Advances in UHV Transmission and Distribution
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Lecture - 38
Upgradation/uprating of transmission lines – advantages

We have discussed about various conductors both of ACSR type that is aluminium conductors which has a application for high voltage transmission. And also we have discussed about the recent advances in the conductor technology particularly the high temperature low sag conductors in brief. Now, we will focus on the design considerations particularly and also for the selection of the uprating or upgradation of the existing transmission lines how this new conductor are beneficial or how are they economical and how can they be used for the higher rating or uprating of the existing transmission towers.

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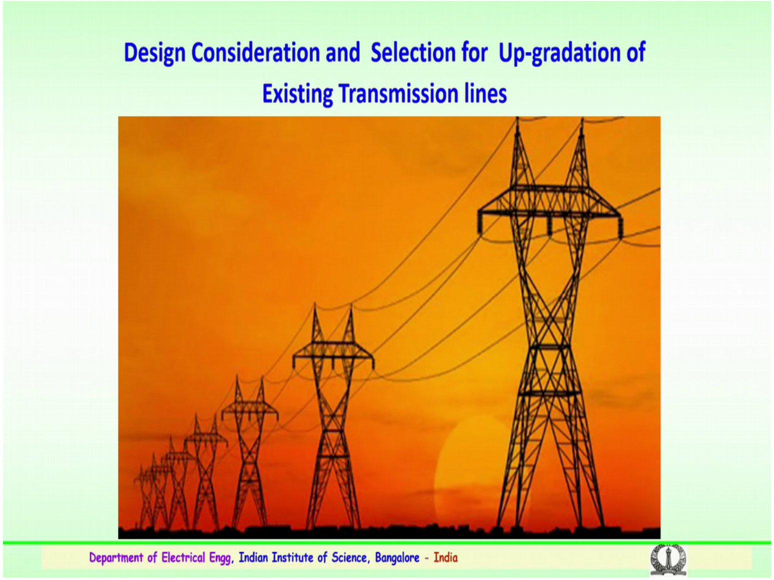

So, this in detail we will focus on the new type of conductors which have been used in the country and several of the projects are being executed and somehow already been executed and there in workings presently. So, we look into the important that design considerations about the new conductors, which are being a used for the uprating or upgradation of the existing transmission lines.

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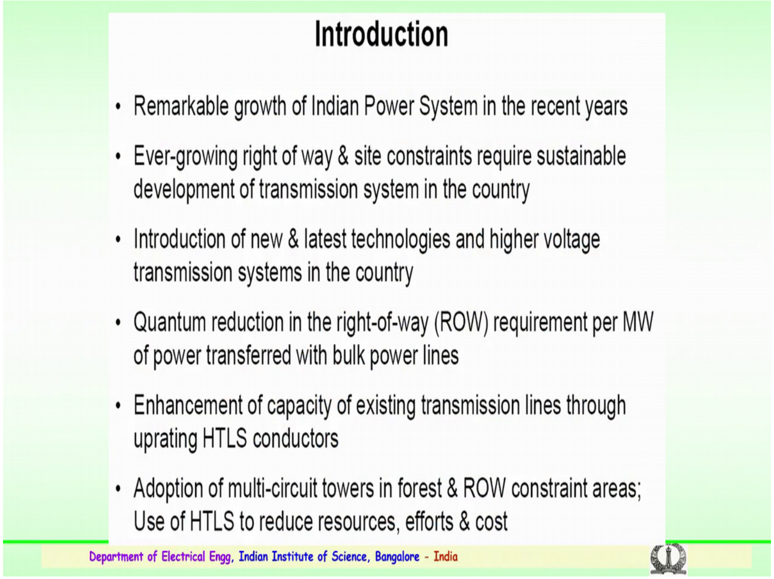

So, there we have known that remarkable growth particularly in the Indian power system in the recent year about decade. So, in terms of voltage levels on the country is already operating the lines at 765 kv AC and 800 kvhv DC lines and mentioned earlier in the lectures 1200 kv experimentation line is already in progress. So, with the ever growing right-of-way which is a very important aspect to be considered for the design of towers for UHV transmission and available site constraints require sustainable development particularly in the transmission system in our country.

So, with the introduction of the new and latest technologies for the higher voltage transmission a systems in the country, there is a quantum reduction in the newer towers which have been designed particularly the right-of-way as been reduced. And the requirement per megawatt of power transferred with the bulk power transmission lines operating at very high voltage and ultra high voltage transmission.

So, the enhancement pertaining to the capacity of the existing transmission lines could be done by either uprating the existing or newer type of conductors which are available that is the high temperature low sag conductors which we briefly discussed how this conductors could be used for the uprating or upgradation of the existing transmission a lines. We will focus into these aspects. And also the adoption of multi-circuit towers particularly in the forest areas and where the right-of-way is a constraint in such places the use of high temperature low sag conductors are being used to particularly reduce the resources, the efforts and also the economical cost pertaining to the transmission lines. So, we will discuss in brief.

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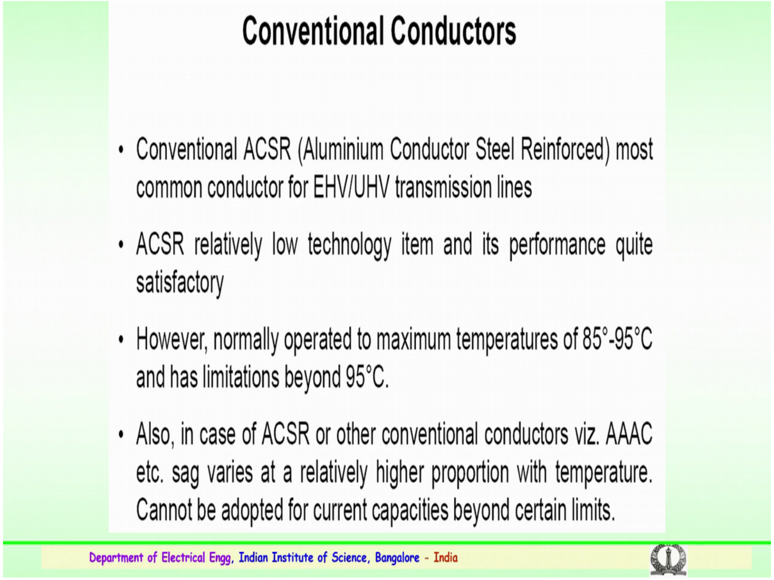

We will discuss about the conventional conductor initially then we will be moving on the high temperature low sag or high temperature high current conductors. So, the conventional ACSR that is aluminium conductor steel reinforced which we have a discussed in the earlier lecture is the most common conductor which is being used for the EHV, there is a extra high voltage and ultra high voltage transmission lines. We know that ACSR technology is relatively lesser technology and it is low technology and its performance is quite satisfactory and it is being used for several decades both in the country and also in many other countries.

However, a normally when operated to a maximum a temperature between 85 to 90 degrees, this a ACSR conductors have limitations beyond 95 degrees. Here they in case if it is operated the sag is increased. And also, in case of ACSR or any other conventional conductors it could be triple AC all aluminium alloy conductors etcetera the sag varies at a relatively higher proportion with temperature. So, in case the temperature exceeds more than ninety five with the higher proportion that a sag increases. So, this type of conductors for operational above 90 degrees cannot be adopted. So, in alternative and a newer technology is being recommended and it is being a used. And being operated in the country at a very high a temperatures.

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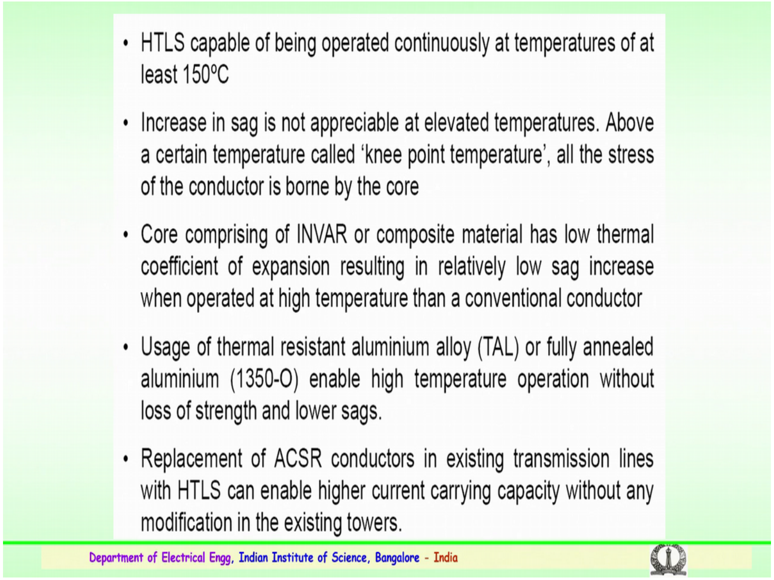

So, the HTLS or the high temperature low sag conductors which we have discussed these conductors are capable of being operated continuously at temperature of at least more than 150 degrees minimum of 150. We have seen their performance in the laboratory up to 200 degrees. So, this conductors increase in sag particularly is not appreciable at a very high elevated temperature between 150 to 200 degrees. So, above a certain temperature which is known as a knee point temperature all the stress of the conductor will be borne by the core that is the characteristics of the conductor.

So, the core of the conductor basically comprising of invar or a composite material has low thermal coefficient of expansion. This results in relatively low sag because the operation of this conductor at a very high temperature because of its a inherent properties having a low thermal coefficient will result in a low sag or no sag when operated at higher temperature then the conventional ACSR or triple AC conductors.

Here the usage of thermal resistant alloy that is the thermal resistant alloy or fully annealed aluminium which is at 1350 degrees enable high temperature operation without loss of a strength and to reduce the sag. So, the replacement of aluminium conductor with steel reinforcement or triple AC that is all aluminium alloy conductors or other conductors in the existing transmission lines with the high temperature low sag conductors will enable to see that the higher current carrying capability could be increased without any modification in the existing tower. So, this the very important point when we are going in for the operating of the existing conductors, it is to be noted that while interchanging the conductors at a very high capability with the very high capability HTLS conductors, there is no modification in the existing towers which is required.

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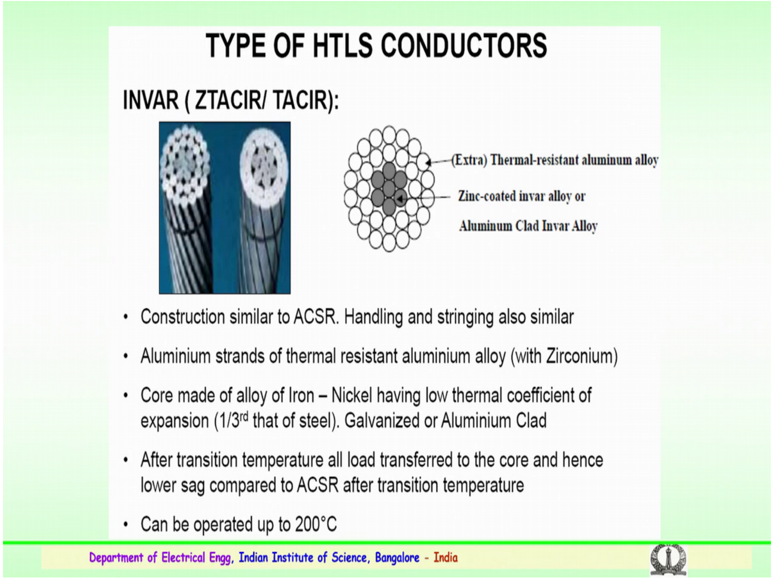

So, we have earlier discussed about the different a types of HTLS conductors we will go slightly go in depth about their construction and also the details of this types of HTLS or high temperature low sag conductors. So, the first one is the invar type of conductors which is a given here this is the invar type of conductors having various thermal resistant aluminum alloy extra conductor which is shown here inside is a zinc coated invar alloy or aluminum clad invar alloy is present.

Here the construction of this conductor is similar to aluminium conductor steel reinforced conductor and handling and stringing also is similar in the tower. So, you can see the aluminium strands which are of thermal resistant and are of aluminium alloy with composition of a zirconium added into the aluminium alloy. So, the core of the alloy or of iron consisting of the alloy of iron and the nickel which has a low thermal coefficient of expansion. So, this is supposed to be one-third that of the steel in comparison to the thermal coefficient. So, it is lesser by one-third and comparison to the steel, galvanized or aluminium clad.

So, after transition temperature all the load entire load is being transferred to the core here the core of the conductor and hence the low sag is compared to that of a aluminium conductor steel reinforced after the transition temperature. So, this is important aspect. So, as a temperature after the transition, the entire all the load is transferred to the core that is a core which consist of aluminum clad invar alloy or a zinc coated invar alloy, this helps to see that on the transition temperature is compared when compared to the ACSR gets reduced, this will help in reducing the sag.

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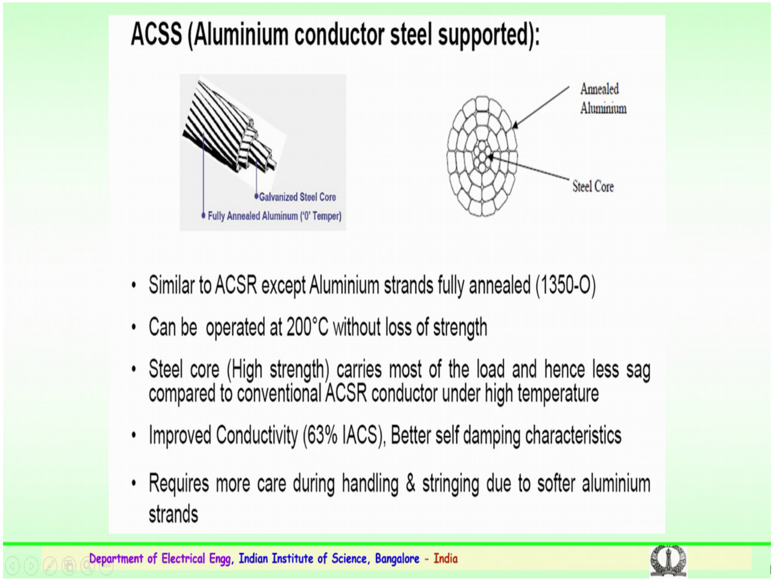

The second type of HTLS conductors is the aluminium conductor steel supported. So, this is the typical structure of the annealed aluminium conductors which are seen; and the central steel core with the central steel core. So, here it is the galvanized steel core with a fully annealed aluminium conductors depending upon the voltage or a current level the conductor size varies. Again this ACSS conductor is in similar to the construction of aluminium conductor steel ACSR except here the aluminium strands which are being used are the fully annealed where 1350 degrees.

So, and these conductor ACSR can be operated at 200 degrees without loss of its mechanical or electrical or thermal strength. Here the steel core of the conductor which is a very high a strength and most of the load and hence lesser sag is noticed in comparison to the conventional ACSR conductor which operate under high a temperature. Usage of aluminium conductor steels supported type also improves the conductivity by more than

63 percent and has a better and self damping characteristics. So, this conductor require more care during handling and also stringing because of the softer aluminium strands which are in the conductor.

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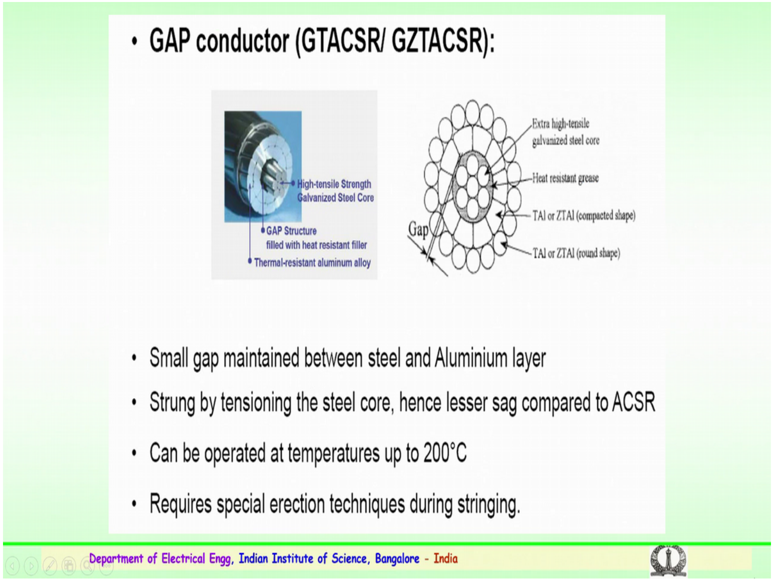

So, the third is the gap conductor gap which has a small gap, you can see the construction of the conductor here. These are the extra high tensile galvanized steel core, you have follow to that is the heat resistance grease which is surrounded that then the conductors of the compact size conductors are placed. And finally, the round type of conductors are at the last periphery. So you can see that height tensile strength galvanized steel core and a gap structure; and finally, you see a small gap in between the conductors where this gap structure is basically filled with heat resistant filler.

So, this thermal resistant aluminium alloy and a small gap between these is a heat resistant filler where this is maintained between the steel and aluminium, here basically this junction is the gap here. And this conductor strung by tensioning the steel core. So, hence this have lesser sag again in comparison to the aluminium conductor steel reinforced type. So, this conductor requires special erection techniques during stringing particularly during stringing these require a special techniques.

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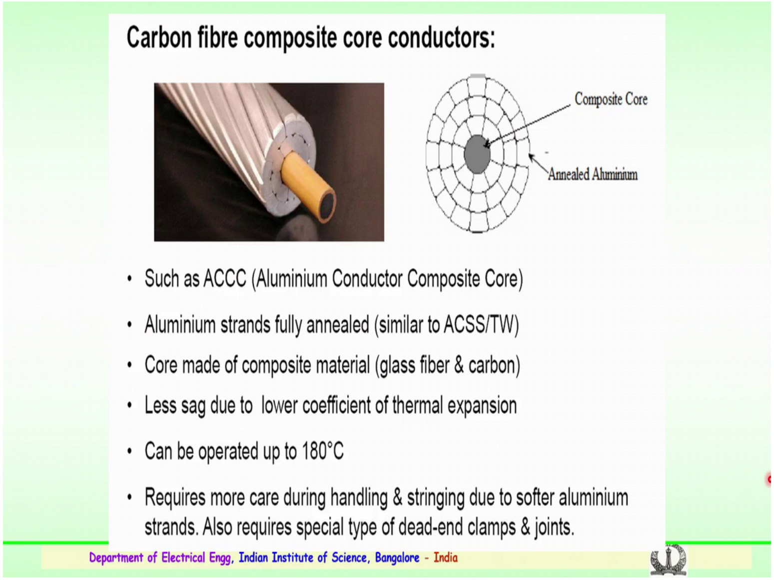

So, fourth is the carbon fibre composite core conductors, this is conductor which is the shown here. You can see number of conductor are arranged in such a fashion with the center being the composite core, all are annealed aluminium conductor. You can see the construction the center being the carbonized core. These conductor sample of the conductor is also shown here.

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Where you can see the construction, there is no gap particularly with the conductors which are being connected at the tapes, and this is the carbon core composite core which is the replaced by the steel core for the earlier conductors which we have discussed. So, this has a special properties in comparison with the ACSR conductor. And this ACC or aluminium conductor with the composite core which is as shown here having an alloys with aluminium strands fully annealed similar to the previous two types of composite previous high temperature conductors, but the core is made up of composite a material this could be glass fiber and carbon. This also posses less sag and operates at 180 degrees and has lower coefficient of thermal expansion like the earlier high temperature conductors. But these require more care during handling and also during stringing of the line due to the softer aluminium conductors, annealed aluminium conductors at the for the conductor. So, this has a softer aluminium strands also requires a special type of dead end clamps and joints. So, this is the requirement for this type of composite core conductors.

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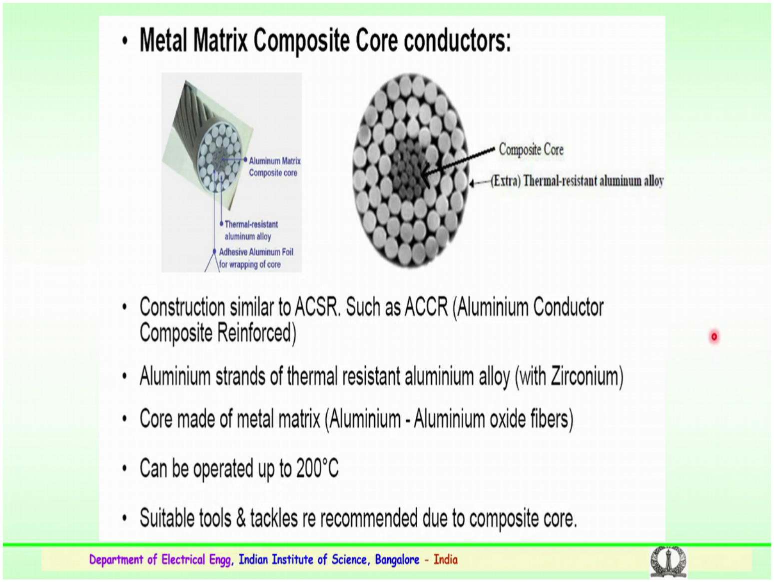

The other type of conductor is the metal matrix composite core conductor, where you can see here the aluminium matrix with the composite core, this is the composite core with the aluminium matrix and these conductors are all shown here with the extra thermal resistant aluminum alloy. So, the adhesive of the aluminium foil for wrapping the core is also indicated here. So, this is again a special conductor it is similar in construction to the ACSR conductor and also similar to the ACCR conductor with the composite reinforcement which is been done. For this type of conductor aluminium strands are again of thermal a resistant like the aluminium alloy containing the zirconium and its composition. So, here the core is made up of metal matrix that is aluminium-aluminium oxide fibers the previous is the carbon and fiber glass core. Here the metal matrix composite core consist of aluminium-aluminium oxide fibers, and this type of conductor can be operated up to 200 degree centigrade. Suitable tools particularly and other accessories are to be used and recommended for this type of conductor while stringing in the transmission lines.

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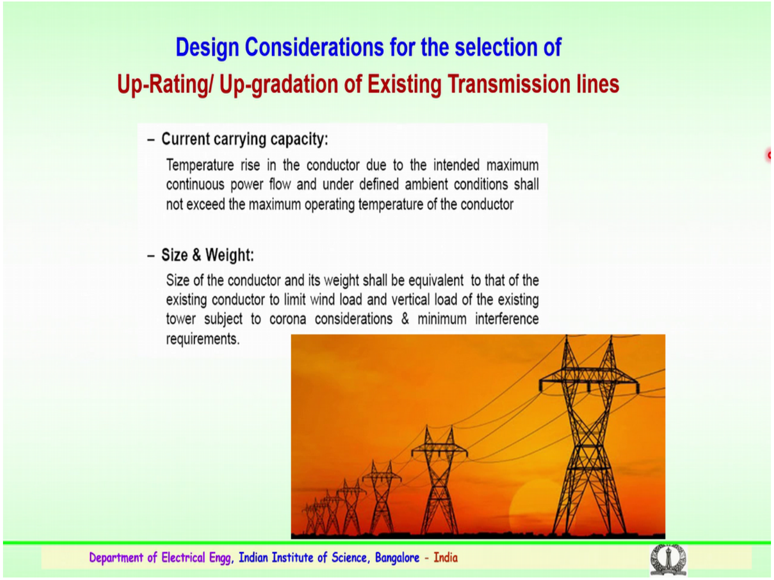

So, there were about the five various types of recently advanced a conductors which are being used for the upgradation or uprating of the existing transmission lines. So, we will discuss about some of the design considerations particularly for the selection and upgradation of the existing lines. So, how the conductors while replacing could be advantages, and what are the necessary consideration design aspect to be followed.

So, for the current carrying a capability, we know that the temperature arise in a conductor is due to the intended maximum continuous power flow under defined ambient conditions. This should not exceed the maximum operating temperature of the conductor. So, in case of the high temperature conductors anywhere typically between 150 to 200 degrees is the current carrying capability temperature thermal rise could happen. And the size and weight, the size of the conductor and the weight also be equivalent to that of the existing ACSR conductor.

So, in case of the operating of the conductor or the mechanical strength, the mechanical weight of the conductor should be a similar to the previous conductor which is being replaced. And followed by that it has to have the weight of the existing conductor and also it should be able to limit the wind load and vertical load of the existing tower, when subjected to corona considerations and minimum interference requirements like RIV or the corona inception or extension voltage levels at that operating voltage as earlier which were required for the ACSR type conductors.

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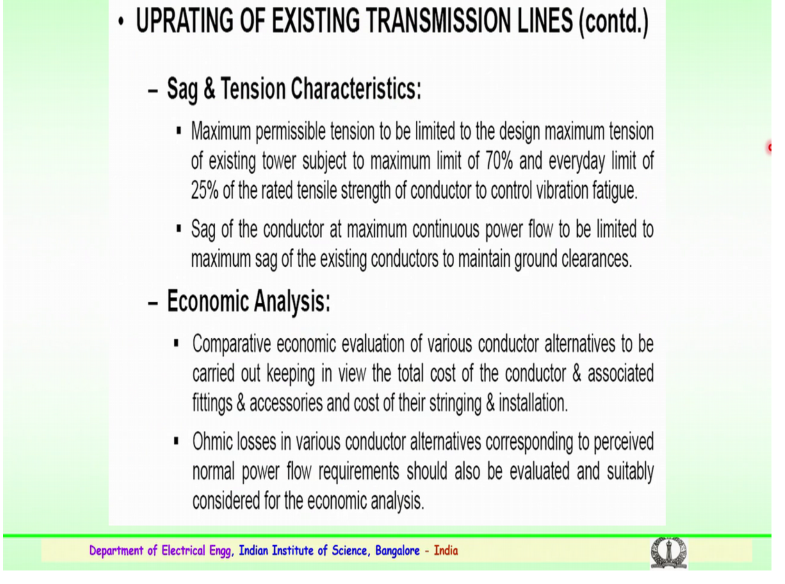

So, the uprating or upgradation of the existing transmission lines is the very, very important. When considerations earlier we have seen some of the considerations like the current carrying capability, the size and weight, now it is the sag and tension characteristics have also to be considered. So, here the maximum permissible tension to be limited to the design is the maximum tension of existing tower which is subjected to maximum limit of 70 percent and everyday limit of 25 percent of the rated tensile strength of conductor to control the vibration or fatigue due to vibration or a wind aspect.

So, the sag of the conductor at maximum continuous power flow is to be limited to the maximum sag of a existing conductors to maintain and also the minimum ground clearances. The fourth point being the economical analysis economical analysis an important factor to be considered in the design. So, here the comparative economic evaluation of various conductor alternatives are to be verified carried out keeping in view the total cost of the conductor and the associated hardware or accessories and the cost of the entire stringing and the new installation. And the point important point also to be considered is the Ohmic losses which could occur in various conductor alternatives corresponding to the perceived normal power flow requirements should also be properly evaluated and suitably considerations are to be done for the economic analysis.

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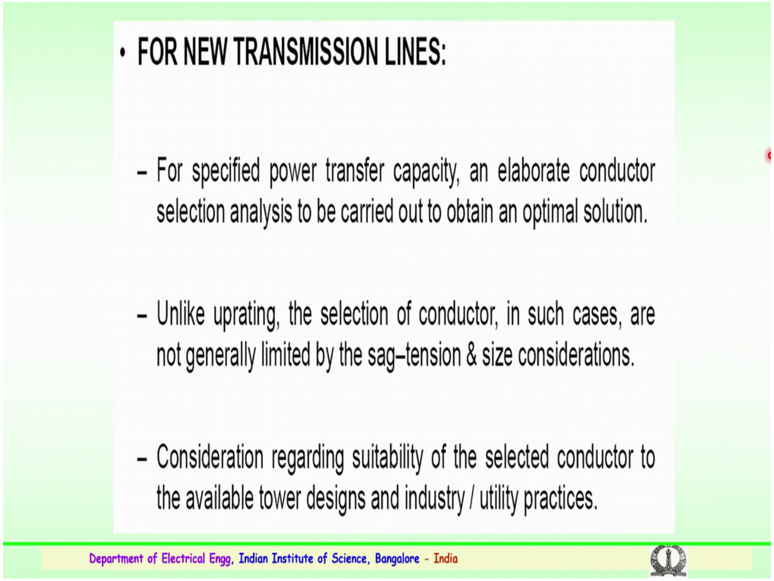

So, when going in for a new a transmission lines for a specified power transfer capability, an elaborate conductor section or a selection analysis is to be carried out to see and obtain an optimal solution. So, unlike the upgrading or uprating of the conductors, here the selection of conductor in such cases are not generally limited by the sag tension and sag consideration. So, the consideration regarding the suitability of the selected conductor to the available designs and the industry or utility practices have to be followed for are the new transmission lines which are being adopted or which are going in for the HTLS conductor transmission system.

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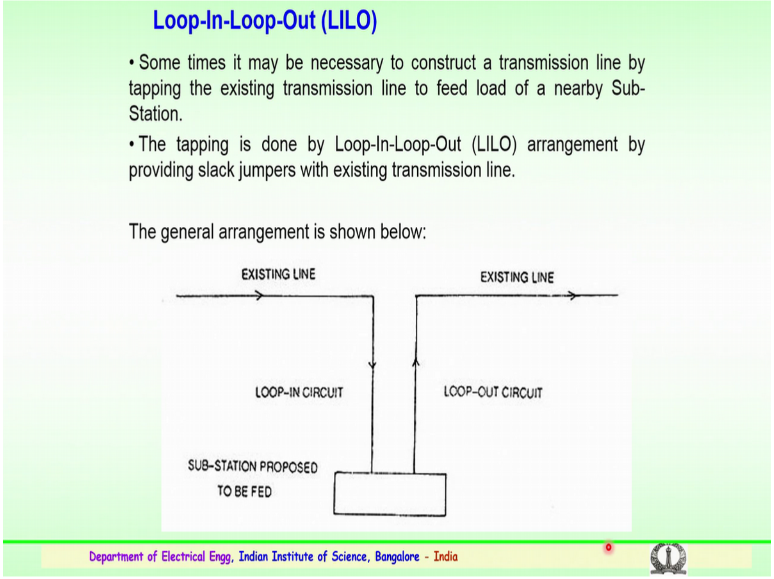

So, before going in for the operating or upgradation of the existing conductors, we will find out some important aspects how it is practically done, and what is the necessity for the requirement for before actually the uprating or upgradation of the conductor is done. So, sometimes it may be necessary to construct a transmission line by tapping the existing transmission line, so which is to feed load say for a nearby sub-station or any other equivalent utility.

So, the tapping of this transmission is done by loop-in-loop out arrangement which is known as LILO arrangement, this by providing a slack jumper conductors with the existing transmission line. So, how this arrangement is done is shown in the single line diagram here, where you can see the existing line, here it is the existing line. So, the existing transmission line is to be connected to a proposed say sub-station or a feeder. So, in such case the existing line has to be properly split and it has to be terminated near the sub-station in this arrangement. So, the tapping of the conductor that is a loop-in and loop-out arrangement is to provide suitable jumpers with the existing transmission lines have to be carried out.

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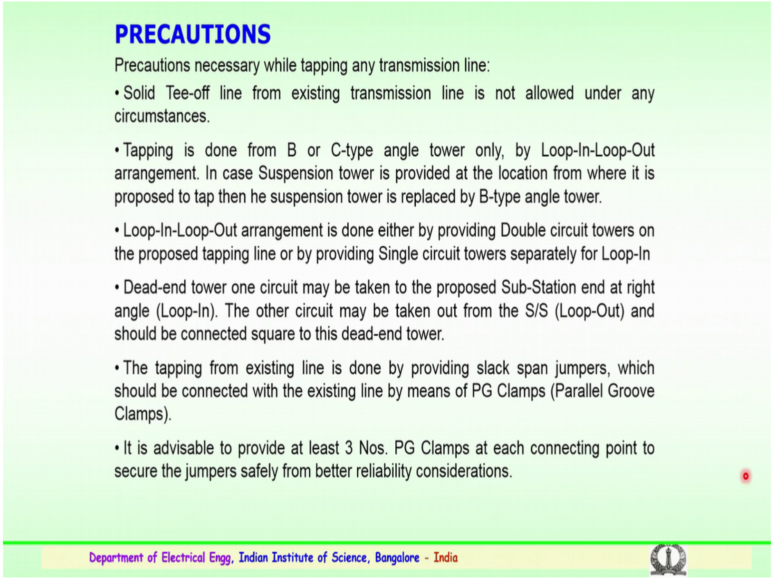

So, some precautions have to be taken while going in for the tapping of any existing transmission lines. There should be a solid tee-off line from the existing transmission line is not allowed under any circumstances. So, the solid tee-off line from existing line is not allowed, you cannot take the connections from the existing with the solid tee-off. So, tapping is done from either a B or a C- type angle tower only by the loop-in or loop-out arrangement has the indicated earlier. So, in case if their exist suspension tower at the location where it is to see the loop-in-loop-out arrangement is to be done then this suspension existing tower is to be replaced by a suitable B-type angle tower. So, before it is being done tower arrangement necessary tower arrangement has to be made. So, then the loop-in-loop-out arrangement is done either by providing a double circuit towers on the proposed line or by providing a single circuit towers separately for the loop-in.

Next point to be considered is a dead-end tower. In case on the dead-end tower, one circuit may be taken to the proposed sub-station or a feeding station at a right angle as a loop in the other circuit may be taken out from the sub-station that is a loop out should be connected square to this dead-end tower as shown. So, one existing is loop-in circuit the other is a loop-out circuit which is to be taken out from the sub-station. So, the tapping from the existing line is generally done by a providing a slack span jumpers. So, jumper conductors of actual rating of the conductor are provided for the tapping of the existing transmission lines, which should be connected with the existing lines by means of parallel groove clamps that is a PG clamps which are known by the utility engineers.

So, these have to be employed. So, it is also advisable to provide at least three parallel groove clamps at each connecting point to secure the jumpers safely from better reliable conditions considerations.