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Foreword

Alhamdulillah. First of all a big thank you and congratulations to the Editorial Board of *Esteem Academic Journal* of Universiti Teknologi MARA (UiTM), Pulau Pinang for their diligent work in producing this issue. I also would like to thank the academicians for their contributions and the reviewers for their meticulous vetting of the manuscripts. A special thanks to University Publication Centre (UPENA) of UiTM for giving us this precious opportunity to publish this first issue of volume 5. In this engineering issue we have upgraded the standard of the manuscript reviewing process by inviting more reviewers from our university as well as other universities in Malaysia. We have embarked from previous volume to establish a firm benchmark and create a journal of quality and this current issue remarks a new height of the journal quality. Instead of publishing once in every two years, now *Esteem* publishes two issues annually.

In this issue, we have compiled an array of 13 interesting engineering research and technical based articles for your reading. The first article is entitled "The Response of Tube Splitting on Circular Tubes by Using Various Types of Semi-angles Dies and Slits". The authors, Mohd Rozaiman Aziz and Roslan Ahmad investigated the axial splitting and curling behavior of aluminum circular metal tubes which was compressed axially under static loading using three types of dies with different semi-angles. The authors concluded that the introduction of slit to the specimen is necessary to initiate slitting rather than inversion.

Salina Budin, Aznifa Mahyam Zaharudin, and Sugeng Priyanto presents a model of energy conversion and impact energy generation during collision based on free falling experiment, which is closely resembles direct collision between ball and inner wall of the vial. Simulation results from the proposed impact energy model demonstrated that the impact energy generated during the collision is strongly influenced by the thickness of the work materials and reaches zero at certain value of the work materials thickness, which increases with an increase of falling height.

Salina Alias, Caroline Marajan and Mohamad Azrul Jemain wrote an article that looks at adsorption of zinc from waste water using bladderwort (*Utricularia vulgaris*). In batch adsorption studies, data show that dried bladderwort has considerable potential in the removal of metal ions from aqueous solution. The fourth article written by

Muhammad Khusairi Osman et al. looked at 3D object recognition using affine moment invariants and Multiple Adaptive Network Based Fuzzy Inference System (MANFIS). The experimental results show that Affine Moment Invariants combined with MANFIS network attain the best performance in both recognitions, polyhedral and free-form objects.

The article entitled "Construction Waste Management Methods Used by Contractors in the Northern Region" authored by Siti Hafizan Hassan, Nadira Ahzahar and Mohd Nasrul Nizam Nasri reports an ongoing study on the use of construction waste management methods by contractors and its impact on waste reduction in the Northern Region. In conclusion, the sizing and amount of materials to be ordered to reduce wastage is significant in reducing construction waste generation waste, alleviating the burden associated with its management and disposal. The sixth article by Muhammad Sofian Abdullah et al. examined on the performance of Performance of Palm Oil Fuel Ash (POFA) with lime as stabilizing agent for soil improvement. The authors concluded that POFA can be used to treat the silty soil as well as to reduce the environmental problem.

The seventh article penned by Soffian Noor Mat Saliah, Noorsuhada Md. Nor and Megat Azmi Megat Johari presents the results of an experimental study on the interfacial bond strength (IBS) of polypropylene fiber concrete (PFC). It was found that the interfacial bond strength between concrete and reinforcement bar was not affected by the inclusion of polypropylene fibers. However, concrete containing fibers exhibited no breaking of concrete and no debonding of reinforcement. The article by Juliana Zaabar and Rusnani measures, evaluates and analyzes the network link performance of fiber optic cable using OTDR. The authors suggested that the major loss for these measurements is connector loss. Preventive maintenance will increase the life time of fiber optic. From some of the findings, the PVC dust cap has been identified as a main source of contamination for the SC connector.

The article entitled "Symbolic Programming of Finite Element Equation Solving for Plane Truss Problem" by Syahrul Fithry Senin proposed a plane truss problem to be solved by finite element method using MAPLE 12 software. The numerical solution computed by the author was almost matched with the commercial finite element software solution, LUSAS. The tenth article by Nor Azlan Othman, Nor Salwa Damanhuri and Visakan Kadirkamanathan presents a detail review of fault diagnosis in rotating machinery using pattern recognition technique. The authors proposed a solution based on artificial neural network (ANNs) which is Multi-Layer Perceptron (MLP). The authors concluded that the proposed methods are suitable for rotating machinery on fault detection and diagnosis.

The eleventh article is entitled "RAS Index as a Tool to Predict Sinkhole Failures in Limestone Formation Areas in Malaysia". Damanhuri Jamalludin et al. found that, using the RAS classification method, the prediction of sinkhole occurrences can be easily be made by simply knowing the weekly rainfall especially in areas having limestone as the bedrock. The twelfth by Muhammad Hafeez Osman et al. explores cases regarding the histories of rock slope repair and stabilization of unstable boulder along the road from Bukit Cincin to Genting Highland and along the road from Gap to Fraser Hill. The last article is "Soil Nail and Guniting Works in Pahang". The authors, Damanhuri Jamalludin et al. concluded that if the stability of the embankment needs to be improved, soil nails can be installed and embankment surface can be covered with gunite to prevent erosion.

We do hope that you not only have an enjoyable time reading the articles but would also find them useful. Thank you.

Mohd Aminudin Murad
Chief Editor
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Experience in Stabilisation of Rock Slopes in Pahang

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ABSTRACT

Two cases regarding the histories of rock slopes repair and stabilisation of unstable boulder along Bukit Cincin to Genting Highlands and along the road from Gap to Fraser Hill in Pahang are presented. On 30th October 1997, 10 locations of road failure occurred along the road from Bukit Cincin to Genting Highland and in December 1997, 33 locations of slope failures occurred along the road from Gap to Fraser Hill during the monsoon seasons. Loose and fractured rocks were removed and covered with polyvinyl chloride (PVC) coated anchored wire netting to prevent rocks fall while rock buttress was used to stabilise unstable boulders in soil slope. The repair works at Location 5 along the road from Bukit Cincin to Genting Highland where highly fractured rock slope and unstable boulder in soil slope occurred and the repair works at Location 10 along the road from Gap to Fraser Hill where highly fractured rock slope occurred are fully discussed in this paper.

Keywords: *Highly fractured rock slope, rock netting, unstable boulder, rock buttress*

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Introduction

Failures in Soil Slopes with Boulders

In Malaysia, like in many other tropical and subtropical countries, rocks are weathered greatly as a result of warm and wet climatic conditions. Deep cuttings into residual soils suffer severe instability problems particularly during the wet seasons between October and February.

Most of the landslides or slope failures in Malaysia are triggered by prolonged intense rainfall. Heavy rainfall can result in excessive infiltration especially when the soil is very permeable; adequate surface drainage is not provided; slope vegetation is not complete or ineffective (Md. Noor, Mahamood, Jamalludin, Mohamed Jais, 2006). The addition of rainwater into slope (saturation) increases the stress and at the same time also significantly reduces the shear strength due to loss of suction. Brand (1985) has observed that the landslides in Hong Kong depend on the intensity of short period rainfall with a threshold value of about 70 mm/hour. Many experts, including Kassim, Gofar, Mokhtar & Lee, (2006) and Mohd Ishak, Omar, Gazali, Jamalludin (2006) also reported that the failure of residual soil slope is often attributed to the effect of rainfall infiltration. Boulders in residual soil matrix are due to the incomplete weathering of parent rocks. Rainwater flowing down and around boulders in soil slope will cause erosion to the soil supporting the boulders and cause them to be unstable.

Failures of Rock Slopes

Rock slope instability is mainly due to discontinuities such as relic joints, stratification, foliation, cracks, bedding planes, fractures and faults, which as mentioned by Tan (2000) and Othman et al. (2006) are treacherous and difficult to be identified. Most of the joints and cracks are formed as the molten rock is solidified into hard igneous rocks while bedding planes are formed as the sediments settle in layers before they are solidified into sedimentary rocks. Highly fractured rocks are due to extreme folding of rock bedding or due to shearing of rock mass near fault zone.

History of the Road from Genting Highlands to Bukit Cincin

The Genting Highland to Bukit Cincin road links Genting Highland town and the Department of Civil Aviation (DCA) Radar station. Figure 1 shows the location of Genting Highlands town while Figure 2 shows the location of the unstable rock slope and boulder at Location 5. The total length of this hilly and winding road is about 2 km and its width is 3.5 m. It was constructed in 1975. On 30th October 1997, 10 locations of road failures occurred during the monsoon seasons. Of these 10 repaired locations, only the repair works at Locations 5 is fully described in this paper. The cost to repair failures at Location 5 was RM20,000.00 and the total cost to repair the whole 10 locations was RM3.7 million.

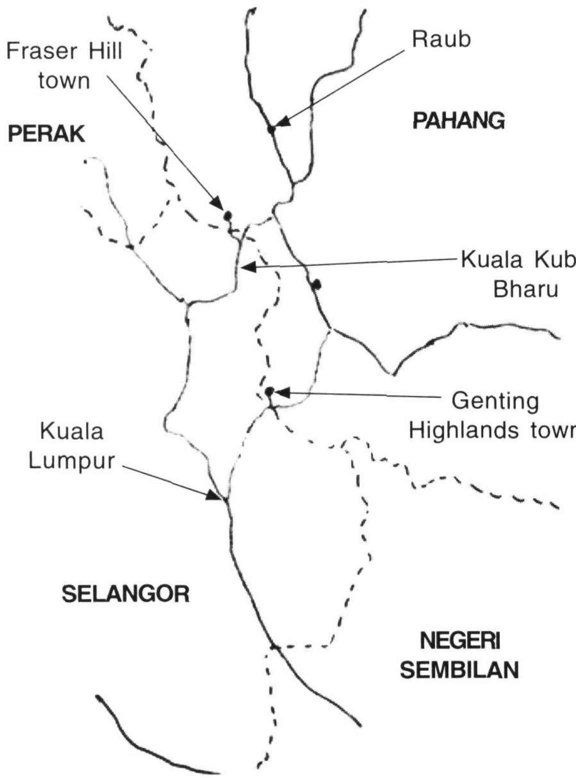

Figure 1: Location Plan of the Fraser Hill Town and Genting Highlands Town

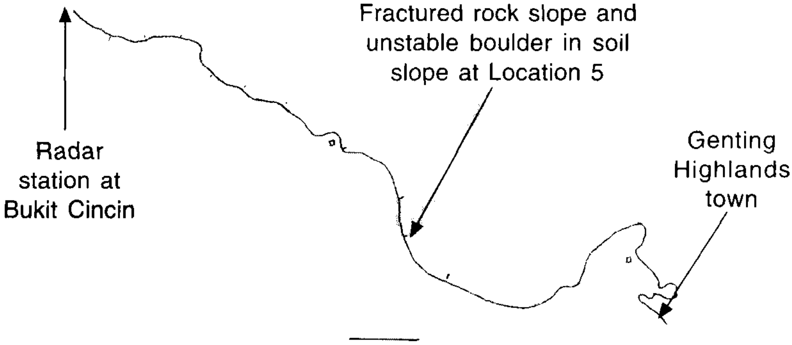

Figure 2: Fractured Rock Slope and Unstable Boulder in Soil Slope at Location 5 along Genting Highlands Town to Bukit Cincin Road

History of the Road from Gap to Fraser Hills

The Gap route to Fraser Hill links the town of Kuala Kubu Bharu in the state of Selangor and Raub in the State of Pahang via the hill resort of Fraser Hill, which is about 300 m above the mean sea level. Figure 1 shows the location plan of Fraser Hill. The newly constructed road is supposed to ease the congestion of the present route to Fraser Hill, which is quite narrow and cannot cater for two-way traffics. Before the completion of the new route, vehicles going up and down the Fraser Hill have to queue up and wait for their turn. Once completed, the existing route was used as the road leading up to Fraser Hill from Gap while the new route allowed vehicles to travel down from Fraser Hill to Gap. The new Gap route was about 9 km long and the total cost was RM25 million. The road has a maximum climbing gradient of about 15%. The slope failures occurred in December 1997 during the monsoon season and they occurred during the defect liability period which ended in August 1998. After the occurrence of the slope failures, an assessment of the new road was carried out to identify the existing and potential slope instability problems. A selective tender was called in May 1998 so that repair works can be carried out. A total of 33 locations of slope failures were identified along the route. Only the repair works at Location 10 is fully described in this paper. Figure 3 shows the location of the highly fractured rock slope at Location 10.

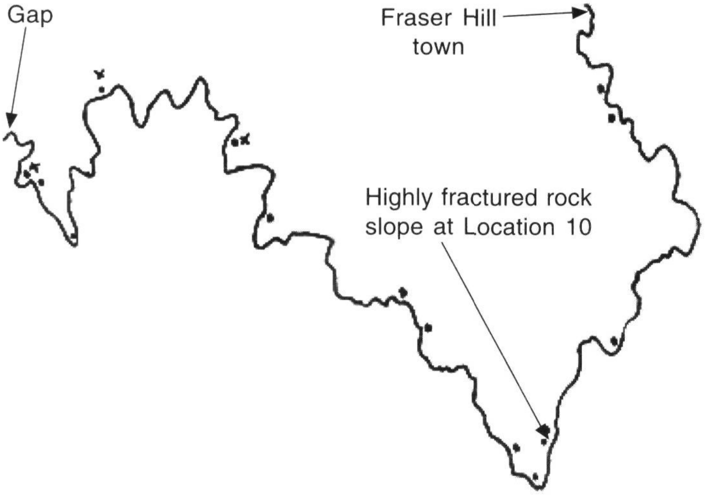

Figure 3: Plan Showing Highly Fractured Rock Slope at Location 10 along the Road from Gap to Fraser Hill Town

Description and Causes of Slope Failures at Location 5

At Location 5, some rock outcrops were observed on the cut slope. Loose and fractured rocks were observed at the rock slope and unstable boulder, which protruded out from the cut soil slope, presented danger to the road users. The exposed rock slope was essentially of grade I to II granite rocks. Figure 4 shows the plan locations of the fractured rock slope and the unstable boulder.

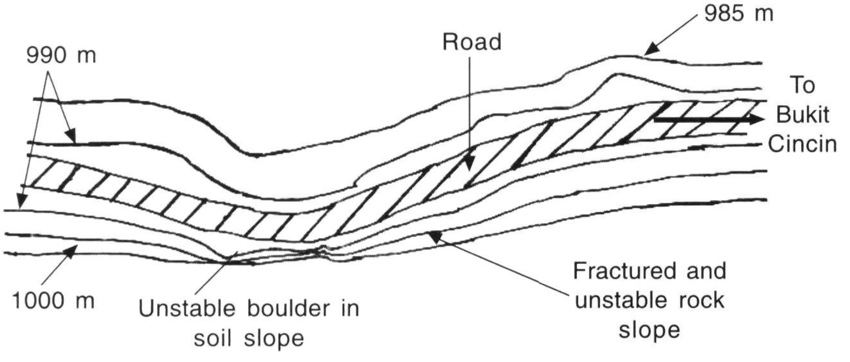

Figure 4: Unstable Boulder and Fractured Rock Slope at Location 5

Figures 5 and 6 show the fractured rock slope at Location 5. Instability in the fractured rock was due to the inherent cracks or joints and became worst due to weathering process that caused loosening of rock materials (Ahmad, Mohamed, Mahamood, 2000a). Cracks can be seen on the vertical rock surface.

Figure 7 shows the unstable boulder in the soil slope. Instability of the boulder was due to surface erosion of the fine materials surrounding the boulder when the rainwater flow down the slope surface (Ahmad, 2000b).

Description and Causes of Failures at Location 10

The angle of the rock slope was about 60 degrees with slope height of 15 m. The rock, highly fractured granite, was slightly weathered and

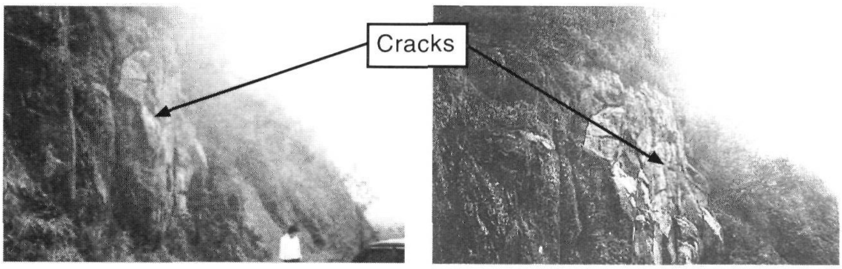

Figure 5: Fractured Rock Slope at Location 5

Figure 6: Closed Up View of the Rock Surface. Cracks can be Seen on the Vertical Rock Surface

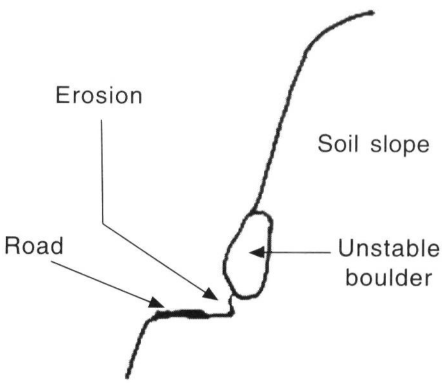

Figure 7: Cross Section of the Soil Slope with Unstable Boulder

was characterised with discontinuties. The engineering geology of the area consisted mostly of granitic formation with weathering grades ranging from Grade II (slightly weathered rock). The highly fractured rock was either due to extreme folding of rock bedding or due to shearing of rock mass near fault zone as described by Ahmad et al. (2000a) and Jamaluddin (2007). Since the rock slope was highly fractured, it was unstable and rocks fall could occur at any time. Figure 8 shows the location of the highly fractured rock slope while Figure 9 shows the cross section of the highly fractured rock slope at Location 10. Figures 10 and 11 show the highly fractured rock slop.

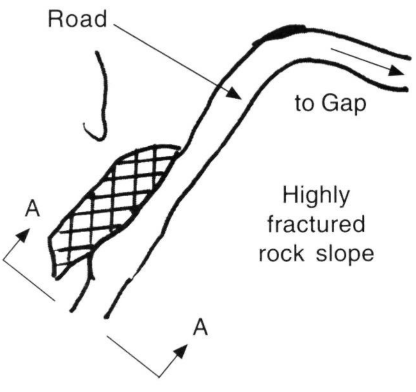

Figure 8: Plan of the Highly Fractured Rock Slope at Location 10

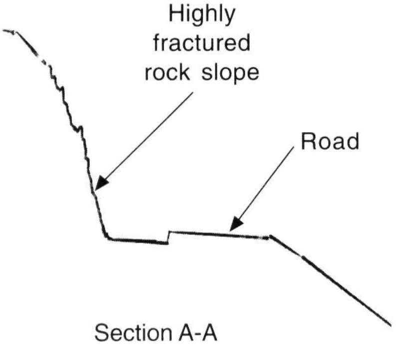

Figure 9: Cross Section of the Highly Fractured Rock Slope at Location 10

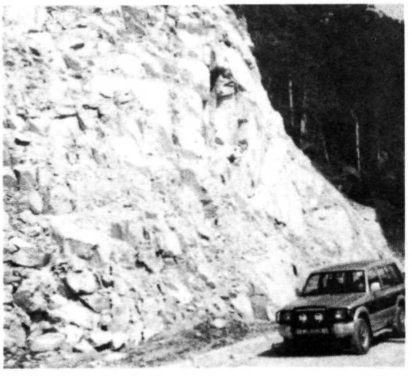

Figure 10: Close Up View of the Highly Fractured Rock Slope at Location 10

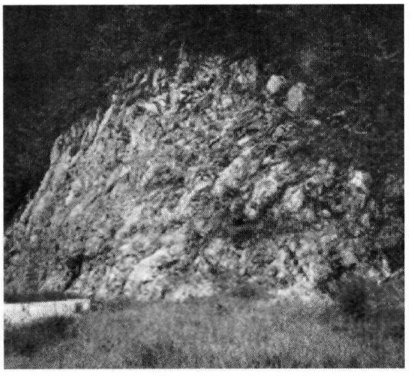

Figure 11: Another View of the Highly Fractured Rock Slope at Location 10

Repair Works at Location 5

Loose and Fractured Rocks at Location 5

Loose and fractured rocks were removed before the rock surface was covered with rock netting. Figure 12 shows the typical cross section of the repaired rock slope surface where rock was covered with wire netting and fixed to the rock surface using rock bolts. The rock netting consisted of double twisted hexagonal PVC coated wire mesh, which was a product of Maccferri Sdn. Bhd. Rock bolts of size 35 mm diameter and 500 mm long were used to fixed the rock netting to the rock surface with the help of anchor wires. The anchor wires and rock bolts fixed the rock netting firmly on to the rock surface. A hole of 50 mm in diameter was drilled in the rock mass. Rock bolt was then placed in the hole and later grouted. The rock bolts were placed at a grid of 0.5 m spacing as designed by Bumi Hiway (1998). Figure 13 shows the typical cross section of the rock bolts fixed into the rock mass. Figures 14 and 15 show the repaired rock slope covered with rock netting after all the loose and fractured rocks were removed. Figure 16 shows the rock bolt with the help of anchor wire fixing the rock netting firmly onto the rock slope surface.

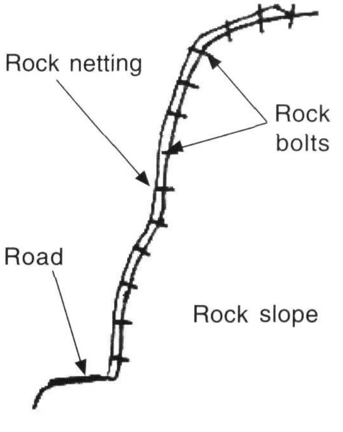

Figure 12: Rock Slope Covered with Rock Netting at Location 5

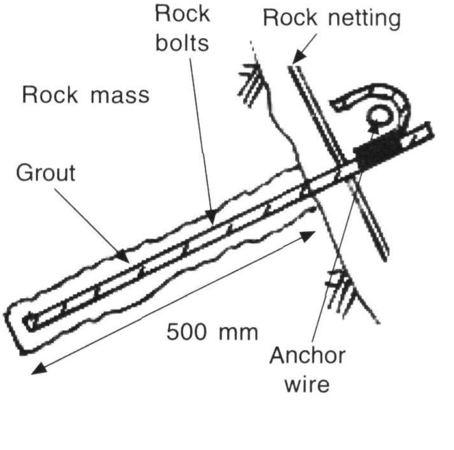

Figure 13: Typical Cross Section of the Rock Bolt for Repair Work at Location 5

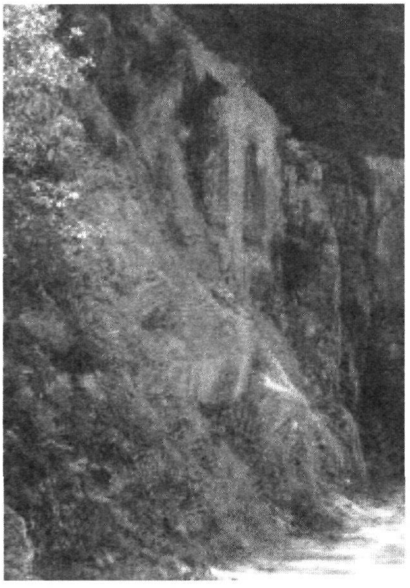

Figure 14: Loose and Fractured Rocks were Removed and Covered With Rock Netting at Location 5

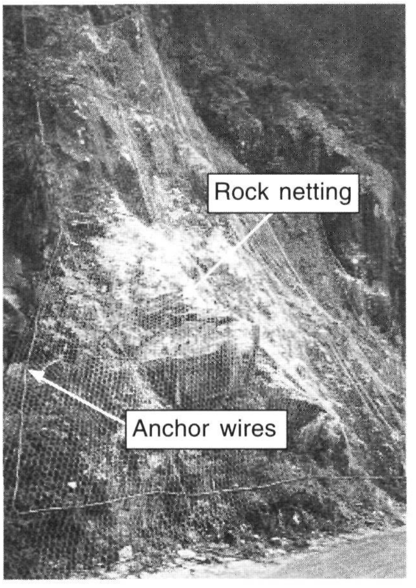

Figure 15: Another View of the Rock Slope Covered with Rock Netting at Location 5

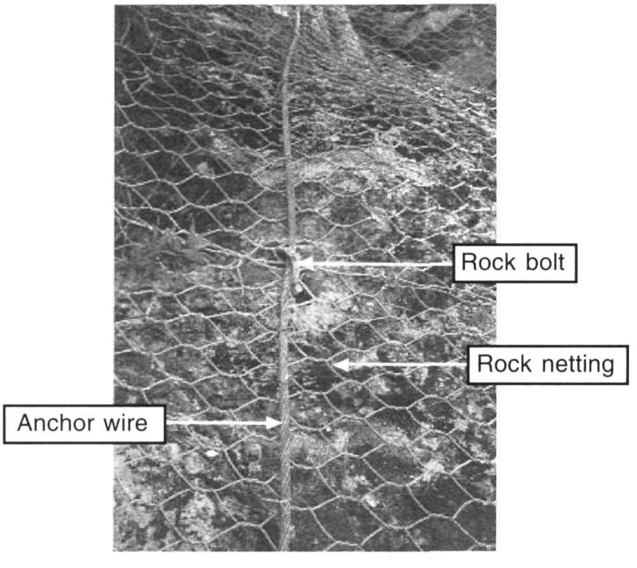

Figure 16: Rock Netting Firmly Fixed to the Rock Slope Surface by Rock Bolt with the Help of Anchor Wire at Location 5

Unstable Boulder at Location 5

Loose soil surrounding the unstable boulder was removed. Stone pitching rock buttress was then constructed under the boulder as described by Bumi Hiway (1998). Figure 17 shows the detail of the repair works to stabilize the unstable boulder.

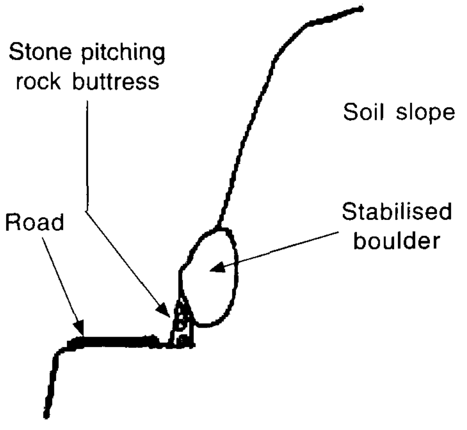

Figure 17: Stone Pitching Rock Buttress was Constructed under the Boulder at Location 5

Repair Works at Location 10

Highly Fractured Rock Slope at Location 10

All loose and fractured rocks were removed and the firm rock surface was covered with wire netting. The netting was fixed to the rock surface using 1 m long rock bolt at 2 m vertical and horizontal spacing as described by Terratech Consultant (1998). Figure 18 shows the cross section of the repaired rock slope while Figure 19 shows the completed repair works at Location 10.

Effectiveness of Rock Wire Netting

Figures 20 and 21 show how effective the usage of rock wire netting in preventing loose rocks from falling onto the road. The falling is controlled and loose rocks are trapped behind the netting.

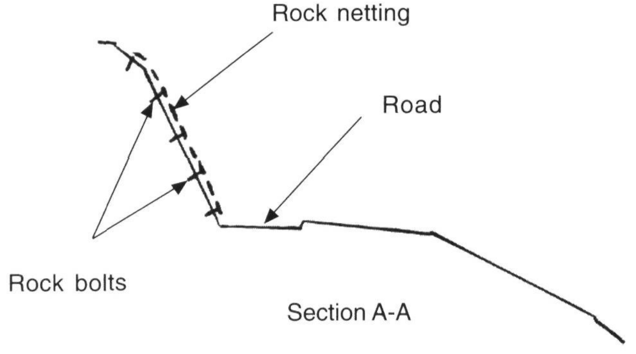

Figure 18: Cross Section of Repaired Rock Slope Using Wire Betting at Location 10

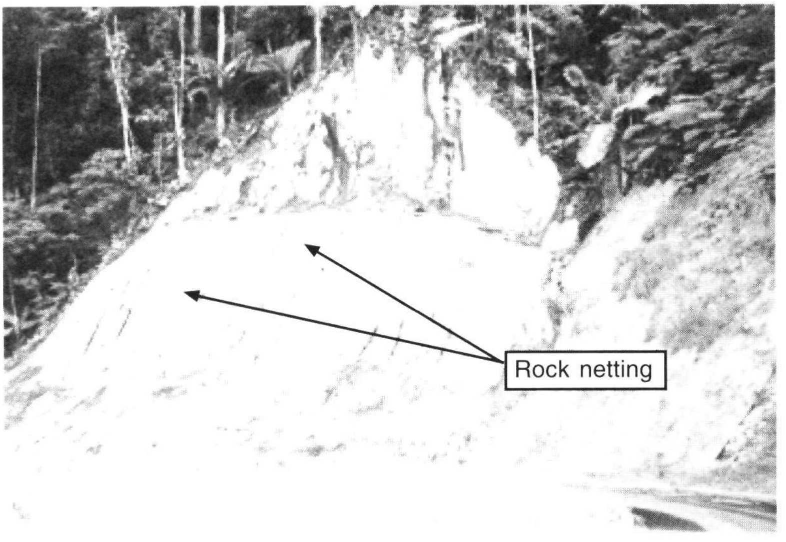

Figure 19: Loose Rocks were Removed and Firm Rock Surface was Covered with Rock Netting at Location 10

Conclusion

After removing all the loose and fractured rocks, rock bolts and anchor wires are used to fix the rock netting firmly to the rock slope surface to prevent rocks fall. Stone pitching rock buttress is constructed under an unstable boulder to stabilize it in soil slope.

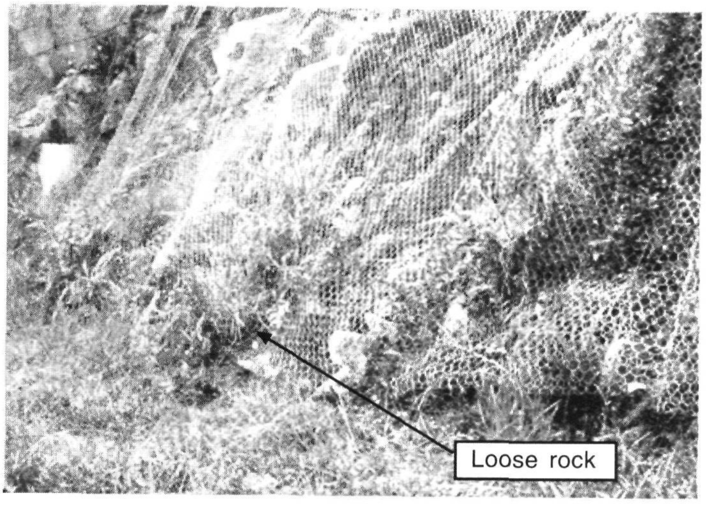

Figure 20: Loose Rocks are Trapped behind the Wire Netting

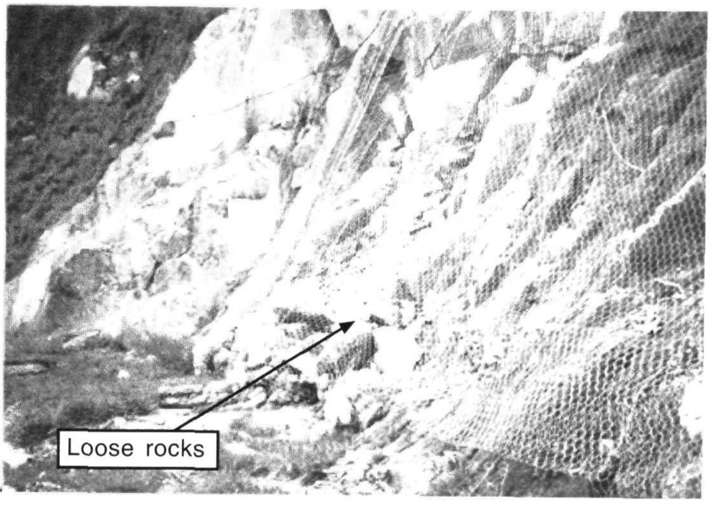

Figure 21: Another View where Loose Rocks are Trapped behind the Wire Netting

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