Integrating Solution for Road Slide Repair, Northern Part of Thailand

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ABSTRACT: The 2-lane highway route number 1004 was the major road to Phrathat Doi Suthep temple and pagoda, landmark of "Chiang Mai", the significant province of northern Thailand. Part of the road was eroded and slide since steep of side slope road to mountain. At Km.12, the road was eroded of side slope through back slope of lower road that may become slide failure in the future. The method of solving was constrained by high traffic and limited width of area. The integrating solving method by using Soil nail and Geogrid reinforced slope during and after construction, pile foundations was applied for firm bearing conditions and indefinite layer of soil foundation. Erosion control mat was applied to prevent surface erosion in the future and long life structure. The post benefit after construction was the widening road as 3-lane traffic service safety.

1 INTRODUCTION

When rainy season was occurred, high runoff water always made erosion and started failure from surface especially steep slope. Northern part of Thailand had contained many area risk of slide failure when was rainy season come. Some areas had heavy land slide, some had erosion, some occurred in important area or in critical situation. (The most cases failure started from eroded surface till slope inclination as over engineering soil properties then started huge sliding) For northern part feature of Thailand, are the mountains.

Chiang Mai was the significant province in northern territory of Thailand, which had a lot of famous sightseeing and temples especially Phrathat Doi Suthep temple. Phrathat Doi Suthep tempe was the most famous temple in Chiang Mai and was the landmark of Chiang Mai because there had a long history for 700 years.

The road to Phrathat Doi Suthep was first built in 1935 by famous monk name "Chru ba srivichai" that to be the name of this road is "Srivichai road". After that, Srivichai road was used to be the main road to Phrathat Doi Suthep temple for Buddhism to come to worship Phrathat Doi Suthep temple and visit Phu Ping Palace which was built in 1962 for the dynasty of Thailand.

Afterwards, Srivichai road was designated by Department of Highway to be route number 1004 of Thailand. Department of Highway had responded for maintenances and repairs the occurred failure and erosion of the road.

This paper contained with the integrating solution for slope repairing of this road with small scale project that could be the model for large scale project in the future.

2 SITE AND DESIGN CONDITIONS

The failure site was occurred on the road to Phrathat Doi Suthep temple and pagoda, the famous temple and landmark of Chiang Mai. A lot number of tourists and local people had come to worship Phrathat that caused this road had high traffic all day. The major problem was repair construction must not affect the traffic during and after construction.

The major constraint for repair construction was the slope stability of existing soil when start excavation. Due to natural of soil, soil particles will move and arrange themselves nearly to friction angle of soil (ϕ). Especially of this case that soil was excavated and had load above existing soil. Hence, repair constructions with conventional construction by benching or any methodologies that do not

improve soil structure were not used. The repair construction had to improve soil structure to make existing soil had steep slope both during and after construction.

Furthermore, no soil profile ready to be the data for designing due to the government process and limited budget. The owner of this project, Chiang Mai highway district II, had inadequate budget for soil investigation both with themselves and external company. Even though the bureau of inspection and analysis from main of department of highway had soil investigation team and had competency to investigate soil. Nevertheless, they had a lot of jobs and queues to investigate soil over country because that time occurred a lot number of landslide all of Thailand. Nevertheless, Chiang Mai highway district II could not wait for investigation team from bureau of inspection and analysis since the road had to be repaired as fast as possible since the failure road was very important for Chiang Mai tourism.

3 PROBLEMS SOLVING SOLUTIONS

From the major problems of this project, the limited space and soil movement after excavation, geogrid reinforcement was used for solving limited space problem. Reinforced slope was the significant way to make steep slope that different from conventional solutions such as benching or gabion. The grass facing of geogrid was another advantage. Green solution for environmental mildness was more preferable for this ancient road than other solutions. Especially if consider the beautiful along the road due to this road was the main road for Chiang Mai tourism and dynasty's palace.

Due to traffic load all day from many people to Phrathat Doi Suthep temple, the existing soil after excavation when start repairing with geogrid reinforcement would move and become to be landslide easily. Soil nail was used for sticking the existing soil during excavation that made existing soil had steep slope and enough road width for traffic.

For the unknown soil properties and profile to be used for designing in this project, raft footing and piles were used for solving this problem. Piles were blown to find firm layer of soil and then raft footing was constructed over the piles caps to support above reinforced structure. Nevertheless, beneath the footing was the existing natural slope which had no erosion protection that may cause erosion and failure in the future. The erosion control mat was used to solve this problem by lying from bottom of footing trough to lower road.

4 CONSTRUCTION SEQUENCE

First step, problem of soil movement when excavated had to be solved. 5-m length of soil nails were used of every 1.5 m. x 1.5 m. to stick vertical existing soil during excavation for repair construction.

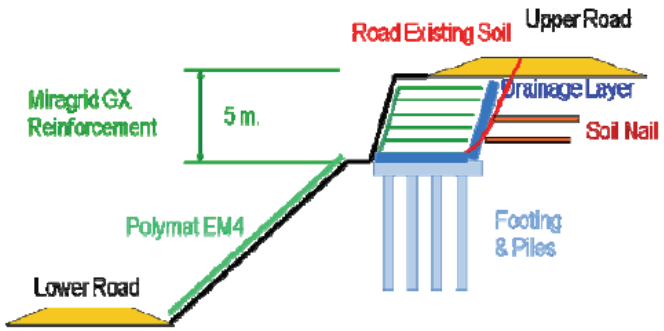

Figure 1: Typical section for repairing solution.

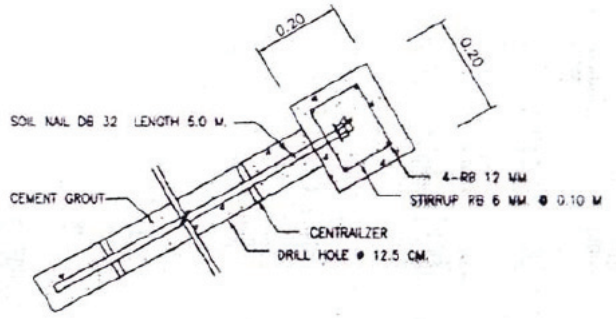

Figure 2: Typical section of soil nail.

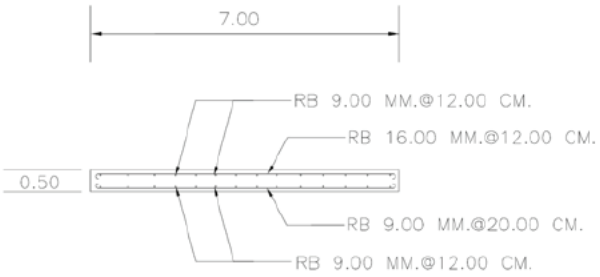

Figure 3: Typical section of footing.

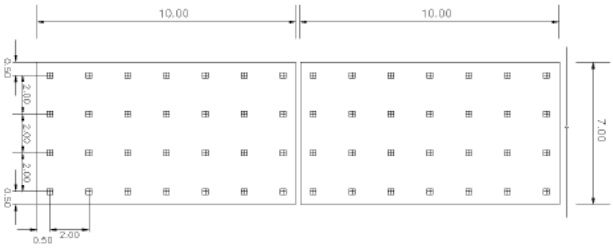

Figure 4: Plan of footing.

Second step, the unknown soil properties and profile had to be solved. Piles and footing had to be used for solving this problem. 6-m length piles had blown to find the firm layer of soil. Then raft footing had been constructed over piles to support above

structure. These footing and piles were used to ensure the above structure that support road repair structure would lay on firm layer.

Figure 5: Soil nail construction.

Figure 6: Piles construction.

Figure 7: Footing construction.

Third step, problem of limited space of repairing was solved by soil reinforcement. 5-m height embankment was reinforced by geogrid to repair failure road and make steep slope under limited space condition. 10 layers of 5-m anchorage length uniaxial geogrid by Miragrid® GX 100/30 were used for major reinforcement and 10 layers of 1.5-m anchorage length biaxial geogrid by Miragrid® GX 80/80 were used for minor reinforcement.

For the reinforced structure, 1-m of crushed rock was laid on lowest of structure to be drainage layer. 0.50 m-thickness of sand was used for drainage blanket between reinforced structure and existing soil. Drainage layer and blanket would relief the water pressure from saturated soil when occurred rainfall. Both drainage layer and blanket were sandwiched with non-woven geotextile, Polyfelt® PS140, for separation between rock, sand and existing, backfill fined grain soil.

Figure 8: Drainage layer construction.


Figure 9: Geogrid (Miragrid®GX) reinforced slope and Erosion control mat (Polyfelt®Polymat) construction.

After finished reinforced structure construction, geomembrane (HDPE:High Density Poly Ethylene) was laid above reinforced structure to prevent upcoming rainfall. The geomembrane would prevent water from rainfall that would cause soil saturated and made soil particles had less cohesion that cause soil particles started moving and became to occur landslide in the future.

When finished main solutions for failure road repairing, the preventing solution of landslide in the future was using the erosion control mat, Polyfelt® Polymat EM4 were used to prevent erosion of rainfall and runoff water that may erode soil surface and make landslide in the future. The erosion control mat was laid from bottom of footing trough to lower road.

Figure 10: Finish project.

5 CONCLUSION

For complex problems which have many constraints, integrating solution that contains with many solutions is the great alternative to solve problems. Not only solve the confront problems but also prevent the upcoming problems in the future. Because of there could solve more than 1 problem, each solution could solve different problem.

For this project, piles were used to solve uncertain soil profile, raft footing was used to solve uncertain bearing capacity of existing soil, soil nails were used to solve existing soil movement when excavated, reinforced slope was used to solve limited space of construction and limited width of road, geogrid grass facing was used to environment mildness along the road, drainage blanket was used to relief water pressure in saturated soil, HDPE was used to prevent rainfall to soak reinforced structure, erosion control mat was used to prevent soil erosion from rainfall and runoff water. These are example for integrating solutions that could be the model for bigger project in the future.

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