Er. G. K. Sahu, Chief Scientist, CSIR-CRRI New Delhi and having more than 34 years of experience in the field of Bridge Engineering. His area of interest is Health Monitoring of Bridges through instrumentation, Condition Assessment, Load test, NDT, repair & rehabilitation, and quality control of Bridges. He is the Ex Secretary and Chairman of Indian Concrete Institute, Ghaziabad Centre. He has also served NHAI as a GM (T) for more than 5years.

G K SAHU, Chief Scientist

Bridge Engineering and Structures Division
CSIR-Central Road Research Institute New Delhi

Affiliation: IRC; Member Secretary, Bearings and Expansion joints of Bridges.

Outline of Presentation

Introduction

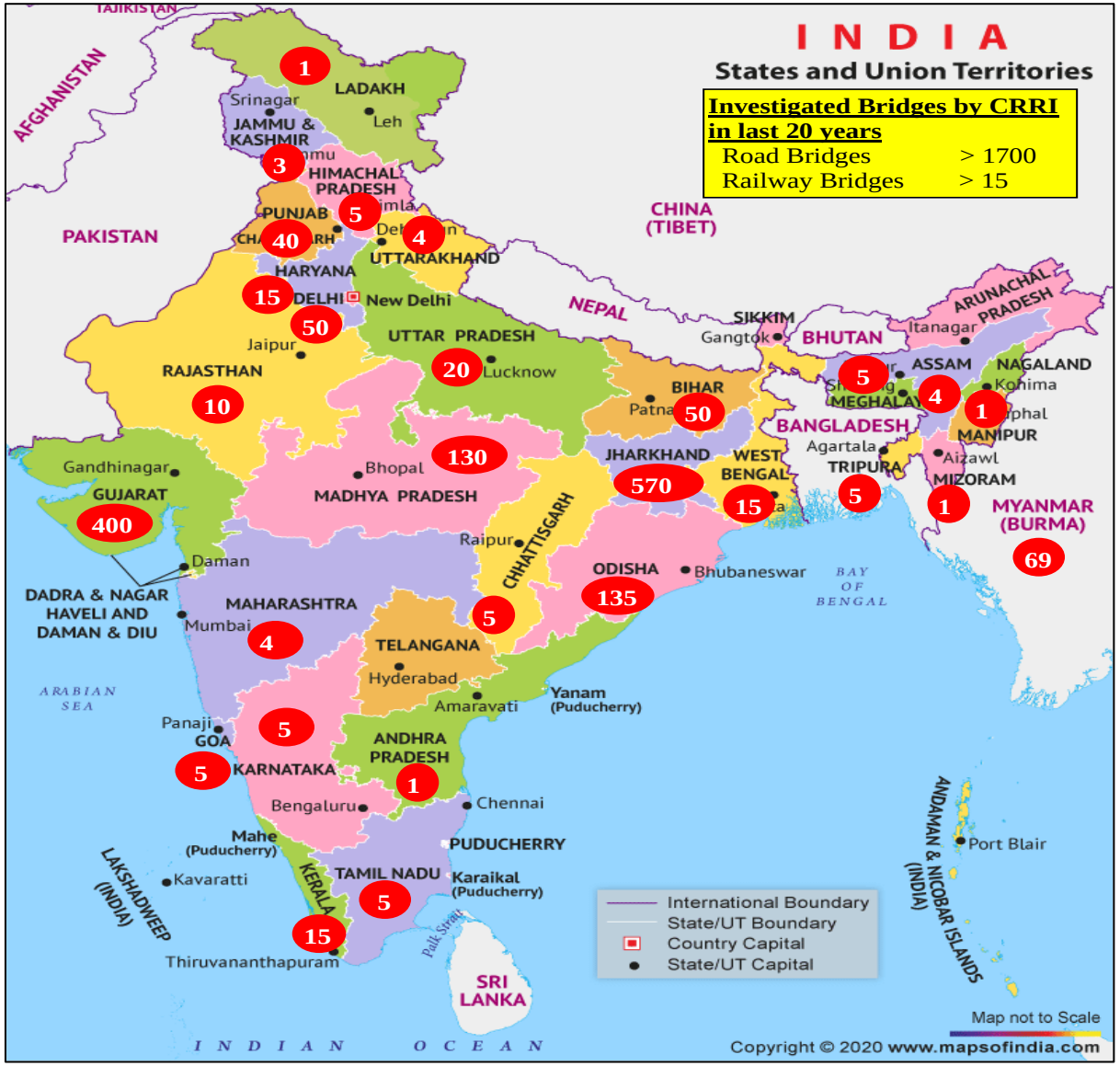
Inspection of Bridges

Non Destructive Test

Structural Health Monitoring

Rehabilitation Measures

Bridge Engg. & Structures since 1952



- India is having second-largest road network in the word
- NH > 1.46 lakhs Km (about 2%)
- SH >1.71 Lakhs Km (about 3%) and
- Other Road Network > 63.4 lakhs Km (about 95%)
- Bridges are the vital link of the road network
- National Highways > 1.69 lakhs structures
- Railways > 1.58 lakhs bridges

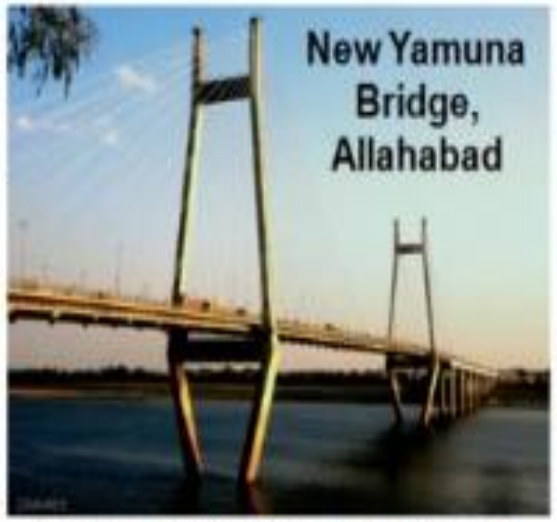
Types of Bridges in general

ARCH BRIDGE

SOLID SLAB BRIDGE

VOIDED SLAB BRIDGE

T-BEAM BRIDGE



CABLE STAYED BRIDGE

SUSPENSION BRIDGE

Mission 2024: Clean and Maintain (C M) Structures Save Structures

1. CM - Clean and Maintain Drainage Spout
2. CM - Clean and Maintain Expansion Joint
3. CM - Clean and Maintain Water Logging on Deck Slab
4. CM - Clean and Maintain the Excessive Dead Weight on Deck Slab
5. CM - Clean and Maintain Vegetation Growth
6. CM - Clean and Maintain Abutment and Pier heads
7. CM - Clean and Maintain Bearings
8. CM -Clean Water ways/silting & Maintain it
9. CM -Excessive Live Load & Maintain it
10. CM-Clean exposed reinforcement, damages, honeycombing, cracks, erosion, protective apron by proper repair & rehabilitation and Maintain it
11. CM - Clean and Maintain Cables and Anchors in case of Special Bridges

INSPECTION OF BRIDGES

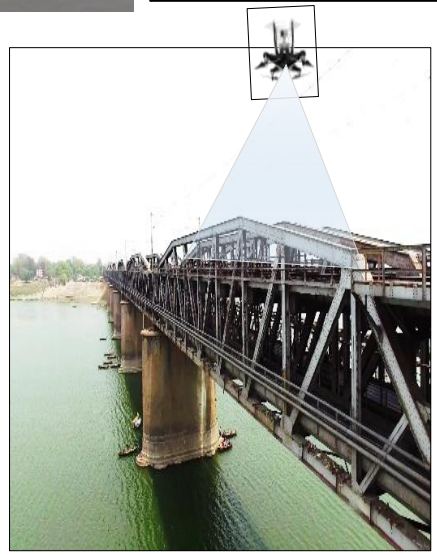
- Mobile Bridge Inspection Unit (MBIU), Man lifters, Motor Boats, Rafters and ladders

- Under water scanning through special robots/ divers.

- Drones for Special Structures Suspension Bridges, Cable Stayed Bridges and Extradoses Bridges

INSPECTION OF BRIDGES

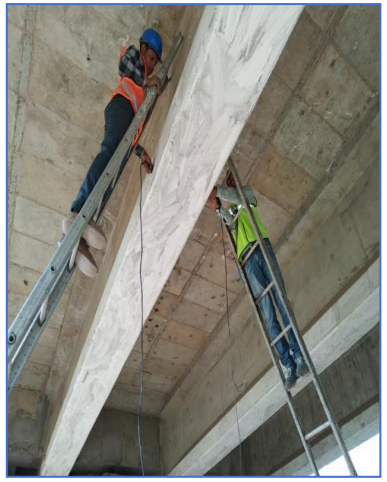
MBIU



DRONE

BOAT

MANLIFTER



Ladders

INSPECTION OF BRIDGES

Inspection, Maintenance and Structural Health Monitoring of Bridges

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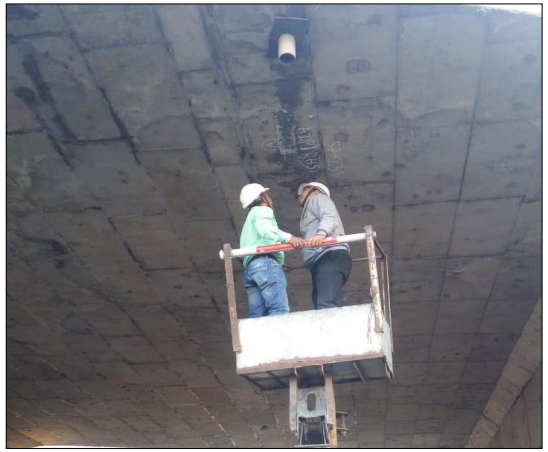
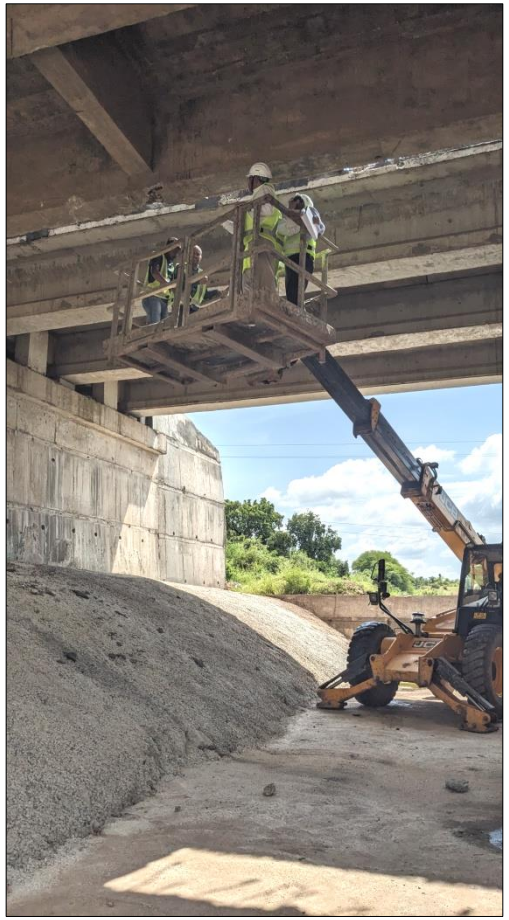
Inspection of Bridges through Man lifter





Man lifter with Fixed Platform

Inspection of Bridges through Man lifter

Man lifter with Moveable Platform

Inspection through Boats

Inspection, Maintenance and Structural Health Monitoring of Bridges

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Inspection of Bridges through Ladders

Inspection of Bridges along Barrages

INSPECTION OF BRIDGES THROUGH MBIU

Inspection of Bridges through MBIU

Inspection of Bridges through MBIU

Inspection of Bridges through MBIU

Inspection of Bridges through MBIU

Inspection, Maintenance and Structural Health Monitoring of Bridges

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Pre opening Structural Safety Audit of Dwarka Expessway

Inspection, Maintenance and Structural Health Monitoring of Bridges

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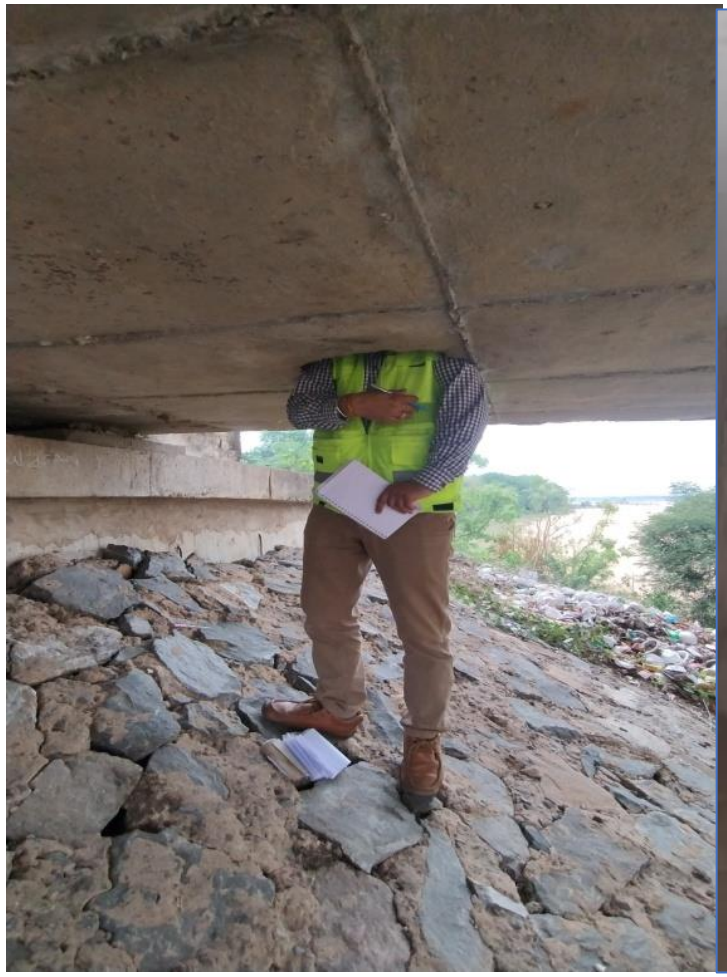
INSPECTION Of STEEL BRIDGE

Inadequate Provision of Access in Bridges



Pre opening Structural Safety Audit of Dwarka Expessway

Pre opening Structural Safety Audit of Dwarka Expessway

Inspection, Maintenance and Structural Health Monitoring of Bridges

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Inspection of Bridges

Inspection, Maintenance and Structural Health Monitoring of Bridges

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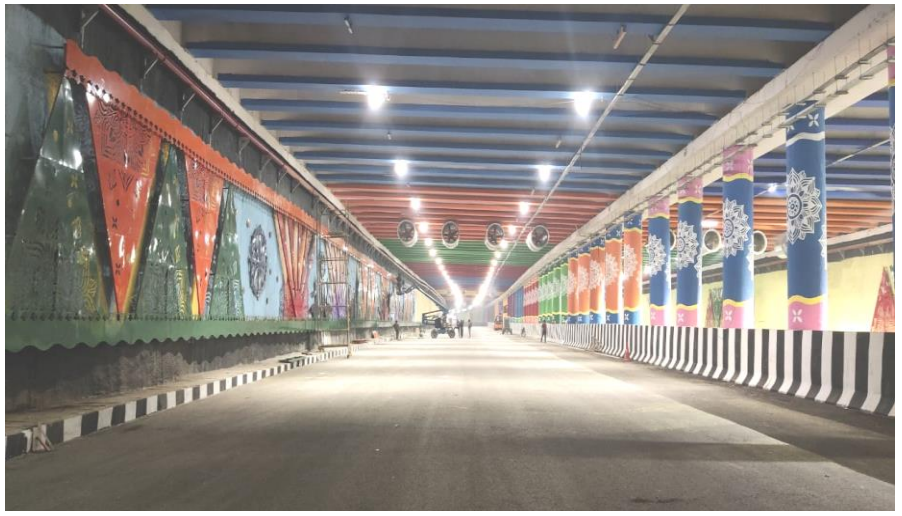
Inspection of Bridges through Rope way & DRONE

DRONE

Inspection of Tunnel






Inspection, Maintenance and Structural Health Monitoring of Bridges

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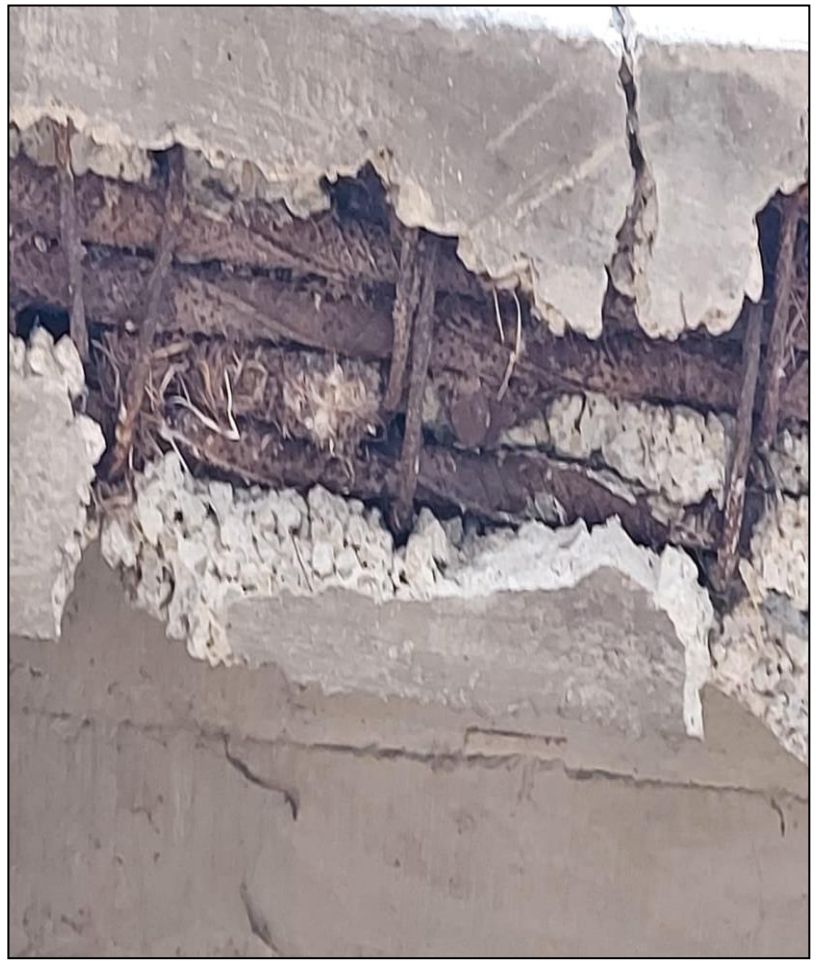
Inspection of Bridge



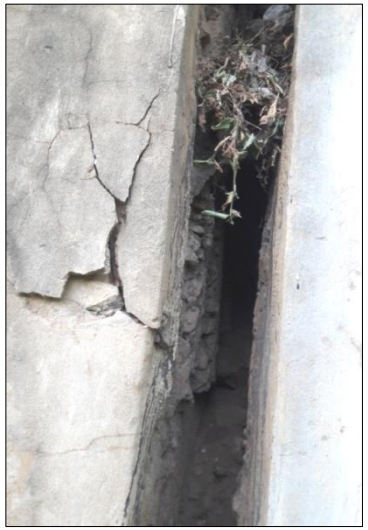
INSPECTION OF BRIDGES

Leakage through Drainage Spouts






Expansion Joints



Excessive Dead Load of Bituminous Concrete

Vegetation Growth

Cleaning of Pier Heads

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Inspection of Bearings

Inspection, Maintenance and Structural Health Monitoring of Bridges

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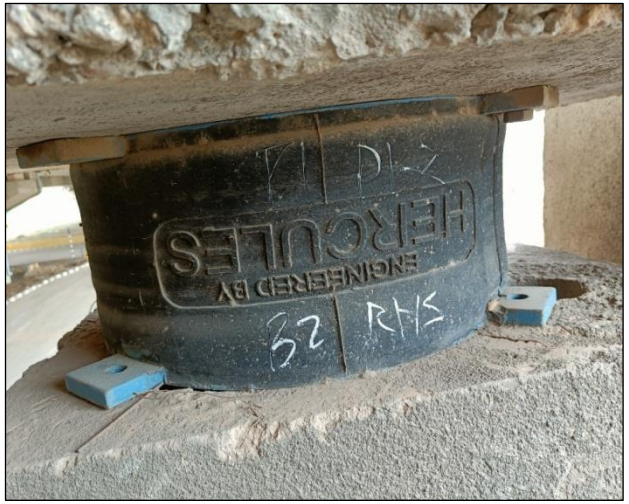
Inspection of Bearings



Inspection of Bearings

Inspection, Maintenance and Structural Health Monitoring of Bridges

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Replacement of Bearings

Replacement of Bearings

Client: PWD, Orissa

Total Bridges : 304

PWD Divisions: 31

Major Bridges: 52

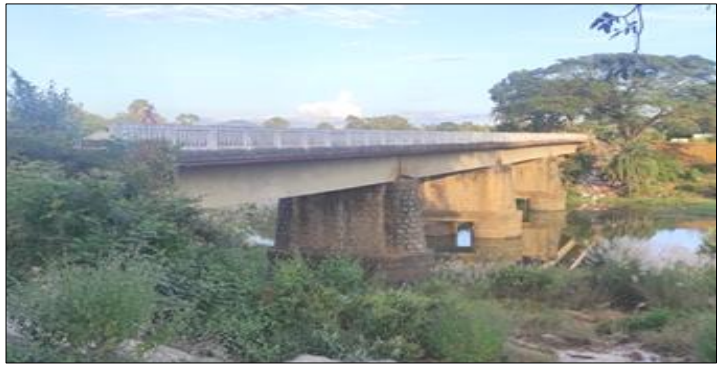
Minor Bridges: 252

Client : RWD, Orissa

Proposed 200 Bridges

INSPECTION OF BRIDGES

Typical Major Bridges



Bramhani Bridge, Dhenkanal

1X28m+24X52m+1 X28m Length = 1304m

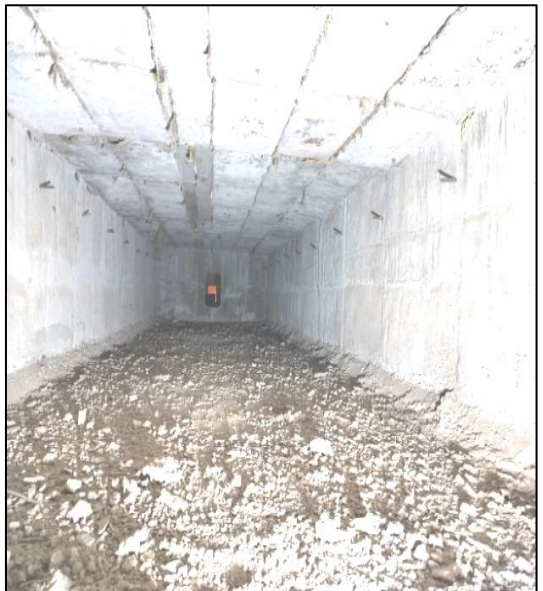
SUSPENDED SPAN

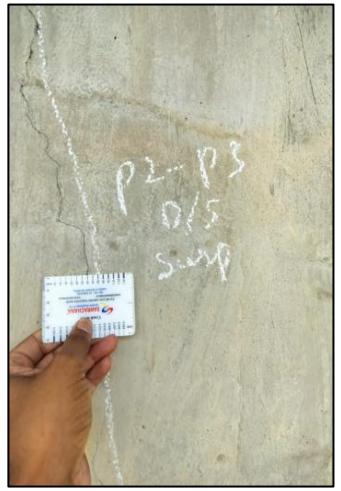
Bramhani Bridge, Dhenkanal

1X28m+24X52m+1 X28m (1304m)

INSPECTION OF BOTH THE END OF SUSPENDED SPAN

Bramhani Bridge, Dhenkanal



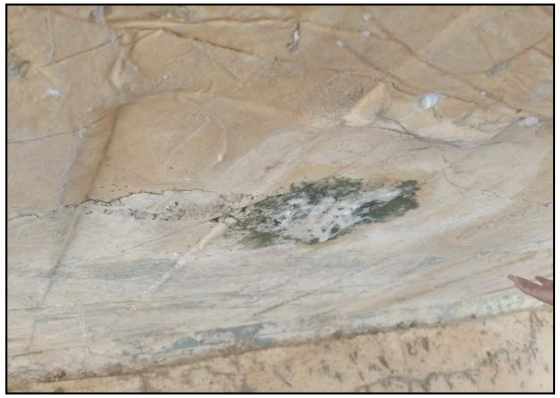


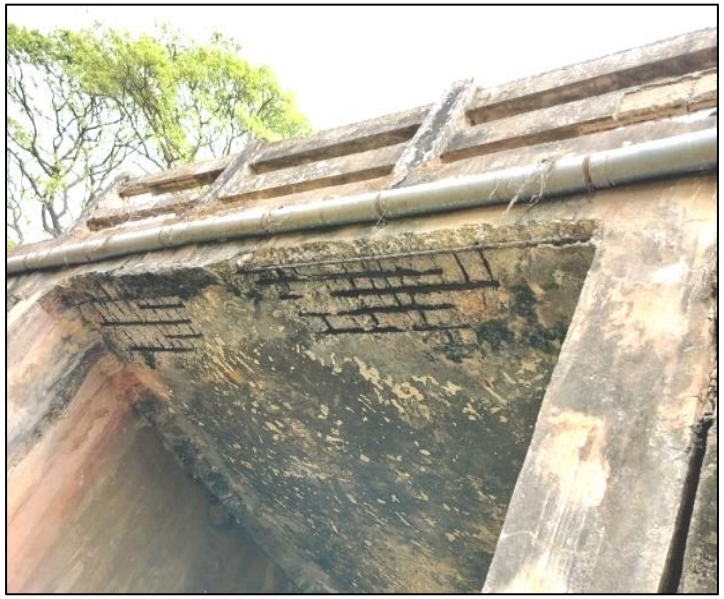
INSIDE VIEW OF BOX GIRDER
BRAMHANI BRIDGE, DHENKANAL

OUTSIDE VIEW OF BOX GIRDER
BRAMHANI BRIDGE, DHENKANAL

BAJIRAO BRIDGE AT DHENKANAL

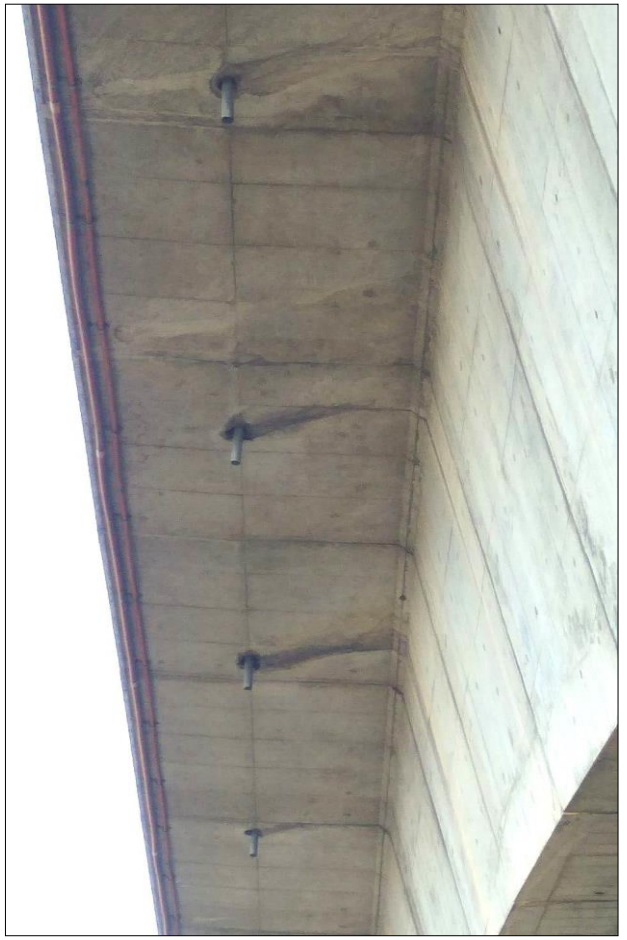
BEARING LOCKS AND TEMPORARY SUPPORTS





Inspection and Testing through Man lifter

Drainage Spout with extended pipes



Inspection, Maintenance and Structural Health Monitoring of Bridges

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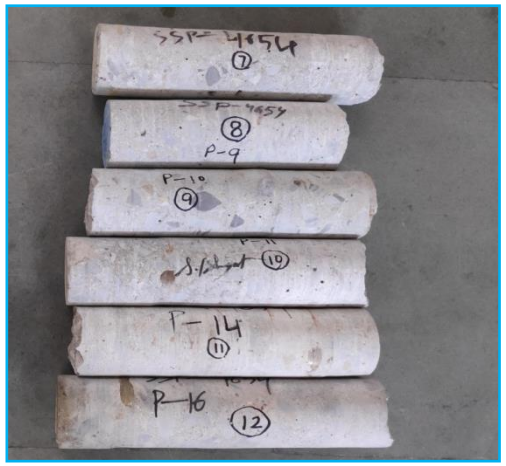
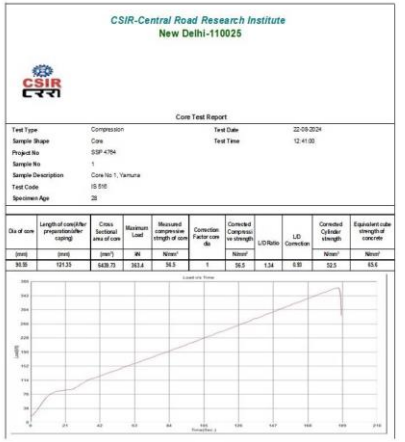
Non Destructive Test and Core Test





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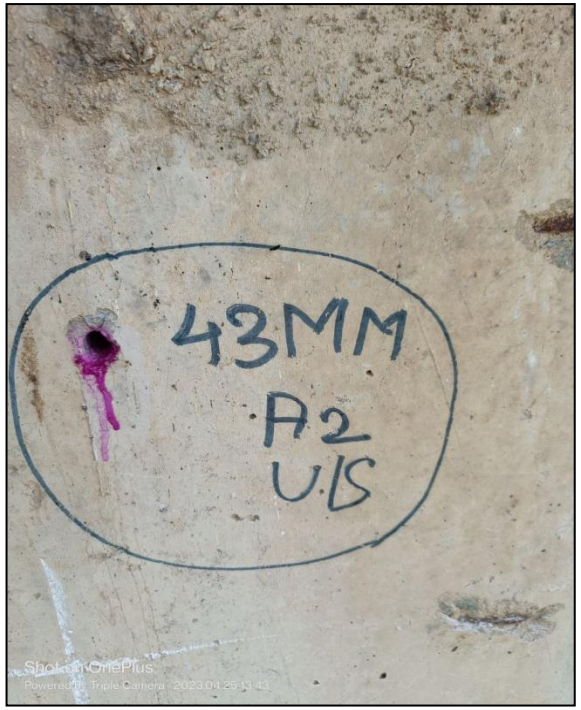
Carbonation Test



LOAD TEST ON BRIDGES

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Concrete Family

Head of the Concrete Family - Cement

Workability of Concrete- Water

Filler Materials- Fine and Coarse Aggregates

Admixture

Fly ash

Our Family

Head of our Family- Grand Father/Mother

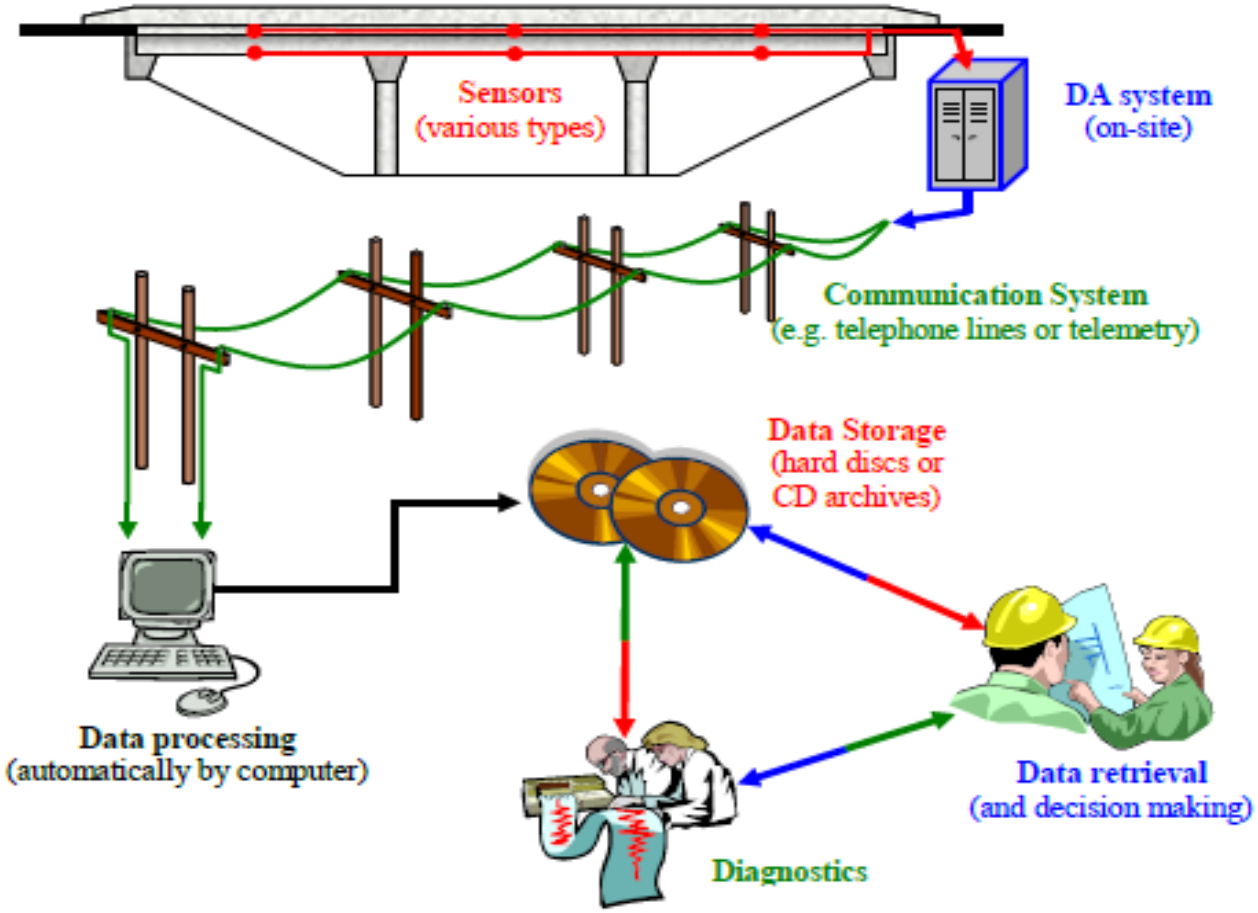
Workability of our Family- Earning Members

Filler for our Family-Children

Daughter In-law(Bahu)

Mother in-law(Sas)

Visual Schematic of Typical SHM



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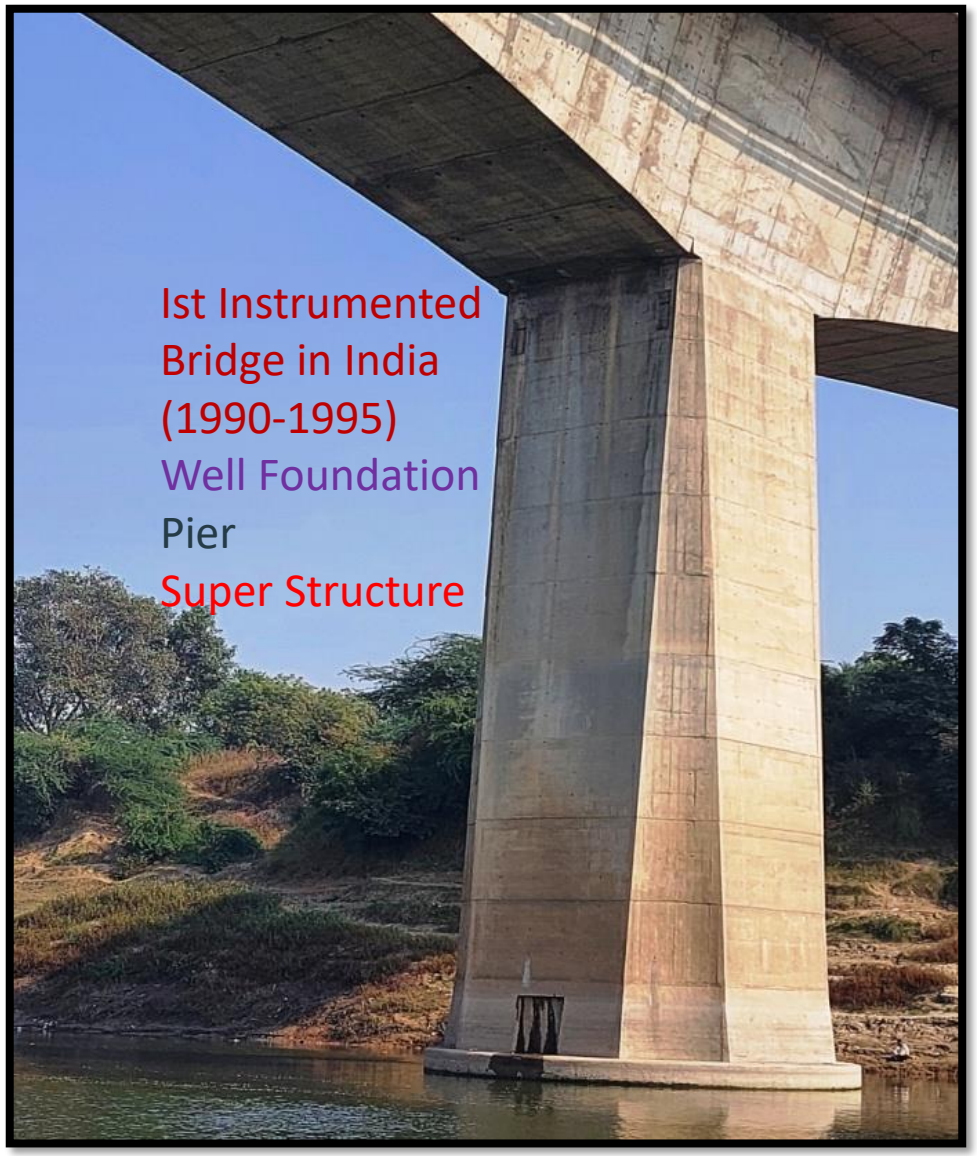
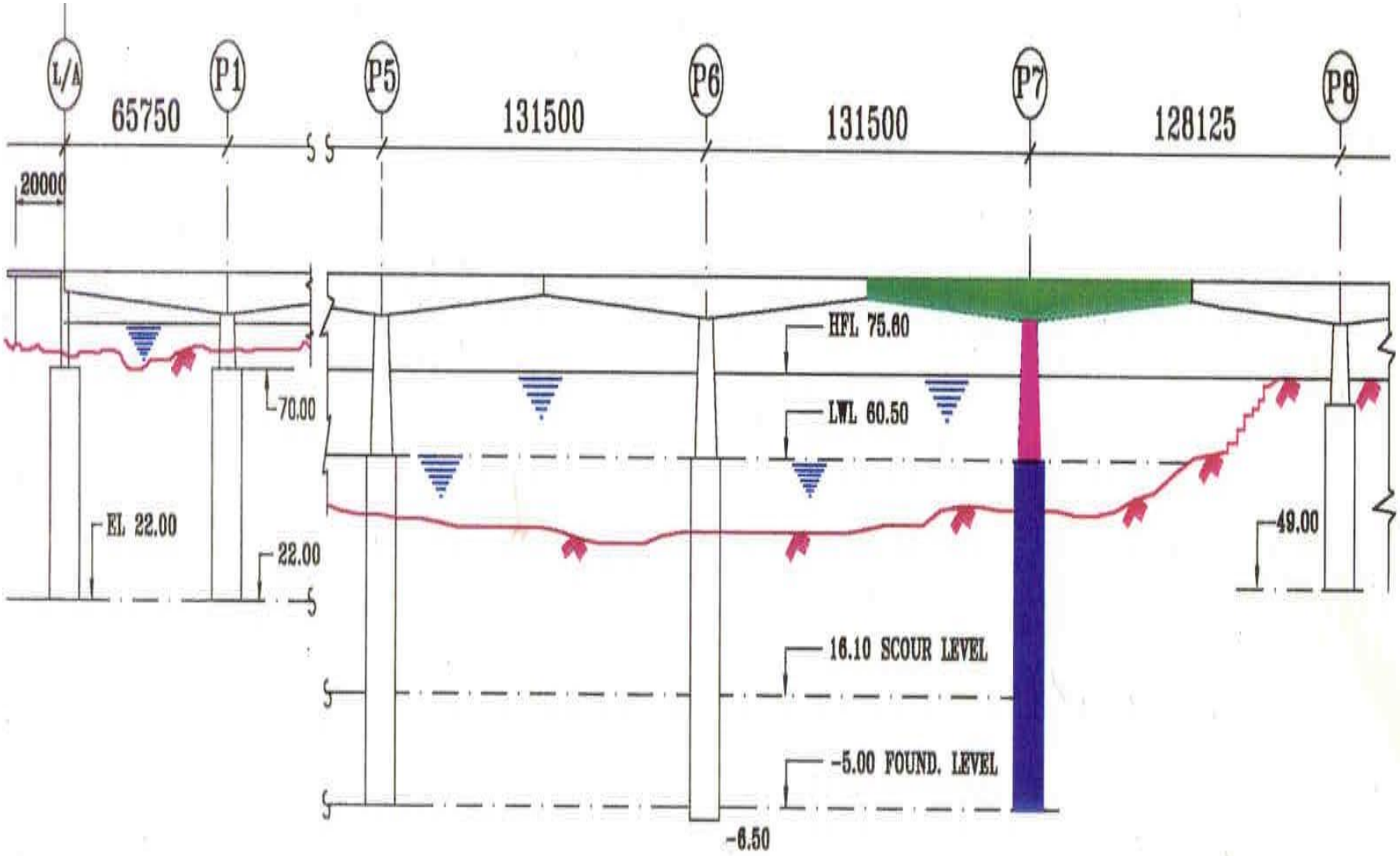
GANGA BRIDGE VARANASI (U. P.)



GANGA BRIDGE VARANASI (U. P.)



Performance Parameters

- Strain/stress
- Temperature
- Deflection
- Lateral Pressure
- Tilt
- Crack width
- Corrosion
- Acceleration
- Prestressing Force

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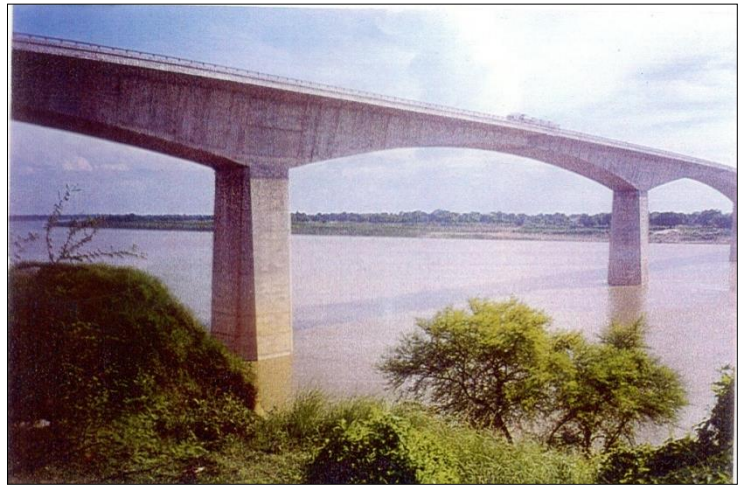
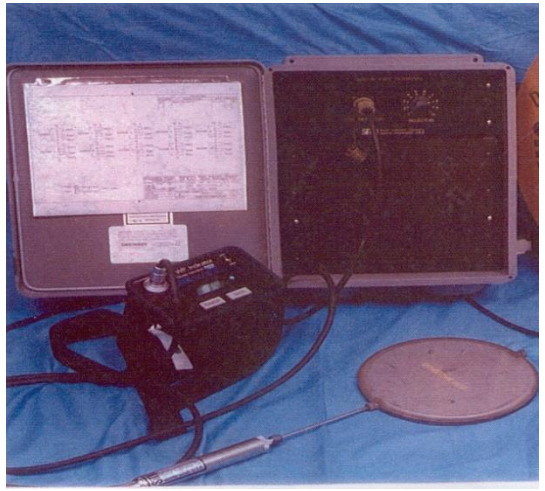
Health Monitoring through Instrumentation

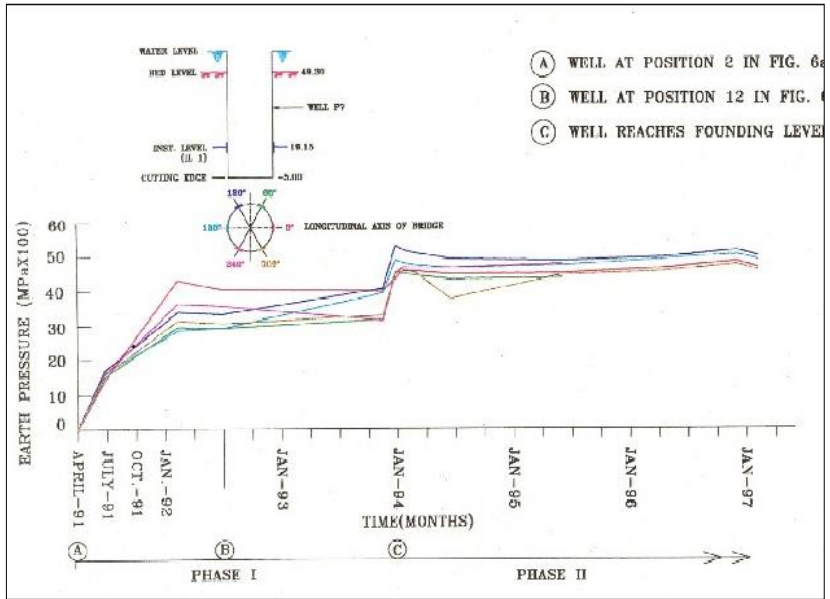




Ganga Bridge

Varanasi, India

Lateral Pressure Well Foundation



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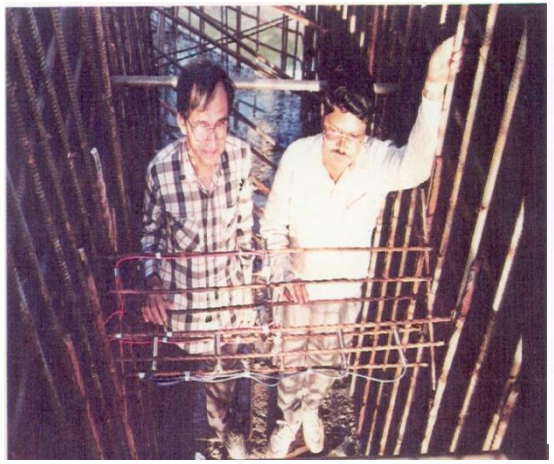
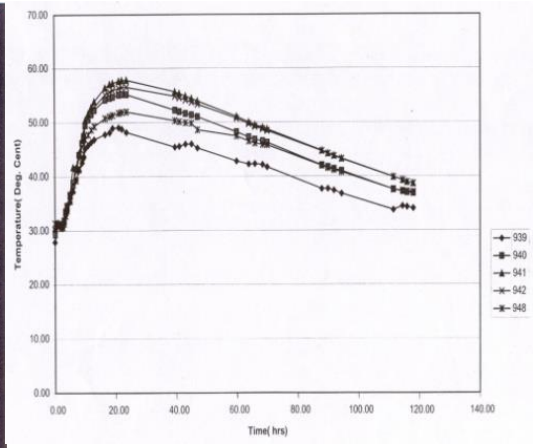
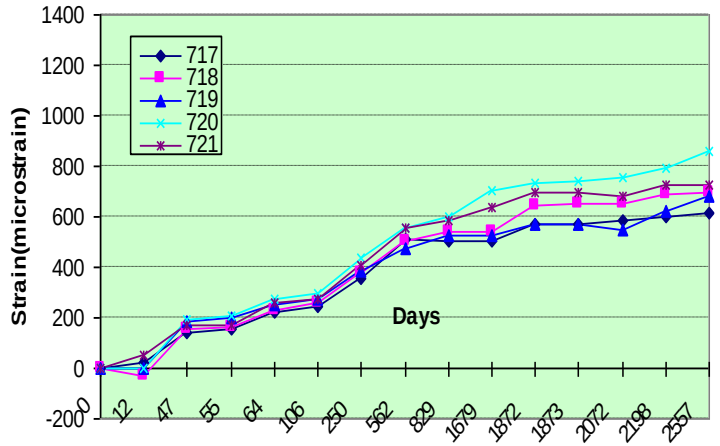
Ganga Bridge, Varanasi





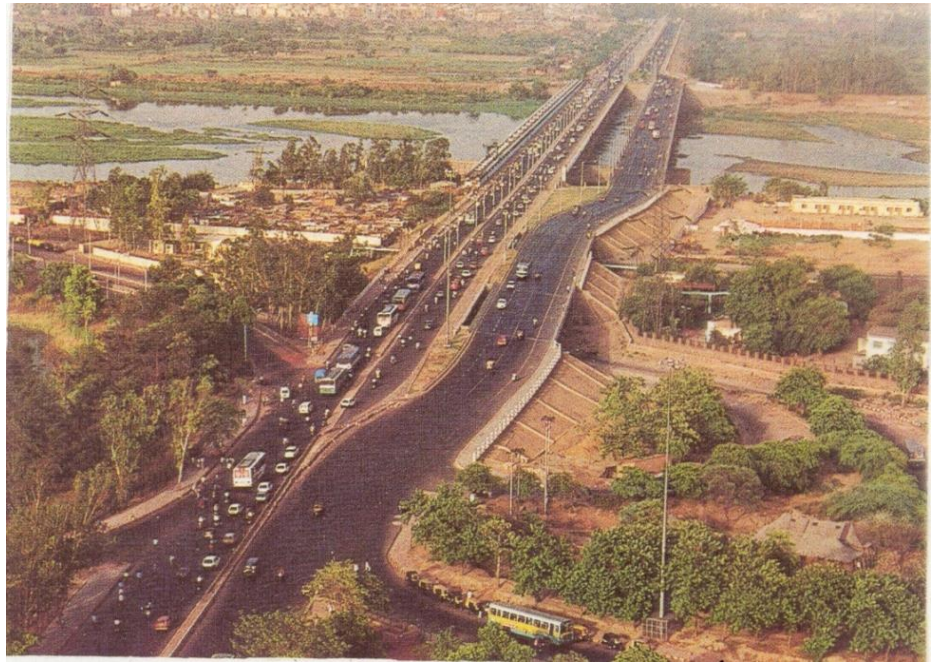
Temperature Variation during Hardening

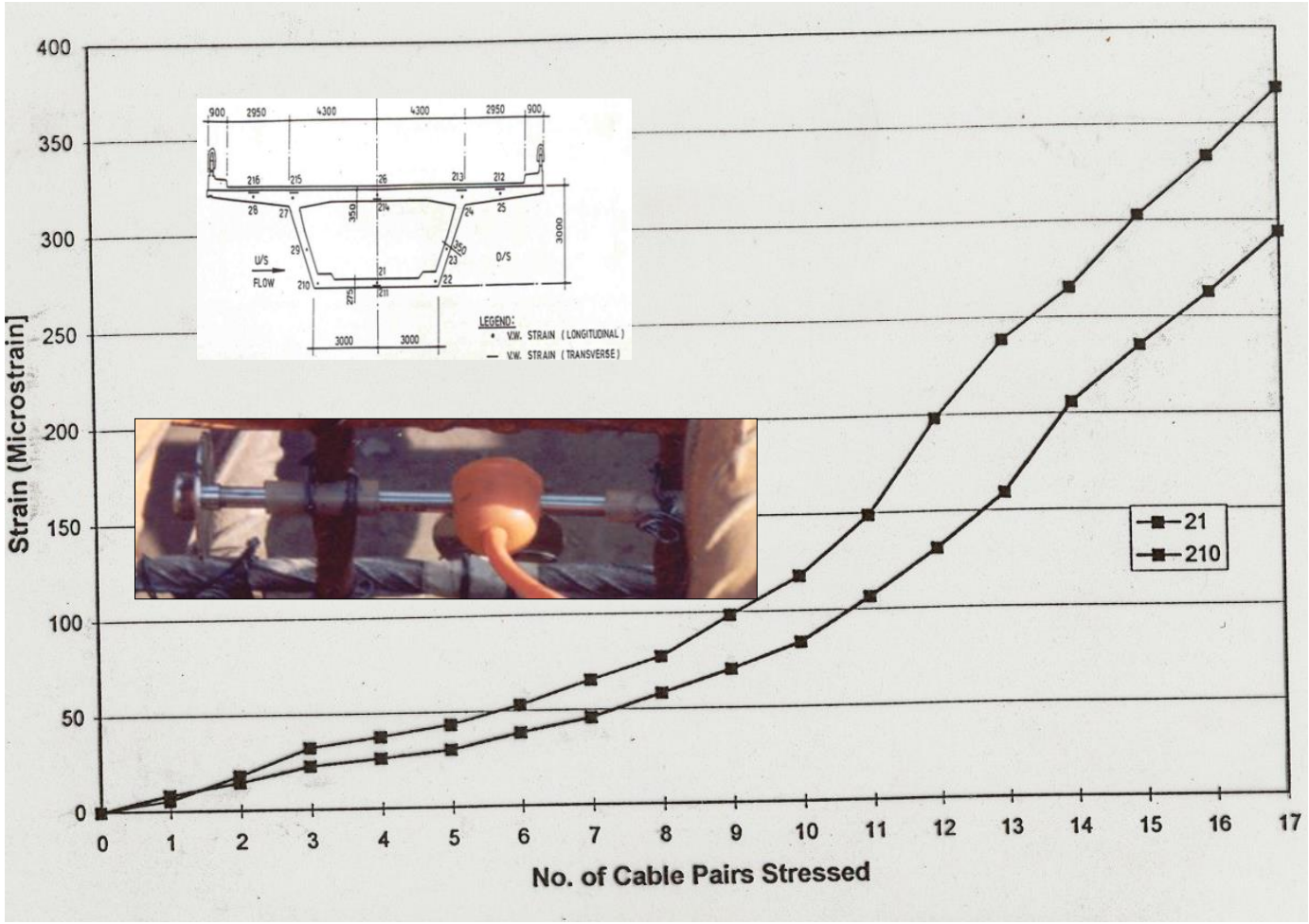


Strain Variation in Cantilever Arm

Ganga Bridge Varanasi, Deflection Measurement of Cantilever Arms

New ITO Bridge New Delhi

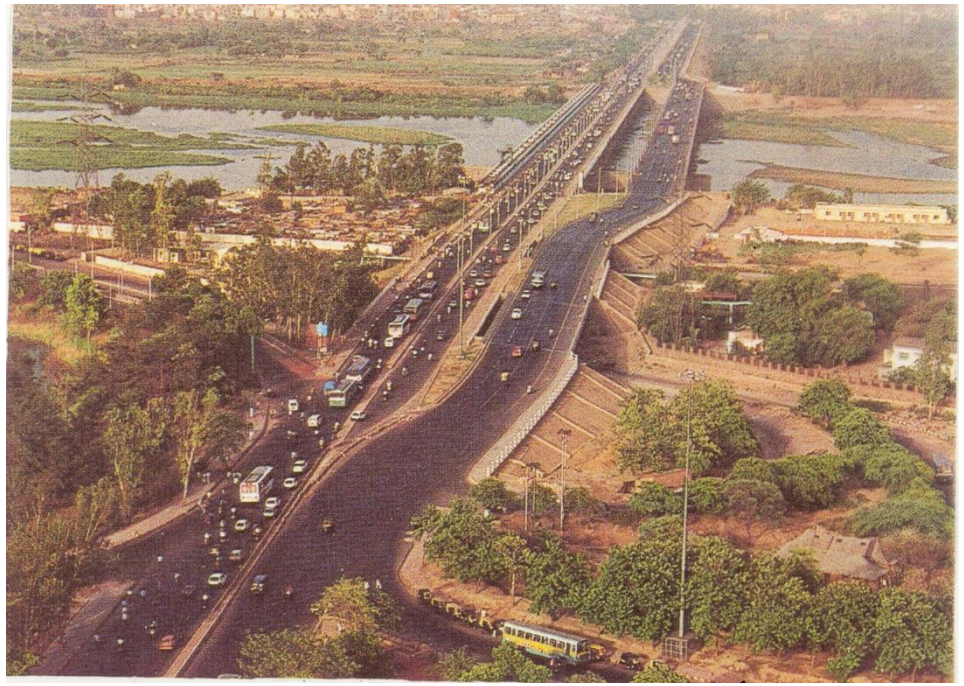


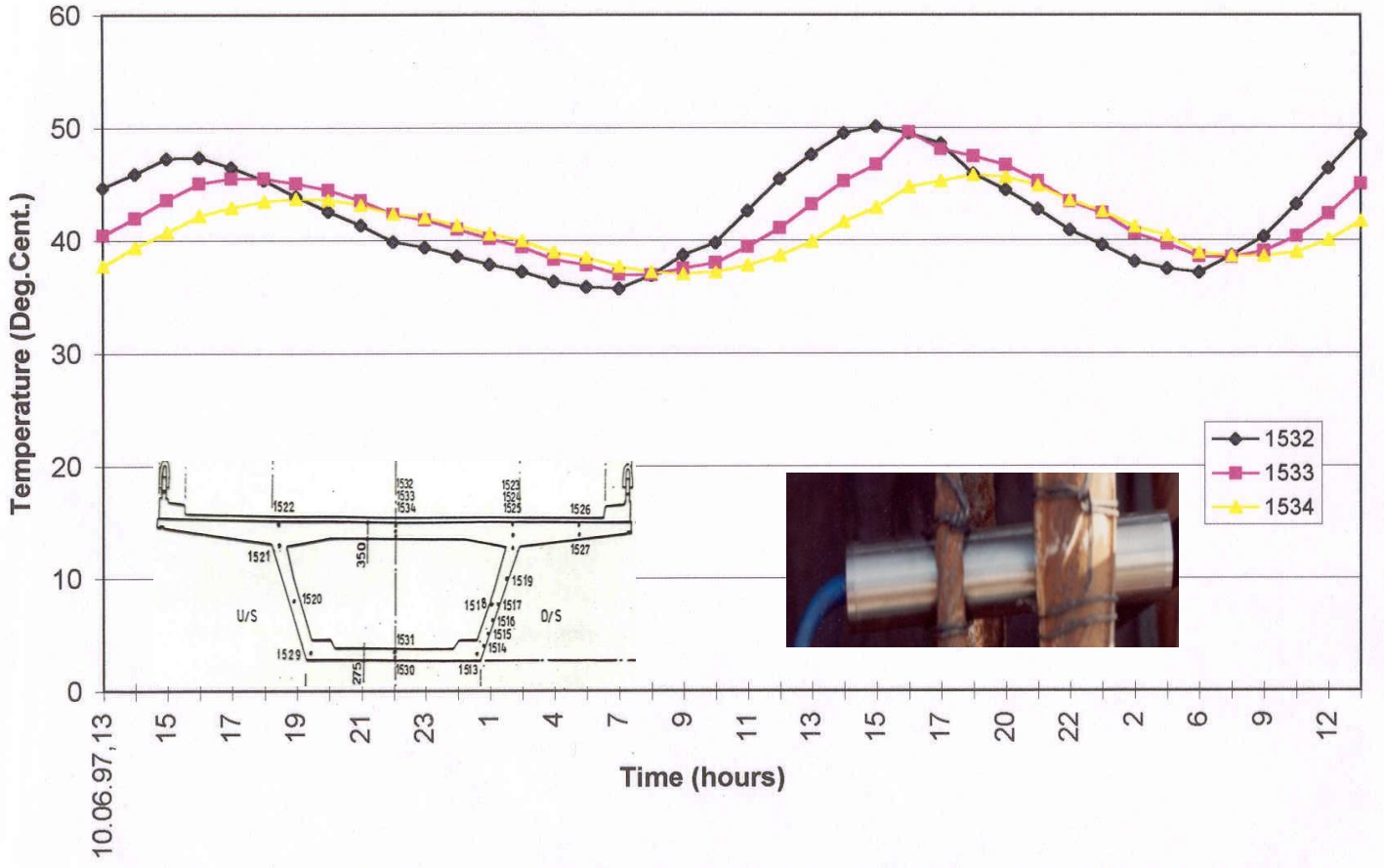


Strain Monitoring in the soffit of the Box Girder during prestressing

Health Monitoring of Bridges

Temperature Variation in the deck slab
ITO Bridge, New Delhi, India

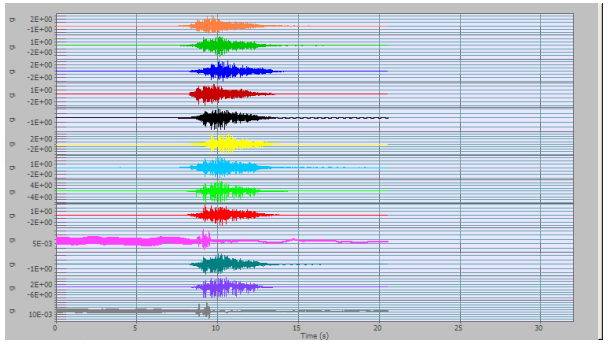




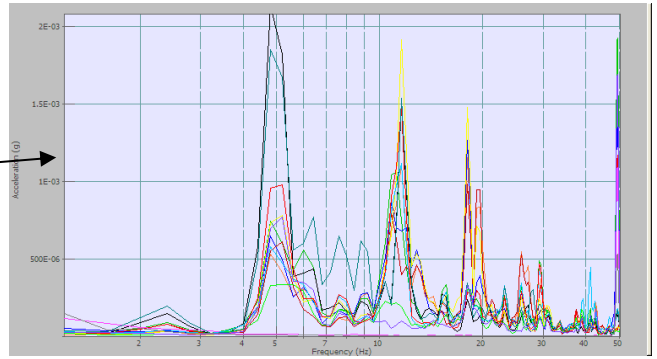
Vibration Monitoring

Accelerometer

FFT Analyzer

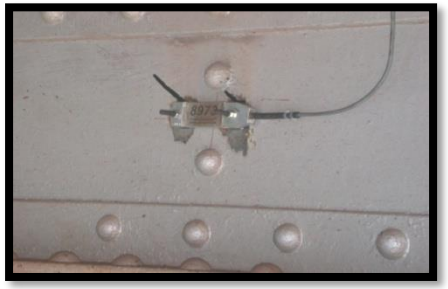


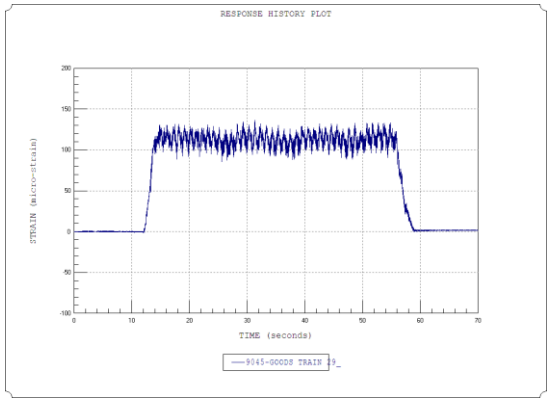
Time signal



Spectrum

Health Monitoring of Steel truss Railway Bridge through Instrumentation at Jamshedpur, India

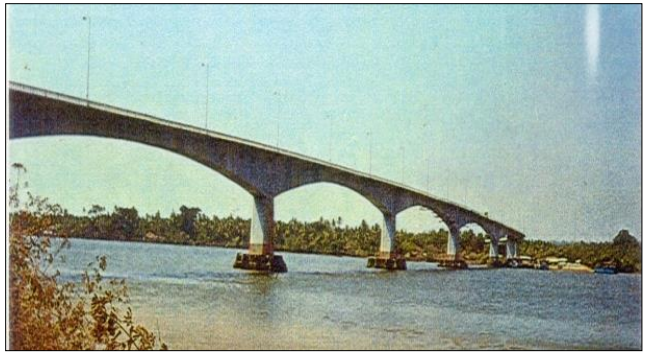


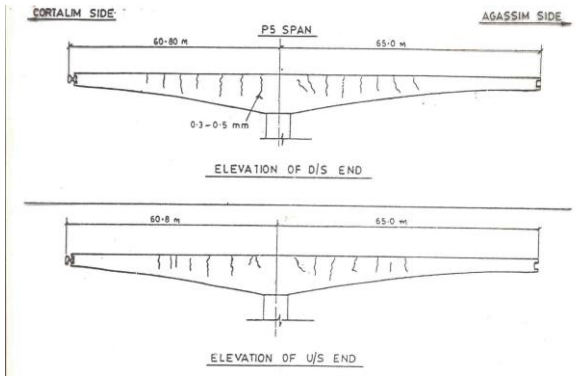


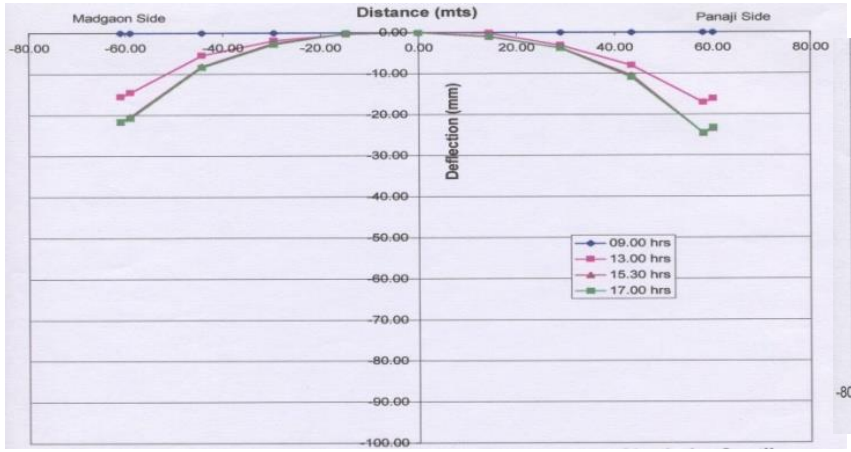
Strain Variation During Passage of Goods Train on a Bottom Chord Member

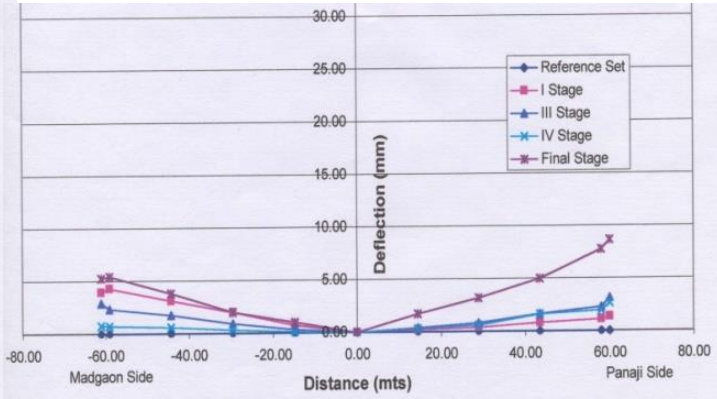
Installation of Sensors for the Health Monitoring

External Prestressing of Zuari Bridge, Panjim, Goa









Handling Stresses During Construction

Inspection, Maintenance and Structural Health Monitoring of Bridges

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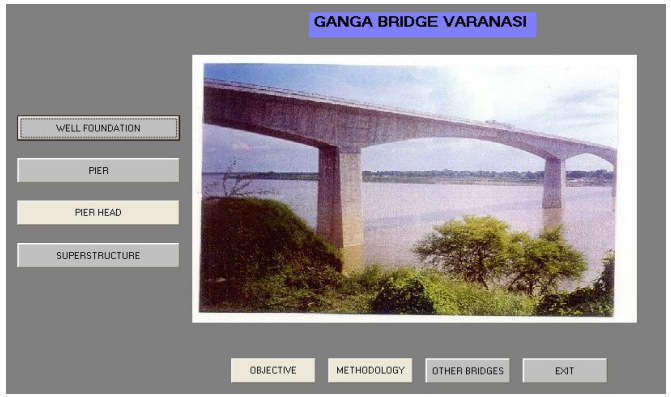
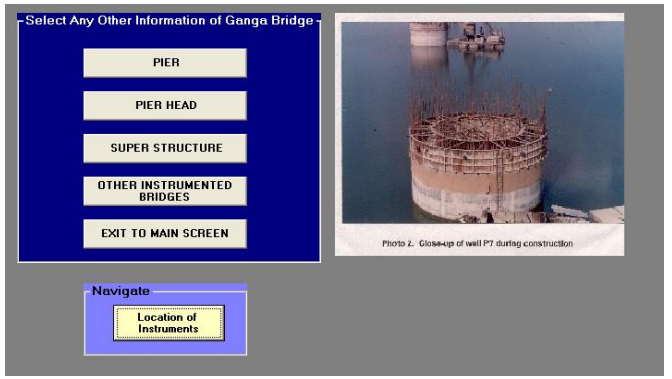
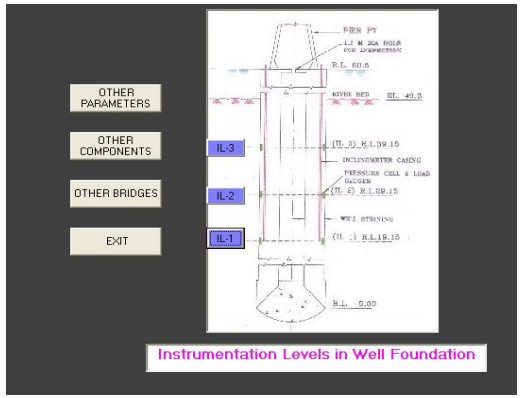
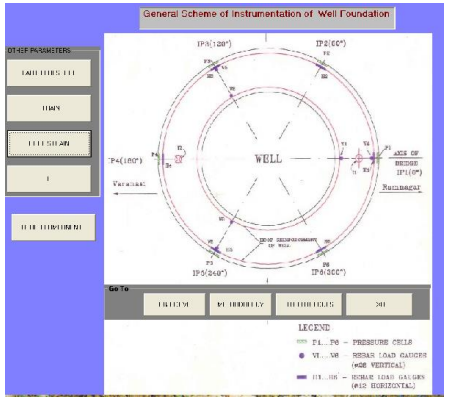
DATA BASE MANAGEMENT SYSTEM FOR INSTRUMENTED BRIDGES

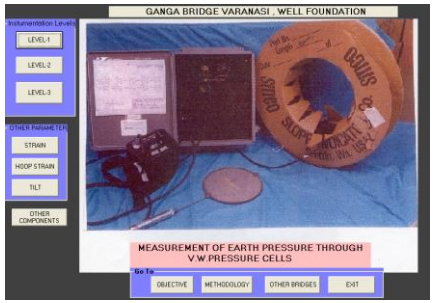


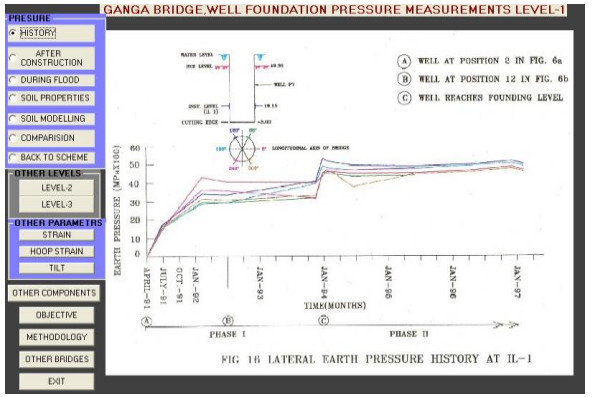
DBMS











Inspection, Maintenance and Structural Health Monitoring of Bridges

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UTTARAKHAND

Public Works Department, Uttarakhand

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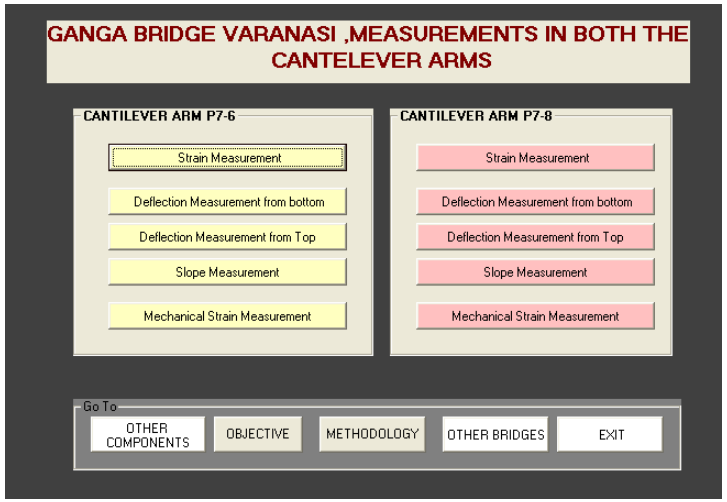

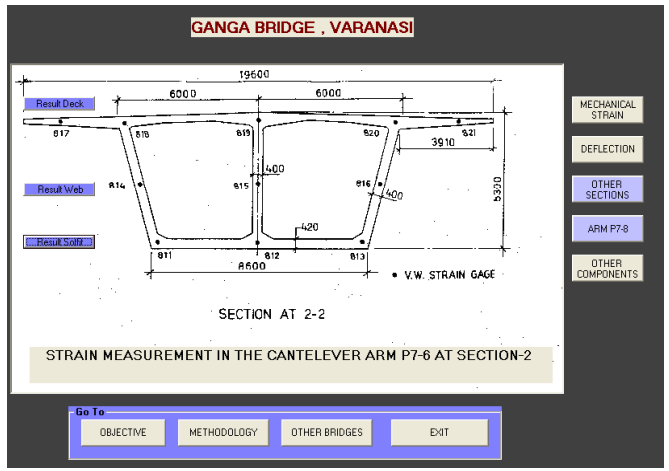

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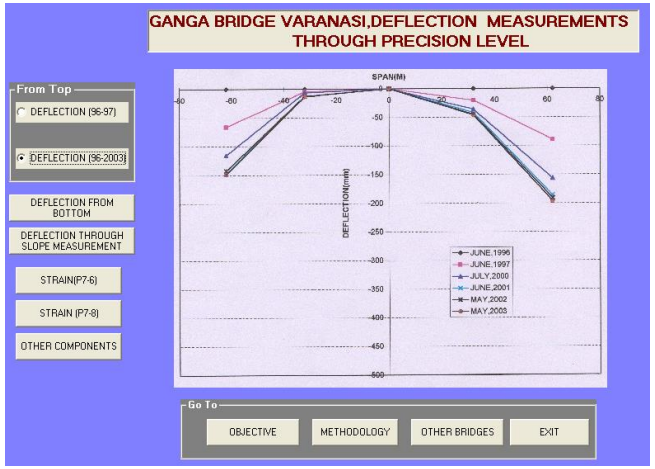
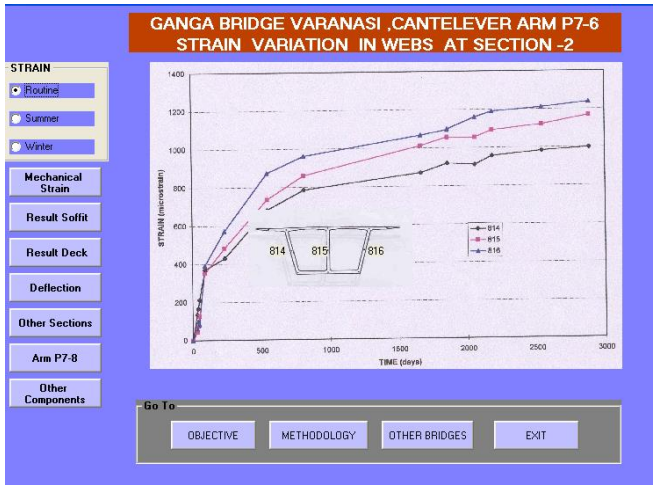




Observations

- Temporary Supports seen at various bearing locations
- Some of the Hinged Bearings completely corroded
- Some of the Roller Bearings miss-aligned
- Cracks and leaching on the deck slab
- Shear Punching , patch repair on the deck slab
- Cracks on the Webs, Soffit and Deck Slab of Box girder

Rehabilitation Measures Codes

IRC:SP-40 2019 Guidelines on Techniques for Strengthening and Rehabilitation

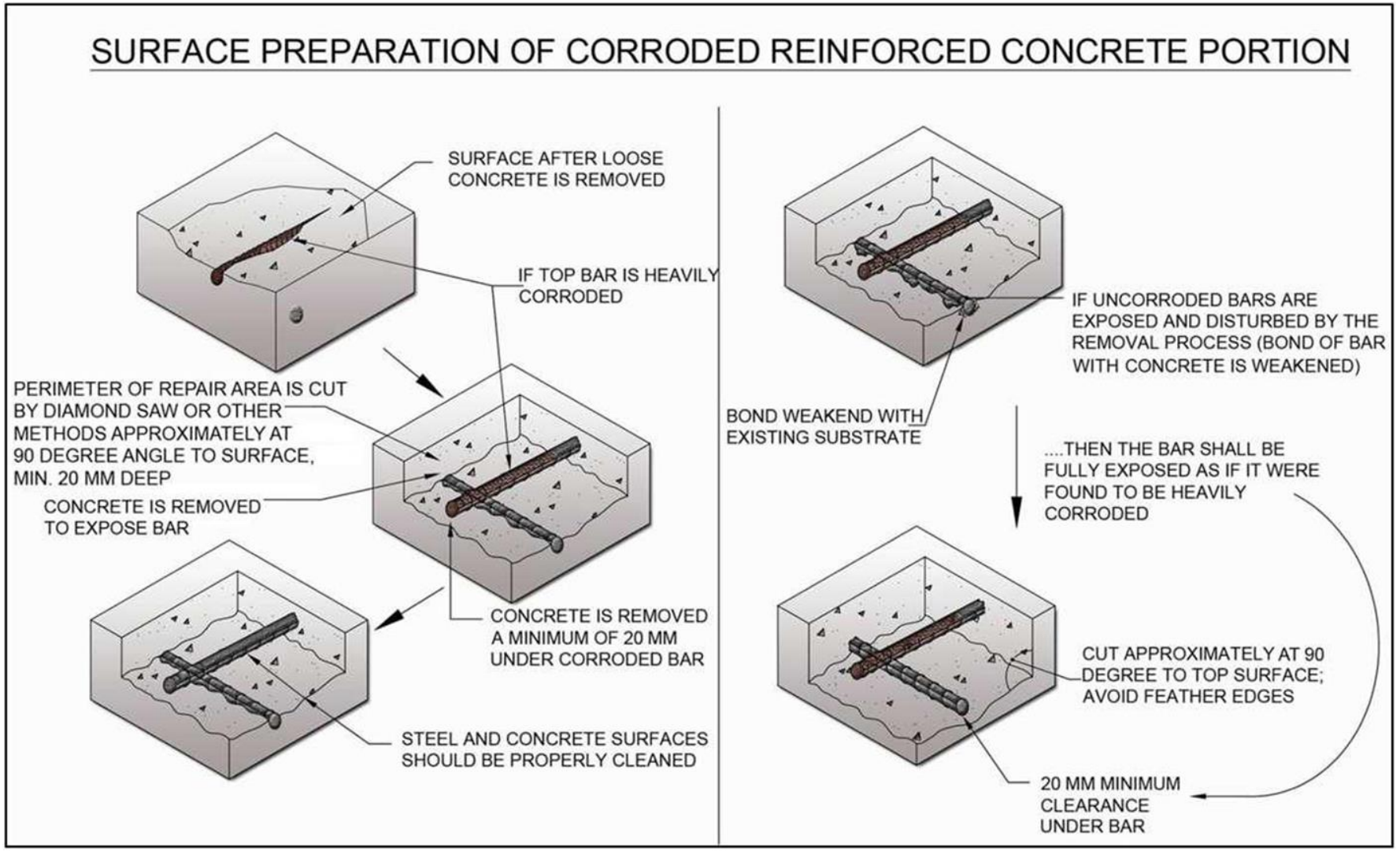
ACI: 562 2019 Assessment, Repair and Rehabilitation of existing Concrete Structures

EN:1504 2017 Product and System for Protection and repair of Concrete Structures

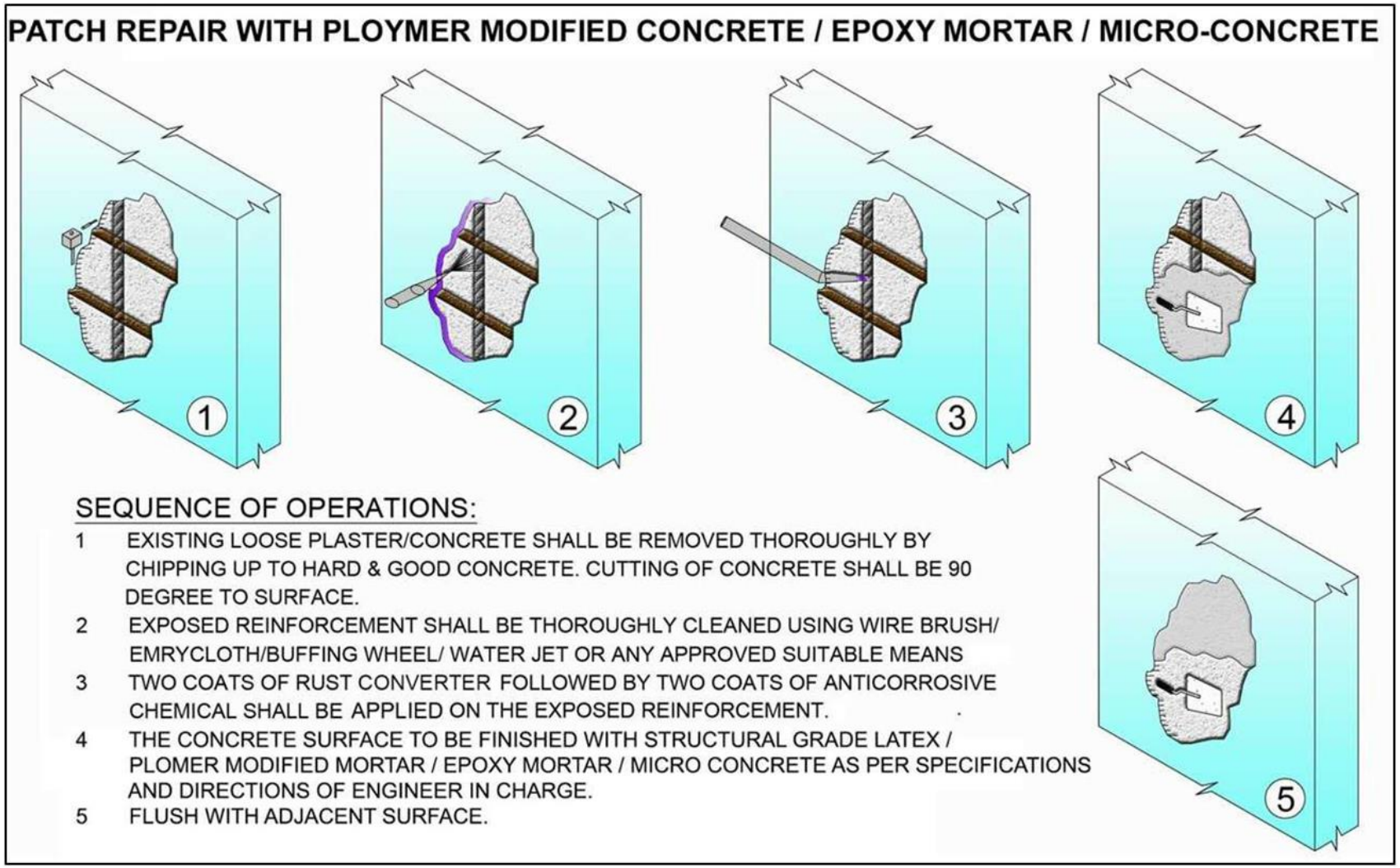
REPAIR/REHABILITATION/RETROFITTINGS OF BRIDGES

- Polymer mortar/Concrete patch repair
- Pressure Grouting for cracks and Honey combed Concrete
- Jacketing
- Shotcreting/Guniting
- External Prestressing
- Fiber Wrapping

Surface Préparation for Corroded Areas



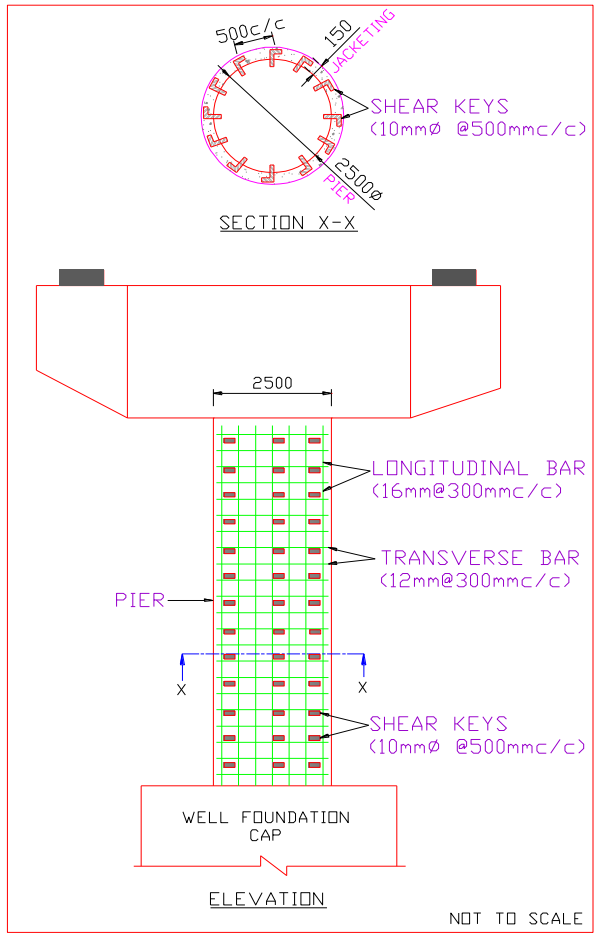
Patch Repair for Corroded Areas

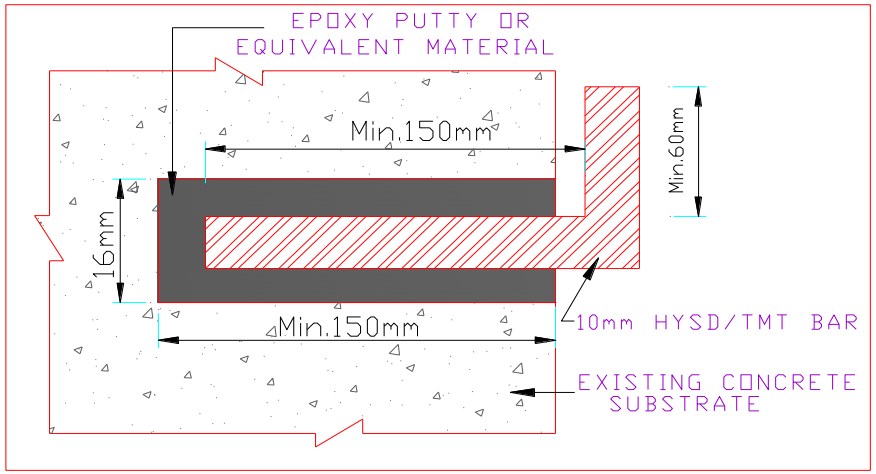


JACKETING AND FRP WRAPPING

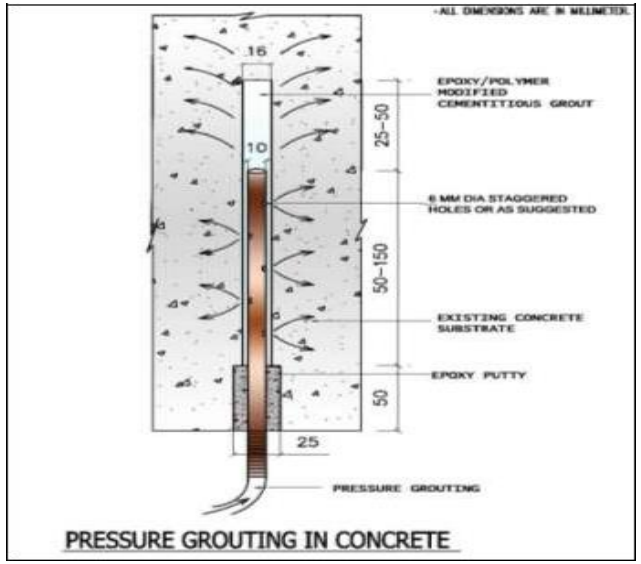
JACKETING OF COLUMNS OF ROB

Jacketing of Pier

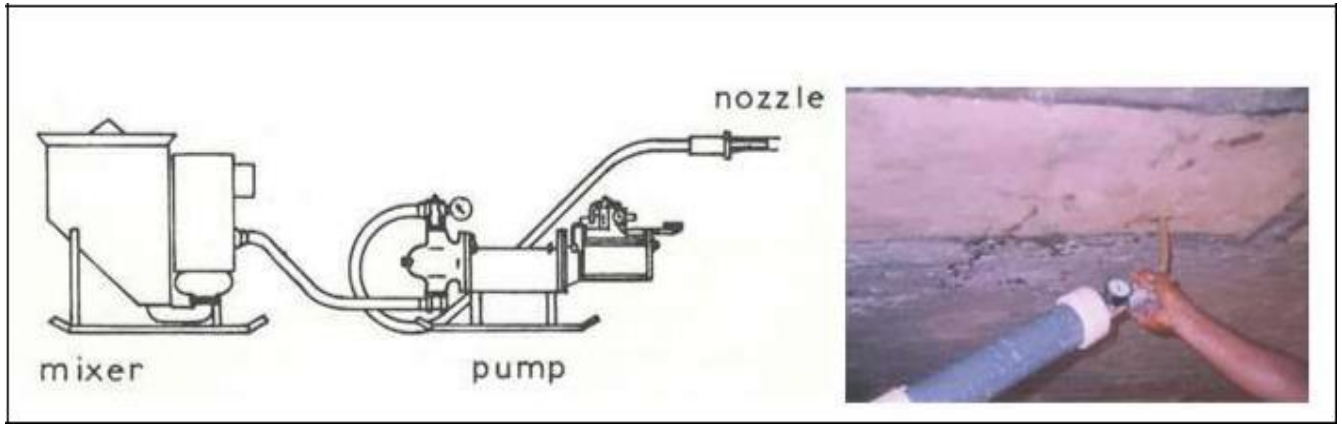


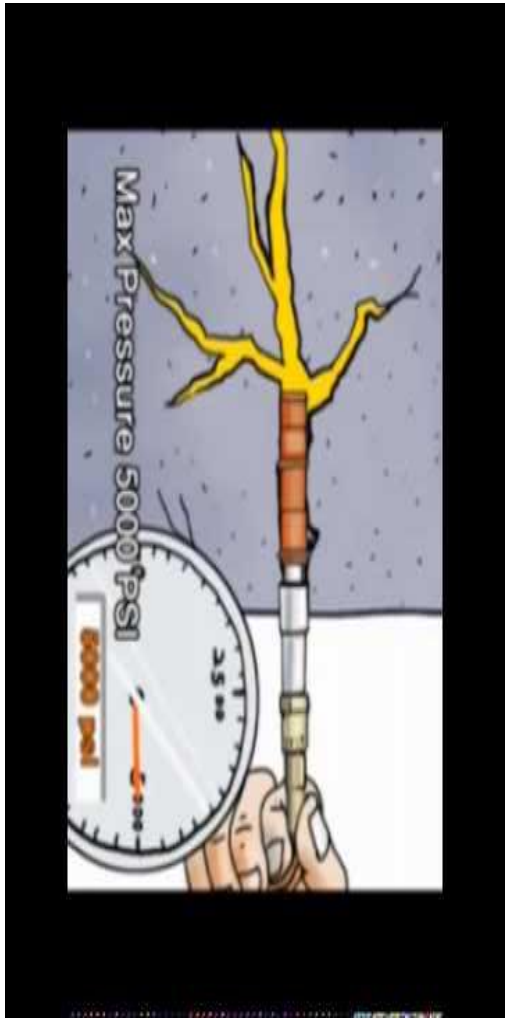


Pressure Grouting



PRESSURE GROUTING IN CONCRETE





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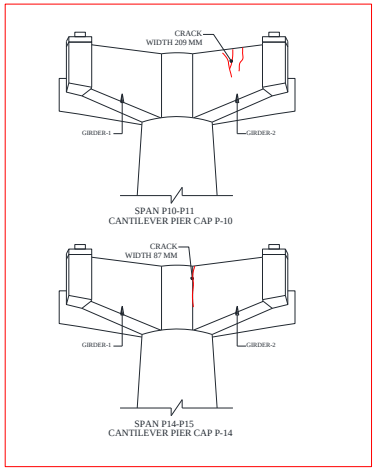
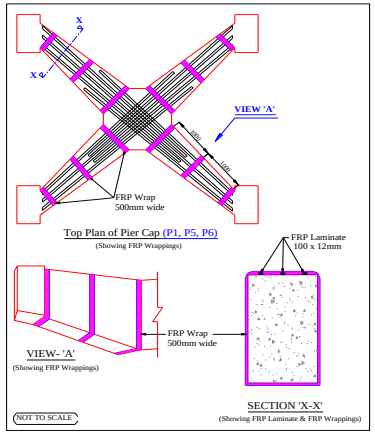
Structural Safety audit and SUGGESTIONS FOR Rehabilitation MEASURES of major Bridges

Pressure Grouting

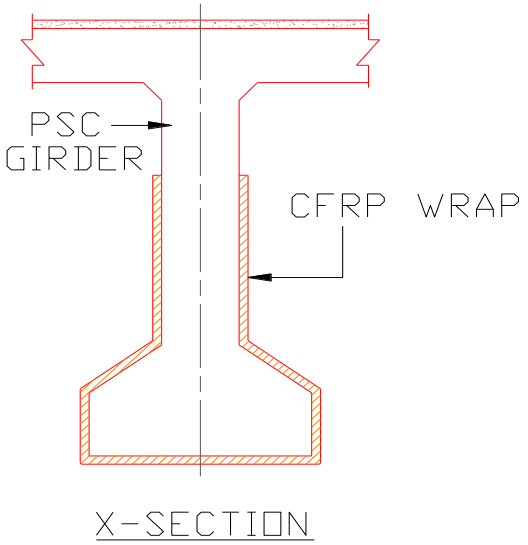
Jacketing



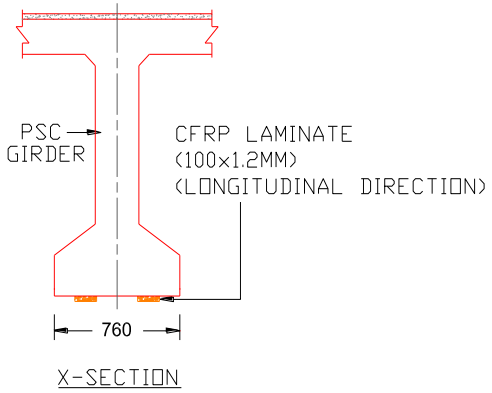
FRP Laminates & WRAPS



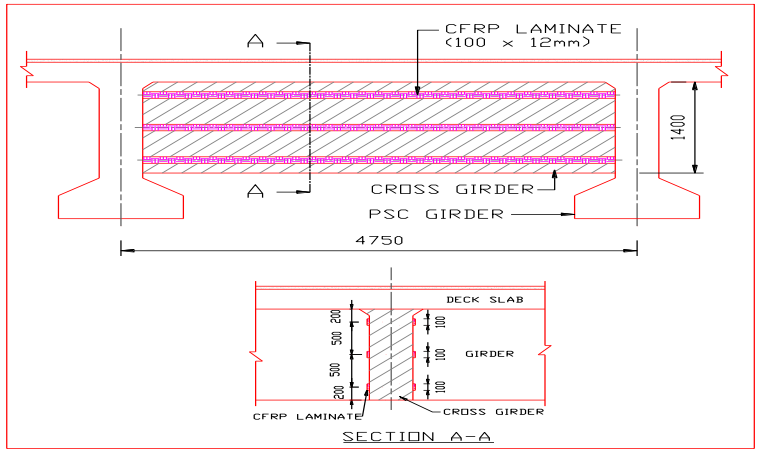
FRP WRAPS &



FRP Laminates



Cracks on Cross Girders & Deck Slabs FRP LAMINATES



Deck Slab & Cross Girders

ISLB &

Steel Plate

Pressure Grouting, FRP Laminates &Wrapps and Guniting

Pressure Grouting, External Prestressing and WRAPPING

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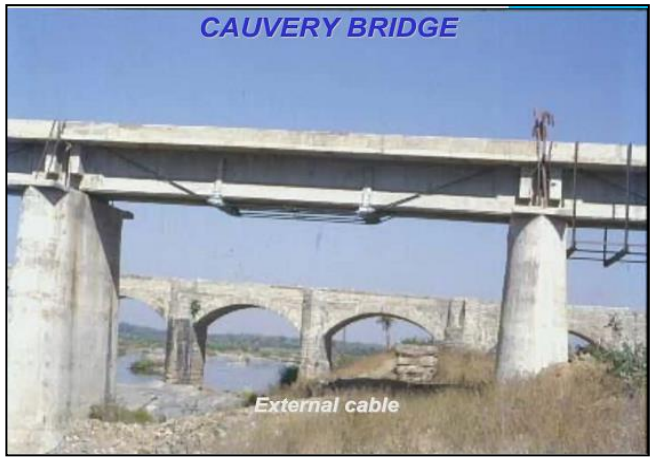
External Prestressing



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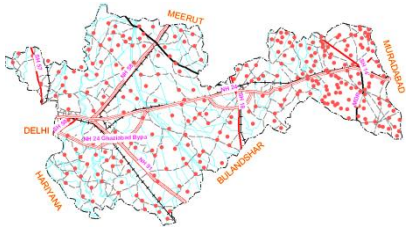

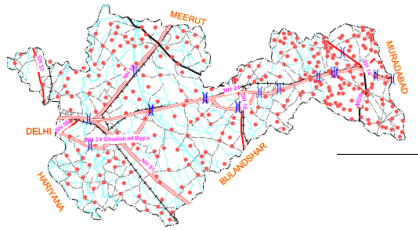

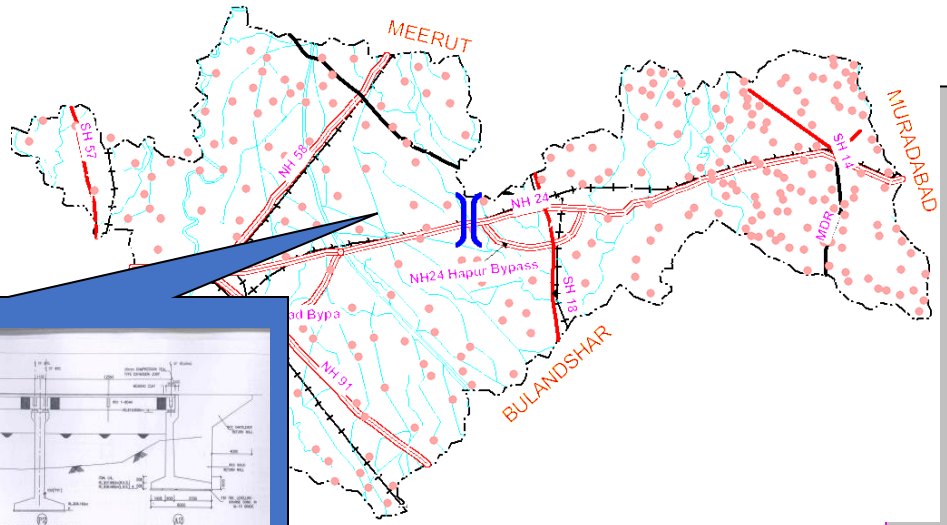

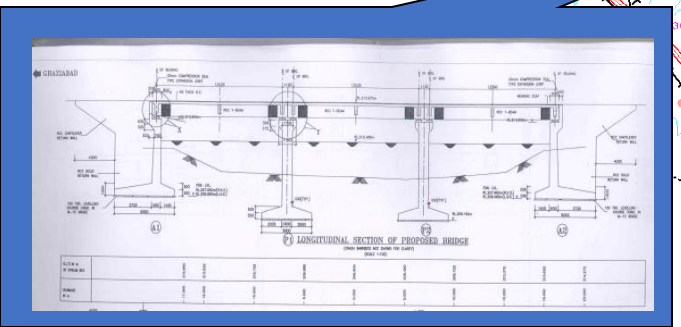

Critical Infrastructure Information System for Maintenance of Bridges

SOI TOPO Sheet & PWD Maps → Preparation of Base Map

Satellite data → Updating Base Map ← Validation through Field Survey

Updating Base Map → Generation of Road Network (NH & SH)

Collection of bridge data from NHAI/PWD → Analysis of bridge data collected from NHAI/PWD

Analysis of bridge data collected from NHAI/PWD → DATABASE MSSQL SERVER

DATABASE MSSQL SERVER ↔ Inventory Module

DATABASE MSSQL SERVER ↔ Inspection Module

DATABASE MSSQL SERVER ↔ Load Carrying Capacity Module

DATABASE MSSQL SERVER ↔ Strengthening Module

DATABASE MSSQL SERVER ↔ Budgeting Module

DATABASE MSSQL SERVER ↔ Prioritization Module

DATABASE MSSQL SERVER ↔ Thematic Map & Report Generation

Thematic Map & Report Generation ↔ Web Publication

- Instrumentation offers scientific and convenient tools for periodic inspection of bridges

- Instrumentation offers alarm to adopt timely and appropriate remedial measures to avoid aggravation of distresses in structure

Mission 2024: Clean and Maintain (C M) Structures Save Structures

1. CM - Clean and Maintain Drainage Spout
2. CM - Clean and Maintain Expansion Joint
3. CM - Clean and Maintain Water Logging on Deck Slab
4. CM - Clean and Maintain the Excessive Dead Weight on Deck Slab
5. CM - Clean and Maintain Vegetation Growth
6. CM - Clean and Maintain Abutment and Pier heads
7. CM - Clean and Maintain Bearings
8. CM -Clean Water ways/silting & Maintain it
9. CM -Excessive Live Load & Maintain it
10. CM-Clean exposed reinforcement, damages, honeycombing, cracks, erosion, protective apron by proper repair & rehabilitation and Maintain it
11. CM - Clean and Maintain Cables and Anchors in case of Special Bridges

Thanks for your kind attention !

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