Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P01 Room:Convention Hall Time:May 23 18:15-19:30

Analysis of landslide monitoring using an e-GPS system and multi-antenna GPS technology

Ta-Kang Yeh[1*], Hsin-Chang Liu[2]

[1]Department of Real Estate and Built Environment, National Taipei University, [2]Engineering and Environment Geophysics Laboratory, Chien Hsin University

Based on GPS technology, this study monitored the movement of the landslide that impacted Taiwan's Formosa Freeway. Two monitoring systems and two data-processing software programs were employed. Auxiliary data were obtained from the GPS, raingauges, inclinometers, and water table meters for landslide analysis. The goal of multi-sensor monitoring was to construct an automatic early warning system for driver safety. Analytical results indicate that the landslide moved on average 1 cm/month in the southeast direction; that is, it moved slowly toward the Formosa Freeway, thereby posing a potential safety hazard for drivers. The positioning precision of the multi-antenna GPS (0.18, 0.25, and 0.57 cm in the north, east and vertical directions, respectively) was better than that of static relative positioning (0.29, 0.44 and 1.01 cm) and that of e-GPS technology (1.69, 1.35 and 2.45 cm).

Keywords: e-GPS, multi-antenna GPS, landslide, Taiwan

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P02 Room:Convention Hall Time:May 23 18:15-19:30

A Possible Slope Failure monitored by GPS Ranging in Tamagusuku Village, Southern Region of Okinawa Island

Takeshi Matsumoto[1*]

[1]University of the Ryukyus

According to the GEONET GPS baseline ranging operated by Geographical Survey Institute (GSI), the station in Tamagusuku Village, southern region of Okinawa Island, at which the operation was stopped in March 2012, was showing different movement from that at most of the other stations in Okinawa Island. The baseline between the Tamagusuku station and other stations in the central and northern areas on the island decreases gradually since around 2000. And then, according the GPS-based horizontal deformation record, the Tamagusuku GPS Station shifted NE relative to other stations in Okinawa Island. The ratio of NE-ward shift is not uniform and fluctuates from 2001. The fluctuation has good correlation with the amount of rainfall at the nearest AMeDAS (Automated Meteorological Data Acquisition System) Itokazu Station by Japan Meteorological Agency. The Tamagusuku station was located on the southward dipping slope surrounded by hills. A lot of cracks on the roads and walls on the buildings nearby are observed on these neighbouring hills. Since the basement rock in Tamagusuku Village is mudstone (Shimajiri Formation, 1.5-3Ma.), a slope failure may occur easily. Therefore, a possible reason of the shift and fluctuation of the GPS-based ranging record may be weakening of the mudstone basement (Shimajiri formation) at the Tamagusuku Station due to absorption of water after the heavy rainfalls. The GPS antenna of the Tamagusuku Station tends to lean towards northeast as the result of a possible slump. The geographical condition around the Station suggests a downslope focusing of soil, especially after a heavy rainfall. The large-scale slump which occurred in Shuri and in Nakagusuku in 2006 was the result at the final stage of the collapse due to the accumulation of weakening of the ground. On the other hand, the deformation observed around the Tamagusuku Station is regarded as the early stage of the slump. Considering that the amount of deformation is growing year by year, a sudden large-scale slump may take place at any time in Tamagusuku Village.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P03 Room:Convention Hall Time:May 23 18:15-19:30

Fluctuations in pore-water pressures triggered by earthquakes at the Busuno landslide

Hikaru Osawa[1*], Takashi Okamoto[2], Sumio Matsuura[3], Kazutoki Abe[4]

[1]Graduate School of Bioresource Sciences, Nihon University, [2]Forestry and Forest Products Research Institute (FFPRI), [3]Disaster Prevention Research Institute (DPRI), Kyoto University, [4]Bioresource Sciences, Nihon University

1. Introduction

Many strong earthquakes (EQs) of magnitude >6, such as the 2004 Mid Niigata prefecture EQ and the 2008 Iwate-Miyagi inland EQ above magnitude 6 have occurred over the past few decade. As dynamic stresses from EQs act upon the slope, pore-water pressure increases in soils with low permeability, which causes destabilization of the slope.

Okamoto et al. (2006) reported spike-like fluctuations in pore-water pressure in the landslide masses during the Mid Niigata prefecture EQ activity. However, they did not examine the relationship between fluctuations in pore-water pressure and seismic vibration characteristics. This study seeks to identify the fluctuations in pore-water pressure in the landslide masses that result from EQ seismic motion.

2. Methods of monitoring

We observed pore-water pressure and seismic motions at the Busuno landslide site in Joetsu City, Niigata Prefecture, Japan. We analyzed the seismic motions of five EQs, namely the 2004 Mid Niigata prefecture EQ of M6.8 (EQ1), its largest aftershock of M6.5 (EQ1'), the 2007 Niigataken Chuetsu-oki EQ of M6.8 (EQ2), the 2011 Naganoken Hokubu EQ of M6.6 (EQ3), and its largest aftershock of M6.6 (EQ3'). We installed a seismometer at the Busuno landslide in 2010. Analysis of strong motions that occurred before 2010 (EQ1-2) was conducted using data from the National Research Institute for Earth Science and Disaster Prevention (NIED) K-NET database Yasuzuka. To estimate the fluctuations in pore water pressure due to the EQs, we evaluated attenuation relationships for peak ground acceleration (PGA) and velocity, taking into consideration the effects of the fault type and site conditions (Si and Midorikawa, 1999).

We installed piezometers (pore water pressure gauges) in areas where large movements were observed in past years, and pore-water pressure was recorded every 10 min. Five piezometers (P21, P22, P23, P31, and P33) were installed in 2002, and pore-water pressure during EQ1, EQ1', and EQ2 was observed. These piezometers were crushed by heavy snow in 2006, and two new ones (P61 and P62) were installed and recorded the data during EQ3 and EQ3'. As the piezometers recorded measurements every 10 min, the peak pore-water pressure immediately following an EQ is not always recorded. We calculated a damping curve for the pore-water pressure data, and the peak of the curve was assumed from the decreasing trend of the data. The damping curve was applied to the positive pore-water pressure data.

3. Results and discussion

All piezometers showed fluctuations in pore-water pressures during the five EQs. The fluctuations in pore-water pressures increased with the Peak Ground Acceleration (PGA). EQ3 showed the highest PGA (NS 236 gal, EW 382 gal, and UD 108 gal) and the largest increase in pore-water pressure (14 kPa). Other EQs caused much lower fluctuations, of 2 kPa and less.

We believe the effects of a heavy snow pack on the slope were the cause of the largest increase of pore-water pressure. A layer of ˜3 m of snow covered the landslide area during EQ3 (March 12, 2011), thus subjecting the sliding surface to greater pressure.

The data from the five EQs showed correlations between PGA, Peak Ground Velocity, and the dominant frequency of up and down directional movement and fluctuations in the pore-water pressure before and after the EQ events.

References

Si, H., Midorikawa, S., 1999. New attenuation relationships for peak ground acceleration and velocity considering effects of fault type and site condition. J. Structural and Construction Engineering, Transactions of AIJ (523), 63-70.

Okamoto, T., Matsuura, S., Asano, S., Takeuchi, Y., 2006. Displacement and fluctuation in pore water pressure of active landslide area by the Mid Niigata Prefecture Earthquake, J. Jpn. Landslide Soc, (43)1, 20-26.

National research institute for earth science and disaster prevention (NIED). Kyoshin-network (K-NET) http://www.k-net.bosai.go.jp/k-net/

Keywords: seismic motions, excess pore water pressure, peak ground acceleration

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P04 Room:Convention Hall Time:May 23 18:15-19:30

Extremely rapid debris slide - debris flows induced by extreme rainfall on Aso volcano caldera slope in July 2012

Hiroshi Fukuoka[1*]

[1]Hiroshi FUKUOKA, [2]Yuki MATSUSHI, [3]Gen FURUYA, [4]Hiroshi SAITO

An extreme rainfall affected Kyusuh Island of western Japan in July and induced hundreds of fluidized landslides claiming tens of casualties. Especially on the Aso volcano caldera cliff, a number of extremely rapid debris slide ? debris flows were induced and affected the downslope communities. Measured trigger precipitation was recorded by the nearby ground-based station of the AMeDAS network (Automated Meteorological Data Acquisition System) as about 80 mm/h for consecutive 4 hours. Analysis of Radar Rain-gauge Analyzed Precipitation operated by the Japan Meteorological Agency showed landslide affected area almost coincided with the ones of heavier precipitation. Most of the landslides were initiated on the boundary of strongly weathered soils, which used to be new volcanic accretion materials. Outstanding features of these landslides are: (1) This area had been affected by similar heavy rainfall decades ago, however, again a number of landslides took place in the nearby past scars; (2) Many of the soil slide bodies are shallow less than 5 meters deep and possibly immediately transformed into debris flows or mud flows and traveled long distance to reach the downslope communities; (3) Visual observation of the sources showed the high possibility that some of the slides were apparently induced by liquefaction. Similar cases were reported of past 2 landslide disasters in Japan. This strongly suggests that excessive rainfall can trigger numerous mud flows of unexpected reach. We conducted close field study at a typical soil slide - mud flow site. It originally initiated as debris or soil slide on a thin steep bedding plane of about 34 degrees consisting of coarser accretion materials. Needle penetration test showed comparatively weaker strength in the layer. It is underlain by a layer of finer materials. Such a higher permeability contrast could contribute to higher susceptibility of excess pore pressure generation. We took soil samples from the vicinity of sliding surface and conducted pore-pressure-controlled ring shear test. We increased pore pressure at constant rate

until failure after applying normal/shear stresses of certain ratio representing the steepness of the sliding surface for the normally consolidated (of 100 kPa) specimen prepared by disturbed samples. Immediately after failure took place, we observed quick and large drop of shear resistance in a few seconds. Although the applied normal stress of this test is larger than the actual one, this implied strongly the occurrence of the sliding surface liquefaction. The resultant shear resistance was so small and it can explain the mechanism of those long run-out and low apparent friction angle of those landslides.

Keywords: extreme rainfall, landslide, debris flow, excess pore pressure, caldera cliff

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P05 Room:Convention Hall Time:May 23 18:15-19:30

Investigation of landslides on inner slope of Mt.Aso caldera triggered by heavy rainfall in Northern Kyushu in July 2012

Hufeng Yang[1*], Fawu Wang[1], Tomokazu Sonoyama[1], Yasuhiro Mitani[1]

[1]Research Center on Natural Disaster Reduction, Shimane University

Mt. Aso caldera is one of the largest calderas in the world. It is also known for typhoons and heavy rainfall during the rainy season. These relatively annual events have triggered shallow landslides and debris flows, which have caused severe casualties, destroyed properties and displaced local city dwellers. From July 11 to 14, 2012, an intensive rain fell on the Northern Kyushu during rainy season. a value higher than the highest local precipitation recorded in the last decade. This high precipitation triggered shallow landslides, especially around the rim of the caldera, which affected many villages and local settlers. Detailed field investigation was conducted to study the motion mechanism of shallow slope failures triggered by the heavy rainfall. A representative site, which is located in Ichinomiya, Aso-gun, Kumamoto Prefecture was selected for this study. Several field geotechnical tests were carried out in the landslide site. Portable cone penetration tests were conducted to evaluate the nature and degree of consolidation of the sediments which are mainly composed of tephra and pyroclastics; in-situ permeability tests were conducted with variations in depth of hand-drilled bore holes so as to measure rainfall infiltration rate. Representative soil samples were collected from different layers of the main scarp for particle size distribution analysis, shear strength tests, and other laboratory soil strength analyses. Results obtained from detailed field and laboratory investigations carried out in the area show that the main factors contributing to the occurrence of shallow landslides and debris flows are incessant rainfall, surficial drainage and runoffs, topography, geologic and soil strength properties. These factors are enhanced by the interplay between the steep wall of the caldera (over 30 degrees) and high precipitation coupled with high number of irregular cracks that acts as conduits for easy infiltration to subsurface drainage system. Another process that could have affected the slope stability could be from steady undercutting of the slope toe by strong surface floods, which overtime reduces the shear strength of the material leading to shallow sliding failure.

Keywords: Landslide, Rainfall, Mt.Aso caldera, Northern Kyushu

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P06 Room:Convention Hall Time:May 23 18:15-19:30

Study on characteristics of ground vibration during times of flooding in mountainous rivers

Nagazumi Takezawa[1*], YAMAKOSHI Takao[2], ISHIZUKA Tadanori[3], NAKAYA Hiroaki[4]

[1]Public Works Research Institutes, [2]Public Works Research Institutes, [3]Public Works Research Institutes, [4]Ministry of Land, Infrastructure, Transport and Tourism

Large scale sediment movement phenomenon such as deep catastrophic landslide generates ground vibration. So previous studies showed, analytical results of the data based on high-sensitivity seismometer networks can have higher resolution in time and location of landslide.

On the other hand, it is confirmed that the amplitude vibration of seismometer during heavy rain or flooding is large in related to amplitude of vibration during without rain or flood. This phenomenon has influence on lowering of Signal-Noise ratio. It means, accuracy of detecting the large scale sediment movement phenomenon using these networks is reduced.

We examined microtremor in seismometer during heavy rain or flooding and compared the amplitude of microtremor with discharge of mountainous river. Also we estimated seismic wave by the sediment movement phenomenon during flooding. At a result, it was found that amplitude of microtremor and discharge before observing the peak discharge reveals correlation.

Keywords: Vibration sensor, Flood, Discharge, Amplitude of velocity, sediment movement phenomenon

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P07 Room:Convention Hall Time:May 23 18:15-19:30

Simulations of seismic signals induced by landslides by numerical coupling of PFC and FLAC

Zheng-yi Feng[1*], Cyun-Fu Lin[1], Pei-hsun Tsai[2]

[1]Department of Soil and Water Conservation, National Chung Hsing University, Taichung 402, Taiwan, [2]Department of Construction Engineering, Chaoyang University of Technology, Taichung 413, Taiwan

We developed a two-dimensional numerical coupling approach using the Particle Flow Code (PFC) and Fast Lagrangian Analysis of Continua (FLAC) code to simulate the flow process of landslides and rock avalanches. We used the Xiaolin rock avalanche as a case study. The sliding of the rock fragments was simulated by PFC. When the rock fragments impact on the top boundary of FLAC, forces and displacements of the boundary grids will be transmitted between the two codes. We assigned monitoring locations in the coupled numerical model to record the seismic signals induced by the simulated rock avalanche. The time-frequency spectrograms of the seismic signals were analyzed using Hilbert-Huang transform (HHT) for examining the seismic characteristics. The simulated results were compared with the seismic signals recorded during the landslide from a broadband seismic station, SGSB, which is 11.4 km away from the Xiaolin landslide site.

Keywords: PFC, FLAC, HHT, Xiaolin, landslide

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P08 Room:Convention Hall Time:May 23 18:15-19:30

Variations of topographic feature of a Major Typhoon

Chih-Ming Tseng[1*], Ching-Weei Lin[2], Paolo Tarolli[3], Giancarlo Dalla Fontana[3]

[1]Department of Land Management and Development, Chang Jung Christian University, Taiwan, [2]Department of Earth Sciences, National Cheng Kung University, Taiwan, [3]Department of Land and Agroforest Environments, University of Padova, Italy

In August 2009, in Taiwan, Typhoon Morakot with a maximum rainfall of over 2,900 mm, induced over 23,000 landslides in mountainous area throughout southern Taiwan. One large scale deep-seated landslide, the Hsiaolin landslide, with an area of about 250 ha, buried the entire village causing 397 casualties, the disappearance of 53 people, and the destruction of over 100 houses (Lin et al., 2011; Tsou et al., 2011). The LiDAR-derived 2m resolution DEMs before and after Typhoon Morakot was utilized in this study to perform the relation between slope and contributing area. Montgomery and Foufoula-Georgiou (1993) suggested a partitioning of the landscape into drainage and slope regimes that include hillslopes (Region A), unchanneled valleys (Region B), debris flow-dominated channels (Region C), and alluvial channels (Region D). The comparison of slope-area relationship of Hsiaolin village before and after Typhoon Morakot indicates, no matter pre or post typhoon, the slope?area figure shows four regions with different scaling responses. However, there are remarkable for the significantly variation of scaling pattern in slope-area diagram after the deep-seated landslide. Sediment mass produced by deep-seated landslide with approximately 2.7x107 m3 (Wu et al., 2011) depleted from hillslope, nearly 90m deepest failure depth resulted in outward extend of upstream catchment boundary. Huge amount of sediment mass was transported downward also formed significant deposition in debris flow channel and alluvial channel, respectively. These phenomenon also reflects in slope-area graph, contributing area at parting between Region I and Region II migrate from 20 m2 to 50 m2, that means hillslope length become longer due to outward development of upstream catchment boundary. The local slope in debris flow channel (Region C) and alluvial channel (Region D) both become gentler after this catastrophic landslide. The analysis only after an intense event, really represent a strategic tool for a directly quantification of the processes that affected and significantly changed the earth surface.

Keywords: DTM, High resolution topography, LiDAR, Slope?area relation

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P09 Room:Convention Hall Time:May 23 18:15-19:30

Visualization of precursory features of Typhoon-induced Shiaolin landslide by ALOS pan-sharpened stereoscopic imagery

Ching-Ying Tsou[1*], Masahiro Chigira[1], Ryuzo Yokoyama[2], Micho Sirasawa[2]

[1]Disaster Prevention Research Institute, Kyoto University, [2]Yokoyama Geo-Spatial Information Laboratory

Precursory topographic features of gravitational slope deformation may provide a clue in predicting potential sites of catastrophic landslides. Visual photo-interpretation of high-resolution images such as optical satellite imagery and aerial photographs together with field survey remains the most used method to recognize the precursory topographic features and locate gravitational slope deformation. Here, we utilized ALOS pan-sharpened stereoscopic imagery of anaglyph to recognize the precursory topographic features before Typhoon Morakot-induced catastrophic Shiaolin landslide in southern Taiwan on 9 August 2009. Developed by the coauthors, Ryuzo Yokoyama and Michio Sirasawa, the ALOS pan-sharpened stereoscopic imagery is generated from the data of PRISM (a panchromatic stereo mapping sensor of 2.5 m resolution) and AVNIR-2 (a visible and near infrared sensor of 10 m resolution). We compared it with underlying geological structure that was exposed by the catastrophic landslide and was investigated after the event. The results indicate that the source area had the precursory topographic features: irregularly shaped bulges and depressions in many locations, suggesting the slope had been gravitational deformed beforehand. At least four of the locations were confirmed that the precursory topographic features were related to gravitationally deformed beds of alternating beds of sandstone and shale on a dip slope. The deformed beds were buckled and result in undulating beds or asymmetrical folds near the exposed ground surface. Consequently, the precursory topographic features might reflect the internal geological structures of the deformed slope. Besides, several slopes near the Shiaolin landslide site also appear as gravitational deformed slopes and can be characterized as potential sites of large and catastrophic landslides.

Keywords: ALOS pan-sharpened stereoscopic imagery, gravitational slope deformation, catastrophic landslide, precursory topographic feature

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P10 Room:Convention Hall Time:May 23 18:15-19:30

Experimental examinations of the soil-water characteristics of a loess soil, China

Yao Jiang[1*], Wenwu CHEN[2], Guanping SUN[2], Gonghui Wang[1], Toshitaka KAMAI[1]

[1]Research Center on Landslides, DPRI, Kyoto University, [2]School of Civil Engineering and Mechanics, Lanzhou University

In Northwest of China, many loess landslides have occurred without obvious triggering factors (i.e., rainfall, earthquake, etc). These landslides have loess that is desiccated from the ground surface to a considerable depth, and pore-water pressure at shallow depths is generally negative with respect to atmospheric pressure. To understand and analyze the pore-water pressure distribution of these slopes and then provide evidence for their stability analysis subjected to matric suction, it is essential to study soil-water characteristics. Furthermore, the soil-water characteristic curve (SWCC), representing the relationship between volumetric water content and matric suction, has been developed to interpret and predict the mechanical behaviors of unsaturated slopes. In this study, A set of experimental trials were carried out to examine the influences of initial dry density, moulding water content and particle size fraction upon the soil-water characteristics of loess soil in Northwestern China. The experimental results were obtained by using a conventional volumetric pressure-plate extractor. The results indicated that volumetric water content had a monotone-decreasing nonlinear relationship with matric suction for all loess specimens. However, the dry density had considerable influence on soil-water characteristics. When the dry density increases, the air-entry value increases and rate of desorption decreases. Moreover, by comparing the soil-water characteristics of the specimens that have the same dry density but were compacted at different initial water contents, it was found that the initial moulding water content could affect soil structure (aggregation) significantly. Higher initial water content specimens had a higher air-entry value and a lower rate of desorption. The specimens with different particle size fractions appeared to exhibit distinct soil-water characteristics. A coarse-grained specimen had a lower air-entry value and higher rate of desorption compared with a fine-grained specimen.

Keywords: loess landslide, soil-water characteristic, dry density, water content, particle size fraction

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P11 Room:Convention Hall Time:May 23 18:15-19:30

PROMPT REPORT OF NATURAL DAM FORMED IN THE WAY ELA RIVER, AMBON, INDONESIA

Koji MORITA[1*], ISHIZUKA, Tadanori[1], Takao Yamakoshi[1], KAJI, Akihito[1], NAKAYA, Hiroaki[2], KATSURA, Shin'ya[2], SAWANO, Hisaya[3], MATSUNAGA, Shigeru[4], TAKESHIMA, Hidehiro[4]

[1]Public Works Research Institute, [2]Ministry of Land, Infrastructure, Transport and Tourism, [3]Japanese International Cooperation Agency, [4]Yachiyo Eng. Co. Ltd.

On July 13, 2012, a huge natural dam was formed by the large scale landslide in the Way Ela River, Ambon, Maluku, Indonesia. Its height is about 150 meter. It still remains and its water level keeps high. In the downstream of the natural dam, there is a village with populations of 5,000, which is exposed to the catastrophe in case of the collapse of the natural dam. In order to prevent the damage from collapse of natural dam, Indonesian government has been promoting the countermeasures such as constructing a spillway, and establishing the early warning system. We have investigated the site of the Way Ela River three times and collected information about the natural dam. Here, we promptly report the interim results about the natural dam based on the information obtained so far.

Keywords: natural dam, Indonesia, landslide

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P12 Room:Convention Hall Time:May 23 18:15-19:30

Rapid weathering and erosion mechanisms of mudstone in a badland under the humid, subtropical climate: A case study in a

Kohei Higuchi[1*], Masahiro Chigira[1], LEE, Der-Her[2]

[1]Disaster Prevention Research Institute, Kyoto University, [2]National Cheng Kung University

The badlands of Plio-Pleistocene mudstone in southwest Taiwan are characterized by sharp ridges and gullies and are located in humid subtropical area that experiences contrasting dry and rainy seasons. Erosion depths measured using erosion pins over a period of 4 years, averaged up to 9 cm/y. Mudstone sample cores recovered from slope surfaces in the dry season (April) and early rainy season (July), prior to the extensive erosion that occurs later in the rainy season, and monitoring dataset of salinity and water content near the slope surface through one and half year, suggested the following weathering and erosion mechanisms. Near surface layers (<10 cm depth) would become rich in salts with little change in physical properties of rock during dry season, and then decrease its bulk densities and increase its larger void ratios during the early rainy season. Thus deteriorated near surface layers are rapidly removed by slaking and erosion during intense precipitation in the main rainy season.

Keywords: Badlands, Mudstone, Weathering, Erosion, Slaking

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

HDS06-P13 Room:Convention Hall Time:May 23 18:15-19:30

Model test of the submarine landslide impact forces acting on cables and the motion mechanism

Yohei Kuwada[1*], WANG, Fawu[1], HONDA, mitsuki[1], SONOYAMA, tomokazu[1]

[1]Shimane University, Department of Geoscience

Communication cables, which cross the oceans between continents all over the world, are sometimes damaged due to the occurrence and motion of submarine landslides, causing interruption of data transmission, and even of international communications. When cable failure occurs, the economic loss is vast for cable restoration coupled with temporary or permanent breach in information transmission. Submarine landslides are usually triggered by many factors which include rapid sedimentation, retrogressive failure, earthquake and tectonic activity, gas hydrate dissociation and wave loading. These activities cause severe damage to transocean fibre optic cables. Direct observation of this phenomenon is still not enough because these events occur deep beneath the sea surface, and direct observation of submarine landslide would be extremely expensive and difficult because of its unpredictability. Many features of submarine landslides and the damage they cause to communication cables are unclear. The aim of this study is to use experimental approach to analyze and understand the motion mechanism of submarine landslides and its effect on communication cables. Our interest in submarine landslides lies in disaster mitigation of communication cables. An experimental apparatus to study submarine landslides was developed for this purpose. The apparatus consists of a wheel-shaped hollow disc of height 1.8m, an axle shaft at the center and a trough with a width of 0.4m at the inner circumference. Submarine landslides is simulated by using silica sand-water mixture in the lower part of the trough as the wheel rotates in a anticlockwise direction on the axle shaft with silica sand-water mixture in the same direction of motion, all controlled by a speedometer. Using this apparatus, with silica sand no.7-and no.8-water mixtures for these experiments, normal stress, shear stress, pore water pressure on the bottom of the apparatus and impact force on a communication cable model were measured using high definition transducers, sensors and data loggers. Experiments were carried out considering four factors: (1) the effect of motion velocity of submarine landslides; (2) the effect of submarine landslide volume; (3) Material composition of submarine landslides; and (4) the effect of different cable diameters. From data obtained from series of experiments, the friction angle of submarine landslides and impact force on a communication cable was obtained. In addition, small plastic balls which have specific gravity similar to silica sands were used as tracers to observe the characteristic bulk movement of soil masses during the experiments; results obtained were compared with the friction angle and impact force on a cable. Result obtained from the experiments show that four critical values of velocities and five stages of soil mass flow evolution conditions exist in these experiments. Impact force on the communication cable model is high for submarine landslides with low motion velocity, but decreases until the velocity gets to a critical value where liquefaction occurs, and subsequently increases in a linear fashion with velocity. On the other hand, friction coefficient is positively correlated with velocity of soil mass, but shows different tendency before and after the critical value of velocity. Also, large diameter cables are subjected to high impact forces. When the diameter of the cable is increased by 10%, the impact force also increases by 50%. The experiment with setting height of 20mm showed the high impact force. Conversely, experiments with higher setting height (40mm and 80mm) showed low impact force. This may be due to the influence of different relative densities of submarine landslide sediments. Although it is difficult to simulate the flow conditions which occur in deep water, we hope the test results provide some hints for communication cable design and cable positioning in the ocean.

Keywords: submarine landslide, motion mechanism, submarine cable, internal friction angle