Non-Frame Method employed for the slope failure prevention project at the Second Toba district, Toba city, Mie Prefecture

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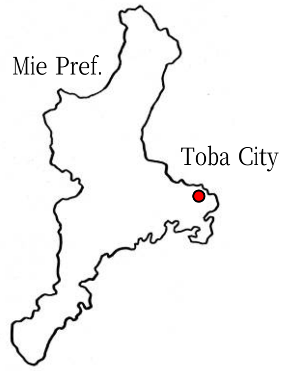
1. Introduction

Toba City is located at the northern base of Shima peninsula in the eastern area of Mie Prefecture of the central part of Japan. The entire city is included in the marine resort of Ise-Shima National Park. The city has been growing as a comprehensive marine resort.



Location

Under this circumstance, a slope failure prevention project had been launched at the Second Toba district which is located at the location next to the busy downtown area. The project site is also closer to the Toba station of Kinki Railways Co. Ltd. which is the gateway of the city.

The project must therefore be environment-friendly. The Non-Frame method was employed as the construction method in response to the requests of local communities and in order to preserve forest cover on the slopes.

2. Landform and geological condition of the target area

2-1. Landform

The project was launched on the slopes which are located next to the busy downtown.

The slope is as high as 40 meters and is located eastern part of the steep range of hills. The slope is as steep as 30 degrees or more up to 50 degrees and covered well with thick natural vegetation, but the slope surface has been heavily weathered so that the area was prone to rock fall and slope failure.

The situation of steep slope with broad leaf tree and bamboo

2-2. Geological conditions

The project site is located along the median tectonic line which runs crossing the Kii peninsula. The area is, in terms of geology, dominated by Sanbagawa metamorphic rocks generated in the Mesozoic era.

The rocks were generated under high pressure and widespread metamorphism so that the rocks contain a lot of schistosity planes with high fissility. The schistosity planes folded heavily, but, in a large sense, run from the east to the west along the median tectonic line.

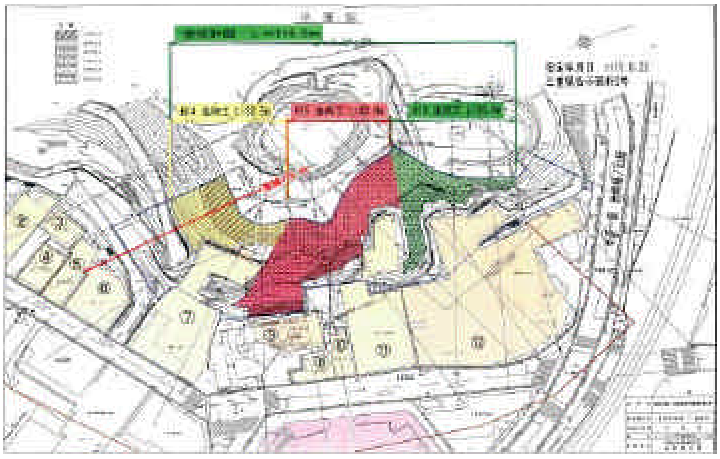
3. The mechanism of possible slope failures

3-1. Causes of slope failure

The followings are assumed causes of slope failure;

(1) unstable talus deposit on the base rock consisted of green schist, black schist and sand schist,

(2) a fractured zone was identified on the south end of the slopes. Slope failure might therefore take place along the fractured zone,


Design plane figure

(3) a fractured zone which is running horizontally was identified on the north end of the slopes, but the dip of the fractured zone was identified to be opposite.

3-2. Triggers of slope failure

The followings are observations regarding the triggering effects;

(1) no clay layer which might play a role as a sliding surface was identified,

(2) slope failures of which size is from 1 to 2 meters high and 3 to 5 meters wide were identified. Irregularities in counter lines on the map strongly suggest past hazardous events due to slope failure,

(3) triggering effects resulted from weather conditions, tectonic movements and erosional processes might cause slope failure.

Taking into account the above observations and assessment, it was decided that a slope failure prevention project be launched.

4. Slope Stability Analysis

4-1. Designed Factor of safety(PFs)

The PFs was determined, taking into account residential houses, to be 1.20.

4-2. Postulated Slide Surface

Field reconnaissance and geological survey gave no evidence of existing slide surface, but slope analysis was conducted based on a designed circular sliding surface.

5. Design of the construction method

5-1. Stability and social settings of the slope

5-1-1. A few houses, most of which are inns, are located at the foot of the slope. The slope is tilted at a 30 degrees angle or more and densely covered with trees and bamboo plants.

5-1-2. The slope is located in the national park and situated closer to the Toba station which is the gateway for the tourism center, Ise-Schima. It is therefore not acceptable to impair scenery by putting unfamiliar structures on the slope.

5-2. Comparative analysis of construction methods

A comparative analysis was made in order to find the most appropriate construction method among the following three:

1) non-frame method
2) anchor method
3) rock bolt.

It was decided that the non-frame method was the most appropriate because of the following reasons:

1) no cut-down is required,
2) no heavy-duty machine is required,
3) the slope can be stabilized by means of stiffeners and clip plates

6. Some points to keep in mind and innovation

6-1. Efforts made

6-1-1. preparation of a haul road and stock yards,

6-1-2. careful preparation of scaffold, installation and removal of machines in order not to destroy natural vegetation cover,

6-1-3. stiffener must be fixed at the locations at which few tree is standing.

6-2. Points of elaboration

6-2-1. noises from air compressor, leg hummer and air ducts were dissipated using thick fabric sheets, suction pipe and silencer respectively.

6-2-2. a monorail railway was installed at the center of the slope in order to transport construction materials and equipment on the target slope of which size was 40 meters high, 45 meters long and as steep as 30 to 50 degrees.

The capacity of the monorail railway is 400kg/45^0

7. Conclusion

The construction work was undertaken putting the highest priority on preservation of natural environment and scenic beauty taking into account the high value of tourism resources of the Ise-Shima area.


Completed

The non-frame method was, at the beginning, not familiar to the people concerned including local residents, but, as a result of frequent and closer contacts with them, the project won a public support.

Since they identified no change and damage in natural environment and scenic beauty, they satisfied with the project. An agreement on the maintenance practices for vegetation cover was concluded between the communities concerned and the project office.

※Translated from Journal of Japan Sabo Association, Sabou to Chisui, Vol.168, pp.41-43, 2005