Advances in UHV Transmission and Distribution
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Lecture - 17
Introduction of HTLS conductors and their advantages

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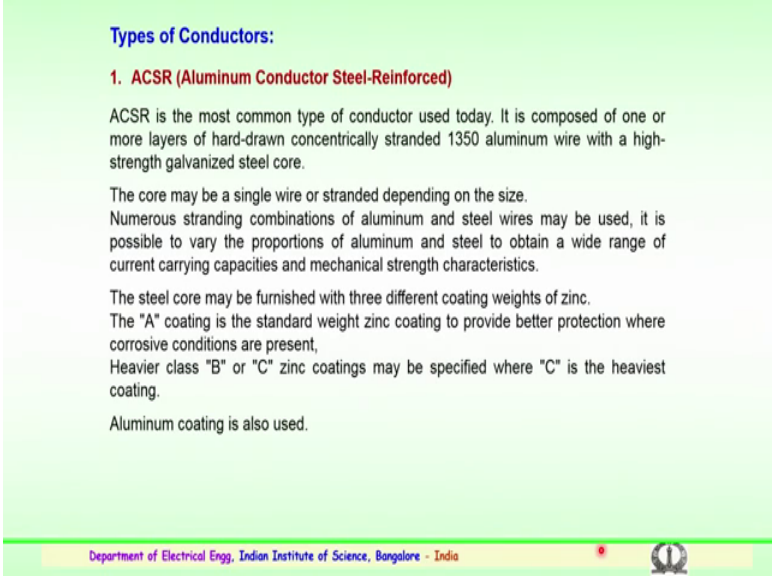

So types of conductors which are being used, we saw the 4 main categorized types of conductor triple AC, ACSR, ASC and the ASCR. So, these have been again sub classified in to several types which we will be a discussing one by one of various conductors which are being employed for the transmission or distribution systems. So, the first one being the ACSR that is ACSR is aluminum conductor steel reinforced which is most common type of conductor which is even used today it is composed of one or more layers of hard drawn concentrically stranded 1350 aluminum wire, 1350 is the alloy aluminum alloy type of aluminum alloy with a high strength galvanized steel cores.

So, in between the center of the conductor will be a steel core either a single 3, 7 or many steel core depending upon the size of the conductor which are stranded aluminum conductor which are stranded. The core may be a single wire as mentioned or stranded depending upon the size. So, it could be 3 7 further or many more. So, we will see how the ACSR conductors various types different standard and how many steel core exist. So, numerous a stranding combinations of aluminum and steel wires could be used it is

possible to vary the proportions of aluminum and steel to obtain a wide range of current carrying capacities and mechanical strength characteristics. So, that is important a point the steel core could be furnished with three different coatings with zinc coating to see the corrosion does not happen the a coating is the standard weight zinc coating to provide better protection for corrosive conditions.

Apart from that the heavier class B or class C zinc coating may also be specified in case where the C type of coating heavier coating is used to be used for the heavy corrosive zones A where the corrosive could be seem to be very heavy. So, the aluminum coating is also being used.

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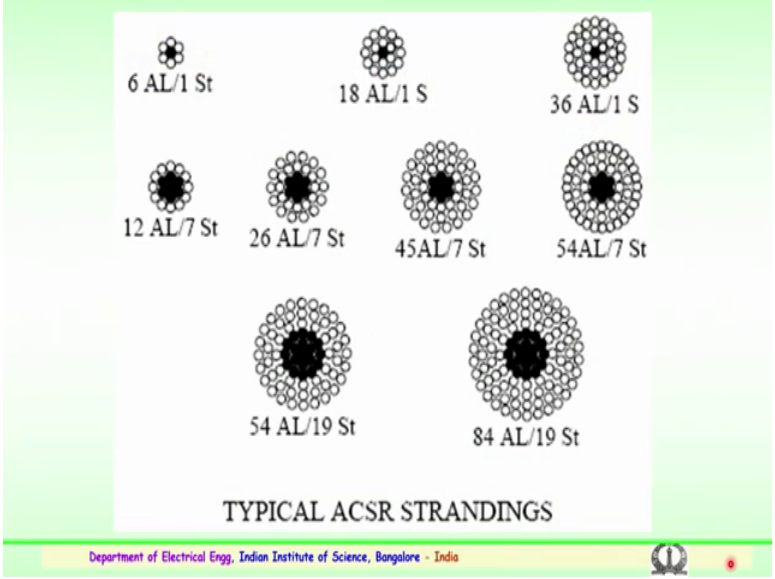

Apart from this zinc based coatings, these are the typical aluminum conductor steel reinforcement standings you can see here 6AL slash 1 t, this represents the center conductor is a single conductor, one conductor of steel surrounded by 6 strands of aluminum. So, 6AL is 6 strands of aluminum the center conductor is one of steel. So, this is the nomenclature similarly it could have a one steel center conductor and 18 aluminum which are standard as shown here.

Again a single steel conductor with 36 aluminum; depending upon the voltage requirement and the current caring capability the size and the type of conductors are used. So, further 7 steel with 12 aluminum conductor stranded steel numbers are increased mainly for the mechanical strength the span length and so on.

So, 7 steel, 26 aluminum, 7 steel, 48 aluminum, stranded 7 steel, 54 aluminum, 19 steel, 54 aluminum, 19 steel, 84 aluminum. So, these are the various types or a typical ACSR stranded conductors which are in use for different voltage levels and different current carrying capability and mechanical strength; the second after ACSR the second type of conductor is ACSR AW.

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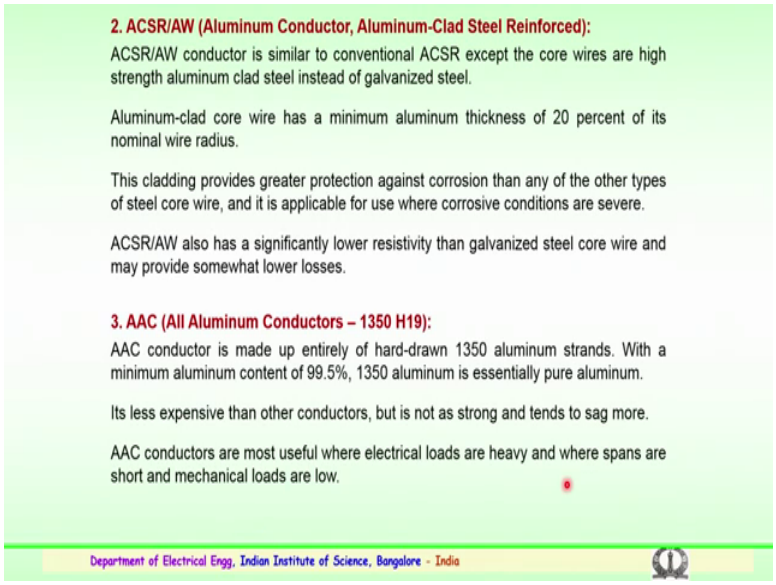

Aluminum conductor aluminum clad steel reinforcement. So, here ACSR AW conductor is similar to the conventional earlier ACSR conductor except the core wires are high strength aluminum clad steel instead of galvanized steel.

So, here the material is used a slightly different in comparison to the ACSR. So, aluminum clad core wire has a minimum aluminum thickness of 20 percent of it is normal wire radius. So, that is one of the important point and the cladding provides greater protection against corrosion than any of the other types of steel core wire and this is a applicable to use in areas where corrosive conditions are very high or severe. So, the ACSR a w type of conductors also have significantly lower resistivity than galvanized steel core wire and they may provide better or lower losses particular somewhat lower losses in comparison to the ACSR type of conductors.

The third type is AAC that is all aluminum conductors 1350 is the aluminum alloy h 19 is that particular alloy which is used for manufacturing of this conductors. So, AAC all aluminum conductor is made up of entirely of hard drawn 1350 alloy aluminum strands

with a minimum aluminum content of 99.5 purity that is 1350 aluminum is essentially a pure aluminum conductors.

So, this is less expensive than other type of conductors, but is not as strong as you see the steel reinforcement is not available. So, mechanically the conductor tries to sag more and comparison to the ACSR or ACSR AW type of a conductors. So, AAC conductors are most useful where electrical loads are heavy that is a high electrical power and where spans are short there is tower to tower distances are short and mechanical loads are low in such cases AAC conductors are used for the transmission or a distribution networks systems.

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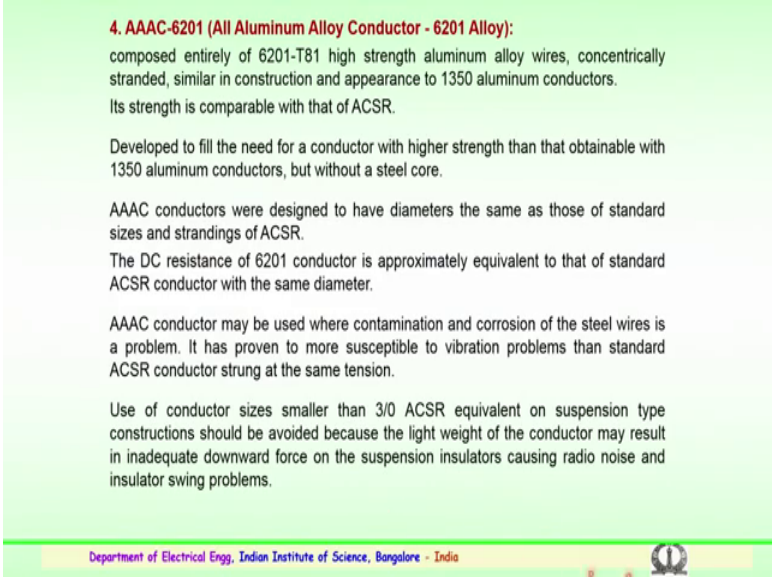

Before these triple AC 6201 that is the all aluminum alloy conductor 6201 is alloy of aluminum this is composed entirely of a 6201 T81 alloy with the high aluminum strength where wires concentrically stranded similar in construction and appearance to the previous 1350 aluminum conductors and it is strength is comparable with that of the aluminum conductors steel reinforced first conductor.

. So, this is developed a mainly to fulfill the need for a conductor with higher strength than that which is obtained with 1350 aluminum conductors, but without a steel core. So, AAAC or AAC conductors were initially designed to have diameters same as the those of the standard sizes and strandings of similar to aluminum conductors steel

reinforcement here the d c resistance of this conductor is approximately equivalent to that of the standard ACSR conductor for the same diameter.

So, AAC conductor may be used where contamination important the pollution problems are more, the transmission line runs near the contamination areas and corrosion particularly of the steel wires is the problem. So, in such cases triple AAC conductors are used and this us proven to more susceptible to vibration problems than standard ACSR conductors stranded same tension. So, this has been advantageous to overcome some of the vibration related problems.

So, use of this conductor is that sizes smaller than 3 ACSR equivalent and suspension type construction should be avoided if a initially you can see there are no steel core here only 3 standard aluminum conductors if you are using for a longer length have to go avoided because the light weight of the conductor may result in adequate inadequate downward force on the suspension and so, there is a sag causing and also the noise radio noise and the insulator swinging problems could arise because of the mechanical steel conductor not present in this type.

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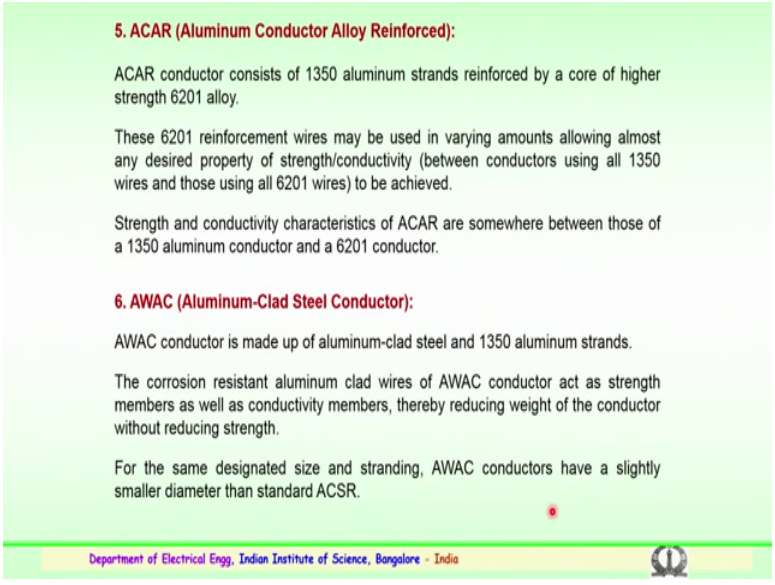

The fifth is the ACAR aluminum conductor alloy reinforced this consist of again 1350 aluminum strands reinforced by a core of higher strength 6201 alloy. So, this 6210 reinforcement wires may be used in varying amounts allowing almost any desired property of strength or conductivity that is between conductors using all 1350 conducting

wires and those using 6201 wires are to be achieved a strength and conductivity characteristics of this ACAR conductors are somewhere between those of a 1350 aluminum conductor and a previous 6201 conductor aluminum conductor.

The sixth is aluminum clad steel conductor AWAC; AWAC is made up of aluminum clad steel and 1350 aluminum alloy strands the corrosion resistant aluminum clad wires of AWAC conductor act as a strength members as well as conductivity members thereby this reduces the weight of the conductor without the reducing the actual strength of the conductor. So, for the same designated size of the conductor and the strandings AWAC conductors have a slightly smaller diameter comparison to that of the standard aluminum conductor steel reinforcement this is one advantage with the aluminum clad steel conductor.

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Typically aluminum conductor that is strandings are of this measure we have a 7 strand we have 19 37 strand, 37 91 strand. So, 1350 aluminum conductors strands of typically in this type.

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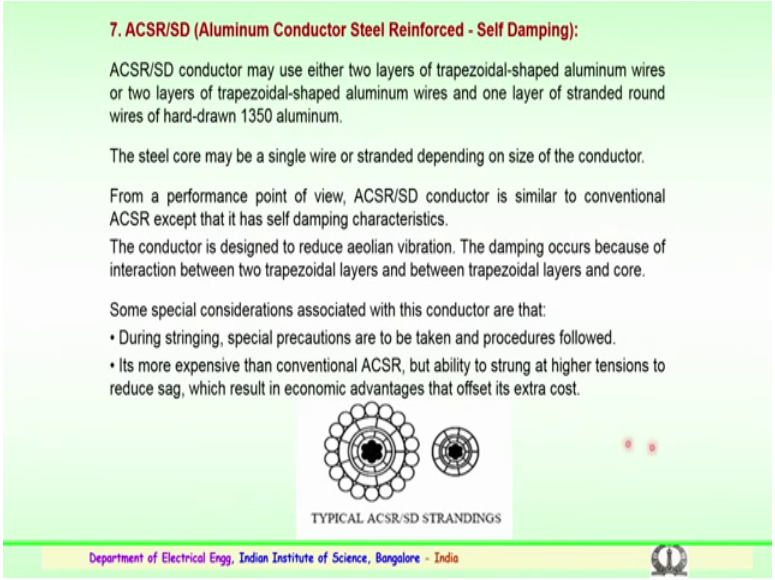

The seventh is ACSR SD aluminum conductor steel reinforced that is self damping that is very important here. So, the similar aluminum conductor steel reinforced having it is a self damping characteristics could be used either 2 layers of trapezoidal as shown here or one layer of stranded round as a shown here of hard drawn 1350 aluminum alloy conductors the steel core; the steel core which is in the middle may be a single wire or stranded. So, this could be single or may be stranded like 17. So, on depending upon the size of the overall conductor, from performance that is the in the field in the performance matters the performance point of view.

So, ACSR conductor with SD is similar to the conventional aluminum conductor steel reinforced except that this has a self damping arrangement very important characteristics this conductor is design to reduce Aeolian vibrations we will be discussing about what are the Aeolian vibrations. So, in case of the Aeolian vibrations these damping characteristics will help the conductor to see that the oscillations are damped are reduced because of this arrangement. So, the damping accurse because of interaction between 2 trapezoidal layers which is have been here and between the trapezoidal layers and the core that is a steel core inside. So, this will be helpful of for damping the oscillations mainly because of Aeolian vibrations.

So, some special considerations associated with this conductor are particularly during stringing special precautions have to be taken and follow and necessary procedures have

to be followed it is slightly more expensive than conventional ACSR, but it has a ability to strung at higher tensions to reduce the sag that is very important this results in economic advantages that offset it is extra cost because we say here it is slightly expensive, but it because of it is ability to see the reduction of a sag and also has a properties where it could reduce the vibration stone extend this stands a better in comparison to the ACSR conductor.

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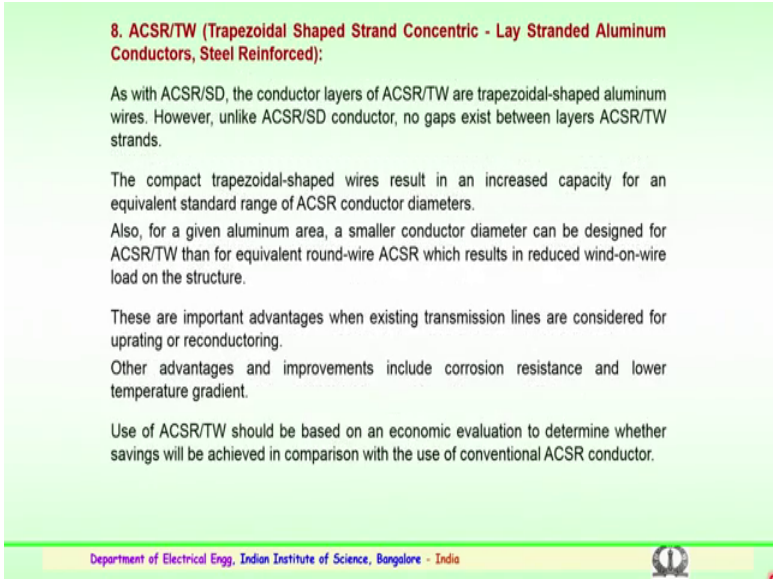

So, the eighth being the ACSR TW that is trapezoidal shaped stranded concentric lay stranded aluminum conductors with steel reinforcement. So, this; the conductor layers of ACSR TW are trapezoidal shaped aluminum wires not the round type which is being normally followed; however, unlike ACSR SD conductor no gaps exist between layers. So, there are no gaps ACSR TW strands the compact trapezoidal shaped wires result in an increased capacity of equivalent standard range of ACSR conductor diameters also for a given aluminum area a smaller conductor diameter can be designed for ACSR TW than for equivalent round wire of ACSR this results in reduced wind on wire load on the structure.

So, these are important advantages when existing transmission lines are considered for uprating or reconductoring that is a upratings; upgrading the conductors or reconditioning that the remove conductors and changing the conductors. So, this a type of advantages exist in this type of conductors. So, other advantages could also be the

improvements based on the corrosion resistance and a lower temperature gradient the use of this particular ACSR TW conductor mainly should be based on an economic evaluation to determine whether savings will be achieved in comparison with the use of conventional ACSR conductors.

So, any conductor before that is being chosen the economical considerations have to be evaluated and the technical aspects have to be also looked in to before it is being used in the transmission or a distribution.

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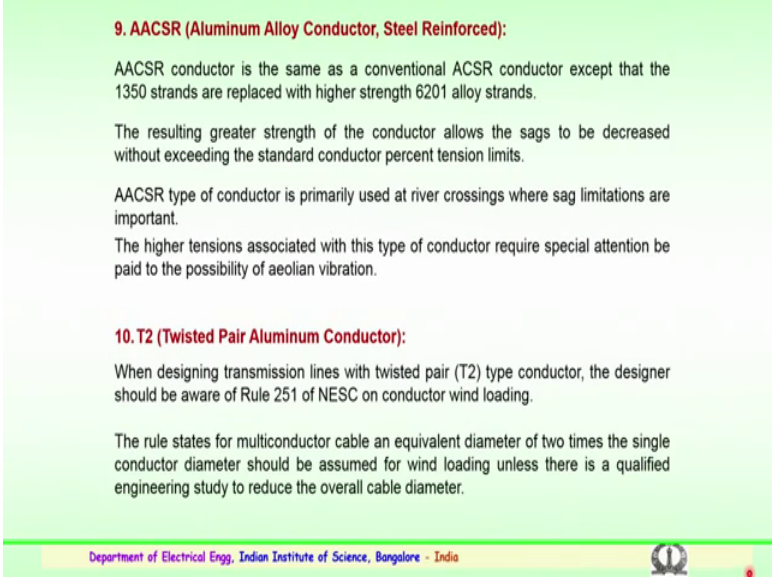

The ninth is ACSR aluminum alloy conductor with steel reinforced. So, this conductor is same as conventional aluminum conductor steel reinforcement except that 1350 strands of a aluminum alloy are replaced with higher strength that is 6201 alloy strands here. So, the alloy strands are the changes which have been use the resulting this results in greater strength of the conductor which allows a sags particularly voltage sag in the conductor sag sorry the conductor sag to be decreased without exceeding the standard conductor percent tension limits. So, ACSR type of conductor is primarily used at river crossings where sag limitations are very important.

So, there the higher quality of alloy a steel are employed to see the important the limitations on the sag the higher tension associated with this type of conductor require special attention it has to be paid to possibly of the Aeolian vibrations the tenth and the final type of a conductor which is being in existence is a t 2 that is a twisted pair

aluminum conductor. So, the when designing transmission lines with twisted pair t 2 type conductor the designer should be aware of the rules as per national stranded code on conductors particularly wind loading the rule states for multi-conductor cable an equivalent diameter of 2 times the single conductor diameter should be assumed for wind loading unless there is a qualified study it has to be used to reduce the overall cable diameter.

So, these type of conductors could be used these are the various types of aluminum conductors which are in existence and is being used by various utilities and the in the country and elsewhere.

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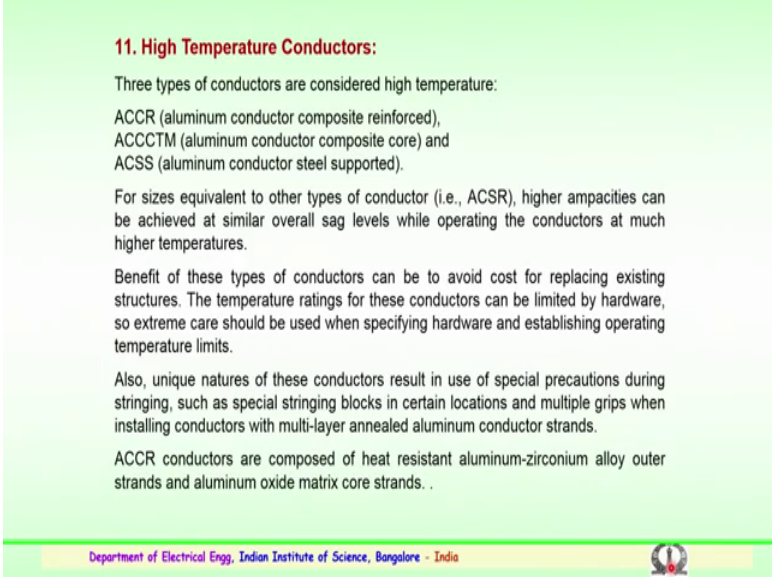

Very recently the newer type of conductors have coming to existence these are very important particularly for the distribution segment high temperature low sag high current conductors have been used been used over a period recently and high temperature high current low sag conductors are mainly of 3 types ACCR that is aluminum conductor composite reinforcement enforced aluminum conductor composite core and aluminum conductor steel supported. So, these are the 3 different conductors types in high temperature conductors this high temperature conductors are become very useful of the recent and for sizes equivalent to other type of conductor similar to ACSR same size of ACSR and high temperature conductors the higher current that is the higher ampacities

can be achieved at similar over all sag levels while operating the conductors at much higher temperature.

So, a normal aluminum conductors which operate between 90 to 110 degrees the high temperature conductors operate anywhere between 200 to 250 during temperature. So, benefit of these type of conductors can be to avoid cost for replacing the existing structures the temperature rating of these conductors can be limited by hardware. So, extra care should be used while specifying the hardware and establishing the operating temperature limits.

So, suitable hardware the conductor which employs the hardware also should be of high temperature high current carrying capability also the unique nature of the these conductor result in use of special precautions during stringing such as special stringing blocks in certain locations and multiple grips when installing conductors with multi layer annealed aluminum conductor strands, very important point to be noted. So, ACCRR high temperature conductors are normally composed of heat resistant aluminum zirconium alloy earlier does aluminum alloy now aluminum zirconium alloy outer strands and aluminum oxide matrix the core strands.

So, this give the conductor to perform at high temperatures carry high currents and with strand the high temperatures and also the reduction in sag.

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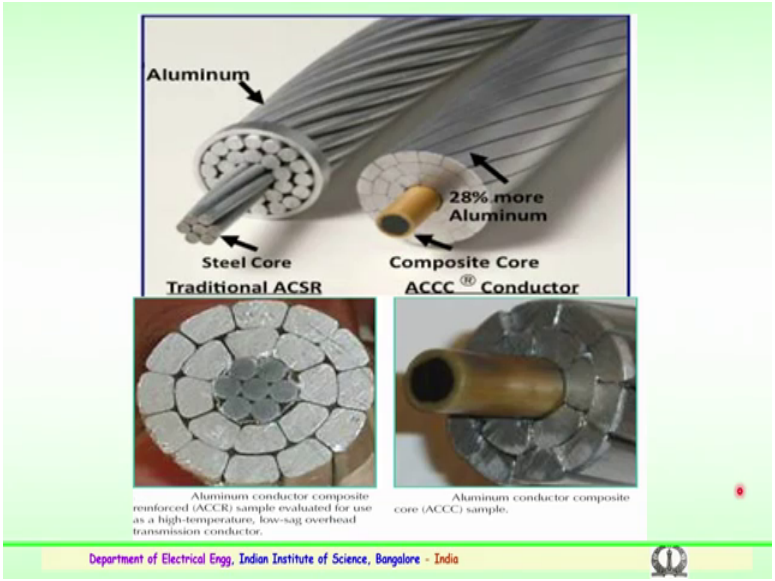

So, comparison of the traditional aluminum conductor steel reinforce you can see this is a steel reinforcement 7 strands steel reinforcements with several aluminum conductors this is known as the ACSR traditional ACSR conductor this gives the high conta high temperature high current a low sag conductor or ACC conductor which has a composite core. You can see the core is a composite in nature composite material with a special aluminum conductors particularly with the trapezoidal nature and this clearly there is no air gap or a gap between conductor to conductor this could be further seen here how the strandings of conductors aluminum are placed.

For better a conductor management here the conductor with composite core helps in more better higher temperature more current carrying capability lesser skin affect and. So, on very important this will help the distribution system to improve to transmit more power and comparison to the standard ACSR type conductors.

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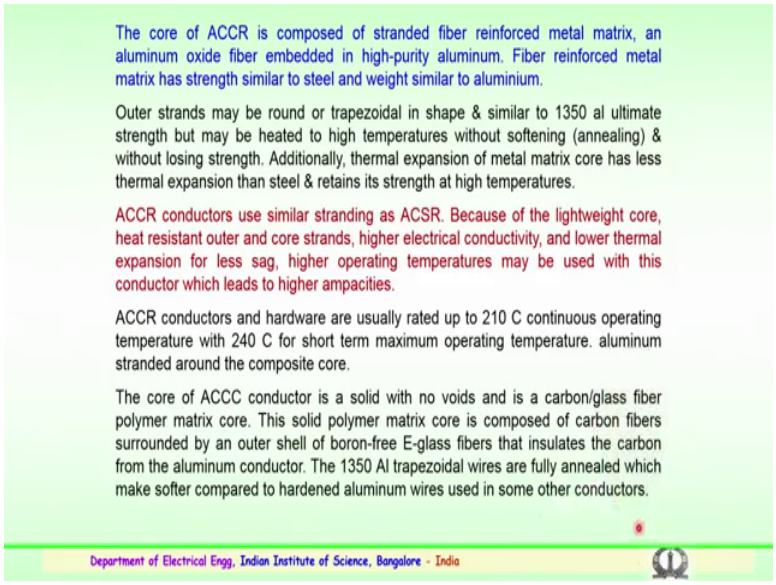

The core of this high temperature high current conductors for ACCR is composed of strands with fiber reinforced metal matrix is an aluminum oxide fiber embedded in high purity aluminum it has to be noted here the fiber reinforced metal matrix are strength a similar to the steel and weight similar to the aluminum.

So, the core is having the mechanical strength equivalent to the steel the outer strands could be round or trapezoidal in shape and there are similar to the 1350 aluminum ultimate strength may be heated to high temperatures without softening that is the

annealing and without losing strength additionally thermal expansion of a metal matrix core has less thermal expansion than steel and this retains it is strength at very high temperatures and operates at very high temperatures.

So, the ACCR or high temperature conductors use similar stranding as the aluminum conductor steel reinforcement because of the lightweight core which is being used in a c ACCRR the high temperature conductors heat resistant outer and core strands higher electrical conductivity and lower thermal expansion for less sag and higher operating temperature may be used with this conductor which further leads to higher current carrying capability; so, very important.

So, this conductors and hardware are usually rated as mentioned earlier up to 210 degree centigrade. So, the operational temperature could be anywhere between 210 degree continuous operating up to 240 degrees for short term maximum operating temperature. So, the aluminum earlier ACSR conductors normally operate anywhere between 90 to 110 degrees. So, here the high temperature conductor operates anywhere between 210 to 240 degrees, this is very important double the conductor temperature the current carrying capability also is twice or more then aluminum strands around the composite core.

The core of this high temperature conductors are ACCC conductor is a solid with no voids there are and is a carbon or a glass fiber or a polymer matrix core it could be of anyone this solid polymer matrix is composed of a carbon fibers surrounded by an outer shell of boron free e glass fibers which insulates the carbon from aluminum conductor very important particularly for the core. So, the 1350 AL aluminum trapezoidal wires are fully annealed which make softer-softer compared to the hardened aluminum wires used in some other conductors like ACSR other type of conductors.

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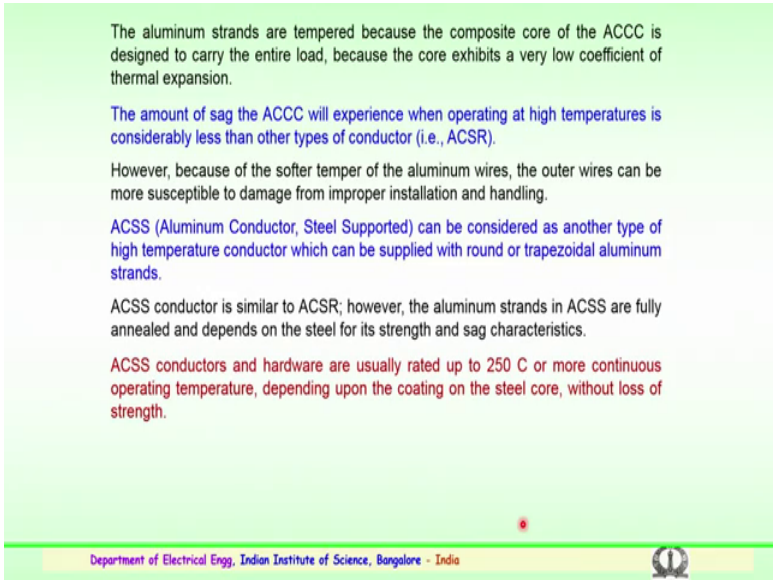

Here the aluminum strands are tempered because the composite core of the high temperature conductors or ACC conductor is designed to carry the entire load because the core exhibits a very low coefficient of thermal expansion.

So, that is important where this helps to conductor to operate at higher temperatures the amount of sag that the high temperature conductor will experience when operating at high temperatures is considerably less in compare to other conductors like ACSR and several other types of conductor use full transmission. So, this is a important point to be considered; however, because of the softer temper of the aluminum wires the outer wires can be more susceptible to damage from improper installation in handling. So, care has to be taken to see that the handlings of the outer wires have to be carefully considered while handling the ACC type of or type of high temperature conductors.

Similarly, ACSS aluminum conductor steel reinforced supported could be considered as another type of high temperature conductor which can be supplied with round or trapezoidal aluminum strands this again high temperature high conductor high current carrying conductors the ACCS conductor similar to ACSR.

However, the aluminum strands in high temperature (Refer Time: 29:01), it is of fully annealed and depends on the steel for it is strength and the sag characteristics that is the point to be noted and the high temperature conductor that is ACSS conductors and hardware; necessary hardware which are used for the conductors are usually rated up to

250 degrees centigrade the hardware could be (Refer Time: 29:21) plate it could be clamps it could be mid span computation joint, so, any of this or repair sly or T connecters.

So, several of this hardware associated with the high temperature conductor should also varieted up to 250 degrees or more for continuous operation this depends upon the coating and the steel core without much loss of mechanical strength.