RESILIENT BRIDGE SOLUTIONS

New Jersey Short Span Steel Bridge Workshop
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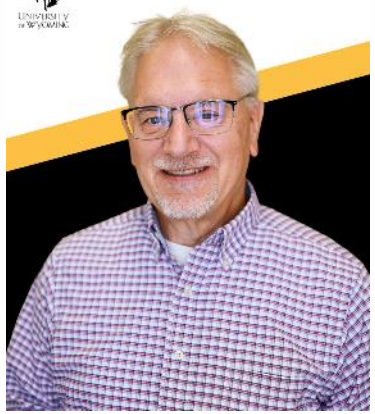
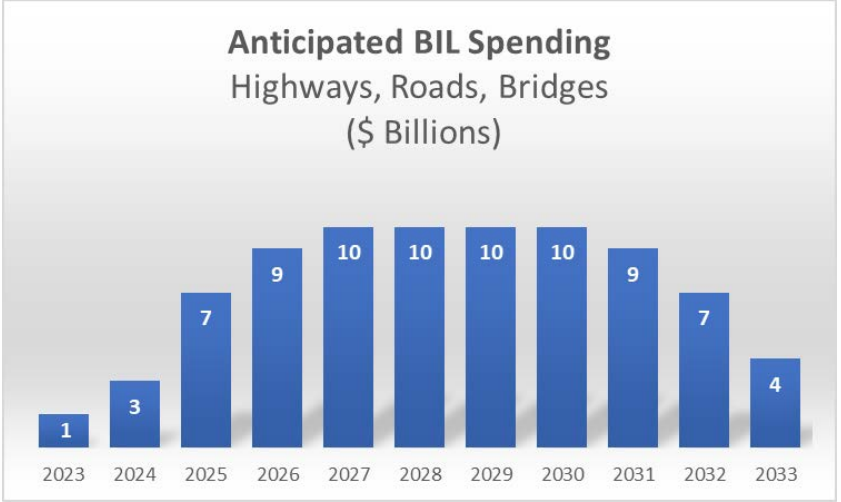


Resiliency – Infrastructure

- **Bipartisan Infrastructure Law**
  - $39.5 billion over 5 years to repair or replace as many as 15,000 bridges
  - Minimum 15% must be used to build off-system bridges



* Source: McKinsey Insights

- **PROTECT ($7.2 billion)**
  - BIL establishes the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Formula Program
    - Make surface transportation more resilient to natural hazards (support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure).

Resiliency

U.S. Department of Transportation
Federal Highway Administration

Challenge

Because of deterioration, individual bridge components and systems such as bearings, decks, joints, columns, and girders require frequent and costly inspections, maintenance, and repairs that are often difficult to conduct. These activities cause lane closures that create congestion and impact safety for road workers and motorists. Bridge engineers need improved design options so they can deliver bridges that are operational for 100 years or more.

What is a Resilient Bridge?

Learn more - https://www.shortspansteelbridges.org/steel-bridges-beyond-100-years

- Service Life & Life Cycle Performance – New Target is 100 Years Life
- Robustness for Unexpected Demands: Seismic, Natural, Man-Made
- Inspectable & Repairable
- Rehabilitation & Strengthening
- Sustainable

Resilience - Service Life & Life Cycle Performance

1000's of Steel Bridges Over 100 Years Old

Steel Bridge Longevity

- Practical and Effective Design
- Durable Materials
- Inspection, Maintenance & Repair
- Corrosion Protective Systems – Steel Chemistry and Protective Coatings

Service Life & Life Cycle Performance

As an Example: 95 ft Simple Span, 5 Plate Girders

Weathering Steel with Painted Ends

Integral Abutments – No Joints

Bolted Diaphragms/Cross-Frames - Fatigue

How Long Will This Bridge Last?

Steel Bridge Longevity

- Practical and Effective Design
- Durable Materials
- Inspection, Maintenance & Repair
- Corrosion Protective Systems – Steel Chemistry and Protective Coatings

Resilience - Robustness for Unexpected Demands

Steel bridge robustness is a bridge's ability to withstand damage and maintain its structural integrity, especially in the face of unexpected events or local failures: **Seismic, Natural, Man-Made**

- **Ductility**

Steel can deform significantly without breaking

- **Redundancy**

Alternate load paths and ability for load redistribution

- **Lightweight Yet Strong**

Steel structures are lighter, reducing seismic forces

- **Bolted and Welded Connections**

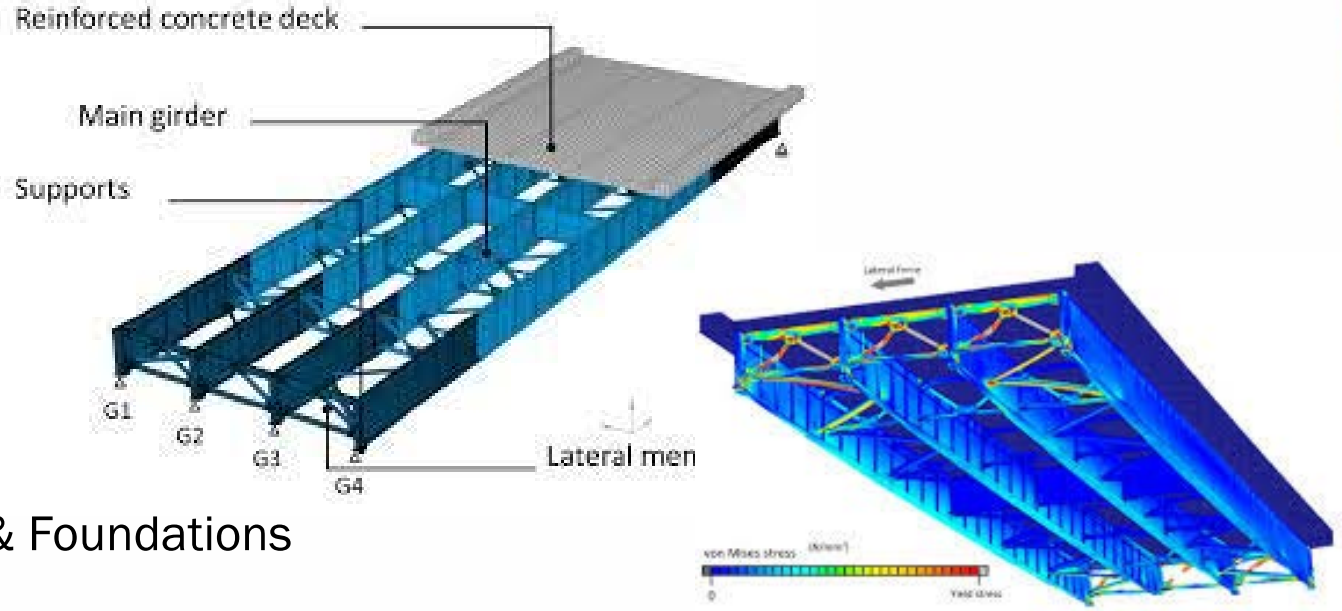
Steel bridges use high-strength bolted or welded joints

- **Ease of Retrofitting**

Steel bridges can be easily repaired, rehabilitated & retrofitted

Robustness for Unexpected Demands

Seismic: Survivability & Service



High Ductility
- Energy Absorption & Dissipation
- Prevents Brittle Fracture and Collapse

Lighter Self-Weight
- Smaller Inertial Forces
- Reduces Demand on Abutments, Piers & Foundations

Strong & Reliable Connections
- Bolted/Welded
- Designed for Seismic Distortions

Redundancy
- Alternate Load Paths
- Redistribution of Force Effects

Kobe, Japan (1995): Many modern steel bridges survived with repairable damage.

Northridge, USA (1994): Minor local damage, many bridges remained operational.

Chile (2010): Steel bridges demonstrated strong resilience and quick post-quake recovery.

Resilience - Inspectable & Repairable

Structural Steel Bridge Damage or Deterioration

- Overload
- High or wide vehicle collision
- Fire
- Structural vandalism
- Fatigue
- Corrosion

Accessibility - Exposed structural components

Ease of Nondestructive Testing (NDT)

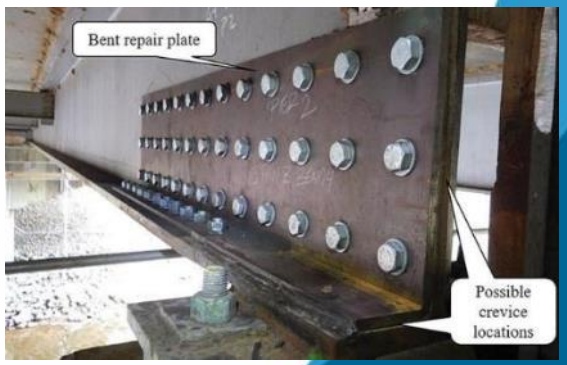
Steel is compatible with NDT techniques

Repairable Characteristics of Steel Bridges

Modular Repairs of Damaged sections

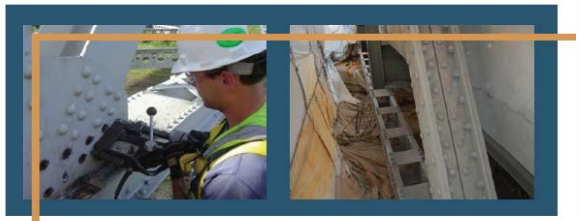
Fatigue Management Fatigue cracks can be fixed

Corrosion Repair repainted or metalized



Inspectable & Repairable

Inspectable



Guidelines for Field Repairs and Retrofits of Steel Bridges
G14.2—2023

AASHTO/NSBA STEEL BRIDGE COLLABORATION
American Association of State Highway and Transportation Officials
National Steel Bridge Alliance

Inspectable & Repairable

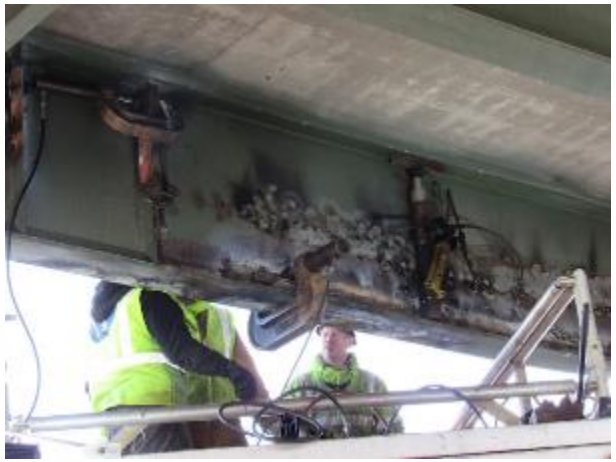
Overheight Bridge Strikes:
The National Highway Traffic Safety Administration reports an average of 15,000 such incidents a year

Repairable - Heat Straightening, Kansas 2018

https://kansastransportation.blogspot.com/2019/02/hot-news-damaged-steel-bridge-girders.html

Damaged steel bridge girders can be repaired

Distortions were deemed repairable
Heat straightening process to repair
Clamps and hydraulic jacks used to help influence the return of the steel to its former shape
Seven days of the heat straightening

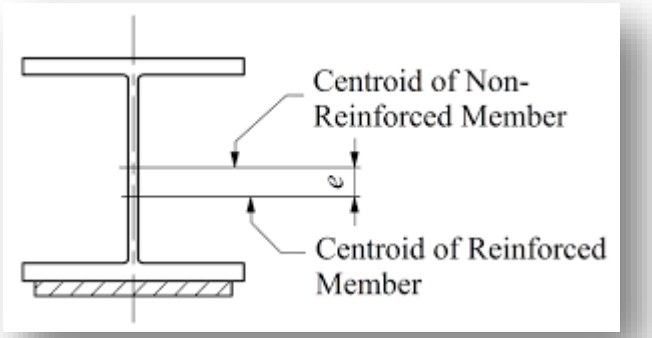


Cool Oklahoma State Video at https://www.aisc.org/nsba/design-and-estimation-resources/preservation-and-repairability

Resilience - Rehabilitation & Strengthening

Rehabilitation & Strengthening

- Extend service life
- Restore or increase load capacity
- Prevent or mitigate corrosion and fatigue
- Upgrade for seismic or traffic demands
- Improve safety and user experience



Rehabilitation & Strengthening

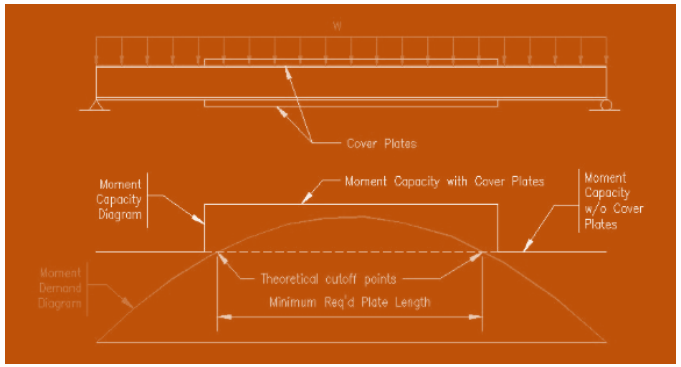
Strengthening

Why?

- Traffic Loads/Postings
- Corrosion Reduced Capacity

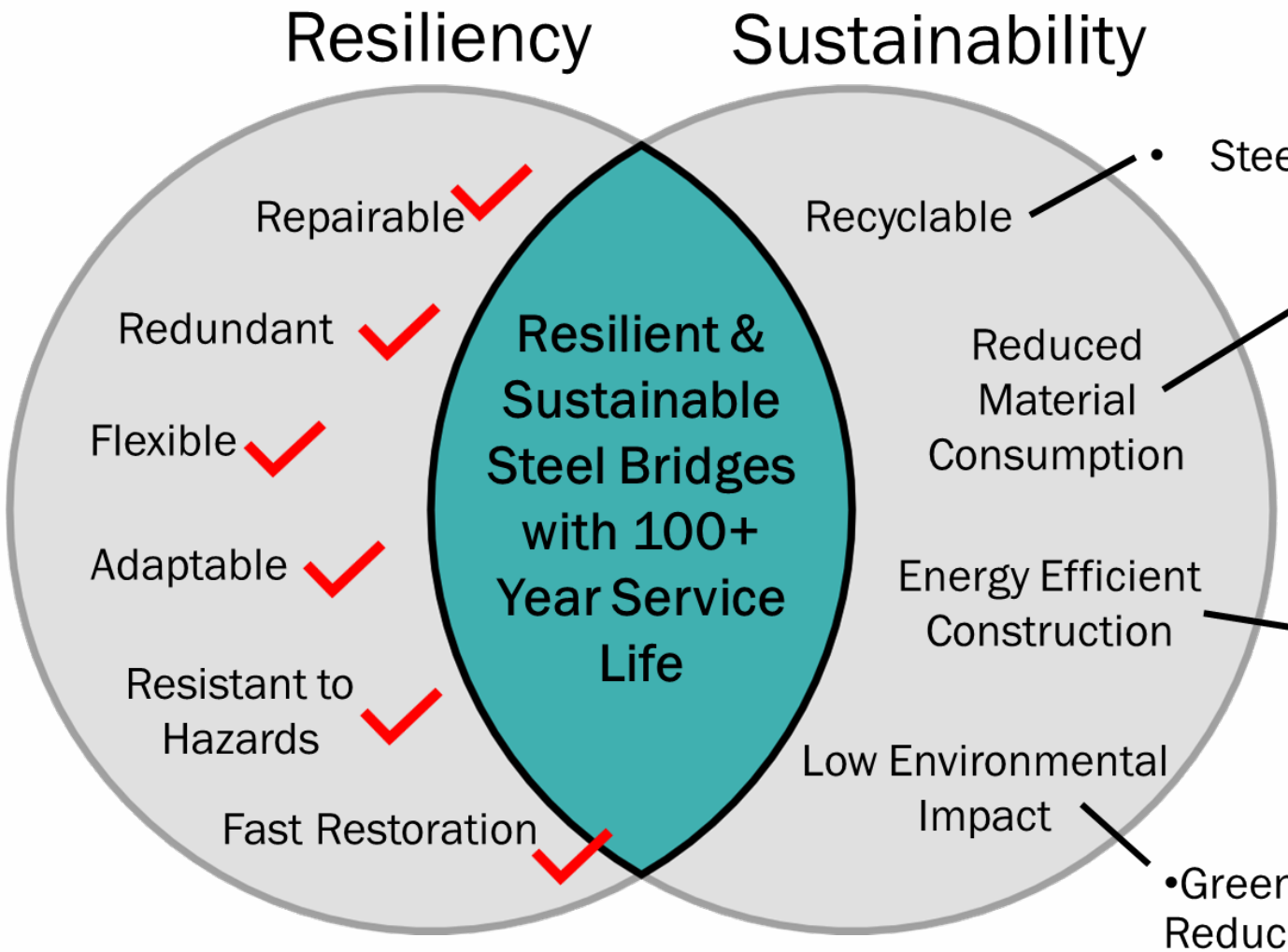
How?

- Adding Steel (Flanges/Webs)
- Replace Deteriorated Members
- Add Composite Action
- Reduce Dead Loads
- Post-Tensioning



Resilience - Sustainable

Crossover Between Resiliency & Sustainability



- Steel is North America's #1 Recycled Material
- High Strength to Weight Ratio
- Optimal Weight while Maintaining Strength, Durability & Safety
- Recycled Steel Conserves Energy, enough to power 18 million homes
- Steel's Energy Use Reduced 33% Since 1990
- Greenhouse Gas Emissions Reduced by 45% since 1975

Steel Advantages for Resiliency

- **Long Service Life**
  - Thousands of 100-year-old steel bridges still in service.
  - Innovative new systems have life expectancy of 100+ years.
- **Robustness, Strength and Durability**
  - High strength-to-weight ratios, which allows steel bridges to resist structural damage.
  - Ductile, Redundant and Robust Structure
- **Ease of Inspection/Repair**
  - Signs of problems are clearly apparent at an early stage, making steel bridges easier to inspect and repair.
- **Rehabilitation & Strengthening for Increased Loads**
  - Quickly rehabilitate & strengthen a steel bridge, while keeping the bridge in service with minimal traffic disruption.
- **Sustainability:** >90% Steel is from Recycled Material

Quiz

An Owner Should Be able to Expect a 100 Year Life Span for a Typical Steel Girder Bridge

a. True
b. False

True –

Practical & Effective Design (Details and Joints)

Durable Materials (Chemistry) & Corrosion Protection Systems

Inspectability, Maintenance & Repair

Quiz

Approximately What percentage of Steel is Made From Recycled Products?

a. 0% - it is Raw Iron Ore & Element Additives
b. 70%
c. 90%
d. 132%

Quiz

There was a Lot of Information Presented in Today's Workshop. For More Information on Any Steel Bridge Topic, a Person Could Contact (Select All That Apply):

a. The Short Span Steel Bridge Alliance (www.ShortSpanSteelBridges.org)

b. The National Steel Bridge Alliance (www.AISC.org/NSBA)