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REPORT ON

Geological Field Investigation of ground subsidence in Khamroli Village, Kalsi Block

December 2023

Geological Field Investigation of ground subsidence in Khamroli Village, Kalsi Block, Dehradun, Uttarakhand

1.0 Introduction

In respond to letter no 1361/USDMA/2023 dated 16th October 2023 and letter no 1185/XVIII-B-1/2023-15(25)/2021 dated 17 August 2023 received from Indian Geological Congress to Department of Disaster, Uttarakhand in order to study the cracks/subsidence issues at Khamroli village, a team visited the affected area with following members on 20th December 2023

- Dr Ruchika Tandon, Senior Geologist, ULMMC
- Dr Anju Panwar, Environmental Expert, ULMMC
- Mr Deepak Bhatt, Surveyor, ULMMC

Shri Jagat Ram Sharma, Patwari, Kalsi Block from revenue department has also accompanied the investigated team during the field investigation.

2.0 Location Khamroli is a village in Kalsi Block in Dehradun District of Uttarakhand State, India. It is located 36 km towards north from district head quarter, Dehradun and surrounded by Chakrata Block towards North, Vikasnagar Block towards South, Mussoorie Block towards East and Sahaspur Block towards South and falls under Survey of India Toposheet no 53 F 14. About 50 families are settled in the area out of 40 families/houses are located just above village road and clustered between an elevation of 1610 m and 1660 m and rest houses are sparsely spreaded in the area along with broaden agricultural terraces all around (Fig1).

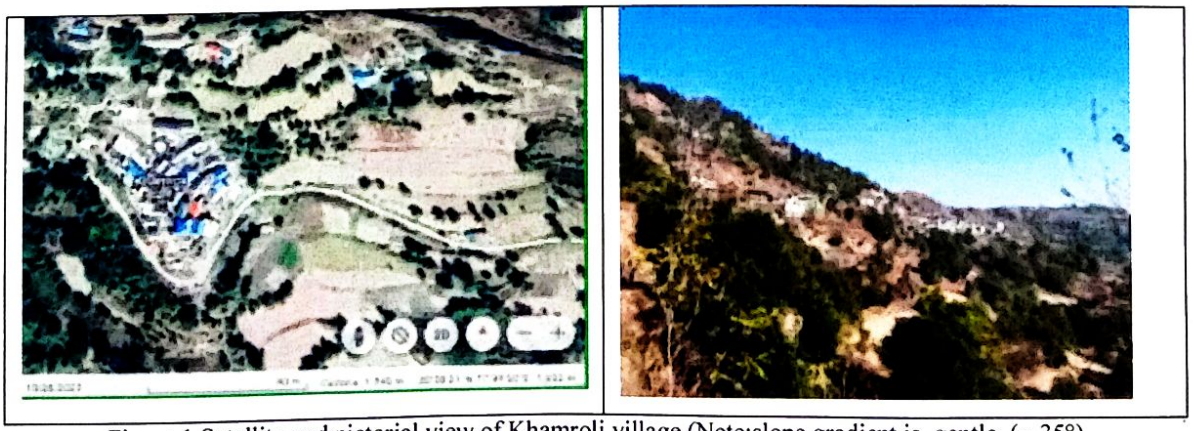

Figure 1 Satellite and pictorial view of Khamroli village (Note:slope gradient is gentle (~ 35°)

The Khamroli village is located at latitude 30°38'21" N and longitude 77°49'50" E just above the village road passing from Sahiya towards NW (Fig 1). The entire area is occupied by the overburden ranges from ~1-2 m at steeper gradient slope to 5-10 m at gentler slopes. The slope faces towards south and completely dry with no springs, no rivulet and no waterfall

Geologically, the rock exposed in the area is thinly bedded shale belongs to Lesser Himalaya. It is of grey in colour and occupies below light brown, coarse grained and less clayey soil cover (overburden). The shale beds are sub horizontally aligned and slightly weathered with no major open joint pattern appeared near to site visited. In general, the overall slope gradient is 35° towards SE.

Figure 2 exhibiting well bedded shale without major joint set

3.0 Observations

1. Most of the houses are made up of bricks and stone (concrete) whereas few having wooden structures with only one storey or two stories. Out of all the houses, few houses have differential settlement of ground observed in form of cracks that too in concrete structure and no tentional cracks on field/natural ground were observed.

2. The maximum widen cracks is of < 4-6 cm on concrete ground and 5 m length as observed only in 2 adjacent houses whereas rest of the houses either have no cracks or observed hairline or 1-2 mm on walls. It has been observed that just above the mentioned ground crack in one house, the roof is covered by slanting tin shed that too fix with the back side wall so the rainwater from upslope as well as tilted shed collected near the base (where cracks have been observed)(Fig 3). Since, there is no proper drainage so collected water slowly percolate inside and may be the reason of cracks initiated and widen. Also both the houses are located near the manmade drainage (sloping towards road) without impermeable base concrete layer, which is steeper and may have heavy flow during rains. In addition, house owner confirmed that the minor cracks in houses initiated in 2022 and widen in 2023. Also in 2023, nearby area received heavy rainfall due to cloud burst activity at Tikochi, therefore ground crack and widening may link with the heavy rainfall activity of 2023, which is common in himalayan terrain which itself is dynamic in nature

Figure 3 : (left) widen crack on ground of a house just above village metalled road located at N 30.640540' lat and E77.830775 longitude , (right) just above the crack, a tinshed is placed that ingress the rainwater inside the closed room without having proper drain out system

3. There are neither tentional cracks observed in any agricultural lands nor villagers confirmed the presence of such cracks.

4. A house is located (N30.640903°, E77.831849°) at an elevation of 1675m, having cracks in retaining walls which may indicate differential movement of ground, whereas on floor unusual oriented cracks have been observed which is already filled by clayey material by the

house owner (Fig 4). Since the cracks are not on the natural ground and only in constructed concrete structure therefore it is hard to find out the depth of these unusual oriented cracks and could not be related with ground subsidence.

Figure 4 exhibiting unusual crack pattern on concrete base which is filled by mud and broken newly constructed retaining wall

5. Entire area is covered with tilted trees indicating the creeping of slopes therefore minute cracks on houses may common and link with very slow movement.

Figure 5: Tilted trees and trunk of cutted trees showing creeping slope movement

6. There are no developmental activities like cutting of slopes, road construction etc have been observed which can facilitate the ground movement.

7. A small scale landslide was also observed just below a primary school facilitate the school building in critical stage (Fig 6). The site is little far away from the cluster settlement area of Khamroli village. As a prima facie, it appears that area has vegetation till 2019

(as confirmed by temporal images obtained from Google earth) and removal of vegetation (Fig 7) along with further extension

Figure 6 exhibits shallow landslide activity near Primary school (left) and broken wall of school building (right)

of school building near the periphery of steeper slope (>45°) initiated the subsidence activity in 2022 in form of building cracks and finally landslide occurred in monsoon of 2023 and damaged the school building as well as completely fallen of school boundary wall (Fig 6).

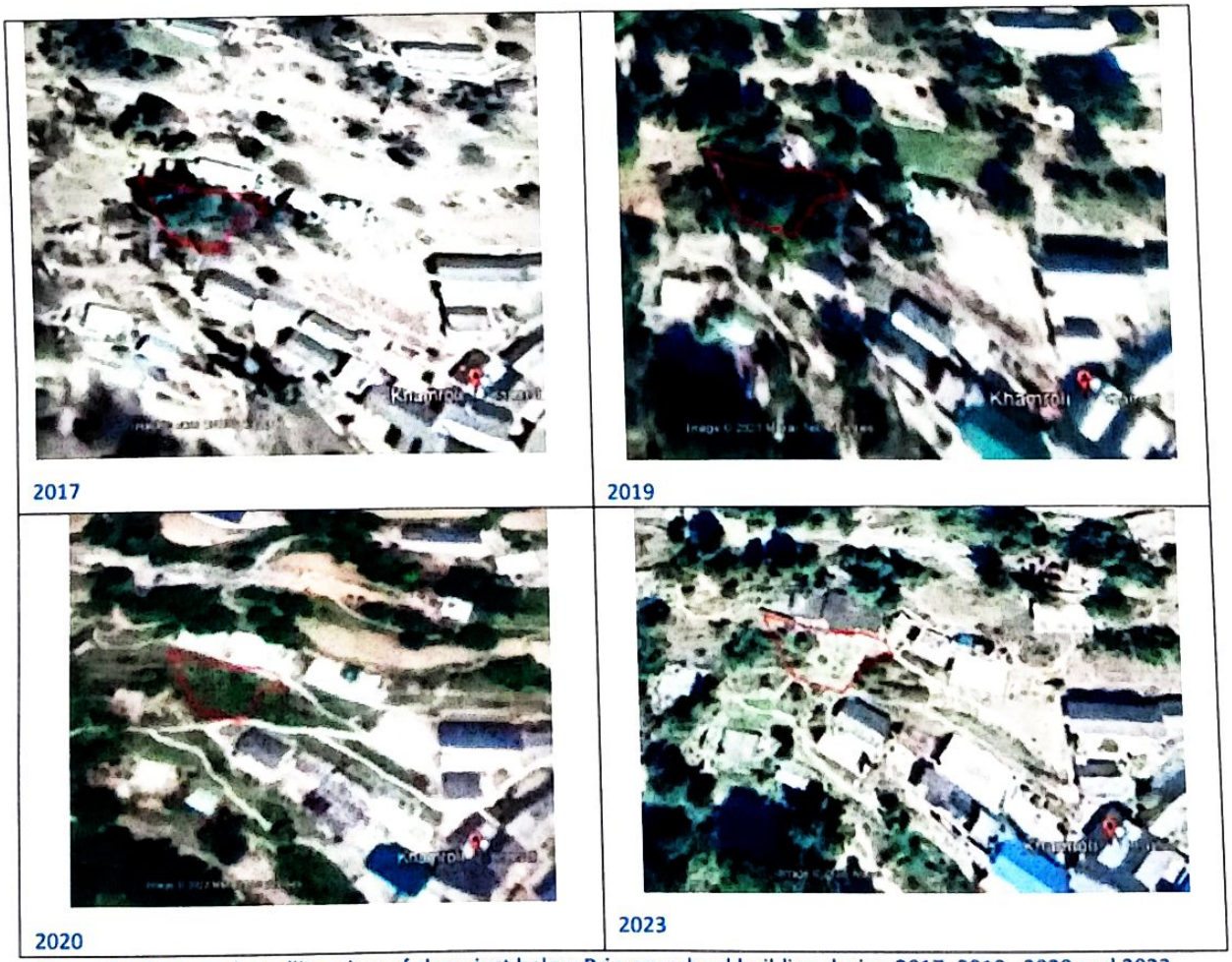

Figure 7 : Temporal satellite view of slope just below Primary school building during 2017, 2019 , 2020 and 2023 respectively (Note: In year 2020, there is no vegetation cover below the school whereas in 2017 and 2019, thick vegetation cover observed on the slope and in 2023, landslide scar appeared)

8. The cracked ground tiles were also observed in one of the house that too far-off located from the main village and may link with the slow ground movement or may be removal of any vegetation. A crack was also observed at right side wall of one of the house that too located far off from main settlement and may link with the development of gully erosion and ingress of water adjacent to house (Fig 8). Other than these, no other ground cracks and displacement were observed during field work.

Figure 8 exhibiting broken tiles in one of the house and site of gully erosion just adjacent to house with minor crack (note that such cracks do not appear inside the house and only restricted in small portion of outside of house)

4.0 Suggestions:

1. In our opinion , the village does not poses any critical condition of ground subsidence and may falls under low to moderate differential ground movement. However, the shifting of school building is recommended.
2. The site below the school building should be covered with certain type of vegetation which can hold the soil.
3. All the man-made drains must be concreted to ensure no percolation of water.
4. The widen wall cracks observed only in 2 houses should be repaired and if further movement/ abnormal widening occur, it is suggested to report to the concern department for further investigations.
5. The cracks on floor of houses should be filled up with bentonite mud slurry or any impermeable material to prevent enlargement of the cracks by water action. Tin shed must be removed or proper arrangement be made to drainout the rainwater in one of the house where ground crack appeared (fig 3)

6. Removal of vegetation cover should be strictly abandoned
7. Promoting the plantation especially at sites of gully erosion in order to stabilize the disturbances is important. If gullies will continue to move by headward erosion or by slumping of sidewalls, it will facilitate further soil erosion and ingress of water into ground.
8. The building codes and guidelines must be consider if further construction and development of buildings take place

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