Predicting Earthquake Induced Landslide Displacements

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PREDICTING EARTHQUAKE-INDUCED LANDSLIDE DISPLACEMENTS ...

Estimation of the earthquake-triggered landslide displacement is one of the most important topics of slope engineering. • Newmark sliding block model is a widely used method for predicting earthquake-induced ground displacement. • A new useful and more appropriate regression equation has been obtained to estimate the Newmark displacement.

Prediction of amount of earthquake-induced slope ...

Applying Newmark's method requires knowing the yield or critical acceleration of the landslide (above which permanent displacement occurs), which can be determined from the static factor of safety and from the landslide geometry. Earthquake acceleration-time histories can be selected to represent the shaking conditions of interest, and those parts of the record that lie above the critical acceleration are double integrated to determine the permanent landslide displacement.

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Predicting Earthquake Induced Landslide Displacements

A PROBABILISTIC METHOD FOR THE PREDICTION OF EARTHQUAKE-INDUCED SLOPE DISPLACEMENTS. Simone Barani Paolo Bazzurro Fabrizio Pelli. Dip.Te.Ris. AIR Worldwide Co. Geodeco S.p.A. University of Genoa San Francisco, CA, USA Via Aurelia 24 Viale Benedetto XV 16031 Genoa, Italy 16132 Genoa, Italy ABSTRACT

A Probabilistic Method for the Prediction of Earthquake ...

Reddit. Wechat. Abstract. The paper brings up to date and amplifies earlier work on earthquake?induced ground displacements using near?field strong?motion records, improved processing procedures and a homogenizing treatment of the seismological parameters. A review of upper bound limits to seismic displacements is given and a predictive procedure is examined that allows the probabilistic assessment of the likelihood of exceedance of predicted displacements to be made in the near field ...

Earthquake?induced ground displacements - Ambraseys - 1988 ...

Abstract Predicting approximate earthquake-induced landslide displacements is helpful for assessing earthquake hazards and designing slopes to withstand future earth- quake shaking.

RESEARCH ARTICLE Newmark displacement model for landslides ...

Predicting approximate earthquake-induced landslide displacements is helpful for assessing earthquake hazards and designing slopes to withstand future earthquake shaking. In this work, the basic methodology outlined by Jibson (1993) is applied to derive the Newmark displacement of landslides based on strong ground-motion recordings during the 2013 Lushan Ms 7.0 earthquake. By analyzing the ...

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Predicting Earthquake Induced Landslide Displacements

The permanent displacement of seismic slopes can be regarded as an effective criterion for stability estimation. This paper studied the characteristics of permanent displacements induced by velocity pulse-like ground motions and developed an empirical model to readily evaluate the stability of seismic slopes in a near-fault region.

Permanent displacement models of earthquake-induced ...

Earthquakes are a major triggering factor of landslides, and earthquake-induced landslides pose a major threat to infrastructure and human life. This paper presents the effects of slope angle, soil sensitivity, ground motion orientation, and multidirectional shaking on the results of seismic slope stability analyses.

The rigid sliding-block analysis introduced by Newmark in 1965 has become a popular method for assessing the stability of slopes during earthquakes. Estimates of sliding displacement calculated using this methodology serve as an index of seismic performance and are used for mapping seismic landslide hazard potential. The original approach of rigorously integrating ground acceleration time-histories to compute estimates of sliding displacement has been replaced by the use of simple, empirical models that predict displacement as a function of a slope's yield acceleration and one or more measures of ground shaking. To be useful the results of these models must be compared with observations of landslides from previous earthquakes. Seven different empirical models were evaluated by comparing predicted displacements with an inventory of observed landslides from the 1994 Northridge, California earthquake. Using a comprehensive set of ground motion data and shear strength properties from the Northridge earthquake, sliding displacements were calculated within a geographic information system (GIS) and the accuracy of each model was computed. The influence of factors such as landslide size, geologic unit, slope angle, and material strength on the prediction of landslides was also evaluated. The results were used to show that the accuracy of the predictive models depends less on the model used and more on the uncertainty in the model parameters, specifically the assigned shear strength values. Because current approaches do not take into account the spatial variability of strength within individual geologic units, the accuracy of the predictive models is controlled by the distribution of slope angles within observed and predicted landslide cells. Assigning overly conservative (low) shear strength values results in a higher percentage of landslides accurately identified, but also results in a large over-estimation of the seismic landslide hazard.

Earthquake-induced sliding displacements are commonly used to assess the seismic performance of slopes. These displacements represent the cumulative, downslope movement of a sliding block due to earthquake shaking. While the sliding block model is a simplified representation of the field conditions, the displacements predicted from this model have been shown to be a useful index of seismic performance of slopes. Current evaluation procedures that use sliding block displacements to evaluate the potential for slope instability typically are based on a deterministic approach or a pseudo-probabilistic approach, in which the variabilities in the expected ground motion and predicted displacement are either ignored or not treated rigorously. Thus, there is no concept of the actual hazard (i.e., the annual probability of exceedance) associated with the computed displacement. This dissertation focuses on quantifying the risk for earthquake-induced landslides. The basic approach involves a probabilistic framework for computing the annual rate of exceedance of different levels of sliding displacement for a slope such that a hazard curve for sliding displacement can be developed. The framework incorporates the uncertainties in the prediction of earthquake ground shaking, in the prediction of sliding displacement, and in the assessment of soil properties. The framework considers two procedures that will yield a displacement hazard curve: the scalar hazard approach that utilizes a single ground motion parameter and its associated hazard curve to compute permanent sliding displacements; and a vector hazard approach that predicts displacements based on two (or more) ground motion parameters and the correlation between these parameters. Current predictive models for sliding displacement provide the expected level of displacement as a function of the characteristics of the slope (e.g., geometry, strength, yield acceleration) and the characteristics of earthquake shaking (e.g., peak ground acceleration, peak ground velocity). However, current models contain significant aleatory variability such that the range of predicted displacements is large. To reduce the variability in the sliding displacement prediction and to provide models appropriate for the presented probabilistic framework, sliding displacement predictive equations are developed that utilize single and multiple ground motion parameters. The developed framework is implemented to the Mint Canyon 7.5-minute quadrangle in California to generate a map of earthquake-induced landslide hazard. Application of the probabilistic procedure to a 7-1/2 minute quadrangle of California is an important exercise to identify potential difficulties in California Geological Survey's (CGS) current application for hazard mapping, and for the eventual adoption by CGS and USGS.

This book sheds new light on improved methods for the study of the initiation and run-out of earthquake-induced landslides. It includes an initiation study method that considers tension-shear failure mechanism; an improved, rigorous, dynamic sliding-block method based on dynamic critical acceleration; and a run-out analysis of earthquake-induced landslides that takes account of the trampoline effect, all of which add to the accuracy and accessibility of landslide study. The book includes abundant illustrations, figures and tables, making it a valuable resource for those looking for practical landslide research tools.

Earthquake-induced landslides are a significant seismic hazard that can generate large economic losses. Predicting earthquake-induced landslides often involves an assessment of the expected sliding displacement induced by the ground shaking. A deterministic approach is commonly used for this purpose. This approach predicts sliding displacements using the expected ground shaking and the best-estimate slope properties (i.e., soil shear strengths, ground water conditions and thicknesses of sliding blocks), and does not consider the aleatory variability in predictions of ground shaking or sliding displacements or the epistemic uncertainties in the slope properties. In this dissertation, a probabilistic framework for predicting the sliding displacement of flexible sliding masses during earthquakes is developed. This framework computes a displacement hazard curve using: (1) a ground motion hazard curve from a probabilistic seismic hazard analysis, (2) a model for predicting the dynamic response of the sliding mass, (3) a model for predicting the sliding response of the sliding mass, and (4) a logic tree that incorporates the uncertainties in the various input parameters. The developed probabilistic framework for flexible sliding masses is applied to a slope at a site in California. The results of this analysis show that the displacements predicted by the probabilistic approach are larger than the deterministic approach due to the influence of the uncertainties in the slope properties. Reducing these uncertainties can reduce the predicted displacements. Regional maps of seismic landslide potential are used in land-use planning and to identify zones that require detailed, site-specific studies. Current seismic landslide hazard mapping efforts typically utilize deterministic approaches to estimate rigid sliding block displacements and identify potential slope failures. A probabilistic framework that uses displacement hazard curves and logic-tree analysis is developed for regional seismic landslide mapping efforts. A computationally efficient approach is developed that allows the logic-tree approach to be applied for regional analysis. Anchorage, Alaska is used as a study area to apply the developed approach. With aleatory variability and epistemic uncertainties considered, the probabilistic map shows that the area of high/very high hazard of seismic landslides increases by a factor of 3 compared with a deterministic map.

This book contains the full papers on which the invited lectures of the 4th International Conference on Geotechnical Earthquake Engineering (4ICEGE) were based. The conference was held in Thessaloniki, Greece, from 25 to 28 June, 2007. The papers offer a comprehensive overview of the progress achieved in soil dynamics and geotechnical earthquake engineering, examine ongoing and unresolved issues, and discuss ideas for the future.

Seismicity is a major trigger for landslides with often devastating effects. The Japan Landslide Society (JLS) therefore organized a meeting fully dedicated to the research area of earthquake induced landslides. The symposium covers all aspects of earthquake-induced landslides including the phenomena occurred in manmade embankments as well as in natural slopes in mountainous areas. In this comprehensive volume on landslide science the JLS presents the Proceedings of this First International Symposium on Earthquake-Induced Landslides, held in November 2012 in Kiryu, Japan.

Landslides and Engineered Slopes. Experience, Theory and Practice contains the invited lectures and all papers presented at the 12th International Symposium on Landslides, (Naples, Italy, 12-19 June 2016). The book aims to emphasize the relationship between landslides and other natural hazards. Hence, three of the main sessions focus on Volcanic-induced landslides, Earthquake-induced landslides and Weather-induced landslides respectively, while the fourth main session deals with Human-induced landslides. Some papers presented in a special session devoted to "Subareal and submarine landslide processes and hazard” and in a “Young Session” complete the books. Landslides and Engineered Slopes. Experience, Theory and Practice underlines the importance of the classic approach of modern science, which moves from experience to theory, as the basic instrument to study landslides. Experience is the key to understand the natural phenomena focusing on all the factors that play a major role. Theory is the instrument to manage the data provided by experience following a mathematical approach; this allows not only to clarify the nature and the deep causes of phenomena but mostly, to predict future and, if required, manage similar events. Practical benefits from the results of theory to protect people and man-made works. Landslides and Engineered Slopes. Experience, Theory and Practice is useful to scientists and practitioners working in the areas of rock and soil mechanics, geotechnical engineering, engineering geology and geology.

In this research study, a new probabilistic methodology for landslide hazard assessment in regional scale using Copula modeling technique is presented. In spite of the existing approaches, this methodology takes the possibility of dependence between landslide hazard components into account; and aims at creating a regional slope failure hazard map more precisely. Copula modeling technique as a widely accepted statistical approach is integrated with the hazard assessment concept to establish the dependence model between "landslide magnitude", "landslide frequency" and "landslide location" elements. This model makes us able to evaluate the conditional probability of occurrence of a landslide with a magnitude larger than an arbitrarily amount within a specific time period and at a given location. Part of the Seattle, WA area was selected to evaluate the competence of the presented method. Based on the results, the mean success rate of the presented model in predicting landslide occurrence is 90% on average; while the success rate is only 63% when these hazard elements were treated as mutually independent. Also, Seismic-induced landslides are one of threatening effects of earthquakes around the world that damage structures, utilities, and cause human loss. Therefore, predicting the areas where significant earthquake triggered hazard exists is a fundamental question that needs to be addressed by seismic hazard assessment techniques. The current methods used to assess seismic landslide hazard mostly ignore the uncertainty in the prediction of sliding displacement, or lack the use of comprehensive field observations of landslide and earthquake records. Therefore, a new probabilistic method is proposed in which the Newmark displacement index, the earthquake intensity, and the associated spatial factors are integrated into a multivariate Copula-based probabilistic function. This model is capable of predicting the sliding displacement index (Dn) that exceeds a threshold value for a specific hazard level in a regional scale. A quadrangle in Northridge area in Northern California having a large landslide database was selected as the study area. The final map indicates the sliding displacements in mapping units for the hazard level of 10% probability of exceedance in 50 years. Furthermore, to reduce human losses and damages to properties due to debris flows runout in many mountainous areas, a reliable prediction method is necessary. Since the existing runout estimation approaches require initial parameters such as volume, depth of moving mass and velocity that are involved with uncertainty and are often difficult to estimate, development of a probabilistic methodology for preliminary runout estimate is precious. Thus, we developed an empirical-statistical model that provides the runout distance prediction based on the average slope angle of the flow path. This model was developed within the corridor of the coastal bluffs along Puget Sound in Washington State. The robustness of this model was tested by applying it to 76 debris-flow events not used in its development. The obtained prediction rates of 92.2% for pre-occurred and 11.7% for non-occurred debris flow locations showed that the model results are consistent with the real debris-flow inventory database.

This book provides an integrated approach to the assessment of seismic hazards. The reduction of losses expected by future earthquakes is probably the most important contribution of seismology to society. Large earthquakes occurred in densely populated areas highlight the dramatic inadequacy of a massive portion of the buildings demonstrating the high risks of modern industrial societies. Building earthquake-resistant structures and retrofitting old buildings on a national scale can be extremely expensive and can represent an economic challenge even for developed western countries. Earthquakes can cause also several psychological problems due to the fact that such kind of disasters will result in casualties, collapsing of houses, strategic buildings and facilities and deeply affect a community. Moreover in our society it is necessary to properly plan emergency responses and rescues taking into account any possible secondary effect in order to avoid more casualties.