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Pittsburgh, PA

An Effective Bridge Maintenance Program - Reflections of a Former State Bridge Engineer

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Lawrenceville, New Jersey, U.S.A

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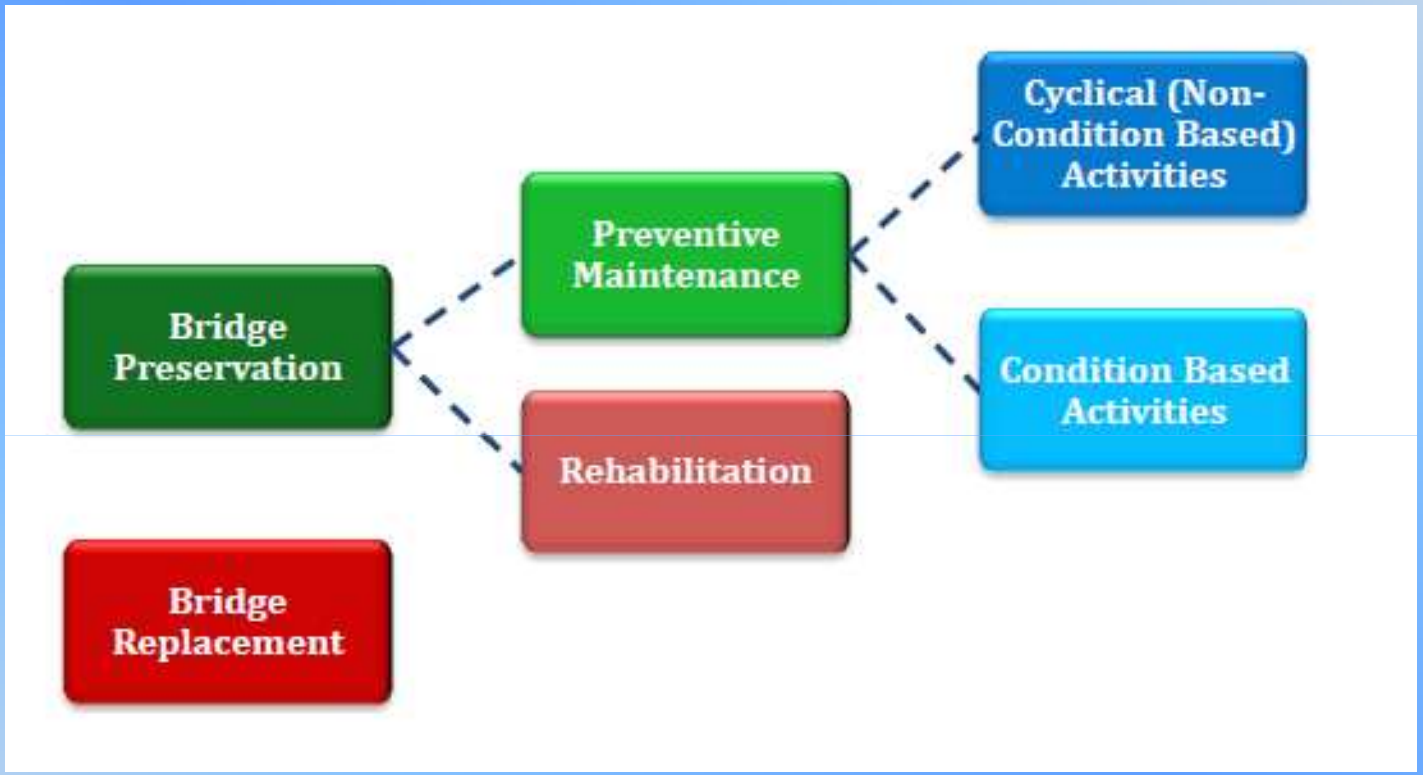
Disclaimer

- These are my reflections based on my own experiences
- My goal is to provide observations based on 32 years of experience in about 15 minutes
- What I say will certainly reflect my own bias
- Any similarities to other material is not Coincidental but because of the willingness of my predecessors, other associates in practice and many professionals I had the opportunity to interact with over the years willingness to share

Preservation vs. Replacement



Source - Federal Highway Administration Office of Infrastructure, 2011 *Bridge Preservation Guide - Maintaining State of Good Repair Using Cost Effective Investment Strategies*

Definition of Bridge Preservation

- “Bridge preservation is defined as actions or strategies that prevent, delay or reduce deterioration of bridges or bridge elements, restore the function of existing bridges, keep bridges in good condition and extend their useful life. Preservation actions may be preventive or condition-driven.”

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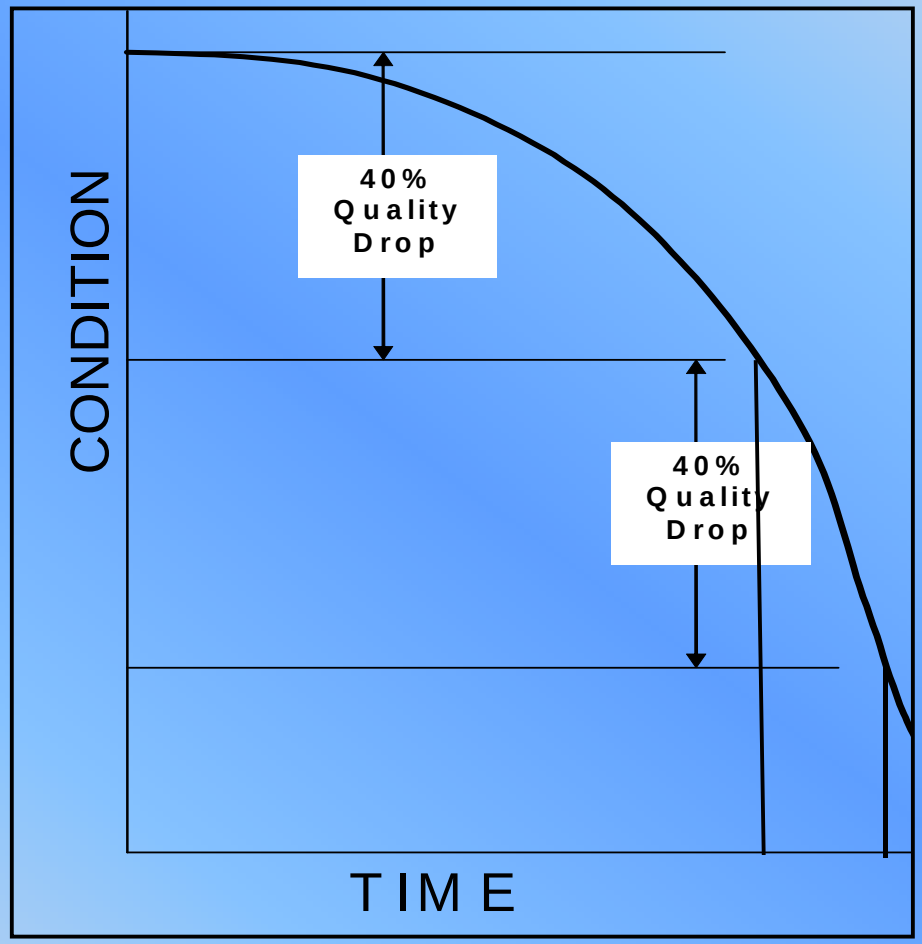
Why Preventive Maintenance?

- Cost effective - Lower user costs
- Public safety
- Reduce need to rehabilitate and replace
- Preventive maintenance starts when the bridge is new.

Time vs. Deterioration



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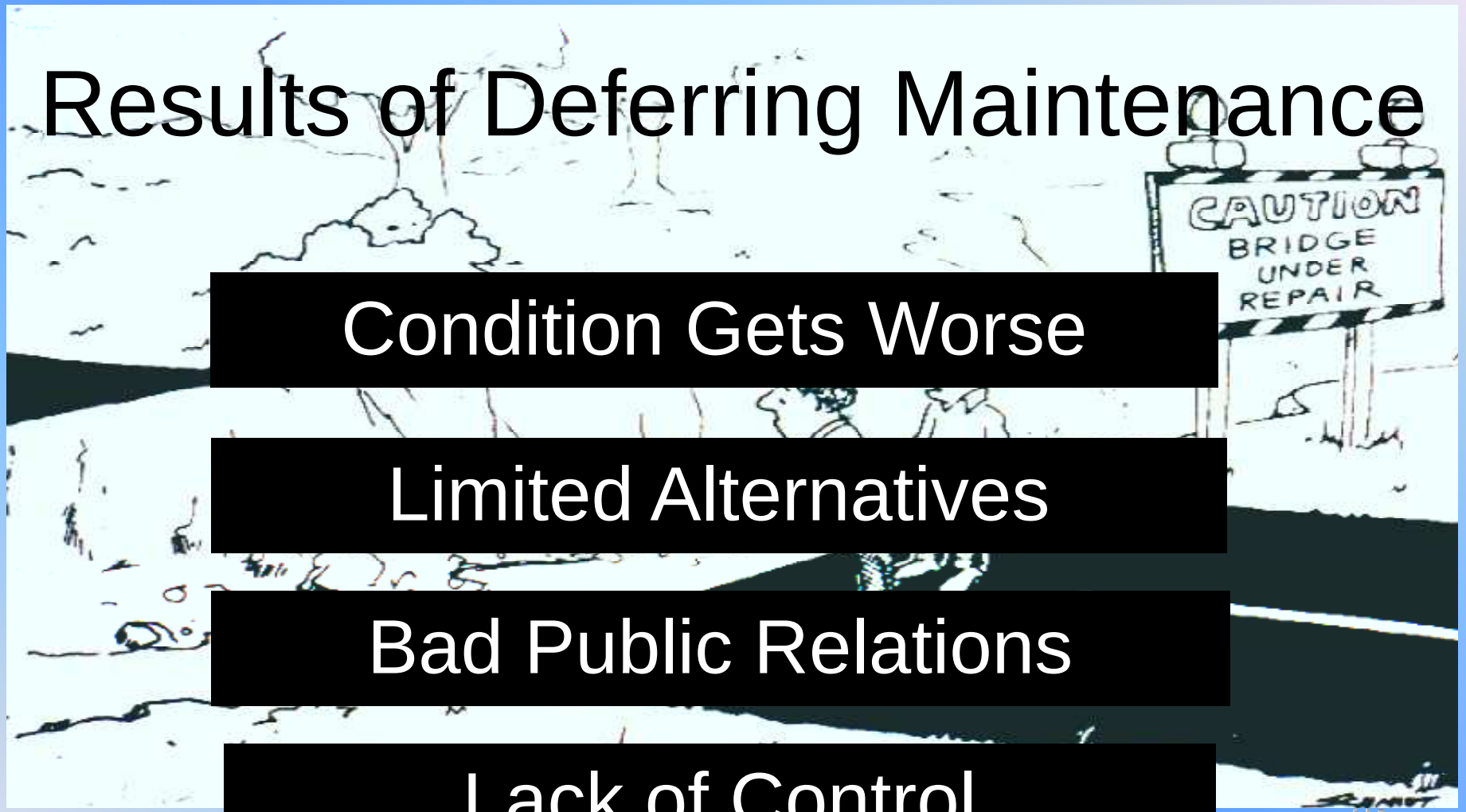
Results of Deferring Maintenance



- Condition Gets Worse
- Limited Alternatives
- Bad Public Relations
- Lack of Control
- Most Costly

Ideal Strategy

- Identify maintenance needs – Use inspection reports, field observation, complaints, etc.
- Prioritize maintenance needs
- Get budget approved
- Plan your work
- Work your plan

Bridge Maintenance Challenge

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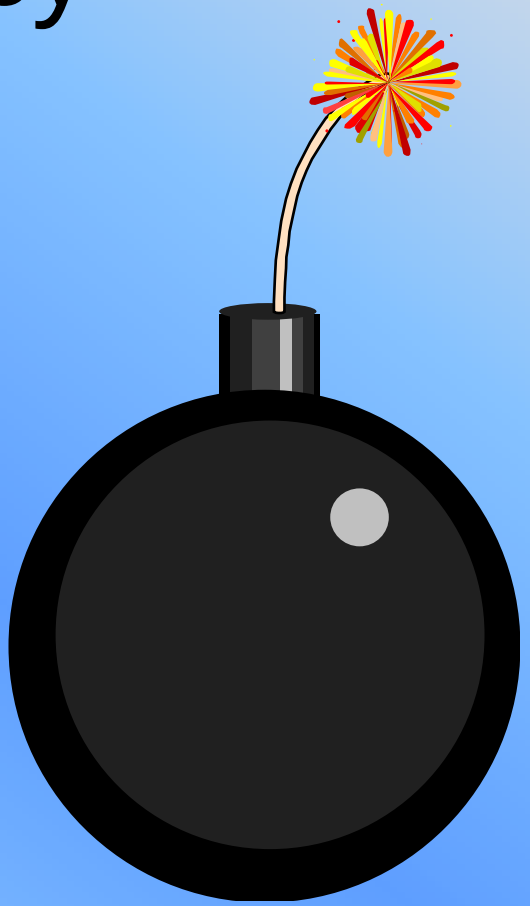
Urgency

- Emergency
- High priority
- Routine



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DP. FTE 44,757 02/20/02

NEW JERSEY DEPARTMENT OF TRANSPORTATION
DIVISION OF BRIDGE DESIGN - STRUCTURE INVENTORY AND APPRAISAL

PAGE 1
STATE ERROR NO
FEDERAL ERROR NO
LAST UPDATE 021702

AA ROUTE 295 # STR. NO. 0429189 AB STRUCTURE NAME I-295 NB OVER NJ ROUTE 73

IDENTIFICATION

1 STATE	NEW JERSEY
2 HIGHWAY DISTRICT	04
3 COUNTY	CAMDEN
4 PLACE CODE	12280
A TOWN	CHERRY HILL TWP.
5 INVENTORY ROUTE	11002960
6 FEATURES INTERSECTED	NJ ROUTE 73
7 FACILITY CARRIED	I-295 NB
8 LOC	AT RT 70 INTERCHANGE
10 VERTICAL CLEAR	99 FT 99 IN
11 MILEPOINT	024.990
100 DEFENSE HIGHWAY	YES
101 PARALLEL STRUCTURE	R
102 DIRECTION OF TRAFFIC	1-WAY
103 TEMPORARY STRUCTURE	
16 LATITUDE	39 D 54.8 M
17 LONGITUDE	074 D 59.0 M
19 BYPASS DETOUR LENGTH	01 MI
20 TOLL 3	ON FREE ROAD
21 MAINTENANCE 01	NJDOT
22 OWNER 01	NJDOT

CLASSIFICATION

104 HIGHWAY SYSTEM INVENTORY ROUTE (1)	ON NHS AC NON-INV.FEATURE
26 FUNCTIONAL CLASS 11	INTERSTATE LRRAM AD ADMINISTRATIVE
98 BORDER BRIDGE	AE ALTERNATE AGENCY
99 BORDER BRIDGE STRUCTURE NO.	AF ALTERNATE STRUCTURE NO.

STRUCTURE DATA

27 YEAR BUILT	1993
106 YEAR RECONSTR	0000
28 LANES ON/UNDER	04/00
29 ADT	053400
30 YR OF ADT	01
109 TRUCK ADTT	09 %
31 DESIGN LOAD	HS-20
32 APP. ROADWAY WIDTH	052 FT
33 BRIDGE MEDIAN	NONE
34 SKEW	00 D
35 STRUCT.FLARED	NO
36 SAFETY FEATURES	1011
A0 BR.RAILING TYPE	24
AH RAILING HT.	3 FT 09 IN
37 HISTORIC SIG	4
38 NAVIG. CONTROL	N/A
39 NAV.VERT.CLEAR	000 FT
40 NAV.HOR.CLEAR	0000 FT
116 MIN.NAV.VRT.CL	FT

41 OPEN/CLOSED/POSTED A	OPEN-NO RESTRICTION
42 TYPE OF SERVICE	HIGHWAY/HWY UNDR PED PRJS CONSTRUME OR
43 STRUC TYPE MAIN SPAN	NONE
44 STRUC TYPE APPR SPANS	002
45 NUMBER OF SPANS MAIN	0000
46 NUMBER OF APPROACH SPANS	052.0 FT
47 INVENT. ROUTE HORIZ. CLEAR	0006 FT
48 MAXIMUM SPAN LENGTH	000135 FT
49 STRUCTURE LENGTH	LEFT 01.5 FT RIGHT 01.5 FT
50 SIDEWALK / CURB	052.0 FT
51 BRIDGE RDWY. WIDTH CURB TO CURB	057.0 FT
52 DECK WIDTH OUT TO OUT	99 FT 99 IN
53 VERTICAL CLEARANCE OVER DECK	H 16 FT 01 IN
54 MIN. VERTICAL UNDERCLEARANCE	16 FT 01 IN
DJ MIN.VERT.UNDER R (INC. SHOULDERS)	H 22.9 FT
55 MIN.LAT.UNDERCLEARANCE RIGHT	01.5 FT
56 MIN.LAT.UNDERCLEARANCE LEFT	100
108 WEARING SURFACE/PROTECTIVE SYSTEM	CONCRETE
A TYPE WEARING SURFACE 1	NONE
B TYPE MEMBRANE 0	NONE
C TYPE DECK PROT 0	

A0 SPEED POSTING	MPH
AJ SLOPE PROT.	NONE
AK ABUT.	FULL HEIGHT
AL PIER	HAMMER HEAD
AM FILL OVER	. FT
STRUCTURE	
AN PLAN ANAL	YES
AO UTILITY	
AP FENDER SYSTEM	NONE
AQ CHLK FNC HT	FT IN
AR SPECIAL DESIGN	
AS SPECIAL TESTING	
AT SPECIAL MATERIAL	
AU ADD. STRUCT.TYPE	
AV WIDENING TYPE	
107 DECK STRUCT. TYPE	1
113 DESIGNATED REPAIR	YES
111 NAVIGATION PROT.	
112 NBIS BRIDGE	YES
92 CRITICAL FEATURE BRI	
A FRACT.CRIT.DET.	NO
INSP.FREQUENCY	NO
B UNDERWATER INSP	NO
INSP.FREQUENCY	NO
C OTHER SPEC.INSP.	NO
INSP.FREQUENCY	NO

CONDITION RATINGS

58 DECK	6
59 SUPERSTRUCTURE	5
60 SUBSTRUCTURE	6
61 CHANNEL AND CHAN. PROTECTION	N
62 CULVERT	N
8A APPROACH RDWY CONDITION	8
64 OPER. RATING	299
65 INV.RATING	250

APPRAISAL RATINGS

67 STRUCTURAL EVALUATION	5
68 DECK GEOMETRY	2
69 UNDERCLEARANCE VERT. & LAT.	N
70 BRIDGE POSTING	5
71 WATERWAY ADEQ.	N
72 APPR. ROWAY ALIGNMENT	8

RAILROAD ITEMS

8A ORPHAN BRIDGE	
8C USRA LINE CODE	
8D RR TRUS OWNER	/
8E RR MILEPOST	

REMARKS

BF (58) DET DECK JOINTS LESS THAN 2% SPALLS MEDIUM TO WIDE CRACKS DETERIORATED CURBS EXPOSED REBARS

BG (59) COLLISION DAMAGE EXPOSED STRANDS RUSTED BEARINGS

BH (60) MEDIUM/WIDE CRACKS

SEVERE SPALLING

BI (61)
BJ (62)

LOAD FACTOR

REMARKS

PROPOSED IMPROVEMENTS (COSTS IN THOUSANDS)

75 TYPE OF WORK	331
76 IMPROVEMENT LENGTH	000135 FT
94 BRIDGE IMPROVEMENT COSTS	$000118
95 ROADWAY IMPROVEMENT COST	$000000
96 TOTAL PROJECT COST	$000274
97 YEAR OF IMPROVEMENT COST ESTIMATE	99
114 FUTURE ADT	062600
115 YEAR OF FUTURE ADT	21
80 STATE MAINTENANCE COST	$
BP BRIDGE TO BE DEMOLISH/NO REPLACEMENT	
DA DESCRIPTION OF PROPOSED IMPROVEMENTS	

WIDEN STRUCT;INTERM.UPGRD SFTY FTRS;PTCH DK SPLS;SL APR SLB ENDS;CLN&PL PR DK JOINT;PTCH SUPRSTR SPLS;CLN&PNT PR&MNT BRNGS; PTCH SUBSTR SPLS;RMV HVY VEG GROWTH FROM ;REPAC RPLC MISNG UTILITY POLE SCREWS

RATINGS OTHER

ITEMS	INV. RTG-RV	OPER. CA-CO
H TRUCK/LDI		
H/TRUCK/LD2	30	99
TYPE 3 /LD3	36	99
TY.3-3 /LD4	40	99
TT.3-3 /LD5	47	99
ML.LD /LD6		
POSTED LOAD		
CH MISC. RATING		L
ADJUNV. TONNAGE		
DEDUCT CODE		A

INSPECTION DATA

90 LATEST INSPECTION	01/02
CI CYCLE NUMBER	12
CJ TYPE INSPECTION	S
91 DESIGN INSP. FREQ	24 MO
CK INSP. CREW NO	P
CL NEXT INSP. DATE	0104
CM CONSULTANT	ARORA & ASSOC.
CN PREV.INSP. DATE	8-01/00
CO PREV CONS	ARORA & ASSOC.
CP FEDERAL REPORT	YES
CQ BRIDGE LIST	
CR OFF ROUTE BRIDGE	

AZ FATIGUE DETAILS
LOC. 1
LOC. 2
LOC. 3

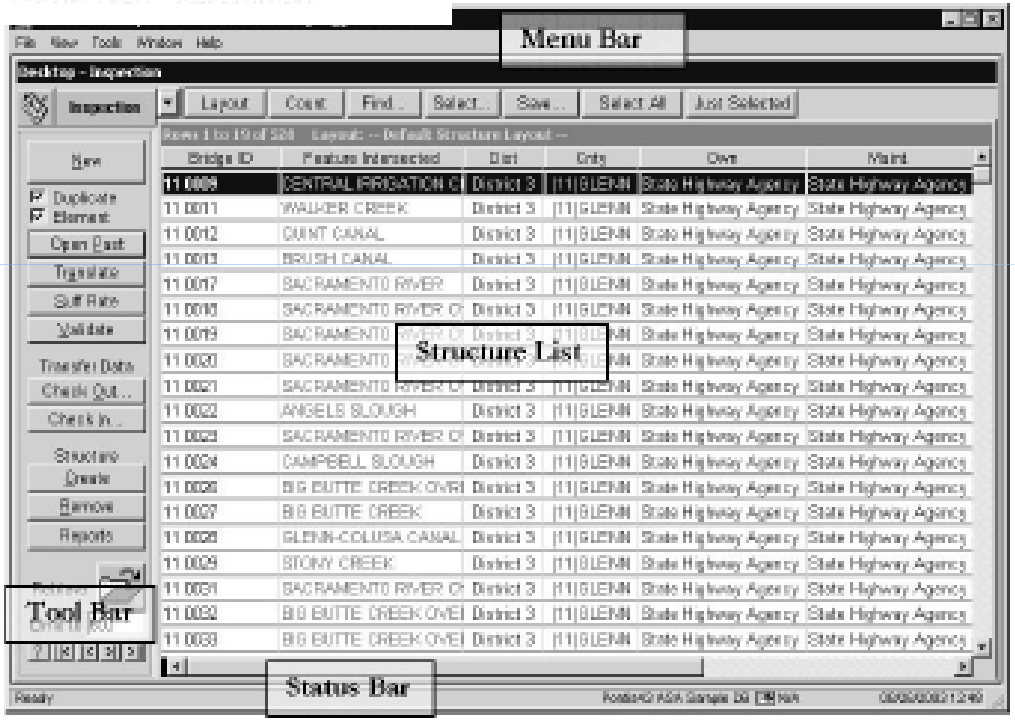
SUFFICIENCY RATING (FUNC OBS) 087.4

FINANCING

BL DISCRETIONARY FUNDS	
BM FED.JOB NO.	BR NB6737
BN STATE JOB NUMBER	3203471
STATUS	2

9K PERCENT OVERDESIGN

113 SCOUR CRITICAL N N/A



Pontis Desktop – Inspection Module

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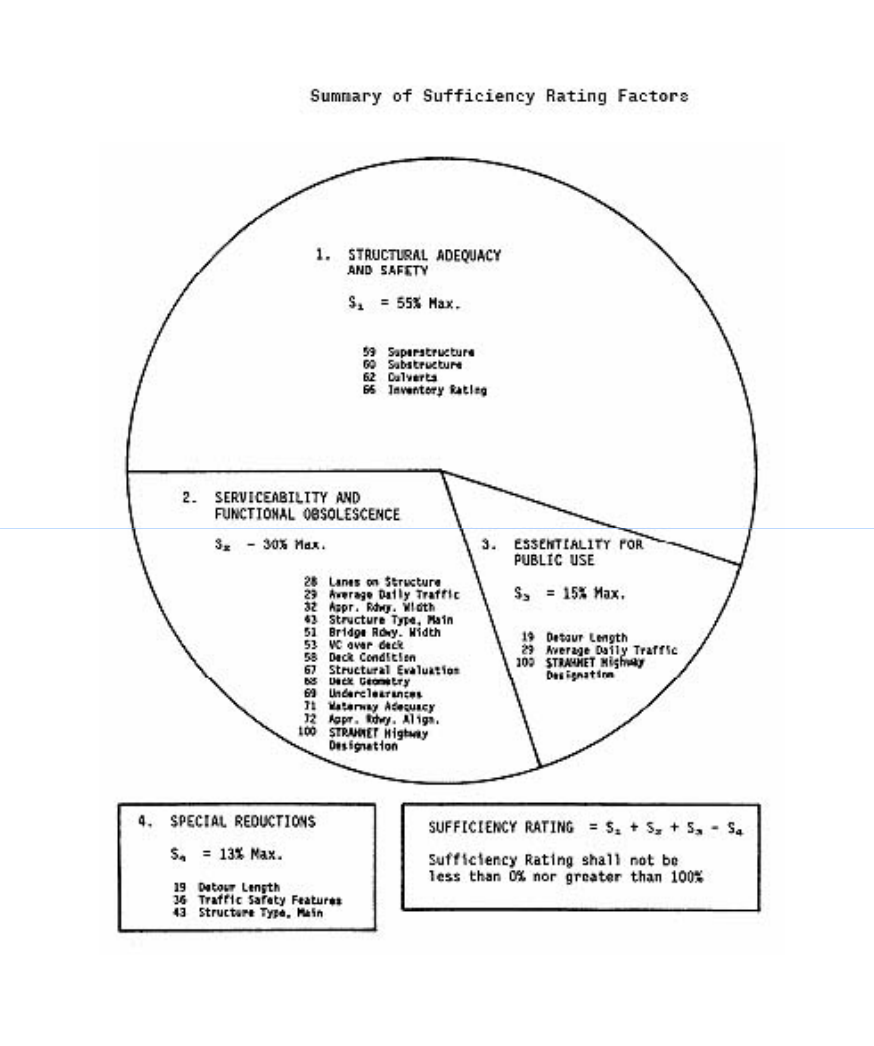
Sufficiency Rating



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Key

Exercise 1

Bridge Inspection Record

District: ___ County ___ Cont-Sec: ___ - ___ Structure: ___ Route: ___

Description: 3-span steel girder w/concrete column bents

Feature Crossed: ___ Inspector's Signature: ___ Date: ___

Firm Name: ___

N- Not applicable
9- Excellent condition
8- Very good condition - no problems noted
7- Good condition - some minor problems
6- Satisfactory condition - minor deterioration of structural elements (limited)
5- Fair condition - minor deterioration of structural elements (extensive)
4 Poor condition - deterioration significantly affects structural capacity
3- Serious condition - deterioration seriously affects structural capacity
2- Critical condition -bridge should be closed until repaired
1- Failing condition - bridge closed but repairable
0 Failed condition - bridge closed and beyond repair

Enter a rating for each element of each component. The rating should equal or exceed the minimum rating listed to the left of each element. Component ratings should equal the lowest rating of any element of the component. Fully supportive comments are to be made hereon or on attachments for all ratings of 7 or below.

Min.	Deck (Item 58)		Rating
1	Deck -Rating	1.	6
6	Wearing Surface		N
6	Joints, Expansion, Open	2.	6
6	Joints, Expansion, Sealed		N
6	Joints, Other		N
6	Drainage System	3.	6
6	Curbs, Sidewalks & Parapets		N
6	Median Barrier		N
6	Railings	4.	6
7	Railing Protective Coating	5.	7
7	Delineation (curve Markers)		N
	Other		N

Comments:
1. Cracking w/some spalls
2. Clogged expansion joint
3. Clogged drainage ports
4. Unrepaired area of railing
5. Protective coating flaking

Min.	Superstructure (Item 59)		Rating
0	Main Members - Steel	1.	6
0	Main Members - Concrete		N
0	Main Members - Timber		N
0	Main Members - Connections		N
1	Floor System Members		N
1	Floor System Connections		N
5	Secondary Members	2.	7
5	Secondary Members Connections	3.	6
6	Expansion Bearings	4.	6
6	Fixed Bearings	5	7
6	Steel Protective Coating	6.	7
	Other		
	Component Rating		6

Comments:
1. Corrosion at some girder ends
2. Some rusting
3. Some connections near failure due to corrosion
4. Some expansion frozen due to corrosion
5. Some rusting
6. Some paint failure areas with rusting

Bridge Inspection Record (page 1 of 2)

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Publication No. FHWA NHI 03-001
October 2002
Revised December 2006

U.S. Department
of Transportation

Federal Highway
Administration

Bridge Inspector's Reference Manual

BIRM

Volume 1

NATIONAL HIGHWAY INSTITUTE

Other Sources Of Needs

- Observed needs
- Accident reports
- Complaints

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Bridge Approach

Why Include the Approach?

It affects the bridge's:

- Smooth ride
- Dynamic impact load
- Safety
- Drainage requirements

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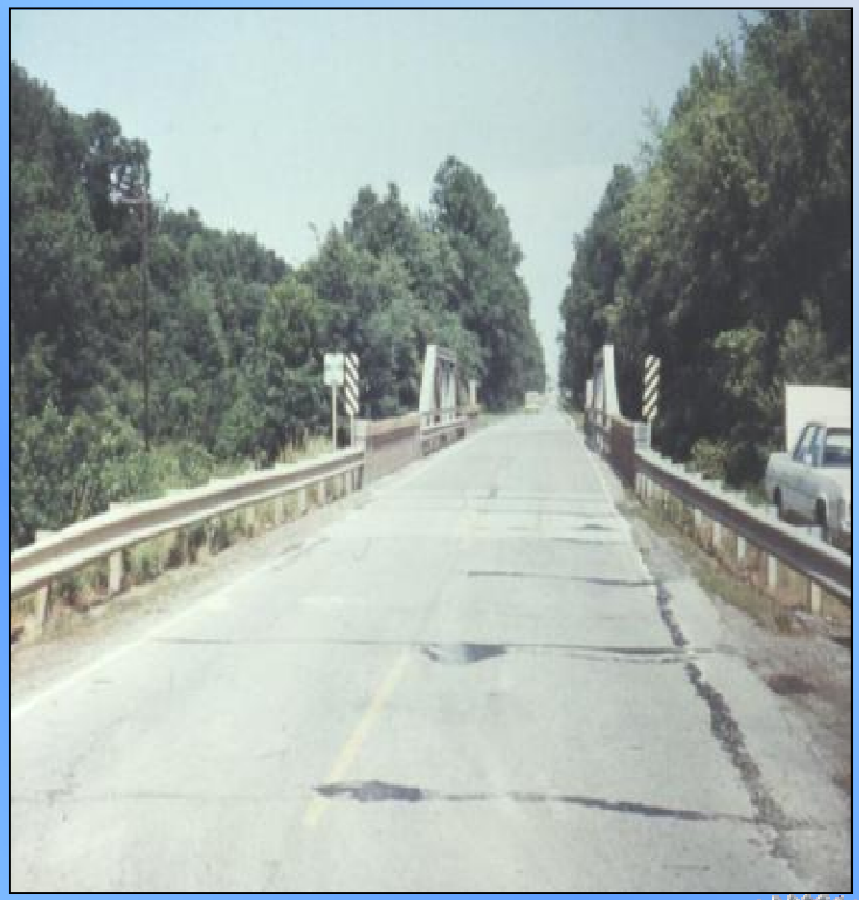
Approach Relief Joints

- Patch/Repave
- Add relief/expansion joints



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Approach Relief Joints

Relieve concrete pavement expansion pressure to prevent damage to:

- –Abutment
- –Backwall
- –Joints
- –Bearings
- –Parapets and Rails

Pavement Growth Symptoms

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Pressure Relief Joints

- Symptoms of Pavement Growth
  - Closed Pin and Hangers During Cold Weather
  - Excessively Tilted Rockers
  - Barrier Wall Distress
  - Diagonal Quadrant Cracking
  - Abutment Spalls
  - Buckled Tail Spans
  - Expansion Joint Cracking (Skewed Structures)
- Quick and economical repair
- Eliminates extensive and costly repairs down the road i.e.
  - Temporary supports
  - Pin and hanger replacements
  - Barrier wall rehab
  - Span replacement

Approach Settlement

- Patch/Repave
- Add relief/expansion joints
- Grade and shape shoulders and unpaved roadways
- Clear obstructions and clean signs and guide rail
- Repair settlement

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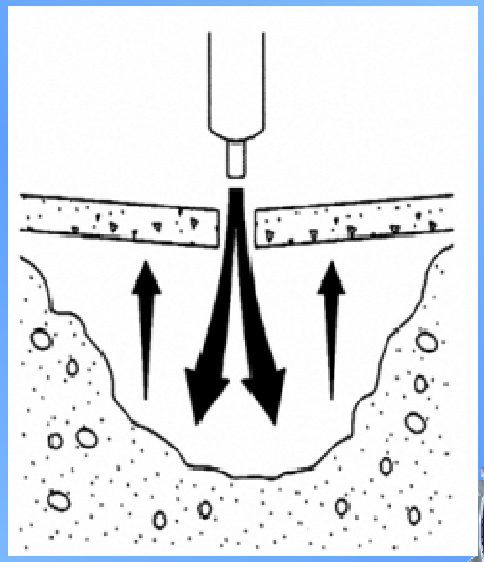
Approach Settlement

- Poor compaction
  - Ramp from pavement
  - Build up pavement
- Void under pavement
  - Excavate and replace embankment
  - “Mud jacking”, flowable fill or polyurethane foam



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Elements of a Durable Deck

- Quality concrete
- Proper cover
- Rebar corrosion protection

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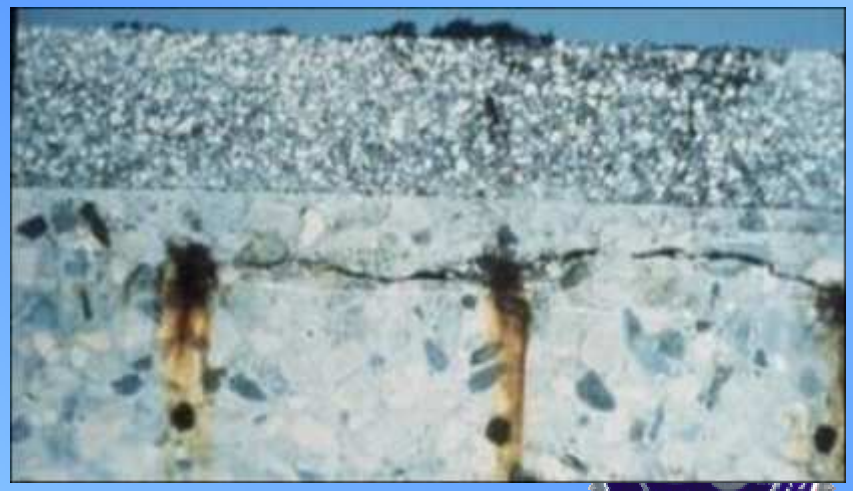
Bridge Deck Problems

- Corrosion of reinforcing steel
- Delamination/Spalling
- Cracking
- Freeze-thaw scaling
- Wear and lack of skid resistance



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Preventive Maintenance

- Keep clean by removing salt and debris
- Waterproof (seal) concrete surface
- Seal cracks
- Overlay deck
- Perform **durable** repairs

Sealing Concrete Decks

- Penetrating sealers
- Surface sealers
- Membranes

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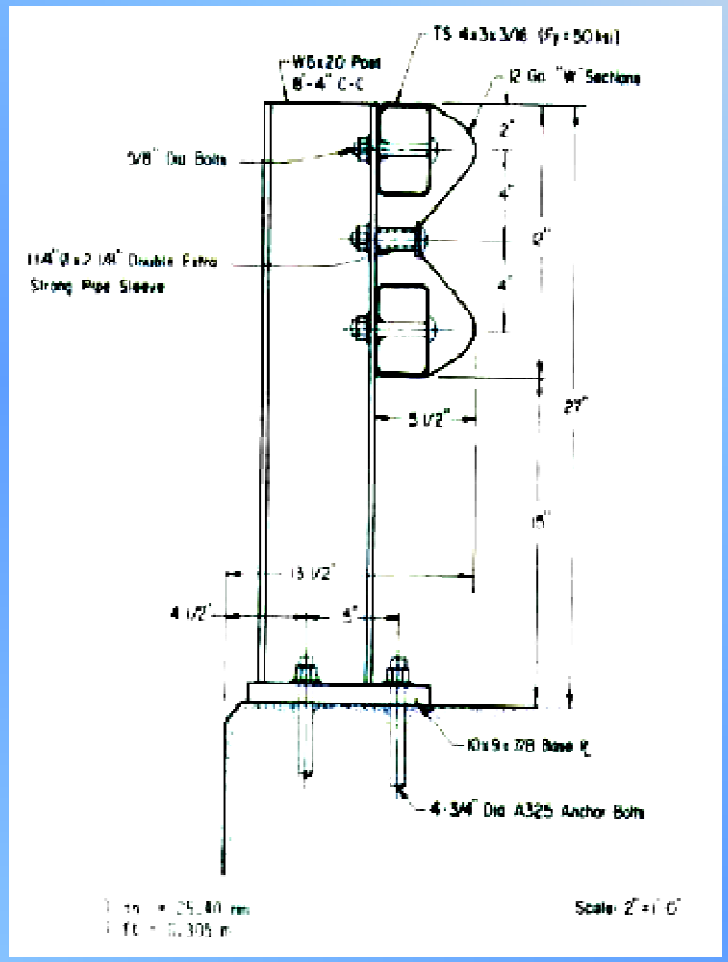
Damaged Rails

- Massive fixed object
- Structural member
- Substandard
- Approach transition
- Temporary repair

Replacement Rail Top Mounted

Issues

- Approved type
- Sound concrete
- Anchor type
- Roadway clearance
- Corrosion protection



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Ideal Deck Joint

- Watertight
- Accommodates the full range of movement
- As durable as the deck
- Low maintenance

Until This Marvel is Available

Preventive maintenance is necessary:

- To keep joints functioning and
- To avoid costly structural damage

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Bridge Joint Problems

Common problems:

- Water and contaminants leaking through joint due to poor bond or sealer damage
- Non-compressible debris lodged in joint
- Damaged concrete edges
- Slippage or deterioration of filler material
- Edge damage

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Impact of Poor Joint Maintenance

- End diaphragms
- Beam ends
- Bearings
- Seats
- Substructure

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Bearing Problems

- Corroded
- Out-of-Position
- Damaged support

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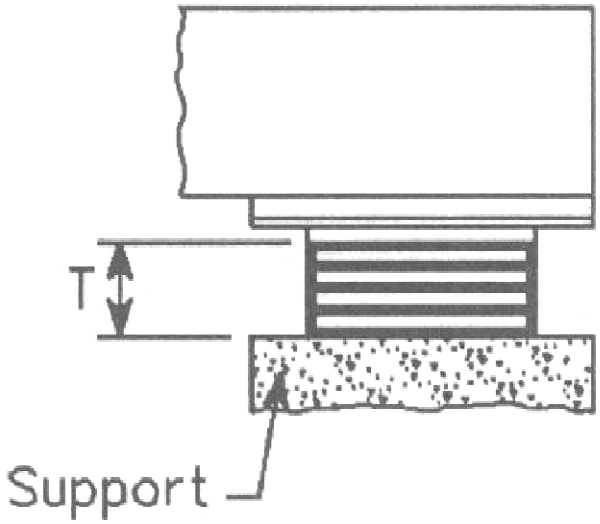
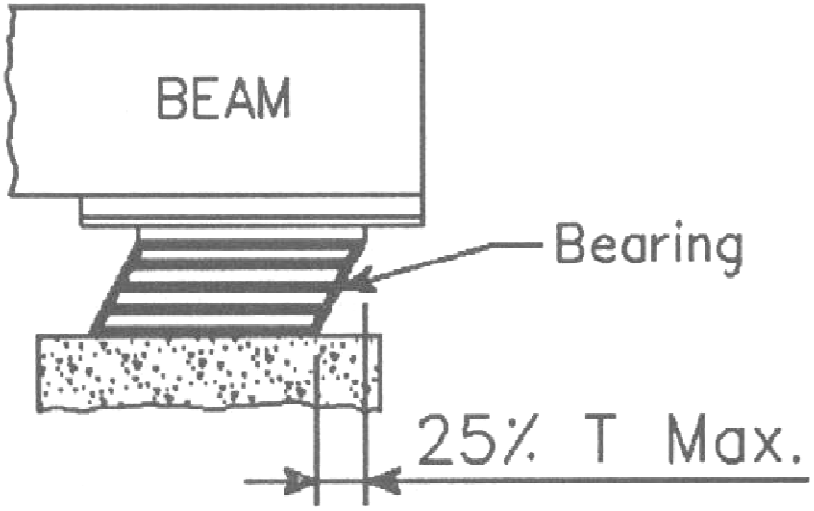
Elastomeric Limitations





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Related Problems

- Beam ends
- Seats

Preventive Maintenance

- Watertight joint
- Remove salt and debris
- Corrosion protection
- Prevent friction
  - Monitor movement
  - Lubricate

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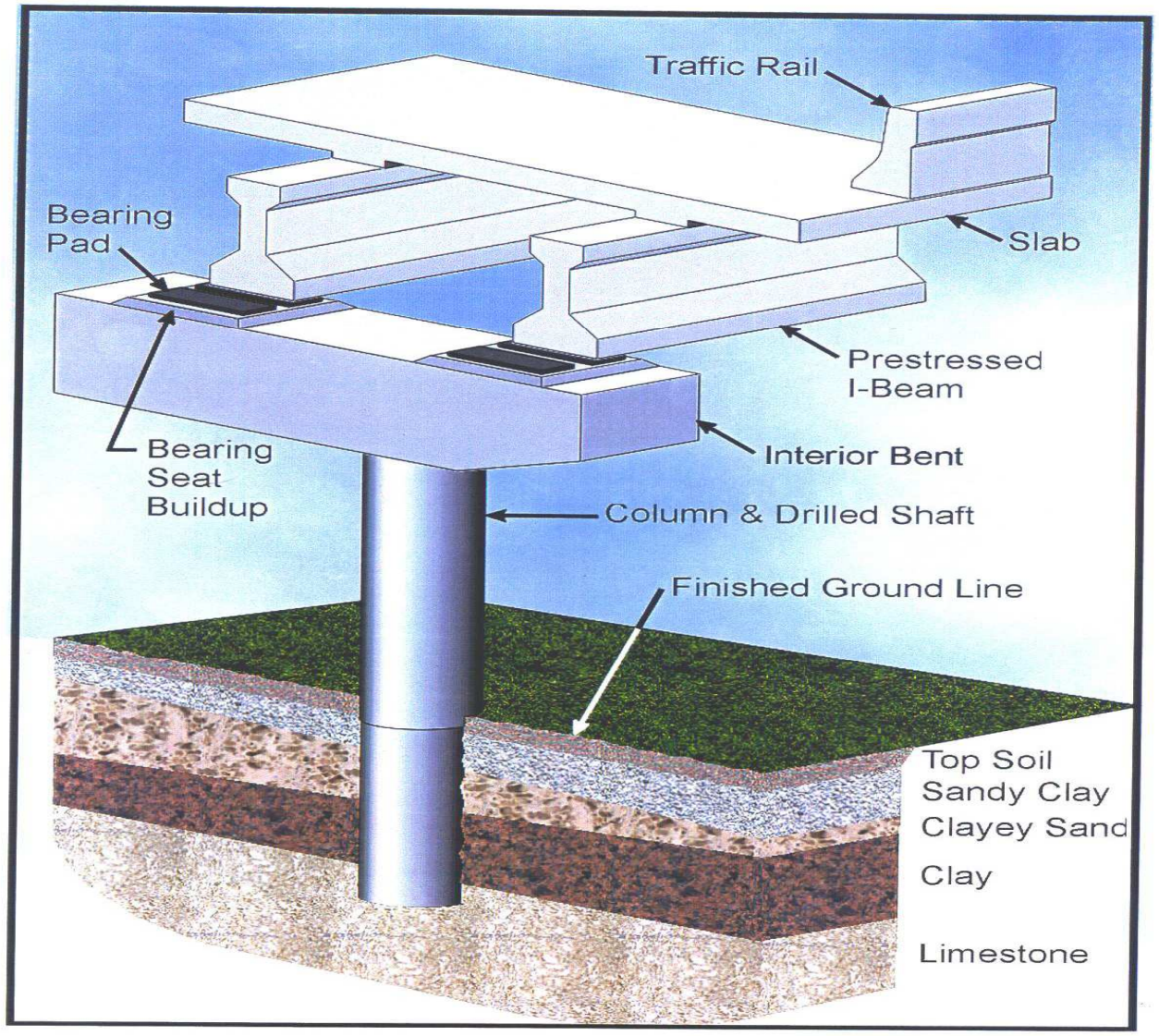

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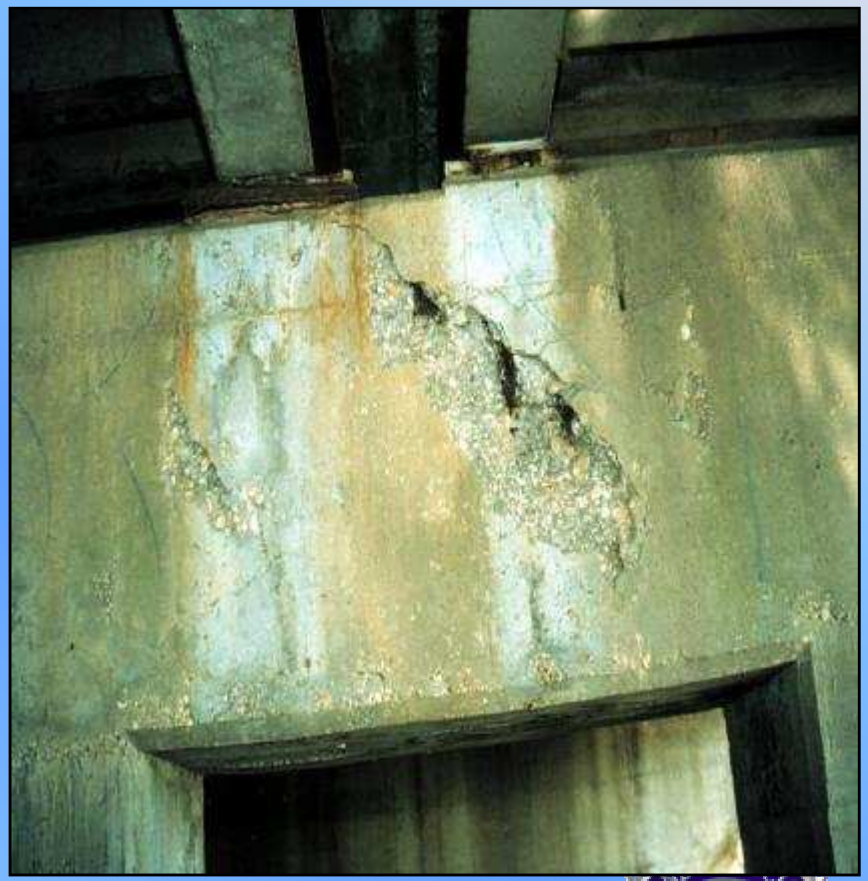
Preventive Maintenance

- Remove debris and pressure wash exposed surfaces
- Coat exposed surfaces
- Waterproof joints
- Lubricate bearings
- Protect against substructure movement



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Substructure Deterioration

- Concrete – Spalling or deterioration
- Timber – Decay or vermin attack
- Steel – Corrosion
- All – Buckling and impact damage

Pile Maintenance

- Protective coatings
  - Paint (exposed steel)
  - Waterproof sealant (exposed concrete)
  - Preservative (timber)
- Pile jackets
- Impact protection
- Remove brush as fire protection
- Scour protection

Precautions Around Streams

- Excavation in channel
- Debris removal
- Channel blockage
- Channel diversion
- Drainage into stream

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Debris Removal Issues

- Environmental habitat
- Sediment control
- Damage to bridge
- Damage to property upstream

Debris Damage

- Scour
- Impact

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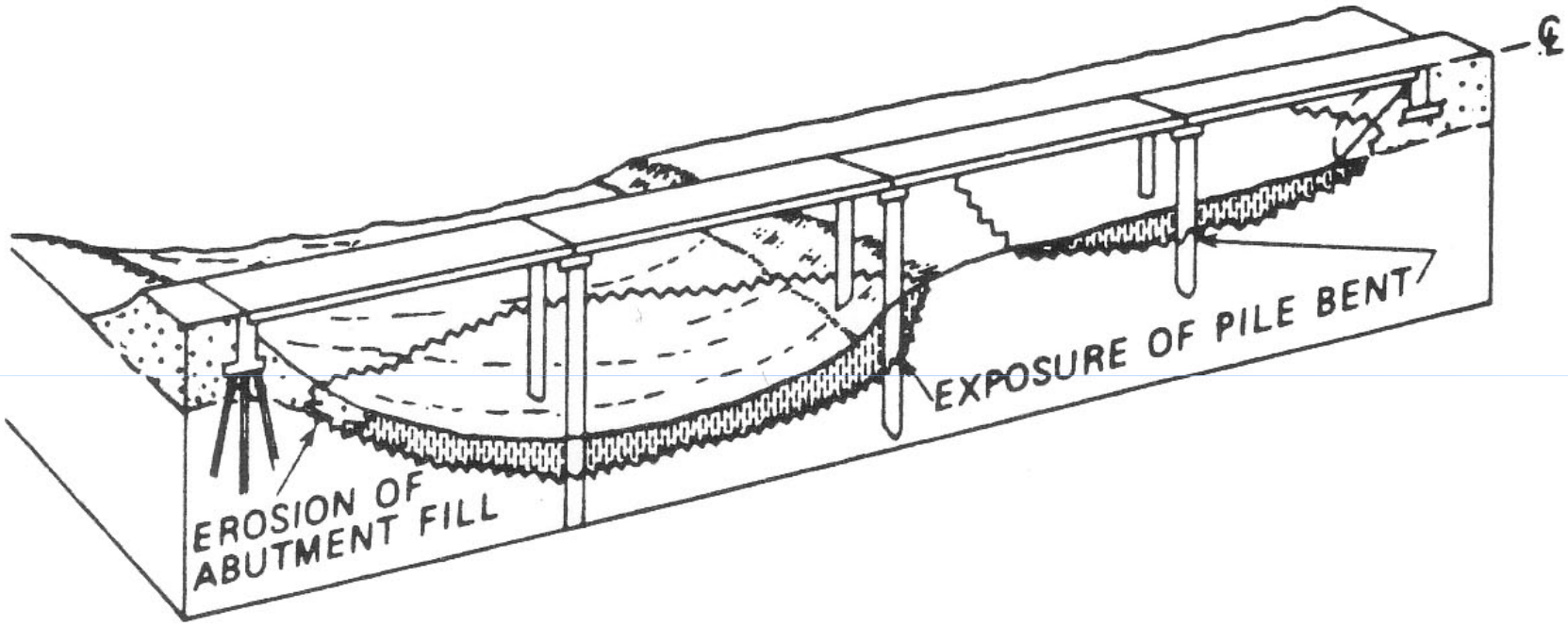
Countermeasures

- Structure modification
- Debris deflectors
- Flood relief
- Debris and sediment traps
- Land use regulations



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Role of Maintenance

- Develop emergency plan
- Respond to emergencies
- Perform scour repairs
- Identify, install, and maintain protection devices

Scour Control Methods

- Revetments (slope protection)
- Flow control (stream training)
- Structure or channel modification

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In Summary Preventive Bridge Maintenance Basics Are

- Maintain bridge approach roadway and deck
- Control deck drainage
- Keep joints clean and sealed
- Clean/maintain bearings
- Remove debris from streambed/channel
- Control drainage and scour

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Maintain the bridge approach

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Control deck drainage

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Keep joints clean

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Restore bearings

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Control drainage and scour

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Remove debris

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Questions?

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