Historical Failures, Lessons Learned and Design Improvements

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Turbo-Generator Shafts Failure
Shaft is subjected to transient Torques
Mode of Failure
Life Estimation

Crack Length $c$

$2r_N$

$2r_0$

$V_C = \text{Electrical Potential Across } x, x'$

Chart Recorder

Amplifier
Failure Modes
ISUZU Failure of the Break
Inspection of the System
Mechanism of Failure
Metallography Study
Merrimack River Dam Failure

- Mechanism of Failure, Strain Hardening of Rods
Hyatt Hotel Failure in Kansas City
Design and Factual Information

- Hyatt Walkway Collapse
- Kansas City Hyatt Regency hotel opened in 1980
- 40-story tower
- Function block
- Connecting atrium with three elevated walkways 117 ft (36 m) long
Initial Design
Designed was changed to this
The Change in Design Doubled the stress in the joint
Since both the 4th and 2nd floor walkways fell, which parts of the walkways could have failed?
1940 suspension bridge in Washington state
Third-longest in the world in 1940
(5000 ft; 2800 ft center span)
Quite narrow (39 feet; two lanes)
Bridge deck supported by vertical cables hung from two long cables strung from one shore, over two towers, to other shore
To reduce costs, sides constructed of solid 8-foot tall I-beams rather than typical open trusses.
November 7, 1940

(four months after opening)

- Midnight storm weakens bridge deck and cable stays
- Mid-morning wind reaches 40-45 mph
- Bridge closed at 10 am and bridge begins torsional wave motion
Why did this bridge oscillate so much?
Why did this bridge fail when other, longer bridges didn’t?
What design changes might have prevented this failure?
Solid I-beam girders, unlike trusses, did not allow wind to flow through Flexible bridge oscillated vertically (transverse waves) due to vertical forces from “vortex shedding” as wind flowed around side girders
Why did this bridge fail when other, longer bridges didn’t?

- More Vertical Deflection
- More Torsional Deflection
Failure Due to Inspections

- Nondestructive Evaluation such as
  - Ultrasonic
  - Eddy Current
  - Thermography
  - Radiography
  - Vibrations
  - Etc.
I 95 Bridge section failure due to missing a large crack during inspections of the bridge
Poor inspections, missing cracks, resulted in a disaster
• Thank you