Bridge Asset Management
Lessons Learned & Way Forward

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BMS ??? Bridge Maintenance / Serviceability

- Bridges in any road network are valuable assets and **cannot be built and just forgotten**.
- It is a **misconception** that a bridge once constructed does not require any substantial maintenance for the first couple of decades.
- Though the pavement **failures are common and visible**, bridge failure when they occur often become catastrophic.
- Even **high quality of construction** without proper maintenance, will lead to early failure of the bridge
- **Bridge management** is not merely a routine, but an art, which ensures that the bridges remain fit for their intended purpose over long period **at minimum life cycle cost.**


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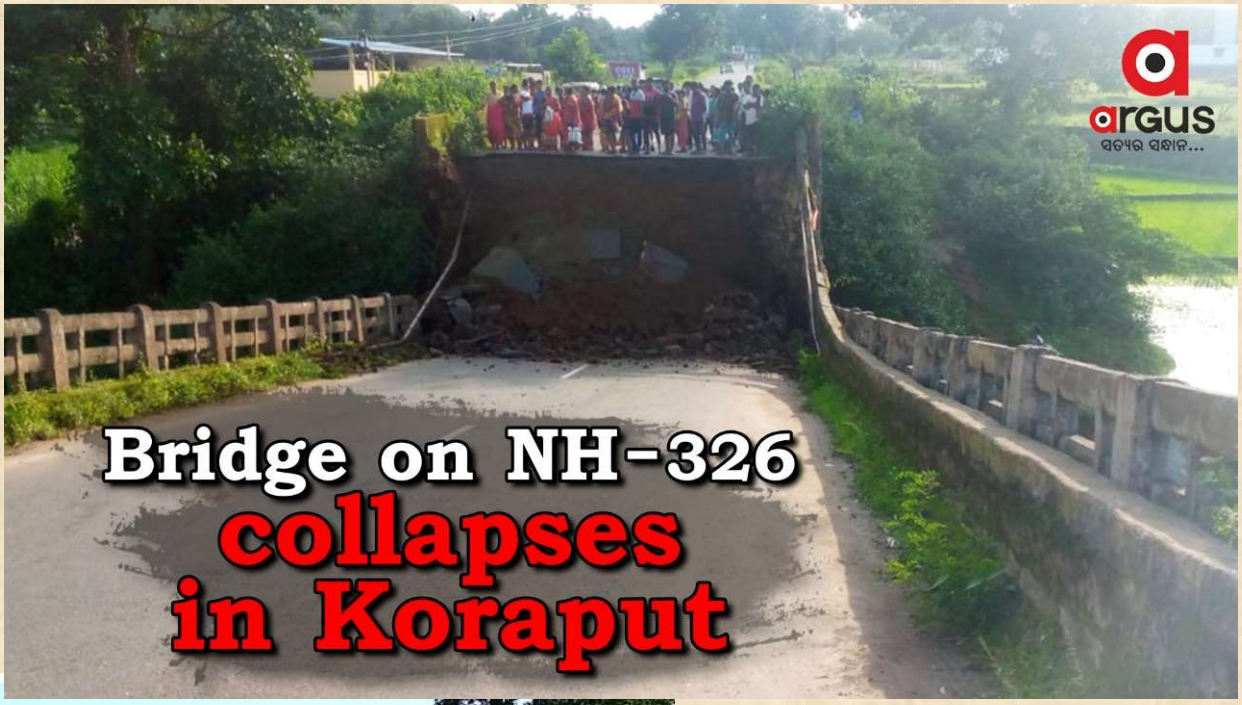
Bridge Condition Survey

Bridge Collapses In Koraput Amid Heavy Rains, -16th August 2022



BRIDGE FAILURE
NEED FOR RECONSTRUCTION

BRIDGE FUNCTIONAL
NEED FOR REHABILITAION


2013/12/20

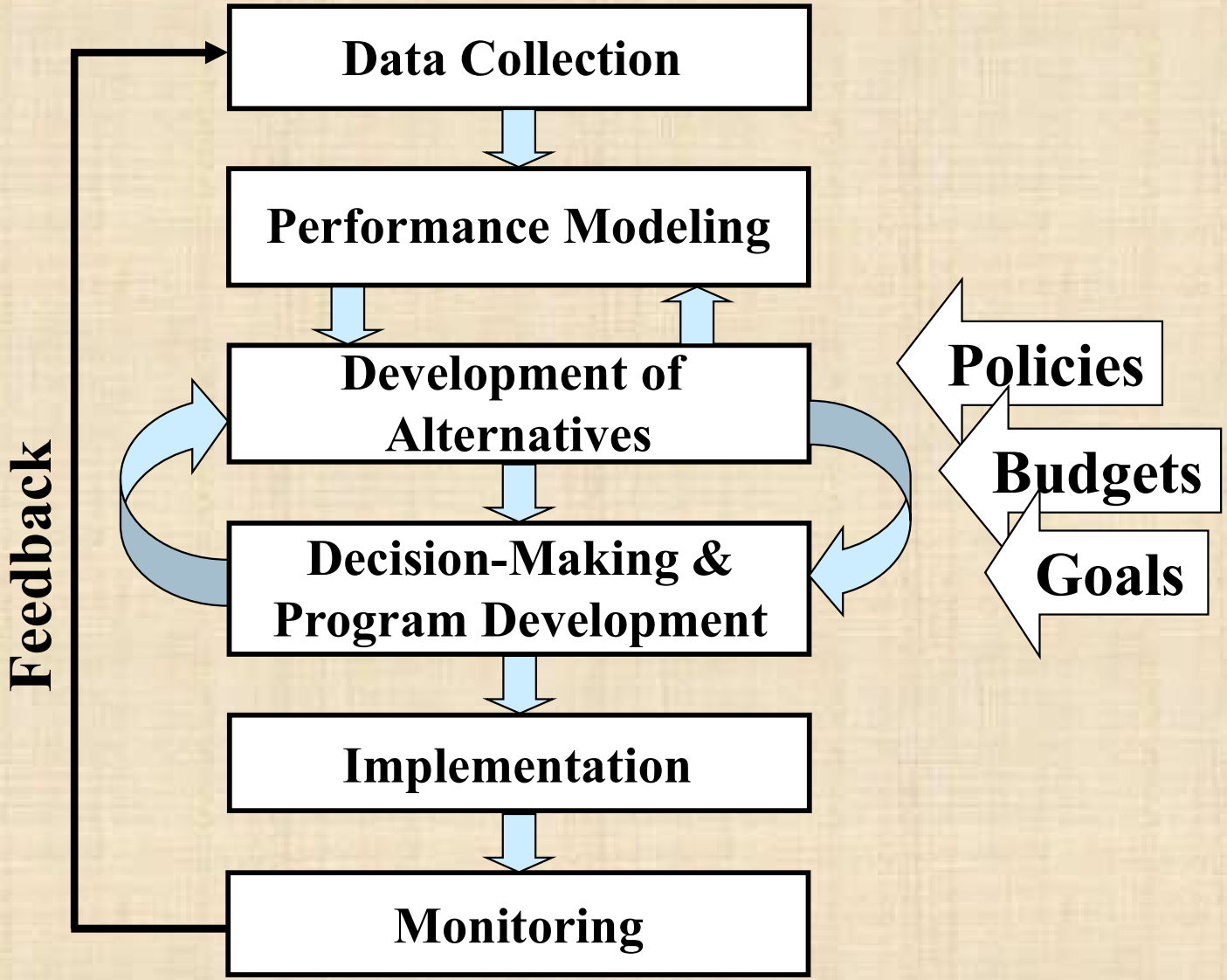
What is Asset Management ?

1. Systematic process of maintaining, upgrading and operating physical assets cost-effectively based on a continuous physical inventory and condition assessment.

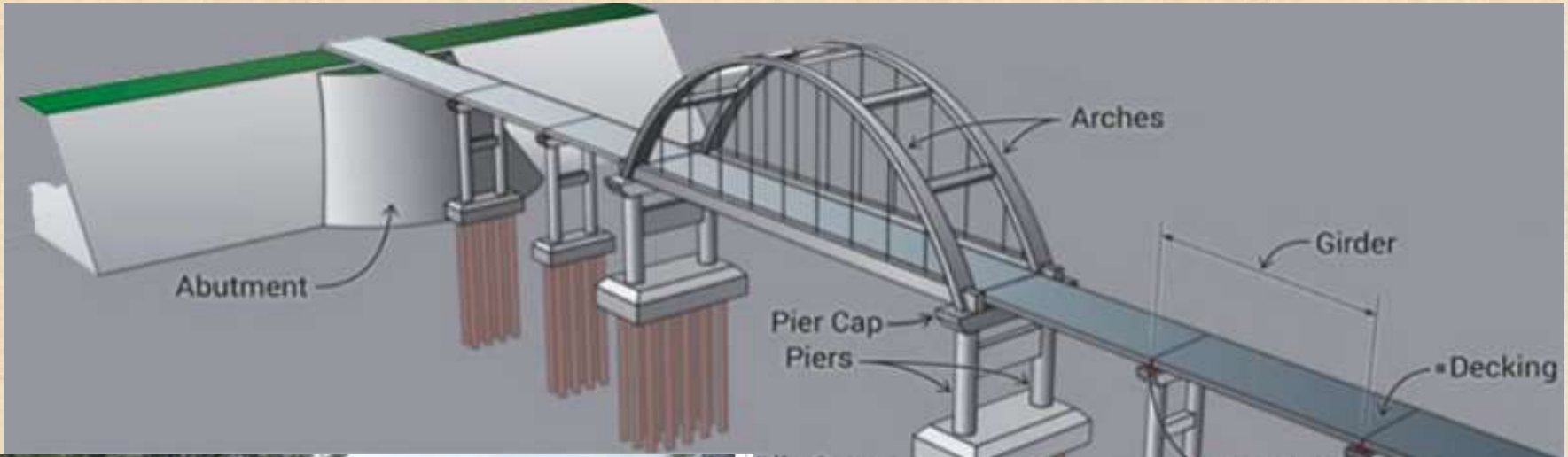
2. It combines sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision- making.

3. Provides a framework for handling “short- and long-range planning”

Generic Process of Asset Management



Bridge Componets / Assets



ASSET DATA & ASSET INVENTORISATION

- **Asset Inventory**
- **Asset inventory is the foundation stone on which asset management processes are to be built**

- **Desirable Data**
- The inventory data requirements for the adoption of a fully implemented asset management approach can be **determined from considering the purpose and potential use of such data.**

. BRIDGE ASSET DATA COLLECTION

- The data base is a central feature of BMS in the modern context.
- The types of data needed for BMS can be broadly classified as **inventory data and condition data.**
- **Network-level data** should answer the general planning, programming, and policy decisions supported by the network-level BMS;
- **Project-level data** should support decisions about the best treatment to apply to a specific bridge project. As these data are collected, they can be stored to create a more complete database over time. However, a method must be established to keep the data current; and,
- **Research-level data** should be established to collect detailed data on specific attributes to answer selected questions.

METHOD OF DATA COLLECTION

- The cost of data collection tends to be the largest component of managing and running a BMS.
- It is therefore important to select data acquisition technology that is appropriate to the objectives, resources and modus operandi of the agency.
- The criteria that can guide the selection of the data collection method are:
- **Reliability:** A trade-off between the accuracy of the method and its productivity.
- **Accessibility** (Resources): Deals with the **efforts required to transfer the data from the collection medium to the database**, the capability for reviewing and verifying the data before storage, and the speed and accuracy with which transference to storage can be made;
- **Affordability:** Includes **technical support, staff and financial resources required to sustain the data acquisition process** continually through the annual operations of the agency.

FREQUENCY OF DATA COLLECTION

- Data should be **collected only as frequently as is required** to ensure proper management of the Bridges .

- The frequency can vary depending upon the data of interest.

- Frequency of data collection is guided by the following factors:

a) Level of data collection (Network or Project);

b) Intended use of the data (Planning or programming etc);

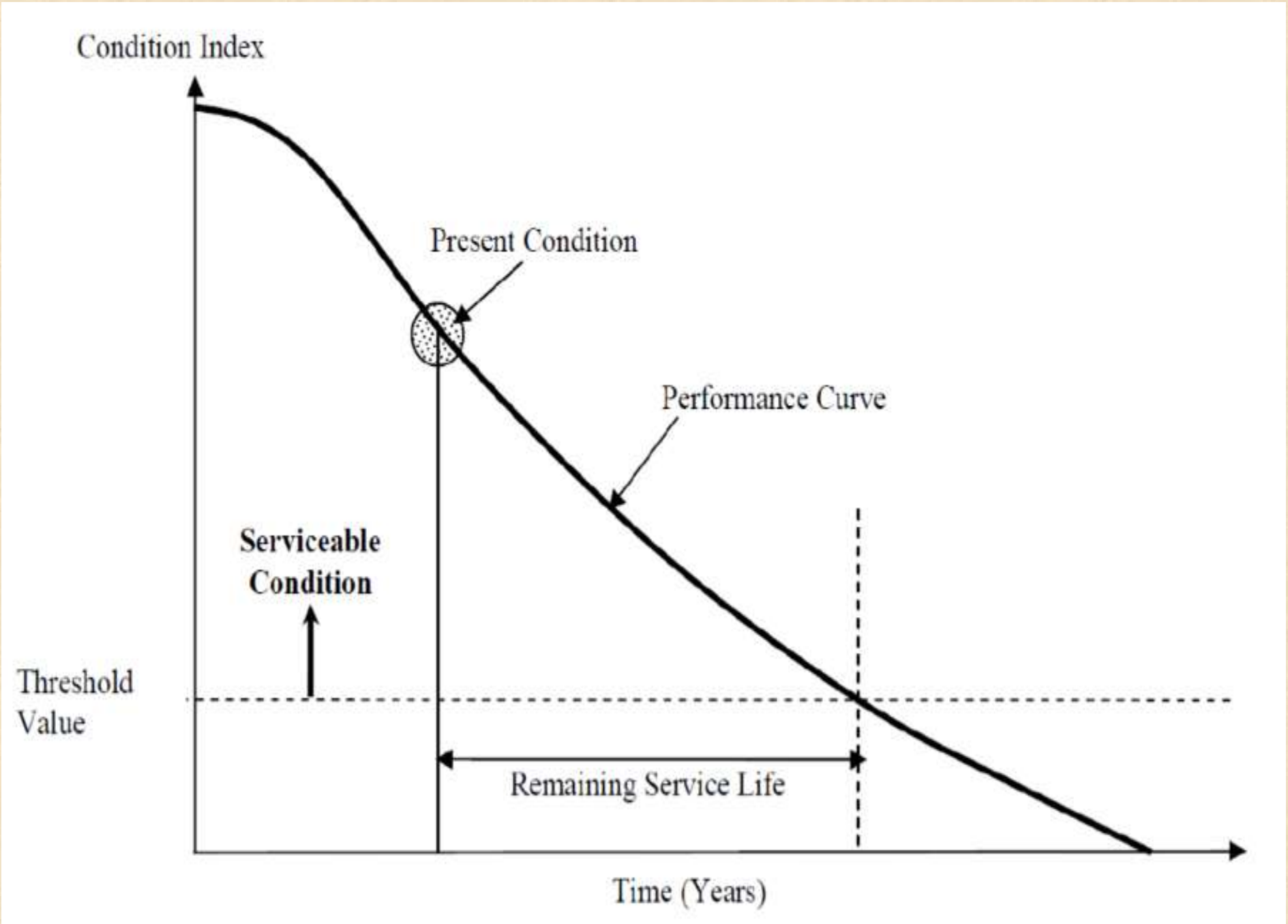
c) Method of data collection (sampling or continuous);

d) Significance of the Bridge ;

e) Type of funding (public funds or private funds or loan/grant);

f) Availability of human resources (In-house or outsourced);

Assessment of Remaining Service Life



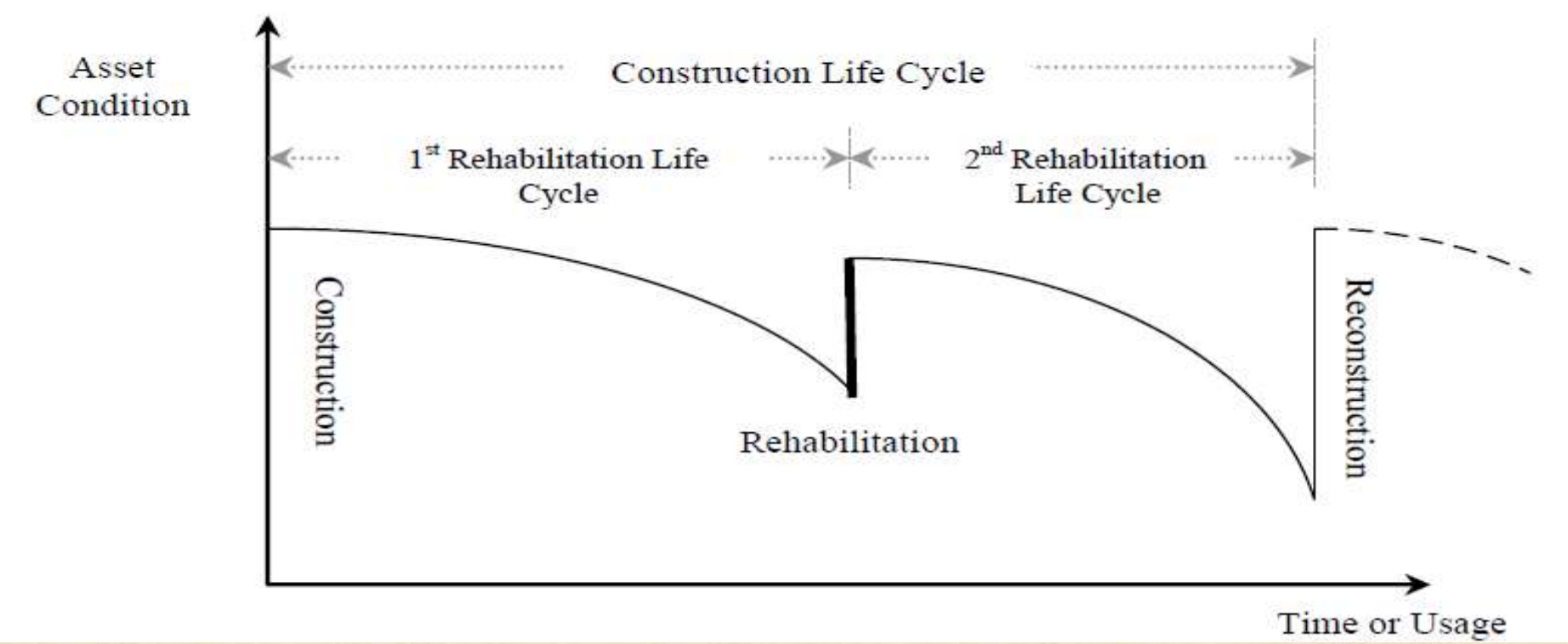
ASSET MANAGEMENT DECISION MAKING & MAINTENANCE PLAN

Decision Making Criteria

Project Level Decision Making

Network Level Decision Making

Asset Maintenance Planning



Institutionalization of RAMS

- For sustainability of Road Asset Management within an organization, it is important that **institutional support is available from high ranking decision-makers**.

- A **separate organizational unit** within the department / agencies staffing structure is essential with explicit responsibility for the RAMS development/ commissioning, implementation, operationalization

- Responsibility includes **awareness of the system, manage data collection, constantly look for ways of improving data collection procedures and data quality assurance**, periodical review of off-the-shelf RAMS packages available and used worldwide.

- There **should be a budget for the operation of the system**, including all staffing, equipment, data collection (outsourced or in-house), field travel, quality assurance etc.

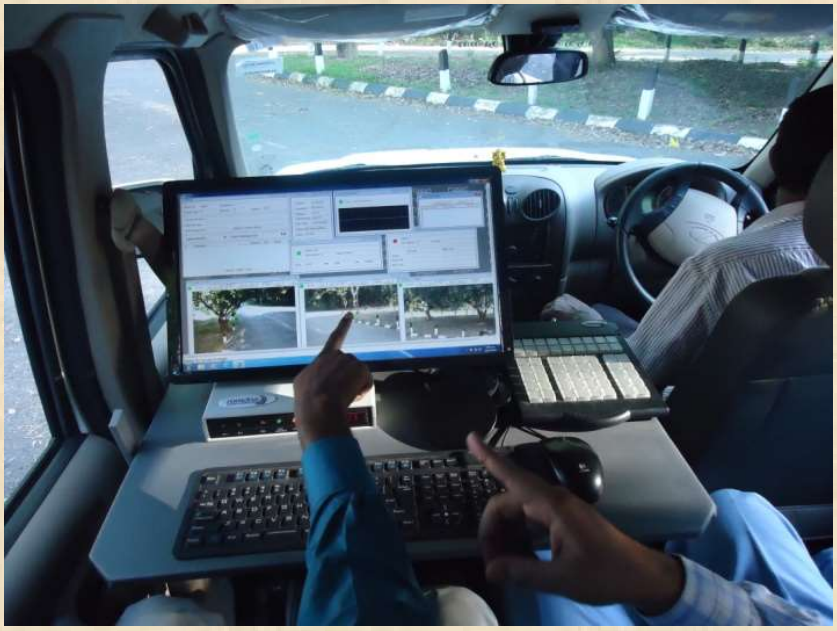
Adoption of Appropriate Technology

- It is important that the RAMS implementation **should fit within the overall IT strategy** of the department / highway agency,.
- Technical requirements should describe the technology environment within which the RAMS will fit (**ie hardware, operating systems, databases, GIS, and other applications**).
- IT implementations **should preferably use commercial off-the-shelf (COTS) products**, wherever possible as custom developed applications have often proved difficult and expensive to sustain.
- It must be acknowledged that **RAMS like any other system is not static as technology continues to move forward** in a number of areas such as IT, data collection, road deterioration modeling, maintenance treatments etc

IRC:130-2020

GUIDELINES FOR
ROAD ASSET MANAGEMENT SYSTEM (RAMS)

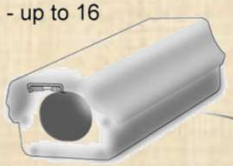
Pathways Video Inspection Vehicle



Automated Road Survey Equipment

Automated Road Survey System – CRRI New Delhi

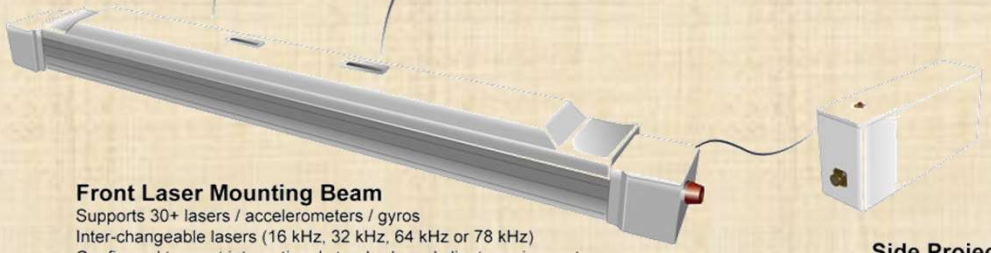
Digital Cameras
Asset and Pavement View cameras - up to 16
High resolution - 1280 x 960 pixels
Fully Digital interface



GPS or DGPS

Data Acquisition System
Compact PC system with operator LCD(s)
No dedicated equipment rack required
Real-time data processing
Unified database correlates all data

GIPSI-Trac Geometry
3D road geometry maps



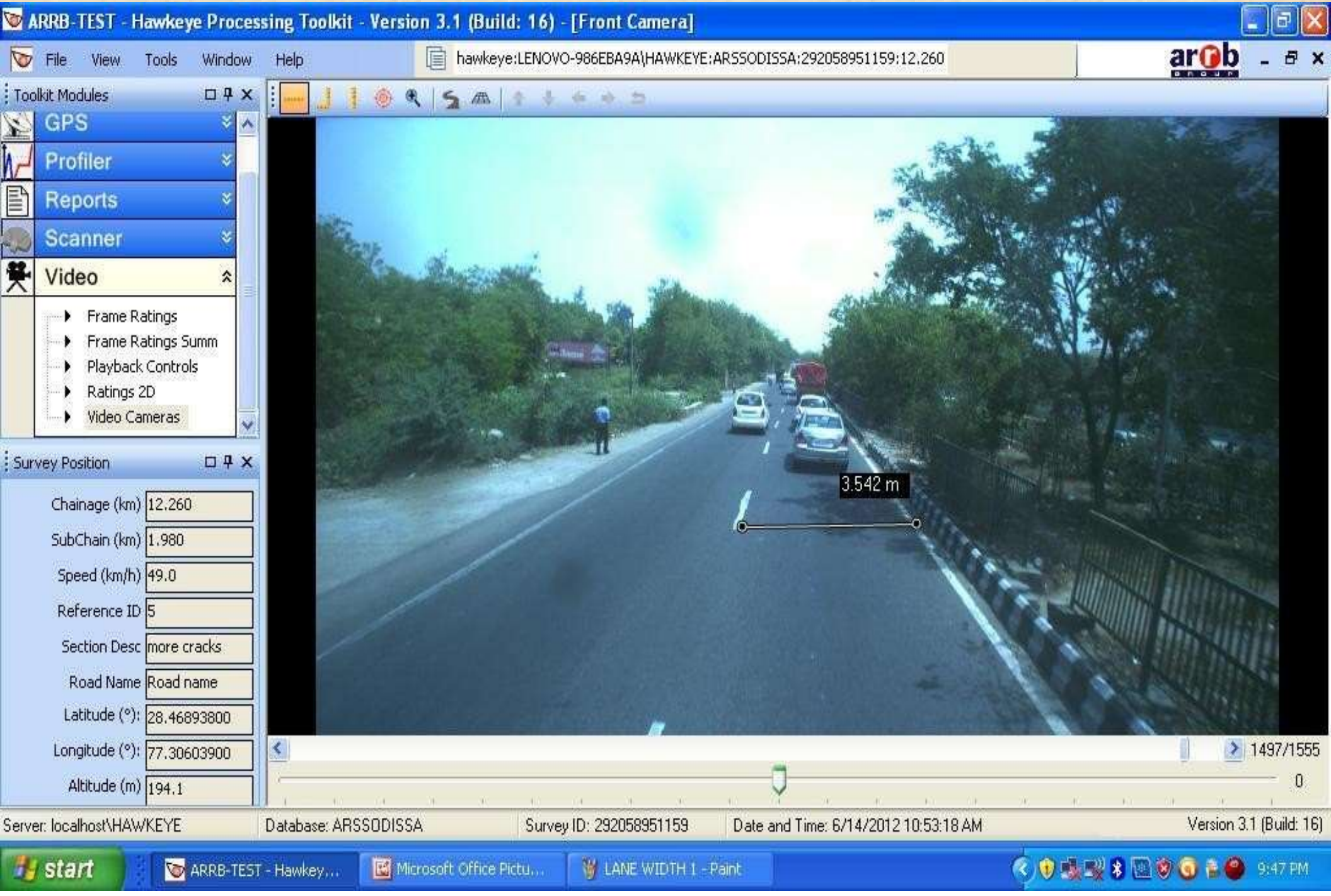
Front Laser Mounting Beam
Supports 30+ lasers / accelerometers / gyros
Inter-changeable lasers (16 kHz, 32 kHz, 64 kHz or 78 kHz)
Configured to meet international standards and client requirements

Side Projection Lasers
Full lane width (typically 3.5 m)
Enables full transverse profile

CSIR CRRI

ARSS-Rut Scanner

Asset Camera Measurements



Operator's Console and Display

Comparison of Rut data with the Real Pavement Surface Condition (High Rut Depth)

CSIR CRRI

Bridge Management System(BMS)

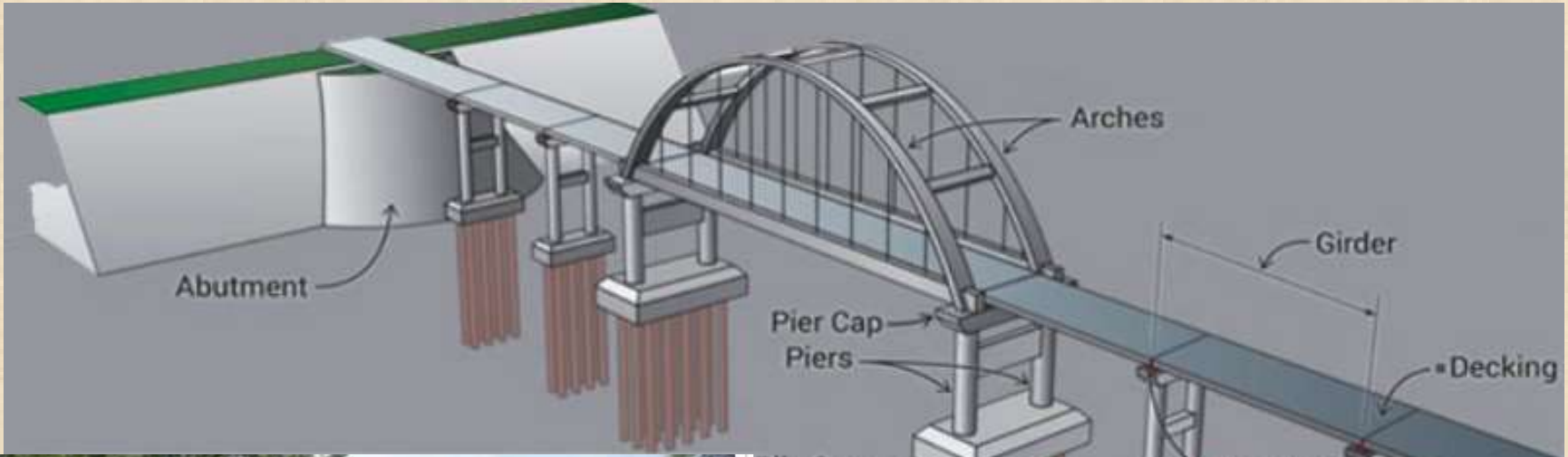
- **Bridge Management System(BMS) is** a system designed to optimize the use of available resources for the inspection, maintenance, rehabilitation, and replacement of bridges **(AASHTO)**

- Bridge inspection is an essential element of any **Bridge Management System** particularly for aged and deteriorated bridges and a path way to condition rating.

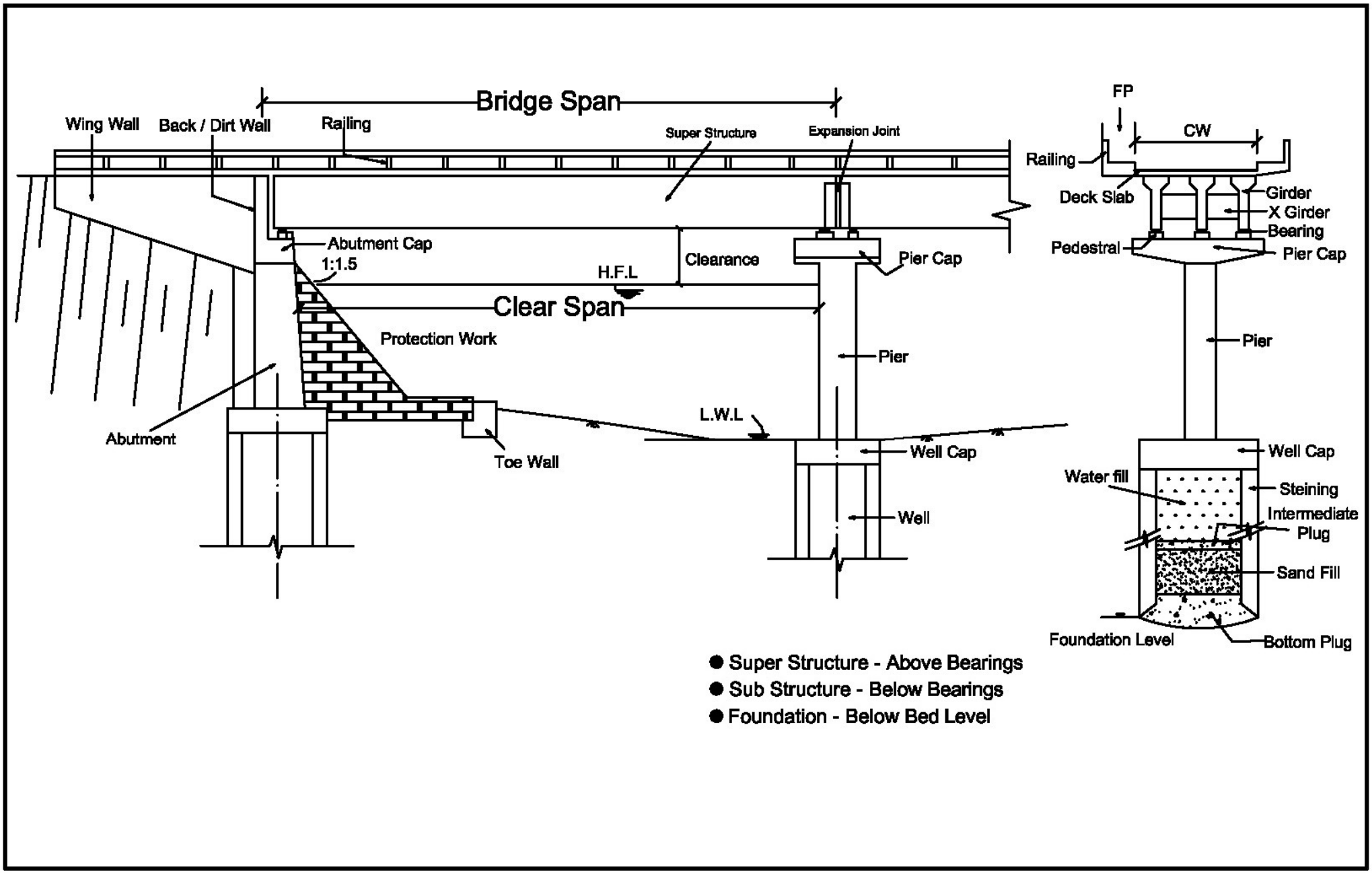
- The validity of **Condition Assessment** relies heavily on the quality of the inspection.

- A BMS consists of a database of bridge information and analysis tools to identify **needs and prioritization for bridge maintenance, rehabilitation, and replacement.**

Bridge Componets / Assets



Bridge Components/ Assets



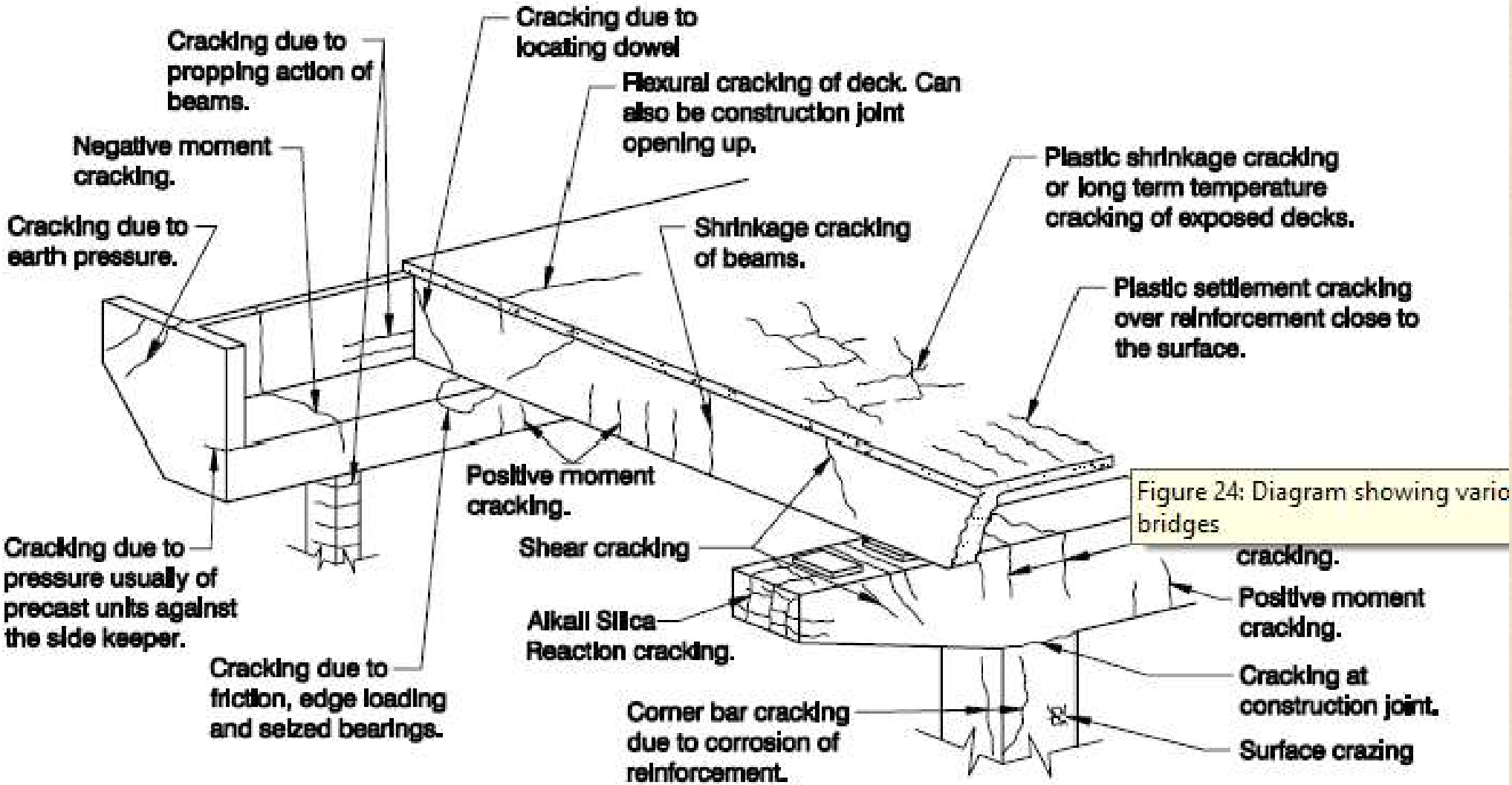


Figure 24: Diagram showing vario
bridges

Figure 24: Various types of cracks in bridges

Bridge Maintenance Activity & BMS

- Bridge Maintenance is a critical component of an **Organization's Road Asset Management plan** that includes both routine and preventive- maintenance for Minor Bridges, Major Bridges, Culverts / other Cross Drainage Structures, which are important component of a highway /road network system

- Maintenance and repair are complementary operations and are both essential components of **Bridge Management**.

- Maintenance is **cyclic activity** which is repeated over the life of the structure. It is preventative in principle and is generally straightforward, routine and repetitive.

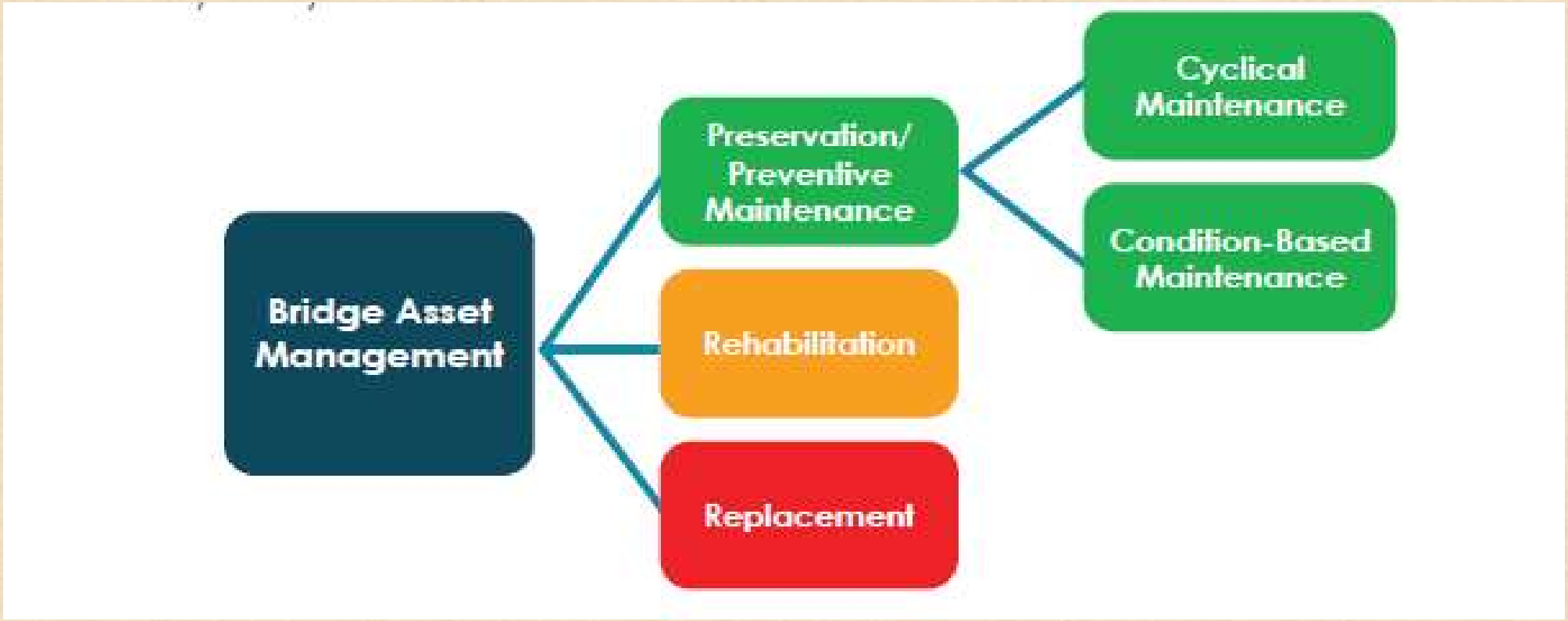
Bridge Routine Maintenance & Preservation

- **Bridge Routine Maintenance** encompasses work that is performed **in reaction to an event, season, or activities that are done for short-term operational need** that do not have preservation value. This work requires regular reoccurring attention.

- **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 or fair condition; and extend their service life.

- **Preservation actions may be cyclic or condition-driven**.

Bridge Maintenance & Preservation



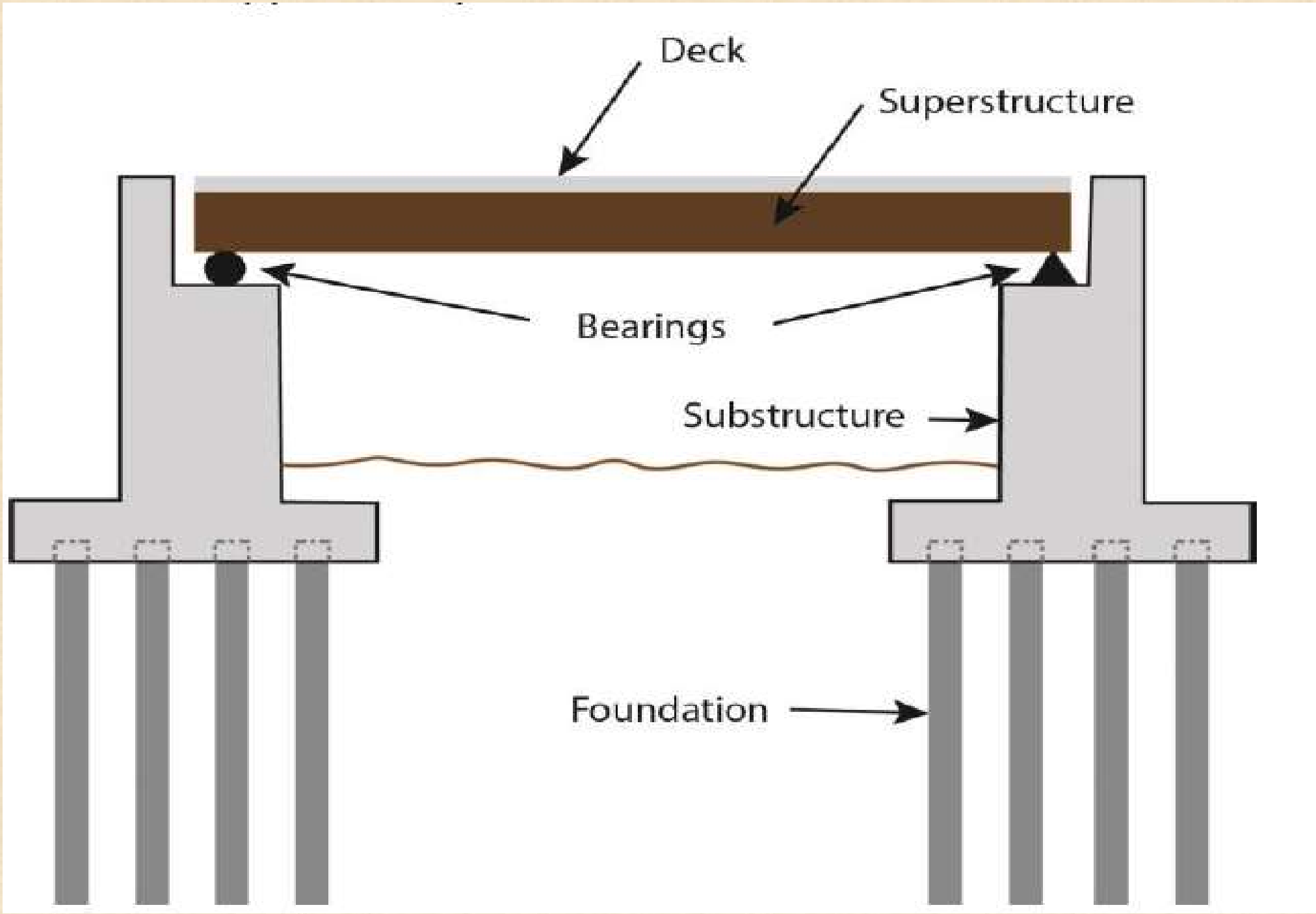
Bridge Maintenance & Preservation is generally done through a systematic process of **Bridge Asset Management**, which in turn is an integral part of any complete highway/road asset management planning for an organization.

Methodology

Seven-steps process

- Inspection & Identification of distress types
- Severity & extent of distress
- Condition rating for elements
- Overall rating of the bridge
- Maintenance Strategy –Decision making
- Prioritization & Implementation
- Performance Monitoring & Evaluation (KPI)

What to inspect & How ???



Benefits of Preventive Maintenance and Consequences of Deferred Maintenance

- Bridge preservation strategy that employs the **right treatments at the right times** is the most cost-effective strategy for the management of highway bridges
- It costs less to maintain bridges in good condition than to maintain them in a **deteriorated condition**.
- Applying the **wrong treatments or deferring maintenance altogether**, leads to a major rehabilitation or possible complete replacement.
- Rehabilitation projects and replacement projects are costly.
- Bridge repairs and rehabilitation improve the condition of the bridge.

Benefits of Preventive Maintenance and Consequences of Deferred Maintenance

- **Each repair adds to the length of time the bridge will remain in service.**

- As the **structure ages further, the condition rating drops** and soon another repair or rehabilitation becomes necessary.

- Eventually, the **deterioration becomes extensive** and the structure has to be replaced.

- During the life of a bridge, **some elements such as expansion joints and approach slabs are repaired several times**, each time improving the element condition but not the overall bridge condition rating.

- **More extensive rehabilitation, such as deck or superstructure replacement have a greater effect on the bridge condition ratings, but are done less frequently.**

- The **deck may be replaced once during the life of the bridge**.

- A **second deck replacement project is not common** as too many other elements of the bridge may also require replacement

- At that point the service life of the bridge is reached. The bridge becomes a replacement candidate.

Funding Bridge Preservation

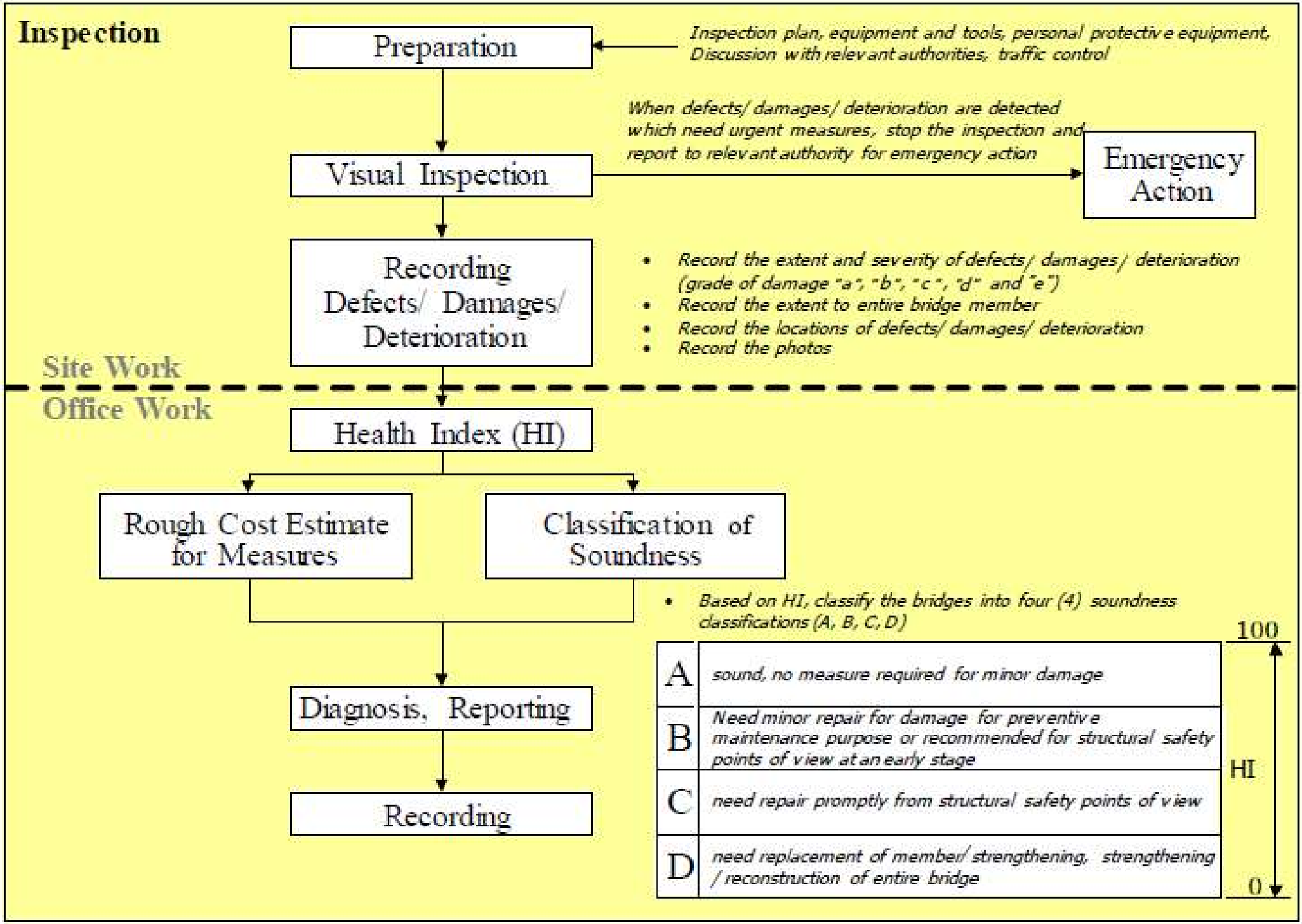
- Bridge managers look to address the needs of all bridges in their inventory / **Network (Odisha 3700 cases)**

- They **balance investments** in new bridges, rehabilitation, and preventive maintenance activities.

- Just as using all available funds for bridge **replacements would neglect the preservation of existing bridges,** using all resources on preventive maintenance would ignore more significant needs, such as bridge replacements and rehabilitations.

- Decisions on funding bridge preservation require **clear objectives and measureable goals** and are based on needs.

- An objective could be as simple as: Implement timely preservation treatments on **structurally sound bridges**, thereby extending their useful life.


Inspection
Preparation
Inspection plan, equipment and tools, personal protective equipment, Discussion with relevant authorities, traffic control
When defects/ damages/ deterioration are detected which need urgent measures, stop the inspection and report to relevant authority for emergency action
Visual Inspection
Emergency Action
Recording Defects/ Damages/ Deterioration
Record the extent and severity of defects/ damages/ deterioration (grade of damage "a", "b", "c", "d" and "e")
Record the extent to entire bridge member
Record the locations of defects/ damages/ deterioration
Record the photos
Site Work
Office Work
Health Index (HI)
Rough Cost Estimate for Measures
Classification of Soundness
Based on HI, classify the bridges into four (4) soundness classifications (A, B, C, D)
A
sound, no measure required for minor damage
B
Need minor repair for damage for preventive maintenance purpose or recommended for structural safety points of view at an early stage
C
need repair promptly from structural safety points of view
D
need replacement of member/ strengthening, strengthening / reconstruction of entire bridge
100
HI
0
Diagnosis, Reporting
Recording

Current Practices in our country by MORTH /NHAI /State PWDS

vis-s-vis

Literature Survey on Bridge Maintenance Practices Around the World

BRIDGE INSPECTION / CONDITION RATING MAINTENANCE STRATEGY

BMS GLOBAL APPROACH

Road Development Authority

Japan International Cooperation Agency

Bridge Inspection and Diagnosis Manual

October 2017

The Project for Capacity Development on Bridge Management
In The Democratic Socialist Republic of Sri Lanka

THE MANUAL FOR BRIDGE EVALUATION

2019 Interim Revisions

AASHTO

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IOWA DOT

Office of Bridges and Structures

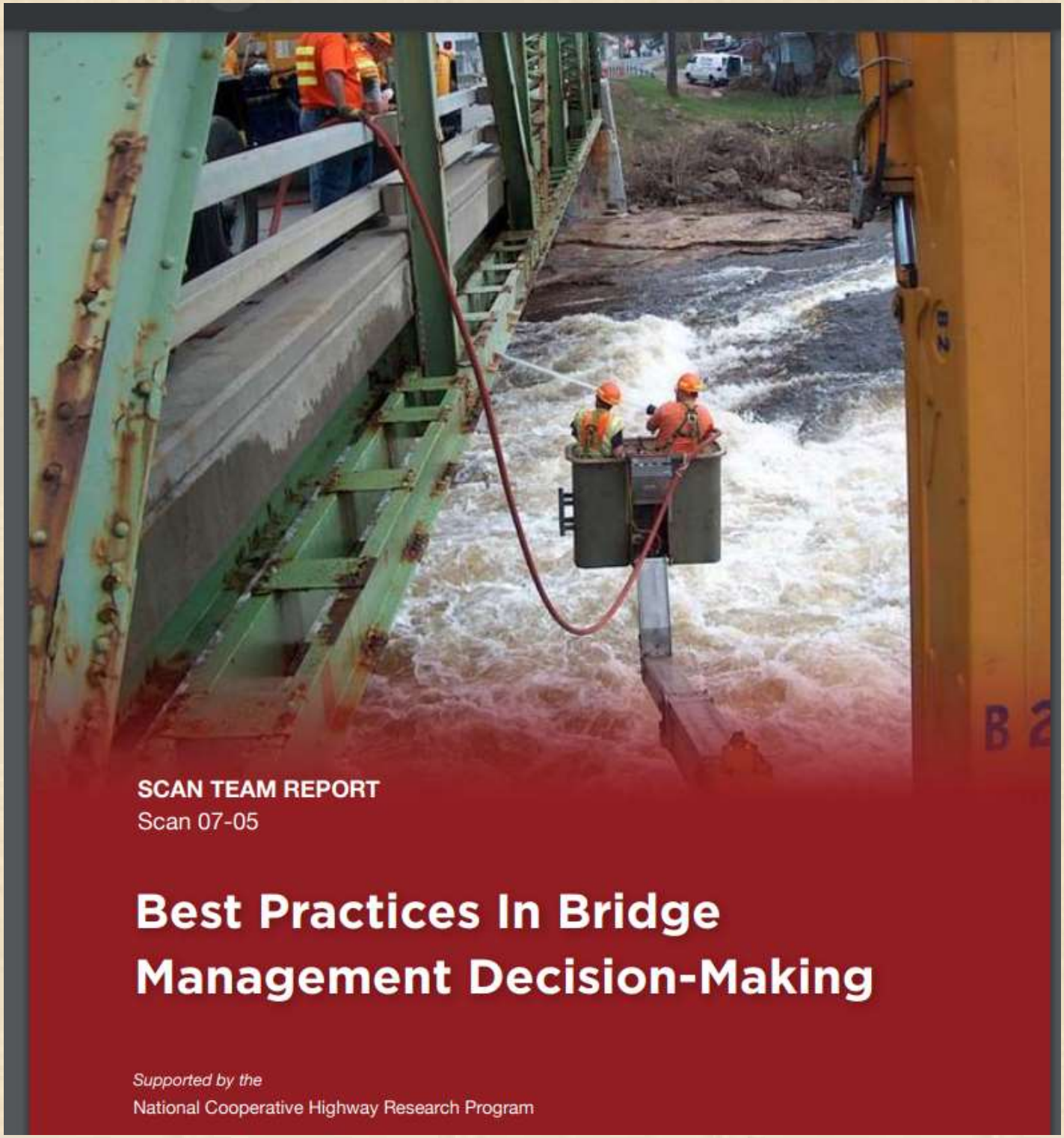
Bridge Maintenance Manual

Issue Date: January 1, 2014

Developed By:

HDR

PROJECT NO. TR-646 SPONSORED BY THE IOWA HIGHWAY RESEARCH BOARD



SCAN TEAM REPORT
Scan 07-05

Best Practices In Bridge Management Decision-Making

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INTERNATIONAL TECHNOLOGY EXCHANGE PROGRAM

Bridge Preservation and Maintenance in Europe and South Africa

U.S. Department of Transportation
Federal Highway Administration

APRIL 2005

Bridge Maintenance Manual

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

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JOINT TRANSPORTATION
RESEARCH PROGRAM
INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY

Bridge Preservation Treatments and Best Practices

Mark D. Bowman, Luis M. Moran

SPR-3617 • Report Number: FHWA/IN/JTRP-2015/22 • DOI: 10.5703/1288284316007

Bridge Preservation Guide

Maintaining a Resilient Infrastructure to Preserve Mobility

Spring 2018

U.S. Department of Transportation
Federal Highway Administration

Report on Techniques for Bridge Strengthening

Main Report

April 2019

U.S. Department of Transportation

Federal Highway Administration

FHWA-HIF-18-041

Alberta
INFRASTRUCTURE AND TRANSPORTATION

Bridge Inspection & Maintenance System

BIM
Bridge Inspection and Maintenance

BIM INSPECTION MANUAL

Version 3.1

BRIDGE INSPECTION & CONDITION RATING - **JAPAN**

- Each element in the structure is evaluated based on every single kind of defect, such as cracking, corrosion, etc., **A demerit rating is assigned** to each element in a tabular format.

- According to the Regular Inspection Procedure for Road Bridge (2014) regulated by the Ministry of **Land, Infrastructure, Transport and Tourism (MLIT)** , there is basically one inspection type; **Regular Inspection**.

- Regular inspection in Japan is a **hands-on visual inspection of components or elements** in a close distance.

- For every structural member in each span, the condition is translated into either of the **maintenance urgency ratings**

CONDITION RATING OF BRIDGES IN JAPAN

Condition		Description
I	Good	No obstacle to the function of the structure.
II	Preventive maintenance phase	There is no obstacle to the function of the structure, but it is desirable to take preventive maintenance.
III	Early rehabilitation phase	There is a possibility that the function of the structure may be hindered, so a rehabilitation strategy must be taken.
IV	Emergency repair phase	Presence of an obstacle to the function of the structure, or a possibility of occurrence is extremely high. An urgent action must be taken.

Maintenance urgency ratings are diagnoses given by experienced engineers in a very subjective manner, for each member, taking into account the damage type, location of damage, direction of crack, earlier remedial work history, etc.

BRIDGE INSPECTION & RATING - UNITED STATES OF AMERICA

- **National Bridge Inspection Standards (NBIS)** set the criteria for proper inspection and evaluation of all highway bridges in the United States.
- According to the American Association of State Highway and Transportation Officials (AASHTO) manual for Condition Evaluation of Bridges, the overall condition rating is assigned for three major components: **deck, superstructure and substructure** which are further divided into various elements
- Federal regulations address bridge inspection population, inspection intervals, inspection methods, inspection personnel, and inspection reporting

Eight types of bridge inspections- USA

Inspection	Description
Initial	First inspection of a bridge as it becomes a part of the bridge inventory to determine baseline structural conditions.
Routine	Regularly scheduled inspection consisting of observations and/or measurements needed to determine the physical and function condition of the bridge.
Damage	Unscheduled inspection to assess structural damage resulting from environmental factors or human actions.
In-Depth	A close-up inspection which investigates deficiencies that were not detected during Routine Inspection.
Special	An inspection scheduled at the discretion of the bridge owner, used to monitor a particular known defect or suspected deficiency.
Underwater	Inspection of the underwater portion of a bridge substructure and the surrounding channel.
Hands-on	Inspection within arm's length of the component. Inspection uses visual techniques that may be supplemented by NDT.
Fracture-Critical Member	A hands-on inspection of a fracture-critical member or components that may include visual and other non-destructive evaluation.

NDT: Non-destructive Test

CONDITION RATING SYSTEM – USA

Rating	Description
N	Not Applicable.
9	Excellent Condition.
8	Very good Condition – no problems discovered.
7	Good Condition – some minor problems.
6	Satisfactory Condition – structural elements show some minor deterioration.
5	Fair Condition – all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.
4	Poor Condition – advanced section loss, deterioration, spalling, or scour.
3	Serious Condition – loss of section, deterioration, spalling or scour have seriously affected primary structural elements.
2	Critical Condition – advanced deterioration of primary structural elements.
1	Imminent Failure Condition – major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability.
0	Failed condition – out of service.

Table 5: Descriptive condition rating for elements

Condition	Description
Good	Element is limited to only minor problems.
Fair	Structural capacity of element is not affected by minor deterioration, spalling, cracking etc.
Poor	Structural capacity of element is affected by advanced deterioration, section loss, spalling, cracking or other deficiency.

FIVE TYPES OF BRIDGE INSPECTION IN UK

Inspection	Description
Acceptance	Performed for new bridges, newly repaired bridges, and newly start of a new maintenance contract.
Superficial	Checks for outstanding defects that pose a risk to safety are highlighted and action taken immediately to remedy them.
General	Applies to bridge elements that are easily accessible.
Principal	All bridge elements, including those that are difficult to access. This may sometimes require specialist access machinery or tools.
Special	Detailed investigation of a particular bridge component. Bridges that have been strengthened using plates bonded to them also require special inspections.

Methodology of visual inspection in U.K. is primarily based on *Severity* – *Extent* code prescribed procedure set out by Highway Agency.

UK Bridge Condition Rating System

- The **severity** defines as the degree of damage while **extent** is a measure of the length, area, or number of defects of the bridge element.
- Condition rating used in the UK is **a scale of 1-5,** describing the degree of deterioration, from minor (structurally sound) to a collapsed state (non-functional).

	Code	Description
Extent	A	No significant defect.
	B	Slight, less than 5% of length/area affected.
	C	Moderate; 5% – 20% of area/length affected.
	D	Wide, 20% – 50% affected.
	E	Extensive; over 50% of surface area/length.
Severity	1	As new, or has no significant defect.
	2	Early signs of deterioration, minor defect.
	3	Moderate, some loss of functionality expected.
	4	Severe defect and/or element is close to failure.
	5	The element is non-functional/failed.

BRIDGE INSPECTION IN SOUTH AFRICA

- Inventory and inspection of bridges is done by the **South Africa National Roads Agency Limited (SANRAL)** for bridges on national roads, Provincial departments of transport for bridges on provincial roads and municipal transport agencis for bridges on municipal roads.
- South African maintenance practice includes **five types of inspections .**
- The defects are rated for their **Degree, Extent, Relevancy and Urgency (DER&U).**
- The DER&U rating system identifies defects **and prioritizes them by evaluating their relative importance to the structural integrity of the bridge.**
- It is important to note that the ratings are **not directly associated with the elements but with the damage**

BRIDGE INSPECTION IN SOUTH AFRICA

Inspection	Description
Monitoring	A quick check on the new defects and the status of the previously known defects. A monitoring inspection does not produce any condition rating.
Principal	A thorough examination and record of a bridge for all defects.
Verification	Are performed annually by SANRAL in order to verify the accuracy of inspection data.
Project-level	Inspection to collect information for contract documents.
Acceptance	Inspection of work during and after a contract.

BRIDGE INSPECTION IN DENMARK

- **Danish Road Directorate** used a computer-based BMS, called **DANBRO**, to manage their bridges.
- DANBRO throughout Denmark **since 1988** identifies **eight types of bridge inspections** .
- For each defect reported, the inspector will recommend a repair scheme, its year of application, and also estimate the costs for repair actions
- Condition ratings in Denmark are built up from three contributors: **damage (3 points), function (1 point), and consequence (1 point).**
- The **overall rating scale is 0-5**, with '0' meaning no damage and '5' implying that the component can no longer fulfil its function

Eight Types Bridge Inspection in Denmark

Inspection	Description
Inventory	Collect bridge data and baseline conditions.
Daily*	Cursory examination noting failure, damage, debris, etc.
Routine—Extended	Planning and checking routine cleaning and maintenance.
Reports from Users	Reports of: impact damage, vandalism, debris on bridge or road and erosion damage.
Principal	Thorough and systematic visual inspection of all the components of the bridge.
Special	Collection of more detailed information for decisions on maintenance actions.
Economic Special Inspection	Preparation for major repair project for a bridge.
Technical Special Inspection	Damage investigations, Special investigations, Load-carrying capacity evaluations.

* | Not a formal part of the Directorate Bridge Inspection Program.

DANISH ROAD DIRECTORATE "DANBRO" RATING SYSTEM

Rating	Description
0	Insignificant deterioration; little or no damage.
1	Minor deterioration; damage with a very slow rate of development.
2	Damage is at an early stage of development or there are a few fully developed defects.
3	Damage has developed to such a degree and/or extent that it is likely that within a short time the component will no longer fulfil its function.
4	The component is severely deteriorated, such that its capacity to fulfil its function has or will soon disappear. Repair is necessary in the near future.
5	The component has completely deteriorated and can no longer fulfil its function.

Bridge Inspection & Condition Rating in Germany

- Bridge inspections at two levels called Major Test and Minor Test .
- Major tests are arms-length (DIN wording is “touching-distance”) inspections of all elements with access to all parts.
- Minor tests are done three years after each major test.
- In Germany, condition rating scales run from 0 (good) to 4 (very poor).
- Each bridge component is assigned three ratings; one each for structural damage, traffic safety, and bridge durability.

Bridge Inspection Type in Germany

Inspection	Description
Major Test	Arms-length inspection of all components; uses access equipment and includes underwater inspection.
Acceptance	*Major test.*
Guarantee	*Major test.*
Minor Test	Verification of current state of known damage and defects.
Superficial	Cursory inspection for safety.
Ad Hoc	After significant events, such as storms, floods, etc.; also for known, severe damage.
Systems	Inspection of electrical or mechanical systems.

GERMANY - RATING FOR STRUCTURAL DEFECT & BRIDGE COMPONENTS

Rating	Description
0	Defect has no effect on the strength of the element or structure.
1	Defect affects the strength of the structural element, but does not affect the strength of the structure.
2	Defect affects the strength of the structural element and has little effect on the strength of the structure.
3	Defect affects the strength of the structural element and the structure. Structure does not have adequate strength.
4	Structural strength of the structural element is lost. Structure does not have adequate strength. Repair or rehabilitation is needed.

Grade	Description
1.0–1.4	Very good structural condition.
1.5–1.9	Good structural condition, but may have less long-term durability.
2.0–2.4	Satisfactory structural condition, but may have less long-term durability.
2.5–2.9	Unsatisfactory structural condition. Traffic safety may be affected.
3.0–3.4	Critical structural condition. Traffic safety is affected.
3.5–4.0	Inadequate structural condition. Traffic safety is not adequate.

Canadian rating (Bridge Condition Index),

- One of the option could be to **consider the replacement cost of the bridge and then define BCI (Bridge Condition Index)**.

- To calculate the **BCI rating, the current value is divided by the replacement cost of the bridge**.

- **Good - BCI Range 70 -100** (For a bridge with a BCI greater than 70, maintenance work may not be required within the next five years).

- **Fair - BCI Range 60 -70** (For a bridge with a BCI between 60 and 70 the maintenance work can be scheduled within the next five years. This is the ideal time to schedule major bridge repairs from an economic perspective.

- **Poor - BCI Less than 60** (For a bridge with a BCI rating of less than 60, maintenance work should be scheduled within one year).

Scenario in India – Indian Roads Congress IRC Guidelines

IRC Guidelines for Inspection, Maintenance, Repair, Strengthening , Retrofitting & Rating of Bridges

1. IRC:SP:18 Manual for Highway Bridge Inspection
2. IRC:SP:35, Guidelines for Inspection and Maintenance of Bridges
3. IRC: SP:37 Guidelines for Evaluation of Load Carrying Capacity Bridges.
4. IRC: SP:40 Guidelines on Repair, Strengthening and Rehabilitation of Bridges
5. IRC:SP:52 Bridge Inspectors Reference Manual
6. IRC:SP:51 Load Testing of Bridges
7. IRC: SP:74 Guidelines for Repair and Rehabilitation of steel bridges
8. IRC:SP 75 Guidelines for Retrofitting of Steel Bridges

BRIDGE CONDITION RATING - IRC SP 40-2019

Table 6.2 Condition States for Bridge Components

Sl. No.	Condition State	Condition	Extent & Severity of Distress	Type of maintenance
1	Excellent	Sound structural condition; component do not individually or as a whole impair the strength, stability, traffic safety, durability and serviceability of the structure.	Only constructional deficiencies may be present. Extent of deficiencies is nil or insignificant. Severity of deficiencies is very low.	No need of repair except routine maintenance.
2	Good	More than satisfactory structural condition; component do not individually or as a whole impair strength/stability: traffic safety, durability and/or serviceability of the structure might be impaired slightly in the long term.	Extent of deficiencies is minor; Severity of deficiencies is low.	Specialized maintenance and repairs may be needed at convenience.
3	Fair	Satisfactory structural condition; strength, stability and traffic safety of the components/ structure is assured however considerable reduction is possible in the long term; serviceability and durability of the affected component is reduced and durability of the structure might be impaired considerably in the long term.	Extent of deficiencies is major; Severity of deficiencies is medium.	Specialized maintenance and repairs needed soon.

BRIDGE CONDITION RATING -INDIA- AS PER IRC SP 40-2019

Sl. No.	Condition State	Condition	Extent & Severity of Distress	Type of maintenance
4	Poor	Structurally deficient bridge; strength/stability/ traffic safety no longer assured; durability may be affected in short term; monitoring is required; restriction of use of the bridge may be needed.	Extentofdeficiencies is large; Severity of deficiencies is high.	Rehabilitation/ replacement on program basis is needed; measures for reconstruction or warning signs for upholding traffic safety might be necessary in the short-term; detailed investigations and economic analysis is required for justification of funds.
5	Critical	Weak structural condition; partial failure or risk of total failure of the component or as a whole; durability of the structure is no longer ensured; immediate propping of the structure and closing may be required.	Extentofdeficiencies is very large/ expensive; Severity of deficiencies is very high.	Repair/rehabilitation/ replacement is required immediately; design strength, expected serviceability and desired remaining service life of a component/bridge can no more be achieved with economic costs.

Decision processes for maintenance

- Quality of Inspection & Reliability of insitu data
- Bridge Condition Rating (Element level & Full)
- Maintenance Needs (Element level & full)
- Effectiveness of Maintenance (Alternatives)
- Funding Availability & Economic Evaluation
- Project Level Work Program
- Network Level Work Program
- Implementation & Monitoring

Inspection by Bridge Inspection Vehicle

Inspection by Pole Camera

Inspection by Ladder

Typical Mobile Bridge Inspection Unit

Typical Mobile Bridge Inspection Unit

Typical Mobile Bridge Inspection Unit


24-Jul-06 1:54 pm


24-Jul-06 2:07 pm

Challenges in Insitu Testing

Challenges Insitu Testing

BRIDGE REHABILITATION TECHNIQUES

Table 1: Protective Coating Material and Properties

Product Category	Classification	CO_2 Resistance	Water Vapour Transmission	Cl/H_2O Resistance	Application		Durability		Cost	
					Damp Condition	Ease	Strong UV	Wet \Dry	Recoat Interval	Ease of Recoat
Film Forming										
Polyurethane	Coating	Very High	Very Low	Very High	No	Poor	Poor	Good	Good	Poor
Epoxy Resin	Coating	Very High	Very Low	Very High	Fair	Poor	Fair	Good	Good	Poor
Epoxy Coal Tar	Coating	Very High	Very Low	Very High	No	Good	Poor	Good	Fair	Good
Chlorinated Rubber	Coating	Very High	Moderate	Very High	Yes	Good	Fair	Fair	Fair	Good
Acrylics	High Build Coating	Very High	Very Low	High	Fair	Good	Good	Poor	Poor	Good
Bituminous	Coating	High	High	High	Yes	Good	Good	Excellent	Excellent	Good
Polymer Modified Cementitious					Yes					
Non-Film Forming										
Silane Siloxane	Impregnation	Very Low	Very High	Very High	Yes	Good	Good	Very Good	Excellent	Good

External Post-Tensioning

Over the service life of a pre-stressed concrete member, loss in pres-stress may occur due to a variety of reasons. Post-tensioned bridges can be effectively rehabilitated by external post-tensioning technique to compensate for loss in pre-stress or increase in wheel loads.

Maintenance Items & Objectives / Alternatives

Sl NO	Maintenance Approach	Objectives / Maintenance Response
1	Seal or replace leaking joints or eliminate deck joints	Minimizes the deterioration of superstructure and substructure elements beneath the joints.
2	Deck overlays	Significantly increase the life of the deck by sealing of aging and weathering. Overlay systems include waterproofing membrane with asphaltic concrete overlay, low permeability or high performance concrete overlays, and methyl methacrylate and polymer-system overlays.
3	Cathodic Protection (CP) systems for bridge decks	Proven technology for stopping the corrosion of reinforcing steel.

Maintenance Items, Objectives & Best Practices

Sl NO	Maintenance Approach	Objectives / Maintenance Response
4	Electrochemical Chloride Extraction (ECE) treatment	Removes the chloride ions from the vicinity of the reinforcing steel and thus eliminates the source of corrosion.
5	Concrete deck repairs in conjunction with installation of deck overlays, CP systems, or ECE treatment	Proven technology for stopping the corrosion of reinforcing steel.
6	Painting/coating or overcoating of structural steel	Protects against corrosion. Reduces the deterioration of the structural steel
7	Retrofit of fracture critical members	Methods to add redundancy to the structure such as installing a redundant catch system for pin and link assemblies.

Maintenance Items, Objectives & Best Practices

Sl NO	Maintenance Approach	Objectives / Maintenance Response
8	CP systems for substructure elements	Proven technology for stopping the corrosion of reinforcing steel.
9	ECE treatment for substructure elements	Removes the chloride ions from the vicinity of the reinforcing steel and thus eliminates the source of corrosion. Can be very effective when the source of chlorides is eliminated
10	Installation of scour countermeasures	Protects the substructure elements from undermining and failure due to scour.
11	Removing large debris from channels	Prevents channel bed material from scouring.
12	Installation of jackets with CP systems around concrete piles	Protects against corrosion and deterioration.
13	Application of concrete sealants, coatings, and membranes for surface protection of the concrete -	Protect the reinforcing steel from corrosion by stopping or minimizing the intrusion of water and chloride through the concrete.

Performance Monitoring and Evaluation

- It is desirable to have a process for monitoring and evaluating the asset management implementation through performance measure parameters.

- Some of the key performance indicators (KPI)

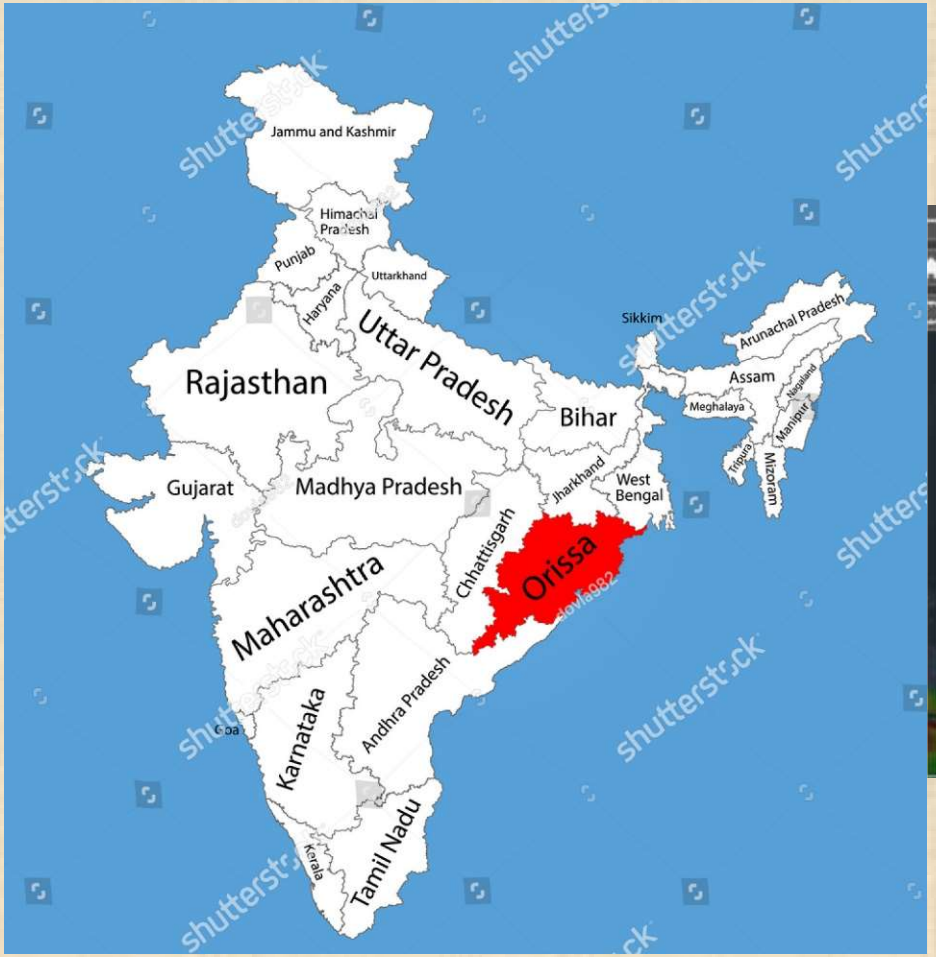
  a) Average condition of the all bridges on a network in terms of Bridge Condition Indices (BCI) before and after implementation of BMMS

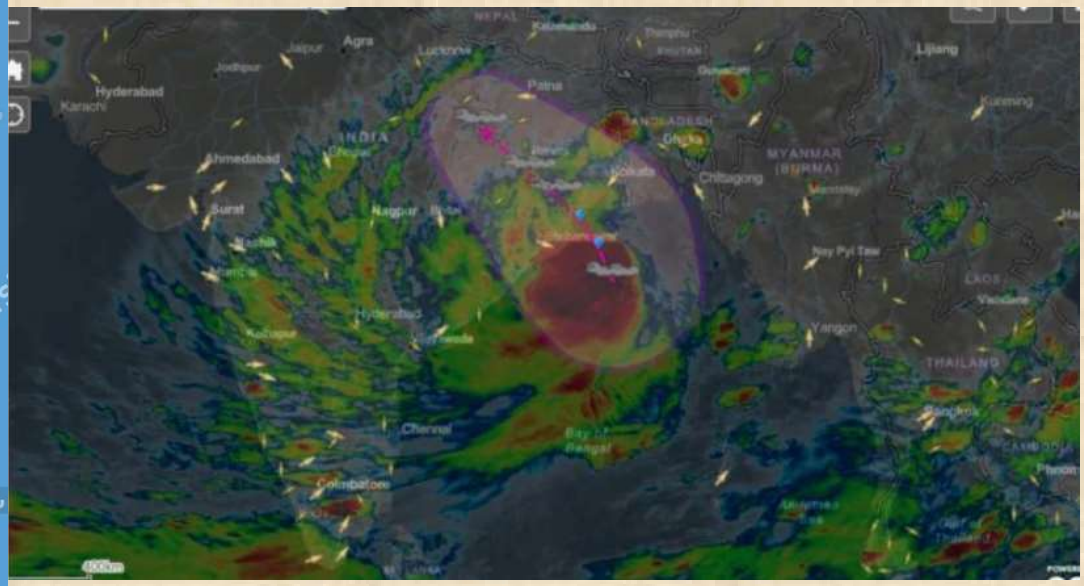
  b) Percentage of III condition bridges in a road network above a threshold values of SHI as an indication of timely intervention for improvement in functionality / serviceability,

  c) Percentage of distress in a network level over a threshold values of Cracking/Corrossion / Spalling / or combination of these,

  d) number of Bridges maintained per year

ODISHA CASE STUDY





OWD Bridge Example


2013/12/20


2013/12/20


2013/12/20


2013/12/20


2013/12/20


2013/12/20

Bridge Condition Survey

- Critical attributes of bridge condition survey

I. Cracking

II. Spalling

III. Corrosion

IV. Settlement / scour / deformity

V. Condition of bearings

Bridge Condition Survey

- Elements for evaluation

I. Foundation

II. Protection works

III. Substructure

IV. Bearings

V. Superstructure

condition of expansion joints, drainage spout, wearing coat etc. also to be evaluated

Bridge Condition Rating

Severity

Level	Description
Nil	No visible damage
Low	All elements are in good condition with minor deterioration
Medium	Element has only minor/advance section problems
High	Structural capacity of element is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, or other deficiency

Extent

Level	Description
Nil	No distress visible
Few	Less than 10% surface area affected
Moderate	10 to 25% surface area affected
Extensive	More than 25% surface area affected

Methodology

Four-step process

- Identifying the distress types
- Visual observation of distress (of severity & extent)
- Condition rating for elements
- Overall rating of the bridge

Identification of Distress

- Nature and Type of distress
  1. Cracking
  2. Spalling
  3. Corrosion in reinforcement
  4. Honey combing
  5. Leaching
  6. Loss of Plaster, loss of mortar, loss of element in Masonry structure
  7. Damage in Expansion Joint, Non functioning of Expansion Jt.
  6. Damage of railing/Crash Barrier/Parapet wall
  7. Scour of Foundation, Settlement of Foundation
  8. Distress in Bearing
  10. Damage in Wearing Coarse
  11. Damage in Floor Pitching and Slope Pitching
  12. Vegetation Growth in Structural Element and in Bed
  13. Damage in Drainage Spout

Cracking (Pattern, Width and Location)

Severity

Description	Rating
No cracking	Nil
Hair line cracks width <1mm	Low
Narrow and medium Cracks width 1mm to 5mm	Medium
Wide cracks width > 5mm	High

Extent

Description	Rating
No cracks visible	Nil
Up to 10% of surface area affected, mostly localized	Few
10% - 25% of surface area affected, either localized or evenly over structure	Moderate
More than 25% of the surface area affected, almost evenly over length	Extensive

Spalling of Concrete

Severity

Description	Rating
No Spalling	Nil
Slight spalling. Depth of spalling less than 10mm. Reinforcement not exposed.	Low
Extensive spalling. Depth 10mm to 50mm. Less exposure of reinforcement.	Medium
Extensive spalling. Depth > 50mm. Reinforcement exposed and corroded.	High

Extent

Description	Rating
No Spalling	Nil
Up to 10% of surface area affected, mostly localized	Few
10% to 25% of surface area affected, mostly localized	Moderate
> 25% of surface area affected, either localized or evenly over length	Extensive

Corrosion

Severity

Description	Rating
No corrosion	Nil
Reinforcement is partly exposed and corrosion has just started	Low
Reinforcement is fully exposed and scaling due to corrosion is observed	Medium
Pit corrosion and section loss of reinforcement bars are observed	High

Extent

Description	Rating
No corrosion	Nil
Up to 10% of surface area affected, mostly localized	Few
10% - 25% of surface area affected, either localized or evenly over structure	Moderate
More than 25% of the surface area affected, almost evenly over length	Extensive

Scour and Settlement

Severity

Description	Rating
No Scour visible	Nil
Observed depth of scour at foundation location is normal	Low
Depth of scour is more and settlement is less	Medium
Depth of scour is more and critical. Settlement of sub structure is also more and there is vertical dislodgement of pier and abutment	High

Extent

Description	Rating
No Scour, No Settlement	Nil
Up to 10% of foundations scoured	Few
10% to 25% of foundations scoured	Moderate
> 25% of foundations scoured	Extensive

Bearings

Severity

Description	Rating
No damage	Nil
Surface cracks in pedestal and slight deformation of bearings	Low
Cracks having 1mm to 5mm wide, and spalling in pedestal, appreciable deformation in bearings	Medium
Slitting and wide cracks in pedestal, bulging, deformation, bearing not sitting in full length, anchor bolts missing, rusting of bearings	High

Extent

Description	Rating
No damage	Nil
Minor damages in pedestal and bearings	Few
In 10 to 25% of bearings, there are damages in pedestal, but no damage observed in bearings	Moderate
More than 25% of the pedestal and bearings are damaged	Extensive

Expansion Joints

Severity

Description	Rating
The movement of the superstructure is free over the bearings (expansion joint is fully functional)	Nil
The movement of the superstructure is restrained partially (joint is filled with loose material)	Low
The movement of the superstructure is restrained partially (joint is filled with solid material – dust or bituminous material), expansion joint is also showing sign of damage of its material	Medium
The movement of the superstructure is totally restrained over the bearings (joint is filled with hard solid material such as stone aggregate pieces with dust/concrete/bitumen etc.). Expansion joint has become non-functional, concrete near joint cracks, starts failing and comes out, loses its anchorage system or even the material joint starts failing	High

Masonry Bridges

Severity

Description	Rating
No loosening/loss of area	Nil
Slight loosening of masonry/loss of area (< 5%)	Low
Extensive loss of area or showing the loosening of masonry at various locations and tendency of further loss of area	Medium
Extensive loss of area or showing the loosening of masonry at various locations, substantial loss of area, regular feature of reducing area	High

Extent

Description	Rating
No loosening of masonry/loss of area	Nil
< 5% surface are of masonry affected at isolated locations	Few
5% to 10% of surface area of masonry affected at different locations	Moderate
10% of surface area of masonry affected at different locations but covering the entire length of the component	Extensive

Other Elements

Condition of the following elements will also be evaluated

- Wearing coat
- Drainage spout
- Railing

Bridge Condition – Overall Rating

Overall R	GOOD	FAIR	POOR	SEVERE (VERY POOR)
Cracking	No cracking/ hairline cracking	Both extent and severity are moderate. Cracks are narrow	Extensive, medium to wide cracks, area covered by the cracks is large	Extensive, wide cracks, continuous cracks
Spalling	Slight or no spalling	Cracks becoming prominent and likely to lose cover, on the verge of spall	Extensive and deep spalling, loss of cover, falling of concrete in small pieces	Extensive deep spalling, total loss of cover, concrete chunks falling, reinforcement exposed
Corrosion	No corrosion	Slight corrosion	Corrosion visible on bars	Heavy corrosion, rust on reinforcement is easy to remove, loss of diameter of bars
Settlement / Scour	No settlement/ less scour	No settlement. Normal scour	No settlement. Normal scour	Settlement of substructure. Scour in foundation and protection works
Bearings	No deformity	No deformity	Damages of pedestal observed, shifting of bearings from original position, deformation/ bulging of bearings	Bearings out of sitting, shifted from its position and showing sign of failure. Pedestal damaged
Expansion Joints	Free movement	Partially restrained, loose material in joint	Severely restrained, loose/solid material in joint	Totally restrained, solid material in joint, adjacent concrete spalling
Masonry	No loss/loosening	Slight loss/loosening	Extensive loosening, tendency to loss	Extensive loss

Bridge Conditions: Action Needed

GOOD CONDITION

No intervention required

FAIR CONDITION

All primary structural elements are in good condition but have minor section losses.

Minor repair may be done on short-term basis

POOR CONDITION

Losses of section, deterioration, spalling, cracking or scour have seriously affected primary structural components.

Local failures are possible. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.

Immediate repairs are required.

SEVERE (VERY POOR) CONDITION

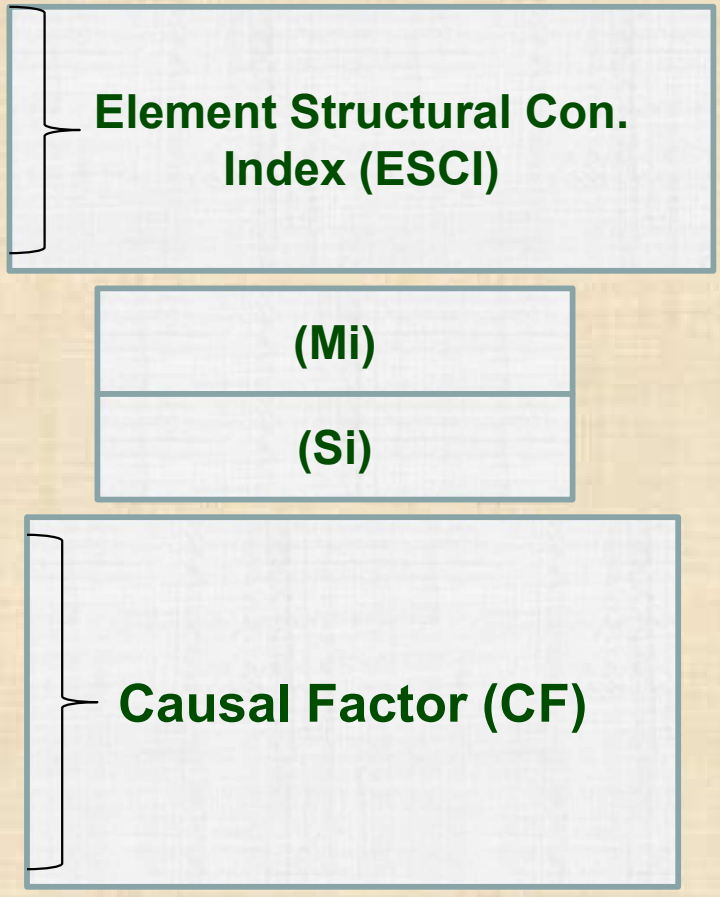
Major deterioration or section loss present in critical structural components.

Bridge to be closed to traffic, requires major rehabilitation or reconstruction.

Structural Health Index (SHI)

- SHI - indicator of overall condition of Structure,
  - Relative index for prioritization of Rehabilitation
  - Basis for finding the cost of rehabilitation
- It takes into account

1. Type of distress
2. Area of distress
3. Degree of deterioration
4. Material Vulnerability
5. Structural Significance Factor
6. Age Factor (A)
7. Environment Factor (E)
8. Road Importance (R)
9. Inspection Factor (I)



Structural Health Index (SHI)

Table 4: Material Vulnerability Factor Mi

Material of the element	Material Vulnerability Factor, mi
Steel	1
Reinforced Concrete	2
Precast concrete	3
Pre stressed concrete	4

Table 5: Structural Significance Factor Si

Element	Structural Significance
Barrier, Footway, Kerbs, Joints	1
Foundation, Abutment, Wingwall	2
Deck, Bearings	3
Beams, Headstocks, Piers	4

Structural Health Index (SHI)

- Causal Factor calculated on the basis of:
  - Analytical Hierarchy Process (AHP)
  - Developed by SAATY
- SHI is calculated :-
  - **SHI = CF*Sum (ESCI*Mi*Si)/n**

Overall Structural Condition Index (OSCI)

- OSCI/Rating is assigned on the basis of SHI values

1. SHI = 1 -10 → OSCI = 1 → Good
2. SHI = 10 - 30 → OSCI = 2 → Fair
3. SHI = 30 - 70 → OSCI = 3 → Poor
4. SHI = > 70 → OSCI = 4 → Very Poor

Items Considered for Bridge Repair

Sl. No.	Nature of distress	Severity	Maintenance treatment	Ref to Data Book Item No.
1	Vegetation growth in structural element		Clean and uproot rank vegetation	2.3
2	Spalling	low	Apply Epoxy mortar/ Polymer mortar	16.8
		Medium	Gunniting concrete surface with cement mortar after cleaning surface and spraying Epoxy	16.3
		High	Patching of damaged concrete surface with polymer concrete / Shortcreting with cement concrete mixed with quick setting compound over prepared surface painted with epoxy.	16.9
3	spalling/cracking (with section loss)	High	Jacketing of distressed surface with concrete and steel reinforcement .	13.5
4	Cracking	low and medium	Sealing of cracks with cement grout/epoxy resin by injection process.	16.5
		High	Provide and fix nipples and seal the cracks with cement grout/ epoxy resin by injection process.	16.4 and 16.5
5	Corrosion	low and medium	Exposed reinforcement should be thoroughly cleaned free of rust ,scales etc. before any treatment for spalling	
		High	Corroded reinforcement should be removed and replaced by additional reinforcement before treatment for spalling	14.2
6	Honeycombing/Leaching		Apply Epoxy mortar/ Polymer mortar	16.8
7	Loss of mortar in Brick/Stone masonry	Medium and high	Pointing with cement mortar 1:3 or plastering with cm :3	13.2 and 13.5
8	Loss of Brick/ stone masonry in sub structure		Remove loose masonry and replace with brick/stone masonry in cement mortar 1:3	12.5 ,13.1,13.4
9	Damage of Expansion Joint	Medium and high	Repair /Replace Expansion Joints	16.17
10	Damage of Railing		Replace / repair damaged railing	16.18, 16.22

Rehabilitation Cost

Cost of Rehabilitation per Sqm.					
Rating	**SHI**	**Span Range**			**Average**
		0 - 30	**30 - 60**	**>60**	
Good	1 - 8				250
Fair	8 - 16	1122	683	206	403
Poor	16 - 81	2581	2772	741	2685
Very Poor	81 - 256	New Bridge			

Total cost for Rehabilitation per Bridge					
Rating	**SHI**	**Span Range**			**Average**
		0 - 30	**30 - 60**	**>60**	
Good	1				
Fair	1 - 16	1.11 Lac	1.41 Lac	1.09 Lac	1.20 Lac
Poor	16 - 81	3.00Lac	4.95 Lac	3.39 Lac	3.78 Lac
Very Poor	81 - 256				

Minor Bridge on Badasankha Nallah at Km 7.1 of Chatrapur-Ganjam Road

Structural Health Index (SHI) for Bridge – Example

		D23_R03_CH - 7.16 - (Chatrapur Ganjam Road (Old abandoned NH-5))									
Item	Element description	Total quantity	Units	Estimated quantity in various condition states				ESCI (Eq1)	Si	Mi	ESCI*Si*Mi
				1	2	3	4				
				No damage	Sevirity: Low	Sevirity: Medium	Sevirity: High				
1	Bearing	0.00	each	0.00	0.00	0.00	0.00	0.000	3	3	0
2	Abutment & dirt wall	48.72	m2	0.00	0.00	0.00	48.72	4.000	2	2	16.00
3	Wing Wall	113.54	m2	93.67	19.87	0.00	0.00	1.175	2	2	4.70
4	Concrete deck Slab	126.00	m2	47.25	0.00	0.00	78.75	2.875	3	2	17.25
5	Concrete abutment & pier caps	11.59	m3	0.00	11.59	0.00	0.00	2.000	4	2	16.00
6	Piers	100.39	m2	66.51	2.51	0.00	31.37	1.963	4	2	15.70
7	RCC / PSC/Steel girder	135.00	m2	50.63	0.00	0.00	84.38	2.875	4	1	11.50
8	Expansion joints	22.40	m	0.00	0.00	22.40	0.00	3.000	1	3	9.00
9	Approach carriageway	39.20	m2	39.20	0.00	0.00	0.00	1.000	1	3	3.00
10	Batter protection	160.75	m2	0.00	0.00	0.00	160.75	4.000	1	2	8.00
11	General cleaning	0.00	each	0.00	0.00	0.00	0.00	0.000	1	3	0.00
12	Wearing surface	105.75	m2	0.00	105.75	0.00	0.00	2.000	1	3	6.00
13	waterway	3.00	each	3.00	0.00	0.00	0.00	1.000	1	3	3.00
14	Parapet/Railing/Crash barrier	45.00	m	45.00	0.00	0.00	0.00	1.000	1	2	2.00
15	Floor protection work	292.56	m2	0.00	0.00	0.00	292.56	4.000	1	2	8.00
16	Foundation	0.00	m2	0.00	0.00	0.00	0.00	0.000	4	2	0.00
	∑(ESCI*SI*CPIL)										120.15
				A	E	R	I				
	CF=0411 A+0 120E+0. 107R+0.362I			4.00	4.00	3.00	3.00				3.53
SHI=CF*{(ESCI*SI*MI)/n			SHI = 120.15 X 3.531 / 13								32.637

Bridge Maintenance Strategy – Example

D23_R03_CH - 7.16 - (Chatrapur Ganjam Road) (Old NH-5)						POOR < 30m	
Sl. No.	MORTH Ref.	Item description	Unit	Rate ₹	Quantity	Amount ₹	Remarks
1	2.3	Clearing and uprooting rank vegetation, bushes, shrubs, saplings etc including removal and disposal.	m2	10	LS	5 000	
4	16.3	Guniting concrete surface with cement mortar applied with compressor after cleaning surface and spraying with epoxy complete as per Technical specification (25mm thick)	m2	1 255	90	113 374	Deck slab and caps
6		Jacketing of concrete surface and exposed steel reinforcement complete as per Technical specification using 200mm thick M 30 grade concrete including reinforcement(@ 40 kg per m3), formwork etc and all accessories to complete the work.	m2	2 223	149	331 474	Total abutment and pier
7		Supplying ,hoisting, fixing steel joists in superstructure including painting and all required materials complete.	tonne	75 000	2	150 000	For welding of steel joists
9	16.11	Anti corrosive painting to all steel joists including sand blasting	m2	91	135	12 285	
12	13.1	Brick masonry work in 1:3 in sub-structure complete excluding pointing and plastering, as per drawing and Technical Specifications	m3	5 143	2	10 286	For replacemen of severe
15	13.5	Plastering with cement mortar (1:3) on brick work in sub-structure as per Technical specifications	m2	100	20	1 987	Wing wall
17	16.5	Sealing of crack / porous concrete with cement grout by injection process through nipples / grouting complete as per clause 2803.1.	kg	66	9996	659 704	For grouting in pier and abutments
20	15.4	Providing and laying Pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications.	m3	1 289	48	62 164	For slope protection work
21	15.5	Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification.	m3	962	24	23 197	
22		Construction of toewall for pitching slope	m3	3 482	20	71 377	
24		Construction of Cut off wall for bed protection with m15 grade cement concrete	m3	4 792	73	350 774	Floor protection work
25		Providing and laying rouble stone flooring laid in cement mortar 1:3 as per drawing and technical specification laid over cement concrete bedding.	m3	4 778	66	314 517	
34	8.3	Printing new letter and figures of any shade (Printing new letter and figures of any shade with synthetic enamel paint black or any other approved colour to give an even shade)	Each bridge	611	2	1 222	
35		Safety measures, traffic regulation, scaffolding and other logistic arrangement for execution of works		10 000	LS	10 000	
36		Provision for miscellaneous items not accounted for			LS	30 000	
					Total Cost :	2147 360	

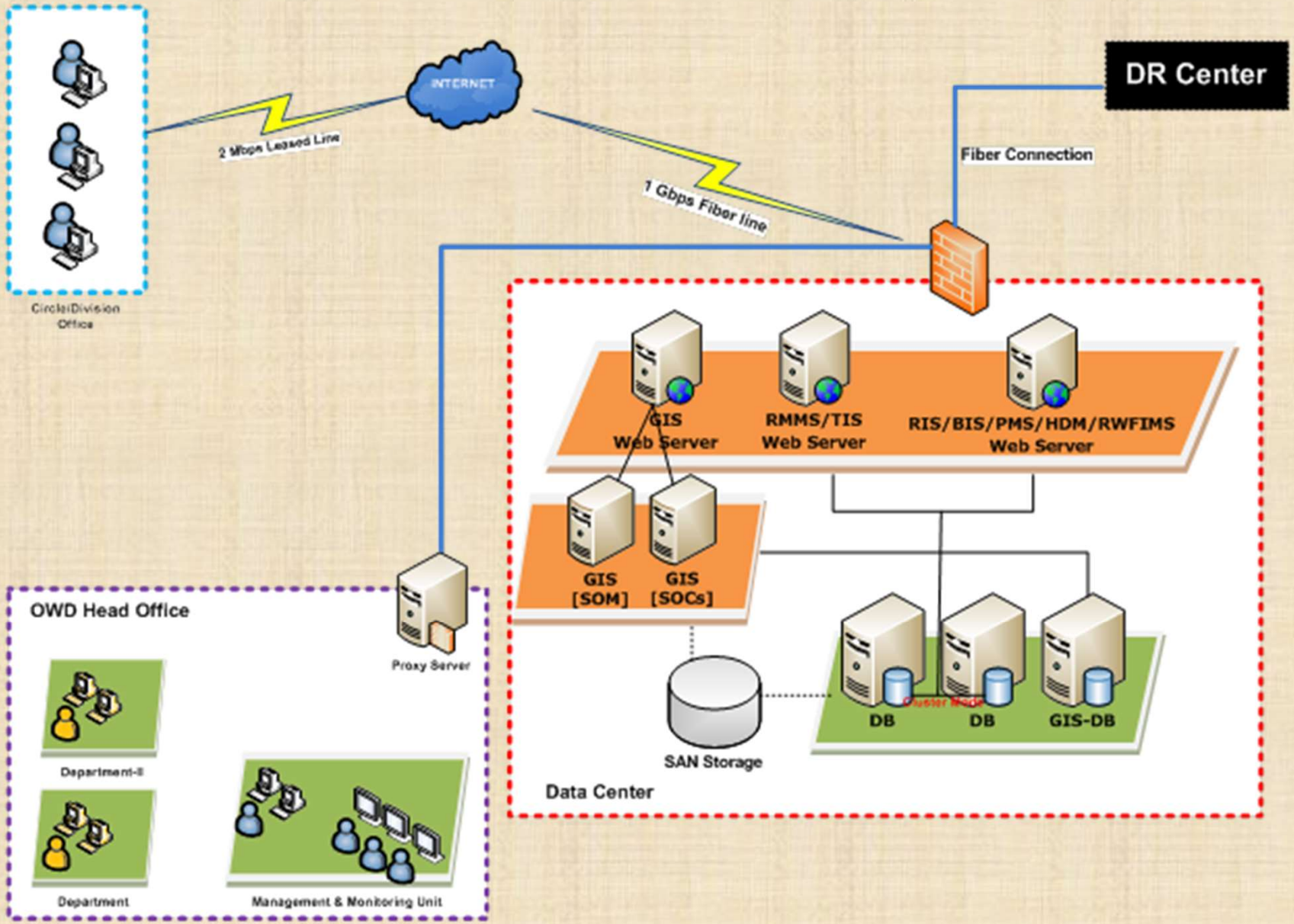
Bridge unique id : D31_R02_CH 23.27 - Papadhandi-Umerkote-Yerla Road														
Item	Element description	Total quantity	Units	Estimated quantity in various condition states				ESCI (Eq1)	Si	Mi	ESCI*Si*Mi			
				1	2	3	4							
				No damage	Sevirity: Low	Sevirity: Medium	Sevirity: High							
1	Bearing	0	each	0.00	0.00	0.00	0.00	0.000	3	3	0	0	Year of construction	
2	Abutment & dirt wall	65.12	m2	65.12	0.00	0.00	0.00	1.000	2	2	4.00	1	Road type	SH
3	Wing Wall	82.14	m2	82.14	0.00	0.00	0.00	1.000	2	2	4.00	1	Number of Span	7
4	Concrete deck Slab	517.44	m2	506.35	0.00	0.00	11.09	1.064	3	2	6.39	1	Each span length(m)	8.4
5	Concrete abutment & pier caps	82.97	m2	78.82	4.15	0.00	0.00	1.050	4	2	8.40	1	Width of bridge(m)	8.8
6	Piers	367.69	m2	367.69	0.00	0.00	0.00	1.000	4	2	8.00	1	Total plan area(m^2)	517.44
7	RCC / PSC/Steel girder	0.00	m2	0.00	0.00	0.00	0.00	0.000	4	2	0.00	0	Number of pier	6
8	Expansion joints	70.40	m	70.40	0.00	0.00	0.00	1.000	1	3	3.00	1	Top width of pier(m)	0.8
9	Approach carriageway	61.60	m2	58.52	3.08	0.00	0.00	1.050	1	3	3.15	1	Bottom width of pier(m)	1
10	Batter protection	116.30	m2	116.30	0.00	0.00	0.00	1.000	1	2	2.00	1	Height of pier(m)	3
11	General cleaning	0.00	each	0.00	0.00	0.00	0.00	0.000	1	3	0.00	0	Length of return/wing wall(m)	5.55
12	Wearing surface	435.12	m2	413.36	21.76	0.00	0.00	1.050	1	3	3.15	1	Number of bearings	0
13	waterway	7.00	each	7.00	0.00	0.00	0.00	1.000	1	3	3.00	1	Thickness of superstructure (m)	0.7
14	Parapet/Railing/Crash barrier	117.60	m	117.60	0.00	0.00	0.00	1.000	1	2	2.00	1	width of bridge between kerbs	7.4
15	Floor protection work	0.00	m2	0.00	0.00	0.00	0.00	0.000	1	3	0.00	0	Thickness of caps	0.6
16	Foundation	0.00	m2	0.00	0.00	0.00	0.00	0.000	4	2	0.00	0	Depth of girder	0
	Σ(ESCI*SI*CPIL)										47.0857143	11	No of girder per span	0
				A	E	R	I							
	CF=0411 A+0 120E+0. 107R+0.362I			4.00	3.00	3.00	3.00				3.41			
SHI=CF*{(ESCI*SI*MI)/n				SHI = 47.0857142857143 X 3.411 / 11							14.602			
OSCI=1 when SHI=1 OSCI=2 when 1<SHI =< 16 OSCI=3 when 16<SHI<81 OSCI=4 when 81<SHI<256				16<SHI<81							OSCI = 2			

D31_R02_CH 23.27 - (Papadhandi-Umerkote-Yerla Road)							FAIR > 30m
Sl. No.	MORTH Ref.	Item description	Unit	Rate ₹	Quantity	Amount ₹	Remarks
1	2.3	Clearing and uprooting rank vegetation, bushes, shrubs, saplings etc including removal and disposal.	m^2	10	LS	5 500	
2		Cleaning and Greasing of Metallic bearings complete as per Technical specification	no.	1 093	0	0	NA
3	16.8	Applying epoxy mortar over leached, honey combed and spalled concrete surface and exposed steel reinforcement complete as per Technical specification (10mm thick)	m^2	537	4	2 228	
4	16.3	Guniting concrete surface with cement mortar applied with compressor after cleaning surface and spraying with epoxy complete as per Technical specification (25mm thick)	m^2	1 168	0	0	
5	16.6	Patching of damaged concrete surface with polymer concrete and curing compounds, initiator and promoter, available in present formulations, to be applied as per instructions of manufacturer and as approved by the	m^2	2 580	11	28 607	
6		Jacketing of concrete surface and exposed steel reinforcement complete as per Technical specification using 200mm thick M 30 grade concrete including reinforcement(@ 40 kg per m3), formwork etc and all accessories to complete the work.	m^2	2 214	0	0	NA
7		Supplying ,hoisting, fixing steel joists in superstructure including painting and all required materials complete.	tonne	75 000	0	0	NA
8	14.2	Supplying, fitting and placing HYSD bar reinforcement complete as per drawing and technical specifications	tonne	68 793	0	0	
9		Drilling of holes in existing concrete and fixing new reinforcement with epoxy mortar grout but excluding cost of reinforcement	no.	423	0	0	NA
10	16.11	Painting to all steel joists.	m^2	100	0	0	
11	12.5	Brick masonry work in cement mortar 1:3 in foundation complete excluding pointing and plastering, as per drawing and technical specifications	m^3	5 153	0	0	NA
12	13.1	Brick masonry work in 1:3 in sub-structure complete excluding pointing and plastering, as per drawing and Technical Specifications	m^3	5 238	0	0	NA
13	13.4	Stone masonry work in cement mortar 1:3 for substructure complete as per drawing and Technical Specifications	m^3	3 570	0	0	NA
14	13.2	Pointing with cement mortar (1:3) on brick work/stone work in substructure as per Technical specifications	m^2	41	0	0	NA
15	13.5	Plastering with cement mortar (1:3) on brick work in sub-structure as per Technical specifications	m^2	105	0	0	NA
16	16.4	Providing and inserting nipples with approved fixing compound after drilling holes for grouting as per Technical Specifications including subsequent cutting/removal and sealing of the hole as necessary of nipples after completion of grouting with Cement/Epoxy	no.	501	0	0	NA
17	16.5	Sealing of crack / porous concrete with cement grout by injection process through nipples / grouting complete as per clause 2803.1.	kg	66	0	0	NA
18	16.7	Sealing of crack / porous concrete with Epoxy Grout by injection through nipples complete as per clause 2803.1.	kg	925	0	0	NA

D31_R02_CH 23.27 - (Papadhandi-Umerkote-Yerla Road)							FAIR > 30m
Sl. No.	MORTH Ref.	Item description	Unit	Rate ₹	Quantity	Amount ₹	Remarks
19	16.17	Replacement of Expansion Joints complete as per drawings	m	2 654	0	0	
20	15.4	Providing and laying Pitching on slopes laid over prepared filter media including boulder apron laid dry in front of toe of embankment complete as per drawing and Technical specifications.	m^3	1 231	0	0	Stone pitching
21	15.5	Providing and laying Filter material underneath pitching in slopes complete as per drawing and Technical specification.	m^3	905	0	0	Filter material
22	15.11	Flexible Apron: Construction of flexible apron 1 m thick comprising of loose stone boulders weighing not less than 40 kg beyond curtain wall.	m^3	1 190	0	0	
23		Construction of Cut off wall for bed protection with m15 grade cement concrete	m^3	4 948	0	0	NA
24		Providing and laying rouble stone flooring laid in cement mortar 1:3 as per drawing and technical specification laid over cement concrete bedding.	m^3	4 896	0	0	NA
25	16.2	Removal of existing asphaltic wearing coat comprising of 50 mm thick asphaltic concrete laid over 12 mm thick mastic asphalt including disposal with all lift and lead upto 1000m.	m^2	47	22	1 023	
26	5.14	Providing and laying in position 65 mm thick wearing coat consisting of 25mm thick layer of mastic asphalt over 40 mm bituminous concrete over deck slab after applying prime coat complete as per drawings and technical specification sections 500 and 2700 or as directed by the Engineer.	m^2	1 356	22	29 501	
27	14.4	Providing and laying Cement concrete wearing coat M-30 grade including reinforcement complete as per drawing and Technical Specifications	m3	11 592	0	0	
28		Providing new guard post in both side of carriage way as per technical specifications.	no.	800	0	0	NA
29	16.18	Replacement of Damaged Concrete Railing.	m	2 035	0	0	NA
30	16.22	Repair of RCC Railing	m	122	0	0	
31	14.9	Providing Drainage Spouts complete as per drawing and Technical specification	no.	1 114	0	0	NA
32	8.3	Printing new letter and figures of any shade (Printing new letter and figures of any shade with synthetic enamel paint black or any other approved colour to give an even shade)	Each bridge	611	2	1 222	
33		Safety measures, traffic regulation, scaffolding and other logistic arrangement for execution of works		10 000	LS	10 000	
34		Provision for miscellaneous items not accounted for			LS	20 000	
					Total Cost :	98 080	

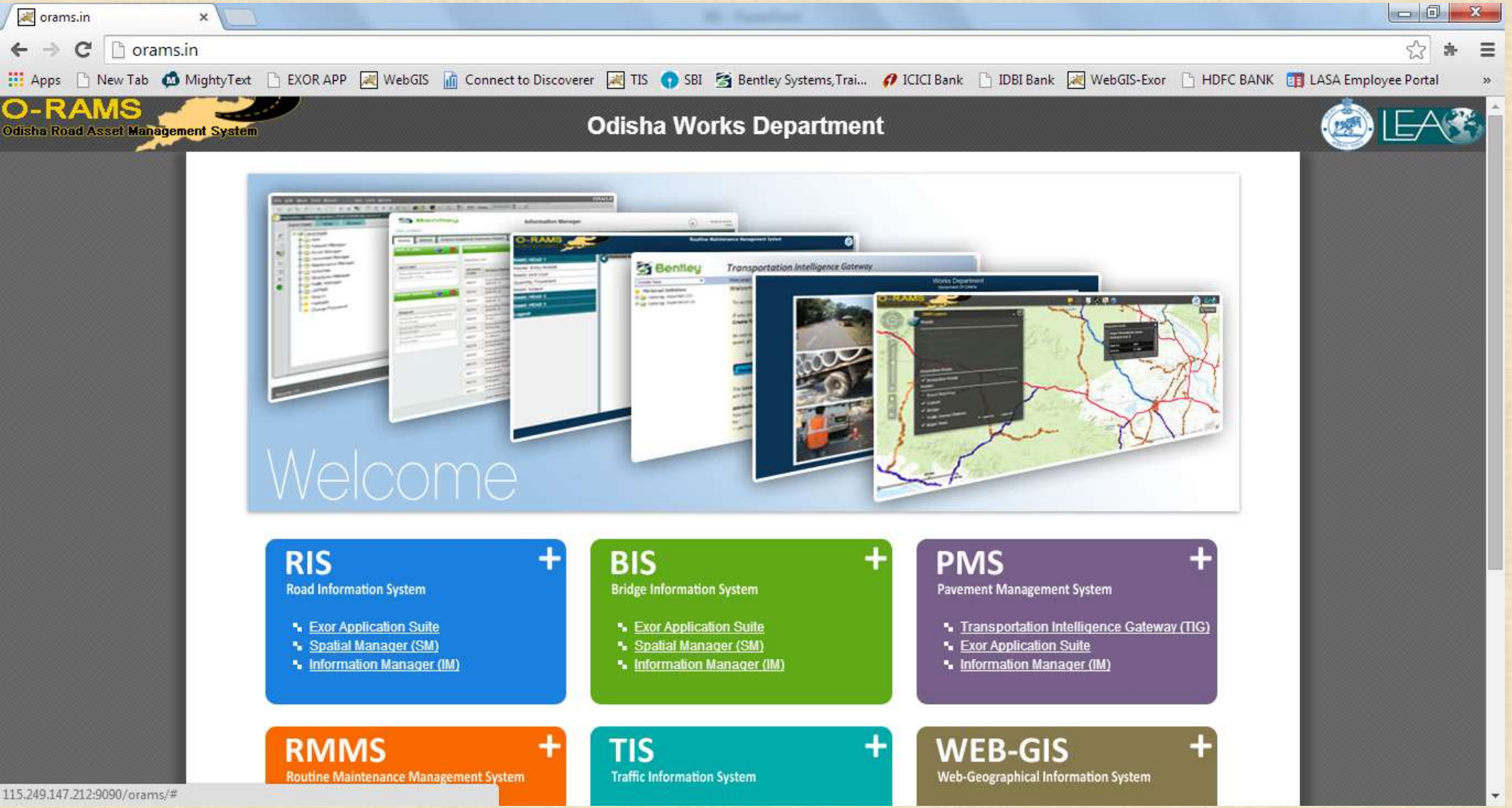
IT Enabled Solution & Procurements

O-RAMS Implementation Architecture



Log-in Details

O-RAMS home page



Condition Assessment of Bridges under PWD , Odisha

Typical
Major Bridges

Training imparted so far

Field training on Data Collection (during consultant's data collection in various circles)

Training imparted so far

Automatic Road Survey System (ARSS) by CRRI


AUTOMATED ROAD SURVEY SYSTEM
GOVERNMENT OF INDIA
KEEP DISTANCE
MINIMUM 25 METRES
ROAD SURVEY IN PROGRESS
DL 3C BV 0720


AUTOMATED ROAD SURVEY SYSTEM
GOVERNMENT OF INDIA
KEEP DISTANCE
MINIMUM 25 METRES
ROAD SURVEY IN PROGRESS
DL 3C BV 0720


KUAB
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GOVT. OF INDIA
Central Road Research Institute
New Delhi
MDR 4
16

Institutional Arrangements for Sustainability

1. **Dedicated AMS Cell**
   - In-house Trained Engineering Team
   - Handholding for technology transfer
2. **Use of Local Resources**
   - Dedicated IT (GIS & DBA) Team from NIC & IT Department
   - ORSAC for spatial data (new network inclusion)
3. **Outsourcing Data Collection**
   - Automated Data (Pavement Condition, Roughness, Geometry, FWD)
   - Traffic and Bridge Condition Data

Odisha Road Asset Management System(O-RAMS)

Works Department, Govt of Odisha

Consultant

LEA Associates South Asia Pvt. Ltd. India

***In JV with* LEA International Ltd. Canada**

in association with

Geo InfoSpace Private Ltd. (GIPL), India

COTS Software "EXOR"

By

Bentley Systems(India)Pvt Ltd.

O-RAMS Modules
Web-based Applications

1. Road Information System (RIS)

   Road Network & Data Management
2. Bridge Information System (BIS)

   Bridge Inventory & Condition
3. Pavement Management System (PMS)

   Interface to HDM-4
4. Traffic Information System (TIS)

   Traffic Data processing for RIS/PMS modules
5. Web-GIS View & Reporting Tools

   GIS based search, satellite image overlay, thematic maps
6. Routine Maintenance Management System (RMMS)

   Estimate for Routine Maintenance Requirements

Lunching of O-RAMS Website- 2015
www.orams.in


Thank you
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MH-47TC095-013