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RELIABLE SUPPLY IN DISTRIBUTION SYSTEM BY STRENGTHENING EXISTING EHT LINE AND PERFORMANCE ANALYSIS OF HTLS CONDUCTOR-CASE STUDY

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ABSTRACT

In the era of digital globalization, reliable electrical power supply plays very important role which requires uninterrupted power supply. This paper describes the implementation of strengthening of existing Extra High Tension (EHT) Line economically to overcome the power transmission congestion and to improve reliable power supply in the distribution system. As part of the strengthening of EHT Line, the existing 132KV feeders ACSR Panther conductors are replaced with the High Temperature Low Sag (HTLS) conductor on the existing tower structures and the existing substation bay equipment are strengthened by replacing existing equipment with higher rating. The High Temperature Low Sag (HTLS) conductor carries double the current carrying capacity that of the ACSR Panther conductor. The performance of the HTLS conductor is analyzed and compared with existing panther conductor in terms of Load, Sag, Loss, Thermographs for the 132KV Chandrayangutta –Jubilee Hills Circuits- I & II. This paper presents overcoming of power transmission congestion and achievement of reliable power supply at 132KV Substation Jubilee Hills after replacing the existing ACSR Panther Conductor with HTLS (CASABLANCA) conductor for the 132KV Chandrayangutta –Jubilee Hills Circuits – I & II as a case study.

Keywords:ACSR Conductor, HTLS Conductor Performance Transmission System Maximum Demand Reliable Supply

1. INTRODUCTION

The Power Sector of Telangana viz., Generation, Transmission and Distribution is playing a vital role in the development of the newly formed Telangana State. Before Telangana State Formation, there was a huge gap between power generation and demand. The Government of Telangana took a decision to ensure all the consumers to get 24 Hours (Uninterrupted) power supply for the development in all sectors. The Telangana Power Sector Companies have been taking number of steps for strengthening of Generation, Transmission and Distribution since the formation of Telangana. In the existing transmission system, some of the transmission lines are overloaded and not able to meet the increased demand. In order to overcome the power transmission congestion, general methods to be adopted for increasing the power transfer from one substation to other substation are 1) Construction of new separate lines 2) Upgrading voltage i.e from low voltage level to high voltage level 3) Re-conductoring of existing transmission line conductors with high ampacity, same weight, low sag, high operating temperature conductors on the existing transmission towers. The first two methods involve a lot of Right of Way (ROW) problems, which are expensive, time taking and very difficult to carry out in highly populated cities, urban areas. To achieve the goal of reliable power supply and to meet the increased demand, feasible optimal solution is to replace the existing overhead transmission lines ACSR conductor with High Temperature Low Sag (HTLS) conductor which is capable of double the ampacity and high operating temperatures up to 180^0 C compared to that of Aluminum Conductor Steel Reinforced (ACSR) conductor. The maximum operating temperature of ACSR conductor is 80^0 C and the current carrying capacity of ACSR conductor is less. Power transmission capacity can be improved economically by replacing the existing transmission lines ACSR conductor with HTLS conductor on the existing towers itself within very short duration without any Right of Way issues.

Increasing the power transfer capability of the existing transmission line by using HTLS conductors and also comparison of ACSR and various HTLS conductors thermal and current carrying capacity were explained in [1], [2], [5] & [6]. HTLS conductor testing at APAR industries [3] & [4]. Aluminum Conductor Composite-core is one of those High Temperature Low Sag conductor invented by CTC Global in which steel strands of conventional ACSR line are replaced by a hybrid core of glass/carbon fiber-reinforced polymer matrix composite [5]. The core has high strength and light weight which allowed the incorporation of as much as 30% more aluminum without a weight or diameter penalty which effectively reduces conductor resistance and thereby increases the current carrying capacity and also reduces line losses compared to that of ACSR conductor of same diameter and weight [4]. The cost evaluation method for current uprating of overhead transmission line was proposed and suggested to consider the option of replacing ACSR conductor with HTLS conductor explained in [6].

The cost of energy losses is the most important cost component, especially when the line is heavily loaded and recommended to operate ACSR or HTLS conductor lower than its nominal current rating, instead of operating it at high temperature, to avoid high energy losses. The extra margin of current rating should be kept for contingency or emergency conditions. Compared technical performances of ACSR and various HTLS conductors in current uprating of 230-kV overhead transmission line are explained in [7] and the technical evaluation aspects on sag and tension, clearance to ground, right of way, electric and magnetic fields, line load ability, and steady-state stability limit.

The financial aspects of replacing ACSR conductor with HTLS conductor were discussed in [8] and explained that line revitalization with HTLS conductor is justified by the savings in line losses over the planned lifetime of the line besides the technical advantages of increasing throughput capacity and having a lower sag. The impact of ACCC conductors on power losses and advantages of reconductoring old lines with ACCC conductor are discussed in [9]. The advantages of HTLS conductor over ACSR conductor such as high ampacity, reduction in losses, mechanical characteristics like sag and economical aspects such as right of way problems due to construction of new lines to overcome power transmission congestion problems discussed in [10] to [13].

The advantage of High Temperature Low Sag (HTLS) conductors are 1) high current carrying capacity 2) low sag tension property 3) High Mechanical strength 4) Easy and rapid installation 5) Long term reliability and low line loss .The replacement of existing conductor with HTLS conductor can be carried out within very short duration on the existing towers and also economical compared with new EHT line construction.

This paper presents the transmission line power congestion of 132KV Jubilee Hills Substation and remedial measures taken to overcome the congestion problem, for increasing reliable supply at 132KV Jubilee Hills and further connected 132KV & 33KV substations. In this paper, it was proposed for strengthening of transmission lines, which are connecting between 220 KV SS Chandrayangutta and 132 KV SS Jubilee Hills in Hyderabad at 132KV level by replacing the existing ACSR conductor with HTLS conductor (ACCC conductor) in view of the advantages of HTLS conductor. This paper also presents practical performance regarding increase in ground clearance, variation in sag under idle and loaded conditions with ACSR and ACCC conductors, line loss comparison, thermo graph survey report analysis which were not covered in the references mentioned.

2.0 PROPOSED METHOD:

This section describes about the importance of 132KV Jubilee Hills Substation, connected transmission lines power congestion problems, essentiality of reliable supply to the distribution system and proposed method to overcome these problems.

2.1 SYSTEM DESCRIPTON

The 132 KV Substation (SS) Jubilee Hills, Hyderabad was commissioned in the year 1982 at 132 KV level availing supply from 132KV SS Erragadda. It is a very important Substation in Hyderabad city feeding power supply to residential, commercial areas and various Multi National Information Technology Companies. Later in the year 1991, the 132 KV Substation, Jubilee Hills was connected with 220KV Substation Chandrayangutta through 2No's of 132KV Feeders (on Double Circuit towers). The existing 3No.s 132KV Feeders namely: 132 KV Chandrayanagutta -I feeder, 132 KV Chandrayanagutta -II feeder and 132 KV Erragadda feeder are with ACSR Panther Conductors. As on 2015, 132 KV Substation Jubilee Hills is consists of 3 No.s 132 KV feeders viz., 132 KV Chandrayanagutta -I feeder, 132 KV Chandrayanagutta -II feeder and 132 KV Erragadda feeder and 4No's PTRs (viz.,2No.s 80MVA PTRs, 1 No. 50 MVA PTR, 1 No.10/16 MVA PTR) and 22 No's 33 KV feeders. The Schematic Diagram of 132KV SS Jubilee Hills as on 2015 is shown Figure 1.

The maximum Station load of 132 KV SS Jubilee Hills in the year 2015 is 170 MW on 21-05-2015 at 14:00 hrs and the loads on 132 KV feeders were 132KV Chandrayanagutta-I: 85 MW, 132 KV Chandrayanagutta -II: 85 MW and 132 KV Erragadda under idle charge. However, 132 KV Erragadda feeder load is limited to 60MW due to overloading of 220/132KV PTRs at 220KV Substation, Erragadda. The month wise maximum loads in MW and Amps for the year 2016-17 of 132KV Chandrayangutta – Jubilee Hills Feeders –I & II are shown in table 1 and Figure.2.

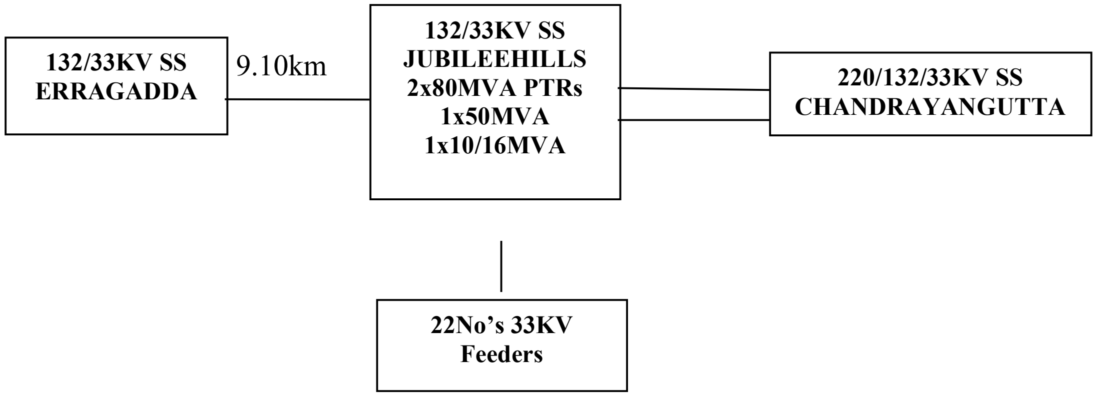


Figure 1. Schematic Diagram of 132KV SS Jubilee Hills with connected feeders

Table 1. Month wise Maximum Loads reached on 132KV Chandrayangutta-Jubilee Hills Feeders-I&II

Month	Feeder-1 with ACSR Panther Conductor		Feeder-2 with ACSR Panther Conductor	
	Maximum Load in MW	Maximum Load in Amps	Maximum Load in MW	Maximum Load in Amps
Apr-16	76	380	76	380
May-16	78	390	79	395
Jun-16	75	375	75	375
Jul-16	77	385	77	385
Aug-16	71	355	71	355
Sep-16	66	330	68	340
Oct-16	68	340	68	340
Nov-16	61	305	61	305
Dec-16	60	300	60	300
Jan-17	58	290	58	290
Feb-17	55	275	55	275
Mar-17	72	360	72	360
Apr-17	78	390	78	390
May-17	84	420	84	420

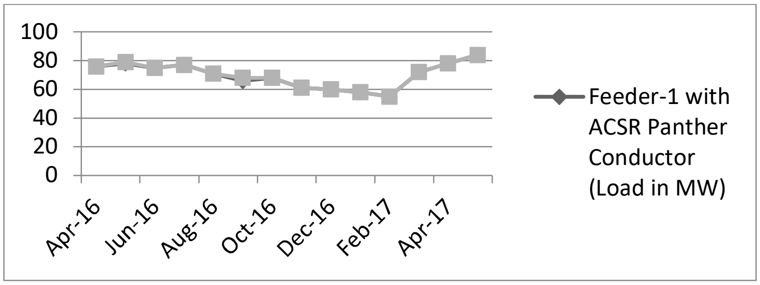


Figure 2. Maximum Loads reached on 132KV Chandrayangutta-Jubilee Hills Feeders-I&II with ACSR Panther

During the typical conditions at 132KV SS Jubilee Hills like i) Shutdown or Maintenance on one of the 132 KV Chandraganagutta feeders (ii) Tripping of one of the 132 KV Chandrayanagutta feeders on any fault, the other feeder also trips on overload causing complete interruption to the substation (iii) Incoming supply failure from 220 KV SS Chandrayanagutta and (iv) Increased demand, results in (i) Some of the 33 KV feeder loads diversion to alternate sources from other adjacent EHT 132 KV substations (ii) In some cases, load relief arranged to some of the 33KV feeders as there was only a provision of 60 MW load import through 132 KV Erragadda feeder from 132 KV SS Erragadda. Thus, it was not possible to meet increased demand and reliable power supply in the surroundings of Jubilee Hills with the existing system as there is a limitation on current carrying capacity of ACSR Panther Conductor.

2.2 PROPOSED METHOD TO OVERCOME TRANSMISSION LINE POWER CONGESTION:

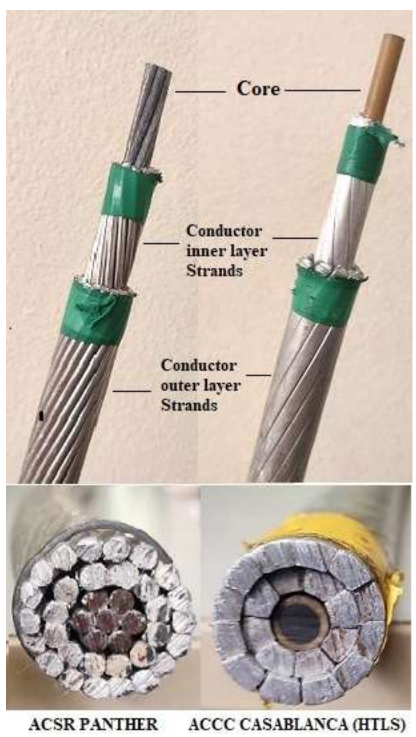


Figure 3. ACSR Panther Conductor and HTLS Casablanca (ACCC) Conductor

2.2.1 ACSR Panther Conductor:

The Aluminum conductors' galvanized steel reinforced briefly called as ACSR comprises of seven or more Aluminum and galvanized steel wires, built up in concentric layers. The Centre wire or wires are of galvanized steel and the outer layer or layers are of Aluminum. As such steel cored - Aluminum conductors have been widely adopted for high voltage transmission lines especially for long spans. It has high tensile strength but it reduces with rise of temperature above 65^0C [2]. Aluminum Conductor Steel Reinforced (ACSR) Conductor is normally used for transmission of electrical power from one substation to other substations through over head lines. For Power Transmission at 132KV level, normally Panther ACSR Conductors (30+7/3.00mm) are used. It has 4 layers with 2 inner layers (1+6) strands of reinforced steel, other 2 layers (12+18) strands of Aluminum. Each strand of steel and conductor are circular in shape. The continuous maximum current rating of this conductor in still air at 45^0 ambient temperatures is 486A.The ACSR Panther conductor and its cross section view are shown in Figure 3.

2.2 HTLS Conductor:

Aluminum Conductor Composite Core (ACCC) is one of HTLS conductor made out of aluminum, which is very soft and annealed which has maximum conductivity level and also shape of wire geometrically manufactured either trapezoidal shape. So we can achieve lower resistance which enables a higher current flow in the line. As the aluminum is annealed its parameter is not going to change while operating at higher temperature and neither going to affect in sag. For this type of conductor the core is manufactured from carbon fiber matrix composite which is very light in weight and extremely higher strength and very low coefficient of thermal expansion which is taking maximum load of conductor without significant force deterioration after long term operation at high temperature and achieving low sag [2]. The core has high strength and light weight which allowed the incorporation of 30% more aluminum without a weight or diameter penalty which effectively reduces conductor resistance and thereby increases the current carrying capacity and also reduces line losses compared to that of ACSR conductor of same diameter and weight [5]. The equivalent HTLS conductor for ACSR Panther conductor is ACCC CASABLANCA. It can withstand operating temperatures of up to 180 °C and carrying double the current carrying capacity compared to ACSR conductors. For increasing the capacity of load transfer with ACSR conductors, new lines have to be constructed which is highly expensive and time taking. Instead of constructing the new lines to increase power transmission capacity, replacing ACSR Panther conductors with HTLS conductor on the existing towers is most economical, less time taking and avoids Right of way problems.

In view of the advantages of high current carrying capacity nearly double the current capacity of that of ACSR conductor with low sag at higher operating temperatures of HTLS conductors, it was proposed for the replacement of existing ACSR Panther conductor with ACCC CASABLANCA CONDUCTOR (High Temperature Low Sag Conductor) for 132 KV Chandrayanagutta-Jubilee Hills I & II feeders on the existing transmission towers as 220KV SS Chandrayangutta is most reliable power source at 220KV level which is connected with 6No's 220KV grid connected lines. In addition to the replacement of the existing conductor, insulators and hardware are also to be replaced in the proposed EHT lines. The existing bay equipment of these feeders at both ends are to be strengthened by replacing existing equipment with high rating equipment to carry the increased current capacity.

3.0 STRENTHENGING OF EXISTING 132KV CHANDRAYANAGUTTA- JUBILEE HILLS FEEDERS – I &II AND SUBSTATION BAY EQUIPMENT:

The 132KV Chandrayanagutta – Jubilee Hills feeders –I & II were commissioned in the year 1991 with ACSR panther conductor and has served for more than 25 years. In order to overcome the transmission congestion of these feeders and to achieve reliable supply to 132KV SS Jubilee Hills economically, the two transmission lines are emanating from 220KV SS Chandrayangutta to 132KV SS Jubilee hills to be strengthened by replacing the existing ACSR panther conductor with HTLS conductor (ACCC CASABLANCA) on the existing tower structures. The bay equipment of these feeders at respective substations also to be strengthened to withstand the enhanced ampacity of HTLS conductor as shown in the Figure 4.

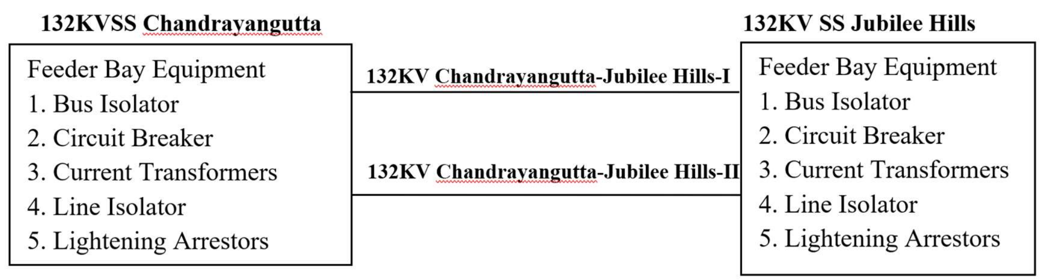


Figure 4. Schematic Diagram of Strengthening of Existing 132KV Chandarayanagutta – Jubilee Hills Feeders-I&II and Substation Bay Equipment.

3.1 Feeder Strengthening:

The existing ACSR (Aluminium Conductor Steel Reinforced) Panther Conductor of both the feeders were replaced with ACCC (Aluminium Conductor Composite Core) HTLS Conductor Panther equivalent (CASABLANCA) on the existing tower structures. The existing Hardware of the feeders viz., single suspension, double suspension, single tension, double tension hardware and vibration dampers etc., were replaced with new Hardware compatible to HTLS conductor. The existing insulators of were replaced with new insulators as the existing insulators have already served for more than 25 years.

3.2 Bay equipment Strengthening in the Substations:

The bay equipment of the 132KV Chandrayanagutta – Jubilee Hills feeders –I & II at both ends of feeders i.e at 220KVSS Chandrayangutta and 132KV SS Jubilee Hills were strengthened to withstand the enhanced ampacity of HTLS conductor**.** The existing 800A rating Bus Isolators, 800A rating Line Isolators and 600A rating Current Transformers (CTs) were replaced with 1200A rating Bus Isolators, 1200A rating Line Isolators and 1200A CTs respectively. The existing connected single Zebra ACSR jumpers were replaced with Twin Zebra ACSR conductors.

The strengthening work including bay equipment of 132KV Chandrayanagutta – Jubilee Hills feeder –I was carried out from 10.02.2017 to 13.04.2017 and 132KV Chandrayanagutta –

Jubilee Hills feeder –II was from 11.09.2017 to 01.11.2017. After successful completion of the above works, 132KV Chandrayanagutta – Jubilee Hills feeder –I was charged on 13.04.2017 and 132KV Chandrayanagutta – Jubilee Hills feeder –II was charged on 01.11.2017. The system was strengthened in a short period.

3.3 Equipment Enhancement and Improved interconnectivity for achieving Reliable supply:

To utilize the enhanced capacity of 132KV Chandrayangutta – Jubilee Hills Feeders-I&II, the total capacity at 220KV SS Chandrayangutta was enhanced from 520MVA (2No.s 160 MVA, 2No.s 100 MVA Power Transformers) to 640MVA (4No.s 160MVA Power Transformers) and the total capacity at 220KV SS Erragadda was enhanced from 320MVA (2No.s 160MVA Power Transformers) to 480MVA (3 No.s 160MVA Power Transformers). For increasing reliable supply at 132KV Jubilee Hills Substation, inter connectivity of the substation increased by connecting it with 3No.s 132KV Feeders with 400KV SS Raidurg and 1No. 132KV Feeder with 220KV SS Erragadda. The latest schematic diagram of 132KV SS Jubilee Hills as on August-2022 is shown in figure.5. At present the substation is having 7 No.s of 132KV Feeders connected to 3 No. of 220KV substations and consists of 4 No. of PTRs with a capacity of 260MVA (2x80MVA + 2x50MVA) and 27No.s 33KV Feeders. All the 33/11KV substations in the area of 132KV Jubilee Hills SS are further interconnected with each other to have alternate supply from different EHT substations or from different Bus-sections of the same station thus increasing reliable supply at 33KV and 132KV voltage level. Now, all the 132KV interconnected lines to Jubilee Hills SS are in grid. These lines are connected with strong source at 220KV level from 220KV Chandrayanagutta SS, 220KV Erragadda SS and 400KV Raidurg SS.

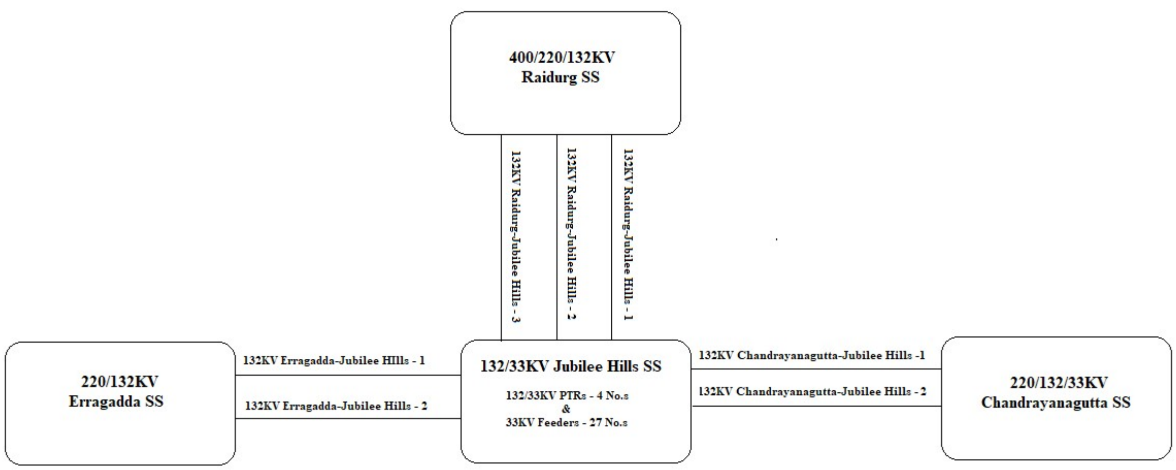


Figure. 5. Schematic Diagram of 132KV Jubilee Hills Substation as on August 2022

4.0 RESULTS AND ANALYSIS :

The performance of the 132KV Chandrayanagutta-Jubilee Hills feeders I & II after stringing with HTLS CASABLANCA conductors were evaluated and compared with the earlier ACSR panther conductor.

4.1 Loading Pattern of the two feeders with HTLS conductor:

The feeders were continuously loaded from the date of commissioning for 15 days to the maximum extent load possible for performance evaluation of the newly commissioned ACCC CASABLANCA (HTLS) conductor and sample data for continuous loading of the feeder for few days is shown in the Table 2. The maximum load on 132KV Chandrayangutta – Jubileehills- I & II feeders observed to be 148MW (732A) and 181MW (872A) respectively as shown in Table 2. Load curves in Amps for continuous loading for maximum loading in day are shown in figure 6 which shows the increased current carrying capacity of Feeders-I&II with HTLS conductors. During this continuous loading condition, the line to ground clearance (variation in sag), thermo vision scanning carried out for both the feeders.

Table 2. Continuous Loading of 132KV Chandrayangutta-Jubileehills-I & II Feeders with HTLS Conductor

132KV Chandrayangutta-Jubileehills-I Feeder								**132KV Chandrayangutta-Jubileehills-II Feeder**					
S. No	**Date/ Time In Hrs**	**03.06.2017**		**05.06.2017**		**06.06.2017**		**05.11.2017**		**06.11.2017**		**07.11.2017**	
		MW	**Amps**	**MW**	**Amps**	**MW**	**Amps**	**MW**	**Amps**	**MW**	**Amps**	**MW**	**Amps**
1	0:00	58	264	54	248	52	236	106	476	110	520	115	568
2	1:00	56	250	52	230	50	220	105	470	100	500	105	510
3	2:00	54	240	52	230	45	200	105	470	100	500	105	510
4	3:00	52	200	50	220	92	190	105	470	100	500	105	510
5	4:00	52	200	49	210	38	180	105	470	100	500	105	510
6	5:00	115	428	92	420	38	180	105	470	100	500	116	570
7	6:00	115	428	92	420	37	176	105	477	104	510	124	564
8	7:00	113	438	92	420	38	176	113	518	140	654	143	666
9	8:00	98	448	100	460	44	200	120	512	144	664	145	770
10	9:00	106	488	112	516	52	240	105	624	144	664	151	780
11	10:00	120	560	132	640	50	252	155	624	155	732	159	750
12	11:00	130	625	**148**	732	66	306	140	640	152	748	162	760
13	12:00	140	710	72	346	66	306	139	644	157	752	168	796
14	13:00	140	715	72	346	65	300	139	644	160	760	168	796
15	14:00	136	680	72	345	65	300	125	680	157	718	163	768
16	15:00	135	670	72	345	63	290	129	590	157	740	164	776
17	16:00	134	660	72	344	63	290	132	600	157	740	164	776
18	17:00	134	650	54	250	63	290	134	610	159	750	173	810
19	18:00	132	640	69	314	60	274	154	720	176	845	**181**	872
20	19:00	136	650	68	314	60	270	154	710	171	840	180	870
21	20:00	134	640	57	266	56	250	150	700	169	784	162	748
22	21:00	65	300	62	280	52	232	136	600	153	712	136	616
23	22:00	62	200	59	270	52	232	134	600	140	628	136	616
24	23:00	60	260	56	256	50	224	120	540	124	556	121	670
25	24:00	60	260	52	236	48	212	132	13:00	129.3	12:00	132	13:00
Max Voltage		136	08:00	136.8	08:00	137	24:00	135.2	1:00	137	0:00	135	1:00

Min Voltage	132.6	21:00	132.6	21:00	131.7	13:00	132	13:00	129.3	12:00	132	13:00

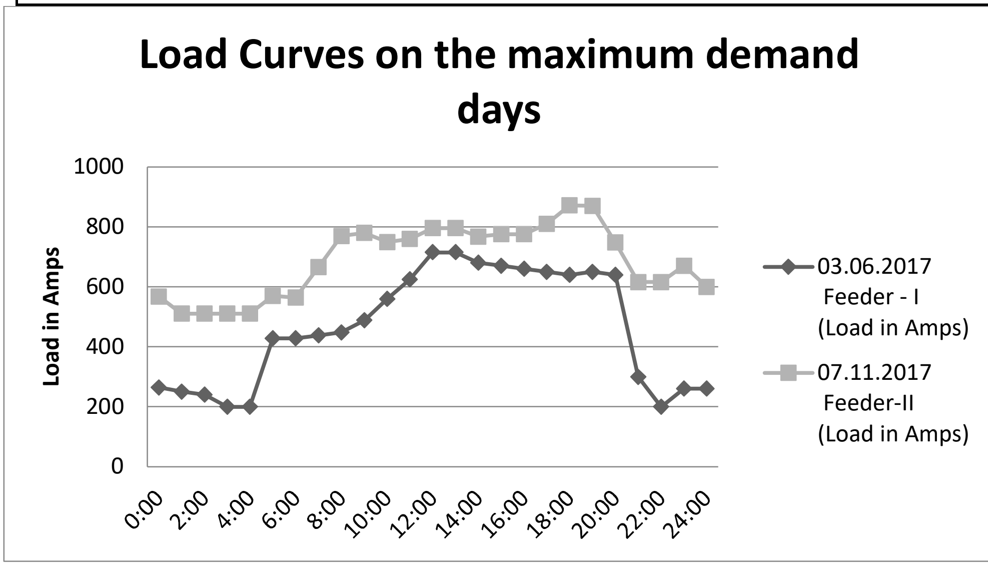


Figure 6. Load Curves of 132KV Chandrayangutta-Jubilee Hills Feeders– I&II with HTLS Conductor

4.2 Maximum Loads on 132KV Chandrayangutta –Jubilee Hills Feeders –I&II with HTLS Conductor:

The 132KV Chandrayanagutta – Jubilee Hills Feeders –I & II were continuously loaded from the date of commissioning for 15 days to the maximum extent load possible for actual performance evaluation of the newly commissioned ACCC CASABLANCA (HTLS) conductor and the day wise maximum load particulars of these feeders I &II for 10 days are shown in the Table 3 as sample data. During this continuous loading From the table 3 the Maximum loads on 132KV Chandrayangutta -Jubilee Hills Feeder-I &II with HTLS conductor are 148 MW ,732 A and 181 MW,872 A. The maximum load on feeder-I observed to be 198MW (920Amps) when feeder – II tripped on 31.05.2018 and there was no interruption to the loads of 132KV Jubilee Hills Substation

Table 3. Maximum Load Particulars of 132KV Chandrayangutta - Jubilee Hills Feeders - I & II

S.No.	Maximum Load Particulars of 132KV Chandrayanagutta - Jubilee Hills Feeder - I					Maximum Load Particulars of 132KV Chandrayanagutta - Jubilee Hills Feeder - II			
	MW	Amps	Date	Time		MW	Amps	Date	Time
1	136	680	27.05.2017	14:00		162	760	02.11.2017	19:00
2	112	530	28.05.2017	19:00		172	820	03.11.2017	18:00
3	120	600	29.05.2017	09:00		156	732	04.11.2017	18:00
4	136	680	30.05.2017	10:00		154	720	05.11.2017	18:00
5	140	715	31.05.2017	09:00		176	845	06.11.2017	18:00
6	135	630	01.06.2017	10:00		**181**	**872**	**07.11.2017**	**18:00**
7	140	692	02.06.2017	11:00		172	832	08.11.2017	18:00
8	140	715	03.06.2017	12:00		152	710	09.11.2017	11:00

9	60	274	04.06.2017	11:00		163	768	10.11.2017	18:00
10	**148**	**732**	**05.06.2017**	**11:00**		138	605	11.11.2017	18:00

4.3 LINE TO GROUND CLEARANCES AND SAG VARIATION

Line to Ground clearance were measured for 132KV Chandrayangutta -Jubilee Hills Feeders-I &II during idle condition with ACSR conductor and HTLS conductor and during loading condition with HTLS conductor. Sample data of line to ground clearance, sag variation from idle to load for bottom conductor of feeder-II is shown in Table 4.

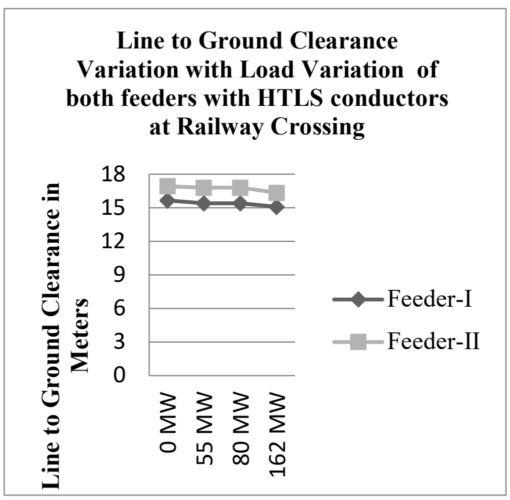
Table 4. 132KV Chandrayangutta-Jubilee Hills Feeder-II Line to Ground Clearances and Sag Variation

S. No.	**Tower No.**	**Type of Tower** Tension(T) Suspension(S)	**Span (M)**	**Line to Ground Clearance from Bottom conductor**			**SAG Variation for Bottom HTLS conductor idle - load**	**Load in MW**
				With ACSR Conductor (after creep in idle)	**With ACCC Conductor (Idle)**	**With ACCC Conductor (Load)**		
1	1,2	T,T	315	8.5	9.1	8.5	0.6	152
2	2,3	T,T	293	6.5	7.5	7.3	0.2	147
3	3,4	T,T	279	7.2	8.9	7.6	1.3	146
4	4,5	T,T	190	6.7	8.3	8	0.3	146
5	11,12	T,S	172	9.5	10	9.6	0.4	152
6	12,13	S,S	154	8.7	8.9	8.4	0.5	150
7	13,14	S,S	361	9.3	9.5	7.9	1.6	153
8	14,15	S,S	336	10	10.7	10	0.7	152
9	15,16	S,T	279	7.1	7.2	6.2	1	158
10	16,17	T,S	276	8.3	8.9	8	0.9	157
11	17,18	S,S	346	9.1	9.7	8.5	1.2	153
12	18,19	S,S	303	11.5	12.2	11.7	0.5	152
13	19,20	S,S	237	11.1	12.1	11.5	0.6	152
14	20,21	S,S	325	11.5	12.5	11.3	1.2	158
15	21,22	S,T	139	11.6	12.9	12.4	0.5	147
16	37,38	S,S	293	14.8	15.8	15.6	0.2	147
17	38,39	S,S	341	9.7	10.2	9.7	0.5	152
18	39,40	S,S	353	8	8.4	7.3	1.1	159
19	40,41	S,T	279	10	11.1	10.4	0.7	163

From the line to Ground Clearance and sag variation shown in Table 4, it is observed that line to ground clearance of feeder-II under idle condition with HTLS conductor improved when compared with ACSR conductor. The variation in sag i.e line to ground clearance of HTLS conductor from idle to load condition observed to be very less for normal loading i.e up to 120MW and slight increase in sag is observed with increase in loading which is within the limits. For longer spans, it is observed that the sag is on higher side compared to shorter spans but has sufficient clearance even at higher loads. Table 5 shows the measured values of Line to Ground Clearances for both the feeders with HTLS conductors for specific spans like railway crossing and national highway at different loads. Figure 7 & 8 shows the variation of line to ground clearance with load variation for specific spans.

Table 5: Line to Ground Clearances of Feeders in specific spans with load variation

S.No.	Specific Span	Span in Meters	Load in MW	Feeder-I		Feeder-II	
				Line to Ground Clearance (Meters)	Sag variation	Line to Ground Clearance (Meters)	Sag Variation
1	Railway Crossing	212	0	15.66	-	16.92	-
2			55	15.4	0.26	16.8	0.12
3			80	15.4	0.26	16.8	0.12
4			162	15.09	0.57	16.34	0.58
1	National Highway	315	0	12.31	-	11.94	-
2			162	11.64	0.65	11.3	0.64



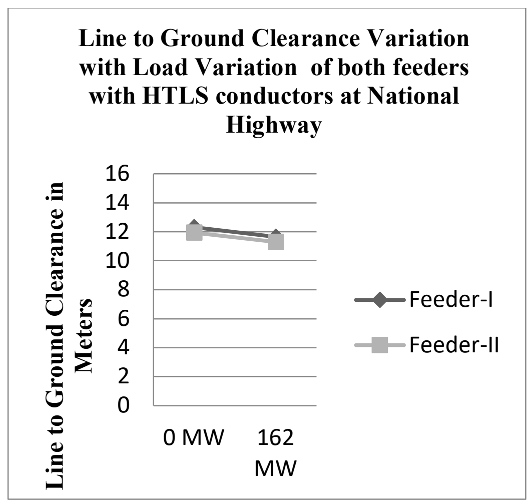


Figure 7. Variation of Line to Ground Clearance with load variation at Railway crossing & National Highway

From the Table 5, Figure.7, the variation in line to ground clearance (i.e variation in sag) from no load (0 MW) to the maximum possible load (162 MW) at railway crossing for feeder-I & II is 0.57 and 0.58 respectively. At national high way, for feeder-I & II is 0.67 and 0.64 respectively. The performance analysis of ACSR panther and HTLS CASABLANCA conductors for the railway crossing studied using PLS-CADD software and are shown in the figure.8 and comparison is shown in the Table 6.

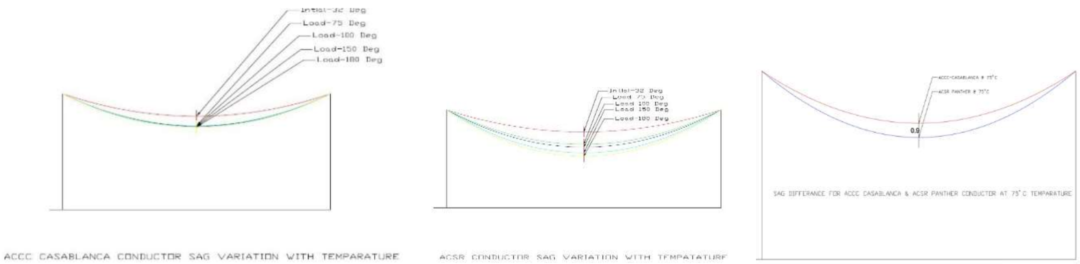


Figure 8. Sag Variation with Temperature of ACSR Panther and ACCC CASABLANCA Conductors

Table 6: Comparision of Sag Variation of both conductors with Temperature

S.No.	Temperature (^{0} C)	ACSR Panther		ACCC CASABLANCA	
		Idle Sag	Load Sag	Idle Sag	Load Sag
1	32	2.7	2.83	2.31	2.87
2	75	3.71	4.04	2.63	3.31
3	100	4.33	4.49	2.84	3.34
4	125	4.83	4.85	3.06	3.37
5	150	5.18	5.2	3.3	3.4
6	180	5.6	5.61	3.44	3.44

4.4 Line Loss Comparison with HTLS (CASABLANCA) and ACSR Panther Conductors:

Line Losses for both the circuits i.e 132KV Chandrayangutta – Jubilee Hills Feeders–I&II were calculated with ACSR Panther and HTLS conductors.

Table 7 : Line Loss Calculation for 132KV Chandrayangutta -Jubilee Hills Feeder-I

Month	Year 2016-17 (Panther Conductor)			Year 2017-18 (HTLS Conductor)		
	Sending End Energy (MWH)	Receiving End Energy (MWH)	% Loss	Sending End Energy (MWH)	Receiving End Energy (MWH)	% Loss
April	40317.84	40213.44	0.259	24201.36	24475	1.131
May	37938.96	37921.68	0.046	24233.04	24349	0.479
June	36718.56	36766.8	0.131	37591.92	37518	0.197
July	38752.56	38317.52	1.123	34970.4	35302	0.948
August	35819.28	36034.56	0.601	33504	33848	1.027
September	31878	32132.16	0.797	43238.4	43020	0.505
October	31004.64	31299.12	0.95	56035.2	56024	0.02
November	29031.84	29311.2	0.962	25720.8	25944	0.868
Decembe	27951.12	28237.68	1.025	37476	37736	0.694

r						
January	27889.2	28175.76	1.027	37668	37946	0.738
February	6073.2	6158.88	1.411	37516.8	37754	0.632
March	15356.16	15515.84	1.04	44695.2	44968	0.61
Year	358731.36	360084.64	0.377	436851.12	438884	0.465

Table 8: Line Loss Calculation for 132KV Chandrayangutta -Jubilee Hills Feeder-II

Month	**Year 2016-17 (Panther Conductor)**			**Year 2017-18 (HTLS Conductor)**		
	Sending End Energy (MWH)	**Receiving End Energy (MWH)**	**% Loss**	**Sending End Energy (MWH)**	**Receiving End Energy (MWH)**	**% Loss**
November	29053.44	29334.96	0.969	52032.96	51782	0.482
December	28016.64	28298.88	1.007	37195.2	37518	0.868
January	27911.52	28191.6	1.003	37323.36	37674	0.939
February	23220	23460.48	1.036	37491.84	37788	0.79
March	28514.16	28782.72	0.942	44308.8	44634	0.734
For 5 Months	136715.76	138068.64	0.989	208352.16	209396	0.5

As per the above loss particulars shown in Table 7 and Table 8, it is observed that there is no appreciable change in energy loss for both feeders with ACSR Panther or HTLS conductors. Normally, transmission line loss limitation for 132KV Line is <2% and for the above cases line losses are observed to be around 1% only for both feeders. However HTLS proved to carry higher current i.e double the capacity of that of the ACSR Panther within the permissible limits of percentage loss which increased the reliable supply for the distribution system.

5. CONCLUSION

By strengthening of the 132KV Transmission lines (length of 37.6km) emanating from 220KV SS Chandrayangutta to 132KV SS Jubilee Hills with HTLS (ACCC Casablanca) conductor, other line equipment and respective bay equipment at both ends of substations, Reliable supply is made available at 132KV Jubilee Hills Substation., 132KV Erragadda Substation and 132KV Loads of 220KV Shivarampally Substation in case of any exigencies at the respective substations.Maintenance works of the lines and substation equipment can be carried out without any interruption as the total load of 132KV Jubilee Hills substation can be met with single circuit itself. Re-conductoring/Strengthening of these transmission lines with HTLS Conductor are carried out on the existing transmission towers economically in a short duration avoiding the Right of Way (ROW) problems which is most predominant factor for construction of new lines in the urban areas to meet the increased demand.From the loading records in the recent years, the maximum possible load carried by these transmission lines with HTLS conductor is 198MW (920A) which is double the current carrying capacity of that the ACSR

Panther conductor without any interruption to the loads.From the Line to Ground Clearance and Sag variation records, it was observed that the line to ground clearances (sag variation) of feeders with HTLS conductors is within the limits. Further, from the line to ground clearance variation (variation in sag) with HTLS conductors in three crictical spans for different load conditions, it is observed that the variation in sag is less with increase in load when compared to ACSR Panther conductor.As the maximum loading capacity of each transmission line with HTLS conductor is 200MW (1050A), a total of 400MW power can be transmitted through both the feeders safely thus increasing the transmission capacity. This increases the reliable supply at 132KV SS Jubilee hills and also to other EHT substations connected through 132KV lines viz. 220KV SS Erragadda, 400KV SS Raidurg, 132KV SS Manikonda and 220KV SS Shivarampally. All the 33KV Substations are well inter connected for alternate supply with these EHT substations which increases reliable supply in the distribution system at 33KV level in and around Jubilee Hills area.After the performance evaluation of these two transmission lines, it was proposed and commissioned 8No.s 220KV transmission lines are strengthened with HTLS conductor (ACCC DRAKE conductor) to overcome transmission lines power congestion in the Greater Hyderabad Muncipal Corporation area.

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