Sequence n° 1: the origins of waves

ACTIVITY 1 : Galloping Gertie (The Tacoma bridge), a resonance phenomenon

The Tacoma Narrows Bridge is famous for collapsing in a spectacular fashion during a windstorm. In this activity, you'll dive into the physics of this collapse.

Document 1: Galloping Gertie Bending in the Wind

On July 1st, 1940, the **Tacoma Narrows Bridge** opened to the public in Washington. It was a suspension bridge that spanned Puget Sound's Tacoma Narrows Straight. This bridge was the third largest suspension bridge in the world for its time.

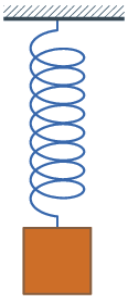
During construction the bridge had garnered the nickname 'Galloping Gertie' due to the way it swayed and bent in the wind. This wave-like swaying eventually became its downfall as the bridge collapsed on November 7th, 1940 during a windstorm; a mere four months after its construction was complete.

Source: https://study.com/academy/lesson/physics-of-resonance-tacoma-narrows-bridge-collapse.html

Document 2: Harmonic motion

When you have an object oscillating back and forth periodically, we say it is experiencing **harmonic motion**. One great example of an object experiencing harmonic motion is a free hanging spring with a mass attached to it. The mass causes the spring to stretch downwards, until eventually the spring contracts back upwards to return to its original shape. This process keeps repeating itself, and we say the spring is in harmonic motion.

Spring and mass in harmonic motion



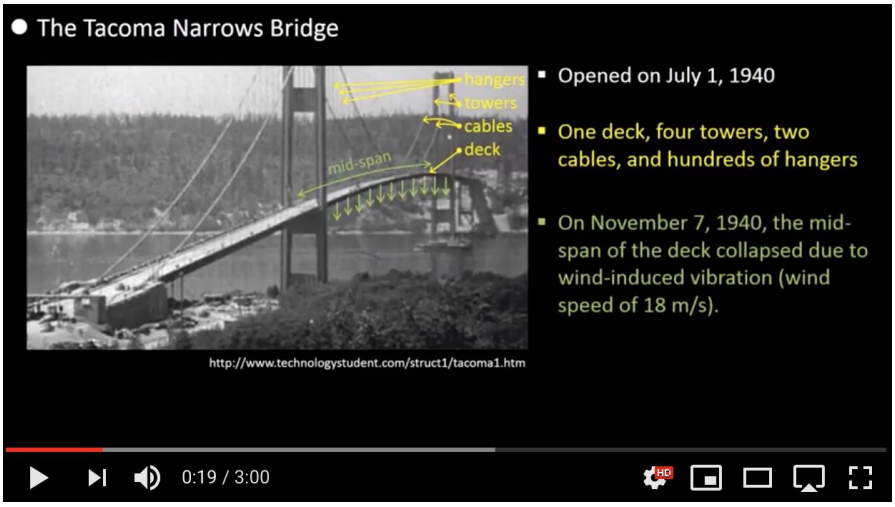
If you look at the video of the Tacoma Narrows Bridge (document 3), you can see that it was oscillating before it collapsed. Though the physics of a large structure oscillating are much more complex than the spring example, they both fall under the same basic concepts. It was undergoing harmonic motion just like a spring with a mass attached to it.

[…]

A **driven harmonic oscillator** is given energy by some **external source**. In the case of the Tacoma Bridge, it was the wind that was adding energy to it in order to keep it oscillating. Without the wind keeping it going the bridge would have eventually slowed down to a stop.

Source: https://study.com/academy/lesson/physics-of-resonance-tacoma-narrows-bridge-collapse.html

Document 3: Tacoma bridge video



Watch the video from 0s-50s

Source: https://www.youtube.com/watch?v=OrqdFxpM_N4

Understanding harmonic motion

Explain in your own terms why the Tacoma bridge was also named Galloping Gertie?

_____

Define harmonic motion?

_____

What is a driven harmonic oscillator?

_____

Explain the analogy with the Tacoma bridge and give one possible reason for its collapse

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Activity summary

What you must remember:
- harmonic motion
- driven harmonic oscillator

Skills linked to the curriculum**:**

Compétences	Capacités à maitriser
– APP	Faire le lien entre la situation réelle et le modèle proposé. Identifier une situation d'oscillation forcée.
– ANA	Proposer une hypothèse pour expliquer l'effondrement du pont. Exploiter le dispositif pour étudier à quelles conditions on obtient une résonance. Décrire un phénomène de résonance en en mécanique et le caractériser par sa fréquence de résonance et son facteur de qualité.
– COM	Formuler et argumenter des réponses structurées Formuler et présenter une conclusion