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Table of Contents

Oral Presentations	1
Common Keynotes	1
Engineering Keynotes	2
CS1: Seismic Input for Design (EC8 and Others)	2
CS2: Historical Investigations of Earthquake Effects, Damage and Vulnerability	6
CS3: Applications of the EMS-98 and Related Future Evolutions	8
CS4: Strong Motion : Use and Modelling	10
CS5: Site Response and Site Effects	16
CS6: Early Warning, Shaking and Loss Scenarios	23
CS7: Strategies in Earthquake Mitigation	27
CS8: Secondary Earthquake Hazards: Tsunami, Landslide, Rock Fall, Liquefaction	30
ES 1: Geotechnical Engineering	31
ES 2: Dam Engineering	37
ES 3a: Structural Engineering - Analysis	38
ES 3b: Structural Engineering - Bridges	46
ES 3c: Structural Engineering - Concrete	49
ES 3d: Structural Engineering - Control	52
ES 3e: Structural Engineering - Experimental	55
ES 3f: Structural Engineering - Masonry and Timber	61
ES 3g: Structural Engineering - Steel	64
ES 3h: Structural Engineering - Miscellaneous	66
ES 4: Design Criteria and Methods, Codes	68
ES 5: Existing Structures and Earthquake Risk Reduction	72
ES 6: Lifeline Systems	77
ES 8 & ES 7: Earthquake Engineering Practice (Recent Projects) and Architectural Aspects, Nonstructural Components and Contents (Joint Session)	79
ES 9 & SS 5: Lessons from Recent Earthquakes	81
STS E1 & SS 6: The Last Mile, Implementation of Risk Mitigation Measures in Europe	83
STS E2: Practice-oriented Nonlinear Approaches for Performance Assessment and Design	84
STS E3: Irregular Structures.	85
STS E4: Displacement Based Design: Initial Versus Secant Stiffness	86
STS E5: Eurocode 8 : How to Apply ?	86
STS E6: Seismic Assessment and Retrofit of Bridges	87
STS E7: European Research on the Performance of Experimental Facilities	89
STS E8: Shaking Table Facilities and Testing for Advancement of Earthquake Engineering	91
STS E9: Analysis and Design of RC Frames with Masonry Infills	92
STS E10: By How Much Does the Natural Frequency of Structures Decrease During Seismic Response ?	93
STS E11: Petrochemical Facilities and Large LNG Storage Tanks	93

STS E12: Joint IAEE-IASPEI Session on International Collaboration of Earth Science and Earthquake Engineering Professional Associations	95
STS E13: LESSLOSS Project: General Assembly	95
SC-A 1: Archaeological and Historical Studies on the Earthquakes of the Past Centuries	96
SC-A 2: Volcano Seismology and Applications to Hazard Evaluation	98
SC-B 1: Theory of Wave Propagation and New Techniques of Data Processing	100
SC-B 2: The 20th Century Strong Euro-Mediterranean Earthquakes from Historical Seismograms	103
SC-C 1: Earthquake Source Complexity: From Geology Through Kinematic and Dynamic Models to Realistic Ground Motion Simulations	106
SC-C 2: Recent Developments in Theoretical and Numerical Earthquake Source Dynamics: New Horizons to Predict Seismic Radiation and Near-Field Ground Motions	108
SC-D 1: 2-D and 3-D Crustal Models of Europe	111
SC-E 1: Earthquake Forecasting and Society	113
SC-E 2: Deterministic and Probabilistic Prediction Methods: Theory, Applications and Case Studies	115
SC-E 3 & SC-F 2: Time-Dependant Earthquake Hazard Assessment	118
SC-E 5: Earthquakes : To Predict or not to Predict? (Controversial Debate)	121
SC-E 6: Earthquake Physics - Field and Laboratory Study	121
SC-F 1: Approaches to Model Seismic Scenarios	123
SC-F 3: Multiparametric Test Sites in Europe for the Evaluation of Ground Motion Amplification	125
SC-F 4: Geoinformation Technologies Oriented to Seismic Hazard and Seismic Risk Assessment	127
SC-F 5: Seismic Hazard and Risk due to Induced Seismicity	129
SC-F 6: Geophysical and Civil Engineering Aspects of Hazard, Risk, and Mitigation for Major European Cities	131
SC-F 7: Potential for Very Large Earthquake Disasters in the European Mediterranean Region	133
SC-F 8: Near Real-Time Damage and Loss Assessment due to Strong Earthquakes	134
SC-G 1 & SC-F WG: National Methodologies for Macroseismic Field Surveys (Joint Session with SC-F WG on Macroseismology)	138
SC-G 2: Recent Macroseismic Field Surveys	139
SS 1: Tsunamis in the European Mediterranean Region and the Sumatra Earthquake and Tsunami in the Indian Ocean	140
SS 2: Earthquake Loss Modelling : From Earth Sciences to Insurance Applications	142
SS 3: Education and Outreach for Risk Reduction	147
SS 4: ESC-UNESCO Workshop on Earthquake Hazard and Seismic Risk Reduction : Studies in the Southern Mediterranean Countries	150

Poster Presentations - From Monday to Wednesday 155

CS1: Seismic Input for Design (EC8 and Others)	155
CS2: Historical Investigations of Earthquake Effects, Damage and Vulnerability	162
CS3: Applications of the EMS-98 and Related Future Evolutions	162
CS4: Strong Motion : Use and Modelling	164
ES 3b: Structural Engineering - Bridges	180
ES 3c: Structural Engineering - Concrete	188
ES 3d: Structural Engineering - Control	198
ES 3e: Structural Engineering - Experimental	208
ES 3g: Structural Engineering - Steel	225
ES 5: Existing Structures and Earthquake Risk Reduction	232
ES 9 & SS 5: Lessons from Recent Earthquakes	248
ES 10: Other Issues	255
STS E2: Practice-oriented Nonlinear Approaches for Performance Assessment and Design	256
STS E3: Irregular Structures.	260

STS E4: Displacement Based Design: Initial Versus Secant Stiffness	262
STS E6: Seismic Assessment and Retrofit of Bridges	263
SC-A 0: Seismicity of the European-Mediterranean Area (Open Session – Posters Only)	265
SC-A 2: Volcano Seismology and Applications to Hazard Evaluation	276
SC-B 0: Data Acquisition, Theory and Interpretation (Open Session – Posters Only)	277
SC-B 2: The 20th Century Strong Euro-Mediterranean Earthquakes from Historical Seismograms	285
SC-D 0: Crust and Upper Mantle Structures (Open Session – Posters Only)	287
SC-D 1: 2-D and 3-D Crustal Models of Europe	290
SC-E 0: Earthquake Prediction Research (Open Session – Posters Only)	291
SC-E 1: Earthquake Forecasting and Society	295
SC-E 2: Deterministic and Probabilistic Prediction Methods: Theory, Applications and Case Studies	296
SC-E 3 & SC-F 2: Time-Dependant Earthquake Hazard Assessment	298
SC-F 3: Multiparametric Test Sites in Europe for the Evaluation of Ground Motion Amplification	300
SC-F 4: Geoinformation Technologies Oriented to Seismic Hazard and Seismic Risk Assessment	302
SC-F 6: Geophysical and Civil Engineering Aspects of Hazard, Risk, and Mitigation for Major European Cities	302
SC-F 7: Potential for Very Large Earthquake Disasters in the European Mediterranean Region	304
SC-F 8: Near Real-Time Damage and Loss Assessment due to Strong Earthquakes	305
SS 1: Tsunamis in the European Mediterranean Region and the Sumatra Earthquake and Tsunami in the Indian Ocean	307
SS 2: Earthquake Loss Modelling : From Earth Sciences to Insurance Applications	308
SS 4: ESC-UNESCO Workshop on Earthquake Hazard and Seismic Risk Reduction : Studies in the Southern Mediterranean Countries	313
Poster Presentations - From Thursday to Friday	315
CS5: Site Response and Site Effects	315
CS6: Early Warning, Shaking and Loss Scenarios	335
CS7: Strategies in Earthquake Mitigation	341
CS8: Secondary Earthquake Hazards: Tsunami, Landslide, Rock Fall, Liquefaction	347
ES 1: Geotechnical Engineering	351
ES 2: Dam Engineering	365
ES 3a: Structural Engineering - Analysis	371
ES 3f: Structural Engineering - Masonry and Timber	398
ES 3h: Structural Engineering - Miscellaneous	408
ES 4: Design Criteria and Methods, Codes	413
ES 6: Lifeline Systems	426
ES 8 & ES 7: Earthquake Engineering Practice (Recent Projects) and Architectural Aspects, Nonstructural Components and Contents (Joint Session)	432
STS E1 & SS 6: The Last Mile, Implementation of Risk Mitigation Measures in Europe	435
STS E5: Eurocode 8 : How to Apply ?	436
STS E9: Analysis and Design of RC Frames with Masonry Infills	437
STS E10: By How Much Does the Natural Frequency of Structures Decrease During Seismic Response ?	439
STS E11: Petrochemical Facilities and Large LNG Storage Tanks	442
SC-A 1: Archaeological and Historical Studies on the Earthquakes of the Past Centuries	444
SC-B 1: Theory of Wave Propagation and New Techniques of Data Processing	446
SC-C 0: Physics of the Earthquake Sources (Open Session – Posters Only)	448
SC-C 1: Earthquake Source Complexity: From Geology Through Kinematic and Dynamic Models to Realistic Ground Motion Simulations	452

SC-C 2: Recent Developments in Theoretical and Numerical Earthquake Source Dynamics: New Horizons to Predict Seismic Radiation and Near-Field Ground Motions	454
SC-E 6: Earthquake Physics - Field and Laboratory Study	455
SC-F 0: Engineering Seismology (Open Session – Posters Only)	456
SC-F 1: Approaches to Model Seismic Scenarios	464
SC-F 5: Seismic Hazard and Risk due to Induced Seismicity	466
SC-G 0: Rapid Intervention Field Investigation Teams (Open Session – Posters Only)	470
SC-G 2: Recent Macroseismic Field Surveys	471
SS 3: Education and Outreach for Risk Reduction	471

Author’s Index	475
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the flow of good and services due to direct physical damages to stocks or lifelines. It has been observed that the recover time is significantly contributed in the indirect losses. Existing models for estimation of recovery time of facilities has been mostly developed by expert opinion. In this paper, an analytical model for estimation of earthquake induced indirect economic impacts of industrial facilities based on system dynamic approaches is introduced.

In the proposed model, system dynamic approach is employed for estimation of recovery time of factory after a probable earthquake by estimation of reconstruction time and recovery time after reconstruction. In this method, first a conceptual recovery framework for recovery of industry after earthquake has been developed by considering contributing factors on recovery level like availability of financial resource for reconstruction, lifeline, households, availability of source for production and demands. Then a simulation technique is employed for developing the numerical platform of the model and the method is applied to a hypothetical refinery and the results are presented in addition to some parametric studies. The numerical results have shown that the degree of indirect losses is significantly higher than direct one in the numerical example.

MODELLING SEISMIC RISK IN SWITZERLAND – ID 1202

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Earthquake hazard in Switzerland is low relative to regions of Southern Europe and the Mediterranean. Yet the region has experienced damaging earthquakes, such as the 1356 Basel and 1855 Visp earthquakes. In this, the 650th anniversary year of the 1356 Basel earthquake, government and private researchers are reassessing seismic risk in Switzerland in light of both the low probability threat and the less seismic resistant building inventory. As part of this effort, the authors have developed a probabilistic earthquake loss-estimation model for Switzerland to facilitate the management of catastrophe risk by the (re)insurance industry. The model includes ground motion estimation and building vulnerability modules, as well as an industry-wide building inventory database that categorizes structures by wall material and building height. This paper presents technical details on the ground motion hazard and building vulnerability. Ground motions are calculated based on Bay et al. (2003) and Ambraseys et al. (1996) attenuation relations, which is then adjusted through the NEHRP (National Earthquake Hazard Reduction Program) soil-amplification procedure according to surface geology. Building vulnerability is measured as a function of Roof Drift Ratio (RDR), which is estimated through the Capacity Spectrum Method (CSM). For masonry construction which is a dominant type in Switzerland, the capacity curve is developed based on experimental and/or analytical studies of buildings specific to the Swiss practice. The model is used to estimate loss distributions of selected historical events, were these events to recur today. The loss distributions reflect the uncertainty in the source parameters of these events as estimated from pre-instrumental era. The selected events include the 1356 Basel and the 1855 Visp earthquakes.

EARTHQUAKE DAMAGE AND LOSS ESTIMATION ON A REGIONAL SCALE – ID 1422

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The main goal of earthquake damage and loss estimation studies is to provide information and support for the decision-making process to guide cost-effective risk management policy in earthquake-prone regions taking into account their specific needs and existing circumstances. The necessary information should include, on the one hand, spatial distribution of existing risk in the area under study and, on the other hand, the level of damage and losses from probable future earthquakes. The paper presents

a methodology of damage and loss analysis, which is developed in the frame of an interdisciplinary project “Risk Map Germany” conducted by the Center for Disaster Management and Risk Reduction Technology – CEDIM. The conceptual framework of the GIS-based methodology follows the traditional pattern and includes analysis of probable seismic influence, structural vulnerability of the built environment and exposed assets in communities of the country. For analyses of damage and losses both hazard-based and scenario-based approaches are used in the study. The former provides the possibility of comparative analysis of risk distribution in the whole country for identification of most endangered communities. The latter offers the possibility of estimation of the level of probable damage and losses from potential single seismic events. The results obtained with the use of the hazard-based approach are presented as maps of the probable seismic damage and seismic risk distributions. In parallel, the scenario-approach is applied for a few selected earthquake-prone communities of the country. The results are calibrated with the observations from several damaging earthquakes in Germany and the nearby area in the past 30 years.

RISKScape (NZ) - A MULTIHAZARD RISK ASSESSMENT PROGRAMME – ID 1501

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New Zealand has long been recognized as having a high exposure to earthquake related hazards. In fact New Zealand has the dubious privilege of being exposed to nearly all natural hazards and in many cases this exposure is recognized as being “high” to “severe” by international standards. While considerable advances have been made over the past few decades in understanding the mechanics that underpin these phenomena, only recently has sufficient knowledge been acquired to enable some rational probabilistic models to be developed to quantify the intensity/recurrence relationships of these hazards. By establishing fragility functions for all items of community inventory to the actions resulting from each of these natural phenomena, community risk and thence probable losses can now be ascertained, albeit with varying degrees of reliability.

This paper discusses the development of RiskScape New Zealand, a national multi-hazard impact model that will be able to ascertain relative risks and community exposure to a range of natural hazards. The prototype currently under development and will include earthquake, tsunami and volcanic exposure together with flood and storm impact. Three representative New Zealand communities will be used in the pilot with the default inventory database including buildings, infrastructure, public utility and transportation networks.

The challenge of presenting data derived using either the probabilistic or scenario approach proposed to an essentially non-technical user group and getting their uptake remains before us but will be discussed in the paper along with progress to date.

CONSEQUENCE ASSESSMENT OF EARTHQUAKES: BAM CASE STUDY – ID 1597

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The present paper reports on the methodical developments in regard to the modelling and assessment of consequences due to earthquakes within a multidisciplinary research project presently performed at the Swiss Federal Institute of Technology. The research project aims to develop a generic decision theoretical framework for the consistent quantitative and rational management of earthquake risks in three situations, namely before, during and after an earthquake. First the general framework for the earthquake risk management project is outlined. Thereafter the specific issues relating to the modelling of consequences of earthquakes are addressed including a review of existing methodologies and results of research projects reported in the literature. Finally an example of a Bayesian Probabilistic Net model considered in the project for consequence analysis is presented and it is explained how the net may be utilized for assessing the consequences of relevance prior, during and after an earthquake.