

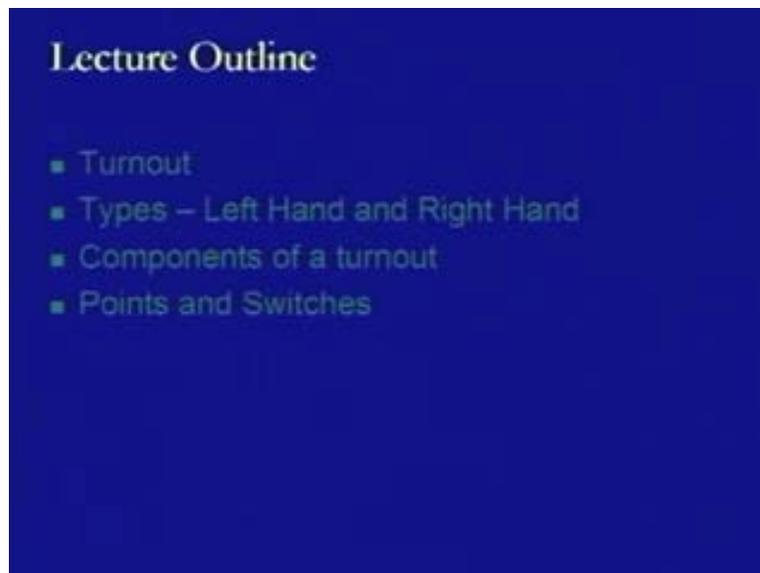
Transportation Engineering - II
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Lecture - 19
Turnouts - Components

Dear students, I welcome you back to the lectures in the course series of Transportation Engineering – II. In this course series, we have already covered a lot many aspects on railway track. In the previous some 3 or 4 lectures, we have been discussing about the geometrics of railway tracks, where we have discussed about the horizontal profile and the vertical profile of railway track. In today's lecture and 2 or 3 lectures more to come we will be discussing about another specific aspect of railway tracks that is turnouts. The turnouts will be divided in three forms. That is we will be looking at the components, we will be looking at the different type of crossings and we will also look at the various types of designs which needs to done related to the turnouts and the crossings.

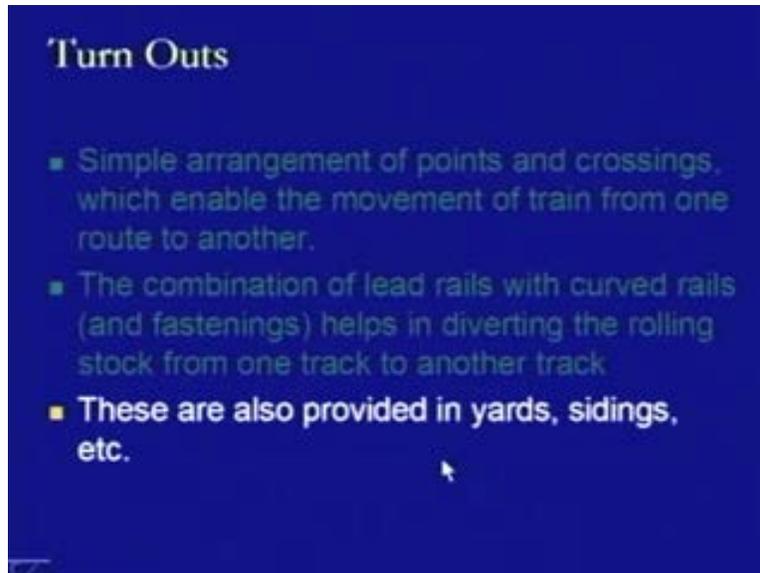
In today's lecture it is being outlined with the following.

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We will be discussing about turnout, we will discuss about the different types of the turnouts that is the left hand turnout and the right hand turnout and we will be discussing about the various components of a turnout and another thing is that we will discussing about the points and switches related to turnouts.

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Starting with turnouts, the turnouts can be defined as simple arrangement of points and crossings which enable the movement of train from one route to another. This is a condition where we are interested in changing the direction of a track. In the previous design features which we have discussed in the geometrics, what we have discussed is there is a single track which is moving in a horizontal or vertical profile and therefore, we have tried to design that.

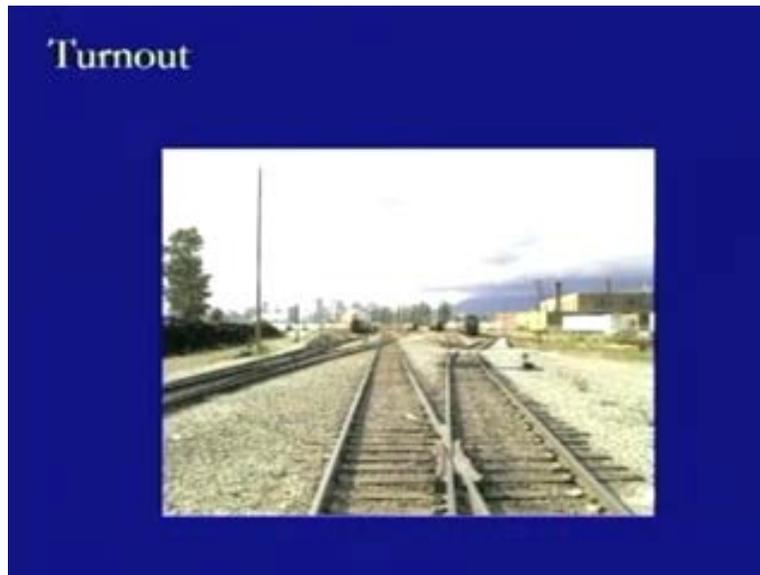
Now, in today's lecture what we are discussing is that there are two tracks which are either merging or diverging from each other or there may be some tracks which are moving parallel to each other and still they are being connected with each other. This connection between the two tracks or the merging or the diverging of the two tracks from each other helps in changing the direction of a train and this is done or this is achieved by

using the two types of systems. One is the points, another one is the crossings and when you use this points and crossings together, then what we get is nothing but turnout.

The combination of lead rails with curved rails and fastenings helps in diverting the rolling stock from one track to another track. This is another part of the definition which tries to define that what type of main components will be there **in a** layout and turnout. In this case what we are discussing, what we are trying to dwell is that there are different type of rails depending on their straightness or their curvature. If the rails are straight then they are termed as lead rails, whereas if they are having a curvature then they are termed as curved rails and obviously, whatever rails are provided and they are provided over the sleepers, so fastenings have to be there and this combination of the lead rails which are the straight rails, when they are joined with curved rails they help in diverting the rolling stock from one track to another track.

These are also provided in yards, sidings, etc. That is an obvious reason because, in the case of yards and sidings their main function is that we have to take the trains away as soon as they have completed their operation that is their journey is over and they have reached the terminal points. So, they are taken to the yards where they are just kept as storage or they are also formed into the new train using the different cabins and compartments which are available in the sidings of the yards and then that new train is brought to the platform for further operation. So, in that sense, there are different operations which are going on and due to which the directions have to be changed and this is why the turnouts are also required in yards, sidings or the similar sort of conditions.

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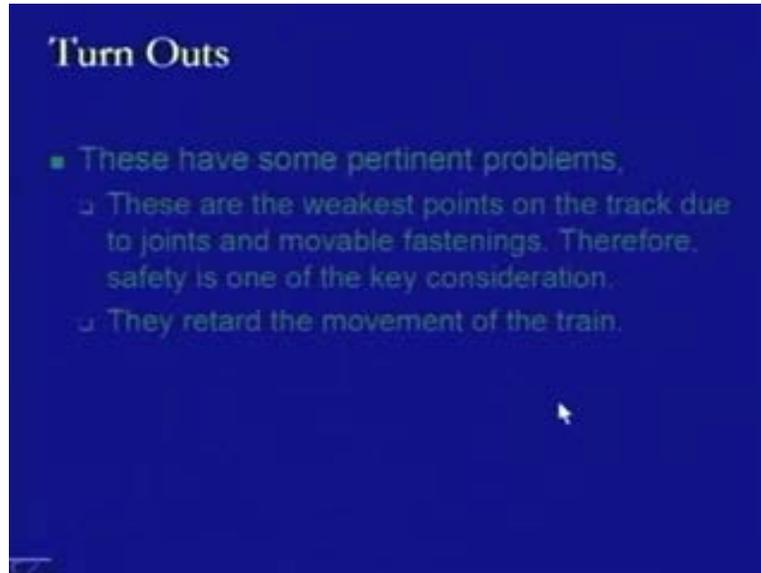
Now, we look at this diagram. This is a diagram which is having different tracks like we can see there are some tracks which are coming from this side. Then, there are two tracks which are coming from this side and these tracks are going further here and again there are some diversions or straight movements and there is again, this is merging of the two tracks. Then, this track is coming from this side and this track is going from this side and they two are merging here and then they are again diverging and going in this direction.

Similarly, there is a diversion at this point and the track is going this way and we find there are some cabins which are standing at this location. So, this may be side or sidings of the yards on any station. Now, in this case if the train is coming from this direction, then this is one condition which is being provided here, which is known as crossing, so as to take a turn and go and use this particular track instead of this track, depending on the requirements. So, this is a combination.

This type of a combination along with another combination which is provided on another side, like here also we can see that this is a straight line and then there is a curved line being provided on this direction. So, using this straight line and curved line, here we are trying to divert a train, which can go in this direction or otherwise which can also go in

the straight direction like this. So, we are interested in designing this part of the track and this is what we will be looking in this lecture as well as in the coming lectures.

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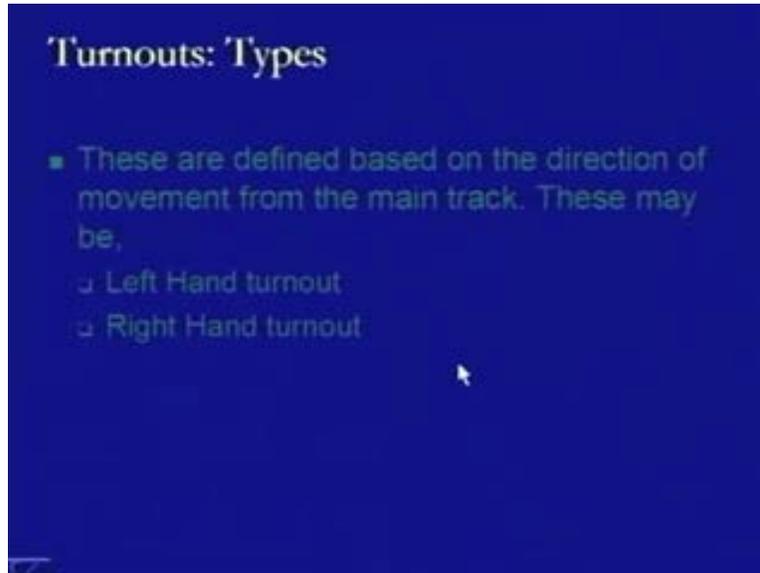


But, when you are talking about these turnouts, obviously there remain some of the problems. So, we look at those problems, right now. These are the weakest points on the track due to joints and movable fastenings. We have already discussed about the joints, we have also discussed about the fastenings. Wherever there is connectivity, that connectivity becomes the weakest point, because there is no support available at that location other than the fastenings being provided, so as to connect the two components of the track. So, it means wherever the turnout has been provided that turnout point location becomes the weakest point on the track and in such condition, the safety becomes the main consideration of the design.

So, we have to look at that while making a turn from one track to another track, there should not be any derailment or there should not be any overriding of the rails at that particular location. So, this is one of the aspects which need to be taken care of. Then, they also retard the movement of the train. This is another aspect, because at this point, the train has to reduce its speed. So, when the speed is being reduced, therefore the

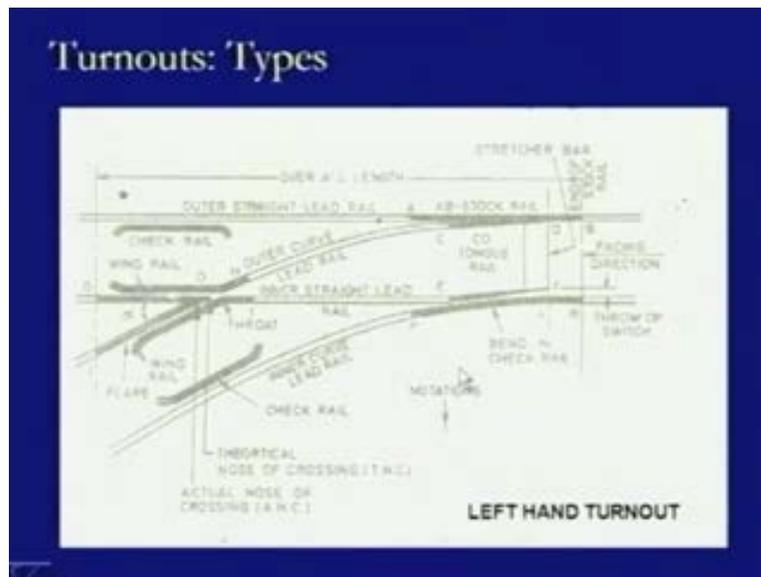
overall movement of the train has reduced and it takes a little longer time depending on the number of locations where the turnouts or the crossings have been provided.

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Now, we come to the various types of the turnouts. As we have just seen in the case of the layout, there are two types of turnouts which we will be looking at, the left hand turnout and the right hand turnout. But, how they are going to define whether it is a left hand turnout or it is a right hand turnout, these are defined based on the direction of movement from the main track and on the basis of that movement, it can be a left hand turnout or it can be a right hand turnout. So, we will be looking at that how on the basis of this directional movement from the main track, we can find out whether it is left hand or a right hand turnout.

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Now, this is one diagram which is trying to show the overall composition of the points and the crossings which constitute any turnout. Now in this case, all the components can be seen very clearly. What we see is that this is the rail which is provided. So, what will be happening is that so there is one track which is being laid like this. These are the two rails of the track which are being laid like this and then, there is a requirement of changing the direction from this track in this direction. So, there is another track which is being laid and here in this portion there is an overlapping of the two tracks. So, we are trying to facilitate the change in the direction by using certain features which have been provided along this one.

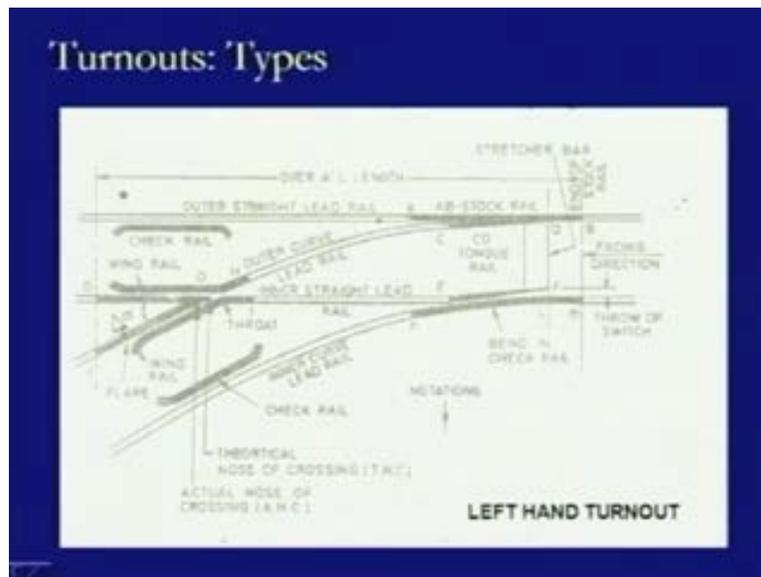
So, what we can see is that it is a combination. As we have discussed in the definition itself it is the combination of the lead rails and the curved rails. Because this is a straight portion, so there is a lead rail on this side. Similarly, this is also a straight portion. So, there is another lead rail on this side. At the same time, there is a curved section here and the curved section here, so these are the curved lead rails. These are the straight lead rails and these are the curved lead rails.

Now, if we are coming from this side, then this becomes the outer side of the turnout. So, therefore this is known as outer straight lead rail and this is known as inner straight lead rail. Whereas, if again looking from the same direction if we look at this one, this is termed as the outer curved lead rail, whereas this one is termed as the inner curved lead rail. So, this is how we are distinguishing between the straight and the curved lead rails as well as within the straight and the curved lead rails respectively.

Now, this portion is termed as points. These are the points and the switches being located here, whereas this portion is known as crossing, because the two tracks are crossing each other at this location. So, if we look at this crossing first of all, what we find is that there are two rails which are coming like this and they have been joined together in this form. This is what is being done here and then this curved rail which is coming from this direction is made parallel to this straight lead rail. So, this is being made parallel like this and then it is flared towards the outer side like this. Similarly, on the other side also it is coming this way and then it is made parallel to this one and then, again it is being flared like this. So, this is what is written that this is a flare and this is also a flare on this side and these two rails which have been made first of all parallel and then being flared, they are known as wing rails.

So, these are wing rails, one on this side, one on this side. So, there is one pair of wing rail provided on the crossing. Just opposite to this wing rail, there is another type of a rail being provided on the other side of the rail section and the inside of that rail section which is parallel to that one and is flared on the two ends. So, this is another type of rail; this is one and this is one being provided on this side and this is known as check rail. So, this is another component - the wing rails and the check rails being provided on the crossing of the turnout.

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Then, this is an angle alpha which is defined here in terms of the angle which is being made by this one inner straight lead rail and another inner straight lead rail of the curved section here. So, this is the angle alpha being defined here. This is also known as angle of crossing. We will be looking at that what is angle of crossing, how it is defined and the two rails which have been joined here, again they are of specific nature and at this location where they are being connected with each other, what we have find is there are two types of noses. One is the theoretical nose of crossing and another one is the actual nose of crossing. So, we will look at that what is this theoretical nose and what is this actual nose, we will discuss further. But just for a moment, what we are interested in to look that what are the different terminologies which are associated with any of the turnout.

Now, similarly when you come towards the points or the cross in this side, what we are looking is that there is one rail section like this, where there is some band in the rail section. Similarly, there is one rail section which is provided on this side like this, the straight portion and this is known as the stock rail. So, they have the stock rail here, we have another stock rail here. Then, there is a rail section. Up to this portion it is curved and then after, it becomes straight. So, there is one rail section which is being formed

straight like this and this is another rail section which we can see is a straight rail section and this is having a thickness equal to the ... rail section, as been shown here.

The thickness here means this is the thickness of the rail head. So, it is having the same thickness at this point, but as we go further it becomes tapered and has a very small, lesser thickness at the point, end point. So, this pair of rails, this is known as tongue rail. So, in this direct side, what we are having, we are having a combination of a pair of stock rails and a pair of tongue rails and these two tongue rails which are being provided on the two, either side of the rail sections like this one, they are connected with each other.

So, these are the bars by which they have been connected with each other and these bars are known as stretcher bars. So, this is what is being shown this way. Then, there is some distance at which this tongue rail will remain. So, this is the distance at which the tongue rail is and this is known as throw of switch, because this is what is the switch location. So, this is, we are operating this switch so as to move these tongue rails to this direction or to this direction, depending in which direction the trains have to be moved. So, this is the distance by which it is moving and this distance by which it is moving is known as throw of switch.

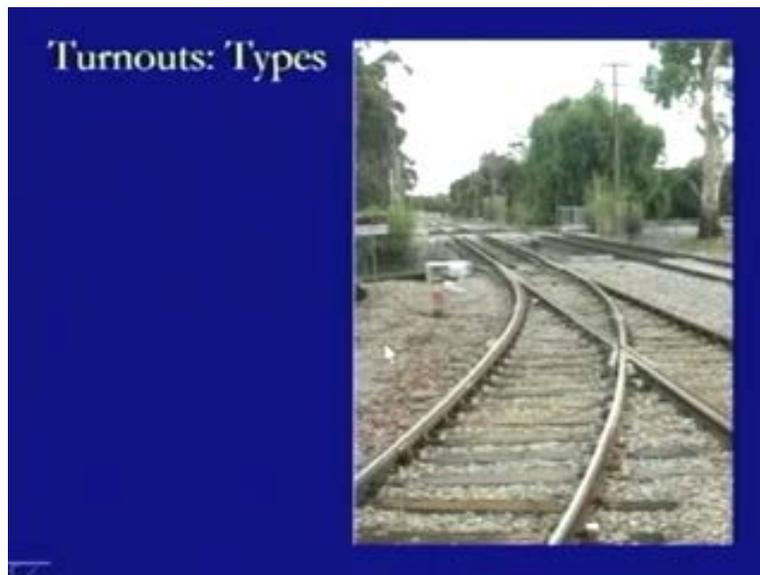
Similarly, when we come back to this crossing side, what we find is that there is some distance which is being left here and this distance which is being left here in this location between the two sections and because of the blankness of the connectivity of these two rail sections, what we find is that some gap is being maintained and this gap is known as the **throat** of crossing. So, this is another terminology which we are using, the throat of crossing and another thing is that these two rails which have been joined here, they are the point rail and the slice rail and how we differentiate between a point rail and a slice rail, we will be looking further when we take up another definition of those one and here this is the facing direction.

Facing direction is being taken with respect to this track, where we are standing on the points and we are looking towards the crossing. On the basis of this one, then the facing

direction is defined. Whereas, if you are standing on the crossing and we are looking towards the points, so these are the points and this is the crossing; so, if you are standing here and looking towards this one, then it is known as trailing direction. So, this is facing direction and this way it will be trailing direction. Then, further starting from this point this is the ... of our crossing to this point. That is the last point of the points that is the end of the stock rail where we are having, so this is the overall length of the turnout.

So, this is what is to be designed. When we take the design we have to design the curved rails, we have to design the straight rails, we have to design the overall length of this section, we have to design for how much distance this needs to be curved and then for how much distance these have to be provided, what is angle alpha and there is also one angle at this side that is beta. So, what is that angle beta? So, likewise the design has to be done for this.

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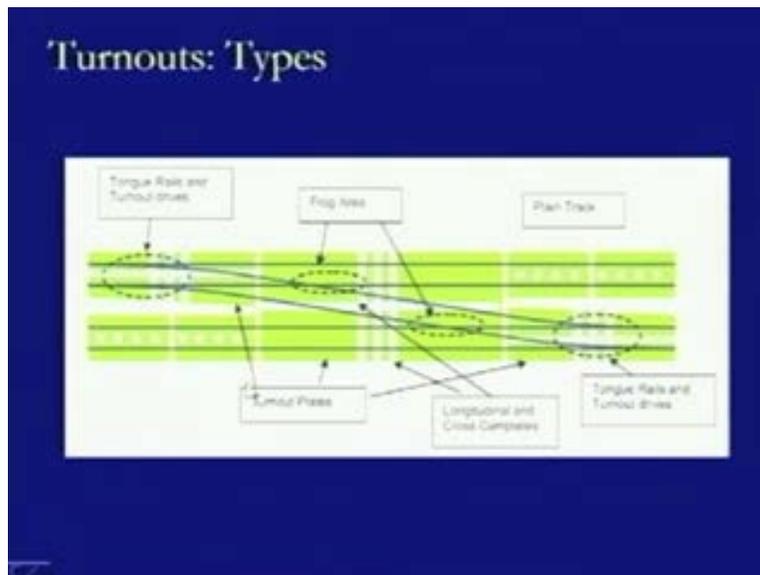


This is another diagram, another picture basically of a track which is taken and here we are again trying to show you that there is a one straight track and from this straight track we are providing a flexibility, so as to take a turn like this. So, it means we are providing a crossing at this location. So, this is what we can see. There is a crossing, we have a

point and splice rail provided here. This is a wing rail being provided on this side, this is a wing rail provided on this side, this is the curved section, this is the straight section, this is another curved section here. So, we have the inner or outer curved section. We have the inner or outer straight lead rails and then, on this side we are providing the extra safety features here, in the form of may be the check rails.

So, if you are standing at the location of the point, the points will be provided on this location and if you are looking towards the crossing, then this is the facing direction here and on the basis of that facing direction we can define whether it is a left hand turnout or a right hand turnout. In this case, when we are standing here and looking in this direction, then this track is turning in the right hand direction. So, if it is turning in the right hand direction when you are looking in the facing direction, it is termed as right hand turnout, whereas if it is taking a turn like this, then this will be a left hand turnout.

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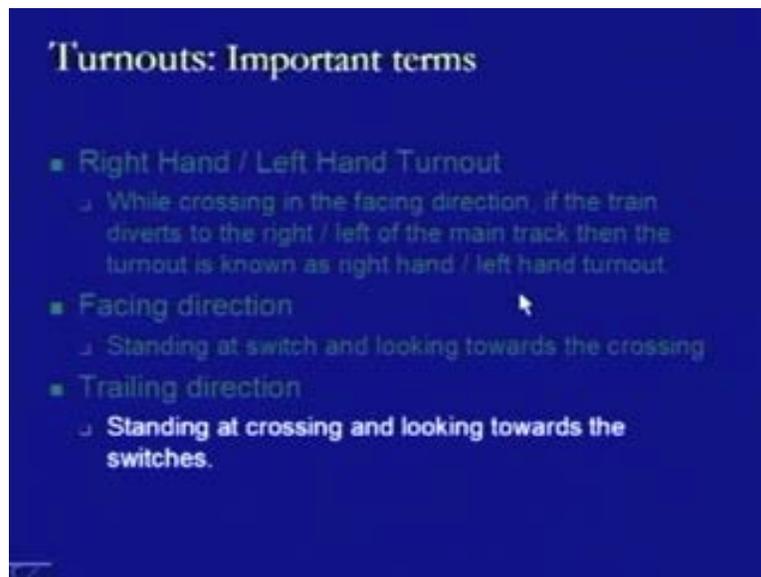


In the similar form, this diagram also is trying to show you that what are the things which need to be discussed or designed, when a turnout is planned or designed. Here, this is one track and this is another track and we are trying, we are providing a flexibility so as to take a turn from this track and come to this track or if you are coming from this side we

can come this way and go to another track like this. In this sequence, we will be designing the tongue rails and the turnout devices or the points or the switches at this location. Then, we will be designing this crossing area, which is also known as frog area. That is based on the type of the designing we are having, frog is a distance or gap which is being provided. Similarly, if we are coming from this side, then we have this points or switches in the form of tongue rails or the stock rails and then, here also again we have the frog area. So, this is how the things need to be designed.

So, now we come to the various important terms which needs to be discussed, which we should know before designing any turnout.

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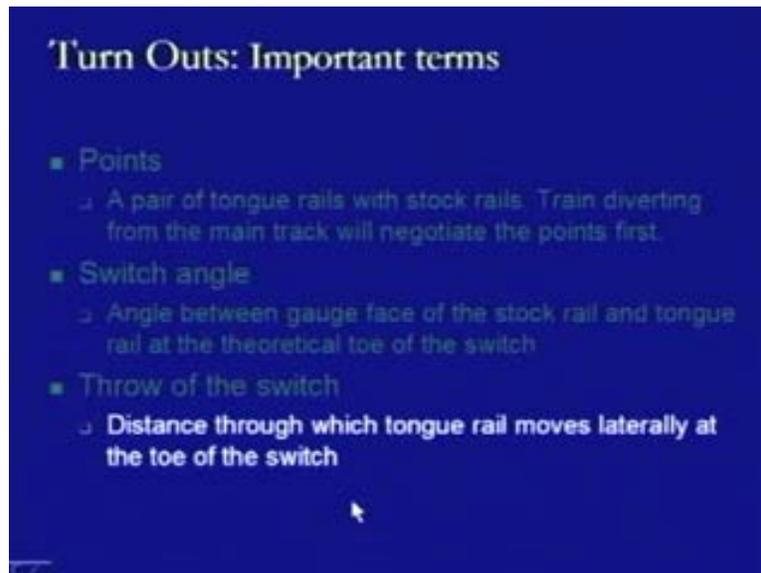


The very first thing is that what type of turnout we are designing, whether we are designing a right hand turnout or a left hand turnout. Now, I have already defined that how we can try and we can find out what is a right hand turnout or a left hand turnout. The same is being defined here that while crossing in the facing direction if the train diverts to the right or to the left of the main track, then the turnout is known as right hand or left hand turnout respectively. That is if you are standing in the facing direction and crossing in the facing direction that is what we have seen that we are standing on the

points and looking towards the crossing, then if the train diverts to the right, then it is termed as right hand turnout and if it diverts to the left of the main track then it is termed as left hand turnout.

Now, what is facing direction? The facing direction is standing at switch and looking towards the crossing. So, this direction is known as facing direction. So, just stand on the points or the switches, look towards the crossing. Similarly, in opposite form we can define the trailing direction. The trailing direction is standing at crossing and looking towards the switches. So, means now you just stand where the two tracks are crossing each other and look towards that direction from where the change of direction is provided, then that will become the trailing direction. Then points; points is the pair of tongue rails with the stock rails.

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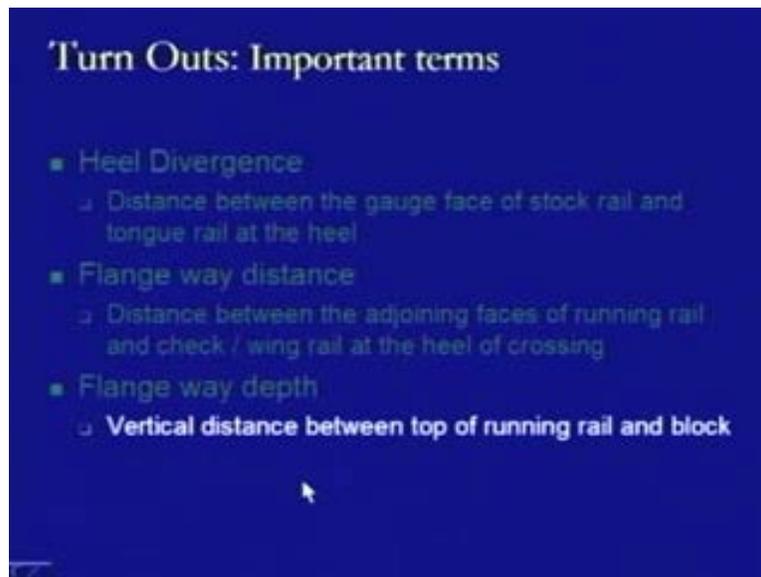
The trains diverting from the main track will negotiate the points first. So, this is what we have seen also. If a train is coming from the main track from the facing direction, then it will be first of all crossing the points and then only it will be coming to the crossing. So, that is why this is the first device or a family of devices which is used or operated for changing the direction of a train and as I have told previously while we were looking at

the diagram where the different components were shown, it is combination of pair of tongue rails and the stock rails.

Then, there is a switch angle. The switch angle is the angle between the gauge face of the stock rail and tongue rail at the theoretical toe of the switch. So, wherever the tongue rail and the stock rail they are meeting with each other, that is where, at that particular location if you try to make an angle between the gauge face of the stock rail and the tongue rail, then whatever that angle is coming that is what is termed as the theoretical what is known as the switch angle. We have looked at that diagram where there was a stock rail like this and one tapered section of the rail section was coming and joining it. So, this angle between the straight lead rail and this slanting rail is known as the switching angle. Then, throw of the switch; throw of the switch is the distance through which the tongue rail moves laterally at the toe of the switch.

We have seen that there is a possibility or the tongue rails are being joined together using certain bars and with the help of that bars, the set of tongue rails can be moved either in this direction or in this direction, if this is the straight track. So, in that sense, there will be some gap which will be left between the main track and the tongue rail at one of the locations, whereas at the other location, other side of this one, there will not be any gap. So, the point where the gap is there, whatever that distance will remain that is known as the throw of the switch.

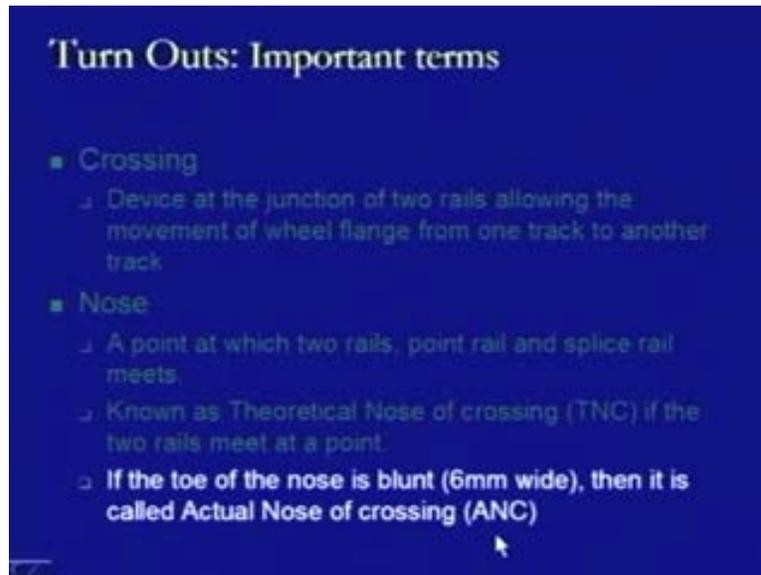
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Then, there is another terminology that is heel divergence. Heel divergence is the distance between the gauge face of stock rail and tongue rail at the heel. So, we have the stock rail and we have the tongue rail and at the heel location where the tongue rail is having the thickness equal to the thickness of the rail section, so that is what is termed as the heel divergence. Now, this flange way distance is defined as the distance between the adjoining faces of running rail and check rail or the wing rail at the heel of the crossing. So, at the heel of the crossing what we are trying, we are providing is that there is a combination of the check rail and the wing rails, may be on the location where there is crossing or if we look at the farther end, then whatever distance is being provided between the running rail and between the face of this wing rail or a check rail that is what is termed as the flange way distance.

Then, another thing is the flange way depth. This flange way depth is the vertical distance between the top of the running rail; whatever is the running rail is being there, just from the top of the head of that running rail and we are taking it up to the block. There is a block which is provided between the check rail and the running rail, so that these two remains attached with each other at the heel location. So, up to the top of that heel whatever depth is being provided that is what is a flange way depth.

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Then crossing; crossing is the device at the junction of the two rails along the movement of wheel flange from one track to another track. So, if we are interested in moving from one side to another side, then this is the device which will allow us to do so. Whereas, if there is a nose, nose is a point at which two rails that is point rail and splice rail meets and this point is termed as nose. Now, it is termed as the theoretical nose of crossing if the two rails meet at a point.

What happens is that when we are taking these two rails and they are going in the forward direction at an angle, so we are trying to make them taper or **overall** assembly is becoming tapered, but the two rails that is the point rail and the splice rail, they may be having the same thickness as being provided initially in the normal conditions. Now, one of these rails have to be tapered, so that it can accommodate another rail and still we can have a tapered section at the end. So, if it is going in the same tapered form and finally there is one point remains at which the two rail sections are supposed to be meeting, then that is what is known as a theoretical nose of crossing. Whereas, if the toe of the nose is blunt, it is say 6 mm wide, then it is called the actual nose of crossing and this actual nose of crossing means, like what will happen is that we are not making it totally pointed condition.

The reason behind is that whatever the loads are coming, due to those loads it may happen that it may break down. So, what we have to do is that we have to provide that sufficient thickness at the end which can take the loads or the impacts which are coming from the trains. So, that is the one reason why it is provided as a 6 mm wide thing.

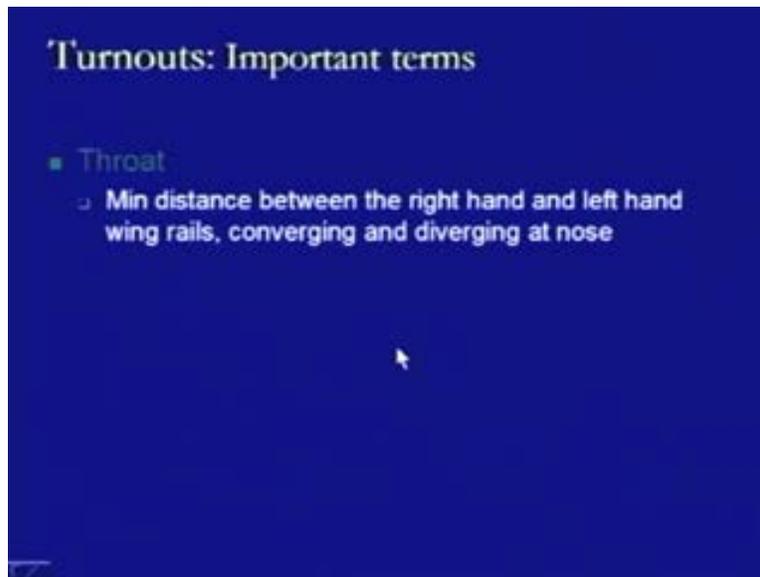
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Then, in this one, we are trying to show some of the things like this is one curved section or a straight section and here we have one rail and this is another rail. These are being joined together. One of these is a point rail and another is a splice rail. Now, this point rail and splice rail, they have been connected together and they have been formed into the form of this V section; we can see this v. Now, if this V section is coming up to the end and this is a very pointed condition, then in that case there are all chances that that point may cut down. So, what we do is that we are providing it having a thickness of 6 mm at this end. So, the distance between this 6 mm location, this point is known as the actual nose of crossing, whereas the point up to which it is going as a pointed form finally, is known as the theoretical nose of crossing. So, this is how the differentiation is there between the two things.

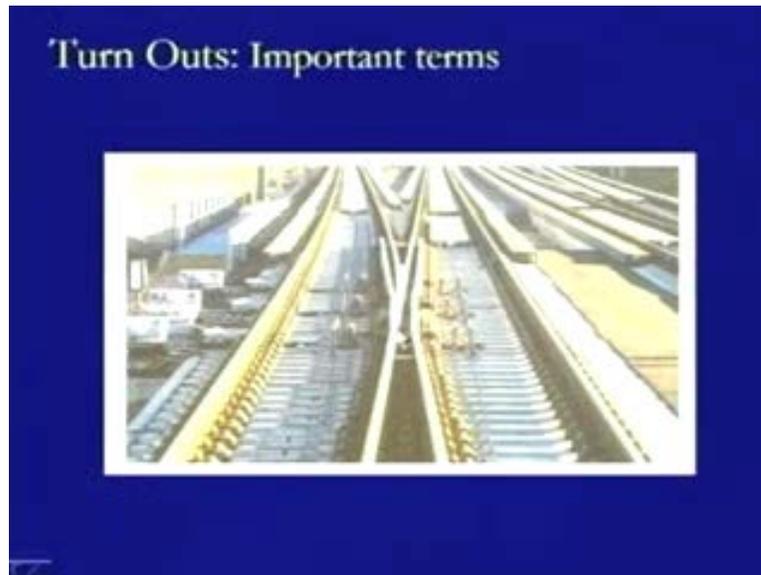
Then, what we have discussed is this wing rail. This is another wing rail which is provided on the two sides of this crossing, then using this wing rail and its connectivity at this location, using a block with a straight lateral section if we take this depth that is from the top of this point to the top of the block here, then that will be the depth of the flange way.

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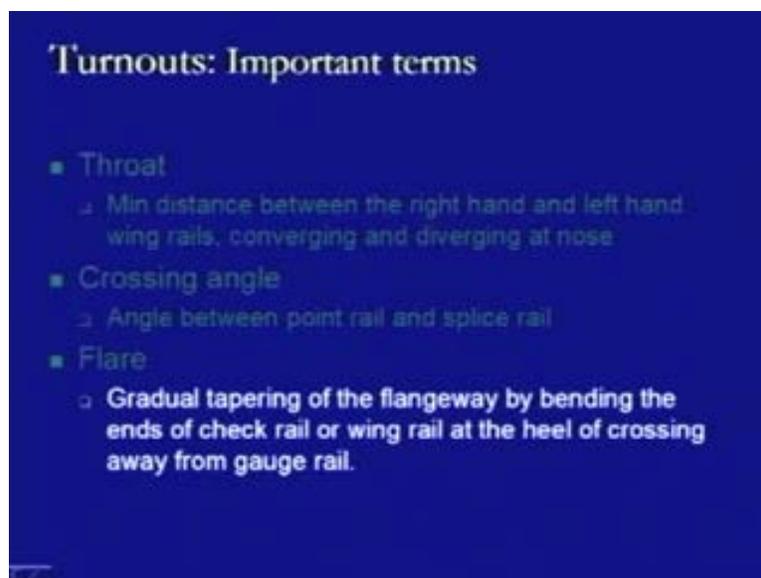
So, we continue with some other important terms, the throat. The throat is the minimum distance between the right hand and the left hand wing rails converging and diverging at the nose. So, that is what is the throat. It is the distance between the right hand and left hand wing rails converging and diverging at the nose.

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So, if you look at this direction, this is a wing rail, this is another wing rail and they are just converging at this location. So, wherever they are locating this minimum value, this distance, this is known as the throat. So, this is a throat and this is how after that it starts diverging this way.

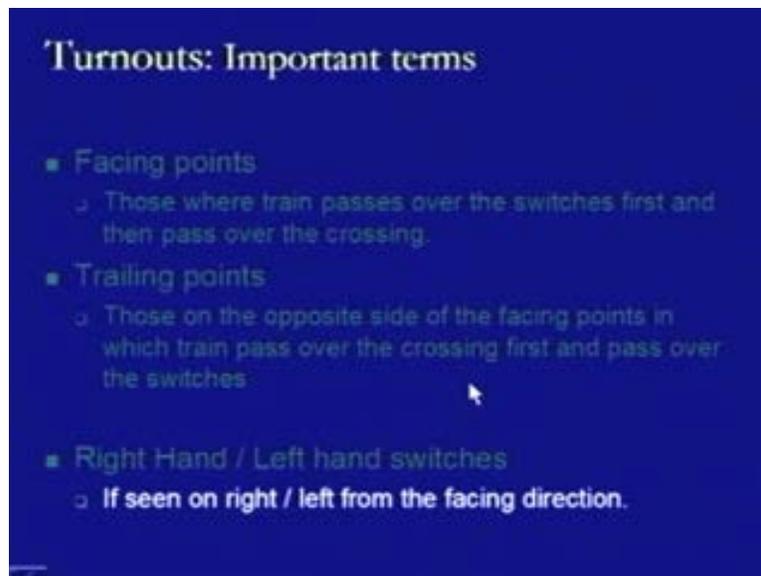
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Then, crossing angle; crossing angle is the angle between the point rail and the splice rail. You have already seen the point rail and the splice rail and if we take an angle between these two, that is what is crossing angle. Then flare; flare is the gradual tapering of the flangeway by bending the ends of the check rail or the wing rail at the heel of crossing away from the gauge rail. What we are doing is that we are just tapering the section, we are just making the, flaring the section towards the outer side.

The reason behind is that the train which is coming, which is trying to negotiate this crossing, there are safety reasons associated with it. So, what we are interested in is that to have a smooth entry of the train on the crossing and due to that reason, we are providing the flared surfaces and due to that flared surfaces if at all there is a movement, lateral movement of the wheels in one direction, that will be taken care of by the flair and as soon as the wheel strikes on this flair, it will come back on the normal condition. So, that is the reason why the flares are provided with the wing rails and the check rails.

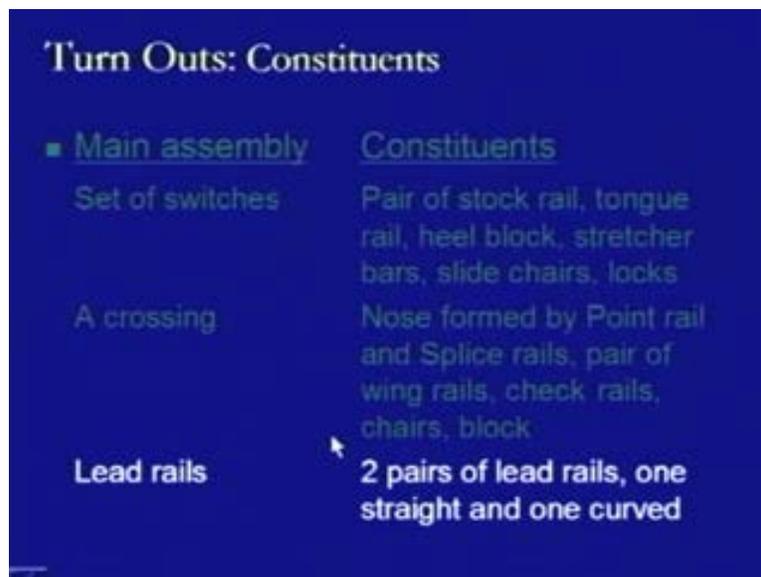
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The other terminology is facing point. The facing point is those, where the train passes over the switches first and then pass over the crossing. So, if the train is passing over switch first and then it goes to the crossing, then that point is termed as facing point.

Similarly, there is trailing point, where if those on the opposite sides of the facing points in which the train first of all passes over the crossing and then pass over the switches, so that is how we define the trailing points. So, we have seen the crossing, we have seen the points and depending on the movement, we have to define the facing points and the trailing points. Then, the right hand and left hand switches if seen on the right or the left from the facing direction that is how they are termed as the right hand or the left hand switches.

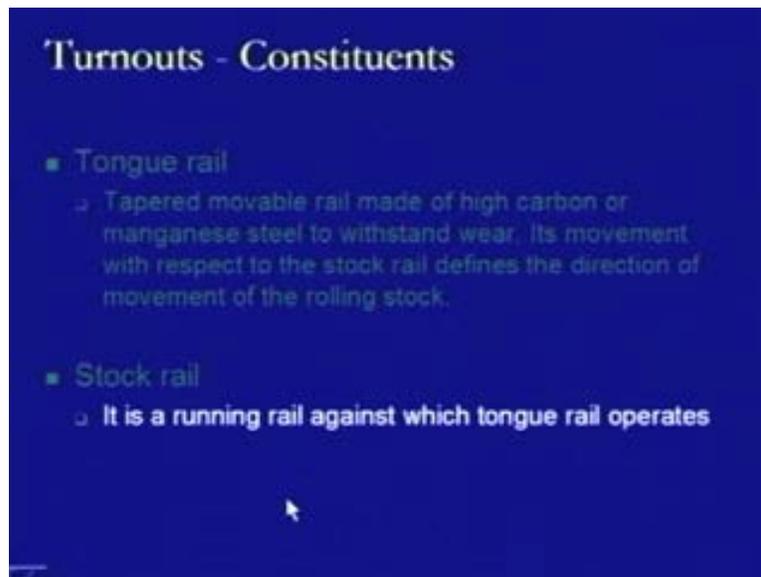
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Main assembly	Constituents
Set of switches	Pair of stock rail, tongue rail, heel block, stretcher bars, slide chairs, locks
A crossing	Nose formed by Point rail and Splice rails, pair of wing rails, check rails, chairs, block
Lead rails	2 pairs of lead rails, one straight and one curved

Now, we look at the constituents of any turnouts. There are some main assemblies and there are constituents of those main assemblies. The first one is the set of switches. In the case of set of switches, we have the pair of stock rails, tongue rails, heel blocks, stretcher bars, slide chairs, locks. In the case of a crossing, we have a nose which is formed by the point rail and the splice rail combination, a pair of wing rails, a pair of check rails, chairs, block and likewise. So, these are the two types of main assemblies. Then, there are the lead rails. There are two pairs of lead rails. One is the curved and another one is the straight pair of the lead rail.

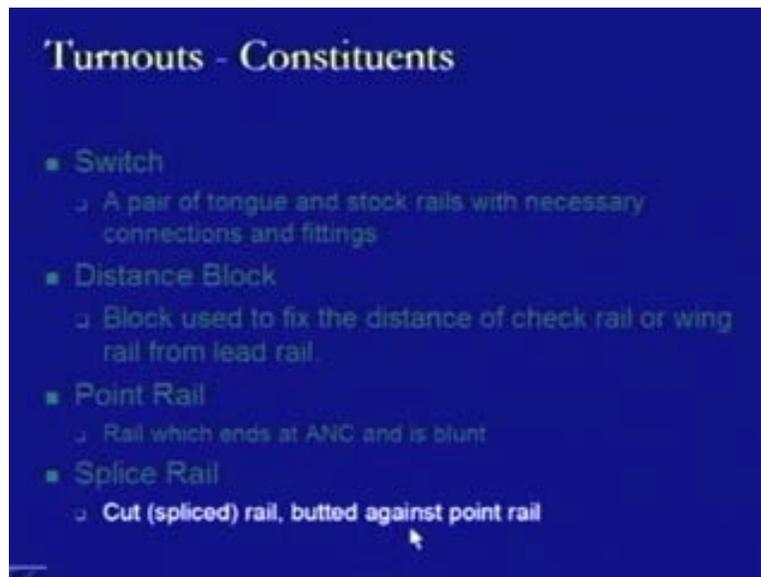
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Then, coming to the constituents, what is tongue rail and how we define, it is a tapered movable rail which is made of high carbon or manganese steel to withstand wear, its movement with respect to the stock rail defines the direction of movement of the rolling stock. So, depending on that in which particular direction it is moving and with which it is combining, which side of a stock rail it is combining, we can define in which direction the train will be moving, whether it is going on the straight section or a curved section.

Stock rail - it is running rail against which the tongue rail operates. We have seen that the tongue rail was slanted and stock rail was straight, so it comes and touches the stock rail or it goes away from the stock rail. This is what is a stock rail.

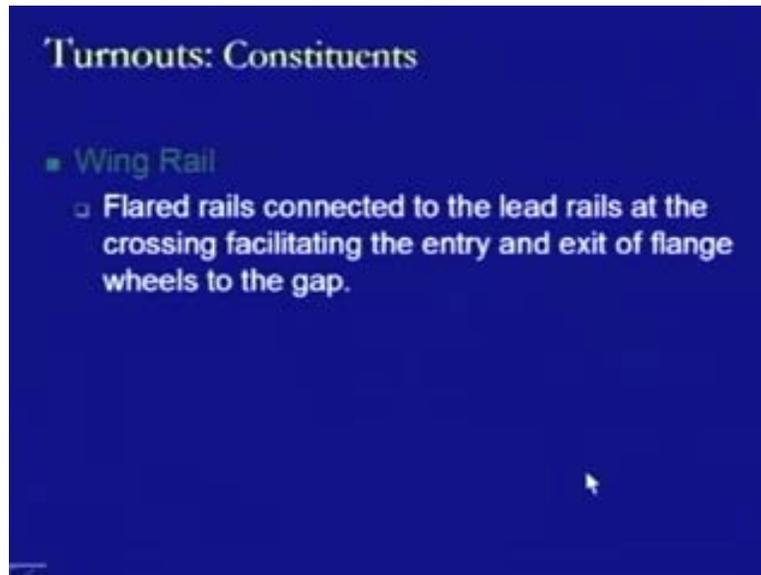
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Then, switch - a pair of tongue and stock rails with necessary connections and fittings is known as a switch. Then, distance block; distance block is a block which is used to fix the distance of check rail or wing rail from the lead rail. That is what we have seen when we defined it in terms of a flangeway depth. So, this is the block which is used, so as to keep the check rail or the wing rail at some distance from the lead rail and so as to maintain that.

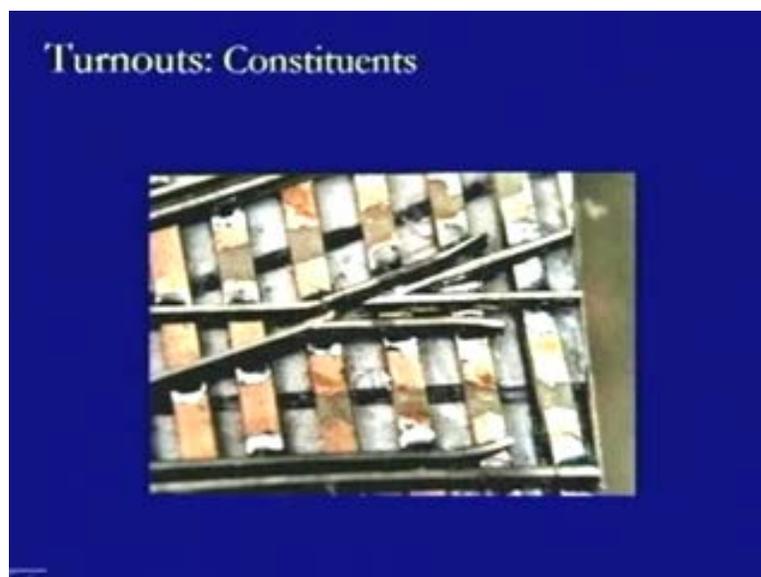
Then point rail - point rail is a rail which ends at ANC and is blunt. ANC is actual nose of the crossing. So, this is a rail which is blunt and this one, we have discussed that the bluntness is of the range of 6 mm thickness. So, if there is a rail which is having a 6 mm thickness at the end at ANC, then that is what is a point rail. Whereas, there is a splice rail, this splice rail is a cut rail which butts against the point rail. So, a rail is being cut, so that it just butts against the pointed rail and that is how the connectivity of the point rail and this sliced rail makes a crossing.

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Then, wing rail; wing rail is a flared rail which is connected to the lead rails at the crossing, facilitating the entry and exit of flange wheels to the gap. As being discussed previously also that it is trying to make the smooth entry or exit, so that there is no impact while the train is or while the wheels are coming in this area or they are going away from this area due to the lateral movement of the **axials**.

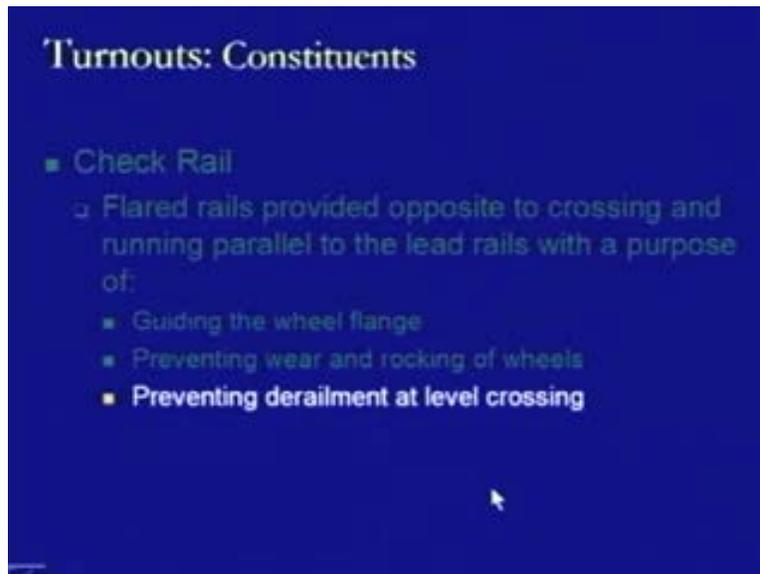
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In this diagram, again we are trying to show the same thing that this is a wheel. So, in this one, what we can easily see is that this rail, this is being tapered at this one and it has a thickness of 6 mm at this point and this is what is the ANC, the actual nose of crossing, whereas this rail which is coming is **averting** this rail at this location, so it has to be cut down. So, this is a splice rail and this is point rail. So, we have this splice rail and point rail being shown in this very clearly along with this wing rail on this side and this wing rail on this side and in between, at this location the block is provided here as well as here, so that they are kept in location and this is the throat at this point.

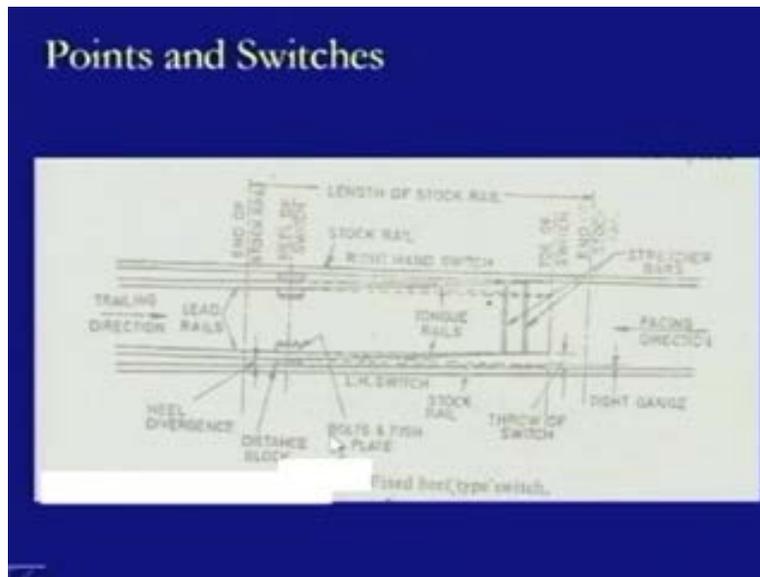
So, whatever is the minimum distance which is available that is throat and if you continue with this one, if this is V and if it ends here as a point, then that will become the theoretical nose of crossing. We can also see the check rail being provided on this side with a flair here. So, if a train is coming, a wheel is coming it will touch here due to the lateral displacement and will come back. If this is not being provided, then it will hit this rail section and there can be hazardous or accident condition. So, that is how it helps. Similarly, this is also being flared this side, this is this side.

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Check rail check rail is the flared rail which provides provided opposite to the crossing and the running parallel to the lead rail with a purpose. There are certain purposes with which it is provided. It guides the wheels flanges, it prevents the wear and rocking of wheels and it prevents the derailment at the level crossing. So, these are the three reasons due to which the check rail is provided.

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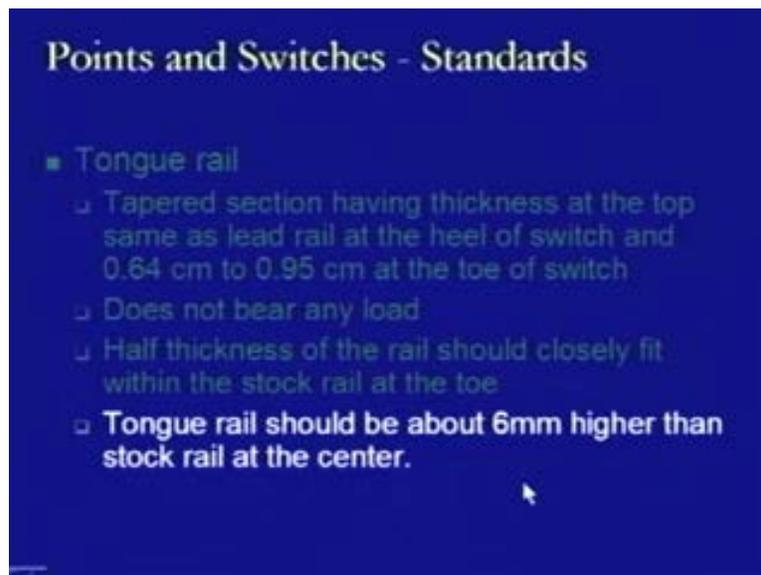


Now, this is another diagram, where we are trying to show the things which we have already discussed in terms of the points and switches. This is a straight section rail, this is another straight section rail and this is the tongue rail which is inclined. This is also another tongue rail which is inclined. This is having 6 mm thickness at the end here, whereas at this location which is the heel of the switch and this is the toe of the switch, at heel of the switch it is having a thickness equal to the normal rail section. So, this is trailing direction, this is facing direction, these are the stretcher bars.

Now, in this location, what is happening is if the train is coming from this direction, it is going to take a track like this, because it will be taking a curved section, because this tongue rail is touching at this side. So, this is the distance by which the tongue rail has moved away from this rail section and this is what is the throw of the switch. Similarly,

the angle of switch which we have discussed is that this is a straight section that is a stock rail and this is a slanting rail that is tongue rail. The angle being made by these two here that is what is the angle of the switch and we can move this tongue rail in this direction and this direction. So, if we bring it in this direction, this is what is shown by a dotted line. So, this is a dotted line, so in that case it will be touching here, but this will come away from this side. So, this will be the throw of the switch on this side. So, that is if a dotted condition is being maintained, then in that condition, the train will move on a straight track instead of a curved track, means it is touching on this side; it is away from this side, so it will be using the main track only.

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Then, in the case of this tongue rail, some standards are there like the tapered section having thickness at the top same as the lead rail at the heel of the switch, whereas at the toe of the switch it is either 0.64 centimeter to 0.95 centimeter in thickness. It does not bear any load. It is just trying to provide the change over from one to another side. Half thickness of the rail should closely fit within the stock rail at the toe. This is another thing as far as the design, as far as the implemented condition is concerned that half of the thickness of that rail, it should closely get in with the stock rail at the toe, otherwise there will be a big difference between the movement and that jerk may cause derailment.

Tongue rail should be about 6 mm higher than the stock rail at the center. Now, this is being made 6 mm higher than the stock rail just to make the driver understand that the train has started negotiating the points. So, the driver should be careful enough that the speeds have to be maintained in a lower value as well as the things should remain in a perfect condition, so that it safely negotiates that curve. So, as soon as the wheel comes at this 6 mm higher condition, there will be a sort of a jerk and with that jerk the driver can understand that the locomotive is just traversing the point.

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Points and Switches - Standards

↳ Theoretical length of tongue rail
 $L = R \tan (\beta/2)$

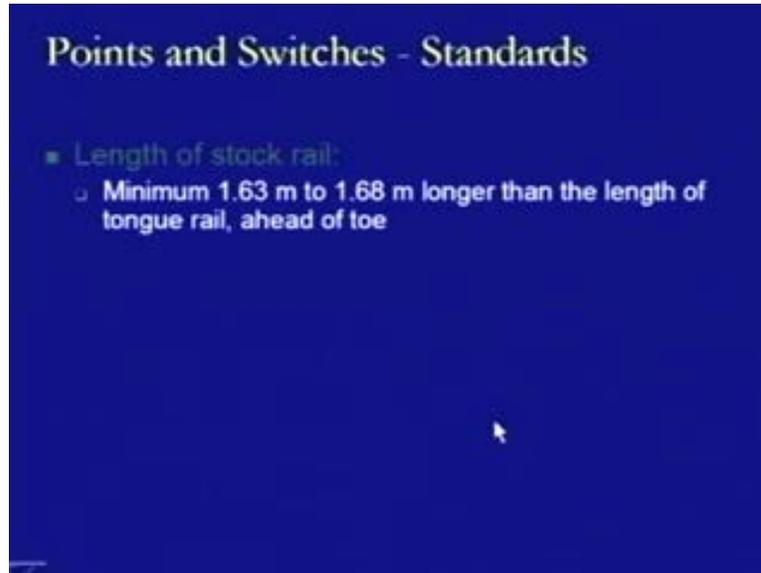
↳ Length of Tongue rail

Gauge	Number of crossing	Length
BG	1 in $8\frac{1}{2}$	4.72 m
BG	1 in 12	6.40 m
BG	1 in 16	9.76 m
MG	1 in $8\frac{1}{2}$	3.96 m
MG	1 in 12	5.49 m

Then, theoretical length of the tongue rail; this theoretical length of the tongue rail is given by $L = R \tan \beta / 2$ and in this case, R is the radius and β is the switch angle. Then, length of this tongue rail it is depending on the gauge and the number of crossing and what you see is that if it is a broad gauge and the number of crossing is 1 in eight and a half, then the length of the tongue rail is taken as 4.72 meters, whereas if the angle of, this number of crossing is changed to 1 in 12, then it becomes 6.4 meters, because it is becoming a little flatter, means the curve is flatter. That is why the length will be more or if it is 1 in 16, then it will be 9.76 meters.

In the case of meter gauge if it is 1 in eight and a half, then it is 3.96 meters. We can see it; in the case of broad gauge it was 4.72 meters or if it is 1 in 12, it is 5.49

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Then, coming to the stock rail, the length of the stock rail is minimum 1.63 meter to 1.68 meter longer than the length of the tongue rail. This already we have seen that, at the heel both of the rails are joined together by a distance block, but then the point at which the tongue rail will be touching the stock rail after that it should be minimum 1.63 to 1.68 meter longer. That is why it is written as ahead of the **toe** of this tongue rail.

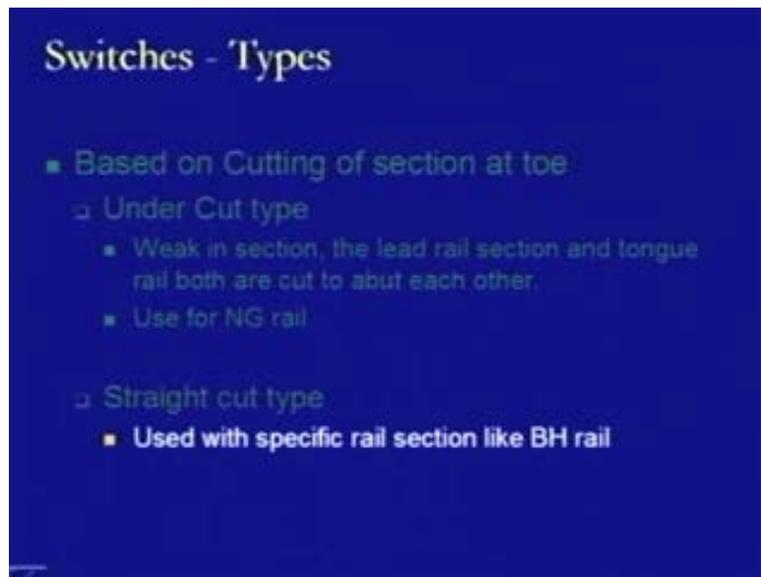
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Then, we come to the different type of switches which are provided. They are defined on the basis of the fixation at the heel. They may be stud type, they may be split type. Then, within the split type, then again they are categorized as loose heels type which is, which are loose at the connectivity with the lead rail using fish plate and bolts. This is how they have been provided, but then they remain a little loose at this connectivity and they are used for the short tongue rails.

Then, fixed heel type; they are fixed at the heel and they are tightened with the fish plates and the bolts and they are used for long tongue rails.

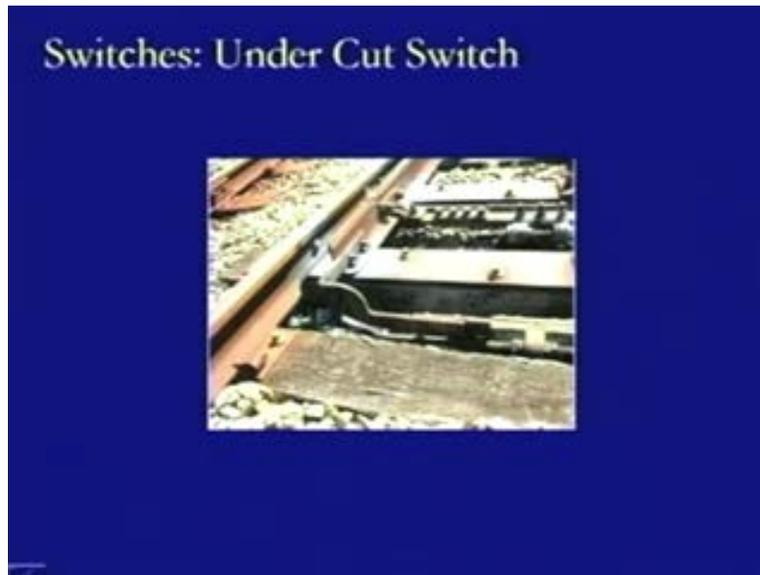
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Then, based on the cutting of the section at the toe, means whatever the rail section is there, if we cut that rail section at the toe, then on the basis of that, again we can define one is under-cut type of a switch. In this case what we are doing is, it is being cut at the lower level and provides the flexibility to just touch another section of the rail and **abut** with each other, but this is weak in section, because it is being cut at the bottom and the lead rail section and tongue rail both are cut to abut each other. So, that is why this weakness is coming in the overall rail section at this location, but they are used for narrow gauged rails.

There is another type which is straight cut type section. In this one, this is used with specific rail sections like bull headed rail section.

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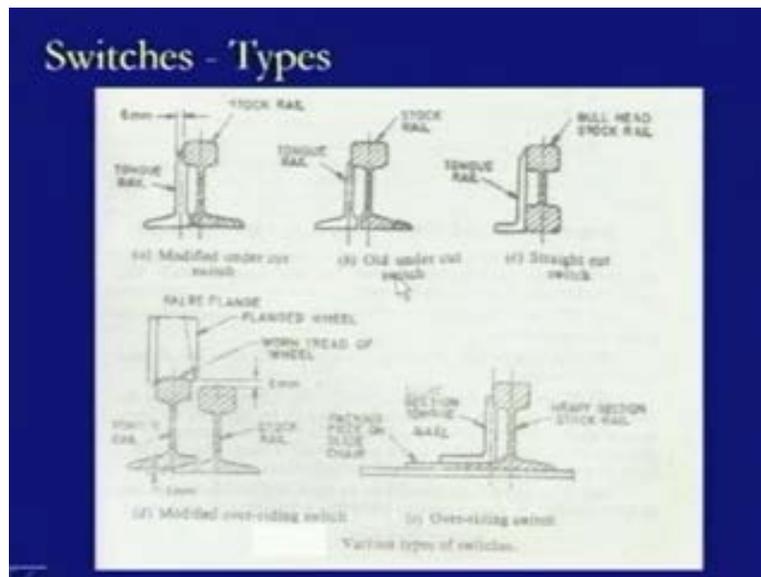
Here we are looking at one such type of a switch. This is main rail section and this is the tongue rail section which is coming and this is how the switch is working. This is how these are the bars which are provided which helps in running this one in this direction or in this direction. So, here what we see is that this is you can see this curvature here, like this. This is the foot of the rail section. This foot of the rail section has been cut. You can see this; this is being cut, so that this rail section, where for this rail section also this foot is being cut on this side like this one. As soon as it comes here, here again there is a little grooving, so that this 6 mm thickness which can come inside and then they will become this one condition. So, this is how this is an under-cut switch being worked.

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Further, based on the cutting of the two sections we can also have the overriding type, where the one rail that is the tongue rail is riding the main rail, means it is placed at a little higher, this height with respect to the main rail that is above the foot of the main rail. There is no section being cut in this case and the stock rail is of heavier section and the tongue rail is of lighter section and there is a combination fish plate used at this location, so as to connect the things. They are used for both the broad gauge and the meter gauge.

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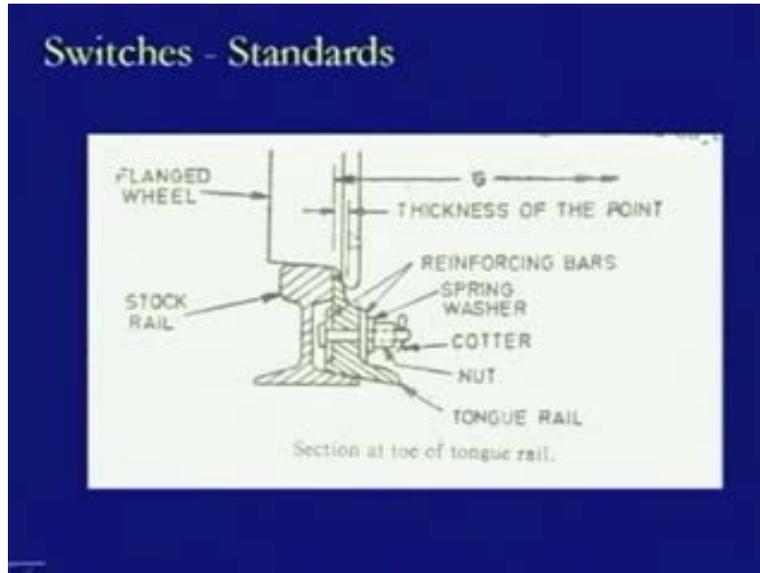


Here, the different types of switches have been shown. We can see this is the under-cut switch, because you can see that this is being cut here. This is being cut here. This is the stock rail, because it is provided with the complete section. This is the tongue rail, because in this case, the tongue rail is having a 6 mm thickness at the top and this is touching this stock rail, so this is a tongue rail. Whereas, if it is on the heel condition, then that tongue rail is also having the same thickness at the top of the head; so, this is tongue rail, this is stock rail and both are having the same size.

This is heel condition, this is a toe condition. This is the modified under-cut switch, this is an older version of the under-cut switch. This one is straight cut switch which is used with the bull headed rail as been discussed. So, we have this bull headed rail and there is a straight cut section like this, whereas in this one this was curved like this, v. Then, here this is an overriding switch. As I told you that this is being made to ride at the foot of the other section. So, this is a stock rail and this tongue rail is coming and is resting at the top of this one and it is being made a little higher than the level of the stock rail and this is again 6 mm height and this we have already discussed as in the case of the standards. This is another type of the overriding switch, where packing is being used, so as to give a support to this section which is available at the toe of the switch. This is the condition at

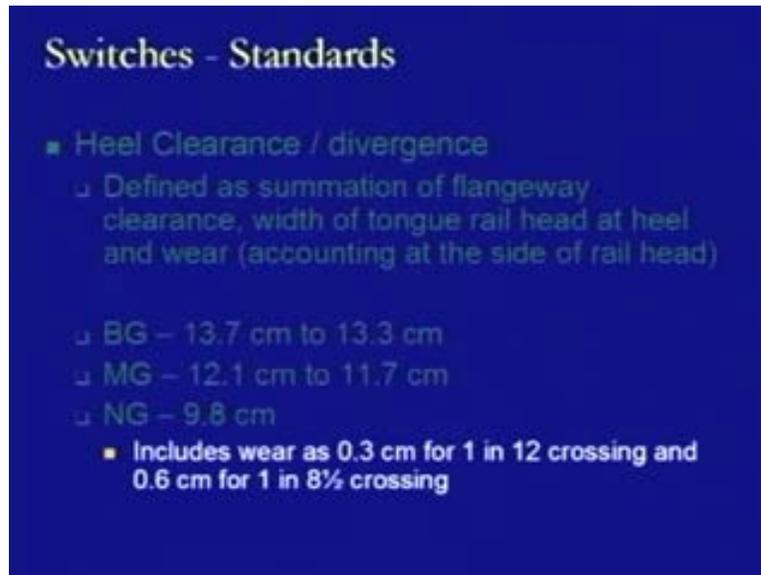
the heel of the switch, this is the condition at the toe of the switch, because the thickness here of the tongue rail is 6 mm.

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This is another diagram which is trying to show you how they are going to be connected and this is a wheel being traversing. So, this is stock rail, this is tongue rail which has come and which is touching the stock rail, so that this wheel can negotiate and take a curve. So, these are the connectivities which are to be provided in this location, cotter, nut, tongue rail, spring washer, reinforcing bars, etc.

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Switches - Standards

- Heel Clearance / divergence
 - Defined as summation of flangeway clearance, width of tongue rail head at heel and wear (accounting at the side of rail head)
 - BG – 13.7 cm to 13.3 cm
 - MG – 12.1 cm to 11.7 cm
 - NG – 9.8 cm
 - Includes wear as 0.3 cm for 1 in 12 crossing and 0.6 cm for 1 in 8½ crossing

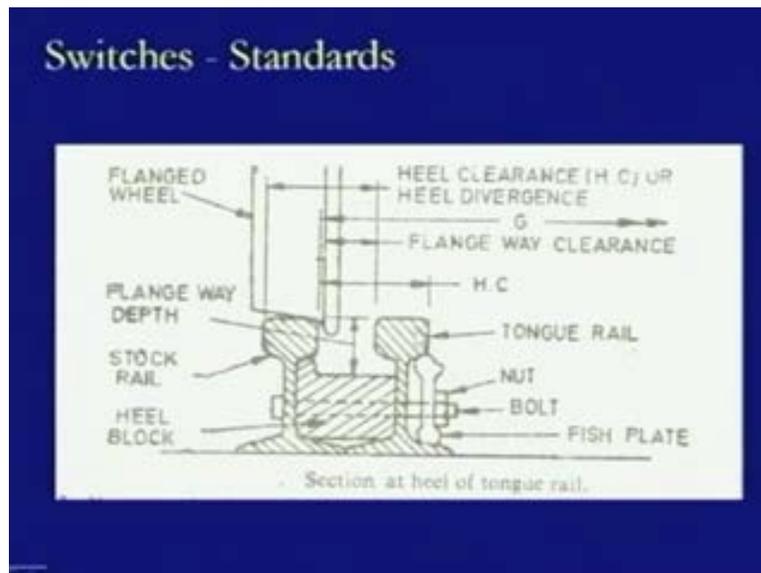
Then, another standard which we can look is for heel clearance and divergence. Here, they are defined as the summation of flangeway clearance, width of tongue rail head at the heel and the wear which is to be accounted for, because of the movement on the rail heads and this is in the case of broad gauge taken as 13.7 centimeters to 13.3 centimeters, for meter gauge 12.1 centimeters to 11.7 centimeters, for narrow gauge it is 9.8 centimeters and it includes wear as 0.3 centimeter for 1 in 12 crossing and 0.6 centimeters for 1 in eight and a half crossing. The reason behind is that there is more of the shocks or the impacts in the case of 1 in eight and a half crossing, because of the sharper curve as compared to the 1 in 12 which is a relatively flatter curve. So, the amount of wear is taken more on the sharper than on the flatter curve.

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Then, this flangeway clearance, this in the case of 1 in eight and a half crossing is taken as 6.6 centimeters, whereas for 1 in 12, it is taken as 6.3 centimeters, a difference of actually 0.3 centimeters coming here.

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We look at this diagram and further the different definitions which we have seen becomes clarified. Here, this is a distance block by which the tongue rail or the stock rail has been

maintained at a distance. So, this is the top of the stock rail and this is the top of the distance block. So, this depth is nothing but the flangeway depth. Similarly, the distance which is there in this case, this is heel divergence which we look at. This is outer side of the rail and this is another respective outer side of the tongue rail. So, this distance is nothing but this is heel clearance or heel divergence being shown as like this. Then, the distance between this flange and this side of the tongue rail that is being shown here and this is what is flangeway clearance.

Flangeway can move within this distance, so that is flangeway clearance. If we take along with this one the head also, then this is the heel clearance. That is what is being shown here. So, the flangeway clearance, the heel clearance can be from this to this or from this to this and the other assemblies are also being shown here, the fish bolt, ..., etc.

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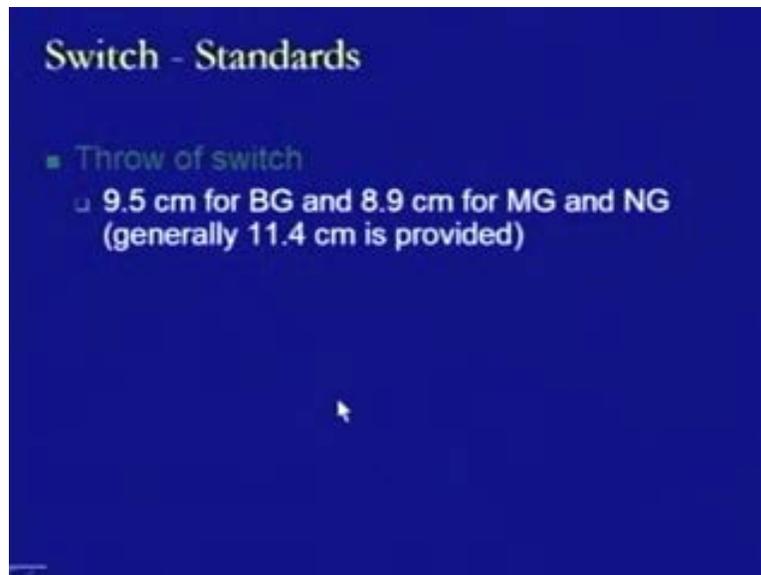
Switch - Standards

- Switch angle (β)
 - Depends whether thickness of tongue rail is considered or not
 - If not considered then
$$L = \sin^{-1}(\text{Heel divergence} / \text{length of tongue rail})$$
 - If thickness is considered then
$$L = \sin^{-1}(\text{thickness} / \text{difference in theoretical and actual length of tongue rail})$$

Then, coming to switch angle, this depends upon the thickness of tongue rail is considered or not and if it is not considered, then it is given by sin inverse of the heel divergence divided by the length of the tongue rail. We have seen the divergence, we have also seen the length of the tongue rail and we can compute this way. Whereas, if the thickness is considered that is 6 mm thickness at the toe of the rail, then it is sin inverse

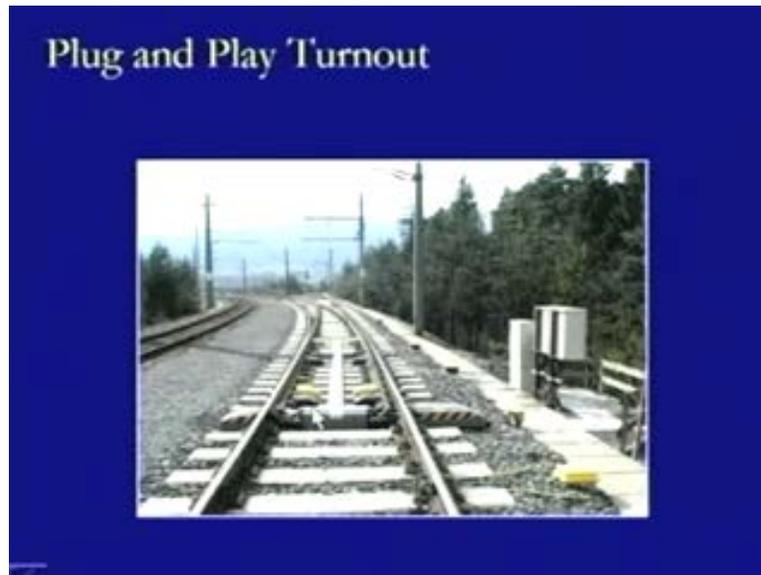
of thickness divided by difference in theoretical and actual length of the tongue rail. That whatever is the length we are providing or whatever is the length which will be there if there is no thickness, that difference if we take with respect to thickness, we can find out the value of the switch angle in this form.

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Then, throw of switch; this is 9.5 centimeter for broad gauge and 8.9 centimeters for meter gauge and narrow gauge; generally 11.4 is used.

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This is another type of turnout which is being shown, a new type of turnout, the plug and play turnout, where we see that turning is taking in this direction and this is the point which is being provided and it gets operated with the use of these boxes and the connectivity between the two locations are provided using these boxes at this location.

So, this is, what we have discussed today is the different components which are needed, so as to design any turnout and what we have seen is that this turnout is a mechanism or the device which helps us in changing the direction of any train from one track to another track or only from one track to another direction. Now, another related components or another related features of these turnouts, we will be looking at in the coming lectures and we are stopping at this point. I say thank you and good bye to you.