

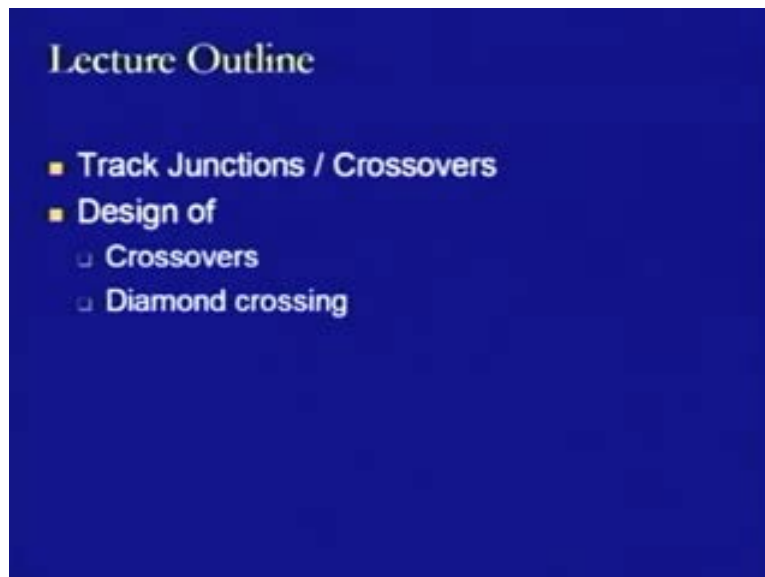
Transportation Engineering - II
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Lecture - 21
Track Junctions & Designs

Dear students, I welcome you back to the lecture series on course material of Transportation Engineering - II. In the previous two lectures, we have already discussed about the turnout. The turnouts, as we have discussed, are the devices which are used for changing the direction of any train or rolling stock and in association of this one, we have already discussed about the various terminologies which are used in the design of turnouts, the various concepts, the methods for which we are using for design of turnouts and the specific details of crossings.

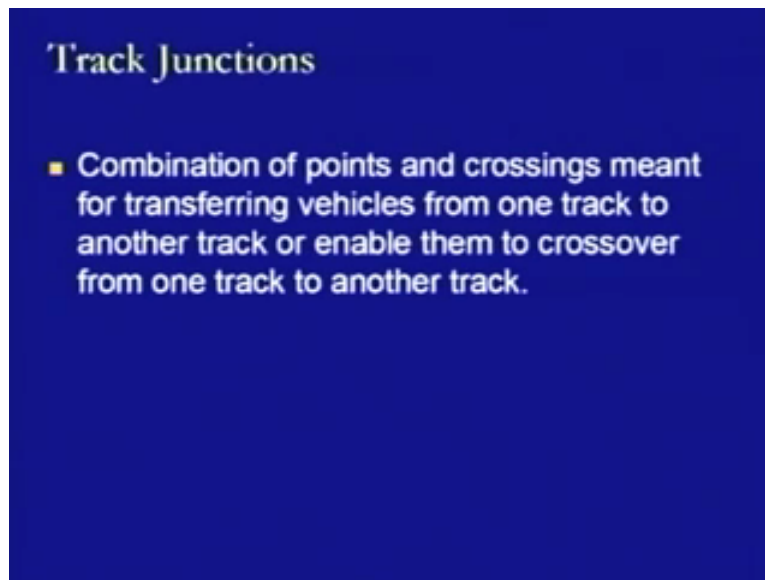
In continuation of the same, today we will be looking at the composition of the two tracks and then, how the tracks are joined together that is what is known as the track junctions and specific design of some of the type of track junctions.

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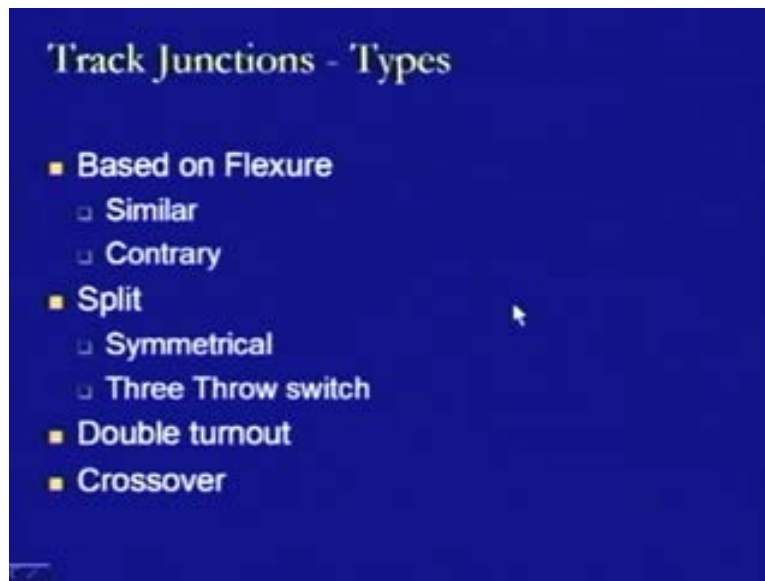
The lecture has been outlined in the form, we will be discussing about track junctions. These are also known as crossovers and we will be looking at the design of crossovers and diamond crossing. These are the two types of track junctions which we will be specifically taking for design purpose.

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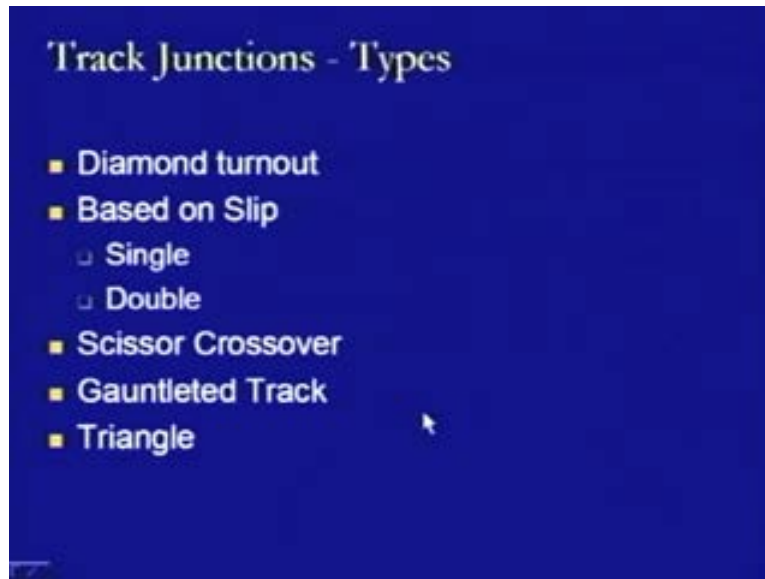
Starting with track junctions or crossovers, the track junctions or crossovers can be defined as a combination of points and crossings meant for transferring vehicles from one track to another track or enable them to crossover from one track to another track. That is what can be the definition of any track junction or a crossover. So, as I started this lecture, that it is a combination, where there may be two tracks which are moving parallel to each other or may not be parallel to each other, may be at certain curvature and we are interested to transport the whole of the rolling stock from one track to another track. In that condition, whatever is the combination of points and crossings being provided along with all its accessories, then that is known as the track junction and this can also be termed as crossovers and this is what is the word being used here in the one line of this definition.

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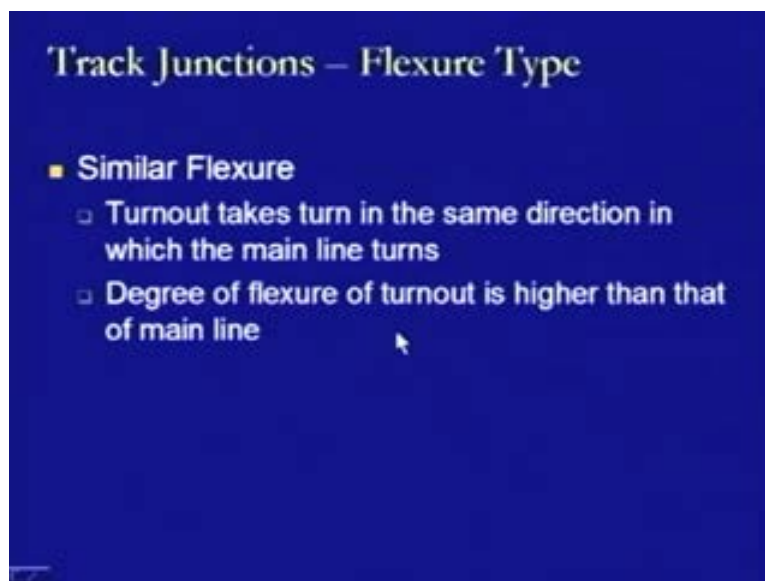
So, in this case of track junction what we find is, on the basis of shape or the geometry and the function which it is supposed to perform, we can have different types of track junctions. These track junctions can be defined on the basis of the flexure that is the way they are going to turn and at what angle, what curvature they are going to take a turn and in the case of this flexure, they may be similar flexure train junctions or they may be contrary flexure train junctions. Then, on the basis of split, they may be symmetrically split or three throw switch. Then, there can be a double turnout. In the case of double turnout, we have the condition where we are providing a facility in taking a turn in either of the direction, but at different location; we will be looking at that again. Then, crossover that is from one to other side.

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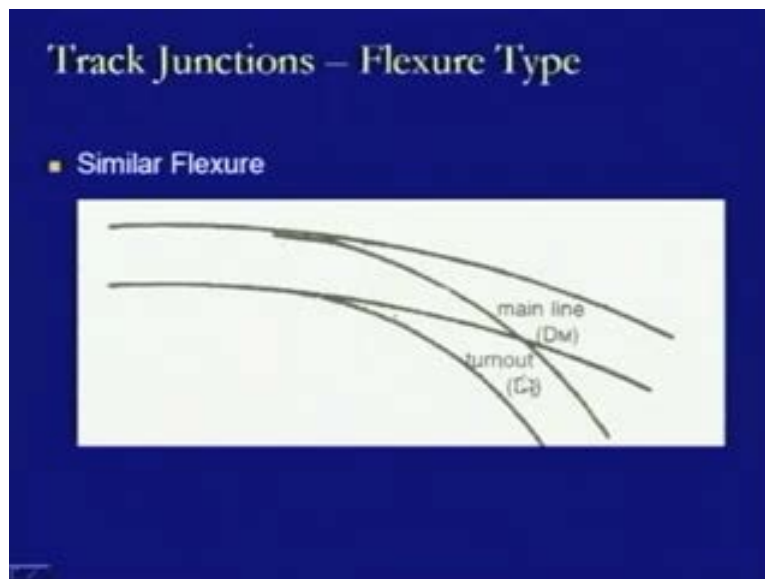
Further, there can be a diamond turnout. Based on slip, again it can be defined as single slip turnout track junction or double slip turnout track junction. We have scissor crossover, we have gauntleted track and we have triangle. So, these are different types of track junctions which are provided depending on the specific function which they have to perform or the requirement of that track or the area.

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So, now will be looking at all these track junctions one by one and we are starting with the first type of track junction which is defined on the basis of flexure and this one is similar flexure track junction. In this case, the turnout takes turn in the same direction in which the main line turns. That means at whatever the way the main line is taking a turn, is making a curve or whatever is the curvature of the main line, the turnout is also coming out of it and it is also having the same curvature. That is what is known as the similar flexure that is the similar curvature is being provided to the two things. Degree of flexure of turnout is higher than that of main line and that is why only in that condition it will be going away from the main line. Otherwise, it cannot go away from the main line.

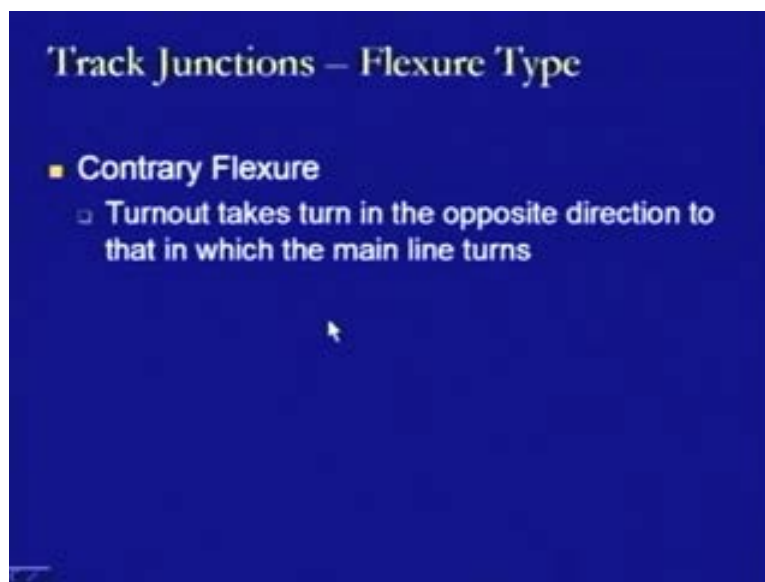
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Just look at this diagram. We have this as a main line. This is the track which is provided for the main line and we have a turnout which is coming out of it and it is going in this direction. So, we are trying to use the same curvature here which is being provided. Using this one, in the same direction in which this flexure is going, we are providing a flexure of turnout also in this direction only. The only thing is the flexure by which it is being taken a turn is little more than what is being provided for the main line, then only it is going to differentiate with respect to this one.

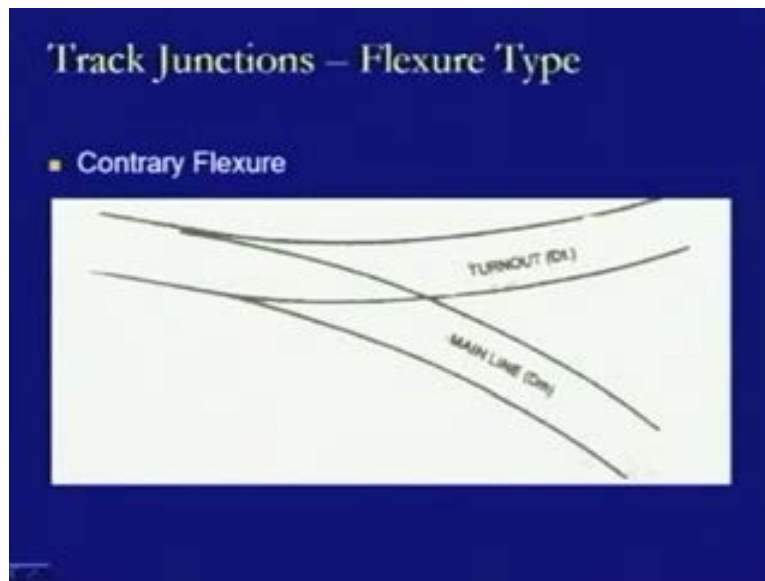
So, if you look at this diagram, what we can observe is that there is one pair of points and switches being provided at this location and there is one crossing or V for a frog being provided at this location. So, this is what will be the similar flexure turnout and here we will be providing, if we have details of this turnout as we have seen in the case of a turnout designs and their figures, we will be having a pair of wing rail at this location like this, at this location like this and a jack rail will be provided in this location as well as in this location, so a pair of jack rails will also be there. So, a pair of wing rails, a pair of jack rails, one pair of point and switches and one crossing plus we have the curve leads, we have two pairs of curve leads and that is what becomes the similar flexure track junction or turnout.

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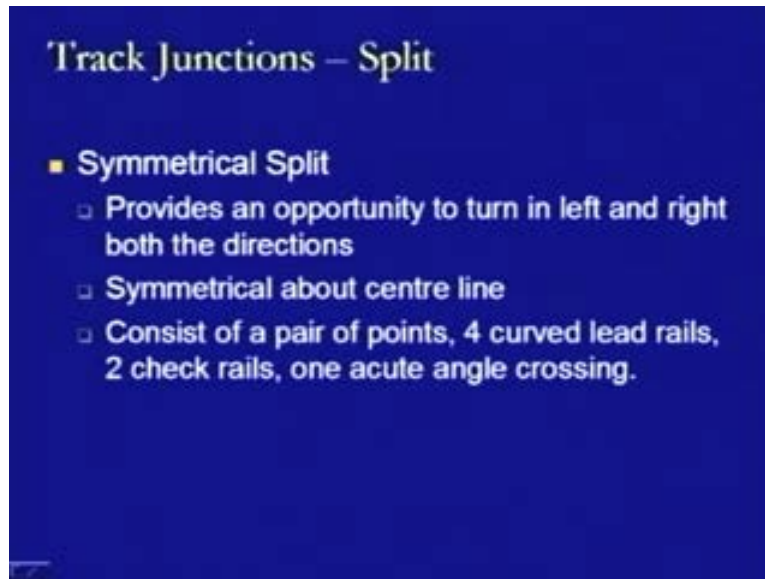
Then, in the case of a contrary flexure, the turnout takes a turn in the opposite direction to that in which the main line turns. That is it is just an opposite case of what we have seen in the previous one, where we found that both of the things or both of the tracks were taking a turn in the same direction, in the same way. But here, it is like this.

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Here we have this as a main line and then, the turnout is taking a turn in this way. So we have, this flexure is going in this direction, whereas this flexure is going opposite to that one in this direction. So, that is why it is termed as contrary flexure track junction. Now, in this contrary flexure track junction, again if you look at, we have the similar conditions of the components which need to be provided as being provided in the similar flexure turnout. We have one pair of points and switches being located here, by which we can provide the movement either on the main line or on the turnout. We have a crossing at this location. We will be having a pair of wing rails here, we will be having pair of jack rails here and that is what constitutes this particular contrary flexure turnout. Similarly, there are two pairs of curve rails in this section also.

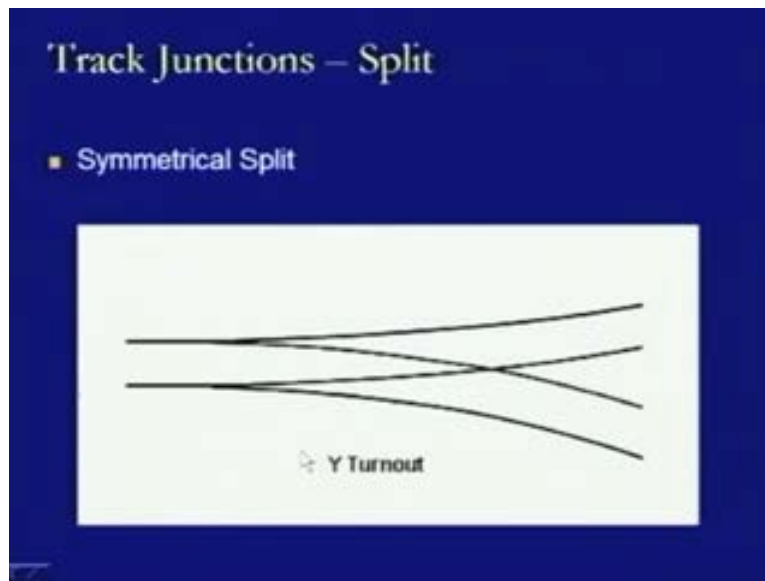
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Now, coming to another type of a track junction which is defined as a split track junction, here we have the first type category which is symmetrical split. In the case of symmetrical split, what happens is that there is an opportunity to take a turn in the left or the right or both of the directions basically, because in the previous case it was either in the left direction or it was in the right direction. So, that was just a modification of the normal turnout, where the main line remains straight and the turnout line or the branch line or the line which is taking a turn is curved. So, in the previous two cases, what we have seen is even the main line along with the turnout, both were having curvature.

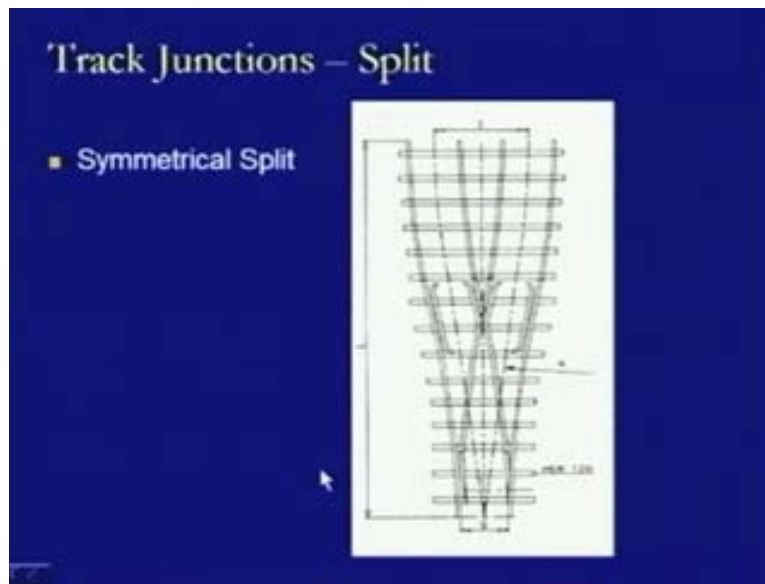
Now, **in this case** in the previous case, it was turning either to the left or to the right, but in this case it may be taking a turn to both left and right and it is symmetrical about the centre line of the initial profile after which it is taking this type of a split. So, in this sense we will be looking at a diagram of this one and what we will find is that it is consisting of a pair of points, 4 curved lead rails as we have seen in the previous cases, two check rails and one acute angle crossing.

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This is symmetrical split which is also known as Y, because if you come this way this is the main track in the case of Y and then it is getting split in the two directions symmetrically. That is why it is also termed as Y. So, this is main line and it is taking a turn in this direction as well as it is also providing a turn in this direction. Therefore, the train has a rolling stock, has the flexibility of taking a turn either in the left or in the right direction and here what we see is that, again we have one pair of points or switches being provided at this location and because it is symmetrical in nature, therefore there will be only one crossing being provided here. So, there is one crossing, one pair of wing rails, one pair of jack rails and four that is two pairs of **curved** rails in the contrary direction or contrary flexure direction.

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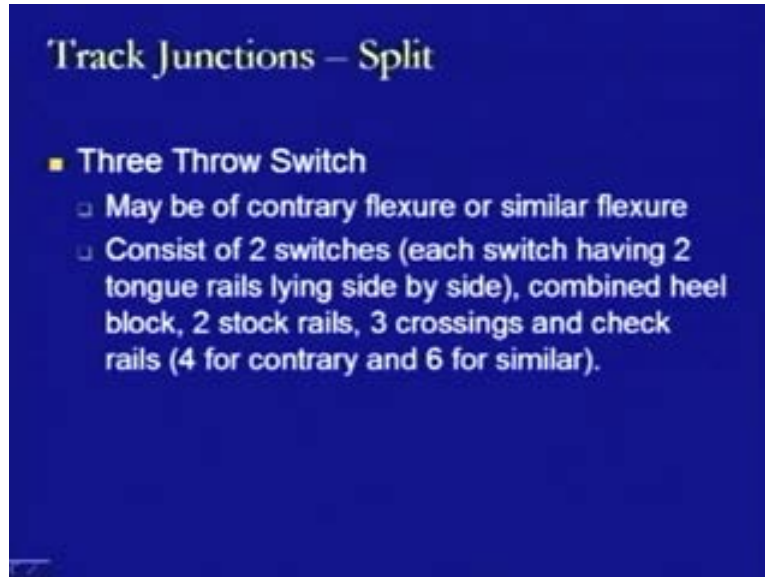


This is another diagram of the similar sort of a split, where the jack rails, wing rails and wheels, etc., are all being shown properly with the thickness diagram. That is this is one track, the thickness of the rail has been shown. The sleepers are also shown in this one, where the sleepers are moving like this across. As we have seen in the case of the turnout, we provide the through sleepers that is a better option than the interlaced sleepers and here this is the centre line of the main track and this centre line of the main track is produced like this and at whatever angle it is taking a turn in this direction, the same angle is there at which it is taking a turn in this direction and because it is symmetrical, so we have only one point where the crossing is and this is the V crossing being provided which there is an acute angle crossing and at this acute angle crossing we have these as wing rails.

We can see these wing rails and a pair of jack rails being provided, one on this side and one on this side. So, that is a pair of jack rails and we have the points that is we have the tongue rail being shown here like this and this is being shown here like this with ending as a black one and connected by a dotted line that is a stretcher bar. So, at this point, when it is being shifted with throw off switches being provided on this side that means it

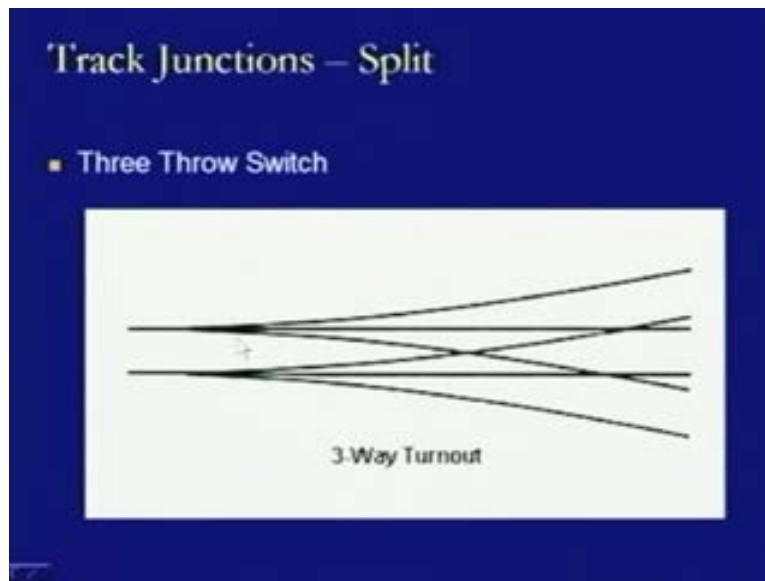
is providing the movement on this track. But, if the throw off switch is on this side that is towards the right hand side, then it will be providing the movement on this track.

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Then, we come to another category of the split track junction that is three throw switch. In the case of three throw switch, it may be a contrary flexure or similar flexure. That is if there are three switches, three throw switches has been provided in three directions, the traffic can move then out of those or it may happen that two may be coming contrary to each other or may be having the similar flexure as we have seen in the previous first two categories and in that sense it will be consisting of two switches, each switch having two tongue rails lying side by side, a combined heel block, two stock rails, three crossings and check rails, four for contrary and six for similar flexure conditions. So, these are the way things need to be provided if we are having a three throw switch.

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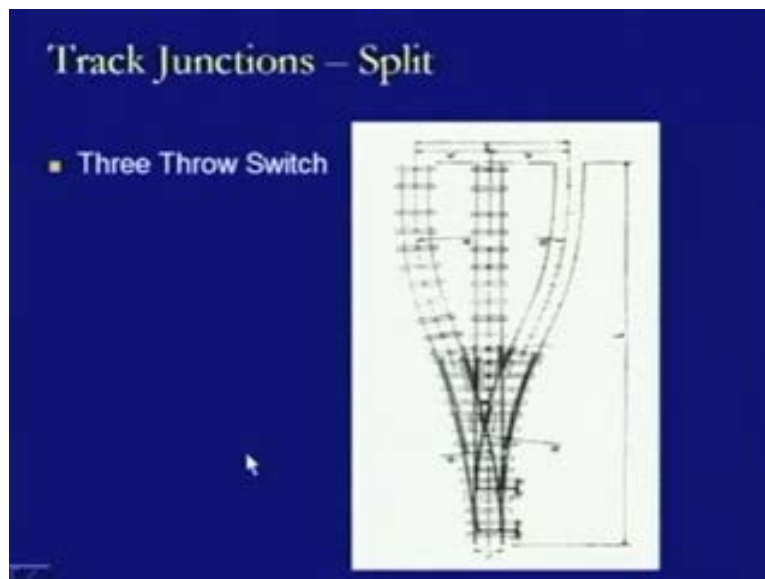
This is the diagram of a three throw switch. What we can see is that this is a main track, this one and then this is getting splitted into two more tracks which are going in either of the direction. That is it is going in this direction or it is going in this direction, again symmetrical in nature. Then, this is known as a symmetrical three throw switch with the contrary fractures, because this is this way, this is other side. Now, here what we can see is that we are having one here of points and switches being provided at this location, which allow the traffic to move either straight or in this way or in this direction and here what we find is that there is a connectivity of this curved rail at this location. At the same time, there is a connectivity of this one also at this location with respect to this lead rail which is a continuous lead rail.

So, it means we are supposed to provide two tongue rails at this location. Similarly, we have to provide two tongue rails at this location. Then only we can define whether the train will be going straight or whether it will be coming to this one with respect to this particular lead rail, because if there is a wheel on this lead rail and if the connectivity of this one is having a throw off switch, whereas this is being connected to this one, then it will go on the main track. Whereas if this is also being connected and this is also being connected, another one also, then that for this curved track, then the train will be coming

on this one turnout. So, that is why the two tongue, pair of tongue rails need to be provided here and here there is a crossing as we can see and this is V shape.

So, this V shape will be having like this and then this rail which is coming this way will be having a wing rail at this location, whereas this location and then we come to this particular location again there will be a crossing at this location as well as this location. That is why we will be having one wing rail condition at this location also. So, that means we are having three crossings at this one and one point and switch, but with the two sets of tongue rails.

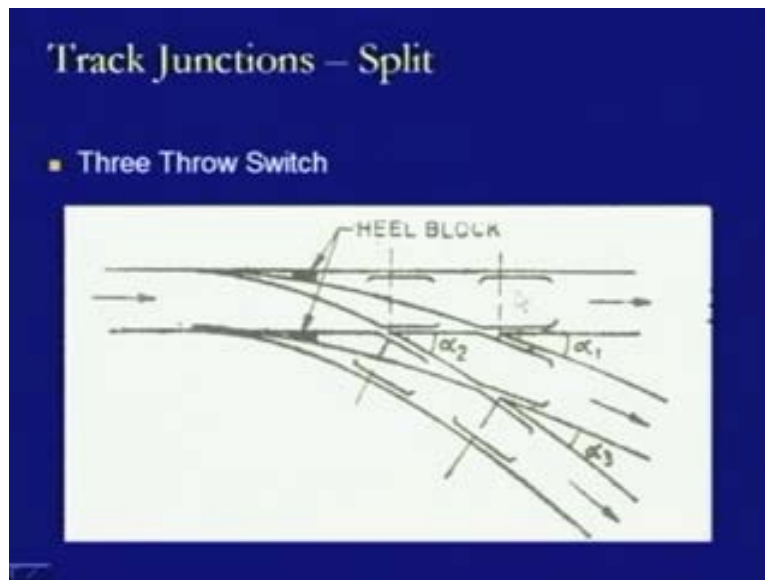
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This is another diagram of the similar condition, where the same sort of things have been tried to be shown. That is this is one track, this is another track and we are having two tongue rails at this location, similarly in this is at this location. Then, there is a crossing coming at this one and there is a crossing condition which is coming at this one and this one. So, this darker line, this is showing the wing rail here as well as the wing rail here. This is bigger check rail being provided on this side and a bigger check rail being provided on this side, so as to provide an extra proportion of safety measure to this type of a split switch.

So, we can see here that there is an operation at one point, this point at this location as well as this location, so as to define whether the train is going to this track or it is going to this track or further it is going to this track.

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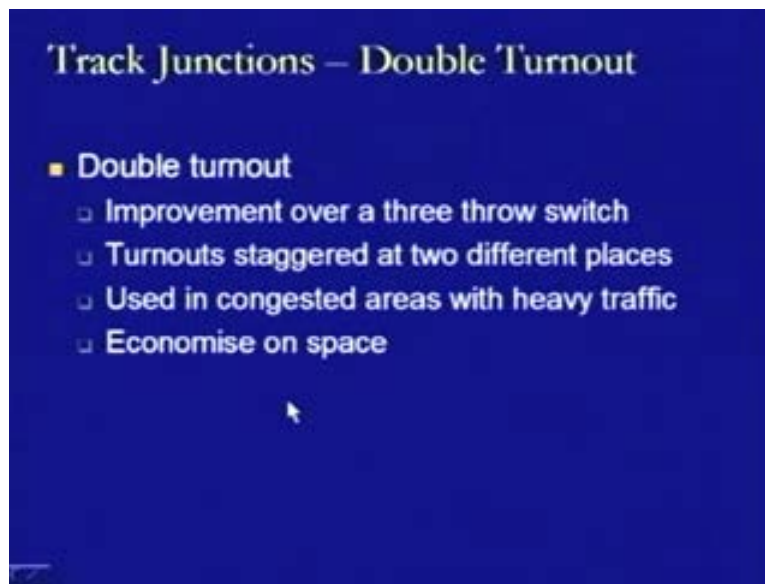


Then, in this case, this was the contrary flexure condition. Now, this is a similar flexure condition where the two tracks which are coming out of the main track are moving in the similar same direction, not opposite to each other and the only thing which is different in this case is that the one track is having more flexure as compared to the other turnout track and this other turnout track is having a more flexure as compared to this one which has a straight profile that is the main track.

Now, here what we find is that again there will be two pairs of the tongue rails, because this is one pair of the tongue rail, this is a distance block or the heel block which is provided at the heel of the switch. This is the toe of the switch. Therefore, there are two types of movement. One movement is for this track that is governed by this connectivity and this is another movement for this track, again this is governed by this connectivity. So, this distance block will also come up to this location and will connect to it like this, so that it remains in position and there is an extra safety measure here, because we are

providing one wing rail at this location. Therefore, the check rail has to be provided at this location opposite to it, whereas again we are having two more crossings being provided here. They are just coming overlapping each other in the similar position, because of the type of the curvature which is being provided. So, here also we will be having a check rail being provided here and at this location. So, we have two pairs of check rails, three pairs of wing rails, two pairs of tongue rails and the point three crossings likewise and we have the different angle of crossing. This is angle alpha 1, this is alpha 2 and this is alpha 3.

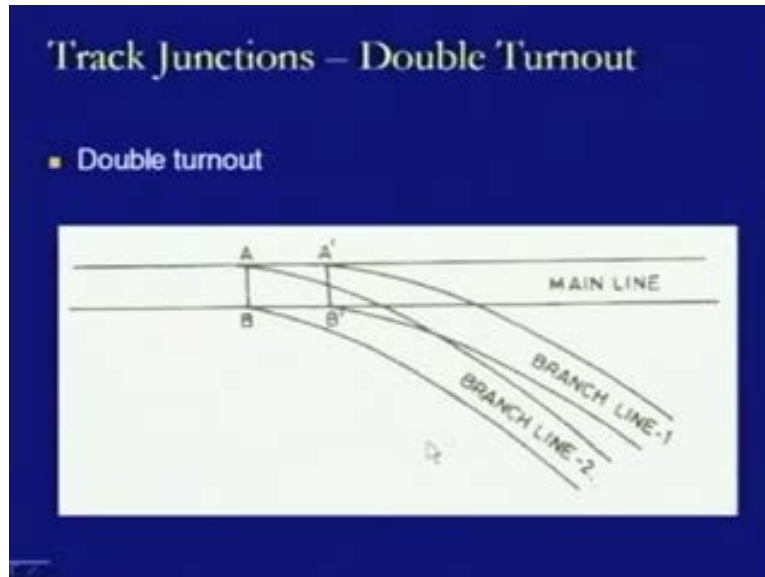
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Now, coming to the double turnout, in the case of double turnout it is an improvement over a three throw switch. The turnout is staggered at two different places. In the case of the three throw switch, what we have seen is that the turnouts are coming from the same location. But in this case, the turnouts are not coming from the same location; they are coming from different places. So, in the previous case, we were requiring two pairs of tongue rails at the same location and therefore, the movements were a little complex movements and the design was also a little complex. But in this case, as they have been staggered, therefore the design remains the normal sort of a turnout design as we have seen previously and it is used in congested areas with heavy traffic, where the possibility

of getting any mishappening occurring at a point where the two sets of tongue rails are moving side by side that is removed and it economize on space also, this is another feature which is being observed.

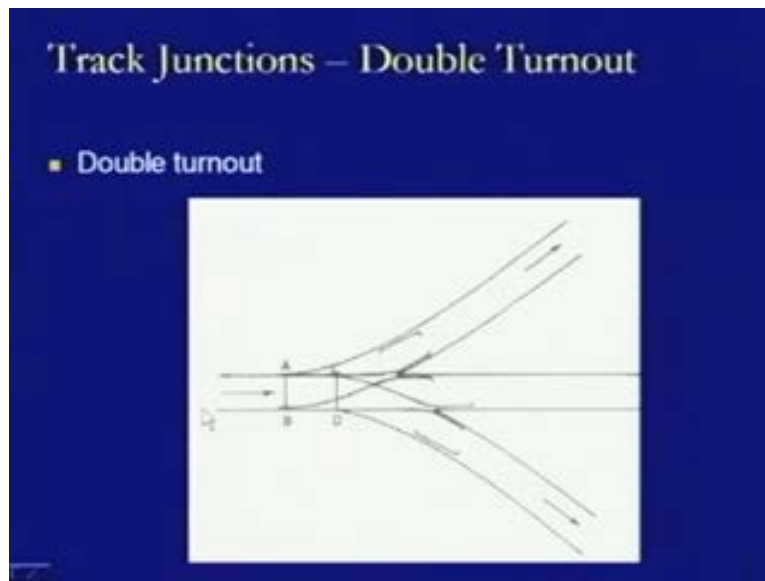
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We will look at the diagram of double turnout. The diagram is something like this that this is a main line, this is one branch line, this is another branch line and the two branch lines are not starting from the same location of the point or the switch. This is one pair of point and switch, this is another pair of point and switch. This branch line which is having more flexure is coming from this pair of point and switch that is A B, whereas in the case of branch line which is having a lower flexure that is line 1, it is coming out of a point or switch being provided or shown as A dash B dash.

So, this is a staggering of the points at this location and we are operating either this and if we are operating this, then there is not going to be problem with respect to this one, because we are not making any change to the location, to this one and there is no possibility that by some chance that the train may move on this track as compared to this one, if both of the things have been provided at the same location. So, that is already being eliminated in this case.

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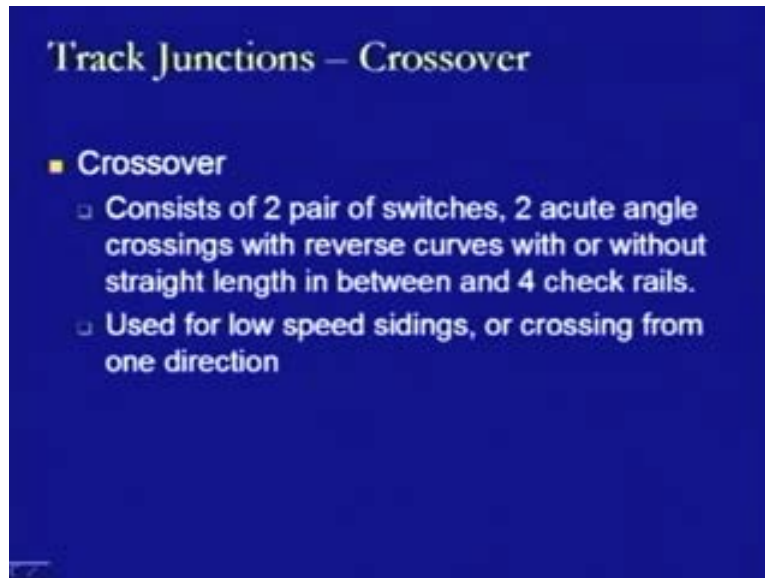


Then we also look at another type of double turnout, where instead of similar flexure, we have the contrary flexure and this is the main line. This is again being shown here and we observe that there is a left hand turnout which is coming from the initial release point and later point that is CD is related to another turnout which is coming in the right hand direction. So, on the basis of these locations, the type of components which needs to be provided on any double turnout, they are the two pairs of points and switches being provided and shown as AB and CD here and we have the two crossings. One crossing is at this location, another crossing is at this location.

So, here we have one pair of wing rails, here there is another pair of wing rails and then, with respect to these wing rails we will be providing the jack rails. One jack rail is being provided here, another on this side and the small one can be provided at this location too. So, that is how they are crossing each other in this side as well as there will be a crossing at this location you can see here. So, this is V and at this V, again there will be a pair of wing rails being provided like this. So, this is another place where the crossing will be provided. So, we have three crossings and depending on the flexure, this crossing may be the centre line position or it may shift towards either the left or towards the right.

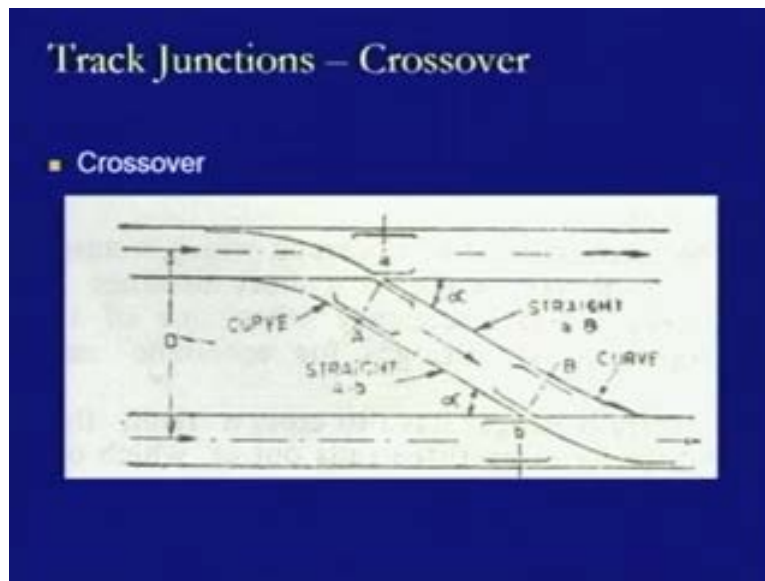
Then, we come to another category of train junction that is crossover.

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In the case of crossover, it consists of two pairs of switches, two acute angle crossings with reverse curves with or without the straight length in between and 4 check rails. These are the constituents of any crossover and we will look at how this crossover looks like or shape is. It is used generally for the low speed sidings or the crossings from one direction only.

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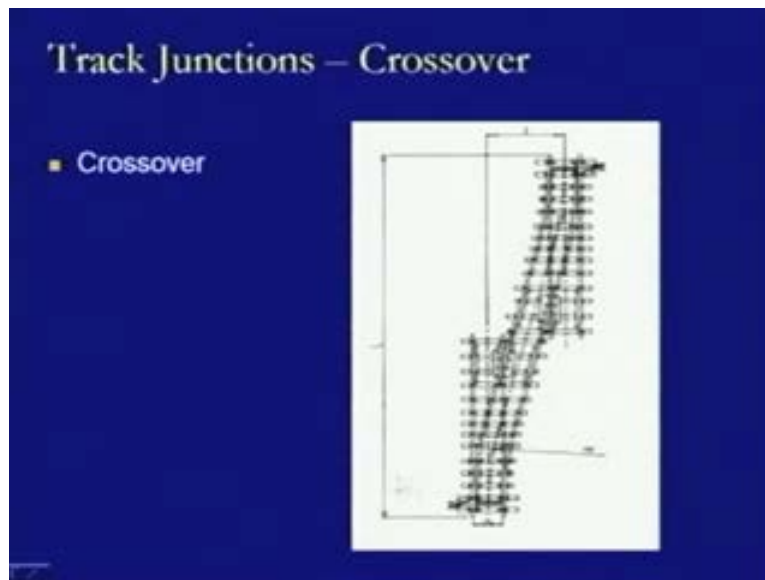


So, we have this figure, which tries to show the crossover, where we can see that there are two parallel tracks. One parallel track is like this. These are the two parallel tracks which are moving at a distance of, centre to centre distance, D that is the capital D and then, we have this crossover from this direction to this side or from this direction to this side. That is how the crossover is being provided. There is no connectivity from this direction, so as to go to the track in this direction. So, that connectivity is not there in the case of crossover; one directional connectivity is there.

So, we have a curve being provided at this location. Then, there is a straight portion in between and again there is a curve, but the curvature are opposite to each other and that is why it is a reverse curve condition with the straight portion in between. So, this is one curve in this curvature, this is another curve in opposite curvature, with a straight portion in between and this is the design of the reverse curve and this straight **lanes** can be completed based on this angle of crossing that is α which is because they are parallel to each other. So, this is the same angle being here, α as well as here and here we have a crossing at this location and we have another crossing at the bottom also at this location and so, we have a pair of wing rails here, we have a pair of wing rails here. We have a check rail on this side, check rail on this side, check rail here also and here. So,

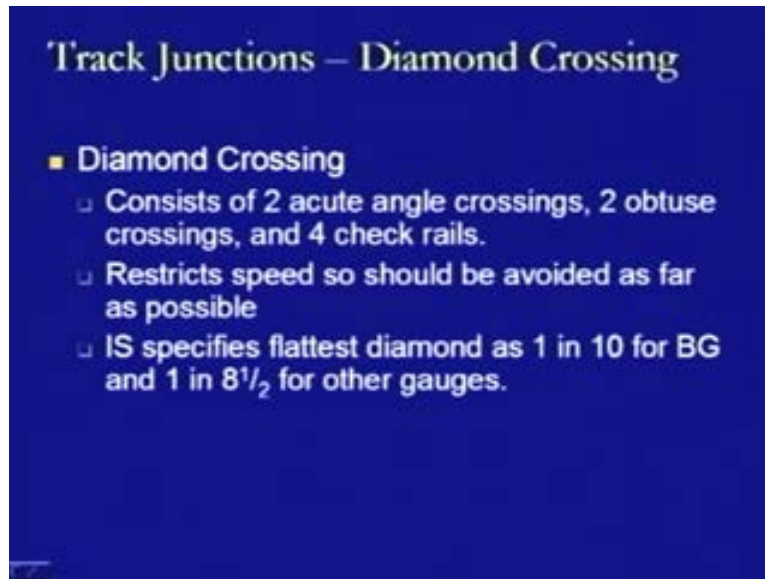
two pairs of check rails are there. Then, there is one point of switch here and one point of switch here, so two pairs of point and switch will also be provided in this case. So, these are the constant assemblies for any crossover.

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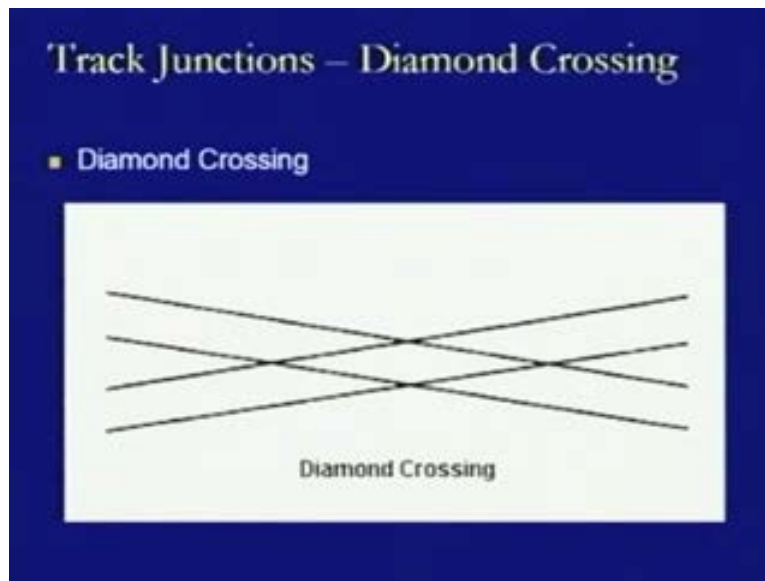
This is another diagram which tries to show the similar sort of condition that is if we have the two parallel lines like this as well as this one, these are the two parallel lines and we have a possibility by using this crossover, so as to move in the right direction and merge with the track which is provided on the right hand side of the initial track or if you are coming from the other direction then, so as to merge with the track which is provided on the left hand side of the previous track. So, that is what is the connectivity being provided and in that connectivity we are having a crossing at this location and we are having a crossing at this location. So therefore, we have the wing rails provided here. This wing rail is being provided at this location. This is this one and this one and then, we have the point location at this and the point switch location at this one.

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Now, coming to the diamond crossing, diamond crossing is a specific sort of crossing being provided and it has acute angle and obtuse angle conditions. So, it consists of the two acute angle crossings, two obtuse crossings and four check rails. So, as I just started discussing that, because of its shape like a diamond it will be having two acute angle crossings and at the same time, there will be on the other side at 90 degrees to that one and we will be having two obtuse angle crossings and looking at this thing, we have to provide four check rails or may be, we can say the two pairs of check rails needs to be provided and it restricts the speed, so should be avoided as far as possible. That is one of the limitations of provision of a diamond crossing. Indian standard specifies the flattest diamond as 1 in 10 for broad gauge and 1 in eight and half for other gauges.

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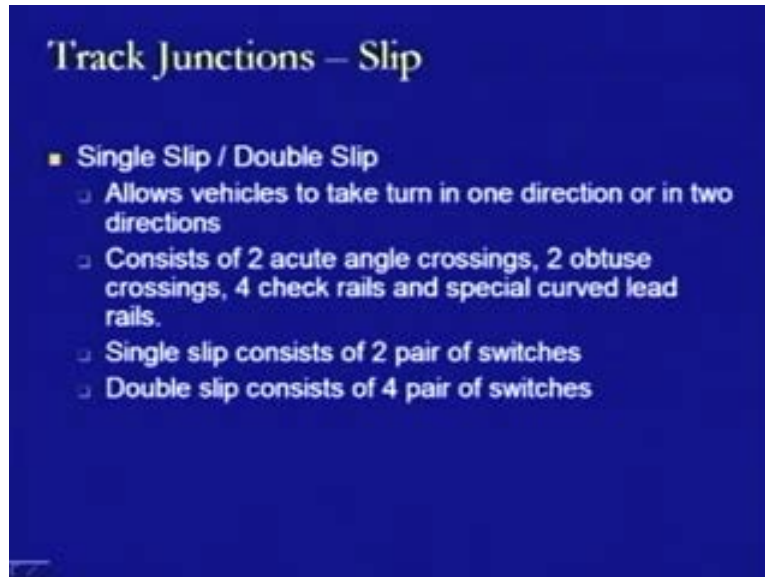


We will look at diagram of diamond crossing. These are the two tracks which are crossing each other like this, you can see. So, what we have is we have acute angle at this side, we have an acute angle at this location, whereas we have this as an obtuse angle here and this obtuse angle here. That is why there are two acute angle crossings and two obtuse angle crossings. So, this is one crossing location, this is another crossing location; both are similar in nature, alpha being the same and this is another crossing and opposite to this there is another crossing. Again, these two are similar in nature, being alpha is same for these two.

So, we will be having four such crossings being provided and therefore, we have wing rails provided at this location, we have the wing rails provided at this location. These are the two locations where the wing rails have to be provided. So, these are the things which will be there in this case. If the wing rail is here, then the check rail will be located here as well as here. Similarly, a check rail will be located here as well as this location. So, they are the locations of the check rails.

Now, we will be looking at the design of this diamond crossing in detail at the end of this lecture along with the design of the crossover which we have just seen that it was having a reverse curve with straight portion in the centre.

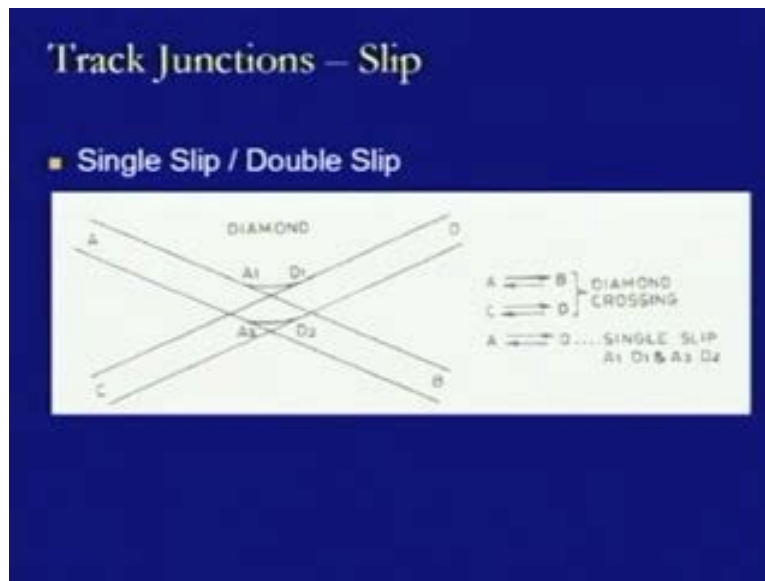
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So, apart from these, then there are some more type of junctions like there is a junction where it is termed as slip and this slip, it may be single slip track junction or a double slip track junction. What happens in this one is that it allows the vehicles to take a turn in one direction or in two directions, depending on whether it is being provided with a single slip or it is being provided with a double slip. So, that is what is to be seen, that what is being provided, accordingly the single direction or the two directional turning may take place and it consists of two acute angle crossings, two obtuse crossings, four check rails and special curved lead rails.

So, as we will be looking at the diagram, we will see that two acute angle crossings are there, two obtuse angle crossings are there, as it was there in the case of the diamond crossing and here we have four check rails that is two pairs of check rails and special curved lead rail. Single slip consists of two pair of switches, whereas the double slip consist of four pair of switches.

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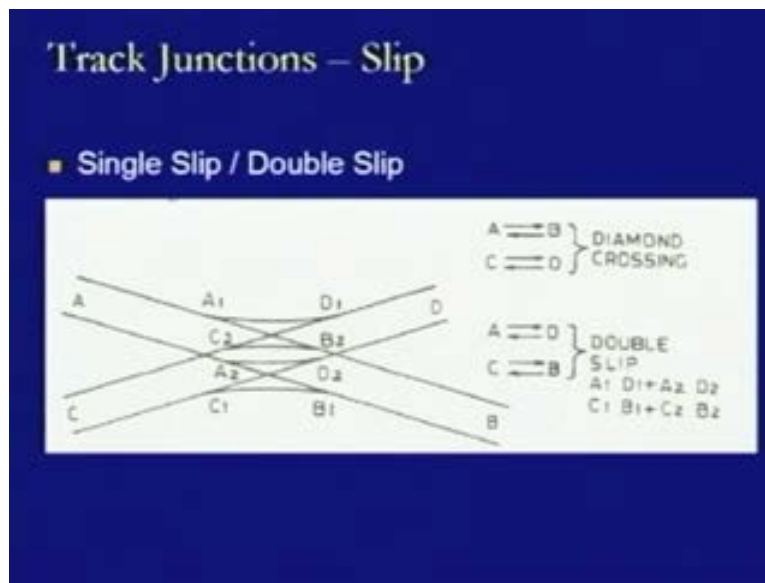
So, we look at the diagram of single slip and double slip condition. This is the diagram of single slip and double slip condition. This is a modification of diamond crossing basically, as you can see from the diagram itself. Here, what we see is that this is one track and this is another track and they are crossing each other. That is why they are making, forming a diamond at the centre like this. But, the problem with the diamond is that it is not allowing you to take a turn and move in this direction. So, this is not being allowed.

Similarly, the movement from this direction to this direction is not allowed. Only a straight directional movement is allowed in the case of diamond crossing. That is the biggest limitation of a diamond crossing. So, to improve upon that limitation, the single slip and double slip track junctions have been devised and in this case of a single slip condition, what we are doing is that we are connecting A 1 with D 1 that is like this one. So, there is a curved track being provided at this location and similarly there is a curved track being provided at another location. This refers to this one that is A 2 D 2.

Now, as soon as this curve position is being provided, then it will allow the movement from A to D, which was otherwise not possible initially. So, in the diamond crossing, as

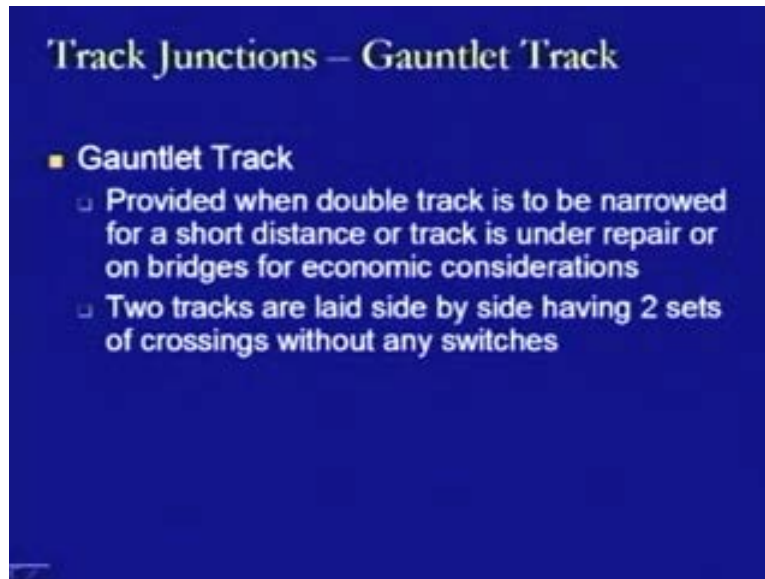
we see, it is also being written, the movements are either from A to B or back that is from B to A as well as from C to D and back that is from D to C. That was the type of movement available in the case of the diamond crossing. But in the case of single slip, we also have A to D or D to A. So, it means the number of movements have been increased in the case of a single slip.

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So, in the single slip and double slip condition, now we look at another diagram which tries to define the double slip. Here, what we can see is that apart from the movements which are provided on a diamond crossing that is A to B and back and C to D and back, we are now also having another movement that is from A to D and back and C to B and back. So, we are providing a curved condition on this location and this location for A to D and similarly for C and B connectivity like this and like this. So, two sets of, two pairs of the curved lead rails are also being provided in this form and that is why, now there is a possibility of taking a movement in any of the direction. So, the restrictions associated with the diamond crossing movement have been removed or eliminated by using a double slip.

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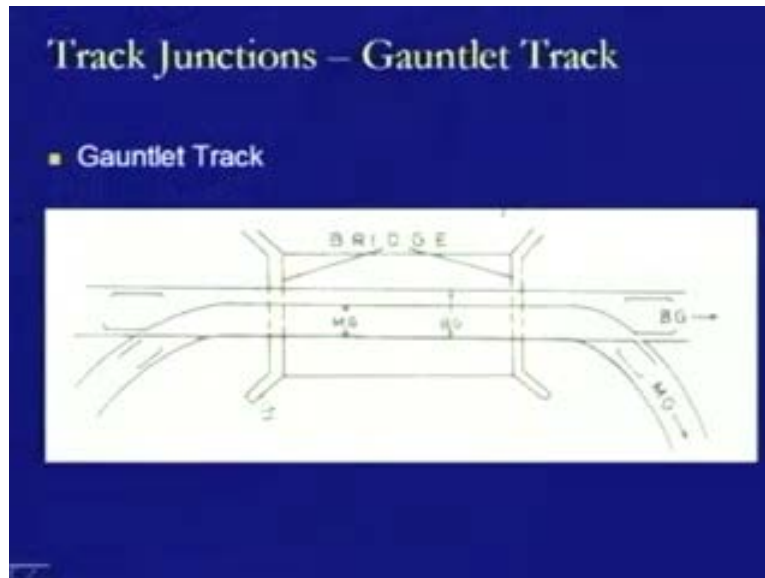


Now, we come to another category of track junction which is known as gauntlet track. In this gauntlet track, it is provided where the double track is to be narrowed for a short distance or the track is under repair or on bridges for economic considerations. What happens is that if there is a requirement of providing the two tracks, which are of different specifications at the same location, then that type of condition is a gauntlet track. This may be provided because there is narrow space available and that is why it is to be done in that one or it is to be done on the bridges from the economic point of view or sometimes if there is a repair going on, then we provide another track which is a temporary track being provided on the side and that is also termed as the gauntlet track.

The two tracks are laid side by side having two sets of crossings without any switches. So, there is no chance of movement from one track to another track in this case and that is why there is no switch in between, because we are not interested in providing the movement from one track to another track being the specification may be different or being the one track is not in use and therefore, there is no point in making that switch over.

We are looking at the diagram of this gauntlet track.

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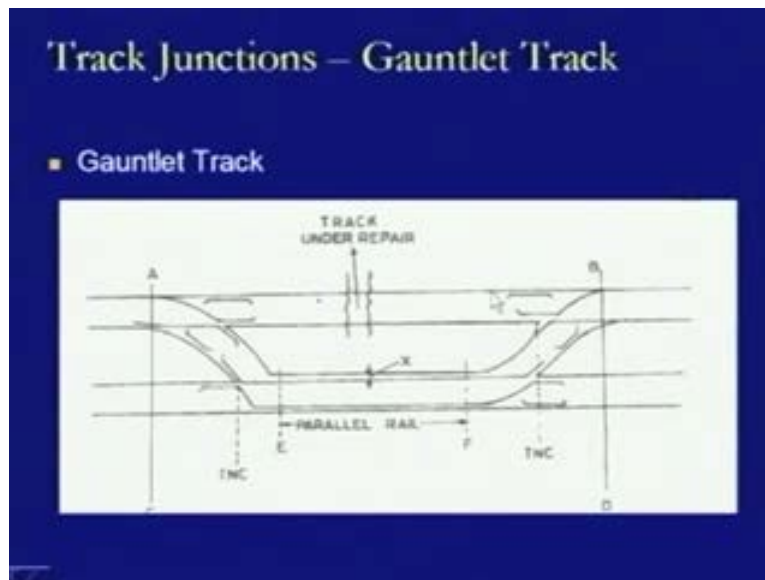


Here, what we see is that this is a main track being provided and this main track is of a broad gauge specification. There is another track which is coming from this side which is meter gauge specification. It also has to cross the river and has to go to the other side. Now, there are two ways of doing the same thing. One is that we provide two bridges or we expand the bridge and provide one line for a broad gauge and another line for the meter gauge. So, in both those cases, where a new bridge is being constructed or the existing bridge is being extended, it becomes costly affair; it is not economical.

So, what we are doing here is we are merging the meter gauge with the broad gauge. So, this meter gauge line will come and will join this broad gauge at this location. So, we have to provide a connectivity at this location here. What we find is that this becomes a crossing. So, we have a wing rail located here along with the check rails and because the size of the meter gauge is lower than the broad gauge, so this line will remain extra line other than this one. So, we are not providing a shift from this meter gauge to broad gauge. So, that is why there is no point or switch being provided and here again we have one crossing at this location and that is how it goes out again and away from the main line.

So, that is what is termed as the gauntlet track. Similar may be the condition other than if there is not a bridge and there is a repair work going on, on the main track, then we can provide another track which goes this way and come back to the normal condition. So, that will be another condition of gauntlet track.

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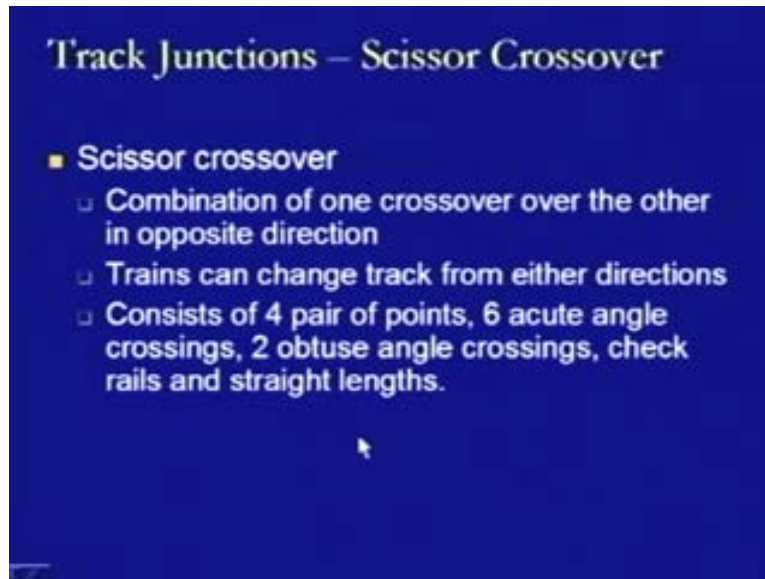


Like, if we see in this diagram, this is the location where the repairs are going on. So, that is why it has become unoperational. Now, so as to make it operational, the traffic has to move, what we are doing is we are using the help of another track being laid on the other side without disturbing the movements on that track. So, we have provided this connectivity from this side that is from point A it becomes parallel to another track in this area and goes back to the point B.

So, we can see that this is **line** rail, which is placed side by side of inner side, whereas there is another rail which is placed side by side on the outer side, so that the gauge remains the same, but there is no change over in another track. But here, we are required to provide four sets of crossings. One at this location, one is this, one here and one here. So, therefore four sets of crossings means four sets of wing rails and here we will be having one set of check rails on this side and similarly a set of check rail has to be

provided on this side also, not being shown here. So, these are the different types of gauntlet tracks need to be provided.

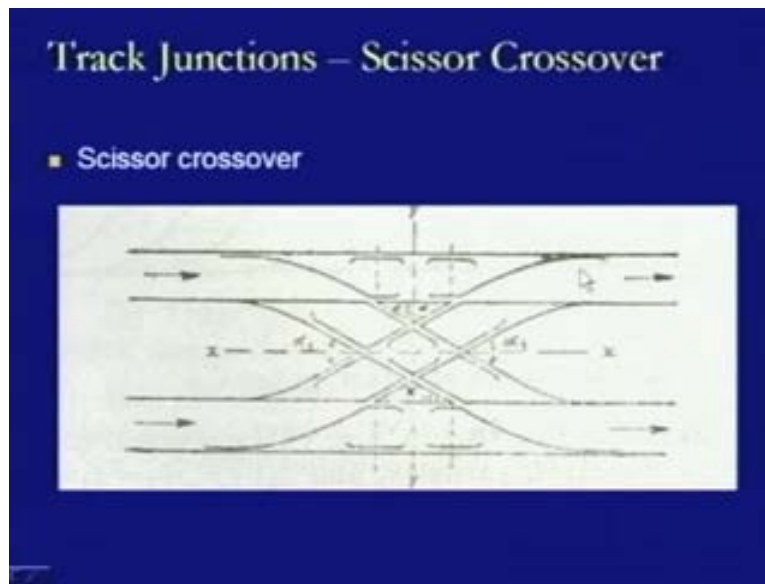
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Then, there is a scissor crossover. In the previous crossover, what we have seen is that only one directional crossing was provided from one track to another track, whereas this one is the combination of one crossover over the other in opposite direction. That is if you are overlapping the two crossovers over each other and take them in opposite direction, then that type of a combination is known as a scissor crossover. The scissor means it is a shape of a scissor which we use for cutting any of the object.

The trains can change track from either of the direction because of the connectivities being provided both the sides and it consists of four pair of points: 6 acute angle crossings, 2 obtuse angle crossings, check rails and straight lengths. So, these are the constituents of any scissor crossover.

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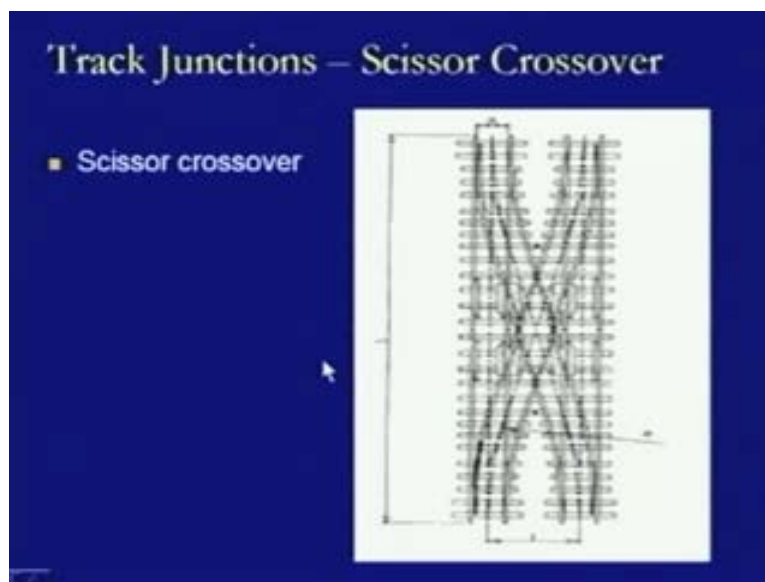
We will look at the diagram of a scissor crossover and this is a typical diagram of a scissor crossover, where the two tracks are laid parallel to each other and we are interested in providing a connectivity from both the tracks, so that we can take a turn from any of the track to the other track in either of the direction. So, there is one connectivity being provided from this side and there is another connectivity provided from this side. Because of this sort of a connectivity, what we find is that we have number of crossings and at the same time, we have a diamond crossing provided at the centre. So, here this is one point or switch, there is another point or switch here. There is a point switch here and point switch here. That is four sets of switches are being provided. Then, there is a crossing at this location as well as this location. So, we have a wing rail at this direction, at this direction.

Similarly, there is a wing rail here and there is a wing rail here. This wing rail is extended, so as to form a part of diamond crossing and so, this is coming here, goes this way and it becomes a wing rail again on the other side that is of this acute angle crossing. So, this is the way we are using the same rail sections, so as to become a wing rail or a lead rail, at the same point of time. So, here again what we find is that this is a wing rail

..... becomes a part of diamond crossing and again it becomes a wing rail on this side, where another acute angle crossing is being provided.

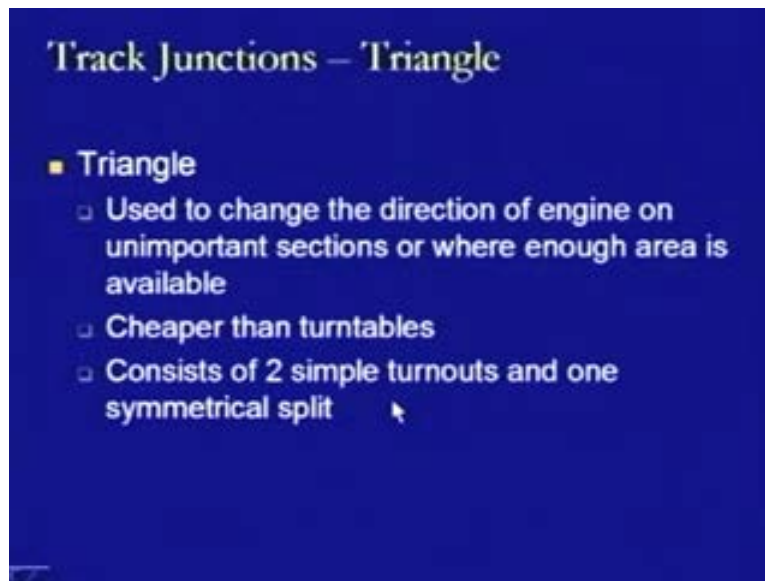
In the case of the obtuse angle crossing also, where we find that there is one crossing in this location, one at this location, so we have wing rail here on this side and this side, but the other wing rail is becoming a part of the diamond crossing. So, we have a wing rail pair provided inside like this here as well as this, this way here and we have the check rails being provided. There are two here, so two sets of check rails being provided here; this is one and this is one, this is another and another. So, these are the pairs which are provided here.

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This is another diagram of scissor crossing, which is trying to depict the locations of points, switches, crossovers and the type of accessories which are required at those locations.

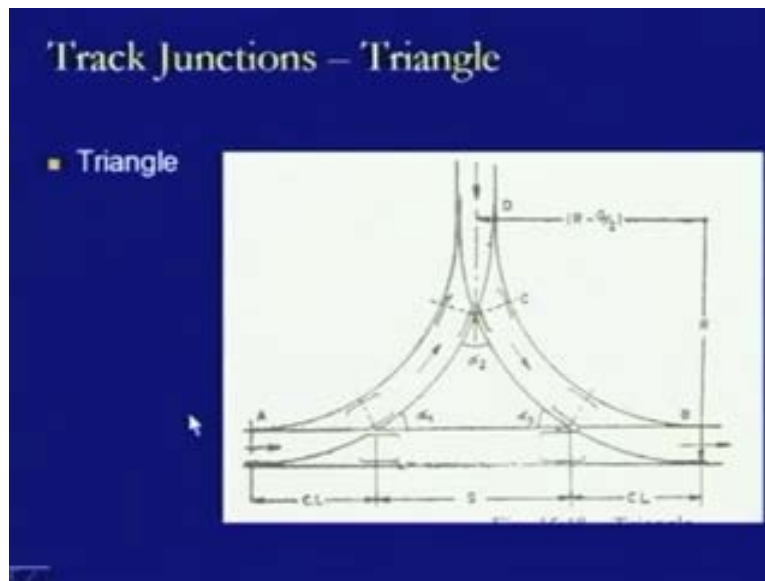
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Now, we come to another type of a track junction which is known as triangle. Triangle has been typical type of a track junction which has been provided generally in the olden days and this is also available in this area of Roorkee - Saharanpur belt, where the connectivity is being provided and the engine has to take a turn. Generally what is done is that it is used to change the direction of engine on unimportant sections or where enough area is available. These are the two conditions, either the section is not very important or there is a large amount of area which is available due to which a triangle can be provided, so as to make a change in the reversed direction of the engine.

Another reason associated with this one is that it is cheaper than the turntables. The turntables which are provided, which are very small in size, the size of a locomotive and they are circular in section, so that on that circular section the rails have been provided and the locomotive comes and stands on the turntable. Then, the turntable is rotated and it will reverse the direction of the locomotive and the locomotive goes out of the turntable. So, that is the type of a facility which is known as turntable, but it is very costly and it requires a large amount of energy. Whereas, the triangle is not requiring any extra energy, only some directional movement is required by which we can reverse the direction of the engine and it consists of two simple turnouts and one symmetrical split.

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We will be looking at the diagram of a triangle. This is the main track and we interested to change the direction of the engine. So, it is not possible to do by using the same single one track. So, what we are doing is we have provided this connectivity like this. So, the engine will go in this direction in this form and then, it will come back on this track and will go in this direction and now, it will be having its head in this direction instead of the previous condition. So, in this sense we are having one crossing at this location, one crossing at this location and another crossing at this location. So, there are three crossings being provided.

Similarly, there will be three switches: one at this A location, one at this B location and one at this D location. So, these are the locations of switches and accordingly we have to provide the wing rails and check rails depending on wherever the crossings that have been provided. So, this a typical one diagram of any triangle which is used to change the direction of locomotive.

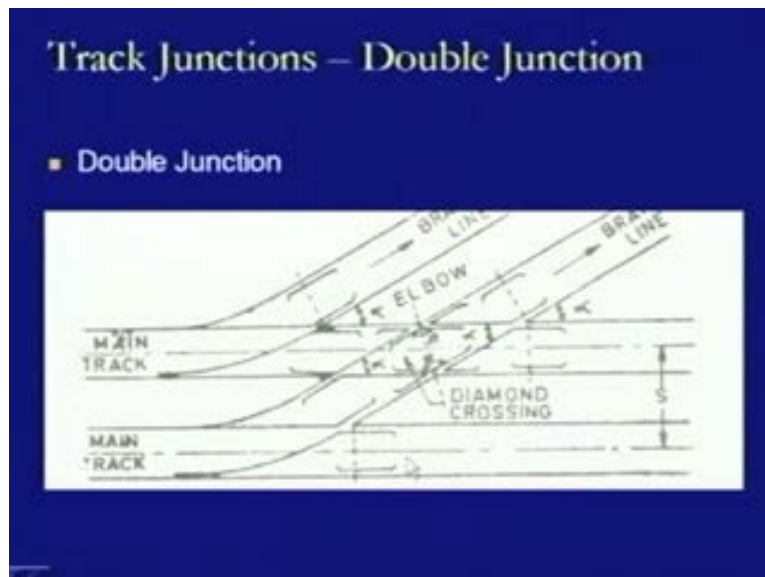
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Track Junctions – Double Junction

- Double Junction
 - Provided with two or more main tracks having branches
 - Consists of turnouts and diamond crossing

Now, we come to the double junction. In the case of double junction, they are provided with two or more main tracks having branches and it consists of turnouts and diamond crossing

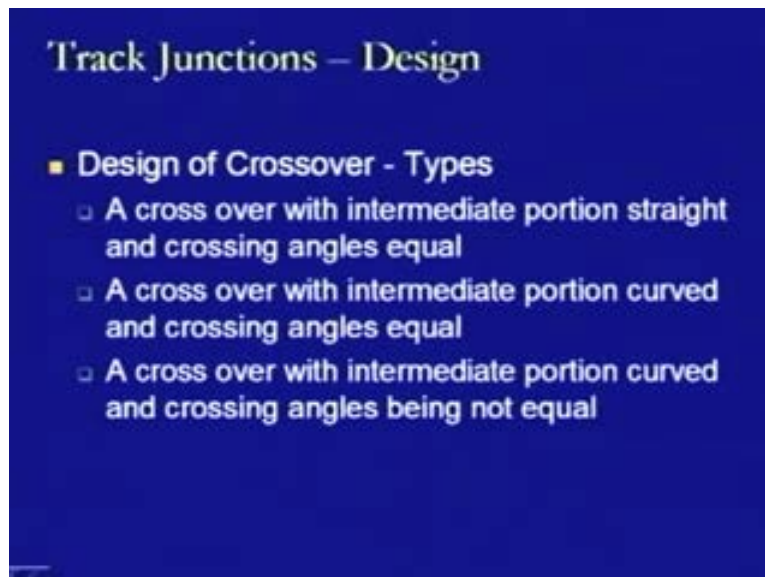
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We will be looking at its diagram, how it is done. We have two main tracks moving side by side with each other and what we find is that there is one turnout which is coming out of this main track and it also crosses another main track and then goes like this. So, it means it is creating a diamond crossing at the location of another main track. So, this is the location of the diamond crossing at this point and this is what is termed as double junction. So, there is one junction here, there is another junction here and then it goes away, whereas in this case, when it is going like this, this is a simple turnout, a left hand turnout.

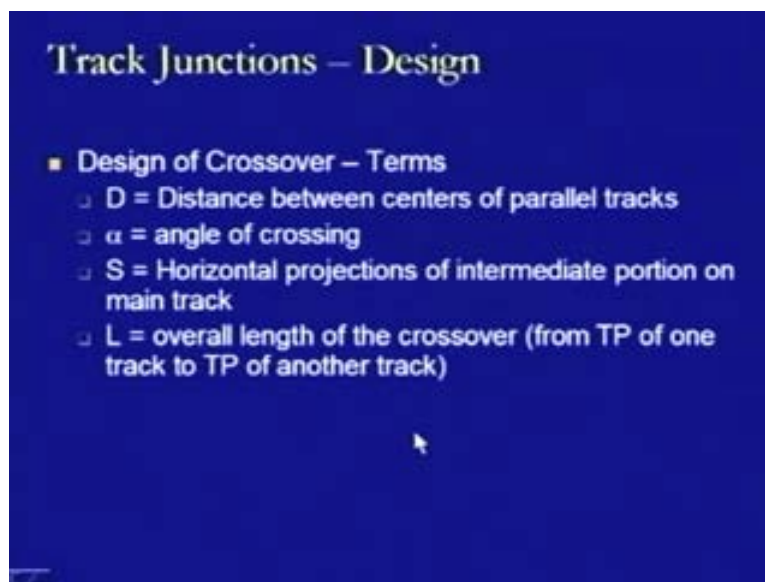
Therefore, whatever are the accessories, whatever the types of crossings need to be provided on a diamond crossing that is two pairs of acute angle crossing and two pairs of obtuse angle crossings, needs to be provided in a diamond crossing. So, this is acute angle, this is acute angle, this is obtuse angle and this is obtuse angle. We have a switch here, we have the switch here and that is how they are operated and this is another point of location where the crossing will be there because of this one or there is one crossing which is provided at this location. That is two extra locations where the two more crossings will be there.

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Now, we come to the design part of the track junctions. In the design part of track junctions, as being defined previously, we will be looking at two designs - design of crossover and the design of diamond crossing. Now, within the design of crossover, there are three types of designs, a crossover with intermediate portion straight and crossing angles equal. That is one type of condition of a crossover. Then, there is another crossover which is again having an intermediate portion, but instead of straight and crossing angles equal, we have the curved and crossing angles equal. So, the portion is having a curved section and the crossing angles instead and the third condition is that where we have the intermediate portion curved and the crossing angles are not equal. So, we will be looking at these three design propositions one by one.

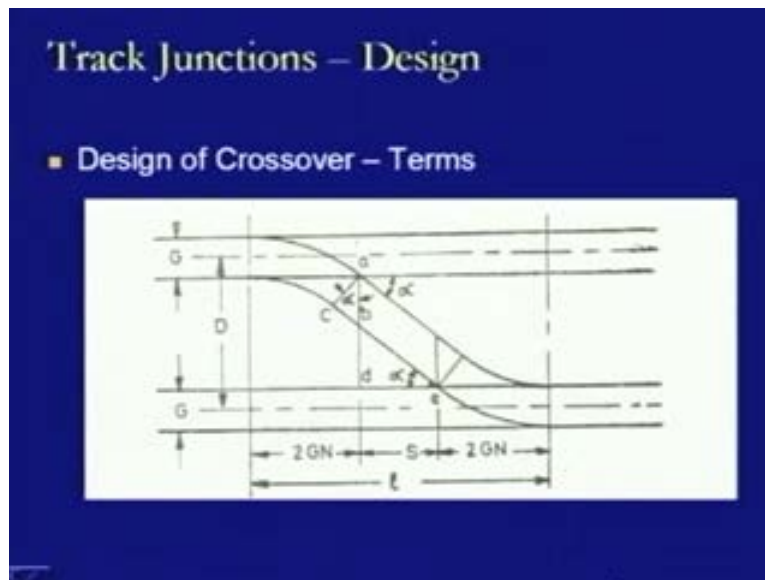
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In this case, let us first look at some of the terminologies which we will be using for the design purpose. D is the distance between the centers of the parallel tracks, as I have shown in one of the previous diagrams. So, if you have two parallel tracks, then the centrelines of those will be there and the distance between the centreline will be D, alpha is the angle of crossing, S is the horizontal projection of intermediate portion on main track. We have a straight intermediate portion as we have seen in the case of a crossing, where the reverse curve was provided with the intermediate straight section. So, that

intermediate straight section will be having one horizontal projection. So, if you take this as an intermediate portion, by using angle alpha we will be having this **cos** alpha will be the projection. L is the overall length of the crossover that is from one tangent point on the track to another tangent point on another track because of the S curve.

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Then, further in this case, the things are clearly being shown. These are the one track, this is another track with the gauge G and this is the centreline. These are at a distance capital D . Now, we have a reverse curve here. Then, there is straight portion in between and then, we are again having a curve on this side. That is why this is reverse curve. Now, this straight portion is having, this is starting from this to this one if you take the projection of this one, then this is S and then, this is a curved section.

So, this curved lead is there between this point and this point and this curved lead as we have seen in the case of design of turnout is equivalent to two times of G into N . So, this is two times of G into N , this horizontal distance. Similarly, this horizontal distance related to this curved lead will be two times of G into N . This is an approximate value of finding the curved lead here and then in between we have S . So, the total length of L , small l that is the length of this crossover will be nothing but this S plus $2GN$ plus $2GN$.

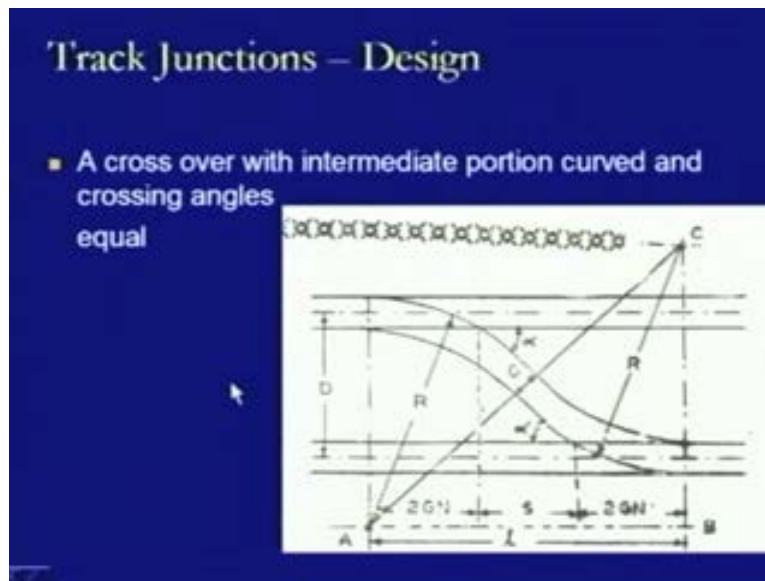
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Track Junctions – Design

- Design of Crossover
 - A cross over with intermediate portion straight and crossing angles equal
 - D = Distance between centers of parallel tracks
 - α = angle of crossing
 - $S = (D - G) N - G \sqrt{1 + N^2}$
 - $L = (D - G) N + G \{4N - \sqrt{1 + N^2}\}$

So, what we find is that the crossover with intermediate portion straight and crossing angles equal, then in that case S is D minus G multiplied with N minus G into, G is multiplied with the under root of 1 plus N square. That is how the value of S can be computed and the value of L will be nothing but, this plus 4 times of GN and it comes out to be D minus G multiplied with N plus G multiplied with combination of 4 N minus under root of 1 plus N square. This is how we can compute in a case as we have depicted in the previous diagram.

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Then, if you are having a crossover with intermediate portion curved and crossing angles, then here crossing angles being equal, so this is another diagram. We have the intermediate portion. Instead of a straight section, now it is a curved section. So, this curve comes up to this location and then, it is a reverse curve and this curve starts from here and goes like this. So, we are having two curves joined together in this form. So, therefore the curved lead for this one will be up to this point that is up to this way and the curved lead for another will be in the similar form. So, we have that one curved lead here, another curved lead here and then, this straight portion as will be defined on the basis of this curvature in the reverse form.

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Track Junctions – Design

- Design of Crossover
 - A cross over with intermediate portion curved and crossing angles equal
 - $S = L - 4GN$
 - $L = \sqrt{D(4R - 2G - D)}$

And can be given by S is equal to L minus 4 times of GN, where the crossing angle is still equal, but the intermediate portion is curved and L will be defined as that is the total length of the crossover under root of it is a combination of D multiplied with 4 R minus 2 G minus D.

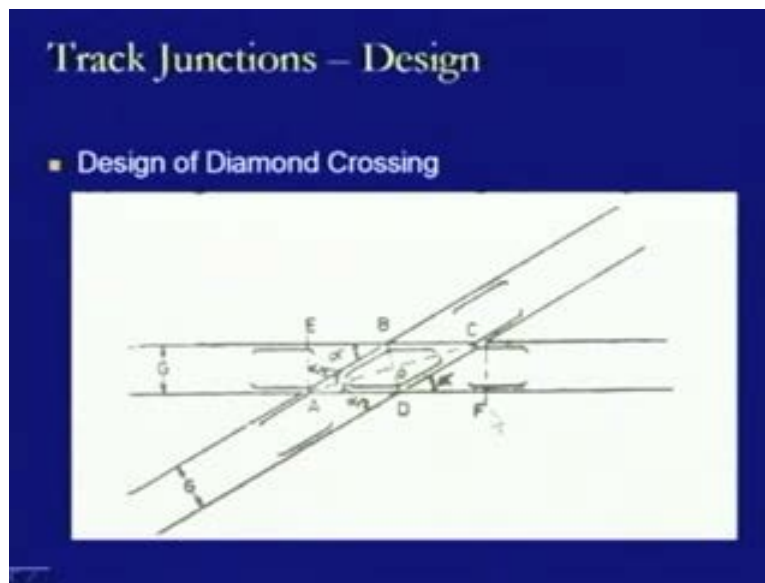
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Track Junctions – Design

- Design of Crossover
 - A cross over with intermediate portion curved and crossing angles being not equal
 - $S = L - 2GN_1 - 2GN_2$
 - $L = \sqrt{D(2R_1 + 2R_2 - 2G - D)}$

It says that the crossover with intermediate portion curved and here the crossing angles are not equal, so S will be given by $L \sin N_1 \sin N_2$, whereas the overall length will be given by $\sqrt{D^2 + 2R_1^2 + 2R_2^2 - 2GD}$. If we look at this N_1 and N_2 , they are related to the two crossing angles and similarly R_1 and R_2 are related to the two curves which will be there joining at the centre.

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Now, we come to the design of the diamond crossing. In this design we are having, as we see, this the gauge G and G . This is point A B C and D , this is the diamond and then, we are having a point with respect to this A on the other side as E . Similarly, for C you have F . This is angle α , this is also angle α ; this angle is a crossing angle and then, we have also connected AC and BD with the centre as O . So, using the geometry of this figure which is a simple geometry, we can now find out the length of different components of this one that is AD , AB , BC , CD . This is equivalent to this one, this is equivalent to this one. AD is equal to BC , AB equals to DC and then, we can also compute the value of EB and CF and DF .

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Track Junctions – Design

- **Design of Diamond Crossing**
 - From shape of Rhombus
 - $AB = BC = CD = DA$
 - From Property of Rhombus
 - $EB = DF = G N$
 - $AB = BC = CD = DA = G \text{ Cosec } \alpha$
 - From ΔACF
 - $AC = G \text{ Cosec } \alpha/2$
 - Similarly,
 - $BD = 2 BC \text{ Sin } \alpha/2$

How you can do this is that from the shape of rhombus AB equals to BC equals to CD equals to DA, all the four sides are equal property of rhombus can be found at EB equals to DF and it is computed to G multiplied with N, whereas AB equals to BC equals to CD equals to DA that is computed as G cosec alpha and from triangle ACF, AC equals to G cosec alpha by 2. Similarly, the BD is given as 2 BC sin alpha by 2. So, just by the simple geometry of triangles and the rhombus, we can compute all the components of any diamond crossing.

So, in this lecture what we have seen today is, what we have understood today is that is different types of track junctions which can be provided, so as to provide the connectivity between two tracks being laid simultaneously with each other, parallel to each other or sometimes there is a requirement of crossing, so how we can provide that type of crossing. At the same time, we have also looked at the two designs - one related to crossover, another related to diamond crossing. So, in this lecture along with the previous two lectures, we have discussed about the turnouts and the types of crossovers. Now, we stop at this one and we will be starting another new topic in the coming lecture. Thank you and good bye.