Detailed design for the slope face in association with the road disaster prevention work

The face and toe of slope of the prefectural road were deformed due to the passages of a front in August and No. 22 and 23 typhoons in October, 2004. This disaster was likely to be caused by heavy rain, but its mechanism was unsolved. In this project, we worked on identifying the causes to consider the construction method appropriate as countermeasure. Our analysis on hydrologic groundwater revealed that the groundwater level under the slope face rises before and after the road construction, and that the rise in the groundwater level weakens the stability of the slope. Based on these result, we proposed and implemented the construction of a relief well as permanent measure.

Object region

Deformed face of slope

(1) Estimate the occurrence mechanism of deformations

(a) Analyze the existing data

(b) Simulation analysis
- Analysis on a planar flow of the groundwater
-Analysis on the stabilization of the face of slope to take countermeasure against the rise in the groundwater level

(c) Assume the occurrence mechanism of deformation

(2) Study the permanent countermeasures

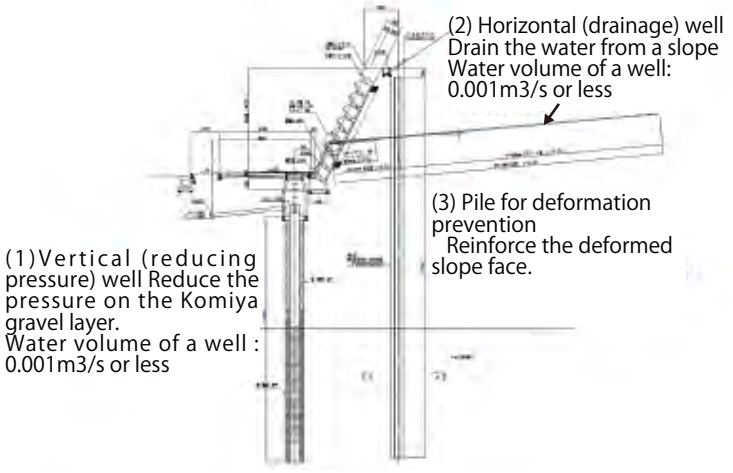
(d) Develop, compare, and select the construction method as countermeasure

(E) Design section

(3) Detailed design for the disaster prevention measure

(F) Detailed design
(Creation of the drawings, Estimation of the quantity, Rough estimate of the construction cost)

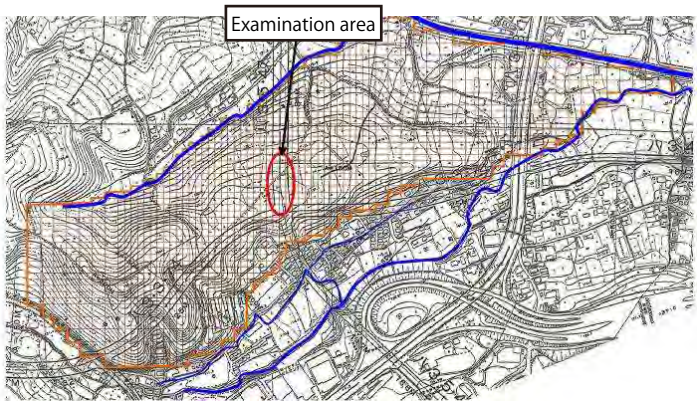
Flowchart



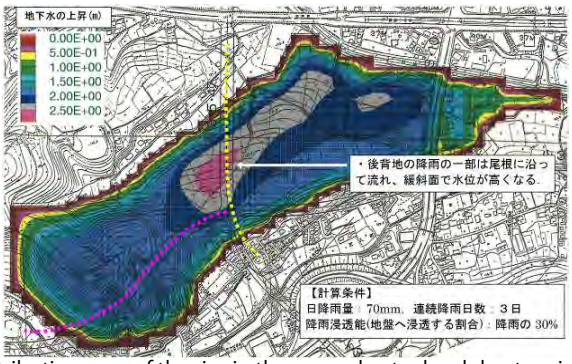
Cross-section of the construction to be conducted as countermeasure

Analysis on the hydrologic groundwater

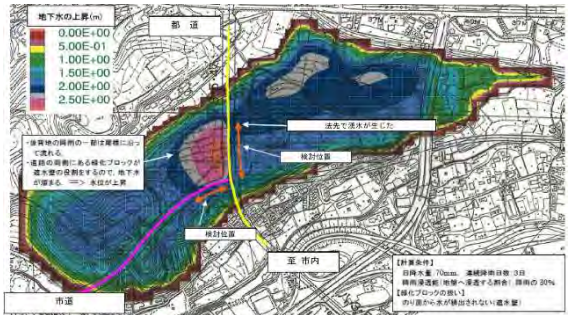
We conducted the hydrologic groundwater analysis (quasi-three-dimensional analysis) [AC-GWAP] to evaluate the groundwater flow of the deformed slope face, and found a large rise in the groundwater level after the road construction.



Analytic region and mesh drawing



Distribution map of the rise in the groundwater level due to rainfall (Before construction)



Distribution map of the rise in the groundwater level due to rainfall (After construction)

Calculation on stability of the slope face using a circular arc method (Sensibility analysis on the groundwater level)

To support the groundwater level rising as a cause for the destabilization of the slope face, we conducted the sensitivity analysis on the groundwater level and found that the slope face got destabilized when the groundwater exceeded a certain level.

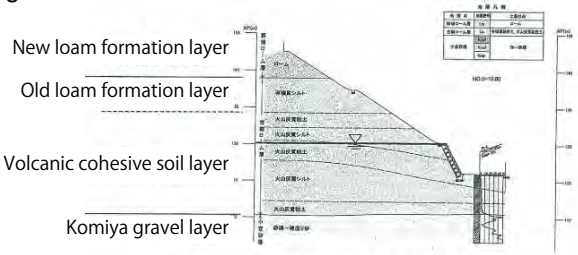
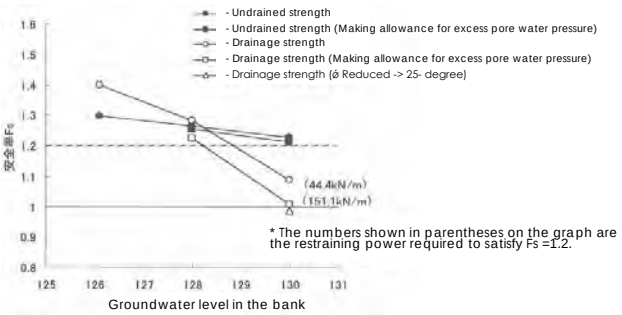


Fig. Soil constants and cross section

*1: Strength parameter on the drawing is the drainage strength unless otherwise stated.
*2: The phreatic surface is kept horizontally to the back of the retaining wall.The base level is set at 130m with reference to the result of groundwater observation.



Relation between the groundwater level in the slope and the safety factor

Unsaturated seepage flow analysis with two-dimensional cross section (Study on time required for the groundwater rising)

The unsaturated seepage flow analysis was conducted to see whether the water level in the bank goes beyond the water head of the measured confined aquifer within a predetermined time, and it revealed that the water level rises while deformation is occurring.

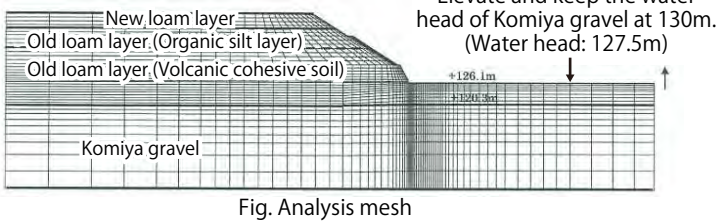
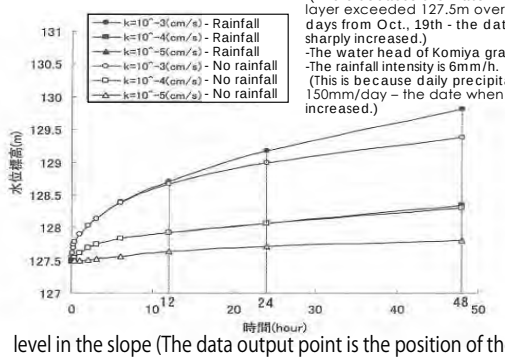


Fig. Analysis mesh

Analysis conditions :
-Initial water head : 127.5m
(This is because the water head of Komiya gravel layer exceeded 127.5m over a period of about 20 days from Oct., 19th - the date when displacement sharply increased.)
-The water head of Komiya gravel is set at 130.0m.
-The rainfall intensity is 6mm/h.
(This is because daily precipitation on Oct. 19th was 150mm/day – the date when displacement sharply increased.)



level in the slope (The data output point is the position of the retaining wall.)