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भारत सरकार
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भारतीय भूवैज्ञानिक सर्वेक्षण
Geological Survey of India

REPORT ON
SHIRUR LANDSLIDE, ANKOLA TALUK, UTTARA KANNADA DISTRICT,
KARNATAKA
&
LANDSLIDE SUSCEPTIBILITY ALONG NH-66 (KARWAR TO NORTH OF BAINDUR)

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कार्य सत्र 2024-25
Field Season 2024-25

डॉ आर सजीव, निदेशक
राहुल वडाक्केडथ, वरिष्ठ भूवैज्ञानिक
अचन कोन्याक, वरिष्ठ भूवैज्ञानिक

Dr. R Sajeew, Director
Rahul Vadakkedath, Senior Geologist
Achan Konyak, Senior Geologist

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MISSION-IV

Engg. Geology & Landslide Division

State Unit: Karnataka & Goa

Southern Region

जुलाई, 2024
July 2024

**REPORT ON
SHIRUR LANDSLIDE, ANKOLA TALUK, UTTARA KANNADA DISTRICT,
KARNATAKA &
LANDSLIDE SUSCEPTIBILITY ALONG NH-66 (KARWAR TO NORTH OF BAINDUR)**

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1. SHIRUR LANDSLIDE, ANKOLA TALUK, UTTARA KANNADA DISTRICT, KARNATAKA

1.1 Introduction

This report presents the findings from a slope stability investigation conducted at Shirur landslide, by the Geological Survey of India (GSI). A team led by Dr. R Sajeev, Director, Shri. Rahul Vadakkedath and Shri. Achan Konyak Senior Geologists carried out the investigation. On July 16, 2024, at 8:30 AM, a large debris flow occurred on the left-hand side of Chainage number 148.000 (14.603554°N / 74.371219°E) of NH-66, in Shirur village, Ankola Taluk, Uttara Kannada District, Karnataka. This event caused severe disruptions, including the loss of 10 lives, and substantial damage to infrastructure and property (Fig. 1.1, Fig. 1.2). This report provides an overview of the landslide, its causes, and recommended remedial measures.

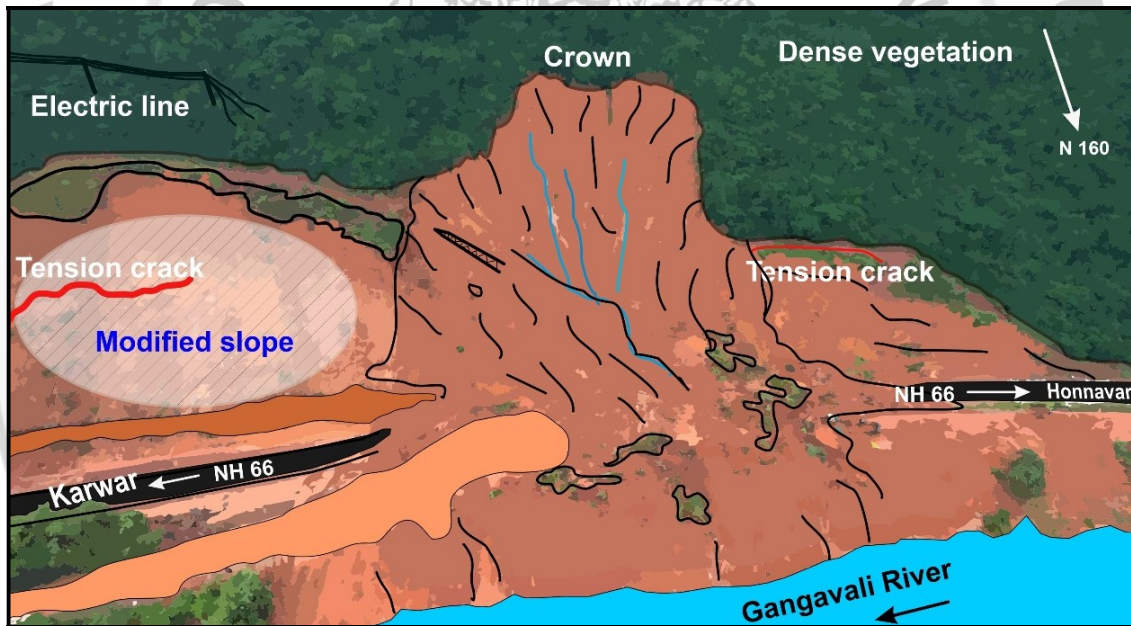


Fig. 1.1: Schematic sketch of Shirur landslide (Not to scale)

The preliminary assessment of the Shirur landslide was conducted by GSI on the 17th and 18th of July 2024. The primary objectives were to understand the geogenic causes of the landslide, assess the potential for reactivation, and develop temporary remedial measures to restore communication that the district administration can implement. The initial findings were submitted to the district administration on the 19th of July. A subsequent site visit was conducted from the 24th to the 26th of July, 2024, to observe the activity and distribution of the landslide, and to assess the condition of the adjoining slopes, including the crown and flanks for signs of potential enlargement.



Fig. 1.2: Aerial view of Shirur landslide blocking the communication corridor NH-66 (courtesy IRB)

1.2 Casualties and Damage

The landslide resulted in ten fatalities and washed away two gas tankers and one truck. Additionally, a semi-permanent hotel structure was destroyed. The debris from the landslide travelled over 200 meters, eventually depositing into the Ganagavali River, creating an impact wave that demolished four houses on the opposite bank. The scar left by the landslide measured approximately 150 meters in length, 120 meters in width, and 60 meters in height, with the total volume of debris exceeding 100,000 cubic meters (Fig. 1.2).

1.3 Lithology

The site is mainly comprised of Pyroxenite of the Motimakki Ultramafites (Fig. 1.3). The base of the landslide exposes medium to coarse-grained, dark green to black pyroxenite with high specific gravity, dominated by pyroxenes that exhibit a characteristic luster on the cleavage surfaces. Intermittent pegmatite intrusions, 5-10 meters wide, are present on both flanks of the slide. These pegmatites are highly weathered, forming whitish clay (Fig. 1.4). The depleted zone of the landslide has greenish-tinted, medium to coarse-grained boulders, rich in olivine, and showing serpentinization. Vanadiferous titanomagnetite bodies are observed at higher elevations above the landslide, composed mainly of magnetite with subordinate plagioclase, exhibiting banding and high specific gravity. The flanks and crown area also expose large laterite boulders.



Fig. 1.3: Pyroxenite exposed at the base of cut slope section near Shirur landslide



Fig. 1.4: Weathered pegmatite forming whitish clay Kaolinite

1.4 Structure

The toe area of the right flank exposes hard, compact pyroxenite, with rock mass quality assessed as fair according to RMR_{basic} (Bieniawski, 1989). The area features at least four prominent joint sets, i.e. two sub-vertical (NW-SE, NE-SW) and two moderately dipping (NE-SW, NW-SE) along with numerous fractures allowing free water flow. Open folding is observed, with the left limb oriented $155^{\circ}/30^{\circ}$ (Strike/Dip) and the right limb $335^{\circ}/10^{\circ}$ and affected by radial fractures along the hinges. Localized faults trending NW-SE are present on both the left and right flanks of the landslide (Fig. 1.5).



Fig. 1.5: Minor Fault observed at the base of the cut slope on the right flank of the slide

1.5 Susceptibility Status as per NLSM

The slope sector from Chainage 147.400 to 148.200 shows moderate to high susceptibility according to the National Landslide Susceptibility Map (NLSM) of GSI (Fig. 1.6). Multi-temporal satellite imagery indicates anthropogenic interference on the slopes from

Chainage 147.400 to 148.200 since 2017, exacerbating some landslide scars above the cut slopes (Fig.1.7).

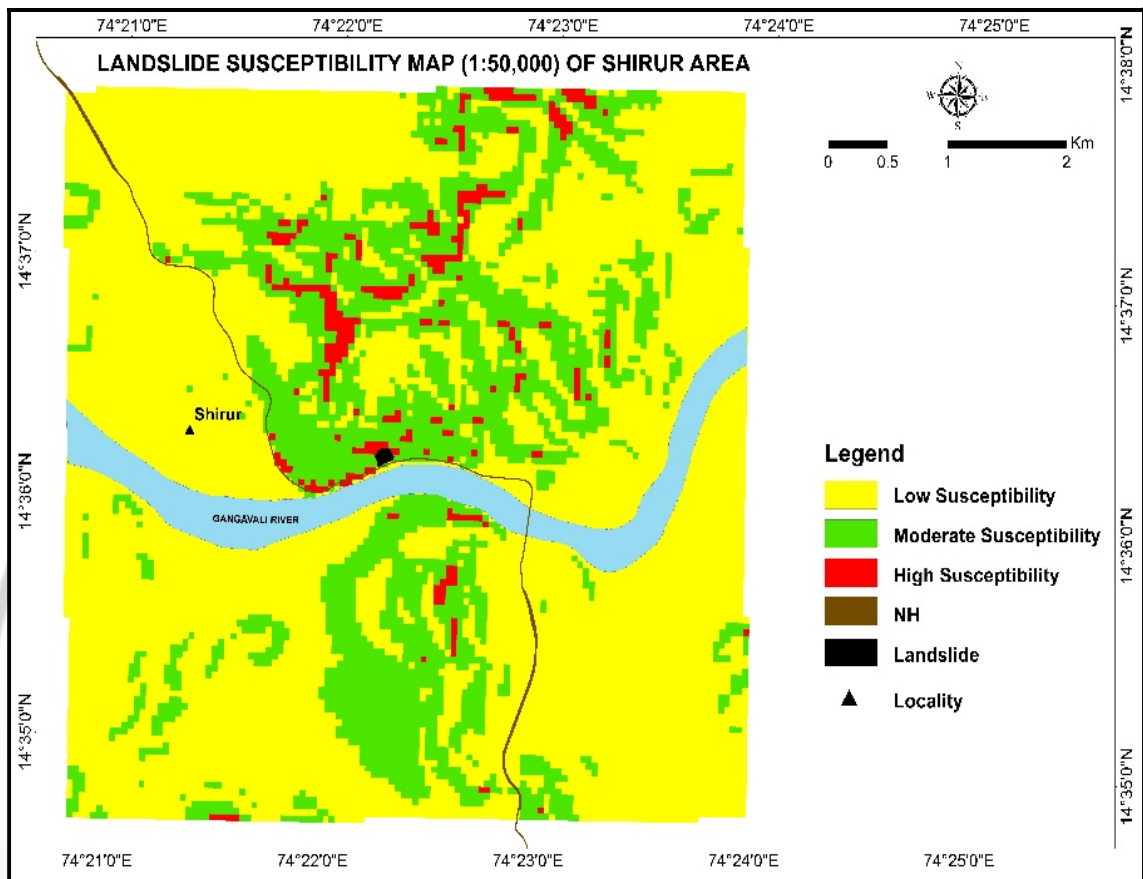


Fig. 1.6: Landslide Susceptibility Map of Shirur area, (NLSM GSI)

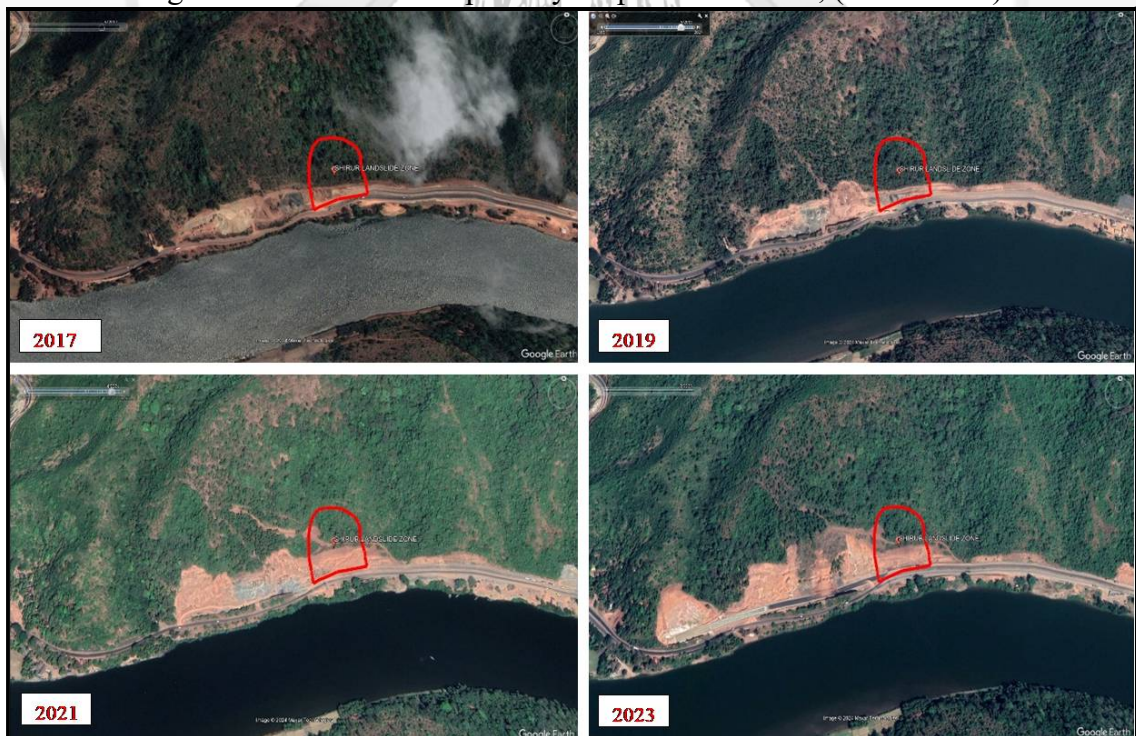


Fig. 1.7: Multi-temporal satellite imageries of Shirur

1.6 Observations

- a. **Chainage 148.000:** Prior signs of slope instability include at least two minor slumps observed in Google Street View (Fig. 1.8 & 1.9).

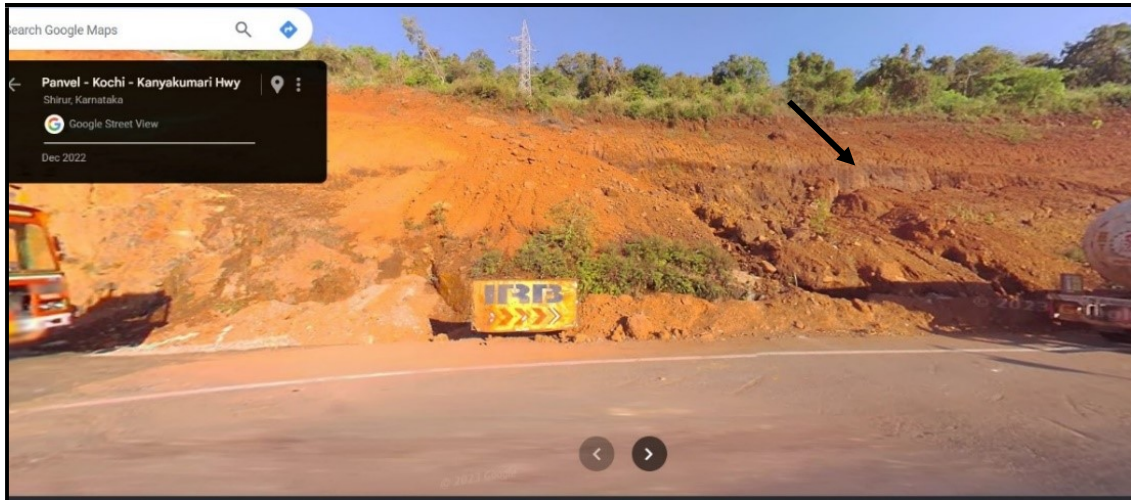


Fig. 1.8: Slump as seen through Google Street View of the Shirur landslide site

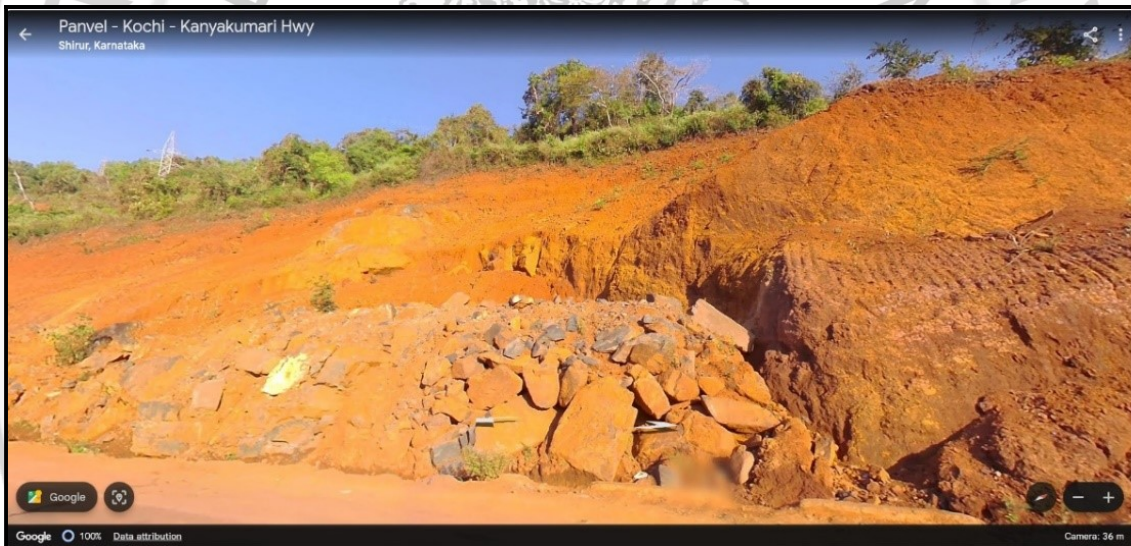


Fig. 1.9: Slump as seen through Google Street View of the Shirur landslide site

- b. **Right Flank:** Fresh pyroxenite at the base tapers towards the toe of the rupture, providing minimal natural buttress due to rock unit warping and thick soil development. Extensive rill erosion was observed pre-landslide.
- c. **Slope Material:** The site investigation of the slopes shows that the slope-forming material has a striking variation both along the depth and the lateral extension of the cut slope section. The upper part is hard ferruginous laterite while the lower sections expose mottled clay-rich horizons where hydrostatic pressure has built up. The hard rock is inconsistently present only at the toe area.
- d. **Tension Cracks:** The left flank has two transverse cracks at different elevations – a crack at a higher elevation (Fig. 1.10) trending N120° (20m long, 1.5m deep) and also

at a lower elevation (Fig. 1.11) trending N80° (30m long, 2 ft deep), with no visible expansion by 25th July 2024. The Crack in the right flank (Fig. 1.12) trends N15° (15m long, 2m behind the scarp). Here, in the right flank there is relatively thicker soil with 6-7 m while the left flank exposes at least 3-4m of soil. No visible cracks were noticed on the crown area. The main scarp exposes soil of about 3-4 m (Fig. 1.13).



Fig. 1.10: Tension cracks behind the side scar of the slide trending N120°



Fig. 1.11: Tension cracks at lower elevation of the left flank of the slide



Fig. 1.12: Transverse cracks at the right flank of the landslide trending N15°



Fig. 1.13: Thickness of overburden at the main scarp

- e. **Rupture Surface:** The rupture surface also exposes moderately weathered rock which is highly jointed and favours displacement of slope material along the overburden-rock interface. The right flank exposes a vulnerable joint plane of 70:75 (Dip: Direction).
- f. **Water seepages:** The water seepages are pronounced along the soil-rock interface on the main scarp area of the landslide and also observed along the interface of ferruginous and clay-rich laterite horizons
- g. **Slope Morphometry:** A non-perennial stream is observed on the upslope above the crown. The immediate upslope has a concave morphometry which facilitates water infiltration thereby increasing the probability of slope failure.

1.7 Factors Contributing to the Landslide

It is imperative to understand the multifaceted factors contributing to the Shirur landslide. Key elements include anthropogenic activities, geological characteristics, and meteorological conditions, all of which played critical roles in the event.

1.7.1 Anthropogenic Activities

Multi-temporal satellite imagery has shown significant anthropogenic interference with the slopes since 2017. Continuous slope modifications and the presence of landslide scars above the cut slopes have exacerbated the slope's vulnerability. The lack of proper retaining structures further destabilized the area, increasing the risk of slope failure.

1.7.2 Meteorological Conditions

Intense and prolonged rainfall acted as the immediate trigger for the landslide. Specifically, a three-day antecedent rainfall totalling 503 mm led to the saturation of debris material, increasing pore water pressure and reducing shear strength (Fig.1.14). This intense rainfall significantly weakened the slope's stability, and acted as a trigger.

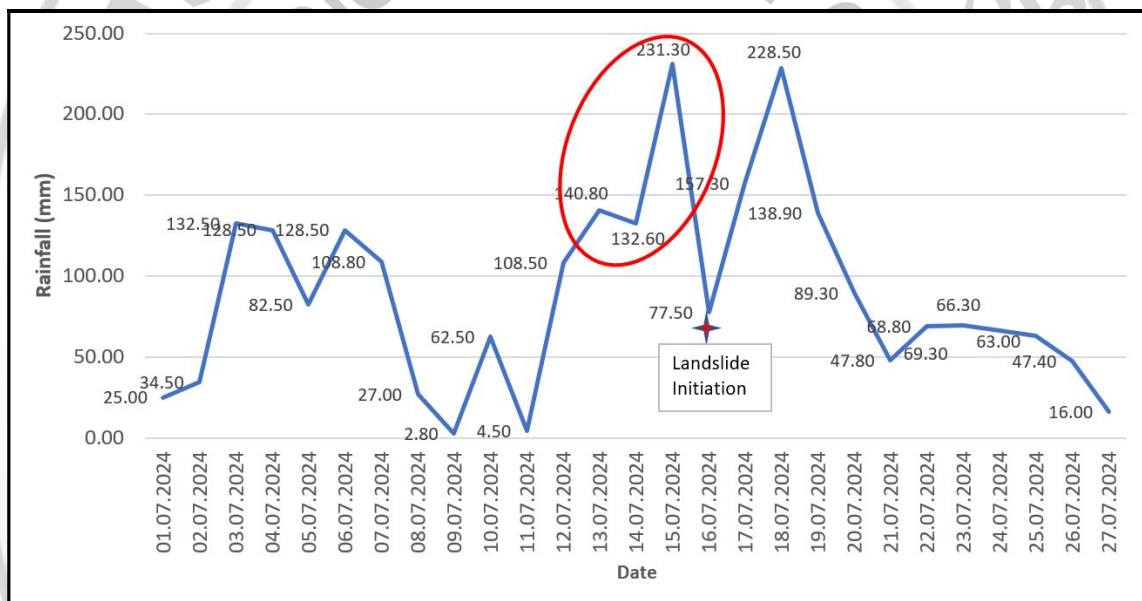


Fig. 1.14: Rainfall distribution near Shirur during July 2024 (source:IRB)

1.7.3 Geological Characteristics

The site features a complex lithology with a combination of hard ferruginous laterite and clay-rich horizons, creating variations in slope material along both depth and lateral extensions. The steep gradient of the cut slope combined with thick, highly porous slope material was a major contributing factor. The fresh pyroxenite rock exposed at the base of the right flank of the Shirur landslide is observed to taper towards the toe of rupture of the slide thereby providing minimal natural toe buttress. This tapering of the rock is attributed partly due to the warping of the rock unit over which thick soil has developed. There is also a considerable subsurface water flow which could have played a major role in saturating the soil column.

1.7.4 Slope Morphometry

The concave slope morphometry at the crown area and thick overburden material at the site facilitated the convergence of surface and subsurface water flow. This morphometric characteristic increased the probability of slope failure, suggesting a potential for further widening or retrogression during prolonged rainfall events.

1.8 Recommendations for the Shirur Landslide and Adjoining Slopes

1. **Road alignment, Slope Gradient and Benching:** At the Shirur area, since the road is under construction, an alignment shift towards RHS from chainage 147.300 to 147.800 is proposed if the land is available. This would reduce the height of the slope cut of the currently undisturbed or unmodified slope from 147.300 to 147.500 to a minimum and shift the carriageway from the toe of the disturbed horizon from 147.500 to 148.100. For any slope modification at the site, a detailed investigation is necessary. Ensure compliance with BIS codes for slope modification with appropriate benching, based on geotechnical properties of the soil. Bench width should be adequate to enable slope segments to act independently (IS code 14680:1999).
2. **Drainage:** Trenches (Fig. 1.15) above Ch. 147.500 should be lined. It is observed that the surface water is draining freely (Fig. 1.16) along the boundary wall towards the slope which should be diverted or provided with stepped chute drains on the slope face.
3. **Erosion Control:** Install adequate surface drainage channels along with slope reinforcement and erosion control measures.
4. **Culvert Installation:** The convergence of natural drainage is anticipated at the landslide face with time. A culvert with sufficient diameter pre-cast pipes should be provided to accommodate water and debris discharge at the toe of the landslide at Ch. No. 148. 000. Else the water may be diverted by lined toe drainage.
5. **Monitoring and Surveying:** It is recommended to monitor and survey for signs of instabilities even above the Right of Way especially for slope sections with higher relative relief on the right and left flanks of Shirur landslide. Shirur landslide is a classic case where the rupture surface extended beyond the ROW due to higher relief above the cut slope. Deploy flaggers for traffic control and restrict access to high-risk areas.



Fig. 1.15: Trenches observed above the Ch. no. 147.500



Fig. 1.16: Unguided surface water flowing along the slope above the Ch. no. 147.500

6. **Subsurface Water Drainage:** Include perforated horizontal pipes of appropriate diameter and sufficient length in engineered slopes to manage subsurface water flow.
7. **Geotechnical Investigation:** Conduct comprehensive investigations to determine suitable stabilization strategies for the Shirur landslide, considering potential landslide enlargement due to the considerable thickness of soil in the crown and hydrological conditions.

1.9 Conclusion

The Shirur landslide was the result of a combination of anthropogenic activities, geological characteristics, and meteorological conditions. Understanding these factors is crucial for implementing effective monitoring, stabilization, and remedial measures to mitigate future risks and ensure slope stability. Anthropogenic activities, including slope modifications and the absence of proper retaining structures, have significantly destabilized the area while the key geological factors include the variability in soil strata, sub-surface hydrological conditions, and a weathered, deformed rock mass. Meteorological factors, particularly intense and prolonged rainfall, contributed to the saturation and weakening of the soil. The concave slope morphometry, with higher relative relief, facilitated the convergence of surface and subsurface water flow, increasing the probability of slope failure. Despite the challenges in predicting the magnitude and timing of such deep-seated landslides, it is crucial to implement comprehensive monitoring and stabilization measures.

Recommendations include strict adherence to slope gradient and benching guidelines, improved drainage systems, regular monitoring for signs of instability, and comprehensive geotechnical investigations. Public safety measures should continue, with restricted access to high-risk areas and the deployment of traffic control measures. Long-term monitoring using advanced technologies and periodic inspections of remedial measures are essential to mitigate future risks and ensure the stability of the affected slopes.

2. LANDSLIDE SUSCEPTIBILITY ALONG NH-66 (KARWAR TO NORTH OF BAINDUR)

2.1 Introduction

A slope stability investigation was conducted from July 27 to July 29, 2024 along NH-66 covering chainages 109.9 to 245.6 from Karwar to the north of Baindur, focusing on the Shirur sector and other landslide-vulnerable sections of NH-66. The primary objectives were to identify landslide-prone areas, evaluate the contributing factors, and develop strategic mitigation measures to enhance the stability and safety of the highway corridor. The team was accompanied by National Highway Authority of India (NHAI) officials and engineers from IRB Infrastructure Developers Ltd.

The highway passes through the western margin of Western Ghat mountain ranges and has a few sections where the hill slopes had to be cut to make way for the road corridor. The major geological unit exposed in the corridor is the Peninsular Gneissic Complex (PGC), a suite of rocks with mainly granitic composition. The corridor also cut through various mafic and ultramafic rock units at different locations (Fig. 2.10).

The landslide susceptibility map, produced after the National Landslide Susceptibility Mapping (NLSM) of GSI in 1:50,000 scale, is available for the road corridor up to 220.000 chainages (Fig. 2.11). Most of the landslide incidences in the corridor have occurred in moderate to high landslide susceptibility areas. The road corridor was divided into four sectors, each with unique slope instability scenarios and contributing factors.

2.2 Sector-1 (Chainage 109.500 to 129.000)

2.2.1 Geological Characteristics:

The corridor passes through Granitoids and Granite Gneisses of the PGC and some basic intrusive rocks. The typical road section in this corridor consists of hard granitic rocks at the bottom, overlain by weathered lithomarge and soil cover of varying thickness.

2.2.2 Slope Instability Factors

- The debris thickness is high and is cut at a steeper angle where minor failures are observed along the exposed debris face (Fig. 2.1).
- Drainage from the upslope saturates the debris thereby reducing its strength and resulting in a rotational failure (Fig. 2.2)
- The groundwater is seeping between the rock-debris interface and debris is sliding down the interface due to a reduction in friction between the layers.



Fig. 2.1: Typical cut section in the sector showing rock-debris interface



Fig. 2.2: Deep rotational failure with possible piping at chainage 160.080

2.2.3 Recommendations

- Reducing the debris thickness exposed by maintaining a shallower cut slope angle along with benching and proper drainage.

- Arrest surface water erosion by channelling the streams to proper drainage systems. Geo jutes installation with suitable grass (Vetiver) varieties can also be implemented.
- Reducing debris saturation by providing effective horizontal drainage systems. The existing horizontal drainage systems installed in the corridor are observed to be ineffective in discharging water.

It is to be noted that the soil thickness and composition vary considerably across the slope and to suggest a uniform solution for the entire corridor is not possible. The vulnerable sectors should be identified and site-specific engineering solutions should be provided depending on the site conditions.

At chainages 111.300 to 111.400 where the relative relief is very high and the road cut is steep, the rocks are highly jointed with some having near vertical dips. The rocks also exhibit exfoliation joints which are formed due to repeated heating and thawing of the rocks. The intersection of these two planes produces blocks, which fall along the slope (Fig. 2.3). The stretch requires a detailed study to figure out engineering solutions such as rock bolting intervals, shotcreting, etc. However, if the land is available, a slight deviation (20m) in the road alignment towards the south western side away from the vertical slope cut can be considered after detailed studies to minimize the risk factor associated with rock falls (Fig. 2.4).



Fig. 2.3: Rockfall incidence at chainage 111.400



Fig. 2.4: Proposed alignment to mitigate the direct risk of rockfalls

2.3 Sector-2 (Chainage 141.600 to 153.600)

2.3.1 Geological Characteristics

This sector exposes Gneisses of PGC, Pyroxenites of Layered Ultramafic Complex and Hornblende Actinolite Chlorite schist of Dharwar Supergroups. The areas where the road corridor intersects rocks of the Layered Ultramafic Complex were observed to cause complex slope instability problems.

2.3.2 Slope Instability Factors

The ultramafic rocks are susceptible to a high degree of weathering. The thickness of debris and lithomarge would be higher as compared to areas occupied by granitic rocks. There is also a considerable variability in the litho units exposed from bottom to top as is typical in such layered complexes. The weathered rock horizon and soil also show vertical variability where the top of the hill is characterized by ferruginous laterite and the middle part shows lateritic clay-rich horizons. The clay layers have lesser permeability, leading to water accumulation in the column. Slope cuts in this region should be kept to a minimal height as possible so that the exposed cut slopes can be stabilized by providing good drainage and retaining structures. Benching of slopes alone is not an effective slope stabilization method as observed in the Shirur site. Shotcreting in such thick debris cover also would be ineffective. The landslide management strategy in such cases should be to minimize the slope cut height

by shifting the alignment wherever land is available and providing efficient surface and subsurface drainage solutions.

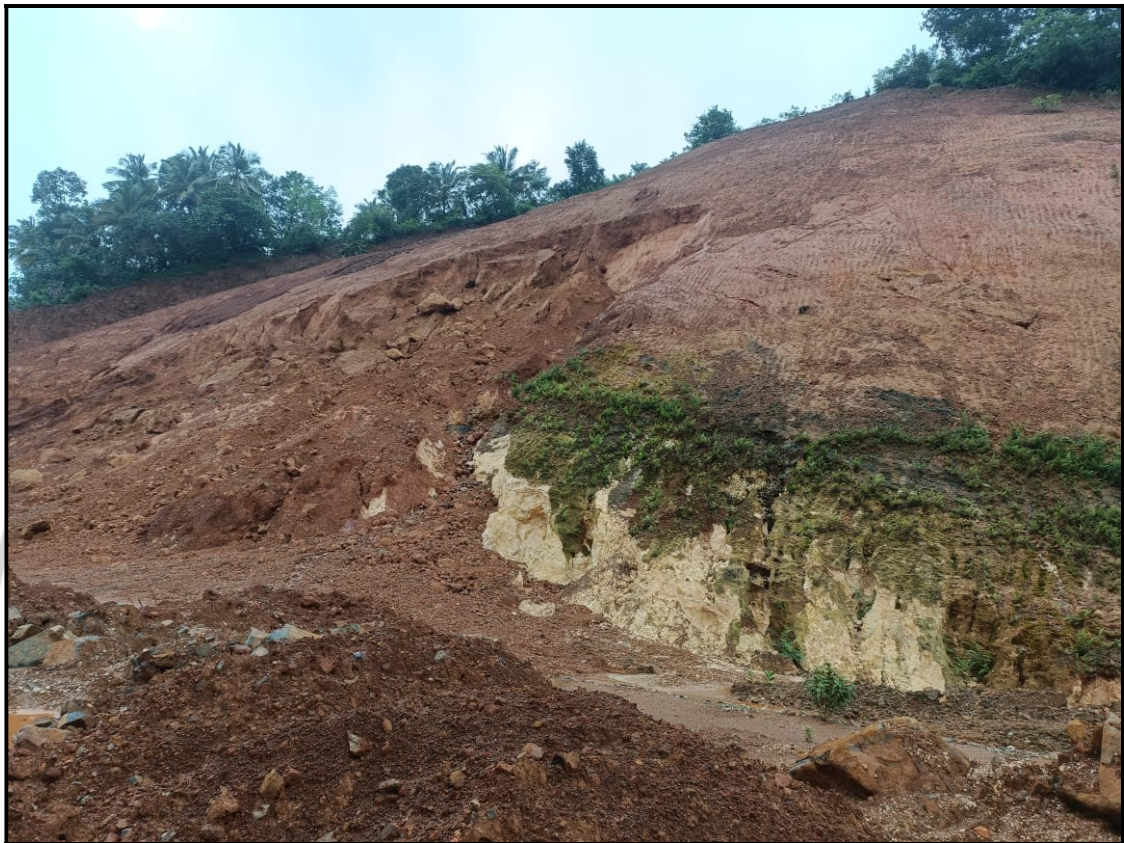


Fig. 2.5: Variability in lithounits near the right flank of the Shirur landslide

2.3.3 Recommendations

At the Shirur area, since the road is still under construction, an alignment shift from chainage 147.300 to 147.800 can be considered after detailed studies, and if the land is available (Fig.2.6). This would also reduce the height of the planned slope cut for the current undisturbed slope from 147.300 to 147.500 to a minimum and shift the carriageway from the toe of the disturbed horizon along 147.500 to 148.100 chainages.

Geomorphologically, the planned slope cut from chainages 147.300 to 147.500 will be cutting across a “spur” which could cause slope instability issues post-modification. If the alignment shift is not feasible, it is recommended to provide the newly cut slope with adequate drainage management and support measures immediately. However, it is advised to avoid or minimize slope cuts in the location as far as possible.



Fig. 2.6: Proposed alignment shift to prevent further slope failures at the Shirur site.

2.4 Sector-3 Chainage 163.000 to 170.000

2.4.1 Geological Characteristics

This sector exposes Gneisses of PGC, Gabbro of Layered Ultramafic Complex and Hornblende Actinolite Chlorite schist of Dharwar Supergroups.

2.4.2 Slope Instability Factors

There are three major vulnerable zones in this sector at **166.250, 168.200 and 168.700** chainages respectively.

The landslide at 166.250 is a 90m in length and 120m in width debris slump that has occurred in the cut slope made for the road (Fig.2.7). The cut slope exposes a thick lithomarge and laterite cover developed over Gabbroic rocks. The laterite layer is not strong enough to withstand the existing overburden slope profile which resulted in a slump. A drone survey was conducted at the site by IRB which revealed a large crack at the top of the cut slope. Widening of the slide parallel to the slope is possible due to the similar lithology and slope cut on the southern side. A detailed study in the zone is recommended to analyse possible slope stabilization measures or road alignment changes.

Another potentially vulnerable zone was observed at 168.200 where the slope has been cut almost vertically for a length of approximately 60m (Fig. 2.8). During the field visit, minor tension cracks were observed on the slope. The road passes right beneath the slope and

there are settlements opposite to the slope cut. It is recommended to monitor the slope for any crack development and take immediate action if any movement is noticed. It is also recommended to sensitize the local population regarding the potential hazard and the families living just opposite the slope may be shifted in case of any crack development. Detailed studies for proper slope grading, drainage provisions and to arrest gully erosion are recommended.



Fig. 2.7: Drone footage showing the recent landslide scar at 166.250



Fig. 2.8: Slope cut at chainage 168.200 exposing lithomarge and debris

Another similar slope cut was observed at chainage 168.700 where a 50 m horizon of lithomarge and debris is exposed in the slope cut (Fig. 2.9). There are approximately 12 buildings opposite to the slope cut. It is recommended to conduct a detailed site-specific study to provide mitigation measures for the slope.



Fig. 2.9: Slope cut at chainage 168.700 showing the debris and minor scars

The zones at 168.200 and 168.700 have settlements in the down-slope area which significantly increases the risk involved in case of any slope failures. The residents may be made aware of early slope failure signatures and instructed to inform local authorities in case of any observed movement. They may also be instructed to shift to safer locations in case of any observed movement in the slope.

2.5 Sector 4 (Chainages 198.100 to 205.400)

This sector is characterized by flat-topped laterite-covered hills and the slope instabilities are smaller in dimensions mainly involving the soil layer. The hill slopes from this sector to chainage 245.600 have minor instabilities that do not pose a major risk to the traffic and local population.

The landslide incidences recorded all along the NH-66 route in Uttara Kannada have been elaborated in Annexure-1.

2.6 General Recommendations

- Proper drainage management is of paramount importance in any such project. Water flow from the slopes should be diverted using lined drainage and culverts. Subsurface water management is also a crucial part of slope stability.
- The horizontal drainages at most of the slopes are observed to be clogged. Alternative designs for the drainage pipes have to be adopted for efficient drainage of subsurface water.
- It should be noted that planning in the DPR stage and construction stage would significantly reduce the cost and risk during the operational phase. Sufficient time and budgetary allocation should be made for the DPR stage of any project.
- Landslide susceptibility map is a free database from GSI that can be consulted during the planning of any large-scale project in mountainous terrains to avoid potentially vulnerable zones and minimize the associated risks.
- The best mitigation strategy for landslides is to avoid it. Extensive slope cuts should be minimized as far as possible by shifting the alignment during the planning stage.

2.7 Acknowledgment

The GSI team extends its gratitude to the District Administration of Karwar for their essential logistical support during the two spells of landslide studies. We also acknowledge the valuable coordination provided by the NHAI and IRB officials during our visits to the Shirur landslide site and other critical sectors of NH-66. Our thanks go to the state government's Forest officials for accommodating us at the Guest House during the field visits. Finally, we gratefully acknowledge the support of Dr. S. Ravi, DDG, SU: KG, Shri. K V Maruthi, DDG & RMH-IV, GSI, SR, and Shri. S.D. Patbhaje, ADG & HoD, SR, whose contributions were indispensable to our efforts.

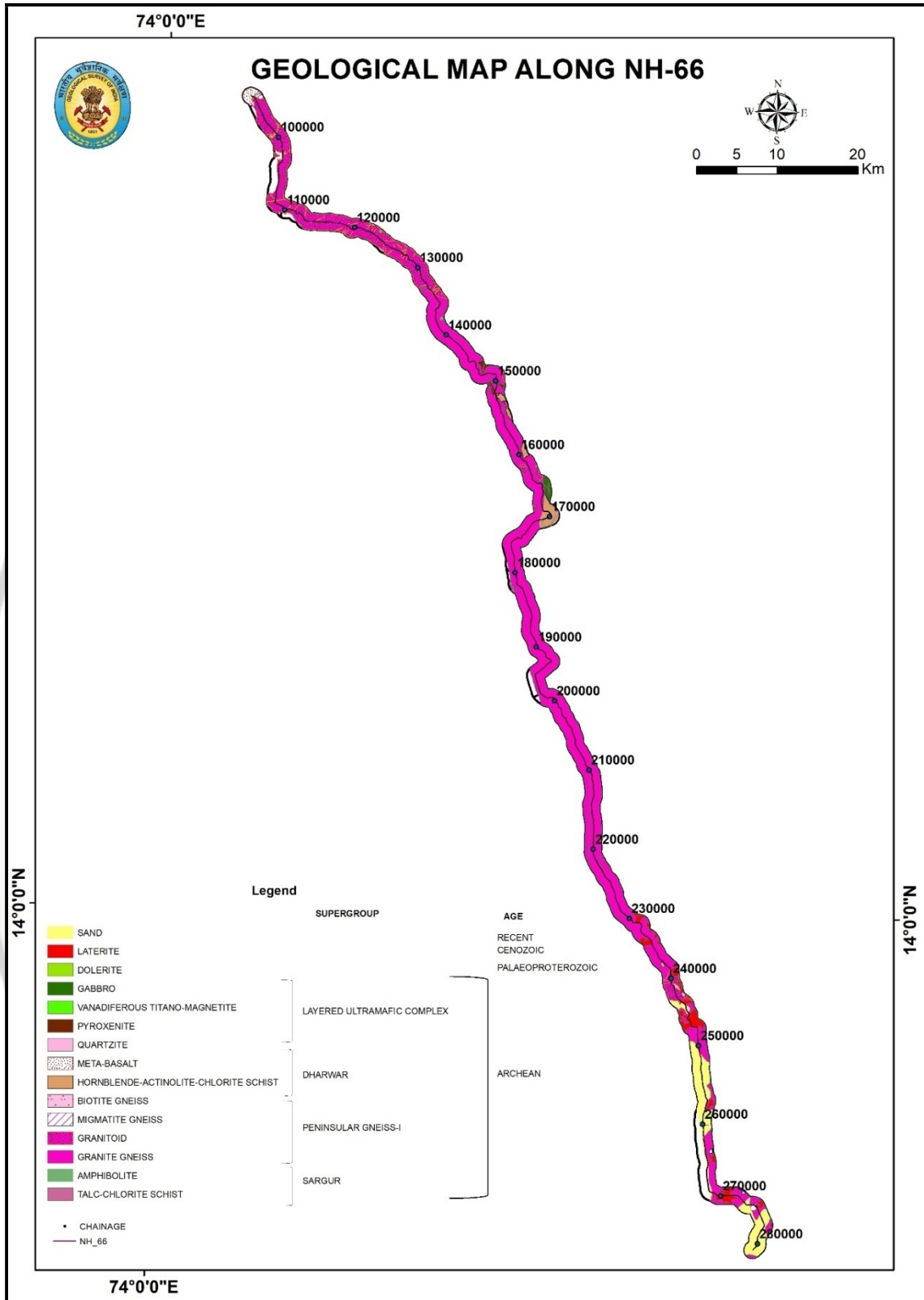


Fig. 2.10: Geological map of the road corridor

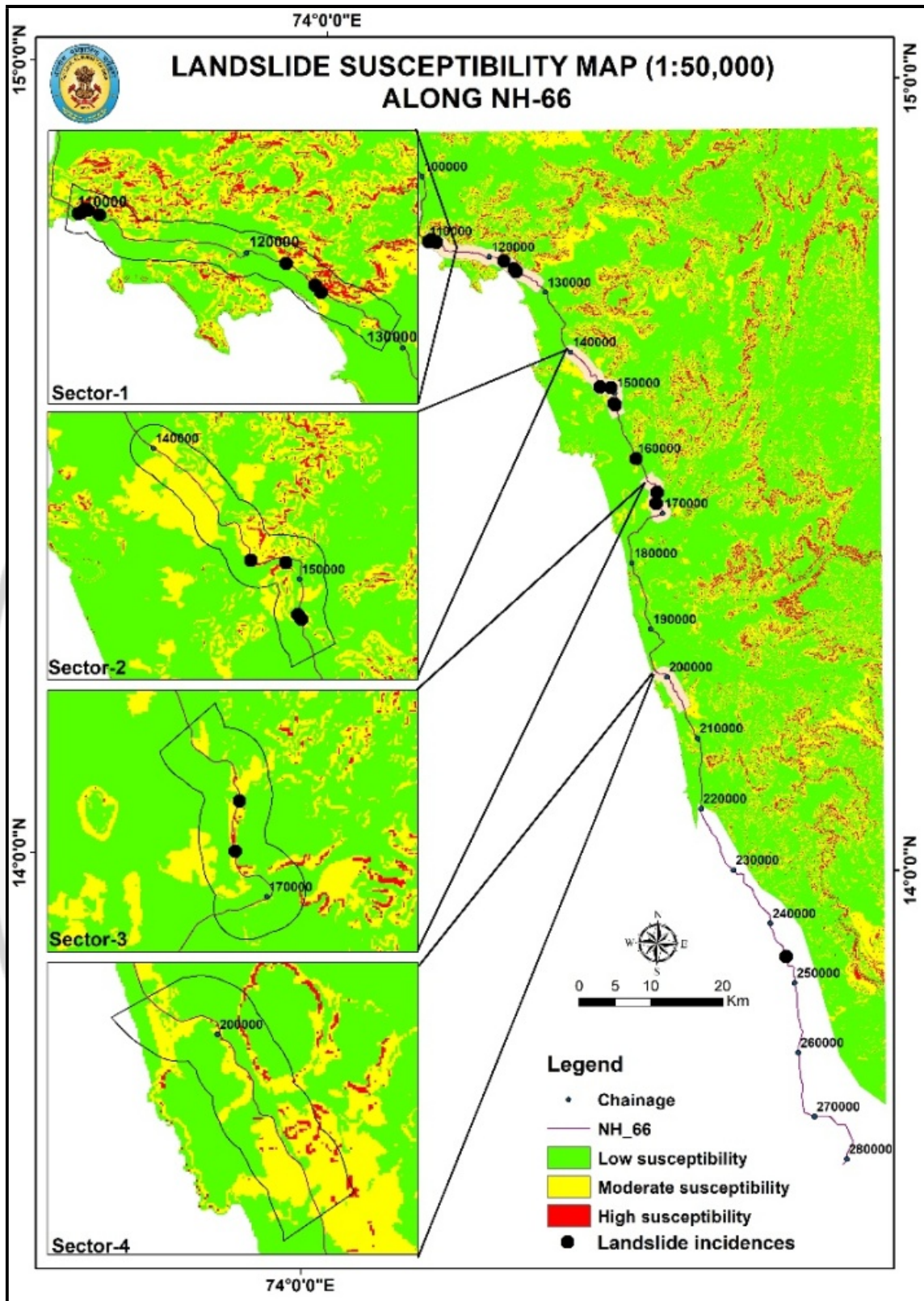



Fig. 2.11: Landslide susceptibility map of the road corridor


GEO PARAMETRIC DATA FOR LANDSLIDES

Annexure-1


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/01
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage – 110.200)
7	Latitude	14.781677° N
8	Longitude	74.136913° E
9	Length	~ 40m
10	Width	~ 60m
11	Height	~ 35m
12	Area	~ 2400m ²
13	Depth	~2-5m
14	Volume	--
15	Run out distance	NA
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Suspended
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	Old landslide
24	Geomorphology	Low dissected hills
25	Geology	Granitoids of Peninsular Gneissic Complex
26	Structure	Foliation - 55°→30° ; J1- 78° →135 ; J2- 80° →85° ; J3- 6° →25°
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Slope cut has been done in a high-relief area exposing the rock-debris interface. The landslide has occurred in the debris due to saturation of the material.
37	Remedial measures	Monitor the slide area regularly for any movement. Any further slope modification might contribute to further instability
38	Remarks, if any	The debris has been depleted from the slide area. Debris exposed on the crown and the flanks of the slide may lead to minor slides during intense rainfall events.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/02
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 110.340)
7	Latitude	14.782055° N
8	Longitude	74.138237° E
9	Length	~ 6m
10	Width	~ 10m
11	Height	~ 5m
12	Area	~60m ²
13	Depth	~ 1-2m
14	Volume	--
15	Run out distance	~ 25m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Extremely rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	Initiated in 07/2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-75:240, J2 – 18:10, J3 - 78:145
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	Nil
35	Agriculture/forest/Barr en	Forest

36	Geo-scientific Causes	The road cut is along a 25m thick rock layer overlain by lithomarge and soil. The steep cut in the soil layer has caused the slide.
37	Remedial measures	Easing of the soil layer and providing adequate drainage measures.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/03
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 110.430)
7	Latitude	14.782712° N
8	Longitude	74.138830° E
9	Length	~ 8m
10	Width	~ 12m
11	Height	~ 7m
12	Area	~ 96m ²
13	Depth	~ 2-4m
14	Volume	--
15	Run out distance	~ 20m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	Initiated on 07/2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	--
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest
36	Geo-scientific Causes	Reduction of strength of soil layer due to saturation and steep slope gradient.

37	Remedial measures	Slide movement should be monitored. Detailed studies should be carried out before any future slope modification.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/04
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage- 110.530)
7	Latitude	14.783218° N
8	Longitude	74.139477° E
9	Length	~ 15m
10	Width	~ 20m
11	Height	~ 12m
12	Area	~ 300m ²
13	Depth	>5m
14	Volume	--
15	Run out distance	~ 25-30m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Deep rotational failure
23	History	Initiated prior to 2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	--
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Reduction of strength by saturation of debris in the slope which has been cut steeply.
37	Remedial measures	Slide movement should be monitored. Detailed studies should be carried out before any future slope modification.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/05
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage- 110.620)
7	Latitude	14.783530° N
8	Longitude	74.140167° E
9	Length	~ 15m
10	Width	~ 40-45m
11	Height	~ 10-12m
12	Area	--
13	Depth	>5m
14	Volume	--
15	Run out distance	~ 25-30m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Extremely rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Deep rotational failure
23	History	Initiated during 2022
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-68:40, J2 – 89:110, J3 - 20:180
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Saturation of debris in a steeply cut slope.
37	Remedial measures	Slide movement should be monitored. Detailed studies should be carried out before any future slope modification.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/06
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage- 110.690)
7	Latitude	14.783522° N
8	Longitude	74.140903° E
9	Length	~ 10-15m
10	Width	~ 20m
11	Height	~ 12m
12	Area	~ 200m ²
13	Depth	<5m
14	Volume	--
15	Run out distance	~ 25-30m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	3 rd week of July 2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-78:18, J2 – 70:70, J3 - 15:150
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Saturation of debris in a steeply cut slope.
37	Remedial measures	Detailed analysis of the slope is required for long term remedial measures.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/07
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage- 110.750)
7	Latitude	14.783217
8	Longitude	74.141485
9	Length	~ 15m
10	Width	~ 25m
11	Height	~ 10m
12	Area	--
13	Depth	<5m
14	Volume	--
15	Run out distance	~ 40-50m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Extremely rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	July 2024
24	Geomorphology	Low dissected hills
25	Geology	Basic intrusives
26	Structure	J1-85:10, J2 – 78:145, J3 - 80:255
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Saturation of debris in a steeply cut slope. Failure is along the rock-debris interface
37	Remedial measures	Adequate drainage measures like horizontal perforated pipes for discharging the water from the debris. Detailed geotechnical study is required for long term stabilization measures.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/08
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 111.380)
7	Latitude	14.781229° N
8	Longitude	74.146864° E
9	Length	~ 40m
10	Width	~ 81 m
11	Height	~ 40m
12	Area	~
13	Depth	~ >5m
14	Volume	~
15	Run out distance	~ 40m
16	Type of Material	Rock
17	Type of movement	Fall
18	Rate of movement	Extremely rapid
19	Activity	Active
20	Distribution	Widening
21	Style	Multiple
22	Failure mechanism	Deep translational
23	History	
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	Slope direction → N200° ; Exfoliation joints parallel to the slope
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	--
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked and damaged
34	Infrastructure	--
35	Agriculture/forest/Barren	forest

36	Geo-scientific Causes	The slope has a road cut of approximately 30m in height. The cut has exposed highly jointed rock mass. The thick exfoliation joints in the rock surface dip sub parallel to the slope. This along with the vertical joints in the rock creates blocks of rocks without support. The rock falls occur along the exfoliation joint plane.
37	Remedial measures	Detailed studies are required along the Chainage 111.300 to 111.450. Precarious blocks may be removed and adequate support measures like proper netting should be provided for the slope.
38	Remarks, if any	The area is highly susceptible to rock falls. Traffic may continue in the old parallel alignment and only be resumed after geotechnical interventions are made in the slope
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	I


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/09
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/01
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 122.220)
7	Latitude	14.759265° N
8	Longitude	74.234887° E
9	Length	~ 10-12m
10	Width	~ 15m
11	Height	~ 10m
12	Area	--
13	Depth	<5m
14	Volume	--
15	Run out distance	--
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Widening
21	Style	Single
22	Failure mechanism	Shallow rotational
23	History	--
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-80:130, J2 – 50:230, J3 - 20:20
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Saturation and lack of support for the debris material exposed after steep slope cut.
37	Remedial measures	Remove the precarious boulders mechanically. Easing of the slope.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II

No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/10
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/02
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage-124.090)
7	Latitude	14.749197° N
8	Longitude	74.248513° E
9	Length	~ 20m
10	Width	~ 40m
11	Height	~ 15m
12	Area	--
13	Depth	>5m
14	Volume	--
15	Run out distance	--
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Deep rotational failure
23	History	Initiated during 2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-20:195, J2 – 89:110, J3 - 70:340
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Saturation and lack of support for the debris material exposed after steep slope cut.
37	Remedial measures	Easing of the slope of the debris layer. Providing erosion control mats like geo jute with suitable grass variety plantation can be an effective solution for such slopes
38	Remarks, if any	The location has chances for further landslides
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II

No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/11
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage-124.620)
7	Latitude	14.745973° N
8	Longitude	74.251330° E
9	Length	~ 25m
10	Width	~ 20m
11	Height	~ 22m
12	Area	--
13	Depth	>5m
14	Volume	--
15	Run out distance	~ 30-40m
16	Type of Material	Rock and debris
17	Type of movement	Slide
18	Rate of movement	Extremely rapid
19	Activity	Active
20	Distribution	Confined
21	Style	Single
22	Failure mechanism	Shallow planar failure
23	History	--
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-40:40, J2 – 60:220, J3 - 75:95
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Lithomarge and soil layer exposed in a vertical slope cut.
37	Remedial measures	Easing of the slope
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/12
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 147.030)
7	Latitude	14.602864° N
8	Longitude	74.362828° E
9	Length	~ 80m
10	Width	~ 100m
11	Height	~ 60m
12	Area	--
13	Depth	>5m
14	Volume	--
15	Run out distance	~ 40m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Deep rotational failure
23	History	August 2023
24	Geomorphology	Low dissected hills
25	Geology	Ultramafic rocks
26	Structure	--
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	The thick lithomarge and soil layer which is clay rich was exposed after slope modification. Saturation of the material resulted in reduction of strength. The benches provided in the slope have also been failed.
37	Remedial measures	Detailed assessment is required for stabilization of the slope
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/13
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 151.580)
7	Latitude	14.582058° N
8	Longitude	74.381403° E
9	Length	~ 6m
10	Width	~ 40m
11	Height	~ 5m
12	Area	--
13	Depth	~ 3-4m
14	Volume	--
15	Run out distance	~ 5m
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Widening
21	Style	Multiple
22	Failure mechanism	Shallow rotational failure
23	History	NA
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	Initiated prior to 2024. Reactivated on 2024
27	Land use/ Land cover	Forest
28	Hydrological condition	Wet
29	Triggering Factor	Rainfall 1851
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road (Has been cleared)
34	Infrastructure	Nil
35	Agriculture/forest/Barr en	Forest

36	Geo-scientific Causes	Landslide occurred due to saturation of debris exposed on steep cut.
37	Remedial measures	Easing of slope
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	III


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/14
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 151.800)
7	Latitude	14.580318° N
8	Longitude	74.382860° E
9	Length	~ 10-12 m
10	Width	~15-20 m
11	Height	~ 10m
12	Area	--
13	Depth	~ 1-2 m
14	Volume	--
15	Run out distance	--
16	Type of Material	Earth
17	Type of movement	Slide
18	Rate of movement	Very rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	Initiated prior to 2024, Reactivated on 2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-75:315, J2 – 88:235, J3 - 8:260
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road (cleared)
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	The road cut is along an approximately 15 m height section which exposed granite gneiss at the bottom and clay rich laterite at the top. The failure is due to the saturation of the laterite layer due to rainfall.
37	Remedial measures	The slope may not be disturbed by any excavation as it may further destabilize the slope.
38	Remarks, if any	The area is susceptible to minor slope failures from the laterite layer.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/15
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66
7	Latitude	14.521306° N
8	Longitude	75.409556° E
9	Length	~ 7m
10	Width	~20m
11	Height	~ 6m
12	Area	--
13	Depth	~1-2m
14	Volume	--
15	Run out distance	--
16	Type of Material	Earth
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Shallow rotational failure
23	History	Reactivated on 2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	--
27	Land use/ Land cover	Forest
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road (cleared)
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	The section exposes a 6-7 m thick lithomarge and clay-rich lateritic soil over the granite gneiss. The section is vertically cut, thereby facilitating minor slides in the unsupported soil horizon
37	Remedial measures	The slope may not be disturbed by any excavation as it may further destabilize the slope.
38	Remarks, if any	The area is susceptible to minor slope failures from the laterite layer.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/16
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 160.080)
7	Latitude	14.513155° N
8	Longitude	74.411225° E
9	Length	~ 20m
10	Width	~ 10m
11	Height	~10m
12	Area	~
13	Depth	>5m
14	Volume	~
15	Run out distance	~ 40m
16	Type of Material	Debris
17	Type of movement	Flow
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Deep rotational
23	History	Reactivation on 18/07/2024
24	Geomorphology	Low dissected hills
25	Geology	Peninsular Gneissic Complex
26	Structure	J1-80:30, J2 – 60:50, J3 - 80:260
27	Land use/ Land cover	Forest
28	Hydrological condition	Flowing
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	Nil
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	The debris flow is caused by oversaturation and resultant piping in the soil layer
37	Remedial measures	Remove the debris from the run-out zone. Any further slope modification without detailed studies is not recommended.
38	Remarks, if any	The area is susceptible to similar failures in the future.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II


No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/17
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/07
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage 166.250)
7	Latitude	14.470933° N
8	Longitude	74.439445° E
9	Length	~ 80-90m
10	Width	~ 120m
11	Height	~ 30-40m
12	Area	--
13	Depth	>5m
14	Volume	--
15	Run out distance	--
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Moderate
19	Activity	Active
20	Distribution	Enlarging
21	Style	Multiple
22	Failure mechanism	Deep rotational failure
23	History	Reactivated on 2024
24	Geomorphology	Low dissected hills
25	Geology	Vanadiferous Titano-Magnetite Gabbro
26	Structure	--
27	Land use/ Land cover	Forest
28	Hydrological condition	Damp
29	Triggering Factor	Rainfall 1851
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road blocked
34	Infrastructure	--
35	Agriculture/forest/Barr en	Forest

36	Geo-scientific Causes	The road cut is through a thick lithomarge and laterite cover developed over Gabbroic rocks. The laterite layer is not strong enough to withstand the existing slope profile resulting in a slump.
37	Remedial measures	A detailed study on the slope section is recommended with emphasis on drainage management, slope geometry modification and structural support measures. Since the slide scar has almost reached the hilltop, major retrogression may not occur, but widening of the slide is likely
38	Remarks, if any	The latest drone footage has revealed a major scar developed.
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II

No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/18
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J/06 (Chainage 167.800)
5	Name of the slide	--
6	NH/SH/Locality	NH-66
7	Latitude	14.457233° N
8	Longitude	74.438342° E
9	Length	~ 35m
10	Width	~ 40m
11	Height	~ 30m
12	Area	--
13	Depth	~ 1-2m
14	Volume	--
15	Run out distance	--
16	Type of Material	Debris
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Shallow translational failure
23	History	--
24	Geomorphology	Low dissected hills
25	Geology	Hornblende-Chlorite-Actinolite Schist
26	Structure	--
27	Land use/ Land cover	Forest
28	Hydrological condition	Wet
29	Triggering Factor	Rainfall 1851
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Road
34	Infrastructure	--
35	Agriculture/forest/Barren	Forest

36	Geo-scientific Causes	Steep cut in lateritic horizon. The shotcrete provided in the slope is observed to be falling off due to the development of pore water pressure in the laterite.
37	Remedial measures	Adequate horizontal drainage measures may be provided for the slope.
38	Remarks, if any	--
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II

No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J01/2024/19
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48K/09
5	Name of the slide	--
6	NH/SH/Locality	NH-66 (Chainage245.500)
7	Latitude	13.888483° N
8	Longitude	74.617990° E
9	Length	~ 30m
10	Width	~ 100m
11	Height	~ 25m
12	Area	~
13	Depth	>5m
14	Volume	--
15	Run out distance	~ 15m
16	Type of Material	Earth
17	Type of movement	Slide
18	Rate of movement	Rapid
19	Activity	Suspended
20	Distribution	Enlarging
21	Style	Multiple
22	Failure mechanism	--
23	History	Reactivated on 2024
24	Geomorphology	Low dissected hill
25	Geology	
26	Structure	
27	Land use/ Land cover	Vegetation
28	Hydrological condition	Dripping
29	Triggering Factor	Rainfall
30	Death of persons	Nil
31	People affected	Nil
32	Live-stock loss	Nil
33	Communication	Nil
34	Infrastructure	Nil
35	Agriculture/forest/Barr en	

36	Geo-scientific Causes	The hard and ferruginous blocks of laterite in the upslope have fractures within them. The blocks of laterite are sliding down after being detached from the surface.
37	Remedial measures	The existing retaining wall may be continued till the slide location to arrest the movement of the blocks till the road. Else steel piles may also be erected instead of the RCC wall. Enough provisions should be provided for the unhindered flow of the subsurface water.
38	Remarks, if any	The slope is not susceptible to deep rotational failure
39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	--
41	Pdf	--
42	Landslide category	II

No	Field	Description
1	Slide No (LS .No.)	KA/UK/48J06/2024/01
2	State	Karnataka
3	District	Uttara Kannada
4	Toposheet	48J06
5	Name of the slide	Shirur Slide
6	NH/SH/Locality	NH-66
7	Latitude	14.603554° N
8	Longitude	74.371219° E
9	Length	~150m
10	Width	~120m
11	Height	~60m
12	Area	~18000m ²
13	Depth	~10m
14	Volume	>1,00,000 m ³
15	Run out distance	~200 m
16	Type of Material	Debris
17	Type of movement	Flow
18	Rate of movement	Extremely Rapid
19	Activity	Active
20	Distribution	Enlarging
21	Style	Single
22	Failure mechanism	Deep rotational
23	History	Initiation-16-07-2024, 08:30 am
24	Geomorphology	Low dissected hill
25	Geology	Pyroxenite
26	Structure	Foliation - 210°/45°; J1- 35°:30°; J2 – 80°:295°; J3 - 80°:230°
27	Land use/ Land cover	Dense vegetation
28	Hydrological condition	Flowing

29	Triggering Factor	Rainfall
30	Death of persons	10 at the time of investigation
31	People affected	4 people critically injured on the opposite bank
32	Live-stock loss	NA
33	Communication	Road blockage
34	Infrastructure	Road damaged, 4 houses destroyed, one tea stall washed away, two high tension power transmission towers destroyed, 3 trucks washed away
35	Agriculture/forest/Barren	Forest
36	Geo-scientific Causes	<ol style="list-style-type: none"> 1. The site has a very thick weathered rock and in-situ clay-rich lateritic soil exposed by slope cutting. 2. The pyroxenite rock in the area is highly weathered, topped by a thick soil cover. The fresh pyroxenite rock exposed at the toe tapers, providing minimal natural toe buttress. 3. Natural drainage flows have been disturbed due to slope modifications. 4. The slide area and the left flank are structurally deformed, presenting friable and gouge-like material. 5. <i>The steep gradient of the cut slope, presence of highly weathered rock, thick debris, saturation due to rainfall, and lack of toe support are the primary causative factors of the debris flow</i>
37	Remedial measures	<p>1. Road alignment, Slope Gradient and Benching: At the Shirur area, since the road is under construction, an alignment shift from chainage 147300 till 147800 is proposed if the land is available. This would reduce the height of slope cut of the currently undisturbed slope from 147300 to 147500 to a minimum and shift the carriageway from the toe of the disturbed horizon from 147500 to 148100 For any slope modification at the site, ensure compliance with BIS codes for slope gradient with appropriate benching, based on geotechnical properties of the soil. Bench width should be adequate to enable slope segments to act</p>

		<p>independently (IS code 14680:1999).</p> <p>2. Drainage Improvements: Contour drains (Fig. 13) above Ch. 147.500 should be lined and provide stepped chute drains on slope faces depending on hydrological conditions.</p> <p>3. Erosion Control: Install lined ditches or drainage on benches, along with slope reinforcement measures.</p> <p>4. Culvert Installation: The convergence of natural drainage is anticipated at the landslide face with time. A culvert with sufficient diameter pre-cast pipes should be provided to accommodate water and debris discharge at the toe of the landslide at Ch. No. 148.000.</p> <p>5. Monitoring and Surveying: It is recommended to monitor and survey for signs of instabilities even above Right of Way especially for slope sections with higher relative relief on the right and left flanks of Shirur landslide. Shirur landslide is a classic case where the rupture surface extended beyond the ROW due to higher relief above the cut slope. Deploy flaggers for traffic control and restrict access to high-risk areas.</p> <p>6. Subsurface Water Drainage: Include perforated horizontal pipes of appropriate diameter and sufficient length in engineered slopes to manage subsurface water flow.</p> <p>7. Geotechnical Investigation: Conduct comprehensive investigations to determine suitable stabilization strategies for Shirur landslide, considering potential landslide enlargement due to considerable thickness of soil in the crown and hydrological conditions.</p>
38	Remarks, if any	Detailed geotechnical studies should be carried out before implementation of recommended remedial measures.

39	Photos. Sketch of Plan & section of the slide	
40	Summary/Abstract	<p><i>The landslide incident at Shirur village, Ankola Taluk, in Uttara Kannada district occurred on 16th July 2024 at approximately 08:30 Hrs. The steep gradient of the cut slope, presence of highly weathered rock, thick debris, saturation due to rainfall, and lack of natural toe support are the primary causative factors of the debris flow. A comprehensive geotechnical investigation is recommended to determine appropriate slope stabilization strategies for the Shirur site.</i></p>
41	Pdf	Attached
42	Landslide category	I

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BEFORE THE NATIONAL GREEN TRIBUNAL
SITTING AT CHENNAI(SZ)

O.A.261 OF 2024

Suo moto News Item titled "Unscientific
Work by NHAI led to Shirur landslide
Geological Survey of India Report
appearing in the Indian Express dated
02.08.2024

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S.JANARTHANAM
COUNSEL FOR 2ND RESPONDENT