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**भारतीय भूवैज्ञानिक सर्वेक्षण (भा. भू. स.)/ Geological Survey of India (GSI)**

# हिमाचल प्रदेश के किन्नौर जनपद की निचार तहसील में राष्ट्रीय राजमार्ग – 05 पर, निगुल्सरी के निकट 11/08/2021 को हुए शैल-स्खलन की घटना के अवीक्षण अध्ययन पर एक फ़ील्ट नोट

**(भा. स. वि. टोपोशीट सँख्या: 53ई/14)**
**(अतिरिक्त कार्य)**
**(मिशन - 4/ कार्यवर्ष: 2021-22)**

# A FIELD NOTE ON THE RECONNAISSANCE STUDY OF ROCKSLIDE INCIDENCE OF 11/08/2021 AT NH-05, NEAR NIGULSARI VILLAGE, TEHSIL NICHAR, DISTRICT KINNAUR, HIMACHAL PRADESH

**(SoI Toposheet No.: 53E/14)**
**[ADDITIONAL WORK]**
**(Mission - IV Field Season: 2021-22)**


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**राज्य इकाई: पंजाब, हरियाणा तथा हि. प्र. / State Unit: Punjab, Haryana and H.P.**
**चण्डीगढ़ - 160 020 (के. शा. प्र.) / Chandigarh - 160 020 (U.T.)**


***अगस्त August, 2021***

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**(Toposheet No.: 53E/14)**
**[ADDITIONAL WORK F.S. 2021-22]**

**By:**
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## INTRODUCTION

On 11/08/2021, around noon, a rock slide incidence took place along NH-05 near Nigulsari village in Tehsil Nichar of District Kinnaur, Himachal Pradesh. The above rock slope failure incidence brought down appreciable volume of large rock blocks of foliated gneissic rock mass comprising rock blocks of varying dimensions and soil mostly with relatively coarser fraction. As per media reports, the slide debris engulfed one HRTC Bus with reportedly 30 passengers onboard. Moreover, at least 4-5 smaller four wheelers and a few cattle have also been engulfed in debris causing loss to life and property. Furthermore, damage to highway and valley side metallic girders/railing have also been caused by the above incidence. As on the day of field observation, 23 dead bodies were recovered, as intimated by the Gram Pradhan, Trianda.

As a quick disaster response, GSI Chandigarh contacted District Administration, Kinnaur and GSI was invited by DC Kinnaur to undertake the geological investigation of this incidence, after the rescue work almost got over. The authors of this note, on being instructed by Dr. G.S.Tiwari, DDG-SUPHHP, GSI (NR), Chandigarh, carried out field investigation in and around the slope failure affected area during 15 and 16/08/2021.

The spot where the incidence took place is located about 265 km from Chandigarh. Telephonic discussions were held with DC, Kinnaur, SDM, Nichar and JE, HPPWD (NH-Division) on 14/08/2021 reg. the incidence. It was conveyed to the authors that required officials would be available at the site to accompany during the field traverses. On 15/08/2021, discussions were carried out with JE, HPPWD and Gram Pradhan etc. and a field traverse was taken in and around the area including area near the crown of the slide (upslopes near the village Thach and along NH-05). Field observations were recorded during the field traverse. Following is a brief account of the field traverses that were carried out at the site.

## STUDY AREA AND ITS REGIONAL GEOMORPHIC AND GEOLOGICAL SETTING

The study area i.e. the hill slope affected by rock slide and associated rock fall incidence is located along NH-05 near Nigulsari village. The study area is a part of Kinnaur District of Himachal Pradesh and falls in Survey of India (SoI) Toposheet No. 53E/14 (Coordinates: 31° 33'46.07"N, 77°52'20.70" E ). The study area forms a part of Satluj Valley and the NH-05 here twirls through left bank slopes of Satluj River. The highway connects Firozpur in Punjab to Shipki La in Indo-China Boarder and, therefore, serves as an important National Highway serving to the border areas. Geologically, the study area forms a small part of the Jeori Wangtu Gneissic Complex (JWGC), with gneissic rocks exposed in the area. The rocks are highly foliated and well jointed with at least three sets of joints as exposed at many rock exposures in and around the slide area (Fig. 1, 2, 3; Annexure-I).

## FIELD OBSERVATIONS RECORDED DURING THE RECONNAISSANCE STUDY

01) Field traverses were taken around (i) area immediate around the crown, from where the actual failure initiated and along (ii) nearly 400m road stretch.
02) In the present incidence, loss to life and property has taken place as stated above.

03) As informed by JE, HPPWD (NH Division) and Gram Pradhan and other local residents present during the reconnaissance study, one slope failure has already taken place way back in 2019 during monsoon period and, therefore, this incidence can be stated as 1st reactivation at the site.
04) It was intimated to the authors of this note that although the present incidence also took place during the ongoing SW Monsoon, incessant/continuous rainfall spell was there since about 3 days prior to the actual date of incidence i.e. 11/08/2021.
05) Based on Macroscale Landslide Susceptibility Mapping (NLSM) studies carried out during 2016-17, the incidence falls in a High Susceptibility Zone (Vadakkedath and Biswal, 2017).
06) From the field traverse also, the site appears to have been perceived as a location vulnerable to landslide hazard as the same is characterized by the presence of moderately to steeply inclined and dissected hill slopes, bottomed by steeper cut slopes and further bottomed by steeper natural slopes. The rocks exposed are highly foliated and jointed, with open joints at several places (Fig. 4; Annexure-I).
07) The actual slope failure incidence took place from natural slopes above the cut slopes. Voluminous debris comprising rock blocks of varying dimensions as well as soil, mostly with coarse fraction failed in the incidence.
08) Immediately after the incidence of 11/08/2021, another incidence took place on 13/08/2021 in which another HRTC bus had a minor escape.
09) At the time of field observation, although water was neither observed flowing nor trickling, both from crown area and from rock slopes, but wet and damp conditions were observed immediately above the crown.
10) In all, a total of 400m stretch along NH-05 (including main failure zone), is characterized by the presence of highly jointed and foliated rock mass as observed along the cut slopes.
11) Although the rock failure had resulted in the road blockade and the failed material had already been removed before traverse, due to continuous falling of loose rock blocks, officials were deployed by the administration above the crown and along the road to clean the road for smooth flow of traffic and to avoid any mishap.
12) Based on the photographs in electronic media and field observations, rock blocks lying close to the site of failure, it can be inferred that the size of the failed blocks could have been as large as few cubic meter.
13) The crown of the slide is about 120 m above road (visual estimate) and the bottom end of the zone of depletion is above the road level. The width of the crown area is about 25m. The maximum depth of depletion is about 4 m in the crown part.
14) Based on the material and type of movement involved, the slope failure incidence can be classified as Rock slide (in upper parts of the zone of depletion) and associated rock fall (in most parts of the zone of depletion). The discontinuity (joint) along which the movement occurred in the upper reaches of the zone of depletion, dips valley-ward at moderate to steep angle (Annexure-I).
15) The crown portion of the slide shows traces of contour parallel tension cracks, piping holes in in-situ soil, traces of rills, tilted trees, partly shaved off vegetation, exposed roots lying over the plane of sliding which might have played a role in widening of the joint planes.
16) The density of vegetation over the rocky slopes can be at best termed as sparse, whereas in the upper reaches of the hill section, it is moderate.
17) The spacing, continuity and mutually interfering spatial disposition of these joints have made the rockmass an assemblage of individual blocks varying in size from few cubic cm to few cubic meters cemented by relatively weaker links along and across the joints.
18) A rock block with some in-situ soil developed over it was observed protruding valley-ward, slightly towards left side of crown, which appears to be highly vulnerable based on field observation. In addition, several insecurely positioned blocks on cut slope were observed.

## PRELIMINARY INFERENCES DRAWN AT THE END OF THE RECONNAISSANCE

01) Prima facie, the failure appears to be a natural rock slope failure with no signatures of anthropogenic activity seen in or adjoining areas of the crown, from where the failure was initiated as per the field observation.

02) There appear to be no preventive measures in place that are capable of reducing uncontrolled flow of water over the moderately to steeply inclined slope/valley facing joint planes, above the cut slope section.

## SUGGESTIONS BASED ON PRESENT FIELD INVESTIGATION

On the basis of the reconnaissance, following suggestions are given that can be useful in minimizing the slope failure incidences and risk to commuters. These suggestions need to be converted into actionable points only after adequate investigations, wherever necessary.

01) **Vigil along the slope failure affected stretch as well as nearby vulnerable stretches and slope failure/landslide locations along NH-05 irrespective of whether or not the preventive measures are in place:** This may help in early detection of likely failure and measures such as closure of lanes likely to be affected for specific time etc. can be implemented.
02) **Identification and removal of rock blocks that are insecurely positioned and are likely to fall on the road alignment:** As far as possible, blasting should be avoided for carrying out the removal of such blocks. This include a vulnerable block ready to fall above the crown (Fig. 3).
03) **Contour parallel drains:** At least two to three contour parallel drains all along the crown at appropriately identified levels to diver the surface water towards *nalas* on either side.
04) **Immediate filling of tension cracks:** with suitable impervious material.
05) **Protective measures for cut slope:** Possibility of double layer shotcrete or wire mesh can be explored for the cut slope section as several loose rock blocks are appearing that may fall at any point of time, especially during the course of incessant or perennial rainfall spells. Detailed studies, however, may pl. be carried out for the same.
06) The slope preparedness is a long term process and such susceptible slopes can be identified with fair degree of confidence through the process of landslide susceptibility/zonation on different scales. However it must be understood that susceptibility maps classifies the area on 'as is' basis (like a snapshot) and low susceptibility does not rule out landslide occurrence forever.

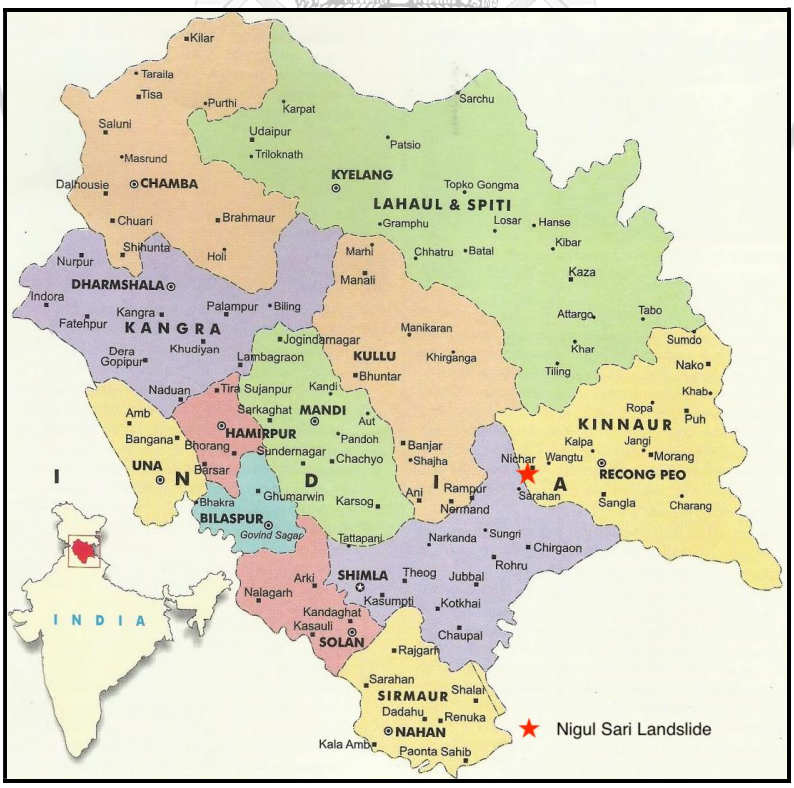


Fig. 1: Tentative Location map of Nigulsari landslide, Kinnaur District, indicated in H.P. Tourist Map (Source: H.P. tourist Map)

Fig. 2: Distal view of Nigulsari landslide, Kinnaur District

Fig. 3: Valley side view (looking from crown) of Nigulsari landslide, Kinnaur District

Fig. 4: Highly jointed rock mass exposed along cut slopes in Nigulsari landslide area, Kinnaur District

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**ANNEXURE-I**

| 42 POINT GEOPARAMETER DATA SHEET FOR NIGULSARI LANDSLIDE, NH-05, DIST. KINNAUR, H.P. | | | |
|---|---|---|---|
| **No** | **Field** | | **Description** |
| 1 | Slide No (LS.No.) | : | H.P./KIN/53E14/2021 |
| 2 | State | : | Himachal Pradesh |
| 3 | District | : | Kinnaur |
| 4 | Toposheet | : | No. 53E/14 |
| 5 | Name of the slide | | Nigulsari(Rockslide) |
| 6 | NH/SH/Locality | : | NH-5, Thachh Village |
| 7 | Latitude | : | N 31° 33' 46.692" |
| 8 | Longitude | : | E 77° 52' 20.676" |
| 9 | Length | : | ~160m |
| 10 | Width | : | ~70m |
| 11 | Height | : | ~125 |
| 12 | Area | : | $m^2$ |
| 13 | Depth | : | <5m |
| 14 | Volume | : | $m^3$ |
| 15 | Run out distance | : | 450m |
| 16 | Type of Material | : | Rock boulders |
| 17 | Type of movement | : | Rock Slide |
| 18 | Rate of movement | : | high |
| 19 | Activity | : | Reactivated |
| 20 | Distribution | : | Retrogressive |
| 21 | Style | : | Single |
| 22 | Failure mechanism | : | Shallow transitional failure |
| 23 | History | : | Also observed on a day before the main incident (2019) |
| 24 | Geomorphology | : | Highly dissected hill and Denudational hill slope |
| 25 | Geology | : | JeoriWangtu Gneiss formation. |
| 26 | Structure | : | Three sets of joints.S0/$J_0$: 35°/N240° (VF); $J_1$:50°/N74°; $J_2$: 80°/N350°;Slope direction: N50°E |
| 27 | Landuse/ Land cover | : | Moderately vegetated and agriculture |
| 28 | Hydrological condition | : | Wet and damp at places in and around crown area. |
| 29 | Triggering Factor | : | Rainfall |
| 30 | Death of persons | : | In the incidence 1 HRTC bus and 4-5 small four wheelers got engulfed in the slide debris including a few cattle. As on the day of field observation, 23 dead bodies were recovered, as intimated by the Gram Pradhan, Trianda. |
| 31 | People affected | : | Loss of life |
| 32 | Livestock loss | : | 01 Cattle |
| 33 | Communication | : | Road damaged and blocked by boulders |
| 34 | Infrastructure | : | HPRTC bus, 3 Private vehicle |
| 35 | Agriculture/forest/ Barren | : | Agriculture |

| | | | | |
|---|---|---|---|---|
| 36 | Geo-scientific Causes | : | Steeply inclined slope and incessant rainfall from last three days before the main incidence, as intimated by Gram Pradhan and local residents present at the time of field study. | |
| 37 | Remedial measures | : | 1) | Identification and removal of rock blocks that are insecurely positioned and are likely to fall on the road alignment |
| | | | 2) | Contour parallel drains: At least two to three contour parallel drains all along the crown at appropriately identified levels to diver the surface water towards *nalas* on either side. |
| | | | 3) | Immediate filling of tension cracks: with suitable impervious material. |
| | | | 4) | Protective measures for cut slope: Possibility of double layer shotcrete or wire mesh can be explored for the cut slope section as several loose rock blocks are appearing that may fall at any point of time, especially during the course of incessant or perennial rainfall spells. Detailed studies, however, may pl. be carried out for the same. |
| 38 | Remarks | : | | |


Fig. 1: Distal view of Nigulsari landslide, Kinnaur District

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|---|---|---|---|
| 39 |  | | |
| | Fig. 2: Highly jointed rock mass exposed along cut slopes in Nigulsari landslide area, Kinnaur District | | |
| | | | |
| 40 | **Summary/Abstract:**Rock fall incident took place on NH-5 road on 11th August 2021 district Kinnaur H.P.As per the media reported twenty three death and damage to HPRTC Bus and Private vehicle .The dimensions of the slide is 250mtr in length ,70mtr in widths along the road and height is 135mtr with run out distance of 450 mtr.The rock type expose in the area is JeoriWangtugneiss . The litho units are traverses by 3 set of joint have been noticed in the area. Prima facie geo scientific causes were Steeply inclined slope and incessant rainfall from last three days before the main incident. The remedial measures are being explored are : Provision of mesh trapping and afforestation and crate wall and rock fall shelters. The landslide awareness programme should be launched in the form of a mission for all villages located in such fragile geo environmental condition. | | |
| 41 | Pdf | : | -- |
| 42 | Alert | : | I |

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|---|---|---|---|
| Sd/- | Sd/- | Sd/- | Sd/- |
| S.R. Mohapatra, Director | Atul Kohli, Director | Vijit Thakur, Geologist | Abhinav Poonia, Assistant Geologist |
| **Date: 15/08/2021** | | **Place: Nigulsari, Dist. Kinnaur (H.P.)** | |

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