Formulation of the impact on yarding cable using spring-dashpot model

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Introduction

Previous research of skyline vibration

The vibration of skyline ropes during cable yarding operations sometimes becomes greater than that in stationary states because of various reasons. When there are operation lines, especially haulback lines, the vibration is suppressed because the cable has a vibration control function. In the case of a simple logging cable, there are no operation lines, and as the line is not damped, the vibration is large.

Irie (1957) reported
the natural vibration of a cable with a carriage hanging in the middle. It was clarified that in the vertical vibration of the cable tension with a small droop ratio and no difference in height, the frequency decreased owing to the influence of the support.

Hori (1979) studied
the impact of the load on the skyline and operation lines when operating lifting or hoist lines to raise or lower the load and illustrated the history of the dynamic action of the load.

Matsuhisa et. al (1993) approximated
the carriage with a pendulum and examined the vibration when it was subjected to crosswind.

although research on the vibration of the gathering logging cable has been conducted sporadically, the vibration of a simple cable has not been investigated in recent years.

The purpose of this study is

to apply the damped spring model to The vibration of a simple logging cable

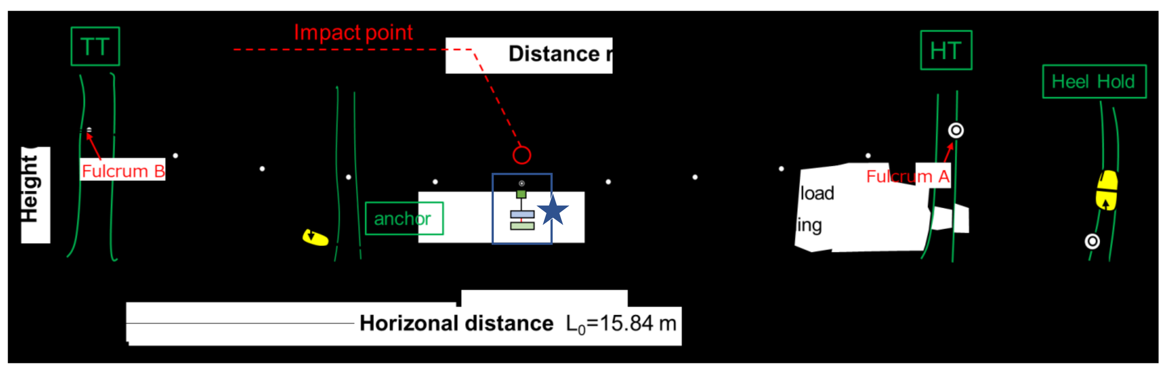
To achieve this purpose, we aimed to

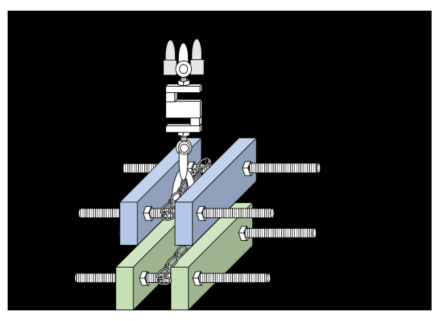
1. the impact was measured using a small-scale cable with a simple structure
2. a physical model considering the impact condition was constructed, and
3. verified using experimental values.

Materials & Methods

Experimental cables for impact tension measurement

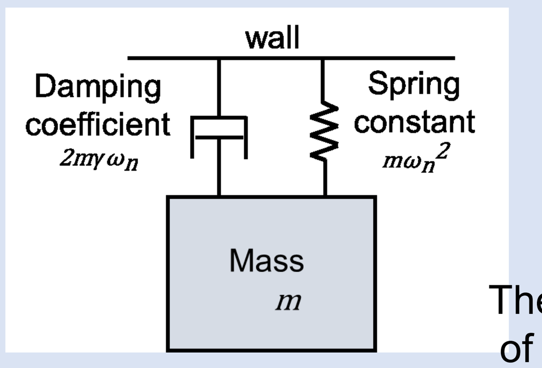
Study area	Fuchu campus of Tokyo Univ. of Agric. and Tech.,
Measurement	Tension of a lifting line Load cell (Load capacity 4.9 kN)
Instruments	Cut off a part of the load to simulate the release of logs caught by obstacles.
Impact Conditions	Impact point (Distance ratio 0.5), Weights (Upper 13.0 kg, Lower 12.0kg) , 100 replications for each condition.





Enlarged view of ★

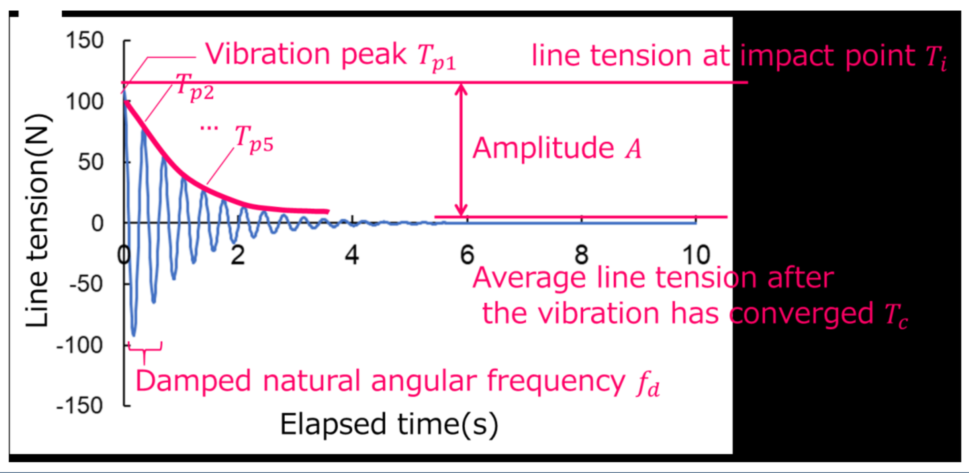
Spring–dashpot model



Equation of motion of damped motion
$$m\ddot{x} + 2m\gamma\omega_n\dot{x} + m\omega_n{}^2x = 0$$

General solution of damped motion
$$x_{(t)} = Ae^{-\gamma t}\cos(\sqrt{\omega_n{}^2 - \gamma^2}t + \theta_0)$$

The coefficient γ, ω_n, A was obtained and the solution of the damped vibration was calculated.



Attenuation rate $\gamma = \frac{1}{4} \cdot \ln\frac{T_{p1}}{T_{p5}}$

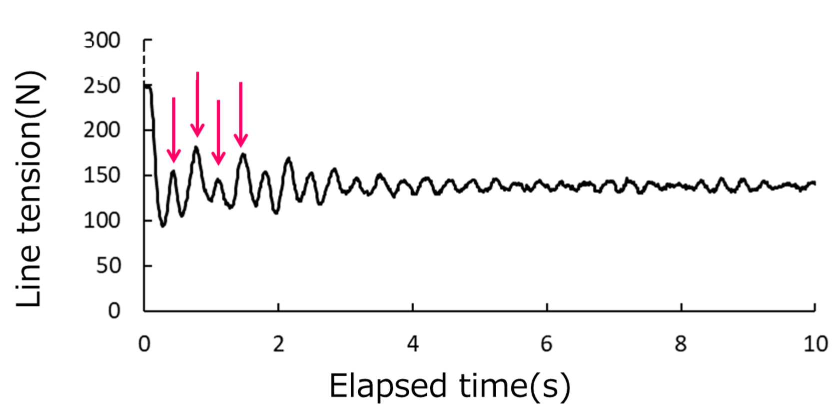
Natural angular frequency $\omega_n = \frac{2\pi f_d}{\sqrt{1-\gamma^2}}$

Amplitude $A = T_i - T_c$

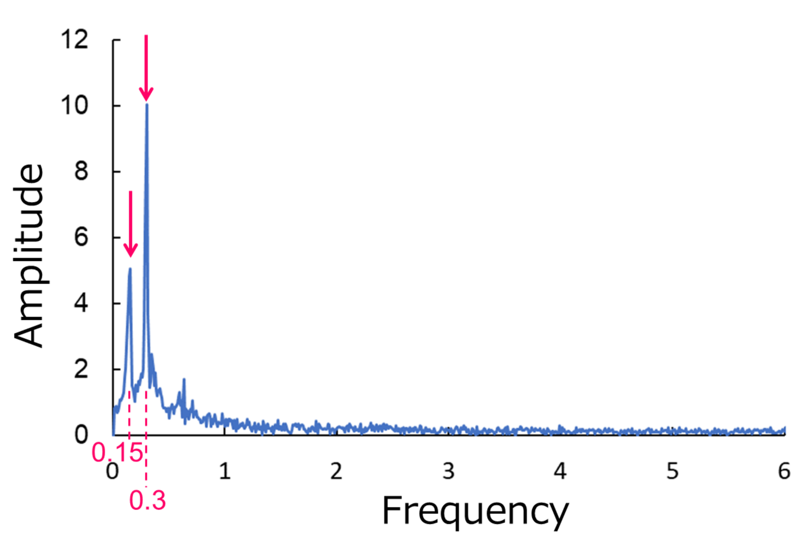
Results

Experimental decay curve

a composite wave having a frequency of 1:2



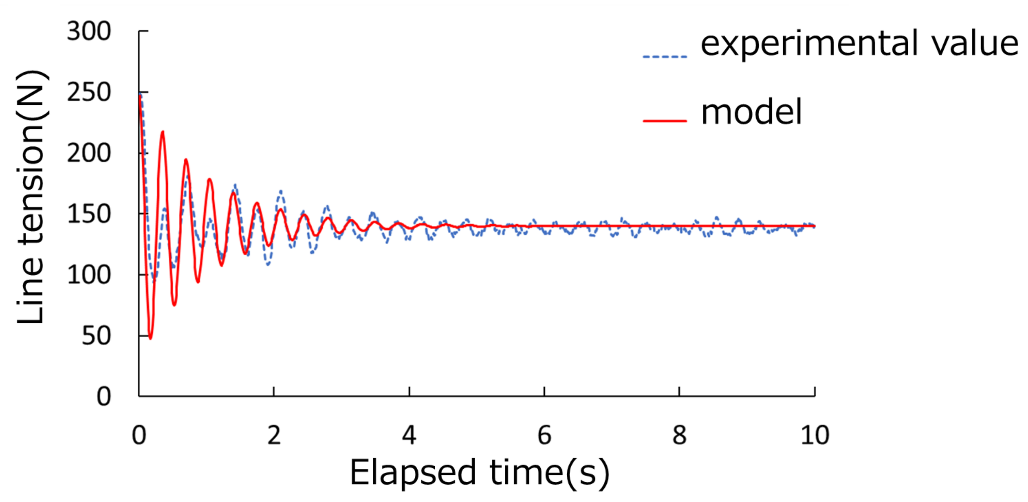
As a result of FFT conversion, 1/2-wave and 2/2-wave were confirmed.



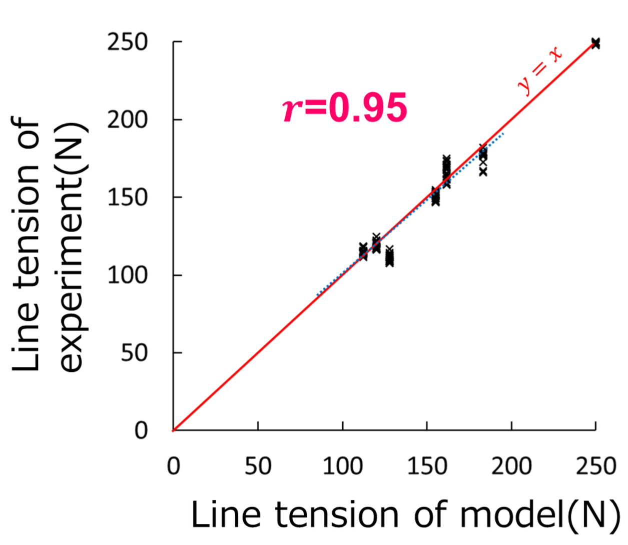
It was confirmed that two waves were synthesized.

Falloff Curve Created

$\omega_n = 18, \gamma = 0.74, A = 110$



The range where the markers are concentrated is called a peak. Using the impact point as a reference and drawing a line with y = x, we found that the peak almost appears on this line.



Conclusions

In this study, we assumed that an abrupt load is applied to the skyline when the material was caught on the convex parts of the ground during the gathering and released according to the winding of the rope, and the tension of the load suspension rope when this load was applied was assumed. The aim was to adapt the spring-dashpot model to the fluctuations.
Although all the assumed damped vibration phenomena could not be explained by a damped one-degree-of-freedom system, it was confirmed that the peak with the largest tension after the impact could be used.

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