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Retro-fitting of Pre-Stressed Concrete Poles Using Carbon Fibre Reinforced Polymer

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Abstract – *Development and growth are often accompanied by increase in energy demand and consumption thereby arising the need for establishing a strong and effective network for supply of this energy through transmission and distribution lines far across. Pre-Stressed Concrete Poles in this regard are still the preferred choice for laying the overhead electricity distribution network in India because of the ease and low cost of manufacturing at any given location, strength and durability along with desired performance in various climatic and weather conditions, easy availability of raw material and relatively low skilled manpower required. However, since these poles require steel moulds for manufacturing, scope of any change in physical parameters of these poles once designed is minimal as it would involve high cost for modification of existing steel moulds for fabrication of new ones. With the continuous rise in electricity load and ever increasing number of new connections, there is a need to enhance the strength of these poles to cater loads without frequent changes in the physical parameters. This paper discusses the use of Carbon Fibre Reinforced Polymers for retrofitting of PSC poles to enhance their strength and meet the increased load requirement without making any changes in design and other physical parameters. This would eliminate the need for any modification in existing manufacturing set up which is capital intensive and requires time.*

Key Words: TPDDL (TATA Power Delhi Distribution Limited), kV (Kilo Volt), PSC (Pre-Stressed Concrete), LT (Low Tension), HT (High Tension), CFRP (Carbon Fibre Reinforced Polymer, RCC (Reinforced Cement Concrete) UTS (Ultimate Tensile Strength).

1. INTRODUCTION

TATA Power Delhi Distribution Limited is one of the top Electricity Distribution Utilities in India with a consumer base of around 1.8 Million and an operating area spanning over 500 SqKm with around 11,000 Circuit Km Installed Capacity.

The distribution network is generally laid over Pre-stresses Concrete Poles apart from being underground depending upon the techno-commercial feasibility and site conditions. There are two types of PSC poles – LT & HT being used with the features shown in Table -1.

Table -1: PSC Pole Details

S. No.	Description	LT Pole	HT Pole
1	Overall Length	9 M	11 M
2	Planting Depth	1.5 M	1.8 M
3	Grade of Concrete	M-40	M-40
4	UTS of HT Wires	175 KG/SqMM	175 KG/SqMM
5	Working Load along Major Axis	40	92
6	Breaking Load along Major Axis	100	230

2. METHODOLOGY

These poles are of trapezoidal shape with uniform thickness. The axis perpendicular to the thickness is minor axis and the axis perpendicular to trapezoidal face is the major axis. The poles are designed and manufactured such that the strength about minor axis is $1/4^{th}$ the strength about major axis. The reasons for such type of design are primarily to keep the weight of pole as minimal as possible for easy handling and transportation. Also the design is economical and more viable. And accordingly the poles are installed such that these are loaded about major axis. Due to this disparity in strengths about the two axis, the poles are vulnerable to breaking about minor axis during handling, erection and operation. There have been several incidents of breaking wherein injuries to the workers working over these poles have also occurred. The objective accordingly was to enhance the strength of poles about minor axis without making changes in design and physical parameters.

CFRP Laminates and Wraps are being used for quite some time now for enhancing the flexural strength of RCC structural members including columns, beams, slabs in retrofitting of buildings and bridges and have yielded very good results. The idea was to apply the same concept to the LT PSC Pole to enhance the strength about minor axis. In the

project of ours, three test samples were prepared as described in Table -2 with laminate and wrap application using thixotropic, structural two part adhesive, based on a combination of epoxy resins.

Table -2: PSC Pole Breaking Loads

Sample No.	Description	Observed Breaking Load (KG)
1	PSC Pole with no retrofitting	240
2	PSC Pole retrofitted with two laminates - 50 mm wide & 100 wide	280
3	PSC Pole retrofitted with two 50 mm wide laminates	350
4	PSC Pole retrofitted with CFRP wrap	350

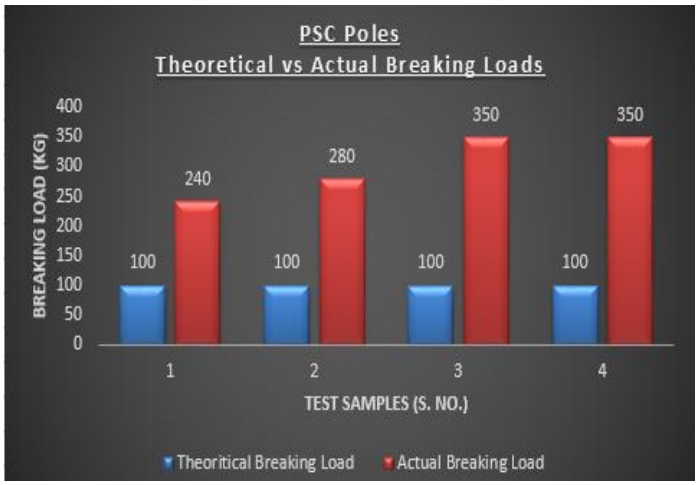

Chart -1: Theoretical vs Actual Breaking Loads

Fig -2: Test Sample No. 3

Fig -2: Test Sample No. 3

Fig -3: Test Sample No. 4

3. CONCLUSION

The three treated and one bare poles were subject to transverse strength tests about minor axis as per IS: 2905. During the tests, it was observed that there was considerable increase in the breaking load of poles. The increase was from a minimum of 16% to a maximum of 45% with average of 35%. In addition, no failure was observed either in epoxy or in laminates/ wrap during the testing and instead the poles broke at the junction of CFRP laminate/wrap where the treatment ended which implies that point of failure lay outside the treated zone and the CFRP laminates and wrap were able to sustain the loads and increase the flexural strength of poles. The test established the viability of CFRP usage in PSC Poles with small application however high scalability.

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