CHRIST
(DEEMED TO BE UNIVERSITY)
BANGALORE · INDIA

# Notice for the PhD Viva-Voce Examination

Mr Hadiya Pritesh Dulabhai (Registration Number: 1670086), PhD scholar at the School of Engineering and Technology, CHRIST (Deemed to be University), Bangalore will defend his PhD thesis at the public viva-voce examination on Saturday, 24 August 2024 at 10.00 am in the CDI Conference Room, III Floor, Block V, Bangalore Kengeri Campus, Bengaluru 560074.

| | | |
|---|---|---|
| **Title of the Thesis** | : | **Evaluation of Bending Stiffness of Transmission Line Conductors** |
| **Discipline** | : | **Mechanical Engineering** |
| **External Examiner** (Outside Karnataka) | : | **Dr Gnanavel B K**<br>Professor<br>Department of Mechanical Engineering<br>College of Engineering and Technology<br>SRM Institute of Science and Technology<br>Kattankulathur, Chennai- 603203<br>Tamil Nadu |
| **External Examiner** (Within Karnataka) | : | **Dr Manjunath S H**<br>Professor and Head<br>Department of Mechanical Engineering<br>Adichunchanagiri University<br>B G Nagara, Nelamangala Taluk<br>Karnataka - 571448 |
| **Supervisor** | : | **Dr Gurumoorthy S Hebbar**<br>Professor<br>Department of Mechanical and Automobile Engineering<br>School of Engineering and Technology<br>CHRIST (Deemed to be University)<br>Bengaluru-560074<br>Karnataka |

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

**Registrar**

**Place:** Bengaluru
**Date:** 12 August 2024

# ABSTRACT

This thesis considers the cables used in overhead electrical power transmission lines, where they are subjected to axial, torsional and bending loads during vibrations. Though many mathematical models exist as on date, the evaluation of stiffness at any bending stage has not been explained adequately. This thesis has looked into the gaps and has proposed two major parameters to narrow down the variation in the estimation scheme. Whenever a wire takes up a helical form, the wire undergoes pulling or stretch first, much before the other deformations like twisting, bending etc. This stretch has become a permanent resident and the strain due to this has to be reflected in the wire curvatures and twist and in the subsequent estimation of wire forces and moments. This thesis has included the wire stretch parameter, neglected in the cable research till date and has formulated expressions to estimate the maximum bending stiffness. The maximum stiffness has been found to increase by 3%,3.15% and 4% respectively in two, three and four layered conductors.

Another significant inclusion in this thesis is the proposal of a combined slip model, encompassing the traditional macro slip adopted by the researchers till date and the microslip caused by the radial clenching contact forces from the wires in the layers above. The micro slip has been estimated using the Hertzian contact stress theory. Using the combined slip model, the curvatures at which the cable transforms from a stick or monolithic stage to the other stages of partial; full slip are identified and the corresponding loss of cable stiffness is estimated. A maximum reduction in bending stiffness of 3.7%,5.2%s has been observed in two- and three-layered conductors with the combined slip model proposed in this thesis against the existing model advocating macro slip and with no stretch effects. The theoretical predictions with the above inclusions are validated by conducting elaborate experimental works in a transmission line laboratory at Central Power Research Institute (C.P.R.I), Bangalore on the conductors that are commonly used in Indian power transmission lines. The experimental and analytical stiffness of the cable vary by maximum of 6% in three layered cables like Panther and around 7.5% in four layered cables like Moose & Bersimis. However, all the stiffness values lie within the stiffness range obtained with monolithic wire approach and loose wire approach. It is hoped that this study will be useful for the cable designer to estimate a priori the status of stress and strain induced in the wires and to avoid premature failures in service.



*Keywords: Stranded cables, interwire friction, macro and micro slip, effective stiffness*


**Publications:**


1. **H. P. Dulabhai**, N. S. Parthasarathy, and G. S. Hebbar, "Numerical analysis and finite element simulation of axial stiffness of overhead transmission line conductor," *International Journal of Mechanical and Production Engineering Research and Development.*, vol. 10, no. 2, pp. 463–476, 2020.
2. **H. P. Dulabhai**, N. S. Parthasarathy, and G. S. Hebbar (2023). Evaluation of Maximum Bending Stiffness of Stranded Cables with Refined Kinematic Relations. In: Dikshit, M.K., Soni, A., Davim, J.P. (eds) Advances in Manufacturing Engineering. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-19-4208-2_25
3. **H. P. Dulabhai**, N. S. Parthasarathy, and G. S. Hebbar (2023). Improvised Model for Estimation of Cable Bending Stiffness Under Various Slip Regimes. In: Dikshit, M.K., Soni, A., Davim, J.P. (eds) Advances in Manufacturing Engineering. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-19-4208-2_28
4. **Dulabhai, H. P.**, Parthasarathy, N. S., & Hebbar, G. S. (2024). Analytical Estimation and Experimental Validation of the Bending Stiffness of the Transmission Line Conductors. Journal of Mechanical Engineering, 21(1), 2550–164. https://doi.org/10.24191/jmeche.v21i1.25357