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ANALISYS OF OSCILLATIONS IN A CABLEWAY: WIND LOAD EFFECTS

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Summary

- Free oscillations of a cabin-loaded cable span
- Wind load influence on the cables' oscillation

1. Free oscillations of a cableway span

Basic principle

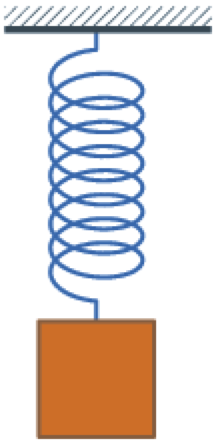
Smooth movement during motion

No oscillations

The deceleration induces the vertical inertial force

Fast deceleration: **induced oscillations**

Mass - spring - damper



Boundary Conditions for the analisys

- ✓ Span loaded by 5 cabins
- ✓ The load is supposed to be distributed along the span
- ✓ Statical model

Forces involved in a free oscillation

The total force rempresented by the system

The damping force: the air friction amplitude reducer force

No forces are applied: the total sum is 0

$$F_{tot} = F_i + F_c + F_s = 0$$

The inertia force: the force that causes the motion

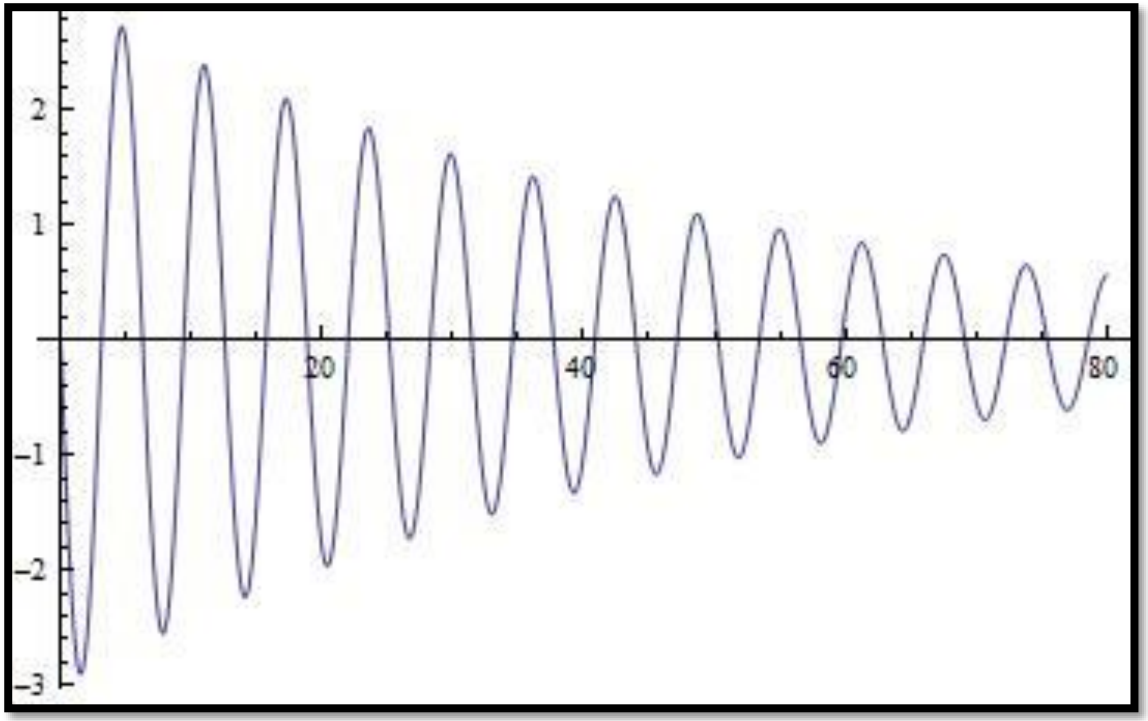
The elastic restoring force: the force resposinble for the restoring of the initial position

Linear Homogeneous Differential Equation with constant coefficients

$$0 = m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx$$

Simulation results with Wolfram Mathematica

Amplitude [m]



Time [s]

Table I	Simbol	Value	Unit
Cabins masses on the rope	m	7000	kg
Cabin - rope speed	v	6	m/s
Elastic coefficient of the rope	k	7000	N/m
Damping coefficient – air friction	c	290	Ns/m

2. Wind load

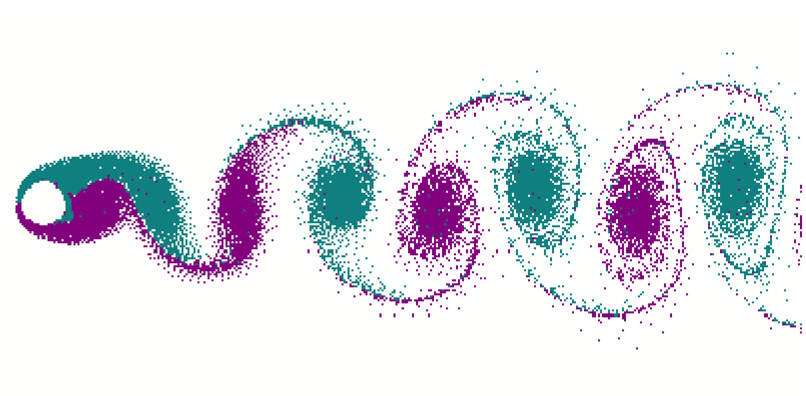
influence on cableways' cable's oscillations

Modeling the wind force

Wind force

✓ Periodical force

✓ Depending on the surface invested by the stream, fluid density, dragging coefficient, fluid speed

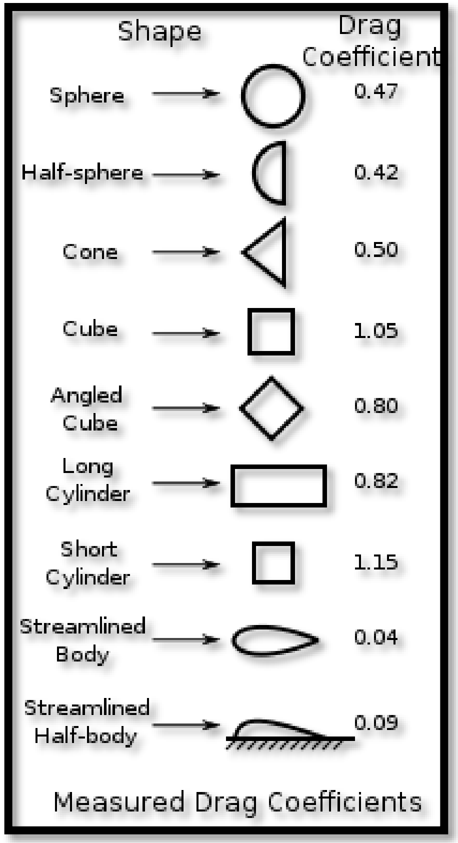


Boundary conditions for the analisys

✓ Same as the conditions of the first part (distributed load with 5 cabins)

Dragging coefficient

✓ Dimensionless quantity that is used to quantify the drag or resistance of an object in a fluid environment such as air



Wind force

Drag coefficient

Spacially varying excitation frequency

The wind force

Fluid speed

$$F_{wind} = 0.5\ Cos(\omega t)\rho c_l A V^2$$

Fluid density

Surface invested by the fluid

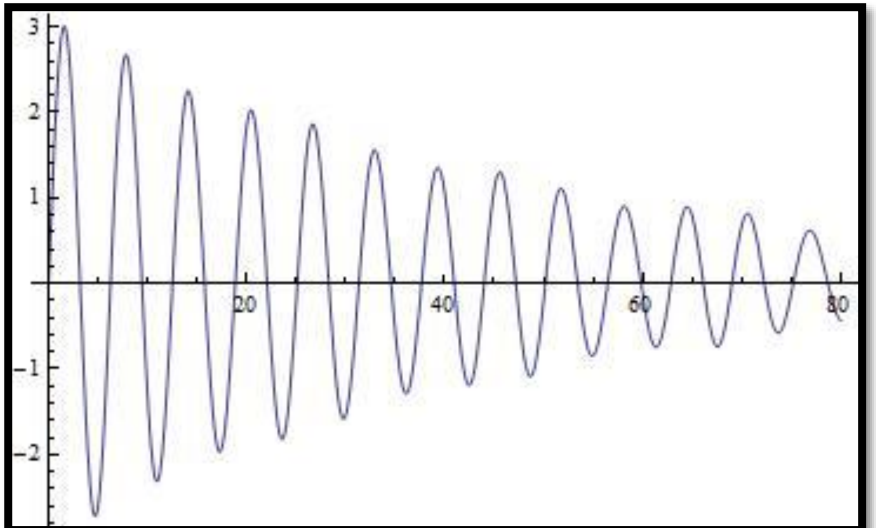
$$F_{wind}(x, t, \ldots) = \mathrm{m}\frac{d^2 x}{dt^2} + c\frac{dx}{dt} + kx$$

Total force acting on the system

Simulation results with Wolfram Mathematica

10 m/s wind speed - Dragging coefficient 0.5

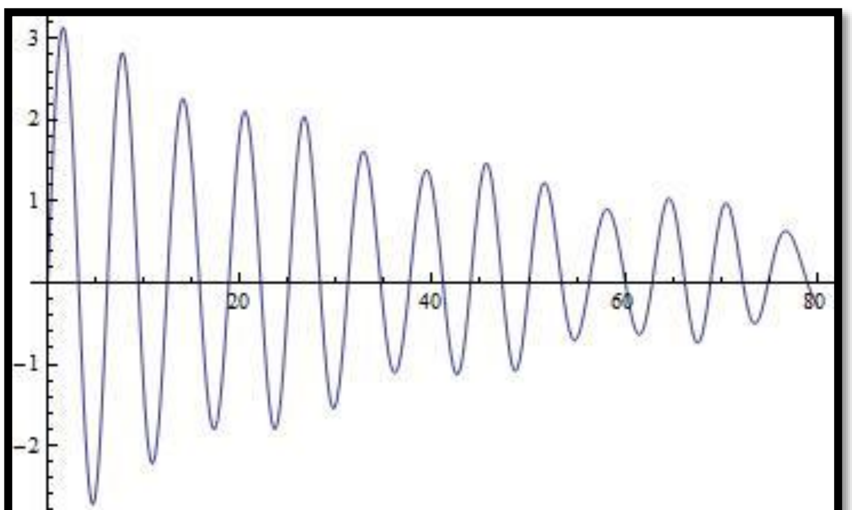
Amplitude [m]



Time [s]

10 m/s wind speed - Dragging coefficient 1.15

Amplitude [m]



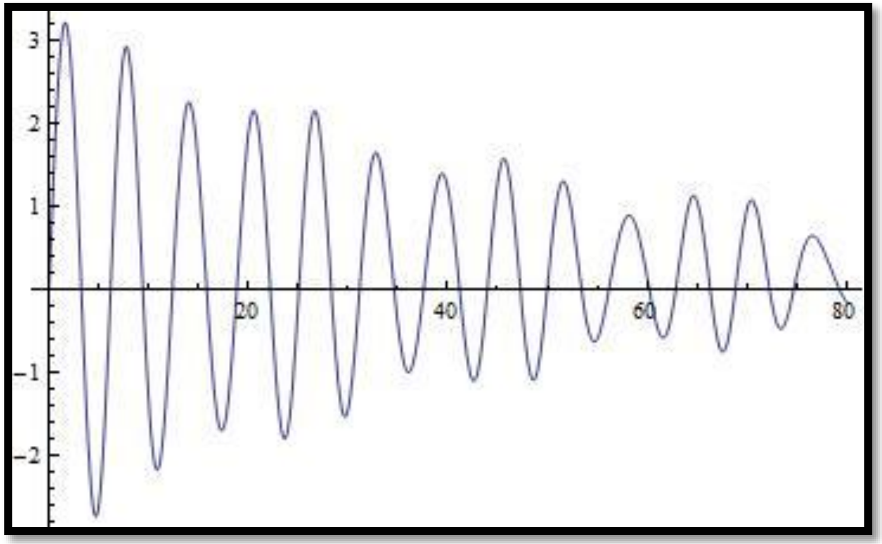
Time [s]

Table II	Simbol	Value	Unit
Lift coefficient	c_l	0.5-1.15[7]	[1]
Spatially varying ecitation frequency	ω	1.8	rad
Density of the fluid	ρ	1.3163	Kg/m^3
Total area of the cabins	A_{tot}	20	m^2
Relative speed of the wind	V	10-30	m/s

Simulation results with Wolfram Mathematica

20 m/s wind speed - Dragging coefficient 0.5

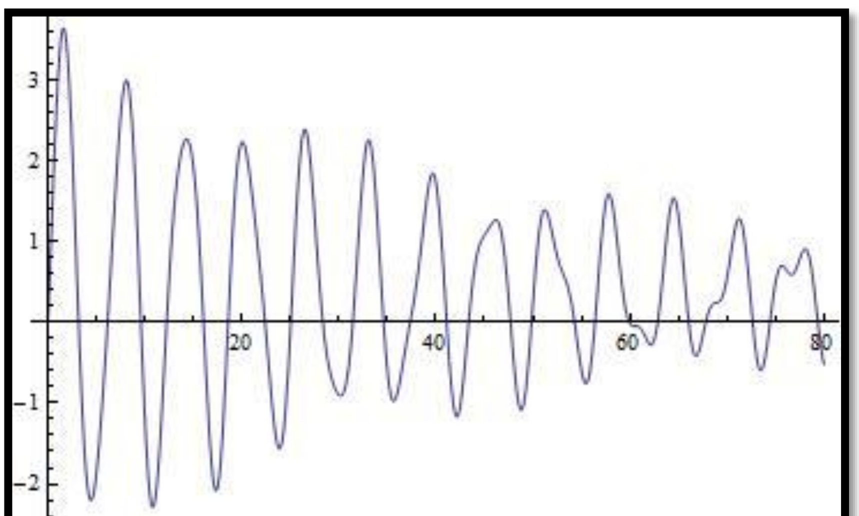
Amplitude [m]



Time [s]

20 m/s wind speed - Dragging coefficient 1.15

Amplitude [m]



Time [s]

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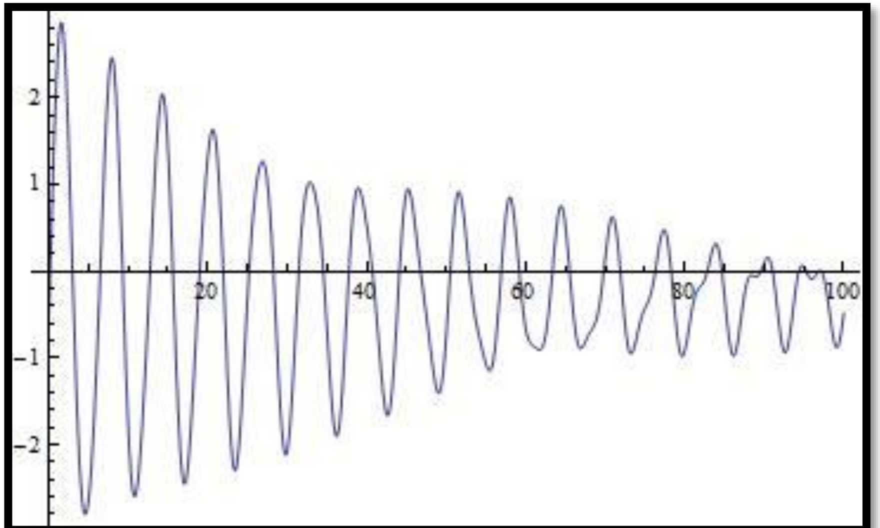
Relative speed of the wind	V	10-30	m/s

Simulation results with Wolfram Mathematica

30 m/s wind speed - Dragging coefficient 0.5

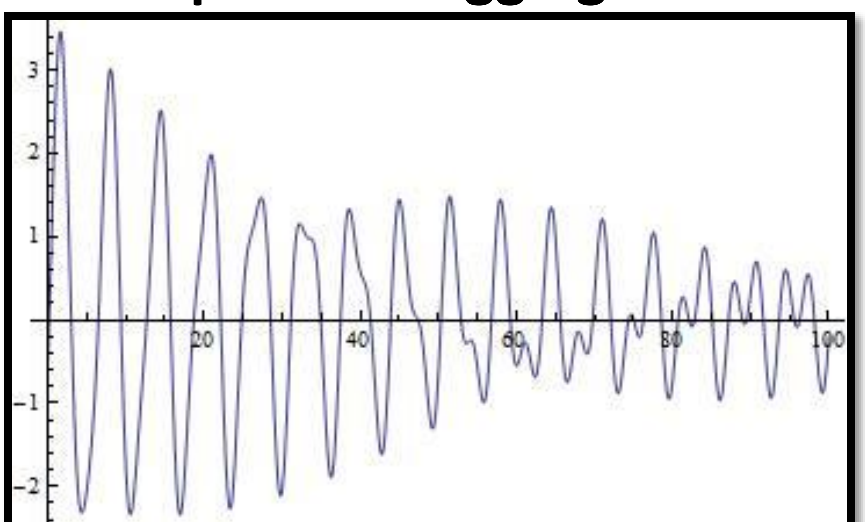
Amplitude [m]



Time [s]

30 m/s wind speed - Dragging coefficient 1.15

Amplitude [m]



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Conclusions and Outlook

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The research has been made by covering the following topics: free oscillations‘ analisys for a cableway‘s loaded cable‘s span and wind induced oscillations on the cable.

Free oscillations

A free oscillation cable string can be well described with a mass-spring-damper system. Results made with Wolfram Mathematica show that results that we can get appear to be definitely realistic. A further research on the parametres could be done for researching purposes.

Wind load effects on cableways’ oscillations

A simple periodical force can describe well the wind oscillation force. Furthermore, it can be easily used with the mass – spring – damper system. Results show that dragging coefficients play a very big role in the aerodynamics of the cableway, which can play an important role in the energy saving of the system itself and the cableway components.

Thank you for your attention

Analisys of oscillations in a cableway: wind load effects
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