

**2017 UTC Spotlight Conference: Rebuilding and
Retrofitting the Transportation Infrastructure
September 26-27, 2017**

Keck Center

500 5th Street, NW

Washington, DC

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Transportation Research Board

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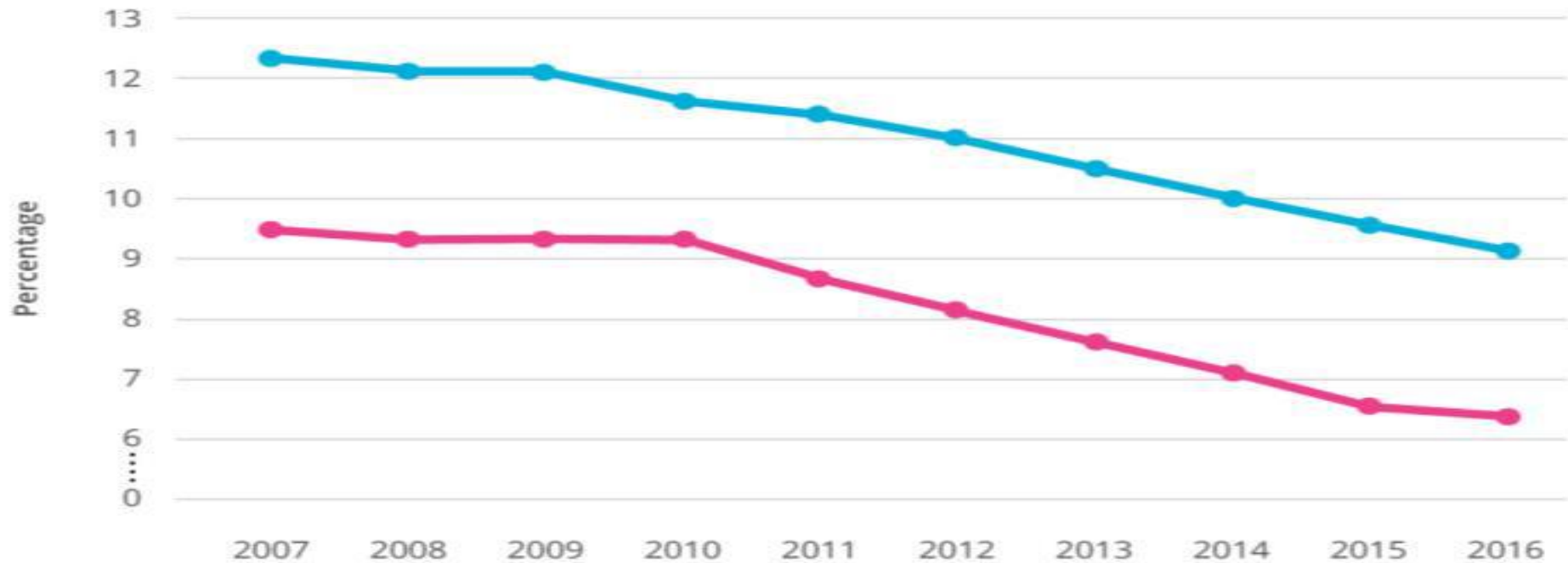
Office of the Assistant Secretary for Research and

Technology, U.S. Department of Transportation (OST-R)

Bridges

9.1% of bridges rated structurally deficient

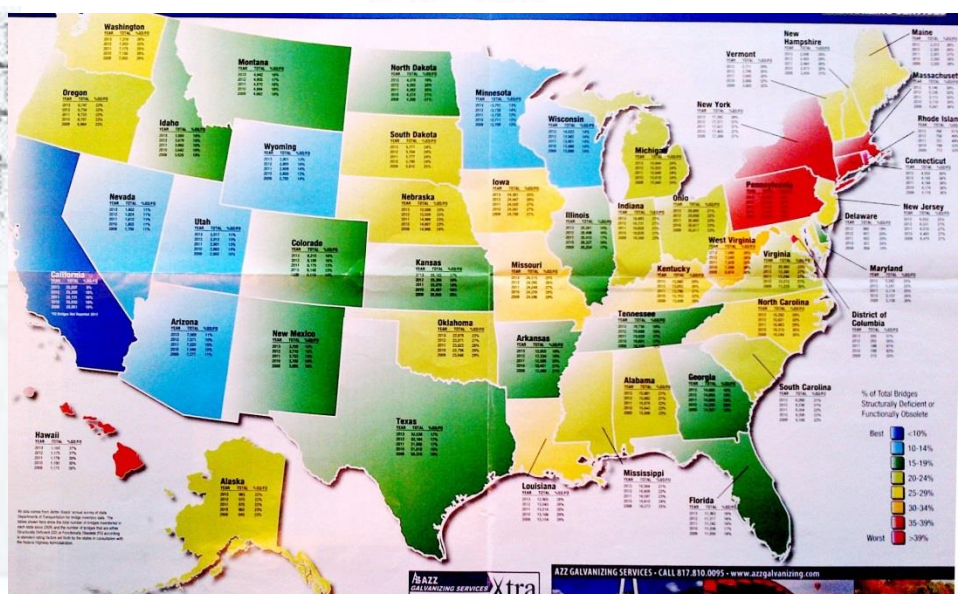
Structurally Deficient Bridges



Structurally Deficient
Bridges by Number



Structurally Deficient
Bridges by Area



BRIDGES: CONDITIONS & CAPACITY

2013 GRADE C

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The health of our nation's bridges is directly tied to the nation's ability to compete in a global marketplace. Therefore, it is of growing concern that the bridges in our nation's metropolitan areas, which are an indispensable link for both millions of commuters and freight on a daily basis, are decaying more rapidly than our rural bridges. Approximately 210 million trips are taken daily across deficient bridges in the nation's 102 largest metropolitan regions.

The percentage of bridges that are either functionally obsolete or structurally deficient has been declining slowly over the last decade as states and cities have increased efforts to prioritize repairs and replacements. In 2012, one in nine, or just below 11%, of the nation's bridges were classified as structurally deficient. The number of bridges defined as functionally obsolete has also declined, with currently 24.9% of the nation's bridges defined in either deficiency category. However, while billions have been spent annually on bridge construction, rehabilitation, and repair in the last twenty years, current funding levels are not enough to repair or replace the nation's large-scale, urban bridges, which carry a high percentage of the nation's traffic. To illustrate, the nation's 66,749 structurally deficient bridges make up one-third of the total bridge decking area in the country, showing that those bridges that remain classified as structurally deficient are significant in size and length, while the bridges that are being repaired are smaller in scale.

At the state level, 22 states have a higher percentage of structurally deficient bridges than the national average, while five states have more than 20% of their bridges defined as structurally deficient. Pennsylvania tops the list with 24.4%, while Iowa and Oklahoma are not far behind, each having just over 21% of their bridges classified as structurally deficient. When looking at the highest percentage of deficient bridges (combined structurally deficient and functionally obsolete bridge categories), the nation's capital tops all 50 states, with 77%, or 185 of 239, of bridges in the District of Columbia falling into at least one of these categories.

While it is important to look at the decrease in the overall number of bridges that are classified as either structurally deficient or functionally obsolete, there are other critical aspects to assess when grading the nation's bridges. Looking beyond deficiency classifications, the total percentage of postings on the nation's bridges has declined gradually over the past five years. While the number of bridges closed to traffic has climbed from 2,816 in 2007 to 3,585 in 2012, the number of bridges posted for load restrictions has decreased from 67,969 to 60,971 in that same period. Posted bridges are not necessarily a public safety risk, but they can create congestion and force emergency vehicles and trucks to take lengthy detours when the bridge is closed, making it harder, and more costly, for goods to get to market.

Finally, the average age of the nation's bridges has also slightly declined, as bridges have been constructed or replaced, from 43 years in 2009 to 42 years currently. Regardless, the FHWA calculates that more than 30% of existing bridges have exceeded their 50-year design life, meaning that maintenance, repair, and rehabilitation programs will still require significant investment in the upcoming years. Unfortunately, preserving aging bridges while replacing deficient bridges is a significant challenge for cash-strapped state and local governments to manage.

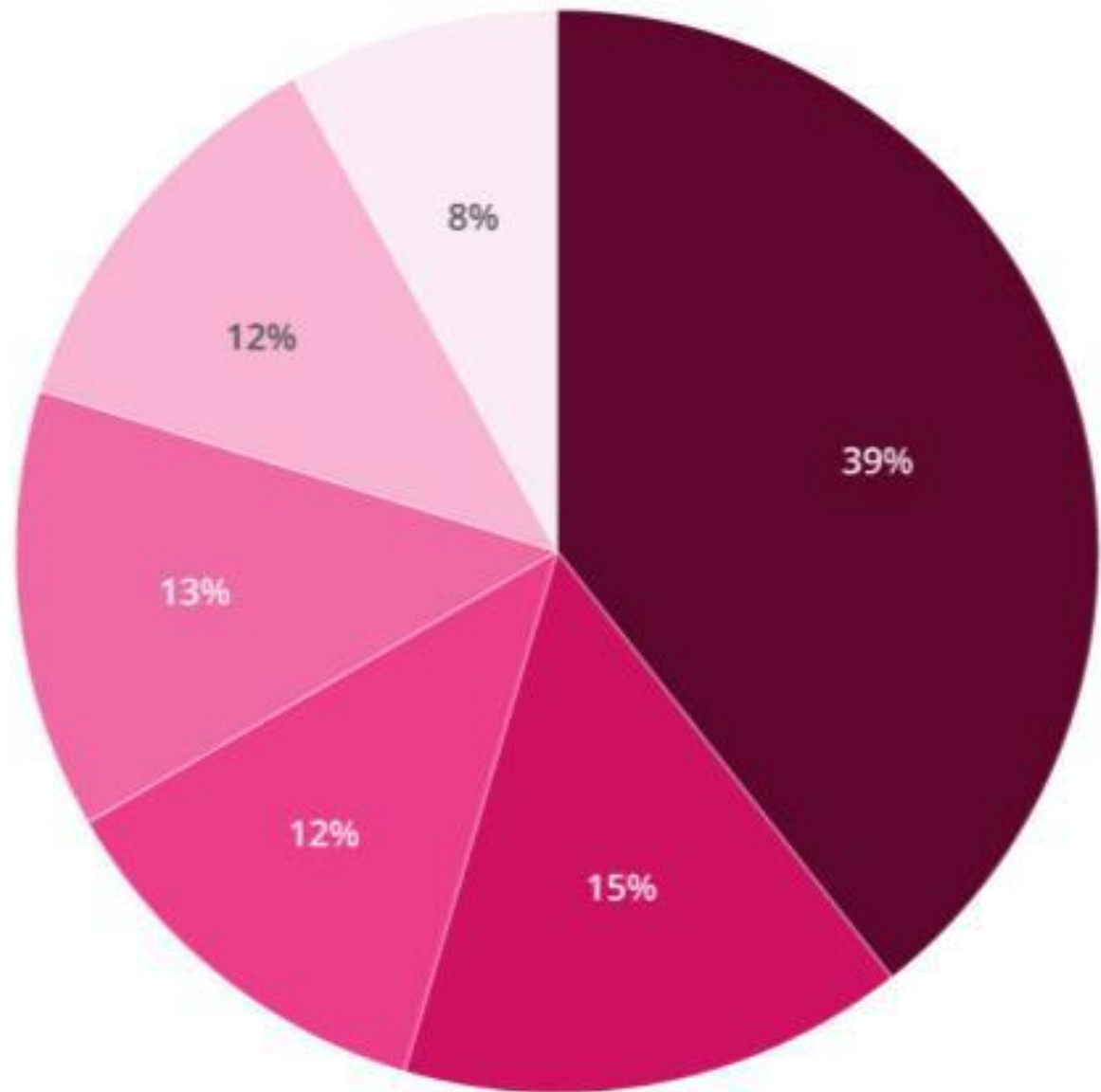


Deficient Bridges Per County [Map icon] VIEW >

Structurally Deficient and Functionally Obsolete Bridges by Year

America's Bridges by Age

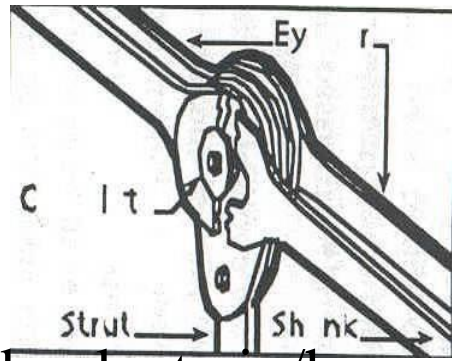
Age of Bridge



Bridge management is disaster-driven

1967 Silver Bridge:

- National Bridge Inventory (NBIS),
- Biennial inspections,
- Fracture-critical elements



1983 Mianus Bridge: non-redundant pin/hangers

1987 Schoharie: -underwater inspections for scour

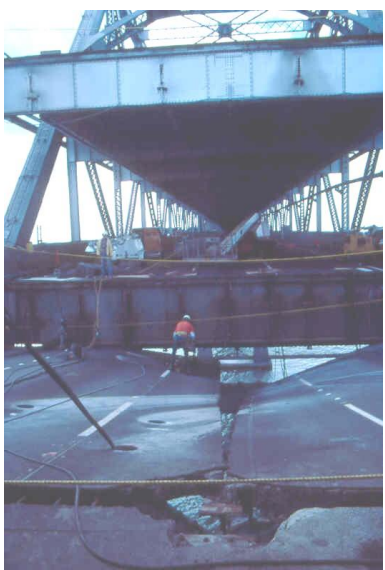
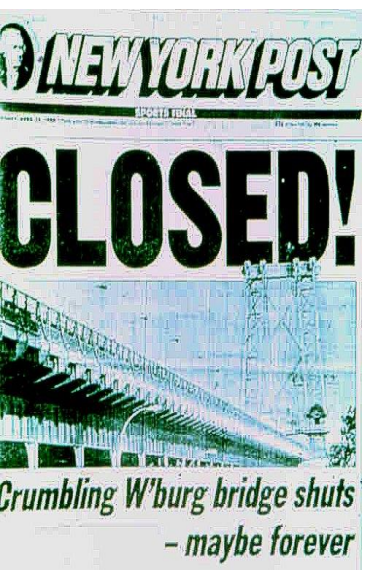
1988 Williamsburg: NYC DOT Bridge Bureau

1989 Loma Prieta:

seismic retrofitting

1989 FDR spalling accident – NYC DOT Unit of Bridge Inspection & Management

2001 WTC: Bridge security



NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
REPORT **300**

BRIDGE MANAGEMENT SYSTEMS

S. W. HUDSON, R. F. CARMICHAEL III, L. O. MOSER
and W. R. HUDSON
ARE INC, Engineering Consultants
Austin, Texas
and
W. J. WILKES
Figg & Muller Engineers Inc.
Austin, Texas

RESEARCH SPONSORED BY THE AMERICAN
ASSOCIATION OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS IN COOPERATION
WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:

Administration
Planning
Finance
Structures Design and Performance
Maintenance
(Highway Transportation, Public Transit, Rail Transportation)

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C.

DECEMBER 1987

NCHRP

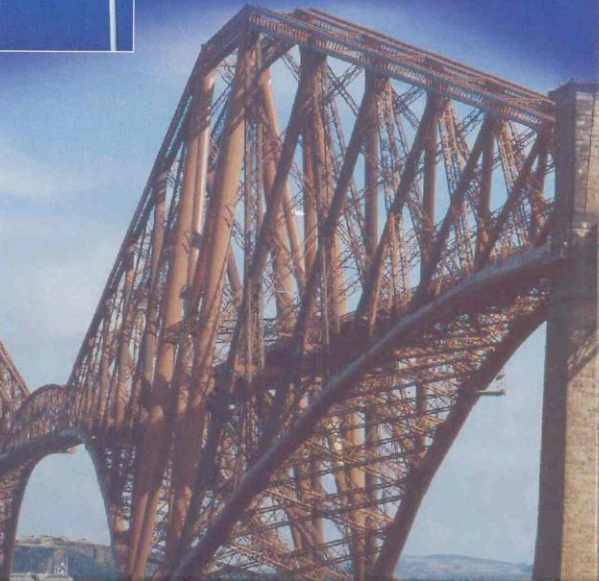
REPORT 483

Bridge Life-Cycle Cost Analysis



BRIDGE MANAGEMENT

M. J. RYALL



Infrastructure Management

- ▶ DESIGN
- ▶ CONSTRUCTION
- ▶ MAINTENANCE
- ▶ REHABILITATION
- ▶ RENOVATION

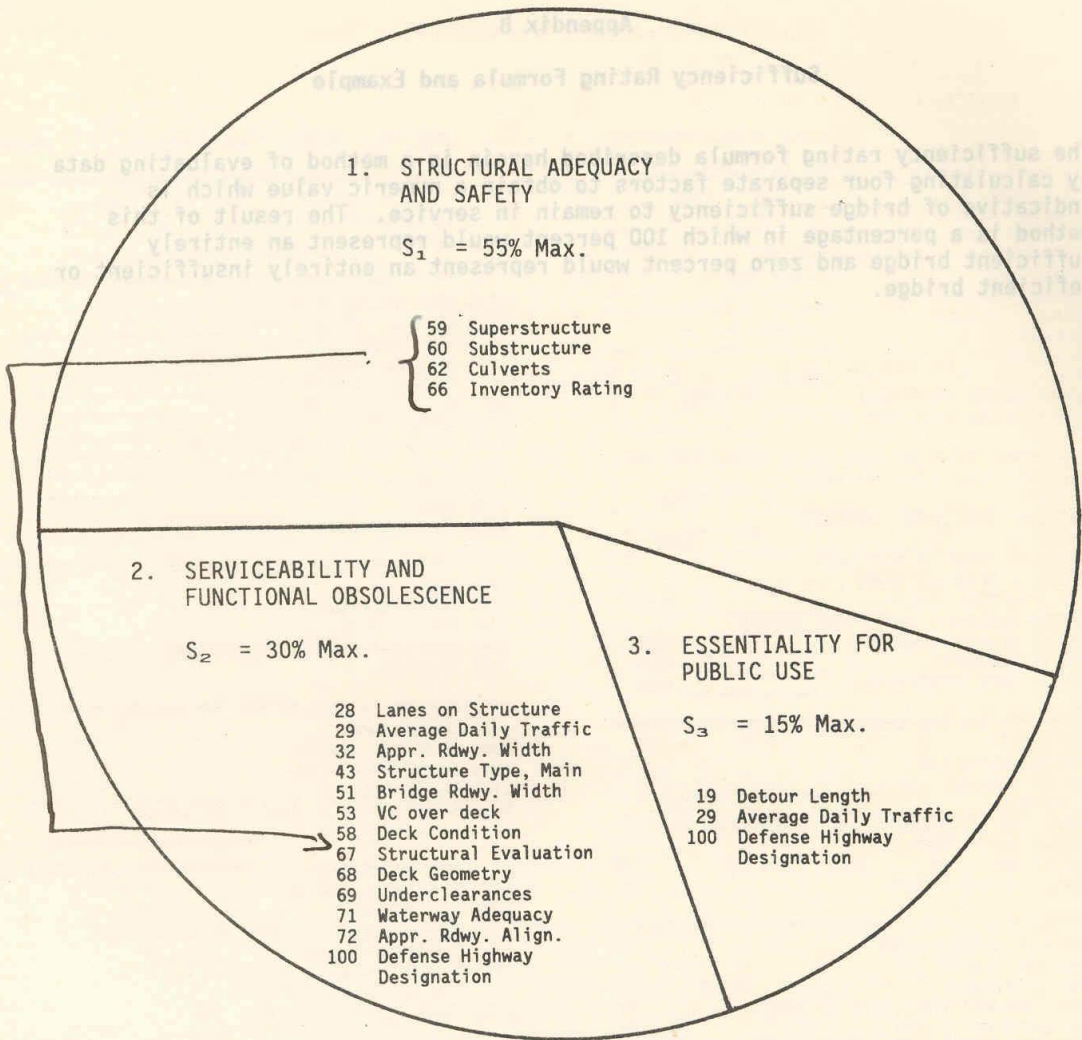
W. Ronald Hudson
Ralph Haas
Waheed Uddin



BRIDGE MANAGEMENT

BOJIDAR YANEV





4. SPECIAL REDUCTIONS
 $S_4 = 13\% \text{ Max.}$
 19 Detour Length
 36 Traffic Safety Features
 43 Structure Type, Main

SUFFICIENCY RATING = $S_1 + S_2 + S_3 - S_4$
 Sufficiency Rating shall not be less than 0% nor greater than 100%

RATING

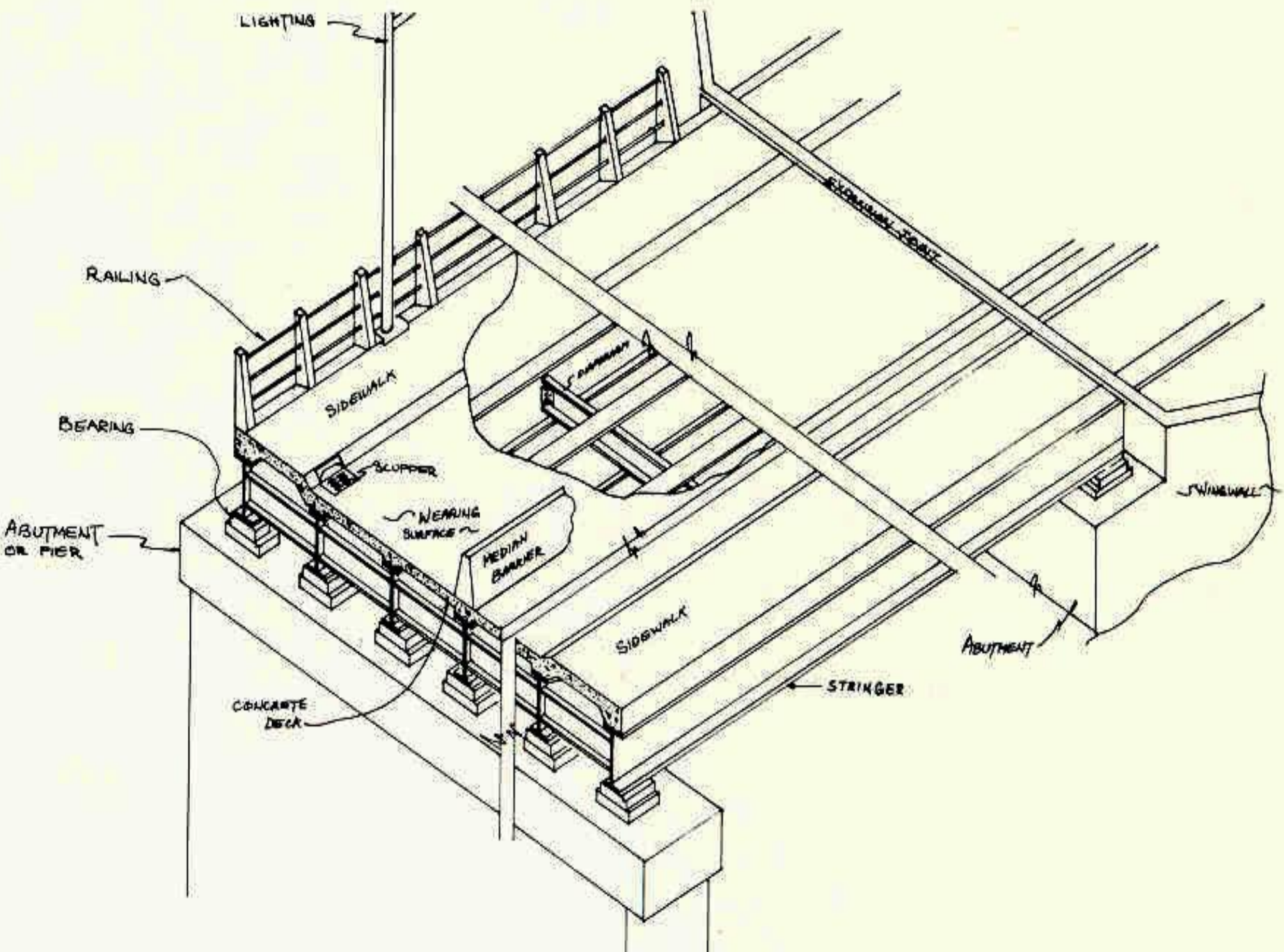
The inspector evaluates the system comprising the "Superstructure Elements" by using the rating number that best describes his opinion of the system's condition and ability to function.

- 1 — POTENTIALLY HAZARDOUS
- 2 — Used to shade between a rate of 1 and 3
- 3 — SERIOUS DETERIORATION OR NOT FUNCTIONING AS ORIGINALLY DESIGNED
- 4 — Used to shade between 3 and 5
- 5 — MINOR DETERIORATION AND IS FUNCTIONING AS ORIGINALLY DESIGNED
- 6 — Used to shade between 5 and 7
- 7 — NEW CONDITION
- 8 — NOT APPLICABLE
- 9 — UNKNOWN

SUFFICIENCY RATING

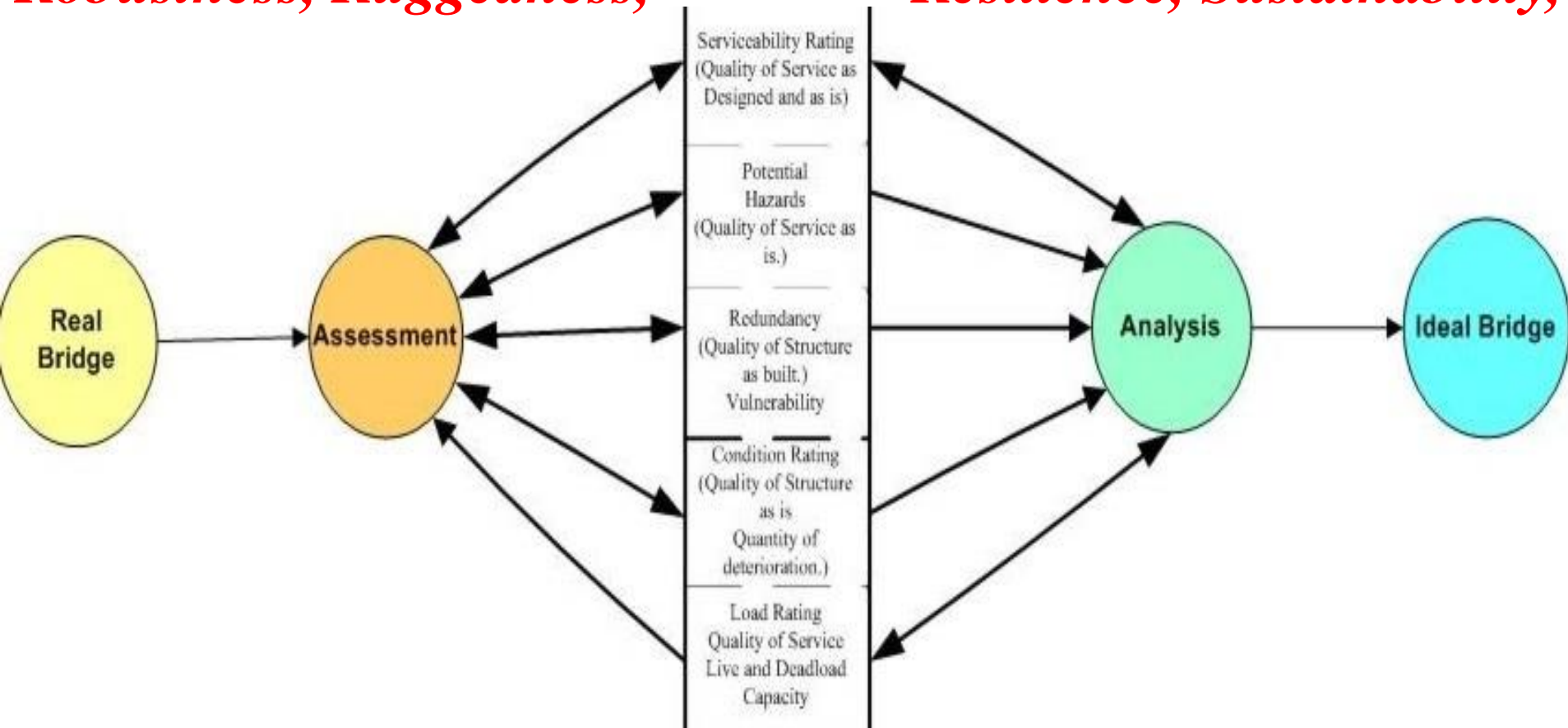
CONDITION EVALUATION

Figure 1. Summary of sufficiency rating factors



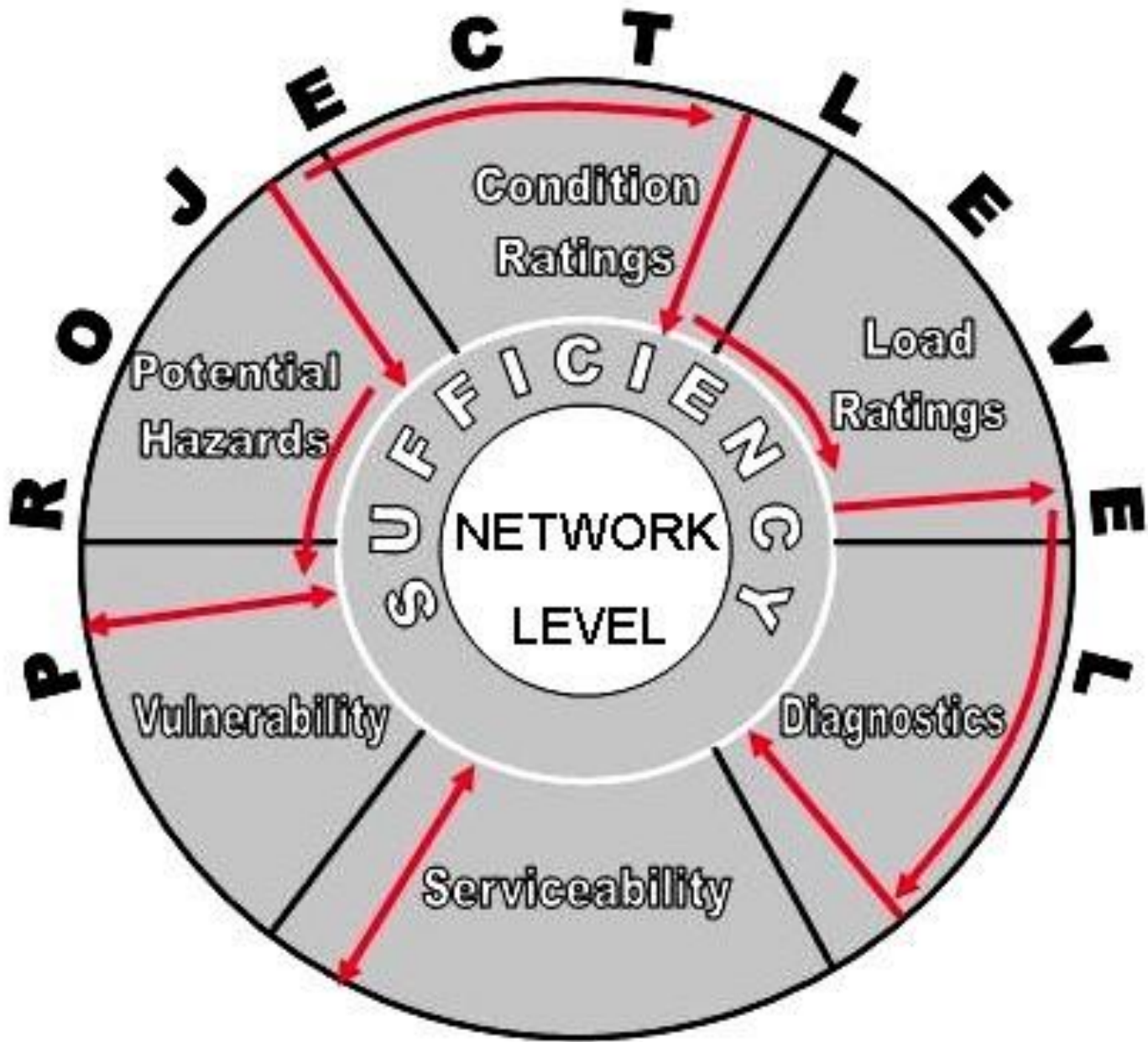


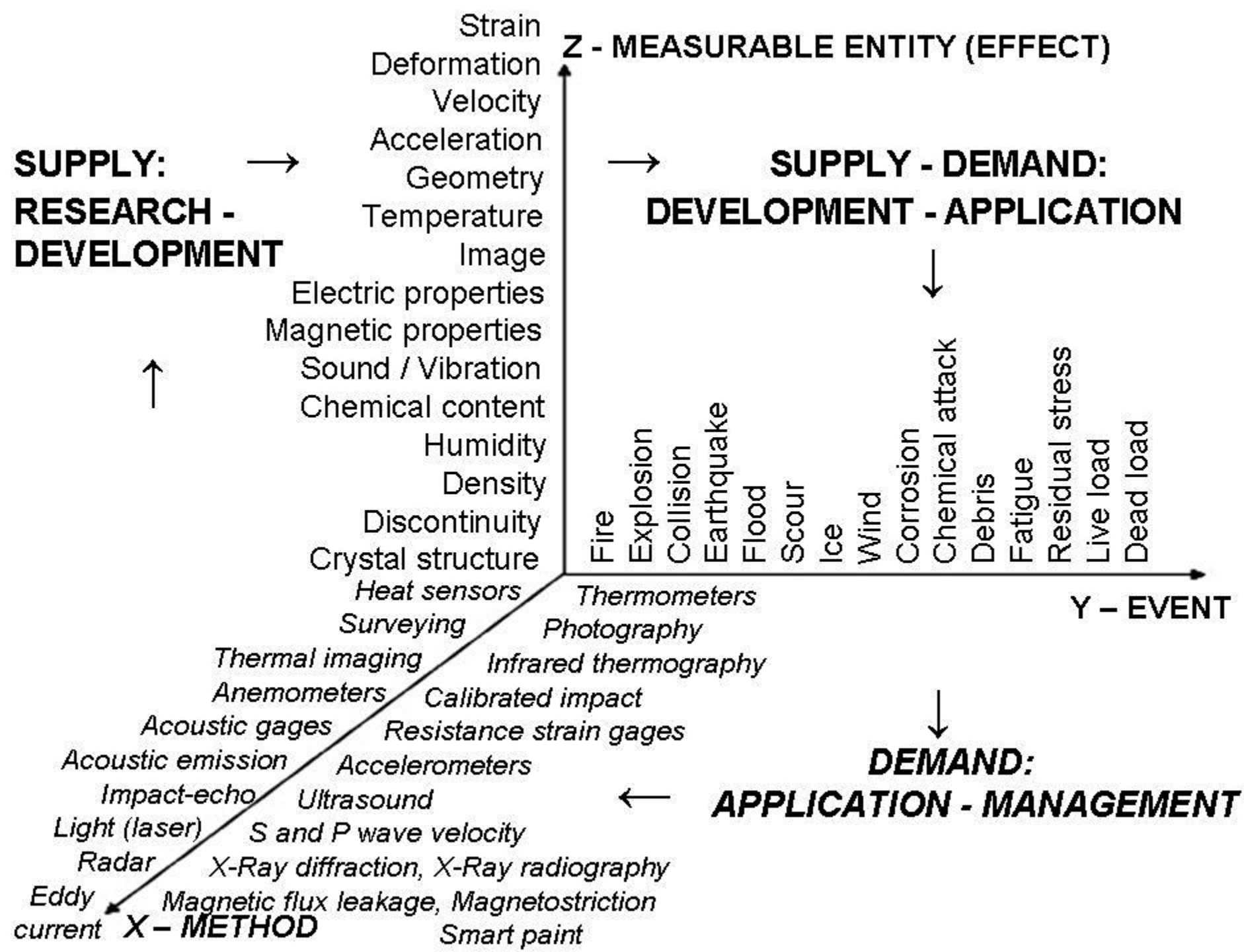
***Redundancy, Ductility, Inspectability, Maintainability.
Robustness, Ruggedness, Resilience, Sustainability,***

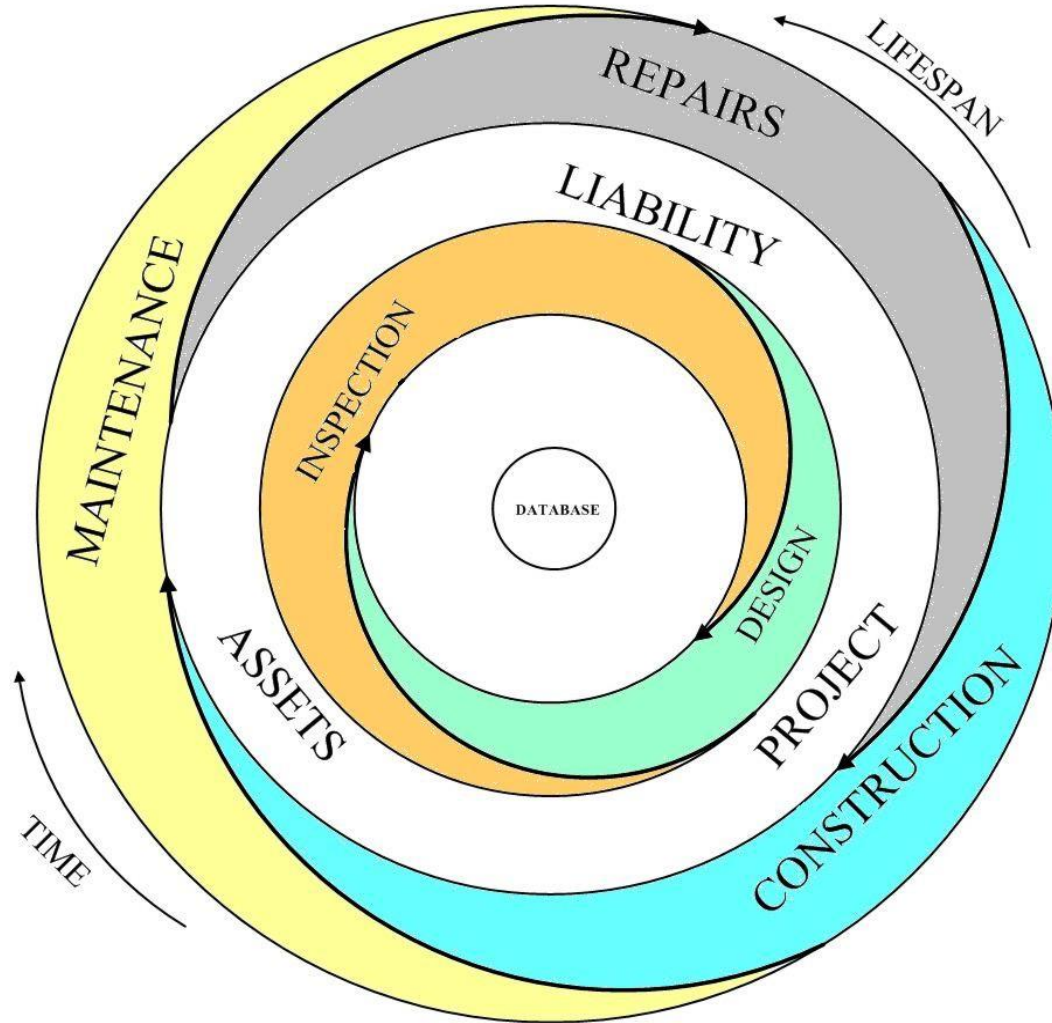
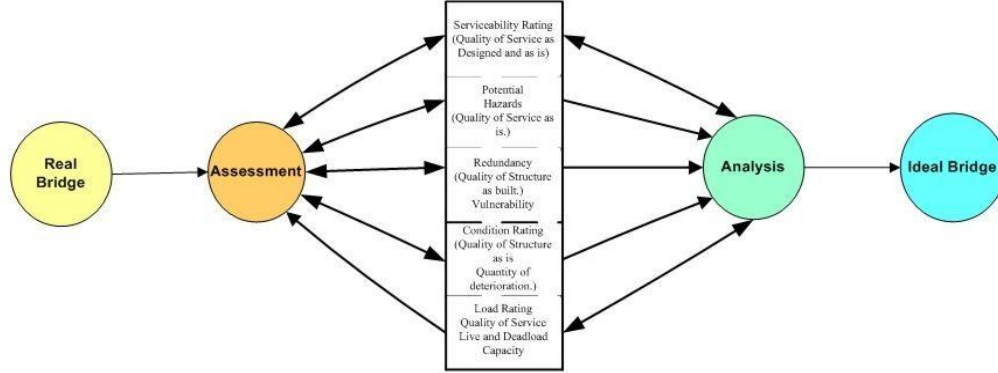


The *descriptive* evaluation system uses *declarative* knowledge representation.

The *prescriptive* system is a *procedural* representation.

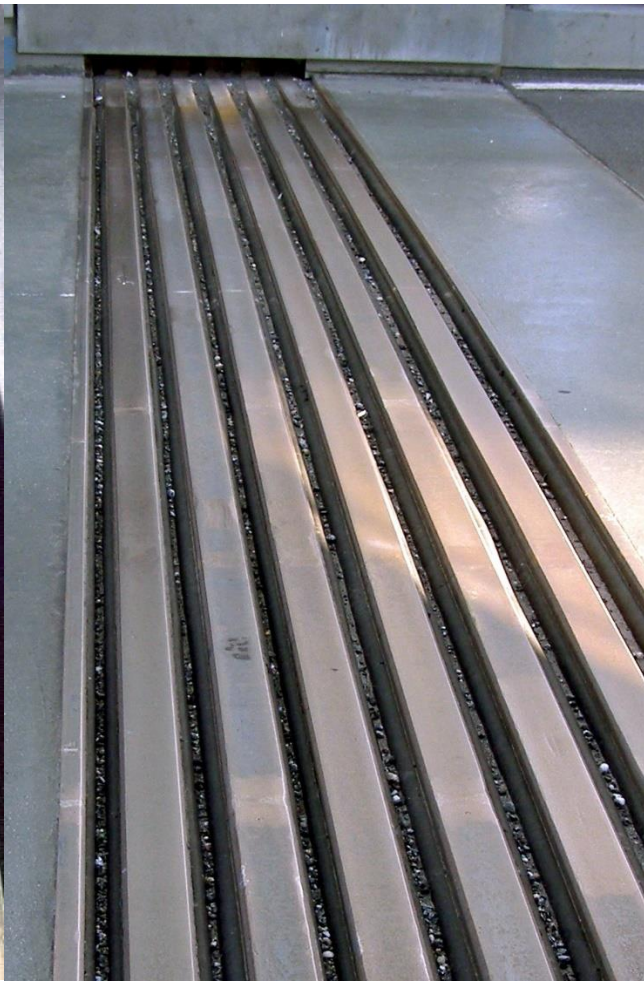
















10/07/2009 10:15





AASHTO LRFD Bridge Design Specifications

Fifth Edition • 2010

Part I:
Sections 1-5



AASHTO LRFD Bridge Design Specifications

Fifth Edition • 2010

Part II:
Section 6-Index

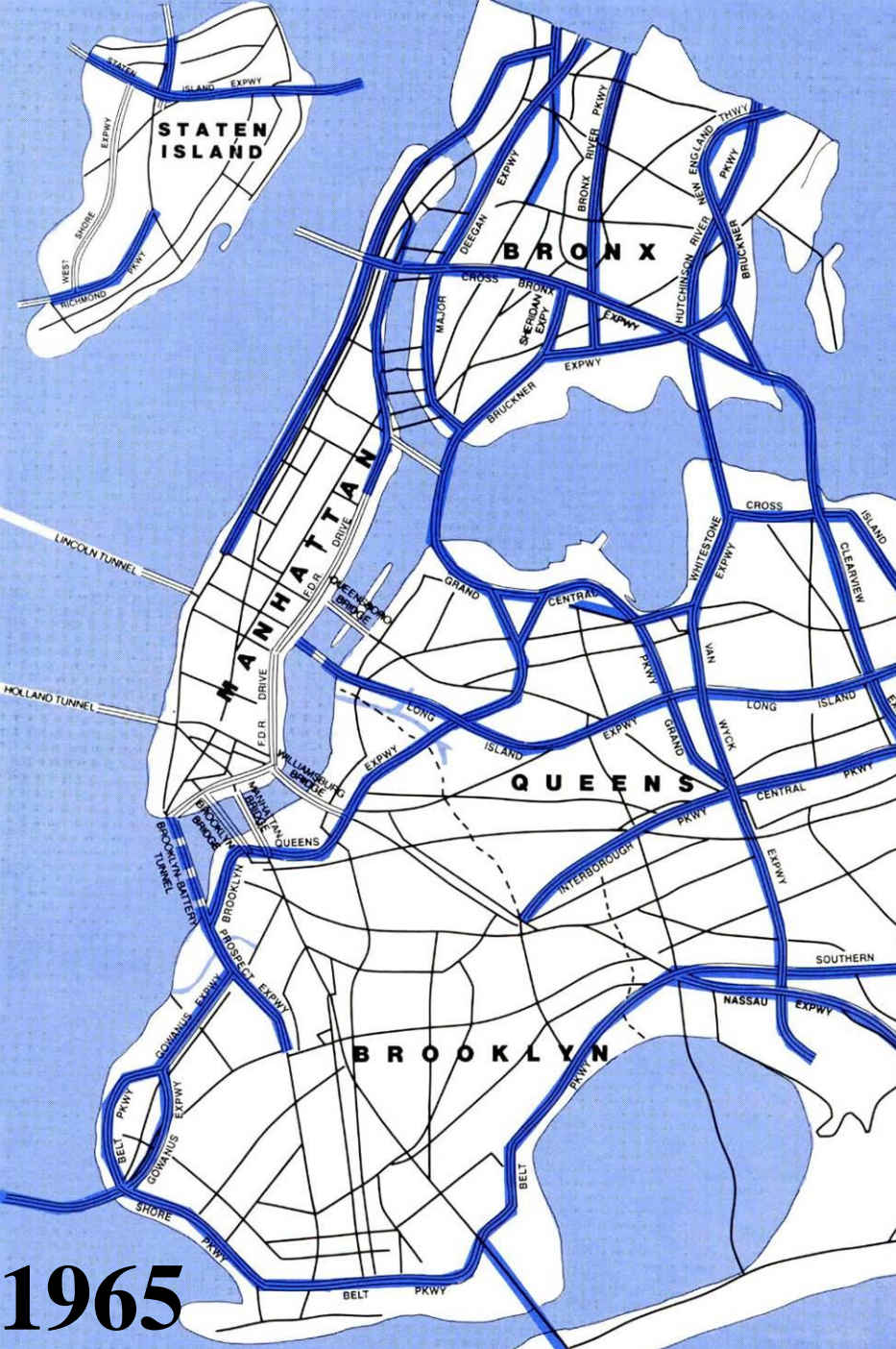


Ch. 14 87 p.
Joints & Bearings

Chapter 9 39 p.
Decks & Deck Systems
R/C Slabs 9 p.

Chapter 5 265 p.
Reinforced Concrete

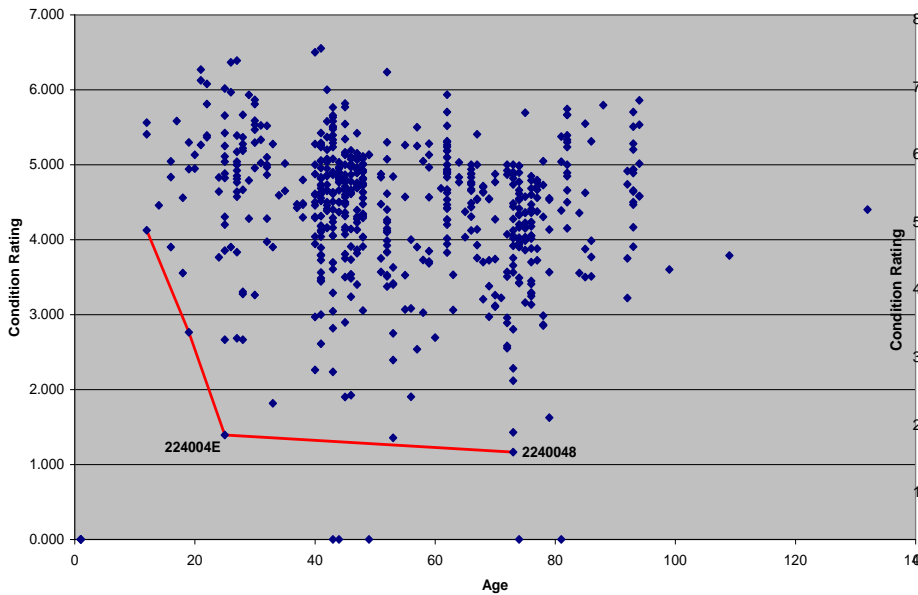
1865 -
1915



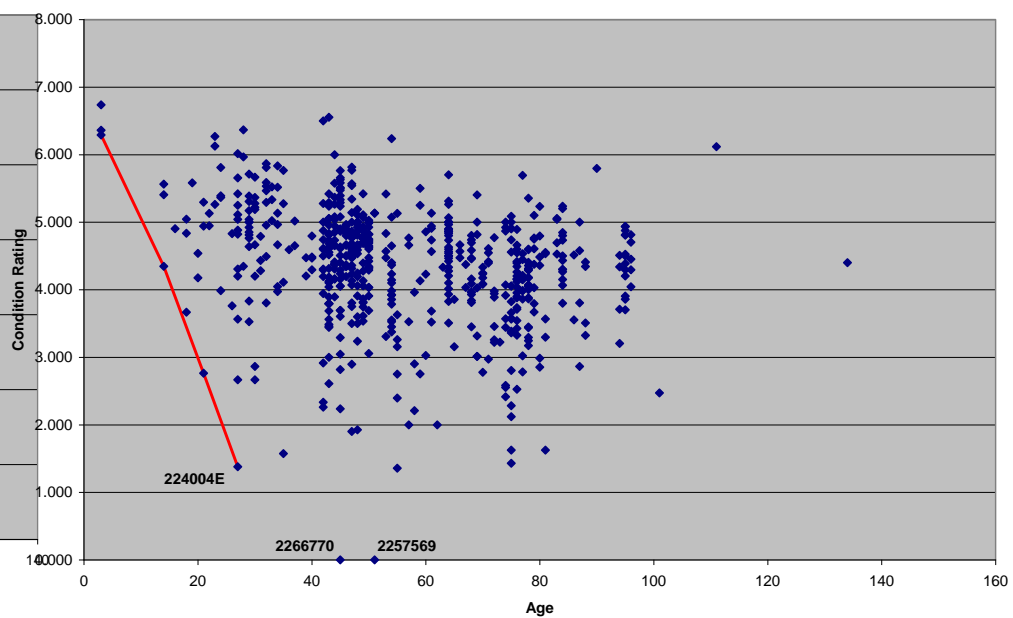
1915 - 1965

BRIDGE TYPE	QUANTITY
Arterial	208
Off-System (Local)	389
Pedestrian	107
Waterway	51
Movable	25
Tunnels	6
East River	4

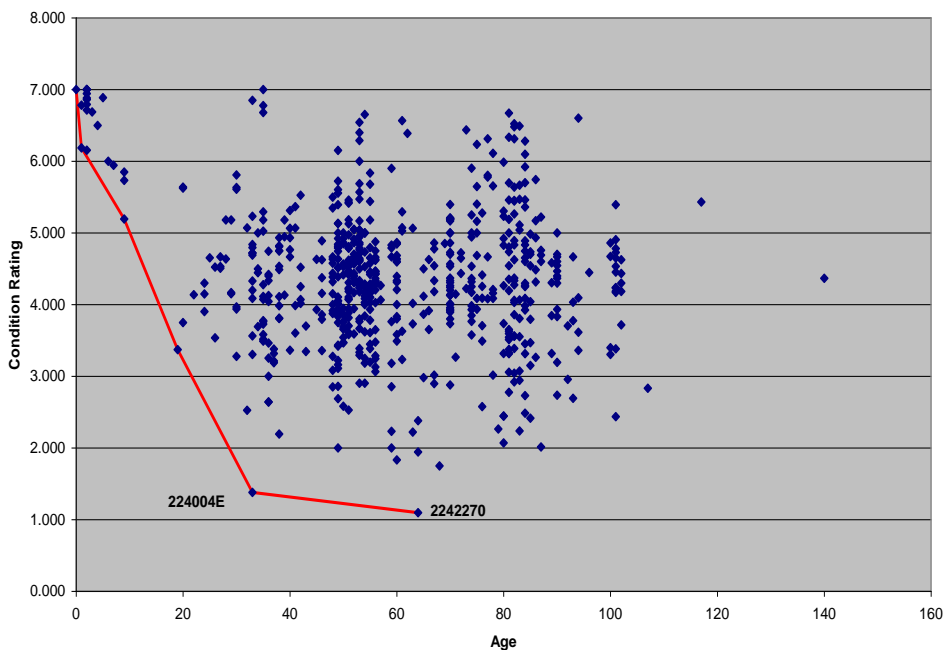
1982 Age Vs Condition Rating (No Ped)



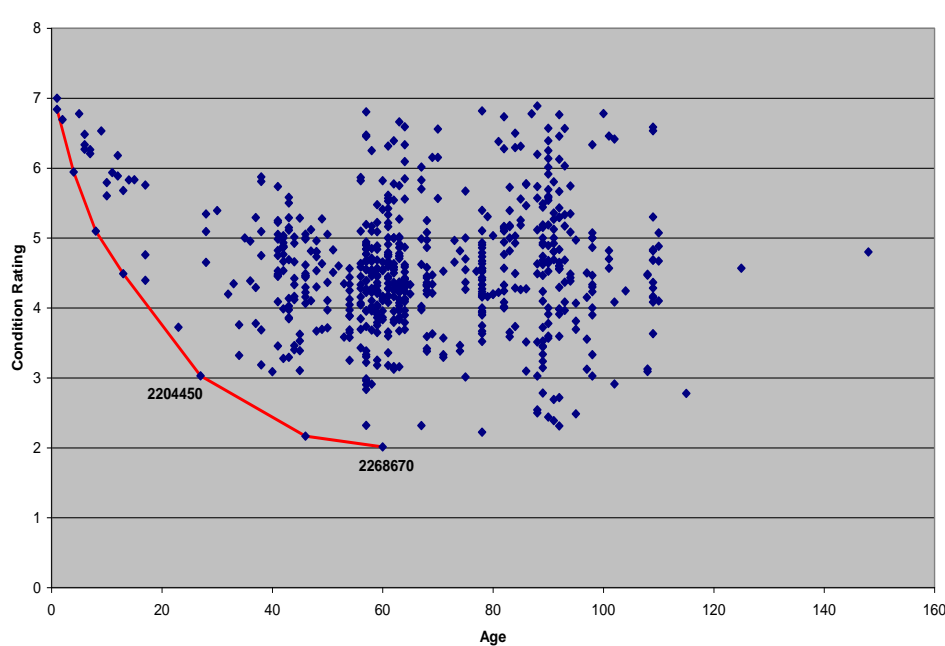
1984 Age Vs Condition Rating (No Ped)



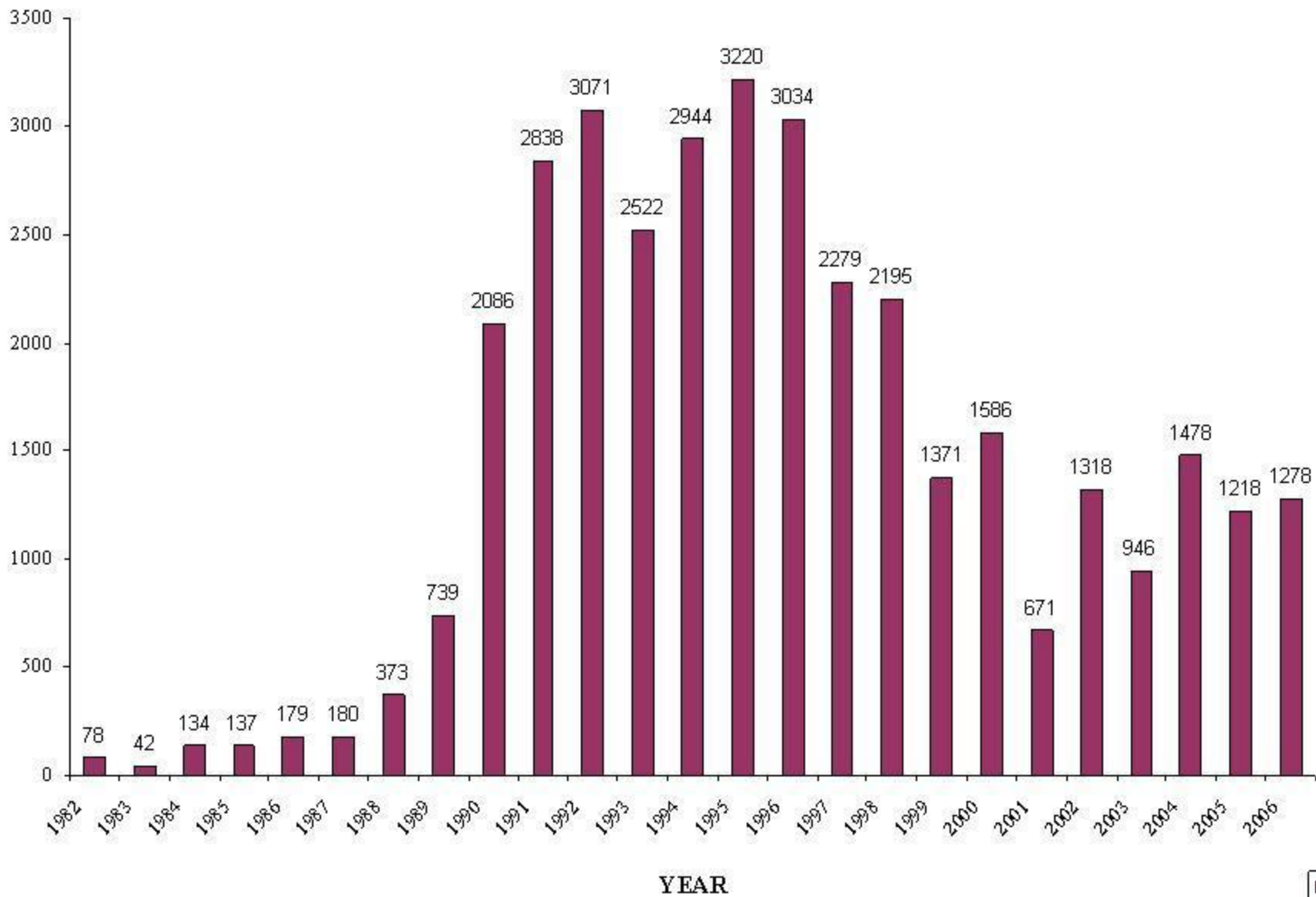
1990 Age Vs Condition Rating (No Ped)

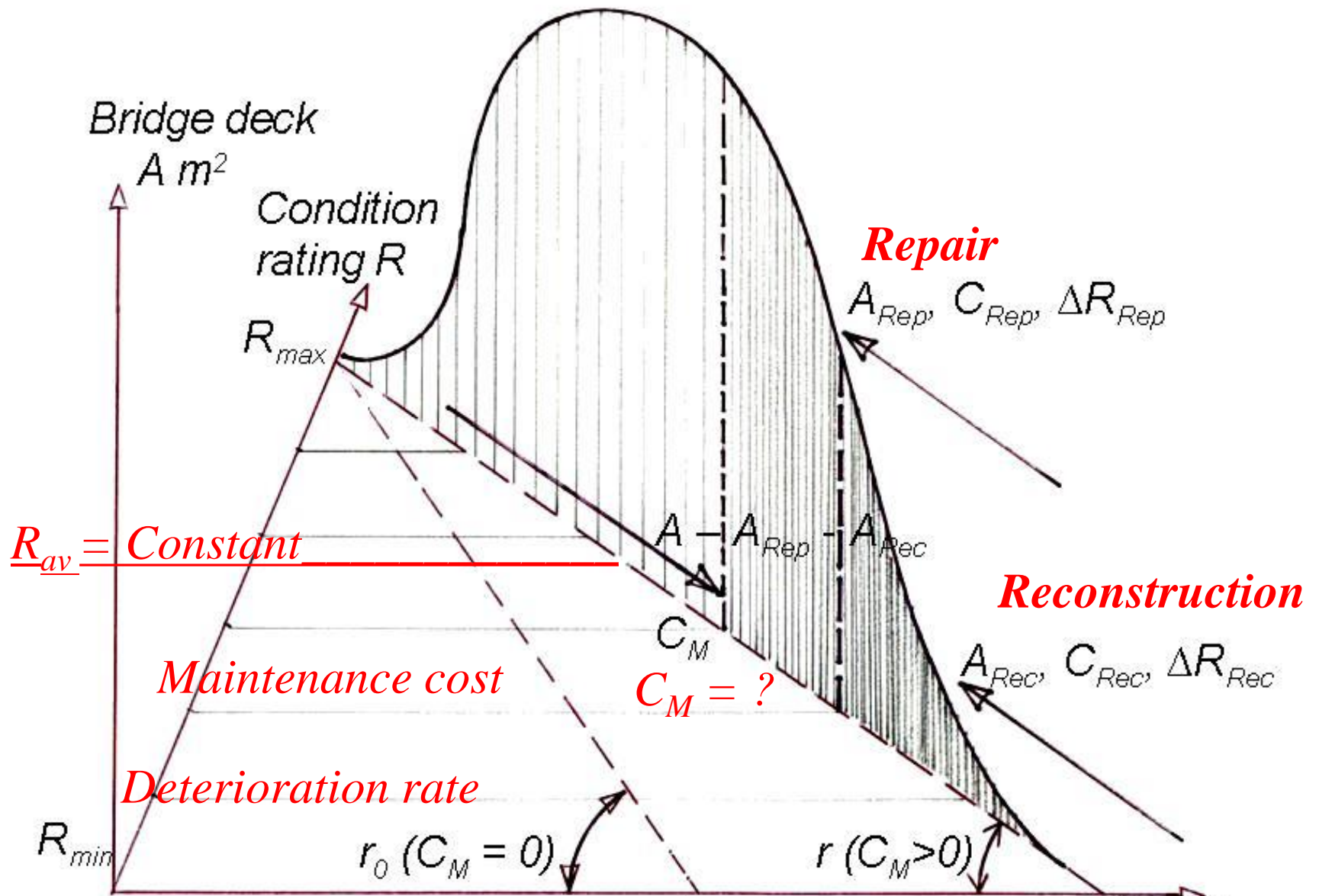


1998 Condition Rating vs Age (No Ped)



TOTAL FLAGS RECEIVED(NYSDOT AND NYCDOT)

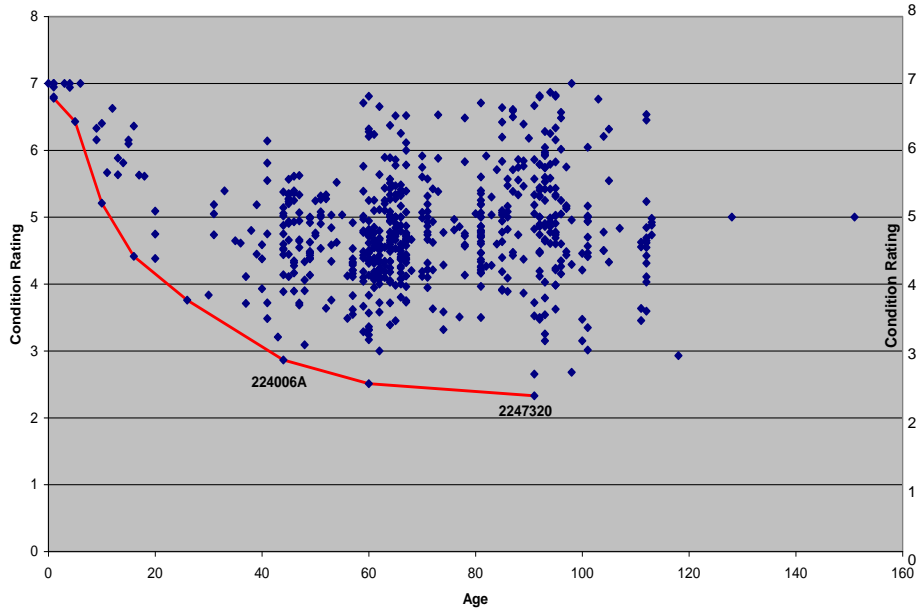




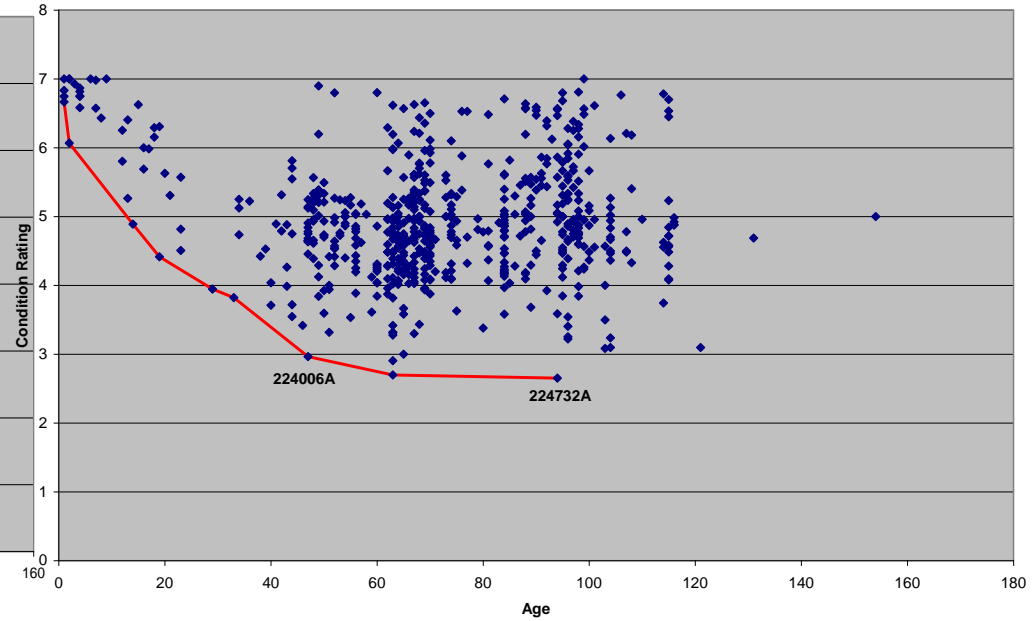
$$(A - A_{rec} - A_{rep}) r = A_{rec} \Delta R_{rec} + R_{rep} \Delta R_{rep}$$

$$\rightarrow r_0 = 0.2 \quad \rightarrow r = f(\text{Maint}) \rightarrow r = f(C_{\text{Maint}})$$

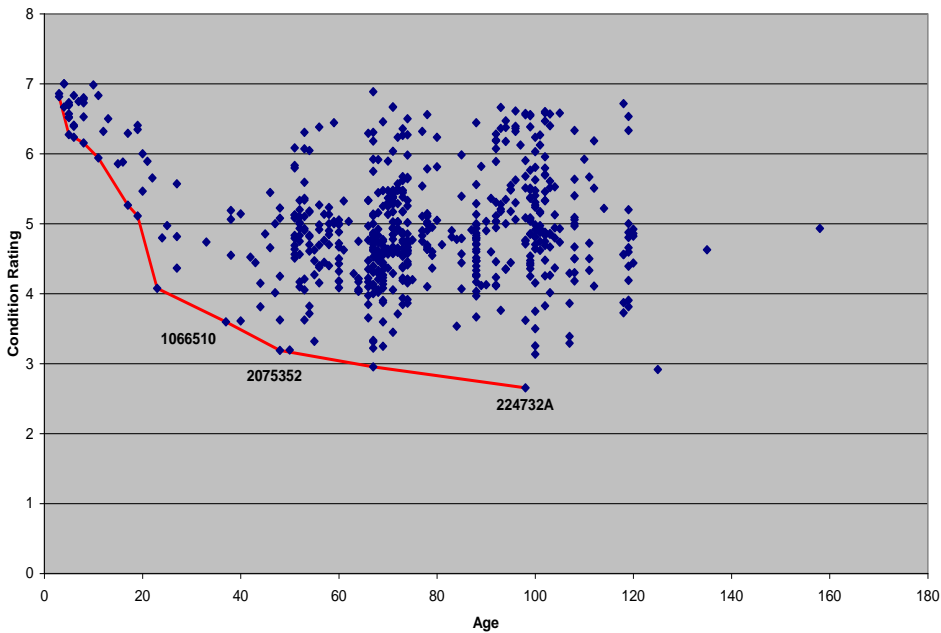
2001 Age Vs Condition Rating (No Ped Bridges)



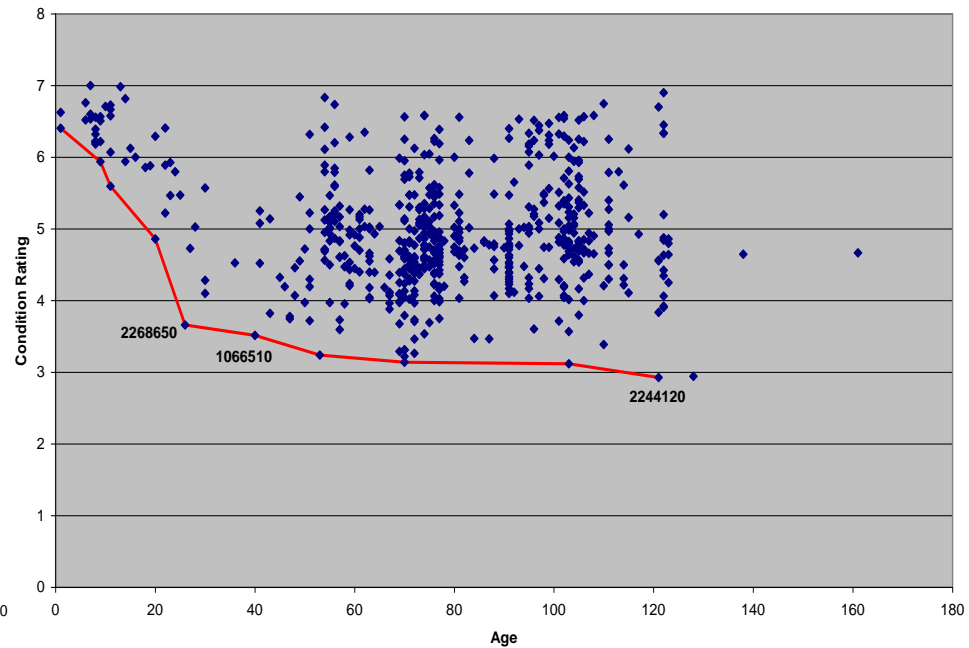
2004 Age vs Condition Rating (No Ped. Bridges)



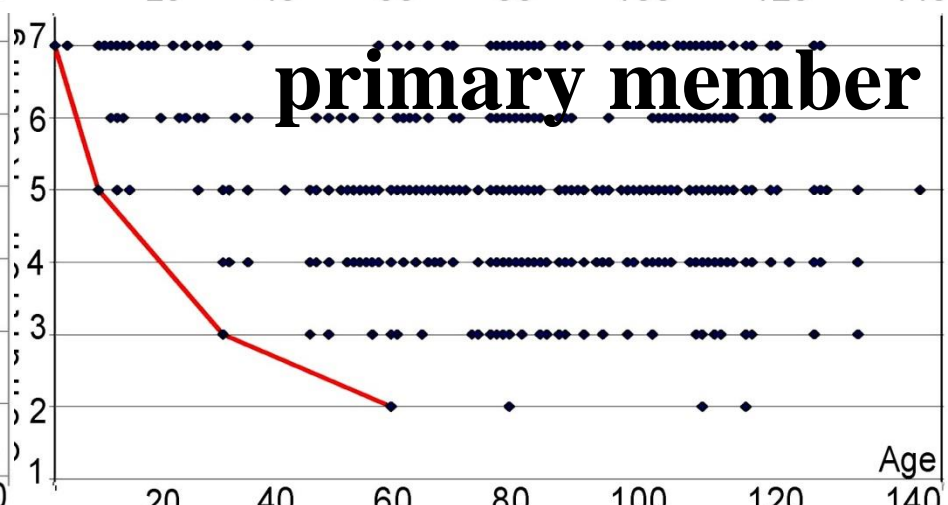
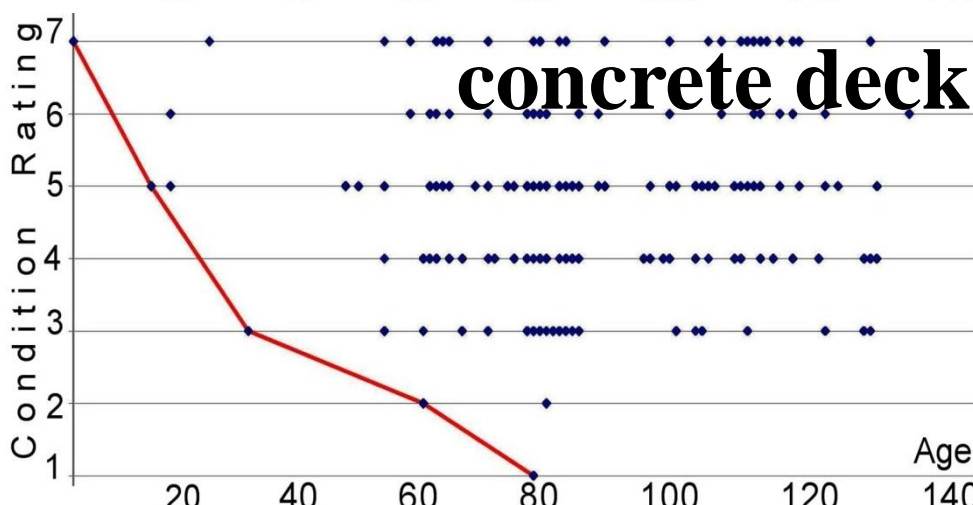
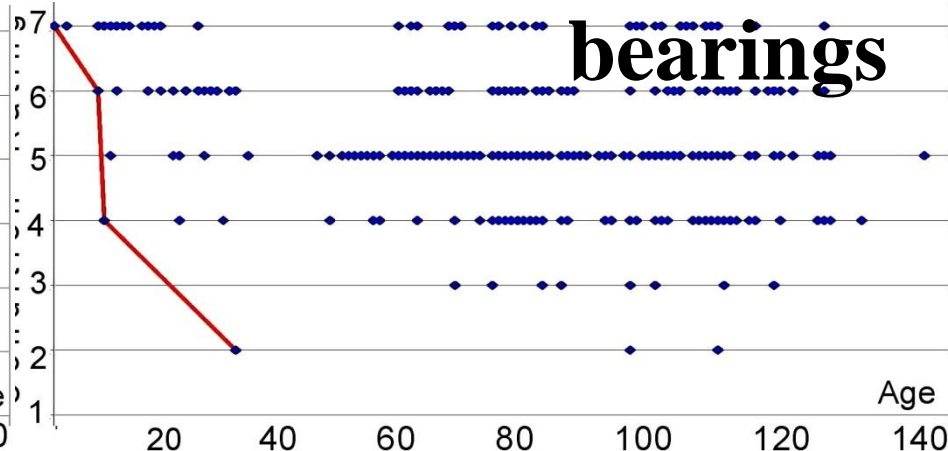
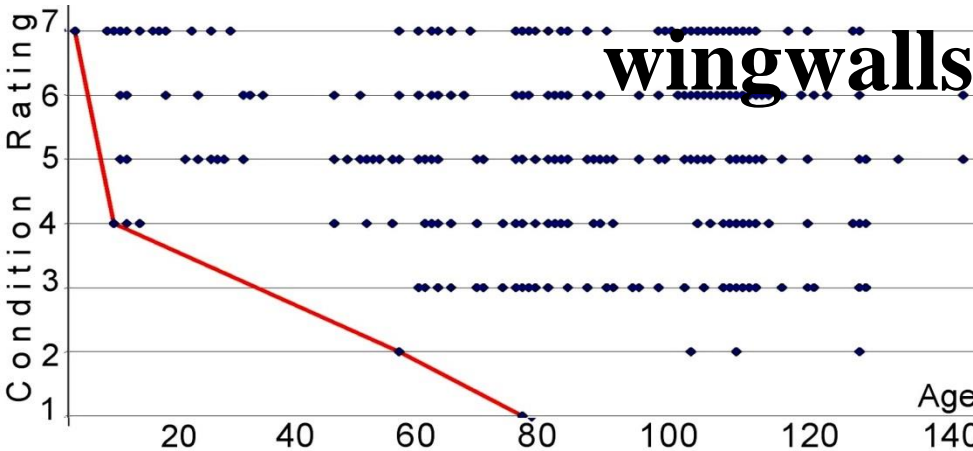
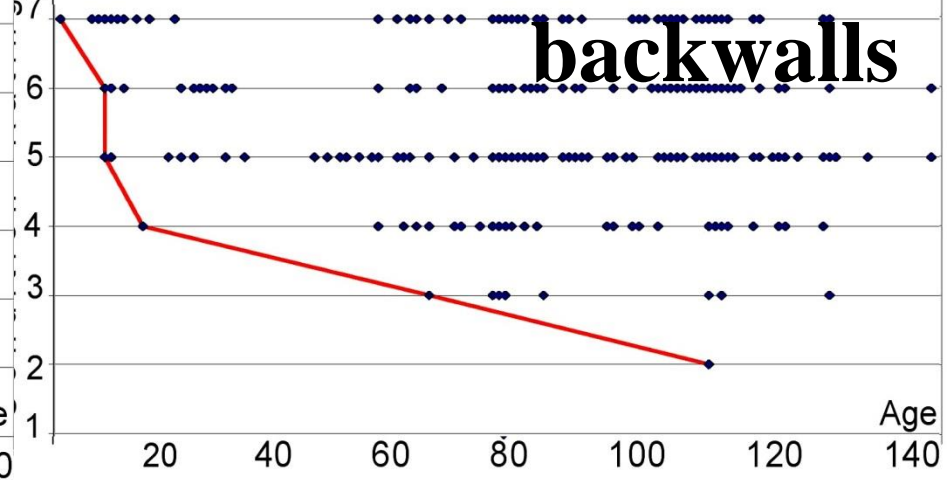
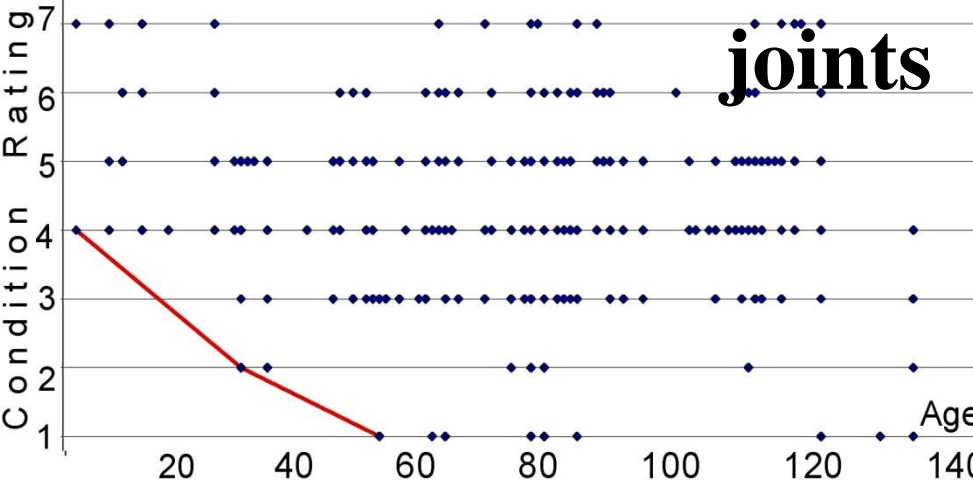
2008 Age vs Condition Rating (No Ped. Bridges)



2011 Age vs. Condition Rating (No Ped. Bridges)







Bridges

