

Rockslides in Mumbai

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Abstract

Mumbai island, comprising basalt of Deccan Volcanic suites, has been experiencing number of rockslides due to anthropogenic activities like quarrying at various locations. The heavy precipitation reduces the shear strength along the joint planes within basalt and lava flow interfaces, resulting into block displacement. Rockslide on Gilbert hill in Andheri West is due to excavation and construction activities in the area. The paper highlights prohibition of quarrying in residential areas. The emphasis is laid on appropriate stabilisation measures like guniting, retaining wall, rock bolts etc., on quarry faces.

Introduction

Rockslides and similar mass-wasting movements are very common in Himalayas due to high precipitation, steep valley slopes, structural discontinuities like bedding, foliation joints, faults and streams and anthropogenic activities. But, rockslides have been, shockingly, almost an annual ritual in residential areas in the island city of Mumbai, taking a heavy toll of human lives at times. The sites where rockslides have been and are still occurring, their causes and preventive measures that can be taken are discussed in this paper.

Geological set-up

The Mumbai Island comprises predominantly black basalts of the Deccan Volcanics suite, with trachytes, spilites, tuffs and intertrappean shales occurring sporadically. The island presents basalts dipping to the west from 13 degrees at the IIT campus to 23 degrees at the Madh Island on the coast. All the hills are homoclinal ridges of the 'cuesta' type, with gentle to moderate westerly dip slopes and short and steep easterly escarpment slopes (Fig.1). To the east of the Thane Creek, which forms the eastern boundary of the island city, the basalts are horizontal and have formed flat-topped ridges with spectacular vertical scarps. A monoclinial flexure, called the

Panvel Flexure by Auden (1949) has its axis in this region and has brought about the significant transition from horizontal strata essentially to the east of the Thane Creek to homoclinal rocks all over the Mumbai Island. The contrast in the landforms described above bears testimony to this important structural transition - flat-topped hills and ridges with vertical scarps are totally absent in the Mumbai Island and cuestas are likewise completely absent in the vast Deccan Volcanic Province to the east of the Thane Creek right up to Madhya Pradesh.

Sites prone to Rockslides

A few isolated hills and some continuous ridges of basalt are present in the Mumbai Island and rockslides have been often occurring on all of them sometime or the other. The localities where they frequently occur are: Ghatkopar West (where a rockslide occurred in the Chiragnagar locality in 2002 leading to the loss of 70 lives), Andheri East (where 80 people lost their lives in a massive slide at Saki Naka in 2005), Andheri West (where a rockslide occurred recently on top of the Gilbert Hill, which is a unique hill composed entirely of 60 metres high columns of basalt, Chembur and Kurla, to mention only a few (Fig.2).



Fig.1 A view, looking north, of the 'cuesta' type of landform at the northern end of the IIT Bombay campus in Powai, Mumbai. Note the westerly dipslope and the easterly escarpment slope.

Causes of Rockslides

The cuestas of basalts described above, present all over the Mumbai Island, are perfectly stable where they are not disturbed by anthropogenic activities. But quarrying of basalt for use in road and building constructions has been going on for several years in Mumbai and this has disturbed the equilibrium in the hills and destabilized their slopes leading to rockslides at several places. Quarrying of rock on the westerly dip slopes with vertical cuts removes the toe support of the inclined blocks of rock present in the hill. During the monsoon heavy showers loosen the jointed rock blocks due to rainwater that lubricates the lava flow planes and the multidirectional joints. Such conditions are ideal for the occurrence of rockslides and sooner or later, the rock blocks slide down (Fig.3). Quarrying also brings about an over-steepening of the slopes, which is one of the acknowledged causes of landslides.

Unfortunately, the abandoned quarries become the abode of new slums that spring up overnight since space for living is hard to get in Mumbai. It is these slum-dwellers that fall prey to the slides, which hit their huts and houses with great speed, giving them no chance to flee to safety. This tragic drama gets enacted every monsoon with such a

rhythmic regularity that tens of people loose their lives.

The rockslides on the Gilbert Hill in Andheri (West) are the only sites, which are not due to quarrying because it is a natural heritage feature that has been declared a National Park and so quarrying is not permitted around this hill. Here only vertical columns of basalt make up the hill that is 60 metres high. But a lot of excavation and construction activities have been going on around the hill, which appears to have undermined the columns at the base

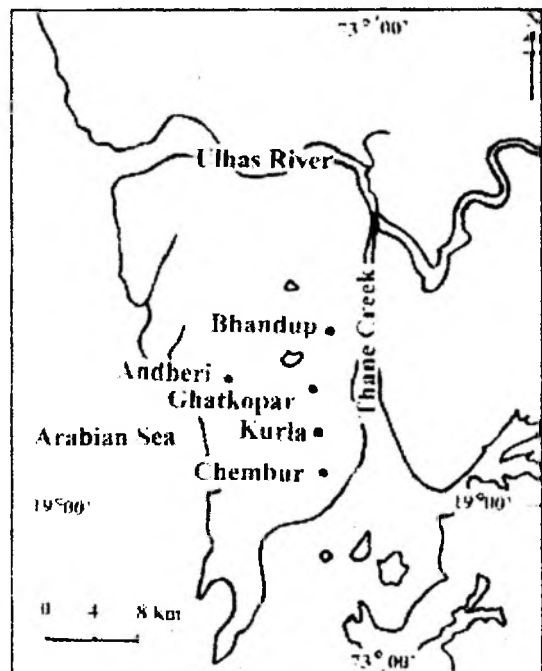


Fig.2 A map of Mumbai Island showing some of the sites of major rockslides.

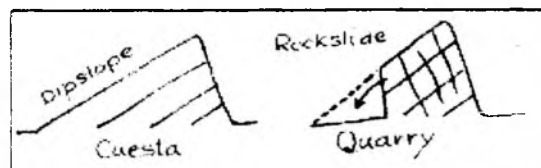


Fig.3 Schematic diagrams to explain the mechanics of rockslides in Mumbai.

thereby, the facilitating for loosening of rock blocks, which ultimately detach and slide down from the main mass.

Preventive Measures

Landslides occurring around Mumbai island can be predicted and prevented to a large extent by monitoring regularly in the unstable zones. The development of cracks on the hill-slopes, enable an understanding of the slope-movements in advance. To prevent the rockslides in Mumbai, first of all it is necessary to prohibit quarrying altogether in residential areas and permit it only in remote areas like the Kanheri hill range in the northeastern part of the city. Secondly, a 50 metre wide zone below the quarried hills should be declared a rockslide-prone zone

and the growth of slums in these stretches should not be allowed at all. Thirdly, the quarry owners should be required to leave the quarry faces properly protected by using the appropriate slope stabilizing measures like guniting, construction of retaining walls with weep holes, rock bolting, cutting benches, etc., so that rockslides do not occur over them.

Reference

Auden, J.B. (1949): Dykes in Western India. *Trans. Nat. Inst. Sci. India*, Vol. 3, pp. 123-157.