

A Study on Rock units for Landslide Hazard between Yinmabin and Kalaw areas, Mandalay Region and Shan State (South)

Dr. Me Me Thein

Professor & Head, Department of Engineering Geology,
West Yangon Technological University, Yangon, Myanmar

How to cite this paper: Dr. Me Me Thein "A Study on Rock units for Landslide Hazard between Yinmabin and Kalaw areas, Mandalay Region and Shan State (South)" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.2558-2563, <https://doi.org/10.31142/ijtsrd28041>



IJTSRD28041

Copyright © 2019 by author(s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



ABSTRACT

The research area is situated along the Thazi-Taunggyi road-section and Thazi-Shwenyaung railway-section in western part of the Shan Plateau. It is one of the most socio-economically important transportation routes in Myanmar. Most of the land slide hazards occur annually along the pathways for transportation because of the mountainous terrain area with high steep cutting slopes.

The study area involves a sequence of Yinmabin metamorphic complex (Early Paleozoic), Lebyin Group (Early Carboniferous), Plateau Limestone Group (Middle Permian-Middle Triassic), Loi-an Group (late Middle Jurassic-early Late Jurassic), Pyinnyaung Formation (Late Jurassic – Early Cretaceous), Kalaw Red Bed (Cretaceous) and Alluvium (Holocene).

The various types of rock units are igneous and meta-igneous rock units, metamorphic rock units, sedimentary and meta-sedimentary rock units. The igneous rock units are also comprised the granitic rocks, dioritic rocks, rhyolite and biotite microgranite. Metamorphic Rock units of Yinmabin Metamorphic Complex are low to medium-grade metamorphosed pelitic rocks, medium to high-grade metamorphosed quartzo-feldspatic rocks and medium-grade metamorphosed calcareous rocks. The Lebyin Group consists of greywackes, pebbly mudstone, quartzite and shales. The Plateau Limestone Group is composed of medium to thick-bedded, light gray to bluish gray calcitic limestone, dolomitic limestones, brecciated limestone and argillaceous calcitic limestone. The two Jurassic units consists of interbedded sequences of sandstone, siltstone, shale. Generally the rocks of the Loi-an Group are turbiditic nature of siliciclastic sedimentary rock units. Kalaw Red Beds are totally of continental origin of fluvial fan conglomeratic deposits containing conglomeration, thin to medium-bedded sandstone, siltstone and shale.

Moreover, the study area is structurally unstable because it lies in the Shan Scarp Fault Zone. So, most of the landslide types occur in this area. Wedge Failure and plane failure are the common type of landslides and other types occur as minor.

KEYWORDS: Landslides, wedge failure, plane failure

I. INTRODUCTION

1.1. Location and Accessibility

The research area is situated along the Thazi-Taunggyi road-section and Thazi-Shwenyaung railway section, between Yinmabin and Kalaw area, Mandalay Region and Shan State (South). The area lies between north latitudes $20^{\circ} 47' 30''$ to $20^{\circ} 49' 15''$ and east longitudes $96^{\circ} 15' 30''$ to $96^{\circ} 33' 15''$, in one inch topographic map No. 93 D/5, D/6 and D/9 (Figure1). It is about 35 miles long in east-west direction from the eastern border (from Yinmabin) to the western border (to Kalaw). The car-section (Yinmabin to Kalaw) is 45 miles long and the rail-way section (Yinmabin to Kalaw) is 60 miles long.

1.2. Physiography

Physiographically, the study area is divided into three parts. They are (1) the western part of the area is rugged terrain where Yinmabin Metamorphic Complex and Lebyin Group are exposed. (2) the middle part is hilly with steep sided hills comprising Mesozoic clastic. (3) the eastern part is characterized by ridge and valley topography where Kalaw

Red Bed fanglomerates and soft sedimentary rocks were formed. The average elevation of the study area is 500 meters above sea-level.

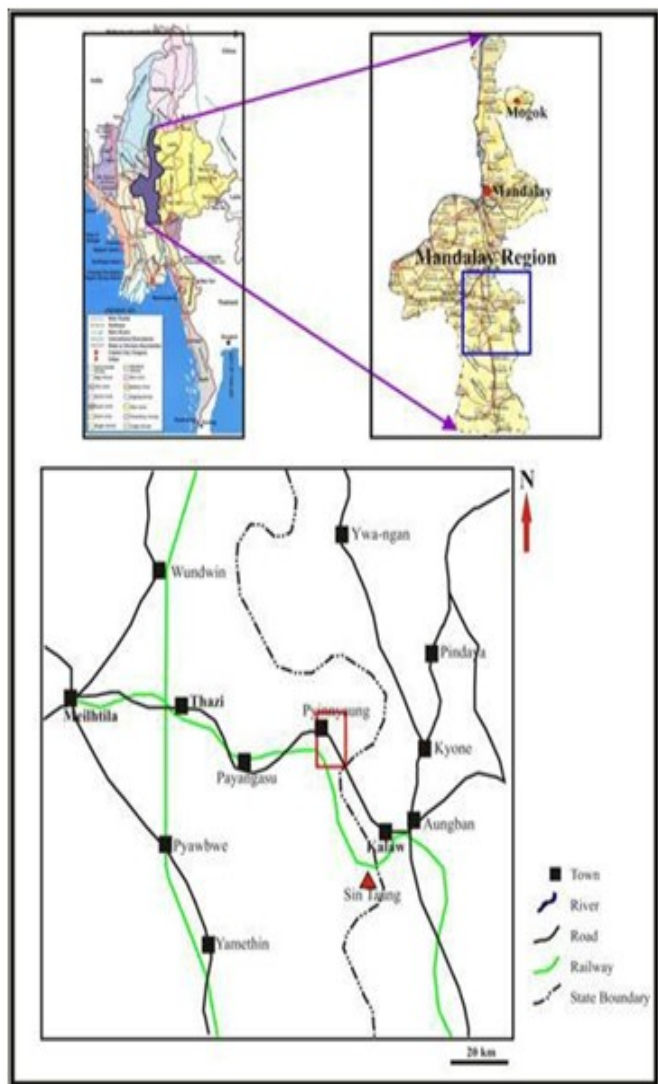


Figure (1) Location map of the study area.

1.3. Drainage Pattern

There are five types of drainage pattern. They are dendritic pattern, sub-dendritic pattern, radial pattern, trellis pattern and sub-parallel pattern. Dendritic pattern and sub-dendritic pattern are occurred at the central and western part of the study area. Radial pattern is formed at the forming of solution holes in karst topography of carbonate rock units of Plateau Limestone Group. Trellis pattern and sub-parallel pattern is also found in the eastern part of the sandstone and shale interbedded area.

The main stream is Myiththa Chaung which flows from east to west. The other tributaries are Thedashe Chaung, Thayet Chaung, The Chaung and Mobinson Chaung which flows from north to south in the western part of the area. The next streams, Thepanbauk Chaung, Gegauk Chaung, Kalaw Chaung are also affected to the road-sections in the eastern part of the area.

1.4. Climate, Vegetation and Rainfall

The study area is tropical climatic zone. There are 60% reserve forests covering the area. The forest is dense and many kinds of trees are observed. They are teak, hardwood, bamboo, etc.

According to the rainfall data, highly rainfall is significant in rainy season, especially June to September. The highest rainfall data are in August, 2011 and it continued to September and October in 2011.

II. Regional Geologic Setting

2.1. Rock Sequence

The generalized rock sequences are as follows;	
Alluvial Sediments	
Alluvial soils	Holocene
Travertine Deposits	Pleistocene
Sedimentary Rocks	
Pyinnyaung Formation	Late Jurassic – Early Cretaceous
Loi-an Group	late Middle Jurassic – early Late
Jurassic	
Plateau Limestone Group	Middle Permian – Early Triassic
Metasedimentary Rocks	
Lebyin Group	Lower Carboniferous
Yinmabin Metamorphics	
Calc-Phyllite and Sandy Phyllite	Early Paleozoic
Igneous Rocks	
Dyke	

2.2. Regional Geological Structure

The area occupies the western part of the Shan Plateau which has become a stable block since the close of Mesozoic. It is a deformed zone in which large –scale intrusion of the granitoid and dioritic rocks occurred probably during Late Mesozoic. The study area is bounded by two major fault zones, the Sagaing Fault Zone in the west and the Pyinnyaung Scarp Fault Zone in the east. The major lineament, Pyinnyaung Scarp Fault extends NNW-SSE direction pass through Pyinnyaung area. In this area, Plateau Limestone was up block-faulted to appear as the high and rugged mountain ranges. There are four major longitudinal faults of which two are major thrusts. One is the Hkweyok-Pinmon thrust in the east along which the Plateau Limestone was thrust upon the younger Loi-an Group. The other is situated west of Lebyin along which the Lebyin Group was thrust upon the younger Kalaw Red bed. There are many cross-faults which cut and off-set the thrust and parallel longitudinal faults.

The Yinmabin metamorphics are folded into a major south-plunging syncline, Kywedatson Syncline. The Carboniferous (Lebyin Group) beds are folded into an anticline at Hlanyotaung situated west of Pyinnyaung station. Tightly folding, locally overturned and obvious isoclinal folding can be observed in the Loi-an Group indicating that these rocks had gone intense deformation. Kalaw Red Beds are broadly folded.

The prominent joint sets are roughly (1)ENE-WSW and NNW-SSE in the granitic rocks(2)NNE-SSW and ENE-WSW in the Yinmabin metamorphics (3) E-W and N-S in the Lebyin rocks (4)WNW-ESE and NNE-SSW in the Jurassic rocks.

According to the satellite image interpretation, there are four major fracture systems of NNW-SSE, NE-SW, NW-SE and ENE-WSW in directions.

2.3. Distribution of Major Rock Units

The bulk of the igneous complex constitute now-porphyrific and predominantly biotite-bearing granites, diorites and microgranite which was emplaced into a belt of low to medium grade metamorphic (of originally lower Paleozoic

age) and a sedimentary sequence of Upper Paleozoic and Upper Mesozoic ages. It is the most widely distributed rock units between Yinmabin and Yebokson area.

The Yinmabin Metamorphic Complex is occurred to the Yinmabin area. It consists of calc-silicate, migmatite, schist, gneiss and phyllites.

The Lebyin Group consisting of greywackes, indurated mudstones, pebbly mudstones, tuffaceous sandstones and conglomerates are occurred along the railway section near Lebyin village. The carbonate sequence of the Plateau Limestone Group consists of brecciated dolomitic limestone, dolomite and lithographic limestone. The carbonate rock units are mainly exposed in Pyinnyaung village (on the car-section and on the railway section). The siliclastic sedimentary rocks units of Loi-an Group and Pyinnyaung Formation are exposed in the hilly area with steep sided hills. These units are distributed along the road-section between Pyinnyaung and Kyatsakan villages and the railway-section between Lebyin station and Myindaik station. The continental deposits of Kalaw Red Beds are fanglomerates and clastic sedimentary rocks. These rocks units are widely distributed the surroundings Kalaw village.

III. Major Rock Types

3.1. Igneous Rock Units

Biotite bearing granites, microgranites, leucogranites and diorite are well exposed at car-road section between Yinmabin and Pyinnyaung (Figure 2&3). They are also occur as dykes or veins in the form of igneous intrusions into the Yinmabin metamorphic complex. Most of the outcrops of biotite bearing granites are highly weathered condition and yellowish-brown in nature. It is medium-grained and composed of orthoclase feldspar, quartz and biotite. It is well jointed, highly deformation and exfoliation nature is present (Figure 4).

3.2. Yinmabin Meramorphic Complex

The rock units are suffered by regional metamorphism and contact metamorphism. Phyllites and calc-phyllites are major rock units (Figure 5&6). Spotted schists and spotted phyllites are found along the contact zones between the granites and the Lebyin clastic in some areas, e.g .east of Yebokeson (Figure 7). Calc-phyllite is fine-grained and moderately weathered. Migmatite can be found as folded structure (Figure 8&9).

3.3. Lebyin Group

This group is consisting of indurated mudstone, greywacke, pebbly mudstone, conglomerate and tuffaceous sandstone. These rock units are well exposed along the railway section between Pyinnyaung station and Lebyin station.

3.4. Plateau Limestone Group

The rocks of the Plateau Limestone Group are well distributed along the railway section between Ngok and Hkweyok railway station, occupying the whole of Pinmon Taung (4495') and extended north up to Pyinnyaung scarp and south down beyond Sindaung (6015'). Brecciated dolomitic limestone, calcitic limestone, bedded limestone and lithographic limestone are widely distributed along the car-road section between Pyinnyaung and Kyatsakan (Figure 10).

3.5. Loi-an Group

It is mainly composed of dark grey to black, indurated, slightly fissile shales and mudstones with thin, medium to thick-bedded, compact and grey sandstone and grey, pinkish or reddish, indurated calcareous sandstone and siltstone with intercalated shales (Figure 11&12). Load casts, flute cast and cross-bedding are common.

3.6. Kalaw Red Bed

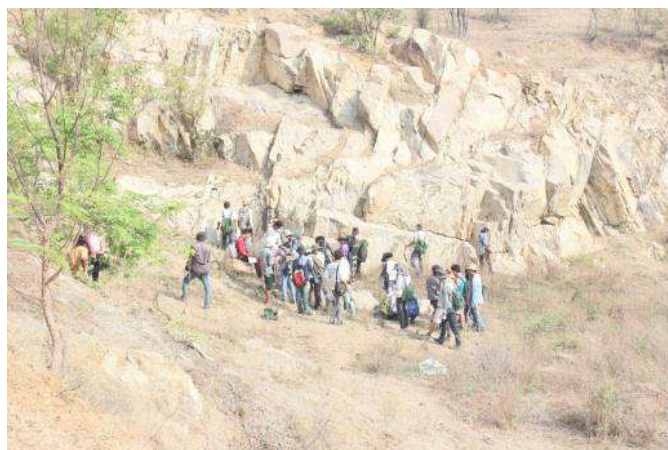
The Kalaw Red Bed is composed of pinkish, purplish or red color conglomerate, thick-bedded to massive and indurated sandstone and siltstone (Figure 13).



Figure(2) Biotite bearing microgranite intrusion into Yinmabin Metamorphic Unit (N20° 47' 30"E96° 15' 15")



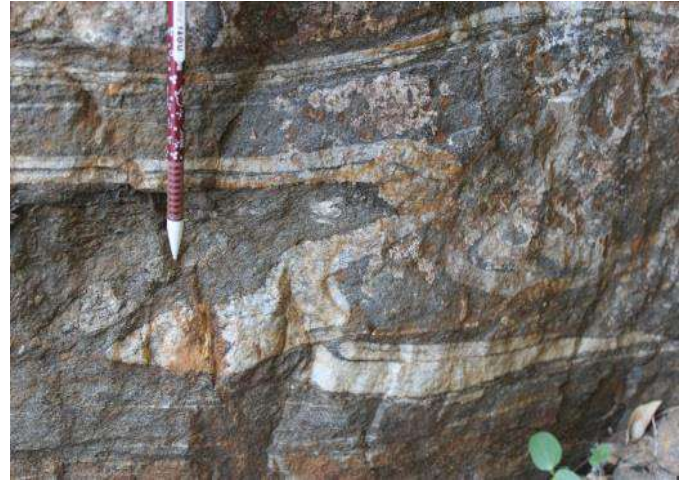
Figure(3) Leucogranite intrusion into Yinmabin Metamorphic Unit (N20° 47' 30"E96° 16' 15")



Figure(4) Highly jointed nature of microgranite of Yinmabin Metamorphic Unit (N20° 47' 30"E96° 33' 15")



**Figure(5) Phyllite of Yinmabin Metamorphic Unit
(N20° 47' 50"E96° 20' 18")**



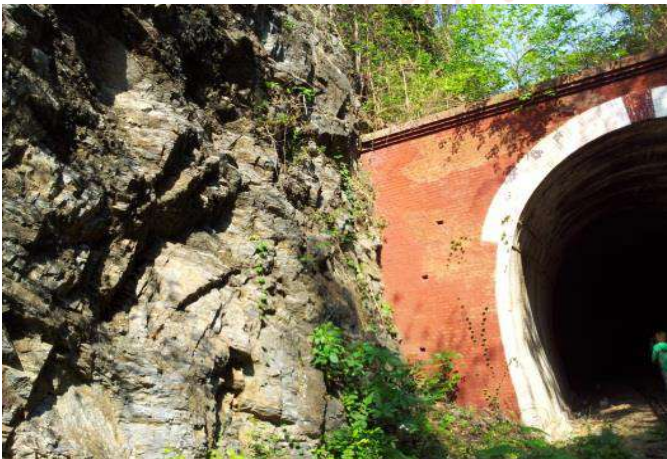
**Figure(9) Folded (Ptygmatic) structure of migmatite
in Yinmabin Metamorphic Unit
(N20° 47' 50"E96° 20' 35")**



**Figure (6) Calc-phyllite of Yinmabin Metamorphic Unit
(N20° 47' 50"E96° 20' 20")**



**Figure(10) Brecciated dolomitic limestone unit of
Plateau Limestone Group
(N20° 49' 37"E96° 25' 15")**



**Figure(7) Medium to thick-bedded schist of Yinmabin
Metamorphic Unit(N20° 47' 30"E96° 20' 25")**



**Figure(11) Interbedded nature of sandstone and fissile
shale unit of Loi-an Group
(N20° 47' 30"E96° 23' 15")**



**Figure(8) Migmatite of Yinmabin Metamorphic
Unit(N20° 47' 50"E96° 20' 35")**

IV. Landslide potential Analysis

Rock mass characterization and slope stability analysis are carried out for potential analysis of landslides. Most of the slopes are dangerous for slope stability because some rocks are very weak in geological condition as well as slope condition.



Figure (12) A small-scale chevron fold occur in Loi-an Group (N20° 47' 30"E96° 23' 15")



Figure(13) Reddish- brown color, interbedded sandstone and shale unit of Kalaw Red Bed (N20° 40' 00"E96° 33' 15")

In the research area, the highly rugged terrain of Plateau Limestone Group are occurred around the Pyinnyaung area. The moderately hilly region is occurred in the area between Yinmabin and Kywedatson area. Three main types of slope failure: rock falls, debris fall and creep occur in this area (Figure 14, 15 & 16). According to the analyzing the slope failure, the wedge failure and plane failure are the common type of failure along both the car-road and railway sections. Most of the slope failure occurs in highly jointed and foliated metamorphic rock units of Yinmabin Metamorphic and interbedded nature of sandstone and soft nature of clastic sedimentary rock units of Kalaw Red Bed.

Possible danger zones for landslide occur in the Yinmabin area, Yebokeson area, Pyinnyaung area and Kalaw area. The other places are moderate zone.

4.1. Rock Mass Characterization

The strength and joint density of the rock that can influence the stability of the slopes. The strength of of the rock mass depends on the number of joint sets. The greater the joint sets, the lower the the rock strengths. Closely spaced joint sets produce low mass cohesion.

According to the Rock Mass Rating (after Bieniawski,1989), Yinmabin metamorphic and Loi-an Group having low strength, highly jointed and highly weathered condition lie in Class IV (poor Rock). Some rocks of Yinmabin metamorphic and Plateau Limestone Group having high strength, moderately jointed and poorly weathered condition lie in

Class II (good rock). Rocks of Lebyin Group having moderate strength, fairly jointed and moderately weathered condition which lie in Class III (fair rock).

4.2 Slope Stability Analysis

In the research area, the slope directions are mostly facing to north-eastern part and the second face directions are southern part. The slope inclinations with high angles are found at the Kywedatson-Yinmabin area, Yebokson area and Pyinnyaung area. According to the types of landslides (Varnes',1975) there are three types of landslides along the road and railway sections are rock falls, debris flows and creep. Rock falls are are occurred in the rocks of of the Yinmabin metamorphics between Kywedatson and Yinmabin .Rock slides are are occurred in the Kalaw Red Bed and debris flows are more prominent in Loi-an Group. The most danger zones are occurred in the western part of the Yinmabin and eastern part of the Pyinnyaung area. The stable zones are formed in the eastern part of the Yinmabin Area and western part of the area. The other places are moderate zones.



Figure(14) Rock Fall in Yinmabin Metamorphic Unit(N20° 47' 30"E96° 20' 15")



Figure(15) Rock slide in Yinmabin Metamorphic Unit(N20° 47' 30"E96° 20' 15")

V. Conclusion

The research area, along the road-section and railway section between Yinmabin-Kalaw area, is one of the most socio-economically transportation routes in Myanmar .In this area, numerous high rock cuts are found in mountainous

terrain area and a certain amount of rock fall and slide movement is often unavoidable along rights of way for transportation routes. Most of the landslides are occurred annually along the road because of the hilly region with high steep cutting slopes and not systematic excavation system of design.



**Figure(16) Debris flow of landslide in Loi-an Group
(N20° 43' 30"E96° 23' 18")**

Geologically, the rock units exposed in the study area are the metamorphic rock units such as sandy phyllite, calc-phyllite and spotted phyllite of Yinmabin Metamorphics with igneous intrusions, the sedimentary rock units such as brecciated limestone and fine-grained lithographic limestone units of Plateau Limestone Group, siliciclastic rock units of sandstone and shale interbedded units of Loi-an Group and red colored sandstone, siltstone and conglomerate of Kalaw Red Bed.

According to the Rock Mass Rating, the rock units of the Plateau Limestone Group are good rocks and some rocks of

the Loi-an Group and Yinmabin Metamorphics are poor rocks because of sort-sedimentary rocks and deformed bedding planes on Loi-an Group and deformed foliations on Yinmabin Metamorphic rocks. The research area is tectonically deformed and structurally complex. According to the RMR system. There are poor rock(ClassI), good rock (ClassII) and fair rock(ClassIII). Three main types of zones are occurred as danger zone , moderate zone and stable zone. So, the suitable retaining structures and systematic drainage system should make to protect the rock mass failures.

Acknowledgements

Firstly, I would like to mention my thanks to Rector Dr. Kyi Soe, West Yangon Technological University, who gives permission of field trip to Pyinnyaung area. Additional thanks allow to Daw Thuzar Win, Ma Thin Sandar Myint and Maung Zaw Moe Lwin. I would likemost thankful to the manager and the staffs of the Shwetaung Development Co., Ltd.

REFERENCES

- [1] A. E. Adams, W. S. Mackeanzie and C. Guilford, 1984. *Atlas of Sedimentary rocks under the microscope*, p-34-74.
- [2] Dumhan, R. J, 1962, Classification of carbonate rocks according to depositional texture. 108-121, in W. E Ham, Ed., *Classification of carbonate rocks*, Tulsa, Okla, Amer, Asso, Petrol Geol., Mem.1.1.108-121
- [3] Folk, R. L., 1959, *Practical Petrographic Classification of Limestone*, Bull, Amer, Asso, Petrol, 43, 1-38.
- [4] MyintLwinThein, 1973. *The Lowest Paleozoic Stratigraphy of Western part of the Southern Shan State, Burma*, Geol. Soc. Malaysia, Bull. 6, 143-163.