

TRAFFIC AND INDUSTRIAL VIBRATIONS AND A SNAKE HIBERNACULUM

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1 Presentation (English)

Anecdotal evidence suggests that hibernating snakes can be disturbed or even awoken by ground vibrations, and if they emerge in winter, this can be fatal. A concern was raised about vibrations from a pile-driving operation some 350 metres from a garter-snake hibernaculum. Preliminary measurements in winter showed that vibrations from traffic may be more of an issue than the pile-driving, and additional measurements were taken near the existing hibernaculum, which is located within 30 metres of a secondary highway. These readings may indicate levels which are acceptable to the snakes.

2 Présentation (Français)

Des preuves anecdotiques suggèrent que les serpents en hibernation peuvent être perturbés ou même réveillés par les vibrations du sol, et si elles apparaissent en hiver, cela peut être fatal. Une préoccupation a été soulevée au sujet de vibrations d'une opération de battage à environ 350 mètres d'un hibernaculum pour serpents de types *Thamnophis*. Des mesures préliminaires en hiver ont montré que les vibrations dues au trafic peuvent être plus un problème que le battage, et des mesures supplémentaires ont été prises près de l'hibernaculum existant, qui est situé à moins de 30 mètres d'une route secondaire. Ces relevés peuvent indiquer des niveaux qui sont acceptables pour les serpents.

3 Nature of the Issue

3.1 Snakes and Vibrations

There have been a number of instances (Haicheng China 1975, Tangshan China, 1976, and southern Taiwan 2006, and others) where snakes have reacted just prior to earthquakes. As snakes are very sensitive to ground vibrations, there is concern that industrial activities could disturb hibernation, which could lead to arousal and possible death if this occurs during winter conditions. Early investigations were conducted at a range of distances (100 to 500 metres) from an industrial operation in a forested area in winter. Traffic passing the monitor sites registered higher ground vibration levels than the industrial activities. As the hibernaculum of concern is less than 20 metres from a secondary highway, further measurements were taken in summer to assess the ground vibrations from traffic on this road, where it appears the snakes are not adversely disturbed during their hibernation.

3.2 Methodology

Accelerometers were placed at 10 and 20 metres from a secondary highway. In order to couple to the ground, the

accelerometers were mounted on a small (15 cm by 15 cm) plywood plate which was designed based on a paper by Barman and Coulter (1981, ref 1). The plate was designed to accommodate a Brüel and Kjaer (B&K) type 8306 accelerometer within the criterion presented in their paper. The B&K type 4370 accelerometers are about 1/10 the mass of the 8306 units, and so meet the criterion easily.

The vertical vibration levels were measured with B&K Sound Level Meters at 10 metres and 20 metres, both using the accelerometer as input and recording the levels in 1/3 octaves in 1 second intervals.

The acceleration readings were converted to vibration velocity levels using the formula:

$$L_v = L_a - 20 * \log_{10}(f) + K$$

Where f is the centre frequency of each 1/3 octave band, and the constant K depends on the accelerometer sensitivity and choice of reference units used. Once the band acceleration levels are converted to velocity, the bands are added together (using deciBel math, of course).

4 Results

Vibration velocity was used as the relevant index, as it has been shown to correlate well with human perception as well as structural and architectural damage to buildings. Whether it is relevant for snakes is an outstanding question.

Figure 1 shows the location of the hibernaculum adjacent to the road. Figure 2 shows the overall vertical velocity levels over a sample hour from within the approximately 8 hour measurement period, at both the 10 metre and 20 metre distances. Figure 3 shows the levels for a large truck moving at speed, while Figure 4 shows the levels for a front-end loader moving slowly. Figure 5 shows the vertical velocity levels for a pickup truck and a passenger car, both moving at speed. It is apparent that the vibration levels depend both on the speed and size of the vehicles. The passage of the large truck (in Figure 3) presents the highest vibration level

Figure 1: Hibernaculum (Fenced) Near Road



($L_v = 111.8 \text{ dB ref } 1 \text{ nm/s} = 83.8 \text{ dB ref } 1 \text{ } \mu\text{in/sec}$) measured over the entire measurement period.

Figure 2
Vertical Velocity Due to Traffic
One Hour Time Period

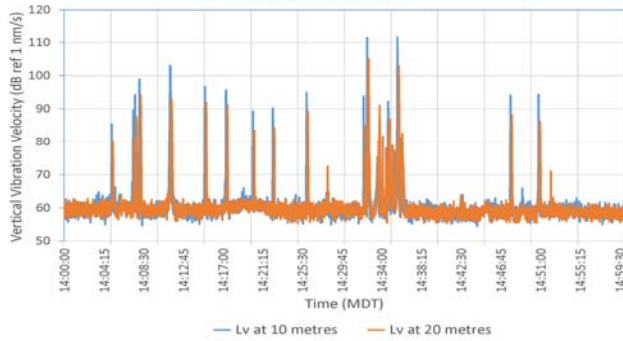


Figure 3
Vertical Velocity Due to Traffic
Large Truck in Near Lane at Speed

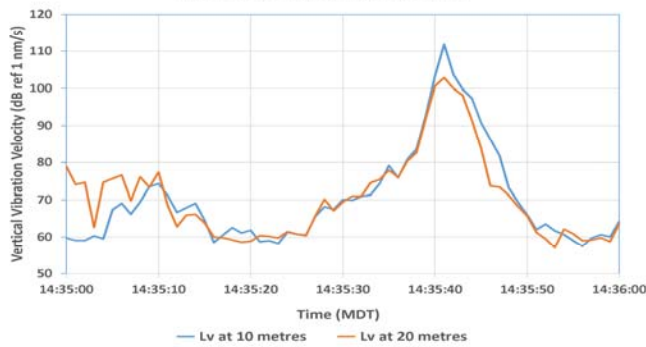


Figure 4
Vertical Velocity Due to Traffic
Loader in Far Lane (Slow)

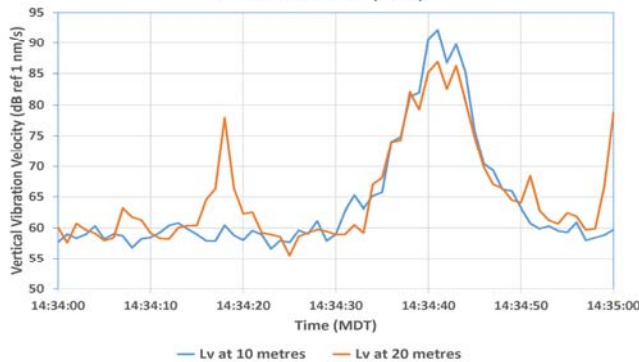
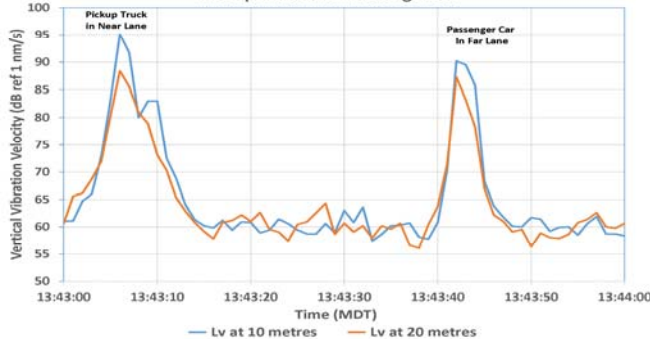


Figure 5
Vertical Velocity Due to Traffic
Pickup Truck and Passenger Car



5 Limitations of the Study

For survival, a snake hibernaculum must be below the frost line. This study measured surface vibrations only.

The surface vibrations were transmitted through undisturbed continuous ground. By its very nature, the ground in and around the hibernaculum must be disturbed and porous, so that the snakes can inhabit it. Therefore, these vibration levels are the levels which impact on the hibernaculum, but not necessarily the levels within the hibernaculum.

It is recognised that industrial vibration may involve vibratory activities taking place deeper under the ground surface, which may not be reflected in these observations.

These readings were taken in summer. During winter, the propagation of vibrational energy may be higher, but also may be restricted more to the surface (frozen) layers of the ground which can act as a wave guide. Vibrations occurring or generated before the frozen layers of ground should not be affected by this effect.

6 Conclusion

The continuing presence and use of a hibernaculum located beside a road indicates that the vibrations, generated by the passing traffic, do not disturb the hibernating snakes to a significant degree. The maximum measured vibration levels may be taken as a threshold level of vibration which is acceptable to the snakes.

Therefore, industrial vibrations well below these thresholds should not disturb the hibernating garter snakes. This finding may serve to indicate an acceptable level for the assessment of industrially generated vibrations in the vicinity of a hibernaculum.

References

1. M. Barman and J.E. Coulter. An Improved Transducer Mount for Ground Vibration Measurements. *JCAA Vol 9(1), Jan. 1981*
2. The Independent, December 2006

Acknowledgements

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