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SETTLEMENT BEHAVIOR OF AN AVALANCHE PROTECTION GALLERY FOUNDED ON LOOSE SANDY SILT

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ABSTRACT: An avalanche protection gallery located in the Swiss Alps was founded on alluvial ground close to the steep rocky mountainside. The rear retaining wall, at a variable distance of a few to twenty meters from the wall of rock, was founded on a strip footing. The footings for the face columns were placed on pile caps supported by driven piles of more than 20 meters length. The settlement and inclination behavior of the rear wall was monitored during backfilling. At the southern end of the structure the observed settlement substantially exceeded the anticipated settlement. Therefore, an additional boring was drilled and in-situ flat dilatometer (DMT) tests were performed. The much thicker and more compressible layer of loose silt and sand encountered explained the settlement of the rear wall and column footings. Computed settlements with dilatation moduli from DMT-tests agree well with the observed settlements. An in-situ coefficient of secondary settlement C_α=0.28 % was obtained.

INTRODUCTION

In mountainous regions with heavy snowfall the protection of traffic and other communication lines from snow avalanches is of major concern. Requirements on safety and all-year-round access has increased over the years. One particular type of protective structure is the gallery or snowshed, basically a short span bridge of large width, that covers the traffic lines and is designed to carry the

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continuous over the entire length and contained minimum reinforcement according to Swiss concrete standards. Joint 41/42 closed by 1/350 or 20 to 30 mm initially opened up by a similar amount, but this caused no problems to the structure since the waterproofing membrane can slide over it.

Transversely, the northern elements 1 through 17 tilted forwards with an inclination of 0.31% to 0.71%. The three southernmost sections tilted backwards, the maximum tilt being 1.5% for section 48.

Auxiliary Measures to Limit Settlements

The retaining wall settled an unanticipated amount. The source of the settlement was the backfill between the retaining wall and the rock face at a distance of 20 m from the southern end. The possibility of substituting the backfill with a lighter material, like burnt clay, was studied. The cost was estimated to be in the order of half a million Swiss Francs. None of the occurred settlement could have been eliminated and the prevention of future settlement was estimated at some 50 mm. Since no visible damage to the structure was detected and the settlement occurred slowly, it was decided to take no action regarding changing the loading conditions. The settlement behavior was monitored until 1990, showing that the rate of settlement was slowing down. No damage has developed so far.

CONCLUSIONS

An avalanche protection gallery founded on a strip footing suffered more than the anticipated settlements without damage to the structure. The reason for the settlement was deeper-lying hard bedrock overlain by lacustrine loose silty and sandy soils. Also the soil was locally looser due to a different depositional environment in a lateral rock ravine in the former lake. The backfill also produced settlements of 24 m long piles located 20 m from the fill. This settlement developed essentially below the pile tip. The observed tilt and distortions of the retaining wall are in the range of limiting published values.

The ground conditions after the occurrence of the unanticipated settlements were investigated using a core boring, while Marchetti flat dilatometer tests (DMT) were also performed. These tests provided data on the compressibility of the soil. Using this data in settlement computations good agreement was shown with the observed settlements. The DMT test is a good tool for the determination of the in-situ compressibility of cohesionless soils.

If the compressibility of the underground had been known prior to construction a much more expensive deep foundation might have been chosen. New insights into settlement behavior of structures were obtained and a very economical construction with guaranteed serviceability and structural safety was achieved.

Coefficients of secondary settlement were estimated which were found to be in good agreement with published data. However, it appears that secondary settlement is also dependent on the size of the applied load.