Characterization of Bridge Deck and Culvert Deterioration in Western States using NBI Data

Western Bridge Engineers' Seminar 2023

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Project Objective

- Analyze the deterioration of concrete bridge decks and culverts between 1992 and 2022 using the NBI database in:
  1. Alaska
  2. California
  3. Idaho
  4. Nevada
  5. Oregon
  6. Washington
  7. Arizona
- Concrete deck deterioration is the principal cause of bridge superstructure repairs and rehabilitation.

NBI Data - Overview

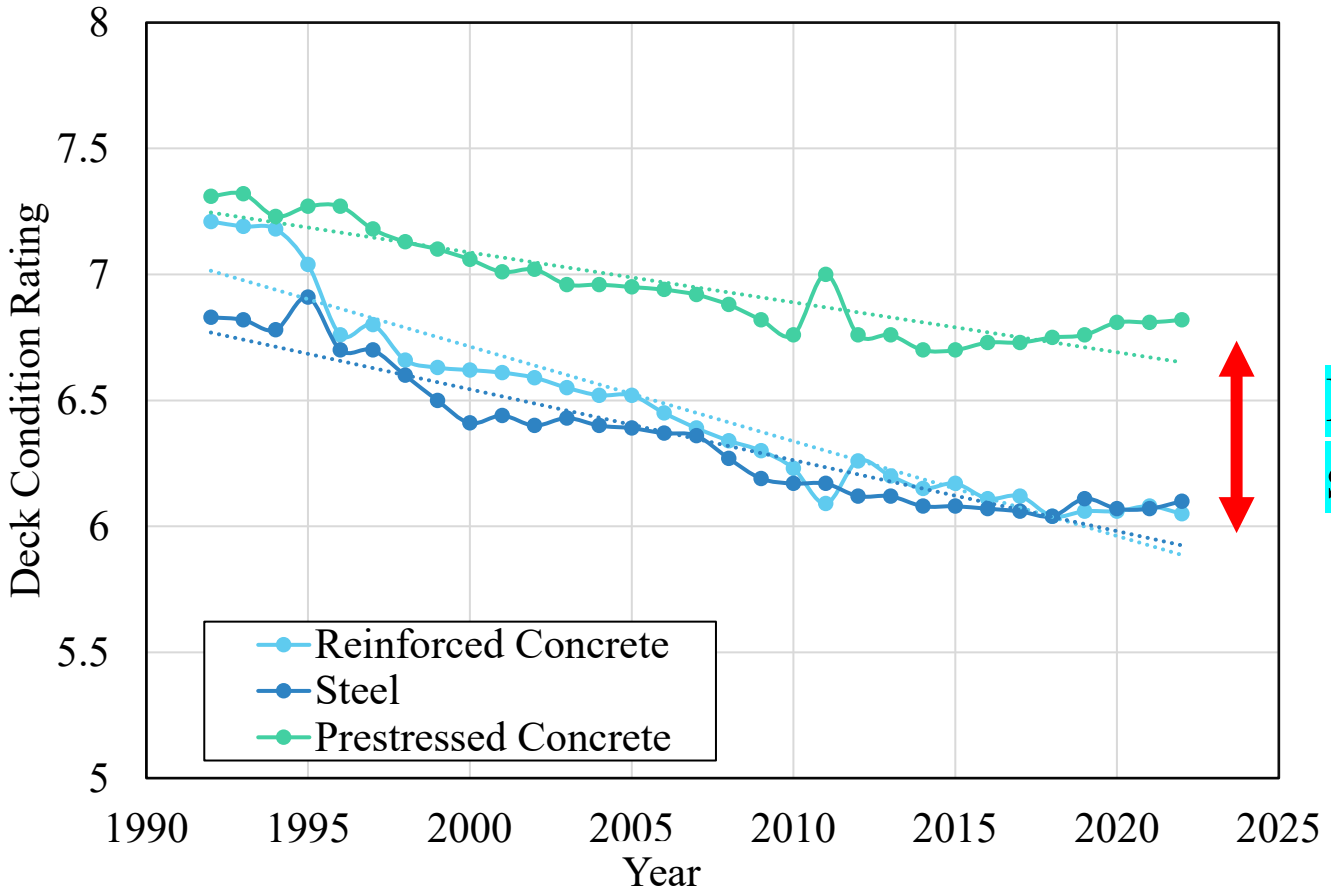
- NBI Condition Scale, from 0 → 9
  - "0" denoting a failed condition and "9" denoting excellent condition
- NBI Item Coding
  - Deck → NBI Item 58
  - Culvert→ NBI Item 62
- Variables investigated:
  - Girder superstructure material (NBI Item 43A)
  - Superstructure cross-sectional geometry (NBI Item 58 or 62)
  - Average daily traffic (ADT) (NBI Item 29)
  - Wearing surface material (NBI Item 108A)

NBI Data – Variables Investigated

- Girder superstructure material
  - Reinforced concrete girders (Code 1)
  - Steel girders (Code 3)
  - Prestressed girders (Code 5)
- Superstructure cross-sectional geometry
  - Slab
  - Girder/Stringer
  - Culvert
  - Multiple or single box beam
- ADT
  - ADT $\leq$ 5000
  - 5000 < ADT < 10,000
  - ADT $\geq$ 10,000
- Wearing surface material (NBI Item 108A)
  - Monolithic concrete
  - Bituminous
  - Wood or Timber

Arizona → 7794 bridges (4307 culverts) (2022)

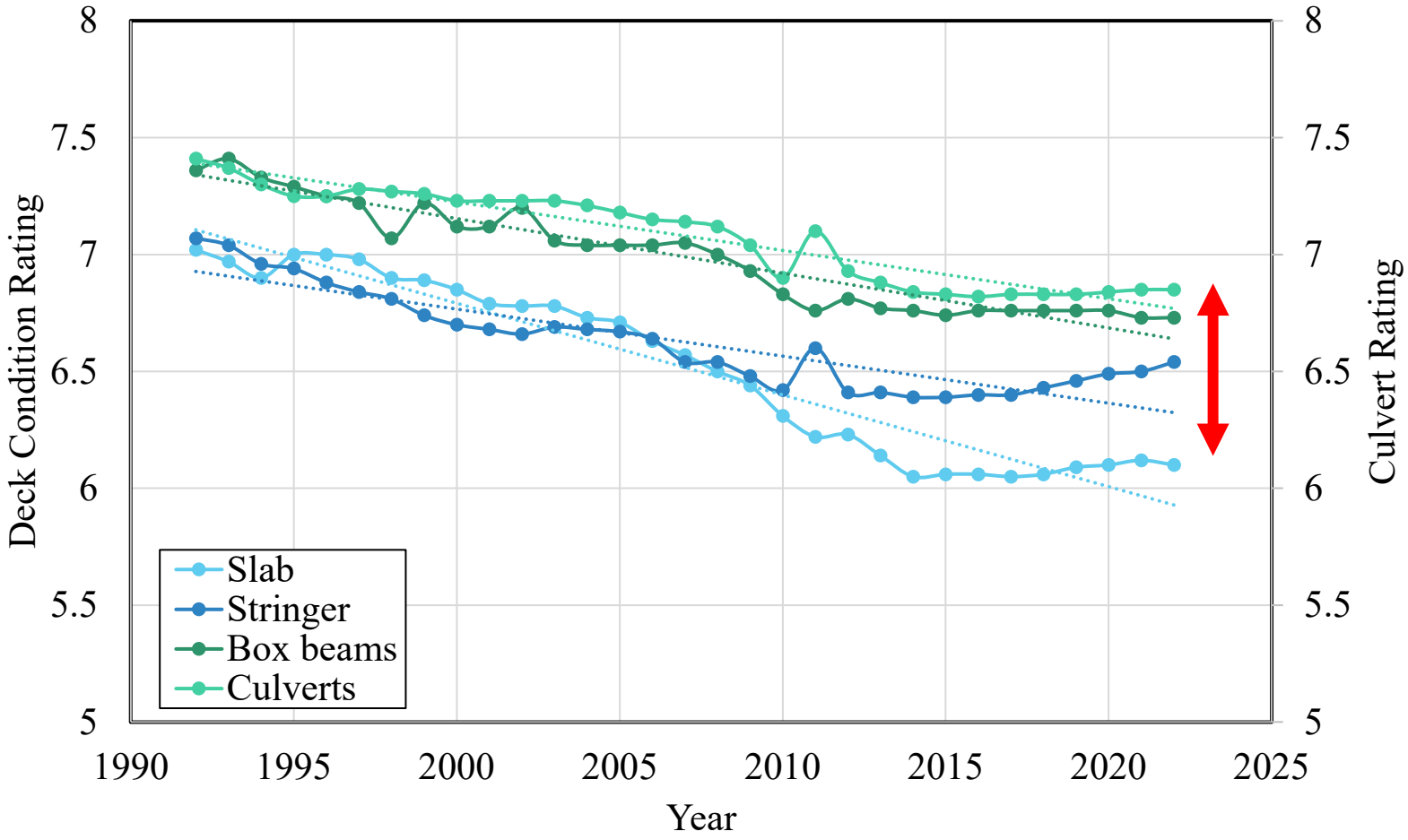
Girder superstructure material



Prestressed concrete >
steel and reinforced concrete

Arizona

Superstructure cross-sectional geometry

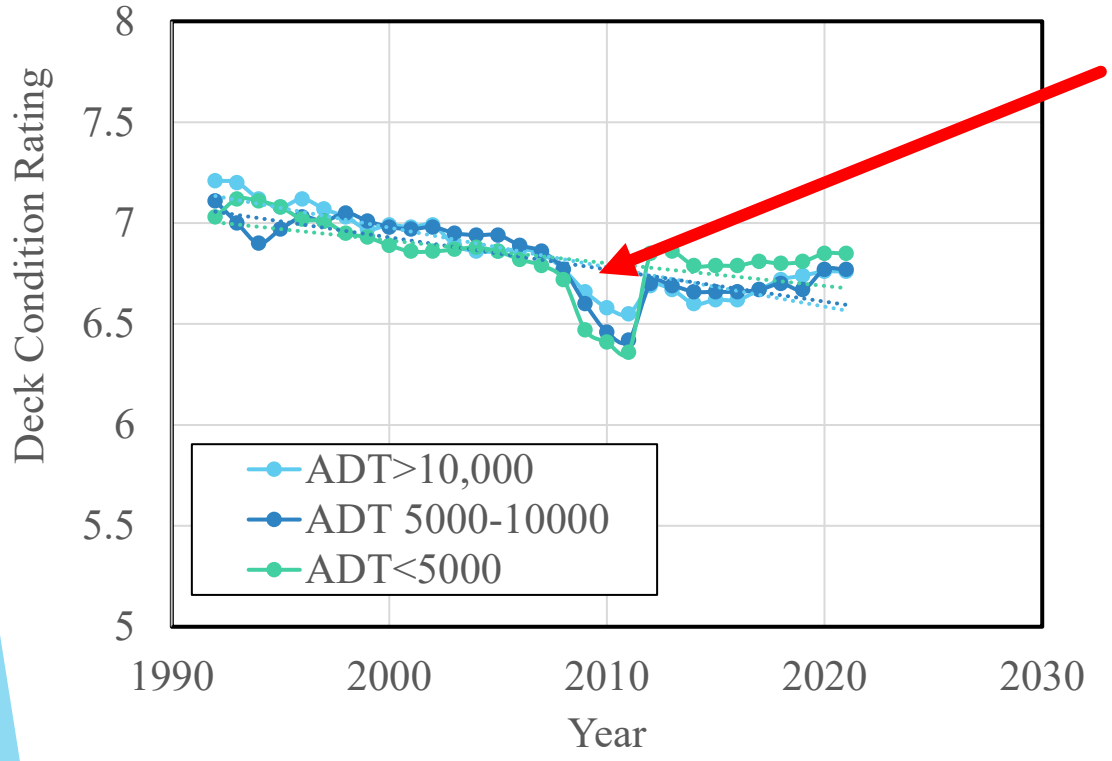


Culverts > common bridges

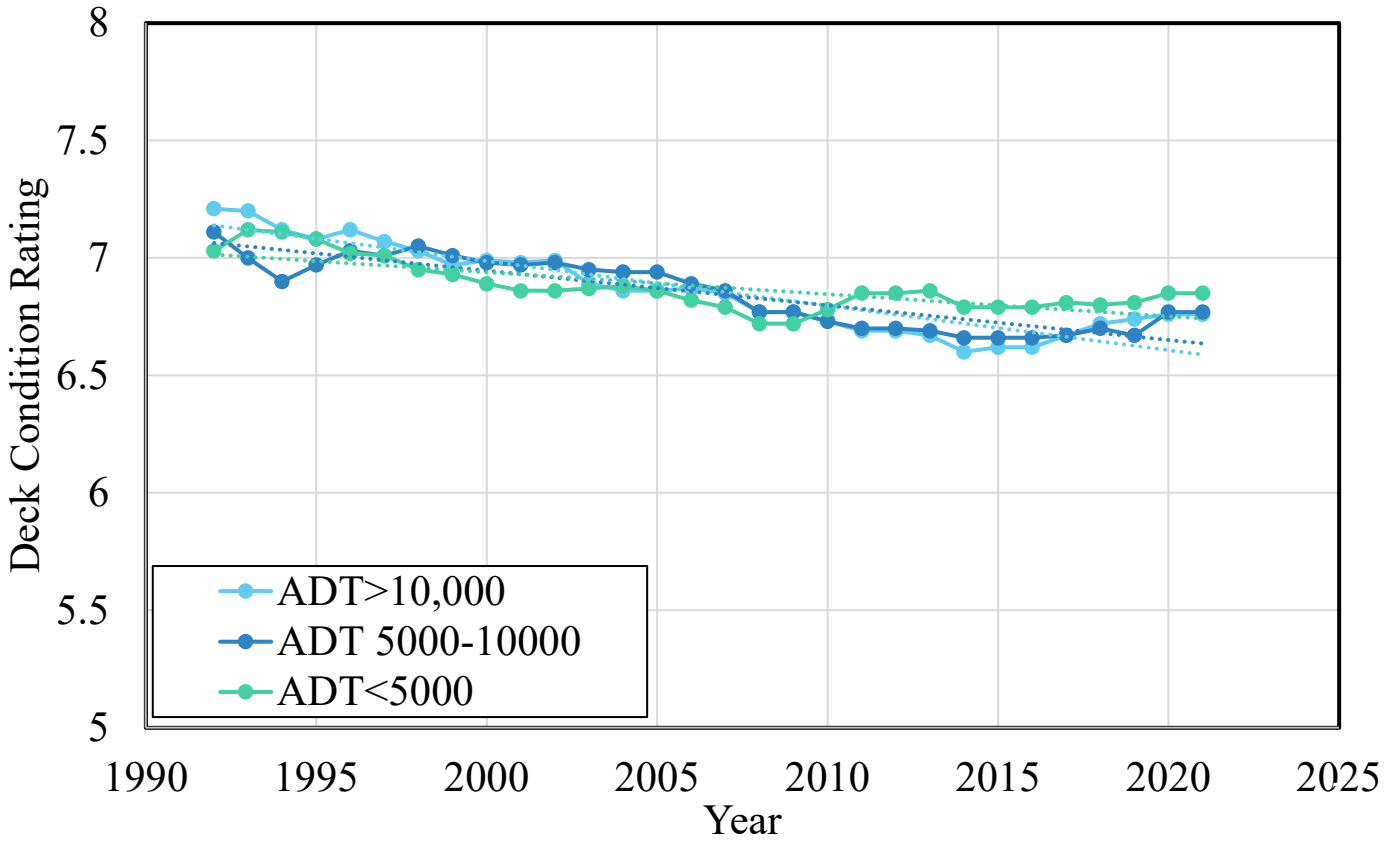
Box beams > girder > slab

Arizona

ADT

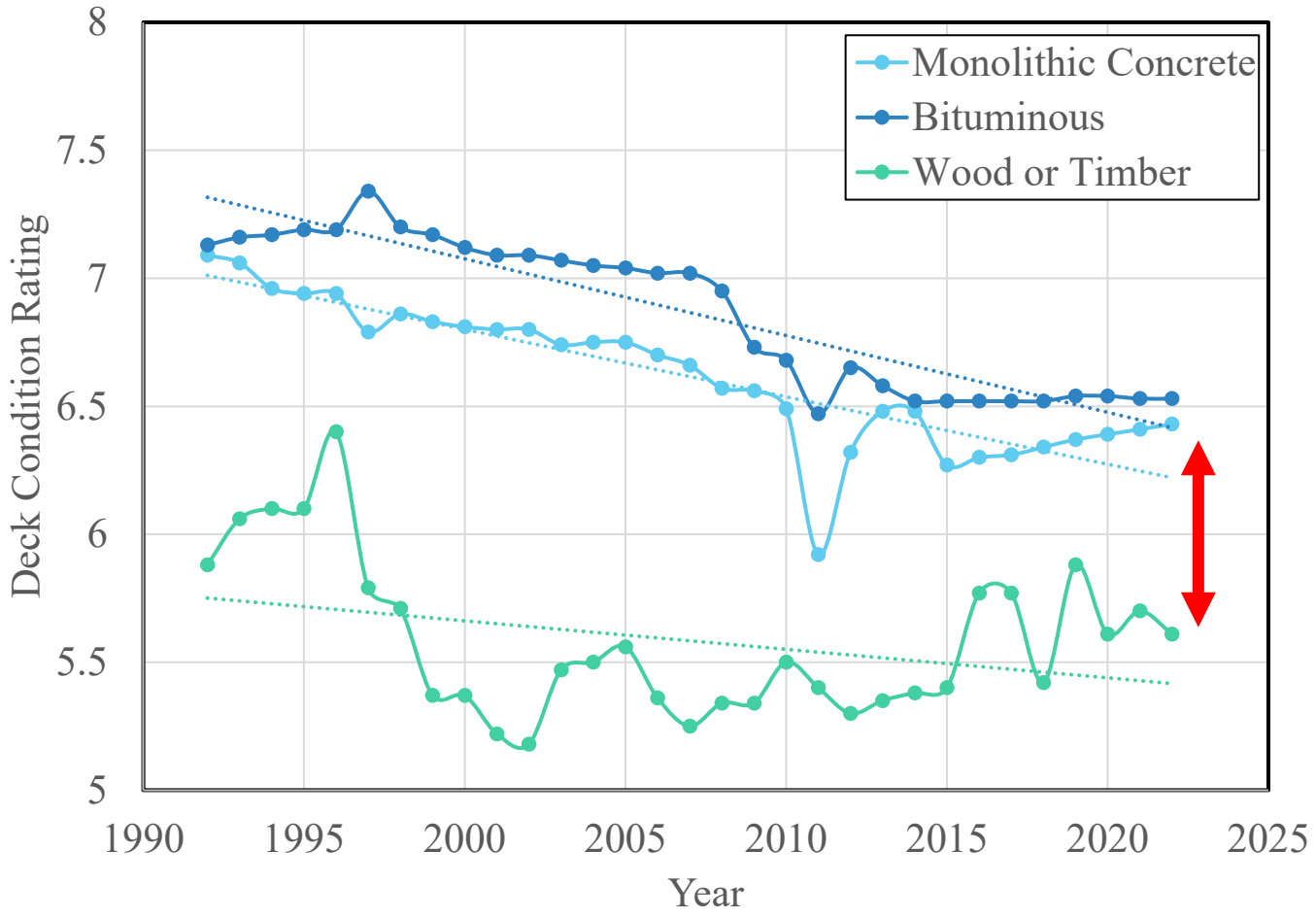


Outliers removed



Arizona

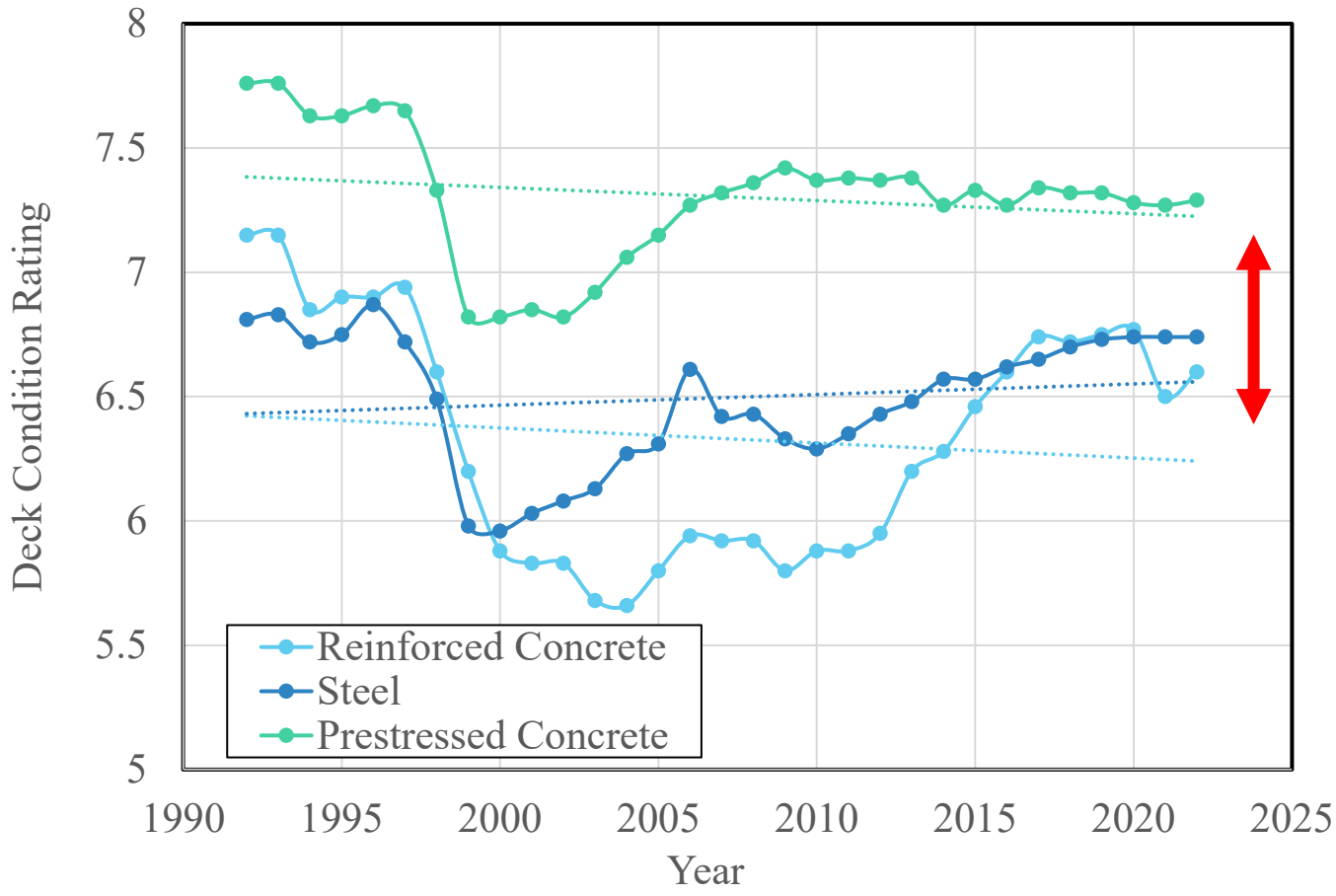
Wearing surface material



Bituminous & concrete > wood

Alaska → 1517 bridges (2022)

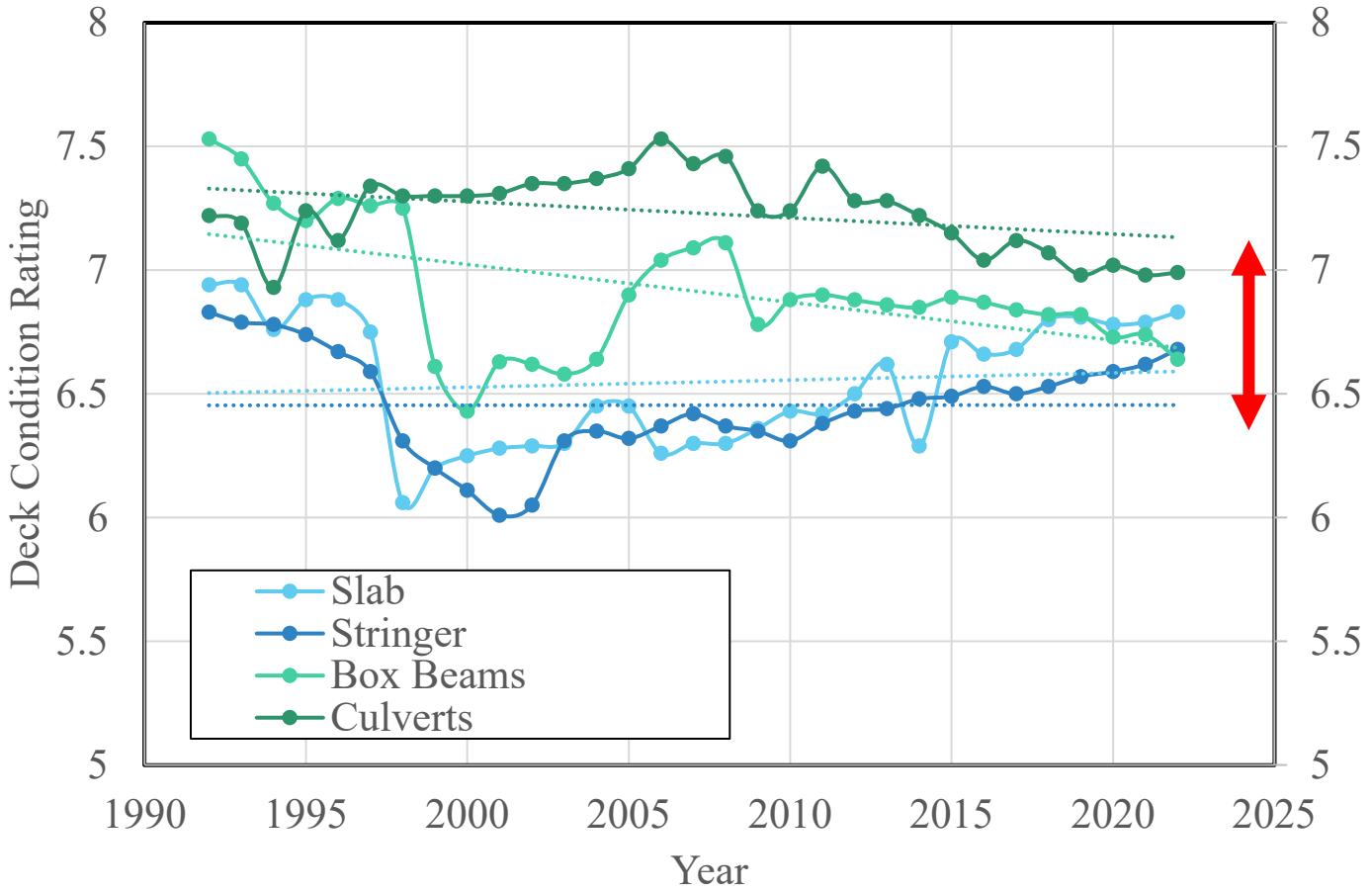
Girder superstructure material



Prestressed concrete > steel and reinforced concrete

Alaska

Superstructure cross-sectional geometry

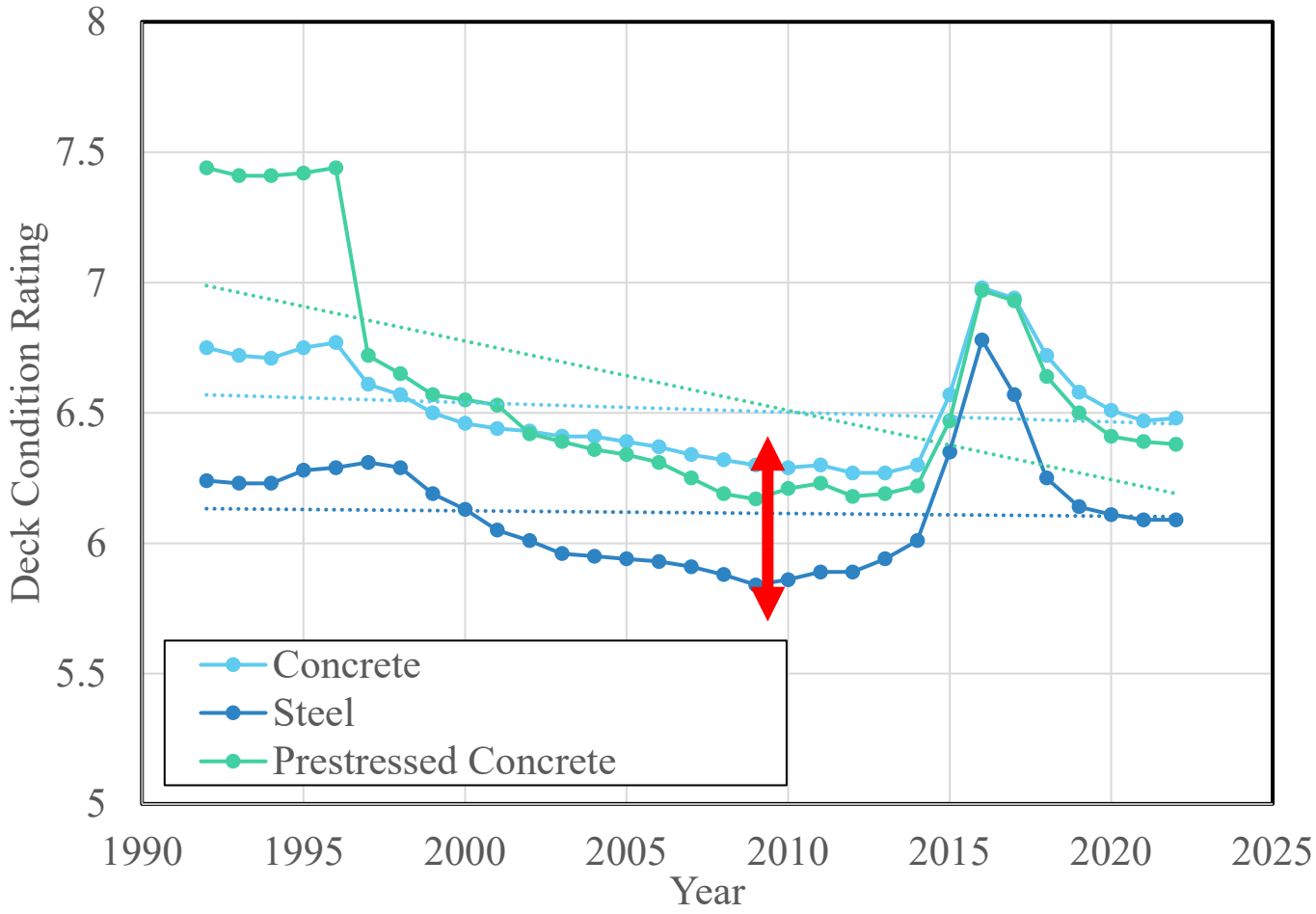


Culverts > common bridges

Box beams > girder > slab

California → 25,811 bridges (3536 culverts) (2022)

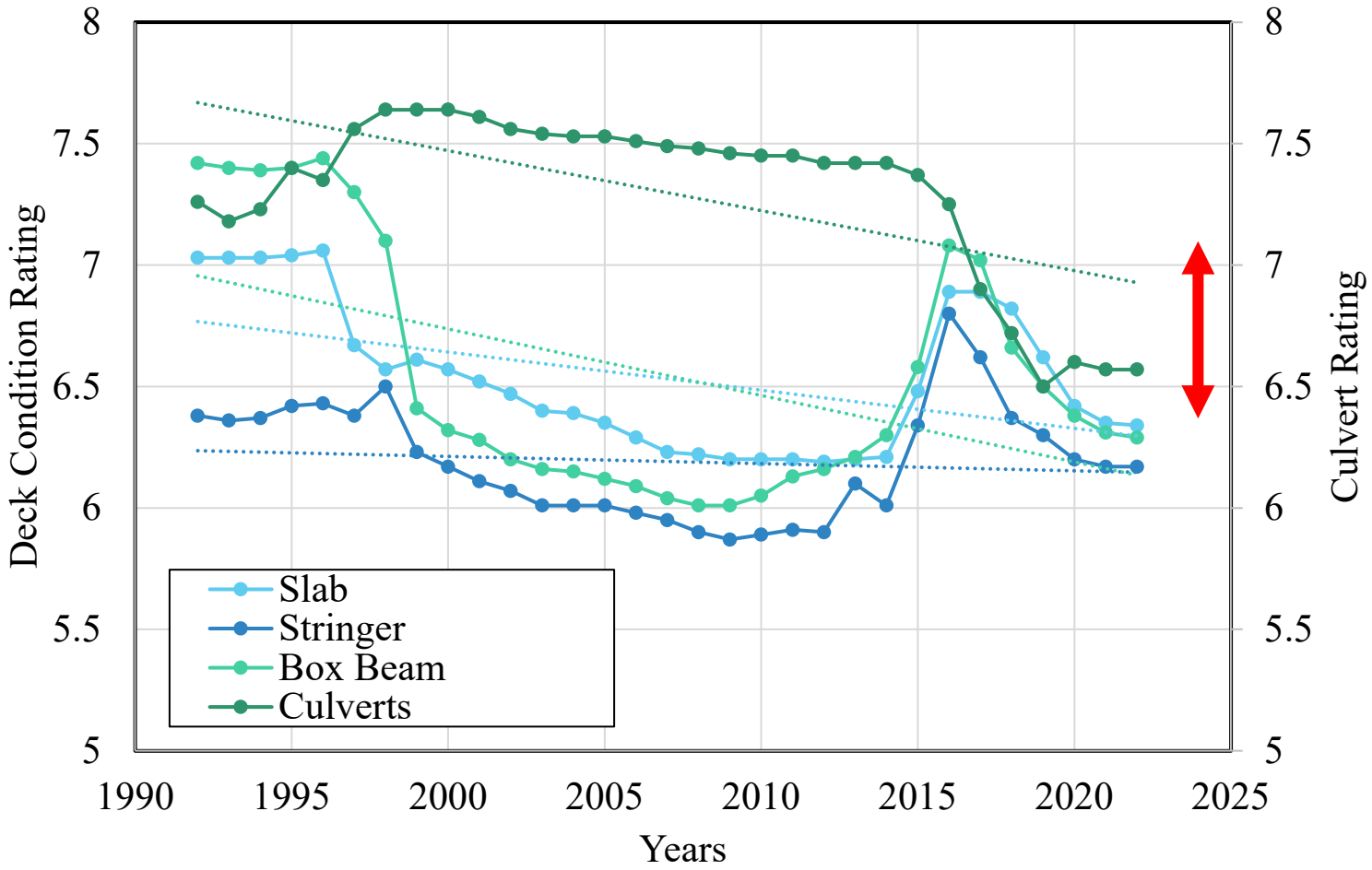
Girder superstructure material



Concrete > steel

California

Superstructure cross-sectional geometry

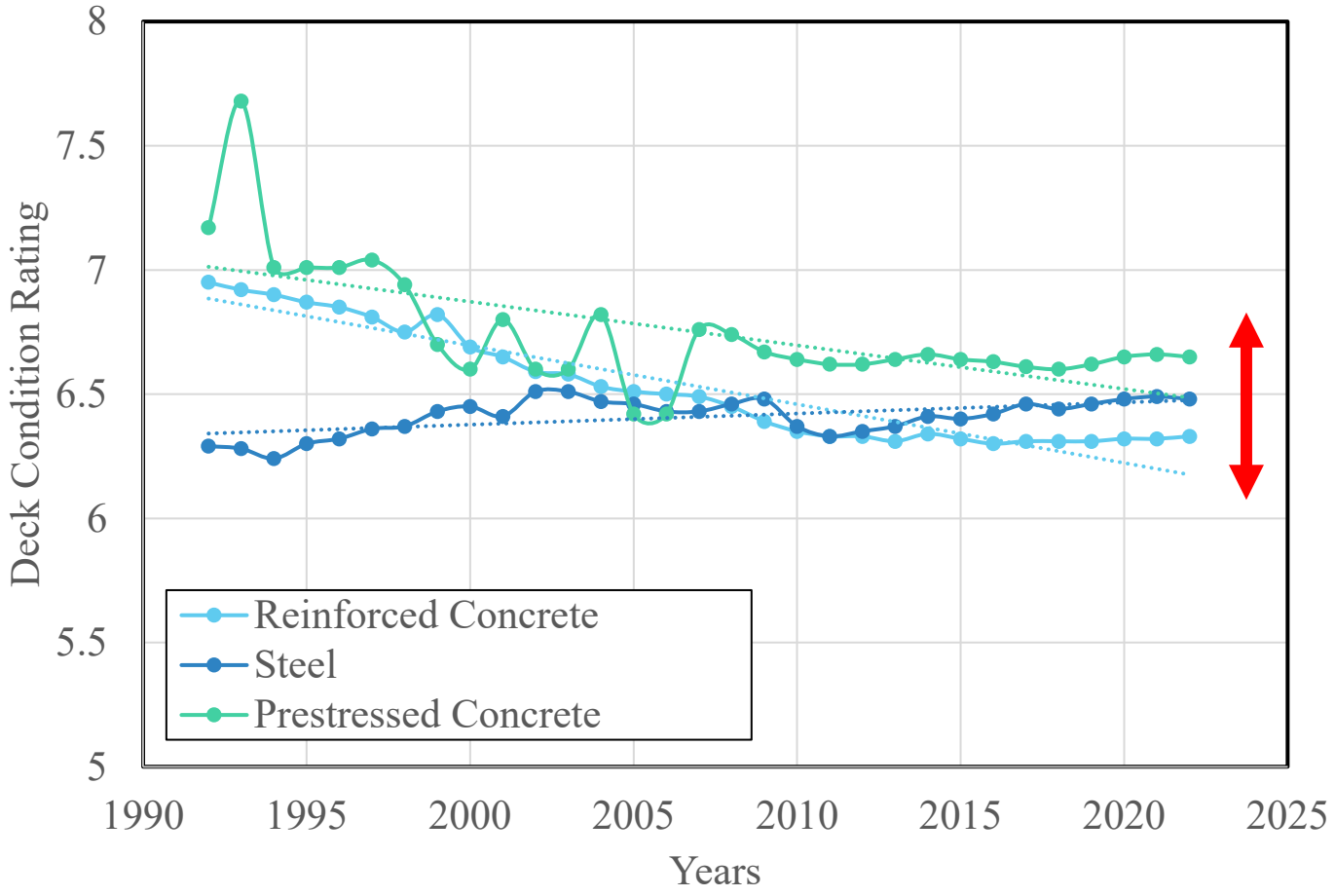


Culverts > common bridges

Slabs > box beams > girder

Idaho → 4580 bridges (2022)

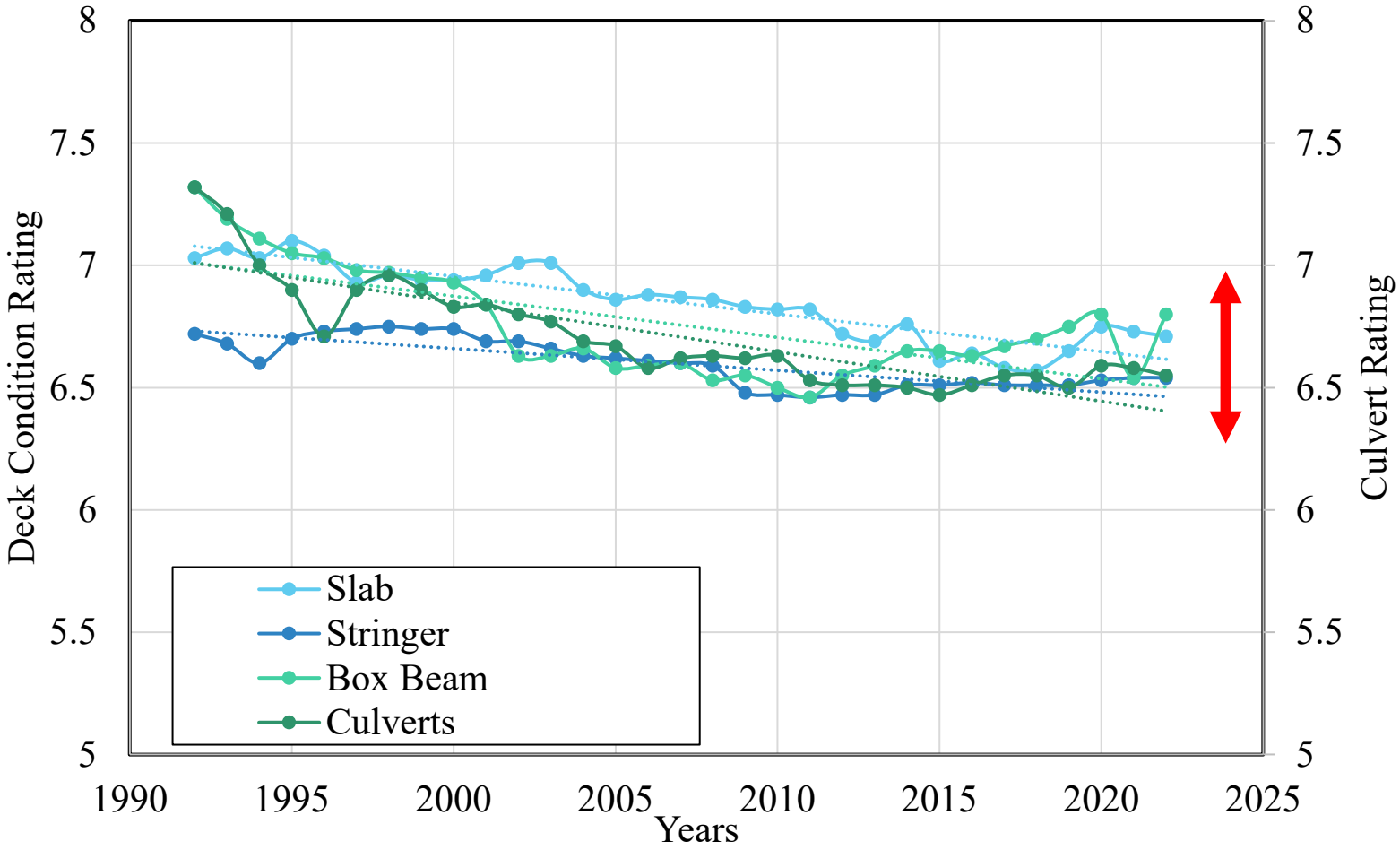
Girder superstructure material



Prestressed concrete > steel and reinforced concrete

Idaho

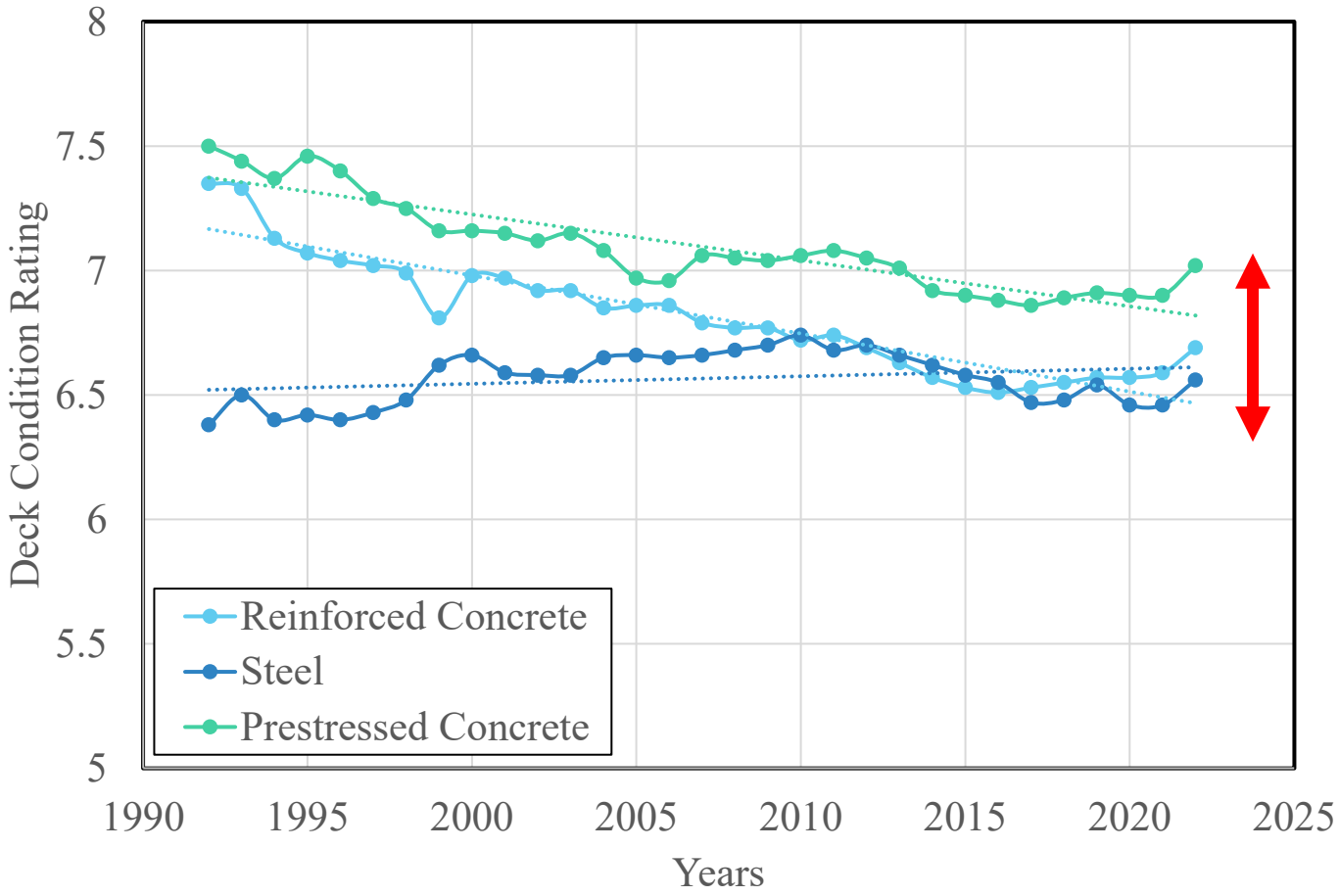
Superstructure cross-sectional geometry



Slabs > other types

Nevada → 1431 bridges (2022)

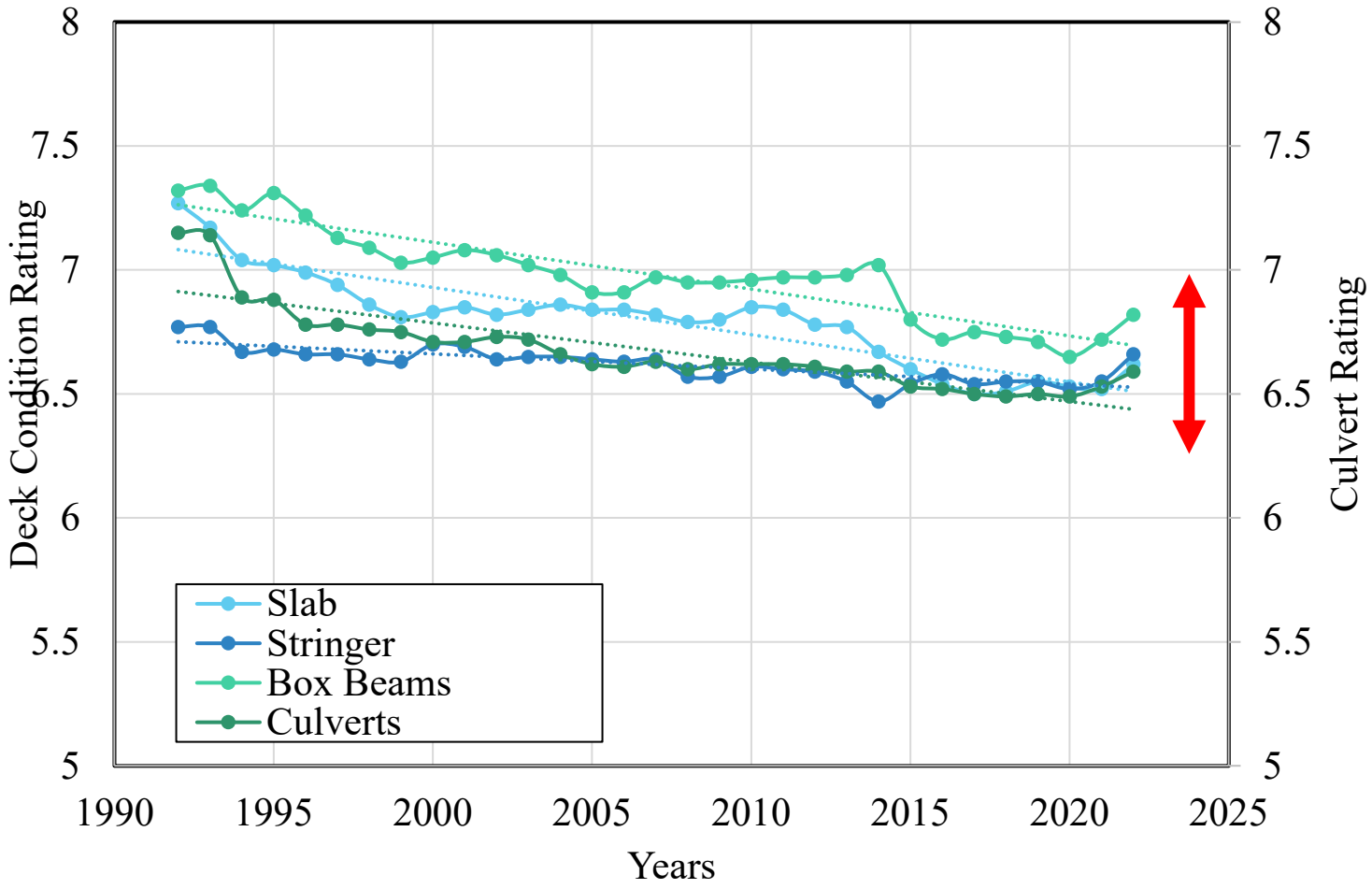
Girder superstructure material



Prestressed concrete > steel and reinforced concrete

Nevada

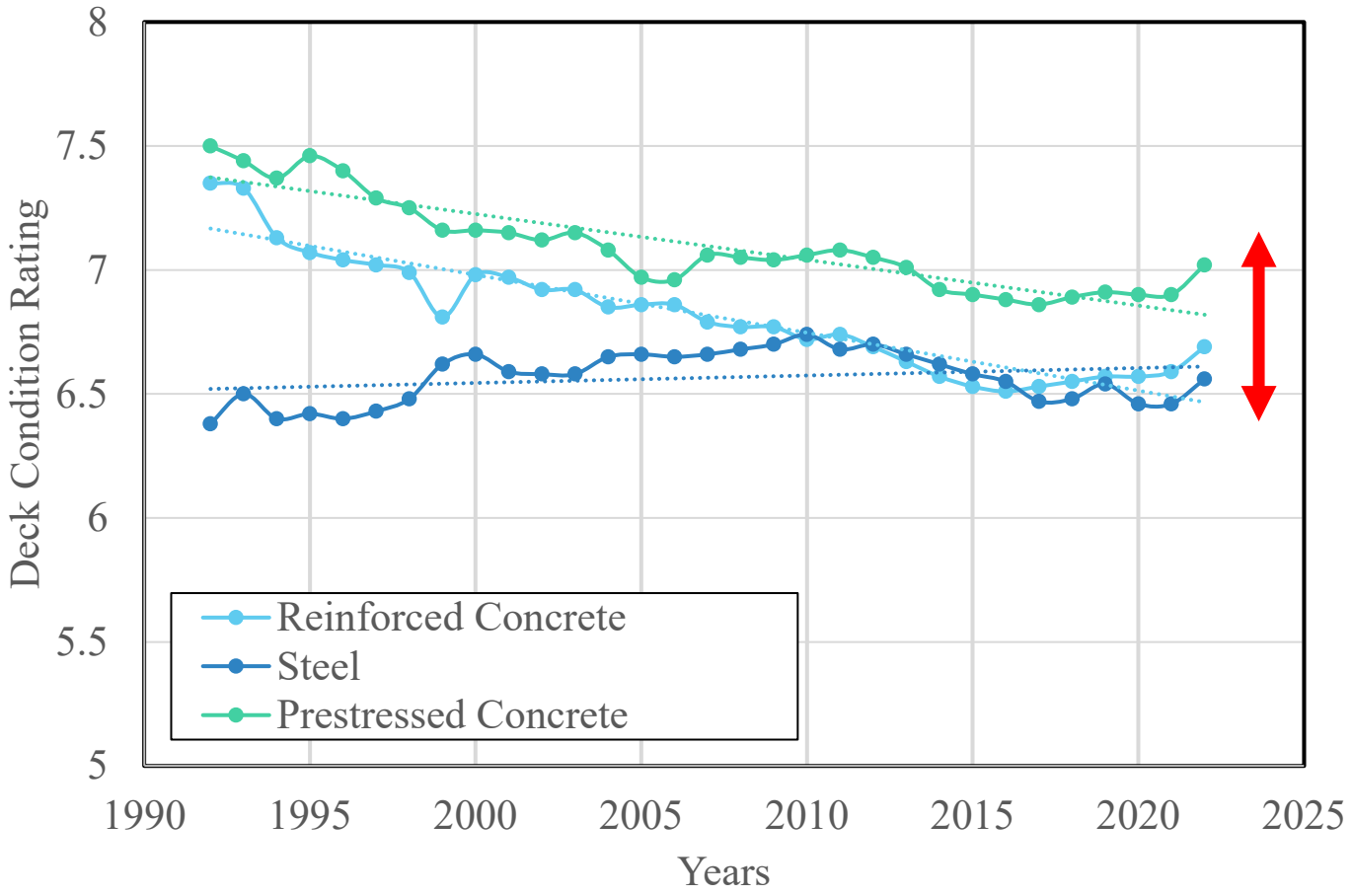
Superstructure cross-sectional geometry



Box beams & slab > girder

Oregon → 8256 bridges (2022)

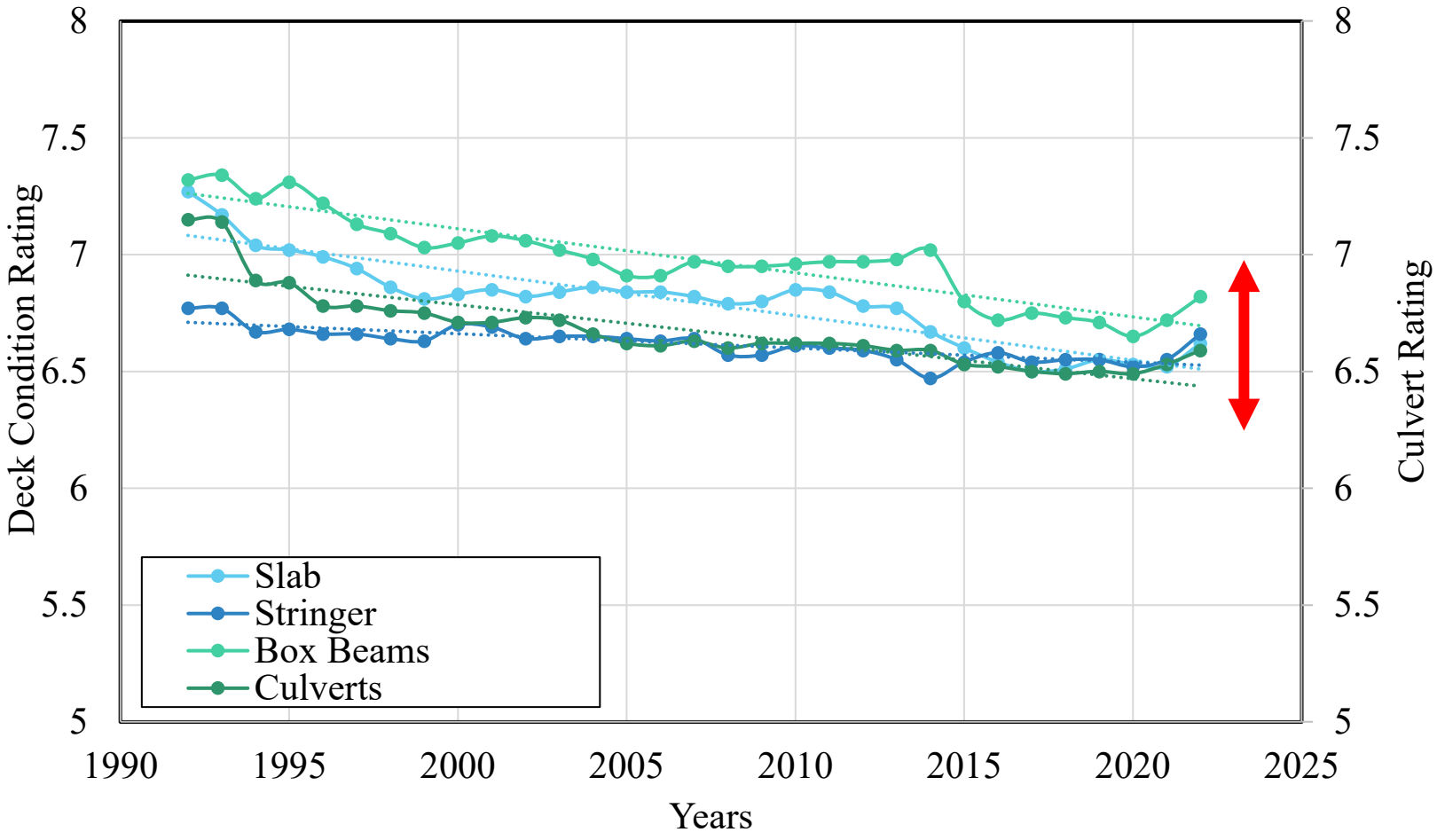
Girder superstructure material



Prestressed concrete > steel and reinforced concrete

Oregon

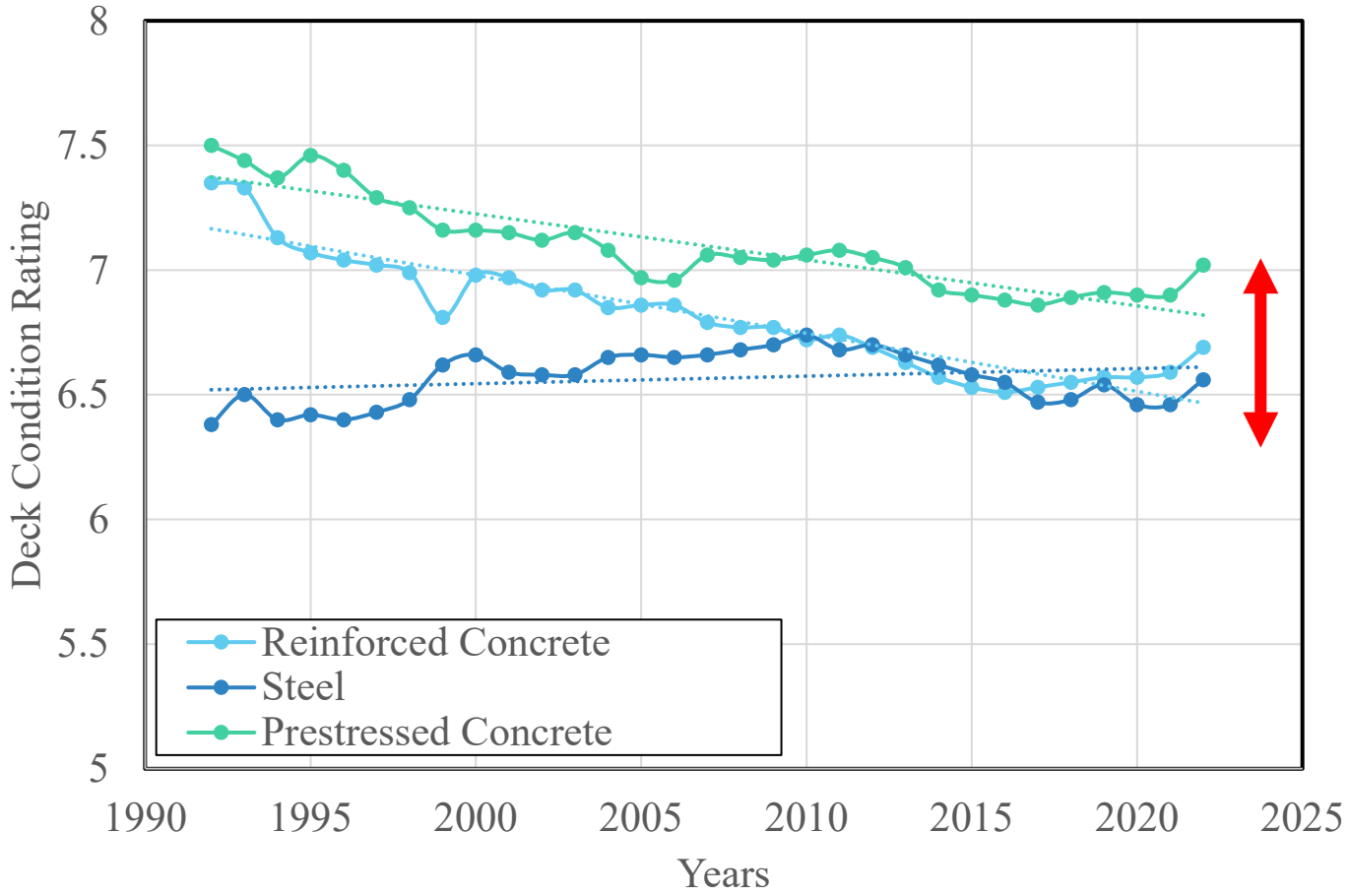
Superstructure cross-sectional geometry



Box beams & slab > girder

Washington → 7741 bridges (2022)

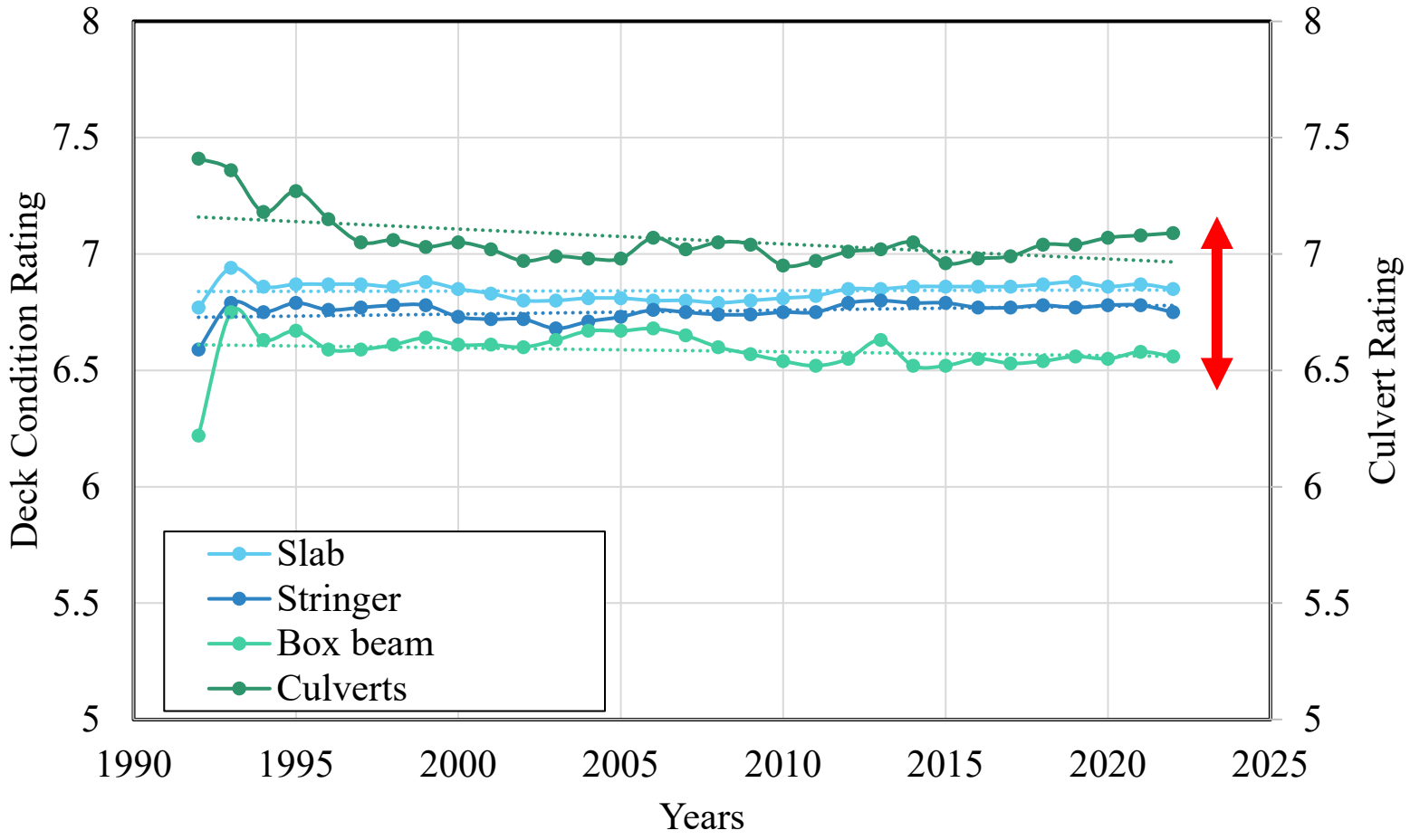
Girder superstructure material



Prestressed concrete > steel and reinforced concrete

Washington

Superstructure cross-sectional geometry



Culverts > common bridges

Slabs > box beams & girder

Conclusions

- Girder superstructure material (NBI Item 43A)
  - Prestressed concrete typically outperforms reinforced concrete and steel
  - Performance of steel vs. reinforced concrete varies by state
- Superstructure cross-sectional geometry (NBI Item 58 or 62)
  - Enclosed/solid (culverts, slabs, boxes) > girder
- Average daily traffic (ADT) (NBI Item 29)
  - Performance varies by state
  - > 10,000 performs well (more $$?) OR < 5,000 performs well (less ADT?)
- Wearing surface material (NBI Item 108A)
  - Bituminous / concrete outperform wood

Questions?

Thank you for your attention!

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