AND

Global Analytics for Bridge Management [GABM]
and
Global Analytics for Risk and Resilience Management [GARM]

BASED ON RESEARCH BY UBMS RESEARCH GROUP

Traditionally, bridge maintenance and rehabilitation across many countries, regions, and cities have been constrained by manual systems that heavily depend on inspections and the engineering judgement of field personnel. These inspections, though valuable, were often conducted without real-time data, automated condition tracking systems, or predictive analytics. As a result, evaluations focused only on visible symptoms and lacked the ability to diagnose the root causes of deterioration.

In such an environment, infrastructure owners—particularly those managing small or micro bridge inventories within financial constraint—faced constant challenges in forecasting bridge failures, effectively allocating maintenance budgets, and planning long-term structural interventions. The absence of integrated geospatial hazard information and time-based deterioration models forced authorities into a **reactive posture**—responding to crises only after damage had occurred.

In many cases, structurally critical but visually inconspicuous issues, such as internal corrosion, foundation instability, or hidden material fatigue, remained undetected until they escalated into major risks. The lack of real-time monitoring tools and absence of sensor-driven analytics meant these risks were not captured until after failure.

This judgement-based, non-standardised approach to asset management led to:

1) Inefficient use of funds and poorly prioritised maintenance

2) Escalating lifecycle costs from delayed repairs

3) Increased exposure to climate hazards like floods, landslides, earthquakes, and cyclones

4) Systematic neglect of ageing infrastructure with hidden vulnerabilities

In a world where we see a rapidly urbanisation landscape, increasing vehicular loads, and growing exposure to extreme weather events, this conventional method of bridge management is no longer sufficient. This results in a critical and growing need for a modern, integrated, data-driven platform—one that could offer comprehensive visibility across the bridge network, anticipate failures, and enable strategic, performance-based, and risk-informed decisions.

Implemented Measure:

To fill this critical gap, the UBMS Research Group [**URG**] and Global Bridge Management Systems Pty, Australia [**GBMS**] developed a groundbreaking duo of digital solutions: GABM (Global Analytics for Bridge Management) and GARM (Global Analytics for Risk and Resilience Management). These tools together form a robust framework that not only enhances the resilience of bridges but also helps urban stakeholders mitigate and manage risks proactively.

GABM is an innovative, software solution designed specifically for small and micro bridge inventory owners. It is a stand-alone offline Analytical system. It redefines bridge management by shifting the focus from judgement-based, symptom-only models to a comprehensive, cause-based deterioration model. GABM uses cutting-edge technology like Structural Health Monitoring (SHM), natural hazard risk assessment and Life-Cycle Cost Analysis (LCCA) to evaluate the performance, risk, and sustainability of each bridge.

Key features of GABM and GARM include:

1) Real-time integration of SHM data for accurate structural performance assessment essential for ageing bridges.

2) Detailed deterioration modelling of bridge components (deck, superstructure, substructure, foundation) based on three inputs [Symptoms, Cause identified, and Short term Structural health monitoring]

3) Geospatial risk mapping and hazard exposure analysis

4) Generation of Bridge Vulnerability Index and Risk Index using the Risk and Vulnerability Analysis [RVA] tool.

5) Budget prioritization using automated fund optimisation algorithms.

URG submitted a Voluntary Commitment under the Sendai Framework for Voluntary Commitment to United Nations office of Disaster Risk Reduction [**UNDRR**] to evaluate a tool for evaluation of the probability of bridge survival post natural hazard event. This forms the base for our RVA.

The duo of GABM & GARM works in tandem to produce the most comprehensive Bridge Management System. The reports that can be generated from GABM and GARM together can be fine tuned to every countries BMS requirements and standards. The report below is typically for a hypothetical bridge in India [data required is assigned hypothetically] and so the report generated adheres to the latest Indian Road Congress Special Publication [IRC SP35 – 2025].

Key reports generated from GABM and GARM include:

The primary reports generated are as follows

A. Inventory Report [Aligned to any Countries standards]
B. Inspection Report [Aligned to any Countries standards]
C. Bridge Historical narrative
D. GABM analytical results [Deterioration modelling, BSL, ABSL, and MSL defined]
E. Estimate of Rehabilitation Cost
F. Estimate of Resilience enhancement cost
G. Probability of Bridge survival, Risk and Vulnerability Index report
H. Fund optimisation using the Multi-Criteria Decision-Making processes evolved by URG.

The generated reports are based on inputs which the Bridge Inspection Engineer has to submit to GABM and then proceed to provide inputs for estimation of costs leading to Fund optimisation for allocation set of most critical bridges.

BRIDGE INSPECTION REPORT: FOR IND2-1

GENERATED FROM GABM - R & D BY UBMS RESEARCH GROUP

Information Center

GABM identity number	**IND2-1**
State Name	**MH**
District Name	**Kolhapur**
Nearest City Town/Village	**Kolhapur**
Name of Circle	**Kur, Konvade**
Name of the Region	**Kolhapur**
Namae of the Division /PIU	**Konvade**
Name of the Sub Division	**Kur**
Name of the Section/Link No.	**NA**
Location of Bridge (Chainage) km	**12.54**
Name of Bridge	**INSH0189B002**
Name of River	**Veda Ganga River**
Name of Bridge (if any)	**Kur Bridge**
Road Type	**SH**
Name of the Road	**SH189**

Number of Road	189
Latitude	16.375
Longitude	74.148
Altitude	3
Name of the Agency/Custodian	MH- PWD
Year of FIRST Inventory	1936
Whether Pre-Monsoon/Post-Monsoon	N/A
Date of Inspection	2026-01-21
Year of Constrution (Start)	1925
Year of Completion	1936
Date of Opening to the Traffic	1936
Name of Builder/Contractor	NA
Supervision Consultant (AE,IE)	NA
Date of latest improvement rehabilitation	N/A
Speific Comment if any	N/A
STRUCTURE NUMBER	MHSH189B0001
AGE OF BRIDGE	90
INVESTMENT YEARS	N/A
FUNCTION/TYPE OF CROSSING FACILITY CARRIED BY THE BRIDGE	RIVER
TYPE OF BRIDGE	RIVER BRIDGE
Whether Permenant/Temporary	PERMENANT
Type of Bridge	RIVER BRIDGE
Whether Permenant/Temporary	PERMENANT
Type of Underpass	NA
Whether the Bridge is in Grade	NA
Whether Right angled/Skew bridge	NA

Skew angle in degree	NA
Structural Configuration	STONE MASANORY
Type of Foundation	OPEN
Foundation Material	RCC
Depth of foundation	5 m
Maximum Depth of Foundation	5 m
Type of Sub Structure	PIER
Pier Material	STONE
Pier Type/Shape	WITH ROUNDED ENDS
Dimension of Pier	12
Dimension of Abutment	12
Abutment Type	SOLID
Abutment Cap	RECTANGULAR
Abutment Cap Material	RCC
Depth of Abutment	10
Abutment Material	STONE
Type and Length of Retaining/Wing Wall	WINGWALL
Pier Cap	RECTANGULAR SOLID
Pier Cap Material	RCC
Protection Work for Abutment & Pier	STONE
Dimension of Pier	12
Depth/Height of Pier	N/A
Dimension of Abutment	12
Abutment Type	SOLID
Abutment Cap	RECTANGULAR
Abutment Cap Material	RCC

Depth of Abutment	10
Abutment Material	STONE
Type and Length of Retaining/Wing Wall	WINGWALL
Pier Cap	RECTANGULAR SOLID
Pier Cap Material	RCC
Protection Work for Abutment & Pier	STONE
Type of Superstructure	ARCH
Type of Carriage Way	MULTILANE RCC
Wearing Course	BITUMEN
Type of Bearing	NA
Type of Expansion Joint	NA
Median Type	NA
Median Width in M	N/A
Shoulder Type	NA
Shoulder Width in M	N/A
Foot Path	NO FOOTPATH
Foot Path Type	N/A
Kerb Type	STONE KERB
Kerb Width in M	N/A
Utilities/Service Ducts	N/A
Guard Rail/Parapet Type	RCC
Road Level	546 AMSL
Approach Roadway Width Including Shoulder	10.5
Approach Shoulder Width	1.5
Height of Approach Embankment in M	7.5
Depth of Approach Cutting in M	N/A

Approach Embankments	25
Invert/Aprons	N/A
Fenders	NA
Retaining Wall/Revetment	WINGWALL
Drainage System	WEEP HOLES
Waterproofing	BITUMEN
Specific Comments, if any	N/A
Total Length of Bridge in M	76
Total Number of Spans	5
Effective Span Length in M	11
Waterway Clearance Height in M	6 TO 8 M
Width of Carriageway in M	N/A
Width of Footpath in M	NO FOOTPATH
Overall Width of Deck in M	6 TO 7.5M
Overall Length	76
Overall Width	N/A
Number of Lanes (2/4/6)	2
Width of Lanes in M	3.5
Number of Beams/Girders	N/A
Depth of Main Beams in M	N/A
Width of Main Beams in M	N/A
Dia of Secondary Reinforcement in Girder in MM	N/A
Spacing of Secondary Reinforcement in MM	N/A
Number of Transverse Beams	N/A
Depth of Transverse Beams in M	N/A
Width of Transverse Beams in M	N/A

Depth of Concrete Slab in M	0.250
Centre to Centre of Bearings in M	N/A
Span of Masonry Arch in M	6.5
Rise of Arch at Crown in M	3
Rise of Arch Barrel at Quarter Points in M	N/A
Thickness of Arch Barrel Adjacent to Key Stone in M	0.75
Average Depth of Arch Fill Between Road Surface and Arch Barrel in M	0.8
Height of Parapet (M)	1.2
Height of Column Piers (M)	10
Thickness of Wearing Course (MM)	0.15
High Level or Submersible	HL
Whether Navigable?	NO
Whether located in back water/chemical zone?	NO
Whether Marshy Protected?	No
Drainage Pattern	N/A
Length under Submergence (km)	1.5
Length under Water Logging (km)	1.5
Design High Flood Level (HFL) AMSL	546
Abnormal Flood Level AMSL	555
Low Water Level AMSL	540
Ground Level AMSL	540
Height of Slab/Superstructure (MM)	N/A
Free Board (M) [WATERWAY]	OCCATIONAL OVERTOPPING HEIGHT 4 TO 6 M
Average Rainfall (MM) per Month	2500
Specific Comments	N/A
Traffic Volume (Through crossing)	N/A

Suspension of Traffic if any	N/A
Duration of suspension of Traffic	N/A
Documentation of Traffic data	N/A
Brief description of accident classification (Fatal, Grievous Injury etc.)	N/A
Brief description of accident classification (overturning, Head on collision etc.)	N/A
Probable reasons for accidents (Engineering, Driver etc.)	N/A
Average Daily Traffic (ADT)	6001 TO 8500
Year of ADT	2025
Detour/alternate route Length	POOR
Vertical Clearance in M	10
Horizontal Clearance in M	11
Access gantry	N/A
Walkways/Ladders	N/A
Specific comments, if any	N/A
Pay Load to be Carried Over the Bridge (GVW)	70000
Live Load Analysis Details	NA
Specific Comments, if any	N/A
Type of Terrane	Plain
ROW in M	20
Land Use	Residential
Year of holding/transfer	1930
Land Category	Waterbody
Whether Marshy protected?	No
Area in Ha.	N/A
Type of Soil	N/A
Foundation Strata	N/A

Bearing capacity of soil	N/A
Soil Investigation Done	N/A
Date of Soil Investigation	N/A
Water Table Depth (m)	1.25
Land Acquisition Status	Completed
Land Ownership	Government
Specific comments, if any	N/A
Name of Meteorological Station (IMD)	KOLHAPUR
Temperature (Daily/Monthly/Average) in °C	2 TO 40
Humidity (%)	40
Air Quality Index	N/A
Snow Fall Duration/Thickness (mm)	N/A
Earthquake/Seismic Zone	3
Climate Zone	N/A
Whether subjected to contaminated water?	NO
Whether subjected to harmful chemicals & gases?	NO
Annual Rainfall (mm)	2500
Monsoon Rainfall (mm)	2000
Monsoon Period (months)	JUNE TO OCT
Average Wind Speed (km/h)	18
Maximum Wind Speed (km/h)	22
Pollution Level	Moderate
Erosion Risk	Medium
Flood Frequency	Frequent
Environmental Clearance Status	Obtained
Environmental Clearance Date	N/A

Specific comments, if any	N/A
HQ/RO/Agencies/Police/Any other	KOLHAPUR
Emergency Contact Person Name	N/A
Emergency Contact Number	N/A
Nearest Police Station	KUR, KOLHAPUR
Police Station Contact Number	100
Maintenance Office Details	MH PWD
Maintenance Office Contact	N/A
Engineer In-charge Name	N/A
Engineer Contact Number	N/A
Site Supervisor Name	N/A
Supervisor Contact Number	N/A
Alternate Emergency Contact	N/A
Nearest Hospital Details	KOLHAPUR
Nearest Fire Station Details	KOLHAPUR
Specific Comments, if any	N/A
Flooding	SEVERE
Cyclones	VERY HIGH
Landslide	VERY HIGH
Earthquake	VERY HIGH
Is the bridge located within 100 Km of the Coastal Lines?	N/A
Is the bridge located in Himalayan sub-region?	N/A
Does the bridge experience extreme weather conditions [Above 40°C and Below 5°C]?	N/A
Is the bridge located on a Non-Saline contaminated water body?	N/A
Is the bridge located on the Saline water body?	N/A
Does the bridge experience tidal variations?	N/A

Is the bridge located in earthquake zone 5?	**N/A**
Is the bridge located in earthquake zone 3 or 4?	**1:Yes**
Has the bridge been repaired in the last 10 years?	**1:Yes**
Has the Bridge undergone Structural repairs?	**1:Yes**
Has the Bridge undergone Surface cover repairs?	**1:Yes**
Has the bridge undergone Corrosion preventive treatment?	**N/A**
Is the bridge experiencing 20% more traffic than the Designed ADT?	**N/A**
Construction Cost	**50000**
Conversion Ratio	**0.9**
LCCA as per Age	**N/A**
Date of Entry	**2026-01-20 00:00:00**
Department Budget for One GABM	**350000000**

BRIDGE STRUCTURAL RATING NUMBER

DECK RATING	4
SUPER STRUCTURE RATING	4
SUBSTRUCTURE RATING	3
FOUNDATION RATING	4

BRIDGE SOCIO-ECONOMIC RATING NUMBER

SOCIAL IMPORTANCE	3
ECONOMIC GROWTH	3
ENVIRONMENTAL IMPACT	3

Cause Matrix

Impact	3
Abrasion	4
Erosion	3

Overload	4
Fatigue	3
Temperature	3
Shrinkage	3
Settlement	2
Chloride Attack	3
Sulphates	3
Carbonation	3
Alkali-Aggregate	3
Estimation for Rehabilitation	12500000

SHM CHANGE RATING

SHM CHANGE RATING	N/A

Hazard Details	Flooding	Cyclones	Landslide	Earthquake
What was the duration of the last recorded event? [IN DAYS OR INTENSITY]	**36**	**2**	**4**	**1**
What was the average intensity?	**6**	**30**	**1**	**5.6**
What was the last known severe event occurrence mention year occurred?	**2021**	**2018**	**2020**	**2018**
What percentage of bridges were heavily damaged?	**20**	**18**	**18**	**10**
What percentage of bridges failed?	**8**	**5**	**8**	**3**
Average Number of Events Happened in the last 10 years	**5**	**3**	**4**	**3**
Latest year of event occurrence (During the last 10 Years)	**2021**	**2020**	**2021**	**2021**

BRIDGE INSPECTION REPORT: ID 2

GENERATED FROM GABM - R & D BY UBMS RESEARCH GROUP

Approaches Assessment

pproaches Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgenc
Alignment	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Signage	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
ankment/Cutting	3	EROSION	LSSLOPE	25%	LOW	II	POORDRAINAGE	REHAB	HIGH
		EROSION	RSSLOPE	20%	LOW	II	POORDRAINAGE	REHAB	HIGH
		CRACKS	MIDLEVELRSSLOPE	35%	SEVERE	IV	SOILMOVEMENT	REHAB	URGEN
Railing/Crash Barriers/Guard Stones/Parapet	1	CRACKS	MULTIPLE	25%	LOW	II	POORMAINTENANCE	REHAB	MEDIU
Approach Slab	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Approach Joint	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Slide Drain	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
lope Protection	1	VEGETATIONGROWTH	ENTIRESLOPE	75%	MODERATE	III	NOMAINTENANCE	VEGERTATIONREMOVAL	MEDIU

Substructure Assessment

Substructure Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
Abutment	2	CRACKS	MIDLEVELEASTSIDEABUTMENT	15%	LOW	II	POORMAINTENANCE	REHAB	MEDIUM
		DELAM	EDGEEASTABUTMENT	10%	LOW	II	POORMAINTENANCE	REHAB	LOW
Abutment Cap	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Dirt Wall	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Weep holes	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Wing Walls	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Abutment protection works	1	SCOURING	LS	35%	HIGH	III	POORMAINTENANCE	REHAB	HIGH
Pier	4	SURFACESPALL	PIER3	15%	LOW	II	POORMAINTENANCE	REHAB	HIGH
		SURFACESPALL	PIER4	10%	LOW	II	POORMAINTENANCE	REHAB	HIGH
		SURFACESPALL	PIER2	20%	MODERATE	III	POORMAINTENANCE	REHAB	HIGH
		SURFACESPALL	PIER5	45%	HIGH	IV	POORMAINTENANCE	REHAB	HIGH
Pier cap	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Pier protection works	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL

Waterway/Channel Assessment

Waterway/Channel Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
River/Channel bed	1	SILTING	EDGE	35%	FAIR	III	HIGHVELOCITY	REHAB	HIGH
Guide bunds	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Spurs	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Retaining wall	2	CRACK	MIDSECTIONLS	15%	MODERATE	II	POORMAINTENANCE	PATCH	MEDIUM
		CRACK	TOPEDGELS	25%	HIGH	III	POORMAINTENANCE	PATCH	MEDIUM
Toe walls	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Floor/Channel protection	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Apron	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Curtain/cutoff walls	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Ground/Rock anchors	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL

Foundation Assessment

Foundation Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
Foundations(Raft/Open/pile/well)	2	SETTLEMENT	NEARPIER1	5%	HIGH	III	SOILINSTABLE	REHAB	HIGH
		SETTLEMENT	NEARPIER3	10%	SEVERE	IV	SOILINSTABILITY	REHAB	HIGH
Apron	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Foundation protection	1	SCOURING	ALLPIERS	15%	HIGH	III	ERROSION	REHAB	MED

Superstructure Assessment

Superstructure Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
		HONEYCOMBING	CENTERG1S2RS	15%	LOW	II	POORMAINTENANCE	REHAB	HIGH
irders/Main Beams/cables	3	CRACKS	CENTERG1SS5ALLSIDES	35%	SEVERE	IV	POORMAINTENANCE	REPAIR	HIGH
		DELAM	EDGEG1S1LS	25%	HIGH	III	POORMAINTENANCE	REHAB	HIGH
Cross ms/Diaphragms/suspenders	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Articulation	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
		CRACKS	CENTERS3	15%	LOW	II	TRAFFICEWEAR	RESURFACING	HIGH
Deck Slab	3	CRARCKS	CENTERS4	15%	LOW	II	TRAFFICEWEAR	RESURFACING	HIGH
		CRACKS	EDGES5	20%	HIGH	III	TRAFFICEWEAR	RESURFACING	HIGH
Cantiliver slab	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Joints	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL

Appurtenances/Auxillary works Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
Wearing surface	1	CRACKS	MULTIPLE	50%	HIGH	III	WEAR	RESURFACING	HIGH
Footpaths	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Expansion Joints	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Pre-stressing elements(anchorage etc.)	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Medium	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Kerbs/cornices	1	VEGETATIONGROWTH	ENTIREMEDIAN	15%	MOD	II	NOMAINTENANCE	CLEARING	MEDIUM
Light posts	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Drainage spouts	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Parapet/railing/guard stones/crash barrier	1	MISSINGELEMMENT	RS	45%	HIGH	III	IMPACT	REPLACE	HIGH
waterproofing system	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Painting syatem	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Utilites	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL

Bearing Assessment

Bearing Sub-components	Number of Distress	Distress Type	Location	Extent of Distress	Severity of Distress	Condition State no	Probable Reasons	Maintenance Action Required	Urgency
Bearings	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Bearings Seats/caps	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Earthquake restraints	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Top Plate	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL
Bottom Plate	1	NIL	NIL	NIL	NIL	I	NIL	NIL	NIL

GLOBAL ANALYTICS FOR BRIDGE MANAGEMENT TOOL

INSH0189B002 - KUR BRIDGE

Description	1st Year	2nd Year
YEAR OF INPUT	2025	2026
DEPARTMENTAL BUDGET FOR PARTICULAR YEAR	200.0	200.0
ESTIMATE FOR REHABILITATION FOR EACH BRIDGE	10000000.0	10000000.0
BRIDGE IDENTITY		
GABM Id	IND2-1	IND2-1
Length in meters	76	76
Total No. of Spans	5	5
Span Length	11	11
Latitude	16.375271	16.375271
Longitude	74.148714	74.148714
CLASSIFICATION		
Traffic Lane	2	2
Type of Road	2	2
Age of Bridge	89	90
Load Capacity	70000	70000
Foundation Type	OPEN	OPEN
BRIDGE STRUCTURAL RATING NUMBER [BSRN]		
Deck Rating	4	4
Superstructure	4	4
Substructure	3	3
Foundation	3	4
BRIDGE FUNCTIONAL RATING NUMBER [BFRN]		
Deck Geometry	4	4
Vertical Clearance	2	2
Waterway	2	2
ADT	4	4
SOCIO-ECONOMIC RATING NUMBER [SERN]		
Social Importance	3	3
Economic Growth	3	3
Alternate Route	3	3
Enviorno Impact	3	3
CAUSE MATRIX		
Impact (M1)	3	3
Abrasion (M2)	4	4
Erosion (M3)	3	3
Overload (M4)	4	4
Fatigue (M5)	3	3
Temperature (P1)	3	3
Shrinkage (P2)	3	3
Settlement (P3)	3	2
Chloride Attack (C1)	3	3
Sulphates (C2)	3	3
Carbonation (C3)	3	3
Alkali-Aggregate (C4)	3	3
Total of Cause Ratings	35	34
DATA FROM SHORT TERM STRUCTURAL HEALTH MONITORING		
SHM Change Rating		
Construction Cost Per KM	50000.0	50000.0
Years Over Which Investment Is Spread	10	10
Conversion Ratio of Financial to Economic	0.9	0.9

INSH0189B002 - KUR BRIDGE

-Bridge is in severe distress

Description	1st Year	2nd Year
YEAR OF INPUT	2025	2026
DEPARTMENTAL BUDGET FOR PARTICULAR YEAR	200.0	200.0
ESTIMATE FOR REHABILITATION FOR EACH BRIDGE	10000000.0	10000000.0
RANKING AND PRIORITY		
50 Years Design Life		
Deterioration time in Years (DT/ BSL)	0.0	0.0
Median Service Life in Years (MSL)	0.0	0.0
Absolute Balance Service Life in years	0.0	0.0
100 Years Design Life		
Deterioration time in Years (DT/ BSL)	5.27	5.31
Median Service Life in Years (MSL)	36.65	36.65
Absolute Balance Service Life in years	1.05	1.06
Engineering Impact Index	3.2%	3.2%
Financial Impact Index	11.19%	11.19%
Sustainability Index	3.58%	3.58%
Risk Index	0.89%	1.18%
Final Cost	4.7150%	4.7875%
Wsum	150	150
Life Cycle Cost Analysis (LCCA)		
STANDARD IRR	10.92	10.92
ENHANCED IRR	29.88	29.88
CAUSE OF DISTRESS	MECHANICAL	MECHANICAL
CURRENT STATUS OF BRIDGE	-Bridge is in severe distress	-Bridge is in severe distress

Adequacy Parameters

PARAMETERS	LANE ADEQUACY	ADT ADEQUACY	VERTICAL CLEARANCE ADEQUACY	SPAN LENGTH ADEQUACY	ADEQUACY FOR WATERWAY	ADEQUACY FOR OVER TOPPING
Status	BAD	BAD	GOOD	GOOD	GOOD	GOOD

Social Parameters

PARAMETERS	AGE OF BRIDGE	SOCIAL IMPORTANCE	ECONOMIC GROWTH IMPORTANCE	CONNECTION BETWEEN 2 IMPORTANT CENTERS	ECONOMICAL GROWTH POTANTIAL	ALTERNATE ROUTE
Status	90	Not Critical	Not Critical	Critical	MODERATE	Critical

	SUGGESTED RECOMMENDATION
Is the bridge a candidate for reconstruction?	RI Recommended
Is providing Remedial Interventions feasible for this bridge? What will be the	BUOM
efficiency of remedial intervention provided?	RI Efficiency is 50%
Is there any special requirements essential due to age of the bridge?	Age is critical
Are there any critical issues with respect to age of the bridges which are essential to implement?	Age is super critical
What is the Incremental RI Cost taking into account the safety aspect diversion requirements speed and time lost considerations?	11140054.34
What is the increment in costing of RI due to very high BSRN not accounted in the design of RI?	No Increment Essential

-Bridge is in severe distress

Main Cause of deterioration	Principle of Remedical Intervention	Method of Rehabilitation/Repair
Abrasion	Concrete Restoration	Application of modified concrete or mortar systems(hand and mechanical)
Overload	Structural Strengthening	Strengthening the concrete components by providing external Post or Pre-Stressing system
Impact	Concrete Restoration	Application of modified concrete or mortar systems(hand and mechanical)

SERVICE LIFE EVALUATION PRE-SHM

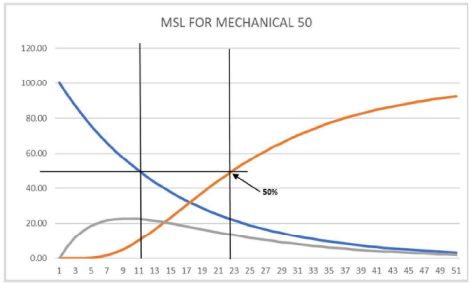
DESIGNED SERVICE LIFE	BALANCE SERVICE LIFE	ABSOLUTE SERVICE LIFE	MEDIAN SERVICE LIFE
50 YEARS	N/A	N/A	21.8
100 YEARS	5.31	1.06	37.2

SERVICE LIFE EVALUATION POST-SHM

DESIGNED SERVICE LIFE	BALANCE SERVICE LIFE	ABSOLUTE SERVICE LIFE	MEDIAN SERVICE LIFE
50 YEARS	N/A	N/A	21.8
100 YEARS	N/A	N/A	37.2

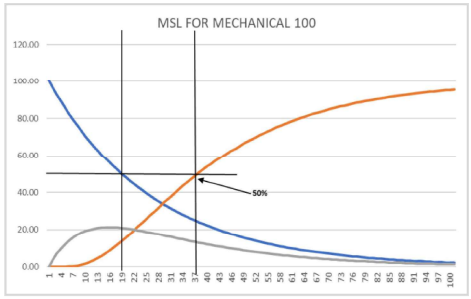
MECHANICAL DETERIORATION ANALYSIS

MECHANICAL - 50 YEARS



MEDIAN SERVICE LIFE: 21.8 YEARS

MECHANICAL - 100 YEARS



MEDIAN SERVICE LIFE: 37.2 YEARS

100 YEARS LIFE CYCLE COST ANALYSIS

INTERNAL RATE OF RETURN [DIRECT]	INTERNAL RATE OF RETURN [INCLUDING INDIRECT]

10.92	29.88

BRIDGE VULNERABILITY AND RISK INDEX BASED ON DETERIORATION MODEL

HAZARD	VULNERABILITY INDEX	RISK INDEX
EARTHQUAKE	0.013	0.004
CYCLONE	0.023	0.009
FLOODING	0.035	0.02
LANDSLIDE	0.018	0.009
AVERAGE INDEX	0.0223	0.0105

BRIDGE FAILURE SCENARIO

Bridge Identity Number	FAILURE TYPE	STATUS BASED ON HISTORICAL DATA OF HAZARDS				BRIDGE STATUS
		EARTHQUAKE	CYCLONE	FLOODING	LANDSLIDE	
MHSH0189B002	SHEAR FAILURE OF PIER	PROBABILITY OF BRIDGE COLLAPSE	PROBABILITY OF BRIDGE COLLAPSE	PROBABLE BRIDGE COLLAPSE	PROBABILITY OF BRIDGE SURVIAL	N/A
	SUPER STRUCTURE UNSEATING	N/A	PROBABILITY OF BRIDGE COLLAPSE	PROBABILITY OF BRIDGE COLLAPSE	N/A	
	SUPER STRUCTURE SHEAR FAILURE	PROBABILITY OF BRIDGE COLLAPSE	PROBABILITY OF BRIDGE COLLAPSE	PROBABILITY OF BRIDGE COLLAPSE	N/A	

BILL OF QUANTITIES (BOQ) FOR MHSH0189B002

GENERATED FROM GABM - R & D BY UBMS RESEARCH GROUP

Bridge Name	MHSH0189B002		
Latitude	16.37	Longitude	74.14
Inspection Date	13-Jan-2026	Engineer Name	SJ
Bridge Length	76	No Of Lanes	2
Distress Severity	4	Total Rehabilitation Cost	35104000.00

General Items Applied Prior to Start of Rehabilitation

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
1	To design and provide approach to all such identified areas and to ensure total approachability for the entire bridge structure. To design and install support mechanism/system to ensure load transfer from superstructure and deck elements.	Sq. meter	800.00	800.00	500.00	400,000.00
2	Remove deceased concrete from all identified distress area including crack surfaces. Cleaning of exposed surfaces by appropriate mechanism/system. Ensure all exposed rebars are cleaned and rust removed.	Sq. meter	1,200.00	1,200.00	100.00	120,000.00
3	To apply appropriate bonding agent for concrete surfaces, rust inhibation coat for exposed rebar/ steel surfaces. Ensure proper curing time.	Sq. meter	1,200.00	1,200.00	500.00	600,000.00
4	To identify areas which require fresh concrete/micro concrete. To design and create formwork for all such areas.	Lump sum	1.00	1.00	3,500,000.00	3,500,000.00
5	To design the quality control systems for all items of work, define the frequency, type of test, acceptance criteria. To submit the same to appropriate authority for their approval. To apply this appoved quality control system during the entire rehabilitation program.	Lump sum	1.00	1.00	50,000.00	50,000.00
6	To design and get approval for all such situations with respect to safety of workers and protection of other people in the vicinity of rehabilitation area.	Lump sum	1.00	1.00	75,000.00	75,000.00
7	To design and develope alternate route for traffic diversion. Maintain this diversion to ensure smooth traffic movement during the entire rehabilitation program.	Lump sum	1.00	1.00	1,500,000.00	1,500,000.00
8	Structural Assessment, Inspection and Identification / mapping of distress area	Lump sum	1.00	1.00	75,000.00	75,000.00
					Sub-Total (Prior to Start):	₹ 6,320,000.00

General Items Applied Post Completion of Rehabilitation

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
1	To provide appropriate protective coating for the entire bridge surface. Ensure that the surface is properly finished, cured and prepared for protective coating application. Such preparation will entail surface levelling and finishing.	Lump sum	1,200.00	1,200.00	1,000.00	1,200,000.00
2	To design and get approval for all test methodologies, frequencies and acceptance criteria for post rehabilitation work. This testing will ensure to have load capacity evaluation and shall be performed prior to opening the bridge for regular traffic.	Lump sum	1.00	1.00	75,000.00	75,000.00
3	To design and provide concrete mix for all such areas which require fresh concrete.	Lump sum	1.00	1.00	50,000.00	50,000.00
					Sub-Total (Post Completion):	₹ 1,325,000.00

Method Based Items - Section #1

Cause Matrix:
FATIGUE
Principle:
Structural strengthening
Method:
Surface panel / plates for strengthening (Application/bonding/external sections)

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
1	To design and provide approach to all such identified areas and to ensure total approachability for the entire bridge structure. To design and install support mechanism/system to ensure load transfer from superstructure and deck elements.	Sq. meter	800.00	800.00	500.00	400,000.00
2	Remove deceased concrete from all identified distress area including crack surfaces. Cleaning of exposed surfaces by appropriate mechanism/system. Ensure all exposed rebars are cleaned and rust removed.	Sq. meter	1,200.00	1,200.00	100.00	120,000.00
					Section #1 Total:	₹ 520,000.00

Method Based Items - Section #2

Cause Matrix:
OVERLOAD
Principle:
Concrete Restoration
Method:
Surface panel / plates for restoration (Application/bonding/external sections)

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
1	To apply appropriate bonding agent for concrete surfaces, rust inhibation coat for exposed rebar/ steel surfaces. Ensure proper curing time.	Sq. meter	1,200.00	1,200.00	500.00	600,000.00

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
2	To identify areas which require fresh concrete/micro concrete. To design and create formwork for all such areas.	Lump sum	1.00	1.00	3,500,000.00	3,500,000.00
					Section #2 Total:	₹ 4,100,000.00

Method Based Items - Section #3

Cause Matrix:
AGGRESSION BY CHLORIDES
Principle:
Protection against Ingress
Method:
Coating to improve physical resistance

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
1	To design the quality control systems for all items of work, define the frequency, type of test, acceptance criteria. To submit the same to appropriate authority for their approval. To apply this appoved quality control system during the entire rehabilitation program.	Lump sum	1.00	1.00	50,000.00	50,000.00
2	To design and get approval for all such situations with respect to safety of workers and protection of other people in the vicinity of rehabilitation area.	Lump sum	1.00	1.00	75,000.00	75,000.00

S.No	Items of Work (Description)	Unit of Measurement	Observed Quantity	Area/Vol for Rehab	Rate per Unit (₹)	Amount (₹)
3	To design and develope alternate route for traffic diversion. Maintain this diversion to ensure smooth traffic movement during the entire rehabilitation program.	Lump sum	1.00	1.00	1,500,000.00	1,500,000.00
					Section #3 Total:	₹ 1,625,000.00

All Method Based Items Total: ₹ 6,245,000.00

TOTAL REHABILITATION COST: ₹ 13,890,000.00

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BOQ ID: #1

RESILIENCE ENHANCEMENT BOQ FOR MHSH0189B002

GENERATED FROM GABM - R & D BY UBMS RESEARCH GROUP

Bridge Name	MHSH0189B002		
Latitude	16.37	Longitude	74.14
Inspection Date	13-Jan-2026	Engineer Name	SJ
Bridge Length	76	No Of Lanes	2
Distress Severity	4	Total Resilience Cost	**₹ 42,650,000.00**

Resilience Enhancement - Section #1

Cause Matrix:
Against Shear Failure of Substructure
Principle:
Design and Provide required systems

S.No	Items of Work	Item Description	Unit	Observed Qty	Rate/Unit (₹)	Amount (₹)
1	Identify member needing increased shear capacity		50.00	100,000.00	5,000,000.00	
2	Design of systems required to increase shear capacity of substructure elements.		1.00	50,000.00	50,000.00	
3	Provide the designed system		1.00	6,000,000.00	6,000,000.00	
4	Load capacity check by testing.		1.00	100,000.00	100,000.00	
					Section #1 Total:	₹ 11,150,000.00

Resilience Enhancement - Section #2

Cause Matrix:
Against the Toppling of the Superstructure
Principle:
Design and Provide required systems

S.No	Items of Work	Item Description	Unit	Observed Qty	Rate/Unit (₹)	Amount (₹)
1	Identify member likely to topple		10.00	15,000.00	150,000.00	
2	Design of systems required toavoid toppling of elements.		1.00	750,000.00	750,000.00	
3	Provide the designed system		10.00	1,500,000.00	15,000,000.00	
4	Load capacity check by testing.		1.00	100,000.00	100,000.00	
5	Design and provide lateral restraints to main girder or main beams in superstructure		5.00	500,000.00	2,500,000.00	

S.No	Items of Work	Item Description	Unit	Observed Qty	Rate/Unit (₹)	Amount (₹)
					Section #2 Total:	₹ 18,500,000.00

Resilience Enhancement - Section #3

Cause Matrix:
Against overturning of Superstructure
Principle:
Design and Provide required systems

S.No	Items of Work	Item Description	Unit	Observed Qty	Rate/Unit (₹)	Amount (₹)
1	Identify member likely to topple		10.00	15,000.00	150,000.00	
2	Design of systems required toavoid toppling of elements.		1.00	250,000.00	250,000.00	
3	Provide the designed system		10.00	1,000,000.00	10,000,000.00	
4	Load capacity check by testing.		1.00	100,000.00	100,000.00	
5	Design and provide lateral restraints to main girder or main beams in superstructure		5.00	500,000.00	2,500,000.00	
					Section #3 Total:	₹ 13,000,000.00

All Resilience Enhancement Items Total: ₹ 42,650,000.00

TOTAL RESILIENCE ENHANCEMENT COST: ₹ 42,650,000.00

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BOQ ID: #1

GENERATED FROM GABM

R & D BY UBMS RESEARCH GROUP

RESULTS FOR FUND OPTIMIZATION POST APPLICATION OF MULTI-CRITERIA DECISION-MAKING PROCESSES

Selected Bridge : 'MHDR0018B009', 'MHDR0037B015', 'MHDR0039B010', 'MHDR0053B014', 'MHSH0130B004', 'MHSH0150B007', 'MHSH0166B016', 'MHSH0189B003', 'MHSH0192B008', 'MHSH0192B011'

RESULT AS PER SIMPLE MULTI-ATTRIBUTE RATING TECHNIQUE [SMART]

RANK BRIDGES AND DETERMINE REHABILITATION POSSIBILITY

RANK OF THE BRIDGE	Bridge ID	Weighted Score	Rehabilitation Cost	Cumulative Cost	Rehabilitation Possible
1	MHSH0150B007	3.1	9,585,000.00	9,585,000.00	YES
2	MHDR0018B009	3.1	33,558,250.00	43,143,250.00	YES
3	MHDR0039B010	3.1	23,165,575.00	66,308,825.00	YES

RANK OF THE BRIDGE	Bridge ID	Weighted Score	Rehabilitation Cost	Cumulative Cost	Rehabilitation Possible
4	MHSH0192B011	3.1	29,235,000.00	95,543,825.00	YES
5	MHSH0189B003	2.95	60,471,250.00	156,015,075.00	YES
6	MHSH0130B004	2.95	74,842,250.00	230,857,325.00	YES
7	MHSH0192B008	2.95	58,446,250.00	289,303,575.00	NO
8	MHDR0053B014	2.95	37,507,000.00	326,810,575.00	NO
9	MHDR0037B015	2.95	22,615,000.00	349,425,575.00	NO
10	MHSH0166B016	2.95	13,537,500.00	362,963,075.00	NO

REFINEMENT AS PER ANALYTICAL HIERARCHY PROCESS (AHP)

ASSIGNMENT OF BUDGET FOR RI

ASSIGNED RANK	BRIDGE ID	ESTIMATED COST	ASSIGNED BUDGET
1	MHSH0150B007	9,585,000.00	7,188,750.00
2	MHDR0018B009	33,558,250.00	25,168,687.50
3	MHDR0039B010	23,165,575.00	17,374,181.25
4	MHSH0192B011	29,235,000.00	21,926,250.00
5	MHSH0189B003	60,471,250.00	45,353,437.50
6	MHSH0130B004	74,842,250.00	56,131,687.50
7	MHSH0192B008	58,446,250.00	43,834,687.50

ASSIGNED RANK	BRIDGE ID	ESTIMATED COST	ASSIGNED BUDGET
8	MHDR0053B014	37,507,000.00	28,130,250.00
9	MHDR0037B015	22,615,000.00	16,961,250.00
10	MHSH0166B016	13,537,500.00	10,153,125.00

BRIDGE WISE EVALUATION FOR FEASIBILITY TO PROCEED WITH REHABILITATION AND RESILIENCE ENHANCEMENT(ALL FIGURES ARE IN MILLIONS)

RANKIG AS PER MCDM	BRIDG ID	REHAB COST	RESILIENCE COST	TOTAL OF R&R	BENEFIT DUE TO BRIDGE	FEASIBILITY TO UNDERTAKE R&R
1	MHSH0150B007	10	17	27	424	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
2	MHDR0018B009	34	41	75	667	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
3	MHDR0039B010	23	16	39	926	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
4	MHSH0192B011	29	13	42	1389	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
5	MHSH0189B003	60	24	84	1111	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
6	MHSH0130B004	75	20	95	1429	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT

RANKIG AS PER MCDM	BRIDG ID	REHAB COST	RESILIENCE COST	TOTAL OF R&R	BENEFIT DUE TO BRIDGE	FEASIBILITY TO UNDERTAKE R&R
7	MHSH0192B008	58	22	81	1111	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
8	MHDR0053B014	38	45	83	676	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
9	MHDR0037B015	23	11	34	893	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT
10	MHSH0166B016	14	18	32	490	YES PROCEED FOR REHAB AND RESILIENCE ENHANCEMENT

FEASIBILITY OF ENHANCING BUDGET TO ENSURE STRUCTURAL AND RESILIENCE ADEQUACY(ALL FIGURES ARE IN MILLIONS)

	Extra Budget essential (+)/ Excess budget available (-) FOR RESILIENCE AND STRUCTURAL ADEQUACY	Extra Budget essential (+)/ Excess budget available (-) FOR ONLY STRUCTURAL ADEQUACY	Extra Budget essential (+)/ Excess budget available (-) FOR ONLY RESILIENCE ADEQUACY	TOTAL BENEFITS ACCRUED DUE TO RESILIENCE AND STRUCTURAL ADEQUACY
TOTAL IMPACT FOR ALL BRIDGES	**345.96**	**117.85**	**-17.01**	**9,114.73**

TOTAL BENEFITS ACCRUED CONSISTS OF: a. Direct Benefit b. Indirect Benefit
Direct Benefit consists of Savings in Vehicle Operating Cost (VOC) and Vehicle Operating Time (VOT) for the trip. **Indirect Benefit** consists of Impact of Economic Growth Potential, Social Benefit accrued, Time saved due to reduction in distance and time because of the bridge and Environmental Impact. It evaluates the impact of the bridge on the regions GDP, increase in employment, productivity and social benefits due to ease of connectivity to schools, hospitals, place of work, recreation.