

Study Committee B2

Overhead Lines
10446_2022

Design and testing of monopole structures for 400kV and 765kV Overhead lines- POWERGRID's experience

Karanvir Singh Pundir*, Hemant Tiwari, Sumana Mukherjee, Nitesh Kumar Sinha*,
Subhash C Taneja

INTRODUCTION

- With the rising living standards, demand for electricity is on the rise and with the continued increase in urbanization in India, the original suburbs/rural areas are gradually becoming the new cities and building new transmission lines with conventional towers having large footprint is often very difficult.



- In order to solve this issue in particular, many monopoles from 132 kV to 400 kV voltage level have earlier been developed. As the requirement of bulk power transmission in urban area grew further, monopoles of 765 kV Single circuit towers with hex bundle configuration and 400 kV Double circuits with Quad bundle configuration have been developed.

UHV MONOPOLES BY POWERGRID

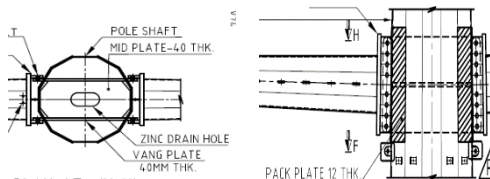
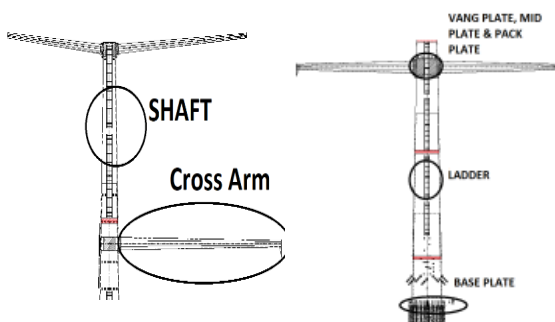
- 765KV S/C HEXA ACSR ZEBRA conductor Suspension.
- 765KV S/C HEXA ACSR ZEBRA conductor (0-60 Deg)/Dead End
- 400KV D/C QUAD ACSR MOOSE conductor Suspension
- 400KV D/C QUAD ACSR MOOSE conductor (0-60 Deg)/Dead End



CHALLENGES

- Design, fabrication, construction, assembly and finally proto type testing of these monopoles has put many challenges and this process has been performed with taking due consideration of all these aspects
- One of the most important design parameter "Design Span" has been chosen so as to limit the loading on pole to an extent considering fabrication and testing capability of the testing stations in India. It has been ensured that width of welded pieces which will go into the galvanizing bath does not exceed the maximum width of plate available .
- Welding and metallizing of last welded piece.

MONOPOLE PARTS



Vang and Mid plate at cross arm level &
Pack plate at cross arm level

CONCLUSION

UHV monopoles shall carry more power through such corridors and areas where ROW issues persist.

This will not only help in hurdle free execution of project but will also save time, which was lost by length in order to avoid dense urban areas

Study Committee B2

Overhead Lines
10446_2022

Design and testing of monopole structures for 400kV and 765kV Overhead lines- POWERGRID's experience

DESIGN PARAMETERS

CONTINUED

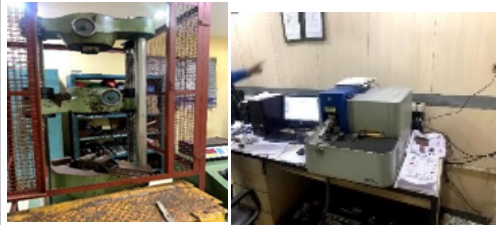
Sno.	Parameters	400KV D/C QUAD PA	400KV D/C QUAD PD	765 KV S/C PA	765 KV S/C PD
1	Line Voltage	400 KV	400 KV	765 KV	765 KV
2	Circuit	2 Nos.	2 Nos.	1 Nos.	1 Nos.
3	Pole Type	Suspension Type	Tension/Dead End Type	Suspension Type	Tension/Dead End Type
4	Angle of Deviation	PA(0-2d)	PD(0-60d) /DE(0-15d)	PA(0-2d)	PD(0-60d) /DE(0-15d)
5	Design Span	250 Mtr.	150 Mtr.	250 Mtr.	150 Mtr.
6	Wind Zone	IV	IV	IV	IV
7	Reliability level	1	1	2	2
8	Terrain category	2	2	2	2
9	Conductor Name	ACSR- MOOSE	ACSR-MOOSE	ACSR-ZEBRA	ACSR- ZEBRA
10	Sub-Conductor	QUAD BUNDLE	QUAD BUNDLE	HEXA BUNDLE	HEXA BUNDLE
11	Conductor Configuration	54/3.53 mm AL+7/3.53 mm Steel	54/3.53 mm AL+7/3.53 mm Steel	54/3.18 mm AL+7/3.18 mm Steel	54/3.18 mm AL+7/3.18 mm Steel
12	Operating Temperature (°C)	85	85	85	85

LOADS AND MOMENTS

Sno.	Moment/Force	400KV D/C QUAD PA	400KV D/C QUAD PD	765 KV S/C PA	765 KV S/C PD
1	Bending Moment (kN-m)	23180	41609	26219	39729
2	Shear Force (kN)	651	2019	697	1660
3	Axial Force (kN)	565	671	522	654

Sr no	Outer diameter of pole segment (mm)	Max permissible no of fabricated parts per pole segment/seams
1	Up to 600	1
2	greater than 600 and up to 1200	2
3	greater than 1200 and less than 2000	3
4	greater and equal to 2000	4

MANUFACTURING



TEST ON RAW MATERIAL

POLE DESIGN

Sno.	Design features	400KV D/C QUAD PA	400KV D/C QUAD PD	765 KV S/C PA	765 KV S/C PD
1	Pole Top Dia (mm)	830	750	825	750
2	Pole Bottom Dia (mm)	2135	2268	2260	2308
3	Thickness of shaft(mm)	8-16	10-25	10-18	8-25
4	Taper Ratio (mm/m)	28	42.5	29	40.7
5	Geometry of monopole shaft	12 Sided	12 Sided	12 Sided	12 Sided
6	Thickness of cross arm(mm)	10	16	16	22
7	Geometry of cross arm	8 Sided	6 Sided	8 Sided	6 Sided
8	Total tested monopole height (m)	51.205	38.633	54.475	42.193
9	Base Plate Outer Dia (mm)	2570	2775	2700	2825
10	Weight of tested monopole (MT)	43	52	54	56
11	Grade of Steel	IS 2062 E450/E350	IS 2062 E450/E350	IS 2062 E450/E350	IS 2062 E450/E350



DECOILER



PLASMA CUTTING

<http://www.cigre.org>

Study Committee B2
Overhead Lines
10446_2022
Design and testing of monopole structures for 400kV and 765kV Overhead lines- POWERGRID's experience
CONTINUED PROTO TYPE TESTING

BENDING

WELDING

GALVANISING

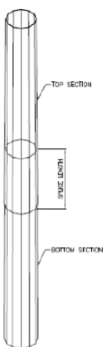
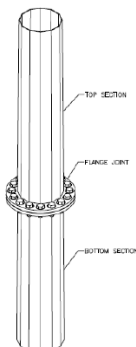
ERECTION OF MONOPOLE

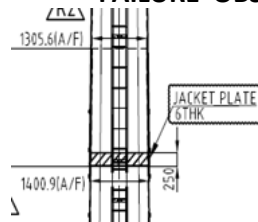
LOAD APPLICATION

SPECIAL MANUFACTURING PROCESS

- Use of high capacity welding machine.
- Due to large size, pole was galvanised in two pieces, then welded & metallizing done.


STIFFENERS WELDED

SAFETY GIRDER
USE OF SLIP JOINT INSTEAD OF FLANGE JOINT

SLIP JOINT

FLANGE JOINT

TEST BED
FAILURE OBSERVED DURING TESTING

JACKET PLATE
CORRECTIVE MEASURE
<http://www.cigre.org>