SUGGESTED MEASURES TO MITIGATE

ASIAN ELEPHANT - TRAIN COLLISIONS ON VULNERABLE RAILWAY STRETCHES

IN THE STATE OF

KARNATAKA

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

AUGUST 2024

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Graphics, Illustrations & Deisgn
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Citation: PE-MoEFCC-WII (2024). Suggested Measures to Mitigate Asian Elephant - Train Collisions on Vulnerable Railway Stretches in the state of Karnataka. Project Elephant Division, Ministry of Environment, Forest and Climate Change, Government of India and Wildlife Institute of India. Pp. 40

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To minimize the risk of collisions between elephants and trains, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways in India have jointly undertaken several measures.These include the construction of underpasses and overpasses for safe elephant passage, setting up of signage boards to warn locomotive drivers, and speed regulations in elephant corridors. Further, efforts have also been made to sensitize train drivers and railway staff about elephant movements and using technology to track and predict elephant movements near railway tracks .These collaborative efforts aims to safeguard elephant populations while ensuring the smooth operation of railway services, and are part of a comprehensive strategy to reduce train-elephant collisions.

By implementing early warning systems like DAS, underpasses, overpasses, level crossings and installing barriers at vulnerable points along railway tracks, the Ministry of Environment, Forest and Climate Change and the Ministry of Railways aim to create a safer environment for elephants while maintaining efficient rail operations.

The collaboration between the Ministry of Environment, Forest and Climate Change and the Ministry of Railways underscores the importance of inter-departmental cooperation in wildlife conservation. By aligning their efforts, these ministries are working towards a sustainable solution to mitigate the risk of elephant-train collisions.

A combination of technological innovations, such as the use of thermal imaging cameras and automated alert systems, & traditional methods, like patrolling and community involvement, are being employed by the Ministry of Environment, Forest and Climate Change and the Ministry of Railways to protect elephants from train accidents.

ACKNOWLEDGEMENT

Shri Bhupender Yadav
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01. Introduction

Among the anthropogenic causes leading to human-elephant conflict, train collision has been a matter of serious concern for the past several years. Between 2009-2010 and from 2011-2021, 186 elephants were killed on railway tracks[1], and 80 elephant deaths were reported in a five-year span (between 2018-2023)[2]. Being a long-lived social species, such a loss can heavily impact the entire herd dynamics and an entire generation of the species. The ecological importance of the species in maintaining the ecosystem balance is undeniably of the highest magnitude. It is a prudent responsibility to stop such loss. With that aim the Ministry of Environment, Forest and Climate Change (MoEF&CC) and Ministry of Railways met on June 2023 to deliberate upon the mitigation measures to be adopted on the railway track to minimize such incidents of train-elephant collision.

Project Elephant Division of MoEFCC, India and the Wildlife Institute of India, Dehradun had identified 110 railway stretches passing through sensitive elephant habitats of India with the objective to implement effective mitigation measures to minimize wildlife-train collision. In this regard Ministry of Railways and MoEF&CC planned to conduct joint surveys on these 110 stretches across 13 states. Technical representatives from the Wildlife Institute of India and Project Elephant Division along with state forest officers and senior railway personnel visited these stretches to suggest and evaluate feasibility of wildlife-specific mitigation measures.

With 6395 elephants[3] (21% of India's elephant population in 2023), 2 elephant reserves[4] (spanning more than 15,000 km^2) and 7 elephant corridors[5], the state of Karnataka plays a significant role in India's elephant conservation. However, rapid linear infrastructure development, such as roads and railway, and agricultural practices in the state has severely fragmented the forested habitats. Elephant herds are forced to venture out of the forest in search of forage. Such long-distance movement entails crossing roads and railways which inadvertently puts the species to a life-threatening scenario. This report highlights in detail the survey done in the state of Karnataka. The survey was done between 26/02/2024 and 06/03/2024. Five vulnerable stretches spanning four districts were identified in the state (Table 1). Each stretch was thoroughly inspected by the joint technical team of WII-Forest Department-Railways and collective decision was taken on construction of wildlife mitigation structures at sensitive locations.

Table 1: Details of railway stretches passing through sensitive elephant habitats of Karnataka as identified by the Project Elephant Division of MoEF&CC and the Wildlife Institute of India.

Stretch	Width (km)	Between stations	District
1	24.9	Ambewadi – Alnavar	Uttar Kannada
2	42.7	Londa – Khanapura – Desur	Belgaum
3	86	Tinaighat – Londa – Nagargali	Uttara Kannada - Belgaum
4	100	Shimoga – Kumsi – Anandapura - Talaguppa	Shimoga
5	131.5	Subrahmanya Road – Sakleshpura – Ballupet	Hassan

1 186 elephants killed on railway tracks in over 10 years: MoEFCC - The Hindu
2 Mongabay.com
3 Number of elephants in Karnataka has gone up by 346 - The Hindu
4 wiienvis.nic.in/Database/eri_8226.aspx
5 Press Information Bureau (pib.gov.in)

02. Field Survey

Concerned staffs from the Department of Forest and Indian Railways for each of the identified stretches were informed in advance about the locations through which a stretch passes. Accordingly, the survey date, time, start-end locations and other logistics were arranged. The inspection team comprised of Range Forest Officer, Assistant Divisional Engineer of Railways and WII representative. Motorised trolley was used which was a convenient and faster mode for surveying the stretches (Figure 1). The trolley allowed swift and careful inspection of each of the sensitive locations. Locations with report of elephant movement or previous/current records of elephant mortality/injury were considered sensitive to wildlife-train collision. All such locations were visited and upon inspection and thorough deliberation mitigation measures such as wildlife level-crossings, overpass and underpass were suggested. Apart from feasibility of constructing the mitigation structures, the suggestions were also based on criteria such as distance to the nearest forest patch, distance to the nearest human settlement, distance to water source and seasonality of incidences. For each location chainage number and geo-coordinates were recorded (using GPS). Data on past records of wildlife-rail collision was collected from the Forest Department offices. Data on type and dimension of existing structures near the sensitive locations (if any) were recorded. The structures were inspected for any animal usage based on indirect signs, such as footprint.

Figure 1: Field survey conducted by WII representative in collaboration with Indian Railways and Karnataka State Forest Department officials in sensitive railway line stretches in the state.

* The objective of the field survey was to minimise elephant-train collisions either by constructing underpasses and overpasses wherever possible, by reducing the time taken by elephants to cross the railway tracks by easing movement across the track through construction of ramps and level crossings, and by implementation of technology for early detection and warning systems.

03. Site-Specific Findings & Mitigation Measures

3.1. Ambewadi – Alnavar

25 km of this stretch, between Ambewadi – Alnavar, was surveyed in presence of Range officers of three forest ranges, viz. Dandeli, Barchi and Haliyal and Railway Section Engineers on 27/02/2024. The stretch falls within an active elephant and gaur corridor. From Dandeli towards Kalyanpura, the right side of the stretch has dense contiguous forest (Figure 2). The left side of the stretch however has patchy forest with few villages and human settlements (Figure 2). Illicit felling and logging by the villagers are a major problem the forest department faces here. This stretch is currently used for transportation of goods to a paper mill located at Ambewadi.

Table 2: Suggested mitigation measures and their dimensions for the Ambewadi – Alnavara railway stretch

S. No.	Chainage	Suggested mitigation structure	Dimension (meters)	Latitude	Longitude
1	25/700	Level Crossing*	50	15.2746	74.6216
2	22/500	Level Crossing*	50	15.2906	74.6431
3	21/500	Level Crossing*	50	15.2924	74.6529
4	17/100	Level Crossing*	50	15.3226	74.6676
5	14/100	Level Crossing*	50	15.3420	74.6605
6	5/200	Level Crossing*	50	15.4031	74.7002

** Rubberized level crossings with Ramps and Distributed Acoustic Sensing (DAS) early warning system*

3.2. Londa – Khanapura – Desur

The survey in this stretch was done between Khanapura station and Londa station on 29/02/2024. This section of the stretch passes through forested habitats majorly. As reported by the forest and the railway staff, the section between Khanapura and Desur has minimal to zero movement of elephant or gaur. The forested habitat through which the railway passes between Khanapura and Londa is interspersed with occasional agricultural fields creating a patchy forest network (Figure 3). This section is heavily used by gaur with several reports of deaths and injury repeatedly in certain locations (Figure 4 & Table 4). The movement is primarily during night when animals cross from the forest habitats towards agricultural fields in search of food and water and falls victim to the fast-moving trains. In addition to implementation of all the suggested measures, controlling the speed is crucial for minimizing such fatal accidents. During the survey itself an adult gaur was found dead hit by train in the preceding night at chainage 575/8 (Figure 5).

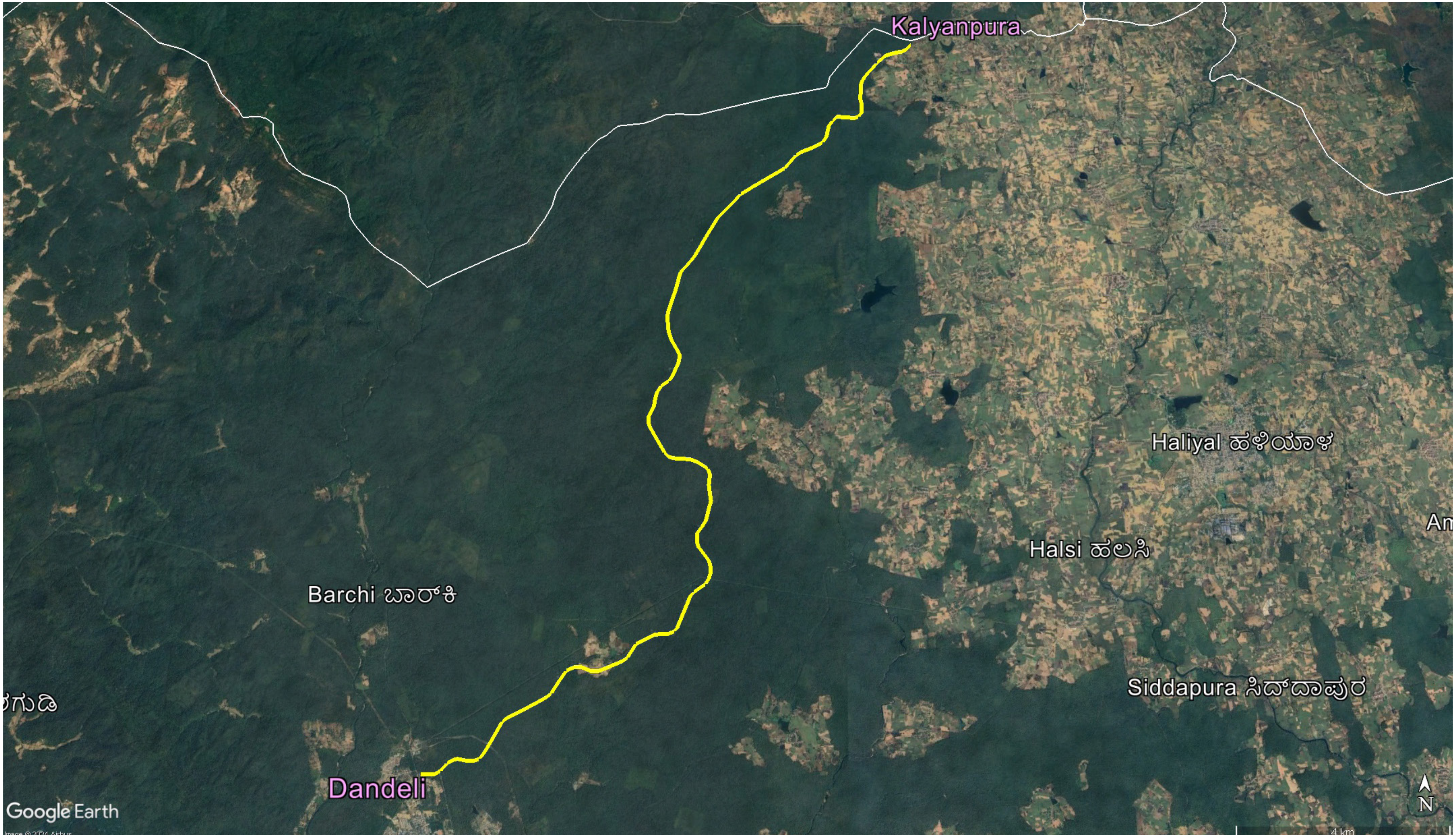


Figure 2: Map showing stretch of railway line surveyed between Ambewadi – Alnavar, Karnataka

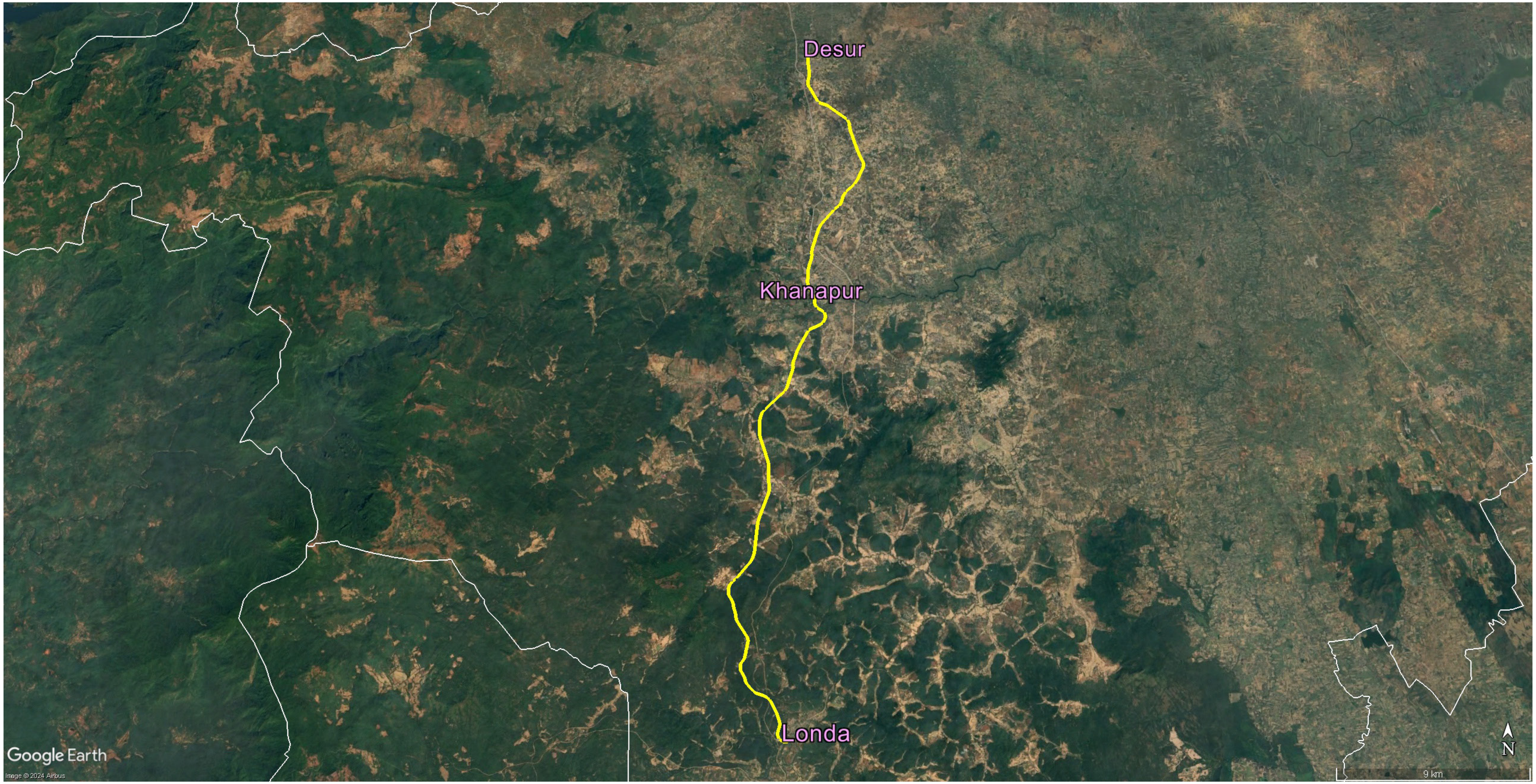


Figure 3: Map showing the railway stretch between Londa and Desur, Karnataka.

Figure 4: Mortality locations of gaur (red circles) on the railway track between Londa and Khanapur, Karnataka (2014-2024)

Table 3: Suggested mitigation measures and their dimensions for the Khanapura – Desur railway stretch, Karnataka

S. No.	Chainage	Suggested mitigation structure	Dimension (meters)	Latitude	Longitude
1	578/0-577/9	Level Crossing*	50	15.5866	74.4818
2	578/1-578/2	Underpass	6(H) x 20(W)	15.5874	74.4827
3	577/9-577/2	Retaining Wall#		15.5874	74.4827
4	576/0-576/1	RCC Box	6(H) x 15(W)	15.5707	74.4781
5	575/0-575/1	Level Crossing*	50		
6	571/9	RCC Box	6(H) x 15(W)	15.5345	74.4770
7	571/1	Level Crossing*	50	15.5272	74.4762
8	569/9	Level Crossing*	50	15.5176	74.4732
9	568/23	Overpass	30	15.5056	74.4648
10	567/1-567/0	Level Crossing*	50	15.4954	74.4682
11	565/0-564/9	Underpass	6(H) x 20(W)	15.4781	74.472
12	563/7	Underpass	6(H) x 20(W)	15.4677	74.4737

** Rubberized level crossings with Ramps and Distributed Acoustic Sensing (DAS) early warning system*
 # Retaining wall should be provided with ramps on both sides for facilitating wildlife movement;
H = Height, W = Width

Figure 5: An adult gaur found dead because of collision with a train on the Londa-Khanapura-Desur railway line, Karnataka, during the joint survey.

Table 4: Records of animal mortality due to collision with trains in the Londa – Khanapura railway stretch between 2014 and 2024. [Source: Range Forest Office, Londa.]

Sl No	Year	FOC No	FIR No/ WLOR No	Date	Time	Details of wild Animal	Location	GPS Reading		Chinage No
1	2013-14			22-02-2014		Indian Gaur	Watra Fs No: 71	15.46427	74.47787	563/300
2	2015-16			29-02-2016		Indian Gaur-2 Nos	Akrali Fs No: 79/A	1)15.45457 2)15.45473	1)74.44832. 2)74.44827	7/250
3				02-03-2016		Indian Gaur	Akrali Fs No: 79/A	15.45613	74.42748	7/200
4				19-03-2016		Indian Gaur	Kirawale Fs No: 62	15.51288	74.46896	567/00
5	2016-17			27-09-2016		Indian Gaur	Kirawale Fs No: 62	15.47766	74.2452	554/900
6				12-01-2017		Indian Gaur	Kirawale Fs No: 62	15.51074	74.46673	568/100
7				01-03-2017		Indian Gaur	Kirawale Fs No: 62	15.31087	74.28423	570/100
8	2017-18			07-04-2017		Indian Gaur	Akrali Fs No: 78, 79	15.45630	74.43698	7/400
9				12-12-2017		Wild Dog	Kirawale Fs No: 62	15.51437	74.47014	571/100
10				28-12-2017		Indian Gaur	Kirawale Fs No: 62	15.29782	74.2808	568/100
11				28-12-2017		Indian Gaur	Kirawale Fs No: 62	15.31341	74.27744	567/200
12				13-07-2017		Bear	Kirawale Fs No: 62	15.29580	74.27040	569/300
13				07-01-2018		Indian Gaur	Gunji Fs No: 62	15.54820	74.48148	573/400
14	2018-19			23-08-2018		Indian Gaur	Akrali Fs No: 78, 79	15.45690	74.43329	7/700
15				19-12-2018		Indian Gaur	Akrali Fs No: 78, 79	15.45690	74.43329	7/700
16				25-03-2019		Indian Gaur	Railway	15.45610	74.43842	7/000
17	2019-20	05/2019-20	01/2019-20	18-05-2019	4.00 pm	Indian Gaur	Akrali Fs No: 121	15.44495	74.47002	3/300
18		23/2019-20	01/2019-20	24-02-2020	Night	Indian Gaur	Kirawale Fs No: 62/A	15.50499	74.69960	567/8
19		24/2019-20	02/2019-20	06-03-2020	Night	Indian Gaur	Goshe Fs No: 58	15.47005	74.51240	556/3
20		25/2019-20	03/2019-20	16-03-2020	Night	Indian Gaur	Tivoli Fs No: 16	15.32070	74.28370	576/6
21	2020-21	04/2020-21	02/2020-21	11-06-2020	Night	Indian Gaur	Kumrutwadi Fs No: 59	15.32070	74.28370	572/0
22		05/2020-21	01/2020-21	25-07-2020	3.20 pm	Sambar	Akrali Fs No: 78, 79	15.456191	74.442348	6/800
23		08/2020-21	01/2020-21	03-12-2020	5:00 AM	Bison	Shindoli BK Fs No: 34	15.47470	74.53233	553/4
24		13/2020-21	01/2020-21	29-12-2020	10.30 am	Indian Gaur	Goshe kh Fs No: 41	15.32070	74.28370	555/7
25		15/2020-21	02/2020-21	08-01-2021	9.10 am	Indian Gaur	Potoli Fs No: 37	15.475461	74.526525	554/2
26		16/2020-21	02/2020-21	19-01-2021	3.40 pm	Indian Gaur	Akrali Fs No: 78	15.456645	74.433832	7/700
27		18/2020-21	03/2020-21	02-02-2021	4.10 pm	Bison	Akrali Fs No: 78	15.456776	74.427617	8/500
28		19/2020-21	19/2020-21	13-02-2021	6.00 am	Indian Gaur	Watra Fs No: 71	15.494591	74.46850	567/0
29		20/2020-21	01/2020-21	21-02-2021	3.00 am	Bison	Tivoli Fs No: 16			577/1
30		23/2020-21	03/2020-21	07-03-2021	10.30 pm	Indian Gaur	Kirawale Fs No: 62/A	15.49633	74.46812	567/2
31	2021-22	04/2021-22	04/2021-22	08-06-2021	3.40 pm	Indian Gaur	Akrali Fs No: 79	15.45459	74.44456	6/500
32				09-04-2021		Indian Gaur	Tvoli Fs No: 16	15.57156	74.47778	576/100
33		07/2021-22	01/2021-22	11-08-2021	Night	Indian Gaur	Londa Fs No: : 51	15.45273	74.48794	563/3
34		08/2021-22	02/2021-22	22-08-2021	Night	Bison	Tvoli Fs No: 27	15.56316	74.48083	575/1
35		10/2021-22	01/2021-22	24-09-2021	Night	Bison	Goshe BK Fs No: 18			555/2
36		12/2021-22	02/2021-22	27-10-2021	Night	Sambar	Gunji Fs No: : 35	15.52736	74.47522	571/2
37		14/2021-22	02/2021-22	20-11-2021	4.20 pm	Indian Gaur	Watra Fs No: 71	15.477399	74.471401	564/9
38		14/A/2022-23	01/2022-23	27-01-2022	Night	Bison	Mohishet Fs No : 10	15.467567	74.474018	563/700-800
39				15-02-2022	-	Indian Gaur	Londa Fs No: : 18	15.46212	74.50799	557/200
40				17-02-2022	-	Indian Gaur	Shindoli Fs No: 32	15.474627	74.529839	553/700
41	2022-23			14-04-2022	-	Indian Gaur	Potoli Fs No: 37	15.47471	74.52704	554/1
42		18/2022-23	2/2022-23	10-01-2023	4.30 am	Bison	Tivoli Sy No: 56	15.569308	74.47874	575/800
43				01-02-2023	-	Indian Gaur	Potoli R S No: 40	15.47559	74.81354	555/7
44	2023-24			07-01-2024	-	Indian Gaur	Goshe kh Fs No: 58	15.468996	74.511554	556/4
45		19/2023-24	19/2023-24	21-02-2024	-	Indian Gaur	Tivoli R S No: 52	15.5726	74.4889	575/8
46		20/2023-24	20/2023-24	22-02-2024	-	Indian Gaur	Gavegali R S No: 26	15.4533	74.429	9/0
47		22/2023-24	22/2023-24	28-02-2024	-	Indian Gaur	Dokegali Fs No: 32	15.5863	74.4819	578/0
48	2024-25	01/2024-25	01/2024-25	07-04-2024	-	Indian Gaur	Mohishet Fs No : 10	15.44849	74.49162	562/300
49		02/2024-25	02/2024-25	09-04-2024	Night	Indian Gaur - 2 Nos	Akrali Fs No: 78	15.456129	74.442702	6/800
50		03/2024-25	03/2024-25	13-04-2024	-	Indian Gaur	Akrali Fs No: 78	15.456134	74.442622	6/800
51		04/2024-25	04/2024-25	05-05-2024	-	Indian Gaur	Shivathan Sy No: 56	15.459307	74.542418	551/7
52		05/2024-25	05/2024-25	13-05-2024	-	Indian Gaur	Tivoli Fs No: 16	15.57276	74.47749	576/3
53		06/2024-25	06/2024-25	03-06-2024		Indian Gaur	Goshe KH	15.464559	74.509209	556/9

3.3. Castlerock – Tinaighat – Londa – Nagargali

In this stretch the section between Tinaighat – Londa – Nagargali was surveyed on 29/02/2024 and 02/03/2024. The section passes through forested habitat interspersed by agricultural field and human settlements. Movement of gaur is frequent across the railway track of this section. Low forage availability in the fragmented forest and scarce water availability in dry season probably forces the animal to venture into agricultural fields. Such movements render the species vulnerable to train collision (Figure 6 and 7).

The section between Castlerock and Tinaighat which falls under the buffer of Kali Tiger Reserve was systematically surveyed and chainage-wise appropriate mitigation measures were suggested by WII during an earlier project "Cumulative Environmental Impact Assessment on wildlife habitat and ecological values due to proposed doubling of railway track from Tinaighat to Kulem in the northern Western Ghats". The technical details of these mitigation measures can be found in the report "Mitigation measures for the doubling of railway track between Tinaighat (Karnataka) and Goa". The stretch is separately considered for doubling and mitigation by Indian Railways.

Table 5: Suggested mitigation measures and their dimensions for the Tinaighat – Londa – Nagargali railway stretch

S. No.	Chainage	Suggested mitigation structure	Dimension (meters)	Latitude	Longitude
1	8/400	Level Crossing*	50	15.4535	74.42427
2	556/3	Level Crossing*	50	15.4697	74.51228
3	555/7	Level Crossing*	50	15.4755	74.8135
4	554/2	Underpass	4(H)*20(W)	15.4753	74.5257
5	550/5-550/6	Level Crossing*	50	15.4518	74.5435
6	548/4-548/5	Level Crossing*	50	15.4458	74.5614
7	545/1-545/2	Underpass	5(H)*20(W)	15.449	74.5873
8	542/3	Level Crossing*	50	15.4308	74.6003

** Rubberized level crossings with Ramps and Distributed Acoustic Sensing (DAS) early warning system*

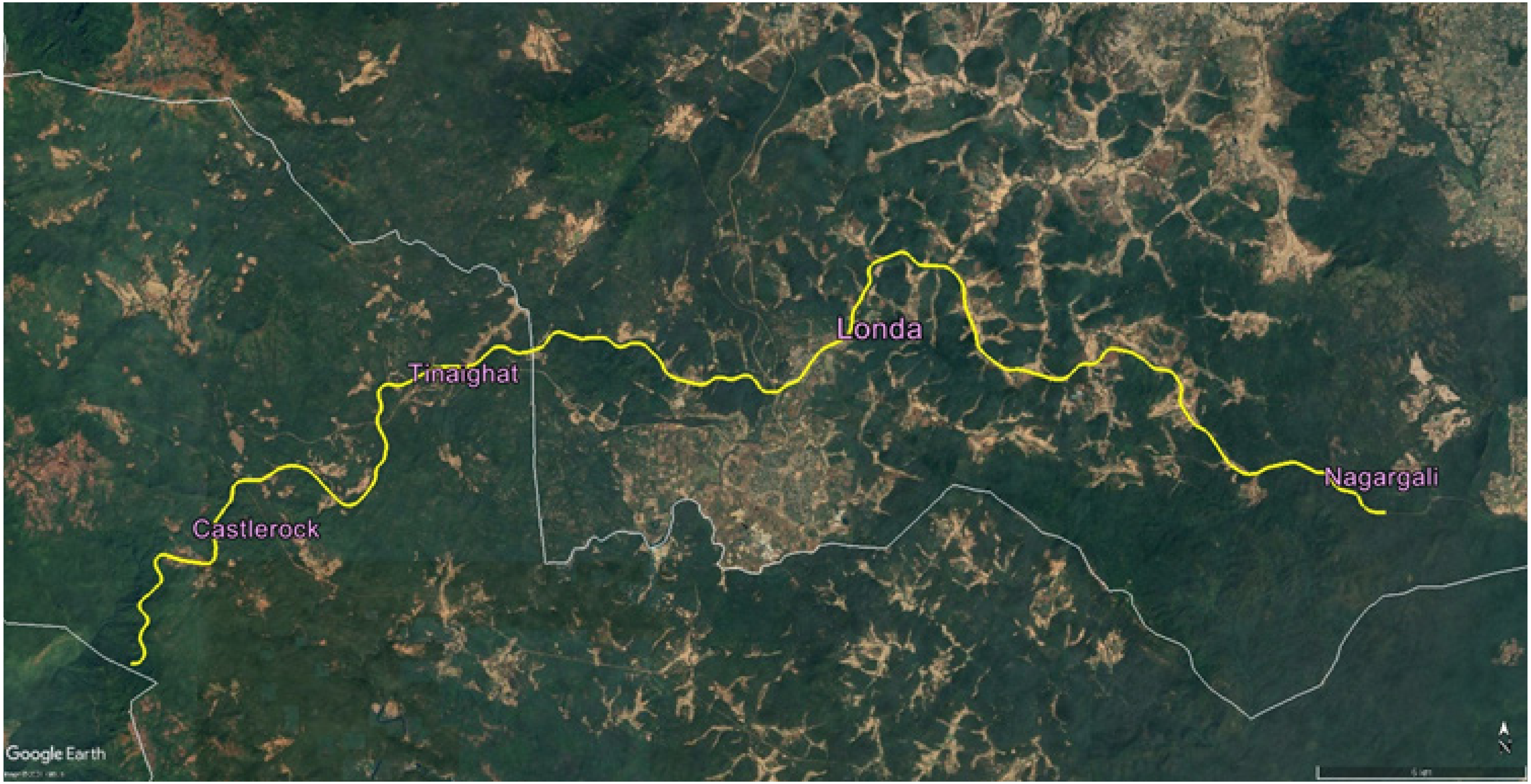


Figure 6: Map showing the railway stretch between Castlerock – Tinaighat – Londa – Nagargali, Karnataka

Figure 7: Map showing mortality locations of gaur (red circle) on the Tinaighat – Londa – Nagargali railway stretch, Karnataka.

3.4. Shimoga – Kumsi – Anandapura – Talaguppa

This stretch was surveyed on 05/03/2024. The major span of this stretch passes through human habitation with no forest (Figure 8). The area adjacent to the railway track is predominately of Arecanut plantations. Only about 10 km of the total 100 km stretch passes through forest on one side, where there has been very infrequent report of elephant movement. Railway track ends at the Talaguppa.

Table 6: Suggested mitigation measures and their dimensions for the Khanapura – Desur railway stretch, Karnataka.

S. No.	Chainage	Suggested mitigation structure	Dimension (meters)	Latitude	Longitude
1	92/2	Overpass	30	13.9874	75.3433
2	92/0	Level Crossing*	50	15.5874	74.4827

* *Rubberized level crossings with Ramps and Distributed Acoustic Sensing (DAS) early warning system*

3.5. Balupete – Sakleshpura – Subrahmanya Road

This stretch was surveyed on 07/03/2024. Half of the stretch passes through extensive coffee plantations before it enters the Ghat section with dense forest and hilly terrain (Figure 9). The section between Ballupet and Sakleshpura could be extensively surveyed with the motorised trolley. Several locations of the section had active elephant movement as was evident from presence of dung as well from report of forest and railway staff. For the rest of the stretch, section between Sakleshpura till Yedakumari could only be surveyed due to absence of motorised trolley. The motorised trolley was not permitted to run between Sakleshpura and Subrahmanya Road due to technical difficulties on the day of survey. Hence, only those elephant crossing points were visited, between Sakleshpura and Kadagaravalli, which could only be accessed through the vehicular road passing parallel to the rail track.

N.B: Assessment of the section between Kadagaravalli and Subrahmanya Road which passes through the critical Ghat section will require 3/4 days of prior planning, as on-foot survey seems to be the only option of surveying the stretch. The stretch however has several elephant crossing points and requires a thorough inspection for finalising the mitigation measures.

Table 7: Suggested mitigation measures and their dimensions for the Ballupet – Sakleshpura – Kadagaravalli railway stretch, Karnataka.

S. No.	Chainage	Suggested mitigation structure	Dimension (meters)	Latitude	Longitude
1	28/100-28/200	Level Crossing*	50	12.95611	75.87834
2	29/100-29/200	Overpass	50	12.9595	75.86961
3	34/600-34/700	Overpass	30		
4	35/200-35/300	Level Crossing*	50		
5	35/900-36/000	Overpass	50	12.9611	75.8176
6	44/300-44/300	Level Crossing*	50	12.9403	75.7596
7	54/600-54/700	Level Crossing*	50	12.8637	75.7242
8	54/350	Railway Under Bridge	6(H) x 30(W)	12.8655	75.7262
9	54/200-54/300	Overpass	50	12.8664	75.7269
10	56/400-56/500	Overpass	50	12.8553	75.7116

11	58/300-58/400	Overpass	30	12.8413	75.7055
12	58/400-58/500	Level Crossing*	50	12.8413	75.7037
13	58/600-58/700	Overpass	30	12.8416	75.7021

** Rubberized level crossings with Ramps and Distributed Acoustic Sensing (DAS) early warning system*

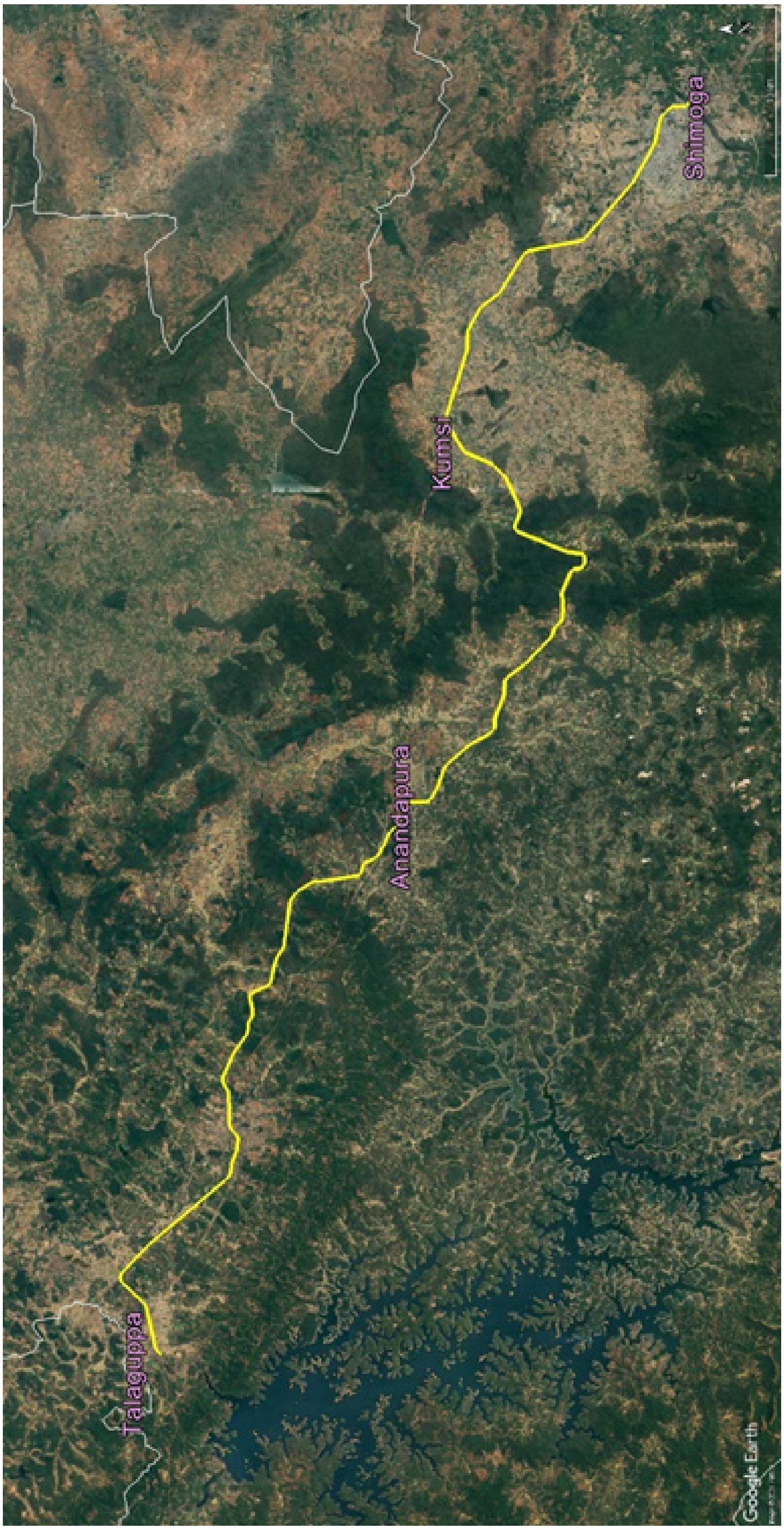


Figure 8: Map showing the railway stretch between Shimoga – Kumsi – Anandapura – Talaguppa, Karnataka.

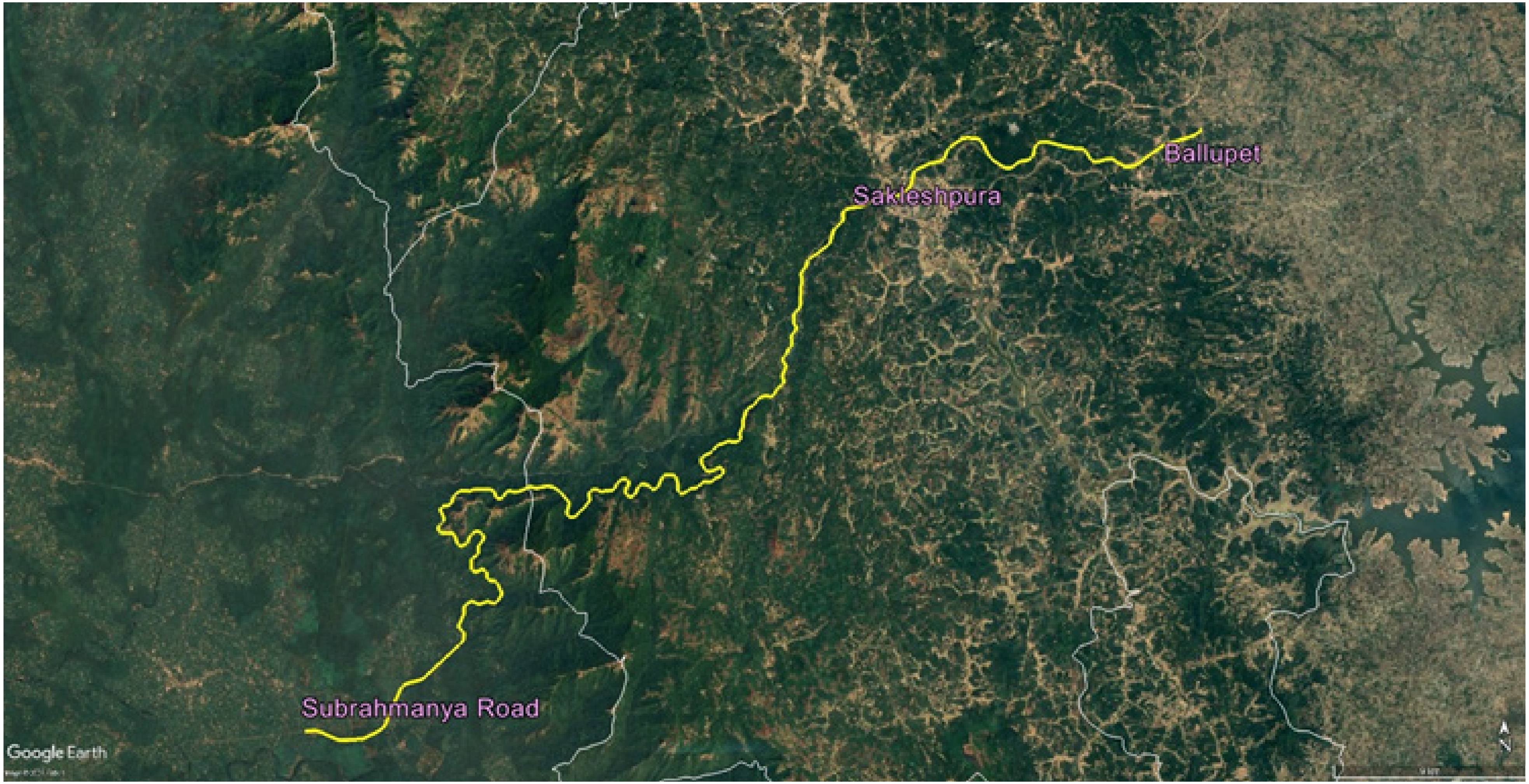


Figure 9: Map showing the railway stretch between Ballupet – Sakleshpura – Subrahmanya Road, Karnataka.

04. General recommendations for all sites

The following blanket recommendations are to be implemented across all sites:

1. Distributed Acoustic Sensing (DAS) – based Intrusion Detection Systems (IDS) are to be implemented on all sensitive stretches on priority. Further all level crossings and ramps should incorporate the DAS IDS system as well.

2. Sign boards on the sensitive stretches should be erected to alert loco pilots, along with indications of specific wildlife-crossing zones.

3. Goods trains should be scheduled for the daytime as much as possible or during the time period when the activity of the wildlife species especially elephants is at its minimum.

4. For construction of structural mitigation measures (underpasses, overpasses, level crossings and ramps), the WII report on specifications of mitigation measures should be referred.

5. Regular clearing of vegetation till at least 30 m on either side of the railway tracks is to be done to increase visibility for both loco pilots and elephants. The frequency and responsibility of carrying out pruning may be decided mutually by both parties.

6. Strict restriction and fines on disposal of garbage, especially food items, from operating trains on railway tracks in sensitive stretches and railway stations near them should be imposed.

7. Joint teams of railways and forest department personnel should be formed for all critical stretches. The team would be responsible for joint patrolling on the track of elephant presence, coordination and information sharing, and regular cleaning of railway tracks. This can be achieved by creating WhatsApp groups for each region comprising of senior officials and frontline staff of the railways and forest department.

8. There should be regular cooperation and exchange of information between forest department and railways staff. Regular sensitization workshops for railway staff, especially loco pilots and ground staff should be conducted.

9. Most railway tracks in the surveyed areas are in the process of getting electrified. Adequate measures (insulation and proofing of all electric infrastructure) should be taken to avoid incidents of electrocution of wildlife because of the railway electric infrastructure.

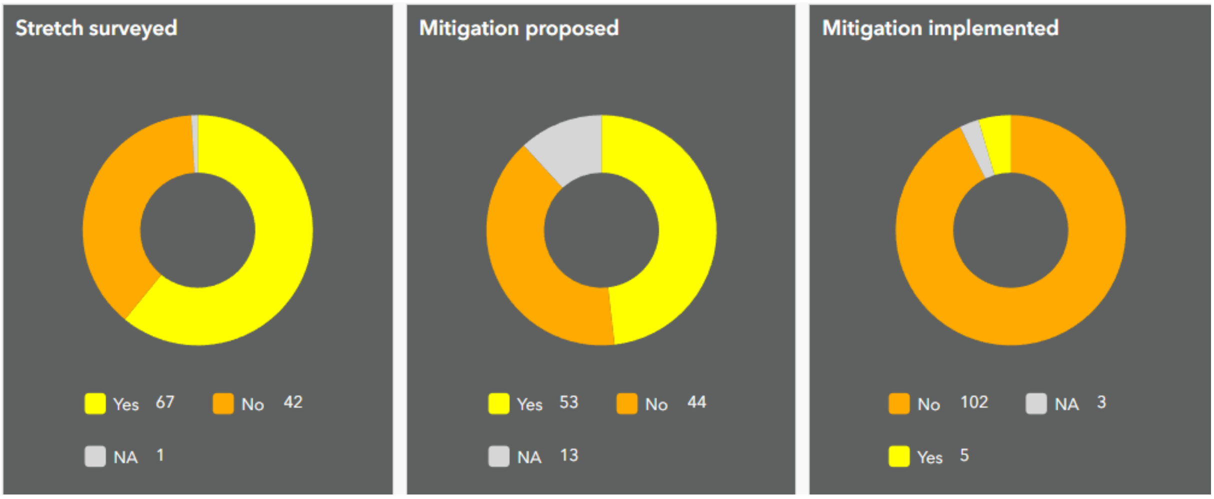
10. To discourage use of wildlife-friendly ramps and level crossings by people and vehicles, concrete barrier poles and/or other barriers should be built that are high enough to block passage of 2 and 4-wheelers, but low enough to allow elephants to pass.

11. Incidences of elephant and wildlife injury and mortality should be documented by both parties, with complete details on GPS location, chainage, date and time of day.

12. In the future, all metre-gauge to broad-gauge conversion projects in elephant landscapes should include comprehensive elephant mitigation plans.

13. In the future, railway stretches posing collision and barrier risks to wildlife should be identified that exist beyond elephant reserves and protected areas, such as corridors.

05. Dashboard for monitoring implementation of mitigation measures



Crossing zone details

Serial No	Name of area	State	Crossing zone width (m)	Stretch surveyed	Mitigation proposed	Mitigation implemented	Remarks	ReportLink
1	Elephant reserve	Uttarakhand	8.60	Yes	Yes	No		https://drive.google.com/file/d/1PZ2YCcHrQKnVcRywn7iyoOgDLiYQQkpe/view?usp=drive_link
2	Elephant reserve	Uttarakhand	14.30	Yes	Yes	No		-
3	Elephant reserve	Uttarakhand	28.90	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
4	Elephant reserve	Uttarakhand	4.50	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
5	Elephant reserve	Uttarakhand	21.30	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
6	Elephant distribution	Uttarakhand	5.90	Yes	No	No	Stretch falls within Kathgodam city limits	-
7	Elephant distribution	Uttarakhand	4.40	Yes	Yes	No	Surveyed by Forest Deparment	https://drive.google.com/file/d/1tFFaY4n5kYA9OhcBqeO5egHMzq9TjWlt/view?usp=sharing
8	Elephant distribution	Uttarakhand	39.80	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
9	Elephant distribution	Uttarakhand	30.70	Yes	Yes	Yes	This stretch has been surveyed under Harrawala Project & seperately discussed with MoR	-
10	Elephant reserve	Uttar Pradesh	7.60	No	No	No		
11	Elephant distribution	Uttar Pradesh	7.60	No	No	No		
12	Elephant distribution	Uttar Pradesh	3.30	No	No	No		
13	Elephant distribution	Uttar Pradesh	10.30	No	No	No		
14	Elephant distribution	Uttar Pradesh	49.80	No	No	No		
15	Elephant distribution	Uttar Pradesh	19.00	No	No	No		

India is a megadiverse country, with only 2.4% of the world's land area, but accounts for 7-8% of all recorded species of the world, including about 91,000 species of animals and 45,500 species of plants. India is also the second-most populous country in the world with a population of over 1.3 billion people! To transport and cater to the needs of such a large population, the Indian Railway is the main artery of inland transportation in India. In 2020, it carried a total of 808.6 crore passengers! Indian Railways is also the single largest employer in India and the eighth largest in the world, employing approximately 13 Lakh people. It is the country's lifeline for large-scale traffic movement – freight and passengers. Railways are at the core of India's economic development and make it possible to conduct many activities like business, sightseeing, and pilgrimage along with the transportation of goods over longer distances. In fact, the Indian Railways is among the world's largest rail networks and runs thousands of trains daily. To cater to India's fast-growing economy, the railway sector has envisaged Vision 2024 to achieve targets of 2024 MT freight loading by 2024. The railway also aims to electrify the entire network.

Recognized as economic, energy-efficient, and environment-friendly relative to other means of transport such as roads and air, the expansion and upgrading of railways is seen as an important measure in supporting development through large-scale movement of people and goods. However, railway construction and operation has its ecological effects, and a range of impacts on wildlife and habitats have also been documented. Several of India's passenger

and freight trains crisscross through some of the country's most sensitive wildlife habitats, particularly protected areas and corridors that are home to critically endangered tigers and elephants, amongst other animals. The extensive network of our Railways cuts through several of these forested landscapes, compromising the connectivity of the landscape and resulting in a barrier effect.

To reduce the impact of railways on our wildlife, it is important to come together and develop measures that can protect India's rich biodiversity and also help to develop a system that is more sustainable and effective in minimizing mortalities and reducing barrier effects across the railways tracks passing through sensitive habitats in India

Project Elephant Division of MoEF&CC in coordination with Ministry of Railways and Wildlife Institute of India has identified sensitive stretches which need prioritization for mitigation planning. The portal is developed to monitor the progress of implementation of mitigation measures from the beginning. The process involves joint surveys of the identified stretches by officials of the Forest Department, Railways and Wildlife Institute of India, recommendation of mitigation measures and implementation of the mitigation measures. The mitigation proposed on the stretches surveyed by various team has been upload on the dashboard. The dashboard can be accessed at Railway Crossing Zones Dashboard (arcgis.com)

The purpose of the dashboard is to monitor the implementation of the mitigation measures on the surveyed stretches. The officers are requested to update the information on the dashboard developed for the purpose. In case of any issues please reach us at projectelephant.moef@gmail.com or elephantcell@wii.gov.in

06. List of State Forest Department and Indian Railways officials consulted during the survey

Forest Department of Karnataka:

1. Mr Nilesh Shinde, *Deputy Conservator of Forest and Director Kali Tiger Reserve, Dandeli*
2. Mahantesh Patel, *RFO, Kulgi*
3. Y P TEJ, *RFO*, *Londa*
4. Mahesh Marenavar, *RFO, Bhimgad*
5. B.L.Dinesh, *DRFO, Sakleshpura*
6. Mr.Venugopal, *DyRFO, Sakleshpura*
7. Lokesh K.N., *DRFO*
8. Arun Hampiholi, *DRFO*
9. Manikanta Vaidya, *DRFO*
10. Somashekar Naik, *DRFO*
11. Akandappa Horkiri, *BFO*

Indian Railways:

12. Ajit Astekal, *SSE / PWAY / LONDA*
13. Mr Chandregowda, *PM / SSE*
14. Mayank Raj, *JE / WORKS / BGM*
15. Chetan M.P., *JE / WORKS / DWR*
16. Mahesh Vaddar, *JE / PWAY / DWR*

07. References

Project Elephant, MoEF&CC, Government of India (2023), Elephant Corridors of India 2023 (Edition – 1/2023).

WII, (2024). General Guidelines for Suggesting Mitigation Measures on Existing Railway Tracks Through Elephant Habitats in India.

APPENDIX 1

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

GENERAL GUIDELINES

FOR SUGGESTING MITIGATION MEASURES ON EXISTING RAILWAY TRACKS THROUGH ELEPHANT HABITATS IN INDIA

General Guidelines for Suggesting Mitigation Mesaurs on Railways Tracks through Elephant Habitats in India

Railway lines passing through elephant habitats can alter movement patterns and cause collisions of elephants with trains. Considering the threats to both elephant and human life, WII in consultation with Project Elephant Division of MoEFCC and State Forest Departments has identified 105 stretches of railway lines cutting through elephant reserves and elephant distribution beyond elephant reserves. Subsequently, the Ministry of Environment, Forests and Climate Change (MoEF&CC) and the Ministry of Railways (MoR) in a joint meeting directed that surveys by the railway officials, respective state forest department officers, and WII should be conducted within these stretches. The objectives of the joint field surveys would be to identify specific elephant crossing zones on these stretches and to suggest site-specific mitigation measures based on the location and the extent of these crossing zones.

In the case of existing railway lines, designing and locating structural mitigation measures for wildlife are confounded by several factors. Most critical among these is the limitation of the track height i.e., the height of the railway track with respect to surrounding terrain, making it difficult to allocate the minimum underpass height of 6 m required for animal underpasses in elephant landscapes. Additionally, excavating the ground under the track to achieve the prescribed height makes structures vulnerable to damage by rainwater, and also renders the structures unusable by wildlife. Thus, the choice of mitigation measures on existing railway lines has to be based on multiple factors that include wildlife, landscape as well as railway track design considerations. However, in the case of new railway lines, allocating adequate height to the railway tracks to incorporate wildlife mitigation measures along the line should be ensured.

In light of these factors, the following general pointers are prescribed to guide the Railway and Forest Officials in designing and choosing between different structural mitigation measures in the identified critical elephant zones intersected by railway lines. The choice of mitigation measures can be based on landscape, topography, railway track height, and other logistics.

1. Level crossings

The coarse ballast used on railway tracks is unsuitable for movement by wildlife, particularly elephants. For this reason, level crossings for elephants built using suitable material (soil, cement) and with smooth gradient can help ease movement across the railway track at grade. Level crossings are ideally located where the surrounding land is at level (flat) with the railway track and coincides with a known/identified elephant crossing area. Rubberized level crossings[1] (Fig. 1) may also be used in place of cement and soil.

[1] Functional Specification for Rubberised Surface at Level Crossings. 2019. Ministry of Railways, Govt of India. https://rdso.indianrailways.gov.in/

Figure 1. A level crossing with a rubberised surface that can be replicated on level crossings for wildlife.

2. *Ramps*

At most elephant crossing locations intersected by railway lines, the elevation in track height and the additional layer of ballast makes it difficult for a large-bodied hoofed animal like an elephant to make quick decisions and move away from a railway track in the event of an approaching train, leading to elephant-train collisions. At such locations, ramps using suitable material (soil, cement) may be constructed that flattens towards the top of the track, and allow for smooth and quick movement by elephants. It is important to include a level crossing instead of ballast at the top of the ramp (near the railway track) to ensure smooth movement by elephants. The sites for construction should be based on identified animal crossing zones and suitable terrain. Ramps should be levelled with the surrounding terrain by smoothening out the slope (Fig. 2). Additionally, in areas with human presence, the ramps may be fenced to funnel elephant movement across the railway track.

The orientation of the ramps with respect to the railway track may be oblique or perpendicular, depending on the land available for flattening the ramp to a navigable slope. The width of ramps and level crossings for elephants should be at least 50 m wide. Early warning systems or wildlife sensors may be provided at these places as additional measures to detect elephant movement and to avoid collision with trains.

Figure 2. An example of a ramp built for aiding elephant movement across a railway line near Coimbatore, Tamil Nadu, India (Top) and an elephant group using a ramp constructed for ease of movement in Deepor Bheel Assam, India (Bottom).

3. *Wildlife underpasses*

The term wildlife underpass can be used to describe different types of structures built below the railway track to facilitate wildlife movement. These can be box culverts, viaducts, or bridges with natural drainage of different heights and widths, depending on the target wild species or community. In elephant landscapes, the minimum height of an underpass should be 6 m, with adequate width (minimum 30 m) to allow for the movement of large elephant herds (Fig. 3). However, the actual size would depend on the width of the crossing zone and feasibility of construction of underpass considering track height and curvature. Nonetheless, all efforts should be made to maintain a minimum width of 30 m. At locations where the track height is suitable, the topography of the adjacent land should be such to avoid flooding of the underpass by rainwater. Additionally, light and sound barriers should be installed above the railway track to reduce the disturbance due to train traffic on animals using underpasses.

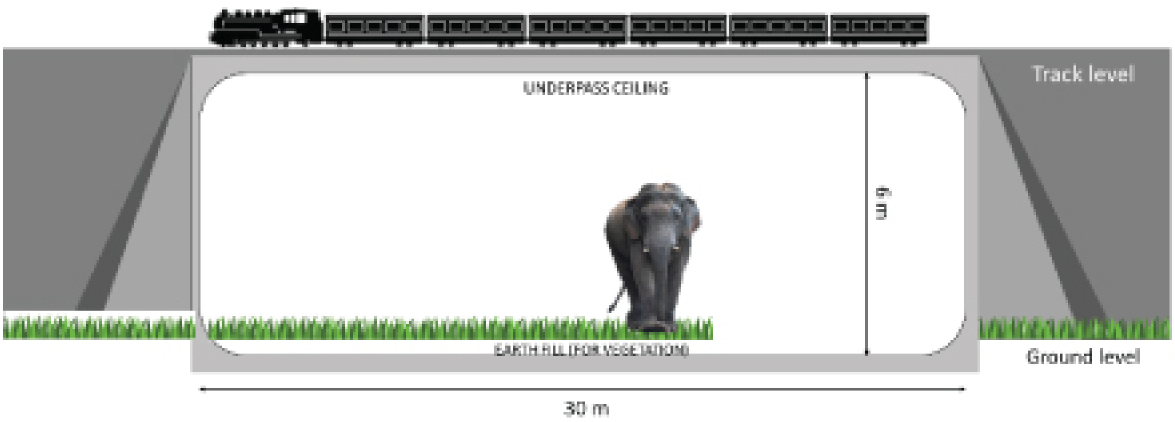


Figure 3. Graphic representation of an underpass for elephants below a railway track.

4. *Wildlife overpasses*

Wildlife overpasses are bridge-like structures built at a height across linear infrastructure (roads and railway lines) to allow wildlife to move across the gap in the habitat. Such structures are usually enhanced with natural habitat features such as native vegetation, rocks and logs. Wildlife overpasses are less confining, quieter and have ambient natural conditions of light and weather as compared to wildlife underpasses. Since wildlife overpasses are built at a height, construction of overpasses requires adequate height on either side of the road/railway line. Thus, overpasses should be built at locations with suitable height (> 7m) and topography on either side. A wildlife overpass should not be less than 30 m wide, and may be wider in case of double or triple parallel railway lines.

Overpasses should ideally be built using pre-fabricated material and installed on-site. The overburden from the construction site or excavated from other sites may be used for filling. Further a suitably thick layer of soil should be laid on top of the pre-fabricated material. Revegetation should then be carried out using native grasses and shrubs on the substrate to provide a natural movement path. Either side of the top of the overpasses should be fenced with light and sound barriers (Fig. 4). The slope/approach of the overpass should be not more than 30 degrees at any point. If the overpass is to be constructed across two or more railway tracks, a supporting pillar/post may be provided for structural support (Fig. 5).

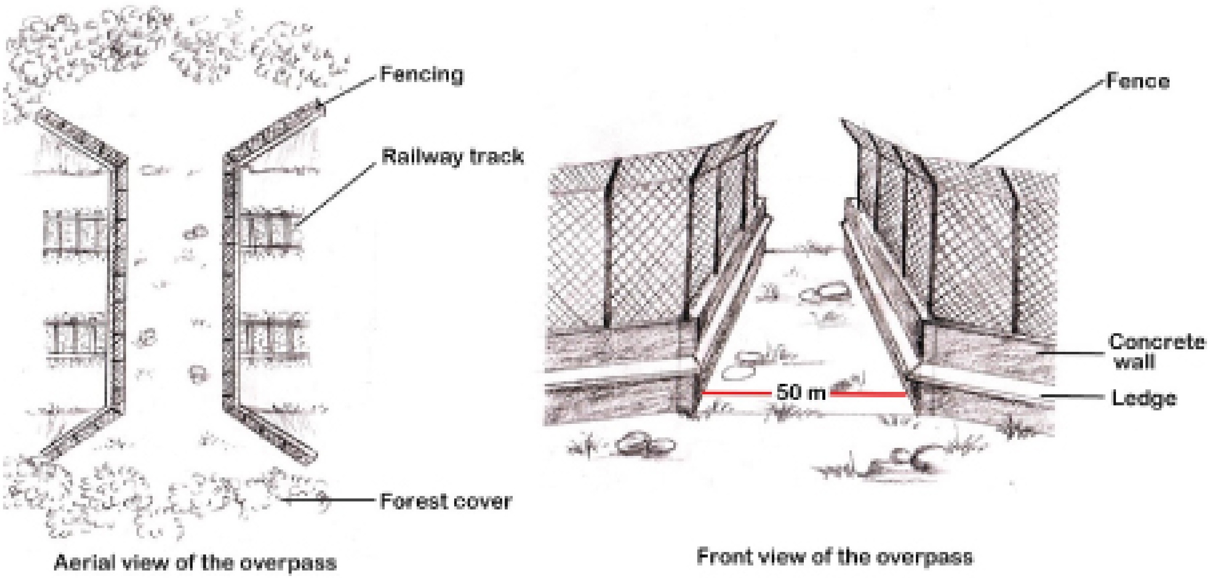


Figure 4. Aerial and front view of overpasses on railway tracks, with fencing/noise and sound barrier details.

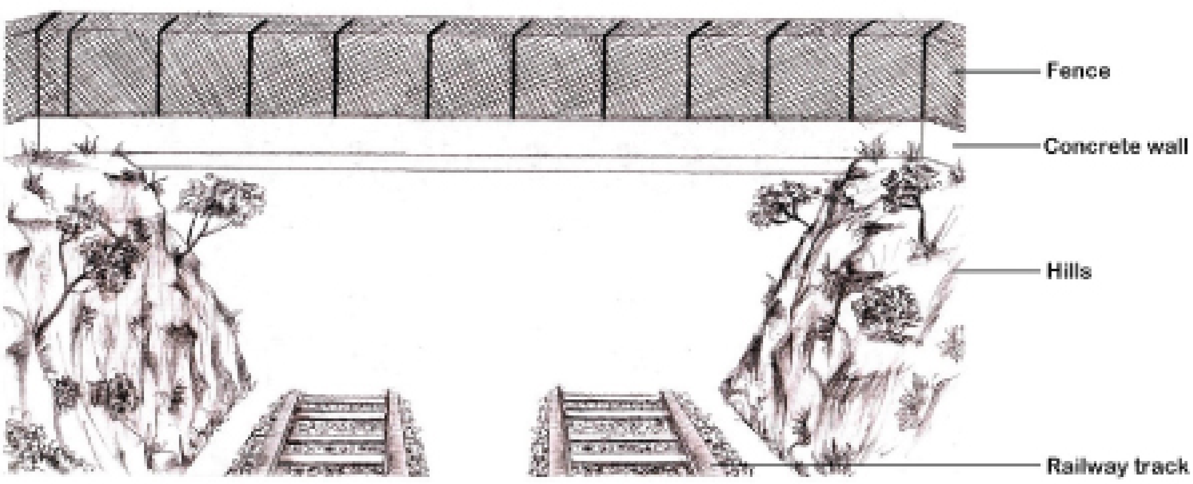


Figure 5. Lateral view of a wildlife overpass on a double-track railway line.

5. Installation of Distributed Acoustic Sensing (DAS) System

Irrespective of the type of mitigation measures to be employed across the sensitive railway stretches, all the sensitive stretches have to be installed with DAS. The system developed by railways to detect the presence and movement of the elephants along the railway tracks is basically an intrusion-based detection system based on Distributed Acoustic Sensing (DAS). A DAS monitoring interrogator converts a standard communications single-mode fiber into thousands of extremely sensitive acoustic and vibration sensors. The Distributed Acoustic Sensor connected to one end of the fiber uses a laser to send thousands of short pulses of light along the fiber every second. A small portion of the light traveling in fiber is reflected by the process known as Rayleigh Backscatter. The concept of securing a network from malicious entities by capturing and monitoring data packets was first employed by James Anderson in 1980. Since then, researchers have developed various approaches to enhance the performance and accuracy of intrusion detection.

Vibrations from the surrounding environment will disturb the light in the fiber and will therefore be observed by the DAS interrogator. The events that are of concern are reported to the alarm server. As the data is processed in real-time, advanced algorithms can recognize the unique signatures of each type of event.

The system can show the precise location of the event, and information about what event has taken place, which means the laser pulse frequency, pulse width, and many other parameters. These parameters can be controlled, enabling the system to be tuned to the desired requirement. Integrated with machine learning and artificial intelligence, the system can differentiate even between minor variations in the scatter. The optic fiber cable running along infrastructure and other important assets can give uninterrupted and real-time feedback on activities occurring along and around them.

The recommendations of the MoEFCC committee constituted vide office order No. WL-8/28/2022-WL on 3rd January 2023 needs to be considered for the implementation of the DAS.

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