Transportation Engineering -II
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Lecture - 2
Gauges and Permanent Way

Dear students, I welcome you all to the lecture series on course material of transportation engineering two. In the previous lecture we have discussed about the history of Indian railways and we also seen the administrative set up of the Indian railways. In today's lecture we will be giving the focus on the different types of the gauges, their associative features and the permanent way.

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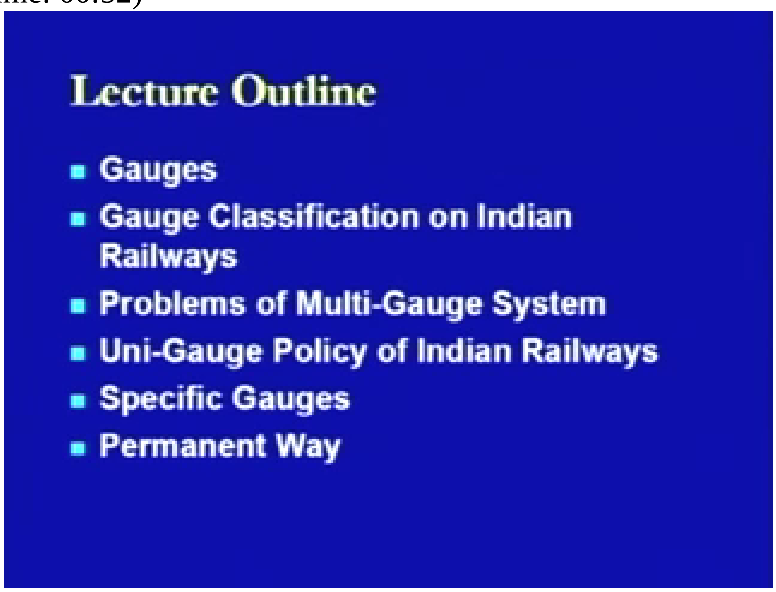

In this lecture, we will be discussing gauges, the gauge classification on Indian railways, the problems of multi gauge system, the uni gauge policy of Indian railways, the specific gauges and the permanent way. Now, we will be starting with the gauges and its classification adopted on Indian railways. The gauges as we see in this diagram. This diagram shows us a rail where in the head of the rail and the foot of the rail has been shown and the two rails have been placed parallel to each other. The tail distance between the head of these two rails is defined as gauge. Therefore, definition of the gauge will be- it is the clear distance between the two parallel rails laid in any track. So, with this definition we will try to look at what are the different distances or the clear dimensions which have been provided between the two rail sections of the heads of the rail sections by which we can classify the various gauges.

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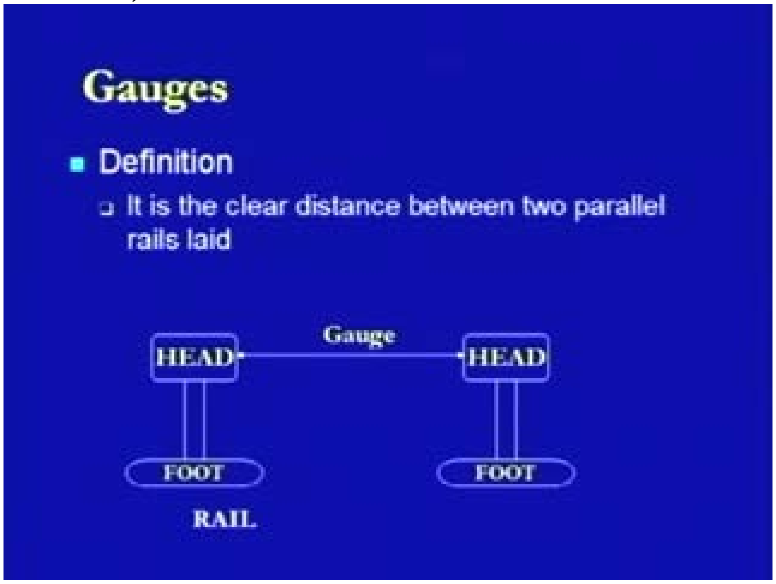

When we look at this classification, what we found is that they are different gauges which are available throughout the world. We have gauges like standard gauges. In the case of the standard gauges, the clear distance between the two rail sections is 1435 mm and these standard gauges are available throughout the world in on an average about 62 percent of the countries of the gauges which have been provided in the world, they are the standard gauges.

Another category is broad gauge. In the case of the broad gauge, the clear dimensions are 1676 mm or it is 1524 mm. On an average throughout the world the share of broad gauge is 15 percent. When we look at some of the countries in which the standard gauges have been provided, we found that they have been provided in United Kingdom, United States of America, Canada, Turkey and China. These are the major countries in which the standard gauges have been provided, though, there are some other countries too where these gauges have been provided. In the case of broad gauge, it is been provided mostly in the Indian sub continent or some other developing countries like India , Pakistan, Sri Lanka, Brazil, Argentina and Russia, again are the major countries in which the broad gauge has been provided.

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Other than the standard gauge and the broad gauge, there is another category which is known as Cape gauge where the dimensions or the clear distance between the rails sections is 1067 mm and it constitutes around 8 percent of the total gauges which have been provided throughout the world. Other than the cape gauge there is a meter gauge where the clear distance between the rail sections remains as 1000 mm and in this case the share of meter gauge throughout the world, worldwide is 9 percent. We can see it is a very similar to somewhere around 8 percent of the cape gauge. Other than these four meter gauges which have been provided throughout the world there are twenty three other gauges which have been used in different countries of the world.

Again, looking at different countries in which these gauges have been provided we found that the cape gauge has been provided in Africa, Japan, Australia, and New Zealand. The meter gauge; again in India, France, Argentina, Switzerland and then the number of other countries in which the other gauges have been provided. So, these are different gauges which are provided through different countries and what we found is that out of all these gauges, some of the gauges have been provided in our country, that is, in India.

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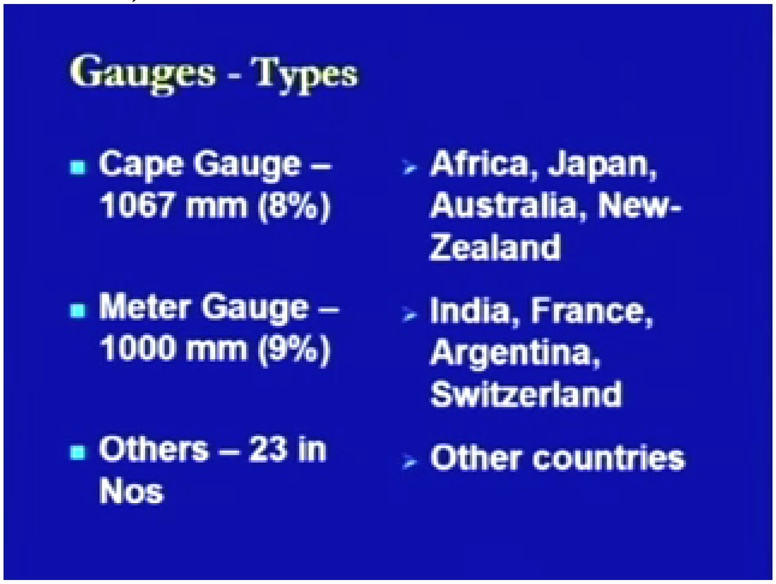

So, we will try to look at the gauges which have been provided in India. In India, we have provided broad gauge. The broad gauges have been provided on 63 percent of the route kilometers and dimensions which have been taken between the rail sections, they are 1676 mm. Normal clear dimensions which is being adopted in some of the countries like 1524 mm is not being adopted in India. Then another gauge which is used in India is meter gauge. In the case of the meter gauge, the distance between the two rail sections or clear distance is 1000 mm and this has been provided in 31 percent of the route kilometers provided throughout the railway network in India. Then there is another gauge which is termed as narrow gauge. There is a specific gauge which is provided in very specific area in our country and the clear dimensions in this case, they remain as 762 mm or 610 mm and it constitutes around 6 percent of the route kilometers.

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These narrow gauges as they found, as they have been provided in mostly the hilly areas where the terrain are such that we cannot go for the bigger gauges like meter gauges or broad gauges. Now the question comes, how we are going to select the gauge? Whether we should provide the broad gauge in any area or we should provide a meter gauge or we should go for a narrow gauge or a hill gauge, that is, 610 mm gauge.

The second factors which needs to be considered, the first factor which needs to be considered is the cost of construction. Of course, whatever decisions we take the very first factor which comes into consideration is the cost. The cost of the gauge or the provision of the gauge needs to be checked in terms of different components. It is to be checked in terms of the total amount of the area which is to be acquired, it distribute thousand times of the different other components of the construction or it is to be termed in terms of the earth work involved in constructing a broad gauge or a meter gauge or a narrow gauge.

Similarly, there is another factor is some specific features which needs to be provided on any track. One such feature like this is bridges. So we have to look at the cost of the construction of bridges also. Then there is a cost associated with the buildings, the cost associated with the plat forms or the physical features which needs to be provided at a terminal building or a junction building or any intermediate station. There is a cost which is involved in the controlling features like signals. Then there is a cost associated with the rolling stock, that is, the things which are moving on the track.

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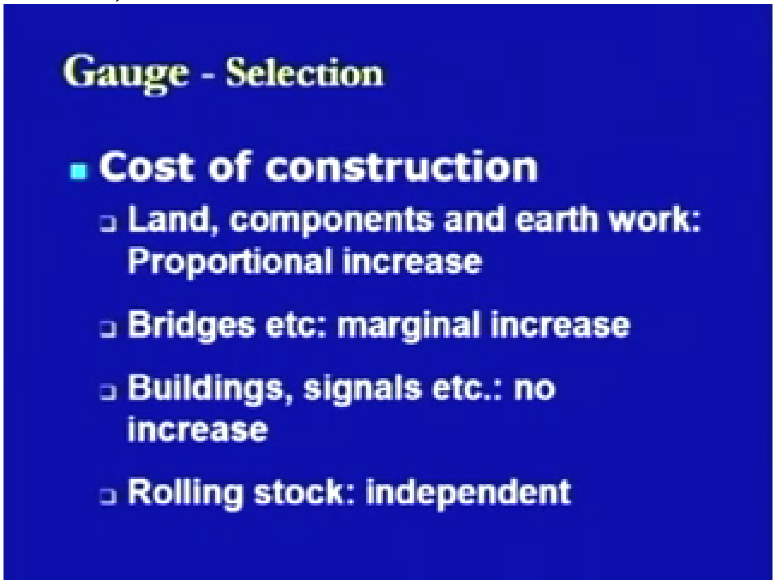

So, when we are looking at different cost of constructions, what we found is that all the components which we have just discussed now, they are not having the similar effect. If we are moving from say narrow gauge to meter gauge or we are moving from meter gauge to broad gauge construction, then what we found is that if we are taking a component like land or earthwork then there is going to be a proportional increase in the cost of construction, as we shift from the lower gauge to the higher gauge. Whereas if we are talking about the bridges, all the similar type of structures then there is a marginal increase in the cost, it is not proportional. In the case of the buildings of the signals because these are the, as these are the features which needs to be provided whatever gauge we are using, therefore, there is no effect of cost of building or signals in terms of the provision of a narrow gauge or a meter gauge or a broad gauge or changing from narrow gauge to meter gauge or changing from meter gauge to broad gauge. In the case of a rolling stock mostly we have to take at independently of the cost of the construction because there are specific features and specification which are associated with the meter gauge or the narrow gauge or the broad gauge and therefore that cannot be considered in this component.

Similarly, there is another factor which needs to be considered when we have to discuss about the provision of the gauge, that is, the physical features of the country. It is another important feature because we have to look at the capacity; we have to look at the different specifications which are associated with the constructions of that gauge. If you are looking at the broad gauge where the wider section has been provided or if you looking at the narrow gauge where a very narrow section has been provided with respect to the broad gauge . Then the total amount of specifications or the type of its specification they also remain in the same context. In that sense if we look at some of the specific features, physical features of the country like gradients, then we have to look at that whether it is feasible to provide a broad gauge or it is feasible to provide a narrow gauge so as to traverse arc gradient which is provided in any hilly mountainous area. Probably that is the reason that we have provided narrow gauges or heavy gauges in very specific locations like Ooty, Darjeeling etcetera.

There is another specific feature or physical feature, that is, curves. When rolling stock is moving on any of the track of any specification may be broad gauge, meter gauge or narrow gauge. Then we have to look at the ease at which the movement can be made and this movement is going to be controlled by the total amount of resistances or the total amount of forces which are acting on that track or the rolling stock. Looking at that aspect, there is again some limitations with respect to the curves. So it means we have to look at the gradients, the curves or similarly some other physical features of the country and then on the basis of that we should decide whether we can go for the construction of a broad gauge or a meter gauge or a narrow gauge. What we found is that if we are having a steep gradients or there are very extensive curves, narrow curves have been provided then it is better to go for narrow gauge, in the state of the broad gauge or the meter gauge, but if the gradients are quite feasible or the curves are having a large radius, that is, they are much of flatter curves in that sense we can go for broad gauge constructions. This is a example which has been given here, this hill railway like from Kalka to Shimla as you must have seen, you must have heard about or probably some of you have also gone through that experience of moving from Kalka to Shimla by a train and that is a hill railways.

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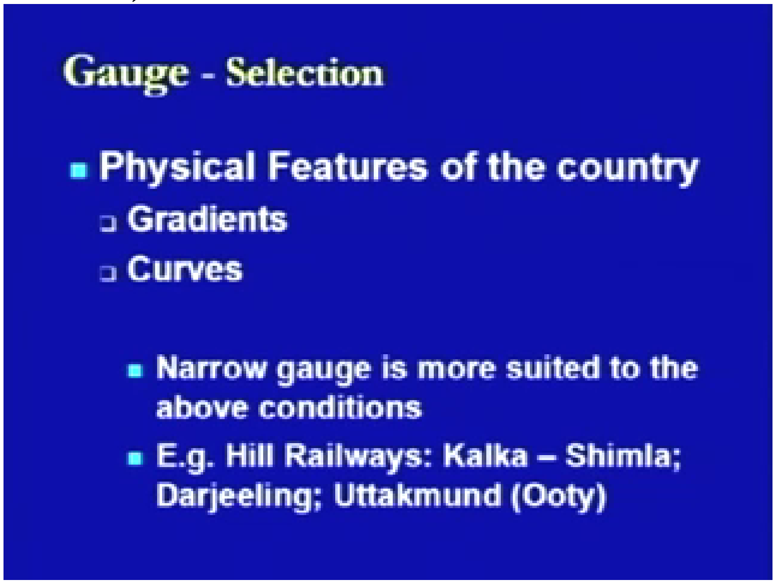

Similarly, there is another railway which is being provided in the Darjeeling area. You have to go from Siliguri to Darjeeling and that is another scenic beauty area where we have the heritage rural section still walking or the locomotive still working. Then, a third area here it is the Ooty area. So all these are specific area where the hill gauge or the narrow gauge has been provided with some further specific features, probably we will be discussing when we taking of the alignments of the rail sections. Then, the next factor which is there, which controls the selection of the gauge is traffic. What is the total amount of traffic which is going to traverse, which is going to use that facility? What is the nature of that traffic?

We have to look at all these aspects. Horizontal we look on all these aspects we cannot decide whether we can go for a broad gauge construction or a meter gauge construction. If there is no traffic at all or there is very small traffic available, then if we are incurring cost equivalent to the broad gauge construction that is going to be something like a useless thing or it will be extra expenditure which is being incurred in the provision of that facility. So, that is why there is a judicious requirement of thinking about what type of gauge can be provided with respect to the traffic which will be there or which will be going to use that facility. Now in this case if we found that there is a very heavy traffic, a large number of steps are going to be made by the railways, then we can go for a wider gauge that is the broad gauge. similarly, the another condition is that is there is a high volume, large amount of traffic is going to be there , large number of persons are going to use the facility or there are chances that commodities are going to be varied through the railway system , that is, the freight transportation has the potential in that area. In that case we again can go for the broad gauge constructions but if the volumes are low, then we can go for smaller gauges too.

Another aspect is the speed, in the case of the broad gauge as the size and diameter of the wheel increases, in that case what happens is that the total circumstantial area distance which can be moved by that will also increases and therefore the speed of the vehicle will increase, in the case of a higher gauge. That is why if they are interested in achieving higher speeds we can go for broad gauges instead of the narrow gauges or the meter gauges. In this case, again the traction or signaling they are independent things; signaling is one is that which controls or provides the safety on the track, whatever are the speeds, is not going to be controlled by the speed. It is going to define the things in terms of the movements going on any of the track so as to reduce the chances of any accidents taking place because of the unidirectional traffic or the bi directional traffic.

Similarly, it is the case in traction; traction means the total amount of practical effort which is available with any locomotive which needs to be provided on the basis of the traffic. If there is a higher traffic, obviously we are going for the broad gauge construction and then for those broad gauge constructions we have specific locomotives which can be used. Similarly, if we are talking about the meter gauge construction then again we have the specific locomotives which can be used for the meter gauge construction. Therefore, the things are quite independent as far as the traffic is concerned. Now another aspect is that if you are going for a wider gauge, it means we can haul large amount of persons or we can haul a large amount of freight between the horizons of the destination.

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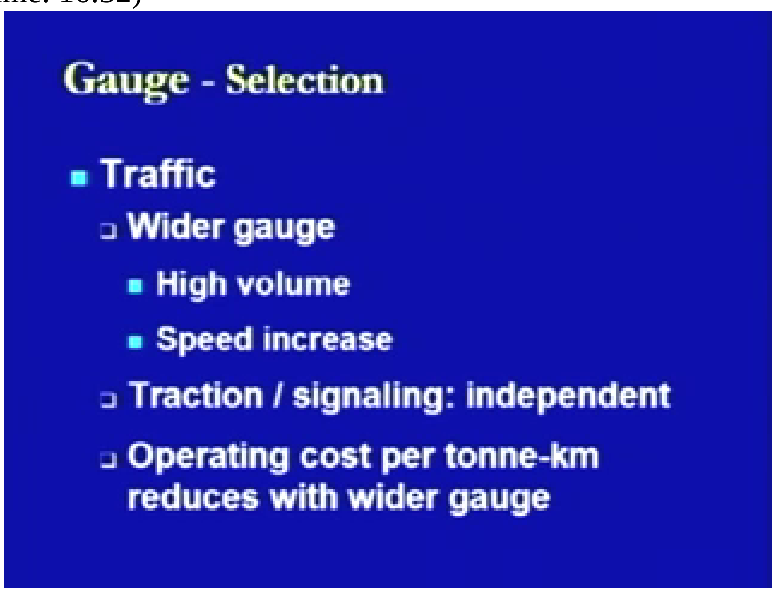

In that sense, the total operating cost per tonne kilometer will reduce. So there is another operational advantage which will be there in case we shift from a lower gauge to a higher gauge. So in this sense, there are so many factors which are interlinked with each other and therefore we have to take all of these together into consideration and then only we can decide that what type of gauge can be provided, it is not a single factor decision which can be taken as such.

Now, on the basis of all these, a certain classification which has been adopted in variables regarding all the types of the tracks of the gauges which can be provided. In the case of the broad gauge track classification, we have different groups like A, B, C, D and E and for these groups we are selecting features specifications which needs to be complied with. Now, these further slides, we will be looking at these groups of the broad gauge class classification and the specific features related to them. Here in this slide, we are taking the specification related to group A and group B of the broad gauge track classification.

In this case of the broad gauge track classification by this one the speeds are controlled up to 160 kilometers per hour, in the case of A category of broad gauge, whereas in the case of B category of broad gauge, the speeds are controlled, limited up to 130 kilometers per hour. Another aspect is the type of the rail section which can be used; this type of the rail section is defined in terms of the kg weight per meter length of the rail section. That is the one specific unit which is been adopted in Indian railways or in other railways too depending on the unit in which they are working. So we have to look at this aspects and this is defined in terms of the total amount of traffic which can be hauled. In this case the classification of this total amount of the traffic is being done in three categories. We have the traffic in less than 10 GMT, and then another category from 10 to 20 GMT and the third category is greater than 20 GMT. For all these categories the section of the rail has been defined in terms of the weight per meter rail length.

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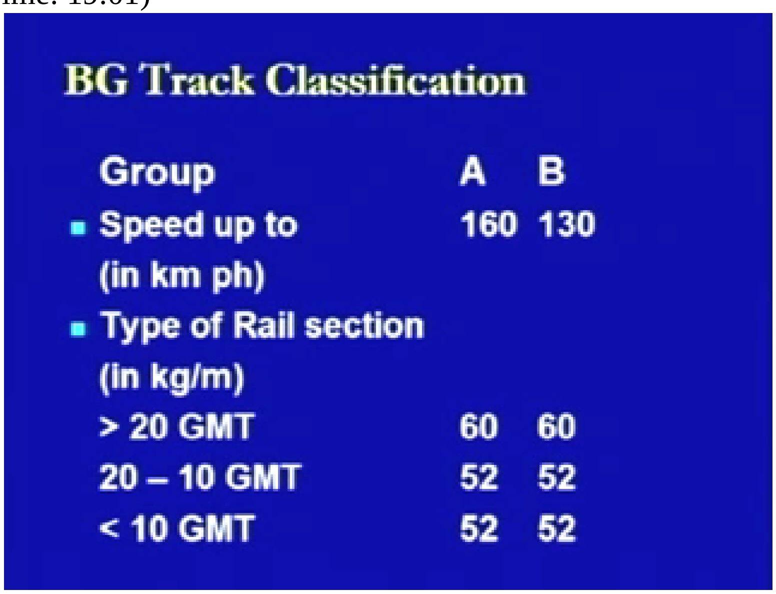

And that is been taken as 60 kg per meter in the case of traffic load which is more than 20 GMT , for both the cases of category A and category B of the broad gauge track classification, there it is being taken as 52 kg per meter rail section length in terms of the two other categories of the traffic that is 10 to 20 GMT and less than 10 GMT, in both the cases of category A and category B broad gauge track classification.

Further, in the case of another two categories, that is, category C and category D of the broad gauge track classification, what we look is that the speeds are being restricted in the case of category C to sub urban railway conditions. These sub urban railway conditions are synonyms to the rail conditions or the local trains which have been provided in Bombay or the metro trains being provided in Kolkata or Delhi or another railway which is being provided in Madras or Chennai.

In the case of the D category of the broad gauge track classification, the speeds are restricted to 100 kilometers per hour. The type of the rail section again in kg per meter section weight, it is being defined for the rest of the three categories that is greater than 20 GMT, 10 to 20 GMT and less than 10 GMT. In this case too, what we found is that the rail section is being used as 60 kg per meter rail section for the traffic load of greater than 20 GMT in both the cases of C and D category of broad gauge track classification. Where as in the rest of the two categories, that is, from 10 to 20 GMT and less than 10 GMT or both the categories of C and D broad gauge track classification conditions, the type of the rail section used is 52 kg per meter length.

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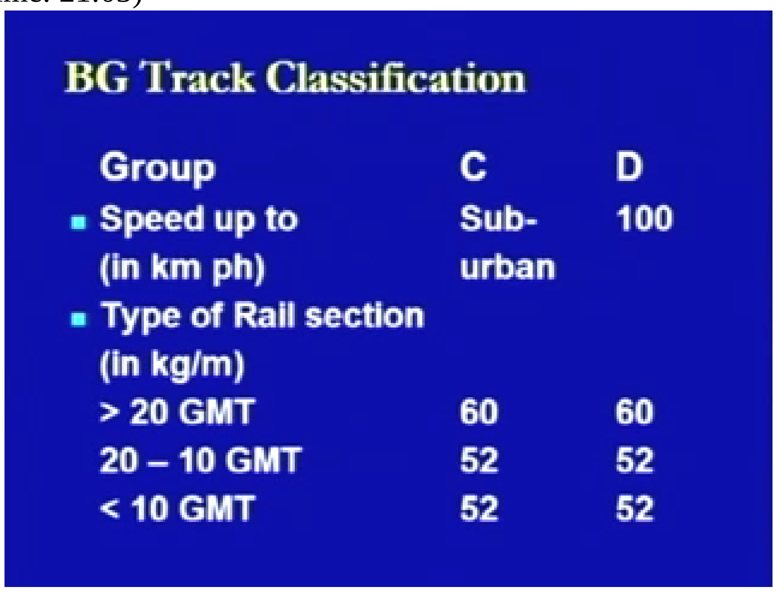

Again, coming back to the A and B category, we look at some other specific specifications which are associated with these tracks. They are sleeper density; sleeper density is a term where it is defined as a total number of sleepers which needs to be provided per kilometer length of the rail section or the track. So, if we have laid one kilometer length of the track or the rails then how many sleepers we are going to provide below the rail , that is ,what I termed as sleeper density and this sleeper density in the case of category A broad gauge track classification is 1660 sleepers. It means 1660 sleepers need to be provided in one kilometer rail length in the case of the A category of the broad gauge track classification whereas in the B category of broad gauge track classification, we have either or two conditions, that is, we can go for 1660 sleeper density or we can go for 1540 number of sleepers per kilometer length of the track.

Another aspect is the ballast cushion; ballast cushion is defined in terms of the total depth of the ballast which is provided below the sleepers, so this ballast which is provided below the sleepers is 300 mm depth in case of A category of broad gauge track classification whereas in the case of B category of broad gauge track classification it is either 300 mm or 250 mm.

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Again coming to C and D category of the broad gauge classifications, we are looking back on the same aspects of the specification which we have seen for A and B categories just in the previous slide. Here, what we found is that in the case of the C category which is related to the sub urban railways or in the case of the D category, we have the similar conditions of the sleeper density in terms of the total number of the sleepers per kilometer track length, that is, 1660 or 1540 sleepers per kilometer length. In case of the ballast cushion, the values are again in the case of C is 300 mm and in the case of D category it is 300 mm or 250 mm.

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Now, coming to the last group in the broad gauge track classification category, that is, group E. They found that the speeds are less than 100 kilometer per hour. The rail section in kg per meter in the terms of perfect which is greater than 20 GMT, they are generally not the cases where the traffic is going to be more than 20 GMT in the case of E category of broad gauge track classifications. In the category of time to 20 GMT, we are using 52 kg per meter rail section, that is, the length for per meter length of the section, the weight of the rail section id 52 kg and then in the case of less than 10 GMT, the rail section which we are using is another specific rail section which is defined as 52 SS section. The sleeper density again in terms of numbers per kilometer rail length is 1540 to 1310. These are the two values which can be used in the case of the category E or the broad gauge track classification and the ballast cushion ranges from 300 mm to 200 mm.

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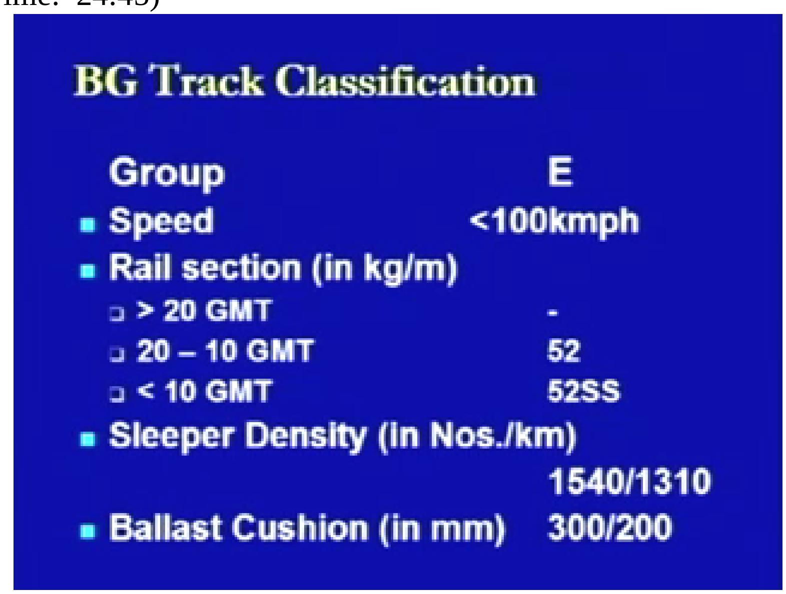

In that sense, what we found is that we are having certain ranges for the speed of the rail section for the sleeper densities and for the ballast cushion. The speed is changing from somewhere around from 100 kilometer per hour to 160 kilometers per hour, the rail sections are varying from 52 SS to 52 to 60 kg per meter. The sleeper density is varying from 1310 to 1540 to 1640 and ballast cushion is varying from 200 to 250 to 300 mm. So, this is how the specifications of the broad gauge track are varying for the five categories which we have seen just now.

Now, further things are that the rails which are to be used for group A to group D they should to ninety UTS rails. Ninety UTS rails means, this is, UTS is ultimate tensile strength and the units are kg per mm square. So it means the rail sections which were using for the categories group A to category group D, they should have ultimate tensile strength of 90 kg per mm square, that is how they are being defined. There is another category of rail section which is being used in Indian railways, that is, 72 UTS railway section. Then the sleepers, they should be general F concrete or there is another category of rail sleeper which is CST nine sleepers. So, we will be looking at these types of the sleepers; the concrete sleepers or the CST nine sleepers when the sleepers will be taken up through the lecture series of transportation engineering two.

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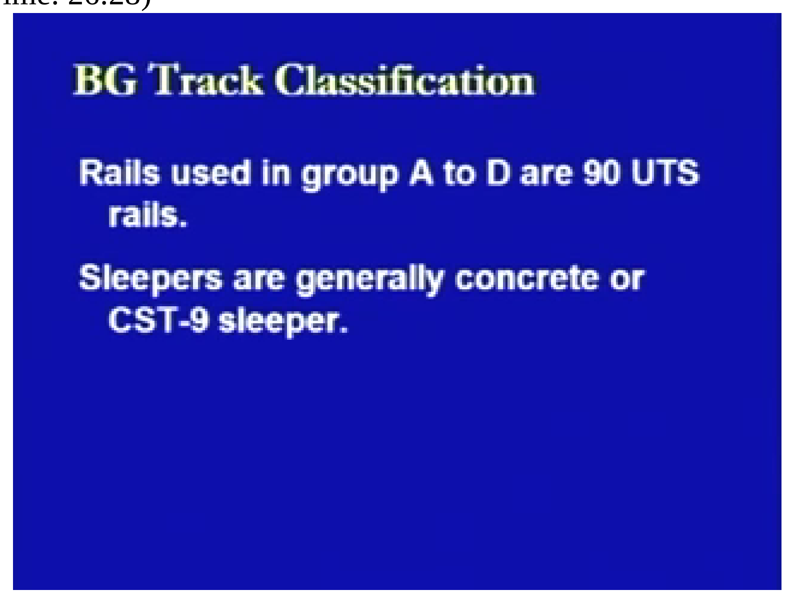

Now, here we are going to look at certain tracks which have been defined under the different groups of broad gauge, that is, group A B C D and E. In the case of group A, there are 5 sections which have been defined under this category. The one section is New Delhi Howrah, another section is New Delhi to Mumbai central, then another section is the New Delhi to Madras central , then Howrah to Mumbai V T and the new section which was added sometime back was Ratnagiri to Sawantwadi that is on Konkan railways ,that is why it is termed as KR here.

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Then in the case of group B we have 25 such rail sections. They are Allahabad to Bhusaval via Jabalpur, Kalyan to Kazipet via Daund Wadi in Pune, Vadodara to Ahmadabad, Mathura to Ratlam, Sitarampur to Mughalsarai via Patna, Howrah to Barddhaman via Bendel, Kharagpur to Vijayawada via Waltair, Kiul to Barharwa via Sahibganj.

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Delhi to Kalka via Ambala Cantt., Ambala Cantt. to Pathankot via Ludhiana, Ambala Cantt. to Mughalsarai via Moradabad, Lucknow and Pratapgarh.

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Then there is another section from Agra Cantt. to Lalitpur, Lucknow to Kanpur, Virar to Godhara, Lalitpur to Bina, Khanna to Malda town via Farakka. Wadi to Madras central via Raichur, Jolarpettai to Bangalore, Arakkonam to Ernakulum via Erode, Coimbatore, New Jalpaiguri to Malda town that is not frontier railway.

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Chennai beach to Dindigul, Chennai beach to Chennai Egmore, Bangalore to Gooty, Ghaziabad to Saharanpur.

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Some more are like Ahmadabad to Delhi via Bandikui, Kanpur to Agra.

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So these are the broad gauge track classifications which are there. In the case of the group C, we have not gone for the group C conditions because they are the sub urban railways as I have just discussed in the previous slides that they belong to the local trains which are sub urban railways or local trains moving in Mumbai , Kolkata, Delhi Madras and likewise. Now we come to the group D. In the case of the group D there are 38 rail sections which have been classified into this category. Similarly, in group E there are more than 38 rail sections which have been categorized in this one. I am not going into the details of these rail sections now because of the lack of time.

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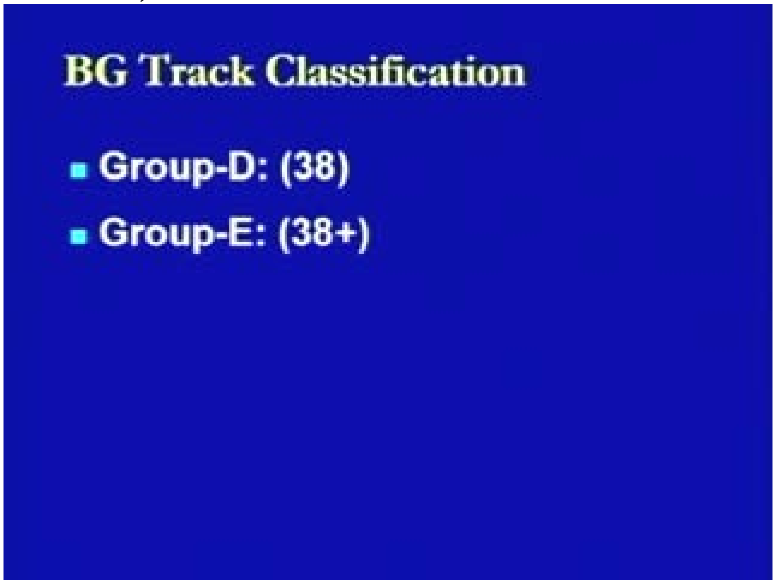

Now we move to the meter gauge track classification. In the case of meter gauge track classification, we have three categories of track classifications; the first classification category is the Q routes where the speeds are more than 75 kilometers per hour and the traffic density is defined in terms of more than 2.5 GMT, and in this case some of the examples are the Rewari -Ringus- Phulera, Ratangarh to Degana, Delhi Sarai Rohilla to Ratangarh, Ajmer to Khandwa.

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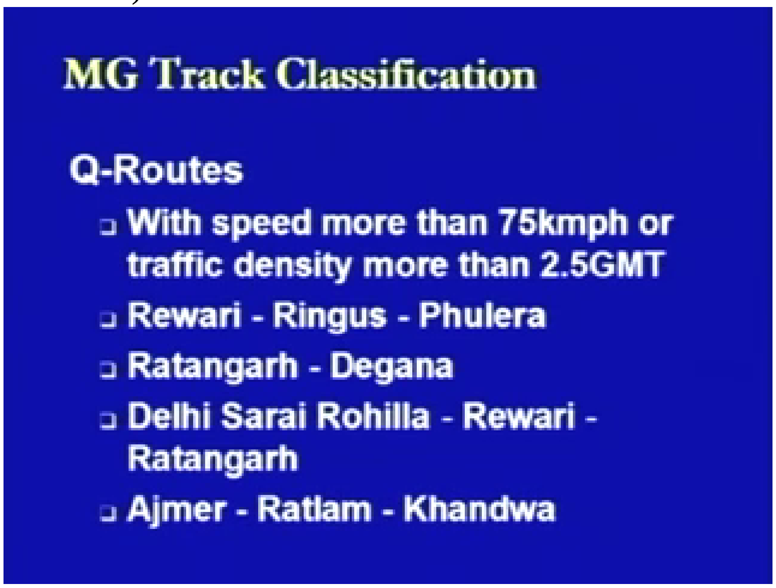

Then Jaipur to Ajmer, Ahmadabad to Bhavnagar, Agra to Lalkuan via Bhojipura Mathura, Bhojipura to Lucknow junction.

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Villupuram to Thiruchirapalli via Thanjavur, Chennai beach to Villupuram, Dindigul to Madurai, Jodhpur to Agra east bank via Jaipur, Kathgodam to Bhojipur, Bangalore to Miraj.

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All the category in the case of meter gauge track classification is R- routes. In this case, the tracks have the potential of moving the train at a speed of 75 kilometers per hour but they are not moving the trains at this speed, but if required that can be done. In the case of the traffic density it is a little lower than the previous category that is the Q routes here. It is 1.5 GMT or more. In this case, we have again some categories like R 1 route, where it is defined as greater than 5 GMT per year and these are the some of the routes which are there like Hospet to Hubli, Secunderabad to Guntakal, Londa to Marmagoa, Katihar to New Bangaigaon, Guwahati to Tinsukia, Gandhidham to Palanpur or so on.

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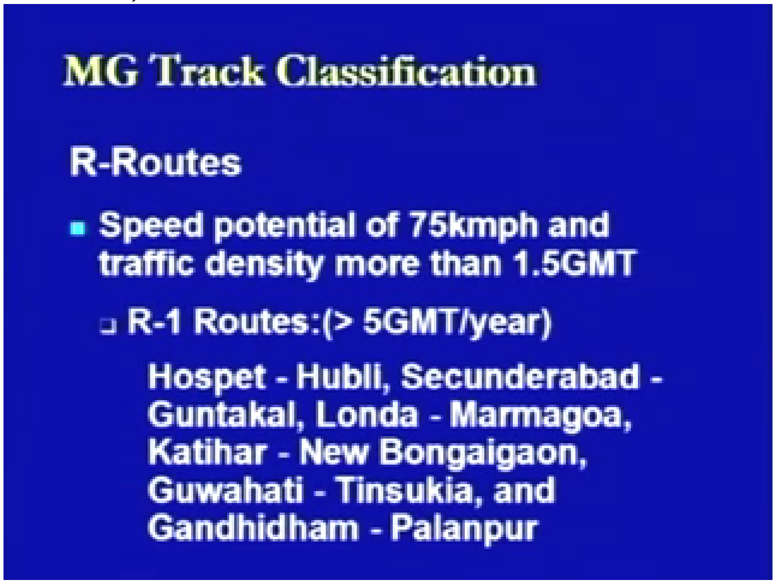

Coming to the next category under R routes is the R 2 routes, where the traffic density intensity have been defined in terms of 2.5 to 5 GMT per year. Some examples of the routes here are Guntakal to Hospet, Guntakal to Villupuram Ttiruchirapalli to Manamadurai, Virudhunagar, Purna, Secunderabad, Jodhpur and Marwar.

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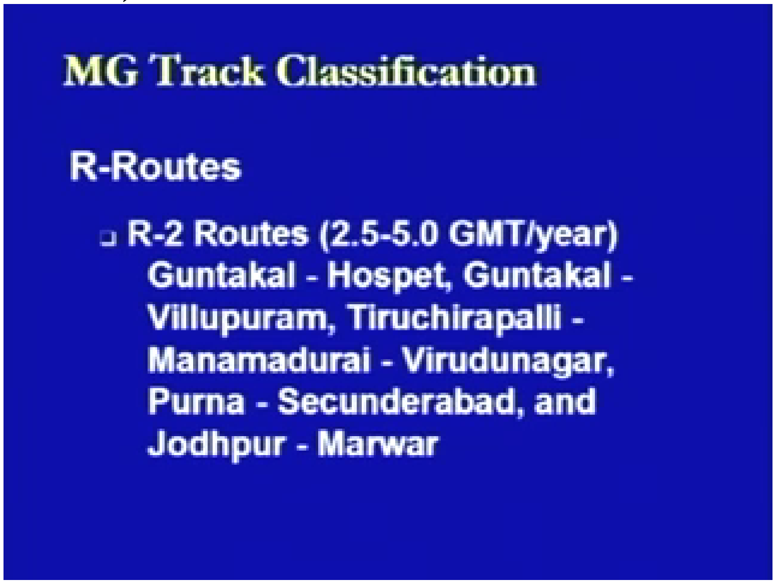

Now we look upon another meter gauge track classification. Here, again in the case of route R category we have the third category: R three routes, where the traffic intensity is being defined in terms of 1.5 to 2.5 GMT per year and in this case again there are certain examples which have been given for the tracks; the Madurai Rameswaram section, Virudhunager Tenkasi section, Dindigul Pollachi, Ratangarh Bikaner Merta road, Muzaffarpur Narkatiyaganj and Birur Shimoga town.

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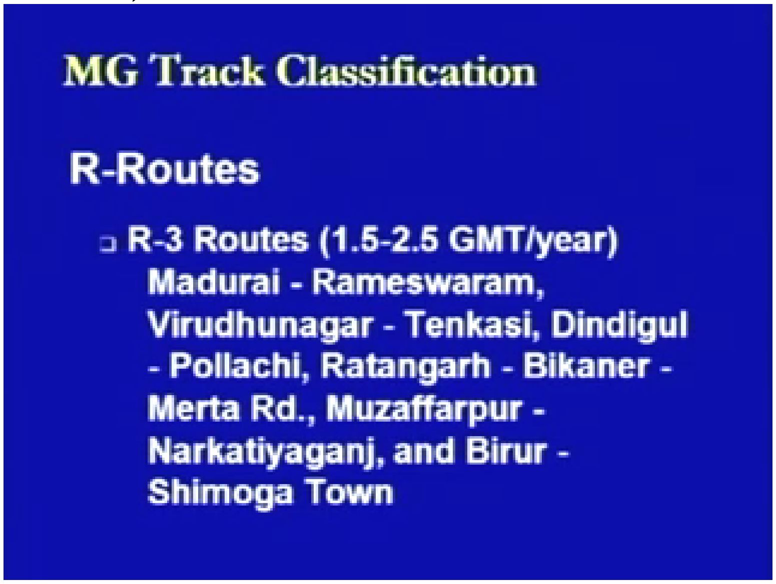

There are some of the sections of the railways or rail tracks which fall under the R three route categories. Then there is another category which is termed as S class where all the remaining meter gauge lines which are rated for below 75 kilometer per hour and or with low traffic densities, that is, generally below 1.5 GMT per year, they fall under this category. So they all are meter gauge track classification.

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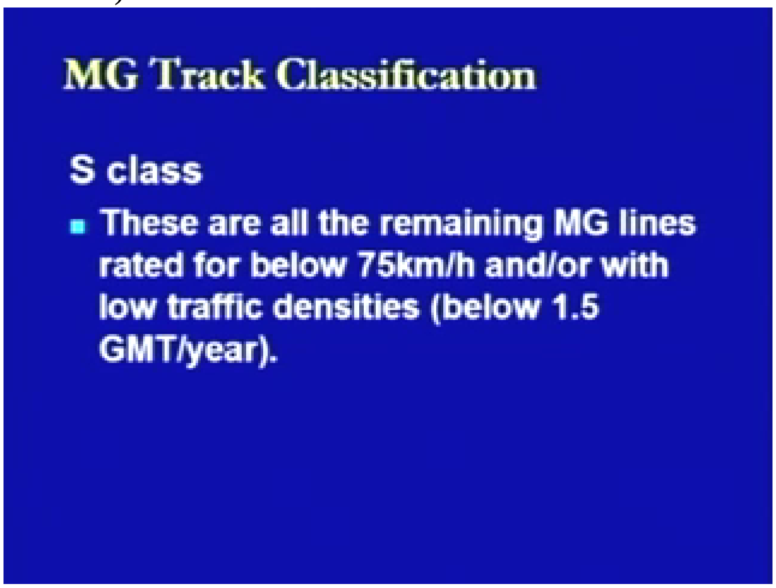

Now coming to the Indian railways track specifications, some of the basis of whatever track we have seen so far, the very first is specification is permissible degree of curvature, that is, the amount of the angle which is being fall on the centre of the curve by a specified length of the curve. In the case of the broad gauge, this is defined as 10 degree, that is the maximum value of the degree of curvature which can be provided on any broad gauge track. In the case of the meter gauge it is 16 degrees and in the case of the narrow gauge it is 40 degrees. So, these are permissible values which need to be provided for the Indian railway tracks.

In the case of the ballast cushion as we have seen previously, it varies from 20 to 30 centimeter thickness, that is, 200 to 300 mm thickness as we have written or we have seen in the previous slides. The sleeper density here it is being defined in another notation that is M plus 7 to M plus 4. Then it is also being defined here in terms of those similar notations which we have discussed previously under the categories of broad gauge track classifications moving from category A to category E. In that category categorization, we have seen that the value of the sleeper density was changing from 1310 per kilometer to 1660 per kilometer with intermediate value of 1540 per kilometer.

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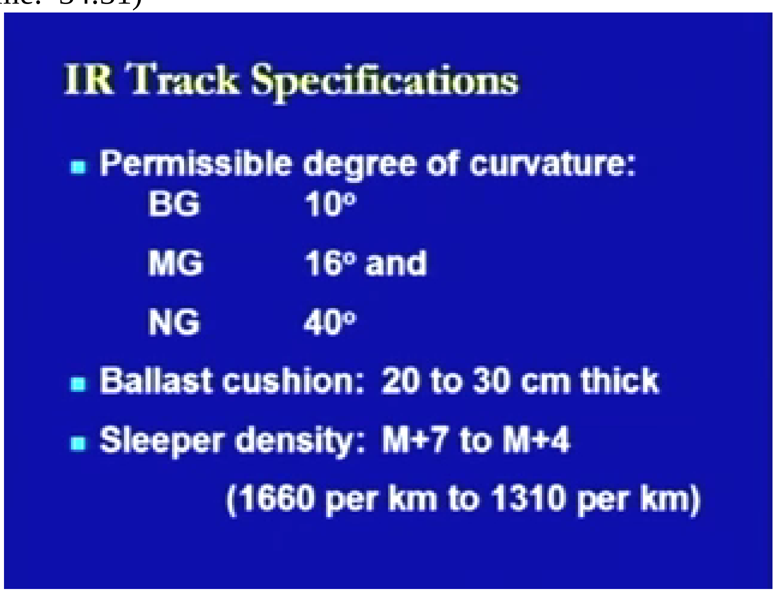

Here, there is a another way of defining the same thing in terms of affecter or value defined as M plus 7 to M plus 4 where 7 or 4 are the arbitrary values being taken, so it can be 4, 5, 6 or 7 and M is defined as the length of the rail section manufactured at any of the company. So, if there is a 12 meter rail section, it means it will transform to 12 plus 7 means 19 or 12 plus four means 16. So that is the range in which the sleeper density can be there for that rail section; if there is a heavier load we go for the more of the sleepers to be provided within the rail sections ,if there is a lesser of the load then we go towards the lower value. So both are the ways by which we define generally a sleeper density. Of course, we will be looking at the suspect of the sleeper density when we will be discussing sleepers in detail in some of the other lectures.

Then another specification related to the Indian railway track is regarding type of the sleepers which can be provided; they are prestressed concrete sleepers especially for group A and group B routes , that is the high speed routes as far as the prevailing conditions are concerned. Those slowly and slowly they will be moving towards the speeds to as high as 250 to 300 kilometers per hour and they are trying to find out the feasibility of providing those things or the changes to be made in the track specifications so that we can accommodate or provide the operational speed of that much range. In the case of the standard rails, we have to provide in the case of the broad gauge, the rail sections has 60 kg or 52 kg and we say 60 kg or 52 kg , it means we are talking in terms of per meter rail length. Then in the case of the meter gauge, there are three categories of the standard rail sections which are provided. There are different than the rail section which we have discussed so far. They are 90 R rail sections, 75 R rail section and 60 R rail section. This 95 R, 75 R and 60 R rail section, they have been borrowed from the British railway standards.

British were the people who started railways in India and therefore the standards were also borrowed from them. In this case when we are talking about 90 R means, we are talking about 90 pound per yard rail length. Similarly, it is for 75 and 60 R rail section. The length of the rail is either 13 meter in case of the broad gauge or 12 meter in case of the meter gauge. This is the round off value of the actual length which were manufactured in different companies, which were manufacturing the rail sections.

Another important thing is the fastening which needs to be provided. Fastening means those things which are used to connect the different rail sections with each other or the rail sections with the sleepers. These fastening should be elastic in nature and, that is, as far as possible, we should use those fastenings where the elasticity is being maintained.

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Then, another specific feature of tracks is turn out. Turnout is a condition where we can change the direction from one track to another track. Of course, we will be taking out the turnouts again in details in some of the lectures. Here, we are looking at just the main specification related to turn out. It is defined in terms of one in N value, where N can be anything like it is 8 and a half in the case of a movement of goods train. In the case of passenger train it varies from 1 to 12 to 1 in 16. As the value keeps on increasing, it means we are providing more flatter curve as compared to the sharper curve.

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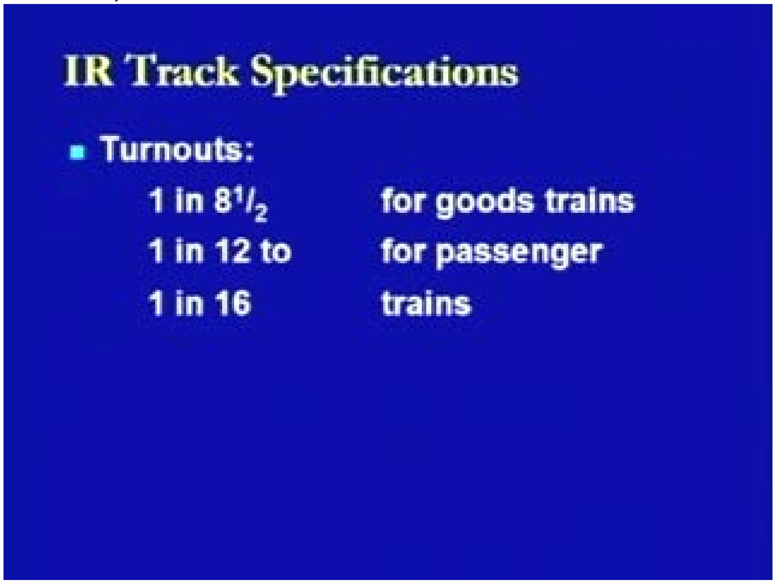

It means there is an ease of turning and there is a comfort being maintained and because in the case of the passenger movement, more comfort or ease of safety needs to be maintained and therefore that is why we have 1 in 12 or 1 in 16 sort of turnouts. Again, when we are going for high speeds as I told you, they are trying to achieve the speeds to as high as 250 to 300 kilometers per hour. We will be looking at the turn outs which will be having the values of something like 1 in 20 or 1 in 24. Again, they are under considerations and as soon as the things will be finalized we will be moving these aspects.

Now we come to another aspect of the provision of the tracks of the gauges; tracks are multi gauge and what is the problem associated with that multi gauge system? As you have seen in the case of the Indian railways, we are providing broad gauges, we are providing meter gauges and then we have narrow gauges up to specifications, that is, 760 and 610 mm. Is there any problem of providing so many gauges or shifting from one gauge to another gauge? We can understand this problem when we keep our self into that condition. We assume that we have to go from say point A to point B and there is an intermediate stop at point C where the change from one gauge to another gauge has to be done. In that if you are traveling yourself in that sense then what all the different problems you can foresee or you can experience.

Well we will be looking at this problem which can be there. The very first thing is in convenience to the passengers; in this case what are the different kinds of inconveniences which can be there? The one inconvenience is that because the specifications are different, therefore the tracks are provided at different locations for the meter gauge or for the broad gauge or for the narrow gauge. So if you are coming by a broad gauge train and you have to take a narrow gauge train or a meter gauge train, it means you have to go to some other platform , that is, the change of the platform is necessary. So if you take either thing with you and move towards that side that means either you have to cross the gauges or climb the gauges. That is another problem of associated with the change in the gauge. So we have to carry out with all the luggage's with yourself or you have to look for some man power who can take all your luggage and you can move to the another gauge or the platform. So these are all types of inconveniences which will be there to any of the passengers when this type of change over needs to be made or the transfer needs to be made. The hauling of luggage, the tension regarding catching the link train, that is the important aspect.

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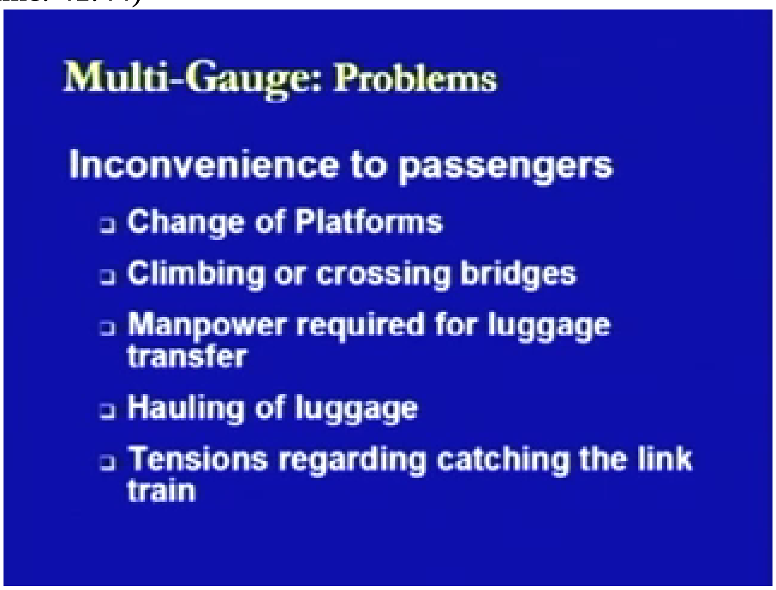

You do not know whether you are moving on a right time or you are going to be late and therefore if there is a link train for that journey, then if you are going at the right time you can catch that one otherwise you are going to miss it. So that sort of a tension will always remain with you and the another big aspect is that if you are reaching that transfer point that is, the station C as we have taken an example, then if it is at the night time, the transfer at the night time is another very, very important and considerable thing because that the safety is associated at that point of the time. So that is another sort of inconvenience to the passengers to stay awake or somebody has to awaken them and then only they can go and change over.

Another aspect related to the multi gauges; the transshipment of the goods. Again in this case there can be a number of types of problem which may be associated with it like there is damage to goods; you have to take the goods from one point to another point there are always chances that something may get damaged. If you have booked your luggage then it is to be transferred from one luggagement to other luggagement and during that time again there are chances getting the things damaged. There are chances of theft also. You are transferring the things and somehow at some point of the time on a bad day you found that something is being lost, it is being theft or storage facilities are required in some of the cases. There is a large shiftment which is going on and that case of the large shiftment when it is to be transferred there is some other train of another gauge. Then you have to put that material at some place, you have to store it, so the storage facilities need to be provided at that transfer point. Delays are caused many of the times. These are another aspects associated with it.

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Mishandling is the another specific case related to goods only , that is, instead of going to place B the things are going to place D because of just mishandling case. Then there is inefficient use of rolling stock. The inefficient use of the rolling stock means that whatever the total amount, total locomotives which are in use we are not using them to the complete efficiency, complete 100 percent utilization is not there. As we have taken an example that you are coming up to two point C by the broad gauge and then after that we are probably going by meter gauge or a narrow gauge. Then in that sense whatever locomotive or the train or the compartments have come up to two point C on the broad gauge they will remain as such if they are not going to be moved to some other place. If they are moving to some other place then it is ok.

Then they are under use and therefore there is no inefficiency involved in the use of the rolling stock but if they have to stay there and they have to wait for another link train which comes and then they will be taking back the passenger traffic or the goods traffic and move back, in that sense, it is the inefficient use of the rolling stock. So in that case what will happen is that if you are interested in not having inefficient use and we think that we can transfer our train back to the origin point, then in that case it will be moving empty. That is another sort of inefficient use of the rolling stock because we are not handling revenue.

Now another case is that we are having the track which is lying idle for long period of time because we are waiting for the traffic to come from the link line. If this is the case then this is also termed as the inefficient use of the rolling stock. Then the transferability of the equipment is not possible because there are of the different specifications.

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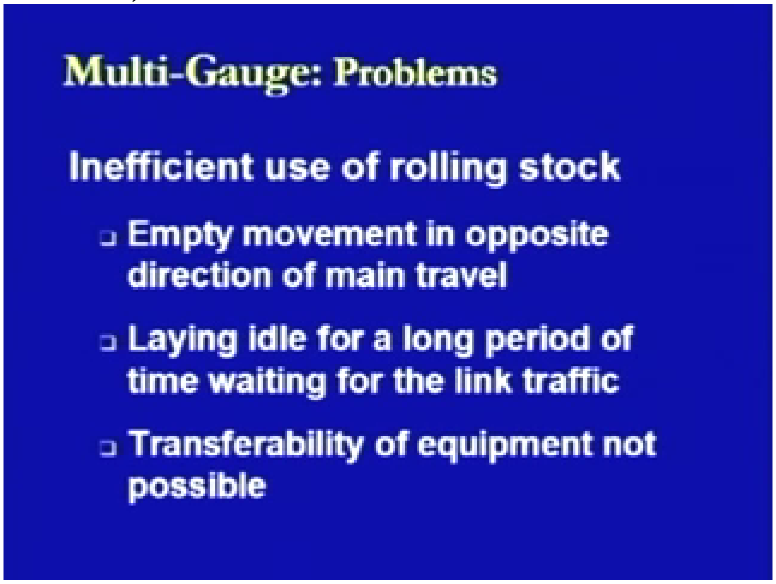

So because of this difference in the specification we cannot make use of one thing at some other location. It has to be used where they are. So it means they will keep lying as such and we are not in the position to use them efficiently.

Another factor associated with the multi gauge problem is the additional facility which needs to be provided at stations or in the yards. We have to provide the sheds of different specifications , we have to provide the yards of different specifications because different types of rolling stocks is going to be there at that station , then the maintenance equipment again they are different from different types of the rolling stocks. So we have to have all those types of the maintenance equipments. Waiting rooms or areas because the different platforms are associated, therefore they require waiting room on this platform as well as on the other platform ,that is, called the platform of the broad gauge or a platform for the gauge other than the broad gauge. The platforms are also of different specifications because of the size differences of the specification differences in the meter gauge and the broad gauge or the rolling stock specification differences.

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Then there is a factor, that is, hindrance to fast movement of goods and passenger traffic. You cannot move the things at the faster speeds because it needs to be transferred at intermediate points. When you are transferring your things at your intermediate points then it means there will be some time lack which will be associated with that transfer and therefore that is a hindrance and it is a big problem especially during emergencies. If there is a emergency and there is a big shiftment which needs to be transferred or transported to that location and if in between there is transfer associated then that cannot be done at a faster rate or a speedier rate. The delays associated with those transshipment are on the reason.

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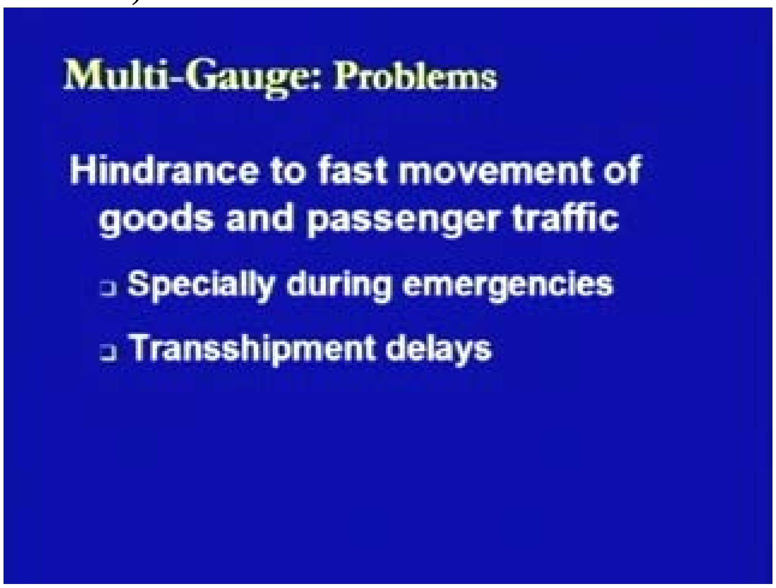

Another aspect here is the difficulty in the balanced economic growth. Now this is the aspect of provision of different type of the gauges in different areas because of the total resources gets distributed and in the total resources of getting distributed it can become an hindrance to the different types of the development which can take place in any of the area; like there is a industrial development there is a heavy industry which is to be placed in any area then it will be requiring a broad gauge but if the heavy industry is not there probably we can go for another gauge but in that sense there will be a multi gauge problem, that you cannot transfer the one thing from one point to the another point and there is efficiency involved with the industrial processes also. So, it will be lost. The movement between the points of production and the consumption is another aspect in the case of the economic conditions. How much time it is going to take to move the things from the point of production to the place where things are going to be consumed, that is another important aspect.

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Now difficulties in the future gauge conversion, this is next aspect that is the problem in the case of the multi gauge system because if you going to change over from the meter gauge or the narrow gauge to the broad gauge then again the resources are involved in that one and when the number resources are involved in that one you have to get all those resources you have to take out the things, you have to suspend the movements and that is the type of the difficulty which will be there in that aspect.

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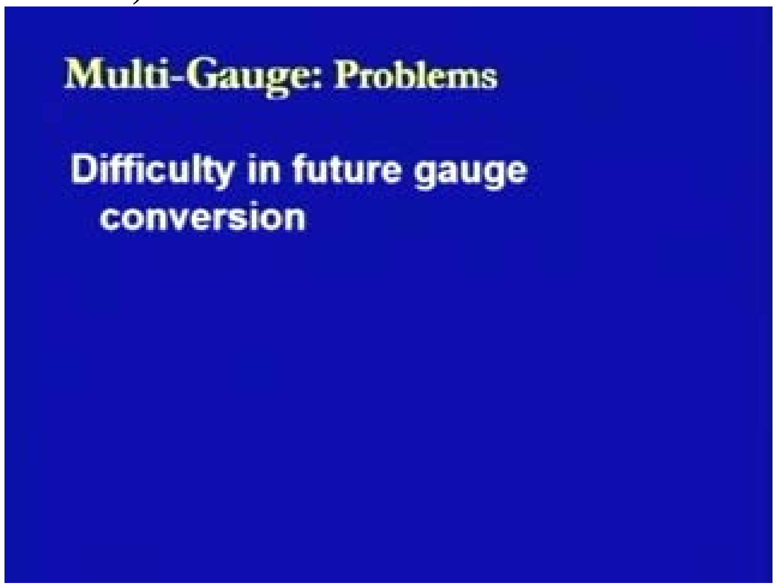

Now we come to the related aspect of this one; that is uni gauge policy. Looking at all those problems which are being faced by the freight movements or the passenger movements because of multi gauge system the Indian railways and the government of India in 1992 decided to provide uniform gauges throughout the countries and therefore they came out with the uni-gauge policy and in this uni-gauge policy there are certain advantages involved which are just the reverse of the all those problems which we have seen previously, like there is no transport bottlenecks. In this case there is no need of transshipment because we are going from point A to point B in the example, which we have taken previously without stopping at point C or without changing the things at point C. No waiting and delays are associated here, the elimination of inconveniences because we are not going to come out at point C with all your luggage's and your moving ,handling of luggage is easier because it is to be placed once and to be taken out once.

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There is no transshipment hazard but the safety is involved with the material, there is a better safety. There is no damage , no theft, no mishandling of luggage because nothing is going to be transferred from one compartment to the other compartment, one wagon to the other wagon, one platform to the other platform. There is elimination of unsafe night time transfers.

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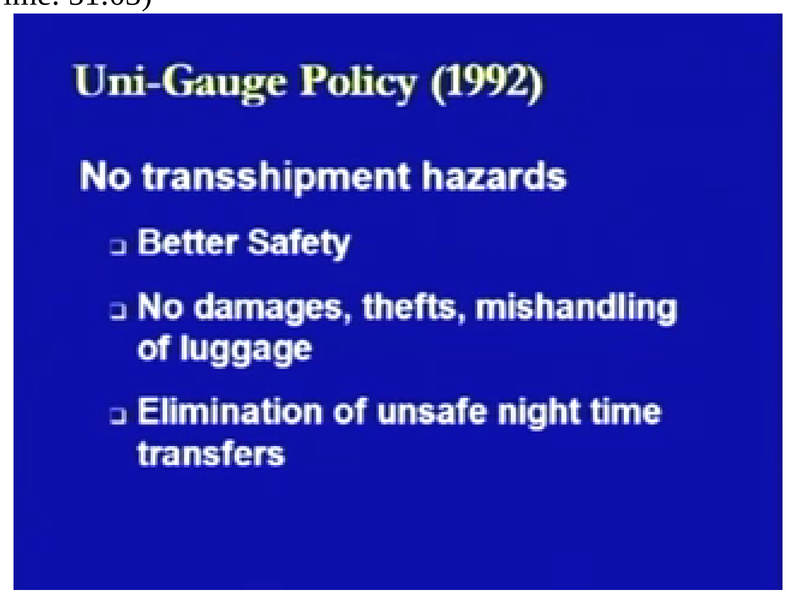

Then there is a another better aspect of uni-gauge policy is that we can think of provision of alternate routes which was not possible in the pervious conditions because all the resources was ,that in, consumed in the provision of different type of facilities, different type of gauges throughout the country.

Now we can think of that if there is a wrong route, whether there is a possibility of providing any alternate route of the same specification, so that, the total load or the traffic can be diverted between those two points by using the alternate routes or we can develop any other area and there can be a more of the development in that area; may be a industrial development or the employment generation likewise. So here we at looking at the pressure on the existing network will reduce, economic scenario will improve, higher penetration of products will be there because we are reaching different sections which we should not reach in the previous conditions and there is a more flexibility of movements because we have the rolling stock available to us and we can use that rolling stock without changeovers and there is a better connectivity, that is, because the alternate routes are feasible things.

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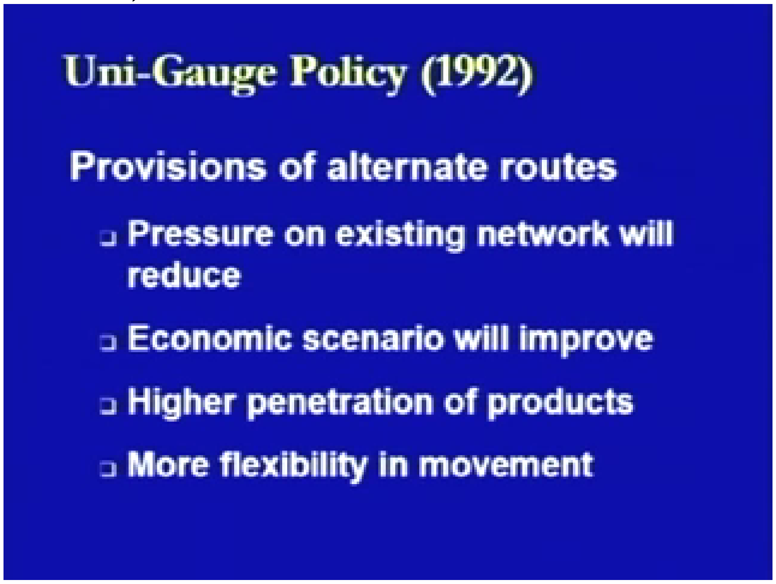

There is also improved utilization of the track. There is more efficiency associated here, the higher efficiency will be there. There is a reduction in the operating expenses because we are not yet stopping at one point. We are achieving the things at higher speeds and there is the more of the efficiency involved, that is why the operation expenses are going down. There is lesser or no idling situation.

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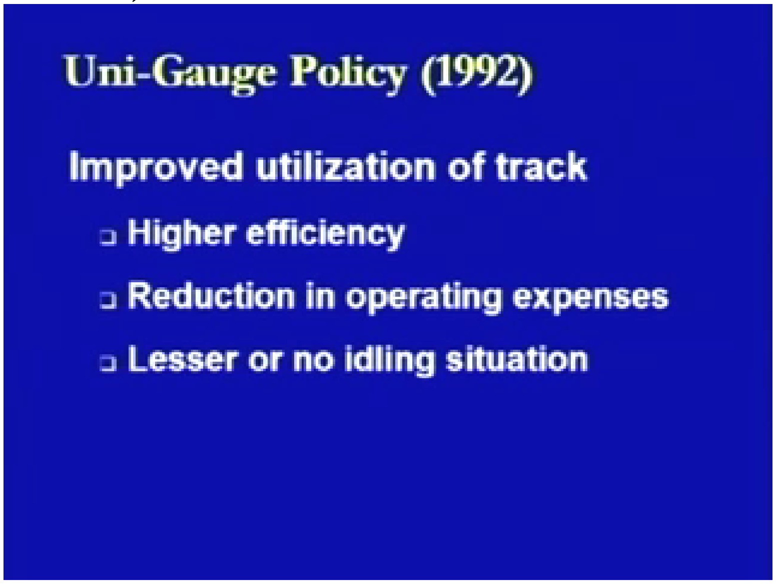

Better turn around conditions because the rolling stock has not to wait at the intermediate or the transfer point for the link traffic to come. Therefore, in that sense the things can just change or take a turn from the next point to the previous point. The higher use of the equipment will be there in this case, the operational expenses again will reduce, more operations can be scheduled because we are having a better turn over time, no idling of the years are involved here, higher benefits to the users because they are getting the facilities again and agreeing at a lower time periods. There is an optimization of the facilities because we are not required to provide the facilities at different locations. So you can optimize the things, locate them centrally or locate them specifically depending on the situations.

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There is better balanced economic growth and in this case we have the regional effects will reduce because there is a better connectivity from one part of the country to another part of the country and that is how, that is what we have seen in the independence condition of the India also, where the railways were provided and they provided the connectivity to all of the different parts of the country. There is a higher growth of areas otherwise which are being left unconnected. There is another economic aspect of the uni-gauge policy; more dispersal of activities will be there because there is no concentration of activities in one area. We have the greater connectivity, people start thinking of starting the different activities in different sections, different areas, so that they can achieve better economic balance growth.

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Then the next aspect is then no multiple tracking will be there. In this case the extra facilities need not to be provided because the specifications are same on all the platforms, on any of the sections or any of the station. Multiple tracks, yards, equipments of different specifications again are not required and in this case it is going to cut off the cost which is clear in terms of the multi gauge conditions.

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Better transport infrastructure will come up with the uniform gauge policy, with the provision of the same gauge throughout the country. Better and efficient movements will be there, direct connectivity to different areas previously served by only the meter gauge, higher opportunities to masses and of course this is another important aspect as far as the economic conditions are concerned.

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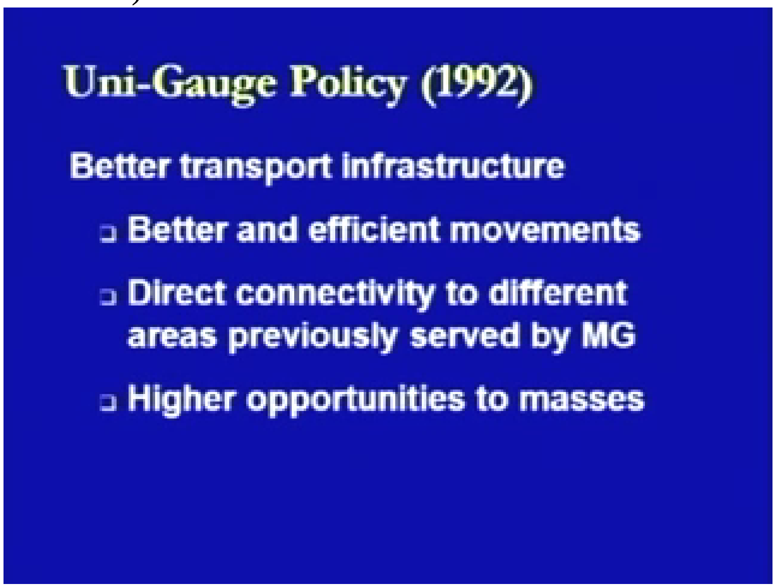

It will boost the investor's confidence, because there is no transshipment of materials, the long distance movement of the freight will be possible and this is what we are seeing nowadays in the Indian railways where the Indian railways are earning large amount of revenues because of the booster investors confidence by the provision of the long distance high speed freight trains or the container trains.

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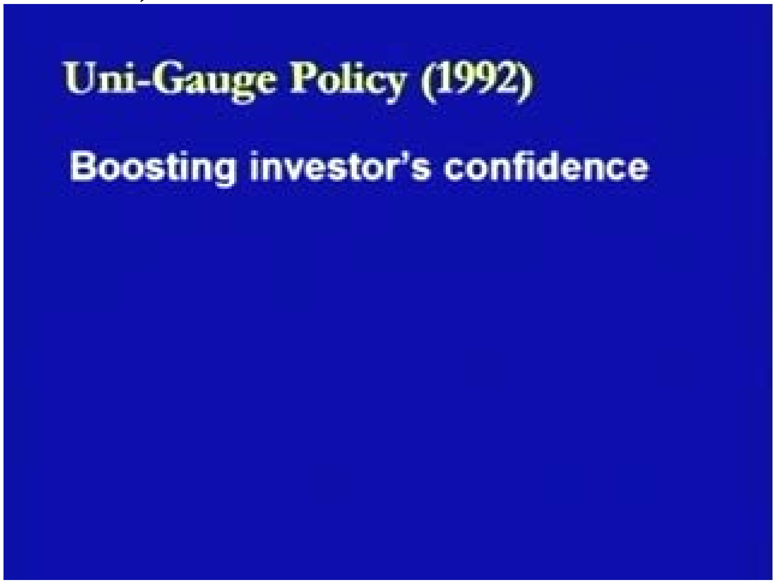

Now, once we have completed all those aspects the two specific aspects of the gauges we will be looking at two or three next slides, that is, loading gauge and construction gauge. Now, here in this diagram loading gauge has been shown. This loading gauge shows the dimensions in terms of there is a one "L" shape angle condition from which there is a suspended arm or arch. This arch is having certain height at the center as well as at the ends from the rail section which have been provided here at the bottom. So, this is total amount of height which can be there at any loaded wagon. Similarly, this is going to be the total width of the section of the wagon which can be filled with any material, that is mostly it is going to be use in the case of the freight transportation. This is very important because we have to look at the different specification which has been provided to the Indian railways and the wagons have to comply with all those specifications. So therefore the loading gauge represents the maximum height and width to which a rolling stock may be built or loaded.

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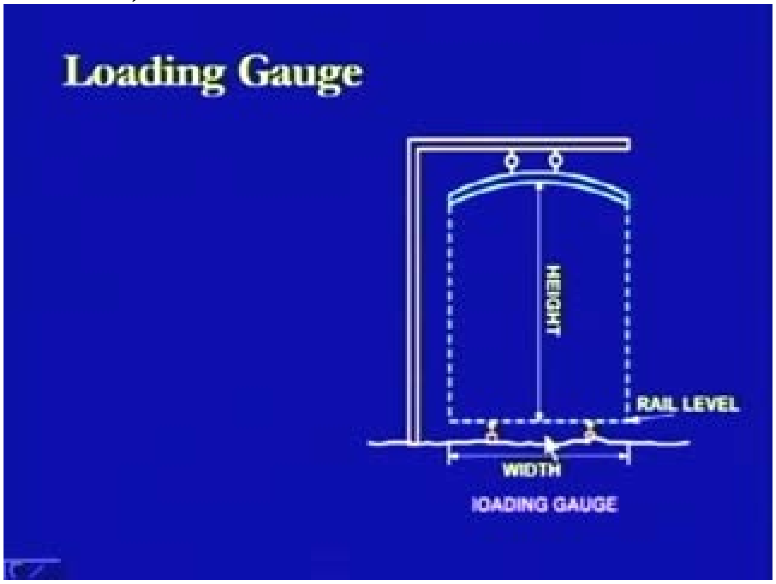

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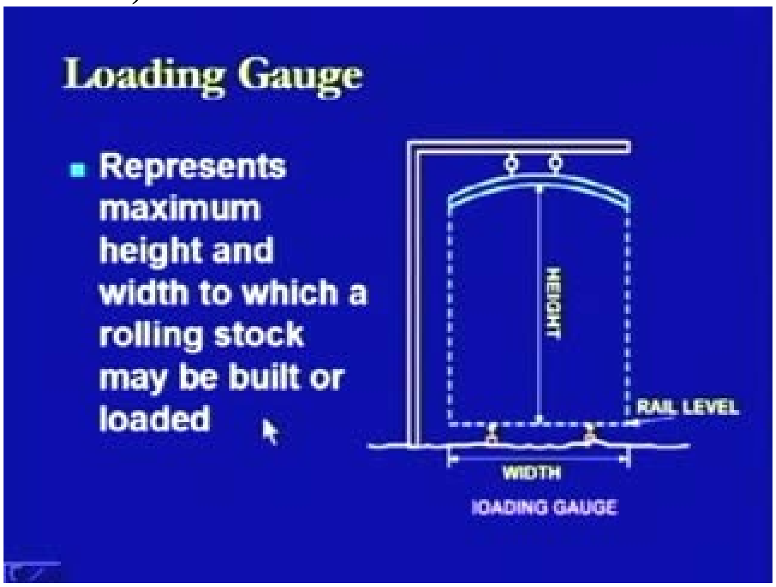

Now we can look at the specifications in the case of the broad gauge; the maximum height is 4140 mm where as the width is 3250 mm. In the case of the meter gauge, though we are of still continuing with the meter gauge that is why we are looking at this aspect, the height here is 3455 mm and the width is 2745 mm.

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Then, there is a construction gauge. Construction is the gauge which is decided by adding necessary clearances to the loading gauge so that the vehicle can move safely without infringement.

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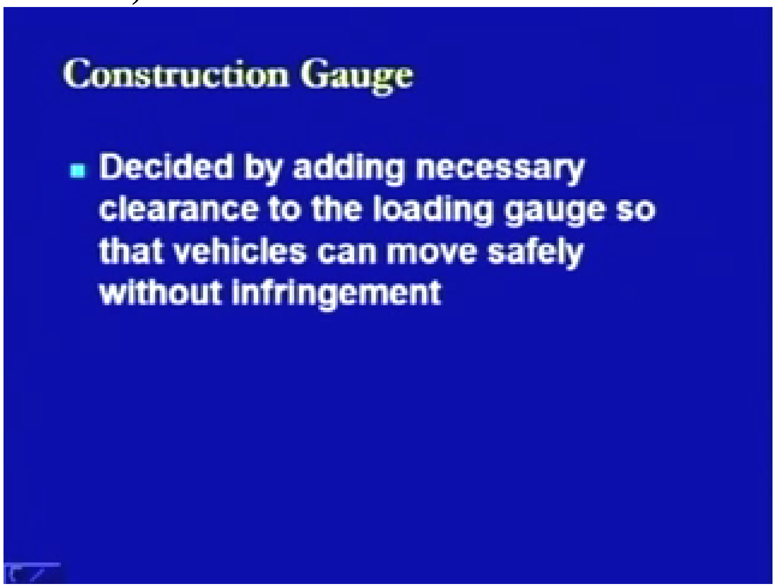

This is the condition which is to be provided in case of all the bridges or the tunnels or the pavements or the platforms which needs to be constructed or the shapes of all the platforms because there are certain clearances which are added to the loading gauge and then with those clearances this construction gauges is provided.

Now, today what we have discussed so far is the different types of the gauges and the specific gauges and the problems associated with those gauges and the way out by which the problems can be nullified. Now in this case what we have seen is that the provision of uniform gauge policy can bring in the balanced growth in the country, at the same time it can reduce the inconveniences for the passengers or for the shippers who are going to haul their freight to from one point to the other point. So, therefore it is going to be a good condition as far as the Indian railways is concerned. We are going to stop at this point and in the future lecture we will be looking at the permanent way, the aspects related to the permanent way, the wheels and the locomotives and the associated features with that one, that is, the crowning of wheels. So students we stop at this point. Have a nice day. Bye.