Industry Day Theme # {CE}

PIEZOELECTRIC ENERGY HARVESTING FROM TRAFFIC-INDUCED BRIDGE VIBRATIONS

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Abstract

Energy harvesting using piezoelectric element from the vibrations of civil structures is emerging as a promising renewable source to generate power for microelectronic devices such as wireless sensor nodes (WSNs) deployed for structural health monitoring (SHM), sustainable transportation, Internet of Things (IoTs), etc. Conventional batteries as a source of power may not be feasible due to finite lifespan and environmental issues during disposal. Therefore, energy harvesting from ambient vibrations is a promising technology for fully autonomous wireless sensor nodes, which can give birth to new applications in biomedical, industrial, and environmental monitoring.

Introduction

Energy can be harvested from civil structural vibrations by employing one of the various transduction mechanisms such as piezoelectric, electrostatic and electromagnetic. Experiment was performed to get first hand information of the frequency and amplitude of possible voltage generation from the flyover situated in front of the Indian Institute of Technology Delhi. After real life bridge measurement, further experiments were performed in the laboratory environment in order to estimate harvestable power at fixed frequency (5 Hz) but different input voltage using MFC patch bonded to the cantilever.

Fig. 1 Deployment of accelerometer on girder

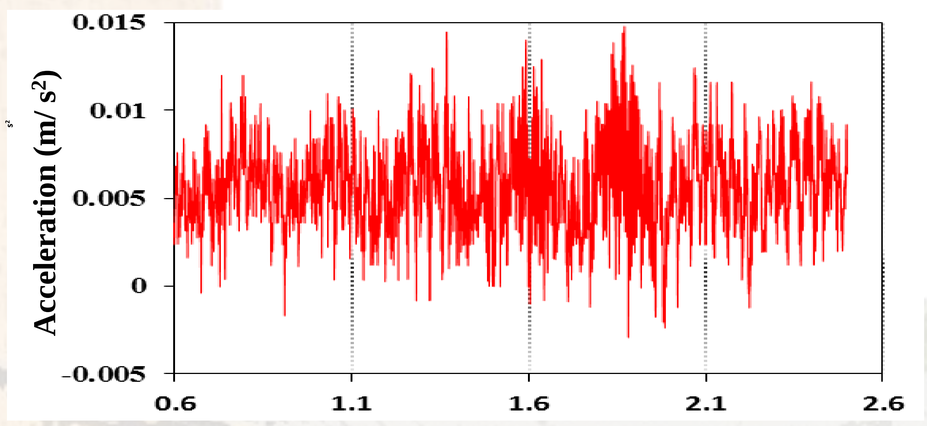

Fig. 2 Traffic induced vibration signal in time domain

Result

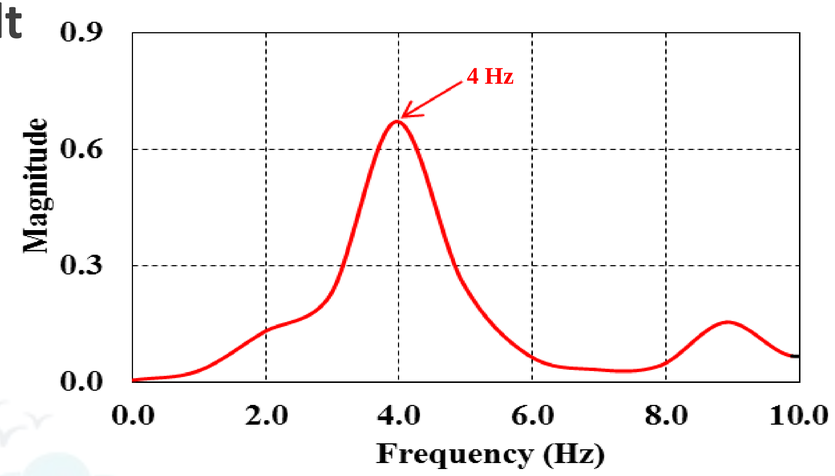

Fig. 3 Same vibration signal (see Fig. 2) in frequency domain

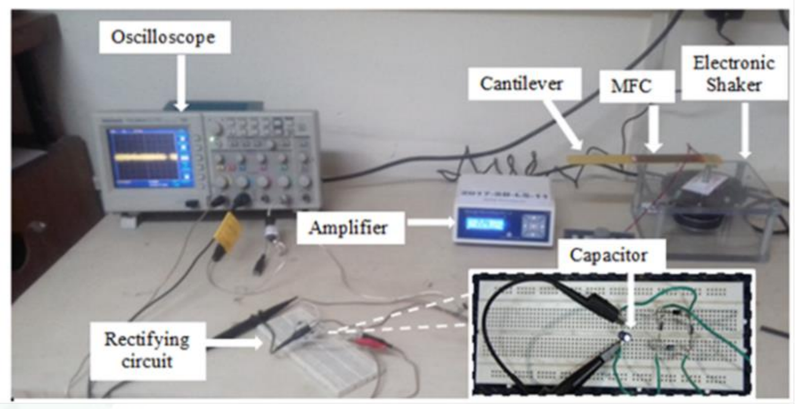

Fig. 4 Lab Experimental Setup

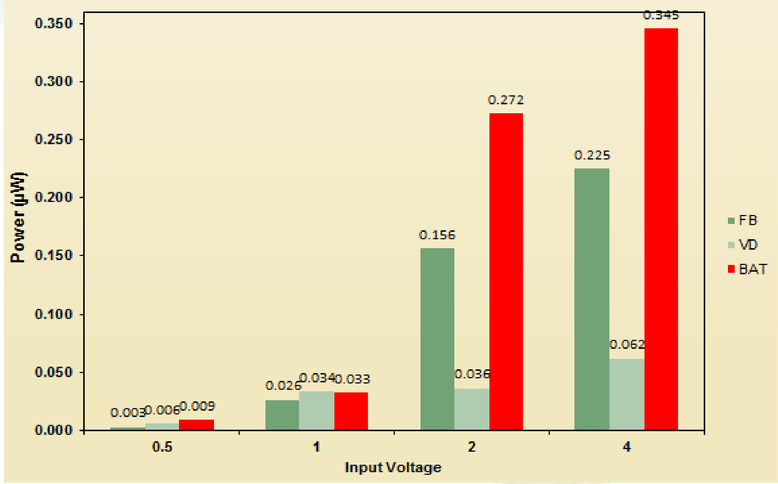

Fig. 5 Comparison of Power

Fig. 6 Close up of PZT bonded on girder.

Conclusions

- The measurement shows that the natural frequency of the structure was 4 Hz.
- If a PZT patch of 10×10×0.3 mm size were employed instead of accelerometers, computations show [Balguvhar and Bhalla,2016] that it would generate a peak voltage of 0.736 V.
- Voltage in case of Voltage Doubler (VD) is higher (taking more time) as compared to others.
- Experiments demonstrate higher yield for higher voltage.
- Power is more in case BAT rectifier (taking less time).

References

1. Balguvhar S, Bhalla S. “Evaluation of power extraction circuits on piezo-transducers operating under low-frequency vibration-induced strains in bridges”. Strain. Vol. 55 No. 3, pp. e12303.
2. Balguvhar, S, Dalal, P and Bhalla, S "Feasibility of piezoelectric energy harvesting from real-life city flyover: a case study," Proc. SPIE 10973, Smart Structures and NDE for Energy Systems and Industry 4.0, 3-7, March 2019, Denver, USA doi: 10.1117/12.2511941.
3. Balguvhar, S and Bhalla, S “Green Energy Harvesting Using Piezoelectric Materials from Bridge Vibrations”, 2018 2nd International Conference on Green Energy and Applications (ICGEA 2018), March 24-26, 2018, Singapore.

Industrial Significance

The market for industrial applications of piezoelectric energy harvesting is expected to grow significantly on account of its increasing application in industrial environments such as oil and gas manufacturing as it is a cost-effective alternative to expensive wired infrastructure. The primary drivers of growth in the piezoelectric energy harvesting market include the highest reliability, efficiency and power output by size and cost offered by the piezoelectric energy devices harvesters against the alternative energy harvesting technologies.

Department Name