Advances in UHV Transmission and Distribution
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Lecture – 39
Upgradation/uprating of transmission lines – advantages (cont)

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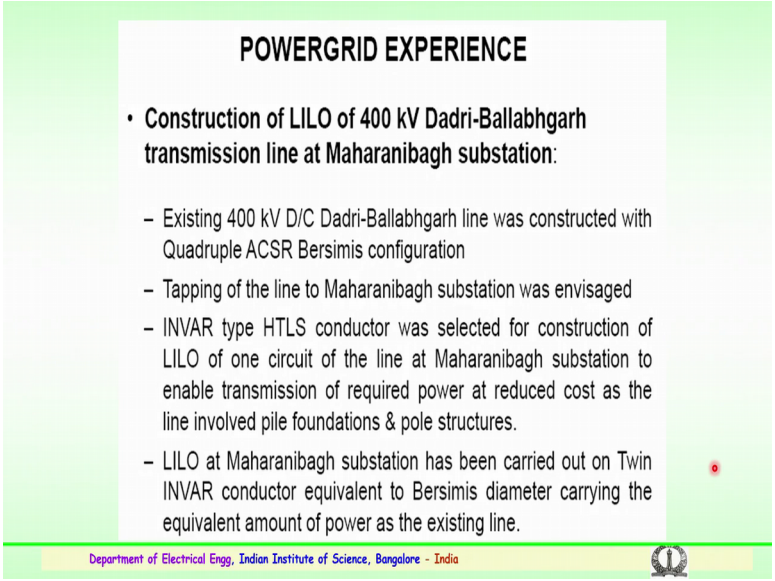

So, that is about the mastering arrangement and the requirement for the loop in loop out arrangements to be carried out for the HTLS conductors. In India the government of India with the help of power grid corporation have experiences, in constructing of several new lines and several upgraded lines in the country by the loop in loop out arrangement for many transmission voltage levels.

We will briefly go through the information which the lines have been upgraded or the new lines which have been energized with use of a new type of INVAR or HTLS type of conductors. So, a particular example the construction of the loop in loop out of 400 kV Dadri Ballabhgarh, that is in Delhi the transmission lines at Maharanibagh substation in Delhi.

This was carried out for the existing 400 kV double circle Dadri Ballabhgarh line by the power grid corporation. And was constructed with the quadrupole ACSR bersimis configuration. So, here for this project the tapping of the line to Maharanibagh substation was envisaged. And HTLS conductor of type INVAR was selected for construction of the

line in line out or the loop in loop out arrangement of one circuit of the line in Maharani Bagh station to the enable transmission at of required power for the reduced cost as a line involved pile foundations and pole structures.

So, the loop in loop out arrangement at the same substation has been carried out using the twin INVAR conductors, which are equivalent to the bersimis diameter approximately thirty 6 mm dia which carries the equivalent amount of power as the existing line.

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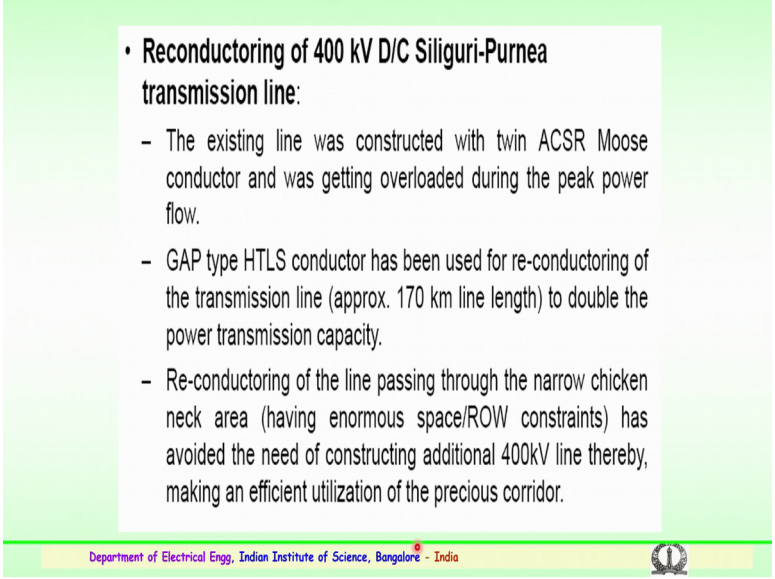

The second was the upgradation or operating of the 400 kV double circuit Siliguri Purnea transmission line.

Ah this existing line was constructed with earlier twin conductor ACSR Moose conductors, and was getting overloaded a particularly during the peak power flow. So, it was thought to replace the Moose conductors with the HTLS conductor and upgradation or reconductoring of the project of double circuit 400 kV line was carried out with the help of a gap type HTLS conductors, and has been used for successfully for reconductoring of the transmission line, which is approximately 170 kilometer a line length to double the transmission capability.

Ah we know that the HTLS conductor can operate at a very high temperature, and the power also could be 2 to 3 times the capability of the ACSR conductors. So, this

intention reconductoring of this line was carried out. And reconduting of the line which passes through the narrow chicken area chicken neck area particularly having enormous space or right of way constraints, have been avoided and the need for constructing additional 400 kV line thereby makes an efficient utilization of the precious corridor.

So, here the right of way could also be reduced instead of going in for INVAR towers with the same right of way or space available with the existing towers reconductoring has been conducted satisfactory.

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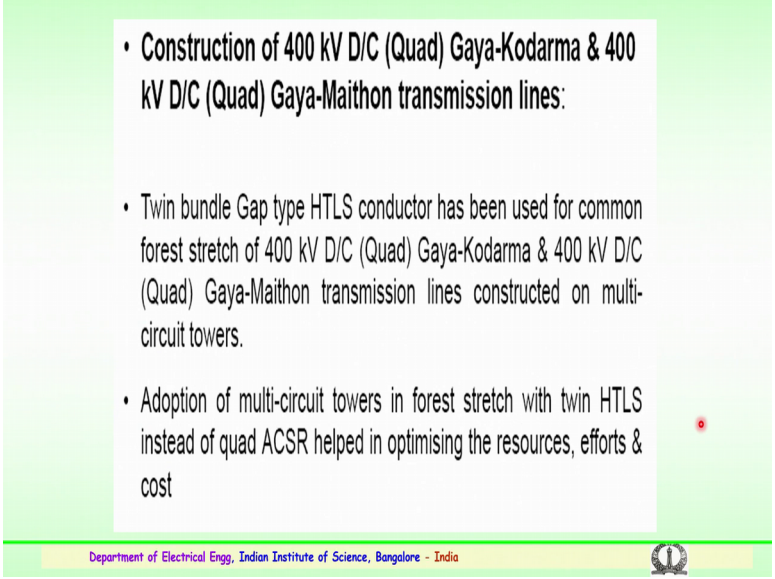

The third project being the construction of the 400 kV double circuit Gaya Kodarma, and 400 kV double circuit Gaya Maithon transmission lines. Again here HTLS conductors of twin bundle gap type were employed and used for a common forest areas stretch area of 400 kV double circuit earlier used as a quad conductors have been used. Then the second line that is a Gaya Kodarma and 400 kV double circuit Gaya Maithon transmission line were constructed on multi circuit towers. So, the adoption of multi circuit towers particularly in the forest stretch area with twin high temperature low sag conductor instead of quadra pole ACSR helped in optimizing the resources. So, you can see that earlier 4 conductors of ACSR why used presently replaced by 2 conductors of HTLS.

So, this optimizes the resources efforts and also the economy involved.

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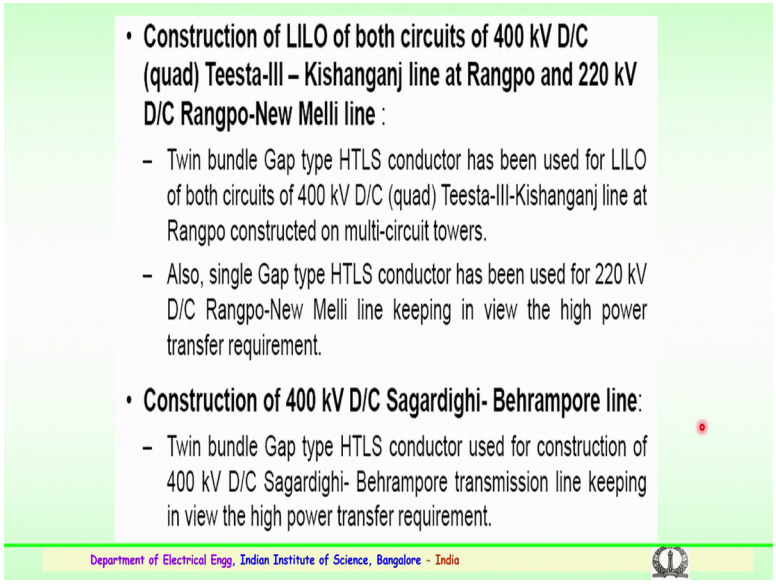

The next was the construction of the loop in loop out of both circuit is of 400 kV double circuit quadrapole line which is from Teesta third stage to Kishanganj line at Rangpo, and 220 kV double circuit line to Delhi that Rangpo to new Melli line a new Melli line. So, here the 2 bundle gap type of high temperature conductors were used for loop in loop out, and both the circuit is of 400 kV double circuit quadra pole conductors were used for Teesta Kishanganj line and Rangpo constructed on multi tower arrangements.

So, here the single gap type high temperature low sag conductors were being used upto 20, 220 kV double circuit line keeping in view of the high power transfer requirement. So, further to this the construction of 400 kV double circuit Sagardighi Behrampore line this is in Orissa. So, here that twin bundle gas type of high temperature low sag conductors were used for the construction of 400 kV double circuit transmission line keeping in view of the high power transfer requirement.

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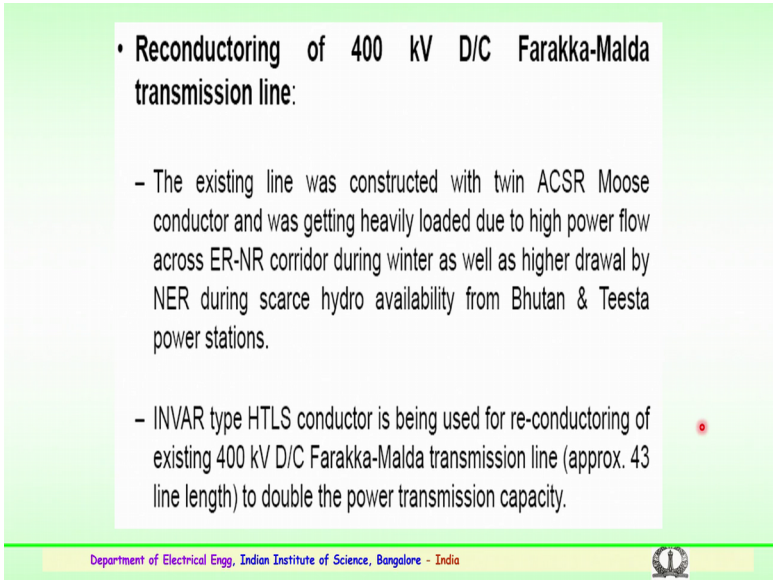

So, several of this type of projects are being constructed in the country for over a period of time. And several are being new, new lines are also been using the HTLS conductor. So, similarly 400 kV double circuit Farakka Malda transmission line was constructed with the help of earlier twin ACSR Moose conductor which was getting heavily loaded due to high power flow, and then eastern region northern region corridor particularly.

Ah during winter as well as their high withdrawal by the north eastern region during low availability hydro availability from Bhutan and Teesta power stations. So, here for this project INVAR type of high temperature low sag conductor was used for reconductoring of existing 400 kV double circuit line, approximately 43 line length to double the power transmission requirement.

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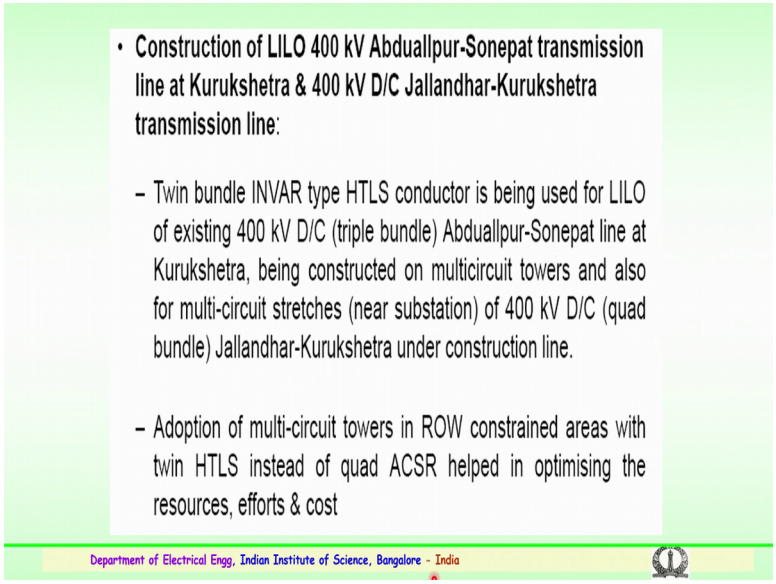

Several advantages of going in for this type of conductor. So, you can see further 400 kV line in Haryana Sonepat transmission and at Kurukshetra and also Jallandhar to Kurukshetra transmission line were upgraded or constructed with that twin bundle INVAR type of high temperature conductors, which were used as a loop in loop out of the existing 400 kV double circuit consisting of triple bundle conductors, particularly at kurukshetra which were been constructed on multi tower arrangement and also for multi circuit structures near the substation at Jallandhar, which was under construction line.

So, the adoption of multi circuit towers particularly in the right of way constrained areas, with the 2 conductors twin conductor high temperature low sag, instead of 4 conductor or of ac ACSR helps in optimizing the resources efforts.

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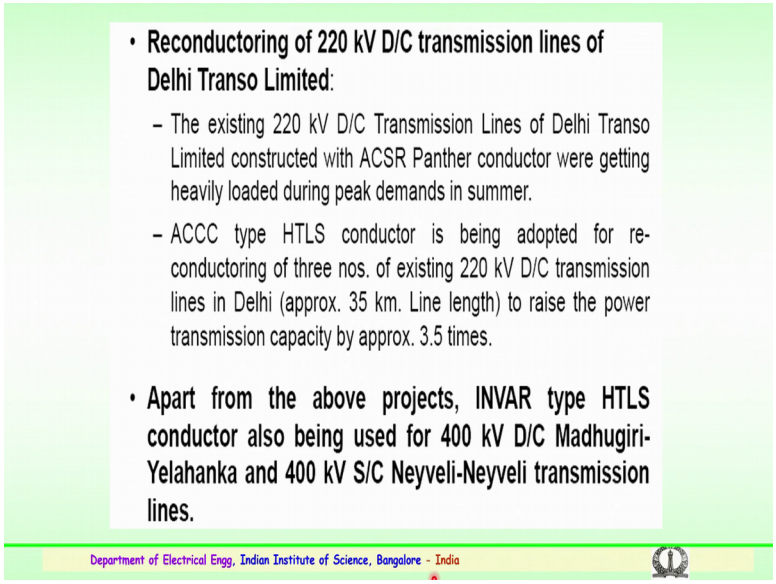

And the final cost for going in such Projects. So, apart from this reconductoring of 220 kV DC transmission double circuit transmission lines of Delhi transo have also been carried out.

Ah the existing 220 kV double circuit line of Delhi transo which had a ACSR panther conductor which are getting heavily loaded during particularly peak demand in summer, have been replaced by ACCC type HTLS conductor being adopted for the reconductoring of 3 numbers of existing 220 kV double circuit lines in Delhi, which is approximately 35 kilometer line length to raise the power transmission capacity to approximately to 3.5 times the existing the capability.

So, this is very important. So, apart from several of this projects in the country new projects and reconductoring projects are being carried out with the use of INVAR type HTLS conductors are being used for several projects including the one 400 kV double circuit Madhugiri to Yelahanka in Bangalore in Karnataka, and 400 kV a single circuit at Neyveli to Neyveli transmission lines.

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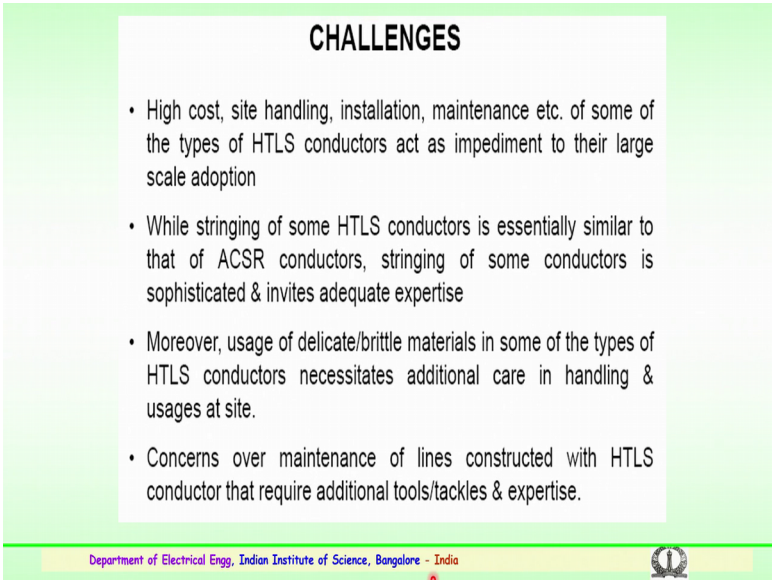

Though several projects are being executed in the country with the initiative of the power grid and the government of India.

So, lot of challenges are there for going in for the new type of technology that is a high temperature low cost low sag conductor technology, initially because of it is higher cost and also the site handling installation maintenance etcetera, are for some of the types of conductors which act as an impediment to the large scale adoption immediately.

So, as the time the conductor cost also could reduce with the number of players coming into the market and which would be very useful for the reconductoring or going in for the new projects. So, this conductors while stringing particularly some HTLS conductor it is essential similar to that of the ACSR conductors so no much of technology differs in the construction or a stringing aspect. And stringing of some conductor is sophisticated and invites special adequate expertise.

So, some of the cases it is similar and some of the cases it requires adequate expertise in this technology as it is a newer technology, this have to be overcome over a period of time. More over usage of delicate or a brittle materials in some of the types of HTLS conductors would could necessitates additional care particularly in handling usage at the site where the lines are being constructed.

There are also concerns over the maintenance of these lines constructed with the high temperature conductors, where it requires an additional tools or a tackles and more expertise as the technology is newer. So, require little bit of extra expertise in handling the situations, or some of the concerns or the challenges which are being posed by this new technology for the reconductoring or going in for the new transmission systems.

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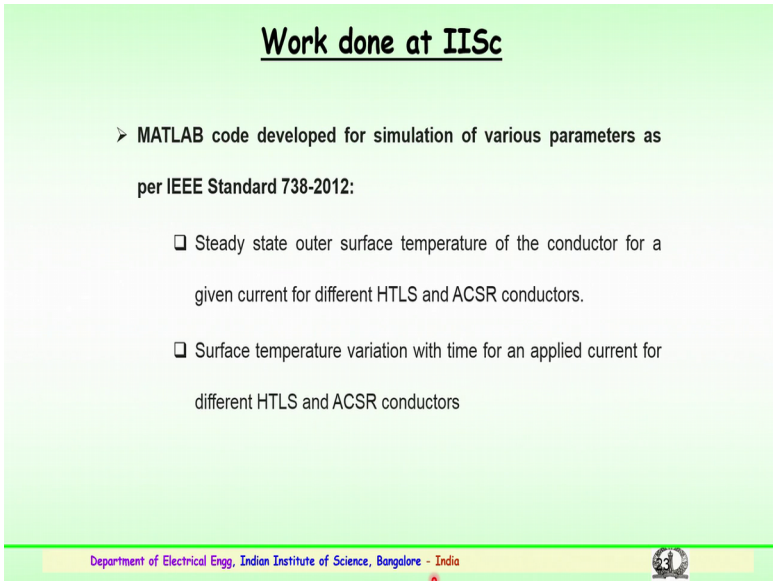

So, pertaining to the higher temperature low sag conductors, we have also carried out some work at the Indian institute of science, where we have to carry out of both the simulation and also the experimental work pertaining to various type of a conductors which are being used in the country and elsewhere. So, we have developed a code based on the matlab, for the simulation of various parameters as per the IEEE standard.

Ah this developed code will be very useful for the utility and also for the manufacturers to have idea about the performance of the conductor for it is operational in the field. So, with the help of the code we can see the steady state outer surface temperature of the conductor for a given current for various HTLS and also for the ACSR conductor, program has been developed with where very simple GUI that is a graphic user interface is also been adopted for the simulation.

Here the surface temperature variation with time for an applied current for different high temperature low sag and also for the ACSR conductors could be a simulated.

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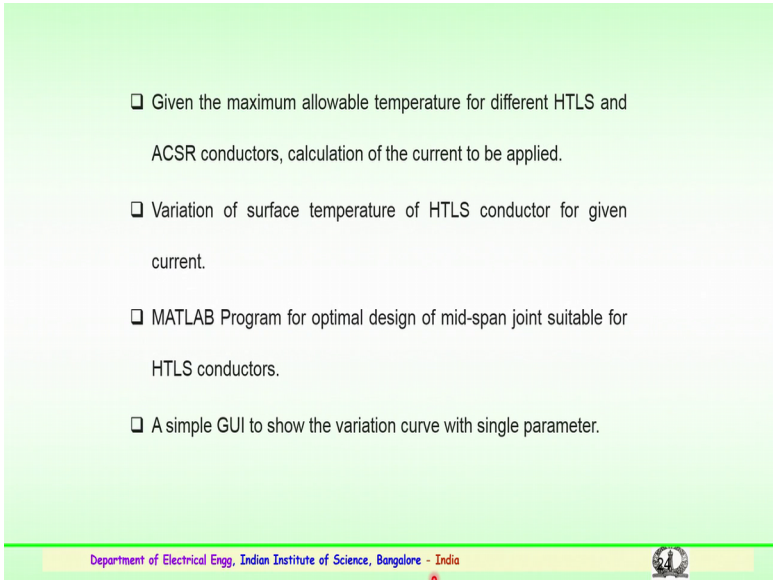

Given a maximum allowable temperature for different high temperature low sag conductors and ACSR conductors the calculation for the current can be applied, and also the variation of surface temperature for HTLS conductors for a given current could be simulated.

This program has been made for the optimal design including the accessories like, the mid span joint which or any other accessories suitable for to be used in the high temperature low sag conductors. A simple user interface that the graphic user interface, to show the variation with the any parameters is also been developed.

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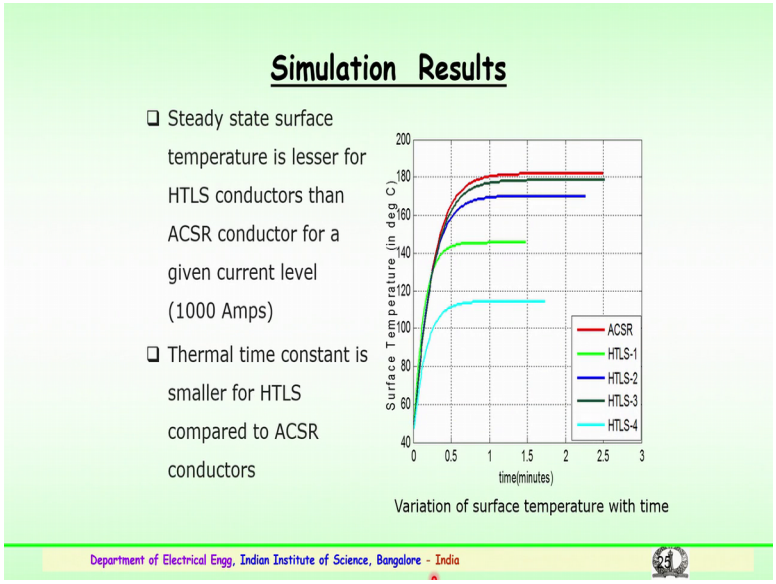

So, some of the simulation results are displaced here you can see the surface temperature in y axis and the time in minutes in the x axis.

Here the study state surface temperature is observed for various types of high temperature low sag conductors, we have considered 4 conductors both for simulation and experimentation and we have also compared with the existing ACSR conductors, it is observed that the surface steady state temperature is low for the high temperature low sag conductors, in comparison to the ACSR conductor for a given current values.

So, we have tried to simulate for various current levels, and we have comparison which has been made. And thermal time constant is also lesser in case of HTLS in comparison to the ACSR conductor this is obtained by the simulation. So, you can see the graphs here. Red curve indicates the curve for the ACSR conductors, and other 4 colour graphs indicates for various HTLS conductors which have been considered.

So, you can see the surface temperature drops for the high temperature conductors, with various combinations or various lay high temperature conductors in comparison to the ACSR conductor. So, the variation of surface temperature with time has been shown and the performance of HTLS is much better in comparison to the ordinary ACSR type of conductors.

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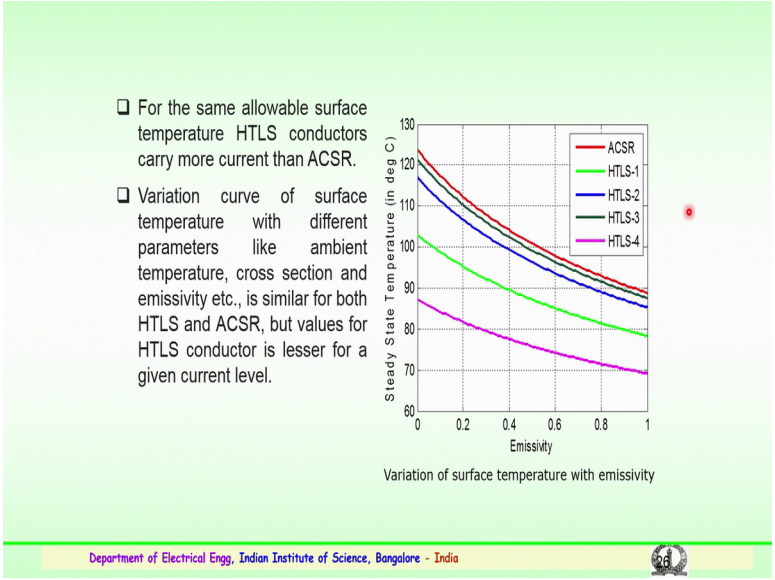

This graph shows the variation of surface temperature with the emissivity very important factor ah, the versus the steady state temperature in degrees for so, the simulation were carried out for various temperature levels. And the performance of the 5 conductors including 4 HTLS and ACSR have been indicated here. So, you see that HTLS conductor perform much better in comparison to the HTLS conductor which sorry, ACSR conductor which has been shown in the red colour curve.

So, for the same allowable surface temperature HTLS conductor carry more current then the ACSR. So, the variation curves here we show of the surface temperature with different parameters like the ambient temperature or cross section and emissivity is a similar for both HTLS and ACSR. But values of HTLS conductor are lesser in for a given current level.

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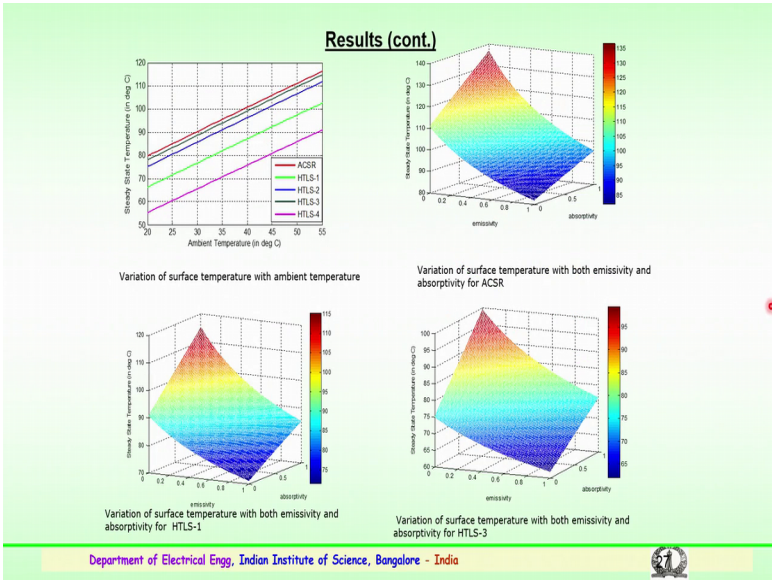

These are some more results which have been simulated for the 4 types of HTLS and ACSR conductors.

So, this curves give the steady state temperature versus the variation of surface temperature and comparison with the ambient temperature. Whose surface temperature variations have been plotted, and the performance of HTLS conductor are much better and compared to the surface temperature performance of the ACSR conductor. So, this graph shows the variation of surface temperature with emissivity and absorptivity for the absorptivity and emissivity.

Ah here again the variation of surface temperature for both emissivity and observing in case of high temperature conductors. This is for the ACSR conductor; this is again the other type of high temperature conductors. So, 4 types of high temperature conductors were used for the simulation and experimental study.

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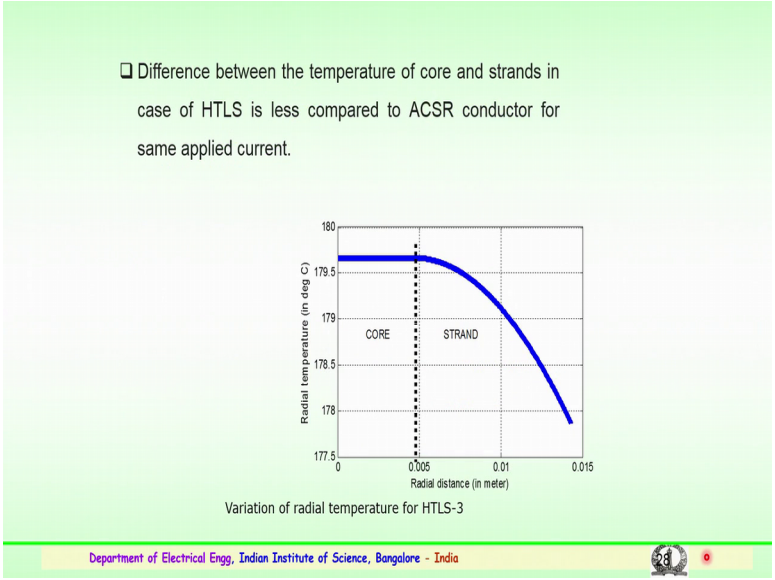

So, we also conducted the study on the variation of radial temperature versus the radial temperature.

So, here the difference between the temperature of the core and the outside stands a particular in case of HTLS was observed to be lesser in compare to the ACSR conductor, for the same applied current. So, that is a very important point where HTLS performs better in comparison to the ACSR type conductors. So, further we tried to conduct the experimentation on the new type of conductors.

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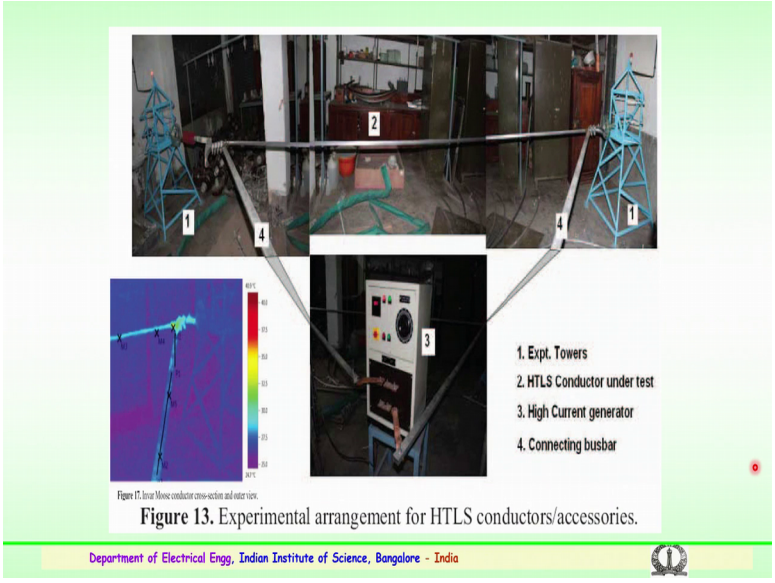

So, for experimentation we had to suitably use the source so, we have developed a 2000 amp source current source which is 6 kV, 2000 amp source and we have an experimental arrangement made 2 towers which are at a distance of 6.5 meters apart from each other, this is as per the international standard requirement for conducting the experiments.

So, 1.5 meter height towers metallic towers which have been permanently connected to the ground and proper having a proper tension arrangement, higher the conductors have been connected and the experiments have been performed for various HTLS conductors. And also the aluminium ACSR conductor, further after the conductors the experiments are also been extended for the accessories including the mid span T connector repair sleeve So on, and the performance also was monitored.

Ah during the experimentation it was also observed the temperature raise was monitored. So, the temperature raise was monitored with the use of thermal imaging camera and try to see the hot spots on the connections and hot spots on the conductors and see how the temperature variation was observed for fixed current levels. So, both short term and long term experimentation.

A short term include 5 to 10 minutes of the application of the current levels. So, long term includes half an hour to one hour experimentation or more of the time period and the performance was verified for all the 5 types of conductors. So, this arrangement shows the experimental towers which are of 1.5 meter height, and the distance between the towers been 6.5 meters.

Ah the high temperature conductors and ACSR were used for the experimentation. These are the connecting leads from the conductor to the generator which could which can generate 2000 amps, which is the high current generator and these are the connecting busbars. So, these busbars are also important and this busbar connecting busbars should be able to carry the current which is being supplied by the generator.

So, else the could be a sag and the conductor if it is not of current carrying capability could melt during the experimentation.

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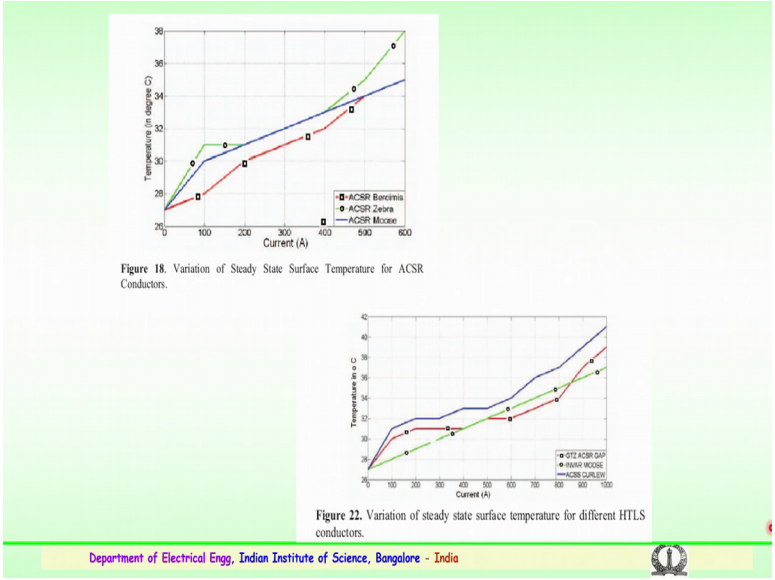

Some of the experimental results are being shown here, these or for various type of the aluminium conductors that is ACSR and also for the HTLS conductors, you can see here the temperature in degrees with the current for various current values, experiments have been repeated and steady state surface temperature for the ACSR conductors have been plotted.

So, 3 types of ACSR conductor the bercimis, zebra type and the Moose conductor were carried out, and their performance was experimentally studied. Further to that the HTLS conductors. So, various type of HTLS conductors which were available were also studied and their performance monitored which have shown here the temperature versus the current in x axis, shows the steady state surface temperature for different HTLS conductors.

So, these are some of the experiments and simulation work carried at the laboratory, to verify the new conductors which are being used recently in the transmission system in the country.

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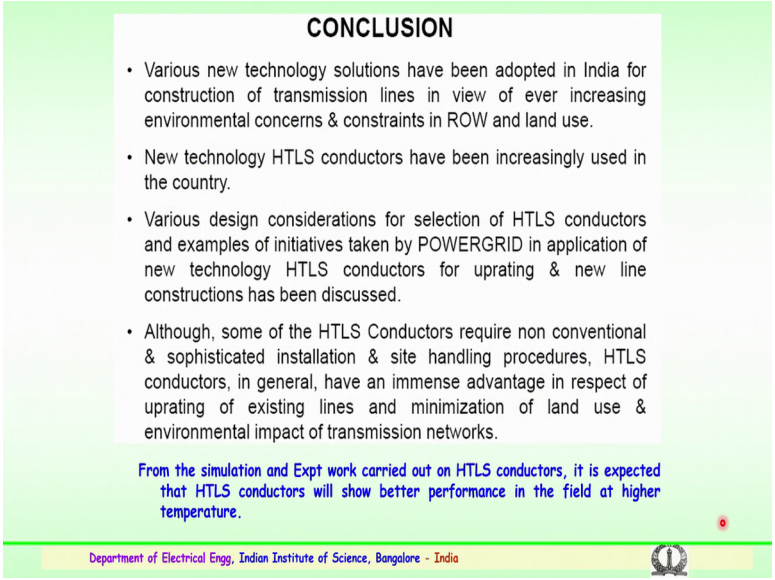

So, some conclusions of the technology which is being used. So, various a new technology solutions have been adopted in the country for particularly construction of a transmission lines. This is in view of the ever increasing environmental constraints, and also concerns particularly in the right of way and the use of the proper utilization of the land available.

So, the new technology that is the high temperature low sag conductors have been increasingly used in the country. And several projects are being executed, and many have already been in use. So, various design considerations a particularly for selection of high temperature low sag conductors, and some examples of initiatives which are taken by the power grid government of India in application of the new technology that is a high temperature low sag conductors, for the uprating or upgrading and also adopting the new line have also been discussed in the talk.

Although some of the high temperature low sag conductors require non conventional and highly sophisticated installation and also the site handling procedures. But the HTLS conductor in general have an immense advantage in respect of operating or upgradation of the existing lines. And particularly towards the minimization of the usage of the available land and also the environmental impact which is happening because of the transmission networks.

So, further we have also try to do lot of simulation and experimentation work on various type of HTLS conductor and accessories. With the results available it is expected that the high temperature low sag conductors will perform and show much better performance in the field, particular at higher temperature which the technology will be very useful in the country which is being adopted presently. With that will end this lecture.

Thank you.