

A political cartoon by Aislin (Montreal Gazette) depicting a bridge under construction. A single vertical column of the bridge is shown with a large, pink, bandaged wound on its side, symbolizing the state of infrastructure. The bridge's deck is incomplete, with some sections supported by wooden beams and others by temporary structures. In the background, a factory or industrial building is emitting a thick plume of white smoke into the sky. The overall theme of the cartoon is the need for infrastructure rehabilitation.

Why is
rehabilitation of
structures an
important topic
of study?

Our urban infrastructure is currently deteriorating rapidly

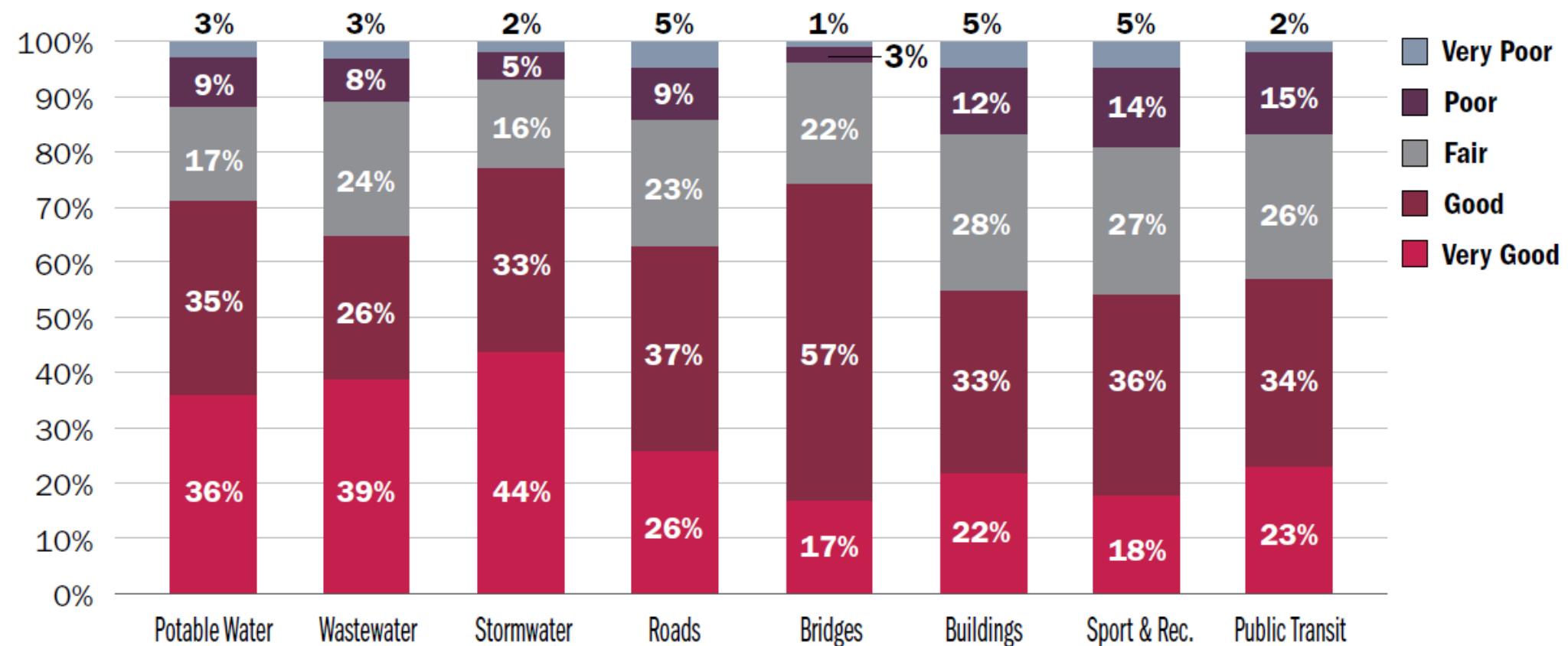
There are more than 617,000 bridges across the United States. Currently, 42% of all bridges are at least 50 years old, and 46,154, or 7.5% of the nation's bridges, are considered structurally deficient, meaning they are in "poor" condition. Unfortunately, 178 million trips are taken across these structurally deficient bridges every day. In recent years, though, as the average age of America's bridges increases to 44 years, the number of structurally deficient bridges has continued to decline; however, the rate of improvements has slowed. A recent estimate for the nation's backlog of bridge repair needs is \$125 billion.

Our urban infrastructure is currently deteriorating rapidly

The cost of upgrading our deteriorating urban roads and bridges in Canada was estimated to be \$66 billion according to a 2005 survey by the Council of the Federation. A more recent study by the CSCE (see link below) places the value of our urban infrastructure at \$1.1 trillion (about \$80,000 per household) and finds that roughly one third of it is in poor / rapidly deteriorating condition.

<http://canadianinfrastructure.ca>

Our urban infrastructure is currently deteriorating rapidly



<http://canadianinfrastructure.ca>

Our maintenance budgets are currently not enough to keep up

In the 2013 ASCE Infrastructure Report Card, an investment of \$3.6 trillion between 2013 and 2020 was estimated to be the cost of upgrading the American public infrastructure to an acceptable level.

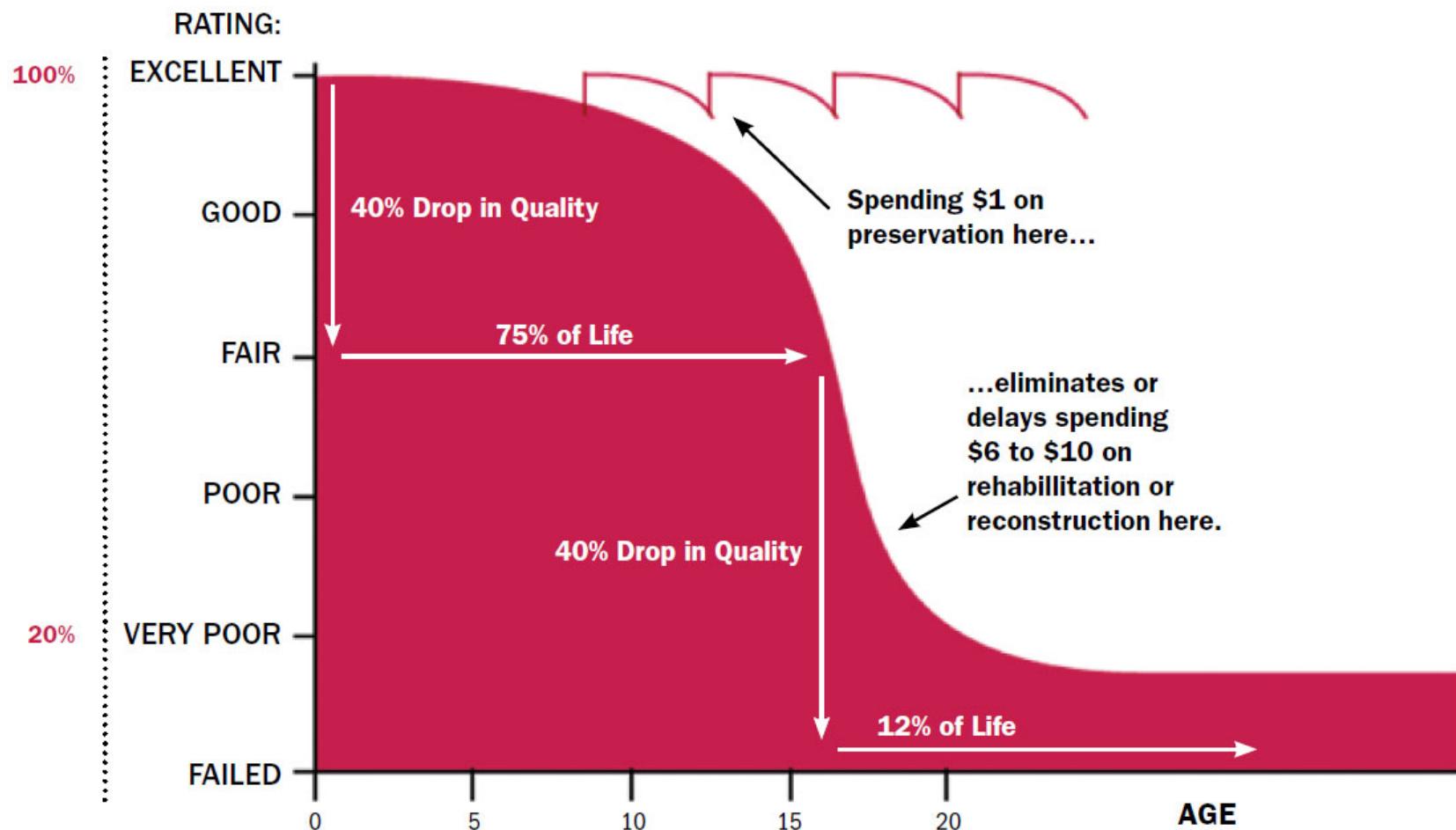
In December 4, 2015 Barak Obama announced \$305 billion of spending to improve the state of American civil infrastructure.

In the 2016 US election, significantly increased funding for civil infrastructure renewal **was one of the few things the two candidates agreed on**, with funding promises over a five-year period in the \$250-500 billion US range for roads, hospitals, schools, and power plants.

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The consequences of structural failures can be very high



Laval Bridge collapse, 2006, five fatalities

Our infrastructure is deteriorating
gradually for various reasons



Structures can be damaged by extreme loading events

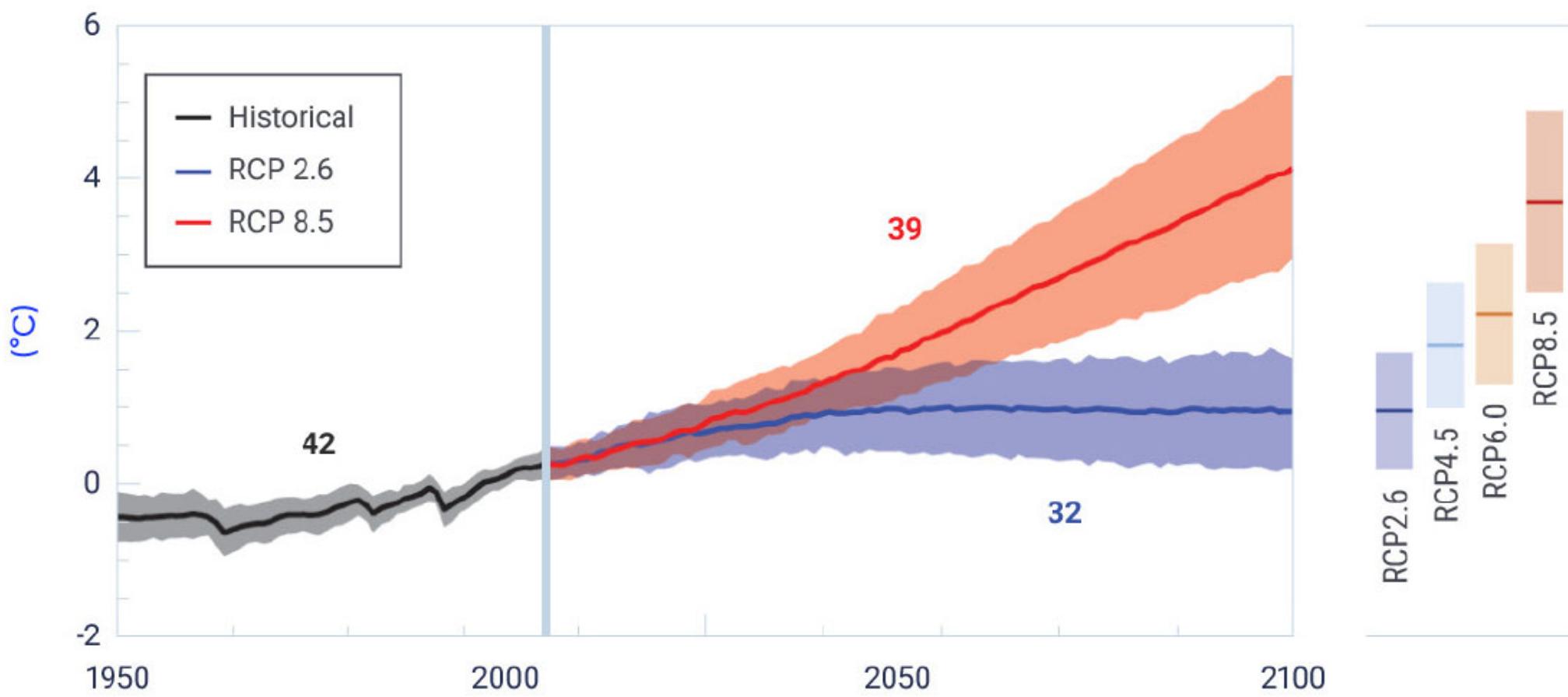
- Overload
- Impact
- Explosion
- Fire
- Seismic events



Structures can be damaged by extreme loading events

a) Global average surface temperature change
(relative to 1986–2005)

Mean over
2081–2100



'A new focus for us': Canada's building code being modernized to address climate change



The update is being done this year, and 'the major action will come in 2025,' says National Research Council

The Canadian Press · Posted: Jan 01, 2020 2:48 PM ET | Last Updated: January 3



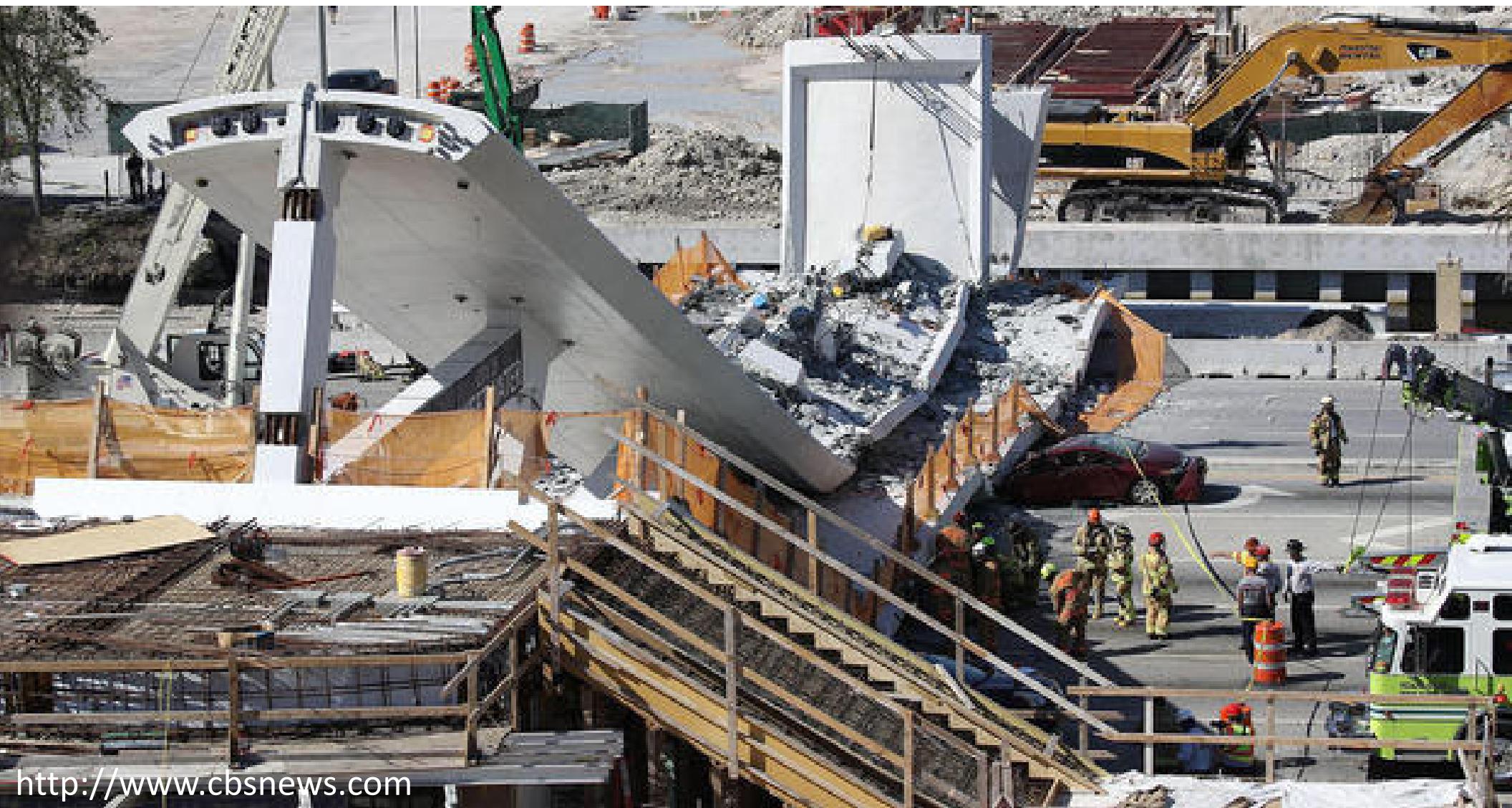
A man stands on a residential street surrounded by floodwaters in the town of Rigaud, Que., west of Montreal on April 21, 2019. The new code will upgrade building requirements for wind resistance and how buildings bear snow loads. (Graham Hughes/The Canadian Press)

A photograph of a cable-stayed bridge under construction. The bridge has a tall, light-colored central pylon from which multiple stay cables fan out to support the roadway. In the foreground, a concrete pier is visible, and the bridge deck appears to be incomplete or under construction. The background shows a line of trees and a clear sky.

Problems can arise
in construction

Problems can arise in construction

Miami Bridge Collapse, 2018



Accidents happen...



Burlington Skyway, 2014



www.cbc.ca



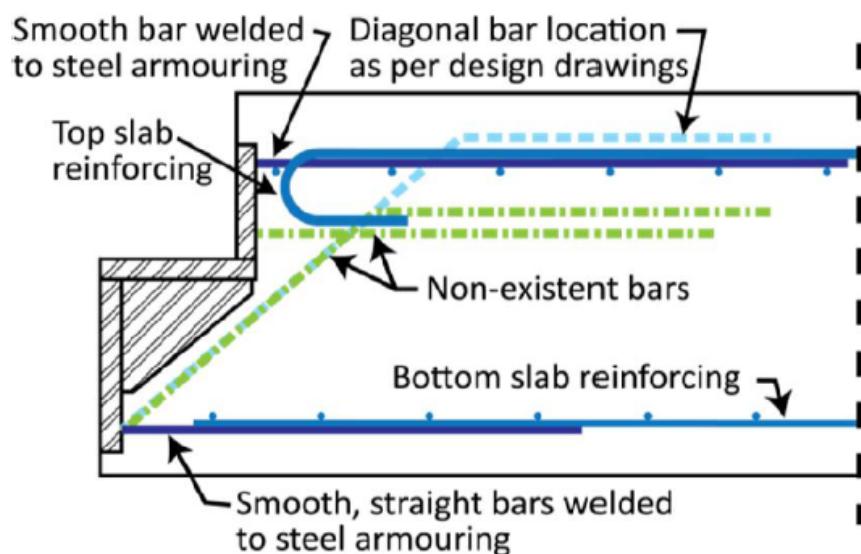
toronto.ctvnews.ca



Needs change over time...



We are still learning new things about the behaviour of structures



Challenges in the Evaluation of Existing Concrete Structures: Margaret Avenue Bridge, Habel, K.; Laaber, C.; Allen, S., IABSE Conference Geneva, 2015.

Rehabilitation : more than just “strengthening”

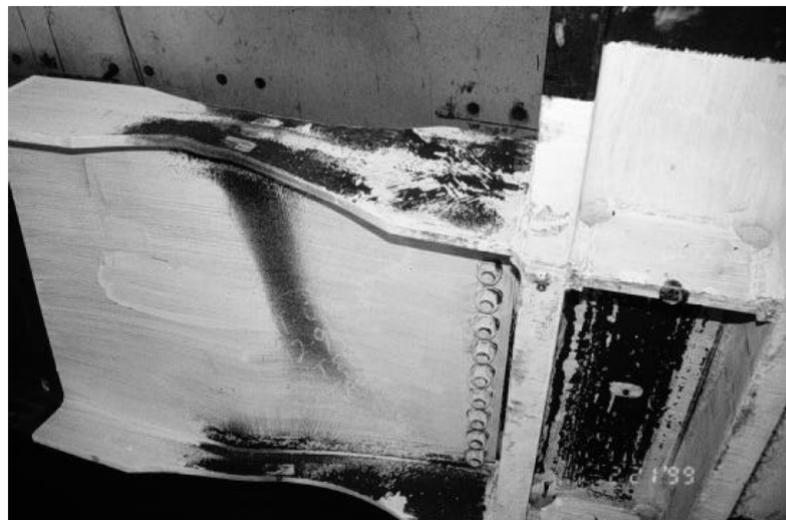
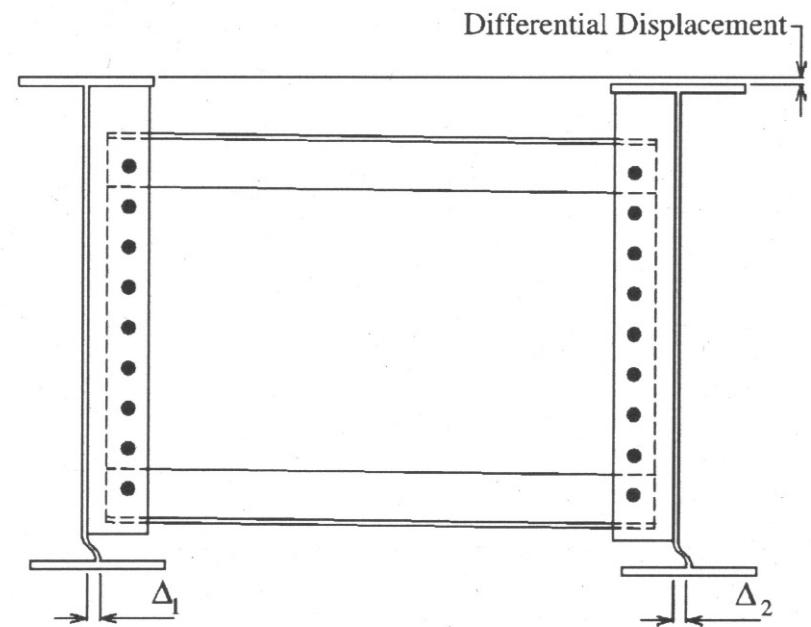
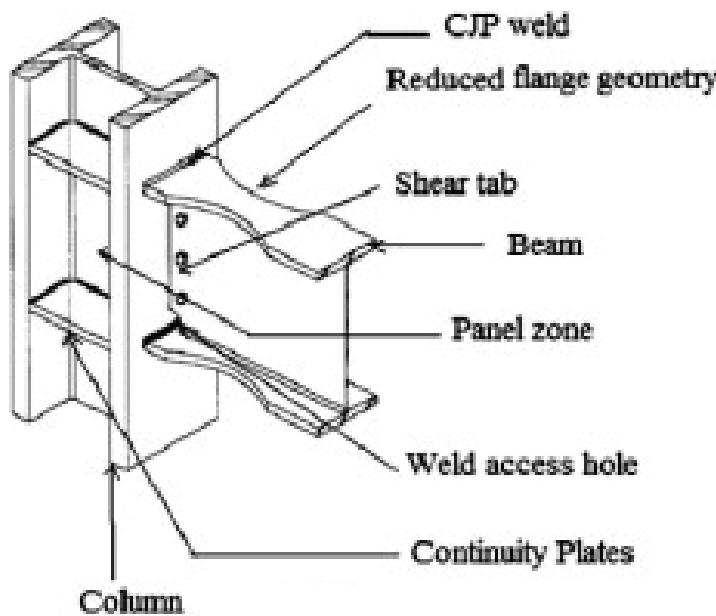
- Providing alternative load path
- Replacing damaged elements
- Stabilizing
- Softening
- Post-tensioning
- Additions
- Repurposing
- Posting load limits
- Reducing dead load
- Corrosion protection
- Surface treatment
- Damping
- Straightening

Construction

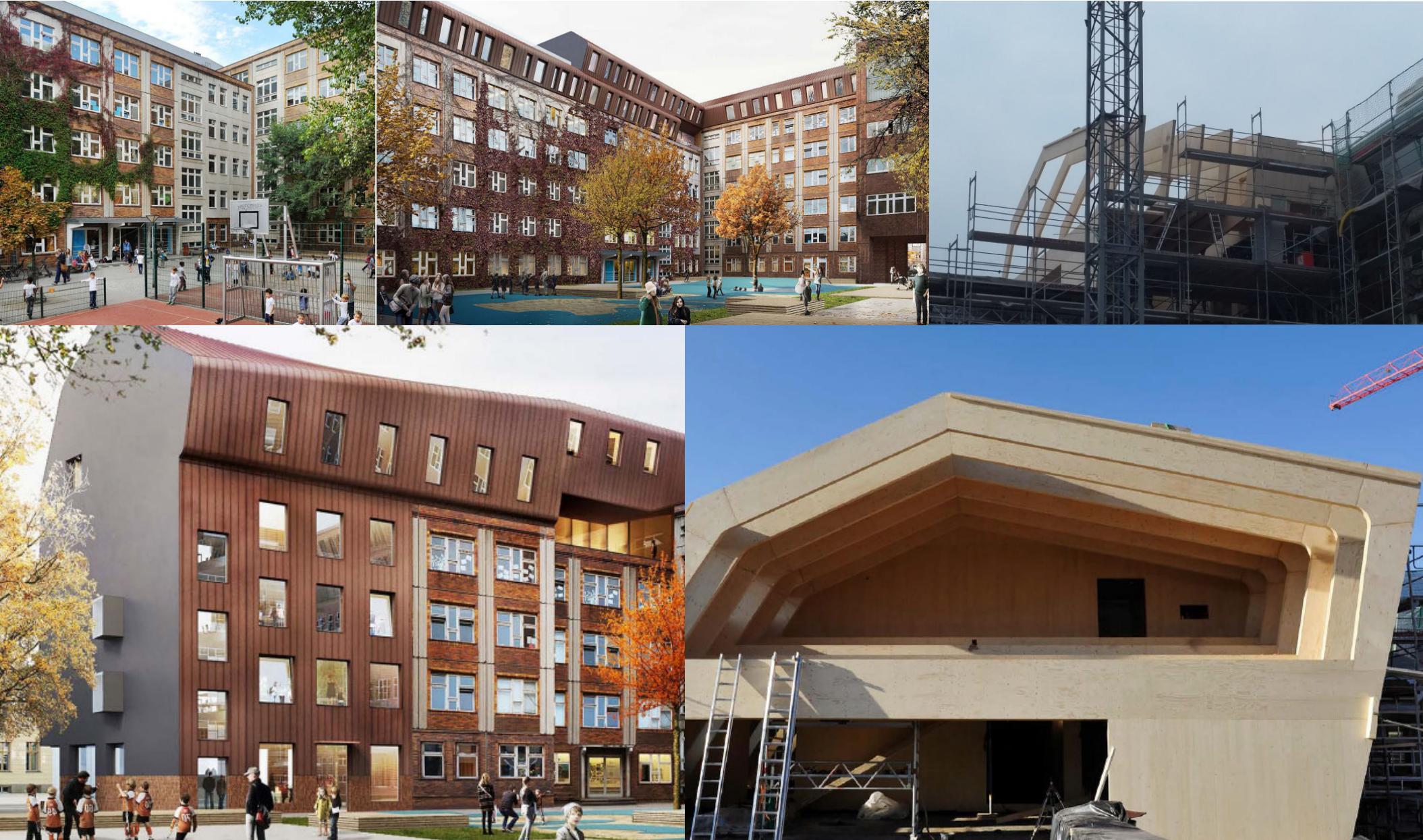
Strengthening



Softening



Additions

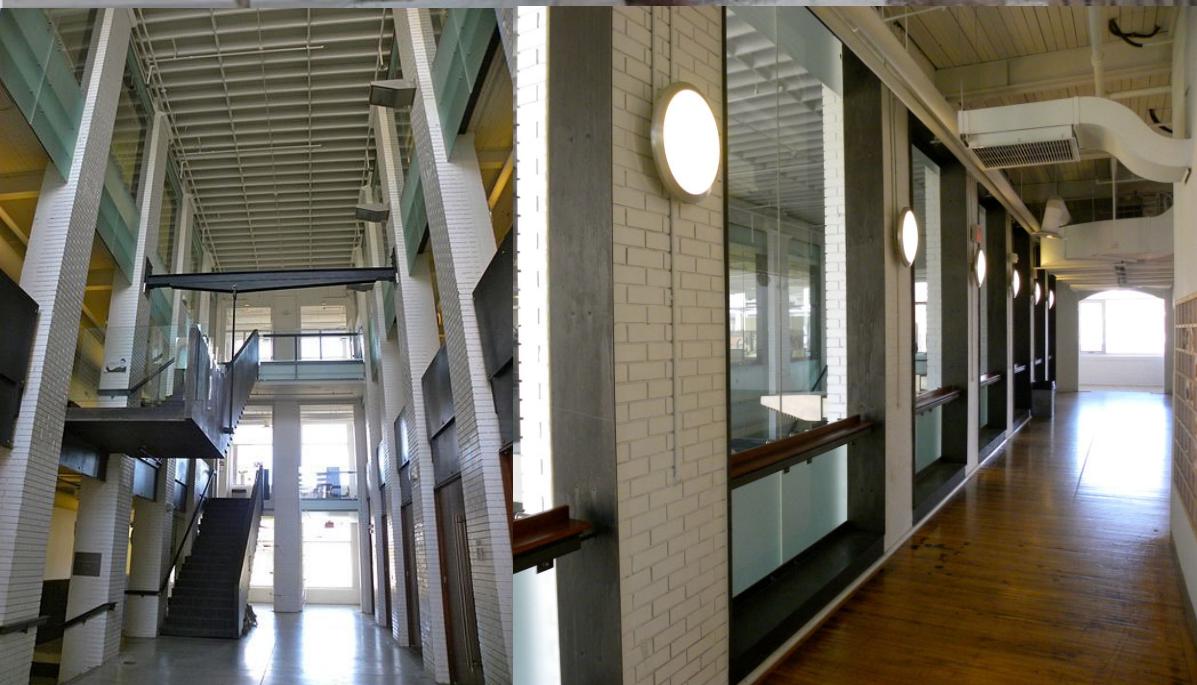


Additions



Cantilever Sidewalk
/ Bikepath Addition
North Carolina,
2002

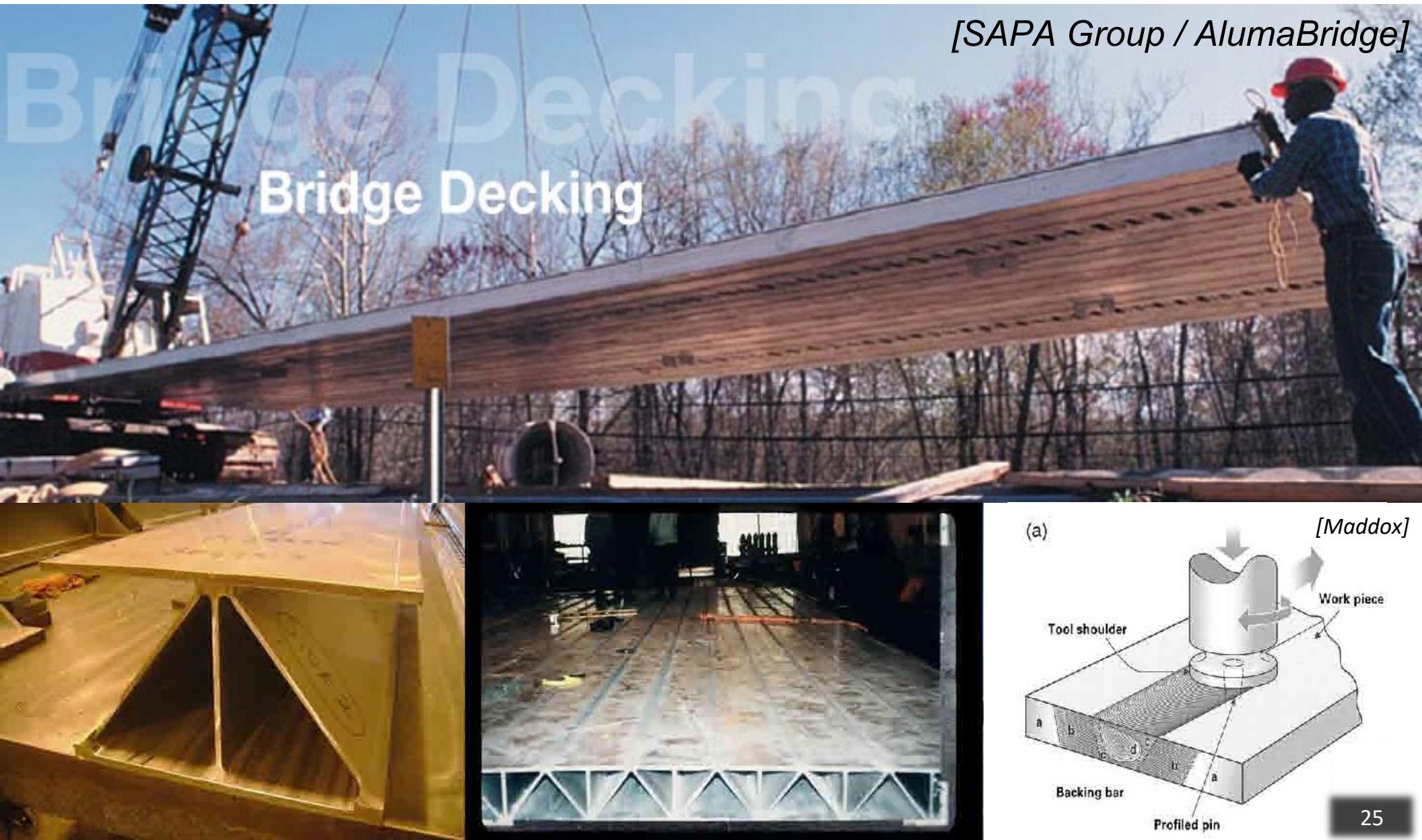
Repurposing



Posting load limits



Reducing dead load

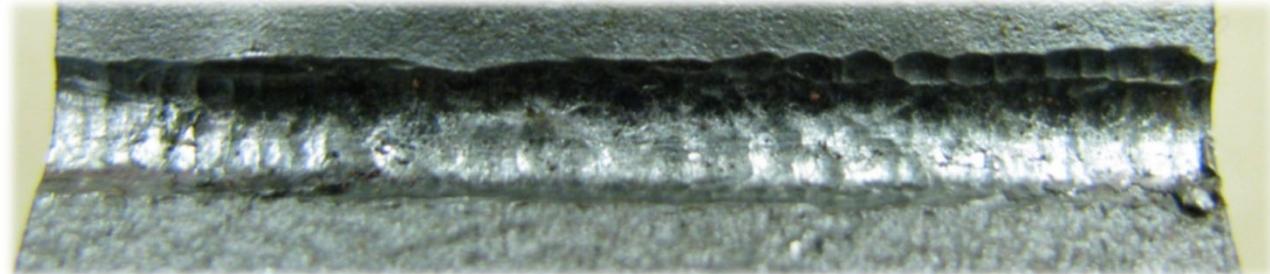
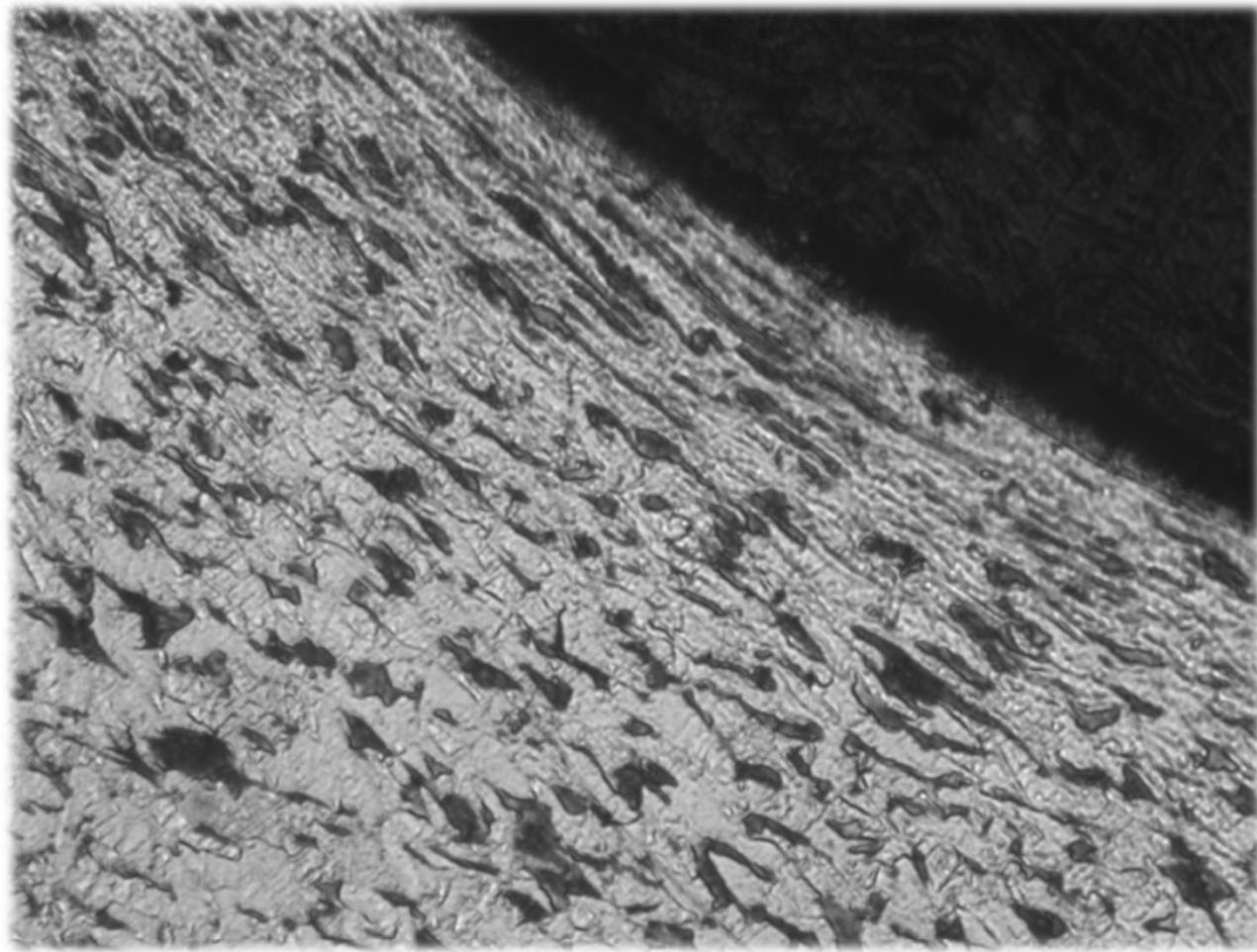
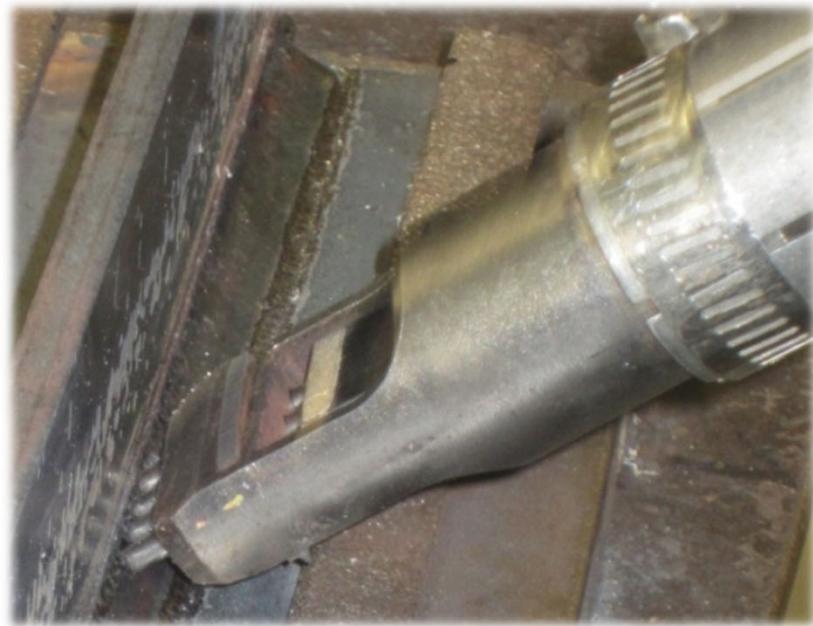


Corrosion protection

[Photos: CANAM, Vector]



Surface treatment



Damping

