can understand that it is a stop condition and therefore the vehicle has to be stopped. This is the natural condition of the semaphore stop signal. In the normal conditions the semaphore stop signals will remain on position, that is, the arm will be horizontal or the light will be red in color. Similarly, we can look at another condition in signal indications, that is, off position signal indication. Here the arm is lowered at an angle of 45 or 60 degrees and during night operation it will be visible with the help of the green light which will be seen on the side of this movable arm. So that is how we have another position which is termed as off position and which allows the movement of the rolling stock on the railway track. So these are the 2 signal indications in the case of the semaphore stop signal; the on position and the off position.

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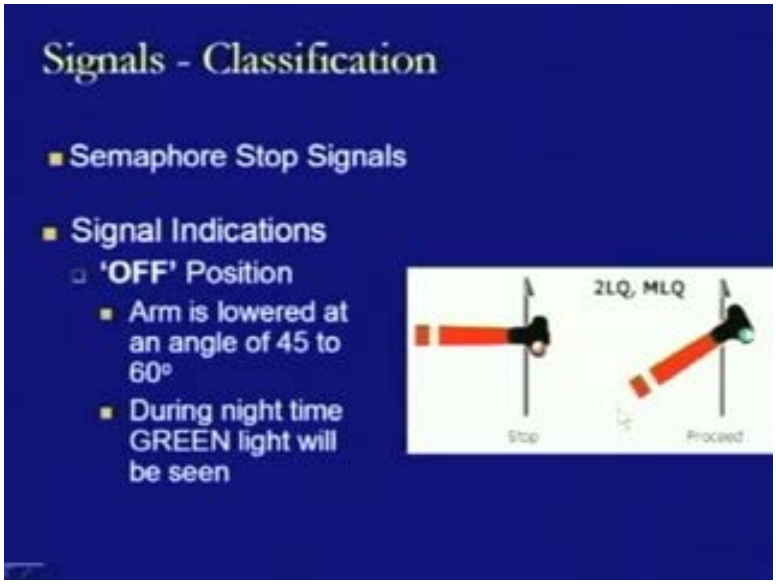

Further, in the normal position it always shows stop, that is, the arm remains horizontal or what we can say is that on position of the semaphore signal. If there is any failure of the signal or if suppose there is no light, then in that case it turns to the stop condition.

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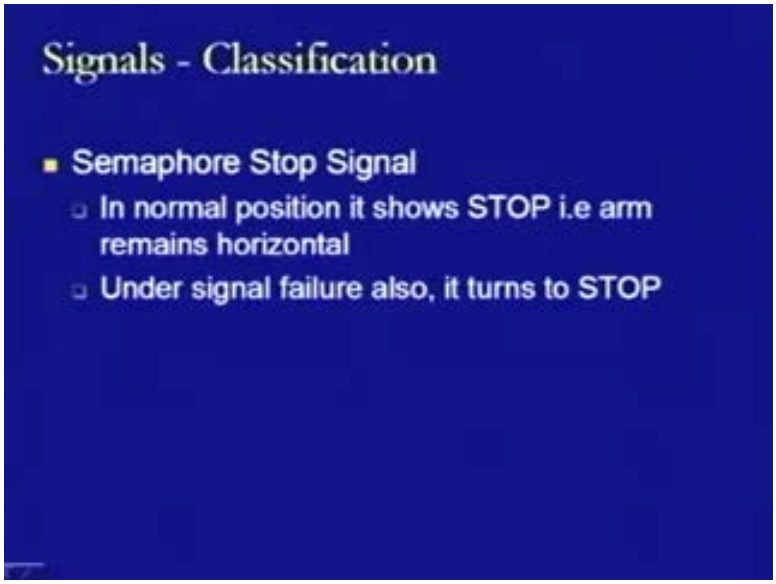

So that is another feature which is being installed because if there is any problem with the operation of signals then the signals should switch to the off position, that is, to the stop position, that is, to the on position normally. The red colored side of arm remains towards the driver but we have seen is that there is a white band on the movable arm with red back ground. Now this side will remains towards the driver but how we are going to identify whether this is the front side or back side is defined by the color of the this movable arm.

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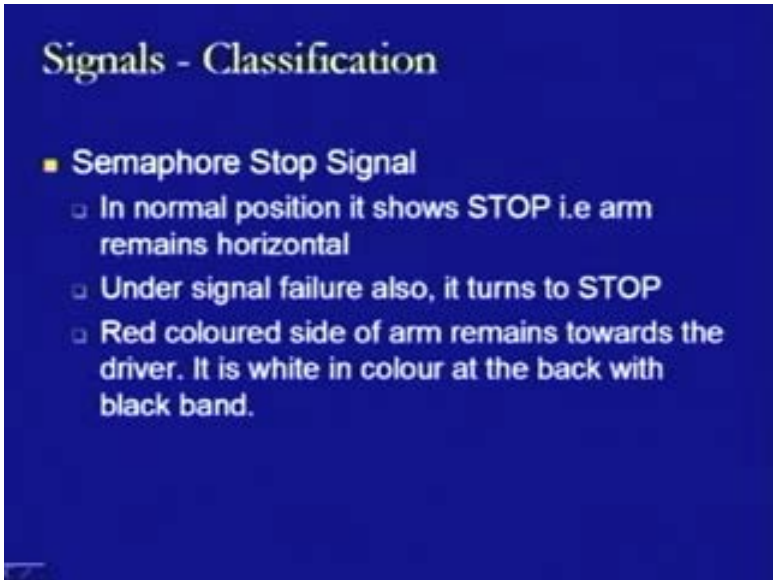

At the back, this is white in color with black band, in between the same location where the white band is provided on the same side. So it means, if the driver is looking at the signal and he sees the white color of the movable arm with black band then it means the signal is not pertaining to him operation of the rolling stock or the train on the track and he has to look for some other signal. Whereas if the driver looks and finds that color of the movable arm is red with white band then it means it is related to his track and he has to follow the instructions given by that. These are generally placed on the left hand side of the direction of movement. So that is another guide line which is provided for the provision of these types of signals.

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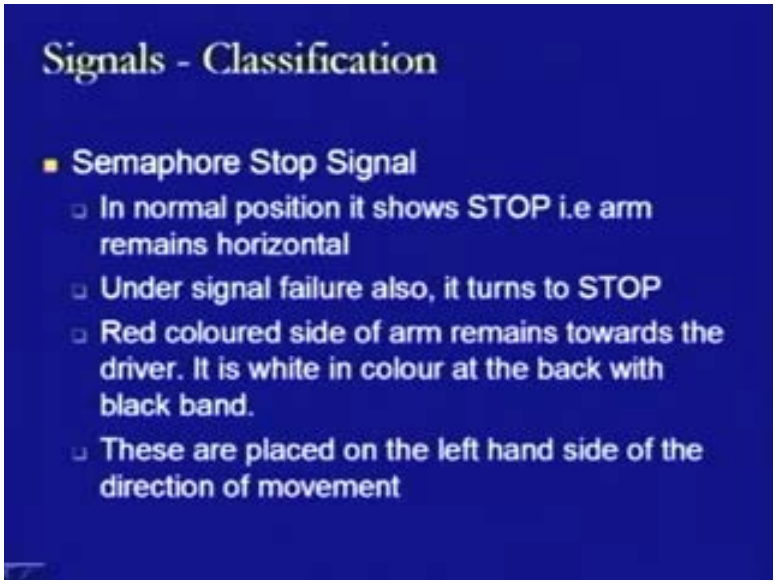

Now, in this case of semaphore stop signals, we have one category of signal which is termed as lower quadrant signal. This lower quadrant signal uses the fourth quadrant of the 4 directions in which the overall space can be divided and it works with only 2 aspects namely horizontal and inclined downwards, that is, on condition, off condition, red or green position.

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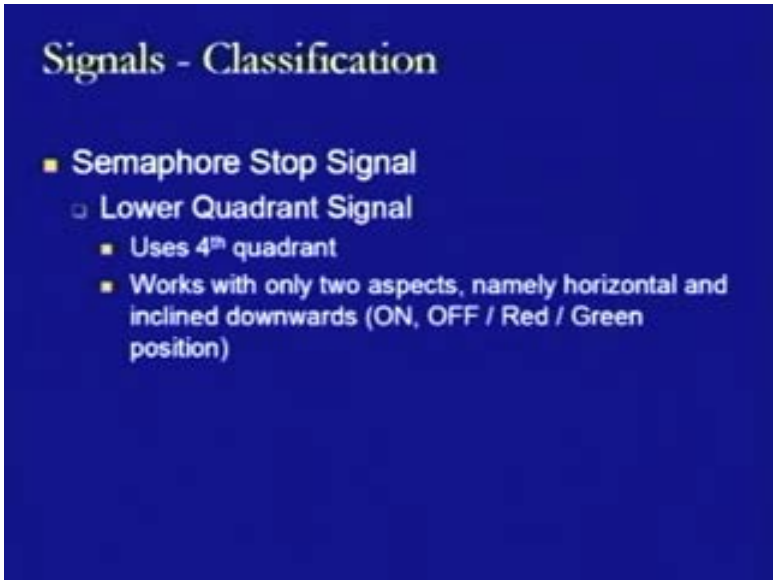

Whereas there is another category where it is termed as upper quadrant signal and just opposite to lower quadrant signal and most of the time it is used in those locations where there is a high density on the routes. How it works is that it has 3 aspects instead of 2 aspects as being used so far in the previous cases and they are horizontal which means it is in on position and it indicates the red light means now the vehicle has to be stopped. It may have inclined position instead of a downward inclined position.

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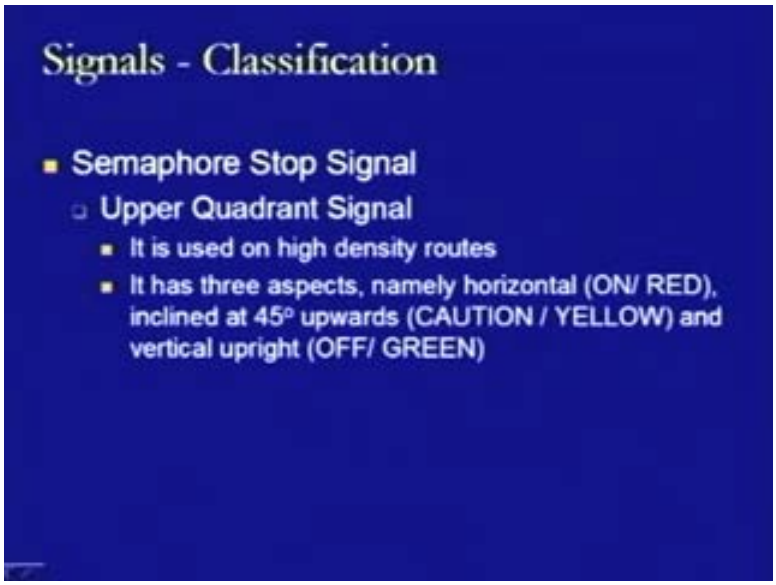

Now in this case of upward quadrant signal it is 45 degree upwards and it indicates caution or in the color aspect system it will be yellow in color. Then there is a third condition which is vertically up right. This vertically up right means this is off condition and it means it is green and the train is allowed to move with same speed with which it is coming. In the case of lower quadrant most of the time we have not provided this vertically downward condition because it becomes just synonymous to the rail post and therefore at times the driver may find

it difficult to understand that this is a problem in this case and that driver will not be knowing where the downward arm of the signal is there and that is why in the case of high density routes it becomes more efficient as compared to the lower quadrant signal.

This is the multi aspect upper quadrant signal being shown that is M A U Q, Multi Aspect Upper Quadrant. So here we have the horizontal condition, we have the inclined upward condition at 45 degrees and vertically upward condition, all the 3 have been shown along with the 3 light conditions, that is, in first case where it is on position it is stop. That is why this is red in color. In the second case it is caution and that is why it is yellow in color and in the third case it is proceed and that is why it is off situation and it is green in color. So that is how this aspect signal will work.

Now, instead of this one if we have lower aspect signal, we assume that this remains vertically downwards then it will become very difficult for the driver to see the position of the arm with respect to the post and that is why this is not provided in this form in the lower quadrant signal system.

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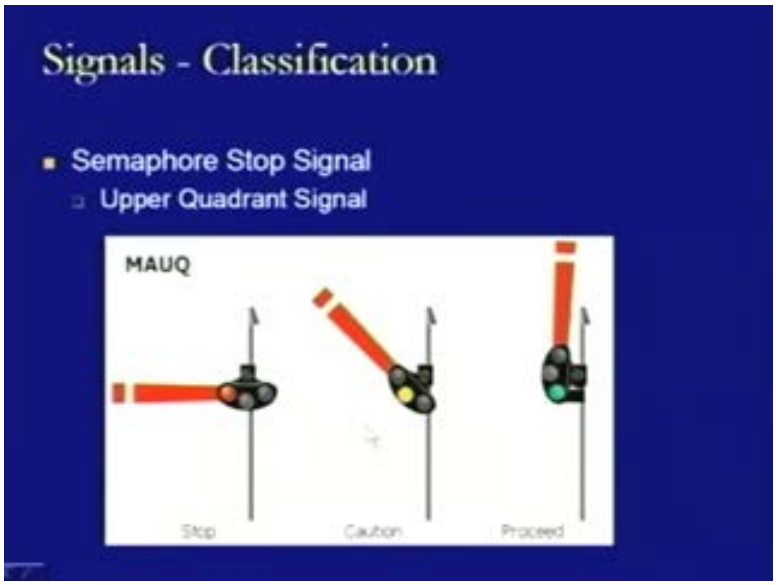

Now, we are looking at some more semaphore type of stop signals in this diagram. These are basically the variants of the semaphore stop signals and this case the first one is defining the goods yard condition, that is, the stop signal which controls the approaches provided to the goods yards. So in that case along with this white band a circle is being provided like this, so this is how it is defined. Whereas the same location where the white band is provided, a d is also provided like this, then it means it is defining the stop signal which is controlling approaches to dogs.

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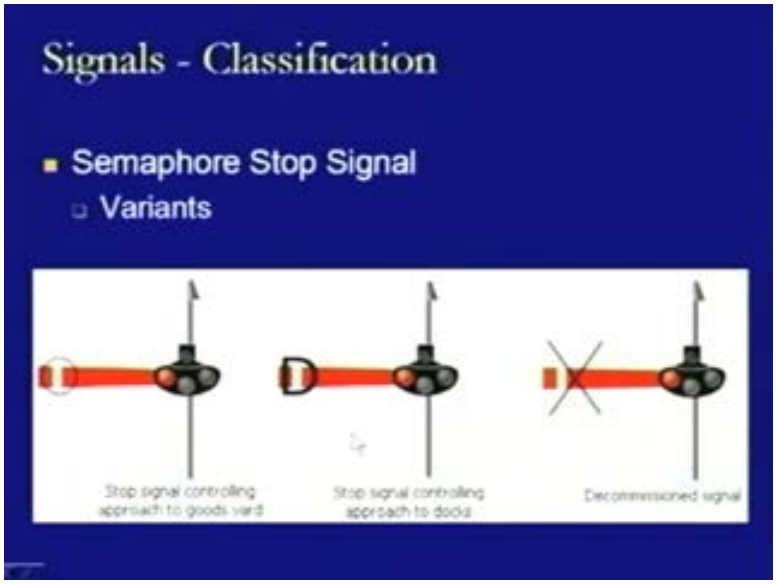

Similarly, at times there may be a big x or a crossing wires being provided alongside this one. It indicates that this signal is no more in use and is decommissioned and driver has not to follow this particular signal. Similarly, we have another variant also available. Some of the important variants are being shown here. This we have already seen in the stop condition with red background is provided with a white band. This is the circular condition. This circular will be having certain thickness which is black in color and this is for goods signals. In the case of locomotive signals L is provided just in front of the white band. So this L is overlapping this white band and this I defines locomotive signals. Locomotives has to follow this one. Then there may be a calling on signal where in the case of calling on signal we have the white background with red band and that is how it is identified that this is calling on a signal. Then there are automatic signals where that we observe is that this is v in shape and then we have band which is again v and here this band is white in color and it is provided with the background as red.

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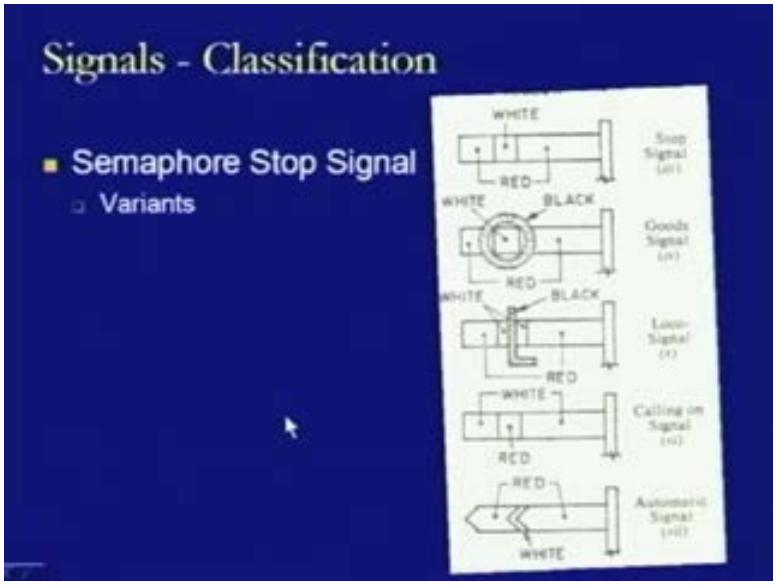

So what we have seen is about the semaphore signals where we are provided with the movable arms. Now, we will be looking at another category of signals which is the fixed signal in nature but they are provided with color aspect conditions, that is, they are provided with the lights which are different colors and still they work as a stop signal. So in this case the semaphore signals are replaced, that is the movable arms are replaced by color aspect signals which are provided on electrified tracks. Most of the time this high intensity color beam is focused at the level of the eye of the driver and this high intensity color is so intense maybe having the wave length in such a way that it is visible even during the day time as well as it is also visible during night.

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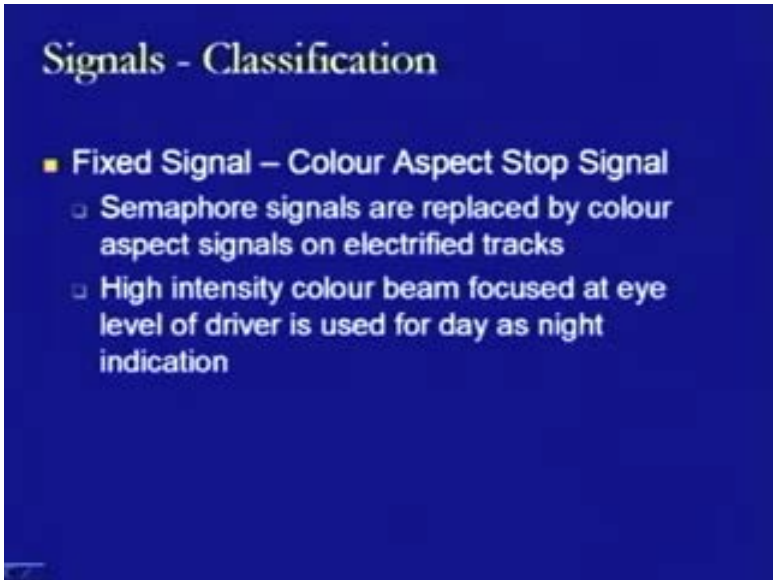

So it provides both indications during day as well as during the night. The normal position of color aspect signal is off, that is, green indicating proceeds. So this is just opposite to what is being given by the semaphore type of signals, some movable arms signals. In the case of movable arm signals, the arm position was defining the normal condition where it was defining the stop or the danger ahead condition. Whereas in the case of color aspect signals the normal position is off, that is, it is defined in terms of a green color indicating proceeds. Unless and until there is a problem, it will not be turned to a red light or if it is being occupied then only it will be turned to the red light, otherwise you are allowed all the time to move on the track.

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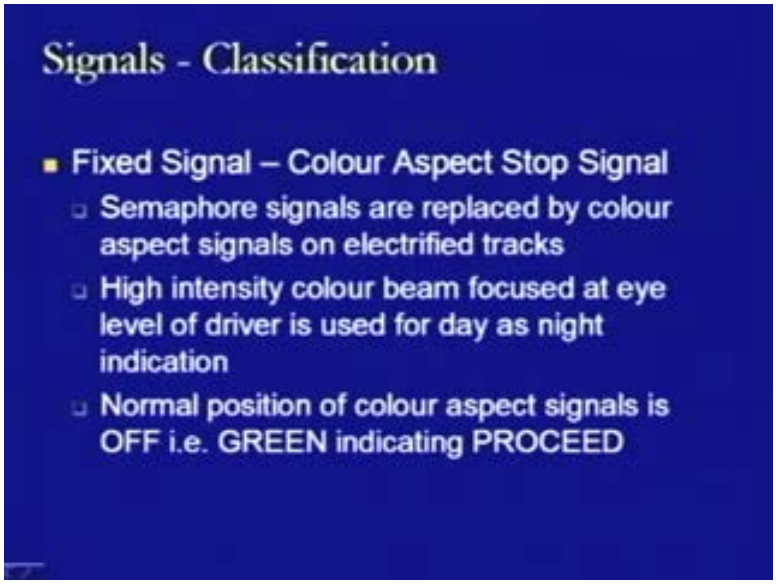

Now, as we are discussing about this color aspect stop signal, what we observe is that as soon as the track is occupied then this color of the color aspect signal will turn from green to red and this indicates the on position and which is defining the stop or danger, that is, now no other train or rolling stock is allowed to take this position or occupy this track unless or until it is made open again that is it is not being occupied the color of the signal will not turned back to green.

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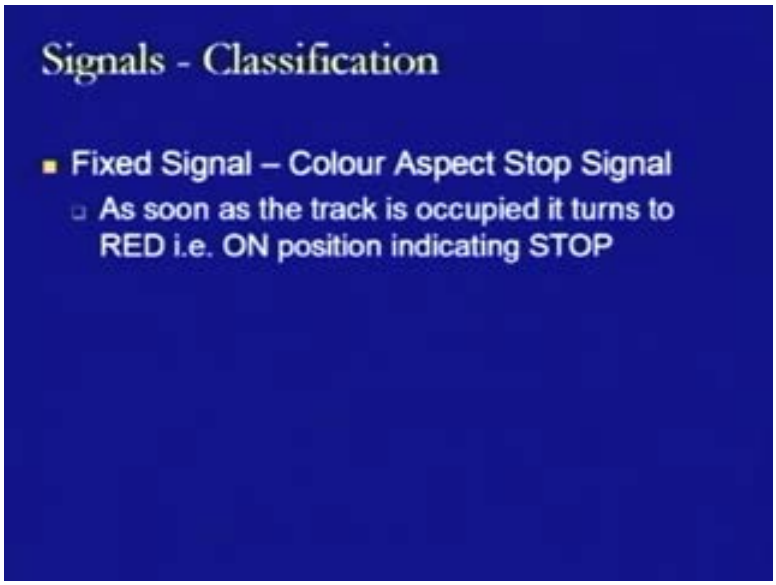

Incase if there is a failure, then it will always show a stop condition, that is, on condition will come by itself. That is the default condition of any such signal because otherwise if it remains in green condition, that is, it allows the traffic to move on and there is a failure then there are chances that accidents will take place. Most of the times this color aspect stop signals are used for locations or section where the traffic is very heavy, the volume is very high or they

are also used for urban and suburban tracks being provided in cities where the local train or metros etcetera are playing.

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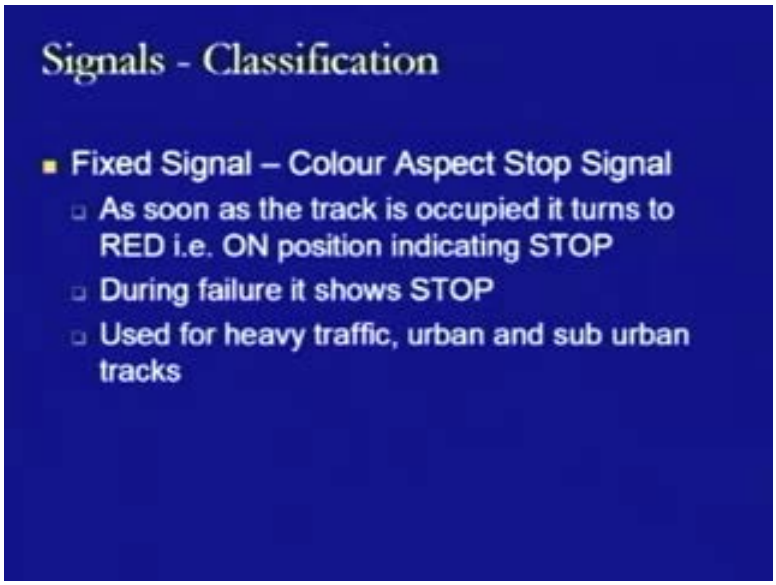

Now this is one diagram which tries to show the fixed signal which is the color aspect stop signal. This is a 3 aspect signal. In this 3 aspect stop signal it is being provided with 3 color conditions, that is, we have the stop condition where the red color is being shown. We have the proceed condition the green color is being shown and there is a third condition in between. Sometimes we find that the signals are just having 2 colors, sometimes 3 colors in that condition, the central color will be yellow color or amber in color and that defines the caution that means if it is there the train has to move at restricted speed till a green color is being provided or the green color comes on the signal.

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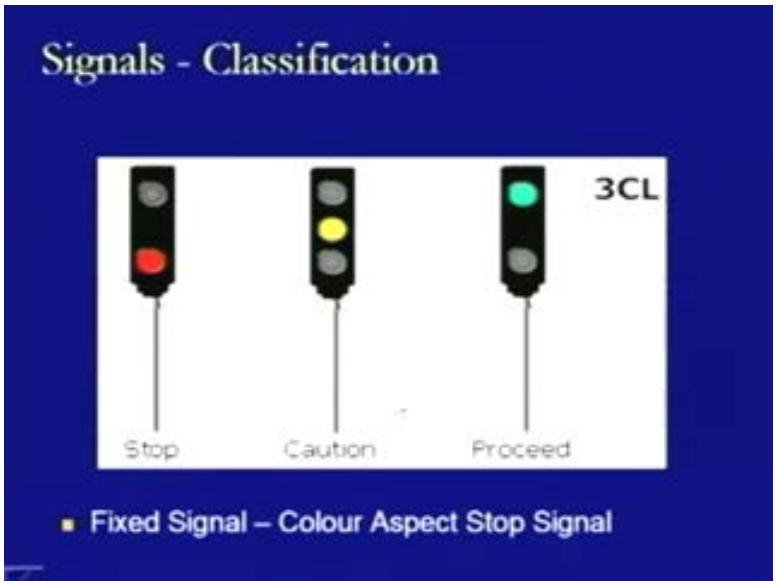

Now, in this case, another diagram which we can see, this is a 2 color aspect signal where as we have seen in the previous case only 2 things have been defined. One is, if it is in stop condition, it shows red light or if it is a proceed condition it is green light. So 2 lights are only being given in this one. So we have a 2 color aspect signal, we have seen a 3 color aspect signal.

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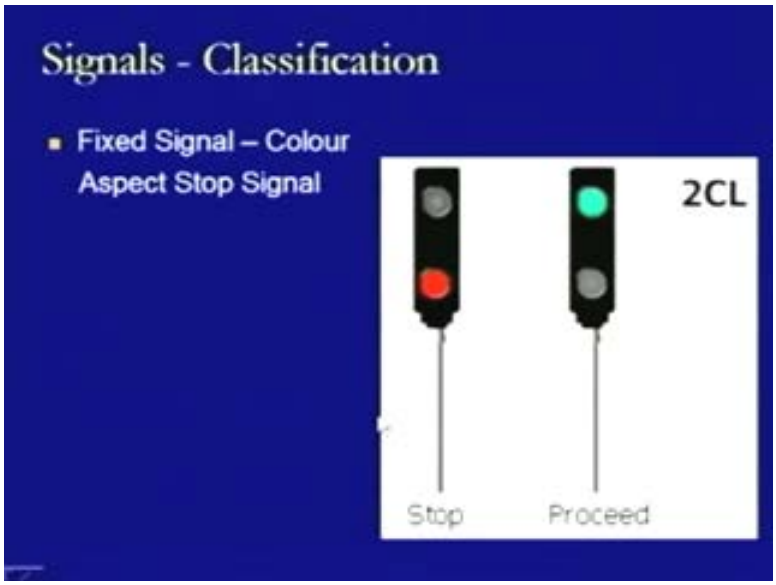

Similarly, we can also have 4 color aspect signal 2. We will be looking at that one. In the case of the 2 color aspect signal it shows either stop or danger that is being shown by a red light and a proceed being shown by a green light or there is a warning which is shown by yellow and proceed by green. This is the 2 combinations which can be there. Either it is in the form of red and green or it is in the form of yellow and green means whatever be the conditions, the number of colors there on that signal post will remain 2. So that is how it is defining. So either it will define a stop or danger condition along with proceed or it will define a warning condition along with proceed.

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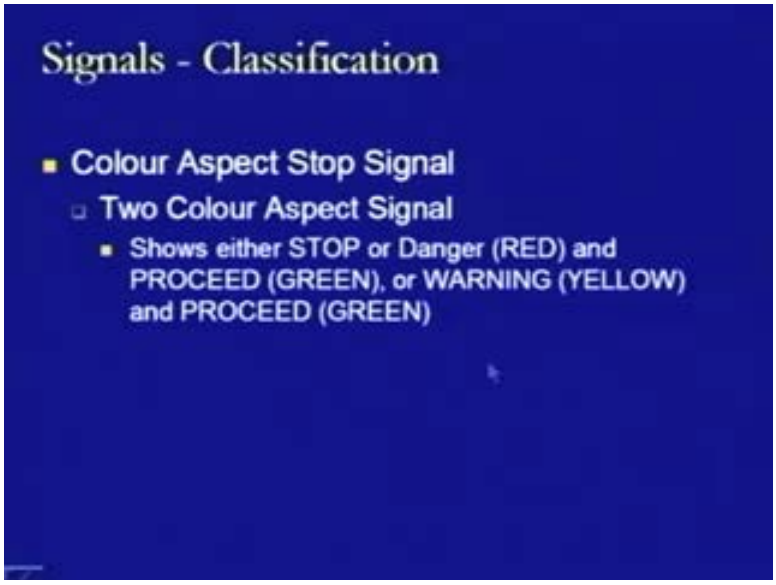

Then in the case of a 3 color aspect signal it uses 3 aspects, that is, the stop condition where it is come as strong here, it is not green, you read it as red here because this is in stop condition, it is red in color and it defines the danger then it means train is not allowed to move on this track because it is already being occupied by some other train or there may be a caution condition where it is going to be defined by yellow in color and there is proceed condition which is defined by green color of the signal that means now the train can move with full speed.

This 3 color aspect signal now a days is more common as compared to the 2 color aspect signal which has been used previously for all those sections where the traffic was not very heavy, but now as the traffic is increasing day by day therefore what is being observed is that there is a need to provide the 3 color aspect signal which are mostly in use in all the locations. Now within this category as I have described previously that there can be a 4 color aspect signal also. Now in the case of 4 color aspect signal, we will be having one color as red another as green and then we have 2 collides which are devoted to yellow and these colors are termed as yellow color and double yellow color. So this is what is the sequence of the red, the yellow, double yellow and green. Red as usual means a stop or danger position, that is, it is in the case of this color aspect signals it is in on position defining stopping. The yellow means warning that means you can pass the signal cautiously and prepared to stop at the next signal unless you are being given a green indication. So this is what is the meaning of the first yellow, that is, it is simple caution that you have to move the signal slowly.

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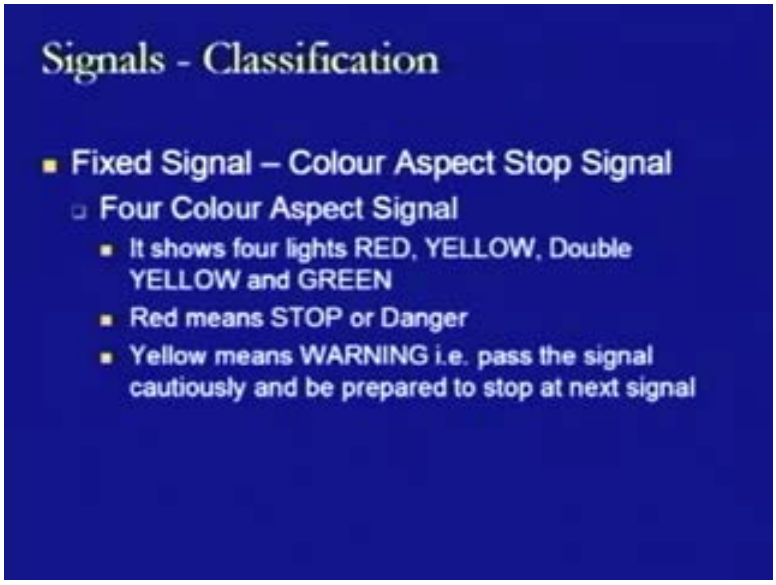

Whereas we have 2 more options in this one, that is, second yellow or double yellow condition and this yellow condition means that you can pass the signal at full speed but be prepared to pass the next signal at cautious speed. So that is the difference between 2. In the first case it was that you can pass this signal cautiously and then you have to look at whether you have to stop at the next signal but when double yellow is there then it means you have to pass with full speed and here and you just check out for the cautious condition which can be there at the next signal. Green again as usual means that the signal can be passed at complete full speed and it is most likely that the next signal will also be green in color allowing the train to move in the next section.

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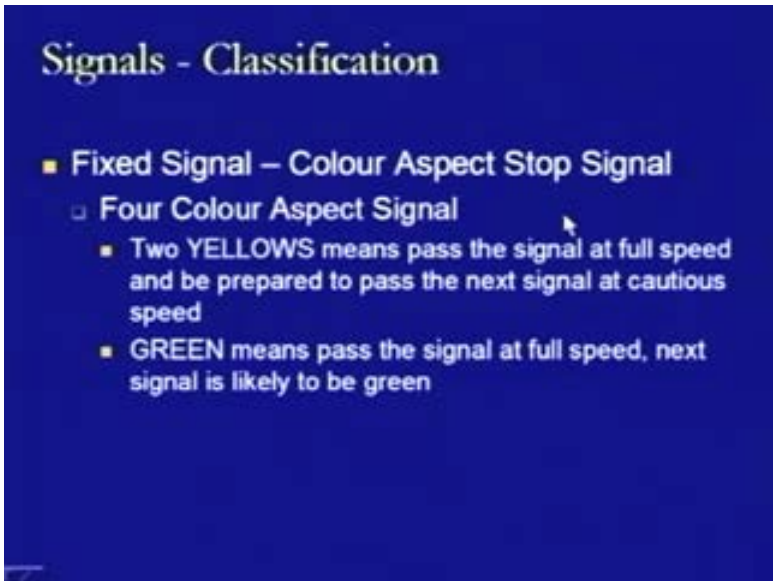

Now, this is how it looks like as we see that this is the 4 color aspect signal. In the case of 4 color aspect signal the sequencing remains like this. This is red, this yellow, this is green and

this is another yellow and we have the 2 yellow working together then that is double yellow condition.

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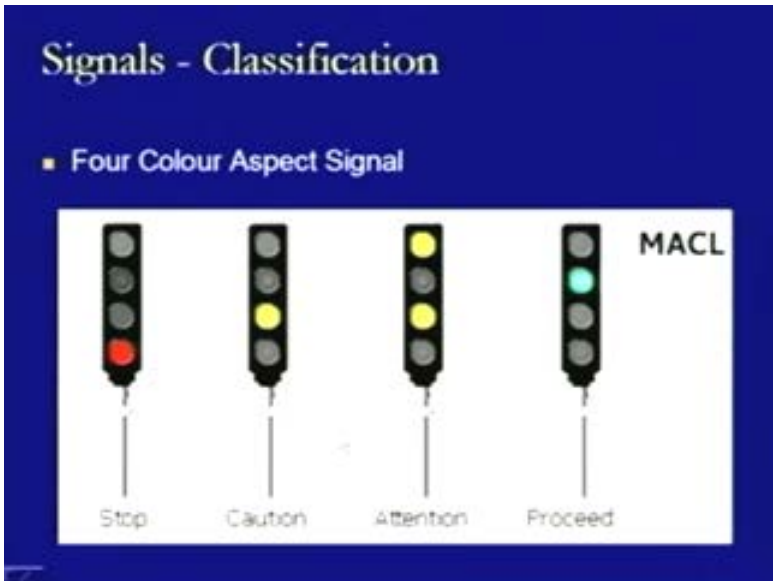

So we have a red means we have a stop condition where the train has to stop completely. This yellow condition means the train has to move with caution and has to looked whether it to be stopped in the next signal. This is a simple attention that you are moving at a high speed and most likely you are going to get a green color on the another one also but just be attention that you have another signal very near and proceed means that it is green color and therefore it is defining that the train is allowed to move at the full speed and at the next signal also you probably will allow to move again with next full speed. So that is how these 4 color aspect signal works and it has an advantage in the form that it tries to indicate the driver about the condition which may be prevalent on the next condition or the section from where the another set of signals will be working

Now we come to another type of fixed signal that is termed as Warner signal. This we have seen this defines the caution of the train movement and in this case it is provided there is some difference in the movable arm which is provided in the Warner signal and this difference is that it is provided with v notch at the free end and with respect to this v notch a v band is provided, that is the difference between this semaphore signal and this one.

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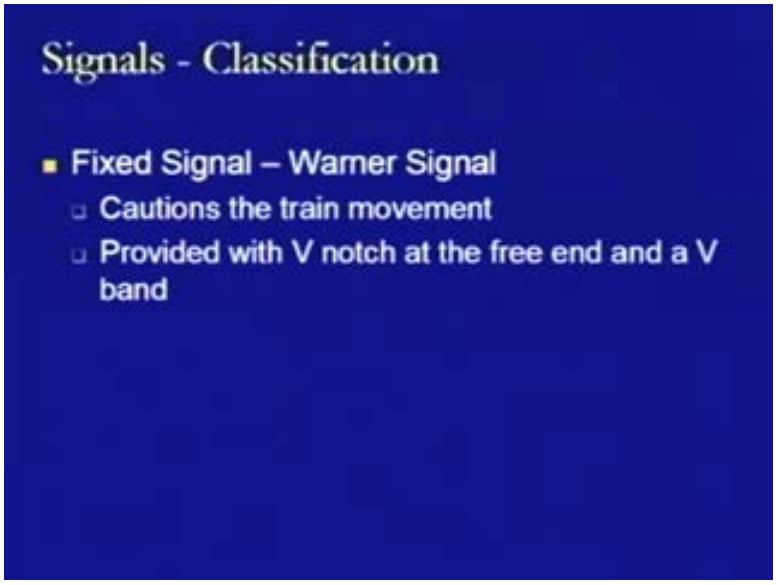

In the case of semaphore signal what we have seen is this was rectangular arm and there was no notch being provided and therefore the band which was provided white in color was also rectangular in section but here at the end it is v and similarly the band is also v. Then the another difference which comes is that in the case of semaphore signal as we have seen it was red background with white band whereas in the Warner signal it is yellow background with white band. So that is another difference between the Warner signal and semaphore signal. Then this type of Warner signal which is trying to define caution can be placed either separately on a post or it can be also be placed in combination with the stop semaphore signal. So these are the ways by which we can do it. It depends what is the requirement where the thing is to be provided and accordingly we can either economize or provide things.

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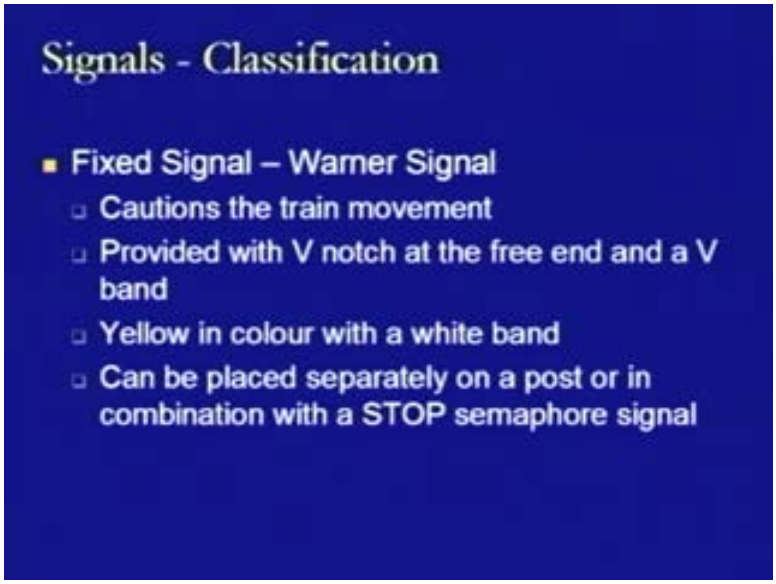

Now, in the same another thing is that if it is provided a tall with stop semaphore signal on the same signal post then it is to be placed at a distance of around 1 point 7 to 2 point 1

meters below the semaphore signals. That is below the center line of the center line of the semaphore signal movable arm, at this much distance we can provide a Warner signal.

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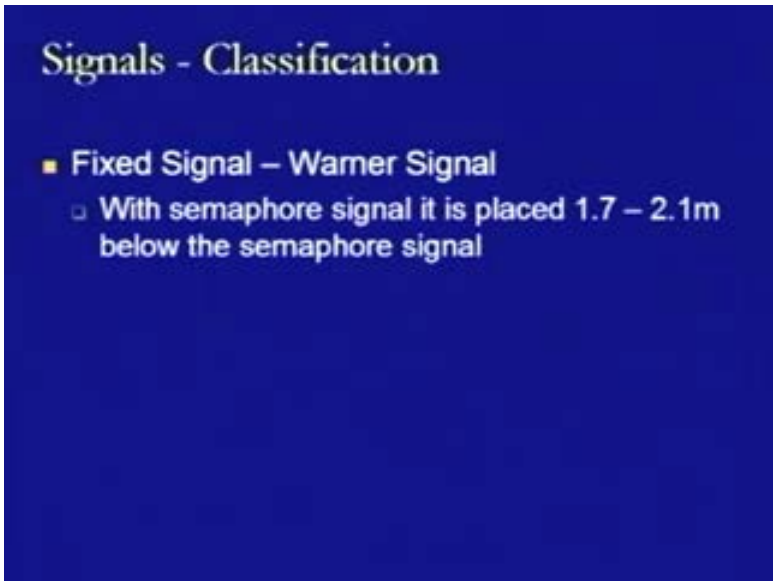

It indicates the yellow color lights and green color light instead of red color light and green color light being given out of semaphore signal. This is a caution signal it is not defining the stopping of the vehicles defining the restriction of the movement of the vehicle in terms of its speed, that is why it is yellow in color or green in color.

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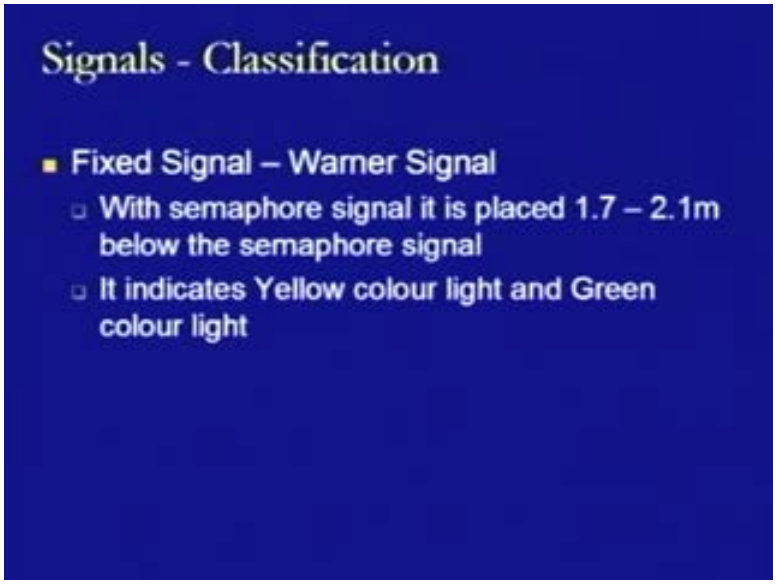

Now, how the indications work that is another important aspect which needs to be understood. This is to be seen in terms of whether the Warner signal is provided on individual signal post or it is being provided in combination with semaphore signal. Now here first of all we are discussing about the condition where the Warner signal is being installed separately on a post and therefore in this condition we have 2 conditions; one is that the Warner arm is

horizontal and it means that it is defining the on position which defines the stop condition or the Warner arm is inclined and it is in off position for it and it means it indicates that the proceeding is being allowed at this signal. As for as the lights are concerned that is the first 2 cases were defined in terms of the movement of all movable arms whereas in the case of light, if the light is yellow then it means it is in on position or stop position whereas if the light is green then it means off position is there that is the train is allowed to proceed with full speed.

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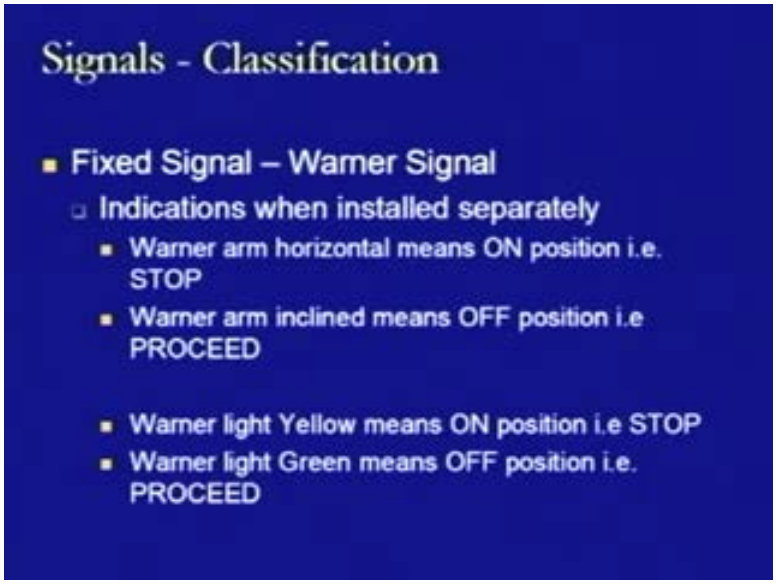

Now, in this diagram we are looking at one of the Warner signals. As being defined Warner signals are provided with yellow background and band which is again as a v notch and at the end it is having a v notch as we can see that v notch is provided here as well as here and it has 2 colored glasses as in the case of semaphore signals and one glass is yellow in color and other glass is green in color and depending on its movement we will be having the movement of these glasses with respect to lamp and we will be having the indication either yellow or green in color defining the caution or the proceed respectively. So that is how these multicolor conditions or lower aspect quadrant signals works.

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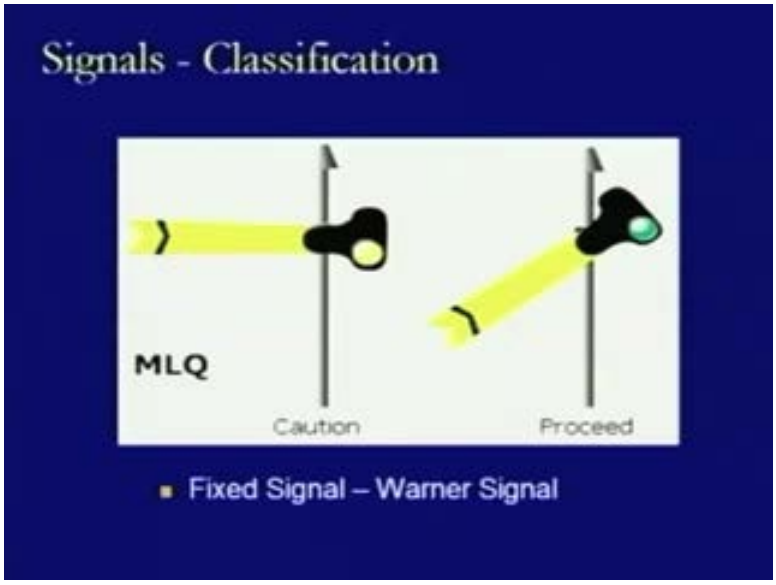

Further, this is a multi aspect upper quadrant Warner signal where it is working in the same way as we have seen previously in the case of semaphore signal but some difference is there in terms of not only the type of the movable arm which we are using but in this case also we are here. Here this is yellow in color and this yellow in color means in the centre not caution but attention here that means it is the change is allowed to move with speed and the only thing is that the driver has to be cautious enough to look at another signal and its definition.

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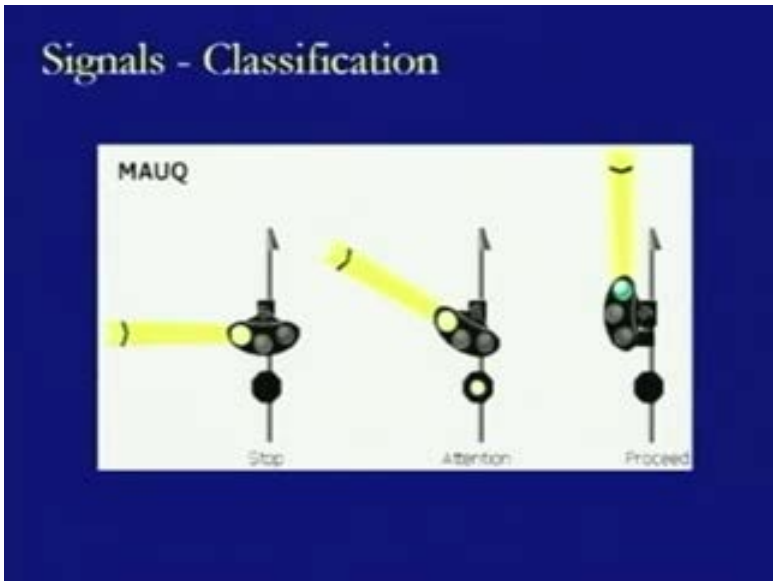

Whereas in the case of what you call it upward condition where it is defined in terms of a green light and it shows proceed so that is some difference in the case of multi aspect upper quadrant signal system in the Warner condition as compared to the semaphore type of the signals. Now further, if we look at this Warner signal where the Warner signal are provided in combination with the stop semaphore signals, that means they are being located at some distance below the movable arm of the semaphore signal as we have seen the distance is 1

point 7 to 2 point 1 meters. So here, number of conditions may happen depending on the position of the movable arms of the Warner signal and semaphore signal together. Now in combination with stop semaphore signal what may happen is that the both arms are horizontal, that is, the semaphore signal movable arm and Warner signal movable arm both are horizontal and it means this is in on position and it defines the stop that is neither approaching nor block section is clear. Means we have the 2 section, one is the section which the train is approaching just ahead of the signal which is to be crossed and another one is the next section which it will be taking up.

In that sense if both the arms are horizontal, it means both the approaching section and another section big block section both are occupied and they are not clear for the movement of the string. Whereas, if the semaphore arm is lowered, it is made down and Warner arm remains horizontal then it indicates that the train can proceed but with caution for the approaching section which is clear but the block section may not be still be clear. So there is some restriction in the speed in this case as the approaching section is cleared the train can move and but then it may probably has to stop to the next signal because it was not clear.

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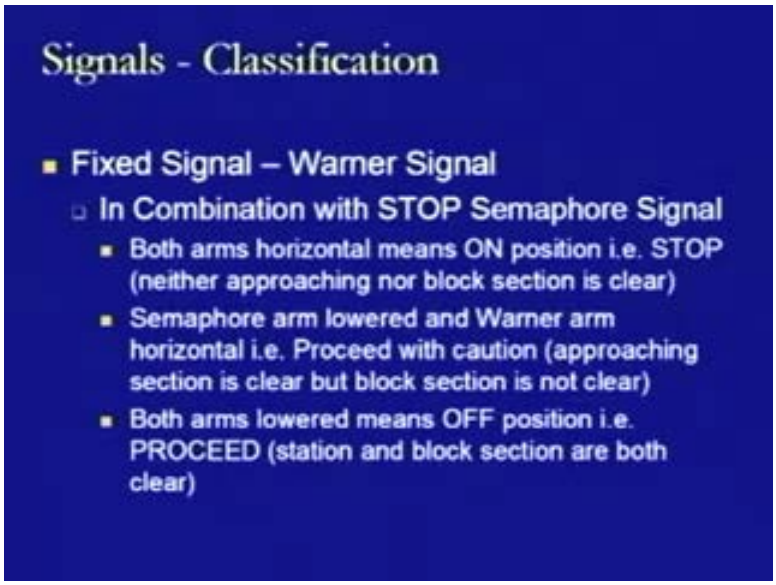

In case both the arms that is arm of the Warner signal and the stop semaphore signal both are lowered then this is defined as the off position and it is the condition where the train is allowed to proceed with full speed and the section ahead as well as the block section both are assumed to be clear. So that is why the train can move with complete speed in this case.

Further, there is a condition where the semaphore and Warner both signals are having light yellow color this is in terms of the light instead of movable arms and it means this is an on position and the stop condition will be there that is neither approaching nor block section is clear. That is the first condition as we have seen in the previous one where both the arms are horizontal. Then semaphore light is green and Warner light is red or its yellow then it means we can proceed with caution, the approaching section is clear but the block section is not clear and semaphore and Warner if both the lights are green then it means it is off position that is it allows the proceeding and stations and block sections are both clear. That is way

how we define the combination of different conditions as being shown here in this diagram also.

So we have the Warner signal, the fixed signal, the first condition where we have the 2 movable arms, this is for semaphore signal this is v notch arm which is for Warner signal, this is yellow in color, this is red in color and when both are horizontal it means stop condition. Whereas if this semaphore signal is lowered that it is showing a green light whereas this Warner is horizontal showing the yellow light then it is a cautious condition means you can move with caution but the next section is going to be occupied. Then there is a third condition where both the arms are downwards and that means both are showing green light and in this condition we can move with the same speed as we are moving and another section is also going to be on, that is, we can move it on that section too.

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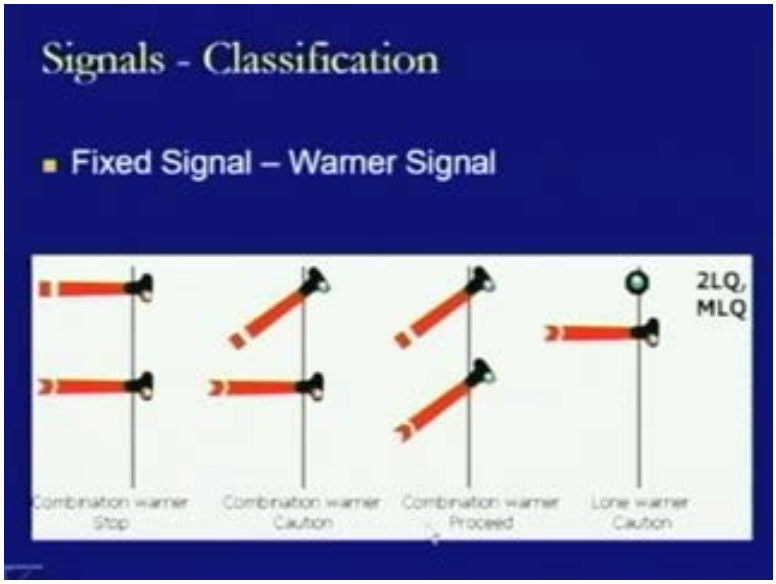

So this is the case when we are having the combination of the Warner with semaphore signal on the same post but there are conditions where this is provided in this form that is this is the green light in the top and there is lone Warner which is provided like this and then it tries to define portion if it goes down then it defines the proceed. So that is the combination with the stop semaphore signals. So this is what we have discussed. We have tried to see the 2 types of classifications of signals, that is, one which was based on the operational characteristics and another which was based on functional characteristics. In the case of operational characteristics we have seen that how the 2 signals are operated may be it is in the form of detonators and may be in the form of signals which are made to be visible to be looked by eye. In the case of the function we have the hand operated signals and the fixed signals and in the case of hand operated signals we have seen that it may be in the form of flag, it may be in the form of light or it may be in the form of the hand indication.

Similarly, in the case of fixed signal what we have seen is that the signals can be divided into 2 parts. The Stop category of signals which are termed as semaphore signals and Warner category of signals that is signals which tries to caution. So in the case of this fixed category we have seen that we have the Warner signal and we have the semaphore type of stop signals and then these 2 type of signals can also be used in combination with each other in locations

where there is a heavy density or heavy traffic which is moving. So this is 2 types of categories of the classifications of the signals. The 2 other classifications of the signals, that is based on their locational characteristics and based on their special characteristics will be discussed in the coming lecture. Till then we stop at this point and I say thank you to you and good bye